Function- and Data Sheet

Extent shown:	
Blocks chosen:	ABK, APP, FB, FDEF, FW
System:	SG ME7.3H
Project:	ME 7.3.1H Alfa 2.0l BTS
Project code:	9/633.3;16
Release:	
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BOSCH

Vivace (version fdr3-14 of Jun 16 2000 13:19:02), processed at Thu Jul 20 08:13:15 2000

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1183	CDCUB	code word CARB: battery voltage UB (onboard)
1183	CDCUF2SG	Code word CARB: monitoring of the function: data from other ECU
1184	CDCUFMV	Code word CARB: monitoring of the function: torque comparison
1184	CDCUFSKA	Code word CARB: monitoring of the function: safety fuel cut-off
1184	CDCURRAM	Code word CARB: monitoring of the controller: RAM
1184	CDCURROM	Code word CARB: monitoring of the controller: ROM
1184	CDCURRST	Code word CARB: monitoring of the controller: Reset
1184	CDCVKUP	code word CARB: electr. clutch, speed dependent
1184	CDLFRAO	code word lamp : LR-Adaptation multiplicative upper threshold
1184	CDLFRAO2	code word lamp : LR-Adaptation multiplicative upper threshold bank 2
1184	CDLFRAU	code word lamp: LR-Adaptation multiplicative lower threshold
1184	CDLFRAU2	code word lamp: LR-Adaptation multiplicative lower threshold bank 2
1184	CDLFRST	code word lamp: feul supply system short test
1184	CDLFRST2	code word lamp: feul supply system short test bank 2
1184	CDLRKAT	code word lamp : LR-Adaptation additive per time
1184	CDLRKAT2	code word lamp : LR-Adaptation additive per time bank 2
1184	CDLRKAZ	code word lamp : LR-Adaptation additive per ingnition
1184	CDLRKAZ2	code word lamp : LR-Adaptation additive per ingnition bank 2
1184	DECKSTAI	decrement-step for STADAP-factor
1184	DEVTMAGR	offset for evtmod depending on tsges_w at high tans caused by EGR
1184	DFPSLBIT	Section bits for indication of the activated error paths
1184	DFSEFO2N	max. plausible speed-dependent variance of FSE values
1184	DFSEFON	max. plausible speed-dependent variance of FSE values
1184	DKNOTBEGR	Limtation of set value as f(nmot) if B_dknot = true
1184	DKROFN	limit of integrator rise for zero test
1184	DLAMOB	delta lamda at overboost
1184	DLBTS	Delta nominal Lambda for component protection
1184	DLRKIONLP0	I component as f(abs(dwdkdlr_w)), above NLP
1184	DLRKIUNLP0	I component as f(abs(dwdkdlr_w)), below NLP (weak)
1184	DLRKIUNLP1	I component as f(abs(dwdkdlr_w)), below NLP (medium)
1185	DLRKIUNLP2	I component as f(abs(dwdkdlr_w)), below NLP (strong)
1185	DLURMIN	speed dependensy of engine roughness referenz minimum value 1
1185	DMAUFN	delta torque rise after torque intervention
1185	DMDDLWS	Torque for power steering function of the
1185	DMDLWS	Torque for power steering
1185	DMDNSM	Torque offset for after cranking compensation
1185	DMDPUG	delta torque threshold end of dashpot
1185	DMLLNG	LLR: D-gain depending of ngasf for air path
1185	DMLLNGV	LLR: D-gain depending of ngasf for air path
1185	DMLLRLMNN	Lower limit for dmllrl
1185	DMLLRLMXN	Safety concept: upper limit for dmllrl
1185	DMLLRMNN	Lower limit for dmllr_w
1185	DMLLRMXN	Safety concept: upper limit for dmllr
1185	DMLSDUG	Delta torque for finishing positive slope limitation
1185	DMRIFW	Delta relative torque for FGR initialization
1185	DMSTES	characteristic line maximum increase of purge mass flow
1185	DNBURN	Minimum difference in engine-speed for detected combustion
1185	DPUPVDK	pressure difference pu-pvdk
1185	DRLSOLA	Misfire Detection : load-dynamic treshold for deactivation
1185	DTLRTML	proportion factor to decrease waiting time up to tmot-threshold for closed loop
1185	DTVKAML	delta-tv for cat oxygen neutralization (air mass dependent)
1185	DTVKAML2	delta-tv for cat oxygen neutralization (air mass dependent) bank2
1185	DVNG	LLR: D-gain depending of ngfil for vehicle at rest
1185	DVNGV	LLR: D-gain depending of ngfil for vehicle rolling
1185	DVSKNBGA	delta velocity for set value correction after acceleration
1185	DVSKNVGA	delta velocity for set value correction after deceleration
1185	DWKRMSN	delta ignition angle knock control distance from mean retarding
1185	DZWAML	Up/down regulation speed between the maps of limitation
1186	DZWDYN	Spark advance for burning-limit angle at tip-in
1186	DZWETA	delta ignition angle from efficiency
1186	DZWMNSTN	nmot dependent offset on latest ign. angle during start
1186	DZWNWSUE	Delta ignition angle dependent on the camshaft overlap
1186	DZWOAGR	AGR-rate-dependent offset of optimum ignition angle
1186	DZWOLA	Lambda dependency of optimum ignition angle referred to Lambda 1
1186	DZWOM	temperature-dependent offset of optimum ignition angle
1186	DZWSPM	delta latest ignition angle relative to engine temperature
1186	DZWSTTA	Delta ignition angle during start
1186	DZWTIN	delta ignition angle at tip-in
1186	EFFDFPM	Declaration of freeze frame extension out of table DFFT
1186	ETADZW	ignition efficiency depending on delta ignition angle
1186	ETALAM	Lambda effectiveness
1186	EVTMODO	offset for evtmod depending on filtered engine temperature
1186	FABMDWA	Factor to decrease the converter torque depending of nturb
1186	FABSTT	Factor parking time for model temperature
1186	FATMRML	divide factor exhaust-/exhaust-pipe temperature
1186	FATMRML2	divide factor exhaust-/exhaust-pipe temperature bank2
1186	FA_CALID	
1186	FBFGRSFW	Correction factor for FGR target acceleration
1186	FBTEB	factor ftefvab-depending limitation of the canister charge adaptation speed
1186	FBTEVA	factor ftefva-depending canister charge adaptation speed
1186	FBZBTEML	Weighting factor integration speed for canister charge adaptation

Page	Parameter	Descriptor
1186	FBZFRAT	weighting factor for integration speed KFFRAT as f(abo)
1186	FDDN	LLR: weightning factor for D-amplification
1186	FDVAGR	factor temperature for flow through EGR valve
1186	FDVANS	Temperature factor for air at throttle valve
1186	FETATEBN	characteristic line: reduction of engine efficiency as f(nmot)
1187	FFLDZ	Follow-on ignition charging time
1187	FFRITMS	tmst dependent factor to modify I-dynamic of lambda control
1187	FFTCAS	Freeze Frame table: CAN, timeout ASC
1187	FFTCINS	Freeze frame table: CAN-Timeout, instrument panel
1187	FFTCKUP	freeze frame table: CAN-timeout KUP-message
1187	FFTEV1	freeze frame table: injector power stage 1
1187	FFTEV2	freeze frame table: injector power stage 2
1187	FFTEV3	freeze frame table: injector power stage 3
1187	FFTEV4	freeze frame table: injector power stage 4
1187	FFTEV5	freeze frame table: injector power stage 5
1187	FFTEV6	freeze frame table: injector power stage 6
1187	FFTEV7	freeze frame table: injector power stage 7
1187	FFTEV8	freeze frame table: injector power stage 8
1187	FFTHSH	Table of ambient condition for heating O2-sensor post cat
1187	FFTHSH2	Table ambient conditions heating lambda sensor downstream catalyst bank2
1187	FFTHSV	Table of ambient condition for heating O2-sensor pre cat
1187	FFTHSV2	Table of ambient condition for heating O2-sensor post cat bank 2
1187	FFTHSVE	Freeze frame table: 02 Sensor Heater power stage
1187	FFTHSVE2	Freeze frame table: 02 Sensor Heater power stage bank 2
1187	FFTKPE	Freeze frame table: fuel pump relay power stage
1187	FFTKRNT	freeze frame table: knock control zero test
1187	FFTKROF	freeze frame table: knock control offset
1187	FFTKRTP	freeze frame table: knock control test pulse
1187	FFTKS1	freeze frame table: knock sensor 1
1187	FFTKS2	freeze frame table: knock sensor 2
1187	FFTKS3	freeze frame table: knock sensor 3
1187	FFTKS4	freeze frame table: knock sensor 4
1187	FFTLASH	Table ambient conditions for Lambda sensor downstream catalyst
1188	FFTLASH2	Table ambient conditions Lambda sensor downstream catalyst bank2
1188	FFTLATP	Table ambient conditions Lambda sensor aging Tp upstream catalyst
1188	FFTLATP2	Table ambient conditions Lambda sensor aging Tp upstream catalyst bank2
1188	FFTLATV	Table ambient conditions Lambda sensor aging Tv upstream catalyst
1188	FFTLATV2	Table ambient conditions Lambda sensor aging Tv upstream catalyst bank2
1188	FFTLSH	Table of ambient conditions Lambda sensor downstream catalyst
1188	FFTLSH2	Table of ambient conditions Lambda sensor downstream catalyst bank 2
1188	FFTMDB	freeze frame table: Target torque limitter
1188	FFTMILE	freeze frame table: MIL power stage
1188	FFTNWKW	freeze frame table: alignment between camshaft and crankshaft
1188	FFTNWKW2	freeze frame table: alignment between camshaft 2 and crankshaft
1188	FFTNWS	freeze frame table: camshaft control
1188	FFTNWS2	freeze frame table: camshaft control bank 2
1188	FFTPH	freeze frame table: phase sensor
1188	FFTPH2	freeze frame table: phase sensor
1188	FFTTA	freeze frame table: air intake temperature TANS
1188	FFTTES	freeze freme table: canister purge valve
1188	FFTTEVE	freeze frame table: canister purge valve (power stage)
1188	FFTTM	freeze frame table: engine temperature TMOT
1188	FFTUB	freeze frame table: battery voltage UB (onboard)
1188	FFTUF2SG	Freeze frame table: monitoring of the function: data from other ECU
1188	FFTUFMV	Freeze frame table: monitoring of the function: torque comparison
1188	FFTUFSKA	Freeze frame table: monitoring of the function: safety fuel cut-off
1188	FFTURRAM	Freeze frame tabele: monitoring of the controller: RAM
1188	FFTURROM	Freeze frame tabele: monitoring of the controller: ROM
1188	FFTURRST	Freeze frame tabele: monitoring of the controller: Reset
1188	FFTVKUP	freeze frame tabele: ”Engine OFF”-request from F1-gearbox (KUP)
1188	FHSTT	factor hot start
1189	FIMHU	Factor pulse abrupt
1189	FIMWU	Factor pulse smooth
1189	FKATEB	Characteristic line fuel portion depending on te / TEMIN
1189	FKAXAVKAT	weighting factor for oxygen capacity depending on avkatf
1189	FKDISA	faktor difference for integrator ambient pressure during fuel cut off
1189	FKHLA	Weighting factor Lambda nominal for catalyzer heating
1189	FKHMD	Weighting factor torque reserve for catalyzer heating
1189	FKKVS	Factor to correct fuel delivery system
1189	FKSTT	factor cold start
1189	FLRAWG	amplification of load controller
1189	FLRFKATE	Rating of factor fkatei from %TEB to optimize the regulation parameter
1189	FLRHG	amplification of load controller
1189	FLRM	Engine temperature dependent factor to modify I-dynamic of lambda control
1189	FLUTN	filter factor running irregularity
1189	FMDGENTA	factor: generator torque due to temperature
1189	FMDKHFH	altitude correction of torque reserve for catalyst heating
1189	FMDKHTM	tmot-correction of torque reserve for catalyst heating
1189	FMDWAT	Factor to calculate the converter torque depending of oil temperature
1189	FNSHO	weighting of afterstart enrichment
1189	FNSSM	after start increase
1189	FNSSTKM	Factor to weight the desired speed at start during catalyst heating

Page	Parameter	Descriptor
1189	FNSSTM	Faktor for taget engine speed during start
1189	FNSTABNV	Factor for engine speed stabilisation by torque
1189	FPLMRM	weighting factor for P component of air-mass controller
1189	FPVMXN2	factor for pressure ratio maximum with secondary last sensor
1189	FPWDKAPP	throttle angle dependent on accelerator pedal position, only for calibration
1189	FQTEDL	Factor for exponential decrease of flow rate
1189	FQTEFR	characteristic line: purge rate reduction with big frm-deviation
1190	FQTEPT	characteristic line: for fuel-tank underpressure limitation
1190	FQTEVA	progression of purge rate controller
1190	FRARAWG	amplification factor
1190	FRARHG	amplification factor
1190	FRINH1	Multiplication factor for RIN nominal value downstream of the catalyzer
1190	FRINH2	Multiplication factor for RIN nominal value downstream of the catalyzer
1190	FRINV1	Multiplicativ factor for RIN desired value pre cat
1190	FRINV2	Multiplicativ factor for RIN desired value pre cat
1190	FRLFSDP	injection correction for RLFS
1190	FRLMNHO	correction factor rlmin depending on altitude
1190	FSTHO	weighting of factor start
1190	FSWALUV	rough road detection threshold = f (vehicle speed)
1190	FSWALUV1	rough road detection threshold = f (vehicle speed)
1190	FSZTM	Factor dwell angle correction tmot depending
1190	FTAGRV	Factor for temperature drop from EGR_pipe to EGR_valve
1190	FTDAG	factor for temperature drop on EGR line
1190	FTEINIX	characteristic line for max. purge rate = F(integral purge flow after TE-Stop)
1190	FTMFFANZ	Follow-on ignition weighting factor
1190	FTMLAKH	tmot-correction of lambda-weighting at catalyst heating
1190	FUEPMLD	Factor for gliding transition average pressure (reference pressure turbo)
1190	FUKNSTHO	altitude dependent transient control post cranking factor
1190	FUKNSTM	initial value of transient control post cranking factor
1190	FVERMN	characteristic line: filter factor for purge flow in the manifold with fresh air
1190	FVERZDYN	dynamic factor delay of purge flow in the manifold
1190	FVRMDYN	dynamic factor for purge flow in the manifold with fresh air
1190	FWDMVAD	factor for the weighting of dmvad_w in %MDMIN
1190	FWEMXT	maximum factor for fuel cut-in temperature characteristic
1190	FWFTBRTA	Weighting for ftbr as a function of tans
1191	FWLKFTBR	warm up correction for combustion chamber model
1191	FWMLHFMMN	Weighting factor for min. HFM air-mass threshold as a function of the altitude
1191	FWSTAA1	afterstart correction
1191	FWSTAB1	weighting afterstart decrease range 1
1191	FWSTAB2	weighting afterstart decrease range 2
1191	FWSTAB3	weighting afterstart decrease range 3
1191	FWSTAS1	correction of threshold 1 for afterstart
1191	FWSTAS2	correction of threshold 2 for afterstart
1191	FZANSSA1	factor for ign. sync. decreasing of afterstart enrichment at hot start range 1
1191	FZANSSA2	factor for ign. sync. decreasing of afterstart enrichment at hot start range 2
1191	FZANSSM1	factor for ign. sync. decreasing of afterstart enrichment above SZANSSM
1191	FZANSSM2	factor for ign. sync. decreasing of afterstart enrichment below SZANSSM
1191	FZANSSM3	factor for ign. sync. decreasing of afterstart enrichment in range 3
1191	FZDASHTM	factor for time constant dashpot
1191	FZN1	Cylinder individual factor at neutral camshaft position EV 1
1191	FZNWN1	Cylinder individual factor at active camshaft position EV 1
1191	FZPUSA	correction faktor time constant ambient pressure adaptation during fuel cut-off
1191	FZWSTNM	Ignition angle during start
1191	FZWSTTM	Ignition angle during start
1191	GFDLDN	LLR: weightning factor for D-amplification on the air path
1191	IGESGA	Total transmission ratio
1191	ILMLKAXTK	Threshold of richness area of O2 purging after fuel cat off, funct. of cat-temp
1191	ILMLKAXTK2	Thresh. of richness area of O2 purging after fuel cut off, funct. of cat-temp.
1191	ILMRN	integrator gain of air mass controller
1191	IMLKAXTK	integr. air mass threshold f(tkatm) for cancelation of cat oxygen neutralization
1191	IMLKAXTK2	integr. air mass threshold f(tkatm2) for cancelation of cat oxygen neutral.
1191	IMLKHTMS	imlpr-threshold, changing to lambda catalyst heating
1191	INCKSTAI	increment-step for STADAP factor
1192	IVDN	LLR: I-gain for vehicle at rest
1192	IVDNDTE	LLR: I-gain at DTEV
1192	IVDNV	LLR: I-gain for vehicle rolling
1192	KATBFML	filter time constant for signal attenuation in catalyst stress
1192	KATBFML2	filter-time constant for signal attenuation in catalyst stress (assymmetrical)
1192	KATBFXM	max. catalyst load threshold for stop condition
1192	KATMEXML	Temperature of the exotherme in the catalyst tkatm
1192	KATMEXML2	Temperature of the exotherme in the catalyst , bank 2
1192	KATMIEXML	Temperature of the exotherme in the catalyst tikatm
1192	KATMIEXML2	Temperature of the exotherme in the catalyst tikatm, bank 2
1192	KDLASHKI	evaluation factor of I-part of LRHK, f(dlashkm)
1192	KDLASHKI2	evaluation factor of I-part of LRHK, f(dlashkm), bank 2
1192	KDLASHKP	evaluation factor of P-part of LRHK, f(dlashkm)
1192	KDLASHKP2	evaluation factor of P-part of LRHK, f(dlashkm), bank 2
1192	KE1N	knock detection threshold at cylindertimer 1
1192	KE2N	knock detection threshold at cylindertimer 2
1192	KE3N	knock detection threshold at cylindertimer 3
1192	KE4N	knock detection threshold at cylindertimer 4
1192	KE5N	knock detection threshold at cylindertimer 5

Page	Parameter	Descriptor
1192	KE6N	knock detection threshold at cylindertimer 6
1192	KE7N	knock detection threshold at cylindertimer 7
1192	KE8N	knock detection threshold at cylindertimer 8
1192	KEMLN	length of the sampling window for knock control
1192	KFABAK	share factor wall wetting for acceleration enrichment
1192	KFAFTE	map flow-characteristic of PCV (incl. PCV carcoal-canister line)
1192	KFAMAL	map reduction factor of the engine roughness reference value at multiple misfire
1192	KFAMAL1	map reduction factor of the engine roughness reference value at multiple misfire
1192	KFATMLA	map exhaust gas temperature correction = f(lambda)
1193	KFATMLA2	map exhaust gas temperature correction = f(lambda) bank2
1193	KFATMZW	map exhaust gas temperature correktion = f(ignition-variation)
1193	KFATMZW2	map exhaust gas temperature correktion = f(ignition) bank2
1193	KFAVAK	share factor wall wetting for deceleration enleanment
1193	KFBAKL	factor accel. enrichment (short- and long-time part)
1193	KFBRAWA	Target acceleration for resumption
1193	KFBS	bank-selective mixture factor
1193	KFCFO	map for definition of range characteristics (dominant..)
1193	KFCFO2	map for definition of range characteristics (dominant..)
1193	KFDETATE	correction of ignition angle effectiveness for diagnosis of PCV
1193	KFDFBTMN	dynamic factor for combustion chamber temperatur model negativ gradient
1193	KFDFBTMP	dynamic factor for combustion chamber temperatur model positiv gradient
1193	KFDLSD	Damping of PT2 filter in positive torque slope limitation
1193	KFDLUR	map engine roughness difference dluts referenz value
1193	KFDLUR1	map engine roughness difference dluts referenz value
1193	KFDLUR2	map engine roughness difference dluts referenz value
1193	KFDLURZ	map engine roughness difference dluts referenz value at ZAS (cylinder cut-off)
1193	KFDMDADP	upper threshold for torque-intervention during dashpot
1193	KFDMDARO	Upper threshold for torque intervension
1193	KFDMDKOE	Starting value torque filter when air-conditioner compressor is activated
1193	KFDMDPO	Delta torque for starting negative slope limitation
1193	KFDMLSDO	Delta torque for starting positive slope limitation
1193	KFDMLSDS	delta torque for triggering of load-shock damping after shifting procedure
1193	KFDTMRS	char.line for gradient of engine coolant temp. during cutoff for reference model
1193	KFDTMTE	char. map for gradient of engine coolant temperature in substitute temp. model
1193	KFDTMTR	char. map for gradient of engine coolant temperature in reference model
1193	KFDTMTU	char. map for correction gradient of engine coolant temp. at low warming up
1193	KFDYES	Threshold for dynamic presetting values
1194	KFDYESOF	Offset threshold for dynamic presetting values
1194	KFDZWKG	ignition angle correction due to knock limit shift
1194	KFETATE	characteristic map for efficency at active purging when te is near TEMIN
1194	KFFDLBTS	Factor delta nominal Lambda for component protection
1194	KFFFANZ	Number of sequential sparks
1194	KFFFANZUB	Number of sequential sparks
1194	KFFRAT	load and speed dependent gradient of FRAT integrator
1194	KFFRMIN	lower limit of control range
1194	KFFTEAN	characteristic map for limitation of the purge rate with no Lambda control
1194	KFFTEAX	Characteristic map for limitation of the purge rate
1194	KFFTV	weighting map for TVLRH
1194	KFFTV2	weighting map for TVLRH bank 2
1194	KFFWL	map warm-up factor
1194	KFFWLRL	map warm-up factor load dependent fraction
1194	KFFWLW	map weighting warm-up factor
1194	KFFWTBR	Weighting factor for combustion chamber temperature model
1194	KFFWTBRA	Weighting factor for combustion chamber temperature model B_agr=true
1194	KFKABMT	Map for correction of calculated amplitude, dependent on ml and cat. temperature
1194	KFKHFM	HFM-correction characteristic map
1194	KFKSWF	map for catalyst protection, weighting factors
1194	KFKWTMP	Characteristic torque reserve for keeping catalyst warm, temporary
1194	KFLASKH	Performance characteristics lambda exhaust nominal at catalyst heating
1194	KFLBTS	Nominal Lambda for component protection
1194	KFLF	lambda characteristic map at part load
1194	KFLMSKH	Performance characteristics lambda engine nominal at catalyst heating
1194	KFLUAR	map for engine roughness distance reference value
1194	KFLUAR1	map for engine roughness distance reference value
1194	KFLUAR2	map for engine roughness distance reference value
1195	KFLUARZ	map for engine roughness distance reference value at ZAS (cylinder cut-off)
1195	KFLURB	map for engine roughness - reference base value
1195	KFLURB1	map for engine roughness - reference base value
1195	KFLURB2	map for engine roughness - reference base value
1195	KFLURBZ	map for engine roughness base value, in case of ZAS
1195	KFLURM	reference base value map for engine roughness for misfire detection
1195	KFLURM1	reference base value map for engine roughness for misfire detection
1195	KFMAKR	map for starting measuring window knock control
1195	KFMDBGRG	map with the value of the torque limitation
1195	KFMDDSLA	Map torque reserve at tester demand of SAI-diagnosis short test
1195	KFMDGEN	Torque intake generator
1195	KFMDKH	Characteristic torque reserve for catalyst heating
1195	KFMDKO	map for torque needed for air condition
1195	KFMDPWM	steady state load of ac-compressor for PWM-signal of its load
1195	KFMDPWME	initial load of ac-compressor for PWM-signal of its load
1195	KFMDRKO	look-up-table: torque loss depended of rl, nmot
1195	KFMDRKOE	look-up-table: torque loss dyn. part dependend of rl, nmot

Page	Parameter	Descriptor
1195	KFMDS	map for engine drag torque
1195	KFMDSZAS	map for engine drag torque during cyclinder cut off
1195	KFMDZOF_UM	map for offset tolerance depending on permissible torque
1195	KFMIFABG	delta torque for gradient limitation
1195	KFMIFALS	Indicated driver's request torque for charge path at load-shock damping
1195	KFMILSD	Initial value for positive torque slope limitation
1195	KFMIMN	minimum drag torque
1195	KFMIOP	map optimum engine torque
1195	KFMIRED	Map of decreasing control torque for VMAX control
1195	KFMIRL	map for calculation of nominal charge
1195	KFMIZUFIL	Maximum permitted indicated set torque for torque limitation before Filter
1196	KFMIZUNS	Authorized torque for post-start torque increase
1196	KFMIZUOF	Maximum permitted indicated set torque for torque limitation
1196	KFMI_UM	map of optimum engine torque
1196	KFMLDMN	air mass flow threshold for min. failure
1196	KFMLDMX	air mass flow threshold for max. failure
1196	KFMPED_UM	map for permissible torque from the pedal position in function monitoring
1196	KFMPNS_UM	map for permissible torque from pedal position for a cold engine
1196	KFMRES	LLR: torque reserve at idle and near-idle zone
1196	KFMRESK	LLR: torque reserve at idle and near-idle zone clutch disengaged
1196	KFMRESKH	Torque reserve during catalyst heating
1196	KFMRESNL	Torque reserve in non idling state
1196	KFMRESTA	Torque margin dependent on tans
1196	KFMRESTM	Map temp-dependent limiting of torque reserve
1196	KFMSNWDK	Map for scaled mass flow over throttle valve
1196	KFNLLNST	idle speed after start
1196	KFNSA	after start increase
1196	KFNSWRL	weighting of afterstart enrichment
1196	KFNW	characteristic map for variable camshaft spread
1196	KFNWEGM	Fuel cut in map depending on rpm
1196	KFNWWL	
1196	KFPBRK	factor to correct pressure at combustion chamber
1196	KFPBRKNW	factor to correct pressure at combustion chamber by active Camshaft control
1196	KFPED	accelerator pedal characteristic
1196	KFPEDR	Pedal characteristic for reverse gear (only automatic transmission)
1196	KFPLMR	P-component of air mass controller
1196	KFPRG	internal partial exhaust gas pressure dependent on camshaft adjustment sumode=0
1196	KFPRG2SU	internal partial exhaust gas pressure depent on camshaft adjustment sumode=2
1196	KFPRG3SU	internal partial exhaust gas pressure dpent on camshaft adjustment sumode=3
1197	KFPRGSU	internal partial exhaust gas pressure dependent on camshaft adjustment sumode=1
1197	KFPU	pulsation characteristic map
1197	KFPUNW	pulsation map for camshaft control switch over
1197	KFPUSU	pulsation characteristic map at active variable intake system by sumode=1
1197	KFPUSUNW	pulsation characteristic map at active variable intake system and camshaft cont.
1197	KFQTE	Map for purge rate increase / decrease
1197	KFRI	I characteristic map
1197	KFRI2	LR-I-Map for bank 2
1197	KFRINH	MAP for Nernst resistor post cat
1197	KFRINH2	MAP for Nernst resistor post cat bank 2
1197	KFRINV	MAP for Nernst resistor pre cat
1197	KFRINV2	MAP for Nernst resistor post cat , bank 2
1197	KFRLIP_UM	characteristic map for load signal calculation on throttle angle
1197	KFRLMN	Minimum charge during fuel on
1197	KFRLMNSA	Minimum rl during fuel cut off
1197	KFRLW	rlw-map from throttle valve angle
1197	KFRLWNW	rlw-map from throttle valve angle during variable camshaft
1197	KFRLWSU	rlw-map from throttle valve angle during manifold switch over
1197	KFRLWSUNW	rlw-map from throttle valve angle during manifold switch over and aktive var. ch
1197	KFRP	P characteristic map
1197	KFRP2	LR-P MAP for bank 2
1197	KFRTV	delay time characteristic map
1197	KFRTV2	delay time characteristic map
1197	KFSU	Load/speed performance characteristics for suction tube switchover
1197	KFSU2	map for intake manifold switch over, flap 2
1197	KFSZT	Dwell angle characteristic map
1197	KFTADMS	dynamic evaluation factor for close off of PCV
1197	KFTAGAV	EGR temperature at outlet valve
1198	KFTATM	map exhaust gas temperature f(nmot,rl)
1198	KFTATM2	map exhaus gas temperature f(nmot,rl) bank2
1198	KFTATX	map for max. duty cycle
1198	KFTEKA	characteristic map of desired fuel portion purge control
1198	KFTEVP	Characteristic map for period time of the PCV
1198	KFTPKOR	correction map for the measured cycle duration TP (tpsvkof)
1198	KFTVFRR	Map: Lambda controll after this time reset at reference value
1198	KFTVSA	Retard time for overrun fuel cut-off
1198	KFURL	conversion factor from ps->rl dependent on camshaft adjustment sumode=0
1198	KFURL2SU	conversion factor from ps->rl dependent on camshaft adjustment sumode=2
1198	KFURL3SU	conversion factor from ps->rl dependent on camshaft adjustment sumode=3
1198	KFURLSU	conversion factor from ps->rl dependent on camshaft adjustment sumode=1
1198	KFUSHK	lambda sensor reference value for lambda control downstream of catalyst
1198	KFUSHK2	lambda sensor reference value for lambda control downstream of catalyst bank2
1198	KFVAKL	factor decel. enleanment (short- and long-time part)

Page	Parameter	Descriptor
1198	KFVERST	weighting map for increasing control of friction torque
1198	KFVOFFS	velocity offset for cruise control
1198	KFWDKMSN	Map for the desired throttle blade angle
1198	KFWDKPP	throttle blade position dependent on air charge signal
1198	KFWDKSMX	max. desired throttle angle
1198	KFWDKSST	desired throttle position at start-up
1198	KFWDKTHO	desired throttle position at start-up - f (hight, engine start temperatur)
1198	KFWEE	characteristic map angle end of injection
1198	KFWEEK	map for end of injection angle (cold parameters)
1198	KFWHSTT	map weighting of hot start factor
1198	KFWKSTAB	factor cold re-start for reduction of starting fuel
1198	KFWKSTN	map weighting of factor cold start
1198	KFWKSTT	map weighting of factor cold start
1199	KFWMABG	map for heat-quantity threshold dew-point end upstream bank1
1199	KFWMABG2	map for heat-quantity threshold dew-point end upstream bank2
1199	KFWMKAT	map for heat quantity threshold dew-point end downstream
1199	KFWMKAT2	map for heat quantity threshold dew-point end downstream bank 2
1199	KFWPFGR	Inverse pedal characteristic for cruise mode
1199	KFWTBR	Weighting factor Tans/Tmot for combustion chamber temperature model
1199	KFWTBRA	Weighting factor Tans/Tmot for combustion chamber temperature model B_agr=true
1199	KFWWLML	map weighting warm-up factor
1199	KFWWNS	repeated start time factor
1199	KFZDASH	Time constant for negative torque slope limitation
1199	KFZDASH2	time constant PT1-filter dashpot at low clutch torque
1199	KFZKPUA	time constant for ambient pressure
1199	KFZLSD	Time constant for positive torque slope limitation
1199	KFZNSM	time constant for decay of reference speed
1199	KFZW	Ignition advance-angle characteristik map
1199	KFZW2	Ignition angle performance characteristics variant 2
1199	KFZWMN	Map for minimal ignition angle
1199	KFZWMNKH	Map for minimal ignition angle catalyst warm-up
1199	KFZWMNST	minimal ignition spark advance for engine start and after start
1199	KFZWMS	Map for ignition value as latest possible value
1199	KFZWOP	optimum ignition angle
1199	KFZWOP2	Optimum ignition angle, variant 2
1199	KFZWWLNM	Delta ignition sparc advance during engine warm up phase
1199	KFZWWLTM	Delta ignition sparc advance during engine warm up phase
1199	KFZW_UM	map of optimum ignition angle
1199	KIFZGAWG	amplification of vehicle model integrator at AT
1199	KIFZGHG	amplification of vehicle model integrator at AT
1199	KINMXG	gain of integral component for NMAX control
1200	KINMXRLG	gain of integral component for NMAX control
1200	KIRMSMS	Integration speed matching of mass flow PCV with calculated mass flow
1200	KKFFGRGA	amplification rate during cruising for cruise control
1200	KLAF	characteristic of Saint-Venant
1200	KLAFTE	characteristic of Saint-Venant of purge control valve an line AKF-TEV
1200	KLATMILAE	Temperature of the exotherme decrease during enrichment tikatm
1200	KLATMILAE2	Temperature of the exotherme decrease during enrichment tikatm, bank2
1200	KLATMIZWE	Temperature of the exotherme decrease in cat during ignition retard tikatm
1200	KLATMIZWE2	Temperature of the exotherme decrease in cat during ignition retard tikatm, bank
1200	KLATMLAE	Temperature of the exotherme decrease during enrichment
1200	KLATMLAE2	Temperature of the exotherme decrease during enrichment, bank 2
1200	KLATMZWE	Temperature of the exotherme decrease in cat during ignition retard tkatm
1200	KLATMZWE2	Temperature of the exotherme decrease in cat during ignition retard, bank2
1200	KLDMDLF1	Characteristic curve reserve torque fan
1200	KLDMDLF2	Characteristic curve reserve torque fan 2
1200	KLDMMX	Maximum delta torque for air path
1200	KLDPDK	pressure drop at throttle blade
1200	KLDTPH	Fixed value characteristic for weighting the engine dynamic
1200	KLDTPHST	Fixed value characteristic for the engine start
1200	KLDYNCOR	Value for the dynamic correction after the first ignition
1200	KLETAZW_UM	ignition efficiency depending on delta ignition angle
1200	KLFZWMNKH	Spark retard gradient of burning limit during after-start at cat.heating
1200	KLFZWMNST	Spark retard gradient of burning limit during after-start
1200	KLNLPHN	Correction of the phase frequency characteristic of the sensor
1200	KLNPED_UM	Speed lim. as func. of nominal pedal value, in DK drive standby func.,func.mon.
1200	KLNWRLTM	Weighting of relative nominal filling over engine temp. for addressing KFNWS
1200	KLRSYNIN	
1200	KLRSYNPN	
1201	KLTDS	Conversion line for tank pressure sensor DS-T2
1201	KLTNRDE	characterisitic for tooth times at reverse rotation
1201	KLWDKABST	Weighting desired throttle position at start-up
1201	KLWDKPED	Offset desired throttle position at start-up
1201	KLWDKTAN	weight of throttle position at start up with intake air temperatur
1201	KLWNWI	Fixed value characteristic for weighting the angular displacement
1201	KRAFGRGA	amplification rate at ramp for cruise control
1201	KRAL1N	load range for adaption maps 1
1201	KRAL2N	load range dor adaption maps 2
1201	KRAL3N	load range for adaption maps 3
1201	KRDWSN	knock control delta angle safety
1201	KRFKN	retard step knock occurrence
1201	KRMXN	maximum retard adjustment

Page	Parameter	Descriptor
1201	KRNLZAR	cylinder individual rpm limit for lead by leading cylinder
1201	KRVFN	number of firings/cyl. or time for ignition advancing
1201	KRVFSN	number of firings/cyl. or delay-time during fast ignition advancing of the KC
1201	KSTAI	workingrange for STADAP factor
1201	LALIUSH	lambda linearization, sensor behind catalyst
1201	LALIUSH2	lambda linearization, sensor behind catalyst, bank 2
1201	LALIUSRH	lambda linearization, sensor behind catalyst
1201	LALIUSRH2	lambda linearization, sensor behind catalyst
1201	LAMFA	Lamda driver demand
1201	LAMKAML	lambda setpoint for catylyst deoxidation (dependent on air mass)
1201	LAMKAML2	lambdasetpoint for catalyst deoxidation (air mass dependent), bank 2
1201	LAMLGMTM	lambda limit ”lean”
1201	LASDSLA	Lambda exhaust nominal at secondary air adaption/short test
1201	LASTMOT	tmot-correction of lambda exhaust nominal
1201	LIMXDNS	upper integrator limit for standing car
1202	LIMXVDNS	upper integrator limit for rolling car
1202	LISTM	value of idle speed control integrator during start
1202	LKRN	load-signal threshold knock control
1202	LMSTMOT	tmot-correction of lambda engine nominal
1202	LNXQTM	natural logarithm from temperature quotient
1202	LSAKTD	Impact of slow front sensor on cat. monitoring
1202	LURBRL8	reference value for engine roughness, vehicle speed zero
1202	LURKH	dmrkh-depen. engine roughness reference correction value, during cat heating
1202	LURKTM	Tmot-dependent engine roughness reference correcting value
1202	LURMIN1	speed dependensy of engine roughness referenz minimum value 1
1202	LURMIN2	speed dependensy of engine roughness referenz minimum value 2
1202	LURMIN3	speed dependensy of engine roughness referenz minimum value 3
1202	LZFUER	guide cylinder assignment
1202	MASK_40MS	40ms mask for function monitoring
1202	MASK_FUAE	Mask for task splitting in monitoring functions (part 1: inputs)
1202	MDKOAB	Torque threshold to shut down the compressor during acceleration
1202	MDKOAN	Torque threshold to switch the AC-compressor off
1202	MDKOEN	Torque threshold to switch the AC-compressor on
1202	MDSH	Part of the resistant torque depending on altitude
1202	MDSM	temperatuer share of enginie friction torque
1202	MDSMZAS	temperatuer share of enginie friction torque during cylinder cut off
1202	MIFAMXNOT	maximum indicated engine torque at limp home
1202	MKFADPN	clutch torque for switch-over dashpot-filter time
1202	MKFADPN1	clutch torque for switch-over dashpot-fil. time when AC comp. has been enabled
1202	MKLLS	torque needed for air condition fan
1202	MLHFM	air-mass meter characteristic line
1202	MLSUS	reference of air mass flow integral
1202	MRFARUGDN	Reset threshold for linear pedal travel in the non-reduced DK range
1203	MRFAVLN	Full load detection threshold of the relative driver request
1203	MRFAVW	threshold to switch end of injection angle at max. driver request
1203	MRFGRIMX	Maximum FGR initialization value
1203	MSNTAG	EGR mass flow standardised
1203	MSNTATE	Characteristic standardized mass flow through TEV
1203	M_SRST_UM	Mask B_srst_um - information SW-reset from cyclic RAM-check
1203	NARLLGA	speed threshold for AR at idle
1203	NASNOTKL	characteristic line rotational speed against engine stall
1203	NDFILOG	Threshold for filter output ndfil
1203	NDIFFOG	Threshold engine speed difference for initialization of AR during braking
1203	NFS2M	Target idle speed 2, B_fs = 1
1203	NFSKHM	LL nominal speed with driving graduations and catalyzer heating
1203	NFSM	desired engine speed DRIVE-position switch on
1203	NGALUN	Misfire Detection : treshold for gradient of engine speed
1203	NGKRWN	threshold revolution gradient for dynamics detection
1203	NLL2M	Target engine speed 2
1203	NLLCVTMXV	Limitation of the target speed (CVT transmission)
1203	NLLKHM	Nominal idling speed during catalyzer heating
1203	NLLM	desired engine speed
1203	NMAXDVG	rpm limit in case of fault detection velocity signal
1203	NMXDAEF	maximum permitted engine speed for throttle actuator substitute function
1203	NMXPG	P component for NMAX control
1203	NMXPRLG	P component for NMAX control
1203	NNSTA	engine-speed transition normal -> start
1203	NSLPP	Target speed depending on the pump pressure of power steerung
1203	NSLPPFS	Target speed depending on the pump pressure of power steering with B_fs=1
1203	NSTAMXHA	engine speed limit until STADAP is active depend. on altitude
1203	NSTNM	transition start -> normal
1204	NWDKSST	threshold for deactivation desired throttle position without torque structur
1204	NWECVTM	Fuel restart-speed at CVT
1204	NWENG	Fuel cut-in engine speed
1204	NWENGFS	Delta Fuel cut-in engine speed with Drive
1204	NZHDTL	Speed threshold for decrementing time counter for hot idling
1204	NZHITL	Speed threshold for incrementing time counter for hot idling
1204	PAGAVML	exhaust gas pressure at outlet valve
1204	PLRHAV	Weighting factor of P-part LRHK depending on catalyst age
1204	PLRHAV2	Weighting factor of P-part LRHK depending on catalyst age range 2
1204	PLRHML	p-part of LRHK, f(dushk)
1204	PLRHML2	Partie p. dans LRHK, agit avec la difference de tension de sonde aval cata banc2

Page	Parameter	Descriptor
1204	PRG2SUNM	internal exhaust-gas part. press. dependent on the speed at active SU (2nd flap)
1204	PRG3SUNM	inter. exhaust-gas part. press. dependent on speed at active SU (1st + 2nd flap)
1204	PRGNM	internal exhaust-gas partial pressure dependent on the speed
1204	PRGSUNM	inter. exhaust-gas partial press. dep. on speed in case of active SU (1st flap)
1204	PUKANS	correction of pulsation depending on intake air temperature
1204	PVDN	LLR: P-gain for vehicle at rest
1204	PVDNKH	proportional ISC when secondary air activ
1204	PVDNST	proportional ISC in start
1204	PVDNV	LLR: P-gain for vehicle rolling
1204	PVLDN	LLR: P-gain for vehicle at rest (air path)
1204	PVLDNV	LLR: P-gain for vehicle at rest (air path)
1204	REDABM	fuel cut-off table for torque reduction
1204	REDABMB	fuel cut-off table for torque reduction slave1 or ecu B (SGB)
1204	REDABMC	fuel cut-off table for torque reduction slave 2 or ecu C
1204	REDABMZ	fuel cut-off table for torque reduction during ZAS
1204	REDZEM	threshold between ignition intervention and injector disabling
1204	RKBAUM	rk-threshold for acceleration enrichment display
1205	RKRMX1N	Maximum of reference level for knock detection threshold cylinder group 1
1205	RKRMX2N	maximum of reference level for knock detection threshold cylinder group 2
1205	RKVAUM	rk-threshold for deceleration enleanment display
1205	RLDKTSO	upper load characteristic line for DKAT-active
1205	RLDKTSU	lower load characteristic line for DKAT-active
1205	RLLRHON	char. line on nmot, upper rl control threshold for downstream lambda control
1205	RLLRHUN	char. line on nmot, lower control threshold rl for downstream lambda control
1205	RLLRUN	char.line above nmot,lower rL control limit for controller in front of catalyst
1205	RLNOT	limp-home relative air charge rl in case of E_DK and E_LM
1205	RLSALUN	threshold load fuel cut-off detection for deactivating misfire detection
1205	RLVMXN	maximum volumetric flow with open throttle valve
1205	RLVSMXN	maximum volumetric flow with open throttle valve and SU
1205	SDK10TEUB	wdkba dependet basic point (number 10)
1205	SDN06LLSB	10 Sst.
1205	SENZZYL	knock sensor for sw-cylinder counter 0-7
1205	SFR05TEUB	frmit dependet basic point (number 5)
1205	SGA08MDUB	base point distribution of actual gear 8 b.pt.
1205	SGSC_ANZ	number of module calls of %UFSGSC (refer to %URPAK) in the monitoring function
1205	SGSC_K	Constant for module %UFSGSC (see %URPAK)
1205	SIM06ESUW	Distribution for integrated air massflow since end of start
1205	SKO06KOUB	Distribution PWM-signal: load of ac-compressor
1205	SKS06ESUB	Distribution for the start adaption factor kstaa
1205	SLFOO2N	speed dep. upper threshold for learning filter value at fuel-on/-off adaptation
1205	SLFOON	speed dep. upper threshold for learning filter value at fuel-on/-off adaptation
1205	SMI04LLUB	distribution: ind. torque for torque-reserve
1205	SMK08MDSW	Antisurge torque dependent basic point (number =8)
1205	SML05DKUB	base point distribution air mass
1205	SML06TEUB	ml dependet basic point (number 6)
1206	SNG06LLSB	Datapoint distribution, speed gradient, 6 datapoints
1206	SNM05DKUB	base point distribution nmot
1206	SNM06ESUB	Distribution for engine speed
1206	SNM06KOUB	distribution for ac-compressor torque function
1206	SNM06LLUB	distribution of engine speed
1206	SNM08DMUB	Datapoint distribution in DMD, 8 speed datapoints
1206	SNM08KOUB	Datapoint distribution for air-conditioner compressor control 8 nmot
1206	SNM08__UB	Base point distribution engine speed, 8 base points
1206	SNM10TEUB	nmot dependet basic point (number 10)
1206	SNM12FEUB	set points of WDKSMX, WDKUGDN
1206	SNM16KRUB	datapoint distribution engine speed, 16 datapoints
1206	SNM16OPUW	16 speed set points for ?
1206	SNM16ZUUW	break point distribution engine speed, 16 base pts.
1206	SNS06LLSB	Datapoint distribution, set-speed deviation, 06 datapoints., idle-speed control.
1206	SQM05TEUB	air mass quotient dependet basic point (number =5)
1206	SRL04DYUB	basepoint distribution of rl, 4 basepoints
1206	SRL04KRUB	datapoint distribution relative charge, 4 datapoints
1206	SRL06KOUB	6 air charge set points for A/C-compressor torque loss
1206	SRL08DMUB	Datapoint distribution in DMD, 8 load datapoints
1206	SRL08NXUB	
1206	SRL11OPUW	set point distribution relative charge
1206	SRL12ZUUW	break point distribution of relative air charge, 12 base points
1206	SRP06ESUB	Distribution for relative air charge
1206	SRST1_UR	value for RAM data redundancy of bit B_SRST_UM = 1
1206	STA04LLUB	distribution: tans for torque resreve
1206	STA06ESUB	Distribution for the air temperature in the intake manifold
1206	STA06LLUB	temperature: ambient air, PWM -signal of AC/compressor
1206	STM04SAUB	Datapoint distribution, engine temperature, 4 datapoints
1207	STM06LLUB	Datapoint distribution, engine temperature, 6 datapoints
1207	STM06__UB	Datapoint distribution, engine temperature, 6 datapoints
1207	STM12ESUB	Distribution for the engine coolant temperature tmot
1207	STN06LLUB	distribution: time after start; for determination of idle speed after start
1207	STS08ESUB	Distribution for engine coolant temperature at start
1207	STS12ESUB	Distribution for engine coolant temperature at start
1207	SY_2SG	system constant 2 motronic systems
1207	SY_650ICLK	system constant: external clock frequency of CC650
1207	SY_AGR	System constant AGR present

Page	Parameter	Descriptor
1207	SY_ASG	automatic standard transmission
1207	SY_ASR	system constant ASR present
1207	SY_AWUE	injection valve cutoff possible by function AWUE
1207	SY_BDE	system constant GDI
1207	SY_BGVZS	
1207	SY_BKV	system constant: brake booster
1207	SY_BLOOP	sys. con. resetting of irreversible EGAS fault possible during clearing of FCM
1207	SY_CANAC	systemconstant: AC-compressor signal from CAN
1207	SY_CDCSIZE	System constant: Number of values CDC to each fault path
1207	SY_CDKSIZE	System constant: Number of values CDK to each fault path
1207	SY_CDTSIZE	System constant: Number of values CDT to each fault path
1207	SY_CLASIZE	System constant: Number of values CLA to each fault path
1207	SY_CONFSL	System constant: secondary air present vorhanden
1207	SY_COPOTI	System constant CO-Poti present
1207	SY_CVT	system constant: CVT transmission exists
1207	SY_DEGFE	system constant diagnosis input values load monitoring
1207	SY_DFPMENV	system constant: environmental conditions in fault code memory
1207	SY_DGANZ	system constant number rotational-speed sensor
1207	SY_DLDP	SY_DLDP = 1 there ist a DLDP in system
1208	SY_DLS	system constant digital idle speed control
1208	SY_DLSHV	Sys. constant condition %DLSHV (sensor exchange behind KAT) existent
1208	SY_DOPZW	System constant doubled ignition output included
1208	SY_DTES	system constant diagnosis evap system
1208	SY_DVEADA	system constant BGVE: disabling injection and ignition during DV-E-adaptation
1208	SY_EGAS	System constant E-GAS present
1208	SY_EGFE	system constant input variable for charge detection
1208	SY_FANT	system constant increase of the fuel cut-off speed at tester intervention
1208	SY_FFESIZE	system constant: Size of Freeze Frame-extension
1208	SY_FFTSIZE	System constant: Number of values FFT to each fault path
1208	SY_FFZ	system constant interval ignition
1208	SY_FREQ_CP	system constant cpu frequency
1208	SY_FWFGR	
1208	SY_GAP	system constant: number of missing teeth in the gap
1208	SY_GGGTS	system constant: sensor variable exact temperature signal
1208	SY_GRDWRT	System constant basic value, space between SW reference mark to OT in ° KW
1208	SY_GRDWRTB	system constant basic value 2.ECU, space between SW reference mark to OT in °KW
1208	SY_GRNDWRT	system constant basis angle ref. tr-mark
1208	SY_INI_OBD	system constant to select the communication protocols for scan tool operation
1208	SY_KL50	System constant: information available in the ECU if starter is cranking
1208	SY_KLDF	system constant for generator DF-signale
1208	SY_KOBIDIR	AC- with bidirect. connection
1208	SY_KOEVAB	coordination injection valve cutoff by function KOEVAB
1208	SY_KOPWM	PWM-compressor-signal enabled
1208	SY_KR_INT	system constant: CC650 present
1208	SY_KS1	system constant: input of the CC195 onto which knock sensor 1 is connected
1208	SY_KS2	system constant: input of the CC195 onto which knock sensor 2 is connected
1208	SY_KS3	system constant: input of the CC195 onto which knock sensor 3 is connected
1209	SY_KS4	system constant: input of the CC195 onto which knock sensor 4 is connected
1209	SY_KSDIFF	system constant: connection type of knock sensor(s)
1209	SY_LFS	System constant Fan Control configuration
1209	SY_LWS	system constant steering angle via CAN
1209	SY_ME7	system constant ECU
1209	SY_NACH	System constant ignition output after KL15 off included
1209	SY_NWS	system constant camshaft control: none, 2 point, continous
1209	SY_NWSA	system constant camshaft control outlet
1209	SY_NWVAR	system constant for camshaft configuration
1209	SY_NZUEB	system constant engine speed threshold for switching between ignition modes 1+2
1209	SY_PBRPW	system constant plausibility check brake/PWG
1209	SY_PGRAD	system constant: kind of the phase signal
1209	SY_PGRAD2	system constant: kind of the 2. phase signal
1209	SY_PGRAD3	system constant: kind of the 3. phase signal
1209	SY_PH2OFST	system const. offset in syncros between the 2 active phase signals,2 PGs only
1209	SY_PHTWIN	system constant 1/2 phase sensing system (sensor, wheel)
1209	SY_RDE	detection of reverse rotation of the engine in project included
1209	SY_REDMX	system constant: max. cylinder cutoff step
1209	SY_RLAPP	rlsol control during application possible
1209	SY_SGANZ	system constant number engine control unit
1209	SY_SLS	system constant for engines with secondary air pump
1209	SY_STADAP	system constant start adaptation
1209	SY_STERHK	system parameter condition stereo downstream catalyst
1209	SY_STERSY	System constant Condition stereo Lambda control symmetrical
1209	SY_STERVK	system constant condition: stereo exhaust system upstream of cat
1209	SY_SU	system constant: version of intake runner length adjuster
1209	SY_SWE_B	system constant for rough road detection using PWM signal from ABS
1209	SY_SWE_C	system constant for rough road detection using CAN
1210	SY_SWE_S	system constant for rough road detection using engine roughness statistics
1210	SY_TEETH	system constant: number of teeth at the crankshaft wheel (gapteeth included)
1210	SY_TFA	configuration for installtion position for intake-air sensor
1210	SY_TFBA	system constant service device intervention accel. enrichment
1210	SY_TFNS	system constant service device intervention afterstart factor
1210	SY_TFST	system constant service device intervention start factor
1210	SY_TFVA	system constant service device intervention decel. enleanment

Page	Parameter	Descriptor
1210	SY_TFWL	system constant service device intervention warm-up factor
1210	SY_TSFSIZE	System constant: Number of values TSF to each fault path
1210	SY_TURBO	system constant for exhaust-gas turbocharger
1210	SY_TWDKS	system constant: input of desired angle DVE via tester is possible
1210	SY_TZW	System constant tester manipulation of zwist included
1210	SY_UBR	system constant: Voltage behind main relay ubr exists
1210	SY_VS	system constant valve stroke control: no, 2 position
1210	SY_WMAX	System constant earliest ignition timing that can be outputed
1210	SY_WMIN	System constant latest ignition timing that can be outputed
1210	SY_ZAS	system constant cylinder deactivation ZAS included
1210	SY_ZNDAUS	System constant ignition timing output (single or double fir.), 1: single,2: d.
1210	SY_ZYLZA	system constant number of cylinders
1210	SY_ZZBANK	system constant assignment of cyl. to bank1/bank2, 0 bank1, 1 b.2, binary value
1210	SY_ZZBANKB	system const. ass. of cyl. to exhaust bank1/2 for slave1/SGB; 0 b1, 1 b2 bynary
1210	SY_ZZBANKC	system const. ass. of cyl. to exhaust bank1/2 for slave2/SGC; 0 b1, 1 b2 bynary
1210	SZANSSM1	switching level 1 of afterstart enrichment
1210	SZANSSM2	switching level 2 of afterstart enrichment
1210	TADTEAMX	characteristic line for max. duty cycle = F(integral purge flow after TE-Stop)
1210	TANDT	threshold difference intake air temperature for hot start
1210	TANDT1	delta threshold intake air temperature for hot start
1210	TANSELI	intake air temperature calculation, inverse function
1211	TAPVLTM	threshold soak time for EKP-lead time
1211	TATEMSN	characteristic line of the PCV duty-cycle depending on the desired mass-flow
1211	TDLAMBTSTA	delay time to enable nominal Lambda component protection
1211	TDMFWEMI	filter-time constant at hard fuel cut-in
1211	TFWDKPN	time constant for filtering DK angle before comp. with subs. value from charging
1211	THSHKTK	Line for switch off time of lambda sensor heating post cat dep. on temp
1211	THSHKTK2	ine for switch off time of lambda sensor heating 2 post cat dep. on temp
1211	THSVKTA	Line of switching off time for lambda sensor heating depending on exh.gas temp
1211	THSVKTA2	Line of switching off time for lambda sensor heating depending on exh.gas temp 2
1211	TKOAMNN	minimum shutdown time for air-conditioning compressor
1211	TKOAMXN	maximum shutdown time for air-conditioning compressor
1211	TKOBEMNN	Minimum switch-on time for compres. after triggering by B_kobped or B_kobwped
1211	TKODPAMNN	Minimum cut-out time of the air-conditioner compressors during acceleration (dwp
1211	TKODPAMXN	Maximum cut-out time for compressor cut-out by dwped
1211	TKOEMNN	minimal time of air-condition compressor beeing swiched on
1211	TKOWPAMNN	Minimum cut-out time at full load (by wped)
1211	TKOWPAMXN	Maximum cut-out time at full load (by wped)
1211	TLRBAM	blocking time for activation LC after BA
1211	TLRTMS	lock time for CL lambda control after start, depending on engine start temperatu
1211	TLRVAM	blocking time for activation LC after VA
1211	TLRZWTMS	Time until hard LC switch on after start (CARB)
1211	TMDMMAT	Default temperature dependent on parking time during TDTMMA
1211	TMLFAROF	Engine coolant temperature below which After run is termined
1211	TMLRTMS	engine temp. threshold for lambda control depending on cranking temp. tmst
1211	TMOTELI	engine temperature calculation, inverse function
1211	TN2FGRGA	double denominator time constant for cruise control
1211	TNLSGM	Delay time for ECU shut-off
1211	TSBBVTMS	time delay control readiness after sensor readiness
1212	TSPERN	lock time for p-offset after lambda sensor voltage jump
1212	TSPERN2	lock time for p-offset after lambda sensor voltage jump, bank 2
1212	TSWKNBGA	time to set value correction after acceleration finished
1212	TSWKNVGA	time to set value correction after deceleration finished
1212	TTEVUB	Battery-voltage depending delay time of canister purge valve
1212	TVFSAM	Delay time after DRIVE-position switch off
1212	TVFSEM	delay time after DRIVE-position switch on
1212	TVKTDTK	temperature dependant delay time for catalyst monitoring
1212	TVKUPHS	delay time for clutch switch during shifting in higher gear
1212	TVKUPRS	delay time for clutch switch during shifting in lower gear
1212	TVLADV	Integrator time constant at vlast-calculation
1212	TVLLRI	delay time to enable I-component after start-up
1212	TVLLRPD	Maximal delay time to enable PD components after start-up
1212	TVNWSTTM	delay time : enable of camshaft control after start, depending on engine temp
1212	TVSATEM	delay time for closing of the PCV after readyness for fuel cut off
1212	TVSATM	delay time after cranking for fuel cut off
1212	TVSLR	Duration of LRS downtime commanded via valve stroke control
1212	TVSUM	delay time for intake manifold switch over in dependence of engine temperatur
1212	TVUB	voltage correction
1212	TWDKSNST	time constant for filtering of reference throttle blade position
1212	TWDKSV	time constant for filtering of reference throttle blade position
1212	TWLRTMS	waiting time up to check engine temp. signal exceeding threshold for closed loop
1212	TWSTT	threshold soak time for re-start
1212	TZ2FGRGA	double numerator time constant for cruise control
1212	UDKSNO	upper reference voltage threshold for diagnosis knock sensors
1212	UDKSNU	lower reference voltage threshold for diagnosis knock sensors
1212	UEVERG	Gear ratio depending of the gear
1212	URL2SUNM	conversion factor from ps->rl dependent on nmot_w for active SU (2nd flap)
1213	URL3SUNM	conversion factor from ps->rl dependent on nmot_w for active SU (1st + 2nd flap)
1213	URLNM	conversion factor from ps->rl dependent on nmot_w
1213	URLSUNM	conversion factor from ps->rl dependent on nmot_w for active SU (1st flap)
1213	VLMXVZ	Max. value for vlast_w
1213	WDKARN	threshold throttle angle for activation of the mixture adaptation

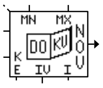
Page	Parameter	Descriptor
1213	WDKHKDN	High threshold throttle plate for altitude adaptation
1213	WDKHKN	Low threshold throttle plate for altitude adaptation
1213	WDKPMXN	maximum throttle angle for plausibility check with charge signal
1213	WDKSNLN	desired throttle angle at kl15 off
1213	WDKUGDN	throttle angle necessary for 95 % of the maximum possible air charge
1213	WEAN	angle injection break off
1213	WEEM	correction of prestorage angle
1213	WEEMRFAN	end of injection angle at max relative driver request
1213	WEESTATI	Offset for injection end angle towards early
1213	WEESTM	correction of pretiming of injection during start
1213	WEESTN	end of injection angle during start
1213	WFRL	fuel wall hang.up
1213	WKRLZOF	Bloc of fixed values: ignition reatard offset for guided cylinder
1213	WPEDKO	Accelerator position treshold for the A/C cut off
1213	WPFGRBMR	Back-calculated pedal value during acceleration with FGR
1213	WPHN	phase correction
1213	WPUAVLN	Throttle valve angle as of which VL ambient pressure adaptation is active
1213	WPUAVLSN	Throttle valve angle as of which VL ambient pressure adaptation is blocked
1213	ZATMAML	time constant for exhaust gas temperature model
1213	ZATMAML2	time constant for exhaust gas temperature model bank2
1213	ZATMIKML	time constant for modelled temperature in catayst tikatm
1213	ZATMIKML2	time constant for modelled temperature in catayst bank 2
1213	ZATMKML	time constant for catalyst temperature model tkatm
1214	ZATMKML2	time constant for catalyst temperature model bank2
1214	ZATMRML	time constant for exhaust model temperature - pipe temperature
1214	ZATMRML2	time constant for exhaust model temperature - pipe temperature bank2
1214	ZBALM	reduction factor L-memory (tmot) for accel. enrichment
1214	ZBTEML	integration speed for canister charge adaptation
1214	ZDBTMN	time constant combustion chamber temperatur model for negativ gradient
1214	ZDBTMP	time constant combustion chamber temperatur model for positiv gradient
1214	ZKFRAOA	time constant for frao-integrator, f(number of starts with fuel in oil)
1214	ZKFRAUA	time constant for frau-integrator, f(number of starts with
1214	ZKMSDKT	integrator speed for fast constant mass-flow adaption
1214	ZKPVDKT	integrator speed for slow constant mass-flow adaption
1214	ZKRKATA	integration speed integrator rkat, f(abo)
1214	ZKRKAZA	integration speed integrator rkaz, f(abo)
1214	ZKTABTU	time constant for engine cooling
1214	ZLASOHML	time constant for PT1-filter of the pseude lambda behind catalyst
1214	ZLASOHML2	Time constant for PT1-filter of pseudo lambda post cat, bank 2
1214	ZLRHML	time constant of lambda control integrator downstream catalyst
1214	ZLRHML2	time constant of lambda control integrator downstream catalyst bank 2
1214	ZMDNSM	time constant for decay of torque offset after cranking
1214	ZPVDKR	time constant for filtering of pvdkr
1214	ZVALM	reduction factor L-memory (tmot) for decel. enleanment
1214	ZZWEETM	Switchover threshold pattern angle

ASCETBLK 1.10 Description of ASCET block library

FDEF ASCETBLK 1.10 Function definition

Representation of engine management functions:

To represent engine management functions physical information (data flow) is distinguished from digital control information (control flow).
Data flow: load signal, speed, control factor
Control flow: condition idle, switch driving position, error catalyst
Solid lines mark the data flow, dotted lines mark the control flow.

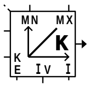


Baseblocks (general description):
- Blocks with marker "NOV" store the value of the output (integrator value, flag, RAM-cell) in a non volatile RAM (otherwise in a volatile RAM). The behaviour of these blocks is identical to their pendants without "NOV" marker.
- The main inputs and outputs ("in" and "out") have no symbol in the block icon; if there are no other characteristics their default values are 0.0 (float) bzw. FALSE (bool).
- Unconnected inputs are configured with 0.0 (float) bzw. FALSE (bool), if there are no other agreements.
- Some blocks have a special input at their left upper corner (default TRUE), usually connected with a calculation raster trigger to determine the frequency of calculation explicitly. Raster time describes the time gap between two cycles.
- Any deviation from following default configuration of input and output values will be described in the documentation of each block.

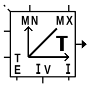
	breve in icon	default value	designation
INPUTS:	E	TRUE	enable calculation
	I	FALSE	initialization
	IV	0.0	initial value
	K	0.0	here: integration factor K
	MX	1E35	upper limitation of output
	MN	-1E35	lower limitation of output

ascetblk-teil0gb

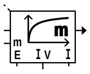
ascetblk-teil0gb



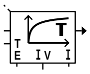
Integrator K
new value of integrator := old value of integrator + K * rasterTime * in
INPUTS: K integration factor



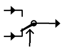
Integrator T
new value of integrator := old value of integrator + (rasterTime / T) * in
The minimum value of T is limited to rasterTime.
INPUTS: T time constant of integration



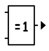
Recursion
new value := old value + m * (in - old value)
INPUTS: m weighting factor



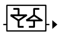
Lowpass
new value of lowpass := old value of lowpass + (rasterTime / T) * (in - old value of lowpass)
The minimum value of T will be limited to rasterTime.
INPUTS: T time constant



Input-Switchover
The icon shows the default position of the switch, default value of non-wired inputs is 0.0 .



Exclusive-OR
Output-signal is TRUE when exactly one input-signal is TRUE.



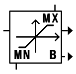
Edge (bidirectional)
A positive or negative edge at input triggers a TRUE at output during this simulation step.

Maximum (2 inputs)
The value of output is equal to maximum of all input values.
Output i indicates the index of first input generating maximum.

-

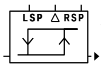
ascetblk-teil1gb

ascetblk-teil1gb



Limiter
The value of output-signal is equal to input-signal limited to the range [MN, MX].
TRUE at output "B" indicates an active limitation, otetherwise this output is FALSE.

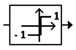
Absolute value
The value of output-signal is equal to absolute value of input-signal.



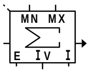
Hysteresis
Wiring of hysteresis determines right and left breakover point of hysteresis:

wired	left breakover point	right breakover point
LSP und delta	LSP	LSP + delta
LSP und RSP	LSP	RSP
delta und RSP	RSP - delta	RSP

All other wirings of the inputs LSP, RSP and delta produce FALSE as output-value (incorrect wiring).

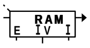


Signum
Input value < 0.0, causes -1.0 at output, otherwise output value is equal to 1.0 .



Accumulator
The accumulator-value is changed by input-value and limited to the range [MN, MX].

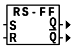
FLAG
Imitation of one volatile 1 bit-RAM-cell.



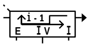
RAM
Imitation of an volatile RAM-cell.

ascetblk-teil2gb

ascetblk-teil2gb



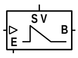
RS-FlipFlop
The RS-FlipFlop has a set-input S and a reset-input R, reset dominates set.
The value of output !Q is always inverted to output Q.



Delay raster
Signal delay by one cycle of calculation grid, out(i) := in(i-1).
A non-wired raster-input causes signal delay of one simulation step.

Turn-off delay
If input-signal switches from TRUE to FALSE the output-signal follows this alteration with a delay. Delay time is determined by input DELAY. Switching input to TRUE during delay time causes TRUE at output immediately.

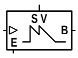
Turn-on delay
If input-signal switches from FALSE to TRUE the output-signal follows this alteration with a delay. Delay time is determined by input DELAY. Switching input to FALSE during delay time causes FALSE at output immediately.



Timer
A positive Edge at input starts the timer running down:
- the start value of timer is determined by value at input SV (in seconds).
- the output switches to TRUE and stays TRUE until timer expires.

Further positive edges at input have no effect until the timer time has expired.
FALSE at input E stops the timer until TRUE at this input causes continuation of running down.

INPUTS:	in	start timers
	SV	start value of timer
OUTPUTS:	B	timer is running



Timer-Retrigger
Basic function like "Timer", difference: A further positive edge at input causes always restart of timer.

ascetblk-teil3gb

ascetblk-teil3gb

Time-Counter
TRUE at input resets time-counter to 0.0. R = FALSE, starts time-counter.
FALSE at input E stops the time-counter. The time-counter output shows the elapsed time in seconds.
INPUTS: R reset of time-counter

Counter
The counter will be incremented or decremented in every simulation step. True at input I causes determination of count-direction depending on actual startvalue and endvalue.
If value of input SV is greater than value of input EV then counter counts up, otherwise it counts down until endvalue is reached. Reaching endvalue will be indicated by TRUE at output B.
The counter may be stopped wih help of input E.

INPUTS:	SV	startvalue of counter
	EV	endvalue of counter
	I	initialize and start counter
OUTPUTS:	B	endvalue reached

Statemachine
The control flow is represented by logical gate arrays and statemachines. The sequence control in a statemachine may be modeled with help of states and transitions.

State: (ellipsis) In a statemachine is always exactly one state active, that means all corresponding actions will be done. The name of every state is represented inside the ellipsis.

Transition: (arrow) The Transition from one state to an other one in case of fulfilling the state transition condition. All corresponding transition actions will be done. The condition, that will be checked for transition, is shown beside the transition arrow. The string beside the transition is only a logical name representing the condition. The afterfollowing text contains the ful description. The condition with the lowest number has the highest priority.

Every statemachine has exactly one welldefined start state (S) and a reset state (R).
If RESET-condition is fulfilled in any state, the reset state becomes actual state for next simulation step.

ascetblk-teil4gb

ABK ASCETBLK 1.10 Abbreviations

FW ASCETBLK 1.10 Fixed Values

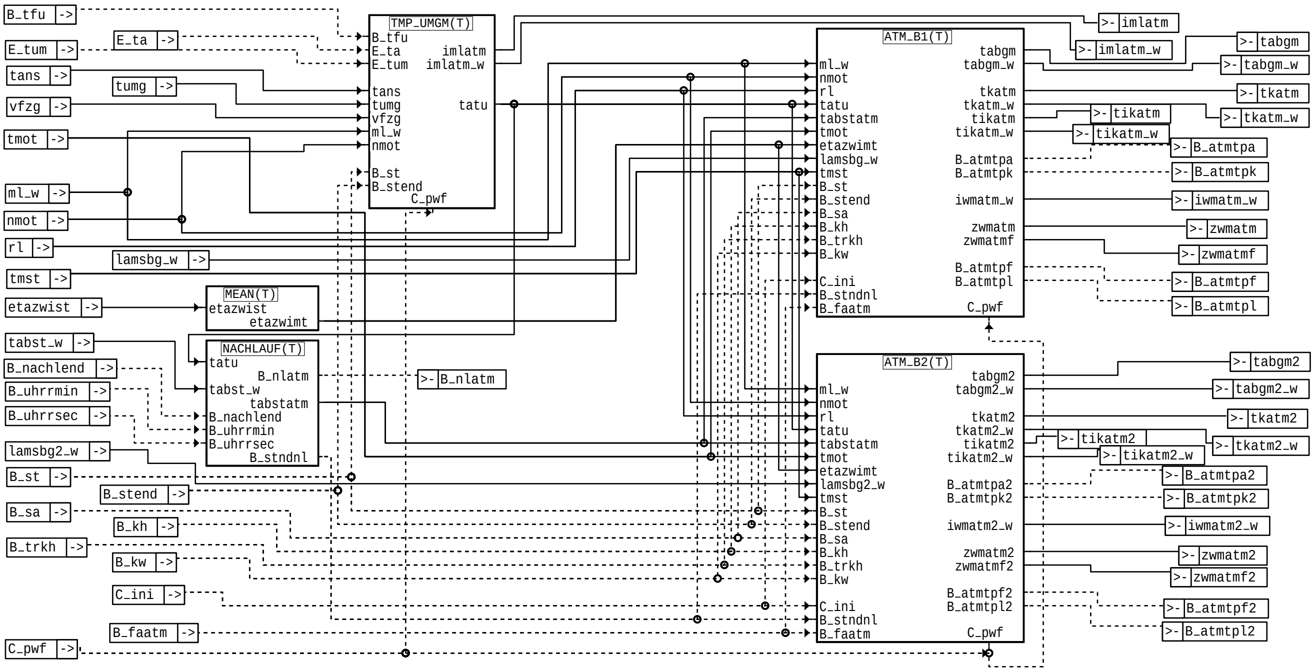
Parameter	Value	Description

FB ASCETBLK 1.10 Detailed description of function

APP ASCETBLK 1.10 Application hint

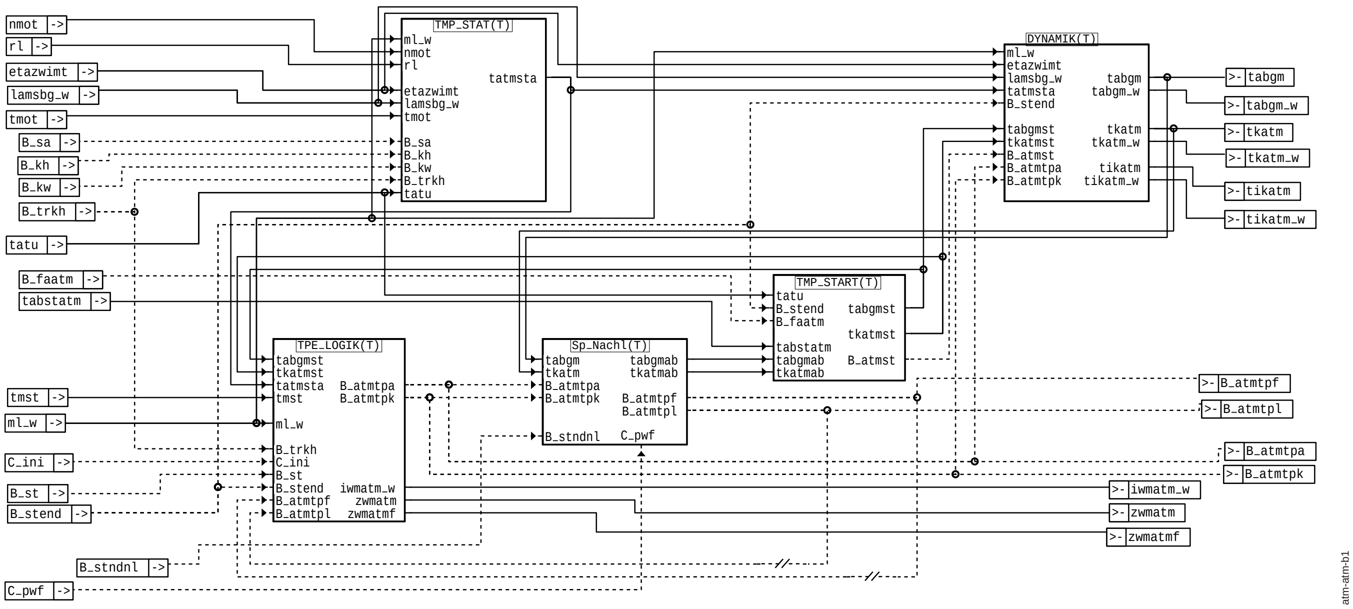
ATM 33.10 Exhaust temperature model

FDEF ATM 33.10 Function definition



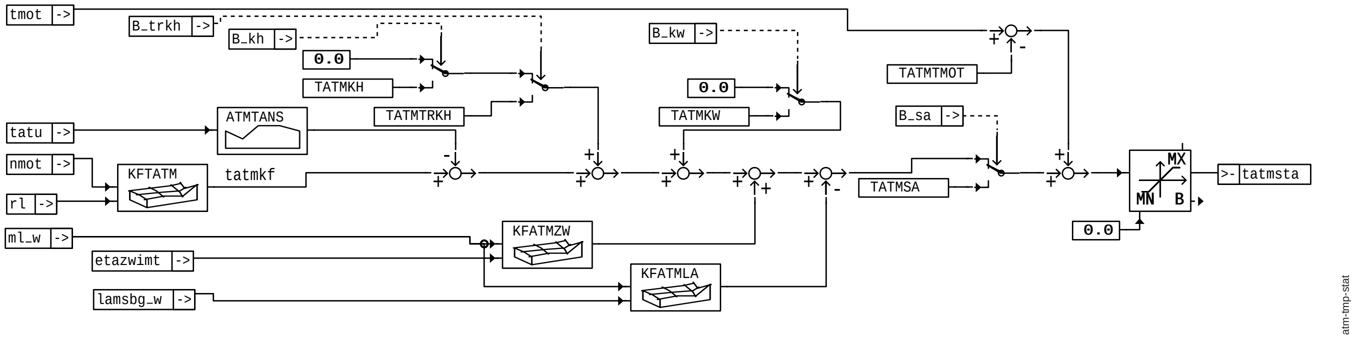
atm-atm

ATM_B1 Model overview



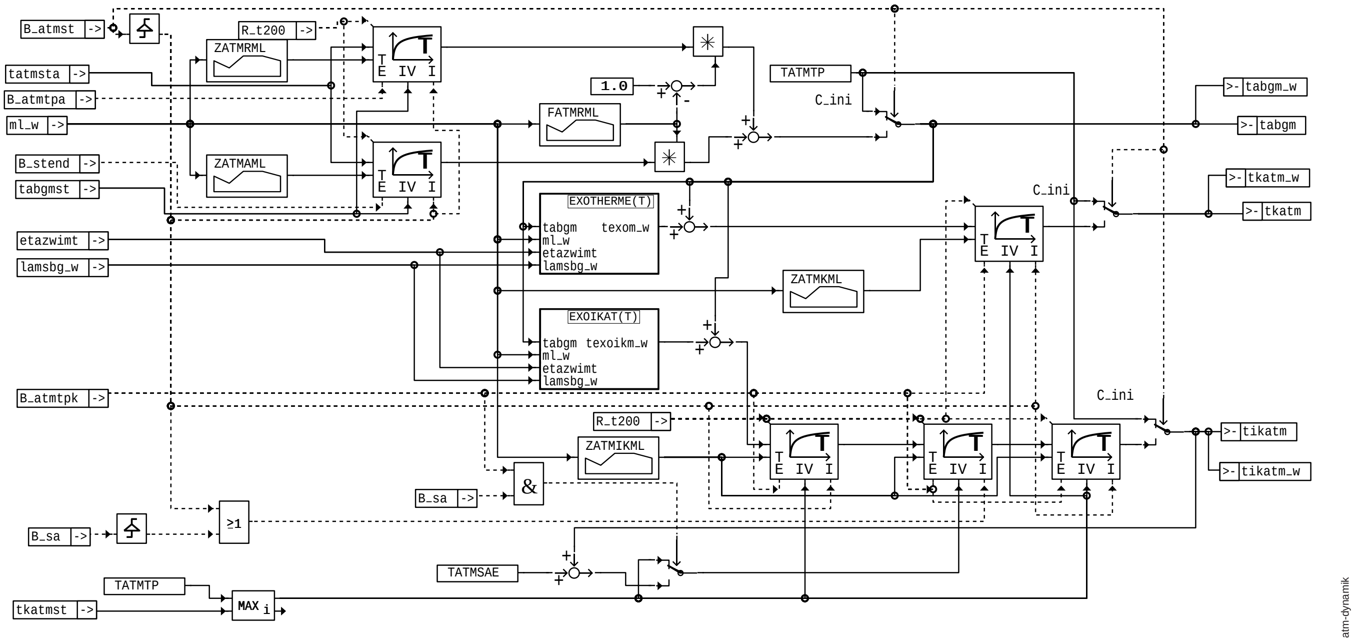
atm-atm-b1

TMP_STAT Temperature correction at fuel cutoff, intake air, catalyst heating warming, ignition angle, lambda and cold engine



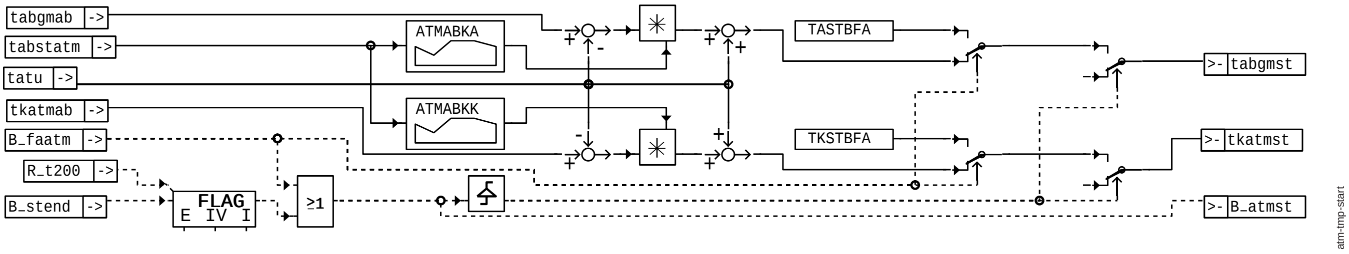
atm-tmp-stat

DYNAMIK Temperature-dynamics of exhaust gas, pipe-wall and catalyst



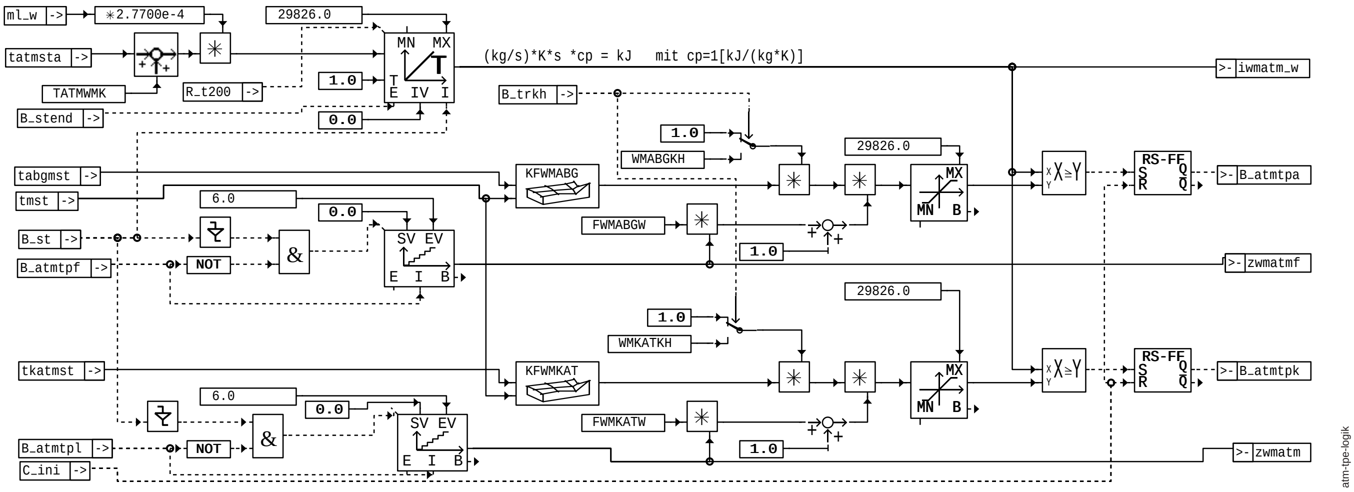
atm-dynamik

TMP_START   Calculation of exhaust gas - and pipe-wall temperature at engine start



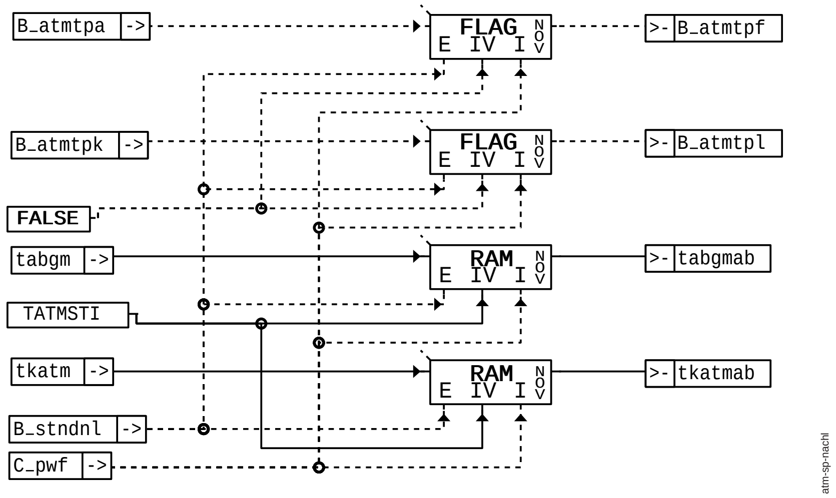
atm-tmp-start

TPE_LOGIK   Calculation of exceed dew-point for lambdasensor upstream and downstream



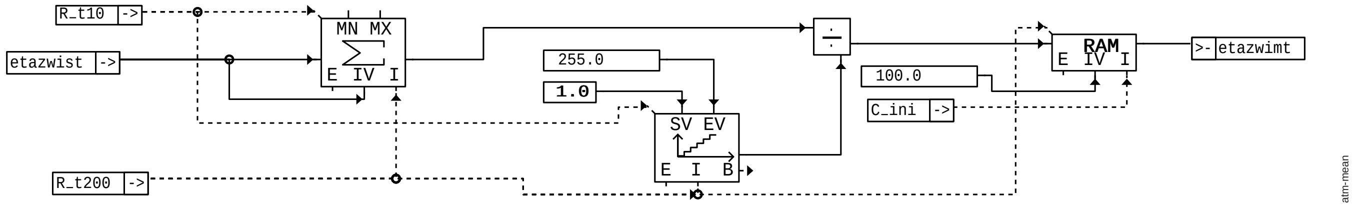
atm-tpe-logik

SP_NACHL   Store exceed dew-point flag and temperature tabgm, tkatm at switch off delay



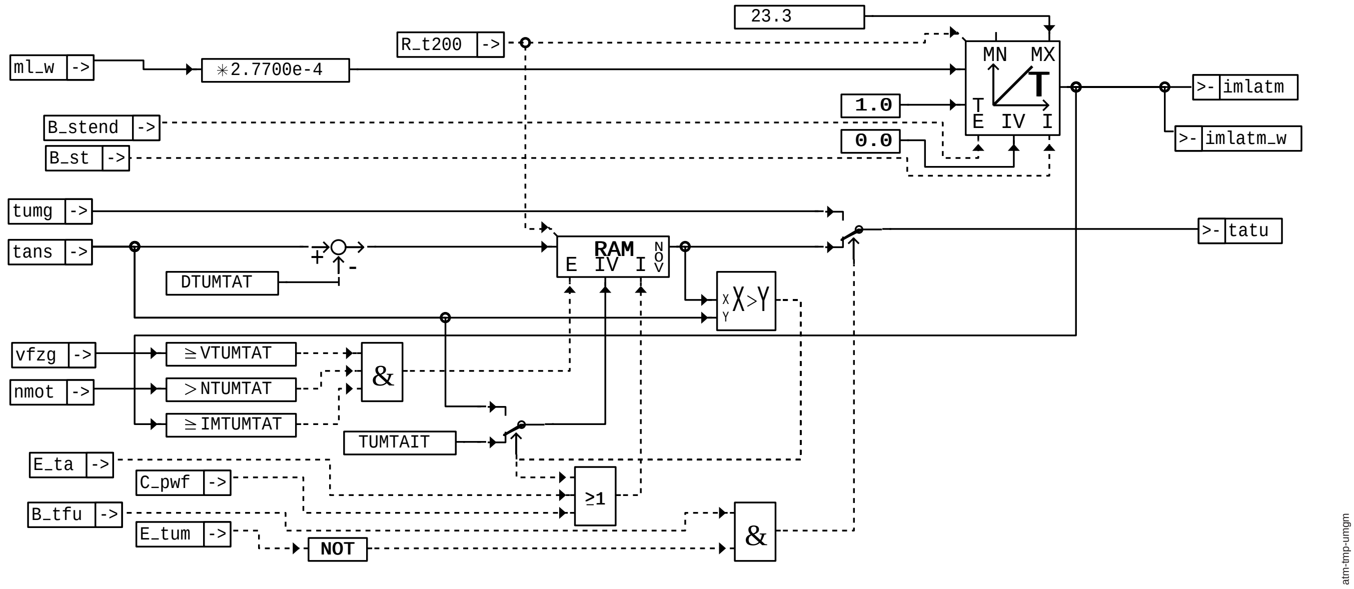
atm-sp-nachl

MEAN   etazwist-mean-value



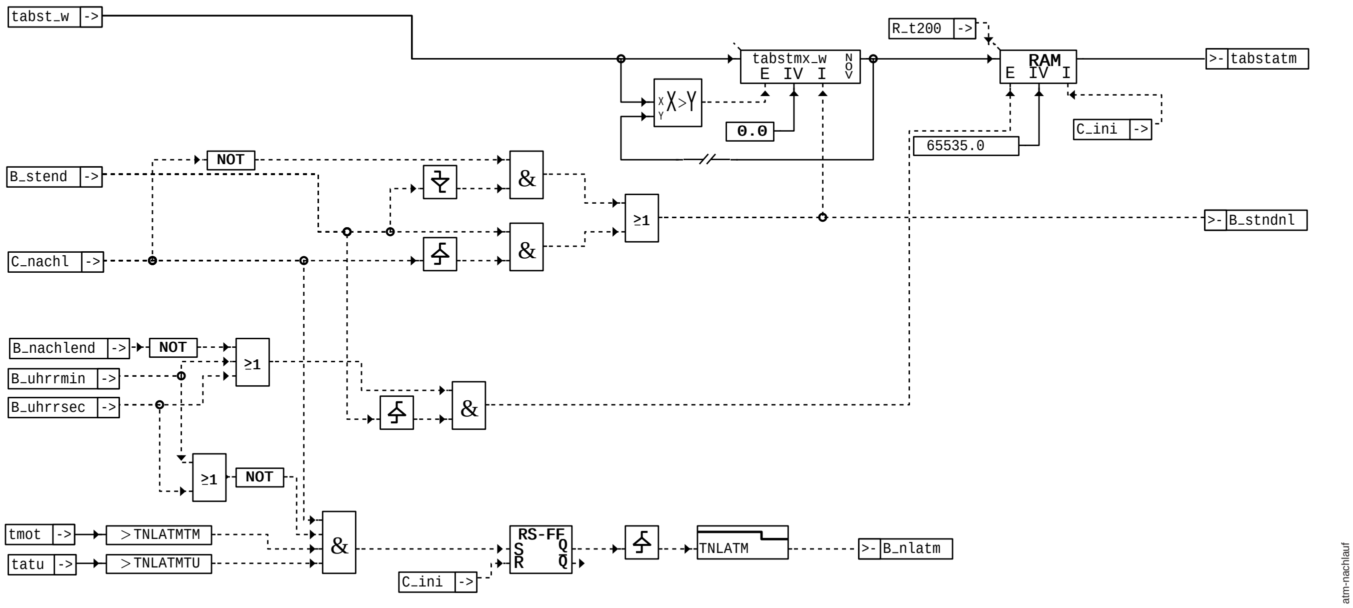
atm-mean

`TMP_UMGM     If there is no ambient-air-sensor, calculation of the ambient tempereature from   tans (intake air temperature)`



atm-tmp-umgm

`NACHLAUF        If tabst_w not ok  tabstatm = max-value,   B_nlatm = f(tmot,tatu)`



atm-nachlauf

ABK ATM 33.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ATMABKA	TABSTATM		KL	factor reduction of exhaust gas temperature = f(soak time)
ATMABKK	TABSTATM		KL	factor reduction for catalyst temperature = f(soak time)
ATMTANS	TATU		KL	temperature correction of the exhaust model temperature
DTUMTAT			FW	offset intake-air temperatur -> ambient temperature
FATMRML	ML_W		KL	divide factor exhaust-/exhaust-pipe temperature
FATMRML2	ML_W		KL	divide factor exhaust-/exhaust-pipe temperature bank2
FWMABGW			FW	factor heat quantity upstream when dew-point end not reached last trip
FWMABGW2			FW	factor heat quantity upstream when dew-point end not reached last trip bank2
FWMKATW			FW	factor heat quantity downstream when dew-point end not reached last trip
FWMKATW2			FW	factor heat quantity downstream when dew-point end not reached last trip bank2
IMTUMTAT			FW	threshold integrated air mass for determination ambient temp. (from TANS)
KATMEXML	ML_W		KL	Temperature of the exotherme in the catalyst tkatm
KATMEXML2	ML_W		KL	Temperature of the exotherme in the catalyst , bank 2
KATMIEXML	ML_W		KL	Temperature of the exotherme in the catalyst tikatm
KATMIEXML2	ML_W		KL	Temperature of the exotherme in the catalyst tikatm, bank 2
KFATMLA	ML_W	LAMSBG_W	KF	map exhaust gas temperature correction = f(lambda)
KFATMLA2	ML_W	LAMSBG2_W	KF	map exhaust gas temperature correction = f(lambda) bank2
KFATMZW	ML_W	ETAZWIMT	KF	map exhaust gas temperature correktion = f(ignition-variation)

Parameter	**Source-X**	**Source-Y**	**Type**	**Description**
KFATMZW2	ML_W	ETAZWIMT	KF	map exhaust gas temperature correktion = f(ignition) bank2
KFTATM	NMOT	RL	KF	map exhaust gas temperature f(nmot,rl)
KFTATM2	NMOT	RL	KF	map exhaus gas temperature f(nmot,rl) bank2
KFWMABG	TABGMST	TMST	KF	map for heat-quantity threshold dew-point end upstream bank1
KFWMABG2	TABGMST2	TMST	KF	map for heat-quantity threshold dew-point end upstream bank2
KFWMKAT	TKATMST	TMST	KF	map for heat quantity threshold dew-point end downstream
KFWMKAT2	TKATMST2	TMST	KF	map for heat quantity threshold dew-point end downstream bank 2
KLATMILAE	LAMSBG_W		KL	Temperature of the exotherme decrease during enrichment tikatm
KLATMILAE2	LAMSBG2_W		KL	Temperature of the exotherme decrease during enrichment tikatm, bank2
KLATMIZWE	ETAZWIMT		KL	Temperature of the exotherme decrease in cat during ignition retard tikatm
KLATMIZWE2	ETAZWIMT		KL	Temperature of the exotherme decrease in cat during ignition retard tikatm, bank
KLATMLAE	LAMSBG_W		KL	Temperature of the exotherme decrease during enrichment
KLATMLAE2	LAMSBG2_W		KL	Temperature of the exotherme decrease during enrichment, bank 2
KLATMZWE	ETAZWIMT		KL	Temperature of the exotherme decrease in cat during ignition retard tkatm
KLATMZWE2	ETAZWIMT		KL	Temperature of the exotherme decrease in cat during ignition retard, bank2
NTUMTAT			FW	threshold engine speed for determination ambient temperature (from TANS)
TABGMEX			FW	Exhaust-gas temperature below the catalyzer light-off temperature
TASTBFA			FW	modelled-temperature exhaust gas start value at B_faatm-condition function
TATMKH			FW	exhaust gas temperature correction at catalyst heating
TATMKH2			FW	exhaust gas temperature correction at catalyst heating bank2
TATMKW			FW	exhaust gas temperature correction at catalyst warming
TATMSA			FW	exhaust gas temperature at fuel cut off
TATMSAE			FW	exothermal temperature offset at fuel cut off
TATMSAE2			FW	exothermal temperature offset at fuel cut off, bank2
TATMSTI			FW	initial value tabgm, tkatm at power fail
TATMTMOT			FW	engine temperature warmed up engine, for temperature correction cold engine
TATMTP			FW	exhaust temperature at dew point
TATMTRKH			FW	correction of exhausgas temperature at catalyst fast heating
TATMTRKH2			FW	correction of exhausgas temperature at catalyst fast heating, bank2
TATMWMK			FW	Temperature offset for heat-quantity calculation
TIKATMOE			FW	Temperature correction in catatyst without exotherm reaction tikatm
TKATMOE			FW	Temperature correction catatyst without exotherm reaction tkatm
TKSTBFA			FW	modelled-temp. catalyst start value at B_faatm-cond.(short dew-point end time)
TNLATM			FW	minimal ECM-afterrun for ATM - afterrun-time
TNLATMTM			FW	at tmot > limit ECM_afterrun for ATM B_nlatm = 1
TNLATMTU			FW	at tumg (tatu-ATM) > limit SG-afterrun-time B_nlatm = 1
TUMTAIT			FW	inital value of ambient temperature (from TANS)
VTUMTAT			FW	threshold velocity for determination ambient temperature from TANS
WMABGKH			FW	factor for heat-quantity-correction at catalyst heating for dew-point end
WMABGKH2			FW	factor for heat-quantity-correction at catalyst heating for dewpoint-end bank2
WMKATKH			FW	factor for heat-quantity-correction at cat. heating for B_atmtpk downstream cat.
WMKATKH2			FW	factor for heat-quantity-correction at cat. heating for B_atmtpk downstream cat.
ZATMAML	ML_W		KL	time constant for exhaust gas temperature model
ZATMAML2	ML_W		KL	time constant for exhaust gas temperature model bank2
ZATMIKML	ML_W		KL	time constant for modelled temperature in catayst tikatm
ZATMIKML2	ML_W		KL	time constant for modelled temperature in catayst bank 2
ZATMKML	ML_W		KL	time constant for catalyst temperature model tkatm
ZATMKML2	ML_W		KL	time constant for catalyst temperature model bank2
ZATMRML	ML_W		KL	time constant for exhaust model temperature - pipe temperature
ZATMRML2	ML_W		KL	time constant for exhaust model temperature - pipe temperature bank2

Variable	**Source**	**Type**	**Description**
B_ATMST	ATM	LOK	Flag start-value tabgmst, tkatmst calculated
B_ATMST2	ATM	LOK	Flag start-value tabgmst, tkatmst calculated bank 2
B_ATMTPA	ATM	AUS	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	AUS	condition temperature upstream catalyst exceeds dew-point2
B_ATMTPF	ATM	AUS	condition dew-point exceeds upstream (last trip)
B_ATMTPF2	ATM	AUS	condition dew-point exceeds upstream (last trip) bank2
B_ATMTPK	ATM	AUS	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	AUS	condition temperature downstream catalyst exceeds dew-point2
B_ATMTPL	ATM	AUS	condition temperature downstream catalyst exceeds dew-point (last trip)
B_ATMTPL2	ATM	AUS	condition temperature downstream catalyst exceeds dew-point (last trip) bank2
B_FAATM		EIN	condition function request short dew-point end time
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KW	BBKHZ	EIN	Condition catalyst warming
B_NACHLEND	MOTAUS	EIN	conditon ECU switch off delay regularly finished
B_NLATM	ATM	AUS	request for ECM exhaust-temp.modell ATM
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_STNDNL	ATM	LOK	condition start of ECU-after run or end of start (1->0)
B_TFU	PROKON	EIN	condition ambient temperature sensor exists
B_TRKH	BBKHZ	EIN	Flag for catalyst fast heating
B_UHRRMIN	PROKON	EIN	Condition clock with a relative counter of minutes
B_UHRRSEC	PROKON	EIN	Condition clock with a relative counter of seconds
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
ETAZWIMT	ATM	LOK	mean efficiency at actual ignition angle (200 ms)
ETAZWIST	MDIST	EIN	actual ignition angle effectiveness
E_TA	GGTFA	EIN	error flag: TANS

Variable	Source	Type	Description
E_TUM		EIN	Error Flag: ambient (air) temperature tumg
IMLATM	ATM	AUS	integrated air mass flow from engine start to maximum value
IMLATM_W	ATM	AUS	integrated air mass flow from engine start to max. value (word)
IWMATM2_W	ATM	AUS	heat quantity to dew-point end
IWMATM_W	ATM	AUS	heat quantity to dew-point end
LAMSBG2_W	LAMSOLL	EIN	required lambda limitation Bank2
LAMSBG_W	LAMSOLL	EIN	Desired Lambda limitation (word)
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
R_T200		EIN	Time schedule 200 ms
TABGM	ATM	AUS	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	AUS	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TABGM2_W	ATM	AUS	Exhaust gas temperature in front of the catalyzer from model (Word) bank2
TABGMAB	ATM	LOK	exhaust gas temperature (modelled) at switch off
TABGMAB2	ATM	LOK	exhaust gas temperature (modelled) at switch off
TABGMST	ATM	LOK	Exhaust gas temperature at engine start
TABGMST2	ATM	LOK	Exhaust gas temperature at engine start bank2
TABGM_W	ATM	AUS	Exhaust gas temperature in front of the catalyzer from model (Word)
TABSTATM	ATM	LOK	soak time at ECM for ATM
TABSTMX_W	ATM	LOK	soaking time maximum query for exhaust gas temp. model
TABST_W	BGTABST	EIN	soak time
TANS	SWADAP	EIN	Intake air temperature
TATMKF	ATM	LOK	exhaust gas temperature-modelled from map KFTATM
TATMKF2	ATM	LOK	exhaust gas temperature-modelled from map KFTAMT bank2
TATMSTA	ATM	LOK	exhaust gas temperature-modelled steady-stade
TATMSTA2	ATM	LOK	exhaust gas temperature-modelles steady-stade
TATU	ATM	LOK	intake air or ambient temperature
TEXOIKM2_W	ATM	LOK	Bank2
TEXOIKM_W	ATM	LOK	exothermic temperature increase in the catalyst for tikatm
TEXOM2_W	ATM	LOK	exothermic temperature increase in the catalyst for tkatm2, bank2
TEXOM_W	ATM	LOK	exothermic temperature increase in the catalyst for tkatm
TIKATM	ATM	AUS	exhaust gas temperature in catalyst (modelled)
TIKATM2	ATM	AUS	exhaust gas temperature in catalyst (modelled) bank2
TIKATM2_W	ATM	AUS	exhaust gas temperature in catalyst (modelled) bank2
TIKATM_W	ATM	AUS	exhaust gas temperature in catalyst (modelled)
TKATM	ATM	AUS	catalyst temperature (model)
TKATM2	ATM	AUS	catalyst temperature (model), bank2
TKATM2_W	ATM	AUS	catalyst temperature modelled (word) bank2
TKATMAB	ATM	LOK	exhaust gas temperature downstream cat.(modelled) at switch off
TKATMAB2	ATM	LOK	exhaust gas temperature downstream cat.(modelled) at switch off bank 2
TKATMST	ATM	LOK	catalyst temperature modelled start value = f(last value, soak time)
TKATMST2	ATM	LOK	catalyst temperature modelled start value = f(last value, soak time) bank 2
TKATM_W	ATM	AUS	catalyst temperature modelled (word)
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TUMG		EIN	Ambient air temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)
ZWMATM	ATM	AUS	counter for dew-point end not reached for heat quantity threshold
ZWMATM2	ATM	AUS	counter for dew-point end not reached for heat quantity threshold
ZWMATMF	ATM	AUS	counter for dew-point end not reached for heat quantity threshold upstream
ZWMATMF2	ATM	AUS	counter for dew-point end not reached for heat quantity threshold upstream

FB ATM 33.10 Detailed description of function

The simulated exhaust and catalyst temperature is used:

1. For catalyst monitoring: If the catalyst temperature falls short of its light-off temperature, then this catalyst could erroneously be detected as defective.

2. For the downstream Lambda control: The downstream Lambda controller is activated after cranking, but only, if the catalyst has exceeded its light-off temperature.

3. For sensor heater control after engine start: If the simulated dew point temperature has been exceeded, then the sensor heater can be completely turned on.

4. For sensor heater control monitoring: If the exhaust temperature exceeds a given threshold (e.g. 800 deg C), then the sensor heater is turned off (in order to avoid overheating of the sensor).

5. For engine fan control: Activation of engine fan during power latch when tabgm > TABGLF and other conditions (see %MLS).

6. For switch-on protection of components by mixture enrichment

By introducing this function, only approximations of the exhaust and catalyst temperature are obtained. For application especially the monitoring areas
- dew point characteristic of the exhaust
- catalyst monitoring
- activation and deactivation of the sensor heater
- switch-on protection of components

must be critically observed.

1. Base function temperature tatmsta

The steady state exhaust gas temperature upstream catalyst is determined by the nmot/rl dependent characteristic map KFTATM.

This temperature is corrected by
- ambient temperature (ATMTANS)
- fuel cutoff (TATMSA)
- catalyst heating or - warming (TATMKH, TATMKW)
- ingnition angle (KFATMZW temperature = f(ML, ETAZWIST)
- lambda nominal value (KFATMLA temperature = f(ML, LAMSBG_W)
- cold engine temperature (TMOT - TATMTMOT ; TATMTMOT = 90 °C)

The temporal influence of the exhaust gas temperataure upstream and downstream of the catalyst:

This function is simulated with filter for exhaust gas, pipe-wall and catalyst. The "heat transport" is approx. proportional to the air massflow. Therefore, the filter time constants are depending on airflow and determined by a characteristic line. The appropriate filter values reflect the exhaust gas temperature upstream of catalyst (ZATMAML), pipe-wall (ZATMRML) and downstream of catalyst (ZATMKML).

Correction of exhaust gas temperature with time characteristic of the pipe wall temperature.

If the exhaust gas temperature in the manifold increases ’in jumps’, initially with a small time constant (5-15s) the exhaust gas temperature upstream of the cat. increases by a specific (smaller) amount. Then the exhaust gas temperature increases further as a result of the heating up of the exhaust pipe, with a larger time constant (50-200s).
This pipe wall temperature effect is especially necessary in more precise exhaust gas temperature simulation.
The pipe wall temperature effect is shown by a filter (with high time constant) which is calculated parallel to the filter for the exhaust gas temperature. Splitting of the two effects is dependent on air-mass. At low air-mass flow the pipe wall temperature effect is significantly greater than at higher air-mass flow. The filter value for the exhaust gas temperature is multiplied directly by the splitting factor (FATMRML), while the filter value for the pipe wall temperature is multiplied by a factor (1-FATMRML).
The two corrected filter values are added together and produce the exhaust gas temperature.

During extended fuel cutoff conditions with low exhaust gas temperatures, the catalyst may fall short of the light-off temperature. For these operating conditions, the exhaust temperature at the filter input is switched to the constant value TATMSA.
During catalyst heating (B_kh = 1) temperature TATMKH is added to TATMML characteristic line.

As long as condensation in the exhaust system is detected by the "Dewpoint end" detecting logic, then the almost constant temperatures tabgmst or tkatmst are simulated by switching (B_atmtpa, B_atmtpk) the filters to this values.
The "Dewpoint end" set time must always be longer then the condensed water in the wall near the lambdasensor.

At low tatu tkabgm and tkatm are corrected with the curve ATMTANS.

2. "Dewpoint end"-detection

Temperature tabgmst and tkatmst at engine start.

At switch off delay (C_nachl = 1) the modelled temperatures tabgm and tkatm are stored.
At engine start the start-temperature tabgmst is calculated as a function of stored temperature tabgm and stop-time (tabst_w) as a charcteristic curve ATMABKA (cooling down factor) corrected with ambient temperature.
The calcualtion for tkatmst is similar to the calculation of tabgmst.

Integrated heat quantity iwmatm_w

The exceed dew-point time is nearly proportional to the integrated heat quantity after engine start.
Heat quantity is the integral of temperature (tatmsta) * ml * cp (nearly 1 kJ /(kg*k))

Exceed dew-point time for the lambdasensor upstream flag B_atmtpa and lambdasensor downstream flag B_atmtpk

The calculated start-temperature tabgmst should be the pipe-wall-temperature at engine start.
If the temperature tabgmst is lower than 60 °C then condensation water could be in the pipe. At the map KFWMABG the threshold values for the heat quantity can be set.
The higher the air massflow and the temperature tatmsta get after cranking, the shorter are the "dewpoint end" times.

Extention of the "dewpoint end" times

In case the condensation has not completely evaporated after the last start (due to short engine operation), and in the meantime the exhaust system has cooled off, then even more condensation must evaporate during the following engine run.
If the "dewpoint end" time for the catalyst temperature has not been reached (B_atmtpk) after the last engine start, then a counter is incremented. The higher the number of those starts the higher is the factor to increae the threshold value of the map KFWMABG-values.
If the integrator (iwmatm_w) reaches the thresholds, then the appropriate conditions B_atmtpa resp. B_atmtpk = 1 are set.

3. Temperature changes on ignition retard and fuel enrichment.

As the engine efficiency falls due to ignition retard the exhaust gas temperature increases. The temperature changes can be set at the map KFATMZW. (etazwimt is the mean value over 200ms of the etazwist-value)
With fuel enrichment the exhaust gas temperature falls. The temperature correction is set in the map KFATMLA.

APP ATM 33.10 Application hint

1. Installation locations of temperature measuring sensors for application purposes (listed in direction of exhaust flow)

- For sensor installation upstream of catalyst
  1. Exhaust gas temperature (center of pipe) for high temperatures at high load for sensor heating shut-off
  2. Pipe wall temperature for determining the "dewpoint end" times (protection from condensation)

- upstream of catalyst
  3. Exhaust gas temperature (center of pipe) for determining the light-off temperature of the catalyst

- in catalyst
  4. Ceramic temperature in catalyst (in the last third of catalyst or touching the end of monolith) for determining the airflow dependent time constants

- downstream of catalyst
  5. Pipe wall temperature at the Lambda sensor location for determining the "dewpoint end" time

The temperature measuring point 3 may not be necessary if the distance from sensor to catalyst is less than 30 cm. In this case, the temperature difference from sensor location to catalyst may be neglected.

2. Characteristic map KFTATM

   The steady state exhaust gas temperature upstream catalyst depends on nmot and rl. The values of the charcteristic map could be set at driving on a roller test bench.Better values have to be set at driving on road conditions.

3. Characteristic line ZATMAML, ZATMKML, ZATMRML, FATMRML

   The air massflow dependent time constants ZATMAML (temperature measuring points 1 and 3), as well as ZATMKML (temperature measuring point 4) can be determined by means of "load jumps", or more accurately of "airflow jumps". In this case, full load and especially fuel cutoff conditions are to be avoided at "airflow jumps".

   Example: For an airflow jump from 30 kg/h to 80 kg/h, the measured time constant is referred to 80 kg/h.

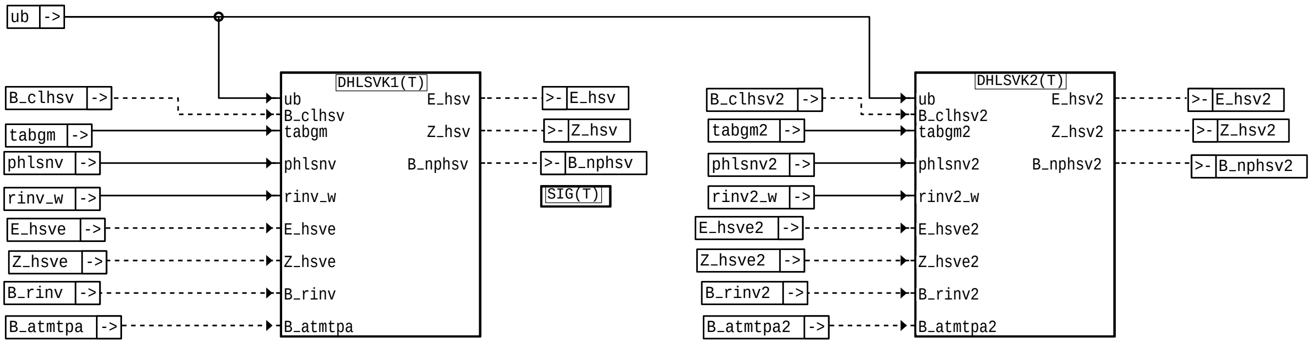
4. The "dewpoint end" times for exhaust gas temperatures (exhaust pipe center) and pipe wall are very different. For "dewpoint end" times, the pipe wall temperatures upstream of catalyst (measuring point 2) resp. downstream of catalyst (temperature measuring point 5) should be used. In case, these times are too long (concerning delayed readiness for operation of the Lambda control), then the temperature characteristics at the sensor location must be evaluated in more detail. In order to avoid sensor damaging due to condensation, the maximum sensor heating may only be applied, when the dewpoint temperature has been exceeded or the "dewpoint end" time has been detected, and therefore, condensation can no longer occur.

```
   Typical values:

   KFTATM  [grd C]   nmot [1/min]  800   1200  1800  2400  3000  4000   5000   6000
               rl[-]       15      380   400    420   450   480   520    550    580
               22      400   420    450   480   520   550    580    610
               30      420   450    480   520   550   580    610    650
               50      450   480    520   550   580   610    650    700
                   70      470   520    550   580   610   660    700    750
              100      490   550    580   610   650   700    750    790
                  120      510   560    610   650   700   750    790    840
                  140      530   580    650   700   750   790    840    900

   KFATMZW [grd C]     ML [kg/h]    20    40     80   150   250   400
            ETAZWIST[-]     1.0      0     0      0     0     0     0
                            0.95    15    40     50    60    70    75
                            0.90    15    60     80   100   125   140
                            0.80    20    80    120   150   180   200
                            0.70    25   100    150   190   210   220
                            0.60    30   115    175   210   230   245

   KFATMLA [grd C]     ML [kg/h]    20    40     80   150   250   400
             LAMSBG_W[-]   1.15      5    10     30    50    60    70
                           1.0       0     0      0     0     0     0
                           0.95     5     10     20    30    40    45
                           0.90     15    25     40    50    60    75
                           0.80     30    40     60    70    85   100
                           0.70     40    60     80    90    100  120

KFWMABG [kJ]      tabgmst [Grad C]      -40     0       15       25       50
              tmst [Grad C]  -40     200       160     150      140      100
                               0         180       150     120      110       80
                              15         160       140      60       55       30
                              25         140       120      30       30       15
                              60         120        30      15       10        5
   KFWMKAG   the values correspond to  KFWMABG * 5

   ZATMAML  ml   [kg/h], Zeitkonst. [sek]    10,  30  ;  20,  20  ;  40, 13  ;  80,   5  ; 180,  4   ; 400,  3  ;
   ZATMKML  ml   [kg/h], Zeitkonst. [sek]    10, 150  ;  20,  60  ;  40, 35  ;  80,  20  ; 180, 10   ; 400,  7  ;
   ZATMRML  ml   [kg/h], Zeitkonst. [sek]    10, 300  ;  20,  80  ;  40, 55  ;  80,  30  ; 180, 20   ; 400, 10  ;
   FATMRML  ml   [kg/h], Zeitkonst. [sek]    10, 0.5  ;  20,  0.6 ;  40, 0.7 ;  80,  0.8 ; 180, 0.95 ; 400,0.95 ;
   TATMTP   Temp [Grad C]                    50

   ATMABKA  tabst [s]  , Faktor              10, 0.95 ;  50,  0.7 ; 180, 0.5 ; 360, 0.3  ; 600, 0.15 ; 1000, 0  ;
   ATMABKK  tabst [s]  , Faktor              10, 0.90 ;  50,  0.6 ; 180, 0.4 ; 360, 0.25 ; 600, 0.15 ; 1000, 0  ;

   ATMTANS  TANS [°C], Temp [Grad C]        -40, 60   ; -10, 20   ;  20,  0  ;

   TATMSA   Temp [Grad C]                  100
   TATMKH   Temp [Grad C]                  200
   TATMKW   Temp [Grad C]                  100
   TATMTMOT Temp [Grad C]                   90

   TUMTAIT  Temp [Grad C]                   20
   TASTBFA  Temp [Grad C]                   40
   TKSTBFA  Temp [Grad C]                   40

   TATMWMK  Temp [Grad C]                 - 80
   WMABGKH  Faktor                         0.3
   FWMABGW  Faktor             0.25
   FWMKATW  Faktor                 0.25

   DTUMTAT  temperature [°C]                20
   VTUMTAT  velocity  [km/h]                40
   NTUMTAT  engine speed [1/min]          1800
   IMTUMTAT air mass [kg]                    1

   TNLATMTM temp [deg. C]                   80
   TNLATMTU temp [deg C]            5
   TNLATM   time [s]                       660
```

DHLSVK 3.20 Diagnosis sensor heating upstream catalyst

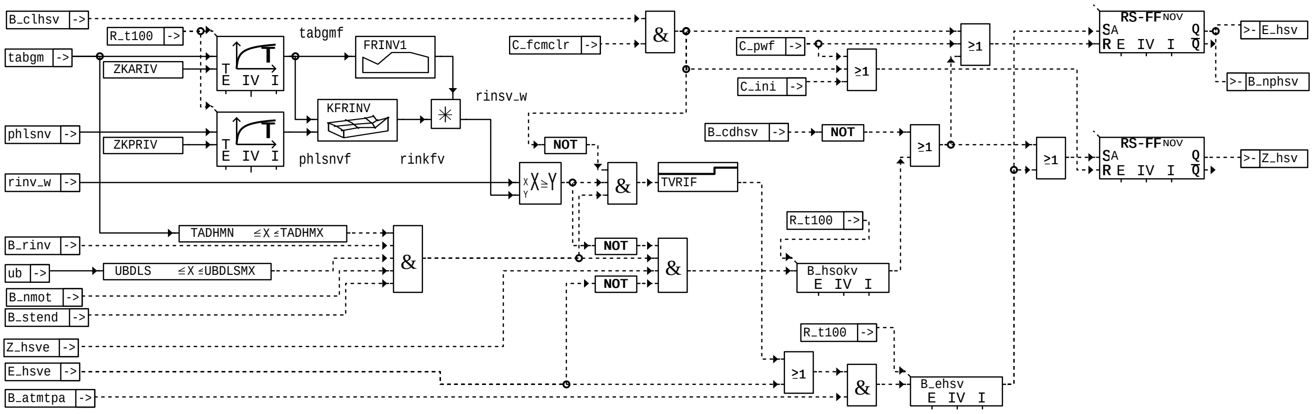
FDEF DHLSVK 3.20 Function definition

`Overview heater diagnosis`



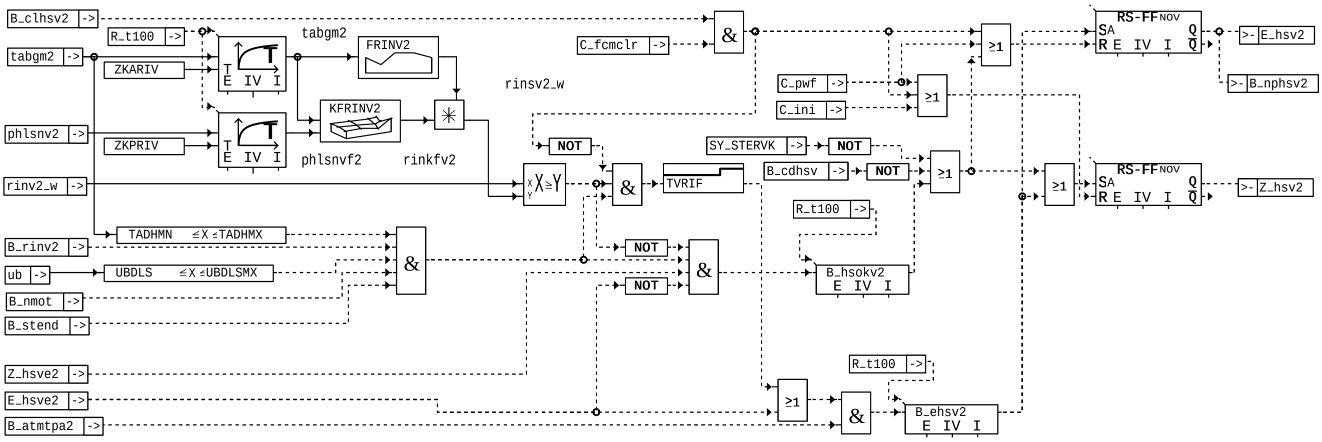
dhlsvk-dhlsvk

`Heater diagnosis bank1 uptream catalyst`



dhlsvk-dhlsvk1

`Heater diagnosis bank2 upstream catalyst`



dhlsvk-dhlsvk2

```
Status fault path:      sfphsv
Error flag:             E_hsv
Cycle flag:             Z_hsv
Fault type:             TYP_hsv:
                        (B_mxhsv, B_mnhsv, B_sihsv, B_nphsv)
Clear fault path:       B_clhsv
```

```
Default value active:    B_bkhsv  (optional)
Fault path code:         CDTHSV
Fault class:             CLAHSV
Fault intensity:         TSFHSV
 CARB CODE:              CDCHSV
Table of ambient cond.:  FFTHSV
```

ABK DHLSVK 3.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCHSV	BLOKNR		KL	code word CARB: lambda sensor heating upstream cat
CDCHSV2	BLOKNR		KL	code word CARB: lambda sensor heating upstream cat; (bank2)
CDTHSV			FW	code word tester: oxygen sensor heater upstream catalyst
CDTHSV2			FW	code word tester: oxygen sensor heater upstream catalyst, cyl. row 2
CLAHSV			FW	fault class: heating of O2 sensor upstream cat
CLAHSV2			FW	fault class: heating of O2 sensor upstream cat bank 2
FFTHSV	BLOKNR		KL	Table of ambient condition for heating O2-sensor pre cat
FFTHSV2	BLOKNR		KL	Table of ambient condition for heating O2-sensor post cat bank 2
FRINV1	TABGMF		KL	Multiplicativ factor for RIN desired value pre cat
FRINV2	TABGMF2		KL	Multiplicativ factor for RIN desired value pre cat
KFRINV	TABGMF	PHLSNVF	KF	MAP for Nernst resistor pre cat
KFRINV2	TABGMF2	PHLSNVF2	KF	MAP for Nernst resistor post cat , bank 2
TADHMN			FW	lower Temperature threshold for die heater diagnostic routine
TADHMX			FW	upper Temperature threshold for die heater diagnostic routine
TSFHSV			FW	fault active time: lambda sensor heating catalyst upstream
TSFHSV2			FW	fault active time: lambda sensor heating catalyst upstream, bank 2
TVRIF			FW	Delay time for Ri fault
UBDLS			FW	battery voltage threshold for release the sensor diagnosis
UBDLSMX			FW	upper battery voltage threshold for the sensor diagnosis
ZKARIV			FW	Filter time constant for modeling of dynamic of ceramic temp. from ATM pre cat
ZKPRIV			FW	Filter for modeling of dynamic of ceramic temp. from electric circuit pre cat

Variable	Source	Type	Description
A	DHLSVK	LOK	vector ECU-states
BLOKNR		EIN	DAMOS source for block number
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_CDHSV	PROKON	EIN	function active per codeword CDHSV
B_CLHSV		EIN	condition clear failure path DHLSVK
B_CLHSV2		EIN	condition clear failure path DHLSVK2
B_EHSV	DHLSVK	LOK	Condition error HSV
B_EHSV2	DHLSVK	LOK	Condition error HSV2
B_HSOKV	DHLSVK	LOK	Condition Lambda sensor heating OK pre cat
B_HSOKV2	DHLSVK	LOK	Condition Lambda sensor heating 2 OK pre cat
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NPHSV	DHLSVK	AUS	Nernst resistance sensor upstream of the catalyzer too large
B_NPHSV2	DHLSVK	AUS	Nernst resistance sensor 2 upstream of the catalyzer too large
B_RINV	GGLSV	EIN	Condition: Internal resistance Ri of O2 sensor activ,pre cat
B_RINV2	GGLSV	EIN	Condition: Internal resistance Ri of O2 sensor activ,pre cat bank 2
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_HSV	DHLSVK	AUS	error flag: lambda sensor heating upstream cat
E_HSV2	DHLSVK	AUS	error flag: lambda sensor heating upstream cat on the right
E_HSVE	DHLSVKE	EIN	error flag: lambda sensor heating upstream cat (Endstufe)
E_HSVE2	DHLSVKE	EIN	error flag: lambda sensor heating upstream cat on the right (Endstufe)
PHLSNHF	DHLSVK	DOK	Standardized heating power of Lambda sensor downstream of catalyzer, filtered
PHLSNV	HLS	EIN	normalized heating power of lambda sensor upstream of catalyst
PHLSNV2	HLS	EIN	normalized heating power of lambda sensor 2 upstream of catalyst
PHLSNVF2	DHLSVK	DOK	Norm heating power of lambda sensor 2 pre cat, filtered
RINKFV	DHLSVK	DOK	Internal resistance of lambda sensor from map pre cat
RINKFV2	DHLSVK	DOK	Internal resistance of lambda sensor 2 from map pre cat
RINSV2_W	DHLSVK	DOK	Limit value of internal resistor of Nernst cell of lambda sen post cat bank 2
RINSV_W	DHLSVK	DOK	Limit value of internal resistor of Nernst cell of lambda sen. post cat
RINV2_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (word)
R_T100		EIN	Time schedule 100 ms
SFPHSV	DHLSVK	AUS	Fault-path status: Lambda-sensor heating upstream of catalytic converter
SFPHSV2	DHLSVK	AUS	Fault-path status: Lambda-sensor 2 heating upstream of catalytic converter
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TABGMF	DHLSVK	DOK	Exhaust gas temperature upsteam cat from exhaust temperature -filtered-
UB	SWADAP	EIN	battery voltage
Z_HSV	DHLSVK	AUS	cycle flag of lambda sensor heating upstream cat
Z_HSV2	DHLSVK	AUS	cycle flag of lambda sensor heating upstream cat, cylinder row 2
Z_HSVE	DHLSVKE	EIN	cycle flag of lambda sensor heating upstream cat (Endstufe)
Z_HSVE2	DHLSVKE	EIN	cycle flag of lambda sensor heating upstream cat, cylinder row 2 (Endstufe)

Parameter	Value	Description
CDTHSV		code word tester: oxygen sensor heater upstream catalyst
CDTHSV2		code word tester: oxygen sensor heater upstream catalyst, cyl. row 2
CLAHSV		fault class: heating of O2 sensor upstream cat
CLAHSV2		fault class: heating of O2 sensor upstream cat bank 2
TADHMN		lower Temperature threshold for die heater diagnostic routine
TADHMX		upper Temperature threshold for die heater diagnostic routine
TSFHSV		fault active time: lambda sensor heating catalyst upstream
TSFHSV2		fault active time: lambda sensor heating catalyst upstream, bank 2
TVRIF		Delay time for Ri fault

Parameter	Value	Description
UBDLS		battery voltage threshold for release the sensor diagnosis
UBDLSMX		upper battery voltage threshold for the sensor diagnosis
ZKARIV		Filter time constant for modeling of dynamic of ceramic temp. from ATM pre cat
ZKPRIV		Filter for modeling of dynamic of ceramic temp. from electric circuit pre cat

FB DHLSVK 3.20 Detailed description of function

```
With this DHLSVK an indirect check is performed on whether the heating of the Lambda sensor is operational, i.e. the measurement
of the heater current by means of a shunt performed so far is abandoned.
As criterion for the diagnosis the internal resistance of the Nernst cell of the Lambda sensor is used. With defective sensor
heating the internal resistance (rinv_w) is essentially larger. For the determination of rinv_w the sensor voltage must be
periodically connected to load with 0,5mA for 10ms (%GGLSV).
In addition the switching behaviour of the heater power stage is monitored in the CJ920.

Diagnosis internal resistance of the Nernst cell
------------------------------------------------
Since the internal resistance rinv_w is also dependent on the exhaust gas temperature and on the el. heating performance (phlsnv),
the typical value of rinv_w is stored in a map from tabgm and phlsnv.
tabgm and phlsnv are filtered, since a change only affects rinv_w after a delay.

Preconditions:
1. rinv_w is updated (B_rinv = 1)
2. The exhaust gas temperature is greater than the threshold TADHMN and lower than TADHMX
3. UB is within the diagnosis range

Diagnosis:
If rinv_w is less than rinsv_w, then B_hsokv is set (Ri OK!) if additionally the switching behaviour of the power stage is OK.
If rinv_w is greater, then B_nphsv is set (Ri is of too high-resistance).

Diagnosis switching behaviour of the heater power stage
-------------------------------------------------------
For diagnosis purposes the power stage is switched off every 10s for 100ms (in %HLS resp. %HLSHK).
The diagnosis of the power stage %DECJ detects via a serial interface to the CJ920 an abnormal behaviour of the power stage and
gives the faults B_mxhsve, B_mnhsve and B_sihsve.
The fault E_hsve also sets the fault E_hsv.

Fault management
----------------
The debouncing of the heater faults is performed during two drives. If a heater fault is detected the fault lamp is only triggered
if a fault is again detected during the second drive.
```

APP DHLSVK 3.20 Application hint

```
Fault memory relevant values of the %DHLSVK are assigned to the %DFPM_hsv in the function-orientated selection.

To be adjusted:
TADHMN  = 200°C            UHSN = 13.0V (%HLSHK)         Filter values        LSH25P  LSH25PL LSF4.7
UBDLS   = 10.7V            TADHMX = 600°C                         ZKARIH  =     20s     46s     21s
UBDLSMX = 15.5V                                                   ZKPRIH  =     35s     35s     10s


TVRIF = 6s
-----
The debouncing time for B_nphsv is set to the triple value of TRIIMPH (in %GGLSV), i.e. the fault is only registered after three
Ri measurements.

KFRINV_W
--------
The map values are determined by a measuring sensor with typical Nernst and heater internal resistance (from K3-LS/ESV).
The measuring sensor must be of the same type as the intended control sensor.
Adjust exhaust gas temperature to a base point value by an according selection of load and engine speed. It is possible to adjust
phlsnv (performance) to a base point value by changing THSVKTA (in %HLS resp. %HLSHK). Enter the value of rinv_w into the map
after approx. 60s.
```

```
        |               LSF4.7                  |                |               LSH25PL                 |
 phlsnv |  E X.  G A S T E M P E R A T U R E    |         phlsnv |  E X .  G A S  T E M P E R A T U R E  |
P       |  200  |  300  |  400  |  500  |  600  |        P       |  200  |  300  |  400  |  500  |  600  |
E-------+-------+-------+-------+-------+-------+        E ------+-------+-------+-------+-------+-------+
R   1.0 |  288  |  256  |  224  |  192  |  160  |        R   1.0 |       |       |       |       |       |
F-------+-------+-------+-------+-------+-------+        F ------+-------+-------+-------+-------+-------+
O   0.8 |  448  |  384  |  352  |  320  |  224  |        O   0.8 |       |       |       |       |       |
R-------+-------+-------+-------+-------+-------+        R ------+-------+-------+-------+-------+-------+
M  0.7 |  6704  |  608  |  544  |  384  |  320 |         M   0.7 |       |       |       |       |       |
 ------+-------+-------+-------+-------+-------+           ------+-------+-------+-------+-------+-------+
```

```
FRINV1/2   tkatmf/FRINV  200/63   300/63   400/30  500/10  600/5
--------
```

The larger the factor FRINV is adjusted the more "inaccurate" the diagnosis of the internal resistance of the Nernst cell becomes.
The map KFRINH and the %HLS resp. the %HLSHK must already have been adjusted.
The faults E_hsv and B_nphsv should be entered, if the sensor heating operates with little heating performance only. This can be achieved by connecting a resistor in series to the heater and if FRINV is changed accordingly.
Necessary resistor: LSF4.7 approx. 20 Ohm, LSH25 approx. 5 Ohm.
Approach:
Connecting the resistor in series to the heater, then do the same as description for KFRINV (only for phlsnv = 1).
FRINV = rinv_w with series-resistor / rinv_w without series_resistor.

DSWEC 6.20 Bumpy road detection from wheel acceleration, -> via CAN from ABS CU

FDEF DSWEC 6.20 Function definition

Rough road detection by means of the wheel acceleration derived from the ABS sensor signal.
Hint: The %DSWEC is given the input signal bsc(n) from the customer-specific function %BGRBS !

```
B_wk ---------------------------------------------------------------------------------------------------------+
                                             exp. upw. control          lin. downw. control                   |
                                          |bsc(t)| > bssp(t-1)      |bsc(t)| < bssp(t-1)                      |
                                        +----------------------------------------------+                      |
                                        | ^ bssp(t)    *  **  |                        |              fswares V
wheel acceleration  bsc(n)              | |       *           |      *                 |  bssp(n)  +------------+  B_swev
from %BGRBS         ------------------->| |   *               |            *           +---------->| >FSWALUV,1 +------+
                                        | | *   FIBSALU       | FABSALU          *     |           +------------+      |
                                        | +----------------------------------------> t |             ^                 |
                                        +----------------------------------------------+             |                 |
vfzg ------------------------------------------------------------------------------------------------+                 |
                                                                            +------------------------------------------+
                                                                            |
                                                                            |          +----+
+------------------------+                                                  +--------->| &  +------> B_swe_c
| E_swe set in the status +----------------------------------------------------------->o|    |
| array of the %DFPM      |                                                             +----+
+------------------------+
```

Hint : The rough road function %DSWEC can be deactivated by means of the Euro-switch (B_cdswe = 0).
In this case B_swe_c = 0 applies.

ABK DSWEC 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FABSALU			FW	decrease factor for acceleration signal at bad road conditions
FIBSALU			FW	filter factor acceleration signal at bad road conditions
FSWALUV	VFZG		KL	rough road detection threshold = f (vehicle speed)
FSWALUV1	VFZG		KL	rough road detection threshold = f (vehicle speed)

Variable	Source	Type	Description
BSC		EIN	Wheel acceleration calculated from ABS sensor signal
BSSP	DSWEC	LOK	storage value signal acceleration sensor
B_CDSWE	PROKON	EIN	function active per codeword CDSWE
B_SWEV	DSWEC	LOK	Condition rough road supposed
B_SWE_C	DSWEC	AUS	Condition rough road detected from %DSWEC
B_WK		EIN	condition: converter lockup clutch closed
E_SWE		EIN	error flag: acceleration sensor for rough surface detection
FSWARES	DSWEC	LOK	
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW DSWEC 6.20 Fixed Values

Parameter	Value	Description
FABSALU		decrease factor for acceleration signal at bad road conditions
FIBSALU		filter factor acceleration signal at bad road conditions

FB DSWEC 6.20 Detailed description of function

1. General function description

1.1 Task of the function

The task of the %DSWEC is to detect that a rough road is being driven across by means of the transmitted wheel acceleration bsc. As soon as a rough road is detected the bit b_swe_c is set upon which, e.g. the rough road detection is temporarily deactivated (also see %DMDSTP). The deactivation is necessary since drive shaft vibrations due to a rough road can lead to a misdetection of misfire.

1.2 Reference source of the wheel acceleration signal bsc(n)

The wheel acceleration signal bsc(n) needed for the evaluation is made available by a customer-specific function %BGRBS. In principle 3 different versions of the %BGRBS can be distinguished:

(a) In the standard version the %BGRBS receives that wheel acceleration (maximum selection), which is send by the ABS ECU via the CAN-bus.

(b) In case the ABS ECU transmits the no. of wheel rotations instead of the wheel acceleration via the CAN-bus, a conversion of the no. of wheel rotations into wheel acceleration is performed in the %BGRBS.

(c) Special solution for vehicles without CAN-bus on which, however, an ABS-sensor is mounted, but no segment times are formed in the motronic. In this case the %BGRBS calculates the wheel acceleration from the wheel speed.

Hint : On vehicles without CAN-bus (resp. also without ABS ECU) but with mounted ABS-sensor the segment times should preferably be formed from the ABS sensor signal and for the rough road detection the %DSWER should be used.

1.3 Signal requirement for bsc(n)

The wheel acceleration signal bsc(n) must have been derived from the ABS wheel sensor signal. The accuracy should be at least 1 [m/sˆ2] and it should preferably be present in the 10ms time grid.

2. Concrete description of the signal path

2.1 Filtering of the the acceleration signal

From the acceleration signal bsc(n) the memory value bssp(n) is formed by non-linear filtering as follows:

$$bssp(n) = bssp(n-1) + FIBSALU \ast [\,bsc(n) - bssp(n-1)] \qquad \text{for } bsc(n) > bssp(n-1) \qquad (1)$$

$$bssp(n) = bssp(n-1) - FABSALU \ast (\text{time interval}) \qquad \text{for } bsc(n) < bssp(n-1) \qquad (2)$$

(time interval = 100 ms)

The filter calculation for the upward control (1) is performed in the same time grid in which the signal bsc(n) is available [usually in the 10ms or in the 20ms grid]. The filter calculation for the downward control (2) is on contrast performed only in the 100ms time grid.
[For the selection of the filter coefficients also see application hints.]

2.3 Rough road decision

The filter output value bssp(n) is compared to the threshold FSWALUV,1. FSWALUV,1 is a speed-dependent characteristic line with 4 base points. (with interpolation, result is fswares).
For B_wk=0 FSWALU is accessed, for B_wk=1 FSWAKLUV1 is accessed.
As long as the value bssp(n) lies above FSWALUV,1 the bit B_swev is set.

As long as no error is detected (E_swe = 0; is formed in %BGRBS), the output signal b_swe_c corresponds to the bit B_swev. However, as soon as the result of the rough road calculation is no longer meaningful, due to an error (E_swe = 1;e.g. defect ABS wheel sensor) the rough road bit b_swe_c is set to zero. Thus it is avoided that, e.g. in case of a sensor fault, the misfire detection is permanently deactivated via b_swe_c. [The decision on whether in this case the misfire detection should be deactivated or not must take place in the %DMDSTP].

2.4 Deactivation of the function via the Euro-switch B_cdswe

The function %DSWEC is deactivated if the Euro-switch has the value B_cdswe = 0. In this case always b_swe_c = 0.

APP DSWEC 6.20 Application hint

Reference source bsc(n)

For the use of the %DSWEC a customer-specific function %BGRBS is necessary, which supplies the necessary input signal bsc(n).
[For this also see point 1.2 of the function description !]

Selecting the filter coefficients

The filter coefficient FIBSALU for the upward control of the value bssp(t) must be chosen so great that a sufficiently quick rough road detection is possible. In case the acceleration signal is directly available from the ABS ECU via CAN-bus, a filtering may possibly not be necessary for upward control. In this case FIBSALU can be set to one.

Calculation of the acceleration

Measured values e.g. DIM:
Mode of acquisition: time-synchronous
ECU-grid: 10ms
Scanning time: 10ms

Analog window1 (length: 30sec or longer): bsc, bssp
Digital window (length: as analog window1): b_swe_c
Digits: vfzg

DMLSE 9.30 Diagnosis; power stage check of electric cooling fan

FDEF DMLSE 9.30 Function definition

```
Diagnosis CJ400, resp. CJ 920  see %DECJ

+-----------+------------+
| CJ400     |  B_mxluea  +-----------------------------+
| bzw.      |            |                             |
| CJ920     |  B_siluea  +---------------------------+ |
|           |            |                           | |
| Endstufe  |            |                           | |
|           |  B_mnluea  +-------------------------+ | |
|   Motor-  |            |                         | | |
|  Lüfter   |            |                         | | |   +-+
|           |            |                         | | +-->| |       (#)                             +-+---+
|           |            |                         | +---->|v+------+--------------------+---------->|S|   +-------> E_luea (*)
|           |            |                         +------>| |      |                    |    +-+    +-+---+
|           |            |                                 +-+      |               +-+  +-->o|v+--->|R|   |
|           |  B_desee   +---+                                      |    C_pwf ---->|v+------>| |    +-+---+
+-----------+------------+   |                                      |            +->| |  (*)  +-+
                 +-----------+                                      |            |  +-+
                 |   +-+                                            |    +-+     |
                 +-->|&|      +-+---+       +-+    +------------+   +--->| |     |
B_lf1s -------+--|-->| +----->|S|   +------>| |    | 500 ms +-  |        |v|     |                   +-+---+
              |  |   +-+      +-+---+       |&+--->| -------+-> +------->| +-----|------------------>|S|   +-------> Z_luea (*)
              |  |         +->|R|   |   +-->| |    +------------+        +-+     |                   +-+---+
              |  |         |  +-+---+   |   +-+                                  |            +----->|R|   |
              |  |   +-+   |            |                                +-+     |            |      +-+---+
              |  +-->|&|   |  +-+---+   |             B_clluea --------->|&|     |     +-+    |
              +---->o| +---|->|S|   +---+             C_fcmclr --------->| +-----+---->| |    |
                     +-+   |  +-+---+                                    +-+           |v+----+ (*)
        C_ini -------------+->|R|   |                 C_ini -------------------------->| |    |
                           |  +-+---+                                                  +-+    |
                           +------------------------------------------------------------------+
```

```
(*)  deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#)  deviant from the description this path is served in the module %DECJ;
```

Diagnosis CJ400, resp. CJ 920 see %DECJ

```
+-----------+------------+
| CJ400     |  B_mxlueb  +-----------------------------+
| bzw.      |            |                             |
| CJ920     |  B_silueb  +---------------------------+ |
|           |            |                           | |
| Endstufe  |            |                           | |
|           |  B_mnlueb  +-------------------------+ | |
|   Motor-  |            |                         | | |
|  Lüfter   |            |                         | | |   +-+
|           |            |                         | | +-->| |       (#)                             +-+---+
|           |            |                         | +---->|v+------+--------------------+---------->|S|   +-------> E_lueb (*)
|           |            |                         +------>| |      |                    |    +-+    +-+---+
|           |            |                                 +-+      |               +-+  +-->o|v+--->|R|   |
|           |  B_desee   +---+                                      |    C_pwf ---->|v+------>| |    +-+---+
+-----------+------------+   |                                      |            +->| |  (*)  +-+
                 +-----------+                                      |            |  +-+
                 |   +-+                                            |    +-+     |
                 +-->|&|      +-+---+       +-+    +------------+   +--->| |     |
B_lf2s -------+--|-->| +----->|S|   +------>| |    | 500 ms +-  |        |v|     |                   +-+---+
              |  |   +-+      +-+---+       |&+--->| -------+-> +------->| +-----|------------------>|S|   +-------> Z_lueb (*)
              |  |        +->|R|   |   +-->| |    +------------+        +-+     |                   +-+---+
              |  |        |  +-+---+   |   +-+                                  |            +----->|R|   |
              |  |   +-+   |            |                                +-+     |            |      +-+---+
              |  +-->|&|   |  +-+---+   |             B_cllueb --------->|&|     |     +-+    |
              +---->o| +---|->|S|   +---+             C_fcmclr --------->| +-----+---->| |    |
                     +-+   |  +-+---+                                    +-+           |v+----+ (*)
        C_ini -------------+->|R|   |                 C_ini -------------------------->| |    |
                           |  +-+---+                                                  +-+    |
                           +------------------------------------------------------------------+
```

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

```
 rror memory management:
 -----------------------

Status error path luea, lueb:   SFPLUEA, SFPLUEB
Error flag :                    E_luea, E_lueb
Cycle flag :                    Z_luea, Z_lueb
Error type :                    B_mnluea, B_mnluea
                                B_mxluea, B_mxluea
                                B_siluea, B_siluea
Delete error path:              C_fcmclr & B_clluea / C_fcmclr & B_cllueb
Error path :                    CDTLUEA, CDTLUEB
Error class :                   CLALUEA, CLALUEB
Error intensity :               TSFLUEA, TSFLUEB
Carb code :                     CDCLUEA, CDCLUEB
Environmental conditions :      FFTLUEA, FFTLUEB
```

ABK DMLSE 9.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCLUEA	BLOKNR		KL	code word CARB: Power stage engine fan A
CDCLUEB	BLOKNR		KL	Code word CARB: Power stage engine fan B
CDTLUEA			FW	code word tester: Power stage engine fan A [253]
CDTLUEB			FW	code word tester: Power stage engine fan B [252]
FLCLUEA			FW	fault set debouncing: Power stage engine fan A
FLCLUEB			FW	Fault set debouncing: Power stage engine fan B
HLCLUEA			FW	fault reset debouncing: Power stage engine fan A
HLCLUEB			FW	fault reset debouncing: Power stage engine fan B
TSFLUEA			FW	fault active time: power stage engine fan A
TSFLUEB			FW	fault active time: power stage engine fan B

Variable	Source	Type	Description
B_CLMLE		EIN	condition: clear fault path cooling fan power stage
B_DESEE	DMLSE	LOK	Diagnosis power stage: entry conditions fulfilled
B_LF1S	LFS	EIN	fan 1 on condition
B_LF2S	LFS	EIN	fan 2 on condition
C_INI	SWADAP	EIN	ECU-condition for intialisation
E_LUEA	DMLSE	AUS	error flag: electric fan output stage A
E_LUEB	DMLSE	AUS	error flag: electric fan output stage B

Variable	Source	Type	Description
Z_LUEA	DMLSE	AUS	cycle flag: electric fan output stage A
Z_LUEB	DMLSE	AUS	cycle flag: electric fan output stage B

FW DMLSE 9.30 Fixed Values

Parameter	Value	Description
CDTLUEA		code word tester: Power stage engine fan A [253]
CDTLUEB		code word tester: Power stage engine fan B [252]
FLCLUEA		fault set debouncing: Power stage engine fan A
FLCLUEB		Fault set debouncing: Power stage engine fan B
HLCLUEA		fault reset debouncing: Power stage engine fan A
HLCLUEB		fault reset debouncing: Power stage engine fan B
TSFLUEA		fault active time: power stage engine fan A
TSFLUEB		fault active time: power stage engine fan B

FB DMLSE 9.30 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the secondary air valve power stage diagnosis forms a function unit.
The diagnosis describes the forming of the error bit E_luea/b and of the cycle bit Z_luea/b.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitete check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

APP DMLSE 9.30 Application hint

DMILE 8.20 OBDII; MIL-power stage

FDEF DMILE 8.20 Function definition

Diagnose CJ 400, or   CJ 920 see %DECJ

```
+----------+----------+
|  CJ400   | B_mxmile +-------------------------------+
|  or      |          |                               |
|  CJ920   | B_simile +--------------------------+    |
|          |          |                          |    |
|  MIL-    |          |                          |    |
|  power   |          |                          |    |
|  stage   | B_mnmile +---------------------+    |    |
|          |          |                     |    |    |
|          |          |                     |    |    |    +-+
|          |          |                     |    |    +--->| |        (#)                             +---+-----+
|          | B_desee  +-------+             |    +-------->|V+--------+--------------------+--------->| S |     |
+----------+----------+       |             +------------->| |        |                    |    +-+   +---+     +----> E_mile(*)
                              |                            +-+        |               +-+  +-->o|V+-->| R |     |
                 +------------+                                       |  C_pwf ------>|V+------>| |   +---+-----+
                 |   +-+                                              |           +-->| |  (*)  +-+
                 +-->| |     +---+----+                               | (#) +-+   |   +-+
B_mil ------+----|-->|&+---->| S |    |       +-+    +-------------+  +---->| |   |
            |    |   +-+     +---+    +------>| |    | 500 ms +--- |        |V|   |                   +---+-----+
            |    |        +->| R |    |   +-->|&+--->| -------+->t +------->| +---|------------------>| S |     |
            |    |        |  +---+----+   |   +-+    +-------------+        +-+   |                   +---+     +----> Z_mile(*)
            |    |   +-+  |               |                                  +-+  |             +---->| R |     |
            |    +-->| |  |  +---+----+   |              B_clmile ---------->|&|  |      +-+    |     +---+-----+
            +------>o|&+--|->| S |    |   |              C_fcmclr ---------->| +--+----->| |    |
                     +-+  |  +---+    +---+                                  +-+         |V+----+ (*)
                          +->| R |    |                    C_ini ----------------------->| |    |
                          |  +---+----+                                                  +-+    |
                          |                                                                     |
                          +---------------------------------------------------------------------+
```

(*) in difference to this description this part is handled within module %DFPM.
(#) in difference to this description this part is handled within module %DECJ.

```
Fault path managment:
---------------------

Status of fault path mile: sfpmile
Errorflag MILE:         E_mile
Cycleflag MILE:         Z_mile
Fault types MILE:       B_mxmile; B_mnmile; B_simile

Delete fault path:             C_fcmclr & B_clmile
Tester code fault path MILE:   CDTMILE
Class of fault path MILE:      CLAMILE
Fault active time MILE:        TSFMILE
CARB-code MILE:                CDCMILE
Ambient conditions MILE:       FFTMILE
```

ABK DMILE 8.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCMILE	BLOKNR		KL	Code word CARB: MIL power stage
CDTMILE			FW	code word tester: MIL power stage
CLAMILE			FW	error class: MIL power stage
FFTMILE	BLOKNR		KL	freeze frame table: MIL power stage
TSFMILE			FW	fault active time: MIL power stage

Variable	Source	Type	Description
B_CLMILE	DMILE	LOK	condition clear fault path MIL power stage
B_DESEE	DKOSE	EIN	Diagnosis power stage: entry conditions fulfilled
B_MIL		EIN	MIL turn-on
B_MNMILE	DMILE	AUS	Error type: short circuit to ground at MIL power stage
B_MXMILE	DMILE	AUS	Error type: short circuit to B+ at MIL power stage
B_SIMILE	DMILE	AUS	Error type: interruption at MIL power stage
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_MILE	DMILE	AUS	Error flag: MIL power stage
SFPMILE	DMILE	AUS	status fault path: MIL power stage
Z_MILE	DMILE	AUS	Cycle flag: MIL power stage

FW DMILE 8.20 Fixed Values

Parameter	Value	Description
CDTMILE		code word tester: MIL power stage
CLAMILE		error class: MIL power stage
TSFMILE		fault active time: MIL power stage

FB DMILE 8.20 Detailed description of function

```
Precondition for this diagnostic of the MIL powerstage is the use of powerstage type CJ401.
Recognition of non plausible function of the powerstage and its fault type is descriped in %DECJ.

Activation of the cycle flag:
Whenever both states on/off of the powerstage are reached without fault, the cycle flag is set.
If with one of the states on/off a fault occurs, %DECJ starts a verification in addition to the regular use of the powerstage.
Duration of this verification is less than 500ms. If the fault is detected with this verification, the cycle flag is set.
```

APP DMILE 8.20 Application hint

```
Default value for CDTMILE = 165 dez.
```

DMS 6.10 Diagnosis; permanent data aquisition (serial)

FDEF DMS 6.10 Function definition

```
                           +------------------+                 +---+--------+
                           |     +----------  +---------------->| S |        |
B_atmtpk ----------------->|     | TVDRREC    |                 +---+        +-------+-----> B_drrec
                           | ----+            |            +--->| R |        |       |
                           +------------------+            |    +---+--------+       |
                                            +---+          |                         |
B_init------------------------------------->| V +----------+                         |
                                        +-->|   |                                    |
                 +------------------+   |   +---+                                    |
                 |     +----------  |   |                                            |
            +--->|     | 1000 ms    +---+                                            |
            |    | ----+            |                                                |
            |    +------------------+                                                |
            +------------------------------------------------------------------------+
```

ABK DMS 6.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TVDRREC			FW	Delay time for trigger driverecorder

FW DMS 6.10 Fixed Values

Parameter	Value	Description
TVDRREC		Delay time for trigger driverecorder

FB DMS 6.10 Detailed description of function

Zur Auslösung der Aufzeichnung des Drive-Recorder-Dauermessmodus wird das Bit B_drrec erzeugt.
Gemäß der Spezifikation des Drive-Recorders soll das Triggerbit < 10 s anstehen.

Um bei den Dauerlaufmessungen zu kurze Fahrzyklen auszuschließen (z.B. um auch die Werte der Widerstandsmessung der Hinterkat-Sonde korrekt zu erfassen) wird das Triggerbit B_drrec ans die Taupunkterkennung nach Kat mit zusätzlicher Verzögerungszeit gekoppelt.

Ferner werden für das Dauerlaufmesssystem verschiedene Bits auf Byte bzw. Wortgrößen zusammengefasst, um die Datenübertragung zu vereinfachen.

Byte-Größen: (zur einfacheren grafischen Darstellung bei Auswertung der Messungen)
Zur einfacheren Auswertung der Bytes sind nicht verwendete Bits mit 1 auf gefüllt. (Alles ok = FF)

Projekte Fire, B-Motor - Eco:

B0.0 = Z_kat1
B0.1 = Z_hsh
B0.2 = Z_lash1
B0.3 = Z_lsh1
B0.4 = Z_hsv
B0.5 = Z_latv1
B0.6 = Z_latp1
B0.7 = Z_lsv1

B1.0 = Z_tfm
B1.1 = Z_fra1
B1.2 = Z_swe
B1.3 = Z_md04
B1.4 = Z_md03
B1.5 = Z_md02
B1.6 = Z_md01
B1.7 = z_md

W150.0 = 0
W150.1 = 0
W150.2 = B_tehb
W150.3 = B_te
W150.4 = B_lrhk
W150.5 = B_lr
W150.6 = B_sa
W150.7 = B_ll
W150.8 = 0
W150.9 = 0
W150.10 = 0
W150.11 = 0
W150.12 = B_dkatlp
W150.13 = B_dkatsp
W150.14 = B_dkatsp
W150.15 = B_dkatst

W151.0 = B_tesl15h
W151.1 = B_mldyn
W151.2 = B_dlatp
W151.3 = B_gaefra
W151.4 = B_gae
W151.5 = B_fra
W151.6 = B_tra
W151.7 = B_lra
W151.8 = 0
W151.9 = 0
W151.10 = 0
W151.11 = 0
W151.12 = 0
W151.13 = 0
W151.14 = 0
W151.15 = 0

Projekte C-Motor

B0.0 = Z_kat1
B0.1 = Z_hsh
B0.2 = Z_lash1
B0.3 = Z_lsh1
B0.4 = Z_hsv
B0.5 = Z_latv1
B0.6 = Z_latp1
B0.7 = Z_lsv1

B1.0 = Z_ev1
B1.1 = Z_swe
B1.2 = Z_md05
B1.3 = Z_md04
B1.4 = Z_md03
B1.5 = Z_md02
B1.6 = Z_md01
B1.7 = z_md

B2.0 = 1
B2.1 = 1
B2.2 = 1
B2.3 = 1
B2.4 = Z_sue
B2.5 = Z_nwse
B2.6 = Z_tfm
B2.7 = Z_fra1

W150.0 = 0
W150.1 = 0
W150.2 = B_tehb
W150.3 = B_te
W150.4 = B_lrhk
W150.5 = B_lr
W150.6 = B_sa
W150.7 = B_ll
W150.8 = 0
W150.9 = 0
W150.10 = 0
W150.11 = 0
W150.12 = B_dkatlp
W150.13 = B_dkatsp
W150.14 = B_dkatsp
W150.15 = B_dkatst

W151.0 = B_tesl15h
W151.1 = B_mldyn
W151.2 = B_dlatp
W151.3 = B_gaefra
W151.4 = B_gae
W151.5 = B_fra
W151.6 = B_tra
W151.7 = B_lra
W151.8 = 0
W151.9 = 0
W151.10 = 0
W151.11 = 0
W151.12 = 0
W151.13 = 0
W151.14 = 0
W151.15 = 0

Projekte B-Motor y

B0.0 = Z_hsv2
B0.1 = Z_latv2
B0.2 = Z_latp2
B0.3 = Z_lsv2
B0.4 = Z_hsv
B0.5 = Z_latv1
B0.6 = Z_latp1
B0.7 = Z_lsv1

B1.0 = 1
B1.1 = Z_tfm
B1.2 = Z_fra2
B1.3 = Z_fra1
B1.4 = Z_kat1
B1.5 = Z_hsh
B1.6 = Z_lash1
B1.7 = z_lsh1

B2.0 = 1
B2.1 = Z_ev1
B2.2 = Z_swe
B2.3 = Z_md04
B2.4 = Z_md03
B2.5 = Z_md02
B2.6 = Z_md01
B2.7 = Z_md

W150.0 = 0
W150.1 = B_gae2
W150.2 = B_gae1
W150.3 = B_lra2
W150.4 = B_lra1
W150.5 = B_lrhk
W150.6 = B_lrb2
W150.7 = B_lrb1
W150.8 = 0
W150.9 = 0
W150.10 = b_gefra2
W150.11 = b_gefra1
W150.12 = B_frao2
W150.13 = B_frao1
W150.14 = B_rkat2
W150.15 = B_rkat1

W151.0 = B_mldyn
W151.1 = B_teslash
W151.2 = B_dlatp2
W151.3 = B_dlatp1
W151.4 = B_tehb
W151.5 = B_te
W151.6 = B_sa
W151.7 = B_ll
W151.8 = 0
W151.9 = 0
W151.10 = 0
W151.11 = B_lrsync
W151.12 = B_dktlp
W151.13 = B_dkatsp
W151.14 = B_dkatsb
W151.15 = B_dkatst

Projekte V6

B0.0 = Z_hsv2
B0.1 = Z_latv2
B0.2 = Z_latp2
B0.3 = Z_lsv2
B0.4 = Z_hsv
B0.5 = Z_latv1
B0.6 = Z_latp1
B0.7 = Z_lsv1

B1.0 = Z_kat21
B1.1 = Z_hsh2
B1.2 = Z_lash2
B1.3 = Z_lsh2
B1.4 = Z_kat1
B1.5 = Z_hsh
B1.6 = Z_lash1
B1.7 = z_lsh1

B2.0 = Z_swe
B2.1 = Z_md06
B2.2 = Z_md05
B2.3 = Z_md04
B2.4 = Z_md03
B2.5 = Z_md02
B2.6 = Z_md01
B2.7 = Z_md

B3.0 = 1
B3.1 = 1
B3.2 = Z_ev1
B3.3 = 1
B3.4 = 1
B3.5 = Z_tfm
B3.6 = Z_fra2
B3.7 = Z_fra1

W150.0 = B_tehb
W150.1 = B_te
W150.2 = B_sa
W150.3 = B_ll
W150.4 = B_lrhkb2
W150.5 = B_lrhkb1
W150.6 = B_lrb2
W150.7 = B_lrb1
W150.8 = B_frao2
W150.9 = B_frao1
W150.10 = B_rkat2
W150.11 = B_rkat1
W150.12 = B_gae2
W150.13 = B_gae1
W150.14 = B_lra2
W150.15 = B_lra1

W151.0 = 0
W151.1 = B_mldyn
W151.2 = B_gaefra2
W151.3 = B_gaefra1
W151.4 = B_teslash2
W151.5 = B_teslash1
W151.6 = B_dlatp2
W151.7 = B_dlatp1
W151.8 = 0
W151.9 = B_dktlp
W151.10 = B_dkatsp2
W151.11 = B_dkatsp1
W151.12 = B_dkatsb2
W151.13 = B_dkatsb1
W151.14 = B_dkatst2
W151.15 = B_dkatst1

APP DMS 6.10 Application hint

Wertebereich von TVDDREC: 0 ... 255 s

ASCETSDB 1.13 ASCET-SD descripton of block library

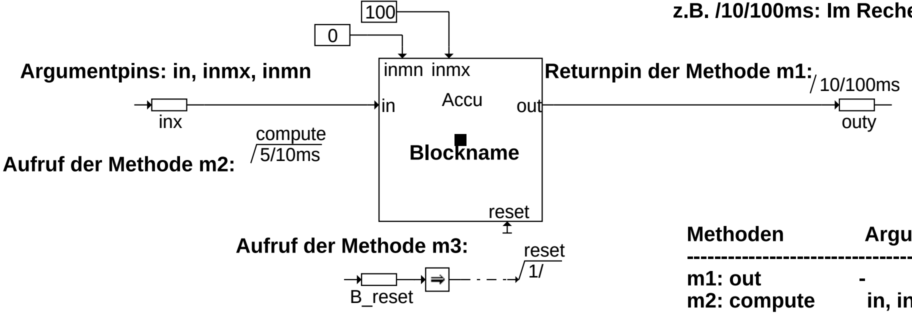
FDEF ASCETSDB 1.13 Function definition

Graphische Darstellung der Grundelemente

**Die Grundelemente werden im Diagramm durch rechteckige Bloecke dargestellt. Die Kommunikation der Grundelemente wird durch Verbindungslinien dargestellt.
Die Schnittstellen der Grundelemente sind die Pins am Rand der Bloecke. Jeder Block besitzt einen Returnpin, der das Ergebnis des Blocks ausgibt. Weiterhin gibt es Argumentpins, die Eingaben in den Block bereitstellen, und Methodenpins, die bei Methoden ohne Eingabeargumente und Rueckgabewert verwendet werden.**

Die Methoden rufen Funktionen im Block auf.

**Die Angabe des Prozesses und der Rechenreihenfolge erfolgt in der Form: "/Rechenreihenfolge/Prozess"
z.B. /10/100ms: Im Rechenraster 100ms der zehnte Aufruf.**



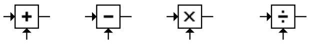
Methoden	Argumente	Rueckgabewert
m1: out	-	Float
m2: compute	in, inmx, inmn	-
m3: reset	-	-

**Obiges Beispiel zeigt einen Block mit 3 Methoden:
- Die Methode m1 "out" hat einen Rueckgabewert.
Die Methode "out" wird durch die Anforderung des Rueckgabewerts vom nachfolgenden Block outy, der im Rechenraster 100 ms in der Rechenreihenfolge an zehnter Position steht, aufgerufen.
- Die Methode m2 "compute" hat drei Argumente (in, inmn, inmx), jedoch keinen Rueckgabewert.
Die Methode "compute" wird im Rechenraster 10 ms in der Rechenreihenfolge an fnfter Position aufgerufen.
- Die Methode m3 "reset" hat weder Argumente noch Rueckgabewert. Deshalb ist diese durch den "Methodenpin" dargestellt. Die Methode "reset" wird aufgerufen, wenn B_reset true ist.**

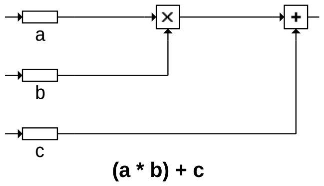
ascetsdb-abeschreib

ascetsdb-abeschreib

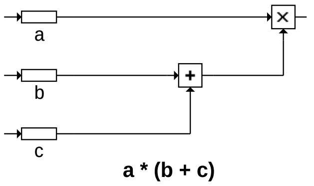
Arithmetische Operationen



Mit Hilfe der arithmetischen Operationen (Addition, Subtraktion, Multiplikation und Division) koennen Gleichungen beschrieben werden. Gleichungen werden graphisch so dargestellt, da der Rueckgabewert der einen Operation das Argument der nachfolgenden Operation ist.

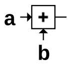


(a * b) + c

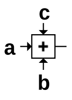


a * (b + c)

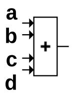
Nachfolgend werden die Argumente der Primitivoperationen und deren Rechenreihenfolge dargestellt:



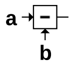
a + b



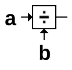
a + b + c



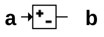
a+b+c+d



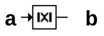
a - b



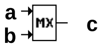
a / b



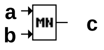
Negation: b = - a



Betrag: b = |a|



Maximum der Eingangswerte: c = MAX(a,b)

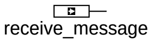


Minimum der Eingangswerte: c = MIN(a,b)

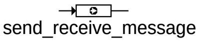
ascetsdb-a1artihmet

ascetsdb-a1artihmet

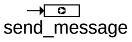
Variablen



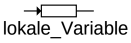
Receive Messages sind Eingangsvariablen der Funktion, die von einer anderen Funktion bereitgestellt werden.



Send/Receive Messages sind Ausgangsvariablen der Funktion, die sowohl innerhalb als auch ausserhalb der Funktion verwendet werden.



Send Messages sind Ausgangsvariablen der Funktion und stehen den uebrigen Funktionen zur Verfuegung.



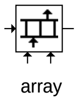
Lokale Variablen werden nur innerhalb der Funktion bereitgestellt und verwendet.

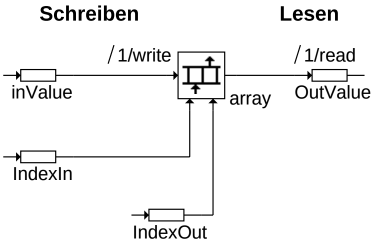
ascetsdb-a2variable

ascetsdb-a2variable

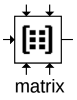
Arrays und Matrizen

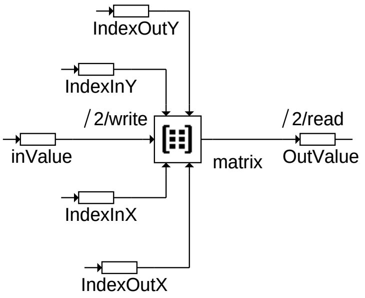
Arrays und Matrizen haben zwei Methoden, um auf die Elemente schreibend und lesend zuzugreifen. Das Schreiben und Lesen kann unabhaengig von einander erfolgen





Array:
- Der zu schreibende Wert wird an den linken Pin, der zugehoerige Index an den linken unteren Pin angeschlossen.
- Der zu lesende Wert wird an den rechten Pin, der zugehoerige Index an den rechten unteren Pin angeschlossen.

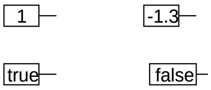




Matrix:
Matrizen verhalten sich wie Arrays, jedoch haben hier die Methoden zwei Indexargumente (x,y):
- Um schreibend zuzugreifen, wird der Index x unten linken, der Index y oben links angeschlossen.
- Um lesend zuzugreifen, wird der Index x unten rechts, der Index y oben rechts angeschlossen.

ascetsdb-a3arraysun

ascetsdb-a3arraysun



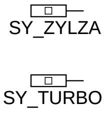
Konstanten

Boolsche Konstanten

ascetsdb-a4konstant

ascetsdb-a4konstant

Systemkonstanten



Systemkonstanten sind Konstanten, die fest im Programm verankert sind. Diese sind nicht applizierbar. Die Systemkonstanten koennen Funktionsteile bedingt ein oder ausschalten.

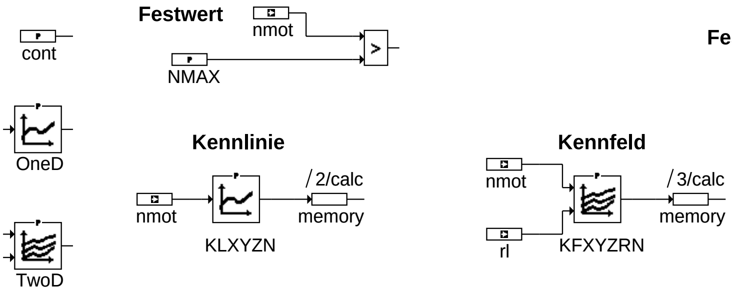
Beispiel

SY_ZYLZA: Zylinderzahl
SY_TURBO: Motor mit bzw. ohne Turbolader

ascetsdb-a5systemko

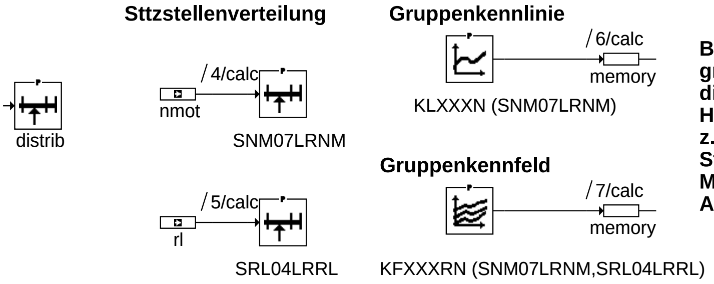
ascetsdb-a5systemko

Festwerte, Kennlinien, Kennfelder, Gruppenkennlinien, Gruppenkennfelder und Sttzstellenverteilung



Festwerte sind applizierbare Parameter.

**Kennlinien haben ein Argument,
Kennfelder haben zwei Argumente als Eingang.
Beide haben einen Rueckgabewert.**

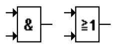


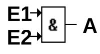
**Bei Gruppenkennlinien und Gruppenkennfelder greifen mehrere Kennlinien bzw. Kennfelder auf die gleiche Sttzstellenverteilungen zu.
Hierzu wird zuerst aus der abhaengigen Groee, z.B. nmot, die aktuelle Stuetzstelle aus der Stuetzstellenverteilung, z.B. SNM07LRNM, berechnet.
Mit dieser aktuellen Stuetzstelle erfolgt die Berechnung de Ausgabewerts der Gruppenkennlinie bzw. -kennfelds.**

ascetsdb-a6klkfgklu

ascetsdb-a6klkfgklu

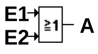
Bitoperationen





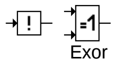
UND-Glied:

E1	E2	A
0	0	0
1	0	0
0	1	0
1	1	1



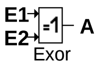
ODER-Glied:

E1	E2	A
0	0	0
1	0	1
0	1	1
1	1	1



Negation

E	A
0	1
1	0



Exklusive-Oder:

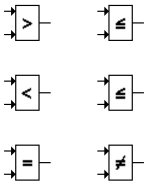
E1	E2	A
0	0	1
1	0	0
0	1	0
1	1	1

ascetsdb-a7bitopera

ascetsdb-a7bitopera

Vergleicher

**Die Vergleicher liefern am Ausgang TRUE, wenn der Vergleich zutrifft.
Ist der Vergleich nicht erfuellt, liefert der Ausgang FALSE.**



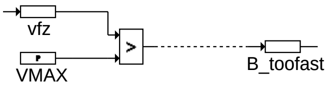
Groesser, Groesser gleich

Der Vergleich wird immer von oben nach unten gelesen:

Kleiner, Kleiner gleich

Wenn vfz groesser als VMAX, ist die Bedingung B_toofast TRUE

Gleich, Ungleich

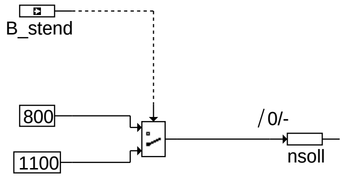


ascetsdb-a8vergleic

ascetsdb-a8vergleic

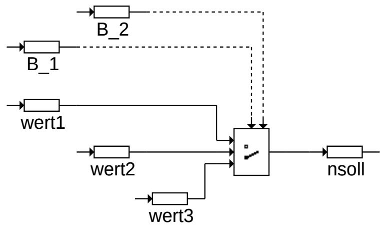
Multiplex Operator "Muxer", "Schalter"

**Ein Muxer schaltet abhaengig von Eingangsbedingungen einen Wert zum Ausgang durch.
Das Icon des Muxers ist in Ruhestellung dargestellt, d.h. wenn die Eingangsbedingungen false sind.**



Beispiel "Einfach-Muxer":
- wenn B_stend = false: nsoll = 1100
- wenn B_stend = true: nsoll = 800

Bei kaskadierten Muxern ist jedem Wert eine Eingangsbedingung zugeordnet. Der oberste Wert, dessen Eingangsbedingung true ist, wird durchgeschaltet. Ist keine Eingangsbedingung true wird der unterste Wert durchgeschaltet.

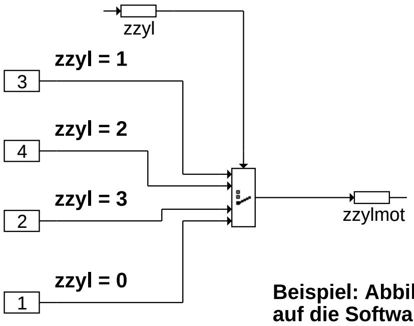


Beispiel "Mehrfach-Muxer":
- wenn B_1 = true: nsoll = wert1
- wenn B_1 = false & B_2 = true: nsoll = wert2
- wenn B_1 = false & B_2 = false: nsoll = wert3

ascetsdb-a9multiple

ascetsdb-a9multiple

CASE Operator



**Der CASE Operator schaltet abhaengig von einem oben anliegenden diskreten Steuerwert (1,2,3,..) einen der brigen linken Eingaenge auf den Ausgang durch.
Ist der Steuerwert 1 wird der erste, ist er 2 wird der zweite Wert und sofort durchgeschaltet.
Ist der Wert auerhalb des Bereiches, wird der unterste Eingang (default) durchgeschaltet.**

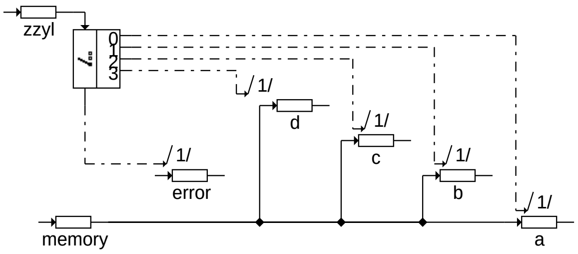
Beispiel: Abbildung der physikalischen Zylindernummer auf die Software-Zylindernummer

ascetsdb-a10caseope

ascetsdb-a10caseope

Switch

Der SWITCH Operator aktiviert abhaengig von einem oben anliegenden diskreten Steuerwert (1,2,3,..) die passenden Kontrolfluesse ueber die rechten Ausgaenge. Existiert kein passender Ausgang, wird der Kontrollflu am untere Ausgang aktiviert.



Beispiel:

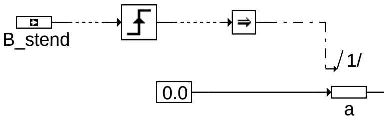
Abhaengig von zzyl wird eine der folgenden Operationen ausgefuehrt:
- wenn zzyl = 0: a = memory
- wenn zzyl = 1: b = memory
- wenn zzyl = 2: c = memory
- wenn zzyl = 3: d = memory
- sonst: error = memory

ascetsdb-a11kontrol

ascetsdb-a11kontrol

If .... then

Die If .. Then Operation wertet eine logische Bedingung aus und aktiviert bei TRUE alle Rechenfolgen, die an den Kontrollflu angeschlossen sind. Die Recheneihenfolge ist durch die Numerierung festgelegt.

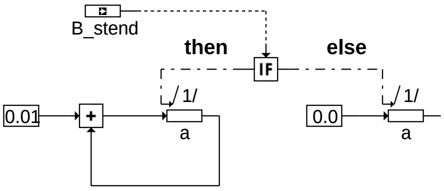


Beispiel: Wenn B_stend nach true wechselt, wird tnst = 0 gesetzt.

If

then **else**

Die If .. Then .. Else Operation wertet eine logische Bedingung aus und aktiviert bei TRUE alle Rechenfolgen des then-Kontrollzweigs und bei FALSE alle Rechenfolgen des else-Kontollzweigs. Die Recheneihenfolge am jeweiligen Kontrollzweig ist durch die Numerierung festgelegt.



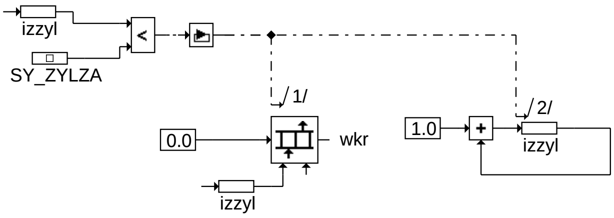
Beispiel: Wenn B_stend = true, wird tnst im 10 ms Raster um 0.01 sec erhoeht. Sonst (B_stend = false) wird tnst = 0 gesetzt.

ascetsdb-a12kontrol

ascetsdb-a12kontrol

While-Schleife

Die Rechenfolge innerhalb des Kontrollfusses der Schleife wird solange ausgefuehrt, wie die Eingangsbedingung erfllt ist, also TRUE ist. Die Schleife wird abgebrochen, wenn die Eingangsbedingung FALSE ist. Der Wert fr das Beenden der While-Schleife wird normalerweise innerhalb der Schleife gebildet. Meistens handelt es sich hierbei um einen Zaehler, der bis zu einem bestimmten Wert zaehlen soll.



Beispiel:
Das Array wkr[i] wird solange mit 0 beschrieben, wie izzyl < SY_ZYLZA ist. Mit der Zaehlvariablen izzyl am Indexeingang des Arrays wird jedes Element des Arrays mit 0 initialisiert wird.

ascetsdb-a13while

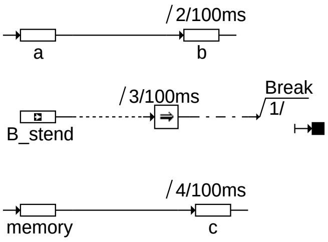
ascetsdb-a13while

Break

Break
0/-

Die Break Operation bricht einen Prozess, z.B. den Funktionsanteil in einem Rechenraster, vorzeitig ab. Alle nachfolgenden Berechnungen der Funktion im Prozess mit hoeherer Nummer bei der Rechenreihenfolge werden nicht ausgefuehrt.

Beispiel:

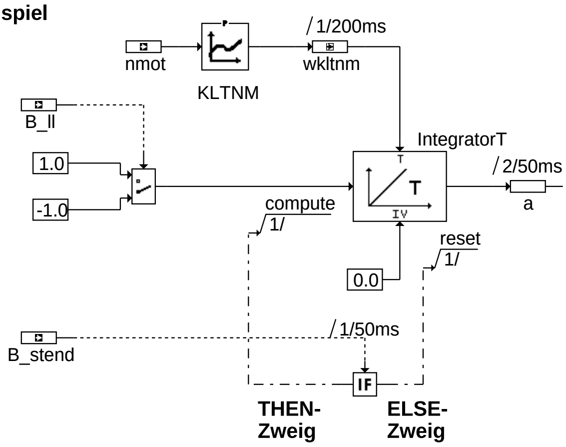


Entsprechend der Rechenreihenfolge wird nach der Operation b = a genau dann ein Break ausgeloest, wenn B_stend = TRUE ist. Tritt ein Break ein, wird der Prozess 100ms angebrochen. Die nachfolgende Operation c = memory wird nicht mehr ausgefuehrt.

ascetsdb-a14kontrol

ascetsdb-a14kontrol

Beispiel



Solange die Bedingung B_stend = FALSE ist, wird im Rechenraster 50ms die Methode "reset" des Integrators ausgefhrt. Diese Methode bewirkt, da die interne Speicherzelle des Integrators mit dem IV-Wert, also 0.0, initialisert wird. Wird jetzt die Bedingung B_stend =TRUE, wird der linke Kontrollflu aktivert und die Methode "compute" des Integrators zur Ausfhrung gebracht. Die Methode "compute" hat als Argumente die Zeit T und den Eingangswert. Dieser ist von B_ll abhngig. Mit B_ll = TRUE ist der Eingangswert = 1.0, mit B_ll = FALSE ist der Eingangswert = -1.0. Die Zahlen vor dem Rechenraster geben die Rechenreihenfolge an: Im Rechenraster 200ms wird die Zeitkonstante T berechnet und in der Send/Receive Message wkltnm gespeichert. Im Rechenraster 20ms wird zuerst die IF .. THEN .. ELSE Abfrage durchgefhrt. Im zweiten Schritt wird der Integrationswert in die Variable a geschrieben.

ascetsdb-bbeispiele

ascetsdb-bbeispiele

ABK ASCETSDB 1.13 Abbreviations

FW ASCETSDB 1.13 Fixed Values

Parameter	Value	Description

FB ASCETSDB 1.13 Detailed description of function

APP ASCETSDB 1.13 Application hint

SYABK 8.3 Symbols and abbreviations

FDEF SYABK 8.3 Function definition

```
SYMBOLS:

                                        |                                        |
                                        |       -----+                           |        +------------+
      --------+---------->              |       -----|----------->               |        |   +--+10 ms|
              |                         |            |                           |     -->| --+  +--   +-->
              +---------->              |            +----------->               |        +------------+
      branching of signal lines         |      crossing of signal lines          |        mono-flop 10 ms
                                        |                                        |
                                        |                                        |        +-+
F1 ->o---  addition point  F1 + F2      | F1 ->o     subtraction point F1 - F2   |    --->|&|-->   AND member
   + ^ F2                               |     -^ F2                              |    --->| |
     |                                  |      |                                 |        +-+
                                        |                                        |
       +-+                              |                                        |
  ---->|V|---->   OR member             |      +-+                               |     +-+
  ---->| |        (in descriptions      |  -->o| |----> tendency at input        | --->| |o---> tendency at output
       +-+         "/" is also          |      +-+      (in descriptions         |     +-+
                   used)                |                "!" is also used)       |
                                        |                                        |
      B_lr   switches; are designated in|                    dummy connectors    |
"       /     in dormant position        |   +-+              (replaces output of |"
   --o   o--   Text describes switchover|   |0|-* * * ----  in factor frames acc.|
               condition                |   +-+             to given section)    |
                                        |                                        |
          +-+                           |                                        |         +-+
   a ---->|*|--> a*b  multiplication    |tl  +-----+                             |   a --->|:|-->  a / b    division of two
   b ---->| |         of two variables  |  ->| Fns |- multiplication tl * Fns    |   b --->| |              Variables (b can also
          +-+         (b can also come  |    +-----+                             |         +-+              come from below)
                       from below)      |                                        |
                                        |                                        |
      +--------+      dead time member  |          +-+------+                    |        +-----------+       two-point member
   xe | Tt+----| xa                     |  B_s --->|S| flip |--->   R/S flip     |   xe   |     +-- 1 | xa
 ---->|   |    |-->  xa delayed by Tt   |          +-+------+            flop    |    --->| ----+---- |--->   xe continuously
      |---+    |                        |  B_r --->|R| flop |                    |        | -1--+     |       xa either -1 or 1
      +--------+                        |          +-+------+                    |        +-----------+
                                        |                                        |
    +-------------+         switch-on   |    +------+   complex function see     |   e  +-----+  a    quantity formation
B_lr| TBLRH +--   | B_lrhk  restrainer  |    | %ZWB |   page %ZWB                |   -->| |x| |--->
 -->| ------+-->t |-->                   |    +------+                            |      +-----+     a = |e|
    +-------------+                     |                                        |
  if B_lr for t= TBLRH uninterrupted    |                                        |
  after which B_lrhk=1                  |                                        |
"  / B_lr=0 => B_lrhk=0                         |                                        |"
```

```
 +--------+                             |    +--------+                          |    +--------+
 |WMAX +--| upper limiting to WMAX      |    | +----- | upper limiting to        |    | TLMIN /| lower limiting to
 |   /    | and lower limiting to       | -->|/ TLMX  |--->             TLMX     | -->| -----+ |--->             TLMIN
 |--+ WMIN| WMIN                        |    +--------+                          |    +--------+
 +--------+                             |                                        |
                                        |                                        |
                                        |                                        |     +--<--+---- LR on
                                        |                                        |   ->|DTMR |<-  hysteresis,
  +-----+                               |    +-----+                             | LR  V     ^    switch on if
  | MIN |    smallest value selection   |    | MAX |    largest value selection  | off |     |    Tmot > TMRE
  +-----+                               |    +-----+                             | ----+-->--+    shut-down if
                                        |                                        |      TMRE |    Tmot < TMRE - DTMR
                                        |                                        |
                                        |   +------------+      integrator       |   +--------------+      low pass
        +-----+ B_lr   comparator       | e | ^  /       | a                     | e | ^   . *      |em
 Tmot ->|>TMLR|------> if Tmot > TMLR   |-->| | /  ZLRHK |-->   with time        | ->| | *  ZKFRM   |-->   with time constants
        +-----+       then B_lr = 1     |   | +-------->t|      constants  ZLRHK |   | *---------->t|      ZKFRM
                                        |   +------------+                       |   +--------------+
                                        |                                        |
```

```
Symbolic abbreviations used in  plausibility checks:
--------------------------------------------------------
SB1, SB2...      Specification conditions 1 and 2
F1,  F2....      Error 1 and 2
SB1 & SB2        Condition 1 and condition 2 fulfilled
                             ---
SB1 \ SB2        Condition 1 or condition 2 fulfilled
                             ----
!SB1             Condition 1 not fulfilled
                             -----
F1: SB1          Error 1 set if condition 1 is fulfilled
F2: SB1 & !SB2   Error 2 set if condition 1 is fulfilled and condition 2 is not fulfilled
```

SWADAP 1.2 Software adapter ME2.3 -> ME7

FDEF SWADAP 1.2 Function definition

```
Umsetzung Flags:
================

ME2.3                   ME7.x

EMS_KLIMA               B_ko
B_AC & !EMS_KLIMA       B_acres
B_AC                    B_ac
B_br                    B_bremse
B_kup                   B_kuppl
B_dknot_fr              B_dknolu
B_ska                   B_dkpu
B_start                 B_st
B_ursta                 B_pwf
E_hfm oder E_lm         E_lm
B_fs                    B_fs
                        B_dllr = 0
B_pn = 0
                        B_mdmin = 0
                        B_mdmax = 0


Umsetzung RAM-Daten:
====================

Korrekturfaktor Druck vor Drosselklappe
ME2.3: fdkha            1 Byte, [0...<2], 1Inc = 2/256
ME7.x: fpvdk_w          2 Byte, [0...<4], 1Inc = 4/65536

gefilterter Drehzahlgradient
ME2.3: ngrad2cpl        1 Byte, [-10240... 10160 Upm/s], 1Inc = 80 Upm/s
ME7.x: ngfil            1 Byte, [-12800... 12700 Upm/s], 1Inc = 100 Upm/s
ME7.x: ngfil_w          2 Byte, [-12800...<12800 Upm/s], 1Inc = 100/256 Upm/s

Motordrehzahl
ME2.3: nist_1u          2 Byte, [0...65535 Upm], 1Inc = 1 Upm
ME7.x: nmot             1 Byte, [0...10200 Upm], 1Inc = 40 Upm
ME7.x: nmot_w           2 Byte, [0...16383.75 Upm], 1Inc = 0.25 Upm

relative Last
ME2.3: FAKTOR * tl_     2 Byte, 14.18%/ms * [0...174.76ms], 1Inc = 2.666us
ME7.x: rl               1 Byte, [0...191.25%], 1Inc = 0.75%
ME7.x: rl_w             2 Byte, [0...1535.98 %], 1Inc = 0.75%/32

Luftmassenstrom, 8Bit
ME2.3: mlsm             1 Byte, [0...1020 kg/h], 1Inc = 4 kg/h
ME7.x: ml               1 Byte, [0...1020 kg/h], 1Inc = 4 kg/h
```

```
Luftmassenstrom, 16Bit
ME2.3: mlsmw           2 Byte, [0...6553.5 kg/h], 1Inc = 0.1 kg/h
ME7.x: ml_w            2 Byte, [0...6553.5 kg/h], 1Inc = 0.1 kg/h

Motortemperatur
ME2.3: tmotlin         1 Byte, [-40...216°C], 1Inc = 1K
ME7.x: tmot            1 Byte, [-48...143.25 °C], 1Inc = 0.75K

Ansauglufttemperatur
ME2.3: tanslin         1 Byte, [-40...216°C], 1Inc = 1K
ME7.x: tans            1 Byte, [-48...143.25 °C], 1Inc = 0.75K

Winkel Fahrpedal
ME2.3: sw_ped          2 Byte, [0...<100%], 1Inc = 100%/32768
ME7.x: wped_w          2 Byte, [0...<102.4%], 1Inc = 0.4%/256

Batteriespannung
ME2.3: ubatt           1 Byte [0...17V], 1Inc = 0.067V
ME7.x: ub              1 Byte [0...17V], 1Inc = 0.067V

Lambdasondenspannung vor Kat
ME2.3: Usvk1_w [0...5V], 1Inc = 5V/1024
       Usvk2_w [0...5V], 1Inc = 5V/1024
ME7.x: usvk_w  [0...5V], 1Inc = 5V/1024
       usvk2_w [0...5V], 1Inc = 5V/1024

Lambdasondenspannung hinter Kat
ME2.3: Ushk1_w [0...5V], 1Inc = 5V/1024
       Ushk2_w [0...5V], 1Inc = 5V/1024
ME7.x: ushk_w  [0...5V], 1Inc = 5V/1024
       ushk2_w [0...5V], 1Inc = 5V/1024


Mit der ME7.x neu eingeführte RAM-Größen:
=========================================

AGR-Rate
agrr = 0                       1 Byte, [0..99.6%], 1Inc = 0.39%

Delta-Drehmoment von Antiruckel-Funktion
dmar_w = 0%                    2 Byte, [-100%...<100%], 1Inc = 2/65536

Momentenreserve für Katheizen
dmrkh_w = 0%                   2 Byte, [0...<100%], 1Inc = 1/65536

Lastsignaländerung
drl_w = rl_w[z] - rl_w[z-1]    2 Byte, [-768...768%/seg], 1Inc = 0.75% / 32

Korrekturfaktor Temperatur vor Drosselklappe
ftvdk = 1                      1 Byte, [0... <2], 1Inc = 2/256

Gangstufe
gangi = 2                      1 Byte, [0...255], 1Inc = 255

Basis-Lambda für Momentenschnittstelle, 8Bit
lambas = 1                     1 Byte, [0... <2], 1Inc = 2/256

Basis-Lambda für Momentenschnittstelle, 16Bit
lambas_w = 1                   2 Byte, [0...<16], 1Inc = 16/65536

Ladebilanz der Batterie
lbz = 0                        1 Byte, [0..99.6%], 1Inc = 0.39%

Wandler-Verlustdrehmoment
mdwan_w = 0%                   2 Byte, [0...<100%], 1Inc = 1/65536

Drehmoment, Tankentlüftung, begrenzt
mitebg_w = 0%                  2 Byte, [0...<100%], 1Inc = 1/65536

Drehmoment für Geschwindigkeitsbegrenzung
mivmx_w = 99.992%              2 Byte, [0...<100%], 1Inc = 1/65536

langsamer Anteil des ASR-Eingriffs
miasrl_w = 100%                2 Byte, [0...<100%], 1Inc = 100% / 65536

ASR-Drehmomentanforderung
miasrs_w = 100%                2 Byte, [0...<100%], 1Inc = 100% / 65536

indiziertes Soll-Motormoment für Getriebeschutz
miges_w = 100%                 2 Byte, [0...<100%], 1Inc = 100% / 65536

indiziertes Soll-Motormoment Getriebeschutz für schnellen Eingriff
migs_w = 100%                  2 Byte, [0...<100%], 1Inc = 100% / 65536

MSR-Drehmomentanforderung
```

```
mimsr_w = 0                     2 Byte, [0...<100%], 1Inc = 100% / 65536

relative Momentanforderung aus Fahrgeschwindigkeitsregelung
mrfgr_w = 0                     2 Byte, [0...<100%], 1Inc = 100% / 65536

Leerlaufdrehzahl Fahrstufe bei Katheizen
nfskh = 0                       1 Byte, [0...2550Upm], 1Inc = 10Upm

Leerlaufdrehzahl bei Katheizen
nllkh = 0                       1 Byte, [0...2550Upm], 1Inc = 10Upm

Reduzierstufe Basis vor Drehmomentschnittstelle
redbas (!B_sa)=0, (B_sa)=0      1 Byte, [0...255], 1Inc = 1

eingestelle Reduzierstufe
redist (!B_sa)=0, (B_sa)=REDMX  1 Byte, [0...255], 1Inc = 1

berechnete Soll-Reduzierstufe
redsol (!B_sa)=0, (B_sa)=0      1 Byte, [0...255], 1Inc = 1

maximal zulässige Füllung
rlmax_w = 1535.97%              2 Byte, [0...1535.97%], 1Inc = 0.75%/32

Motorstarttemperatur
tmotst = 20°C                   1 Byte, [-48...143.25 °C], 1Inc = 0.75K

Öltemperatur im Drehmomentwandler
twan = 80°C                     1 Byte, [-48...143.25 °C], 1Inc = 0.75K

Fahrzeuggeschwindigkeit
vfzg = 4km/h                    1 Byte, [0...318.75km/h], 1Inc = 1.25km/h
vfzg_w = 4km/h                  2 Byte, [0...<4096km/h], 1Inc = 1/16km/h
```

ABK SWADAP 1.2 Abbreviations

Variable	Source	Type	Description
AGRR	SWADAP	AUS	exhaust gas recirculation rate
B_AC	SWADAP	AUS	Condition for additional air by air condition on
B_ACRES	SWADAP	AUS	Condition for increasing the torque reserve by AC-stand-by
B_BREMSE	SWADAP	AUS	condition brake pressed
B_DKNOLU	SWADAP	AUS	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	AUS	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DLLR	SWADAP	AUS	Active diagnostic: ISC-actuator diagnostic
B_KUPPL	SWADAP	AUS	EGAS Condition cluch is disengaged
B_MDMAX	SWADAP	AUS	Condition maximal possible indicated torque reached
B_MDMIN	SWADAP	AUS	Condition minimal possible indicated torque reached
B_PN	SWADAP	AUS	condition: position P or N of automatic transmission selected
B_ST	SWADAP	AUS	condition for start
C_INI	SWADAP	AUS	ECU-condition for intialisation
C_PWF	SWADAP	AUS	ECU-condition powerfail initialisation
DRL_W	SWADAP	AUS	charge change (Word)
E_LM	SWADAP	AUS	Error flag: main load sensor
FPVDK	SWADAP	AUS	correction factor for pressure upstreams throttle
FTVDK	SWADAP	AUS	correction factor for temperature upstream of throttle valve
GANGI	SWADAP	AUS	Engaged gear
LAMBAS	SWADAP	AUS	basic Lambda
LAMBAS_W	SWADAP	AUS	lambda base value
LBZ	SWADAP	AUS	charge state of the battery
MIASRL_W	SWADAP	AUS	desired indicated torque from ASR for slow intervention
MIASRS_W	SWADAP	AUS	desired indicated torque from ASR for quick intervention
MIGES_W	SWADAP	AUS	desired indicated torque for transmission protection
MIGS_W	SWADAP	AUS	desired indicated torque form GS for quick intervention
MIMSR_W	SWADAP	AUS	desired indicated torque from MSR
ML	SWADAP	AUS	air mass flow
ML_W	SWADAP	AUS	air mass flow filtered (Word)
MRFGR_W	SWADAP	AUS	relative torque demand from cruise control
NFSKH	SWADAP	AUS	Idling speed driving level for catalyzer heating
NGFIL	SWADAP	AUS	filtered engine-speed gradient
NGFIL_W	SWADAP	AUS	filtered engine-speed gradient
NLLKH	SWADAP	AUS	Idling speed for catalyzer heating
NMOT	SWADAP	AUS	engine speed
NMOT_W	SWADAP	AUS	engine speed
REDBAS	SWADAP	AUS	Base cut-off step
REDIST	SWADAP	AUS	real cylinder cut-off step
REDSOL	SWADAP	AUS	calculated desired cylinder cut-off step
RL	SWADAP	AUS	relative air charge
RL_W	SWADAP	AUS	relative air charge (Word)
S_FS	SWADAP	AUS	Drive position selected
S_KO	SWADAP	AUS	A/C compressor active
TANS	SWADAP	AUS	Intake air temperature
TMOT	SWADAP	AUS	Engine temperature
TMOTST	SWADAP	AUS	engine temperature at start
TWAN	SWADAP	AUS	Converter oil temperature
UB	SWADAP	AUS	battery voltage

Variable	Source	Type	Description
USHK2_W	SWADAP	AUS	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHK_W	SWADAP	AUS	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USVK2_W	SWADAP	AUS	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVK_W	SWADAP	AUS	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
VFZG	SWADAP	AUS	vehicle speed (km/h)
WPED_W	SWADAP	AUS	normed angle acceleration pedal

FW SWADAP 1.2 Fixed Values

Parameter	Value	Description

FB SWADAP 1.2 Detailed description of function

```
Diese Funktion setzt für die ersten Programmstände der ME7, die in der ME2.3 -
Umgebung laufen, die erforderlichen ME2.3 - Größen in die neuen Hauptsignale für
die ME7 um.
```

APP SWADAP 1.2 Application hint

STECK 420.11 Plug pin arrangement

FDEF STECK 420.11 Function definition

```
Steckerbelegung ME3.1 auf Basis Anschlussplan  Y 261 C21 878 / 1  (09/610.X)

Motor-Stecker
=============
+-------+-------+---------------+------------------------------------------------------------------------------------+
|PCB-   |Hybrid |  Signal       |       Function                                                                     |
|Pin-No |Pin-No |  09/610       |                                                                                    |
+-------+-------+---------------+------------------------------------------------------------------------------------+
|F01/1  |M01    |A.T.DCM        |       C-Motor Throttle Valve Minus                                                 |
|A03    |M02    |A.S.LSHVK2     |       Oxygen Sensor Heating 2 in Front Of Catalyst                                 |
|E13    |M03    |A.P.EV3        |       Fuel Injector Driver 3, Cyl. 4                                               |
|E12    |M04    |A.S.SU1        |       Driver Output Variable Intake Manifold 1                                     |
|C21    |M05    |A.T.TEV        |       Driver Output Canister Purge Valve                                           |
|E43    |M06    |M.R.KS2        |       Reference Ground Knock Sensor B                                              |
|D10    |M07    |M.R.LS2VK      |       Reference Ground Oxygen Sensor 2 In Front Of Catalyst                        |
|E21    |M08    |---            |       ---                                                                          |
|E46    |M09    |---            |       ---                                                                          |
|E38    |M10    |E.F.DGA        |       Engine Speed Sensor, Connector A                                             |
|C35    |M11    |---            |       ---                                                                          |
|C23    |M12    |---            |       ---                                                                          |
|E08    |M13    |---            |       ---                                                                          |
|F17    |M14    |A.P.ZUE3I      |       Ignition Coil Driver 4, Cyl 1, 4  Lateral Spark                              |
|F06    |M15    |---            |       ---                                                                          |
|F20    |M16    |A.P.ZUE1I      |       Ignition Coil Driver 1, Cyl 1, 4  Central Spark                              |
|F02/1  |M17    |A.T.DCP        |       DC-Motor Throttle Valve Plus                                                 |
|B01    |M18    |---            |       ---                                                                          |
|E25    |M19    |A.P.EV1        |       Fuel Injector Driver 1, Cyl. 1                                               |
|E01    |M20    |---            |       ---                                                                          |
|E05    |M21    |---            |       ---                                                                          |
|E42    |M22    |E.A.KS1        |       Knock Sensor 1                                                               |
|D08    |M23    |E.A.LS1VK      |       Oxygen Sensor 1 In Front Of Catalyst                                         |
|E31    |M24    |E.A.IP1S       |       Throttle Valve Position Potentiometer 1                                      |
|E29    |M25    |E.A.TMOT       |       Engine Temperature                                                           |
|E28    |M26    |M.R.SEN *      |       Reference Ground HFM,TANS,TMOT, IP, SP                                       |
|D13    |M27    |---            |       ---                                                                          |
|C32    |M28    |E.A.LS1HK      |       Oxygen Sensor 1 in Behind Catalyst                                           |
|C37    |M29    |---            |       ---                                                                          |
|F05    |M30    |A.P.ZUE4I      |       Ignition Coil Driver 3 / Cyl 2, 3 Lateral Sark                               |
|F19    |M31    |A.P.ZUE2I      |       Ignition Coil Driver 2 / Cyl 2, 3 Central Spark                              |
|F13    |M32    |---            |       ---                                                                          |
|F01/2  |M33    |A.T.DCM        |       DC-Motor Throttle Valve "Minus"                                              |
|A01    |M34    |A.S.LSHVK1     |       Oygen Sensor Heating 1 In Front Of Catalyst                                  |
|E26    |M35    |A.P.EV2        |       Fuel Injector Driver 2 / Cyl 3                                               |
|E02    |M36    |A.S.NWS        |       Variable Camshaft Phasing On/Off                                             |
|E05    |M37    |---            |       ---                                                                          |
|E44    |M38    |---            |       ---                                                                          |
|D09    |M39    |E.A.LS2VK      |       Oxygen Sensor 2 In Front Of Catalyst                                         |
```

```
|E34    |M40    |E.A.IP2S       |       Throttle Valve Position Potentiometer 2                                       |
|E18    |M41    |---            |                                                                                     |
|E40    |M42    |E.S/F.ZYHA     |       CAM Sensor (Hall)                                                             |
|C34    |M43    |---            |       ---                                                                           |
|C33    |M44    |---            |       ---                                                                           |
|E04    |M45    |---            |       ---                                                                           |
|       |M46    |---            |       ---                                                                           |
|       |M47    |---            |       ---                                                                           |
|       |M48    |---            |       ---                                                                           |
|F02/2  |M49    |A.T.DCP        |       DC-Motor Throttle Valve "Plus"                                                |
|A05    |M50    |A.S.LSHHK1     |       Oxygen Sensor Heating 1 Behind Catalyst                                       |
|E33    |M51    |U.U.5V1 *      |       Stabilized Sensor Supply Voltage 1                                            |
|E14    |M52    |A.P.EV4        |       Fuel Injector Driver 4 / Cyl 2                                                |
|E03    |M53    |---            |       ---                                                                           |
|E41    |M54    |M.R.KS1        |       Reference Ground Knock Sensor 1                                               |
|D07    |M55    |M.R.LS1VK      |       Reference Ground Oxygen Sensor 1 In Front Of Catalyst                         |
|E47    |M56    |---            |       ---                                                                           |
|E45    |M57    |---            |       ---                                                                           |
|C22    |M58    |A.U.5V23*      |       Stabilized Sensor Supply Voltage 2 (Accelerator Pedal /  Throttle Sensor)     |
|E37    |M59    |E.F.DGB        |       Engine Speed Sensor, Connector B                                              |
|C31    |M60    |M.R.LS1HK      |       Reference Ground Oxygen Sensor 1 Behind Catalyst                              |
|C36    |M61    |---            |       ---                                                                           |
|       |M62    |---            |       ---                                                                           |
|       |M63    |---            |       ---                                                                           |
|       |M64    |---            |       ---                                                                           |
+-------+-------+---------------+-------------------------------------------------------------------------------------+


Fahrzeugstecker
===============
+-------+-------+---------------+-------------------------------------------------------------------------------------+
|E06    |F01    |---            |       ---                                                                           |
|D02    |F02    |---            |       ---                                                                           |
|A06    |F03    |B.D.IMMO       |       Immobilizer Interface                                                         |
|E27    |F04    |---            |       ---                                                                           |
|E22    |F05    |---            |       ---                                                                           |
|E18    |F06    |E.S.KO         |       AC Compressor Request                                                         |
|D20    |F07    |U.U.5V22       |       Stabilized Sensor Supply Voltage (Accelerator Pedal)                          |
|C24    |F08    |E.A.SP1S       |       Accelerator Pedal Position Input 1                                            |
|C40    |F09    |E.S.ML1        |       Quadrinary (Input Switch FAN 1) Low Level                                     |
|D24    |F10    |E.S.AUS        |       Cruise Control on/off                                                         |
|D23    |F11    |---            |       ---                                                                           |
|D12/1  |F12    |B.D.CANL       |       CAN-Interface "Low"                                                           |
|D03    |F13    |A.S.KOS        |       Driver Output AC Control                                                      |
|       |F14    |---            |       ---                                                                           |
|B04    |F15    |U.U.UBD        |       Continuous Supply Voltage                                                     |
|B03/3  |F16    |U.U.UBR        |       Switched Battery Voltage, Main Relay                                          |
|       |F17    |---            |       ---                                                                           |
|E11    |F18    |---            |       ---                                                                           |
|C30    |F19    |A.S.TMOT       |       Motor Temperature Warning Lamp                                                |
|E23    |F20    |U.U.UPROG      |       FLASH Programming Enable                                                      |
|E32    |F21    |---            |       ---                                                                           |
|D06    |F22    |E.A./S.FST     |       Fuel Level Information                                                        |
|       |F23    |---            |       ---                                                                           |
|C26    |F24    |M.R.SP1        |       Reference Ground 1 Accelerator Pedal                                          |
|A04    |F25    |M.R.SP2/SEN1 * |       Ref. Ground 2 Accelerator Pedal , Reference Ground HFM,TANS,TMOT,IP           |
|D21    |F26    |E.S.BR         |       Brake Light Switch                                                            |
|D14    |F27    |E.S.BL         |       Brake Light                                                                   |
|D15    |F28    |E.S.FP         |       Program Switch / Program Switch Control Light                                 |
|D11/1  |F29    |B.D.CANH       |       CAN-Interface "High"                                                          |
|C29    |F30    |A.S./T.EKP     |       Fuel Pump Relay / Switchmode Fuel Pump Driver                                 |
|B02    |F31    |A.S.HR         |       Driver Output Main Relay                                                      |
|B03/2  |F32    |U.U.UBR        |       Switched Battery Voltage, Main Relay                                          |
|E15    |F33    |---            |       ---                                                                           |
|C28    |F34    |---            |       ---                                                                           |
|C38    |F35    |A.P.DMTN       |       Engine Speed Signal (TN Signal)                                               |
|       |F36    |---            |       ---                                                                           |
|D05    |F37    |---            |       ---                                                                           |
|E17    |F38    |---            |       ---                                                                           |
|       |F39    |---            |       ---                                                                           |
|C25    |F40    |E.A.SP2S       |       Accelerator Pedal Position Input 2                                            |
|C27    |F41    |E.S.ML2        |       Quadrinary (Input Switch FAN 2) Hight Level                                   |
|D22    |F42    |E.S.WA         |       Cruise Control Resume                                                                           |
|D20    |F43    |E.S.SB         |       Cruise Control Set Acceleration
|D13    |F44    |E.F.VFZ        |       Vehicle Speed Sensor                                                          |
|D11/2  |F45    |B.D.CANH       |       CAN-Interface "High"                                                          |
|D01    |F46    |A.S.FELA       |       Malfunction Indicator Light                                                   |
```

```
|A02    |F47    |E.S.KL15       |       Ignition Switch                                                              |
|B03/1  |F48    |U.U.UBR        |       Switched Battery Voltage, Main Relay                                         |
|       |F49    |---            |       ---                                                                          |
|E07    |F50    |A.S.FAN1       |       Driver Output FAN Contr. 1                                                   |
|       |F51    |---            |       ---                                                                          |
|D04    |F52    |A.S.FGR        |       Control Light Cruise Control                                                 |
|C39    |F53    |B.D.DIAK       |       Diagnostic K-Line                                                            |
|E45    |F54    |E.A.TANS       |       Intake Air Temperature                                                       |
|       |F55    |---            |       ---                                                                          |
|E20    |F56    |A.U.5V21       |       Stabilizied Sensor Supply 1 (PWG + DVE)                                      |
|E47    |F57    |E.A.HFM        |       Hot Film Air Mass Meter                                                      |
|D17    |F58    |E.S.SV         |       Cruise Control Set Deceleration                                              |
|D16    |F59    |E.S.KUP        |       Input Switch Clutch Control                                                  |
|D19    |F60    |E.S.PMOEL      |       Oil Pressure Switch                                                          |
|D12/2  |F61    |B.D.CANL       |       CAN-Interface "LOW"                                                          |
|E10    |F62    |A.S./T.FAN2    |       Driver Output Fan Control 2                                                  |
|E33    |F63    |A.U.5V1        |       Stabilized Sensor Supply Voltage 1                                           |
|       |F64    |---            |       ---                                                                          |
+-------+-------+---------------+------------------------------------------------------------------------------------++-------+-----
--+---------------+-------------------------------------------------------------------------------------+


Legende:
========

1.Pinart                                2.Signalart
------------------------------------------------------------------------
A   Ausgang                             A.  Analoge Spannung
E   Eingang                             F.  Frequenzsignal
EA  Ein- und Ausgang                    M.  Masse
U   Spannungsversorgung                 P.  Pulsdauersignal
M   Masse                               R.  Referenzmasse
M/A Alternativbelegung,                 S.  Schaltsignal
    hier Masse- bzw. Ausgang            C.  Schirmung
                                        D.  Serielle Datenleitung
                                        U.  Spannungsversorgung für/von SG
                                        T.  Tastverhältnis, Pulsweitenmodulation


         ECU MOTRONIC ME3.1 u-HYBRID                                    ECU MOTRONIC ME3.1 PC BOARD
         ===========================                                    +-------------------------+
                                   +----------------------+             | 21           14      7 |
                                   |                 16   |             | 20           13      6 |
                                   |       48   32        |             | 19           12      5 |
                                   |  64             15   |             | 18           11      4 |
                                   |       47   31        |             | 17           10      3 |
   +----------------------+        |  63             14   |             | 16            9      2 +-+
   |                 49   |        |       46   30        |             | 15            8      1 |F|
   |       17   33        |        |  62             13   |             +-------------------------+-+
   |                 50   |        |       45   29        |             | 48     36     24      12|
   |  1    18   34        |        |  61             12   |             | 47     35     23      11|
   |                 51   |        |       44   28        |             | 46     34     22      10|
   |  2    19   35        |        |  60             11   |             | 45     33     21       9 |
   |                 52   |        |       43   27        |             | 44     32     20       8 |
   |  3    20   36        |        |  59             10   |             | 43     31     19       7 |
   |                 53   |        |       42   26        |             | 42     30     18       6 |
   |  4    21   37        |        |  58             9    |             | 41     29     17       5 |
   |                 54   |        |       41   25        |             | 40     28     16       4 |
   |  5    22   38        |        |  57             8    |             | 39     27     15       3 |
   |                 55   |        |       40   24        |             | 38     26     14       2 +-+
   |  6    23   39        |        |  56             7    |             | 37     25     13       1 |E|
   |                 56   |        |       39   23        |             +-------------------------+-+
   |  7    24   40        |        |  55             6    |             |  24    18     12      6 |
   |                 57   |        |       38   22        |             |  23    17     11      5 |
   |  8    25   41        |        |  54             5    |             |  22    16     10      4 |
   |                 58   |        |       37   21        |             |  21    15      9      3 |
   |  9    26   42        |        |  53             4    |             |  20    14      8      2 +-+
   |                 59   |        |       36   20        |             |  19    13      7      1 |D|
   |  10   27   43        |        |  52             3    |             +-------------------------+-+
   |                 60   |        |       35   19        |             |  40    30     20     10 |
   |  11   28   44        |        |  51             2    |             |  39    29     19     9  |
   |                 61   |        |       34   18        |             |  38    28     18     8  |
   |  12   29   45        |        |  50             1    |             |  37    27     17     7  |
   |                 62   |        |       33   17        |             |  36    26     16     6  |
   |  13   30   46        |        |                      |             |  35    25     15     5  |
   |                 63   |        +----------------------+             |  34    24     14     4  |
   |  14   31   47        |           Vehicle Connector                 |  33    23     13     3  |
   |                 64   |                                             |  32    22     12     2  +-+
   |  15   32   48        |                                             |  31    21     11     1  |C|
   |                      |                                             +-------+-----------------+-+
   |  16                  |                                             |  4    |   8     4       |
   +----------------------+                                             |  3    |   7     3       |
     Engine Connector                                                   |  2  +-+   6     2       +-+
                                                                        |  1  |B|   5     1       |A|
                                                                        +-----+-++----------------+-+
```

ABK STECK 420.11 Abbreviations

FW STECK 420.11 Fixed Values

Parameter	Value	Description

FB STECK 420.11 Detailed description of function

APP STECK 420.11 Application hint

PROKON 53.11 Project configurations

FDEF PROKON 53.11 Function definition

```
1. Software-Konfiguration über nicht applizierbare Systemkonstanten
===================================================================

1a. Kundenspezifische Systemkonstanten (FERRARI)
------------------------------------------------

Label       |Wert      |Beschreibung
------------+----------+--------------------------------------------------------------------------------
SY_AIRBAG   |1         |1 = Airbagsignal bzw. Crash-Schalter vorhanden
SY_ELKUP    |1         |1 = mit elektronischer Kupplung (= SY_ME73)
SY_HYBRID   |1         |1 = Hybrid-SG (0 = Leiterplatten-SG)
SY_SERIE    |0         |0 = Applikationseprom (1 = Serieneprom)
SY_SGALAD   |0         |0 = keine Lastabfalldiagnose
SY_ZYKL_... |0         |= SY_ZYKL_ROM_CHECK_INAKTIV; 0 = aktiv (Serie)
SY_2HFM     |1         |1 = Berücksichtigung des 2.HFM aufgrund der Saugrohrgeometrie


1b. Motorspezifikation
----------------------

Label       |Wert      |Beschreibung
------------+----------+--------------------------------------------------------------------------------
SY_EGFE     |1         |Eingangsgröße Füllungserfassung (siehe App.hinweise)
SY_GAP      |2         |Anzahl fehlender Zähne in Lücke
SY_GRDWRT   |114       |Grundwert, Abstand Software-Bezugsmarke (2. neg. Flanke nach Lücke) zu OT 120 [° KW] - 6° KW
SY_GRUNDWERT|114       |(= SY_GRDWRT)
SY_G_INKR   |75        |Inkremente pro Zahn (= (SY_G_ZAHN*100)/SY_N_INKR))
SY_G_ZAHN   |6         |°KW pro Zahn (=720/SY_NWZAEHNE)
SY_INGASOS  |6         |(= SY_OVERSIZE+SY_ZYLZA)
SY_NWZAEHNE |120       |Anzahl Zähne pro NWU (ohne Lücke) (= 2*SY_TEETH)
SY_N_INKR   |8         |Anzahl Inkremente pro Zahn
SY_OVERSIZE |2         |siehe %BGNG
SY_PH2OFST  |0         |Offset für 2. Phasengeber
SY_TEETH    |60        |Anzahl Zähne pro KWU (ohne Lücke)
SY_TNZAEHNE |30        |Anzahl Zähne je TN (= SY_NWZAEHNE/SY_ZYLZA)
SY_TNZAEH...|28        |Anzahl Zähne je TN-Lücke (= SY_TNZAEHNE-SY_GAP)
SY_ZWOFFSET |152       |Inkremente zwischen TR und OT (= SY_Z_OT*SY_N_INKR)
SY_ZYLZA    |4         |Zylinderanzahl (pro SG)
SY_Z_OT     |19        |Zähne zwischen TR und OT (= SY_GRUNDWERT/SY_G_ZAHN)
```

1c. Motorfunktionen (HW-Komponenten)

Label	Wert	Beschreibung
SY_AGR	0	0 = AGR nicht vorhanden
SY_CAN	0	0 = kein full CAN
SY_CONFSL	1	1 = Sekundärluftpumpe vorhanden
SY_DOPZW	1	1 = doppelte Zündausgabe bei Phasengebernotlauf
SY_EGAS	1	1 = EGAS vorhanden
SY_FGR	1	1 = mit FGR (nur in der Software wegen Überwachung!)
SY_GGGTS	0	0 = ohne Auswertung Gebergröße genaues Temperatursignal
SY_KOPWM	0	0 = kein PWM-Signal vom Klimakompressor
SY_LECK	0	0 = kein DVE mit hoher Leckluft
SY_LENKH...	0	= SY_LENKHILFE_PORT; 0 = kein Schalter Lenkhilfe verbaut
SY_MAX_EV	4	Anzahl Ausgangspins für EVs
SY_NLDG	0	0 = kein DG-Notlauf
SY_NWS	1	Nockenwellensteuerung: 1 = 2-Pkt.verstellung (siehe App.hinweise)
SY_NZUEB	800	Umschaltung des Zündbereiches (Schließzeit/Winkelausgabe) [U/min]
SY_PBRPW	0	0 = keine Plausibilitätsprüfung Bremse/PWG
SY_PGRAD	1	Typ des Nockenwellengeberrades: 1 = ein Impuls pro 720°KW (siehe App.hinweise)
SY_PGRAD2	0	Typ des 2. Nockenwellengeberrades: 0 = kein Geberrad vorhanden (siehe App.hinweise)
SY_PHTWIN	0	0 = kein zweiter Phasensensor vorhanden (= SY_PGRAD2)
SY_SU	2	Saugrohrumschaltung: 2 = zwei Schaltausgänge (siehe App.hinweise)
SY_TFA	0	0 = TANS-Sensor (siehe App.hinweise)
SY_TFMA	1	1 = TANS-Sensor vorhanden (Initial. GGTFM-Ersatzwert)
SY_TFMAP	0	0 = TANS-Sensor-Beschaltung ohne Parallel-Widerstand
SY_TFMO	0	0 = TOEL-Sensor nicht vorhanden (Initial. GGTFM-Ersatzwert)
SY_TFUMG	0	0 = kein Umgebungstemperaturfühler vorhanden
SY_TURBO	0	0 = ohne Turbolader (LDR)
SY_UBR	0	0 = keine Spannung ubr hinter Hauprelais
SY_WNBM	6	Winkel Zahnabstand Kurbelwellensignal (= 360/SY_TEETH)

1d. Systemkonstanten für Diagnose

Label	Wert	Beschreibung
SY_AAV	1	1 = mit AAV (in %TEBEB)
SY_CDCSIZE	8	Anzahl CARB-Fehler-Code pro Fehler (= 4*SY_SGANZ)
SY_CDKSIZE	2	Anzahl Kunden-Fehler-Code pro Fehler (= SY_SGANZ)
SY_CDTSIZE	2	Anzahl CDT-Code pro Fehler (= SY_SGANZ)
SY_CLASIZE	2	Anzahl Fehlerklassen pro Fehler (= SY_SGANZ)
SY_DELFCMS	0	0 = Lösche alle FCM
SY_DFPMENV	2	Anzahl Umweltbedingungen, die im freeze frame gespeichert sind
SY_DFPMVAR	3	DFPM Version
SY_DFPMTIM	2	Größe der Zeit (Betrieb oder Real) in Bytes
SY_DLDP	0	0 = ohne DFP_LDPE
SY_DLS	0	0 = kein DLS-Eingriff in AZUE
SY_DLSUV	0	0 = ...
SY_DTANKL	0	0 = keine Diagnose leerer Tank vorhanden
SY_DVEADA	1	1 = BGDVE: Sperren von Einspritzung durch DV-E-Adaption erlaubt
SY_ENVBLOK	2	DFPM: Anzahl Blöcke mit Umweltbedingungen
SY_FCMSIZE	20	Anzahl der FCM Zeilen
SY_FFCSIZE	11	Größe des CARB freeze frame
SY_FFESIZE	0	Größe des erweiterten freeze frame
SY_FFTSIZE	2	Anzahl Umweltbedingungen pro Fehler, die im freeze frame gespeichert sind (= SY_DFPMENV)
SY_INI_OBD	0	0 = System unterstützt ISO 14230-4 mit schneller Ini und ISO 9141 mit 5 Baud Initialisierung
SY_ISOPROT	0	0 = ISO 9141
SY_TSFSIZE	1	Anzahl Fehlerschwere pro Fehler

1e. Zylinderabhängige Systemkonstanten

Label	Wert	Beschreibung
SY_KOEVAB	0	0 = keine Koordination der EV-Abschaltung über KOEVAB
SY_REDMX	4	maximale Reduzierstufe (= SY_ZYLZA)
SY_TN	1	Drehzahlmesser-Signal: 0=kein tn-Sign., 1=Syncroausgabe, 2=toggeln
SY_ZAS	0	0 = Zylinderabschaltung (ZAS) nicht vorhanden
SY_ZKANZAHL	4	Zündkreisanzahl (= SY_ZYLZA/SY_ZNDAUS)
SY_ZNDAUS	1	Zündausgabe (1 = Einzelfunken oder 2 = Doppelfunken) (siehe App.hinweise)
SY_ZZBANK	0	Zylinderzuordnung Bank1 und Bank2 (siehe App.hinweise)
SY_ZZBANKB	0	Zylinderzuordnung Bank1 und Bank2 (siehe App.hinweise)

1f. Systemkonstanten der Klopfregelung

Label	Wert	Beschreibung
SY_INJTIM...	64	=SY_INJTIM_PRE; Vorteiler des Timers, an dem die KR hängt (= SY_TIMER8_PRESCALER)
SY_KRMFTI...	64	=SY_KRMFTIM_PRE; Vorteiler des Timers, an dem die KR hängt (= SY_TIMER8_PRESCALER)
SY_KR_EXT	1	1 = KR extern (wenn 0, dann muß SY_KR_INT = 1 sein)
SY_KR_INT	0	0 = KR intern (wenn 0, dann muß SY_KR_EXT = 1 sein)
SY_KS1	0	Eingang des CC195 an den Klopfsensor 1 angeschlossen ist
SY_KS2	1	Eingang des CC195 an den Klopfsensor 2 angeschlossen ist
SY_KS3	2	Eingang des CC195 an den Klopfsensor 3 angeschlossen ist
SY_KS4	3	Eingang des CC195 an den Klopfsensor 4 angeschlossen ist
SY_SHK_OT	1	1 = ...

1g. Systemkonstanten der Lambdaregelung

Label	Wert	Beschreibung
SY_AAU	0	0 = keine Vorgabe Sollambda für Abgasuntersuchung
SY_LAMBTS	0	0 = kein Bauteileschutz
SY_STEREO	0	0 = Mono - Lambdaregelung
SY_STERVK	0	0 = Mono - Lambdaregelung vor Kat.
SY_STERHK	0	0 = Mono - Lambdaregelung hinter Kat.
SY_STETLR	1	1 = Stetige Lambda-Regelung vorhanden
SY_UBDEDIS	5.9247	Ubatt-Schwelle (physikalisch) für Sperren der DV-E-Endstufe
SY_UBDEEN	6.9462	Ubatt-Schwelle (physikalisch) für Freigeben der DV-E-Endstufe
SY_UBOKDIS	5.9247	UB-Wert (physikalisch) für ES-Abschaltung von DC-Motor
SY_UBOKEN	6.9462	UB-Wert (physikalisch) für ES-Freigabe von DC-Motor
SY_UB13V	13.0071	UB-Wert für HLSU [V] (= 191 dez)
SY_USOFF	0.0	Spannungsoffset zwischen El.masse und Lanbdasondenmasse [0...5V] (= 205 dez)
SY_ZP_LA...	0	=SY_ZP_LAMREG_EUII; 0 = Standard, VK-Sonde an VK-AD-Kanal angeschlossen

1h. Systemkonstanten zur Konfiguration von Software und Funktionen

Label	Wert	Beschreibung
EPK_MAX_LEN	50	Länge der Epromkennung
ERCOS_T...	5	= ERCOS_TIMER_INPUT_SEL (= SY_ERCOS_TIMER_INPUT_SEL)
FREQ_CPU	20000	(= SY_FREQ_CPU)
PRESCALER	5	(= SY_PRESCALER)
SY_ASICR...	1	= SY_ASICRUNTIME; 1 = ASIC-Laufzeit aufgerundet auf ganze ms
SY_ATR	0	0 = keine Abgastemperaturregelung
SY_EEPROM...	1	=SY_EEPROM_ADDRESS_MODE; 1 = Wordadressierung (Hybridversion) (=SY_HYBRID)
SY_EEPROM...	1024	=SY_EEPROM_SIZE; Eepromgröße in Bytes
SY_ERCOS...	5	= SY_ERCOS_TIMER_INPUT_SEL
SY_FREQ_CPU	20000	CPU-Frequenz
SY_KWP71	0	0 = Keyword-Protokoll KWP71 nicht vorhanden
SY_ME71	0	0 = kein ME7.1-SG
SY_ME73	1	1 = ME7.3-SG
SY_ME75	0	0 = kein ME7.5-SG
SY_ME751	0	0 = kein ME7.5.1-SG
SY_PRESCALER	5	...
SY_REVTIM...	16	=SY_REVTIM_PRE; Vorteiler des Timers, an dem die Drehzahlerkennung hängt (= SY_TIMER1_PRESCALER)
SY_RLTEST	50	Testkonstante für rlvsol_w
SY_TIMER1...	16	=SY_TIMER1_PRESCALER; Prescaler von Timer1
SY_TIMER3...	64	=SY_TIMER3_PRESCALER; Prescaler von Timer3
SY_TIMER8...	64	=SY_TIMER8_PRESCALER; Prescaler von Timer8
SY_WFS	1	1 = WFS-Funktion aktiv
SY_WMAX	72	frühester ausgebbarer Zündwinkel (entspricht 58,5°KW)
SY_WMIN	-36	spätester ausgebbarer Zündwinkel (entspricht -24°KW)

1i. Systemkonstanten zur Konfiguration der SCATT-Testerschnittstelle

Label	Wert	Beschreibung
SY_M1I00A	190	Codierung von DATA A in Mode 1 PID $00 nach SAE J1979
SY_M1I00B	31	Codierung von DATA B in Mode 1 PID $00 nach SAE J1979
SY_M1I00C	224	Codierung von DATA C in Mode 1 PID $00 nach SAE J1979
SY_M1I00D	16	Codierung von DATA D in Mode 1 PID $00 nach SAE J1979
SY_M2I00A	127	Codierung von DATA A in Mode 2 PID $00 nach SAE J1979
SY_M2I00B	184	Codierung von DATA B in Mode 2 PID $00 nach SAE J1979
SY_M2I00C	0	Codierung von DATA C in Mode 2 PID $00 nach SAE J1979
SY_M2I00D	0	Codierung von DATA D in Mode 2 PID $00 nach SAE J1979
SY_M5IH00A	194	Codierung von DATA A in Mode 5 PID $00 nach SAE J1979 f. S.h. Kat
SY_M5IH00B	0	Codierung von DATA B in Mode 5 PID $00 nach SAE J1979 f. S.h. Kat
SY_M5IH00C	0	Codierung von DATA C in Mode 5 PID $00 nach SAE J1979 f. S.h. Kat
SY_M5IH00D	0	Codierung von DATA D in Mode 5 PID $00 nach SAE J1979 f. S.h. Kat
SY_M5IV00A	0	Codierung von DATA A in Mode 5 PID $00 nach SAE J1979 f. S.v. Kat
SY_M5IV00B	0	Codierung von DATA B in Mode 5 PID $00 nach SAE J1979 f. S.v. Kat
SY_M5IV00C	0	Codierung von DATA C in Mode 5 PID $00 nach SAE J1979 f. S.v. Kat
SY_M5IV00D	1	Codierung von DATA D in Mode 5 PID $00 nach SAE J1979 f. S.v. Kat
SY_M5IH20A	0	Codierung von DATA A in Mode 5 PID $20 nach SAE J1979 f. S.h. Kat
SY_M5IH20B	0	Codierung von DATA B in Mode 5 PID $20 nach SAE J1979 f. S.h. Kat
SY_M5IH20C	0	Codierung von DATA C in Mode 5 PID $20 nach SAE J1979 f. S.h. Kat
SY_M5IH20D	0	Codierung von DATA D in Mode 5 PID $20 nach SAE J1979 f. S.h. Kat
SY_M5IV20A	0	Codierung von DATA A in Mode 5 PID $20 nach SAE J1979 f. S.v. Kat
SY_M5IV20B	0	Codierung von DATA B in Mode 5 PID $20 nach SAE J1979 f. S.v. Kat
SY_M5IV20C	0	Codierung von DATA C in Mode 5 PID $20 nach SAE J1979 f. S.v. Kat
SY_M5IV20D	0	Codierung von DATA D in Mode 5 PID $20 nach SAE J1979 f. S.v. Kat
SY_M5IH40A	0	Codierung von DATA A in Mode 5 PID $40 nach SAE J1979 f. S.h. Kat
SY_M5IH40B	0	Codierung von DATA B in Mode 5 PID $40 nach SAE J1979 f. S.h. Kat
SY_M5IH40C	0	Codierung von DATA C in Mode 5 PID $40 nach SAE J1979 f. S.h. Kat
SY_M5IH40D	0	Codierung von DATA D in Mode 5 PID $40 nach SAE J1979 f. S.h. Kat
SY_M5IV40A	0	Codierung von DATA A in Mode 5 PID $40 nach SAE J1979 f. S.v. Kat
SY_M5IV40B	0	Codierung von DATA B in Mode 5 PID $40 nach SAE J1979 f. S.v. Kat
SY_M5IV40C	0	Codierung von DATA C in Mode 5 PID $40 nach SAE J1979 f. S.v. Kat
SY_M5IV40D	0	Codierung von DATA D in Mode 5 PID $40 nach SAE J1979 f. S.v. Kat
SY_M5IH60A	0	Codierung von DATA A in Mode 5 PID $60 nach SAE J1979 f. S.h. Kat
SY_M5IH60B	0	Codierung von DATA B in Mode 5 PID $60 nach SAE J1979 f. S.h. Kat
SY_M5IH60C	0	Codierung von DATA C in Mode 5 PID $60 nach SAE J1979 f. S.h. Kat
SY_M5IH60D	0	Codierung von DATA D in Mode 5 PID $60 nach SAE J1979 f. S.h. Kat
SY_M5IV60A	0	Codierung von DATA A in Mode 5 PID $60 nach SAE J1979 f. S.v. Kat
SY_M5IV60B	0	Codierung von DATA B in Mode 5 PID $60 nach SAE J1979 f. S.v. Kat
SY_M5IV60C	0	Codierung von DATA C in Mode 5 PID $60 nach SAE J1979 f. S.v. Kat
SY_M5IV60D	0	Codierung von DATA D in Mode 5 PID $60 nach SAE J1979 f. S.v. Kat
SY_M5IH80A	0	Codierung von DATA A in Mode 5 PID $80 nach SAE J1979 f. S.h. Kat
SY_M5IH80B	0	Codierung von DATA B in Mode 5 PID $80 nach SAE J1979 f. S.h. Kat
SY_M5IH80C	0	Codierung von DATA C in Mode 5 PID $80 nach SAE J1979 f. S.h. Kat
SY_M5IH80D	0	Codierung von DATA D in Mode 5 PID $80 nach SAE J1979 f. S.h. Kat
SY_M5IV80A	0	Codierung von DATA A in Mode 5 PID $80 nach SAE J1979 f. S.v. Kat
SY_M5IV80B	0	Codierung von DATA B in Mode 5 PID $80 nach SAE J1979 f. S.v. Kat
SY_M5IV80C	0	Codierung von DATA C in Mode 5 PID $80 nach SAE J1979 f. S.v. Kat
SY_M5IV80D	0	Codierung von DATA D in Mode 5 PID $80 nach SAE J1979 f. S.v. Kat
SY_M6I00A	160	Codierung von DATA A in Mode 6 PID $00 nach SAE J1979
SY_M6I00B	0	Codierung von DATA B in Mode 6 PID $00 nach SAE J1979
SY_M6I00C	0	Codierung von DATA C in Mode 6 PID $00 nach SAE J1979
SY_M6I00D	0	Codierung von DATA D in Mode 6 PID $00 nach SAE J1979
SY_M8I00A	128	Codierung von DATA A in Mode 8 PID $00 nach SAE J1979
SY_M8I00B	0	Codierung von DATA B in Mode 8 PID $00 nach SAE J1979
SY_M8I00C	0	Codierung von DATA C in Mode 8 PID $00 nach SAE J1979
SY_M8I00D	0	Codierung von DATA D in Mode 8 PID $00 nach SAE J1979
SY_M8I00E	0	Codierung von DATA E in Mode 8 PID $00 nach SAE J1979

1j. Systemkonstanten zur Applikation über den Diagnosetester

Label	Wert	Beschreibung
SY_TAGR	0	0 = keine AGR-Verstellung über Tester
SY_TEBF	0	0 = keine Kraftstoffbefüllung-Anforderung über Tester
SY_TFBA	0	0 = keine Verstellung BA über Tester in %ESUK
SY_TFNS	0	0 = keine Verstellung Nachstartfaktor über Tester in %ESNST
SY_TFRK	0	0 = keine Korrektur des Faktors relative Kraftstoffmasse über Tester in %ESGRU
SY_TFST	0	0 = keine Verstellung Startfaktor über Tester in %ESSTT
SY_TFWL	0	0 = keine Verstellung Warmlauffaktor über Tester in %ESWL
SY_TFVA	0	0 = keine Verstellung VA über Tester in %ESUK
SY_TVVR	0	0 = keine Freigabe der Testeranbindung an VMAX-Regelung (%VMAXMD)

1k. Systemkonstanten der Aussetzererkennung

Label	Wert	Beschreibung
SY_FLUQ	37	... (= ((SY_ZYLZA/2)+36)
SY_KORRZ	1	... (= (3.0/2.0 - (1.0/2.0*(SY_ZYLZA*SY_SGANZ/5))))
SY_SWE_S	0	0 = SWE nicht über Statistik
SY_SWE_B	1	1 = SWE über CAN (Raddrehzahlsignale)
SY_SWE_C	0	1 = SWE nicht über CAN (PWM-Signal)

1l. Systemkonstanten 2SG

Label	Wert	Beschreibung
SY_SGANZ	2	Anzahl der Steuergeräte
SY_DGANZ	2	Anzahl Drehzahlgeber (= SY_SGANZ)
SY_2SG	1	1 = 2 Steuergeräte im Verbund

2. Projektkonfiguration über Datenänderungen oder Testerinterface:

Folgende RAM-Zellen werden während der Initialisierung (C_ini) gesetzt:

```
      bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0
           +---------------+                      +---------------+                      +---------------+
  CWKONFZ1 |x x x x x x x x|                CWTF  |x x x x x x x x|               CWUHR  |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_autget             | | | | | | | +-- B_tfu                | | | | | | | +-- B_uhrrmin
            | | | | | | +---- B_mt                 | | | | | | +----                      | | | | | | +---- B_uhrrsec
            | | | | | +------ B_cvt                | | | | | +------                      | | | | | +------ B_abstnl
            | | | | +-------- B_f1getr             | | | | +--------                      | | | | +--------
            | | | +----------                      | | | +----------                      | | | +----------
            | | +------------                      | | +------------                      | | +------------
            | +-------------- B_asrfz              | +--------------                      | +--------------
            +---------------- B_4wd                +----------------                      +----------------


      bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0
           +---------------+                      +---------------+                      +---------------+
  CWKONLS  |x x x x x x x x|             CWKONABG |x x x x x x x x|              CWKLIMA |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_lsv                | | | | | | | +-- B_katfz              | | | | | | | +-- B_klima
            | | | | | | +---- B_lsh                | | | | | | +---- B_kath               | | | | | | +----
            | | | | | +------ B_ls3                | | | | | +------ B_slsfz              | | | | | +------
            | | | | +-------- B_ls4                | | | | +--------                      | | | | +--------
            | | | +---------- B_lsv2               | | | +----------                      | | | +----------
            | | +------------ B_lsh2               | | +------------                      | | +------------
            | +-------------- B_ls32               | +--------------                      | +--------------
            +---------------- B_ls42               +----------------                      +----------------


      bit   7 6 5 4 3 2 1 0
           +---------------+
  CWOBD    |x x x x x x x x|----------> cw_obd
           +---------------+

      bit   7 6 5 4 3 2 1 0
           +---------------+
  CWERFIL  |x x x x x x x x|----------> cw_erfil
           +---------------+
```

Folgende RAM-Zellen werden im 100ms-Raster aktualisiert:

```
      bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0
           +---------------+                      +---------------+                      +---------------+
  CWMDAPP  |x x x x x x x x|               CW..   |x x x x x x x x|              CW..    |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^
            | | | | | | | +-- B_zwappl             | | | | | | | +--                      | | | | | | | +--
            | | | | | | +---- B_fpwdkap            | | | | | | +----                      | | | | | | +----
            | | | | | +------ B_wdksap             | | | | | +------                      | | | | | +------
            | | | | +--------                      | | | | +--------                      | | | | +--------
            | | | +----------                      | | | +----------                      | | | +----------
            | | +------------                      | | +------------                      | | +------------
            | +--------------                      | +--------------                      | +--------------
            +----------------                      +----------------                      +----------------
```

```
3. Drehzahlabhängige Aktivierung von Funktionen:
================================================

                    +--------+
nmot   ------------>|        |  nmot > NSWO1
+-------+           |  <>    +--------------------> B_nswo1
| NSWO1 +---------->|        |
+-------+           +--------+


                    +--------+
nmot   ------------>|        |  nmot > NSWO2
+-------+           |  <>    +--------------------> B_nswo2
| NSWO2 +---------->|        |
+-------+           +--------+
```

```
4. Konfiguration von OBDII-Diagnose-Funktionen (Euro-Schalter)
==============================================================
Folgende RAM-Zellen werden während der Initialisierung (C_ini) gesetzt:

     bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0                  bit   7 6 5 4 3 2 1 0
           +---------------+                      +---------------+                      +---------------+
    CDMD   |x x x x x x x x|             CDSWE    |x x x x x x x x|              CDTANKL |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_cdmd               | | | | | | | +-- B_cdswe              | | | | | | | +-- B_cdtankl


           +---------------+                      +---------------+                      +---------------+
    CDLSV  |x x x x x x x x|             CDLSH    |x x x x x x x x|              CDHSV   |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_cdlsv              | | | | | | | +-- B_cdlsh              | | | | | | | +-- B_cdhsv


           +---------------+                      +---------------+                      +---------------+
    CDLSA  |x x x x x x x x|             CDKVS    |x x x x x x x x|              CSCATT  |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------
             ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                       ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_cdlsa              | | | | | | | +-- B_cdkvs              | | | | | | | +-- B_cscatt


           +---------------+                      +---------------+                      +---------------+
    CDDST  |x x x x x x x x|             CDTES    |x x x x x x x x|              CDLDP   |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_cddst              | | | | | | | +-- B_cdtes              | | | | | | | +-- B_cdldp


           +---------------+                      +---------------+                      +---------------+
    CDAGR  |x x x x x x x x|             CDSLS    |x x x x x x x x|              CDSLSE  |x x x x x x x x|
           +---------------+                      +---------------+                      +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^                        ^ ^ ^ ^ ^ ^ ^ ^

            | | | | | | | +-- B_cdagr              | | | | | | | +-- B_cdsls              | | | | | | | +-- B_cdslse
```

```
      bit   7 6 5 4 3 2 1 0              bit   7 6 5 4 3 2 1 0              bit   7 6 5 4 3 2 1 0
           +---------------+                  +---------------+                  +---------------+
    CDHSH  |x x x x x x x x|         CDKAT    |x x x x x x x x|        CDNWS     |x x x x x x x x|
           +---------------+                  +---------------+                  +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^
            | | | | | | | +-- B_cdhsh          | | | | | | | +-- B_cdkat          | | | | | | | +-- B_cdnws


           +---------------+                  +---------------+                  +---------------+
    CDATS  |x x x x x x x x|         CDATR    |x x x x x x x x|        CDLATP    |x x x x x x x x|
           +---------------+                  +---------------+                  +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^
            | | | | | | | +-- B_cdats          | | | | | | | +-- B_cdatr          | | | | | | | +-- B_cdlatp


           +---------------+                  +---------------+                  +---------------+
    CDLLR  |x x x x x x x x|         CDLATV   |x x x x x x x x|        CDLASH    |x x x x x x x x|
           +---------------+                  +---------------+                  +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^
            | | | | | | | +-- B_cdllr          | | | | | | | +-- B_cdlatv         | | | | | | | +-- B_cdlash


           +---------------+                  +---------------+                  +---------------+
    CDHSHE |x x x x x x x x|         CDHSVE   |x x x x x x x x|        CDAGRL    |x x x x x x x x|
           +---------------+                  +---------------+                  +---------------+
            ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^                    ^ ^ ^ ^ ^ ^ ^ ^
            | | | | | | | +-- B_cdhshe         | | | | | | | +-- B_cdhsve         | | | | | | | +-- B_cdagrl
```

ABK PROKON 53.11 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDAGR			FW	code word DAGR inactiv (EURO-coding)
CDAGRL			FW	code word to disable position sensor diagnosis (EURO coding)
CDATR			FW	configuration byte diagnosis exhaust temperature control
CDATS			FW	configuration byte diagnosis exhaust temperature sensor
CDDST			FW	code word CARB: EURO byte for deactivation of tank press. sensor diagn.
CDHSH			FW	code word heating diagnose after Kat (CDHSH = 0 => no diagnosis)
CDHSHE			FW	Eurobit for output stage diag. of lambda sensor heating downstream of the cat.
CDHSV			FW	code word heating diagnose upstr. Kat (CDHSV = 0 => no diagnosis)
CDHSVE			FW	Code word DHLSE power stage of heater for diagnosis pre cat
CDKAT			FW	code word: catalyst diagnosis in OBDII-mode (inverse: European mode)
CDKVS			FW	code word: DKVS active/inactive, CD..=0 -> no diagnosis
CDLASH			FW	code word O2-sensor aging diagnosis (SHK) in OBDII mode (invers => Europe mode)
CDLATP			FW	code word oxgen sensor aging diagnosis (TP) in OBDII mode (inv.: in Europe mode)
CDLATV			FW	code word lambda sensor monitoring (Tv) in OBDII mode (invers: Europe mode
CDLDP			FW	code word LDP diag. in OBDII mode (inverse: Europe mode), CD..=0 -> no diapos.
CDLLR			FW	code word DLLR inactiv (EURO-coding), CD..=0 -> no diagnosis
CDLSA			FW	code word oxgen sensor aging diagnosis, configuration byte, for application
CDLSH			FW	code word lambda sensor diagnosis behind KAT in OBDII-Mode (invers: Europe mode)
CDLSV			FW	code word oxygen sensor diagnosis upstr. KAT in OBDII mode
CDMD			FW	code word DMD inactive(EURO-coding), CD..=0 -> no diagnosis
CDNWS			FW	code word DNWS disable (EURO-coding), CD..=0 -> no diagnosis
CDSLS			FW	code word secondary air system in OBDII mode (inv: Europe mode)
CDSLSE			FW	eurobyte for output stage diagnosis of secondary-valve/pump
CDSWE			FW	code word DSWE inactive (EURO-Coding), CD..=0 -> no diagnosis
CDTANKL			FW	code word DTANKL inactiv (EURO-coding), CD..=0 -> no diagnosis
CDTES			FW	code word disable canister-purge monotoring (Euro coding), CD..=0 -> no dia.
CSCATT			FW	eurobyte for scan-tool
CWERFIL			FW	Codeword for selection of misfire fault codes for output to scan tool
CWKLIMA			FW	code word air condition
CWKONABG			FW	code word for configuration exhaust emission treatment
CWKONFZ1			FW	code word for configuration vehicle
CWKONLS			FW	code word for configuration lambda sensor
CWMDAPP			FW	code word for calibration without torque structure
CWOBD			FW	code word for configuration OBD certifikation
CWTF			FW	code word for configuration temperature sensors
CWUHR			FW	code word for the clock
NSWO1			FW	engine-speed threshold 1 for switching calculation
NSWO2			FW	engine-speed threshold 2 for switching calculation

Variable	Source	Type	Description
B_4WD	PROKON	AUS	Condition 4 wheel drive
B_ABSTNL	PROKON	AUS	condition soak time calculation via ECM-afterrun
B_ASRFZ	PROKON	AUS	Condition for ASR in the automobile
B_AUTGET	PROKON	AUS	condition automatic gearbox
B_CDAGR	PROKON	AUS	function active per codeword CDAGR
B_CDAGRL	PROKON	AUS	function active per codeword CDAGRL
B_CDATR	PROKON	AUS	condition: diagnose exhaust temperature control enabled
B_CDATS	PROKON	AUS	condition diagnosis exhaust temperature sensor enabled
B_CDDST	PROKON	AUS	function active per codeword CDDST
B_CDHSH	PROKON	AUS	function active per codeword CDHSH
B_CDHSHE	PROKON	AUS	function active per codeword CDHSHE

Variable	Source	Type	Description
B_CDHSV	PROKON	AUS	function active per codeword CDHSV
B_CDHSVE	PROKON	AUS	function active per codeword CDHSVE
B_CDKAT	PROKON	AUS	function active per codeword CDKAT
B_CDKVS	PROKON	AUS	function active per codeword CDKVS
B_CDLASH	PROKON	AUS	function active per codeword CDLASH
B_CDLATP	PROKON	AUS	function active per codeword CDLATP
B_CDLATV	PROKON	AUS	function active per codeword CDLATV
B_CDLDP	PROKON	AUS	function active per codeword CDLDP
B_CDLLR	PROKON	AUS	function active per codeword CDLLR
B_CDLSA	PROKON	AUS	function active per codeword CDLSA
B_CDLSH	PROKON	AUS	function active per codeword CDLSH
B_CDLSV	PROKON	AUS	function active per codeword CDLSV
B_CDMD	PROKON	AUS	function active per codeword CDMD
B_CDNWS	PROKON	AUS	function active per codeword CDNWS
B_CDSLS	PROKON	AUS	function active per codeword CDSLS
B_CDSLSE	PROKON	AUS	function active per codeword CDSLSE
B_CDSWE	PROKON	AUS	function active per codeword CDSWE
B_CDTANKL	PROKON	AUS	function active per codeword CDTANKL
B_CDTES	PROKON	AUS	function active per codeword CDTES
B_CSCATT	PROKON	AUS	Function shut down by code word CSCATT
B_CVT	PROKON	AUS	Condition continuously variable transmission
B_F1GETR	PROKON	AUS	Condition F1-gearbox (electronic clutch control)
B_FPWDKAP	PROKON	AUS	throttle-valve control by accelerator pedal
B_KATFZ	PROKON	AUS	condition: cat fitted in vehicle
B_KATH	PROKON	AUS	Condition cat-heater installed in vehicle
B_KLIMA	PROKON	AUS	Condition air condition
B_LDSAFW	PROKON	AUS	Boost control in open loop application mode with fixed value LDRAPP
B_LDSAPP	PROKON	AUS	Boost control in open loop application mode with KFLDRAPP
B_LS3	PROKON	AUS	Condition 3. Lambda sensor installed downstream of outlet (Bank1)
B_LS32	PROKON	AUS	Condition 3. Lambda sensor installed downstream of outlet (Bank2)
B_LS4	PROKON	AUS	Condition 4. Lambda sensor installed downstream of outlet (Bank1)
B_LS42	PROKON	AUS	Condition 4. Lambda sensor installed downstream of outlet (Bank2)
B_LSH	PROKON	AUS	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank1)
B_LSH2	PROKON	AUS	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank2)
B_LSV	PROKON	AUS	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank1)
B_LSV2	PROKON	AUS	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank2)
B_MT	PROKON	AUS	Condition manuell gear box
B_NSWO1	PROKON	AUS	condition engine speed > NSWO1
B_NSWO2	PROKON	AUS	condition engine speed > NSWO2
B_SLSFZ	PROKON	AUS	condition: SLS fitted in vehicle
B_TFU	PROKON	AUS	condition ambient temperature sensor exists
B_UHRRMIN	PROKON	AUS	Condition clock with a relative counter of minutes
B_UHRRSEC	PROKON	AUS	Condition clock with a relative counter of seconds
B_WDKSAP	PROKON	AUS	throttle-blade contol by fixed value, bit 1 has priority
B_ZWAPPL	PROKON	AUS	Condition ignition-timing applications without torque intervention
CW_ERFIL	PROKON	AUS	Status codeword for selection of misfire fault codes for output to scan tool
CW_OBD	PROKON	AUS	Status Code word CWOBD
NMOT	SWADAP	EIN	engine speed
SY_2SG	PROKON	AUS	system constant 2 motronic systems
SY_AAU	PROKON	AUS	system constant: lambda value possible for exhaust-emission check by tester
SY_AAV	PROKON	AUS	system constant condition : shut-off-valve available
SY_AGR	PROKON	AUS	system constant EGR present
SY_AIRBAG	PROKON	AUS	system constant airbag-signal present
SY_ATR	PROKON	AUS	system constant exhaust-gas temperatur controller built in
SY_CAN	PROKON	AUS	system constant CAN configuration
SY_CDCSIZE	PROKON	AUS	system constant: freeze frame count
SY_CDKSIZE	PROKON	AUS	system constant CDK-size
SY_CDTSIZE	PROKON	AUS	system constant: freeze frame count
SY_CLASIZE	PROKON	AUS	system constant: freeze frame count
SY_CONFSL	PROKON	AUS	system constant: secondary air present
SY_DELFCMS	PROKON	AUS	system constant: selection of the reset routine for scan tool mode $04
SY_DFPMTIM	PROKON	AUS	system constant: Time info in fault code memory
SY_DFPMVAR	PROKON	AUS	system constant: Version of DFPM
SY_DGANZ	PROKON	AUS	system constant, number of speed sensors
SY_DLS	PROKON	AUS	system constant
SY_DOPZW	PROKON	AUS	system constant, ignition type (0=single, 1=double)
SY_DTANKL	PROKON	AUS	system constant "fuel tank empty" diagnosis active
SY_DVEADA	PROKON	AUS	system constant BGVE: disabling injection and ignition during DV-E-adaptation
SY_EGAS	PROKON	AUS	system constant E-GAS present
SY_EGFE	PROKON	AUS	system characteristic input-value
SY_FCMSIZE	PROKON	AUS	system constant: Maximum number of fault entries
SY_FFCSIZE	PROKON	AUS	system constant: Size of CARB-Freeze Frame
SY_FFESIZE	PROKON	AUS	system constant: Size of Freeze Frame-extension
SY_FFTSIZE	PROKON	AUS	System constant: freeze frame count/field
SY_FLUQ	PROKON	AUS	System constant misfire detection quantization irregular running
SY_FREQCPU	PROKON	AUS	System constant CPU frequency
SY_GAP	PROKON	AUS	system constant: number of missing teeth in the gap
SY_GGGTS	PROKON	AUS	system constant: sensor variable exact temperature signal
SY_GRDWRT	PROKON	AUS	System constant basic value, space between SW reference mark to OT in teeth
SY_HYBRID	PROKON	AUS	System constant hybrid ECU (false = conventional, true = hybrid)
SY_ISOPROT	PROKON	AUS	System constant: tester protocol selection of the ISO-standards for scan tool
SY_KMTR	PROKON	AUS	system constant: cooling-agent temperature control exists

Variable	Source	Type	Description
SY_KS1	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 1 is connected
SY_KS2	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 2 is connected
SY_KS3	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 3 is connected
SY_KS4	PROKON	AUS	system constant: input of the CC195 onto which knock sensor 4 is connected
SY_KWP71	PROKON	AUS	System constant key-word protocol KWP71 present
SY_LAMBTS	PROKON	AUS	system constant component protection present
SY_LLR	PROKON	AUS	System constant LLR configuration
SY_M1I00A	PROKON	AUS	System constant coding from DATA A in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00B	PROKON	AUS	System constant coding from DATA B in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00C	PROKON	AUS	System constant coding from DATA C in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00D	PROKON	AUS	System constant coding from DATA D in Mode 1 PID $00 acc. to SAE J1979
SY_M2I00A	PROKON	AUS	System constant coding from DATA A in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00B	PROKON	AUS	System constant coding from DATA B in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00C	PROKON	AUS	System constant coding from DATA C in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00D	PROKON	AUS	System constant coding from DATA D in Mode 2 PID $00 acc. to SAE J1979
SY_M5IH00A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH20A	PROKON	AUS	Sys. con. cod. DATA A in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20B	PROKON	AUS	Sys. con. cod. DATA B in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20C	PROKON	AUS	Sys. con. cod. DATA C in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20D	PROKON	AUS	Sys. con. cod. DATA D in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH40A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $40 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH40B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $40 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH40C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $40 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH40D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $40 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH60A	PROKON	AUS	Sys. con. cod. DATA A in mode 5 PID $60 acc. to SAE J1979 sen. downstream cat.
SY_M5IH60B	PROKON	AUS	Sys. con. cod. DATA B in mode 5 PID $60 acc. to SAE J1979 sen. downstream cat.
SY_M5IH60C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $60 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH60D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $60 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH80A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $80 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH80B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $80 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH80C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $80 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH80D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $80 acc. to SAE J1979 for sen. downst. cat.
SY_M5IV00A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80A	PROKON	AUS	Sys. const. cod. DATA A Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80B	PROKON	AUS	Sys. const. cod. DATA B Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80C	PROKON	AUS	Sys. const. cod. DATA C Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80D	PROKON	AUS	Sys. const. cod. DATA D Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M6I00A	PROKON	AUS	System constant coding from DATA A in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00B	PROKON	AUS	System constant coding from DATA B in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00C	PROKON	AUS	System constant coding from DATA C in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00D	PROKON	AUS	System constant coding from DATA D in Mode $06 PID $00 acc. to SAE J1979
SY_M8I00A	PROKON	AUS	System constant coding from DATA A in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00B	PROKON	AUS	System constant coding from DATA B in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00C	PROKON	AUS	System constant coding from DATA C in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00D	PROKON	AUS	System constant coding from DATA D in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00E	PROKON	AUS	System constant coding from DATA E in mode 8 PID $00 according to SAE J1979
SY_MAX_EV	PROKON	AUS	Maximal amount of outputs resered for injectors
SY_NLDG	PROKON	AUS	System constant: TRUE crankshaft limp home function available
SY_NWS	PROKON	AUS	system constant camshaft control: none, 2 point or continuous
SY_NZUEB	PROKON	AUS	nmot Schwelle für Übergang von Z1 nach Z2
SY_PBRPW	PROKON	AUS	system constant plausibility check brake/pedal-travel sensor
SY_PGRAD	PROKON	AUS	system constant: kind of the phase signal
SY_PGRAD2	PROKON	AUS	system constant: kind of the 2. phase signal
SY_PH2OFST	PROKON	AUS	system const. offset in syncros between the 2 active phase signals,2 PGs only
SY_PHTWIN	PROKON	AUS	system constant 1/2 phase sensing system (sensor, wheel)
SY_REDMX	PROKON	AUS	system constant: max. cylinder cutoff step
SY_SGANZ	PROKON	AUS	system constant, number of engine ECU's
SY_STEREO	PROKON	AUS	system constant condition: stereo lambda control
SY_STERHK	PROKON	AUS	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	AUS	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	AUS	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	AUS	System constant condition continuous Lambda control present

Variable	Source	Type	Description
SY_SU	PROKON	AUS	system constant: version of intake runner length adjuster
SY_SWE_S	PROKON	AUS	System constant: SWE by statistics
SY_TAGR	PROKON	AUS	system constant service device intervention EGR rate
SY_TCNS	PROKON	AUS	system constant service device
SY_TDZW	PROKON	AUS	System constant
SY_TEBF	PROKON	AUS	system constant initial filling fuel system (service device)
SY_TEETH	PROKON	AUS	system constant: number of teeth with gap teeth on the crankshaft wheel
SY_TFA	PROKON	AUS	configuration of the fitting position of air temperature sensor
SY_TFBA	PROKON	AUS	system constant service device intervention accel. enrichment
SY_TFMA	PROKON	AUS	system constant: intake air temperature signal available (initial. GGTFM)
SY_TFMAP	PROKON	AUS	system constant: intake air temp.sensor with shunt resistor in input circuitry
SY_TFMO	PROKON	AUS	system constant: engine oil temperature signal available (initial. GGTFM)
SY_TFNS	PROKON	AUS	system constant service device intervention afterstart factor
SY_TFRK	PROKON	AUS	system constant service device correction of relative fuel mass rk
SY_TFST	PROKON	AUS	system constant service device intervention start factor
SY_TFUMG	PROKON	AUS	system constant: ambient temperature sensor present
SY_TFVA	PROKON	AUS	system constant service device intervention decel. enleanment
SY_TFWL	PROKON	AUS	system constant service device intervention warm-up factor
SY_TLR	PROKON	AUS	system constant service device intervention LR, modif. of integrator stop time
SY_TMDR	PROKON	AUS	system constant service device
SY_TN	PROKON	AUS	system constant tn-signal, SY_ZYLZA/SY_TN = amount tn-impulses over 720 ° crank.
SY_TNLS	PROKON	AUS	system constant service device
SY_TRLX	PROKON	AUS	System constant for correction by service tester to rlmax exists
SY_TSFSIZE	PROKON	AUS	System constant: freeze frame count
SY_TURBO	PROKON	AUS	system constant for turbocharged engine
SY_TVVR	PROKON	AUS	system constant tester connection to vmax-control
SY_UB13V	PROKON	AUS	System constant UB value for 13 Volt
SY_UBDEDIS	PROKON	AUS	Ubatt threshold for disabling the DV-E output stage
SY_UBDEEN	PROKON	AUS	Ubatt threshold for enabling the DV-E output stage
SY_UBOKDIS	PROKON	AUS	System constant UB value for ES shutoff of DC motor
SY_UBOKEN	PROKON	AUS	System constant UB value for ES enabling of DC motor
SY_UBR	PROKON	AUS	system constant onboard battery voltage scanned from main relay input
SY_UMALS	PROKON	AUS	System constant voltage difference between sensor ground and electronic ground
SY_USOFF	PROKON	AUS	System constant voltage difference between sensor ground and electronic ground
SY_WMAX	PROKON	AUS	System constant earliest ignition timing that can be outputed
SY_WMIN	PROKON	AUS	System constant latest ignition timing that can be outputed
SY_WNBM	PROKON	AUS	System constant for angle of tooth distance from crankshaft signal
SY_ZAS	PROKON	AUS	system constant cylinder deactivation ZAS included
SY_ZNDAUS	PROKON	AUS	System constant ignition timing output (single or double fir.)
SY_ZYLZA	PROKON	AUS	system constant number of cylinders
SY_ZZBANK	PROKON	AUS	system constant cylinder assignment bank1/bank2, 0 bank1, 1 b.2, binary value

FW PROKON 53.11 Fixed Values

Parameter	Value	Description
CDAGR		code word DAGR inactiv (EURO-coding)
CDAGRL		code word to disable position sensor diagnosis (EURO coding)
CDATR		configuration byte diagnosis exhaust temperature control
CDATS		configuration byte diagnosis exhaust temperature sensor
CDDST		code word CARB: EURO byte for deactivation of tank press. sensor diagn.
CDHSH		code word heating diagnose after Kat (CDHSH = 0 => no diagnosis)
CDHSHE		Eurobit for output stage diag. of lambda sensor heating downstream of the cat.
CDHSV		code word heating diagnose upstr. Kat (CDHSV = 0 => no diagnosis)
CDHSVE		Code word DHLSE power stage of heater for diagnosis pre cat
CDKAT		code word: catalyst diagnosis in OBDII-mode (inverse: European mode)
CDKVS		code word: DKVS active/inactive, CD..=0 -> no diagnosis
CDLASH		code word O2-sensor aging diagnosis (SHK) in OBDII mode (invers => Europe mode)
CDLATP		code word oxgen sensor aging diagnosis (TP) in OBDII mode (inv.: in Europe mode)
CDLATV		code word lambda sensor monitoring (Tv) in OBDII mode (invers: Europe mode
CDLDP		code word LDP diag. in OBDII mode (inverse: Europe mode), CD..=0 -> no diapos.
CDLLR		code word DLLR inactiv (EURO-coding), CD..=0 -> no diagnosis
CDLSA		code word oxgen sensor aging diagnosis, configuration byte, for application
CDLSH		code word lambda sensor diagnosis behind KAT in OBDII-Mode (invers: Europe mode)
CDLSV		code word oxygen sensor diagnosis upstr. KAT in OBDII mode
CDMD		code word DMD inactive(EURO-coding), CD..=0 -> no diagnosis
CDNWS		code word DNWS disable (EURO-coding), CD..=0 -> no diagnosis
CDSLS		code word secondary air system in OBDII mode (inv: Europe mode)
CDSLSE		eurobyte for output stage diagnosis of secondary-valve/pump
CDSWE		code word DSWE inactive (EURO-Coding), CD..=0 -> no diagnosis
CDTANKL		code word DTANKL inactiv (EURO-coding), CD..=0 -> no diagnosis
CDTES		code word disable canister-purge monotoring (Euro coding), CD..=0 -> no dia.
CSCATT		eurobyte for scan-tool
CWERFIL		Codeword for selection of misfire fault codes for output to scan tool
CWKLIMA		code word air condition
CWKONABG		code word for configuration exhaust emission treatment
CWKONFZ1		code word for configuration vehicle
CWKONLS		code word for configuration lambda sensor
CWMDAPP		code word for calibration without torque structure
CWOBD		code word for configuration OBD certifikation
CWTF		code word for configuration temperature sensors
CWUHR		code word for the clock

Parameter	Value	Description
NSWO1		engine-speed threshold 1 for switching calculation
NSWO2		engine-speed threshold 2 for switching calculation

FB PROKON 53.11 Detailed description of function

1. Introduction:

The function describes the project configuration. That is to say that all system constants, all global code words (affecting several functions) and all Euro switches are listed here.

2.1. Software configuration by means of system constants SY_...:
System constants cause a differing (certain) compilation and thereby lead to different Hex files.
System constants cannot be applied and cannot be read by VS100.

In %PROKON, system-constant send connectors are defined as receive connectors in the functional FDEFs.
The differentiation is made:
"- System computing variables: "
  purely computing variables, e.g.: SY_REDMX
"- System description constants: "
  can switch over functional sections/characteristics, e.g.: SY_ZYLZA,

2.2. Project configuration by code words CW..:
Code words can be applied as fixed values. The same program is always used for implementating changes in code words.
E.g.: CWKONFZ1
The interface between %PROKON and the functions that use global words is established by means of status bits and bytes. These bits are evaluated in %PROKON from the code words (send connector) and read into the corresponding functions (receive connector).
Project configuration at a late date is thereby possible by using a tester at the end of the line.

2.2.1. Deactivation of diagnostic functions by means of the Euro switch CD..:
Code words which cause a shut-down of diagnostic functions (Euro switches) are designated with CD... .
E.g.: CDSLS

APP PROKON 53.11 Application hint

```
SY_ZZBANK: Zylinderzuordnung
    Ferrari F131 --> 2 Steuergeräte, die getrennt betrachtet werden (jedes für sich ist Bank1):
    Zündreihenfolge Gesamtsystem: 1 8 3 6 4 5 2 7

    Bank rechts  Zylinder Nr.   - - - - 2 4 3 1 <--- Zündreihenfolge in Pfeilrichtung
    Bank links   Zylinder Nr.   - - - - 7 5 6 8 <--- Zündreihenfolge in Pfeilrichtung
                 EvNr           8 7 6 5 4 3 2 1 <--- Einspritzreihenfolge in Pfeilrichtung-Zählweise 1 ... SY_ZYLZA
                                | | | | | | | |
    SY_ZZBANK = zzbank = 0 dez  0 0 0 0 0 0 0 0      Zylinderzuordnung zur Bank:  Bit = false (0)= Ev gehört zu Bank1,
  SY_ZZBANKB = zzbankb = 0 dez  0 0 0 0 0 0 0 0                                   Bit = true  (1)= Ev gehört zu Bank 2

SY_NWS: Nockenwellenverstellung
                = 0:    keine NWS
                = 1:    2-Punkt-NWS
                = 2:    stetige NWS
                > 2:    nicht definiert

SY_PGRAD: Typ des Nockenwellengeberrades
                = 0:    kein Geberrad vorhanden
                = 1:    1 Impuls pro 720°KW
                = 2:    nicht definiert
                = 3:    nicht definiert
                = 4:    4 Impulse pro 720°KW (BOSCH Standard Schnellstartgeberrad)

SY_PGRAD2: Typ des 2. Nockenwellengeberrades --> siehe SY_PGRAD

SY_SU: Saugrohrumschaltung
                = 0:    keine SU
                = 1:    ein Schaltausgang
                = 2:    zwei Schaltausgänge
                > 2:    nicht definiert

SY_EGFE:  Eingangsgröße Füllungserfassung
                   Bit 0: HFM vorhanden (B_hfmv)
                   Bit 1: Drucksensor hinter der Drosselklapee vorhanden (B_dssv)
                   Bit 2: Drucksensor vor der Drosselklappe vorhanden (B_dslvh)
                   Bit 3: Umgebungsdrucksensor (Pu-Sensor) (B_dsuv)

SY_TFA: Einbauort TANS-Sensor
                   Bit0: TANS-Sensor im HFM
                   Bit1: TANS-Sensor nicht im HFM

SY_ZNDAUS: 1= Einzelfunken, 2= Doppelfunken
```

DEKON 40.10 Configuration of power stage diagnosis

FDEF DEKON 40.10 Function definition

Assignment of output stages to components
----

1. Configuration of output stages
   ==============================

The configuration is made with the Label ESKONF by 7 bytes.
Every byte is standing for 4 output stages. Therefore every output stage has got 2 consecutive configuration Bits.

For Hybrid-ECUs and PCB-ECUs the Label have to be filled with different data, becaus of the different assignment of output stages to the components.

Enable of the output stages diagnosis

With the configurations-Bytes in ESKONF the functions have to be set active / inactive depending on the available components in the car. At the same time with the 2 Bits the function of the diagonis is set.
Assignment of the Bit pattern:

Pair of Bits:

1. Bit	2. Bit	
0	0	Diagnosís active with OBDII-malfunction storage with test of healing
0	1	Diagnosis active without OBDII-malfunction storage with test of healing
1	0	Diagnosis active without OBDII-Fehlerspeicherung without test of healing (-> EKP)
1	1	Diagnosis not active

The output stage diagnosis is set to "inactive" when the component ist not built-in, or also when no output stage diagnosis for is available for that component.

The following tables show a surview of the assignment of the output stages in the hybrid ECU for the proyects Alfa Romeo B-Motor.

Projekt: ME 7.3.1H B-Motor 2.0l, 1.8l mit SU- und NM-Verstellung

ESKONF Byte "	Wert /dez "	Bit 76	54	32	10
0	0	EV4 00 E_ev4/PIN M52	EV3 00 E_ev3/PIN M03	EV2 00 E_ev2/PIN M35	EV1 00 E_ev1/PIN M19
1	48	LSHVK1 00 E_hsve/PIN M34	xxxx 11 E_xxxx/PIN M21	TEV 00 E_teve/PIN M05	MIL 00 E_mile/PIN F46
2	131	EKP 10 E_kpe/PIN F30	LUE1 00 E_luea/PIN F50	LSHVK2 00 E_hsve2/PIN M02	xxxx 11 E_xxxx/PIN F02
3	240	---- 11	---- 11	KOS 00 E_kose/PIN F13	LUE2 00 E_lueb/PIN F62
4	195	xxxx 11 E_xxx /PIN M53	SU1 00 E_sue/PIN M04	NWS 00 E_nwse/PIN M36	xxxx 11 E_xxxx/PIN M20
5	255	xxxx 11 E_xxxx/PIN F18	xxxx 11 E_xxxx/PIN F33	xxxx 11 E_xxxx/PIN F34	xxxx 11 E_xxxx/PIN F01
6	255	xxxx 11 E_xxxx/PIN M13	xxxx 11 E_xxxx/PIN M13	xxxx 11 E_xxxx/PIN M45	xxxx 11 E_xxxx/PIN M45

```
Projekt:ME 7.3.1H B-Motor 1.6l Y mit NW-Verstellung
 Byte  Wert             Bit     76              54              32              10
"       /dez    "
----------------------------------------------------------------------------------------
                        |       EV4     |       EV3     |       EV2     |       EV1     |
  0     0               |       00      |       00      |       00      |       00      |
                        | E_ev4/PIN M52 | E_ev3/PIN M03 | E_ev2/PIN M35 | E_ev1/PIN M19 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
                        |     LSHVK1    |      xxxx     |       TEV     |       MIL     |
  1     48              |       00      |       11      |       00      |       00      |
                        |E_hsve/PIN M34 |E_xxxx/PIN M21 |E_teve/PIN M05 |E_mile/PIN F46 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
                        |       EKP     |      LUE1     |     LSHVK2    |      xxxx     |
  2     131             |       10      |       00      |       00      |       11      |
                        | E_kpe/PIN F30 |E_luea/PIN F50 |E_hsve2/PIN M02|E_xxxx/PIN F02 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
                        |      ----     |      ----     |       KOS     |       LUE2    |
  3     240             |       11      |       11      |       00      |       00      |
                        |               |               |E_kose/PIN F13 |E_lueb/PIN F62 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
                        |      xxxx     |      xxxx     |       NWS     |      xxxx     |
  4     243             |       11      |       11      |       00      |       11      |
                        |E_xxx /PIN M53 | E_xxx/PIN M04 |E_nwse/PIN M36 |E_xxxx/PIN M20 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
                        |      xxxx     |      xxxx     |      xxxx     |      xxxx     |
  5     255             |       11      |       11      |       11      |       11      |
                        |E_xxxx/PIN F18 |E_xxxx/PIN F33 |E_xxxx/PIN F34 |E_xxxx/PIN F01 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
                        |      xxxx     |      xxxx     |      xxxx     |      xxxx     |
  6     255             |       11      |       11      |       11      |       11      |
                        |E_xxxx/PIN M13 |E_xxxx/PIN M13 |E_xxxx/PIN M45 |E_xxxx/PIN M45 |
                        |               |               |               |               |
----------------------------------------------------------------------------------------
```

```
Projekt:ME 7.3.1H B-Motor 1.6l ECO
 Byte  Wert            Bit     76              54              32              10
"       /dez    "
------------------------------------------------------------------------------------------
                        |      EV4       |      EV3       |      EV2       |      EV1       |
  0     0               |      00        |      00        |      00        |      00        |
                        | E_ev4/PIN M52  | E_ev3/PIN M03  | E_ev2/PIN M35  | E_ev1/PIN M19  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
                        |     LSHVK1     |      xxxx      |      TEV       |      MIL       |
  1     48              |      00        |      11        |      00        |      00        |
                        |E_hsve/PIN M34  |E_xxxx/PIN M21  |E_teve/PIN M05  |E_mile/PIN F46  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
                        |      EKP       |      LUE1      |     LSHVK2     |      xxxx      |
  2     131             |      10        |      00        |      00        |      11        |
                        | E_kpe/PIN F30  |E_luea/PIN F50  |E_hsve2/PIN M02|E_xxxx/PIN F02  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
                        |      ----      |      ----      |      KOS       |      LUE2      |
  3     240             |      11        |      11        |      00        |      00        |
                        |                |                |E_kose/PIN F13  |E_lueb/PIN F62  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
                        |      xxxx      |      xxxx      |      xxxx      |      xxxx      |
  4     255             |      11        |      11        |      11        |      11        |
                        |E_xxx /PIN M53  | E_xxx/PIN M04  |E_xxxx/PIN M36  |E_xxxx/PIN M20  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
                        |      xxxx      |      xxxx      |      xxxx      |      xxxx      |
  5     255             |      11        |      11        |      11        |      11        |
                        |E_xxxx/PIN F18  |E_xxxx/PIN F33  |E_xxxx/PIN F34  |E_xxxx/PIN F01  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
                        |      xxxx      |      xxxx      |      xxxx      |      xxxx      |
  6     255             |      11        |      11        |      11        |      11        |
                        |E_xxxx/PIN M13  |E_xxxx/PIN M13  |E_xxxx/PIN M45  |E_xxxx/PIN M45  |
                        |                |                |                |                |
------------------------------------------------------------------------------------------
```

```
Definition der Fehlerspeicherschnittstellen
--------------------------------------------
```

ABK DEKON 40.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ESKONF			FW	configuration of power stage (actuators)

FW DEKON 40.10 Fixed Values

Parameter	Value	Description
ESKONF		configuration of power stage (actuators)

FB DEKON 40.10 Detailed description of function

APP DEKON 40.10 Application hint

VS_VERST 2.40 Adjusting parameters for McMess

FDEF VS_VERST 2.40 Function definition

Position	Label	Adjusting variable	Initial.value	Variable	Limit	Quant/INC.	Frame	%Section
1	vszw	Ignition timing	0° KW	Byte	-96..95.25°KW	0.75 °KW		ZUE
2	vsfrk	Mixture factor	1,0	Byte	0.75..1.25	0.001953		ESGRU
3	vsvw	Advancement angle	0° KW	Byte	-768°...762°	6° KW		ESVW
4	vsns	Nominal speed	0 RPM	Byte	0..2550/min	10 RPM		LLRNS
5	vszwkr[0]	Ignition timing firing 1	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
6	vszwkr[1]	Ignition timing firing 2	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
7	vszwkr[2]	Ignition timing firing 3	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
8	vszwkr[3]	Ignition timing firing 4	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
9	vszwkr[4]	Ignition timing firing 5	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
10	vszwkr[5]	Ignition timing firing 6	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
11	vszwkr[6]	Ignition timing firing 7	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
12	vszwkr[7]	Ignition timing firing 8	0°	Byte	-96..95.25°KW	0.75 °KW		KRRA
13	vske	Knock detection threshold	0	Byte	-8..8	0,0627		KRKE
14	vsdmr	Torque reserve	0 %	Byte	0..99.6%	0.3906%		MDKOL
15	vsfpses	Manifold air pressure	1	Byte	0..2	0,0078		AES

In case turbo installed: SY_TURBO = true

16	vsrlmx	max.rl for LDR	0%	Byte	Conv.: rel_sb_q0p75		LDRLMX
17	vsldtv	TV LDR for appl. control	0%	Byte	Conv.:tv_ub_q0p64		LDTVMA

In case camshaft adjustment present: SY_NWS = 2

18	vswnws	Angle NW for VANOS	0°	Byte	wkw_ub_q0p25	0,25 °KW		WNWEIN

%VS_VERST describes the parameters to be adjusted by means of McMess. The effects of the adjustment are described in the pertinent sections on the individual functions (refer to above table in %Section).

The RAM cells are set once to the initialization values given above for the following conditions:

1. C_ini
2. For B_mcacti = 0 (McMESS is not active). B_mcacti is updated in the 1-sec time frame.
3. For entry and exit in McMESS communication (item 3 not applicable as required, corresponds to item 2).

If CWVSV = 0 VS_VERST isn't active. Only for CWVSV > 0 adjustment with McMess is possible.

ABK VS_VERST 2.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWVSV			FW	code word f. deactivation VS_VERST (CWVSV = 0: VS_VERST inactive)

Variable	Source	Type	Description
B_MCACTI	VS_VERST	LOK	Condition McMESS active
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
SY_TURBO	PROKON	EIN	system constant for turbocharged engine
VSDMR	VS_VERST	AUS	adjustable torque reserve via VSxy
VSFPSES	VS_VERST	AUS	factor for modifying intake manifold pressure during Application injection
VSFRK	VS_VERST	AUS	Correction of the relative fuel mass by adjusting systems
VSKE	VS_VERST	AUS	adjustable offset for knock detection threshold via VS20
VSLDTV	VS_VERST	AUS	Correction value boost control from VS-sysrem for application
VSNS	VS_VERST	AUS	Change of target engine speed with calibrationg tool VSxy

Variable	Source	Type	Description
VSRLMX	VS_VERST	AUS	Additive load correction for rlmx from application system
VSVW	VS_VERST	AUS	change in the phase injection angle by the application system
VSWNWS	VS_VERST	AUS	Change of the variable camshaft angle by adjusting system VSxy
VSZW	VS_VERST	AUS	Ignition-timing correction by adjusting system
VSZWKR	VS_VERST	AUS	cylinder individual adjustment of ignition angle by VS2x

FW VS_VERST 2.40 Fixed Values

Parameter	Value	Description
CWVSV		code word f. deactivation VS_VERST (CWVSV = 0: VS_VERST inactive)

FB VS_VERST 2.40 Detailed description of function

APP VS_VERST 2.40 Application hint

EG 4.0 Input variables including diagnostics for these

FDEF EG 4.0 Function definition

The functional group EG contains the detection of input signals of the engine control system (ECS) and its diagnosis. Over and above that, further engine parameters are calculated using the measured input values.

The group is structured in following subgroups:

EGNWE: input values rotational speed- and angle detection
EGFE: input signals load detection
EGTE: input parameter of temperature acquisition
EGAK: input signal of exhaust value of catalyst
EGEG: input variable E-Gas
EGKE: input signals knock detection
EGAG: general input values

ABK EG 4.0 Abbreviations

FW EG 4.0 Fixed Values

Parameter	Value	Description

FB EG 4.0 Detailed description of function

The function group "input signals" separates parts of the system that depend direct on the sensor acquisition, from these parts of the engine control functions which are independent from the hardware.

Inputs of the group EG are signals from sensors (e.g. output signal of the inductive rotational speed sensor). These signals are calculated in the corresponding function to physical - sensor independent - state variables of the engine or vehicle (e.g. engine speed nmot in 1/min). There is a diagnosis of the detected signals. If a fault is detected an adequate limp home function is activated.

Finally further engine parameters are calculated using the direct measured values, because of their physical relationship (e.g. speed gradient using the rotational speed, relative air charge using the intake-air mass). For this calculation simple relationships like differential quotients for computing the gradient are used as well as complex physical models in calculating the engine load.

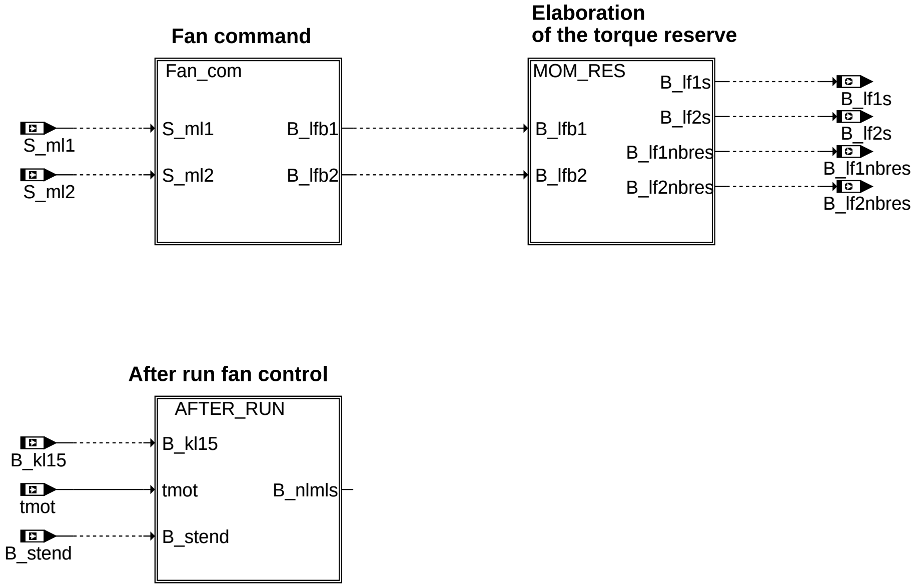
The relevant functions are designated after following conventions in general:

```
contraction     |     description
----------------+-----------------------------------------------------------------------------
  - EG...       |    functional group of input value detection.
  - GG...       |    function for sensor signals which describes the evaluation of the sensor signals and often the diagnosis
                |     of the sensor. These functions are sensor specific and depend on the ECU hardware.
  - D...        |    diagnosis function which describes the check of the sensor signal if it is not included in GG functions.
  - BG...       |    calculated value: describes the determination of engine parameters which can not be measured directly.
```

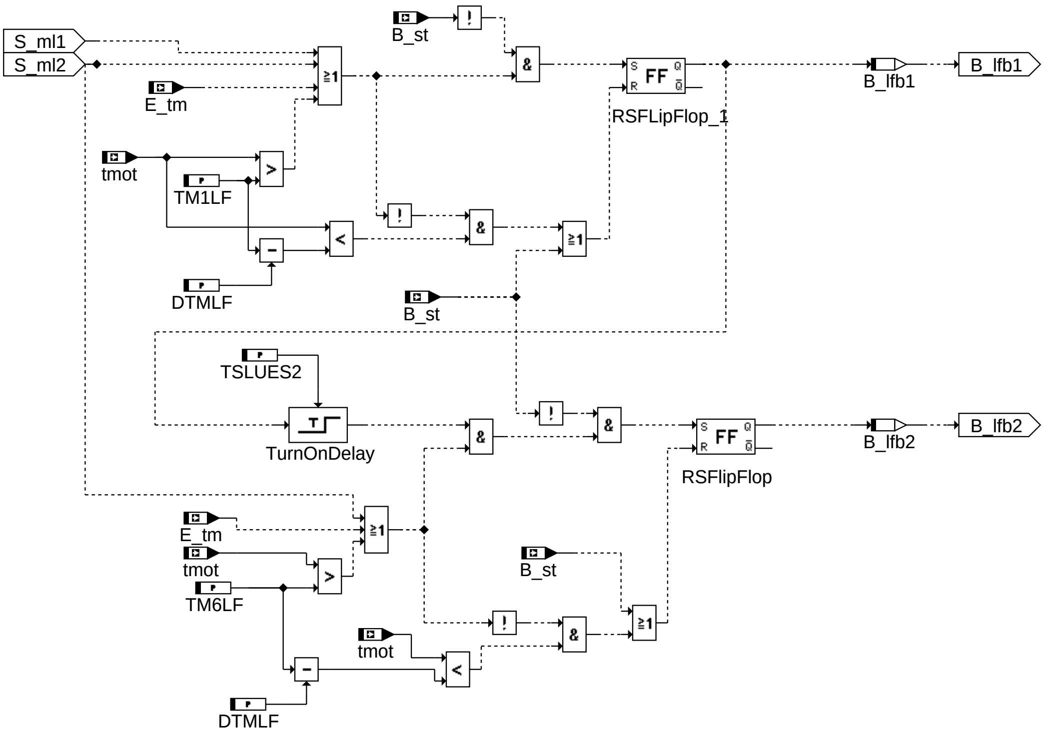
APP EG 4.0 Application hint

LFS 18.30 Engine cooling fan control

FDEF LFS 18.30 Function definition

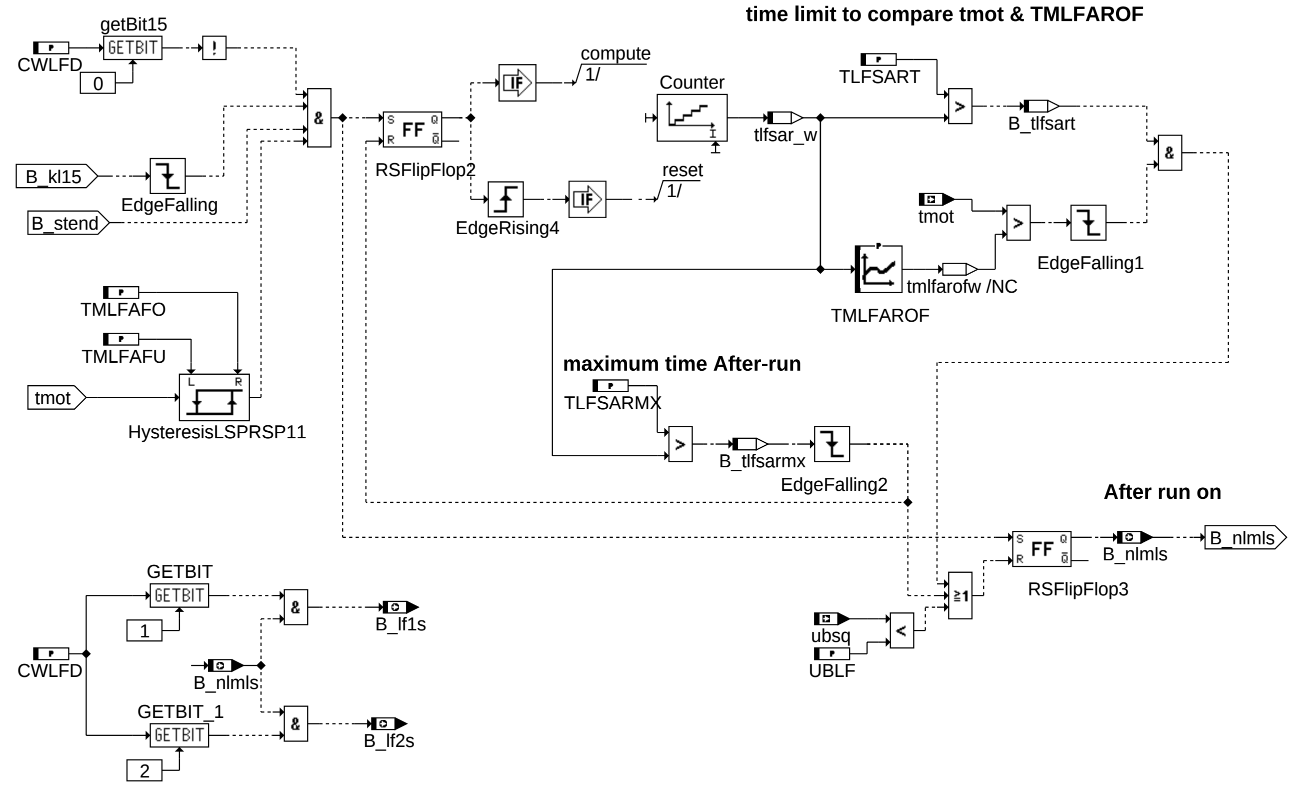


lfs-main

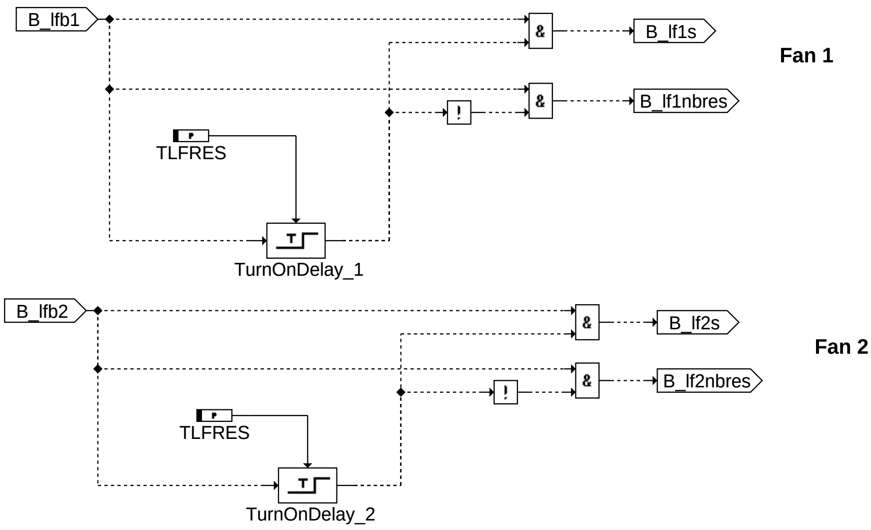


lfs-fan-com

After run Cooling fan Control



lfs-after-run



lfs-mom-res

```
No text for FDEF available!
```

ABK LFS 18.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWLFD			FW	Codewort : configuration of the fan control
DTMLF			FW	hysteresis engine temperature fan control
TLFRES			FW	time of delay prior to changing the fan speed (torque reseve)
TLFSARMX			FW	maximum time for the after-run operation
TLFSART			FW	time limit in after-run to compare engine coolant temperature
TM1LF			FW	Engine temperature threshold 1 for cooling fan control step 1
TM6LF			FW	Engine temperature threshold 6 for cooling fan control step 2
TMLFAFO			FW	engine cooling temperature above which After-run operation is started
TMLFAFU			FW	engine cooling temperature above which After run operation is started

Parameter	Source-X	Source-Y	Type	Description
TMLFAROF	TLFSAR_W		KL	Engine coolant temperature below which After run is termined
TSLUES2			FW	Delay time of fan stage 1 to 2 in [sec]
UBLF			FW	minimal battery voltage for fan afterrun

Variable	Source	Type	Description
B_KL15		EIN	condition ignition switch on
B_LF1NBRES	LFS	AUS	Condition for torque reserve for engine cooling fan step 1 normal operation on
B_LF1S	LFS	AUS	fan 1 on condition
B_LF2NBRES	LFS	AUS	Condition for torque-reserve build at engine-fan stage 2, normal operation on
B_LF2S	LFS	AUS	fan 2 on condition
B_LFB1	LFS	LOK	fan 1 stand by condition
B_LFB2	LFS	LOK	fan 2 stand by condition
B_NLMLS	LFS	AUS	request for ECM afterrun from the engine-fan-control
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TLFSARMX	LFS	LOK	Condition: time limit during After run to compare tmot
B_TLFSART	LFS	LOK	Condition: time limit during After run to compare tmot
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
S_ML1		EIN	
S_ML2		EIN	
TLFSAR_W	LFS	LOK	time during After run to compare Engine coolant temperature
TMOT	SWADAP	EIN	Engine temperature
UBSQ	GGUB	EIN	battery voltage (on board), conversed to standard quantization

FW LFS 18.30 Fixed Values

Parameter	Value	Description
CWLFD		Codewort : configuration of the fan control
DTMLF		hysteresis engine temperature fan control
TLFRES		time of delay prior to changing the fan speed (torque reseve)
TLFSARMX		maximum time for the after-run operation
TLFSART		time limit in after-run to compare engine coolant temperature
TM1LF		Engine temperature threshold 1 for cooling fan control step 1
TM6LF		Engine temperature threshold 6 for cooling fan control step 2
TMLFAFO		engine cooling temperature above which After-run operation is started
TMLFAFU		engine cooling temperature above which After run operation is started
TSLUES2		Delay time of fan stage 1 to 2 in [sec]
UBLF		minimal battery voltage for fan afterrun

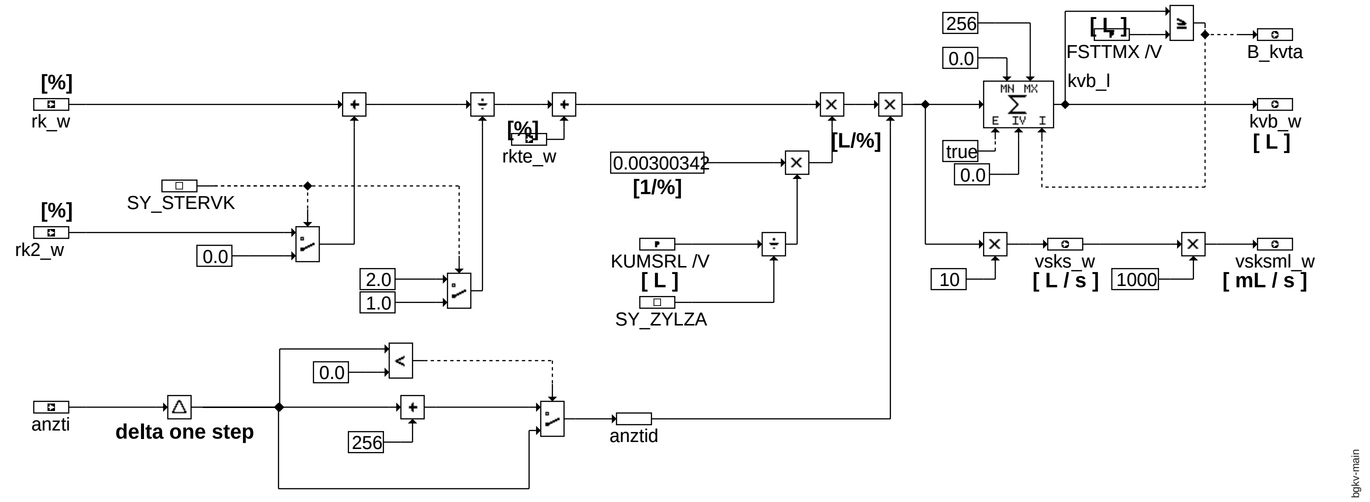
FB LFS 18.30 Detailed description of function

APP LFS 18.30 Application hint

BGKV 1.30 Calculation variable consumed fuel

FDEF BGKV 1.30 Function definition

`Overview of the function: BGKV`



bgkv-main

ABK BGKV 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FSTTMX			FW	maximum fuel tank capacity
KUMSRL			FW	conversion constant from mass flow to relative air charge
SY_STERVK			SYS	system constant condition: stereo exhaust system upstream of cat
SY_ZYLZA			SYS	system constant number of cylinders

Variable	Source	Type	Description
ANZTI	ACIFI	EIN	injection counter
ANZTID	BGKV	LOK	difference between injection counters in the calculation matrix
B_KVTA	BGKV	AUS	condition consumed fuel larger then tank capacity
KVB_W	BGKV	AUS	consumed fuel
RK2_W	MSF	EIN	relative fuel mass Bank2
RKTE_W	TEB	EIN	relative fuel part of the purge control
RK_W	MSF	EIN	relative fuel mass
VSKSML_W	BGKV	AUS	volumetric flow of fuel in ml/s
VSKS_W	BGKV	AUS	Volumetric flow of fuel in L/s

FW BGKV 1.30 Fixed Values

Parameter	Value	Description
FSTTMX		maximum fuel tank capacity
KUMSRL		conversion constant from mass flow to relative air charge

FB BGKV 1.30 Detailed description of function

```
Motivation:
===========
The quantity of fuel used up is needed for diagnosis of the fluid-level sensor in the tank with respect to the consumption.
The value for the amount of fuel consumed can also be used as consumption information for the driver.

Task:
=======
Calculation of the fuel consumed, whereby the integration can only then be reset when the quantity of fuel consumed is the same as
the tank contents.

Principle:
==========
The relative quantity of fuel injected rk_w is totaled together with the quantity of fuel from the tank ventilation rkte_w
following a conversion of this into a volume.
The total of the fuel masses rk_w and rk2_w calculated in synchronization is carried out in the 100-ms time frame. To do this, the
difference is formed from the injection counter anzti from the last 100-ms mark and multiplied by the current value from rk_w.
For a two-bank system, the fuel consumed is calculated from the mean value from both of the relative fuel masses rk_w and rk2_w.

The conversion of the relative fuel mass rk_w to the magnitude of the fuel consumed kvb_w is realized by multiplication of a
constant conversion factor (0.00300342) and KUMSRL/cylinder number.

Physical relationship of the conversion factor:
==============================================
Initially it applies that:
                KUMSRL = VH [dm^3] / 2578 = engine displacement volume / 2578

The conversion factor is then given from the definition for rk_w:

                                                           Air density * Cylinder displacement volume
       kvb_w / rk_w  = Fuel consumed / rel. fuel mass  =  ------------------------------------------   =
                                                           Fuel density * A/F ratio lambda 1.0 * 100%

        rho0air [g/dm^3] * KUMSRL[dm^3]/cylinder no. * 2578
        ---------------------------------------------------
        rho0KS   [g/dm^3] * LST * 100 [%]

using the values:
        rho0air = 1.293 [g/dm^3]
        rho0KS   = 755.0 [g/dm^3]
        LST      = 14.7
it is given that:                   rk_w[%] * 0.00300342[1/%] * KUMSRL [L] /ZYLZA = kvb_w [L]


A value in liters should be given as the output variable of the function for the fuel consumed during the current driving cycle.
The totalizer shall not overrun and is only then reset when an applicable mark KVBMX is reached.
FSTTMX is thereby the maximum possible volume of fuel consumed during a driving cycled. This maximum volume should be the maximum
tank quantity.

Remarks on ASCET-SD diagram
============================
a)
The function with the remark "delta one step" realizes the following function in accordance with the name assigned for this:
                        anztid(t) = anzti(t) - anzti(t-1)
if t is discrete time variable.
b)
The switching design according to "delta one step" shall support the overrun function of the anzti
 counter.
```

APP BGKV 1.30 Application hint

```
For the application,
                - the maximum tank quantity must be entered in FSTTMX
```

BGBSZ 4.10 Calculated Variable Operating Track Counter

FDEF BGBSZ 4.10 Function definition

Die im Folgenden berechneten Daten werden über KWP 2000 an den Diagnose-Tester ausgegeben.

Betriebsstrecke kmst_l:

Ebenfalls wird durch Aufaddieren der Geschwindigkeit vfzg_u in einem festen Zeitraster (100ms) die in diesem Fahrzyklus zurückgelegte Strecke kmst100m berechnet. Die Strecke wird im Nachlauf auf die gesamte mit dem Fahrzeug zurückgelegte Strecke aufaddiert und im EEPROM abgelegt als kmst_l. Der 'Kilometerstand wird als 32bit Größe mit 100m/Inc abgespeichert.

Achtung: In Verbindung mit einem Geschwindigkeitsgeber-Fehler kann der 'Kilometerstand' verfälscht werden.

```
             +------------+
vfzg_u ----->|Integration |
             |je 100ms    |            +--------+       +-------+
             |      /     +----------->|A  A>=B +------>|   +-- +-----+----------+
             |     /      | 0,1 km --->|B       |       |   ^   |     |          V
  -0,1 km +->|  __/       | (3600 inc) +--------+       | --+   |     |     +-----------+
          |  +------------+                             +-------+     |     | ^  T      |
          +-----------------------------------------------------------+     | |    /    |--+-->kmst_l
                                                                            | |         |  |
                                                                            | | /       |  +-->kmst100m_w
                                                                            | +-------> |  |
                                                                         1->|           |  +-->kmst6553_w
                                                                            +-----------+
```

Maximaldrehzahl nmaxa:

In dem Programm wird die jemals gefahrene Höchstdrehzahl erfaßt und abgespeichert (nmaxa).
Dieser Wert wird ebenfalls im EEPROM abgespeichert.

Anzahl und Dauer der Fahrten in der Drehzahlbegrenzung:

```
B_nmax --------------------+     +---+                                             +----------------+
             +---------+   +---->| & |                        +---+----+           |   Zeitzähler   |
nmot ------->| > NMAXU +-------->|   +--+-------------------->| S |    |           | ^ t            |    c_nmax
             +---------+         +---+  |    +-----------+    +---+    +---+------>| |   /  c_nmax  +----------->
                                        |    | 300 ms+-- +--->| R |    |   |       | |  / 100 ms/inc|
                                        +-->o|-------+   |    +---+----+   |       | | /   16 bit   |
                                             +-----------+                 |       | +------------->|
                                                                  +--------+       +----------------+
                                                                  |
                                                                  |    +------+    +----------------+
                                                                  |    |  +-- |    |   Zähler       |
                                                                  +--->|--+   +--->| ^              |   anznmax
                                                                       +------+    | |   /  anznmax +----------->
                                                                                   | |  /   8 bit   |
                                                                                   | | /            |
                                                                                   | +------------->|
                                                                                   +----------------+
```

NMAXU: Da B_nmax auch bei Drehzahlbegrenzung bei EGAS-Notlauf oder Getriebeschutz gesetzt wird.
Vorschlagswert NMAXU: Nähe NMAXD   ca. 6000 1/min.
Entprellzeit 300 ms: notwendig, da B_nmax bei aktiver Drehzahlbegrenzung ca. im "100 ms-Takt" jittert.

ABK BGBSZ 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NMAXU			FW	lower n max threshold

Variable	Source	Type	Description
ANZNMAX	BGBSZ	AUS	Number of times NMAX exceeded
B_NMAX	NMAXMD	EIN	1 = maximum engine speed exceeded
C_NMAX	BGBSZ	AUS	
KMST100M_W	BGBSZ	AUS	Kilometers covered by vehicle (Odometer) 100m/Inc as 16 bit low-word
KMST6553_W	BGBSZ	AUS	Kilometers covered by vehicle (Odometer) 6553,6km /Inc as 16 bit high-word
KMST_L	BGBSZ	AUS	Kilometers covered by vehicle (Odometer) 100m/Inc as 32bit-longword
NMOT	SWADAP	EIN	engine speed
VFZG_U	DFFTCNV	EIN	Vehicle speed

FW BGBSZ 4.10 Fixed Values

Parameter	Value	Description
NMAXU		lower n max threshold

FB BGBSZ 4.10 Detailed description of function

APP BGBSZ 4.10 Application hint

EGNWE 1.0 Input values rotational speed- and angle detection

FDEF EGNWE 1.0 Function definition

ABK EGNWE 1.0 Abbreviations

FW EGNWE 1.0 Fixed Values

Parameter	Value	Description

FB EGNWE 1.0 Detailed description of function

`description missing !!!!`

APP EGNWE 1.0 Application hint

GGDPG 14.30 Input Signals: engine speed and phase sensor

FDEF GGDPG 14.30 Function definition

```
Overview                                       %GGDPG:  +--------------------------------------+
                                                        | Synchronization via run-out position |
                                                        | Synchronization via quick-start      |
           +----------------+                           | Synchronization via gap search       |
           | Conditioning   | NBM                       | Formation of the signals:            |
DG ------->| circuit        |--------------+----------->|      Cylinder counter                |-------------> zzyl
           | DG ---> NBM    |              |            |      Tooth counter in the segment    |-------------> zzseg
           +----------------+        +-----|----------->|      Cycle synchro                   |-------------> R_syn
                                     |     |            |      Quick-start synchronization     |-------------> B_qsyn
                                     |     |            |      BM in the window                |-------------> B_bm
                                     |     |            |      BM-fault                        |-------------> B_fbm
                                     |     |            |      Synchronization performed       |-------------> B_syn
           +----------------+        |     |            |      Synchronization via phase       |-------------> B_synph
           | Conditioning   |        |     |            |      Phase signal/s                  |-------------> B_phase/B_phas2
PG ------->| circuit        | PH/PH2 |     |            |      Cycle for phase inquiry/s       |-------------> R_synph/R_synph2
PG2------->| PG   ---> PH   |--------+     |            |      Engine speed/underspeed         |-------------> B_nmot/B_nmin
           | PG2 ----> PH2  |        |     |            |      Angle crankshaft                |-------------> wkw_w
           +----------------+        |     |            |      Tooth edge counter              |-------------> znbm_w
                                     |     |            |      Tooth time table                |-------------> zztab
                                     |     |            |      Phase edge counter              |-------------> zrph/zrph2
                                     |     |            |      .                               |     .         .
                                     |     |            |      .                               |     .         .
                                     |     |            |      .                               |     .         .
                                     |     |            +--------------------------------------+
                                   PH|     |NBM                          ||||
                                  PH2|     |            +--------------------------------------+
                                     |     |            |      Angle adaptation camshaft       |
                                     +-----|----------->|      to crankshaft: %WANWKW          |
                                     |     |            +--------------------------------------+
                                   PH|     |NBM                          ||||
                                  PH2|     |            +--------------------------------------+
                                     |     |            |                                      |
                                     +-----|----------->|      Diagnosis speed sensor: %DDG    |
                                     |     |            |                                      |
                                     |     |            +--------------------------------------+
                                   PH|     |NBM                          ||||
                                  PH2|     |            +--------------------------------------+
                                     |     |            |                                      |
                                     +-----|----------->|      Diagnosis phase sensor: %DPH    |
                                     |     |            |                                      |
                                     |     |            +--------------------------------------+
                                  PH/PH2  NBM
```

```
  mechanical 60-2 crankshaft ring gear:
                                                   BM ... reference mark                       TDC cylinder 1
                   !                        !    !                                             !
        tnbm       !<------ tooth gap ----->!    !<----- GDWRT          -------------->!
    !<------->!    !                        !    !       ( = reference mark position )         !
                   V                        V    V                                             !
    +----+    +----+    +....+    +....+    +----+    +----+    +----+    +----+          +----+    +----+    +----+
    |\\\\|    |\\\\|                        |\\\\|    |\\\\|    |\\\\|    |\\\\|          |\\\\|    |\\\\|    |\\\\|
  --+\\\\+----+\\\\+------------------------+\\\\+----+\\\\+----+\\\\+----+\\\\+---....---+\\\\+----+\\\\+----+\\\\+--
" /////////////////////////////////////////////////////////////////////////////////////////////////////////////////////"
                        <----------------------------  direction of rotation                   !
                                                                                               !
  digital input signal NBM:                               !<---------- Software-BM ------------>!
                                                         !                                     .
  +----+    +----+    +....+    +....+    +----+    +----+    +----+    +----+          +----+ .  +----+    +----+
  |    |    |    |                        |    |    |    |    |    |    |    |          |    | .  |    |    |    |
  +    +----+    +------------------------+    +----+    +----+    +----+    +---....---+    +----+    +----+    +--
                                                         !                                     .
Phase signal of the camshaft:                            !                                     .
                                                         !                                     .
                                                         !                                   ITDC cylinder 1
  - Phase signal before ITDC cylinder 1:                 !                                     !
          5V --------------------------+                 !                 +-....-----------------------------
                                       |                 !                 |                   .
          0V ................          +-------...--------------...--------+                   .
                                       <---------------->!<---------------->                   .
                                                  reference tooth edge                         .
                                                         !                                     .
                                                         !                                  CTDC cylinder 1
  - Phase signal before CTDC cylinder 1:                 !                                     !
          5V ................          +-------...--------------...--------+                   .
                                       |                 !                 |                   .
          0V --------------------------+                 !                 +-....-----------------------------
                                       <---------------->!<---------------->                   .
```

The section %GGDPG contains the following functions:

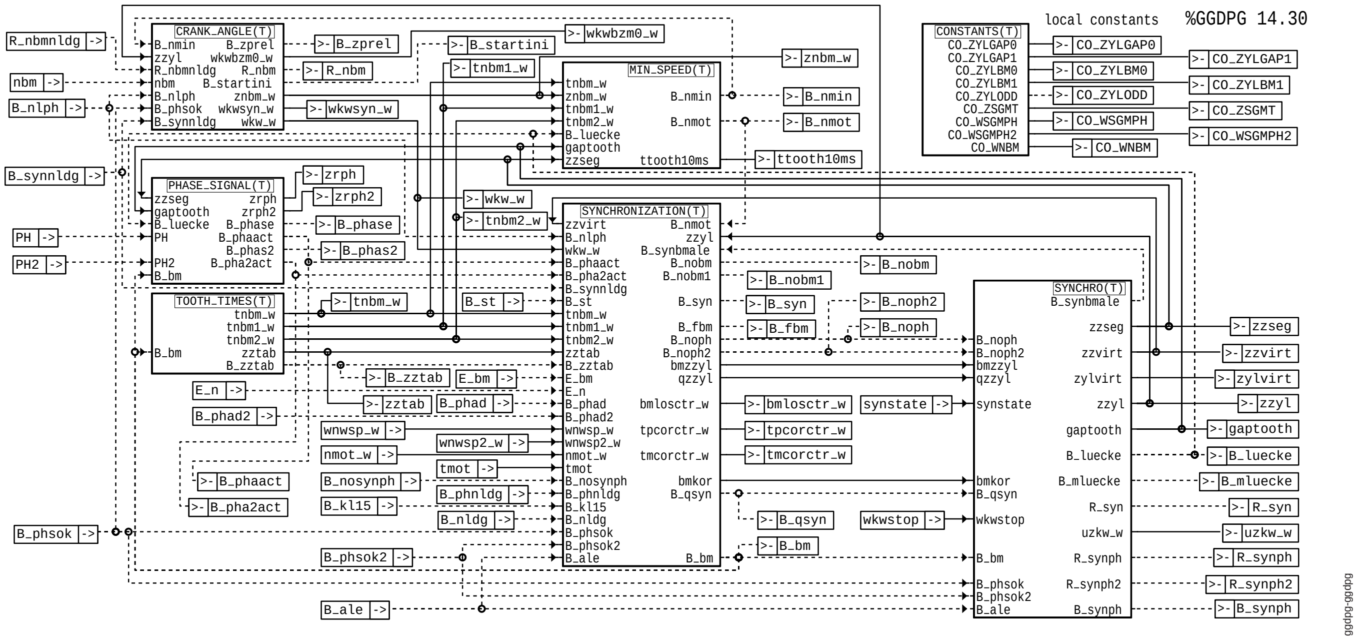
- CRANK_ANGLE
  - * Tooth debouncing, B_zprel
  - * Continuous tooth counter znbm_w resp. angle counter wkw_w
  - * Angle at the beginning of the working cycle wkwbzm0_w
  - * Angle at the beginning of the segment wkwsyn_w
- PHASE_SIGNAL
  - * Scanning of the phase signal B_phase, B_phas2
  - * Phase edge counter zrph, zrph2
- TOOTH_TIMES
  - * Formation of the tooth times tnbm_w, tnbm1_w and tnbm2_w during the gap search
  - * Formation of the tooth time table zztab after found gap
- MIN_SPEED
  - * Monitoring of the crankshaft (CS) signal for engine speed (B_nmot) resp. underspeed (B_nmin)
- SYNCHRONIZATION
  - * Synchronization search
    - Gap search, setting of B_bm
    - Phase synchronization at the gap
    - Quick-start synchronization via the quick-start sensor wheel

  - * Monitoring of the synchronization search, B_nobm

  - * Gap check, B_bm, B_fbm
    - Gap correct ==> B_bm=1, B_fbm=0
    - Gap 1 tooth incorrect ==> B_bm=1, B_fbm=1, trigger correction by 1 tooth
    - Gap not found ==> B_bm=1, B_fbm=1, trigger new synchronization
- SYNCHRO
  - * Formation of the cylinder counter

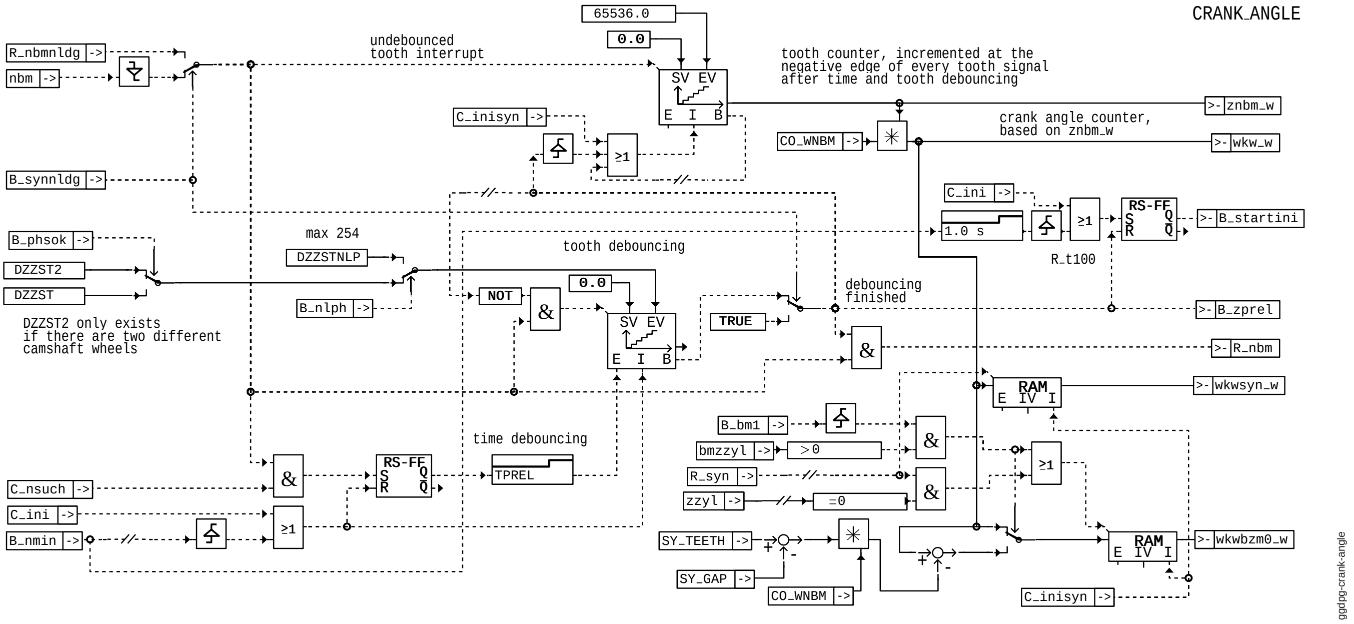
  - * Generation of the synchro interrupt (R_syn)
  - * Generation of the cycles for the phase inquiry (R_synph, R_synph2)
  - * Crankshaft revolution counter (uzkw_w)

  - * Calculation of the initialization values for the cylinder and the tooth counter from the stop position wkwstop calculated in the run-out detection.



ggdpg-ggdpg

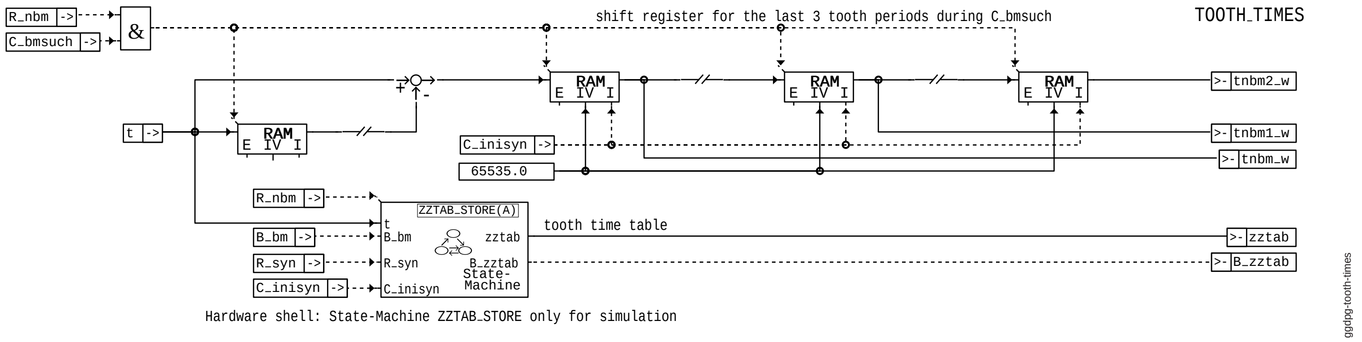
```
Functional Overview %GGDPG
--------------------------
```



ggdpg-crank-angle

Partial function for tooth debouncing, formation of tooth counter znbm_w resp. of sensing of the continuous crank angle wkw_w.

During the speed search phase (C_nsuch) the time debouncing TPREL is started at the first tooth. After this debouncing the tooth debouncing counter is started and B_zprel is set delayed by DZZST teeth. If the system is in the limp home mode for the camshaft sensor, then the counter is switched to DZZSTNLP to achieve a delay of the synchronization. znbm_w resp. wkw_w is again reset with B_zprel. The angle wkw_w is re-stored to wkwsyn_w at each synchro interrupt R_syn. The current crank angle wkw_w is written into wkwbzm0_w at the beginning of the working cycle (R_syn and zzyl = 0). If the synchronization takes place at the second reference gap (BM1) so wkwbzm0_w is once set to the beginning of the working cycle.



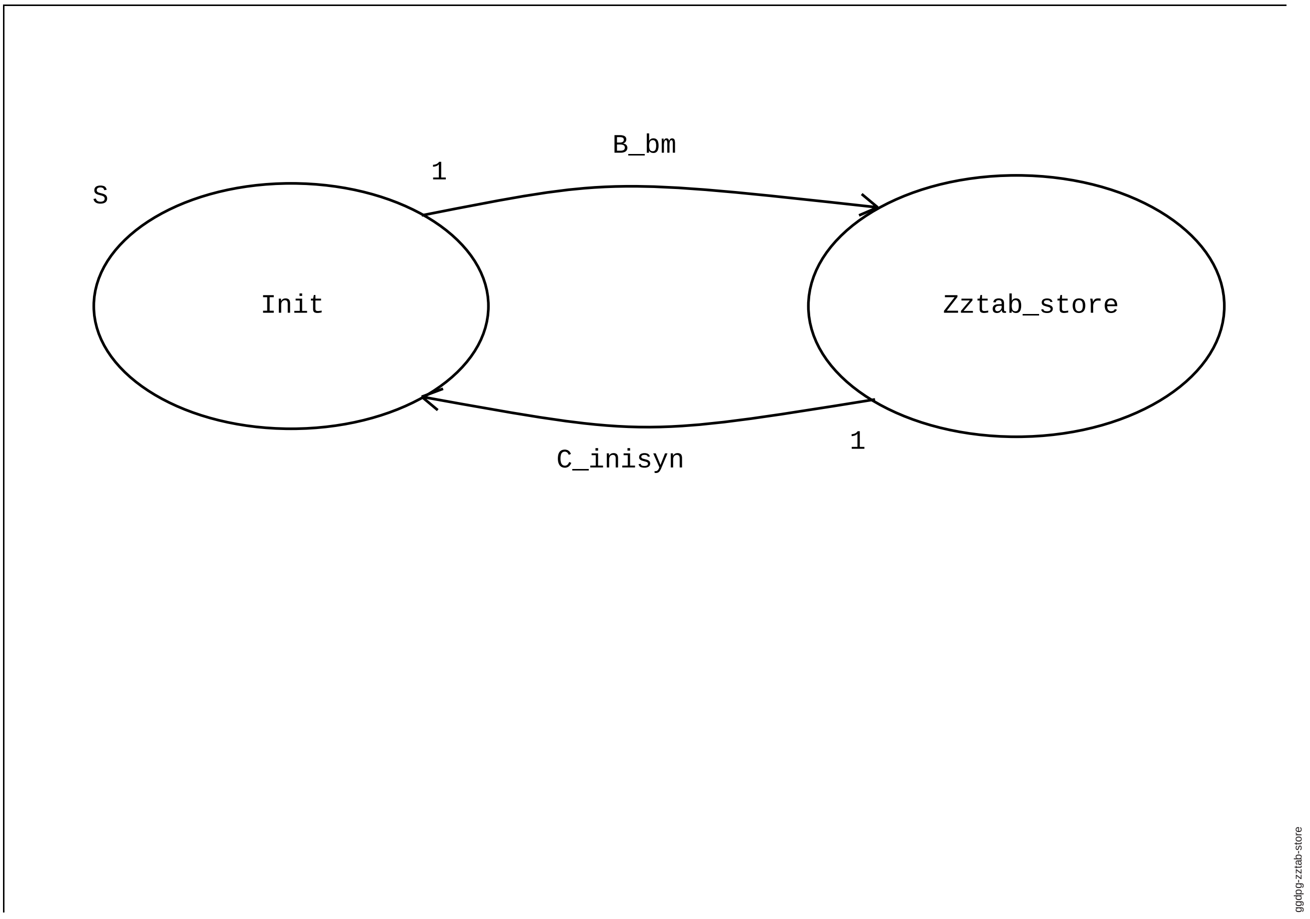
ggdpg-tooth-times

Calculation of the tooth times resp. formation of the tooth time table.

During the reference mark search phase (C_bmsuch) the period tnbm_w is formed with each tooth and shifted to a shift register with 3 elements (tnbm_w, tnbm1_w and tnbm2_w).

As soon as the reference mark was found (B_bm = 1) the system time t of the respective tooth is written into the tooth time table in ZZTAB_STORE. The condition B_zztab is set as soon as the tooth time table is completely filled (2. synchro).

The partial function ZZTAB_STORE is calculated in the hardware casing and is illustrated here as state machine for the simulation.

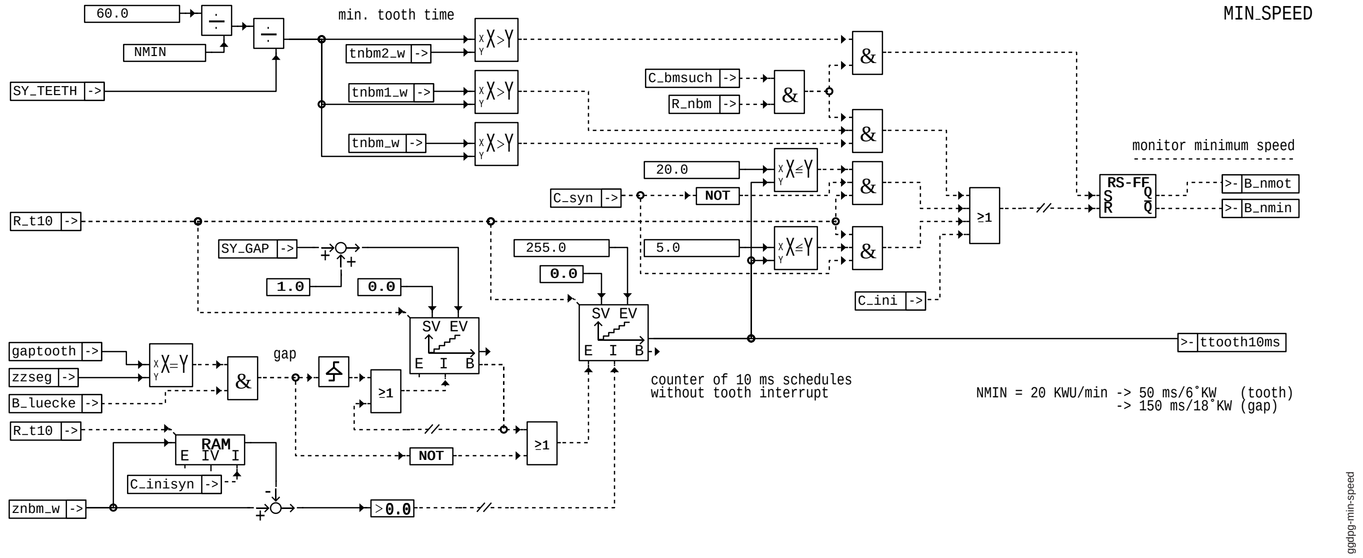


ggdpg-zztab-store

State machine to store the system time t into the tooth time table when a tooth interrupt occurs.

At each tooth interrupt the table pointer zztabptr is increased and the current segment time t is written into the tooth time table. In the synchro interrupt the two latest tooth times are copied to the beginning of the table and the pointer is set to the second table entry.

```
 State                                  State-Machine ZZTAB_STORE
 |    Transition name  +- Transition condition
 |    |    Actions     +- Action code
 |    |    |           |
 V    V    V           V
------------------------------------------------------------------------------------------------------------------------------------

 Init
          Entry:                                                  -- ZZTAB_STORE
                                                                  -- generates the tooth time table
                      B_zztab := false;
                      zztabptr := 2;

     B_bm:            B_bm = true

------------------------------------------------------------------------------------------------------------------------------------

 Zztab_store                                                      --  Model of the tooth time table
                                                                  --  Description of the parameters:
                                                                  --  Inputs:
                                                                  --      R_nbm:     tooth interrupt schedule
                                                                  --      R_syn:     synchro schedule
                                                                  --      t:         time, based on processor cycle time
                                                                  --      C_inisyn:  initializing state
                                                                  --      B_bm:      condition reference gap found, to
                                                                  --                 enable the writing of the table
                                                                  --  Outputs:
                                                                  --      zztab(0:SY_ZSGMT+2):  tooth time table,
                                                                  --                            length: segment length + 3
                                                                  --      B_zztab:              tooth time table valid
                                                                  --  Variables:
                                                                  --      zztabptr:  Pointer to last entry in the table
          Entry:      zztab(zztabptr) := t;

          Action:     if ( R_nbm ) then                           -- tooth-interrupt
                          zztabptr := zztabptr + 1;               -- increase pointer
                          zztab(zztabptr) := t;                   -- store time
                      endif;

                      if ( R_syn ) then                           -- synchro schedule
                          zztab(1) := zztab(zztabptr);            -- move the last 2 times
                          zztab(0) := zztab(zztabptr - 1);        -- to the beginning of the table
                          if ( B_zztab = false ) then             -- if table not yet valid
                            B_zztab := true;                      -- table filled up the first time
                          endif;
                          zztabptr := 1;                          -- reset pointer
                      endif;

     C_inisyn:        C_inisyn
====================================================================================================================================
 Local variables:

     Int zztabptr := 2;
```

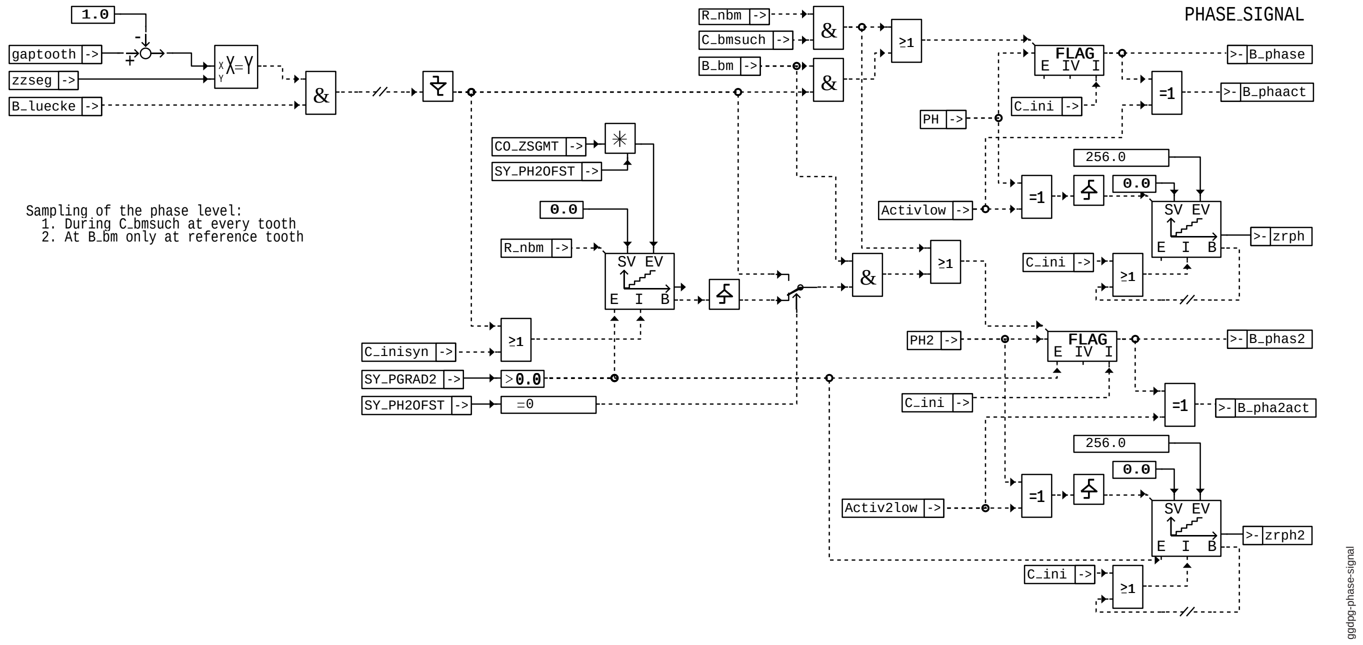


ggdpg-min-speed

Formation of the condition underspeed (B_nmin) resp. engine speed (B_nmot).

During the speed search (C_nsuch) the tooth time tnbm2_w is compared in the tooth interrupt to the minimum tooth time NMIN and if necessary B_nmot is set. Resetting of B_nmot is performed, if during the speed search phase tnbm_w and tnbm1_w again become greater than the minimum tooth time or if the counter ttooth10ms reaches the value 20 (200 ms) resp. during synchronized operation 5 (corresponds to a tooth time of 50 ms). B_nmin results as a complement of B_nmot.

The counter ttooth10ms is incremented in the 10 ms cycle, if no new tooth has occurred, otherwise the counter is reset to 0. During the gap the counter is incremented only every 3rd cycle, so as to make sure that an early underspeed exiting at the gap does not occur.

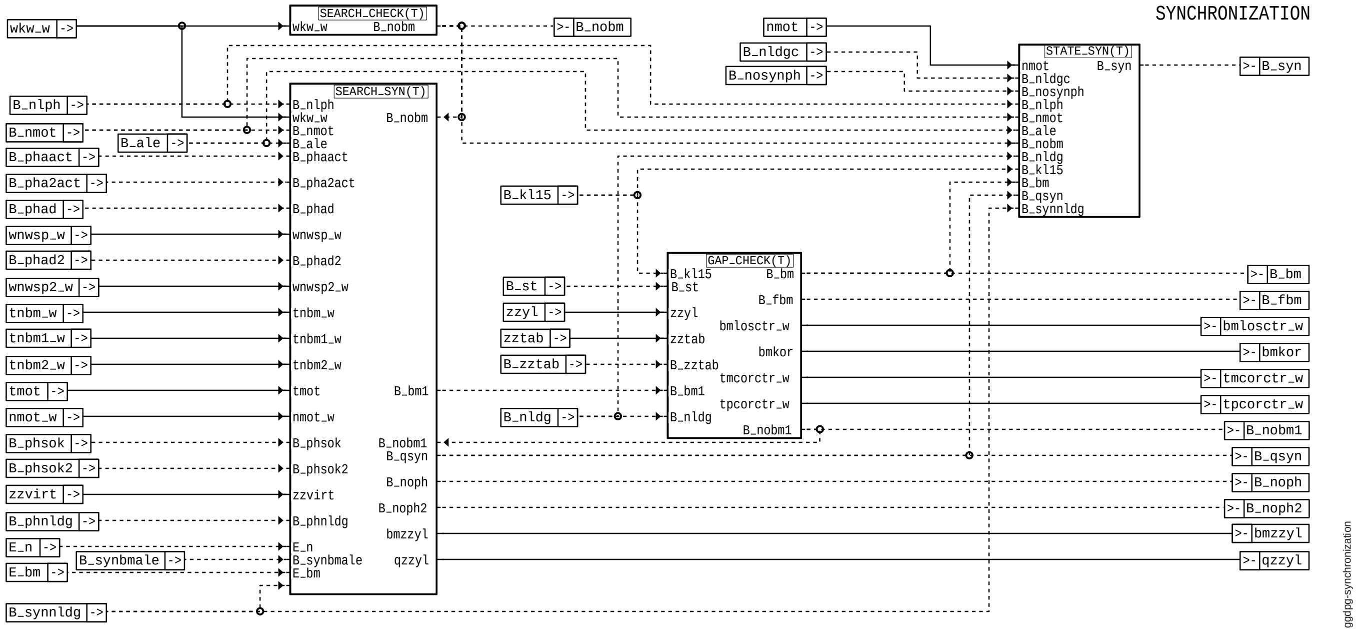


ggdpg-phase-signal

Scanning of the phase level PH resp. PH2.

The phase levels PH resp. PH2 are scanned in the tooth interrupt during the reference mark search phase (C_bmsuch). During the subsequent operation synchronized via B_bm, PH is scanned at the second tooth after the gap (zzseg = (gap tooth - 1) and B_luecke = true). When SY_PH2OFST = 0, PH2 is scanned together with PH, otherwise delayed by SY_PH2OFST segments to PH. The thus scanned variables B_phase and B_phas2 (standardization: B_phaact, B_pha2act) can be represented at the VS100.

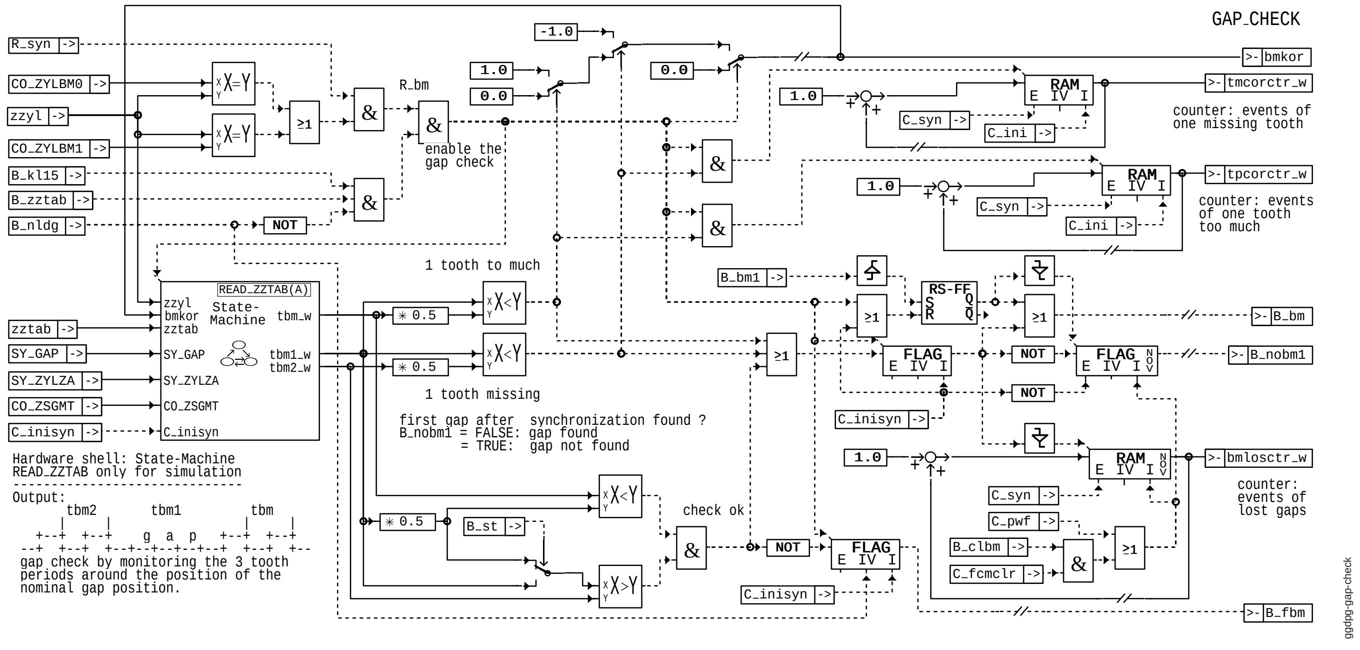
For the hardware casing the level at the first reference mark of the respective phase sensor is defined by means of the macros Activlow resp. Activ2low. By means of the logic operation (PH* EXOR Activ*low) the ’active’ phase edge is determined and the number of ’active’ phase edges is summed up in zrph*.



ggdpg-synchronization

Functional overview synchronization:

SEARCH_SYN	Synchronization search
SEARCH_CHECK	Checking of the synchronization search
GAP_CHECK	Checking of the gap
STATE_SYN	Formation of the condition synchronization



ggdpg-gap-check

Checking of the gap by means of the tooth time table: Gap check

As soon as the gap was found (B_bm1 0->1) B_bm is set. Thereafter it is checked during the gap check, whether the gap has been found correctly. The gap check is performed during the synchro after the gap segment (zzyl=CO_ZYLBM0 or zzyl=CO_ZYL_BM1) if: Terminal 15 ON, tooth time table valid and not speed sensor limp-home. The state machine READ_ZZTAB calculates the 3 tooth periods of the teeth in front (tbm2_w), during (tbm1_w) and after (tbm_w) the expected gap. The partial function READ_ZZTAB is calculated in the hardware casing and is illustrated here as state machine for the simulation.

By means of these 3 tooth times the following 3 conditions are checked:

1. Gap correct:

```
               ! tbm2_w  !         tbm1_w              ! tbm_w   !
          +----+    +----+                        +----+    +----+
          |    |    |    |                        |    |    |    |
        --+    +----+    +----+----+----+----+----+    +----+    +---
```

```
B_st = TRUE     -> Condition:       (tbm1_w > tbm2_w) and (tbm1_w * 0.5 > tbm_w)
B_ST = FALSE    -> Condition: (tbm1_w * 0.5 > tbm2_w) and (tbm1_w * 0.5 > tbm_w)
```

A differentiation for engine start is necessary, because of the very high relative dynamic at this operating point.

If the gap is at the correct position, B_bm remains set and the gap check is terminated.

2a. Gap by 1 tooth too late ==> 1 tooth too many:

```
               ! tbm2_w  ! tbm1_w  !         tbm_w               !
          +----+    +----+    +----+                        +----+
          |    |    |    |    |    |                        |    |
        --+    +----+    +----+    +----+----+----+----+----+    +---
```

Condition: tbm1_w < 0.5 * tbm_w

2b. Gap by 1 tooth too early ==> 1 tooth too little:

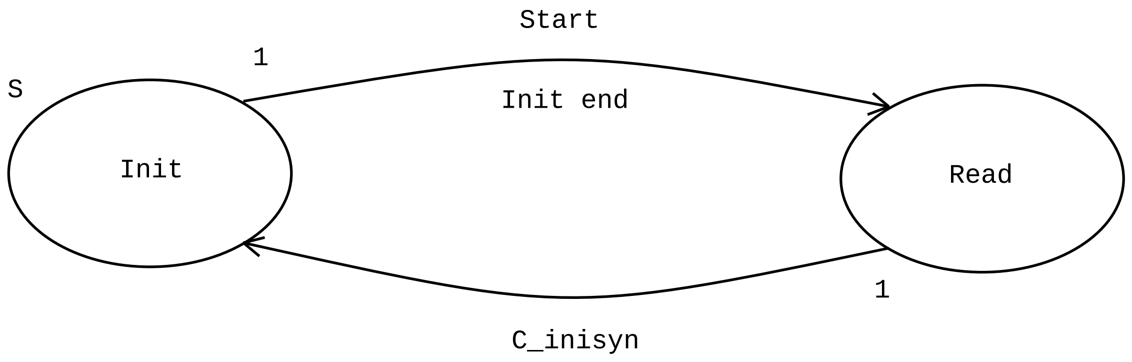
```
               !         tbm2_w              ! tbm1_w  ! tbm_w   !
          +----+                        +----+    +----+    +----+
          |    |                        |    |    |    |    |    |
        --+    +----+----+----+----+----+    +----+    +----+    +---
```

Condition: tbm1_w < 0.5 * tbm2_w

If the gap is incorrect by one tooth, then B_bm also remains set. Parallel to that B_fbm is set and the tooth counter zzseg for the subsequent segment is corrected by means of bmkor and the corresponding counter tmcorctr_w resp. tpcorctr_w is incremented.

If neither of these conditions is fulfilled, then the gap was not found. B_bm was reset and the counter bmlosctr_w was incremented. This causes an immediate new synchronization, since B_syn is also reset via B_bm.

If the gap is not found during the 1st gap check, then B_nobm1 (permanent RAM) is set simultaneously in order to suppress the quick-start during the following start.

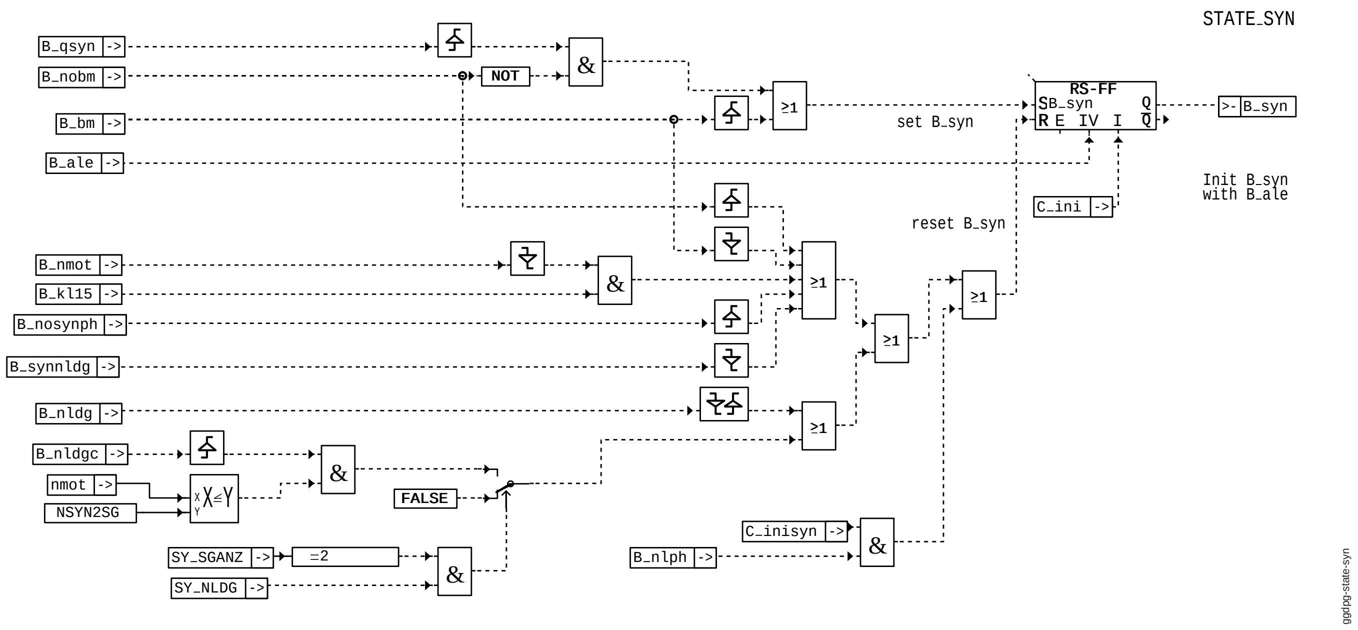


ggdpg-read-zztab

State machine to calculated the 3 tooth times around the gap from the tooth time table.

During the gap check the pointer zztabptr is set to the 2nd tooth after the expected gap and the periods are outputted as differences of the last tooth times. On engines with an odd number of cylinders the 2nd gap (zzyl > 0)lies at mid segment, otherwise the gap lies at the end of the segment.

```
 Zustand

 |    Übergangsname    +- Übergangsbedingung
 |    |    Aktionen    +- Aktions-Code
 |    |    |           |
 V    V    V           V
------------------------------------------------------------------------------------------------------------------------------------

 Init                                                                      -- -- READ_ZZTAB
                                                                           --
                                                                           -- read out of tooth time table and calculation
                                                                           -- of the 3 tooth periods around the gap:
                                                                           --                           zztabptr---+
                                                                           --                                      |
                                                                           --                                      v
                                                                           --            tbm2          tbm1              tbm
                                                                           --         |       |                       |       |
                                                                           --     +---+   +---+     g   a   p     +---+   +---+
           Entry:      tbm_w := 65535;                                     --   --+   +---+   +---+---+---+---+---+   +---+   +--
                       tbm1_w := 65535;                                     -- zztabptr is the pointer to the reference
                       tbm2_w := 65535;                                        -- tooth in the tooth time table.

           Action:     call noOp(0);

      Init end:        tbm_w = 65535
------------------------------------------------------------------------------------------------------------------------------------

 Read
           Action:     if ( R ) then
                           if ( (SY_ZYLZA = 3 or SY_ZYLZA = 5 ) and zzyl > 0 ) then          -- mid segment at engines
                                                                                             -- with odd cylinder number
                               zztabptr := CO_ZSGMT / 2 + 1 - SY_GAP;                        -- gap is in the middle of the segment
                           else
                               zztabptr := CO_ZSGMT + 1 - SY_GAP;                            -- gap is at the end of the segment
                           endif;

                           if (SY_ZYLZA = 3 and zzyl = 0) then                         -- correction of tooth time table position
                               zztabptr := zztabptr + bmkor;                           -- only necessary if the correction is at
                           endif;                                                      -- the beginning of a gap segment
                                                                                       -- calculation of the tooth 3 periods

                           tbm_w  := zztab(zztabptr)     - zztab(zztabptr - 1);        -- calculation of the 3 tooth periods
                           tbm1_w := zztab(zztabptr - 1) - zztab(zztabptr - 2);
                           tbm2_w := zztab(zztabptr - 2) - zztab(zztabptr - 3);
                       endif;

      C_inisyn:        C_inisyn
====================================================================================================================================
 Local Variables:

      Float zztabptr := 0.0;
```



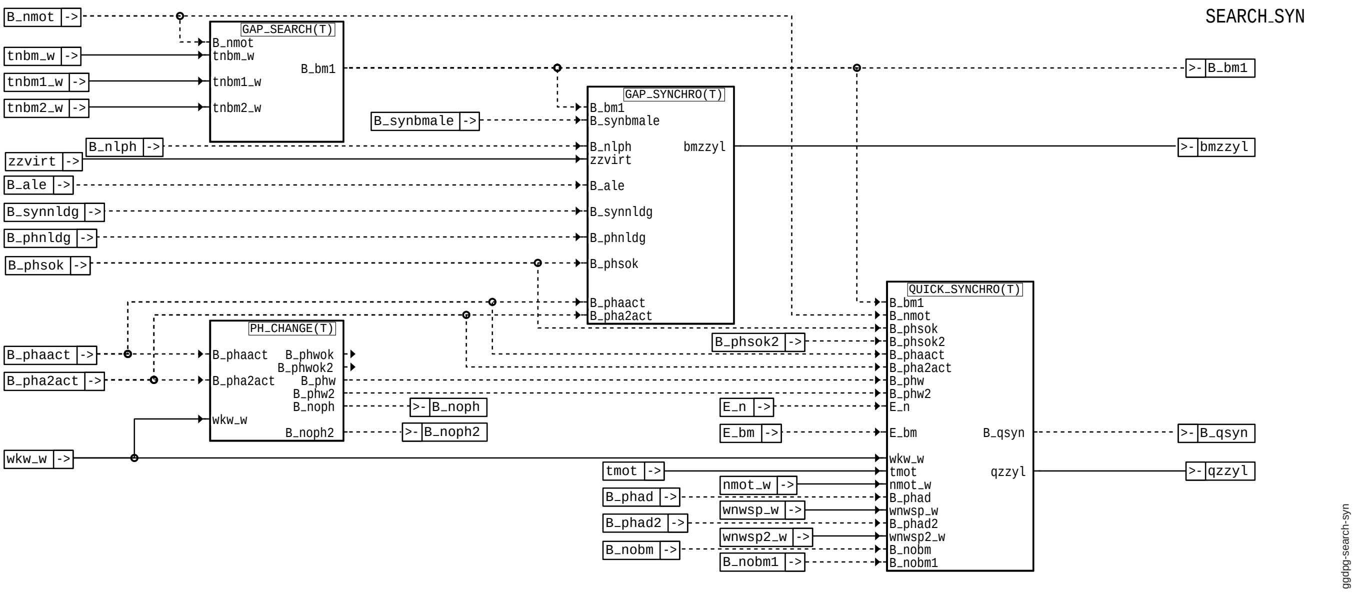
ggdpg-state-syn

Formation of the condition for synchronization B_syn

B_syn shows if the system is synchronized. The synchronization could therfore be found by the run-out position, the quick-start sensor wheel or the reference gap. If the system is at engine start at the camshaft sensor limp home mode (B_nlph), so there is no quick start via run-out position permitted (Reset of B_syn in the initialization).

A reset of B_syn cause an new synchronization in the funktion %SYSYNC.

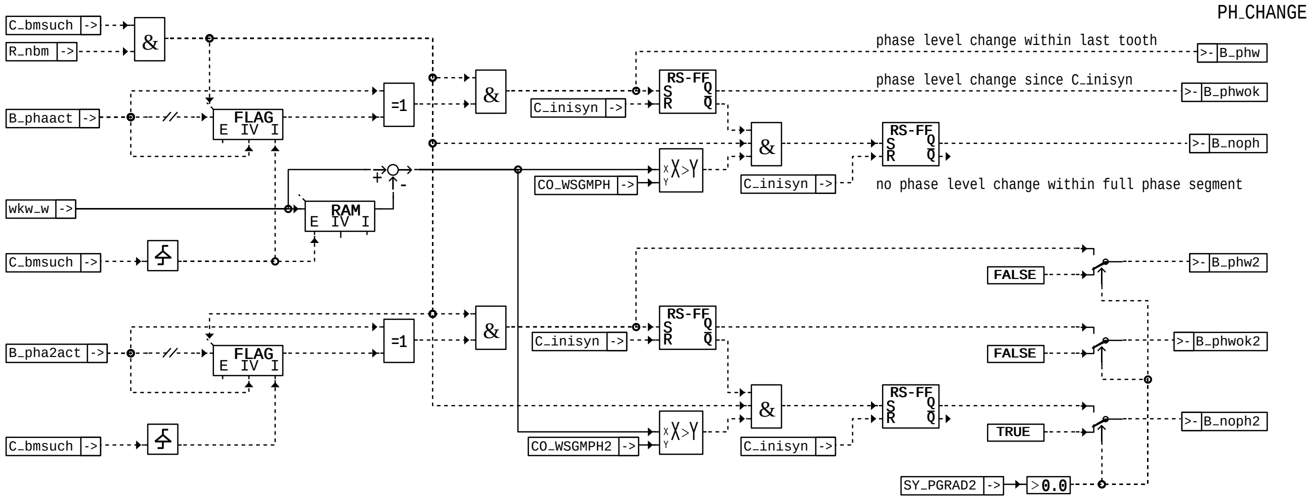
At a 2 ECU-concept a new-synchronization is forced if the second ECU change to the the crankshaft sensor limp home mode and the engine is still not run-up.



ggdpg-search-syn

The partial function SEARCH_SYN searches a synchronization via quick-start or via the reference mark and determines the accompanying cylinder number for the initialization of the cylinder counter

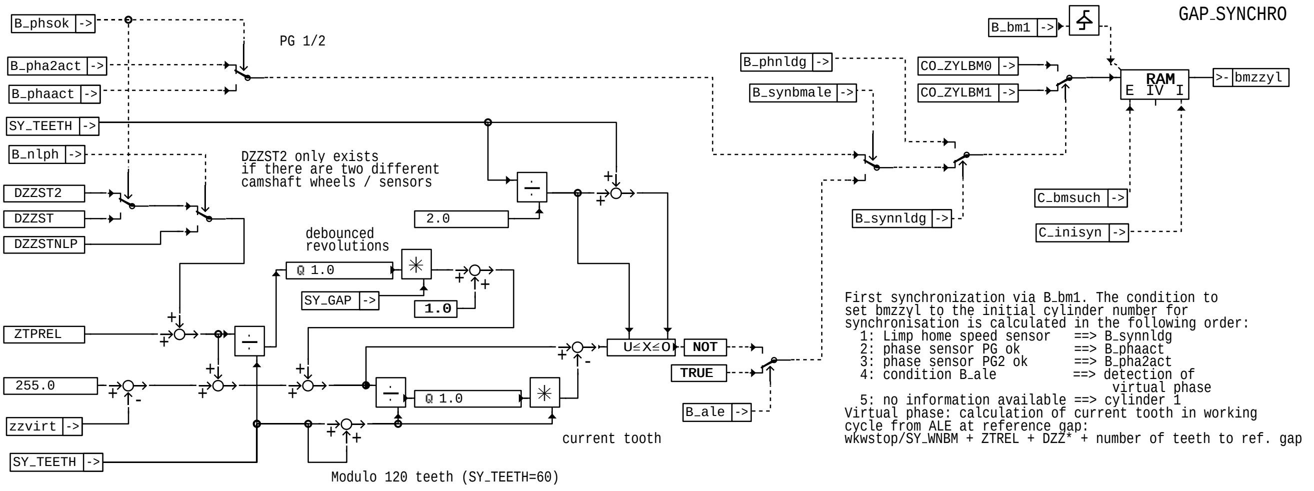
- PH_CHANGE	Monitoring of the phase level and detection of phase edges
- GAP_SEARCH	Gap search
- GAP_SYNCHRO	Determination of the cylinder number at 1st reference mark
- QUICK_SYNCHRO:	Synchronization search via quick-start sensor wheel



ggdpg-ph-change

Monitoring of the phase level (B_phaact resp. B_pha2act) in the tooth cycle during C_bmsuch.

Via the temporarily stored phase level it is checked by an exclusive OR whether the respective phase level B_pha*act has changed since the last tooth interrupt and if necessary the bit for an occurred phase change (B_phw*) is set. During the first phase change the bit B_phwok* is additionally set. Thereby it is possible to inquire later whether a phase change has occurred since C_inisyn. If no edge occurs within the crank angle CO_WSGMPH*, then the bit B_noph* is set.



```
First synchronization via B_bm1. The condition to
set bmzzyl to the initial cylinder number for
synchronisation is calculated in the following order:
  1: Limp home speed sensor   ==> B_synnldg
  2: phase sensor PG ok       ==> B_phaact
  3: phase sensor PG2 ok      ==> B_pha2act
  4: condition B_ale          ==> detection of
                                    virtual phase
  5: no information available ==> cylinder 1
Virtual phase: calculation of current tooth in working
cycle from ALE at reference gap:
wkwstop/SY_WNBM + ZTREL + DZZ* + number of teeth to ref. gap
```

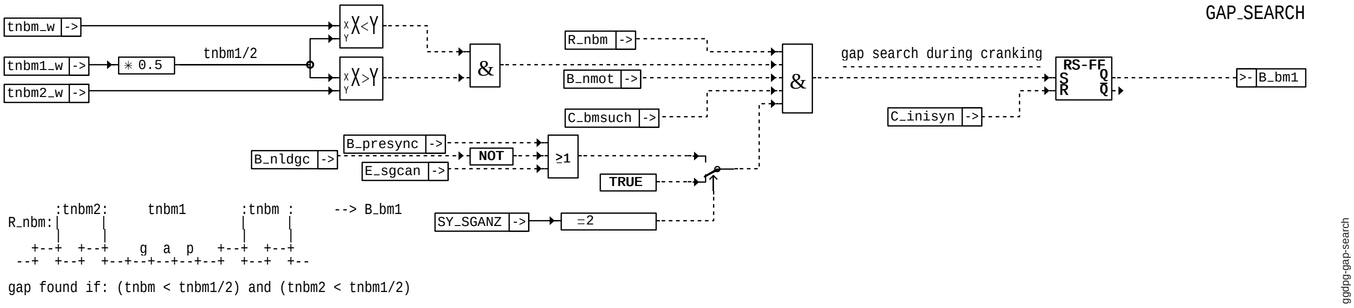
ggdpg-gap-synchro

Determination of the cylinder number at synchronization via the reference mark.

If the gap is found (B_bm1 0 -> 1), then the initialization value bmzzyl for the cylinder counter is loaded in dependency on the phase information with CO_ZYLBM0 or CO_ZYLBM1. The phase information is calculated with the following priority:

1. Synchronization at speed sensor limp-home, phase position is calculated in %NLDG:	B_synnldg
2. Phase sensor PG has been diagnosed as being o.k. (B_phsok), phase from PG:	B_phaact
3. Phase sensor PG2 has been diagnosed as being o.k. (B_phsok2), phase from PG2:	B_pha2act
4. Phase from run-on detection (B_ale) via virtual engine position:	zzvirt
5. No information, synchronization to cylinder 1:	CO_ZYLBM0

At priority 2 and 3 the normalized phase signal (high-level at BM0) is scanned at the detected reference gap.
Priority 3 is only calculated if a 2nd phase sensor exists in the system (SY_PGRAD2 > 0) and if this sensor provides a signal at the reference mark that can be used for the synchronization (SY_PH2OFST = 0).
At priority 4 the angle in the working cycle is calculated at the reference gap via the information of the run-out detection. This only takes effect if there is no camshaft sensor for synchronization available and B_ale=TRUE.



```
        :tnbm2:      tnbm1        :tnbm :     --> B_bm1
R_nbm:|      |                    |     |
      |      |                    |     |
   +--+  +--+    g  a  p    +--+  +--+
 --+  +--+  +--+--+--+--+--+  +--+  +--
gap found if: (tnbm < tnbm1/2) and (tnbm2 < tnbm1/2)
```

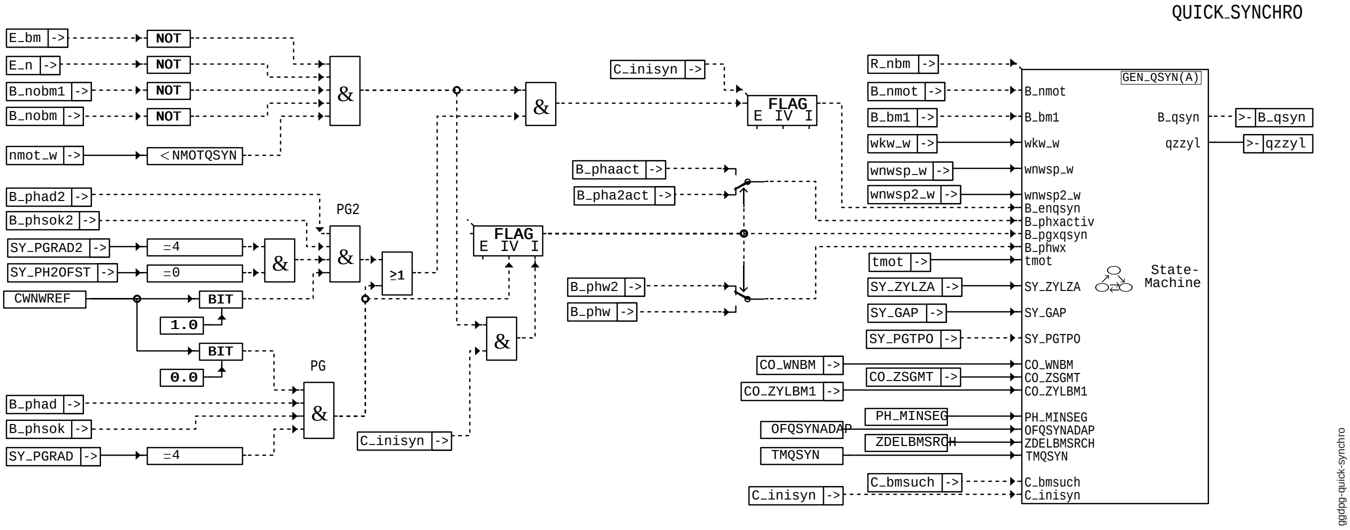
ggdpg-gap-search

Gap search by an evaluation of the last 3 tooth times.

During the gap search phase (C_bmsuch) the tooth time tnbml_w is halved and compared to the tooth times tnbm_w, tnbm2_w at set B_nmot. If (tnbm_w < tnbm1_w / 2) and (tnbm2 < tnbm1 / 2) results, then the gap is detected and B_bm1 is set.

```
               ! tnbm2_w !         tnbm1_w             ! tnbm_w  !
          +----+    +----+                        +----+    +----+
          |    |    |    |                        |    |    |    |
        --+    +----+    +----+----+----+----+----+    +----+    +---

B_bm1 1                                                          +---
                                                                 |
      0 ---------------------------------------------------------+
                                                                 ^
                                                                 |
                                                                 +----- Reference mark found
```

At a 2 ECU concept the synchronization via B_bm1 is locked if the second ECU is in the crankshaft sensor limp home mode and the synchronization via the limp home function is not yet found. If there is an error E_sgcan the synchronization is released in general, because it is not to be assumed of a double error.

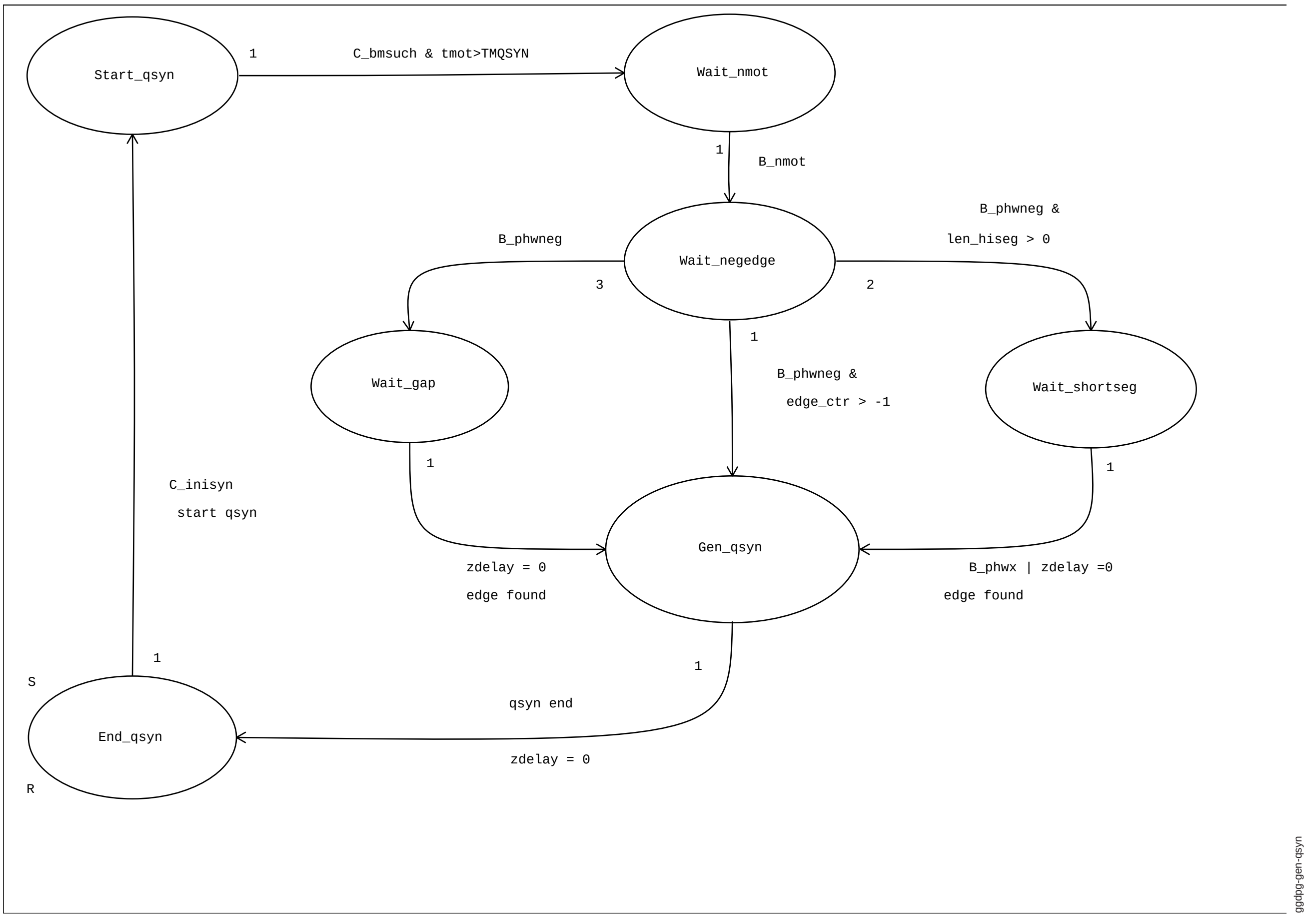


ggdpg-quick-synchro

Enabling (B_enqsyn) and selection of the phase sensor (B_pgxqsyn) for the quick-start via the phase sensor signal.

Preconditions for the quick-start are: The quick-start sensor wheel (SY_PGRAD* = 4), the adaptation of the phase edges must have been performed (B_phad* = true), the phase sensor may not be defective (B_phsok* = 1, E_n = 0, B_bm = 0), the engine temperature must be above the threshold TMQSYN, the speed limit NMOTQSYN must have been undershot and no reference-mark fault may have occurred (B_nobm = 0, B_nobm1 = 0). To be able to use the phase sensor PG2 for the quick-start, its phase signal must lie in-phase to the phase sensor PG (SY_PG2OFST = 0). B_enqsyn is set, if during C_inisyn these conditions are fulfilled for at least one phase sensor. When enabling the quick-start the phase sensor for the quick-start is selected by means of B_pgxqsyn (B_pgxqsyn = 0 ==> PG2, B_pgxqsyn = 1 ==> PG).

The CodeWord CWNWREF indicates whether the camshaft is in reference position during start.



ggdpg-gen-qsyn

The state machine GEN_QSYN tries to calculate the engine position from the phase signal and to trigger a synchronization via B_qsyn. Exactly at the beginning of a synchro B_qsyn must be set, in which qzzyl contains the cylinder number of this segment.

Due to the initialization C_inisyn the state changes to Start_qsyn, provided B_enqsyn is enabled and remains there until the reference mark search phase (C_bmsuch) and the engine temperature is above a threshold (tmot > TMQSYN). During a re-synchronization (C_inisyn) the Bit B_qsyn is reset to FALSE.

In Wait_nmot information on possible phase edges are collected, but not yet evaluated since B_nmot is not yet given. With B_nmot the state changes to Wait_negedge. Exit condition from this state is a found negative phase edge in the phase signal.
As long as the exit condition is not fulfilled, the phase signal is evaluated analogous as in Wait_nmot. In dependency on the available information a jump to Wait_gap, to Wait_shortseg or directly to Gen_syn is performed.

In Wait_gap a certain number of teeth is waited for until a gap should occur, provided that the engine is after the 2nd or 4th phase edge. If the reference mark does not occur then a distinction can be made between the 1st and 3rd phase edge and thereby the engine position can be determined.

In Wait_shortseg the length of the phase segment before the falling edge is known. Now it is waited whether a rising edge will occur after the falling edge within the crank angle PH_MINSEG. With this additional information it is known, which edge it is.

When jumping into Gen_qsyn, the last negative edge and the angle difference since this edge is known. Now the number of teeth until the next segment and the cylinder number are calculated. Once this amount of teeth has passed B_qsyn is set and the quick-start is terminated.

An early termination and jump to the state End_qsyn is achieved as soon as the gap was found (reset-condition B_bm1).

```
Zustand                                         State-Machine GEN_QSYN
|    Übergangsname    +- Übergangsbedingung
|    |    Aktionen    +- Aktions-Code
|    |    |           |
V    V    V           V
-------------------------------------------------------------------------------------------------------------------------------------

End_qsyn              Reset-Bedingung: B_bm1 or (B_enqsyn = false)       -- Dies ist der Reset-Zustand, er wird aus allen
                                                                            Zuständen angesprungen, wenn die Reset-Bedingung
                                                                            erfüllt ist.
                                                                         -- Start and Resetstate.
                                                                            In synchronized condition or if the quick start
                                                                            function is disabled (B_enqsyn = false) the State-
                                                                            Machine remains in this state without any action.
                                                                            The function is not calculated.
```

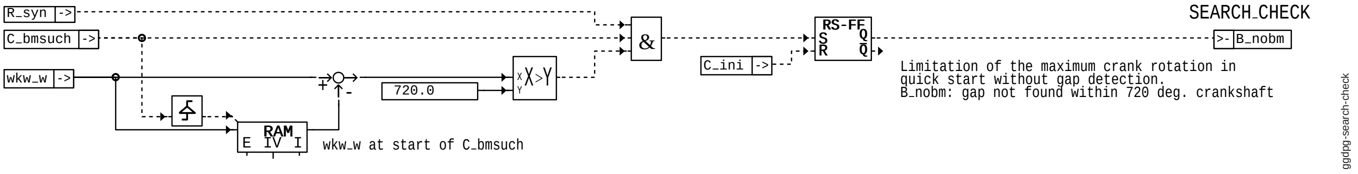
```
          Entry:                                                          -- End_qsyn: Entry
                      stateqsyn := 6;

          Action:     call noOp(0);                                       -- No operation, the quick start function is
                                                                          -- not enabled or already finished

     C_inisyn:        C_inisyn                                            -- Exit to Start_qsyn.

------------------------------------------------------------------------------------------------------------------------------------

Start_qsyn                                                                -- The state is called during C_inisyn). The system
                                                                             remains in this state untill C_bmsuch to start the
                                                                             quick synchronization via the phase signal.

          Entry:                                                          -- Start_qsyn: Entry
                      stateqsyn := 0;

          Action:     call noOp(0);                                       -- No operation, waiting for C_bmsuch

     C_bmsuch & tmot>TMQSYN:
                      C_bmsuch and (tmot > TMQSYN)                        -- Tooth debouncing finished and tmot greater threshold
                                                                          --   ==>  exit to Wait_nmot

------------------------------------------------------------------------------------------------------------------------------------

------------------------------------------------------------------------------------------------------------------------------------

Wait_nmot                                                                 -- The system is in C_bmsuch condition, but B_nmot is
                                                                             not yet set. In this state the phase edges are
                                                                             monitored, a flag for the phase change is set and
                                                                             the corresponding wkw_w is stored.

          Entry:                                                          -- Wait_nmot: Entry
                                                                          -- Initialization
                      stateqsyn := 1;
                      B_phwneg  := false;                                 -- reset flag for falling edge
                      B_phwpos  := false;                                 -- reset flag for rising edge
                      edge_ctr  := -1;                                    -- reset edge index
                      len_hiseg := 0;                                     -- reset indicator for length of high segment
                      len_loseg := 0;                                     -- reset indicator for length of low segment
                      if ( B_pgxqsyn ) then                               -- select adaptation value from correct PG
                        tmp := wnwsp_w(0);                                -- PG
                      else
                        tmp := wnwsp2_w(0);                               -- PG2
                      endif;
                      tmp := (tmp - OFQSYNADAP) / CO_WNBM;                -- calculation from first phase edge to the
                      wnwspx_w(0) := truncate(tmp);                       -- tooth before wnwsp_w(0) - OFQSYNADAP
                      if ( wnwspx_w(0) < tmp ) then                       -- correct wnwspx_w(0) to tooth after wnwsp_w(0)
                        wnwspx_w(0) := wnwspx_w(0) + 1;                   -- tooth after wnwsp_w(0)
                      endif;                                              -- Calculate from tooth to crank angle:
                      wnwspx_w(0) := wnwspx_w(0) * CO_WNBM;               -- Adapted phase edge, rounded to the next tooth

                      if ( B_pgxqsyn ) then                               -- select adaptation value from correct PG
                        tmp := wnwsp_w(1);                                -- PG
                      else
                        tmp := wnwsp2_w(1);                               -- PG2
                      endif;
                      tmp := (tmp - OFQSYNADAP) / CO_WNBM;                -- calculation from second phase edge to the
                      wnwspx_w(1) := truncate(tmp);                       -- tooth before wnwsp_w(1) - OFQSYNADAP
                      if ( wnwspx_w(1) < tmp ) then                       -- correct wnwspx_w(1) to tooth after wnwsp_w(1)
                        wnwspx_w(1) := wnwspx_w(1) + 1;                   -- tooth after wnwsp_w(1)
                      endif;                                              -- Calculate from tooth to crank angle:
                      wnwspx_w(1) := wnwspx_w(1) * CO_WNBM;               -- Adapted phase edge, rounded to the next tooth

                      if ( B_pgxqsyn ) then                               -- select adaptation value from correct PG
                        tmp := wnwsp_w(2);                                -- PG
                      else
                        tmp := wnwsp2_w(2);                               -- PG2
                      endif;
                      tmp := (tmp - OFQSYNADAP) / CO_WNBM;                -- calculation from third phase edge to the
                      wnwspx_w(2) := truncate(tmp);                       -- tooth before wnwsp_w(2) - OFQSYNADAP
                      if ( wnwspx_w(2) < tmp ) then                       -- correct wnwspx_w(2) to tooth after wnwsp_w(2)
                        wnwspx_w(2) := wnwspx_w(2) + 1;                   -- tooth after wnwsp_w(2)
                      endif;                                              -- Calculate from tooth to crank angle:
                      wnwspx_w(2) := wnwspx_w(2) * CO_WNBM;               -- Adapted phase edge, rounded to the next tooth

                      if ( B_pgxqsyn ) then                               -- select adaptation value from correct PG
                        tmp := wnwsp_w(3);                                -- PG
                      else
                        tmp := wnwsp2_w(3);                               -- PG2
                      endif;
                      tmp := (tmp - OFQSYNADAP) / CO_WNBM;                -- calculation from 4. phase edge to the
                      wnwspx_w(3) := truncate(tmp);                       -- tooth before wnwsp_w(3) - OFQSYNADAP
                      if ( wnwspx_w(3) < tmp ) then                       -- correct wnwspx_w(3) to tooth after wnwsp_w(3)
                        wnwspx_w(3) := wnwspx_w(3) + 1;                   -- tooth after wnwsp_w(3)
```

```
                      endif;                                              -- Calculate from tooth to crank angle:
                      wnwspx_w(3) := wnwspx_w(3) * CO_WNBM;               -- Adapted phase edge, rounded to the next tooth

          Action:                                                         -- Wait_nmot: Action
                      if ( R_nbm and B_phwx ) then                        -- phase change during last tooth
                        if ( B_phxactiv ) then                            -- phase level activ ==> falling edge
                          wkwneg_w := wkw_w;                              -- store wkw_w at falling edge
                          B_phwneg := true;                               -- falling phase change detected
                                                                          -- check length of last high segment:
                          if ( B_phwpos ) then                            -- rising edge already detected
                            if ( wkwneg_w - wkwpos_w > 90 ) then          -- if segment was longer than 90 degree crank
                              len_hiseg := 2;                             --   ==> segment was long
                            else                                          -- otherwise:
                              len_hiseg := 1;                             --   ==> segment was short
                            endif;                                        -- end of if loop
                          else                                            -- rising edge not yet detected
                            if ((wkwneg_w > PH_MINSEG) and SY_PGTPO) then -- if segment was longer than short segment
                              len_hiseg := 2;                             --   ==> segment was long (only with TPO sensor)
                            endif;                                        -- end of if loop
                          endif;                                          -- end of checking length of last high segment
                        else                                              -- phase level not active ==> rising edge
                          wkwpos_w := wkw_w;                              -- store wkw_w at rising edge
                          B_phwpos := true;                               -- rising phase change detected
                                                                          -- check length of last low segment:
                          if ( B_phwneg ) then                            -- falling edge already detected
                            if ( wkwpos_w - wkwneg_w > 90 ) then          -- if segment was longer than 90 degree crank
                              len_loseg := 2;                             --   ==> segment was long
                            else                                          -- otherwise:
                              len_loseg := 1;                             --   ==> segment was short
                            endif;                                        -- end of if loop
                          else                                            -- falling edge not yet detected
                            if ((wkwpos_w > PH_MINSEG) and SY_PGTPO) then -- if segment was longer than short segment
                              len_loseg := 2;                             --   ==> segment was long (only with TPO sensor)
                            endif;                                        -- end of if loop
                          endif;                                          -- end of checking last low segment
                        endif;                                            -- end of phase level check
                      endif;                                              -- end of phase change during last tooth

     B_nmot:          B_nmot                                              -- B_nmot is now set, exit to Wait_neg_edge.

------------------------------------------------------------------------------------------------------------------------------------

Wait_negedge                                                              -- B_nmot is now set. In the entry code the current
                                                                             wkw_w is stored in wkwstart_w. Then the results from
                                                                             the previous state are checked, whether the current
                                                                             position is already known and in case the edge_ctr
                                                                             is set to the index of the detected edge. If a
                                                                             falling is not yet detected, the system remains in
                                                                             this state, until it arises. Then the conditions are
                                                                             checked again and the next state is called depending
                                                                             on the collected information.

          Entry:                                                          -- Wait_negedge: Entry
                      stateqsyn := 2;
                      wkwstart_w := wkw_w;                                -- store wkw_w at entry (B_nmot)
                                                                          -- check information:
                                                                          -- if already falling and rising edge and
                                                                          -- rising edge after falling edge?
                                                                          -- ==> last segment was a low segment
                      if ( B_phwneg and B_phwpos and (wkwpos_w > wkwneg_w) ) then

                        if ( len_hiseg > 0 ) then                         -- if length of high segment already known:
                          if ( len_loseg = 2 ) then                       -- low segment was long
                            if ( len_hiseg = 2 ) then                     -- previous high segment was long
                              edge_ctr := 2;                              --   ==> egde was 1.
                            else                                          -- previous high segment was short
                              edge_ctr := 3;                              --   ==> egde was 3.
                            endif;                                        -- end checking previous high segment
                          else                                            -- low segment was short
                            if ( len_hiseg = 2 ) then                     -- previous high segment was long
                              edge_ctr := 1;                              --   ==> egde was 1.
                            else                                          -- previous high segment was short
                              edge_ctr := 0;                              --   ==> egde was 0.
                            endif;                                        -- end checking previous high segment
                          endif;                                          -- end of checking last low segment
                        else                                              -- otherwise length of high segment unknown:
                          B_phwneg := false;                              --   ==> discard falling edge,
                        endif;                                            -- end checking length of high segment
                      endif;                                              -- end of checking last edge

          Action:                                                         -- Wait_negedge: Action
                      if ( R_nbm and B_phwx ) then                        -- phase change during last tooth
                        if ( B_phxactiv ) then                            -- phase level activ ==> falling edge
                          wkwneg_w := wkw_w;                              -- store wkw_w at falling edge
                          B_phwneg := true;                               -- set flag for falling edge
                                                                          -- check length of last high segment:
```

```
                          if ( B_phwpos ) then                            -- rising edge already detected
                            if ( wkwneg_w - wkwpos_w > 90 ) then          -- if segment was longer than 90 degree crank
                              len_hiseg := 2;                             --   ==> segment was long
                            else                                          -- otherwise:
                              len_hiseg := 1;                             --   ==> segment was short
                            endif;                                        -- end of if loop
                          else                                            -- rising edge not known
                            if ((wkwneg_w > PH_MINSEG) and SY_PGTPO ) then-- if segment was longer than short segment
                              len_hiseg := 2;                             --   ==> segment was long (only with TPO sensor)
                            endif;                                        -- end of if loop
                          endif;                                          -- end of checking length of last high segment
                                                                          -- negative edge found, calculate exit condition
                          if ( len_hiseg = 2 ) then                       -- if last high segment was long
                                                                          -- if wkwstart_w before gap
                            if ( wnwspx_w(2) - (wkwneg_w - wkwstart_w) < 360  - (3 + SY_GAP) * CO_WNBM ) then
                              edge_ctr := 1;                              --   ==> edge was 1.
                            endif;                                        -- end if wkwstart_w before gap
                          elseif ( len_hiseg = 1 ) then                   -- else if high segment was short
                                                                          -- if wkwstart_w before gap
                            if ( wnwspx_w(0) - (wkwneg_w - wkwstart_w) < - (3 + SY_GAP) * CO_WNBM ) then
                              edge_ctr := 3;                              --   ==> edge was 3.
                            endif;                                        -- end if wkwstart_w before gap
                          endif;                                          -- end if length of last high segment
                                                                          -- ==> end of calculate exit condition
                        else                                              -- phase level not active ==> rising edge
                          wkwpos_w := wkw_w;                              -- store wkw_w at rising edge edge
                          B_phwpos := true;                               -- set flag for rising edge
                                                                          -- check length of last low segment:
                          if (( wkwpos_w > PH_MINSEG) and SY_PGTPO ) then -- if segment was longer than short segment
                            len_loseg := 2;                               --   ==> segment was long
                          endif;                                          -- end of if loop
                        endif;                                            -- end of phase level check
                      endif;                                              -- end of phase change during last edge

     edge_ctr > -1:   B_phwneg and edge_ctr > -1                          -- The crank position is known (edge_ctr is set to the
                                                                             index of the last falling edge). Exit to Gen_qsyn.
     len_hiseg > 0:   B_phwneg and len_hiseg > 0                          -- A negative edge was found, the length of the last
                                                                             high segment is known. Exit to Wait_shortseg.
     B_phwneg:        B_phwneg                                            -- A negative edge was found, more information is not
                                                                             available. Exit to Wait_gap.

-----------------------------------------------------------------------------------------------------------------------------------

Wait_shortseg                                                             -- The falling edge is already detected and the length
                                                                             of the previous high segment is known. The system
                                                                             remains in this state, untill the rising phase edge
                                                                             appears or a calculated number of teeth has passed.
                                                                             This number of teeth is calculated from the phase
                                                                             edge with a following long segment plus the length
                                                                             of the short segment plus the number of teeth to
                                                                             the next synchro schedule.
                                                                             In the Exit-code the phase level is checked again.
                                                                             In case of a high level, the level has changed and
                                                                             the edge is set to the edge with a following short
                                                                             segment.

          Entry:                                                          -- Wait_shortseg: Entry
                      stateqsyn := 4;
                                                                          -- calculation of the maximum number of teeth to wait
                                                                          -- for the rising edge (time out for long segment).
                      if ( len_hiseg = 2 ) then                           -- high segment was long
                        edge_ctr := 2;                                    -- calc. teeth for R_syn after wnwspx_w(2) + PH_MINSEG
                      else                                                -- high segment was short
                        edge_ctr := 3;                                    -- calc. teeth for R_syn after wnwspx_w(3) + PH_MINSEG
                      endif;                                              -- end length of high segment
                                                                          -- tooth after wnwspx_w(edge_ctr) + PH_MINSEG
                      znbm_act := (wnwspx_w(edge_ctr) + PH_MINSEG) / CO_WNBM;

                                                                          -- teeth from last falling edge to next synchro
                                                                          -- after: ’wnwspx_w(edge_ctr) + PH_MINSEG’
                      zdelay := PH_MINSEG / CO_WNBM;                      -- minimum number of teeth to wait for rising edge
                      if ( modulo(znbm_act, CO_ZSGMT) > 0 ) then          -- current tooth within segment
                        zdelay := zdelay + CO_ZSGMT - modulo(znbm_act, CO_ZSGMT);
                                                                          -- zdelay to next synchro
                      endif;

                      if ( zdelay > 90  / CO_WNBM ) then                  -- Limit maximum number of teeth to wait for
                        zdelay := 90 / CO_WNBM;                           -- falling edge to 90 degree crankshaft
                      endif;                                              -- end of limitation

                      if ( zdelay > (wkw_w - wkwneg_w) / CO_WNBM ) then   -- if zdelay after current position
                        zdelay := zdelay - (wkw_w - wkwneg_w) / CO_WNBM;
                                                                          --   calculate zdelay from the difference
                      else                                                -- otherwise
                        zdelay := 0;                                      --   long segment detected
                      endif;                                              -- end of limitation
```

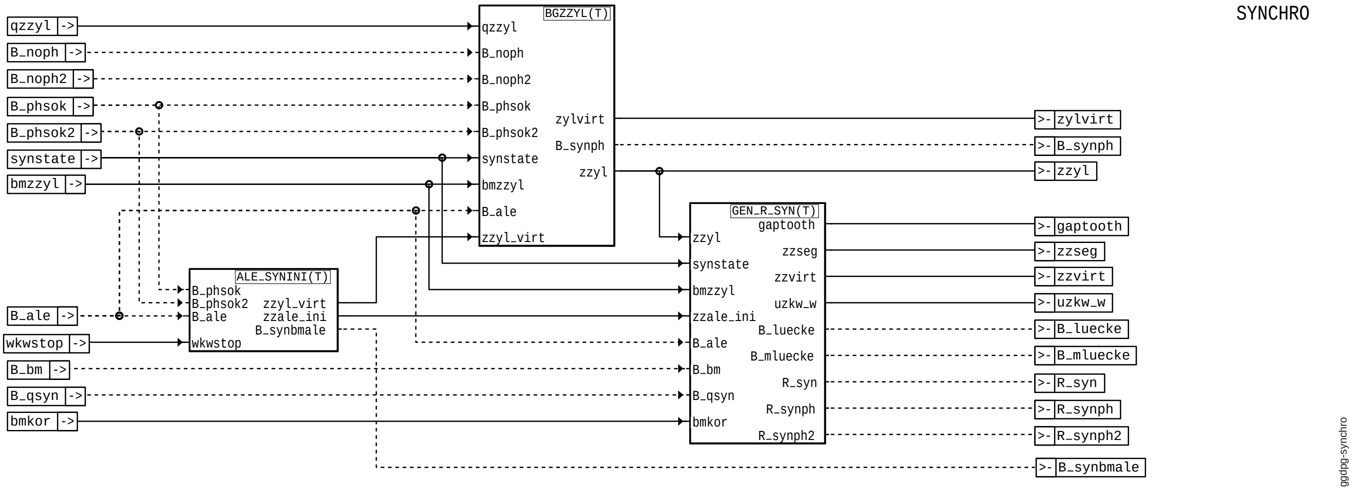
```
          Action:                                                         -- Wait_shortseg: Action
                      if ( R_nbm ) then                                   -- waiting for the rising edge
                        zdelay := zdelay - 1;                             -- decrement zdelay
                      endif;

          Exit:                                                           -- Wait_shortseg: Exit
                                                                          -- Check current phase level:
                      if ( B_phxactiv = false ) then                      -- If phase is high ==> phase change
                                                                          -- edge_ctr from entry code was wrong: reset
                        if ( len_hiseg = 2 ) then                         -- if long segment before falling edge
                            edge_ctr := 1;                                --   ==> long high, short low ==> edge 1
                        else                                              -- otherwise
                            edge_ctr := 0;                                --   ==> short high, short low ==> edge 0
                        endif;                                            -- end of if loop segment length
                      endif;

     B_phwx | zdelay =0:
                      (B_phwx  and (wkw_w <> wkwneg_w)) or (zdelay = 0)   -- The crank position is known (edge_ctr is set to the
                                                                             index of the last falling edge). Exit to Gen_qsyn.
                                                                             The exit condition is checked before the action code.
                                                                             B_phwx is only set for one tooth interrupt.
------------------------------------------------------------------------------------------------------------------------------------

Wait_gap                                                                  -- The last edge was a falling one, more information is
                                                                             not available.
                                                                             In the entry code the system calculates zdelay as
                                                                             the maximum between the number of teeth from the
                                                                             adapted phase edge 1 to the reference tooth after
                                                                             the first gap and the number of teeth from the
                                                                             adapted phase edge 3 to the reference tooth after
                                                                             the second reference gap.
                                                                             In the action code, the system waits for 'zdelay'
                                                                             number of teeth. If the reference gap appears after
                                                                             during this 'delay', the quick start function is
                                                                             finished aborted by the reset condition B_bm1.
                                                                             Otherwise the current position is known by checking
                                                                             the phase level. The number of delayed teeth is in
                                                                             all cases longer than a short segment (between
                                                                             edge(1) and the 1. reference gap is a phase change).
                                                                             In case of B_phactiv the phase level did not change,
                                                                             which means the last segment wasn't a short one, so
                                                                             the system was at the third edge (edge_ctr = 2),
                                                                             otherwise the system was at the first edge
                                                                             (edge_ctr = 0).

          Entry:                                                          -- Wait_gap: Entry
                      stateqsyn := 3;                                     -- calculate max = maximum number of teeth between:
                                                                          --        wnwspx_w(1) and the 1. reference tooth
                                                                          --   and  wnwspx_w(3) and the 2. reference tooth
                      zdelay := (max(360 - wnwspx_w(1), 720 - wnwspx_w(3)) - (wkw_w - wkwneg_w)) / CO_WNBM - SY_GAP + ZDELBMSRCH;

          Action:                                                         -- Wait_gap: Action
                      if ( R_nbm ) then                                   -- Waiting for 'zdelay' teeth
                        zdelay := zdelay - 1;                             -- decrement zdelay
                      endif;

          Exit:                                                           -- Wait_gap: Exit
                                                                          -- check current phase level:
                      if ( B_phxactiv ) then                              -- phase is low ==> no phase change
                        edge_ctr := 2;                                    --   ==> edge 2
                      else                                                -- otherwise phase change
                        edge_ctr := 0;                                    --   ==> edge 0
                      endif;                                              -- end checking phase level
     zdelay = 0:      zdelay = 0                                          -- In this transition the gap did not appear. So the
                                                                             crank position is known (edge_ctr is set to the
                                                                             index of the last falling edge). Exit to Gen_qsyn.
------------------------------------------------------------------------------------------------------------------------------------

Gen_qsyn                                                                  -- The system had a falling edge at wkwneg_w. The index
                                                                             of the edge is stored in edge_ctr. So the current
                                                                             engine position is calculated from the tooth after
                                                                             (wnwspx[edge_ctr] + (wkw - wkwneg_w))/SY_WNBM.
                                                                             In the entry-code the current engine position
                                                                             (znbm_act), the cylinder number (qzzyl) und the
                                                                             number of teeth (zdelay) to the next synchro
                                                                             schedule are calculated.
                                                                             If qzzyl is less than SY_ZYLZA, zdelay is checked
                                                                             against 0. In this case the engine is exactly at the
                                                                             synchro position and B_qsyn is set immediatly,
                                                                             otherwise 'zdelay' number of teeth are waited in the
                                                                             action-code, until B_qsyn is set. If qzzyl is equal
                                                                             to SY_ZYLZA, the engine is already in the last
                                                                             synchro before the reference gap 0. In this case it
                                                                             does not make sense to wait for B_qsyn.
```

```
           Entry:                                                          -- Wait_qsyn: Entry
                       stateqsyn := 5;
                                                                           -- current engine position
                       znbm_act := (wnwspx_w(edge_ctr) + wkw_w - wkwneg_w) / CO_WNBM;

                       if ( znbm_act >= 720 / CO_WNBM ) then               -- overflow correction
                         znbm_act := znbm_act - 720 / CO_WNBM;
                       endif;

                       qzzyl := truncate(znbm_act / CO_ZSGMT);             -- current cylinder number
                       zdelay := CO_ZSGMT - modulo(znbm_act, CO_ZSGMT);    -- teeth to next synchro
                       if ( zdelay = CO_ZSGMT ) then                       -- current tooth is a synchro start tooth
                         zdelay := 0;                                      --   ==> no delay, qzzyl is correct
                       else                                                -- otherwise
                         qzzyl := qzzyl + 1;                               --   increase cylinder counter qzzyl
                       endif;
                                                                           -- check next synchro
                       if ( qzzyl < SY_ZYLZA ) then                        -- if synchro ok.
                         if ( zdelay = 0 ) then                            --   if zdelay already zero:
                           B_qsyn := true;                                 --     ==> start immediatly
                         endif;                                            --    end if zdelay zero
                       else                                                -- else no valid synchro found,
                         zdelay := 0;                                      --   quick start finished immediatly
                       endif;                                              -- end checking next synchro

           Action:                                                         -- Wait_qsyn: Action
                       if ( R_nbm ) then                                   -- wait zdelay teeth
                         zdelay := zdelay - 1;                             -- decrement zdelay
                         if ( zdelay = 0 ) then                            -- if delay end:
                           B_qsyn := true;                                 --   ==> start synchro
                         endif;
                       endif;

      zdelay = 0:      zdelay = 0                                          -- Qsyn is finished. Exit to End_qsyn.
====================================================================================================================================

 Lokale Variablen:

      Bool B_phwneg     := false;
      Bool B_phwpos     := false;
      Float edge_ctr    := -1.0;
      Float wkwneg_w    := 0.0;
      Float wkwpos_w    := 0.0;
      Float wkwstart_w  := 0.0;
      Float zdelay      := 0.0;
      Float znbm_act    := 0.0;
      Float len_loseg   := 0.0;
      Float len_hiseg   := 0.0;
      Float wnwspx_w(4) := 0.0;
      Float stateqsyn   := 0.0;
      Float tmp         := 0.0;
```



ggdpg-search-check

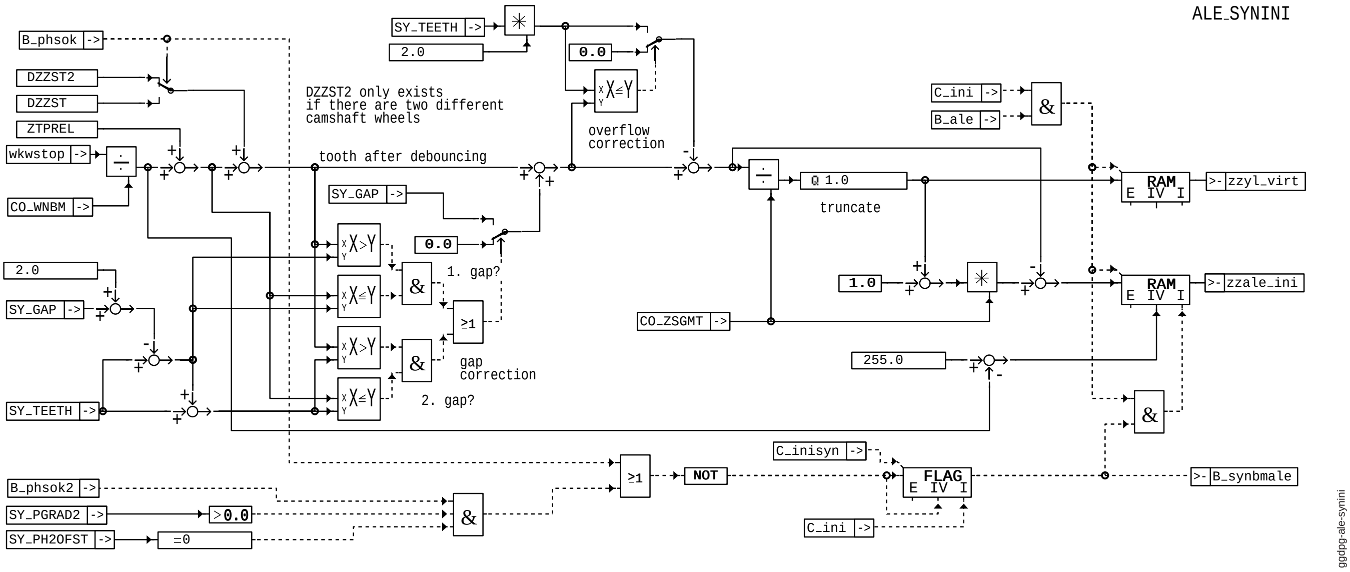
If the system is already in the synchronized state during the reference mark search (due to run-out detection or quick-start sensor wheel) then it is checked whether the reference mark is found within 720 degrees crankshaft (CS) and if necessary B_nobm is set and thereby the synchronization is aborted.



ggdpg-synchro

Overview regarding the generation of the synchro interrupt. It consists of the following partial functions:

- GEN_R_SYN
  - Generation of the synchro interrupt R_syn and of the interrupt for the phase inquiry R_synph resp. R_synph2
  - Downward counting tooth counter zzseg resp. zzvirt in the virtual synchronized state
  - Revolution counter uzkw_w
- BGZZYL
  - Cylinder counter
- ALE_SYNINI
  - Calculation of the initialization values for zzvirt and zzyl from the engine stop position wkwstop

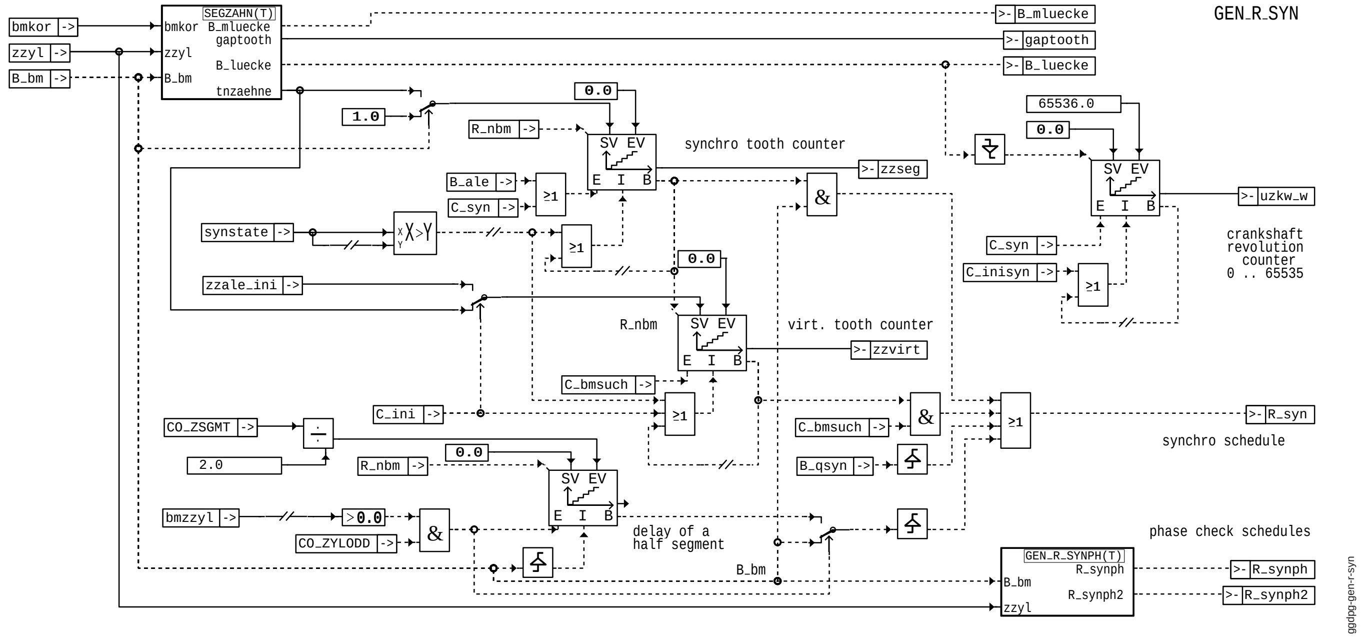


ggdpg-ale-synini

Calculation of the initialization values zzale_ini for the virtual tooth counter (zzvirt) and zzyl_virt for the cylinder counter (zzyl) from the engine stop position wkwstop.

At first ZTPREL then DZZST teeth (teeth from the tooth debouncing) are added to wkwstop. ZTPREL represents the teeth passed during the time debouncing, DZZST are the teeth adjusted for the tooth debouncing. Thereafter it is inquired upon whether the crankshaft has moved across the gap during the tooth debouncing and if necessary the missing teeth are added. The initialization values zzale_ini and zzyl_virt are then calculated after the possible overflow correction.

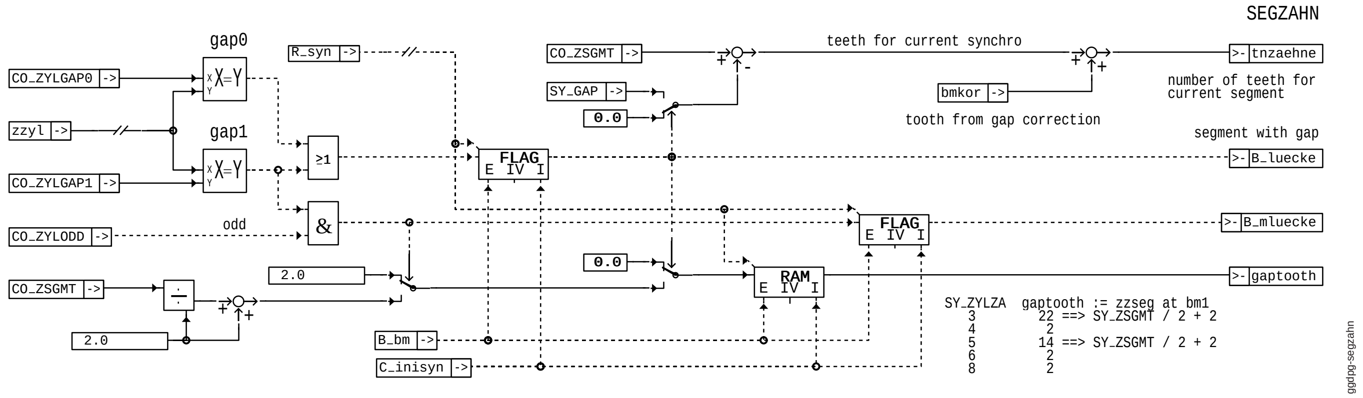
B_synbmale indicates whether there is no camshaft sensor for synchronization (synchronization at the reference gap via engine run-out position). If B_ale is TRUE at this case the initialization value zzale_ini of the virtuel tooth counter is set to the maximum value minus the tooth position of wkwstop.



ggdpg-gen-r-syn

Partial function to generate the synchro interrupt R_syn.

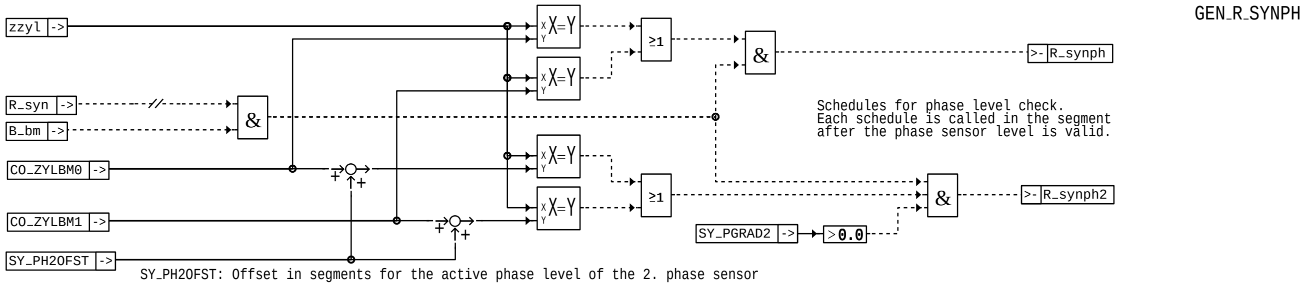
The counter zzvirt is set to zzale_ini in C_ini with valid run-out detection (B_ale). This counter is enabled in C_bmsuch and decremented in the tooth interrupt. If zzseg = 0, then a synchro interrupt R_syn is triggered and zzseg is set to the number of teeth per segment (tnzaehne). If a re-synchronization (B_qsyn or B_bm) occurs, then the counter is increased by changing the synchronizing state (synstate). R_syn is also triggered when B_qsyn and B_bm are set for the first time. On engines with an odd amount of cylinders R_syn is triggered, at B_bm and 2nd reference mark (bmzzyl > 0) delayed by half a segment to the reference mark. When the reference mark occurs the state C_bmsuch is terminated. Now the counter zzseg becomes active, which counts down tnzaehne respectively and which triggers an R_syn at 0. The counter uzkw_w is incremented in each synchro after the gap (every crankshaft revolution).



ggdpg-segzahn

SEGZAHN provides the following information for the respective current segment:

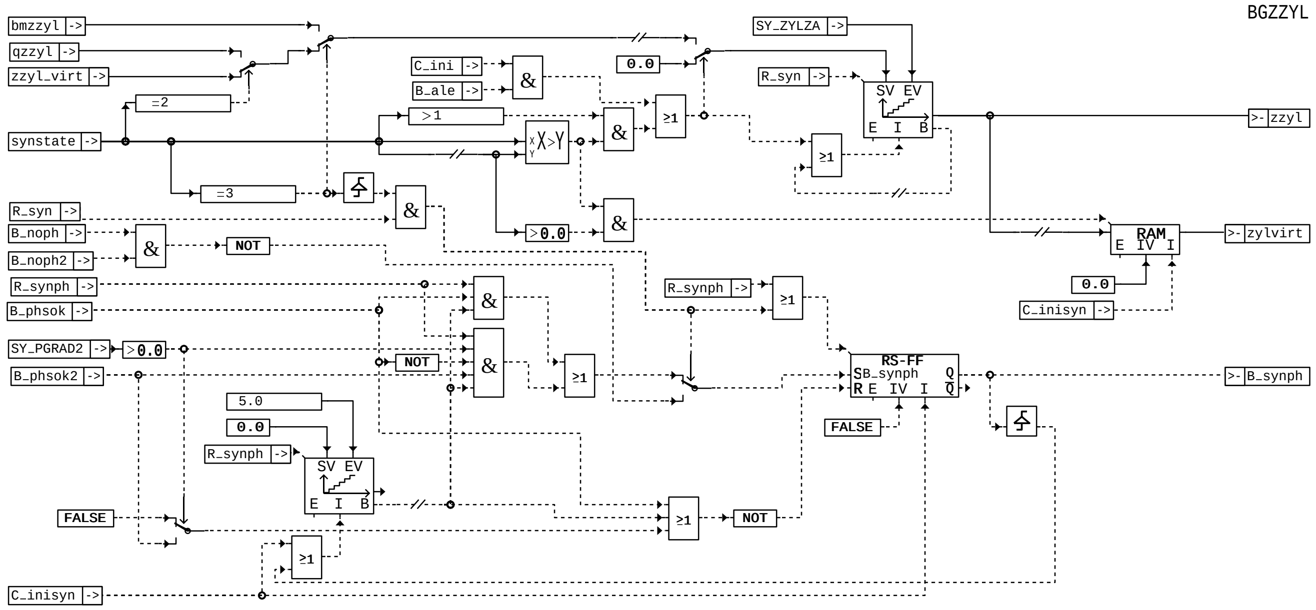
- tnzaehne:	Number of teeth of the segment to initialize the counters zzvirt resp. zzseg. The tooth to be corrected from the gap check is taken into account in this variable.
- B_luecke:	The reference mark lies within the current segment
- B_mluecke	The middle reference mark lies within the current segment (only with odd cylinder numbers)
- gaptooth:	Tooth count of the tooth after the gap



ggdpg-gen-r-synph

Generation of the cycle for the phase inquiry.

In the cycle R_syn the cylinder counter is checked on whether the phase inquiry of the respective phase sensors can be performed in this synchro and if necessary a R_synph* is triggered.

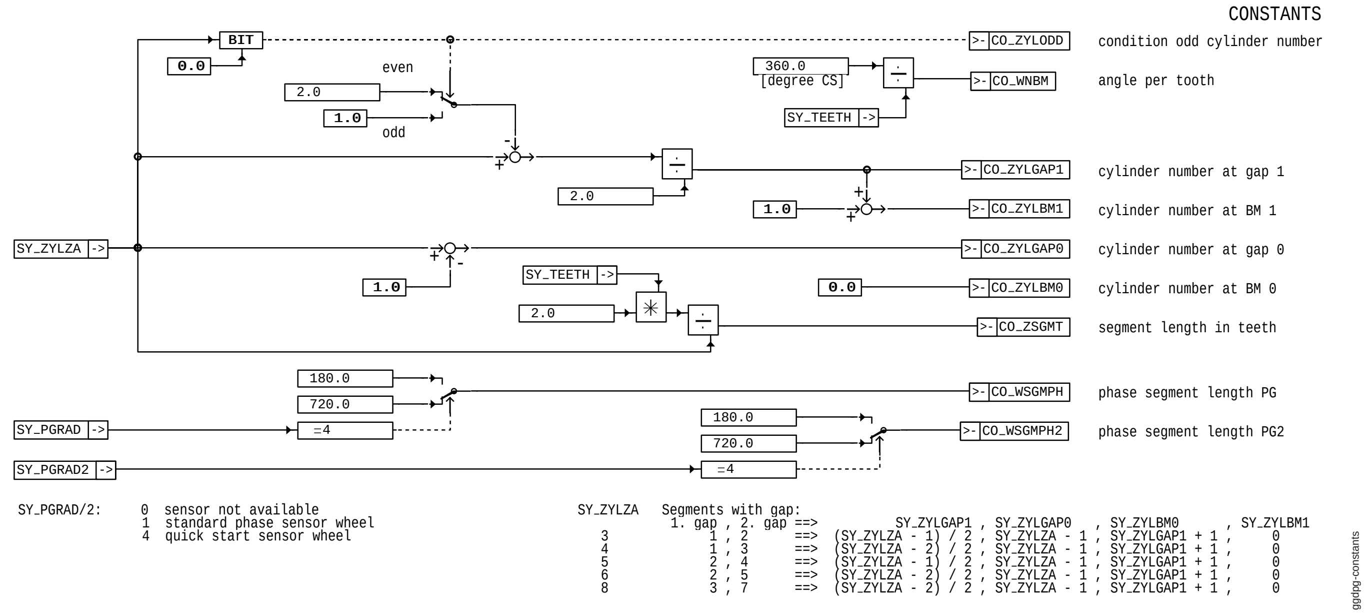


ggdpg-bgzzyl

Management of the cylinder counter zzyl.

At new synchronization resp. re-synchronization after quick-start (ALE -> QSYN, ALE -> BM or QSYN -> BM) the cylinder counter is initialized from zzyl_virt, qzzyl or bmzzyl. At each synchro cycle R_syn, zzyl is incremented until zzyl = SY_ZYLZA - 1. When zzyl = SY_ZYLZA, zzyl is immediately reset to 0. When a re-synchronization occurs the value of zzyl is re-stored into zylvirt prior to the initialization.

The correct synchronization is indicated in B_synph. At the first synchro B_synph is set provided no fault has been diagnosed. During the next 5 cycles for the phase inquiry R_synph the synchronization is checked. If still no fault occurs till then, B_synph remains set and the checking is terminated.



```
SY_PGRAD/2:     0  sensor not available
                1  standard phase sensor wheel
                4  quick start sensor wheel
```

```
SY_ZYLZA   Segments with gap:
            1. gap , 2. gap ==>          SY_ZYLGAP1 , SY_ZYLGAP0   , SY_ZYLBM0       , SY_ZYLBM1
   3              1 , 2     ==>  (SY_ZYLZA - 1) / 2 , SY_ZYLZA - 1 , SY_ZYLGAP1 + 1 ,     0
   4              1 , 3     ==>  (SY_ZYLZA - 2) / 2 , SY_ZYLZA - 1 , SY_ZYLGAP1 + 1 ,     0
   5              2 , 4     ==>  (SY_ZYLZA - 1) / 2 , SY_ZYLZA - 1 , SY_ZYLGAP1 + 1 ,     0
   6              2 , 5     ==>  (SY_ZYLZA - 2) / 2 , SY_ZYLZA - 1 , SY_ZYLGAP1 + 1 ,     0
   8              3 , 7     ==>  (SY_ZYLZA - 2) / 2 , SY_ZYLZA - 1 , SY_ZYLGAP1 + 1 ,     0
```

ggdpg-constants

Generation of the constants important for %GGDPG, which are derived from system constants.

ABK GGDPG 14.30 Abbreviations

Abbreviation	Meaning
DG	crankshaft position sensor
PG	camshaft position sensor
TPO	TRUE POWER ON (camshaft position sensor)
*	Wildcard to distinguish between phase sensor 1 and 2, e. g. PG* = PG1 or PG2
KW	Crankshaft
NW	Camshaft

Label	Source	Type	Quantization	Description
Activlow	System	Macro		Level definition: Phase level PG low at first reference mark BM0
Activ2low	System	Macro		Level definition: Phase level PG2 low at first reference mark BM0
CO_WNBM	Constants	const	1° CA	Angle per tooth (6° CA at a 60-2 pulse-generator wheel)
CO_ZSGMT	Constants	const	1	Number of teeth per segment (without gap)
CO_WSGMPH	Constants	const	6° CA	Distance in degrees CA between the falling edges in the phase sensor signal
CO_WSGMPH2	Constants	const	6° CA	Distance in degrees CA between the falling edges in the 2. phase sensor signal
CO_ZYLODD	Constants	Flag	0/1	Flag engine with odd number of cylinders
CO_ZYLGAP0	Constants	const	1	Cylinder number at gap 0
CO_ZYLBM0	Constants	const	1	Cylinder number at reference mark 0
CO_ZYLGAP1	Constants	const	1	Cylinder number at gap 1
CO_ZYLBM1	Constants	const	1	Cylinder number at reference mark 1

```
CWNWREF  -> characterisitc of the camshaft at start
        Bit 0:  =1      camshaft of PG1 secure in reference position at engine start
        Bit 2:  =1      camshaft of PG2 secure in reference position at engine start
        Bit 2 - 7       not in use
```

Parameter	Source-X	Source-Y	Type	Description
CWNWREF			FW	characteristics of the camshaft at engine start
DZZST			FW	number of teeth when tooth suppression during start
DZZST2			FW	Number of teeth for tooth debouncing with second phase sensor
DZZSTNLP			FW	Number of teeth for tooth debouncing at camshaft limp home mode
NMIN			FW	minimum engine speed
NMOTQSYN			FW	engine speed threshold to enable quick start via phase sensor signal
NSYN2SG			FW	Engine speed threshold for new synchronization at 2 ECU-concept with NLDG
OFQSYNADAP			FW	offset between adapted phase edge and phase edge in start
PH_MINSEG			FW	length of short segment at the quick start phase sensor signal
TMQSYN			FW	engine temperature threshold to enable quick start via phase sensor signal
TPREL			FW	tooth debouncing time during initialisation
ZDELBMSRCH			FW	additional tooth offset to wait for the next gap in quick start
ZTPREL			FW	number of teeth during start recognition

Variable	Source	Type	Description
BMLOSCTR_W	GGDPG	AUS	counter (word) re-synchronizations due to a loss of the reference gap
BMZZYL	GGDPG	LOK	initial value for cylinder counter after first reference gap

Variable	Source	Type	Description
B_ALE	ALE	EIN	condition engine stop position detected
B_BM	GGDPG	AUS	condition reference mark detected
B_CLBM		EIN	condition clear fault path reference mark sensor
B_ENQSYN	GGDPG	LOK	condition enable phase signal quick start
B_FBM	GGDPG	AUS	condition reference mark error => at least 1 tooth too few/many
B_KL15		EIN	condition ignition switch on
B_LUECKE	GGDPG	AUS	current segment covers the reference gap
B_MLUECKE	GGDPG	AUS	condition segment at mid reference gap at engines with odd number of cylinders
B_NLDG		EIN	condition limp-home function speed sensor
B_NLDGC		EIN	Second ECU is in the speed sensor limp home mode (via CAN)
B_NLPH	NLPH	EIN	condition no signal from the phase sensors
B_NMIN	GGDPG	AUS	condition lower speed: n < NMIN
B_NMOT	GGDPG	AUS	condition engine speed: n > NMIN
B_NOBM	GGDPG	AUS	condition BM-gap after > 60 teeth not found
B_NOBM1	GGDPG	AUS	condition 1. BM-gap after synchronization not found
B_NOPH	GGDPG	AUS	Phase signal not found
B_NOPH2	GGDPG	AUS	2. phase signal not found
B_NOSYNPH	NLPH	EIN	Flag for wrong cylindernumber at synchronisation-gap
B_PGXQSYN	GGDPG	LOK	condition for using phase sensor PG/PG2 für quick start
B_PHA2ACT	GGDPG	AUS	condition signal of phase sensor 2 is high activ
B_PHAACT	GGDPG	AUS	condition signal of phase sensor 1 is high activ
B_PHAD	WANWKW	EIN	adaptation crankshaft/camshaft performed
B_PHAD2	WANWKW	EIN	adaptation crankshaft/camshaft 2 performed
B_PHAS2	GGDPG	AUS	Condition phase 2 low/high
B_PHASE	GGDPG	AUS	Condition phase low/high
B_PHNLDG	NLDG	EIN	phase identification in speed sensor limp home function
B_PHSOK	DPH	EIN	Condition phase signal ok
B_PHSOK2	DPH	EIN	Condition phase signal 2 ok
B_PHW	GGDPG	LOK	condition phase change during last tooth in gap search
B_PHW2	GGDPG	LOK	condition phase change on 2. PG during last tooth in gap search
B_PHWNEG	GGDPG	LOK	condition falling edge in phase signal used for quick start
B_PHWOK	GGDPG	LOK	condition phase change recognized
B_PHWOK2	GGDPG	LOK	condition phase change PG2 recognized
B_PHWPOS	GGDPG	LOK	condition rising edge in phase signal used for quick start
B_PRESYNC		EIN	Synchronization is found by the second ECU at limp home (via CAN)
B_QSYN	GGDPG	AUS	Condition quick synchronization
B_ST	SWADAP	EIN	condition for start
B_STARTINI	GGDPG	AUS	start bit to distinguish first synchronization with KL15 from new synchr.
B_SYN	GGDPG	AUS	condition synchronization succeeded
B_SYNBMALE	GGDPG	LOK	Condition: No camshaft sensor for synchronization available
B_SYNNLDG	NLDG	EIN	condition: limp home crank position detected from PG-signal
B_SYNPH	GGDPG	AUS	condition synchronization phase
B_ZPREL	GGDPG	AUS	condition tooth debouncing ready
B_ZZTAB	GGDPG	AUS	condition: tooth time table valid
C_BMSUCH		EIN	ECU-condition: searching for reference mark
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NSUCH		EIN	ECU-conditon: searching for engine speed signal
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
C_SYN		EIN	ECU-condition angle synchronization available
EDGE_CTR	GGDPG	LOK	index of the phase edge at recognized quick start position
E_BM	DDG	EIN	error flag: reference mark sensor
E_N	DDG	EIN	error flag: engine speed sensor
E_SGCAN		EIN	Error local CAN (2 ME)
GAPTOOTH	GGDPG	AUS	content of the tooth counter to check the gap
LEN_HISEG	GGDPG	LOK	length of the last ’high’ phase segment during quick start
LEN_LOSEG	GGDPG	LOK	length of the last ’low’ phase segment during quick start
NBM		EIN	input speed signal
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
PH		EIN	Input signal phase
PH2		EIN	Input signal phase 2
QZZYL	GGDPG	LOK	initial value cylinder counter at B_qsyn
R	GGDPG	DOK	vector computing base flags (only CU model)
R_BM	GGDPG	DOK	Schedule of reference mark (BM-gap)
R_NBM	GGDPG	AUS	Schedule of tooth signal
R_NBMNLDG	NLDG	EIN	software generated tooth interrupt from limp home speed sensor
R_SYN	GGDPG	AUS	Synchro schedule
R_SYNPH	GGDPG	AUS	synchro schedule for phase scan
R_SYNPH2	GGDPG	AUS	synchro schedule for phase scan 2
R_T10		EIN	Time schedule 10 ms
STATEQSYN	GGDPG	LOK	state of the quick-start State-Machine GEN_QSYN
SYNSTATE		EIN	current mode of synchronization
SY_GAP	PROKON	EIN	system constant: number of missing teeth in the gap
SY_NLDG	PROKON	EIN	System constant: TRUE crankshaft limp home function available
SY_PGRAD	PROKON	EIN	system constant: kind of the phase signal
SY_PGRAD2	PROKON	EIN	system constant: kind of the 2. phase signal
SY_PGTPO		EIN	system constant: performance of the camshaft sensor at power on
SY_PH2OFST	PROKON	EIN	system const. offset in syncros between the 2 active phase signals,2 PGs only
SY_SGANZ	PROKON	EIN	system constant, number of engine ECU’s
SY_TEETH	PROKON	EIN	system constant: number of teeth with gap teeth on the crankshaft wheel

Variable	Source	Type	Description
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
T		EIN	time
TMCORCTR_W	GGDPG	AUS	counter reference gap correction at a missing tooth
TMOT	SWADAP	EIN	Engine temperature
TNBM1_W	GGDPG	AUS	tooth periode of the second last NBM signal
TNBM2_W	GGDPG	AUS	tooth periode of the third last NBM signal
TNBM_W	GGDPG	AUS	tooth periode of the last NBM signal
TPCORCTR_W	GGDPG	AUS	counter reference gap correction at an additional tooth
TTOOTH10MS	GGDPG	AUS	counter 10 ms schedules without tooth interrupt
UZKW_W	GGDPG	AUS	revolution counter crankshaft
WKWBZM0_W	GGDPG	AUS	crank angle at the zero point of the working cycle: R_syn & zzyl = 0 (word)
WKWNEG_W	GGDPG	LOK	crank angle at the falling phase edge in quick start
WKWPOS_W	GGDPG	LOK	crank angle at the rising phase edge in quick start
WKWSTART_W	GGDPG	LOK	crank angle at NMIN detection in quick start
WKWSTOP	ALE	EIN	engine stopping position in working cycle
WKWSYN_W	GGDPG	AUS	crank angle at start of the synchro (word)
WKW_W	GGDPG	AUS	crank angle (word)
WNWSP2_W	WANWKW	EIN	Adaptation angle of the camshaft 2 in retarded end position
WNWSP_W	WANWKW	EIN	Adaptation angle of the camshaft in retarded end position
ZDELAY	GGDPG	LOK	tooth delay counter in quick start
ZNBM_W	GGDPG	AUS	counter tooth interrupt (word)
ZRPH	GGDPG	AUS	counter schedule of phase signal
ZRPH2	GGDPG	AUS	counter schedule of phase signal 2
ZYLVIRT	GGDPG	AUS	content of the cylinder counter before new synchronisation from quick start
ZZALE_INI	GGDPG	LOK	initial value for tooth counter zzseg at active engine stop position (B_ale)
ZZSEG	GGDPG	AUS	tooth counter in segment
ZZTAB	GGDPG	AUS	tooth time table
ZZVIRT	GGDPG	AUS	virtual teeth counter in start until synchronisation
ZZYL	GGDPG	AUS	SW-cylinder counter
ZZYL_VIRT	GGDPG	LOK	initial value cylinder counter at active engine stop position (B_ale)

FW GGDPG 14.30 Fixed Values

Parameter	Value	Description
CWNWREF		characteristics of the camshaft at engine start
DZZST		number of teeth when tooth suppression during start
DZZST2		Number of teeth for tooth debouncing with second phase sensor
DZZSTNLP		Number of teeth for tooth debouncing at camshaft limp home mode
NMIN		minimum engine speed
NMOTQSYN		engine speed threshold to enable quick start via phase sensor signal
NSYN2SG		Engine speed threshold for new synchronization at 2 ECU-concept with NLDG
OFQSYNADAP		offset between adapted phase edge and phase edge in start
PH_MINSEG		length of short segment at the quick start phase sensor signal
TMQSYN		engine temperature threshold to enable quick start via phase sensor signal
TPREL		tooth debouncing time during initialisation
ZDELBMSRCH		additional tooth offset to wait for the next gap in quick start
ZTPREL		number of teeth during start recognition

FB GGDPG 14.30 Detailed description of function

```
Overview of the partial functions
---------------------------------
                                                        +---------+
                                                        |         |
                                                        | %GGDPG  |
                                                        |         |
                                                        +----+----+
                                                             |
                                                             |
       +----------------+-----------------+------------------+-----------------+--------------+--------------------------+
       |                |                 |                  |                 |              |                          |
       |                |                 |                  |                 |              |                          |
+------+------+  +------+-------+  +------+------+  +--------+--------+  +-----+-----+   +----+----+               +-----+-----+
|             |  |              |  |             |  |                 |  |           |   |         |               |           |
| TOOTH_TIMES |  | PHASE_SIGNAL |  | CRANK_ANGLE |  | SYNCHRONIZATION |  | MIN_SPEED |   | SYNCHRO |               | CONSTANTS |
|             |  |              |  |             |  |                 |  |           |   |         |               |           |
+------+------+  +--------------+  +-------------+  +--------+--------+  +-----------+   +----+----+               +-----+-----+
       |                                                     |                                |
       |                                                     |                                |
       |                   +--------------+------------------+-----------------+              +--------------+------------+
       |                   |              |                  |                 |              |              |            |
       |                   |              |                  |                 |              |              |            |
+------+------+      +-----+-----+  +-----+------+  +--------+--------+  +-----+-----+  +-----+------+  +----+------+  +---+----+
|             |      |           |  |            |  |                 |  |           |  |            |  |          |  |        |
| ZZTAB_STORE |      | STATE_SYN |  | SEARCH_SYN |  |   SEARCH_CHECK  |  | GAP_CHECK |  | ALE_SYNINI |  | GEN_RSYN |  | BGZZYL |
|             |      |           |  |            |  |                 |  |           |  |            |  |          |  |        |
+-------------+      +-----------+  +-----+------+  +-----------------+  +-----+-----+  +------------+  +----+------+  +--------+
                                          |                                    |                             |
                                          |                                    |                             |
       +--------------+---------------+---+-------------+                      |                     +-------+-------+
       |              |               |                 |                      |                     |               |
       |              |               |                 |                      |                     |               |
+------+-----+  +-----+-----+  +------+------+  +-------+-------+        +-----+------+         +----+----+   +------+------+
|            |  |           |  |             |  |               |        |            |         |         |   |             |
| GAP_SEARCH |  | PH_CHANGE |  | GAP_SYNCHRO |  | QUICK_SYNCHRO |        | READ_ZZTAB |         | SEGZAHN |   | GEN_R_SYNPH |
|            |  |           |  |             |  |               |        |            |         |         |   |             |
+------------+  +-----------+  +-------------+  +-------+-------+        +------------+         +---------+   +-------------+
                                                        |
                                                        |
                                                        |
                                                        |
                                                        |
                                                +-------+-------+
                                                |               |
                                                |    GEN_QSYN   |
                                                |               |
                                                +---------------+
```

The sequential control for the synchronization and reference mark search is realized in %SYSYNC as follows:

```
Synchronization:
----------------

  +-------+      +----------+  Init. +-----------+                 +-----------------+  Init. +------------------+
  |       |      |          |  end   |   Speed   |  B_syn & R_syn  | Initialization  |  end   | synchronized     |
  | C_ini +--+-->+  Init.   +------->+           +---------------->+ of the Synchro  +------->++                 |----+
  |       |  |   |          |        |   search  |                 |    processes    |        |     operation    |    |
  +-------+  |   +----------+        +-----------+                 +-----------------+        +------------------+    |
             |     C_inisyn            C_nsuch                                                      C_syn             |
             |                                                                                                        |
             |                                                                                                        |
             |                                 Synchronization loss                                                   |
             |                                        B_syn = 0                                                       |
             +--------------------------------------------------------------------------------------------------------+
```

```
Reference mark search:
----------------------

  +----------+      +-----------------+      End of the  +----------+        +--------------+
  |          |      | Initialization  | tooth debouncing | reference|  B_bm  | ref. mark    |
  | C_inisyn +--+-->+ reference mark  +----------------->+ mark     +------->+              +----+
  |          |  |   |     search      |      B_zprel     | search   |        |    check     |    |
  +----------+  |   +-----------------+                  +----------+        +--------------+    |
                |                                          C_bmsuch                B_bm          |
                |                                                                                |
                |                                                                                |
                |                         Reference mark loss                                    |
                |                               B_bm = 0                                         |
                +--------------------------------------------------------------------------------+
```

By this control the following sequence results after terminal 15 ON:

1. In the control unit initialization C_ini the cylinder counter zzyl and the virtual tooth counter zzvirt are initialized from the stop position wkwstop and the bit B_syn is set with valid stop position (B_ale = true).
2. After the control unit initialization C_ini immediately the synchro initialization follows C_inisyn.
3. Subsequent to C_inisyn immediately the speed search C_nsuch is performed.
4. The speed search C_nsuch starts the debouncing of the speed signal, for this at first the time TPREL, hence the number of teeth DZZST are debounced in the partial function CRANK_ANGLE. After the debouncing B_zprel is set.
5. With B_zprel the reference mark search phase C_bmsuch starts. The tooth time tnbm_w is formed during C_bmsuch, which is shifted to a shift register in the tooth interrupt (tnbm1_w, tnbm2_w). As soon as tnbm2_w < tooth time(NMIN), B_nmot is set.
6. With B_nmot the actual gap search is started in GAP_SEARCH. Parallel to the gap search the virtual angular basis runs provided a valid stop position is given (B_ale) and the synchronization search via the quick-start sensor wheel. In the process the virtual position can be re-synchronized when the quick-start position is found (B_qsyn). B_qsyn leads to an immediate triggering of a virtual synchro interrupt.
7. With the first synchro interrupt (also virtual) the system changes to the synchronized state C_syn. The current synchronization state is outputted in the variable synstate (0=not, 1=run-out detection, 2=quick-start wheel, 3=reference mark). In the state synstate = 1 (synchronized via run-out detection) only the injection is enabled, in the states synstate > 1 (quick-start sensor wheel resp. reference mark) the injection as well as the ignition are enabled.
8. When finding the gap, B_bm is set and the system changes from C_bmsuch to the reference mark check. This state is described by B_bm. If in each synchro cycle after the gap the reference mark is not found, then B_bm and B_syn are reset and a new synchronization (C_inisyn) is triggered.

Tooth debouncing

After the initialization C_inisyn the state directly enters the speed search phase C_nsuch. At the first tooth edge the debouncing time TPREL is started. During this time no tooth interrupts are evaluated. Subsequent to TPREL also DZZST tooth edges are debounced. If the first camshaft sensor is defective and a second sensor is available there are DZZST2 tooth edges debounced (different sensor or camshaft wheel). B_zprel is set after this tooth debouncing and the counter znbm_w resp. wkw_w is reset.
If the condition B_nlph is set (camshaft limp home function) then tooth edges for several engine cycles are debounced to clear out possible residual charge.

Reference mark search phase

With B_zprel the reference mark search (C_bmsuch) is started. In this state the following functions are calculated in the tooth interrupt:

- The virtual engine position from the stop position (zzvirt, zzyl)
- Crank-angle determination and synchronization via the quick-start sensor wheel (B_syn, qzzyl)
- Reference mark search (B_bm)

Once the gap is detected the system changes from the state C_bmsuch to the reference mark check (B_bm).

Synchronization via run-out detection

In C_ini the virtual cylinder counter zzvirt and the cylinder counter zzyl are initialized from the stop position wkwstop at valid run-out detection. The tooth counter zzvirt is incremented in the tooth interrupt after the tooth debouncing (C_bmsuch). When zzvirt = 0, a synchro interrupt R_syn is triggered and zzvirt is set to the number of teeth per segment.

Scanning of the phase signal

The phase level is scanned in the tooth interrupt during C_bmsuch. With found reference mark (B_bm) the phase level PH is scanned at each second tooth edge after the gap. For the second phase sensor a distinction is made on whether its active phase level also lies within the gap (SY_PH2OFST = 0) or is shifted by a manifold of a segment (SY_PH2OFST > 0).
SY_PH2OFST corresponds to the distance between the phase levels in segments.

Example:

```
Synchro cylinder:                                     0                     1                     2         ...
                                                      .                     .
                                                      .                     .
PG-single sensor wheel:                 -------+      .     +-----------------------------------------------...
                                               |      .     |               .
                                               +------------+               .
                                                      .                     .
PG2- single sensor wheel SY_PH2OFST = 1 -----------------------------+      .     +-------------------------...
                                                      .              |      .     |
                                                      .              +------------+
                                                      .                     .
                                                      |<-- Segment length -->|
                                                         ==> SY_PH2OFST = 1
```

When SY_PH2OFST = 0, the phase level PH2 lies simultaneous to PH and can therefore also be scanned at the reference mark.
When SY_PH2OFST > 0, the phase level is scanned staggered by SY_PH2OFST segments (SY_PH2OFST * CO_ZSGMT) to the reference mark.

Phase level

The signal levels can either be low-active (low level at reference mark cylinder 0) or high-active (high level at reference mark cylinder 0). For the hardware casing a negation of the low-active signal (B_phase EXOR Activlow) is performed, so that by means of B_phactiv a high-active signal is always available (B_phaact).

Quick-start sensor wheel

A 4-segment phase sensor wheel with the signal shape given below is referred to as quick-start sensor wheel. This sensor wheel is described by the system constant SY_PGRAD=4 for the first resp. SY_PGRAD2=4 for the second phase sensor.

The active phase edges (falling edge at low-active resp. rising edge at high-active signal) lie equidistant with 180° KW distance to each other and the positions related to the crankshaft are adapted in %WANWKW.
With valid adaptation (B_phad = true), wnwsp_w(i) provides the crank-angle position of the edge i (with i = 0 ... 3). After the identification of the phase edge thus the position of the crankshaft is known and the following synchro can be triggered.

Assignment phase signal, synchro cycle to crank angle, single sensor wheel

```
SW-reference mark
       |
       |
8.cyl: 0              1              2              3              4              5              6              7              0
       |              .              .              .              .              .              .              .              |
6.cyl: 0              .    1         .         2    .              3              .    4         .         5    .              0
       |              .    .         .         .    .              .              .    .         .         .    .              |
5.cyl: 0              .    .   1     .         .    .  2           .           3  .    .         .     4   .    .              0
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
4.cyl: 0              .    .   .     1         .    .  .           2           .  .    .         3     .   .    .              0
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
3.cyl: 0              .    .   .     .         1    .  .           .           .  .    2         .     .   .    .              0
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
    BM0|              .    .   .     .         .    .  .        BM1.           .  .    .         .     .   .    .          BM0|
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
||||  ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||  ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||  |||||
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
       .                             .                             .                             .                             .
° KW:  0                            180                           360                           540                           720
```

Single phase sensor wheel SY_PGRAD = 1, low-active:

```
 --+            +----------------------------------------------------------------------------------------------------------+
   |            |                                                                                                          |
   +------------+                                                                                                          +------

Edge:          1
edge_ctr:      0
Position:  wnwsp_w(0)
```

Single phase sensor wheel SY_PGRAD = 1, high-active:

```
   +------------+                                                                                                          +------
   |            |                                                                                                          |
 --+            +----------------------------------------------------------------------------------------------------------+

Edge:          1
edge_ctr:      0
Position:  wnwsp_w(0)
```

Assignment phase signal, synchro cycle to crank angle, quick-start sensor wheel

```
SW-reference mark
       |
       |
8.cyl: 0              1              2              3              4              5              6              7              0
       |              .              .              .              .              .              .              .              |
6.cyl: 0              .    1         .         2    .              3              .    4         .         5    .              0
       |              .    .         .         .    .              .              .    .         .         .    .              |
5.cyl: 0              .    .   1     .         .    .  2           .           3  .    .         .     4   .    .              0
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
4.cyl: 0              .    .   .     1         .    .  .           2           .  .    .         3     .   .    .              0
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
3.cyl: 0              .    .   .     .         1    .  .           .           .  .    2         .     .   .    .              0
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
    BM0|              .    .   .     .         .    .  .        BM1.           .  .    .         .     .   .    .           BM0|
       |              .    .   .     .         .    .  .           .           .  .    .         .     .   .    .              |
||||  ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||  ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||  |||||
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
       .                             .                             .                             .                             .
° KW:  0                            180                           360                           540                           720
```

Quick-start phase sensor wheel SY_PGRAD = 4, low-active:

```
          +------+      +----------------------+      +----------------------+                      +------+                      +
          |      |      |                      |      |                      |                      |      |                      |
  --------+      +------+                      +------+                      +----------------------+      +----------------------+

Edge:            1                             2                             3                             4
edge_ctr:        0                             1                             2                             3
Position:    wnwsp_w(0)                    wnwsp_w(1)                    wnwsp_w(2)                    wnwsp_w(3)
```

Quick-start phase sensor wheel SY_PGRAD = 4, high-active:

```
  --------+      +------+                      +------+                      +----------------------+      +----------------------+
          |      |      |                      |      |                      |                      |      |                      |
          +------+      +----------------------+      +----------------------+                      +------+                      +

Edge:            1                             2                             3                             4
edge_ctr:        0                             1                             2                             3
Position:  wnwsp_w(0)                    wnwsp_w(1)                    wnwsp_w(2)                    wnwsp_w(3)
```

Synchronization via quick-start sensor wheel

If a system possesses a quick-start sensor wheel (SY_PGRAD* = 4) and if the phase edges have been adapted (B_phad = true), then the phase sensor signal is used for the quick-start synchronization below the speed threshold NMOTQSYN. The function is only released via a CodeWord if the camshaft is in the reference position at engine start. The phase level scanned in the tooth interrupt is checked for edge changes and if necessary the flag B_phw is set. During quick-start always B_nmot is waited for. After B_nmot the negative phase edge is evaluated and the quick-start is initiated. By evaluating the positive edges resp. by waiting for further teeth at first the index of the edge (edge_ctr) is determined and then the number of teeth till the next segment beginning. Once these teeth have been waited for B_qsyn is set and thereby a synchronization via the quick-start sensor is triggered. If the system is already in the synchronized state (run-out detection), then a re-synchronization is performed. The detailed sequence of the quick-start is as follows:

stateqsyn	State	Remark
0	Start_qsyn	Entry state into the quick-start at C_inisyn. Nothing is calculated in this state, waiting for tooth debouncing. Transition to Wait_nmot in the reference mark search phase C_bmsuch if tmot > TMQSYN.
1	Wait_nmot	B_nmot is not yet set, the tooth debouncing has taken place. The phase changes are recorded (wkwneg_w and B_phwneg at negative, wkwpos_w and B_phwpos at positive phase edge). Transition to Wait_negedge with B_nmot.
2	Wait_negedge	Waiting for a negative phase edge (B_phwneg). During entry a check is performed on whether a negative phase edge has already been detected and if necessary the exit condition is checked. If B_phwneg is not yet given then the negative edge is waited for and hence the exit condition is checked. The following exit conditions are possible: Prio 1: Phase edge has already been detected (edge_ctr > -1) ==> Gen_qsyn Prio 2: Length of the high segment is known (len_hiseg > 0) ==> Wait_shortseg Prio 3: Only the negative phase edge has been detected ==> Wait_gap
3	Wait_gap	In this state only the negative phase edge was detected. The number of teeth from the 2nd phase edge to the 1st reference mark as well as from the 4th phase edge to the 2nd reference mark is calculated and the tooth counter zdelay is set to maximum value. Once these teeth have passed either a reference mark occurs (this terminates the quick-start immediately, exit via the reset condition after End_qsyn) or the negative edge can be determined by the current phase level, at high level the engine was at the 1st otherwise at the 3rd edge. The exit therefore takes place when zdelay = 0 after Gen_qsyn, where here the phase edge (edge_ctr) during the exit is determined by level inquiry.

4	Wait_shortseg	The length of the last high segment is known in this state. With a high segment the engine is at the 2nd or 3rd, otherwise at the 1st or 4th phase edge. By waiting for a short low segment it is possible to identify the phase edge. The exit to Gen_qsyn is therefore performed at a positive edge or after zdelay teeth have passed. Zdelay is calculated from the distance of the phase edge with following long low segment plus PHMINSEG until the next synchro beginning. During the exit a check is then performed on whether a edge change has occurred and thereby the phase edge (edge_ctr) is defined.
5	Gen_qsyn	The negative phase edge (edge_ctr) and the difference between the current position and the phase edge (wkw_w - wkwneg_w) is known when entering this state. Thereby the current position is determined, the number of teeth until the next synchro (zdelay) as well as its cylinder number (qzzyl) is calculated. Thereafter zdelay teeth are waited for and then B_qsyn is set. Thereby the quick-start is terminated and the state machine changes to End_qsyn.
6	End_qsyn	End of the quick-start. This state is start as well as reset state at the same time. The reset condition is B_bm1 (reference mark found) or B_enqsyn (quick-start not enabled).

Synchronization via reference mark, gap search

At virtual synchronized operation (run-out detection resp. quick-start sensor wheel) the system is in the state C_bmsuch. The gap is still searched for in the tooth interrupt in this state. For this, each last tooth time tnbm_w is shifted to the shift register tnbm1_w and tnbm2_w and the current tooth time is calculated again. The gap is detected in GAP_SEARCH and B_bm is set, if the following condition is fulfilled:

```
                (tnbm_w < tnbm1_w / 2) and (tnbm2_w < tnbm1_w / 2)
```

```
Ex.:
               --+       +-------+       +-------+       +-------+                                       +-------+       +-------+
                 |       |       |       |       |       |       |                                       |       |       |       |
                 |       |       |       |       |       |       |                                       |       |       |       |
                 +-------+       +-------+       +-------+       +---------------------------------------+       +-------+       +-
                 .               .               .               .                                               .               .
                 ^               ^               ^               ^                                               .               .
tooth before     |               |               |               |                                               .               .
the gap:         |<-- tnbm2_w -->|<-- tnbm1_w -->|<-- tnbm_w --->|                                               .               .
                 |               |               |               |                                               .               .
                                 .               .               .                                               .               .
                                 ^               ^               ^                                               ^               .
1. tooth after                   |               |               |                                               |               .
the gap:                         |<-- tnbm2_w -->|<-- tnbm1_w -->|<----------------- tnbm_w -------------------->|               .
                                 |               |               |                                               |               .
                                                 .               .                                               .               .
                                                 ^               ^                                               ^               ^
2. tooth after                                   |               |                                               |               |
the gap:                                         |<-- tnbm2_w -->|<----------------- tnbm1_w ------------------->|<-- tnbm_w --->|
                                                 |               |                                               |               |
```

==> Reference mark at the 2nd tooth after the gap found, B_bm = 1

The cylinder counter is initialized new by means of the phase information and a re-synchronization is triggered after B_bm was set. Simultaneously the state C_bmsuch is terminated, the system runs in the state "synchronized via reference mark" (B_bm = true).

Monitoring of the gap search

If the gap is not found within 720° KW in the speed search phase, then the bit B_nobm is set and thereby a virtual synchronization is reset via B_syn. The synchronized operation is aborted after this resetting and the system can only still be synchronized by the reference mark (B_bm 0->1). The bit B_nobm is reset in C_ini.

Synchronized via reference mark, gap check

The synchro cycle (R_syn) is generated via the counter zzseg during operation B_bm. At the beginning of the synchro, zzseg is each time loaded with the number of teeth of the subsequent segment. This counter is decremented in the tooth interrupt and when zzseg = 0 the next synchro cycle is generated. When loading the counter zzseg after a gap segment a possible correction by 1 tooth from the last segment is taken into consideration.

Each gap check is performed in the segment after the gap. Since the position of the gap in the last segment is known, this can be checked by means of the tooth time table. At first the 4 tooth times at the gap are read and the 3 tooth periods are calculated as follows:

```
               ----+       +-------+                                       +-------+       +-------+
                   |       |       |                                       |       |       |       |
                   |       |       |                                       |       |       |       |
                   +-------+       +---------------------------------------+       +-------+       +---

4 tooth times:     1               2                                               3               4

                   ^               ^                                               ^               ^
                   |               |                                               |               |
3 tooth periods:   |<-- tnbm2_w -->|<----------------- tnbm1_w ------------------->|<-- tnbm_w --->|
                   |               |                                               |               |
```

With the condition:
B_st = TRUE: (tnbm_w < tnbm1_w / 2) and (tnbm2_w < tnbm1_w)
B_st = FALSE: (tnbm_w < tnbm1_w / 2) and (tnbm2_w < tnbm1_w / 2)

the gap is detected as being correct analogous to the gap search. In this case B_fbm = 1 and B_bm = 0 do not change. If a fault by one tooth occurred since the last reference mark, then this can be detected by the following conditions and it can be corrected by setting bmkor. In case of a fault by 1 tooth B_bm = 1 remains set and B_fbm is additionally set.

1 tooth too many:

```
               ----+       +-------+       +-------+                                       +-------+
                   |       |       |       |       |                                       |       |
                   |       |       |       |       |                                       |       |
                   +-------+       +-------+       +---------------------------------------+       +---
                   ^               ^               ^                                               ^
                   |               |               |                                               |
                   |<-- tnbm2_w -->|<-- tnbm1_w -->|<----------------- tnbm_w -------------------->|
                   |               |               |                                               |
```

Detection by: tnbm_w / 2 > tnbm1_w

In this case the tooth counter zzseg is decremented by 1 via bmkor = -1 and the fault is corrected in the segment to follow. At each correction by -1 tooth the counter tpcorctr_w is increased by 1.

1 tooth too little:

```
               ----+                                       +-------+       +-------+       +-------+
                   |                                       |       |       |       |       |       |
                   |                                       |       |       |       |       |       |
                   +---------------------------------------+       +-------+       +-------+       +---

                   ^                                               ^               ^               ^
                   |                                               |               |               |
                   |<----------------- tnbm2_w ------------------->|<-- tnbm1_w -->|<--- tnbm_w -->|
                   |                                               |               |               |
```

Detection by: tnbm2_w / 2 > tnbm1_w

In this case the tooth counter zzseg is incremented by 1 via bmkor = 1 and the fault is corrected in the segment to follow. At each correction by 1 tooth the counter tmcorctr_w is increased by 1.

If none of these conditions occur, then the gap was not found, the reference mark loss counter bmlosctr_w was incremented, B_bm and thereby B_syn were reset and thus a new synchronization was forced.

Tooth periods, tooth time table

During the reference mark search phase the tooth period tnbm_w is calculated as of the second tooth interrupt and shifted to the shift register tnbm_w, tnbm1_w, tnbm2_w. These tooth periods are used to set resp. reset the conditions B_nmot resp. B_nmin, to calculate the engine speed (%BGNMOT) and to search the gap.

As of B_bm only the counter zzseg is still decremented in the tooth interrupt and the accompanying segment time t is written into the tooth time table zztab. The tooth time table is an array of tooth times with (SY_ZSGMT + 3) elements. The table is written into as of the 2nd element when the first synchro triggered by B_bm1 occurs. At each following synchro cycle (R_syn) the two last tooth times are copied to the table positions 0 and 1 and the table is again written into as of position 2. Once the table has been written into for the first time, B_zztab is set. The length of the table (CO_ZSGMT + 3) thus results from the 2 entries of the teeth from the previous segment and the segment length plus one tooth, which can be corrected without a synchronization loss.

Monitoring of minimum speed

The 3 last tooth periods are used during the reference mark search (C_bmsuch) for the monitoring of the minimum speed.
The tooth period for the setting of B_nmot is obtained from the speed threshold NMIN as follows:

min. tooth time = (60 / NMIN) / SY_TEETH.

B_nmot is set when: tnbm2_w < min. tooth time

By using tnbm_2 to set B_nmot it is ensured that the tnbm shift register is completely filled and that the gap can immediately be searched for with B_nmot. When B_nmot is set, B_nmin is reset.

Resetting of B_nmot is performed when: (tnbm_w > tnbm_min_w) and (tnbm1_w > tnbm_min_w)

By monitoring the two tooth times tnbm_w and tnbm1_w it is ensured that B_nmot cannot be reset by the "gap tooth".

At operation synchronized via reference mark (B_bm) the minimum speed is monitored by the counter ttooth10ms. If no tooth interrupt occurred since the last 10 ms cycle, then this counter is incremented (if the crankshaft is at the "gap tooth" -> triple tooth time, then only every third cycle is incremented), otherwise the counter is reset to 0. If no tooth interrupt occurs within 50 ms (50 ms tooth period corresponds to a minimum speed of 20 rpm at SY_TEETH = 60), then B_nmot is reset.

When resetting B_nmot, B_nmin is automatically set again. With B_nmot also B_syn is reset and thereby a new synchronization (C_inisyn) is triggered.

Formation of the cylinder counter

The cylinder counter zzyl indicates the SW cylinder number of the current synchro. In the process zzyl is incremented at the beginning of the synchro cycle, when zzyl = SY_ZYLZA it is reset to 0 again.

In case of a new resp. re-synchronization the cylinder counter is initialized as follows:

synstate	Initialization from:	Meaning
1	zzyl_virt	With valid run-out position the start position is determined in C_ini from wkwstop by adding the debounced teeth and from this the start values for the tooth counter zzale_ini and the cylinder counter zzyl_virt are initialized. Taking this position as a basis the virtual angular basis is followed up after the tooth debouncing until a re-synchronization is performed via the quick-start or the gap.
2	qzzyl	At quick-start the cylinder number of the following segment is determined when the engine position was found and at its synchro beginning a synchro cycle is triggered via B_qsyn. By the change from synstate to synstate = 2, the cylinder counter zzyl is initialized to qzzyl.
3	bmzzyl	When the gap was found, the cylinder number for the segment following the gap is determined (bmzzyl) by means of phase determination (see below). During the change from synstate to synstate = 3, zzyl is initialized with bmzzyl.

Calculation of bmzzyl:

The segment to follow the gap must be initialized by bmzzyl = CO_ZYLBM0 or bmzzyl = CO_ZYLBM1, dependent on the current phase position. The phase position is determined according to the following sequence:

1. At limp-home speed sensor the phase position is calculated in %NLDG and made available by B_phnldg ==> B_phnldg
2. Phase sensor PG detected as not defective (B_phsok) ==> B_phaact
3. Optional second phase sensor PG2 detected as not defective (B_phsok2) ==> B_pha2act
4. Run-out detection valid (B_ale), the virtual position calculated from the stop position is valid ==> zzvirt
5. Neither phase position nor virtual engine position known, synchronization to cylinder after BM 0 ==> CO_ZYLBM0

Priority 3 is only available if a second phase sensor exits (SY_PGRAD2 > 0) and if it provides a signal at the reference mark that can be used for the synchronization (SY_PH2OFST = 0).

If there is no camshaft sensor information available at the reference gap for synchronization and B_ale is TRUE so the engine position is calculated via the run-out position. The actual engine position results in the following way:

wkwstop / CO_WNBM + ZTPREL +DZZSTNLP + tooth edges from the end of tooth debouncing till the reference gap + gap correction

there zzvirt is initialized with zzale_ini = 255 - wkwstop / CO_WNBM in C_ini (zzvirt is decremented at each tooth)

Tooth number at reference gap: ZTPREL + DZZSTNLP + 255 - zzvirt + gap correction

Cycle for phase inquiry, R_synph and R_synph2

The cylinder number zzyl is inquired upon in the synchro interrupt to generate a cycle for the phase inquiry. If the beginning of the current segment lies in resp. directly after the active phase position, then the cycle for phase inquiry/phase monitoring is triggered. That angle range is referred to as active phase position, at which the phase position can definitely be determined. For the first phase sensor PG these are always those segments, which follow the gap. For the second phase sensor PG2 the active phase position lies staggered by SY_PH2OFST.

Example (6 cylinder, SY_PH2OFST = 1):

```
6.cyl:    0                   1                   2                   3                   4                   5                   0
          .                   .                   .                   .                   .                   .                   .
R_synph:  X                   .                   .                   X                   .                   .                   X
          .                   .                   .                   .                   .                   .                   .
R_synph2: .                   X                   .                   .                   X                   .                   X
          .                   .                   .                   .                   .                   .                   .
   ||||  ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||  ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||  ||
   ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
     .           .        .                                      .            .       .            .
   --+           +----------------------------------------------------------------------------------------------------------+
     |           |        .                                      .            .       .            .                        |
     +-----------+        .                                      .            .       .            .                        +------
     .           .        .                                      .            .       .            .
     |<- active->|        .                                      |<- active-->|       .            .
     .                    .           .                                               .            .
     |<--- SY_PH2OFST --->|           .                                               .            .
     .                    .           .                                               .            .
   -----------------------+           +--------------------------------------------------------------------------------------------
     .                    |           |                                               .            .
     .                    +-----------+                                               .            .
     .                    .           .                                               .            .
     .                    |<- active->|                                               |<- active-->|

1. Timing: Sequence of a typical operating cycle:
-------------------------------------------------

B_kl15    1   +------------------------------------------------------.....----------------------------+
          0 --+                                                                                       +----------------------------
              .                                                                                       .
C_ini     1   . +--+                                                                                  .
          0 ----+  +-------------------------------------------------.....---------------------------------------------------------
                   .                                                                                  .
C_norm    1        +-------------------------------------------------.....----------------------------+
          0 -------+                 N o r m a l         O p e r a t i o n                            +----------------------------
                   .                                                                                  .
C_nachl   1        .                                                                                  +-------------------+
          0 ---------------------------------------------------------.....----------------------------+    ECU after-run  +--------
                   .                                                                                  .
Speed       ^      .                              ******   **********.....*****************           .
            |      .                            *       ***                                ************
            |      .                          *                                                       .*
            |      .                         *                                                        .  *
            |      .                       *                                                          .   *
            |      .        **************                                                            .     *
            |      .     **                                                                           .       *
            |      .  **                                                                              .          *
          0 +-*******------------------------------------------------.....-------------------------------------------**************
                   .                                                                                  .
B_nmin    1 ------------+                                                                             .              +-------------
          0        .    +--------------------------------------------.....-------------------------------------------+
                   .                                                                                  .
B_nmot    1        .    +--------------------------------------------.....-------------------------------------------+
          0 ------------+                                                                             .              +-------------
                   .                                                                                  .
B_syn     1        +-------------------------------------------------.....---------------------------------------------------------
          0 -------+                                                                                  .
                   .                                                                                  .
B_bm      1        .            +------------------------------------.....---------------------------------------------------------
          0 --------------------+                                                                     .
                   .            .                                                                     .
C_inisyn  1        +-+          .                                                                     .
          0 -------+ +-----------------------------------------------.....---------------------------------------------------------
                     .          .                                                                     .
C_nsuch   1          +-----+    .                                                                     .
          0 ---------+     +-----------------------------------------.....---------------------------------------------------------
                     .     .    .                                                                     .
C_syn     1          .     +-----------------------------------------.....---------------------------------------------------------
          0 ---------------+                                                                          .
                     .     .    .                                                                     .
C_bmsuch  1          .+---------+                                                                     .
          0 ----------+    .    +------------------------------------.....---------------------------------------------------------
                           ^    ^
                           |    |
                           |    +----- Start 2. synchro (reference mark)
                           +----- Start 1. synchro (virtual, from run-out detection or quick-start)
```

```
2. Timing: Synchronization loss (e.g. two teeth too many detected):
-------------------------------------------------------------------

B_kl15    1   +-----------------------------------------------.....-----------------------------------+
          0 --+                                                                                       +----------------------------
              .                                                                                       .
C_ini     1   . +--+                                                                                  .
          0 ----+  +------------------------------------------.....----------------------------------------------------------------
                   .                                                                                  .
C_norm    1        +------------------------------------------.....-----------------------------------+
          0 -------+                 N o r m a l         O p e r a t i o n                            +----------------------------
                   .                                                                                  .
C_nachl   1        .                                                                                  +-------------------+
          0 --------------------------------------------------.....-----------------------------------+    ECU after-run  +--------
                   .                                                                                  .
Speed       ^      .                              ******   ***.....******        **********           .
            |      .                            *       ***            ^ **     *          ************
            |      .                          *                        |   **  *                      .*
            |      .                         *                         |     **                       .  *
            |      .                       *              Gap loss  ---+     .                        .   *
            |      .        **************                             .     .                        .     *
            |      .     **                                            .     .                        .       *
            |      .  **                                               .     .                        .          *
          0 +-*******-----------------------------------------.....--------------------------------------------------**************
                   .                                                   .     .                        .
B_nmin    1 ------------+                                              .     .                        .              +-------------
          0        .    +-------------------------------------.....--------------------------------------------------+
                   .                                                   .     .                        .
B_nmot    1        .    +-------------------------------------.....--------------------------------------------------+
          0 ------------+                                              .     .                        .              +-------------
                   .                                                   .     .                        .
B_syn     1        +------------------------------------------.....----+     +-----------------------------------------------------
          0 -------+                                                   +-----+                        .
                   .                                                   .     .                        .
B_bm      1        .            +-----------------------------.....----+     +-----------------------------------------------------
          0 --------------------+                                      +-----+                        .
                   .            .                                      .     .                        .
C_inisyn  1        +-+          .                                      +-+   .                        .
          0 -------+ +----------------------------------------.....----+ +---------------------------------------------------------
                     .          .                                      .     .                        .
C_nsuch   1          +-----+    .                                      . +---+                        .
          0 ---------+     +----------------------------------.....------+   +-----------------------------------------------------
                     .     .    .                                      .     .                        .
C_syn     1          .     +----------------------------------.....----+     +-----------------------------------------------------
          0 ---------------+                                           +-----+                        .
                     .          .                                      .     .                        .
C_bmsuch  1          .+---------+                                      .   +-+                        .
          0 ----------+    .    +-----------------------------.....--------+ +-----------------------------------------------------
                           ^    ^                                            ^
                           |    |                                            |
                           |    +----- Start 2. synchro (reference mark)     +----- Start 1. synchro after BM-loss (reference mark)
                           +----- Start 1. synchro (virtual, from run-out detection or quick-start)
```

```
3. Timing: Stalling and Kl.15 remains on, hence restart without Kl.15 off
-------------------------------------------------------------------------

B_kl15    1 -----------------------------------------.....---------------------------------------------------------------.....-----
          0

C_ini     1
          0 -----------------------------------------.....---------------------------------------------------------------.....-----

C_norm    1 -----------------------------------------.....---------------------------------------------------------------.....-----
          0                          N o r m a l         O p e r  a t i o n

C_nachl   1
          0 -----------------------------------------.....---------------------------------------------------------------.....-----

Speed       ^                      +--- Stalling (Kl.15 on)              +--- Restart               *******   *****  ****.....*****
            |****   ***  **        |                                     |                         *       ***     **
            |    ***   **  ***     |                                     |                        *
            |                 *    |                                     |                      **
            |                  *   |                                     |                    **
            |                   *  |                                     |       *************
            |                    * |                                     |    **
            |                     *v                                     v **
          0 +----------------------******************.....****************-----------------------------------------------.....-----
                                   .                                        .
B_nmin    1                        +-----------------.....------------------+
          0 -----------------------+                                        +--------------------------------------------.....-----
                                   .                                        .
B_nmot    1 -----------------------+                                        +--------------------------------------------.....-----
          0                        +-----------------.....------------------+
                                   .                                        .
B_syn     1 -----------------------+                                        .      +-------------------------------------.....-----
          0                        +-----------------.....-------------------------+
                                   .                                        .      .
B_bm      1 -------------------------+                                      .      .     +-------------------------------.....-----
          0                        . +---------------.....-------------------------------+
                                   . .                                      .      .     .
C_inisyn  1                        +-+                                      .      .     .
          0 -----------------------+ +---------------.....---------------------------------------------------------------.....-----
                                   . .                                      .      .     .
C_nsuch   1                        . +---------------.....-------------------------+     .
          0 -------------------------+                                      .      +-------------------------------------.....-----
                                   . .                                      .      .     .
C_syn     1 -----------------------+ .                                      .      +-------------------------------------.....-----
          0                        +-----------------.....-------------------------+     .
                                   . .                                      .      .     .
C_bmsuch  1                        . +---------------.....-------------------------------+
          0 -------------------------+                                      .      .     +-------------------------------.....-----
                                                                                   ^     ^
                                                                                   |     |
                                                                                   |     +----- Start 2. synchro (reference mark)
                                                                                   +----- Start 1. synchro (virtual, quick-start)
```

Monitor for New-Synchronization

At a new synchronization all relevant values are initialized to neutral values. Because of the immediately initialization after the new synchronization it is not possible to see the corresponding Bit which has requested the new synchronization. To make the fault location easier a new synchronization monitor is formed. This monitor makes it possible to register the reason of the last new synchronization with VS100.

In the Byte NSYNGGDPG a Bit is set at a corresponding position, which tells the condition which has requested the new synchronization. The Byte NSYNGGDPG is always initialized at C_ini with 00000000.

NSYNGGDPG	Bit 0	new synchronization requested via B_nobm
	Bit 1	new synchronization requested via rising edge of B_nmin and C_syn
	Bit 2	new synchronization requested via falling edge of B_bm

Are there are occuring several new synchronizations during one driving cycle with different reasons, so there are several Bits of NSYNGGDPG set to 1.

APP GGDPG 14.30 Application hint

For the application of the %GGDPG the following variables possibly need to be adjusted:

Speed-signal debouncing

TPREL	30 ms	Time debouncing at engine start. During the speed search phase (C_nsuch) the time debouncing TPREL is started at the first tooth interrupt. No tooth interrupts are evaluated during this time.

DZZST	2	Tooth debouncing at engine start. After the time debouncing (TPREL) additionally DZZST teeth are debounced. The condition B_zprel is set after this debouncing and thereby the gap search (C_bmsuch) is started. Dependent of the used camshaft sensor (TPO / not TPO -> default phase level) and the position of the phase signal to the reference mark, the value DZZST must be set appropriate. It must be guaranteed that the phase level at the first found reference mark has the correct level.
DZZST2	2	This value only exists if there are two different camshaft signals. As long as there are no different camshaft sensors or wheels are usedit is DZZST2 = DZZST. If on the other hand for example PG1 is a TPO sensor and PG2 is a none TPO sensor, then there must be a appropriate bigger value applied.
DZZSTNLP	232	Makes sure that at camshaft sensor limp home the engine is turned several times to clear out possible residual charge.
ZTPREL	8	To calculate the virtual engine start position the debounced teeth (DZZST and ZTPREL) are added to the stop position wkwstop determined in the section %ALE. In the process, ZTPREL represents the teeth passed before resp. during the time debouncing (TPREL). To determine ZTPREL the virtual engine position at the first reference mark needs to be observed (without PG quick-start). The counter zzvirt (virtual segment tooth counter) is frozen when the gap is found and the cylinder counter zzyl is re-stored in zylvirt. At optimum virtual engine position zzvirt must stop at SY_GAP and the cylinder counter must be incremented by 1 (due to the gap the virtual engine position runs at SY_GAP teeth too late and would trigger a virtual segment after these teeth). If the virtual engine position lies by a certain variable incorrect during several starts, then this can be corrected with ZTPREL.

Condition engine speed B_nmot

NMIN	20 rpm	Speed threshold for the setting of B_nmot in the speed search phase (C_nsuch). In case of systems with a high rotational dynamik at start / cold start the value has to be increased (for e.g. 35 rpm), else there could be a wrong detection of the gap. Danger of a wrong synchronization !

PG quick-start

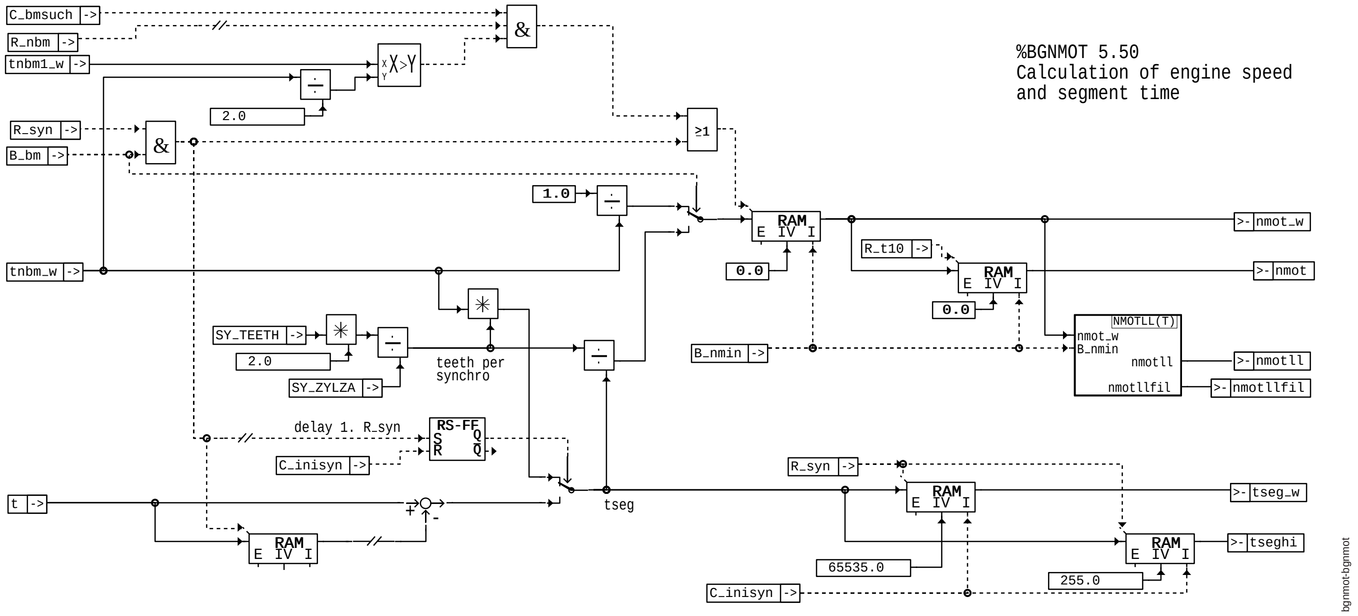
NMOTQSYN	500 rpm	Upper speed threshold for PG quick-start. For run-time reasons the PG quick-start function GEN_QSYN calculated in the tooth interrupt is switched off. The functionality is anyhow not needed at higher engine speeds.
OFQSYNADAP	0 °KW	Offset between adapted phase edge and the phase edge at start (phase response correction). The phase edge stored in wnwsp_w_x has been adapted at idle speed. Due to a phase response of the phase sensor signal the PG edge may be shifted at start (typ. 100 rpm). The actual phase angle at quick-start is therefore calculated according to: Angle_actual(edge x) = wnwsp_w_x - OFQSYNADAP
PH_MINSEG	54 °KW	Segment length of a short segment. This variable is used at quick-start to inquire upon a small resp. large segment. For safety reason this value should be chosen at least by one tooth (6°KW) larger than the longest 'Short-Segment' occurring in the PG signal. In the process high as well as low segments must be taken into consideration. If this value is chosen too large, the worst-case is that a short segment is detected too late and a synchro can no longer be triggered. Rule of the thumb for the definition: PH_MINSEG = longest 'Short-Segment' rounded to next full tooth + 6 °KW EX.: longest 'Short-Segment' = 44 °KW, rounded to 48 °KW ==> PH_MINSEG = 54 °KW
TMQSYN	143.25 °C	Lower engine temperature threshold to enable the phase sensor PG for the quick-start.
ZDELBMSRCH	1	At quick-start, in the state 'Wait_gap' it is calculated after how many teeth the reference mark occurs, in case the engine is at the 2nd resp. 4th phase edge. To this number of teeth additionally ZDELBMSRCH teeth are added. If no gap occurs within this crank angle, then the last edge can be identified by means of the phase level. This value may not be chosen too large since the inquiry for phase level will no longer work and a synchro beginning can no longer be found due to waiting for too long (especially on 4- and 8-cylinder engines). Recommendation: ZDELBMSRCH < 6 for all engines, dependent on the length of the short segment and on the mounting position of the sensor signal related to the crankshaft ZDELBMSRCH = 1 for 4- and 8-cylinder engines ZDELBMSRCH = 3 for all other engines
CWNWREF		Indicates whether the camshaft is in reference position during engine start. It is the case if the system has no camshaft adjustment or the camshaft has a mechanical locking element.

2 ECU-concept

NSYN2SG	800 1/min	engine speed threshold up to which a new synchronisation is triggered if there was no run-up of the engine at the moment of detection of the crankshaft sensor limp home at the second ECU.

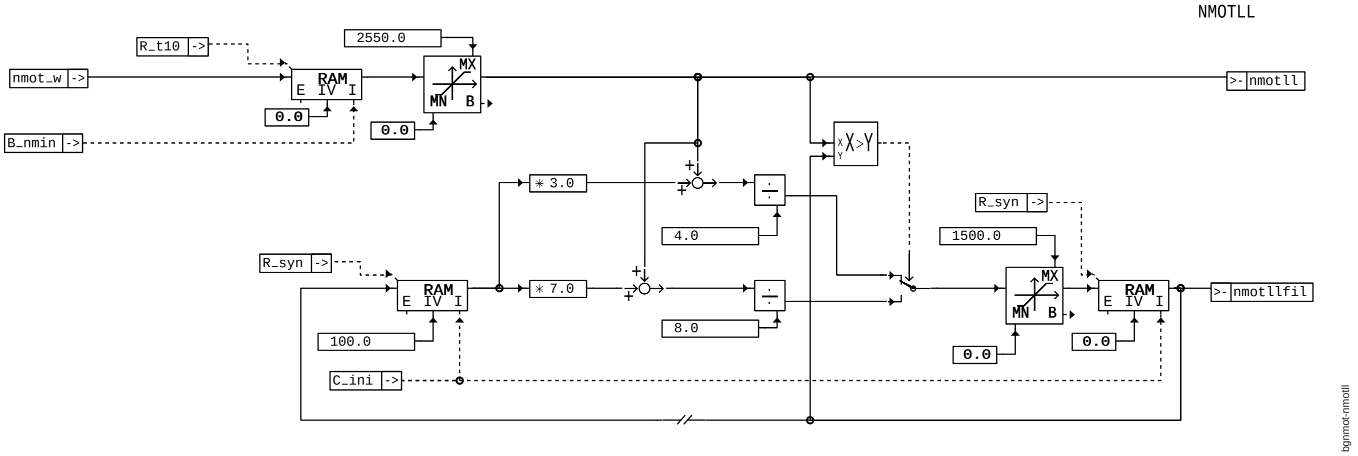
BGNMOT 5.50 Calculated variable: engine speed

FDEF BGNMOT 5.50 Function definition



bgnmot-bgnmot

Calculation of the engine speed nmot resp. nmot_w as well as of the segment time tseg_w (tseghi represents a high-level byte of tseg_w since an overflow can occur in tseg_w at low engine speeds). The engine speed nmot_w is calculated from the tooth-period time tnbm_w during the gap search (C_bmsuch). At synchronized operation (B_bm = true) the calculation is performed from the segment time.



bgnmot-nmotll

Engine speed for lower speed range

The actual engine speed is stored from nmot_w to nmotll with the corresponding quantization at the 10 ms cycle. If the engine speed is greater than 2550 rpm nmotll stops at the value of 2550 rpm. In the ECU switch off nmotll is no longer calculated.

The engine speed nmotll is filtered by a first-order time-delay element (nmotllfil). The time constant of the filter is different, dependent whether there is a acceleration or a deceleration. The filtered engine speed is only calculated up to 1500 rpm to keep the running time as short as possible.

$$\text{nmotllfil}(k) = \frac{7 * \text{nmotfill}(k-1) + \text{nmotll}(k)}{8} \qquad \text{at acceleration}$$

$$\text{nmotllfil}(k) = \frac{3 * \text{nmotfill}(k-1) + \text{nmotll}(k)}{4} \qquad \text{at deceleration}$$

ABK BGNMOT 5.50 Abbreviations

Variable	Source	Type	Description
B_BM	GGDPG	EIN	condition reference mark detected
B_NMIN	GGDPG	EIN	condition lower speed: n < NMIN
C_BMSUCH		EIN	ECU-condition: searching for reference mark
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
NMOT	BGNMOT	AUS	engine speed
NMOTLL	BGNMOT	AUS	engine speed
NMOTLLFIL	BGNMOT	AUS	filtered engine speed nmotll
NMOT_W	BGNMOT	AUS	engine speed
R_NBM	GGDPG	EIN	Schedule of tooth signal
R_SYN	GGDPG	EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms
SY_TEETH	PROKON	EIN	system constant: number of teeth with gap teeth on the crankshaft wheel
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
T		EIN	time
TNBM1_W	GGDPG	EIN	tooth periode of the second last NBM signal
TNBM_W		EIN	tooth periode of the last NBM signal
TSEGHI	BGNMOT	AUS	segment cycle time, high, low byte of the high word
TSEG_W	BGNMOT	AUS	segment cycle time

FW BGNMOT 5.50 Fixed Values

Parameter	Value	Description

FB BGNMOT 5.50 Detailed description of function

The calculation of the segment time tseg_w is performed in the synchro-interrupt. The temporarily stored time of the previous synchro is subtracted from the current system time t. Since no temporarily stored time yet exists at the first synchro the segment time is calculated from the latest tooth time, tnbm_w multiplied by the number of teeth per segment. At low engine speeds overflows occur in tseg_w, which are stored in tseghi.

The engine speed nmot_w is calculated in the tooth interrupt from the latest tooth time tnbm_w during the reference mark search (C_bmsuch). If triple the tooth time occurs after the reference mark gap then the speed value of the latest tooth is maintained. At synchronized operation (B_bm = true) nmot_w is calculated in the cycle R_syn from the segment time tseg. In the 10 ms-cycle nmot and nmotll from nmot_w are re-quantized and updated.

APP BGNMOT 5.50 Application hint

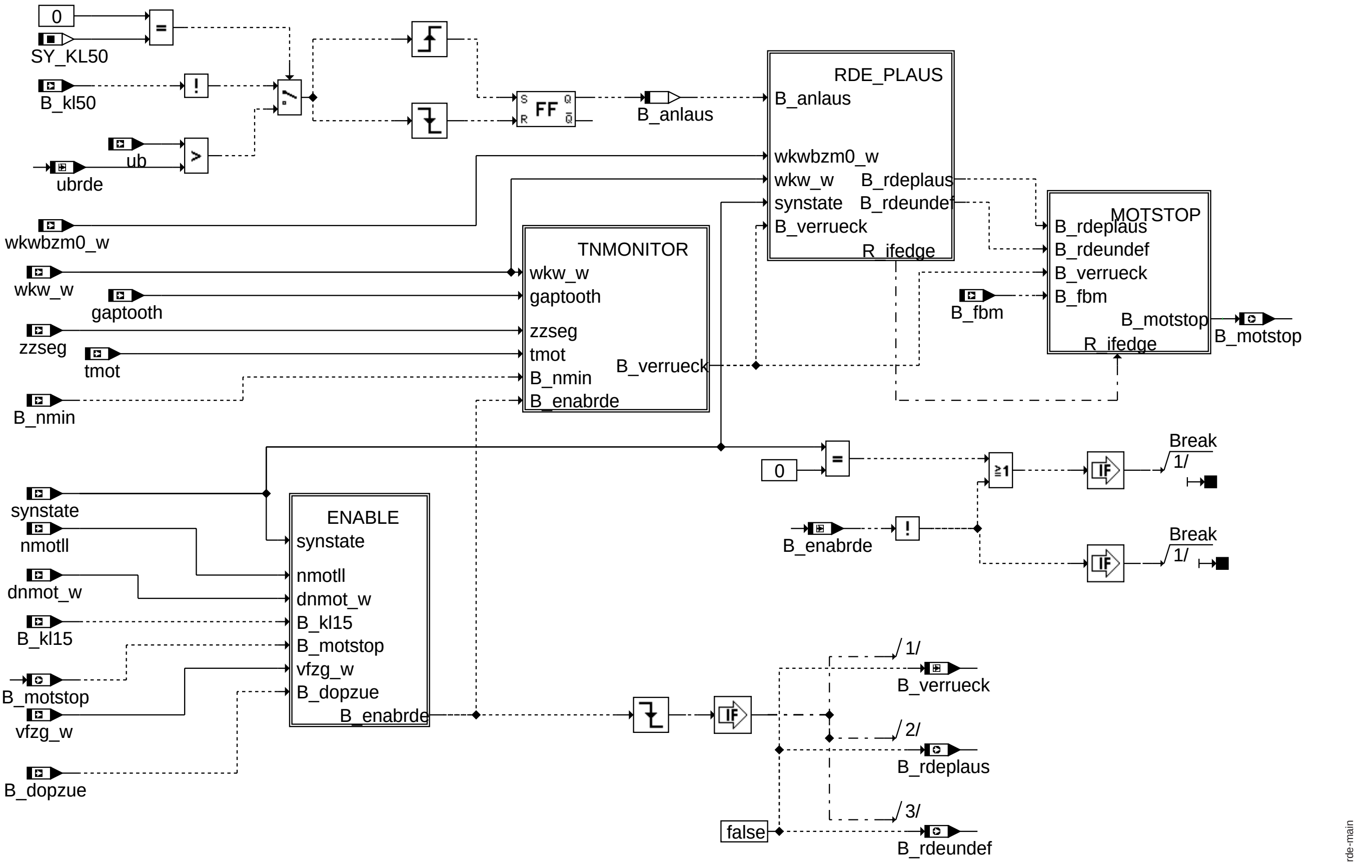
RDE 1.40 Detection of reverse rotation

FDEF RDE 1.40 Function definition

The decision whether to include the function in the program status can be made using the system constant SY_RDE.

```
SY_RDE = 1  (TRUE)   Function included in the program status (must be applied with care whatever the case)
SY_RDE = 0  (FALSE)  Function not included in the program status
```

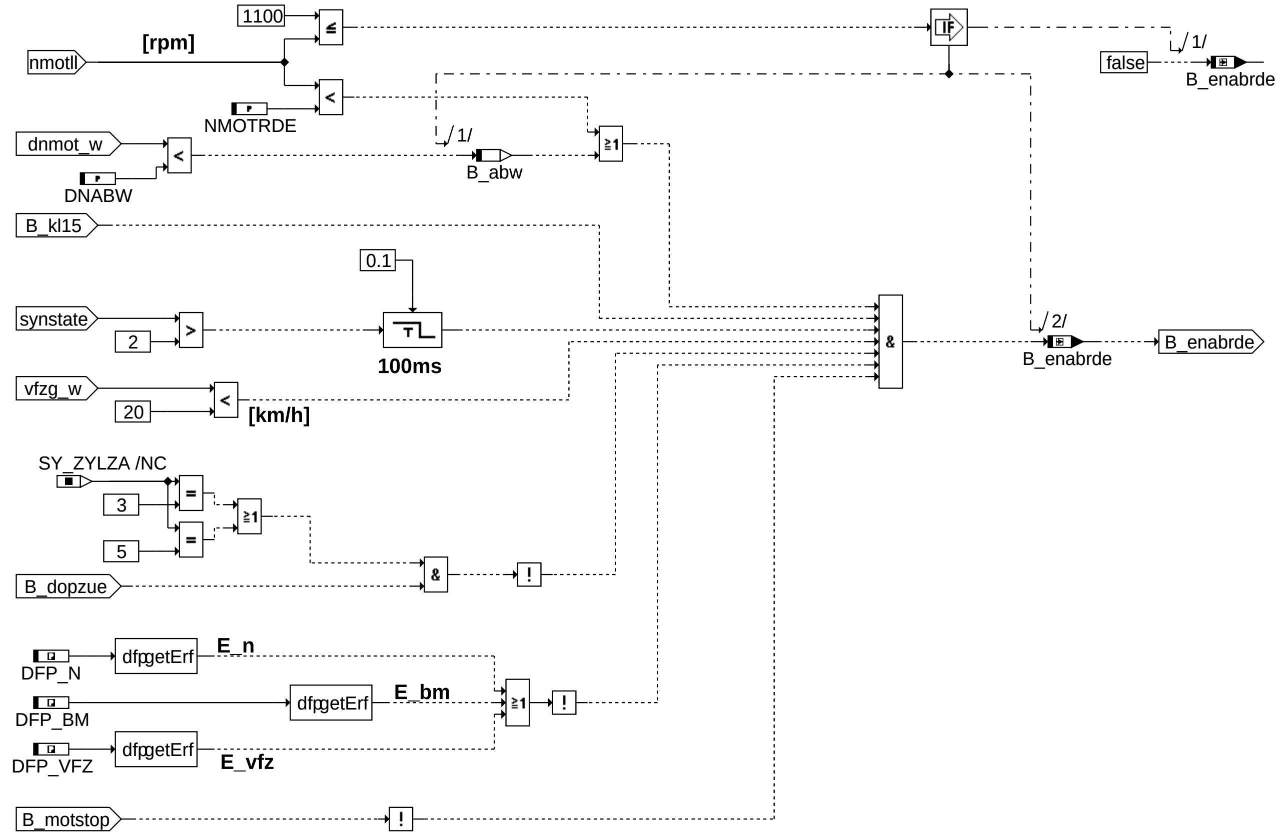
RDE 1.40: Detection of reverse rotation



rde-main

```
Function overview of turn-back detection
----------------------------------------

 - Enable turn-back detection on the basis of various parameters and thresholds
 - Check whether the starter is disengaged
 - Monitoring the tooth periods
 - Plausibility check of the turn-back points found
 - Suppression of injections and ignitions
```

Hierarchy: ENABLE



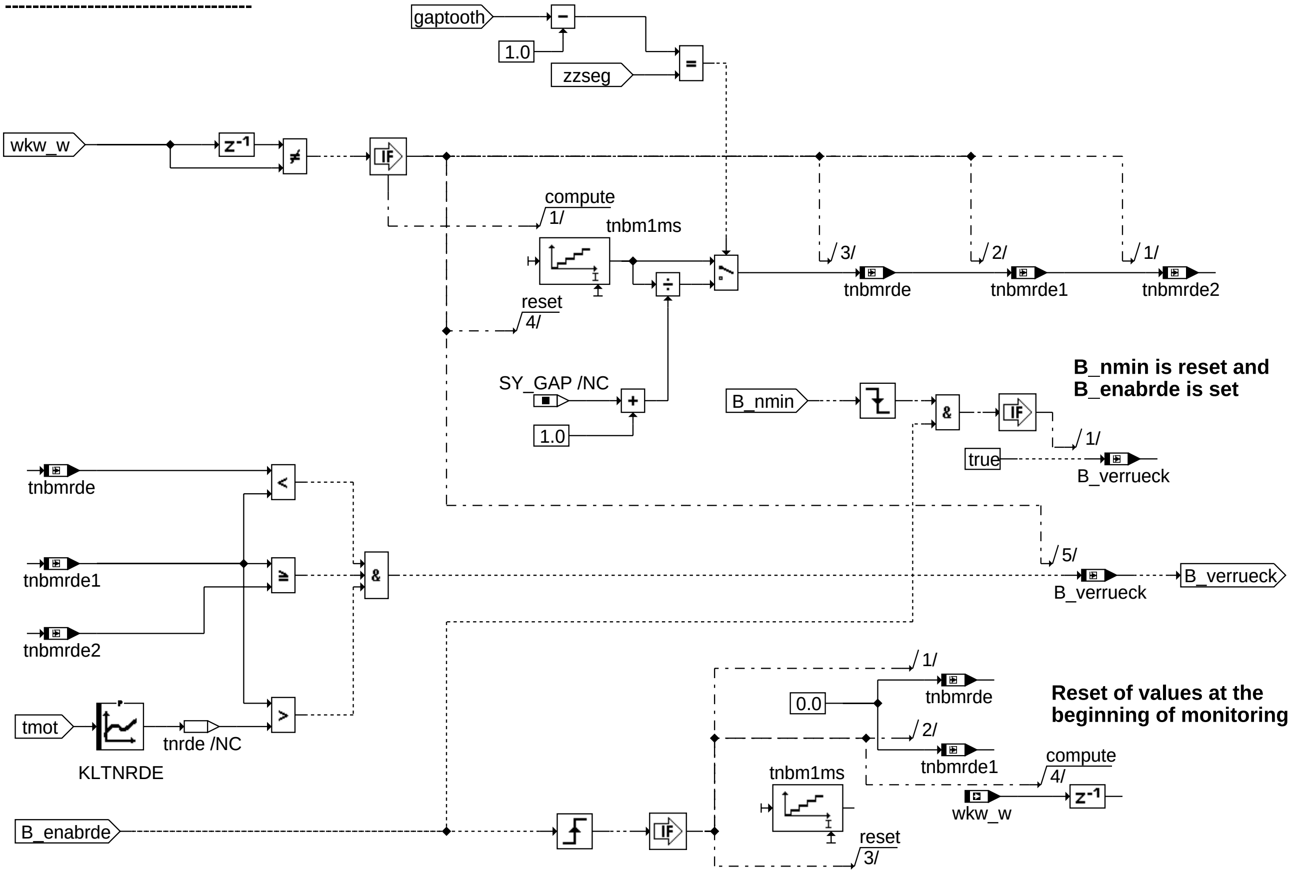
rde-enable

ENABLE: Enable turn-back detection

The function is only calculated if the speed is less than 1100 RPM. The bit B_enabrde is otherwise set to FALSE. A further speed condition must be fulfilled so that B_enabrde will be set. The function is enabled when the speed is below the threshold NMOTRDE (less than the idle speed) or there are large negative speed dynamics (quick stalling of the engine). In this case, the condition B_abw is set if dnmot_w is less than the threshold DNABW.

The function only runs at key ON (terminal 15) and when the engine is in synchronization. The function will continue running for 100 ms after synchronization has been lost (detection of turn back and underspeed exit).

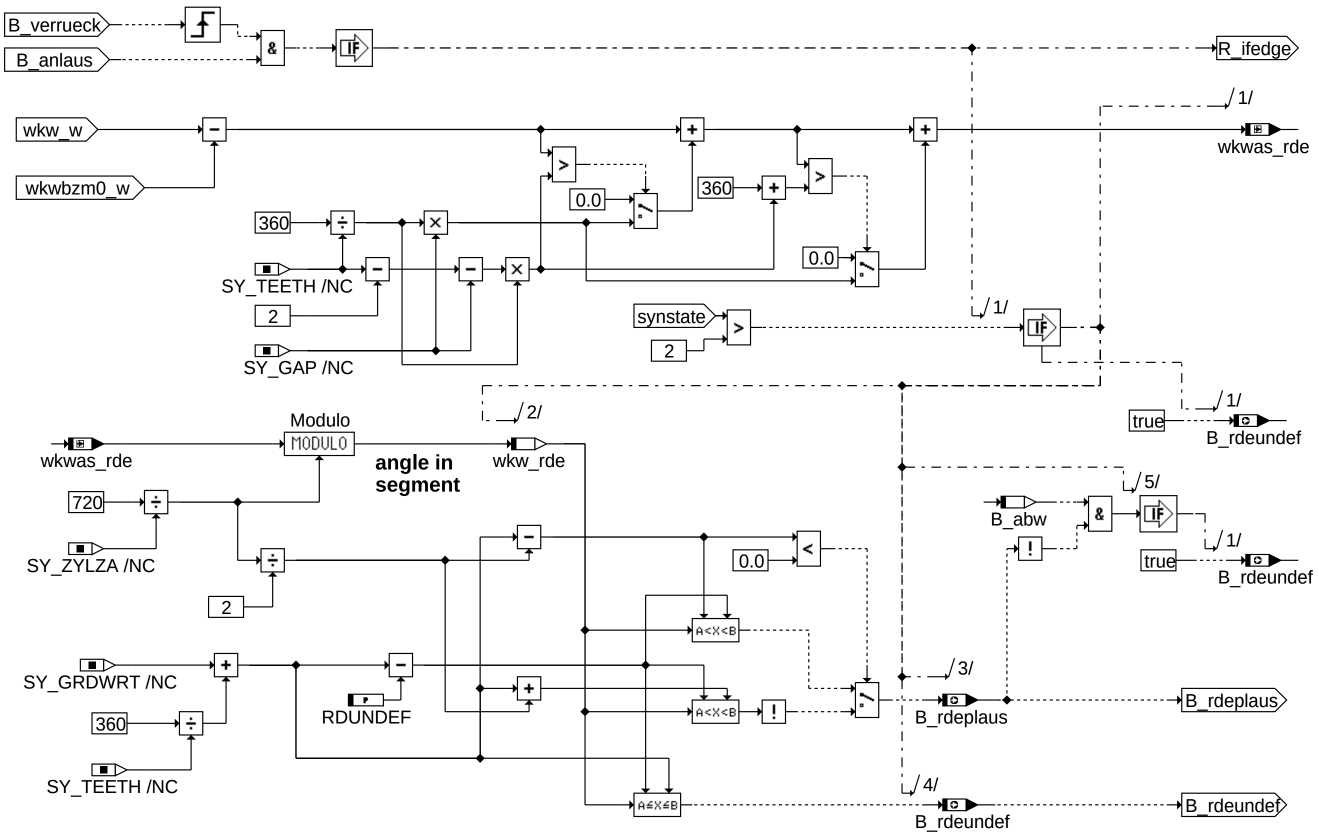
Hierarchy: TNMONITOR



rde-tnmonitor

```
TNMONITOR: Monitoring the tooth periods
-----------------------------------

A counter is incremented in the 1-ms schedule as long as there is no tooth interrupt. The three most recent values are
temporarily stored in a shift register. If the value tnbmrde1 exceeds an absolute value and if the condition:

                   tnbmrde < tnbmrde1 >= tnbmrde2       also applies, then the condition of suspected turn-back is set.

The two most recent values from the shift register are initialized when tooth-time monitoring has been enabled by B_enabrde.
The calculation of the tooth periods is only executed in synchronized operation (synstate = 3).

The turn-back tooth period is saved over a tmot-dependent characteristic curve. The tooth periods in the compression
phase are longer at low temperatures because of the higher friction.

If B_nmin is reset when B_enabrde is still set, then the condition B_verrueck is also set.
```

Hierarchy: RDE_PLAUS



rde-rde-plaus

rde-rde-plaus

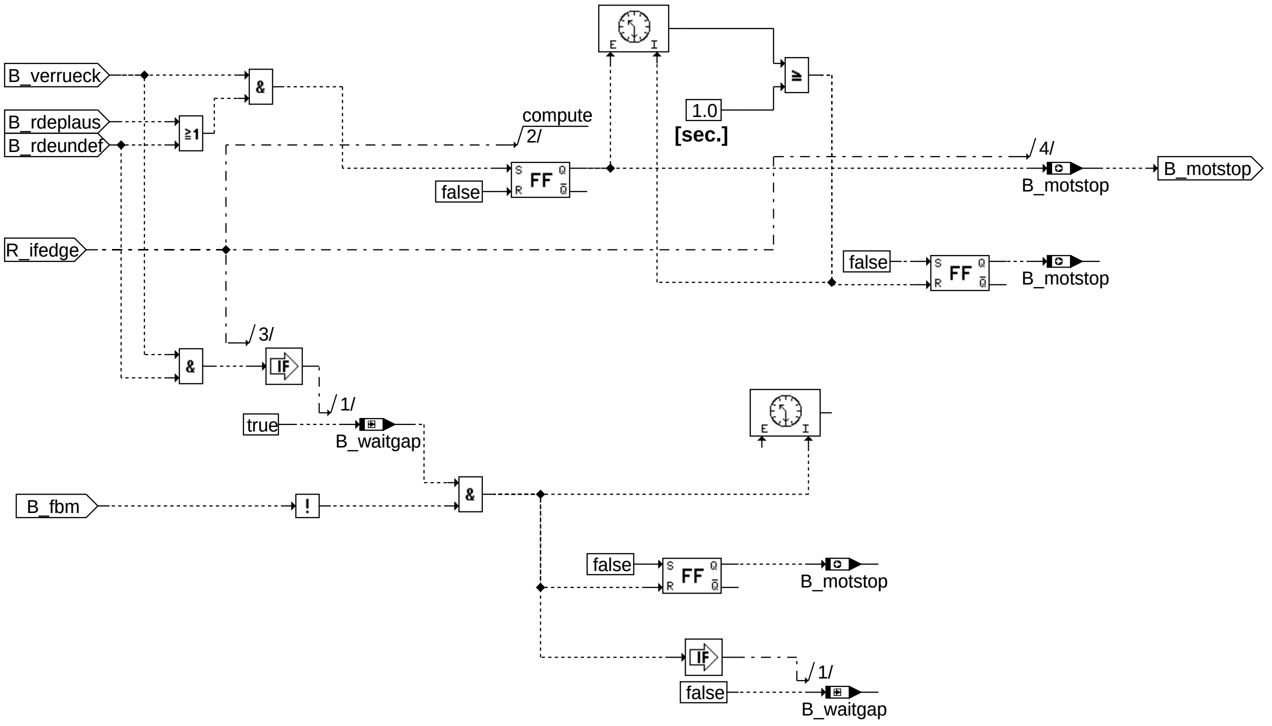
RDE_PLAUS: Plausibility check of the turn-back point

When a potential turn-back point has been found (B_verrueck), then the angle in the working cycle (wkwas_rde) is first of all calculated using the gap correction. It is determined on the basis of wkwas_rde whether the engine is in a compression phase at this angle or is just before the ITDC. Two conditions are deduced from this:

B_rdeplaus: Possible turn-back in a plausible turn-back range
B_rdeundef: No statement is possible whether the tooth periods come from a turn-back

The condition B_rdeundef is set if the possible turn-back point does not lie in a plausible range yet the condition B_abw is set. A plausibility check of the position of the turn-back point is only executed for synchronized operation. The condition B_rdeundef is set without a plausibility check if there is no synchronization.

Hierarchy: MOTSTOP



rde-motstop

MOTSTOP: Suppression of injections and ignitions

The condition B_motstop is set and a timer s started when turn-back has been detected (B_verrueck and (B_rdeplaus or B_rdeundef). There is no further output of injections or ignitions when the condition B_motstop is set. The condition is canceled when the timer reaches a value of 1000 ms.

Provided the following gap check was successful, the condition is canceled before the 1000 ms elapse if B_motstop has been set by B_rdeundef.

ABK RDE 1.40 Abbreviations

RDE: Turn-back detection

Parameter	Source-X	Source-Y	Type	Description
DNABW			FW	engine speed difference at engine stall
KLTNRDE	TMOT		KL	characterisitic for tooth times at reverse rotation
NMOTRDE			FW	engine speed threshold to release function RDE
RDUNDEF			FW	angle range within there is no validity of the reverse detection
SY_GAP			SYS (REF)	system constant: number of missing teeth in the gap
SY_GRDWRT			SYS (REF)	System constant basic value, space between SW reference mark to OT in ° KW
SY_KL50			SYS (REF)	System constant: information available in the ECU if starter is cranking
SY_TEETH			SYS (REF)	system constant: number of teeth at the crankshaft wheel (gapteeth included)
SY_ZYLZA			SYS (REF)	system constant number of cylinders
UBDTRDE			FW	battery voltage drop for recognizing 'starter cranking'

Variable	Source	Type	Description
B_ABW	RDE	LOK	condition engine stalled
B_ANLAUS	RDE	LOK	Condition for starter disengaged
B_DOPZUE	NLPH	EIN	Condition double ignition
B_ENABRDE	RDE	LOK	Condition for release the function for engine reverse detection
B_FBM	GGDPG	EIN	condition reference mark error => at least 1 tooth too few/many
B_KL15		EIN	condition ignition switch on
B_KL50		EIN	Condition clamp 50
B_MOTSTOP	RDE	AUS	Condition to abort injection and ignition for a definite time
B_NMIN	GGDPG	EIN	condition lower speed: n < NMIN
B_RDEPLAUS	RDE	AUS	Condition: reverse rotation is plausible
B_RDEUNDEF	RDE	AUS	Condition: there is no validity for of a reverse rotation
B_VERRUECK	RDE	LOK	Condition: suspect of engine reverse rotation
B_WAITGAP	RDE	LOK	condtion: waiting for the next gap check at RDE
DFP_BM	RDE	DOK	ECU int. fault path no.: reference mark
DFP_N	RDE	DOK	ECU int. fault path no.: engine speed sensor

Variable	Source	Type	Description
DFP_VFZ	RDE	DOK	ECU int. fault path no.: vehicle speed signal
DNMOT_W	BGNG	EIN	engine speed difference between two following segments
E_BM	DDG	EIN	error flag: reference mark sensor
E_N	DDG	EIN	error flag: engine speed sensor
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
GAPTOOTH	GGDPG	EIN	content of the tooth counter to check the gap
NMOTLL	BGNMOT	EIN	engine speed
SYNSTATE		EIN	current mode of synchronization
TMOT	SWADAP	EIN	Engine temperature
TNBMRDE	RDE	LOK	Tooth periode of the last nbm signal (at 1ms schedule)
TNBMRDE1	RDE	LOK	Tooth periode of the second to last nbm signal (at 1ms schedule)
TNBMRDE2	RDE	LOK	Tooth period of the third to last nbm signal (at 1ms schedule)
UB	SWADAP	EIN	battery voltage
UBRDE	RDE	LOK	Threshold for battery voltage to detect starter disengaged
VFZG_W	GGVFZG	EIN	Vehicle speed
WKWAS_RDE	RDE	LOK	Corrected angle at working cycle for RDE
WKWBZM0_W	GGDPG	EIN	crank angle at the zero point of the working cycle: R_syn & zzyl = 0 (word)
WKW_W	GGDPG	EIN	crank angle (word)
WUB		EIN	battery voltage; scanned value of ADC
ZZSEG	GGDPG	EIN	tooth counter in segment

FW RDE 1.40 Fixed Values

Parameter	Value	Description
DNABW		engine speed difference at engine stall
NMOTRDE		engine speed threshold to release function RDE
RDUNDEF		angle range within there is no validity of the reverse detection
UBDTRDE		battery voltage drop for recognizing 'starter cranking'

FB RDE 1.40 Detailed description of function

```
1. Enable turn-back detection
=============================

Any turn-back by the engine can only take place at a low speed or when at a standstill. It is no longer necessary to
calculate the function above 1100 1/min. Furthermore, synchronization must have occurred based on the reference mark
because it is only as of here that the gap information is available. Monitoring is not necessary if there is no syn-
chronization because neither injections nor ignitions are outputted. So as to be able to detect a turn-back point with
subsequent underspeed exit however, the function still has to be calculated 100 ms after loss of synchronization.

In the normal case, it is sufficient to calculate the function at speeds below the idle speed. If the engine stalls very
quickly however, then the speed cannot be updated sufficiently quickly (speed determined over one segment). The function
is therefore also enabled if a large negative speed gradient is given at speeds lower than 1100 RPM.

The vehicle speed must be less than 20 km/h so as not to falsely detect turn-back in there is interference in the speed-sensor
signal.

Neither is there any turn-back detection for 3 and 5-cylinder engines if the phase position is not known (engine is running
with double ignition output). If the phase position is not determined in engines with an odd number of cylinders, then it
is not possible to check the plausibility of the turn-back angle.

Also, there is no turn-back detection executed if there is an error in the speed-sensor signal. The function is disabled
as well if an error is determined in the vehicle speed.




2. Monitoring the tooth period
==============================

There is no longer any tooth interrupt in the ECU during synchronized operation. The hardware counter, wkw_w, is therefore
monitored in the 1-ms schedule for monitoring the tooth period. The number of 1-ms frames is incremented by a counter as long
as the value for wkw_w does not change. This time has to be converted to a standard tooth period at the gap. The most recent
tooth periods are stored temporarily in a shift register.

Usual course for the signal (nbm) at the turn-back point:
```

```
           +-----+          +-------+            +--------------+           +-----------+         +-------+
           |     |          |       |            |              |           |           |         |       |
       ----+     +----------+       +------------+              +-----------+           +---------+       +-------

                 |<---------------->|<------------------------->|<--------------------->|
                      tnbmrde2                 tnbmrde1                  tnbmrde
                                                                                        |--->
                                                                                         B_verrueck = TRUE
```

The condition for a suspected turn-back is set when the following requirements are met:

```
        tnbmrde2 =< tnbmrde1 > tnbmrde   and   tnbmrde1 > KLTNRDE(tmot)
```

If the tooth period at the turn-back point is greater than 50 ms, then underspeed exit follows (synchronization is canceled). Also, the condition B_verrueck is set if the condition B_nmin is set again within 100 ms after abort of the synchronization.

3. Plausibility check of the turn-back point
==

There is no plausibility check executed for the turn-back range if it is detected that the starter motor has engaged.
It is assumed in this case that the engine cannot turn back if the starter has disengaged.

If the B_kl50 is available in the system for the starter, then this condition will be inquired. If the condition is not available in the system, then the battery voltage is evaluated accordingly in order to detect whether the starter has engaged.
A battery-voltage threshold is defined in the initialization, C_ini, for this: ubrde = wub - UBDTRDE.
A maximum selection is executed (plausibility check) and ubrde = 10 V is set if the threshold is less than 10 V.

Correction of the angle wkw_w - wkwbzm0_w by the teeth missing in the gap. If the angle is after the first gap, then the correction angle is added to the missing teeth. If the position for this is after the second gap, then this angle is added a second time.

The current crankshaft angle wkwas_rde is checked for a plausible turn-back range by the condition B_verrueck.
The engine is in a plausible range when, to within half a segment in front of the ITDC, the piston is in the cylinder undergoing compression. The condition is therefore given for the plausible turn-back range:

```
B_rdeplaus          lower limit < angle in the segment < upper limit

                where:    lower limit =  SY_GRDWRT + 1 tooth  increment - segment/2     ==> tnbmrde1 for segment/2 in front of ITDC
                          upper limit  =  SY_GRDWRT + 1 tooth increment - RDUNDEF       ==> tnbmrde1 at ITDC - fixed value
```

If the corresponding tooth periods occur directly in front of or at the ITDC, then no information can be obtained whether the engine is turning back or is still running over the TDC, and hence continues to turn in the forwards direction. The condition B_rdeundef is set in this case.

The following 2 cases are given for the lower limit since the tooth in the segment is always >= 0:

1. Lower limit >= 0:

```
                                                                       ITDC
                   Beginning of segment                                 |                                End of segment
                        |                 |RRRRRRRRRRRRRRRRRRRRRRRRRR|UU|                                  |
        ----------------+-----------------+--------------------------+--+----------------------------------+----------
                        0            Lower limit                 Upper limit                              ZpS
```

2. Lower limit < 0:

```
                                         ITDC
                   Beginning of segment    |                                                           End of segment
                        |RRRRRRRRRRRRRR|UU|                                                    |RRRRRRRRRRR|
        ----+-----------+--------------+--+----------------------------------------------------+-----------+----------
      Lower limit     0         Upper limit                                       Lower limit + ZPS    ZpS
```

RRRR = Plausible turn-back range
UU   = Undefined range

If the engine stalls quickly (B_abw = TRUE), then turn-back can take place at any engine position because of the high kinetic energy in the powertrain. The condition B_rdeundef is therefore always set in this case.

The condition B_rdeundef is also set during non-synchronized operation since no plausibility check is possible in this case.

```
4. Disabling ignition and injection
===================================
```

If the condition B_verueck was set and there is a plausible turn-back range, then the condition B_motstop is set and hence both injection and ignition are disabled. The disabled injection and ignition are canceled again following elapse of a time of 1000 ms. It is assumed that an engine that has turned-backed has come to a standstill without any further ignition after a time of 1000 ms.

If the condition B_verrueck was set and no information is possible on the basis of the turn-back range (B_rdeundef), then whereas injection and ignition are disabled as before, the bit B_waitgap is also set. If the next gap check is successful (gap found, no correction necessary), then it is assumed that the engine has continued to turn in the forward direction.
Disabling injection and ignition are canceled again.

The bit B_motstop is canceled in C_ini and in R_t100 when the time value >= 1000 ms.

```
5. Schematics (engine turn-back when start-up is aborted)
=========================================================

                                                  ub > ubrde
                              +-----------------------------------------------------------------------------------------------
ubrde - - - - - - -           |                       |
ub  --------------------------+                       v

NBM with reverse rotation:                         |----> reverse
 BM       BM       BM       BM                                         BM
|--||...||--||...||--||...||--|||||||||||||| |  T  | ||||||||||||||||--|||||||||||||||||||||||||||||||||||||||||||||||||||||

Engine position:       60   56   0        10   14    14    10         0  56
-----------------------------------------------------------------------------------------------------------------------------
Tooth counter:  0       30   56   0        10   14    15    20         30  32      40        50    56BM
Cylinder counter:   2   3    4   1    2   3    4   1
                                                      |<---- Ignition and injection disabled------------------->|
                                                      |<-------------------- 1000 ms ------------------------>|
```

APP RDE 1.40 Application hint

Application of the function %RDE must be with greater care under all circumstances because this function can shut down the engine completely.

Guiding values for the initial application:

UBDTRDE:	1.4 V	Battery-voltage drop for detection of starter engaged (when SY_KL50 = TRUE is not present) If the applied value is too small, then it can happen that after an aborted start-up, the battery no longer surpasses ubrde and that a turn-back will not be detected. If UBDTRDE is too large, then problems can be expected for a cold start-up.
RDUNDEF:	12 °CA	Undefined angle range before ITDC for plausibility check of the turn-back point (whatever the case, RDEUNDEF must be smaller than the angle SY_GRDWRT because a range limit will otherwise be exceeded).
NMOTRDE:	600 1/min	Speed threshold in calculating the function for a 3-cylinder engine
	550 1/min	Speed threshold in calculating the function for a 4-cylinder engine
	500 1/min	Speed threshold in calculating the function for a > 4-cylinder engine
DNABW:	-75 1/min	Speed difference per synchronization for stalling

KLTNRDE: Characteristic curve for tooth-period times of the turn-back tooth period as a dependency on the engine temperature (interpolated).

tmot	-48.0 °C	0 °C	143.25 °C
Output	30 ms	25 ms	2 2ms

The turn-back tooth periods can differ considerably from system to system. If times are selected that are too short, then this can lead to problems during a cold start-up.

The speed-sensor signal must also be recorded as a analog value (e.g. INCA-VADI) in order to determined the turn-back times for each project. Engine turn-back can be provoked by interrupting the attempted start (at terminal 50 before the engine has revvedup). The turn-back time can be determined from the tooth signal because of the analog nature of the signal course. The test shall be repeated several times in order to find the shortest turn-back time.

KVA 36.10 Output signal: display of fuel consumption

FDEF KVA 36.10 Function definition

No text for FDEF available!

ABK KVA 36.10 Abbreviations

FW KVA 36.10 Fixed Values

Parameter	Value	Description

FB KVA 36.10 Detailed description of function

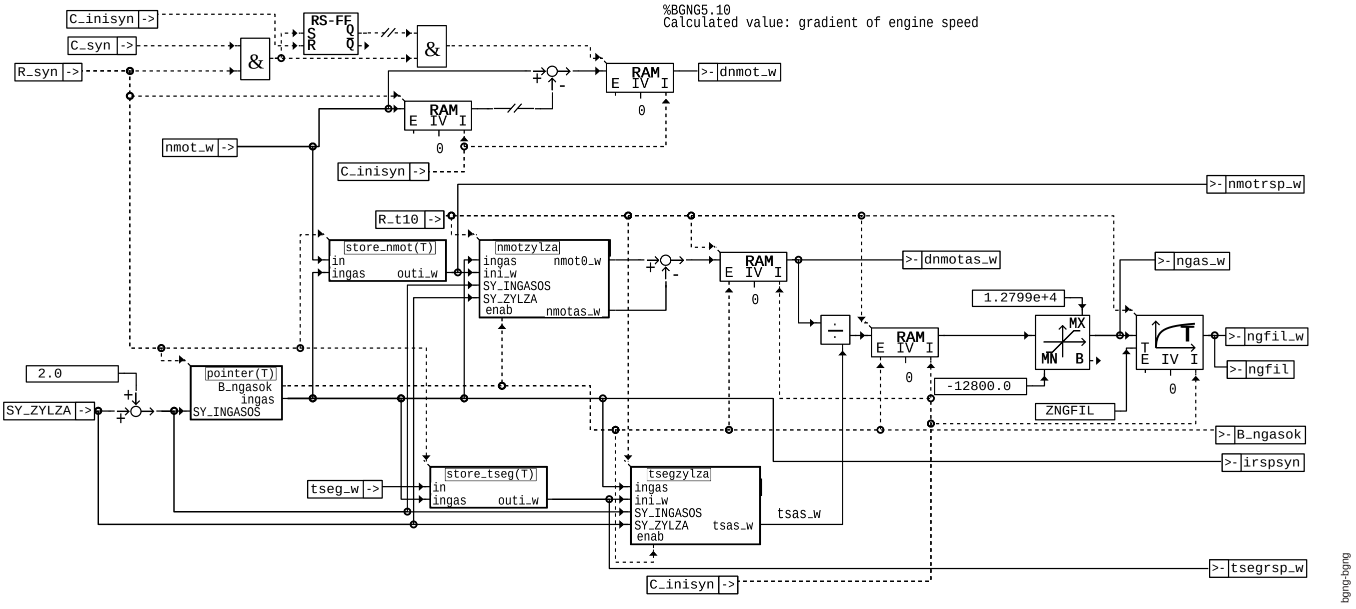
APP KVA 36.10 Application hint

BGNG 5.20 Calculated variable: engine-speed gradient

FDEF BGNG 5.20 Function definition

```
The function %BGNG calculates the following values:
        - dnmot_w:      The engine speed gradient over one segment, calculated in the synchro schedule
                                dnmot_w = nmot(iact) - nmot(iact-1)
        - dnmotas_w:    Differenz in engine speed over one engine cycle, calculated in the 10 ms schedule
                                dnmotas_w = nmot_w(iact) - nmot_w(iact-SY_ZYLZA).
                        The required engine speed values nmot_w(i) are stored in a memory array in the synchro
                        schedule.
        - tsas_w:       Time for one engine cycle:
                                tsas_w = Summe(tseg_w(i), i=1, SY_ZYLZA).
                        The required segment time values tseg_w(i) are stored in a memory array in the synchro
                        schedule.
        - ngas_w:       Engine speed gradient over one engine cycle, calculated in the 10 ms schedule
                                ngas_w = dnmotas_w / tsas_w.
        - ngfil_w:      Engine speed gradient ngas_w, filtered with the time constant ZNGFIL.


        Engine speed gradient at a 4 cylinder engine: SY_ZYLZA = 4

                            :<--------- tsas_w -------->:
                            :<tseg_w->:                 :
        R_syn: |            |         |      |     |    |     |    |   |  |  |  |  |  |   |    |    |    |      |       |
                            :         :                 :
     nmot_w ^               :         :                 :
            |               :         :                 :
            |               :         :                 :                 *******
            |               :         :                 :          ***                     ****
            |               :         :                 :    **
            |               :         :                 **  ------------------- nmot(iact)            **
            |               :         :             **                    ^                                 **
            |               :         :        **                         |                                      ***
            |               :         :   **                              |
            |               :         ** ------------------          dnmotas_w
            |               :      **                ^                    |
            |               :   **                 dnmot_w                |
            |                 *                      v                    v
            |               * ------------------------------------------------- nmot(iact-SY_ZYLZA)
            |           *
            |         *
            +------------------------------------------------------------------------------------------------------> t
```

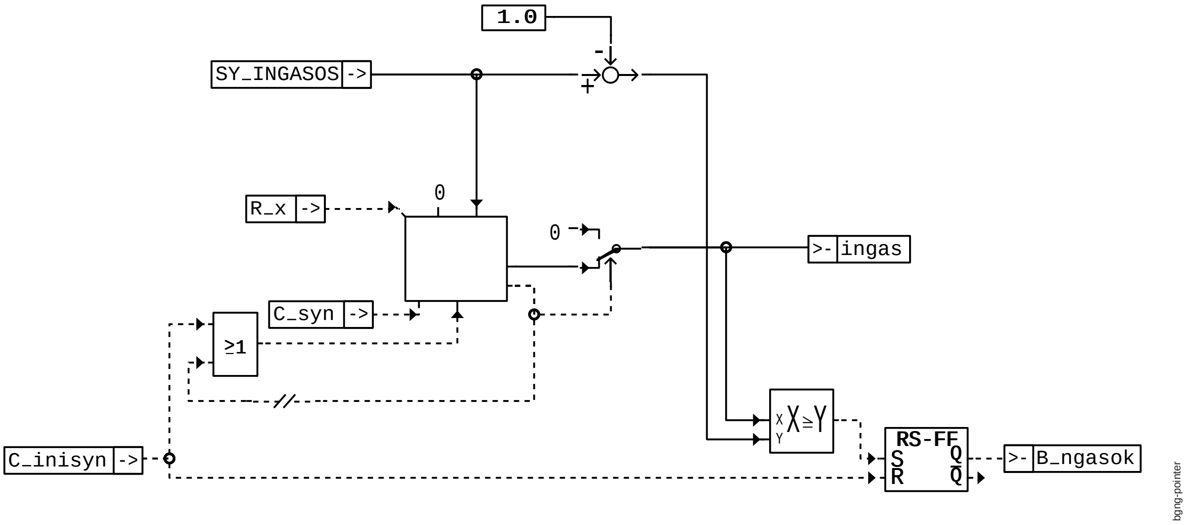
```
Overview of engine speed gradient calculation:
----------------------------------------------
```



bgng-bgng

Pointer for the engine speed and segment time memory array:

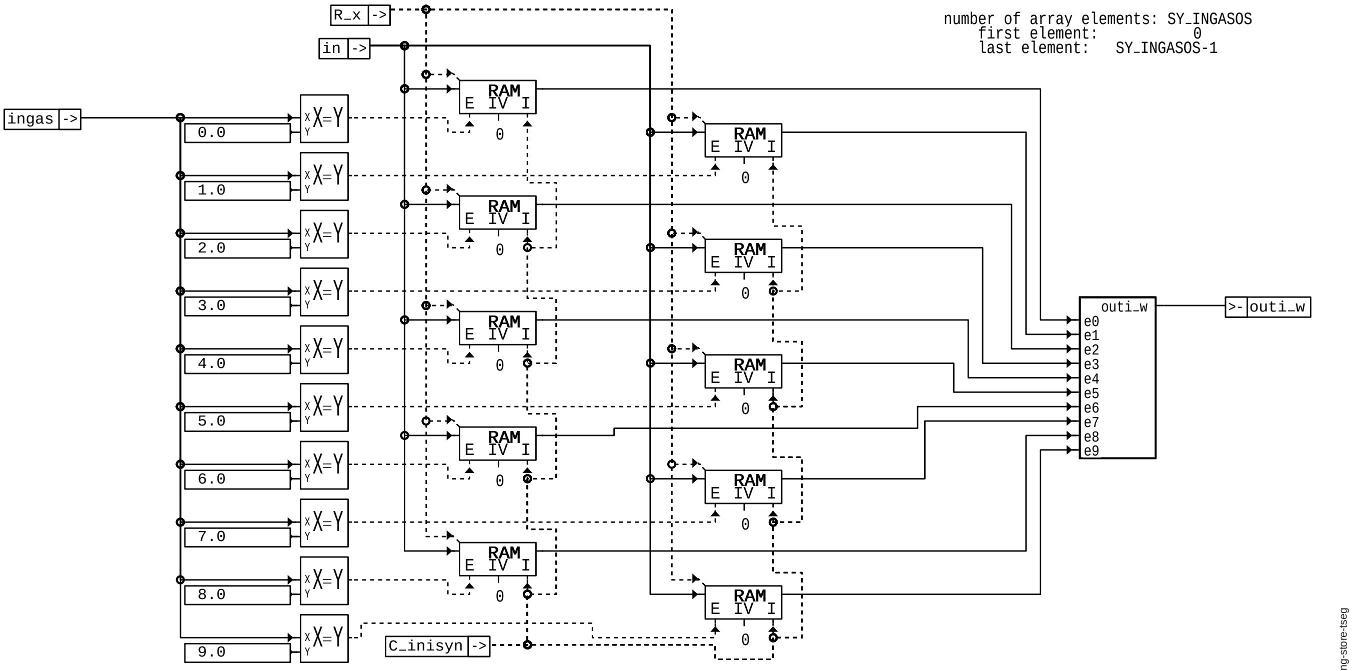
The array contains SY_INGASOS = SY_ZYLZA + 2 values to prevent overwriting during the calculation in the 10 ms schedule by a synchro interrupt. B_ngasok enables the calculation of the values over the engine cycle.



bgng-pointer

Storing the segment times in the synchro schedule:

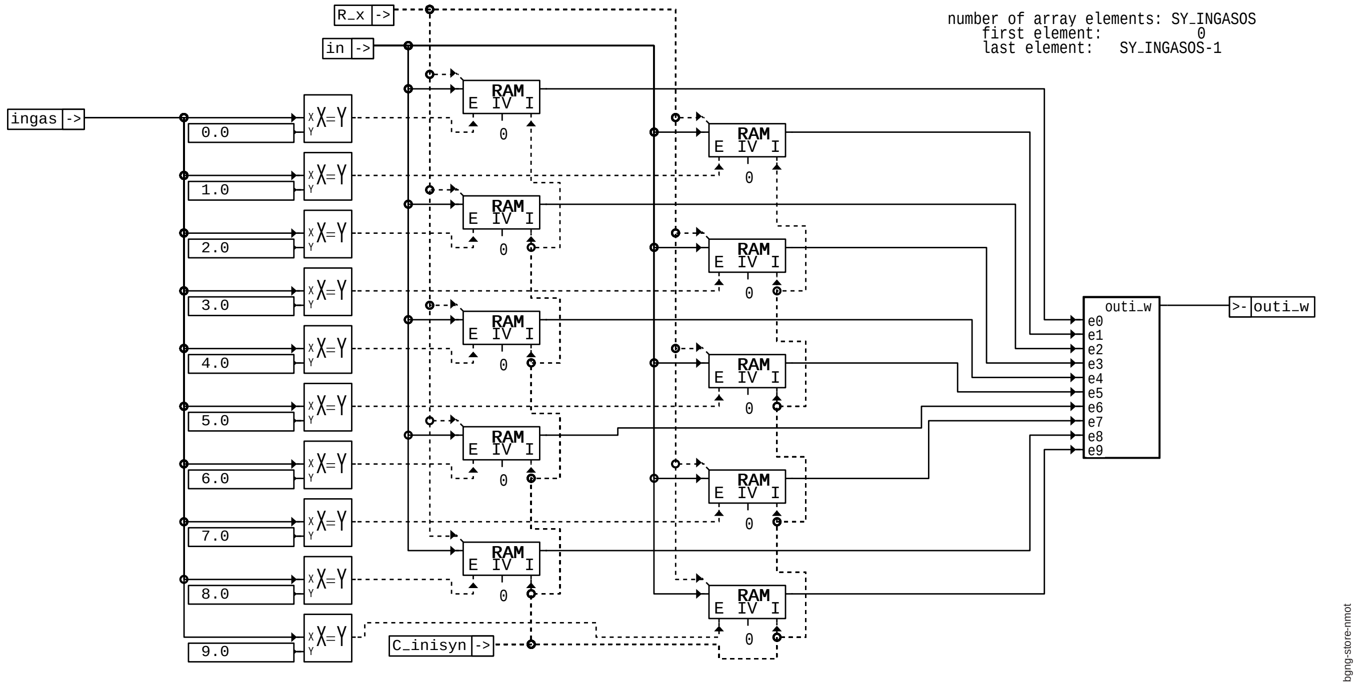
The array is filled dependand on SY_ZYLZA with maximum SY_INGASOS values.



bgng-store-tseg

Storing the engine speed values in the synchro schedule:

The array is filled dependand on SY_ZYLZA with maximum SY_INGASOS values.



bgng-store-nmot

ABK BGNG 5.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZNGFIL			FW	time constant for engine gradient filter

Variable	Source	Type	Description
B_NGASOK	BGNG	AUS	condition memory array for ngas calculation valid
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_SYN		EIN	ECU-condition angle synchronization available
DNMOTAS_W	BGNG	AUS	engine speed difference during one working cycle
DNMOT_W	BGNG	AUS	engine speed difference between two following segments
INGAS	BGNG	LOK	Memory array pointer for engine speed gradient calculation over the engine cycle
IRSPSYN	BGNG	AUS	index to address memory of tsegrsp_w, nmotrsp_w, rlsp_w
NGAS_W	BGNG	AUS	engine speed gradient during one working cycle
NGFIL	BGNG	AUS	filtered engine-speed gradient
NGFIL_W	BGNG	AUS	filtered engine-speed gradient
NMOTRSP_W	BGNG	AUS	Start Ring buffer for rpm value
NMOT_W	SWADAP	EIN	engine speed
R_SYN	GGDPG	EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms
SY_INGASOS	BGNG	LOK	system constant size of the memory array for engine speed gradient calculation
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TSAS_W	BGNG	LOK	time during one working cycle for ngas_w
TSEGRSP_W	BGNG	AUS	Begin of ring buffer for segment time
TSEG_W	BGNMOT	EIN	segment cycle time

FW BGNG 5.20 Fixed Values

Parameter	Value	Description
ZNGFIL		time constant for engine gradient filter

FB BGNG 5.20 Detailed description of function

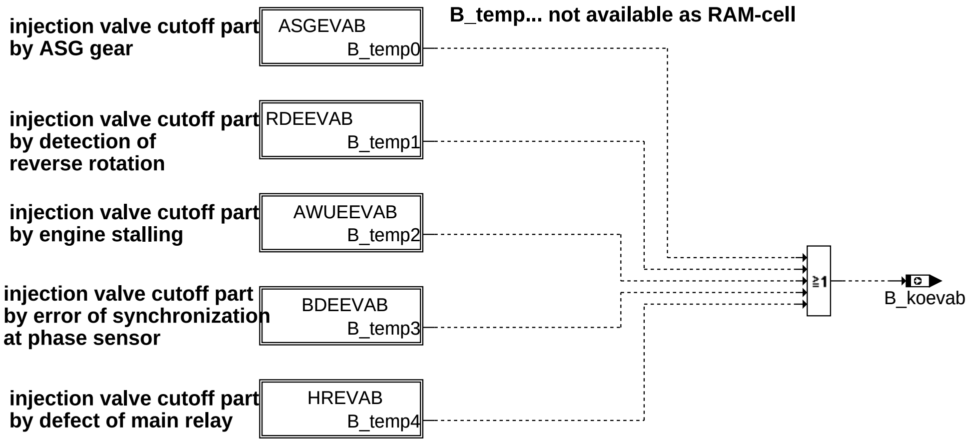
APP BGNG 5.20 Application hint

```
Recommendation for first application:
-------------------------------------
        ZNGFIL = 50 ms
```

KOEVAB 1.20 coordination of injection valve cutoff

FDEF KOEVAB 1.20 Function definition

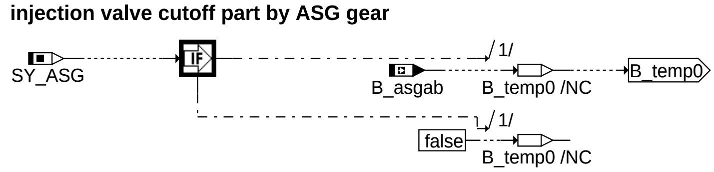
KOEVAB 1.20



koevab-main

koevab-main

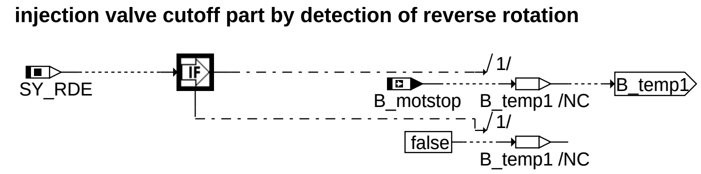
`Injection valve cutoff by Automatic Gear Box (AGB/ASG)`



koevab-asgevab

koevab-asgevab

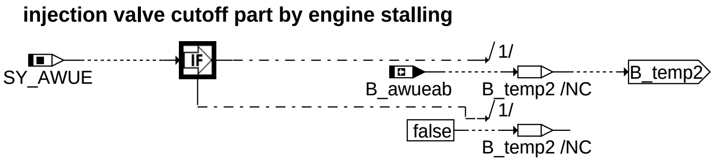
`Injection valve cutoff after recognized backward rotation during engine coasting`



koevab-rdeevab

koevab-rdeevab

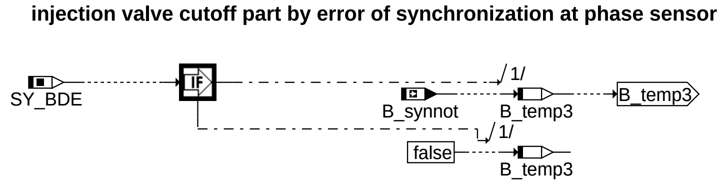
`Injection valve cutoff after recognized engine stalling`



koevab-awueevab

koevab-awueevab

`Ev Disconnection because of lost synchronization on BDE systems`

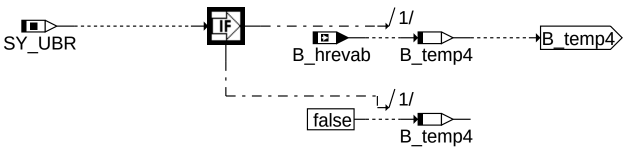


koevab-bdeevab

koevab-bdeevab

Injection valve cutoff after recognized main relay error

injection valve cutoff part by defect of main relay



koevab-hrevab

ABK KOEVAB 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_ASG			SYS (REF)	automatic standard transmission
SY_AWUE			SYS (REF)	injection valve cutoff possible by function AWUE
SY_BDE			SYS (REF)	system constant GDI
SY_RDE			SYS (REF)	detection of reverse rotation of the engine in project included
SY_UBR			SYS (REF)	system constant: Voltage behind main relay ubr exists

Variable	Source	Type	Description
B_ASGAB	DVKUP	EIN	Engine shut off by ASG
B_AWUEAB		EIN	injection valve cutoff active by function AWUE
B_HREVAB		EIN	demand injection valve cutoff at error of main relay
B_KOEVAB	KOEVAB	AUS	injection valve cutoff active by function KOEVAB
B_MOTSTOP	RDE	EIN	Condition to abort injection and ignition for a definite time
B_SYNNOT		EIN	Prohibits injection if phase synchronization could not be detected

FW KOEVAB 1.20 Fixed Values

Parameter	Value	Description

FB KOEVAB 1.20 Detailed description of function

The function Co-ordination of injection valve cutoff (KOEVAB) links the individual interventions which result in a complete injection valve cutoff.
The system constant value activates the respective intervention. To ensure this, the system constant values must be specified in the section PROKON.
The individual interventions are linked together by a logical OR operation; this means: if one of the interventions is active (B_...), the value B_koevab is set true. This causes the function AEVABZK to cutoff all injection valves commanded by the respective Motronic control device.

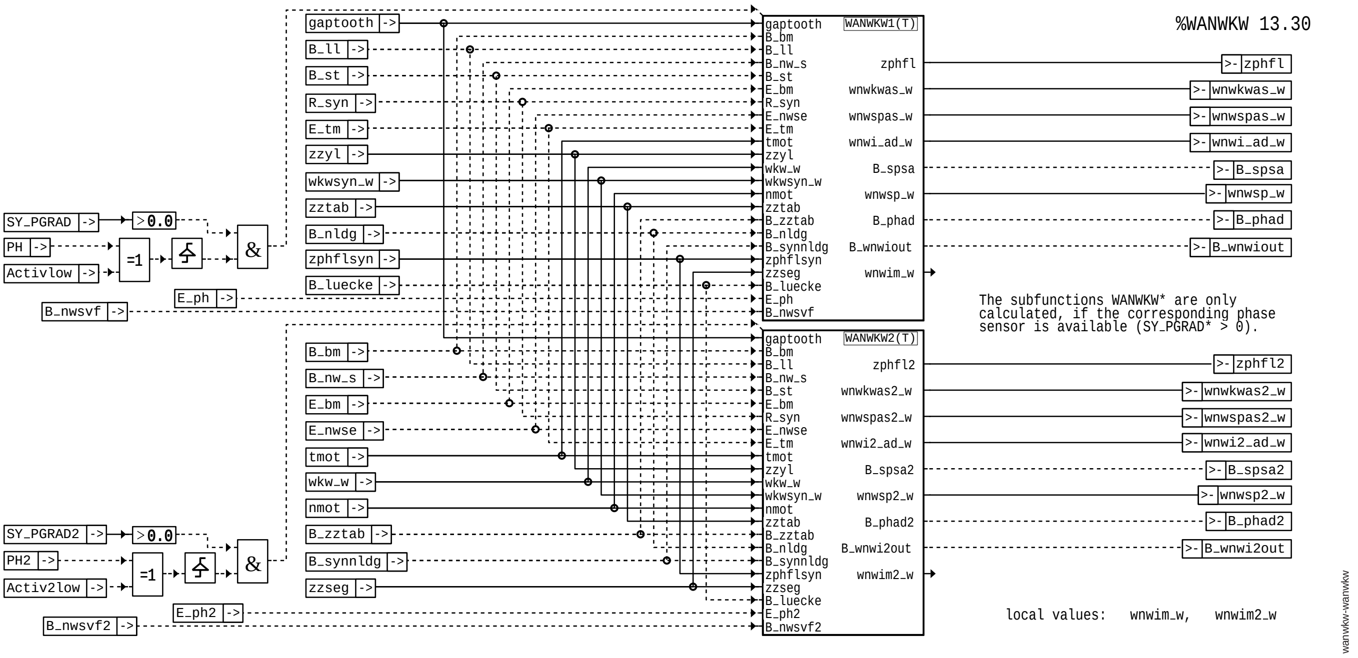
APP KOEVAB 1.20 Application hint

WANWKW 13.30 Angle adaptation of alignment between camshaft and crankshaft

FDEF WANWKW 13.30 Function definition

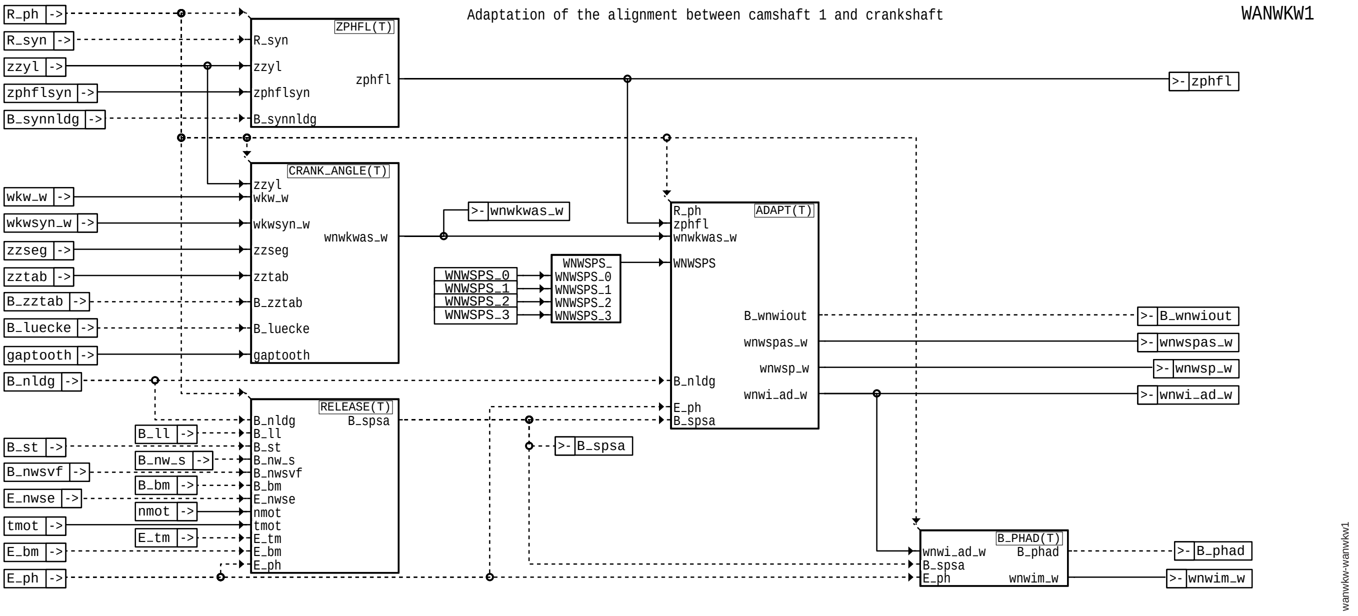
```
Task of the function angle adaptation of alignment between camshaft und crankshaft:
-----------------------------------------------------------------------------------

        - Determination of the position of the camshaft signal relative to the crankshaft signal in the working cycle: wnwkwas*_w
        - Phase edge counter in the working cycle: zphfl*
        - Adaptation of a defined normal position of the camshaft (retarded position) relative to the crankshaft
          during idling, edge-specific: wnwsp*_w(i) with i=zphfl*
        - Formation of the deviation between current actual position of the camshaft relative to the adapted position:wnwi*_ad_w
        - Formation of the condition "angle adaptation permissible": B_spsa*
        - Formation of the condition "angle adaptation successful": B_phad*
```

```
Signal assignment, crankshaft - camshaft:
-----------------------------------------
                                                                                    Setpoint position of phase edge
             BM: Software reference mark 0 (zzyl=0)                                 in retarded position: WNWSPS(i)
                      !                                                                  !  with  i = zphfl (0,1,2,3)
                      V                                                                  V
             +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+
 ....  ....  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
 +  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--+  +--

                      |<--------------- Adaptation value: wnwsp_w(i)-------------------->| adapted retarded position
                      |                                                                  |
                      |<----------- Measured value: wnwkwas_w ---------->|<- wnwi_ad_w ->|
                                                                         .               |
                                                                         .               |
electrical phase signal:                                                 .               .
  ...............................----------------------------------------+---------------+
                                                     adjusted to advance |               |
                                                                         +----...        +----------------
                                                                                         .
                                                                                 <-------|------>
           <----------------------------  Direction of rotation  --------   advanced     .   retarded
```



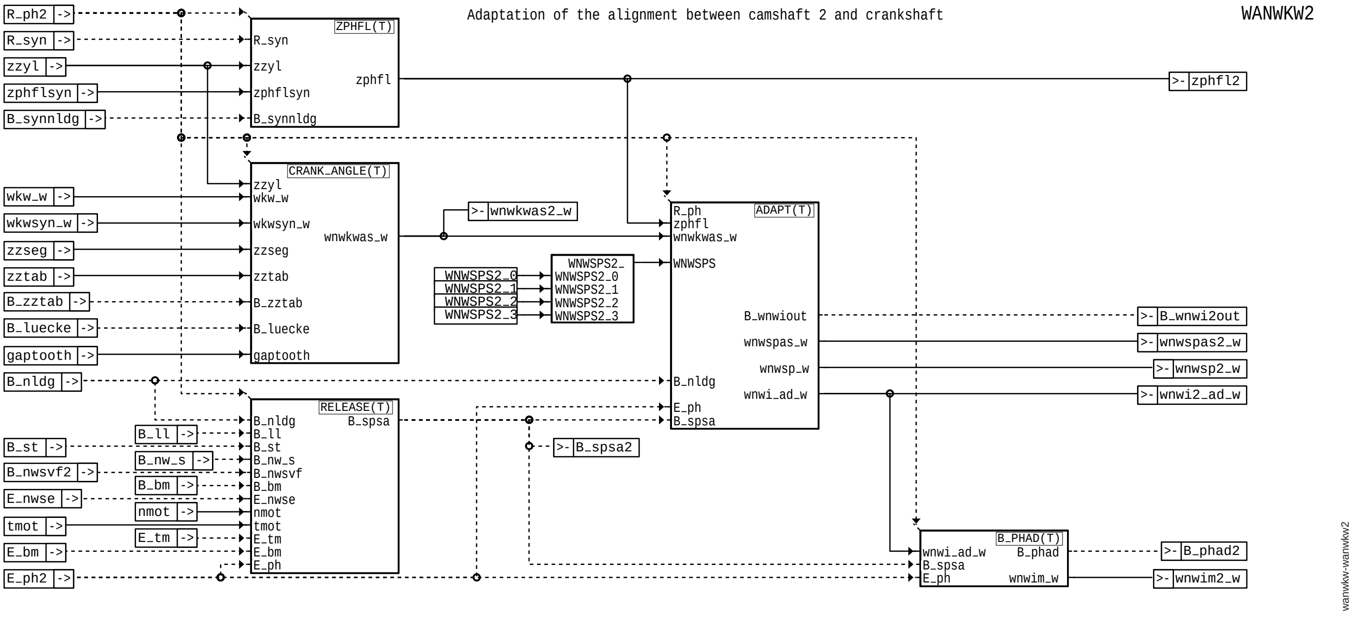
wanwkw-wanwkw

```
Overview over the angle adaptation:
        - Representation of the angle adaptation for 2-bank-system (V-engines):  WANWKW1, WANWKW2. The adaptation for systems
          with two banks is calculated separately for both banks. Apart from the output values the subfunctions are identical.
        - Deactivation of the one bank WANWKW* via the system constant SY_PGRAD* = 0 (see configuration in %PROKON).
        - Activ*low is used for the hardware shell and defines the phase level at the first reference gap (zzyl = 0).

WANWKW1: Subfunction for bank 1:
--------------------------------
```



wanwkw-wanwkw1

```
WANWKW2: Subfunction for bank 2:
-------------------------------
```



wanwkw-wanwkw2

Overview of the subfunctions of the angle adaptation WANWKW*:
(subfunctions are calculated separately for both banks, *: wildcard for bank 1 or bank 2)

- ZPHFL: Calculation of the current edge number, values go from zero up to SY_PGRAD* - 1: zphfl*

- CRANK_ANGLE: Hardware casing for the calculation of the crankshaft angle in the working cycle at the current phase edge (0..720°KW); tooth improvement of the angle by forming the ratio of the current tooth time with regard to the last tooth period tnbm_w: wnwkwas*_w

- ADAPT: Adaptation of the reference position (retard position) of the edges, if the adaptation release is given via B_spsa*: wnwspas*_w resp. wnwsp*_w(zphfl*);
  Calculation of the adjustment angle of the camshaft or rather the deviation of the actual angle from the adapted reference angle: wnwi*_ad_w

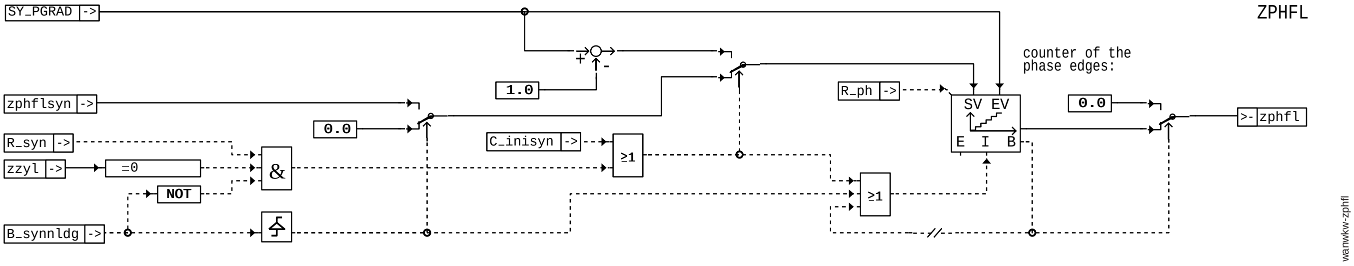
- RELEASE: Release of the adaptation: B_spsa*

- B_PHAD: Determination "angle adaptation successful": B_phad*

ZPHFL: Determination of the counter phase edges:

zphfl*: The phase edge counter zphfl resp. zphfl2 is incremented at the phase interrupts R_ph* and synchronized during each working cycle at the reference mark gap 0 (R_syn & zzyl = 0). In limphome DG zphfl is initialized after detection of the engine position (B_synnldg). The synchronization on acount of the speed sensor signal at the t-mark (R_syn & zzyl = 0) should not occur at the speed sensor limp-home. The order of the limp-home extrapolated angular base can be shifted at high dynamic. Therefore the counter could be mis-synchronized.

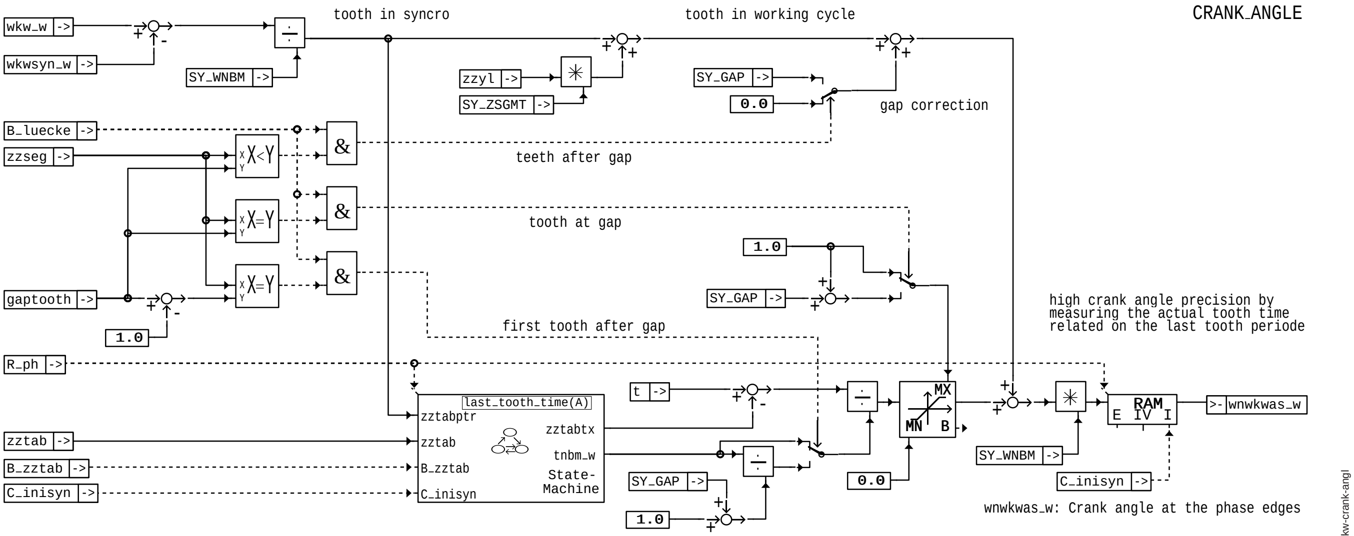
Mode of counting: 0,1,2,3 (max. SY_PGRAD* - 1)



wanwkw-zphfl

CRANK_ANGLE: Determination of the engine position at the phase edges related to the crankshaft reference mark 0 (zzyl=0):

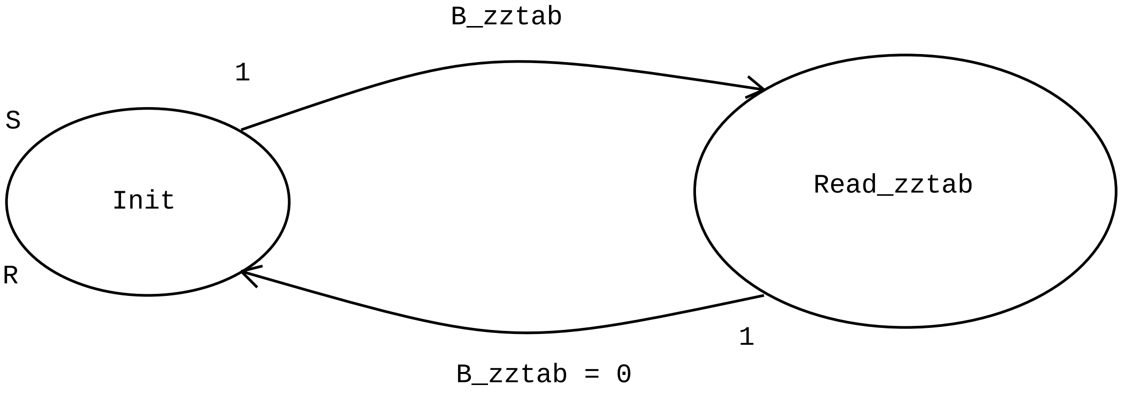
wnwkwas*_w: The current position of the engine in the working cycle is determined in the phase interrupt R_ph*. First, the actual tooth in the working cycle is calculated. Afterwards a tooth improvement is achieved by an evaluation of the tooth period tnbm_w and the time difference between the phase interrupt and the last tooth (t - zztabtx). At the tooth after the gap, the last tooth period is reduced by (1 + SY_GAP), because this period contains 1 plus the 'missing' teeth. Zero point of the crankshaft angle: Software reference mark at cylinder 1 (R_syn & zzyl=0).
Value range: 0..720 °CKS



wanwkw-crank-angl

last_tooth_time: read out of the system time of the tooth before the phase edge and the corresponding phase edge

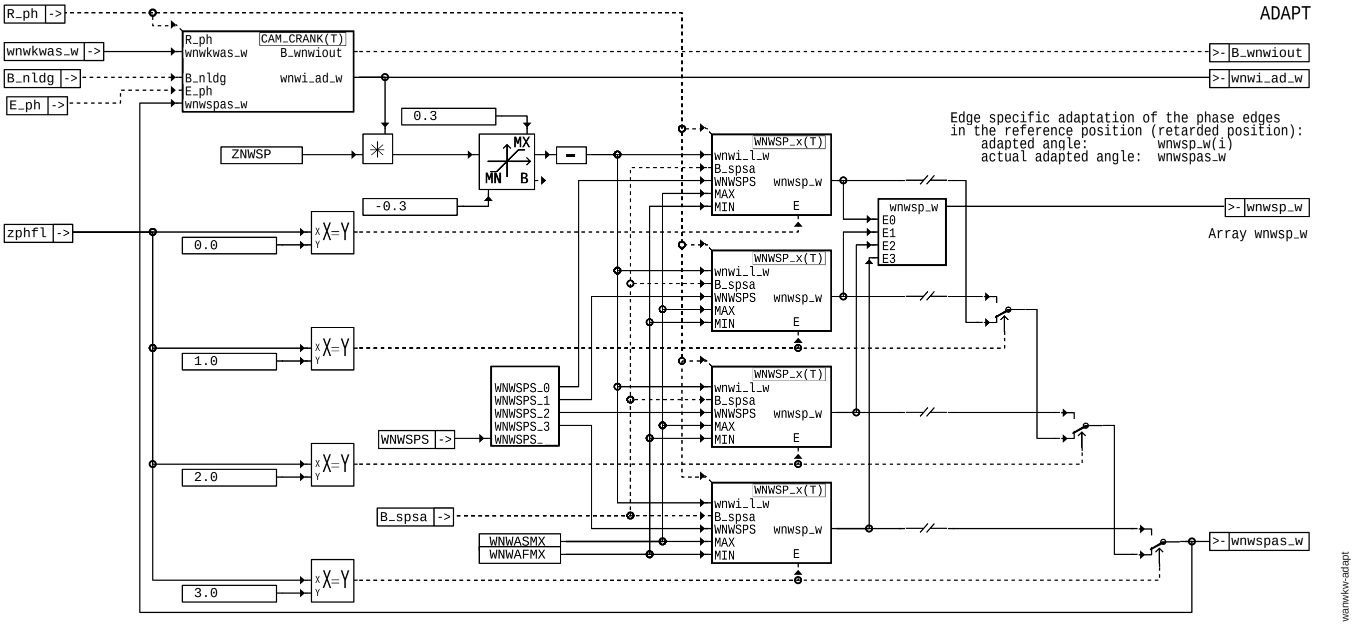
The State-machine last_tooth_time reads the system time of the tooth before the phase edge (zztabtx) and and calculates the corresponding tooth period out of the tooth time table. Both values are read out if the condition B_zztab is TRUE.



wanwkw-last-tooth

ADAPT: Adaptation of the edge-specific reference position (retard position) in the working cycle:
----

wnwsp*_w(i): Adaptation of phase edge i. Value range: 0 .. 720°CKS, zero point as wnwkwas*_w
WNWSPS*_i Initialization of wnwsp*_w(i) in case of powerfail (C_pwf) resp. "delete fault memory" (C_fcmclr)



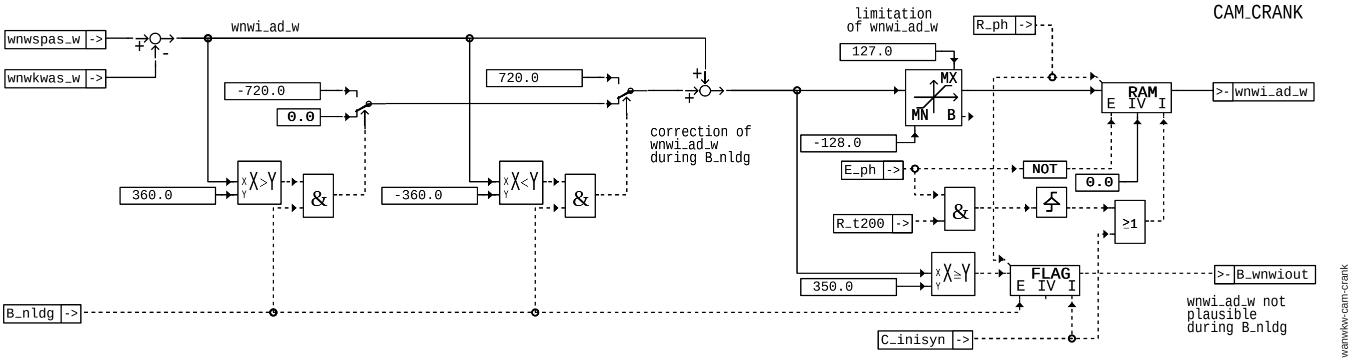
wanwkw-adapt

The angle deviations wnwi*_ad_w, weighted with ZNWSP, are integrated during the adaptation (B_spsa* = 1) at the corresponding phase edge zphfl* in the accumulators wnwsp*_w(i) with i = zphfl*. With decreasing angle deviation the edge-specific adaptation values wnwsp*_w(i) stabilize. The last adaptation value is made available to the subfunction CAM_CRANK via the value wnwspas*_w for the calculation of the current wnwi*_ad_w.

All subfunctions WNWSP_* are identical and therefore only once described

CAM_CRANK: Determination of the angle deviation of the current angle position of the CMS edges to the adapted reference value:
----

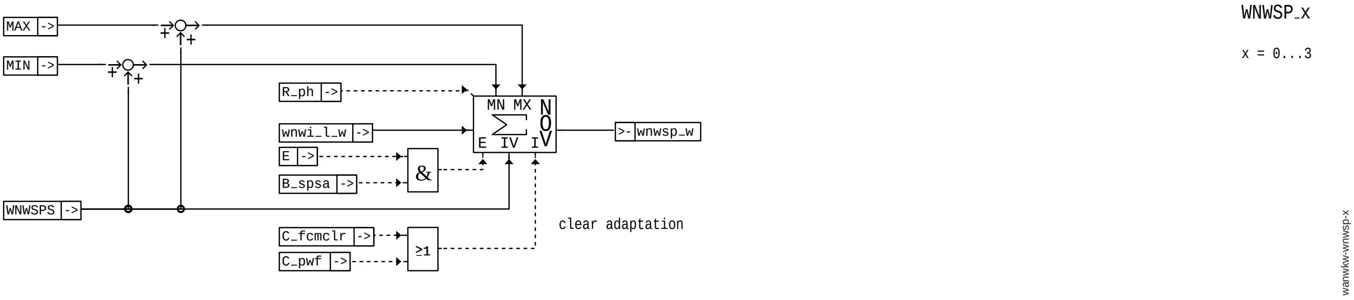
wnwi*_ad_w: Difference between adapted value of the current phase edge wnwspas*_w and the actual position wnwkwas*_w. In limphome DG, wnwi*_ad_w may have an overflow of one working cycle (720°CKS), which is corrected. If the difference after this correction is still to high, the condition B_wnwiout is set. Value range: -128 .. 128°CKS



wanwkw-cam-crank

WNWSP_x: Accumulator to integrate the angle deviation wnwi*_ad_w
----

All subfunctions WNWSP_* are identical and are illustrated only once in the following definition.



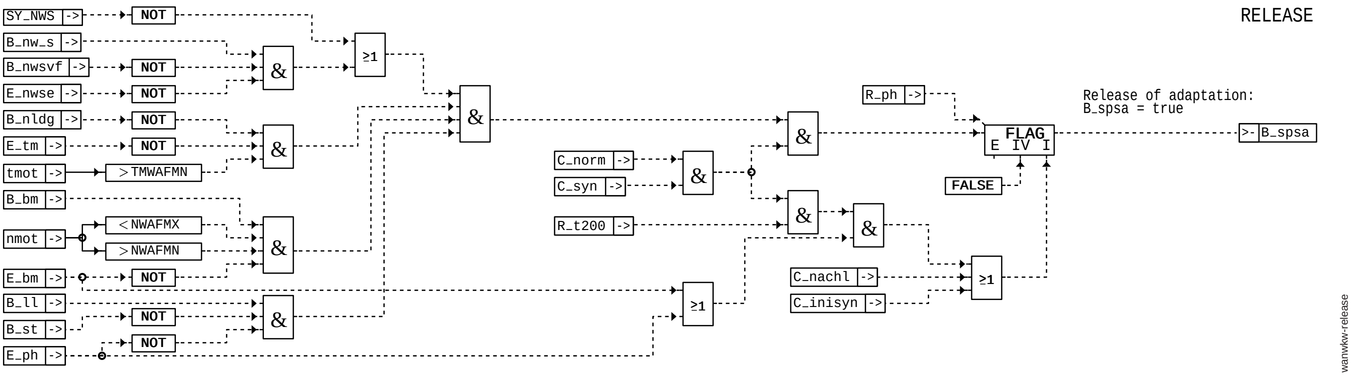
wanwkw-wnwsp-x

Via the enable-input E, the adaptation is released at the actual phase edge (zphfl* = i). The angle deviation wnwi*_ad_w is added up to the limitation of the accumulator WNWSPS + MIN, WNWSPS + MAX. So WNWSP_x is an integrator for the angle deviation at the phase edge i.

The adapted value is initialized to the nominal phase edge WNWSPS at powerfail (C_pwf) and at clearing the error flags (C_fcmclr).

RELEASE: Release of the adaptation

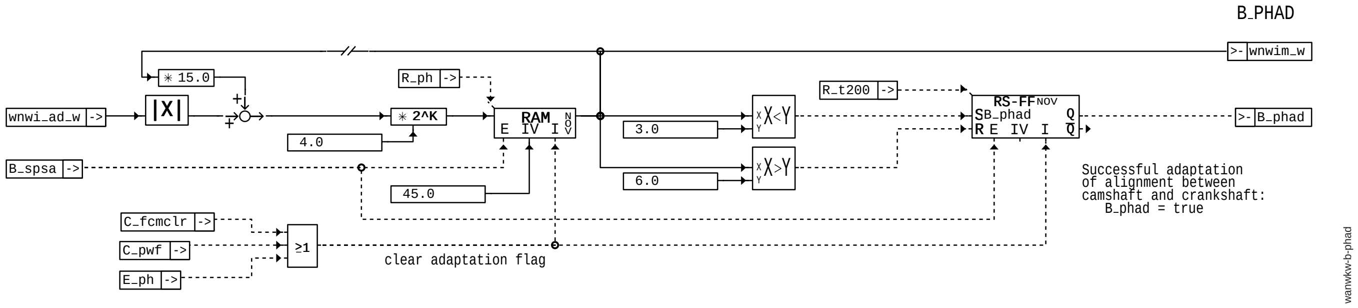
Dependent on the following illustrated conditions the adaptation is released via the condition B_spsa*.



wanwkw-release

B_PHAD: Condition "adaptation successful"

The adaptation is considered to be successful (B_phad*=true) if the amount of the floating average value of wnwi*_ad_w in wnwim*_w remains under a lower threshold value (3°). If an upper threshold value (6°) is exceeded the condition B_phad* is reset again. An error on the phase signal (E_ph*) or deleting the adaptation values (C_pwf or C_fcmclr) also lead to the condition B_phad* being reset.



wanwkw-b-phad

ABK WANWKW 13.30 Abbreviations

BM	reference gap
BM0	reference gap at cylinder 1 (zzyl = 0)
*	wildcard for bank1 (* = ’’), Bank2 (* = ’2’)
DG	engine speed sensor
PG*	phase sensor
Activ*low	definition of the phase level PG* at BM0 for the hardware shell
CKS	crankshaft
°CKS	degree crank angle
CMS	camshaft
°CMS	degree cam angle

Parameter	Source-X	Source-Y	Type	Description
NWAFMN			FW	lower limit of engine speed for release of camshaft adaptation
NWAFMX			FW	upper limit of engine speed for release of camshaft adaptation
TMWAFMN			FW	minimum engine temperature for angle adaptation camshaft
WNWAFMX			FW	adaptation limit of the retarded end position in the advanced direction
WNWASMX			FW	upper camshaft adaptation limit of the retarded end position(retarded direction)
WNWSPS2_0			FW	setangle of the edge 0 of the camshaft 2 in the reference position
WNWSPS2_1			FW	setangle of the edge 1 of the camshaft 2 in the reference position
WNWSPS2_2			FW	setangle of the edge 2 of the camshaft 2 in the reference position
WNWSPS2_3			FW	setangle of the edge 3 of the camshaft 2 in the reference position
WNWSPS_0			FW	setangle of the edge 0 of the camshaft in the reference position
WNWSPS_1			FW	setangle of the edge 1 of the camshaft in the reference position
WNWSPS_2			FW	setangle of the edge 2 of the camshaft in the reference position
WNWSPS_3			FW	setangle of the edge 3 of the camshaft in the reference position
ZNWSP			FW	time constant for camshaft adaptation of the retarded end position

Variable	Source	Type	Description
B_BM	GGDPG	EIN	condition reference mark detected
B_LL	MSF	EIN	Condition idle
B_LUECKE	GGDPG	EIN	current segment covers the reference gap
B_NLDG		EIN	condition limp-home function speed sensor
B_NWSVF	DNWS	EIN	condition camshaft control in advanced end position
B_NWSVF2	DNWS	EIN	condition camshaft control of bank 2 in advanced end position
B_NW_S	NWS	EIN	state information: camshaft control in retarded position
B_PHAD	WANWKW	AUS	adaptation crankshaft/camshaft performed
B_PHAD2	WANWKW	AUS	adaptation crankshaft/camshaft 2 performed
B_SPSA	WANWKW	AUS	condition adaptation of alignment between crankshaft and camshaft released
B_SPSA2	WANWKW	AUS	condition adaptation of alignment between crankshaft and camshaft 2 released
B_ST	SWADAP	EIN	condition for start
B_SYNNLDG	NLDG	EIN	condition: limp home crank position detected from PG-signal
B_WNWI2OUT	WANWKW	AUS	condition: difference in crank angle wnwi2_ad_w not plausible
B_WNWIOUT	WANWKW	AUS	condition: difference in crank angle wnwi_ad_w not plausible
B_ZZTAB	GGDPG	EIN	condition: tooth time table valid
C_FCMCLR		EIN	system state: reset fault memory
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NACHL		EIN	ECU condition for ECU switch off delay
C_NORM		EIN	ECU-condition normal engine management operation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
C_SYN		EIN	ECU-condition angle synchronization available
E_BM	DDG	EIN	error flag: reference mark sensor
E_NWSE	DNWSE	EIN	error flag: power stage of camshaft control valve
E_PH	DPH	EIN	error flag: phase sensor
E_PH2	DPH	EIN	error flag: phase sensor 2
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
GAPTOOTH	GGDPG	EIN	content of the tooth counter to check the gap
NMOT	SWADAP	EIN	engine speed

Variable	Source	Type	Description
PH		EIN	Input signal phase
PH2		EIN	Input signal phase 2
R_PH	WANWKW	LOK	Schedule of phase signal
R_PH2	WANWKW	LOK	Schedule of phase signal 2
R_SYN	GGDPG	EIN	Synchro schedule
R_T200		EIN	Time schedule 200 ms
SY_GAP	PROKON	EIN	system constant: number of missing teeth in the gap
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
SY_PGRAD	PROKON	EIN	system constant: kind of the phase signal
SY_PGRAD2	PROKON	EIN	system constant: kind of the 2. phase signal
SY_WNBM	PROKON	EIN	System constant for angle of tooth distance from crankshaft signal
SY_ZSGMT		EIN	system constant segment length in camshaft teeth
T		EIN	time
TMOT	SWADAP	EIN	Engine temperature
TNBM_W	WANWKW	DOK	tooth periode of the last NBM signal
WKWSYN_W	GGDPG	EIN	crank angle at start of the synchro (word)
WKW_W	GGDPG	EIN	crank angle (word)
WNWI2_AD_W	WANWKW	AUS	difference in crank angle between adapted and current 2. phase edge (word)
WNWIM2_W	WANWKW	LOK	average deviation of the adaptation camshaft 2 /crankshaft
WNWIM_W	WANWKW	LOK	average deviation of the adaptation camshaft / crankshaft
WNWI_AD_W	WANWKW	AUS	difference in crank angle between adapted and current phase edge (word)
WNWKWAS2_W	WANWKW	AUS	angle between camshaft and crankshaft regarding a working cycle
WNWKWAS_W	WANWKW	AUS	angle between camshaft and crankshaft regarding a working cycle
WNWSP2_W	WANWKW	AUS	Adaptation angle of the camshaft 2 in retarded end position
WNWSPAS2_W	WANWKW	AUS	adaptation angle of the camshaft position regarding a working cycle
WNWSPAS_W	WANWKW	AUS	adaptation angle of the camshaft position regarding a working cycle
WNWSP_W	WANWKW	AUS	Adaptation angle of the camshaft in retarded end position
ZPHFL	WANWKW	AUS	counter of the equidistant phase edges
ZPHFL2	WANWKW	AUS	counter of the equidistant phase edges 2
ZPHFLSYN	NLDG	EIN	phase edge counter at detecting the crank position in limp home DG
ZZSEG	GGDPG	EIN	tooth counter in segment
ZZTAB	GGDPG	EIN	tooth time table
ZZYL	GGDPG	EIN	SW-cylinder counter

FW WANWKW 13.30 Fixed Values

Parameter	Value	Description
NWAFMN		lower limit of engine speed for release of camshaft adaptation
NWAFMX		upper limit of engine speed for release of camshaft adaptation
TMWAFMN		minimum engine temperature for angle adaptation camshaft
WNWAFMX		adaptation limit of the retarded end position in the advanced direction
WNWASMX		upper camshaft adaptation limit of the retarded end position(retarded direction)
WNWSPS2_0		setangle of the edge 0 of the camshaft 2 in the reference position
WNWSPS2_1		setangle of the edge 1 of the camshaft 2 in the reference position
WNWSPS2_2		setangle of the edge 2 of the camshaft 2 in the reference position
WNWSPS2_3		setangle of the edge 3 of the camshaft 2 in the reference position
WNWSPS_0		setangle of the edge 0 of the camshaft in the reference position
WNWSPS_1		setangle of the edge 1 of the camshaft in the reference position
WNWSPS_2		setangle of the edge 2 of the camshaft in the reference position
WNWSPS_3		setangle of the edge 3 of the camshaft in the reference position
ZNWSP		time constant for camshaft adaptation of the retarded end position

FB WANWKW 13.30 Detailed description of function

```
Angle detection of alignment between crankshaft and camshaft
------------------------------------------------------------

In the case CMS interrupt, the angle wnwkwas*_w is measured relative to the zero point in the working cycle (R_syn & zzyl=0):
        wnwkwas*_w = (tooth in working cycle + tooth improvement) * SY_WNBM

Release of the adaptation:
--------------------------

The adaptation is only released if the first gap check was successful (B_bm=1), if a engine speed window is not exceeded,
if the engine is idling and no longer in the start range and if the engine speed and phase signals are error-free.

On systems with camshaft adjustment the adaptation is only released if it is sure that adjustment is in the retarded position
(B_nw_s) and that the diagnosis for camshaft adjustment has not detected the advanced position (B_nwsvf*).

Each adaptation of the CMS position to the software reference mark wnwsp*_w(i) is performed in the CMS interrupt (R_ph*) providing
that the condition B_spsa* is fulfilled: The difference to the current adaptation value is given by the deviation wnwi*_ad_w.
With, e.g., a positive wnwi*_ad_w, the current value wnwkwas*_w is greater than the adaptation value wnwsp*_w(i). The adaptation
then tracks wnwsp*_w(i).
```

The adaptation angle wnwsp*_w(i) is tracked via a low pass with the time constant ZNWSP and is limited by the limit values WNWASMX and WNWAFMX with reference to the setpoint value WNWSPS*(i). The adaptation value wnwsp*_w(i) is stored in the permanent RAM. In the event of powerfail, the RAM-cells wnwsp*_w(i) are loaded with the fixed values WNWSPS*(i).

The floating average value wnwim*_w of the angle wnwi*_ad_w is used to determine whether the adaptation condition can be applied. The adaptation status is stored in the condition B_phad*:

B_phad* = 1: Adaptation of the phase edge is being performed and is valid
B_phad* = 0: Adaptation of the phase edge is not valid

The adaptation for the second camshaft is performed in the same way as for the first camshaft. The adaptation is performed separately for both sides, i.e. two adaptation angles wnwsp_w(i), wnwsp2_w(i) exist as well as, two deviations wnwi_ad_w, wnwi2_ad_w from these adaptation angles, two floating average values of the adaptation value wnwim_w, wnwim2_w, and two resulting conditions B_phad, B_phad2. The values wnwkwas_w, wnwkwas2_w und wnwspas_w, wnwspas2_w are also both available in this case.
There are the labels of the first bank: WNWSPS_0, WNWSPS_1, WNWSPS_2, WNWSPS_3,
and the labels of the second bank: WNWSPS2_0, WNWSPS2_1, WNWSPS2_2, WNWSPS2_3.

Example:

```
                                                                  wnwsp_w(i) =
        Crankshaft signal:                            |<--------- WNWSPS(i) ---->|
         -+ +-+ +-+ +-+ +-+ +-+ +-+ +-+         +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+
          | | | | | | | | | | | | | | | | ... ... | | | | | | | | | | | | | | | | | | | | | | | | | |
          +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+-+-+-+-+-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-
                                                                                  .
        Camshaft signal in retard position: wnwi_ad_w = 0
         ------------------------------------------------------------------------+
                                                                                  +--------------------------------
                                                                                  .
        Camshaft signal more advanced: wnwi_ad_w > 0:                  |<------->|
         --------------------------------------------------------------+         .
                                                                        +----------------------------------------
                                                                                  .
        Camshaft signal more retarded: wnwi_ad_w < 0:                            |<------->|
         ----------------------------------------------------------------------------------+
                                                                                           +----------------------
```

APP WANWKW 13.30 Application hint

Guidance values for initial application:

WNWSPS(i) Setpoint value for the crankshaft between software refence mark before cylinder 1 and phase edge [°CKS]

```
                                                                      +-------+-------+-------+-------+
                                                               edge:  |   1   |   2   |   3   |   4   |
                                                                      +-------+-------+-------+-------+
          e.g. 1-finger rotor [°CKS]:                   ==> SY_PGRAD=1 |  690  |         any           |
               quick start wheel with 4-finger-rotor [°CKS]: ==> SY_PGRAD=1 |  104  |  284  |  464  |  644  |
                                                                      +-------+-------+-------+-------+
```

TMWAFMN	60°C
NWAFMX	1500 rpm
NWAFMN	600 rpm
ZNWSP	< 10%
WNWAFMX	- 25°CKS
WNWASMX	+ 25°CKS

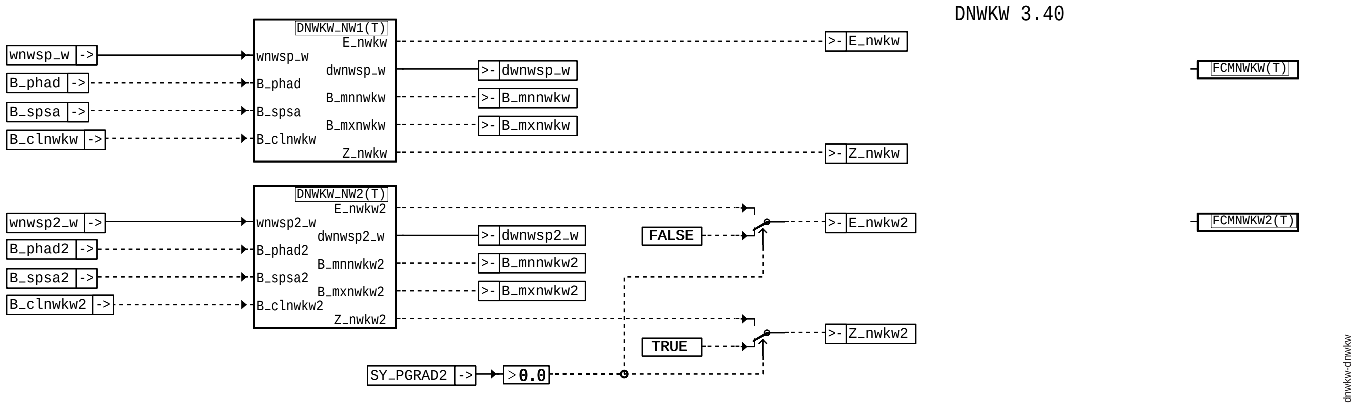
Function check procedure:
----

1. Locate the position of the phase signal in the working cycle (INKA-VADI or oszilloscope)
2. check parameter against unplausible values, adjust WNWSPS to the position of the phase signals
3. check the following labels against unplausile values in idle condition (VS100-VSO):
    zphfl (way of counting: 0, ... SY_PGRAD-1),
    wnwkwas_w (position of actual phase edge)
    B_spsa (Release of Adaptation, changes true/false by changing engine speed or idle/part load),
    wnwspas_w (wnwspsas_w = wnwsp_w(zphfl), note: values should not run into limitation: WNWSPS+WNWASMX
    or WNWSPS+WNWAFMX),
    wnwi_ad_w (differenz wnwspas_w - wnwkwas_w, --> zero, if adaptation successfull),
    B_phad (compare against wnwim_w, = true, if wnwim < 3°)
4. Check of the adaptation in idle condition (VS100-VSO):
   set WNWASMX/WNWAFMX to high values, p.e. +/- 100°; set WNWSPS to a value, so that wnwsp runs into limitation;
   reset WNWSPS to correct value and monitor the adaptation values; stabilisation of the values after
   about 10 sec.
5. Check of the adaptation in no idle condition and camshaft control
   B_spsa = false, camshaft in retarded position: wnwi_ad_w = 0 , in advanced position wnwi = CMS shift angle
   (Check analog signals of speed and phase sensors with INKA-VADI or oszilloscope)

DNWKW 3.40 Diagnosis alignment between camshaft and crankshaft

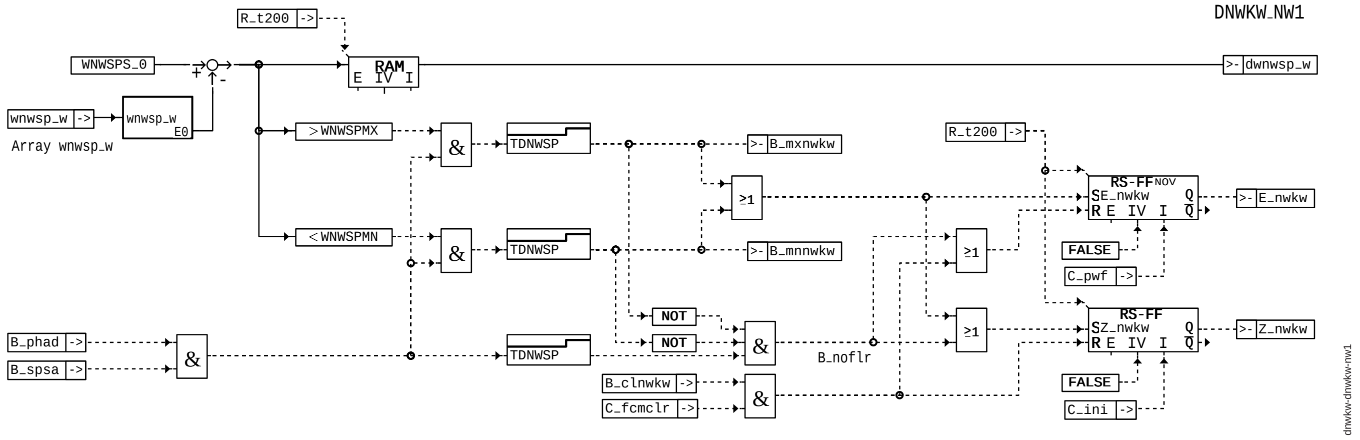
FDEF DNWKW 3.40 Function definition

The section %DNWKW discribes the diagnosis of the alignment between the camshaft/s and the crankshaft. Therefore the adapted position of the first phase edge (see %WANWKW) is compaired with its nominal position.



dnwkw-dnwkw

In case of a system with two phase sensors (SY_PGRAD2 > 0), both sensors are monitored separately. The diagnosis of the 2. phase sensor PG2 is done in the same way as for the 1. phase sensor PG, due to this the DNWKW_NW2 is not illustrated in the following. If the system includes only one phase sensor, DNWKW_NW2 is not calculated and the flags E_nwkw2 and Z_nwkw2 are initialized with neutral values.



dnwkw-dnwkw-nw1

```
Determination of the deviation of the camshaft position from the setpoint position:
---------------------------------------------------------------------------------

        dwnwsp*_w = WNWSPS*_0 - wnwsp*_w(0);                  adjusted to advanced:  dwnwsp*_w > 0
                                                                          retarded:  dwnwsp*_w < 0

Formation of the fault condition E_nwkw* and of the fault type:
---------------------------------------------------------------

Fault:
        dwnwsp*_w > WNWSPMX:    B_mxnwkw*       Camshaft position adjusted to advanced
        dwnwsp*_w < WNWSPMN:    B_mnnwkw*       Camshaft position adjusted to retarded
        else:                   E_nwkw*=0       Camshaft position is within the permissible range of tolerance

Fault memory management:
------------------------

Status fault path NWKW: SFPNWKW                             Status fault path NWKW2:  SFPNWKW2
Error flag NWKW:        E_nwkw                              Error flag NWKW2:         E_nwkw2
Cycle flag NWKW:        Z_nwkw                              Cycle flag NWKW2:         Z_nwkw2
Fault type NWKW:        B_mxnwkw                            Fault type NWKW2:         B_mxnwkw2
                        B_mnnwkw                                                      B_mnnwkw2

Delete fault path:     C_fcmclr & B_clnwkw                 Delete fault path:      C_fcmclr & B_clnwkw2
Fault path NWKW  :                CDTNWKW                  Fault path NWKW2  :                CDTNWKW2
Fault class NWKW:                 CLANWKW                  Fault class NWKW2:                 CLANWKW2
Fault intensity NWKW:             TSFNWKW                  Fault intensity NWKW2:             TSFNWKW2
Carb code NWKW:                   CDCNWKW                  Carb code NWKW2:                   CDCNWKW2
Environmental cond. NWKW:         FFTNWKW                  Environmental cond. NWKW2:         FFTNWKW2
```

ABK DNWKW 3.40 Abbreviations

*	wildcard for PG or PG2
PG	first phase sensor
PG2	second phase sensor
CKS	crankshaft

Parameter	Source-X	Source-Y	Type	Description
CDCNWKW	BLOKNR		KL	code word CARB: alignment between camshaft and crankshaft
CDCNWKW2	BLOKNR		KL	code word CARB: alignment between camshaft 2 and crankshaft
CDTNWKW			FW	code word tester: alignment between camshaft and crankshaft
CDTNWKW2			FW	code word tester: alignment between camshaft 2 and crankshaft
CLANWKW			FW	fault class: alignment between camshaft and crankshaft
CLANWKW2			FW	fault class: alignment between camshaft 2 and crankshaft
FFTNWKW	BLOKNR		KL	freeze frame table: alignment between camshaft and crankshaft
FFTNWKW2	BLOKNR		KL	freeze frame table: alignment between camshaft 2 and crankshaft
TDNWSP			FW	Time delay for the checking of the camshaft shift
TSFNWKW			FW	fault active time: alignment between camshaft and crankshaft
TSFNWKW2			FW	fault active time: alignment between camshaft 2 and crankshaft
WNWSPMN			FW	Border angle of the retarded shift for the assignment of camshaft to crankshaft
WNWSPMX			FW	Border angle of the advanced shift for the assignment of camshaft to crankshaft
WNWSPS2_0			FW	setangle of the edge 0 of the camshaft 2 in the reference position
WNWSPS_0			FW	setangle of the edge 0 of the camshaft in the reference position

Variable	Source	Type	Description
B_CLNWKW		EIN	condition clear fault path alignment between camshaft and crankshaft
B_CLNWKW2		EIN	condition clear fault path alignment between camshaft 2 and crankshaft
B_MNNWKW	DNWKW	AUS	fault type: camshaft retarded
B_MNNWKW2	DNWKW	AUS	fault type: camshaft 2 retarded
B_MXNWKW	DNWKW	AUS	fault type: camshaft advanced
B_MXNWKW2	DNWKW	AUS	fault type: camshaft 2 advanced
B_PHAD	WANWKW	EIN	adaptation crankshaft/camshaft performed
B_PHAD2	WANWKW	EIN	adaptation crankshaft/camshaft 2 performed
B_SPSA	WANWKW	EIN	condition adaptation of alignment between crankshaft and camshaft released
B_SPSA2	WANWKW	EIN	condition adaptation of alignment between crankshaft and camshaft 2 released
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DWNWSP2_W	DNWKW	AUS	Deviation of the adap. angle 2 from engine-spec. setpoint angle of the camshaft
DWNWSP_W	DNWKW	AUS	Deviation of the adap. angle from engine-spec. setpoint angle of the camshaft
E_NWKW	DNWKW	AUS	error flag: alignment between camshaft and crankshaft
E_NWKW2	DNWKW	AUS	error flag: alignment between camshaft 2 and crankshaft
R_T200		EIN	Time schedule 200 ms
SFPNWKW	DNWKW	AUS	status fault path: alignment between camshaft and crankshaft
SFPNWKW2	DNWKW	AUS	status fault path: alignment between camshaft 2 and crankshaft
SY_PGRAD2	PROKON	EIN	system constant: kind of the 2. phase signal
WNWSP2_W	WANWKW	EIN	Adaptation angle of the camshaft 2 in retarded end position
WNWSP_W	WANWKW	EIN	Adaptation angle of the camshaft in retarded end position
Z_NWKW	DNWKW	AUS	cycle flag: alignment between camshaft and crankshaft
Z_NWKW2	DNWKW	AUS	cycle flag: alignment between camshaft 2 and crankshaft

FW DNWKW 3.40 Fixed Values

Parameter	Value	Description
CDTNWKW		code word tester: alignment between camshaft and crankshaft
CDTNWKW2		code word tester: alignment between camshaft 2 and crankshaft
CLANWKW		fault class: alignment between camshaft and crankshaft
CLANWKW2		fault class: alignment between camshaft 2 and crankshaft
TDNWSP		Time delay for the checking of the camshaft shift
TSFNWKW		fault active time: alignment between camshaft and crankshaft
TSFNWKW2		fault active time: alignment between camshaft 2 and crankshaft
WNWSPMN		Border angle of the retarded shift for the assignment of camshaft to crankshaft
WNWSPMX		Border angle of the advanced shift for the assignment of camshaft to crankshaft
WNWSPS2_0		setangle of the edge 0 of the camshaft 2 in the reference position
WNWSPS_0		setangle of the edge 0 of the camshaft in the reference position

FB DNWKW 3.40 Detailed description of function

```
Determination of the deviation of the camshaft position from the setpoint position:
------------------------------------------------------------------------------------

    The deviation of the camshaft position from the engine-specific setpoint position is given by:

            dwnwsp*_w = WNWSPS*_0 - wnwsp*_w(0).     (* = Wildcard for PG oder PG2)

    By comparing the limitation values the conditions "adjusted to advanced" B_mxnwkw*, "adjusted to retarded" B_mnnwkw*,
    resp. "adjustment in the permissible range" E_nwkw* are set = false.
    The setting of the conditions is only performed if the angle adaptation (B_spsa*) is active and if it was successful
    (B_phad*). In order to set the fault condition the limit must have been exceeded for the period of time TDNWSP. If after
    this period of time the limit is still exceeded the fault condition is set.
```

```
Formation of the fault condition E_nwkw* and of the fault type:
---------------------------------------------------------------

     The error and cycle flags are formed via the above-defined conditions B_mxnwkw* and B_mnnwkw*.

Position of the camshaft:
-------------------------

     dwnwsp*_w > 0 °CKS      :       Position of the phase sensor wheel is too advanced
                             Action: Turn the sensor wheel or the camshaft against the direction of rotation

     dwnwsp*_w < 0 °CKS      :       Position of the phase sensor wheel is too retarded
                             Action: Turn the sensor wheel in the direction of rotation
```

Example:

```
Crankshaft signal:                            |<--------- WNWSPS(0)----->|
 -+ +-+ +-+ +-+ +-+ +-+ +-+ +-+         +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+
  | | | | | | | | | | | | | | | ... ... | | | | | | | | | | | | | | | | | | | | | | | | | |
  +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+-+-+-+-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-
                                                                         .
Camshaft signal in setpoint position: dwnwsp_w = 0                       +--------------------------------
 ------------------------------------------------------------------------+

                                                               |<------->|
Camshaft signal too advanced: dwnwsp_w  > 0:                   +------------------------------------------
 --------------------------------------------------------------+
                                                                         |<------->|
Camshaft signal too retarded: dwnwsp_w  < 0:                                       +----------------------
 ----------------------------------------------------------------------------------+
```

APP DNWKW 3.40 Application hint

Guidance values for initial application:

WNWSPMX:	+ 10°CKS
WNWSPMN:	- 10°CKS
TDNWSP:	2.0 sec
WNWSPS*_0:	see %WANWKW

ALE 6.20 Detection of engine stop position

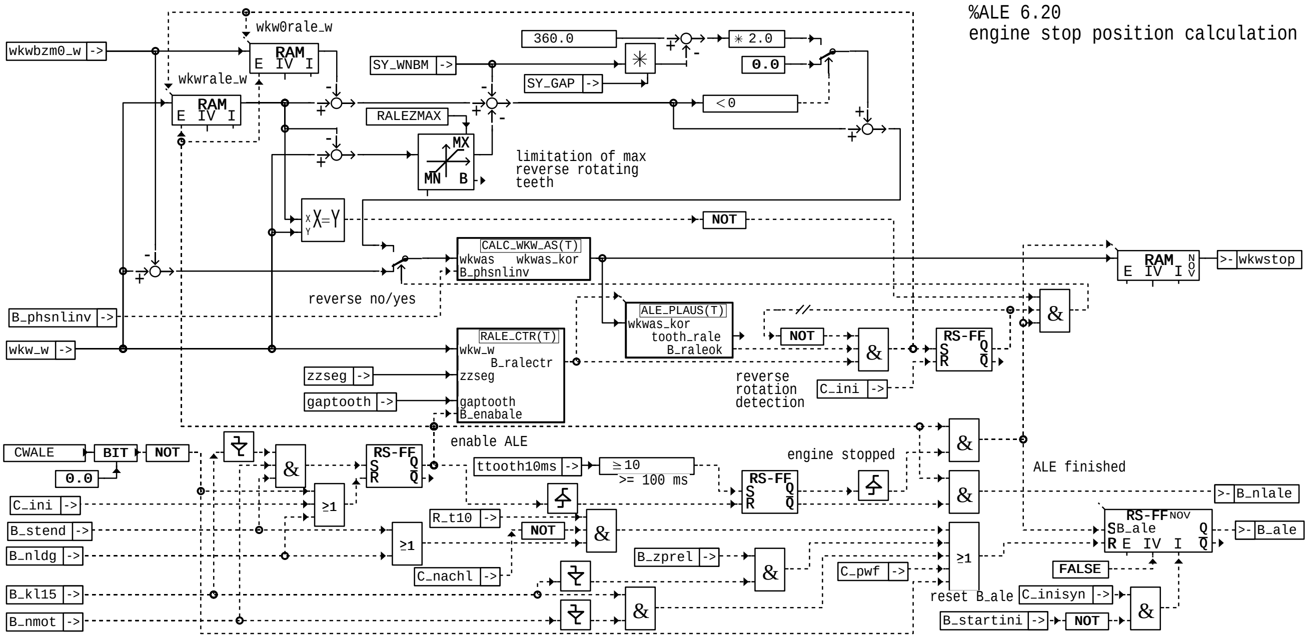
FDEF ALE 6.20 Function definition

The run-out detection provides the position of the engine, at which the engine stops rotating. The found stop position is used during the following engine start for the quick-start synchronization in %GGDPG (synstate = 1). The injection is enabled in this synchronization state, the ignition is blocked.

The calculation of the run-out detection is started once the engine is turned off via the ignition key B-K115. The signals of the speed sensor are evaluated while the engine runs on. In the end the found stop position (wkwstop) is stored in the permanent RAM and the condition for the stop position is set (B_ale).

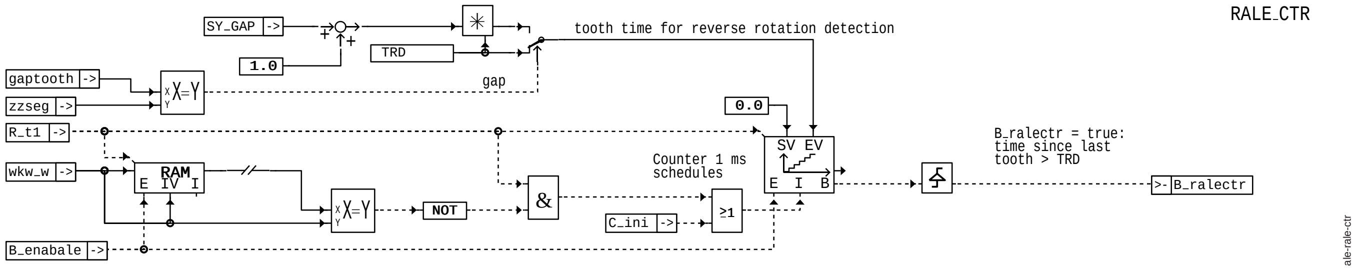
By a reverse rotation detection it is determined whether the engine rotates backward when turning it off and if necessary the reverse rotation position of the engine is stored. When there is no back-swing motion the stop position results directly from the current crank angle. When there is a back-swing motion the stop position results from the back-swing position minus the crank angle rotated backward minus one tooth.

```
Run-out Detection with Back-Swing Detection:

B_kl15:
--------+                                                                                                                       1
        +---------------------------------------------------------------------------------------------------------------------  0
B_enabale:
        +---------------------------------------------------------------------------------------------------------------------  1
--------+                                                                                                                       0
B_nlale:
        +-----------------------------------------------------------------------------------------------------------------+     1
--------+                                                                                                                 +---  0
B_ale:
                                                                                                                          +---  1
--------------------------------------------------------------------------------------------------------------------------+     0
                                                                                                               .<-100 ms->.
                                                                                                               .          .
NBM with back swing:                                                                                           .          .
                                                                        forward --->|---> backward             .          .
 BM       BM       BM       BM       BM       BM                                                                          .
|--||...||--||...||--||...||--||...||--||...||--|| | | | | | | | | | | |  | T0 |  T1  |T2 |   |   |   |      |          .
                                                                                                               .          .
Crank angle wkw_w  (6 °KW):  120... 239 240...360  361.... . . . . . . . .373  374    375 376 377 378 379    380        .
Engine position wkwas (6 °KW):0 ... 119 0  ...  0  1 2 3 . . . . . . . . . 13   14     14  13  12  11  10      9        .
--------------------------------------------------------------------------------------------------------------------------.---
                                                                                        ^                                 .
Back-swing detection:                                                                   |                                 .
-------------------------------------------------+--------------------------------------+---------------------------------+---
                                                 |                                      |                                 |
                                                 |                                      +--> wkwrale_w = 375              |
                                                 +-------------------------------------------> wkw0rale_w = 360           V
Stop position:                                                                                                        wkwstop = 9
```


%ALE 6.20
engine stop position calculation

ale-ale

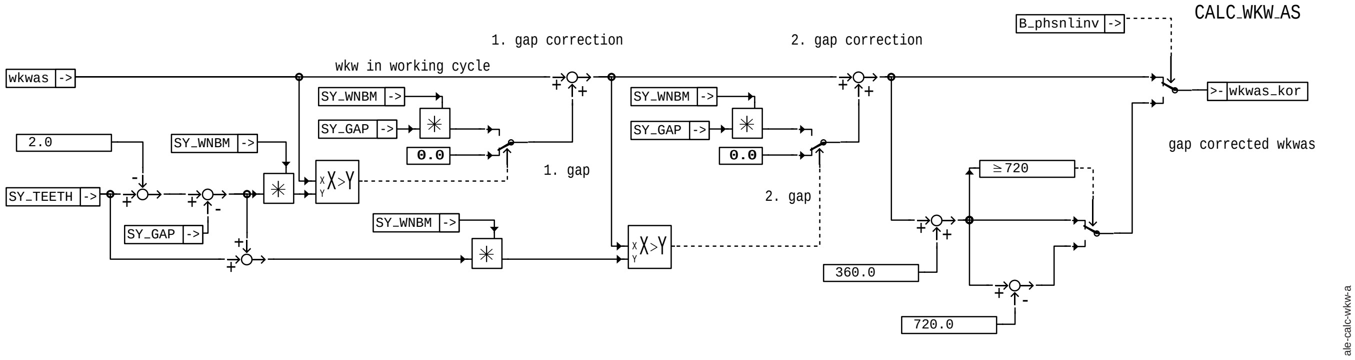
```
Functional Overview of Run-out Detection
----------------------------------------

        - Calculation of wkwstop from wkw_w, wkwbzm0_w, wkw0rale_w and wkwrale_w
        - Reverse rotation detection with the setting of a RS_FF's at first detection
        - Logic for the setting and resetting of B_enabale, B_nlale and B_ale
```



ale-rale-ctr

RALE_CTR: Condition last tooth time > TRD

B_ralectr is formed from a counter, which counts in the 1 ms cycle for as long as no tooth interrupt occurs. The counter is reset after each tooth interrupt. As soon as the counter reaches the value TRD (resp. in the gap (1 + SY_GAP) * TRD), B_ralectr is set.

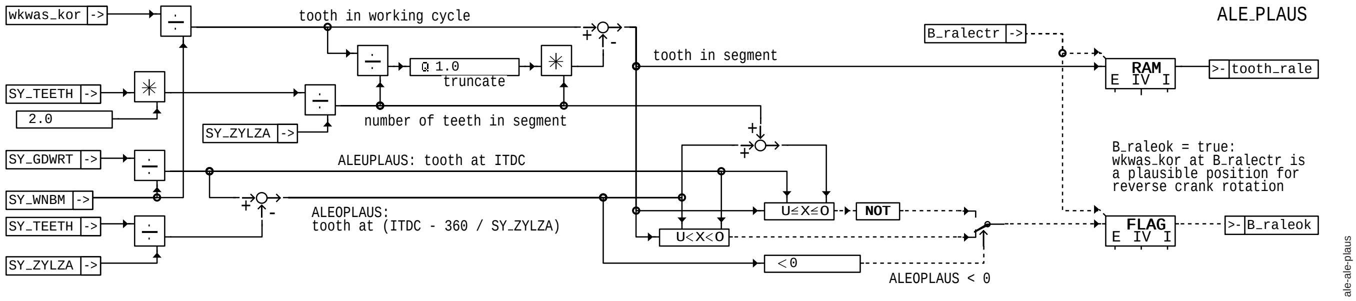


ale-calc-wkw-a

CALC_WKW_AS: Correction of the angle wkwas

Correction of the angle wkwas by the missing teeth of the gaps. If wkwas lies after the first gap then the correction angle of the missing teeth is summed up. If this position lies after the second gap then this angle is summed up again.

When the phase sensor limp-home has detected in the current driving cycle that the angle position is incorrect by one crankshaft revolution (B_phsnlinv = 1), the stop position is corrected accordingly.



ale-ale-plaus

ALE_PLAUS: Checking of the crank angle wkwas_kor for plausible reverse rotation range

With the condition B_ralectr the current crank angle wkwas_kor is checked for plausible reverse rotation range.
The engine is within a plausible range, if the piston in the cylinder is just in compression within half a segment before ignition TDC. The condition for the plausible reverse rotation range therefore results:

```
ALEOPLAUS < tooth in the segment < ALEUPLAUS

with:   ALEUPLAUS =  SY_GDWRT/SY_WNBM                   ==> ZOT
        ALEOPLAUS = (ALEUPLAUS - SY_TEETH/SY_ZYLZA)     ==> segment/2 before ignition TDC
```

Since the tooth in the segment is always >= 0, the following 2 cases result from ALEOPLAUS:

1. ALEOPLAUS >= 0:

```
                   Segment beginning                                                                  Segment end
                        |                 |RRRRRRRRRRRRRRRRRRRRRRRRRRRRR|                                  |
        ----------------+-----------------+-----------------------------+----------------------------------+----------
                        0              ALEOPLAUS                     ALEUPLAUS = ignition TDC                 ZpS
```

2. ALEOPLAUS < 0:

```
                   Segment beginning                                                                 Segment end
                        |RRRRRRRRRRRRRRRRR|                                                    |RRRRRRRRRRR|
        ----+-----------+-----------------+----------------------------------------------------+-----------+----------
         ALEOPLAUS      0              ALEUPLAUS = ignition TDC                            ALEOPLAUS+ZPS    ZpS
```

RRRR = plausible reverse rotation range

ABK ALE 6.20 Abbreviations

ZOT = ignition TDC
ZpS = teeth per segment = 2 * SY_TEETH / SY_ZYLZA

Parameter	Source-X	Source-Y	Type	Description
CWALE			FW	run-out position is calculated
RALEZMAX			FW	Limitation of the number of reverse rotating teeth during engine stopping
TRD			FW	tooth period time for reverse rotation during stop

Variable	Source	Type	Description
B_ALE	ALE	AUS	condition engine stop position detected
B_ENABALE	ALE	LOK	condition: release for calculation of the engine stop position
B_KL15		EIN	condition ignition switch on
B_NLALE	ALE	AUS	request for ECM afterrun from the function ALE
B_NLDG		EIN	condition limp-home function speed sensor
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_PHSNLINV	NLPH	EIN	condition invert phase relation
B_RALECTR	ALE	LOK	condition last tooth time > TRD
B_RALEOK	ALE	LOK	condition last tooth was in the plausible reverse rotation range
B_STARTINI	GGDPG	EIN	start bit to distinguish first synchronization with KL15 from new synchr.
B_STEND	BBSTT	EIN	condition end of start
B_ZPREL	GGDPG	EIN	condition tooth debouncing ready
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
GAPTOOTH	GGDPG	EIN	content of the tooth counter to check the gap
R_T1		EIN	Time schedule 1 ms
R_T10		EIN	Time schedule 10 ms
SY_GAP	PROKON	EIN	system constant: number of missing teeth in the gap
SY_GDWRT		EIN	system constant: crank angle between reference gap to ITDC cylinder 1
SY_TEETH	PROKON	EIN	system constant: number of teeth with gap teeth on the crankshaft wheel
SY_WNBM	PROKON	EIN	System constant for angle of tooth distance from crankshaft signal
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TOOTH_RALE	ALE	LOK	first reverse rotating tooth in segment
TTOOTH10MS	GGDPG	EIN	counter 10 ms schedules without tooth interrupt
WKWAS	ALE	LOK	crank position in working cycle without gap correction
WKWAS_KOR	ALE	LOK	crank position in working cycle with gap correction
WKWBZM0_W	GGDPG	EIN	crank angle at the zero point of the working cycle: R_syn & zzyl = 0 (word)
WKWSTOP	ALE	AUS	engine stopping position in working cycle
WKW_W	GGDPG	EIN	crank angle (word)
ZZSEG	GGDPG	EIN	tooth counter in segment

FW ALE 6.20 Fixed Values

Parameter	Value	Description
CWALE		run-out position is calculated
RALEZMAX		Limitation of the number of reverse rotating teeth during engine stopping
TRD		tooth period time for reverse rotation during stop

FB ALE 6.20 Detailed description of function

The calculation of the stop position is enabled when terminal 15 is off (B_kl15 1->0), provided end of start was reached (B_stend), engine speed is still detected (B_nmot) and no limp-home speed sensor is given ==> B_enabale = true. In this case the after-run bit (B_nlale) is also set.

If a tooth period with a period time greater than TRD occurs while the engine is running on (B_ralectr) and if the current engine position lies within a plausible reverse rotation range (B_raleok), then reverse rotation is detected and the crank angle position wkw_w resp. wkwbzm0_w is re-stored to wkw_rale_w resp. wkw0rale_w.

After the back-swing detection the counter wkw_w continues. 100 ms after the last tooth interrupt (Counter: ttooth10ms >= 10) the run-out detection is aborted and the stop position wkwstop is calculated. In the process two cases need to be distinguished:

1. Reverse rotation detected and engine has rotated back by at least 1 tooth (wkwrale_w

wkw_w).

The backward rotated crank angle results from the current crank angle and the crank angle, which was stored at the moment of the reverse rotation. To minimize the fault in case of a further ’reverse rotation’ of the engine (engine rotates forward again), this angle is limited to RALEZMAX. This angular difference plus one tooth must be subtracted from the reverse rotation point and then results in the stop position:

wkwstop = (wkwrale_w - wkw0rale_w) - (Min((wkw_w - wkwrale_w), RALEZMAX) + SY_WNBM)

Thereafter a possibly occurring overflow in the working cycle still needs to be corrected.

2. Engine has not rotated backward.

   The current stop position results from:

   wkwstop = wkw_w - wkwbzm0_w

In both cases a gap correction is still performed by means of CALC_WKW_AS. After wkwstop has been calculated the condition run-out detection valid (B_ale = 1) is set and the after-run bit (B_nlale) is reset.

B_ale is reset at power fail (C_pwf), when stalling the engine (B_kl15 and B_nmot 1->0), at terminal 15 off and once the tooth debouncing has elapsed (B_kl15 1->0 and B_zprel) as well as during transition to the post-start range (B_stend 0->1), new synchronization at drive (B_startini = FALSE) or at limp-home speed sensor (B_nldg 0->1).

If the engine position is changed once the vehicle has been parked (e.g. pushing while gear is engaged) then the actual engine position is changed. Since then the start position does not correspond to the run-out position, at restart a timing fault of the first injection pulses occurs until a new synchronization is performed. Thereby prolonged starting times may occur.

The calculation of the run-out position can be switched off via the code word CWALE. The bit B_ale is set in this case to FALSE in the ECU run-on.

APP ALE 6.20 Application hint

TRD:

This value determines, at which tooth period duration a back swing of the engine is detected. If the value is chosen too high, back swinging is not always detected. If on the other hand the value is chosen too low, back swinging is detected too early or incorrectly. In order to choose the correct value several run-on attempts are to be performed and in the process the digital tooth signals after the conditioning circuit (CJ53, CJ400) should be recorded. From this the back-swing position can be detected and typical values for the tooth period during back swing can be measured.
The smallest tooth period, at which back swinging occurs is to be chosen as application value.
Typical values for the tooth period during back swinging are: 25 to 50 ms.

RALEZMAX:

This value indicates the maximum permitted number of backward rotated teeth. If the reverse rotation point lies shortly before TDC then the engine rotates back far and into the previous compression. This can lead to another reversing of the direction of rotation so that the engine rotates forward again. Since this reversing of the direction of rotation can no longer be detected, the number of backward rotating teeth is limited.

CWALE:

CWALE = 1: the run-out position is calculated the normal engine turn off
CWALE = 0: the run-out position is not calculated. The bit B_ale is set to FALSE

The code word must set to 1 in normal case. It is because of the calculation of the camshaft limp home position. So the run-out position is not only used for a fast synchronization in the start. The code word is to switch off the run-out detection with the object to test. If there is no injection permitted via the run-out position this must be applied by the temperature threshold TMESP.

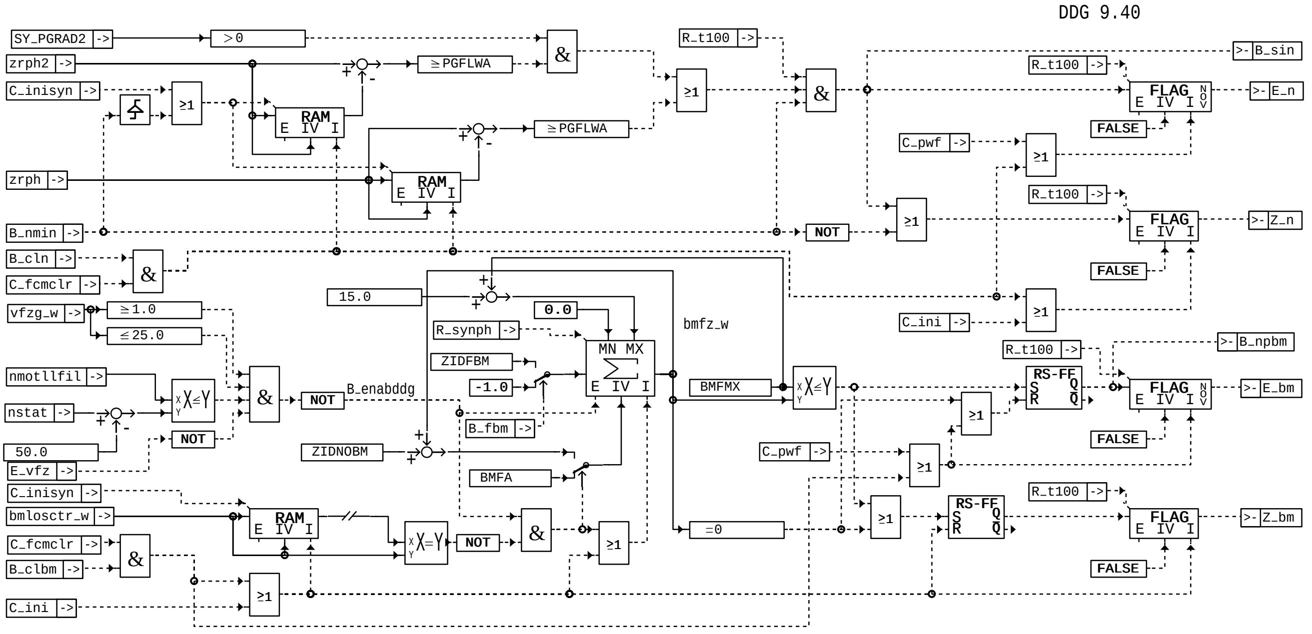
In order to ensure a reliable run-out detection the maximum after-run time should be at least 3 sec.

Check of the virtual engine position:

At start virtual R_syn cycles are triggered already prior to the synchronization. During the transition into the next synchronization state (quick-start wheel or reference mark) the deviation to the actual engine position can be evaluated.

DDG 9.50 Diagnosis: engine speed sensor

FDEF DDG 9.50 Function definition



ddg-ddg

The section DDG describes the diagnosis of the engine speed sensor (DG) at the camshaft.
The diagnosis is using the following signals/events:

- DG diagnosis by monitoring the phase sensors (PG and PG2) level changes below minimum speed
- DG diagnosis by monitoring the reference gap

Fault memory management:

Status fault path:	SFPN	Status fault path BM:	SFPBM
Error flag N:	E_n	Error flag BM:	E_bm
Cycle flag N:	Z_n	Cycle flag BM:	Z_bm
Fault type N:	B_sin	Fault type BM:	B_npbm

Delete fault path:	C_fcmclr & B_cln	Delete fault path:	C_fcmclr & B_clbm
Fault path N:	CDTN	Fault path BM:	CDTBM
Fault class N:	CLAN	Fault class BM:	CLABM
Fault intensity N:	TSFN	Fault intensity BM:	TSFBM
Carb code N:	CDCN	Carb code BM:	CDCBM
Environmental cond. N:	FFTN	Environmental cond. BM:	FFTBM

Fault	Fault type	Description
E_n	B_sin	during engine speed search no DG-signal (PGFLWA PG-phase level changes during B_nmin = 1 ==> no DG-signal)
E_bm	B_npbm	multiple loss of the reference gap or tooth corrections in synchronized condition (counter value = BMFMX)

ABK DDG 9.50 Abbreviations

DG	engine speed sensor at the crankshaft
PG	phase sensor
PG2	optional 2. phase sensor
PH	phase sensor signal from the camshaft
BM	reference gap

Parameter	Source-X	Source-Y	Type	Description
BMFA			FW	Numbers of BM-errors (initial value of counter)
BMFMX			FW	Counter maximale value for BM-errors
PGFLWA			FW	Number of edges of phase signal for error B_signal of the engine speed sensor
ZIDFBM			FW	counter increments on tooth correction at BM-check
ZIDNOBM			FW	counter increments after a loss of the reference gap

Variable	Source	Type	Description
BMFZ_W	DDG	LOK	counter errors in reference gap detection for speed sensor diagnosis
BMLOSCTR_W	GGDPG	EIN	counter (word) re-synchronizations due to a loss of the reference gap
B_CLBM		EIN	condition clear fault path reference mark sensor
B_CLN		EIN	condition clear fault path engine speed sensor
B_ENABDDG	DDG	LOK	suppression of the engine speed diagnose for E_bm
B_FBM	GGDPG	EIN	condition reference mark error => at least 1 tooth too few/many
B_NMIN	GGDPG	EIN	condition lower speed: n < NMIN
B_NPBM	DDG	AUS	Fault type: reference gap is often lost
B_SIN	DDG	AUS	Fault type: no signal from the crankshaft position sensor
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_BM	DDG	AUS	error flag: reference mark sensor
E_N	DDG	AUS	error flag: engine speed sensor
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
NMOTLLFIL	BGNMOT	EIN	filtered engine speed nmotll
NSTAT	LLRNS	EIN	Stationary reference speed
R_SYNPH	GGDPG	EIN	synchro schedule for phase scan
R_T100		EIN	Time schedule 100 ms
SY_PGRAD2	PROKON	EIN	system constant: kind of the 2. phase signal
VFZG_W	GGVFZG	EIN	Vehicle speed
ZRPH	GGDPG	EIN	counter schedule of phase signal
ZRPH2	GGDPG	EIN	counter schedule of phase signal 2
Z_BM	DDG	AUS	cycle flag: reference mark sensor
Z_N	DDG	AUS	cycle flag: engine speed sensor

FW DDG 9.50 Fixed Values

Parameter	Value	Description
BMFA		Numbers of BM-errors (initial value of counter)
BMFMX		Counter maximale value for BM-errors
PGFLWA		Number of edges of phase signal for error B_signal of the engine speed sensor
ZIDFBM		counter increments on tooth correction at BM-check
ZIDNOBM		counter increments after a loss of the reference gap

FB DDG 9.50 Detailed description of function

The input signals of the DDG are built in the sections %GGDPG, %SYSCON and %SYSYNC.

Fault E_n: The diagnosis of the DG is made as follows:

Monitoring the phase level changes below minimum engine speed:
The PG-signal is used as a referenz. When getting some phase interrupts R_ph without detecting an engine speed signal, then the speed sensor is faulty. To detect this, the number of phase interrupts are checked via the phase interrupt counter zrph below minimum engine speed (B_nmin). The error flag E_n and the fault type B_sin is set, as soon as PGFLWA number of phase level changes during B_nmin are monitored.
The error is reset as soon as engine speed is detected.

```
C_inisyn     +
            -+------------------------------------------------------------------------------------------------------

DG- signal
            --------------------------------------------------------------------------------------------------------

R_ph               +         +                     +                       +         +                    +
            -------+---------+---------------------+-----------------------+---------+--------------------+---------


       PGFLWA                                                                                 PGFLWA ->   +---------
                                                                                     +--------------------+
counter zrph/zrph2                                                         +---------+
                                                   +-----------------------+
                             +---------------------+
                   +---------+
         0  -------+

B_sin                                                                                                     +---------
            ----------------------------------------------------------------------------------------------+

E_n                                                                                                       +---------
            ----------------------------------------------------------------------------------------------+

Z_n                                                                                                       +---------
            ----------------------------------------------------------------------------------------------+
```

Fault E_bm: The diagnosis of the DG is made as follows:

In synchronized condition the reference gap is checked in %GGDPG in each synchro after the gap. A loss of the gap causes a re-synchronization (B_bm 1 -> 0) which increases a counter (bmlosctr_w). In case the gap is wrong by one tooth, a gap correction will be made and the flag B_fbm will be set. The diagnosis uses this information. At a gap loss a counter is increased by ZIDNOBM. At a gap correction the counter is increased by ZIDFBM. If the gap is correct, the counter will be decreased by 1. As soon as the counter reaches BMFMX the error B_npbm is set. The error is reset as soon as the counter has counted down to 0.

Fade out of the Diagnose (E_bm):
If there is a operating error of the driver (slowly engine stalling, wrong gear shifting at start) there could be a vibration of the crankshaft. This may affect a frequently loss of the reference gap during this operation point, which cause an error entry although there is no damage at the system.

To prevent the error entry in this case, the diagnose for intermittent contact (E_bm) will fade out, if the engine speed is below idling speed and the car is in motion. The calculation of the fade out condition takes part in the 10ms cycle. Because of large fluctuation of the engine speed during this operation point the filtered engine speed nmotllfil is used as input value. If the error bit E_vfz is set, there is no fade out of the diagnose on principle.

APP DDG 9.50 Application hint

Recommendation for first application:

PGFLWA:	depending on the number of phase signal per cam rotation, minimum 8 rotations should be used until the error is set (standard wheel: 8 quick start wheel: 24)		
ZIDFBM:	150		
ZIDNOBM:	1200		
BMFA:	1000		
BMFMX:	4000		
CDTN:	110	CDTBM:	111
CLAN:	3	CLABM:	6
TSFN:	255	TSFBM:	255
CDCN:	824,823,821,822d	CDCBM:	824,823,821,822d
FFTN:	ub, tmot	FFTBM:	ub, tmot

Function test:
----

1. Measure the following signals with VS100-VSO:
   - RAM cells: nmot, B_nmin, zrph, E_n, E_bm, Z_n, Z_bm, B_sin, B_fbm, bmlosctr_w, B_npbm
   - Label: PGFLWA, ZIDFBM, ZIDNOBM, BMFA, BMFMX

2. Check, if DG-signal is existing:
   ignition on: B_nmin = true, zrph = 0, E_n = false, Z_n = false, E_bm = false, Z_bm = true
   start engine: B_nmin = false, Z_n = true, zrph is incremented, nmot plausible, E_n = false

3. Check not connected DG (disconnect DG sensor or disconnect both DG signal wires at the ECU adaptor)
   ignition on: B_nmin = true, zrph = 0, E_n = false, Z_n = false
   apply starter, engine does not start: B_nmin = true, Z_n = false, zrph is incremented;
   as soon as zrph > PGFLWA: E_ n =true and Z_n = true, B_sin = true;

4. Reset error flag: Reconnect the DG sensor / wires
   ignition on: B_nmin = true, zrph = 0, E_n = true, Z_n = false
   start engine: B_nmin = false -> E_n = false, Z_n = true

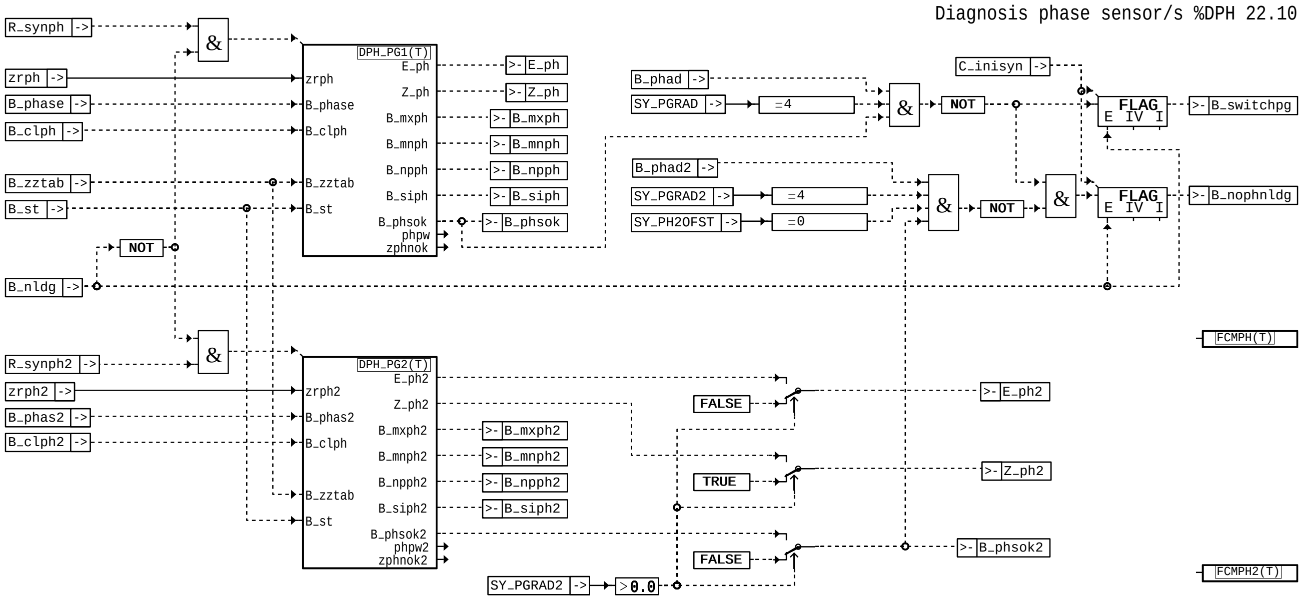
5. At systems with 2. phase sensor, disconnect PG and repeat steps 1 to 4 by monitoring zrph2 instead of zrph

6. Test intermittend contact:
   Connect DG, start engine and wait until Z_bm = true. During monitoring the counter bmfz_w disconnect and connect the DG wires several times. Reconnect the DG wires correctly as soon as the error is detected (E_bm = 1) and wait until the error disappears (E_bm = 0).

In the function %GGVFZG the change-over threshold for vfzg_w to 0 (Label VRFGRMN) should not be set higher than 3 km/h because of the perfect funktion of the diagnose fade out.

DPH 22.10 Diagnosis; plausibility test phase sensor

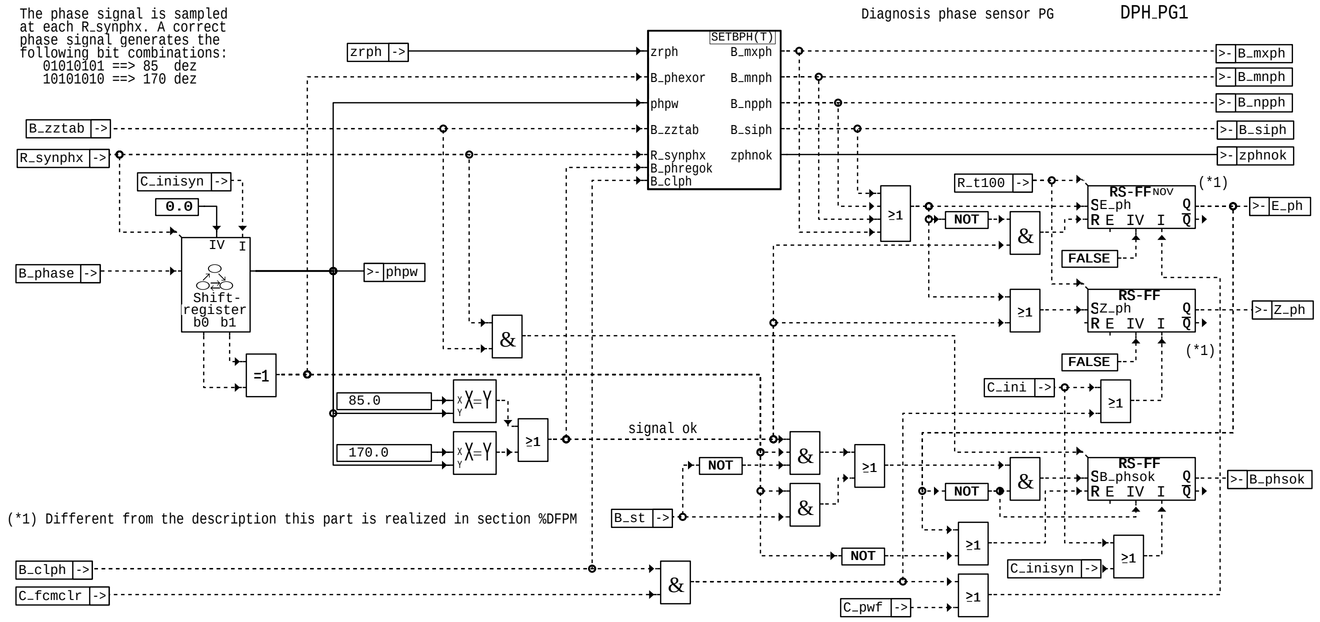
FDEF DPH 22.10 Function definition


Diagnosis phase sensor/s %DPH 22.10

dph-dph

dph-dph

The section DPH describes the diagnosis of the phase sensor / of the phase sensors (PG/PG2) at the camshaft (CMS).


Diagnosis phase sensor PG DPH_PG1

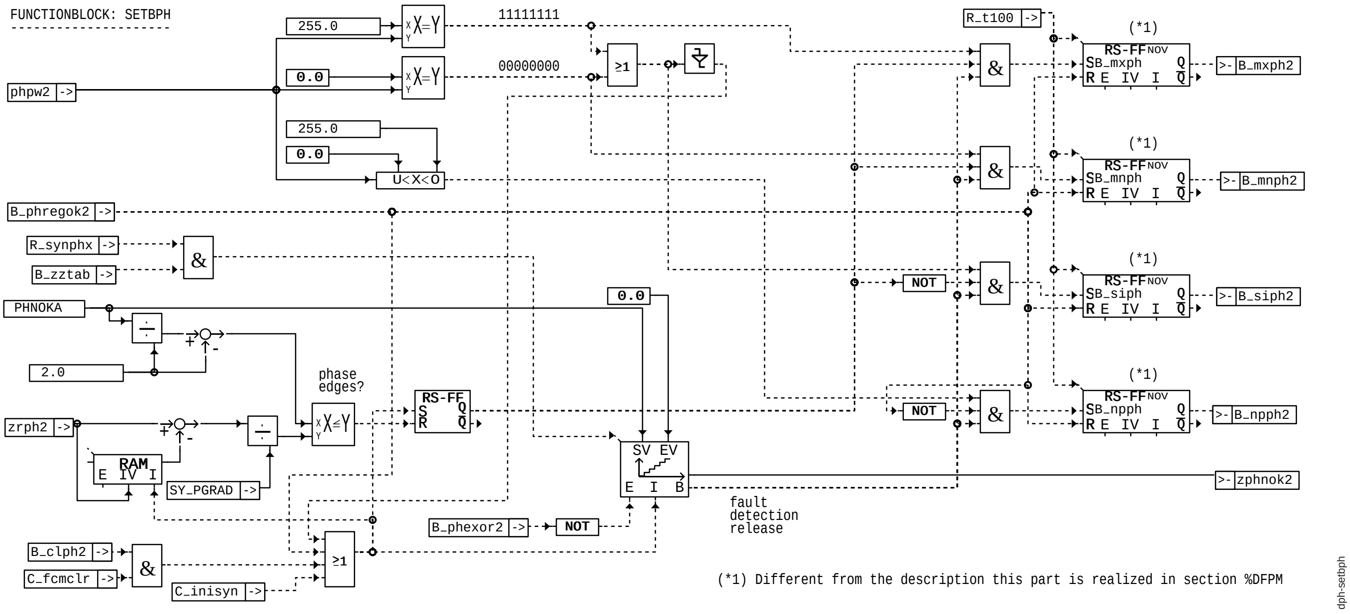
(*1) Different from the description this part is realized in section %DFPM

dph-dph-pg1

dph-dph-pg1

DPH_PG1: Diagnosis of the phase sensor PG

For the diagnosis the level of the PG signal is inquired upon in each synchro grid for phase inquiry (R_synph*). During correct operation the PG level changes alternately (010101...). If it does not change then a PG fault is assumed.



dph-setbph

Setting of error types

If there appears another type of the error E_ph, the previous error type will reset and the new type will set.

DPH_PG2: Diagnosis of the phase sensor PG2

In case of a system with two phase sensors (SY_PGRAD > 0), both of them are monitored separately. The diagnosis of the 2nd phase sensor PG2 is analogous to the 1st phase sensor PG, therefore the subfunction DPH_PG2 is not illustrated in the following definition. In case of only one phase sensor, DPH_PG2 is not calculated and the flags E_ph2, Z_ph2 and B_phsok2 are initialized with neutral values.

Fault memory management:

Status fault path PH:	sfpph	Status fault path PH2:	sfpph2
Error flag PH:	E_ph	Error flag PH2:	E_ph2
Cycle flag PH:	Z_ph	Cycle flag PH2:	Z_ph2
Fault type PH:	B_mxph	Fault type PH2:	B_mxph2
	B_mnph		B_mnph2
	B_npph		B_npph2
Delete fault path:	C_fcmclr & B_clph	Delete fault path:	C_fcmclr & B_clph2
Fault path PH:	CDTPH	Fault path PH2:	CDTPH2
Fault class PH:	CLAPH	Fault class PH2:	CLAPH2
Fault intensity PH:	TSFPH	Fault intensity PH2:	TSFPH2
Carb code PH:	CDCPH	Carb code PH2:	CDCPH2
Environmental cond. PH:	FFTPH	Environmental cond. PH2:	FFTPH2

ABK DPH 22.10 Abbreviations

PG	first phase sensor
PG2	second phase sensor
*	wildcard for PG or PG2

Parameter	Source-X	Source-Y	Type	Description
CDCPH	BLOKNR		KL	code word CARB: phase sensor
CDCPH2	BLOKNR		KL	code word CARB: phase sensor 2
CDTPH			FW	code word tester: phase sensor
CDTPH2			FW	code word tester: phase sensor 2
CLAPH			FW	fault class: phase sensor
CLAPH2			FW	fault class: phase sensor 2
FFTPH	BLOKNR		KL	freeze frame table: phase sensor
FFTPH2	BLOKNR		KL	freeze frame table: phase sensor
PHNOKA			FW	start value for counter phase signal not ok
TSFPH			FW	fault active time: phase sensor
TSFPH2			FW	fault active time: phase sensor 2

Variable	Source	Type	Description
B_CLPH		EIN	condition clear fault path PH
B_CLPH2		EIN	condition clear fault path Phase sensor 2
B_MNPH	DPH	AUS	error type: short circuit ground of phase sensor

Variable	Source	Type	Description
B_MNPH2	DPH	AUS	error type: short circuit ground of phase sensor 2
B_MXPH	DPH	AUS	error type: short circuit Ubat phase sensor
B_MXPH2	DPH	AUS	error type: short circuit Ubat phase sensor 2
B_NLDG		EIN	condition limp-home function speed sensor
B_NOPHNLDG	DPH	AUS	condition no phase sensor signal for limphome engine speed sensor available
B_NPPH	DPH	AUS	condition signal of camshaft sensor not plausible (ph)
B_NPPH2	DPH	AUS	condition signal of camshaft sensor not plausible (ph2)
B_PHAD	WANWKW	EIN	adaptation crankshaft/camshaft performed
B_PHAD2	WANWKW	EIN	adaptation crankshaft/camshaft 2 performed
B_PHAS2	GGDPG	EIN	Condition phase 2 low/high
B_PHASE	GGDPG	EIN	Condition phase low/high
B_PHEXOR	DPH	LOK	The two lowest significant bits of phpw are unequal
B_PHEXOR2	DPH	LOK	The two lowest significant bits of phpw2 are unequal
B_PHREGOK	DPH	LOK	No error of bit pattern in phase register 1
B_PHREGOK2	DPH	LOK	No error of bit pattern in phase register 2
B_PHSOK	DPH	AUS	Condition phase signal ok
B_PHSOK2	DPH	AUS	Condition phase signal 2 ok
B_SIPH	DPH	AUS	condition no alternating phase levels PG in the reference marks
B_SIPH2	DPH	AUS	condition no alternating phase levels PG2 in the reference mark s
B_ST	SWADAP	EIN	condition for start
B_SWITCHPG	DPH	AUS	condition to switch to phase sensor PG2 for the engine speed sensor limphome
B_ZZTAB	GGDPG	EIN	condition: tooth time table valid
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_PH	DPH	AUS	error flag: phase sensor
E_PH2	DPH	AUS	error flag: phase sensor 2
PHPW	DPH	LOK	Slopes of phase signal (8 bit shifting)
PHPW2	DPH	LOK	Slopes of phase signal 2 (8 bit shifting)
R_SYNPH	GGDPG	EIN	synchro schedule for phase scan
R_SYNPH2	GGDPG	EIN	synchro schedule for phase scan 2
R_T100		EIN	Time schedule 100 ms
SFPPH	DPH	AUS	status fault path: phase sensor
SFPPH2	DPH	AUS	status fault path: phase sensor
SY_PGRAD	PROKON	EIN	system constant: kind of the phase signal
SY_PGRAD2	PROKON	EIN	system constant: kind of the 2. phase signal
SY_PH2OFST	PROKON	EIN	system const. offset in syncros between the 2 active phase signals,2 PGs only
ZPHNOK	DPH	LOK	Counter fault of phase signal
ZPHNOK2	DPH	LOK	Counter fault of phase signal 2
ZRPH	GGDPG	EIN	counter schedule of phase signal
ZRPH2	GGDPG	EIN	counter schedule of phase signal 2
Z_PH	DPH	AUS	cycle flag: phase sensor
Z_PH2	DPH	AUS	cycle flag: phase sensor 2

FW DPH 22.10 Fixed Values

Parameter	Value	Description
CDTPH		code word tester: phase sensor
CDTPH2		code word tester: phase sensor 2
CLAPH		fault class: phase sensor
CLAPH2		fault class: phase sensor 2
PHNOKA		start value for counter phase signal not ok
TSFPH		fault active time: phase sensor
TSFPH2		fault active time: phase sensor 2

FB DPH 22.10 Detailed description of function

The current level of the PG is entered into a shift register (phpw*) in the synchro grid for phase inquiry (R_synph*). During the next R_synph* schedule the content of the register is shifted and the new PG level is recorded.

Thus, under normal conditions, the 8-bit register is allocated with 01010101 or 10101010.
If this register allocation is not given a PG fault exists:

```
        Register contents                               Fault

        1111 1111 and no phase edges           ->      B_mx***       Max fault (e. g. short circuit to UB)

        0000 0000 and no phase edges           ->      B_mn***       Min fault (e. g. short circuit to ground)

        1111 1111 or 0000 0000
        and phase edges                        ->      B_si***       Signal fault (e. g. wrong mounted PG*)

        not equal 0101 0101  or
        not equal 1010 1010                    ->      B_np***       Plausibility fault (e. g. intermittend contact)

        0101 0101 =  85 dez or
        1010 1010 = 170 dez                    ->      no fault or fault healing
```

At the same time the number of fault occurrences are counted (zphnok*), during which no change of level is detectable in the synchro grid for phase inquiry (R_synph*). If the downward counter zphnok* reaches the value 0 then in connection with the above-described fault type a fault is set (E_** = 1, Z_** = 1, B_**** =1).

In the initialization (C_inisyn), when deleting the error B_clph* or at a correct PG*-signal the fault counter (zphnok*) gets the starting value PHNOKA. This value is also set, as soon as one of the fault types B_mxph* or B_mnph* changes from 1 to 0 (disabling the fault type B_siph* during fault healing).

During the start of the engine it is important to obtain information about the functioning of the PG as quickly as possible (before the entire shift register has been filled). B_phsok* (phase sensor PG* OK) is initialized during C_ini and C_inisyn from E_ph*. This condition is reset as soon as the first missing phase change is detected.

For the setting and resetting of B_phsok* the last two entries of the shift register are used. In order to guarantee the correct setting of B_phsok*, the condition is first calculated after C_inisyn (e.g. while the engine starts) at the second R_synph*.
At the first R_synph* there is no sufficient information.

Case example for B_phsok:

Case 1: No fault entry is yet made in E_ph:

```
                                                 1   2   3   4   5   6   7   8
R_synph:         |---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---
                                 .
Phase fault:  1                  +---------------+
              0  ----------------+               +-----------------------------------------------------------
                                 .
zphnok:          ----------------+               .              PHNOKA -->   +-------------------------------
                                 +---+           .                           |
                                 .   +---+       .                           |
                                 .       +---+   . > 0                       |
                                 .           +-------------------------------+
              0  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
E_ph:         1                  .               .                           .
              0  --------------------------------------------------------------------------------------------
signal ok     1  ----------------+               .                           +-------------------------------
              0                  +-------------------------------------------+
                                 .               .                           .
if B_st = 1:                     .               .                           .
B_phsok:      1  ----------------+               +-----------------------------------------------------------
              0                  +---------------+                           .
                                 .                                           .
if B_st = 0:                     .                                           .
B_phsok:      1  ----------------+                                           +-------------------------------
              0                  +-------------------------------------------+
```

Case 2: A fault entry is done in E_ph:

```
                                                         1   2   3   4   5   6   7   8
R_synph:         |---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---
                                 .
Phase fault:  1                  +-----------------------+
              0  ----------------+                       +---------------------------------------------------
                                 .
zphnok:          ----------------+                       .             PHNOKA -->    +-----------------------
                                 +---+                   .                           |
                                 .   +---+               .                           |
                                 .       +---+           .                           |
                                 .           +---+     <= 0                          |
              0  . . . . . . . . . . . . . . .   +-----------------------------------+ . . . . . . . . . . .
                                 .                       .                           .
E_ph:         1                  .               +-----------------------------------+
              0  --------------------------------+       .                           +-----------------------
                                 .                       .                           .
signal ok     1  ----------------+                       .                           +-----------------------
              0                  +---------------------------------------------------+
                                 .                       .                           .
if B_st = 0 or =1:               .                       .                           .
B_phsok:      1  ----------------+                       .                           +-----------------------
              0                  +---------------------------------------------------+
```

```
signal ok => 1 means: Contents of the shift register is 01010101 or 10101010
          => 0 otherwise
```

APP DPH 22.10 Application hint

PHNOKA: 12   (> 7, so that the correct fault type is entered in B_mx**, B_mn**, B_np** or B_si**)

Function test:

```
1. Measurement values:
        digital values:         B_phase , B_phsok, B_st, E_ph, Z_ph, B_npph, B_mnph, B_mxph, B_siph
                                phpw.0 (bit 0), phpw.1 (bit 1), ..

        analog values:          zphnok (0..20), zzyl (0..20), phpw (0..260), nmot (0..2000),
                                if required: PH and NBM via analog card (VADI)

        Measurement grid:       10 ms
```

2. Measurement sequence:

2.1 Test of signal position:

procedure: start engine, during engine operation connect the phase signal as follows:

- Disconnection of the phase signal at the ECU-adapter:
- Phase short circuit to ground: --> B_phase=0, E_ph=1, B_mnph=1, phpw=0
- Phase short circuit to UB/cable drop-off: --> B_phase=1, E_ph=1, B_mxph=1, phpw=255
- Phase loose contact: --> B_phase=*, E_ph=1, B_npph=1, 0 < phpw < 255
- Phase ok: --> B_phase=alternating, E_ph=0, phpw=85 V phpw=170
  --> phpw.0=B_phase
- Phase signal fault: -->B_phase=const(0 or 1), E_ph=1, B_siph=1, phpw=0 or 255

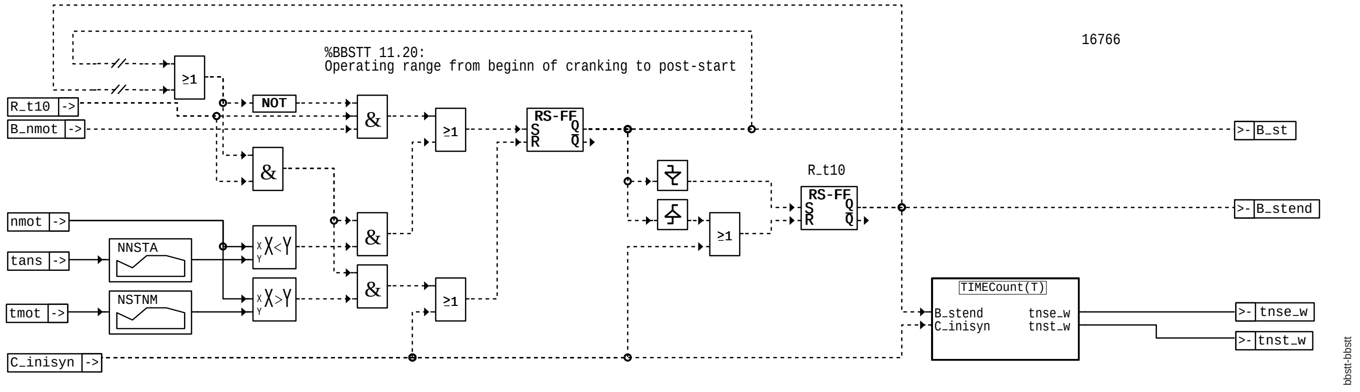
The fault type B_siph = 1 can only occur at a wrong mounted phase senor. To test this, the signal needs to be shifted so that no alternating phase level appears.

2.2 Fault entry, fault healing:

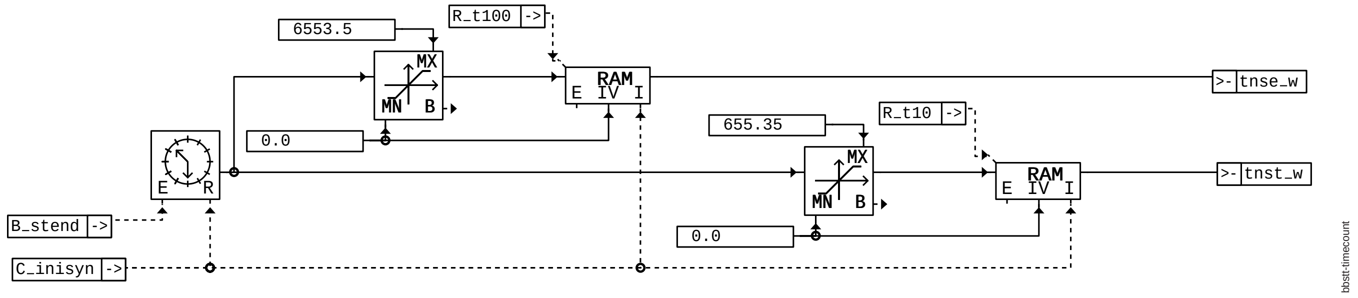
- Engine operation with phase ok: --> B_phsok=1, E_ph=0
- Engine stop/start (phase ok): --> B_phsok=1, E_ph=0
- Transition from phase ok to "not ok": --> B_phsok=0, if zphnok=0: E_ph=1
- Engine stop/start (phase not ok): --> B_phsok=0, E_ph=1
- Transition from phase "not ok" to ok: --> after 8 alternating entries in phpw: E_ph=0, B_phsok=1
- Engine stop/start (phase ok): --> B_phsok=1, E_ph=0
- Transition from phase ok to "not ok": --> B_phsok=0, if zphnok=0: E_ph=1
- Engine stop, after KL15 off: phase ok
- Engine start (phase ok): --> B_phsok=0, E_ph=1
  after 8 alternating entries in phpw: E_ph=0, B_phsok=1

BBSTT 11.20 Condition Engine start

FDEF BBSTT 11.20 Function definition



bbstt-bbstt



bbstt-timecount

Start condition B_st:
- B_st is set if after KL15 On the start detection is completed and the engine is cranking (!B_nmin).
- B_st is reset when the start end speed NSTNM is exceeded. The start condition applies again if the engine speed drops below NNSTA.

Time after start tnst_w: At the end of start, the post-start time tnst_w is initiated. As soon as the maximum value of tnst_w is reached, tnst_w is limited to this value (dito tnse_w).

ABK BBSTT 11.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NNSTA	TANS		KL	engine-speed transition normal -> start
NSTNM	TMOT		KL	transition start -> normal

Variable	Source	Type	Description
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_ST	BBSTT	AUS	condition for start
B_STEND	BBSTT	AUS	condition end of start
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
NMOT	SWADAP	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TNSE_W	BBSTT	AUS	time counter at end of start (16 bit)
TNST_W	BBSTT	AUS	time after end of start

FW BBSTT 11.20 Fixed Values

Parameter	Value	Description

FB BBSTT 11.20 Detailed description of function

1. Transition from initialization to start: start process (overview):

```
KL15 on:                      speed         |----------.... BM search ....------------------------------------------>|<--Syncro-
 |C_ini                       debouncing    |                                                                        |   nization
       rpm search ------->|   & nmot > NMIN |B_nmin =0                                                               |   occurs
      (n-interrupt)       |<--------------->|                                                                        v

rpm signal:             |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |        |  |  |  |
---------------+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
                                            |-->
                                              B_st=1
```

After initialization the tooth interrupt is enabled and the system is waiting for the first rpm signal. With the first rpm signal the speed debouncing is initiated. After the rpm signal is debounced and the minimum engine speed is exceeded, the start condition is set.

2. Transition from start to post-start:

```
      B_st=1------------+------>->-+
                        |          |
                        ^          v
                        |          |
                        +-<-<------+--------------  B_st=0
             -----------.----------.----------------> nmot
                      NNSTA      NSTNM
```

APP BBSTT 11.20 Application hint

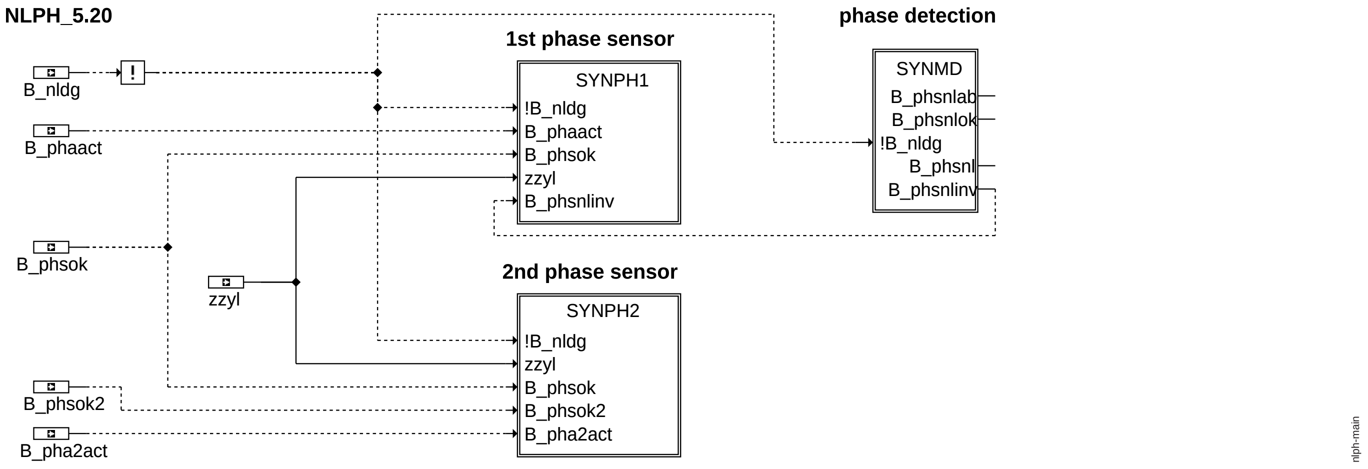
```
     Speed   ^                                                 * *
             |                                              *      ******.....********
             |                                           *                              *
             |                NSTNM   ------------>   *                                    *
             |                                    *                       NNSTA ----------->   *
             |                                 *                                                 *
             |               ****************                                                        *
             |           *                                                                                *
             |       *                                                                                         *
           0 +-*****----------------------------------------------------------------------------------------------******--->  t

B_nmin       --------+                                                                                            +--------
                     +---------------------------------------------------.....------------------------------------+

                     +--------------------------------+                                       +--------------------+
B_st         --------+                                +------------------.....----------------+                    +-------

                                                      +------------------.....----------------+
B_stend      -----------------------------------------+                                       +----------------------------

                                                      0                      |FFFFh                                0
tnst_w                                                +->->->->->->->->->->->--------------------------------------+
```

NLPH 5.20 limp-home for phase synchronization

FDEF NLPH 5.20 Function definition

The section NLPH describes the checking of the synchronization by means of the correctly operating phase sensors given in the system. The cylinder counter zzyl is initialized from the phase information during the synchronization in %GGDPG. With defective phase sensor (PG) and not defective phase sensor 2 (PG2) (SY_PGRAD2 > 0 and B_phsok2) the latter is used for the synchronization (SYNPH2). If the PG2 signal also lies above the reference mark (SY_PH2OFST = 0), then it is possible to synchronize directly to PG2 with defective PG. Otherwise always PG is synchronized to and in the cycle R_synph2 PG2 is used to check for correct synchronization and to trigger a new synchronization (SYNPH1) if necessary. If no PG2 is given or if it is also defective the cylinder counter is initialized from the virtual engine position, provided the run-on position is valid (B_ale = 1).

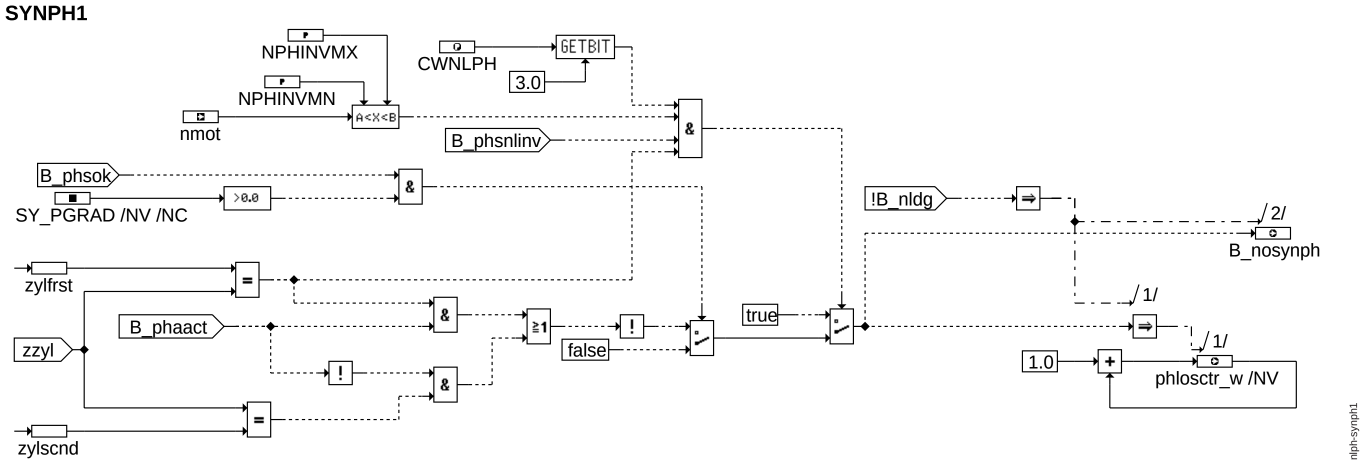
At not clear phase position it is optionally possible to cause a double ignition output and by means of injection cut-out misfiring can be stimulated, by the evaluation of which the correct phase position can be determined and possibly a new synchronization is started (SYNMD).



nlph-main

Subfunction Block SYNPH1

The function SYNPH1 is calculated in the synchro cycle for the phase inquiry of the phase sensor PG1. With correctly operating PG1 the cylinder number zzyl is compared to the cylinder number of the phase position of the PG1. If the phase position does not agree an immediate new synchronization is triggered via B_nosynph.
If it was detected in PHNLERK that the phase position is not correct then the new synchronization is triggered also here.

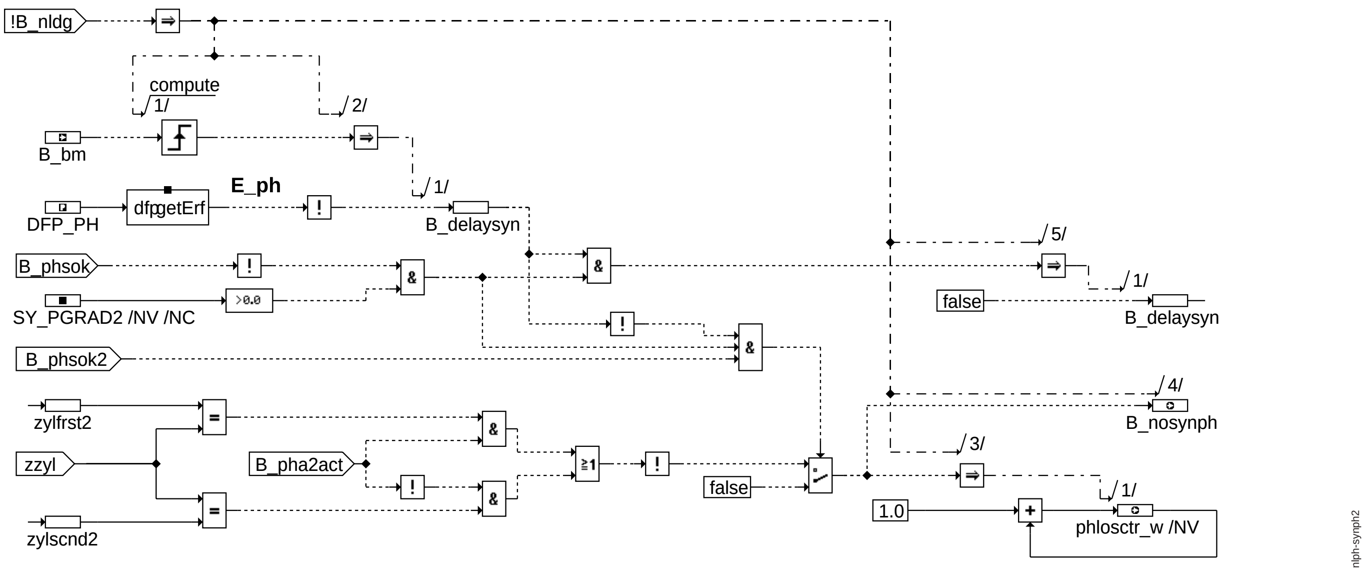


nlph-synph1

```
Subfunction Block SYNPH2
------------------------
```

At given PG2 and defective PG the function is calculated in the synchro cycle for the phase inquiry of the PG2. With correctly operating PG2 and inactive B_delaysyn the cylinder number zzyl is compared to the cylinder number of the phase position for PG2. If the phase position does not agree a new synchronization is triggered via B_nosynph. At active B_delaysyn the check is not performed but B_delaysyn is reset. This causes the synchronization check being delayed by one reference mark. Thereby a possible new synchronization is also delayed by one reference mark cycle and thus it is performed 3 reference marks later.

SYNPH2

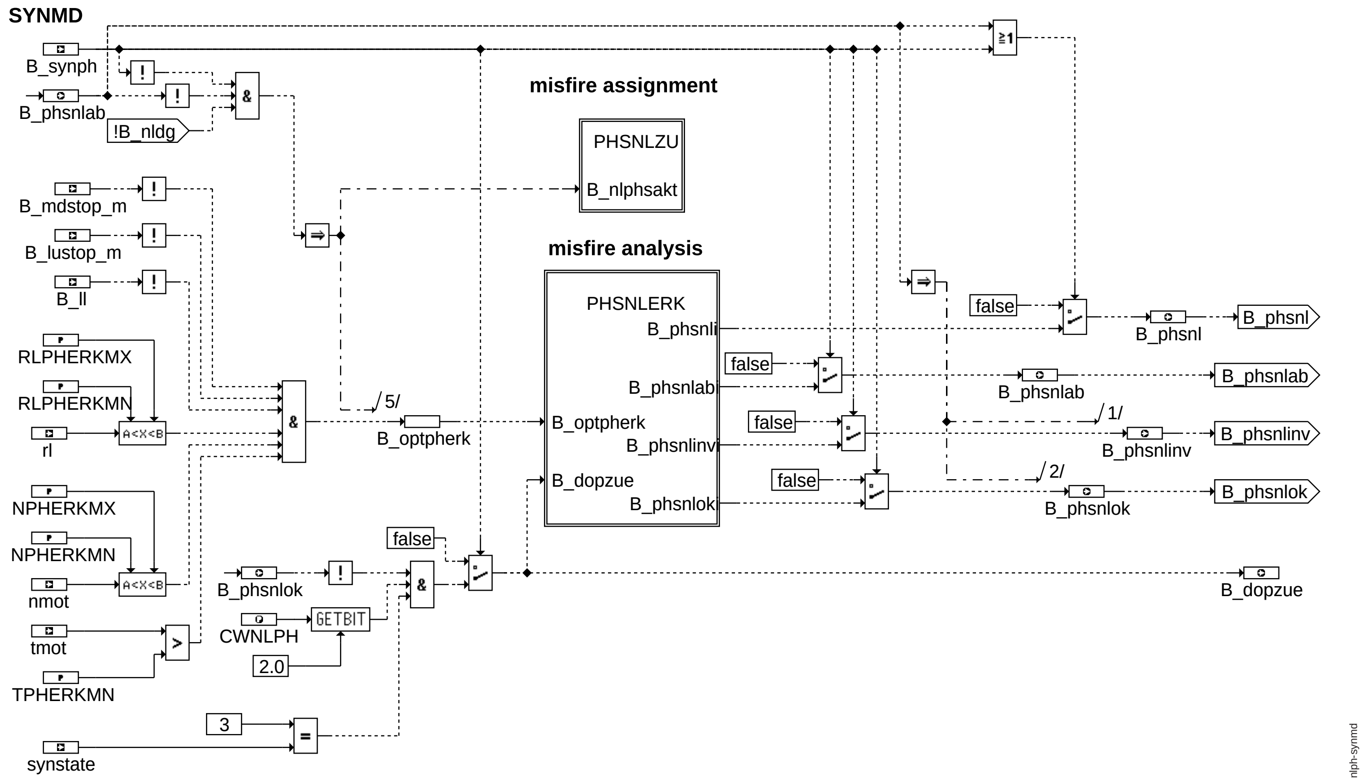


nlph-synph2

```
Subfunction Block SYNMD
-----------------------
```

SYNMD decides by means of the operating parameters of the engine and the readiness bits of the misfire detection on a possible phase detection and on the output of the double ignition.

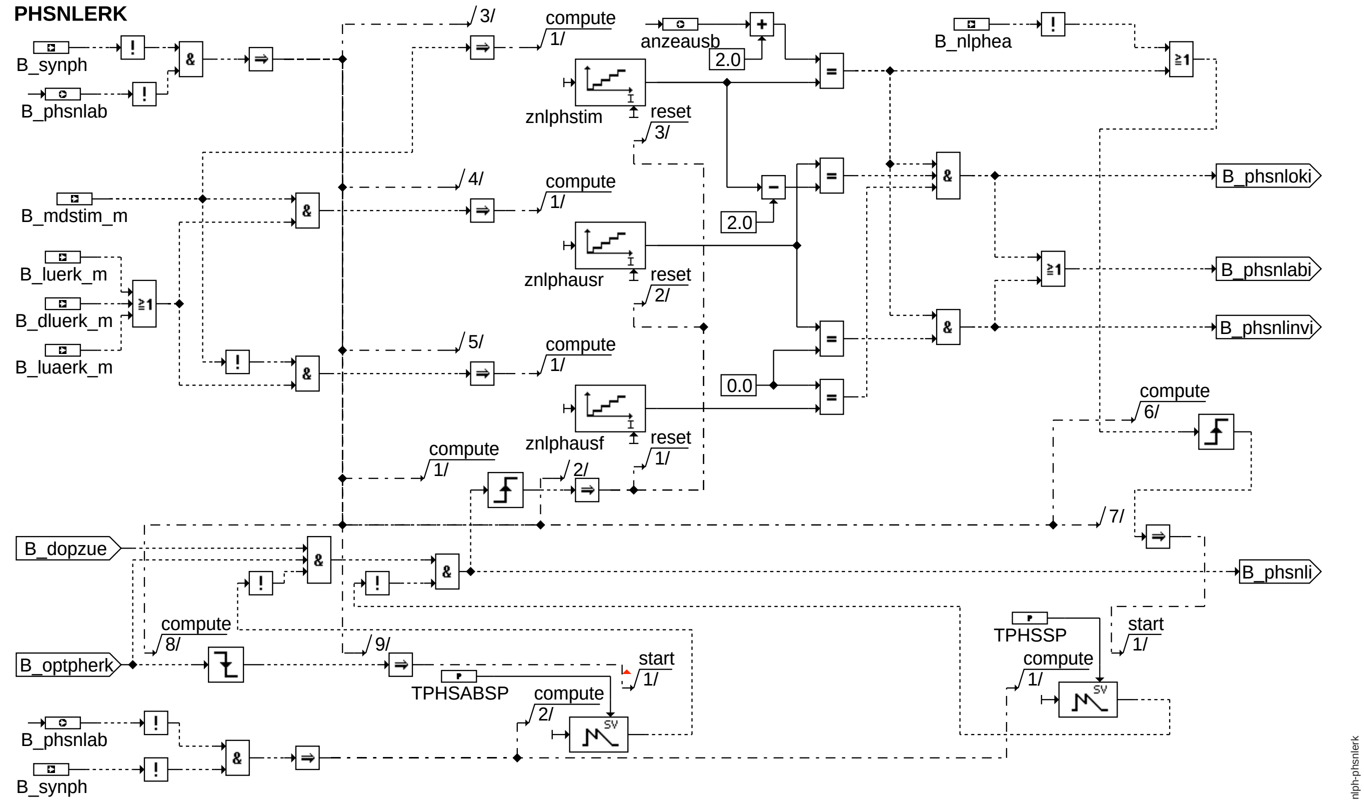
The bit B_dopzue is set in the first synchro after found reference mark (BM), if B_synph = FALSE. Due to the sequence of the processes, however, the double ignition is only outputted in the next synchro (second synchro).



nlph-synmd

```
Subfunction Block PHSNLERK
--------------------------
```

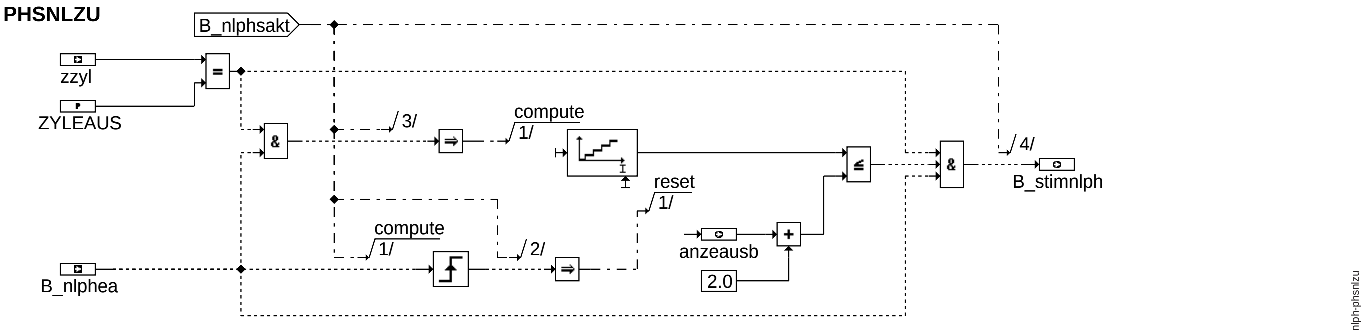
By comparison of the stimulated misfiring with the detected misfiring it is checked whether the present phase position is correct, incorrect or whether it cannot be precisely decided upon. If the bit patterns of stimulation and detection agree, the phase position is correct. The phase position is incorrect if there is no agreement. By means of the two timers it is possible to delay another detection.



nlph-phsnlerk

```
Subfunction Block PHSNLZU
-------------------------
```

By the pieces of information injection cut-out started, cylinder counter and cylinders to be cut-out a bit pattern is generated for the misfire detection so that it can supply the bit B_mdstim_m needed in PHSNLERK. B_stimnlph is generated twice as many times as misfires occur, since the first injection cut-out will not lead to misfiring in the present and possibly also not in the next working cycle but only in the one after that (pre-injection etc.)



nlph-phsnlzu

ABK NLPH 5.20 Abbreviations

Abbreviation	Description

Variable	TYPE	Description
ZYL_FRST	const	Cylinder counter for segment with active PG signal (zzyl = 0)
ZYL_SCND	const	Cylinder counter for segment with inactive PG signal (zzyl = int((SY_ZYLZA + 1) / 2))
ZYL_FRST2	const	Cylinder counter for segment with active PG2 signal (zzyl = ZYL_FRST + SY_PH2OFST)
ZYL_SCND2	const	Cylinder counter for segment with inactive PG2 signal (zzyl = ZYL_SCND + SY_PH2OFST)

Parameter	Source-X	Source-Y	Type	Description
ANZEAUS			FW	number of the injections to fade out
CWNLPH			FW	release of the specific phase sensor limp home function

Parameter	Source-X	Source-Y	Type	Description
NPHERKMN			FW	minimal engine speed for phase detection
NPHERKMX			FW	maximum engine speed for phase detection
NPHINVMN			FW	minimal engine speed for initialisation
NPHINVMX			FW	maximum engine speed for initialisation
RLPHERKMN			FW	minimal load for phase detection
RLPHERKMX			FW	maximum load for phase detection
SY_PGRAD			SYS (REF)	system constant: kind of the phase signal
SY_PGRAD2			SYS (REF)	system constant: kind of the 2. phase signal
SY_PH2OFST			SYS (REF)	system const. offset in syncros between the 2 active phase signals,2 PGs only
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TPHERKMN			FW	minimal engine temperrature for phase detection
TPHSABSP			FW	lockout time for phase detection, after leaving the suitable operating range
TPHSSP			FW	lockout time for phase detection after unsuccessful detection
ZYLEAUS			FW	cylinder to fade out

Variable	Source	Type	Description
ANZEAUSB	NLPH	AUS	number of injections to fade out; limited between 4 and 7
B_BM	GGDPG	EIN	condition reference mark detected
B_CLPH		EIN	condition clear fault path PH
B_DELAYSYN	NLPH	LOK	Flag for delaying a re-synchronisation by 1 synchronisation gap
B_DLUERK_M		EIN	monitor, misfire detected in DMDDLU
B_DOPZUE	NLPH	AUS	Condition double ignition
B_LL	MSF	EIN	Condition idle
B_LUAERK_M		EIN	monitor, misfire detected in DMDLUA
B_LUERK_M		EIN	monitor, condition for misfire detected in DMDLU
B_LUSTOP_M		EIN	misfire detection stop, monitor value
B_MDSTIM_M		EIN	monitor, cond. for stimulated ignition misfiring, stimuli-signal from ZAG
B_MDSTOP_M		EIN	monitor, misfire detection stopped
B_NLDG		EIN	condition limp-home function speed sensor
B_NLPH	NLPH	AUS	condition no signal from the phase sensors
B_NLPHEA	AEVAB	EIN	Injector deactivation for limp-home phase synchronization active
B_NOSYNPH	NLPH	AUS	Flag for wrong cylindernumber at synchronisation-gap
B_OPTPHERK	NLPH	LOK	condition suitable engine operating state for phase detection
B_PHA2ACT	GGDPG	EIN	condition signal of phase sensor 2 is high activ
B_PHAACT	GGDPG	EIN	condition signal of phase sensor 1 is high activ
B_PHSNL	NLPH	AUS	Condition phase search during phase sensor limp-home
B_PHSNLAB	NLPH	AUS	condition phase detection during phase sensor emergency operation finished
B_PHSNLINV	NLPH	AUS	condition invert phase relation
B_PHSNLOK	NLPH	AUS	condition phase detection during phase sensor emergency operation successful
B_PHSOK	DPH	EIN	Condition phase signal ok
B_PHSOK2	DPH	EIN	Condition phase signal 2 ok
B_PWF		EIN	Condition for powerfail
B_STIMNLPH	NLPH	AUS	condition misfire stimulated by NLPH
B_SYNPH	GGDPG	EIN	condition synchronization phase
DFP_PH	NLPH	DOK	ECU int. fault paht no.: phase sensor
E_PH	DPH	EIN	error flag: phase sensor
NMOT	SWADAP	EIN	engine speed
NSYNNLPH	NLPH	LOK	Monitor for reasons of new synchronization at NLPH
PHLOSCTR_W	NLPH	AUS	counter re-synchronisation due to wrong synchronisation at reference gap (word)
RL	SWADAP	EIN	relative air charge
SYNSTATE		EIN	current mode of synchronization
TMOT	SWADAP	EIN	Engine temperature
ZNLPHAUSF	NLPH	LOK	Counter of detected misfire at wrong position
ZNLPHAUSR	NLPH	LOK	Counter of detected misfire at right position
ZNLPHSTIM	NLPH	LOK	Counter of stimulated Bits from misfire detection monitor
ZYLEAUSB	NLPH	AUS	cylinder to fade out; binary description
ZZYL	GGDPG	EIN	SW-cylinder counter

FW NLPH 5.20 Fixed Values

Parameter	Value	Description
ANZEAUS		number of the injections to fade out
CWNLPH		release of the specific phase sensor limp home function
NPHERKMN		minimal engine speed for phase detection
NPHERKMX		maximum engine speed for phase detection
NPHINVMN		minimal engine speed for initialisation
NPHINVMX		maximum engine speed for initialisation
RLPHERKMN		minimal load for phase detection
RLPHERKMX		maximum load for phase detection
TPHERKMN		minimal engine temperrature for phase detection
TPHSABSP		lockout time for phase detection, after leaving the suitable operating range
TPHSSP		lockout time for phase detection after unsuccessful detection
ZYLEAUS		cylinder to fade out

FB NLPH 5.20 Detailed description of function

The function NLPH describes the synchronization monitoring by means of phase sensor PG1 resp. PG2. In case of incorrect synchronization a new synchronization is triggered. The initialization of the cylinder counter is performed in %GGDPG.
In the process a distinction is made between 3 modes of operation:

1. Systems without second phase sensor (SY_PGRAD2 = 0) resp. second phase sensor defective. With valid run-on detection the current tooth number is calculated via the virtual engine position. If this tooth lies between 30 and 90 then the engine lies within the synchronization range of ZYL_SCND, otherwise ZYL_FRST:

```
          BM1                                                   BM2                                                    BM1
         +--+                        |                         +--+                        |                          +--+
       --+  +------------------------+-------------------------+  +------------------------+--------------------------+  +---
  tooth: 120|1 .  .  .  .  .  .  . 29|30 .  .  .  .  .  .  .  .   60 .  .  .  .  .  .  . 90|91 .  .  .  .  .  .  .  . 120|1
            ZYL_FRST                 |                            ZYL_SCND                 |
```

   With invalid run-on detection zzyl is synchronized to ZYL_FRST.

2. Systems with second phase sensor (SY_PGRAD2 > 0) and phase position of PG2 above the reference mark (SY_PH2OFST = 0).

```
          BM1                                   BM2                                   BM1                                   BM2
         +--+                                  +--+                                  +--+                                  +--+
       --+  +----------------------------------+  +----------------------------------+  +----------------------------------+  +--

   Phase 1 active:
        +-----+                                                                     +-----+
       -+ (A) +---------------------------------------------------------------------+     +----------------------------------(E)--

   Phase 1 inactive:
                                              +-----+                                                                     +-----+
       ---------------------------------------+ (B) +---------------------------------------------------------------------+     +

   Phase 2 active:
        +-----+                                                                     +-----+
       -+ (A) +---------------------------------------------------------------------+ (D) +---------------------------------------

   Phase 2 inactive:
                                              +-----+                                                                     +-----+
       ---------------------------------------+ (C) +---------------------------------------------------------------------+     +
```

   With defective PG synchronization is performed directly to PG2 in the reference mark. If no fault entry of the phase sensor PG is given at engine start then synchronization to the latter is performed at the first reference mark (A) and the flag B_delaysyn is set. A defective PG is detected at the second reference mark (B) by B_phase = false and a switch-over to PG2 is performed. B_delaysyn has the effect that the phase position is checked by means of PG2 only at the next reference mark (D). With incorrect synchronization a new synchronization is triggered by setting B_nosynph. Since no PG fault entry is given up to this new synchronization, synchronizing is again performed to PG at the next reference mark (E). Since this reference mark has an inverse phase position with regard to (A) a correct synchronization is now performed.

3. Systems with second phase sensor (SY_PGRAD2 > 0) with phase position of PG2 not above the reference mark. The system constant SY_PH2OFST indicates the offset in segments between the active phase positions:

```
       BM1                                   BM2                                   BM1                                   BM2
      +--+                                  +--+                                  +--+                                  +--+
    --+  +----------------------------------+  +----------------------------------+  +----------------------------------+  +--

Phase 1 active:
     +-----+                                                                      +-----+
    -+ (A) +----------------------------------------------------------------------+     +----------------------------------(E)--

Phase 1 inactive:
                                           +-----+                                                                      +-----+
    ---------------------------------------+ (B) +----------------------------------------------------------------------+     +

Phase 2 active:
                    +-----+                                                                      +-----+
    ----------------+     +----------------------------------------------------------------------+ (D) +------------------------
     |<-SY_PH2OFST->|

Phase 2 inactive:
                                                           +-----+
    -------------------------------------------------------+ (C) +--------------------------------------------------------------
```

In this case synchronization cannot be performed via PG2. If no fault message is given at engine start then the bit B_delaysyn is set and the engine is synchronized with PG (A). The defect of the phase sensor is only detected at the next reference mark by B_phase = false (B). With defective PG the phase position for the phase inquiry of PG2 is checked only two segments later due to B_delaysyn (D). If now an incorrect phase position is given then a new synchronization to PG is triggered by setting B_nosynph. This new synchronization is performed at the next reference mark (E), where here the inverse phase position to the first synchronization (A) is now given and thereby a correct synchronization will be performed by the defective PG.

If no phase sensor is available and if the operations have been enabled via CWNLPH, the engine will start with double ignition output. In case the engine is at an appropriate operating point, a number of injections to be adjusted for a cylinder also to be defined will be cut-out in the function %AEVAB.
Since the misfire detection operates in the background the bit B_stimnlph is put at its disposal for the ignition-synchronous assignment in PHSNLZU. Then the bit patterns of stimulation and detected misfiring generated by it are to be compared (PHSNLERK). With correct phase position both are congruent. For this anzeausb cut-outs must have led to misfiring in the respective cylinder and no other misfiring may have occurred. On these conditions the double ignition output can be terminated.
If no misfire is detected for the cut-out cylinder, the phase position is not correct. Dependent on the application of CWNLPH either a new synchronization to suitable phase position is triggered in SYNPH1, which hence leads to another check, or the double ignition output is maintained.
Should it not be possible to precisely determine the phase position on above-mentioned conditions or should %AEVAB abort the injection cut-out early, the detection is aborted and at the earliest after TPHSSP another attempt is made. If the guidelines, which are required for a successful phase search, change during the detection this will lead to an abort. A new attempt is only possible at the earliest after TPHSABSP.

Monitor for New Synchronization
===============================

During a new synchronization relevant variables are initialized to neutral values. Since a new synchronization is performed immediately once the respective requirement is set, it can no longer be seen with VS100, which condition has requested the new synchronization. In order to make the search for faults easier a new-synchronization-monitor is therefore formed that makes it possible to capture the reason for the last new synchronization with VS100.

In the byte NSYNNLPH a bit is set to one at the corresponding position that indicates which condition has requested the new synchronization. The byte NSYNNLPH is always initialized in C_ini with 00000000.

NSYNNLPH	Bit 0	New synchronization requested by B_nosynph (first phase sensor)
	Bit 1	New synchronization requested by B_nosynph (second phase sensor)
	Bit 2	not occupied
	Bit 3	not occupied
	Bit 4	New synchronization requested by B_nosynph (phase detection via misfire detection)

If several new synchronizations occur during a driving cycle with various causes then it is also possible that several bits of NSYNNLPH are set to one.

APP NLPH 5.20 Application hint

With double ignition output it may be necessary to decrease the maximum engine speed (NMAXDZ) in order to protect components.

Allocation of CWNLPH (condition: respective bit = 1):
0. Bit: not occupied
1. Bit: run-on detection permissible
2. Bit: limp-home via double ignition (NLPH 5.10)
3. Bit: new synchronization after detection by means of cylinder cut-out permissible
The remaining bits are still free.
The cylinder cut-out can be disabled by a limitation of the operating map.

Typical Values:

ANZEAUS:	5	Number of injections to be cut-out
NPHERKMN:	2000 rpm	Minimum engine speed for phase search
NPHERKMX:	4000 rpm	Maximum engine speed for phase search
NPHINVMN:	2520 rpm	Minimum engine speed for new synchronization
NPHINVMX:	3520 rpm	Maximum engine speed for new synchronization
RLPHERKMN:	40 %	Minimum load for phase search
RLPHERKMX:	60 %	Maximum load for phase search
TPHERKMN:	80 °C	Minimum engine temperature for phase search
TPHSABSP:	10 s	Blocking time for the phase search, if the appropriate operating range was exited (should not be chosen too high!)
TPHSSP:	60 s	Blocking time for phase search after unsuccessful search
ZYLEAUS:	0	Cylinder to be cut-out

The number of injections to be cut-out is to be limited between 4 to 7.
For ZYLEAUS a 0 is to be entered for the 1st cylinder and so on until n-1 for the nth cylinder.

Adjustable variables in other functions for NLPH:

%NMAXMD	NMAXDZ	Half the maximum engine speed, e.g. 3400 rpm for systems with single-spark coils Maximum engine speed, e.g. 6800 rpm for systems with twin-spark coils
	DNMADZ	10 corresponds to a ramp of 1000 rpm
%GGDPG	DZZSTNLP	116 corresponds to 2 engine revolutions

NLDG 2.10 limp-home for defective engine speed sensor

FDEF NLDG 2.10 Function definition

Dummy Modul

This modul doesn’t include any functionality of a limp home function for the crankshaft position sensor. There is only a definition of some variables which are used in other functions. These variables are set to default values:

B_synnldg = false
B_nldg = false
B_phnldg = false
zphflsyn = 0

DMDUE 9.120 Diagnostic routine misfire detection Overview

FDEF DMDUE 9.120 Function definition

modular concept misfire detection

```
        +-------------------------------------------------------------------------------------------------------------------------+
 B_swe  |                                                                                                                         |
------->|                                            DMDSTPx.xx  (customized)                                                     |
        |                                                                                                                         |
        +-^----------+-----------+------------+-----------+------------------------^----------------+--------------^--------------+
          |B_tsroov  |B_fonstp   |B_fofstp    |B_lustop   |B_mdstop                |B_mderk         |B_milstp      |E_md
          |  +-------+           |            |           |                        |                |              |
          |  |  +----------------+            |           |                        |                |              |
          |  |  |  +----------------+---------|-----------+---------------------+  |                |              |
    +-----+  |  |  |                |  +------+--------+--|------------------+  |  |                |              |
    |        |  |  |                |  |               |  |                  |  |  |                |              |
    |   +----v--v--v-+ tsk    +-----v--V---+ B_analu+--V--v------+        +--V--V--+---+            |              |
    |   |            +------->|            +<------>|            |        |            |        +---V--------+     |
    |   | DMDFON6.40 | fostat |  DMDLU4.70 | B_tnalu| DMDDLU7.50 |B_dluerk|            |B_mderk |            |     |        E_md
    |   |            +------->|            +<------>| (*)        +------->| DMDLAD5.10 +------->| DMDMIL3.60 +-----+-------------->
    |   |            |        |            +---+--->|            |        |            |        |            |
    |   +-----^------+        |            |   |    +------------+B_luerk |            |        +------------+
    +------+  |               |            +---|-------|--|-------------->|            |
tooth      |  |tsroh          |            |   |       |  |B_md/lustop    |            |
inter-  +--+--+------+        |            |   |    +--V--v------+        |            |
rupt    |            |        |            |   |    | DMDLUA4.30 |B_luaerk|            |
------->| DMDTSB3.10 |        |            |   +--->|            +------->|            |
        |            |        |            | luts   |            |        |            |
        +------------+        +------------+        +------------+        +------------+
```

* function only for engines with even number of cylinders

With the Codeword CDMD the whole misfire detection can be stopped.
If B_cdmd=0, misfire detection is stopped and E_ase=0, E_ask=0, Z_ase=1, Z_ask=1, B_mderk=0.
For B_cdmd=1 misfire detection is active.

In case of 2 ecu's (SY_2SG = 1) all function except of %DMDSTP are deactivated in the Master-ECU (B_master = 1) and are calculated in the Slave-ECU (B_master = 0).
The Stop-Conditions have to be transmitted via CAN from the Master-ECU to the Slave-ECU. The Slave-ECU has to evaluate the stop-conditions from the Master-ECU.

To ensure correct function of the misfire-detection algorithms the system for measuring the segment durations (speed sensor, sensor wheel) has to met the following specifications:

1) Chapter: Komponenten Gruppe Sensoren
   Designation: KGS_DG
   Title: Eingeber-Inkrementsystem

2) Geberradspezifikation zur Aussetzererkennung über Drehzahlerfassung

ABK DMDUE 9.120 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDMD			FW	code word DMD inactive(EURO-coding), CD..=0 -> no diagnosis

Variable	Source	Type	Description
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTIM_M	DMDUE	LOK	monitor, cond. for stimulated ignition misfiring, stimuli-signal from ZAG
B_MDZYL1_M	DMDUE	LOK	monitor, cylinder 1 identification
B_PHSNL	NLPH	EIN	Condition phase search during phase sensor limp-home
B_ZASA_M	DMDUE	LOK	monitor, ZAS load switchover is active
FDMD_M	DMDUE	LOK	status diagnosis misfire detection, drum, delayed output
FLG_M	DMDUE	LOK	monitor status calculation of the engine roughness
SY_2SG	PROKON	EIN	system constant 2 motronic systems

FW DMDUE 9.120 Fixed Values

Parameter	Value	Description
CDMD		code word DMD inactive(EURO-coding), CD..=0 -> no diagnosis

FB DMDUE 9.120 Detailed description of function

The description can be found in the single function-descriptions

This function only describes the interface between the different functions.

APP DMDUE 9.120 Application hint

```
1)  Monitor function
    Because of the calculation in background the output-variables are not synchronized. For the application it is necessary
    to measure some values like segment time, engine roughness, etc. synchroneously.
    This is ensured in the monitor-function, which provided these signals synchroneously but related up to 128 ignitions.
    For the differentiation between the actual and the related values, the related byte- and word-values and bits will end
    with '_m'.

    Following values are provided synchroneously but related:
      ts_m       segment duration ts(n-1) (s. %DMDTSB)
               (from tr(n-1) bis tr(n)), crankshaft segment (n-1)              2 byte
          tsk_m      segment duration tsk(n-1) (in case of B_for=1: corrected after  completed adaptation), (s. %DMDFON)
             (from tr(n-1) to tr(n)), crankshaft segment (n-1)                         2 byte
          luts_m     engine roughness value, segment (n-1) (s. %DMDLU)                             1 byte
          lurs_m     engine roughness reference value (s. %DMDLU)                                  1 byte
          lums_m     engine roughness mean value (s. %DMDLU)                                       1 byte
          lurms_m    refernce value for engine roughness mean value (s. %DMDLU)                    1 byte
          dluts_m    differential engine roughness (s. %DMDDLU)                                    1 byte
          dlurs_m    differential engine roughness reference value (s. %DMDDLU)                    1 byte
          fluts_m    filtered engine roughness (s. %DMDLUA)                                        1 byte
          luar_m     filtered engine roughness reference value (s. %DMDLUA)                        1 byte
          fostat_m   status of adaptation (s. %DMDFON)                                             1 byte
      rl_m       corresponding load signal                                     1 byte

          flg_m    ASEFLAG, status bits                                                            1 byte
                     bit 7: B_mdstop_m  = 1 --> engine roughness calculation is locked for specific operating conditions (%DMDSTP)
                     bit 6: B_fof_m     = 1 --> conditions for fuel-off adaptation are fulfilled (see %DMDFON)
                     bit 5: B_tsroov_m  = 1 --> overflow in segment duration (see %DMDTSB)
                     bit 4: B_mdzyl1_m  = 1 --> cylinder detection, active at cyl. 1 and ignition 1
                     bit 3: B_lustop_m  = 1 --> engine roughness calculation is locked for specific operating conditions (%DMDSTP)
                     bit 2: B_luerk_m   = 1 --> misfire detected; luts > lurs
                     bit 1: B_mdstim_m  = 1 --> stimuli signal from misfire generator (ZAG), ignition misfiring enabled
                        in case of active phase angle emergency mode (B_dpozue=1) B_mdstim is got from
                        %NLPH (B_stimnlph).
                     bit 0: B_fon_m     = 1 --> conditions for fuel-on adaptation are fulfilled (see %DMDFON)

     fdmd_m    DMDFLAG, status bits                                                            1 byte
             bit 7: B_plokn_m   = 1 --> plausibility in actual speed range (see %DMDFON)
             bit 6: B_forn_m    = 1 --> adaptation stabilized in current speed range (B_for=1) (see %DMDFON)
             bit 5: B_fordo_m   = 1 --> at least 1 dominant range has stabilized (see %DMDFON)
             bit 4: B_for_m     = 1 --> adaptation stabilized in current operating range (see %DMDFON)
             bit 3: B_tnalu_m   = 1 --> test phase after detected misfire in DMDLU or DMDDLU (see %DMDLU)
             bit 2: B_analu_m   = 1 --> deactivation after first detected misfire active (see DMDLU)
             bit 1: B_luaerk_m  = 1 --> misfire detected in DMDLUA (see %DMDLUA)
             bit 0: B_dluerk_m  = 1 --> misfire detected in DMDDLU (see %DMDDLU)
```

DMDTSB 3.10 Diagnosis misfire detection by segment time formation

FDEF DMDTSB 3.10 Function definition

```
                     +--------------------+
        tooth        | segment time form. +---------> B_tsroov
        time    ---->|        for         |
        table        | misfire detection  +---------> tsroh_w (, tsroh2_w for systems with 2 control units)
                     +--------------------+
```

The duration of crankshaft segments is continuously measured. The data stored in the memory correspond to the segment duration of consecutive segments: segment times. For each ignition a segment time (tsroh_w) is determined. Segment start resp. segment end lie between 2 consecutive DTCs. (in systems with 2 control units per ignition one segment duration, per synchro (R_syn) two segment durations (tsroh_w, tsroh2_w) are determined.)

In systems with 2 control units (SY_2SG = 1) the funktion %DMDTSB is stoped in the master control unit (B_master = 1), no determination of segment durations.

ABK DMDTSB 3.10 Abbreviations

Conversion formula:

tsquant   Quantization segment time

Parameter	**Source-X**	**Source-Y**	**Type**	**Description**
KAMFZ			FW	start of sampling segment time monitoring misfire detection

Variable	**Source**	**Type**	**Description**
B_MASTER		EIN	Condition MASTER-ECU
B_TSROOV	DMDTSB	AUS	condition segment duration word overflow
R_SYN	GGDPG	EIN	Synchro schedule
SY_2SG	PROKON	EIN	system constant 2 motronic systems
SY_FREQCPU	PROKON	EIN	System constant CPU frequency
SY_GRDWRT	PROKON	EIN	System constant basic value, space between SW reference mark to OT in teeth
TSROH2_W	DMDTSB	AUS	second segment duration uncorrected (just for 2 control units)
TSROH_W	DMDTSB	AUS	segment duration uncorrected

FW DMDTSB 3.10 Fixed Values

Parameter	Value	Description
KAMFZ		start of sampling segment time monitoring misfire detection

FB DMDTSB 3.10 Detailed description of function

The beginning of the measuring window (= segment start) can be shifted via KAMFZ in 6 deg. crankshaft angle (CA) steps (corresponds to one tooth).
KAMFZ gives the beginning of the measuring window in deg. CA before DTC. KAMFZ is limited by the software to the following values:

KAMFZ,max = SY_GRDWRT + (segment length in no. of teeth - 1) * 6 deg. CA
KAMFZ,min = SY_GRDWRT - (segment length in no. of teeth - 1) * 6 deg. CA

(KAMFZ is a signed value!; SY_GRDWRT is the distance R_syn (tr-mark) to DTC)

The lenght of the measuring window in deg. CA is dependent on the amount of cylinders. It corresponds to the distance between two DTCs:
Length of measuring window = 360 /(SY_ZYLZA/2) deg. CA.

For the quantization of tsroh_w (tsroh2_w) two system frequencies are distinguished (20 MHz, 24 MHz, see table).

Quantization for tsroh_w (tsroh2_w):

	system frequency	
cylinder number	20 MHz (SY_FREQCPU = 20 000) tsquant = 0,8 us	24 MHz (SY_FREQCPU = 24 000) tsquant = 0,666 us
3	3/2 * tsquant	3/2 * tsquant
4	3/2 * tsquant	4/3 * tsquant
5	1 * tsquant	4/3 * tsquant
6	1 * tsquant	1 * tsquant
8	1 * tsquant	1 * tsquant
12	1 * tsquant	1 * tsquant

In case of segment time overflow, i.e. tsroh_w or tsroh2_w can no longer be represented as 16 bit value, the condition B_tsroov (ts-overflow) is set and tsroh_w resp. tsroh2_w is limited to maximum value.

CA signal (ex. 6-cyl.):

```
              R_syn         DTC (cyl. 1)              R_syn         DTC (cyl. 2)            R_syn
                |               |                       |               |                     |
                v               v                       v               v                     v

                |                                       |                                     |
 ...  | |     | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  .....
 ... -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+- .....
                    SY_GRDWRT
                |<------------->|

Ex. 1:                |<------->|
                         KAMFZ = 30 deg. CA (= 5 teeth * 6 deg. CA)

                      |<------------------------------------->|<----------------------------------->|<---- .....
                         segment pos. for tsroh_w of cyl. 1      segment pos. for tsroh_w of cyl. 2


Ex. 2:                          |<->|
                                KAMFZ = -12 deg. CA (= 2 teeth * 6 deg. CA * neg. direction)

                                    |<------------------------------------->|<---------------------------------.....
                                       segment pos. for tsroh_w of cyl. 1      segment pos. for tsroh_w of cyl. 2
```

```
CA-signal (ex. 12-cyl., 2 control units):
              R_syn         DTC (cyl. 1)                            DTC (cyl. 2)              R_syn
                |               |                                       |                       |
                v               v                                       v                       v

                |                                                                               |
 ...        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  .....
 ... -+-+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+- .....
                SY_GRDWRT - 720 °KW/(SY_ZYLZA *2) !!
                |<------------->|

Ex. 1:             |<--------->|
                       KAMFZ = 18 deg. CA (= 3 teeth * 6 deg. CA)

                    |<------------------------------------->|<----------------------------------->|<---- .....
                       segment pos. for tsroh_w of cyl. 1      segment pos. for tsroh2_w of cyl. 2


Ex. 2:                         |<->|
                                KAMFZ = -6 deg KW (= 1 tooth * 6 deg KW * neg. direction)

                                    |<------------------------------------->|<---------------------------------.....
                                       segment pos. for tsroh_w of cyl. 1      segment pos. for tsroh2_w of cyl. 2
```

APP DMDTSB 3.10 Application hint

KAMFZ may not be adjusted such that a segment start or a segment end is in the gap (attention with 3- and 5-cylinder projects). If possible the segment borders should have a mimimum clearance of 3 teeth to the gap. Reason: The gap distorts the magnetic flow in front of and behind the gap, i.e. the measurements of the tooth edges taken in the area around the gap are applied to with a greater error.

By an optimization of the measuring window position the noise ratio of the misfire detection can be improved. The measuring window must be positioned such that an optimal detection of the segment time increase, occuring due to a misfire is ensured. During the ignition beforehand resp. afterwards no segment time increase may be detectable. As far as the engine roughness lut is concerned there should be a clear-cut lut value in case of a misfire. If the segment position is not optimal this one clear-cut lut value distributes itself to 2 lut increases.
Possibly the wrong cylinder is then identified.

Typical values for KAMFZ, which can vary vehicle-specifically:

Engine:	KAMFZ (deg. CA before DTC)
4-cyl.	108
6-cyl.	60
8-cyl.	42

The measuring window position should be determined on the roller dynamometer during steady-state at high engine speeds and low loads (e.g. 5000 rpm, zero load resp. low load). Generally it applies: optimize the measuring window position at an operating point at which an improvement of the noise ratio is especially necessary!

Conditions for systems with 2 control units: constant distance of ignitions (also between the 2 systems)

DMDFON 6.40 Diagnosis Misfire Detection fuel-on Adaptation

FDEF DMDFON 6.40 Function definition

1.0 Overview:

The combined acting of the function %DMDFON together with other functions of the misfire detection and the outwardly connections are shown in the overview %DMDUE.

The adaptation can be switched off by the code word CDFO. CDFO > 0: function active. By means of the code word CDFO the adaptation can also be reset (like after powerfail): CDFO = 0, thereafter again CDFO > 0 to reactivate the adaptation.

The complete misfire detection can be switched off by the code word CDMD. If bit B_cdmd = 0, then the function DMDFON is stopped, if B_cdmd = 1 the function is active.

If two control units are used (SY_2SG = 1) then DMDFON is not active in the master unit (B_master = 1). In addition to this there is a second segment duration tsroh2_w.

The reset counters dfseresz, flmxresz are set to zero after powerfail or if CDFO is set to zero. If the reset is triggered by the function itself then the reset counters are not set to zero.

Distinction btween AT, MT cars:
not AT cars: KFCFO, SLFOON, DFSEFON is used if B_autget = 0
AT cars: KFCFO2, SLFOO2N, DFSEFO2N is used if B_autget = 1

ABK DMDFON 6.40 Abbreviations

Indices and reference points used:
(n) = Crankshaft segments
(i) = Camshaft revolutions; NW - rev.
(j) = Crankshaft revolutions; KW - rev.
(t) = Time

ts(n)	Segment duration of Crankshaft segment n
ts(n+1)	Segment duration of Crankshaft segment n+1
zylza	Number of cylinders
Zdg.	Ignition, is counted through in ignition order
xx	Operating ranges (speed, load)
nn	Engine speed range

Parameter	Source-X	Source-Y	Type	Description
ALFO			FW	start value for learning filter at fuel-on/fuel-off adaptation
ANWFOHE			FW	number of camshaft rotations for healing
ANWFOST			FW	number of camshaft rotations for reactivation the adaptation after disabling
CDFO			FW	code to deactivate and reset the adaptation
DFSEFO2N	NMOT		KL	max. plausible speed-dependent variance of FSE values
DFSEFON	NMOT		KL	max. plausible speed-dependent variance of FSE values
DFSERES			FW	difference of adaptation values to reset fuel-on/-off adaptation
FLFO			FW	filter factor for learningfilter of fuel-on/-off adaptation
FS1FO			FW	filter factor segment duration filter 1 of fuel-on/-off adaptation
FS2FO			FW	filter factor segment duration filter 2 of fuel-on/-off adaptation
KFCFO	NMOT	RL	KF	map for definition of range characteristics (dominant..)
KFCFO2	NMOT	RL	KF	map for definition of range characteristics (dominant..)
LURFOST			FW	engine roughness referenz value for stop of the fuel-on/-off adaptation
MDERFOKH			FW	number of misfires to stop adaptation (healing) when B_kh = 1
MDERKFON			FW	number of misfires to stop adaptation (healing)
SLFOO2N	NMOT		KL	speed dep. upper threshold for learning filter value at fuel-on/-off adaptation
SLFOON	NMOT		KL	speed dep. upper threshold for learning filter value at fuel-on/-off adaptation
SLFOU			FW	lower threshold for learning filter value at fuel-on/-off adaptation
TNSTFON			FW	time after engine start to enable adaptation stop (healing)

Variable	Source	Type	Description
ANWFOH	DMDFON	LOK	counts number of camshaft rotations for healing of fuel-on/-off adaptation
ANWFOS	DMDFON	LOK	counts number of camshaft rot.(conditions for adapt. OK to beginning of learing)
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_FODO	DMDFON	LOK	condition fuel-on/-off adaptation in a dominant operating range active
B_FODON	DMDFON	LOK	condition fuel-on adaptation in a speed dominant operating range active
B_FOF	DMDFON	DOK	condition fuel-off adaptation active
B_FOFSTP	DMDSTP	EIN	condition fuel-off adaptation stopped
B_FOF_M	DMDFON	LOK	monitor, condition fuel-off adapation active
B_FOHE	DMDFON	LOK	actual range is a healing range
B_FOHOLD	DMDFON	LOK	fuel-on adaptation deactivated
B_FOLUNW	DMDFON	LOK	condition to large for fuel-on/-off adaptation
B_FON	DMDFON	DOK	condition fuel-on adaptation active
B_FONSTP	DMDSTP	EIN	condition fuel-on adaptation stopped
B_FONTM	DMDFON	LOK	engine temperature high enough for fuel-on-adaption
B_FON_M	DMDFON	LOK	monitor, condition fuel-on adaptation active
B_FOR	DMDFON	DOK	condition fuel-on/-off adaptation actual ready
B_FOR11	DMDFON	LOK	map range 11 ready
B_FOR12	DMDFON	LOK	map range 12 ready
B_FOR13	DMDFON	LOK	map range 13 ready
B_FOR21	DMDFON	LOK	map range 21 ready
B_FOR22	DMDFON	LOK	map range 22 ready
B_FOR23	DMDFON	LOK	map range 23 ready
B_FOR31	DMDFON	LOK	KF range 31 already learned
B_FOR32	DMDFON	LOK	KF range 32 already learned
B_FOR33	DMDFON	LOK	KF range 33 already learned
B_FOR41	DMDFON	LOK	KF range 41 already learned
B_FOR42	DMDFON	LOK	KF range 42 already learned
B_FOR43	DMDFON	LOK	KF range 43 already learned
B_FOR51	DMDFON	LOK	KF range 51 already learned
B_FOR52	DMDFON	LOK	KF range 52 already learned
B_FOR53	DMDFON	LOK	KF range 53 already learned
B_FOR61	DMDFON	LOK	KF range 61 already learned
B_FOR62	DMDFON	LOK	KF range 62 already learned
B_FOR63	DMDFON	LOK	KF range 63 already learned
B_FOR71	DMDFON	LOK	KF range 71 already learned
B_FOR72	DMDFON	LOK	KF range 72 already learned
B_FOR73	DMDFON	LOK	KF range 73 already learned
B_FOR81	DMDFON	LOK	KF range 81 already learned
B_FOR82	DMDFON	LOK	KF range 82 already learned
B_FOR83	DMDFON	LOK	KF range 83 already learned
B_FORDO	DMDFON	DOK	condition fuel-on/-off adaptation in at least one dominant range ready
B_FORDO_M	DMDFON	LOK	monitor, cond. adaptation in at least one dominant range ready
B_FORN	DMDFON	DOK	condition fuel-on/-off adaptation actual speed range ready
B_FORN01	DMDFON	LOK	at least one range in speed range 01 is ready

Variable	Source	Type	Description
B_FORN02	DMDFON	LOK	at least one range in speed range 02 is ready
B_FORN03	DMDFON	LOK	at least one range in speed range 03 is ready
B_FORN04	DMDFON	LOK	at least one range in speed range 04 is ready
B_FORN05	DMDFON	LOK	at least one range in speed range 05 is ready
B_FORN06	DMDFON	LOK	at least one range in speed range 06 is ready
B_FORN07	DMDFON	LOK	at least one range in speed range 07 is ready
B_FORN08	DMDFON	LOK	at least one range in speed range 08 is ready
B_FORN_M	DMDFON	LOK	monitor, cond. adaptation in actual speed range ready
B_FORSET	DMDFON	LOK	reset of fuel-on/-off adaptation
B_FORUN	DMDFON	LOK	state fuel-on/-off adaptation active
B_FOR_M	DMDFON	LOK	monitor, cond. adaptation in actual range ready
B_FOS	DMDFON	LOK	condition fuel-on/-off actual range is a fuel cut-off range
B_FOXFG	DMDFON	LOK	condition fuel-on/-off allowed
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_MASTER		EIN	Condition MASTER-ECU
B_MDERK	DMDLAD	EIN	misfiring detected from multpile functions
B_MDSTOP	DMDSTP	EIN	misfire detection stop
B_MDSTOP_M		EIN	monitor, misfire detection stopped
B_MDZYL1	DMDFON	DOK	con. for cylinder ident. (f.t>TALUST),LU-calculation disabled (f.t<TALUST)
B_MDZYL1_M		EIN	monitor, cylinder 1 identification
B_PLOK	DMDFON	LOK	FSE values in all speed ranges plausible
B_PLOK01	DMDFON	LOK	FSE values in speed range 01 plausible
B_PLOK02	DMDFON	LOK	FSE values in speed range 02 plausible
B_PLOK03	DMDFON	LOK	FSE values in speed range 03 plausible
B_PLOK04	DMDFON	LOK	FSE values in speed range 04 plausible
B_PLOK05	DMDFON	LOK	FSE values in speed range 05 plausible
B_PLOK06	DMDFON	LOK	FSE values in speed range 06 plausible
B_PLOK07	DMDFON	LOK	FSE values in speed range 07 plausible
B_PLOK08	DMDFON	LOK	FSE values in speed range 08 plausible
B_PLOKN	DMDFON	DOK	FSE values in actual speed range plausible
B_PLOKN_M	DMDFON	LOK	monitor, FSE values in actual speed range plausible
B_TSROOV	DMDTSB	EIN	condition segment duration word overflow
B_TSROOV_M	DMDFON	LOK	monitor, condition segment duration word overflow
CFOXX	DMDFON	LOK	shows characteristics of actual map area (fuel-on/-off adaptation)
DFSE01	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 01 positiv
DFSE02	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 02 positiv
DFSE03	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 3 positiv
DFSE04	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 4 positiv
DFSE05	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 5 positiv
DFSE06	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 6 positiv
DFSE07	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 7 positiv
DFSE08	DMDFON	LOK	state plausibility check of fuel-on/-off adaptation in map range 8 positiv
DFSEN	DMDFON	LOK	difference of FSE values in normal operation at actual speed range
DFSERESZ	DMDFON	LOK	reset counter plausibility check FSE
FDMD_M	DMDFON	LOK	status diagnosis misfire detection, drum, delayed output
FFONN1	DMDFON	LOK	status byte fuel-on/-off adaptation (map ranges ready)
FFONN2	DMDFON	LOK	status byte fuel-on/off adaptation (map ranges ready)
FFONN3	DMDFON	LOK	status byte fuel-on/-off adaptation (map ranges ready)
FFORN1	DMDFON	LOK	status byte fuel-on/-off adaptation (speed ranges ready)
FFPL1	DMDFON	LOK	status byte of fuel-on/-off adaption (FSE values in speed ranges plausible I)
FLG_M	DMDFON	LOK	monitor status calculation of the engine roughness
FLMX	DMDFON	LOK	actual maximum learning filter value
FLMXRESZ	DMDFON	LOK	reset counter learning filter not plausible
FLN11_02	DMDFON	LOK	learning filter value, negative, operating range 11, cylinder 2
FLN11_03	DMDFON	LOK	learning filter value, negative
FLN11_04	DMDFON	LOK	learning filter value, negative
FLN11_05	DMDFON	LOK	learning filter value, negative
FLN11_06	DMDFON	LOK	learning filter value, negative
FLN11_07	DMDFON	LOK	learning filter value, negative
FLN11_08	DMDFON	LOK	learning filter value, negative
FLN11_09	DMDFON	LOK	learning filter value, negative
FLN11_10	DMDFON	LOK	learning filter value, negative
FLN11_11	DMDFON	LOK	learning filter value, negative
FLN11_12	DMDFON	LOK	learning filter value, negative
FLN12_02	DMDFON	LOK	learning filter value, negative
FLN12_03	DMDFON	LOK	learning filter value, negative
FLN12_04	DMDFON	LOK	learning filter value, negative
FLN12_05	DMDFON	LOK	learning filter value, negative
FLN12_06	DMDFON	LOK	learning filter value, negative
FLN12_07	DMDFON	LOK	learning filter value, negative
FLN12_08	DMDFON	LOK	learning filter value, negative
FLN12_09	DMDFON	LOK	learning filter value, negative
FLN12_10	DMDFON	LOK	learning filter value, negative
FLN12_11	DMDFON	LOK	learning filter value, negative
FLN12_12	DMDFON	LOK	learning filter value, negative
FLN13_02	DMDFON	LOK	learning filter value, negative
FLN13_03	DMDFON	LOK	learning filter value, negative
FLN13_04	DMDFON	LOK	learning filter value, negative
FLN13_05	DMDFON	LOK	learning filter value, negative
FLN13_06	DMDFON	LOK	learning filter value, negative
FLN13_07	DMDFON	LOK	learning filter value, negative
FLN13_08	DMDFON	LOK	learning filter value, negative

Variable	Source	Type	Description
FLN13_09	DMDFON	LOK	learning filter value, negative
FLN13_10	DMDFON	LOK	learning filter value, negative
FLN13_11	DMDFON	LOK	learning filter value, negative
FLN13_12	DMDFON	LOK	learning filter value, negative
FLN21_02	DMDFON	LOK	learning filter value, negative
FLN21_03	DMDFON	LOK	learning filter value, negative
FLN21_04	DMDFON	LOK	learning filter value, negative
FLN21_05	DMDFON	LOK	learning filter value, negative
FLN21_06	DMDFON	LOK	learning filter value, negative
FLN21_07	DMDFON	LOK	learning filter value, negative
FLN21_08	DMDFON	LOK	learning filter value, negative
FLN21_09	DMDFON	LOK	learning filter value, negative
FLN21_10	DMDFON	LOK	learning filter value, negative
FLN21_11	DMDFON	LOK	learning filter value, negative
FLN21_12	DMDFON	LOK	learning filter value, negative
FLN22_02	DMDFON	LOK	learning filter value, negative
FLN22_03	DMDFON	LOK	learning filter value, negative
FLN22_04	DMDFON	LOK	learning filter value, negative
FLN22_05	DMDFON	LOK	learning filter value, negative
FLN22_06	DMDFON	LOK	learning filter value, negative
FLN22_07	DMDFON	LOK	learning filter value, negative
FLN22_08	DMDFON	LOK	learning filter value, negative
FLN22_09	DMDFON	LOK	learning filter value, negative
FLN22_10	DMDFON	LOK	learning filter value, negative
FLN22_11	DMDFON	LOK	learning filter value, negative
FLN22_12	DMDFON	LOK	learning filter value, negative
FLN23_02	DMDFON	LOK	learning filter value, negative
FLN23_03	DMDFON	LOK	learning filter value, negative
FLN23_04	DMDFON	LOK	learning filter value, negative
FLN23_05	DMDFON	LOK	learning filter value, negative
FLN23_06	DMDFON	LOK	learning filter value, negative
FLN23_07	DMDFON	LOK	learning filter value, negative
FLN23_08	DMDFON	LOK	learning filter value, negative
FLN23_09	DMDFON	LOK	learning filter value, negative
FLN23_10	DMDFON	LOK	learning filter value, negative
FLN23_11	DMDFON	LOK	learning filter value, negative
FLN23_12	DMDFON	LOK	learning filter value, negative
FLN31_02	DMDFON	LOK	learning filter value, negative
FLN31_03	DMDFON	LOK	learning filter value, negative
FLN31_04	DMDFON	LOK	learning filter value, negative
FLN31_05	DMDFON	LOK	learning filter value, negative
FLN31_06	DMDFON	LOK	learning filter value, negative
FLN31_07	DMDFON	LOK	learning filter value, negative
FLN31_08	DMDFON	LOK	learning filter value, negative
FLN31_09	DMDFON	LOK	learning filter value, negative
FLN31_10	DMDFON	LOK	learning filter value, negative
FLN31_11	DMDFON	LOK	learning filter value, negative
FLN31_12	DMDFON	LOK	learning filter value, negative
FLN32_02	DMDFON	LOK	learning filter value, negative
FLN32_03	DMDFON	LOK	learning filter value, negative
FLN32_04	DMDFON	LOK	learning filter value, negative
FLN32_05	DMDFON	LOK	learning filter value, negative
FLN32_06	DMDFON	LOK	learning filter value, negative
FLN32_07	DMDFON	LOK	learning filter value, negative
FLN32_08	DMDFON	LOK	learning filter value, negative
FLN32_09	DMDFON	LOK	learning filter value, negative
FLN32_10	DMDFON	LOK	learning filter value, negative
FLN32_11	DMDFON	LOK	learning filter value, negative
FLN32_12	DMDFON	LOK	learning filter value, negative
FLN33_02	DMDFON	LOK	learning filter value, negative
FLN33_03	DMDFON	LOK	learning filter value, negative
FLN33_04	DMDFON	LOK	learning filter value, negative
FLN33_05	DMDFON	LOK	learning filter value, negative
FLN33_06	DMDFON	LOK	learning filter value, negative
FLN33_07	DMDFON	LOK	learning filter value, negative
FLN33_08	DMDFON	LOK	learning filter value, negative
FLN33_09	DMDFON	LOK	learning filter value, negative
FLN33_10	DMDFON	LOK	learning filter value, negative
FLN33_11	DMDFON	LOK	learning filter value, negative
FLN33_12	DMDFON	LOK	learning filter value, negative
FLN41_02	DMDFON	LOK	learning filter value, negative
FLN41_03	DMDFON	LOK	learning filter value, negative
FLN41_04	DMDFON	LOK	learning filter value, negative
FLN41_05	DMDFON	LOK	learning filter value, negative
FLN41_06	DMDFON	LOK	learning filter value, negative
FLN41_07	DMDFON	LOK	learning filter value, negative
FLN41_08	DMDFON	LOK	learning filter value, negative
FLN41_09	DMDFON	LOK	learning filter value, negative
FLN41_10	DMDFON	LOK	learning filter value, negative
FLN41_11	DMDFON	LOK	learning filter value, negative
FLN41_12	DMDFON	LOK	learning filter value, negative
FLN42_02	DMDFON	LOK	learning filter value, negative

Variable	Source	Type	Description
FLN42_03	DMDFON	LOK	learning filter value, negative
FLN42_04	DMDFON	LOK	learning filter value, negative
FLN42_05	DMDFON	LOK	learning filter value, negative
FLN42_06	DMDFON	LOK	learning filter value, negative
FLN42_07	DMDFON	LOK	learning filter value, negative
FLN42_08	DMDFON	LOK	learning filter value, negative
FLN42_09	DMDFON	LOK	learning filter value, negative
FLN42_10	DMDFON	LOK	learning filter value, negative
FLN42_11	DMDFON	LOK	learning filter value, negative
FLN42_12	DMDFON	LOK	learning filter value, negative
FLN43_02	DMDFON	LOK	learning filter value, negative
FLN43_03	DMDFON	LOK	learning filter value, negative
FLN43_04	DMDFON	LOK	learning filter value, negative
FLN43_05	DMDFON	LOK	learning filter value, negative
FLN43_06	DMDFON	LOK	learning filter value, negative
FLN43_07	DMDFON	LOK	learning filter value, negative
FLN43_08	DMDFON	LOK	learning filter value, negative
FLN43_09	DMDFON	LOK	learning filter value, negative
FLN43_10	DMDFON	LOK	learning filter value, negative
FLN43_11	DMDFON	LOK	learning filter value, negative
FLN43_12	DMDFON	LOK	learning filter value, negative
FLN51_02	DMDFON	LOK	learning filter value, negative
FLN51_03	DMDFON	LOK	learning filter value, negative
FLN51_04	DMDFON	LOK	learning filter value, negative
FLN51_05	DMDFON	LOK	learning filter value, negative
FLN51_06	DMDFON	LOK	learning filter value, negative
FLN51_07	DMDFON	LOK	learning filter value, negative
FLN51_08	DMDFON	LOK	learning filter value, negative
FLN51_09	DMDFON	LOK	learning filter value, negative
FLN51_10	DMDFON	LOK	learning filter value, negative
FLN51_11	DMDFON	LOK	learning filter value, negative
FLN51_12	DMDFON	LOK	learning filter value, negative
FLN52_02	DMDFON	LOK	learning filter value, negative
FLN52_03	DMDFON	LOK	learning filter value, negative
FLN52_04	DMDFON	LOK	learning filter value, negative
FLN52_05	DMDFON	LOK	learning filter value, negative
FLN52_06	DMDFON	LOK	learning filter value, negative
FLN52_07	DMDFON	LOK	learning filter value, negative
FLN52_08	DMDFON	LOK	learning filter value, negative
FLN52_09	DMDFON	LOK	learning filter value, negative
FLN52_10	DMDFON	LOK	learning filter value, negative
FLN52_11	DMDFON	LOK	learning filter value, negative
FLN52_12	DMDFON	LOK	learning filter value, negative
FLN53_02	DMDFON	LOK	Learning filter value, negative
FLN53_03	DMDFON	LOK	learning filter value, negative
FLN53_04	DMDFON	LOK	learning filter value, negative
FLN53_05	DMDFON	LOK	learning filter value, negative
FLN53_06	DMDFON	LOK	learning filter value, negative
FLN53_07	DMDFON	LOK	learning filter value, negative
FLN53_08	DMDFON	LOK	learning filter value, negative
FLN53_09	DMDFON	LOK	learning filter value, negative
FLN53_10	DMDFON	LOK	learning filter value, negative
FLN53_11	DMDFON	LOK	learning filter value, negative
FLN53_12	DMDFON	LOK	learning filter value, negative
FLN61_02	DMDFON	LOK	learning filter value, negative
FLN61_03	DMDFON	LOK	learning filter value, negative
FLN61_04	DMDFON	LOK	learning filter value, negative
FLN61_05	DMDFON	LOK	learning filter value, negative
FLN61_06	DMDFON	LOK	learning filter value, negative
FLN61_07	DMDFON	LOK	learning filter value, negative
FLN61_08	DMDFON	LOK	learning filter value, negative
FLN61_09	DMDFON	LOK	learning filter value, negative
FLN61_10	DMDFON	LOK	learning filter value, negative
FLN61_11	DMDFON	LOK	learning filter value, negative
FLN61_12	DMDFON	LOK	learning filter value, negative
FLN62_02	DMDFON	LOK	learning filter value, negative
FLN62_03	DMDFON	LOK	learning filter value, negative
FLN62_04	DMDFON	LOK	learning filter value, negative
FLN62_05	DMDFON	LOK	learning filter value, negative
FLN62_06	DMDFON	LOK	learning filter value, negative
FLN62_07	DMDFON	LOK	learning filter value, negative
FLN62_08	DMDFON	LOK	learning filter value, negative
FLN62_09	DMDFON	LOK	learning filter value, negative
FLN62_10	DMDFON	LOK	learning filter value, negative
FLN62_11	DMDFON	LOK	learning filter value, negative
FLN62_12	DMDFON	LOK	learning filter value, negative
FLN63_02	DMDFON	LOK	learning filter value, negative
FLN63_03	DMDFON	LOK	learning filter value, negative
FLN63_04	DMDFON	LOK	learning filter value, negative
FLN63_05	DMDFON	LOK	learning filter value, negative
FLN63_06	DMDFON	LOK	learning filter value, negative
FLN63_07	DMDFON	LOK	learning filter value, negative

Variable	Source	Type	Description
FLN63_08	DMDFON	LOK	learning filter value, negative
FLN63_09	DMDFON	LOK	learning filter value, negative
FLN63_10	DMDFON	LOK	learning filter value, negative
FLN63_11	DMDFON	LOK	learning filter value, negative
FLN63_12	DMDFON	LOK	learning filter value, negative
FLN71_02	DMDFON	LOK	learning filter value, negative
FLN71_03	DMDFON	LOK	learning filter value, negative
FLN71_04	DMDFON	LOK	learning filter value, negative
FLN71_05	DMDFON	LOK	learning filter value, negative
FLN71_06	DMDFON	LOK	learning filter value, negative
FLN71_07	DMDFON	LOK	learning filter value, negative
FLN71_08	DMDFON	LOK	learning filter value, negative
FLN71_09	DMDFON	LOK	learning filter value, negative
FLN71_10	DMDFON	LOK	learning filter value, negative
FLN71_11	DMDFON	LOK	learning filter value, negative
FLN71_12	DMDFON	LOK	learning filter value, negative
FLN72_02	DMDFON	LOK	learning filter value, negative
FLN72_03	DMDFON	LOK	learning filter value, negative
FLN72_04	DMDFON	LOK	learning filter value, negative
FLN72_05	DMDFON	LOK	learning filter value, negative
FLN72_06	DMDFON	LOK	learning filter value, negative
FLN72_07	DMDFON	LOK	learning filter value, negative
FLN72_08	DMDFON	LOK	learning filter value, negative
FLN72_09	DMDFON	LOK	learning filter value, negative
FLN72_10	DMDFON	LOK	learning filter value, negative
FLN72_11	DMDFON	LOK	learning filter value, negative
FLN72_12	DMDFON	LOK	learning filter value, negative
FLN73_02	DMDFON	LOK	learning filter value, negative
FLN73_03	DMDFON	LOK	learning filter value, negative
FLN73_04	DMDFON	LOK	learning filter value, negative
FLN73_05	DMDFON	LOK	learning filter value, negative
FLN73_06	DMDFON	LOK	learning filter value, negative
FLN73_07	DMDFON	LOK	learning filter value, negative
FLN73_08	DMDFON	LOK	learning filter value, negative
FLN73_09	DMDFON	LOK	learning filter value, negative
FLN73_10	DMDFON	LOK	learning filter value, negative
FLN73_11	DMDFON	LOK	learning filter value, negative
FLN73_12	DMDFON	LOK	learning filter value, negative
FLN81_02	DMDFON	LOK	learning filter value, negative
FLN81_03	DMDFON	LOK	learning filter value, negative
FLN81_04	DMDFON	LOK	learning filter value, negative
FLN81_05	DMDFON	LOK	learning filter value, negative
FLN81_06	DMDFON	LOK	learning filter value, negative
FLN81_07	DMDFON	LOK	learning filter value, negative
FLN81_08	DMDFON	LOK	learning filter value, negative
FLN81_09	DMDFON	LOK	learning filter value, negative
FLN81_10	DMDFON	LOK	learning filter value, negative
FLN81_11	DMDFON	LOK	learning filter value, negative
FLN81_12	DMDFON	LOK	learning filter value, negative
FLN82_02	DMDFON	LOK	learning filter value, negative
FLN82_03	DMDFON	LOK	learning filter value, negative
FLN82_04	DMDFON	LOK	learning filter value, negative
FLN82_05	DMDFON	LOK	learning filter value, negative
FLN82_06	DMDFON	LOK	learning filter value, negative
FLN82_07	DMDFON	LOK	learning filter value, negative
FLN82_08	DMDFON	LOK	learning filter value, negative
FLN82_09	DMDFON	LOK	learning filter value, negative
FLN82_10	DMDFON	LOK	learning filter value, negative
FLN82_11	DMDFON	LOK	learning filter value, negative
FLN82_12	DMDFON	LOK	learning filter value, negative
FLN83_02	DMDFON	LOK	learning filter value, negative
FLN83_03	DMDFON	LOK	learning filter value, negative
FLN83_04	DMDFON	LOK	learning filter value, negative
FLN83_05	DMDFON	LOK	learning filter value, negative
FLN83_06	DMDFON	LOK	learning filter value, negative
FLN83_07	DMDFON	LOK	learning filter value, negative
FLN83_08	DMDFON	LOK	learning filter value, negative
FLN83_09	DMDFON	LOK	learning filter value, negative
FLN83_10	DMDFON	LOK	learning filter value, negative
FLN83_11	DMDFON	LOK	learning filter value, negative
FLN83_12	DMDFON	LOK	learning filter value, negative
FLP11_02	DMDFON	LOK	learning filter value, positive
FLP11_03	DMDFON	LOK	learning filter value, positiv
FLP11_04	DMDFON	LOK	learning filter value, positiv
FLP11_05	DMDFON	LOK	learning filter value, positiv
FLP11_06	DMDFON	LOK	learning filter value, positiv
FLP11_07	DMDFON	LOK	learning filter value, positiv
FLP11_08	DMDFON	LOK	learning filter value, positiv
FLP11_09	DMDFON	LOK	learning filter value, positiv
FLP11_10	DMDFON	LOK	learning filter value, positiv
FLP11_11	DMDFON	LOK	learning filter value, positiv
FLP11_12	DMDFON	LOK	learning filter value, positiv

Variable	Source	Type	Description
FLP12_02	DMDFON	LOK	learning filter value, positiv
FLP12_03	DMDFON	LOK	learning filter value, positiv
FLP12_04	DMDFON	LOK	learning filter value, positiv
FLP12_05	DMDFON	LOK	learning filter value, positiv
FLP12_06	DMDFON	LOK	learning filter value, positiv
FLP12_07	DMDFON	LOK	learning filter value, positiv
FLP12_08	DMDFON	LOK	learning filter value, positiv
FLP12_09	DMDFON	LOK	learning filter value, positiv
FLP12_10	DMDFON	LOK	learning filter value, positiv
FLP12_11	DMDFON	LOK	learning filter value, positiv
FLP12_12	DMDFON	LOK	learning filter value, positiv
FLP13_02	DMDFON	LOK	learning filter value, positiv
FLP13_03	DMDFON	LOK	learning filter value, positiv
FLP13_04	DMDFON	LOK	learning filter value, positiv
FLP13_05	DMDFON	LOK	learning filter value, positiv
FLP13_06	DMDFON	LOK	learning filter value, positiv
FLP13_07	DMDFON	LOK	learning filter value, positiv
FLP13_08	DMDFON	LOK	learning filter value, positiv
FLP13_09	DMDFON	LOK	learning filter value, positiv
FLP13_10	DMDFON	LOK	learning filter value, positiv
FLP13_11	DMDFON	LOK	learning filter value, positiv
FLP13_12	DMDFON	LOK	learning filter value, positiv
FLP21_02	DMDFON	LOK	learning filter value, positiv
FLP21_03	DMDFON	LOK	learning filter value, positiv
FLP21_04	DMDFON	LOK	learning filter value, positiv
FLP21_05	DMDFON	LOK	learning filter value, positiv
FLP21_06	DMDFON	LOK	learning filter value, positiv
FLP21_07	DMDFON	LOK	learning filter value, positiv
FLP21_08	DMDFON	LOK	learning filter value, positiv
FLP21_09	DMDFON	LOK	learning filter value, positiv
FLP21_10	DMDFON	LOK	learning filter value, positiv
FLP21_11	DMDFON	LOK	learning filter value, positiv
FLP21_12	DMDFON	LOK	learning filter value, positiv
FLP22_02	DMDFON	LOK	learning filter value, positiv
FLP22_03	DMDFON	LOK	learning filter value, positiv
FLP22_04	DMDFON	LOK	learning filter value, positiv
FLP22_05	DMDFON	LOK	learning filter value, positiv
FLP22_06	DMDFON	LOK	learning filter value, positiv
FLP22_07	DMDFON	LOK	learning filter value, positiv
FLP22_08	DMDFON	LOK	learning filter value, positiv
FLP22_09	DMDFON	LOK	learning filter value, positiv
FLP22_10	DMDFON	LOK	learning filter value, positiv
FLP22_11	DMDFON	LOK	learning filter value, positiv
FLP22_12	DMDFON	LOK	learning filter value, positiv
FLP23_02	DMDFON	LOK	learning filter value, positiv
FLP23_03	DMDFON	LOK	learning filter value, positiv
FLP23_04	DMDFON	LOK	learning filter value, positiv
FLP23_05	DMDFON	LOK	learning filter value, positiv
FLP23_06	DMDFON	LOK	learning filter value, positiv
FLP23_07	DMDFON	LOK	learning filter value, positiv
FLP23_08	DMDFON	LOK	learning filter value, positiv
FLP23_09	DMDFON	LOK	learning filter value, positiv
FLP23_10	DMDFON	LOK	learning filter value, positiv
FLP23_11	DMDFON	LOK	learning filter value, positiv
FLP23_12	DMDFON	LOK	learning filter value, positiv
FLP31_02	DMDFON	LOK	learning filter value, positiv
FLP31_03	DMDFON	LOK	learning filter value, positiv
FLP31_04	DMDFON	LOK	learning filter value, positiv
FLP31_05	DMDFON	LOK	learning filter value, positiv
FLP31_06	DMDFON	LOK	learning filter value, positiv
FLP31_07	DMDFON	LOK	learning filter value, positiv
FLP31_08	DMDFON	LOK	learning filter value, positiv
FLP31_09	DMDFON	LOK	learning filter value, positiv
FLP31_10	DMDFON	LOK	learning filter value, positiv
FLP31_11	DMDFON	LOK	learning filter value, positiv
FLP31_12	DMDFON	LOK	learning filter value, positiv
FLP32_02	DMDFON	LOK	learning filter value, positiv
FLP32_03	DMDFON	LOK	learning filter value, positiv
FLP32_04	DMDFON	LOK	learning filter value, positiv
FLP32_05	DMDFON	LOK	learning filter value, positiv
FLP32_06	DMDFON	LOK	learning filter value, positiv
FLP32_07	DMDFON	LOK	learning filter value, positiv
FLP32_08	DMDFON	LOK	learning filter value, positiv
FLP32_09	DMDFON	LOK	learning filter value, positiv
FLP32_10	DMDFON	LOK	learning filter value, positiv
FLP32_11	DMDFON	LOK	learning filter value, positiv
FLP32_12	DMDFON	LOK	learning filter value, positiv
FLP33_02	DMDFON	LOK	learning filter value, positiv
FLP33_03	DMDFON	LOK	learning filter value, positiv
FLP33_04	DMDFON	LOK	learning filter value, positiv
FLP33_05	DMDFON	LOK	learning filter value, positiv
FLP33_06	DMDFON	LOK	learning filter value, positiv

Variable	Source	Type	Description
FLP33_07	DMDFON	LOK	learning filter value, positiv
FLP33_08	DMDFON	LOK	learning filter value, positiv
FLP33_09	DMDFON	LOK	learning filter value, positiv
FLP33_10	DMDFON	LOK	learning filter value, positiv
FLP33_11	DMDFON	LOK	learning filter value, positiv
FLP33_12	DMDFON	LOK	learning filter value, positiv
FLP41_02	DMDFON	LOK	learning filter value, positiv
FLP41_03	DMDFON	LOK	learning filter value, positiv
FLP41_04	DMDFON	LOK	learning filter value, positiv
FLP41_05	DMDFON	LOK	learning filter value, positiv
FLP41_06	DMDFON	LOK	learning filter value, positiv
FLP41_07	DMDFON	LOK	learning filter value, positiv
FLP41_08	DMDFON	LOK	learning filter value, positiv
FLP41_09	DMDFON	LOK	learning filter value, positiv
FLP41_10	DMDFON	LOK	learning filter value, positiv
FLP41_11	DMDFON	LOK	learning filter value, positiv
FLP41_12	DMDFON	LOK	learning filter value, positiv
FLP42_02	DMDFON	LOK	learning filter value, positiv
FLP42_03	DMDFON	LOK	learning filter value, positiv
FLP42_04	DMDFON	LOK	learning filter value, positiv
FLP42_05	DMDFON	LOK	learning filter value, positiv
FLP42_06	DMDFON	LOK	learning filter value, positiv
FLP42_07	DMDFON	LOK	learning filter value, positiv
FLP42_08	DMDFON	LOK	learning filter value, positiv
FLP42_09	DMDFON	LOK	learning filter value, positiv
FLP42_10	DMDFON	LOK	learning filter value, positiv
FLP42_11	DMDFON	LOK	learning filter value, positiv
FLP42_12	DMDFON	LOK	learning filter value, positiv
FLP43_02	DMDFON	LOK	learning filter value, positiv
FLP43_03	DMDFON	LOK	learning filter value, positiv
FLP43_04	DMDFON	LOK	learning filter value, positiv
FLP43_05	DMDFON	LOK	learning filter value, positiv
FLP43_06	DMDFON	LOK	learning filter value, positiv
FLP43_07	DMDFON	LOK	learning filter value, positiv
FLP43_08	DMDFON	LOK	learning filter value, positiv
FLP43_09	DMDFON	LOK	learning filter value, positiv
FLP43_10	DMDFON	LOK	learning filter value, positiv
FLP43_11	DMDFON	LOK	learning filter value, positiv
FLP43_12	DMDFON	LOK	learning filter value, positiv
FLP51_02	DMDFON	LOK	learning filter value, positiv
FLP51_03	DMDFON	LOK	learning filter value, positiv
FLP51_04	DMDFON	LOK	learning filter value, positiv
FLP51_05	DMDFON	LOK	learning filter value, positiv
FLP51_06	DMDFON	LOK	learning filter value, positiv
FLP51_07	DMDFON	LOK	learning filter value, positiv
FLP51_08	DMDFON	LOK	learning filter value, positiv
FLP51_09	DMDFON	LOK	learning filter value, positiv
FLP51_10	DMDFON	LOK	learning filter value, positiv
FLP51_11	DMDFON	LOK	learning filter value, positiv
FLP51_12	DMDFON	LOK	learning filter value, positiv
FLP52_02	DMDFON	LOK	learning filter value, positiv
FLP52_03	DMDFON	LOK	learning filter value, positiv
FLP52_04	DMDFON	LOK	learning filter value, positiv
FLP52_05	DMDFON	LOK	learning filter value, positiv
FLP52_06	DMDFON	LOK	learning filter value, positiv
FLP52_07	DMDFON	LOK	learning filter value, positiv
FLP52_08	DMDFON	LOK	learning filter value, positiv
FLP52_09	DMDFON	LOK	learning filter value, positiv
FLP52_10	DMDFON	LOK	learning filter value, positiv
FLP52_11	DMDFON	LOK	learning filter value, positiv
FLP52_12	DMDFON	LOK	learning filter value, positiv
FLP53_02	DMDFON	LOK	learning filter value, positiv
FLP53_03	DMDFON	LOK	learning filter value, positiv
FLP53_04	DMDFON	LOK	learning filter value, positiv
FLP53_05	DMDFON	LOK	learning filter value, positiv
FLP53_06	DMDFON	LOK	learning filter value, positiv
FLP53_07	DMDFON	LOK	learning filter value, positiv
FLP53_08	DMDFON	LOK	learning filter value, positiv
FLP53_09	DMDFON	LOK	learning filter value, positiv
FLP53_10	DMDFON	LOK	learning filter value, positiv
FLP53_11	DMDFON	LOK	learning filter value, positiv
FLP53_12	DMDFON	LOK	learning filter value, positiv
FLP61_02	DMDFON	LOK	learning filter value, positiv
FLP61_03	DMDFON	LOK	learning filter value, positiv
FLP61_04	DMDFON	LOK	learning filter value, positiv
FLP61_05	DMDFON	LOK	learning filter value, positiv
FLP61_06	DMDFON	LOK	learning filter value, positiv
FLP61_07	DMDFON	LOK	learning filter value, positiv
FLP61_08	DMDFON	LOK	learning filter value, positiv
FLP61_09	DMDFON	LOK	learning filter value, positiv
FLP61_10	DMDFON	LOK	learning filter value, positiv
FLP61_11	DMDFON	LOK	learning filter value, positiv

Variable	Source	Type	Description
FLP61_12	DMDFON	LOK	learning filter value, positiv
FLP62_02	DMDFON	LOK	learning filter value, positiv
FLP62_03	DMDFON	LOK	learning filter value, positiv
FLP62_04	DMDFON	LOK	learning filter value, positiv
FLP62_05	DMDFON	LOK	learning filter value, positiv
FLP62_06	DMDFON	LOK	learning filter value, positiv
FLP62_07	DMDFON	LOK	learning filter value, positiv
FLP62_08	DMDFON	LOK	learning filter value, positiv
FLP62_09	DMDFON	LOK	learning filter value, positiv
FLP62_10	DMDFON	LOK	learning filter value, positiv
FLP62_11	DMDFON	LOK	learning filter value, positiv
FLP62_12	DMDFON	LOK	learning filter value, positiv
FLP63_02	DMDFON	LOK	learning filter value, positiv
FLP63_03	DMDFON	LOK	learning filter value, positiv
FLP63_04	DMDFON	LOK	learning filter value, positiv
FLP63_05	DMDFON	LOK	learning filter value, positiv
FLP63_06	DMDFON	LOK	learning filter value, positiv
FLP63_07	DMDFON	LOK	learning filter value, positiv
FLP63_08	DMDFON	LOK	learning filter value, positiv
FLP63_09	DMDFON	LOK	learning filter value, positiv
FLP63_10	DMDFON	LOK	learning filter value, positiv
FLP63_11	DMDFON	LOK	learning filter value, positiv
FLP63_12	DMDFON	LOK	learning filter value, positiv
FLP71_02	DMDFON	LOK	learning filter value, positiv
FLP71_03	DMDFON	LOK	learning filter value, positiv
FLP71_04	DMDFON	LOK	learning filter value, positiv
FLP71_05	DMDFON	LOK	learning filter value, positiv
FLP71_06	DMDFON	LOK	learning filter value, positiv
FLP71_07	DMDFON	LOK	learning filter value, positiv
FLP71_08	DMDFON	LOK	learning filter value, positiv
FLP71_09	DMDFON	LOK	learning filter value, positive
FLP71_10	DMDFON	LOK	learning filter value, positive
FLP71_11	DMDFON	LOK	learning filter value, positive
FLP71_12	DMDFON	LOK	learning filter value, positive
FLP72_02	DMDFON	LOK	learning filter value, positiv
FLP72_03	DMDFON	LOK	learning filter value, positiv
FLP72_04	DMDFON	LOK	learning filter value, positiv
FLP72_05	DMDFON	LOK	learning filter value, positiv
FLP72_06	DMDFON	LOK	learning filter value, positiv
FLP72_07	DMDFON	LOK	learning filter value, positiv
FLP72_08	DMDFON	LOK	learning filter value, positiv
FLP72_09	DMDFON	LOK	learning filter value, positive
FLP72_10	DMDFON	LOK	learning filter value, positive
FLP72_11	DMDFON	LOK	learning filter value, positive
FLP72_12	DMDFON	LOK	learning filter value, positive
FLP73_02	DMDFON	LOK	learning filter value, positiv
FLP73_03	DMDFON	LOK	learning filter value, positiv
FLP73_04	DMDFON	LOK	learning filter value, positiv
FLP73_05	DMDFON	LOK	learning filter value, positiv
FLP73_06	DMDFON	LOK	learning filter value, positiv
FLP73_07	DMDFON	LOK	learning filter value, positiv
FLP73_08	DMDFON	LOK	learning filter value, positiv
FLP73_09	DMDFON	LOK	learning filter value, positive
FLP73_10	DMDFON	LOK	learning filter value, positive
FLP73_11	DMDFON	LOK	learning filter value, positive
FLP73_12	DMDFON	LOK	learning filter value, positive
FLP81_02	DMDFON	LOK	learning filter value, positiv
FLP81_03	DMDFON	LOK	learning filter value, positiv
FLP81_04	DMDFON	LOK	learning filter value, positiv
FLP81_05	DMDFON	LOK	learning filter value, positiv
FLP81_06	DMDFON	LOK	learning filter value, positiv
FLP81_07	DMDFON	LOK	learning filter value, positiv
FLP81_08	DMDFON	LOK	learning filter value, positiv
FLP81_09	DMDFON	LOK	learning filter value, positive
FLP81_10	DMDFON	LOK	learning filter value, positive
FLP81_11	DMDFON	LOK	learning filter value, positive
FLP81_12	DMDFON	LOK	learning filter value, positive
FLP82_02	DMDFON	LOK	learning filter value, positiv
FLP82_03	DMDFON	LOK	learning filter value, positiv
FLP82_04	DMDFON	LOK	learning filter value, positiv
FLP82_05	DMDFON	LOK	learning filter value, positiv
FLP82_06	DMDFON	LOK	learning filter value, positiv
FLP82_07	DMDFON	LOK	learning filter value, positiv
FLP82_08	DMDFON	LOK	learning filter value, positiv
FLP82_09	DMDFON	LOK	learning filter value, positive
FLP82_10	DMDFON	LOK	learning filter value, positive
FLP82_11	DMDFON	LOK	learning filter value, positive
FLP82_12	DMDFON	LOK	learning filter value, positive
FLP83_02	DMDFON	LOK	learning filter value, positiv
FLP83_03	DMDFON	LOK	learning filter value, positiv
FLP83_04	DMDFON	LOK	learning filter value, positiv
FLP83_05	DMDFON	LOK	learning filter value, positiv

Variable	Source	Type	Description
FLP83_06	DMDFON	LOK	learning filter value, positiv
FLP83_07	DMDFON	LOK	learning filter value, positiv
FLP83_08	DMDFON	LOK	learning filter value, positiv
FLP83_09	DMDFON	LOK	learning filter value, positive
FLP83_10	DMDFON	LOK	learning filter value, positive
FLP83_11	DMDFON	LOK	learning filter value, positive
FLP83_12	DMDFON	LOK	learning filter value, positive
FOSTAT	DMDFON	AUS	state of fuel-on/-off adaptation in actual map range
FS11_02	DMDFON	LOK	filter value segment duration, operating range 11
FS11_03	DMDFON	LOK	filter value segment duration, operating range 11
FS11_04	DMDFON	LOK	filter value segment duration, operating range 11
FS11_05	DMDFON	LOK	filter value segment duration, operating range 11
FS11_06	DMDFON	LOK	filter value segment duration, operating range 11
FS11_07	DMDFON	LOK	filter value segment duration, operating range 11
FS11_08	DMDFON	LOK	filter value segment duration, operating range 11
FS11_09	DMDFON	LOK	filter value segment duration, operating range 11
FS11_10	DMDFON	LOK	filter value segment duration, operating range 11
FS11_11	DMDFON	LOK	filter value segment duration, operating range 11
FS11_12	DMDFON	LOK	filter value segment duration, operating range 11
FS12_02	DMDFON	LOK	filter value segment duration, operating range 12
FS12_03	DMDFON	LOK	filter value segment duration, operating range 12
FS12_04	DMDFON	LOK	filter value segment duration, operating range 12
FS12_05	DMDFON	LOK	filter value segment duration, operating range 12
FS12_06	DMDFON	LOK	filter value segment duration, operating range 12
FS12_07	DMDFON	LOK	filter value segment duration, operating range 12
FS12_08	DMDFON	LOK	filter value segment duration, operating range 12
FS12_09	DMDFON	LOK	filter value segment duration, operating range 12
FS12_10	DMDFON	LOK	filter value segment duration, operating range 12
FS12_11	DMDFON	LOK	filter value segment duration, operating range 12
FS12_12	DMDFON	LOK	filter value segment duration, operating range 12
FS13_02	DMDFON	LOK	filter value segment duration, operating range 13
FS13_03	DMDFON	LOK	filter value segment duration, operating range 13
FS13_04	DMDFON	LOK	filter value segment duration, operating range 13
FS13_05	DMDFON	LOK	filter value segment duration, operating range 13
FS13_06	DMDFON	LOK	filter value segment duration, operating range 13
FS13_07	DMDFON	LOK	filter value segment duration, operating range 13
FS13_08	DMDFON	LOK	filter value segment duration, operating range 13
FS13_09	DMDFON	LOK	filter value segment duration, operating range 13
FS13_10	DMDFON	LOK	filter value segment duration, operating range 13
FS13_11	DMDFON	LOK	filter value segment duration, operating range 13
FS13_12	DMDFON	LOK	filter value segment duration, operating range 13
FS21_02	DMDFON	LOK	filter value segment duration, operating range 21
FS21_03	DMDFON	LOK	filter value segment duration, operating range 21
FS21_04	DMDFON	LOK	filter value segment duration, operating range 21
FS21_05	DMDFON	LOK	filter value segment duration, operating range 21
FS21_06	DMDFON	LOK	filter value segment duration, operating range 21
FS21_07	DMDFON	LOK	filter value segment duration, operating range 21
FS21_08	DMDFON	LOK	filter value segment duration, operating range 21
FS21_09	DMDFON	LOK	filter value segment duration, operating range 21
FS21_10	DMDFON	LOK	filter value segment duration, operating range 21
FS21_11	DMDFON	LOK	filter value segment duration, operating range 21
FS21_12	DMDFON	LOK	filter value segment duration, operating range 21
FS22_02	DMDFON	LOK	filter value segment duration, operating range 22
FS22_03	DMDFON	LOK	filter value segment duration, operating range 22
FS22_04	DMDFON	LOK	filter value segment duration, operating range 22
FS22_05	DMDFON	LOK	filter value segment duration, operating range 22
FS22_06	DMDFON	LOK	filter value segment duration, operating range 22
FS22_07	DMDFON	LOK	filter value segment duration, operating range 22
FS22_08	DMDFON	LOK	filter value segment duration, operating range 22
FS22_09	DMDFON	LOK	filter value segment duration, operating range 21
FS22_10	DMDFON	LOK	filter value segment duration, operating range 21
FS22_11	DMDFON	LOK	filter value segment duration, operating range 21
FS22_12	DMDFON	LOK	filter value segment duration, operating range 21
FS23_02	DMDFON	LOK	filter value segment duration, operating range 23
FS23_03	DMDFON	LOK	filter value segment duration, operating range 23
FS23_04	DMDFON	LOK	filter value segment duration, operating range 23
FS23_05	DMDFON	LOK	filter value segment duration, operating range 23
FS23_06	DMDFON	LOK	filter value segment duration, operating range 23
FS23_07	DMDFON	LOK	filter value segment duration, operating range 23
FS23_08	DMDFON	LOK	filter value segment duration, operating range 23
FS23_09	DMDFON	LOK	filter value segment duration, operating range 23
FS23_10	DMDFON	LOK	filter value segment duration, operating range 23
FS23_11	DMDFON	LOK	filter value segment duration, operating range 23
FS23_12	DMDFON	LOK	filter value segment duration, operating range 23
FS31_02	DMDFON	LOK	filter value segment duration, operating range 31, cylinder 2
FS31_03	DMDFON	LOK	filter value segment duration, operating range 31
FS31_04	DMDFON	LOK	filter value segment duration, operating range 31
FS31_05	DMDFON	LOK	filter value segment duration, operating range 31
FS31_06	DMDFON	LOK	filter value segment duration, operating range 31
FS31_07	DMDFON	LOK	filter value segment duration, operating range 31
FS31_08	DMDFON	LOK	filter value segment duration, operating range 31
FS31_09	DMDFON	LOK	filter value segment duration, operating range 31

Variable	Source	Type	Description
FS31_10	DMDFON	LOK	filter value segment duration, operating range 31
FS31_11	DMDFON	LOK	filter value segment duration, operating range 31
FS31_12	DMDFON	LOK	filter value segment duration, operating range 31
FS32_02	DMDFON	LOK	filter value segment duration, operating range 32, cylinder 2
FS32_03	DMDFON	LOK	filter value segment duration, operating range 32
FS32_04	DMDFON	LOK	filter value segment duration, operating range 32
FS32_05	DMDFON	LOK	filter value segment duration, operating range 32
FS32_06	DMDFON	LOK	filter value segment duration, operating range 32
FS32_07	DMDFON	LOK	filter value segment duration, operating range 32
FS32_08	DMDFON	LOK	filter value segment duration, operating range 32
FS32_09	DMDFON	LOK	filter value segment duration, operating range 32
FS32_10	DMDFON	LOK	filter value segment duration, operating range 32
FS32_11	DMDFON	LOK	filter value segment duration, operating range 32
FS32_12	DMDFON	LOK	filter value segment duration, operating range 32
FS33_02	DMDFON	LOK	filter value segment duration, operating range 33, cylinder 2
FS33_03	DMDFON	LOK	filter value segment duration, operating range 33
FS33_04	DMDFON	LOK	filter value segment duration, operating range 33
FS33_05	DMDFON	LOK	filter value segment duration, operating range 33
FS33_06	DMDFON	LOK	filter value segment duration, operating range 33
FS33_07	DMDFON	LOK	filter value segment duration, operating range 33
FS33_08	DMDFON	LOK	filter value segment duration, operating range 33
FS33_09	DMDFON	LOK	filter value segment duration, operating range 33
FS33_10	DMDFON	LOK	filter value segment duration, operating range 33
FS33_11	DMDFON	LOK	filter value segment duration, operating range 33
FS33_12	DMDFON	LOK	filter value segment duration, operating range 33
FS41_02	DMDFON	LOK	filter value segment duration, operating range 41, cylinder 2
FS41_03	DMDFON	LOK	filter value segment duration, operating range 41
FS41_04	DMDFON	LOK	filter value segment duration, operating range 41
FS41_05	DMDFON	LOK	filter value segment duration, operating range 41
FS41_06	DMDFON	LOK	filter value segment duration, operating range 41
FS41_07	DMDFON	LOK	filter value segment duration, operating range 41
FS41_08	DMDFON	LOK	filter value segment duration, operating range 41
FS41_09	DMDFON	LOK	filter value segment duration, operating range 41
FS41_10	DMDFON	LOK	filter value segment duration, operating range 41
FS41_11	DMDFON	LOK	filter value segment duration, operating range 41
FS41_12	DMDFON	LOK	filter value segment duration, operating range 41
FS42_02	DMDFON	LOK	filter value segment duration, operating range 42, cylinder 2
FS42_03	DMDFON	LOK	filter value segment duration, operating range 42
FS42_04	DMDFON	LOK	filter value segment duration, operating range 42
FS42_05	DMDFON	LOK	filter value segment duration, operating range 42
FS42_06	DMDFON	LOK	filter value segment duration, operating range 42
FS42_07	DMDFON	LOK	filter value segment duration, operating range 42
FS42_08	DMDFON	LOK	filter value segment duration, operating range 42
FS42_09	DMDFON	LOK	filter value segment duration, operating range 42
FS42_10	DMDFON	LOK	filter value segment duration, operating range 42
FS42_11	DMDFON	LOK	filter value segment duration, operating range 42
FS42_12	DMDFON	LOK	filter value segment duration, operating range 42
FS43_02	DMDFON	LOK	filter value segment duration, operating range 43, cylinder 2
FS43_03	DMDFON	LOK	filter value segment duration, operating range 43
FS43_04	DMDFON	LOK	filter value segment duration, operating range 43
FS43_05	DMDFON	LOK	filter value segment duration, operating range 43
FS43_06	DMDFON	LOK	filter value segment duration, operating range 43
FS43_07	DMDFON	LOK	filter value segment duration, operating range 43
FS43_08	DMDFON	LOK	filter value segment duration, operating range 43
FS43_09	DMDFON	LOK	filter value segment duration, operating range 43
FS43_10	DMDFON	LOK	filter value segment duration, operating range 43
FS43_11	DMDFON	LOK	filter value segment duration, operating range 43
FS43_12	DMDFON	LOK	filter value segment duration, operating range 43
FS51_02	DMDFON	LOK	filter value segment duration, operating range 51, cylinder 2
FS51_03	DMDFON	LOK	filter value segment duration, operating range 51
FS51_04	DMDFON	LOK	filter value segment duration, operating range 51
FS51_05	DMDFON	LOK	filter value segment duration, operating range 51
FS51_06	DMDFON	LOK	filter value segment duration, operating range 51
FS51_07	DMDFON	LOK	filter value segment duration, operating range 51
FS51_08	DMDFON	LOK	filter value segment duration, operating range 51
FS51_09	DMDFON	LOK	filter value segment duration, operating range 51
FS51_10	DMDFON	LOK	filter value segment duration, operating range 51
FS51_11	DMDFON	LOK	filter value segment duration, operating range 51
FS51_12	DMDFON	LOK	filter value segment duration, operating range 51
FS52_02	DMDFON	LOK	filter value segment duration, operating range 52, cylinder 2
FS52_03	DMDFON	LOK	filter value segment duration, operating range 52
FS52_04	DMDFON	LOK	filter value segment duration, operating range 52
FS52_05	DMDFON	LOK	filter value segment duration, operating range 52
FS52_06	DMDFON	LOK	filter value segment duration, operating range 52
FS52_07	DMDFON	LOK	filter value segment duration, operating range 52
FS52_08	DMDFON	LOK	filter value segment duration, operating range 52
FS52_09	DMDFON	LOK	filter value segment duration, operating range 52
FS52_10	DMDFON	LOK	filter value segment duration, operating range 52
FS52_11	DMDFON	LOK	filter value segment duration, operating range 52
FS52_12	DMDFON	LOK	filter value segment duration, operating range 52
FS53_02	DMDFON	LOK	filter value segment duration, operating range 53, cylinder 2
FS53_03	DMDFON	LOK	filter value segment duration, operating range 53

Variable	Source	Type	Description
FS53_04	DMDFON	LOK	filter value segment duration, operating range 53
FS53_05	DMDFON	LOK	filter value segment duration, operating range 53
FS53_06	DMDFON	LOK	filter value segment duration, operating range 53
FS53_07	DMDFON	LOK	filter value segment duration, operating range 53
FS53_08	DMDFON	LOK	filter value segment duration, operating range 53
FS53_09	DMDFON	LOK	filter value segment duration, operating range 53
FS53_10	DMDFON	LOK	filter value segment duration, operating range 53
FS53_11	DMDFON	LOK	filter value segment duration, operating range 53
FS53_12	DMDFON	LOK	filter value segment duration, operating range 53
FS61_02	DMDFON	LOK	filter value segment duration, operating range 61, cylinder 2
FS61_03	DMDFON	LOK	filter value segment duration, operating range 61
FS61_04	DMDFON	LOK	filter value segment duration, operating range 61
FS61_05	DMDFON	LOK	filter value segment duration, operating range 61
FS61_06	DMDFON	LOK	filter value segment duration, operating range 61
FS61_07	DMDFON	LOK	filter value segment duration, operating range 61
FS61_08	DMDFON	LOK	filter value segment duration, operating range 61
FS61_09	DMDFON	LOK	filter value segment duration, operating range 61
FS61_10	DMDFON	LOK	filter value segment duration, operating range 61
FS61_11	DMDFON	LOK	filter value segment duration, operating range 61
FS61_12	DMDFON	LOK	filter value segment duration, operating range 61
FS62_02	DMDFON	LOK	filter value segment duration, operating range 62, cylinder 2
FS62_03	DMDFON	LOK	filter value segment duration, operating range 62
FS62_04	DMDFON	LOK	filter value segment duration, operating range 62
FS62_05	DMDFON	LOK	filter value segment duration, operating range 62
FS62_06	DMDFON	LOK	filter value segment duration, operating range 62
FS62_07	DMDFON	LOK	filter value segment duration, operating range 62
FS62_08	DMDFON	LOK	filter value segment duration, operating range 62
FS62_09	DMDFON	LOK	filter value segment duration, operating range 62
FS62_10	DMDFON	LOK	filter value segment duration, operating range 62
FS62_11	DMDFON	LOK	filter value segment duration, operating range 62
FS62_12	DMDFON	LOK	filter value segment duration, operating range 62
FS63_02	DMDFON	LOK	filter value segment duration, operating range 63, cylinder 2
FS63_03	DMDFON	LOK	filter value segment duration, operating range 63
FS63_04	DMDFON	LOK	filter value segment duration, operating range 63
FS63_05	DMDFON	LOK	filter value segment duration, operating range 63
FS63_06	DMDFON	LOK	filter value segment duration, operating range 63
FS63_07	DMDFON	LOK	filter value segment duration, operating range 63
FS63_08	DMDFON	LOK	filter value segment duration, operating range 63
FS63_09	DMDFON	LOK	filter value segment duration, operating range 63
FS63_10	DMDFON	LOK	filter value segment duration, operating range 63
FS63_11	DMDFON	LOK	filter value segment duration
FS63_12	DMDFON	LOK	filter value segment duration, operating range 63
FS71_02	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 2
FS71_03	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 3
FS71_04	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 4
FS71_05	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 5
FS71_06	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 6
FS71_07	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 7
FS71_08	DMDFON	LOK	filter value segment duration, operating range 71, cylinder 8
FS71_09	DMDFON	LOK	filter value segment duration
FS71_10	DMDFON	LOK	filter value segment duration
FS71_11	DMDFON	LOK	filter value segment duration
FS71_12	DMDFON	LOK	filter value segment duration
FS72_02	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 2
FS72_03	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 3
FS72_04	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 4
FS72_05	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 5
FS72_06	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 6
FS72_07	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 7
FS72_08	DMDFON	LOK	filter value segment duration, operating range 72, cylinder 8
FS72_09	DMDFON	LOK	filter value segment duration
FS72_10	DMDFON	LOK	filter value segment duration
FS72_11	DMDFON	LOK	filter value segment duration
FS72_12	DMDFON	LOK	filter value segment duration
FS73_02	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 2
FS73_03	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 3
FS73_04	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 4
FS73_05	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 5
FS73_06	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 6
FS73_07	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 7
FS73_08	DMDFON	LOK	filter value segment duration, operating range 73, cylinder 8
FS73_09	DMDFON	LOK	filter value segment duration
FS73_10	DMDFON	LOK	filter value segment duration
FS73_11	DMDFON	LOK	filter value segment duration
FS73_12	DMDFON	LOK	filter value segment duration
FS81_02	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 2
FS81_03	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 3
FS81_04	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 4
FS81_05	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 5
FS81_06	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 6
FS81_07	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 7
FS81_08	DMDFON	LOK	filter value segment duration, operating range 81, cylinder 8

Variable	Source	Type	Description
FS81_09	DMDFON	LOK	filter value segment duration
FS81_10	DMDFON	LOK	filter value segment duration
FS81_11	DMDFON	LOK	filter value segment duration
FS81_12	DMDFON	LOK	filter value segment duration
FS82_02	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 2
FS82_03	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 3
FS82_04	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 4
FS82_05	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 5
FS82_06	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 6
FS82_07	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 7
FS82_08	DMDFON	LOK	filter value segment duration, operating range 82, cylinder 8
FS82_09	DMDFON	LOK	filter value segment duration
FS82_10	DMDFON	LOK	filter value segment duration
FS82_11	DMDFON	LOK	filter value segment duration
FS82_12	DMDFON	LOK	filter value segment duration
FS83_02	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 2
FS83_03	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 3
FS83_04	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 4
FS83_05	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 5
FS83_06	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 6
FS83_07	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 7
FS83_08	DMDFON	LOK	filter value segment duration, operating range 83, cylinder 8
FS83_09	DMDFON	LOK	filter value segment duration
FS83_10	DMDFON	LOK	filter value segment duration
FS83_11	DMDFON	LOK	filter value segment duration
FS83_12	DMDFON	LOK	filter value segment duration
FSE	DMDFON	LOK	actual filter value segment duration, for correction of segment duration
FSE11_02	DMDFON	LOK	filter value segment duration, for calculation, operating range 11, cylinder 2
FSE11_03	DMDFON	LOK	filter value segment duration, for calculation
FSE11_04	DMDFON	LOK	filter value segment duration, for calculation
FSE11_05	DMDFON	LOK	filter value segment duration, for calculation
FSE11_06	DMDFON	LOK	filter value segment duration, for calculation
FSE11_07	DMDFON	LOK	filter value segment duration, for calculation
FSE11_08	DMDFON	LOK	filter value segment duration, for calculation
FSE11_09	DMDFON	LOK	filter value segment duration, for calculation
FSE11_10	DMDFON	LOK	filter value segment duration, for calculation
FSE11_11	DMDFON	LOK	filter value segment duration, for calculation
FSE11_12	DMDFON	LOK	filter value segment duration, for calculation
FSE12_02	DMDFON	LOK	filter value segment duration, for calculation
FSE12_03	DMDFON	LOK	filter value segment duration, for calculation
FSE12_04	DMDFON	LOK	filter value segment duration, for calculation
FSE12_05	DMDFON	LOK	filter value segment duration, for calculation
FSE12_06	DMDFON	LOK	filter value segment duration, for calculation
FSE12_07	DMDFON	LOK	filter value segment duration, for calculation
FSE12_08	DMDFON	LOK	filter value segment duration, for calculation
FSE12_09	DMDFON	LOK	filter value segment duration, for calculation
FSE12_10	DMDFON	LOK	filter value segment duration, for calculation
FSE12_11	DMDFON	LOK	filter value segment duration, for calculation
FSE12_12	DMDFON	LOK	filter value segment duration, for calculation
FSE13_02	DMDFON	LOK	filter value segment duration, for calculation
FSE13_03	DMDFON	LOK	filter value segment duration, for calculation
FSE13_04	DMDFON	LOK	filter value segment duration, for calculation
FSE13_05	DMDFON	LOK	filter value segment duration, for calculation
FSE13_06	DMDFON	LOK	filter value segment duration, for calculation
FSE13_07	DMDFON	LOK	filter value segment duration, for calculation
FSE13_08	DMDFON	LOK	filter value segment duration, for calculation
FSE13_09	DMDFON	LOK	filter value segment duration, for calculation
FSE13_10	DMDFON	LOK	filter value segment duration, for calculation
FSE13_11	DMDFON	LOK	filter value segment duration, for calculation
FSE13_12	DMDFON	LOK	filter value segment duration, for calculation
FSE21_02	DMDFON	LOK	filter value segment duration, for calculation
FSE21_03	DMDFON	LOK	filter value segment duration, for calculation
FSE21_04	DMDFON	LOK	filter value segment duration, for calculation
FSE21_05	DMDFON	LOK	filter value segment duration, for calculation
FSE21_06	DMDFON	LOK	filter value segment duration, for calculation
FSE21_07	DMDFON	LOK	filter value segment duration, for calculation
FSE21_08	DMDFON	LOK	filter value segment duration, for calculation
FSE21_09	DMDFON	LOK	filter value segment duration, for calculation
FSE21_10	DMDFON	LOK	filter value segment duration, for calculation
FSE21_11	DMDFON	LOK	filter value segment duration, for calculation
FSE21_12	DMDFON	LOK	filter value segment duration, for calculation
FSE22_02	DMDFON	LOK	filter value segment duration, for calculation
FSE22_03	DMDFON	LOK	filter value segment duration, for calculation
FSE22_04	DMDFON	LOK	filter value segment duration, for calculation
FSE22_05	DMDFON	LOK	filter value segment duration, for calculation
FSE22_06	DMDFON	LOK	filter value segment duration, for calculation
FSE22_07	DMDFON	LOK	filter value segment duration, for calculation
FSE22_08	DMDFON	LOK	filter value segment duration, for calculation
FSE22_09	DMDFON	LOK	filter value segment duration, for calculation
FSE22_10	DMDFON	LOK	filter value segment duration, for calculation
FSE22_11	DMDFON	LOK	filter value segment duration, for calculation
FSE22_12	DMDFON	LOK	filter value segment duration, for calculation

Variable	Source	Type	Description
FSE23_02	DMDFON	LOK	filter value segment duration, for calculation
FSE23_03	DMDFON	LOK	filter value segment duration, for calculation
FSE23_04	DMDFON	LOK	filter value segment duration, for calculation
FSE23_05	DMDFON	LOK	filter value segment duration, for calculation
FSE23_06	DMDFON	LOK	filter value segment duration, for calculation
FSE23_07	DMDFON	LOK	filter value segment duration, for calculation
FSE23_08	DMDFON	LOK	filter value segment duration, for calculation
FSE23_09	DMDFON	LOK	filter value segment duration, for calculation
FSE23_10	DMDFON	LOK	filter value segment duration, for calculation
FSE23_11	DMDFON	LOK	filter value segment duration, for calculation
FSE23_12	DMDFON	LOK	filter value segment duration, for calculation
FSE31_02	DMDFON	LOK	filter value segment duration, for calculation
FSE31_03	DMDFON	LOK	filter value segment duration, for calculation
FSE31_04	DMDFON	LOK	filter value segment duration, for calculation
FSE31_05	DMDFON	LOK	filter value segment duration, for calculation
FSE31_06	DMDFON	LOK	filter value segment duration, for calculation
FSE31_07	DMDFON	LOK	filter value segment duration, for calculation
FSE31_08	DMDFON	LOK	filter value segment duration, for calculation
FSE31_09	DMDFON	LOK	filter value segment duration, for calculation
FSE31_10	DMDFON	LOK	filter value segment duration, for calculation
FSE31_11	DMDFON	LOK	filter value segment duration, for calculation
FSE31_12	DMDFON	LOK	filter value segment duration, for calculation
FSE32_02	DMDFON	LOK	filter value segment duration, for calculation
FSE32_03	DMDFON	LOK	filter value segment duration, for calculation
FSE32_04	DMDFON	LOK	filter value segment duration, for calculation
FSE32_05	DMDFON	LOK	filter value segment duration, for calculation
FSE32_06	DMDFON	LOK	filter value segment duration, for calculation
FSE32_07	DMDFON	LOK	filter value segment duration, for calculation
FSE32_08	DMDFON	LOK	filter value segment duration, for calculation
FSE32_09	DMDFON	LOK	filter value segment duration, for calculation
FSE32_10	DMDFON	LOK	filter value segment duration, for calculation
FSE32_11	DMDFON	LOK	filter value segment duration, for calculation
FSE32_12	DMDFON	LOK	filter value segment duration, for calculation
FSE33_02	DMDFON	LOK	filter value segment duration, for calculation
FSE33_03	DMDFON	LOK	filter value segment duration, for calculation
FSE33_04	DMDFON	LOK	filter value segment duration, for calculation
FSE33_05	DMDFON	LOK	filter value segment duration, for calculation
FSE33_06	DMDFON	LOK	filter value segment duration, for calculation
FSE33_07	DMDFON	LOK	filter value segment duration, for calculation
FSE33_08	DMDFON	LOK	filter value segment duration, for calculation
FSE33_09	DMDFON	LOK	filter value segment duration, for calculation
FSE33_10	DMDFON	LOK	filter value segment duration, for calculation
FSE33_11	DMDFON	LOK	filter value segment duration, for calculation
FSE33_12	DMDFON	LOK	filter value segment duration, for calculation
FSE41_02	DMDFON	LOK	filter value segment duration, for calculation
FSE41_03	DMDFON	LOK	filter value segment duration, for calculation
FSE41_04	DMDFON	LOK	filter value segment duration, for calculation
FSE41_05	DMDFON	LOK	filter value segment duration, for calculation
FSE41_06	DMDFON	LOK	filter value segment duration, for calculation
FSE41_07	DMDFON	LOK	filter value segment duration, for calculation
FSE41_08	DMDFON	LOK	filter value segment duration, for calculation
FSE41_09	DMDFON	LOK	filter value segment duration, for calculation
FSE41_10	DMDFON	LOK	filter value segment duration, for calculation
FSE41_11	DMDFON	LOK	filter value segment duration, for calculation
FSE41_12	DMDFON	LOK	filter value segment duration, for calculation
FSE42_02	DMDFON	LOK	filter value segment duration, for calculation
FSE42_03	DMDFON	LOK	filter value segment duration, for calculation
FSE42_04	DMDFON	LOK	filter value segment duration, for calculation
FSE42_05	DMDFON	LOK	filter value segment duration, for calculation
FSE42_06	DMDFON	LOK	filter value segment duration, for calculation
FSE42_07	DMDFON	LOK	filter value segment duration, for calculation
FSE42_08	DMDFON	LOK	filter value segment duration, for calculation
FSE42_09	DMDFON	LOK	filter value segment duration, for calculation
FSE42_10	DMDFON	LOK	filter value segment duration, for calculation
FSE42_11	DMDFON	LOK	filter value segment duration, for calculation
FSE42_12	DMDFON	LOK	filter value segment duration, for calculation
FSE43_02	DMDFON	LOK	filter value segment duration, for calculation
FSE43_03	DMDFON	LOK	filter value segment duration, for calculation
FSE43_04	DMDFON	LOK	filter value segment duration, for calculation
FSE43_05	DMDFON	LOK	filter value segment duration, for calculation
FSE43_06	DMDFON	LOK	filter value segment duration, for calculation
FSE43_07	DMDFON	LOK	filter value segment duration, for calculation
FSE43_08	DMDFON	LOK	filter value segment duration, for calculation
FSE43_09	DMDFON	LOK	filter value segment duration, for calculation
FSE43_10	DMDFON	LOK	filter value segment duration, for calculation
FSE43_11	DMDFON	LOK	filter value segment duration, for calculation
FSE43_12	DMDFON	LOK	filter value segment duration, for calculation
FSE51_02	DMDFON	LOK	filter value segment duration, for calculation
FSE51_03	DMDFON	LOK	filter value segment duration, for calculation
FSE51_04	DMDFON	LOK	filter value segment duration, for calculation
FSE51_05	DMDFON	LOK	filter value segment duration, for calculation
FSE51_06	DMDFON	LOK	filter value segment duration, for calculation

Variable	Source	Type	Description
FSE51_07	DMDFON	LOK	filter value segment duration, for calculation
FSE51_08	DMDFON	LOK	filter value segment duration, for calculation
FSE51_09	DMDFON	LOK	filter value segment duration, for calculation
FSE51_10	DMDFON	LOK	filter value segment duration, for calculation
FSE51_11	DMDFON	LOK	filter value segment duration, for calculation
FSE51_12	DMDFON	LOK	filter value segment duration, for calculation
FSE52_02	DMDFON	LOK	filter value segment duration, for calculation
FSE52_03	DMDFON	LOK	filter value segment duration, for calculation
FSE52_04	DMDFON	LOK	filter value segment duration, for calculation
FSE52_05	DMDFON	LOK	filter value segment duration, for calculation
FSE52_06	DMDFON	LOK	filter value segment duration, for calculation
FSE52_07	DMDFON	LOK	filter value segment duration, for calculation
FSE52_08	DMDFON	LOK	filter value segment duration, for calculation
FSE52_09	DMDFON	LOK	filter value segment duration, for calculation
FSE52_10	DMDFON	LOK	filter value segment duration, for calculation
FSE52_11	DMDFON	LOK	filter value segment duration, for calculation
FSE52_12	DMDFON	LOK	filter value segment duration, for calculation
FSE53_02	DMDFON	LOK	filter value segment duration, for calculation
FSE53_03	DMDFON	LOK	filter value segment duration, for calculation
FSE53_04	DMDFON	LOK	filter value segment duration, for calculation
FSE53_05	DMDFON	LOK	filter value segment duration, for calculation
FSE53_06	DMDFON	LOK	filter value segment duration, for calculation
FSE53_07	DMDFON	LOK	filter value segment duration, for calculation
FSE53_08	DMDFON	LOK	filter value segment duration, for calculation
FSE53_09	DMDFON	LOK	filter value segment duration, for calculation
FSE53_10	DMDFON	LOK	filter value segment duration, for calculation
FSE53_11	DMDFON	LOK	filter value segment duration, for calculation
FSE53_12	DMDFON	LOK	filter value segment duration, for calculation
FSE61_02	DMDFON	LOK	filter value segment duration, for calculation
FSE61_03	DMDFON	LOK	filter value segment duration, for calculation
FSE61_04	DMDFON	LOK	filter value segment duration, for calculation
FSE61_05	DMDFON	LOK	filter value segment duration, for calculation
FSE61_06	DMDFON	LOK	filter value segment duration, for calculation
FSE61_07	DMDFON	LOK	filter value segment duration, for calculation
FSE61_08	DMDFON	LOK	filter value segment duration, for calculation
FSE61_09	DMDFON	LOK	filter value segment duration, for calculation
FSE61_10	DMDFON	LOK	filter value segment duration, for calculation
FSE61_11	DMDFON	LOK	filter value segment duration, for calculation
FSE61_12	DMDFON	LOK	filter value segment duration, for calculation
FSE62_02	DMDFON	LOK	filter value segment duration, for calculation
FSE62_03	DMDFON	LOK	filter value segment duration, for calculation
FSE62_04	DMDFON	LOK	filter value segment duration, for calculation
FSE62_05	DMDFON	LOK	filter value segment duration, for calculation
FSE62_06	DMDFON	LOK	filter value segment duration, for calculation
FSE62_07	DMDFON	LOK	filter value segment duration, for calculation
FSE62_08	DMDFON	LOK	filter value segment duration, for calculation
FSE62_09	DMDFON	LOK	filter value segment duration, for calculation
FSE62_10	DMDFON	LOK	filter value segment duration, for calculation
FSE62_11	DMDFON	LOK	filter value segment duration, for calculation
FSE62_12	DMDFON	LOK	filter value segment duration, for calculation
FSE63_02	DMDFON	LOK	filter value segment duration, for calculation
FSE63_03	DMDFON	LOK	filter value segment duration, for calculation
FSE63_04	DMDFON	LOK	filter value segment duration, for calculation
FSE63_05	DMDFON	LOK	filter value segment duration, for calculation
FSE63_06	DMDFON	LOK	filter value segment duration, for calculation
FSE63_07	DMDFON	LOK	filter value segment duration, for calculation
FSE63_08	DMDFON	LOK	filter value segment duration, for calculation
FSE63_09	DMDFON	LOK	filter value segment duration, for calculation
FSE63_10	DMDFON	LOK	filter value segment duration, for calculation
FSE63_11	DMDFON	LOK	filter value segment duration, for calculation
FSE63_12	DMDFON	LOK	filter value segment duration, for calculation
FSE71_02	DMDFON	LOK	filter value segment duration, for calculation
FSE71_03	DMDFON	LOK	filter value segment duration, for calculation
FSE71_04	DMDFON	LOK	filter value segment duration, for calculation
FSE71_05	DMDFON	LOK	filter value segment duration, for calculation
FSE71_06	DMDFON	LOK	filter value segment duration, for calculation
FSE71_07	DMDFON	LOK	filter value segment duration, for calculation
FSE71_08	DMDFON	LOK	filter value segment duration, for calculation
FSE71_09	DMDFON	LOK	filter value segment duration, for calculation
FSE71_10	DMDFON	LOK	filter value segment duration, for calculation
FSE71_11	DMDFON	LOK	filter value segment duration, for calculation
FSE71_12	DMDFON	LOK	filter value segment duration, for calculation
FSE72_02	DMDFON	LOK	filter value segment duration, for calculation
FSE72_03	DMDFON	LOK	filter value segment duration, for calculation
FSE72_04	DMDFON	LOK	filter value segment duration, for calculation
FSE72_05	DMDFON	LOK	filter value segment duration, for calculation
FSE72_06	DMDFON	LOK	filter value segment duration, for calculation
FSE72_07	DMDFON	LOK	filter value segment duration, for calculation
FSE72_08	DMDFON	LOK	filter value segment duration, for calculation
FSE72_09	DMDFON	LOK	filter value segment duration, for calculation
FSE72_10	DMDFON	LOK	filter value segment duration, for calculation
FSE72_11	DMDFON	LOK	filter value segment duration, for calculation

Variable	Source	Type	Description
FSE72_12	DMDFON	LOK	filter value segment duration, for calculation
FSE73_02	DMDFON	LOK	filter value segment duration, for calculation
FSE73_03	DMDFON	LOK	filter value segment duration, for calculation
FSE73_04	DMDFON	LOK	filter value segment duration, for calculation
FSE73_05	DMDFON	LOK	filter value segment duration, for calculation
FSE73_06	DMDFON	LOK	filter value segment duration, for calculation
FSE73_07	DMDFON	LOK	filter value segment duration, for calculation
FSE73_08	DMDFON	LOK	filter value segment duration, for calculation
FSE73_09	DMDFON	LOK	filter value segment duration, for calculation
FSE73_10	DMDFON	LOK	filter value segment duration, for calculation
FSE73_11	DMDFON	LOK	filter value segment duration, for calculation
FSE73_12	DMDFON	LOK	filter value segment duration, for calculation
FSE81_02	DMDFON	LOK	filter value segment duration, for calculation
FSE81_03	DMDFON	LOK	filter value segment duration, for calculation
FSE81_04	DMDFON	LOK	filter value segment duration, for calculation
FSE81_05	DMDFON	LOK	filter value segment duration, for calculation
FSE81_06	DMDFON	LOK	filter value segment duration, for calculation
FSE81_07	DMDFON	LOK	filter value segment duration, for calculation
FSE81_08	DMDFON	LOK	filter value segment duration, for calculation
FSE81_09	DMDFON	LOK	filter value segment duration, for calculation
FSE81_10	DMDFON	LOK	filter value segment duration, for calculation
FSE81_11	DMDFON	LOK	filter value segment duration, for calculation
FSE81_12	DMDFON	LOK	filter value segment duration, for calculation
FSE82_02	DMDFON	LOK	filter value segment duration, for calculation
FSE82_03	DMDFON	LOK	filter value segment duration, for calculation
FSE82_04	DMDFON	LOK	filter value segment duration, for calculation
FSE82_05	DMDFON	LOK	filter value segment duration, for calculation
FSE82_06	DMDFON	LOK	filter value segment duration, for calculation
FSE82_07	DMDFON	LOK	filter value segment duration, for calculation
FSE82_08	DMDFON	LOK	filter value segment duration, for calculation
FSE82_09	DMDFON	LOK	filter value segment duration, for calculation
FSE82_10	DMDFON	LOK	filter value segment duration, for calculation
FSE82_11	DMDFON	LOK	filter value segment duration, for calculation
FSE82_12	DMDFON	LOK	filter value segment duration, for calculation
FSE83_02	DMDFON	LOK	filter value segment duration, for calculation
FSE83_03	DMDFON	LOK	filter value segment duration, for calculation
FSE83_04	DMDFON	LOK	filter value segment duration, for calculation
FSE83_05	DMDFON	LOK	filter value segment duration, for calculation
FSE83_06	DMDFON	LOK	filter value segment duration, for calculation
FSE83_07	DMDFON	LOK	filter value segment duration, for calculation
FSE83_08	DMDFON	LOK	filter value segment duration, for calculation
FSE83_09	DMDFON	LOK	filter value segment duration, for calculation
FSE83_10	DMDFON	LOK	filter value segment duration, for calculation
FSE83_11	DMDFON	LOK	filter value segment duration, for calculation
FSE83_12	DMDFON	LOK	filter value segment duration, for calculation
FZABGS		EIN	fault counter, summary, counts emission relevant misfirings of all cylinders
IDXFOB	DMDFON	LOK	index: shows actual map range (speed, load)
IDXFON	DMDFON	LOK	speed index operating range fuel-on adaptation
IDXFORL	DMDFON	LOK	load index operating range fuel-on adaptation
LUNW	DMDFON	LOK	Engine roughness for 1 camshaft revolution
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
R_SYN	GGDPG	EIN	Synchro schedule
TNST_W	BBSTT	EIN	time after end of start
TS01	DMDFON	LOK	segment duration cylinder 1
TS02	DMDFON	LOK	segment duration cylinder 2
TS03	DMDFON	LOK	segment duration cylinder 3
TS04	DMDFON	LOK	segment duration cylinder 4
TS05	DMDFON	LOK	segment duration cylinder 5
TS06	DMDFON	LOK	segment duration cylinder 6
TS07	DMDFON	LOK	segment duration cylinder 7
TS08	DMDFON	LOK	segment duration cylinder 8
TSK	DMDFON	AUS	corrected segment duration
TSK01	DMDFON	LOK	corrected segment duration cylinder 1
TSK02	DMDFON	LOK	corrected segment duration cylinder 2
TSK03	DMDFON	LOK	corrected segment duration cylinder 3
TSK04	DMDFON	LOK	corrected segment duration cylinder 4
TSK05	DMDFON	LOK	corrected segment duration cylinder 5
TSK06	DMDFON	LOK	corrected segment duration cylinder 6
TSK07	DMDFON	LOK	corrected segment duration cylinder 7
TSK08	DMDFON	LOK	corrected segment duration cylinder 8
TSK_M	DMDFON	LOK	monitor corrected segment duration
TSROH2_W	DMDTSB	EIN	second segment duration uncorrected (just for 2 control units)
TSROH_W	DMDTSB	EIN	segment duration uncorrected
TS_M	DMDFON	LOK	monitor segment duration
XS02	DMDFON	LOK	segment deviation, standardized
XS03	DMDFON	LOK	segment deviation, standardized
XS04	DMDFON	LOK	segment deviation, standardized
XS05	DMDFON	LOK	segment deviation, standardized
XS06	DMDFON	LOK	segment deviation, standardized
XS07	DMDFON	LOK	segment deviation, standardized

Variable	Source	Type	Description
XS08	DMDFON	LOK	segment deviation, standardized
ZZYL	GGDPG	EIN	SW-cylinder counter

FW DMDFON 6.40 Fixed Values

Parameter	Value	Description
ALFO		start value for learning filter at fuel-on/fuel-off adaptation
ANWFOHE		number of camshaft rotations for healing
ANWFOST		number of camshaft rotations for reactivation the adaptation after disabling
CDFO		code to deactivate and reset the adaptation
DFSERES		difference of adaptation values to reset fuel-on/-off adaptation
FLFO		filter factor for learningfilter of fuel-on/-off adaptation
FS1FO		filter factor segment duration filter 1 of fuel-on/-off adaptation
FS2FO		filter factor segment duration filter 2 of fuel-on/-off adaptation
LURFOST		engine roughness referenz value for stop of the fuel-on/-off adaptation
MDERFOKH		number of misfires to stop adaptation (healing) when B_kh = 1
MDERKFON		number of misfires to stop adaptation (healing)
SLFOU		lower threshold for learning filter value at fuel-on/-off adaptation
TNSTFON		time after engine start to enable adaptation stop (healing)

FB DMDFON 6.40 Detailed description of function

1.1. Introduction:

The adaptation learns systematic camshaft-synchronous and therewith cylinder-individual disturbances of the segment time tsroh_w (in addition tsroh2_w if there are two control units). These disturbances include disturbances caused by mechanical inaccuracies of the sensor wheel (crankshaft-synchronous) as well as distrubances caused by torsional vibrations (camshaft-synchronous).

The adaptation can be performed during load operation (fuel-on adaptation -> "fon") and during fuel cut-off operation (fuel-off adaptation -> "fof").

The adaptation is stopped if misfire operation is detected and during non-steady-state operating conditions.

1.2. Data acquisition:

The duration of crankshaft segments is measured continuously and stored in a drum memory. The data are then processed asynchronously. (The values no longer needed are deleted so that updated measuring values may always be entered into the memory.) More details of the drum memory are described in %DMDUE. Measured values that come from the drum memory are marked by the extension _m.

The data stored in the memory comply with the segment duration of consecutive segments.

More details of data acquisition and application of the measurement window are shown in %DMDTSB.

1.3. Overview of operating ranges (load and engine speed ranges):

24 operating ranges are defined. Eight speed base points (x) and three load base points (y) are used to share out these ranges. The currently active range is identified by the index idxfob. If the current map range is out of a range that is used for adaptation then idxfob is set to 0.

The operating ranges are set by the nmot/rl base points of the characteristic map KFCFO:

```
        y4      +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
        rl3    _|         13|         23|         33|         43|         53|         63|         73|        83*|_
    ^           |           |           |           |           |           |           |           |           |
    |   y3      +-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+
 rl |   rl2    _|         12|         22|         32|         42|         52|         62|         72|         83|_
    |           |           |           |           |           |           |           |           |           |
        y2      +-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+
        rl1    _|         11|         21|         31|         41|         51|         61|         71|         81|_
                |           |           |           |           |           |           |           |           |
        y1      +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
                x1    |     x2          x3          x4          x5          x6          x7          x8          x9

                      n1          n2          n3          n4          n5          n6          n7          n8

                                                                                                --------> nmot


        n1, ...: engine speed base points of KFCFO for the interpolation of fse.. (shown by index: idxfon)
        rl1,...: load base points of KFCFO for the interpolation of fse.. (shown by index: idxforl)
        x1,....: engine speed range limits, are calculated from n*:
                x1 = n1 - (n2-n1)/2,     x2 = n2 - (n2-n1)/2,      x3 = n3 - (n3-n2)/2  .........  x9 = n8 + (n8-n7)/2

        y1,....: load range limits, are calculated from rl*:
                y1 = rl1 - (rl2-rl1)/2,  y2 = rl2 - (rl2-rl1)/2,   y3 = rl3 - (rl3-rl2)/2  ......  y4 = rl3 + (rl3-rl2)/2

        *: Index: idxfob   (current characteristic map range)
```

1.4. Overview of RAM areas resp. of the adaptation values stored in the RAM:

In each of the 3x8 nmot/rl-ranges (zylza - 1) filter values fsxx_02, fsxx_03, ... , fsxx_(zylza) are formed.
The values are each time stored non-volatily in the cache of the RAM. The values indicate the current status of the adaptation in the individual operating ranges.

```
                                                           fsxx_(zylza)  +---+---+---+---+---+---+---+---+
                                                                         +---+---+---+---+---+---+---+---+
                    fsxx_04         +---+---+---+---+---+---+---+---+    +---+---+---+---+---+---+---+---+
                fsxx_03      +---+--++--++--++--++--++--++--++--+---+    +---+---+---+---+---+---+---+---+
            fsxx_02    +---+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+---+--+---+
                       +---+---+---+---+---+---+---+---+-+---+--+---+                   amount: zylza - 1
                       +---+---+---+---+---+---+---+---+-+---+
                       +---+---+---+---+---+---+---+---+
```

There also exists a RAM characteristic map reflecting current filter values fsexx_(Zdg) (i) which are used for the calculation of the segment time correction.

Segment time correction:
By interpolation over load and engine speed the correcting value is formed from the range-specific filter values fsexx_(Zdg)(i). The raw segment time ts(n) is corrected synchronous to ignition by the interpolation result fse(n). The product is the corrected segment duration tsk(n) (e.g. tsk(n) = (1 + fse(n)) * ts(n)).

(Attention: ECU-internal calculation; in the VS100-system fse is given in degrees crankshaft).
The inclusion in the calculation depends on the progress of the adaptation.

```
                                                          fsexx_(zylza)  +---+---+---+---+---+---+---+---+
                                                                         +---+---+---+---+---+---+---+---+
                   fsexx_04         +---+---+---+---+---+---+---+---+    +---+---+---+---+---+---+---+---+
               fsexx_03      +---+--++--++--++--++--++--++--++--+---+    +---+---+---+---+---+---+---+---+
           fsexx_02    +---+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+---+--+---+
                       +---+---+---+---+---+---+---+---+-+---+--+---+                   amount: zylza - 1
                       +---+---+---+---+---+---+---+---+-+---+
                       +---+---+---+---+---+---+---+---+
```

In each of the 3x8 nmot/rl-ranges 2 * (zylza - 1) learning filter values are formed. The values are also stored non-volatily in the cache of the RAM.

```
                                                          flpxx_(zylza)  +---+---+---+---+---+---+---+---+
                                                                         +---+---+---+---+---+---+---+---+
                   flpxx_04         +---+---+---+---+---+---+---+---+    +---+---+---+---+---+---+---+---+
               flpxx_03      +---+--++--++--++--++--++--++--++--+---+    +---+---+---+---+---+---+---+---+
           flpxx_02    +---+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+---+--+---+
                       +---+---+---+---+---+---+---+---+-+---+--+---+                   amount: zylza - 1
                       +---+---+---+---+---+---+---+---+-+---+
                       +---+---+---+---+---+---+---+---+

                                                          flnxx_(zylza)  +---+---+---+---+---+---+---+---+
                                                                         +---+---+---+---+---+---+---+---+
                   flnxx_04         +---+---+---+---+---+---+---+---+    +---+---+---+---+---+---+---+---+
               flnxx_03      +---+--++--++--++--++--++--++--++--+---+    +---+---+---+---+---+---+---+---+
           flnxx_02    +---+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+---+--+---+
                       +---+---+---+---+---+---+---+---+-+---+--+---+                   amount: zylza - 1
                       +---+---+---+---+---+---+---+---+-+---+
                       +---+---+---+---+---+---+---+---+
```

Furthermore the adaptation status B_forxx is also stored range-specifically in the RAM:
B_forxx = 1: Adaptation stabilized resp. completed;
B_forxx = 0: Adaptation not yet stabilized

```
                             B_forxx       +---+---+---+---+---+---+---+---+
                                           +---+---+---+---+---+---+---+---+
                                           +---+---+---+---+---+---+---+---+
                                           ++--++--+---+---+---+---+---++--+
            z. B.:        B_for11   --------+   |                       |
                          B_for21   ------------+    . . . . . . . . .  |
                          B_for81   ------------------------------------+
```

2. Calculation procedure:

The adaptation comprises the following points:
Calculation of cylinder assignment, segment deviation, dynamic correction, normalization and filtering.

2.1. Overview:

```
                            +-------+
tsroh_w, (tsroh2_w) ------->|cyl.-  +------> B_mdzyl1
                            |assign-|
zzyl ---------------------->|ment   +------+ ts01...ts(zylza)
                            +-------+      |
                                           |
               +---------------------------+
               |                                                              e.g. operating range 01
               |   +-----------+            +---------+                       +----------------+
               |   |segment-   | ds02..     |         | xs02..                | ˆ FS1FO  *  *  |    fs11_02..
               +-->+deviat.    +----------->|normaliz.+-----------o o------o->| |     *        +--o--------->
                   |+ dyn.comp.| ..ds(zylza)|         |.xs(zylza)  /       |  | |  *   FS2FO   |  |..fs11_(zylza)
                   +-----------+            +---------+            ˆ       |  +--*-------------+  |
                                                                   |       v                      |
                                                                   |      -o<---------------------+
                                                                   |       |
                                                                   |       |  +----------------+
                                                                   |       |  | ˆ*      FLFO   |
                                                                   |       |  | |  *           |
B_forun -----------------------------------------------------------+       |  | |     *        | flp11_(Zdg)
                                                                           +->+-+---------*--*-+------------->
                                                                              | |     *        | fln11_(Zdg)
                                                                              | |  *           | flmx
                                                                              | v*             |
                                                                              +-+--------------+
                                                                           .
                                                                           .  e.g. operating range xx
                                                                           .  +----------------+
                                                                  .        .  | ˆ FS1FO  *  *  |    fsxx_02..
                                                                  .  -o o--o->| |     *        +--o--------->
                                                                  .    /   |  | |  *    FS2FO  |  |..fsxx_(zylza)
                                                                  .        |  +-+--------------+  |
                                                                  .        v                      |
                                                                  .      - o<---------------------+
                                                                           |         .
ds02,...ds(zylza): segment deviation (see 2.4)                                       .
xs02,...xs(zylza): segment deviation standardized (see 2.4)
```

Values that are stored im the drum memory (see %DMDUE) cannot be measured directly. They can only be measured with a time delay. Corresponding values are marked with the extension _m.

2.2. Conditions for adaptation:

2.2.1. Conditions for fuel-on adaptation resp. setting of B_fon:

Overview:

```
1. lunw < LURFOST,           +-+
   B_folunw --------------->o| |
                             | |
2. B_fohold --------------->o| |
                             | |
3. B_mdstop --------------->o| |
                             | |
4. B_fonstp --------------->o| |
                             |&+-----------------------------------> B_fon
5. CDFO > 0  --------------->| |
                             | |
6.       +----------+        | |
nmot---->|checking  |        | |
         |operating +------->| |
 rl----->|range     |        | |
         +----------+        +-+
```

Fuel-on adaptation is carried out (B_fon = 1) if
1. no strong segment time changes occur (lunw(n) <= LURFOST); B_folunw = 0.
   These segment time changes may be caused by misfire or by engine speed dynamics.

$$lunw(n) \quad = \quad \frac{abs\ [\ tsk(n)\ -\ tsk(n-zylza)\ ]}{tsk(n)\ \hat{}\ 3}$$

(The conversion is done in (U/s)ˆ2 -> dimension engine roughness -> conversion by fluq -> see %DMDLU)

2. no misfires are detected (in this case all detection methods are taken into consideration) and the learning filter flmx does not drift away (flmx <= SLFOON, B_fohold = 0). See chapter "healing"

3. no deactivation of misfire detection or fuel-on adaptation occurs (B_mdstop=0, B_fonstp=0).

4. no further conditions to deactivate fuel-on adaptation occur (see %DMDSTP).

5. The adaptation can be switched off by the code word CDFO. CDFO > 0: function active. By means of the code word CDFO the adaptation can also be reset (like after powerfail): CDFO -> 0, thereafter again CDFO > 0 to reactivate the adaptation.

6. the engine speed and the load lie within one of the operating ranges.

Since calculation is carried out asynchronously (virtually off-line) a retroactive masking is performed on the already stored values (for this look at "Course of the calculation": Favourable: retroactive masking for e.g. 2 camshaft revolutions)

2.2.2. Conditions for fuel-off adaptation resp. setting of B_fof:

Overview:

```
1. lunw < LURFOST,           +-+
   B_folunw --------------->o| |
                             | |
2. B_fofstp --------------->o|&|----------------------------> B_fof
                             | |
3. CDFO > 0  --------------->| |
                             | |
4.       +-----------+       | |
         |checking   |       | |
nmot --->|eng. speed +------>| |
         |range      |       | |
         +-----------+       +-+
```

A fuel-off adaptation is carried out if
1. no strong segment time changes occur (lunw(n) <= LURFOST); B_folunw = 0. (see fuel-on adaptation)

2. no deactivation of fuel-off-Adaptation occurs (B_fofstp=0).

3. see above, as with B_fon

4. there exists a corresponding engine speed range (set by KFCFO; value 4 in lowest operation range of the speed range => fuel cut-off range)

Since calculation is carried out asynchronously (virtually off-line) a retroactive masking is performed on the already stored values (for this look at "Course of the calculation": Favourable: retroactive masking for e.g. 2 camshaft revolutions)

2.2.3. Further conditions for the learning start (learning strategy):

Once the condtions for fuel-on (B_fon) or fuel-off adaptation (B-fof) have been fulfilled, ANWFOST camshaft revolutions are still waited for, until the learning starts (-> camshaft counter anwfos).

Due to the learning strategy, the learning may be blocked in a map range at a certain moment. An engine speed dominant range, for example, cannot learn until a dominant range has stabilized. A normal range cannot learn until the engine speed dominant range of the engine speed range has stabilized.
(Description of the range characteristics see chapter 3.1)

```
B_tsroov ---------------------------+
                                    | RESET
                                    v
                      +-+         +----------------+
B_fon --------------->| |         | ANWFOST +----  |         +-+
                      |v+-------->| --------+----> +-------->| |
B_fof --------------->| |         |                | B_foxfg | |
                      +-+         +----------------+         | |
                                     |                       | |
                                     +-> anwfos              |&+---------------->
                                                             | |    B_forun
                                             +-+             | |
B_fodo ------------------------------------->| |             | |
                                             | +------------>| |
B_fos -------------------------------------->| |             +-+
                       +-+                   | |
B_fodon -------------->| |                   |V|
                       |&|------------------>| |
B_fordo -------------->| |                   | |
                       +-+                   | |
B_forn ------------------------------------->| |
                                             +-+
```

2.3. Cylinder assignment of individual segments:
During adaptation the segment of cylinder 1 (ts01, B_mdzyl1 = 1) is used as the reference (is not corrected).
The other segments (for 4 cyl.: ts02, ts03, ts04) are corrected during the segment time calculation by the learned filter value fsexx_(Zdg)(n).

The chronological sequence of crankshaft segments (period of individual ignition intervals) and their designations are illustrated in the following diagrams:

Example 4-cylinder engine:
The cylinders are listed in their firing order.

```
    cyl. - signal (B_luzyl)             +-----------+                                    +-----------+
                ------------------------+           +------------------------------------+           +----

                |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |
                |     :     |     :     |     :     |     :     |     :     |     :     |     :     |           |
            ----+-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+--
      tsroh_w    <ts03(i-1)> <ts04(i-1)> <-ts01(i)-> <-ts02(i)-> <-ts03(i)-> <-ts04(i)->
                  (180 deg.)              seg. of
                                          cyl.1 resp.
                                          1. Ign.     2. Ign.      3. Ign.    4. Ign.     1. Ign.
```

Example 6-cylinder engine:

```
    cyl. - signal (B_Luzyl)             +-----------+
                 -----------------------+           +----------------------------------------------------

                |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC    |   UTDC     |
                |     :     |     :     |     :     |     :     |     :     |     :     |     :     |            |
            ----+-----------+-----------+-----------+-----------+-----------+-----------+-----------+------------+--
      tsroh_w    <ts05(i-1)> <ts06(i-1)> <-ts01(i)-> <-ts02(i)-> <-ts03(i)-> <-ts04(i)-> <-ts05(i)-> <-ts06(i)->
                  (120 deg.)               seg. of
                                           cyl.1
                                           1. Ign.     2. Ign.      3. Ign.    4. Ign.     5. Ign.    6. Ign.
```

2.4. Calculation of segment deviation and dynamic correction: The calculation described below occurs at every camshaft revolution.
The deviation between a computed value and a measured value (for 2 camshaft revolutions) is evaluated.
The computed value is composed of the reference segment and a dynamic correction.
(The dynamic correction is determined by linear interpolation and serves to compensate for an increase or reduction in engine speed.)

Segment deviation = Reference segment - Measured value + Dynamic correction

Example 4-cylinder engine:

$$ds02(i) = ts01(i) - ts02(i) + \frac{ts01(i+1) - ts01(i)}{zylza}$$

$$ds03(i) = ts01(i) - ts03(i) + \frac{2 * [\, ts01(i+1) - ts01(i) \,]}{zylza}$$

$$ds04(i) = ts01(i) - ts04(i) + \frac{3 * [\, ts01(i+1) - ts01(i) \,]}{zylza}$$

2.5. Normalization of segment deviations:
Subsequent division by the corresponding segment e.g. ts02(i) converts the deviation into an angle-proportional variable (independent of engine speed), which corresponds to the deviation of the segments.

$$xs02'(i) = \frac{ts02(i) + ds02(i)}{ts02(i)}$$

$$xs03'(i) = \frac{ts03(i) + ds03(i)}{ts03(i)}$$

$$xs04'(i) = \frac{ts04(i) + ds04(i)}{ts04(i)}$$

The values xs02‘, xs03‘... are displayed in deg. crankshaft.

```
               ds02(i)
xs02(i) = ----------------
              ts02(i)
```

xs02‘(i) = 1 + xs02(i)

2.6. Filtering of segment deviation resp. calculation of filter values fsxx_(Zdg)(i):
The normalized differential segment times xs*(i) are smoothed by a low-pass filter (filter factor FS1FO or FS2FO).
The result represents the range-specific filter value fsxx_(Zdg)(i):
[Zdg: from 2..zylza]

fsxx_(Zdg)(i) = (1 - FS1/2FO) * fsxx_(Zdg)(i-1) + (FS1/2FO) * xs(Zdg)(i)

```
xs02      +---------------------+    fsxx_02
xs03      | ^ FS1FO       * * * |    fsxx_03
    ----->| |     *             |------>
xs04      | |  *        FS2FO   |    fsxx_04
          +--*------------------+
```

fsxx_(Zdg)(i) is formed in each operating range from the current differential segment times.
The currently learning range is identified by the index idxfob.
The segment time filter values fsxx_(Zdg)(i) are stored non-volatily in the RAM for each operating range. (Output of the filter values fsxx_(Zdg)(i) in the unit deg. crankshaft.)

A restriction to plausible maximum values is performed:
- ALFO <= fsxx_(Zdg)(i) <= ALFO   (Unit: in deg. crankshaft as deviation from reference segment)

ALFO corresponds to the greatest possible deviation (sensor wheel tolerances and torsional vibrations).

The filter factors FS1FO resp. FS2FO are dictated by adjustable fixed values, whereby FS1FO resp. FS2FO are selected dependent on the progress of the adaptation:
FS1FO, if B_forxx=0
FS2FO, if B_forxx=1

The correction of the segment times (with the filter values) takes into account the learning progress or adaptationstatus.
Dependent on the progress, either the current filter value fsxx_(Zdg)(i) or a filter value from the adjacent rangesis used.
(See "Learning strategy")
The filter value used for segment time correction is designated is formed by interplation between the individual operating range filter values fsexx_(Zdg)(i).

2.7.Calculation of learning progress resp. calculation of flpxx_(Zdg)(i)/flnxx_(Zdg)(i) and flmx(i):

Overview learning filter:

```
                                                                            > SLFOON, then B_forxx = 0, FS1FO
                    +-----------------+             +-----------+          +-----------+----
                    | ^ *      FLFO   | flpxx_(Zdg) | max       | flmx(i)  |           ^
xs(Zdg)    -------->| |  *            +------------>| (|flpxx_|,+--------->|           |<--------
 - fsxx_(Zdg)       | |      * * *    | flnxx_(Zdg) |  |flnxx_|)|          v           |   flmx(i)
                    +-----------------+             +-----------+      ----+-----------+
                                                                        < SLFOU, then B_forxx = 1, FS2FO
```

Calculation of flpxx_(Zdg)(i) and flnxx_(Zdg)(i):
To check whether adaptation is complete, 2 learning filter values exist for each filter value fsxx_(Zdgl)(i).
That means 2 filter values are formed for each operating range.
The measure used here is the difference between the normalized segment time deviations xs(Zdg)(i) (= the current measured value) and the filtered values fsxx_(Zdg)(i) (i.e. the values calculated so far).
The filter flpxx_(Zdg)(i) starts at the maximum possible deviation ALFO, flnxx_(Zdg)(i) starts at -ALFO.
The learning filters flpxx_(Zdg)(i), flnxx_(Zdg)(i) filter towards the diminishing deviation
xs(Zdg)(i) - fsxx_(Zdg)(i). [Zdg: from 2..zylza]

flpxx_(Zdg)(i) =
(1-FLFO) * flpxx_(Zdg)(i-1) + FLFO * [xs(Zdg)(i) - fsxx_(Zdg)(i)]

flnxx_(Zdg)(i) =
(1-FLFO) * flnxx_(Zdg)(i-1) + FLFO * [xs(Zdg)(i) - fsxx_(Zdg)(i)]

start. value: flpxx_(Zdg)(i) = ALFO
              flnxx_(Zdg)(i) = -ALFO

flpxx_(Zdg) and flnxx_(Zdg) tend towards 0 during the adaptation.

```
                            +-----------------------------+
                            |        ^ flpxx_(Zdg)(i)     |
                            |        |                    |
                            | ALFO   *                    |
                            |        | *                  |
xs(Zdg)(i) - fsxx_(Zdg)(i)  |        |     * FLFO         |flpxx_(Zdg)
                  --------->+        +-----------* * *----+------>
                            |        |     * FLFO         |flnxx_(Zdg)
                            |        | *                  |
                            |-ALFO  *                     |
                            |        |                    |
                            |        v flnxx_(Zdg)(i)     |
                            +-----------------------------+
```

ALFO corresponds to the maximum possible deviation (sensor wheel tolerances and torsional vibrations).

Formation of flmx(i), Setting of B_forxx:
The absolute value is formed from the filter values flpxx_(Zdg)(i) and flnxx_(Zdg)(i) and then the greatest filter value flmx(i) (-> flmx = max (|flpxx_(Zdg)|, |flnxx_(Zdg)|; maximum across all cylinders) is compared to the threshold values SLFOU (FW) and SLFOON (KL). SLFOON uses the same speed base points as KFCFO.

If the value flmx(i) lies above the threshold SLFOON, then B_forxx = 0 (flmx > SLFOON).
(for: fuel-on/fuel-off adaptation ready; xx: operating range)

If the value lies below the threshold SLFOU, adaptation is regarded as stabilized (respectively ready;
flmx < SLFOU -> B_forxx = 1). If flmx(i) then rises above the threshold SLFOON from below (flmx > SLFOON), the adaptation reacts as follows:

- if the actual range is a dominant range or a fuel cut-off range then the adaptation is restarted (reset), the reset counter flmxresz is incremented
- in other ranges B_forxx is set to zero (B_forxx = 0) and the adaptation is stopped (B_fohold -> 1)

In case of small changes in flmx(i) (< SLFOON) the adaptation is still regarded as stabilized (B_forxx = 1). There is thus a hysteresis range between SLFOU and SLFOON.

In addition to B_forxx, in which the adaptation status of the corresponding range xx is stored, the bit B_for is formed. B_for shows the adaptation status of the current operating range. (B_for is stored in the drum => measure B_for_m.)

The adaptation generates a status (fostat) by the status-bits (B_fordo, B_fornnn, B_forxx and B_ploknn). This status applies to the current operating range. The sensitivity of the misfire detection is adjusted dependent on the adaptation progress (fostat). Corresponding detection thresholds are assigned to each status (see %DMDLU).

If the conditions for the adaptation in the current operating range are fulfilled then B_fon=1 (fuel-on adaptation) resp. B_fof =1 (fuel-off adaptation) is set. Otherwise, if conditions are not fulfilled fuel-on/fuel-off adaptation: B_fon/B_fof=0 . The adaptation is active as soon as bit B_forun is set (B_fon resp. B_fof = 1 and ANWFOST completed and learning strategy allows learning / see 2.2.3). In addition the bit B_fodo is set, if the conditions for the adaptation in a dominant range (dominant fuel-on range or fuel cut-off range) are fulfilled. If a non-dominant range or no range is active B_fodo = 0 applies.

Overview of temporal course:

```
                              idxfob not equal 0
                        +------------------------>
                  ^
^        ALFO   - |******
|                 |      *   flmx(i)
| ° KW            |        *
                  |          *                                                                           ^
                  |             *                                      **                                |  B_forxx = 0
         SLFOON - |------------------*-----------------------------***--**********-- Hysteresis-        -+-
         SLFOU  - |----------------------*-----------------------**----------------- range              -+-
                  |                          *           *******                                         |  B_forxx = 1
              0 - +--------------------------------***-----------------------------------> t             v


                  ^
                  |                                    *       *  *
                  | e.g. fsxx_02            *                       * *
                  |                  *                                  *****
                  |            *                                             ******
                  |        *
                  |     *
              0 - +******----------------------------------------------------------------> t


                1                       +--------------------------+
       B_forxx  0 -----------------------+                          +-------------------

               1       +--------------------------------------------+
       B_fon   0 ------+                                            +-------------------
  resp. B_fof

                1                                                   +-------------------
       B_fohold 0 --------------------------------------------------+
```

Attention: In case the operating range is a dominant range or a fuel cut-off range, the entire adaptation is reset, if flmx > SLFOON (after stabilized adaptation), the reset counter flmxresz is incremented.

3. Learning resp. adaptation strategy:

3.1. Definition resp. setting of the operating range status:

A status can be assigned to each range. The setting of the status is performed via the characteristic map KFCFO.

Value	bit	
1	0	means normal operating range: In this range adaptation is performed (B_fon = 1) and the learned value is used for segment time correction (dependent on the learning progress).
2	1	means dominant range: Range which is frequently entered (B_fodo = 1) and in which misfire should also be detected without adaptation. In the dominant range the first rough adaptation is performed which is spread to adjacent ranges (for B_fordo 0 ->1).
4	2	means fuel cut-off range (fuel-off-range): Each fuel-off-range is automatically dominant. In a fuel cut-off range the load information is not relevant. Within the engine speed limits adjusted via KFCFO adaptation is only performed (B_fodo = 1)if the condition B_fof = 1 is set. It is only possible to define the lowest line (low load) of KFCFO as fuel cut-off range. The load base points of the lowest line are only of interest for the correction of the segment durations with the adaptation values. For the correction of segment durations the fuel cut-off ranges are treated like all other ranges. That means that the values learned during fuel cut-off are used for the correction of segment durations.
8	3	means dominant range within an engine speed range ("dominant n-range"): This range must be the first to be stabilized within an enginge speed range. The adaptation values are then spread to the entire engine speed range (if a rough adaptation has already taken place). This range should frequently be entered and misfires must here be detected as accurately as possible in comparison to the other ranges of the enginge speed range. (Favourable: high load. In each enginge speed range at least one range of the type *+2, *+4 or *+8 must be present. If the first learning phase has been terminated then the ranges of type *+2, *+4, *+8 within an engine speed range have equal rights.(*: can be 0 or 128)
16	4	means blocked range: In this range an adaptation is performed (B_fon = 1), the filter values are calculated, however the bit B_for is not set in this range, that means the learned values are not used for the segment time correction. The value of the 1. learned dominant range of which learning has been terminated (-> spreading of the dominant range, phase 1) or of the 1. learned engine speed range of which learning has been terminated (phase 2) is included in the calculation.
128	7	means healing range. If misfire has been detected at first a healing range must be entered (B_fohe = 1) before adaptation is continued. (Exception: in a fuel cut-off range it is also possible to learn if healing is active (B_fohold = 1). Within a healing range misfire should always definately be detected even without adaptation. Only combinations 128+1, 128+2, 128+8 are possible or useful. That means a healing range can only be a normal range, a dominant range within an engine speed range or a dominant range (a fuel cut-off range can not be defined as a healing range).

The label cfoxx indicates the characteristics of the range that is current for learning (e. g. cfoxx = 130, if the current range is a dominant healing range).

Example KFCFO

```
                  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
  +------------> _|         13|         23|         33|         43|         53|         63|         73|        83*|_  rl
  |   +-------->  |   128+1   |   128+1   |   128+8   |     8     |     8     |     8     |     8     |     8     |   ^
  |   |           +-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+   |
  |   |          _|         12|         22|         32|         42|         52|         62|         72|         82|_
  |   |           |   128+2   |   128+2   |     1     |     1     |     1     |     1     |     1     |     1     |
  |   |           +-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+
  |   |    +-------->       11|         21|         31|         41|         51|         61|         71|         81|_
  |   |    |      |     4     |     1     |     1     |     1     |     1     |     1     |     1     |    16     |
  |   |    |      +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
  |   |    |
  |   |  B_fof                                                                                    --------> nmot
  |   |
  |   |             eng. speed  eng. speed  eng. speed  eng. speed  eng. speed  eng. speed  eng. speed  eng. speed
  |   |           | range 1   | range 2   | range 3   | range 4   | range 5   | range 6   | range 7   | range 8   |
  |   |
  |   |
  +---+----------    *: Index: idxfob
      |
      +----------    Status of operating range
```

3.2. Spreading of the first learned ranges to adjacent ranges (3-phase-adaptation):

The adaptation is subdivided into 3 phases:

Depending on the learning progress in these 3 phases the sensitivity of misfire detection is increased.

1. phase: adaptation in the dominant range resp. fuel cut-off: (-> B_fordo=1)

At first a rough adaptation is performed during which the rough mechanical inaccuracies of the sensor wheel are learned. This first rough adaptation is stabilized if >= 1 dominant fuel-on range or fuel cut-off range has finished learning.(B_fordo=1). (Remark: if a fuel cut-off range is set then it is automatically regarded as being dominant.)

```
Principal picture:
                after powerfail:                                    1 dominant range has finished learning:



                +-------------------------------+                   +-------+-------+-------+-------+
          ^     | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |                   | D | D | D | D | D | D | D | D |
       rl |     |---+---+---+---+---+---+---+---|                   |---+---|---+---|---+---|---+---|
          |     | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |      =====>       | D | D | D | D | D | D | D | D |
          |     |---+---+---+---+---+---+---+---|                   |---+---|---+---|---+---|---+---|
                | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |                   | D | D | D | D | D | D | D | D |
                +-------------------------------+                   +-------------------------------+

                                 -------> nmot
                1: stands for factor = 1.0 in                         D: complies to the filt. values of the 1. learned
                   fs..fse.., i.e.. no ts-correction,                  dominant range, which is used in the entire operating
                   state after powerfail                               range for the segment time correction
```

Once the first dominant range has been learned (B_fordo=1) the values of this range are used for segment time correction in the entire operating range of the engine.These dominant values are spread to the entire engine operating range. This spreading resp. overwriting occurs only once as soon as flmx(i) is smaller than SLFOU (flmx(i) < SLFOU) in the dominant range. If the dominant range continues to adapt spreading to the adjacent ranges resp. overwriting of the adjacent ranges no longer occurs.

When other dominant ranges have finished learning, the adjacent ranges are no longer overwritten. In other words: Once the first dominant range has finished learning, the remaining ranges all adopt equal status regardless of whether they were previously dominant or non-dominant.

The dominant range of a speed range and a normal range con only learn if a dominant range is stabilized.

For the enginge speed range in which the dominant operating range lies the bit B_forn* = 1 is already set after the dominant range has stabilized. (see phase 2)(* e.g. 01...08)

2. phase: adaptation in an engine speed range: (-> B_forn01/02/03... = 1)

An engine speed range is considered to have stabilized if the dominant range of the engine speed range has stabilized.

The dominant range of a speed range can only learn if a dominant range is stabilized.

Example:
In the engine speed range 1 the range 12 is dominant.
Then the engine speed range has stabilized (B_forn1 = 1), if: B_for12 = 1 applies.

```
Principal picture:
                one dominant range has                              in each engine speed range at least 1 dominant
                finished learning (phase 1 completed)               range within the engine speed range has finished learning


                +-------+-------+-------+-------+                    +-------------------------------+
          ^     | D | D | D | D | D | D | D | D |                    | N1| N2| N3| N4| N5| N6| N7| N8|
       rl |     |---+---|---+---|---+---|---+---|                    |---+---+---+---+---+---+---+---|
          |     | D | D | D | D | D | D | D | D |      =====>        | N1| N2| N3| N4| N5| N6| N7| N8|
          |     |---+---|---+---|---+---|---+---|                    |---+---+---+---+---+---+---+---|
                | D | D | D | D | D | D | D | D |                    | N1| N2| N3| N4| N5| N6| N7| N8|
                +-------------------------------+                    +-------------------------------+
                                    -------> nmot                     engine speed range:
                                                                       1   2   3   4   5   6   7   8


                                                                         N1: complies to the filter values which are used in
                                                                             engine speed range 1 for segment time
                                                                             correction.
```

As soon as a dominant range within the engine speed range has finished learning the learned filter values are used within this engine speed range for the segment time correction (spread to the various loads).
In other words: The values learned in the dominant range of the engine speed range are spread to the entire engine speed range.

This spreading resp. overwriting occurs only once as soon as flmx(i) < SLFOU is in the dominant range of the engine speed range. If the dominant range continues to adapt spreading to the adjacent ranges resp. overwriting of the adjacent ranges no longer occurs.

The termination of the learning of the other non-dominant ranges of the engine speed range does not lead to an overwritting of the adjacent ranges. With other words: After the dominant range of the engine speed range has finished learning all ranges of the engine speed range adopt an equal status.

3. phase: Fine adaptation resp. adaptation in the according load/engine speed range: (-> B_forxx = 1)

The fine adaptation has completely stabilized if in all load/engine speed ranges B_forxx is set.

A normal range con only learn if a dominant range and the dominant range of the speed range ist stabilized.

```
Principal picture:
                one dominant range within each engine                all load/engine speed ranges have finished learning,
                speed range has finished learning                    fine adaptation is terminated


                +-------------------------------+                    +-------------------------------+
          ^     | N1| N2| N3| N4| N5| N6| N7| N8|                    |  3|  6|  9| 12| 15| 18| 21| 24|
      rl  |     |---+---+---+---+---+---+---+---|                    |---+---+---+---+---+---+---+---|
          |     | N1| N2| N3| N4| N5| N6| N7| N8|      =====>        |  2|  5|  8| 11| 14| 17| 20| 23|
          |     |---+---+---+---+---+---+---+---|                    |---+---+---+---+---+---+---+---|
                | N1| N2| N3| N4| N5| N6| N7| N8|                    |  1|  4|  7| 10| 13| 16| 19| 22|
                +-------------------------------+                    +-------------------------------+
  engine speed range  1   2   3   4   5   6   7   8


                                 -------> n

                N1: complies to the filter values                     1..: complies to the filter values used in the
                    used in engine speed range 1-                          according load/engine speed range
                    for segment time correction.                           for segment time correction.
```

As soon as an operating range has finished learning (flmx(i) < SLFOU, B_forxx = 1),the learned filter values are used within this operating range for the segment time correction.
If B_forxx = 1, the filter values fsexx are spread together with the filter values fsxx. That means both filter values are identical (except quantization).

3.3. Detailed example for the 3-phase-adaptation:

The following diagram illustrates the engine operating range with the filter values used, after only the dominant range 21 has stabilized (B_for21 = B_fodo = 1). [For the sake of simplicity the cyl. designations have been omitted and just 3x6 operation areas are shown.]

```
                   +------+------+------+------+------+------+------+------+------+------+------+------+
     +--->     rl  _| fse21     13| fse21     23| fse21     33| fse21     43| fse21     53| fse21    63*|. . .
     | +->     ^    | fs13;  0    | fs23;  0    | fs33;  0    | fs43;  0    | fs53;  0    | fs63;  0    |
     | |       |    +-------------+-------------+-------------+-------------+-------------+-------------+
     | |           _| fse21     12| fse21     22| fse21     32| fse21     42| fse21     52| fse21     62|. . .
     | |            | fs12;  0    | fs22;  0    | fs32;  0    | fs42;  0    | fs52;  0    | fs62;  0    |
     | |            +-------------+-------------+-------------+-------------+-------------+-------------+
     | |           _| fse21     11| fse21     21| fse21     31| fse21     41| fse21     51| fse21     61|. . .
     | |            | fs11;  0    | =fs21;  1   | fs31;  0    | fs41;  0    | fs51;  0    | fs61;  0    |
     | |            +------+------+------+------+------+------+------+------+------+------+------+------+
     | |
     | |             B_forn01=0    B_forn02=1    B_forn03=0    B_forn04=0    B_forn05=0    B_forn06=0
     | |
     | |                                                                                      --------> nmot
     +-+------- calculated filter value resp. filter value used for segment time correction
       +------- filter value learned in the range; adaptation status B_forxx
```

Now the dominant range 41 stabilizes within the engine speed range 4.
The value learned in range 41 is spread to the engine speed range 4 and is there used for the segment time correction.

```
                   +------+------+------+------+------+------+------+------+------+------+------+------+
     +--->     rl  _| fse21     13| fse21     23| fse21     33| fse41     43| fse21     53| fse21    63*|. . .
     | +->     ^    | fs13;  0    | fs23;  0    | fs33;  0    | fs43;  0    | fs53;  0    | fs63;  0    |
     | |       |    +-------------+-------------+-------------+-------------+-------------+-------------+
     | |           _| fse21     12| fse21     22| fse21     32| fse41     42| fse21     52| fse21     62|. . .
     | |            | fs12;  0    | fs22;  0    | fs32;  0    | fs42;  0    | fs52;  0    | fs62;  0    |
     | |            +-------------+-------------+-------------+-------------+-------------+-------------+
     | |           _| fse21     11| fse21     21| fse21     31| fse41     41| fse21     51| fse21     61|. . .
     | |            | fs11;  0    | =fs21;  1   | fs31;  0    | =fs41; 1    | fs51;  0    | fs61;  0    |
     | |            +------+------+------+------+------+------+------+------+------+------+------+------+
     | |
     | |             B_forn01=0    B_forn02=1    B_forn03=0    B_forn04=1    B_forn05=0    B_forn06=0
     | |
     | |                                                                                      --------> nmot
     +-+------- calculated filter value resp. filter value used for segment time correction
       +------- filter value learned in the range; adaptation status B_forxx
```

When other ranges (including non-dominant ranges) have stabilized (B_forxx=1), the now-learned filter value fsxx_(Zdg)(i) is used for segment time correction in the stabilized range. _Hereafter: fsexx_(Zdg)(i) = fsxx_(Zdg)(i).

e.g.: ranges 11, 12, 21, 41 and 42 have stabilized (B_for11 = B_for12 = B_for21 = B_for41 = B_for42 = 1)
(Precondition: range 11 is the dominant range of engine speed range 1)

```
                   +------+------+------+------+------+------+------+------+------+------+------+------+
     +--->     rl  _| fse11     13| fse21     23| fse21     33| fse41     43| fse21     53| fse21    63*|. . .
     | +->     ^    | fs13;  0    | fs23;  0    | fs33;  0    | fs43;  0    | fs53;  0    | fs63;  0    |
     | |       |    +-------------+-------------+-------------+-------------+-------------+-------------+
     | |           _| fse12     12| fse21     22| fse21     32| fse42     42| fse21     52| fse21     62|. . .
     | |            | =fs12; 1    | fs22;  0    | fs32;  0    | =fs42; 1    | fs52;  0    | fs62;  0    |
     | |            +-------------+-------------+-------------+-------------+-------------+-------------+
     | |           _| fse11     11| fse21     21| fse21     31| fse41     41| fse21     51| fse21     61|. . .
     | |            | =fs11; 1    | =fs21;  1   | fs31;  0    | =fs41; 1    | fs51;  0    | fs61;  0    |
     | |            +------+------+------+------+------+------+------+------+------+------+------+------+
     | |
     | |             B_forn01=1    B_forn02=1    B_forn03=0    B_forn04=1    B_forn05=0    B_forn06=0
     | |
     | |                                                                                      --------> nmot
     +-+------- calculated filter value resp. filter value used for segment time correction
       +------- filter value learned in the range; adaptation status B_forxx
```

3.4. Consideration of the learning/adaptation progress for the sensitivity of misfire detection:

Corresponding to the adaptation progress in the 3 adaptation phases the sensitivity of the misfire detection is increased. There are 4 sensitivity stages during misfire detection:

	status byte fostat:
- stage 3: after powerfail:	fostat = 3
- stage 2: after adaptation 1. phase:	fostat = 2
- stage 1: after adaptation 2. phase:	fostat = 1
- stage 0: after adaptation 3. phase and B_ploknn = 1: (see under plausiblity check)	fostat = 0

For the current operating range (+ subrange) the adaptation puts a status information (fostat) at the disposal of the misfire detection (%DMDLU). From the status information which indicates the learning progress the misfire detection fixes the according LURMIN* thresholds.

The bits B_fordo, B_fornnn, B_forxx and B_ploknn clearly indicate the adaptation status of the current operating range.

The table shows the definate assignment:

B_fordo	B_fornnn	B_forxx	B_ploknn	Status (fostat)
0	X	X	X	3
1	0	X	X	2
1	1	0	X	1
1	1	1	0	1
1	1	1	1	0

nn = current eng. speed range, xx = current operating range, X = not relevant

The assignment of the adaptation status (fostat) to the according LURMIN thresholds is described in %DMDLU.

fostat indicates the current adaptation status in the corresponding operating range.

Due to interpolation the adaptation state of the adjacent range has to be considered when fixing the status. (see example in app) For this an operating range is again subdivided into 4 equal parts (subranges). The subranges numbered from 0 to 3. When driving in the corresponding subrange each time the adaptation state of the adjacent subranges which lie outside the main range is checked. The least advanced status is then used. That means status of the current range = worst status from: current range,3 adjoining ranges of the current range.

e.g.:
If driving in the main range 22, subrange 2, the main ranges 12, 11 and 21 are checked. If the learning progress of these adjacent main ranges 12, 11 and 21 is worse (no. of the status is larger) than in the main range 22 then the least advanced status is used.

```
                    +--------+--------+--------+--------+--------+--------+
                    |        .      13|        .      23|        .      33|
                    |      0 . 1      |      0 . 1      |      0 . 1      |. . .
            tl3 --  +........*....... +........*....... +........*....... +
                    |      2 . 3      |      2 . 3      |      2 . 3      |
        ^           |        .        |        .        |        .        |
        |   y3      +--------+--------+--------+--------+--------+--------+-
        |           |        .      12|        .      22|        .      32|
      rl|           |      0 . 1      |      0 . 1      |      0 . 1      |. . .
        |   tl2 --  +........*....... +........*....... +........*....... +
                    |      2 . 3      |      2 . 3      |      2 . 3      |
                    |        .        |        .        |        .        |
            y2      +--------+--------+--------+--------+--------+--------+-
                    |        .      11|        .      21|        .      31|
                    |      0 . 1      |      0 . 1      |      0 . 1      |. . .
            tl1 --  +........*........+........*........+........*....... +
                    |      2 . 3      |      2 . 3      |      2 . 3      |
                    |        .        |        .        |        .        |
            y1      +--------+--------+--------+--------+--------+--------+-
                    x1       |        x2       |        x3       |        x4
                             n1                n2                n3
                                                 -----------> nmot
```

*:   position of the adaptation mean values, from here interpolation is performed.
‘......‘: range limit subrange
‘------‘: "   main range

3.5. Healing:

The filtering of the adaptation filters fs* is stopped as soon as misfires are detected and the counter for misfires fzabgs (DMDMIL) is above the threshold MDERKFON (threshold MDERFOKH for B_hk = 1 (catalytic converter heating)) and if tnst_w (time since engine start) > TNSTFON or if the learning filter flmx drifts away (flmx > SLFOON). (If flmx rises above SLFOON (flmx > SLFOON) within a dominant range or a fuel cut-off range then the adaptation gets restarted (reset of all ready-bits).)
MDERKFON, MDERFOHK indicates the number of misfires that can occure within a certain number of crankshaft rotations before the adaptation is stopped (see calculation of fzabgs in DMDMIL).
The learning filter recognizes the changes before the adaptation values drift away (-> important: FLFO = 4 * FS1FO).
The filtering is reactivated only if healing in a healing range is finished. The stop of the adaptation occurs in the entire operating range except in fuel cut-off range (-> B_fohold = 1).
Healing is performed if while driving in a coherent healing range (B_fohe = 1) no misfires were detected . For healing a coherent healing range must be entered constantly for ANWFOHE crankshaft revolutions (counter anwfoh).

After the engine was turned off the healing status must be stored until the next engine start procedure.

```
                       +---+
flmx > SLFOON -------->|   |                   +---+
                       | & +------------------>|   |
B_forxx -------------->|   |                   |   |
                       +---+                   |   |
                                               |   |
                       +----+                  |   |
fzabgs_w ------------->|    |                  |   |
               0       | >= +--+               | V +-----+
MDERKFON -----o---o--->|    |  |               |   |     |
                       +----+  |               |   |     |
MDERFOKH -----o                |               |   |     |
              1 ^              |               |   |     |
                |              |   +---+       |   |     |
B_kh -----------+              +-->|   |       |   |     |                 +---+------------+
                                   |   |       |   |     +---------------->| S |            +-----------------> B_fohold
tnst_w > TNSTFON ----------------->| & +------>|   |                       +---+------------+
                                   |   |       +---+                 +---->| R |            |
B_mderk ---------+---------------->|   |                             |     +---+------------+
                 |                 +---+                             |
                 |                                                   |
                 |                                 (reset            |
                 +-------------------------------+  ANWFOHE)         |
                                                 |                   |
                                                 v                   |
                  +-----------+               +-------------+        |
nmot ------------>| cheching  |    B_fohe     | ANWFOHE +-- |        |
                  | healing   +-------------->| --------+-->+--------+
 rl ------------->| range     |               |             |
                  +-----------+               +----------+--+
                                                  ^      |
                                                  |      +-----------------------------------------------------> anwfoh
 i ----------------o--o---------------------------+
                    ^                camshaft revolution counter
                    |
B_mdstop -----------+
```

Just in exceptional cases the thresholds MDERKFON, MDERFOKH, TNSTFON should be unequal to zero (see applikation hints).
In case both inputs are "1" on the flip-flop then the reset has priority (e.g. flmx > SLFOON, B_forxx = 1, and ANWFOHE completed).

The evaluation of the expression [(flmx > SLFOON) & B_forxx] takes place befor B_forxx is reseted after having exceeded the threshold SLFOON.

The deactivation is carried out retroactive. That means that when misfire is detected the values dating back a few camshaft revolutions are not used for the adaptation.

3.6 Plausibility check of the adaptation values:

The plausibility check should prefent that the learned misfires are taken into account for the calculation. Furthermore it should be prevented that any RAM changes (for example due to EMI stabilization) lead to error detections.

Misfires lead to load-dependent adaptation values. That means if misfires are learned larger adaptation values are obtained with increasing load resp. the differences between the adaptation values of one engine speed range are larger than during normal operating. Torsional vibrations do not necessarily show this load dependance.

The typical deviations during normal operating between the adaptation values of one engine speed range are stored in the characteristic line DFSEFON in deg. crankshaft. The actual value of DFSEON that is used for the plausibility check is named dfsen.

The characteristic line has just as many n-base points as KFCFO.

```
    +------+------+------+------+------+------+------+------+------+------+------+------+------+------+------+------+
   _|           13|           23|           33|           43|           53|           63|           73|           83|_  rl
    | FSE13_(Zdg) | FSE23_(Zdg) | FSE33_(Zdg) | FSE43_(Zdg) | FSE53_(Zdg) | FSE63_(Zdg) | FSE73_(Zdg) | FSE83_(Zdg) |   ^
    +-------------+-------------+-------------+-------------+-------------+-------------+-------------+-------------+   |
   _|           12|           22|           32|           42|           52|           62|           72|           82|_
    | FSE12_(Zdg) | FSE22_(Zdg) | FSE32_(Zdg) | FSE42_(Zdg) | FSE52_(Zdg) | FSE62_(Zdg) | FSE72_(Zdg) | FSE82_(Zdg) |
    +-------------+-------------+-------------+-------------+-------------+-------------+-------------+-------------+
    |           11|           21|           31|           41|           51|           61|           71|           81|_
    | FSE11_(Zdg) | FSE21_(Zdg) | FSE31_(Zdg) | FSE41_(Zdg) | FSE51_(Zdg) | FSE61_(Zdg) | FSE71_(Zdg) | FSE81_(Zdg) |
    +------+------+------+------+------+------+------+------+------+------+------+------+------+------+------+------+

                                                                                                        --------> nmot

      eng.speed     eng.speed     eng.speed     eng.speed     eng.speed     eng.speed     eng.speed     eng.speed
    | range 1     | range 2     | range 3     | range 4     | range 5     | range 6   |   range 7     | range 8     |


char. line DFSEFON:
    +-------------+-------------+-------------+-------------+-------------+-------------+-------------+-------------+
    |             |             |             |             |             |             |             |             |---+
    +-------------+-------------+-------------+-------------+-------------+-------------+-------------+-------------+   |
                                                                                                                        |
                                                                                                                        V
                                                                                                                      dfsen
```

The check should if possible be performed at least once for each background program run and this should be done independent of the current adaptation status.

Each time the maximum deviation of the FSE values is calculated via load for each engine speed range.

```
engine speed range 8:
dfse08 = max[ max(fse81_02, fse82_02, fse83_02) - min(fse81_02, fse82_02, fse83_02),
              max(fse81_03, fse82_03, fse83_03) - min(fse81_03, fse82_03, fse83_03),
              max(fse81_04, fse82_04, fse83_04) - min(fse81_04, fse82_04, fse83_04),
                                  .                               .
                                  .                               .
              max(fse81_08, fse82_08, fse83_08) - min(fse81_08, fse82_08, fse83_08) ]

engine speed range 7:
dfse07 = max[ max(fse71_02, fse72_02, fse73_02) - min(fse71_02, fse72_02, fse73_02),
              max(fse71_03, fse72_03, fse73_03) - min(fse71_03, fse72_03, fse73_03),
              max(fse71_04, fse72_04, fse73_04) - min(fse71_04, fse72_04, fse73_04),
                                  .                               .
                                  .                               .
              max(fse71_08, fse72_08, fse73_08) - min(fse71_08, fse72_08, fse73_08) ]

correspondingly:
dfse06 = max[ ... ]
dfse05 = max[ ... ]
dfse04 = max[ ... ]
dfse03 = max[ ... ]
dfse02 = max[ ... ]
dfse01 = max[ ... ]
```

Checking of the plausibility:

```
                             B_plok08 = 1   +---+
        dfse08  < dfsen    ---------------->|   |
                                            |   |
                             B_plok07 = 1   |   |
        dfse07  < dfsen    ---------------->|   |
                                            |   |
                             B_plok06 = 1   |   |
        dfse06  < dfsen    ---------------->| & +-------------------------> B_plok
                                            |   |
                .               .           |   |
                .               .           |   |
                .               .           |   |
                             B_plok01 = 1   |   |
        dfse01  < dfsen    ---------------->|   |
                                            +---+
```

If the plausibility condition in an engine speed range nn is not fulfilled (B_ploknn=0) then the adaptation status (fostat) is not switched to 0 resp. reswitched from 0 to 1 (see table in chapter 3.4). The detection threshold of the misfire detection is adjusted correspondingly by %DMDLU.

B_plokn shows if values in the actual speed range are plausible.

Should the deviations of the FSE values of an engine speed range differ largly, these may be caused by RAM overturns for example, then the adaptation is reseted (reset) and the reset counter dfseresz is incremented (complete reset of all values except reset counters, B_forset = 1, -> fostat = 3).

```
                                +---+
        dfse08 > DFSERES   ----------->|   |
                                |   |
        dfse07 > DFSERES   ----------->|   |
                                |   |
        dfse06 > DFSERES   ----------->|   |
                                |   |
        dfse05 > DFSERES   ----------->|   |
                                | v |-----------------------> B_forset (*)
        dfse04 > DFSERES   ----------->|   |
                                |   |
        dfse03 > DFSERES   ----------->|   |
                                |   |
        dfse02 > DFSERES   ----------->|   |                       (*): it is not possible to messure B_forset because it is
                                |   |                            set and reset in-between two calculation cycles
        dfse01 > DFSERES   ----------->|   |
                                +---+
```

4. Starting values and filter factors
After a "computer cold start", powerfail (B_pwf: 1 -> 0), CDFON -> 0 the following values are predefined:

ds(Zdg)(i) = 0 usec
xs(Zdg)(i) = 0 °deg. KW
fsxx_(Zdg)(i) = fsexx_(Zdg)(i) = 0 deg. KW (complies to factor = 1.0)

flpxx_(Zdg)(i) = flmx(i) = ALFO deg. KW
flnxx_(Zdg)(i) = - ALFO deg. KW

dfseresz = 0;
flmxresz = 0;

Attention: If the reset is triggered by the function itself then the reset counters dfseresz and flmxresz are not set to zero.

APP DMDFON 6.40 Application hint

```
App.-suggestion for a 4-cyl. engine:
------------------------------------

FS1FO:          0.005...0.01
FS2FO:          0.002
FLFO:           0.02..0.04 = 4 * FS1FO ; the learning filter must always be faster than the adaptation filter so that changes are
                                         detected beforehand, before the adaptation values have drifted away.
                                         At flmx > SLFOON the filtering is then immediately stopped. (reset in dominant and
                                         fuel cut-off range)
                                         The sensitivity of the misfire detection is switched to stage 1 (-> LURMIN1)
                                         important: thus no more misfire detection is possible in this range,
                                                    result: misfires must always be detected before flmx > SLFOON

                important: the filter factors of fluts should be faster (i.e. larger value) than FLFO so that the misfires are
                           detected via fluts and the adaptation is stopped in time.
                           lunw here serves as immediate stop trigger.


k = - (1/F) * ln (1-A);         A: 0..1, percentage of final value
                                k: number of filter steps
e.g.: F = 0.01, A = 0.99 (99 % of final value)

k = 460; (after 460 camshaft revolutions the adaptation has stabilized to 99 % of the final value, jump function presupposed as
         input)

ALFO:           1,2 deg. crankshaft
SLFOU:          0,03 deg. crankshaft
SLFOON:         0,09 deg. crankshaft  (at low speed higher, at high speed lower)
ANWFOST:        25
LURFOST:        15

DFSERES:        same as ALFO            (max. value, on which adaptation can be carried out)
MDERKFON:       0
MDERFOKH:       0
TNSTFON:        0
```

Prior to the application of KFCFO the systematic engine speed fluctuations in the entire operating range of different vehicles of the according project should be looked at.
Here the engine speed dependance and load dependance of the adaptation values (fs* resp. fse) is important.
Depending on this KFCFO must be fixed with regard to the load and engine speed base points as well as the states of the individual ranges.

KFCFO:

```
      80   +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+          b
          -|         13|         23|         33|         43|         53|         63|         73|        83*|- 70  ->  a
    ^      |           |           |           |           |           |           |           |           |          s
    |  60  |-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+          e
  rl|     -|         12|         22|         32|         42|         52|         62|         72|         82|- 50  ->
 in%|      |           |           |           |           |           |           |           |           |          p
      40   |-----------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+          o
          -|         11|         21|         31|         41|         51|         61|         71|         81|- 30  ->  i
           |           |           |           |           |           |           |           |           |          n
      20   +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+          t
                                                                                                                      s
        2250    |   3150    |   4050    |   4750    |   5250    |   5600    |   5800    |   6000    |   6200
                |           |           |           |           |           |           |           |
base points     2700        3600       4500        5000        5500        5700        5900        6100
                                                                                                 -------> nmot
           *: idxfob
```

The range limits always lie in the middle between the base points (not the other way round!).
On the edge of the characteristic map the range limits are spread outwards as described in 1.2.

App. of KFCFO:

Dominant ranges should be positioned such that a stabilization of the adaptation values in the FTP75 test is possible. However this is not layed down by the legislator (CARB). For the certification a vehicle on which adaptation has already been terminated may be provided.

Operation ranges in which the adaptation values are not savely stabilized should be inhibited. Attention, in blocked ranges and partially in their adjacent ranges fostat does not reach 0 (see 3.4)!

In each engine speed range there must be at least one range of the type (value) *+2, *+4 or *+8.
If the first learning phase is completed then the ranges of types *+2, *+4 or *+8 within a engine speed range adopt an equal status.
(*: can be 0 or 128)

Example-value characteristic line DFSEFON: (for vehicles with little torsional vibrations)

```
   +-------------+------------+------------+------------+------------+------------+------------+------------+
   |  0,1        |  0,08      |  0,08      |  0,08      |  0,06      |  0,06      |  0,05      |  0,05      |---+
   +-------------+------------+------------+------------+------------+------------+------------+------------+   |
                                                                                                                |
                                                                                                                V
                                                                                                              dfsen
     eng.speed     eng.speed    eng.speed    eng.speed    eng.speed    eng.speed    eng.speed    eng.speed
   | range 1     | range 2    | range 3    | range 4    | range 5    | range 6    | range 7    | range 8    |
```

During application of DFSEFON it must always be taken into account what happens when misfires are learned in the various different operating ranges. The interrelation between the currently active characteristic line LURMIN* is important.

If the plausibility condition in an engine speed range nn is not fulfilled (B_ploknn=0) the sensitivity of the misfire detection is worsened to stage 1 (LURMIN1).
The sensitivity is worsened no further since only misfires are not detected during small loads. Misfires during higher loads should be detected even though the sensitivity is poor.
Again during smaller load the deviation learned by a misfire is so small that by LURMIN1 no misdetection due to this error learning should be performed.

The sensitivity of the misfire detection is only set back to stage 1 if the plausibility check for all load ranges of an engine speed range has successfully been carried out (B_ploknn=1).

Usually higher load ranges at high engine speeds may be entered much more often than at lower load ranges.

Example-Course of the adaptation values over the load during constant engine speed:

```
                     ^
  ^                  |    ..            ........                                       ........ ^
  | fsenn_02         |  ..  .     ......        ........   normal operating      ......         |
  | ° KW          0 -+-      .....                      ..........................              | dfsen
  |                  |                                                                          |
                     |  **                                                                      V
                     |    ******
                     |          ********
                     |                  **********
                     |                            **********
                     |                                      ********* misfire operation of ignition 2
                     |                                               *********
                     |                                                        **********
                     |                                                                  *********
                     |
                     -                                                          --------------->
                                                                                       load

                     |<--------------------->||<--------------------->||<---------------------->|
                     |     load range 1      ||     load range 2      ||      load range 3      |
```

MDERKFON should be set to zero. If mis-detections occure at special conditions (engaging the clutch, changing gears) and if this mis-detections can not be prevented (conditions for adaptation) then MDERKFON is allowed to be > 0 (as small as possible). This method makes it possible not to stop the adaptation at this special conditions (engaging the clutch, changing gears).
(See calculation of fzabgs in DMDMIL.)

DMDLU 4.90 Diagnostic routine misfire detection: Irregular running

FDEF DMDLU 4.90 Function definition

Overview misfire detection: interface with other functions see %DMDUE

Overview %DMDLU:

```
                        +---+
B_lustop -------------->|   |
B_mdstop -------------->| V |
B_analu --------------->|   |---------------------------------------------+
                        +---+                                             |
                 1.1, 1.2                                                 |
             +-------------+                                              |    * THE NUMBER ON THE RIGHT TOP SHOWS THE CORRESPONDING
zzyl-------->| calculation | luts, luts1..SY_ZYLZA                        |      CHAPTER IN THE FOLLOWING TEXT !
tsk--------->| eng. roughn.+-------------+                                |
nmot-------->| FLUV1,FLUV2 |             |                                |                            DMDDLU
             | NFLUV       |             +--------------------------------|------------------------------------>
             +-------------+             |                                |                            DMDLUA
        +--------------------------------+                                |         1.4, 1.5, 1.6
        |          1.4                   |  luts  +-----+                 |       +---------------+    DMDDLU
        |    +----------------+          +------->|     | luts > lurs     v       | single        |B_analu----->
        +--->| calculation of |             lurs  | < > |----------------o--o---->| misfire       |B_tnalu----->
B_mdstop --->| ref. value     |------------------>|     |                         | detected      |B_luerk----->
rl --------->| KFLURB, LURKTM,|                   +-----+                         +---------------+    DMDLAD
nmot ------->| DMXRLU, KFAMAL,|
tmot ------->| KFLURM,        |
fostat ----->| FAMALU, FIAMALU|
B_zasa ----->|                |
B_lustop --->|                |
             +----------------+
```

The whole misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd = 0 the function DMDLU is locked, i. e. luts, luts1..SY_ZYLZA, B_analu, B_tnalu, B_luerk and lursktm are set to 0.
For B_cdmd = 1 the function DMDLU is active.

In case of 2 ecu's (SY_2SG = 1) the function %DMDLU is deactivated in the Master ecu (B_master = 1)

Overview calculation of reference value:

```
           +---+                                                                       B_kh
B_ll ----->|   |   +-+                                                                   |
vfzg=0 --->| & |---| |o-----+                                                            |
E_vfz --->o|   |   +-+      |                         1 -------------------------------o V
           +---+            |                                     +-------+   flurkh     \
             +---------+    |                         dmrkh ----->| LURKH |------------o  o-----+
rl --------->| LURBRL8 |--+ |                                     +-------+                     |
             +---------+  | |                                                                   |
B_zasa=1 --->| KFLURBZ |  | |                                                                   V
             +---------+  o V    +---+    +---+      +------------+       +---+               +---+              lurs
B_wk=0 ----->| KFLURB  |--o \o-->| + |--->| + |----->| Änderungs- |------>| * |-------------->| * |--------------------->
             |---------|         +---+    +---+      | begrenzung |       +---+               +---+
B_wk=1 ----->| KFLURB1 |           ^        ^        | DMXRLU     |         ^
             |---------|           |        |        +------------+         |
B_wkr=1 ---->| KFLURB2 |           |        |                               |
             +---------+           |        |                               |
                ^  ^               |        |                               |
                |  |               |        +-----------+                   |
rl -------------+  |               |      +---------+   |                   |                                  lurs_min
nmot --------------+--------------------->| offset  |---+---------------------------------------------------------------->
fostat --------------------------------+->| LURMIN* |                       |                                  DMDLUA
                                   |   |  +---------+                       |
             +--------+            |   |                                    |                                  lursktm
tmot ------->| LURKTM |------------+------------------------------------------------------------------------------------>
             +--------+            |   |                     fostat > 1     o                                  DMDDLU
                                   |   +----------------------------------->|
                                   |                                        o
Overview detection of multiple misfire:                                     |
             +---------+           |             famal [0..1]               +---------------+
B_wk=0 ----->| KFAMAL  |---------------------------------------------------------o          |
             +---------+           |             1 ------------------------------o--o-------+
B_wk=1 ----->| KFAMAL1 |           |                                              ^
             +--^--^---+           |                                              |
                |  |               |                                              |
rl -------------+  |               |                                              |
nmot --------------+               V                            +--+              |
             +---------+         +---+ lurms  +------------+    |  |              |
B_wk=0 ----->| KFLURM  |-------->| + |------->| Änderungs- |--->|  |              |
             |---------|         +---+        | begrenzung |    |  | lums > lurms |
B_wk=1 ----->| KFLURM1 |                      | DMXRLU     |    |<>|--------------+
             +---------+                      +------------+    |  |
               ^  ^                                             |  |
               |  |                                             |  |
rl ------------+  |                                             |  |
nmot -------------+                                             |  |
             +------------+                               lums  |  |
luts ------->| calculation|------------------------------------>|  |
B_mdstop --->| lums        |                                     |  |
B_lustop --->| FIMALU,     |                                     +--+
             | FIAMALU     |
             +------------+
```

ABK DMDLU 4.90 Abbreviations

Subscripts and reference points used:
(n) = Crankshaft segments
(i) = Camshaft revolutions;   NW - Umdr.
(j) = Crankshaft revolutions; KW - Umdr.
(t) = Time

tsk(n)	corrected segment duration at the time n
tsk(n+1)	corrected segment duration at the time n+1
luts(n)	engine roughness - test value
lurs(i)	engine roughness reference
lums(n)	engine roughness mean value
lurms(n)	engine roughness mean value reference

DMDLAD	logical and temporary combination of results from different functions for misfire detetion
DMDDLU	differential imbalance
DMDSTP	stopconditions for misfire detection
SY_FLUQ	quantization factor engine roughness computation; system variable. Variation only by means of a new DAMOS specification
U	crankshaft revolution
d...	difference
zzyl	cylinder number
SY_ZYLZA	number of cylinders

Parameter	Source-X	Source-Y	Type	Description
ANALUN	NMOT		KL	number of combustions for deactivation after detected misfire
DMXRLU			FW	variation limitation for max. reduction of the engine roughness reference values
FIAMALU			FW	increase factor for filter mutiple misfire detection
FIMALU			FW	filter factor multiple misfire detection
FLUV1			FW	switch for modification 1 - calculation of running irregularity
FLUV2			FW	switch for modification 2 - calculation of engine roughness
KFAMAL	NMOT	RL	KF	map reduction factor of the engine roughness reference value at multiple misfire

Parameter	Source-X	Source-Y	Type	Description
KFAMAL1	NMOT	RL	KF	map reduction factor of the engine roughness reference value at multiple misfire
KFLURB	NMOT	RL	KF	map for engine roughness - reference base value
KFLURB1	NMOT	RL	KF	map for engine roughness - reference base value
KFLURB2	NMOT	RL	KF	map for engine roughness - reference base value
KFLURBZ	NMOT	RL	KF	map for engine roughness base value, in case of ZAS
KFLURM	NMOT	RL	KF	reference base value map for engine roughness for misfire detection
KFLURM1	NMOT	RL	KF	reference base value map for engine roughness for misfire detection
LURBRL8	RL		KL	reference value for engine roughness, vehicle speed zero
LURKH	DMRKH		KL	dmrkh-depen. engine roughness reference correction value, during cat heating
LURKTM	TMOT		KL	Tmot-dependent engine roughness reference correcting value
LURMIN1	NMOT		KL	speed dependensy of engine roughness referenz minimum value 1
LURMIN2	NMOT		KL	speed dependensy of engine roughness referenz minimum value 2
LURMIN3	NMOT		KL	speed dependensy of engine roughness referenz minimum value 3
NFLUV			FW	rpm threshhold for midification - calculation of running irregularity
P_ZYL			FW	distance for calculation arithm. mean value - DMDLU
TNALU			FW	duration of test-phase after detected misfire

Variable	Source	Type	Description
B_ANALU	DMDLU	AUS	condition for deactivation after first detected misfiring
B_ANALU_M	DMDLU	LOK	monitor, cond. for deactivation after first detected misfire
B_ANALU_M2	DMDLU	LOK	monitor, cond. for deactivation after first detected misfire, 2.ECU
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DOPZUE	NLPH	EIN	Condition double ignition
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_LL	MSF	EIN	Condition idle
B_LUERK	DMDLU	AUS	condition for misfiring detected, from DMDLU
B_LUERK_M	DMDLU	LOK	monitor, condition for misfire detected in DMDLU
B_LUERK_M2	DMDLU	LOK	monitor, condition for misfire detected in DMDLU, 2.ECU
B_LUSTOP	DMDSTP	EIN	misfire detection stop
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTOP	DMDSTP	EIN	misfire detection stop
B_OPTPHERK		EIN	condition suitable engine operating state for phase detection
B_TNALU	DMDLU	AUS	condition for active test phase after detected misfiring
B_TNALU_M	DMDLU	LOK	monitor, cond. for active test phase after detected misfire
B_TNALU_M2	DMDLU	LOK	monitor, cond. for active test phase after detected misfire, 2.ECU
B_WK		EIN	condition: converter lockup clutch closed
B_WKR		EIN	condition clutch controlled
B_ZASA		EIN	ZAS load switchover is active
DMRKH	KHMD	EIN	torque reserve for catalyzer heating
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
FAMAL	DMDLU	LOK	factor for reduction of LUR value at multiple misfire, from KFFAMALU
FLURKH	DMDLU	LOK	factor for reduction of LUR value at cat-heating, from KL LURKH
FOSTAT	DMDFON	EIN	state of fuel-on/-off adaptation in actual map range
LUMS	DMDLU	DOK	engine roughness mean value for multiple misfire detection
LUMS_M	DMDLU	LOK	monitor, engine roughness mean value for multiple misfire detection
LUMS_M2	DMDLU	LOK	monitor, engine roughness mean value for multiple misfire detection, 2.ECU
LURMS	DMDLU	DOK	cranking instability reference for multiple misfire detection -> compar to lums
LURMS_M	DMDLU	LOK	monitor, cranking instability reference for multi misfire detection, signed
LURMS_M2	DMDLU	LOK	monitor, cranking instability reference for multi misfire detection, signed, 2.
LURS	DMDLU	DOK	engine roughness reference value
LURSKTM	DMDLU	AUS	tmot-dependent offset for engine roughness value dlurs, signed
LURS_M	DMDLU	LOK	monitir engine roughness reference value
LURS_M2	DMDLU	LOK	monitir engine roughness reference value, 2.ECU
LURS_MIN	DMDLU	AUS	value of LUR in case of not finished sensor wheel adaptation, value from LURMIN*
LUTS	DMDLU	AUS	engine roughness test value
LUTS1	DMDLU	AUS	engine roughness test value, cylinder or ignition 1, signed
LUTS10	DMDLU	AUS	engine roughness test value, cylinder or ignition 10, signed
LUTS11	DMDLU	AUS	engine roughness test value, cylinder or ignition 11, signed
LUTS12	DMDLU	AUS	engine roughness test value, cylinder or ignition 12, signed
LUTS2	DMDLU	AUS	engine roughness test value, cylinder or ignition 2, signed
LUTS3	DMDLU	AUS	engine roughness test value, cylinder or ignition 3, signed
LUTS4	DMDLU	AUS	engine roughness test value, cylinder or ignition 4, signed
LUTS5	DMDLU	AUS	engine roughness test value, cylinder or ignition 5, signed
LUTS6	DMDLU	AUS	engine roughness test value, cylinder or ignition 6, signed
LUTS7	DMDLU	AUS	engine roughness test value, cylinder or ignition 7, signed
LUTS8	DMDLU	AUS	engine roughness test value, cylinder or ignition 8, signed
LUTS9	DMDLU	AUS	engine roughness test value, cylinder or ignition 9, signed
LUTS_M	DMDLU	LOK	monitor engine roughness test value
LUTS_M2	DMDLU	LOK	monitor engine roughness test value, 2.ECU
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SY_2SG	PROKON	EIN	system constant 2 motronic systems
TMOT	SWADAP	EIN	Engine temperature
TSK	DMDFON	EIN	corrected segment duration
VFZG	SWADAP	EIN	vehicle speed (km/h)
ZZYL	GGDPG	EIN	SW-cylinder counter

FW DMDLU 4.90 Fixed Values

Parameter	Value	Description
DMXRLU		variation limitation for max. reduction of the engine roughness reference values
FIAMALU		increase factor for filter mutiple misfire detection
FIMALU		filter factor multiple misfire detection
FLUV1		switch for modification 1 - calculation of running irregularity
FLUV2		switch for modification 2 - calculation of engine roughness
NFLUV		rpm threshhold for midification - calculation of running irregularity
P_ZYL		distance for calculation arithm. mean value - DMDLU
TNALU		duration of test-phase after detected misfire

FB DMDLU 4.90 Detailed description of function

1. Misfire detection

The following operating steps are performed for each measured segment, corrected by the fuel-on adaptation
The data are processed asynchroneously to the combustion cycle, after several segment data have been collected.

1.1 Calculation of the engine roughness luts(n), Luts1(n), luts2(n), ... lutsSY_ZYLZA(n)

The engine roughness is calculated in general according to the following formula:
lut(n) is related to 1 crankshaft revolution (physical unit: (rev./s)ˆ2). The segment duration (physical unit: us)
is therefore to be multiplied by zylza/2 each.

$$luts(n) = \frac{[tsk(n+1) - tsk(n)] - \text{compensation time}}{tsk(n)^3}$$

The calculated engine roughness value is also stored cylinder specific.

During ZAS-mode (B_zasa=1) the engine roughness is calculated as follows:

$$luts(n) = \frac{[tsk(n+1) - tsk(n-1)] - (2 * \text{compensation time})}{tsk(n)^3}$$

The luts-values for the cylinders cut-off are set to 0.

1.1.1 Calculation of compensation time according to the median procedure

For FLUV=1 and nmot<NFLUV the dynamic compensation time is calculated according to the median procedure.
Median is defined as the mean value of a data sequence (based on the values).
Medians are used for statistical evaluations, in order to eliminate outliers.
The engine roughness must be calculated continuously for each segment. For processing, six measuring values are required.
At first, 5 differences Dts1 to Dts5 are constructed of 2 consecutive segments.
Calculated is the engine roughness value, which is related to the segment tsk(n).

Dts1 = [tsk(n-1) - tsk(n-3)] / 2
Dts2 = tsk(n) - tsk(n-1)
Dts3 = tsk(n+1) - tsk(n)
Dts4 = tsk(n+2) - tsk(n+1)
Dts5 = tsk(n+3) - tsk(n+2)

The first differential value Dts corresponds to the mean value of two consecutive differences. By applying this procedure, it is also possible to detect misfire rates > 50%.

The 5 differences Dts1 to Dts5 are sorted, based on their value and then converted into the values DGts1 to DGts5.
(DGts1 corresponds to the highest value).

DGts1 = highest value of Dts1 to Dts5
DGts2 = second highest value of Dts1 to Dts5
DGts3 = third highest value of Dts1 to Dts5
DGts4 = fourth highest value of Dts1 to Dts5
DGts5 = fifth highest value of Dts1 to Dts5

The engine roughness is calculated based on:

$$\text{compensation time} = DGts3 \quad -> \quad luts(n) = \frac{Dts3 - DGts3}{tsk(n)^3}$$

1.1.2 Calculation of compensation time according to the arithmetical meanvalue

For FLUV1=0 and FLUV2=1 or for FLUV1=1 and nmot>NFLUV the compensation time is calculated according to the arithmetical meanvalue.

Dts6 = [tsk(n-p_zyl+SY_ZYLZA) - tsk(n-p_zyl)] / SY_ZYLZA;   p_zyl = ((SY_ZYLZA/2)-1)

The engine roughness is calculated based on:

$$\text{compensation time} = Dts6 \quad -> \quad luts(n) = \frac{Dts3 - Dts6}{tsk(n)^3}$$

1.1.3 Quantization parameter FLUQ

The parameter SY_FLUQ can be chosen, so that the optimum quantization of the engine roughness values are ensured.
The choice of SY_FLUQ = LUEXP (systemconstant variable)
results with tsquant = T1INCT (system constant variable)
in a quantisation of luquant = LUQUANT (system constant variable)

1.1.4 Overview of the calcualtions of the compensation time:

FLUV1	FLUV2	n	calculation of compensation time
1	x	n < NFLUV	median
1	x	n > NFLUV	arithmetical mean-value
0	1	x	arithmetical mean-value

x: means not relevant here.

1.2 Detecting of multiple misfiring supplementary information lums(n)

If several cylinders are misfiring (e.g., also alternating one combustion/one misfire event), the calculated engine roughness values may be that low so that the reference value is not exceeded during misfiring and therefore, misfiring would not be detected. Based on this fact, the periodicity of the engine roughness value is used as additional information during multiple misfiring.

The engine roughness values are filtered based on the following equation:

lums(n) = (1 - FIMALU) * lums(n-1) + FIMALU * FIAMALU * (| luts(n-1) - 0.5*luts(n-2) - 0.5 * luts(n) |)

During deactivation at specific operating conditions (B_mdstop=1, B_lustop=1, see 1.5), the lums-calculation is going on, but starts after the deactivation with the value 0. Only in case of rough road detection using statistic lums is not initialized after disabling by B_swe_s.
During deactivation after a detected misfire (see 1.6) the filtering resp. the lums-calculation is stopped.
If both deactivations are valid simultaneously, B_analu possesses the higher priority, e.g. lums is stopped and not set to 0.
In case of ZAS-mode (B_zasa=1) lums is set to 0.

1.3 Calculation of the engine roughness reference value:

The engine roughness value lurs consists of a base value (KFLURB) and a coolant-temperature-dependent correction value LURKTM.
The base value is determined by the map KFLURB for B_wk=0, by the map KFLURB1 for B_wk=1 and by the map KFLURB2 for B_wkr=1.
In case of ZAS-mode (B_zasa=1) the base value is determined by the map KFLURBZ independant of B_wk and B_wkr.
In case of idle an vehicle speed = 0 (and E_vfz=0) the base value is determined by the load dependant characteristic line LURBRL8 (independant of B_wk, B_wkr, B_zasa).

Furthermore, the correction value lursktm, determined by a characteristic line LURKTM, is added on the base value.
During cat-heating for better detection during the first 1000 crankshaft rev. the threshhold lurs can be decreased by the factor flurkh. flurkh is calculated from the characteristic line LURKH, dependant on the difference torque dmrkh used for cat-heating.

Offset to lurs of LURMIN* in case of not yet performed resp. not completed adaptation. LURMIN1..3 are characteristic lines over the speed.
If the adaptation is not yet completed to the reference value lurs is added the minimum value LURMIN3. LURMIN3 must hold out the inaccuracy of the segment duration. If the adaptation is completed in a dominant range the reference value is increased by the value LURMIN2. LURMIN2 must hold out the speed and load dependeces. If the adaptation is completed in a speed-dominant range of the actual speed the reference value lurs is increased by the minimum value LURMIN1. LURMIN1 must hold out the load-dependance of the actual speed-range. If the adaptation is completed in the actual range and all values of the actual speed-range are plausible there is no further offset to lurs.
The offset to lurs for the actual range depends on fostat (see %DMDFON):

fostat = 3: offset LURMIN3
fostat = 2: offset LURMIN2
fostat = 1: offset LURMIN1
fostat = 0: no further offset of lurs

different characteristic lines of LURMI*::

```
                  ^
                  |                                                 *               *
        ^         |                                                *
        | luts    |                                  LURMI3      *               *            *
                  |                                            *          LURMI2           *
                  |                                         *                *          *
                  |                                     *                *          *  LURMI1
                  |                                 *               *          *
                  |                            *              *          *
  offset         -| * * * * * *  *  *  *   *   *    *   *   * * * *
 (normal noise)   |
              0 - +---------------------------------------------------------------------------------->
                                                                            n   -->
```

The new reference value lurs(i) is compared with the old reference value lurs(i-2). A change towards smaller reference values is limited by the variation constant DMXRLU. After 2 camshaft-rotations lurs can be decreased of DMXRLU.

1.4 Determination if misfiring
Misfire detection is performed by comparing the engine roughness reference lurs(i) with the engine roughness value luts(n). If luts > lurs, then a single misfire is detected. (exception during deactivation of B_analu=1 (see 1.6) and B_mdstop=1 and B_lustop = 1 (see %DMDSTP)).

In case lums(n) exceeds the value lurms(i), then lurs is reduced by a n-/tl-dependant factor famal in case of completed adaptation (fostat=0 or fostat = 1).
The factor famal is got of a map over nmot and rl (KFAMAL in case of B_wk=0 and KFAMAL1 in case of B_wk=1).
The threshhold lurms results of a base value KFLURM and a coolant-temperature dependant offset lursktm (LURKTM). Changes towards smaller reference values are limited by the variation constant DMXRLU, see lurs (over 2 camshaft rotations).

```
lum > lurms  =>  lurs = lurs * famal[0..1] ;  if fostat = 0 V fostat = 1
```

1.5 Deactivation in case of abnormal conditions
In case of rough road, high load- and speed-changes, engine-torque jumps, ... the misfire detection is deactivated to provide misdetections, B_mdstop=1 or B_lustop=1.
The calculation of luts and lums goes on, so that the rough-road-detection with satistical methods (%DSWES) is able to go on. After the deactivation the calculation of luts and lums starts at 0 so there will be no 'past time information' in the filters.

In case of B_mdstop=1 or B_lustop=1 the bit B_luerk is not set, independant from the comparsion of luts > lurs.

1.6 Deactivation after detected misfiring:
If misfiring is detected within the previous segment, then misfire detection is deactivated during the next ANALUN segments and B_analu = 1. ANALUN is a characteristic line over speed. After this deactivation, a test phase with the duration of about > TNALU segments takes place and B_tnalu=1.
If an additional misfire is detected during this test phase, then no further deactivation via ANALUN is carried out and the test phase remains active (B_tnalu=1). The test phase is completed after TNALU segments after the last detected misfire.
If ANALUN = 0, then no deactivation after detected misfiring takes place.
By applying this measure, misdetection due to post-oscillation (which may be triggered by single misfiring) is suppressed.
Continuous misfiring, however, is detected reliably.
The calcualtion and monitoring of luts is going on. Only the detection of misfire is suppressed. (B_luerk=0 even if luts>lurs).
The lums-calculation is stopped during B_analu=1.
A deactivation also takes place if misfire is detected in %DMDDLU and B_analu = 1 is set.

APP DMDLU 4.90 Application hint

1) Monitor function
For the application of the misfire detection, it is necessary, to synchroneously monitor the segment time, the luts-value and several status bits. This is ensured with the monitor function.
For the description of the monitor-function and a list of related values see %DMDUE.

2) SY_FLUQ is a system variable, a variation is only possible by means of a new DAMOS specification.

3) Function deactivation:
For application purposes the misfire detection can be deactivated by setting NMXALU = 0 rpm in %DMDSTP.

4) Sensitivity of misfire detection:
LURMIN3: corresponds to the maximum possible faults (mechanical sensor wheel tolerances and torsional vibrations)
e.g. +- 1,2°crankshaft
LURMIN2: cornensponds to the max. possible faults over the speed (speed dependance of adaptation values)
e.g. +- 0,15°crankshaft
LURMIN1: corresponds to the max. possible fault over the load (load dependance of adaptation values in each speed range)
e.g. +- 0,1°crankshaft

LURMIN*-expansion to neighbour ranges:

```
                            .                        .
fse    ^    B_forxx = 0     .    B_forxx = 1         .        B_forxx = 1                ^
(zdg)  |                    .                        .                                    |
       | ###############################             .                                    - 100
°KW  1 -                    .^          ************************************              |
       |                    .|fault  *               .                                    |   (U/s)^2
       |                    .|    *                  .                                    |   engine
       |                    .V *                     .                                    |   roughn.
       |                    *                        .                                    |
       |                 *  .                        .                                    |
       |               *    .                        .                                    |
       |            *       .                        .                                    |
       |          *         .           ##########################################        -  0
     0 +-*-*-*-**-----------+-----------+------------+-----------------------------> 
       |      2000        2500        3000         3500
                            |<---------------------->|
                              speed-range

              *: fse value for ts-correction
              #: LURMIN*-offset
```

5) B_analu and B_tnalu:
B_analu and B_tnalu of %DMDLU and %DMDDLU are stored in one physical RAM-cell. So it is possible that both functions influence the other function and B_analu and B_tnalu are simultaneous in- and output.

6) short test of function DMDLU
For a short validation of the function the engine roughness values luts_ap can be compared in normal and in misfire mode (e. g. Mode 6 at ZAG).In areas of mean speed and load the luts_ap values in case of misfire must be visible higher than in case of normal combustions.

DMDDLU 7.50 Diagnostic routine Misfire Detection, forming the diff. for irregular running

FDEF DMDDLU 7.50 Function definition

Overview DMDDLU:

```
luts(n) ---------------+
                       |                                          +--+
                       V                                 dluts(n) |  |
                     - O----------------------------------------->|  |
                       ^                                          |  |
                       |                                          |  | dluts > dlurs
luts(n+(zylza/2)) -----+                                          |<>|---------------------o--o------> B_dluerk(n)
                                                                  |  |                      ^           B_analu(n+(SY_ZYLZA/2))
nmot -----------+                                                 |  |                      |          B_tnalu(n+(SY_ZYLZA/2))
rl ----------+  |                                                 |  |                      |
             |  |                                                 |  |                      |          DMDLAD, DMDLU
             V  V                              +----------+       |  |                      |
           +---------+    +---+    +---+       |variation | dlurs |  |                      |
B_wk=0 --->| KFDLUR  |----| + |--->| + |------>|limiter   |------>+  |                      |
           |---------|    +---+    +---+       |DMXRDL    |       |  |                      |
B_wk=1 --->| KFDLUR1 |      ^        ^         +----------+       +--+                      |
           |---------|      |        |                                                      |
B_wkr=1 -->| KFDLUR2 |      |        |                                                      |
           +---------+      |        |                                                      |
B_zasa --->| KFDLURZ |      |        |                                                      |
           +---------+      |        |                                                      |
                            |        |                                                      |
lursktm --------------------+        |                                                      |
                                     o                                                      |
fostat < 2 ------------------------->|                                                      |
                                     o                                                      |
          +---------+                |                                                      |
nmot ---->| DLURMIN |----------------+                                                      |
          +---------+                                                                       |
                          +---+                                                             |
B_mdstop ---------------->|   |                                                             |
B_lustop ---------------->|   |                                                             |
nmot < NMIDLU ----------->| V |-------------------------------------------------------------+
B_analu(n+SY_ZYLZA/2) --->|   |
                          +---+
```

B_analu, B_tnalu is triggered or retriggered by luts or by dluts.

The whole misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd=0 the function DMDDLU is locked, B_dluerk, B_analu and B_tnalu are set to 0.
For B_cdmd=1 the function DMDDLU is active.

This function is only active for engines with even cylinder numbers.
For SY_ZYLZA 0 odd B_dluerk is set to 0.

In case of 2 ecu’s (SY_2SG = 1) the function %DMDDLU is deactivated in the Master-ecu (B_master = 1).

ABK DMDDLU 7.50 Abbreviations

Indices and reference points used:
(n) = Crankshaft segments

luts(n)	Imbalance test variable, updating in synchro
dluts(n)	Differential imbalance, updating in synchro
dlurs	Differential imbalance reference value
DMDLAD	logical and temporary combination of the results from different functions for misfire detection
DMDLU	misfire detection with engine roughness
DMDSTP	stop conditions for misfire detection
SY_FLUQ	Quantization factor for imbalance calculation; system variable, change only possible via new DAMOS specification.
U	Crankshaft revolution
d...	Differential
SY_ZYLZA	Number of cylinders

Parameter	Source-X	Source-Y	Type	Description
DLURMIN	NMOT		KL	speed dependensy of engine roughness referenz minimum value 1
DMXRDL			FW	variation limit for max. reduction of engine roughness reference value dlur
KFDLUR	NMOT	RL	KF	map engine roughness difference dluts referenz value
KFDLUR1	NMOT	RL	KF	map engine roughness difference dluts referenz value
KFDLUR2	NMOT	RL	KF	map engine roughness difference dluts referenz value
KFDLURZ	NMOT	RL	KF	map engine roughness difference dluts referenz value at ZAS (cylinder cut-off)
NMIDLU			FW	min. engine speed for deactivating misfire detection DMDDLU

Variable	Source	Type	Description
B_ANALU	DMDLU	EIN	condition for deactivation after first detected misfiring
B_ANALU_M	DMDDLU	LOK	monitor, cond. for deactivation after first detected misfire
B_ANALU_M2	DMDDLU	LOK	monitor, cond. for deactivation after first detected misfire, 2.ECU
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DLUERK	DMDDLU	AUS	condition for misfiring detected, from DMDDLU
B_DLUERK_M	DMDDLU	LOK	monitor, misfire detected in DMDDLU
B_DLUER_M2	DMDDLU	LOK	monitor, misfire detected in DMDDLU, 2.ECU
B_LUSTOP	DMDSTP	EIN	misfire detection stop
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTOP	DMDSTP	EIN	misfire detection stop
B_WK		EIN	condition: converter lockup clutch closed
B_WKR		EIN	condition clutch controlled
B_ZASA		EIN	ZAS load switchover is active
DLURS	DMDDLU	LOK	engine roughness difference reference value
DLURS_M	DMDDLU	LOK	monitr, engine roughness difference reference value, signed, delayed output
DLURS_M2	DMDDLU	LOK	monitr, engine roughness difference reference value, signed, delayed out, 2.ECU
DLUTS	DMDDLU	LOK	difference engine roughness test value
DLUTS1	DMDDLU	AUS	difference engine roughness test value
DLUTS10	DMDDLU	AUS	difference engine roughness test value
DLUTS11	DMDDLU	AUS	difference engine roughness test value
DLUTS12	DMDDLU	AUS	difference engine roughness test value
DLUTS2	DMDDLU	AUS	difference engine roughness test value
DLUTS3	DMDDLU	AUS	difference engine roughness test value
DLUTS4	DMDDLU	AUS	difference engine roughness test value
DLUTS5	DMDDLU	AUS	difference engine roughness test value
DLUTS6	DMDDLU	AUS	difference engine roughness test value
DLUTS7	DMDDLU	AUS	difference engine roughness test value
DLUTS8	DMDDLU	AUS	difference engine roughness test value
DLUTS9	DMDDLU	AUS	difference engine roughness test value
DLUTS_M	DMDDLU	LOK	monitor, difference engine roughness test value, signed, delayed output
DLUTS_M2	DMDDLU	LOK	monitor, difference engine roughness test value, signed, delayed output, 2.ECU
FOSTAT	DMDFON	EIN	state of fuel-on/-off adaptation in actual map range
LURSKTM	DMDLU	EIN	tmot-dependent offset for engine roughness value dlurs, signed
LUTS	DMDLU	EIN	engine roughness test value
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SY_2SG	PROKON	EIN	system constant 2 motronic systems

FW DMDDLU 7.50 Fixed Values

Parameter	Value	Description
DMXRDL		variation limit for max. reduction of engine roughness reference value dlur
NMIDLU		min. engine speed for deactivating misfire detection DMDDLU

FB DMDDLU 7.50 Detailed description of function

1. Introduction:
The function described below allows the recognition of single and permanent misfires, and of non-symmetrical multiple misfires.
The quality of detection is independent of sensor wheel accuracy (crankshaft-synchronous segment time fluctuations), so symmetrical multiple misfires (also generating crankshaft-synchronous segment time fluctuations) cannot be recognized.

2. Calculation of differential imbalance dluts(n):
The imbalance values luts(n) and luts(n+(zylza/2)) belonging to the same crankshaft segment are subtracted.

dluts(n) = luts(n) - luts(n+(zylza/2))

If one of the two cylinders misfires, the differential dluts increases.
dluts is compared with the threshold value dlurs. dlurs is calculated relative to load and engine speed (8x8) via the map.
If the differential dluts(n) exceeds the threshold valve dlurs, then combustion misfires occur.

If both cylinders 1 crankshaft revolution apart misfire, the differential dluts is approximated to 0 as in normal operation.

In case of ZAS-mode the engine roughness luts of the non-fired cylinders is equal to 0. So the dlut-calculation doesn’t differ.

3. Calculation of reference value dlurs:
A base value is calculated from the load- and rpm-dependent map KFDLUR for B_wk=0, KFDLUR1 for B_wk=1 and KFDLUR2 for B_wkr=1.
In case of ZAS-mode the map KFDLURZ is used independant of B_wk and B_wkr.
To this base value a tmot-dependent offset lursktm (from %DMDLU) is added.
Depending on the adaptation status (fostat >= 2) an offset will be added to the reference value.
Negative variations in the reference values are limited by the variation limiter DMXRDL (corresponds to DMXRLU, see %DMDLU),
i. e. dlurs(i-2) - dlurs(i) <= DMXRDL.

4. Masking:
As with the basic functions (see %DMDUE), %DMDDLU must also be masked under the same critical operating conditions:
Masking at B_mdstop, B_lustop
Masking at B_analu
B_analu can be triggered here either by dluts misfire detection or by luts misfire detection.
The ANALUN masking is deactivated with TNALU in the event of permanent misfires. (see %DMDLU)

Also the function DMDDLU is masked for speed below the speed-dependant threshhold NMIDLU.
In lower rpm-ranges instabil luts values can occur and will be probrably subtracted or added by the dlut calculation.

Während einer der o.g. Ausblendungen wird die Differenzlaufunruhe dluts weiter berechhcnet, bei dluts > dlurs wird jedoch nicht auf Aussetzer erkannt.

APP DMDDLU 7.50 Application hint

1. A PC simulation program (dmdsim.exe) is provided for the dluts calculation. (Off-line application)

2. For KFDLUR the values of KFLURB can be used in the 1st stage. Usually the values for the corresponding operating points should not overlap. However, the two maps can be used to adjust the sensitivity of the various methods to specific ranges.

3. To be noted in the application of KFDLUR:
Typical dluts curves:

e.g. 4-cylinder engine:

```
              Single MF       Permanent MF                  Multiple MF         Multiple consecutive MF
        ^        *            *   *   *   *   *             symmetrical         **  **  **
        |
 luts   |                                                   * * * * *
        |
       0+--******----*********--------------------**********---------***********----------******************----->
                  ***          *** *** *** *** ***
                                                             * * * *

                                                                                  **  **

        ^
        |            ! !                                                        **  **
        |             |
        |             |
        |        *    |       *   *   *   *   *                                         **
        |             |
        |             |
dluts   |             |                                    *        *
        |       *  <--+      *
       0+--****---*--*******---*---*---*---*---*--********--*******--*********------------********************--->
                   **                           **
                                                          *        *
               *            *                                                 **
                                **  **  **  **


                                                                                  ++  ++
```

In the application of dlurs it must be noted that prior to the actual misfire, a smaller positive dluts value may occur.
Therefore, dlurs must not be set to too small a value.

4. Peculiarities in B_analu-masking due to the retroactive dluts calculation:

e.g. 4-cylinder engine: (prerequisite regarding luts: ZAD has stabilized)

```
              Single MF       Permanent MF
        ^        *            *   *   *   *   *
        |
 luts   |
        |
       0+--******----*********--------------------**********----->
                  ***          *** *** *** *** ***
                  +---+        +---+                        B_analu due to luts > lurs
         ---------+   +--------+   +-----------------------

                      +---+        +----------------+       B_tnalu
         -------------+   +--------+                +-------


        ^        *            *   *   *   *   *
        |
        |
dluts   |
        |       *            *
       0+--****---*--*******---*---*---*---*---*--************--->
                   **                           **
               *            *
                                **  **  **  **
```

If luts<=lurs (luts has detected no misfire):

```
                    +---+        +---+                        B_analu due to dluts > dlurs
           ---------+   +--------+   +-----------------------

                        +---+        +----------------+       B_tnalu
           -------------+   +--------+                +-------
```

dluts(n) requires luts(n+2) for its calculation. (e.g. 4-cyl. engine). In the ECU, dluts(n) can thus only be calculated 2 ignitions later in retrospect. The correct arrangement (resetting by 2 ignitions) is produced via the monitor drum.

If B_analu due to luts>lurs is already set at the time of the dluts(n) calculation, then no B_analu is set with dluts.

Triggering of B_analu due to dluts>dlurs can only occur 2 ignitions later (4-cyl. engine) because of the delayed calculation. B_analu, B_tnalu are thus shifted by 2 ignitions.
Because of the typical luts curve (see above, negative dluts) after a misfire, this is not critical.

5. DMXRDL should cut in slower than DMXRLU, i.e. -> DMXRLU > DMXRDL. Under dynamics (negative load change) the interference of luts may accumulate due to summation, which is why "mis-detections" can occur if cut-in is too fast.
   (Remark: Genuine misfires frequently occur here, but these should not be detected!)

   DMXRDL should be applied especially slowly in vehicles with manual switch or turbocharged engines.

6. Re. monitor function:
   For the application of msifire detection it is necessary that some values like dluts, dlurs, etc. are synchronized.
   This is ensured in the monitor-function.
   For the description of the monitor-function and a list of related values see %DMDUE.

7. short test of function DMDDLU
   For a short test of the function the difference-engine-roughness value dluts can be compared in normal combustion mode and in misfire mode (e. g. Mode 6 at ZAG). In areas of mean speed and load a clear difference of dluts between normal and misfire mode must be visible.

DMDLUA 4.30 Diagnostic routine Misfire Detection irregular running spacing

FDEF DMDLUA 4.30 Function definition

Overview DMDLUA:

```
             +---+
B_lustop --->|   |
B_mdstop --->| V |----------------------------------------------------------+
             +---+                                                          |
                      +-----------+                                         |          +--+
                      |^      * * |fluts1                                   V          |  |
luts1 --------------->||  *       |-----------+----------------------------o--o------->|  |
                      ||*  fflutn |           |                       0 ---o           |  |
                      +--------^--+   .       |                     .                  |  |
                       .       |fflutn        |                     .                  |  |
                       .              .       |                     .                  |  |
                      +-----------+           |                             |          |  |
                      |^      * * |fluts(SY_ZYLZA)                          V          |  |
luts(SY_ZYLZA) ------>||  *       |---------------+------------------------o--o------->|  |
                      ||*  fflutn |           |   |                   0 ---o           |  |
                      +--------^--+           |   |                                    |  |
                               |              |   |                                    |  | fluts(zyl) +----+
                               |fflutn        |   |                                    |  | >luar      |Zyl.| B_luaerk(n)
           +-----------+       |              |   |                                    |<>|------------|zu- |------------>
nmot ----->| FLUTN     |-------+              |   |  +---------+                       |  |            |ord.|
           +-----------+                      |   +->| minimum |                       |  |            +-^--+
                                              |    . | per     |luarmn+---+   luar     |  |              |
                                              |    . | camshaft|------| + |----------->|  |              |
nmot -------------+                           |    . | rotation|      +---+            |  |              |
rl ------------+  |                           +----->|         |        ^              |  |              |
               |  |                                  +---------+        |              +--+              |
               V  V                                                     |                                |
            +---------+                 +---------+                     |                                |
B_wk=0 ---->| KFLUAR  |     +---+       |variation|        luaroff      |                                |
            |---------|---->| + |------>|limiter  |---------------------+                                |
B_wk=1 ---->| KFLUAR1 |     +---+       |DMXRFL   |                                                      |
            |---------|       ^         +---------+                                                      |
B_wkr=1 --->| KFLUAR2 |       |                                                                          |
            +---------+       |                                                                          |
B_zasa=1 -->| KFLUARZ |       |                                                                          |
            +---------+       |                                                                          |
                              |                                                                          |
2 * lurs_min -----------------+                                                                          |
B_mdzyl1 ------------------------------------------------------------------------------------------------+
```

The entire functions for misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd=0 the function DMDLUA is locked and B_luaerk is set to 0.
For B_cdmd=1 the function DMDLUA is active.

In case of 2 ecu's (SY_2SG = 1) the function %DMDLUA is deactivated in the Master-ecu (B_master = 1).

ABK DMDLUA 4.30 Abbreviations

(i)	camshaft revolutions; NW-Umdr.
(n)	crankshaft segments
zzyl	cylinder number
SY_ZYLZA	number of cylinders

Parameter	Source-X	Source-Y	Type	Description
DMXRFL			FW	limitation for max. reduction of the filter engine roughness reference values
FLUTN	NMOT		KL	filter factor running irregularity
KFLUAR	NMOT	RL	KF	map for engine roughness distance reference value
KFLUAR1	NMOT	RL	KF	map for engine roughness distance reference value
KFLUAR2	NMOT	RL	KF	map for engine roughness distance reference value
KFLUARZ	NMOT	RL	KF	map for engine roughness distance reference value at ZAS (cylinder cut-off)

Variable	Source	Type	Description
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_LUAERK	DMDLUA	AUS	condition for misfiring detected, with engine roughness distance, from DMDLUA
B_LUAERK_M	DMDLUA	LOK	monitor, misfire detected in DMDLUA
B_LUAER_M2	DMDLUA	LOK	monitor, misfire detected in DMDLUA, 2.ECU
B_LUSTOP	DMDSTP	EIN	misfire detection stop
B_MASTER		EIN	Condition MASTER-ECU
B_MDSTOP	DMDSTP	EIN	misfire detection stop
B_MDZYL1	DMDLUA	LOK	con. for cylinder ident. (f.t>TALUST),LU-calculation disabled (f.t<TALUST)
B_WK		EIN	condition: converter lockup clutch closed
B_WKR		EIN	condition clutch controlled
B_ZASA		EIN	ZAS load switchover is active
FFLUTN	DMDLUA	LOK	filter facot over speed for filtering the engine roughness
FLUTS1	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 1, signed
FLUTS10	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 10, signed
FLUTS11	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 11, signed
FLUTS12	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 12, signed
FLUTS2	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 2, signed
FLUTS3	DMDLUA	LOK	filter engine roughness test value, cylinder or inition 3, signed
FLUTS4	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 4, signed
FLUTS5	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 5, signed
FLUTS6	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 6, signed
FLUTS7	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 7, signed

Variable	Source	Type	Description
FLUTS8	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 8, signed
FLUTS9	DMDLUA	LOK	filter engine roughness test value, cylinder or ignition 9, signed
FLUTS_M	DMDLUA	LOK	monitr, filtered engine roughness test value, signed, delayed output
FLUTS_M2	DMDLUA	LOK	monitr, filtered engine roughness test value, signed, delayed output, 2.ECU
LUAR	DMDLUA	DOK	engine roughness distance reference value
LUARMN	DMDLUA	LOK	engine roughness distance reference value minimum
LUAROFF	DMDLUA	LOK	engine roughness distance reference value offset
LUAR_M	DMDLUA	LOK	monitor, engine roughness distance reference value, delayed output
LUAR_M2	DMDLUA	LOK	monitor, engine roughness distance reference value, delayed output, 2.ECU
LURS_MIN	DMDLU	EIN	value of LUR in case of not finished sensor wheel adaptation, value from LURMIN*
LUTS1	DMDLU	EIN	engine roughness test value, cylinder or ignition 1, signed
LUTS10	DMDLU	EIN	engine roughness test value, cylinder or ignition 10, signed
LUTS11	DMDLU	EIN	engine roughness test value, cylinder or ignition 11, signed
LUTS12	DMDLU	EIN	engine roughness test value, cylinder or ignition 12, signed
LUTS2	DMDLU	EIN	engine roughness test value, cylinder or ignition 2, signed
LUTS3	DMDLU	EIN	engine roughness test value, cylinder or ignition 3, signed
LUTS4	DMDLU	EIN	engine roughness test value, cylinder or ignition 4, signed
LUTS5	DMDLU	EIN	engine roughness test value, cylinder or ignition 5, signed
LUTS6	DMDLU	EIN	engine roughness test value, cylinder or ignition 6, signed
LUTS7	DMDLU	EIN	engine roughness test value, cylinder or ignition 7, signed
LUTS8	DMDLU	EIN	engine roughness test value, cylinder or ignition 8, signed
LUTS9	DMDLU	EIN	engine roughness test value, cylinder or ignition 9, signed
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SY_2SG	PROKON	EIN	system constant 2 motronic systems

FW DMDLUA 4.30 Fixed Values

Parameter	Value	Description
DMXRFL		limitation for max. reduction of the filter engine roughness reference values

FB DMDLUA 4.30 Detailed description of function

```
1. Introduction
   The described function as follows permits the detection of continuous misfirng in one or more cylinders. For this the
   cylinder individuell engine roughenss luts(cyl) are filtered by a recursive low pass filter (fluts(cyl)) and are compared
   with an adapting threshhold luar.
   The detection ratio is nearly independant of the number of misfiring cylinders.
   The detection ratio is dependant of the adaptation status (e.g. of the fuel-on adaptation).

   Single misifre ( < 2 - 10 misifre per cylinder, according to fflutn) cannot be detected.

2. Calculation of fluts(cyl)
   The engine roughness luts(cyl)(i) are filtered cylinder individuell. The time constant ffluts is determined by a characteristic
   line FLUTN over speed.

   fluts(zyl)(i)  =  ( 1 - fflutn ) * fluts(zyl)(i-1)  +  fflutn * luts(zyl)(i)

   During masking of misfire detection (B_mdstop=1, B_lustop=1) the filtered values fluts(cyl) are set to 0. After the masking
   (B_md/lustop: 1 -> 0 ) the filtering begins at 0. Previous values are not considered.
   In case of ZAS-mode (B_zasa=1) the luts values of the cut-off cylinders are set to 0 so the corresponding fluts values are
   also 0 and the fluts calculation hasn't to be changed.

3. Calculation of reference value luar
   the reference value luar consists of a adapting minimum luarmn and an additive offset luaroff. The offset luaroff is
   calculated from the speed and load dependant map KFLUAR in case of B_wk=0, of KFLUAR1 for B_wk=1 and of KFLUAR2 for B_wkr=1.
   In case of ZAS-mode luaroff is calculated from the map KFLUARZ independant of B_wk and B_wkr.

   If the adaptation is not yet completed the offset value luaroff is increased by twice the value lurmin
   (from LURMIN*, see %DMDLU).
   Negative variations in the reference value are limited by the variation limiter DMXRFL (corresponding to DMXRLU in %DMDLU),
   i. e. luar(i-2) - luar(i) <= DMXRFL.

   The minimum value luarmn is the minimum of all filtered values fluts(cyl) during one camshaft revolution.

4. Determination if continuous misfire
   Continuous misfire is determined with a comparsion of the filtered fluts(cyl) and the referenc value luar. If fluts(cyl)
   exceeds the threshhold luar misfire is detected in the corresponding cylinder.
   The bit B_luaerk(n) is set at the corresponding ignition.
```

APP DMDLUA 4.30 Application hint

```
1. Monitor-function
   For application of misfire detection it is necessary to synchroneously monitor some variables and several status bits.
   This is ensured with the monitor function.
   For the description of the monitor-function and a list of the related values see %DMDUE.
```

2. physical background:
   During normal and misifre conditions the total amount of the luts values during one camshaft revolution is nearly equal to 0. During misfire in cylinder no. one e.g. the luts1 increases whereas the remaining luts2..lutsSY_ZYLZA desrease respectivley become negative. The total amount of all luts values over one camshaft revolution is 0. This is also valid for misfire in multiple cylinders.

   The distance between misfiring cylinder (positive luts) and firing cylinders (negative luts) is nearly the same and independant of the number of misfiring and firing cylinders.

   Example 4-cylinder-engine:

```
              single misfire  continuous misfire            multiple misfire    multiple misfire
                                                            symmetrical         consecutive


        ˆ .......*............*.  *   *   *   *    .........            ........**  **  **   .............
        |                       ...................         * * * * *  .         .          .
*:luts  |                                                    ..      ..           .       ..
".:luar  |                                                      ......              ....... "
       0+--******----*********--------------------**********---------***********----------******************----->
                  ***          *** *** *** *** ***

                                                             * * * *
                                                                                  **  **
```

3. Standard application values:
   DMXRFL: 2 - 4 * DMXRLU, dependant on fflutn, luar must be slower than fluts(cyl) to avoid misdetection during dynamic conditions.

   FLUTN: 0.4 (lower rpm) ... 0.1 (higher rpm, > 4000/min)

   KFLUAR: the values of KFLURN can be used in the 1st stage (see %DMDLU)

4. Difference between DMDLUA and lums (see %DMDLU)
   lums serves espacilly for detection of symmetrical misfire. In this case lums shows advanteges at high cylinder engines. For 4-cyl.-engines DMDLUA ca be sufficient for detection of multiple misfire. So this function shall be applicated first and in case of non sufficient detection ratio lums shall be activated.

5. Improvement with DMDLUA:
   - in case of poor and rough idling detection of continuous misfire can be protected with the function DMDLUA
   - similar in case of unsystematical speed vcariations (unsymmetrical distributed over all cylinders) during cold starting the misfire detection for continuous misfire can be protected. For this lurktm (see %DMDLU) isn't considered.
   - DMDLUA is still now nonsensitive for post-oscillations. For that ANALU/TNALU aren't considered. Post-oscillations vary unsymmetrical over all cylinders (observe flutn, choose smaller -> 0,1)
     It must be tested if post-oscillations appear camshaft synchron. In this case the filters may run away. If the post-oscillations are not camshaft synchron they may disappear after filtering.

6. short test of function DMDLUA
   For a short validation of the function the filtered engineroughness values fluts1..SY_ZYLZA can be compared in normal and in misfire mode (e. g. Mode 6 at ZAG). In areas of mean speed and load a high increasing of the fluts values of the misfiring cylinder must be visible.

DMDSTP 9.90 Diagnostic of misfire detection : Stop conditions

FDEF DMDSTP 9.90 Function definition

1. Overview : Function structure
================================

In the %DMDSTP all deactivation conditions for the functions of the misfire detection with regard to engine roughness (%DMDLU, %DMDDLU,%DMDLUA and %DMDMIL) as well as the function of the fuel-on and fuel-off adaptation (%DMDFON) are evaluated. According to the following block diagram the %DMDSTP generates 4 different stop bits (B_mdstop, B_lustop, B_fonstp and B_fofstp), which each have a blocking effect on the mentioned function blocks:

```
                                                                                          Misfire detection
   +-----------+                                                                        +---------------------+
   |           |  B_lustop      (chapter 3)                                             |   %DMDLU            |
   |           |----------------------------------------------------------------------->|   %DMDDLU           |
   |           |  B_mdstop      (chapter 2)                                             |   %DMDLUA           |
   | %DMDSTP   |----------------------------------------------------------+------------>|   %DMDMIL           |
   |           |                                                          |             +---------------------+
   |           |                                                          |
   |           |                                                          |               Adaptation  %DMDFON
   |           |                                                          |             +---------------------------+
   |           |  B_fonstp      (chapter 4)                               +------------>|  fuel - on adaptation     |
   |           |----------------------------------------------------------------------->|                           |
   |           |  B_fofstp      (chapter 5)                                             +---------------------------+
   |           |----------------------------------------------------------------------->|  fuel - off adaptation    |
   +-----------+                                                                        +---------------------------+
```

Via the Euro switch CDMD it is possible to switch off the functions of the misfire detection.
If B_cdmd=0 the function %DMDSTP is blocked.
If B_cdmd=1 the function %DMDSTP is active.

2. Formation of the stop bit : B_mdstop for the deactivation of the functions : %DMDLU, %DMDDLU, %DMDLUA, %DMDMIL and %DMDFON (fuel-on adaptation)
[Nomenclature for cross coupling matrix : Partial function for common deactivation conditions DMDSTP MD]

```
                                                                                    Numerical figures in square brackets []
                                                                        +-+         refer to the corresponding chapter
[2.01]               +--------------------------------------+ B_mdng    | |         in the function description (FB)
        ngfil_w ---->| |ngfil_w| > NGALU                    |---------->| |
                     +--------------------------------------+           | |
                                                                        | |
[2.02]               +--------------------------------------+ B_mddrla  | |
for ME7:rlgas_w ---->| |rlgas_w|  > DRLSOLA                 |---------->| |
                     +--------------------------------------+           | |
                                                                        | |             +---+         B_luena
[2.03]                                                        B_st      | |   +-------->| 1 |o------------------>
        B_st ---------------------------------------------------------->| |   |         +---+
                                                                        | |   |      +--------------+
[2.04]               +--------------------------------------+ B_mdtnst  | |   |      | ----+ AVRALU | B_mdstop
        tnst_w ----->| < TALUST                             |---------->| |---+----->| ----+------- |-----------> %DMDLU
                     +--------------------------------------+           |V|          +--------------+             %DMDDLU
                                                                        | |                                       %DMDLUA
[2.05]                                                                  | |                                       %DMDMIL
                   CW_SWE                                               | |                                       %DMDFON
                     |                SY_SWE_B                          | |
                     V                    |                             | |
        B_swe_p ---o \                    V                   B_swe     | |
        B_swe_b ---o  o-----------------o--o--------------------------->| |
                              0---------o                               | |
                                                                        | |
                                      SY_SWE_C                          | |
                                          |                             | |
                                          V                   B_swe     | |
        B_swe_c ------------------------o--o--------------------------->| |
                              0---------o                               | |
                                                                        | |
                                      SY_SWE_S                          | |
                                          |                             | |
                                          V                   B_swe     | |
        B_swe_s ------------------------o--o--------------------------->| |
                              0---------o                               | |
                                                                        | |
[2.06]                                                        B_mdein   | |
        B_mdein ------------------------------------------------------->| |
                                                                        | |
[2.07]                                                        B_tsroov  | |
        B_tsroov ------------------------------------------------------>| |
                                                                        | |
[2.08]                                                        C_ini     | |
        C_ini --------------------------------------------------------->| |
                                                              C_inisyn  | |
        C_inisyn ------------------------------------------------------>| |
                                                                        | |
[2.09]               +----------------+                                 | |
        B_koe --+--->|   0  --> 1     |-------------------------------->| |
                |    +----------------+  +------------------+           | |
                +----------------------->|    1  --> 0      |---------->| |
                                         +------------------+           | |
                                                                        | |
[2.10]                                                        B_dtes    | |
        B_dtes -------------------------------------------------------->| |
                                                                        | |
[2.11]                                                        B_sa      | |
        B_sa ---------------------------------------------------------->| |
                                                                        | |
```

```
[2.13]               +----------------+                                  | |
        B_wk ---+--->|   0  --> 1     |--------------------------------->| |
                |    +----------------+  +-------------------+           | |
                +----------------------->|    1  -->  0      |---------->| |
                     +----------------+  +-------------------+           | |
        B_wkr --+--->|   0  --> 1     |--------------------------------->| |
                |    +----------------+  +-------------------+           | |
                +----------------------->|    1  -->  0      |---------->| |
                                         +-------------------+           | |
                                                                         | |
[2.14]               +---------------------------------------+           | |
        tans ------->|  < TAMIALU                            |---------->| |
                     +---------------------------------------+           | |
                                                                         | |
[2.15] SY_SU = 1 oder SY_SU =2                           | |
                 +----------------+                                  | |
       B_su ---+---->|  0  -->  1     |--------------------------------->| |
               |     +----------------+ +--------------------+           | |
               +----------------------->|    1 -->  0        |---------->| |
                                        +--------------------+           | |
       SY_SU = 2                                                         | |
                     +----------------+                                  | |
       B_su2 --+---->|  0  -->  1     |--------------------------------->| |
               |     +----------------+ +--------------------+           | |
               +----------------------->|    1 -->  0        |---------->| |
                                        +--------------------+           | |
                                                                         | |
[2.16] SY_NWS = 1                                | |
                     +----------------+                                  | |
       B_nws --+---->|  0  -->  1     |--------------------------------->| |
               |     +----------------+ +--------------------+           | |
               +----------------------->|    1 -->  0        |---------->| |
                                        +--------------------+           | |


[2.18]                                                         E_bm      | |
        E_bm ----------------------------------------------------------->| |
                                                               E_n       | |
        E_n  ----------------------------------------------------------->| |
                                                               B_fbm     | |
        B_fbm ---------------------------------------------------------->| |
                                                               B_nldg    | |
        B_nldg --------------------------------------------------------->| |
[2.19]                                                         B_dkpu    | |
        B_dkpu --------------------------------------------------------->| |
[2.23]                                                                   | |
        B_asc_reg ------------------------------------------------------>| |
                                                                         | |
[2.25]  (only on customer request)                                       | |
                                                               E_agre    | |
        E_agre --------------------------------------------------------->| |
                                                               E_agrf    | |
        E_agrf --------------------------------------------------------->| |
                                                                         | |
[2.26]  (only on customer request)                                       | |
                                                               E_teve    | |
        E_teve --------------------------------------------------------->| |
                                                               E_tes     | |
        E_tes  --------------------------------------------------------->| |
                                                                         | |
                                                                         +-+


3. Formation of the stop bit : B_lustop for the deactivation of the functions : %DMDLU, %DMDDLU, %DMDLUA and %DMDMIL
   [Nomenclature for the cross coupling matrix : Partial function deactivation conditions specially for engine roughness
    DMDSTP LU]

[3.01]               +---------------------------------------+ B_mdrl    +-+                            B_lustopu
        rl---------->|  < RLSALUN                            |---------->| |     +------------------------------->
                     +---------------------------------------+           | |     |    +--------------+
                                                                         | |     |    | ----+ AVRALU |  B_lustop
[3.02]               +----------------+                         B_mdnmot | |-----+--->| ----+------- |-----------> %DMDLU
        nmot----+--->|  < NMIALU      |--------------------------------->| |          +--------------+             %DMDDLU
                |    +----------------+ +--------------------+  B_mdnmot | |                                       %DMDLUA
                +---------------------->|   >  NMXALU        |---------->| |                                       %DMDMIL
                                        +--------------------+           | |
                                                               --------  | |
[3.03]               +---+                                     B_evasel  |V|
        B_evasel --->| 1 |o--------------------------------------------->| |
                     +---+                                               | |
                                                                         +-+
```

```
4. Formation of the stop bit : B_fonstp for the deactivation of the function %DMDFON (fuel-on adaptation)
   [Nomenclature for cross coupling matrix : Partial function stop of the fuel-on adaptation DMDSTP FO]
                                                              -------
[4.01]               +----------------+   B_fontm     +---+   B_fontm   +-+
        tmot ------->|  > SFONTM      |-------------->| 1 |o----------->| |
                     +----------------+               +---+             | |
                                                                        | |
[4.02]                                                        B_edkvs   | |
        B_edkvs ------------------------------------------------------->| |
                                                                        | |
[4.03]                                                        B_tehb    | |
        B_tehb   ------------------------------------------------------>| |
                                                              -------   | |
[4.05]               +---+                                    B_synph   | |
        B_synph ---->| 1 |o-------------------------------------------->| |                 B_fonstp
                     +---+                                              |V|--------------------------------> %DMDFON
[4.06]                                                        E_md      | |                                  (fuel-on adaptation)
        E_md  --------------------------------------------------------->| |
                                                              B_mdarv   | |
        B_mdarv ------------------------------------------------------->| |
  or:                                                         E_ase     | |
        E_ase --------------------------------------------------------->| |
                                                              E_ask     | |
        E_ask --------------------------------------------------------->| |
                                                                        | |
[4.07]                                                        B_mderk   | |
        B_mderk ------------------------------------------------------->| |
                                                              -------   | |
[4.08]               +---+                                    B_evloc   | |
        B_evloc ---->| 1 |o-------------------------------------------->| |
                     +---+                                              | |
                                                                        | |
[4.09]  SY_SU = 1 oder SY_SU = 2                    | |
                                                              E_sue     | |
        E_sue  -------------------------------------------------------->| |
                                                | |
    SY_SU = 2                                                       | |
                                                              E_sue2    | |
        E_sue2 -------------------------------------------------------->| |
                                    | |
[4.10]                                                        E_lde     | |
        E_lde --------------------------------------------------------->| |
                                                                        | |

[4.11]                                                        E_uvse    | |
        E_uvse -------------------------------------------------------->| |
                                                                        | |
[4.16]               +----------------+                                 | |
        B_su ---+--->|   0  -->  1    |-------------------------------->| |
                |    +----------------+ +-------------------+           | |
                +----------------------->|    1  -->  0      |---------->| |
                                        +-------------------+           | |
                                                                        | |
[4.17]  (does not apply, if the errors are not CARB relevant, then however, include in B_fonstp)
        E_nws   ------------------------------------------------------->| |
        E_nws2 (*)----------------------------------------------------->| |
        E_nwse  ------------------------------------------------------->| |
        E_nwse2 (*)---------------------------------------------------->| |
        E_nwsf  ------------------------------------------------------->| |
        E_nwsf2 (*)---------------------------------------------------->| |
        E_nwkw  ------------------------------------------------------->| |
        E_nwkw2 (*)---------------------------------------------------->| |
        (*) if existing                                                 | |
                                                                        +-+
```

```
5. Formation of the stop bit : B_fofstp for the deactivation of the function %DMDFON (fuel-off adaptation)
   [Nomenclature for cross coupling matrix : Partial function stop of the fuel-off adaptation DMDSTP FF]

[5.01]               +----------------+                                  +-+
        B_koe -+-----|  0  -->  1     |--------------------------------->| |
               |     +----------------+ +-------------------+            | |
               +----------------------->|   1  --> 0        |----------->| |
                                        +-------------------+            | |
                                                                         | |
[5.02]                                                        C_ini      | |
        C_ini ---------------------------------------------------------->| |
                                                              C_inisyn   | |
        C_inisyn ------------------------------------------------------->| |
                                                              -------    | |
[5.03]               +---+                                    B_synph    | |
        B_synph ---->| 1 |o--------------------------------------------->| |
                     +---+                                               | |
                                                              ----       | |
[5.04]               +---+                                    B_sa       | |
        B_sa --------| 1 |o--------------------------------------------->| |
                     +---+                                               | |
                                                                         | |
[5.05]                                                        B_tsroov   | |
        B_tsroov ------------------------------------------------------->| |
                                                                         | |
[5.06]                                                                   | |
                   CW_SWE                                                | |
                     |                SY_SWE_B                           | |
                     V                    |                              | |
        B_swe_p ---o \                    V                   B_swe      | |
        B_swe_b ---o  o-----------------o--o---------------------------->| |
                              0---------o                                | |
                                                                         | |
                                      SY_SWE_C                           | |
                                          |                              | |
                                          V                   B_swe      | |
        B_swe_c ------------------------o--o---------------------------->| |
                              0---------o                                | |
                                                                         | |
                                      SY_SWE_S                           | |
                                          |                              | |
                                          V                   B_swe      | |
        B_swe_s ------------------------o--o---------------------------->| |
                              0---------o                                | |
                                                                         | |                 B_fofstp
                                                                         |V|-------------------------------> %DMDFON
[5.08]                                                        B_mdtnst   | |                                 (fuel-off Adaption)
        B_mdtnst ------------------------------------------------------->| |
                                                                         | |
[5.09]                                                        E_bm       | |
        E_bm  ---------------------------------------------------------->| |
                                                              E_n        | |
        E_n   ---------------------------------------------------------->| |
                                                              B_fbm      | |
        B_fbm ---------------------------------------------------------->| |
                                                              B_nldg     | |
        B_nldg --------------------------------------------------------->| |

                                                                         | |
[5.10]                                                        B_dkpu     | |
        B_dkpu --------------------------------------------------------->| |
                                                                         | |
[5.11]                                                        E_teve     | |
        E_teve --------------------------------------------------------->| |
                                                              E_tes      | |
        E_tes  --------------------------------------------------------->| |
                                                                         | |
[5.12]                                                        B_eev      | |
        B_eev ---------------------------------------------------------->| |
                                                                         | |
[5.15]                                                                   | |
        E_nws   -------------------------------------------------------->| |
        E_nws2 (*)------------------------------------------------------>| |
        E_nwse  -------------------------------------------------------->| |
        E_nwse2 (*)----------------------------------------------------->| |
        E_nwsf  -------------------------------------------------------->| |
        E_nwsf2 (*)----------------------------------------------------->| |
        E_nwkw  -------------------------------------------------------->| |
        E_nwkw2 (*)----------------------------------------------------->| |
        (*) if existing                                                  | |
[5.16]                                                                   | |
        B_asc_reg ------------------------------------------------------>| |
                                                                         | |
                                                                         +-+
```

ABK DMDSTP 9.90 Abbreviations

`(n) = Crankshaft segments`
`(t) = Time`

Parameter	Source-X	Source-Y	Type	Description
AVRALU			FW	No. Camshaft-Revs/Combustions f. reactivation misfire detection a. disablement
CWSTPCNF			FW	code word disabeling criterion 1-> criterion active
DRLSOLA	RL		KL	Misfire Detection : load-dynamic treshold for deactivation
NGALUN	NMOT		KL	Misfire Detection : treshold for gradient of engine speed
NMIALU			FW	min. engine speed for deactivating misfire detection
NMXALU			FW	max. engine speed for deactivating misfire detection
RLSALULL			FW	Threshold load fuel cut-off detection for deactivating misfire detection in idle
RLSALUN	NMOT		KL	threshold load fuel cut-off detection for deactivating misfire detection
SFONTM			FW	threshold value tmot for fuel-on adaptation activ
SNM08DMUB	NMOT		SV (REF)	Datapoint distribution in DMD, 8 speed datapoints
SRL08DMUB	RL		SV (REF)	Datapoint distribution in DMD, 8 load datapoints
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_AGR			SYS (REF)	System constant AGR present
SY_ASR			SYS (REF)	system constant ASR present
SY_FANT			SYS (REF)	system constant increase of the fuel cut-off speed at tester intervention
SY_NWS			SYS (REF)	system constant camshaft control: none, 2 point, continous
SY_NWVAR			SYS (REF)	system constant for camshaft configuration
SY_PGRAD2			SYS (REF)	system constant: kind of the 2. phase signal
SY_SU			SYS (REF)	system constant: version of intake runner length adjuster
SY_SWE_B			SYS (REF)	system constant for rough road detection using PWM signal from ABS
SY_SWE_C			SYS (REF)	system constant for rough road detection using CAN
SY_SWE_S			SYS (REF)	system constant for rough road detection using engine roughness statistics
SY_TURBO			SYS (REF)	system constant for exhaust-gas turbocharger
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TALUST			FW	time for deactivating misfire detection after engine start
TAMIALU			FW	min. induction-air temperature for deactivating misfire-detection
VFZGADMD			FW	vehicle-speed threshold to deactivate the DMD at active brake intervention

Variable	Source	Type	Description
B_ASC_REG		EIN	CAN-message: ASC in action (with break intervention)
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_BR2K	GGEGAS	EIN	Condition brakes actuated 2-channel detection
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DMBV		EIN	Active diagnosis: Torque comparsion cyl.-bank
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EEV	DEVE	EIN	condition injector fault (power stage)
B_ENWS	DNWS	EIN	condition error camshaft control
B_ESGCAN		EIN	Condition error ecu-CAN for 2 ME-ecu's
B_EVASEL	AEVAB	EIN	Status:all local injector relevant to DASE are switched on
B_EVLOC	BGEVAB	EIN	Status: all injection valves are activated
B_FAAN		EIN	condition functional request for general speed increase
B_FAN		EIN	condition functional request for speed increase for quick trip
B_FBM	GGDPG	EIN	condition reference mark error => at least 1 tooth too few/many
B_FOFSTP	DMDSTP	AUS	condition fuel-off adaptation stopped
B_FOFSTPC		EIN	condition fuel-off adaptation stopped from 2nd ECU via CAN
B_FOFSTPT	DMDSTP	AUS	condition fuel-off adaptation stopped from 2nd ECU
B_FONSTP	DMDSTP	AUS	condition fuel-on adaptation stopped
B_FONSTPC		EIN	condition fuel-on adaptation stopped from 2nd ECU via CAN
B_FONSTPT	DMDSTP	AUS	condition fuel-on adaptation stopped from 2nd ECU
B_FONTM	DMDSTP	LOK	engine temperature high enough for fuel-on-adaption
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LUENA	DMDSTP	LOK	Condition LU-calculation allowed (without time-delay)
B_LUSTOP	DMDSTP	AUS	misfire detection stop
B_LUSTOPC		EIN	misfire detection stop from 2nd ECU via CAN
B_LUSTOPT	DMDSTP	AUS	misfire detection stop from 2nd ECU
B_LUSTOPU	DMDSTP	LOK	Engine roughness calculation disabled , no time delay
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MDDRLA	DMDSTP	LOK	Condition gradient of load for misfire detection
B_MDEIN	MDKOG	EIN	Condition actions on the torque are active
B_MDERK	DMDLAD	EIN	misfiring detected from multpile functions
B_MDNG	DMDSTP	LOK	Condition misfire detection gradient of engine speed
B_MDNMOT	DMDSTP	LOK	condition misfire detection high and low engine speed limit
B_MDRL	DMDSTP	LOK	Condition misfire detection low load-treshold
B_MDSTOP	DMDSTP	AUS	misfire detection stop
B_MDSTOPC		EIN	misfire detection stop from 2nd ECU via CAN
B_MDSTOPT	DMDSTP	AUS	misfire detection stop from 2nd ECU
B_MDTNST	DMDSTP	LOK	Condition misfire detection time after cranking
B_MILSTP	DMDSTP	AUS	statistic of misfire detection (%DMDMIL) stop
B_NLDG		EIN	condition limp-home function speed sensor
B_NWS	NWS	EIN	Condition camshaft control
B_NWS2		EIN	Tigger NWS valve 2

Variable	Source	Type	Description
B_PHSNL	NLPH	EIN	Condition phase search during phase sensor limp-home
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	SWADAP	EIN	condition for start
B_SU	SU	EIN	condition intake manifold switch-over
B_SU2	SU	EIN	condition intake manifold switch over, 2.flap
B_SWE_B		EIN	Condition rough road detected via a bit over CAN (from ABS-ECU)
B_SWE_C	DSWEC	EIN	Condition rough road detected from %DSWEC
B_SWE_P		EIN	Condition rough road detected via a PWM-Signal over CAN (from ABS-ECU)
B_SWE_S		EIN	Condition rough road detected from %DSWES
B_SYNPH	GGDPG	EIN	condition synchronization phase
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
B_TSROOV	DMDTSB	EIN	condition segment duration word overflow
B_WK		EIN	condition: converter lockup clutch closed
B_WKR		EIN	condition clutch controlled
DFP_AGRE		EIN	ECU int. fault path no.: EKR power stage
DFP_AGRF		EIN	ECU int. fault path no.: partial pressure EGR
DFP_BM		EIN	ECU int. fault path no.: reference mark
DFP_LDE		EIN	ECU int. fault path no.: electro pneumatic reversing valve power stage
DFP_MD		EIN	ECU int. fault path no. misfire, multiple
DFP_N		EIN	ECU int. fault path no.: engine speed sensor
DFP_NWKW		EIN	ECU int. fault path no.: alignment between carnshaft and crankshaft
DFP_NWKW2		EIN	ECU int. fault path no.: alignment between carnshaft 2 and crankshaft
DFP_NWS		EIN	ECU int. fault path no.: carnshaft control
DFP_NWS2		EIN	ECU int. fault path no.: carnshaft control
DFP_NWSE		EIN	ECU int. fault path no.: carnshaft control power stage
DFP_SUE		EIN	ECU-internal fault-path no.: Output-stage variable-tract intake manifold
DFP_SUE2		EIN	ECU int. fault path no.: Intake manifold valve 2
DFP_TES		EIN	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE		EIN	Internal fault path number: canister purge valve power stage
DFP_UVSE		EIN	Internal fault path number: power stage dump valve turbo
DFP_VFZ		EIN	ECU int. fault path no.: vehicle speed signal
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_BM	DDG	EIN	error flag: reference mark sensor
E_LDE		EIN	error flag: electro pneumaic reversing valve (power stage)
E_MD	DMDMIL	EIN	Error flag: misfire, multiple
E_N	DDG	EIN	error flag: engine speed sensor
E_NWKW	DNWKW	EIN	error flag: alignment between camshaft and crankshaft
E_NWKW2	DNWKW	EIN	error flag: alignment between camshaft 2 and crankshaft
E_NWS	DNWS	EIN	error flag: camshaft control
E_NWS2	DNWS	EIN	error flag: camshaft control bank 2
E_NWSE	DNWSE	EIN	error flag: power stage of camshaft control valve
E_NWSE2		EIN	error flag: driver stage bank 2 of camshaft control valve
E_SUE		EIN	Errorflag: Power stage , Intake manifold valve
E_SUE2		EIN	Errorflag: Power stage, Intake manifold valve (bank2)
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_UVSE		EIN	error flag: power stage dump valve turbo
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
NGFIL_W	SWADAP	EIN	filtered engine-speed gradient
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RLGAS_W	BGRLG	EIN	gradient of air charge at one combustion cycle
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW DMDSTP 9.90 Fixed Values

Parameter	Value	Description
AVRALU		No. Camshaft-Revs/Combustions f. reactivation misfire detection a. disablement
CWSTPCNF		code word disabeling criterion 1-> criterion active
NMIALU		min. engine speed for deactivating misfire detection
NMXALU		max. engine speed for deactivating misfire detection
RLSALULL		Threshold load fuel cut-off detection for deactivating misfire detection in idle
SFONTM		threshold value tmot for fuel-on adaptation activ
TALUST		time for deactivating misfire detection after engine start
TAMIALU		min. induction-air temperature for deactivating misfire-detection
VFZGADMD		vehicle-speed threshold to deactivate the DMD at active brake intervention

FB DMDSTP 9.90 Detailed description of function

```
1. Introduction
===============

With special operating conditions or errors of components, which lead to an increased engine roughness there, is a risk that
an erroneous misfire detection or a mis-adaptation will be performed.
So as to avoid this, the functions for the misfire detection and for the adaptation must be deactivated if the
conditions mentioned below occur.
```

2. Formation of the stop bit B_mdstop for deactivation of the functions : %DMDLU, %DMDLUA, %DMDMIL and %DMDFON (fuel-on adaptation)

If one of the following conditions is fulfilled then the stop bit B_mdstop is set and the functions for the misfire detection by means of engine roughness (%DMDLU, %DMDDLU, %DMDLUA and %DMDMIL) as well as the fuel-on adaptation (%DMDFON - fuel-on adaptation) are deactivated.
Once the setting condition for B_mdstop is no longer valid, the bit B_mdstop is reset with a delay of AVRALU camshaft (NW) revolutions.

[2.01] Deactivation in case of engine speed dynamics, B_mdng
For the detection of engine speed dynamics the absolute value of the filtered engine speed gradient |ngfil_w| is compared to the characteristic line NGALU. If the characteristic line is exceeded B_mdng = TRUE is set.
Remarks : - ngfil_w is formed in %BGNG5.10 by filtering of the engine speed gradient ngas_w.
So that ngfil_w shows enough dynamic response, the filter time constant ZNGFIL there may not be chosen greater than 50ms.
- NGALU is a fixed characteristic line over the engine speed (8 base points, no interpolation)

[2.02] Deactivation in case of load dynamics, B_mddrla
The detection of the load dynamics is performed differently, dependent on the ECU type (ME7 or M7):

ME7 : The absolute value of the load gradient |rlgas_w| (formed via a working cycle) is compared to the characteristic line DRLSOLA. If the characteristic line is exceeded B_mddrla = TRUE is set.
Remark : rlgas_w is formed in the function %BGSRM (as from version 2.80)

Remark : DRLSOLA is a fixed characteristic line over the load (8 base points, no interpolation)

[2.03] Deactivation during engine start, B_st
If B_st = TRUE a deactivation is performed during engine start. (B_st is generated in %BBSTT.)

[2.04] Deactivation for a time interval after end of start, B_mdtnst
For a time interval TALUST after end of start the deactivation condition is fulfilled via the bit B_mdtnst = TRUE.
Hint : According to the CARB legislation (1/97) deactivation may only be performed for 5s after end of start at the maximum.

[2.05] Deactivation in case of rough road condition, B_swe
In case of detected rough road conditions, deactivation is performed via the bit B_swe = TRUE. The deactivation is necessary, since the driving wheels can couple onto the drive shaft and thus also onto the crankshaft when driving across a rough road.

Because of several functions for rough road detection it is switched between several Bit dependant on the system constant value SY_SWE_S, SY_SWE_B, SY_SWE_C, CW_SWE:

SY_SWE_B = 1 and CW_SWE = 0: B_swe_b: vehicle wheel speed or wheel acceleration is evaluated in %BGRBS and %DSWEC
SY_SWE_B = 1 and CW_SWE = 1: B_swe_p: pulse wide modulated signal comes via CAN (from the ABS-ECU)
SY_SWE_S = 1: B_swe_s: rough road detection is calculated from the statistic of the engine roughness values in %DSWES
SY_SWE_C = 1: B_swe_c: a rough road detected bit comes via CAN (from the ABS_ECU)

[2.06] Deactivation in case of active torque action, B_mdein
In case of active torque action the deactivation condition is fulfilled via the bit B_mdein = TRUE. A torque action can be triggered, e.g. by the following events:

- active ABS - control
- active ASR/FDR - control
- change of gears on automatic transmission

Remark : B_mdein is generated in %MDKOG.

[2.07] Deactivation in case of segment time word overflow, B_tsroov
If a word overflow occurs when forming the segment time, then B_tsroov = TRUE and a deactivation takes place.
B_tsroov is generated in %DMDTSB.

[2.08] Deactivation during the initialization phase, C_ini, C_inisyn
During the initialization phase C_ini resp. C_inisyn = TRUE applies.

[2.09] Deactivation when turning on or off the air conditioning compressor, B_koe
When turning the air conditioning compressor on or off (positive and negative edge in B_koe) a deactivation is performed.

[2.10] Deactivation in case of active canister purging diagnosis, B_dtes
In case of active canister purging diagnosis (B_dtes = TRUE) a deactivation is performed.

[2.11] Deactivation in case of fuel cut-off on overrun, B_sa
During active fuel cut-off on overrun (B_sa = TRUE) a deactivation is performed.

[2.13] Deactivation in case of a change of state of the torque converter lockup clutch, B_wk, B_wkr
In case of a change of state of the torque converter lockup clutch a deactivation is performed.

[2.14] Deactivation in case of inlet air temperature being too cold, tans
If the inlet air temperature (tans) falls short of the fixed value TAMIALU, then a deactivation is performed.

[2.16] Deactivation in case of camshaft adjustment, B_nws
During the camshaft adjustment (positive or negative edge of B_nws) a deactivation is performed.

[2.18] Deactivation in case of crankshaft reference mark error, E_bm, E_n, B_fbm, B_nldg
E_bm : Reference mark error
E_n : Error of the engine speed signal sensor, E_n can be done without, if the condition is already included in E_bm.
B_fbm: Reference mark error ; one tooth too many or too little detected
In contrast to the above error bits, B_fbm is set without time delay (debouncing and error memory access time).
B_nldg: speed sensor emergency running (from %DDG10.10 on)

[2.19] Deactivation in case of non-synchronized throttle valve, B_dkpu
The fuel-off adaptation is deactivated, if there no valid information on the current position of the throttle valve. (B_dkpu = 1 ; limp-home)

[2.23] Deactivation in case of ASR-, MSR-, ABS- or FDR-control, B_asc_reg
In addition to the torque action (B_mdein) it covers the brake action.
Possible bits are:
- B_asc_reg
- B_fdr
- B_eds
- B_asr

[2.25] Only on customer request : Deactivation in case of error in the exhaust gas recirculation system, E_agre, E_agrf
E_agre : Error in the power stage for triggering of EGR valve (from function %DAGRE)
E_agrf : Difference between actual and desired EGR partial pressure (from function %DAGRF)
In case of error, a too high EGR rate may result in a delayed combustion and thus in an increased engine roughness.

[2.26] Only on customer request : Deactivation in case of errors in the canister purging system, E_teve, E_tes
E_teve : Error canister purging valve power stage
E_tes : Error canister purging system
In case of faulty open canister purging valve an increased engine roughness may result due to strong enrichment.

3. Formation of the stop bit : B_lustop for the deactivation of the functions : %DMDLU, %DMDDLU, %DMDLUA and %DMDMIL

If one of the conditions to follow is fulfilled, then the stop bit B_lustop is set and the functions for the misfire detection by means of engine roughness (%DMDLU, %DMDDLU, %DMDLUA and %DMDMIL) are deactivated.
Once the setting conditions for B_lustop are no longer valid, the bit B_lustop is reset with a delay of AVRALU NW revolutions.

[3.01] Deactivation below zero load, B_mdrl
If the engine load falls short of the characteristic line RLSALUN, then B_mdrl = TRUE is set. RLSALUN is a characteristic line over the engine speed. (8 base points)

[3.02] Deactivation in case of too low / too high engine speed, B_mdnmot
If the engine speed lies outside of the value range [NMIALU ; NMXALU], the misfire detection is deactivated.

[3.03] Deactivation in case of injection switch-off, B_evasel
For certain operating conditions, for which the motronic actively cuts out the injection of one or several cylinders (B_evasel = 0), the misfire detection must be deactivated.
Possible causes for such cylinder cutouts are:
- Maximum engine speed is exceeded
- Maximum vehicle speed is exceeded
- Torque reduction
- Cylinder cutouts induced by workshop tester

No deactivation of the misfire detection, however, is performed in the following events of a cylinder cutout:
- Error in the power stage of an injector
- Cylinder cutout due to detected misfire on a cylinder

4. Formation of the stop bit : B_fonstp for the deactivation of the function %DMDFON (fuel-on adaptation)

If one of the conditions to follow is fulfilled, then the stop bit B_fonstp is set and the partial function for the fuel-on adaptation (%DMDFON) is deactivated.

[4.01] Deactivation in case of cold engine, B_fontm
The fuel-on adaptation is deactivated in case of a cold engine (B_fontm = 0) due to the engine roughness resulting from this.

[4.02] Deactivation in case of error in the mixture formation, B_edkvs
The fuel-on adaptation is deactivated, if the adaptation error threshold in the mixture formation is exceeded (B_edkvs = 1).

[4.03] Deactivation in case of canister purging with high charge, B_tehb
The fuel-on adaptation is deactivated in case of canister purging with high charge (B_tehb = 1), since here there is a risk of increased engine roughness due to mixture enrichment.

[4.05] Deactivation in case of missing synchronization, B_synph
As long as there is no synchronization (B_synph = 0), the fuel-on adaptation is deactivated.

[4.06] Deactivation in case of existing misfires, E_md, B_mdarv or E_ase, E_ask
In case od DMDMIL1.xx:
If a misfire error entry (E_md=1) or a specific misfire rate (B_mdarv=1)
exist, then the fuel-on adaptation is deactivated.
In case of DMDMIL3.xx:
If a cat. damaging misfire error entry exists (E_ask=1) or a emission rel. mirifre error entry exists (E_ase=1)
then the fuel-on adaptation is deactivated.

[4.07] Deactivation in case of detected misfires, B_mderk
With each detected misfire (B_mderk = 1) the fuel-on adaptation is deactivated.

[4.08] Deactivation in case of injection switch-off, B_evloc
With each kind of active injection switch-off (B_evloc = 0), the fuel-on adaptation is deactivated.

[4.09] Deactivation in case of power stage error during the intake manifold switch-over, E_sue or E_sue2

[4.10] Deactivation in case of error in the power stage of the wastegate, E_lde
(only on turbocharged engines)

[4.11] Deactivation in case of error in the power stage of the divert air valve, E_uvse
(only on turbocharged engines)

[4.16] Deactivation in case of intake manifold switch-over, B_su
During the intake manifold switch-over (positive or negative edge of B_su) a deactivation is performed.

[4.17] Deactivation in case of errors of the camshaft adjustment resp. in case of incorrect assignment between NW and KW
For projects, for which the following errors are CARB relevant it must each time be checked whether a deactivation shall be performed :

E_nws resp. E_nws2 : General error in the system of the camshaft control
E_nwse resp. E_nwse2 : Error in the power stage of the camshaft adjustment
E_nwsf resp. E_nwsf2 : Camshaft control error detected by the diagnosis of the intake manifold pressure
E_nwkw resp. E_nwkw2 : Angle between camshaft and crankshaft is no longer correct

5. Formation of the stop bit : B_fofstp for the deactivation of the function %DMDFON (fuel-off adaptation)

If one of the conditions to follow is fulfilled, then the stop bit B_fofstp is set and the partial function for the fuel-off adaptation (%DMDFON) is deactivated.

[5.01] Deactivation when turning on or off the air conditioning compressor, B_koe
When turning the air conditioning compressor on or off (positive and negative edge in B_koe) a deactivation is performed.

[5.02] Deactivation during the initialization phase, C_ini, C_inisyn
During the initialization phase C_ini resp. C_inisyn = TRUE applies.

[5.03] Deactivation in case of missing synchronization, B_synph
As long as there is no synchronization (B_synph = 0), the fuel-on adaptation is deactivated.

[5.04] Deactivation when not in the overrun, B_sa
The fuel-off adaptation is deactivated, if there is no overrun (B_sa = 0).

[5.05] Deactivation in case of segment time word overflow, B_tsroov
If a word overflow occurs when forming the segment times, then B_tsroov = TRUE is set and a deactivation is performed.
B_tsroov is generated in %DMDTSB.

[5.06] Deactivation in case of rough road condition, B_swe
In case of detected rough road conditions, deactivation is performed via the bit B_swe = TRUE. The deactivation is necessary, since the driving wheels can couple onto the drive shaft and thus also onto the crankshaft when driving across a rough road.

Because of several functions for rough road detection it is switched between several Bit dependant on the system constant value SY_SWE_S, SY_SWE_C, SY_SWE_B, CW_SWE:

SY_SWE_B = 1 and CW_SWE = 0: B_swe_b: vehicle wheel speed or wheel acceleration is evaluated in %BGRBS and %DSWEC
SY_SWE_B = 1 and CW_SWE = 1: B_swe_p: pulse wide modulated signal comes via CAN (from the ABS-ECU)
SY_SWE_S = 1: B_swe_s: rough road detection is calculated from the statistic of the engine roughness values in %DSWES
SY_SWE_C = 1: B_swe_c: a rough road detected bit comes via CAN (from the ABS_ECU)

[5.08] Deactivation for the time interval after end of start, B_mdtnst
For a time interval TALUST after end of start the deactivation condition is fulfilled via the bit B_mdtnst = TRUE.
[also see point 2.04]

[5.09] Deactivation in case of crankshaft reference mark error, E_bm, E_n, B_fbm, B_nldg
E_bm : Reference mark error
E_n : Error of the engine speed signal sensor, E_n can be done without, if the condition is already included in E_bm.
B_fbm: Reference mark error ; one tooth too many or too little detected
In contrast to the above error bits, B_fbm is set without time delay (debouncing and error memory access time).
B_nldg: speed sensor emergency running (from %DDG10.10 on)

[5.10] Deactivation in case of non-synchronized throttle valve, B_dkpu
The fuel-off adaptation is deactivated, if there is no valid information on the current position of the throttle valve.
(B_dkpu = 1 ; limp-home)

[5.11] Deactivation in case of errors in the canister purging system, E_teve, E_tes
E_teve : Error canister purging valve power stage
E_tes : Error canister purging system
In case of faulty open canister purging valve an increased engine roughness may result due to strong enrichment.

[5.12] Deactivation in case of diagnosis error injector, B_eev

[5.15] Deactivation in case of errors of the camshaft adjustment, s. 2.17

[5.16] Deactivation in case of ASC-, MSR-, ABS-control, B_asc_reg, s. 2.23

APP DMDSTP 9.90 Application hint

```
1) Monitor function
   For the application it is necessary to be able to realize the status bits B_mdstop, B_lustop, B_fonstp and B_fofstp in a
   synchronized fashion. This is possible by means of a monitor function.
   The description of the monitor function can be found in %DMDUE.

2) with 2 ECUs:
   On vehicles with two Electronic Control Units it must be checked on whether in case of an error in the load and temperature
   acquisition on one of the two ECUs, the engine bank for the other ECU in the misfire detection is interfered with.

3) The threshold value NMIALU (for deactivation in case of too low engine speeds) should not be chosen smaller than the minimum
   engine speed, which can still be realized due to the quantization tsquant.

4) Application of the characteristic lines NGALU and DRLSOLA
   During the application of the characteristic lines NGALU and DRLSOLA it must be checked to what extent the gradients ngfil_w
   as well as rlgas_w respond to misfires.
   This check should mainly be performed in the range with low engine speed and high load (1000 - 1500 rpm ; 40-60% load ;
   continuous and multiple misfire). The threshold values must in any case be chosen larger than the maximum amplitudes of
   the corresponding gradients occurring during misfire operation.

5) Short test for the check on whether function is active

   - Set threshold NMIALU e.g. to 1400 rpm
   - if the function is active it must apply: B_mdstop = 1 for nmot < NMIALU (e.g. idling) and
                                              B_mdstop = 0 if engine speed is kept above NMIALU
```

DMDLAD 5.10 Logic and Delay; Logical operation,different blocks for misfire detection

FDEF DMDLAD 5.10 Function definition

Overview DMDLAD:

```
                                   +---+
B_luerk(n) ----------------------->|   |
                                   |   |
B_dluerk(n) ---------------------->| V |-------------------------------------------------------------> B_mderk(n)
                                   |   |                                                               DMDFON, DMDMIL
B_luaerk(n) ---------------------->|   |
                                   +---+
```

The entire functions for misfire detection can be locked with the Eurocodeword CDMD.
For B_cdmd=0 the function DMDLAD is locked and B_mderk and B_mderkf are set to 0.
For B_cdmd=1 the function DMDLAD is active.

In case of 2 ecu’s (SY_2SG = 1) the function %DMDLAD is deactivated in the master-ecu (B_master = 1).

ABK DMDLAD 5.10 Abbreviations

Subscripts and reference points used:
(n)   = crankshaft segments

SY_ZYLZA = number of cylinders

Variable	Source	Type	Description
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DLUERK	DMDDLU	EIN	condition for misfiring detected, from DMDDLU
B_LUAERK	DMDLUA	EIN	condition for misfiring detected, with engine roughness distance, from DMDLUA
B_LUERK	DMDLU	EIN	condition for misfiring detected, from DMDLU
B_MASTER		EIN	Condition MASTER-ECU
B_MDERK	DMDLAD	AUS	misfiring detected from multpile functions
SY_2SG	PROKON	EIN	system constant 2 motronic systems

FW DMDLAD 5.10 Fixed Values

Parameter	Value	Description

FB DMDLAD 5.10 Detailed description of function

```
1. Logical and temporal combination of the results different functions for misfire detection
   The detection results several functions for misfire detection are combined.
   It is the matter of the following functions and result signals:
    DMDLU  -> B_luerk
    DMDDLU -> B_dluerk
    DMDLUA -> B_luaerk

   All signals are set at the time/ignition when misfire is detected. So a cylinder identification and temporal association
   is possible (see %DMDMIL).

   The result is a combined signal for detection and identification of misfire and for the stop of the adaptation
   (see %DMDFON).
```

1.1 Temporal synchronisation
The problem of the temporal synchronization is solved in the different functions themselve.
e.g. at the calculation time n+(SY_ZYLZA/2) the result bit B_dluerk(n) is set retroactive.

1.2 Logical combination
All temporal synchronized result signals (B_luerk, B_dluerk, B_luaerk) are OR-combined. If at least one of these signals is set the output B_mderk is set to 1.

APP DMDLAD 5.10 Application hint

DMDMIL 3.60 Fault trestment of misfire detection, control on MIL and rectification

FDEF DMDMIL 3.60 Function definition

1. Fault counting algorithm

```
                                       +---+
1. Interval  ------------------------->| & |---------------------------------------------------------------+
tmot < TMASKIV1 ---------------------->|   |                                                               |
(at the beginning of the 1. Interval)  +---+                                                               |
                   Deactivation DMD                                         Stop +------------------+      V
B_milstp --------------------------+------------------------------------+------->| ivzkat 0-200 KWU |-----o--o--+
                                   |                                    |        +------------------+  +--o     |
                            ti-    |   Stop +-----------------+         |   Stop | ivzkat           |--+        |
             current     deactiv.  +------->|ivzabg 0-1000 KWU|         +------->| 0-FASKIV1*200 KWU|           |
             cylinder     active            +-----------------+                  +------------------+           | Reset
                    |  B_tiab_zzyl                    |                                    +--------------------+--------+
                    |       |                         | Reset                              |                             |
                    V       |                         V                                    V                             V
                    \       V             + +---------+---+ fzabg_0            + +---------+--+fzkat_0       + +---------+--+fzkat_4
                 +-O  O---O--O--+-------+-->|counter ign.1|-->      +----------->|count. ign.1|-->    +------->|count. ign.5|-->
                 |              |       |   +-------------+         |            +------------+       |        +------------+
                 |              |       |                           O                                 |
                 |              |       +------------------------->/                                  |
                 |  |           |                     |             O                      |          |                  |
                 |  V       |   |                     V             |                      V          |                  V
                 |  \       V   |         + +---------+---+ fzabg_1 |          + +---------+--+fzkat_1|      + +---------+--+fzkat_5
B_mderk ---------+-O  O---O--O--|--+----+-->|counter ign.2|-->      |    +------>|count. ign.2|-->    |  +---->|count. ign.6|-->
                 |              |  |    |   +-------------+         |    |       +------------+       |  |     +------------+
                 |              |  |    |                           |    O                            |  |
                 |              |  |    +-------------------------- |-->/                             |  |
                 |  |           |  |                  |             |    O                 |          |  |               |
                 |  V       |   |  |                  V             |    |                 V          |  |               V
                 |  \       V   |  |      + +---------+---+ fzabg_2 |    |     + +---------+--+fzkat_2|  |   + +---------+--+fzkat_6
                 +-O  O---O--O--|--|--+-+-->|counter ign.3|-->      |    |    +->|count. ign.3|-->    |  |  +->|count. ign.7|-->
                                |  |  | |   +-------------+         |    |    |  +------------+       |  |  |  +------------+
                    .       .   |  |  | |            .              |    |    O         .             O  |  |         .
                    .       .   |  |  | +-------------------------- |--- | ->/          .         -->/   O  |         .
                    .       .   |  |  |              .              |    |    O         .             O /   O         .
                                |  |  |     ---------------         |    |    |  --------------       |  O /   --------------
                                |  |  |                |            |    |    |             |         |  |  O             |
                                V  V  V                V            |    |    |             V fzkats1 |  |  |             V fzkats2
                               +--------+   +----------+---+fzabgs  |    |    |  +----------+-+       |  |  |  +----------+-+
                               |    V   |   |counter sum,  +-->     |    |    |  |counter sum +---+   |  |  |  |counter sum +--+
                               +----+---+   |ex.g.relevant |        |    |    |  |bank1,cat.d.|   |   |  |  |  |bank2,cat.d.|  |
                                    |       +--------------+        |    |    |  +------------+   |   |  |  |  +------------+  |
                                    |                  |            |    |    |                   |   |  |  |                  |
                                    V                  V Reset      |    |    |                   |   |  |  |                  |
                               +-----------------------+  aftn..    |    |    |                   +---|--|--|-------->O<-------+
rl, nmot, tmot --------------->| updating temporary AF |--->        |    |    |                       |  |  |       + |   |
                               +-----------------------+  aftrl..   |    |    |                       |  |  |         V   V
       +-------------+                                              |    |    |                       |  |  |  +----------+-+fzkats
rl --->|weighting map|  kswf                                        |    |    |                       |  |  |  |counter sum | all
nmot ->|  KFKSWF     +----------------------------------------------+----+----+-----------------------+--+--+  |total, cat. | cyl.
       +-------------+                                                                                         +------------+


                          Stop  +-----------------+
B_milstp ---------------------->| ivzarv 0-60 KWU |
                                +-----------------+
                                         |
                                         V Reset
                               + +--------------+  fzarv
B_mderk ------------------------>| counter sum  |-------->
                                 +--------------+

B_milstp -----------------------+
                                |
                                V             +---------------------------+ bfnmn/mx, B_bfwrm, B_bfklt
rl, nmot, tmot ---------------o--o----------->|     updating BF           +---->
                                              +---------------------------+ bfrlmn/mx
```

2.1. Fault detection

```
1. Interval  -------------------+-------------------------------------------+                              AF exists    AFNTOL
                                |                                           |                                  |           |
ivzabg=1000*(SY_ZYLZA/2)        |                                           |        if E_md with              V    +------V----+
           |      +-------------+                                           |        B_mxflr vorh.        +--o--o-->|AF=AFT-Tol.|
           V      |                                                         |             |               |         +-----------+
           \      V     +----------+   +-----------+    +------+   B_mnflr  V             V       +---+   |           +---+ E_md
fzabgs --o  o---o---o-->| > AHEAGW |-->| inc.Zähler|--->| >= 4 |----------o--o--+-------o--o----->| V |---+---------->| S |------>
                    o   +----------+   | fivzabg   |    +------+  +-------o     | ------o     +-->|   |   |           +---+
                    |                  +-----------+              | B_npflr     | B_mxflr     |   +---+   | B_sp2 --->| R |
                    |   +-----------+                             |             |             |           |           +---+
                    +-->| > AHEAGWS |-----------------------------+             |             |           |
                        +-----------+                                           |             |           |
                                                                                |             |           |    +---+
                           +----------------------------------------------------+             |           +--->| S |------------->
B_synph=0 -----+           |                                                          B_mxflr |                +---+       B_sp1
               |           V                                                +-----------------+   after-r.---->| R |
               V           \     +--------------------+      +---+          |                                  +---+    E_md_zzyl
fzabg_zzyl ---o--o-------o  o--->| >= fzabgs/SY_ZYLZA |----->| V |----------|---------------------------------------------------->
                                 +--------------------+  +-->|   |          |                                 fault type as E_md
               |                                         |   +---+          |
E_ev_zzyl (B_mnev_zzyl) ---------------------------------|------------------|-----------------------------------------+
               |                                         |                  |                                         |
               V                 +--------------------+  |     +---------+  |    +----------------+    +----------+   V B_tiab_zzyl
fzkat_zzyl ---o--o-------o  o--->| >= fzkats/SY_ZYLZA |--+---->| > AHEKA |--|--->| inc. aint_zzyl |--->| > AINTKA |--o--o-----+-->
                           \     +--------------------+        +---------+  +-->o| dec.           |    +----------+ flgtiab/t |
                 +---+     ^                                                |    +----------------+            +--------------+
1. Interval  --->| & |--+  |                                                |                                  |   +---+ B_milmd
tmot<TMASKIV1 -->|   |  |  |                                                |                                  +-->| & |--------->
(at the begin.   +---+  |  +-------------------+                            |                      MILANTI ----|-->|   |
 of the    +------------+--------+             |                            |                                  |   +---+
 1. Int.)  |                     |             |                            |                                  |
           V      +---------+    V     +---+   |                            |                                  |
fzkats1 --o--o--->| > AHEKS |---o--o-->|   |   |                            |                                  | B_mdkat, B_blkmd
             o-+  +---------+ +-o      |   |---+----------------------------+----------------------------+-----|----------------->
           |   +->| > AHEKS1|-+  |     | V |                                                             |     |    +---+ flgkat_w
           V      +---------+    V     |   |                                                             |     +--->| V |-------->
fzkats2 --o--o--->| > AHEKS |---o--o-->|   |                                                             +---------->|   |
             o-+  +---------+ +-o      +---+                                                                        +---+
               +->| > AHEKS1|-+
                  +---------+

ivzarv=60*(SY_ZYLZA/2)
           |
           |        AHEARV
           V          |
           \     +----V-------+                                                                                          B_mdarv
fzarv ---o  o--->| > ahearv_w |-------------------------------------------------------------------------------------------------->
                 +------------+

                                        +---+
fzkats1 > AHEKS ----------------------->|   |                                                               Z_md, Z_md_zzyl
fzkats2 > AHEKS ----------------------->| V |------------------------------------------------------------------------------------>
                               +---+    |   |
ivzagb = 1000*(SY_ZYLZA/2) --->| S |--->|   |
                               +---+    +---+
                               | R |
                               +---+
```

During the after-run:

```
CWDMDE=1 ---------+
                  |
                  V                       +---+
BF >= AF -------o--o--------------------->|   |
          1 ----o                         |   |
B_sp1 ---------------------------------->o|   |                                                                            B_sp2
B_dcy ----------------------------------->| & |---------------------------------------------------------------------------------->
                               +---+      |   |
ivzabg = 1000*(SY_ZYLZA/2) --->| S |----->|   |
                               +---+      +---+
                               | R |
                               +---+
```

Ambient conditions: tfst (tank filling), rl (load), nmot (engine speed), tmot (engine temperature), B_sch

The function DMDMIL can be blocked via the code word CDMD.
If B_cdmd=0 the function is blocked, i.e. E_md=0, E_md_zzyl=0, Z_md=1, Z_md_zzyl=1.
If B_cdmd=1 the function is active.

ABK DMDMIL 3.60 Abbreviations

zzyl	Cylinder number
SY_ZYLZA	No. of cylinders
BF	Operating window engine operation
AFT	Temporary operating window with misfires
AF	Final operating window with misfires
FSP	Fault memory
exh. fault	Exhaust gas relevant fault
cat. fault	catalyst damaging fault
Start fault	exhaust gas relevant fault during the first interval after start
MD	Misfire Detection (description for cross coupling matrix)
ID	Cylinder identification (description for cross coupling matrix)

Parameter	Source-X	Source-Y	Type	Description
AFNTOL			FW	tolerance for decreasing the misfire window in the speed range
AHEAGW			FW	misfire frequency at which emission limits occures
AHEAGWS			FW	misfire frequency at which emission limits occures
AHEARV			FW	misfire frequency at which other functions will be stopped
AHEKA			FW	misfire frequency at which fuel cutoff occures
AHEKS			FW	misfire frequency at which catalyst damage occures
AHEKS1			FW	misfire frequency at which catalyst damge occurs during first intervall
AINTKAN	NMOT		KL	number of interval misfire frequency at which ti- cutoff
AZYTIAB			FW	maximum number of cylinder with ti- cut off at which catalyst damage occures
CDCMD	BLOKNR		KL	Code word CARB: misfire, multiple
CDCMD00	BLOKNR		KL	Code word CARB: misfire cyl. 0
CDCMD01	BLOKNR		KL	Code word CARB: misfire cyl. 1
CDCMD02	BLOKNR		KL	Code word CARB: misfire cylinder 2
CDCMD03	BLOKNR		KL	Code word CARB: misfire cylinder 3
CDCMD04	BLOKNR		KL	Code word CARB: misfire cylinder 4
CDCMD05	BLOKNR		KL	Code word CARB: misfire cylinder 5
CDCMD06	BLOKNR		KL	Code word CARB: misfire cylinder 6
CDCMD07	BLOKNR		KL	Code word CARB: misfire cylinder 7
CDCMD08	BLOKNR		KL	Code word CARB: misfire cylinder 8
CDCMD09	BLOKNR		KL	Code word CARB: misfire cylinder 9
CDCMD10	BLOKNR		KL	Code word CARB: misfire cylinder 10
CDCMD11	BLOKNR		KL	Code word CARB: misfire cylinder 11
CDTMD			FW	Code word tester: misfire, multiple
CDTMD00			FW	Code word tester: misfire cyl. 0
CDTMD01			FW	Code word tester: misfire cyl. 1
CDTMD02			FW	Code word tester: misfire cylinder 2
CDTMD03			FW	Code word tester: misfire cylinder 3
CDTMD04			FW	Code word tester: misfire cylinder 4
CDTMD05			FW	Code word tester: misfire cylinder 5
CDTMD06			FW	Code word tester: misfire cylinder 6
CDTMD07			FW	Code word tester: misfire cylinder 7
CDTMD08			FW	Code word tester: misfire cylinder 8
CDTMD09			FW	Code word tester: misfire cylinder 9
CDTMD10			FW	Code word tester: misfire cylinder 10
CDTMD11			FW	Code word tester: misfire cylinder 11
CWDMDE			FW	code word for EOBD-application DMDMIL (healing without window overlap)
FAINTEN			FW	number of interval for enabling ti - cutoff
FASKIV1			FW	factor for increasing the 1. cat-interval, misfire detection
KFKSWF	N	TL	KF	map for catalyst protection, weighting factors
MILANTI			FW	MIL is on during ti turn-off in 1. dcy
NLLM	TMOT		KL	desired engine speed
TMASKIV1			FW	temp. threshhold for increasing 1. cat-interval, misfire detection
TMWUC			FW	engine temperture threshold for fulfilment ”warm up cycle”

Variable	Source	Type	Description
AFNMN	DMDMIL	LOK	area of misfirings, minimum engine speed
AFNMX	DMDMIL	LOK	area of misfirings, maximum engine speed
AFRLMN	DMDMIL	LOK	area of misfirings, minimum load
AFRLMX	DMDMIL	LOK	area of misfirings, maximum load
AFTNMN	DMDMIL	LOK	area of misfirings, minimum engine speed, temporary
AFTNMX	DMDMIL	LOK	area of misfirings, maximum engine speed, temporary
AFTRLMN	DMDMIL	LOK	area of misfirings, minimum load, temporary
AFTRLMX	DMDMIL	LOK	area of misfirings, maximum load, temporary
AHEARV_W	DMDMIL	LOK	Misfiring frequency to reach suppression of other functions (from AHEARV
AINTKAMIN	DMDMIL	LOK	number of interval misfire frequency at which ti- cutoff, minimal value
AINT_0	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 1
AINT_1	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 2
AINT_10	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 11
AINT_11	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 12
AINT_2	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 3
AINT_3	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 4
AINT_4	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 5
AINT_5	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 6
AINT_6	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 7
AINT_7	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 8
AINT_8	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 9
AINT_9	DMDMIL	LOK	amount of catalyst damaging intervals for ignition 10
ANZAINTEN	DMDMIL	LOK	number of interval after start for enabling ti- cutoff (200 crankshaft rev.)

Variable	Source	Type	Description
AZYCNT	DMDMIL	LOK	amount of deactivateg cylinders because of cat. damaging misfire
BFNMN	DMDMIL	LOK	area of engine operation, minimum engine speed
BFNMX	DMDMIL	LOK	area of engine operation, maximum engine speed
BFRLMN	DMDMIL	LOK	area of engine operation, minimum load
BFRLMX	DMDMIL	LOK	area of engine operation, maximum load
B_AFKLT	DMDMIL	LOK	window for misfiring, condition cold, TMOT<TMWUC
B_AFTKLT	DMDMIL	LOK	window for misfiring, temporary, condition cold, TMOT<TMWUC
B_AFTWRM	DMDMIL	LOK	window for misfiring, temporary, condition warm, TMOT>TMWUC
B_AFWRM	DMDMIL	LOK	window for misfiring, condition warm, TMOT>TMWUC
B_BFKLT	DMDMIL	LOK	window engine operation, condition cold, TMOT<TMWUC
B_BFWRM	DMDMIL	LOK	window engine operation, condition warm, TMOT>TMWUC
B_BLKMD	DMDMIL	AUS	MIL-trigger blinking controlled by misfire detection
B_CDMD	PROKON	EIN	function active per codeword CDMD
B_DCY	DDCY	EIN	condition for 'driving cycle' fulfilled
B_MDARV	DMDMIL	AUS	critical misfire rate detected
B_MDKAT	DMDMIL	AUS	cat. damaging misfire rate exceeded (for deactivation of other functions)
B_MILMD	DMDMIL	AUS	MIL-trigger on controlled by misfire detection, during ti turn-off
B_MILSTP	DMDSTP	EIN	statistic of misfire detection (%DMDMIL) stop
B_MNEV1C		EIN	Error type: short circuit to ground at power stage injector 1
B_MNEV2C		EIN	Error type: short circuit to ground at power stage injector 2
B_MNEV3C		EIN	Error type: short circuit to ground at power stage injector 3
B_MNEV4C		EIN	Error type: short circuit to ground at power stage injector 4
B_MNEV5C		EIN	Error type: short circuit to ground at power stage injector 5
B_MNEV6C		EIN	Error type: short circuit to ground at power stage injector 6
B_MNMD	DMDMIL	LOK	Fault type min.: misfire, multiple
B_MXMD	DMDMIL	LOK	Fault type max.: misfire, multiple
B_NPMD	DMDMIL	LOK	Fault type not plaus.: misfire, multiple
B_SP1	DMDMIL	AUS	FLC-trigger of misfire detection
B_SP2	DMDMIL	AUS	HLC-trigger of misfire detection
B_SYNPH	GGDPG	EIN	condition synchronization phase
B_TIAB0	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ignition 0
B_TIAB1	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ignition 1
B_TIAB10	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl. 10
B_TIAB11	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl. 11
B_TIAB2	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 2
B_TIAB3	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 3
B_TIAB4	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 4
B_TIAB5	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 5
B_TIAB6	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 6
B_TIAB7	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 7
B_TIAB8	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl/ign. 8
B_TIAB9	DMDMIL	AUS	ti-cutoff at catalyst damaging misfiring, cyl. 9
B_WUC	DWUC	EIN	condition for detected 'warm up cycle'
EEVMNC		EIN	Error type: short circuit to ground at power stage injector 1..8
E_EV		EIN	error flag: general injector fault (power stage)
E_EV1	DEVE	EIN	error flag: injection valve of cyl. 1
E_EV2	DEVE	EIN	error flag: injection valve of cyl. 2
E_EV3	DEVE	EIN	error flag: injection valve of cyl. 3
E_EV4	DEVE	EIN	error flag: injection valve of cyl. 4
E_EV5	DEVE	EIN	error flag: injection valve of cyl. 5
E_EV6	DEVE	EIN	error flag: injection valve of cyl. 6
E_EV7	DEVE	EIN	error flag: injection valve of cyl. 7
E_EV8	DEVE	EIN	error flag: injection valve of cyl. 8
E_MD	DMDMIL	AUS	Error flag: misfire, multiple
E_MD00	DMDMIL	AUS	Error flag: misfire ignition 0
E_MD01	DMDMIL	AUS	Error flag: misfire ignition 1
E_MD02	DMDMIL	AUS	Error flag: misfire ignition 2
E_MD03	DMDMIL	AUS	Error flag: misfire ignition 3
E_MD04	DMDMIL	AUS	Error flag: misfire ignition 4
E_MD05	DMDMIL	AUS	Error flag: misfire ignition 5
E_MD06	DMDMIL	AUS	Error flag: misfire ignition 6
E_MD07	DMDMIL	AUS	Error flag: misfire ignition 7
E_MD08	DMDMIL	AUS	Error flag: misfire ignition 8
E_MD09	DMDMIL	AUS	Error flag: misfire ignition 9
E_MD10	DMDMIL	AUS	Error flag: misfire ignition 10
E_MD11	DMDMIL	AUS	Error flag: misfire ignition 11
FIVZABG	DMDMIL	LOK	intervall counter emission relevant misfiring
FLGKAT_W	DMDMIL	LOK	state flag cat. damaging misfire rates or ti turn-off
FLGTIAB	DMDMIL	AUS	state flag ti turn-of by catalyst damaging misfiring rates
FLGTIABT	DMDMIL	AUS	state flag ti turn-of by catalyst damaging misfiring rates
FZABGS_W	DMDMIL	LOK	fault counter, summary, counts emission relevant misfirings of all cylinders
FZABG_W_0	DMDMIL	LOK	fault counter ign. 1, counts emission relevant misfirings of ignition 1
FZABG_W_1	DMDMIL	LOK	fault counter ign. 2, counts emission relevant misfirings of ignition 2
FZABG_W_10	DMDMIL	LOK	fault counter ign.11, counts emission relevant misfirings of ignition 11
FZABG_W_11	DMDMIL	LOK	fault counter ign.12, counts emission relevant misfirings of ignition 12
FZABG_W_2	DMDMIL	LOK	fault counter ign. 3, counts emission relevant misfirings of ignition 3
FZABG_W_3	DMDMIL	LOK	fault counter ign. 4, counts emission relevant misfirings of ignition 4
FZABG_W_4	DMDMIL	LOK	fault counter ign. 5, counts emission relevant misfirings of ignition 5
FZABG_W_5	DMDMIL	LOK	fault counter ign. 6, counts emission relevant misfirings of ignition 6
FZABG_W_6	DMDMIL	LOK	fault counter ign. 7, counts emission relevant misfirings of ignition 7
FZABG_W_7	DMDMIL	LOK	fault counter ign. 8, counts emission relevant misfirings of ignition 8
FZABG_W_8	DMDMIL	LOK	fault counter ign. 9, counts emission relevant misfirings of ignition 9

Variable	Source	Type	Description
FZABG_W_9	DMDMIL	LOK	fault counter ign.10, counts emission relevant misfirings of ignition 10
FZARV_W	DMDMIL	LOK	fault counter, counts misfirings of all cylinders
FZKATS1_W	DMDMIL	LOK	failure counter, summary, counts catalyst damaging misfiring of cylinder bank 1
FZKATS2_W	DMDMIL	LOK	failure counter, summary, counts catalyst damaging misfiring of cylinder bank 2
FZKATS_W	DMDMIL	LOK	fault counter, summary, counts catalyst damaging misfirings of all cylinders
FZKAT_W_0	DMDMIL	LOK	fault counter ign. 1, counts cat. damaging misfire of ignition 1
FZKAT_W_1	DMDMIL	LOK	fault counter ign. 2, counts cat. damaging misfire of ignition 2
FZKAT_W_10	DMDMIL	LOK	fault counter ign.11, counts cat. damaging misfire of ignition 11
FZKAT_W_11	DMDMIL	LOK	fault counter ign.12, counts cat. damaging misfire of ignition 12
FZKAT_W_2	DMDMIL	LOK	fault counter ign. 3, counts cat. damaging misfire of ignition 3
FZKAT_W_3	DMDMIL	LOK	fault counter ign. 4, counts cat. damaging misfire of ignition 4
FZKAT_W_4	DMDMIL	LOK	fault counter ign. 5, counts cat. damaging misfire of ignition 5
FZKAT_W_5	DMDMIL	LOK	fault counter ign. 6, counts cat. damaging misfire of ignition 6
FZKAT_W_6	DMDMIL	LOK	fault counter ign. 7, counts cat. damaging misfire of ignition 7
FZKAT_W_7	DMDMIL	LOK	fault counter ign. 8, counts cat. damaging misfire of ignition 8
FZKAT_W_8	DMDMIL	LOK	fault counter ign. 9, counts cat. damaging misfire of ignition 9
FZKAT_W_9	DMDMIL	LOK	fault counter ign.10, counts cat. damaging misfire of ignition 10
IVZABG_W	DMDMIL	LOK	interval counter for emission relevant faults (0 - 1000 crankshaft revolutions)
IVZAINT_W	DMDMIL	LOK	interval counter for enable of ti-cut off (0 - 200 crankshaft revs.)
IVZARV_W	DMDMIL	LOK	interval counter for misfires (0-60 crankshaft revolutions)
IVZKAT_W	DMDMIL	LOK	interval counter for catalyst damaging misfirings (0 - 200 crankshaft revs.)
KSWF	DMDMIL	LOK	catalyst protection weighting factors, from KFKSWF
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
TFST	GGFST	EIN	fuel level in tank
TMOT	SWADAP	EIN	Engine temperature
Z_MD	DMDMIL	AUS	Cycle flag: misfire, multiple
Z_MD00	DMDMIL	AUS	Cycle flag: misfire ignition 0
Z_MD01	DMDMIL	AUS	Cycle flag: misfire ignition 1
Z_MD02	DMDMIL	AUS	Cycle flag: misfire ignition 2
Z_MD03	DMDMIL	AUS	Cycle flag: misfire ignition 3
Z_MD04	DMDMIL	AUS	Cycle flag: misfire ignition 4
Z_MD05	DMDMIL	AUS	Cycle flag: misfire ignition 5
Z_MD06	DMDMIL	AUS	Cycle flag: misfire ignition 6
Z_MD07	DMDMIL	AUS	Cycle flag: misfire ignition 7
Z_MD08	DMDMIL	AUS	Cycle flag: misfire ignition 8
Z_MD09	DMDMIL	AUS	Cycle flag: misfire ignition 9
Z_MD10	DMDMIL	AUS	Cycle flag: misfire ignition 10
Z_MD11	DMDMIL	AUS	Cycle flag: misfire ignition 11

FW DMDMIL 3.60 Fixed Values

Parameter	Value	Description
AFNTOL		tolerance for decreasing the misfire window in the speed range
AHEAGW		misfire frequency at which emission limits occures
AHEAGWS		misfire frequency at which emission limits occures
AHEARV		misfire frequency at which other functions will be stopped
AHEKA		misfire frequency at which fuel cutoff occures
AHEKS		misfire frequency at which catalyst damage occures
AHEKS1		misfire frequency at which catalyst damge occurs during first intervall
AZYTIAB		maximum number of cylinder with ti- cut off at which catalyst damage occures
CDTMD		Code word tester: misfire, multiple
CDTMD00		Code word tester: misfire cyl. 0
CDTMD01		Code word tester: misfire cyl. 1
CDTMD02		Code word tester: misfire cylinder 2
CDTMD03		Code word tester: misfire cylinder 3
CDTMD04		Code word tester: misfire cylinder 4
CDTMD05		Code word tester: misfire cylinder 5
CDTMD06		Code word tester: misfire cylinder 6
CDTMD07		Code word tester: misfire cylinder 7
CDTMD08		Code word tester: misfire cylinder 8
CDTMD09		Code word tester: misfire cylinder 9
CDTMD10		Code word tester: misfire cylinder 10
CDTMD11		Code word tester: misfire cylinder 11
CWDMDE		code word for EOBD-application DMDMIL (healing without window overlap)
FAINTEN		number of interval for enabling ti - cutoff
FASKIV1		factor for increasing the 1. cat-interval, misfire detection
MILANTI		MIL is on during ti turn-off in 1. dcy
TMASKIV1		temp. threshhold for increasing 1. cat-interval, misfire detection
TMWUC		engine temperture threshold for fulfilment ”warm up cycle”

FB DMDMIL 3.60 Detailed description of function

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by entering the entire status word of the fault path into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mxxyz etc. are contents of this status word. For error and cycle flags of external fault paths, which occur as inputs access methods, are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path the following values are defined:

Status fault path xyz: sfpxyz
Error flag xyz: E_xyz (bit 0 in sfpxyz)
Cycle flag xyz: Z_xyz (bit 1 in sfpxyz)
Fault type xyz: TYP_xyz
B_mxxyz
B_mnxyz
B_sixyz
B_npxyz
Clear fault path: B_clxyz
Default value active: B_bkxyz
Fault path code xyz: CDTxyz
Fault class xyz: CLAxyz
Fault intensity xyz: TSFxyz
CARB code xyz: CDCxyz
Table of ambient cond. xyz: FFTxyz
Fault index xyz: DFPxyz

The following fault paths are defined in this function definition:
MD = Misfires, total fault (multiple)
MD01 = Misfires, ignition 1
MD02 = Misfires, ignition 2
MD03 = Misfires, ignition 3
MD04 = Misfires, ignition 4
MD05 = Misfires, ignition 5
MD06 = Misfires, ignition 6
MD07 = Misfires, ignition 7
MD08 = Misfires, ignition 8
MD09 = Misfires, ignition 9
MD10 = Misfires, ignition 10
MD11 = Misfires, ignition 11
MD12 = Misfires, ignition 12

Fault memory relevant values of the function DMDMIL are assigned to the function-oriented selection of the function DFPM_DMDMIL.

Precondition for the understanding of the misfire fault treatment is the FDEF %DFPM for the general fault treatment.

1. Reaching of the misfire rate
Corresponding to the OBDII legislation of the CARB a distinction must be made between "exhaust gas relevant" misfires after start and while driving (misfires cause the exhaust emission standard to be exceeded by a factor of 1.5) and "cat. damaging" misfires (CAT is endangered).

1.1 Exhaust gas relevant misfires
For the detection of exhaust gas relevant misfires the number of misfires which have occurred within an interval of 1000 crankshaft revolutions (KWU) are relevant. If the number of occuring misfires during this interval is so high that the exhaust emission standard is exceeded by a factor of 1.5, then the exhaust gas relevant misfire rate has been reached resp. exceeded.

An interval counter ivzabg counts the combustions during which the misfire detection and the statistical evaluation are active (B_milstp=0). When reaching the maximum value of 1000 KWU (complies to 500 * SY_ZYLZA combustions) the interval counter ivzabg is reset.

If a misfire is detected during a combustion the total fault counter fzabgs and the fault counters of the misfiring cylinders fzabg_zzyl are increased by 1. The fault counters are reset at the end of the 1000 KWU interval.

Exhaust gas relevant misfires after start:
If the total fault counter fzabgs exceeds the threshold value AHEAGWS at the end of the first interval after start, then exhaust gas relevant misfires exist after start and a fault entry is performed.

Exhaust gas relevant misfires while driving:
If the threshold value AHEAGW is in total exceeded 4 times by the total fault counter fzabgs during the dcy (as from the 2. interval) then exhaust gas relevant misfires exist during the driving cycle and a fault entry is performed.

1.2 Catalyst damaging misfires
For the detection of catalyst damaging misfires the number of misfires which have occurred during an interval of 200 KWU are relevant. If the number of misfires occurring during this interval is so high that the catalyst is endangered, then the catalyst damaging misfire rate has been reached resp. exceeded.
The first interval after start can be increased up to 1000 KWU via the factor FASKIV1, if the engine temperature tmot after start does not lie above the threshold TMASKIV1 (tmot is measured at the first calcutaing step of DMD). Since the catalyst is not at operating temperature when the engine is cold, no catalyst damage due to misfires can occur during the first 1000 KWU after start.

An interval counter ivzkat counts the combustions during which the misfire detection and the statistical evaluation are active (so B_milstop=0). When reaching the maximum value of 200 KWU (complies to 100 * SY_ZYLZA combustions) the interval counter ivzkat is reset.

If a misfire is detected during a combustion the total fault counter fzkats, the total fault counters fzkats1 and fzkats2, which are each assigned to a bank on separate exhaust systems, and the fault counters of the misfiring cylinders fzkat_zzyl are increased by the value kswf. kswf is calculated from the map KFKSWF over load and engine speed and it contains values which are weighted according to catalyst damage (large value with high engine speed and high load).
The fault counters are reset at the end of the 200 KWU interval.
As soon as one of the total fault counters fzkats1 or fzkats2 exceeds the threshold value AHEKS (or AHEKS1 in the 1. prolonged interval), catalyst damaging misfires exist and a fault entry is made (not only at the end of the interval).
As long as catalyst damaging misfires exist, i.e. fzkats1 or fzkats2 > AHEKS, the bit B_blkmd is set and the MIL flashes.
Also the Bit B_mdkat is set. With this Bit other functions can be deactivated during cat. damaging misfiring.
If at the end of the interval fzkats1 and fzkats2 < AHEKS, the bit B_blkmd and B_mdkat is reset and the MIL no longer flashes.
In case of catalyst damage it is also indicated in the status byte flgkat_w as to which cylinder has catalyst damaging misfires.
flgkat_w resp. the respective bit is reset after an interval without threshold value exceeding, however, remains set in case of ti cut-off.

Ti cut-off:
After AINTKA intervals, during which fzkat_zzyl > AHEKA and fzkats1 or fzkats2 > AHEKS, the injection of the respective cylinder is switched off, if the max. no. of cutout cylinders is not already given and if there is no injector fault at open valve.
In case of 2 ECU's the injector fault with open valve (E_ev_zzyl with B_mnev_zzyl) of the master-ECU (B_master=1) is stored in the bit B_mnevzzylt and transferred via CAN to the slave-ECU. There it is evaluated as B_mnevzzylc.
For this the cyl. fault counters fzkat_zzyl are compared with the threshold AHEKA in case of detected cat. misfires (fzkats1 or fzkats2 > AHEKS). If the threshold is exceeded the counter aint_zzyl is incremented, with fzkats1 < AHEKS and fzkats2 < AHEKS it is decremented.
If aint_zzyl is greater than AINTKA - as long as no AZYTIAB-cylinders have yet been switched off and also no injector fault with open valve yet exists at the misfiring cylinder (E_evxx, fault type B_mnevxx) - then the bit of the respective cylinder in flgtiab and the bit B_tiab_zzyl are set to 1, the injection is switched off and the counter of the cutout cylinder azycnt is increased by 1. In case of 2 ECU's (SY_2SG=1) the bits B_tiab_zzyl are stored in the 2 bytes flgtiab and flgtiabt where flgtiab corresponds to the slave-ECU (B_master=0) and flgtiabt corresponds to the master-ECU (B_master=1). flgtiabt is send via CAN to the master-ECU.
For AZYTIAB = 0 no cut-off takes place. The condition for ti-cut-off is checked immediately as fzkats1/2 increases the threshhold AHEKS (and not at the end of the interval).
The cut-off remains active until a new engine start is performed.
During a deactivation the cylinder-individual fault counters of the cutout cylinders are no longer increased.
If all misfiring cylinders have been cutout, misfires are no longer counted, fzkats1 and fzkats2 < AHEKS, and dependent on the MILANTI the MIL will change from flashing to off (MILANTI=0) or from flashing to on (MILANTI=1) in the 1. dcy and in the 2. dcy it will change from flashing to on.
For the switch-off of the Lambda control see %LREB and for the switch-off of the full-load enrichment see %RLASE.

1.3 Occurence of misfire faults

If the misfire rate for a fault entry has been reached or exceeded, the bit E_md and the trigger B_sp1 are set.
If no misfire window yet exists, then the temporary misfire window is decreased by the permitted tolerance and stored as final misfire window (see 3.).
A cylinder identification is performed if B_synph=1. A cylinder is detected to be misfiring if the cylinder-individual fault counter fzabg_zzyl exceeds the mean value fzabgs/SY_ZYLZA or if the cylinder-individual fault counter fzkat_zzyl exceeds the mean value fzkats/SY_ZYLZA. The bit E_md_zzyl is also set for the misfiring cylinders.
The bits E_md and E_md_zzyl remain set until the end of the first faultless dcy with window overlap.

Misfire faults are debounced via 2 driving cycles (dcy), that means if misfire faults occur for the first time a non-debounced fault entry is performed (pending fault memory entry).

- If misfire faults occur again during the next dcy, then the fault entry is debounced and the error lamp (MIL) comes on (resp. flashes in case of catalyst damaging misfires).
- If no misfire faults occur during a subsequent dcy and the dcy took place under similar conditions (regarding load, engine speed and engine temperature, window overlap s. 3.), then the pending fault memory entry is cleared (resp. remains visible to the customer service) and the misfire window is reset.
- If no window overlap is achieved during the subsequent dcy, then the pending fault memory entry is cleared after 80 dcy.

If a debounced fault entry exists and the MIL is on, then the MIL goes out after 3 faultless dcy with window overlap and the fault entry is cleared 40 warm-up cycles (wuc) later.

1.4 Misfire rate for the switch-off of other ECU functions (e. g. BBLDR)

With exh. misfires, e.g. at 1000 rpm, the bit E_md is only set after 4 min. (4 * 1000 KWU).
In order to enable a quicker reaction to misfires in other functions there is another counter, which counts the misfire rate in an interval of 60 KWU. If a certain misfire rate, e.g. 5% is exceeded within this interval, then the bit B_mdarv is set.

An interval counter ivzarv counts the combustions during which the misfire detection and the statistical evaluation are active (i.e. B_milstp=0). Once the maximum value of 60 KW revolutions has been reached (complies to 30 * SY_ZYLZA comubstions), the interval counter ivzarv is reset.

If misfiring is detected during a combustion, then the fault counter fzarv is increased by 1. At the end of the 60 KWU interval the fault counter is reset.

If the counter fzarv exceeds the value ahearv_w at the end of the interval, then the bit B_mdarv is set. If the threshold is undershot at the end of the interval, then the bit B_mdarv is reset. ahearv_w is set to AHEARV with the following 2 exclusions: AHEARV[%] < AHEAGW[%] then ahearv_w is set to AHEAGW[%], AHEARV[%] > 10% then ahearv_w is limited to 10%.
This is made because of other function may not be permanent deactivated without fault code entry.

2. Setting and resetting of various state conditions

Faultless dcy:
B_dcy = 1 and
ivzabg at least once = 0 (>1000 KWU) and
B_sp1 = 0 (threshold value was not exceeded)

Fault trigger B_sp1:
If fzkats1 or fzkats2 > AHEKS or at the end of the 1000 KWU interval fzabgs > AHEAGW / AHEAGWS (during 1. interval), then the trigger B_sp1 is set. B_sp1 remains set until the after-run has ended.

Healing trigger B_sp2:
If the dcy was faultless and the window overlap was fulfilled, i.e. BF >= AF, the healing trigger B_sp2 is set in the after-run.
B_sp2 is set until the end of the after-run. Once B_sp2 was set 3 times the MIL will go out and the AF is reset.
For EOBD-projects the healing trigger B_sp2 can be performed without checking window overlap (CWDMDE=1).

Cycle bits Z_md, Z_md_zzyl:
The cycle bits Z_md, Z_md_zzyl are set after the first 1000 KWU interval has elapsed or in case a fault already occurs beforehand, that means fzkats1 or fzkats2 > AHEKS.
The cycle bits remain set until the after-run has ended.

Error bits E_md, E_md_zzyl:
The error bits E_md, E_md_zzyl are set, if the no. of misfires for a fault entry has been reached
(fzkats1 or fzkats2 > AHEKS; fzabgs > AHEAGWS in the 1. interval; fzabgs > AHEAGW at least 4x during the dcy).
The error bits E_md, E_md_zzyl are reset at the end of a faultless dcy with window overlap.

Clear bits B_clmd, B_clmd{SY_ZYLZA}:
By setting of the clear bits (call-up of the clearing process) all fault counters, interval counters, error and cycle bits, counters of the ti cut-off and the operating windows are reset.

Operating window BF:
The operating window BF is updated during the entire dcy if there is no cutout (s. %DMDSTP) and it begins with starting values.

Temporary misfire window AFT:
The temporary misfire window AFT is updated with each occurring misfire and it is reset at the end of the 1000 KWU intervals (reset to the starting values).

Misfire window AF:
After misfire faults have occurred for the first time the temporary misfire window is decreased by the permitted tolerance (20% load, 375 rpm) and stored in the final misfire window.
The misfire window is reset in the after-run after 3 faultless dcy with window overlap at debounced entry or after 1 faultless dcy with window overlap or after 80 dcy without window overlap at non-debounced fault entry.

Fault memory entry:
Non-debounced entry: when the first misfire faults occur
Debounced entry: when misfire faults occur during the 2. dcy or during a subsequent dcy, if a non-debounced misfire fault already exists.
Clearing of a non-debounced fault memory entry: after a faultless dcy with window overlap or after 80 dcy without window overlap (still remains visible to customer service)
Clearing of a debounced fault memory entry: 40 wuc after MIL turned off (still remains visible to customer service)
Fault type: with cat. faults: B_mxflr, with exh. faults while driving: B_mnflr, with exh. faults after start: B_npflr.
The fault type B_mxflr is not overwritten by any other fault type, the fault type B_mnflr is not overwritten by the fault type B_npflr.

Output scantool (s. %TCSORT):
- If only one cylinder is identified to be misfiring, then only the fault entry of the corresponding cylinder is output. The output of the total fault (E_md) is then suppressed.
- If several cylinders are identified to be misfiring, then in any case the total fault is output as ’multiple fault’. The additional output of the cylinder-individual faults can be suppressed dependent on the data entered in TCSORT.

B_blkmd:
The bit B_blkmd directly triggers the flashing of the MIL. It is set if fzkats1 > AHEKS or fzkats2 > AHEKS. If this condition is no longer given at the end of the interval, then the bit B_blkmd is reset.

B_mdkat:
The bit B_mdkat is set if fzkats1 > AHEKS or fzkats2 > AHEKS. If this condition is no longer given at the end of the interval then the Bit B_mdkat is reset. With the Bit B_mdkat other functions can be deactivated during cat. damaging misfiring.
B_milmd:
The bit B_milmd turns on the MIL directly, if ti cut-off exists and if MILANTI=1 (relevant only during 1.dcy, with pending fault memory entry)

MIL:
The MIL comes on during the 2. dcy with misfire faults and it goes out again after 3 faultless dcy with window overlap.
In addition the MIL flashes, if the threshold for cat. misfires AHEKS is exceeded by fzkats1 or fzkats2. During the first dcy with misfire faults the MIL flashes with cat. faults and it goes out again, if the cat. faults no longer exist.
In the 2. and in the subsequent dcy with misfire faults the MIL flashes if cat. faults exist and it stays on if cat. faults no longer exist.
With ti cut-off the MIL may also be on during the 1. dcy if MILANTI=1, although catalyst damage is no longer given.

DFPM:
DLC: is decremented if B_wuc=1 incase of debounced error or B_dcy=1 in case of pending error
FLC: is decremented if B_sp1=1 & Z_md=1
HLC: is decremented if B_sp2=1 & Z_md=1

B_mdarv:
If a certain misfire rate is exceeded at the end of the 60 KWU interval, then B_mdarv is set. If the misfire rate is undershot again, then B_mdarv is reset again.

flgtiab/t, B_tiab_zzyl:
With ti cut-off the bit B_tiab_zzyl and the corresponding bit in flgtiab is set.
In case of 2 ECU’s the bits are stored in flgtiab (slave-ECU) and flgtiabt (master-ECU).

flgkat_w:
With catalyst damage the corresponding bit of the misfiring cylinder in flgkat_w is set.

3. Definition of operating windows

In order to turn off the MIL it is necessary to store the operating ranges load, engine speed and engine temperature, in which faults have occurred resp. have been detected.

For this the following operating windows are needed:

```
BF  - operating window, is updated constantly (every 200ms) during the entire driving cycle, if DMD is active
AFT - temporary misfire window, is updated with each misfire
AF  - final misfire window, taken over during the fault memory entry from the AFT
```

A window is defined by 5 parameters:

```
nmn = lowest engine speed       nmx = highest engine speed
rlmn = lowest load              rlmx = highest load
and the warming up status (tmot < or > TMWUC)
```

3.1 Starting values for range windows BF, AFT and AF:

```
bfnmn  = FF (hex),      bfnmx  = 0
aftnmn = FF (hex),      aftnmx = 0
afnmn  = FF (hex),      afnmx  = 0

bfrlmn  = FF (hex), bfrlmx  = 0
aftrlmn = FF (hex), aftrlmx = 0
afrlmn  = FF (hex), afrlmx  = 0

B_bfwrm  = 0,           B_bfklt  = 0
B_aftwrm = 0,           B_aftklt = 0
B_afwrm  = 0,           B_afklt  = 0
```

3.2 Operating window BF

This window is set to starting values at engine start. The updating is performed at active misfire detection (B_milstp = 0, see %DMDSTP) during the entire engine cycle (until ignition off), independent of whether faults are detected or not.

Correction of the operating window (in the 200ms grid):

```
If nmot  > bfnmx, then bfnmx  = nmot,
if nmot  < bfnmn, then bfnmn  = nmot,
if rl > bfrlmx, then bfrlmx = rl,
if rl < bfrlmn, then bfrlmn = rl,
if tmot > TMWUC, then B_bfwrm = 1,
if tmot < TMWUC, then B_bfklt = 1
```

3.3 Misfire windows AF and AFT

Generally speaking the misfire window shows that range, in which misfires have occurred. A distinction is made here between a temporary and a final misfire window.

Updating of the temporary misfire window AFT:
The temporary AFT is updated with each (individual) misfire that is detected:

```
If n  > aftnmx,  then aftnmx   = n,
if n  < aftnmn,  then aftnmn   = n,
if rl > aftrlmx, then aftrlmx  = rl,
if rl < aftrlmn, then aftrlmn  = rl,
if tmot > TMWUC, then B_aftwrm = 1,
if tmot < TMWUC, then B_aftklt = 1,
(with B_aftwrm = B_aftklt = 1, then misfires first with tmot < TMWUC and thereafter with tmot > TMWUC)
```

After every 1000 KWU the AFT is reset to the starting values.

Updating of the final misfire window AF:
The contents of the temporary misfire window is decreased by the legally permitted tolerance and stored in the final misfire window during the first fault memory entry (exhaust gas resp. catalyst damaging faults).

```
afnmx  = aftnmx  - 375/2 rpm (*)
afnmn  = aftnmn  + 375/2 rpm (*)
```

The misfire window is limited to idle speed , that means afnmn > NLLM(tmot).
(In case of misfire during idle speed decreases shortly. Therefor afnmn can be < NLLM(tmot). Healing is than only with 80 wuc possible in case of pending fault code because window overlap cannot be reached. NLLM comes from %LLR).

```
if afnmx < afnmn, then afnmx = afnmn = (afnmx+afnmn)/2
```

(*): by the quantization of nmot with 40 rpm here 320/2 = 160 rpm are realized
The speed tolerance is given in AFNTOL. In older VS100-Versions AFNTOL can be applicated.
CAUTION: AFNTOL must be 160 rpm !!!

```
afrlmx = 0.90 * aftrlmx
afrlmn = 1.10 * aftrlmn.
if afrlmx < afrlmn, then afrlmx = afrlmn = (afrlmx+afrlmn)/2
```

The temperature status is adopted without change

```
B_afklt = B_aftklt
B_afwrm = B_aftwrm
```

3.4 Checking of the window overlap

Similar operating conditions are given, if

```
    1. B_bfwrm = B_afwrm, if B_afwrm = 1
    2. B_bfklt = B_afklt, if B_afklt = 1
    3. bfrlmx >= afrlmx     and bfrlmn <= afrlmn
    4. bfnmx  >= afnmx  and bfnmn  <= afnmn
```

that means the window condition is fulfilled if the operating window overlaps the misfire window (AF is included in the BF).

Example for a fulfilled window condition resp. window overlap:

```
                ˆ rl                                    BF
       bfrlmx  -|   +---------------------------------------+
                |   |                                       |
       afrlmx  -|   |         +-----------------------------+
                |   |         |                        AF   |
                |   |         |                             |
       afrlmn  -|   |         +-----------------------------+
       bfrlmn  -|   +---------------------------------------+               nmot
                +---------------------------------------------------------->
                    |         |                             |
                bfnmn       afnmn                     afnmx = bfnmx
```

4. Flow charts

4.1 Misfire in only 1 dcy

```
                      |y |y |y |y |y |y |y |y |y |y |Nl.|ff oFa|Nl.|ff mFa|Nl.|

                            +-----+  +-----------+
fzabgs > AHEAGW       ------+     +--+           +----------------------------------

                                           +------------------------------+
Fault mem. entry      ---------------------+                              +---------

                                           +------------+
B_sp1                 ---------------------+            +---------------------------

                                                                          +---+
B_sp2                 ----------------------------------------------------+   +-----

                                           +------------------------------+
E_md                  ---------------------+                              +---------

                                           +------------------------------+
E_md00                ---------------------+                              +---------

MIL                   --------------------------------------------------------------

B_blkmd               --------------------------------------------------------------

                                           +------------------------------+
AF                    ---------------------+                              +---------
                                  (take-over of AFT)                   (Reset)
```

y: 1000 KWU interval
Nl.:   after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap

4.2 Misfires in 2 dcy, exhaust gas relevant, during the dcy

```
                    |y |y |y |y |y |y |y |y |y |y |Nl.|y |y |y |y |y |y |Nl.|ff mFa|Nl.|ff mFa|Nl.|ff oFa|Nl.|ff mFa|Nl.|40 wuc|

Misfires                        Ign. 0                        Ign. 1
                       +--------+  +-----+  +--+         +--------------+
fzabgs > AHEAGW     ---+        +--+     +--+  +---------+              +---------------------------------------------------------

         debounced                                           +---------------------------------------------------------+
         pending                      +------------------------------+                                                         |
fault mem. entry    ------------------+                                                                                        +--

                                      +---------------+              +------+
B_sp1               ------------------+               +--------------+      +-----------------------------------------------------

                                                                                   +---+      +---+                  +---+
B_sp2               ---------------------------------------------------------------+   +------+   +-----------------+   +---------

                                      +--------------------------------------------+
E_md                ------------------+                                            +----------------------------------------------

                                      +--------------------------------------------+
E_md00              ------------------+                                            +----------------------------------------------

                                                                     +-------------+
E_md01              -------------------------------------------------+             +----------------------------------------------

                                                                     +--------------------------------------------------+
MIL             -------------------------------------------------+                                                  +---------

B_blkmd             --------------------------------------------------------------------------------------------------------------

                                      +---------------------------------------------------------------------------------+
AF                    ----------------+                                                                                 +---------
                             (take-over of AFT)                                                                      (Reset)
```

```
y:  1000 KWU interval
Nl.:    after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap
wuc:    warm-up cycle
```

4.3 Misfires in 2 dcy, catalyst damaging

```
                    |x |x |x |x |x |x |x |x |Nl.|x |x |x |x |x |x |Nl.|ff mFa|Nl.|ff mFa|Nl.|ff oFa|Nl.|ff mFa|Nl.|40 wuc|

Misfires                       Ign. 0                    Ign. 1
                       +--------+  +-----+         +-----+  +-----+
fzkats > AHEKS      ---+        +--+     +---------+     +--+     +---------------------------------------------------------

         debounced                                 +---------------------------------------------------------------------+
         pending       +---------------------------+                                                                     |
fault mem.entry     ---+                                                                                                 +--

                       +------------------------+  +------------------+
B_sp1               ---+                        +--+                  +-----------------------------------------------------

                                                                             +--+       +--+                  +--+
B_sp2               ---------------------------------------------------------+  +-------+  +------------------+  +----------

                       +-----------------------------------------------------+
E_md                ---+                                                     +----------------------------------------------

                       +-----------------------------------------------------+
E_md00              ---+                                                     +----------------------------------------------

                                                   +-------------------------+
E_md01              -------------------------------+                         +----------------------------------------------

        flashing       +--------+  +-----+         +-----+  +-----+
        on             |        |  |     |         |     +--+     +----------------------------------------------+
MIL off         ---+        +--+     +---------+                                                             +----------

                       +--------+  +-----+         +-----+  +-----+
B_blkmd             ---+        +--+     +---------+     +--+     +---------------------------------------------------------

                       +-----------------------------------------------------------------------------------------+
AF                  ---+                                                                                         +----------
               (take-over of AFT)                                                                             (Reset)
```

```
x:  200 KWU interval
Nl.:    after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap
wuc:    warm-up-cycle
```

4.4 Misfires in 2 dcy, catalyst damaging, with ti cut-off

```
                    |x |x |x |x |x |x |x |x |Nl.|x |x |x |x |x |x |Nl.|ff mFa|Nl.|ff mFa|Nl.|ff oFa|Nl.|ff mFa|Nl.|40 wuc|

Misfires                 Ign. 0                      Ign. 1
                       +--------+                  +-----+
fzkats > AHEKS      ---+        +------------------+     +------------------------------------------------------------------

                                                         +------- +
                                +-----------+            |        |
flgtiab             ------------+           +------------+        +---------------------------------------------------------

         debounced                                 +---------------------------------------------------------------------+
         pending       +---------------------------+                                                                     |
fault mem.entry     ---+                                                                                                 +--

                       +------------------------+  +------------------+
B_sp1               ---+                        +--+                  +-----------------------------------------------------

                                                                             +--+       +--+                  +--+
B_sp2               ---------------------------------------------------------+  +-------+  +------------------+  +----------

                       +-----------------------------------------------------+
E_md                ---+                                                     +----------------------------------------------

                       +-----------------------------------------------------+
E_md00              ---+                                                     +----------------------------------------------

                                                   +-------------------------+
E_md01              -------------------------------+                         +----------------------------------------------

                       +-----------------------------------------------------------------------------------------+
AF                  ---+                                                                                         +----------
               (take-over of AFT)                                                                             (Reset)+

MILANTI=0:
        flashing       +--------+                  +-----+
        on             |        |                  |     +-------------------------------------------------------+
MIL off         ---+        +------------------+                                                             +----------

                       +--------+                  +-----+
B_blkmd             ---+        +------------------+     +------------------------------------------------------------------

B_milmd             --------------------------------------------------------------------------------------------------------



MILANTI=1:
        flashing       +--------+                  +-----+
        on             |        +------------------+     +-------------------------------------------------------+
MIL off         ---+                                                                                         +----------

                       +--------+                  +-----+
B_blkmd             ---+        +------------------+     +------------------------------------------------------------------

                                +-----------+            +--------+
B_milmd             ------------+           +------------+        +---------------------------------------------------------


x:  200 KWU interval
Nl.:    after-run
ff mFa: faultless dcy with window overlap
ff oFa: faultless dcy without window overlap
wuc:    warm-up cycle
```

APP DMDMIL 3.60 Application hint

1. Classes of the fault types:
   CLAMD = 2
   CLAMD{SY_ZYLZA} = 2
   ATTENTION: Since the flashing of the MIL is triggered directly, the class should not be changed.
   Otherwise the MIL will possibly flash without a fault entry having been made.

2. Quicktest of the function DMDMIL
   For a quick check of the function it is possible to measure the interval counters ivzabg and ivzkat as well as the fault counters fzkabgs and fzkats. The interval counters must count the combustions, during B_milstp=0. The fault counters must count each individual misfire that was detected (weighted in fzkats with kswf).

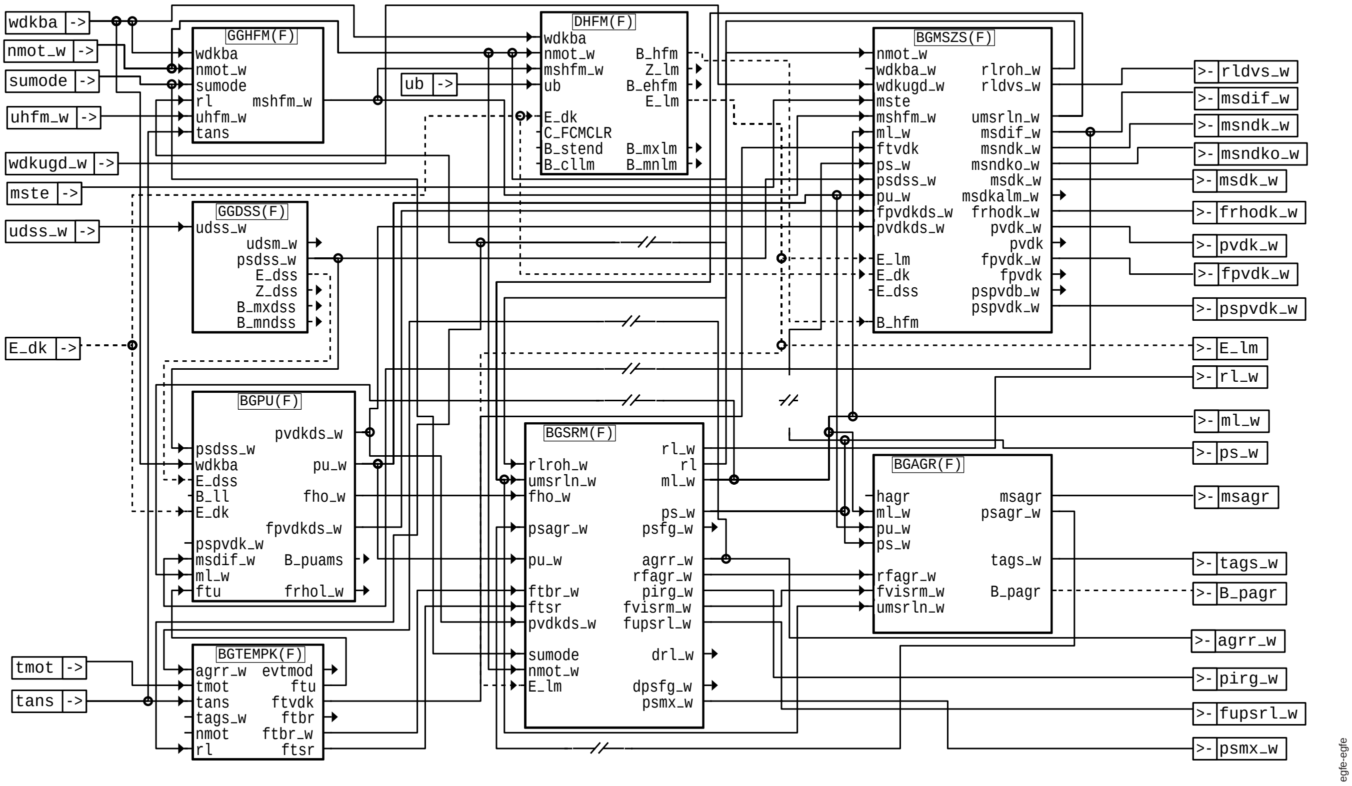
3. ATTENTION: In case of MILANTI=1 it is possible, that during a temp. error (during 1. dcy) the MIL is on but there is only in Mode 7 a fault code entry visible !!!
   To agree with the legislation MILANTI should be 0.

AHEARV: should correspond to 5% misfire during 60 crankshaft rotations.

AFNTOL: must be 160 U/min !!!

EGFE 6.10 Input variables for charging detection

FDEF EGFE 6.10 Function definition



egfe-egfe

ABK EGFE 6.10 Abbreviations

Variable	Source	Type	Description
AGRR_W	EGFE	AUS	exhaust gas recirculation rate
B_CLLM	EGFE	LOK	condition: clear fault path main load sensor
B_EHFM	EGFE	LOK	condition: HFM error (without debounce)
B_HFM	EGFE	LOK	Condition: HFM ready to measure
B_LL	EGFE	LOK	Condition idle
B_MNDSS	EGFE	LOK	Condition: min-error manifold pressure sensor
B_MNLM	EGFE	LOK	Condition: min-error main load sensor
B_MXDSS	EGFE	LOK	Condition: max-error manifold pressure sensor
B_MXLM	EGFE	LOK	Condition: max-error main load sensor
B_PAGR	EGFE	AUS	egr calculation disabled
B_PUAMS	EGFE	LOK	Condition ambient pressure adaptation by comparing mshfm/msdk
B_STEND	EGFE	LOK	condition end of start
C_FCMCLR	EGFE	LOK	system state: reset fault memory
DPSFG_W	EGFE	LOK	delta fresh air partial pressure in manifold
DRL_W	EGFE	LOK	charge change (Word)
EVTMOD	EGFE	LOK	modelled temperature at inlet valve
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_DSS	EGFE	LOK	error flag: Manifold absolute pressure
E_LM	EGFE	AUS	Error flag: main load sensor
FHO_W	EGFE	LOK	correction factor: altitude
FPVDK	EGFE	LOK	correction factor for pressure upstreams throttle
FPVDKDS_W	EGFE	LOK	Factor pressure in front of throttle valve of pressure sensor (word)
FPVDK_W	EGFE	AUS	correction factor for pressure upstream of throttle valve, 16-bit
FRHODK_W	EGFE	AUS	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FRHOL_W	EGFE	LOK	Factor: air density f(intake air temp., altitude), 16-bit
FTBR	EGFE	LOK	factor: temperature correction in combustion chamber
FTBR_W	EGFE	LOK	factor: temperature correction in combustion chamber
FTSR	EGFE	LOK	correction factor for air temperature in the manifold
FTU	EGFE	LOK	factor: ambient temperature
FTVDK	EGFE	LOK	correction factor for temperature upstream of throttle valve
FUPSRL_W	EGFE	AUS	factor system related transformation pressure to load (16-Bit)
FVISRM_W	EGFE	LOK	integrator amplifier factor intake manifold modell
HAGR	EGFE	LOK	Stroke EGR valve
ML_W	EGFE	AUS	air mass flow filtered (Word)
MSAGR	EGFE	AUS	EGR mass flow into intake manifold
MSDIF_W	EGFE	AUS	mass flow difference mshfm_w - msdk_w
MSDKALM_W	EGFE	LOK	Mass flow over throttle (balance with HFM signal)
MSDK_W	EGFE	AUS	air-mass flow through throttle valve

Variable	Source	Type	Description
MSHFM_W	EGFE	LOK	air-mass flow HFM
MSNDKO_W	EGFE	AUS	norm leakage air mass flow through throttle blade
MSNDK_W	EGFE	AUS	standardised air mass flow through throttle valve
MSTE	BGTEV	EIN	mass flow purge control into the manifold
NMOT	EGFE	LOK	engine speed
NMOT_W	SWADAP	EIN	engine speed
PIRG_W	EGFE	AUS	partial pressure residual exhaust gas internal EGR (16-Bit)
PSAGR_W	EGFE	LOK	partial pressure EGR
PSDSS_W	EGFE	LOK	Intake manifold pressure measured with pressure sensor at manifold (DS-S)
PSFG_W	EGFE	LOK	fresh air partial pressure in manifold
PSMX_W	EGFE	AUS	maximum manifold pressure limitation for modeled manifold pressure
PSPVDB_W	EGFE	LOK	quotient:int.manif.press.divided by press.upstream of throttle valve limit
PSPVDK_W	EGFE	AUS	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PS_W	EGFE	AUS	intake manifold pressure (absolute) (Word)
PU_W	EGFE	LOK	Ambient pressure
PVDK	EGFE	LOK	pressure in front of throttle
PVDKDS_W	EGFE	LOK	Pressure in front of throttle valve of pressure sensor (word)
PVDK_W	EGFE	AUS	pressure upstream of throttle valve, 16-bit
RFAGR_W	EGFE	LOK	relative load by external exhaust gas reduction
RL	EGFE	LOK	relative air charge
RLDVS_W	EGFE	AUS	relative air charge through throttle valves on intake manifold
RLROH_W	EGFE	LOK	relative air charge flowing into intake manifold
RL_W	EGFE	AUS	relative air charge (Word)
SUMODE	SU	EIN	status of the intake manifold switch over
TAGS_W	EGFE	AUS	EGR temperature on introduction into intake manifold
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
UB	SWADAP	EIN	battery voltage
UDSM_W	EGFE	LOK	Pressure sensor voltage averaged via a segment (word)
UDSS_W		EIN	Voltage pressure sensor manifold pressure (word)
UHFM_W		EIN	HFM voltage
UMSRLN_W	EGFE	LOK	calculation factor load to mass flow
WDKBA	GGDVE	EIN	throttle angle
WDKBA_W	EGFE	LOK	throttle angle with respect to lower mechanical stop
WDKUGD_W	BGMSZS	EIN	Throttle valve angle during which 95% charge is reached
Z_DSS	EGFE	LOK	cycle flag: Manifold absolute pressure
Z_LM	EGFE	LOK	cycle flag:ˆload determination LMM/HLM/HFM

FW EGFE 6.10 Fixed Values

Parameter	Value	Description

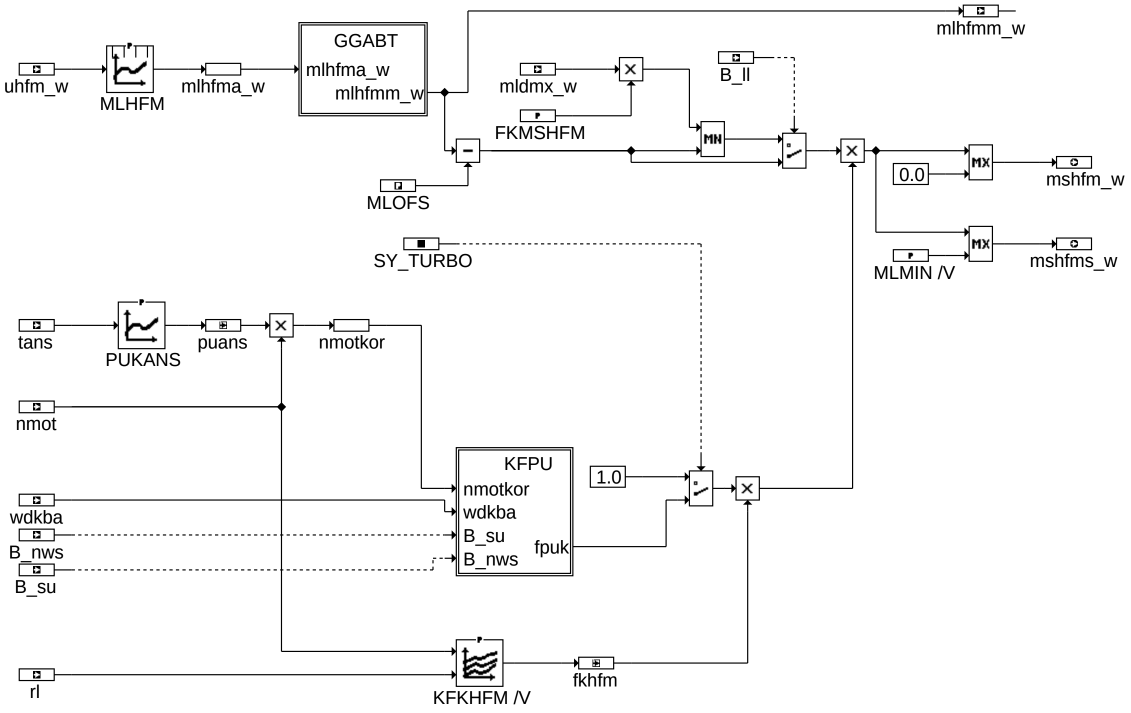
FB EGFE 6.10 Detailed description of function

APP EGFE 6.10 Application hint

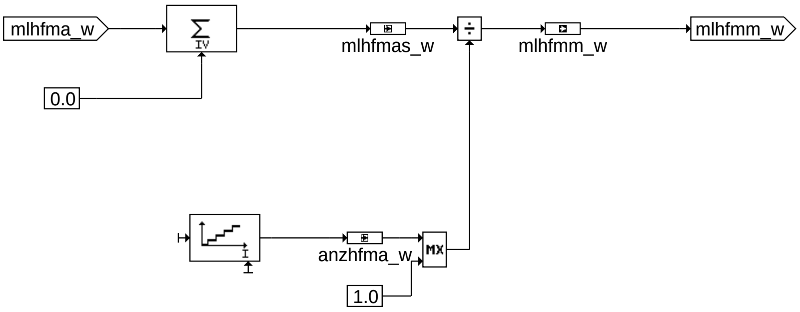
GGHFM 57.30 Sensor signal, hot-film air-mass meter

FDEF GGHFM 57.30 Function definition

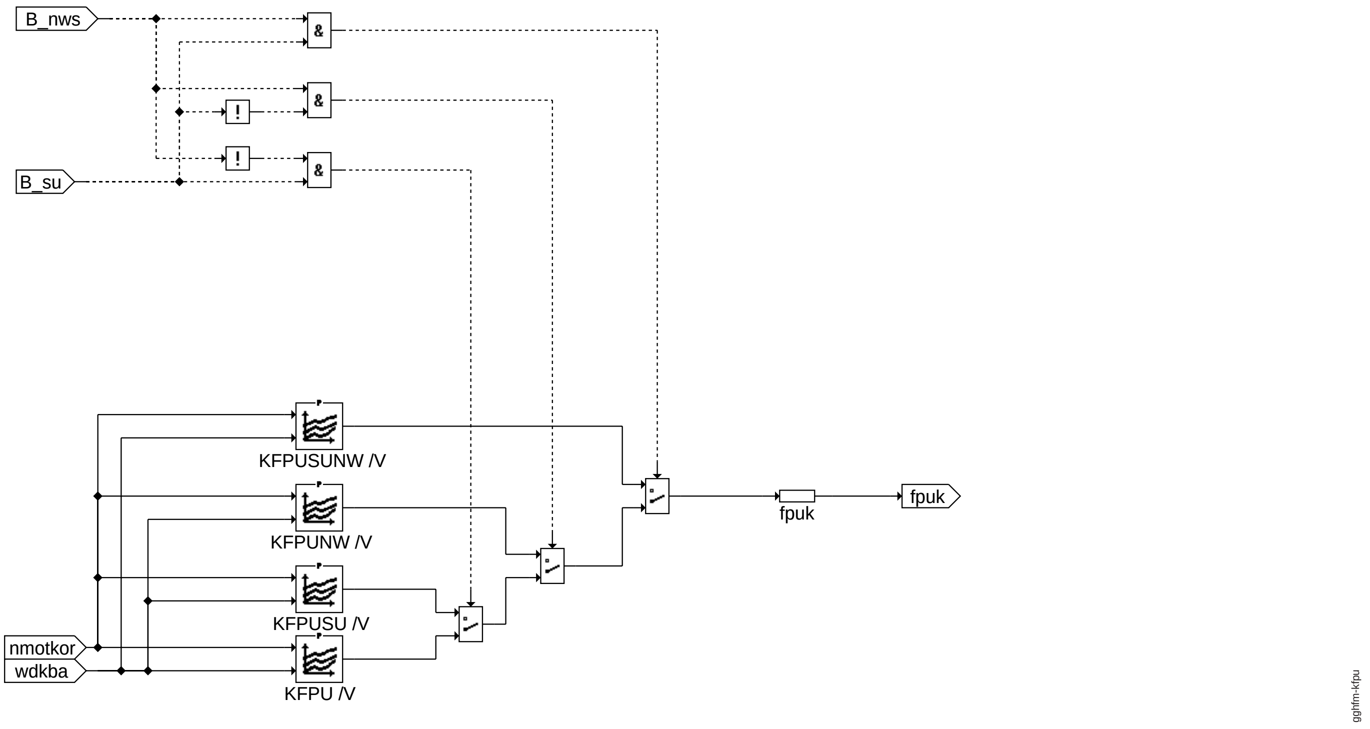
Source: GGHFM 57.20



gghfm-gghfm



gghfm-ggabt



gghfm-kfpu

ABK GGHFM 57.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FKMSHFM			FW	Correction factor for MIN selection with mshfm
KFKHFM	NMOT	RL	KF	HFM-correction characteristic map
KFPU	NMOTKOR	WDKBA	KF	pulsation characteristic map
KFPUNW	NMOTKOR	WDKBA	KF	pulsation map for camshaft control switch over
KFPUSU	NMOTKOR	WDKBA	KF	pulsation characteristic map at active variable intake system by sumode=1
KFPUSUNW	NMOTKOR	WDKBA	KF	pulsation characteristic map at active variable intake system and camshaft cont.
MLHFM	UHFM_W		KL	air-mass meter characteristic line
MLMIN			FW	Minimum HFM air mass
MLOFS			FW (REF)	offset for characteristic line of air mass flow meter HFM 5
PUKANS	TANS		KL	correction of pulsation depending on intake air temperature
SY_TURBO			SYS (REF)	system constant for exhaust-gas turbocharger

Variable	Source	Type	Description
ANZHFMA_W	GGHFM	LOK	number of HFM samplings over one synchro
B_LL	MSF	EIN	Condition idle
B_NWS	NWS	EIN	Condition camshaft control
B_SU	SU	EIN	condition intake manifold switch-over
FKHFM	GGHFM	LOK	correction factor for HFM
FPUK	GGHFM	LOK	correction factor for HFM in pulsation range
MLDMX_W	DHFM	EIN	Maximal air mass from map KFMLDMX
MLHFMAS_W	GGHFM	LOK	cumulative air mass over one synchro
MLHFMA_W	GGHFM	LOK	air mass scanning value of HFM 16-bit
MLHFMM_W	GGHFM	AUS	mean HFM air mass value 16-Bit
MSHFMS_W	GGHFM	AUS	air mass flow HFM (signed)
MSHFM_W	GGHFM	AUS	air-mass flow HFM
NMOT	SWADAP	EIN	engine speed
NMOTKOR	GGHFM	LOK	engine speed correction
PUANS	GGHFM	LOK	pulsation correction as a function of tans
RL	SWADAP	EIN	relative air charge
TANS	SWADAP	EIN	Intake air temperature
UHFM_W		EIN	HFM voltage
WDKBA	GGDVE	EIN	throttle angle

FW GGHFM 57.30 Fixed Values

Parameter	Value	Description
FKMSHFM		Correction factor for MIN selection with mshfm
MLMIN		Minimum HFM air mass

FB GGHFM 57.30 Detailed description of function

The air mass sensor (HFM) is scanned every 1ms. The scanned voltage is first linearised (MLHFM). The characteristic contains only positive values, for further calculation of the air mass flow. For this reason, when using a HFM5 an offset (MLOFS) for the reverse flow range must be taken into account when calculating the values for MLHFM.
The calculated air mass values are then added together via a segment in a memory. Once per segment, at the beginning of the charge calculation, the totalled value is arithmetically averaged via the preceding segment, i.e. it is divided by the number of scans of the last segment and then the characteristic offset MLOFS is deducted. The value is then multiplied by a pulsation correction value taken from the map KFPU. This air mass flow is delivered to the output as a 16-bit value mshfm_w and as an 8-bit value mshfm.

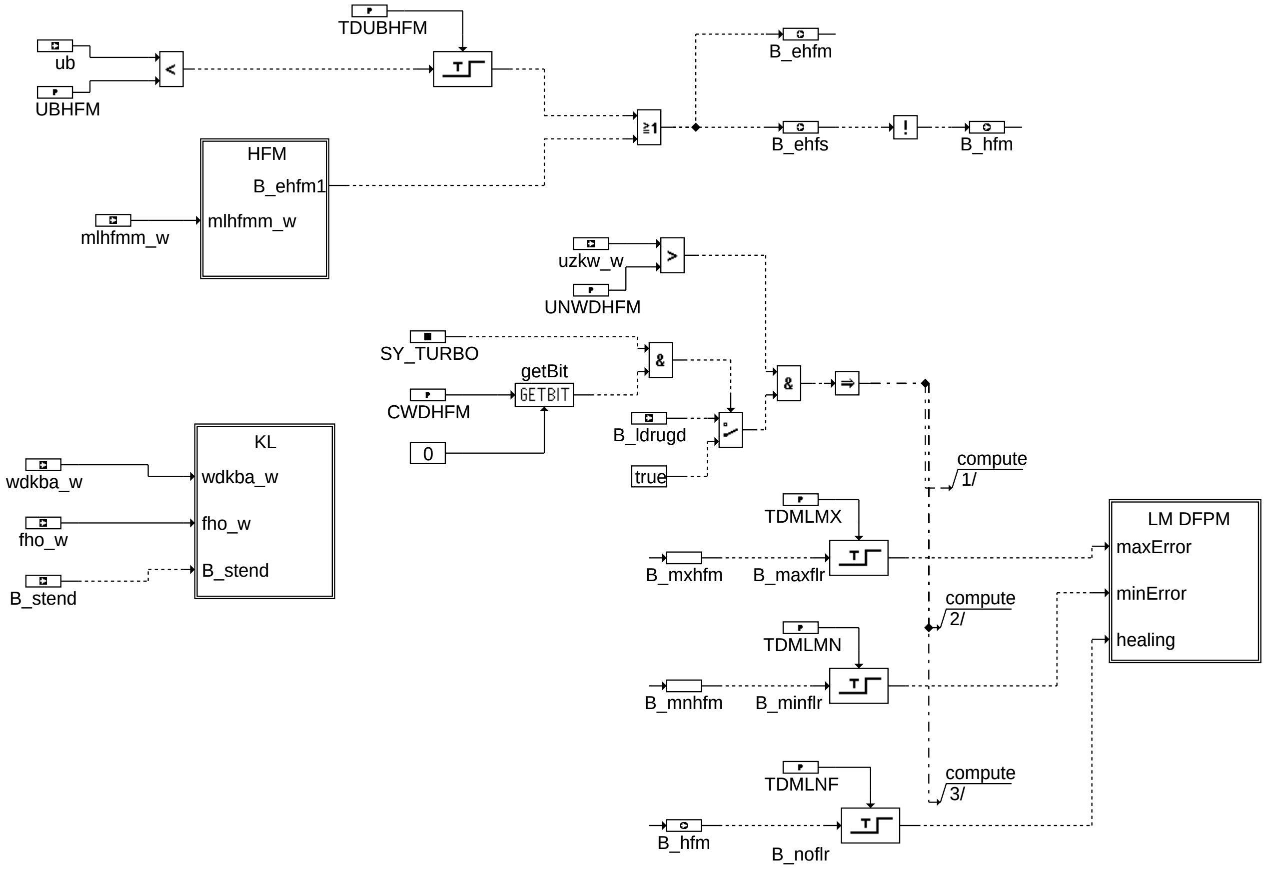
APP GGHFM 57.30 Application hint

```
Procedure in application:
-----------------------------------
Linearisation characteristic of the HFM

 Input/check of the linearisation characteristic of the HFM
 - Characteristic dependent on size and design (hybrid/sensor) of the HFM used
 - HFM2: Characteristic with positive air masses and MLOFS = 0 !!
 - HFM5: Use characteristic with reverse flow range, i.e. pos. and neg. air masses,
   and additional offset (MLOFS = 200 kg/h)
 - Interpolation is the same for HFM2 and for HFM5

When using a plug-in sensor variant the characteristic must be checked in conjunction
with the fitting position used.


Prerequisites for application of the pulsation map
---------------------------------------------------------
 - Adaptation of the battery voltage correction TVUB, poss. determined by way of fuel measuring

 - Neutralisation of all enrichments, i.e. set pre-control to Lambda=1 (e.g. KFLF);
   Pulsation correction initially neutralised (set KFPU to 1);
   Deactivate or increase psmax limitation




Application of the pulsation map
------------------------------------
The pulsation map is used to compensate pulsation errors of the
HFM; it is not intended to correct errors in the reverse flow range.


Definition of pulsation range:
Voltage oszillation of air mass sensor HFM < 0.5V

Definition of reverse range:
Voltage of air mass sensor HFM < 1.0

Adaptation of the pulsation map:
 - Definition of the pulsation range; poss. distribution of interpolation points of the pulsation map for better coverage of the
   pulsation range


In fuel systems without constant differencial pressure upstream of the injection valve (e.g. RLFS), i.e. where the pressure
regulator does not operate against the intake manifold pressure as a reference pressure, this must be specially guaranteed for
application of the pulsation map (connection of the pressure regulator to the intake manifold).

If this is not possible for technical reasons, the varying pressure differential upstream of the injection valve must be taken
into account beforehand in a correction map (see note on RLFS systems).
```

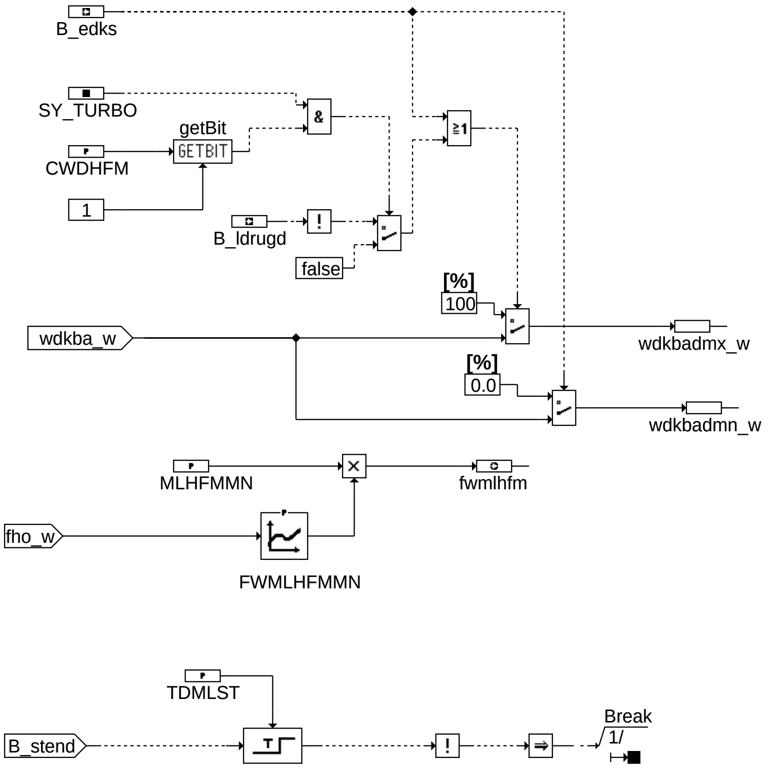
DHFM 63.80 Diagnosis; plausibility test hot film air flow sensor

FDEF DHFM 63.80 Function definition

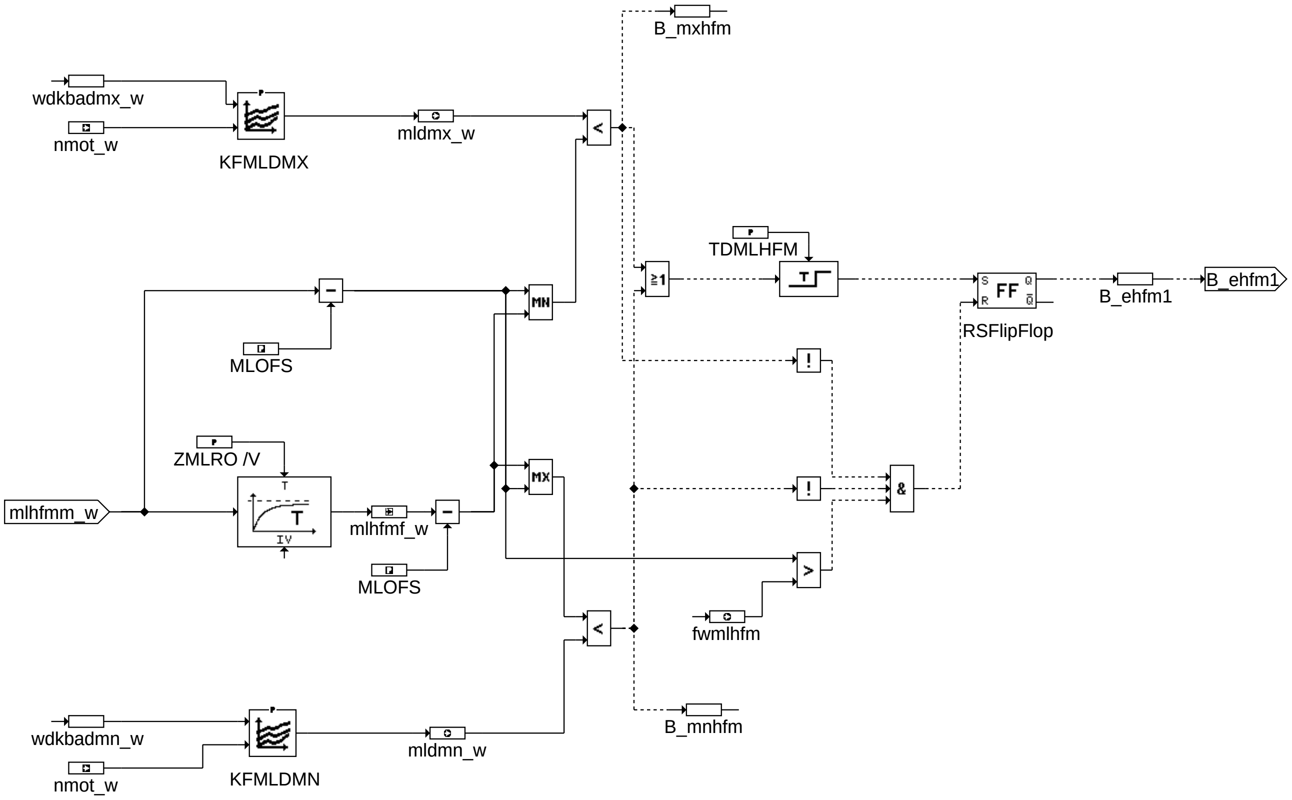
Source: DHFM 63.70



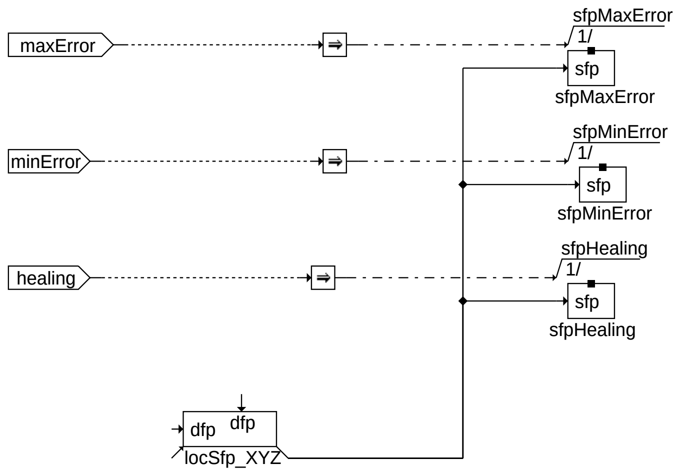
dhfm-dhfm



dhfm-kl



dhfm-hfm



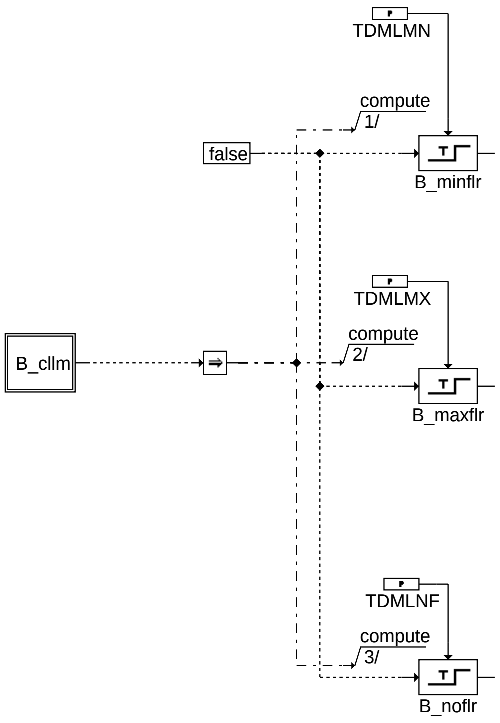
Action Table for fault path * in DFPM:

--------------	E_*	Z_*	B_mx*	B_mn*
maxError:	**S**	**S**	**S**	**R**
minError:	**S**	**S**	**R**	**S**
Healing:	**R**	**S**	**R**	**R**

S: set R: reset

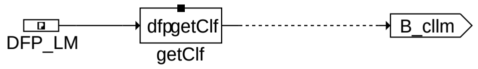
dhfm-lm-dfpm

dhfm-lm-dfpm



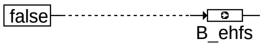
dhfm-fcmclr

dhfm-fcmclr



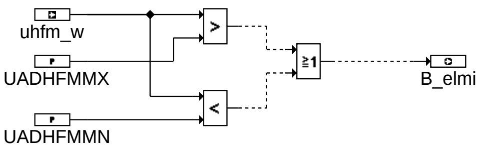
dhfm-b-clxyz

dhfm-b-clxyz



dhfm-nachlauf

dhfm-nachlauf



dhfm-init

```
"- (*1) abweichend zur Beschaltung wird dieser Teil im Modul %DFPM realisiert."
"- (*2) Die durch C_[*] ausgelösten Aktionen (im Bild mit (*2) markiert) werden in der Software in eigenen Prozessen abgearbeitet."


"- Maximalwert von wdkba z.B. bei 8Bit-wdkba --> FF Hex"


Fehlerspeicherverwaltung:
-------------------------

Status Fehlerpfad LM: SFPLM
Errorflag LM:         E_lm
Zyklusflag LM:        Z_lm
Fehlerart LM:         B_mxlm
                      B_mnlm



Löschen Fehlerpfad:     C_fcmclr & B_cllm
Fehlerpfad LM  :                CDTLM
Fehlerklasse LM:                CLALM
Fehlerschwere LM:               TSFLM
Carb-Code LM:                   CDCLM
Umweltbedingungen LM:           FFTLM      Umweltbedingungen siehe %DFFT
```

ABK DHFM 63.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDHFM			FW	Code word in DHFM
FWMLHFMMN	FHO_W		KL	Weighting factor for min. HFM air-mass threshold as a function of the altitude
KFMLDMN	WDKBADMN_W	NMOT_W	KF	air mass flow threshold for min. failure
KFMLDMX	WDKBADMX_W	NMOT_W	KF	air mass flow threshold for max. failure
MLHFMMN			FW	Min. HFM air-mass threshold to reset the min. fault
MLOFS			FW (REF)	offset for characteristic line of air mass flow meter HFM 5
SY_TURBO			SYS (REF)	system constant for exhaust-gas turbocharger
TDMLHFM			FW	Delay time for setting the bit B_hfm
TDMLMN			FW	debounce time for minimum fault detection air-mass meter
TDMLMX			FW	debounce tme for maximum fault detection air-mass metr
TDMLNF			FW	debounce time air-mass meter diagnosis with o.k. status
TDMLST			FW	debounce time fault detection air-mass meter during start
TDUBHFM			FW	time of HFM-diagnosis at u $<$ UBHFM
UADHFMMN			FW	minimum input voltage for HFM during Start
UADHFMMX			FW	maximum input voltage for HFM during start
UBHFM			FW	battery voltage threshold for switch to msdk
UNWDHFM			FW	camshaft rotations for debouncing diagnosis DHFM
ZMLRO			FW	time constant for low-pass-filter air mass flow

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_BELM	DHFM	AUS	condition air flow sensor (MAFS/MAPS) request
B_BKLM	DHFM	AUS	Condition: main load sensor active
B_CLLM		EIN	condition: clear fault path main load sensor
B_EDKS	GGDVE	EIN	Condition fault in throttle-valve sensor
B_EHFM	DHFM	AUS	condition: HFM error (without debounce)
B_EHFM1	DHFM	LOK	condition: HFM error (without debounce)
B_EHFS	DHFM	AUS	Condition substitude value main charge sensor
B_ELMI	DHFM	AUS	Condiion error massflow at initialisation
B_FTLM	DHFM	AUS	Condition fault entry by tester for air mass flow sensor (MAFS/MAPS)
B_HFM	DHFM	AUS	Condition: HFM ready to measure
B_LDRUGD		EIN	Condition unthrottled, Eneable from LDR
B_MNHFM	DHFM	LOK	Condition: Below lower plausibility threshold
B_MNLM	DHFM	AUS	Condition: min-error main load sensor
B_MXHFM	DHFM	LOK	Condition: Upper HFM plausibility threshold exceeded
B_MXLM	DHFM	AUS	Condition: max-error main load sensor
B_NPLM	DHFM	AUS	plausible-error main load sensor
B_SILM	DHFM	AUS	signal-error main load sensor
B_STEND	BBSTT	EIN	condition end of start
DFP_LM	DHFM	DOK	ECU-internal fault path no.: main-load sensor
E_LM	DHFM	AUS	Error flag: main load sensor
FHO_W	BGPU	EIN	correction factor: altitude
FWMLHFM	DHFM	AUS	weighted MLHFMMN in dependence from fho
MLDMN_W	DHFM	AUS	Mimimal air mass from map KFMLDMN

Variable	Source	Type	Description
MLDMX_W	DHFM	AUS	Maximal air mass from map KFMLDMX
MLHFMF_W	DHFM	LOK	Filtered air mass HFM mean value 16 Bit value
MLHFMM_W	GGHFM	EIN	mean HFM air mass value 16-Bit
NMOT_W	SWADAP	EIN	engine speed
SFPLM	DHFM	AUS	status fault path: main load sensor
UB	SWADAP	EIN	battery voltage
UHFM_W		EIN	HFM voltage
UZKW_W	GGDPG	EIN	revolution counter crankshaft
WDKBADMN_W	DHFM	LOK	Throttle-valve angle to address KFMLDMN
WDKBADMX_W	DHFM	LOK	Throttle-valve angle to address KFMLDMX
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
Z_LM	DHFM	AUS	cycle flag:ˆload determination LMM/HLM/HFM

FW DHFM 63.80 Fixed Values

Parameter	Value	Description
CWDHFM		Code word in DHFM
MLHFMMN		Min. HFM air-mass threshold to reset the min. fault
TDMLHFM		Delay time for setting the bit B_hfm
TDMLMN		debounce time for minimum fault detection air-mass meter
TDMLMX		debounce tme for maximum fault detection air-mass metr
TDMLNF		debounce time air-mass meter diagnosis with o.k. status
TDMLST		debounce time fault detection air-mass meter during start
TDUBHFM		time of HFM-diagnosis at u < UBHFM
UADHFMMN		minimum input voltage for HFM during Start
UADHFMMX		maximum input voltage for HFM during start
UBHFM		battery voltage threshold for switch to msdk
UNWDHFM		camshaft rotations for debouncing diagnosis DHFM
ZMLRO		time constant for low-pass-filter air mass flow

FB DHFM 63.80 Detailed description of function

```
Der Funktionsumfang umfaßt folgende Teilbereiche:

Post-start stabilization
----------------------
The diagnostic routine is only enabled following elapse of the debounce time TDMLST for suppression of the incorrect signal after
the HFM2 (12V peak, turn-on preheating fault) has been turned on. Triggering for strat of the debounce time is realizied by the
condition B_stend.
The same condition for enabling the diagnostic routine also aplies for minimum faults

B_mnlm, e.g. cable drop of KS to ground
---------------------------------------------
B_stend is set if
mshfm is less than the speed-dependent threshold value MLDMN
and
the delay time TDMLST triggered by B_stend has elapsed
and then the
debounce time TDMLMN (fault entry delay time for minimum fault) has elapsed.

B_mxlm, e.g. KS to Ubatt
----------------------------
B_mxlm is set if
mshfm is greater than the speed and throttle valve-dependent threshold value KFMLDMX
and
the delay time TDMLST triggered by B_stend has elapsed
and then the
debounce time TDMLMX (fault entry delay time for maximum fault) has elapsed.

In the case of a throttle valve fault (for E_dk), KFMLDMX is addressed with the maximum DK angle,
and only the upper threshold values apply as speed-dependent values.
In the case of a throttle valve fault (for E_dk), KFMLDMN is addressed with the minimum DK angle,
and only the lowest threshold values apply as speed-dependent values.


B_noflr
-------
B_noflr is set if
no fault (Min-Max-Plaus)
is detected
with debounce time TDMLNF.
```

E_lm

Error flag is set after the respective debounce time for
B_minflr or B_maxflr

Z_lm

Cycle flag is set for
B_minflr or B_maxflr or B_noflr

B_ehfm

This flag is set without debounce time for minimum or maximum fault, in order that a switchover to the
standby load signal can be made immediately in the event of a fault.
If for HFM5, the battery voltage is less than 11 Volts, then the HFM signal is no longer
plausible and switch over to the standby filling signal is required by B_ehfm=true.
For HFM2 the UBHFM threshold is of no significance and must be dated such that
no switchover to the standby filling signal occurs (i.e. UBHFM=0)

B_hfm

The flag B_hfm is set following start end (B_stend) and subsequent elapse of TDMLST
and signalizes the readiness of the HFM for measurement and operation. The filling detection is switched over from
the standby filling signal to the main filling signal after the start by the flag B_hfm.

Remarks:
- Fault lamp control: 2 trps after (E_lm & Z_lm)
- No faults are diagnosed on the hardware side
- Refer also to %DVFL for fault memory managment
- C_ini for reseting of the cycle flag is described in more detail in %DFVL

APP DHFM 63.80 Application hint

Stand by measure :

Switchover to secondary filling signal and standby value RLNOT for DK fault at the same time (is realizied in the funct. %BGMSZS)

Different additional measures are possible depending on the project (see cross-reference matrix):

```
disable LR-adaption,                           >
disable LLR characteristics and optional,      >  jeweils aktuelle Adaptionswerte gültig
disable KR-adaption,                           >
Tank venting in continuous operation (no prohibition for adaption)
```

Abgespeicherte Umweltbedingungen beim Auftreten des Fehlers

Für den Fall, daß der freeze-frame nicht über den Kundendienstdiagnosetester ausgelesen werden kann, empfehlen wir beim Auftreten
des Fehler folgende Umweltbedingungen mit abzuspeichern.
1. Umweltwert nmot_u
2. Umweltwert tmot_u
Kann der freeze-frame über den Kundendienstdiagnosetester ausgelesen werden, empfehlen wir zwei weitere (im freeze-frame nicht
enthaltene Größen) als Umweltbedingungen mit abzuspeichern z.B. tans_u,wdkba_u. (Referenztabelle siehe %DFFT).

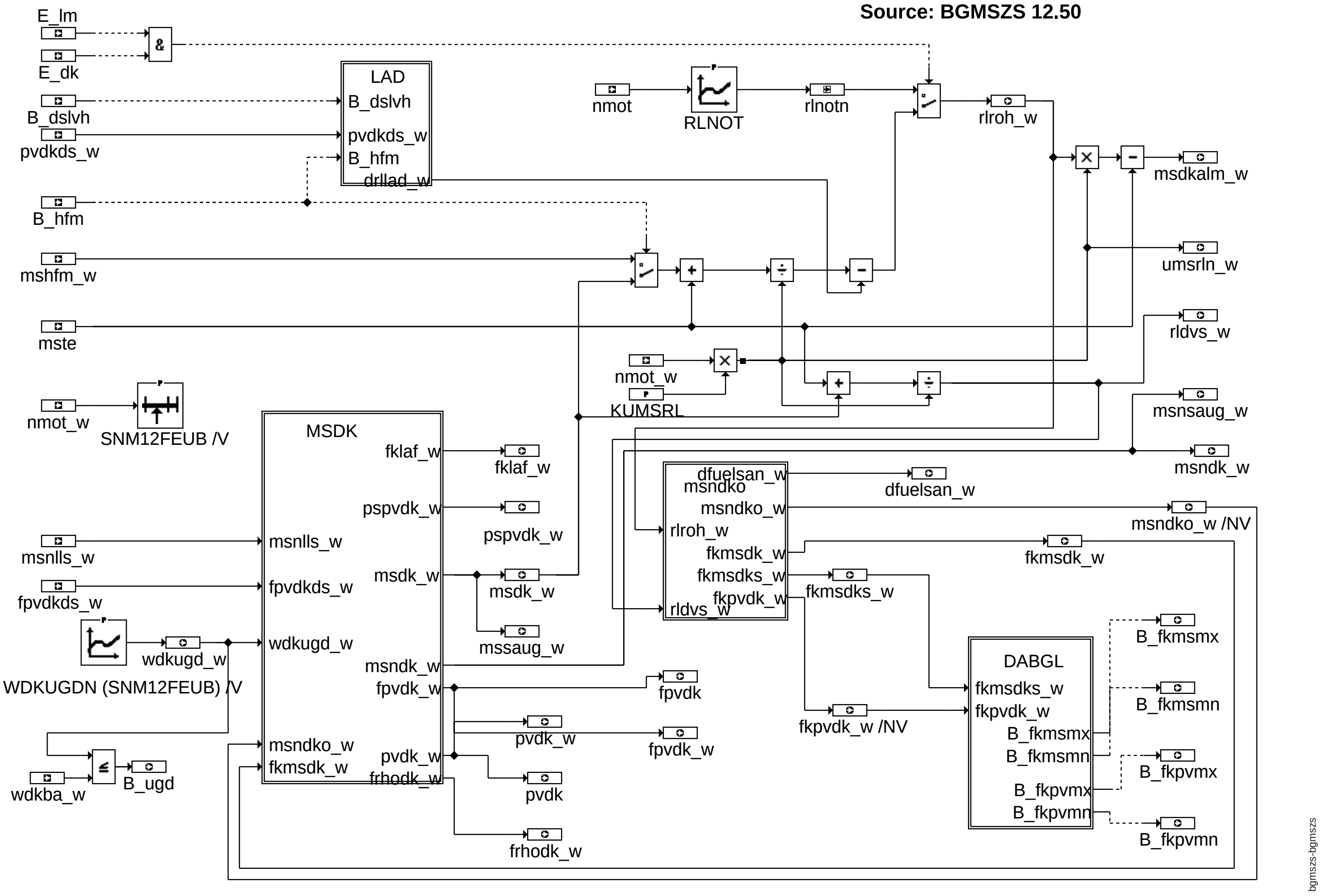
Anhaltswerte für Erstapplikation :

TDMLMN	0.3 sec	possible drop in speed for connector falling off in the LL, without the automobile cutting out
TDMLMX	0.3 sec	
TDMLNF	1.0 sec	Stabilization behaviour of HFM following KS
TDMLST	0.3 sec	dependent on start with cable fallen off
ZMLRO	ca. 0.3 sec	time constant from the intake manifold
KFMLDMX		Less than minimum air mass with closed LLS in trailing throttle
KFMLDMN		dsign approx. 20% above maximum possible air mass at full load

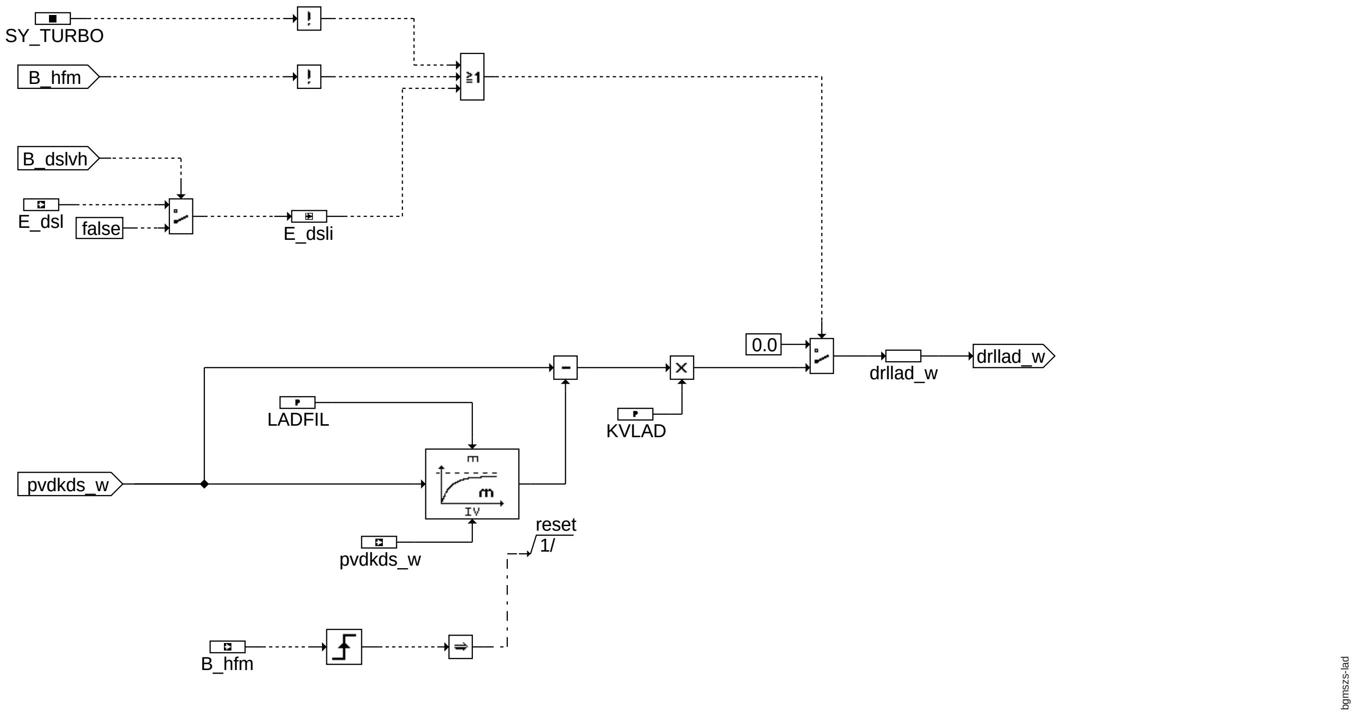
BGMSZS 12.60 Calculation of mass flows into intake manifold

FDEF BGMSZS 12.60 Function definition

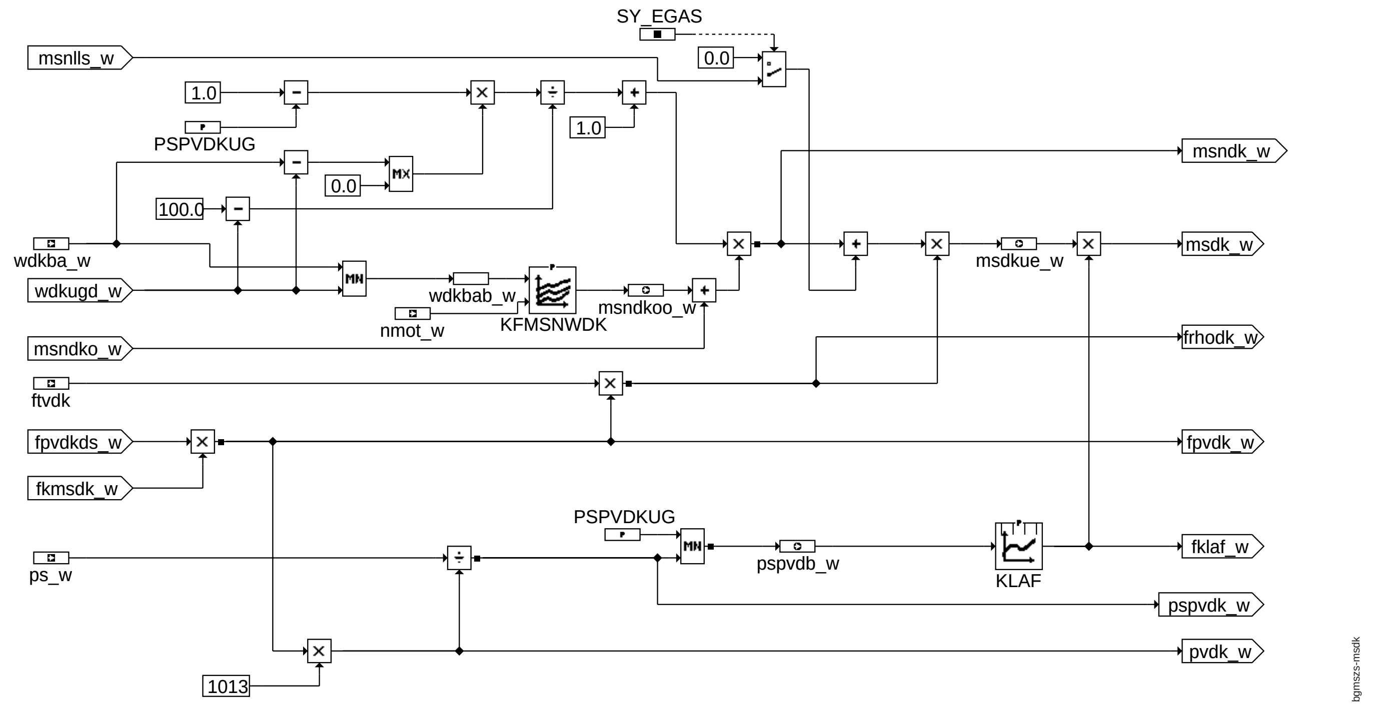
Source: BGMSZS 12.50



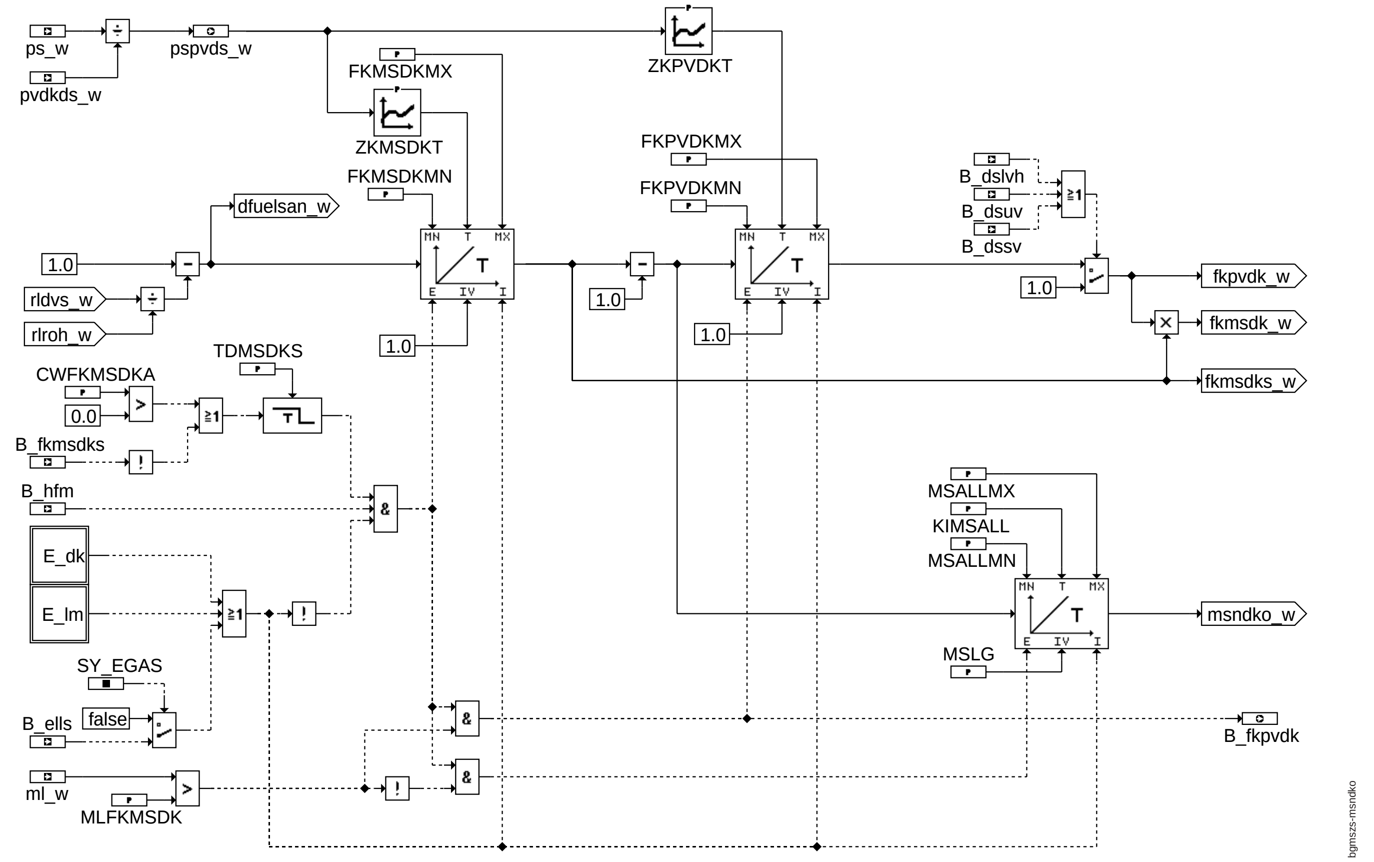
bgmszs-bgmszs



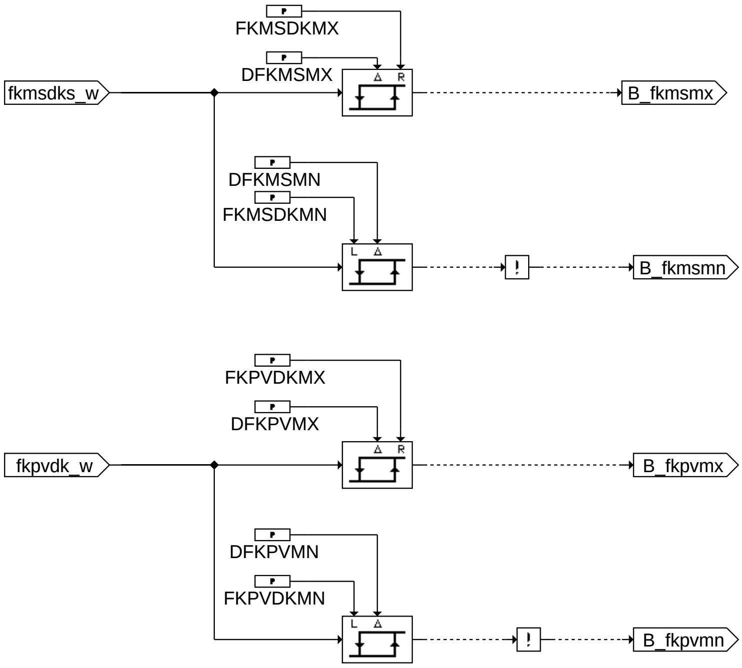
bgmszs-lad



bgmszs-msdk

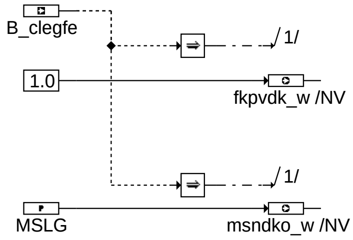


bgmszs-msndko



bgmszs-dabgl

bgmszs-dabgl



bgmszs-fcmclr

bgmszs-fcmclr

ABK BGMSZS 12.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWFKMSDKA			FW	codeword for mass-flow adaption activ
DFKMSMN			FW	Delta FKMSDKMN for resetting of B_fkmsmn
DFKMSMX			FW	Delta FKMSDKMX for resetting of B_fkmsmx
DFKPVMN			FW	Delta FKPVDKMN for resetting of B_fkpvmn
DFKPVMX			FW	Delta FKPVDKMX for resetting of B_fkpvmx
FKMSDKMN			FW	low limit for slow mass-flow correction of throttle valve
FKMSDKMX			FW	high limit for fast mass-flow correction of throttle valve
FKPVDKMN			FW	lower limit for mass-flow correction of throttle valve
FKPVDKMX			FW	high limit for mass-flow correction of throttle valve
KFMSNWDK	WDKBAB_W	NMOT_W	KF	Map for scaled mass flow over throttle valve
KIMSALL			FW	Correction value for idling air mass integrator for E gas
KLAF	PSPVDB_W		KL	characteristic of Saint-Venant
KUMSRL			FW	conversion constant from mass flow to relative air charge
KVLAD			FW	air charge correction caust by boost pressure dynamic
LADFIL			FW	boost pressure filtering for calculation of delta boost pressure
MLFKMSDK			FW	air flow threshold for multipl. adjustment of HFM and throttle air flow
MSALLMN			FW	Minimum idling air mass adaptation for E gas
MSALLMX			FW	Maximum idling air mass adaptation for E gas
MSLG			FW	Mass flow total leakage air
PSPVDKUG			FW	Ratio pspvdk not reduced
RLNOT	NMOT		KL	limp-home relative air charge rl in case of E_DK and E_LM
SNM12FEUB	NMOT_W		SV	set points of WDKSMX, WDKUGDN
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_TURBO			SYS (REF)	system constant for exhaust-gas turbocharger
TDMSDKS			FW	Time delay for the bit B_fkmsdks
WDKUGDN	NMOT_W		KL	throttle angle necessary for 95 % of the maximum possible air charge
ZKMSDKT	PSPVDS_W		KL	integrator speed for fast constant mass-flow adaption
ZKPVDKT	PSPVDS_W		KL	integrator speed for slow constant mass-flow adaption

Variable	Source	Type	Description
B_CLEGFE		EIN	condition clear fault path EGFE
B_DSLVH		EIN	boost-pressure sensor is on the system
B_DSSV		EIN	intake-manifold pressure sensor is mounted
B_DSUV		EIN	ambient pressure sensor is mounted on the system
B_ELLS		EIN	Condition: error idle speed actuator
B_FKMSDKS	FUEDK	EIN	stop for integration of fkmsdk
B_FKMSMN	BGMSZS	AUS	Quick adaption of the mass flow fkmsdks at the lower arrester
B_FKMSMX	BGMSZS	AUS	Quick adaption of the mass flow fkmsdks at the upper arrester
B_FKPVDK	BGMSZS	AUS	Confition for the release of the slow multiplicative load trim
B_FKPVMN	BGMSZS	AUS	Slow mass flow adaption fkpvdk at the lower arrester
B_FKPVMX	BGMSZS	AUS	Slow mass flow adaption fkpvdk at the upper arrester
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_PWF		EIN	Condition for powerfail
B_UGD	BGMSZS	AUS	condition: throttle angle greater or equal wdkugd
DFP_DK	BGMSZS	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_LM	BGMSZS	DOK	ECU-internal fault path no.: main-load sensor
DFUELSAN_W	BGMSZS	AUS	Delta charge sensor to alpha/n-systems
DRLLAD_W	BGMSZS	LOK	dynamic part of relative air charge rl at turbo engine
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_DSL		EIN	error flag: pressure sensor charging pressure
E_DSLI	BGMSZS	LOK	Error flag : Pressure sensor for turbo charge pressure , intern
E_LM	EGFE	EIN	Error flag: main load sensor
FKLAF_W	BGMSZS	AUS	Factor saint venant (KLAF)
FKMSDKS_W	BGMSZS	AUS	correction factor for fast mass flow signal
FKMSDK_W	BGMSZS	AUS	correction factor for mass-flow substitute load signal
FKPVDK_W	BGMSZS	AUS	correction factor for slow mass flow signal
FPVDK	BGMSZS	AUS	correction factor for pressure upstreams throttle
FPVDKDS_W	BGPU	EIN	Factor pressure in front of throttle valve of pressure sensor (word)
FPVDK_W	BGMSZS	AUS	correction factor for pressure upstream of throttle valve, 16-bit
FRHODK_W	BGMSZS	AUS	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSDKALM_W	BGMSZS	AUS	Mass flow over throttle (balance with HFM signal)
MSDKUE_W	BGMSZS	AUS	Air mass flow thru throttle body when overcritical pressure drop
MSDK_W	BGMSZS	AUS	air-mass flow through throttle valve
MSHFM_W	GGHFM	EIN	air-mass flow HFM
MSNDKOO_W	BGMSZS	AUS	Normalized mass flow over throttle without offset (word)
MSNDKO_W	BGMSZS	AUS	norm leakage air mass flow through throttle blade
MSNDK_W	BGMSZS	AUS	standardised air mass flow through throttle valve
MSNLLS_W		EIN	standardised air mass flow through idle speed actuator (word)
MSNSAUG_W	BGMSZS	AUS	standardized air mass flow through intake manifold (word)
MSSAUG_W	BGMSZS	AUS	air mass flow through intake manifold (word)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
PSPVDB_W	BGMSZS	AUS	quotient:int.manif.press.divided by press.upstream of throttle valve limit
PSPVDK_W	BGMSZS	AUS	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PSPVDS_W	BGMSZS	AUS	quotient manifold pressure/pressure before throttle plate
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PVDK	BGMSZS	AUS	pressure in front of throttle
PVDKDS_W	BGPU	EIN	Pressure in front of throttle valve of pressure sensor (word)
PVDK_W	BGMSZS	AUS	pressure upstream of throttle valve, 16-bit
RLDVS_W	BGMSZS	AUS	relative air charge through throttle valves on intake manifold
RLNOTN	BGMSZS	LOK	Relative air charge when main and limp home signal error, depending on rpm
RLROH_W	BGMSZS	AUS	relative air charge flowing into intake manifold
UMSRLN_W	BGMSZS	AUS	calculation factor load to mass flow
WDKBAB_W	BGMSZS	LOK	wdkba_w limited (minimum selection between wdkba_w and wdkugd_w)
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
WDKUGD_W	BGMSZS	AUS	Throttle valve angle during which 95% charge is reached

FW BGMSZS 12.60 Fixed Values

Parameter	Value	Description
CWFKMSDKA		codeword for mass-flow adaption activ
DFKMSMN		Delta FKMSDKMN for resetting of B_fkmsmn
DFKMSMX		Delta FKMSDKMX for resetting of B_fkmsmx
DFKPVMN		Delta FKPVDKMN for resetting of B_fkpvmn
DFKPVMX		Delta FKPVDKMX for resetting of B_fkpvmx
FKMSDKMN		low limit for slow mass-flow correction of throttle valve
FKMSDKMX		high limit for fast mass-flow correction of throttle valve
FKPVDKMN		lower limit for mass-flow correction of throttle valve
FKPVDKMX		high limit for mass-flow correction of throttle valve
KIMSALL		Correction value for idling air mass integrator for E gas
KUMSRL		conversion constant from mass flow to relative air charge
KVLAD		air charge correction caust by boost pressure dynamic
LADFIL		boost pressure filtering for calculation of delta boost pressure
MLFKMSDK		air flow threshold for multipl. adjustment of HFM and throttle air flow
MSALLMN		Minimum idling air mass adaptation for E gas
MSALLMX		Maximum idling air mass adaptation for E gas
MSLG		Mass flow total leakage air

Parameter	Value	Description
PSPVDKUG		Ratio pspvdk not reduced
TDMSDKS		Time delay for the bit B_fkmsdks

FB BGMSZS 12.60 Detailed description of function

The section BGMSZS calculates the air mass flow into intake manifold.
This section is providing the calculation for different systems. Turbo charged and natuaral asperated engines as well as air mass flow or pressure based systems.
The necessary funtionallity of the configuration can be defined by the system values SY_Turbo and SY_EGFE which are explained in the section %PROKON. The following configuration is valid:

```
              SY_Turbo=1  --> Turbo charged engine         SY_Turbo=0  --> Natural asperated engine
```

The system value SYS_EGFE is specifiing different compoments (systems) mounted on the engine or not:
HFM, ambient pressure sensor, intake manifold pressure sensor, induction system pressure sensor

```
                                SY_EGFE     ->  Bit0: HFM present
                                                Bit1: Pressure sensor post throllte body
                                                Bit2: Pressure sensor pre throttle body
                                                Bit3: Ambient pressure sensor;Pu-Sensor

 Example:      System with HFM and ambient pressure sensor      BIT     3       2       1       0
                                                                      -------------------------------
                                                                        1       0       0       1     -> SY_EGFE = 9
```

The calculation is done according to the following explanation.
1) air mass flow measured by air mass flow sensor HFM if sensor is ok (B_hfm = true):
   The air mass measured bei HFM is corrected by adding the air fuel mixture flow from canister purge and then calculated into relative air charge. rlroh = (mshfm + mste) / (KUMSRL * nmot)

2) air mass flow calculated as flow through throttle valve and bypass LLS
   It uses the following physical relation:
The gas mass flow through a throttle valve is dependent on the opening cross-section, the pressure upstream of it, the gas temperature and the ratio between the pressure upstream and downstream of the throttle valve.

Under standardised conditions the flow through a throttle valve is stored in a characteristic dependent on the opening angle or the duty cycle. The standardised conditions are:
Gas temperature =0 degrees Celsius
pressure upstream of throttle valve pvdk = 1013hPa
pressure downstream of throttle valve ps < (0.5283 * pvdk)

The characteristic for the throttle valve (DK) is MSNWDK. It is a function of the throttle angle referred to the stop limit wdkba at closed throttle valve.

The characteristic line for the idle speed actuator (ISA-bypass) is a function of
(a) in case of EWD/ZWD: duty cycle of the ISA (please refer to %ALLS)
(b) in case of stepper: actual position of the stepper (%ALLSTP)

With the temperature correction factor ftvdk the standard mass flow of the throttle valve msndk and the standard mass flow of the canister purge valve msnte are calculated into the mass flow at current gas temperature.
The pressure correction factor fpvdk corrects the standard mass flow to the current pressure upstream of the throttle valve.

The pressure ratio pspvdk between the pressure downstream and upstream of the throttle body addresses the characteristic KLAF (standardised flow through throttle valve), which at supersonic pressure ratios of pspvdk < 0.5283 delivers the value 1.
The gas velocity in this case is equal to the sonic speed. At pressure ratios of pspvdk > 0.5283 the gas velocity falls below the sonic speed. The value from KLAF becomes < 1. Under consideration of this behavior, the actuel air flow through the throttle body can be calculated. The KLAF-line at pspvdk values > 0.9 (full load) is very steep. This behavior results in big changes of the air flow mssaug even there is only small pressure changes pspvdk. During an error of the HFM signal the value mssaug represents the load (limp-home). For this reason it is necessay to limit the KLAF line to avoid swinging systems. A limitiation of the intake manifold pressure calculation PSMXN in %BGSRM secures that during full load a not too high load value rl will be calculated.

The mass air flow over throttle body and idle speed actuator is normaly determinated by HFM if the load sensor is ready to operate. The mass flow over TEV mste, which is not considered by load sensor, must be added to the mass air flow through throttle body and ISA. The division by umsrln_w = (KUMSRL * engine speed) provides a primary signal for the relative charge of cylinder.

Since adaptation of the throttle angle stop limit at closed throttle valve doesn't occur frequently under actual operating conditions (clamp 15 = true & nmot=0 & t>= 30 sec), an adaptation is carried out by means of a comparison of the air mass flow measured with the HFM and the air mass flow calculated via the throttle angles and duty cycle of the ISA (only for systems with bypass).
This "leakage air adaptation" will be released only under idle condition B_ll=1 and when the main charge signal (!E_lm) and secondary charge signal (!E_dk) are ok. With MSALLMX and MSALLMN the maximum and minimum air mass adaption ranges are defined respectively.
Via factor KIMSALL the "leakage air adaptation" speed is set.

The output of the leakage air adaptation is added to the leakage air MSLG at closed throttle valve (wdkba = 0) and stored in the variable msndko_w. If the corrected air mass flow through throttle valve mssaug corresponds to the air mass flow measured by HFM mshfm, the leakage air adaptation has been completed successfully.

For certain functionalities is necessary to use the calculated mass air flow through throttle valve and ISA as back up. For determination of mssuag several variables ftvdk, fpvdk, msndko, msnlls and the char. line KLAF are used which adjust mssaug within allowed ranges. Therefore the second load signal mssaug can be adapted to the main load signal mshfm. For this purpose the difference mass flow msdif (=mshfm-mssaug) is formed and fed to an integrator. For msdif=0 the integrator provides the value fkmsdk=1, otherwise fkmsdk is different from 1. The factor fkmsdk is used to adjust the pressure upstream throttle valve pvdkds. In this way mssaug is adapted to mshfm.

The integrator is activated only by operation ready load sensor (!E_lm) and second load signal (!E_dk), and furthermore the air mass ml must exceed the threshold MLFKMSDK. the limitations of the integrator are given by FKPVDKMX and FKPVDKMN.

APP BGMSZS 12.60 Application hint

The standardised flow through throttle valve KLAF is specified by physics, and is stored as a 501 * 16 bit table in the Eprom. The fine stepping from value to value is particularly necessary in the subcritical operating range, since the intake manifold model tends to oscillate if the stepping is spread too coarsely.
The values table for the outflow characteristic KLAF can be requested as an EXCEL file from H.Pfitz K3/ESY5 Tel. 8502 if required.

!!!! The KLAF is stored only once for the entire project in the EPROM (FLASH), due to the available memory space.!!!!

The KLAF input value is calculated in the relevant modules and transferred in a RAM cell. Then the corresponding output value of the KLAF is calculated using the transfer value, and the KLAF value is used for further calculations in the relevant software modules.
Characteristic MSNWDK for the standard mass flow through the throttle valve, dependent on the throttle angle wdkba, will not always be supplied by the engine manufacturer. In this case the following measurement variables are required to determine the characteristic:
wdkba - Throttle angle referred to stop limit at closed throttle valve
tans - Fresh-air temperature upstream of throttle valve
pvdk - Pressure upstream of throttle valve = ambient pressure in induction engine
ps - intake manifold pressure
mshfm - Air mass flow at HFM

The measuring of the characteristic of throttle valve is described in E-Bericht K3/ESY 28/96.

there are the following relationships:

```
ECU term                                       E-Report term

                 mshfm                                 msd
MSNWDK = -----------------------------         =  -----------------------------------
         fpvk * ftvdk * KLAF(pspvdk)                  (pvd/p0) * (Wurzel(T0/Tvd)) * Psin

fpvdk = pvdk/ 1013hPa                          = pvd/1013 hPa
```

ftvdk = sqrt(273/(tans+273)) -> Square root of the standard temperature 273 Kelvins divided by the intake air temperatur (Kelvin)

KLAF - The value of KLAF as function of the ratio between the intake manifold pressure and the pressure upstreams of throttle valve.

Values for initialize:

LADFIL = 0.25
KVLAD = 0.35 %/hPa
MSALLMN = 0 kg/h
MSALLMX = 12 kg/h
KIMSALL = .01
KLAF is specified by physic

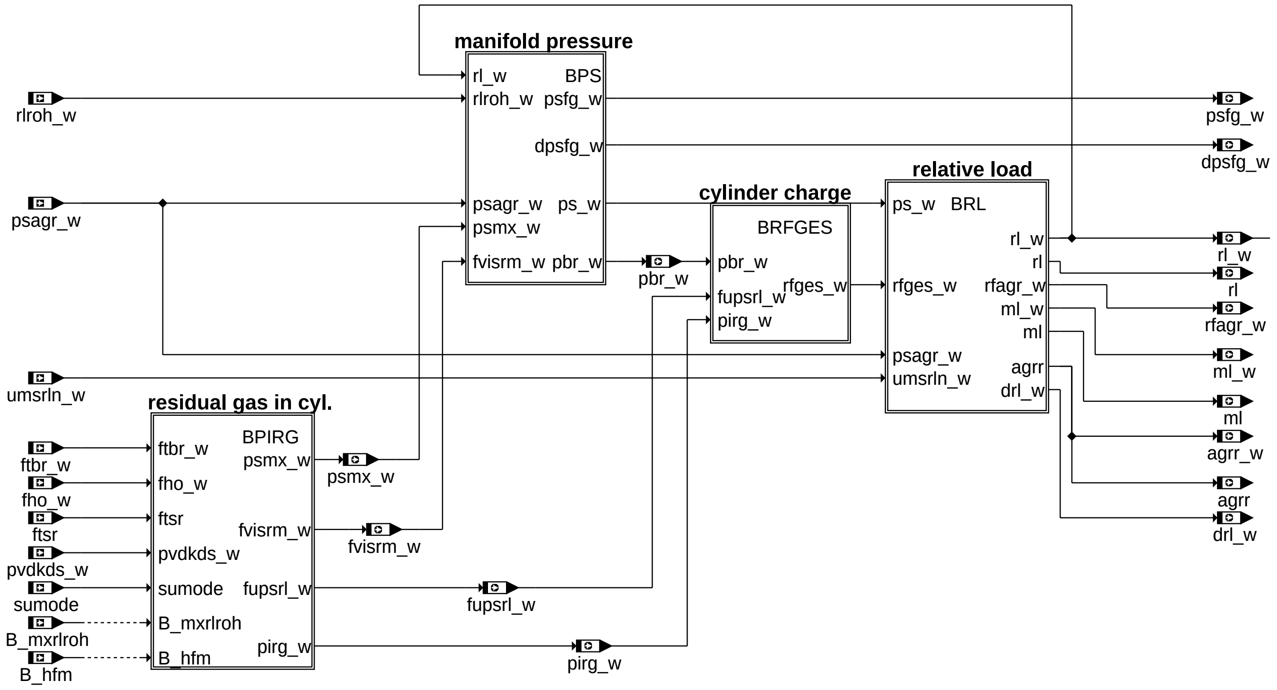
MSNDK: during application there must be a measured actuator characteristic.
for production application a desired value for actuator characteristic MSNDK has to be specified.
the characteristic MSNDK has to be correctected, so that at closed throttle valve (wdkba = 0) the air mass flow through the valve is zero (MSNWDK = 0 kg/h).

MSLG: during application the leakage air mass flow at closed throttle valve is entered in MSLG.
for production application the leakage air mass flow specified in the TKU is entered in MSLG

BGSRM 17.30 Model of intake manif. for calc. relative air charge and intake manif. pressure

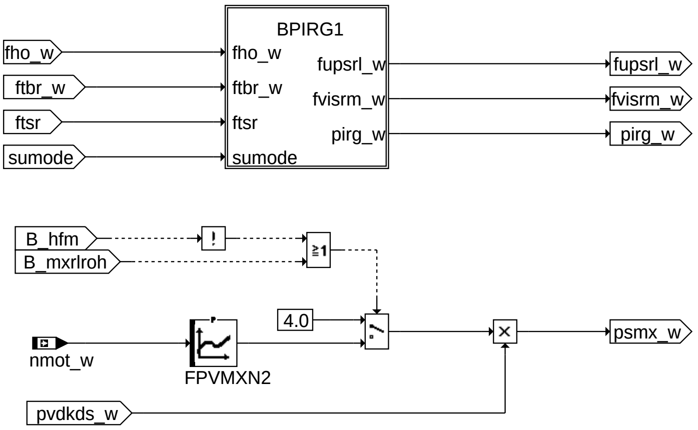
FDEF BGSRM 17.30 Function definition

```
BGSRM: Übersicht
================
```



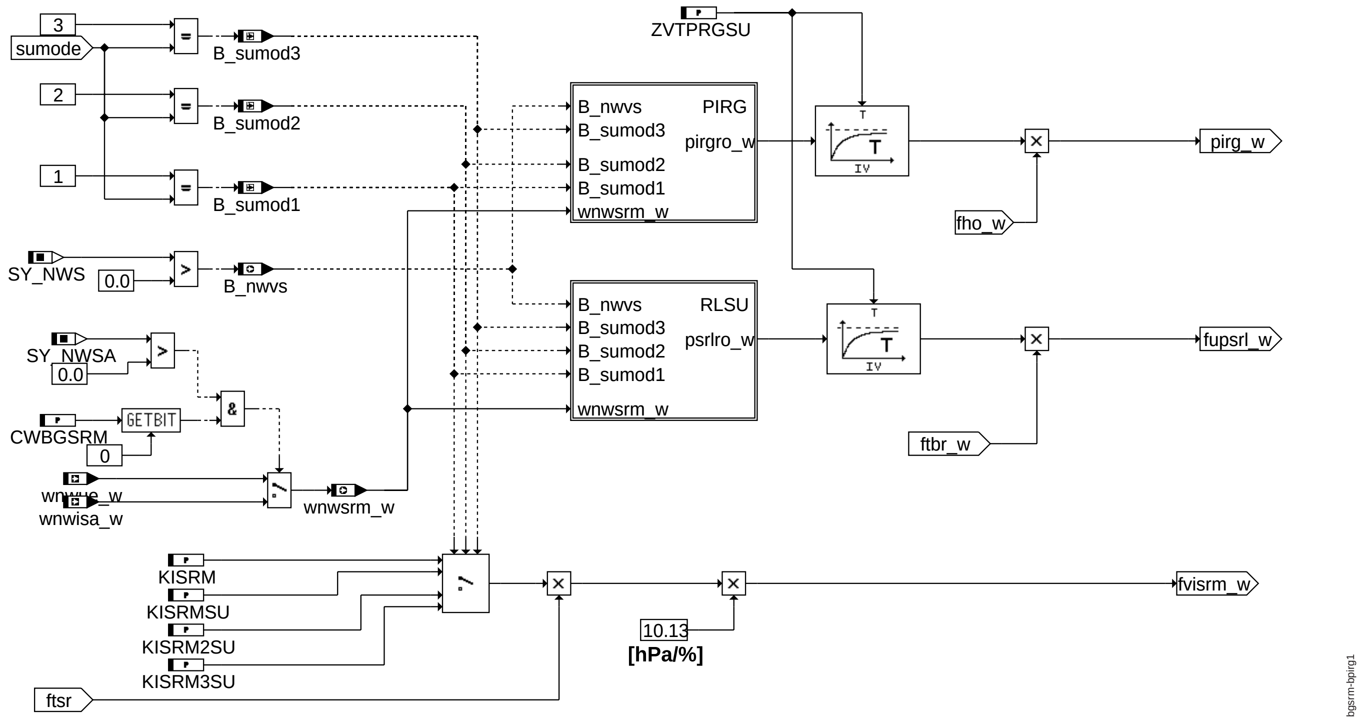
bgsrm-bgsrm

```
BPIRG: Berechnung max. Saugrohrdruck, internes Restgas, Umrechnungsfaktor Druck --> Füllung und Integratorverstärkung
=====================================================================================================================
```



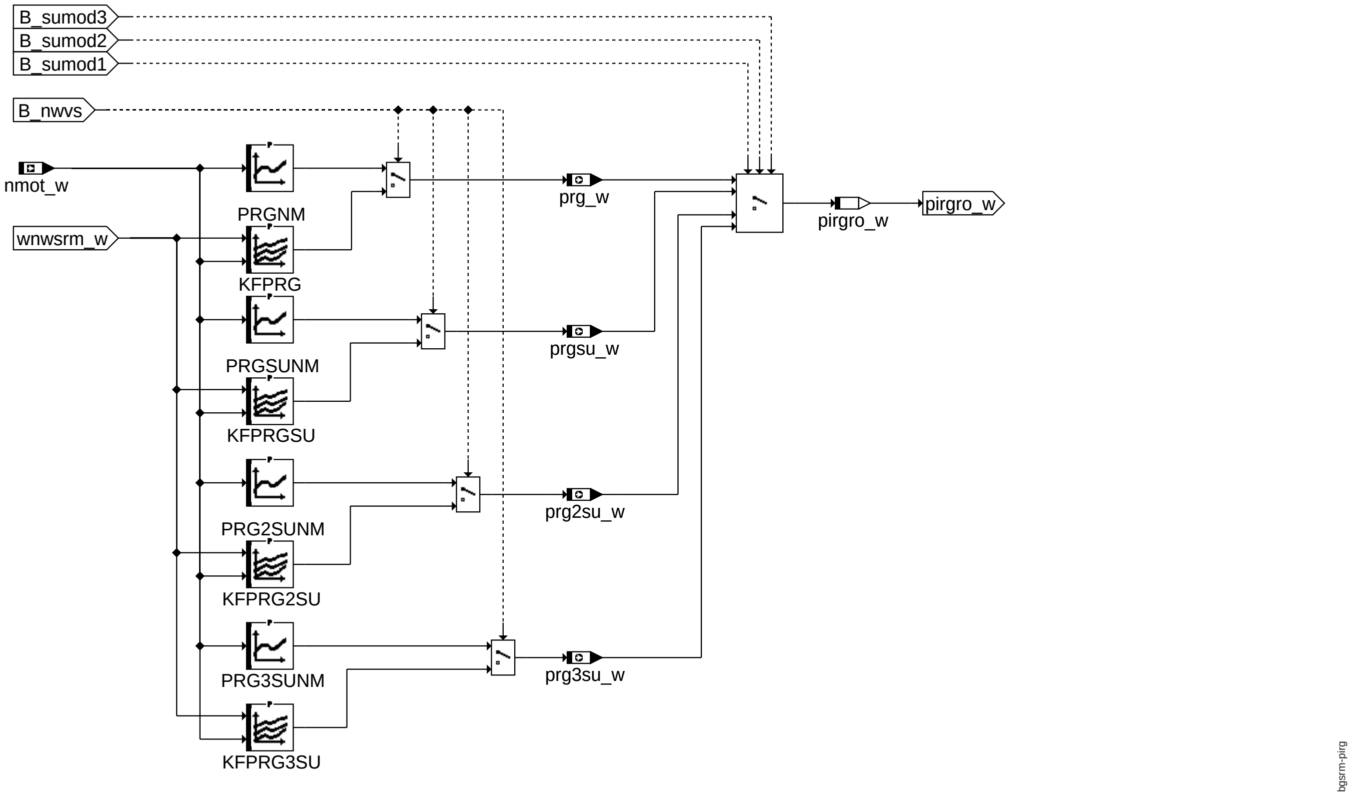
bgsrm-bpirg

BPIRG1: Berechnung internes Restgas, Umrechnungsfaktor Druck --> Füllung und Integratorverstärkung



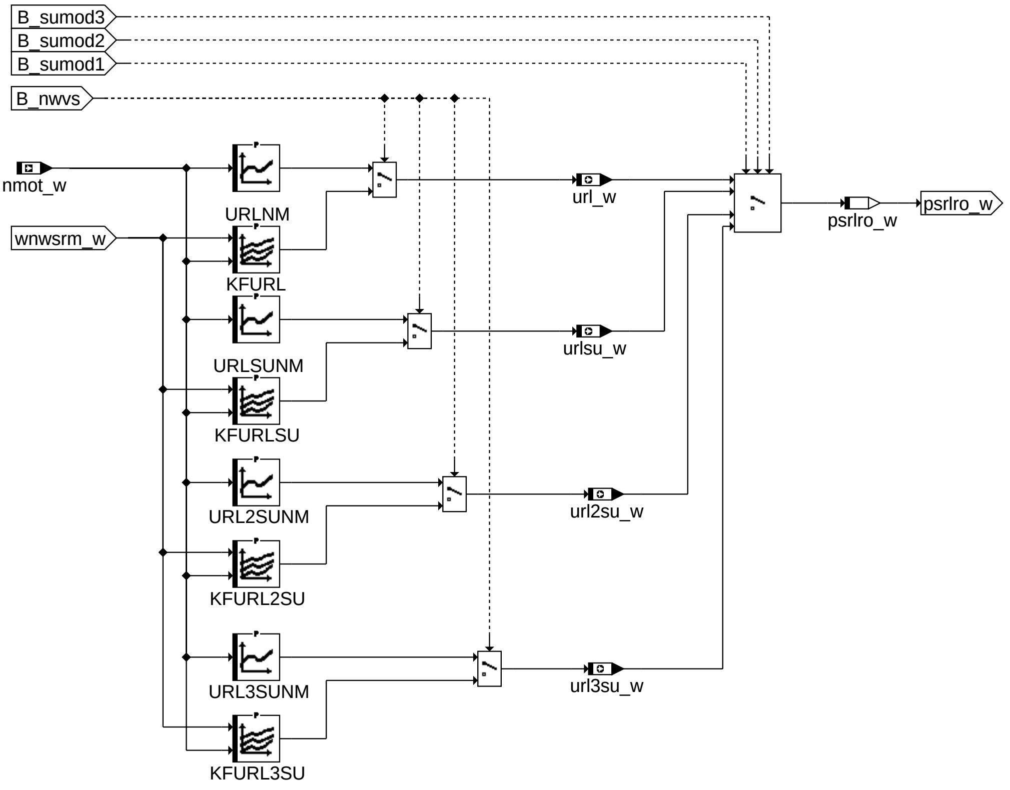
bgsrm-bpirg1

PIRG: Berechnung internes Restgas



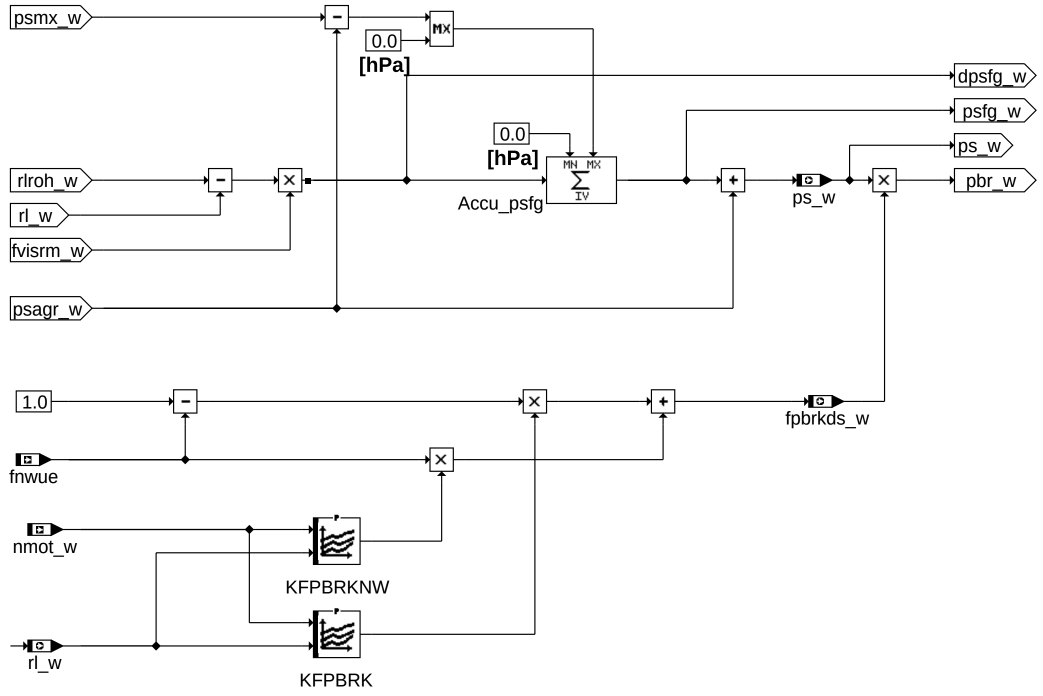
bgsrm-pirg

`PIRG: Berechnung Umrechnungsfaktor Druck --> Füllung`
`=================================================`



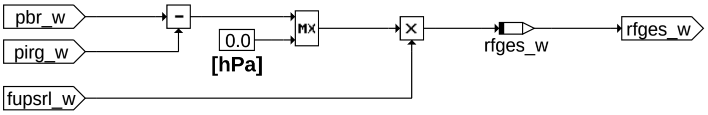
bgsrm-rlsu

`BPS: Berechnung Saugrohr- und Brennraumdruck`
`==========================================`



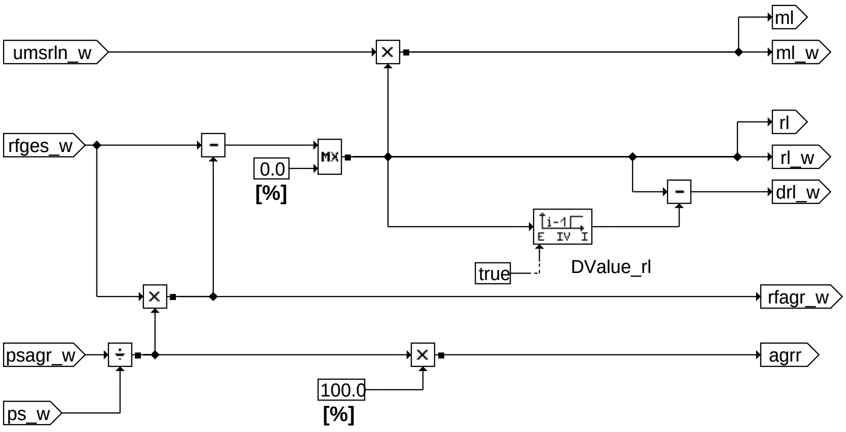
bgsrm-bps

BRFGES: Berechnung Brennraumfüllung ohne internes Restgas



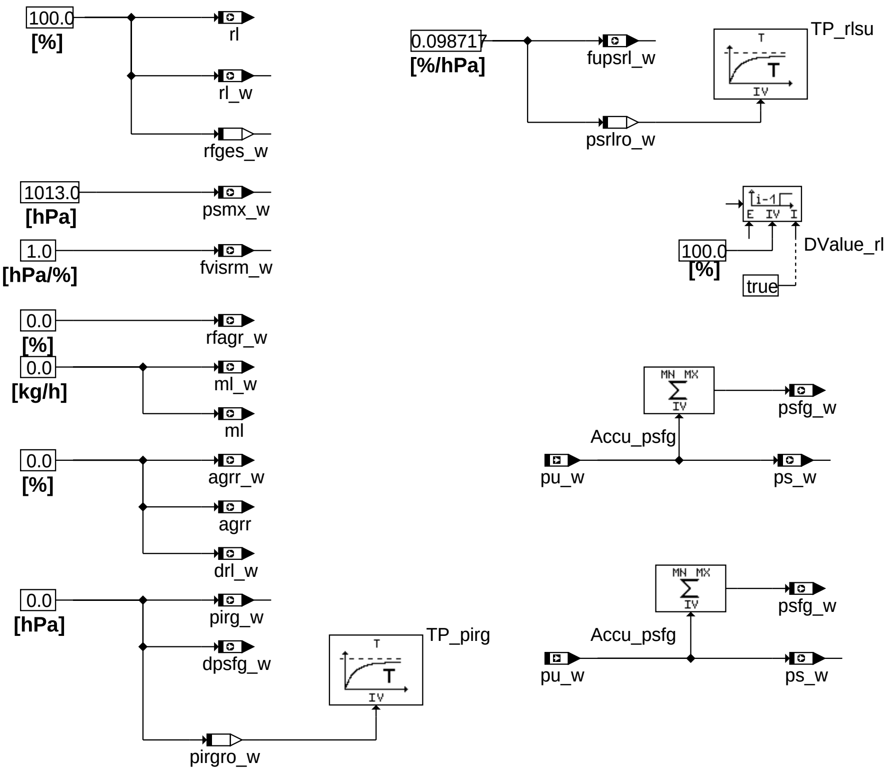
bgsrm-brfges

BRL: Berechnung Frischluftbrennraumfüllung, AGR-Rate und Luftmassenstrom



bgsrm-brl

INIT: Initialisierung



bgsrm-init

ABK BGSRM 17.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWBGSRM			FW	code word in BGSRM
FPVMXN2	NMOT_W		KL	factor for pressure ratio maximum with secondary last sensor
KFPBRK	NMOT_W	RL_W	KF	factor to correct pressure at combustion chamber
KFPBRKNW	NMOT_W	RL_W	KF	factor to correct pressure at combustion chamber by active Camshaft control
KFPRG	WNWSRM_W	NMOT_W	KF	internal partial exhaust gas pressure dependent on camshaft adjustment sumode=0

Parameter	Source-X	Source-Y	Type	Description
KFPRG2SU	WNWSRM_W	NMOT_W	KF	internal partial exhaust gas pressure depent on camshaft adjustment sumode=2
KFPRG3SU	WNWSRM_W	NMOT_W	KF	internal partial exhaust gas pressure dpent on camshaft adjustment sumode=3
KFPRGSU	WNWSRM_W	NMOT_W	KF	internal partial exhaust gas pressure dependent on camshaft adjustment sumode=1
KFURL	WNWSRM_W	NMOT_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=0
KFURL2SU	WNWSRM_W	NMOT_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=2
KFURL3SU	WNWSRM_W	NMOT_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=3
KFURLSU	WNWSRM_W	NMOT_W	KF	conversion factor from ps->rl dependent on camshaft adjustment sumode=1
KISRM			FW	integrator speed constant for intake manifold model
KISRM2SU			FW	integrator speed constant for intake manifold model by sumode=2
KISRM3SU			FW	integrator speed constant for intake manifold model by sumode =3
KISRMSU			FW	integrator speed constant for intake manifold model by sumode=1
PRG2SUNM	NMOT_W		KL	internal exhaust-gas part. press. dependent on the speed at active SU (2nd flap)
PRG3SUNM	NMOT_W		KL	inter. exhaust-gas part. press. dependent on speed at active SU (1st + 2nd flap)
PRGNM	NMOT_W		KL	internal exhaust-gas partial pressure dependent on the speed
PRGSUNM	NMOT_W		KL	inter. exhaust-gas partial press. dep. on speed in case of active SU (1st flap)
SY_NWS			SYS (REF)	system constant camshaft control: none, 2 point, continous
SY_NWSA			SYS (REF)	system constant camshaft control outlet
URL2SUNM	NMOT_W		KL	conversion factor from ps->rl dependent on nmot_w for active SU (2nd flap)
URL3SUNM	NMOT_W		KL	conversion factor from ps->rl dependent on nmot_w for active SU (1st + 2nd flap)
URLNM	NMOT_W		KL	conversion factor from ps->rl dependent on nmot_w
URLSUNM	NMOT_W		KL	conversion factor from ps->rl dependent on nmot_w for active SU (1st flap)
ZVTPRGSU			FW	time constant for low pass filtering by intake manifold flaps dynamic

Variable	Source	Type	Description
AGRR	BGSRM	AUS	exhaust gas recirculation rate
AGRR_W	BGSRM	AUS	exhaust gas recirculation rate
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_MXRLROH		EIN	condition maximum selection for rloh has been fulfilled
B_NWVS	BGSRM	AUS	condition camshaft adjustment (continuous or 2-step) exists
B_SUMOD1	BGSRM	LOK	condition variable intake manifold sumode=1
B_SUMOD2	BGSRM	LOK	condition variable intake manifold sumode=2
B_SUMOD3	BGSRM	LOK	condition variable intake manifold sumode=3
DPSFG_W	BGSRM	AUS	delta fresh air partial pressure in manifold
DRL_W	BGSRM	AUS	charge change (Word)
FHO_W	BGPU	EIN	correction factor: altitude
FNWUE	NWS	EIN	Weighting factor camshaft overlap
FPBRKDS_W	BGSRM	AUS	factor for determination of combustion chamber pressure
FTBR_W	BGTEMPK	EIN	factor: temperature correction in combustion chamber
FTSR	BGTEMPK	EIN	correction factor for air temperature in the manifold
FUPSRL_W	BGSRM	AUS	factor system related transformation pressure to load (16-Bit)
FVISRM_W	BGSRM	AUS	integrator amplifier factor intake manifold modell
ML	BGSRM	AUS	air mass flow
ML_W	BGSRM	AUS	air mass flow filtered (Word)
NMOT_W	SWADAP	EIN	engine speed
PBR_W	BGSRM	AUS	Calculated combustion chamber pressure
PIRGRO_W	BGSRM	LOK	unfilter value for partial pressure residual gas internal EGR
PIRG_W	BGSRM	AUS	partial pressure residual exhaust gas internal EGR (16-Bit)
PRG2SU_W	BGSRM	AUS	raw value of partial pressure residual gas internal EGR at active SU flap (2nd)
PRG3SU_W	BGSRM	AUS	raw val. of part. press. residual gas internal EGR at active SU flap (1st + 2nd)
PRGSU_W	BGSRM	AUS	raw value of part. press. residual gas internal EGR at active SU flap (1st flap)
PRG_W	BGSRM	AUS	raw value of part. press. residual gas internal EGR when no SU-flap is switched
PSAGR_W	BGAGR	EIN	partial pressure EGR
PSFG_W	BGSRM	AUS	fresh air partial pressure in manifold
PSMX_W	BGSRM	AUS	maximum manifold pressure limitation for modeled manifold pressure
PSRLRO_W	BGSRM	LOK	factor for conversion pressure in cylinder filling
PS_W	BGSRM	AUS	intake manifold pressure (absolute) (Word)
PU_W	BGPU	EIN	Ambient pressure
PVDKDS_W	BGPU	EIN	Pressure in front of throttle valve of pressure sensor (word)
RFAGR_W	BGSRM	AUS	relative load by external exhaust gas reduction
RFGES_W	BGSRM	LOK	total relative charge (including EGR)
RL	BGSRM	AUS	relative air charge
RLROH_W	BGMSZS	EIN	relative air charge flowing into intake manifold
RL_W	BGSRM	AUS	relative air charge (Word)
SUMODE	SU	EIN	status of the intake manifold switch over
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
URL2SU_W	BGSRM	AUS	factor for conversion from pressure to charge for active SU flap (2nd)
URL3SU_W	BGSRM	AUS	factor for conversion from pressure to charge at active SU flaps (1st + 2nd)
URLSU_W	BGSRM	AUS	factor for conversion from pressure to charge for active SU flap (1st)
URL_W	BGSRM	AUS	factor for conv. from press. to charge in case of default pos. of manifold flaps
WNWISA_W		EIN	actual shifting angle of the outlet camshaft
WNWSRM_W	BGSRM	AUS	selec. between wnwue and wnwisa for addressing of the maps for pirg and fupsrl
WNWUE_W	NWS	EIN	camshaft overlap angle of inlet and outlet valve opening

FW BGSRM 17.30 Fixed Values

Parameter	Value	Description
CWBGSRM		code word in BGSRM
KISRM		integrator speed constant for intake manifold model
KISRM2SU		integrator speed constant for intake manifold model by sumode=2
KISRM3SU		integrator speed constant for intake manifold model by sumode =3

Parameter	**Value**	**Description**
KISRMSU		integrator speed constant for intake manifold model by sumode=1
ZVTPRGSU		time constant for low pass filtering by intake manifold flaps dynamic

FB BGSRM 17.30 Detailed description of function

The intake manifold model calculates the air charge in the combustion chamber from the air mass flowing into the intake manifold.

An integrator simulates the storage of the intake manifold. It integrates the difference between the in-flowing relative charge rlroh and the extracted relative air charge rl using the integrator constant KISRM, and delivers the standardised air mass in the intake manifold at its output. The integrator is calculated in synchro. This acts like a multiplication of the input variables by the engine speed. If the relative charges are used instead of the air mass flows as input signals, the result obtained at the output is an intake manifold air mass.

With the temperature correction factor ftsr and the value for standard pressure 1013hPa the partial intake manifold pressure of air mass and internal residual gas at a given air mass temperature in the combustion chamber is calculated from the air mass. With an external EGR system, the partial pressure agrp_w, generated by the external EGR, is added on. This produces the total intake manifold pressure, which represents an important intermediate variable for other functions.

With the engine extraction equation rl = (ps - pirg) * fupsrl)*(100%-agrr) the extracted relative air charge rl is calculated from the intake manifold pressure. In this way the relationship between the air charge rl and the intake manifold pressure can be described by a straight line, calculated from the offset pirg and the slope characteristic starting value KFPSURL.
With active exhaust gas recirculation (EGR) the total charge signal rfges is corrected to the relative air charge rl by multiplying-in the EGR rate.

The offset is interpreted as residual gas pirg, which remains in the combustion chamber. The offset is dependent on the engine speed nmot and the overlap angle wnwue at systems with camshaft control. If the camshaft position is between the two extremes of camshaft control, offfset value pirg is calculated by linear interpolation as function of wnwue.

As the ambient pressure falls, the proportion of residual gas falls. The offset is therefore reduced by the altitude factor fho.

The slope of the straight line at standard temperature is also dependent on the engine speed and the overlap angle wnwue at systems with camshaft control. The slope is calculated by the same method as the offset. For calculation of the intake manifold pressure ps to the relative airr charge, the current air temperature in the combustion chamber must additionally be taken into account. This is done using the factor ftbr. The faktor fupsrl = ftbr * KFPSURL takes into account all influences on the slope in translation of pressure into air charge. The factor fupsrl is also provided for other functions.

With an external EGR system the calculation from intake manifold pressure to air charge delivers the total charge rfagr including the EGR portion.
The extracted air mass rl is reduced by the EGR rate agrr. Then: rl = rfagr * (1-agrr).
rl is fed back to the input of the integrator as the extracted air charge. rl is the central variable for calculation of the injection. The extracted air mass flow ml is obtained from the product of engine speed, rl and the constant KUMSRL.

The incorporation of the EGR partial pressure into the intake manifold model allows for calculation of the EGR portion of the combustion chamber charge with the appropriate timing. The associated integrator for simulation of the storage behaviour of the intake manifold referred to the EGR charge is to be found in the function BGAGR.

APP BGSRM 17.30 Application hint

assumptions:
Constant KUMSRL in Funktion BGMSZS must be defined.
Function BGTEMPK is applicated

for application statonary conditions of intake manifold pressure model:
pneumatic filtered measuring of intake manifold pressure.

for application dynamical effects of intake manifold pressure modell:
fast intake manifold pressure measuring (time constant of pressure sensor: <10ms ; sampling rate < 4ms)

appplication data for first steps:

```
               zkorr             z.......number of cylinders:...................................4 - 8
   KISRM = ----------------      VH......engine capacity
             Vs/VH * z           Vs......volume of intake manifold (from throttle blade to inlet valve) ..typ. 1.5 .. 3.0 * VH
                             zkorr...Faktor for correcction................................0.90 at z = 4
                                                                                0.92 at z = 5
                                                                                        0.95 at z = 6
                                                                                                1.00 at z > 6
   example.:  z = 4, Vs/VH = 2.2 -->  KISRM = 0.1023
```

KFPRG = 50 hPa at complet map
KFURL = 0.1 %/hPa at complet map
FPVMXN = 1.20 (disable limitation of intake manifold pressure)

FPVMXN is applicated after KFPU application:
FPVMXN is the measured intake manifold pressure at full opend throttle valve as function of
engine speed corrected by a factor of 1.1.
!!! attention: fpvdk has to correspond with the actual ambient pressure divided by 1013 hPa !!!
if there is a ambient pressure sensor DSUOFS an DSUGRAD must be correct.
if there is a adaptation FPVDKMN and FPVDKMX must be actual ambient pressure divided by 1013 hPa.

application of KFPRG and KFURL:

Measuring of intake manifold pressure ps at steps of 100 hPa, relative air charge rl_w, and ftbr at steps of engine speed nmot and at the two positions of camshaft control represented by the overlap angle wnwue.
The values rl = f(ps) at one engine speed and one camshaft control position are drawing in a diagramm.
Then a regression straight line is calculated for the values. The offset at position rl = 0 divided by fho is the value KFPRG at position nmot, wnwue.
The gradient of the regression straight line divided by a mean value of ftbr is the value KFURL at position nmot,wnwue.

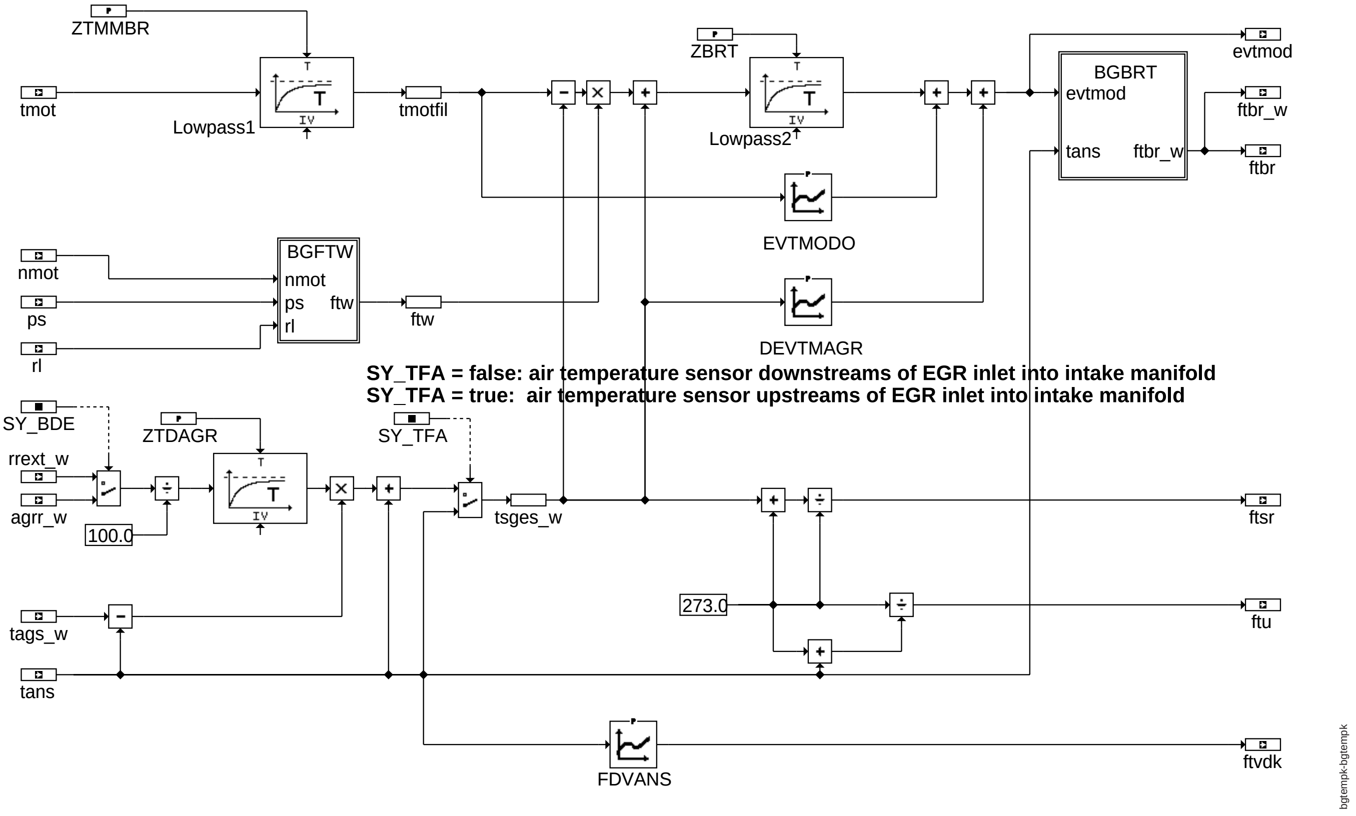
application of intake manifold dynamic:

Measuring of relative air charge (rl_w), intake manifold pressure measured with sensor (psmes) and calculated bei ECU (ps_w) varation of KSIRM, so that the characteristic curves of psmes and ps_w ar conform.

BGTEMPK 10.40 Calculation of temperature compensation for intake manifold model

FDEF BGTEMPK 10.40 Function definition

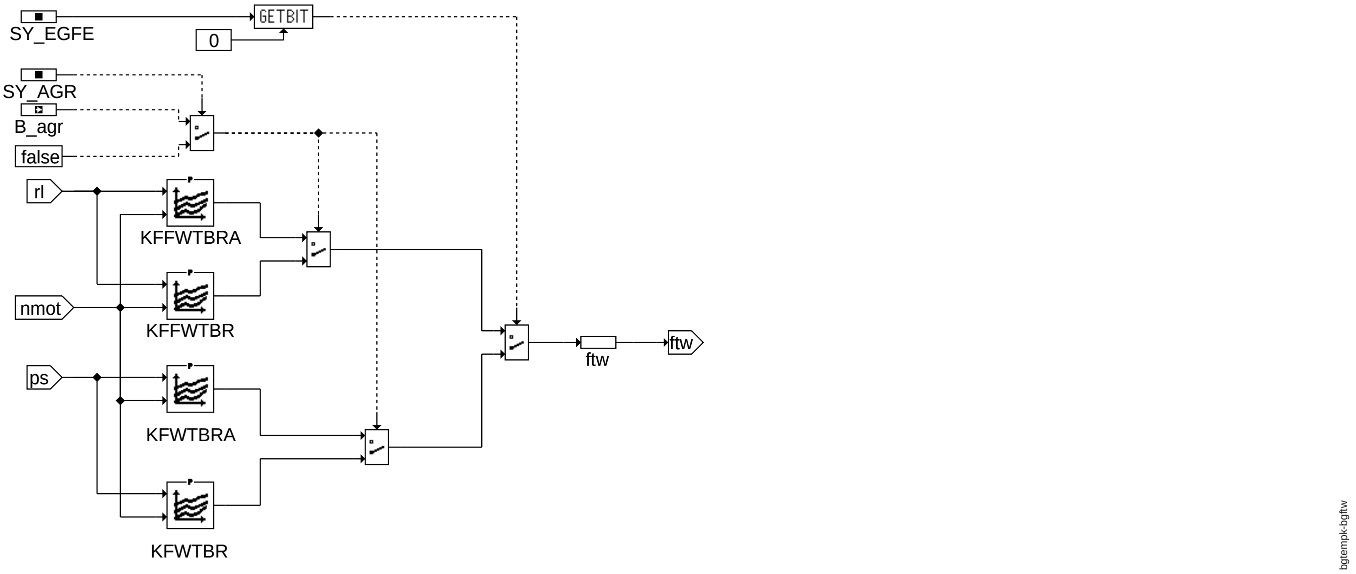
Source: BGTEMPK 10.40



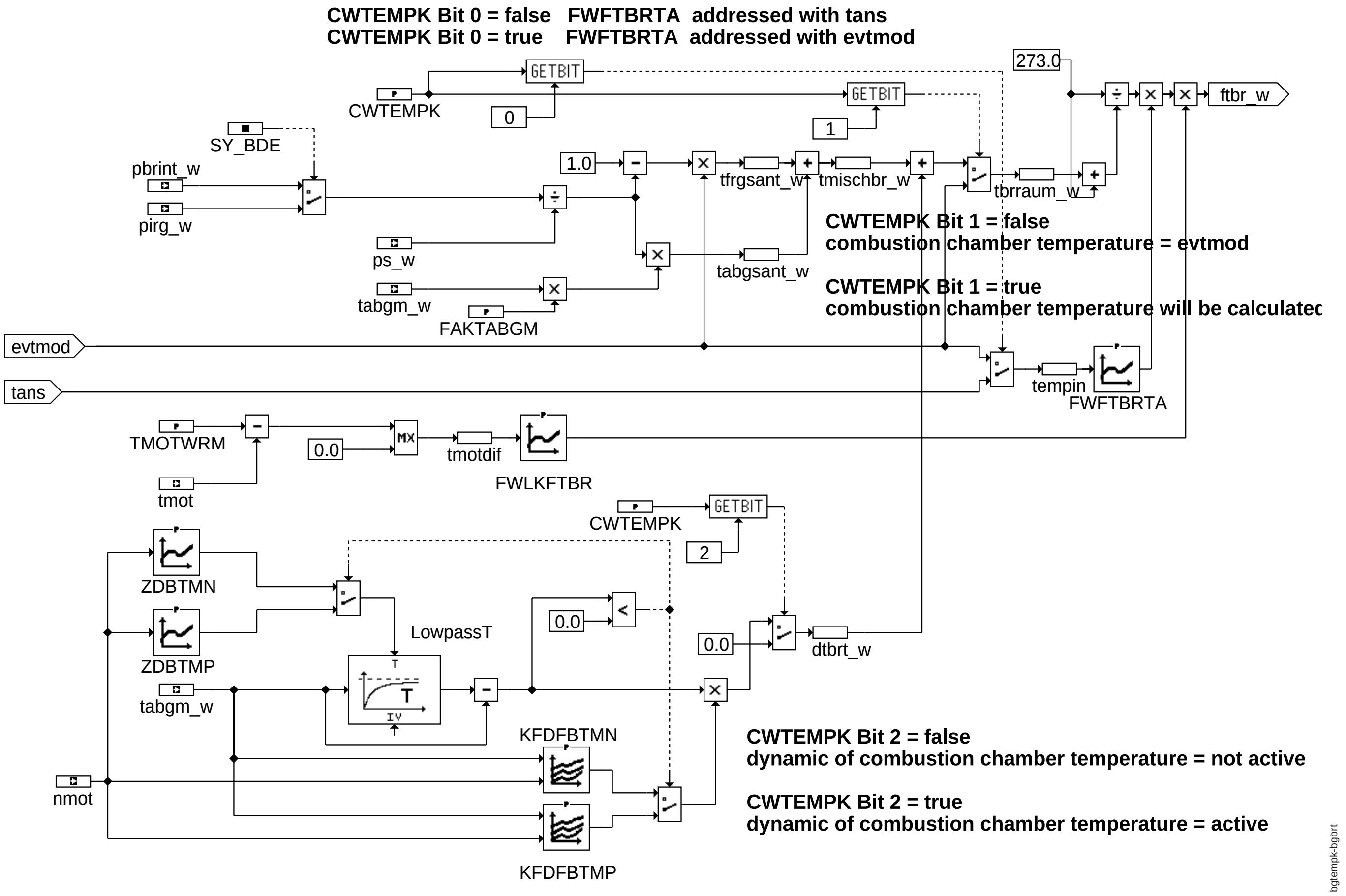
SY_TFA = false: air temperature sensor downstreams of EGR inlet into intake manifold
SY_TFA = true: air temperature sensor upstreams of EGR inlet into intake manifold

bgtempk-bgtempk

SY_EGFE Bit 0 = false ->speed density
SY_EGFE Bit 0 = true -> HFM



bgtempk-bgftw



CWTEMPK Bit 0 = false FWFTBRTA addressed with tans
CWTEMPK Bit 0 = true FWFTBRTA addressed with evtmod

CWTEMPK Bit 1 = false
combustion chamber temperature = evtmod

CWTEMPK Bit 1 = true
combustion chamber temperature will be calculatec

CWTEMPK Bit 2 = false
dynamic of combustion chamber temperature = not active

CWTEMPK Bit 2 = true
dynamic of combustion chamber temperature = active

bgtempk-bgbrt

ABK BGTEMPK 10.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWTEMPK			FW	code word for addressing FWFTBRTA depending on (tans/evtmod)
DEVTMAGR	TSGES_W		KL	offset for evtmod depending on tsges_w at high tans caused by EGR
EVTMODO	TMOTFIL		KL	offset for evtmod depending on filtered engine temperature
FAKTABGM			FW	weigth factor for tabgm (exhaust temp) for calculate stationary combustion cham
FDVANS	TANS		KL	Temperature factor for air at throttle valve
FWFTBRTA	TEMPIN		KL	Weighting for ftbr as a function of tans
FWLKFTBR	TMOTDIF		KL	warm up correction for combustion chamber model
KFDFBTMN	TABGM_W	NMOT	KF	dynamic factor for combustion chamber temperatur model negativ gradient
KFDFBTMP	TABGM_W	NMOT	KF	dynamic factor for combustion chamber temperatur model positiv gradient
KFFWTBR	RL	NMOT	KF	Weighting factor for combustion chamber temperature model
KFFWTBRA	RL	NMOT	KF	Weighting factor for combustion chamber temperature model B_agr=true
KFWTBR	PS	NMOT	KF	Weighting factor Tans/Tmot for combustion chamber temperature model
KFWTBRA	PS	NMOT	KF	Weighting factor Tans/Tmot for combustion chamber temperature model B_agr=true
SY_AGR			SYS (REF)	System constant AGR present
SY_BDE			SYS (REF)	system constant GDI
SY_EGFE			SYS (REF)	system constant input variable for charge detection
SY_TFA			SYS (REF)	configuration for installtion position for intake-air sensor
TMOTWRM			FW	engine temperature for warm engine
ZBRT			FW	time constant for combustion chamber temp. model
ZDBTMN	NMOT		KL	time constant combustion chamber temperatur model for negativ gradient
ZDBTMP	NMOT		KL	time constant combustion chamber temperatur model for positiv gradient
ZTDAGR			FW	time constant for temperature dynamics for EGR add-on - shutdown
ZTMMBR			FW	time constant, engine temperature for combustion chamber temp. model

Variable	Source	Type	Description
AGRR_W	EGFE	EIN	exhaust gas recirculation rate
B_AGR		EIN	Condition AGR active
DTBRT_W	BGTEMPK	LOK	combustion chamber temperature dynamik part
EVTMOD	BGTEMPK	AUS	modelled temperature at inlet valve
FTBR	BGTEMPK	AUS	factor: temperature correction in combustion chamber
FTBR_W	BGTEMPK	AUS	factor: temperature correction in combustion chamber
FTSR	BGTEMPK	AUS	correction factor for air temperature in the manifold
FTU	BGTEMPK	AUS	factor: ambient temperature
FTVDK	BGTEMPK	AUS	correction factor for temperature upstream of throttle valve
FTW	BGTEMPK	LOK	factor weighting of temperature tmot, tans
NMOT	SWADAP	EIN	engine speed

Variable	Source	Type	Description
PBRINT_W		EIN	Partial pressure (inert gas + air) in combustion compart through internal EGR
PIRG_W	EGFE	EIN	partial pressure residual exhaust gas internal EGR (16-Bit)
PS		EIN	intake manifold pressure (absolute)
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
RL	SWADAP	EIN	relative air charge
RREXT_W		EIN	Residual-gas rate (inert gas + air) over external EGR
TABGM_W	ATM	EIN	Exhaust gas temperature in front of the catalyzer from model (Word)
TABGSANT_W	BGTEMPK	LOK	statinary combustion chamber temperature evoked via Inertgas
TAGS_W	EGFE	EIN	EGR temperature on introduction into intake manifold
TANS	SWADAP	EIN	Intake air temperature
TBRRAUM_W	BGTEMPK	LOK	total combustion chamber temperature stationary and dynamik part
TEMPIN	BGTEMPK	LOK	temperature input (addressing from FWFTBRTA)
TFRGSANT_W	BGTEMPK	LOK	stationary combustion chamber temperature evoked via fresh air
TMISCHBR_W	BGTEMPK	LOK	stationary combustion chamber temperature
TMOT	SWADAP	EIN	Engine temperature
TMOTDIF	BGTEMPK	LOK	difference from actuel engine temperature to warm engine temperature
TMOTFIL	BGTEMPK	LOK	filtered engine temperature
TSGES_W	BGTEMPK	LOK	intake mainfold temp. (after EGR introduction)

FW BGTEMPK 10.40 Fixed Values

Parameter	Value	Description
CWTEMPK		code word for addressing FWFTBRTA depending on (tans/evtmod)
FAKTABGM		weigth factor for tabgm (exhaust temp) for calculate stationary combustion cham
TMOTWRM		engine temperature for warm engine
ZBRT		time constant for combustion chamber temp. model
ZTDAGR		time constant for temperature dynamics for EGR add-on - shutdown
ZTMMBR		time constant, engine temperature for combustion chamber temp. model

FB BGTEMPK 10.40 Detailed description of function

This temperature compensation supplies the combustion-chamber temperature factor (ftbr) at the output. This is used for the conversion from intake-manifold pressure to air mass. The general gas equation p*V = m*R*T gives the relationship between the pressure P and air mass m. V is the volume, R the property of the air (air factor = isentropic exponent) and T corresponds to the air temperature.
The intake-air temperature sensor is usually mounted in the air filter container or in the intake manifold. In order to take both constellations occurring in practice into account, allowance for the location of the intake air temperature sensor is accordingly made by the system byte SY_TFA. The rise in temperature due to the mass flow from the exhaust-gas recirculation (EGR) flow is automatically measured as well if the temperature sensor is mounted downstream of the point of introduction.
In this case, the data assignment for the parameter SY_TFA, as defined in the %PROKON function, must be set to false.
If the temperature sensor is mounted upstream of the intake point (e.g. it is in the air filter container) without any consideration for the EGR rate, then the same intake-air temperature would be always be measured irrespective of whether this is with or without EGR. Entering SY_TFA = true in %PROKON means that, depending on the EGR rate, the modeled intake temperature is added to the temperature measured at the point of introduction. This then corresponds to the temperature modeled for the mixed gas (after intake by the EGR system).
The temperature needed for the calculation is however the temperature of the air in the combustion chamber. A fresh-gas temperature equivalent to the temperature near to the inlet valve is formed using the temperature model. Though the modeled fresh-gas temperature can assume different values in the process here depending on the air flow ratio rl, the modeled temperature, evtmod, will however always lie between the engine temperature and the intake-air temperature for weighting factors ftw <= 1.
If it applies for the weighting factor that ftw > 1, then the modeled temperature evtmod is greater than tmot. The map KKWTBR weights the difference between tmot and tans (tmotfil - tsges).
The low pass in the TMOT branch prevents the modeled air temperature from increasing too quickly during engine warm-up.
Adjustment to a new thermal equilibrium (air temperature close to the inlet valve) for load changes occurs within seconds.

The second low pass with the time constant ZBRT takes this into account and prevents any abrupt change in the modeled air temperature in the event of a sudden change in the load.
In systems with EGR, the EGR rate is adjusted by a low-pass filter (ZTDAGR) such that the inclusion of the modeled intake temperature into the intake manifold, tags, will dynamically correspond to reality and that this will not take place abruptly.
The modeled intake-air temperature is converted into Kelvin. Scaling is based on 273 Kelvin (0 degrees Celsius). A combustion-chamber temperature factor (ftbr) is made available at the output for further charging-detection calculations.
The temperature factor ftsr is used for the conversion of air mass to intake-manifold pressure.
The temperature factor ftu is used to convert the charge-air mass to a charge-air pressure during boost-pressure control.
A root tnorm/tans value is made available in the characteristic curve FDVANS to calculate the mass flowing over the throttle valve.
The combustion chamber temperature factor, ftbr, is corrected by multiplication with the characteristic curve FWFTBRTA.
Addressing the characteristic can be either by the code word CWTEMPK, bit 0 = false, intake-air temperature (tans) or by CWTEMPK, bit 0 = true, the modeled temperature, evtmod, at the inlet valve.
Notes on the correct selection for addressing can be found in the application hints given in this FDEF.
A differentiation is made in the system configuration SY_EGFE between HFM-based or pressure-based charging detection (KFWTBR and KFFWTBR respectively). The value for SY_EGFE is defined in %PROKON and is hardware-dependent.
In pressure systems with EGR, a switchover to the weighting map KFWTBRA is made when B_agr = true. In HFM systems with EGR, switchover is made to the map KFFWTBRA when B_agr = true. Using the characteristic FWLKFTBR, the combustion-chamber temperature factor ftbr can be adjusted by multiplication as a function of the difference between TMOTWRM and the current engine temperature (during warm-running).

A further feature is the steady-state calculation of the combustion-chamber temperature in that CWTEMPK, bit 1 = true takes the mixing ratio into consideration both for the fresh gas and residual gas in the combustion chamber as well as for the gas temperature. The exhaust-gas temperature, tabgm, shall be applied before activating this steady-state calculation of the combustion-chamber temperature. evtmod is taken as the steady-state combustion-chamber temperature when bit 1 = false in the code word CWTEMPK. A dynamic portion from the RAM cell dtbrt is then added to the steady-state portion of ftbr.
This sub-function should only be activated by bit 2 = true of the code word CWTEMPK for a pressure-based charging detection.
Any transitional compensation is to be deactivated. Subsequent adjustment of dtbrt for different loads and speeds is such that lambda deviations due to load changes are as close to 1 as possible.
The time constant for the differentiator is ZDBTMN. The height of the jump can be adjusted using KFDFBTMN for a negative gradient of tabgm (positive load change). In this context, the same applies for ZDBTMP and KFDFBTMP for a positive gradient of tabgm (negative load change). An adjustment can also be made by multiplication with the characteristic curve FWLKFTBR as a function of the difference between the current tmot and TMOTWRM of the ftbr. A data assignment deviating from the neutral value becomes necessary if, although the ratio for the modeled to the measured intake-manifold pressure is OK for an engine warm from operation, larger differences occur between the modeled and the measured intake-manifold pressure during warm-running.

APP BGTEMPK 10.40 Application hint

A thermocouple shall be installed in the intake manifold close to the inlet valve for application of the temperature model.
This is necessary in order to adjust the model temperature at the output of the low pass filter with the time constant ZBRT to the temperature of the intake manifold. Attention is to be paid here that the thermocouple is mounted such that its tip is in the middle of the manifold cross-section. This is to prevent radiant heat from non-permissible falsification of the measurement result.
The adjustment of map KFFWTBR is performed at the datapoints defined for nmot and rl (nmot and ps for pressure-based systems).
Entering the weighting factor in the map KFFWTBR for an engine warm from operation and for the different air-flow rates (rl or ps) is such that the model temperature evtmod agrees with the temperature as measured by the thermocouple.
The time constant ZBRT shall be chosen such that for a load change, the newly adjusted model temperature changes at the same time as the intake-air temperature is measured at the thermocouple. In practice, measurements need to be performed for different jumps in the load and at several engine speeds. A mean value for ZBRT is then to be chosen from the thereby determined time constants.
The time constant ZTMMBR can only be checked while the engine is still warm from operation, whereby adjustment of the time constant is shall be adjusted such that the model temperature agrees with the air temperature actually measured (thermocouple) for the previously matched weighting map KFFWTBR. Several warm-up runs are normally necessary to adjust the time constant.
The time constant ZTDAGR shall be adjusted to give the best dynamic agreement at the different EGR rates for the modeled inlet-air temperature, tags, with the true inlet-air temperature as measured by the thermocouple.
Attention shall be paid in systems with EGR that a switchover to KFFWTBRA or KFWTBRA respectively is made when B_agr = true.
The data assignment has to be the same for KFWTBR and KFWTBRA if there is no difference between systems with EGR and systems without EGR.

If during warming-up, a value for evtmod is measured that is higher than the engine temperature, tmot, then, depending on the engine

temperature, an engine-temperature offset can be added to this from the characteristic curve EVTMODO. This allows evtmod's during engine warm-up that are higher than tmot. The offset must be 0 for an engine already warm from running.
Temperatures at the inlet valve higher than tmot can be attributable to e.g a larger valve overlap. Basic data assignment shall be neutral with 0 deg.
The characteristic curve is activated at very high intake-air temperatures tans > tmot. This can occur during active EGR at high engine speeds and high EGR rates for example. Activating the characteristic curve can also show model temperatures (evtmod) that are higher than tmot or tans. Without EGR, the data assignment for the characteristic curve shall be neutral.
By changing the quantization of the maps KFFWTBR and KFWTBR from the previous 0...1 to 0...2 (new), evtmod temperatures higher than tmot are possible as well.

Values for initial application

KFFWTBR	Turbo engine 0, aspirating engine 0.2 (factor > 1 --> evtmod = > as tmot)
KFWTBR	Turbo engine 0, aspirating engine 0.2 (factor > 1 --> evtmod = > as tmot)
KFFWTBRA	Turbo engine 0, aspirating engine 0.2 (factor > 1 --> evtmod = > as tmot)
KFWTBRA	Turbo engine 0, aspirating engine 0.2 (factor > 1 --> evtmod = > as tmot)

Assign data for weighting factors KFWTBR and KFFWTBR at nmot = 0 and rl = 100% (for key ON = Terminal 15 on) as for idling.
Data assignment for difference between ftw Kl.15 (key ON) and engine's idle speed shall be as small as possible.

KFDFBTMN

nmot v / tabgm_w--->	0	200	400	600	800	1000
800	0.2	0.2	0.2	0.2	0.2	0.2
1000	0.1	0.1	0.1	0.1	0.1	0.1
1500	0.1	0.1	0.1	0.1	0.1	0.1
2000	0.1	0.1	0.1	0.1	0.1	0.1
2500	0.1	0.1	0.1	0.1	0.1	0.1
3000	0.2	0.2	0.2	0.2	0.2	0.2
3500	0.2	0.2	0.2	0.2	0.2	0.2
4000	0.0	0.0	0.0	0.0	0.0	0.0

KFDFBTMP

nmot v / tabgm_w--->	0	200	400	600	800	1000
800	0.7	0.7	0.7	0.7	0.7	0.7
1000	0.7	0.7	0.7	0.7	0.7	0.7
1500	0.7	0.7	0.7	0.7	0.7	0.7
2000	0.7	0.7	0.7	0.7	0.7	0.7
2500	0.7	0.7	0.7	0.7	0.7	0.7
3000	0.7	0.7	0.7	0.7	0.7	0.7
3500	0.0	0.0	0.0	0.0	0.0	0.0
4000	0.0	0.0	0.0	0.0	0.0	0.0

ZDBTMN nmot --->	800	1000	1500	2000	2500	3000	3500	4000
	2.0	7.0	5.0	3.0	1.0	2.0	1.0	0.1
ZDBTMP nmot --->	800	1000	1500	2000	2500	3000	3500	4000
	0.8	2.0	0.7	0.5	0.2	0.2	0.1	0.1

FAKTABGM 1 Weighting factor tabgm (modeled exhaust-gas temperature)

FWLKFTBR 1 1 = Neutral data assignment (warm-up not corrected) = basic data assignment

TMOTWRM 90 degrees Celsius (basic data assignment value)

CWTEMPK

Bit 0 = false	FWFTBRTA addressed with tans
Bit 0 = true	FWFTBRTA addressed with evtmod (recommended)
Bit 1 = false	Stationary determination of combustion-chamber temperature not active (recommended)
Bit 1 = true	Stationary determination of combustion-chamber temperature active
Bit 2 = false	Dynamic calculation of combustion-chamber temperature not active (recommended)
Bit 2 = true	Dynamic calculation of combustion-chamber temperature active (activate only for pressure systems)

ZTMMBR	approx. 300 sec
ZBRT	approx. 2 - 5 sec
FDVANS	see table below
ZTDAGR	approx. 10 sec
FWFTBRTA	!!!!!! Attention: Carefully read notes on data assignment!!!!!!
EVTMODO	Basic data assignment neutral shall be with 0 degrees If during warm-up, an evtmod is measured that is greater than the engine temperature tmot, then, depending on the engine temperature, an engine-temperature offset can be added to this from the characteristic curve EVTMODO. Thus evtmot's higher than tmot are possible during engine warm-up. The offset must be 0 for an engine already warm from running. Temperatures at the inlet valve higher than tmot can be attributable to e.g. a larger valve overlap.

DEVTMAGR — Basic data assignment shall be neutral with 0 deg.
The characteristic curve is activated at very high intake-air temperatures tans > tmot.
This can occur in active EGR at high engine speeds and high EGR rates for example.
Activating the characteristic curve can sho model temperatures (evtmod) that are higher than
tmot or tans. Without EGR, the data assignment for the characteristic curve shall be neutral.

The intake-air temperature correction is stored as factor in the characteristic curve FDVANS. It is addressed with tans [°C].
This characteristic curve is needed to correct the density at the throttle valves.

```
                  ---------------
        FDVANS = V  T0[k]/TANS[k]     Base temperature T0 is 0 °C = 273 K, i.e. ftans (0 °C) = 1.0
```

Characteristic curve with 8 datapoints to be used for the intake-air temperature:

TANS	-40	-20	0	20	30	40	50	80
FDVANS	1.0824	1.0388	1.0	0.9653	0.9492	0.9339	0.9194	0.8794

FWFTBRTA — Data assignment for initial application of BGTEMPK with " root characteristic FWFTBRTA".
For tans = 0 deg. C, assign 1.0 as data (neutral) for FWFTBRATA.
Addressing FWFTBRTA shall be via evtmod for a new BGTEMPK application.
That means the code word CWTEMPK must be = 1.

```
                     ---------------
        FWFTBRTA  = V  TANS[K]/T0[K]     Base temperature T0 is 0 °C = 273 K, i.e. ftans (0 °C) = 1.0
```

Characteristic curve with 14 datapoints to be used for modeled air temperature near to the inlet valve:

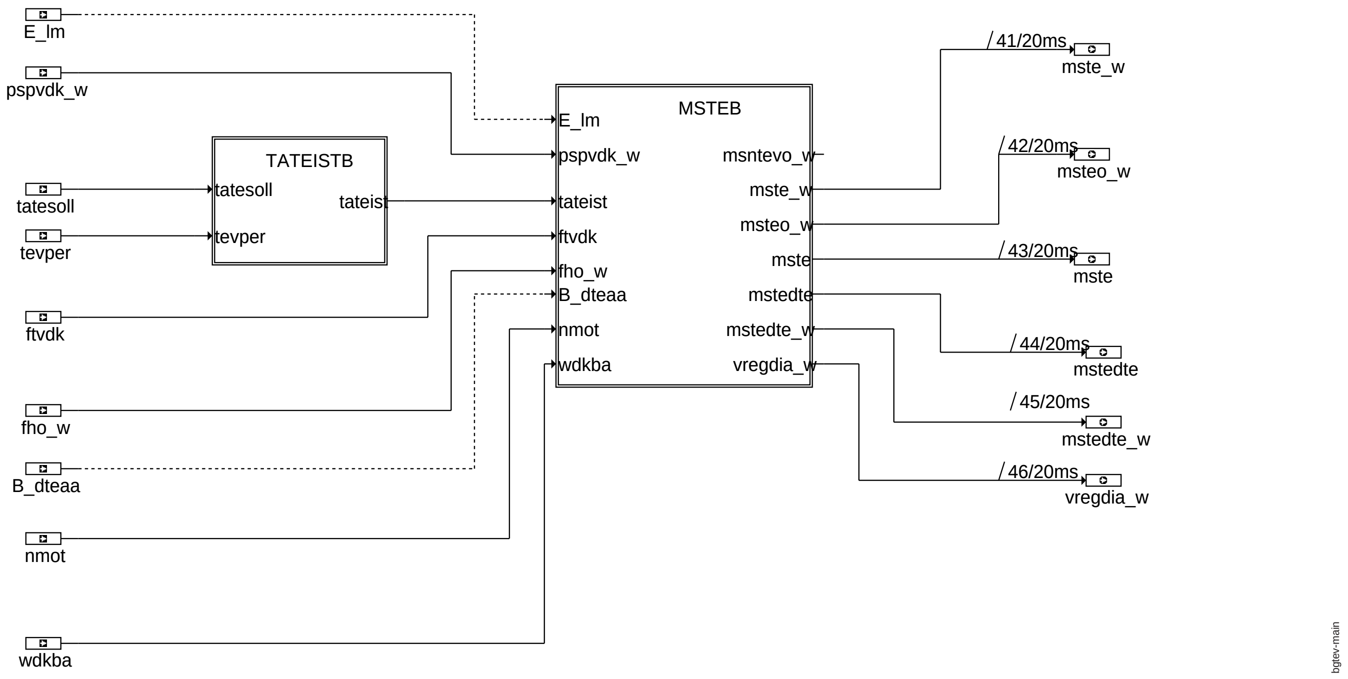
EVTMOD	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90
FWFTBRTA	0.923	0.943	0.962	0.981	1.0	1.018	1.034	1.053	1.072	1.087	1.104	1.12	1.137	1.153

!!!! ATTENTION APPLICATION ENGINEERS !!!!!
If the initial charging-detection application was performed without the root characteristic FWFTBRTA and adjustment was subsequently made for a cold start or for UK-SEFI, then the data assignment shall be 1.0 for the entire corrective characteristic curve FWFTBRTA.
If the basic application was performed with the BGTEMPK 9.10 then the data assignment for the code word CWTEMPK shall be 1.0 because FWFTBRTA was addressed with tans in this FDEF.

BGTEV 1.70 Calculation variable, mass flow TEV

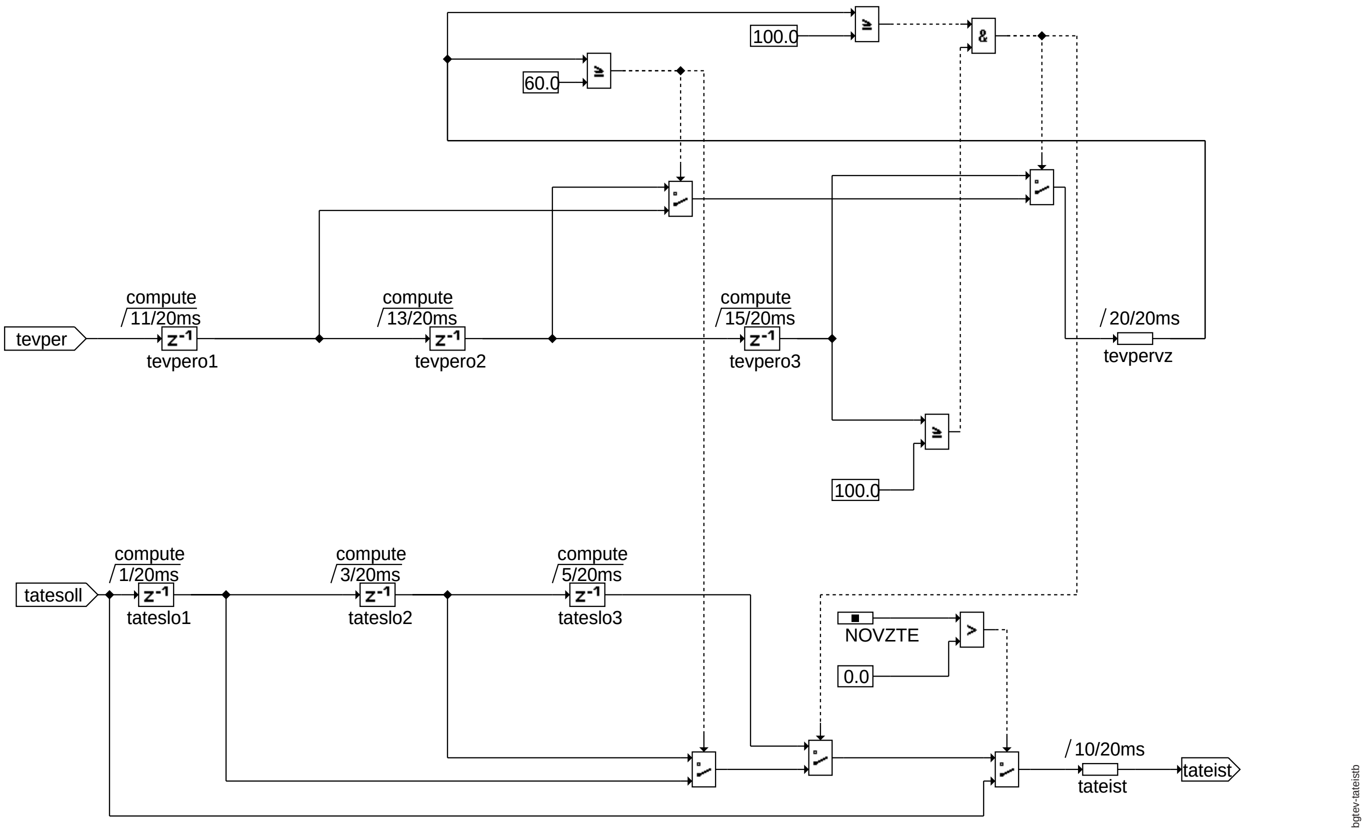
FDEF BGTEV 1.70 Function definition

BGTEV: Function BGTEV:



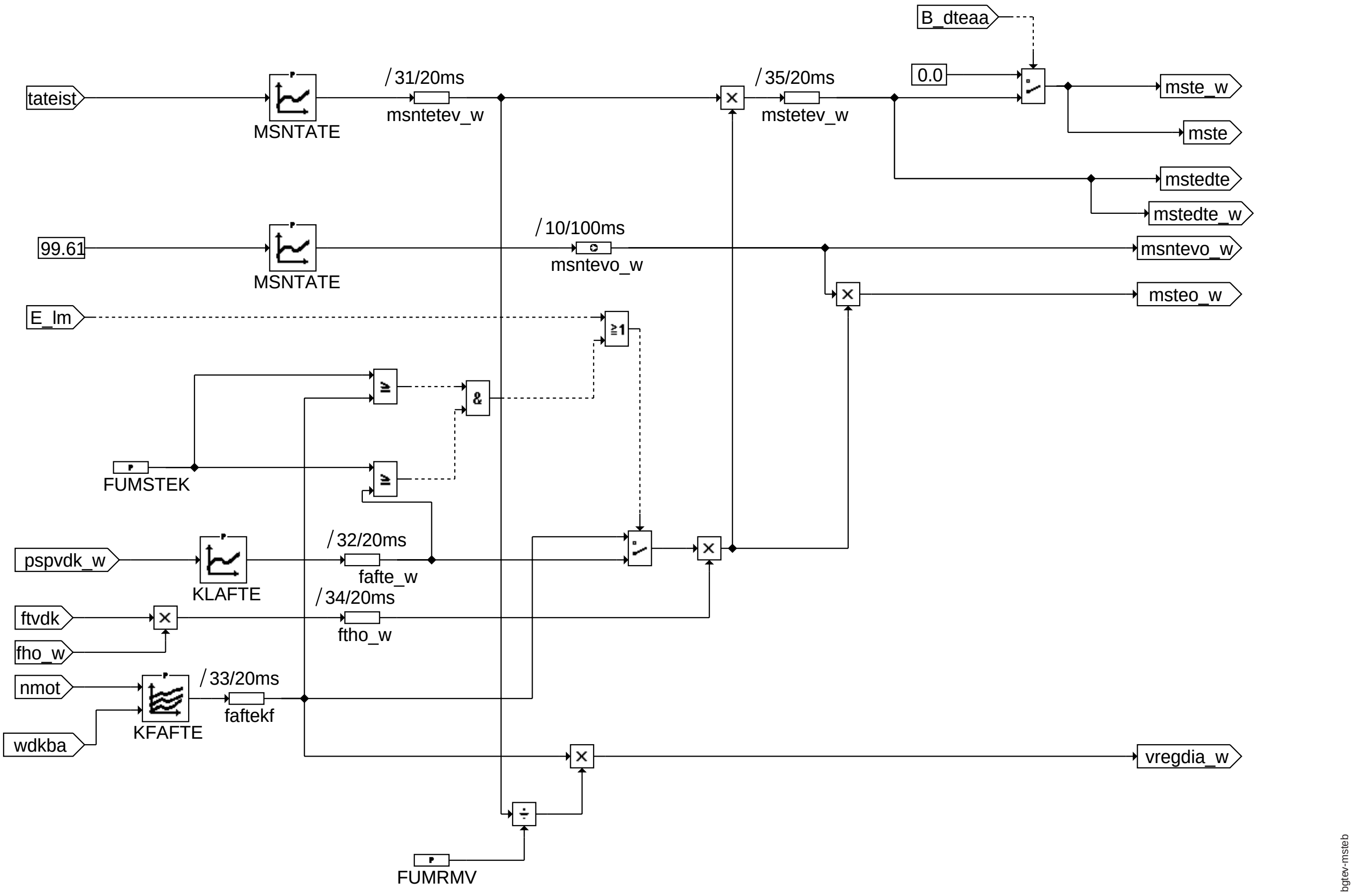
bgtev-main

`TATEISTB: Function part  TATEISTB - Calculation of the actual duty cycle:`



bgtev-tateistb

MSTEB: Function part MSTEB - Calculation of the PCV mass flow:



bgtev-msteb

ABK BGTEV 1.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FUMRMV			FW	factor for density of the air
FUMSTEK			FW	factor for switching over to map-calculation of the mass-flow through the PCV
KFAFTE	NMOT	WDKBA	KF	map flow-characteristic of PCV (incl. PCV carcoal-canister line)
KLAFTE	PSPVDK_W		KL	characteristic of Saint-Venant of purge control valve an line AKF-TEV
MSNTATE	TATEIST		KL	Characteristic standardized mass flow through TEV
NOVZTE			FW	code word for desired duty cycle not delay

Variable	Source	Type	Description
B_DTEAA	DTEV	EIN	Condition diagnosis CPV by opening the CPV active
C_INI	SWADAP	EIN	ECU-condition for intialisation
E_LM	EGFE	EIN	Error flag: main load sensor
FAFTEKF	BGTEV	LOK	factor flow through PCV: value from characteristic map
FAFTE_W	BGTEV	LOK	factor flow through PCV
FHO_W	BGPU	EIN	correction factor: altitude
FTHO_W	BGTEV	LOK	factor temperature and altitude depending correction of mass flow
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
MSNTETEV_W	BGTEV	LOK	normalized mass flow PCV (16 bit)
MSNTEVO_W	BGTEV	AUS	normalized mass flow through the complete open PCV
MSTE	BGTEV	AUS	mass flow purge control into the manifold
MSTEDTE	BGTEV	AUS	purge mass flow for DTEV
MSTEDTE_W	BGTEV	AUS	purge mass flow for DTEV (word)
MSTEO_W	BGTEV	AUS	Mass flow the 100 % opened TEV
MSTETEV_W	BGTEV	LOK	mass flow through the purge control valve
MSTE_W	BGTEV	AUS	mass flow purge control into the manifold
NMOT	SWADAP	EIN	engine speed
PSPVDK_W	EGFE	EIN	quotient: int.manif.pressure divided by pressure upstream of throttle valve
R_T20		EIN	Time schedule 20 ms
TATEIST	BGTEV	LOK	actual duty-cycle of the PCV
TATESLO1	BGTEV	LOK	desired durty cycle of the PVC (delay of one calculation frame)
TATESLO2	BGTEV	LOK	desired durty cycle of the PVC (delay of two calculation frames)
TATESLO3	BGTEV	LOK	desired durty cycle of the PVC (delay of three calculation frames)
TATESOLL	GKRA	EIN	desired duty cycle of the PCV
TEVPER	ATEV	EIN	periode time of purge control valve
TEVPERO1	BGTEV	LOK	periode time of purge control valve delay of one calculation frame
TEVPERO2	BGTEV	LOK	periode time of purge control valve delay of two calculation frames

Variable	Source	Type	Description
TEVPERO3	BGTEV	LOK	periode time of purge control valve delay of three calculation frames
TEVPERVZ	BGTEV	LOK	delayed period time of the PCV
VREGDIA_W	BGTEV	AUS	gas volume flow through the purge control valve: for fuel tank diagnosis
WDKBA	GGDVE	EIN	throttle angle

FW BGTEV 1.70 Fixed Values

Parameter	Value	Description
FUMRMV		factor for density of the air
FUMSTEK		factor for switching over to map-calculation of the mass-flow through the PCV
NOVZTE		code word for desired duty cycle not delay

FB BGTEV 1.70 Detailed description of function

```
 Introduction:
 -------------
```

The section BGTEV calculates the mass flow (mste resp. mste_w) which flows into the intake manifold via the purge control valve (PCV). Mste is included in the calculation in the load acquisition as additional air charge. In the canister purge control function mste_w is needed for the later calculation of the ti-correction (rkte_w). Furthermore the possible volume flow through a fully opened valve is needed (msteo_w) for the canister purge control function.

For the canister diagnosis a value of the volume flow PCV is needed which is independent of HFM tolerances. This value is also formed in BGTEV (vregdia_w). Vregdia_w is the product from the standardized mass flow PCV in the over-critical (msntetev) with the output value of a characteristic map over engine speed and throttle valve angle (KFAFTE) divided by the density of air (FUMRMV).

It is assumed that pure air flows through the PCV. In case of charged activated carbon filter, therefore, the HC molecules which flow through the PCV are considered just like air molecules. The thus resulting charge error can, however, be neglected when taking into consideration that at the max. only approx. 1/46 of the entire volume flow flowing into the intake manifold can consist of fuel particles. So in the extreme case (HC-conc. = 1) a charge error of approx. 2% at 50% fuel proportion canister purge control is obtained.

```
 Calculation of the actual duty cycle on the PCV (tateist):
 ----------------------------------------------------------
```

For the calcualtion of the mass flow through the purge control valve at first the "current, actual" duty cycle at the PCV must be calculated. For this it is assumed that the PCV-timer takes over the desired duty cycle in the mean delayed by half a period. With the thus delayed duty cycle (tateist) the current mass flow mste_w is calculated.

Example: The PCV closes (resp. opens) e.g. at decreasing load (increasing load) with a period of 120 ms in the mean 60 ms later than is demanded by the requirement (tatesoll). By the delay by 60 ms tateist takes into consideration the mean "retarding" of the PCV.

```
80% --------------+
50%               |     signal tatesoll                                   +--------------------
10%               +----------------------------------------------------------------------+

80%  -----------------------+
50%                         |   signal tateist                            |<60 ms->+------------
10%                         +---------------------------------------------------------------------+
                  |<-60 ms->|

80%  |-------------------+
50%   <--  120 ms     -->|      actually given out duty cycle                        +--------
10%                      +-------------------|-------------------|--------------------|-------------------+
                         |<--    120 ms   --> <--     120 ms  --> <--    120 ms  ---> <--   120 ms    -->
```

Example for the calculated delay of the signal tateist and for the actually given out duty cycle Tatesoll

The calculation of tateist in detail:

The duty cycle tatesoll as well as the period are stored delayed up to 3-times (in the 20 ms grid) as a RAM-cell.

Remark: Apart from values for the duty cycle also values for the period need to be stored in order to be able to take into consideration that the PCV-timer each time processes the period transfered in the past and thus a change from a large period to a small period can only be taken over after the large period has passed.

The variable delayed period (tevpervz) is inquired upon:

- if tevpervz < 60 ms then the value of tevper (tevper(-1)) delayed by only one calculation cycle is used
- if tevpervz >= 60 ms but also <= 100 ms then the value of tevper (tevper(-2)) delayed by two calculation cycles is used
- if tevpervz >= 100 ms and at the same time also tevper(-3) >= 100 ms then tevper(-3) is used.
  This additional And-inquiry is necessary so that in case of a period jump from e.g. tevper = 30 ms to tevper = 120 ms at first after one calculation cycle the 120 ms, but then again the 30 ms are given for a calculation cycle as delayed duty cycle tevpervz.

For the calculation of the delayed duty cycle it is now only necessary to give the selection conditions for the period also to the switches for the selection of the corresponding 1-,2-,3-times delayed duty cycle. Thus the value for tateist can be obtained from tatesoll.
Important: The switch is operated only after the calculation of tateist.

With the codeword "NOVZTE" the delay of tatesoll can be switched off.

Calculation of the mass flow into the intake manifold (mste_w):

Principally two different calculation types for the mass flow through the purge control valve must be distinguished:

a) The calculation derived from the KLAFTE - characteristic line
b) The calculation derived from a characteristic map KFAFTE over the engine speed and the throttle valve angle

to a) The mass flow through a valve depends on the quotient of the pressures ps_w/pvdk_w = pspvdk_w. Because of the long pipes there is needed a special KLAFTE for the PCV flow.

to b) It cannot be ruled out that while being at full load ps_w/pvdk_w is silghtly wrong. That causes big deviations in mste_w if the KLAFTE is still used for calculation. Furthermore local small vacuums can occur (Bernoulli) due to flow effects on the PCV. Here it may be necesseray to switch-over to an adjusted characteristic map value. In the characterisic map KFAFTE (characteristic map outflow purge control valve) the actually measured values of the mass flow through the PCV (incl. pipe) must be stored pressure- and altitude-corrected and divided by MSNTATE. So to speak KFAFTE contains the individual flow rate characteristics for PCV and pipe. KFAFTE has just as KLAF values between 0 and 1.0. So as to obtain a harmonic quantization with fafte_w the value range, however, is [0... < 2].

Remark: The mass flow at given external temperature and at given pressure can be measured by means of a "mass flow meter". With this and from the determined characteristic line (MSNTATE) the values of the individual flow rate function PCV + pipe can be calculated.

KFAFTE = mstetev_measured / MSNTATE / (ftho_w)

- ftho_w = correction temperature = SQRT (273 K / tans)   and correction pressure   = pu / 1013 hPa

The change-over from the value determined under a) and the value determined under b) is performed as soon as the KLAFTE as well as once the characteristic map value from KFAFTE lies below the threshold FUMSTEK.

Thus it is achieved that close to full load the characteristic map value is given out. However, in case of lower intake manifold pressures the value calculated from the HFM-signal which is also correct with regard to dynamics is used.

With B_dteaa = TRUE the mass flow mste_w is set Zero to switch off the consideration of the purge mass flow in the complete system. (load detection, throttle activation, purge control function). This is important for the diagnosis of the purge valve, because the effect of valve opening should cause a reaction in the system (idle control closes the throttle, Lambda controller corrects Lambda deviation).

Examples from the application (MSNTATE and KLAFTE) - Taking into consideration the flow resistance of the pipe "ACF-PCV":

Duty cycle-dependent correction:

By the freely adjustable opening characteristic MSNTATE any PCV-characteristic line can be taken into consideration. In addition it can be considered that with a high flow resistance of the pipes and of the ACF also in case of a linear characteristic of the PCV a curved characteristic line msntetev_w = f(tate) is obtained.

Example for MSNTATE for a PCV with mass flow 5.5 kg/h (without pipe, without ACF) and 3.5 kg/h with ACF and pipe

```
    MSNTATE
       ^
  5.5  |                                       -
       |
5 kg/h+
       |                                  -
       |
       |                               -
       |                                                               ++++   characteristic line PCV with pipe and PCV
4 kg/h -                           -                                   ----   characteristic line only PCV
       |
  3.5  |                        -              +
       |                                  +
3 kg/h -                    -         +
       |                          +
       |                 -    +
       |                   +
2 kg/h -             -  +
       |             +
       |          +
       |        +
1 kg/h -      +
       |
       |   +
       |
       +---+---+---+---+---+---+---+---+---+---+-->  tateist
       0      20      40      60      80      100%
```

Example of a characteristic line MSNTATE (correction is dependent on duty cycle).
Characteristic line measured at very low intake manifold pressure (ps/pu < 0.3)

From this example it becomes obvious:

- The pipe upstream of the PCV and the ACF markedly reduce the mass flow (5.5 kg/h -> 3.5 kg/h)
- The linear characteristic line over the duty cycle becomes curved.

Example for the KLAFTE:

```
    KLAFTE
       ^
       |
       |
       |                                                               ++++  KLAFTE short line, normal PCV
1.00   -+*# + # + # + # +  + #                                         ****  KLAFTE long line, normal PCV
       |             *           +   #                                 ####  KLAFTE short line, Laval-PCV
       |                   *             #
       |                               +
0.75   -                       *
       |                                   #
       |                                  +
       |                           *
0.50   -                                    #
       |                             xxxxxxxxxxx    <- lower application limit of KLAFTE: 0.45  !!!!
       |                                               for higher pspvdk_w the map KFAFTE is used => FUMSTEK = 0.46 !!
       |                               *     #
0.25   -
       |                                  *  +
       |
       |                                     *
       +---+---+---+---+---+---+---+---+---+---+-->  pspvdk_w
       0      0.2             0.6             1.0
```

After having selected the best value of the flow rate characteristic (faftekf or fafte_w) for the corresponding operating state the selected value is corrected with regard to altitude and pressure (multiplication by ftho_w). The thus corrected value is multiplied by msntetev_w. The duty cycle-dependent mass flow through the PCV is obtained.

In a later version of the BGTEV also the pipe PCV-intake manifold can be taken into consideration (storage effect).

In this BGTEV mstetev_w is identical to the output value mste_w.

Apart from the current flow rate also the flow rate through the fully opened PCV is needed in the TEB. Msteo_w is calculated from MSTATE if 100% (resp. 99.61% = FF HEX) is assumed as input.

APP BGTEV 1.70 Application hint

Values for the "initial application":

- FUMSTEK = 0.46
- FUMRMV = 1.3
- MSNTATE - base points/ values

0	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	100	[%]
0	0.634	1.269	1.903	2.537	3.1718	3.80664	4.441	5.07500	5.72	[kg/h]

KFAFTE:

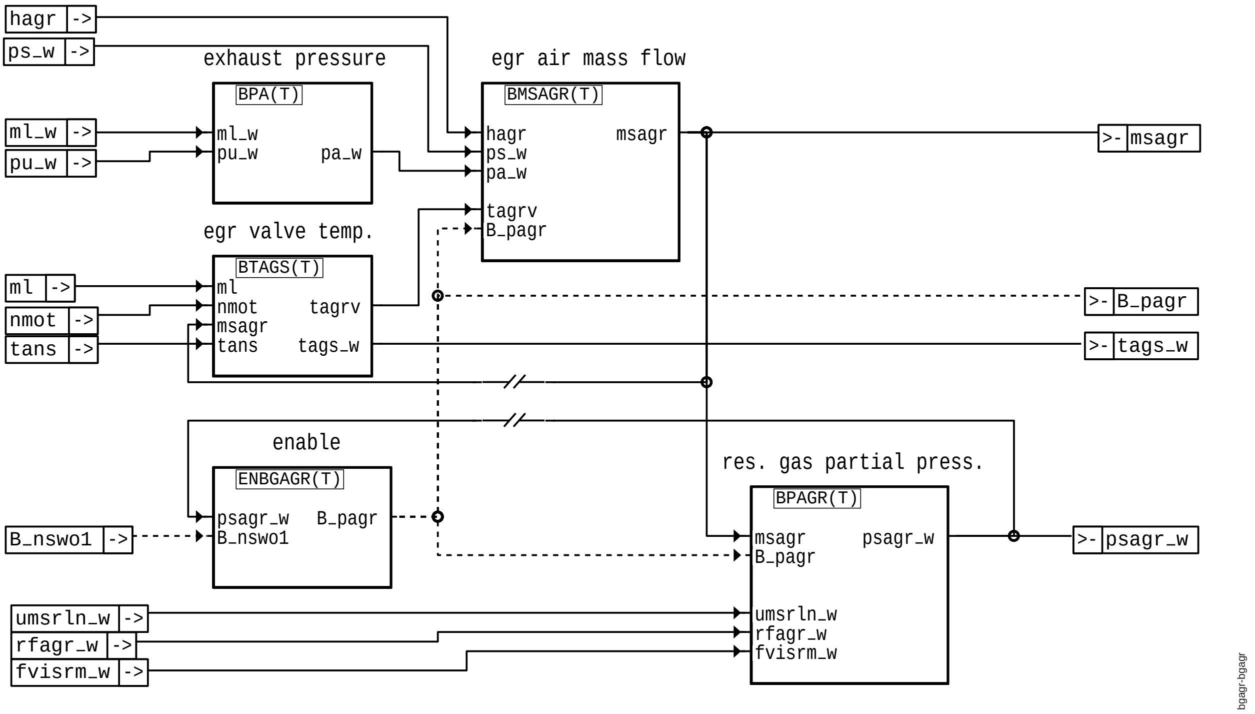
wdkba / nmot	600	800	1000	1400	1800	2400	3000	3500	4000	5000 rpm
4%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10%										
16%	0.60	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24%										
34%	0.20	0.50	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00
45%										
55%	0.05	0.1	0.40	0.60	0.85	0.90	0.95	1.00	1.00	1.00
65%										
80%	0.01	0.02	0.08	0.15	0.40	0.50	0.60	0.70	0.75	0.80
99.61%	0.01	0.01	0.04	0.08	0.20	0.25	0.30	0.35	0.40	0.45

KLAFTE see under %FB.

BGAGR 1.40 Correction air charge calculation by exhaust gas recirculation

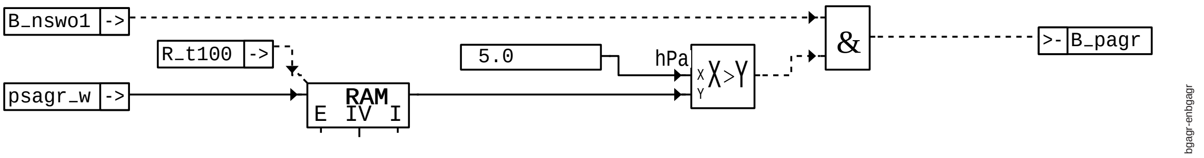
FDEF BGAGR 1.40 Function definition

BGAGR: functional overview



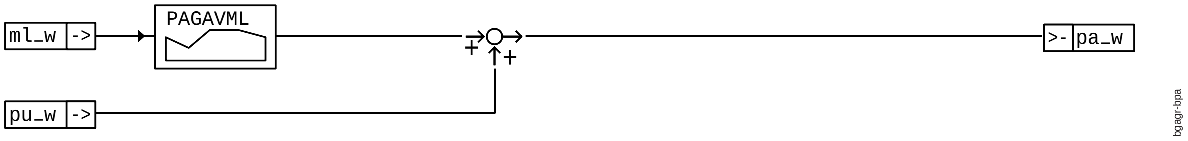
bgagr-bgagr

ENABGAGR: enable condition



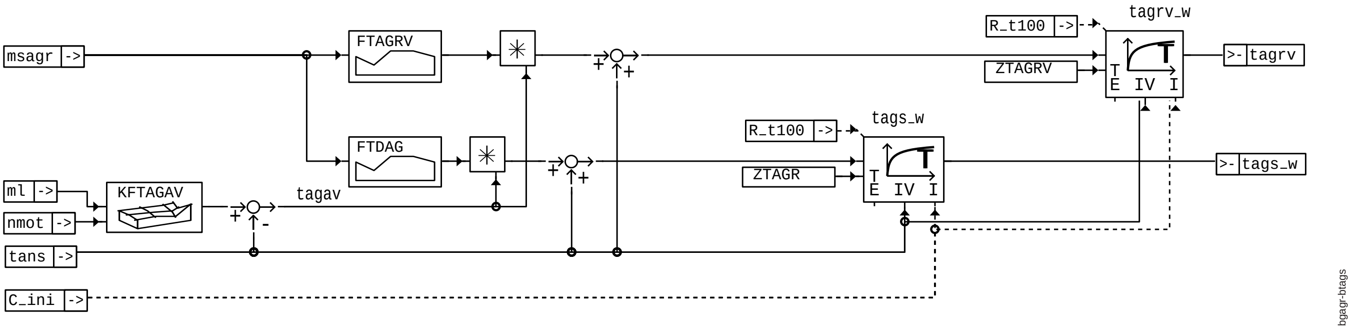
bgagr-enbgagr

BPA: calculation of exhaust pressure



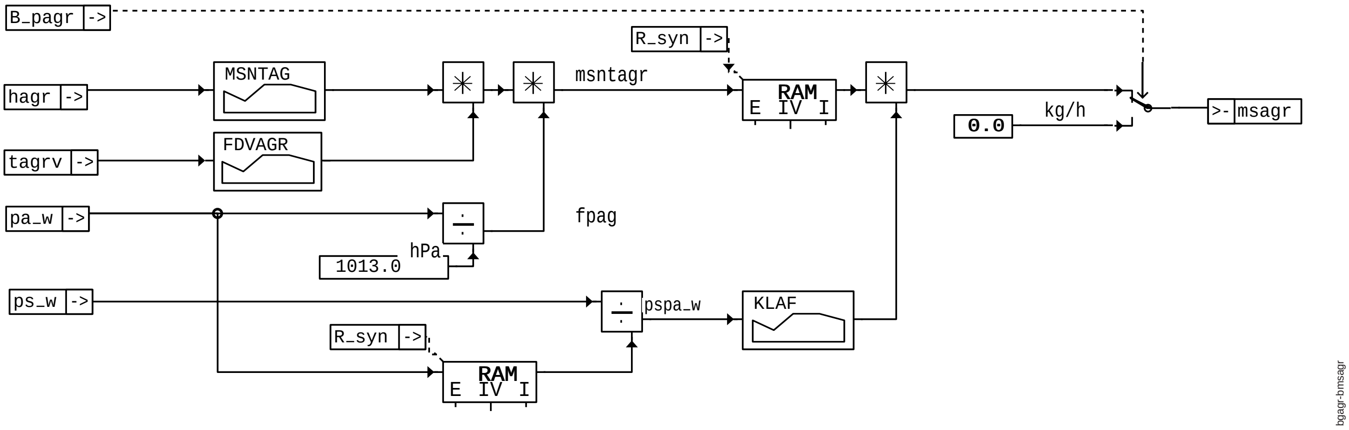
bgagr-bpa

BTAGS: calculation of egr valve temperature



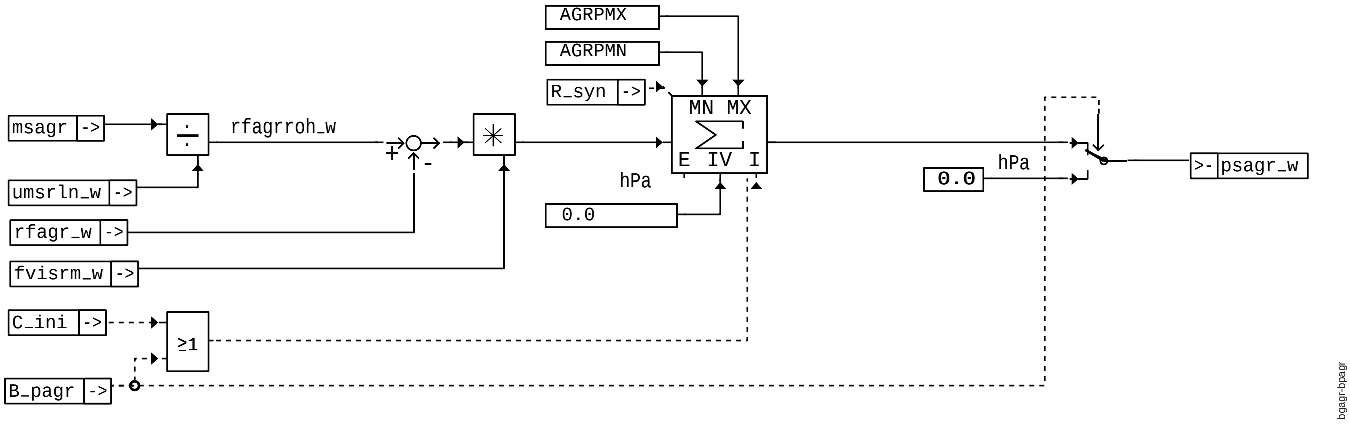
bgagr-btags

BMSAGR: calculation of egr air mass flow



bgagr-bmsagr

BPAGR: calculation of EGR partial pressure inside manifold



bgagr-bpagr

ABK BGAGR 1.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AGRPMN			FW	minimum EGR partial pressure
AGRPMX			FW	maximum EGR partial pressure
FDVAGR	TAGRV		KL	factor temperature for flow through EGR valve
FTAGRV	MSAGR		KL	Factor for temperature drop from EGR_pipe to EGR_valve
FTDAG	MSAGR		KL	factor for temperature drop on EGR line
KFTAGAV	ML	NMOT	KF	EGR temperature at outlet valve
KLAF	PSPA_W		KL	characteristic of Saint-Venant
MSNTAG	HAGR		KL	EGR mass flow standardised
PAGAVML	ML_W		KL	exhaust gas pressure at outlet valve
ZTAGR			FW	time constant for EGR temperature model
ZTAGRV			FW	Time constant for EGR temperature model EGR valve

Variable	Source	Type	Description
B_NSWO1	PROKON	EIN	condition engine speed $>$ NSWO1
B_PAGR	BGAGR	AUS	egr calculation disabled
C_INI	SWADAP	EIN	ECU-condition for intialisation
FPAG	BGAGR	DOK	factor: exhaust gas pressure
FVISRM_W	BGSRM	EIN	integrator amplifier factor intake manifold modell
HAGR	EGAG	EIN	Stroke EGR valve
ML	SWADAP	EIN	air mass flow
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSAGR	BGAGR	AUS	EGR mass flow into intake manifold
MSNTAGR	BGAGR	DOK	aktual supersonic EGR mass flow
NMOT	SWADAP	EIN	engine speed
PA_W	BGAGR	LOK	absolute pressure exhaust manifold
PSAGR_W	BGAGR	AUS	partial pressure EGR
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PU_W	BGPU	EIN	Ambient pressure
RFAGRROH_W	BGAGR	DOK	EGR charge portion into intake manifold
RFAGR_W	BGSRM	EIN	relative load by external exhaust gas reduction
R_SYN	GGDPG	EIN	Synchro schedule
R_T100		EIN	Time schedule 100 ms
TAGAV	BGAGR	DOK	EGR temperature at point of outlet valve
TAGRV	BGAGR	LOK	EGR valve temperature
TAGRV_W	BGAGR	DOK	EGR valve temperature (Word)
TAGS_W	BGAGR	AUS	EGR temperature on introduction into intake manifold
TANS	SWADAP	EIN	Intake air temperature
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow

FW BGAGR 1.40 Fixed Values

Parameter	Value	Description
AGRPMN		minimum EGR partial pressure
AGRPMX		maximum EGR partial pressure
ZTAGR		time constant for EGR temperature model
ZTAGRV		Time constant for EGR temperature model EGR valve

FB BGAGR 1.40 Detailed description of function

The section BGAGR calculates the EGR mass flow into the intake manifold. The EGR temperature necessary for the calculation is determined in a temperature model.
The manufacturer of the EGR valve supplies a characteristic which can be translated into characteristic MSNTAG. The EGR standardised mass flow should be dependent on the targeted duty factor in MSNTAG. The standard conditions are:
EGR mass flow at atemperature of 0 degrees Celsius, ratio of pressure downstream to pressure upstream of valve < 0.52 corresponds to supercritical. Pressure upstream of valve = 1013hPa.
The mass flow is adapted to the actual pressure conditions via the characteristic KLAF (standardised flow through a valve), which is addressed with the ratio pspag of intake manifold pressure ps to exhaust gas pressure pag. The exhaust gas counterpressure is composed from the ambient pressure pu and the pressure loss in the exhaust gas system, which must be measured in the application phase and stored in characteristic PAGAVML. The pressure loss increases as the air flow through the engine increases. PAGAVML is therefore dependent on ml. The pressure correction factor fpag is used to adapt to the actual pressure upstream of the valve.
The characteristic FDVAGR corrects the standardized EGR mass flow to the EGR mass flow at actually temperature at inlet of intake manifold in dependent of the moddelled EGR temperature
The standard EGR mass flow is calculated with the corrections described into the actual mass flow msagr, which flows through the EGR valve.

APP BGAGR 1.40 Application hint

The standardised flow through throttle valve KLAF is specified by physics, and is stored as a 501 * 16 bit table in the Eprom. The fine stepping from value to value is particularly necessary in the subcritical operating range, since the intake manifold model tends to oscillate if the stepping is spread too coarsely.
The values table for the outflow characteristic KLAF can be requested as an EXCEL file from H.Pfitz K3/ESY5 Tel. 8502 if required.

!!!! The KLAF is stored only once for the entire project in the EPROM (FLASH), due to the available memory space.!!!!

The KLAF input value is calculated in the relevant modules and transferred in a RAM cell. Then the corresponding output value of the KLAF is calculated using the transfer value, and the KLAF value is used for further calculations in the relevant software modules.

Characteristic FDVAGR for density correction of the EGR mass flow as function of tags[°C]

FDVAGR = $\sqrt{T0[k]/TAGS[K]}$ satndard temperature T0 ist 0°C = 273K --> ftags (0°C) = 1.0

Values for characteristic FDVAGR:

tags	-40	0	40	100	200	300	400	700
FDVAGR	1.0824	1.0	0.9339	0.8555	0.7597	0.6902	0.6369	0.5296

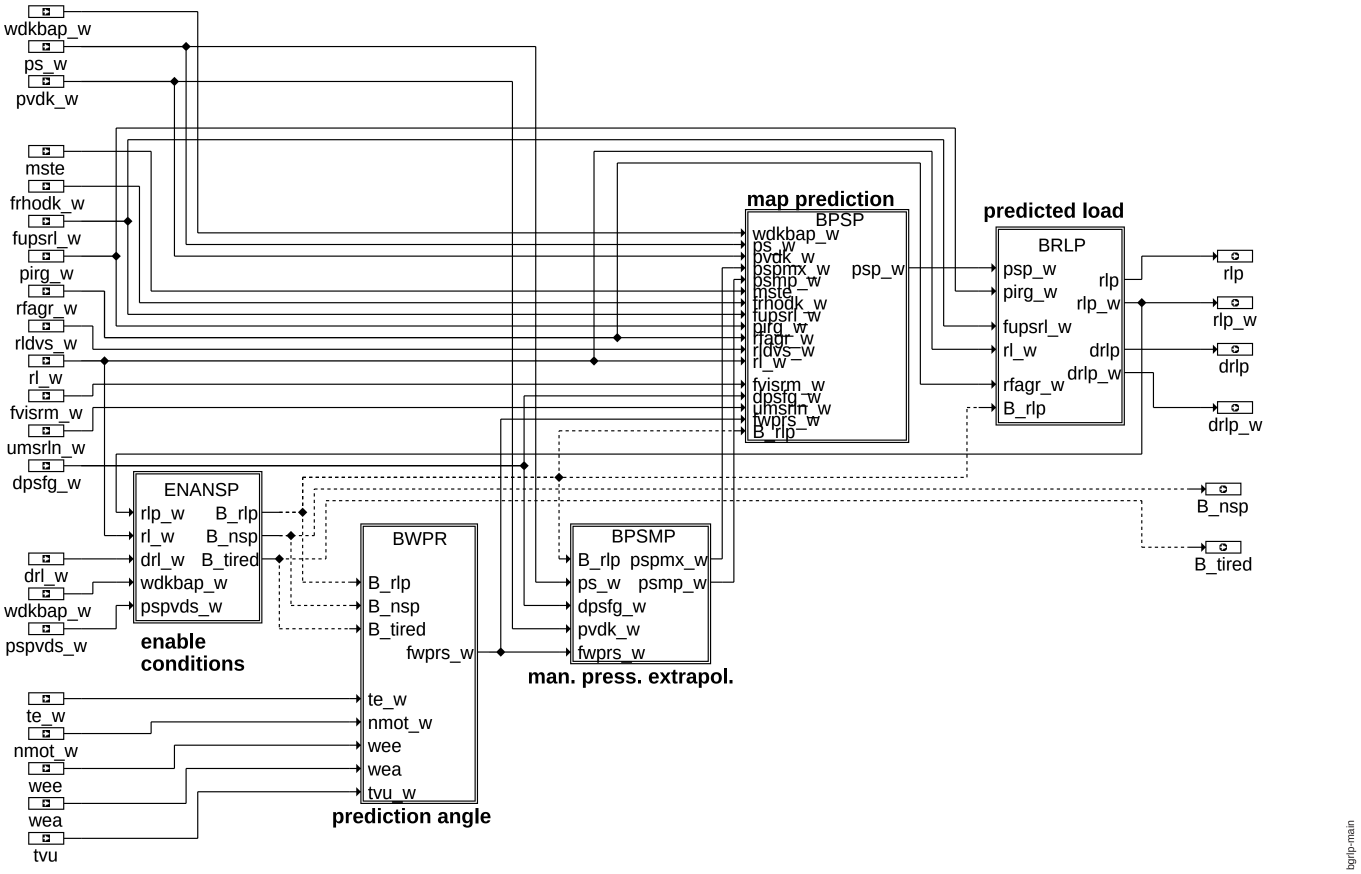
For application:

function disable: agrvp_w = 0 see function GGAGRV, or MSNTAG = 0 completely --> msagr = 0
PAGRMX = PAGRMN = 0 --> psagr_w = 0 hPa

BGRLP 4.50 Calculation variable rlp: predicted air charge

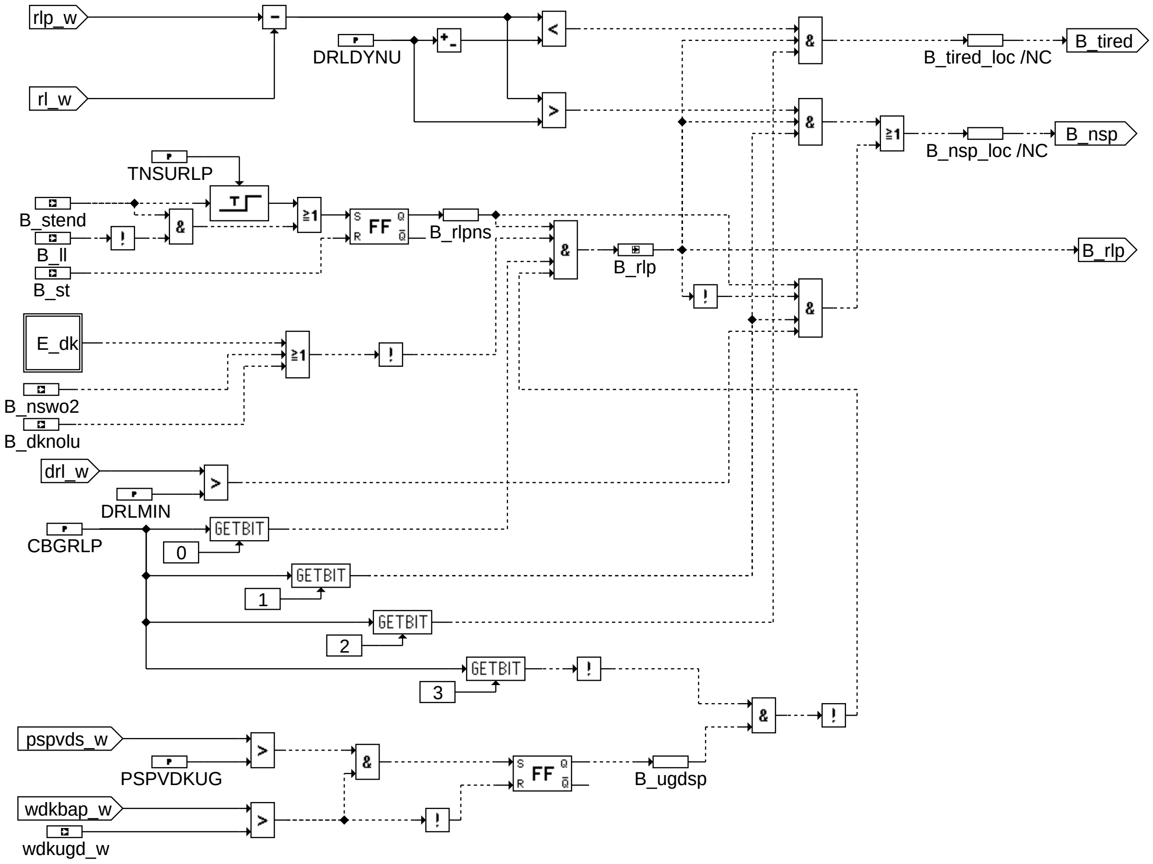
FDEF BGRLP 4.50 Function definition

BGRLP: Overview - load prediction



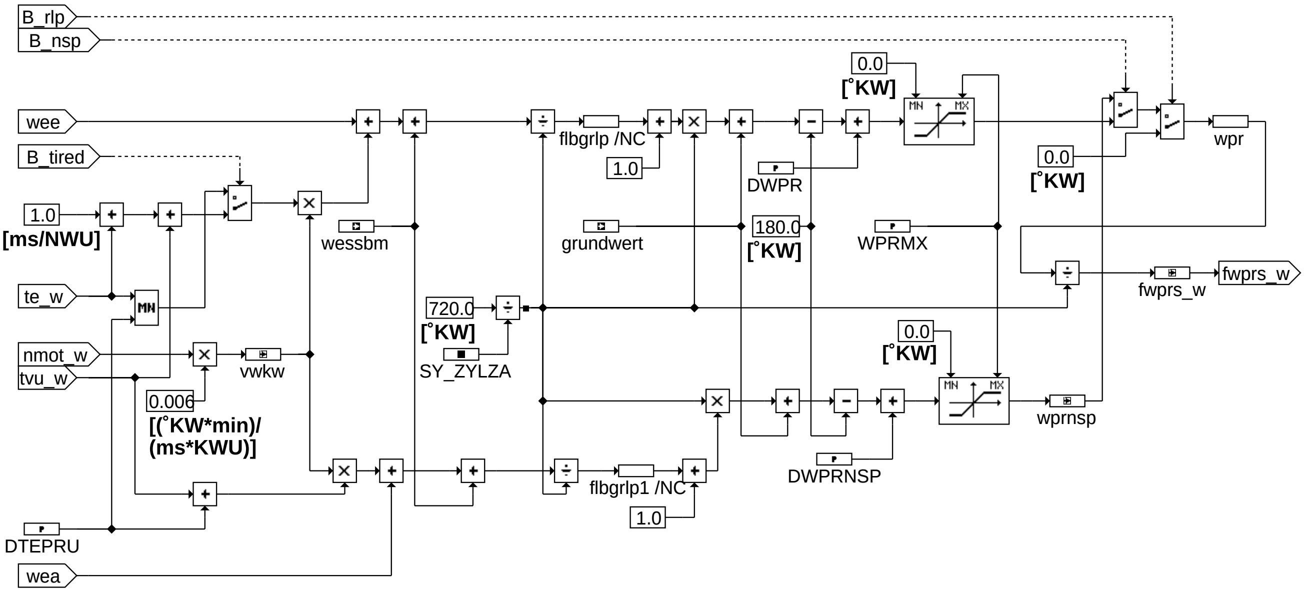
bgrlp-main

`ENANSP: Start-up conditions`



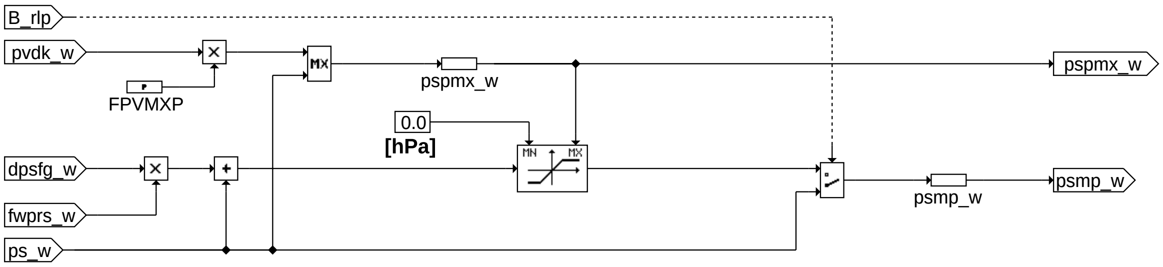
bgrlp-enansp

`BWPR: Prediction angle calculation wpr`



bgrlp-bwpr

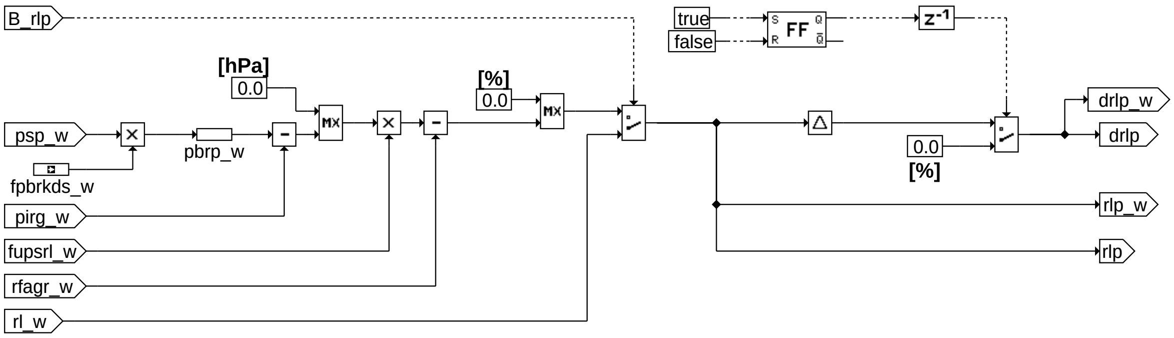
`BPSMP: 1. Inlet manifold pressure extrapolation`



bgrlp-bpsmp

bgrlp-bpsmp

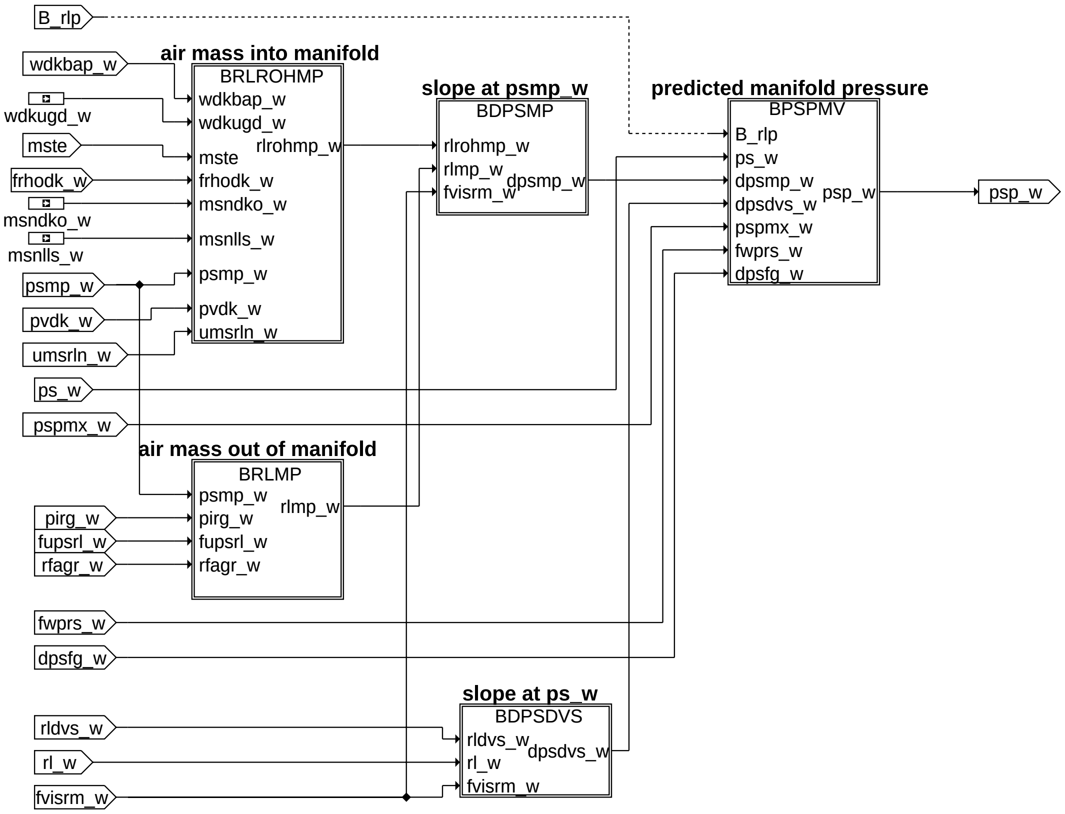
`BRLP: Calculation of predetermined air charge rlp_w`



bgrlp-brlp

bgrlp-brlp

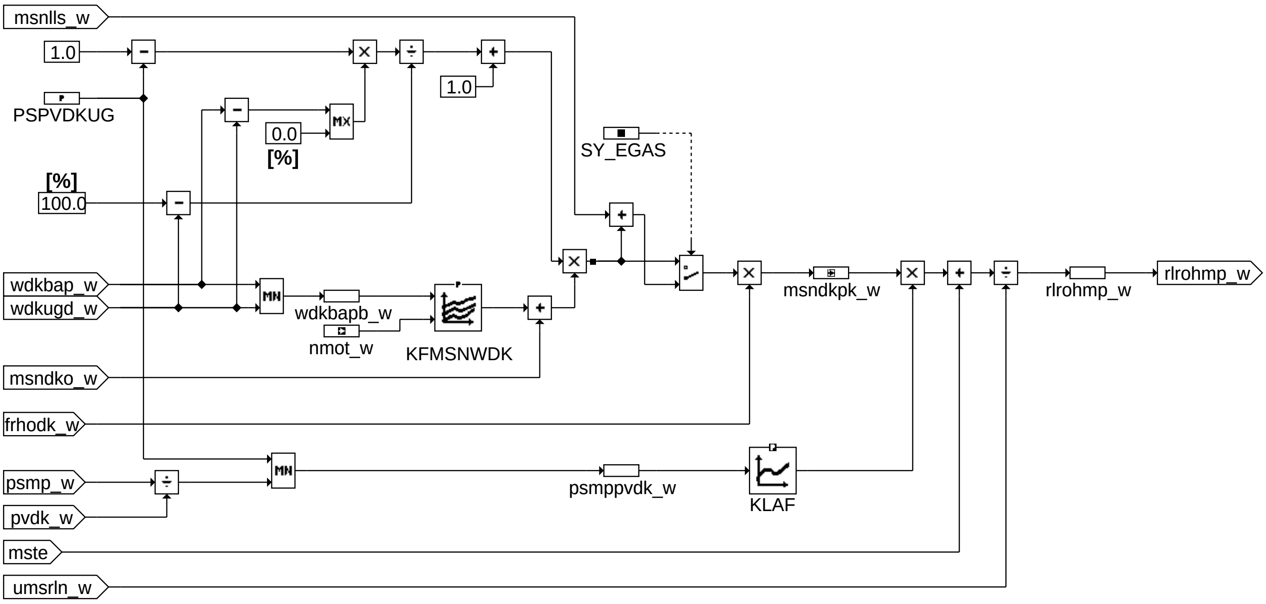
`BPSP: Calculation of predetermined inlet manifold pressure psp_w`



bgrlp-bpsp

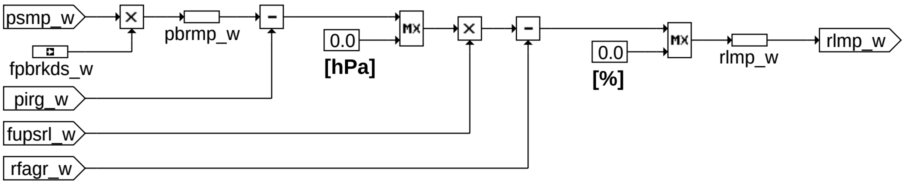
bgrlp-bpsp

`BRLROHMP: Air mass flowing into the inlet manifold at psmp_w`



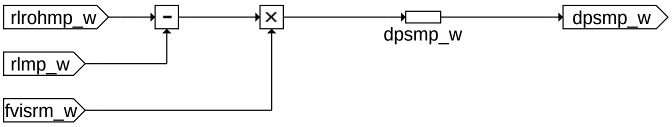
bgrlp-brlrohmp

`BRLMP: Air mass flowing out of the inlet manifold at psmp_w`



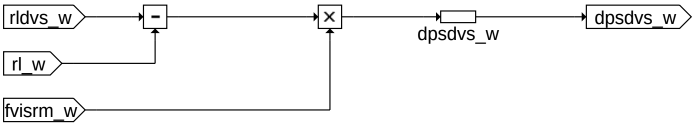
bgrlp-brlmp

`BDPSMP: Inlet manifold pressure gradient at psmp_w`



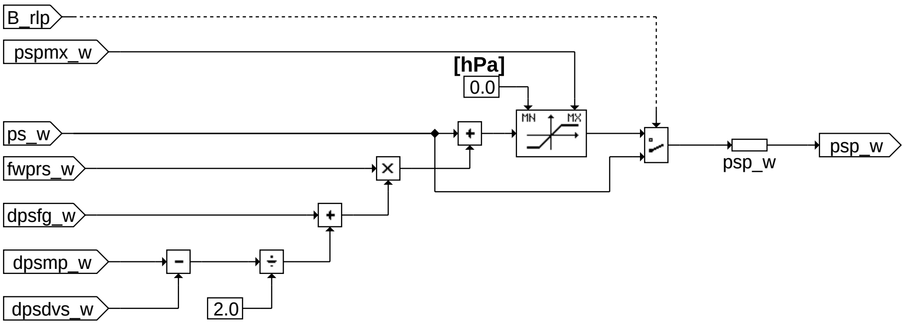
bgrlp-bdpsmp

`BDPSDVS: Inlet manifold pressure gradient at ps_w`



bgrlp-bdpsdvs

`BPSPMV: Calculation of predetermined inlet manifold pressure with the average of dps_w and dpsmp_w`



bgrlp-bpspmv

ABK BGRLP 4.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CBGRLP			FW	Code word configuration function BGRLP
DRLDYNU			FW	drl threshold value for te post injection/reduction
DRLMIN			FW	Minimal charge change for triggering of post injection
DTEPRU			FW	delta-te threshold for post injection/ti-reduction detected
DWPR			FW	Delta prediction angle without post injection/ti-reduction
DWPRNSP			FW	Delta prediction angle at post injection release
FPVMXP			FW	factor for pressure ratio maximum for load prediction
KFMSNWDK	WDKBAPB_W	NMOT_W	KF	Map for scaled mass flow over throttle valve
KLAF	PSMPPVDK_W		KL (REF)	characteristic of Saint-Venant
PSPVDKUG			FW	Ratio pspvdk not reduced
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TNSURLP			FW	Time rl prediction suppression in post-start
WPRMX			FW	maximum prediction angle

Variable	Source	Type	Description
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_LL	MSF	EIN	Condition idle
B_NSP	BGRLP	AUS	condition for post-injection
B_NSWO2	PROKON	EIN	condition engine speed > NSWO2
B_RLP	BGRLP	LOK	condition for load prediction
B_RLPNS	BGRLP	LOK	Enable condition load prediction after cranking
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TIRED	BGRLP	AUS	Condition reduction of active injections
B_UGDSP	BGRLP	LOK	condition predicted set value throttle angle near full load
DPSDVS_W	BGRLP	LOK	Delta intake manifold pressure from throttle valves (Word)
DPSFG_W	BGSRM	EIN	delta fresh air partial pressure in manifold
DPSMP_W	BGRLP	LOK	delta extrapolated intake manifold pressure (Word)
DRLP	BGRLP	AUS	delta predicted load for injection time calculation
DRLP_W	BGRLP	AUS	delta predicted load for injection time calculation (word)
DRL_W	SWADAP	EIN	charge change (Word)
E_DK	DDVE	EIN	Error flag: throttle position sensor
FPBRKDS_W	BGSRM	EIN	factor for determination of combustion chamber pressure
FRHODK_W	EGFE	EIN	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FUPSRL_W	EGFE	EIN	factor system related transformation pressure to load (16-Bit)
FVISRM_W	BGSRM	EIN	integrator amplifier factor intake manifold modell
FWPRS_W	BGRLP	LOK	Factor prediction angle with respect to segment
GRUNDWERT		EIN	space between SW reference mark to TDC in °KW
MSNDKO_W	EGFE	EIN	norm leakage air mass flow through throttle blade
MSNDKPK_W	BGRLP	LOK	normalized predicted corrected mass flow over throttle (word)
MSNLLS_W		EIN	standardised air mass flow through idle speed actuator (word)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
NMOT_W	SWADAP	EIN	engine speed
PBRMP_W	BGRLP	LOK	extrapolated combustion chamber pressure (Word)
PBRP_W	BGRLP	LOK	predicted combustion chamber pressure (Word)
PIRG_W	EGFE	EIN	partial pressure residual exhaust gas internal EGR (16-Bit)
PSMPPVDK_W	BGRLP	LOK	predicted manifold pressure/pressure upstream throttle plate
PSMP_W	BGRLP	LOK	extrapolated intake manifold pressure (Word)
PSPMX_W	BGRLP	LOK	maximum predicted intake manifold pressure
PSPVDS_W	BGMSZS	EIN	quotient manifold pressure/pressure before throttle plate
PSP_W	BGRLP	LOK	predicted intake manifold pressure (Word)
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PVDK_W	EGFE	EIN	pressure upstream of throttle valve, 16-bit
RFAGR_W	BGSRM	EIN	relative load by external exhaust gas reduction
RLDVS_W	EGFE	EIN	relative air charge through throttle valves on intake manifold
RLMP_W	BGRLP	LOK	rel. extrapolated air charge (Word)
RLP	BGRLP	AUS	rel. air charge predicted for injection calculation
RLP_W	BGRLP	AUS	rel. air charge predicted for injection calculation (Word)
RLROHMP_W	BGRLP	LOK	Relative air filling intake manifold flow for intake manifold pres. psmp_w(Word)
RL_W	EGFE	EIN	relative air charge (Word)
TE_W		EIN	effective injection time (word)
TVU		EIN	supply of voltage correction
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
VWKW	BGRLP	LOK	crankshaft angular speed
WDKBAPB_W	BGRLP	LOK	predicted limited throttle angle wdkbl for ti-calculation (Word)
WDKBAP_W	BGWDKM	EIN	predicted throttle angle wdkbl for ti-calculation (Word)
WDKUGD_W	BGMSZS	EIN	Throttle valve angle during which 95% charge is reached
WEA	ESVW	EIN	anglemark injection break off
WEE	ESVW	EIN	angle injection-end in normal operation
WESSBM		EIN	angle: intake valve closes late until reference mark
WPR	BGRLP	LOK	Calculated injection angle for load prediction
WPRNSP	BGRLP	LOK	Calculated injection angle for load prediction for behind injection

FW BGRLP 4.50 Fixed Values

Parameter	Value	Description
CBGRLP		Code word configuration function BGRLP
DRLDYNU		drl threshold value for te post injection/reduction
DRLMIN		Minimal charge change for triggering of post injection
DTEPRU		delta-te threshold for post injection/ti-reduction detected
DWPR		Delta prediction angle without post injection/ti-reduction
DWPRNSP		Delta prediction angle at post injection release
FPVMXP		factor for pressure ratio maximum for load prediction
PSPVDKUG		Ratio pspvdk not reduced
TNSURLP		Time rl prediction suppression in post-start
WPRMX		maximum prediction angle

FB BGRLP 4.50 Detailed description of function

Prediction of the injection calculation load:

The charge cycle BDC determines the air charge of the des cylinder largely irrespective of the camshaft control times, since the pressure between the inlet manifold and the cylinder is balanced.
The load signal rl_w is based on the current inlet manifold pressure ps_w and describes the air charge of the currently inducting cylinder.
Since there is a time lag until the LW-BDC of the cylinder belonging to the currently calculated ti, the inlet manifold pressure can still change greatly.
Based on a future Dk actual angle wdkbap_w and knowing the differential crank angle to LW-BDC (prediction angle wpr), the inlet manifold pressure at LW-BDC psp_w can now be pre-calculated.

The whole prediction of the injection calculation load can be switched off with CBGRLP[bit 0 = 0].

1. Standard case without after-dribble / intermediate dribble or ti reduction enable

The crank angle from tr mark to ignition TDC (basic value) is 108 °KW in this case

```
                                                                      LW-OT             LW-BDC
    tr                tr                tr                tr    Inlet opens    Inlet closes
|---*-------------|---*-------------|---*-------------|---*-------------|---*-------------|---*-------------|
                      ^
                      |           |<----- ti(alt) ----->|<------------- wee -------------->|--|   ti start angle before tr mark
               ti calculation                                                            wessbm

                      |<- 1ms ->|                                                     --->|   |<--- (180°KW - basic value)

                      |<------------------- wpr ------------------------------------------>|      Prediction angle wpr
```

First the crank angle between the current load -/ti calculation in the synchro at a tr mark and the charge cycle BDC of the corresponding cylinder is determined (--> prediction angle wpr). The first step is to determine the angle between tr mark and ti start + 1ms (= estimated synchro calculation time).
This angle is rounded up to whole segments (720°KW/SY_ZYLZA), giving the number of whole segments between ti calculation and tr mark of the cylinder under consideration.
The air mass message for 1 segment means that rl_w can be directly timed to the tr mark;
But then 180°KW - basic value (tr mark v. ignition TDC) must be deducted to give the angle difference from the moment of load measurement to LW BDC (= Prediction angle wpr).

2. with after-dribble / intermediate dribble enable

```
                                                                      LW-OT             LW-BDC
    tr                tr                tr                tr    Inlet opens    Inlet closes
|---*-------------|---*-------------|---*-------------|---*-------------|---*-------------|---*-------------|
                      ^
                      |                                 |<--------------- wee ------------>|--|
               ti calculation                                                            wessbm
                                                          |<- DTEPRU ->|        |<-- wea ->|

                                                          |<---- wprnsp ------------------>|      Prediction angle wprnsp

                                                          XXXXX                                   After-dribble
```

If the predicted load rlp_w is significantly greater than the current load rl_w (--> DRLDYNU), the intermediate/after-dribble mechanism of the CIFI is enabled (B_nsp = 1).
Since extension of ongoing injections or additional after-dribble is now allowed, the KW prediction angle used is the last update opportunity at a tr mark and the inlet closing crankshaft of the cylinder concerned.
It is assumed that the ti for one cylinder can then still be updated if a time of at least DTEPRU (typically 5 ms) remains from the end of the ti calculation to the termination of angle injection wea (see %EA), enabling a viable intermediate dribble length.
This special treatment of the prediction angle wpr where B_nsp = 1 can be prevented by CBGRLP[biz 1 = 0].

3. With ti reduction enable:

```
                                                                      LW-OT             LW-BDC
    tr                tr                tr                tr    Inlet opens    Inlet closes
|---*-------------|---*-------------|---*-------------|---*-------------|---*-------------|---*-------------|
                      ^
                      |           |<----- ti(alt) ----->|<--------------- wee ------------>|--|
               ti calculation                                               wessbm
                                           |<- DTEPRU ->|

                                        |<------- wpr ----------------------------------->|     Prediction angle wpr
```

If the predicted load rlp_w is significantly smaller than the current load rl_w (--> DRLDYNU), the ti reduction mechanism of the CIFI is enabled (B_tired = 1).
Since a ti reduction of ongoing injections is now allowed, the crankshaft prediction angle wprnsp used is the last update opportunity at a tr mark and the inlet closing crankshaft of the cylinder concerned.
The last update opportunity is selected in such a way that at least one more injection time (to be shortened) of DTEPRU (typically 5 ms) remains.
This special treatment of the prediction angle wpr at B_tired = 1 can be prevented by CBGRLP[biz 2 = 0].

At start, when moving from start to after-start, and shortly after start-end, rlp_w is supplied with the direct main load signal rl_w.
Prediction can also be completely switched off with CBGRLP[biz 0 = 0].

APP BGRLP 4.50 Application hint

Requirements:
- Static main load detection correct
- Ancillary load detection correct, i.e. msdk_w must match mshfm_w
- Dynamic load detection correct, i.e. ps_w matches statically and dynamically measured inlet manifold pressure profile

- Tidal air angle as late as possible (fuel flight time before inlet opening = approx. 8ms with normal injector installation)
- Injection termination angle as late as possible (approx. fuel flight time before charge cycle BDC)
- Gap between tidal air angle and injection termination angle so large that intermediate/after-dribble still have room N dynamic too (>= 4ms); otherwise the CIFI cannot initiate any after-dribble!!

- Tidal air angle as late as possible (fuel flight time before inlet opens = approx. 8ms with normal injection valve installation)
- Injection termination angle as late as possible (approximate fuel flight time before charge cycle BDC)
- Gap between tidal air angle to injection termination large enough for space for intermediate and after-dribble even with N dynamic (>= 4ms); otherwise CIFI cannot initiate any after-dribble!!

- Dk prediction correctly applied (see %BGWDKM)
- NSWO2 threshold in %PROKON >= 4500 rpm

Pre-assignment of parameters:
- Threshold for after-dribble /ti reduction enable DRLDYNU = 1.5 %
- Threshold for minimum space after-dribble/ti reduction DTEPRU = 5 ms
- Prediction suppression time in after-start TNSURLP = 5 s
- Configuration CBGRLP = 11 i.e. even in unthrottled operation prediction on, ti after-dribble enabled, ti-reduction off
- Delta prediction angle in standard case DWPR = 0 °KW
- Delta prediction angle in after-dribble enable DWPRNSP = 0 °KW
- Max. prediction angle WPRMX = 1530 °KW
- Factor pvdk for psp delimitation FPVMXP = 1.1

Switching off the function:
- Configuration CBGRLP = 2 i.e. prediction off, ti after-dribble enabled

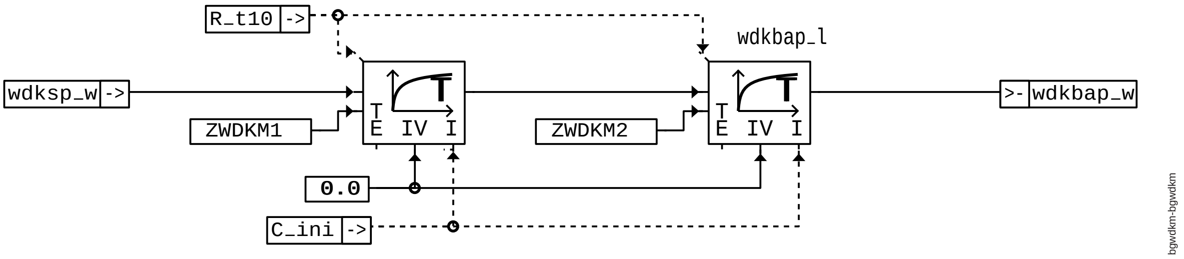
Procedure:
- This function was developed to minimize the application effort; so there is nothing more to do!!
- If lean peaks still occur during acceleration after the above parameter pre-assignment, this can be compensated by increasing the prediction angle using DWPR or DWPRNSP.

Functions affected:
- Transition compensation

  Since the prediction corrects the updating errors of the injection calculation load detection, also controlling the after-dribble-/and ti reduction of the CIFI, the transition compensation application is greatly influenced; the load prediction must therefore be applied before the transition compensation.

BGWDKM 1.0 Calculation of throttle angle model

FDEF BGWDKM 1.0 Function definition



bgwdkm-bgwdkm

ABK BGWDKM 1.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZWDKM1			FW	1. time constant throttle angle model
ZWDKM2			FW	2. time constant throttle angle model

Variable	Source	Type	Description
C_INI	SWADAP	EIN	ECU-condition for intialisation
R_T10		EIN	Time schedule 10 ms
WDKBAP_L	BGWDKM	LOK	predicted throttle angle wdkbl for ti-calculation (Long)
WDKBAP_W	BGWDKM	AUS	predicted throttle angle wdkbl for ti-calculation (Word)
WDKSP_W	FUEDKSA	EIN	predicted desired throttle angle

FW BGWDKM 1.0 Fixed Values

Parameter	Value	Description
ZWDKM1		1. time constant throttle angle model
ZWDKM2		2. time constant throttle angle model

FB BGWDKM 1.0 Detailed description of function

Task of the function:

Calculation of an advancing Dk actual angle wdkbap_w from the advancing Dk nominal angle wdksp_w.

Benefits:

By knowing the future Dk actual angle, very rapid changes in the air filling can be calculated despite an unavoidable dead time between load detection and the actual air filling of the cylinders;
combustion misfiring is thereby avoided for extreme dynamics (see %BGRLP).

Realization:

The dynamics of the Dk actuator (without overshoot) are simulated by 2 PT1 members connected in series;
the model Dk actual angle corresponds to the stationary nominal value for the Dk angle.

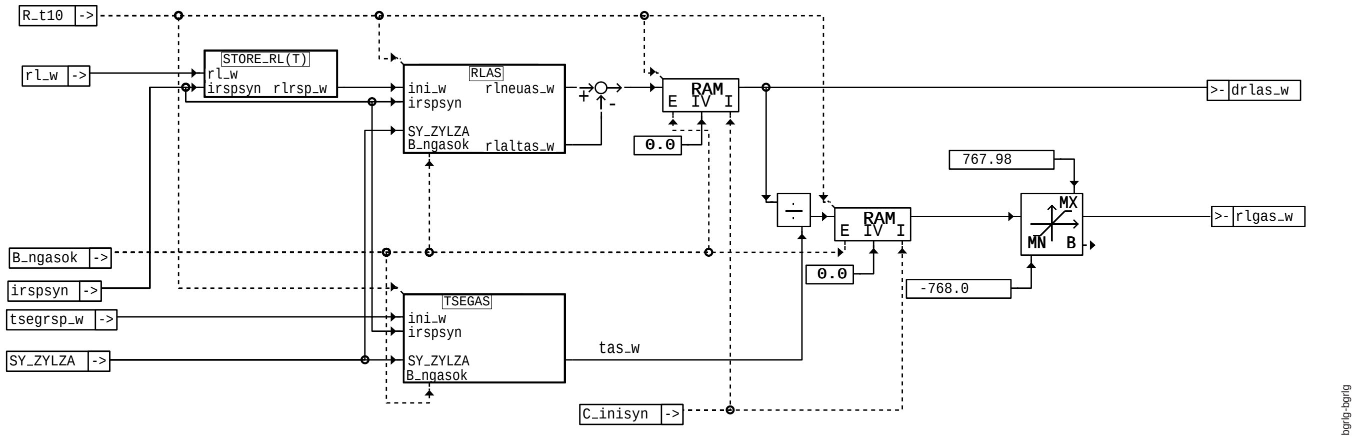
APP BGWDKM 1.0 Application hint

```
Prerequisites:
----------------

 - Dk position regulator applied and stable (i.e. no overshoot in the Dk actual angle !);
   An overshoot of the Dk actual angle cannot be simulated !!

Application tools:
-------------------------

 - VS100

Pre-assignment of parameters:
--------------------------

 - Time constants Dk angle model: ZWDKM1 = 0.01 s, ZWDKM2 = 0.03 s
 - Dead time in the Dk nominal value path (see %FUEDK) TVWDKS = 0.02 s

Shutdown of the function:
-----------------------------

 - TVWDKS (see %FUEDK) = 0.0 s
 - ZWDKM1 = ZWDKM2 = 0.0 s,
   i.e. simulated Dk actual value corresponds to the Dk nominal value

Method of proceeding:
------------

 - Dead time in the Dk nominal value path (see %FUEDK) TVWDKS = 0.0 s

 - Perform Dk nominal value jumps
   Possibility a: by applying a voltage to the pedal input
   Possibility b: by switching over in %FUEDK to Dk nominal value requirement using code word CWMDAPP and WDKSAPP; different Dk
                  nominal values can be realized by paging in the VS100 measurements menu

 - Comparison of measured Dk actual value wdkba_w with the estimated Dk actual value wdkbap_w;
   Optimization in the agreement by adaptation of ZWDKM1 and ZWDKM2

 - Reset the dead time in Dk nominal value path back to the original value (see %FUEDK) TVWDKS = 0.02 s).
```

BGRLG 1.10 RL-GRADIENT

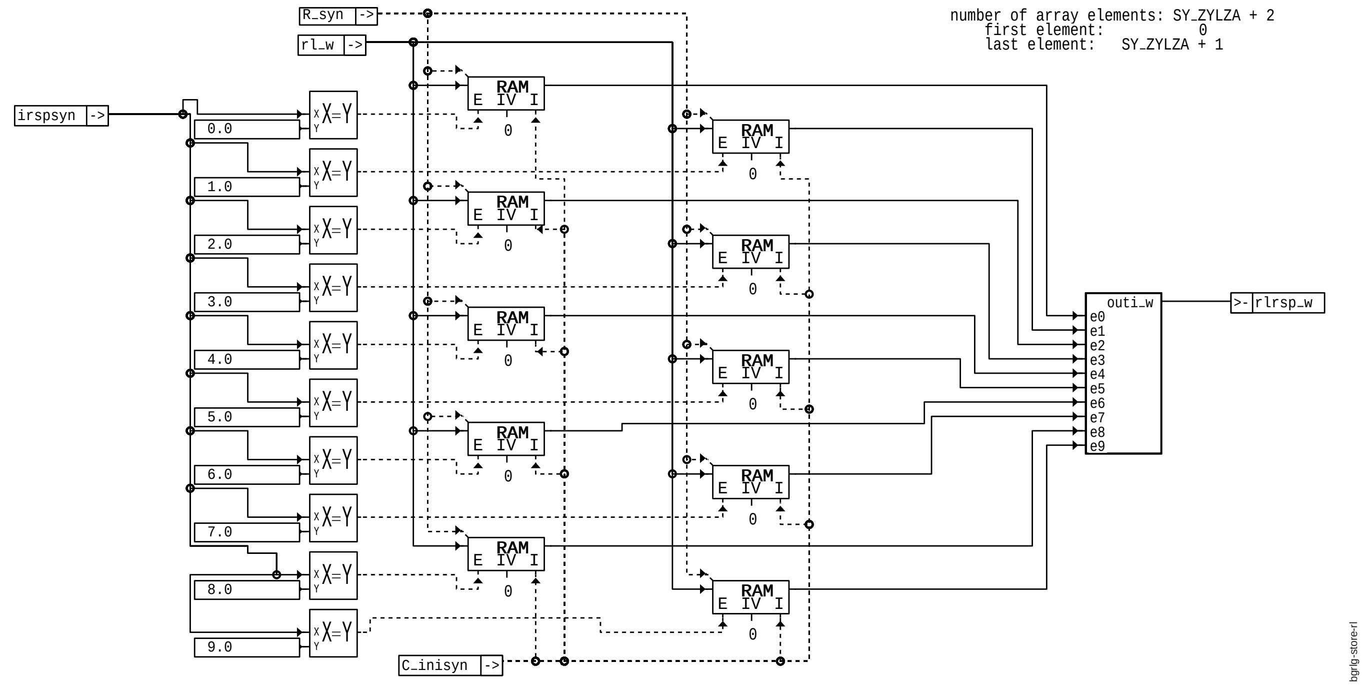
FDEF BGRLG 1.10 Function definition

RLGAS: Calculation of the Charge Gradient rlgas_w over one Working Cycle



bgrlg-bgrlg

STORE_RL: Storage of the Charge in the Segment Cycle



bgrlg-store-rl

ABK BGRLG 1.10 Abbreviations

Variable	Source	Type	Description
B_NGASOK	BGNG	EIN	condition memory array for ngas calculation valid
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
DRLAS_W	BGRLG	AUS	change of air charge at one combustion cycle
IRSPSYN	BGNG	EIN	index to address memory of tsegrsp_w, nmotrsp_w, rlsp_w
RLGAS_W	BGRLG	AUS	gradient of air charge at one combustion cycle
RLRSP_W	BGRLG	LOK	Begin of ring buffer , relative charge
RL_W	EGFE	EIN	relative air charge (Word)
R_SYN	GGDPG	EIN	Synchro schedule
R_T10		EIN	Time schedule 10 ms
SY_ZYLZA	PROKON	EIN	system constant number of cylinders
TAS_W	BGRLG	LOK	time during one working cycle for rlgas_w
TSEGRSP_W	BGNG	EIN	Begin of ring buffer for segment time

FW BGRLG 1.10 Fixed Values

Parameter	Value	Description

FB BGRLG 1.10 Detailed description of function

In the function RLGAS a charge gradient over one working cycle is formed for knock and misfire detection.

For this, the current value of rl_w (STORE_RL) and the segment time tseg_w (STORE_TSEG) are entered into a ring buffer store segment-synchronously. The pointer irspsyn points to the position of the last entry in the ring buffer store. The size of the ring buffer store is SY_ZYLZA + 2 values.

The charge difference drlas_w for one working cycle is calculated in the time cycle. The difference is obtained from the charge at that position in the ring buffer store to which irspsyn points minus the charge prior to SY_ZYLZA ignitions.

The period of time of one working cycle (time for 1 camshaft revolution) tas_w is calculated by adding the individual segment times starting from irspsyn for SY_ZYLZA ignitions.

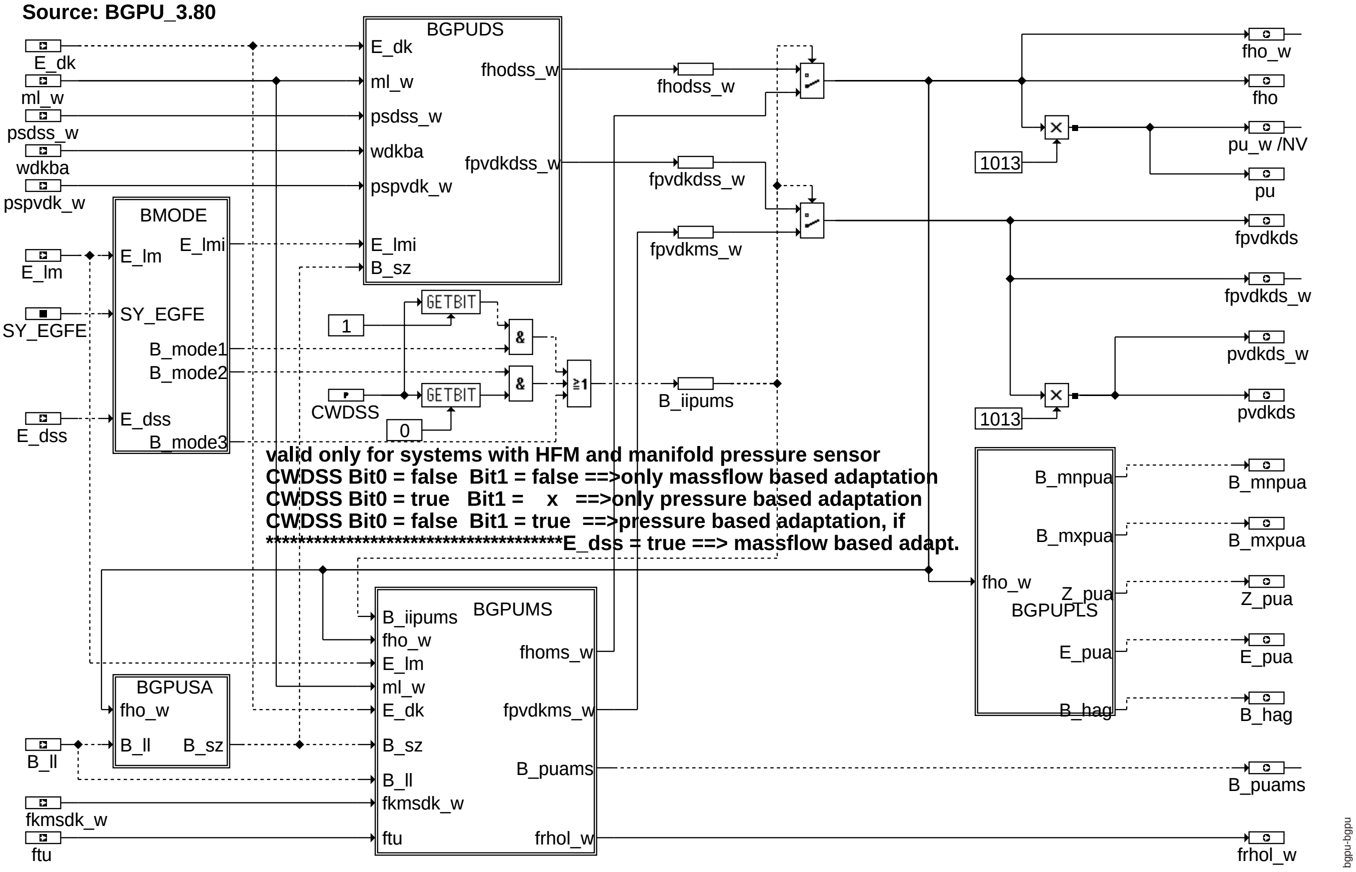
By a division of the charge change drlas_w by the time tas_w needed for this, the charge gradient over one working cycle is obtained.

APP BGRLG 1.10 Application hint

BGPU 3.100 Calculation value ambient pressure

FDEF BGPU 3.100 Function definition

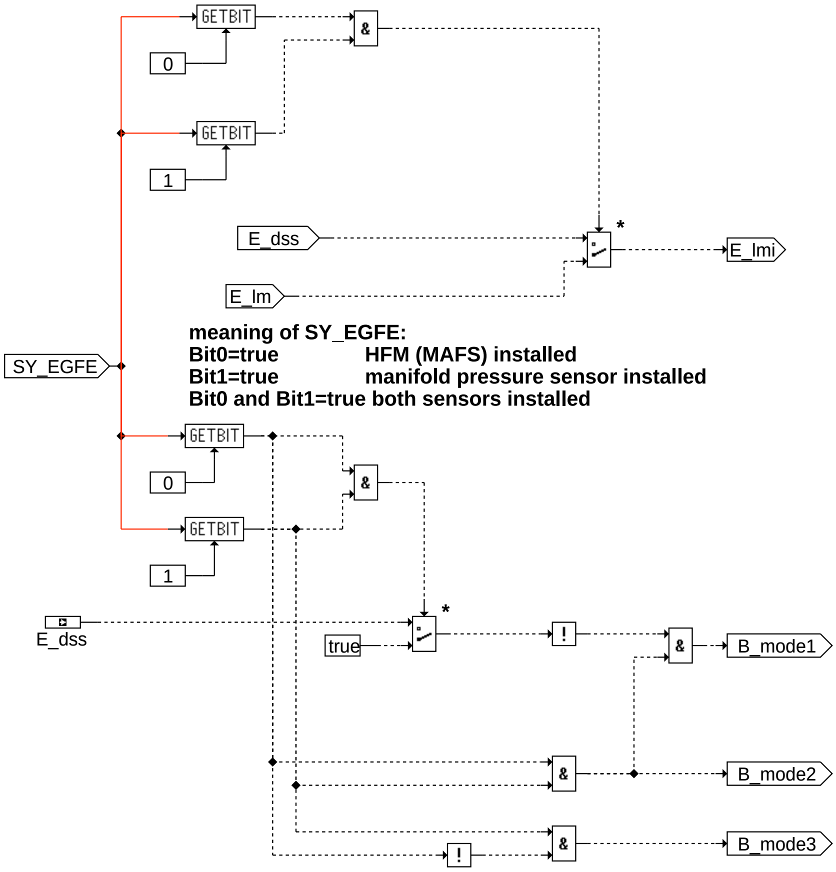
Source: BGPU_3.80



valid only for systems with HFM and manifold pressure sensor
CWDSS Bit0 = false Bit1 = false ==>only massflow based adaptation
CWDSS Bit0 = true   Bit1 =   x   ==>only pressure based adaptation
CWDSS Bit0 = false Bit1 = true ==>pressure based adaptation, if
**************************************E_dss = true ==> massflow based adapt.**

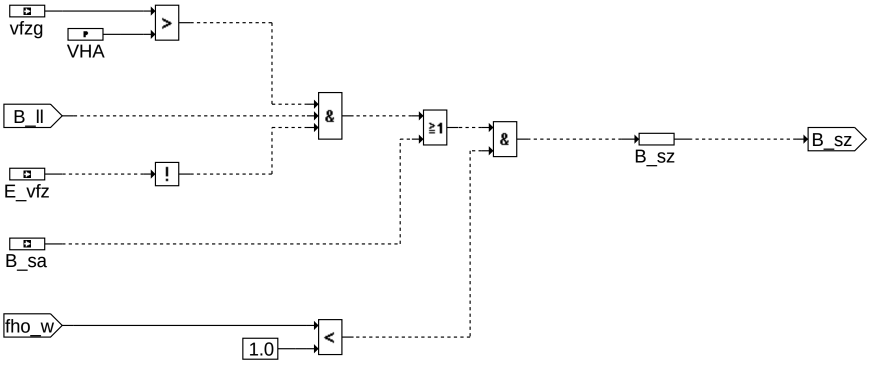
bgpu-bgpu

please note: these switches (*) have to be realised by preprocessor

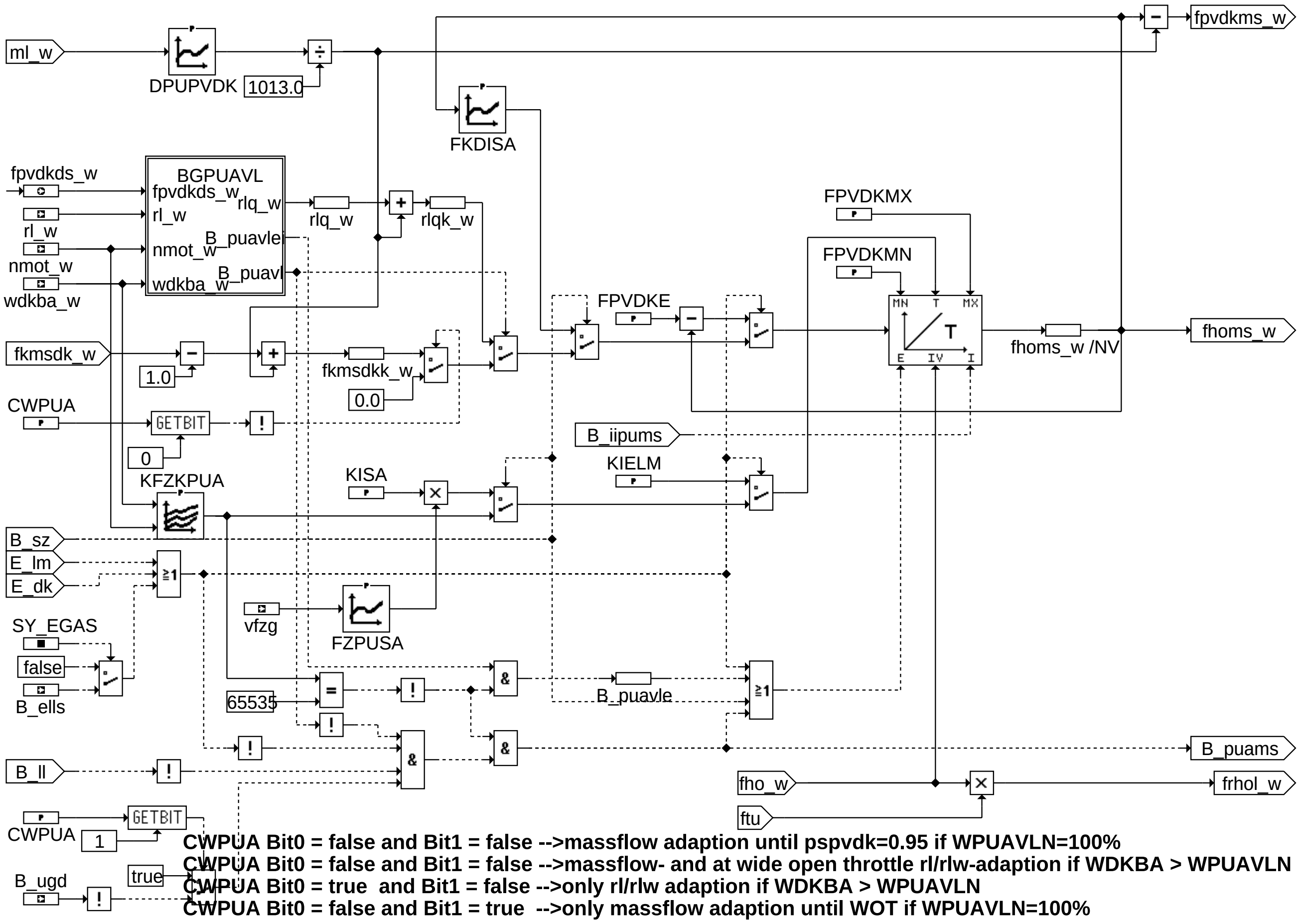


meaning of SY_EGFE:
Bit0=true HFM (MAFS) installed
Bit1=true manifold pressure sensor installed
Bit0 and Bit1=true both sensors installed

bgpu-bmode



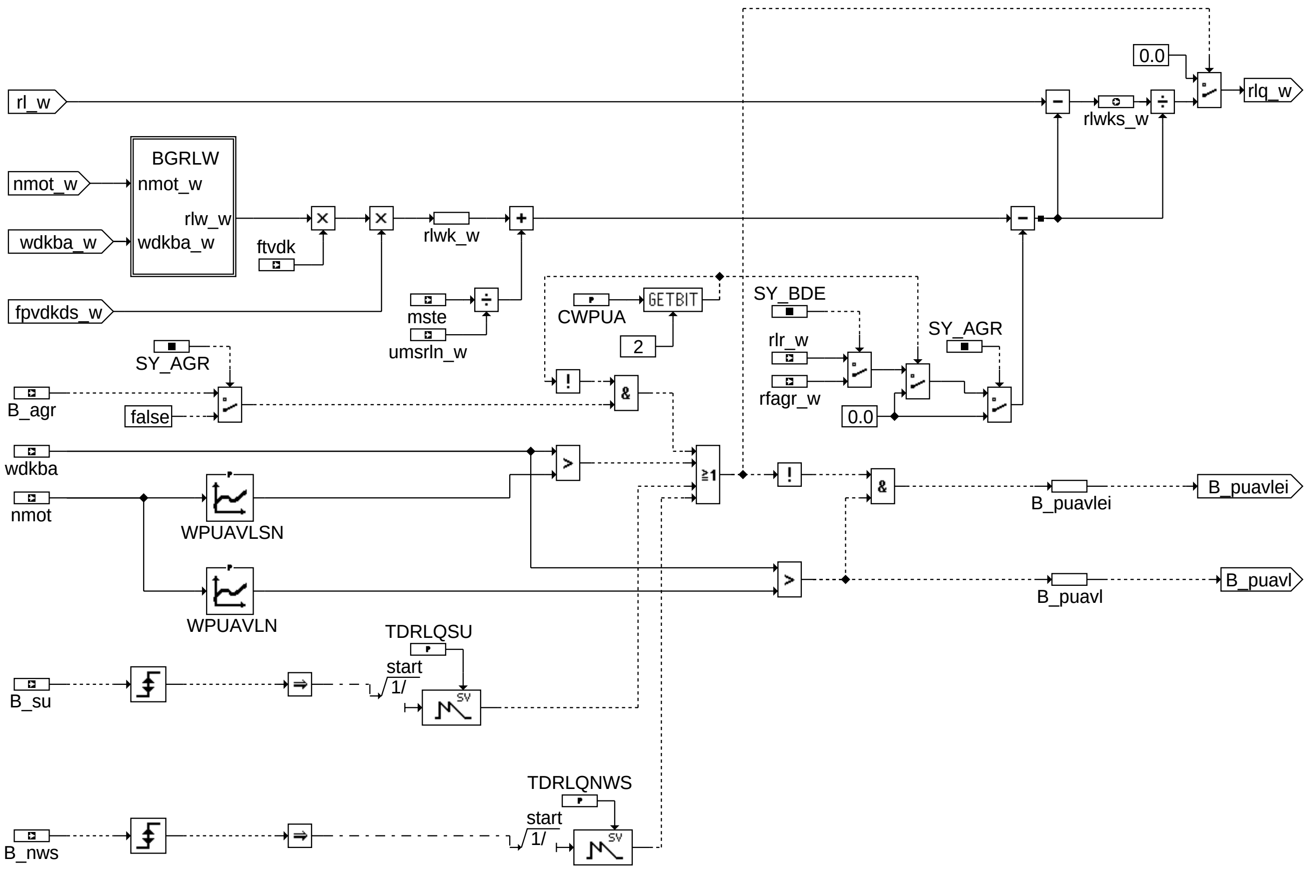
bgpu-bgpusa



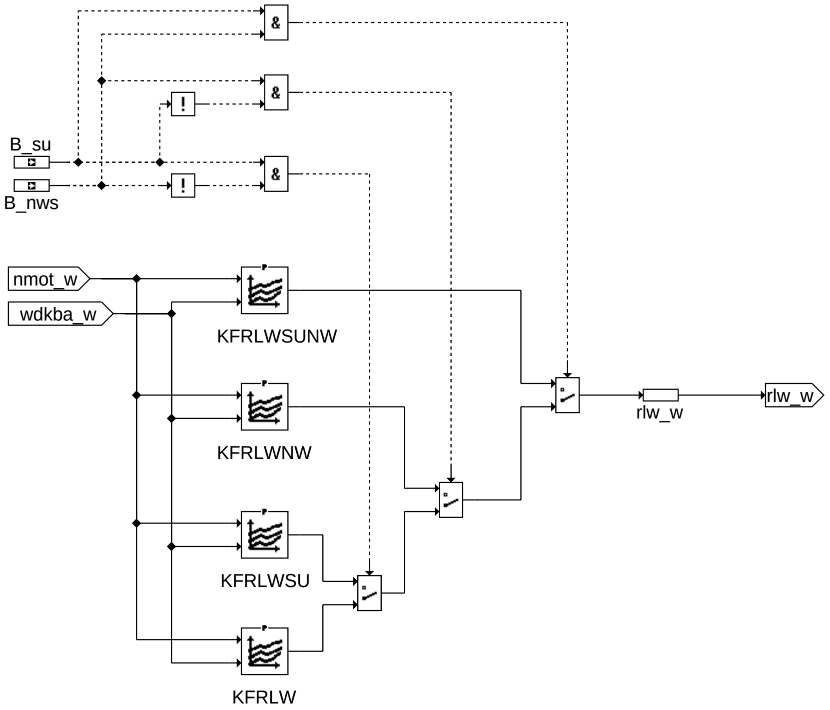
CWPUA Bit0 = false and Bit1 = false -->massflow adaption until pspvdk=0.95 if WPUAVLN=100%
CWPUA Bit0 = false and Bit1 = false -->massflow- and at wide open throttle rl/rlw-adaption if WDKBA > WPUAVLN
CWPUA Bit0 = true and Bit1 = false -->only rl/rlw adaption if WDKBA > WPUAVLN
CWPUA Bit0 = false and Bit1 = true -->only massflow adaption until WOT if WPUAVLN=100%

bgpu-bgpums

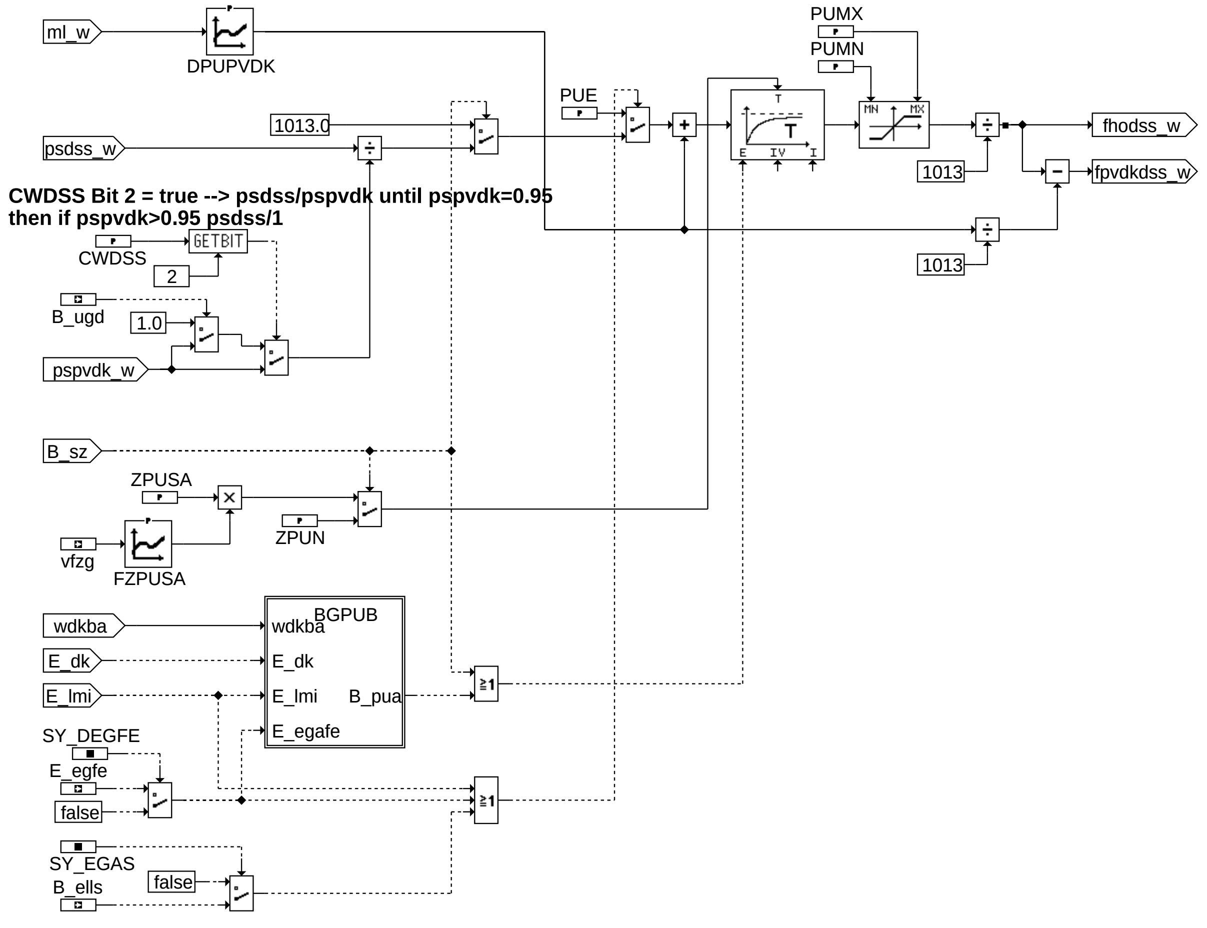
bgpu-bgpums



bgpu-bgpuavl

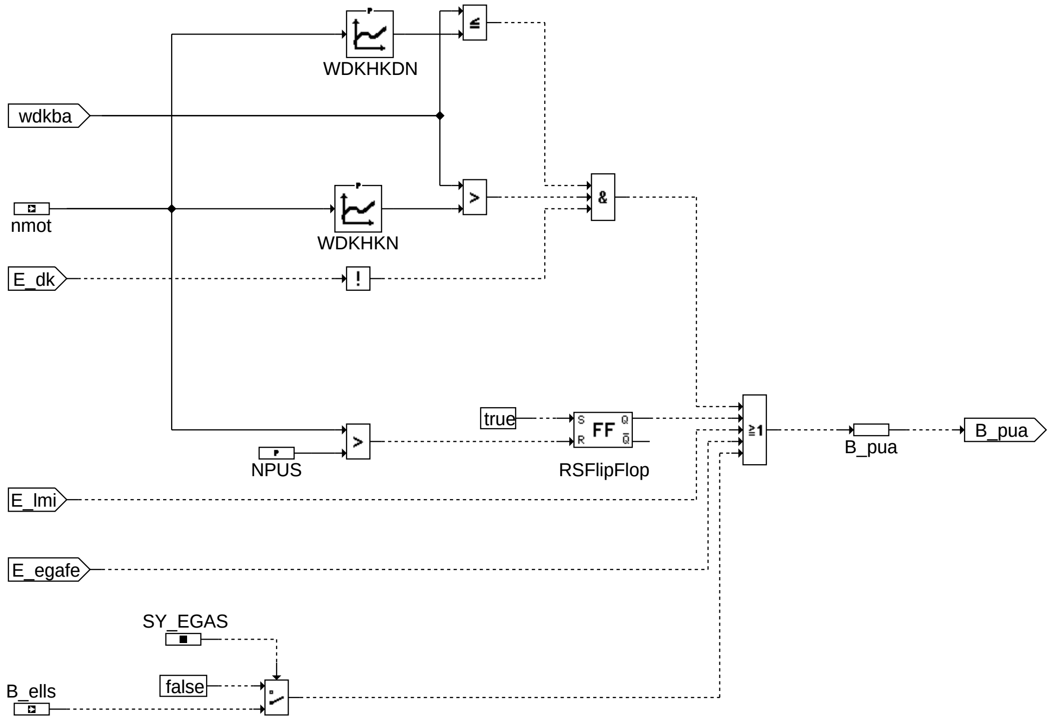


bgpu-bgrlw

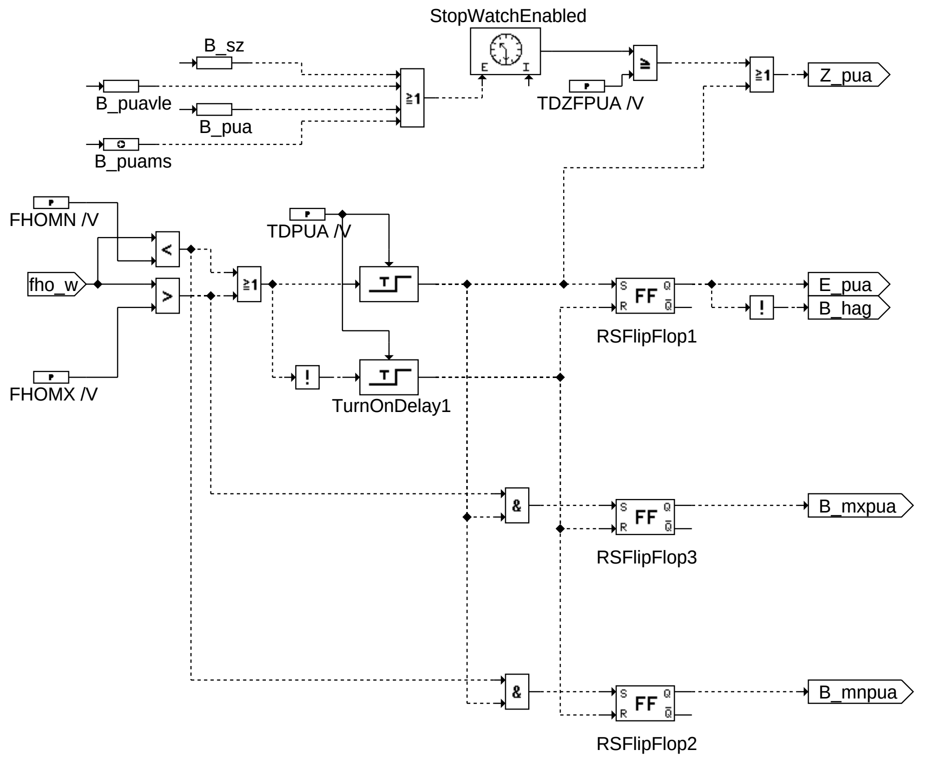


CWDSS Bit 2 = true --> psdss/pspvdk until pspvdk=0.95
then if pspvdk>0.95 psdss/1

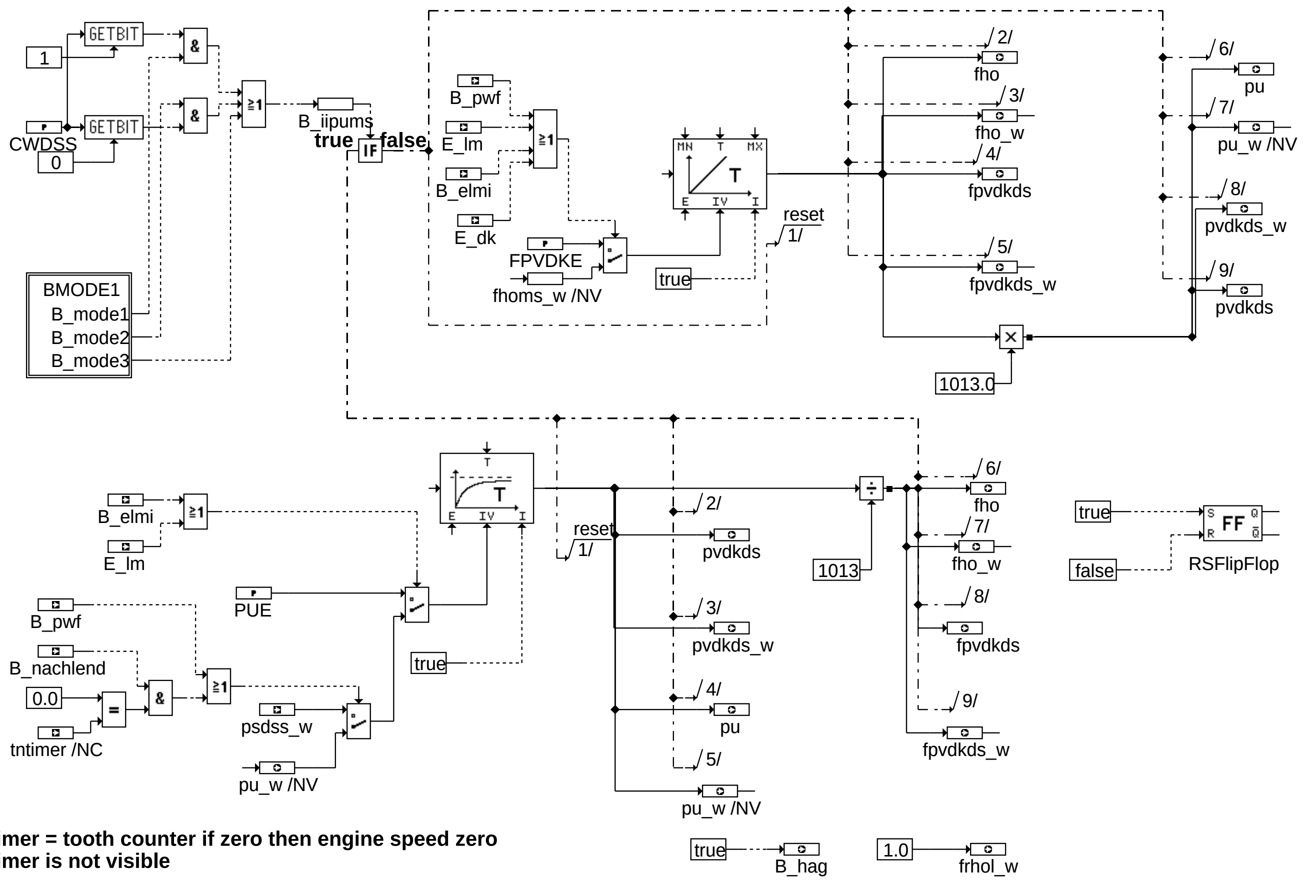
bgpu-bgpuds



bgpu-bgpub



bgpu-bgpupls

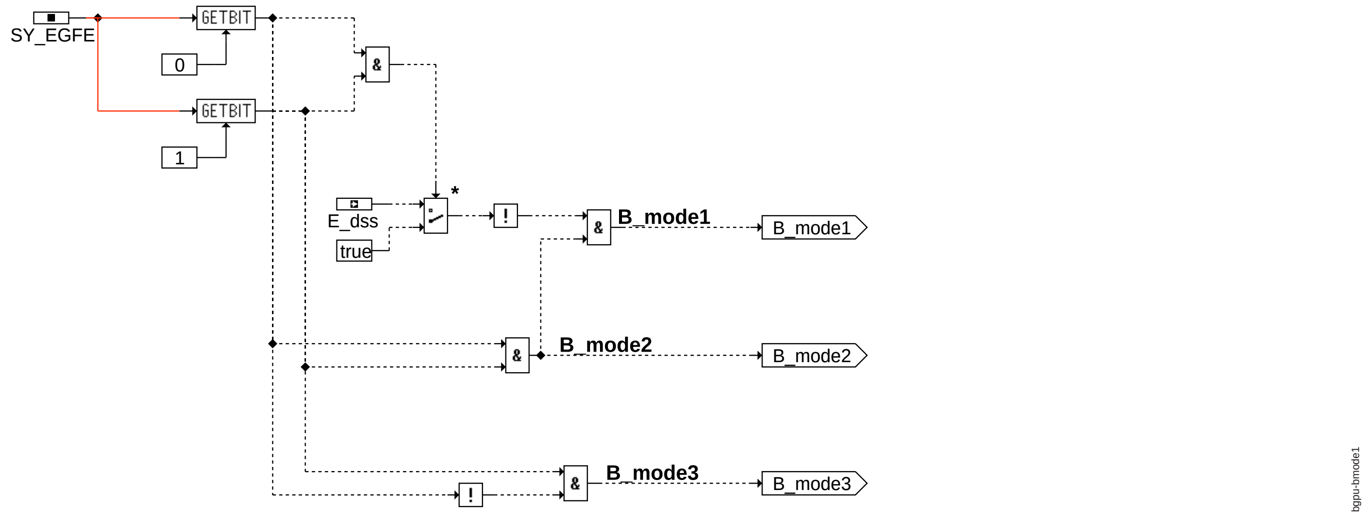


tntimer = tooth counter if zero then engine speed zero
tntimer is not visible

bgpu-init

please note: these switches (*) have to be realised by preprocessor

meaning of SY_EGFE:
Bit0=true HFM (MAFS) installed
Bit1=true manifold pressure sensor installed
Bit0 and Bit1=true both sensors installed



bgpu-bmode1

```
"- (*1) deviant to the circuit this part is realized in the module %DFPM."
"- (*2) The actions triggered by C_[*] (marked in the diagram with (*2)) are processed in the software in separate processes."

Fault Memory Management:
------------------------
Status fault path PUA: SFPPUA
Error flag PUA:        E_pua
Cycle flag PUA:        Z_pua
Fault type PUA:        B_mxpua
                       B_mnpua

Clear fault path:       C_fcmclr & B_clpua
Fault path PUA  :                 CDTPUA
Fault class PUA:                  CLAPUA
Fault severity PUA:               TSFPUA
Carb code PUA:                    CDCPUA                                   Ambient: U1PUA nmot_u
Ambient conditions PUA:           FFTDSU     Ambient conditions see %DFFT           U2PUA rl_u
```

ABK BGPU 3.100 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDSS			FW	Code word ambient presure adaptation via pressure sensor at the intake manifold
CWPUA			FW	Code word ambient pressure adaptation
DPUPVDK	ML_W		KL	pressure difference pu-pvdk
FHOMN			FW	minimum factor for diagnosis of altitude correction
FHOMX			FW	maximum factor for diagnosis of altitude correction
FKDISA	FHOMS_W		KL	faktor difference for integrator ambient pressure during fuel cut off
FPVDKE			FW	default value, pressure upstream of throttle valve
FPVDKMN			FW	lower limit for pressure upstream of throttle valve
FPVDKMX			FW	upper limit for pressure upstream of throttle valve
FZPUSA	VFZG		KL	correction faktor time constant ambient pressure adaptation during fuel cut-off
KFRLW	NMOT_W	WDKBA_W	KF	rlw-map from throttle valve angle
KFRLWNW	NMOT_W	WDKBA_W	KF	rlw-map from throttle valve angle during variable camshaft
KFRLWSU	NMOT_W	WDKBA_W	KF	rlw-map from throttle valve angle during manifold switch over
KFRLWSUNW	NMOT_W	WDKBA_W	KF	rlw-map from throttle valve angle during manifold switch over and aktive var. ch
KFZKPUA	WDKBA_W	NMOT_W	KF	time constant for ambient pressure
KIELM			FW	Integrator coefficient for ambient pressure counter during E_lm=true
KISA			FW	Integrator coefficient for ambient pressure counter during fuel cut-off
NPUS			FW	Deactivation threshold for ambient pressure adaptation during start
PUE			FW	substitute value for ambient pressure in case of sensor failure
PUMN			FW	Ambient pressure limitation minimum
PUMX			FW	Ambient pressure limitation maximum
SY_AGR			SYS (REF)	System constant AGR present
SY_BDE			SYS (REF)	system constant GDI
SY_DEGFE			SYS (REF)	system constant diagnosis input values load monitoring
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_EGFE			SYS (REF)	system constant input variable for charge detection
TDPUA			FW	debounce time for error entry, ambient pressure adaption
TDRLQNWS			FW	disable time for ambient pressure adaptation after switch camshaft

Parameter	Source-X	Source-Y	Type	Description
TDRLQSU			FW	disable time for ambient pressure adaptation after switch manifold flap
TDZFPUA			FW	time delay for setting cycle flag for ambient pressure adaptation
VHA			FW	Speed threshold for altitude adaptation
WDKHKDN	NMOT		KL	High threshold throttle plate for altitude adaptation
WDKHKN	NMOT		KL	Low threshold throttle plate for altitude adaptation
WPUAVLN	NMOT		KL	Throttle valve angle as of which VL ambient pressure adaptation is active
WPUAVLSN	NMOT		KL	Throttle valve angle as of which VL ambient pressure adaptation is blocked
ZPUN			FW	Time constant ambient pressure adaptation during normal operating
ZPUSA			FW	Time constant ambient pressure adaptation during fuel cut-off

Variable	Source	Type	Description
B_AGR		EIN	Condition AGR active
B_ELLS		EIN	Condition: error idle speed actuator
B_ELMI	DHFM	EIN	Condiion error massflow at initialisation
B_HAG	BGPU	AUS	condition altitude adaptation valid
B_IIPUMS	BGPU	LOK	condition initialisation mass flow adaptation
B_LL	MSF	EIN	Condition idle
B_MNPUA	BGPU	AUS	Condition: min-error ambient pressure adaptation
B_MXPUA	BGPU	AUS	Condition: max-error ambient pressure adaptation
B_NACHLEND	MOTAUS	EIN	conditon ECU switch off delay regularly finished
B_NWS	NWS	EIN	Condition camshaft control
B_PUA	BGPU	LOK	Condition ambient pressure adaptation active
B_PUAMS	BGPU	AUS	Condition ambient pressure adaptation by comparing mshfm/msdk
B_PUAVL	BGPU	LOK	Condition ambient pressure adaptation at WOT
B_PUAVLE	BGPU	LOK	Condition ambient pressure adaptation at WOT enable
B_PUAVLEI	BGPU	LOK	Condition ambient pressure adaptation at WOT enable internal
B_PWF		EIN	Condition for powerfail
B_SA	MDRED	EIN	Condition fuel cut-off
B_SU	SU	EIN	condition intake manifold switch-over
B_SZ	BGPU	LOK	Condition fuel cut-off counter during altitude correction
B_UGD	BGMSZS	EIN	condition: throttle angle greater or equal wdkugd
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_DSS		EIN	error flag: Manifold absolute pressure
E_EGFE	DEGFE	EIN	Error flag: input parameters for charging detection
E_LM	EGFE	EIN	Error flag: main load sensor
E_PUA	BGPU	AUS	error flag: ambient pressure adaptation
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
FHO	BGPU	AUS	Correction factor altitude
FHODSS_W	BGPU	LOK	correction factor: altitude manifold pressure based
FHOMS_W	BGPU	LOK	correction factor: altitude mass flow based
FHO_W	BGPU	AUS	correction factor: altitude
FKMSDKK_W	BGPU	LOK	correction factor for mass-flow substitute load signal after calc.from DPUPVDK
FKMSDK_W	BGMSZS	EIN	correction factor for mass-flow substitute load signal
FPVDKDS	BGPU	AUS	Factor pressure in front of throttle valve of pressure sensor
FPVDKDSS_W	BGPU	LOK	Factor pressure in front of throttle valve based of manifold pressure
FPVDKDS_W	BGPU	AUS	Factor pressure in front of throttle valve of pressure sensor (word)
FPVDKMS_W	BGPU	LOK	Factor pressure in front of throttle valve of mass flow based ambient press.adap
FRHOL_W	BGPU	AUS	Factor: air density f(intake air temp., altitude), 16-bit
FTU	BGTEMPK	EIN	factor: ambient temperature
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
PSDSS_W		EIN	Intake manifold pressure measured with pressure sensor at manifold (DS-S)
PSPVDK_W	EGFE	EIN	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PU	BGPU	AUS	Ambient pressure
PU_W	BGPU	AUS	Ambient pressure
PVDKDS	BGPU	AUS	Pressure in front of throttle valve of pressure sensor
PVDKDS_W	BGPU	AUS	Pressure in front of throttle valve of pressure sensor (word)
RFAGR_W	BGSRM	EIN	relative load by external exhaust gas reduction
RLQK_W	BGPU	LOK	Quotient rlw/rl density-corrected behind sumation of DPUPVDK
RLQ_W	BGPU	LOK	Quotient rlw/rl density-corrected
RLR_W		EIN	relative air-load over int. and ext. EGR
RLWKS_W	BGPU	AUS	sum corrected rel. air charge from auxiliary load signal (Word)
RLWK_W	BGPU	LOK	corrected rel. air charge from auxiliary load signal (Word)
RLW_W	BGPU	LOK	relative air charge from auxiliary load signal (Word)
RL_W	EGFE	EIN	relative air charge (Word)
TNTIMER		EIN	tooth counter not recordable with VS100
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
VFZG	SWADAP	EIN	vehicle speed (km/h)
WDKBA	GGDVE	EIN	throttle angle
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
Z_PUA	BGPU	AUS	cycle flag: ambient pressure adaptation

FW BGPU 3.100 Fixed Values

Parameter	Value	Description
CWDSS		Code word ambient presure adaptation via pressure sensor at the intake manifold
CWPUA		Code word ambient pressure adaptation
FHOMN		minimum factor for diagnosis of altitude correction
FHOMX		maximum factor for diagnosis of altitude correction
FPVDKE		default value, pressure upstream of throttle valve
FPVDKMN		lower limit for pressure upstream of throttle valve
FPVDKMX		upper limit for pressure upstream of throttle valve
KIELM		Integrator coefficient for ambient pressure counter during E_lm=true
KISA		Integrator coefficient for ambient pressure counter during fuel cut-off
NPUS		Deactivation threshold for ambient pressure adaptation during start
PUE		substitute value for ambient pressure in case of sensor failure
PUMN		Ambient pressure limitation minimum
PUMX		Ambient pressure limitation maximum
TDPUA		debounce time for error entry, ambient pressure adaption
TDRLQNWS		disable time for ambient pressure adaptation after switch camshaft
TDRLQSU		disable time for ambient pressure adaptation after switch manifold flap
TDZFPUA		time delay for setting cycle flag for ambient pressure adaptation
VHA		Speed threshold for altitude adaptation
ZPUN		Time constant ambient pressure adaptation during normal operating
ZPUSA		Time constant ambient pressure adaptation during fuel cut-off

FB BGPU 3.100 Detailed description of function

An ambient pressure adaptation is realized by means of this function. In the process a switch to two physically different adaptation methods is performed via the system constant SY_EGFE Bit0 and Bit1.
If SY_EGFE Bit0 = false and Bit1 = true (SY_EGFE Bit0=B_hfm and Bit1=B_dssv) the ambient pressure is determined from a pressure sensor mounted in the intake manifold. This kind of ambient pressure adaptation is used for a pressure-sensor-based charge sensing (p-system).
If SY_EGFE Bit0 = true and Bit1 = false the ambient pressure is learned from the output value of the "fast integrator" (fkmsdk). This means that the difference between the two charge signals mshfm and msdk_w, which is outputted as factor in the output value of fkmsdk serves for the ambient pressure adaptation. This method is used for the ambient pressure adaptation on aspirating engines with HFM but without ambient pressure sensor.
If SY_EGFE Bit0 = true and Bit1 = true, the ambient pressure adaptation can either be pressure-sensor-based or mass-flow-based. Here the pressure-sensor-based adaptation should be given preference.
By the code word CWDSS the following selection can be made in the process:

```
                CWDSS   Bit0    Bit1
                        false   false ---> only mass-flow ambient-pressure-based pu-adaptation
                        true     x    ---> only pressure-based pu-adaptation
                        false   true  ---> pressure-based pu-adaptation when E_dss=true switch-over to mass-flow-based
                                           pu-adaptation

                        Bit2 CWDSS is only relevant at pressure-sensor-based ambient pressure adaptation.
                        Bit2 initial data entered --> false     Only in special cases may Bit2=true (fast integrator at
                                                                pspvdk > 0.95 stop and active Pu-adaptation in this range)
                                                                If Bit2=true theoretical fault worst-case 50 hPa = 500 m
```

When SY_EGFE Bit0 = true and Bit1 = false (EGFE=01) the following applies:
An altitude factor resp. the pressure upstream throttle valve, which added to the pressure drop at the air filter DPUPVDK corresponds to the ambient pressure can be learned by comparing the secondary charge signal (msdk) with the main charge signal (mshfm). The comparison of the two charge signals is, however, not performed in this module but in the function %BGMSZS.
The secondary charge path is adjusted to the main charge path by the correction factor fkmsdk via the so-called "fast integrator". This is realized by a feedback of the integrator output to the secondary charge signal. In the temporal mean and with correct application of the secondary charge signal the correction factor fkmsdk will be equal to 1.
Description of the physical effect of the ambient pressure adaptation on mass flow comparison:
When driving at high altitude the secondary charge signal remains constant, the main charge signal becomes smaller and smaller due to decreasing air density with increasing altitude. The "fast integrator" controls this deviation of the two charge signals down to zero in the function BGMSZS. At e.g. 2000 m above sea level the mean correction factor fkmsdk would be at 0.8. The correction factor fkmsdk is now transferred to the function BGPU for the formation of the ambient pressure. There, the input of the ambient pressure integrator is set to the value fkmsdk minus 1. The ambient pressure integrator runs at about 1/10th of the adaptation speed of the "fast integrator". A deviation of the two mass flows, which lasts for longer, is thereby interpreted as ambient pressure change. The output of the integrator keeps on changing until the two mass flows (mshfm/msdk) have matched via the output values fpvdkds and pvdkds in the function BGMSZS. The "fast integrator" in BGMSZS then has the value 1 in the temporal mean as output value fkmsdk. The factor pressure upstream throttle valve and the factor altitude are available at the output of the ambient pressure adaptation. The pressure upstream throttle valve, which corresponds to the ambient pressure, is calculated by a multiplication by the standard pressure (1013hPA). The factors FPVDKMX and FPVDKMN represent a limitation of the upper and of the lower adaptation range. The output value of the integrator after power fail or in case of a fault of one of the two charge signals can be defined by the factor FPVDKE.
The ambient pressure adaptation speed is adjusted dependent on engine speed and throttle angle via the map KFZKPUA.

With code word CWPUA=0 at first a switch to the already described mass-flow-based ambient pressure adaptation is performed. If then the condition wdkba > WPUAVLN = true (e.g. at pspvdk >= 0.9) the rl/rlw-based ambient pressure adaptation is switched to.
With code word CWPUA=1 and WPUAVLN = 100 % always (in the entire operating range) the rl/rlw-based ambient pressure adaptation is active. On engines with manifold switchover resp. camshaft adjustment depending on the operating state different rlw maps exist, which take the influencing of the charge into consideration via intake-manifold flap resp. camshaft adjustment. The following a/n maps are active:

no manifold switch-over and camshaft adjustment active	KFRLW
manifold switchover active	KFRLWSU
camshaft adjustment active	KFRLWNW
manifold switch-over and camshaft adjustment active	KFRLWSUNW

It is recommendable to activate the rl/rlw adaptation at a pressure ratio of approx. 0,9 at the latest, however, at pspvdk 0,95. Attention needs to be paid here, that the two adaptation methods are enabled in the desired adaptation range via the map KFZKPUA. Generally it always applies to rl/rlw adaptation that it can be blocked in pulsation ranges via the characteristic WPUAVLNS. Furthermore attention needs to be paid that the desired adaptation range is enabled via KFZKPUA. This applies to the rl/rlw pu-adaptation as well as to the mass-flow-based ambient pressure adaptation.
With CWPUA Bit1=true and active fast integrator CWFKMSDKA=1 (%BGMSZS fast integrator also active in VL) the mass-flow-based ambient pressure adaptation can also be used in the vicinity of full load. Here it must be ensured that in the pulsation range at VL no too large ambient pressure deviations occur (altitude test). On ME7 systems this kind of ambient pressure adaptation is not recommendable, since sudden deviations from main to secondary charge signal can lead to unsteadiness of the throttle valve movement in the vicinity of full load.

When SY_EGFE Bit0 = false and Bit1 = true (EGFE=2) the following applies:
The factor ambient pressure adaptation (fpvdkds resp. fho) serves to adjust functions to the altitude (e.g. start control, correction of load signal). The ambient pressure factor is determined via a measurement of the manifold pressure in operating and map ranges, in which the manifold pressure approximately corresponds to the ambient pressure.
The first manifold pressure measurement is performed during start, if C_ini is fulfilled and if the engine speed is still below a threshold value (NPUS).
The second adaptation range lies from characteristic WDKHKN until WDKHKDN is reached when the throttle angles are exceeded. Above WDKHKN the measured manifold pressure corresponds to the ambient pressure. This fact is made use of when learning the ambient pressure. By the division of manifold pressure/pressure upstream throttle valve the ambient pressure is determined also from the manifold pressure of a throttled engine (manifold pressure is < than ambient pressure). Up to which manifold pressure this method calculates a sufficiently exact ambient pressure, needs to be determined with each project. If the determined ambient pressure e.g. >= +/- 70 hpa deviates from the actual value, the ambient pressure adaptation needs to be blocked for even smaller throttle angles at this engine speed (with WDKHKN).
On engines with little pulsation the fast integrator can also be enabled if pspvdk >= 0,95. The characteristic WDKHKDN must then be set to 100%; bit 2 of CWDSS must then be false (psdss is always divided by pspvdk).
On engines, which have critical pulsation it is possible to block the adaptation when pspvdk=0.95 is reached by means of the characteristic WDKHKDN. Disadvantage of this being that no adaptation will be performed during a long uphill drive at full load.
By CWDSS Bit2=true a switchover to psdss/1 is performed when pspvdk=0.95 is reached. Attention needs to be paid here that the characteristic WDKHKDN does not prohibit the adaptation; set value everywhere to 100%. Adaptation at full load is also performed with this configuration.
The theoretical worst-case deviation shortly after pspvdk >0.95 has been reached here is 50 hPa = 500m, with increasing pspvdk this fault becomes smaller until it equals zero when pspvdk=1 is reached.

The time constant of the low pass varies as follows:

The initialization value is ZPUSA.
The low pass for the filtering of the manifold pressure signal psdss/pspvdk is filtered with the time constant ZPUN during normal operating.

With detected altitude (fho<1) the adaptation factor increases with the time constant ZPUSA during fuel cut-off or during idling at correspondingly valid vehicle speed (B_sz). Thus it is achieved that during long downhill driving and with closed throttle valve (during which no adaptation is possible) the altitude factor is corrected in the direction of a lesser altitude.
With B_sz=true the low pass filter travels from the current value to the standard value 1013 hPa with the time constant ZPUSA. This means, that e.g. at 3000 m above sea level a quicker control down to low altitude is performed if the condition B_sz=true than at 500 m above sea level. By this behavior, large slope gradients at high altitude and small slope gradients at low altitude, a usual mountain profile is taken into account.

A plausibility check on the fho signal is performed in the subfunction BGPUPLS independent of which ambient pressure adaptation method is active. If the altitude factor fho is less than the fixed value FHOMN or greater than the fixed value FHOMX, the error bit E_pua is set to true after the delay time TDPUA. Inverse to E_pua the flag altitude adaptation valid B_hag is set to false. This information is inquired upon in the EGR valve and secondary air valve diagnosis.

The pressure drop at the air filter element is taken into consideration via the characteristic DPUPVDK dependent on the air mass flow ml for both methods of the ambient pressure adaptation (pressure sensor and mass flow based). The values for the pressure drop at the air filter element differ for each project and must be determined at various air flow rates. Attention must be paid here that an air filter and an air filter container intended for the series production are used.

APP BGPU 3.100 Application hint

The pressure-sensor-based ambient pressure adaptation is realized by an evaluation of the manifold pressure. The mass flow through the throttle valve is corrected by the generated output signals.
The measured manifold pressure approximately corresponds to the ambient pressure in the range close to full load at wide-open throttle valve and during start at low engine speeds. By a division of the manifold pressure by the pressure ratio pspvdk it is possible to determine the pressure upstream throttle valve and thus the ambient pressure.

Definition of the adaptation range:

- Define adaptation range (when entering 65535 the adaptation is disabled) KFZKPUA such that the difference between adapted and real ambient pressure is never more than 10%.
  The ambient pressure adaptation may not be active during idle resp. in a range close to idle psvdk < 0,5 or if WDKBA < 10%.
- Record manifold pressure during start and define engine speed threshold NPUS such that the manifold pressure corresponds to the ambient pressure up to this engine speed.

Adjustment of the time constants:

- Choose time constant ZPUN that slow that small deviations of the pressure, which constantly occur while driving are only slightly corrected
  -> Limit: Altitude factor fho must still be reliably corrected during fast driving at altitude drag fault < 30 hPa
  -> Guidance value: Learning of a delta pu = 30 hPa within approx. 15 sec

Adjustment of the fuel cut-off counter:

- Set ZPUSA and KISA for slow downhill driving
  -> Guidance value: Setting to an altitude difference per time of 1 m/sec

Guidance values for the initial application at pressure-sensor-based ambient pressure adaptation partial function BGPUDS:

PUMX : 1250 hPa
PUMN : 350 hPa
PUE : 1000 hPa
NPUS : 400 rpm
ZPUSA : approx. 2000 sec
ZPUN : approx. 160 sec

WDKHKN : At different engine speeds enter values such that faults psdss/pu are 10% at the maximum. Guidance values for initial data: Determine throttle angle at corresponding engine speed base points in WDKHKN, at which the pressure ratio ps/pu <= 0.525 (over critical).

if CWDSS Bit 2 = false the fast integrator must have been enabled in the VL-range CWFKMSDKA=1 (%BGMSZS)

WDKHKDN : Enter 100% into entire characteristic. If an unlearning can be detected in one ambient pressure adaptation range, this range can be blocked by according data being entered into WDKHKDN (wdkbl < WDKHKDN pu-adaptation blocked)

if CWDSS Bit 2 = true then

WDKHKDN : Enter 100% into entire characteristic. Then adaptation is enabled also when pspvdk => 0.95
When pspvdk => 0.95 is exceeded a switchover from psdss/pspvsdk to psdss/1 is performed via B_ugd.
If an unlearning can be detected in one ambient pressure adaptation range,
this range can be blocked by according data being entered into WDKHKDN (wdkbl < WDKHKDN pu-adaptation blocked)

Guidance values for initial application of mass-flow and rl/rlw ambient pressure adaptation partial function BGPUMS and BGRLW:

FPVDKMX : 1.25
FPVDKMN : 0.35

FKDISA :

fhoms_w ->	0.0	0.499	0.5	0.6	0.7	0.8	0.95	1.00
	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0

(FKDISA=0.001 integrator slow, FKDISA=2 integrator fast)

KISA : 1500 s (KISA=1 integrator fast, KISA=65535 integrator slow)
KIELM : 150 s (KIELM=1 integrator fast, KIELM=65535 integrator slow)
FPVDKE : 1.0

KFZKPUA :

nmot_w ↓ / wdkba_w -->	0	5	10	15	20	30	35	40	60	70	80	100
6000	65535	65535	65535	65535	65535	66	66	66	66	66	66	66
5000	65535	65535	65535	65535	65535	66	66	66	66	66	66	66
4000	65535	65535	65535	65535	66	66	66	66	66	66	66	66
3000	65535	65535	65535	65535	66	66	66	66	66	66	66	66
2000	65535	65535	65535	65535	66	66	66	66	66	66	66	66
1500	65535	65535	65535	66	66	66	66	66	66	66	66	66
1000	65535	65535	65535	66	66	66	66	66	66	66	66	66
800	65535	65535	65535	65535	65535	65535	65535	65535	65535	65535	65535	65535

(KFZKPUA=65535 integrator stop, KFZKPUA=1 integrator fast)

Enter 66 everywhere in KFZKPU with rl/rlw-based ambient pressure adaptation. With this type of adaptation the adaptation is enabled via the characteristic WPUAVLN. The adaptation is blocked via the characteristic WPUAVLSN.

KFRLW : With charge-correct application of the main signal path transfer the according rl-value to each base point of KFRLW when B_su and B_NWS = false. (Set ambient pressure to day pressure, temperature model must have been adjusted). Adjust DPUPVDK, then with currently set pu and charge-correctly adjusted secondary charge signal rlqk_w must be 0 for each base point

KFRLWSU : With charge-correct application of the main signal path transfer the according rl-value to each base point of KFRLWSU when B_su = true and B_NWS = false. (Set ambient pressure to day pressure, temperature model must have been adjusted). Adjust DPUPVDK, then with currently set pu and charge-correctly adjusted secondary charge signal rlqk_w must be 0 for each base point

KFRLWNW : With charge-correct application of the main signal path transfer the according rl-value to each base point of KFRLWNW when B_su = false and B_NWS = true. (Set ambient pressure to day pressure, temperature model must have been adjusted). Adjust DPUPVDK, then with currently set pu and charge-correctly adjusted secondary charge signal rlqk_w must be 0 for each base point

KFRLWSUNW: With charge-correct application of the main signal path transfer the according rl-value to each base point of KFRLWSUNW when B_su and B_NWS = true. (Set ambient pressure to day pressure, temperature model must have been adjusted). Adjust DPUPVDK, then with currently set pu and charge-correctly adjusted secondary charge signal rlqk_w must be 0 for each base point

Example for WPUAVLN only mass-flow-based adaptation

WPUAVLN : nmot -> 800 1000 1500 2000 2500 3000 3500 4000 4500 5000 5550 6000
fill all base points with 100 then rl/rlw adaptation never becomes active
(Since the start of the ambient pressure adaptation takes place at wdkba > characteristic value of WPUAVLN

```
                 !! enter data into KFZKPUA such that mass flow based adaptation starts as from desired throttle angle)
                CWPUA = 0

        Example for WPUAVLN mass-flow-based and rl/rlw adaptation
WPUAVLN   : nmot ->  800  1000  1500  2000 2500  3000   3500  4000   4500  5000  5550  6000
                       Enter throttle angle at pspvdk 0,90 for each engine speed base point
                (In the chosen example start of the ambient pressure adaptation at wdkba > characteristic value of WPUAVLN
                 !! enter data into KFZKPUA such that integrator is enabled as from mass-flow-based adaptation up to and including
                    rl/rlw adaptation (pspvdk<0,9).
                    CWPUA = 0

        Example for WPUAVLN only rl/rlw adaptation
WPUAVLN   : nmot ->  800  1000  1500  2000 2500  3000   3500  4000   4500  5000  5550  6000
                      12  15    18     20   22    24     28    30     35    35    35    35
                (In the chosen example start of the ambient pressure adaptation at wdkba > characteristic value of WPUAVLN
                 !! Important: Ambient pressure adaptation will only adapt if time constant is not equal to 65535 in KFZKPUA)
                    CWPUA = 1


        Example for WPUAVLSN pu-adaptation rl/rlw based from 1500- 2000 rpm at > 60 %DK blocked
WPUAVLSN   : nmot ->  800  1000  1500  2000 2500  3000   3500  4000   4500  5000  5550  6000
                      100  100    60    60   60   100    100   100    100   100   100   100
                (In the chosen example stop of the ambient pressure adaptation at wdkba > 60 deg. from nmot 1500 rpm to 2500 rpm
                 The rl/rlw adaptation is enabled without limits if it says 100 in the entire characteristic line)


TDRLQSU :       approx. 2 sec
TDRLQNWS:       approx. 2 sec




Guidance values for the initial application independent of the type of ambient pressure adaptation:

FHOMX    : 1.2
FHOMN    : 0.4
TDZFPUA  : Adjust time 150 sec such that incorrect ambient pressure adaptation will stabilize during the emission test.
           (On engines with large displacement do not choose TDZFPUA too large, since cycle flag is then not set during
           the emission test [Reason being that vehicle is operated at such small throttle angles that the ambient pressure
           adaptation is only enabled for e.g. 50 seconds during the entire test] set TDZFPUA = 40 seconds in given example)
DPUPVDK  : Pressure drop at air filter element with varying air mass flows (ml) set up between idle value and ml
            value at maximum engine speed  (extremely project-dependent)
           (if value is unknown enter 0 into DPUPVDK, then the pressure upstream throttle valve is the same as ambient pressure)


FZPUSA: Base points vfzg 20  40  50  60  70  80  90  100
        Values              .... 1.0....                        the speed-dependent intervention at fuel cut-off is
                                                                switched off by this.
TDPUA    : 200 ms
VHA      :  15 km/h
```

BGRML 1.20 Calculation Value of Relative Air Mass according to SAE J1979 Mode $01 + $02 PID

FDEF BGRML 1.20 Function definition

SY_TURBO = 0:

```
                                                  +---+
       ml_w ------------------------------------->| : +---------------------------> rml (Q: 1 Byte, 0 ... FF hex)
                                                  +---+
                               +---+                ^
      fpvdk_w ---------------->| * +----------------+
                               +---+
                                 ^
      MLMAX ---------------------+
```

SY_TURBO = 1:

```
                                                  +---+
       ml_w ------------------------------------->| : +---------------------------> rml (Q: 1 Byte, 0 ... FF hex)
                                                  +---+
                                                    ^
      MLMAX ----------------------------------------+
```

ABK BGRML 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MLMAX			FW	maximum air-quantity for load calculation SAE J1979
SY_TURBO			SYS	system constant for exhaust-gas turbocharger

Variable	Source	Type	Description
FPVDK_W	EGFE	EIN	correction factor for pressure upstream of throttle valve, 16-bit
ML_W	EGFE	EIN	air mass flow filtered (Word)
RML	BGRML	AUS	relative air mass (calc. load value) acc. to SAE J1979

FW BGRML 1.20 Fixed Values

Parameter	Value	Description
MLMAX		maximum air-quantity for load calculation SAE J1979

FB BGRML 1.20 Detailed description of function

```
Areas of utilization such as e.g. the SCAN TOOL transfer according to SAE J1979 necessitate the variable "relative air mass" (rml),
also referred to as "Calculated Load Value" (CLV) in the SAE J1979. In accordance to SAE J1979 the formula is:

               Current airflow           Atmospheric pressure (@sea level)
    CLV = --------------------------- * ----------------------------------- * 100 %
           Peak airflow (@sea level)           Barometric pressure


Derived from this the following results
a) for an aspirating engine (SY_TURBO = 0):
               ml_w
    rml = ----------------- * 100%
           MLMAX * fpvdk_w

b) for a turbo engine (SY_TURBO = 1):
               ml_w
    rml = --------------- * 100%
               MLMAX
On systems with turbo charger the inclusion of altitude correction factors is dropped!


The calculation of rml is performed for a) + b) with the quantization 0 ... 255 dec corresponds to 0 ... 100 % .
The calculation is to be performed every 100 ms.
```

APP BGRML 1.20 Application hint

```
Determination of MLMAX:
MLMAX corresponds to the peak airflow of the engine at fully open throttle valve and high engine speed.
The value MLMAX is usually known to engine manufacturers and is to be adjusted in agreement with the customer.

Example (with open throttle valve):
                                                       MLMAX
                                                          |
     ml ^                                                 v
        |                                               *   *
        |                                          *            *
        |                                      *                  *
        |                                  *                         *
        |                              *
        |                          *
        |                      *
        |                  *
        |              *
        |          *
        |      *
        |  *
        +----------------------------------------------------------------->
                                                                         n
```

EGTE 1.0 Input variables for recording the temperature

FDEF EGTE 1.0 Function definition

Responsible:

ABK EGTE 1.0 Abbreviations

FW EGTE 1.0 Fixed Values

Parameter	Value	Description

FB EGTE 1.0 Detailed description of function

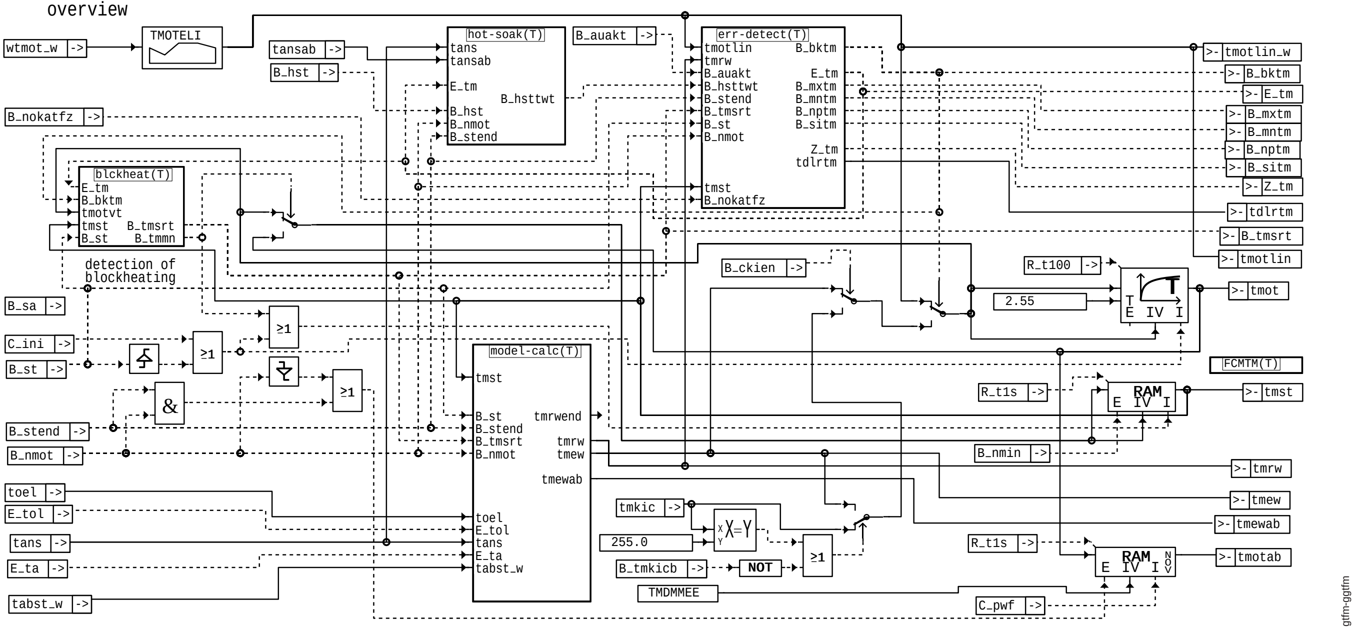
```
There is no text for this FDEF !!!!

Responsible:
```

APP EGTE 1.0 Application hint

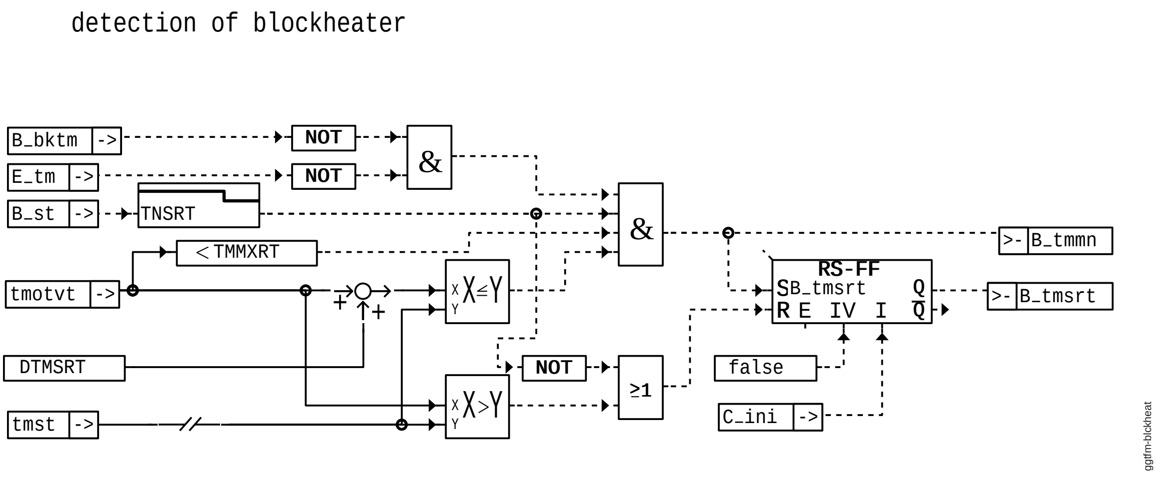
GGTFM 40.60 Signal engine temperature sensor

FDEF GGTFM 40.60 Function definition

overview

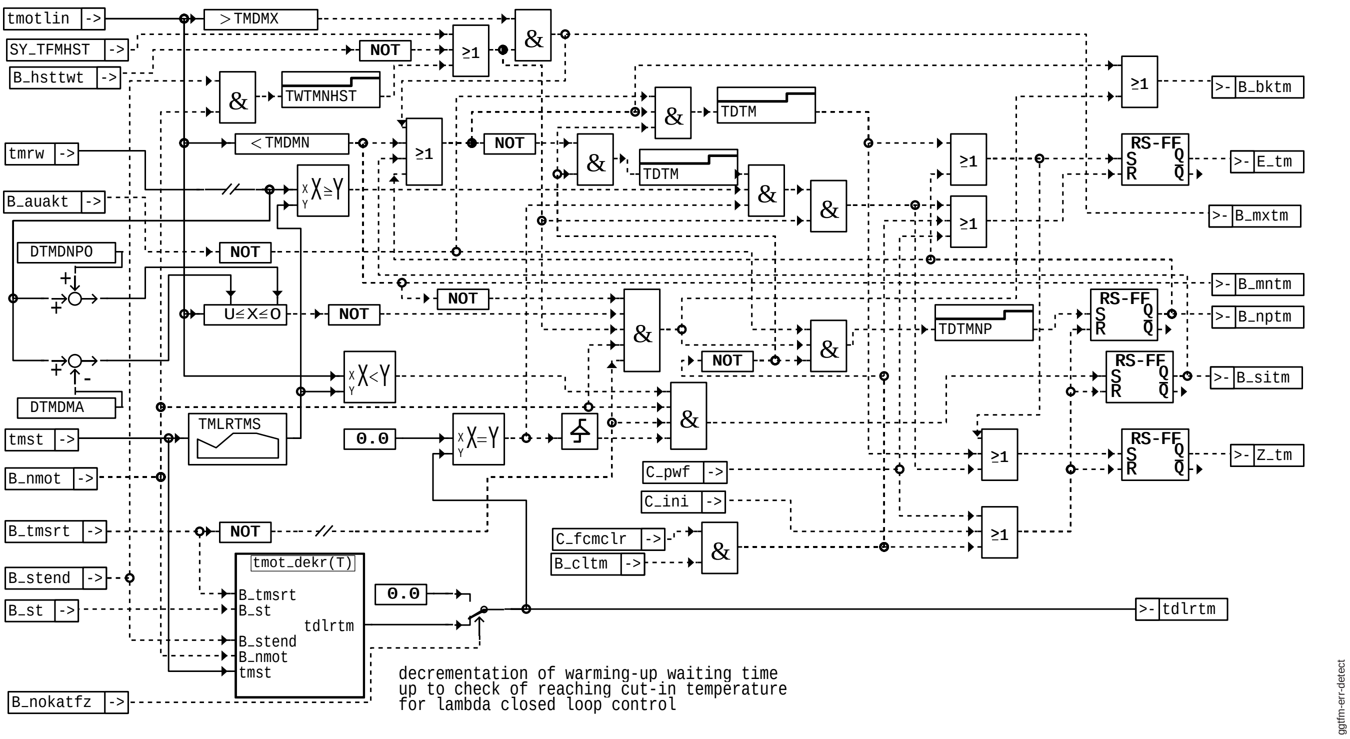


ggtfm-ggtfm

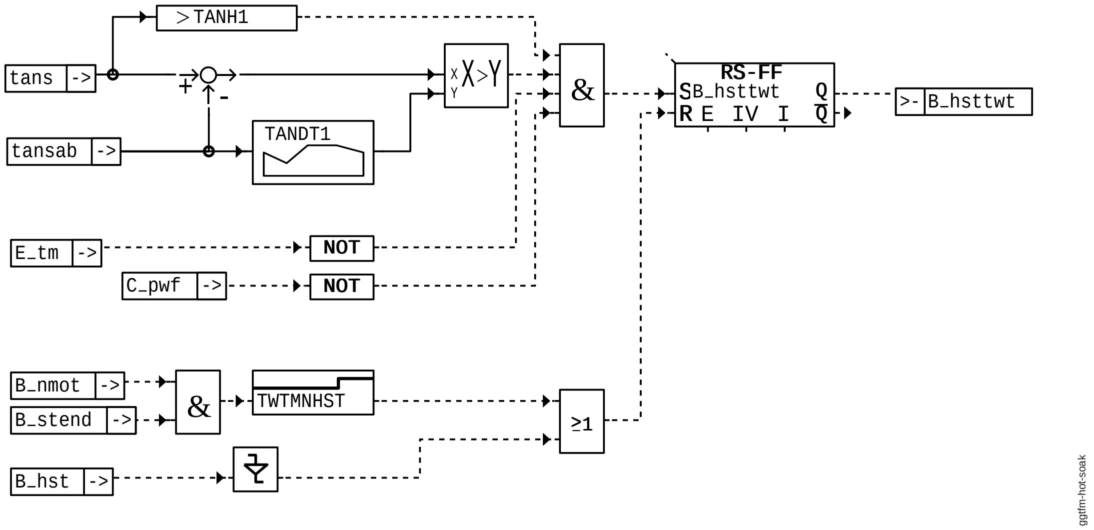


ggtfm-blckheat

section for error detection

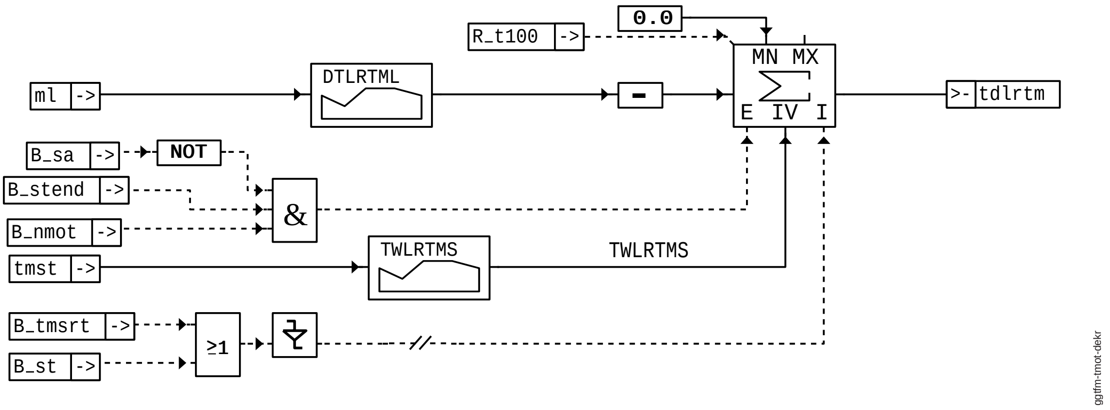


ggtfm-err-detect



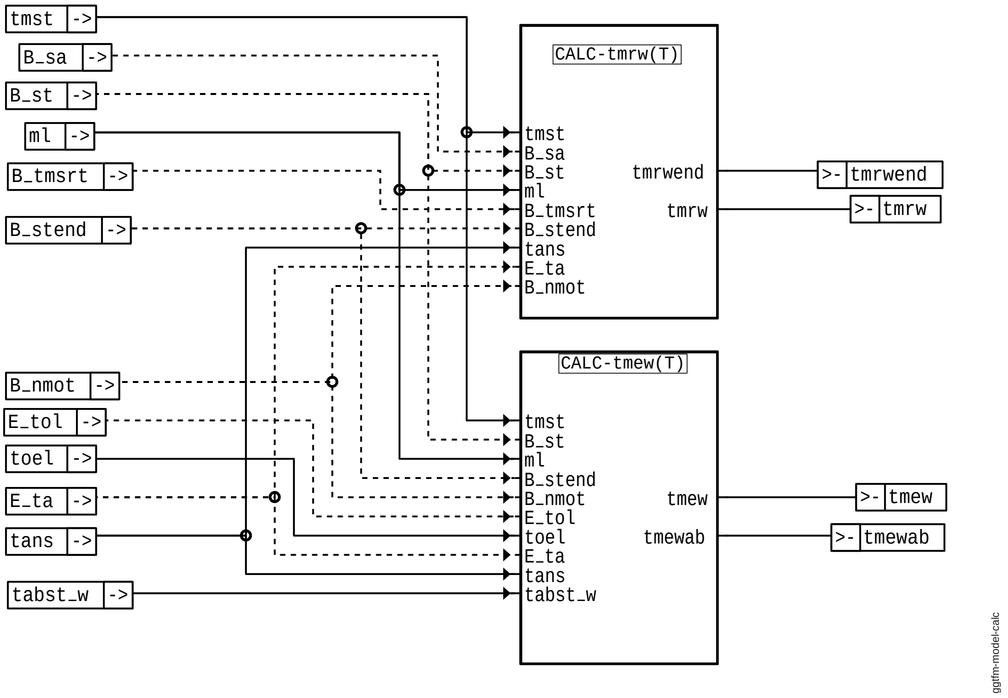
ggtfm-hot-soak

initialization and control of
warming-up waiting time counter

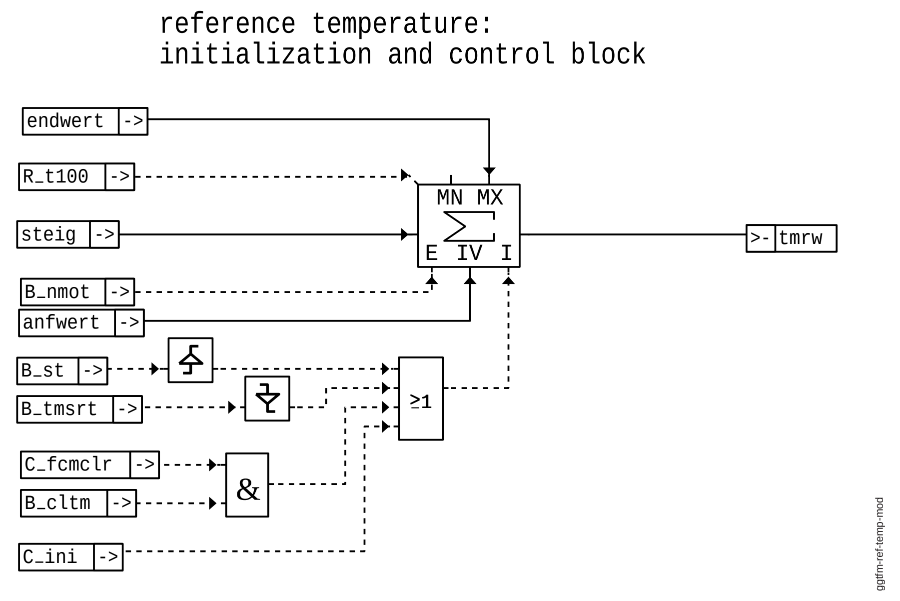


ggtfm-tmot-dekr

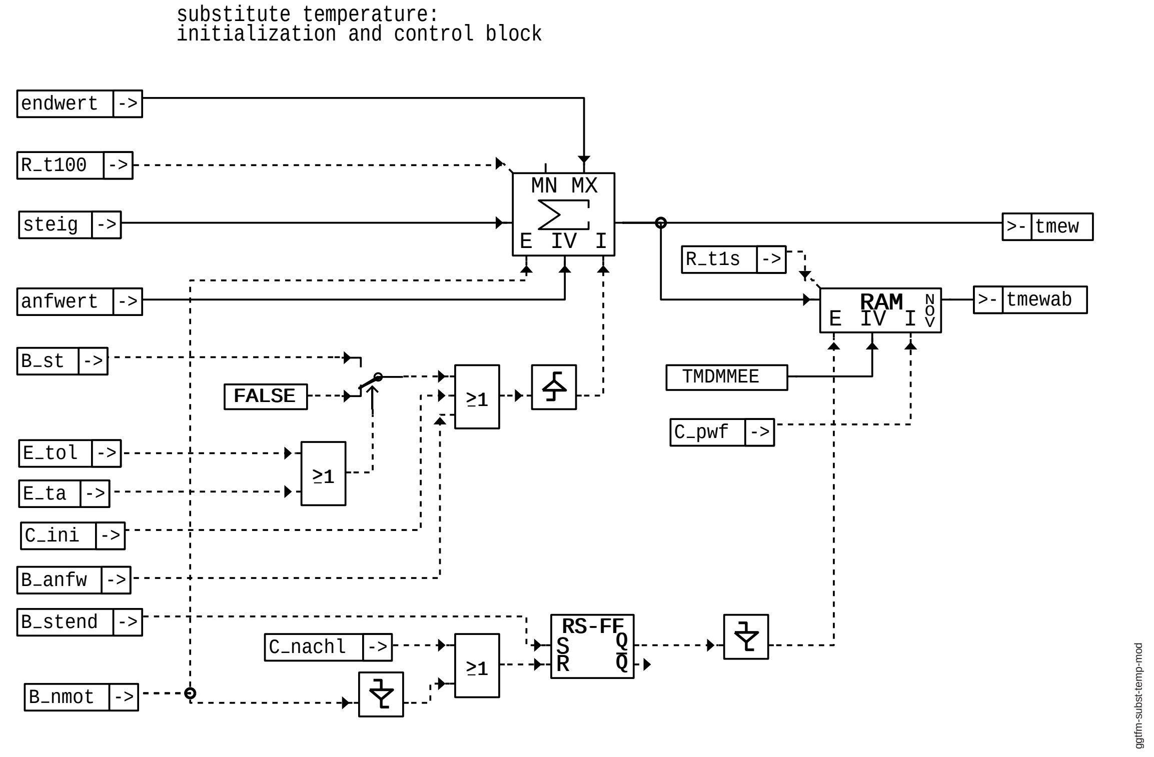
model calculations for engine coolant temperature (overview)



ggtfm-model-calc



ggtfm-ref-temp-mod



ggtfm-subst-temp-mod

Fault memory management:

Status fault path TMOT: SFPTM
Error flag TMOT: E_tm
Cycle flag TMOT: Z_tm
Fault type TMOT: B_mxtm
B_mntm
B_nptm
B_sitm

```
Reset fault path:      C_fcmclr & B_cltm
Fault path TMOT :                 CDTTM
Fault class TMOT:                 CLATM
Fault rate TMOT:                  TSFTM
Carb Code TMOT:                   CDCTM
Freeze frame table TMOT:          FFTTM
```

ABK GGTFM 40.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTM	BLOKNR		KL	code word CARB: engine coolant temperature TMOT
CDTTM			FW	code word tester: engine temperature
CLATM			FW	error class: engine coolant temperature TMOT
DTLRTML	ML		KL	proportion factor to decrease waiting time up to tmot-threshold for closed loop
DTMDMA			FW	start offset for engine temperature model
DTMDNPO			FW	offset on engine temperature model to upper threshold for non-plausibility
DTMSRT			FW	difference of engine cool.temp.to starttemp.for retriggering models (blockheater
FABSTT	TABST_W		KL	Factor parking time for model temperature
FFTTM	BLOKNR		KL	freeze frame table: engine temperature TMOT
KFDTMRS	ML	TMRW	KF	char.line for gradient of engine coolant temp. during cutoff for reference model
KFDTMTE	ML	TMEW	KF	char. map for gradient of engine coolant temperature in substitute temp. model
KFDTMTR	ML	TMRW	KF	char. map for gradient of engine coolant temperature in reference model
KFDTMTU	ML	TUM	KF	char. map for correction gradient of engine coolant temp. at low warming up
TADMM			FW	1. step width (time) for engine temperature model
TANDT1	TANSAB		KL	delta threshold intake air temperature for hot start
TANH1			FW	intake air temperature - threshold hot start
TDTM			FW	debouncing time, engine temperature sensor
TDTMMA			FW	delay time load value engine temperature model
TDTMNP			FW	debouncing time, engine temperature sensor signal not plausible
TMDMMA			FW	begin temperature for engine temperature model
TMDMMAT	TABST_W		KL	Default temperature dependent on parking time during TDTMMA
TMDMMAU			FW	lower start temperature from tans for engine temperature model
TMDMMEE			FW	final temperature for substitute value of engine temperature
TMDMMER			FW	final temperature for reference value of engine temperature
TMDMN			FW	minimum engine temperature
TMDMX			FW	maximum engine temperature
TMLRTMS	TMST		KL	engine temp. threshold for lambda control depending on cranking temp. tmst
TMMXRT			FW	max. engine cool.temp. for retriggering models (blockheater-detection)
TMOTELI	WTMOT_W		KL	engine temperature calculation, inverse function
TNSRT			FW	max. time after start to retrigger calculation of engine temperature model
TSFTM			FW	fault active time: engine coolant temperature sensor TMOT
TUMDETM			FW	substitute value of ambient (-air) temperature for engine coolant temp. model
TWLRTMS	TMST		KL	waiting time up to check engine temp. signal exceeding threshold for closed loop
TWTMNHST			FW	waiting time for max.-range check of TMOT following hot soak start

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_ABSTNLG		EIN	condition soak time calculation via ECM-afterrun is valid
B_ANFW	GGTFM	LOK	condition drive away support activated
B_AUAKT		EIN	condition emission check active
B_BKTM	GGTFM	AUS	condition backup value for engine coolant temperature
B_CKIEN		EIN	condition CAN transfer from instrument cluster enabled
B_CLTM		EIN	condition clear fault path engine coolant temperature TMOT
B_HST	ESSTT	EIN	condition hot start
B_MNTM	GGTFM	AUS	fault type: minimum value of engine coolant temperature
B_MXTM	GGTFM	AUS	fault type: maximum value of engine coolant temperature exceeded
B_NMIN	GGDPG	EIN	condition lower speed: n < NMIN
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NOKATFZ		EIN	condition: no cat vehicle
B_NPTM	GGTFM	AUS	Error type: engine coolant temperature signal not plausible to model
B_SA	MDRED	EIN	Condition fuel cut-off
B_SITM	GGTFM	AUS	Error type: coolant temperature below threshold to cut in lambda closed loop
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TMKICB		EIN	condition engine temperature from instrument message can be evaluated
B_TMMN	GGTFM	LOK	Condition: blockheater detected
B_TMSRT	GGTFM	AUS	condition: retriggering engine temperature model after start
CW_TABST		EIN	code word to influence initialization of substitute value by switch off time
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	AUS	Error flag: engine temperature tmot
E_TOL		EIN	Error flag: oil temperature
ML	SWADAP	EIN	air mass flow
R_T100		EIN	Time schedule 100 ms
R_T1S		EIN	Time schedule 1 s
SFPTM	GGTFM	AUS	status fault path: engine coolant temperature TMOT
SY_TFMA	PROKON	EIN	system constant: intake air temperature signal available (initial. GGTFM)
SY_TFMHST		EIN	sastem constant:
SY_TFMO	PROKON	EIN	system constant: engine oil temperature signal available (initial. GGTFM)
SY_TFUMG	PROKON	EIN	system constant: ambient temperature sensor present

Variable	Source	Type	Description
TABST_W	BGTABST	EIN	soak time
TANS	SWADAP	EIN	Intake air temperature
TANSAB	GGTFA	EIN	Intake air temperature when engine is shut-off
TDLRTM	GGTFM	AUS	remaining time up to check of tmot-signal exceeding threshold for closed loop
TMEW	GGTFM	AUS	model-based substitute value for engine temperature signal in case of error
TMEWAB	GGTFM	AUS	Engine temperature default value from model when parking
TMKIC		EIN	engine temperature from instrument message
TMOT	GGTFM	AUS	Engine temperature
TMOTAB	GGTFM	AUS	engine coolant temperature at engine stop or cut-off cranking
TMOTLIN	GGTFM	AUS	Engine coolant temperature, linearised and calculated
TMOTLIN_W	GGTFM	AUS	Engine coolant temperature, linearised and calculated, 16bit word
TMOTVT	GGTFM	LOK	engine coolant temperature at low-pass input
TMRW	GGTFM	AUS	model-based reference value for plausibility check of engine temperature signal
TMRWEND	GGTFM	LOK	final value for the reference value of the engine temperature model
TMST	GGTFM	AUS	engine temperature at start
TOEL		EIN	Oil temperature
TUM	GGTFM	LOK	ambient (air) temperature
WTMOT_W		EIN	ADC result of engine temperature sensor 10 bit
Z_TM	GGTFM	AUS	cycle flag:ˆengine temperature TMOT

FW GGTFM 40.60 Fixed Values

Parameter	Value	Description
CDTTM		code word tester: engine temperature
CLATM		error class: engine coolant temperature TMOT
DTMDMA		start offset for engine temperature model
DTMDNPO		offset on engine temperature model to upper threshold for non-plausibility
DTMSRT		difference of engine cool.temp.to starttemp.for retriggering models (blockheater
TADMM		1. step width (time) for engine temperature model
TANH1		intake air temperature - threshold hot start
TDTM		debouncing time, engine temperature sensor
TDTMMA		delay time load value engine temperature model
TDTMNP		debouncing time, engine temperature sensor signal not plausible
TMDMMA		begin temperature for engine temperature model
TMDMMAU		lower start temperature from tans for engine temperature model
TMDMMEE		final temperature for substitute value of engine temperature
TMDMMER		final temperature for reference value of engine temperature
TMDMN		minimum engine temperature
TMDMX		maximum engine temperature
TMMXRT		max. engine cool.temp. for retriggering models (blockheater-detection)
TNSRT		max. time after start to retrigger calculation of engine temperature model
TSFTM		fault active time: engine coolant temperature sensor TMOT
TUMDETM		substitute value of ambient (-air) temperature for engine coolant temp. model
TWTMNHST		waiting time for max.-range check of TMOT following hot soak start

```
Immediate constant
          ZFTMOT = 2.4 s  (realization with 2.55 sec)
```

FB GGTFM 40.60 Detailed description of function

```
Description of the overview and detection of blockheating:
----------------------------------------------------------
    Under normal circumstances, the engine temperature tmot is established from the input signal utmot linearized via TMOTELI.
    In the event of an error, which is determined via the fault detection, there is an immediate switchover to
    a substitute temperature which is computed from a model.
    The fault detection tests for plausibility of the temperature course as well as testing the minimum and maximum values.

        That temperature initially sampled is stored as engine start temperature (under tmst), to be refreshed at the beginning
    of start.
        A start with pre-heated block is supposed according to the measured temperature curve during a one-shot timeout after
    start (TNSRT). As long as the engine temperature is determined to be lower than the value intially measured (in this case
    B_tmsrt =true is valid), the value for engine start temperature is refreshed up to its minimum as preparation for
    retriggering models. As soon as these conditions disappear, the calculations of the minimum plausibility limit
    (reference temperature model) resp. the waiting time up to check exceeding cut-in temperature for lambda closed loop
    control will be released.

    In order to receive a "turn-off ignition" temperature, the validated temperature value is stored cyclically in a
    permanent-RAM cell named tmotab under nomal operation conditions after end-of-start; restoring additionally during
    start up to any break.

Description of the fault detection:
------------------------------------
    If the linearized engine temperature tmotlin exceeds the maximum or minimum plausibility limits,
    B_maxflr and B_minflr are set respectively, as are the error and cycle flags after the debounce time TDTM has elapsed.

    A plausibility check of the engine temperature is performed by a comparison of the measured engine temperature tmotlin with
    a reference temperature tmrw. The reference temperature tmrw which is continually updated is reduced by the safety margin
        DTMDMA and compared with the temperature determined. If this does not increase by the amount expected (e.g. parallel
        circuit or short circuit to a plausible potential),the error flag is set is set after the same debounce time TDTM as above.
    During the retrigger phase induced by blochheating, the plausibility check is precautionarily disabled.
```

Furthermore, it is checked whether the engine temperature exceeds the switch-on threshold for lambda closed loop control. The engine temperature must exceed this threshold after a given period of time which depends on the engine starting temperature. The processing of the waiting time tdlrtm is influenced depending on the air mass flow. Decreasing of the waiting time is stopped during fuel cutoff mode in particular. If the temperature threshold to cut in lambda control is not reached within the time this period has elapsed, the B_signal=1 is set and a fault entry is made by E_tm.
As the waiting time until attainment of the cut-in threshold is itself dependent on this temperature, the waiting time must be adjusted accordingly to a change in the temperature threshold.
The error path B_signal is suppressed after a start with the block heater as long as the conditions for this are present (B_tmsrt=1).

The cycle flag is set immediately upon occurrence of a fault E_tm. The cycle flag is set without a fault entry, not only after expiration of the waiting time tdlrtm but also when the reference temperature tmrw has reached the cut-in temperature for lambda closed loop control.

The error flag is reset by B_noflr, if there is no fault present for the debounce time TDTM. This debounce time is necessary in order that at scattered interferences on e.g. a broken line will not always be detected as being in order.

B_maxflr: - low input voltage by short circuit to ground
The picked up signal by the RB's standard NTC engine temperature sensor permit the direct information of an unplausible temperature range above TMDMX.

B_minflr: - high input voltage by cable drop or short circuit to supply voltage
For the circuitry variant without R_parallel, this threshold must be disabled, i.e. TMDMN=00h.

B_plaus: - increase in the engine temperature is not plausible

B_signal: - engine temperature threshold to enable lambda closed loop control not attained after the waiting period

Model temperatures:
By the creation of a model, a reference temperature for the diagnosis and a substitute temperature, which is employed, if a fault condition exists, are established. Both model temperatures' characteristic lines are independent of each other.

Description of the reference temperature:
Beginning with the measured starting temperature, the reference temperature is updated after a delay time TADMM with a (rising or falling) gradient map-dependent on the air mass flow and the temperature level currently computed. The increase of the model temperature is limited by an upper final value tmrwend. This final value is derived from the maximum of TMDMMER and the engine temperature threshold to cut in the lambda closed loop control.
Unlike the versions up to 25.xx, possible drops in the engine temperatures or very low rises, such as can occur for example for very low ambient temperatures and operations near to idling/fuel cutoff, are taken into account in the calculation of the reference temperature; i.e. temperature gradients (= gradient S) with a negative sign can be stored in the map KFDTMTR resp. in the characteristic line KLDTMRS, that is selected during fuel cutoff.

Description of the substitute temperature:
The substitute temperature is established similar to the reference temperature. They differ however in the following points: In order to prevent an incorrect selection in case of a later detected non-plausibility of tmotlin, initialization here is not done by starting temperature. Instead of this the initial value is taken from the engine oil temperature, if this signal is available and correct, otherwise from the intake air temperature tans. Finally a substitute value TMDMMA is taken in case of an error E_ta or if no TANS-sensor is present. The initial value taken from tans is also limited to TMDMMA as required.
The earliest possible detection of an unplausible Tmot value (following the first AD conversion or for the E_tm already set from the previous cycle) leads to the selection of a substitute value. Unlike the versions up to 25.xx, calculations are permitted to reduce the substitute temperature for operations near idling (negative temperature gradients are hence also possible in the map KFDTMTE).

APP GGTFM 40.60 Application hint

Method of proceeding for applications:

IMPORTANT (OBDII recall may occur if not observed):
The passenger compartment heating(s) is to be operated at the highest power level for all measurements around the GGTFM applications, i.e. heater fan at the highest level as well, intaken air from the outside, windows open (so-called "coffee start" conditions).
As a minimum, both measurements designated with (***) shall be performed in the cold cell at -40 degC.
A blower shall be directed to the radiator grill for circulation in the engine compartment.

1. The following measurable signals shall be recorded: air mass flow, engine speed, engine temperature. A sampling rate of once per second would be sufficient.

2. 5 warm-up characteristics should be recorded for generation of the characteristic maps KFDTMTR,-E:
   - (***) Warming-up at nominal idling speed (minimum air mass flow)
   - Warming-up at full load and nominal speed (maximum air mass flow)
   - 3 additional warming-ups between these with the following levels of speed and air mass flow:
     - (***) double idling speed and triple idling air mass flow
     - half the nominal speed and 25 % of the maximum air mass flow
     - 75 % of the nominal speed and 60 % of the maximum air mass flow

3. The gradients of the temperature are to be transferred into the map points accordingly to their dependency on air mass flow and temperature. IMPORTANT: the gradient 0 is to be entered for the idling air mass flow and that minimal temperature, which adjusts itself under above mentionned worst-case conditions in the stationary idling operation mode. The gradients are negative signed above this temperature !

4. The dead time until inception of the temperature modelling (TADMM) is determined as follows:
   - the temperature curves recorded shall be approximated by compensating straight lines.
   - the intersection of these straight lines with the initial temperature gives the dead time.
   - The maximum value of the 5 temperature curves is to be chosen for the dead time.

5. DTMDMA shall be set such that the actual engine temperature cannot fall below (tmrw-DTMDMA) under any circumstances (recommended value 10 degC).

6. The starting temperature TMDMMA, which is assumed for as the starting temperature for the model, if not only the coolant temperature but also the (oil- and) intake air temperature have already been detected as being faulty, shall be set such that an engine start takes place under most of all conditions (especially for a turned-off engine which is still warm).

7. The final values for the temperature model shall be set as follows:
   - TMDMMEE = nominal opening temperature of the radiator thermostat valve (recommended value 90 degC).
   - TMDMMER = minimum possible temperature during normal operation under worst-case conditions (recommended value 60 degC).

8. The time for a possible retriggering of the model TNSRT takes a drop in the engine temperature after starting into account in case of engine pre-warming (block heater). TNSRT shall be set such that the output temperature will be reached within this time even if the engine has been warmed-up considerably (recommended value: 2 min).
   The fixed value DTMSRT means a hystersis threshold to reset the retrigger condition of blockheater (recommended value: 2 degC).

9. The characteristic line DTLRTML shall be filled by value 0 up to twice the idling air mass flow as a minimum. Above this, values can be set to 1.

GGPOEL 5.30 Sensor signal oil pressure sensor, incl. diagnosis

FDEF GGPOEL 5.30 Function definition

```
                                                                                                   +---+
!S_poel o----------------------------------------------------------------------------------------->| V +------>  B_poel
                                                                                             +---->|   |         (über CAN)
                  +----------+                                                               |     +---+
nmot_w  o-------->| <=NPMOL1 +--+---------+                                                  |
                  +----------+  |         |    +---+          +------------+      +-+---+    |
             +---+              |         +--->| & +--------->| TDEPOEL+-- +-+--->|S|   +----+---------------->  E_poel
S_poel  o--->| & +-+------------|------------->|   |          | -------+-> | |    +-+---+                        B_nppoel
B_flbc  o--->|   | |            |              +---+          +------------+ | +->|R|   |
             +---+ |            |                                            | |  +-+---+
                   |            |             +-------------+                | |
                   |            |   +---+     | TDEPOEL+--  |                | |
                   |            +-->| & +---->| -------+--> +-------------+--|-+
                   +-------------->O|   |     +-------------+             |  |
                                    +---+                                 |  |        +---+
                                                                          |  +------->| V |        +-+---+
                                                                          +---------->|   +------->|S|   +----> Z_poel
                                                                                      +---+        +-+---+
B_ini   o----------------------------------------------------------------------------------------->|R|   |
                                                                                                   +-+---+
```

FB GGPOEL 5.30 Detailed description of function

Die Funktion liest den Öldruckschalter (S_poel1) ein und gibt das Ergebnis über CAN an das Armaturenbrett aus. Der Schalter zeigt an, ob der Öldruck ein bestimmtes Niveau überschritten hat. Dieser Druck kann nur bei laufendem Motor erreicht werden. Wird er jedoch schon bei stehendem Motor angezeigt (S_poel1 = TRUE), wird auf einen defekten Schalter geschlossen. Es wird nach Ablauf der Entprellzeit TDEPOEL ein Fehler im Fehlerspeicher abgelegt. Der Fehler wird nur bei Drehzahlen <= NPMOL1 geprüft und ggf. geheilt. Bei gesetztem Fehler E_poel wird, wie bei zu niedrigem Druck, die Öldruckwarnlampe angesteuert.

APP GGPOEL 5.30 Application hint

ATWAL 3.20 Output engine temperature warning lamps

FDEF ATWAL 3.20 Function definition

```
              +---+                                 +---+------+
B_kl15 ----->o| & +-------------------------------->| S |      |
B_wal  ------>|   |                                 +---+      +----------------------------> B_walalt
              +---+                      +--------> | R |      |
                   +-----------------+   |          +---+------+
                   |   counter       |   |
B_stend --------->o|reset +----------|   |        +---+     +---+
                   |      | > TVTMWAL+---+------->| V +---->|   |
                   +-----------------+      +---> |   |     |   |
                                            |     +---+     |   |
                                            |               |   |
B_walalt -----------------------------------+               |   |
                                                            |   |
E_tm    -------------------------------------------------->o|   |
               +---------+                                  |   |
tmot    --+--->|> TMWALE |-----------+   +---+-----+        | & +-----+
          |    +---------+           +-->| S |     |        |   |     |
          |    +---------+               +---+     |------->|   |     |
          +--->|< TMWALA |-------------->| R |     |        |   |     |      +---+
               +---------+               +---+-----+        +---+     +----->|   |             Triggering of the TMOT warning light
                                                                             | V |----------------->
                         +---+-----+            B_lampe                      |   |             B_wal
B_ini  ----------------->+ S |     +---------+------------------------------>1   |
                         +---+     |         |                               +---+
          +------------->| R |     |         |    +-----------------+
          |              +---+-----+         |    |     +---------  |
          |                                  +--->|  ---+ T_LAMPE   |----+
          |                                       +-----------------+    |
          +--------------------------------------------------------------+
```

ABK ATWAL 3.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TMWALA			FW	Engine temperature threshold for switching off of warning lamp ”too hot”
TMWALE			FW	Engine temperature threshold for switching on of warning lamp ”too hot”
TVTMWAL			FW	Delay time after start when the TMOT warning lamp is switched on
T_LAMPE			FW	lamp on time after system start

Variable	Source	Type	Description
B_INI		EIN	Condition initialization
B_LAMPE	ATWAL	AUS	Lamps on condition after system start for dashboard test
B_STEND	BBSTT	EIN	condition end of start
B_WAL	ATWAL	AUS	Condition switch on warning light in the dashboard
B_WALALT	ATWAL	LOK	Condition warning light when Key Off
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
TMOT	SWADAP	EIN	Engine temperature

FW ATWAL 3.20 Fixed Values

Parameter	Value	Description
TMWALA		Engine temperature threshold for switching off of warning lamp ”too hot”
TMWALE		Engine temperature threshold for switching on of warning lamp ”too hot”
TVTMWAL		Delay time after start when the TMOT warning lamp is switched on
T_LAMPE		lamp on time after system start

FB ATWAL 3.20 Detailed description of function

The TMOT warning light is installed in the dashboard and is triggered when TMOT becomes greater than an adjustable value (TMWALE). The correct operation of the warning light is checked by triggering it for the time T_LAMPE while terminal 15 is switched on and with the engine at standstill (when T_LAMPE = FFhex it applies: Permanently on until end of start). When the engine is turned off (key off) the current value of B_wal is stored in the permanent RAM (B_walalt).
To prevent a possible incorrect triggering by stored heat of the engine, the warning light is only triggered after an adjustable time after end of start. If the light was already triggered when the engine was last turned off (B_walalt = TRUE), this blocking time is ignored.

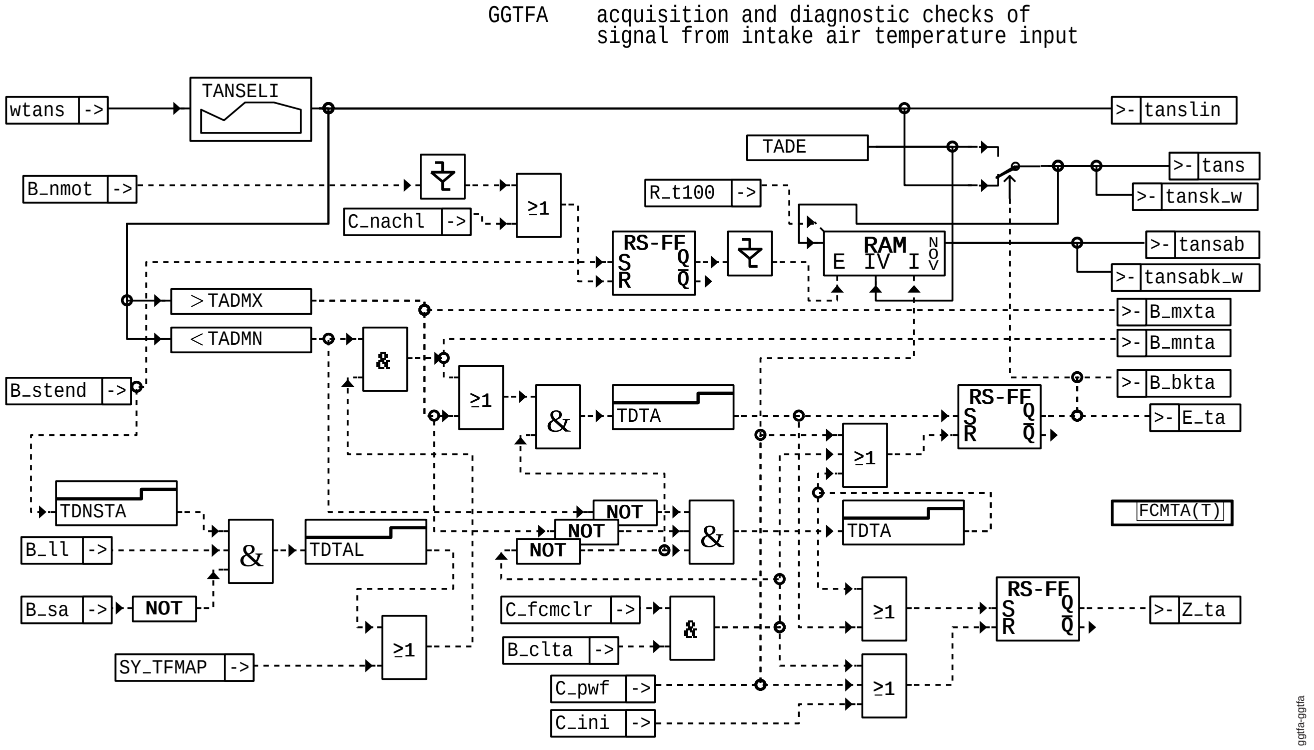
APP ATWAL 3.20 Application hint

Value Range / Initial Entering of Data into the Adjustable Labels:

```
TMWALE:   100 deg.......125 deg. / 120 deg.
TMWALA:   100 deg.......125 deg. / 118 deg.
TVTMWAL:    0 sec.......204 sec     30 sec
T_LAMPE:    0 sec......25.5 sec /    4 sec (Remark: T_LAMPE = 25.5 sec corresponds to light permanently on with engine
                                            at standstill)
```

GGTFA 15.50 Diagnosis; intake air temperature sensor

FDEF GGTFA 15.50 Function definition



ggtfa-ggtfa

```
Fault memory management:
------------------------

Status fault path TANS: SFPTA
Error flag TANS:        E_ta
Cycle flag TANS:        Z_ta
Fault type TANS:        B_mxta
                        B_mnta
                        B_npta
            B_sita


Reset fault path:      C_fcmclr & B_clta
Fault path TANS :                 CDTTA
Fault class TANS:                 CLATA
Fault rate TANS:                  TSFTA
Carb Code TANS:                   CDCTA
Freeze frame table TANS:          FFTTA
```

ABK GGTFA 15.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTA	BLOKNR		KL	code word CARB: intake air temperature
CDTTA			FW	code word tester: intake-air temperature
CLATA			FW	error class: intake air temperature TANS
FFTTA	BLOKNR		KL	freeze frame table: air intake temperature TANS
TADE			FW	substitute value air temperature in case of fault
TADMN			FW	intake-air temperature min.
TADMX			FW	intake-air temperature max.
TANSELI	WTANS		KL	intake air temperature calculation, inverse function
TDNSTA			FW	exhaust manifold warming time from start, for TANS - Diagnostic
TDTA			FW	time for diagnosis intake air temperature sensor
TDTAL			FW	intake-air temperature error detection/time-out from B_LL = 1
TSFTA			FW	fault active time: intake air temperature sensor TANS

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_BKTA	GGTFA	AUS	condition backup value for intake air temperature
B_CLTA		EIN	condition clear fault path intake air temperature TANS
B_LL	MSF	EIN	Condition idle
B_MNTA	GGTFA	AUS	fault type: minimum value of intake air temperature TANS
B_MXTA	GGTFA	AUS	fault type: maximum value of intake air temperature TANS exceeded
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_SA	MDRED	EIN	Condition fuel cut-off
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_TA	GGTFA	AUS	error flag: TANS
R_T100		EIN	Time schedule 100 ms
SFPTA	GGTFA	AUS	status fault path: air intake temperature TANS
SY_TFMAP	PROKON	EIN	system constant: intake air temp.sensor with shunt resistor in input circuitry
TANS	GGTFA	AUS	Intake air temperature
TANSAB	GGTFA	AUS	Intake air temperature when engine is shut-off
TANSABK_W	GGTFA	AUS	Intake air temperature when engine is shut-off in Kelvin
TANSK_W	GGTFA	AUS	Intake air temperature in Kelvin
TANSLIN	GGTFA	AUS	intake air temperature, linearised and calculated
WTANS		EIN	ADC-value for intake air temperature
Z_TA	GGTFA	AUS	cycle flag: intake air temperature

FW GGTFA 15.50 Fixed Values

Parameter	Value	Description
CDTTA		code word tester: intake-air temperature
CLATA		error class: intake air temperature TANS
TADE		substitute value air temperature in case of fault
TADMN		intake-air temperature min.
TADMX		intake-air temperature max.
TDNSTA		exhaust manifold warming time from start, for TANS - Diagnostic
TDTA		time for diagnosis intake air temperature sensor
TDTAL		intake-air temperature error detection/time-out from B_LL = 1
TSFTA		fault active time: intake air temperature sensor TANS

FB GGTFA 15.50 Detailed description of function

Following function description for version TANS-NTC circuitry with pullup-R and with parallel resistor to TANS-sensor (e.g. 2,87 kOhms resp. 36,5 kOhms) --> SY_TFMAP=1 !

Fault detection (set Errorflag E_ta)
Directly scanning of exceeding the threshold values is practicable without any additional conditions.
Debouncing times overlap electric disturbance by coupling on the lines as well as line-conducted faults or short loose contacts.
In a tolerance calculation the following fault cases were observed:

- Short circuit at sensor input (E.A.TANS) to UBat/5V : Sampling maximum value of utans --> tanslin below TADMN. Generally sensor or/and printed circuit board parts melted in event of short-circuit to UB; damages in case of short circuits to 5V dependent on temperature resp. current on occurrence of fault!

- Short circuit at sensor input (E.A.TANS) to ground : Sampling minimum value of utans --> tanslin above TADMX. Taking into account voltage drops and other uncertainties, the threshold should be choosen corresponding to a value of a regular intake air temperature of more than approx. 125 deg.C (does not occur).

- Interruption of sensor lines : Sampling high value of utans --> tanslin exceeding TADMN Assuming a shunt at the sensor input (E.A.TANS) of RN = 500 kOhms, a fault under those conditions corresponds to a plausible intake air temperature of less than -35 deg.C.

Faults are only cleared after a debouncing time to prevent switchover to faulty plausible values, e.g. resulting from electrical interference coupled in the cable, when dropped off.

Cycle flag Z_ta is set either as soon as a fault is detected or, in case of no fault, after all branches of the test have been run through.

Following function description for version TANS-NTC circuitry with pullup-R only (e.g. 1kOhm), no parallel resistor to TANS-sensor --> SY_TFMAP=0 !

Fault detection (set Errorflag E_ta)
Directly scanning of exceeding of threshold values is only practicable for maximum limit without additional conditions.
Debouncing times overlap electric disturbance by coupling on the lines as well as line-conducted faults or short loose contacts.
In a tolerance calculation the following fault cases were observed:

- Short circuit at sensor input (E.A.TANS) to UBat/5V : Sampling maximum value of utans --> tanslin below TADMN. Generally sensor or/and printed circuit board parts melted in event of short-circuit to UB; damages in case of short circuits to 5V dependent on temperature resp. current on occurrence of fault!

- Short circuit at sensor input (E.A.TANS) to ground : Sampling minimum value of utans --> tanslin above TADMX. Taking into account voltage drops and other uncertainties, the threshold should be choosen corresponding to a value of a regular intake air temperature of more than approx. 140 deg.C (does not occur).

- Interruption of sensor lines : Sampling high value of utans --> tanslin exceeding TADMN (?) Assuming a shunt at the sensor input (E.A.TANS) of RN = 500 kOhm, a fault under those conditions corresponds to a plausible intake air temperature of (-30 ..-32) deg.C. That won’t be low enough for cold-starts in many applications. In order to diagnose this fault, additional conditions (as waiting time TDNSTA after end-of-start elapsed, idling for time TDTAL at a minimum and no fuel cutoff) are scanned and, if matched, enable to assume safely, that the TANS sensor must output a higher value as a result of heat transmission from the engine. Otherwise --> below TADMN.

Faults are only cleared after a debouncing time to prevent switchover to faulty plausible values, e.g. resulting from electrical interference coupled in the cable, when dropped off.

Cycle flag Z_ta is set either as soon as a fault is detected or, in case of no fault, after all branches of the test have been run through.

APP GGTFA 15.50 Application hint

Checking of the tanslin < TADMN fault detection, which can occur as a consequence of a short circuit to supply voltage or a break, may only be provoked by a break; applying battery voltage may cause the NTC sensor to be damaged !

Reference values for RB-TANS standard sensor circuitry with shunt resistor
(under above mentionned dimensioning R_vor = 2,87 kOhms , R_par = 36,5 kOhms):
TADMX approx. 125 deg.C ; TADMN approx. -35 deg.C (tolerance!) ; TADE 20 deg.C ; TDTA approx. 200 msec

Reference values for RB-TANS standard sensor circuitry without shunt resistor
(under above mentionned dimensioning R_vor = 1 kOhm , no R_par):
TADMX ca. 140 deg.C ; TADMN ca. -30 deg.C (Toleranz!) ; TADE 20 deg.C ; TDTA ca. 200 msec , TDNSTA ca. 4 min

EGAK 3.0 Input values of exhaust value of catalyst

FDEF EGAK 3.0 Function definition

zuständig:

ABK EGAK 3.0 Abbreviations

FW EGAK 3.0 Fixed Values

Parameter	Value	Description

FB EGAK 3.0 Detailed description of function

Beschreibung fehlt !!!!

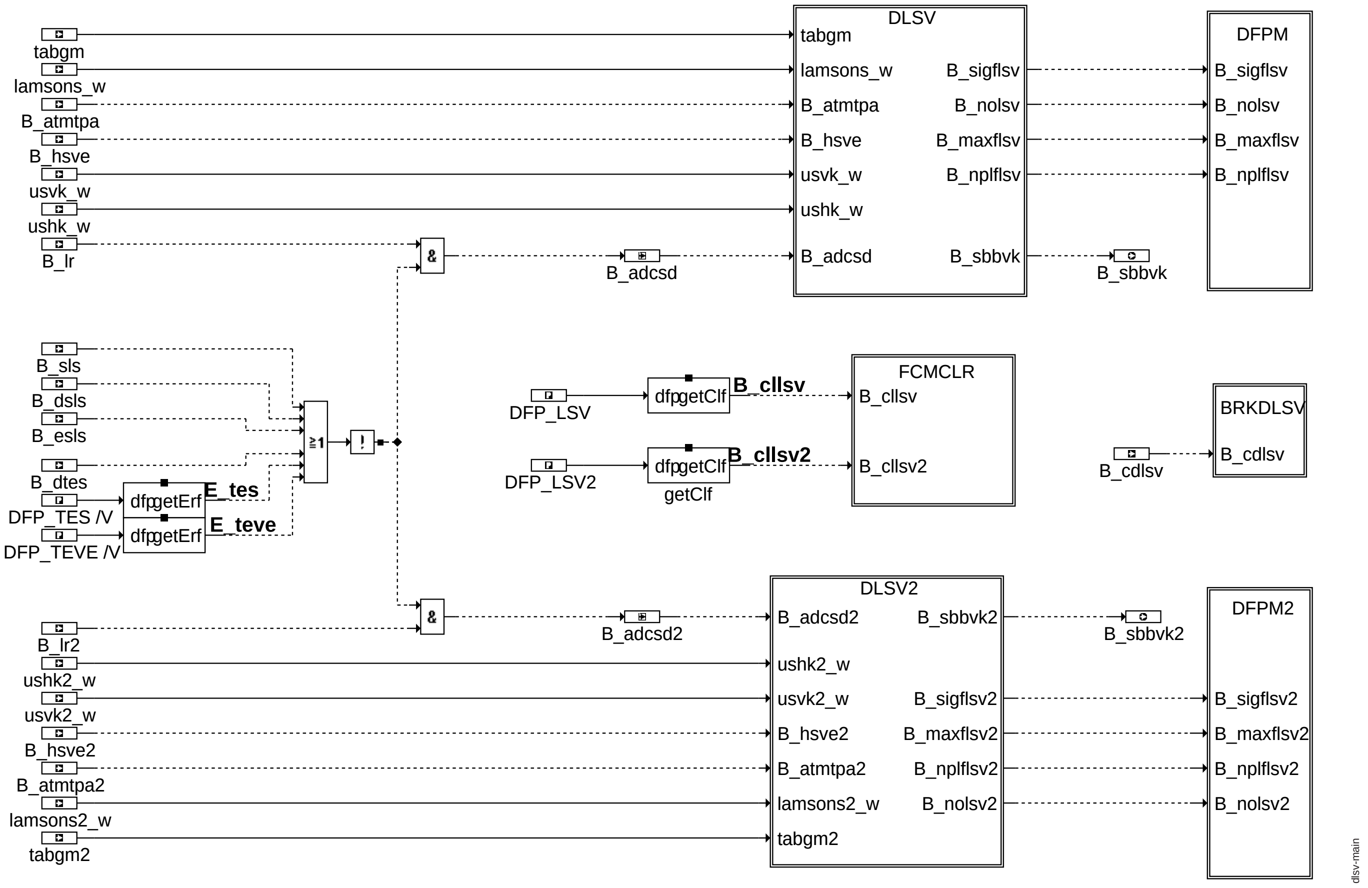
zuständig:

APP EGAK 3.0 Application hint

DLSV 32.60 Diagnosis; Readiness for operation of sensor upstream catalyst

FDEF DLSV 32.60 Function definition

```
MAIN: Übersicht und Darstellung der elektrischen Sonden-Diagnose vor KAT
-----------------------------------------------------------------------
```



dlsv-main

```
DLSV: Funktion
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```
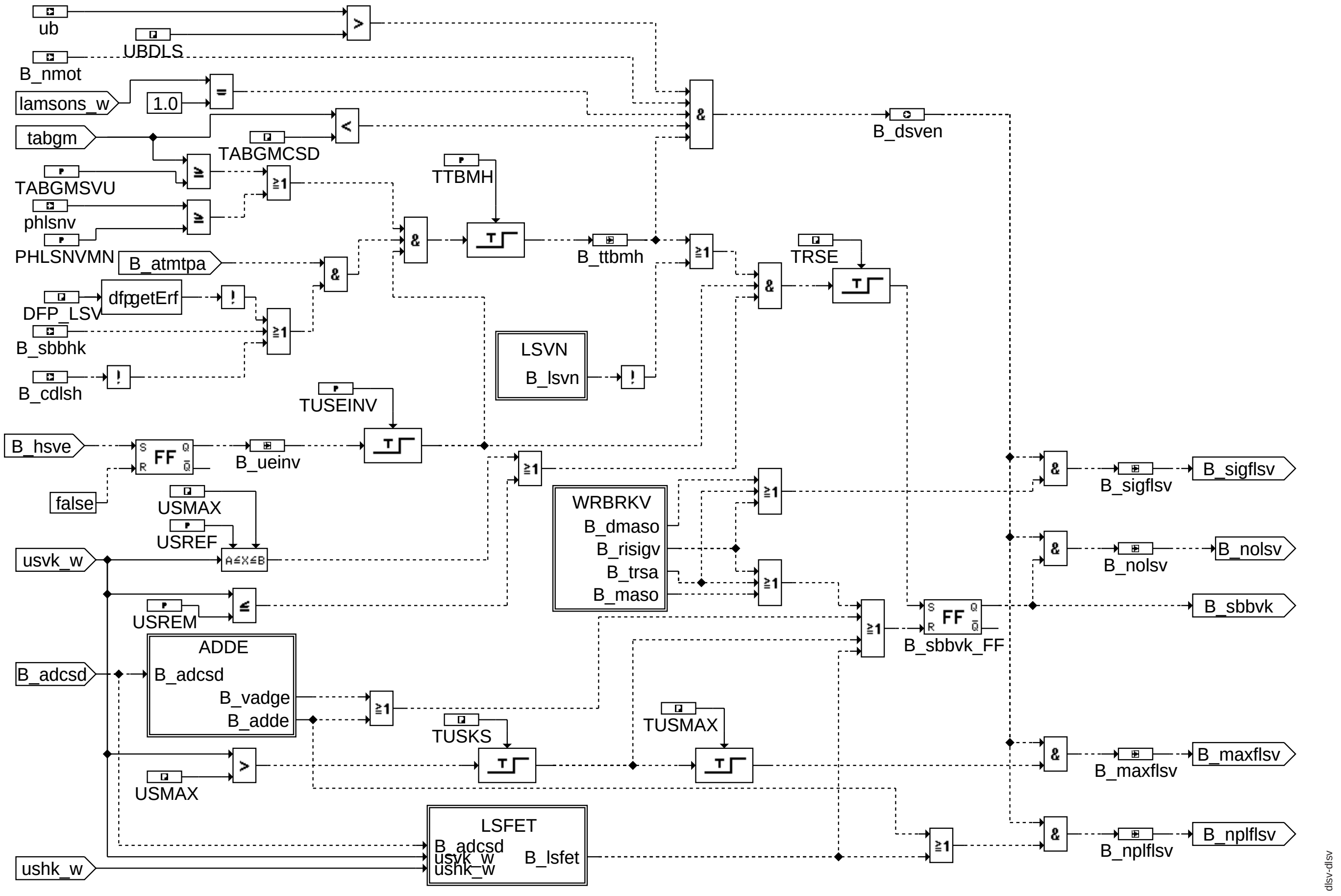
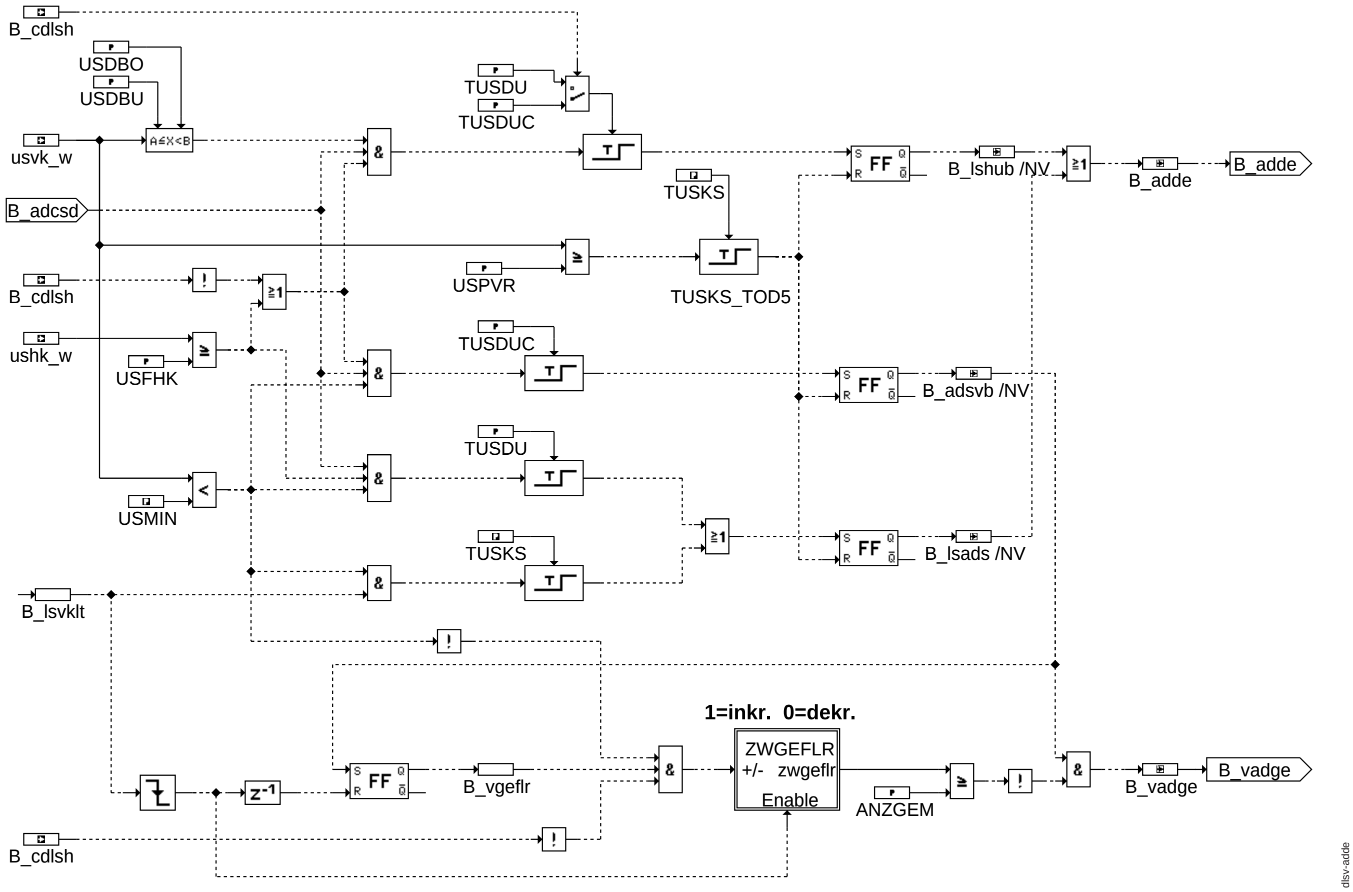



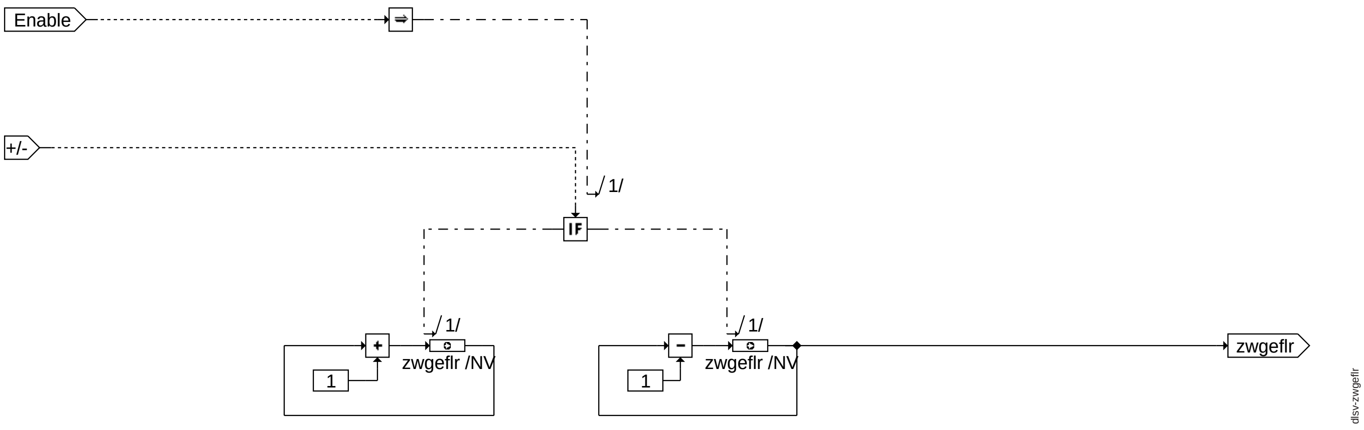
dlsv-dlsv

`ADDE: Erkennung Adernschluß und Sonde mit begrenztem Spannungshub`



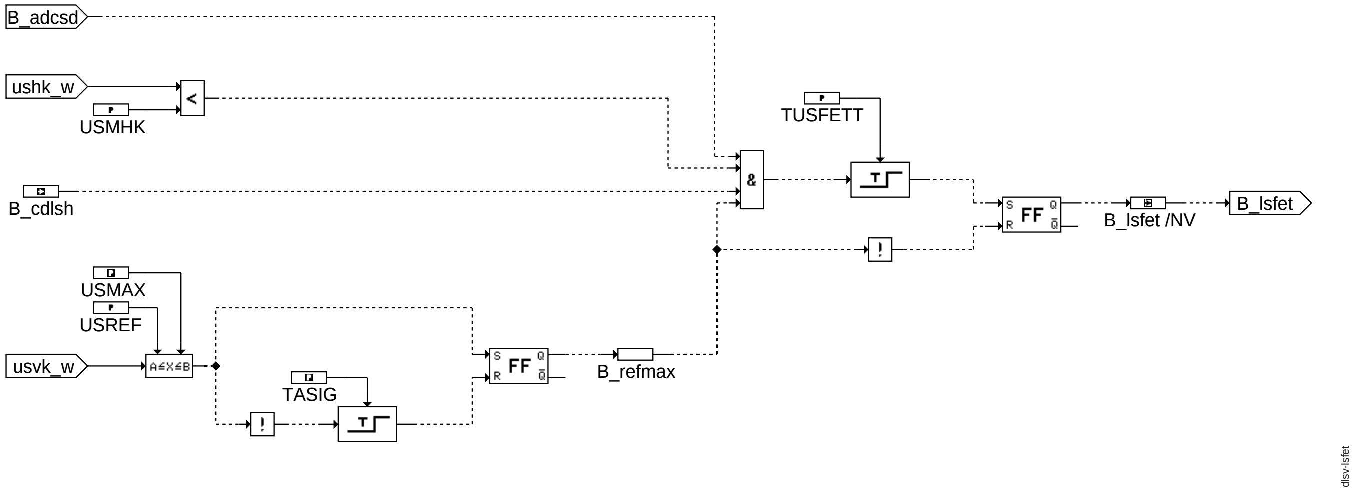
dlsv-adde

`ZWGEFLR: Ereigniszähler für Europa-Version zur Unterscheidung Adernschluß oder Gemischfehler`



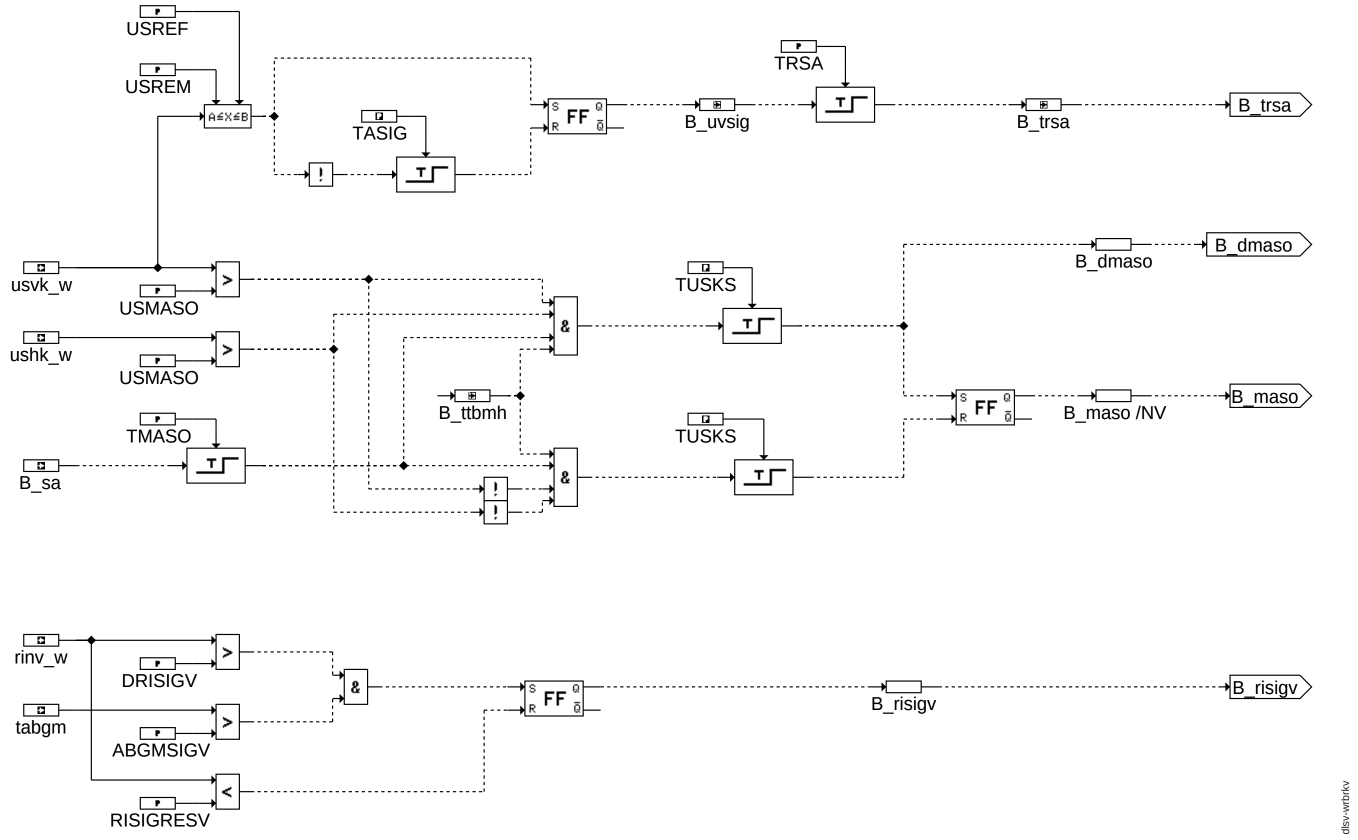
dlsv-zwgeflr

`LSFET: Erkennung Nebenschluß nach Ubatt und Kabelbruch der Sondenmasse einer planaren Sonde`



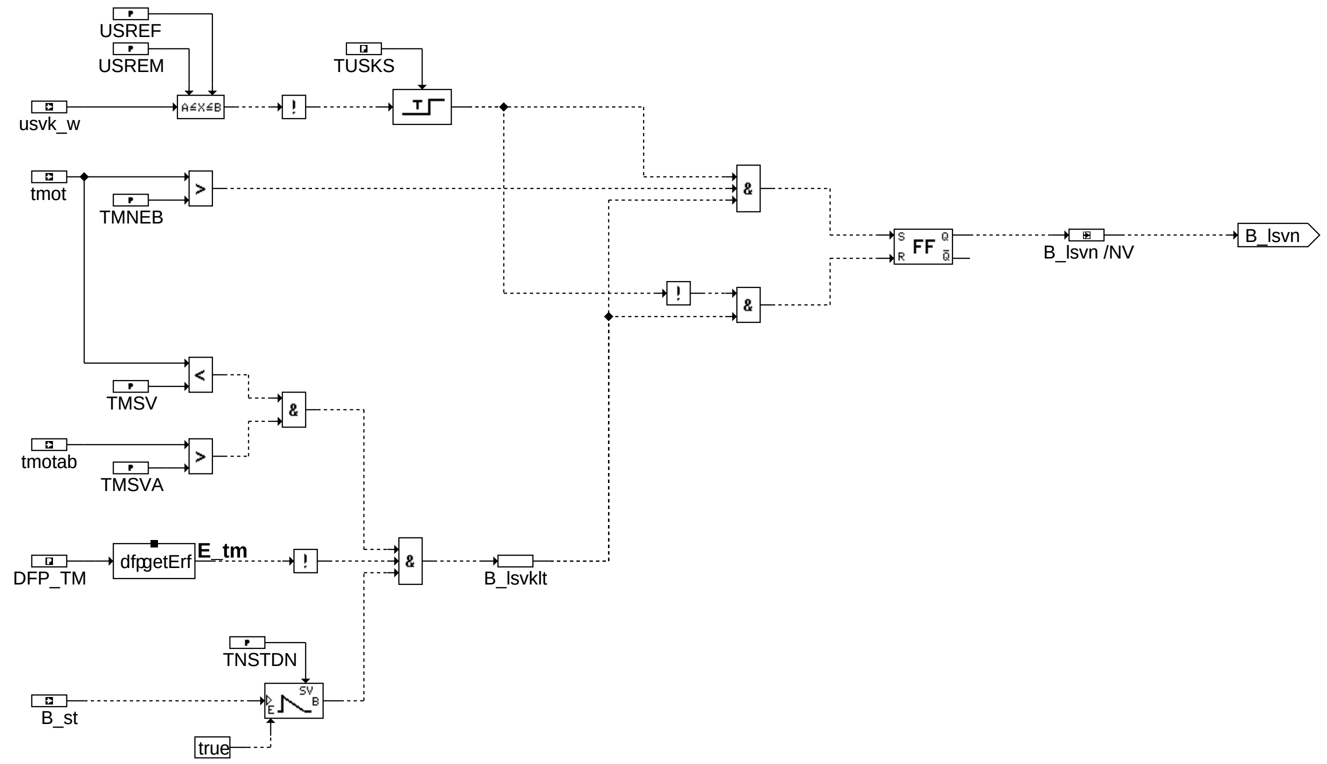
dlsv-lsfet

`WRBRKV: Erkennung Signalunterbrechung; Erkennung Abfall gemeine Sondenmasse; Erkennung Unterbrechung Sondenmasse einer plan. Sonde`



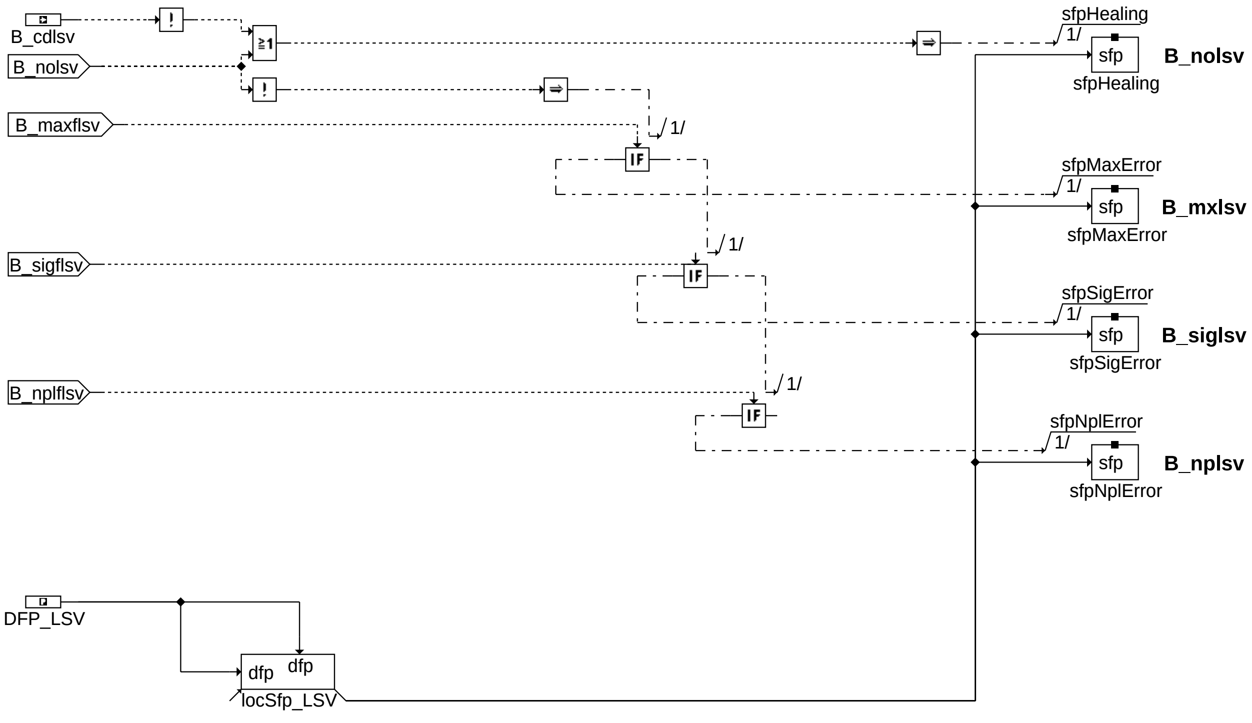
dlsv-wrbrkv

`LSVN: Erstellung der Kaltbedingung B_lsvklt (kalte Sonde) und Erkennung Nebenschlußnch UBatt und SG-Masse bei Kalter Sonde`



dlsv-lsvn

`DFPM: Fehlerverwaltung DLSV`



E_lsv = 1 if B_mxlsv or B_siglsv or B_nplsv is set
E_lsv = 0 if B_nolsv is set

Z_lsv = 1 if B_nolsv or B_mxlsv or B_siglsv or B_nplsv is set

dlsv-dfpm

dlsv-dfpm

```
DLSV2: Funktion Bank2
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```
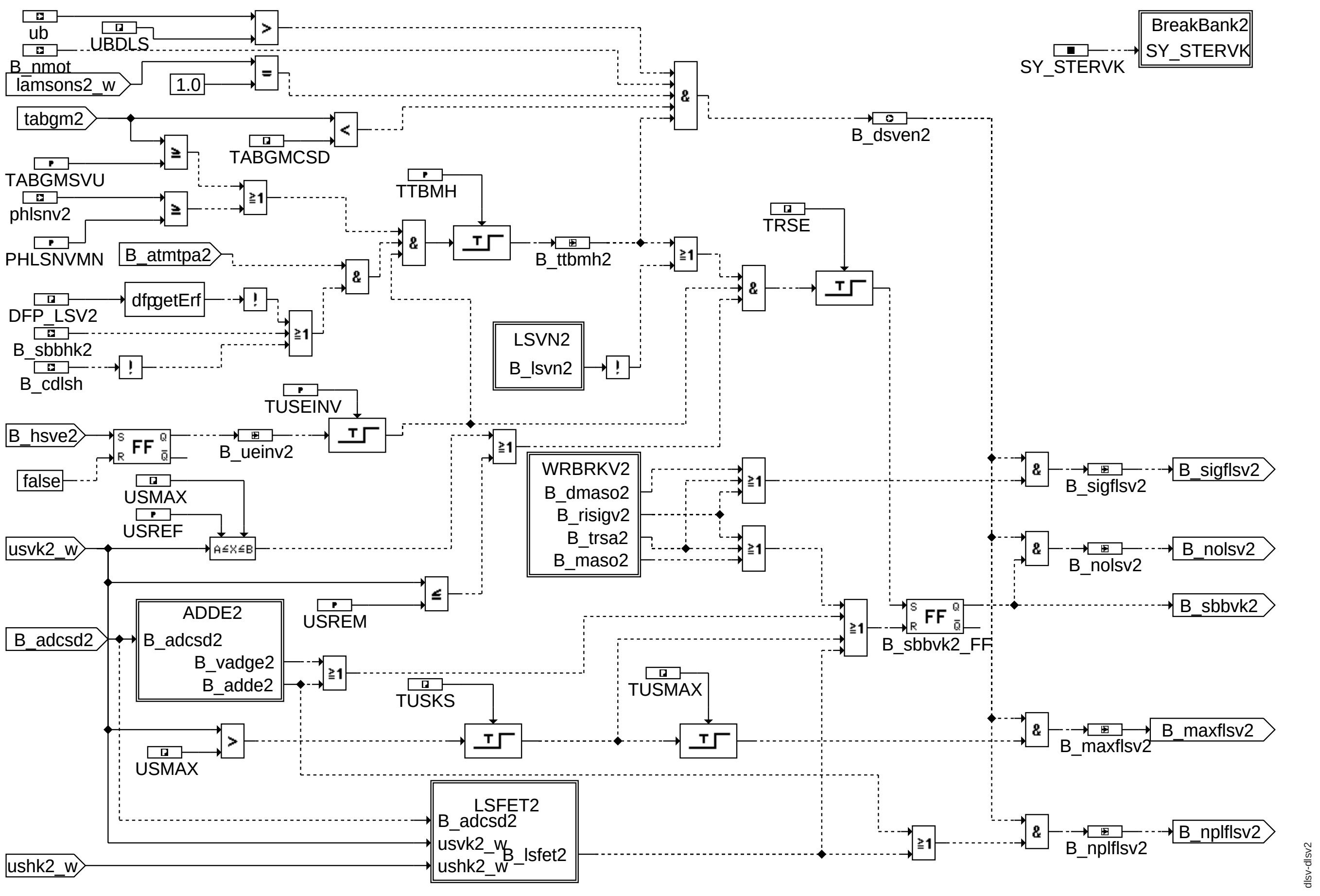
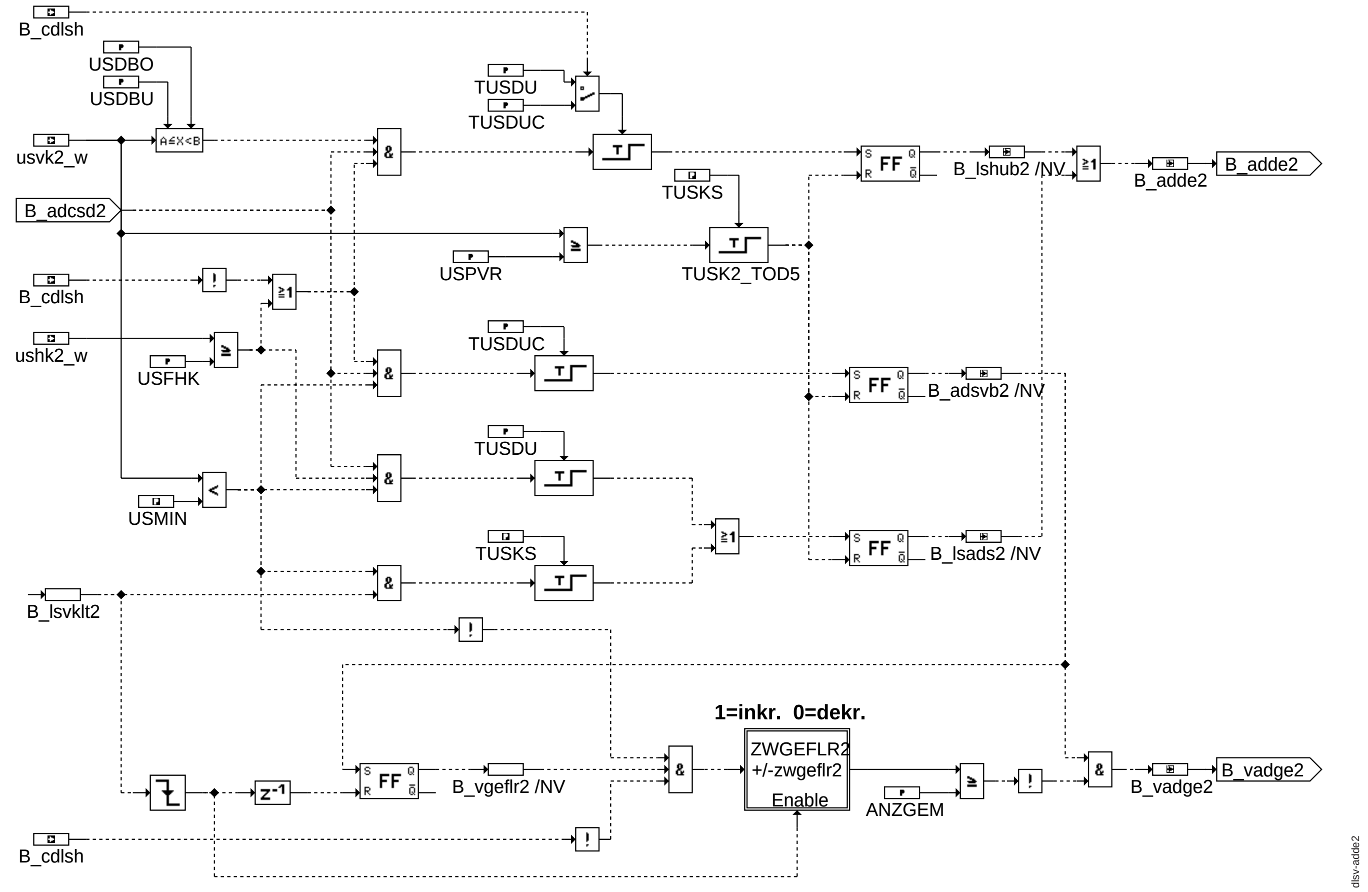



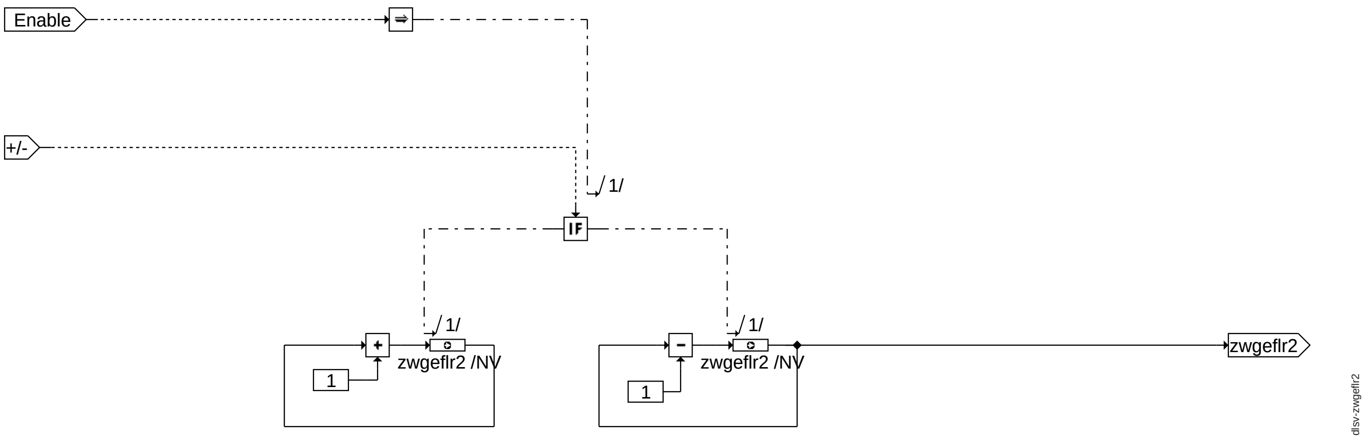
dlsv-dlsv2

ADDE2: Erkennung Adernschluß und Sonde mit begrenztem Spannungshub Bank2



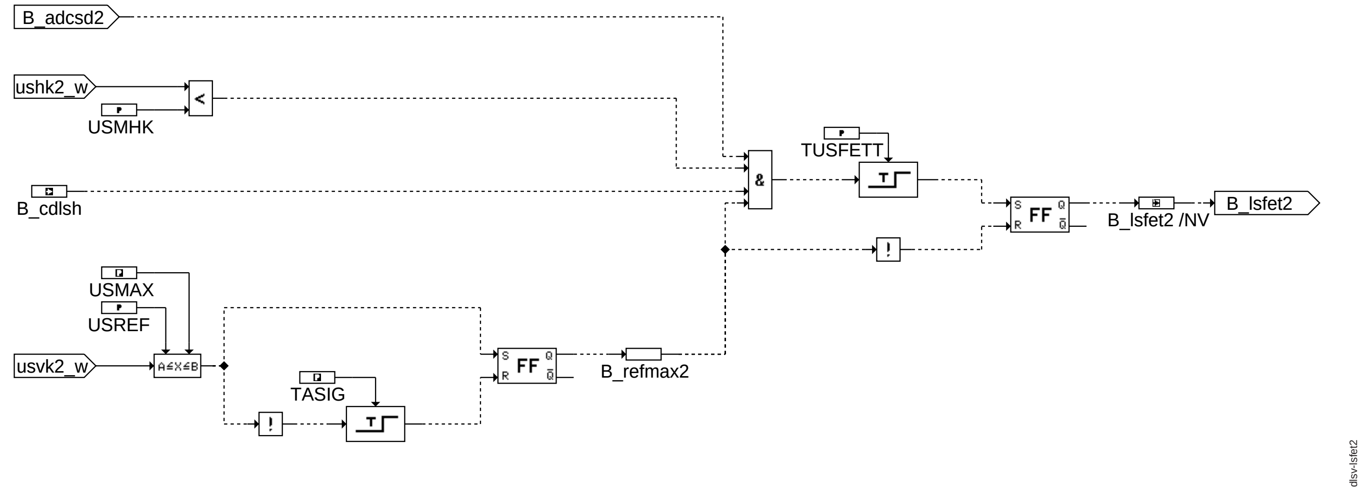
dlsv-adde2

ZWGEFLR2: Ereigniszähler für Europa-Version zur Unterscheidung Adernschluß oder Gemischfehler Bank2



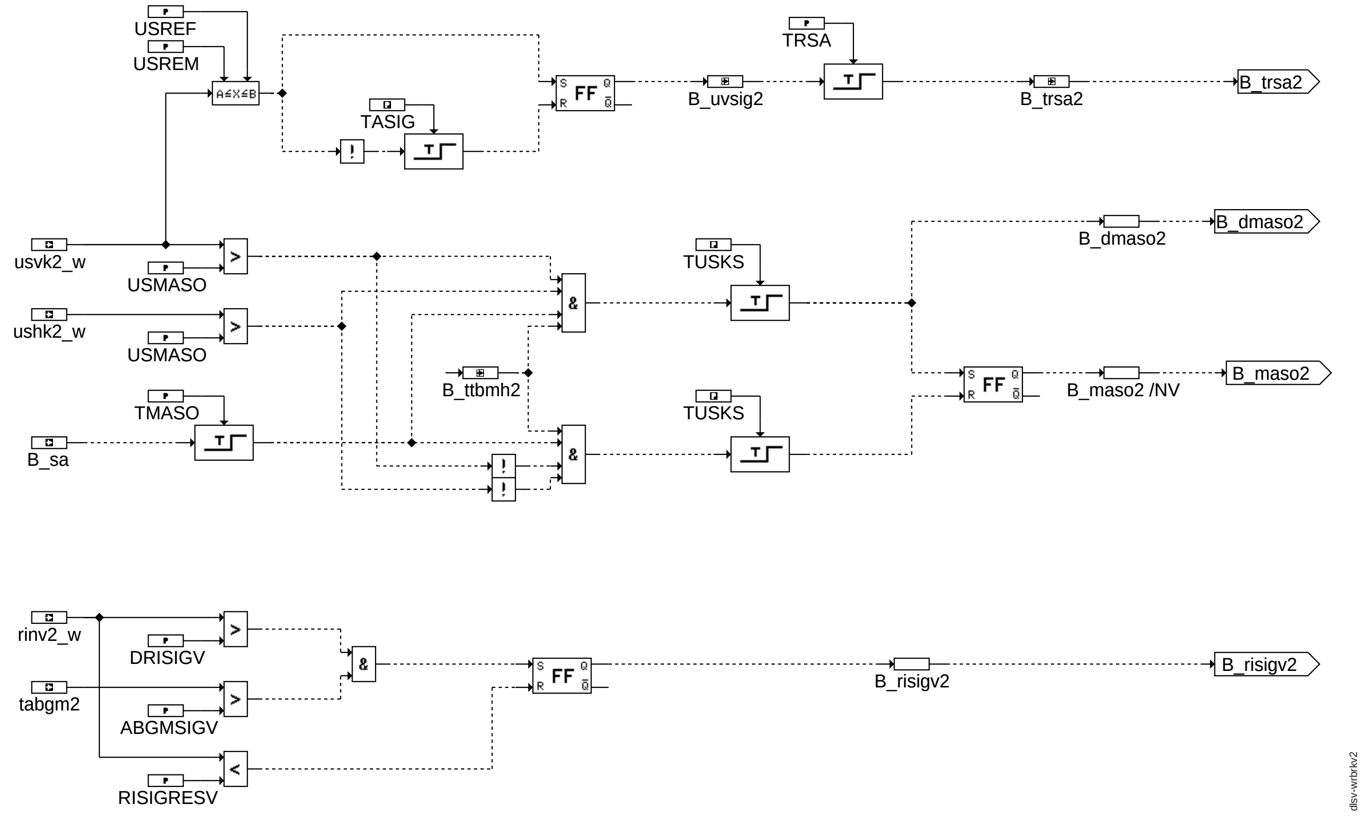
dlsv-zwgeflr2

LSFET2: Erkennung Nebenschluß nach Ubatt und Kabelbruch der Sondenmasse einer planaren Sonde Bank2



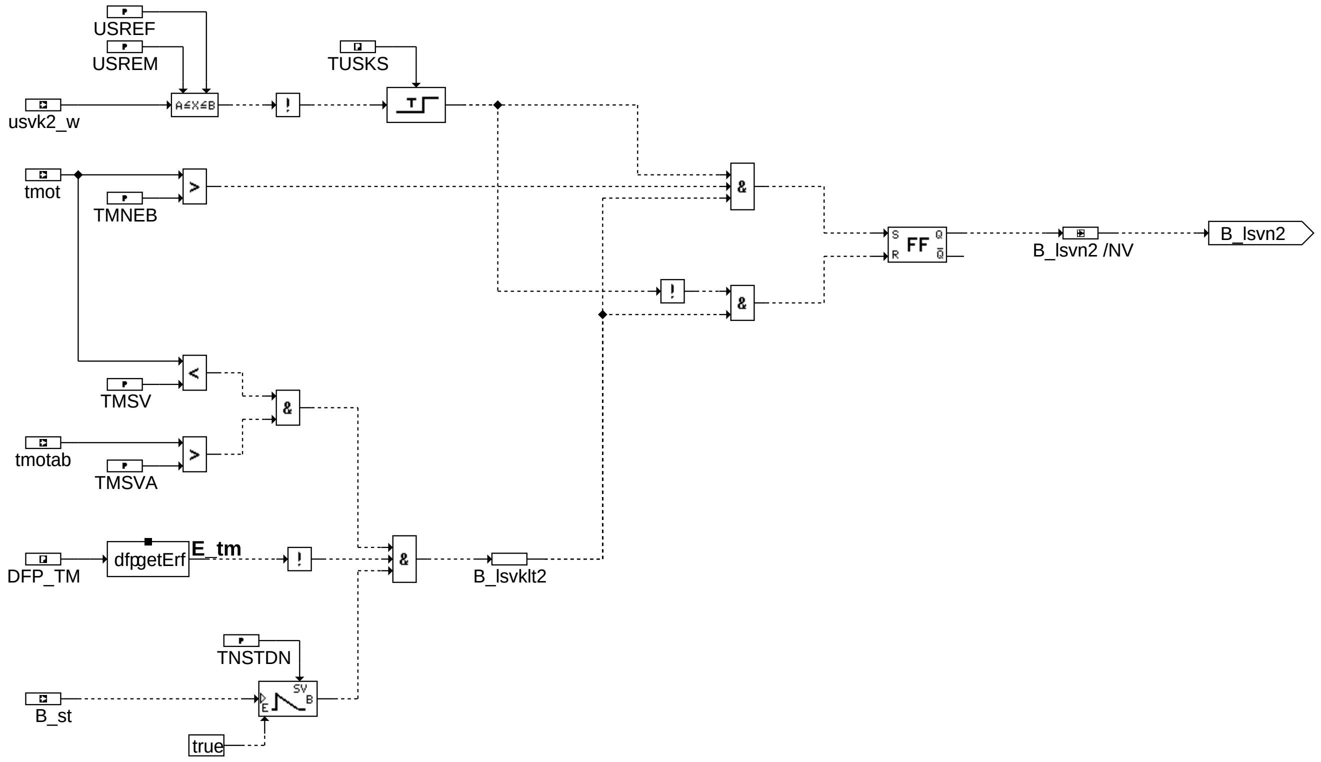
dlsv-lsfet2

WRBRKV2: Erkennung Signalunterbrechung; Erkennung Abfall gemeine Sondenmasse; Erkennung Unterbrechung Sondenmasse einer plan. Sonde



dlsv-wrbrkv2

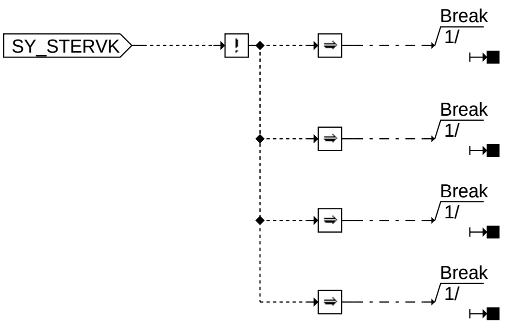
`LSVN2: Erstellung der Kaltbedingung B_lsvklt (kalte Sonde) und Erkennung Nebenschlußnch UBatt und SG-Masse bei Kalter Sonde Bank2`



dlsv-lsvn2

dlsv-lsvn2

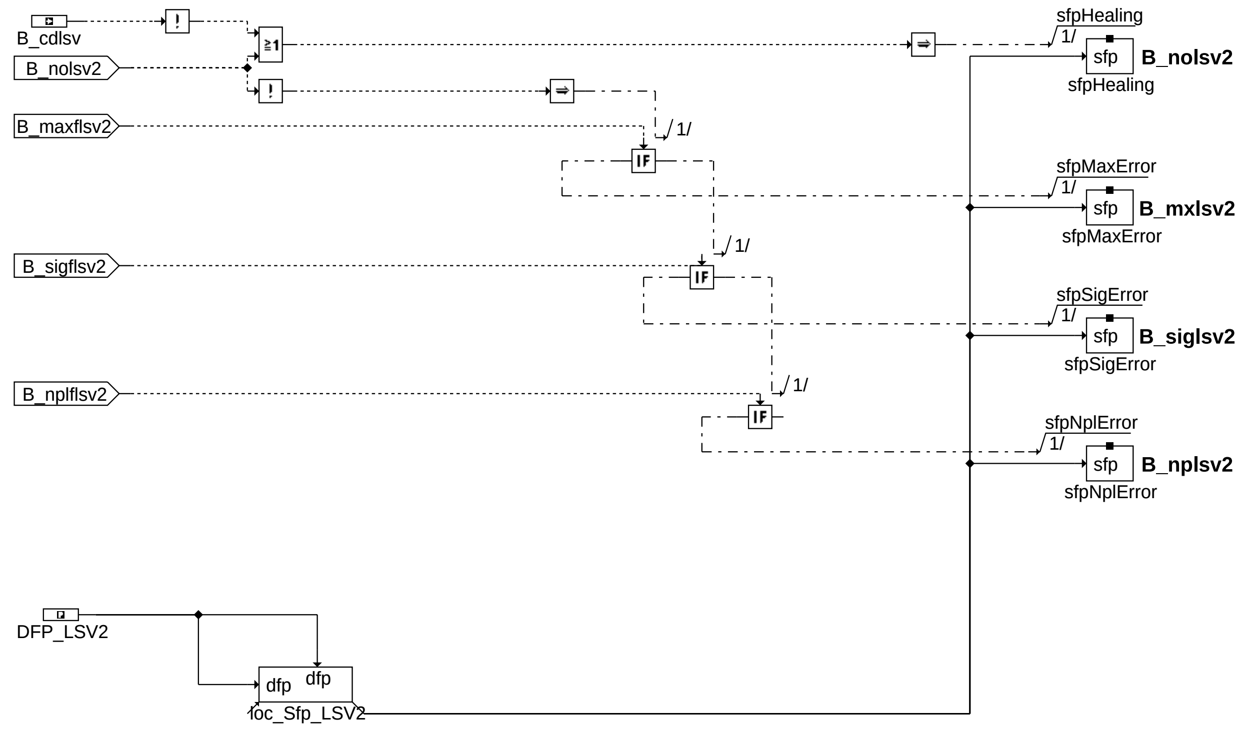
`BreakBank2: SY_STERVK`



dlsv-breakbank2

dlsv-breakbank2

DFPM2: Fehlerverwaltung DLSV



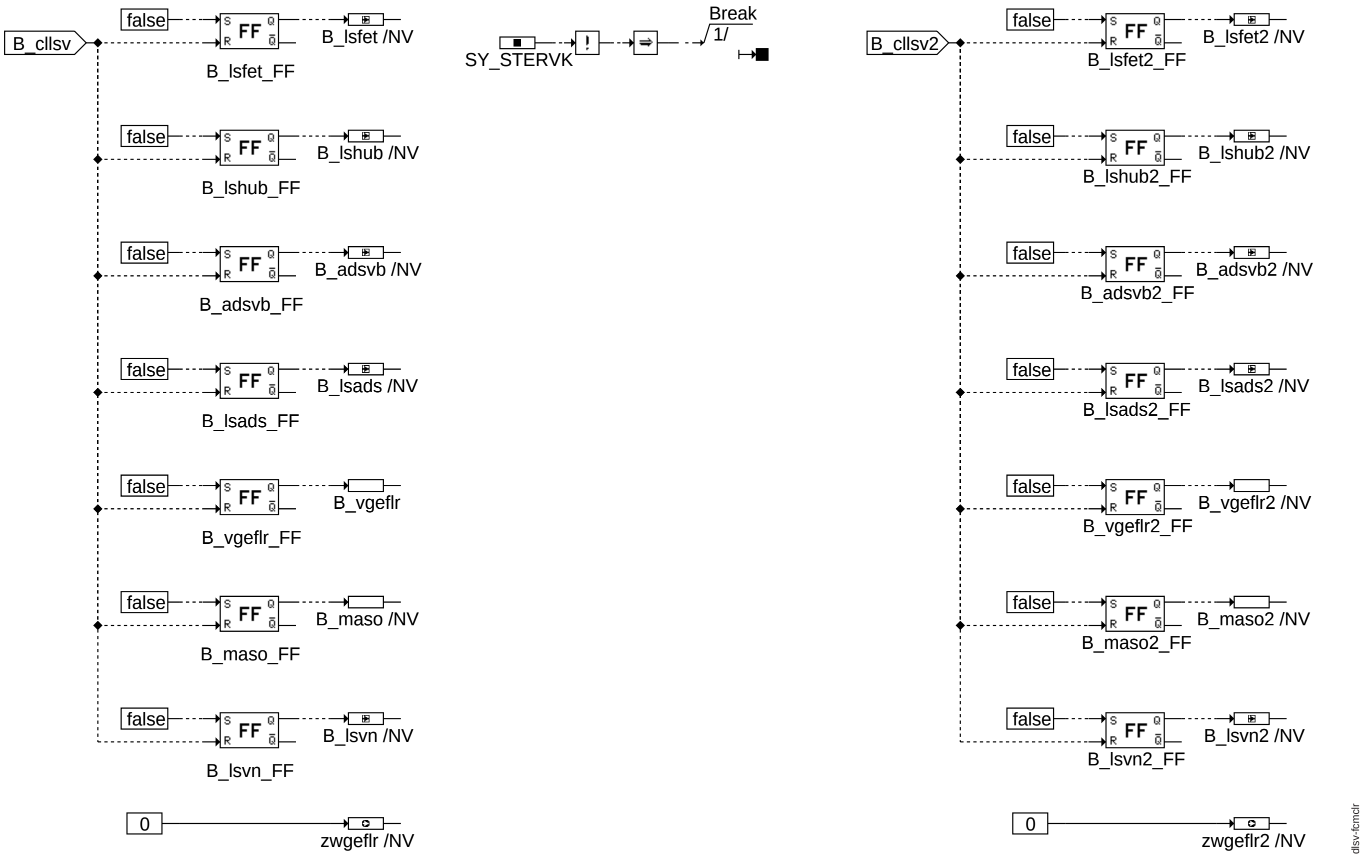
E_lsv2 = 1 if B_mxlsv2 or B_siglsv2 or B_nplsv2 is set
E_lsv2 = 0 if B_nolsv2 is set

Z_lsv2 = 1 if B_nolsv2 or B_mxlsv2 or B_siglsv2 or B_nplsv2 is set

dlsv-dfpm2

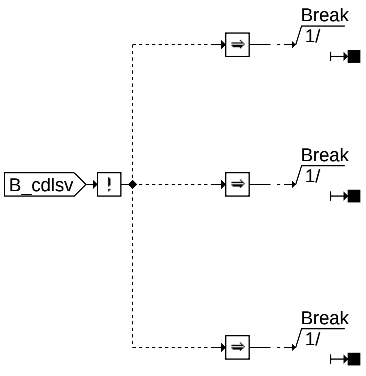
dlsv-dfpm2

FCMCLR: Fehlerspeicher löschen



dlsv-fcmclr

BRKDLSV: Abschalten der Funktion



Bei B_cdlsv = 0 wird Funktion DLSV nicht gerechnet

dlsv-brkdlsv

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

```
For each fault path "lsv" of this diagnosis function the following values are defined:

                                    |   Bank 1                                  |  Bank 2
------------------------------------|-------------------------------------------|-------------------------------------------
    Status fault path lsv:          |   sfplsv                                  |    sfplsv2
       Error flag xyz:              |   E_lsv                                   |    E_lsv2
       Cycle flag xyz:              |   Z_lsv                                   |    Z_lsv2
       Fault type  xyz:             |   TYP_lsv: (B_mxlsv, B_silsv,B_nplsv)     |    TYP_lsv2: (B_mxlsv2, B_silsv2,B_nplsv2)
       Clear fault path:            |   B_cllsv                                 |    B_cllsv2
       Default value active:        |   B_bklsv  (optional)                     |    B_bklsv2  (optional)
    Fault path code lsv:            |   CDTlsv                                  |    CDTlsv2
    Fault class lsv:                |   CLAlsv                                  |    CLAlsv2
    Fault intensity lsv:            |   TSFlsv                                  |    TSFlsv2
    CARB CODE lsv:                  |   CDClsv                                  |    CDClsv2
    Table of ambient cond. lsv:     |   FFTlsv                                  |    FFTlsv2
                                    |                                           |
```

ABK DLSV 32.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABGMSIGV			FW	threshold for exhaust temp. for wiring-interruption with Ri-diagnosis upstr. cat
ANZGEM			FW	number of mixture fault
CDKLSV2			FW	code word customer: lambda sensor downstream cat
CDTLSV2			FW	code word tester: lambda sensor 2 upstream catalyst [018]
CLALSV2			FW	fault class: O2 sensor bank 2 pre cat
DRISIGV			FW	diagnosis threshold for Ri sensor for signal disconnection pre cat
PHLSNVMN			FW	minimal normalised heating-power-diagnosis sensor pre catalyst
RISIGRESV			FW	threshold for reset wiring-interruption with Ri-diagnosis upstr. cat
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TABGMCSD			FW (REF)	threshold for exhaust temperature for measuring CSD
TABGMSVU			FW	temp. threshold from exhaust temp. modell for diagn. sensor upstream
TASIG			FW (REF)	Time for the deactiv.of interf. peaks outside of range for det.of signal interr.
TMASO			FW	time after fuel cut off for commen open sensor ground
TMNEB			FW	Engine temprerature threshold for measurement of sensor shunt pre cat
TMSV			FW	engine temp. threshold for recognition cold start for measuring sensor upstream
TMSVA			FW	threshold for engine switch-off temp. for measuring cooling sensor upstream cat
TNSTDN			FW	time after start for diagnosis shunt resistance fault (monoflop)
TRSA			FW	monitoring time closed-loop control (upstream CAT) -> sensor off
TRSE			FW (REF)	monitoring time -> closed-loop control on
TSFLSV2			FW	fault active time: lambda sensor catalyst upstream, bank 2
TTBMH			FW	period for theoretical operation readiness of sensor with heating
TUSDU			FW	time delay for detec. intercore short circ. and sensor with limit. volt. up.cat
TUSDUC			FW	delay time code for detec. wire-to-wire sh. circ. of the oxyg. sens. upstr. cat
TUSEINV			FW	Delay time for condition Lambda sensor ready bit
TUSFETT			FW	time delay for detec. current leakage to Ubatt upstream cat
TUSKS			FW (REF)	delay time for short circuit detection on the oxygen sensor
TUSMAX			FW (REF)	monitoring time for Usmax
UBDLS			FW (REF)	battery voltage threshold for release the sensor diagnosis
USDBO			FW	upper limit wire-to-wire detection and defective O2-sensor limited voltage range
USDBU			FW	lower limit wire-to-wire detection and defective O2-sensor limited voltage range
USFHK			FW	sensor voltage threshold for detection 'rich' downstream cat
USMASO			FW	sensor voltage threshold for commen open sensor ground
USMAX			FW (REF)	threshold for short circuit of sensor to Ubat
USMHK			FW	sensor voltage threshold for detection 'rich' downstream cat
USMIN			FW (REF)	threshold for short circuit of sensor to ground
USPVR			FW	threshold for reset of fault ”potential offset” of sensor upstream cat
USREF			FW	threshold for operation readiness of sensor at rich mixture (upstream CAT)
USREM			FW	threshold for operation readiness of sensor at lean mixture (upstream CAT)

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_ADCSD	DLSV	LOK	condition for test of short-circuit and CSD
B_ADCSD2	DLSV	LOK	condition for test of short-circuit and CSD bank2
B_ADDE	DLSV	LOK	condition short circuit or defective sensor with limited voltage amplitude
B_ADDE2	DLSV	LOK	condition short circuit or defective sensor bank2 with limited voltage amplitude
B_ADSVB	DLSV	LOK	prohibition operating readiness because of SC wire-to-wire
B_ADSVB2	DLSV	LOK	prohibition operating readiness because of SC wire-to-wire bank2
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_BELSV	DLSV	AUS	Condition: function request for elctr. diag. sensor voltage upstream cat
B_BELSV2	DLSV	AUS	Condition: function request for elctr. diag. sensor voltage upstream cat bank2
B_BKLSV	DLSV	AUS	Condition: lambda sensor upstream cat. active
B_BKLSV2	DLSV	AUS	Condition: lambda sensor upstream cat. active bank2
B_CDLSH	PROKON	EIN	function active per codeword CDLSH
B_CDLSV	PROKON	EIN	function active per codeword CDLSV
B_CLLSV		EIN	Delete fault path in DLSV.
B_CLLSV2		EIN	Delete fault path in DLSV. Bank2
B_DMASO	DLSV	LOK	condition common lamda sensor ground open ”dynamic”
B_DMASO2	DLSV	LOK	condition common lambda sensor ground open ”dynamic” bank2
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DSVEN	DLSV	AUS	condition enable sensor diagnosis upstream catalyst
B_DSVEN2	DLSV	AUS	condition enable sensor diagnosis upstream catalyst bank2
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system

Variable	Source	Type	Description
B_ESLS		EIN	Condition secondary air fault by wrong air mass flow
B_FTLSV	DLSV	AUS	Condition fault entry by tester for lambda sensor upstream cat
B_FTLSV2	DLSV	AUS	Condition fault entry by tester for lambda sensor upstream cat bank2
B_HSVE	HLS	EIN	condition for lambda sensor heating-switch upstream cat on
B_HSVE2	HLS	EIN	condition for lambda sensor2 heating-switch upstream cat on
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LSADS	DLSV	LOK	condition for lambda sensor upstream cat SC wire to wire
B_LSADS2	DLSV	LOK	condition for Lambda sensor upstream cat wire to wire bank2
B_LSFET	DLSV	LOK	condition for sensor voltage current leakage to UBatt upstream cat
B_LSFET2	DLSV	LOK	condition for sensor voltage current leakage to UBatt upstream cat bank2
B_LSHUB	DLSV	LOK	condition for lambda sensor upstream cat with restricted signal amplitude
B_LSHUB2	DLSV	LOK	condition for lambda sensor upstream cat with restricted sensor voltage bank 2
B_LSVKLT	DLSV	LOK	condition cold oxygen sensor upstream catalyst
B_LSVKLT2	DLSV	LOK	condition cold oxygen sensor upstream catalyst bank2
B_LSVN	DLSV	LOK	condition leakage resistance at cold oxygen sensor upstream catalyst
B_LSVN2	DLSV	LOK	Condition leakage resistance at cold sensor upstream catalyst
B_MASO	DLSV	LOK	condition common lamda sensor ground open
B_MASO2	DLSV	LOK	condition common lambda sensor ground open on bank 2
B_MAXFLSV	DLSV	LOK	Short circiut to battery voltage at O2 sensor pre cat
B_MAXFLSV2	DLSV	LOK	Short circiut to battery voltage at O2 sensor pre cat Bank 2
B_MNLSV	DLSV	AUS	Condition for fault type ”minimum value” upstream cat detected
B_MNLSV2	DLSV	AUS	Condition for fault type ”minimum value” upstream cat detected bank2
B_MXLSV	DLSV	AUS	Condition for fault type ”maximum value” upstream cat detected
B_MXLSV2	DLSV	AUS	Condition for fault type ”maximum value” upstream cat detected bank2
B_NMOT	GGDPG	EIN	condition engine speed: n $>$ NMIN
B_NOLSV	DLSV	LOK	Condition diagnosis finished with o.k. upstream cat report
B_NOLSV2	DLSV	LOK	Condition diagnosis finished with o.k. upstream cat report bank2
B_NPLFLSV	DLSV	LOK	Short circuit between cables at O2 sensor pre cat
B_NPLFLSV2	DLSV	LOK	Short circuit between cables at O2 sensor pre cat bank 2
B_NPLSV	DLSV	AUS	Condition fault type ”value not plausible” detected
B_NPLSV2	DLSV	AUS	Condition fault type ”value not plausible” detected bank2
B_PWF		EIN	Condition for powerfail
B_REFMAX	DLSV	LOK	Condition O2-sensor voltage in plausible area between USREF and USMAX,pre cat
B_REFMAX2	DLSV	LOK	Condition O2-sensor voltage in plausible area between USREF and USMAX ,bank2
B_RISIGV	DLSV	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis
B_RISIGV2	DLSV	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis, bank 2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_SBBVK	DLSV	AUS	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	AUS	condition oxygen sensor upstream cat. bank2 ready for operation
B_SIGFLSV	DLSV	LOK	Signal interruption at O2 sensor upstream cat
B_SIGFLSV2	DLSV	LOK	Signal interruption at O2 sensor upstream cat bank 2
B_SILSV	DLSV	AUS	condition for fault type ’signal missing’ upstream cat detected
B_SILSV2	DLSV	AUS	condition for fault type ’signal missing’ upstream cat detected bank2
B_SLS	AK	EIN	Condition for active secondary air
B_ST	SWADAP	EIN	condition for start
B_TRSA	DLSV	LOK	Condition wiring interruption for sensor upsteam catalyst
B_TRSA2	DLSV	LOK	Condition wiring interruption for sensor downstream catalyst bank 2
B_TTBMH	DLSV	LOK	condition theoretical lambda sensor operation readyness with heating
B_TTBMH2	DLSV	LOK	condition theoretical lambda sensor operation readyness with heating bank2
B_UEINV	DLSV	LOK	Condition: preparation of setting the O2 sensor ready condition
B_UEINV2	DLSV	LOK	Condition: preparation of setting the O2 sensor ready condition bank 2
B_UVSIG	DLSV	LOK	Condition O2 sensor voltage pre cat in voltage band for signal interruption
B_UVSIG2	DLSV	LOK	Condition O2 sensor voltage pre cat in voltage band for signal interruption ba.2
B_VADGE	DLSV	LOK	condition suspect for short circuit or mixture failure
B_VADGE2	DLSV	LOK	condition suspect of short-circuit or mixture failure on bank 2
B_VGEFLR	DLSV	LOK	condition suspicion of mixture fault
B_VGEFLR2	DLSV	LOK	condition suspicion of mixture fault bank 2
DFP_LSV	DLSV	DOK	ECU int. fault path no.: electrical diagnosis for lambda sensor upstream cat.
DFP_LSV2	DLSV	DOK	ECU int. fault path no.: electr. diagnos. for lambda sensor upstream cat. bank 2
DFP_TES	DLSV	DOK	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE	DLSV	DOK	Internal fault path number: canister purge valve power stage
DFP_TM	DLSV	DOK	Internal fault path number: engine temperature
E_LSV	DLSV	AUS	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	AUS	error flag: lambda sensor upstream catalyst
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
PHLSNV	HLS	EIN	normalized heating power of lambda sensor upstream of catalyst
PHLSNV2	HLS	EIN	normalized heating power of lambda sensor 2 upstream of catalyst
RINV2_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (word)
SFPLSV	DLSV	AUS	status fault path: diagnosis of lambda sensor upstream of catalyzer
SFPLSV2	DLSV	AUS	status fault path:
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TMOT	SWADAP	EIN	Engine temperature
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking

Variable	Source	Type	Description
UB	SWADAP	EIN	battery voltage
USHK2_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHK_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USVK2_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVK_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
ZWGEFLR	DLSV	AUS	counter value of mixture fault
ZWGEFLR2	DLSV	AUS	counter value of mixture fault bank 2
Z_LSV	DLSV	AUS	cycle flag: lambda sensor upstream of catalyst
Z_LSV2	DLSV	AUS	cycle flag: 2nd lambda sensor upstream of catalyst

```
Abbreviations and terminology
-----------------------------

CSD       'chemical shift down' lowered sensor characteristic line due to poisoning
ECU,SG    Electronic control unit
SC,KS     Short circuit


Abbreviations for cross coupling matrix:
----------------------------------------
Partial function sensor operating readiness - outputs: SB=sensor operating readiness

                                            - Inputs: S/SB=block/sensor operating readiness

Partial function sensor diagnosis           - Outputs: SD=sensor diagnosis
                                                     F/SD=flip-flop sensor diagnosis

                                            - Inputs: S/SD=block/sensor diagnosis
                                                    B/SD=condition/sensor diagnosis
```

FW DLSV 32.60 Fixed Values

Parameter	Value	Description
ABGMSIGV		threshold for exhaust temp. for wiring-interruption with Ri-diagnosis upstr. cat
ANZGEM		number of mixture fault
CDKLSV2		code word customer: lambda sensor downstream cat
CDTLSV2		code word tester: lambda sensor 2 upstream catalyst [018]
CLALSV2		fault class: O2 sensor bank 2 pre cat
DRISIGV		diagnosis threshold for Ri sensor for signal disconnection pre cat
PHLSNVMN		minimal normalised heating-power-diagnosis sensor pre catalyst
RISIGRESV		threshold for reset wiring-interruption with Ri-diagnosis upstr. cat
TABGMSVU		temp. threshold from exhaust temp. modell for diagn. sensor upstream
TMASO		time after fuel cut off for commen open sensor ground
TMNEB		Engine temprerature threshold for measurement of sensor shunt pre cat
TMSV		engine temp. threshold for recognition cold start for measuring sensor upstream
TMSVA		threshold for engine switch-off temp. for measuring cooling sensor upstream cat
TNSTDN		time after start for diagnosis shunt resistance fault (monoflop)
TRSA		monitoring time closed-loop control (upstream CAT) -> sensor off
TSFLSV2		fault active time: lambda sensor catalyst upstream, bank 2
TTBMH		period for theoretical operation readiness of sensor with heating
TUSDU		time delay for detec. intercore short circ. and sensor with limit. volt. up.cat
TUSDUC		delay time code for detec. wire-to-wire sh. circ. of the oxyg. sens. upstr. cat
TUSEINV		Delay time for condition Lambda sensor ready bit
TUSFETT		time delay for detec. current leakage to Ubatt upstream cat
USDBO		upper limit wire-to-wire detection and defective O2-sensor limited voltage range
USDBU		lower limit wire-to-wire detection and defective O2-sensor limited voltage range
USFHK		sensor voltage threshold for detection 'rich' downstream cat
USMASO		sensor voltage threshold for commen open sensor ground
USMHK		sensor voltage threshold for detection 'rich' downstream cat
USPVR		threshold for reset of fault "potential offset" of sensor upstream cat
USREF		threshold for operation readiness of sensor at rich mixture (upstream CAT)
USREM		threshold for operation readiness of sensor at lean mixture (upstream CAT)

FB DLSV 32.60 Detailed description of function

Introduction:

The diagnosis function serves the purpose to detect all possible wiring faults of the Lambda sensor. Output signals are: the fault bit E_lsv, the cycle bit Z_lsv and the sensor operating readiness bit B_sbbvk.
The following fault types are transferred to the fault management logic: (B_maxflsv (KS_UBat), B_sigflsv (wiring interruption, sensor heating defective), B_nplflsv (wire-to-wire SC or O2 sensor with limited voltage amplitude). B_minflsv is not transferred since a short-circuit to electronic ground is tantamount to wire-to-wire SC.
These fault types are stored in a flip-flop in the permanent RAM and they are transferred to the fault memory as B_mxlsv (SC-UBat), B_mnlsv (0), B_silsv (wiring interruption); B_nplsv (wire-to-wire SC).
Generally, a transfer to the fault management can only take place (B_dsven = 1) if the dew point end B_atmtpa = 1 is exceeded and thus the sensor heating is switched on with B_hsve =1 and if a sensor-specific time TUSEINV has elapsed and hence was permanently switched on for at least the time TTBMH (that means especially not dutycycled). At the same time the battery voltage ub may not lie below the threshold UBDLS, lamsons_w must be equal to 1 and the exhaust gas temperature from the model must be less than the threshold TABGMCSD. With the bit B_cdlsv = 0 the entire diagnosis function DLSV is switched off.

Requirements for a properly working diagnosis function:

The described diagnosis and detection of operating readiness of the sensor can only be performed, if a potential-free sensor, a sensor evaluation circuit with reverse voltage source and a two-level Lambda control is used.
The function can only be used in combination with the function %HLS.

Operating readiness:

The internal resistance of the the cold sensor is very high so that the voltage of the sensor evaluation circuit always remains within a given range (independent of the mixture), determined by the reverse-voltage source (USREM < usvk_w < USREF).
With increasing sensor temperature, the internal resistance decreases and the sensor voltage dominates the reverse voltage source. Due to the steep sensor characteristic, the sensor voltage is always different to the reverse voltage, so that the voltage of the evaluation circuit leaves the range USREM < usvk_w < USREF. The operating readiness of the sensor is not only, like so far, switched on via the sensor parameters. Only once the time TUSEINV has elapsed the operating readiness can be detected, if the following applies permanently for at least the time t = TRSE to the voltage usvk:
USREF <= usvk_w <= USMAX or usvk <= USREM. During the time TUSEINV all interferences which cause an early turn-on are suppressed. Furthermore, the faults 'wire-to-wire SC' as well as 'defective sensor with limited voltage amplitude' (B_nplsv) may not exist in the lower lean turn-on range.

If the time TUSEINV is adjusted towards zero then a too early turn-on is prevented, like so far, by means of the current leak detection, if with a highly restrictive current leak to U_Bat or to ECU ground the Lambda control is erroneously activated (formation of B_lsvn see below: "+/- detection current leakage for cold sensor"). Readiness for operation can only be set, if either the sensor voltage is outside of the window USREM < usvk_w < USREF and there is no current leak or if the sensor has been heated for a sufficient time.
In this second case, operating readiness is only set if the sensor heating has been turned on for the time TTBMH without any interruption.
The operating readiness of the sensor is reset in case of all detected faults of the sensor upstream catalyst. In case of initialization (C_ini = 1) the operating readiness is generally reset.

Possible faults:

If the sensor heating has been turned on (B_hsve = 1) without any interruption for the time TTBMH, then it can be assumed that, with properly working sensor heating, the sensor has a low impedance (high impedance shunt does not affect sensor signal) and, theoretically, the sensor should therefore be ready for operation.
If the sensor voltage usvk remains within the voltage range USREM < usvk_w < USREF, the flip-flop B_uvsig is set. When leaving this voltage range this flip-flop B_uvsig is again reset. The reset is performed after a delay by the time TASIG.
If influence peaks (e.g. clocked heating), which lie outside the voltage range, take place on the sensor voltage in case of wiring interruption (sensor voltage within the range), then they are deactivated by the time TASIG and the flip-flop B_uvsig is not reset.
If the flip-flop B_uvsig remains set for longer than the time TRSAH (sensor voltage within the range), then a wiring interruption or a defective sensor heating is assumed. The fault (B_silsv) is reported.

In case of an interruption of the common sensor ground (sensor grounds of the individual sensors are, however, connected) an undefined sensor voltage in the plausible voltage range is obtained, so that a Lambda control is no longer possible. This interruption can be detected with warm sensor (the time TTMBH has elapsed) during fuel cut-off (B_sa = 1) after the time TMASO, if the sensor voltages usvk and ushk exceed the threshold value USMASO. After the interference suppression time TUSKS a flip-flop B_maso is set and the operating readiness B_sbbvk is switched off. The fault (B_silsvl) is set via the trigger B_dmaso. During the next trip B-sbbvk remains switched off and E_lsv is set in the fault management, since the B_nolsv cannot be reset via B_maso in the permanent RAM. Only during the next check in the fuel cut-off phase B_sa the fault "open sensor ground" is either confirmed again or reset in case of healing B_maso, if the sensor voltages usvk and ushk are less than USMASO for the time TMASO. By resetting B_maso, B_nolsv = 1 and thus the E_lsv is reset. The cycle flag Z-lsv is only then set again.
By means of B_dmaso it is prevented that the MIL lamp is triggered prior to the check "open sensor ground" during the 2. trip.

If the voltage of the evaluation circuit permanently exceeds the value USMAX for longer than the time TUSKS then there is a short circuit of the sensor signal lead to the supply voltage. The operation readiness B-sbbvk is reset after the time TUSKS. Once the time TUSMAX has elapsed the fault B_mxlsv is reported.

If the voltage of the evaluation circuit lies permanently longer than the time TUSFETT between the voltage range USREF <= usvk_w <= USMAX with defined low-resistance current leak 2...3 kOhm and with active control B_lr = 1, and if also the sensor voltage ushk downstream of catalyst lies below the threshold USMHK, then with not turned on Euro code bit (Euro version) B_cdlsh = 1, the flip-flop B_lsfet is set in the permanent RAM and the operation readiness B_sbbvk is reset. The fault B_nplsv is set.
Only once the sensor voltage usvk lies outside of the voltage range USREF <= usvk_w <= USMAX, is the flip-flop B_lsfet reset and the fault B_nplsv is cleared via B_nolsv = 1.

A defective sensor with limited voltage amplitude is indicated (B_lshup=1) if the evaluation voltage in case of B_adcsd=1 lies within the limits USDBU <= usvk < USDBO for the time TUSDU (without any interruption) and if in addition the sensor voltage downstream of catalyst (ushk_w) in the rich range lies above the threshold USFHK. The fault B_nplsv is set in the permanent RAM via the flip-flop B_lshub and via B_adde and the operation readiness B_sbbvk is reset.
In addition the setting of the operation readiness (B_sbbvk) is prevented in the lower lean turn-on range.
Only once the sensor voltage usvk leaves the window USDBU <= usvk_w < USDBO, this flip-flop is reset again.
In case of a defective sensor downstream catalyst it is not possible to detect a defective sensor upstream catalyst.
A simultaneously occurring fault of the upstream and downstream sensor is not assumed.

Generating a cold bit (B_lsvklt)

With sufficient cooling down of the exhaust system the sensor is cold, so that in case of start the evaluation voltage is determined by the reverse voltage. Such a start is definitely given, if during the starting procedure the engine temperature lies below the threshold TMSV and if in addition the engine was turned off at a temperature above TMSVA. Additionally no tmot-fault may exist.

If all above-mentioned conditions are fulfilled then the monoflop TNSTDN is triggered with the start bit.
The duration of the cold bit is determined with the adjustable time TNSTDN.

On the Euro version there is no sensor downstream catalyst. With the code word CDLSH = 0 (Euro version) the time TUSDU is switched to a marginally greater time TUSDUC, and checking of the threshold USFHK is set to "1" via an OR gate.
The time TUSDUC may not be chosen too high, since otherwise the mixture adaptation controller will deviate too much in case of a defective sensor.

With a short circuit between sensor signal and ground or with a defective fuel supply system (e.g. reduced system pressure, leakage), the sensor voltage upstream catalyst (usvk) lies around 0 Volt below the lean threshold USMIN.
In order to distinguish these two faults the evaluation is performed by means of 2 flip-flops in the Euro Version.

Detection of wire-to-wire SC with OBD II version:

If the sensor voltage upstream catalyst lies below the lean threshold USMIN and the sensor voltage downstream catalyst does not lie above the threshold USFHK with above-mentioned fault, then a mixture fault is assumed, that means the operating readiness of the sensor is not switched off and the mixture adaptation has a chance to compensate for this fault. If the mixture adaptation controller in the process reaches the limit then, consequently, this fault will be reported by the mixture adaptation.

A wire-to-wire SC between sensor signal and ground lead is detected, if the following applies:
The evaluation voltage for B_adcsd=1, i.e. for active Lambda control (B_lr =1) and switched off secondary air (B_sls = 0) and secondary air diagnosis (B_dsls = 0 or B_esls), as well as the "not set" error flags of the secondary air pump (E_slpe = 0; E_slp = 0), and the "not set" error flags of the canister purge control (E_tes = 0; E_teve = 0), lies below the limits of the threshold USMIN without interruption, while at the same time the sensor voltage downstream catalyst (ushk) remains in the rich area above the threshold USFHK for the time TUSDU. Via a flip-flop B_lsads in the permanent RAM and via B_adde the operating readiness upstream catalyst (B_sbbvk) is reset and in the lower lean turn-on band the setting of the operating readiness is prevented. The fault B_nplsv is set.
A wire-to-wire SC is also immediately detected, if during start with cold sensor (B_lsvklt = 1), the sensor voltage lies below the threshold USMIN. The flip-flop B_lsads in the permanent RAM is set and once the time TTBMH has elapsed the fault B_plaus is indicated. Only once the sensor voltage usvk lies above the threshold USPVR, this flip-flop is reset.
Thus an additional information on whether a mixture fault or a wire-to-wire SC is present can be obtained during the start with cold sensor.

Detection of wire-to-wire SC with Europe version:

On the Europe version the sensor downstream catalyst is not installed. With the code word CDLSH = 0 (Euro version) a switch from the time TUSDU to the marginally greater time TUSDUC is performed and the inquiry on the threshold USFHK is set to the value = 1 by means of an OR-gate.
A wire-to-wire SC during start with cold sensor (B_lsvklt = 1) is immediately detected, if the sensor voltage lies below the threshold USMIN.
In the process the sensor operating readiness is blocked via the flip-flop (B_lsads=1) and B_adde and the fault B_plaus is set once the time TTBMH has elapsed.
If the sensor voltage lies below the threshold USMIN for longer than the time TUSDUC without interruption, with active Lambda control (B_lr = 1) and switched off secondary air (B_sls = 0) and secondary air diagnosis (B_dsls = 0; B_esls), as well as with the "not set" error flags of the secondary air pump (E_slpe = 0; E_slp = 0) and the "not set" error flags of the canister purge control (E_tes = 0; E_teve = 0), then the flip-flop B_adsvb=1 is set in the permanent RAM, the operating readiness upstream catalyst (B_sbbvk) is reset via B_vadge and the setting of the operating readiness is prevented in the lower lean turn-on band.
Simultaneously the flip-flop B_vgeflr=1 is set in the permanent RAM.
At first the operating readiness is only blocked on suspicion and no fault is indicated, since it is not yet known whether there is a wire-to-wire SC or a mixture fault.
However, if during the next cold start (B_lsvklt=1) the sensor voltage of the cold sensor does not lie below ULSMIN, but at the reverse voltage 450 mV, then a mixture fault is assumed. The flip-flop‘s B_adsvb und B_lsads remains set, if ushk_w not exceeds the threshold USPVR. the flip-flop in the permanent RAM with B_vgeflr remains set. The event counter zwgeflr is incremented by 1, by a delay of one operating step once the cold bit B_lsvklt=1 has elapsed. Thereafter the flip-flop B_vgeflr is reset after the delay of one operating step.
The given mixture fault is incremented by 1 after each cold start and the quantity is compared to ANZGEM. Once the quantity of measured mixture faults is reached, B_vadge=0 and thus the operating readiness B_sbbvk of the sensor is no longer reset.
For the mixture adaptation control %LRA it is now possible to correct the mixture fault. This mixture fault can then possibly be indicated via %DKVS.
For the healing (B_vgeflr is not set) the event counter is each time incremented by 1, if during cold start B_lsvklt=1 there is no mixture fault.

Early detection of current leakage with a cold sensor

A high impedance current leakage must be detected in order to:
- prevent a premature turn-on of the Lambda control (formation of B_lsvn)
- provide maximum heating current after start without interruption for high impedance current leakage.

A detected current leakage is stored in a permanent RAM, buffered with a flip-flop (current leakage => B_lsvn = 1).
It is set, if with a cold sensor (B_lsvklt=1), the voltage is outside the band USREF <= usvk_w <= USREM longer than for the debouncing time TUSKS. It is reset accordingly at a following cold start if the voltage is again within the window.
Operating readiness of the upstream sensor is only released if either no current leakage has been detected, or the sensor heating has been turned on for longer than TTBMH without interruption. In the second case, high impedance current leakage does not affect the sensor voltage.
The current leakage detection can be switched off during the emission test if the engine temperature threshold TMNEB is chosen > 50°C.
Thereafter only the turn-on delay TUSEINV has an effect, i.e. if the sensor voltage lies outside of the window USREF <=usvk <=USREM during this time, then no turn-on of the operating readiness takes place.
If TMNEB is chosen < 20°C then the current leakage detection is fully effective during the emission test, i.e. with detected current leakage the operation readiness B_sbbvk is turned on only once the time TTBMH has elapsed.

Fault healed:

If the sensor heating is permanently on for longer than the time TTBMH and if the operation readiness B_sbbvk is set, then, most likely, there is no fault.

Fault management:

From the three fault types the fault flag and the cycle flag is created. The cycle flag, however, is also set after each no-fault resp. healing-trigger and it is reset after each ECU initialization C_ini. If an error is detected as having been healed (B_nolsv = 1), then the fault flag is reset. By the fault management logic the CARB lamp is only triggered if after 2 trips the cycle flag and the fault flag are each set.

APP DLSV 32.60 Application hint

```
Guidance values:    TUSKS  : 100 ms
                    TNSTDN : 1 s
                    TRSE   : 200 ms
                    TRSA   : 5 s
                    TUSDU  : 10 s
                    TUSFETT: 10 s
                    TASIG  : 60 ms
                    DRISIGV: 20000 Ohm
                    RISIGRESV: 1000 Ohm
                    TUSDUC : 20 s
                    TMASO  : 3 s
                    TUSMAX : 5 s
                    USFHK  : 500 mV
                    USMHK  : 100 mV
                    TTBMH  : 90 s
                    TMSPV  : 40 °C
                    TMSPVA : 60 °C
                   TABGMCSD: 800 °C
                   TABGMSVU: 600 °C
                   PHLSNVMN: 0.8
                    ANZGEM : 4
                    UBDLS  : 11 V
                    USMASO : 200 mV (if all graunds of sensors seperately go to ECU, then is this function not required and USMASO
                                       can be dated with 1.2V).

              TUSEINV : less than the turn-on time of the operation readiness by a factor of 0.7 if USREF or USREM
                        are exceeded resp. undershot (5 ...20s).
              TMNEB  : -->   > 50 °C: Current leakage detection is switched off. During the time TUSEINV a current
                                        leakage is suppressed. (Use on the planar sensor LSF4.7)
                       -->   < 20 °C: Current leakage detection is fully effective during the emission test, i.e. in case of a
                      detected current leakage, the operation readiness is turned on only after the time TTBMH.
```

The voltage band is briefly summarized in the following diagram.

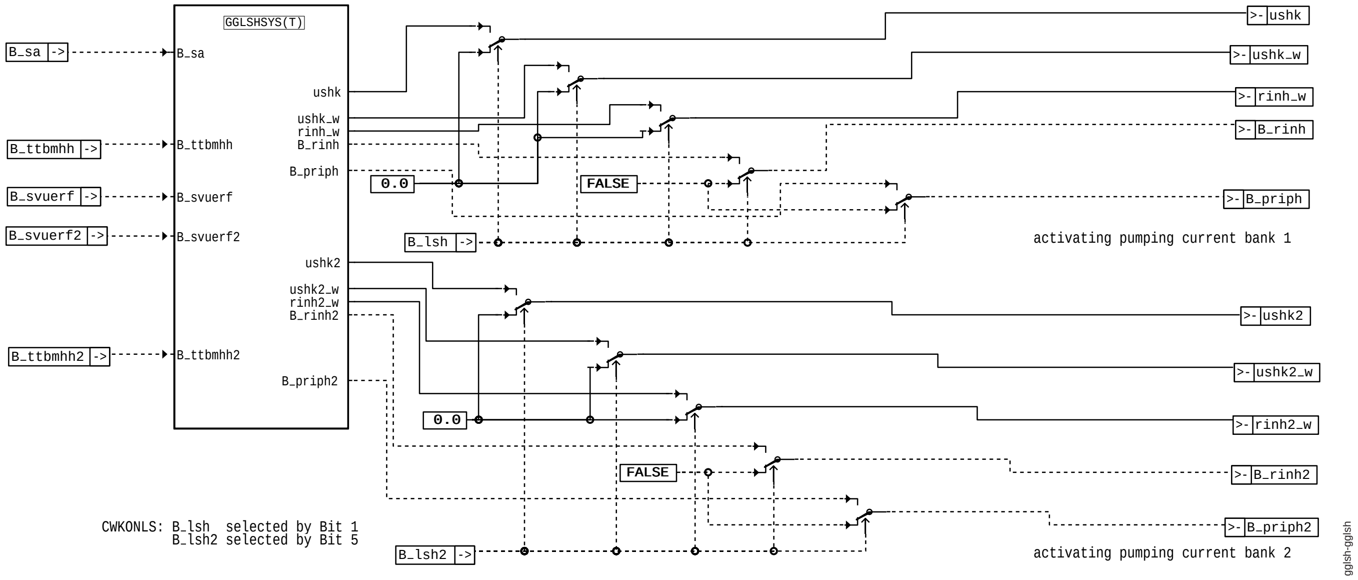
Practical numerical values are indicated

```
                        ^                                                      ^
                 usvk_w |                                                      |    U_ADC        U_Sonde
                        |    SC to U_Bat                                       |
              USMAX    ------------------------------------------------------  +  = 1.50  V      1.50  V
                        |     +----------------------------------------------+
                        |     | Defined low impedance current leakage        |
                        |     | to UBatt                                     |
                        |     +----------------------------------------------+
                        |   Operating readiness after t > TRSE(=200ms)         |
              USREF     ------------------------------------------------------- +  = 0.600 V      0.600  V
                        |  sensor cold / signal interruption                   |
                        |                                                      |
              USR               ---------------- Control threshold             +  = 0.450 V      0.450  V
                        |   / Sensor heating defective after t > TRSA(=5s)     |
              USREM     ------------------------------------------------------- +  = 0.400 V      0.400  V
                        |  Operating readiness after t > TRSE, if no wire-to-  |
                        |  wire SC or SC of sensor ground to ECU ground        |
              USDBO     |     +----------------------------------------------+  = 0.400 V      0,400  V
                        |     | Defective sensor with restricted signal        |
                        |     | amplitude                                      |
              USDBU     |     +----------------------------------------------+  = 0.060 V      0.060  V
                        |                                                      |
              USMASO    -------------------------------------------------------   = 0.200 V      0.200  V
                        | Interruption of the common sensor ground             |
                        ------------------------------------------------------+
              USMIN     ------------------------------------------------------+  = 0.060 V      0.060  V
                        |        Wire-to-wire SC                               |
```

GGLSH 3.30 Sensor variable for lambda sensor downstream of catalytic converter

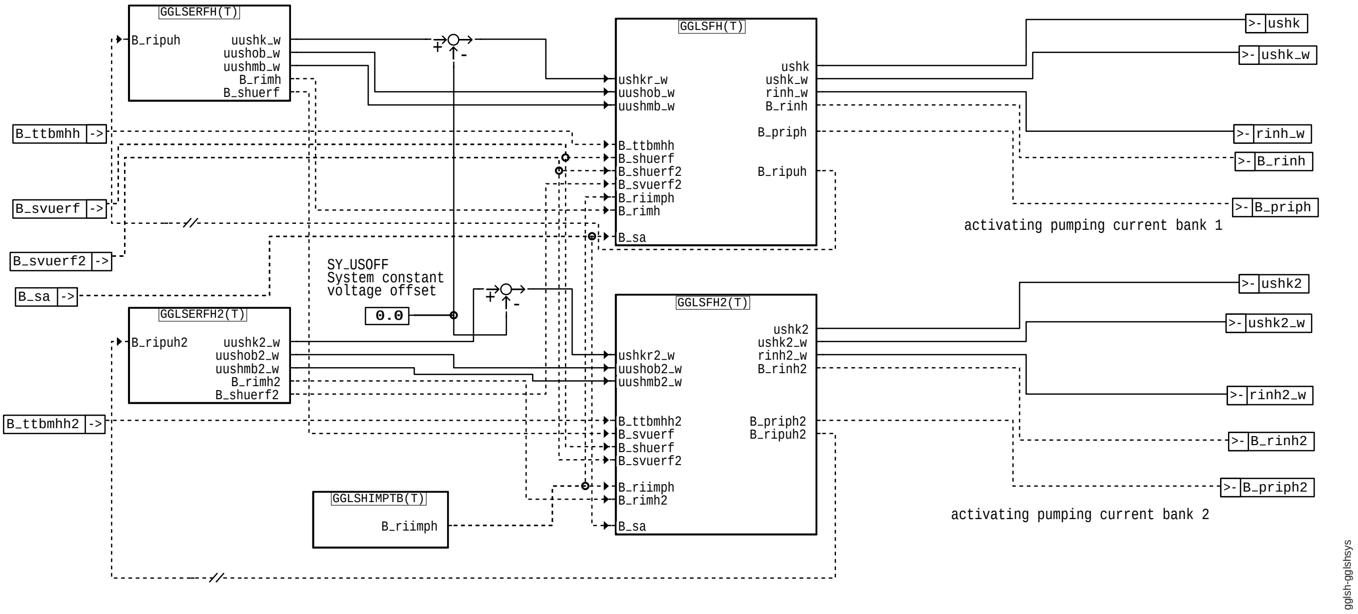
FDEF GGLSH 3.30 Function definition

GGLSH: Analysis of configuration bit



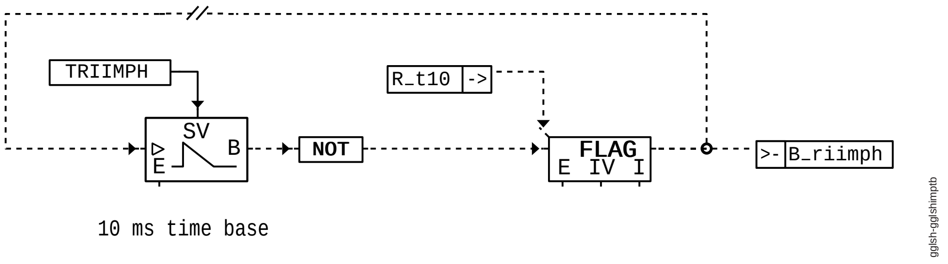
gglsh-gglsh

GGLSHSYS: Overview and description sensor voltage detection, bank1 and bank2



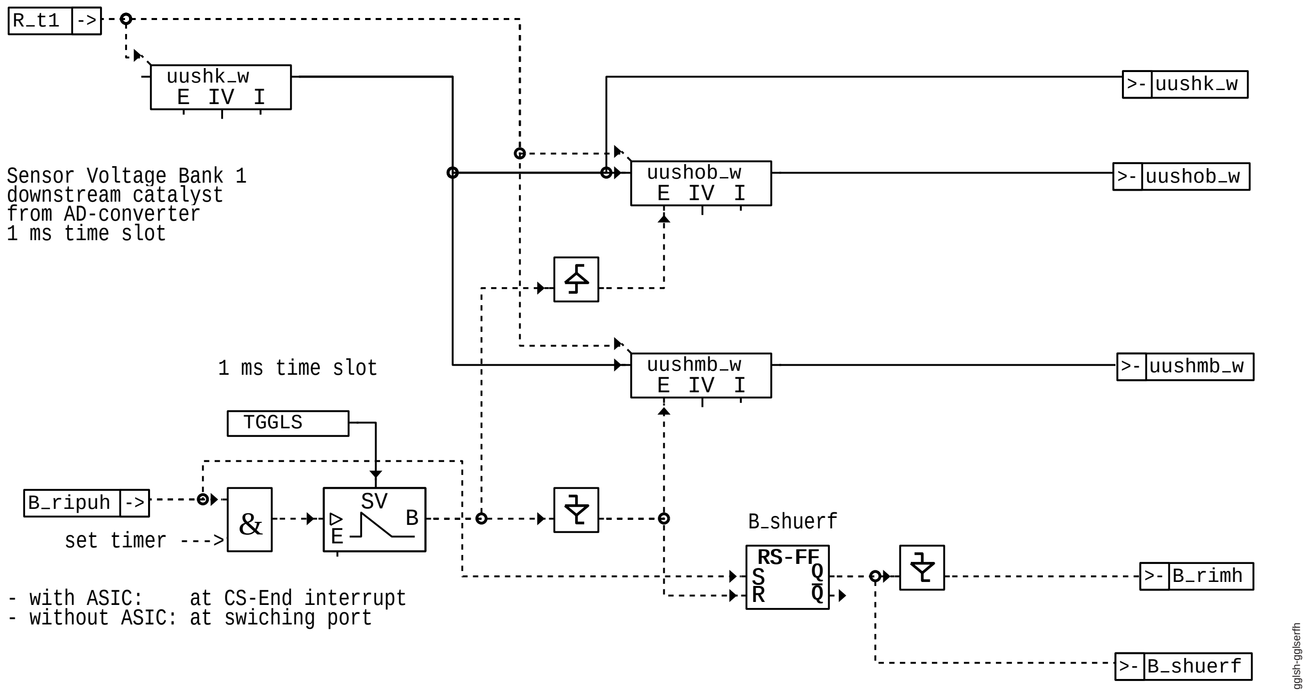
gglsh-gglshsys

GGLSHIMPTP: Generating pumping time intervals for bank1 and bank2



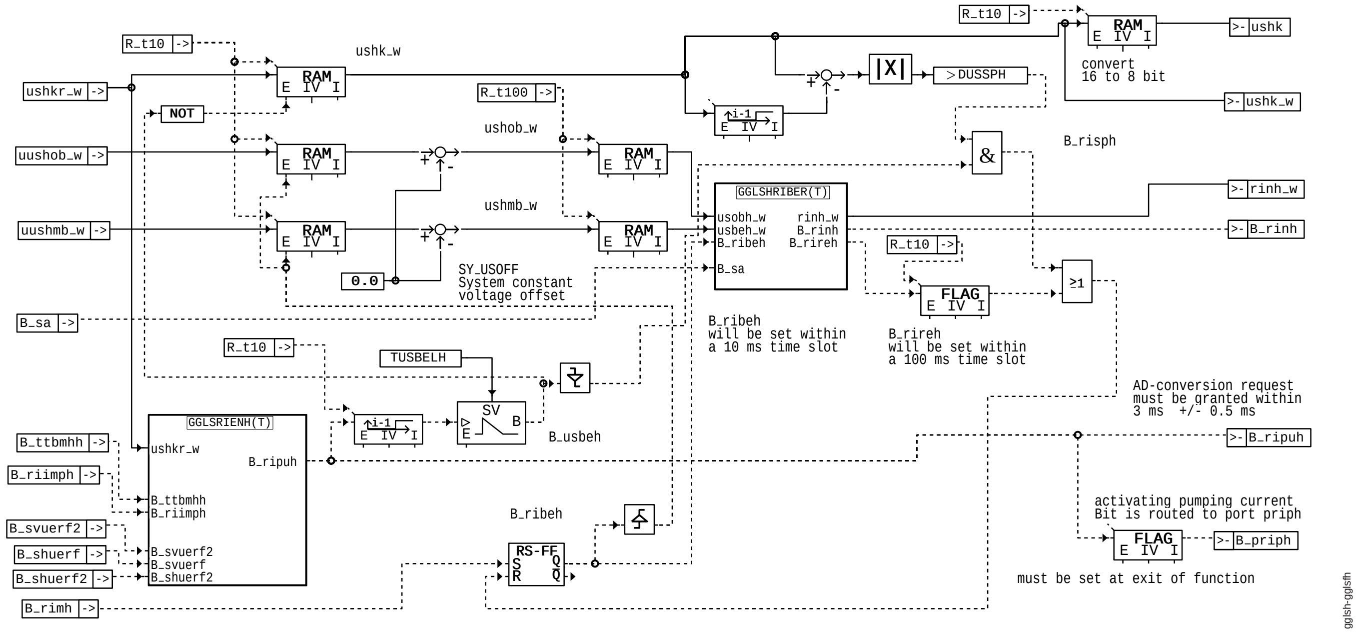
gglsh-gglshimptb

GGLSERFH: Measuring the sensor voltage in the 1 ms cycle with and without load, bank1



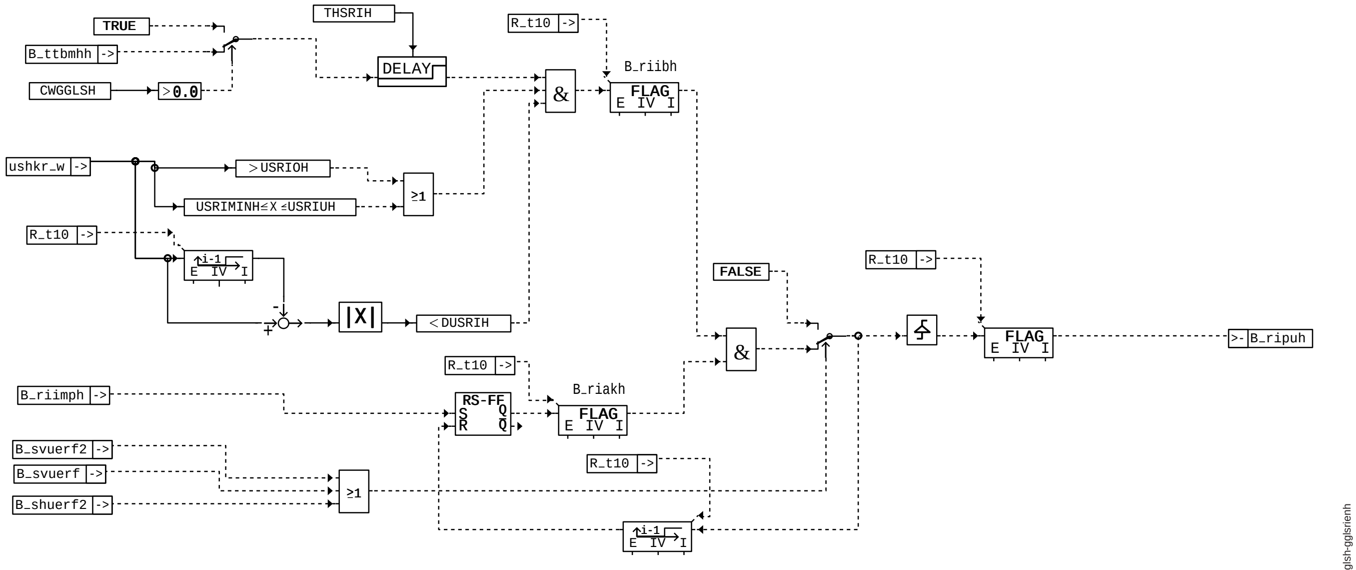
gglsh-gglserfh

GGLSFH: Transfer of the measured values without load after pumping into 100 ms cycle, bank 1



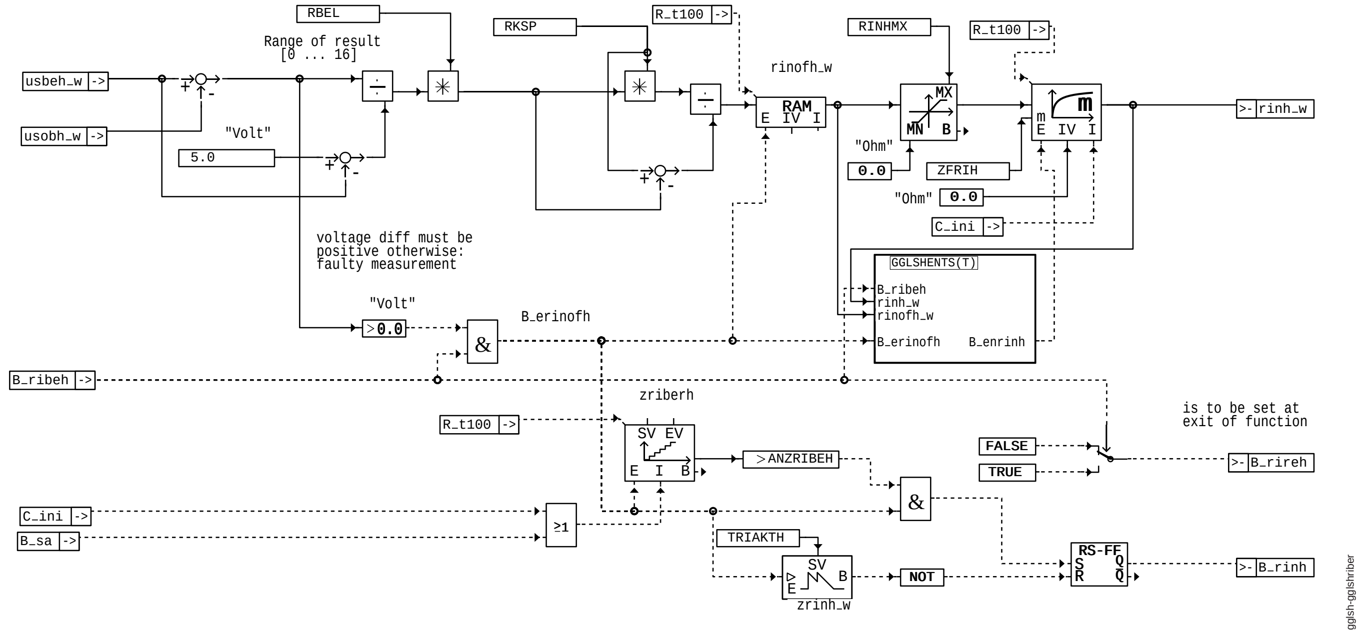
gglsh-gglsfh

GGLSRIENH: Enabling of Ri-measurement, bank 1



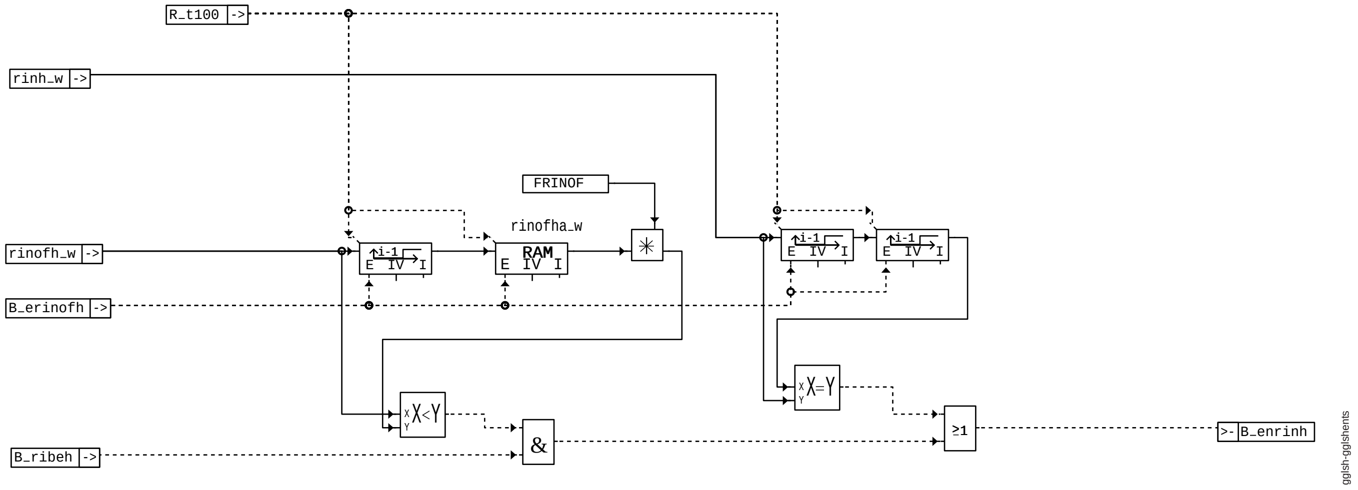
gglsh-gglsrienh

GGLSHRIBER: Calculation of Ri and statistical evaluation, bank 1



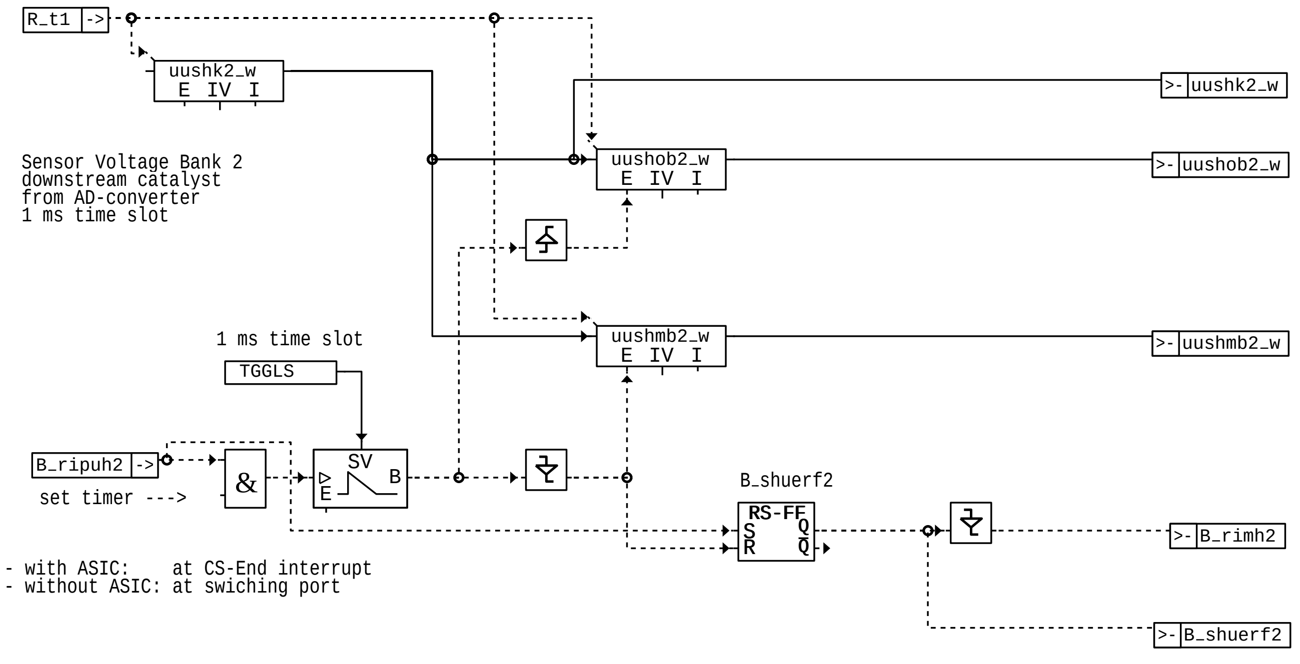
gglsh-gglshriber

GGLSHENTS: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank1



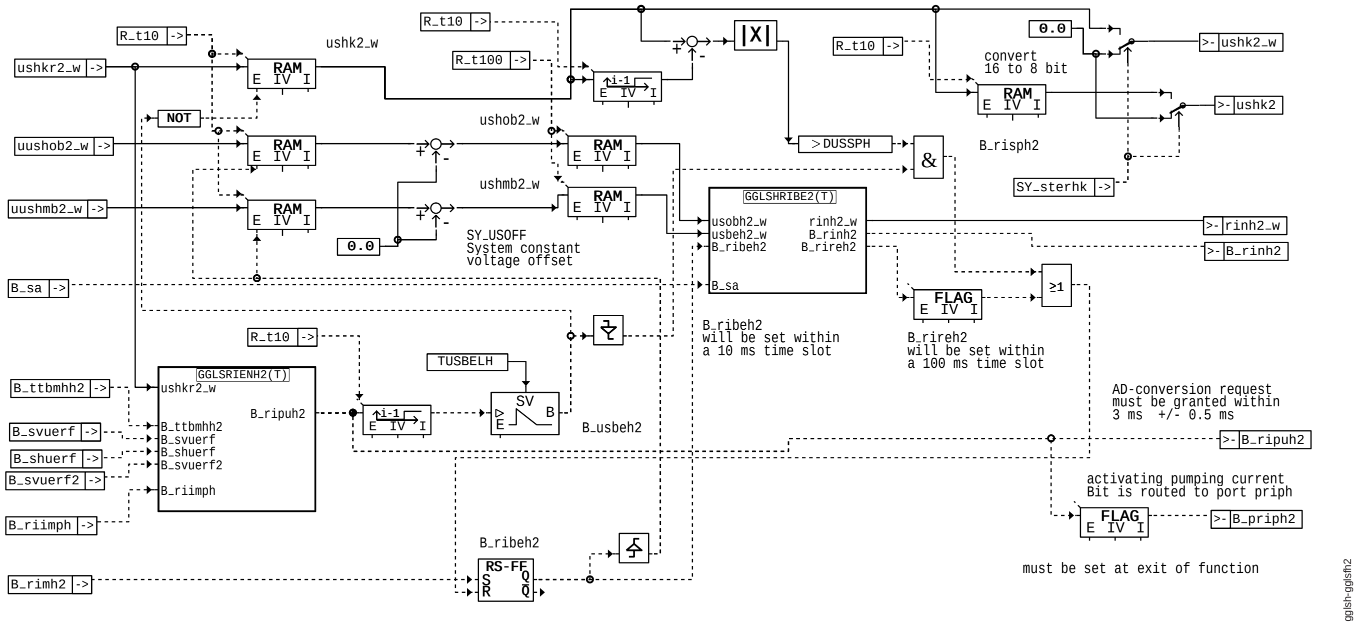
gglsh-gglshents

GGLSERFH2: : Measuring the sensor voltage in the 1 ms cycle with and without load, bank2



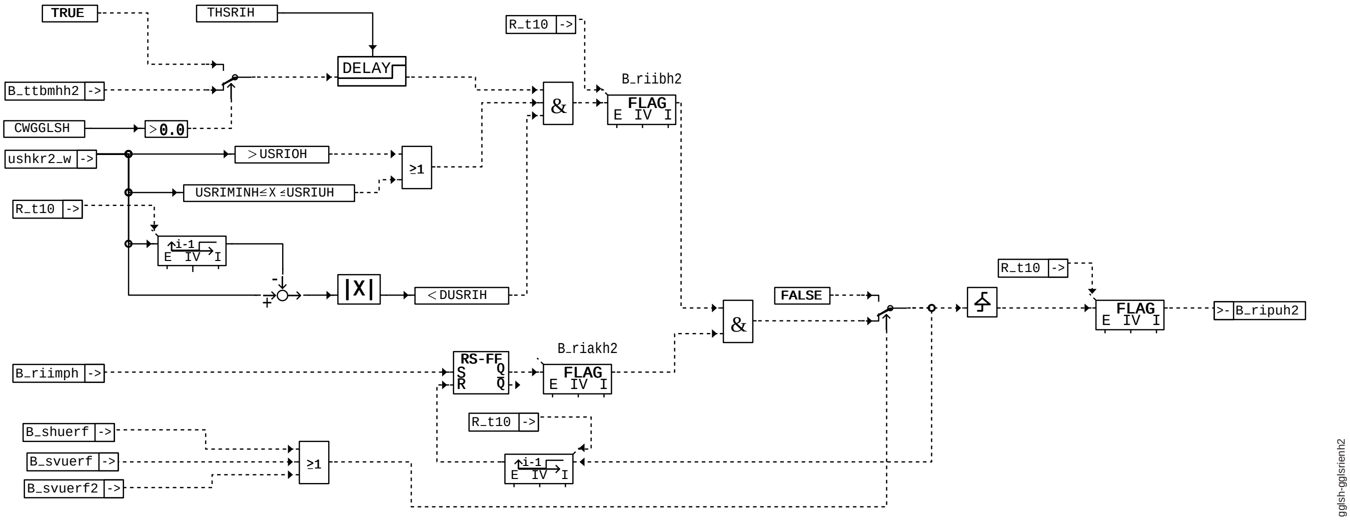
gglsh-gglserfh2

GGLSFH2: Transfer of the measured values without load after pumping into 100 ms cycle, bank 2



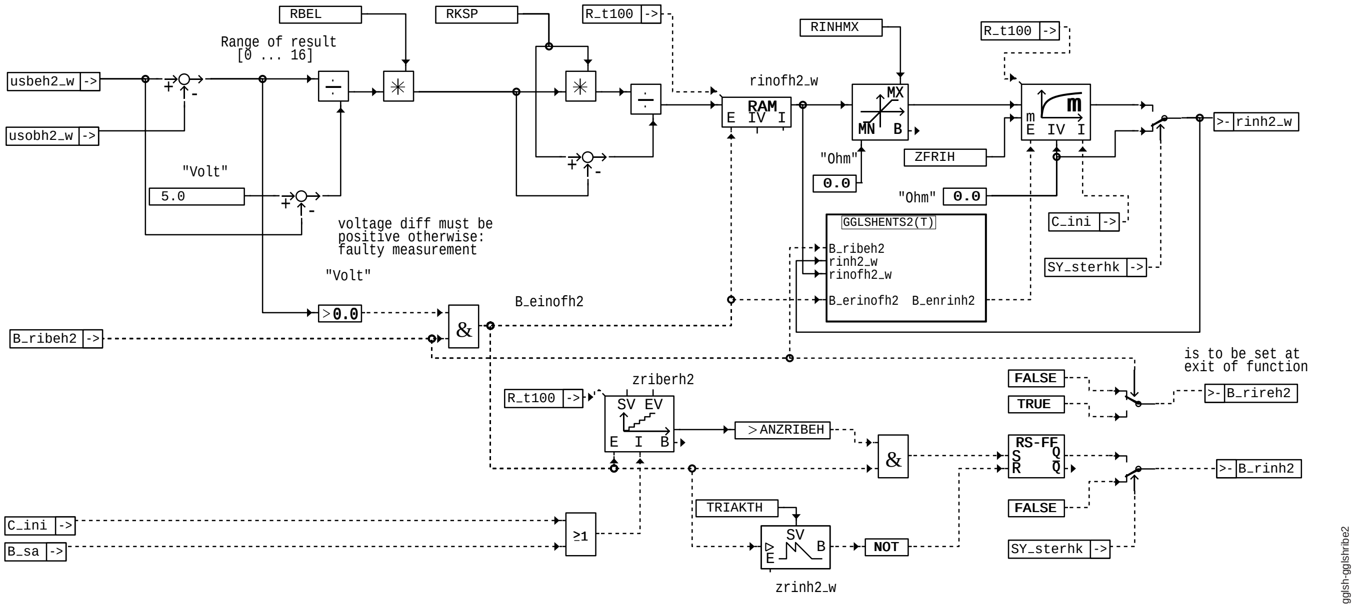
gglsh-gglsfh2

GGLSRIENH2: Enabling of Ri-measurement, bank 2



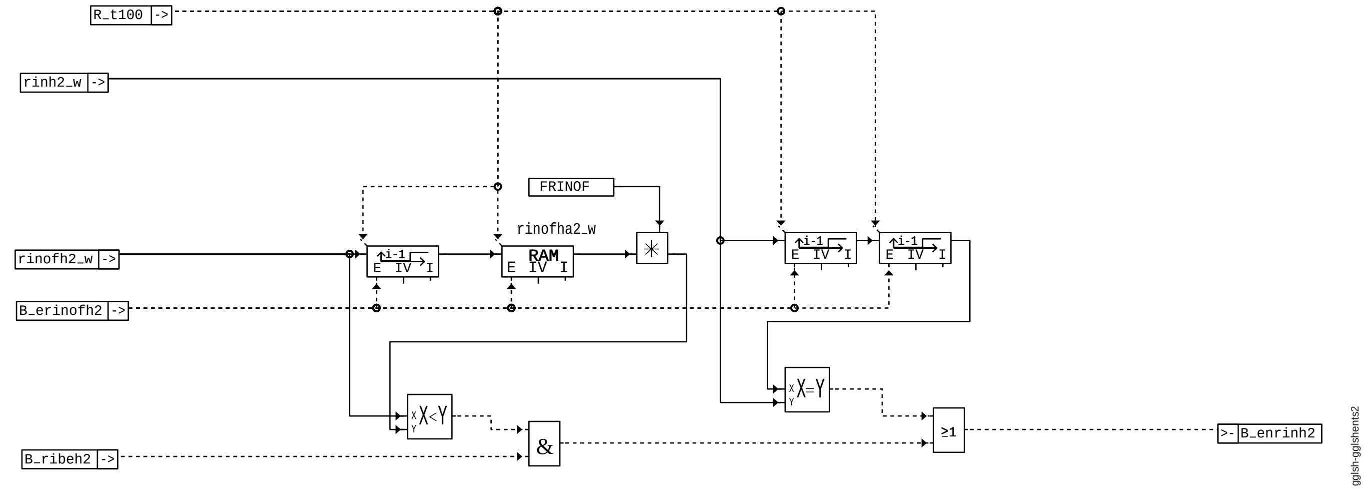
gglsh-gglsrienh2

GGLSHRIBE2: Calculation of Ri and statistical evaluation, bank 2



gglsh-gglshribe2

`GGLSHENTS2: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank2`



gglsh-gglshents2

ABK GGLSH 3.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZRIBEH			FW	Number of Ri.calculations downstream catalyst
CWGGLSH			FW	code word for Ri-evaluation for sensor downstr. of cat (not full heating)
DUSRIH			FW	Delta sensor volt. downstream cat betw. new and old value in grid for Ri-measur.
DUSSPH			FW	Delta sensor volt. rear cat between new and 2 old val. for sensor jump knowledge
FRINOF			FW	Factor for validation of old Ri-value without filter
RBEL			FW	On-load resistance for pump current generation
RINHMX			FW	Limit internal resistance Ri of the Nernst sensor downstream cat to max. value
RKSP			FW	Resistance between congruent voltage and sensor signal
TGGLS			FW	Time needed for ADC after interrupt in the function calculator (Asic)
THSRIH			FW	Time del. readiness of Ri-measure. after switched on sensor heat. downstream cat
TRIAKTH			FW	Time needed for Ri-calculation up to date downstream catalyst
TRIIMPH			FW	Time needed for pump impulse for both banks downstream catalyst
TUSBELH			FW	Time for holding of the sensor voltage after on-load impulse downstream catalyst
USRIMINH			FW	Minimum voltage threshold for Ri-mesurement of the sensor downstream catalyst
USRIOH			FW	Upper voltage threshold for Ri-measurement of the sensor downstream catalyst
USRIUH			FW	Lower voltage threshold for Ri-measurement of the sensor downstream catalyst
ZFRIH			FW	Attenuation factor for the internal resistance Ri Nernst filter downstream cat

Variable	Source	Type	Description
B_ENRINH	GGLSH	LOK	Condition enable for Ri-Nernst with filter post cat
B_ENRINH2	GGLSH	LOK	Condition enable for Ri-Nernst with filter post cat bank 2
B_ERINOFH	GGLSH	LOK	Condition enable for Ri-Nernst without filter post cat
B_ERINOFH2	GGLSH	LOK	Condition enable for Ri-Nernst without filter post cat bank 2
B_LSH	PROKON	EIN	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank1)
B_LSH2	PROKON	EIN	Cond. lambda sensor inst. downstr. of cat., 2. sensor downst. of outlet (Bank2)
B_PRIPH	GGLSH	AUS	Condition switch port for pump impulse downstream catalyst
B_PRIPH2	GGLSH	AUS	Condition switch port for pump impulse downstream catalyst bank2
B_RIBEH	GGLSH	LOK	Condition calculate internal resistance Ri for sensor downstream catalyst
B_RIBEH2	GGLSH	LOK	Condition calculate internal resistance Ri for sensor downstream cat. bank2
B_RIIMPH	GGLSH	LOK	Condition impuls for pumping current downstream catalyst
B_RIMH	GGLSH	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage downstream catalyst
B_RIMH2	GGLSH	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage downstream cat. bank2
B_RINH	GGLSH	AUS	Condition internal resistance of Ri-measur. of sensor active downstream cat.
B_RINH2	GGLSH	AUS	Condition internal resist. of Ri-meas. sensor active downstream cat. bank2
B_RIPUH	GGLSH	LOK	Condition pumping current for sensor downstream catalyst
B_RIPUH2	GGLSH	LOK	Condition pumping current for sensor downstream catalyst bank2
B_RIREH	GGLSH	LOK	Condition result for internal resistance Ri for sensor downsteam catalyst
B_RIREH2	GGLSH	LOK	Condition result for internal resistance Ri for sensor downstream catalyst bank2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SHUERF	GGLSH	LOK	Condition sensor voltage post cat measured
B_SHUERF2	GGLSH	LOK	Condition sensor voltage post cat measured bank 2
B_SVUERF		EIN	Condition sensor voltage pre cat measured
B_SVUERF2		EIN	Condition sensor voltage pre cat measured bank 2
B_TTBMHH	DLSH	EIN	cond. theoretical lambda sensor operation readyness downstr. cat with heating
B_TTBMHH2	DLSH	EIN	cond. theoretical lambda sens. operat. readyness downstr. cat with heating bank2
C_INI	SWADAP	EIN	ECU-condition for intialisation
RINH2_W	GGLSH	AUS	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_W	GGLSH	AUS	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
RINOFH2_W	GGLSH	LOK	Internal resistance (word) Ri Nernst without filtering downstream cat bank2
RINOFH_W	GGLSH	LOK	Internal resistance (word) Ri Nernst without filtering downstream catalyst
R_T1		EIN	Time schedule 1 ms
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms

Variable	Source	Type	Description
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
USBEH2_W	GGLSH	LOK	Voltage (word) lambda sensor loaded with resistance downstream catalyst bank2
USBEH_W	GGLSH	LOK	Voltage (word) lambda sensor loaded with resistance downstream catalyst
USHK	GGLSH	AUS	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	AUS	output voltage oxygen sensor downstream catalyst 2
USHK2_W	GGLSH	AUS	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHKR2_W	GGLSH	LOK	Voltage (word) lambda sensor raw value downstream catalyst bank2
USHKR_W	GGLSH	LOK	Voltage (word) lambda sensor raw value downstream catalyst bank2
USHK_W	GGLSH	AUS	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USOBH2_W	GGLSH	LOK	Voltage (word) lambda sensor without load downstream catalyst bank2
USOBH_W	GGLSH	LOK	Voltage (word) lambda sensor without load downstream catalyst
UUSHK2_W	GGLSH	LOK	ADC-voltage lambda sensor downstream catalyst bank2 (word)
UUSHK_W	GGLSH	LOK	ADC-voltage lambda sensor downstream catalyst (word)
UUSHMB2_W	GGLSH	LOK	Voltage (word,1 ms-time slot) sensor with resistor loaded, downstream cat bank2
UUSHMB_W	GGLSH	LOK	Voltage (word, 1 ms-time slot) O2-sensor with resistor loaded, downstream cat
UUSHOB2_W	GGLSH	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded downstream cat bank2
UUSHOB_W	GGLSH	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded downstream cat

FW GGLSH 3.30 Fixed Values

Parameter	Value	Description
ANZRIBEH		Number of Ri.calculations downstream catalyst
CWGGLSH		code word for Ri-evaluation for sensor downstr. of cat (not full heating)
DUSRIH		Delta sensor volt. downstream cat betw. new and old value in grid for Ri-measur.
DUSSPH		Delta sensor volt. rear cat between new and 2 old val. for sensor jump knowledge
FRINOF		Factor for validation of old Ri-value without filter
RBEL		On-load resistance for pump current generation
RINHMX		Limit internal resistance Ri of the Nernst sensor downstream cat to max. value
RKSP		Resistance between congruent voltage and sensor signal
TGGLS		Time needed for ADC after interrupt in the function calculator (Asic)
THSRIH		Time del. readiness of Ri-measure. after switched on sensor heat. downstream cat
TRIAKTH		Time needed for Ri-calculation up to date downstream catalyst
TRIIMPH		Time needed for pump impulse for both banks downstream catalyst
TUSBELH		Time for holding of the sensor voltage after on-load impulse downstream catalyst
USRIMINH		Minimum voltage threshold for Ri-mesurement of the sensor downstream catalyst
USRIOH		Upper voltage threshold for Ri-measurement of the sensor downstream catalyst
USRIUH		Lower voltage threshold for Ri-measurement of the sensor downstream catalyst
ZFRIH		Attenuation factor for the internal resistance Ri Nernst filter downstream cat

FB GGLSH 3.30 Detailed description of function

1. Introduction:

The sensor function GGLSH is used to detect and quantitize the sensor voltage downstream catalyst, and to generate a pump current while at the same time the internal resistance Ri of the Nernst sensor is determined.

The LSF8 sensor is not equipped with a reference air volume and therefore, it requires a constant pump current which transports oxygen towards the reference electrode. In the present sensor function, the sensor voltage is perodically pulsed by means of a pump current (0.5 mA for 10 ms)
so that the sensors LSF8 sensor is fully compatible to the sensors LSH and LSF4. Thus the sensor diagnosis’ do not need to be changed. The sensors LSH and LSF4 have an air reference and actualally do not need a pump current. However, if a pulsed pump current is used on these sensors, the internal resistance Ri can be determined. By the internal restistance an indirect check is performed in the heater diagnosis DHLS on whether the sensor heater is o.k. In case of defect sensor heating or strongly reduced heating performance at low exhaust gas temperatures the internal resistance increases markedly.

2. Enable sensor function by configuration bit (GGLSH):

The sensor function can be enabled by means of the code word CWKONLS, provided the corresponding bits for the sensor installed upstream of
the catalyst have been set. Bank1 can be enabled by means of bit 1 if B_lsh = 1; Bank2 is enabled enabled via bit 5 if B_lsh2 = 1 (sum = 34).

3. Generation of pump pulse (current impulse) GGLSRIENH:

An instable multi-vibrator with the output B_riimph is used to generate a pump impulse. The multi-vibrator supplies an impulse with the duration of 10 ms after an adjustable timer TRIIMPH has passed. This impuls B_riimph sets the flip-flop B_riakh, i.e. the pumping current is updated. One timer only is used for both banks.

A pumping current with the condition B_ripuh = 1 can be performed if the sensor voltage lies within the permitted permissible voltage ranges (B_riibh = 1) and if the condition B_ttbmhh = 1 from %DLSV was continuously active for a time longer than THSRIH. The condition B_ttbmhh from %DLSH can be disabled by the codeword CWGGLSH in order that Ri can be measured for application purpose even befor end of dewpoint (refer to Application Note).

A permitted voltage range for permissible pumping current exists if the sensor voltage usvkr_w
"- is greater than USRIOH in the rich range"
"- lies between USRIMINH and USRIUH in the lean range"
"- the gradient of the sensor voltage (difference between new value and old value (i-1) in the 10 ms cycle) is less than the "
threshold value DUSRIH

After the pumping current was enabled B_ripuh = 1 the flip-flop B_riakh is reset in the next 10 ms grid (i-1) so that the period for pumping current is exactly 10 ms.

To maintain a correct current balance for the sensor LSF8, a timer TRIIMPH (B_riimph =1, i.e. pump impulse is necessary) has passed and if at the same time sensor voltages occur in the not permitted voltage range (USRIUH < ushkr_w < USRIOH) the triggering of the pump impulse is at first forbidden and stored as information in the flip-flop B_riakh. Only once the non permitted voltage range is left immediately afterwards B_ripuh = 1 is set in the permitted voltage range and by doing so the pump impulse is triggered.

There must be a definite relationship between unloaded and loaded sensor voltage for a sensor in the 10 ms grid. This requirement is met by only one sensor being allowed to be pumped in the 10 ms grid.
B_ripuh canot be used to pump current if the sensor voltage at bank2 upstream of catalyst, or the voltages downstream of catalyst are momentarily being detected by B_shuerf2, or B_svuerf and B_svuerf2 respectively.
Via B_ripuh a port is switched with the bit B_priph = 1 so that a pump current of 0,5 mA can flow for 10 ms from the 5V voltage supply and through a fixed defined resistor RBEL.

```
      Hardware:
      --------
                         5 V
                    -------+--------
                           |
                          +++
                          | | port resistor
                          +++
                           |
                           o
"                            /<---- port B_priph              "
                           o
                           |
                          +++
                          | | RBEL
                          +++                                                       +---------+
                           |                                                        |         |
                      |    +--------------------------+---------------------------->+   ADC   |
               Ipump  |    |                          |                             |         |
                      v   +++                        +++                            +---------+
                          | | Ri (rinh_w)            | |  RKSP = 51 k
                          +++                        +++
                           |                          |
                        ---+---  sensor voltage    ---+--- 450 mV
                          ---                        ---
                           |                          |
                          -+-                        -+-
```

4. Transfer of the sensor voltage measured values (with and without load) into the 100 ms cycle for the Calculation of Ri

It is important for the calcualtion of the internal resistance Ri of the sensor that the sensor voltages with load and without load are read within one 10 ms cycle. This can be achieved if prior to the on-load impulse the unloaded sensor voltage uushk_w is read via the ADC and if during the on-load impulse (10 ms) after approx. 3 ms the loaded sensor voltage uushb_w is read via the ADC.
After the pump impulse was triggered B_ripuh = 1 the sensor voltage ushkr_w is held at the old value via a timer TUSBELH during the following 10 ms grid (i-1) so that the increased loaded sensor voltage cannot have an effect.

4.1 Measuring the loaded and unloaded sensor voltage in the 1 ms time frame (GGLSERFH):

The ADC value of the sensor voltage is sampled in the 1 ms-time frame and is stored as the word uushk_w in the RAM.
If a permissible pump impulse B_ripuh follows, then the unloaded voltage uusvob_w is stored by setting the timer TGGLS with a positive edge. After elapse of the time TGGLS, the loaded sensor voltage uusvob_w is stored is then retained in the 1 ms time frame with the negative edge. Setting the pump impulse B_ripuh will also set the Flip-Flop B_shuerf in the 1 ms frame, i.e. for the sensor upstream of the catalyst at bank1, the requirement is set that only the the sensor voltage will be measured here. TGGLS is reset following elapse of the timer by the negative edge of this detection Flip-Flop B_shuerf.
It must be ensured that the order of the bank calculation is observed (first bank1 and then bank2).

4.2 Transfer of loaded and unloaded sensor voltage from the 1 ms time frame in 10 ms and 100 ms time frames (GGLSFH):

The condition B_rimh is set by resetting the Flip_Flop B_shuerf with the negative edge. The Flip-Flop B_ribeh is set by B_rimh for transfer to the 10 ms and 100 ms time frames. The unloaded sensor voltage uushob_w and the loaded sensor voltage uushmb_w are transfered into a RAM in the 10 ms time frame with the positive edge of this Flip-Flop. The increase from sensor grounding, SY_USOFF, that is specific to the control unit, is sutracted from the unloaded sensor voltage uushob_w or loaded sensor voltage uushmb_w and then receives the unloaded sensor voltage ushob_w and the loaded sensor voltage ushmb_w in the 10 ms time. These are then transferred in the 100 ms time frame to the RAM, usobh_w and usbeh_w respectively.
The increase in the sensor grounding, SY_USOFF, that is specific to the control unit is then also subtracded in the 1 ms-time frame from the ADC voltage and stored in the 10 ms-time frame as the raw value in the RAM ushkr_w (word). This 16 bit sensor voltage ushkr_w is converded to the 8 bit format (ushk) for additional use in sensor diagnostics and lamda control.

Ri-calculation (rinofh_w)

The internal resistance Ri' of the sensor is calculated from:

$$Ri' = \frac{usbeh\_w - usobh\_w}{5V - usbeh\_w} * RBEL$$

Corrected by the counter-resistance RKSP in the hardware Ri results:

$$Ri = \frac{Ri' * RKSP}{RKSP - Ri'} = rinofh\_w$$

This Ri value is given in the 100 ms-time frame by setting the Flip-Flop B_ribeh = 1 and is limited to RINHMX.
The following measures are performed in order to prevent the loaded sensor voltage from being used during a jump of the sensor voltage
in the 10 ms-impulse:

a) If, especially during the rich-to-lean jump, the difference between the sensor voltage usbeh__w (with load) and the sensor voltage usobh_w (without load) is less than zero, then the B_erinofh is not set and Ri is not comuted.

b) If, especially during the lean-to-rich jump, the absolute value of the difference between old and new sensor voltage exceeds DUSSPH after the timer TUSBELH has elapsed in the 10 ms cycle, then the flop-flop B_ribeh is reset prematurely; this causes Ri not to be calculated.

Thereafter rinofh_w is filtered through an event filter with the attenuation factor ZFRIH so that the filtered internal resistance rinh_w of the sensor is obtained. -----> Event filter : y[k] = y[k-1] + ZFRIH(x[k] + y[k-1])

After the calculation of the internal resistance a flag is set in the 10 ms grid via B_rireh = 1 (Ri-calculation terminated) and the flip-flop B_ribeh is reset.

4.3 Additional interference suppression of Ri measurements and formation of enable for the Ri filter (GGLSHENTS):

In the new unfiltered new value of Ri (rinofh_w) is greater by a factor FRINOF than the old Ri value rioffh_w, then B_enrinh is not set and hence the calculated value is transferred to the filter. In order than an increase in the internal resistance Ri is possible during sensor cooling (new Ri value is greater than the old value vby the factor FRINOF), the transfer of rinofh_w to the filter is enabled by B_enrinh = 1 after measuring 2 Ri values.

The Ri-calculations B_ribeh are added-up by means of a counter zriberh. If the number of Ri-calculations is greater than ANZRIBEH then a flip-flop B_rinh is set, which indicates to the heater diagnosis the state that the calculation of the internal resistance is active and up to date. ANZRIBEH = 3/ZFRIH is chosen.
As soon as the counter starts a retriggerable timer zrinh_w is triggered, whose timer time is chosen at TRIAKTH = 4*TRIMPH.
Once the timer has passed zrinh_w = 0 the flip-flop B_rinh is reset (resitance value rinh_w is not updated). If within the period TRIAKTV again current Ri-calculations are performed (B_ribeh =1), then this timer zrinh_w is continoosly started again so that the condition B_rinh is currently active.

Course of the ADC-sequence:

```
           |<-------------------------------  10 ms-grid  ---------------------->|
           |                                                                      |
           +-----------+                                                          +------------+
           |           |<----- duration of the cal. program                       |            |
           |           |                                                          |            |
     ------+           +----------------------------------------------------------+            +---------------------------->
                                                                                                                       time
```

APP GGLSH 3.30 Application hint

SY_USOFF

The fixed value voltage difference between sensor ground and electronic ground can adjustable with a system constant SY_USOFF and it must be adjusted ECU-specific by the software.
Example: If the voltage between sensor grond and electronic ground is 0.268V the SY_USOFF must be adjusted to 0.268V.

Corresponding to the hardware design SY_USOFF becomes 0V; 0,268V or 0,714V.

Typical application values:

```
THSRIH   = 10 s
TUSBELH  = 60 ms
TRIIMPH  = 2 s
TRIAKTHH = 4*TRIMPH = 8 s
ZFRIH    = 0.3
ANZRIBEH = 3/ZFRIH = 10
RBEL     = 8.45 KOhm
RKSP     = 51 KOhm
RINHMX   = 100 KOhm
USRIOH   = 490 mV
USRIUH   = 410 mV
USRIMIN  = 60 mV
DUSRIH   = 25 mV
UBDLS    > 11 V
DUSSPH   = 200 mV
TGGLS    = 3 ms
FRINOF   = 1.5
CWGGLSH = 0   --------> Code word = 0 : Ri is only calculaded after end of dewpoint for full heating power (series)
                                  = 1 : Ri can be measured as high-resistance for application during the phase of dewpoint

CWKONLS :  ----------->  Code word in % PROKON : Sensors present upstream of the catalyst  ---> Bank1: B_lsv by Bit  0 = 1
                                                                                                 Bank2: B_lsv2 by Bit 4 = 16
                                                                                                 (gives 17 as the sum)

                                                 Sensors present downstream of the catalyst --> Bank1: B_lsh by bit 1  = 2
                                                                                                 Bank2: B_lsh2 by bit 5 = 32
                                                                                                 (gives 34 as the sum)

                                                 For all 4 installed seensors: CWKONLS = 51
```

BGMSABG 2.10 Calculation of exhaust emission mass flow - bank-dependent

FDEF BGMSABG 2.10 Function definition

Provision for exhaust emission flow quantity:

In the basic version, the air mass ml is distributed throughout the active exhaust emission banks.

```
                                             +---+                               +---+
ml -----------------------------------------> | / +-------------------+-----------| + +--------------------------> msabg
                                             +---+                   |           +---+
                                               ^                     |             ^
                                               |                     |    +---+    |
                                               |                     +----| + +----|----------------o    o------> msabg2
                                               |                          +---+    |                  /
                                               |                            ^      |        0.0 ----o  ^
msl  ------------------------------------------|----------------------------|------+                   |
                                               |                            |      |                   |
msl2 ------------------------------------------|----------------------------+      |                   |
                                               |                            |      |                   |
                                               |                            |      v                   |
                                               |        +---+               |    +---+                 |
ml_w  -------------------------------------------------->| / +--------+------|----| + +-----------------|--------> msabg_w
                                               |        +---+        |      |    +---+                 |
                                               |          ^          |      v                          |
                                               |          |          |    +---+                        |
                                               |          |          +----| + +------------o    o------|--------> msabg2_w
                                               |          |               +---+              /         |
                                               |          |                      0.0  -----o  ^        |
                   2.0 -------o    o-----------+----------+                                   |        |
"                                /                                                             |        |"
                   1.0 -------o  ^                                                            |        |
                                 |                                                            |        |
                                 |                                                            |        |
SY_STERVK -----------------------+------------------------------------------------------------+--------+
```

ABK BGMSABG 2.10 Abbreviations

Variable	**Source**	**Type**	**Description**
ML	SWADAP	EIN	air mass flow
MLBB	BGMSABG	AUS	air mass flow filtered (Byte), bank1 related
MLBB2	BGMSABG	AUS	air mass flow filtered (Byte), bank2 related
MLBB2_W	BGMSABG	AUS	air mass flow filtered (Word), bank2 related
MLBB_W	BGMSABG	AUS	air mass flow filtered (Word), Bank1 related
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSABG	BGMSABG	AUS	exhaust gas mass flow filtered, bank 1
MSABG2	BGMSABG	AUS	exhaust gas mass flow filtered, bank 2
MSABG2_W	BGMSABG	AUS	exhaust gas mass flow filtered (Word), bank 2
MSABG_W	BGMSABG	AUS	exhaust gas mass flow filtered (Word), bank 1
MSL		EIN	secondary air mass flow
MSL2		EIN	secondary air mass, bank 2

FW BGMSABG 2.10 Fixed Values

Parameter	**Value**	**Description**

FB BGMSABG 2.10 Detailed description of function

APP BGMSABG 2.10 Application hint

DLSH 26.50 Diagnosis; Readiness for operation of sensor downstream catalyst

FDEF DLSH 26.50 Function definition

```
B_falsh------------------+---------------------------------------------------------------+
                         |                                                           +-+ |   +-+
B_nmot ------------------|---------------------------------------------------------->| | +-->| |  +-+
                         |                                           +----------+    | |  +->|&+->| |
tkatm -------------------|------------------------------------------>|<TABGMCSD +--->| |  |  +-+  | |  B_dshen
ub ----------------------|-------------------------------+  +-----+  +----------+    | |  |       |V+---+
lamsons_w ------------o--v--o----------------------------|->| = 1 +----------------->| |  |  +-+  | |   |
               1.0 ---o                +-+  +----------+ |  +-----+    +--------+    | +--+->|&+->| +   |
B_atmtpk ----------------------------->|&+->|TTBMH+--- | +------------>|> UBDLS +--->|&| +->o| |  +-+   |
          +-+----+ B_ueinh          +->| |  | ----+-->t+------------+  +--------+    | | |   +-+        |
B_hshe -->|S|Flip+-+  +-----------+ |  +-+  +----------+       +-+  +-------------+->| | +- B_fa    +---+
          +-+----+ |  |TUSEINH+-- +-+------------------------->| |   +----------+ |  +-+            |
C_ini --->|R|Flop| +->|-------+->t|                       +-+  |&|   | TRSE+--  | +-----------------|---------> B_ttbmhh
          +-+----+    +-----------+     +---------------->|V+->| +-->| ----+-->t+--+                |         (to %GGLSH)
ushk_w  +--------------------------+    |   +------------>| |  +-+   +----------+  |                |     +-+
-----+->| USREFH <= ushk_w <= USMAX+----+   |   +------+  +-+      +-------+       |                +---->|&+->  B_sigflsh
     |  +--------------------------+        |   |TRSAFA+---o  o----+ TRSAH |   +---|----------------|---->| |  (wire interrupt)
     |   +-----------------------+          |   +------+     /<-+  +-------+   |   |                |     +-+
     +-->|    ushk_w <= USREMH   +----------+               o   +----B_falsh   |   |     +-+----+   |          +----------+
     |   +-----------------------+                          | B_risigh--+  +-+ |   +---->|S|Flip+---|-+------->| B_sbbhk  |
     |  +-------------------------+                     +---v-----+     +->| | |  +-+    +-+----+   | |        +----------+
     +->| USREMH <=ushk_w <=USREFH+--+          B_uhsig |     +-- +------->|V+-+->| | +->|R|Flop|   | |         operation
     |  +-------------------------+  |    +-+----+  +-->| ----+->t|B_trsah +-+    | | |  +-+----+   | |    +-+   readiness
     |   +---------------------------+--->|S|Flip+--+   +---------+    +--------->|V+-+             + +--->|&|
     |   |   +-----+   +------------+     +-+----+                     |  +------>| |               +----->| +->  B_nolsh
     |   +-->| NOT +-->| TASIG+---  +---->|R|Flop|         C_ini ------|--|------>| |      +--------|----->| |   (no fault)
     |       +-----+   | -----+--->t|     +-+----+                     |  |       +-+      |        |      +-+
     |                 +------------+                  +---------------+  |                |        |     +-+
     |  +---------+              +------------+        |  +-----------+   |     B_noadsh --+        +---->| |
     +->| > USMAX +------------->| TUSKS  +-- +--------+->| TUSMAX+-- +---|-------------------------|---->|&+->  B_maxflsh
        +---------+              | -------+->t|           | ------+->t|   |                         |     +-+    (SC-UBat)
                                 +------------+           +-----------+   |                         |    +-+
B_adsh --------------------------------+----------------------------------+-------------------------|--->| +->   B_nplflsh
C_ini  --------------------------+     |          +-+----+ B_adshs  +-------------+                 +--->|&|   (SC wire-to-wire)
                +-+              |     +--------->|S|Flip+--------->| TUSTAL +--- |    +-+    +-----|--->| |
B_tal -------->o|&|              |                +-+----+          |--------+-->t+--->| |    |     |    +-+
B_talval ------>| +------+       +--------------->|R|Flop|          +-------------+    |V+----+     |     +-+
                +-+      +------------------+     +-+----+                             | |          +---->|&+->  B_minflsh
B_falsh --------------------------------+   +----------------------------------------->| |     0 -------->| |
                 1.0 ------+            |        (1 will be set if the tank is full)   +-+                +-+
                           |    1.0 --o\v
        +----------+       v +          \                                                            +-----------+
        | DLAMELSH +------>o---------o   o---------------------------------------------------------->| lamelsh_w |
        +----------+     -                                                                           +-----------+
                                                                                                      zur %LAMKO
```

Detection wire-to-wire)

```
                                    +---+       +--------+          +--------+
B_lrhk -------------------->o    o--+ 1 |       |TUSDUFA +--o    o--+ TUSDUH |
             B_falsh ------->\      +---+       +--------+      /   +--------+
                              o                                o<---- B_falsh
ushk_w     +-----------+      |                   +-+          |               +-+               +-+----+    B_adsh
---------->| < USMIN   +------|----------------+->| |          |        +----->|V+-------------->|S|Flip+------------->
           +-----------+      |       B_acsdh  |  |&|    +-----v-----+  |   +->| |        +-+    +-+----+    (fault)
                              |        +-+     |  | +--->|       +-- +--+   |  +-+        | +--->|R|Flop|
                              +------->| +--+--|->| |    | ------+->t|      |   +-------->|V|    +-+----+
B_sls v B_dsls v B_esls v   )-------->o| |  |  |  +-+    +-----------+      |   |   +---->| |
B_dtes v E_teve v E_tes v   )          |&|  |  |              +----------+  |   |   |     +-+
B_frmax ----------------------------->o| |  |  |   +-----+    |TUSKS +-- |  |   |   |            +-+
                                       +-+  |  +-->| NOT +--->|------+->t+--|---+---|----------->| |
                                            |  |   +-----+    +----------+  |       |            |&+---->  B_noadsh
                                            +--|----------------------------|-------|----------->| |        (ok)
                                     +-+       |                            |       |  B_acsdh   +-+
E_tm ------------------------------>o| |       |       +-+    +----------+  |       |
              Monoflop               | |       +------>| |    |TUSKS +-- +--+       |
           +----------+              | |               |&+--->|------+->t|          |
B_st ----->|| TNSTDNH +------------->|&+-------------->| |    +----------+          |
           |+------>t |              | | B_lshklt      +-+                          |
           +----------+        +---->| |                                            |
                               |     +-+                                            |
           +---------+    +-+  |                                                    |
tmotab --->| >TMSHA  +--->| |  |                                                    |
           +---------+    | |  |                                                    |
                          |&+--+                                                    |
           +-------+      | |                                                       |
tmot ----->| <TMSH +----->| |                                                       |
           +-------+      +-+                                                       |
                                                                                    |
                     +-+                                                            |
C_fcmclr ----------->|&|                                                            |
B_cllsh/2 ---------->| +------------------------------------------------------------+
                     +-+
```

With STEREO-control additionally the following labels apply for bank2: ushk2; B_lrhk2; B_sbbhk2; Z_lsh2; E_lsh2;
B_dshen2; B_usrhk2; B_ueinh2; B_adsh2; B_adshs2; B_acsdh2; lamsons2_w; tkatm2; B_uhsig2; B_trsah2; B_falsh2, lamelsh2_w
rinh2_w; B_atmpk2; B_hshe2; B_framax2; B_noadsh2

Moment-reserve for shorttest

```
                  +-+
B_falsh --------->|V+-------------------+
B_falsh2 -------->| |                   |
                  +-+       0---------o\v
        +--------+                      \                                                            +----------+
        | DMRLSH +-------------------o   o---------------------------------------------------------->| dmrlsh_w |
        +--------+                                                                                   +----------+
                                                                                                      zur %MDTRIP
```

Wire-interruption of sensor ground (planar sensor)

```
                          +-----------+            +-+
rinh_w --------+--------->| > DRISIGH +----------->| |           +-+----+
               |          +-----------+            |&+---------->|S|Flip+--------------> B_risigh
               |         +-------------+           | |           +-+----+
tkatm ---------|-------->| > ABGMSIGH  +----------->| |      +--->|R|Flop|
               |         +-------------+           +-+      |    +-+----+
               |        +-------------+                     |
               +------->| < RISIGRESH +---------------------+
                        +-------------+
```

```
Fault management for DLSH:
-------------------------
(Bank1)


                                +-+                                               Dauer-RAM
B_maxflsh --------------------->| |                                                +-+----+
B_sigflsh --------------------->|V+------------------------------------+---------->|S|Flip+------> E_lsh
B_nplflsh --------------------->| |                            +-+     | E_lshres  +-+----+
                                +-+  +------------------------>|V+-----|---------->|R|Flop|
                                     |             +-+   +---->| |     |           +-+----+
B_nolsh  ----------------------------|------------>| |---+     +-+     | (E_lshres = describtion variables)
B_cdlsh -----------------------------|--------+-->o|V|   |             |
(0 = Abschaltung)                    |        |    +-+   |             |
                     +-+             |        |          |             |
C_fcmclr ----------->| |     +-+     |   +-+  |          |             |  +-+
B_cllsh ------------>|&+---->| +-----+-->| |  |          |             +->|V|      +-+----+
                     +-+     |V|         |V|  |          +--------------->| +----->|S|Flip+------> Z_lsh
C_pwf ---------------------->| |         | |  |                           +-+      +-+----+
                             +-+   +---->| +--|----------------------------------->|R|Flop|
C_ini  ----------------------------+     +-+  |                                    +-+----+
                                              |
(Bank2)                                       |
                                              |
                                              |
                                +-+           |                                    Dauer-RAM
B_maxflsh2 -------------------->| |           |                                    +-+----+
B_sigflsh2 -------------------->|V+-----------|------------------------+---------->|S|Flip+------> E_lsh2
B_nplflsh2 -------------------->| |           |                +-+     |E_lshres2  +-+----+
                                +-+  +--------|--------------->|V+-----|---------->|R|Flop|
                                     |        |    +-+  +----->| |     |           +-+----+
                                     |        +-->o| |  |      +-+     | (E_lshres2 = describtion variables)
B_nolsh2 ----------------------------|------------>|V+--+              |
SY_STERHK ---------------------------|----------->o| |  |              |
(Mono = 0)                           |             +-+  |              |
(Stereo = 1)                         |                  |              |
                 +-+                 |                  |              |  +-+
C_fcmclr ------->|&|      +-+        |     +-+          |              +->|V|      +-+----+
B_cllsh2-------->| +----->| +--------+---->| |          +---------------->| +----->|S|Flip+------> Z_lsh2
                 +-+      |V|              |V|                            +-+      +-+----+
C_pwf ------------------->| |      +------>| +------------------------------------>|R|Flop|
                          +-+      |       +-+                                     +-+----+
C_ini -----------------------------+
```

```
Fault types in the fault memory:
--------------------------------
(Bank1)                                                       (Bank2)
                   Permanent-RAM                                                     Permanent-RAM
                      +-+----+                                                        +-+----+
B_maxflsh ----------->|S|Flip+----------> B_mxlsh             B_maxflsh2 ------------>|S|Flip+----------> B_mxlsh2
                      +-+----+           (SC-UBat)                                    +-+----+           (SC-UBat)
E_lshres ---------+-->|R|Flop|                                E_lshres2 ----------+-->|R|Flop|
                  |   +-+----+                                                    |   +-+----+
                  |  Permanent-RAM                                                |  Permanent-RAM
                  |                                                               |
                  |  Permanent-RAM                                                |  Permanent-RAM
                  |   +-+----+                                                    |   +-+----+
B_sigflsh --------|-->|S|Flip+----------> B_silsh             B_sigflsh2 ---------|-->|S|Flip+----------> B_silsh2
                  |   +-+----+         (wire interruption)                        |   +-+----+         (wire interruption)
                  +-->|R|Flop|                                                    +-->|R|Flop|
                  |   +-+----+                                                    |   +-+----+
                  | Permanent-RAM                                                 | Permanent-RAM
                  |   +-+----+                                                    |   +-+----+
B_nplflsh --------|-->|S|Flip+----------> B_nplsh             B_nplflsh2 ---------|-->|S|Flip+----------> B_nplsh2
                  |   +-+----+         (SC wire-to-wire)                          |   +-+----+          (SC wire-to-wire)
                  +-->|R|Flop|                                                    +-->|R|Flop|
                      +-+----+                                                        +-+----+
```

```
For code word CDLSH = 0 (B_cdlsh = 0) (switch-off:                     For Mono with bit switch-over SY_STERHK = 0:
--------------------------------------------------                     --------------------------------------------
                                                                                         +----------------- Mono = 0
                                                                                         |
                                                                                         o   o------------ Stereo = 1
                                                                            SY_STERHK ---->\
                                                                                           o
                                                                                           |
                                                                                       +---+-----------+
                +--------------+                                                       |               +-------> B_nolsh2 = 0
                |              +--------->  B_nolsh/2 = 0                              |               +-------> B_silsh2 = 0
                |              +--------->  B_silsh/2 = 0                              |               +-------> B_mxlsh2 = 0
                |              +--------->  B_mxlsh/2 = 0                              |               +
                |     DLSH     +                                                       |     DLSH      +-------> B_nplsh2 = 0
                |              +--------->  B_nplsh/2 = 0                              |               +-------> B_tvcsd2 = 0
                |              +--------->  B_sbbhk/2 = 0                              |               +-------> B_sbbhk2 = 0
                |              +--------->  Z_lsh/2  = 1                               |               +-------> E_lsh2 = 0
                |              +--------->  E_lsh/2  = 0                               |               +-------> Z_lsh2 = 1
                +--------------+                                                       +---------------+
```

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path "lsh" of this diagnosis the following values are defined:

	Bank 1	Bank 2
Status fault path lsh:	sfplsh	sfplsh2
Error flag lsh:	E_lsh	E_lsh2
Cycle flag lsh:	Z_lsh	Z_lsh2
Fault type lsh:	TYP_lsh: (B_mxlsh, B_silsh,B_nplsh)	TYP_lsh2: (B_mxlsh2, B_silsh2,B_nplsh2)
Clear fault path:	B_cllsh	B_cllsh2
Default value active:	B_bklsh (optional)	B_bklsh2 (optional)
Fault path code lsh:	CDTlsh	CDTlsh2
Fault class lsh:	CLAlsh	CLAlsh2
Fault intensity lsh:	TSFlsh	TSFlsh2
CARB CODE lsh:	CDClsh	CDClsh2
Table of ambient cond. lsh:	FFTlsh	FFTlsh2

ABK DLSH 26.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABGMSIGH			FW	threshold for exh. temp. for wiring-interruption with Ri-diagnosis downstr. cat
CDCLSH	BLOKNR		KL	code word CARB: lambda sensor downstream catalyst
CDCLSH2	BLOKNR		KL	code word CARB: lambda sensor downstream catalyst
CDTLSH			FW	code word tester: lambda sensor downstream catalyst [012]
CDTLSH2			FW	code word tester: lambda sensor 2 downstream catalyst, cyl.row 2 [020]
CLALSH			FW	fault class: O2 sensor downstream catalyst
CLALSH2			FW	fault class: O2 sensor downstream catalyst bank 2
DLAMELSH			FW	Delta Lamda setpoint for electrical sensor diagnosis downstr. catal. (quicktrip)
DMRLSH			FW	torque reserve for diagnosis lambdasensor downstream cat
DRISIGH			FW	diagnosis threshold for Ri sensor for signal disconnection post cat
FFTLSH	BLOKNR		KL	Table of ambient conditions Lambda sensor downstream catalyst
FFTLSH2	BLOKNR		KL	Table of ambient conditions Lambda sensor downstream catalyst bank 2

Parameter	Source-X	Source-Y	Type	Description
RISIGRESH			FW	threshold for reset wiring-interruption with Ri-diagnosis downstr. cat
TABGMCSD			FW	threshold for exhaust temperature for measuring CSD
TASIG			FW	Time for the deactiv.of interf. peaks outside of range for det.of signal interr.
TMSH			FW	engine temp. threshold for recognition cold start for measur. sensor downstream
TMSHA			FW	threshold for engine switch-off temp. for measur. cooling sensor downstream cat
TNSTDNH			FW	time after start for diagnosis wire-to-wire (monoflop)
TRSAFA			FW	monitoring time closed-loop control (downstream CAT) funct. requ. for Short trip
TRSAH			FW	monitoring time closed-loop control (downstream CAT) -> sensor off
TRSE			FW	monitoring time -> closed-loop control on
TSFLSH			FW	fault active time: lambda sensor catalyst downstream
TSFLSH2			FW	fault active time: lambda sensor catalyst downstream, bank 2
TTBMH			FW	period for theoretical operation readiness of sensor with heating
TUSDUFA			FW	time delay for detec. interc. short circuit sens. downstr.(func. rec.short-trip)
TUSDUH			FW	time delay for detection intercore short circuit l. sensor downstr. cat.
TUSEINH			FW	Delay time for turn-on of readiness for operation by sensor downstream of cat.
TUSKS			FW	delay time for short circuit detection on the oxygen sensor
TUSMAX			FW	monitoring time for Usmax
TUSTAL			FW	Delay for detection'wire to wire connection' after 'empty fuel tank for O2 po.ct
UBDLS			FW	battery voltage threshold for release the sensor diagnosis
USMAX			FW	threshold for short circuit of sensor to Ubat
USMIN			FW	threshold for short circuit of sensor to ground
USREFH			FW	threshold for operation readiness of sensor downstream CAT at rich mixture
USREMH			FW	threshold for operation readiness of sensor downstream CAT at lean mixture

Variable	Source	Type	Description
B_ACSDH	DLSH	LOK	condition for test of short-circuit and CSD catalyst downstream
B_ACSDH2	DLSH	LOK	condition for test of short-circuit and CSD catalyst downstream bank 2
B_ADSH	DLSH	LOK	condition for short-circuit downstream sensor
B_ADSH2	DLSH	LOK	condition for short-circuit for downstream sensor bank 2
B_ADSHS	DLSH	LOK	condition for short-circuit "set" downstream sensor
B_ADSHS2	DLSH	LOK	condition for short-circuit "set" downstream sensor bank 2
B_ATMTPK	ATM	EIN	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	EIN	condition temperature downstream catalyst exceeds dew-point2
B_CDLSH	PROKON	EIN	function active per codeword CDLSH
B_CLLSH		EIN	Clear fault path in DLSH
B_CLLSH2		EIN	Clear fault path in DLSH, bank 2
B_DSHEN	DLSH	LOK	condition enable sensor diagnosis downstream catalyst
B_DSHEN2	DLSH	LOK	condition enable sensor diagnosis downstream catalyst bank2
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_ESLS		EIN	Condition secondary air fault by wrong air mass flow
B_FA		EIN	condition general function request
B_FALSH		EIN	condition function request downstream oxygen sensor diagnosis
B_FALSH2		EIN	condition function request downstream oxygen sensor diagnosis bank2
B_FRMAX	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMAX
B_FRMAX2	LR	EIN	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_HSHE	HLS	EIN	condition for lambda sensor heating-switch downstream cat on
B_HSHE2	HLS	EIN	condition for lambda sensor2 heating-switch downstream cat on
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LSHKLT	DLSH	LOK	condition cold oxygen sensor downstream catalyst
B_MAXFLSH	DLSH	LOK	Short-circuit to UBatt on sensor downstream catalyst detected
B_MAXFLSH2	DLSH	LOK	Short-circuit to UBatt on sensor downstream catalyst detected, bank 2
B_MXLSH	DLSH	AUS	Condition for fault type "maximum value" downstream cat detected
B_MXLSH2	DLSH	AUS	Condition for fault type "maximum value" downstream cat detected bank2
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NOADSH	DLSH	LOK	condition for no short-circuit downstream sensor
B_NOADSH2	DLSH	LOK	condition for no short-circuit downstream sensor bank2
B_NOLSH	DLSH	AUS	Condition diagnosis finished with o.k. downstream cat report
B_NOLSH2	DLSH	AUS	Condition diagnosis finished with o.k. downstream cat report bank2
B_NPLFLSH	DLSH	LOK	Wire-to-wire SC on sensor downstream catalyst detected
B_NPLFLSH2	DLSH	AUS	Wire-to-wire SC on sensor downstream catalyst detected bank 2
B_RISIGH	DLSH	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis, post cat
B_RISIGH2	DLSH	LOK	Condition signal disconnection of sensor ground with Ri-diagnosis post cat Bank2
B_SBBHK	DLSH	AUS	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	AUS	condition for lambda sensor downstream cat ready for operation bank2
B_SIGFLSH	DLSH	LOK	Signal interruption (wiring interruption) on sensor downstream catalyst detectet
B_SIGFLSH2	DLSH	LOK	Signal interruption (wiring interruption) on sensor downstr.cat.detectet bank 2
B_SILSH	DLSH	AUS	condition for fault type 'signal missing' downstream cat detected
B_SILSH2	DLSH	AUS	condition for fault type 'signal missing' downstream cat detected bank2
B_SLS	AK	EIN	Condition for active secondary air
B_ST	SWADAP	EIN	condition for start
B_STERHK		EIN	condition Stereo Lambda control behind catalyst
B_TAL	GGFST	EIN	Condition tank empty or reserve
B_TALVAL	GGFST	EIN	condition ; bit empty tank valid
B_TRSAH	DLSH	LOK	Condition wiring interruption for sensor downstream catalyst
B_TRSAH2	DLSH	LOK	Condition wiring interruption for sensor downstream catalyst, bank 2
B_TTBMHH	DLSH	AUS	cond. theoretical lambda sensor operation readyness downstr. cat with heating
B_TTBMHH2	DLSH	AUS	cond. theoretical lambda sens. operat. readyness downstr. cat with heating bank2
B_UEINH	DLSH	LOK	Cond.: Prepar. to turn on the sensor readiness for operation downstream of cat.
B_UEINH2	DLSH	LOK	Cond.: Prepar. to turn on the sensor readiness for operat. downstr. of cat.Bank2

Variable	Source	Type	Description
B_UHSIG	DLSH	LOK	Con.sensor voltage downstr.cat.in the voltage range for signal interrupt.
B_UHSIG2	DLSH	LOK	Con.sensor voltage downstr.cat.in the voltage range for signal interrupt., bank2
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
DMRLSH_W	DLSH	AUS	torque reserve for lambda sensor diagnosis downstream cat
E_LSH	DLSH	AUS	error flag: lambda sensor downstream cat
E_LSH2	DLSH	AUS	Errorflag: Lambda-Sensor downstream bank2
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
LAMELSH2_W	DLSH	AUS	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMELSH_W	DLSH	AUS	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
RINH2_W	GGLSH	EIN	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_W	GGLSH	EIN	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
SFPLSH	DLSH	AUS	status fault path:
SFPLSH2	DLSH	AUS	status fault path:
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TMOT	SWADAP	EIN	Engine temperature
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TYP_LSH	DLSH	AUS	Fault type: lambda sensor 1 downstream
TYP_LSH2	DLSH	AUS	Fault type: lambda sensor 2 downstream
UB	SWADAP	EIN	battery voltage
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
Z_LSH	DLSH	AUS	cycle-flag: lambda sensor downstream cat
Z_LSH2	DLSH	AUS	cycle-Flag: Lambda-sensor downstream cat bank2

```
Abbreviations and terminology
-----------------------------

CSD             'chemical shift down' lowered sensor characteristic line due to poisoning
ECU,SG          Electronic Control Unit
SC,KS           Short-circuit


Abbreviations for cross coupling matrix:
----------------------------------------

Partial function sensor operating readiness - outputs: SB=sensor operating readiness

                                            - inputs: S/SB=block/sensor operating readiness

Partial function sensor diagnosis           - outputs: SD=sensor diagnosis

                                            - inputs: S/SD=block/sensor diagnosis
                                                      B/SD=condition/sensor diagnosis
                                                      F/SD=flip-flop/sensor diagnosis
```

FW DLSH 26.50 Fixed Values

Parameter	Value	Description
ABGMSIGH		threshold for exh. temp. for wiring-interruption with Ri-diagnosis downstr. cat
CDTLSH		code word tester: lambda sensor downstream catalyst [012]
CDTLSH2		code word tester: lambda sensor 2 downstream catalyst, cyl.row 2 [020]
CLALSH		fault class: O2 sensor downstream catalyst
CLALSH2		fault class: O2 sensor downstream catalyst bank 2
DLAMELSH		Delta Lamda setpoint for electrical sensor diagnosis downstr. catal. (quicktrip)
DMRLSH		torque reserve for diagnosis lambdasensor downstream cat
DRISIGH		diagnosis threshold for Ri sensor for signal disconnection post cat
RISIGRESH		threshold for reset wiring-interruption with Ri-diagnosis downstr. cat
TABGMCSD		threshold for exhaust temperature for measuring CSD
TASIG		Time for the deactiv.of interf. peaks outside of range for det.of signal interr.
TMSH		engine temp. threshold for recognition cold start for measur. sensor downstream
TMSHA		threshold for engine switch-off temp. for measur. cooling sensor downstream cat
TNSTDNH		time after start for diagnosis wire-to-wire (monoflop)
TRSAFA		monitoring time closed-loop control (downstream CAT) funct. requ. for Short trip
TRSAH		monitoring time closed-loop control (downstream CAT) -> sensor off
TRSE		monitoring time -> closed-loop control on
TSFLSH		fault active time: lambda sensor catalyst downstream
TSFLSH2		fault active time: lambda sensor catalyst downstream, bank 2
TTBMH		period for theoretical operation readiness of sensor with heating
TUSDUFA		time delay for detec. interc. short circuit sens. downstr.(func. rec.short-trip)
TUSDUH		time delay for detection intercore short circuit l. sensor downstr. cat.
TUSEINH		Delay time for turn-on of readiness for operation by sensor downstream of cat.
TUSKS		delay time for short circuit detection on the oxygen sensor
TUSMAX		monitoring time for Usmax
TUSTAL		Delay for detection'wire to wire connection' after 'empty fuel tank for O2 po.ct
UBDLS		battery voltage threshold for release the sensor diagnosis
USMAX		threshold for short circuit of sensor to Ubat

Parameter	Value	Description
USMIN		threshold for short circuit of sensor to ground
USREFH		threshold for operation readiness of sensor downstream CAT at rich mixture
USREMH		threshold for operation readiness of sensor downstream CAT at lean mixture

FB DLSH 26.50 Detailed description of function

Introduction:

The diagnostic function must detect all electrical connection faults of the lambda sensor. Output signals are the fault bit E_lsh, the cycle bit Z_lsh and the bit for sensor operation readiness B_sbbhk.

The fault types, B_maxflsh (KS_UBat), B_sigflsh (wiring interruption, sensor heating defective), B_nplflsh (wire-to-wire SC) and a signal for fault healing (B_nolsh) are passed to the fault management logic.
These fault types are stored in a flip-flop in the permanent RAM and they are transferred to the fault memory as B_mxlsh (SC-UBat), B_silsh (wiring interruption); B_nplsh (wire-to-wire SC).
Generally, a transfer to the fault management can only take place (B_dshen = 1) if the dew point end downstream catalyst B_atmtpk = 1 is exceeded and thus the sensor heating is switched on with B_hshe =1 and if a sensor-specific time TUSEINH has elapsed and hence was permanently switched on for at least the time TTBMH (that means especially not dutycycled). At the same time the battery voltage ub may not lie above the threshold UBDLS, lamsons_w must be equal to 1 and the exhaust gas temperature from the model must be less than the threshold TABGMCSD and B_nmot mußt be equal to 1 (nmot < NMIN).
With the bit B_cdlsh = 0 the entire diagnostic function %DLSH is switched off. With the bit SY_STERHK = 0 a switch-over from Stereo to Mono can be performed.

Preconditions for the diagnostic function

The diagnosis and the detection of sensor readiness for operation can only be carried out in this form, if a potential-free sensor and a sensor evaluation circuit with a reverse voltage source are used.
The function can only be used in conjunction with the function %HLS.

Operation readiness:

The internal resistance of the cold sensor is very high so that the voltage of the sensor evaluation circuit always remains within a given range (independent of the mixture), determined by the reverse-voltage source (USREMH < ushk < USREFH).
With increasing sensor temperature, the internal resistance decreases and the sensor voltage dominates the reverse voltage source. Due to the steep sensor characteristic, the sensor voltage is always different to the reverse voltage, so that the voltage of the evaluation circuit leaves the range USREMH < ushk < USREFH. The operating readiness of the sensor is not only, like so far, switched on via the sensor parameters. Only once the time TUSEINH has elapsed the operating readiness can be detected, if the following applies permanently for at least the time t = TRSE to the voltage ushk:
USREFH <= ushk <= USMAX or ushk <= USREMH. During the time TUSEINH all interferences which cause an early turn-on are suppressed.
Furthermore, the fault ’wire-to-wire SC’ (B_nplsh) may not exist in the lower turn-on range.
If the sensor heating has been turned on without any interruption for at least the time TTBMH (B_ueinh=1), then it can be assumed that, with properly working sensor heating, the sensor has a low impedance (high impedance shunt does not affect sensor signal) and, theoretically, the sensor should therefore be ready for operation. If the sensor voltage then is still within the voltage range USREMH < ushk < USREFH without interruption for longer than the time TRSAH, then a wiring interruption or a defective sensor heating is assumed (B_silsh).
The operation readiness B_sbbhk is reset for all detected faults of the sensor downstream catalyst. The operation readiness is generally reset for initialization (C_ini = 1).
As long as the sensor is cold, neither a fault is present nor is the sensor ready for operation.

Possible faults:

If the sensor voltage ushk remains within the voltage range USREMH < ushk < USREFH, the flip-flop B_uhsig is set. When leaving this voltage range this flip-flop B_uhsig is again reset. The reset is performed after a delay by the time TASIG.
If influence peaks (e.g. clocked heating), which lie outside the voltage range, take place on the sensor voltage in case of wiring interruption (sensor voltage within the range), then they are deactivated by the time TASIG and the flip-flop B_uhsig is not reset.
If the flip-flop B_uhsig remains set for longer than the time TRSAH (sensor voltage within the range), then a wiring interruption or a defective sensor heating is assumed. The fault B_silsh is reported.

If the voltage of the evaluation circuit is permanently above the value USMAX for longer than the time TUSKS, then there is a SC of the sensor signal wire to UBatt. The fault B_mxlsh is reported.
The fault detection delayed by the time TUSKS serves as a safeguard against interferences.

There is a wire-to-wire SC between sensor signal and ground lead, if the following applies:
The evaluation voltage for B_acsdh = 1, i.e. for active Lambda control (B_lrhk = 1) and switched off secondary air (B_sls = 0) and secondary air diagnosis (B_dsls = 0 ; B_dtes = 0 and B_esls = 0), as well as the "not set" error flag of the secondary air pump (E_slpe = 0), and the "not set" error flags of the canister purge control (E_tes = 0; E_teve = 0), lies below the threshold USMIN without interruption for longer than the time TUSDUH.

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The fault B_nplsh is set by the flip-flop B_adsh in the permanent RAM. If a wire-to-wire SC is still present at the following start, then the closed-loop Lambda control is prohibited in the lower lean turn-on range by the stored fault. The flip-flop is only reset once the sensor voltage ushk is above the threshold USMIN.
If a wire-to-wire SC is already present during a start, then the threshold USREMH is undershot and the operating readiness B_sbbhk is set, so that B_lrhk can become active. Thus it is ensured that a wire-to-wire SC can be detected during start.
A wire-to-wire SC is also immediately detected, if during start with cold sensor (B_lshklt=1), the sensor voltage lies below the threshold USMIN. The flip-flop B_adsh in the permanent RAM is set and once the time TTBMH has elapsed the fault B_plaus is indicated. Only once the sensor voltage ushk lies obove the threshold USMIN, this flip-flop is reset.
Thus an additional information on whether a mixture fault or a wire-to-wire SC is present can be obtained during the start with cold sensor.

A defective sensor with lowered sensor characteristic (CSD ---> caracteristic shift down) is detected in %DLSAHK.
The fault B_mnflsh is set to 0.

Short trip test (function is requested by a tester)

In case a tester is connected (B_fa = 1) the diagnostic function "DLSH" is blocked until the specific request (B_falsh = 1) is made. For this function request the large times TRSAH and TUSDUH are switched to markedly smaller times TRSAFA and TUSDUFA, so that a short trip test becomes possible. In order to detect a wire-to-wire SC the control readiness B_lrhk of the downstream controller is set to the value 1 by B_falsh = 1.
So that the sensor voltage ushk downstream catalyst lies outside the checked voltage bands (throughput of the catalyst is low due to low load) an enrichment by DLAMELSH is performed by B_falsh = 1 in %LAMKO.
The sensor voltage downstream catalyst ushk is then definitely above 500 mV, so that all possible faults (wiring interruption and wire-to-wire SC) can be checked.
If ushk lies above the threshold USFHK, then a wire-to-wire SC test is also possible upstream of catalyst in %DLSV.

No fault, fault healed:

If the sensor heating was permanently switched on for longer than the time TTBMH and if the operating readiness B_sbbhk is set and if the sensor voltage ushk lies above the control threshold usrhk (B_usrhk = 0), then it is very likely that there is no fault. A trigger B_nolsh is sent to the fault management.

Fault management:

From the three fault types the error flag and the cycle flag are created. The cycle flag, however, is also set after each no-fault resp. healing-trigger and it is reset after each ECU initialization C_ini. If an error is detected as having been healed (B_nolsh), then the error flag is reset. By the fault management logic the CARB lamp is only triggered if after 2 trips the cycle flag and the error flag are each set.

APP DLSH 26.50 Application hint

Useful application values:

TUSKS : 100 ms
TRSE : 200 ms
TRSAH : 600 s
TUSDUH : 80 s (duration must be chosen a little shorter than the longest uninterrupted active control readiness B_lrhk in the FTP75 test)
TUSDUFA: 50 s
TRSAFA : 50 s
TTBMH : 90 s (time 10s longer than injection secondary air pump)
TUSEINH : 5 ..20 s dependent on sensor type (smaller than switch-on time in the HT test in the FTP75 by a fact. 0.7)
TASIG : 60 ms
UBDLS : 11 V
TABGMCSD: 700° C
DLAMELSH: 0.05 dependent on catalyst size

In the following diagram the voltage values, which are to be adjusted are entered.

```
               ^                                                      ^
          ushk |                                                      |    U_ADC        U_Sonde
               |    SC to U_Bat                                       |
USMAX          +--------------------------------------------------  +  = 1.50  V      1.50   V
               |   Release of operation readiness                     |
               |   after t > TRSE (=200ms)                            |  = 0.600 V      0.600  V - Control thresh. KFUSRHK
USREFH         +--------------------------------------------------- +  = 0.500 V      0.500  V
               |   Signal interruption  or sensor cold                |
               |   (sensor heating defective)  after t > TRSAH (=600s)|
USREMH         +--------------------------------------------------- +  = 0.400 V      0.400  V
               |   release of operation readiness after               |
               |   t > TRSE (=200ms)                                  |
USMIN          +--------------------------------------------------- +  = 0.060 V      0.060  V
               |   wire-to-wire SC, if t > TUSDUH (=40 s)             |
               +-----------------------------------------------------+
```

DLSAHK 6.50 Ageing monitoring for lambda sensor downstream of catalytic converter

FDEF DLSAHK 6.50 Function definition

```
Oscillation check for sensor downstream catalyst
------------------------------------------------


B_dshk/2--------------------------------------------------------------------------+
                 +---------------+                                                |
                 |TUSENLASH +--- |                                                |
B_sbbhk/2 ------>|----------+-->t+-------------------+                            |                    Dauer-RAM
                 +---------------+                   |           B_ushkf/2        |      +-+B_maxlash/2 +-+----+
                                                     |   +-+     +-+----+         +----->| +----------->|S|Flip+---> B_mxlash/2
                 +---------------+   +------------+  +-->|&+---->|S|Flip+-+-------|---->o|&|            +-+----+
              +->+ ushk >= usrhk +-->| TUSSA +--- +--|-->| |     +-+----+ |       |  +-->| |         +->|R|Flop|
usrhk/2 ---+--|->|               |   | ------+-->t|  |   +-+  +->|R|Flop| |       |  |   +-+         |  +-+----+
           |  |  +---------------+   +------------+  |        |  +-+----+ |  +-+  |  |               |
           |  |                                      |        |           +->| |  |  |               |     +-+
ushk/2 ->--|--+                                      |        |              |&+--|--|---------------|---->| |
           |  |                                      |        |           +->| |  |  |               |     |&+-----> B_nolash/2
           |  |                                      |        |           |  +-+  |  | +-------------|---->| |
           |  |  +---------------+   +------------+  |   +-+  |  B_ushkm/2|       |  | |             |     +-+
           |  +->+ ushk <= usrhk +-->| TUSSA +--- |  +-->|&|  |  +-+----+ |   +---|--|-+  +-+    +-+ |B_minlash/2
           +---->|               |   | ------+-->t+----->| +--|->|S|Flip+-+---|---|--|-->o| +--->| +-|-+
                 +---------------+   +------------+      +-+  |  +-+----+     |   |  +--->|&| +->|V| | |  +-+----+
C_ini --------------------------------------------------------+->|R|Flop|     |   +--|--->| | |  +-+ | +->|S|Flip+-> B_mnlash/2
                                                                 +-+----+     |      |    +-+ |      |    +-+----+
                                           +-+                                |      |        |      +--->|R|Flop|
       B_dylash/2 ----------------------->o|&+--------------------------------+      |        |      |    +-+----+
       B_ushsch/2 ----------------------->o| |                                       |        |      |    Dauer-RAM
                                           +-+                                       |        |      |
       B_enlash/2 -------------------------------------------------------------------+        |      |
                                                                                              |      |    Dauer-RAM
       B_dushsch/2 ---------------------------------------------------------------------------+      |    +-+----+
       B_ddylash/2 ----------------------------------------------------------------------------------|--->|S|Flip+-> B_nplash/2
                                                                                                     |    +-+----+
       E_lashres/2  ---------------------------------------------------------------------------------+--->|R|Flop|
                                                                                                          +-+----+
```

```
Test function for oscillation check with Lambda adjustment in %LAMKO
--------------------------------------------------------------------
                                                                        +-+
                          B_lamlash/2 --------------------------------->| |
                                       +-----------+    +-------+       | |B_lamverg/2        B_lamend/2
B_fash/2----------------------------+  |lamsons/2_w+--->|x      |       | |   +--------------+        +-+----+
                                    |  +-----------+    | x = y +------>|&+-->|TUSLASH +---  +--+---->|S|Flip+---> B_enlash/2
               +---+                | +-----------+  +->|y      |       | |   |--------+--->t|  |     +-+----+     (to fault
B_ushkf/2 ---->|NOT+--------+       | |lamlash/2_w+--+  +-------+       | |   +--------------+  |  +->|R|Flop|      release)
               +---+        |       | +-----------+         +-+         | |                     |  |  +-+----+
                            |       +---------------------->|V+-------->| |                     |  |
                           \v       |     +---------+  +--->| |         +-+      +---------+    |  +---<--- C_ini
  +-----------+     -       \       |     |i-1 +--  |  |    +-+                  | i-1 +-- |    |
  | DLAMLASHF +----->o--o    o---+  |  +->|----+-->t+--+                      +--+ ----+->t|<---+
  +-----------+      ^+          |  |  |  +---------+          1.0---o        |  +---------+
                     |           |  |  |                                      |                                  +-----------+
                     +--o 1.0    +--|--|-----------o     o----------o--^--o---|---------+----------------------->|lamlash/2_w|
                     |           |  |  |                /              |      |         |                        +-----------+
  +-----------+      V+          |  |  |  +-+   1.0---o/^              |      |         |                         (to %LAMKO)
  | DLAMLASHM +----->o--o    o---+  +--|->|V|           |              |      |         |
  +-----------+     +       /          +->| +-----------+              |      |         |
             +---+         /^          |  +-+                          |      |         |    +------+    +---+
B_ushkm/2 -->|NOT+----+     |          +--------------------------+    |      |         +--->|= 1.0 +--->|NOT+---> B_lamlash/2
             +---+    +-----+                              +-+    |    |      |              +------+    +---+     (to %LAMKO)
B_gaeing/2 ----------------------------------------------->| |    |    |      |
B_evloc -------------------------------------------------->| |    |    |      |
B_lrka/2 ------------------------------------------------>o|&|    |    |      |
B_lsahksp/2---------------------------------------------->o| +----+    |      |
                    +----------------------------+         | |B_teslash/2     |
ml_w -------------->| MLUSTEST < ml_w < MLOSTEST +-------->| |         |      |
                    +----------------------------+         | |         +------|---+
frm/2_w                     B_frmlash/2 +---------+  +---->| |                |   |
"--+  +-------------------------------+  |TFRMB+-- |  |  +->| |                |   |          "
  +->|FRMLASHU <= frm/2_w <= FRMLASHO+->|-----+->t+--+  |  +-+                |   |
     +-------------------------------+  +---------+     +---------------------|---|----------------------------+
                                         +---------------+   +----------+     |   |                            |
                                         |  Zeit-Zähler  |   | zlash_w/2|     |   |                            |
                                         |  zlash_w/2    +-->| > TTLASH +--+  |   |                            |
                                         +---E-------R---+   +----------+  |  |   |                            |
                                     +-+     ^       ^                     |  |   |      +-+                   |
B_dlash/2 -------------------------->| |     |       |                     +--|---|----->| |        B_entest/2 |
                          +-+        |&+-----+-------|------------------------|---|----->|&+---+    +-+----+   |
B_ushkf/2 --------------->|&|        | |             |       +-+              |   |      +-+   +--->|S|Flip+---+
B_ushkm/2 --------------->| +---+-->o| |             +-------+V|<-------------+   |     +-+         +-+----+
                          +-+   |    +-+             |       | |<---- C_ini    +--|---->| +-------->|R|Flop|
                                |                    |       +-+               |  +---->|V|         +-+----+
                                |                    +-------------------------+  |     +-+
                                +-------------------------------------------------+
```

```
Checking of the sensor voltage downstream catalyst during fuel cut-off
----------------------------------------------------------------------

                                               +-+
            +-----------+                      | |                               +------------------> B_dushsch/2
ushk/2 ---->| > USSCHUB +---------+----------->| |                               |
            +-----------+         |            | |                               |   Permanent-RAM
             +---------------+    |            | |    +-------------+            |      +-+----+
B_sa ------->| TSLASAH +---- |    |            |&+--->| TUSCHUB +-- +------------+----->|S|Flip+----> B_ushsch/2
             |---------+--->t+----|--+-------->| |    | --------+->t|            |      +-+----+
             +---------------+    |  |         | |    +-------------+            +----->|R|Flop|
B_mldyn   ---------------------+--|--|-------->| |                               |      +-+----+
                  +-+          |  |  |         | |                               |
Z_lsh/2 --------->|&+----------|--|--|--+----->| |                               |
E_lsh/2 -------->o| |          |  |  |  |      +-+                               |
                  +-+          |  |  |  |                                        |
                               |  |  |  |      +-+                               |
                               |  |  |  +----->| |                               |
                               |  |  +-------->|&|   +-------------+      +-+    |
                               |  +----------->o| +-->| TUSCHUB +-- +----->| |    |
                               +-------------->| |   | --------+->t|      | |    |
                    +-+                        +-+   +-------------+      | |    |
C_fcmclr ---------->|&+-------------------------------------------------->|V+----+
B_cllash/2 -------->| |                                                   | |
                    +-+                                                   | |
C_pwf ------------------------------------------------------------------->| |
                                                                          +-+
```

```
Checking of the sensor dynamics downstream catalyst during fuel cut-off
-----------------------------------------------------------------------

         Rt10
"           \  "
            +--------------+
ushk/2      | i-1 +----    |                                 +--------------------------------------+
--------+-->|-----+------>t+-----+          Rt10             |  +--------+                          |
        |   +--------------+     |            \ ushksteig/2  +->|y       |                          |
        |                       -V    +---+    +-----+          |  x > y +--+                       |
        +----------------------->o--->||X|+--->| RAM +----+---->|x       |  |                       |
        |                +-+    +     +---+    +-E---+    |     +--------+  |                       |
B_dshk/2|--------------->| |                     ˆ        |                 |          Rt10        |
B_sa -+-|--------------->| |       B_steigm/2    |        |                 V             \         |
      | |   +---------+  |&|    +-+----+   +-+   |        |                 /              +-----+  |
      | +-->|> USHRICH+->| +--->|S|Flip+-->| |   |        +-----------------o  o---o   o--->| RAM +--+------> ushkmxstg/2
      | |   +---------+  +-+    +-+----+   | |   |                                   /     +-E---+  |
      +-|--------------------->o|R|Flop|   | |   |         +--------+           0--o/ˆ       ˆ      |
        |                       +-+----+   |&|   |         |i-1+--  |                |       |      |
        |   +----------+                   | +---+-------->|---+-->t+----------------+       |      |
        +-->|> USHLEAN +------------------>| |   |         +--------+                        |      |
            +----------+                   +-+   +-------------------------------------------+      |
                                                                                                    |
                                           +--------------------------------------------------------+
                                           |
                         +--------+        |   Ereignisfilter im Dauer-RAM
                         | KMXSTG +-----+  |   ushfmxstg/2                                            +-------------> B_ddylash/2
         mldyn_w         +--------+     |  |   +------------------+                                   |
      +------------+                    |  |   |  ˆ        *   *  |                                   |      Dauer-RAM
      |  |  /      |   +----------+     |  +-->|  |    *          |   +------------+         +-+      |      +-+----+
ml_w->|  | /       +-->| > SMLDYN +-+   |      |  | *             +-->| < USHSTSOLL+--+----->| +------+----->|S|Flip+->B_dylash/2
      |  +-------  |   +----------+ |   +----->|m +------------>  |   +------------+  |      |&|             +-+----+
      +-E---IV---I-+                |          +--E-----IV----I---+             +-----|----->| |          +->|R|Flop|
        ˆ    ˆ   ˆ                  |             ˆ     ˆ     ˆ                 |     |   +->| |          |  +-+----+
        |    |   |                  |             |     |     |                 |     |   |  +-+          |
        | 0--+   |              +---+             +-----|-----|-----------------+     +---|---+           |
        |        ˆpos.Flanke    |                 |     |     +-------------------------+ |   |           |
        |        |              v B_mldyn         |     +--------+ USHSTGMX             | |   |           |
B_sa ---+--------+              |                 ˆpos. Flanke               +-+   +-+  | |   |     +-+   |
                                |    +-+          |             C_fcmlr ---->|&|   | |  | |   +--->o| |   |
                                +--->| |          |             B_cllash/2-->| +-->| |  | |         | |   |
B_steigm/2 --+---------------------->| |B_enfmst/2|                          +-+   |V+--+-|-------->|V+---+
             |  +---------------+    |&+----------+             C_pwf ------------>| |    |         | |
             |  |    +-----+    |    | |          |pos. Flanke                     +-+    |         +-+
             +->|  --+     +--  +-->o| |  +-------vE-------+    +--------------+          |
                +---------------+    +-+  | Ereigniszähler |    | zwdynsh/2 >= |          |
               Monoflop TUSHSMIN          |   zwdynsh/2    +--->| ANZDYNSH     +----------+
                                          +- I|------IV|---+    +--------------+
                                 C_ini -------+        +---- 0
```

```
Release function of the oscillation check downstream catalyst
-------------------------------------------------------------
                                                                  +-----+
B_fash ---------------------------------------------------------->|     |
B_fa -------------------------------------------------------+---->|  &  +------+
                                                            |     +-----+      |
                                                            |      +-----+     |
                                                            +---->o|     |     |
B_cdlash -------------------------------------------------------->|     |     |
B_lrhk/2 -------------------------------------------------------->|     |     |     +---+
                        +-+                                        |     |     +---->|   |
Z_lsh/2  -------------->| |  B_dshk/2                              |     |           | V +----------> B_dlash/2
E_lsh/2  ------------->o|&+--------------------------------------->|  &  +---------->|   |
Z_hsh/2  -------------->| |                                        |     |           +---+
E_hsh/2  ------------->o| |                                        |     |
                        +-+                                        |     |
                           +-----------+                           |     |
ml ----------------------->| > MLLSAH  +-------------------------->|     |
                           +-----------+                       +->o|     |
                                                               |   +-----+
                                       +---------+             |
error flag E_agre -------------------->+         |             |
from %DAGRE                            |         |             |
error flag E_agrf -------------------->+         |             |
from %DAGRF                            |         |             |
error flag B_mdarv-------------------->+         |             |
from %DMDMIL                           |         |             |
error flag E_ph    ------------------->+         |             |
from %DPH                              |         |  B_lsahksp/2|
error flag E_tes   ------------------->+    V    +-------------+
from %DTEV/%DTES                       |         |
error flag E_teve  ------------------->+         |
from %DTEVE                            |         |
error flag E_ub    ------------------->+         |
from %DUBAT                            |         |
condition flag B_edkvs  -------------->+         |
condition flag B_edkvs2 -------------->+         |
from %DKVS                             |         |
condition flag B_dsls   -------------->+         |
from %DSLS                             |         |
condition flag B_tehb   -------------->+         |
from %TEA                              |         |
condition flag B_dtest  -------------->+         |
from %DTEV                             +---------+
```

```
Fault management:
-----------------

Bank1:
                                                                   Permanent RAM
                                +-+                                +-+-----+     E_lash
B_maxlash --------------------->| +--------------------+---------->|S|Flip +----------->
B_minlash --------------------->|V|              +-+   |           +-+-----+
B_ddylash --------------------->| |   +--------->|V+---|---------->|R|Flop |
                                +-+   |    +---->| |   | E_lashres +-+-----+
                            +-+       |    |     +-+   |
B_nolash ------------------>|V|       |    |           | E_lashres = description variable
B_cdlash ----------------->o| +-------+    |           |
(0 = switch-off)            +-+       |    |           |
                                      |    |           |  +-+
                                      |    |           +->|V|      +-+-----+     Z_lash
                                      +----|------------->| +----->|S|Flip |---------->
               +-+                         |              +-+      +-+-----+
C_fcmclr ----->|&|        +-+              |     +-+          +--->|R|Flop |
B_cllash------>| +------->|V+--------------+---->|V+----------+    +-+-----+
               +-+    +-->| |      +------------>| |
C_pwf ----------------+   +-+      |             +-+
C_ini -----------------------------+


Bank2:
                                                                   Permanent RAM
                               +-+                                 +-+-----+     E_lash2
B_maxlash2 ------------------->| +----------------------+--------->|S|Flip +----------->
B_minlash2 ------------------->|V|               +-+    |          +-+-----+
B_ddylash2 ------------------->| |    +--------->|V+----|--------->|R|Flop |
                               +-+    |    +---->| |    |E_lashres2+-+-----+
                                +-+   |    |     +-+    |
B_nolash2 --------------------->| |   |    |            |E_lashres2 = description variable
SY_STERHK -------------------->o|V+---+    |            |
B_cdlash --------------------->o| |   |    |            |
(0 = switch-off)                +-+   |    |            |
                                      |    |            |   +-+
                                      |    |            +-->| |    +-+-----+     Z_lash2
                                      +----|--------------->|V+--->|S|Flip |---------->
                                           |                +-+    +-+-----+
                  +-+                      |     +-+           +-->|R|Flop |
C_fcmclr  ------->|&|   +-+   +------------+---->|V+-----------+   +-+-----+
B_cllash2 ------->| +-->| |   |    +------------>| |
                  +-+   |V+---+    |             +-+
C_pwf ----------------->| |        |
                        +-+        |
C_ini -----------------------------+
```

```
From Codeword CDLASH for B_cdlash = 0 (switch-off):                  For Mono with bit switch-over SY_STERHK = 0:
------------------------------                                       --------------------------------------------

            +------------+
            |            +---------->  B_nplash/2 = 0                                     +-------------  Mono = 0
            |  CDLASH=0  +---------->  B_mxlash/2 = 0                                     |
            | B_cdlash=0 +---------->  B_mnlash/2 = 0                                     o    o--------  Stereo = 1
            |            +---------->  E_lash/2 = 0                             SY_STERHK --->\
            |            +---------->  Z_lash/2 = 1                                         o
            |            |                                                                  |
            +------------+                                                           +--------------+
                                                                                     |    DLSAHK    +-----------> Z_lash2 = 1
                                                                                     |              +-----------> E_lash2 = 0
                                                                                     +--------------+
```

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path "lash" of this diagnosis function the following values are defined:

```
                                  |     Bank 1                                   |    Bank 2
----------------------------------|----------------------------------------------|------------------------------------------
    Status fault path lash        |     sfplash                                  |    sfplash2
    Error flag lash               |     E_lash                                   |    E_lash2
    Cycle flag lash               |     Z_lash                                   |    Z_lash2
    Fault type  lash              |     TYP_lash:(B_mxlash, B_mnlash, B_nplash)  |    TYP_lash2:(B_mxlash2, B_mnlash2, B_nplash2
    Clear fault path:             |     B_cllash                                 |    B_cllash2
    Default value active:         |     B_bklash (optional)                      |    B_bklash2 (optional)
    Fault path code lash:         |     CDTlash                                  |    CDTlash2
    Fault class lash:             |     CLAlash                                  |    CLAlash2
    Fault intensity lash:         |     TSFlash                                  |    TSFlash2
    CARB CODE lash                |     CDClash                                  |    CDClash2
    Table of ambient cond. lash:  |     FFTlash                                  |    FFTlash2
```

ABK DLSAHK 6.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZDYNSH			FW	Amount of dynamic measurement for swinging check of sensor post cat
ANZERDYH			FW	amount of error measurements for sensor dynamics at fuel cut-off downstream cat.
ANZERSCH			FW	amount of error measurements for sensor voltage at fuel cut-off downstream cat.
CDCLASH	BLOKNR		KL	code word CARB: lambda sensor aging downstream cat
CDCLASH2	BLOKNR		KL	code word CARB: lambda sensor aging downstream cat, Cyl.row 2
CDLASH			FW	code word O2-sensor aging diagnosis (SHK) in OBDII mode (invers => Europe mode)
CDTLASH			FW	code word tester: lambda sensor aging downstream catalyst [017]
CDTLASH2			FW	code word tester: lambda sensor aging downstream catalyst, cyl.row 2 [023]
CIDLSCH			FW	comp.ID for single test of measurement at fuel cut-off for sensor downstream cat
CIDLSCH2			FW	comp.ID for single test of meas. at fuel cut-off for sensor downstream cat bank2
CIDLSDY			FW	comp.ID for single test of dyn. meas. at fuel cut-off for sensor downstream cat.
CIDLSDY2			FW	comp.ID single test of dyn. meas. at fuel cut-off sensor downstream cat. bank2
CIDSHKF			FW	component ID for single test of rich voltage downstream catalyst
CIDSHKF2			FW	component ID for single test of rich voltage downstream catalyst bank2
CIDSHKM			FW	component ID for single test of lean voltage downstream catalyst
CIDSHKM2			FW	component ID for single test of lean voltage downstream catalyst bank2
CLALASH			FW	fault class: O2 sensor aging post cat
CLALASH2			FW	Fault class: Lambda-sensor aging downstream of catalytic converter, bank 2
CWDLSAHK			FW	code word for test aging of O2-sensor post cat
CWLSHA			FW	
DLAMLASHF			FW	Delta Lambda set point (rich) for the test oscillation check downstream
DLAMLASHM			FW	Delta Lambda set point (lean) for the test oscillation check downstream
DMRLASH			FW	torque reserve for diagnosis monitoring ageing lambdasensor downstream Kat
FFTLASH	BLOKNR		KL	Table ambient conditions for Lambda sensor downstream catalyst
FFTLASH2	BLOKNR		KL	Table ambient conditions Lambda sensor downstream catalyst bank2
FRMLASHO			FW	upper threshold for mean value of lamda control factor
FRMLASHU			FW	lower threshold for mean value of lamda control factor
KMXSTG			FW	Filter constant for filter max. gradient for sensor downstream catalyst
MLLASH			FW	Air mass threshold for oscillation check downstream catalyst
MLOSTEST			FW	upper air mass threshold for start of test oscillation check downstream catalyst
MLUSSTG			FW	Air mass threshold for dynamic check downstream catalyst
MLUSTEST			FW	lower air mass threshold for start of test oscillation check downstream catalyst
SMLDYN			FW	air mass threshold for sensor dynamic downstream KAT
TABGSTG			FW	threshold for exhaust temperature dynamic-measuring
TFRMB			FW	time delay for detect. the mean value of lamda control factor within thresholds
TLLASH			FW	time delay for reset lamlash_w if lamsons_w is not lamlash_w
TRIPFASH			FW	minimum time for active close loop reguation pre catalyst
TSALASH			FW	Time after fuel cut-off for the checking of the sensor downstream catalyst
TSFLASH			FW	fault active time: lambda sensor ageing catalyst downstream
TSFLASH2			FW	fault active time: lamda sesor ageing catalyst downstream, bank 2
TTLASH			FW	Time for voltage of O2 sensor post cat lower/higher than desired threshold
TUSCHUB			FW	Delay time for interference peaks at thrust detection of the rear oxygen sensor
TUSDYN			FW	Delay time for the detection of dynamic sensor faults downstream catalyst
TUSENLASH			FW	time for duration until lean/rich detection is allowed
TUSHSMIN			FW	Minimum time for measuring the gradient for enable filter
TUSLASH			FW	Test time for duration enrichment/enleanment downstream catalyst
TUSSA			FW	delay time after crossing the control threshold downstream cat
USHLEAN			FW	Threshold for lean volt. for reset dynamic measurement of sensor downstream cat.
USHRICH			FW	Threshold for rich volt. for valid dyn. measurement of sensor downstream cat.
USHSTGMX			FW	Value for maximum gradient for initial value of filter
USHSTSOLL			FW	Threshold for permitted gradient of the sensor voltage downstream catalyst
USSCHUB			FW	Threshold for sensor voltage downstream catalyst after fuel cut-off

Variable	Source	Type	Description
B_ABGSTG	DLSAHK	LOK	condition modeltemperature (tkatm od. tanhkm_w) is above threshold
B_ABGSTG2	DLSAHK	LOK	condition modeltemp. (tkatm od. tanhkm_w) is above threshold bank2
B_CDLASH	PROKON	EIN	function active per codeword CDLASH
B_CLLASH		EIN	Delete fault path in DLSA.
B_CLLASH2		EIN	Delete fault path in DLSA Bank2
B_CWLSHDYN		EIN	cond. disabling of partial func. dynmics check of sensor downstream cat. %DLSAHK
B_CWLSHSCH		EIN	cond. disabling of partial func. fuel cut-off for sensor downstream cat. %DLSAHK
B_DDYLASH	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow
B_DDYLASH2	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow ‘dynamical‘ bank2

Variable	Source	Type	Description
B_DIDYSCH	DLSAHK	LOK	cond. disable dynamics measurement and make available measured values for Mode 6
B_DIDYSCH2	DLSAHK	LOK	cond. disable dyn. measurement and make available measured val. for Mode 6 bank2
B_DISCH	DLSAHK	LOK	cond. disable fuel cut-off measurement and make avail. measured val. for Mode 6
B_DISCH2	DLSAHK	LOK	cond. disable fuel cut-off measurement and make avail. measured val.Mode 6 bank2
B_DLASH	DLSAHK	LOK	active diagnosis:ˆoxygen sensor aging downstream catalyst function
B_DLASH2	DLSAHK	LOK	active diagnosis: oxygen sensor aging downstream catalyst (cylinder row 2)
B_DSHK	DLSAHK	LOK	Condition diagnosis in %DLSH and %DHLS finished with o.k. downstream cat report
B_DSHK2	DLSAHK	LOK	Cond. diagnosis in %DLSH and %DHLS finished with o.k. downstr. cat report bank2
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_DUSHSCH	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘dynamical‘
B_DUSHSCH2	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘dyn.‘ bank2
B_DYLASH	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow ‘static‘
B_DYLASH2	DLSAHK	LOK	Condition sensor downstream catalyst dynamically slow ‘static‘ bank2
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ENFMST	DLSAHK	LOK	Condition enable for filter, take over maximum of the gradient
B_ENLASH	DLSAHK	LOK	Condition test for oscillation check terminated, release cycle bit
B_ENLASH2	DLSAHK	LOK	Condition test for oscillation check terminated, release cycle bit bank2
B_EVLOC	BGEVAB	EIN	Status: all injection valves are activated
B_FASH		EIN	condition diagnosis oxygen sensor aging downstream catalyst function request
B_FASH2		EIN	condition diag. oxygen sensor aging downstream catalyst function request bank2
B_FRMLASH	DLSAHK	LOK	condition mean value of lambda control factor within threshold
B_FRMLASH2	DLSAHK	LOK	condition mean value of lambda control factor within threshold bank2
B_GAEING		EIN	condition basic adaption Bank 1 steady state
B_GAEING2		EIN	condition for adaptive lambda pilot control 2 successful
B_LAMEND	DLSAHK	LOK	Condition end of the Lambda adjustment in %LAMKO
B_LAMEND2	DLSAHK	LOK	Condition end of the Lambda adjustment in %LAMKO bank2
B_LAMLASH	DLSAHK	LOK	Condition for enleanment in %LAMKO
B_LAMLASH2	DLSAHK	LOK	Condition for enleanment in %LAMKO bank2
B_LAMVERG	DLSAHK	LOK	Condition comparison of desired Lambda in %DLSAHK with %LAMKO corresponding
B_LAMVERG2	DLSAHK	LOK	Cond. comparison of desired Lambda in %DLSAHK with %LAMKO corresponding bank2
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LSAHKSP	DLSAHK	LOK	flag for general disabling conditions for DLSAHK
B_LSAHKSP2	DLSAHK	LOK	flag for general disabling conditions for DLSAHK bank2
B_MAXLASH	DLSAHK	LOK	Condition for ”max.value” for oscillat. check downst.cat detec.
B_MAXLASH2	DLSAHK	LOK	Condition for ”max.value” for oscillat. check downst.cat detec. bank2
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MINLASH	DLSAHK	LOK	Condition for ”min. value” of oscillation check downstr. cat detec.
B_MINLASH2	DLSAHK	LOK	Condition for ”min. value” of oscillation check downstr. cat detec. bank2
B_MLDYN	DLSAHK	LOK	Condition for minimal air mass in fuel cut off for dynamic measurement
B_MLUSTEST	DLSAHK	LOK	condition ml is within threshold
B_MNLASH	DLSAHK	AUS	Condition for fault type ”min. value” of oscillation check downstr. cat detec.
B_MNLASH2	DLSAHK	AUS	Condition for fault type ”min. value” of oscill. check downstr. cat detec. bank2
B_MXLASH	DLSAHK	AUS	Condition for fault type ”max.value” for oscillat. check downst.cat detec.
B_MXLASH2	DLSAHK	AUS	Condition for fault type ”max.value” for oscillat. check downst.cat detec. bank2
B_NDYLASH	DLSAHK	LOK	Condition no Dynamic Error at fuel cut off for sensor downstream catalyst
B_NDYLASH2	DLSAHK	LOK	Condition No Dynamic Error During Acceleration for sensor downstream of catalyst
B_NESCH	DLSAHK	LOK	Condition No Sensor Voltage Error During Acceleration
B_NESCH2	DLSAHK	LOK	Condition No Sensor Voltage Error During Acceleration Bank2
B_NOLASH	DLSAHK	LOK	Condition diagnosis oscillation check finished with o.k. report
B_NOLASH2	DLSAHK	LOK	Condition diagnosis oscillation check finished with o.k. report bank2
B_NPLASH	DLSAHK	AUS	Error typ ’value not plausible’ for swinging check post cat
B_NPLASH2	DLSAHK	AUS	Error typ ’value not plausible’ for swinging check post cat bank 2
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_STEIGM	DLSAHK	LOK	Condition measure gradient of the sensor signal
B_STEIGM2	DLSAHK	LOK	Condition measure gradient of the sensor signal bank2
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
B_TESLASH	DLSAHK	LOK	Condition perform test for check of the sensor downstream catalyst
B_TESLASH2	DLSAHK	LOK	Condition perform test for check of the sensor downstream catalyst bank2
B_TRFASH	DLSAHK	LOK	Condition Short trip started for oszilation check of O2-sensor post cat
B_TRFASH2	DLSAHK	LOK	Condition Short trip started for oszilation check of O2-sensor bank 2
B_USHKF	DLSAHK	LOK	Condition sensor voltage downstream cat. ”Rich” (set point exceeded)
B_USHKF2	DLSAHK	LOK	Condition sensor voltage downstream catalyst ”Rich” (set point exceeded) bank2
B_USHKM	DLSAHK	LOK	Condition sensor voltage downstream catalyst ”Lean” (set point undershot)
B_USHKM2	DLSAHK	LOK	Condition sensor voltage downstream catalyst ”LEAN” (set point undershot) bank2
B_USHSCH	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘statical‘
B_USHSCH2	DLSAHK	LOK	Cond. threshold sen. downst. cat. during fuel cut-off not undershot ‘stat.‘bank2
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DMRLASH_W	DLSAHK	AUS	torque reserve for lambda sensor ageing diagnosis downstream cat
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_HSH	DHLSHK	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLSHK	EIN	error flag: lambda sensor heating downstream cat on the right
E_LASH	DLSAHK	AUS	error flag: lambda sensor aging downstream cat
E_LASH2	DLSAHK	AUS	error flag: lambda sensor aging downstream cat (cylinder row 2)
E_LSH	DLSH	EIN	error flag: lambda sensor downstream cat
E_LSH2	DLSH	EIN	Errorflag: Lambda-Sensor downstream bank2

Variable	Source	Type	Description
E_PH	DPH	EIN	error flag: phase sensor
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_UB	GGUB	EIN	error flag: power supply voltage UB
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRMTRIP2_W	DLSAHK	LOK	Mean value of fr-factor for short trip of oszillation check
FRMTRIP_W	DLSAHK	LOK	Mean value of fr-factor for short trip of oszillation check
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
LAMFRM2_W	DLSAHK	LOK	Lamdba offset from mean value lambda regulation factor bank 2
LAMFRM_W	DLSAHK	LOK	Lamdba offset from mean value lambda regulation factor
LAMLASH2_W	DLSAHK	AUS	Desired Lambda for test oscillation check downstream catalyst bank2
LAMLASH_W	DLSAHK	AUS	Desired Lambda for test oscillation check downstream catalyst
M6CLSCH	DLSAHK	AUS	Mode 6-Memory: Comp. ID sensor voltage during fuel cut-off downstream cat.
M6CLSCH2	DLSAHK	AUS	Mode 6-Memory: Comp. ID sensor voltage during fuel cut-off downstream cat. bank2
M6CLSDY	DLSAHK	AUS	Mode 6-Memory: Comp. ID dynamic response measurement for sensor downstream cat
M6CLSDY2	DLSAHK	AUS	Mode 6-Memory: Comp. ID dyn. resp. measurement for sensor downstream cat. bank2
M6CSHKF	DLSAHK	AUS	Mode 6-Memory: Comp. ID rich volt. for sensor downstream cat.(osci. test)
M6CSHKF2	DLSAHK	AUS	Mode 6-Memory: Comp. ID rich volt. for sensor downstream cat.(osci. test) bank2
M6CSHKM	DLSAHK	AUS	Mode 6-Memory: Comp. ID lean volt. for sensor downstream cat.(osci. test)
M6CSHKM2	DLSAHK	AUS	Mode 6-Memory: Comp. ID lean volt. for sensor downstream cat.(osci. test) bank2
M6SLSCH	DLSAHK	AUS	Mode 6-Memory: Threshold sensor voltage during fuel cut-off downstream cat.
M6SLSCH2	DLSAHK	AUS	Mode 6-Memory: Threshold sensor volt. during fuel cut-off downstream cat. bank2
M6SLSDY	DLSAHK	AUS	Mode 6-Memory: Threshold dynamic response measurement for sensor downstream cat.
M6SLSDY2	DLSAHK	AUS	Mode 6-Memory: Threshold dyn. resp. measurement for sensor downstream cat. bank2
M6SSHKF	DLSAHK	AUS	Mode 6-Memory: Threshold rich volt. for sensor downstream cat.(osci. test)
M6SSHKF2	DLSAHK	AUS	Mode 6-Memory: Threshold rich volt. for sensor downstream cat.(osci. test) bank2
M6SSHKM	DLSAHK	AUS	Mode 6-Memory: Threshold lean volt. for sensor downstream cat.(osci. test)
M6SSHKM2	DLSAHK	AUS	Mode 6-Memory: Threshold lean volt. for sensor downstream cat.(osci. test) bank2
M6WLSCH	DLSAHK	AUS	Mode 6-Memory: Measured value sensor voltage during fuel cut-off downstream cat.
M6WLSCH2	DLSAHK	AUS	Mode 6-Mem.: Measured value sensor volt. during fuel cut-off downst. cat. bank2
M6WLSDY	DLSAHK	AUS	Mode 6-Mem.: Measured value dyn. resp. measurement for sensor downst. cat.
M6WLSDY2	DLSAHK	AUS	Mode 6-Mem.: Measured value dyn. resp. measurement for sensor downst. cat. bank2
M6WSHKF	DLSAHK	AUS	Mode 6-Mem.: Measured value rich volt. for sensor downst. cat.(osci.test)
M6WSHKF2	DLSAHK	AUS	Mode 6-Mem.: Measured value rich volt. for sensor downst. cat.(osci.test) bank2
M6WSHKM	DLSAHK	AUS	Mode 6-Mem.: Measured value lean volt. for sensor downstr. cat.(osci.test)
M6WSHKM2	DLSAHK	AUS	Mode 6-Mem.: Measured value lean volt. for sensor downstr. cat.(osci.test) bank2
MLDYN_W	DLSAHK	LOK	integrated air mass at fuel cut off
ML_W	EGFE	EIN	air mass flow filtered (Word)
SFPLASH	DLSAHK	AUS	status fault path:
SFPLASH2	DLSAHK	AUS	status fault path:
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TYP_LASH	DLSAHK	AUS	Fault type: lambda sensor aging downstream
TYP_LASH2	DLSAHK	AUS	Fault type: lambda sensor aging downstream bank2
USHFMXSTG	DLSAHK	LOK	Filtered maximum gradient of the sensor voltage downstream catalyst
USHFMXSTG2	DLSAHK	LOK	Filtered maximum gradient of the sensor voltage downstream catalyst bank2
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USHKMXSTG	DLSAHK	LOK	Maximum gradient of the sensor voltage downstream catalyst
USHKMXSTG2	DLSAHK	LOK	Maximum gradient of the sensor voltage downstream catalyst bank2
USHKSTEIG	DLSAHK	LOK	Gradient of the sensor voltage downstream catalyst
USHKSTEIG2	DLSAHK	LOK	Gradient of the sensor voltage downstream catalyst bank2
USRHK	LRHK	EIN	momentary control threshold for downstream lambda control
USRHK2	LRHK	EIN	momentary control threshold for downstream lambda control, bank2
ZERDYSH	DLSAHK	LOK	counter for error of the dynamics measurement at fuel cut-off
ZERDYSH2	DLSAHK	LOK	counter for error of the dynamics measurement at fuel cut-off bank2
ZERSCH	DLSAHK	LOK	counter for error measurements (sensor voltage threshold not undershot)
ZERSCH2	DLSAHK	LOK	counter for err. meas.(sensor volt.threshold not undershot)at fuel cut-off,bank2
ZLASH2_W	DLSAHK	LOK	Time counter for sensor voltage downstream cat. above/below the set point bank2
ZLASH_W	DLSAHK	LOK	Time counter for the sensor voltage downstream cat. above/below the set point
ZWDYNSH	DLSAHK	LOK	Counter for amount of dynamic measurement for O2 sensor post cat
ZWDYNSH2	DLSAHK	LOK	Counter for amount of dynamic measurement for O2 sensor post cat bank 2
Z_HSH	DHLSHK	EIN	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLSHK	EIN	cycle flag of lambda sensor heating downstream cat, cylinder row 2
Z_LASH	DLSAHK	AUS	cycle flag of lambda sensor aging downstream cat
Z_LASH2	DLSAHK	AUS	cycle flag of lambda sensor aging downstream cat, cylinder row 2
Z_LSH	DLSH	EIN	cycle-flag: lambda sensor downstream cat
Z_LSH2	DLSH	EIN	cycle-Flag: Lambda-sensor downstream cat bank2

Parameter	Value	Description
ANZDYNSH		Amount of dynamic measurement for swinging check of sensor post cat
ANZERDYH		amount of error measurements for sensor dynamics at fuel cut-off downstream cat.
ANZERSCH		amount of error measurements for sensor voltage at fuel cut-off downstream cat.
CDLASH		code word O2-sensor aging diagnosis (SHK) in OBDII mode (invers => Europe mode)
CDTLASH		code word tester: lambda sensor aging downstream catalyst [017]
CDTLASH2		code word tester: lambda sensor aging downstream catalyst, cyl.row 2 [023]
CIDLSCH		comp.ID for single test of measurement at fuel cut-off for sensor downstream cat
CIDLSCH2		comp.ID for single test of meas. at fuel cut-off for sensor downstream cat bank2
CIDLSDY		comp.ID for single test of dyn. meas. at fuel cut-off for sensor downstream cat.
CIDLSDY2		comp.ID single test of dyn. meas. at fuel cut-off sensor downstream cat. bank2

Parameter	Value	Description
CIDSHKF		component ID for single test of rich voltage downstream catalyst
CIDSHKF2		component ID for single test of rich voltage downstream catalyst bank2
CIDSHKM		component ID for single test of lean voltage downstream catalyst
CIDSHKM2		component ID for single test of lean voltage downstream catalyst bank2
CLALASH		fault class: O2 sensor aging post cat
CLALASH2		Fault class: Lambda-sensor aging downstream of catalytic converter, bank 2
CWDLSAHK		code word for test aging of O2-sensor post cat
CWLSHA		
DLAMLASHF		Delta Lambda set point (rich) for the test oscillation check downstream
DLAMLASHM		Delta Lambda set point (lean) for the test oscillation check downstream
DMRLASH		torque reserve for diagnosis monitoring ageing lambdasensor downstream Kat
FRMLASHO		upper threshold for mean value of lamda control factor
FRMLASHU		lower threshold for mean value of lamda control factor
KMXSTG		Filter constant for filter max. gradient for sensor downstream catalyst
MLLASH		Air mass threshold for oscillation check downstream catalyst
MLOSTEST		upper air mass threshold for start of test oscillation check downstream catalyst
MLUSSTG		Air mass threshold for dynamic check downstream catalyst
MLUSTEST		lower air mass threshold for start of test oscillation check downstream catalyst
SMLDYN		air mass threshold for sensor dynamic downstream KAT
TABGSTG		threshold for exhaust temperature dynamic-measuring
TFRMB		time delay for detect. the mean value of lamda control factor within thresholds
TLLASH		time delay for reset lamlash_w if lamsons_w is not lamlash_w
TRIPFASH		minimum time for active close loop reguation pre catalyst
TSALASH		Time after fuel cut-off for the checking of the sensor downstream catalyst
TSFLASH		fault active time: lambda sensor ageing catalyst downstream
TSFLASH2		fault active time: lamda sesor ageing catalyst downstream, bank 2
TTLASH		Time for voltage of O2 sensor post cat lower/higher than desired threshold
TUSCHUB		Delay time for interference peaks at thrust detection of the rear oxygen sensor
TUSDYN		Delay time for the detection of dynamic sensor faults downstream catalyst
TUSENLASH		time for duration until lean/rich detection is allowed
TUSHSMIN		Minimum time for measuring the gradient for enable filter
TUSLASH		Test time for duration enrichment/enleanment downstream catalyst
TUSSA		delay time after crossing the control threshold downstream cat
USHLEAN		Threshold for lean volt. for reset dynamic measurement of sensor downstream cat.
USHRICH		Threshold for rich volt. for valid dyn. measurement of sensor downstream cat.
USHSTGMX		Value for maximum gradient for initial value of filter
USHSTSOLL		Threshold for permitted gradient of the sensor voltage downstream catalyst
USSCHUB		Threshold for sensor voltage downstream catalyst after fuel cut-off

FB DLSAHK 6.50 Detailed description of function

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Introduction:
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The task of the diagnosis function is to check the voltage level of the sensor downstream catalyst.

1. Oscillation check: If the sensor signal constantly remains below or above the set point, then the pilot control
   (%LRHK, %LRSHK) will enrich or enlean the mixture until the limit stop is reached by means of the integral controller
   (limiting values of the integral component are exceeded). The sensor upstream catalyst, which is absolutely o.k., is in this
   case erroneously detected to be defective.

2. Checking during fuel cut-off: The sensor voltage must fall short of a defined voltage threshold.

3. Dynamics check during fuel cut-off: A dynamically slow sensor can be detected by measuring the ascending gradients.


Release function:
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The release function of the oscillation check for the sensor downstream catalyst is only active B_dlash = 1, if the general
release conditions B_lashksp = 0 are given and if the electrical and the heater diagnosis for the sensor downstream catalyst have
successfully been terminated B_dshk = 1  and if the air mass ml has exceeded a certain threshold (MLLSAH) as well as the pilot
control downstream catalyst B_lrhk = 1 being turned on.


Oscillation check downstream catalyst:
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The two flip-flops B_ushkf and B_ushkm are reset by C_ini. They may be set again until the cycle bit Z_lash = 1 at operating
readiness B_sbbhk = 1 and the delay time TUSENLASH are set, if ushk >= usrhk and ushk <= usrhk are each given for
longer than the time TUSSA.
The sensor downstream catalyst is o.k., if the sensor voltage is greater than or equal to the set point usrhk of the pilot control
and the controller moves into the direction "lean" (B_ushkf = 1) and if ushk is less than or equal to the set point usrhk and the
controller moves into the direction "rich" (B_ushkm = 1).
If the sensor voltage ushk during control operation (B_lrhk = 1 and B_dlash =1) remains below or above the set point usrhk
(one of the flip-flops B_ushkf or B_ushkm is not set) for longer than the time TTLASH, then by a controlled enrichment or
enleanment by means of a test function it is checked, whether the sensor voltage can be moved above or below the set point usrhk.

If the counter zlash_w during control operation downstream catalyst has exceeded the time TTLSAH, then the flip-flop B_entest is
set. Thereafter, with sufficient air mass flow MLUSTEST < ml < MLOSTEST, without catalyst "deoxidization" B_lrka = 0, no fault
flags B_lsahksp = 0 as well as B_evloc = 1 (no fuel cut-off) and also the mean value frm_w of lambda control is inside the
thresholds FRMLASHO and FRMLASHU for the time TFRMB the bit B_teslash is set.
With this bit a switch is closed, by which dependent on set rich/lean flip-flop (B_ushkf or B_ushkm), the delta Lambda value
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DLAMLASH which is added or subtracted from Lambda 1.0, is passed to the RAM lamlash_w. In addition the condition B_lamlash is set in case the Lambda is not equal to 1. For the Lambda coordination %LAMKO the Lamda value lamlash_w to be adjusted and the condition B_lamlash are given. Thereafter lamlash_w over lamsons_w (Lambda set point) is included in the calculation in the fuel path in %GR. The triggering to Lambda "rich" or "lean" is therefore only performed into one direction, dependent on which flip-flop B_ushkf or B_ushkm is set.

Simultaneously the bit B_lamvergl is set by the B_teslash delayed by one clock pulse and the performed comparison of lamlash_w with lamsons_w from %LAMKO and B_lamlash set from Lambda not equal to 1.

The controlled enrichment resp. enleanment and the test time TUSLASH are interrupted during a fuel cut-off phase or if ml < MLUSTEST.

If the sensor voltage ushk moves below or above the set point value usrhk (both flip-flops B_ushkf and B_ushkm are set) during the test time TUSLASH, then the test is aborted, by setting the Lambda equal to 1 by means of another switch. The condition B_nolash =1 (no fault) is set.

If one of the flip-flops B_ushkf or B_ushkm is not set once the test time TUSLASH has elapsed and the set trigger B_lamend, then the flip-flop B_enlash for the fault release is set by B_lamend = 1 and the dynamic fault trigger B_maxlash or B_minlash can be set.

The cycle flag Z-lash and the error flag E_lash are set set via B_maxlash or B_minlash.

Simultaneously the timer counter z_lash_w and the flip-flop B_entest are reset by means of B_lamend = 1, which is delayed by one clock pulse. With the reset of B_entest it is ensured, that the test procedure is switched off , if the sensor is defect.

Since B_enlash always remains set during a trip after the first test procedure for the fault release, a fault entry can only be performed with active Lambda control, i.e. B_dlash = 1. This means that when a fault occurs during the test procedure (e.g. heating E_hsh = 1) and thus one of the flip-flops B_ushkf or B_ushkm cannot be set, then this fault is not accepted, since B_dlash is not set after the test procedure.

Until to the next trip the counters are reset again by C_ini, so that the test procedure can start again.

Short trip for oscillation check:

With connected scan tool and B_fa =1 the oscillation check is blocked. The quick test is performed with B_fash =1, by switching through DLAMLASHF (enrichment) or DLAMLASHM (enleanment) via the switch and by setting B_lamlash = 1. If both flip-flops B_ushkf and B_ushkm have already been set prior to the quick test having been started, then DLAMLASHFor LAMLASHM is not switched through and lamlash_w remains set at 1.0. The sensor downstream catalyst is o.k. then. The short trip must be performed for longer than the time TUSLASH, so that in case a fault is possibly present (B_ushkf or B_ushkm not set) B_enlash can be set for the fault release.

Checking of the sensor voltage downstream catalyst during fuel cut-off

After a fuel cut-off duration TSALSAH has elapsed and no electrical sensor fault from %DLSH (Z_lsh = 1 and E_lsh = 0, the sensor is sufficiently hot) a check is performed during fuel cut-off, on whether the sensor voltage ushk falls short of a threshold USSCHUB.

If the sensor voltage during fuel cut-off remains greater than the threshold USSCHUB, then the bit B_dushsch is set by the trigger and the flip-flop B_ushsch is set in the permanent RAM. The fault B_minlash is set by the bit B_dushsch = 1.

The delay time TUSCHUB is only for suppression of interference peakfrom the sensor voltage.

During normal operating a setting of the cycle bit Z_lash is independent of this check and therefore it must not be waited for the start of a fuel cut-off duration. This is important on vehicles with automatic transmission, on which a fuel cut-off rarely occurs.

By setting the flip-flop B_ushsch in the permanent RAM it is achieved that during the 2. trip the bit B_nolash cannot be set and thus also not the cycle bit Z_lash. The error flag E_lash remains set. The cycle bit can only be set during the next check in the fuel cut-off phase B_sa, by either this fault being confirmed again of by the flip-flop B_ushsch in the permanent RAM being reset in case of healing, if the sensor voltage ushk falls short of the threshold USSCHUB.

B_nolash = 1 results from the resetting of B_ushsch and thus also the error flag E_lash is reset.

By means of the trigger B_dushsch it is avoided that the MIL lamp is triggered prior to this fuel cut-off check during the 2. trip.

Checking of the sensor dynamics downstream catalyst during fuel cut-off

If the sensor downstream catalyst is dynamically slow, then a "bad" catalyst can be detected as being "good" (avkat small).

With a measurement of the sensor edge times it is not possible to differentiate, also during fuel cut-off, between a dynamically good and bad sensor, especially in case of a bad catalyst.

Dynamically good and bad sensors, however, can be detected more easily, if the maximum ascending gradient of the sensor voltage is determined during fuel cut-off.

The ascending gradient ushksteig (absolute value from new-old value of the sensor voltage ushk) is measured, if during fuel cut-off (B_sa = 1) the sensor downstream catalyst is o.k. with regard to heater diagnosis and electrical diagnosis and if the sensor voltage is greater USHRICH and greater USHLEAN. The measurement of the ascending gradient is aborted, if the sensor voltage ushk < USHLEAN or if B_sa = 0. With B_sa = 0 the flip-flop B_steigm is reset. For each measurement during fuel cut-off the maximum ascending gradient ushkmxstg is calculated again. This value is only passed (B_enfmst=1) on to an event filter ushfmxstg, if the fuel cut-off duration B_sa (B_steigm = 1) is present for a minimum duration TUSHSMIN and if the integrated air mass during fuel cut-off has exceeded a threshold value SMLDYN.

In the event of powerfail C_pwf or clear fault path B_cllash the initial value USHSTGMX is written into the event filter in the permanent RAM.

The filter constant amounts to KMXSTG. If with a dynamically slow sensor the filter value ushfmxstg is less than the limiting value USHSTSOLL, then the flip-flop B_dylash in the permanent RAM is set and about the trigger B_ddylash=1 fault B_nplsah in the permanent RAM and the error E_lsah in the permanent RAM are set. B_dylash and B_ddylash can only be set, if after start it takes place a certain number ANZDYNSH of dynamic measurements (transient effect from event filter ushfmxstg).

The fault B_nplash resp. E_lash has healed again, if after a sufficient fuel cut-off duration the maximum ascending gradient ushfmxstg is again greater than the threshold value USHSTSOLL.

During normal operating a setting of the cycle bit Z_lash is independent of this check and therefore it must not be waited for the start of a fuel cut-off duration. This is important on vehicles with automatic transmission, on which a fuel cut-off rarely occurs.

By setting the flip-flop B_dylash in the permanent RAM it is achieved that during the 2. trip the bit B_nolash cannot be set and thus also not the cycle bit Z_lash. The error flag E_lash remains set. The cycle bit can only be set during the next check in the fuel cut-off phase B_sa with sufficient fuel cut-off duration (B_enfmst = 1), by either this fault being confirmed again of by the flip-flop B_dylash in the permanent RAM being reset in case of healing.

B_nolash = 1 results from the resetting of B_dylash and thus also the error flag E_lash is reset.

By means of the trigger B_ddylash it is avoided that the MIL lamp is triggered prior to this fuel cut-off check during the 2. trip.

Fault management:

The error flag E_lash and the cycle flag Z_lash are set by means of the trigger from the 3 fault types B_maxlash, B_minlash and B_ddylash. The cycle flag Z_lash is also set by no-fault B_nolash and it is reset during each Electronic Control Unit initialization C_ini. The cycle flag and the error flag are also reset via the clear bit B_cllash.
With the code bit B_cdlash = 0 the entire function DLSAHK is switched off and the error flag E_lash is reset and the cycle flag Z_lash is set.
The fault triggers B_maxlash, B_minlash and B_ddylash also set the fault flip-flops B_mxlash, B_mnlash and B_nplash in the permanent RAM. These can only be reset again via no-fault B_nolash resp. E_lashres.

General DLSAHK turn-on conditions

For the DLSAHK the following cross-connections with other OBD II diagnosis functions are relevant:

Function:		Processed by means of:
DAGRE	Diagnosis EGR power stage	B_lsahksp
DAGRF	Diagnosis EGR	B_lsahksp
DASE	Diagnosis misfire detection (emission relevant)	B_lsahksp
DEV	Diagnosis injectors	LRVK and LRHK
DHFM	Diagnosis load sensing	E_lm directly
DHLS	Diagnosis sensor heating	B_lsahksp
DKVS	Diagnosis fuel supply system	B_lsahksp
DLSH	Diagnosis downstream lambda sensor	LRHK
DPH	Diagnosis phase sensor	B_lsastp
DSLS	Diagnosis secondary air system	B_dsls
DTEV/DTES	Diagnosis canister purge valve	B_lsahksp
DTEVE	Diagnosis canister purge valve - power stage	B_lsahksp
DUBAT	Diagnosis UBAT	B_lsahksp

APP DLSAHK 6.50 Application hint

Application hints

The oscillation check sensor downstream catalyst can be switched off by the bit B_cdlash:

(B_cdlash=0) --> oscillation check blocked, E_lash/2 = 0, Z_lash/2 = 1
(B_cdlash=1) --> oscillation check active

Preconditions for DLSAHK application:

The two sensor Lambda control (LC or LCS upstream catalyst and Nernst sensor downstream catalyst) and the transient control must have been completely adjusted.

Application values:

TUSSA	2 s	
TFRMB	3 s	
TUSENLASH	30 s	
TUSLASH	10 s	dependent on catalyst size
TSALASH	5 s	dependent on catalyst size
TTLSAH	100 s	dependent on catalyst size
DLAMLASF	0.10	dependent on catalyst size
DLAMLASM	0.07	dependent on catalyst size
FRMLASSHO	1.035	
FRMLASHU	0.975	
TUSHSMIN	3 s	dependent on catalyst size
TUSCHUB	200 ms	
USHRICH	550 mV	
USHLEAN	100 mV	
USHTEST	100 mV	
USSCHUB	100 mV	
USHSTSOLL	5 mV/ms	
USHSTGMX	70 mV/ms	
KMXSTG	0.5	
MLLASH	50 kg/h	choose such that the flow in the catalyst is as large as possible
MLUSTEST	20 kg/h	above mass flow during idling
MLOSTEST	120 kg/h	
SMLDYN	15 g	dependent on catalyst size
ANZDYNSH	4	number of dynamic tests dependent from vehicle (manual/automatic transmission)
DMRLASH	7%	for short-trip: choose such that the flow in the catalyst is as large as possible ml >= MLLASH

DLSSA 14.80 Signal output from lambda sensors

FDEF DLSSA 14.80 Function definition

```
Signal output for labda sensor upstream catalyst with conventional lambda control (SY_STETLR := FALSE)
========================================================================================================
```

While the Lambda sensor aging diagnosis (%DLSA) is active, the Lambda sensor signal upstream catalyst can be considered as being characteristic for the quality of the mounted Lambda sensor upstream catalyst as far as shape and frequency are concerned. By the given Lambda sensor signal, output parameters are continuously calculated, like with the cycle duration monitoring for the upstream Lambda sensor. These parameters describe the shape of the upstream Lambda sensor signal. The calculated parameters together with the integrator value atv of th downstream control and the cycle duration of the upstream Lambda sensor and various constants are then outputted via a tester interface. For the sensor voltage downstream catalyst the min. and max. values as well as the mean control threshold are sent to the tester if requested. The parameters to be calculated, their value range as well as the quantization which is to be used are described by the SAE standard J1979.

Function block diagram:

Is calculated for SY_STETLR :=FALSE

```
tfrn_w/2                                   +--------------------------------+           tuspnf/2
 ------------------------------------->----+ time of the usvkj from the     +----------->------------
B_dlatp/2                                  | positive to the negative edge  |
 ------------------------------------->----+ - - - - - - - - - - - - - - - -+           usmxsan/2
(Enable  flag for the cycle duration       | Determination of the max. value+----------->------------
 monitoring of the %DLSA, is also used     | of the upstr. sensor voltage   |
 for enabling of the DLSSA)                + - - - - - - - - - - - - - - - -+           usmnsan/2
                                           | Determination of the min. value+----------->------------
                                           | of the upstr. sensor voltage   |
                                           + - - - - - - - - - - - - - - - -+           atvfett/2
atv/2     (manipulated variable of LRHK)   |                                +----------->------------
 ------------------------------------->----+ conversion to output format    |           atvmager/2
                                           |                                +----------->------------
tpsvkmf/2_w (cycle duration of the SVK)    + - - - - - - - - - - - - - - - -+           tpsvlssa/2
 ------------------------------------->----+ conversion to output format    +----------->------------
USR       (ZPR-control threshold, %LR)     + - - - - - - - - - - - - - - - -+           USRJ
 ------------------------------------->----+ conversion to output format    +----------->------------
usvk/2    (upstream sensor voltage)        + - - - - - - - - - - - - - - - -+           usvkj/2
 ------------------------------------->----+ Subtraction of the neg. offset +----------->------------
                                           +--------------------------------+
USMNSAMN  (lower limiting value for minimum usvkj)                                      USMNSAMN
 --->-----------------------------------------------------------------------------------> ------------
USMNSAMX  (upper limiting value for minimum usvkj)                                      USMNSAMX
 --->----------------------------------------------------------------------------------->------------
USMXSAMN  (lower limiting value for maximum usvkj)                                      USMXSAMN
 --->----------------------------------------------------------------------------------->------------
USMXSAMX  (upper limiting value for maximum usvkj)                                      USMXSAMX
 --->----------------------------------------------------------------------------------->------------
TUSPNMN   (lower threshold value for the time betw. pos. and neg. edge)                 TUSPNMN
 --->----------------------------------------------------------------------------------->------------
TUSPNMX   (upper threshold value for the time betw. pos. and neg. edge)                 TUSPNMX
 --->----------------------------------------------------------------------------------->------------
ATVFETTO  (upper limiting value for atvfett)                                            ATVFETTO
 --->----------------------------------------------------------------------------------->------------
ATVFETTU  (lower limiting value for atvfett)                                            ATVFETTU
 --->----------------------------------------------------------------------------------->------------
ATVMAGO   (upper limiting value for the atvmager)                                       ATVMAGO
 --->----------------------------------------------------------------------------------->------------
ATVMAGU   (lower limiting value for the atvmager)                                       ATVMAGU
 --->----------------------------------------------------------------------------------->------------
TPSVKMN   (lower limiting value for the cycle duration)                                 TPSVKMN
 --->----------------------------------------------------------------------------------->------------
TPSVKMX   (upper limiting value for the cycle duration)                                 TPSVKMX
 --->----------------------------------------------------------------------------------->------------
```

Determination of the minimum and maximum sensor voltage upstream catalyst:
===

```
    will be calculated for SY_STETLR := FALSE

                                                                               \<----- C_ini
                                                                     USRJ ---o  o---+
                                                                                    |                Non volatile RAM
                                                                     +--------------+---+           +------------------+
                                                                     |det. of extremum  |           |usmxsan:= usmxsaa |  usmxsan/2
                                          +------------------------->|current maximum   +---o   o-->|new maximum       +---->----
                                          |                          |    (usmxsaa)     |    \      |                  |
                               +----------+----------+               +------------------+    ^\     +---^IV--------^I--+
                               |usvkj > USRJ + 40 mV |                                       |          |          |
                               +----------+----------+                                +------+     0.0--+          |
        *----------------+            o---+                  twdlssa/2_w              |                       +-+  |
usvkj/2 | ^    ** *      |usvkjf/2_w                        +--------------+          |     C_pwf ----------->| +--+
------->| | *  SAFK1     +---------o           B_dlatp/2--->|TWDLSSA  +--- +----------+                  +-+  |V|  |
        | *------------> |          \                       | --------+-->t|          |     C_fcmclr --->|&+->| |  |
        +----------------+           \o---+                 +--------------+          | B_lclmod5/2 ---->| |  +-+  |
                                          |                                           +------+   0.0--+  +-+       |
                               +----------+-----------+                                      |        |            |
                               | usvkj < USRJ - 40 mV |              +------------------+    v/     +-vIV----------vI--+
                               +----------+-----------+              |det. of extremum  |    /      |usmnsan:= usmnsaa |  usmnsan/2
                                          +------------------------->|current minimum   +---o   o-->|new minimum       +-------->
                                                                     |    (usmnsaa)     |           |                  |
                                                                     +--------------+---+           +------------------+
                                                                                    |                Non volatile RAM
                                                                     USRJ ---o  o---+
                                                                  C_ini ----->\
```

Delete fault path DLSSA caused from different functions:

```
                        +-+
B_cllsv/2 ------------->| |
B_cllsh/2 ------------->| |
B_cllatp/2 ------------>|V+----------------> B_lclmod5/2
B_cllatv/2 ------------>| |
B_clhsv/2 ------------->| |
B_clhsh/2 ------------->| |
                        +-+
```

Signal output for labda sensor upstream catalyst with continous lambda control (SY_STETLR := TRUE)
==

During active oxygen sensor aging diagnosis the sensor signal (shape and frequency) can be considered as characteristic for the quality of the installed upstream sensor. By means of the present section DLSSA, several parameters are calculated continuously (like cycle duration monitoring of the upstream sensor). These parameters describe the characteristic of the upstream Lambda sensor signal. The calculated values are provided via a tester interface, together with the correction value of the downstream controller, the dynamic property value of the upstream continuos sensor and different constants by a tester interface.

Block diagram of the function:

```
dynlsu_w / dynlsu2_w                                +----------------------------------+         dynlsu/2
 ------------------------------------>--------------+ value of dynamic sensor          +--------->------------
B_dylsu / B_dylsu2                                  | property conversion 16 --> 8 Bit |
 ------------------------------------>--------------+                                  |
(release flag for dynamic test LSU                  |                                  |
 monitoring of %DLSU, additionally used             |                                  |
 for release of %DLSSALRS                           + - - - - - - - - - - - - - - - - -+
                                                    |                                  |
                                                    |                                  |
dlahi_w / dlahi2_w                                  |                                  |
          (correction factor of LRHK)               |                                  |
------------------------------------->--------------| conversion to output standard    |         dlahisa/2
                                                    |                                  |--------->------------
                                                    + - - - - - - - - - - - - - - - - -+
                                                    | conversion to output standard    |
lamsons_w / lamsons2_w   (control threshold  %LRS)  | - - - - - - - - - - - - - - - - -+         lamsosa/2
---->-------------------------------->--------------| conversion to output standard    |--------->------------
lamsoni_w /lamsoni2_w     (lambda upstr. catalyst   | - - - - - - - - - - - - - - - - -|         lamsisa/2
---->-------------------------------->--------------| subtraction of neg. offset       |--------->------------
                                                    +----------------------------------+
LAMSSAMN  (lower limit for lambda upstream cat. lamsonij_w)                                      LAMSSAMN
 --->--------------------------------------------------------------------------------------------->------------
LAMSSAMX  (upper limit for lambda upstream cat. lamsonij_w)                                      LAMSSAMX
 --->--------------------------------------------------------------------------------------------->------------
DLAHISATU (lower limit for control value dlahij_w)                                               DLAHISATO
 --->--------------------------------------------------------------------------------------------->------------
DLAHISATO (upper limit for control value dlahij_w)                                               DLAHISATU
 --->--------------------------------------------------------------------------------------------->------------
DYNLSUTO  (upper threshold for dynamic value LSU)                                                DYNLSUTO
 --->--------------------------------------------------------------------------------------------->------------
DYNLSUTU  (lower threshold for dynamic value LSU)                                                DYNLSUTU
---->--------------------------------------------------------------------------------------------->------------
```

Function block diagram : Sensor downstream catalyst

```
                                          +--------------------------------+
                                          |                                |
B_lrhk /2                                 |                                |
----------------------------------------->+- - - - - - - - - - - - - - - - +           usmxshn/2
                                          | Determination of the max. value|-------->---------------
                                          | of the downstr. sensor voltage |
                                          +- - - - - - - - - - - - - - - - +           usmnshn/2
                                          | Determination of the min. value|-------->----------------
                                          | of the downstr. sensor voltage |
ushk/2    (downstream sensor voltage)     +- - - - - - - - - - - - - - - - +           ushkj/2
 ---------------------------------------->| Conversion to output format    |-------->-----------------
                                          +--------------------------------+

USRHKSHJ  (mean control threshold downstream catalyst)                                 USRHKSHJ
--------------------------------------------------------------------------------------->-----------------
USMNSHMN  (lower limiting value for minimum ushkj)                                     USMNSHMN
-------->------------------------------------------------------------------------------>-----------------
USMNSHMX  (upper limiting value for minimum ushkj)                                     USMNSHMX
-------->------------------------------------------------------------------------------>-----------------
usmxshmn  (lower limiting value for maximum ushkj)                                     USMXSHMN
-------->------------------------------------------------------------------------------>----------------
usmxshmx  (upper limiting value for maximum ushkj)                                     USMXSHMX
-------->------------------------------------------------------------------------------>----------------
```

```
Determination of the minimum and maximum sensor voltage downstream catalyst:
===========================================================================

    will be calculated for SY_STETLR := TRUE / FALSE

                                                                               \<----- C_ini
                                                                 USRHKSHJ ---o  o---+
                                                                                    |               Non volatile RAM
                                                                     +--------------+---+           +------------------+
                                                                     |det. of extremum  |           |usmxshn:= usmxsha |  usmxshn/2
                                          +------------------------->|current maximum   +---o   o-->|new maximum  m     +---->----
                                          |                          |    (usmxsha)     |    \      |                  |
                             +------------+-------------+            +------------------+    ^\     +---^IV--------^I--+
                             | ushkj > USRHKSHJ + 10 mV |                                    |          |          |
                             +------------+-------------+                                    |          +---0.0    |
        *----------------+            o---+                   twdlssh/2_w              +-----+               +-+   |
ushkj/2 | ^    ** *      |ushkjf/2_w                        +--------------+           |     C_pwf --------->|V+-->+
------->| | *  SAFK1     +---------o           B_lrhk/2 --->| TWDLSSA +--- +-----------+                +-+  | |   |
        | *------------> |          \                       | --------+-->t|           |     C_fcmclr ->|&+->| |   |
        +----------------+           \o---+                 +--------------+           |  B_lclmod5/2-->| |  +-+   |
                                          |                                            +-----+  0.0--+  +-+        |
                             +------------+-------------+                                    |       |             |
                             | ushkj < USRHKSHJ - 10 mV |            +------------------+    v/     +vIV-----------vI--+
                             +------------+------------ +            |det. of extremum  |    /      |usmnshn:= usmnsha |  usmnshn/2
                                          +------------------------->|current minimum   +---o   o-->|new minimum       +-------->
                                                                     |    (usmnsha)     |           |                  |
                                                                     +--------------+---+           +------------------+
                                                                                    |                Non volatile RAM
                                                                 USRHKSHJ ---o  o---+
                                                                  C_ini ----->\
```

```
Calculation of the time between crossing the threhold negative to positive and positive to negative upstream catalyst:


                                                               Rt50  recursive filter
                                                                 \   Non volatile RAM
                                                    +-------+     +-----------------+
                                                    | SAFK2 +---->|m^    *  *  *    |
tfrn_w/2  -----------------+                        +-------+     | | *             +--------------------> tuspnf/2
(%LR 10 ms-time slot)      +------------------------------------->| *-------------> +----+B_tusre/2
                                                                  +-E-----IV-----I--+    |
                 +-+                                                 ^      ^     ^      |
B_dlatp/2 ------>|&|          +-+----+  B_tuspn/2                    |      |     |      |
B_lrtpp/2 ------>| +--------->|S|Flip+-------------------------------+      |     |      |
(%LR             +-+          +-+----+                                      |     |      |
10 ms-time slot         +---->|R|Flop|                             0.0 -----+     |      |
                        |     +-+----+                                            |      |
                        |                                                         |      |
                        +---------------------------------------------------------|------+
               +-+                                                                |
C_fcmclr ------|&|    +-+                                                         |
B_lclmod5/2--->| +--->| |                                                         |
               +-+    |V+---------------------------------------------------------+
C_pwf --------------->| |
                      +-+
```

ABK DLSSA 14.80 Abbreviations

The input values for the convetional control are defined in %LR, %LRHK and %DLSA. The corresponding input values for the continuous control are defined in %LRS, %LRSHK, %GGLSU and %DLSU. The local values and the output values need to be defined anew for the Lambda sensor signal output.

Parameter	Source-X	Source-Y	Type	Description
ATVFETTO			FW	upper threshold for atvfett, CARB tester, DLSSA
ATVFETTU			FW	lower threshold for atvfett, CARB tester, DLSSA
ATVMAGO			FW	upper threshold for atvmager, CARB tester, DLSSA
ATVMAGU			FW	lower threshold for atvmager, CARB tester, DLSSA
DLAHISATO			FW	upper threshold for dlahisa, CARB tester, DLSSALRS
DLAHISATU			FW	lower threshold for dlahisa, CARB tester, DLSSALRS
DYNLSUTO			FW	upper threshold for dynlsusa, CARB tester, DLSSALRS
DYNLSUTU			FW	lower threshold for dynlsusa, CARB tester, DLSSALRS
LAMSSAMN			FW	lower threshold for lamsosa and lamsisa, CARB tester, DLSSALRS
LAMSSAMX			FW	upper threshold for lamsosa and lamsisa, CARB tester, DLSSALRS
SAFK1			FW	filter constant 1 for lambda sensor signal access
SAFK2			FW	filter constant 2 for lambda sensor signal access
TPSVKMN			FW	minimum cycle duration of upstream lambda sensor, DLSSA
TPSVKMX			FW	maximum cycle duration of upstream lambda sensor, DLSSA
TUSPNMN			FW	min. time of the sensor voltage between pos. and neg. slope
TUSPNMX			FW	max. time of the sensor voltage between pos. and neg. slope
TWDLSSA			FW	minium test duration for DLSSA extreme value evaluation
USIVMAXH			FW	Init value for max.sensor volt. downstr. cat. after powerfail/clear fault memory
USIVMAXV			FW	Init value for max. sensor volt. upstr. cat. after powerfail/clear fault memory
USIVMINH			FW	Init value for min.sensor volt. downstr. cat. after powerfail/clear fault memory

Parameter	Source-X	Source-Y	Type	Description
USIVMINV			FW	Init value for min. sensor volt. upstr. cat. after powerfail/clear fault memory
USMNSAMN			FW	max. detected sensor voltage for signal output (min. plaus. value)
USMNSAMX			FW	min. detected sensor voltage for signal output (max. plaus. value)
USMNSHMN			FW	max. detected sensor voltage downstr. cat. for signal output (min. plaus. value)
USMNSHMX			FW	min. detected sensor voltage downstr. cat. for signal output (max. plaus. value)
USMXSAMN			FW	max. detected sensor voltage for signal output (min. plaus. value)
USMXSAMX			FW	max. detected sensor voltage for signal output (max. plaus. value)
USMXSHMN			FW	max. detected sensor voltage downstr. cat. for signal output (min. plaus. value)
USMXSHMX			FW	max. detected sensor voltage downstr. cat. for signal output (max. plaus. value)
USR			FW	controller theshold for lambda control upstream catalyst
USRHKSH			FW	controller theshold for lambda control downstream catalyst, DLSSA display
USRHKSHJ			FW	controller theshold for lambda control downstream catalyst, DLSSA display

Variable	Source	Type	Description
ATV	LRHK	EIN	current integrator value of lambda control downstream cat
ATV2	LRHK	EIN	current integrator value of lambda control downstream cat 2
ATVFETT	DLSSA	AUS	atv shifting to 'rich', DLSSA
ATVFETT2	DLSSA	AUS	atv shifting to 'rich', DLSSA (bank2)
ATVMAGER	DLSSA	AUS	atv shifting to 'lean', DLSSA
ATVMAGER2	DLSSA	AUS	atv shifting to 'lean', DLSSA (bank2)
B_DLATP	DLSA	EIN	condition for active diagnosis: lambda sensor aging TP
B_DLATP2	DLSA	EIN	condition for active diagnosis: lambda sensor aging TP (cylinder row 2)
B_LCLMOD5	DLSSA	LOK	Clear nonvalatile RAM of DLSSA
B_LCLMOD52	DLSSA	LOK	Clear nonvalatile RAM of DLSSA
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LRTPP	LR	EIN	Periodic time valid, static cond. for %LR (amplitude/periodic time) = TRUE
B_LRTPP2	LR	EIN	static condition for lambda controller (amplitude/periodic time) bank2
B_TUSPN	DLSSA	LOK	Condition time between sensor transitions tfrn_w (%LR) valid
B_TUSPN2	DLSSA	LOK	Condition time between sensor transitions tfrn2_w (%LR) valid
B_TUSRE	DLSSA	LOK	Condition result for filtred half period for sensor upstream cat
B_TUSRE2	DLSSA	LOK	Condition result for filtred half period for sensor upstream cat bank2
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DLAHI2_W		EIN	I-portion of the continuous LRHK2
DLAHISA	DLSSA	AUS	I part LRSHK, signal output DLSSA (SY_STETLR := TRUE), bank 1
DLAHISA2	DLSSA	AUS	I part LRSHK, signal output DLSSA (SY_STETLR := TRUE), bank 2
DLAHI_W		EIN	I-portion of the LRSHK
DYNLSU2_W		EIN	Dynamical value of the LSU, bank 2
DYNLSUSA	DLSSA	AUS	signal output DLSSA: dynamic value LSU, bank 1
DYNLSUSA2	DLSSA	AUS	signal output DLSSA: dynamic value LSU, bank 2
DYNLSU_W		EIN	Dynamical value of the LSU
LAMSISA	DLSSA	AUS	Signal output DLSSA: measured value lambda, bank 1
LAMSISA2	DLSSA	AUS	Signal output DLSSA: measured value lambda, bank 2
LAMSONI2_W		EIN	Lambda actual value
LAMSONI_W		EIN	Lambda actual value
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
LAMSOSA	DLSSA	AUS	Signal output DLSSA: lambda set value %LRS, bank 1
LAMSOSA2	DLSSA	AUS	Signal output DLSSA: lambda set value %LRS, bank 2
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
TFRN2_W	LR	EIN	time duration lambda controller negativ slope, bank 2
TFRN_W	LR	EIN	time duration lambda controller negativ slope
TPSVKMF2_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat. (word)
TPSVLSA2	DLSSA	AUS	cycle duration (sensor signal upstream cat) for DLSSA (bank2)
TPSVLSSA	DLSSA	AUS	cycle duration (sensor signal upstream cat) for DLSSA
TPSVLSSA2	DLSSA	AUS	cycle duration (sensor signal upstream cat) for DLSSA (bank2)
TUSPNF	DLSSA	AUS	filtered time between positive and negative usvk slope, DLSSA
TUSPNF2	DLSSA	AUS	filtered time between positive and negative usvk slope, DLSSA (bank2)
TWDLSSA2_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation bank2
TWDLSSA_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation
TWDLSSH2_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation downstream cat bank2
TWDLSSH_W	DLSSA	LOK	timer of minimum test duration for DLSSA-extreme evaluation downstream cat
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USHKJ	DLSSA	LOK	output voltage oxygen sensor downstream catalyst without offset, DLSSA, bank 1
USHKJ2	DLSSA	LOK	output voltage oxygen sensor downstream catalyst without offset, DLSSA, bank 2
USHKJF2_W	DLSSA	LOK	fiterd output voltage oxygen sensor downstream cat without offset, DLSSA (bank2)
USHKJF_W	DLSSA	LOK	fiterd output voltage oxygen sensor downstream catalyst without offset, DLSSA
USMNSAA	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMNSAA2	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMNSAN	DLSSA	AUS	minimum established sensor voltage value upstream cat (new), DLSSA
USMNSAN2	DLSSA	AUS	minimum established sensor voltage value upstream cat (new), DLSSA (bank2)
USMNSHA	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMNSHA2	DLSSA	LOK	minimum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMNSHN	DLSSA	AUS	minimum established sensor voltage value downstream cat (new), DLSSA
USMNSHN2	DLSSA	AUS	minimum established sensor voltage value downstream cat (new), DLSSA
USMXSAA	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMXSAA2	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMXSAN	DLSSA	AUS	maximum established sensor voltage value upstream cat (new), DLSSA
USMXSAN2	DLSSA	AUS	maximum established sensor voltage value upstream cat (new), DLSSA (bank2)

Variable	Source	Type	Description
USMXSHA	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 1
USMXSHA2	DLSSA	LOK	maximum established sensor voltage value upstream cat (old), DLSSA, bank 2
USMXSHN	DLSSA	AUS	maximum established sensor voltage value downstream cat (new), DLSSA
USMXSHN2	DLSSA	AUS	maximum established sensor voltage value downstream cat (new), DLSSA
USRJ	DLSSA	AUS	lambda control threshold without offset, DLSSA
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
USVKJ	DLSSA	AUS	output voltage oxygen sensor upstream catalyst without offset, DLSSA
USVKJ2	DLSSA	AUS	output voltage oxygen sensor upstream catalyst without offset, DLSSA (Bank2)
USVKJF2_W	DLSSA	LOK	filterd output voltage oxygen sensor upstream cat. without offset, DLSSA (bank2)
USVKJF_W	DLSSA	LOK	filterd output voltage oxygen sensor upstream catalyst without offset, DLSSA

Parameter	Value	Description
ATVFETTO		upper threshold for atvfett, CARB tester, DLSSA
ATVFETTU		lower threshold for atvfett, CARB tester, DLSSA
ATVMAGO		upper threshold for atvmager, CARB tester, DLSSA
ATVMAGU		lower threshold for atvmager, CARB tester, DLSSA
DLAHISATO		upper threshold for dlahisa, CARB tester, DLSSALRS
DLAHISATU		lower threshold for dlahisa, CARB tester, DLSSALRS
DYNLSUTO		upper threshold for dynlsusa, CARB tester, DLSSALRS
DYNLSUTU		lower threshold for dynlsusa, CARB tester, DLSSALRS
LAMSSAMN		lower threshold for lamsosa and lamsisa, CARB tester, DLSSALRS
LAMSSAMX		upper threshold for lamsosa and lamsisa, CARB tester, DLSSALRS
SAFK1		filter constant 1 for lambda sensor signal access
SAFK2		filter constant 2 for lambda sensor signal access
TPSVKMN		minimum cycle duration of upstream lambda sensor, DLSSA
TPSVKMX		maximum cycle duration of upstream lambda sensor, DLSSA
TUSPNMN		min. time of the sensor voltage between pos. and neg. slope
TUSPNMX		max. time of the sensor voltage between pos. and neg. slope
TWDLSSA		minium test duration for DLSSA extreme value evaluation
USIVMAXH		Init value for max.sensor volt. downstr. cat. after powerfail/clear fault memory
USIVMAXV		Init value for max. sensor volt. upstr. cat. after powerfail/clear fault memory
USIVMINH		Init value for min.sensor volt. downstr. cat. after powerfail/clear fault memory
USIVMINV		Init value for min. sensor volt. upstr. cat. after powerfail/clear fault memory
USMNSAMN		max. detected sensor voltage for signal output (min. plaus. value)
USMNSAMX		min. detected sensor voltage for signal output (max. plaus. value)
USMNSHMN		max. detected sensor voltage downstr. cat. for signal output (min. plaus. value)
USMNSHMX		min. detected sensor voltage downstr. cat. for signal output (max. plaus. value)
USMXSAMN		max. detected sensor voltage for signal output (min. plaus. value)
USMXSAMX		max. detected sensor voltage for signal output (max. plaus. value)
USMXSHMN		max. detected sensor voltage downstr. cat. for signal output (min. plaus. value)
USMXSHMX		max. detected sensor voltage downstr. cat. for signal output (max. plaus. value)
USR		controller theshold for lambda control upstream catalyst
USRHKSH		controller theshold for lambda control downstream catalyst, DLSSA display
USRHKSHJ		controller theshold for lambda control downstream catalyst, DLSSA display

FB DLSSA 14.80 Detailed description of function

Data to be calculated for the Lambda sensor signal output for the conventional control:

tuspnf: Time of the sensor voltage between positive and negative edge
usmxsan: maximum detected sensor voltage value for signal output upstream catalyst
usmnsan: minimum detected sensor voltage value for signal output upstream catalyst
usmxshn: maximum detected sensor voltage value for signal output downstream catalyst
usmnshn: minimum detected sensor voltage value for signal output downstream catalyst
atvfett: Integrator manipulated variable for the pilot control towards RICH
atvmager: Integrator manipulated variable for the pilot control towards LEAN
tpsvlssa: Cycle duration of the sensor signal upstream catalyst for signal output
usrj: Control threshold of the Lambda control (without offset)
usvkj: Sensor voltage upstream catalyst without negative voltage offset

Data to be calculated for the Lambda sensor signal output for the continuous control:

dlahisa: Integrator control variable of the downstream control

Data to be calculated for the Lambda sensor downstream catalyst:

usrhkshj: Control threshold of the pilot control downstream catalyst (without offset)
ushkj: Sensor voltage downstream catalyst (without offset)

1. Determination of the minimum and maximum sensor voltage upstream (SY_STETLR := FALSE) /downstream catalyst

With initialization C_ini the RAM-cells for the old maximum (usmxsaa resp. usmxsha) and for the old minimum (usmnsaa resp. usmnsha) are set to the starting value USRJ resp. USRHKSHJ.
The RAM-cells for the new maximum (usmxsan resp.usmxshn) and for the new minimum (usmnsan resp. usmnshn) are reset with powerfail.
The new extremums (minimum resp. maximum of the Lambda sensor voltage upstream and downstream catalyst) are output via the tester interface.

While driving the absolute minimum resp. maximum is formed within a n-,tl-range, which is preset by the %DLSA.

The current extremum is entered into the RAM-cell "old maximum" resp. "old minimum". The purpose of the filters is to smooth the input signal usvkj and ushkj.

The extremums are formed according to the following principal:
If the sensor voltage usvkjf_w resp. ushkjf_w is greater than the presently stored positive peak value usmxsaa resp. usmxsha, then it is overwritten by the currently filtered sensor voltage usvkj resp. ushkj.
If the sensor voltage usvkj resp.ushkj is less than the presently stored negative peak value usmnsaa resp. usmnsha, then it is overwritten by the currently filtered sensor voltage usvkj resp. ushkj.

As long as the enable flag of the %DLSA cycle duration monitoring (B_dlatp) or of active closed loop B_lrhk remains set for longer than the time TWDLSSA (engine is in a defined nmot-, rl-range), the new extremum is always overwritten by the current old extremum and thus made available to the tester interface. The output signal (usmnsan resp. usmnshn as well as usmxsan resp. usmxshn), however, remains active, i.e. it does not remain frozen for good at an extreme value.

2. Calculation of the time between positive and negative edge upstream catalyst (SY_STETLR := FALSE)

By the section %LR the total time of a controller cycle tpsvkmf_w is calculated summing the positive integrator time tfrp_w and the negative integrator time tfrn_w. tfrn_w is the time for the positive half cycle of the lambda control and is exactly the time requested by the SCAN-tool. For (B_dlatp AND B_lrtpp) = TRUE the most recent time tfrn_w will be taken as input to the recursive filter. As B_lrtpp is calculated in the 10 ms time slot the Bit status is buffered by the Flip Flop B_tuspn. This Flip Flop will be reset at the end of the filter calculation using the Bit B_tusre. The RAM used with the recursive filter is located in a non volatile RAM. The filter constant is SAFK2.

3. I-part of the downstream control (SY_STETLR := FALSE)

The output value atv of the integrator is given in 40ms increments as absolute value in atvfett and atvmager. This conversion is necessary since atv is a signed-byte value and can contain positive as well as negative values, however, the CARB tester interface only allows positive values. For this reason this value is entered into atvfett, if atv contains a positive value and atvmager is zero in this case. If the value of atv is negative this value is entered as absolute value into atvmager and atvfett is set to zero.
The quantization between atv (see %LRHK) and atvfett resp. atvmager (40ms) differs! The limiting values for atvfett are ATVFETTO and ATVFETTU, for atvmager the limiting values are ATVMAGO and ATVMAGU.

4. Cycle duration (SY_STETLR := FALSE)

The cycle duration of the Lambda sensor signal upstream catalyst (tpsvkmf_w) is quantized with 10ms, for the DLSSA the cycle duration (tpsvlssa) needs to be quantized with 40ms. The value tpsvkmf determined in the %LR must therefore be converted accordingly for the DLSSA. The limiting values for tpsvkmf_w are TPSVKMN and TPSVKMX.

5. Control threshold, sensor voltage upstream catalyst (SY_STETLR := FALSE)

The control threshold USR and the sensor voltage upstream catalyst must be converted for the DLSSA output to the CARB tester, since a negative voltage offset is included in the calculation of the BOSCH conversion formula. However, this offset is not provided in the SAE1979. This means that this offset must be subtracted from the constant USR and from the variables usvk. The resulting values are USRJ and usvkj. The conversion formula is the same in both cases.

6. Integrator control variable of downstream control (%LRSHK) (SY_STETLR := TRUE)

The absolute value of the integrator output value dlahi_w is stored in dlahisa (0.0039/increment).
This conversion is required as dlahi_w is considered a two-byte value. Furthermore, dlahi_w may contain positive and negative values. The limits for dlahisa are DLAHISATO and DLAHISATU. However, according to CARB, only unsigned values are permitted. Therefore a offset of HEX 80 is added to dlahisa.

7. Dynamic value dynlsu for the LSU (SY_STETLR := TRUE)

The dynamic properties of the LSU a characterized by the value dynlus calculated by the section %DLSU. dynlsu_w is converted to the Byte-value dynlsusa. The limits for dynlsusa are DYNLSUTU and DYNLSUTO.

8. Threshold value for downstream sensor (SY_STETLR := TRUE/FALSE)

The threshold value USRHKSHJ and the downstream sensor signal voltage must be converted for the DLSSA output, before it is transferred to the CARB tester, since a negative voltage offset is considered in the BOSCH conversion formula (this offset is not considered in SAE 1979). That means that this offset must be subtracted from the variable ushk, which then results in the values ushkj. In either case the conversion formula is the same. The representative controller threshold USRHKSHJ is directly defined as fixed value and output to the tester.

9. DLSSA output routine:

The following values are outputted via the tester interface:

Sensor upstream catalyst (SY_STETLR := FALSE)

tuspnf: filtered time of the sensor voltage between positive and negative edge
usmxsan: maximum detected sensor voltage value for signal output
usmnsan: minimum detected sensor voltage value for signal output
atvfett: TV shift towards RICH
atvmager: TV shift towards LEAN
tpsvlssa: averaged cycle duration of the sensor signal upstream catalyst
usrj: control threshold from %LR (without offset)
USMNSAMN: minimum detected sensor voltage value for signal output (min. plaus. value)
USMNSAMX: minimum detected sensor voltage value for signal output (max. plaus. value)
USMXSAMN: maximum detected sensor voltage value for signal output (min. plaus. value)
USMXSAMX: minimum detected sensor voltage value for signal output (max. plaus. value)
TUSPNMN: minimum time of the sensor voltage between positive and negative edge

TUSPNMX: maximum time of the sensor voltage between positive and negative edge
ATVFETTO: upper limiting value for atvfett
ATVFETTU: lower limiting value for atvfett
ATVMAGO: upper limiting value for atvmager
ATVMAGU: lower limiting value for atvmager
TPSVKMN: lower limiting value for the cycle duration
TPSVKMX: upper limiting value for the cycle duration

Sensor upstream catalyst (SY_STETLR := TRUE)

dlahisa: Integral part calculated by LRSHK
dynlsusa: Dynamic value calculated by section DLSU
lamsosa: controller threshold used by %LRS
lamsisa: actual lambda used by %LRS
LAMSSAMN: minimum lambda for signal output (min. plausible value)
LAMSSAMX: maximum lambda for signal output (max. plausible value)
DLAHISATO: upper threshold for dlahisa
DLAHISATU: lower threshold for dalhisa
DYNLSUSATO: upper threshold for dynamic value LSU
DYNLSUSATU: lower threshold for dynamic value LSU

Sensor downstream catalyst (SY_STETLR := TRUE/FALSE)

usmxshn: maximum detected sensor voltage value downstream catalyst for signal output
usmnshn: minimum detected sensor voltage value downstream catalyst for signal output
USMNSHMN: minimum detected sensor voltage value for signal output (min. plaus. value)
USMNSHMX: minimum detected sensor voltage value downstream catalyst for signal output (max. plaus. value)
USMXSHMN: maximum detected sensor voltage value downstream catalyst for signal output (min. plaus. value)
USMXSHMX: maximum detected sensor voltage value downstream catalyst for signal output (max. plaus. value)
USRHKSHJ: threshold control from %LRHK

The CARB tester interface needs the information in which test IDs data are given, which are to be outputted. This information is given by the test IDs $00, $20, $40, $60, $80, $A0, $C0 and $E0, which are to be understood as bit strings.

The logic "1" in the bit string means that the corresponding value is outputted, the "0" signalizes that no value is outputted from this test ID.
Test ID $00: output upstream sensor , Nernst-Type, conventional control (SY_STETLR := FALSE)

```
                                      selected by date3/bit 0 (bank 1 /sensor 1)
                                     selected by date3/bit 4 (bank 2 /sensor 1)=====> stereo


                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST ID  |01|02|03|04|05|06|07|08||09|0A|0B|0C|0D|0E|0F|10||11|12|13|14|15|16|17|18||19|1A|1B|1C|1D|1E|1F|20|
  output yes/no  |1 |1 |0 |0 |0 |0 |1 |1 ||1 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |1 |
                 +--------------------------------------------------------------------------------------------------+
                  U  U              U   U  T                                                                      ˆ
                  S  S              S   S  U                                                                      |
                  R  R              M   M  S                        f o l l o w i n g  I D’s  u s e d ------------+
                  J  J              N   X  P
                                    S   S  N
                                    A   A  F
                                    N   N
```

Test ID $20:

```
                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |21|22|23|24|25|26|27|28||29|2A|2B|2C|2D|2E|2F|30||31|32|33|34|35|36|37|38||39|3A|3B|3C|3D|3E|3F|40|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |1 ||1 |1 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
                                                                A   A  T
                                                                T   T  P
                                                                V   V  S
                                                                F   M  V
                                                                E   A  L
                                                                T   G  S
                                                                T   E  S
                                                                    R  A
```

Test ID $40, test ID $60, test ID $80, test ID $A0, test ID $C0 and test ID $E0:

```
                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST ID  |x1|x2|x3|x4|x5|x6|x7|x8||x9|xA|xB|xC|xD|xE|xF|x0||x1|x2|x3|x4|x5|x6|x7|x8||x9|xA|xB|xC|xD|xE|xF|x0|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
```

```
Test ID $00: output upstream sensor , LSU-Type, conventional control (SY_STETLR := TRUE)

                                      selected by date3/bit 0 (bank 1 /sensor 1)
                                     selected by date3/bit 4 (bank 2 /sensor 1)=====> stereo


                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |01|02|03|04|05|06|07|08||09|0A|0B|0C|0D|0E|0F|10||11|12|13|14|15|16|17|18||19|1A|1B|1C|1D|1E|1F|20|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |1 |
                 +--------------------------------------------------------------------------------------------------+
                                                                                                                  ˆ
                                                                                                                  |
                                                                    f o l l o w i n g  I D’s  u s e d ------------+

Test-ID $20:

                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |21|22|23|24|25|26|27|28||29|2A|2B|2C|2D|2E|2F|30||31|32|33|34|35|36|37|38||39|3A|3B|3C|3D|3E|3F|40|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |1 |
                 +--------------------------------------------------------------------------------------------------+
                                                                                                                  ˆ
                                                                                                                  |
                                                                    f o l l o w i n g  I D’s  u s e d ------------+


                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |41|42|43|44|45|46|47|48||49|4A|4B|4C|4D|4E|4F|50||51|52|53|54|55|56|57|58||59|5A|5B|5C|5D|5E|5F|60|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |1 |
                 +--------------------------------------------------------------------------------------------------+
                                                                                                                  ˆ
                                                                                                                  |
                                                                    f o l l o w i n g  I D’s  u s e d ------------+


                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |61|62|63|64|65|66|67|68||69|6A|6B|6C|6D|6E|6F|70||71|72|73|74|75|76|77|78||79|7A|7B|7C|7D|7E|7F|80|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |1 |
                 +--------------------------------------------------------------------------------------------------+
                                                                                                                  ˆ
                                                                                                                  |
                                                                    f o l l o w i n g  I D’s  u s e d ------------+
By user definable test-id’s

                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |81|82|83|84|85|86|87|88||89|8A|8B|8C|8D|8E|8F|90||91|92|93|94|95|96|97|98||99|9A|9B|9C|9D|9E|9F|A0|
  output yes/no  |1 |1 |1 |1 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
                  L  L  D  D                                                                                      ˆ
                  A  A  Y  L                                                                                      |
                  M  M  N  A                                    n o  f o l l o w i n g   I D’s       -------------+
                  S  S  L  H
                  I  O  S  I
                  S  S  U  S
                  A  A  S  A
                  J  J  A  J
                        J

Test-ID $A0, Test-ID $C0 und Test-ID $E0:

                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |x1|x2|x3|x4|x5|x6|x7|x8||x9|xA|xB|xC|xD|xE|xF|x0||x1|x2|x3|x4|x5|x6|x7|x8||x9|xA|xB|xC|xD|xE|xF|x0|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
```

```
Test ID $00: output downstream catalyst (SY_STETLR := TRUE/FALSE):
                                         selected by date3/bit 1 (bank 1 /sensor 2)
                                         selected by date3/bit 5 (bank 2 /sensor 2) =====> stereo


                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST ID  |01|02|03|04|05|06|07|08||09|0A|0B|0C|0D|0E|0F|10||11|12|13|14|15|16|17|18||19|1A|1B|1C|1D|1E|1F|20|
  output yes/no  |1 |1 |0 |0 |0 |0 |1 |1 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
                  U  U              U   U                                                                        ^
                  S  S              S   S                                                                        |
                  R  R              M   M                       n o  f o l l o w i n g   I D's       -------------+
                  H  H              N   X
                  K  K              S   S
                  S  S              H   H
                  H  H              N   N
                  J  J
```

```
Test ID $20:

                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |21|22|23|24|25|26|27|28||29|2A|2B|2C|2D|2E|2F|30||31|32|33|34|35|36|37|38||39|3A|3B|3C|3D|3E|3F|40|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
```

```
Test ID $40, test ID $60, test ID $80, test ID $A0, test ID $C0 and test ID $E0:

                 DATA-A                 DATA-B                      DATA-C                   DATA-D
                 +--------------------------------------------------------------------------------------------------+
        TEST-ID  |x1|x2|x3|x4|x5|x6|x7|x8||x9|xA|xB|xC|xD|xE|xF|x0||x1|x2|x3|x4|x5|x6|x7|x8||x9|xA|xB|xC|xD|xE|xF|x0|
  output yes/no  |0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 ||0 |0 |0 |0 |0 |0 |0 |0 |
                 +--------------------------------------------------------------------------------------------------+
```

APP DLSSA 14.80 Application hint

FW name	typical value
ATVFETTO	1.2 s
ATVFETTU	0 s
ATVMAGO	1.2 s
ATVMAGU	0 s
SAFK1	0.1
SAFK2	0.1
TPSVKMN	0.3 s
TPSVKMX	3 s
TUSPNMN	0.15 s
TUSPNMX	1.5 s
TWDLSSA	10 s
USMNSAMN	0.005 V
USMNSAMX	0.4 V
USMXSAMN	0.5 V
USMXSAMX	1.05V
USMNSHMN	0.005 V
USMNSHMX	0.4V
USMXSHMN	0.5 V
USMXSHMX	1.05 V

FW name	typical value
DLAHISATO	0.05
DLAHISATU	-0.05
DYNLSUTU	0.3
DDYNLSTO	4,0
SAFK2	0.1
TWDLSSA	10 s
LAMSSAMN	0.7
LAMSSAMX	2.0

Assignment DLSSA parameter - tester interface

Nernst- sensor upstream catalyst

Test ID	test value	min. Limit	max. Limit
$01	usrj	-	-
$02	usrj	-	-
$07	usmnsan	USMNSAMN	USMNSAMX
	usmnshn	USMNSHMN	USMNSHMX
$08	usmxsan	USMXSAMN	USMXSAMX
	usmxshn	USMXSHMN	USMXSHMX
$09	tuspnf	TUSPNMN	TUSPNMX
$30	atvfett	ATVFETTU	ATVFETTO
$31	atvmager	ATVMAGU	ATVMAGO
$32	tpsvlssa	TPSVKMN	TPSVKMX

LSU- sensor upstream catalyst

$81	lamsisa	LAMSSAMN	LAMSSAMX
$82	lamsosa	LAMSSAMN	LAMSSAMX
$83	dynlsusa	DYNLSUSATU	DDYNLSUSATO
$84	dlahisa	DLAHISATU	DLAHISATO

Nernst- sensor downstream catalyst

Test ID	test value	min. Limit	max. Limit
$01	usrhkshj	-	-
$02	usrhkshj	-	-
$07	usmnshn	USMNSHMN	USMNSHMX
$08	usmxshn	USMXSHMN	USMXSHMX

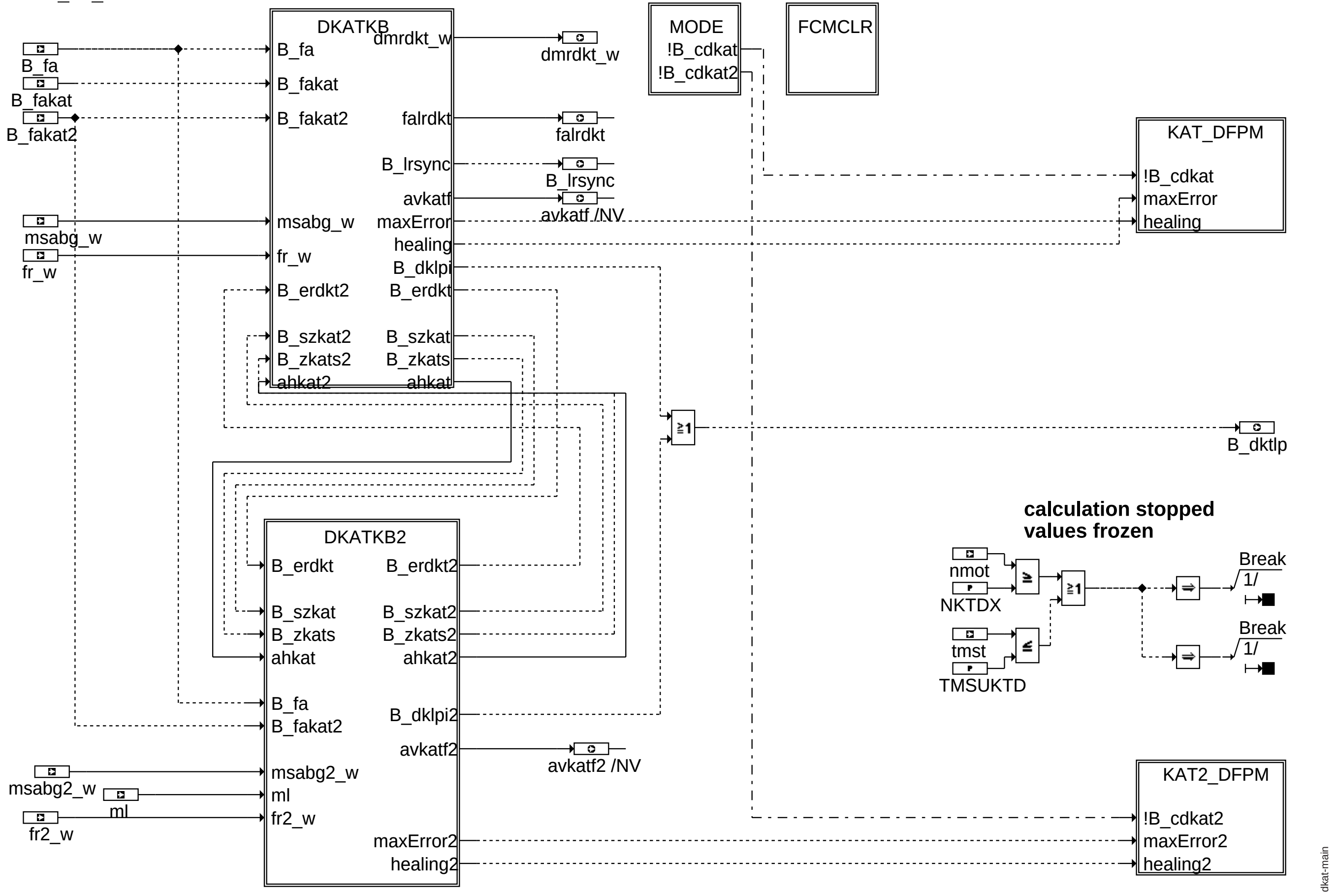
The test IDs $00, $20, $40, $60, $80, $A0, $C0 and $E0 are used for the output management.

DKAT 58.140 Diagnosis; catalyst conversion

FDEF DKAT 58.140 Function definition

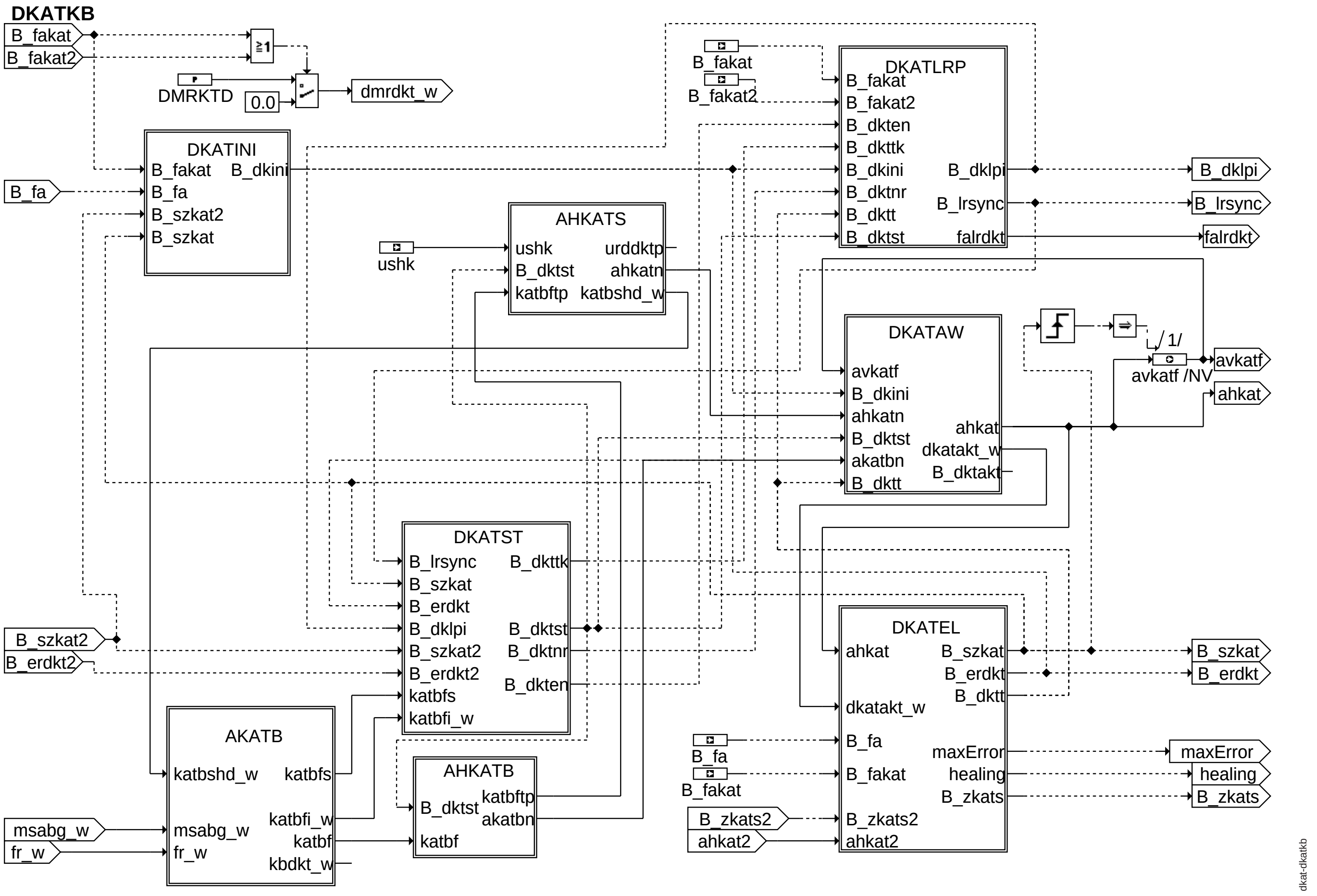
`DKAT : Katalysatorüberwachungsfunktion Bank 1 und 2`

DKAT_58_140



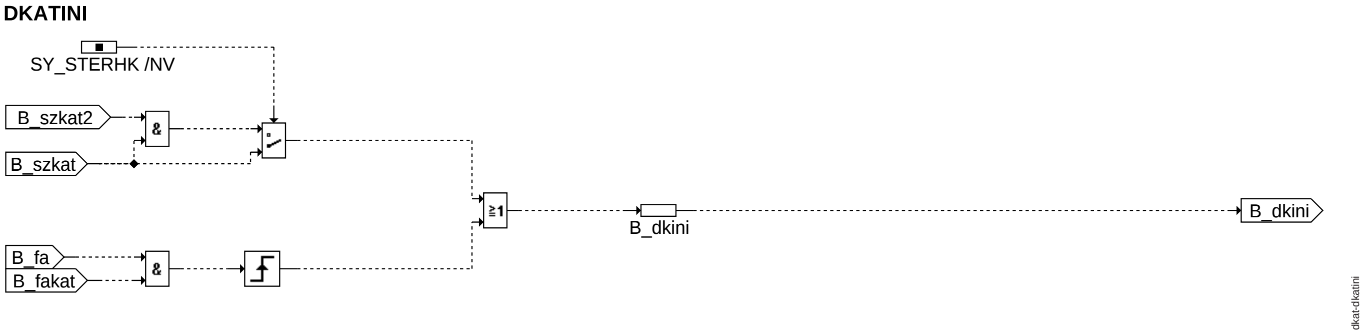
dkat-main

DKATKB : Katalysatorüberwachungsfunktion Bank 1



dkat-dkatkb

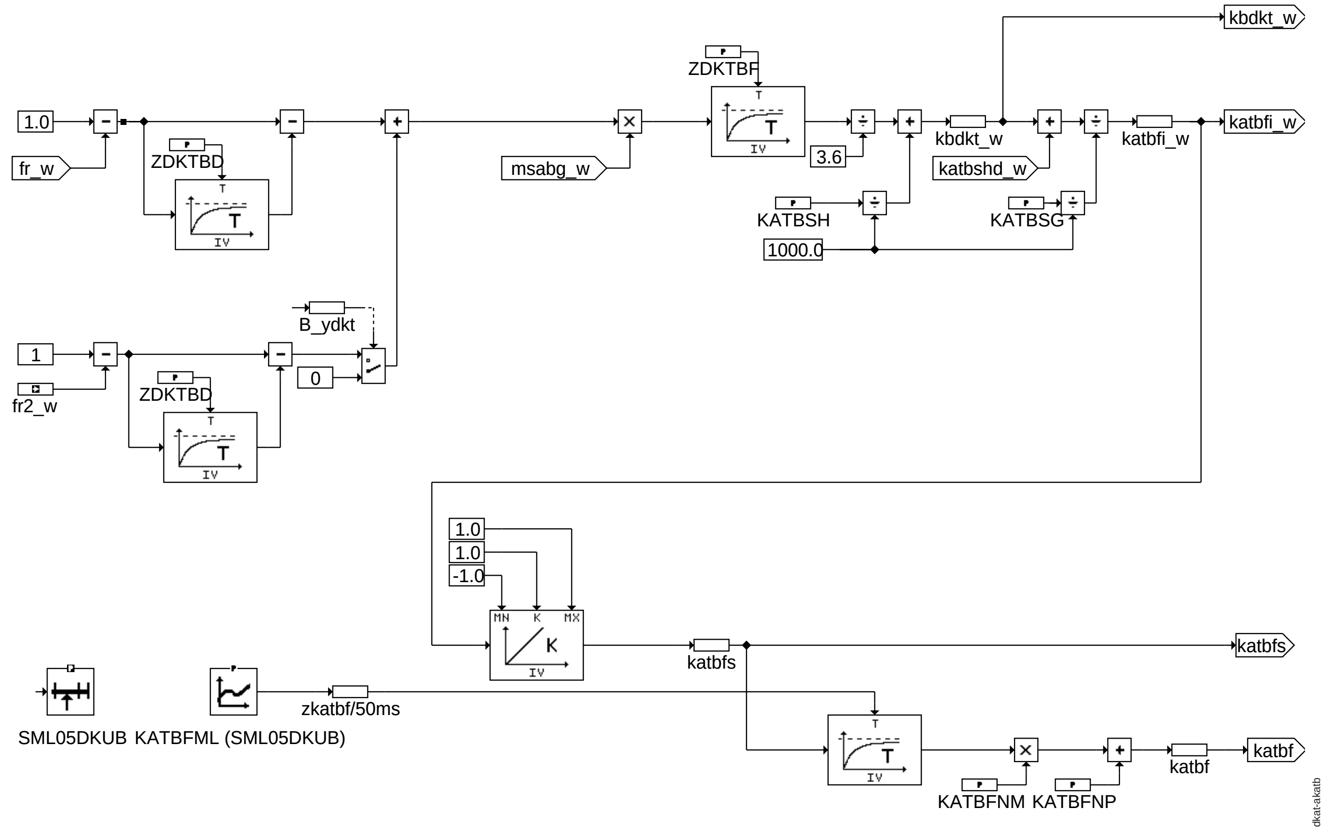
DKATINI : Initialisierung Bank 1



dkat-dkatini

`AKATB : Aufbereitung des Katbelastungssignales Bank 1`

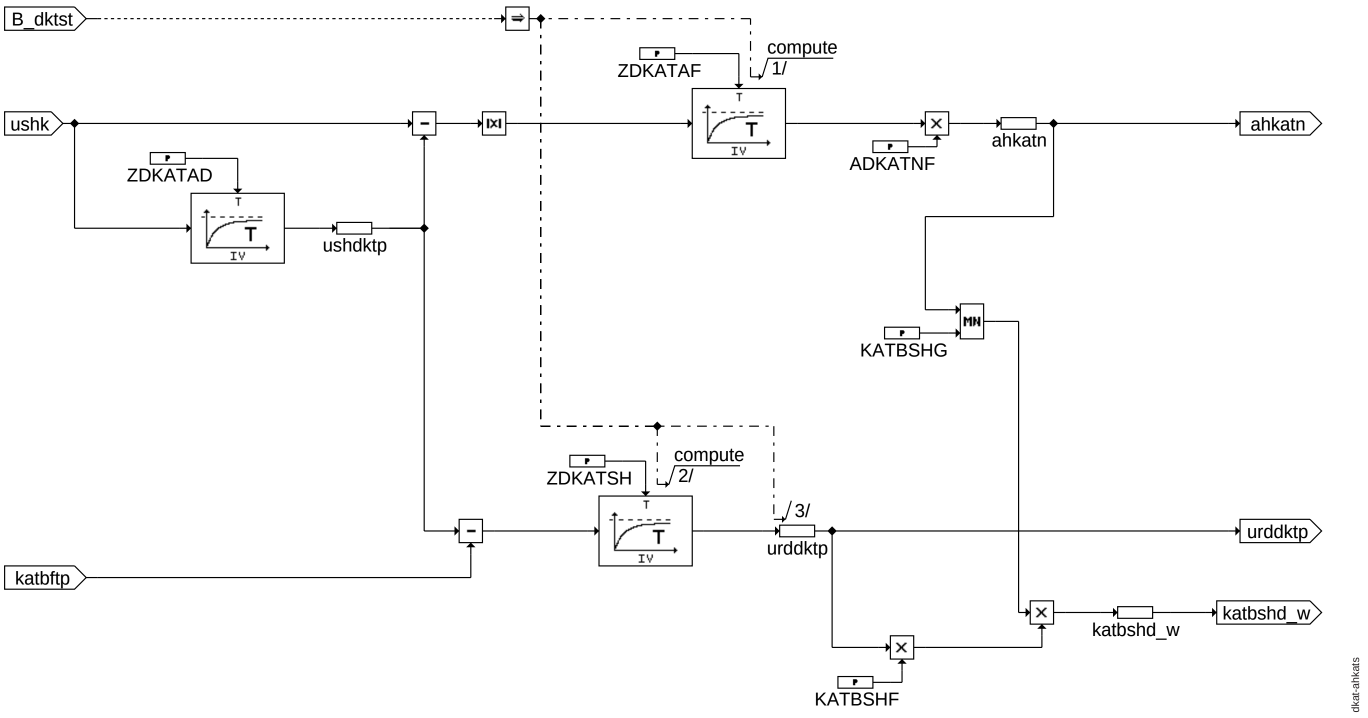
AKATB



dkat-akatb

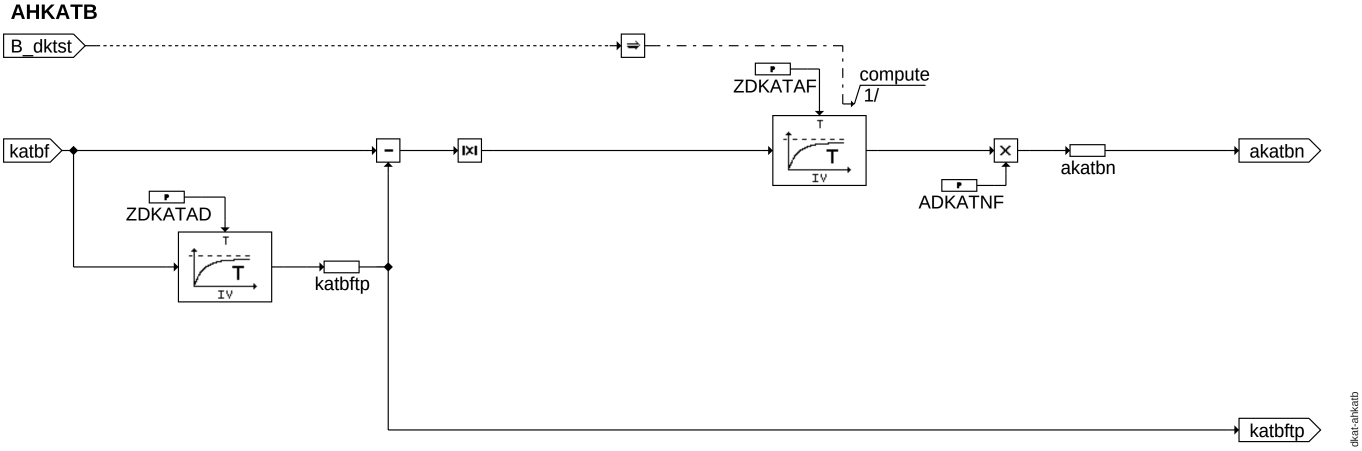
`AHKATS : Amplitudenaufbereitung in Abhängigkeit von der Sondenspannung Bank 1`

AHKATS



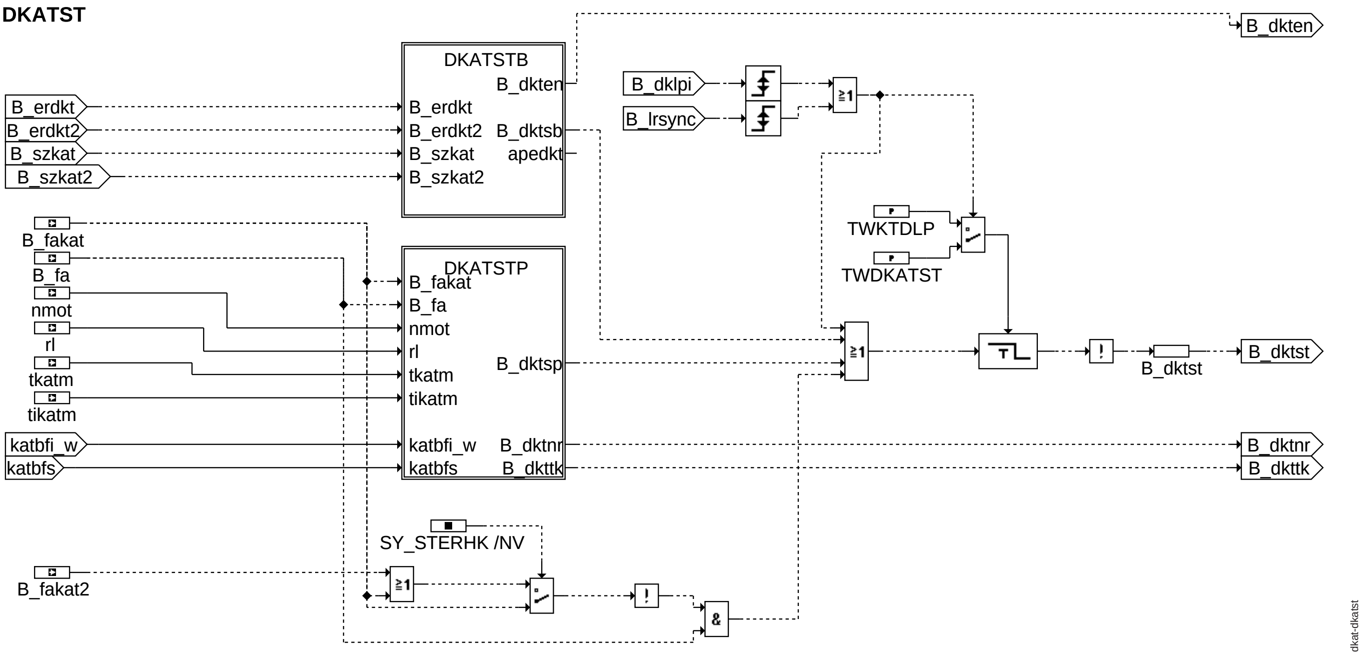
dkat-ahkats

`AHKATB : Amplitudenaufbereitung in Abhängigkeit vom Katbelastungssignal Bank 1`



dkat-ahkatb

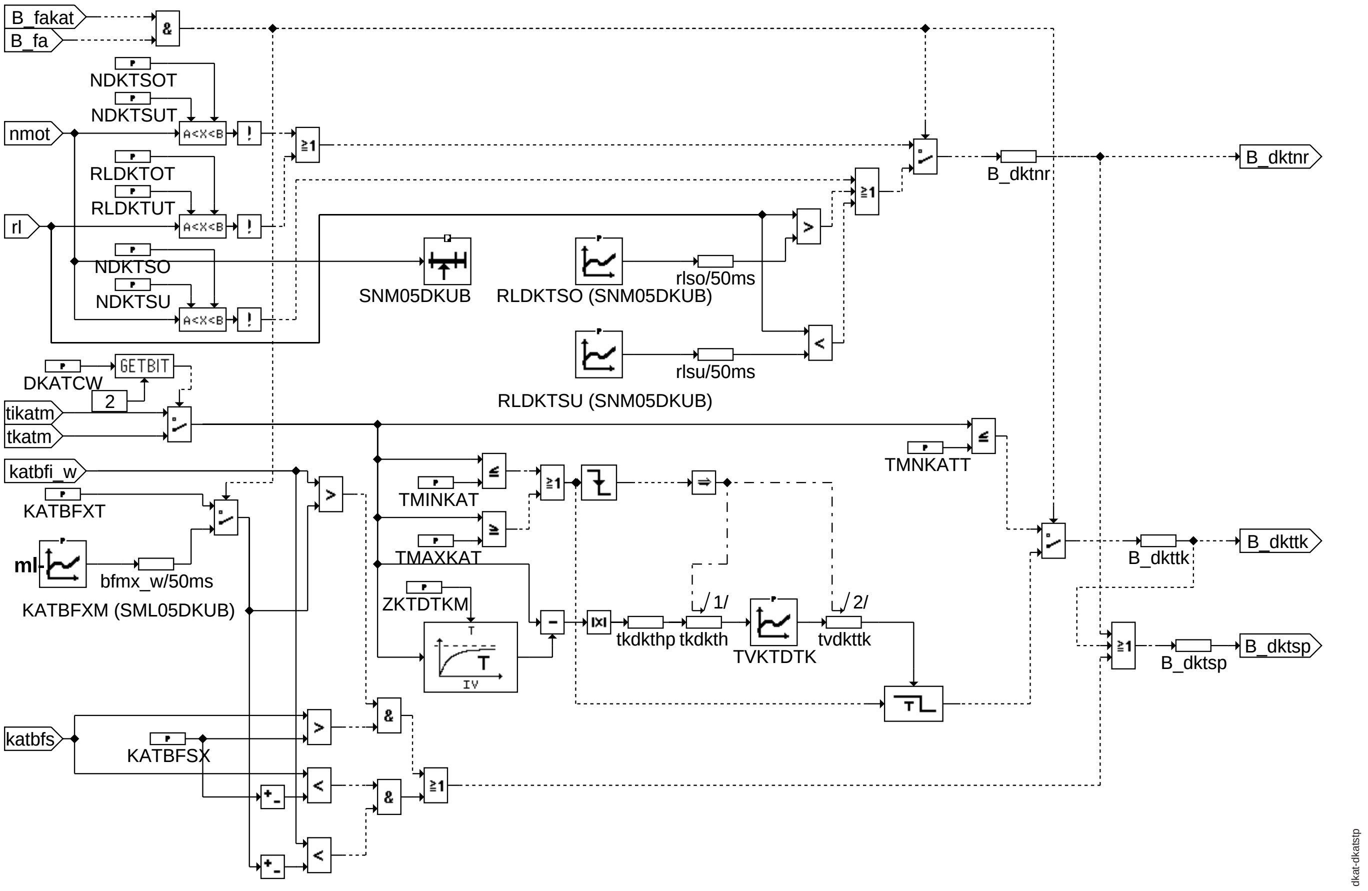
`DKATST : Aufbereitung der Stoppbedingung Bank 1`



dkat-dkatst

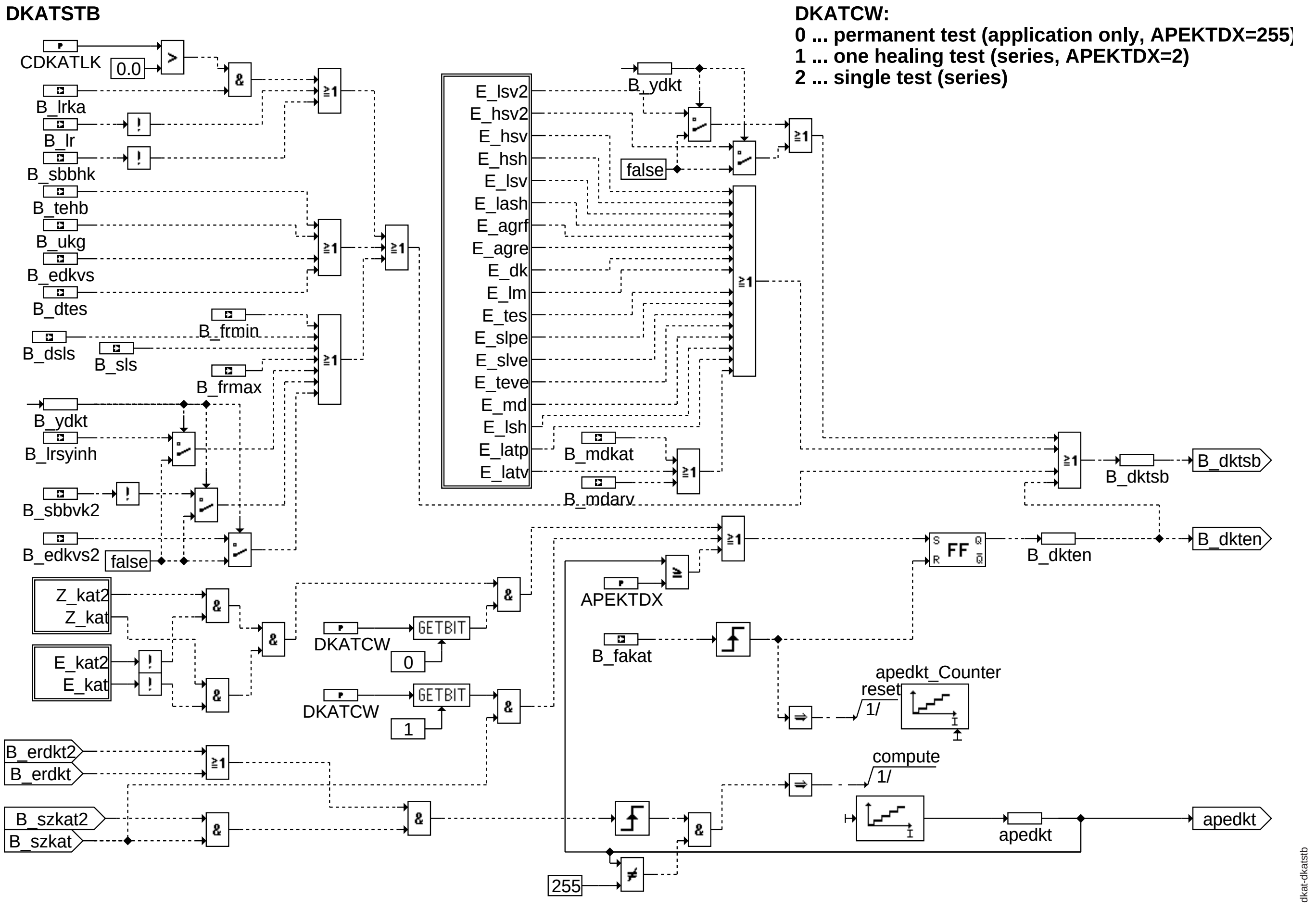
`DKATSTP : Physikalische Stoppkriterien Bank 1`

DKATSTP



dkat-dkatstp

DKATSTB : Bankspezifische Stoppkriterien Bank 1

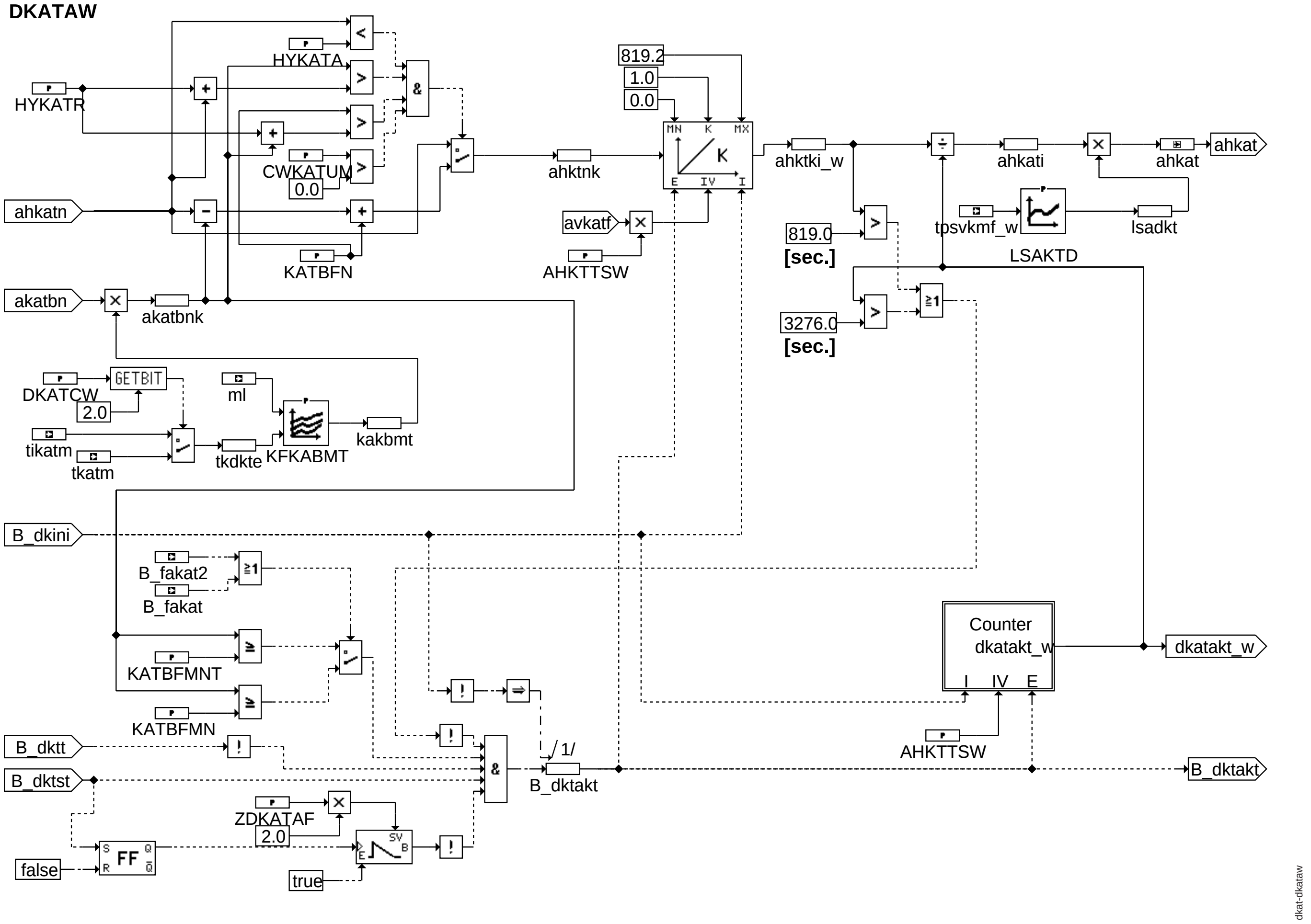


DKATCW:
0 ... permanent test (application only, APEKTDX=255)
1 ... one healing test (series, APEKTDX=2)
2 ... single test (series)

dkat-dkatstb

`DKATAW : Signalauswertung Bank 1`

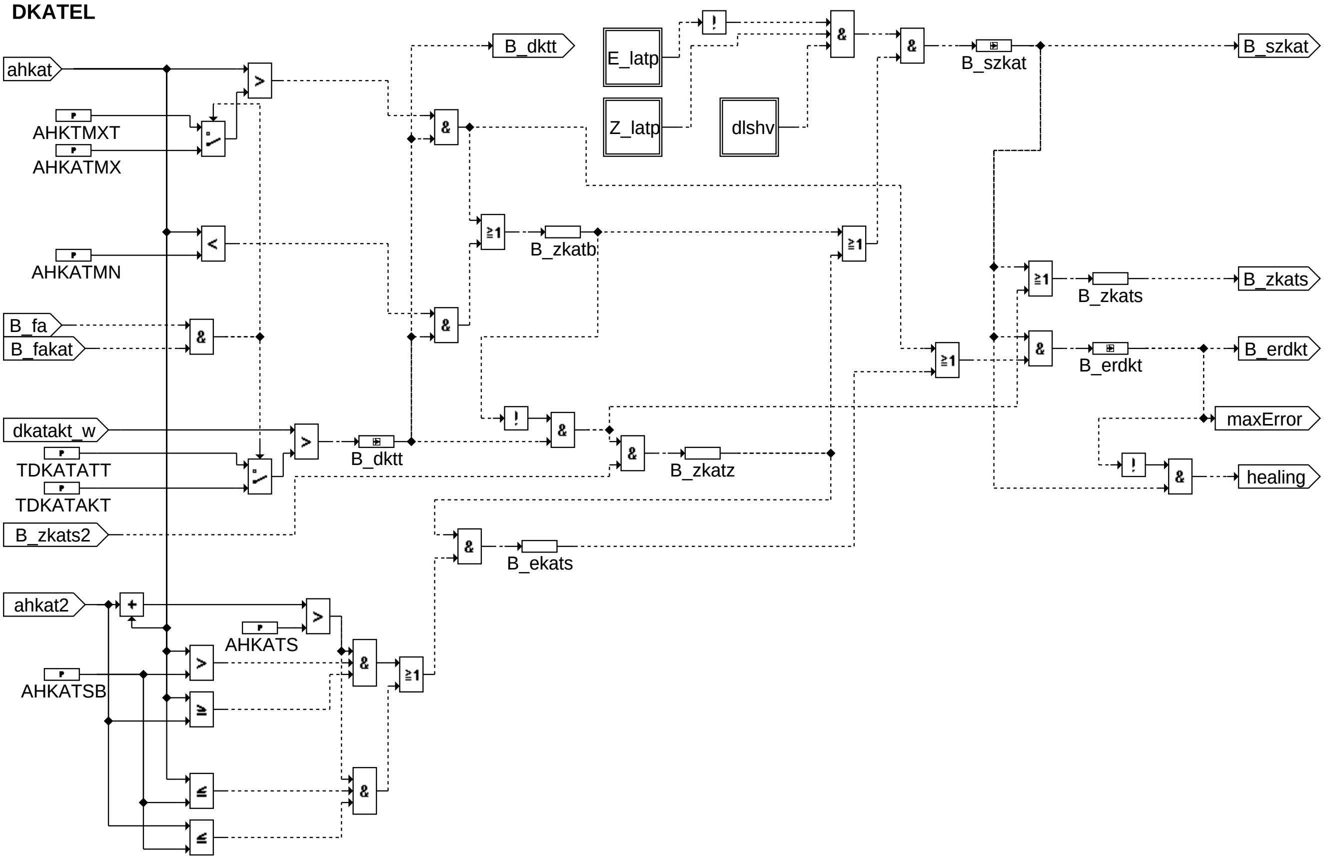
DKATAW



dkat-dkataw

`DKATEL : Setzen der Error- und Zyklusflags Bank 1`

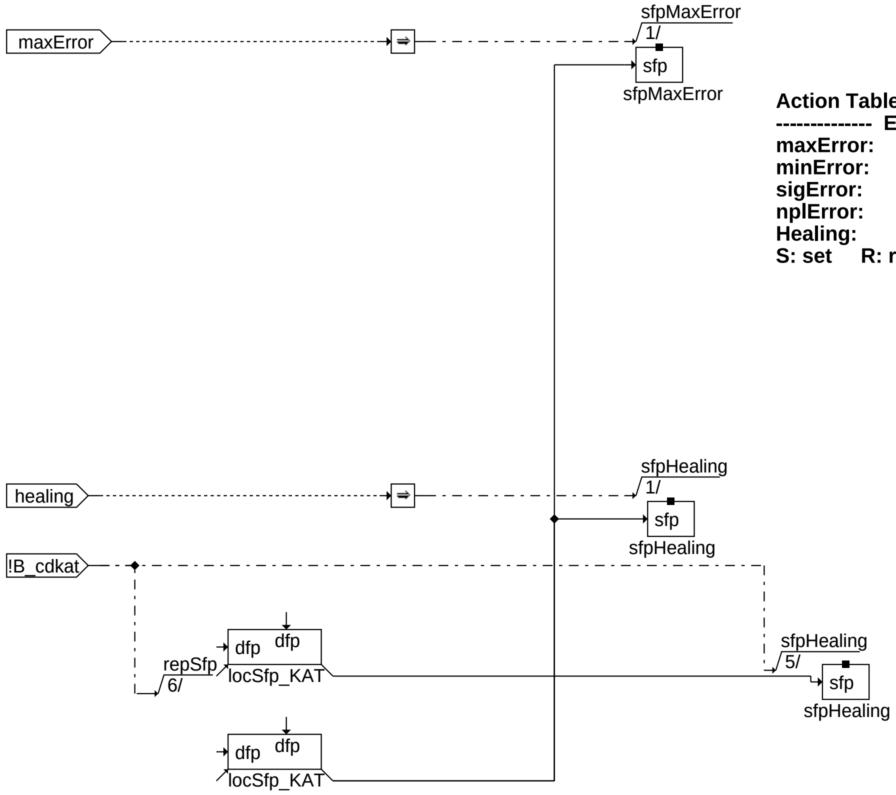
DKATEL



**Origin of B_cdkat: see %Prokon
(CDKAT = 0: B_cdkat := False
CDKAT = 1: B_cdkat := True)**

dkat-dkatel

dkat-dkatel

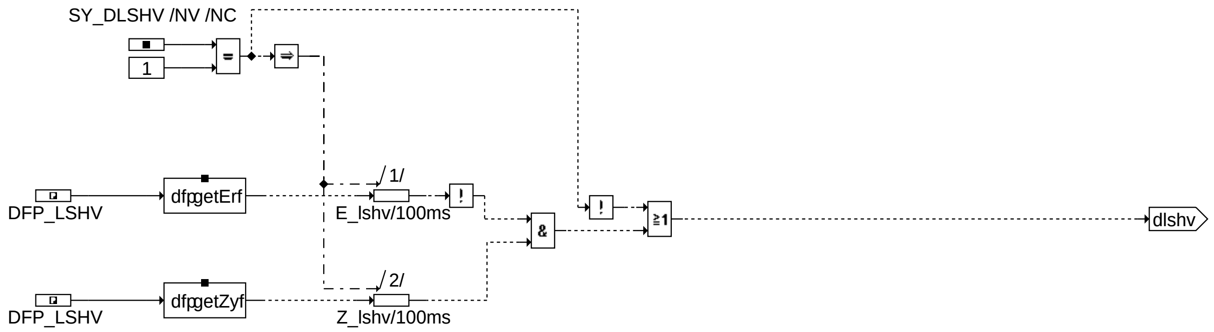


Action Table for fault path * in DFPM:

--------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	**S**	**S**	**S**	**R**	**R**	**R**
minError:	**S**	**S**	**R**	**S**	**R**	**R**
sigError:	**S**	**S**	**R**	**R**	**S**	**R**
nplError:	**S**	**S**	**R**	**R**	**R**	**S**
Healing:	**R**	**S**	**R**	**R**	**R**	**R**

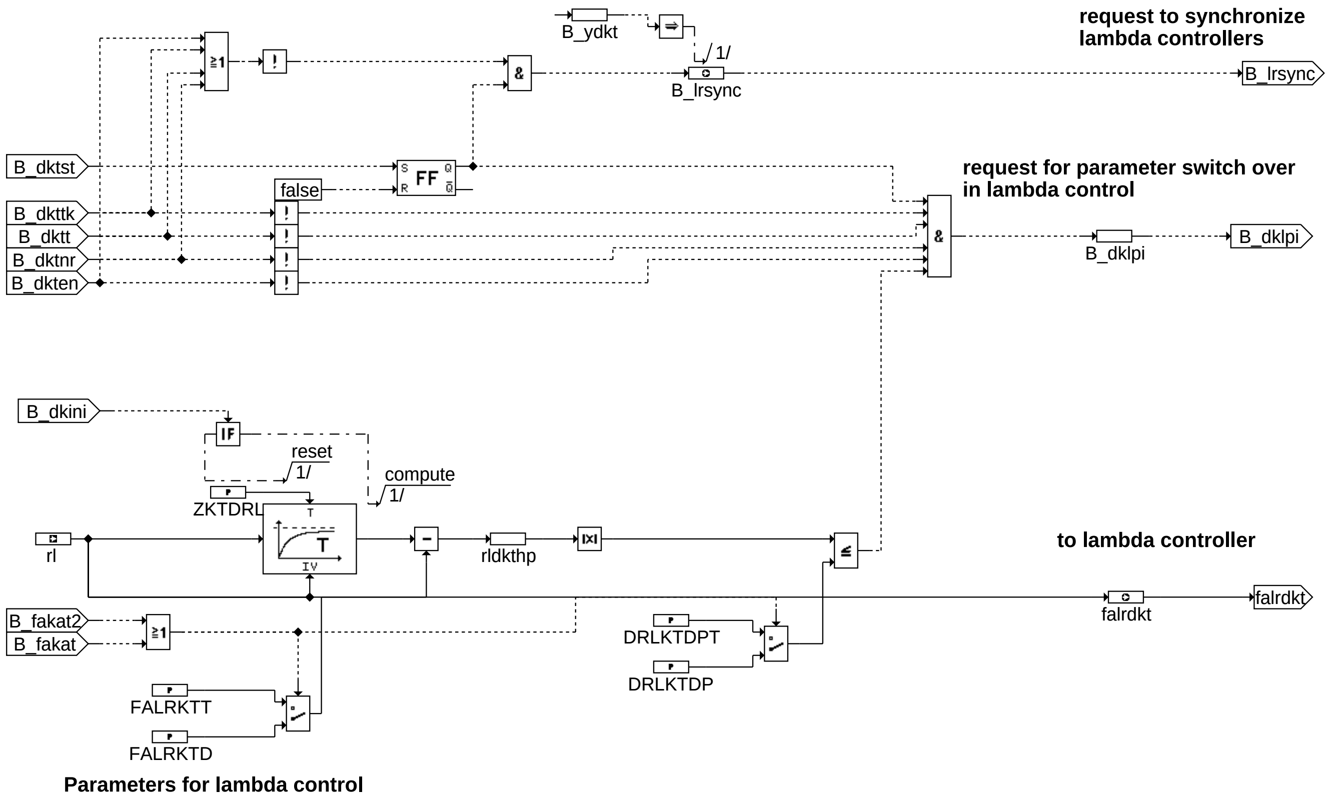
S: set R: reset

dkat-kat-dfpm



dkat-dlshv

DKATLRP



dkat-dkatlrp

`DKATLRP: Parmeter zur Umschaltung der Lambdaregelungsamplitude`

ABK DKAT 58.140 Abbreviations

```
The following values are "describing values" i.e. they are no RAM cells.

B_avktc(2)... condition initialize avkatf(2)
B_erdkt ... catalyst diagnosis error detected (bank1)
B_erdkt2... catalyst diagnosis error detected (bank2)
```

Parameter	Source-X	Source-Y	Type	Description
ADKATNF			FW	scaling factor for signal amplitude of the sensor resp. of the catalyst stress
AHKATMN			FW	threshold value catalyst good, AHKAT $<$ AHKATMN
AHKATMX			FW	threshold value catalyst defect, AHKAT $>$ AHKATMX
AHKATS			FW	threshold value for sum AHKAT,AHKAT2 (stereo)
AHKATSB			FW	threshold value for error of adding range (stereo)
AHKTMXT			FW	threshold value catalyst defect at tester's request
AHKTTSW			FW	setting value for timer in signal evaluation
APEKTDX			FW	max. number of tests with error result
AVKATFS			FW	setting value for AVKATF in case of powerfail
CDCKAT	BLOKNR		KL	code word CARB: catalyst conversion
CDCKAT2	BLOKNR		KL	code word CARB: catalyst conversion, cyl.row 2
CDKATLK			FW	code word for B_lrka active
CDKKAT			FW	code word customer: catalyst conversion
CDKKAT2			FW	Code word customer: Catalyst conversion (Bank 2)
CDTKAT			FW	code word tester: catalyst deteriorated [040]
CDTKAT2			FW	code word tester: catalyst conversion, cyl.row 2 [045]
CLAKAT			FW	Error class: catalyst
CLAKAT2			FW	Error class: catalyst bank 2
CWKATUM			FW	code word for switch-over in the catalyst diagnosis
DKATCW			FW	single run resp. initialization of the DKAT function
DMRKTD			FW	torque reserve for catalyst monitoring
DRLKTDP			FW	Threshold for engine load change
DRLKTDPT			FW	Threshold for engine load change at tester's request
FALRKTD			FW	amplification factor for amplitude of lambda controller
FALRKTT			FW	amplification factor for amplitude of lambda controller at tester mode
HYKATA			FW	Absolute hysteresis, cat. monitoring
HYKATR			FW	Reative hysteresis, cat. monitoring
KATBFML	ML		KL	filter time constant for signal attenuation in catalyst stress
KATBFML2	ML		KL	filter-time constant for signal attenuation in catalyst stress (assymmetrical)
KATBFMN			FW	threshold value for small catalyst stress
KATBFMNT			FW	threshold value for small catalyst stress at tester's request
KATBFN			FW	standardized mean value of the sensor amplitude

Parameter	Source-X	Source-Y	Type	Description
KATBFNM			FW	scaling factor multiplicative for catalyst stress
KATBFNP			FW	scaling factor additive for catalyst stress
KATBFSX			FW	maximum integrator value for stop condition
KATBFXM	ML		KL	max. catalyst load threshold for stop condition
KATBFXT			FW	max. catalyst load threshold for stop condition, tester mode
KATBSG			FW	catalyst storage value for catalyst stress
KATBSH			FW	offset for lambda control slightly in the rich area
KATBSHF			FW	amplification factor for difference of mean values of the O2/S
KATBSHG			FW	limitation factor of model lambda-offset due to sensor mean values
KFKABMT	ML	TKDKTE2	KF	Map for correction of calculated amplitude, dependent on ml and cat. temperature
LSAKTD	TPSVKMF2_W		KL	Impact of slow front sensor on cat. monitoring
NDKTSO			FW	upper engine speed limit for DKAT-active
NDKTSOT			FW	upper engine speed limit for function request
NDKTSU			FW	lower engine speed limit for DKAT-active
NDKTSUT			FW	lower engine speed limit for function request
NKTDX			FW	Maximum speed for DKAT calculation
RLDKTOT			FW	upper load limit for function request
RLDKTSO	NMOT		KL	upper load characteristic line for DKAT-active
RLDKTSU	NMOT		KL	lower load characteristic line for DKAT-active
RLDKTUT			FW	lower load limit for function request
SML05DKUB	ML		SV (REF)	base point distribution air mass
SNM05DKUB	NMOT		SV (REF)	base point distribution nmot
SY_DLSHV			SYS (REF)	Sys. constant condition %DLSHV (sensor exchange behind KAT) existent
SY_SLS			SYS (REF)	system constant for engines with secondary air pump
SY_STERHK			SYS (REF)	system parameter condition stereo downstream catalyst
SY_STERSY			SYS (REF)	System constant Condition stereo Lambda control symmetrical
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TDKATAKT			FW	threshold value cycle finished if active monitoring time > TDKATAKT
TDKATATT			FW	threshold value cycle finished for function request
TMAXKAT			FW	maximum catalyst temp. for active diagnosis
TMINKAT			FW	minimum catalyst temperature for monitoring
TMNKATT			FW	minimum catalyst temperature for monitoring during tester mode
TMSUKTD			FW	minimum engine start temp. for monitoring
TSFKAT			FW	fault active time: catalyst conversion rate
TSFKAT2			FW	fault active time: catalyst conversion rate, bank 2
TVKTDTK	TKDKTH2		KL	temperature dependant delay time for catalyst monitoring
TWDKATST			FW	waiting time after stop condition for filter and integrator
TWKTDLP			FW	delay time after parameter switch over in lambda control
ZDKATAD			FW	filter time constant of the differentiator for signal amplitude
ZDKATAF			FW	time constant ”absolute value filter” for signal amplitude
ZDKATSH			FW	time constant low pass filter, mean sensor values
ZDKTBD			FW	time constant of the differentiator for RF-alternating component
ZDKTBF			FW	time constant for gas mixing procedure in front of catalyst
ZKTDRL			FW	time constant low pass filter, engine load
ZKTDTKM			FW	loss pass filter time constant for tkatm filtering

Variable	Source	Type	Description
AHKAT	DKAT	LOK	mean value of the amplitude sensor signal behind catalyst corrected by KB
AHKAT2	DKAT	LOK	mean value of the amplitude sensor signal behind catalyst corr. by KB (2.bank)
AHKATI	DKAT	LOK	mean value of the amplitude sensor signal behind catalyst corrected by KB,intern
AHKATI2	DKAT	LOK	mean value of the amplitude sensor signal behind catalyst corrected by KB,intern
AHKATN	DKAT	LOK	amplitude sensor signal behind catalyst standardized
AHKATN2	DKAT	LOK	amplitude sensor signal behind catalyst standardized
AHKTKI2_W	DKAT	LOK	amplitude sensor signal behind catalyst corrected and integrated
AHKTKI_W	DKAT	LOK	amplitude sensor signal behind catalyst corrected and integrated
AHKTNK	DKAT	LOK	corrected sensor signal amplitude standardized
AHKTNK2	DKAT	LOK	corrected sensor signal amplitude standardized (sterio 2.bank)
AKATBN	DKAT	LOK	amplitude of the catalyst stress signal
AKATBN2	DKAT	LOK	amplitude of the catalyst stress signal (stereo 2.bank)
AKATBNK	DKAT	LOK	corrected amplitude of the catalyst stress signal
AKATBNK2	DKAT	LOK	corrected amplitude of the catalyst stress signal, bank2
APEDKT	DKAT	LOK	number of tests with error-result
APEDKT2	DKAT	LOK	number of tests with error-result (bank2)
AVKATF	DKAT	AUS	amplitude ratio laafh/laafv strained
AVKATF2	DKAT	AUS	amplitude ratio laafh/laafv strained bank2
BLOKNR		EIN	DAMOS source for block number
B_BEKAT	DKAT	AUS	condition cat monitoring request
B_BEKAT2	DKAT	AUS	condition cat monitoring request, bank2
B_BKKAT	DKAT	AUS	Condition backup value for catalyst
B_BKKAT2	DKAT	AUS	Condition backup value for catalyst, bank2
B_CDKAT	PROKON	EIN	function active per codeword CDKAT
B_CLKAT		EIN	condition clear fault path DKAT
B_CLKAT2		EIN	condition clear failure path DKAT (stereo)
B_DKINI	DKAT	LOK	condition for initialize DKAT function
B_DKINI2	DKAT	LOK	condition for initialize DKAT function (stereo 2.bank)
B_DKLPI	DKAT	LOK	internal request of param. switch over in lambda control
B_DKLPI2	DKAT	LOK	internal request of param. switch over in lambda control, bank2
B_DKTAKT	DKAT	LOK	catalyst monitoring active
B_DKTAKT2	DKAT	LOK	catalyst monitoring active (bank2)
B_DKTEN	DKAT	LOK	DKAT no longer active for this trip
B_DKTEN2	DKAT	LOK	DKAT no longer active for this trip (bank2)

Variable	Source	Type	Description
B_DKTLP	DKAT	AUS	Request of parameter switch over in lambda control
B_DKTNR	DKAT	LOK	speed-/load range left
B_DKTNR2	DKAT	LOK	speed-/load range left, bank2
B_DKTPB2	DKAT	LOK	DKAT: testing finished, bank2
B_DKTSB	DKAT	LOK	bank-specific stop condition
B_DKTSB2	DKAT	LOK	bank-specific stop condition (stereo 2.bank)
B_DKTSP	DKAT	LOK	physical stop condition
B_DKTSP2	DKAT	LOK	physical stop condition (stereo 2.bank)
B_DKTST	DKAT	LOK	DKAT function is stopped (B_dktst=FALSE)
B_DKTST2	DKAT	LOK	DKAT function is stopped (B_dktst=FALSE, stereo 2.bank)
B_DKTT	DKAT	LOK	DKAT active time over
B_DKTT2	DKAT	LOK	DKAT active time over, bank2
B_DKTTK	DKAT	LOK	Catalyst monitoring stopped due to catalyst temperature
B_DKTTK2	DKAT	LOK	Catalyst monitoring stopped due to catalyst temperature
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_EKATS	DKAT	LOK	added-up error for MODE 6
B_EKATS2	DKAT	LOK	added-up error for MODE 6 (stereo 2.bank)
B_ERDKT	DKAT	LOK	Internal faul at catalyst diagnosis
B_ERDKT2	DKAT	LOK	Internal faul at catalyst diagnosis (bank2)
B_FA		EIN	condition general function request
B_FAKAT		EIN	condition function request catalyst monitoring
B_FAKAT2		EIN	condition funktion request catalyst monitoring (stereo 2.Bank)
B_FRMAX	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMAX
B_FRMAX2	LR	EIN	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_FRMIN	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMIN
B_FRMIN2	LR	EIN	lambda control sets bit when lambda control reaches its limit FRMIN,bank2
B_FTKAT	DKAT	AUS	Condition fault entry by tester for catalyst
B_FTKAT2	DKAT	AUS	Condition fault entry by tester for catalyst, bank2
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRKA	LRKA	EIN	condition for neutralization of catalyst oxygen storage
B_LRKA2	LRKA	EIN	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRSYINH	LR	EIN	Condition fr_b1-/fr_b2-synchronization due to min/max limiter disabled
B_LRSYNC	DKAT	AUS	Condition fr_b1-/fr_b2-synchronization requested
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MDKAT	DMDMIL	EIN	cat. damaging misfire rate exceeded (for deactivation of other functions)
B_MNKAT	DKAT	AUS	condition: min-error catalyst detected
B_MNKAT2	DKAT	AUS	Fault type min.: Catalysator 2
B_MXKAT	DKAT	AUS	condition upper plausibility threshold exceeded
B_MXKAT2	DKAT	AUS	condition upper plausibility threshold exceeded (stereo)
B_NPKAT	DKAT	AUS	condition for fault type ”unplausible signal” detected (Catalyst)
B_NPKAT2	DKAT	AUS	condition for fault type ”unplausible signal” detected (Catalyst)2
B_PWF		EIN	Condition for powerfail
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_SIKAT	DKAT	AUS	fault type ’signal missing’ for DKAT detected
B_SIKAT2	DKAT	AUS	fault type ’signal missing’ for DKAT 2 detected
B_SLS	AK	EIN	Condition for active secondary air
B_SZKAT	DKAT	LOK	cycle time and error one bank run out
B_SZKAT2	DKAT	LOK	cycle time and error bank2 run out
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
B_UKG	ESUK	EIN	condition transient control activated
B_VEKAT	DKAT	AUS	error suspected in catalytic-converter diagnosis
B_VEKAT2	DKAT	AUS	error suspected in catalytic-converter diagnosis, bank 2
B_YDKT	DKAT	LOK	Exhaust system with Y configuration (two pre cats, one main cat)
B_ZKATB	DKAT	LOK	bank-specific cycle time for MODE 6
B_ZKATB2	DKAT	LOK	bank-specific cycle time for MODE 6 (stereo 2.bank)
B_ZKATS	DKAT	LOK	cycle time for one bank run out
B_ZKATS2	DKAT	LOK	cycle time for 2. bank run out
B_ZKATZ	DKAT	LOK	condition for added-up error in MODE 6
B_ZKATZ2	DKAT	LOK	condition for added-up error in MODE 6 (stereo 2.bank)
DFP_AGRE	DKAT	DOK	ECU int. fault path no.: EKR power stage
DFP_AGRF	DKAT	DOK	ECU int. fault path no.: partial pressure EGR
DFP_DK	DKAT	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_HSH	DKAT	DOK	ECU int. fault path no.: lambda sensor heating downstream cat.
DFP_HSH2	DKAT	DOK	ECU int. fault path no.: lambda sensor heating downstream cat. bank2
DFP_HSV	DKAT	DOK	ECU int. fault path no.: lambda sensor heating upstream cat.
DFP_HSV2	DKAT	DOK	ECU int. fault path no.: lambda sensor heating upstream cat., bank2
DFP_KAT	DKAT	DOK	internal fault path number: catalyst monitoring
DFP_KAT2	DKAT	DOK	internal failure path number: catalyst monitoring, bank2
DFP_LASH	DKAT	DOK	ECU int. fault path no.: lambda sensor aging downstream Cat.
DFP_LASH2	DKAT	DOK	ECU int. fault path no.: lambda sensor aging downstream Cat. bank 2
DFP_LATP	DKAT	DOK	ECU int. fault path no.: diagnosis lambda sensor upstream cat
DFP_LATP2	DKAT	DOK	ECU int. fault path no.: diagnosis lambda sensor upstram cat bank2
DFP_LATV	DKAT	DOK	ECU int. fault path no.: diagnosis lambda sensor upstream cat
DFP_LATV2	DKAT	DOK	ECU int. fault path no.: diagnosis lambda sensor upstream cat bank2
DFP_LM	DKAT	DOK	ECU-internal fault path no.: main-load sensor
DFP_LSH	DKAT	DOK	ECU int. fault path no.: lambda sensor downstream cat.

Variable	Source	Type	Description
DFP_LSH2	DKAT	DOK	ECU int. fault path no.: lambda sensor downstream cat. bank2
DFP_LSHV	DKAT	DOK	ECU int. fault path no.: lambda sensor exchange downstream Cat.
DFP_LSV	DKAT	DOK	ECU int. fault path no.: electrical diagnosis for lambda sensor upstream cat.
DFP_LSV2	DKAT	DOK	ECU int. fault path no.: electr. diagnos. for lambda sensor upstream cat. bank 2
DFP_MD	DKAT	DOK	ECU int. fault path no. misfire, multiple
DFP_SLPE	DKAT	DOK	Internal fault path number: secondary air pump power stage
DFP_SLVE	DKAT	DOK	Internal fault path number: secondary air valve power stage
DFP_TES	DKAT	DOK	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE	DKAT	DOK	Internal fault path number: canister purge valve power stage
DKATAKT2_W	DKAT	LOK	active monitoring time for DKAT (stereo 2.bank)
DKATAKT_W	DKAT	LOK	active monitoring time for DKAT
DMRDKT_W	DKAT	AUS	torque reserve for catalyst monitoring
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_HSH	DHLSHK	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLSHK	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLSVK	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLSVK	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	AUS	error flag: catalyst conversion
E_KAT2	DKAT	AUS	error flag: catalyst conversion (cylinder row 2)
E_LASH	DLSAHK	EIN	error flag: lambda sensor aging downstream cat
E_LASH2	DLSAHK	EIN	error flag: lambda sensor aging downstream cat (cylinder row 2)
E_LATP	DLSA	EIN	error flag: lambda sensor aging tp
E_LATP2	DLSA	EIN	error flag: lambda sensor aging tp (cylinder row 2)
E_LATV	DLSA	EIN	error flag: lambda sensor aging tv
E_LATV2	DLSA	EIN	error flag: lambda sensor aging tv (cylinder row 2)
E_LM	EGFE	EIN	Error flag: main load sensor
E_LSH	DLSH	EIN	error flag: lambda sensor downstream cat
E_LSH2	DLSH	EIN	Errorflag: Lambda-Sensor downstream bank2
E_LSHV		EIN	error flag: lambda sensor exchange downstream cat
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_MD	DMDMIL	EIN	Error flag: misfire, multiple
E_SLPE		EIN	error flag: secondary air pump (power stage)
E_SLVE		EIN	error flag: secondary air valve (power stage)
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
FALRDKT	DKAT	AUS	Request form cat monitoring: modify lambda controller amplitude
FR2_W	LR	EIN	Lambda controller output (word)
FR_W	LR	EIN	Lambda controller output (word)
KAKBMT	DKAT	LOK	Correction value for the modelled amplitude of the rear sensor
KAKBMT2	DKAT	LOK	Correction value for the modelled amplitude of the rear sensor, bank2
KATBF	DKAT	LOK	signal after memory standardized comparable to ushk
KATBF2	DKAT	LOK	signal donstream of accumulator, standardized, comp. with ushk2 (stereo, bank 2)
KATBFI2_W	DKAT	LOK	amount of oxygen upstream of accumulator (catalyzer model, stereo, bank 2)
KATBFI_W	DKAT	LOK	amount of oxygen upstream of accumulator (catalyzer model)
KATBFS	DKAT	LOK	signal downstream of accumulator (catalyzer model)
KATBFS2	DKAT	LOK	signal downstream of accumulator (catalyzer model, stereo, bank 2)
KATBFTP	DKAT	LOK	signal downstream of accumulator, standardized, low-pass filtered
KATBFTP2	DKAT	LOK	signal downstream of accumulator, standardized, low-pass filtered (bank 2)
KATBSHD2_W	DKAT	LOK	signal for rich-shift of the catalyst model (bank2)
KATBSHD_W	DKAT	LOK	signal for rich-shift of the catalyst model
KBDKT2_W	DKAT	LOK	catalyst load signal, bank2
KBDKT_W	DKAT	LOK	catalyst load signal
LSADKT	DKAT	LOK	Correction value (slow front senosr) of cat. monitoring result
ML	SWADAP	EIN	air mass flow
MSABG2_W	BGMSABG	EIN	exhaust gas mass flow filtered (Word), bank 2
MSABG_W	BGMSABG	EIN	exhaust gas mass flow filtered (Word), bank 1
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RLDKTHP	DKAT	LOK	High pass filteres engine load signal
RLDKTHP2	DKAT	LOK	High pass filteres engine load signal, bank2
SFPKAT	DKAT	AUS	Status fault path: catalyst monitoring
SFPKAT2	DKAT	AUS	Status fault path: catalyst monitoring bank 2
TC6KATA	DKAT	AUS	Number of output codes SCAN-Tool mode6 from catalyst diagnosis
TC6KATC	DKAT	AUS	output code SCAN-tool mode 6 from catalyst diagnosis
TC6KATC2	DKAT	AUS	output code SCAN-tool mode 6 from catalyst diagnosis, bank 2
TC6KATS	DKAT	AUS	output threshold SCAN-tool mode 6 from catalyst diagnosis
TC6KATS2	DKAT	AUS	output threshold SCAN-tool mode 6 from catalyst diagnosis
TC6KATW	DKAT	AUS	output test threshold SCAN-tool mode 6 from catalyst diagnosis
TC6KATW2	DKAT	AUS	output test threshold SCAN-tool mode 6 from catalyst diagnosis, bank 2
TIKATM	ATM	EIN	exhaust gas temperature in catalyst (modelled)
TIKATM2	ATM	EIN	exhaust gas temperature in catalyst (modelled) bank2
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TKDKTE	DKAT	LOK	input temperature for catalyst monitoring
TKDKTE2	DKAT	LOK	input temperature for catalyst monitoring, bank2
TKDKTH	DKAT	LOK	highpass filtered catalyst temperature after sample&hold
TKDKTH2	DKAT	LOK	highpass filtered catalyst temperature after sample&hold
TKDKTHP	DKAT	LOK	high pass filtered catalyst temperature
TKDKTHP2	DKAT	LOK	high pass filtered catalyst temperature

Variable	Source	Type	Description
TMST	GGTFM	EIN	engine temperature at start
TPSVKMF2_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat. (word)
TVDKTTK	DKAT	LOK	temperature depentent delay time
TVDKTTK2	DKAT	LOK	temperature depentent delay time
URDDKTP	DKAT	LOK	difference of sensor mean values, low pass filtered
URDDKTP2	DKAT	LOK	difference of sensor mean values, low pass filtered, bank2
USHDKTP	DKAT	LOK	output voltage oxygen sensor downstream catatalyst, low pass filtered
USHDKTP2	DKAT	LOK	output voltage oxygen sensor downstream catatalyst2,low pass filtered
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
Z_KAT	DKAT	AUS	cycle flag of catalyst conversion
Z_KAT2	DKAT	AUS	cycle flag: catalyst conversion (2nd bank)
Z_LATP	DLSA	EIN	cycle flag of lambda sensor aging tp
Z_LATP2	DLSA	EIN	cycle flag of lambda sensor aging tp (cylinder row 2)
Z_LSHV		EIN	cycle flag of lambda sensor exchange downstream cat

FW DKAT 58.140 Fixed Values

Parameter	Value	Description
ADKATNF		scaling factor for signal amplitude of the sensor resp. of the catalyst stress
AHKATMN		threshold value catalyst good, AHKAT < AHKATMN
AHKATMX		threshold value catalyst defect, AHKAT > AHKATMX
AHKATS		threshold value for sum AHKAT,AHKAT2 (stereo)
AHKATSB		threshold value for error of adding range (stereo)
AHKTMXT		threshold value catalyst defect at tester's request
AHKTTSW		setting value for timer in signal evaluation
APEKTDX		max. number of tests with error result
AVKATFS		setting value for AVKATF in case of powerfail
CDKATLK		code word for B_lrka active
CDKKAT		code word customer: catalyst conversion
CDKKAT2		Code word customer: Catalyst conversion (Bank 2)
CDTKAT		code word tester: catalyst deteriorated [040]
CDTKAT2		code word tester: catalyst conversion, cyl.row 2 [045]
CLAKAT		Error class: catalyst
CLAKAT2		Error class: catalyst bank 2
CWKATUM		code word for switch-over in the catalyst diagnosis
DKATCW		single run resp. initialization of the DKAT function
DMRKTD		torque reserve for catalyst monitoring
DRLKTDP		Threshold for engine load change
DRLKTDPT		Threshold for engine load change at tester's request
FALRKTD		amplification factor for amplitude of lambda controller
FALRKTT		amplification factor for amplitude of lambda controller at tester mode
HYKATA		Absolute hysteresis, cat. monitoring
HYKATR		Reative hysteresis, cat. monitoring
KATBFMN		threshold value for small catalyst stress
KATBFMNT		threshold value for small catalyst stress at tester's request
KATBFN		standardized mean value of the sensor amplitude
KATBFNM		scaling factor multiplicative for catalyst stress
KATBFNP		scaling factor additive for catalyst stress
KATBFSX		maximum integrator value for stop condition
KATBFXT		max. catalyst load threshold for stop condition, tester mode
KATBSG		catalyst storage value for catalyst stress
KATBSH		offset for lambda control slightly in the rich area
KATBSHF		amplification factor for difference of mean values of the O2/S
KATBSHG		limitation factor of model lambda-offset due to sensor mean values
NDKTSO		upper engine speed limit for DKAT-active
NDKTSOT		upper engine speed limit for function request
NDKTSU		lower engine speed limit for DKAT-active
NDKTSUT		lower engine speed limit for function request
NKTDX		Maximum speed for DKAT calculation
RLDKTOT		upper load limit for function request
RLDKTUT		lower load limit for function request
TDKATAKT		threshold value cycle finished if active monitoring time > TDKATAKT
TDKATATT		threshold value cycle finished for function request
TMAXKAT		maximum catalyst temp. for active diagnosis
TMINKAT		minimum catalyst temperature for monitoring
TMNKATT		minimum catalyst temperature for monitoring during tester mode
TMSUKTD		minimum engine start temp. for monitoring
TSFKAT		fault active time: catalyst conversion rate
TSFKAT2		fault active time: catalyst conversion rate, bank 2
TWDKATST		waiting time after stop condition for filter and integrator
TWKTDLP		delay time after parameter switch over in lambda control
ZDKATAD		filter time constant of the differentiator for signal amplitude
ZDKATAF		time constant ”absolute value filter” for signal amplitude
ZDKATSH		time constant low pass filter, mean sensor values
ZDKTBD		time constant of the differentiator for RF-alternating component
ZDKTBF		time constant for gas mixing procedure in front of catalyst
ZKTDRL		time constant low pass filter, engine load
ZKTDTKM		loss pass filter time constant for tkatm filtering

FB DKAT 58.140 Detailed description of function

Introduction :

The catalyst has the characteristics of storing oxygen. The oxygen stored during the lean phase is either completely or partially used during the rich phase. Due to aging or due to environmental influences the storage capability of the catalyst is reduced.
In case of this aging the HC convertion is also reduced. According to OBDII requirements the HC emission in the FTP test may not exceed a given limit. The task of the catalyst monitoring function is to make a statement from the oxygen storage capability of the catalyst about the the HC convertion in the FTP-test. By means of this procedure the oxygen storage capability is determined from the amplitude of the lambda sensor behind the catalyst. Since during non-steady state drive the storage capacity of the catalyst is at times taken up completely the function shall be protected against wrong conclusions by means of adequate measures.

The catalyst conversion monitoring:

The amplitude of the lambda sensor behind the catalyst is strongly dependent on the alternating stress of the oxygen (deficiency / excess) in the catalyst. This catalyst stress may vary in different load ranges. So as to consider the working point influences a correcting function apart from the various stop criteria is introduced. The task of this function is, dependent on the manipulated variable of the lambda controller (fr-signal), to form an expectancy signal for the amplitude of the lambda sensor. The difference between the expectancy signal and the lambda sensor amplitude is integrated and standardized to the time. The standardized signal is a dimension for the aging of the catalyst. The monitoring is carried out in a single load-engine speed range. The structure of bank one and two is identical. Due to this only one bank was described. The differing signals were designated with index 2 for the second bank. The following blocks DKATAW2, DKATSTB2, DKATSTP2, DKATST2, AHKATB2, AHKTS2, AKATB2 are the same as those of bank 1 except for the index 2. So as to increase the overview these block diagrams were therefore omitted.

The catalyst conversion monitoring consists of the following blocks:

Partial function block AKATB:

The task of this partial function is, dependent on the manipulated variable of the lambda controller and of the air mass throughput, to calculate a catalyst stress signal. For this the change of the fr-signal from the neutral position (phys. 1.0) is filtered with a high pass (formed from the low-pass filter and subtraction). This filtering is necessary to be independent of the position of the fr-signal.

In case of Y-configurations (two pre catalysts and one common main catalyst) the catalyst load is calculated by the sum of the catalyst loads of the two individual pre catalysts.

The high-pass filtered signal is multiplied by the air mass throughput ml, which was converted to g/s. Thereafter it is filtered with a low pass. The low-pass filter is used for the gas mixing procedure. The output of the low-pass filter is added to the offset KATBSH and standardized to the catalyst storage value. This signal (katbfi_w) is used for application purposes and for the formation of the stop criteria. The offset KATBSH is dependent on the control threshold of the pilot control and KATBSG is dependent on the catalyst volume of the borderline catalyst.

The catalyst was designed as integrator with limitation. The limitation was standardized to +-1. After the katbfi_w-signal was integrated it is filtered through an air mass throughput-dependent low pass and standardized to the lambda sensor amplitude by means of a multiplying and an adding factor. The standardized signal katbf has a similar course to ushk. The output of the intergrator is called katbfs and it is used for the formation of the physical stop criteria and for application purposes.

The time constant of the high-pass filter ZDKTBD should be chosen such that only the direct component of the fr-signal is filtered. The time constant of the gas mixing filter ZDKTBF lies between 0.05..0.2 sec. By this time constant the threshold values of the stop conditions are influenced.

The air mass-dependent time constant of the low-pass filter is realized via the characteristic line KATBFML (KATBFML2, bank2). In case of very air masses this filter generally has a larger time constant. For the given base points the time constants shall be adjusted so that the standardized katbf-signal shows the best possible match with the lambda sensor amplitude for the the designed borderline catalyst.

All filters and the integrator are reset to zero by B_dkini=TRUE.

Partial function block AHKATS :

By means of this function the alternating components of the ushk-signal are calculated by a high-pass filter (formed from low-pass filter and subtraction). Via the sum and the subsequent filtering the rectified mean value of the alternating components is obtained. The low-pass filter is stopped by the bit B_dktst = FALSE. The output of the low-pass filter is multiplied by the factor ADKATNF so that on very old catalysts (washcoat only) ahkatn becomes = 1. The standardized signal ahkatn then complies to the avkat-signal from the filter procedure carried out so far.

Both filters are set to ZERO by the bit B_dkini=TRUE.

The mean value of the oxygen sensors after catalyst is taken into aacount. This is performed by creating "katbshd" from the difference of the values of the rear sensor and the modelled rear sensor signal. This "katbshd" impacts the catalyst model.

Partial function block AHKATB :

By means of this function the alternating components of the katbf-signal are calculated by a high-pass filter (formed from low-pass filter and subtraction). Via the sum and the subsequent filtering the rectified mean value of the alternating components is obtained. The low-pass filter is stopped by the bit B_dktst = FALSE. The output of the low-pass filter is multiplied by the factor ADKATNF. The standardized signal akatbn is used as expectancy signal (set point).

Both filters are set to ZERO by the bit B_dkini=TRUE.

Partial function block DKATAW :

First of all, the modelled amplitude akatbn is compensated with the correction factor kakbmt, in order to minimize the influence of air mass and corresponding catalyst temperature.
From the two signals ahkatn and akatbn a correcting signal ahktnk is formed for the evaluation of the catalyst conversion.
For this the difference between the ahkatn-signal and the akatbn-signal is formed. The difference is corrected by means of a straight line with a gradient of one. The straight line has the point of intersection KATBFN with the y-axis. The correcting signal ahktnk is integrated and thereafter divided by the time. The result (ahkat-signal) takes up a value between ZERO and one.
The integrator and the timer are definedly set during the initialization (B_dkini=TRUE). The setting values (avkatf*AHKTTSW and AHKTTSW)
are necessary so that in the beginning no division by ZERO or no high value occurs. The integrator and the timer are stopped if

- B_dktst is equal to FALSE.
- akatbn is smaller than KATBFMN.
- the integrator or the timer have reached the limit.
- during the first seconds (2 x ZDKATAF) after monitoring start (B_dktst) in order allow the low pass filters of ahkatn and akatbn to warm up

There is the possibility, to feed the ahkat-integrator either with ahkatn-akatbn+KATBFN or directly with ahkat.
The latter offers the advantage to improve the signal to noise ratio in case of a fresh catalyst and low catalyst load.
The swiching mechanism is performed with CWKATUM=1. The hysterisis thresholds HYKATA and HYKATR respectivley can be tuned to define the switching condition. This condition is fulfilled if:
CWKATUM=1 AND ahkatn<HYKATA AND akatbn > (ahkatn+HYKATR) AND KATBFN > (akatbn+HYKATR).

The output of the timer (dkatakt_w) supplies the active monitoring time. The ahktki_w-signal supplies the actual integration value.
These two signals are needed for application purposes.
The value ahkati can be adjusted dependent on the age of the lambda sensor (lsadkt).

Partial function block DKATST:

Stop criteria :

The catalyst conversion monitoring is not always active The conditions leading to an interruption of the monitoring may either be derived physicaly or they are caused by the errors of other functions in the motronic. Due to this reason the two stop types are seperated from each other.

a) physical stop criteria (partial function DKATSTP)

- The catalyst monitoring is only active within one load-engine speed range. The engine speed range lies between a lower (NDKTSU) and an upper (NDKTSO) threshold. The load range is limited by two engine speed-dependent characteristic lines (RLDKATSO, RLDKATSU). The engine speed base points are identical on both characteristic lines.

- During low temperature (start temperatur) the HC conversion decreases and the amplitudes of the lambda sensor behind the catalyst increase. Therefore a monitoring during this temperatur is excluded.
  The catalyst temperature tkatm is reformed in the function ATM. The catalyst diagnosis is only active if the temperature tkatm is larger than TMINKAT.

- During high temperature (tkatm >= TMAXKAT) the diagnosis will be stopped too, in order to prevent a "false pass" diagnosis.

- Moreover, a delay time tvdkttk can be applicated. It depends from the temperature gradient of tkatm, at the time when tkatm enters the temperature window, that is formed from TMINKAT and TMAXKAT respectively.

- During tester mode the lower temperature threshld TMNKATT must be exceeded.

- The katbfs- resp. katbfi_w-signals gained from the partial function AKATB are used for the formation of the physical stop criteria. Cut-off limits for the katbfs-signal (KATBFSX) and for the katbfi_w-signal (KATBFXM) are fixed.
  The catalyst conversion monitoring is stopped if the katbfi- resp. the katbfs-signal at the same time exceed resp. fall short of the limits (KATBFXM (KATBFXT at tester´s request, KATBFSX).
  By these limiting values resp. by chosing the load-engine speed range it is possible to influence the active monitoring time in the FTP-test.
  Stop criteria if a tester requests a function:
  If a tester requests a function (B_fakat = TRUE) a special load-engine speed range is defined. Thus it is ensured that the request can only be triggered for the intended working point. The engine speed nmot can vary between the limits (NDKTSUT, NDKTSOT) and the load rl can vary between the limits (RLDKTUT, RLDKTOT). Out of these ranges the function is stopped.

b) non-physical stop criteria (partial function DKATSTB)

The monitoring of the catalyst conversion can only take place during undisturbed functioning of the lambda controller. At the same time the sensors in front of and behind the catalyst must be fully available. This includes the results of the heating diagnosis and of the monitoring of the aging. The condition B_lr indicates the normal operating of the lambda controller especially no fuel cut-off and readiness of the front sensor. A high charging of the activated carbon filter can disturb the monitoring and is therefore considered as a ban.
This also applies for quick load changes which require a considerable correction in the transient control (B_ukg).
Furthermore misfires, AGR-errors, TES-errors as well as general errors in the load sensing are used as exclusion criteria.

Test modes:

- Permanent testing (DKATCW=0, APEKTDX=255, for application purpose only)
  The function will be initialized (B_dikini), as soon as the diagnosis has finished on both banks (see chapter DKATINI).
  The function will be stopped for this trip (B_dkten=TRUE), as soon as fault counter apedtk exceeds APEKTDX.
  The fault counter will be increased at the event of a fault at bank1 and bank2 respectively.
  In case of o.k.-testresult the diagnosis will be repeated for ever, in case of a fault it sill be repeated 255 times.
- One healing test (DKATCW=1, APEKTDX=2, for series application)
  In case of an detected fault the diagnosis wil be stopped when the fault counter exceeds the threshold "2". I.e. max. one healing test is possible.
  If in the first test no fault is detected (Z_kat,-2=TRUE, E_kat,-2=FALSE), the diagnosis will be stopped as well (B_dkten=TRUE).
- Single test (DKATCW=2, APEKTDX > 0).
  The diagnosis will be stopped after the first run-through (B_szkat=TRUE and hence B_dkten=TRUE).

From the two stop types the bit B_dktst is generated by connecting the OR function. After the stop condition has ended the waiting time TWDKATST is still waited for until the filters resp. the integrators are again enabled.

Partial function block DKATEL :

For the setting of the error and cycle flags the following considerations were laid down:

1.) An individual error exists that means in one bank after the active monitoring time (TDKATAKT) has run out ahkat is larger than the maximum limit (AHKATMX). In this case E_kat and Z_kat are immediately set to TRUE (individual error has high priority).
2.) An added-up error exists that means that after the active monitoring time has run out the sum of the ahkat-signals of the two banks exceed the preselected border AHKATS. In this case the catalyst which shows a larger ahkat-signal is detected as defective. For this purpose a lower limit (AHKATMN) is defined which may not be undershot. Furthermore the active monitoring time of the two banks must have run out and in none of the banks no individual error may exist.
By forming the flag (B_zkats) three conditions are fixed. Firstly that in one bank the time has run out, secondly that no individual errors have occured and thirdly that the ahkat-signal of the concerned bank does not lie below AHKATMN.
3.) An error of the adding range exists that means after the active monitoring time has run out an added-up error exists if the ahkat-signal is not larger than AHKATSB. The meaning of this being that in case of an added-up error both catalysts will be detected as being defective if they do not differ largely in the state of their age.

Z_kat is set to FALSE by B_dkini = TRUE. The cycle flag is not set until the monitoring end of the lambda sensor period is reported by the setting of the cycle flag Z_latp=TRUE. By setting B_fakat = TRUE the border for the active monitoring time is changed from TDKATAKT to TDKATATT.
The E_kat(2) and the Z_kat(2) are set to FALSE in case of B_pwf =TRUE resp. B_clkat=TRUE. For the European version "CDKAT=0" E_kat (2) is set to FALSE, Z_kat(2) is set to TRUE and thus the function is stopped.
In case of E_kat(2) = TRUE B_mxkat(2) = TRUE is set. B_mxkat(2) is used in the error memory management.

Partial function block DKATINI:

The catalyst conversion monitoring is initialized in case of the following conditions:
a) If the bit B_ini = TRUE
b) If the bits B_szkat resp. B_szkat2 = TRUE were set
c) If the fault code storage is cleared
d) If the diagnosis is started via tester request (B_fakat)

The initialization means that all filters are set to ZERO, the integrators are either set to ZERO or to the setting values, the timer is set to the value AHKTTSW and Z_kat is set to False.

After a single run of the monitoring function (cycle bit was set) it is possible to stop the catalyst conversion via the code word DKATCW bit no. ONE = TRUE.

Due to a historical reason ahkat is stored in a battery-backed RAM-cell with the edge of the Z_kat-signal for the function %LC under the name avkatf. The avkatf-signal is set to the value AVKATFS in case of powerfail = TRUE.

Subfunction block DKATLRP:

In order to amplify the downstream sensor signal, it can be useful to enlarge the lambda pertubations.
The parameter switch over for this performance is requested by B_dktlp, falrdkt is the wanted value for amplification factor of the amplitude of the lambda pertubation.
B_dktlp is set when DKAT is active (dkatakt_w > AHKTTSW) and is cleared when the speed/load-range is left (B_dktnr) or the DKAT-time is elapsed (B_dktt) or the load oscillations are too rough.

APP DKAT 58.140 Application hint

Application process:

The application of DKAT can be started usefully only if the application of the lambda controller and of the transient enrichment/ lean-out has been completed and the FTP-results of the vehicle lie close to the target value. Only in this case it is possible to to select a borderline catalyst. During application always a "mid-range" lambda sensor should be used to avoid the influences of sensor characteristics on FTP-results and on DKAT.
The condition B_dktst indicates whether the function is actually active at the moment (B_dktst = TRUE) or whether it is blocked.
The application is largely carried out off-line. For this an evaluation software is available. Although the application must be carried out for the entire operating range, in this case an attempt is made to give corresponding suggestions for the determination of the individual application values for each individual block.

The results of th catalyst diagnosis can be improved by activating the lambda control after catalyst (rear control, trim control).

In case of "Y" exhaust configurations the RAM cell tikatm has to be applied in the middle of the main catalyst.

- Application of AKATB-block :

Application values

ZDKTBD	filter time constant for differentiator	[0,5....1,0.....1,5] sec
ZDKTBF	filter time constant for low pass	[0,05...0,15....0,2] sec
KATBSH	offset for lambda control threshold	[0,0.....47....80,0] mg/sec
KATBSG	memory value	[2,0....55,0...160] g
KATBFNM	scaling factor multiplicative for KB	[0,0....0.30....1,0] Volt
KATBFNP	scaling factor additive for KB	[0,0....0.40....1,0] Volt
KATBFML	filter time constant for sensor signal attenuation	characteristic line over ml, bank1
KATBFML2	filter time constant for sensor signal attenuation	characteristic line over ml, bank2

Characteristic line KATBFML (KATBFML2)

ml/(kg/h)	12	25	50	80	130
time constant/sec	[0,1..2,0..4,0]	[0,1..1,0..2,0]	[0,01..0,15..1,0]	[0,01..0,14..0,9]	[0,01..0,08,..0,3]

The values indicated in the middle are to be understood as reference values.

Determination of the two scaling factors KATBFNP and KATBFNM by the conformal mapping:
With these two factors the output signal of the low-pass filter for the sensor signal attenuation of +-1 is mapped onto the sensor signal threshold. The mapping is implemented by a straight line (y = a * X + b).
Example:
If the sensor signal has the values 0.7 volt during rich phase and 0.1 volt during lean phase then the factors are to be deteremined by the following equation.

0.7 = KATBFNM * 1 + KATBFNP
0.1 = KATBFNM * (-1) + KATBFNP

The conclusion from this is KATBFNM = 0.3 volt and KATBFNP = 0.4 volt

Determination of the air mass throughput-dependent time constant KATBFML (KATBFML2) :

The time constant generally drops with increasing air mass throughput. For differing air mass the ushk-signal is compared with the katbf-signal. If the katbf-signal is attenuated compared to ushk the time constant is decreased. The time constant may not rise during increasing air mass. Whether the characteristic line was adjusted correctly can easily be read by comparing the katbfs-signal with the ushk-signal. Because if katbfs takes a similar course to ushk but katbf does not then the characteristic line was adjusted incorrectly. The precondition for a comparision between the ushk- and the katbf-signal is good conformance of the two signals ahkatn and akatbn.

Determination of the time constants ZDKTBD and ZDKTBF :

The time constant ZDKTBD should be chosen in such a way that only the direct component of the fr-signal is filtered. Here it is possible to determine the period of the fr-signal during idling and to calculate the time constant as follows.

ZDKTBD = [1,5...2,0] * Tp/6 sec (Tp is the period during idling)

The time constant ZDKTBF should be chosen in such a way that the area filtered of (fr-1.0)*ml approximately equals the area lambda * ml. Lambda may either be measured by a LSU-sensor or it may be determined by linearization of the LSH-sensor. If this time constant is chosen too large then the katbfi_w-signal is very attenuated and the katbfs-signal has no ushk-similiar course. Since katbfi_w is used for the physical stop condition the attenuation has a direct influence on the selection of the two application values KATBFIO, KATBFIU. (See application instruction of DKATSTP)

Determination of the two application values KATBSH and KATBSG :

A conformance of the two signals ahkatn and akatbn can mainly be obtained by the correct selection of the KATBSG-values. Both signals are shown during the entire measurement. If akatbn is smaller than ahkatn then the value of KATBSG is too large. Should no conformance be achieved by reduction of the KATBSG then at first ZDKTBF should be checked whether it was not chosen too large and then the characteristic line KATBFML (KATBFML2) should be changed. Here katbfs shall be similar to ushk.

If the two signals ahkatn and akatbn chiefly correspond the signals ahktki_w and ahkat shall be monitored during the entire measurement range. For this at first the constant KATBFN must be set to ZERO so that it has no influence on the ahktnk-signal during integration.

If the fluctuations of the ahktki_w-signal are smaller than 5 to 10 % and if ahkat fluctuates around zero then KATBSH and KATBSG are adjusted correctly. Should ahkat be positive then KATBSH is too large. If the fluctuations are greater than 10 % then the application of the block should be repeated.

Application of AHKATB and AHKATS :

Application values

ZDKATAD	time constant differentiated signal amplitude	[0,3...0,8...1,0] Sec
ZDKATAF	time constant "absolute value filter" signal amplitude	[2,0...2,5...3,0] Sec
ADKATNF	scaling factor for signal amplitude	[2,0...4,0...8,0] 1/Volt

The values indicated in the middle are reference values

The task of these two blocks is to disconnect the alternating components and to form the rectified mean value of these alternating components.

The ADKATNF factor is introduced due to the comparison of ahkat with avkat from the filter procedure. For this the rectified mean value of the avkat-signal is compared to the rectified mean value of the akatbn-signal after the application of the AKATB-block. The scaling factor results from:

$$\text{ADKATNF} = \frac{\text{mean value of the avkat-signal}}{\text{mean value of the akatbn-signal}} \quad [1/\text{volt}]$$

ADKATNF can also be determined with a washcoat only catalyst such that ahkatn becomes = 1 (ADKATNF*ahkatn = 1). Should no washcoat only catalyst be present it is possible to take into consideration the sensor voltage in front of the catalyst as output signal.

When selecting the time constant attention should be paid that the output signal is not too attenuated and that the input signal is not filtered too quickly. In principal the reference values should be used.

Compensation of mean value of the rear sensor:

ZDKATSH	Time constant difference mean values	[1...3 ...10] Sec
KATBSHF	weighing factor mean value difference	[1...12...30]
KATBSHG	limitation ahkatn-impact	[0.05...0,2...0,5]

KATBSHF to be chosen so low that no oscillation of %DKAT occurs.

Application of the DKATSTP block:

Application values

KATBFSX	limit catalyst stress signal	[0,85.....0,9....1,0] 1/sec
KATBFXM	limit gradient of the KB	[3,0......6,0....9,0]
KATBFXT	limit of the KB at tester´s request	[3,0......6,0....9,0]
TMINKAT	lower limit for temperature	[350......350....450] °C
TMNKATT	lower limit for temperature during tester mode	[350......350....450] °C
TMAXKAT	upper limit for temperature	[450......550....650] °C
TMSUKTD	lower limit for engine start temp.	[-20.....-15....-10] °C
NDKTSU	lower limit engine speed range	[640......720...1000] rpm
NDKTSO	upper limit engine speed range	[1500....2540...4000] rpm
NDKTSUT	lower engine speed function request	[640.....740....1000] rpm
NDKTSOT	upper engine speed function request	[1500....2500...4000] rpm
RLDKTUT	lower load function request	[18.......20......22] %
RLDKTOT	upper load function request	[27.......30......53] %

RLDKTSO	upper limit for rl-characteristic line over nmot	[20...............70] %
RLDKTSU	lower limit for rl-characteristic line over nmot	[10...............30] %

nmot / rpm	640	1200	1600	2000	2500
RLDKTSO / %	27	27	42	53	47
RLDKTSU / %	22	20	20	18	22

TVKTDTK	tkatm gradient dependent delay time	tkdkth [°C] 0 50 100 400 TVKTDTK [s] 0 10 50 200
ZKTDTKM	low pass filter time constant for tkatm	[10......50......100] s

The values indicated in the middle are reference values. The characteristic lines must be adjusted. The above-mentioned characteristic line values may be used as reference values.

TMSUKTD ensures that no monitoring happens in case of extreme low ambient temp. (hazard of snow that might cool down the cat)

TMINKAT shall guarantee the definate operating readiness of the borderline catalyst.

TMAXKAT ensures that the catalyst is not monitored at high temperatures.

ZKTDTKM is the low pass filter time constant for tkatm.
ZKTDTKM and TVKTDTK should be applicated in that way that a significant delay time tvdkttk occurs only if tkatm shows a high slope just before entering the TMINKAT / TMAXKAT window.
If tkatm only slightly exceeds TMAXKAT it is not necessary to delay the catalyst monitoring via tvdkttk.

By means of KATBFXM (KATBFXT at tester´s request), KATBFSX an evaluation of the lambda sensor amplitude is refrained from during steady-state
operation as well as during non-steady state operation with high catalyst stress. Thus the absolute value filters from the partial function blocks AHKATS, AHKATB and the integrator from the partial function block DKATAW are kept on the old value.

By these factors it is possible to influence the active monitoring time in the FTP test. If they are set to the indicated minimum limits and if the active time is smaller than 90 sec in the FTP test then they must be increased very carefully. In the FTP test a monitoring time in CT-phase of 150 sec is sufficient.

The evaluation time may be influenced by the evaluation range. In this case a compromise between load- engine speed range and the stopping with deactivation factors has to be found. The factors are, however, mainly intended for the stopping during non-steady-state drives or for high catalyst stress.

Application of the evaluation range:

The catalyst conversion monitoring works within one load-engine speed range only. The range is limited by two characteristic lines (rl-characteristic lines) and by two limits (engine speed limits). The range should be surrounded by NDKTSU, NDKTSO, RLDKTSO, RLDKTSU. The largest range is adjusted as follows.

-a) Application of RLDKTSO :
The characteristic line shall be adjusted for high load such that during small engine speed ranges high loads are excluded. In the FTP test in high hills the accelerations are excluded. Very large air masses (approx. 150 kg/h) at higher engine speeds are not to occur in the evaluation range. Thus the main points of the RLDKTSO characteristic line are fixed.

-b) Application of RLDKTSU
The characteristic line is adjusted for low loads. During low engine speeds small air masses (approx. 12 kg/h) shall not occur in the evaluation range. During higher engine speeds ranges close to the fuel cut-off are to be excluded. Thus the main points of the RLDKTSU characteristic line are fixed.

-c) Application of the NDKTSU and the NDKTSO values
NDKTSU can be set equal to the idle speed. NDKTSO can be limited to the medium engine speed range.

The excluded area should be made as large as possible. In the middle of the area ahkatn shall be approx. 50 % of the maximum value.

```
rl  |
    | acceleration    |      ___---_____       |  high air masses
    |                 |     /           \      |
    |                 |   /               \    |
    |                 | /  RLDKTSO          \  |
    |                 |/                      \|
    |                 |                        |
    |                 |\                      /|
    | range close to  | \  RLDKTSU          /  |
    |    idling       |  \----______------/    | range close to fuel cut-off
 ---|-----------------|------------------------|----------------------------->
    |         NDKTSU                    NDKTSO                          nmot
```

Application of the DKATSTB block :

Application values

CDKATLK	Codeword stop DKAT while B_lrka	0 ... diagnosis conducted during B_lrka > 0 ... diagnosis topped with B_lrka

DKATCW	Codeword testing mode	0 ... permanent test (-->APEKTDX=255), for application phase only 1 ... one healing test (-->APEKTDX=2) 2 ... single test(-->APEKTDX > 0)
APEKTDX	Max. number of test with an error-result (see DKATCW)	

Application of the DKATAW block:

Application values

AHKTTSW	timer setting value	1,0 Sec
KATBFMN	lower threshold for KB-amplitude	[0,1...0,2...0,3]
KATBFN	standardized correction for signal amplitude	[0,1...0,5...1,0]
HYKATA	absolute hysterisis value	[0.....0,1...0.2]
HYKATR	relative hysterisis value	[0.....0,1...0.2]
CWKATUM	codeword for switching	[0.......0.....1]
LSAKTD	Adjustment line to comensate sensor age	[0,5...1,0...1,0]
KFKABMT	Corrction map of the modelled amplitude	[0......1......2]

After the ahkatn-signal and the akatbn-signal have been adjusted so that the ahktki_w-fluctuations are smaller than 10 % and ahkat is approximately zero KATBFN shall be adjusted to the mean value of the ahkatn-signal. This correction works like a straight line with a gradient of one. It intersects with the y-axis at KATBFN. The KATBFN summand enables a comparison between ahkat and avkat.

In case of very small amplitudes it is impossible to differentiate between the borderline catalyst and a catalyst which is to be detected as "good". Due to this reason the integrator and the timer are stopped in case of such amplitudes. This lower limit should be 20 % of the KB-amplitude at the maximum otherwise no DKAT is possible while driving in small load-engine speed ranges.

There is the possibility, to feed the ahkat-integrator either with ahkatn-akatbn+KATBFN or directly with ahkat.
The latter offers the advantage to improve the signal to noise ratio in case of a fresh catalyst and low catalyst load.
The swiching mechanism is performed with CWKATUM=1. The hysterisis thresholds HYKATA and HYKATR respectivley can be tuned to define the switching condition. This condition is fulfilled if:
CWKATUM=1 AND ahkatn<HYKATA AND akatbn > (ahkatn+HYKATR) AND KATBFN > (akatbn+HYKATR).

KFKABMT has to be tuned with support of the application tool DKAT_Sx.

LSAKTD: First conduct DKAT with a good front sensor. Then do it with an aged front sensor and adjust LSAKTD in such way that ahkat obtains the former value.

Application of the DKATEL block:

Application values

AHKATMX	threshold value catalyst defect	[0,1....0,5....1,0]
AHKATMN	threshold value catalyst good	[0,1....0,3....1,0]
AHKATS	added-up threshold value (stereo 1. and 2.bank)	[0,2....1,1....2,0]
AHKATSB	adding range threshold value (stereo)	[0,2....1,1....2,0]
TDKATAKT	threshold for active monitoring time	[30.....100....400] sec
TDKATATT	time threshold function request	[10.....30......50] sec

The values indicated in the middle are reference values.

The threshold for the active monitoring time should be chosen as large as possible in the FTP test so that the standardized integration (ahkat-signal) can stabalize. Due to the quantization the time should, however, not exceed 400 sec.

The AHKATS-value should be at least double that of AHKATMN, AHKATSB must be larger than AHKATMN.

Application of AVKATFS :

AVKATFS	AVKATF setting value	[0,1...0,5...1,0]

AVKATFS is adjusted for a bad catalyst.

TEXT/ANF

Application of speed threshold NKTDX

Above the speed of NKTDX rpm the diagnosis calculation will be stopped due to ECU computation time saving.

NKTDX	rpm-threshold for calculation inhibit	[3000...4000...5000] rpm

Application of the DKATLRP block :

Application values

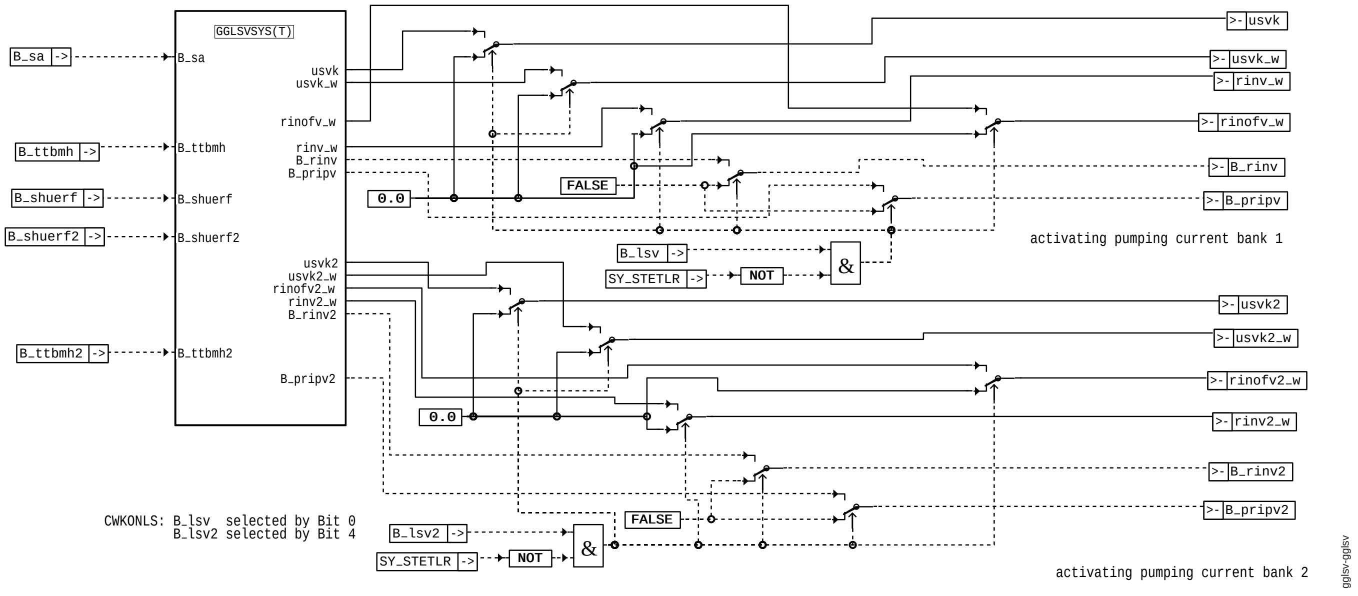
DRLKTDP	Threshold load-transients	[1....5....20 %]
ZKTDRL	Time constant rl-low pass	[0,5....2....4] s
FALRKTD	Ampl. factor of lambda controller amplitude	[1...1...3]

Default-Application: DLRKTDP = -2% (switch off the feature to impact the lambda controller amplitude, because many other moinitoring functions are disturbed).
Recommendation: Switch off this feature of incluencing the lambda controller amplitude.

GGLSV 2.30 Sensorsignal lambda upstream catalyst

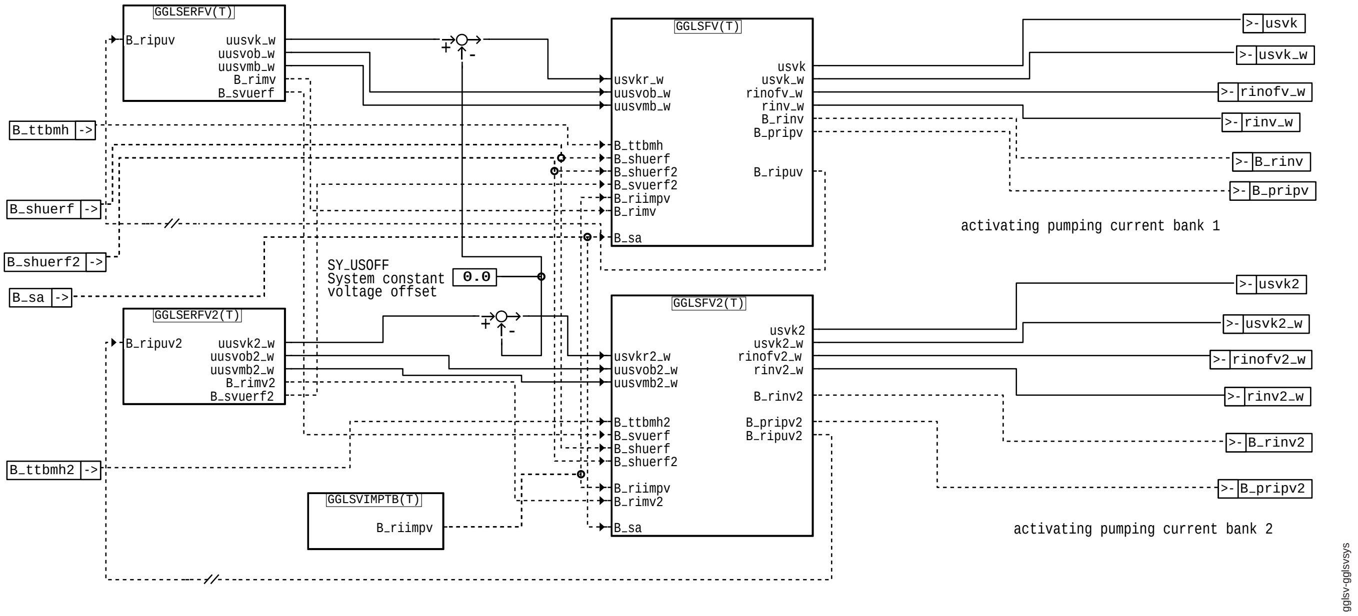
FDEF GGLSV 2.30 Function definition

```
GGLSV: Enable sensor function by configuration bit
--------------------------------------------------
```



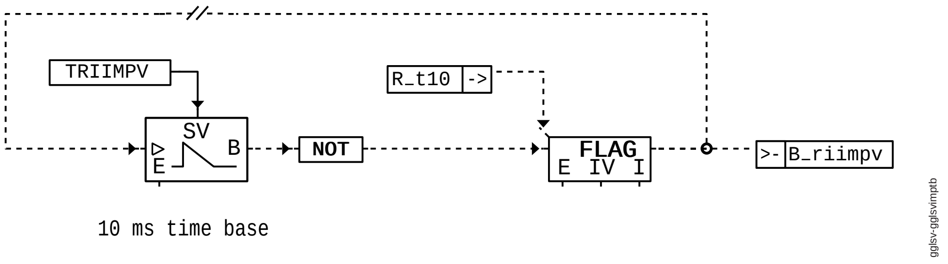
gglsv-gglsv

```
GGLSVSYS: Overview and description of registration from sensor voltage
--------------------------------------------------------------------
```



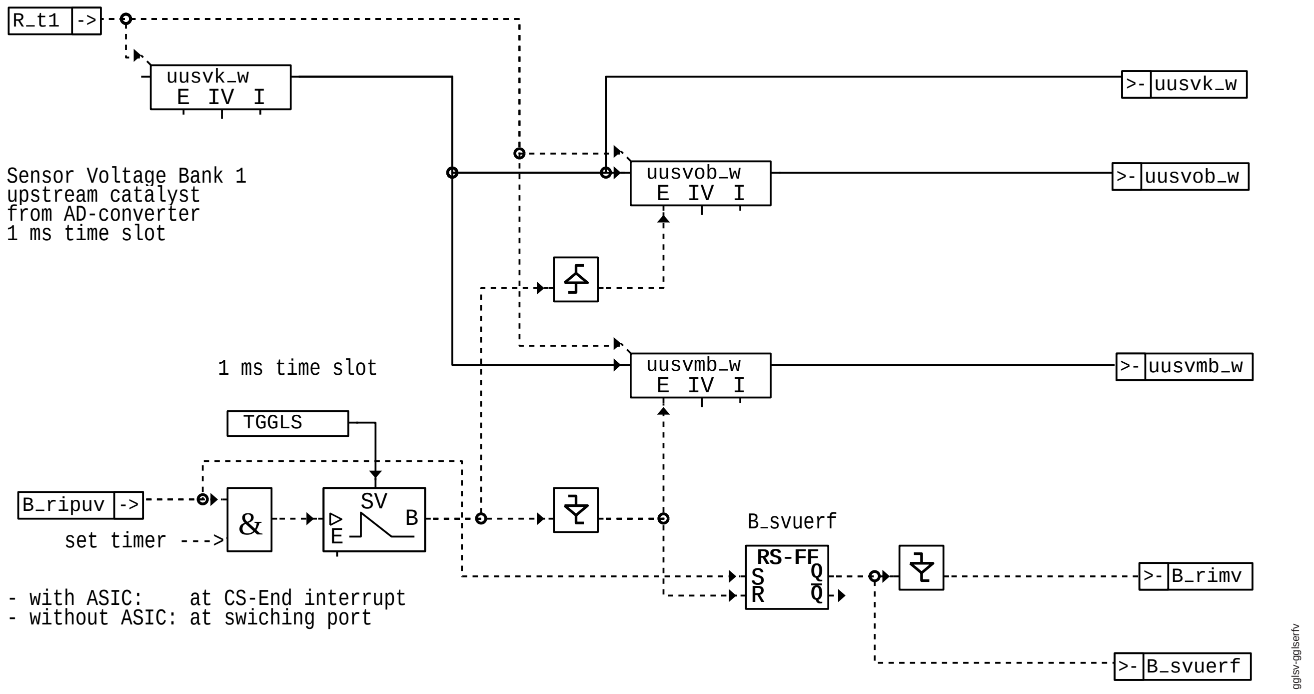
gglsv-gglsvsys

GGLSVIMPTP: Generating pumping time intervals for bank1 und bank2



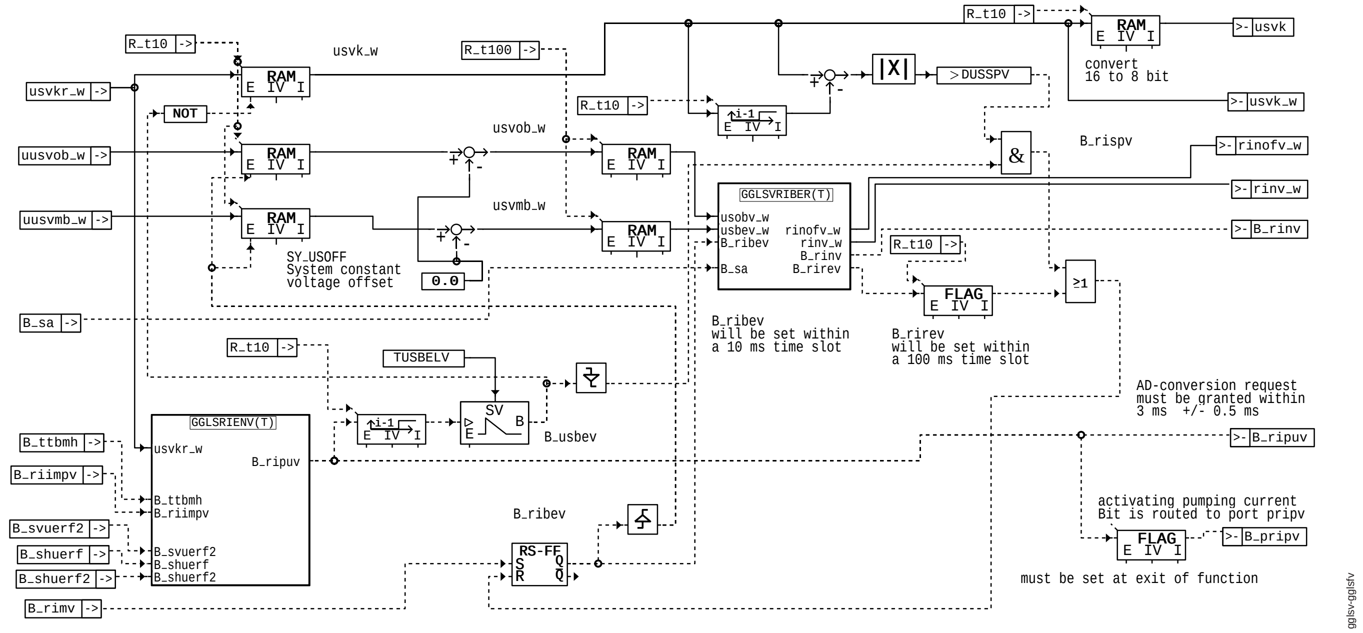
gglsv-gglsvimptb

GGLSERFV: Measuring the unloaded and the loaded sensor voltage into 1 ms-time frame, bank1



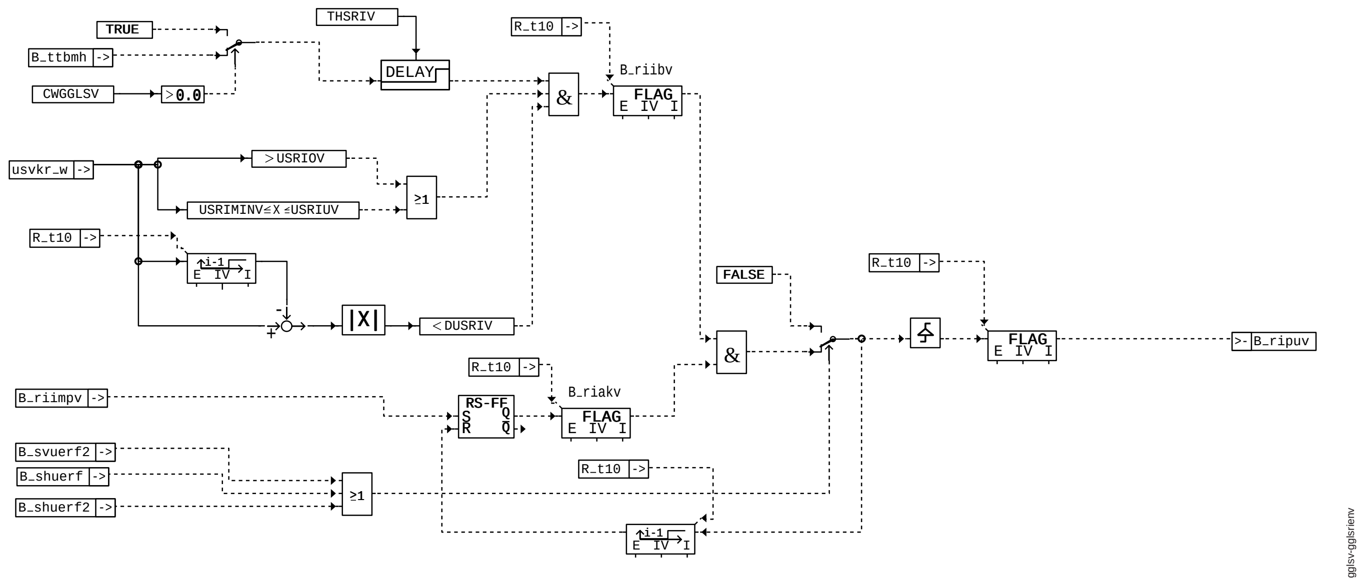
gglsv-gglserfv

GGLSFV: Transfer of the measuered values unloaded and loaded after pumping into 100 ms-time frame, bank 1



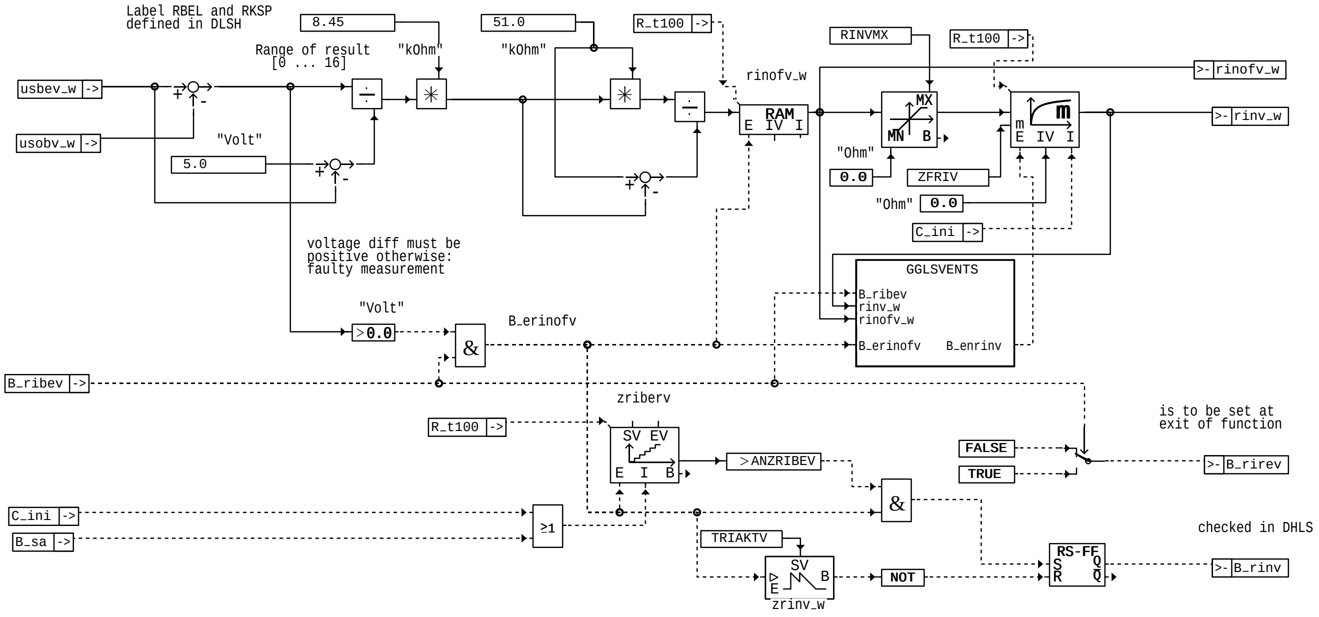
gglsv-gglsfv

GGLSRIENV: Enabling of Ri-measurement, bank 1:



gglsv-gglsrienv

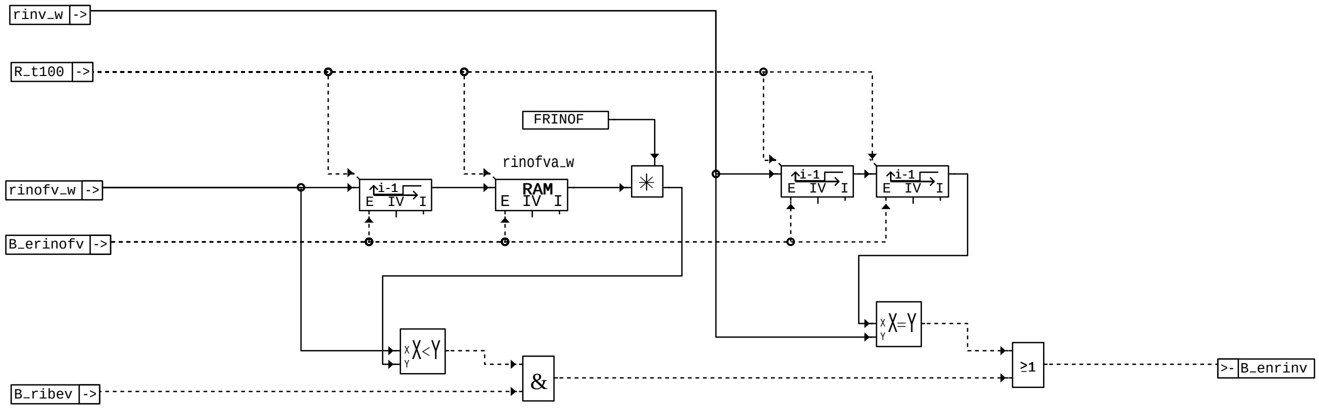
GGLSVRIBER: Ri-calculation and statistical evaluation, bank 1



gglsv-gglsvriber

gglsv-gglsvriber

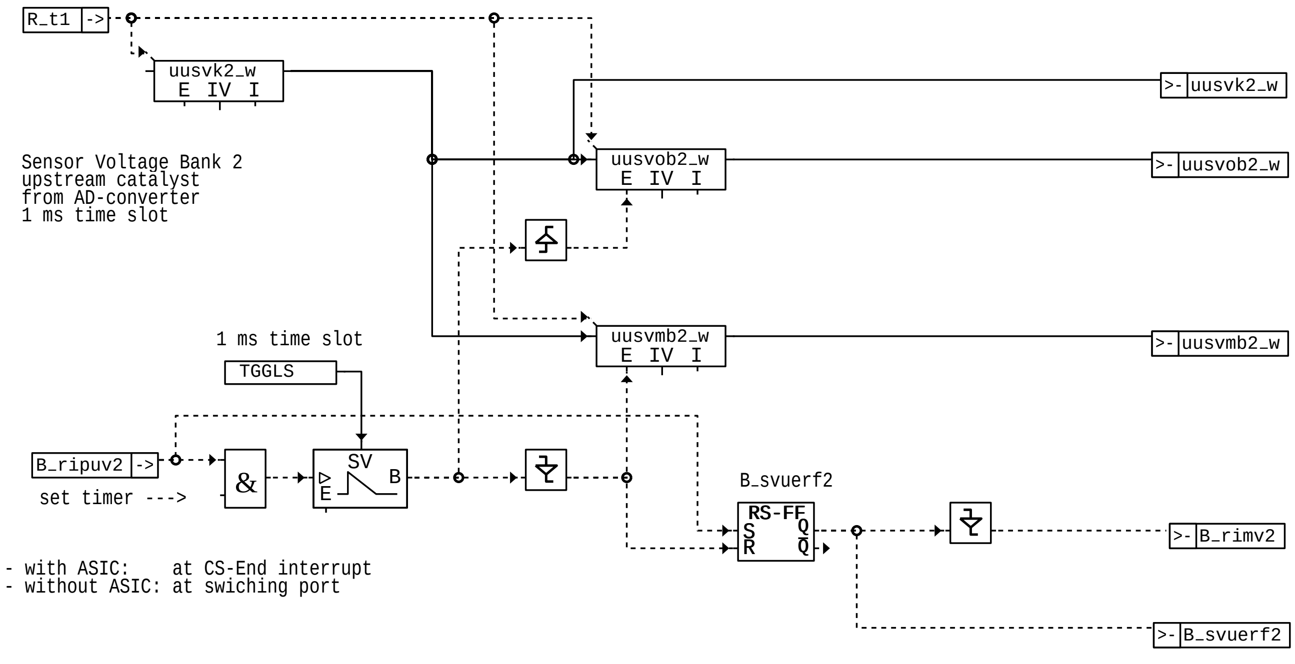
GGLSVENTS: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank1



gglsv-gglsvents

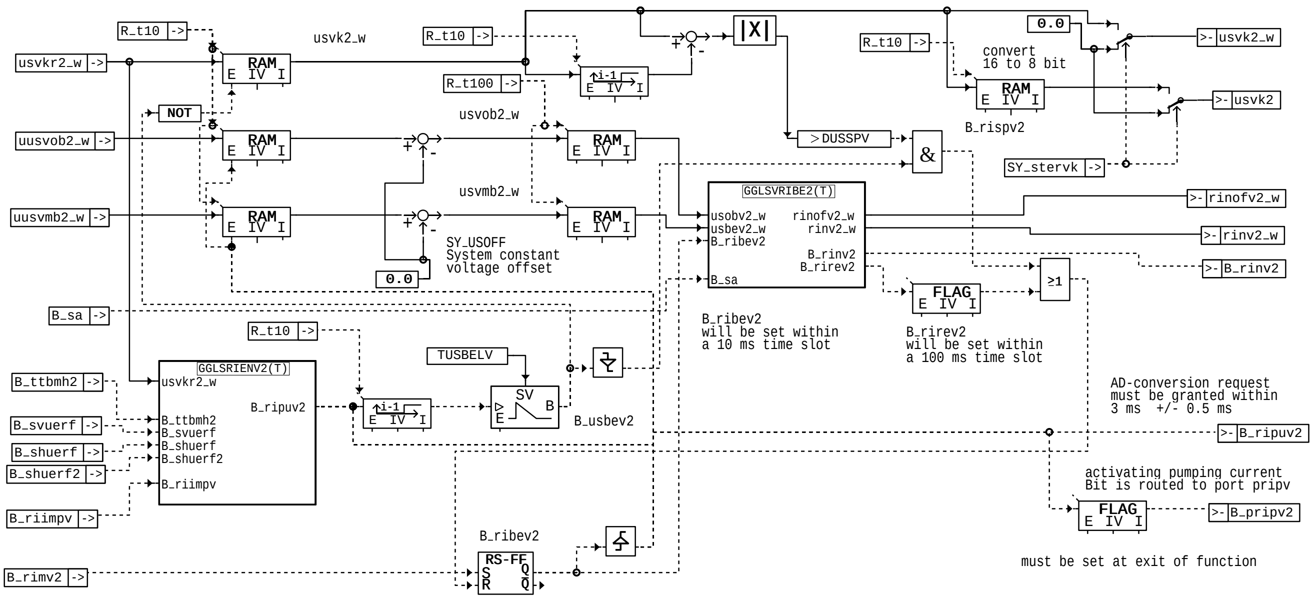
gglsv-gglsvents

GGLSERFV2 : Measuring the unloaded and the loaded sensor voltage into 1 ms-time frame, bank2



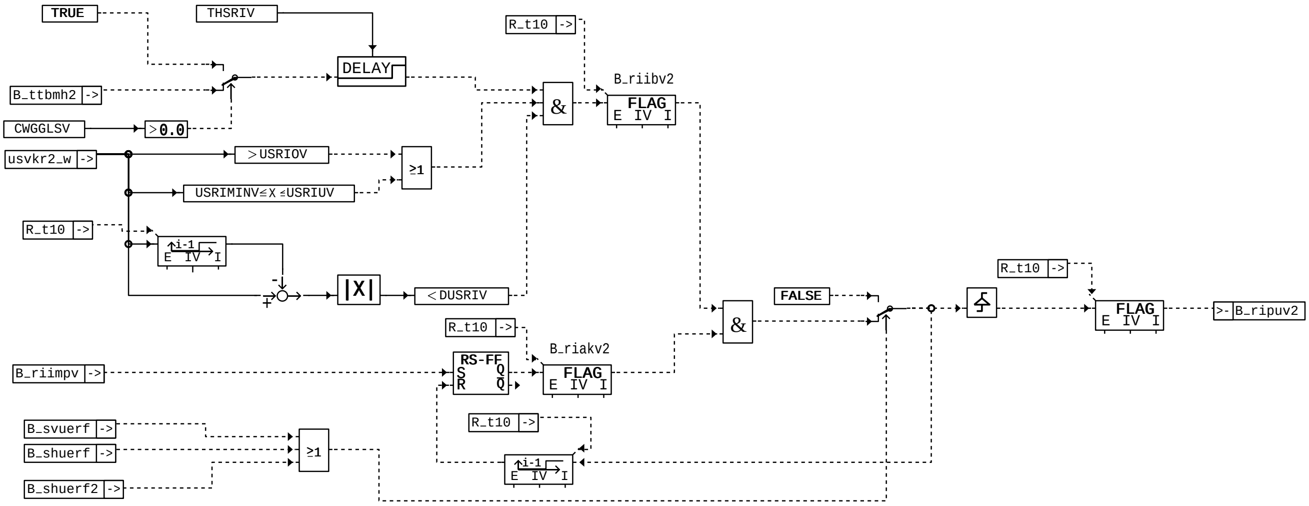
gglsv-gglserfv2

GGLSFV2 : Transfer of the measuered values unloaded and loaded after pumping into 100 ms-time frame, bank 2



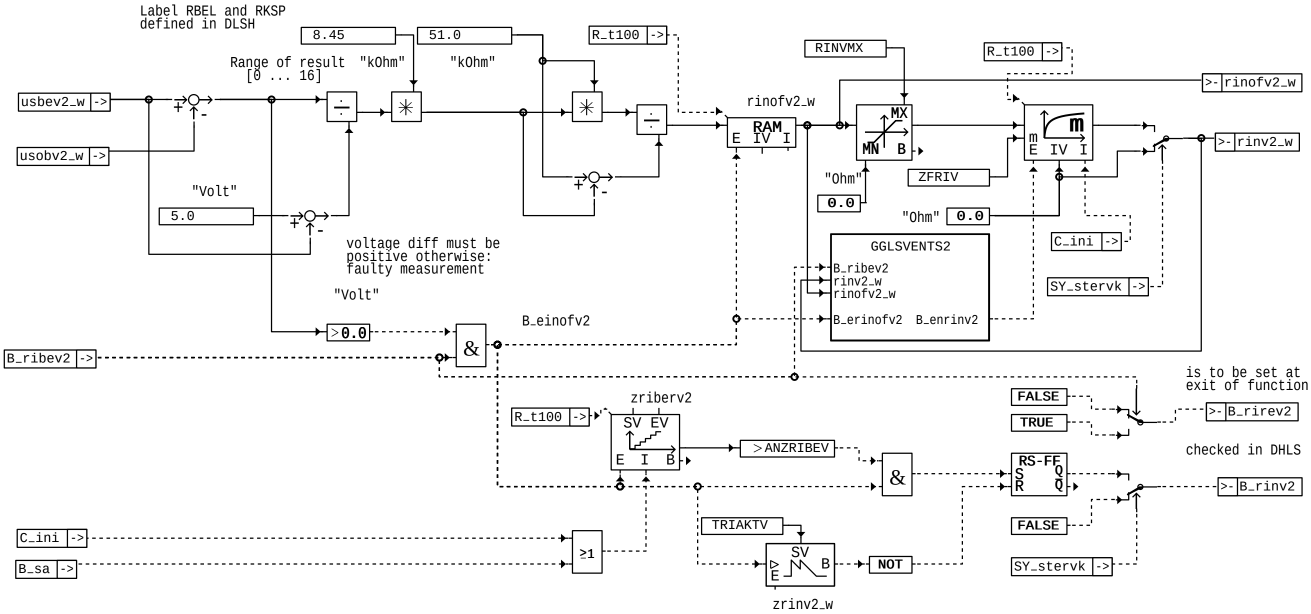
gglsv-gglsfv2

GGLSRIENV2: Enabling of Ri-measurement, bank 2



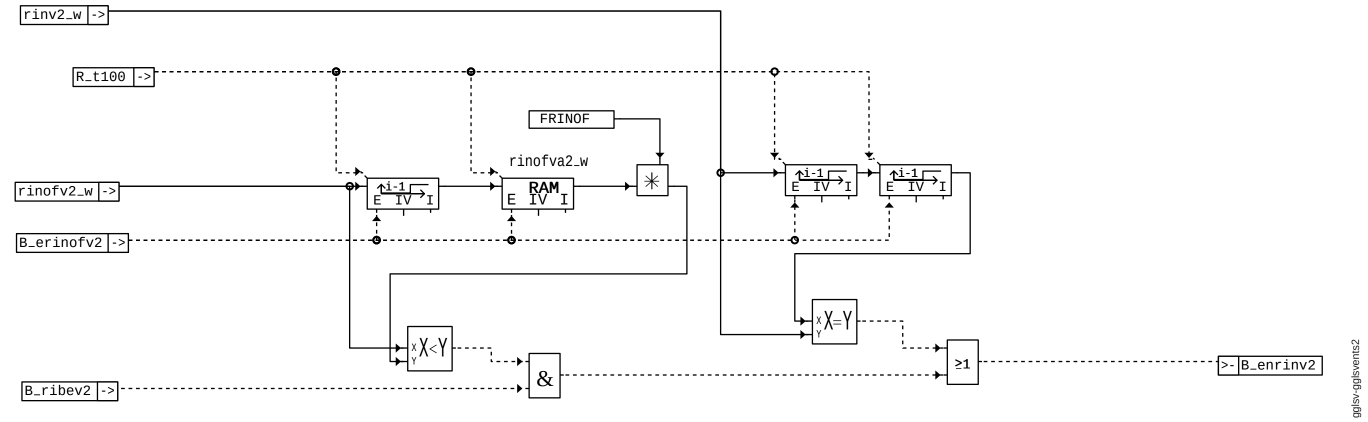
gglsv-gglsrienv2

GGLSVRIBE2: Ri-calculation and statistical evaluation, bank 2



gglsv-gglsvribe2

GGLSVENTS2: Additional interference suppression of Ri-measurement and formation of enable for the Ri-filter, bank 2



gglsv-gglsvents2

ABK GGLSV 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZRIBEV			FW	Amount of Ri calculation pre cat
CWGGLSV			FW	Code word for Ri-measurement for O2sensor pre cat (not fully heated)
DUSRIV			FW	Delta sensor voltage pre cat between new and old value for Ri measurement
DUSSPV			FW	Delta sensor volt.front cat between new and old val. for sensor jump knowledge
FRINOF			FW	Factor for validation of old Ri-value without filter
RINVMX			FW	Internal resistor Ri of nernst sensor limited to maximal value
TGGLS			FW	Time needed for ADC after interrupt in the function calculator (Asic)
THSRIV			FW	Ready condition, time delay,of Ri measurement after sensor heating on pre cat
TRIAKTV			FW	Time for Ri calculation actuel pre cat
TRIIMPV			FW	Time for pump impulse for both banks pre cat
TUSBELV			FW	Time for holding of O2 sensor voltage after Impuls charge
USRIMINV			FW	Minimum voltage threshold for Ri-mesurement for sensor upstream cat
USRIOV			FW	Upper voltage threshold for Ri-measurement of the sensor upstream cat
USRIUV			FW	Lower voltage threshold for Ri-measurement of the sensor upstream cat
ZFRIV			FW	Reduction factor for internal resistor Ri-Nernst filter pre cat

Variable	Source	Type	Description
B_ENRINV	GGLSV	LOK	Condition enable for Ri-Nernst wit filter pre cat
B_ENRINV2	GGLSV	LOK	Condition enable for Ri-Nernst wit filter pre cat bank 2
B_ERINOFV	GGLSV	LOK	Condition enable for Ri-Nernst without filter pre cat
B_ERINOFV2	GGLSV	LOK	Condition enable for Ri-Nernst without filter pre cat bank 2
B_LSV	PROKON	EIN	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank1)
B_LSV2	PROKON	EIN	Cond. lambda sensor inst. upstr. of the cat., 1. sensor downst. of outlet(Bank2)
B_PRIPV	GGLSV	AUS	Condition switch port for pump impuls upstream catalyst
B_PRIPV2	GGLSV	AUS	Condition switch port for pump impuls upstream cat bank2
B_RIAKV	GGLSV	LOK	Condition for pumping current updated upstream catalyst
B_RIAKV2	GGLSV	LOK	Condition for pumping current updated upstream catalyst, bank 2
B_RIBEV	GGLSV	LOK	Condition calculate internal resistance Ri for sensor upstream cat
B_RIBEV2	GGLSV	LOK	Condition calculate internal resistance Ri for sensor upstream cat , bank 2
B_RIIBV	GGLSV	LOK	Cond. sensor volt. in the perm. range for pump. current upstream cat
B_RIIBV2	GGLSV	LOK	Cond. sensor volt. in the perm. range for pump. current upstream cat , bank2
B_RIIMPV	GGLSV	LOK	Condition impuls for pumping current upstream catalyst
B_RIMV	GGLSV	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage upstream cat
B_RIMV2	GGLSV	LOK	Cond. (adc-trigger) for measuring of loaded sensor voltage upstrean cat, bank2
B_RINV	GGLSV	AUS	Condition: Internal resistance Ri of O2 sensor activ,pre cat
B_RINV2	GGLSV	AUS	Condition: Internal resistance Ri of O2 sensor activ,pre cat bank 2
B_RIPUV	GGLSV	LOK	Condition pumping current for sensor upstream catalyst
B_RIPUV2	GGLSV	LOK	Condition pumping current for sensor upstream catalyst bank2
B_RIREV	GGLSV	LOK	Condition result for internal resistance Ri for sensor upstream cat
B_RIREV2	GGLSV	LOK	Condition result for internal resistance Ri for sensor upstream cat , bank2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SHUERF		EIN	Condition sensor voltage post cat measured
B_SHUERF2		EIN	Condition sensor voltage post cat measured bank 2
B_SVUERF	GGLSV	LOK	Condition sensor voltage pre cat measured
B_SVUERF2	GGLSV	LOK	Condition sensor voltage pre cat measured bank 2
B_TTBMH		EIN	condition theoretical lambda sensor operation readyness with heating
B_TTBMH2		EIN	condition theoretical lambda sensor operation readyness with heating bank2
B_USBEV	GGLSV	LOK	Condition for time counter for deactivation of the sensor load upstream cat
B_USBEV2	GGLSV	LOK	Condition for time counter for deactivation of the sensor load upstream cat ban2
C_INI	SWADAP	EIN	ECU-condition for intialisation
RINOFV2_W	GGLSV	AUS	Internal resistor (word) Ri Nernst without filter , pre cat, bank 2
RINOFVA2_W	GGLSV	LOK	Internal resistor (word) Ri Nernst (old value) without filter , pre cat bank2
RINOFVA_W	GGLSV	LOK	Internal resistor (word) Ri Nernst (old value) without filter , pre cat
RINOFV_W	GGLSV	AUS	Internal resistor (word) Ri Nernst without filter , pre cat
RINV2_W	GGLSV	AUS	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_W	GGLSV	AUS	Actuel value of internal resistance of lambda sensor,pre cat (word)

Variable	Source	Type	Description
R_T1		EIN	Time schedule 1 ms
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
USBEV2_W	GGLSV	LOK	Voltage (word) lambda sensor loaded with resistance upstream cat, bank 2
USBEV_W	GGLSV	LOK	Voltage (word) lambda sensor loaded with resistance upstream cat
USOBV2_W	GGLSV	LOK	Voltage (word) lambda sensor without load upstream catalyst bank 2
USOBV_W	GGLSV	LOK	Voltage (word) lambda sensor without load upstream catalyst
USVK	GGLSV	AUS	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	AUS	output voltage oxygen sensor upstream catalyst 2
USVK2_W	GGLSV	AUS	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVKR2_W	GGLSV	LOK	Voltage (word) O2-sensor in raw value, pre cat , bank 2
USVKR_W	GGLSV	LOK	Voltage (word) O2-sensor in raw value, pre cat
USVK_W	GGLSV	AUS	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
USVMB2_W	GGLSV	LOK	Voltage (word, 10 ms time slot) sensor with resistor loaded, upstream cat, bank2
USVMB_W	GGLSV	LOK	Voltage (word, 10 ms-time slot) O2-sensor with resistor loaded , upstream cat
USVOB2_W	GGLSV	LOK	Voltage (word, 10 ms time slot) sensor, unloaded, upstream cat, bank 2
USVOB_W	GGLSV	LOK	Voltage (word 10 ms-time slot) sensor, unloaded, upstream cat
UUSVK2_W	GGLSV	LOK	ADC voltage for lambda sensor upstream of catalyzer 2 (Word)
UUSVK_W	GGLSV	LOK	ADC voltage for lambda sensor upstream of catalyzer (Word)
UUSVMB2_W	GGLSV	LOK	Voltage (word, 1 ms-time slot) sensor with resistor loaded, upstream cat bank2
UUSVMB_W	GGLSV	LOK	Voltage (word, 1 ms-time slot) O2-sensor with resistor loaded , upstream cat
UUSVOB2_W	GGLSV	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded upstream cat bank2
UUSVOB_W	GGLSV	LOK	ADC voltage (word, 1 ms-time slot) O2-sensor unloaded upstream cat
ZRIBERV	GGLSV	LOK	Ri calculation counter after engine start pre cat
ZRIBERV2	GGLSV	LOK	Ri calculation counter after engine start pre cat, bank 2
ZRINV2_W	GGLSV	LOK	Time counter for preparation of the actuel condition Ri-Nernst pre cat bank 2
ZRINV_W	GGLSV	LOK	Time counter for preparation of the actuel condition Ri-Nernst pre cat

FW GGLSV 2.30 Fixed Values

Parameter	Value	Description
ANZRIBEV		Amount of Ri calculation pre cat
CWGGLSV		Code word for Ri-measurement for O2sensor pre cat (not fully heated)
DUSRIV		Delta sensor voltage pre cat between new and old value for Ri measurement
DUSSPV		Delta sensor volt.front cat between new and old val. for sensor jump knowledge
FRINOF		Factor for validation of old Ri-value without filter
RINVMX		Internal resistor Ri of nernst sensor limited to maximal value
TGGLS		Time needed for ADC after interrupt in the function calculator (Asic)
THSRIV		Ready condition, time delay,of Ri measurement after sensor heating on pre cat
TRIAKTV		Time for Ri calculation actuel pre cat
TRIIMPV		Time for pump impulse for both banks pre cat
TUSBELV		Time for holding of O2 sensor voltage after Impuls charge
USRIMINV		Minimum voltage threshold for Ri-mesurement of the sensor upstream cat
USRIOV		Upper voltage threshold for Ri-measurement of the sensor upstream cat
USRIUV		Lower voltage threshold for Ri-measurement of the sensor upstream cat
ZFRIV		Reduction factor for internal resistor Ri-Nernst filter pre cat

FB GGLSV 2.30 Detailed description of function

1. Introduction:

The sensor function GGLSV serves for the acquisition and the quantization of the sensor voltage upstream catalyst as well as for the generating of a pump current while at the same time the internal resistance Ri of the Nernst sensor is determined.

In this sensor function the sensor voltage is perodically pulsed by means of a pump current (0.5 mA for 10 ms) so that the sensors LSH and LSF4 are completely compatible. Thus no sensor diagnosis need to be changed.
The sensors LSH and LSF4 have an air reference and would not need a pump current. However, if a pulsed pump current is used on these sensors then the internal resistance Ri can be determined. By the internal restistance an indirect check is performed in the heater diagnosis DHLS on whether the sensor heater is o.k. In case of defect sensor heating or strongly reduced heating performance at low exhaust gas temperatures the internal resistance increases markedly.

2. Enable sensor function by configuration bit (GGLSV):

The sensor function can be enabled by the code word CWKONLS, provided the corresponding bits for the sensor installed upstream of the catalyst have been set. Bank1 can be enabled by means of bit 0 and with B_lsv = 1 and Bank1 enabled by bit 4 with B_lsv2 = 1 (sum = 17).
If the universal sensor LSU is installed upstream of the catalyst, then th e above condition must also be set by this code word as recognition for the sensor installed upstream of catalyst. SY_STETLR must be set so that this sensor function will not be active for the Nernst sensor.

3. Generation of pump impulse (current impulse) GGLSRIENV:

An instable multi-vibrator with the output B_riimpv serves to generate a pump impulse. The multi-vibrator supplies an impulse with the duration of 10 ms after an adjustable timer TRIIMPV has passed. This impuls B_riimpv sets the flip-flop B_riakv, i.e. the pumping current is updated. One timer only is used for both banks.

A pumping current with the condition B_ripuv = 1 can be performed if the sensor voltage lies within the permitted permissible voltage ranges (B_riibv = 1) and if the condition B_ttbmh = 1 from %DLSV was continuously active for a time longer than THSRIV.
The condition B_ttbmh from %DLSV can be disabled by the codeword CWGGLSV in order that Ri can be measured for application purpose even befor end of dewpoint (refer to Application Note).

A permitted voltage range for permissible pumping current exists if the sensor voltage usvkr_w
"- is greater than USRIOV in the rich range"
"- lies between USRIMINV and USRIUV in the lean range"
"- the gradient of the sensor voltage (difference between new value and old value (i-1) in the 10 ms grid) is less than the "
threshold value DUSRIV

After the pumping current was enabled B_ripuv = 1 the flip-flop B_riakv is reset in the next 10 ms grid (i-1) so that the period for pumping current is exactly 10 ms.

To maintain a correct current balance for the sensor LSF8, a timer TRIIMPV (B_riimpv =1, i.e. pump impulse is necessary) has passed and if at the same time sensor voltages occur in the not permitted voltage range (USRIUV < usvkr_w < USRIOV) the triggering of the pump impulse is at first forbidden and stored as information in the flip-flop B_riakv. Only once the non permitted voltage range is left immediately afterwards B_ripuv = 1 is set in the permitted voltage range and by doing so the pump impulse is triggered.

There must be a definite relationship between unloaded and loaded sensor voltage for a sensor in the 10 ms grid. This requirement is met by only one sensor being allowed to be pumped in the 10 ms grid.
B_ripuv canot be used to pump current if the sensor voltage at bank2 upstream of catalyst, or the voltages downstream of catalyst are momentarily being detected by B_svuerf2, or B_shuerf and B_shuerf2 respectively.
Via B_ripuv a port is switched with the bit B_pripv = 1 so that a pump current of 0,5 mA can flow for 10 ms from the 5V voltage supply and through a fixed defined resistor RBEL.

```
      Hardware:
      --------
                         5 V
                    -------+--------
                           |
                          +++
                          | | port resistor
                          +++
                           |
                           o
"                            /<---- port B_pripv              "
                           o
                           |
                          +++
                          | | RBEL
                          +++                                                       +---------+
                           |                                                        |         |
                      |    +--------------------------+---------------------------->+   ADC   |
               Ipump  |    |                          |                             |         |
                      v   +++                        +++                            +---------+
                          | | Ri (rinv_w)            | |  RKSP = 51 k
                          +++                        +++
                           |                          |
                        ---+---  sensor voltage    ---+--- 450 mV
                          ---                        ---
                           |                          |
                          -+-                        -+-
```

4. Transfer of the sensor voltage measured values (unloaded and loaded) into the 100 ms grid for the Ri-calculation

For the calcualtion of the internal resistance Ri of the sensor it is important that the unloaded and the loaded sensor voltages are read within a time grid of 10 ms. This can be achieved if prior to the on-load impulse the unloaded sensor voltage uusvk_w is read via the ADC and if during the on-load impulse (10 ms) after approx. 3 ms the loaded sensor voltage uusvb_w is read via the ADC.
After the pump impulse was triggered B_ripuv = 1 the sensor voltage ushkr_w is held at the old value via a timer TUSBELH during the following 10 ms grid (i-1) so that the increased loaded sensor voltage cannot have an effect.

4.1 Measuring the loaded and unloaded sensor voltage in the 1 ms time frame (GGLSERFV):

The ADC value of the sensor voltage is sampled in the 1 ms-time frame and is stored as the word uusvk_w in the RAM.
If a permissible pump impulse B_ripuv follows, then the unloaded voltage uusvob_w is stored by setting the timer TGGLS with a positive edge. After elapse of the time TGGLS, the loaded sensor voltage uusvob_w is stored is then retained in the 1 ms time frame with the negative edge. Setting the pump impulse B_ripuv will also set the Flip-Flop B_svuerf in the 1 ms frame, i.e. for the sensor upstream of the catalyst at bank1, the requirement is set that only the the sensor voltage will be measured here. TGGLS is reset following elapse of the timer by the negative edge of this detection Flip-Flop B_svuerf.
It must be ensured that the order of the bank calculation is observed (first bank1 and then bank2).

4.2 Transfer of loaded and unloaded sensor voltage from the 1 ms time frame in 10 ms and 100 ms time frames (GGLSFV):

The condition B_rimv is set by resetting the Flip_Flop B_svuerf with the negative edge. The Flip-Flop B_ribev is set by B_rimv for transfer to the 10 ms and 100 ms time frames. The unloaded sensor voltage uusvob_w and the loaded sensor voltage uusvmb_w are transfered into a RAM in the 10 ms time frame with the positive edge of this Flip-Flop. The increase from sensor grounding, SY_USOFF, that is specific to the control unit, is sutracted from the unloaded sensor voltage uusvob_w or loaded sensor voltage uusvmb_w and then receives the unloaded sensor voltage usvob_w and the loaded sensor voltage usvmb_w in the 10 ms time. These are then transferred in the 100 ms time frame to the RAM, usobv_w and usbev_w respectively.
The increase in the sensor grounding, SY_USOFF, that is specific to the control unit is then also subtracded in the 1 ms-time frame from the ADC voltage and stored in the 10 ms-time frame as the raw value in the RAM usvkr_w (word). This 16 bit sensor voltage usvkr_w is converded to the 8 bit format (usvk) for additional use in sensor diagnostics and lamda control.

Ri-calculation (rinofv_w)

The internal resistance Ri’ of the sensor is calculated from:

$$Ri' = \frac{usbev\_w - usobv\_w}{5V - usbev\_w} * RBEL$$

Corrected by the counter-resistance RKSP in the hardware Ri becomes:

$$Ri = \frac{Ri' * RKSP}{RKSP - Ri'} = rinofv\_w$$

This RI value is given in the 100 ms-time frame by setting the Flip-Flop B_ribev = 1 and is limited to RINVMX.
The following measures are performed in order to prevent the loaded sensor voltage from being used in a jump of the sensor voltage during the 10 ms-impulse:

a) If, primarily the rich tolean jump, the difference between the loaded sensor voltage usbev__w and the unloaded sensor voltage usobv_w is less than zero, then the B_erinofv is not set and Ri is not comuted.

b) If, primarily during the lesn to rich jump, it is determined following elapse of the timer that the magnitude from the difference of the sensor voltage from the new-old value in the 10 ms time frame is grater than DUSSPV and hence Ri is not calculated.

Thereafter rinofv_w is filtered through an event filter with the attenuation factor ZFRIV so that the filtered internal resistance rinh_w of the sensor is obtained. -----> Event filter : y[k] = y[k-1] + ZFRIV(x[k] + y[k-1])

After the calculation of the internal resistance a flag is set in the 10 ms grid via B_rireh = 1 (Ri-calculation terminated) and the flip-flop B_ribev is reset.

4.3 Additional interference suppression of Ri measurements and formation of enable for the Ri filter (GGLSVENTS):

In the new unfiltered new value of Ri (rinofv_w) is greater by a factor FRINOF than the old Ri value rioffv_w, then B_enrinv is not set and hence the calculated value is transferred to the filter. In order than an increase in the internal resistance Ri is possible during sensor cooling (new Ri value is greater than the old value vby the factor FRINOF), the transfer of rinofv_w to the filter is enabled by B_enrinv = 1 after measuring 2 Ri values.

The Ri-calculations B_ribev are added-up by means of a counter zriberv. If the number of Ri-calculations is greater than ANZRIBEV then a flip-flop B_rinv is set, which indicates to the heater diagnosis the state that the calculation of the internal resistance is active and up to date. ANZRIBEV = 3/ZFRIV is chosen.
As soon as the counter starts a retriggerable timer zrinv_w is triggered, whose timer time is chosen at TRIAKTV = 4*TRIMPV.
Once the timer has passed zrinv_w = 0 the flip-flop B_rinv is reset (resitance value rinv_w is not updated). If within the period TRIAKTV again current Ri-calculations are performed (B_ribev =1), then this timer zrinv_w is continuously started again so that the condition B_rinv is currently active.

Course of the ADC-sequence:

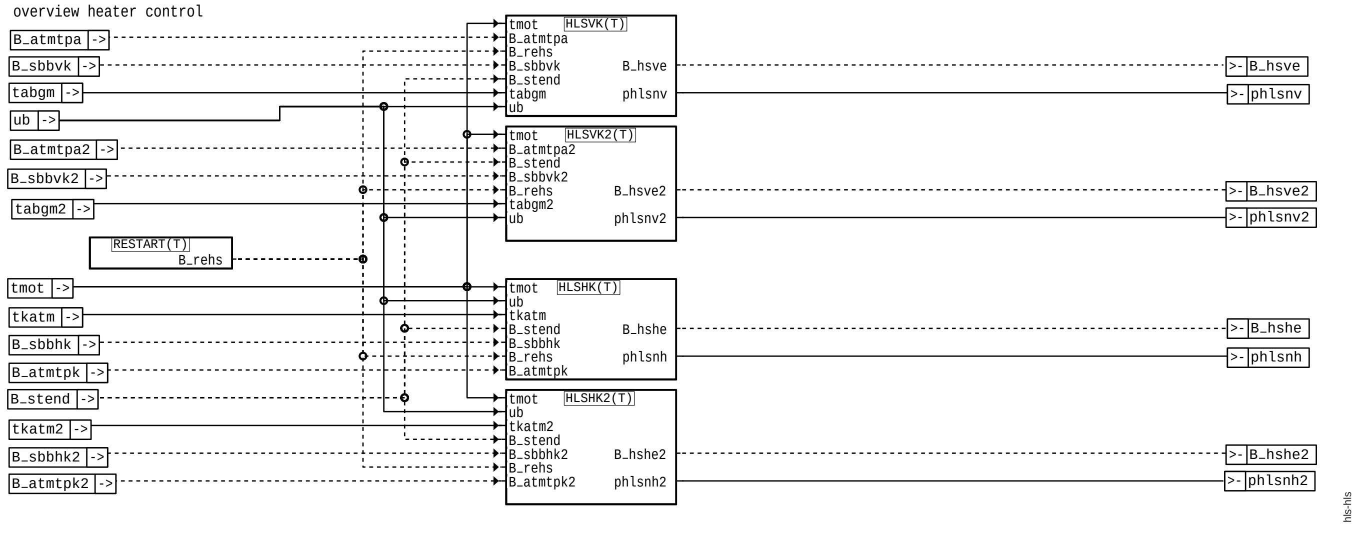
```
           |<-------------------------------  10 ms-grid  ---------------------->|
           |                                                                     |
           +-----------+                                                         +------------+
           |           |<----- duration of the cal. program                      |            |
           |           |                                                         |            |
     ------+           +---------------------------------------------------------+            +----------------------------->
                                                                                                                         time
```

APP GGLSV 2.30 Application hint

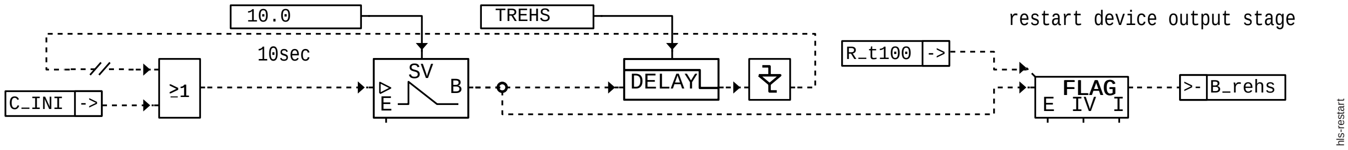
```
SY_USOFF
---------
The fixed value voltage difference between sensor ground and electronic ground can adjustable with a system constant SY_USOFF
and it must be adjusted ECU-specific by the software.
Example: If the voltage between sensor grond and electronic ground is 0.268V the SY_USOFF must be adjusted to 0.268V.

Corresponding to the hardware design SY_USOFF becomes 0V; 0,268V or 0,714V.

Typical application values:

THSRIV   = 10 s
TUSBELV  = 30 ms
TRIIMPV  = 2 s
TRIAKTHV = 4*TRIMPV = 8 s
ZFRIV    = 0.3
ANZRIBEV = 3/ZFRIV = 10
RBEL     = 8.45 KOhm
RKSP     = 51 KOhm
RINVMX   = 100 KOhm
USRIOV   = 550 mV
USRIUV   = 250 mV
USRIMINV  = 60 mV
DUSRIV   = 25 mV
UBDLS    > 11 V
TGGLS    = 3 ms
FRINOF   = 1.5
CWGGLSV = 0   --------> Code word = 0 : Ri is only calculaded after end of dewpoint for full heating power (series)
                                  = 1 : Ri can be measured as high-resistance for application purposes during phase of dewpoint

CWKONLS :  ----------->  Code word in % PROKON : Sensors present upstream of the catalyst  ---> Bank1: B_lsv by Bit  0 = 1
                                                                                               Bank2: B_lsv2 by Bit 4 = 16
                                                                                               (gives 17 as the sum)

                                                 Sensors present downstream of the catalyst --> Bank1: B_lsh by bit 1  = 2
                                                                                               Bank2: B_lsh2 by bit 5 = 32
                                                                                               (gives 34 as the sum)

                                                 For all 4 installed seensors: CWKONLS = 51
```

HLS 16.40 Lambda sensor heater

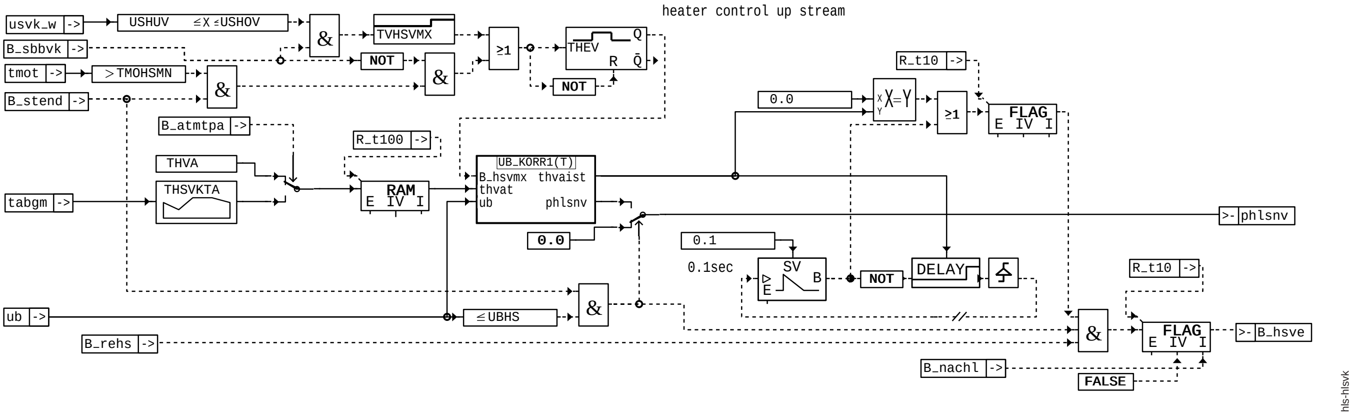
FDEF HLS 16.40 Function definition



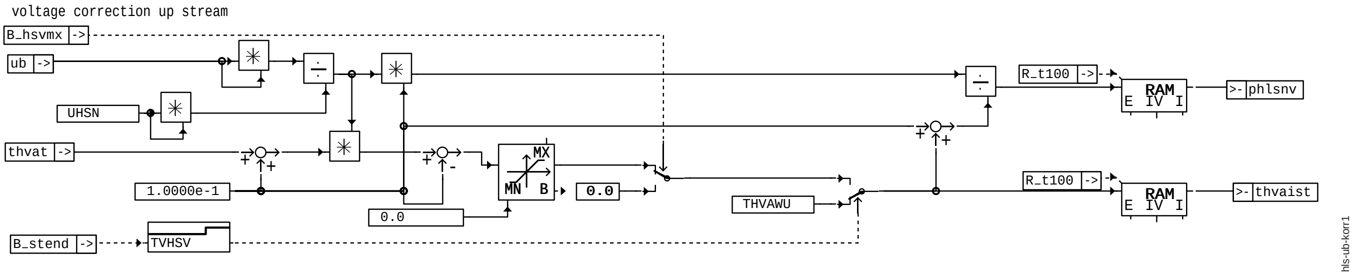
hls-hls



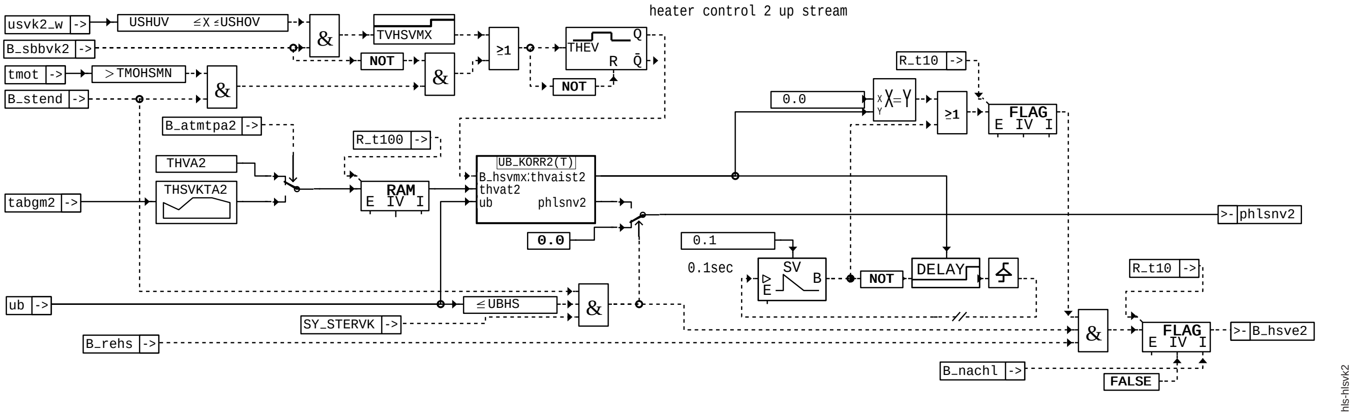
hls-restart



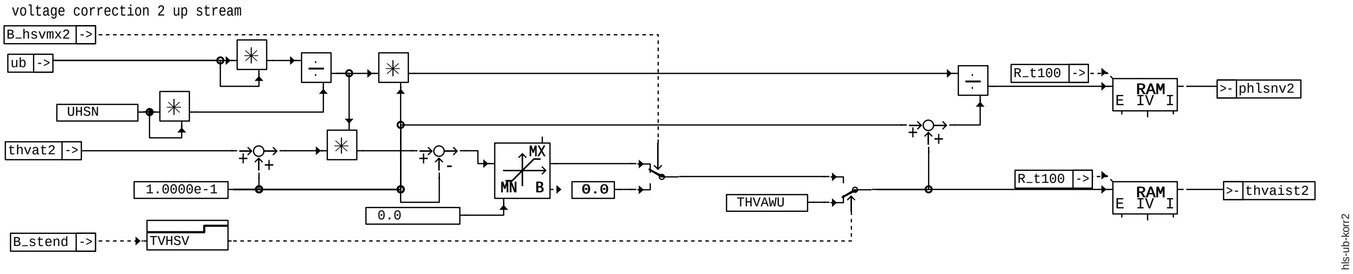
hls-hlsvk



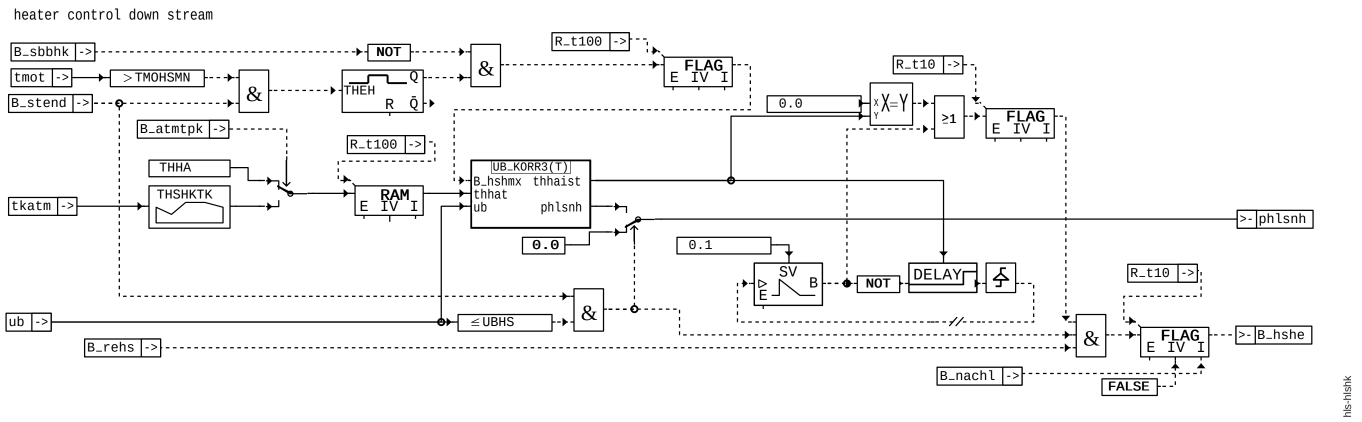
hls-ub-korr1



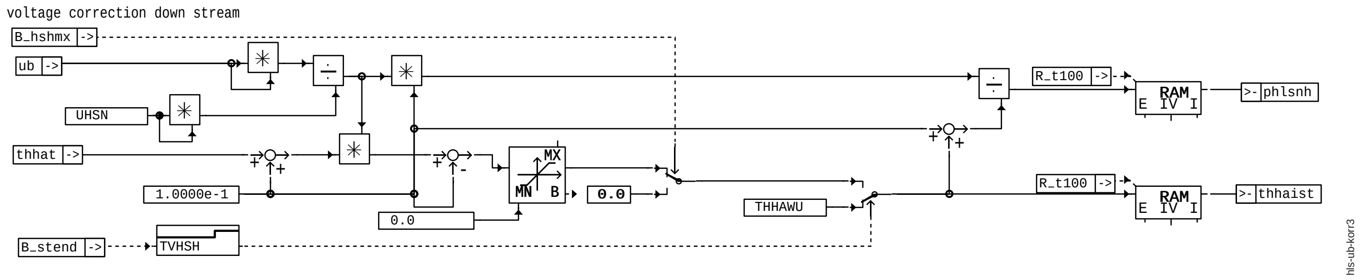
hls-hlsvk2



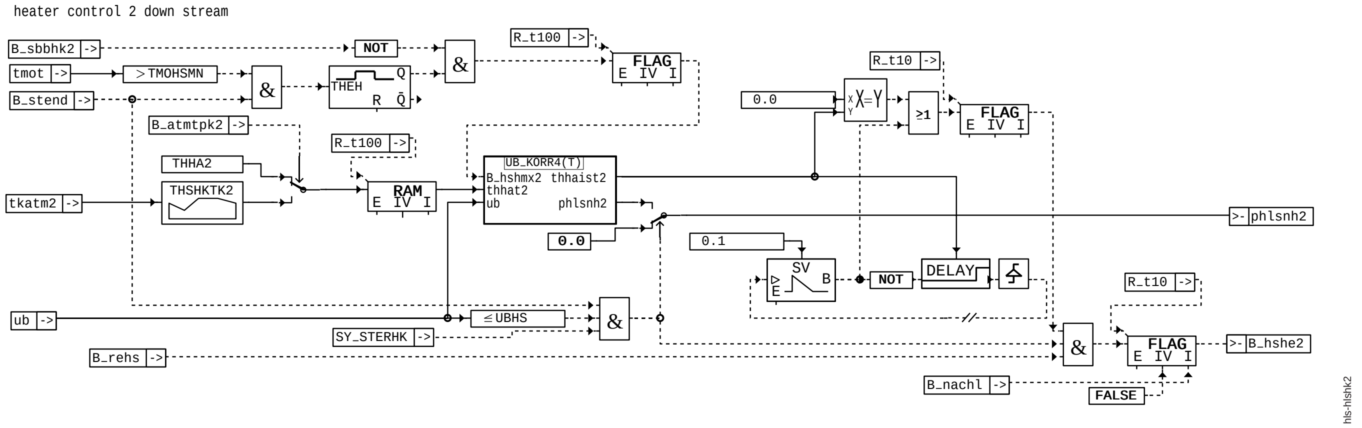
hls-ub-korr2



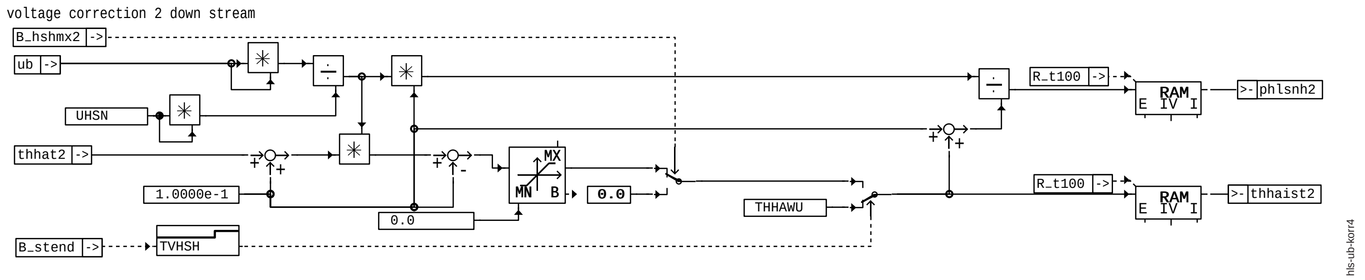
hls-hlshk



hls-ub-korr3



hls-hlshk2



hls-ub-korr4

ABK HLS 16.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
THEH			FW	Time for maximal lambda sensor heating post cat after engine start
THEV			FW	Time for maximal lambda sensor heating after start , pre cat
THHA			FW	off time to reduce heater power of oxygen sensor downstream cat at 13Volt
THHA2			FW	off time to reduce heater power of oxygen sensor2 downstream cat at 13Volt
THHAWU			FW	Switch OFF time during power reduction of sensor heating post cat
THSHKTK	TKATM		KL	Line for switch off time of lambda sensor heating post cat dep. on temp
THSHKTK2	TKATM2		KL	ine for switch off time of lambda sensor heating 2 post cat dep. on temp

Parameter	Source-X	Source-Y	Type	Description
THSVKTA	TABGM		KL	Line of switching off time for lambda sensor heating depending on exh.gas temp
THSVKTA2	TABGM2		KL	Line of switching off time for lambda sensor heating depending on exh.gas temp 2
THVA			FW	off time to reduce heater power of oxygen sensor upstream cat at 13 Volt
THVA2			FW	off time to reduce heater power of oxygen sensor2 upstream cat at 13 Volt
THVAWU			FW	Switch OFF time during power reduction of sensor heating pre cat
TMOHSMN			FW	Minimum engine temperature for lambda sensor heating
TREHS			FW	time for restart sensor heating
TVHSH			FW	delay time for sensor heater downstream cut
TVHSV			FW	delay time for sensor heater upstream cut
TVHSVMX			FW	delay time for maximum sensor heater upstream cut
UBHS			FW	battery voltage threshold for switching off oxygen sensor heater
UHSN			FW	Nominal battery voltage for lambda sensor heating
USHOV			FW	Upper O2-sensor voltage threshold for maximal sensor heatin pre catalyst
USHUV			FW	Lower O2sensor voltage threshold for maximal sensor heating pre catalyst

Variable	Source	Type	Description
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_ATMTPK	ATM	EIN	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	EIN	condition temperature downstream catalyst exceeds dew-point2
B_HSHE	HLS	AUS	condition for lambda sensor heating-switch downstream cat on
B_HSHE2	HLS	AUS	condition for lambda sensor2 heating-switch downstream cat on
B_HSHMX	HLS	LOK	Condition maximal power of lambda sensor heating post cat
B_HSHMX2	HLS	LOK	Condition maximal power of lambda sensor heating 2 post cat
B_HSVE	HLS	AUS	condition for lambda sensor heating-switch upstream cat on
B_HSVE2	HLS	AUS	condition for lambda sensor2 heating-switch upstream cat on
B_HSVMX	HLS	LOK	Condition maximal power of lambda sensor heating pre cat
B_HSVMX2	HLS	LOK	Condition maximal power of lambda sensor heating 2 pre cat
B_NACHL	MOTAUS	EIN	ECU control for ECU switch off delay
B_REHS	HLS	LOK	Restart Lambda sensor heating
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_STEND	BBSTT	EIN	condition end of start
C_INI	SWADAP	EIN	ECU-condition for intialisation
PHLSNH	HLS	AUS	Standardized heating power of the Lambda sensor downstream of the catalyzer
PHLSNH2	HLS	AUS	Standardized heating power of the Lambda sensor 2 downstream of the catalyzer
PHLSNV	HLS	AUS	normalized heating power of lambda sensor upstream of catalyst
PHLSNV2	HLS	AUS	normalized heating power of lambda sensor 2 upstream of catalyst
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
THHAIST	HLS	LOK	”Off”-duration for sensor heating downstream catalyst
THHAIST2	HLS	LOK	”Off”-duration for sensor heating2 downstream catalyst
THHAT	HLS	LOK	Uncorrected switch off time for lambda senor heating post cat
THHAT2	HLS	LOK	Uncorrected switch off time for lambda senor heating 2 post cat
THVAIST	HLS	LOK	”Off”-duration for sensor heating upstream catalyst
THVAIST2	HLS	LOK	”Off”-duration for sensor heating2 upstream catalyst
THVAT	HLS	LOK	Uncorrected switch off time for lambda senor heating pre cat
THVAT2	HLS	LOK	Uncorrected switch off time for lambda senor heating 2 pre cat
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TMOT	SWADAP	EIN	Engine temperature
UB	SWADAP	EIN	battery voltage
USVK2_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVK_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst

FW HLS 16.40 Fixed Values

Parameter	Value	Description
THEH		Time for maximal lambda sensor heating post cat after engine start
THEV		Time for maximal lambda sensor heating after start , pre cat
THHA		off time to reduce heater power of oxygen sensor downstream cat at 13Volt
THHA2		off time to reduce heater power of oxygen sensor2 downstream cat at 13Volt
THHAWU		Switch OFF time during power reduction of sensor heating post cat
THVA		off time to reduce heater power of oxygen sensor upstream cat at 13 Volt
THVA2		off time to reduce heater power of oxygen sensor2 upstream cat at 13 Volt
THVAWU		Switch OFF time during power reduction of sensor heating pre cat
TMOHSMN		Minimum engine temperature for lambda sensor heating
TREHS		time for restart sensor heating
TVHSH		delay time for sensor heater downstream cut
TVHSV		delay time for sensor heater upstream cut
TVHSVMX		delay time for maximum sensor heater upstream cut
UBHS		battery voltage threshold for switching off oxygen sensor heater
UHSN		Nominal battery voltage for lambda sensor heating

Parameter	Value	Description
USHOV		Upper O2-sensor voltage threshold for maximal sensor heatin pre catalyst
USHUV		Lower O2sensor voltage threshold for maximal sensor heating pre catalyst

FB HLS 16.40 Detailed description of function

This heater control is suitable also for power stages without current measuring shunt. The heating of the Lambda sensor is controlled such that independent of the ambient conditions (condensate, exhaust gas temperature, battery voltage) the Lambda sensor is not damaged. The heater power stage is short-circuit-proof and switches off automatically in case of too high current.
Via a port, B_hsve triggers the heater power stage, that means B_hsve=1 ==> sensor is heated.
The port must be inverted for integrated power stages CJ920. It must be operated within 10ms after B_hsve.
The output signal phlsnv represents the standardized heating performance of the sensor heating. With nominal voltage (UHSN = 13 Volt) the output shows the value 1,0 if the heating is not reduced.
If the battery voltage is greater than UHSN then the sensor heating is clocked such that phlsnv = 1.

Function of the heater control after start:
----

1. Ceramic protection (avoiding ceramic stress)
   During the time TVHSV after end of start the heating performance is reduced (dependent on THVAWU) so as to limit the temperature gradient of the sensor ceramic.

2. maximum heating
   Maximum heating (phlsnv > 1) is performed during the time THEV, in order to reach the sensor operating readiness as quickly as possible.
   If the operating readiness stops again due to too little heating performance, maximum heating is again performed during THEV.
   If the sensor voltage is within the limits of the threshold USHUV / USHOV, the sensor heating will be switched on to Maximun when the delay time TVHSVMX is exceded.
   If maximum heating is not allowed (downstream catalyst) then the time THEH must be set to the value zero.

3. Ceramic protection (avoiding thermal shock)
   After the time THEV has elapsed or in case of sensor ready for operating the heating performance is reduced dependent on THVA until dew point end is reached. In addition the heating performance is corrected dependent on the battery voltage (ceramic protection during condensate phase).

4. Temperature control
   After end of dew point the heating performance can be controlled dependent on the exhaust gas temperature (characteristic line THSVKTA) so that the ceramic temperature is e.g. 750°C.

5. Power stage protection
   With high battery voltage (booster start) the heating must be switched off (threshold UBHS).

6. Power stage diagnosis
   For the diagnosis of the power stage the heating is switched off periodically every 10s for TREHS. A power stage switched off due to short-circuit or overloading is activated again by this (block restart).

APP HLS 16.40 Application hint

```
                                     +---------------------------------------------------------------------------------+
1.Determination of THVA/2, THHA/2    |Set point ceramic temperature: upstr. cat 300 to 350°C, downstr. cat 200 to 250°C|
---------------------------------    +---------------------------------------------------------------------------------+
```

During the condensate phase the ceramic temperature of the sensors must be limited. For this, the necessary mean heater voltage is determined. The heater voltage is measured at an exhaust pipe wall temperature of 60°C. Above 60°C condensate no longer occurs.
So as to reach 300 to 350°C on the ceramic, e.g. a heater voltage UHM of 7.5V is necessary on the LSH25-PL (vehicle-specific).
With Te = 100ms the following times result for THVA from the below-mentioned formula.

```
+-----------------------------------+         +---------------------------------------------------------------------------------+
|LSH25P  LSH25PL LSH25PL LSF4.7 LSF4.7|       |The ceramic temperature must definitely be checked by means of a measuring sensor!|
|u.cat   u.cat   d.cat   u.cat  d.cat |       |After each change (engine, exhaust system, engine control), at the latest just    |
|0.16s   0.20s   0.58s   0.24s  0.62s |       |prior to the release the ceramic temperature must be checked again!               |
+-----------------------------------+         +---------------------------------------------------------------------------------+
********* Permitted ceramic temperature of the measuring sensor with condensate 350°C, after end of dew point approx. 650°C.********
```

Determination of the mean heater voltage UHM:
----

a) Mount a measuring sensor instead of the Lambda sensor for the ceramic temperature (from K3-LS/ESV).
   The measuring sensor should be of the same type (heating performance, protection pipe) as the sensor to be substituted.

b) Supply the sensor heating via an external constant-voltage source and adjust the voltage UHM such that the desired ceramic temperature (see above) is reached.
c) Start the vehicle (tmot < 70°C), operate at idling and correct UHM such that the demanded temperature is reached.
   The value UHM is valid at an exhaust pipe wall temperature of 55 to 60°C.
   The measurement should be terminated before the exhaust pipe wall temperature at the location where the sensor is mounted exceeds 60°C.

d) Calculate the off-time from UHM with the formula given below.

$$\text{THVA} = \text{Te} * \left(\frac{13V * 13V}{\text{UHM} * \text{UHM}} - 1 \right)$$

UHM = mean heater voltage for the demanded ceramic temperature
Te = on-time (0.10s)

Checking of the ceramic temperature:

The exhaust gas temperature model must already have been adjusted. Especially the values in %ATM for end of dew point must be adjusted correctly. In case of too early end of dew point (B_atmtpa=1) cracking of the ceramic may result!

a1) Connect measuring sensor to the vehicle wiring harness.
b1) Start vehicle (tmot < 70°C, exhaust pipe wall temperature < 50°C), operate at idling, record the ceramic temperature and the exhaust pipe wall temperature (VS100, thermoscanner).
(attach the measuring position of pipe wall temperature just in front of the location where the sensor is mounted to the exhaust pipe by a conduit clip)
c1) In case of deviations of the ceramic temperature from the set point (moment: pipe wall exceeds 60°C) THVA must be corrected.
Ceramic temperature too high ===> increase THVA resp. THHA!
Should the bit end of dew point already have been set prior to this moment, then the %ATM application must be checked.
d1) After each correction of the off-time the course of the temperature must be checked again in case of a new start.

Hint: The control behaviour of the Lambda control is not good with the temperature-measuring sensor, i.e. the control readiness (B_sbbvk = 1) can be reset during the condensate phase. The control is OK with a normal sensor.

2. UBHS:

UBHS = 15.5V

With very high battery voltage (booster start) and extremely cold sensor it is possible that the power stage switches off due to too high heating performance at it. By means of the threshold UBHS the possible heating performance is limited and a switch-off is avoided. The value of UBHS should be around 15 to 16V.

3. TVHSV, TVHSH

LSH25PL	LSF4.7
0s	4s

Time to reduce heating after start.

4. THVAWU THHAWU

	LSH25P u.Kat	LSH25PL u.Kat	LSH25PL d.Kat	LSF4.7 u.Kat	LSF4.7 d.Kat
THVAWU	0s	0s	-	0.03s	-
THHAWU	-	-	0s	-	0.10s

In order to avoid ceramic stress the heating is clocked after the start during the time TVHSV/H on the LSF4.7.

5. THEV, THEH:

	LSH25 u.Kat	LSH25 d.Kat	LSF4.7 u.Kat	LSF4.7 d.Kat
THEV	50s	-	20s	-
THEH	-	0s	-	0s

After the start the heating can constantly be switched on for the time THEV resp. THEH also during the condensate phase until the sensor becomes ready for operation, (only permissible for upstream sensor!). Advantage: Maximum heating is again performed if the operating readiness is reset during the condensate phase. To protect the sensor for overheating, it is recommended to limit the time for operating readiness.The maximun value must not be higher than 2 times the normal operating readyness because of overheating protection if the sensor signal cable is defect.

6. USHUV, USHOV

UHSOV = 0,63V   UHSUV = 0,37V

If the sensor voltage is within the limits of the threshold USHUV / USHOV, the sensor heating will be switched on to Maximun when the delay time TVHSVMX is exceded to avoid the reset of the sensor operating readyness condition.

7.TVHSVMX = 1s

The delay time for the maximal sensor heating should be higher than the time of the half of one period of the lambda regulation in idle condition.
(Normal swinging of the sensor voltage thru the threshold USHOV / USHUV should not switch on the heating additionally) .

```
8. TREHS = 0,1s
---------------
```

```
9. THSVKTA/2, THSHKTK/2
-----------------------
```

The heating performance of the sensor can be adjusted by this characteristic lines such that a constant ceramic temperature is achieved independent of the exh. gas temp.

tabgm, tkatm	100°C	200°C	650°C	700°C	750°C	800°C	850°C	900°C
LSH25P vK	0	0	0	0	0	0.10	1,3	2.55s
LSH25PL hK	0	0	0	0.01	0.03	0.16	1,3	2.55s
LSF4.7D2 vK	0.03	0	0	0	0	0	0.8	2.00s
LSF4.7D2 hK	0.03	0	0	0.01	0.02	0.03	0.8	2.00s

The values THSVKTA/TK are dependent on the sensor type. The resistance rinh_w should be measured with a reference sensor type "PM" at exhaust gas temperature of 650°C. THSHKT should be calibrated that rinh_w is kept at a constant value. For the sensor upstream catalyst a reduction of the heating performance via THSVKTA in the of 650°C to 800°C is not necessary.
The LSF4.7 is operated at 100°C tabgm with only about 80% heating performance (lesser ceramic stress after end of dew point).

```
                  +-----------------+
10.TMOHSMN        | TMOHSMN = -10°C |
----------        +-----------------+
```

If the engine temperature is less than the threshold TMOHSMN only a reduced sensor heating is performed.

```
                  +--------------+
11.UHSN           | UHSN = 13.0V |
-------           +--------------+
```

If the battery voltage is greater than UHSN the heater voltage is clocked, i.e. the heating performance remains constant.

DLSA 44.20 Lambda sensor aging monitoring

FDEF DLSA 44.20 Function definition

Function definition of the Lambda sensor aging monitoring

The diagnosis of Lambda sensor aging DLSA serves for detection of upstream lambda sensors, which inadmissibly exceed the emission limits because of aging effects.
For detection of a shifted upstream sensor characteristic the correction factor atv of the superimposed I-controller is used. This I-controller ensures (for the two-sensor-control) that by means of the controller delay time TV a lawful emission behaviour is obtained, even in case of a sensor characteristic shift.
For detection of an upstream sensor, which is too slow, cycle duration monitoring of the sensor signal is applied.

Overview: "Two Sensor Control and Lambda Sensor Aging Monitoring Upstream Catalyst"

```
                                 +---------------------------------------------------------------------------+
                                 |                  fault evaluation    (MIL - control)                      |
                                 |                                                                           |
                                 +---------+----+--------------------------------+----+---------------------+
                                           |    |                                |    |
      +-----------+                 E_latp ^    ^ Z_latp                   E_latv ^    ^ Z_latv
      |DLSA-block | B_lsastp               |    |                                |    |
      +conditions +-------->-----------o---+----+-----------------------------o---+----+
      +-----------+                    |   |    |                             |   |    |
                                       v   |    |                             v   |    |
                                 +-----+---+----+-------+               +-----+---+----+-------+
                                 |    cycle duration    |               |    atv-              |
                                 |    monitoring  SVK   |               |    monitoring  SVK   |
                                 +--------+-----------+-+               +------+---+-----------+
                                  B_lrtpp ^    tplrvk ^                    atv ^   ^ B_lrhk
                                          |           |                        |   |
                                          |           |                        |   |
                                          |           |                        |   |                        DLSA
 - - - - - - - - - - - - - - - - - - - - -|- - - - - -| - - - - - - - - - -    | - | - - - - - - - - - - - - - - - - - -
                                          |           |                        |   |   +---------+           2-sensor control
                                          |           |                        |   +---+ PI -    |
                               +----------|-----------|------------------------+---<---+ control.+<----+
                               |          |           |                           atv  +---------+     |
                               v          |           |                                                |
                        +--------------+  |           |                                                |
      +------------+    | Lambda contr.+--+           |                                                |
    +-+ usvk > USR +----| (upstr. cat) +--------------+              +--------+   usvk    +------+     |
    | +------------+    |              +---------------------------->| engine +-----o---->|  cat +-----o------
    |                   +--------------+                    fr       +--------+     |     +------+   ushk
    +----------------------------------------------------------------------------<--+
```

Abbreviations in the block diagram, as far as they are not defined in %DLSA:

atv = regulated variable of the integrator for the reference controller; B_lr = condition flag for the lambda closed loop control
B_lrhk = condition flag for the downstream lambda control; F_sgnlr = flag, for usvk RICH or LEAN
fr = control factor; ushk = voltage of downstream sensor; usvk = voltage of upstream sensor; USR = control threshold

In block diagrams fault type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these informations directly from the fault path status managed in the DFPM.

For each fault path "wxyz" of this diagnosis function the following values are defined:

```
        Status fault path wxyz:                 sfpwxyz
              Error flag wxyz:                  E_wxyz
              Cycle flag wxyz:                  Z_wxyz
              Fault type  wxyz:                 TYP_wxyz: (B_mxwxyz, B_mnwxyz)
              Clear fault path:                 B_clwxyz
              Default value active:             B_bkwxyz  (optional)
          Fault path code wxyz:              CDTwxyz
          Fault class wxyz:                  CLAwxyz
          Fault intensity wxyz:              TSFwxyz
          CARB CODE wxyz:                    CDCwxyz
          Table of ambient cond. wxyz:       FFTwxyz
```

In this FDEF the following fault paths wxyz are treated:

Fault path name	used abbreviation (substitutes "wxyz")
Lambda sensor upstream CAT cycle duration monitoring bank 1	latp
Lambda sensor upstream CAT cycle duration monitoring bank 2	latp2
Lambda sensor upstream CAT atv monitoring bank 1	latv
Lambda sensor upstream CAT atv monitoring bank 2	latv2

DLSA-SVK atv monitoring (bank1)

(Bank1)

```
atv ----------------------+
from %LRHK      +-+       |
                | |       |
B_cdlatv ------>| |       |                                                     Permanent RAM
                | |       |   +-----------+                             +-+      +-+----+
B_lrhk  ------->| |       +-->| > TVLRHMX +----+            +---------->| +----->|S|Flip+--+B_mxlatv
(from %LRHK)    | |       |   +-----------+    |       +-+  |       +-->|&|      +-+----+  |
                | |       |                    +------>| +--+       |   +-+  +-->|R|Flop|  |  +-+
E_kat -------->o|&+-----+ |                 +--|------>|&+          |        |   +-+----+  +->| |     Permanent RAM
(from %DKAT)    | |     | |                 |  |       +-+          |        | Permanent RAM  |V|       +-+-----+    E_latv
B_lsastp ----->o| |     | |  +----------+   |  |      +-+           |   +-+  |  +-+----+  +-->| +------>|S|Flip +--------->
                | |     | +->| < TVLRHMN+-+-|--|----->| +-----------|-->|&+--|->|S|Flip+--+   +-+       +-+-----+
B_fa ----+---->o| |     |    +----------+ | |  |      |&|           +-->| |  |  +-+----+B_mnlatv   +--->|R|Flop |
         |      +-+     |            +----|-+--|----->| |           |   +-+  +->|R|Flop|           |    +-+-----+
         |              |            |    |    |      +-+           |        |  +-+----+           |
         |      +-+     |  +-+B_dlatv|    |    |                    |        +---------------------+
         +----->|&|     +->|V+-------+    |    |   +-+              |    +-+  B_nolatv        +-+  |
B_fatv -------->| +----+-->| |       |    |    +->o| |  +-+         +--->|&+----------------->| |  |
                +-+    |   +-+       |    +------>o|&+->| +---------|--->| |       +--------->|V+--+
                       |             |             +-+  |&|         |    +-+       |    +--->o| |       +-+-----+      Z_latv
                       |             +----------------->| |         |              |    |     +-+  +--->|S|Flip +----------->
                       |             |                  +-+         |              |    |          |    +-+-----+
                       |             |                              |              |    |    +-+   | +->|R|Flop |
B_cdlatv --------------|-------------|------------------------------|--------------|----+-->o|V+---+ |  +-+-----+
(0 = switch-off)       |             |                  +-----------+--------------|-------->| |     |
                       |             |             +-+  |                          |         +-+     |
                       +-------------|------------>|V+--+                          |                 |
                                     |         +-->| |                             |                 |
              +-+                    |         |   +-+                             |                 |
C_fcmclr ---->|&|    +-+             |         |                                   |                 |
B_cllatv ---->| +--->| |             |         |                                   |       +-+       |
              +-+    |V|             |         |            +----------------------|------>|V+-------+
C_pwf -------------->| +-------------|---------|------------|----------------------+------>| |
                     +-+             |         +------------|-------------------------+    +-+
                        +------------v------------+         |         +-----------+   |
                        |time counter tzlsatv_w   +---------|-------->|comparison |   |
                        +-------------+-----------+         |         |tzlsatv_w  +---+
                                 Reset|                     |         |> TWDDTV   |
C_ini --------------------------------+---------------------+         +-----------+
```

DLSA-SVK atv monitoring (bank2)

```
(Bank2)

atv2 -------------------o
SY_STERSY ------------>/        SY_STERSY = 1 corresponds to same parameter as bank1
                    1-o   o-2
                +-+   |   |   +----------+
                | |   |   +-->|> TVLRHMX2+-----+
B_cdlatv ------>| |   |   |   +----------+     |                                 Permanent RAM
                | |   |   |  +----------+      |                        +-+      +-+----+
B_lrhk2 ------->| |   +---|->| > TVLRHMX+------+            +---------->| +----->|S|Flip+--+B_mxlatv2
(from %LRHK)    | |   |   |  +----------+      |       +-+  |       +-->|&|      +-+----+  |
                | |   |   |   +----------+     +------>| +--+       |   +-+  +-->|R|Flop|  |  +-+
E_kat2 ------->o|&+-+ |   +-->|< TVLRHMN2+-+   |   +-->|&|          |        |   +-+----+  +->| |     Permanent RAM
(from %DKAT)    | | | |       +----------+ |   |   |   +-+          |        | Permanent RAM  |V|       +-+-----+   E_latv2
B_lsastp2 ---->o| | | |      +----------+  |   |   |  +-+           |   +-+  |  +-+----+  +-->| +------>|S|Flip +-------->
                | | | +----->| < TVLRHMN+--+---|---|->| +-----+-----|-->|&+--|->|S|Flip+--+   +-+       +-+-----+
B_fa ----+---->o| | |        +----------+  |   |   |  |&|           +-->| |  |  +-+----+B_mnlatv2  +--->|R|Flop |
         |      +-+ |                 +----|---|---+->| |           |   +-+  +->|R|Flop|           |    +-+-----+
         |           |                 |    |   |      +-+          |        |  +-+----+           |
         |      +-+ |      +-+B_dlatv2|    |   |                    |        +---------------------+
         +----->|&| +----->|V+--------+    |   |   +-+              |    +-+  B_nolatv2       +-+  |
B_fatv2 ------->| +----+-->| |        |    |   +->o| |  +-+         +--->|&+----------------->| |  |
                +-+    |   +-+        |    +----->o|&+->| +---------|--->| |       +---------->|V+--+
                       |              |            +-+  |&|         |    +-+   +---|-------->o| |       +-+-----+     Z_latv2
                       |              +---------------->| |         |          | +-|-------->o| |  +--->|S|Flip +----------->
SY_STERHK ---------+   |              |                 +-+         |          | | |   +-+    +-+  |    +-+-----+
(Mono=0, Stereo=1) +---|--------------|-----------------------------|----------|-+-|->o| |         | +->|R|Flop |
B_cdlatv --------------|--------------|-----------------------------|----------+---|->o|V+---------+ |  +-+-----+
(0 = switch-off)       |              |                             +--------------|-->| |           |
                       |              |            +-+              |              |   +-+           |
                       +--------------|----------->|V+--------------+              |                 |
                                      |        +-->| |                             |                 |
              +-+                     |        |   +-+                             |                 |
C_fcmclr ---->|&|    +-+              |        |                                   |                 |
B_cllatv2 --->| +--->| |              |        |                                   |       +-+       |
              +-+    |V|              |        |            +----------------------|------>|V+-------+
C_pwf -------------->| +--------------|--------|------------|----------------------+------>| |
                     +-+              |        +------------|-------------------------+    +-+
                        +-------------v-----------+         |         +-----------+   |
                        |time counter tzlsatv2_w  +---------|-------->|comparison |   |
                        +-------------+-----------+         |         |tzlsatv2_w +---+
                                 Reset|                     |         |> TWDDTV   |
C_ini --------------------------------+---------------------+         +-----------+


For B_cdlatv = 0 (switch-off) :                                       For Mono with bit switch-over SY_STERHK = 0:
-------------------------------                                       --------------------------------------------


            +------------+                                                                +-------------  Mono = 0
            |            +---------->  B_mxlatv = 0                                       |
            | B_cdlatv=0 +---------->  B_mnlatv = 0                                       o   o--------  Stereo = 1
            |            +---------->  E_latv/2 = 0                          SY_STERHK --->\
            |            +---------->  Z_latv/2 = 1                                         o
            |            +---------->  B_dsvkd/2 = 0                                        |
            +------------+                                                                  |
                                                                                            |
                                                                                     +--------------+
                                                                                     |    DLSA      +-----------> Z_latv2 = 1
                                                                                     |              +-----------> E_latv2 = 0
                                                                                     +--------------+



DLSA-SVK monitoring of cycle duration
-------------------------------------
```

```
                                                                          Permanent RAM
                                                                                +-+----+
         +-----------+                          +------------+        +-+  +--->|S|Flip+-----+ B_mxlatp/2
         | > TSVKKO  +---o                      |            +------->|&+--+    +-+----+     |
         | < TSVKKU  |                          |            |    +-->| |   +-->|R|Flop|     |       +-+       +-+-----+ E_latp/2
         +-----------+     o-----o              |            |    |   +-+   |   +-+----+     +------>|V|------>|S|Flip +-------->
       +---------+        /       \ B_fatp/2    | TP-        |    |         | Permanent RAM +------->| |       +-+-----+
       | > TSVKO +-------o         o------------+            |    |   +-+   |  +-+----+     |        +-+    +->|R|Flop |
       | < TSVKU |E_kat/2                       | border line+----|-->|&+---|->|S|Flip+-----+ B_mnlatp/2    |  +-+-----+
       +---------+               o              |            |    +-->| |   |  +-+----+    +----------------+
         +-----------+           |              | scanning   |    |   +-+   +->|R|Flop|    |            +-+ |
         | > TSVKKTO +-----------+              |            |    |  +-+    |  +-+----+    |    +------>| | |
         | < TSVKKTU |                          |            +----|->|&|    +--------------+    |  +-->o|V+-+
         +-----------+                          |            |    +->| +-->---------------------+  | +->| |
B_cdlatp-----------------------------------+    +-----^------+    |  +-+ B_nolatp/2         +------+ |  +-+   +-+-----+  Z_latp/2
(0 = switch-off)                           |          |           |                         |   +-+  | +----->|S|Flip +---------->
                     +----------+          |          |           +-----------------------+-|-->|V+--|-+      +-+-----+
nmot --------------->| KFTPKOR  |          +----------|-----------------------------------|-+->o| |  |     +->|R|Flop |
rl ----------------->|          +----+                +---------------------------------+ |     +-+  |     |  +-+-----+
                     +----------+    |                       Permanent RAM  tpsvkmf/2_w | |          |     |
tplrvk_w/                            |                     /      +------------------+  | |          |     |
tplrvk2_w       /                  +-v-+                  /|      | ^     *  *  *    |  | +---------+|     |
(from %LR) ----o  o--------------->| * |----------->----o/ | o--->| |  *  ZFTSVK     +--+  +-+      ||     |
               B_dlatp/2           +---+      tpsvkof/2_w  |      | *------------  IV+-----+O|      ||     |
                                                           |      +---------------I^-+     +-+      ||     |
"                                                          |     +---------------+ |                ||     |
                                  +---------------->----o/ | o-->| counter zlsatp| |  +-----------+ ||     |
B_lrtpp/                          |            +---+       |     | for number of +-|->| comparison| ||     |
B_lrtpp2 ---+---------------------+----------->|   |       |     | valid measured| |  | zlsatp/2  |-+|     |
(from %LR)  |                                  | & +- - - -+     | cycles        | |  |> ANZDPVK  |  |     |
            |   +----------+   +---------+  +->|   |             +-----------^---+ |  +-----------+  |     |
            |   |countr f- |   |compare  |  |  +---+                         |     |                 |     |
            +-->|delay cyc.+-->|zwpvk >  +--+ B_dlaff/2               Reset  |     |                 |     |
                |zwpvk     |   |ANZTP    |                                   |     |                 |     |
                +----------+   +---------+                                   |     |                 |     |
                   ^                                                         |     |                 |     |
                   |        Reset                                            |     +-----------------+     |
                   +---o--o-----                                             |     |                       |
                      B_dlatp/2                                              |     |         +-+           |
C_ini -----------------------------------------------------------------------+-----|-------->| |           |
                           +-+                                                     |         |V+-----------+
C_fcmclr   --------------->|&|       +-+                                           +-------->| |
B_cllatp/2---------------->| +------>| |                                           |         +-+
                           +-+       |V+-------------------------------------------+
C_pwf ------------------------------>| |
                                     +-+

The filters tpsvkmf_w and tpsvkmf2_w are event-controlled.
```

```
Release function for cycle duration monitoring  with short trip
---------------------------------------------------------------

                                                                   +---------+
                        B_lr/B_lr2  ---------+-------------------->+         |
                              E_lm  ---------|-+----------------->o+         |
                              E_tm  ---------|-|-+--------------->o+         |
                              E_ta  ---------|-|-|-+------------->o+         |
                            B_gasp  ---------|-|-|-|-+----------->o+         |
                        B_lsastp/2  ---------|-|-|-|-|-+--------->o+         |
             NTPVK < nmot < NTPVKO  ---------|-|-|-|-|-|---------->+         |
            RLTPVKU < rl < RLTPVKO  ---------|-|-|-|-|-|---------->+         |               +----+
                    tabgm > TKTPVK  ---------|-|-|-|-|-|-+-------->+         |               |    |
                             Z_hsv/2  -------|-|-|-|-|-|-|-+------>+    &    +-------------->|    |   B_dlatp/2
            B_cdlatp ------------------------|-|-|-|-|-|-|-|-+---->+         |               |  V +----------->
             +-------------+                 | | | | | | | | |     |         |        +----->|    |
             | TSTEAA +--- |     +---+       | | | | | | | | |     |         |        |      |    |
 B_te -->-+--+ -------+-->t+-->--+   |       | | | | | | | | |     |         |        |      +----+
          |  +-------------+     | V +-------|-|-|-|-|-|-|-|-|-+-->+         |        |
          +-------------------->o+   |       | | | | | | | | | |   |         |        |
                                 +---+       | | | | | | | | | |   |         |        |
B_fa ------------------+---------------------|-|-|-|-|-|-|-|-|-|->o|         |        |
                       |                     | | | | | | | | | |   +---------+        |
                       |                     | | | | | | | | | |
                       |                     | | | | | | | | | |   +---------+        |
                       +---------------------|-|-|-|-|-|-|-|-|-|-->|         |        |
B_fatp/2 ------------------------------------|-|-|-|-|-|-|-|-|-|-->|         |        |
                                             | | | | | | | | | +-->|         |        |
                                             | | | | | | | | +---->|         |        |
                                             | | | | | | | +------>|         |        |
                                             | | | | | | +-------->|         |        |
                                             | | | | | +--------->o|         |        |
                                             | | | | +----------->o|    &    +--------+
                                             | | | +------------->o|         |
                                             | | +--------------->o|         |
                                             | +----------------->o|         |
                                             +------------------->o|         |
NTPKTU < nmot < NTPKTO ------------------------------------------->|         |
RLTPKTU < rl < RLTPKTO ------------------------------------------->|         |
                                                                   +---------+
```

```
For B_cdlatp = 0 (switch-off):                                        For Mono with bit switch-over SY_STERVK = 0:
------------------------------                                        --------------------------------------------



            +------------+                                                             +-------------   Mono = 0
            |            +---------->  B_mxlatp/2 = 0                                  |
            | B_cdlatp=0 +---------->  B_mnlatp/2 = 0                                  o   o---------   Stereo = 1
            |            +---------->  E_latp/2 = 0                       SY_STERVK --->\
            |            |                                                               o
            |            +---------->  Z_latp/2 = 1                                      |
            +------------+                                                               |
                                                                                         |
                                                                                  +--------------+
                                                                                  |              +-----------> B_mxlatp2 = 0
                                                                                  |    DLSA      +-----------> B_mnlatp2 = 0
                                                                                  |              +-----------> Z_latp2 = 1
                                                                                  |              +-----------> E_latp2 = 0
                                                                                  +--------------+
```

```
Release function for DLSA
-------------------------

                                            +---------+
error flag E_agre           --------------->+         |
from %DAGRE                                 |         |
error flag E_agrf           --------------->+         |
from %DAGRF                                 |         |
error flag B_mdarv          --------------->+         |
from %DMDMIL                                |         |
error flag E_hsv            --------------->+         |
error flag E_hsv/2          --------------->+         |
error flag E_hsh            --------------->+         |
error flag E_hsh/2          --------------->+         |
from %DHLS                                  |         |
error flag E_ph             --------------->+         |
from %DPH                                   |         |
error flag E_tes            --------------->+    V    +-------------> B_lsastp/2
from %DTEV/%DTES                            |         |
error flag E_teve           --------------->+         |
from %DTEVE                                 |         |
error flag E_ub             --------------->+         |
from %DUBAT                                 |         |
condition flag B_edkvs      --------------->+         |
condition flag B_edkvs/2    --------------->+         |
from %DKVS                                  |         |
condition flag B_dsls       --------------->+         |
from %DSLS                                  |         |
condition flag B_tehb       --------------->+         |
from %TEA                                   |         |
condition flag B_dtest      --------------->+         |
from %DTEV                                  +---------+
```

ABK DLSA 44.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZDPVK			FW	number of periodes for ready flag of Usvk period monitoring
ANZERTV			FW	amount of error measurements for ATV
ANZTP			FW	number of unconsidered cycles for cycle duration monitoring
CDCLATP	BLOKNR		KL	code word CARB: lambda sensor aging tp
CDCLATP2	BLOKNR		KL	code word CARB: lambda sensor aging tp, cyl. row 2
CDCLATV	BLOKNR		KL	code word CARB: lambda sensor aging tv
CDCLATV2	BLOKNR		KL	code word CARB: lambda sensor aging tv, cyl.row 2
CDLATP			FW	code word oxgen sensor aging diagnosis (TP) in OBDII mode (inv.: in Europe mode)
CDLATV			FW	code word lambda sensor monitoring (Tv) in OBDII mode (invers: Europe mode
CDTLATP			FW	code word tester: lambda sensor aging tp [015]
CDTLATP2			FW	code word tester: lambda sensor aging tp, cyl.row 2 [021]
CDTLATV			FW	code word tester: lambda sensor aging tv [016]
CDTLATV2			FW	code word tester: lambda sensor aging tv, cyl.row 2 [022]
CIDATV			FW	component ID for ATV single test
CIDATV2			FW	component ID for ATV single test bank2
CIDTP			FW	component ID for period TP single test
CIDTP2			FW	component ID for period TP single test bank2
CLALATP			FW	fault class: O2 sensor aging upstream cat TP
CLALATP2			FW	fault class: O2 sensor aging upstream cat TP bank 2
CLALATV			FW	fault class: O2 sensor aging upstream cat Tv
CLALATV2			FW	fault class: O2 sensor aging upstream cat Tv bank 2
CWDLSA			FW	Code word for single test of O2 sensor aging pre cat for application
FFTLATP	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tp upstream catalyst
FFTLATP2	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tp upstream catalyst bank2
FFTLATV	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tv upstream catalyst
FFTLATV2	BLOKNR		KL	Table ambient conditions Lambda sensor aging Tv upstream catalyst bank2
KFTPKOR	NMOT	RL	KF	correction map for the measured cycle duration TP (tpsvkof)
NTPKTO			FW	upper speed threshold for cycle duration monitoring, short test
NTPKTU			FW	lower speed threshold for cycle duration monitoring, short test
NTPVKO			FW	upper speed threshold for cycle duration monitoring upstream catalyst
NTPVKU			FW	lower speed threshold for cycle duration monitoring upstream catalyst
RLTPKTO			FW	upper load threshold for cycle duration monitoring, short test
RLTPKTU			FW	lower load threshold for cycle duration monitoring, short test
RLTPVKO			FW	upper load threshold for cycle duration monitoring upstream catalyst
RLTPVKU			FW	lower load threshold for cycle duration monitoring upstream catalyst
TKTPVK			FW	exhaust gas temperature (from ATM) for TP monitoring lambda sensor before KAT
TSFLATP			FW	fault active time: lamda sensor ageing time period
TSFLATP2			FW	fault active time: lambda sensor ageing time period, bank 2
TSFLATV			FW	fault active time: lambda sensor aging TV
TSFLATV2			FW	fault active time: lambda sensor ageing TV, bank 2
TSTEAA			FW	inhibit time after condition B_te (canister purge active)
TSVKKO			FW	upper limit of cycle duration of lambda sensor upstream cat at cat fault
TSVKKTO			FW	upper limit for cycle duration of oxygen sensor upstream, short test
TSVKKTU			FW	lower limit for cycle duration of oxygen sensor upstream, short test
TSVKKU			FW	lower limit of cycle duration of lambda sensor upstream cat at cat fault
TSVKO			FW	upper limit for cycle duration of lambda sensor upstream cat
TSVKU			FW	lower limit for cycle duration of lambda sensor upstream cat

Parameter	Source-X	Source-Y	Type	Description
TVLRHMN			FW	lower limit for tv-correction
TVLRHMN2			FW	lower limit for tv-correction unequal parameter bank2
TVLRHMX			FW	upper limit for tv-correction
TVLRHMX2			FW	upper limit for tv-correction unequal parameter bank2
TWDDTV			FW	delay time for readyness flag delta-TV diagnosis
ZFTSVK			FW	time constant for filter cycle duration of sensor upstream catalyst

Variable	Source	Type	Description
ATV	LRHK	EIN	current integrator value of lambda control downstream cat
ATV2	LRHK	EIN	current integrator value of lambda control downstream cat 2
B_CDLATP	PROKON	EIN	function active per codeword CDLATP
B_CDLATV	PROKON	EIN	function active per codeword CDLATV
B_CLLATP		EIN	Clear fault path in DLSA.
B_CLLATP2		EIN	Clear fault path in DLSA. Bank2
B_CLLATV		EIN	Clear fault path in DLSA.
B_CLLATV2		EIN	Clear fault path in DLSA. Bank2
B_DISTP	DLSA	AUS	condition disable period diagnosis and make available measured values for Mode 6
B_DISTP2	DLSA	AUS	cond. disable period diagnosis and make available measured val. for Mode 6 bank2
B_DISTV	DLSA	LOK	condition disable atv diagnosis
B_DISTV2	DLSA	LOK	condition disable atv diagnosis bank2
B_DLAFF	DLSA	LOK	Number of valid Tp measurements reached since B_dlatp=1
B_DLAFF2	DLSA	LOK	Number of valid Tp measurements reached since B_dlatp2=1 bank2
B_DLATP	DLSA	AUS	condition for active diagnosis: lambda sensor aging TP
B_DLATP2	DLSA	AUS	condition for active diagnosis: lambda sensor aging TP (cylinder row 2)
B_DLATV	DLSA	AUS	condition for active diagnosis of lambda sensor aging TV
B_DLATV2	DLSA	AUS	condition for active diagnosis of lambda sensor aging TV (cylinder row 2)
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ENWS	DNWS	EIN	condition error camshaft control
B_FA		EIN	condition general function request
B_FATP		EIN	condition diagnosis oxygen sensor aging TP function request
B_FATP2		EIN	condition diagnosis oxygen sensor aging TP function request bank2
B_FATV		EIN	condition diagnosis oxygen sensor aging TV function request
B_FATV2		EIN	condition diagnosis oxygen sensor aging TV function request bank2
B_GASP	LRAEB	EIN	condition for basic mixture adaptation disabled
B_GASP2		EIN	condition for basic mixture adaptation disabled, bank2
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRHK	LRHK	EIN	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	EIN	condition for lambda closed loop control downstream cat (bank 2)
B_LRTPP	LR	EIN	Periodic time valid, static cond. for %LR (amplitude/periodic time) = TRUE
B_LRTPP2	LR	EIN	static condition for lambda controller (amplitude/periodic time) bank2
B_LSASTP	DLSA	LOK	flag for general disabling conditions for DLSA
B_LSASTP2	DLSA	LOK	flag for general disabling conditions for DLSA bank2
B_M6ATV	DLSA	LOK	Schwellen und Codewort an MOD6 übertragen
B_M6ATV2	DLSA	LOK	Schwellen und Codewort an MOD6 übertragen Bank2
B_MAXLATV	DLSA	LOK	Condition for fault type ”maximum value” for ATV-test upstr. cat detected ‘dyn.’
B_MAXLATV2	DLSA	LOK	Cond. for fault type ”max. value” for ATV-test upstr. cat detected ‘dyn.’ bank2
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MINLATV	DLSA	LOK	Condition for fault type ”minimum value” for ATV-test upstream cat’dyn.’detected
B_MINLATV2	DLSA	LOK	Cond. for fault type ”minimum value” for ATV-test upstr. cat’dyn.’detect. Bank2
B_MNLATP	DLSA	AUS	Condition for fault type ”minimum value” of cycle duration upstream cat detected
B_MNLATP2	DLSA	AUS	Condition for fault type ”min. value” of cycle duration upstr. cat detec. bank2
B_MNLATV	DLSA	AUS	Condition for fault type ”minimum value” for ATV-test upstream cat detected
B_MNLATV2	DLSA	AUS	Condition for fault type ”minimum value” for ATV-test upstr. cat detected bank2
B_MXLATP	DLSA	AUS	Condition for fault type ”maximum value” for cycle duration upstr. cat detected
B_MXLATP2	DLSA	AUS	Condition for fault type ”max.value” for cycle duration upstr. cat detec. bank2
B_MXLATV	DLSA	AUS	Condition for fault type ”maximum value” for ATV-test upstream cat detected
B_MXLATV2	DLSA	AUS	Condition for fault type ”maximum value” for ATV-test upstr. cat detected bank2
B_NOLATP	DLSA	LOK	Condition diagnosis cycle duration finished with o.k. report
B_NOLATP2	DLSA	LOK	Condition diagnosis cycle duration finished with o.k. report bank2
B_NOLATV	DLSA	LOK	Condition diagnosis atv-test finished with o.k. report
B_NOLATV2	DLSA	LOK	Condition diagnosis atv-test finished with o.k. report bank2
B_TE	TEBEB	EIN	Condition canister purge active
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_HSH	DHLSHK	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLSHK	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLSVK	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLSVK	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	EIN	error flag: catalyst conversion
E_KAT2	DKAT	EIN	error flag: catalyst conversion (cylinder row 2)
E_LATP	DLSA	AUS	error flag: lambda sensor aging tp
E_LATP2	DLSA	AUS	error flag: lambda sensor aging tp (cylinder row 2)
E_LATV	DLSA	AUS	error flag: lambda sensor aging tv
E_LATV2	DLSA	AUS	error flag: lambda sensor aging tv (cylinder row 2)

Variable	Source	Type	Description
E_LM	EGFE	EIN	Error flag: main load sensor
E_PH	DPH	EIN	error flag: phase sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
M6CATV	DLSA	AUS	Mode 6-Memory: Comp. ID for check Lambda sensor aging TV
M6CATV2	DLSA	AUS	Mode 6-Memory: Comp. ID for check Lambda sensor aging TV on bank 2
M6CTP	DLSA	AUS	Mode 6-Memory: Comp. ID for check Lambda sensor aging TP
M6CTP2	DLSA	AUS	Mode 6-Memory: Comp. ID for check Lambda sensor aging TP on bank 2
M6SATV	DLSA	AUS	Mode 6-Memory: Threshold value with Lambda sensor aging TV
M6SATV2	DLSA	AUS	Mode 6-Memory: Threshold value with Lambda sensor aging TV on bank 2
M6STP2_W	DLSA	AUS	Mode 6-Memory: Threshold value with Lambda sensor aging TP on bank 2
M6STP_W	DLSA	AUS	Mode 6-Memory: Threshold value with Lambda sensor aging TP
M6WATV	DLSA	AUS	Mode 6-Memory: Measured value Lambda sensor aging TV
M6WATV2	DLSA	AUS	Mode 6-Memory: Measured value Lambda sensor aging TV on bank 2
M6WTP2_W	DLSA	AUS	Mode 6-Mem.: Measured value Lambda sensor aging TP on bank 2
M6WTP_W	DLSA	AUS	Mode 6-Mem.: Measured value Lambda sensor aging TP
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SFPLATP	DLSA	AUS	status fault path:
SFPLATP2	DLSA	AUS	status fault path:
SFPLATV	DLSA	AUS	status fault path:
SFPLATV2	DLSA	AUS	status fault path:
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TFRN2_W	LR	EIN	time duration lambda controller negativ slope, bank 2
TFRN_W	LR	EIN	time duration lambda controller negativ slope
TFRP2_W		EIN	time duration lambda controller positiv slope, bank 2
TFRP_W		EIN	time duration lambda controller positiv slope
TPLRVK2_W	LR	EIN	cycle duration of sensor upstream cat, calculated by %LR, bank 2
TPLRVK_W	LR	EIN	cycle duration of sensor upstream cat, calculated by %LR
TPOTV2_W	DLSA	LOK	cycle duration of sensor upstream cat, without tv-value bank2
TPOTV_W	DLSA	LOK	cycle duration of sensor upstream cat, without tv-value
TPSVKMF2_W	DLSA	AUS	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_W	DLSA	AUS	filtered cycle duration of sensor signal upstream cat. (word)
TPSVKOF2_W	DLSA	LOK	measured cycle duration of sensor upstream cat, without filter, cylinder row 2
TPSVKOF_W	DLSA	LOK	measured cycle duration of sensor upstream cat, without filter
TYP_LATP	DLSA	LOK	Fault type: lambda sensor aging Tp upstream
TYP_LATP2	DLSA	LOK	Fault type: lambda sensor aging Tp upstream bank2
TYP_LATV	DLSA	LOK	Fault type: lambda sensor aging Tv upstream
TYP_LATV2	DLSA	LOK	Fault type: lambda sensor aging Tv upstream bank2
TZLSATV	DLSA	LOK	present time counter value for ready flag of atv-monitoring
TZLSATV2	DLSA	LOK	present time counter value for ready flag of atv-monitoring, cylinder bank 2
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USRHK	LRHK	EIN	momentary control threshold for downstream lambda control
USRHK2	LRHK	EIN	momentary control threshold for downstream lambda control, bank2
ZERLATV	DLSA	LOK	counter for error of the atv measurement
ZERLATV2	DLSA	LOK	counter for error of the atv measurement bank2
ZLSATP	DLSA	LOK	present cycle counter for ready flag of cycle duration monitoring
ZLSATP2	DLSA	LOK	present cycle counter for ready flag of cycle duration monitoring, cylinder row2
ZWPVK	DLSA	LOK	waiting cycle counter for cycle duration monitoring
Z_HSH	DHLSHK	EIN	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLSHK	EIN	cycle flag of lambda sensor heating downstream cat, cylinder row 2
Z_HSV	DHLSVK	EIN	cycle flag of lambda sensor heating upstream cat
Z_HSV2	DHLSVK	EIN	cycle flag of lambda sensor heating upstream cat, cylinder row 2
Z_LATP	DLSA	AUS	cycle flag of lambda sensor aging tp
Z_LATP2	DLSA	AUS	cycle flag of lambda sensor aging tp (cylinder row 2)
Z_LATV	DLSA	AUS	cycle flag of lambda sensor aging tv
Z_LATV2	DLSA	AUS	cycle flag of lambda sensor aging tv (cylinder row 2)

Parameter	Value	Description
ANZDPVK		number of periodes for ready flag of Usvk period monitoring
ANZERTV		amount of error measurements for ATV
ANZTP		number of unconsidered cycles for cycle duration monitoring
CDLATP		code word oxgen sensor aging diagnosis (TP) in OBDII mode (inv.: in Europe mode)
CDLATV		code word lambda sensor monitoring (Tv) in OBDII mode (invers: Europe mode
CDTLATP		code word tester: lambda sensor aging tp [015]
CDTLATP2		code word tester: lambda sensor aging tp, cyl.row 2 [021]
CDTLATV		code word tester: lambda sensor aging tv [016]
CDTLATV2		code word tester: lambda sensor aging tv, cyl.row 2 [022]
CIDATV		component ID for ATV single test
CIDATV2		component ID for ATV single test bank2
CIDTP		component ID for period TP single test
CIDTP2		component ID for period TP single test bank2
CLALATP		fault class: O2 sensor aging upstream cat TP

Parameter	Value	Description
CLALATP2		fault class: O2 sensor aging upstream cat TP bank 2
CLALATV		fault class: O2 sensor aging upstream cat Tv
CLALATV2		fault class: O2 sensor aging upstream cat Tv bank 2
CWDLSA		Code word for single test of O2 sensor aging pre cat for application
NTPKTO		upper speed threshold for cycle duration monitoring, short test
NTPKTU		lower speed threshold for cycle duration monitoring, short test
NTPVKO		upper speed threshold for cycle duration monitoring upstream catalyst
NTPVKU		lower speed threshold for cycle duration monitoring upstream catalyst
RLTPKTO		upper load threshold for cycle duration monitoring, short test
RLTPKTU		lower load threshold for cycle duration monitoring, short test
RLTPVKO		upper load threshold for cycle duration monitoring upstream catalyst
RLTPVKU		lower load threshold for cycle duration monitoring upstream catalyst
TKTPVK		exhaust gas temperature (from ATM) for TP monitoring lambda sensor before KAT
TSFLATP		fault active time: lamda sensor ageing time period
TSFLATP2		fault active time: lambda sensor ageing time period, bank 2
TSFLATV		fault active time: lambda sensor aging TV
TSFLATV2		fault active time: lambda sensor ageing TV, bank 2
TSTEAA		inhibit time after condition B_te (canister purge active)
TSVKKO		upper limit of cycle duration of lambda sensor upstream cat at cat fault
TSVKKTO		upper limit for cycle duration of oxygen sensor upstream, short test
TSVKKTU		lower limit for cycle duration of oxygen sensor upstream, short test
TSVKKU		lower limit of cycle duration of lambda sensor upstream cat at cat fault
TSVKO		upper limit for cycle duration of lambda sensor upstream cat
TSVKU		lower limit for cycle duration of lambda sensor upstream cat
TVLRHMN		lower limit for tv-correction
TVLRHMN2		lower limit for tv-correction unequal parameter bank2
TVLRHMX		upper limit for tv-correction
TVLRHMX2		upper limit for tv-correction unequal parameter bank2
TWDDTV		delay time for readyness flag delta-TV diagnosis
ZFTSVK		time constant for filter cycle duration of sensor upstream catalyst

FB DLSA 44.20 Detailed description of function

1. DLSA TV monitoring of the upstream Lambda sensor

The definition of the function "Monitoring of Lambda sensor aging" is based on a cascade control with a Lambda sensor installed upstream and downstream of the catalyst. In order to create a rich-shift of the mixture, the present Lambda controller is operating with a dp-portion. Now, a two-level controller with I-portion and "P"-portion has been introduced, where the rich shift is caused by the delay time tvlr. The delay time tvlr is constructed by the map KFRTV (constants) and the corrective value tvlrh. The tvlrh value may be positive or negative.

A two-level controller with the control difference from voltage of downstream sensor and a load point dependent voltage set point creates the corrective value tvlrh by means of an integrator (atv: adaptation TV) and the weighting map KFFTV. The corrective value tvlrh increases or decreases the corresponding TV map value, dependent on the changed sensor characteristics, which result in the course of the sensor life.

The atv-diagnosis is only activated, if the fault flag of DKAT (catalyst diagnosis) has not been set, i.e., the catalyst is working properly. This check is required due to the fact that an aged or defective catalyst can cause a TV-shift. A Lambda sensor which may only cause a marginal TV-shift, can therefore be detected as defective. However, a defective upstream lambda sensor blocks the DKAT, i.e., a defective catalyst could not be detected without this check. Therefore, in case a catalyst is detected as defective, only the dynamic properties of the upstream lambda sensor are monitored. Furthermore the general DLSA turn-on condition (F_lsastp) has to be fulfilled and the downstream lambda control (B_lrhk) must be active.

The evaluation routine includes the comparison of the atv value with the upper and lower threshold for the DLSA (TVLRHMX, TVLRHMN).
By B_stersy = 0 a switch-over is performed for bank2 to not equal parameter TVLRHMN2 and TVLRHMX2.
If the regulated variable atv is below TVLRHMN (falling short of the minimum) or above TVLRHMX (exceeding the maximum), then the sensor error flag E_latv is set, due to a poor upstream lambda sensor.
In case the atv-value is between TVLRHMN and TVLRHMX (no error), then the sensor error flag E_latv will not be set.

The ready-flag Z_latv for the atv-diagnosis of DLSA is only set, if the momentary time count (tzlsatv) is equal to or exceeds the reference time TWDDTV.

Quicktest:
If a scan tool is connected, (B_fa = 1), the atv monitoring of the DLSA is disabled until the command for the atv-quicktest (B_fatv = 1) is received. Since the LRHK control value is relatively slow, no real test for characteristically shifted front sensor is performed. During the atv quicktest the cycle flag Z_latv is set immediately, the actual atv value compared with the border thresholds (TVLRHMN, TVLRHMX) and the result transmitted via E_latv.

2. DLSA cycle duration monitoring of the upstream Lambda sensor

Cycle duration monitoring of the upstream sensor is required due to the fact that the dynamic properties may deteriorate, the mean sensor voltage, however, remains constant. This dynamic shift of the lambda sensor characteristic may result in exceeding the emission limits.

The cycle duration is determined in the lambda control %LR. In the process the P-portion and the tv-time from the catalyst deoxidization are automatically excluded from the calculation.
An incorrectly measured cycle duration (B_lrtpp = FALSE) is not taken over into the filter for the formation of the TP-mean value.
The measurement of the cycle duration only takes place in an adjustable engine speed, load range. If the engine speed, load window is entered for the monitoring of the cycle duration, also a definable number of valid measured cycles (ANZTP) can be disabled.
Together with the steady-state condition of the %LR this possibility is necessary to make the DLSA cycle duration monitoring immune against interferences. In order to be able to increase the detection range and thus to increase the number of detected

cycles, the cycle duration is weighted by the factor KFTPKOR. By this factor the operating point dependent influence of dead time and response time of the sensor on the cycle duration is described. The corrective map KFTPKOR is the same map as the weighting map KFFTV in %LRHK and it must therefore not be adjusted again.

In order to avoid excessively long cycle durations (caused by Lambda deviations) during the transient stage of mixture adaptation, and canister purge adaptation, the condition flag B_te is monitored. Disturbances which can be caused by canister purging at the beginning of a purge control phase are eliminated by means of the blocking time TSTEAA.

The delay counter zwpvk is only reset, when the condition flag B_dlatp releases the cycle duration monitoring.

Tpsvkmf is initialized with 0 in the event of powerfail or when clearing the fault memory. Thereafter tpsvkmf=tpsvkof is set at the first valid measurement of the cycle duration.
Otherwise tpsvkmf is initialized with the last value stored in the RAM.

The mean value of the cycle duration of upstream lambda sensor is compared with an upper and lower limit. It has been proven efficient to operate with two pairs of fault thresholds (TSVKO, TSVKU and TSVKKATO, TSVKKATU). If the catalyst monitoring has detected a fault, then the cycle duration of the upstream sensor signal is compared with more stringent fault thresholds. By evaluating the amplitude ratio (usvk/ushk), a slower upstream sensor may erroneously result in considering a properly working (border line) catalyst as insufficient (concerning emissions).
This comparison takes place in an operating point, where the differences in cycle durations between "good" and "slow" lambda sensors are at a maximum. Depending on the momentary cycle duration of the sensor signal, within the predetermined duration limits or outside, the MIL is/is not activated by the fault evaluation algorithm by means of the cycle duration monitoring of the upstream sensor.
If a defective lambda sensor has been detected, based on the above procedure, then "Fault dynamic sensor characteristic" (slow sensor) must be reported to the diagnosis routine via the flag E_latp.

The ready flag Z_latp for cycle duration monitoring is set after ANZDPVK measured cycles, which are valid. The cycle counter zlsatp is reset during cranking.

Quicktest:
If a scan tool is connected, (B_fa = 1), the cycle duration monitoring of the DLSA is disabled until the command for the quicktest of cycle duration (B_fatp = 1) is received. This quicktest is performed in its own engine operating area (zero load, increased RPM). The cycle duration in this area is compared with the quicktest specific thresholds (TSVKKTO, TSVKKTU).

4. General DLSA turn-on conditions

For the DLSA, the following cross-connections with other OBD II diagnosis functions are relevant:

Function:		Processed by means of:
DAGRE	Diagnosis EGR power stage	B_lsastp
DAGRF	Diagnosis EGR	B_lsastp
DASE	Diagnosis misfire detection (emission relevant)	B_lsastp
DEV	Diagnosis injectors	LRVK and LRHK
DHFM	Diagnosis load sensing	E_lm directly
DHLS	Diagnosis sensor heating	B_lsastp
DKAT	Diagnosis catalyst conversion	E_kat directly
DKVS	Diagnosis fuel supply system	B_lsastp
DLSH	Diagnosis downstream lambda sensor	LRHK
DLSV	Diagnosis upstream lambda sensor	LRVK and LRHK
DPH	Diagnosis phase sensor	B_lsastp
DSLS	Diagnosis secondary air system	B_dsls
DTEV/DTES	Diagnosis canister purge valve	B_lsastp
DTEVE	Diagnosis canister purge valve (driver stage)	B_lsastp
DUBAT	Diagnosis UBAT	B_lsastp

During active DLSA, the DSLS (diagnosis of secondary air system) must not be turned on. This is considered by the condition flag B_dsls. The Lambda closed-loop control is active, when the diagnosis of the secondary air system is performed. However, the cycle duration of the sensor signal and the correction factor of the downstream lambda control are inadmissibly influenced by the operation of the secondary air pump. Therefore, this interaction between DLSA and DSLS must be interrupted by means of the flag B_dsls.

If the DTEV (diagnosis of canister purge valve) is active, then the cycle duration monitoring shows a wrong result based on the air-fuel mixture from active carbon filter and canister purge valve. In order to prevent this effect, the flag B_dtest from the DTEV is checked in the release function for the DLSA.
If B_dtest is set, then the DLSA is blocked. This occurs, when the canister purge valve is opened for DTEV.

5. Stereo version

For stereo exhaust system the three DLSA diagnosis functions must be performed twice, for each exhaust pipe the lambda sensor upstream and downstream catalyst is to be monitored. The general turn-on conditions SY_STERVK/SY_STERHK = 1 (stereo) are to be executed.
Scanned error flags of stereo-OBD II functions are to be scanned, combined by an OR function, by the DLSA turn-on conditions.

6. Measures to be taken in case of clearing of the fault memory or in the event of powerfail

If the fault memory is cleared or in the event of powerfail, the following conditions for the DLSA are given:

a.) The filter for the cycle duration monitoring is initialized, i.e. the starting value for tpsvkmf is again the first valid measurement of the cycle duration value.

b.) The cycle time counter tzlsatv is reset.

c.) The counter for delay cycles zwpvk is reset.

d.) The cycle counter zlsatp is reset.

APP DLSA 44.20 Application hint

Application hints

DLSA - European version (selected via EURO bits)

For the European version, the DLSA-atv-monitoring, the DLSA cycle duration monitoring, and the DLSA oscillation check can be turned off. The partial functions are then not longer processed.

atv-monitoring can be switched off via the bit B_cdlatv:
(B_cdlatv=0) --> atv-monitoring blocked, E_latv/2 = 0, Z_latv/2 = 1, B_dsvkd/2 = 0
(B_cdlatv=1) --> atv-monitoring active

Cycle duration monitoring can be switched off via the bit B_cdlatp:
(B_cdlatp=0) --> Cycle duration monitoring blocked, E_latp/2 = 0, Z_latp/2 = 1
(B_cdlatp=1) --> Cycle duration monitoring active

Function-orientated selection of the diagnosis labels in the VS100:

Fault memory relevant values of the diagnosis function xyz are assigned to the function DFPM_xyz in the function-orientated selection.

Requirements for DLSA calibration:

The two sensor Lambda control and the transient control must have been completely calibrated:

Parameters to be calibrated:
The classification between properly working and defective upstream lambda sensors is carried out by means of the DLSA fault limits TVLRHMX, TVLRHMN, TSVKO, TSVKU, TSVKKATO and TSVKKATU.
It is very unlikely that the lower fault limits for cycle duration monitoring (TSVKU, TSVKKATU) ever will be used for sensor evaluation, since upstream sensors with faster response time do not have a negative impact on emissions. However, the lower limits could be possibly used for detection of "chemical noise".

The constant ZFTSVK determines the filter time constant of the upstream sensor cycle duration monitoring. The lower ZFTSVK, the less the influence of the next input value on the filter output.

With ANZTP, the number of valid measured periods at entrance into the defined n-, tl-window can be calibrated, which are neglected. In order to carry over as many as possible valid periods into the filter, ANZTP should reflect a low value.

NTPVKU, NTPVKO, TLTPVKU and TLTPVKO determine the n-, tl-window, in which the cycle duration monitoring is performed.

TWDDTV is the time threshold, at which the ready flag for atv-monitoring is set.
ANZDPVK contains the minimum number of measured usvk-periods of the cycle duration monitoring, before the ready flag can be set for this diagnosis section.

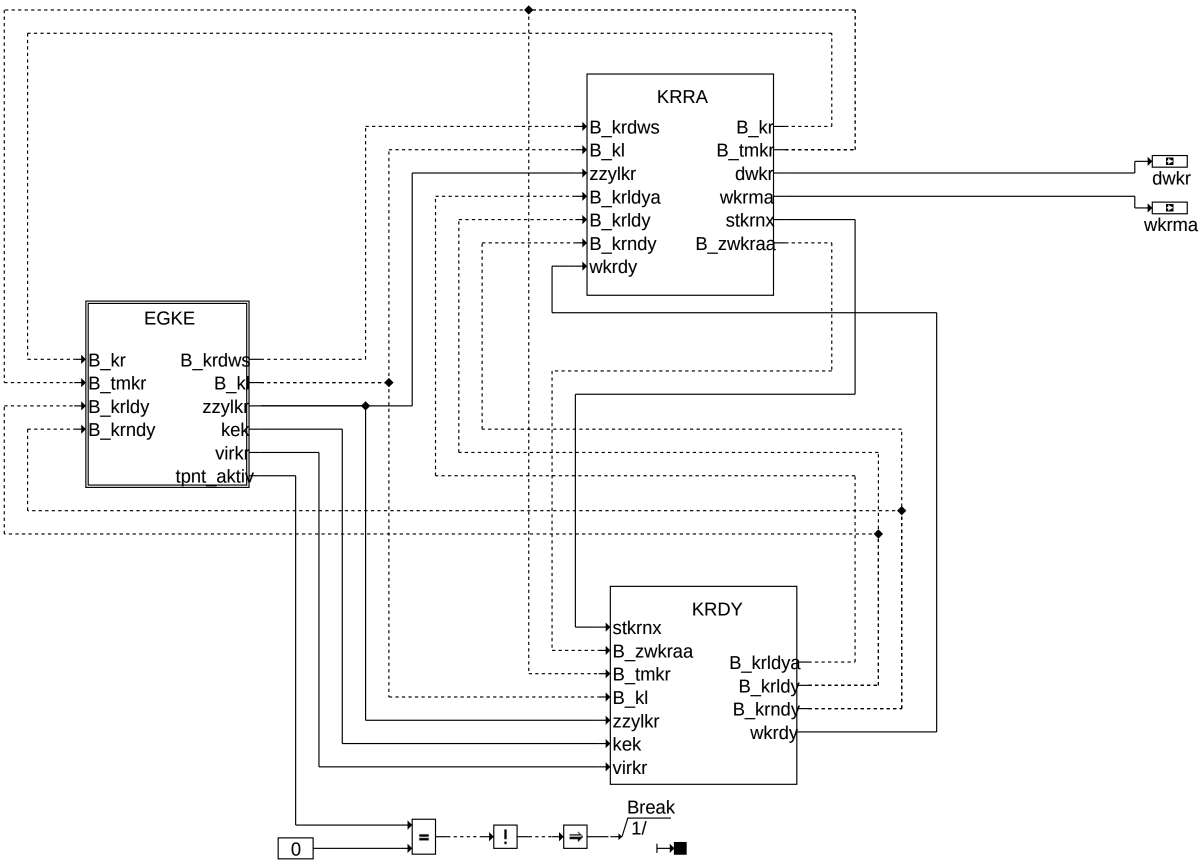
Disturbances, which may occur during the transition stage between mixture adaptation and purge control adaptation, are suppressed by means of the blocking time TSTEAA. Cycle duration monitoring will be only released if the condition flag B_te is still set after the blocking time TSTEAA or the mixture adaptation is active. By this, excessively long cycle durations at the beginning of a canister purge phase can be suppressed.

```
Calibration values:


ANZDPVK     20
ANZTP        1
NTPVKO      2400 rpm
NTPVKU      1800 rpm
NTPKTO      1800 rpm short trip
NTPKTU      1000 rpm short trip
RLTPVKO       70 %  upper load in the large hill in the FTP 75
RLTPVKU       40 % lower load in the large hill in the FTP 75
RLTPKTO       40 %  short trip
RLTPKTU       20 %  short trip
TSTEAA        10 s
TVLRHMX     + 800 ms
TVLRHMN     - 800 ms
ZFTSVK         0.1
TWDDTV        200 s
TSVKO          3 ... 5 s dependent on catalyst volume
TSVKU          0.2 s
TSVKKTO        3 ... 5 s dependent on catalyst volume
TSVKKTU        0.2 s
TSVKKO         2 ... 4 s dependent on catalyst volume
TSVKKU         0.2 s
```

EGKE 1.10 Input variables for knocking detection

FDEF EGKE 1.10 Function definition

```
KUE: overview knock control
===========================
```

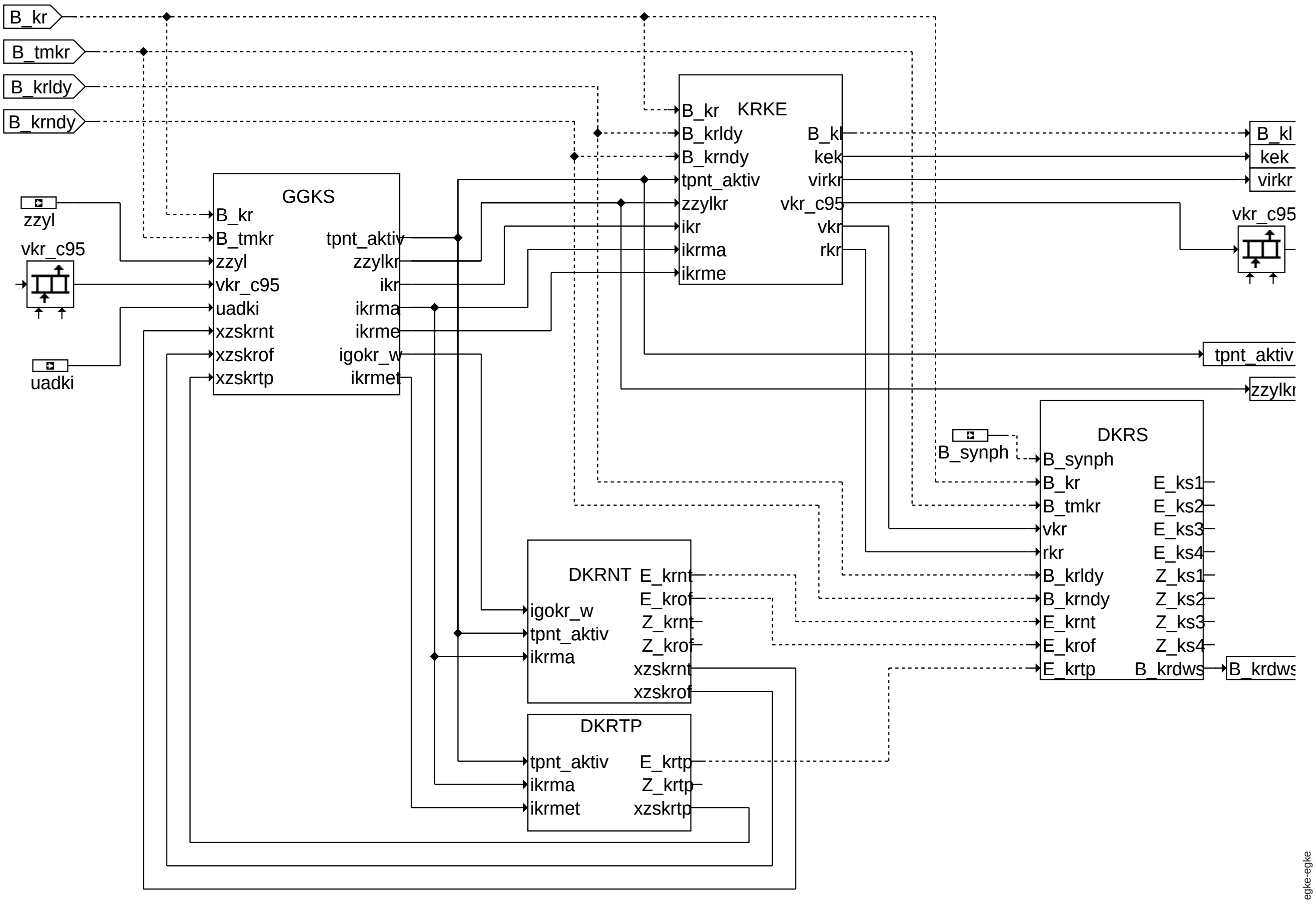


break of KRRA-mfa-process and KRDY-mfa-process

egke-main

egke-main

```
EGKE: input variables
=====================
```



egke-egke

ABK EGKE 1.10 Abbreviations

Variable	Source	Type	Description
B_KL	EGKE	AUS	condition for knocking
B_KR	KRRA	EIN	condition for knock control active
B_KRDWS	EGKE	AUS	condition knock control safety ignition retarding
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRLDYA	EGKE	LOK	Condition load dynamics retard and dynamics adaptation active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_SYNPH	GGDPG	EIN	condition synchronization phase
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
B_ZWKRAA	EGKE	LOK	condition ignition angle of the KC is given
DWKR	EGKE	AUS	cylinder-specific ignition-timing retardation
E_KRNT	EGKE	LOK	error flag: knock control zero test
E_KROF	EGKE	LOK	Errorflag: knock control offset
E_KRTP	EGKE	LOK	error flag: knock control test pulse
E_KS1	EGKE	LOK	error flag: knock sensor 1
E_KS2	EGKE	LOK	error flag: knock sensor 2
E_KS3	EGKE	LOK	error flag: knock sensor 3
E_KS4	EGKE	LOK	error flag: knock sensor 4
IGOKR_W	EGKE	LOK	integrator gradient for offset correction knock control (word)
IKR	EGKE	LOK	integrator value with offset correction
IKRMA	EGKE	LOK	integrator value at start of measurement window, knock control
IKRME	EGKE	LOK	integrator value at end of measurement window, knock control
IKRMET	EGKE	LOK	integrator value at end of measurement window, knock control test pulse
KEK	EGKE	AUS	knock detection threshold corrected
RKR	EGKE	LOK	reference level knock control
STKRNX	EGKE	LOK	speed range adaption map KC
TPNT_AKTIV	EGKE	AUS	activation of kc-functions
UADKI		EIN	current integrator value
VIRKR	EGKE	AUS	Ratio: integrator / reference level knock control
VKR	EGKE	LOK	amplification stage knock control
VKR_C95	EGKE	LOK	amplification stage for input amplification stage of knock-IC
WKRDY	EGKE	LOK	ignition retard during dyn-function of knock control
WKRMA	EGKE	AUS	Average value of ignition retarding by KC, generally(limpe home with safety)
XZSKRNT	EGKE	LOK	safety counter for knock control zero test
XZSKROF	EGKE	LOK	safety counter for knock control offset

Variable	Source	Type	Description
XZSKRTP	EGKE	LOK	Timer knock control error flag E_krtp
ZZYL	GGDPG	EIN	SW-cylinder counter
ZZYLKR	EGKE	AUS	cylinder counter KC
Z_KRNT	EGKE	LOK	cycle flag: knock control zero test
Z_KROF	EGKE	LOK	cycle flag: knock control offset
Z_KRTP	EGKE	LOK	cycle flag: knock control test pulse
Z_KS1	EGKE	LOK	cycle flag: knock sensor 1
Z_KS2	EGKE	LOK	cycle flag: knock sensor 2
Z_KS3	EGKE	LOK	cycle flag: knock sensor 3
Z_KS4	EGKE	LOK	cycle flag: knock sensor 4

FW EGKE 1.10 Fixed Values

Parameter	Value	Description

FB EGKE 1.10 Detailed description of function

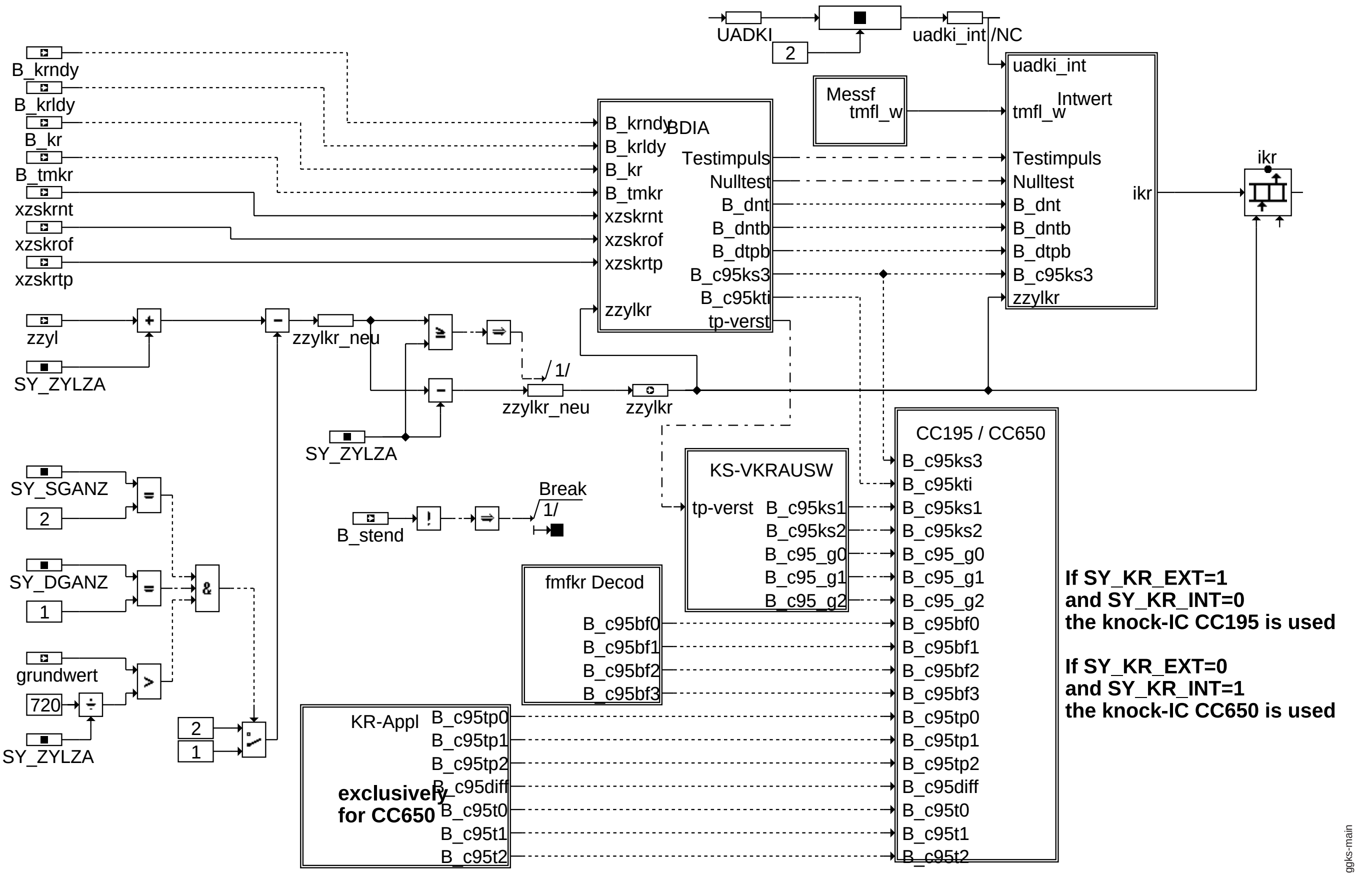
```
EGKE: input variables
=====================

The function group EGKE describes the co-operation of the following functions:
        GGKS    control of IC CC195 and signal processing of A/D-converted knock integral uadki         s. %GGKS 2.*
        KRKE    knock detection by using the signal processed by GGKS                                   s. %KRKE 10.*
        DKRNT   diagnosis of IC CC195 - test with no signal ("zero") and integrator reset value         s. %DKRNT 4.*
        DKRTP   diagnosis of IC CC195 - test with puls                                                  s. %DKRTP 6.*
        DKRS    diagnosis of knock sensors and signal path sensor - CC195                               s. %DKRS 9.*


KUE: kock control overview
==========================

                                                                                      +----------+
                                                      +------------------+            |   DYAMNV |
                                                      | retard adjustment|   wkrdy    |     -----|
                                                +---->| for dyn., adapt. |----------->|    /     |---+
                                                |     | s. %KRDY         |            |----      |   |
                                                |     +------------------+            |DYADMX    |   |
                                                |                                     +----------+   |
                                                |               +------------+                       |
                                                |       wkra    | adaption   |     wkr               o
                                                |     +---------| stationary |<-----------+           / B_krldya
                                                |     |         | s. %KRRA   |            |          o
                                                |     o         +------------+            o          |
                                                |      / B_kra                             / B_kra   |
                                                |     o                                   o          |
                                                |     |                    +---------+    |          |
+---------+  tpnt_aktiv=0 +----------+          |     |   +-----------+    |      0  |    |          |
| input   |               | knock    |          |     +-->| knock     |    |     ----|    |          v  !B_krdws  B_kr  dwkr
| values  |---->o   o---->| detection|----------+-------->| control   |--->|    /    |----+--------> + -->o   o--->o   o------>
| s. %GGKS|       \       | s. %KRKE |          |         | s. %KRRA  |    |----     |                       /        /
+---------+        o      +----------+          |         +-----------+    |KRMXN    |                      o        o
                   |                            |                          +---------+                      ^        ^
                   |                            |   +-------------+                                         |        |
                   |     +-------------------+  +-->| diagnosis   |     krdws                               |    +-----+
                   |     | diagnosis         |      | knocksensor |-----------------------------------------+    |  0  |
                   +---> | CC 195            |----->| s. %DKRS    |                                              +-----+
                         | s. %DKRNT, %DKRTP |      +-------------+
                         +-------------------+


KUE describes the co-operation of EGKE with KRRA and KRDY:
        KRRA    control and stationary adaptation of ignition timing retard                             s. %KRRA 10.*
        KRDY    detection of load and speed dynamics, adaptation of dynamics ignition timing retard     s. %KRDY 10.*
```

GGKS 4.50 Sensor signal for knocking detection

FDEF GGKS 4.50 Function definition

GGKS: Sensor signal knock detection

reduction of knock integral from 10 to 8-bit

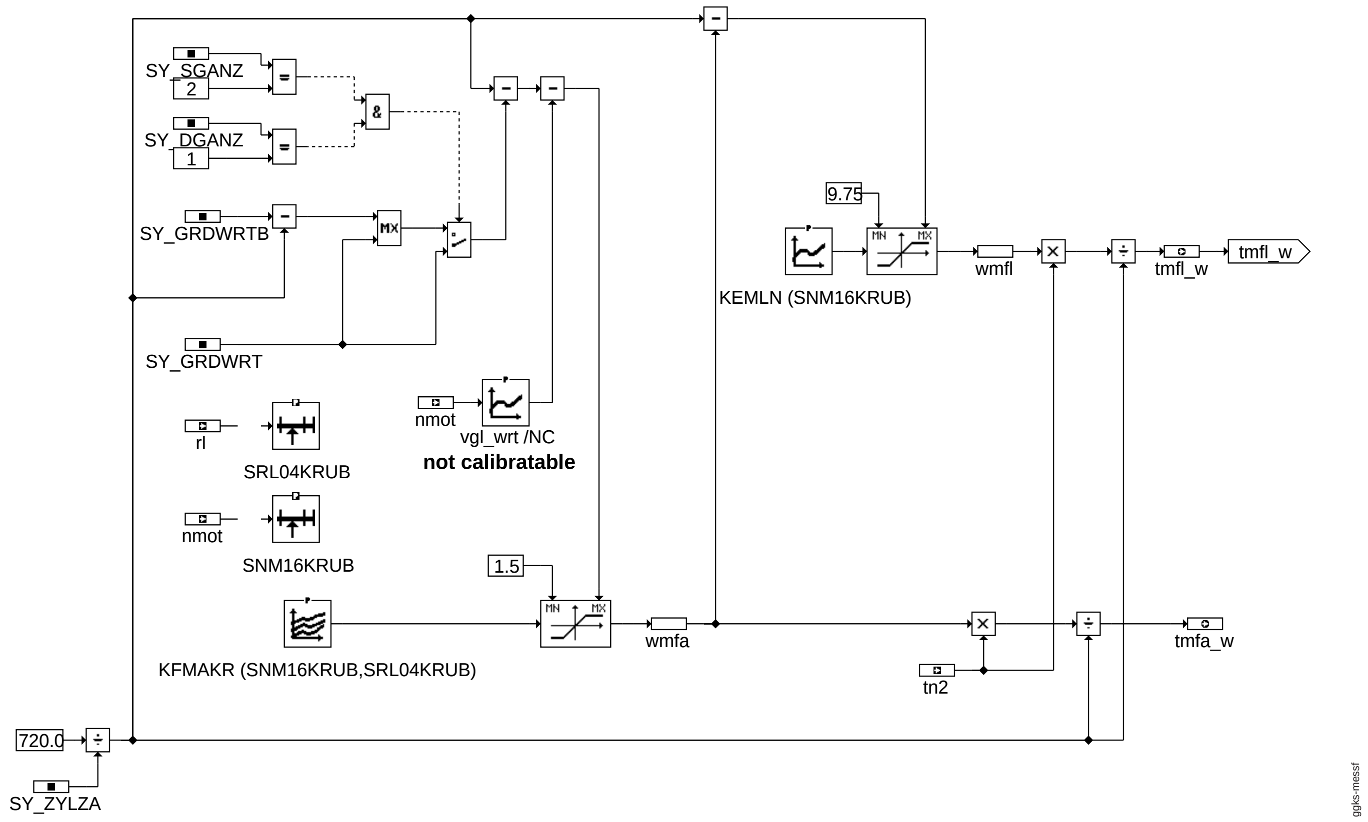


If SY_KR_EXT=1
and SY_KR_INT=0
the knock-IC CC195 is used

If SY_KR_EXT=0
and SY_KR_INT=1
the knock-IC CC650 is used

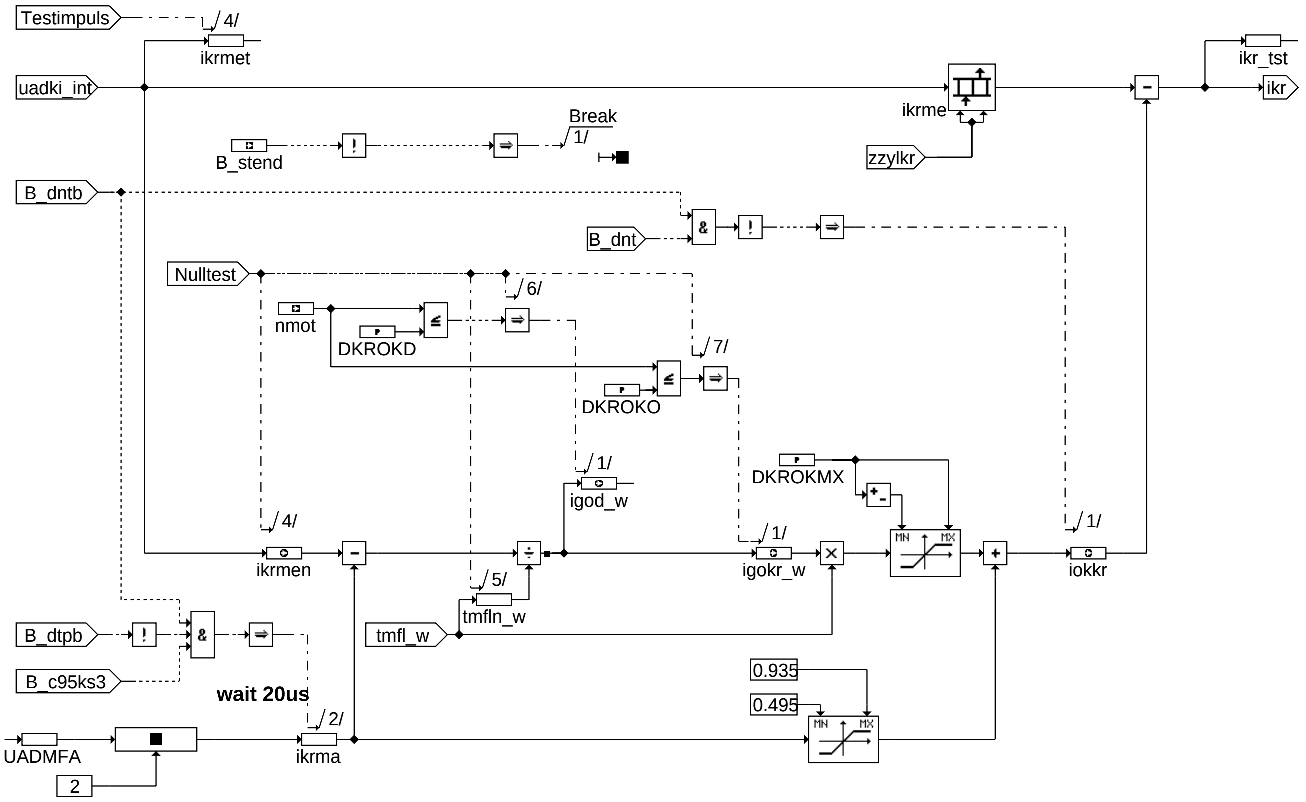
ggks-main

MESSF: Calculation of begining and duration of measuring window



ggks-messf

Intwert: Calculation of the offset corrected integrator value

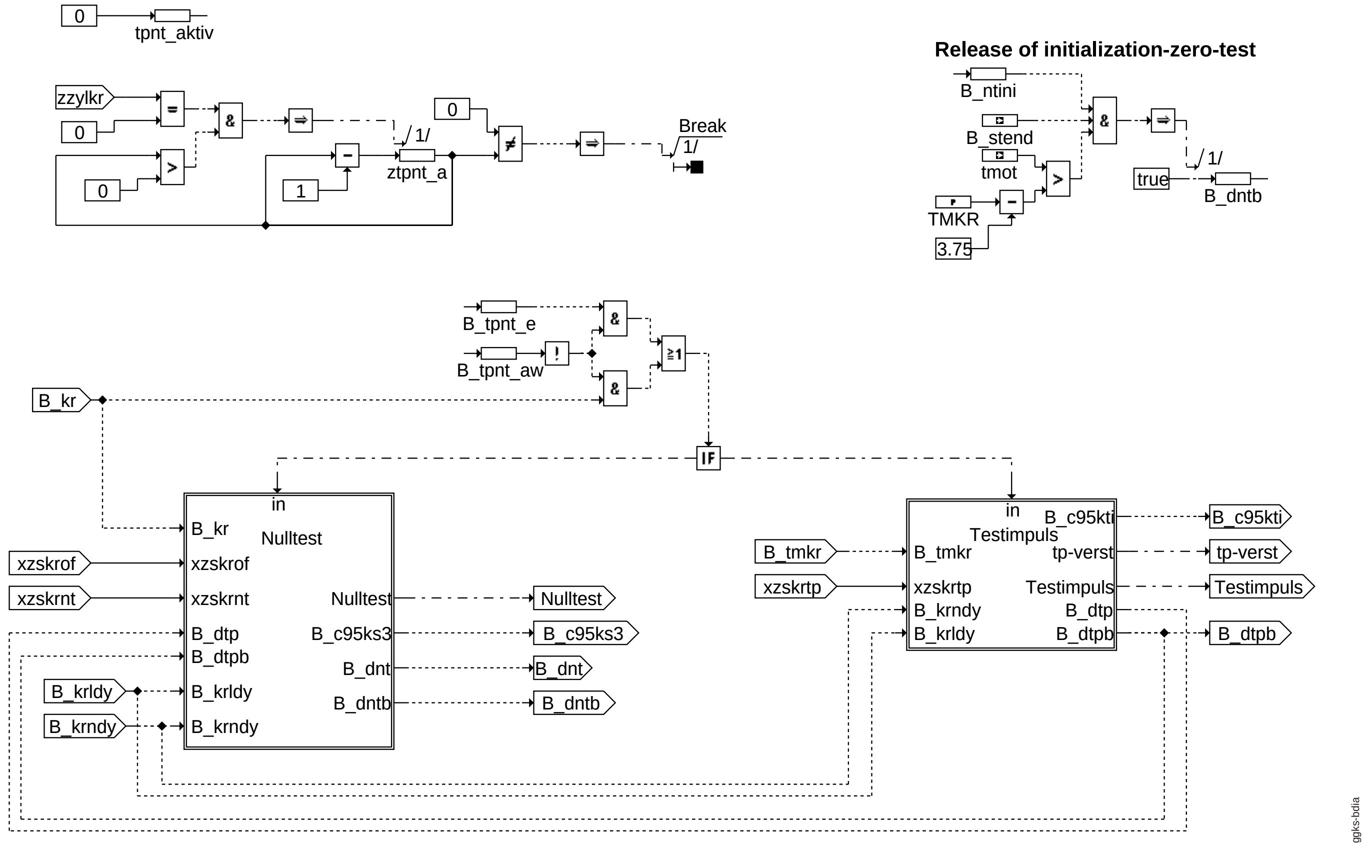


reduction of integrator start value from 10 to 8-bit

ggks-intwert

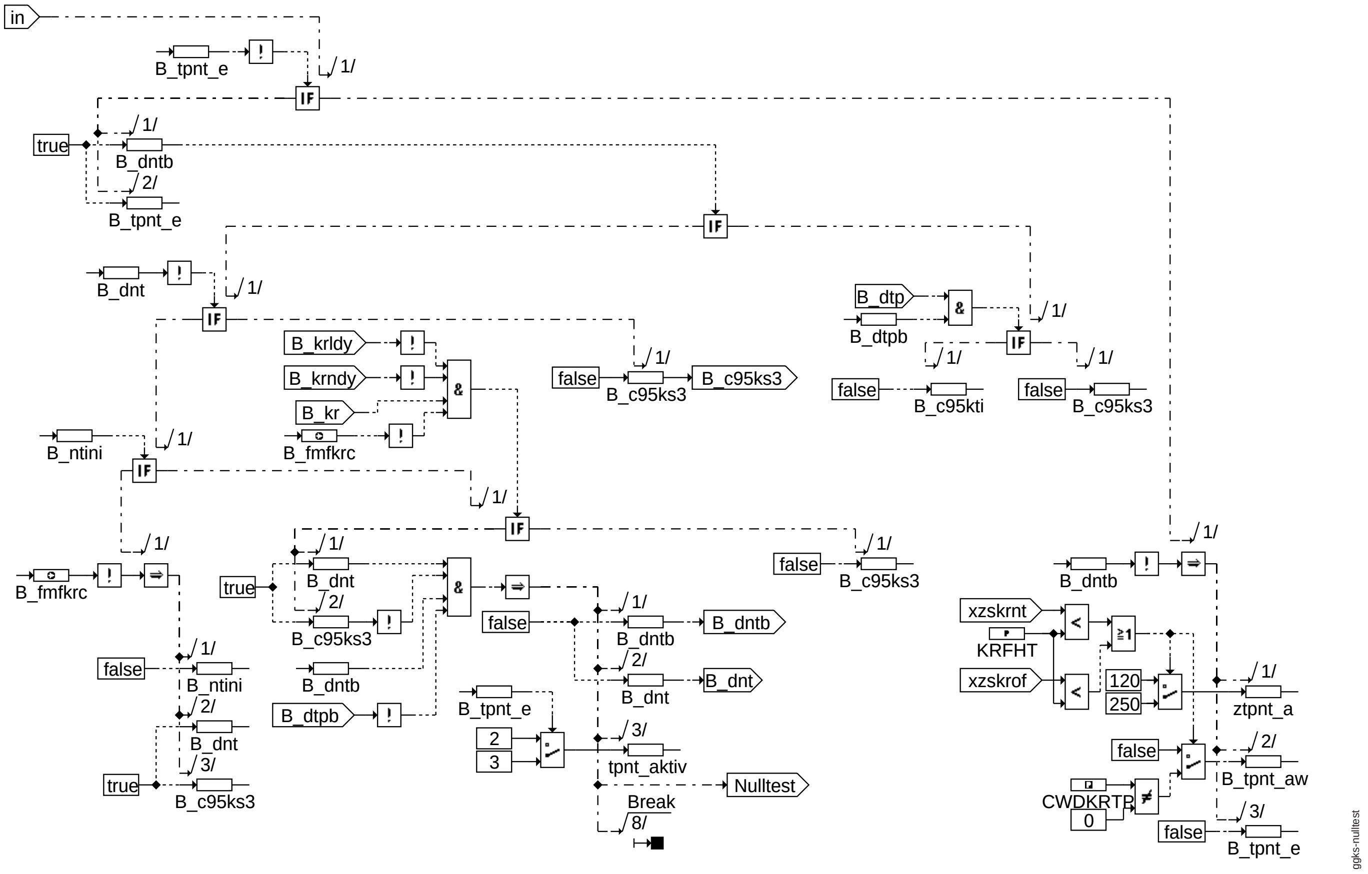
ggks-intwert

BDIA: Release of Diagnosis



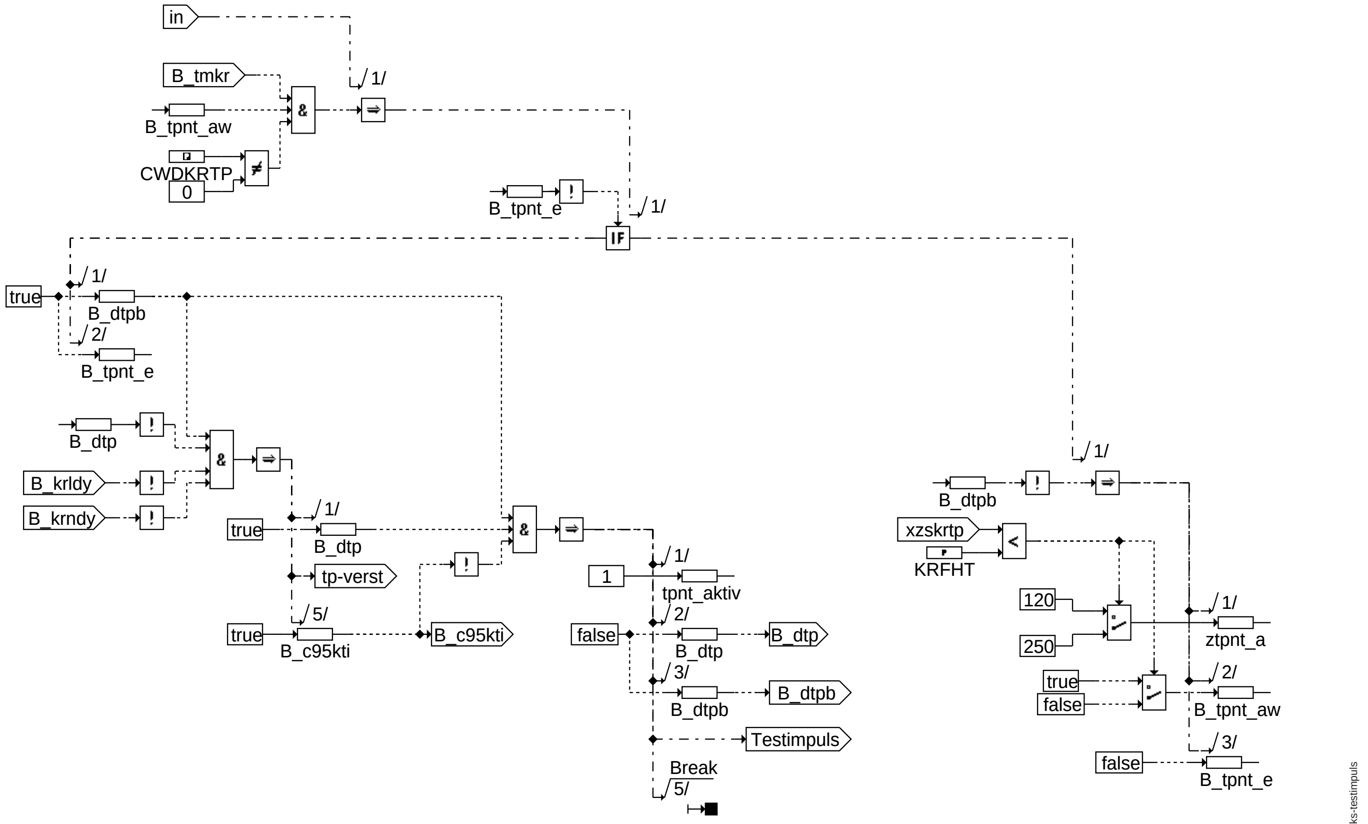
ggks-bdia

Nulltest: Enable Nulltest



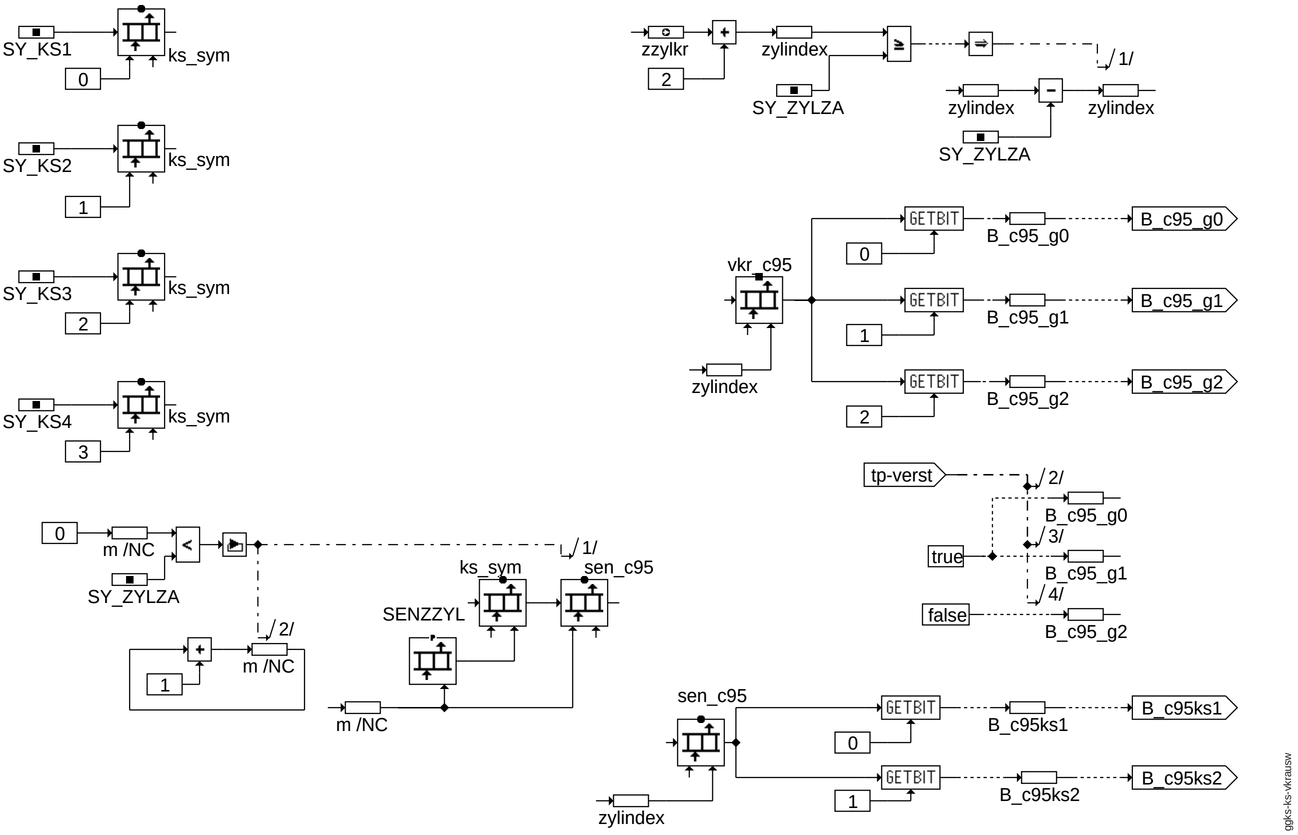
ggks-nulltest

Testimpuls: Enable Testimpuls



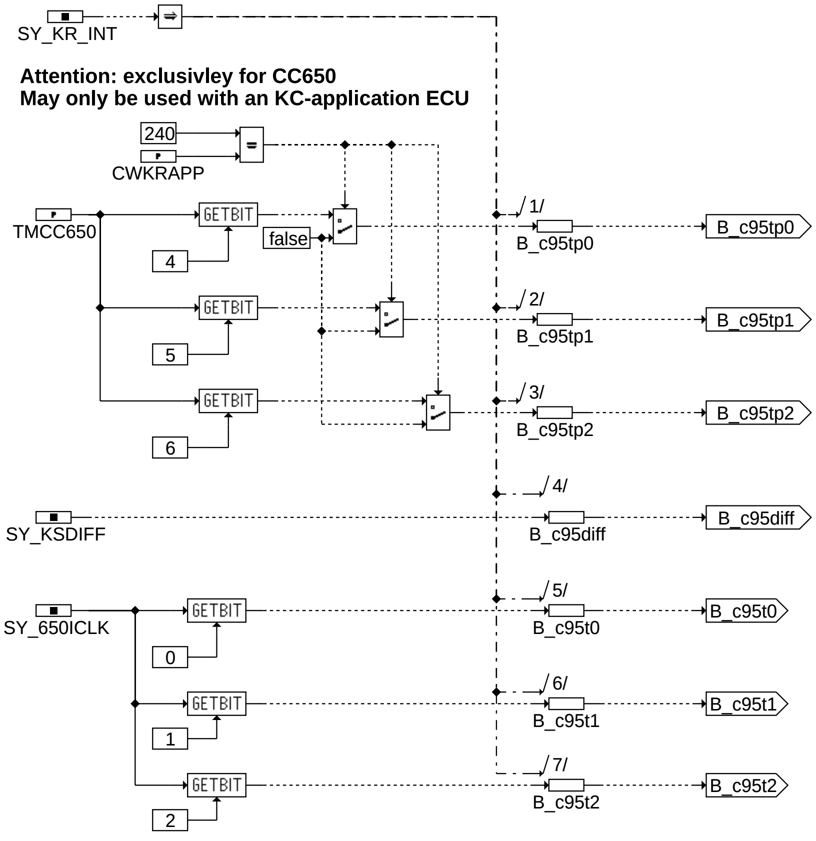
ggks-testimpuls

KS + vkr Auswahl: Choice of the actual knock sensor and amplification level



ggks-ks-vkrausw

KR-Applikation: test mode



Attention: exclusivley for CC650
May only be used with an KC-application ECU

Test mode CC195 integrated in CC650

TMCC650	**KTI/ADT at PIN 61 of CC650**
0	**KTI-input (asymmetrical sensor mode)**
16	**internal frequency CC195**
32	**KTI-input (symmetrical sensor mode)**
48	**testpulse output**
64	**filter output**
80	**rectifier output**
96	**amplifier output**
112	**muxer output**

different values for TMCC650, like specified in the table, may have major inpact on the integrator value uadki.

SY_650ICLK	**ext. Taktfrequenz**
0	**8 MHz**
1	**18 MHz**
2	**4 MHz**
3	**10 MHz**
4	**16 MHz**
5	**12 MHz**
6	**14 MHz**
7	**1 MHz**

ggks-kr-appl

ABK GGKS 4.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDKRTP			FW (REF)	code word: kc-diagnosis testpulse
CWKRAPP			FW	code word for calibration of kc
DKROKD			FW	upper rpm-limit for zero test diagnosis (knock control)
DKROKMX			FW	maximum offset-compensation value
DKROKO			FW	upper rpm-limit for determination of offset-compensation-value
FMFKRB0			FW	filter mean frequency area 0
FMFKRB1			FW	filter mean frequency area 1
FMFKRB2			FW	filter mean frequency area 2
FMFKRB3			FW	filter mean frequency area 3
KEMLN	NMOT		KL	length of the sampling window for knock control
KFMAKR	NMOT	RL	KF	map for starting measuring window knock control
KRANH			FW (REF)	n hysterisis for adaptation maps
KRFHT			FW	error frequency, test pulse
NKRFM1			FW	revolution threshold for filter mean frequency area 1
NKRFM2			FW	revolution threshold for filter mesn frequency area 2
NKRFM3			FW	revolution threshold for filter mean frequency area 3
SENZZYL			KWB	knock sensor for sw-cylinder counter 0-7
SNM16KRUB	NMOT		SV (REF)	datapoint distribution engine speed, 16 datapoints
SRL04KRUB	RL		SV (REF)	datapoint distribution relative charge, 4 datapoints
SY_650ICLK			SYS (REF)	system constant: external clock frequency of CC650
SY_DGANZ			SYS (REF)	system constant number rotational-speed sensor
SY_GRDWRT			SYS (REF)	System constant basic value, space between SW reference mark to OT in ° KW
SY_GRDWRTB			SYS (REF)	system constant basic value 2.ECU, space between SW reference mark to OT in °KW
SY_KR_INT			SYS (REF)	system constant: CC650 present
SY_KS1			SYS (REF)	system constant: input of the CC195 onto which knock sensor 1 is connected
SY_KS2			SYS (REF)	system constant: input of the CC195 onto which knock sensor 2 is connected
SY_KS3			SYS (REF)	system constant: input of the CC195 onto which knock sensor 3 is connected
SY_KS4			SYS (REF)	system constant: input of the CC195 onto which knock sensor 4 is connected
SY_KSDIFF			SYS (REF)	system constant: connection type of knock sensor(s)
SY_SGANZ			SYS (REF)	system constant number engine control unit
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TMCC650			FW	kc test mode on pin ADT of CC650
TMKR			FW	engine-temperature threshold to enable knock control

Variable	Source	Type	Description
B_C95BF0	GGKS	LOK	signal for control of CC195‘s filter frequency (pin BF0)
B_C95BF1	GGKS	LOK	signal for control of CC195‘s filter frequency (pin BF1)
B_C95BF2	GGKS	LOK	signal for control of CC195‘s filter frequency (pin BF2)
B_C95BF3	GGKS	LOK	signal for control of CC195‘s filter frequency (pin BF3)
B_C95DIFF	GGKS	LOK	signal for control CC650: connection type of knock sensor(s)
B_C95KS1	GGKS	LOK	signal for control of knock sensor signal‘s path (pin KSA1)
B_C95KS2	GGKS	LOK	signal for control of knock-sensor signal‘s path (pin KSA2)
B_C95KS3	GGKS	LOK	signal for control of the zero test of the CC195
B_C95KTI	GGKS	LOK	signal for control of the testimpulse of the CC195
B_C95T0	GGKS	LOK	signal for control CC650: external clock frequency
B_C95T1	GGKS	LOK	signal for control CC650: external clock frequency
B_C95T2	GGKS	LOK	signal for control CC650: external clock frequency
B_C95TP0	GGKS	LOK	signal for control of the testmode of CC195/CC650
B_C95TP1	GGKS	LOK	signal for control of the testmode of CC195/CC650
B_C95TP2	GGKS	LOK	signal for control of the testmode of CC195/CC650
B_C95_G0	GGKS	LOK	signal for control of CC195‘s amplifier stage (pin G0)
B_C95_G1	GGKS	LOK	signal for control of CC195‘s amplifier stage (pin G1)
B_C95_G2	GGKS	LOK	signal for control of CC195‘s amplifier stage (pin G2)
B_DNT	GGKS	LOK	condition for active diagnosis: knock control zero test
B_DNTB	GGKS	LOK	condition : ready for knock control zero test (execution: next measure window)
B_DTP	GGKS	LOK	condition : knock control test pulse active
B_DTPB	GGKS	LOK	condition: ready for knock control test pulse(execution: next mesurement window)
B_FMFKRC	GGKS	AUS	filter center frequency of CC195/CC650 changed
B_KR	KRRA	EIN	condition for knock control active
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_NTINI	GGKS	LOK	kc: condition initialization zero test
B_STEND	BBSTT	EIN	condition end of start
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
B_TPNT_AW	GGKS	LOK	KC: selection zerotest or testimpulse
B_TPNT_E	GGKS	LOK	KC: zero test/ testimpulse enable
FMFKRAKT	GGKS	LOK	filter center frequency of kc bandpass
FMFKRAKTOL	GGKS	LOK	filter center frequency of kc bandpass, old value
FMFW	GGKS	LOK	bit coded filter frequency of kc bandpass
GRUNDWERT		EIN	space between SW reference mark to TDC in °KW
IGOD_W	GGKS	AUS	integrator gradient for zero test diagnosis knock control
IGOKR_W	GGKS	AUS	integrator gradient for offset correction knock control (word)
IKR	GGKS	AUS	integrator value with offset correction
IKRMA	GGKS	LOK	integrator value at start of measurement window, knock control
IKRME	GGKS	LOK	integrator value at end of measurement window, knock control
IKRMEN	GGKS	AUS	integrator value at end of measurement window, knock control zero test
IKRMET	GGKS	LOK	integrator value at end of measurement window, knock control test pulse
IKR_TST	GGKS	LOK	integrator value with offset correction updated with cyl.counter
IOKKR	GGKS	AUS	correction of integrator‘s offset, knock control
KRFTPAKT	KRKE	EIN	actual low pass characteristic
KS_SYM	GGKS	AUS	Input of the knock evaluation IC
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SEN_C95	GGKS	AUS	knock sensor input at knock evaluation IC
TMFA_W	GGKS	AUS	beginning of measurement window knock control
TMFLN_W	GGKS	LOK	duration of measurement window knock control zero test
TMFL_W	GGKS	AUS	duration of measurement window
TMOT	SWADAP	EIN	Engine temperature
TN2		EIN	Segment time per ignition
TPNT_AKTIV	GGKS	LOK	activation of kc-functions
UADKI	GGKS	LOK	current integrator value
UADMFA	GGKS	LOK	integrator value at start of measurement window
VKR_C95	KRKE	EIN	amplification stage for input amplification stage of knock-IC
WMFA	GGKS	LOK	beginning of measurement window in degree crank angle
WMFL	GGKS	LOK	duration of measurement window in degree crank angle
XZSKRNT	DKRNT	EIN	safety counter for knock control zero test
XZSKROF	DKRNT	EIN	safety counter for knock control offset
XZSKRTP	DKRTP	EIN	Timer knock control error flag E_krtp
ZKRFMU	GGKS	LOK	Counter knock control filter mean frequency change
ZTPNT_A	GGKS	LOK	kc: counter for release of zero test or test pulse
ZYLINDEX	GGKS	LOK	cylinder counter for knock-IC control
ZZYL	GGDPG	EIN	SW-cylinder counter
ZZYLKR	GGKS	AUS	cylinder counter KC

FW GGKS 4.50 Fixed Values

Parameter	Value	Description
CWKRAPP		code word for calibration of kc
DKROKD		upper rpm-limit for zero test diagnosis (knock control)
DKROKMX		maximum offset-compensation value
DKROKO		upper rpm-limit for determination of offset-compensation-value
FMFKRB0		filter mean frequency area 0
FMFKRB1		filter mean frequency area 1
FMFKRB2		filter mean frequency area 2
FMFKRB3		filter mean frequency area 3
KRFHT		error frequency, test pulse

Parameter	Value	Description
NKRFM1		revolution threshold for filter mean frequency area 1
NKRFM2		revolution threshold for filter mesn frequency area 2
NKRFM3		revolution threshold for filter mean frequency area 3
TMCC650		kc test mode on pin ADT of CC650
TMKR		engine-temperature threshold to enable knock control

FB GGKS 4.50 Detailed description of function

A knock sensor (piezo-ceramic acceleration sensor) records the combustion noises and converts these into electrical signals.
In the evaluation circuit in the ECU which mainly consists of the Bosch IC CC195 or of the CC650, this KS signal consecutively passes through the components multiplexer, control amplifier, active band pass, rectifier and integrator.

The control of the CC195 and of the CC650 (connection of the multiplexer as well as of the cylinder-individual input amplification, starting and stopping of the integrator, selecting the filter center frequency on some ECUs) as well as the signal conditioning in the ECU is realized by the function GGKS.
The signal conditioning in the ECU takes place by an offset correction of the final integrator values.

The processing of the signals is identical in the two IC’s, since the CC650 is an ASIC into which the CC195 is completely integrated. The only difference existing with regard to the knock control lies in the triggering of the CC195 proportion on the CC650. While the triggering of the CC195 is performed via the hardware, i.e. micro controller ports, it is performed via registers, i. e. a parallel bus, on the CC650.
This calls for a knock control application modus for the CC650 which is controlled by the software.
With the CC195 the corresponding adjustments are made via the KC box.

When the CC195 is mentioned in the following FDEF both chips are ment. Differences will be mentioned explicitly.

The designation of the control signals is identical in both chips.

```
                                                                                                                 3,7 V
                                                                                                                   |
                                                                                         +------------------+      v -
                 CC195                                                                   | ikrme(i) - ikrma |----->o-------------->
               * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *   +------------------+        > 0 ==> B_kl
 +----------+  *  +------+                                                           *           |
 |knocksen.1|-----|      |                                                           *           |  +------- +
 +----------+  *  |multi-|  +----------+  +-----------+  +-------------+  +-------+  *  +-----+  |  |ikr(i)  |       > 0 ==> B_kl
 +----------+  *  |plexer|--|amplifier |--| band pass |--|  rectifier  |--|integr.|-----|A/D-C|--+--| ------ |-+-->o-------------->
 |knocksen.2|-----|      |  +----------+  +-----------+  +-------------+  +-------+  *  +-----+     |rkrmx(i)| |   ^ -
 +----------+  *  +------+        ^            ^                            ^   ^    *              +------- + |   |
               *     ^            |            |                            |   |    *                         |   |
               * * * | * * * * * *|* * * * * * | * * * * * * * * * * * * * *|* *|* * *               +---------+   |
    +-------+        |            |            |                            |   |                    |             |
    |SENZZYL|        |            |            |                            |   |                    |             |
    | SY_KS |--------+            |            |                            |   |                    v             |
    +-------+                     |            |                            |   |             +--------------+     |
    +------+                      |            |                            |   |             |reference lev.|     |
    | vkr  |----------------------+            |                            |   |             |calculation f.|     |
    +------+                                   |                            |   |             |next KD       |     |
    +------+                                   |                            |   |             |of this cyl.  |     |
    |FMFKR |-----------------------------------+                            |   |             |rkr(i,k+1)    |     |
    +------+                                                                |   |             |vkr(i,k+1)    |     |
    +------+                                                                |   |             +--------------+     |
    |KFMAKR|----------------------------------------------------------------+   |                                  |
    +------+                                                                    |                                  |
    +------+                                                                    |                                  |
    |KEMLN |--------------------------------------------------------------------+                                  |
    +------+                                                                                                       |
    +------+                                                                                                       |
    | kek  |-------------------------------------------------------------------------------------------------------+
    +------+
```

Hint: The cylinder-individual values (ikr, ikrme) are indicated in the following description by a control variable (i) - like in the ECU-code - for example ikr(i). The corresponding RAM-cell which is illustrated in the ASCET-picture and which can be read via VS100 is marked by _i , for example ikr_i.
The variable i travels from 0 up to SY_ZYLZA-1.

The knock detection and thus the calculation of rkr(i), vkr(i), kek and B_kl is described in %KRKE.

```
Determination of the measuring values (Intwert)
-----------------------------------------------
                .................                       .................                       .................
                .               .                       .               .                       .               .
                .               .                       .               +-----------------------+               .
                .               .                       .              *.   ^         ^         |               .
        --------+               .                       .            *  .   |         |         |               +-------
                |               .                       .          *    . ikr(i)      |         |            *  .
                |               .                       .       *       .   |         |         |         *     .
                |               +------------ .. -------+.....*.............v...      |         |      *        .
                |       *       .      ^                |  *    ^       .             |         |   *           .
                + - - - - -     .      |                +       |       .             |         .               .
                .     ^         .      |                .       |       .         ikrme(i)      .               .
                .     |         .   ikrmen              .    iokkr      .             |         .               .
                .  ikrma        .      |                .       |       .             |         .               .
                .     |         .      |                .       |       .             |         .               .
                .     ^         .      v                .       v       .             v         .               .
 Ground -------------------------------------------------------------------------------------------------------------------
                .               .                       .               .                       .               .
                .<---tmfln_w--->.                       .<---tmfl_w---->.                       .<---tmfl_w---->.

                  zero test measuring                     normal measuring                        normal measuring
                  window                                  window                                  window
```

During each combustion the processor reads the CC195 integrator value via the A/D converter and calculates the offset corrected integrator value ikr(i) relevant to the knock decision:

```
        ikr(i) = ikrme(i) - iokkr,  with
        iokkr = ikrma + (igokr_w * tmfl_w), in which case  ikrma is limited to 715 mV +/- 220 mV  (220 mV = limit value for
                                            diagnosis reset value) and | igokr_w * tmfl_w | to DKROKMX
        igokr_w = igod_w = (ikrmen - ikrma) / tmfln_w,  ikrma is not limited
```

For the calculation of the current offset correction value iokkr the values for the integrator gradient igokr_w and for the integrator reset value ikrma as well as the current measuring window length tmfl_w which were determined in the preceding zero test are used. The product of current measuring window length tmfl_w and integrator gradient igokr_w is limited to the maximum value DKROKMX, so that for the determination of the offset with short measuring windows the conversion error to long measuring windows, due to rough incrementation, remains small.

In the zero test ikrma and igokr are determined for the offset compensation and igod_w for checking the CC195. In the test pulse ikrmet is determined for the checking of the CC195. Thereafter the corresponding diagnosis function is called up and the values are checked for plausiblity.

Due to the ADC resolution (approx. 20 mV) and the small integrator offset values in case of small measuring window lengths the determination of the integrator gradient igokr_w for the offset correction in case of small measuring window lengths may not be performed. This can be achieved by using an upper engine speed threshold DKROKO. When this threshold is exceeded the integrator gradient igokr_w is frozen.
Hints for the application of this engine speed threshold, see below and in %DKRNT.

For the diagnosis of the integrator gradient igod_w is used, not igokr_w. igod_w is also calculated above the engine speed threshold DKROKO. Therefore the diagnosis can be enabled in an extended engine speed range as it is possible while using igokr_w. That means, if nmot <= DKROKO then igokr_w = igod_w. The calculation of igod_w will be stoped if nmot > DKROKD. In this case the value for igod_w is freezed.
DKROKD must be greater than DKROKO.

Generating the measuring window (Messf)

The beginning of the measuring window with regard to DTC is determined by the tooth flank signal (resolution 3°). In order to realize the resolution demanded for tmfa (beginning of measuring window with regard to DTC in s) resp. tmfl_w (measuring window length in s) timers which are on the uC are used. During the measuring window the knock sensor signal is integrated in the CC195.

Triggering of zero test and test pulse (BDIA, BDIA\DIAFR)

Normally the zero test and the test pulse are triggered alternately approx. every 255 working cycles (that means zero test, after 255 working cycles test pulse, after a further 255 again zero test and so on).
The zero test is only performed if the knock control is active (i.e. B_kr = 1) and if the secondary conditions Ztpnt_a=0 and B_tpnt_aw=0 are fulfilled. In case Ztpnt_a=0 and B_tpnt_aw=0 and !B_kr are set, the state is frozen and a zero test is performed during the next transition from !B_kr to B_kr.

The test pulse is performed if the temperature threshold for the KC is exceeded (i.e. B_tmkr = 1) and if the conditions Ztpnt_a=0 and B_tpnt_aw=1 are fulfilled.

Zero test and test pulse are only triggered if no dynamic response (!B_krldy and !B_krndy) exists. A request for zero test or for test pulse which takes place during active dynamic response, is only considered after the end of the dynamic response.

In case of suspected error of a diagnosis, i.e. the error counter of the corresponding diagnosis does not have the value KRFHT, the zero test and test pulse are no longer performed alternately. Instead the test which generated the suspected error is carried out at approx. every 120 working cycles until the error is definitely detected or healed. Thereafter a change back to the standard state is performed. This applies analogous for the healing.
(As far as further marginal conditions for the execution of the diagnosis are concerned see %DKRNT and %DKRTP).

With sufficient time before the beginning of the diagnosis measuring window the following points must be observed:
- for the zero test the signal sources (KS) must be deactivated (e.g. by B_dntb, waiting time until the beginning of the measuring window at least 250 us)
- for the test pulse the test pulse needs to be switched on and the medium amplification stage 2ˆ3 must be adjusted on the CC195 (e.g. by B_dtpb)
  (The change-over of the amplification stage for the test pulse cannot be measured with VS100.)

The amplification during zero test must be equal to the current amplification of the current measuring window. (Theoretically also larger amplifications are possible and sensible so as to increase the reliability of detecting a stuck multiplex switch. However, these can cause additional problems if a disturbance noise from the printed board in the CC195 exists ==> falsely a stuck multiplex switch is then detected).

The test pulse and the diagnosis DKRTP can be switched off by the label CWDKRTP (CWDKRTP = 0 switched off, CWDKRTP > 0 switched on). If the test pulse is switched off also the test pulse activation of the CC195 is no longer performed. In this case the zero test is performed every 255 working cycles.

Due to the diagnosis DKRNT being switched off only the evaluation is suppressed. The zero test, i.e. the determination of ikrma and igokr_w, is still performed because the values are needed for the offset correction. (Labels for the switching off of the zero test diagnosis:
The activation or deactivation of the diagnosis is only allowed to take place during the ECU reset, so as to ensure that the functions are performed correctly.

Hint: The diagnosis may only be switched off for application purposes and not for the mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRNT, CWDKROF and CWDKRTP must be set to a value > 0.)

In order to obtain reasonable starting values for the offset correction, the values for ikrma and igokr are determined once after the start, if tmot > TMKR - (5 increments) and B_kr=0. These values are not diagnosed.

Knock sensor selection (KS-Auswahl)

Up to four knock sensors can be connected to the CC195. By means of the internal multiplexer a selection is made as to which knock sensor input is evaluated. Here, the knock sensor 1 must not be connected to the input KE1 but it may be connected to any input. This also applies to other knock sensors present in the system. The hardware delevopment determines as to which inputs the knock sensors will be connected to.
The internal multiplexer of the CC195 is controlled by the uC. For the correct selection of the sensor it is therefore necessary to establish the relation between a knock sensor and its corresponding input of the CC195 in the software. This is done by the system constants SY_KS.
The control of the multiplexer is performed via two bits. The inputs KE of the CC195 are numbered from 1 to 4. In the following table the bit combinations and the accompanying input KE as well as the decimal value of the bit combination are shown.

Bit combination	Input KE	Decimal value of the bit combination
00	1	0
01	2	1
10	3	2
11	4	3

For the assignment between knock sensor and input KE the two least significant bits of the system constant SY_KS are used.
Thus the SY_KS have a value range from 0 to 3.
The following must be entered into SY_KS1: The decimal value of the bit combination of the input KE of the CC195 to which knock sensor 1 is connected.
The assignment of further knock sensors is performed analogous and it must be determinate (the inputs which are not connected are entered correspondingly into the system constant of the non-existing KS, also see examples). The system values can only be changed by the software development.

Apart from the relation between input KE and knock sensor, also the relation between the order of combustion and the knock sensors must be established in the SW, i.e. which knock sensor belongs to which combustion.
This assignment, between the combustion specified by the software cylinder counter zzyl and the corresponding knock sensor is performed via the fixed value block SENZZYL.
It must be entered into SENZZYL(i) which knock sensor belongs to the respective combustion i.

The knock sensors can be connected either asymmetrically or symmetrically. In the symmetrical mode only two knock sensors can be operated.

Example 1:
Four-cylinder engine with order of combustion 1 3 4 2 and two knock sensors; knock sensor 1 belongs to the cylinders 1 and 2, sensor 2 belongs to the cylinders 3 and 4; knock sensor 1 lies at the CC195 input KE3 and sensor 2 at the input KE1; KE2 and KE4 are not connected.

Cylinder	1	3	4	2
zzyl	0	1	2	3
SENZZYL(zzyl)	1	2	2	1

SY_KS1 = 2 and SY_KS2 = 0   => connected inputs
SY_KS3 = 1 and SY_KS4 = 3   => not connected inputs

```
 -------------
|             |
|        KE 1 |---------- KS 2
|             |
|        KE 2 |---------- not connected
| CC195       |
|        KE 3 |---------- KS 1
|             |
|        KE 4 |---------- not connected
|             |
 -------------
```

Example 2:
Six-cylinder V-engine with order of combustion 1 4 3 6 2 5 and two knock sensors; knock sensor 1 belongs to the cylinders 1, 2 and 3, sensor 2 belongs to the cylinders 4, 5 and 6; knock sensor 1 lies at the CC195 input KE4 and sensor 2 at the input KE3; KE2 and KE4 are not connected.

Cylinder	1	4	3	6	2	5
zzyl	0	1	2	3	4	5
SENZZYL(zzyl)	1	2	1	2	1	2

SY_KS1 = 3 and SY_KS2 = 2   => connected inputs
SY_KS3 = 0 and SY_KS4 = 1   => not connected inputs

```
 -------------
|             |
|        KE 1 |---------- not connected
|             |
|        KE 2 |---------- not connected
| CC195       |
|        KE 3 |---------- KS 2
|             |
|        KE 4 |---------- KS 1
|             |
 -------------
```

Filter center frequency (fmfkr Decod)

The filter center frequency depends on the engine speed. There are four speed areas. The filter center frequency is adjusted by means of the constants FMFKRB0-3. The desired filter center frequency has to be entered in kHz. The areas are limited via the constants NKRFM1-3.

```
                          |           |           |           |
filter center frequency   |  FMFKRB0  |  FMFKRB1  |  FMFKRB2  |  FMFKRB3
                          |           |           |           |
                          +-----------+-----------+-----------+------------> speed
                                   NKRFM1      NKRFM2      NKRFM3
```

To avoid a jitter, a hysteresis (KRANH, hysteresis of the kc-adaptation map) is used. (Application hints for KRANH see %KRRA) According to the desired filter center frequency the corresponding pins of the CC195 are triggered. If a change of the filter center frequency has occured, B_fmfkrc is set true for KRFTPAKT + 1 working cycles. The bit is used in %KRKE.

KC application mode only for the CC650 (Cannot be used for the CC195)

The CC650 must be switched to a KC application mode via the code word CWKRAPP for the KC application with the KID. This is necessary, because the amplification stage is controlled via internal registers. By means of the switch-over the contents of the register is transfered to ports on the outside and it can thus be used for the KID. In this mode also the ADT signal is led to the exterior by a port. By the fixed value TMCC650 it is possible to select which internal signal is to be transfered to the output ADT.

TMCC650	ADT output
0	KTI input (asymmetrical mode)
16	internal pulse of the CC195 proportion
32	KTI input (symmetrical mode)
48	test pulse output
64	filter output
80	rectifier output
96	amplifier output
112	multiplexer output

CWKRAPP = 0   : Normal operating and series production setting
CWKRAPP = F0h = 240 : KC application mode

Hint: The KC application mode may only be used in connection with a KC control unit, since the amplification stage is transfered to ports which are used for other purposes during normal operating. In the KC control unit these lines are then separated. The ADT-output may only be used for special investigations. For the kc-application (for example with KID) TMCC650 must be set to zero (TMCC650=0).
The labels CWKRAPP and TMCC650 have no function in connection with the CC195.

The CC650 is set to asymmetrical or symmetrical mode by means of a system constant. The tabular above for the ADT-output is valid for both the asymmetrical and the symmetrical mode with one exception. The exception is TMCC650 = 0. If the IC is switched to the symmetrical mode via the system constant, the CC650 is in the symmetrical mode at TMCC650=0 too.

The application mode is not necessary for the CC195, since the signals for the KID measurement can be taken directly from the chip.

Setting of the knock sensor evaluation IC

The software modul contains the triggering of the CC195 as well as the triggering of the CC650. The selection is performed by means of system constants. So that a correct selection is performed the following settings are necessary:

CC195: SY_KR_INT = 0
        SY_KR_EXT = 1

CC650: SY_KR_INT = 1
        SY_KR_EXT = 0

APP GGKS 4.50 Application hint

The values B_mf, B_ntinires, B_dnta and B_dtpa are dependend on the representation and they do not exist in the software. The bits B_c95* as well as tpnt_aktiv cannot be measured correctly by VS100, since some of them are updated twice during a synchro program run.

Asymmetric/symmetric sensor operation
Sensors can be connected to the CC195 asymmetrically as well as symmetrically. If the test inputs TP0, TP1 and TP2 are connected to VSS the CC195 operates (compatible to the CC192) in the asymmetrical mode.
If TP1 = high and TP2 = TP0 = low is connected then the CC195 operates in the symmetrical mode. The input multiplexer can only change-over up to two knock sensors.

The CC650 must be switched to the KC application mode for KID measurements. In this mode also the diagnosis test pulse should be switched off.
Hint: The KC application mode may only be used in connection with a KC control unit, since the amplification stage is transfered to ports which are used for other purposes during normal operating. In the KC control unit these lines are then separated. The ADT-output may only be used for special investigations. For the kc-application (for example with KID) TMCC650 must be set to zero (TMCC650=0).
The labels CWKRAPP and TMCC650 have no function in connection with the CC195.

The fixed value block SENZZYL(i) for knock sensor assignment must be adjusted according to the description in the text.

The filter center frequency is adjusted by means of the constant FMFKRB0-3. The desired filter center frequency has to be entered in kHz. The areas are limited via the constants NKRFM1-3. (Application hints for KRANH see %KRRA)

```
                          |           |           |           |
```

```
filter center frequency   |  FMFKRB0  |  FMFKRB1  |  FMFKRB2  |  FMFKRB3
                          |           |           |           |
                          +-----------+-----------+-----------+-------------> Drehzahl
                                NKRFM1      NKRFM2      NKRFM3
```

It may occur that not all pins of the CC195 for the filter center frequency adjustment are connected to the uC in the HW.
In this case not all frequencies which can be adjusted in the software can be adjusted in the CC195. This must be settled with the HW development.

Due to the ADC resolution (approx. 20 mV) and the small integrator offset values with small measuring window length, the determination of the integrator gradient igokr_w for the offset correction with small measuring window lengths may not be performed. This is achieved by using an upper engine speed threshold DKROKO. When this threshold is exceeded the integrator gradient igokr_w is frozen.
The engine speed threshold DKROKO must be adjusted according to the following recommendations:

- The measuring window for the calculation of the gradient igokr_w must be larger than 2 ms.
- The threshold should not fall below 5000 rpm.
- Only if it is not possible to fulfill the two requirements just mentioned, the threshold may be selected such that the measuring window becomes smaller. It may, however, not become smaller than 1,5 ms.
  In this case the following is recommended:
  If the measuring window length at 5000 rpm lies between 1,5 ms and 2,0 ms, then the threshold DKROKO should be set to 5000 rpm.
  If the measuring window length at 5000 rmp is less than 1,5 ms the threshold DKROKO should be set such that the measuring window length is 1,5 ms.

DKROKD must be greater than DKROKO.
Further hints see %DKRNT.

The diagnosis DKRTP can be switched off my means of the label CWDKRTP (CWDKRTP = 0 switched off, CWDKRTP > 0 switched on). If the diagnosis is switched off, also the test pulse triggering of the CC195 is no longer performed. In this case the zero test is performed every 255 working cycles.

Due to the diagnosis DKRNT being switched off only the evaluation is suppressed. The zero test, i.e. the determination of ikrma and igokr, is still performed because the values are needed for the offset correction. (Labels for the switching off of the zero test diagnosis: CWDKRNT and CWDKROF)

The activation or deactivation of the diagnosis is only allowed to take place during the ECU reset, so as to ensure that the functions are performed correctly.

Hint: The diagnosis may only be switched off for application purposes and not for the mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRNT, CWDKROF and CWDKRTP must be set to a value > 0.)

During the application of the characteristic map for the beginning of the measuring window and for the measuring window length it must be observed that at each operating point the sum of the values for beginning of measuring window and for measuring window length is smaller than the segment length. (That means wmfa + wmfl < 720° / SY_ZYLZA). 0°KW may not be entered into KFMAKR and KEMLN.

Hint: The beginning of the measuring window must lie in between TDC and the following SW reference mark. A safety distance betweeen the begin of the measuring window and SW reference mark has to be kept. This limitation of the beginning of the measuring windows is realized via SW.
The maximum beginning of the measuring window is limited to ((720°KW/SY_ZYLZA)-SY_GRDWRT-safety distance). The safety distance depends on the speed.

	nmot < 2000	2000 < nmot < 4000	4000 < nmot < 5000	5000 < nmot < 6000	6000 < nmot
safety distance begin of measuring window to SW reference mark °KW	3,75	5,25	6,75	7,5	9

The characteristic map KFMAKR is not limited. The values from KFMAKR are limited in the SW to the value described above.
The current, limited value of the beginning of the measuring window is wmfa.

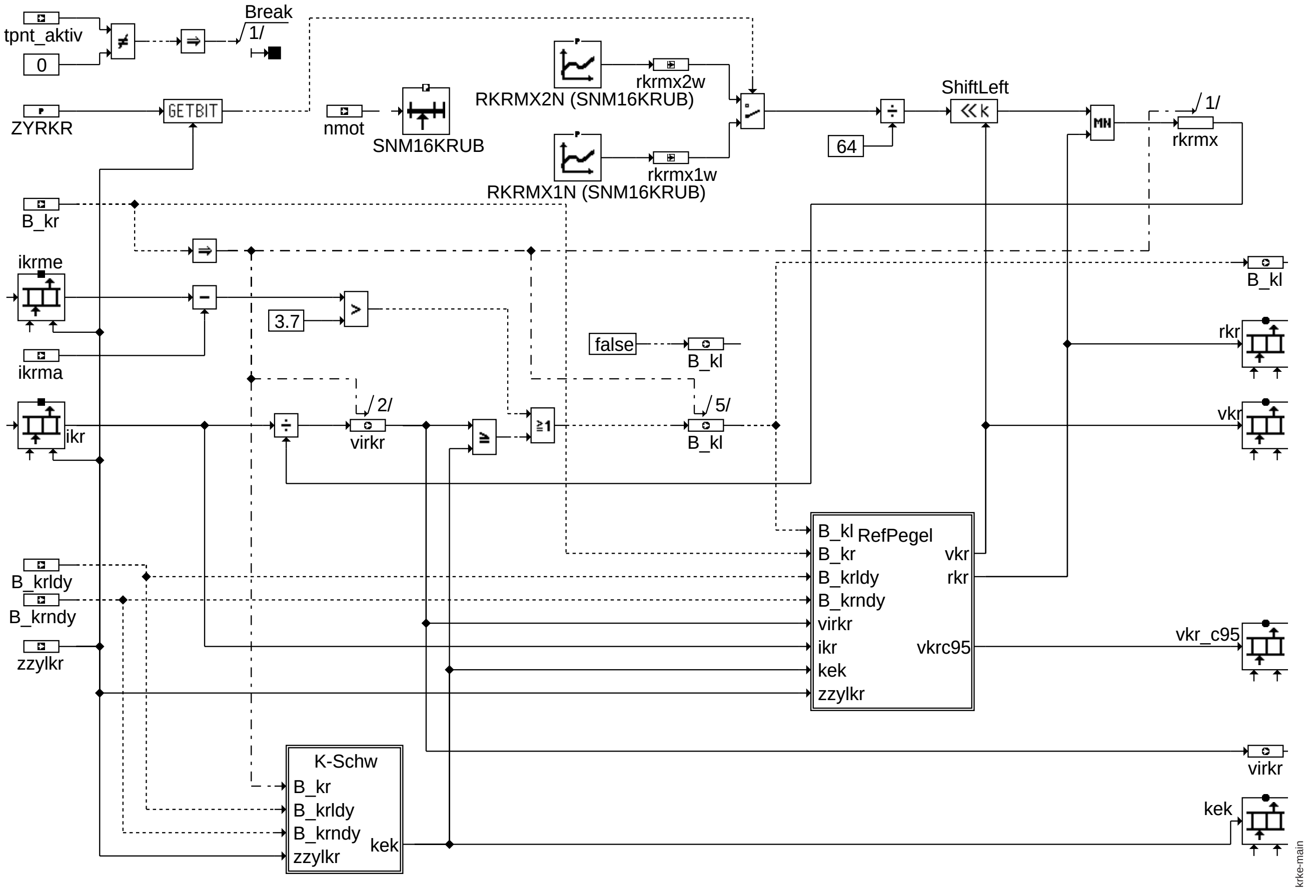
For further application hints regarding the beginning of the measuring window and the measuring window length see %KRKE.

The following guidance values are recommended:
CWDKROF = 1
CWDKRNT = 1
CWDKRTP = 1
CWKRAPP = 0
DKROKMX = 400 mV
DKROKO approx. 5000 rpm (for measuring window > 2 ms)
DKROKD > DKROKO
TMCC650 = 0

KRKE 14.30 Knocking detection

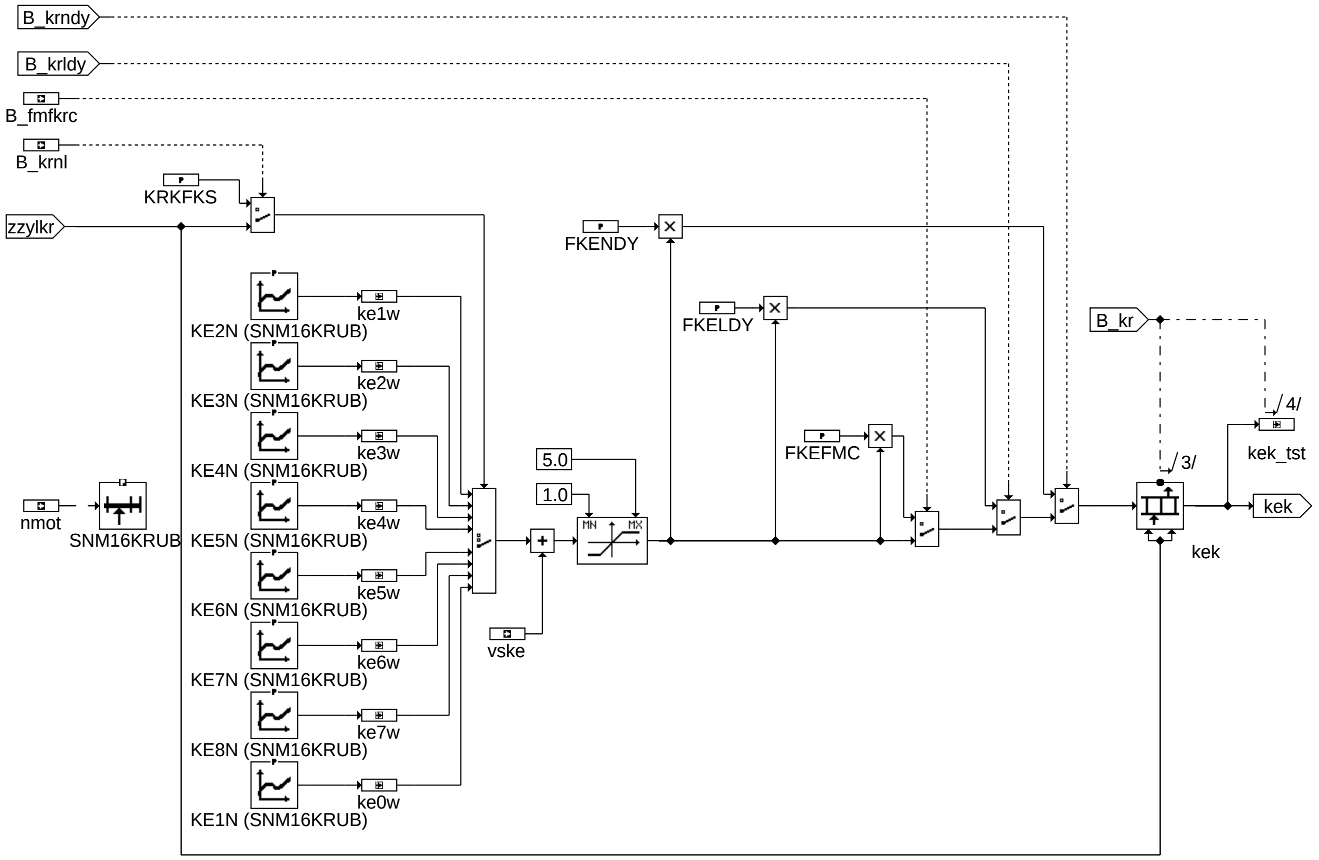
FDEF KRKE 14.30 Function definition

KRKE: knock detection



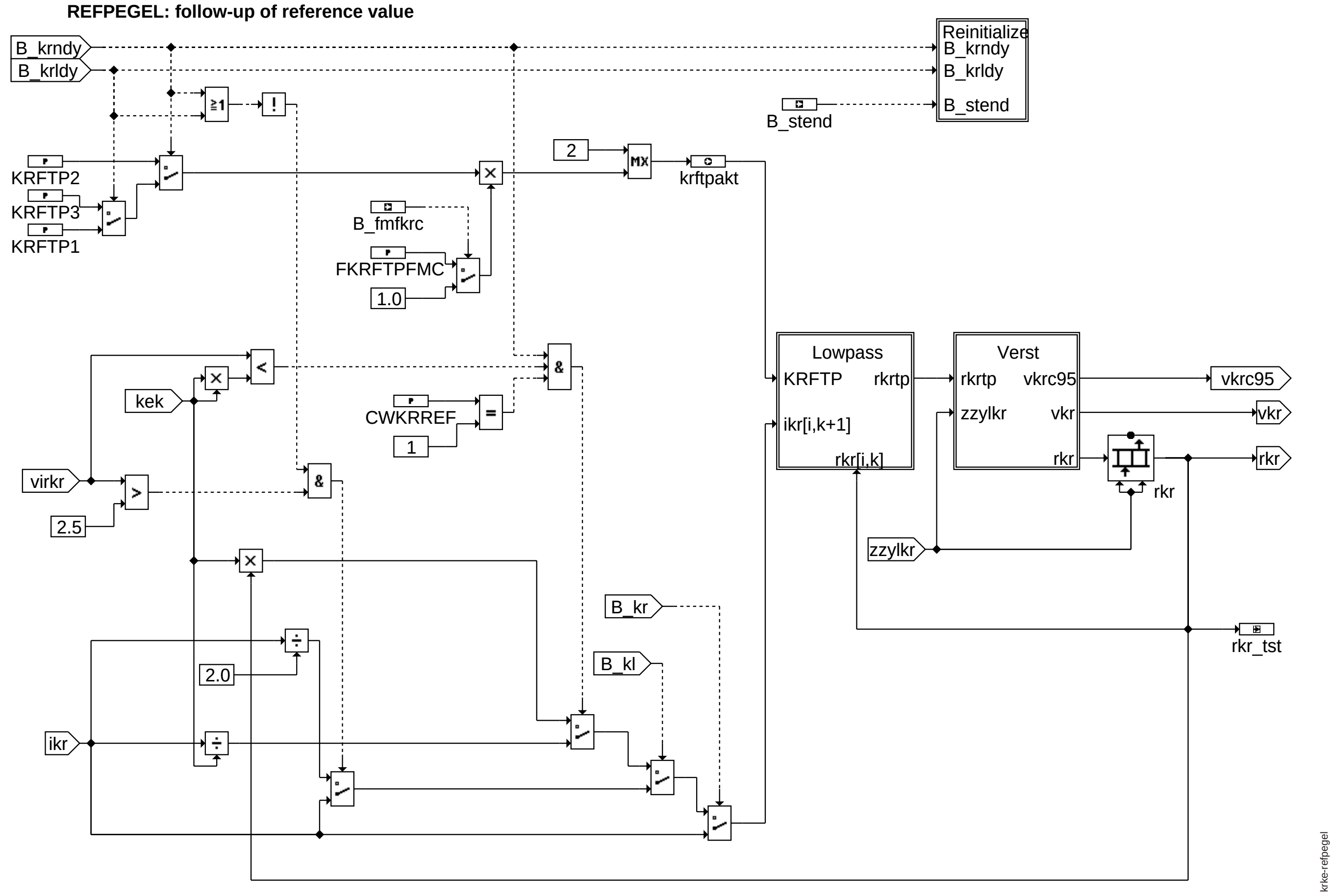
krke-main

K-SCHW: determination of corrected knock detection threshold



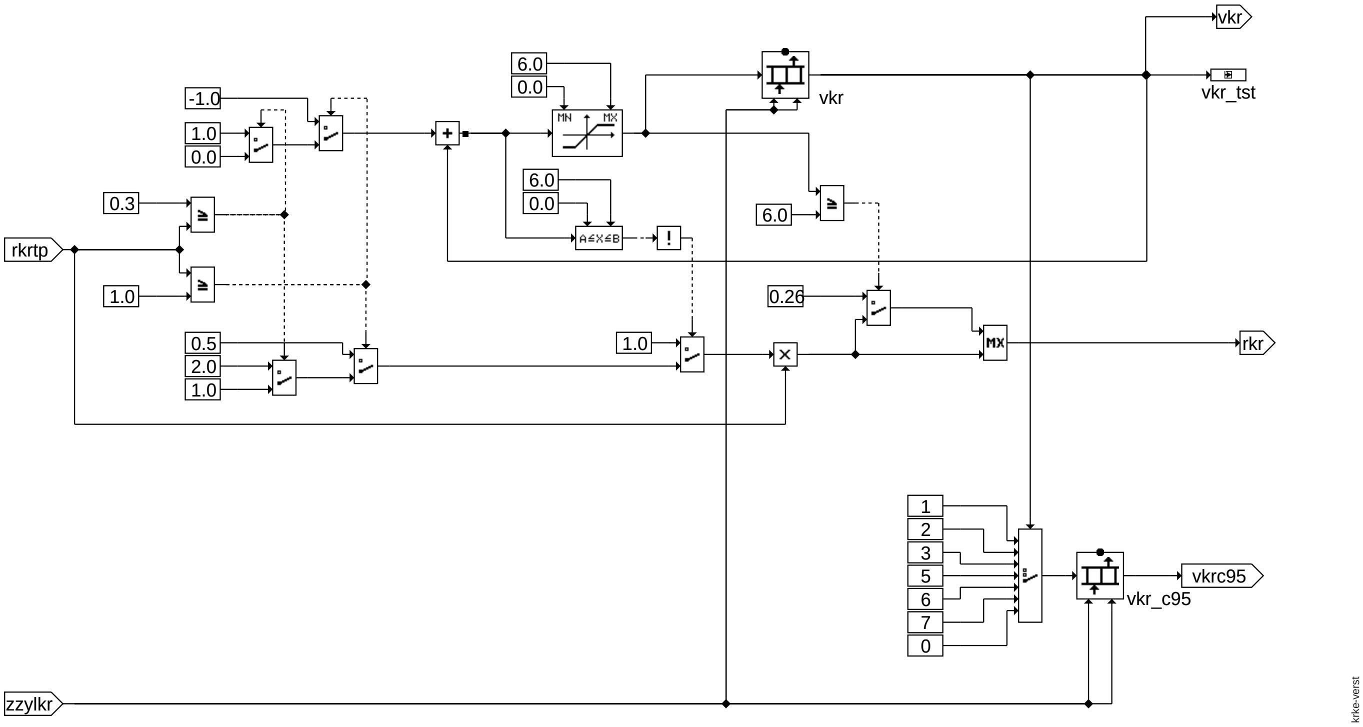
krke-k-schw

REFPEGEL: follow-up of reference value



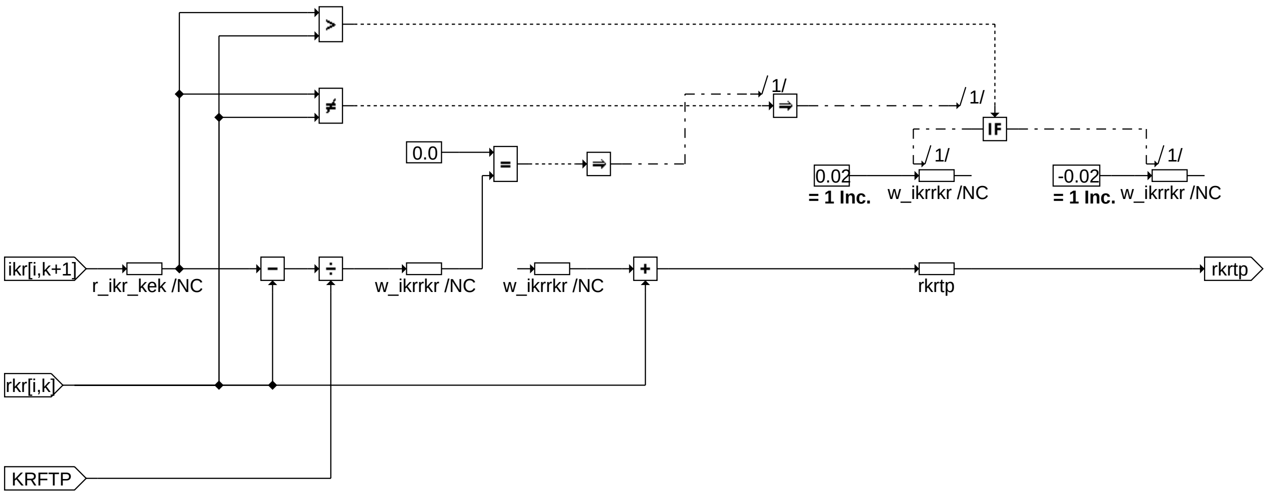
krke-refpegel

VERST: change-over amplification stage



krke-verst

LOWPASS: calculation of reference value



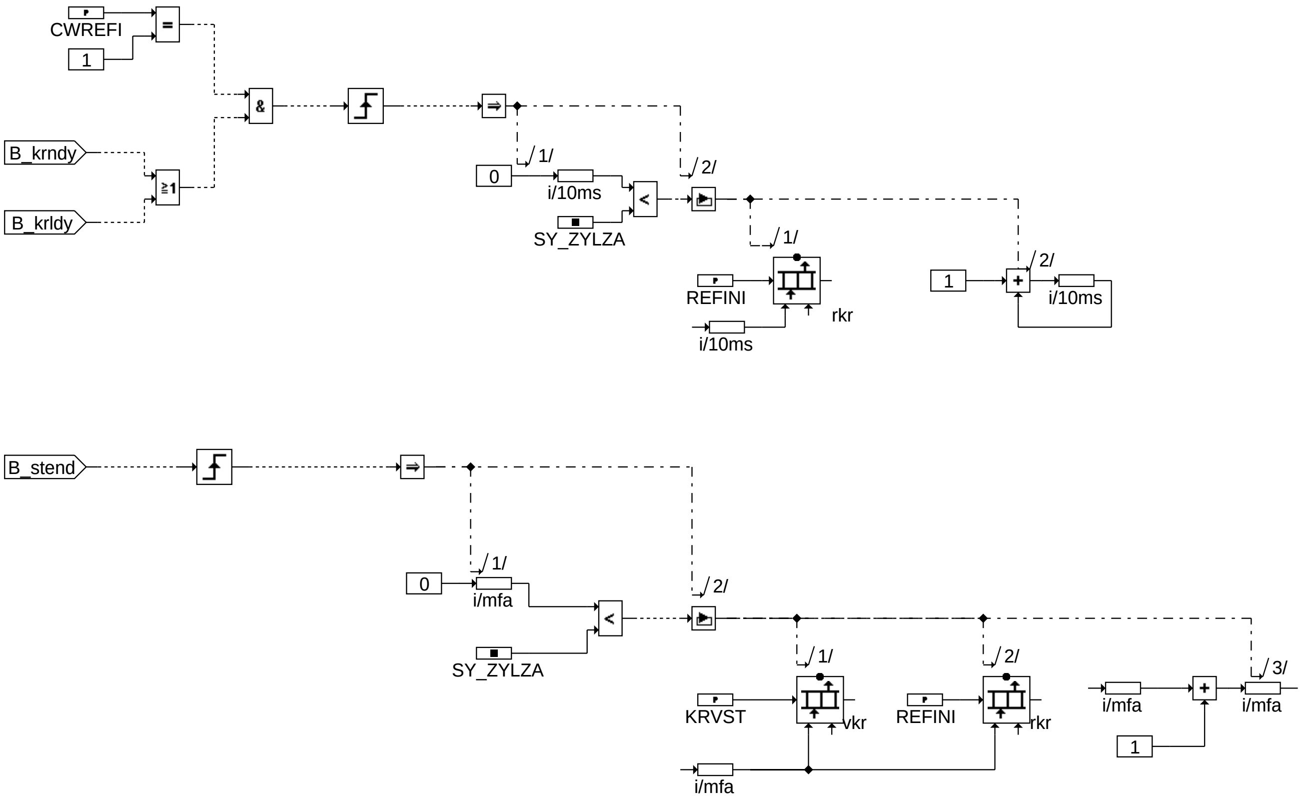
rkr[i,k+1] = rkrtp = rkr[i,k] + (ikr[i,k+1] - rkr[i,k]) / KRFTP

k: combustion cycle
i: cylinder counter

krke-lowpass

krke-lowpass

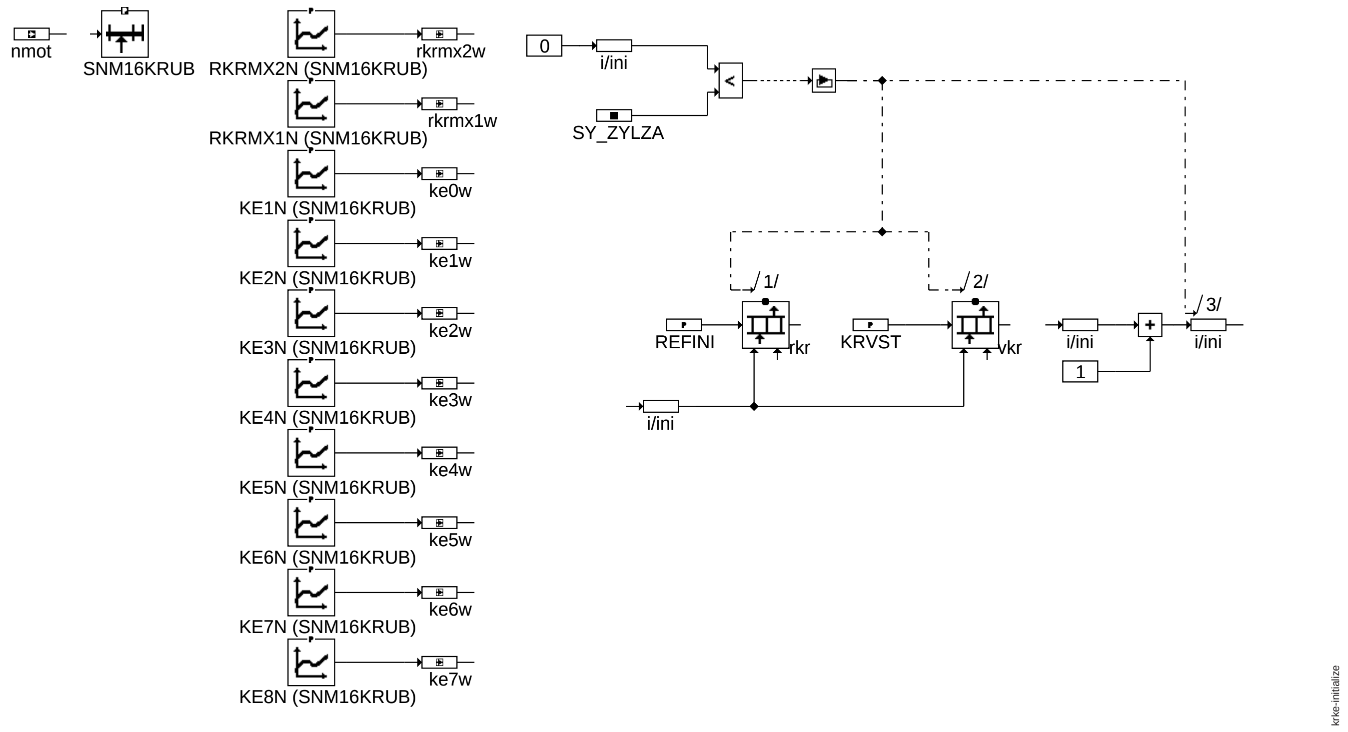
REINITIALIZE: reinitialize of vkr and rkr



krke-reinitiali

krke-reinitiali

INITIALIZE: initialization



krke-initialize

ABK KRKE 14.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWKRREF			FW	code word: characteristic of rkr follow-up at speed dynamics
CWREFI			FW	code word: reinitialize of rkr with REFINI at dynamics conditions
FKEFMC			FW	correction factor for knock detection thresh. in case of change of filter frequ.
FKELDY			FW	correction factor for knock detection threshold during load dynamics
FKENDY			FW	correction factor for knock detection threshold with engine-speed dynamics
FKRFTPFMC			FW	correction factor of low pass characteristic at switch of filter mean frequency
KE1N	NMOT		KL	knock detection threshold at cylindertimer 1
KE2N	NMOT		KL	knock detection threshold at cylindertimer 2
KE3N	NMOT		KL	knock detection threshold at cylindertimer 3
KE4N	NMOT		KL	knock detection threshold at cylindertimer 4
KE5N	NMOT		KL	knock detection threshold at cylindertimer 5
KE6N	NMOT		KL	knock detection threshold at cylindertimer 6
KE7N	NMOT		KL	knock detection threshold at cylindertimer 7
KE8N	NMOT		KL	knock detection threshold at cylindertimer 8
KRFTP1			FW	low pass characteristic normal
KRFTP2			FW	low pass characteristic at engine speed dynamics
KRFTP3			FW	low pass characteristic at load dynamic
KRKFKS			FW	selected knock detection threshold, if missing cylinder one detection
KRVST			FW	gain after cranking
KSZA			FW	number of knock sensor
REFINI			FW	initial value for reference level if knock control enabled
RKRMX1N	NMOT		KL	Maximum of reference level for knock detection threshold cylinder group 1
RKRMX2N	NMOT		KL	maximum of reference level for knock detection threshold cylinder group 2
SNM16KRUB	NMOT		SV (REF)	datapoint distribution engine speed, 16 datapoints
SY_ZYLZA			SYS (REF)	system constant number of cylinders
ZYRKR			FW	cylinder selective reference level limitation

Variable	Source	Type	Description
B_FMFKRC	GGKS	EIN	filter center frequency of CC195/CC650 changed
B_KL	KRKE	AUS	condition for knocking
B_KR	KRRA	EIN	condition for knock control active
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_KRNL	KRRA	EIN	emergency operation of knock detection for emergency operation of phase sensor
B_STEND	BBSTT	EIN	condition end of start
IKR	GGKS	EIN	integrator value with offset correction
IKRMA		EIN	integrator value at start of measurement window, knock control
IKRME		EIN	integrator value at end of measurement window, knock control
KE0W	KRKE	LOK	instantaneous value of characteristic KE0N
KE1W	KRKE	LOK	instantaneous value of characteristic KE1N
KE2W	KRKE	LOK	instantaneous value of characteristic KE2N

Variable	Source	Type	Description
KE3W	KRKE	LOK	instantaneous value of characteristic KE3N
KE4W	KRKE	LOK	instantaneous value of characteristic KE4N
KE5W	KRKE	LOK	instantaneous value of characteristic KE5N
KE6W	KRKE	LOK	instantaneous value of characteristic KE6N
KE7W	KRKE	LOK	instantaneous value of characteristic KE7N
KEK	KRKE	AUS	knock detection threshold corrected
KEK_TST	KRKE	AUS	knock detection threshold corrected updated with cyl.counter
KRFTPAKT	KRKE	AUS	actual low pass characteristic
NMOT	SWADAP	EIN	engine speed
RKR	KRKE	AUS	reference level knock control
RKRMX	KRKE	LOK	reference level limited upwards
RKRMX1W	KRKE	LOK	instantaneous value of chracteristic RKRMX1N
RKRMX2W	KRKE	LOK	instantaneous value of characteristic RKRMX2N
RKRTP	KRKE	LOK	reference level behind low pass knock control
RKR_TST	KRKE	AUS	reference level knock control updated with cyl.counter
TPNT_AKTIV	EGKE	EIN	activation of kc-functions
VIRKR	KRKE	AUS	Ratio: integrator / reference level knock control
VKR	KRKE	AUS	amplification stage knock control
VKR_C95	KRKE	AUS	amplification stage for input amplification stage of knock-IC
VKR_TST	KRKE	AUS	amplification stage knock control updated with cyl.counter
VSKE	VS_VERST	EIN	adjustable offset for knock detection threshold via VS20
ZZYLKR	GGKS	EIN	cylinder counter KC

FW KRKE 14.30 Fixed Values

Parameter	Value	Description
CWKRREF		code word: characteristic of rkr follow-up at speed dynamics
CWREFI		code word: reinitialize of rkr with REFINI at dynamics conditions
FKEFMC		correction factor for knock detection thresh. in case of change of filter frequ.
FKELDY		correction factor for knock detection threshold during load dynamics
FKENDY		correction factor for knock detection threshold with engine-speed dynamics
FKRFTPFMC		correction factor of low pass characteristic at switch of filter mean frequency
KRFTP1		low pass characteristic normal
KRFTP2		low pass characteristic at engine speed dynamics
KRFTP3		low pass characteristic at load dynamic
KRKFKS		selected knock detection threshold, if missing cylinder one detection
KRVST		gain after cranking
KSZA		number of knock sensor
REFINI		initial value for reference level if knock control enabled
ZYRKR		cylinder selective reference level limitation

Hint: The cylinder-individual values (ikr, ikrme, rkr, kek, vkr) are indicated in the following description by a control variable (i) - like in the ECU-code - for example rkr(i). The corresponding RAM-cell which is illustrated in the ASCET-picture and which can be read via VS100 is marked by _i, for example rkr_i.
The KC cylinder counter zzylkr serves as control variable. The following applies to it:

zzylkr = 0 ... SY_ZYLZA -1   ECU-code

FB KRKE 14.30 Detailed description of function

```
                                                                                                                 3,7 V
                                                                                                                   |
                                                                                         +------------------+      v -
                 CC195                                                                   | ikrme(i) - ikrma |----->o-------------->
               * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *   +------------------+        > 0 ==> B_kl
 +----------+  *  +------+                                                           *           |
 |knock se.1|-----|      |                                                           *           |  +-------+
 +----------+  *  |multi-|  +----------+  +-----------+  +-------------+  +-------+  *  +-----+  |  |ikr(i) |        > 0 ==> B_kl
 +----------+  *  |plexer|--|amplifier |--| band pass |--|  rectifier  |--|integr.|-----|A/D-C|--+--|------ |-+--->o-------------->
 |knock se.2|-----|      |  +----------+  +-----------+  +-------------+  +-------+  *  +-----+     |rkrmx  | |    ^ -
 +----------+  *  +------+        ^            ^                            ^   ^    *              +-------+ |    |
               *     ^            |            |                            |   |    *                        |    |
    +-------+  * * * | * * * * * *|* * * * * * | * * * * * * * * * * * * * *|* *|* * *               +--------+    |
    |Senzzyl|        |            |            |                            |   |                    |             |
    |SY_KSi |--------+            |            |                            |   |                    v             |
    +-------+                     |            |                            |   |             +--------------+     |
    +------+                      |            |                            |   |             |reference lev.|     |
    | vkr  |----------------------+            |                            |   |             |calculation f.|     |
    +------+                                   |                            |   |             |next KD       |     |
    +------+                                   |                            |   |             |of this cyl.  |     |
    |FMFKR |-----------------------------------+                            |   |             |rkr(i,k+1)    |     |
    +------+                                                                |   |             |vkr(i,k+1)    |     |
    +------+                                                                |   |             +--------------+     |
    |KFMAKR|----------------------------------------------------------------+   |                                  |
    +------+                                                                    |                                  |
    +------+                                                                    |                                  |
    |KEMLN |--------------------------------------------------------------------+                                  |
    +------+                                                                                                       |
    +------+                                                                                                       |
    | kek  |-------------------------------------------------------------------------------------------------------+
    +------+
```

Knock detection (KRKE)
======================

For the knock detection the oscillations characteristic of knocking are transformed into electrical signals by one or more knock sensors and passed on to the Electronic Control Unit. The evaluation circuit in the ECU mainly consists of a BOSCH-IC, the CC195, which processes the sensor signals, i.e. amplifies, filters, rectifies and integrates them within a measuring window.
In the process the uC cylinder-individually controls the amplification stages in the CC195 and starts and stops the integration in the CC195. The integrator values are read into the uC via the A/D-converter. As can be taken from %GGKS an offset correction of the integrator values takes place in the micro-computer.
Knocking is detected if the following conditions are met:

```
                   B_kl:     ikr(i) / rkrmx >= kek(i)  or  ikrme(i) - ikrma >= 3,7 V
                             with rkrmx = min ( rkr(i), rkrmx1/2w * 2^(vkr(i)-6))
```

during which the cylinder-individual reference level rkr(i) is limited to the maximum value rkrmx1/2w * 2^(vkr(i)-6). (The standardized reference level from the characteristic lines RKRMX1/2N is calculated to a cylinder-individual absolute limit value with the aid of the cylinder-individual amplification stage.) Thus a knock detection is still made possible even in case of an unusually strong increase in engine noise (for example due to a beginning engine trouble)

The cylinders are assigned to the characteristic lines RKRMX1N and RKRMX2N by the label ZYRKR (grouping into "loud" and "quiet" cylinders)

```
Switch logic: bit = 0  =>  RKRMX1N
              bit = 1  =>  RKRMX2N
```

Examples:

```
                        bit              |  7  6  5  4  3  2  1  0
                       --------------------------------------------
                       cyl.counter(zzylkr)|  -  -  -  -  4  3  2  1
4-cylinder             ignition order     |  -  -  -  -  2  4  3  1                                  cyl. 2 a. 3  ==> RKRMX1N
                       bit pattern        |  -  -  -  -  0  1  0  1   ==>  ZYRKR = 0101 B = 05 Hex        "   1 a. 4  ==> RKRMX2N
                       --------------------------------------------
                       cyl.counter(zzylkr)|  -  -  6  5  4  3  2  1
6-cylinder             ignition order     |  -  -  5  2  6  3  4  1                              cyl. 1, 3, 4, 5 ==> RKRMX1N
                       bit pattern        |  -  -  0  1  1  0  0  0   ==>  ZYRKR = 011000 B = 18 Hex   "   2, 6       ==> RKRMX2N
                       --------------------------------------------
                       cyl.counter(zzylkr)|  8  7  6  5  4  3  2  1
8-cylinder             ignition order     |  8  2  7  4  5  3  6  1                                   1, 4, 5, 8 ==> RKRMX1N
                       bit pattern        |  0  1  1  0  0  1  1  0   ==>  ZYRKR = 01100110 B = 66 Hex     2, 3, 6, 7 ==> RKRMX2N
                       --------------------------------------------

                zzylkr = 0 ... SY_ZYLZA -1   ECU-code
```

Knock detection threshold (K-Schw)

The knock detection thresholds are stored in characteristic lines over the engine speed. In connection with a cylinder-1-detection a characteristic line KE(i)N is assigned to each cylinder i. In case of a loss of the cylinder-1-detection (!B_synph) a cylinder-individual control continues to be performed on systems with one knock sensor (KSZA = 1). Here the knock detection for all cylinders is then based on the knock detection threshold characteristic line determined by KRKFKS. This emergency operation of the knock detection is indicated by B_krnl = 1. This condition is set in %DKRS res. %BBKR:
On systems with more than one knock sensor (KSZA > 1) a safety retarding B_krdws takes place in case of !B_synph (s. %DKRS res. %BBKR).

If load resp. engine speed dynamic response is dtecteted or switch of filter mean frequency the knock detection thresholds ke(i)w determined from the characteristic lines are corrected by multiplication with the labels FKELDY, FKENDY resp. FKEFMC. The thus obtained corrected final values in the RAM kek(i) then form the knock detection thresholds for the corresponding cylinders.

relation between ignition order, characteristic line KEiN and sw-cylinder counter zzylkr (ex. V6):

```
        io      1       4       3       6       2       5
        zzylkr  0       1       2       3       4       5
        KEiN   KE1N    KE2N    KE3N    KE4N    KE5N    KE6N
        ke(k)  ke(k)_0 ke(k)_1 ke(k)_2 ke(k)_3 ke(k)_4 ke(k)_5
```

Calculation of reference level (RefPegel)

The calculation of the reference level (rkr(i)) is performed cylinder-individually and contains the background noise for the knock-free operating. By means of a low-pass filter this reference level is followed-up to the current integrator value. If kocking is detected not the high integrator value but the integrator value divided by the corrected knock detection factor (ikr(i) / kek(i)) and in case of virkr > 2,5 && !B_kl && !B_krldy && !B_krndy the halved integrator value is used for the calculation. Thus it is ensured that also in case of constant knocking a knock detection is maintained.
To prevent misdetections in case of speed dynamics, especially for vehicles with automatic transmission, with the code word CWKRREF it is possible to switch over to a fast follow-up mode of the reference levels. If B_krndy && B_kl && CWKRREF=1 instead of ikr(i)/kek(i), the product of rkr(i) and kek(i) is used for the calculation of the reference value. With CWREFI=1 all rkr(i) will be reinitialized with REFINI at speed or load dynamics conditions.
Since the basic noise of the engine changes faster in case of load and engine speed dynamic response than during quasi-steady-state operation the reference levels are followed-up quicker in order to prevent misdetections. For engine speed dynamic response this is done with KRFTP2 and for load dynamic response with KRFTP3. In case of switch of the filter mean frequency the characteristic of the low pass is corrected with FKRFTPFMC by multiplication.

```
Formula for low-pass:  rkr(i,k+1) = (1 - 1/KRFTP) * rkr(i,k) + 1/KRFTP * ikr(i,k+1)     k: working cycles engine
                                                                                         i: SW cylinder counter
                                  =  rkr(i,k) + 1/KRFTP * (ikr(i,k+1) - rkr(i,k))
```

After the engine start (!B_stend --> B_stend) the calculation of the reference level for rkr(i) begins with the starting value REFINI. For the largest amplification stage (vkr=6) the minimum reference level is limited to 260 mV.
The calculation of the reference level is also continued in the KC-not-active-range and if the error flag of the the KC (B_krdws) is set.

Change-over of amplification stages (Verst)

Since the available integrator lift range without offset correction is limited to 3,8 V the reference level must be limited to 1.0 V for usual knock detection factors up to approx. 3,3. This becomes possible by the 7 stages of the input amplifier of the CC195.
If rkr(i) exceeds the upper change-over threshold (1 V) the amplification stage (vkr(i)) for this cylinder is reduced by one and the reference level (rkr(i)) is halved. If the lower change-over threshold (0,3 V) is undershot then the cylinder-individual amplification stage (vkr(i)) is increased by one and the reference level is doubled. The change-over each time takes place up to the largest resp. to the smallest amplification stage.
After the engine start the cylinder-individual amplification stages vkr(i) begin with the starting value KRVST.

The following cylinder-individual amplification stages exist and they can be indicated with the aid of application devices:

```
---------------------------------------------------+------------------------------------
amplification stage CC195 = vkr(i)                 |     6    5    4    3    2    1    0
---------------------------------------------------+------------------------------------
input amplification factor 2^vkr                   |    64   32   16    8    4    2    1
---------------------------------------------------+------------------------------------
amplification factor incl. filter factor  2^vkr *2 |   128   64   32   16    8    4    2
---------------------------------------------------+------------------------------------

                                                       -------------------->
                                                      increase of basic engine noise
                                                       idle               nominal
                                                       speed              engine speed
```

APP KRKE 14.30 Application hint

For the application the following typical values are suggested:
===

FKELDY = approx. 1,1
FKENDY = approx. 1,1
FKEFMC = approx. 1,1
FKRFTPFMC = 0,5 ... 1
KEiN = cylinder-specific and dependent on the dectection quality, standard is 2 - 3, see following description
KRFTP1 = 16
KRFTP2 = 4
KRFTP3 = 4
KRVST = input amplification stage = 4
REFINI = 980 mV (just below the upper change-over threshold)
RKRMX1/2N = maximum value during the application (limitation is not effective), exact explanation see below
ZYRKR = see RKRMX1/2N
KRKFKS should take the value of the kc-cylinder counter by which the most sensitive knock detection threshold is chosen
e.g. KE3N is the most sensitive knock detection threshold and is read into ke_2 when zzylkr=2, consequently KRKFKS has to take the value 2 in this case
vske while applying knock detection thresholds with connected VS2x the value of vske has to be taken into consideration as after the end of communication between VS2x and ECU (disconnection) vske is set to zero (see %VS_VERST)

The following sequence is useful:

1. Determine and check the knock sensor assignment as described in %GGKS (measuring window, phase and multiplexed knock sensor signal to be observed by oscilloscope, test of varying knock sensor assignments)

2. Determine the beginning and the length of the measuring window (MF) for the entire engine speed range (oscilloscope).
   For each base point the MF must be stipulated during full load and partial load. Experience has shown that only in case of large differences in ignition angle between full load and partial load an earlier beginning of the measuring window is necessary during partial load.
   The sum of MF-beginning and MF-length (in deg. crankshaft (° KW)) must be smaller than the segment length (720° KW / amount of cylinders, s.a. %GGKS).
   Both values must each be chosen different from 0. (for further details see %GGKS)
   Generally the MF-lengths and positions must be adjusted in such a way that the main emphasis of the knock occurrence, represented by the knock sensor raw signal from the original mounting place, lies within the MF. Corresponding to the MF-characteristic line base points at first the best compromise for one engine speed regarding the MF-beginning should be found. Here medium and a little heavier knocking during full load and during partial load have to be considered. The beginning of the knocking should each time lie within the MF. Thereafter the MF-length is chosen such that in case of medium knocking the knock occurrence lies within the MF and in case of a little heavier knocking the dying-out oscillations of the knock occurrence are cut off. The adjustment of the MF must be especially optimal for light and medium knocking.
   Heavy knocking as a rule always fills out the entire MF and therefore it is no problem to detect it.
   This procedure now is to be repeated for the remaining engine speed base points.
   It is also important that the knocking for the selection of the MF is generated with basic ignition angles ready to go into production (so no advance adjustment using vszwkr res. zwappl should be carried out). Therefore it is absolutely necessary to operate the engine with fuel of the lowest planned octane number.

   If the engine has disturbing noises then this should be taken into consideration when selecting the MF as follows:
   - continuous disturbing noises may lie in the MF (here too it would, however, be better if they would lie outside the MF)
   - pulsating disturbing noises must lie outside the MF

   In any case the customer needs to be informed about existing disturbing noises.

3. Adjustment of the filter center frequency (VS100, knock intensity detector: KID)
   The filter center frequency must be chosen such that for all operating points the best possible detection is obtained. In this case the behaviour during high load and high engine speed is decisive for the selection of the frequency. The frequency which guarantees the best detection in this range must be selected.

4. Taking over of the above data listing

5. Fixing the knock detection thresholds KE1N , KE2N ... (VS100, KID)
   Now it is useful to decide on the knock detection (KD) thresholds for the individual cylinders. Especially recommendable in this case is the use of combustion chamber pressure sensors in order to be able to measure the pressure amplitudes in the combustion chamber during the knock occurrence. Should the engine not have bore holes for the pressure sensor in the cylinder head then also spark plugs with integrated pressure sensor can be used. If no exact details were given by the customer then the KD thresholds for the individual cylinders are to be fixed in such a way that knock occurrences whose amplitude exceed the following thresholds are detected 100 %.

n <= 1 800 rpm press.amplitude +- 0,5 - 1 bar Here not the engine durabilty is decisive but the audibility threshold in the vehicle. In connection with knock control the knocking which is audible in the engine test bench
n = 3 000 rpm press.amplitude +- 2 - 2,5 bar room or during open bonnet must also be detected. The knocking occurring during active knock control, however, may not be audible later on in the interior of the vehicle.

n = 4 000 rpm press.amplitude +- 3 - 3,5 bar

n = 5 000 rpm press.amplitude +- 5,0 bar Now the engine durabiltiy is decisive. In case of this high engine speed
n = 6 000 rpm press.amplitude +- 5,5 bar the engine noise is so loud that the knocking is no longer audible.

Attention!!! For characteristic lines with 16 engine speed base points only every 2. engine speed base point is to be adjusted (delta 800 RPM).

Thereafter the misdetection thresholds (retarding at control limit) for each cylinder and for each engine speed are to be determined by reducing the above-determined KD thresholds. Up to 5000 rpm these misdetection thresholds should be for at least 0,5 below the above-determined KD thresholds. Above this engine speed the distance to misdetection may be a little smaller.

These measurements also have to be performed with REGULAR UNLEADED fuel.
Standard are knock detection thresholds of 2 - 3. The value 3,3 may under no circumstances be exceeded during steady-state operation. The determined knock thresholds must then be confirmed at an early stage by the customer in an engine endurance test.

6. Fixing of the maximum permitted reference level for the knock detection RKRMX1/2N (VS100)
So that also in case of very loud background noise of the engine or of a cylinder a knock detection keeps on being possible the reference level rkr(i) is limited to the maximum with RKRMX1/2N only for the calculation of the knock condition B_kl (see picture in FDEF).
For the characteristic lines RKRMX1N and RKRMX2N the following concept is recommended:
   - equip the engine with normal noise behaviour with max-KS (upper limit of the tolerance range)
   - by means of the RAM-contents of rkr(i) and vkr(i) on the engine speed base points of the characteristic lines RKRMX1/2N the standardized reference levels rkrn(i) are to be determined with the formula rkr(i) * 64 / (2ˆvkr(i)) cylinder-specific for all cylinders or they are to be measured directly (s.a. %DKRS).
   - divide cylinders into loud and quiet groups, e. g. 4-cyl. and 1 KS ==> cyl. 2+3 loud a. cyl. 1+4 quiet
     in case of 2-cyl./KS a grouping is usually not necessary
     Via a corresponding bit pattern in the label ZYRKR the reference level is limited cylinder-specifically to RKRMX1N or RKRMX2N just as in the KS assignment.
     bit = 0 => RKRMX1N
     bit = 1 => RKRMX2N (see function description earlier on)
   - Approx. the following values are to be stored in RKRMX1N and RKRMX2N:
     # if n = 2 000 rpm approx. 1,5 * mean value of rkrn(i) for the loud resp. quiet cylinder groups
     # if n = 4 000 " approx. 1,3 * " " " " " " " " " " "
     # if n = 6 000 " approx. 1,2 * " " " " " " " " " " "

     The plausibility of the applyed data should be proved at several engines in order to prevent misdetections of knocking.

     Especially RKRMX1/2N must be adjusted in such a way that also when using min-KS a definite detection of heavy knocking is possible that means ikr(heavy knocking) > rkrmx * kek. In order to cover the characteristic line RKRMX1/2N it should be checked with min-KS whether the knock detection for heavy knocking is still at all possible with the above-determined knock thresholds (rkrmx * kek) if rkr is becoming higher by louder engine. So as to simulate this case the knock detection threshold KEiN must be increased since the reference levels cannot be influenced. Thus rkr can (e.g. if light knocking occurs since it is no longer detected as such) be limited by rkrmx1/2w which makes it possible to check whether following heavy knocking is definitely being detected.

For the knock detection the following grades are now obtained:

- normal engine noise: rkr(i) < RKRMX1/2N * (2ˆvkr(i)) / 64 ==> knock detection with rkrmx = rkr(i)

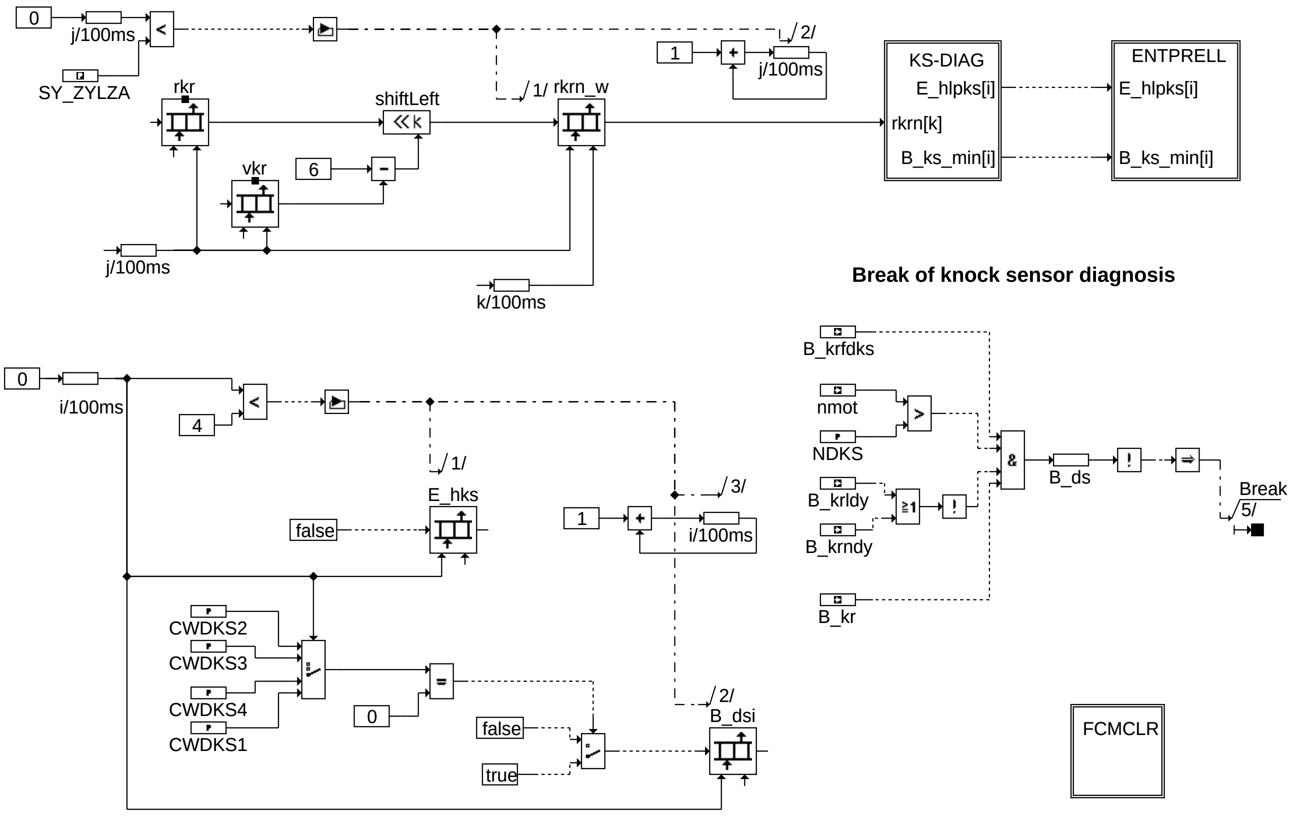
- loud engine: RKRMX1/2N * (2ˆvkr(i)) / 64 < rkr(i) < UDKSNO * (2ˆvkr(i)) / 64 ==> knock detection with rkrmx = RKRMX1/2N * (2ˆvkr(i)) / 64 , since rkr(i) to large

- very loud engine: rkr(i) > UDKSNO (see %DKRS) ==> B_krdws = safety retarding

DKRS 29.80 Diagnosis; knock sensor

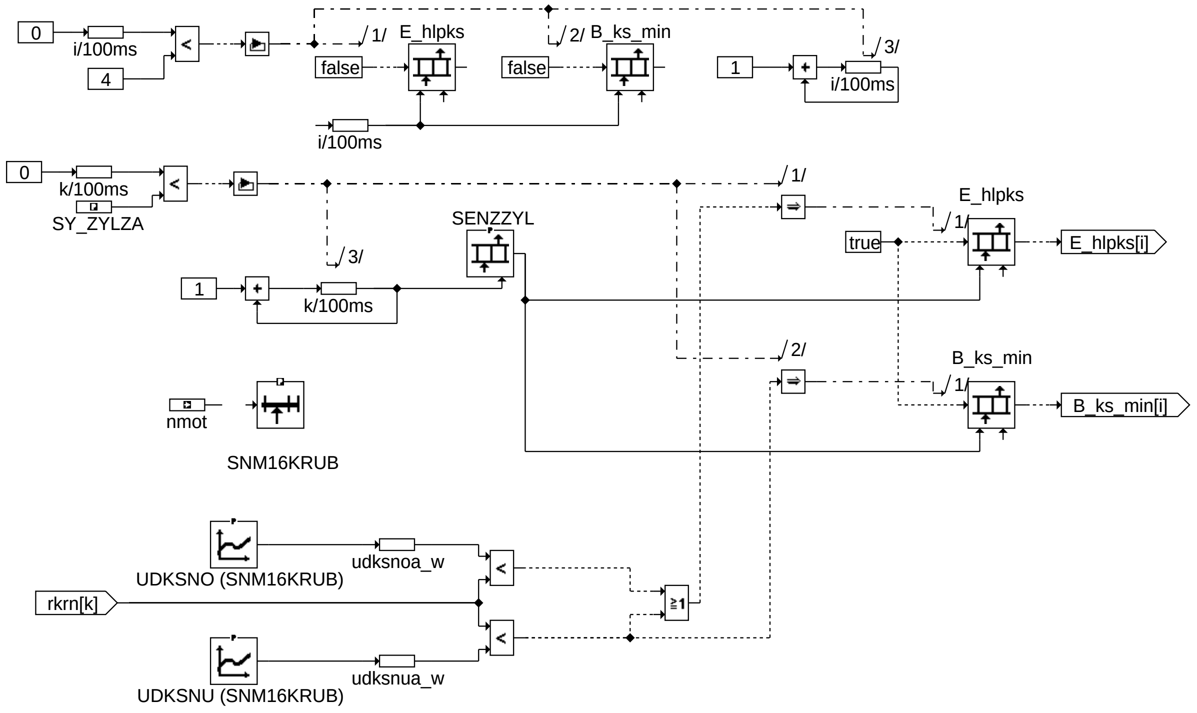
FDEF DKRS 29.80 Function definition

DKRS: Overview knock sensor diagnosis



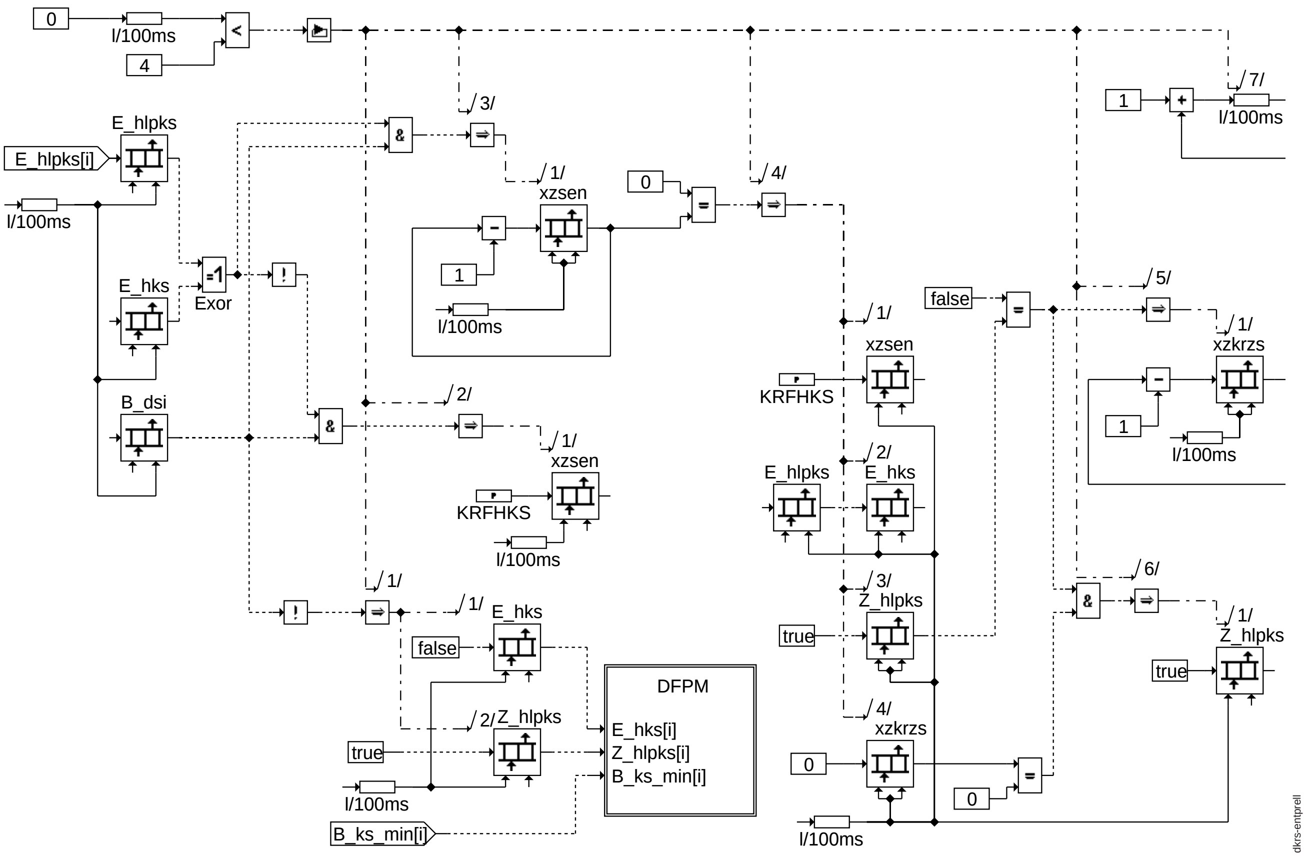
dkrs-main

KS-DIAG: knock sensor diagnosis



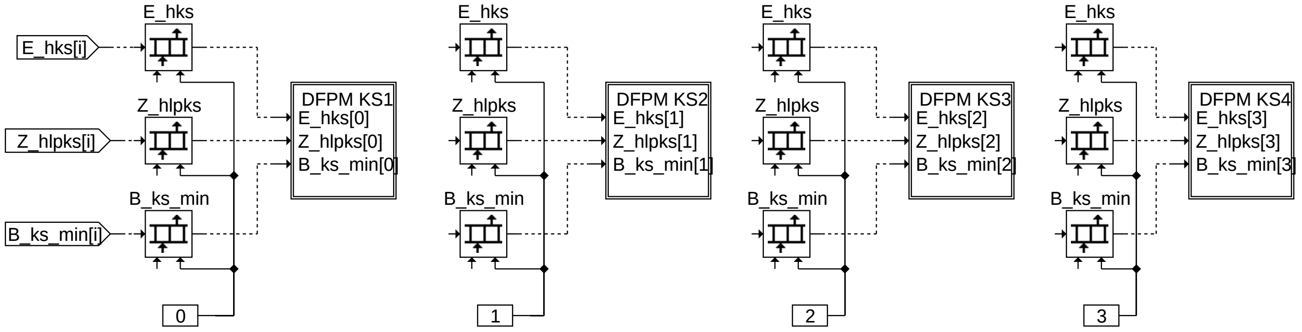
dkrs-ks-diag

ENTPRELL: debounce of fault memory entry

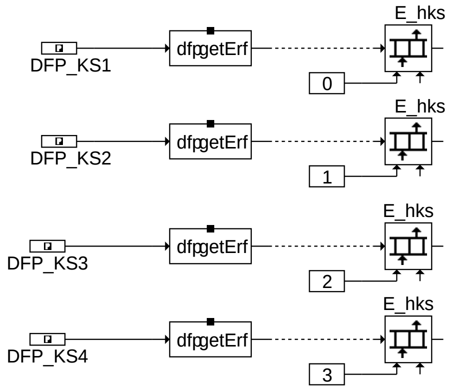


dkrs-entprell

DFPM: Interface: fault memory <==> knock sensor diagnosis



read DFPM

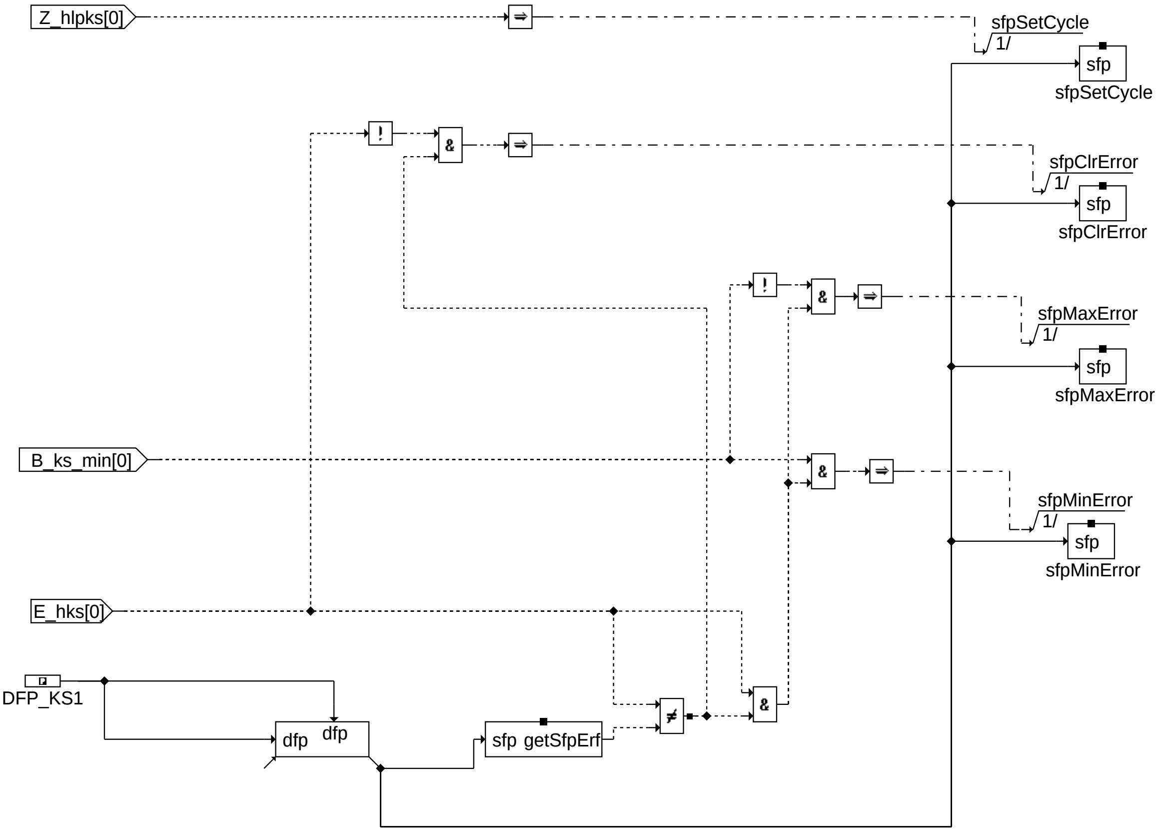


dkrs-dfpm

dkrs-dfpm

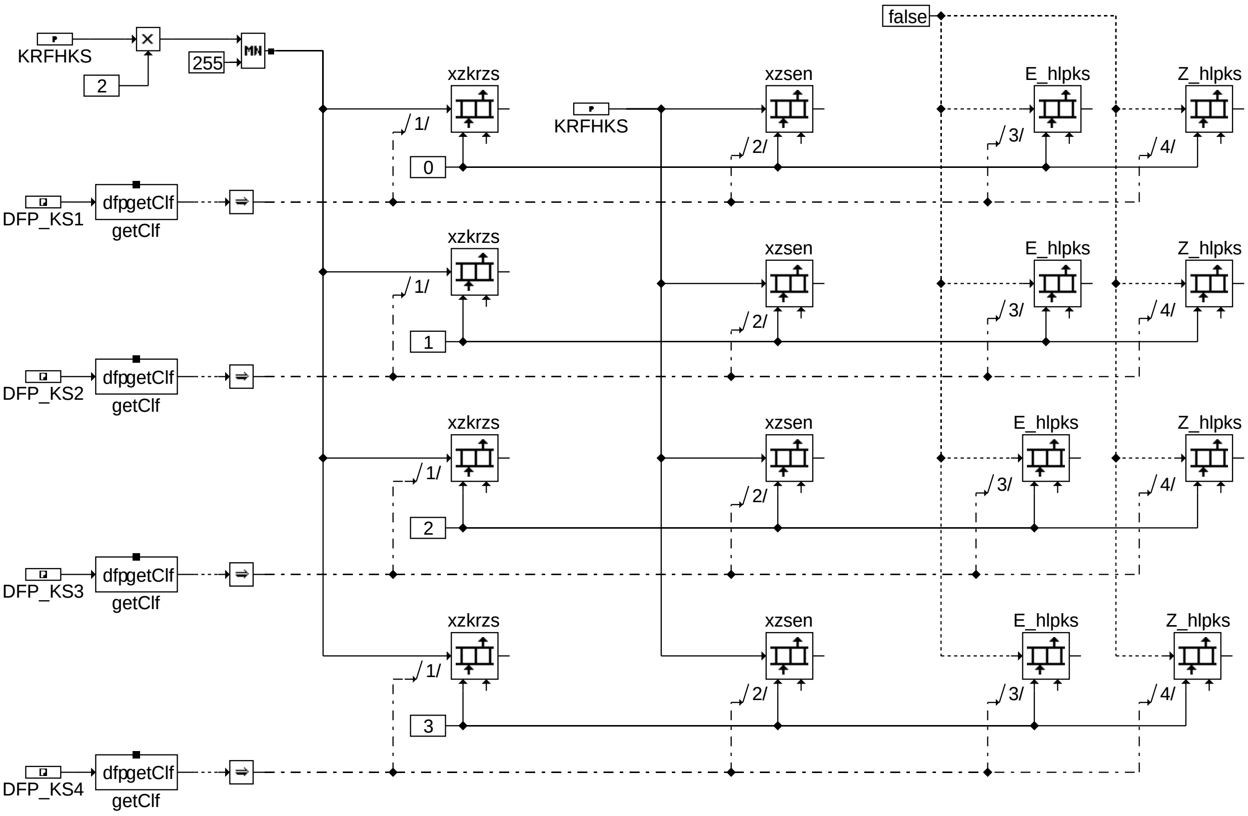
`In this FEDF the interface to the DFPM is only represented for knock sensor one, the other knock sensors are treated analoguos.`

DFPM KS1: Interface for knock sensor 1



dkrs-dfpm-ks1

FCMCLR: clear fault memory



dkrs-fcmclr

In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path the following values are defined:

```
        status error path ks*:                  sfpks*
                error flag ks*:                 E_ks*
                cycle flag ks*:                 Z_ks*
                error type ks*:                 TYPks*
                                                   B_mxks*
                                                   B_mnks*
                delete error path:              B_clks*
        error path code ks*:                    CDTks*
        error class ks*:                        CLAks*
        error intensity ks*:                    TSFks*
        CARB code ks*:                          CDCks*
        table of the environmental cond. ks*:   FFTks*
```

* is a wildcard and stands here for the number of the knock sensor.

In this function definition (FDEF) the following error paths are treated:

```
        knock sensor 1  ks1
        knock sensor 2  ks2
        knock sensor 3  ks3
        knock sensor 4  ks4
```

Substitute measures if E_ks(KS):
- Instead of the current cylinder-specific retardings the safety retarding is given out with KRDWS in the range "knock control active"
- KC adaptation not active (the adjusted values remain stored)
- knock detection algorithm remains active for the error healing
- In the range ’knock control not active’ no retarding is performed

ABK DKRS 29.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCKS1	BLOKNR		KL	code word CARB: knock sensor 1
CDCKS2	BLOKNR		KL	code word CARB: knock sensor 2
CDCKS3	BLOKNR		KL	code word CARB: knock sensor 3
CDCKS4	BLOKNR		KL	code word CARB: knock sensor 4
CDKKS1			FW	code word customer: knock sensor 1
CDKKS2			FW	code word customer: knock sensor 2
CDKKS3			FW	Code word customer: knock sensor 3
CDKKS4			FW	Code word customer: knock sensor 4
CDTKS1			FW	code word tester: knock sensor 1
CDTKS2			FW	code word tester: knock sensor 2
CDTKS3			FW	code word tester: knock sensor 3
CDTKS4			FW	code word tester: knock sensor 4
CLAKS1			FW	fault class: knock sensor 1
CLAKS2			FW	fault class: knock sensor 2
CLAKS3			FW	fault class: knock sensor 3
CLAKS4			FW	fault class: knock sensor 4
CWDKS1			FW	code word: knock sensor diagnosis, sensor 1
CWDKS2			FW	code word: knock sensor diagnosis sensor 2
CWDKS3			FW	code word: knock sensor diagnosis, sensor 3
CWDKS4			FW	code word: knock sensor diagnosis, sensor 4
FFTKS1	BLOKNR		KL	freeze frame table: knock sensor 1
FFTKS2	BLOKNR		KL	freeze frame table: knock sensor 2
FFTKS3	BLOKNR		KL	freeze frame table: knock sensor 3
FFTKS4	BLOKNR		KL	freeze frame table: knock sensor 4
KRFHKS			FW	fault frequency - knock sensors
NDKS			FW	engine-speed threshold for diagnosis knock sensors
SENZZYL			KWB (REF)	knock sensor for sw-cylinder counter 0-7
SNM16KRUB	NMOT		SV (REF)	datapoint distribution engine speed, 16 datapoints
SY_ZYLZA			SYS	system constant number of cylinders
TSFKS1			FW	fault active time: knock sensor 1
TSFKS2			FW	fault active time: knock sensor 2
TSFKS3			FW	fault active time: knock sensor 3
TSFKS4			FW	fault active time: knock sensor 4
UDKSNO	NMOT		KL	upper reference voltage threshold for diagnosis knock sensors
UDKSNU	NMOT		KL	lower reference voltage threshold for diagnosis knock sensors

Variable	Source	Type	Description
B_BKKS1	DKRS	AUS	condition: knock sensor 1 active
B_BKKS2	DKRS	AUS	condition: knock sensor 2 active
B_BKKS3	DKRS	AUS	condition: knock sensor 3 active
B_BKKS4	DKRS	AUS	condition: knock sensor 4 active
B_CLKS1		EIN	condition clear fault path knock sensor 1
B_CLKS2		EIN	condition clear fault path knock sensor 2
B_CLKS3		EIN	condition clear fault path knock sensor 3
B_CLKS4		EIN	condition clear fault path knock sensor 4
B_DS	DKRS	LOK	kc: sensor diagnosis active
B_DSI	DKRS	LOK	condition for active diagnosis: knock sensor i test
B_KR	KRRA	EIN	condition for knock control active
B_KRFDKS	KRRA	EIN	condition permission for knock sensor diagnosis
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_KS_MIN_I	DKRS	LOK	Condition: min error knock sensor i
B_MNKS1	DKRS	AUS	condition: min-error knock sensor 1
B_MNKS2	DKRS	AUS	condition: min-error knock sensor 2
B_MNKS3	DKRS	AUS	condition: min-error knock sensor 3
B_MNKS4	DKRS	AUS	condition: min-error knock sensor 4
B_MXKS1	DKRS	AUS	condition: max-error knock sensor 1
B_MXKS2	DKRS	AUS	condition: max-error knock sensor 2
B_MXKS3	DKRS	AUS	condition: max-error knock sensor 3
B_MXKS4	DKRS	AUS	condition: max-error knock sensor 4
B_NPKS1	DKRS	AUS	not plausible error: knock sensor 1
B_NPKS2	DKRS	AUS	not plausible error: knock sensor 2
B_NPKS3	DKRS	AUS	not plausible error: knock sensor 3
B_NPKS4	DKRS	AUS	not plausible error: knock sensor 4
B_PWF		EIN	Condition for powerfail
B_SIKS1	DKRS	AUS	error type: knock sensor 1
B_SIKS2	DKRS	AUS	error type: knock sensor 2
B_SIKS3	DKRS	AUS	error type: knock sensor 3
B_SIKS4	DKRS	AUS	error type: knock sensor 4
E_HKS_I	DKRS	LOK	auxiliary error flag: knock sensor i
E_HLPKS_I	DKRS	LOK	auxiliary error flag: knock sensor i
E_KS1	DKRS	AUS	error flag: knock sensor 1
E_KS2	DKRS	AUS	error flag: knock sensor 2
E_KS3	DKRS	AUS	error flag: knock sensor 3
E_KS4	DKRS	AUS	error flag: knock sensor 4
NMOT	SWADAP	EIN	engine speed
RKR	KRKE	EIN	reference level knock control
RKRN_W	DKRS	LOK	reference pegel nominaized for knock regulation
SFPKS1	DKRS	AUS	status fault path: knock sensor 1
SFPKS2	DKRS	AUS	status fault path: knock sensor 2
SFPKS3	DKRS	AUS	status fault path: knock sensor 3

Variable	Source	Type	Description
SFPKS4	DKRS	AUS	status fault path: knock sensor 4
UDKSNOA_W	DKRS	LOK	knock sensor diagnosis: actuel value upper threshold (UDKSNO)
UDKSNUA_W	DKRS	LOK	knock sensor diagnosis: actuel value lower threshold (UDKSNU)
VKR	KRKE	EIN	amplification stage knock control
XZKRZS(I)	DKRS	LOK	counter knock sensor cycle flag; individual relationship sensor-counter s.FDEF
XZSEN(I)	DKRS	LOK	safety counter knock sensor; individual relationship sensor - counter s. FDEF
Z_HLPKS_I	DKRS	LOK	auxiliary cycle flag: knock sensor i
Z_KS1	DKRS	AUS	cycle flag: knock sensor 1
Z_KS2	DKRS	AUS	cycle flag: knock sensor 2
Z_KS3	DKRS	AUS	cycle flag: knock sensor 3
Z_KS4	DKRS	AUS	cycle flag: knock sensor 4

FW DKRS 29.80 Fixed Values

Parameter	Value	Description
CDKKS1		code word customer: knock sensor 1
CDKKS2		code word customer: knock sensor 2
CDKKS3		Code word customer: knock sensor 3
CDKKS4		Code word customer: knock sensor 4
CDTKS1		code word tester: knock sensor 1
CDTKS2		code word tester: knock sensor 2
CDTKS3		code word tester: knock sensor 3
CDTKS4		code word tester: knock sensor 4
CLAKS1		fault class: knock sensor 1
CLAKS2		fault class: knock sensor 2
CLAKS3		fault class: knock sensor 3
CLAKS4		fault class: knock sensor 4
CWDKS1		code word: knock sensor diagnosis, sensor 1
CWDKS2		code word: knock sensor diagnosis sensor 2
CWDKS3		code word: knock sensor diagnosis, sensor 3
CWDKS4		code word: knock sensor diagnosis, sensor 4
KRFHKS		fault frequency - knock sensors
NDKS		engine-speed threshold for diagnosis knock sensors
TSFKS1		fault active time: knock sensor 1
TSFKS2		fault active time: knock sensor 2
TSFKS3		fault active time: knock sensor 3
TSFKS4		fault active time: knock sensor 4

FB DKRS 29.80 Detailed description of function

By means of the diagnosis knock sensor drop off a disconnection of the wiring to the knock sensor (e.g. not plugged sensor) as well as a short circuit to U_Batt or ground can be detected. Furthermore it can point to a defect engine if an error is detected (e.g. increased noise level due to expanded piston groove).

The decisive signal for these tests is the normalized reference level rkrn(i) obtained from the reference level rkr and the amplification stages vkr of each cylinder. The calculation of the normalized reference level rkrn(i) for the test UDKSNO > rkrn > UDKSNU is performed according to:

$$rkrn(i) = (1/ (2^{vkr(i)})) * rkr(i) * 2^6$$

The assignment of the knock sensors to the normalized refence levels is performed via SENZZYL which is described in %GGKS. In this case the normalized reference level rkrn_0 belongs to SENZZYL0, i.e rkrn_0 belongs to the error path of the knock sensor entered into SENZZYL0.

The diagnosis is activated in case of:
- knock control activ (B_kr) and
- no dynamics conditions (!B_krndy and !B_krldy) and
- nmot above threshold NDKS and
- no IC-error (!E_krnt, !E_krtp and !E_krof)
- B_krfdks (see %KRRA 18.40 or higher)

If the current reference level - in case of KC active (B_kr) and engine speeds greater than NDKS and no phase sensor error (B_synph) and not detected dynamic response (! B_krndy and ! B_krldy) - undershoots resp. exceeds the reference level thresholds UDKSNU resp. UDKSNO which are stored in the engine speed-dependent characteristic lines for KRFHKS successive tests (i.e. an error which lies in between and is not detected means reset of the error counter) then a knock sensor drop off E_ks(KS) is detected and the above-described substitution measures are taken.

The error check is performed once per 100 ms grid for the normalized reference levels of all cylinders, i.e. each knock sensor path is checked several times in the process. An error is detected if a normalized reference level of the knock sensor path lies outside the limits during the check. No error is only detected if all normalized reference levels of the knock sensor path lie within the limits. To avoid a unneccessary activation of the KC safety measures after a ECU-reset, B_krdws cannot be set in the first 3 seconds after c_inisyn.

The safety measures are lifted again if the current reference level lies again within the range defined by the reference voltage thresholds UDKSNO and UDKSNU for KRFHKS successive checks (i.e. an error check which lies in between means reset of the counter). So that no jumps in the ignition angle (torque) occur during the error healing the transition from safety retarding back to normal operating is performed not until the first ‘knock control-not-active-phase‘ after determined error healing.

The cycle flags Z_ks(KS) are set after an each time (2*KRFHKS)-times diagnosis check (counter xzkrzs(KS-1)) or if an error is definitely dedected or healed. Thus it is ensured that e.g. after the repair in a workshop the error diagnosis is at least run through with the debouncing frequency KRFHKS in order to reliably determine the error clearance.
During the initialization with C_ini the cycle flags Z_ks(KS) as well as the counters xzkrzs(KS-1) are reset.

The sensor diagnosis can be switched off for each knock sensor individually by setting CWDKS(KS) = 0. (The corresponding cycle flags are then set to 1 and the error flags to 0). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means all CWDKS(i) must be set to a value > 0).

The calculation of the normalized reference level and the evaluation of the path for the change-over to safety retarding are not switched off by the switches.

APP DKRS 29.80 Application hint

The characteristic lines UDKSNU and UDKSNO must be adjusted such that there is a sufficient safety margin to normal operating and that a deplugged knock sensor is detected just as a short circuit to ground or U_Batt. The application of the characteristic lines UDKSNU and UDKSNO must be performed with max.- and min.-sensors. Thereby a safety margin of at least factor 2 is to be kept to.

In order to ensure that the application engine with its noise behaviour lies within the tolerance of the mass production the normalized reference levels should be checked every 500 rpm on all engines available during the application and on at least one pilot vehicle.
These measurements are performed with mass production knock sensors. The measured normalized reference levels must lie within the limits determined with min.- and max.-sensors (safety margin of at least factor 2 to the characteristic lines UDKSNU and UDKSNO).

Should no sufficient safety margin be guaranteed in some parts of the range (an intact, connected knock sensor may under no circumstances lead to the error lamp being switched on) then it has to be done without the possibility of diagnosis in these partial ranges (fix threshold in such a way that the diagnosis does not react).
The customer must be informed about these partial ranges.

When load or engine speed dynamic response is triggered the normalized reference levels can possibly exceed the characteristic line UDKSNO for a short time. For this reason the diagnosis is not performed in case of detected dynamic response (B_krldy oder B_krndy).
Nevertheless a check of the debouncing period is recommendable in this case because the refence levels have not yet again stabilized after the end of the dynamic response.

With low engine speeds there may be ranges in which an error detection is not possible. Therefore an engine speed threshold NDKS was introduced below which the diagnosis is blocked. The threshold must be adjusted such that errors which were detected during higher engine speeds are not falsely healed again in the lower range.

The amount available knock sensors must be set in the fixed value KSZA. The amount available knock sensors must be set in the fixed value KSZA. If the guiding cylinder function is active and the system has only one knock sensor, KSZA has to be two.
If phase sensor emergency operating mode with double ignition is possible in the project and the system has only one knock sensor, KSZA has to be two.

The initialization of the reference level with REFINI during the starting phase or during the transition from KC not active to KC active can possibly lead to a wrong error detection or error healing.
When fixing the initialization values for the amplification and for the reference level attention must be paid that the normalized reference level has stabilized prior to the end of the debouncing time (error frequency counter), that means the debouncing period must be large enough so that wrong error detections or healings are ruled out.

The sensor diagnosis can be switched off for each knock sensor individually by setting CWDKS(KS) = 0. (The corresponding cycle flags are then set to 1 and the error flags to 0). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means all CWDKS(i) must be set to a value > 0).

The values E_hks* contained in the ASCET pictures are only aid values for the representation and they cannot be measured.

The following guidance values are recommended:
KRFHKS > 20 (KRFHKS = 0 is inadmissible)
NDKS > 2000 rpm
CWDKS1 = 1
CWDKS2 = 1
CWDKS3 = 1
CWDKS4 = 1

Needed measured values:
- E_ks1 - x
- Z_ks - x
- B_krdws
- nmot
- rkrn_w0 - x
- xzkrzs0 - x
- xzsen0 - x

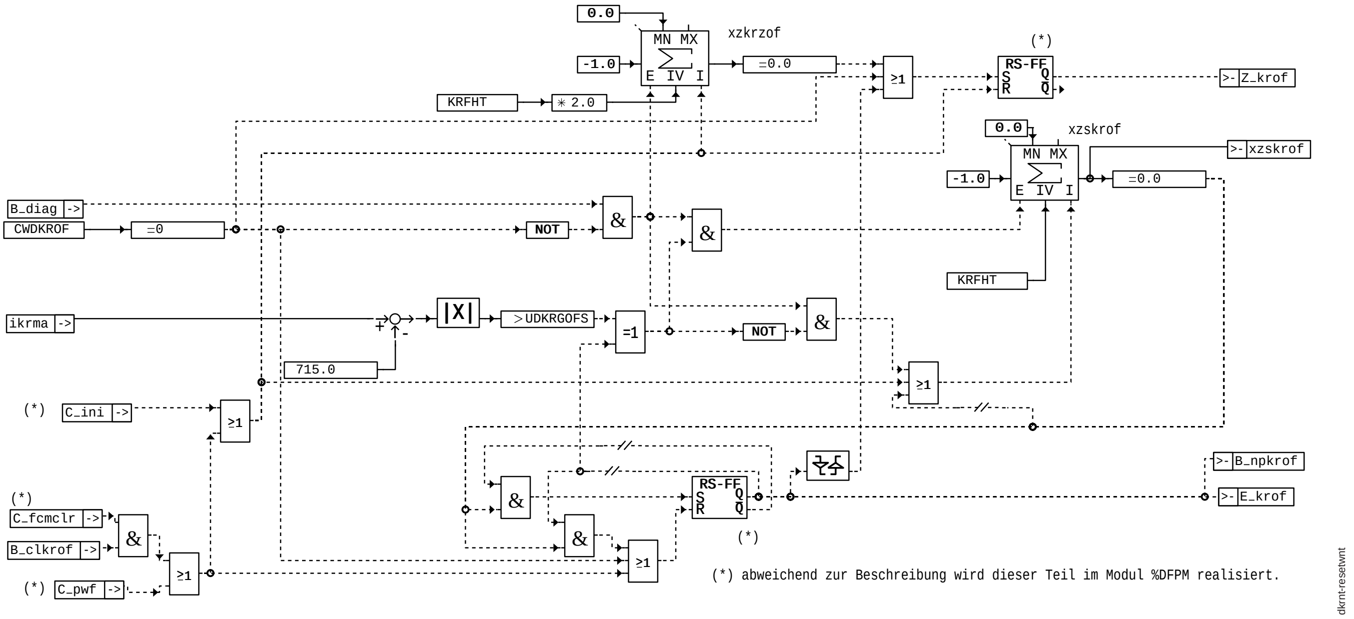
DKRNT 11.10 Diagnosis; Knock-control, zero-test (OBDII)

FDEF DKRNT 11.10 Function definition

Missing picture

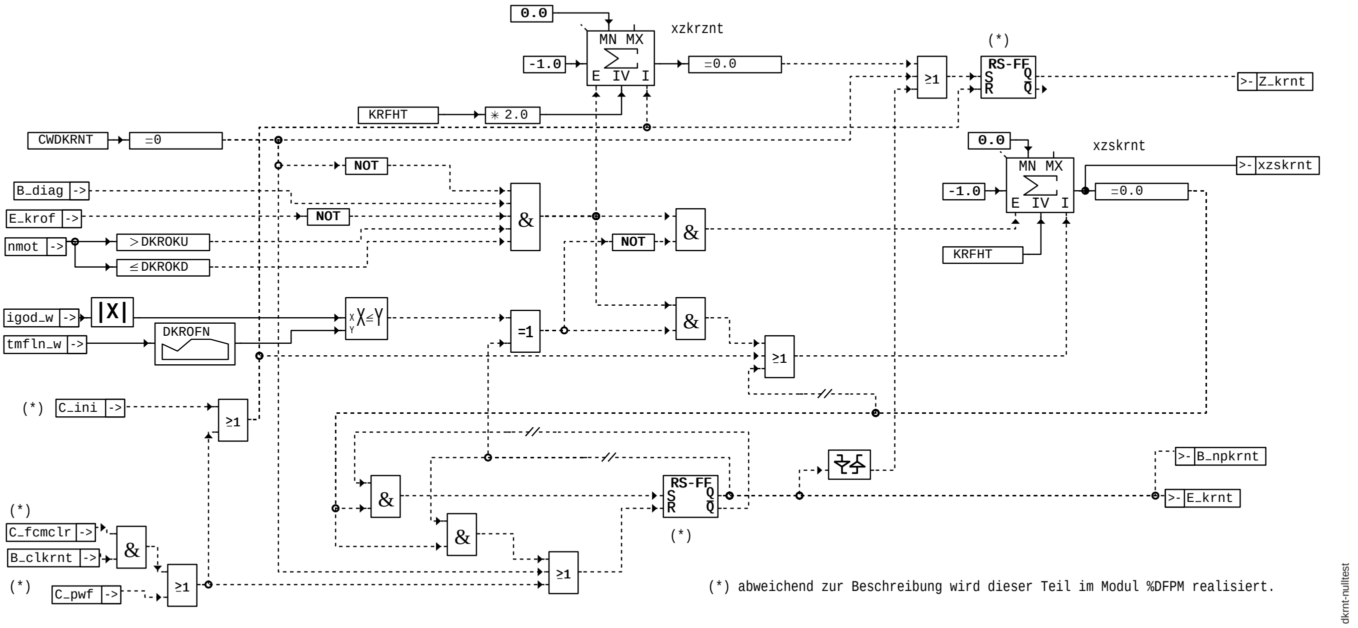
dkrnt-dkrnt

dkrnt-dkrnt



(*) abweichend zur Beschreibung wird dieser Teil im Modul %DFPM realisiert.

dkrnt-resetwnt



(*) abweichend zur Beschreibung wird dieser Teil im Modul %DFPM realisiert.

dkrnt-nulltest

In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path the following values are defined:
status error path krof: sfpkrof
error flag krof: E_krof
cycle flag krof: Z_krof
error type krof: TYPkrof
B_npkrof
delete error path: B_clkrof
error path code krof: CDTkrof
error class krof: CLAkrof
error intensity krof: TSFkrof
CARB code krof: CDCkrof
table of environmental cond. krof: FFTkrof

status error path krnt: sfpkrnt
error flag krnt: E_krnt
cycle flag krnt: Z_krnt
error type krnt: TYPks(i)
B_npkrnt
delete error path: B_clkrnt
error path code krnt: CDTkrnt
error class krnt: CLAkrnt
error intensity krnt TSFkrnt
CARB code krnt: CDCkrnt
table of environmental cond. krnt: FFTkrnt

In this function definition (FDEF) the following error paths are treated:

integrator reset value (offset) krof
integrator gradient (zero test) krnt

Substitute measures :
- Instead of the current cylinder-specific retardings the safety retarding is given out with KRDWS in the range "knock control active"
- KC adaptation not active (the adjusted values remain stored)
- knock detection algorithm remains active for the error healing
- In the range ’knock control not active’ no safety retarding is performed

ABK DKRNT 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCKRNT	BLOKNR		KL	code word CARB: knock control zero test pulse
CDCKROF	BLOKNR		KL	code word CARB: knock control offset
CDTKRNT			FW	code word tester: knock control zero test pulse [220]
CDTKROF			FW	code word tester: knock control offset
CLAKRNT			FW	fault class: knock control zero test
CLAKROF			FW	fault class: knock control offset
CWDKRNT			FW	code word: kc-diagnosis integrator gradient
CWDKROF			FW	code word: kc-diagnosis reset value
DKROFN	TMFLN_W		KL	limit of integrator rise for zero test
DKROKD			FW	upper rpm-limit for zero test diagnosis (knock control)
DKROKU			FW	lower rpm-limit for determination of offset-compensation-value
FFTKRNT	BLOKNR		KL	freeze frame table: knock control zero test
FFTKROF	BLOKNR		KL	freeze frame table: knock control offset
KRFHT			FW	error frequency, test pulse
TSFKRNT			FW	fault active time: knock control zero test
TSFKROF			FW	fault active time: knockcontrol offset
UDKRGOFS			FW	voltage threshold for DIA/KR basic offset amplifier

Variable	Source	Type	Description
B_CLKRNT		EIN	condition clear fault path kc-diagnosis integrator gradient
B_CLKROF		EIN	condition clear fault path kc-diagnosis reset value
B_NPKRNT	DKRNT	AUS	condition plausibility error of kc-diagnosis intgrator gradient
B_NPKROF	DKRNT	AUS	condition plausibility error of kc-diagnosis reset value
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_KRNT	DKRNT	AUS	error flag: knock control zero test
E_KROF	DKRNT	AUS	Errorflag: knock control offset
IGOD_W	GGKS	EIN	integrator gradient for zero test diagnosis knock control
IKRMA		EIN	integrator value at start of measurement window, knock control
NMOT	SWADAP	EIN	engine speed
SFPKRNT	DKRNT	AUS	status fault path: knock control zero test
SFPKROF	DKRNT	AUS	status fault path: knock control offset
TMFLN_W		EIN	duration of measurement window knock control zero test
TPNT_AKTIV	EGKE	EIN	activation of kc-functions
XZKRZNT	DKRNT	LOK	counter for knock control cycle flag Z_krnt
XZKRZOF	DKRNT	LOK	counter for knock control cycle flag Z_krof
XZSKRNT	DKRNT	AUS	safety counter for knock control zero test
XZSKROF	DKRNT	AUS	safety counter for knock control offset

Variable	Source	Type	Description
Z_KRNT	DKRNT	AUS	cycle flag: knock control zero test
Z_KROF	DKRNT	AUS	cycle flag: knock control offset

FW DKRNT 11.10 Fixed Values

Parameter	Value	Description
CDTKRNT		code word tester: knock control zero test pulse [220]
CDTKROF		code word tester: knock control offset
CLAKRNT		fault class: knock control zero test
CLAKROF		fault class: knock control offset
CWDKRNT		code word: kc-diagnosis integrator gradient
CWDKROF		code word: kc-diagnosis reset value
DKROKD		upper rpm-limit for zero test diagnosis (knock control)
DKROKU		lower rpm-limit for determination of offset-compensation-value
KRFHT		error frequency, test pulse
TSFKRNT		fault active time: knock control zero test
TSFKROF		fault active time: knockcontrol offset
UDKRGOFS		voltage threshold for DIA/KR basic offset amplifier

FB DKRNT 11.10 Detailed description of function

The zero test serves for the determination of the integrator offset and for the checking of the KC-evaluation-IC CC195 with regard to

- keeping to the valid limits for the starting value of the integrator (integrator reset value)
- keeping to the admissible integrator offsets
- the function of the multiplexer regarding ’open switch’

During the zero test all multiplexer switches are brought into the position ’open’ (deactivate signal sources). The amplitude of the integrator is watched in a measuring window. Then the plausibility of the reset value and the integrator offset is checked. If the integration result lies within the limits of the permitted offset then the determined value is used for the offset compensation. If the integration result is markedly larger than the permitted offset then it can be assumed that the switch of the multiplexer is stuck in the position ’closed’.

1) Reset values ==> Checking of the integrator value at the beginning of the measuring window (picture RESETWNT):

The plausibility of the integrator voltage ikrma at the beginning of the measuring window and with deactivated signal sources is checked. In this case the following must apply: | ikrma - 715 mV | < UDKRGOFS.

The counters xzskrof, xzkrzof and the flags E_krof and Z_krof are part of this diagnosis (error path offset).

2) Zero test ==> Checking of the integrator gradient igod_w (picture NULLTEST):

The integrator gradient (integrator value at end of measuring window minus integrator at beginning of measuring window with open multiplexer switch divided by the current measuring window length) is checked for plausibility. The following must apply:
| igod_w | < DKROFN(tmfln_w).

DKROFN is a characteristic line over the zero test measuring window length. While using the characteristic line the diagnosis is active in a great speed range.

The value igod_w determined in %GGKS may not be used for the diagnosis of stuck MUX-switches if the measuring window lengths are > 5 ms since in this case a definite distinction between permitted integrator offset and stuck MUX-switch is not possible (in case of 10 ms measuring window lengths the permitted integrator offset is 300 mV and it thus lies within the normal integral range between 300 and 1000 mV ==> double safety results in a max. measuring window lengths of 5 ms). This is achieved by the threshold DKROKU. When the lower engine speed threshold DKROKU is undershot the integrator gradient igod_w is determined but no diagnosis with regard to DKROFN(tmfln_w) (stuck MUX-switch) is performed.

The diagnosis can be swtiched off with an upper engine speed threshold. In this case the diagnosis is not performed. This is achieved by the upper engine speed threshold DKROKD. The diagnosis of the integrator gradient is frozen above the engine speed threshold.
Application hints see below

The counters xzskrnt, xzkrznt and the flags E_krnt and Z_krnt are part of this diagnosis (error path zero test).

3) Conditions for the execution of the zero test (s %GGKS):

The diagnosis zero test (DKRNT) and test pulse (DKRTP) are normally triggered alternately approx. every 255 working cycles (i.e. DKRNT, after 255 working cycles DKRTP, after further 255 again DKRNT etc.)
The zero test is performed if the knock control is active (i.e. B_kr=1). In case the KC is not active while the zero test is to be performed the state is frozen and a zero test is performed at the next transition from !B_kr to B_kr.

In case of suspected error of a diagnosis, i.e. the error counter of the corresponding diagnosis does not have the value KRFHT, zero test and test pulse are no longer performed alternately. Instead the diagnosis which generated the suspected error is carried out at approx. 120 working cycles until the error is definitely detected or healed. Thereafter a change back to the normal state is performed. This applies analogous for the healing.

In order to obtain reasonable starting values for the offset correction the values for ikrma and igokr are determined but not diagnosed if tmot > TMKR-5°C and if the KC is not yet active.

4) Amplification during zero test

The amplification during zero test must be equal to the current amplification of the current measuring window. (Theoretically also larger amplifications are possible and sensible in order to increase the reliability of detecting a stuck multiplex switch. However, these can cause additional problems if a disturbance noise from the printed board in the CC195 exists ==> falsely a stuck multiplex switch is then detected). For the adjustment of the amplification see %GGKS resp. %KRKE.

5) Error healing and error management

If the respective checks result in inadmissible values then the corresponding error counter xzskrxx is decremented. An error entry into the error memory (E_krof resp. E_krnt) and a reset of the respective error counter to KRFHT are performed for the detected error after KRFHT-times consecutive error checks (i.e. an error which lies in between and is not detected means reset of the respective error counter)
After KRFHT-times consecutive healing checks (i.e. an error check which lies in between means reset of the counter) error healing and a reset of the error counter to KRFHT are performed.

So that no jumps in the ignition angle (torque) occur during the error healing the transition from safety retarding back to normal operating is performed only in the first "KC-not-active-phase" after error healing was determined (s. %DKRS).

The cycle flags Z_krof and Z_krnt are set after (2*KRFHT)-times diagnosis checks (counters xzkrzof and xzkrznt) or if an error is definitely detected or healed. Thus it is ensured that, e.g. after the repair in a workshop, the error diagnosis must be at least run through with the debouncing frequency KRFHT in order to reliably determine the error clearance (Z_krtp = 1 & E_krtp = 0).
During the initialization with C_ini the cycle flags Z_krof and Z_krnt as well as the cycle and error flags are reset.

The diagnosis of the integrator gradient can be switched off by CWDKRNT=0 and the diagnosis of the starting value can be switched off by CWDKROF=0. (The corresponding cycle flags are then set to 1 and the error flags are set to 0).
Through deactivation of the diagnosis only the evaluation is suppressed. The zero test is still performed since the values are needed for the offset correction.
The activation or deactivation may only take place during the ECU reset in order to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRNT and CWDKROF must be set to a value > 0.)

APP DKRNT 11.10 Application hint

The limit value for the tolerance of the reset value is 100 mV according to the specification of the CC195 for the reset value. The limit value for the intergrator gradient - according to the specification of the CC195 - is dependent on the internal pulse frequency of the CC195.

Frequency	100 kHz	110 kHz	120 kHz	130 kHz	140 kHz	150 kHz
Limit value f. integrator gradient acc. to specification o.the CC195	+- 30 mV/ms	+- 36 mV/ms	+- 42 mV/ms	+- 48 mV/ms	+- 54 mV/ms	+- 60 mV/ms

(specification values as at September 1996)

However, when using these limits it has shown that disturbance noises from the printed board in the CC195 or disturbances of the supply voltage of the CC195 can easily lead to a diagnosis misdetection. Due to this reason it may be necessary to broaden these limits. This must be checked in each individual case. For this measurements need to be performed.
Generally it should obviously be ensured that no disturbance noises occur into the CC195! (Layout updating!)

The diagnosis threshold UDKRGOFS = 220 mV is recommended for the reset value.

The following is recommended for the integrator gardient threshold DKROFN (internal pulse Frequency of CC195: 100 kHz)

measuring window length	tmfln_w > 3 ms	3 ms > tmfln_w > 2 ms	2 ms > tmfln_w > 1,5 ms	1,5 ms > tmfln_w > 1 ms
DKROFN	40 mV/ms	45 mV/ms	50 mV/ms	60 mV/ms

DKROKU must set to a value, so that the zero test measuring window length is < 5 ms describtion s. 2)).

The diagnosis can be switched off via the upper engine speed threshold DKROKD, so that in case of short measuring window lengths the diagnosis-threshold DKROFN is not too great. DKROKD has to be greater then DKROKO (s.%GGKS).

The protection of the ECU-dependent value is absolutely necessary.

In case a broadening of the recommended values is necessary it should be discussed with the function application or with the function development first.

The error frequency of the functions DKRNT and DKRTP (master functions) is identical. Both use the label KRFHT.

The diagnosis of the integrator gradient can be switched off by CWDKRNT=0 and the diagnosis of the starting value can be switched off by CWDKROF=0. (The corresponding cycle flags are then set to 1 and the error flags are set to 0).
Through deactivation of the diagnosis only the evaluation is suppressed. The zero test is still performed since the values are needed for the offset correction.
The activation or deactivation may only take place during the ECU reset in order to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRNT and CWDKROF must be set to a value > 0.)

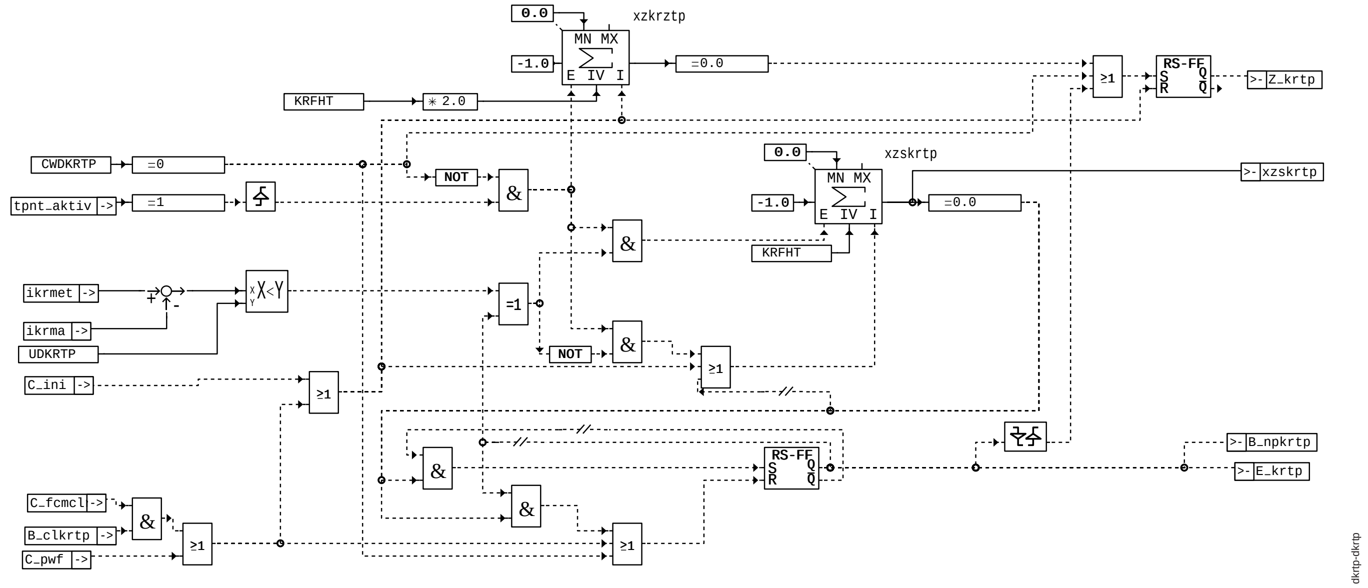
The values tpnt_aktiv and B_diag cannot be measured with VS100.

The following guidance values are recommended:
KRFHT > 2 (KRFHT = 0 inadmissible)
UDKRGOFS = 220 mV
DKROKU ca. 2000 rpm (measuring window > 5 ms)
CWDKRNT = 1
CWDKROF = 1

Needed measured values:
- B_dnt
- B_kr
- E_krnt
- E_krof
- igod_w
- ikrma
- nmot
- xzkrznt
- xzkrzof
- xzskrnt
- xzskrof
- Z_krnt
- Z_krof

DKRTP 11.10 Diagnosis of knock control, test pulse for OBDII

FDEF DKRTP 11.10 Function definition



dkrtp-dkrtp

In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path the following values are defined:
status error path krtp: sfpkrtp
error flag krtp: E_krtp
cycle flag krtp: Z_krtp
error type krtp: TYPkrtp
B_npkrtp
delete error path: B_clkrtp
error path code krtp: CDTkrtp
error class krtp: CLAkrtp
error intensity krtp: TSFkrtp
CARB code krtp: CDCkrtp
table of the environmental cond. krtp: FFTkrtp

In this function definition (FDEF) the following error paths are treated:

test pulse krtp

Substitute measures in case of E_krtp:
- Instead of the current cylinder-specific retardings the safety retarding is given out with KRDWS in the range "knock control active"
- KC adaptation not active (the adjusted values remain stored)
- knock detection algorithm remains active for the error healing
- In the range 'knock control not active' no retarding is performed

ABK DKRTP 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCKRTP	BLOKNR		KL	code word CARB: knock control test pulse
CDTKRTP			FW	code word tester: knock control test pulse
CLAKRTP			FW	fault class: knock control test pulse
CWDKRTP			FW	code word: kc-diagnosis testpulse
FFTKRTP	BLOKNR		KL	freeze frame table: knock control test pulse
KRFHT			FW	error frequency, test pulse
TSFKRTP			FW	fault active time: knock control test pulse
UDKRTP			FW	integr.volt.thresh. f.diagn. knock eval.circ. test pulse

Variable	Source	Type	Description
B_CLKRTP		EIN	condition clear fault path kc-diagnosis test pulse
B_NPKRTP	DKRTP	AUS	condition plausibility error fo kc-diagnosis test pulse
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_KRTP	DKRTP	AUS	error flag: knock control test pulse
IKRMA		EIN	integrator value at start of measurement window, knock control
IKRMET		EIN	integrator value at end of measurement window, knock control test pulse

Variable	Source	Type	Description
SFPKRTP	DKRTP	AUS	status fault path: knock control test pulse
TPNT_AKTIV	EGKE	EIN	activation of kc-functions
XZKRZTP	DKRTP	LOK	Timer knock control cycle flag Z_krtp
XZSKRTP	DKRTP	AUS	Timer knock control error flag E_krtp
Z_KRTP	DKRTP	AUS	cycle flag: knock control test pulse

FW DKRTP 11.10 Fixed Values

Parameter	Value	Description
CDTKRTP		code word tester: knock control test pulse
CLAKRTP		fault class: knock control test pulse
CWDKRTP		code word: kc-diagnosis testpulse
KRFHT		error frequency, test pulse
TSFKRTP		fault active time: knock control test pulse
UDKRTP		integr.volt.thresh. f.diagn. knock eval.circ. test pulse

FB DKRTP 11.10 Detailed description of function

The test pulse serves for the checking of the knock evaluation circuit CC195. By the test pulse an error localization (knock sensor - evaluation circuit) is made possible.

If the raw integral value (ikrmet - ikrma), i.e. without offset compensation (s. GGKS) undershoots the value UDKRTP then the error counter xzskrtp is decremented. After KRFHT-times, consecutive error checks (i.e. an error which lies in between and was not detected means reset of the error counter) an error entry into the error memory (E_krtp = 1) and a reset of the error counter to KRFHT is performed. In the following tests a checking of whether the error state was healed is carried out.
After KRFHT-times consecutive checks of the healing (i.e. an error which lies in between and is detected means reset of the counter) the error healing (E_krtp = 0) and a reset of the error counter to KRFHT is performed.

The diagnosis zero test (DKRNT) and test pulse (DKRTP) are normally triggered alternately approx. every 255 working cycles (i.e. DKRNT, after 255 working cycles DKRTP, after further 255 again DKRNT etc.)
The test pulse is performed if the temperature threshold for the KC was exceeded (i.e. B_tmkr=1 fulfilled).

In case of suspected error, i.e. the error counter of a diagnosis does not have the value KRFHT, the diagnosis are no longer performed alternately. Instead the diagnosis which generated the suspected error is carried out at approx. 120 working cycles until the error is definitely detected or healed. Thereafter a change back to the normal state is performed. This applies analogous for the healing (s. %GGKS)

The test pulse must be performed at a random distribution so that all knock sensor paths are checked in a statistically uniform distribution. By omitting a combustion evaluation the test pulse is carried out in a normal measuring window.
The amplification of the knock evaluation circuit is set to 2ˆ3 (medium amplification). Thus it is ensured that also in case of short measuring windows the integrator is fully activated. The frequency of the test pulse is adjusted to the filter center frequency of the band pass.

So that no jumps in the ignition angle (torque) occur during the error healing the transition from safety retarding back to normal operating is performed only in the first "KC-not-active-phase" after error healing was determined (see %DKRS).

The cycle flag Z_krtp is set after (2*KRFHT)-times diagnosis checks (counter xzkrztp) or if an error is definitely dedected or healed. Thus it is ensured that e.g. after the repair in a workshop the error diagnosis must be at least run through with the debouncing frequency KRFHT in order to reliably determine the error clearance (Z_krtp = 1 & E_krtp = 0).
During the initialization with C_ini the cycle flag Z_krtp and the counter xzkrztp are reset.

The diagnosis can be switched off by CWDKRTP=0. (The cycle flag is set to 1 and the error flag is set to 0).
Through deactivation of the diagnosis the evaluation and the triggering of the CC195 are suppressed (s. %GGKS). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRTP must be set to a value > 0.)

APP DKRTP 11.10 Application hint

The error frequency of the functions DKRNT and DKRTP (master functions) is identical. Both use the label KRFHT.

The diagnosis can be switched off by CWDKRTP=0. (The cycle flag is set to 1 and the error flag is set to 0).
Through deactivation of the diagnosis the evaluation and the triggering of the CC195 are suppressed (s. %GGKS). The activation or deactivation may only take place during the ECU reset so as to ensure that the function is correctly performed.

Hint: This diagnosis may only be switched off for application purposes and not for mass production since otherwise IC-errors cannot be detected which may lead to knock damages on the engine. (That means CWDKRTP must be set to a value > 0.)

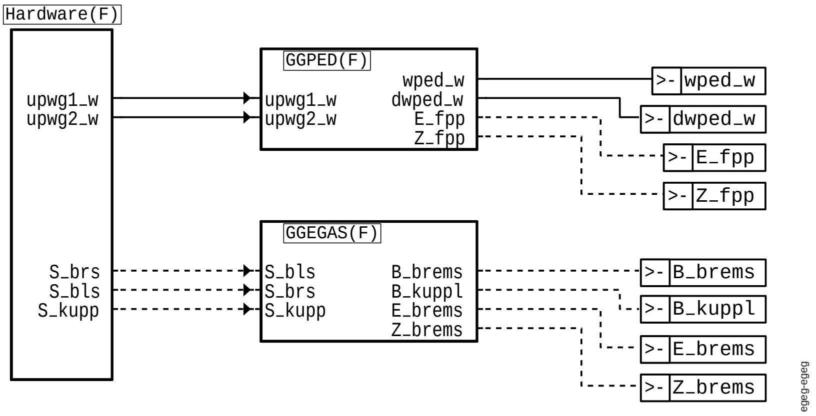
The value tpnt_aktiv cannot be measured with VS100.

The following guidance values are recommended:
UDKRTP = 3,7 V
KRFHT > 2 (KRFHT = 0 inadmissible)
CWDKRTP = 1

Needed measured values:
- ikrma
- ikrmet
- xzkrztp
- xzskrtp
- B_dtp
- E_krtp
- Z_krtp

EGEG 1.0 Input variable E-GAS

FDEF EGEG 1.0 Function definition



egeg-egeg

ABK EGEG 1.0 Abbreviations

Variable	Source	Type	Description
B_BREMS	EGEG	AUS	condition: brake operated
B_KUPPL	EGEG	AUS	EGAS Condition cluch is disengaged
DWPED_W	EGEG	AUS	gradient of the standardized accelerator pedal angle
E_BREMS	EGEG	AUS	error flag: brake pedal signal
E_FPP	EGEG	AUS	Error flag drive pedal potentiometer
S_BLS		EIN	brake light switch (true=activated pedal)
S_BRS		EIN	Switch for brake
S_KUPP		EIN	Clutch switch
UPWG1_W		EIN	Voltage PWG potentiometer 1 (word)
UPWG2_W		EIN	Voltage PWG potentiometer 2 (word)
WPED_W	EGEG	AUS	normed angle acceleration pedal
Z_BREMS	EGEG	AUS	cycle flag: brake pedal signal
Z_FPP	EGEG	AUS	Cycle flag drive pedal potentiometer

FW EGEG 1.0 Fixed Values

Parameter	Value	Description

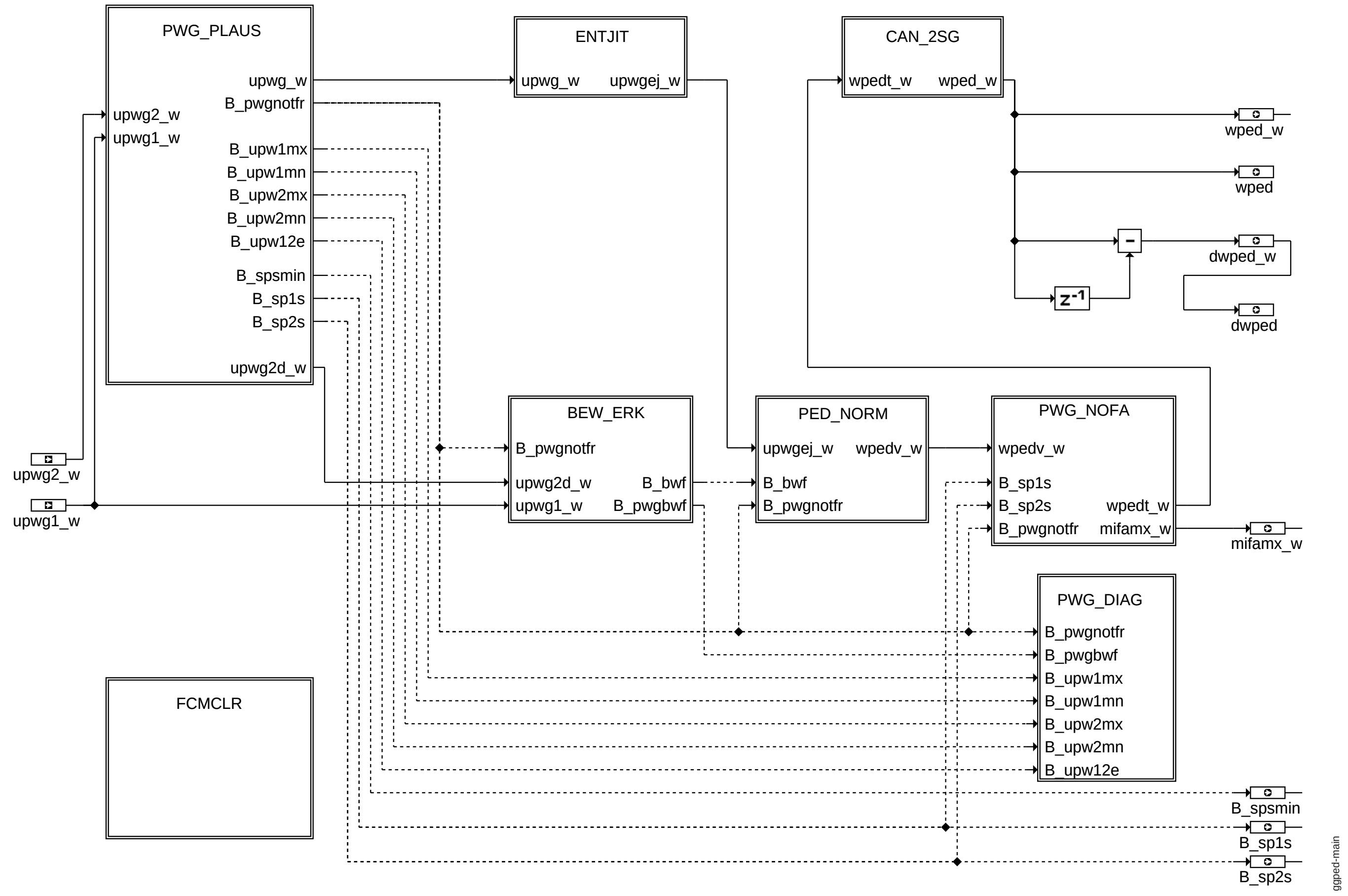
FB EGEG 1.0 Detailed description of function

The overview shows the functions
- GGPED: Evaluation of accelerator pedal sensors with plausibility check,
- GGEGAS: Evaluation of brake switches and clutch switch.

APP EGEG 1.0 Application hint

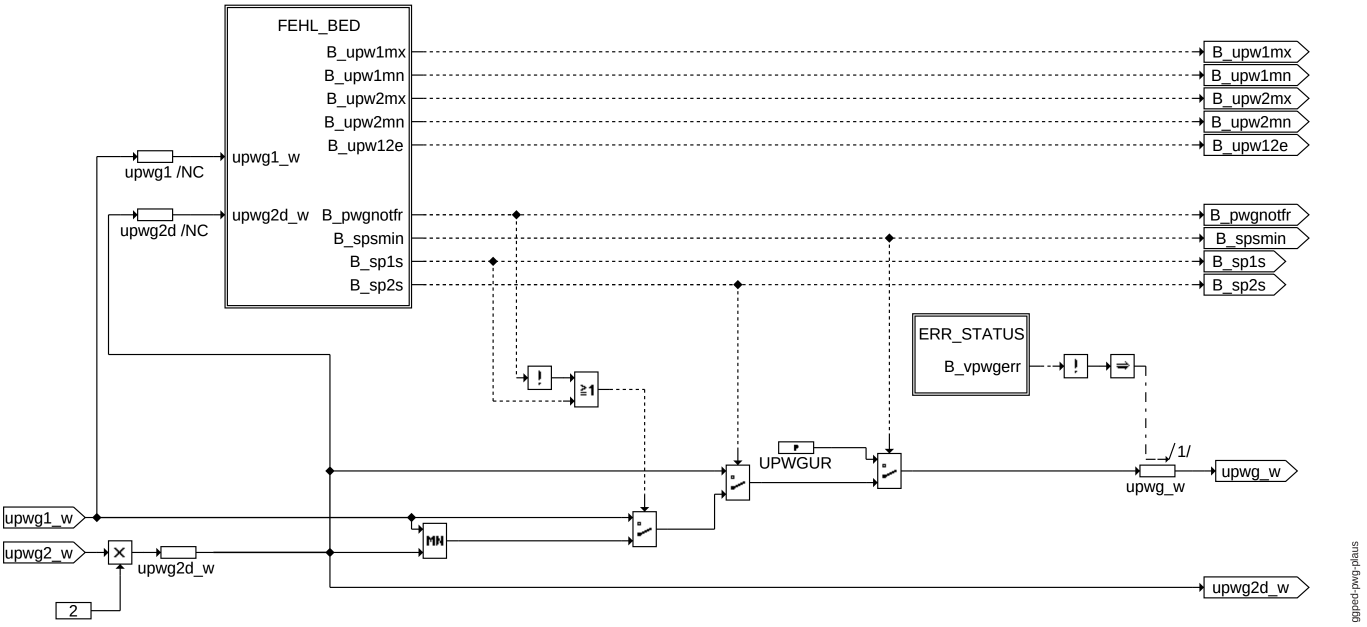
GGPED 8.30 Sensor variable for accelerator pedal

FDEF GGPED 8.30 Function definition



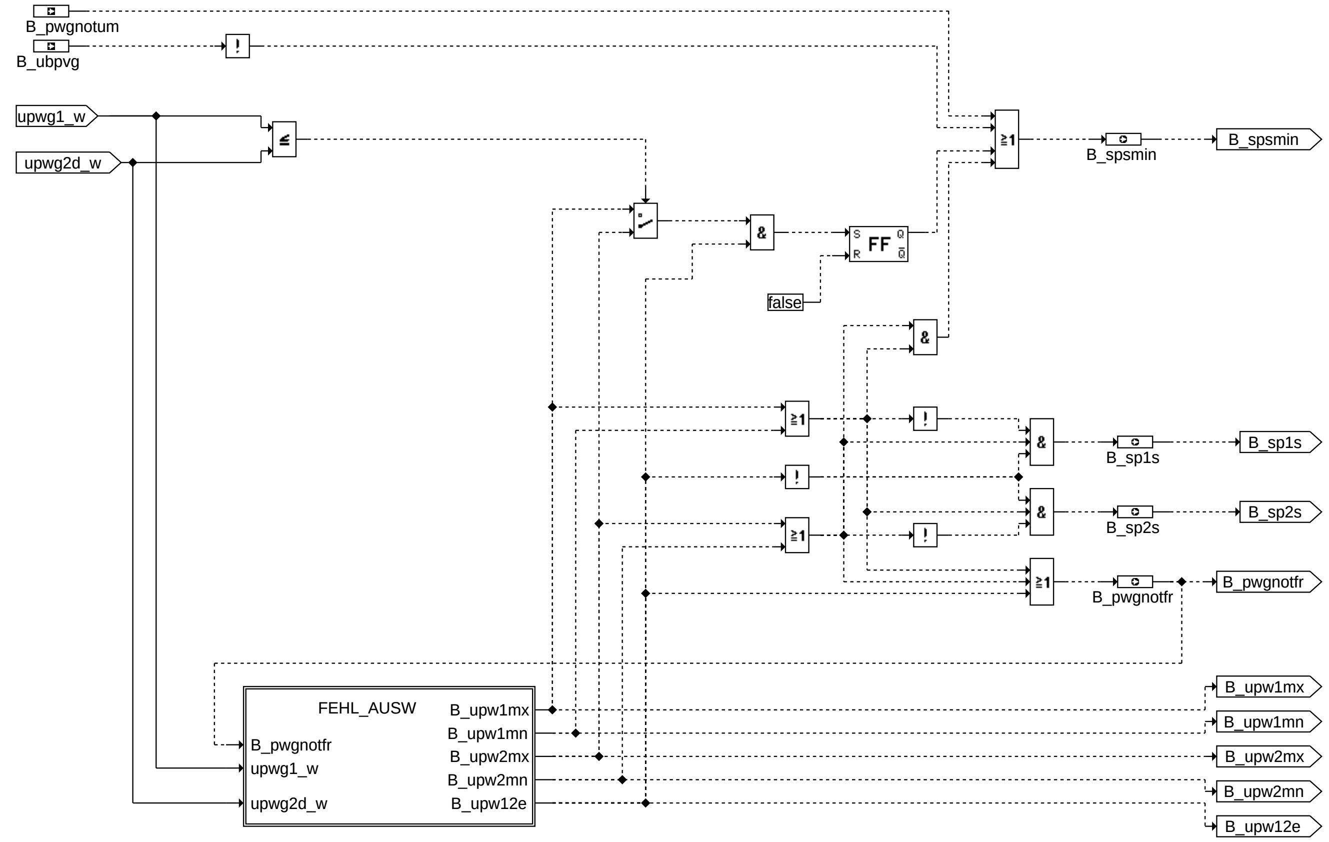
ggped-main

PWG_Plaus: Plausibilitätsprüfung der beiden PWG-Poti-Spannungen



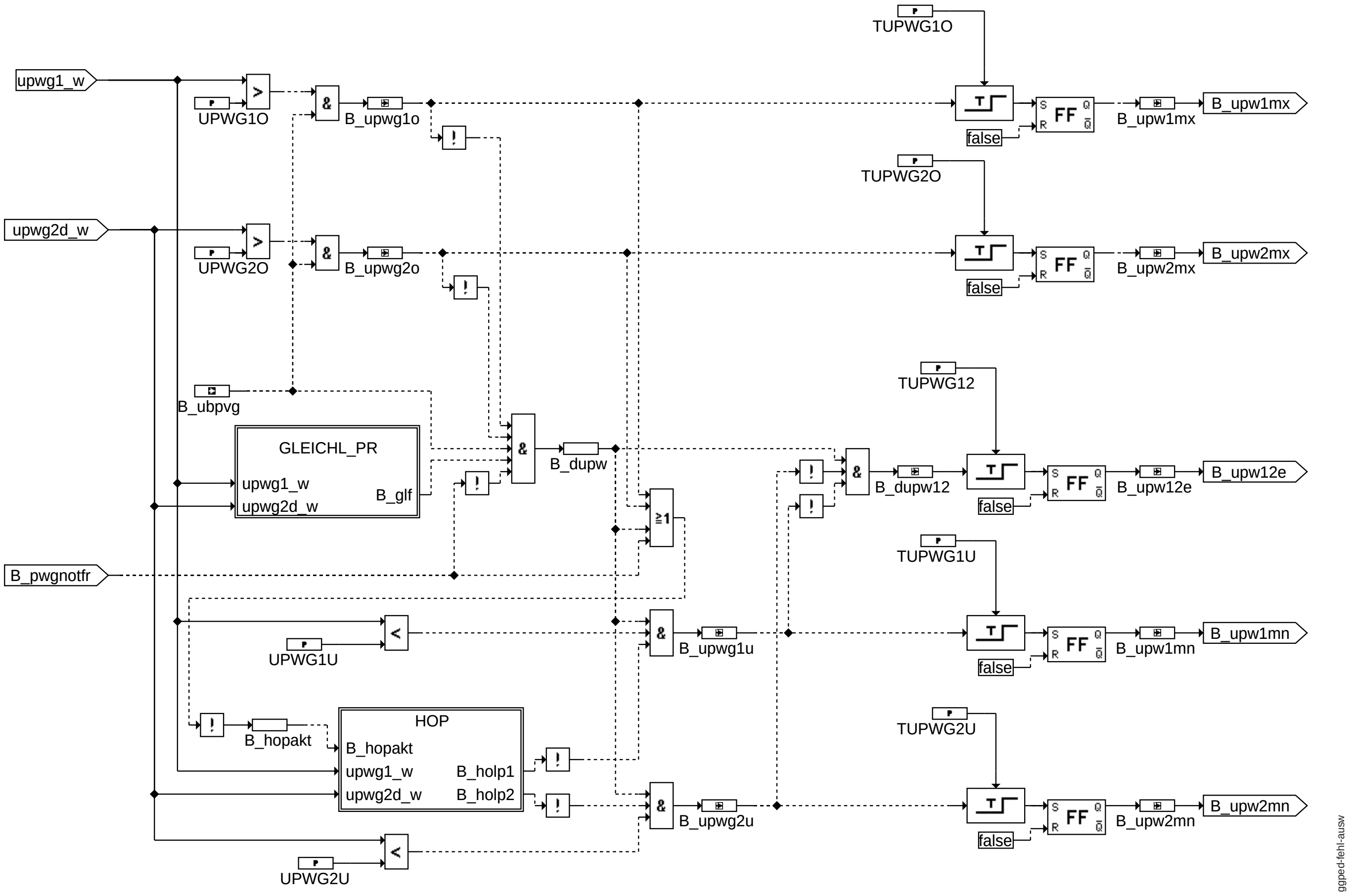
ggped-pwg-plaus

FEHL_BED: Generieren der Fehlerbedingungen



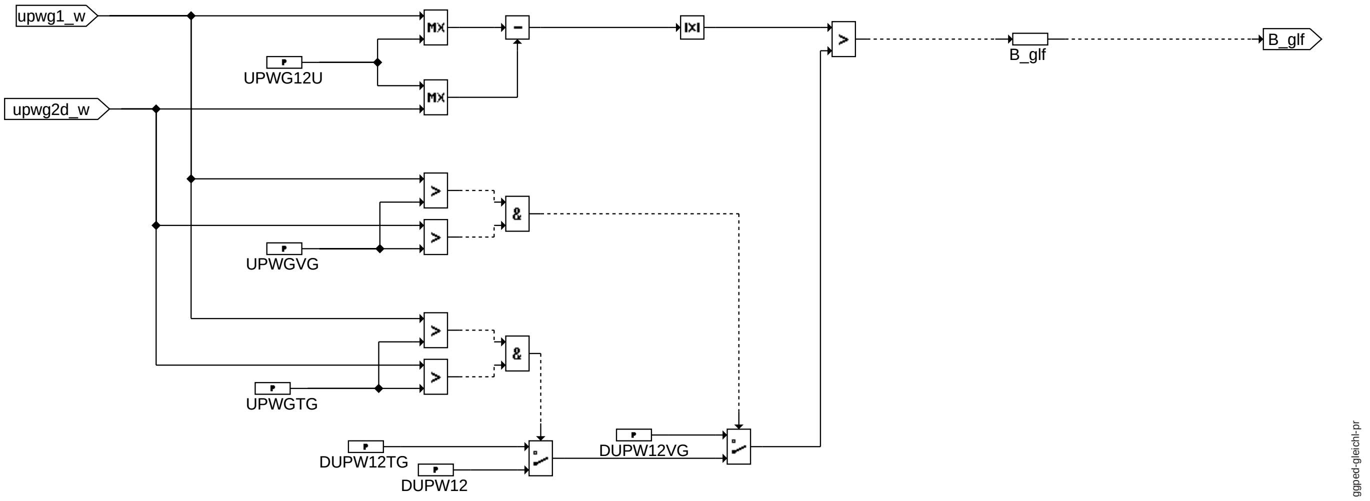
ggped-fehl-bed

Fehl_Ausw: Fehlerauswertung



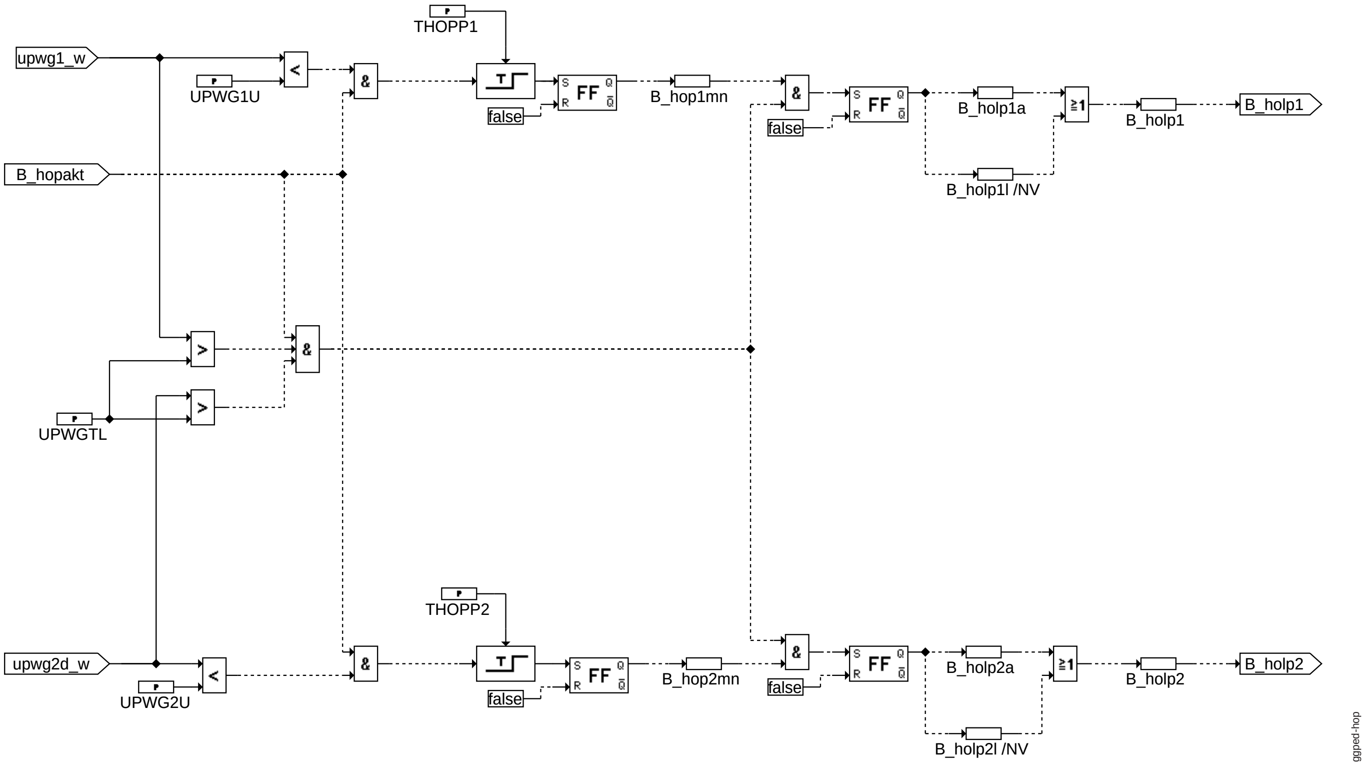
ggped-fehl-ausw

GLEICHL_PR: Gleichlaufprüfung



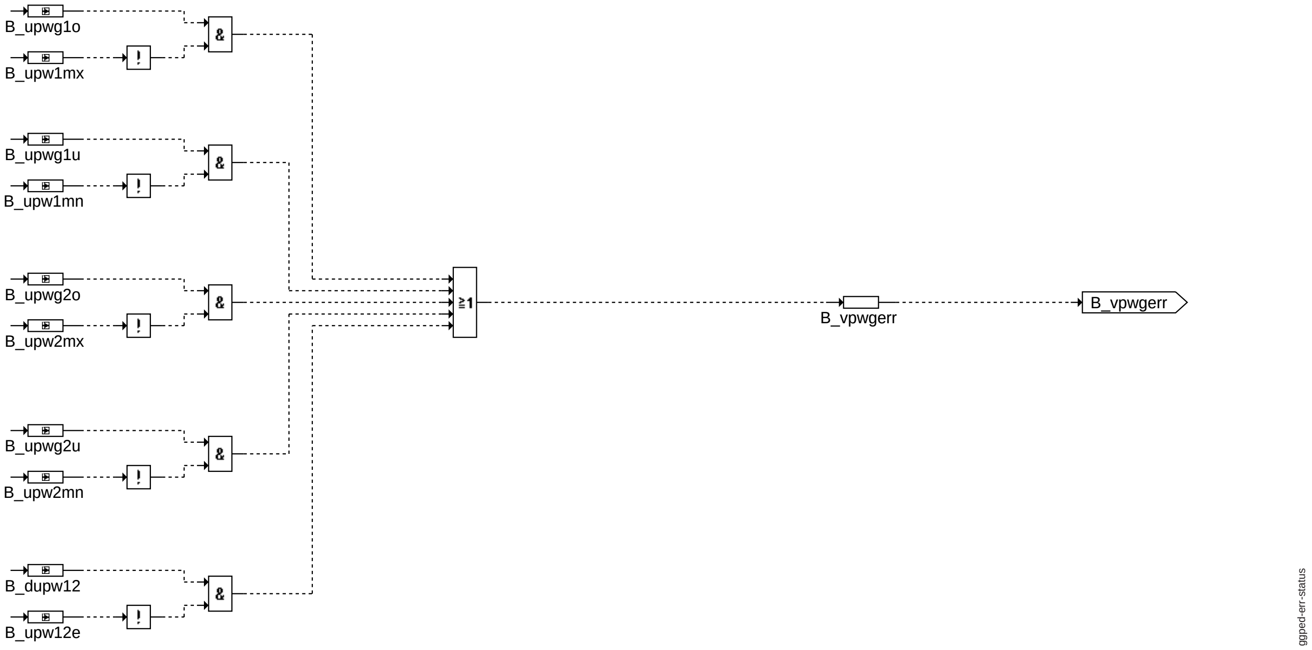
ggped-gleichl-pr

HOP: Hochomigkeitsprüfung im Leerlauf



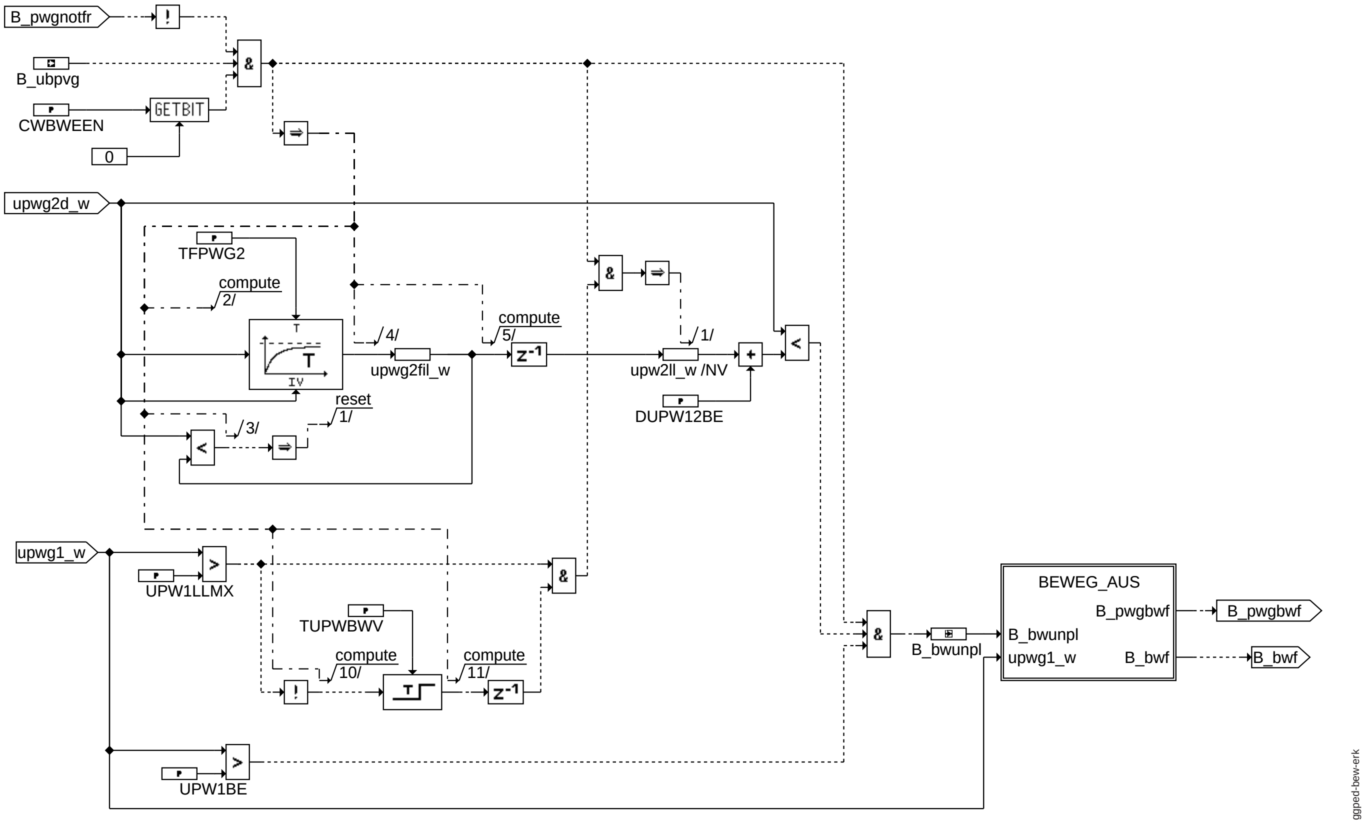
ggped-hop

ERR_STATUS: Fehlerstatus bzgl. Verdacht auf PWG-Fehler



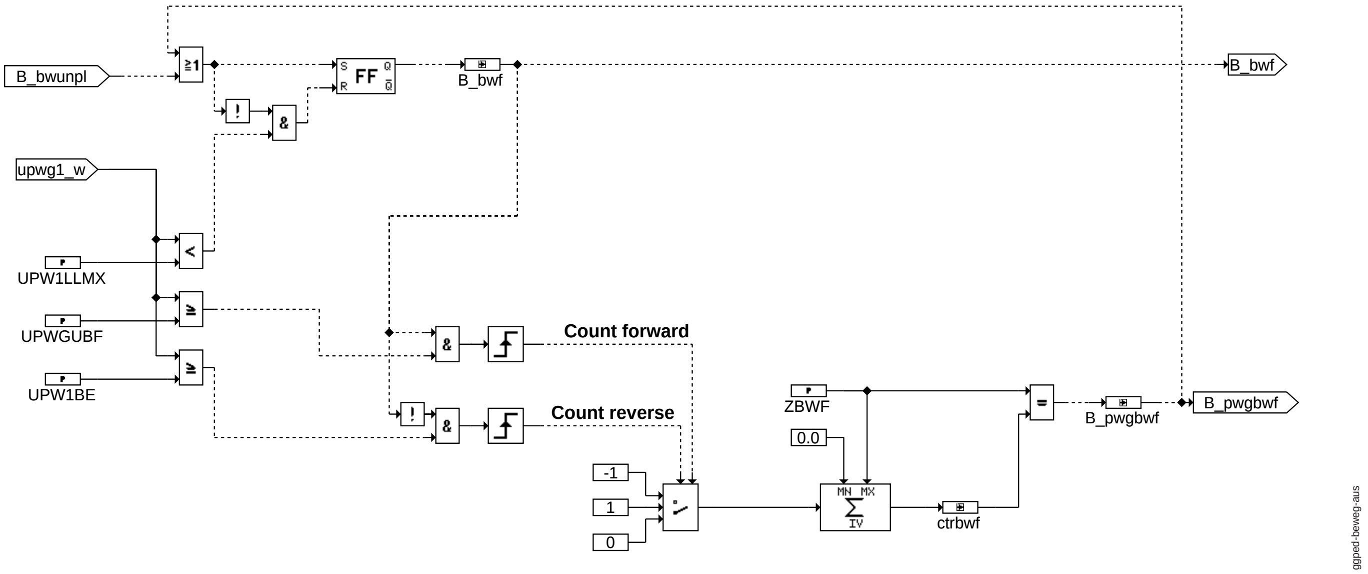
ggped-err-status

BEW_ERK: Bewegungserkennung



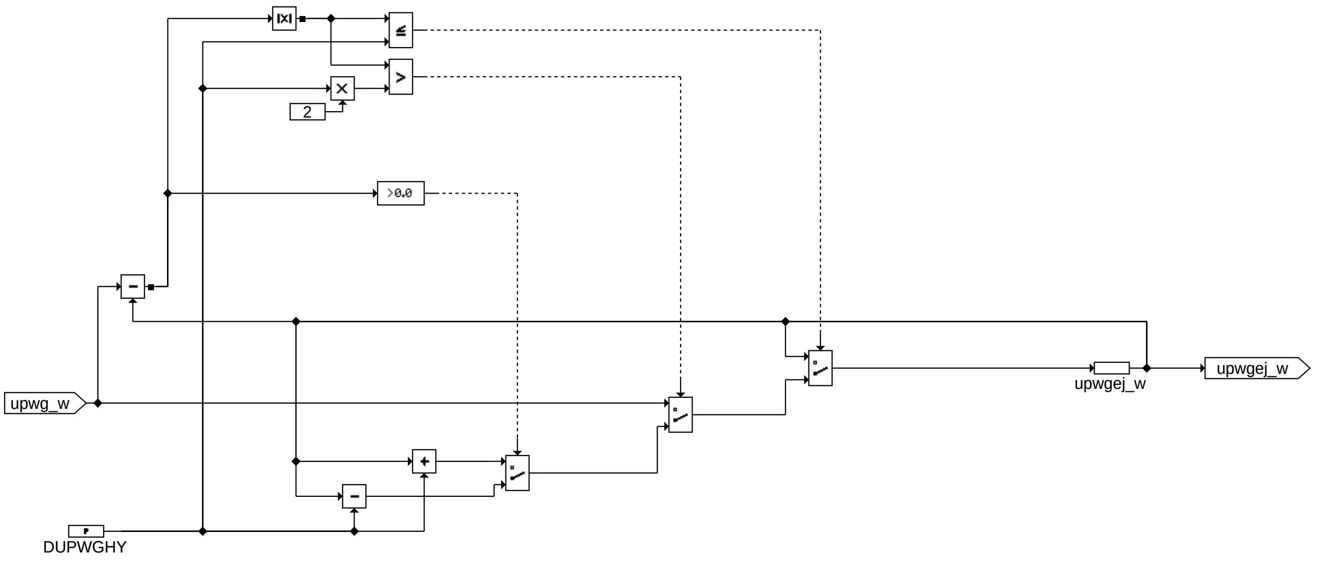
ggped-bew-erk

BEWEG_AUS: Auswertung der Bewegungserkennung



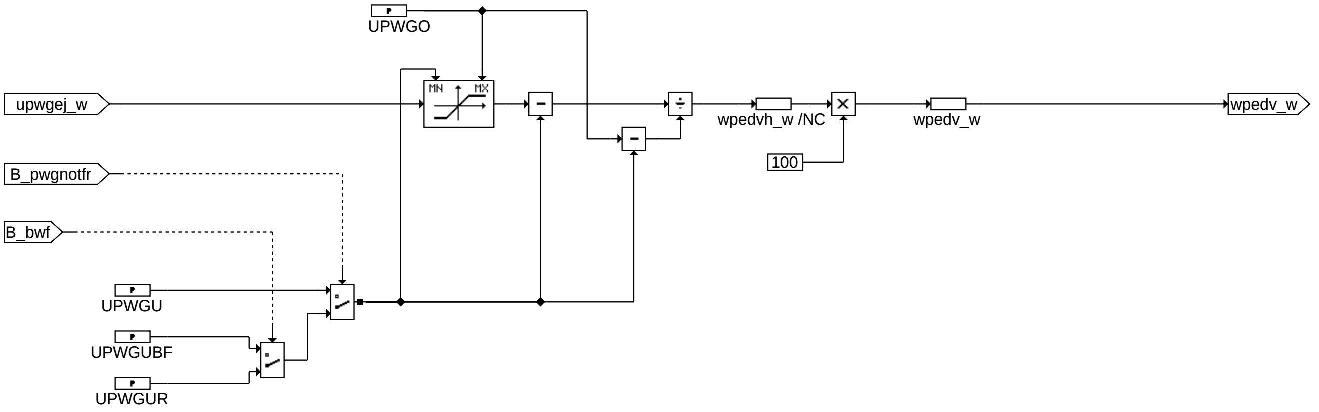
ggped-beweg-aus

ENTJIT: Entjitterung der PWG-Poti_Spannung



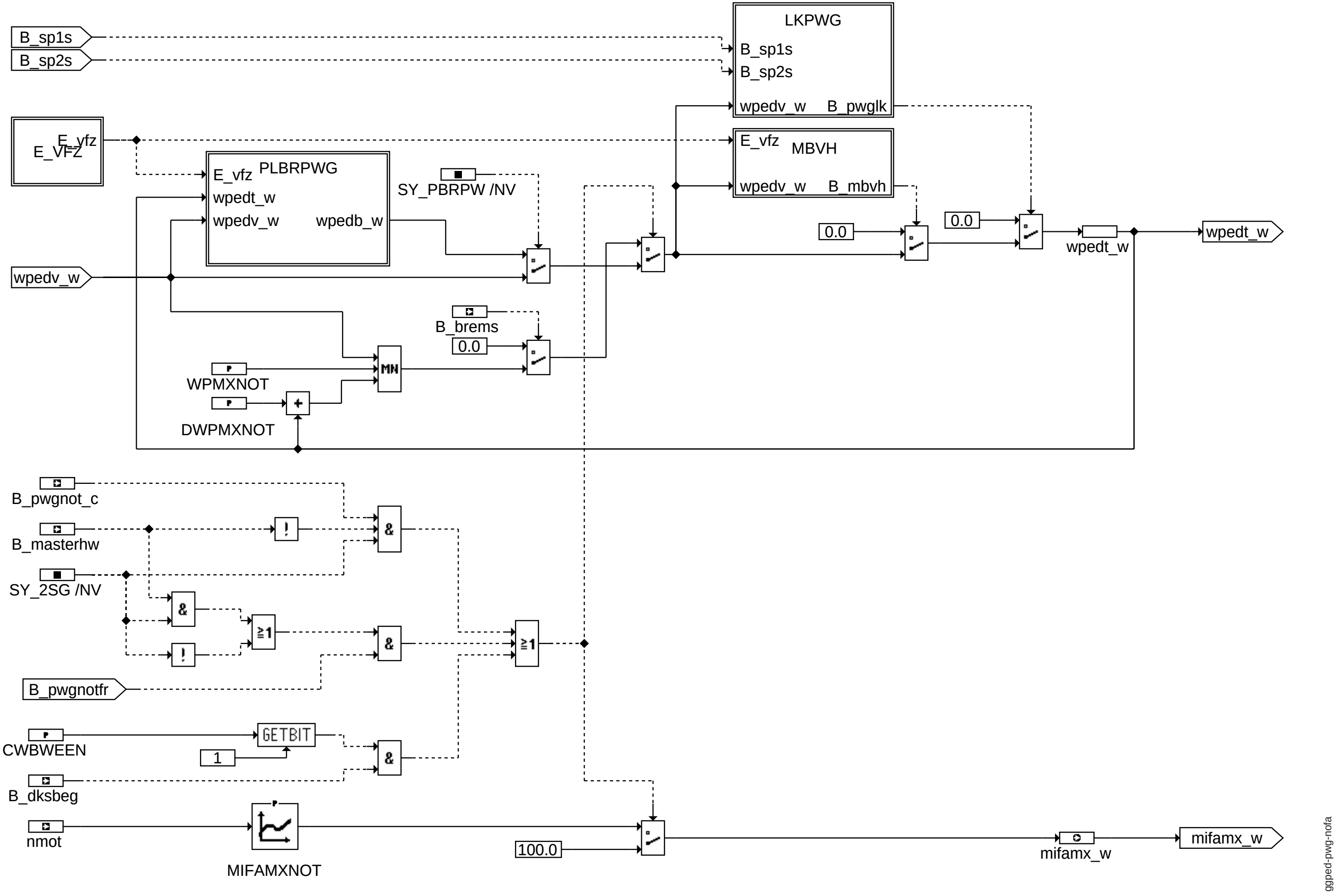
ggped-entjit

PED_NORM: Umrechnung Potispannung in Pedalwert



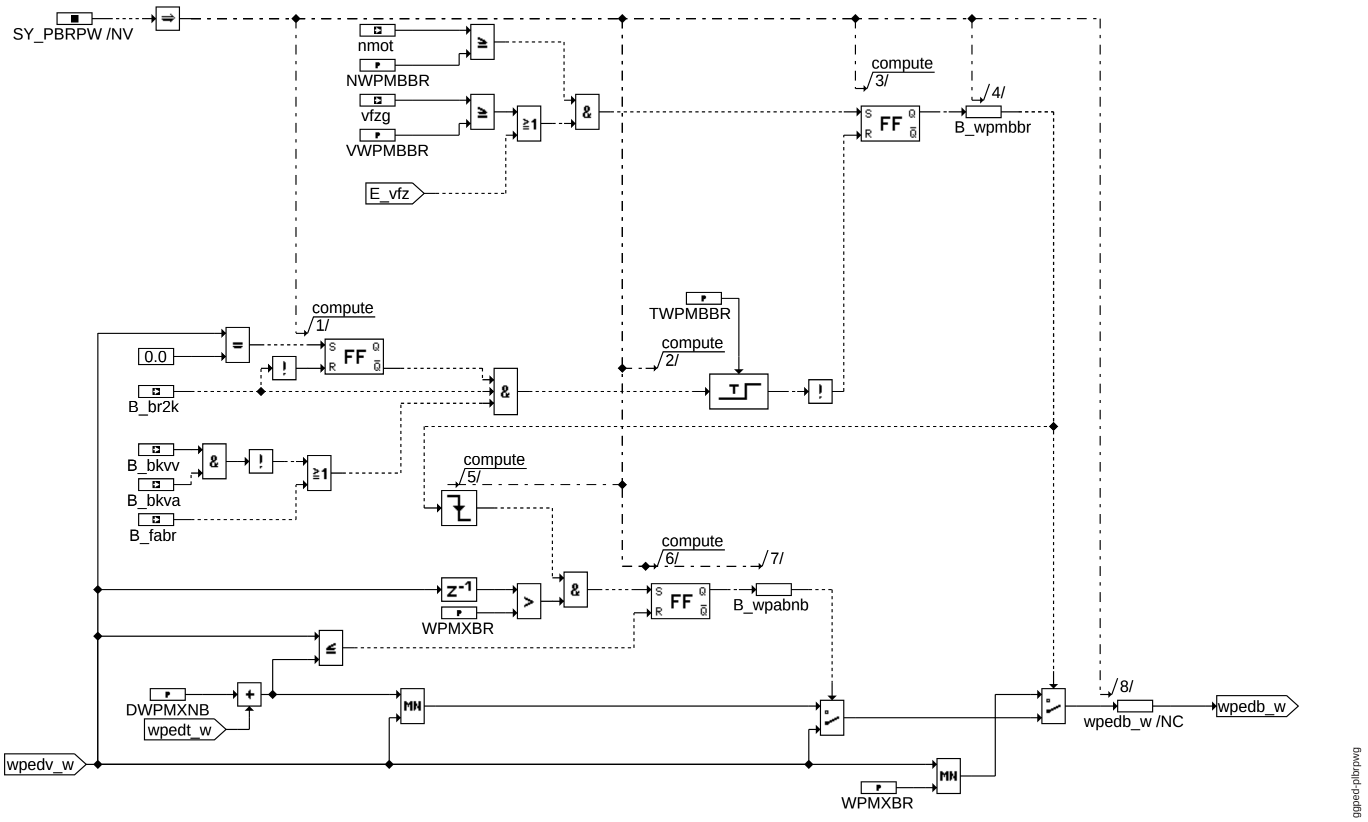
ggped-ped-norm

PWG_NOTFA: Begrenzung des Pedalwerts im PWG-Ersatzbetrieb



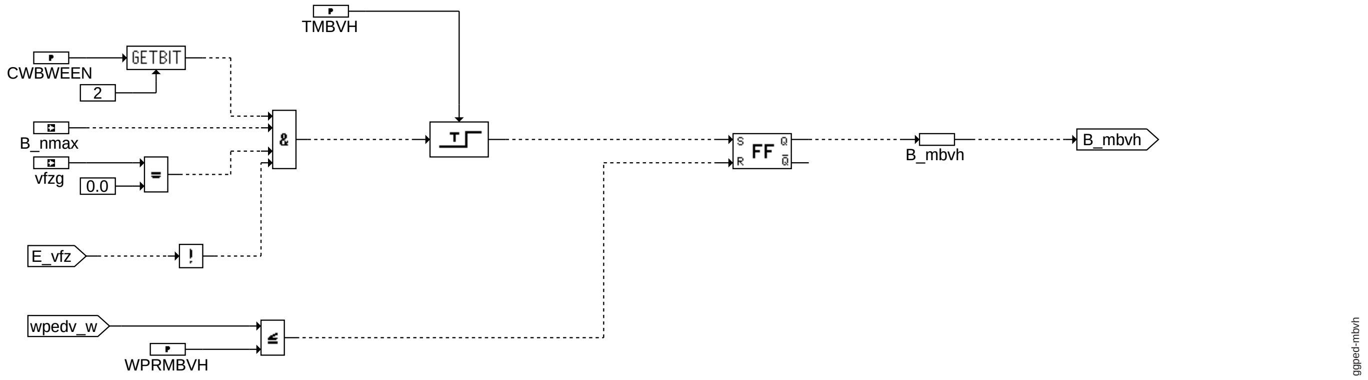
ggped-pwg-nofa

PLBRPWG: Plausibilitätsprüfung Bremse/PWG



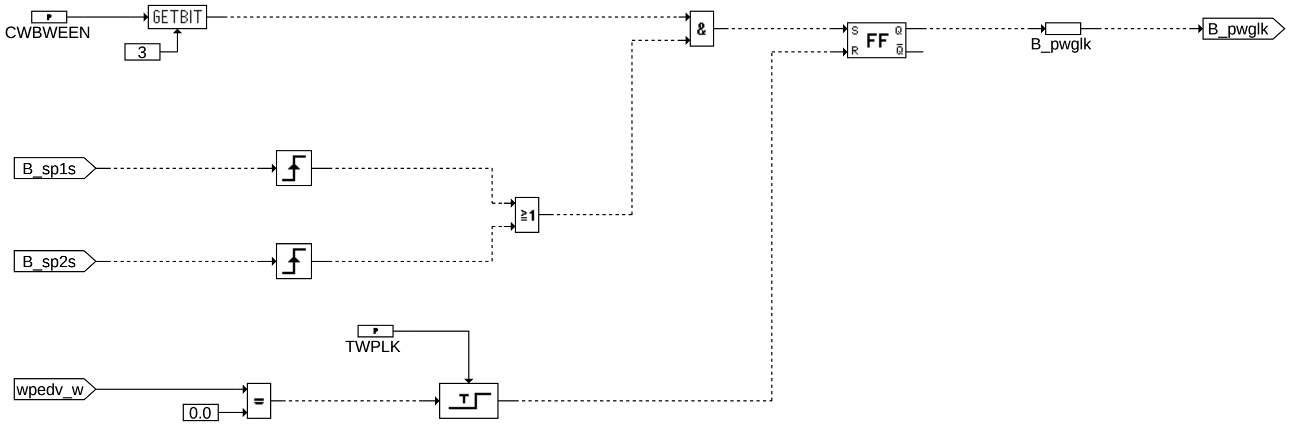
ggped-plbrpwg

MBVH: Mißbrauchsverhinderung

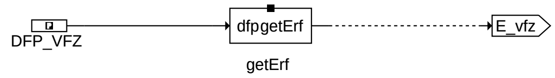


ggped-mbvh

LKPWG: Lebenderkennung des PWG nach erkanntem Fehler

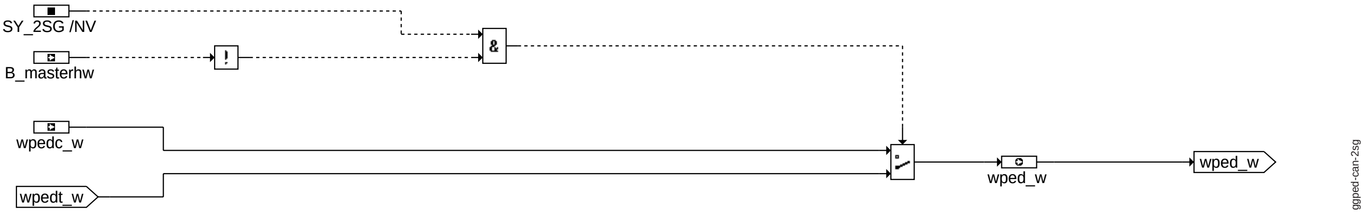


ggped-lkpwg



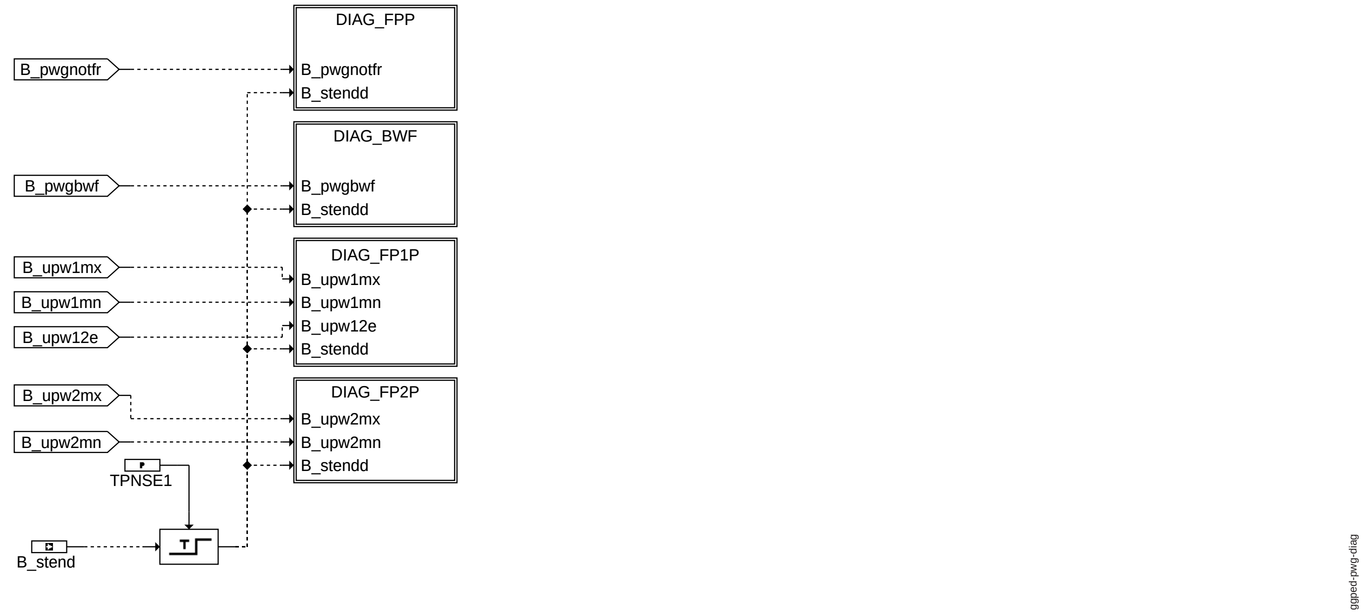
ggped-e-vfz

CAN_2SG: Pedalwertübertragung über CAN mit Plausibilisierung für System mit 2 ME-Steuergeräten



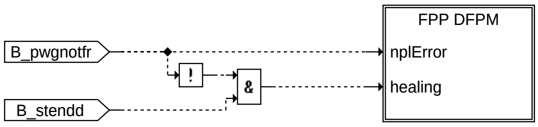
ggped-can-2sg

PWG_DIAG: Diagnose für PWG



ggped-pwg-diag

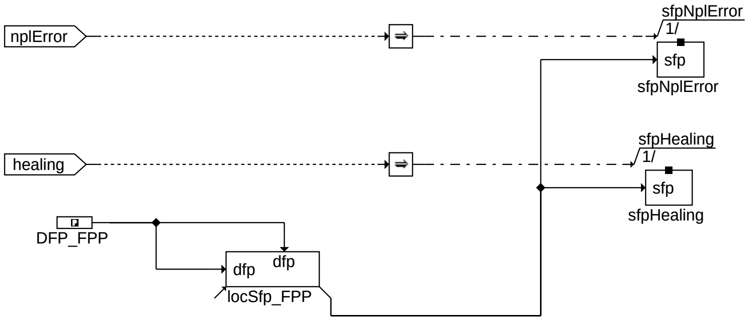
DIAG_FFP: Diagnose für PWG



ggped-diag-fpp

ggped-diag-fpp

FPP_DFPM



Action Table for fault path * in DFPM:

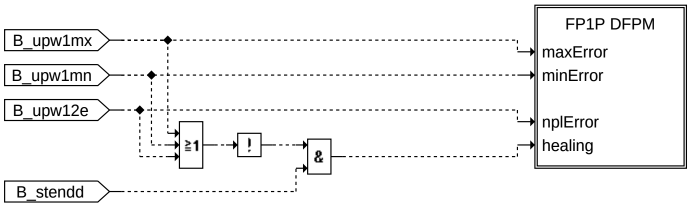
-------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	**S**	**S**	**S**	**R**	**R**	**R**
minError:	**S**	**S**	**R**	**S**	**R**	**R**
sigError:	**S**	**S**	**R**	**R**	**S**	**R**
nplError:	**S**	**S**	**R**	**R**	**R**	**S**
Healing:	**R**	**S**	**R**	**R**	**R**	**R**

S: set R: reset

ggped-fpp-dfpm

ggped-fpp-dfpm

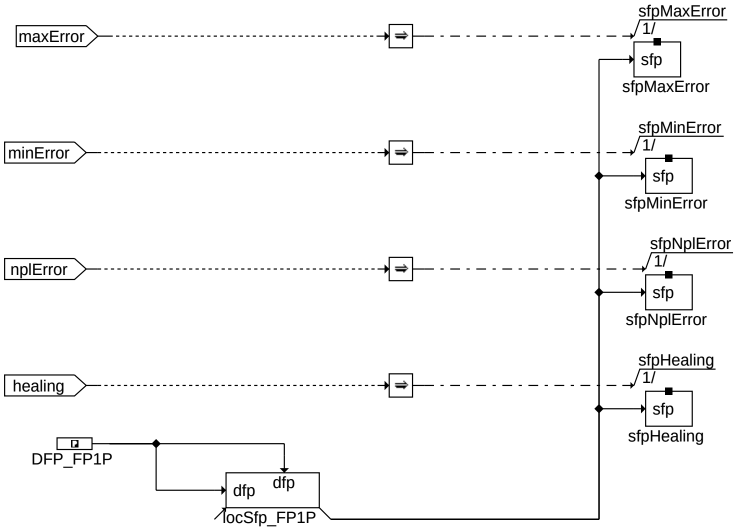
DIAG_FP1P: Diagnose für PWG-Poti 1



ggped-diag-fp1p

ggped-diag-fp1p

FP1P_DFPM



Action Table for fault path * in DFPM:

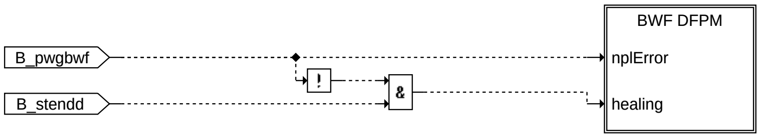
--------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	**S**	**S**	**S**	**R**	**R**	**R**
minError:	**S**	**S**	**R**	**S**	**R**	**R**
sigError:	**S**	**S**	**R**	**R**	**S**	**R**
nplError:	**S**	**S**	**R**	**R**	**R**	**S**
Healing:	**R**	**S**	**R**	**R**	**R**	**R**

S: set R: reset

ggped-fp1p-dfpm

ggped-fp1p-dfpm

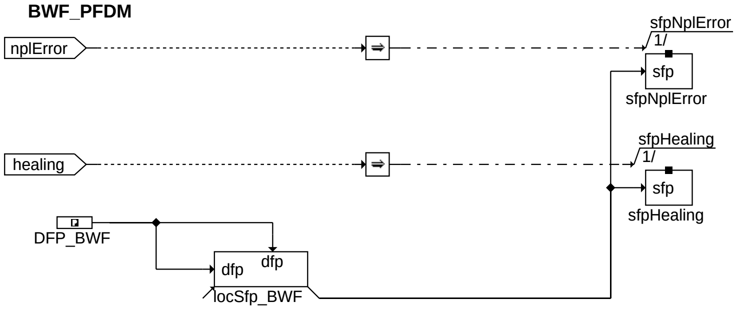
DIAG_BWF: Diagnose PWG-Bewegungserkennung



ggped-diag-bwf

ggped-diag-bwf

BWF_PFDM



Action Table for fault path * in DFPM:

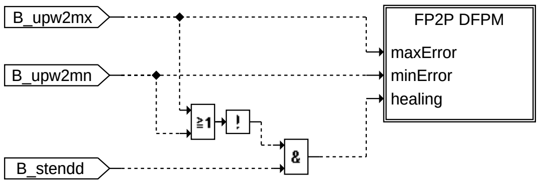
--------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	**S**	**S**	**S**	**R**	**R**	**R**
minError:	**S**	**S**	**R**	**S**	**R**	**R**
sigError:	**S**	**S**	**R**	**R**	**S**	**R**
nplError:	**S**	**S**	**R**	**R**	**R**	**S**
Healing:	**R**	**S**	**R**	**R**	**R**	**R**

S: set R: reset

ggped-bwf-dfpm

ggped-bwf-dfpm

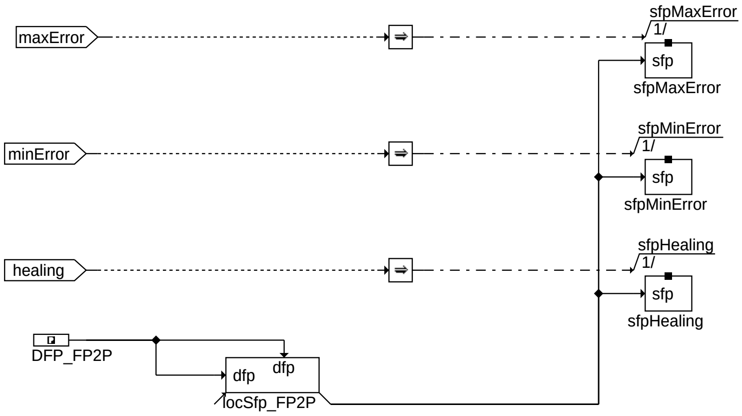
DIAG_FP2P: Diagnose für PWG-Poti 2



ggped-diag-fp2p

ggped-diag-fp2p

FP2P_DFPM



Action Table for fault path * in DFPM:

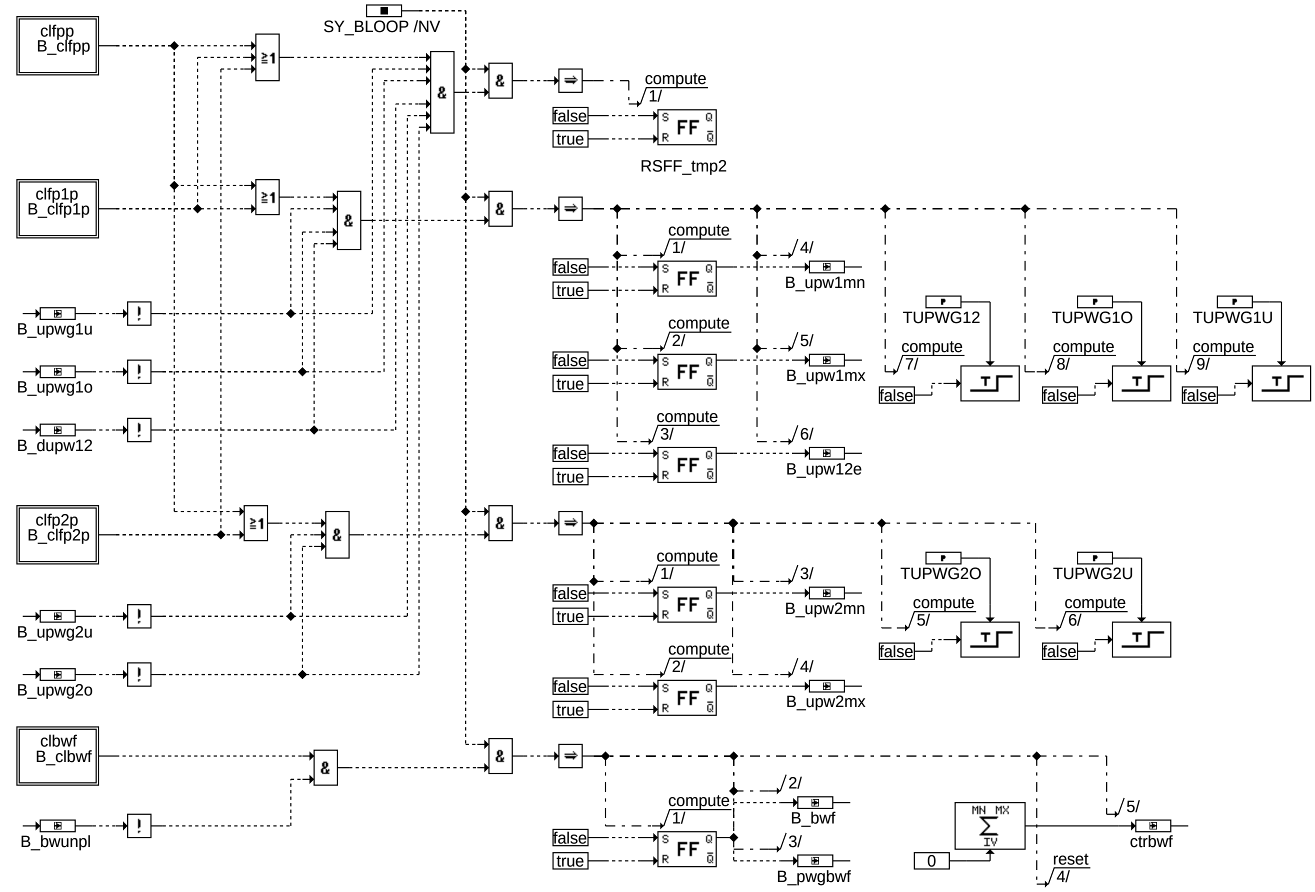
-------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	S	S	S	R	R	R
minError:	S	S	R	S	R	R
sigError:	S	S	R	R	S	R
nplError:	S	S	R	R	R	S
Healing:	R	S	R	R	R	R

S: set R: reset

ggped-fp2p-dfpm

ggped-fp2p-dfpm

FCMCLR



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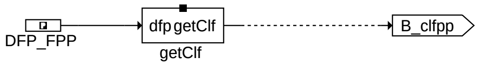

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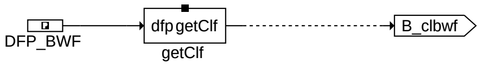

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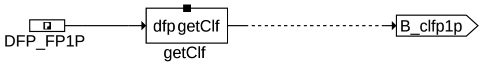
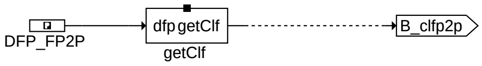
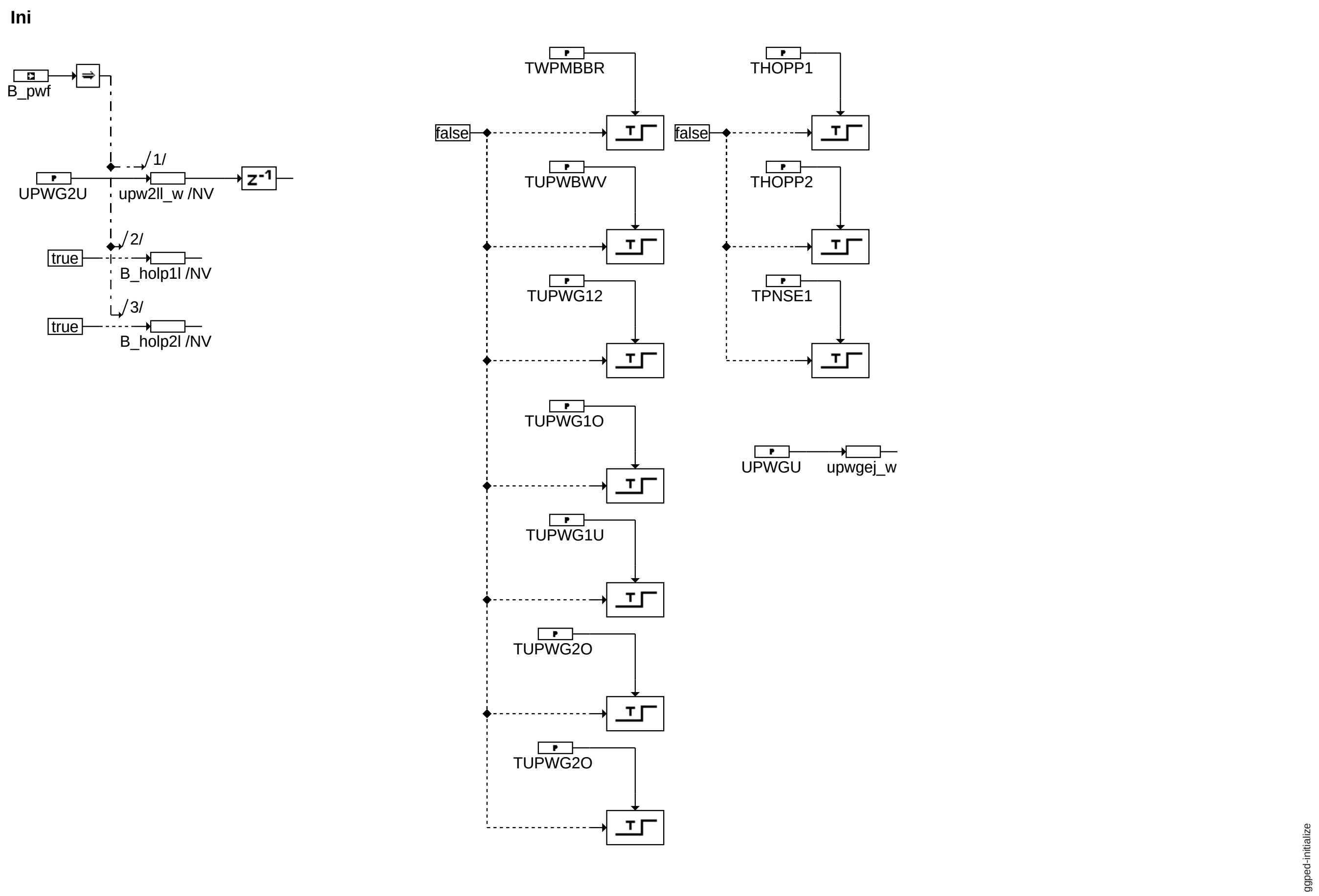


ggped-clfp1p



ggped-clfp2p

ggped-fcmclr
ggped-clfpp
ggped-clbwf
ggped-clfp1p
ggped-clfp2p



ggped-initialize

ABK GGPED 8.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWBWEEN			FW	Code word for deactivation of movement detection
DUPW12			FW	Permissible voltage deviation between PWG potentiometer 1 and 2
DUPW12BE			FW	Necessary voltage path of poti 2 for the movement detection
DUPW12TG			FW	Permitted voltage deviation between PWG poti 1 and 2 during part. throttle range
DUPW12VG			FW	Permissible volt. deviation between PWG potentiometer 1 and 2 in full gas range
DUPWGHY			FW	Voltage hysteresis for dejittering the PWG voltage
DWPMXNB			FW	Max. permissible pedal value increase per computation step after operating brake
DWPMXNOT			FW	Max. permissible increase in pedal travel per calc. step in PWG standby mode
MIFAMXNOT	NMOT		KL	maximum indicated engine torque at limp home
NWPMBBR			FW	minimum speed for limiting pedal travel for operated brake
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_BLOOP			SYS (REF)	sys. con. resetting of irreversible EGAS fault possible during clearing of FCM
SY_PBRPW			SYS (REF)	system constant plausibility check brake/PWG
TFPWG2			FW	Filter time for filtering potentiometer 2 during movement detection
THOPP1			FW	Fault time for high resistance test potentiometer 1
THOPP2			FW	Fault time for high resistance test potentiometer 2
TMBVH			FW	Delay time for activation of misuse prevention
TPNSE1			FW	Test time after start end for PWG diagnostic routine
TUPWBWV			FW	Time delay for storing a new potentiometer-2 value
TUPWG12			FW	Fault time during comparison of PWG potentiometer 1 and 2
TUPWG1O			FW	Fault time for upper violation of range by PWG potentiometer 1
TUPWG1U			FW	Fault time for lower violation of range by PWG potentiometer 1
TUPWG2O			FW	Fault time for upper violation of range by PWG potentiometer 2
TUPWG2U			FW	Fault time for lower violation of range by PWG potentiometer 2
TWPLK			FW	debouncing time for withdrawal of the idle input at life detection
TWPMBBR			FW	Delay time for limiting pedal travel for operated brake
UPW1BE			FW	Voltage PWG potentiometer 1 for executing movement detection
UPW1LLMX			FW	Maximum voltage of potentiometer 1 at no-throttle point
UPWG12U			FW	Lower limit for PWG potentiometer volt. before comparison potentiometer 1 and 2
UPWG1O			FW	Upper barrier for PWG potentiometer-1 voltage
UPWG1U			FW	Lower barrier for PWG potentiometer-1 voltage
UPWG2O			FW	Upper barrier for PWG potentiometer-2 voltage
UPWG2U			FW	Lower barrier for PWG potentiometer-2 voltage
UPWGO			FW	Upper PWG voltage value for re-scaling to pedal value
UPWGTG			FW	PWG voltage threshold for partial throttle range
UPWGTL			FW	Partial load threshold of the PWG voltage in high resistance testing

Parameter	Source-X	Source-Y	Type	Description
UPWGU			FW	Lower PWG voltage value for re-scaling to standard value
UPWGUBF			FW	Lower voltage value for the re-scaling for detected movement fault
UPWGUR			FW	Reduced lower PWG voltage value for re-scaling to pedal value
UPWGVG			FW	PWG voltage threshold for full-throttle range
VWPMBBR			FW	minimum speed for limiting pedal travel for operated brake
WPMXBR			FW	Maximum permissible pedal value for actuated brake (prior to detection of wped=0
WPMXNOT			FW	Max. permissible pedal travel in PWG limp-home
WPRMBVH			FW	pedal angle for deactivation of misuse protection
ZBWF			FW	Counter status for movement-detection fault entry

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_BEBWF	GGPED	AUS	Condition function request for motion control of pedal
B_BEFP1P	GGPED	AUS	Condition function request for error poti1 of pedal
B_BEFP2P	GGPED	AUS	Condition function request for error poti2 of pedal
B_BEFPP	GGPED	AUS	Condition function request for error of pedal
B_BKBWF	GGPED	AUS	Flag for default value: pedal moving detection
B_BKFP1P	GGPED	AUS	Condition: Pedal 1.potentiometer active
B_BKFP2P	GGPED	AUS	Condition: Pedal 2.potentiometer active
B_BKFPP	GGPED	AUS	Codition: drive pedal potentiometer active
B_BKVA		EIN	condition BKV triggered
B_BKVV		EIN	condition BKV installed (for evaluating brakes)
B_BR2K	GGEGAS	EIN	Condition brakes actuated 2-channel detection
B_BREMS	GGEGAS	EIN	condition: brake operated
B_BWF	GGPED	LOK	Condition: movement detection has detected fault
B_BWUNPL	GGPED	LOK	Condition non-plausibility during movement detection
B_CLBWF		EIN	Flag for clearance: pedal moving detection
B_CLFP1P		EIN	Flag for clearing measures: accelerator pedal potentiometer 1
B_CLFP2P		EIN	Flag for clearing measures: accelerator pedal potentiometer 2
B_CLFPP		EIN	Delete condition fault path FPP (drive pedal potentiometer)
B_DKSBEG	GGDVE	EIN	condition: limiting throttle-valve setpoint value
B_DUPW	GGPED	LOK	Condition deviation between potentiometer 1 and 2 too large
B_DUPW12	GGPED	LOK	Condition permissible deviation between PWG potentiometers 1 and 2 exceeded
B_FABR		EIN	condition driver brakes because of CAN message
B_FTBWF	GGPED	AUS	Condition fault entry by tester for motion control of pedal
B_FTFP1P	GGPED	AUS	Condition fault entry by tester for poti1 of pedal
B_FTFP2P	GGPED	AUS	Condition fault entry by tester for poti2 of pedal
B_FTFPP	GGPED	AUS	Condition fault entry by tester for pedal
B_GLF	GGPED	LOK	Condition synchronization between potentiometers 1 and 2 violated
B_HOLP1	GGPED	LOK	Condition high resistance in idling at PWG potentiometer 1 detected
B_HOLP1A	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 1 in current drive cycle
B_HOLP1L	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 1 in previous drive cycle
B_HOLP2	GGPED	LOK	Condition high resistance in idling at PWG potentiometer 2 detected
B_HOLP2A	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 2 in current drive cycle
B_HOLP2L	GGPED	LOK	Cond. high resistance in idling at PWG potentiometer 2 in previous drive cycle
B_HOP1MN	GGPED	LOK	Condition lower violation of range at potentiometer 1 in high resistance testing
B_HOP2MN	GGPED	LOK	Condition lower violation of range at potentiometer 2 in high resistance testing
B_HOPAKT	GGPED	LOK	Condition high resistance testing active
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_MBVH	GGPED	LOK	condition abuse prevention
B_MNBWF	GGPED	AUS	Fault type min.: pedal moving detection
B_MNFP1P	GGPED	AUS	Fault type min.: accelerator pedal potentiometer 1
B_MNFP2P	GGPED	AUS	Fault type min.: Pedal 2. poti
B_MNFPP	GGPED	AUS	Fault type min.: drive pedal potentiometer
B_MXBWF	GGPED	AUS	Fault type max.: pedal moving detection
B_MXFP1P	GGPED	AUS	Fault type max.: Pedal 1. poti
B_MXFP2P	GGPED	AUS	Fault type max.: Pedal 2. poti
B_MXFPP	GGPED	AUS	Fault type max.: drive pedal potentiometer
B_NMAX	NMAXMD	EIN	1 = maximum engine speed exceeded
B_NPBWF	GGPED	AUS	Fault type not plausible: movement by pedal-travel sensor
B_NPFP1P	GGPED	AUS	Fault type not plausible: accelerator pedal potentiometer 1
B_NPFP2P	GGPED	AUS	Fault type unplaus.: Pedal 2. poti
B_NPFPP	GGPED	AUS	Condition potentiometer signals from drive pedal not plausible
B_PWF		EIN	Condition for powerfail
B_PWGBWF	GGPED	LOK	Condition pedal-travel sensor movement fault
B_PWGLK	GGPED	LOK	condition life detection PWG
B_PWGNOTFR	GGPED	AUS	FR error reaction pedal-travel sensor limphome
B_PWGNOTUM	URADCC	EIN	= b_pwgnot_um function monitoring fault response PWG idling (= b_pwgnot_sr)
B_PWGNOT_C		EIN	condition: info PWG limp-home via CAN
B_SIBWF	GGPED	AUS	Fault type sig.: pedal moving detection
B_SIFP1P	GGPED	AUS	error type:Pedal 1.potentiometer
B_SIFP2P	GGPED	AUS	error type:Pedal 2.potentiometer
B_SIFPP	GGPED	AUS	error type: drive pedal potentiometer
B_SP1S	GGPED	AUS	message to SR: SP1S is command variable
B_SP2S	GGPED	AUS	SP2S is valid set value for PWG failure driving
B_SPSMIN	GGPED	AUS	message to SR: '1' = pedal-travel sensor limphome with SPSMIN
B_STEND	BBSTT	EIN	condition end of start
B_UBPVG	ADVE	EIN	condition: battery voltage sufficient for 5-V potentiometer supply
B_UPW12E	GGPED	LOK	Cond.: Fault during comparison of both standardized PWG potentiometer voltages
B_UPW1MN	GGPED	LOK	Condition: Voltage PWG potentiometer 1 below minimum value
B_UPW1MX	GGPED	LOK	Condition: Voltage PWG potentiometer 1 above maximum value

Variable	Source	Type	Description
B_UPW2MN	GGPED	LOK	Condition: Voltage PWG potentiometer 2 below minimum value
B_UPW2MX	GGPED	LOK	Condition: Voltage PWG potentiometer 2 above maximum value
B_UPWG1O	GGPED	LOK	Condition upper violation of range at PWG potentiometer 1
B_UPWG1U	GGPED	LOK	Condition lower violation of range at PWG potentiometer 1
B_UPWG2O	GGPED	LOK	Condition upper violation of range at PWG potentiometer 2
B_UPWG2U	GGPED	LOK	Condition lower violation of range at PWG potentiometer 2
B_VPWGERR	GGPED	LOK	Condition: suspicion on error at pedal-travel sensor
B_WPABNB	GGPED	LOK	condition limit chage in pedal-travel value after brake actuation
B_WPMBBR	GGPED	LOK	condition: max. limiting of pedal-sensor value for brake actuation
CTRBWF	GGPED	LOK	Fault counter movement detection
DFP_BWF	GGPED	DOK	ECU int. fault path no. pedal moving detection
DFP_FP1P	GGPED	DOK	ECU int. fault path no.: pedal 1. potentiometer
DFP_FP2P	GGPED	DOK	ECU int. fault path no.: pedal 2. potentiometer
DFP_FPP	GGPED	DOK	ECU int. fault path no.: pedal potentiometer
DFP_VFZ	GGPED	DOK	ECU int. fault path no.: vehicle speed signal
DWPED	GGPED	AUS	gradient of the standardized accelerator pedal angle
DWPED_W	GGPED	AUS	gradient of the standardized accelerator pedal angle
E_BWF	GGPED	AUS	Error flag: pedal moving detection
E_FP1P	GGPED	AUS	Error flag: accelerator pedal potentiometer 1
E_FP2P	GGPED	AUS	Error flag: accelerator pedal potentiometer 2
E_FPP	GGPED	AUS	Error flag drive pedal potentiometer
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
MIFAMX_W	GGPED	AUS	maximum indicated engine torque at limp home
NMOT	SWADAP	EIN	engine speed
SFPBWF	GGPED	AUS	Status word: pedal moving detection
SFPFP1P	GGPED	AUS	status fault path: pedal 1. potentiometer
SFPFP2P	GGPED	AUS	status fault path: pedal 2. potentiometer
SFPFPP	GGPED	AUS	status fault path: pedal potentiometer
UPW2LL_W	GGPED	LOK	Value for voltage from pedal-travel sensor potentiometer 2 before movement
UPWG1_W		EIN	Voltage PWG potentiometer 1 (word)
UPWG2D_W	GGPED	LOK	Doubled PWG potentiometer-2 voltage (word)
UPWG2FIL_W	GGPED	LOK	Filtered potentiometer 2 voltage
UPWG2_W		EIN	Voltage PWG potentiometer 2 (word)
UPWGEJ_W	GGPED	LOK	De-jittered PWG potentiometer voltage
UPWG_W	GGPED	LOK	Resulting PWG potentiometer voltage following plausibility check
VFZG	SWADAP	EIN	vehicle speed (km/h)
WPED	GGPED	AUS	Standardized accelerator pedal angle
WPEDC_W		EIN	pedal value for 2 ME ECU's (from CAN)
WPEDT_W	GGPED	LOK	Pedal value (temporary) for 2 ME ECU's
WPEDV_W	GGPED	LOK	Standardized drive pedal angle prior to allowance for limiting in standby drive
WPED_W	GGPED	AUS	normed angle acceleration pedal
Z_BWF	GGPED	AUS	Cycle flag: pedal moving detection
Z_FP1P	GGPED	AUS	Cycle flag: Pedal 1. poti
Z_FP2P	GGPED	AUS	Cycle flag: Pedal 2. poti
Z_FPP	GGPED	AUS	Cycle flag drive pedal potentiometer

FW GGPED 8.30 Fixed Values

Parameter	Value	Description
CWBWEEN		Code word for deactivation of movement detection
DUPW12		Permissible voltage deviation between PWG potentiometer 1 and 2
DUPW12BE		Necessary voltage path of poti 2 for the movement detection
DUPW12TG		Permitted voltage deviation between PWG poti 1 and 2 during part. throttle range
DUPW12VG		Permissible volt. deviation between PWG potentiometer 1 and 2 in full gas range
DUPWGHY		Voltage hysteresis for dejittering the PWG voltage
DWPMXNB		Max. permissible pedal value increase per computation step after operating brake
DWPMXNOT		Max. permissible increase in pedal travel per calc. step in PWG standby mode
NWPMBBR		minimum speed for limiting pedal travel for operated brake
TFPWG2		Filter time for filtering potentiometer 2 during movement detection
THOPP1		Fault time for high resistance test potentiometer 1
THOPP2		Fault time for high resistance test potentiometer 2
TMBVH		Delay time for activation of misuse prevention
TPNSE1		Test time after start end for PWG diagnostic routine
TUPWBWV		Time delay for storing a new potentiometer-2 value
TUPWG12		Fault time during comparison of PWG potentiometer 1 and 2
TUPWG1O		Fault time for upper violation of range by PWG potentiometer 1
TUPWG1U		Fault time for lower violation of range by PWG potentiometer 1
TUPWG2O		Fault time for upper violation of range by PWG potentiometer 2
TUPWG2U		Fault time for lower violation of range by PWG potentiometer 2
TWPLK		debouncing time for withdrawal of the idle input at life detection
TWPMBBR		Delay time for limiting pedal travel for operated brake
UPW1BE		Voltage PWG potentiometer 1 for executing movement detection
UPW1LLMX		Maximum voltage of potentiometer 1 at no-throttle point
UPWG12U		Lower limit for PWG potentiometer volt. before comparison potentiometer 1 and 2
UPWG1O		Upper barrier for PWG potentiometer-1 voltage
UPWG1U		Lower barrier for PWG potentiometer-1 voltage
UPWG2O		Upper barrier for PWG potentiometer-2 voltage
UPWG2U		Lower barrier for PWG potentiometer-2 voltage
UPWGO		Upper PWG voltage value for re-scaling to pedal value
UPWGTG		PWG voltage threshold for partial throttle range
UPWGTL		Partial load threshold of the PWG voltage in high resistance testing

Parameter	Value	Description
UPWGU		Lower PWG voltage value for re-scaling to standard value
UPWGUBF		Lower voltage value for the re-scaling for detected movement fault
UPWGUR		Reduced lower PWG voltage value for re-scaling to pedal value
UPWGVG		PWG voltage threshold for full-throttle range
VWPMBBR		minimum speed for limiting pedal travel for operated brake
WPMXBR		Maximum permissible pedal value for actuated brake (prior to detection of wped=0
WPMXNOT		Max. permissible pedal travel in PWG limp-home
WPRMBVH		pedal angle for deactivation of misuse protection
ZBWF		Counter status for movement-detection fault entry

FB GGPED 8.30 Detailed description of function

The function calculates the standardized accelerator angle wped from the poti voltage of the pedal sensor (PWG). The PWG has two potentiometers, which are independently supplied with 5V from the control unit. Poti 2 possesses an additional resistor of the size of the track resistor, so that its characteristic displays only half the gradient as compared to that of poti 1. By various plausibility checks (voltage range, synchronization etc.) it is ensured that due to a single fault wped cannot take on higher values than correspond to the accelerator position. In addition to the component monitoring for the PWG realized here, further parts of the PWG monitoring are contained in the functions %UFSPSC (watchdog function for %GGPED) and %URADCC (watchdog function of the A/D-converter).

Apart from wped further variables are made available:
o The pedal value gradient dwped,
o if needed, several fault code memory entries (FP1P, FP2P, FPP, BWF) as well as
o information on the PWG limp-home operation (B_pwgnotfr, B_spsmin, B_sp1s, B_sp2s) for the watchdog function.

The function is also suitable for use in a system with 2 ME control units (SY_2SG = 1), in which the PWG evaluation and monitoring is performed entirely in the master ECU and in which the pedal value wped is transferred to the slave ECU via CAN.

PWG_PLAUS
=========

Dependent on the result of the plausibility check the resulting poti voltage upwg is selected, which is thereafter used for the calculation of the pedal value. During normal operation (B_pwgnotfr = 0, B_spsmin = 0) upwg1, the signal of poti 1, is used for the calculation of the pedal value. With undervoltage (B_ubpvg = 0), with a fault detection in the watchdog function (B_pwgnot_um = 1) and with a range violation of the remaining poti during PWG limp-home operation, upwg is set to the smallest possible lower standard limit UPWGUR (s. partial function PED_NORM), which leads to wped = 0. In case of a range violation of poti 1, upwg is set to upwg2d, the signal of poti 2. Inversely, upwg is set to upwg1 in case of a range violation of poti 2. With a synchronization fault (B_upw12e = 1) upwg equals the minimum of poti 1 and poti 2.

FEHL_BED
========

From the individual fault conditions, which indicate upper or lower range violations for both potis and synchro faults, the conditions for the selection of the resulting poti voltage upwg are generated. B_pwgnotfr is set if a range violation or a synchro fault is detected. B_spsmin is set in case of undervoltage, with a faulted detected in the watchdog function as well as in case of range violation of both potis and in case of a range violation of the used poti after a synchro fault. B_sp1s is set if a range violation of poti 2 but no range violation of poti 1 is given. Analogous B_sp2s is set, if a range violation of poti 1 but no range violation of poti 2 is given.

FEHL_AUSW
=========

The calculation of the fault conditions is only active if there is sufficient battery voltage to supply the potis (B_ubpvg = 1). All fault conditions are only set once the respective fault tolerance time has elapsed, then, however, they remain set for the entire current driving cycle. At first an upper range check is performed for upwg1 and upwg2d. If necessary B_upw1mx or B_upw2mx is set. If no fault arises during the upper range check the synchro check is performed during normal operation (see partial function GLEICHL_PR). If in the process a fault is detected a lower range check of both potis takes place. If no non-plausibility resulted in the process or if in the current or the previous driving cycle a high-resistance during idle was detected, B_upw12e is set. Otherwise the fault condition for the lower range violation (B_upw1mn or B_upw2mn) is set. If no upper range violation and no synchro fault is given the high-resistance check at idle is performed during normal operation (see partial function HOP). The concerned irreversible fault bits and the accompanying fault counters are cleared when the fault code memory is cleared. Clearing of a fault bit is only possible, if the fault that has triggered it, is actually not given any longer, i.e. the function no longer detects the fault. Resetting of the irreversible fault bits is only allowed, if SY_BLOOP = 1 has been set.

GLEICHL_PR
==========

During the synchro check of the two potis the deviation of upwg1 and upwg2d is compared with the synchro tolerance. If the deviation is large, B_glf is set. After the specification of the PWG very large transition resistance can occur in the idle range. For this reason, upwg1 and upwg2d are low-limited to UPWG12U prior to the calculation of the deviation. A transition resistance at idle thus does not lead to a synchro fault. Since possible transition resistance may have varying effects in different ranges of the poti track the synchro tolerance is switched dependent on the range between DUPW12 (idle), DUPW12TG (partial throttle) and DUPW12VG (full throttle).

ERR_STATUS
==========

Updating of the determined pedal value is only performed, if no fault is suspected. That means, during fault debouncing always the last valid pedal value is maintained. Only once the fault check has been terminated with selection of the remaining sensor signal or when a fault is no longer suspected, is the pedal value updated again.

HOP
===

The high-resistance check at idle serves to increase the availability when the signal lead of a poti is disconnected. With synchro fault and detected lower range violation of this poti it is possible to use - instead of the minimum of both potis, which would permanently lead to wped = 0 - the other poti for the calculation of the pedal value, provided no high-resistance was detected in the current and in the previous driving cycle.

The high-resistance check is only performed during normal operation if neither an upper range violation nor a synchro fault is given. Should a poti in this state show a lower range violation for a certain time, this is stored (B_hop1mn or B_hop2mn). If both potis again exceed the threshold UPWGTL in the same driving cycle, high-resistance at idle is stored for the concerned poti (B_holp1a or B_holp2a). The two bits are stored in the non-volatile memory for the use in the next driving cycle.

BEW_ERK
=======

The movement detection ensures that a safety-relevant power increase of the engine will only take place if the two potis have moved away from their idle position. A slight drift of poti 1, which cannot be detected by the synchro check is thereby intercepted. The movement detection is only executed during normal operation with sufficient poti voltage supply and it can be deactivated via the code word CWBWEEN.

If poti 1 exits the idle range, after it was there for the time TUPWBWV beforehand, then the latest value of poti 2 is stored. The time condition is important so that in case of short-termed interference no erroneous storage will be performed. The signal of poti 2 is filtered at upward movement, so that in case of short-termed interference no too high value of poti 2 will be stored. If poti 1 exceeds the threshold UPW1BE, poti 2 must have moved by at least DUPW12BE as compared to the stored value upw211. Otherwise B_bwunpl is set.

BEWEG_AUS
=========

If a non-plausibility was detected during the movement detection (B_bwunpl = 1), the lower standard limit is switched to UPWGUBF in the partial function PED_NORM by the setting of B_bwf. UPWGUBF lies so high that when it is exceeded a synchro fault occurs. In case of a drifting poti 1, wped remains at zero until the synchro check responds. B_bwf is reset when poti 1 undershoots the threshold UPW1LLMX.

If the accelerator is operated while B_bwf is set, so that poti 1 exceeds the threshold UPWGUBF, the fault counter ctrbwf is incremented. ctrbwf is decremented, if B_bwf was reset and thereafter by operating the accelerator poti 1 exceeds the threshold UPW1BE. B_pwgbwf is set if the fault counter ctrbwf reaches the value ZBWF, and a fault code memory entry is performed (see partial function DIAG_BWF). When the fault code memory is cleared (fault path BWF), B_bwf is set to false and ctrbwf to zero. Clearing of a fault bit is only possible, if the fault that has triggered it, is actually not given any longer, i.e. the function no longer detects the fault.

ENTJIT
======

So as to avoid a jittering of the pedal value especially with aged PWG the resulting poti voltage upwg is smoothed as follows: If the new value does not deviate by more than DUPWGHY from the old value then the old value is maintained. If the deviation from the old value lies between DUPWGHY and 2*DUPWGHY, the new de-jittered value results by an increase resp. decrease of the old value by DUPWGHY. Only once a deviation of more than 2*DUPWGHY is given is the new value accepted without filtering.

PED_NORM
========

For the conversion of the de-jittered poti voltage to a temporary pedal value the voltage range between lower and upper standard limit is linearly imaged to the range 0 to 100%. The upper standard limit is UPWGO. As lower standard limit UPWGUR , the maximum possible voltage value of poti 1 at idle, is used during normal operation. During PWG limp-home operation UPWGU is used, the maximum possible voltage value of poti 2 at idle. With detected movement fault during normal operation standardization is only performed as of UPWGUBF, which lies higher by the value of the synchro tolerance than UPWGU resp. higher by twice the synchro tolerance than UPWGUR.

PWG_NOTFA
=========

During PWG and throttle sensor limp-home operation the pedal value is immediately set to zero when the brake is applied (B_brems = 1) for safety reasons. When the brake is not applied the pedal value is high-limited to fixed value WPMXNOT. Furthermore a rate-of-change limitation is performed with the maximum permissible pedal-value increase DWPMXNOT per calculation step (so within 10 ms). Alternatively it is possible to preset a maximum indicated torque via the characteristic MIFAMXNOT as function of the engine speed. This maximum indicated torque is used in %MDFAW to limit the indicated desired driver's torque.

Plausibility check brake / PWG:

When SY_PBRPW = 1, additionally a plausibility check between brake and PWG is performed.

If, at normal operation, the brake is operated by the driver (not by FDR) for longer than TWPMBBR, then the pedal value is high-limited to WPMXBR, provided engine speed and speed exceed certain minimum values (NWPMBBR, VWPMBBR). Purpose of this functionality is to defuse a possible mechanical defect of the PWG. The limitation is removed, if wpedv goes back to zero and if it is thereby ensured that pedal idle can be detected. If the limitation is still active when the brake pedal is loosened, the pedal value is is brought to the unlimited value wpedv by means of a rate-of-change limitation (DWPMXNB).

B_br2k is set, if both brake switches detect "brake operated" and if no fault has occurred during the plausibility check of the brake switch. In contrast to this, B_brems is already set, if only one brake switch detects "brake operated" or if a fault was detected during the monitoring of the brake switch (cf. %GGEGAS). For the pedal value limitation at operated brake during normal operation B_br2k is used and not B_brems for availability reasons, so that vehicle is not stalled due to a defective brake switch.

Prevention of misuse:

When BIT2(CWBWEEN)=1 (Bit 2 of CWBWEEN set) additionally a misuse prevention is activated.

An automatic idle presetting takes place, if the NMAX-limitation is active for the time TMBVH when vfzg=0. Withdrawal of this automatic presetting is performed, if wped =< WPRMBVH is detected on driver's request.

Life detection:

When BIT3(CWBWEEN)=1 (Bit 3 of CWBWEEN set) additionally a life detection is activated.

After detected wire interruption at the PWG with selection of the remaining sensor signal (B_sp1s, B_sp2s), an automatic idle presetting is performed for as long as the remaining sensor value was within the idle range for the duration TWPLK. That means the default signal for the wped-formation must lead to wped=0 for at least the time TWPLK to terminate the automatic idle presetting. The limitation is only effective after active fault detection, i.e. the automatic idle presetting always assumes an edge detection at the fault bits B_sp1s resp. B_sp2s (refer to block PWGLK).

CAN_2SG
=======

On projects with two ME control units, the pedal value is adopted in the slave ECU from the CAN. The pedal value is otherwise calculated from the PWG poti signals as explained above.

PWG_DIAG
========

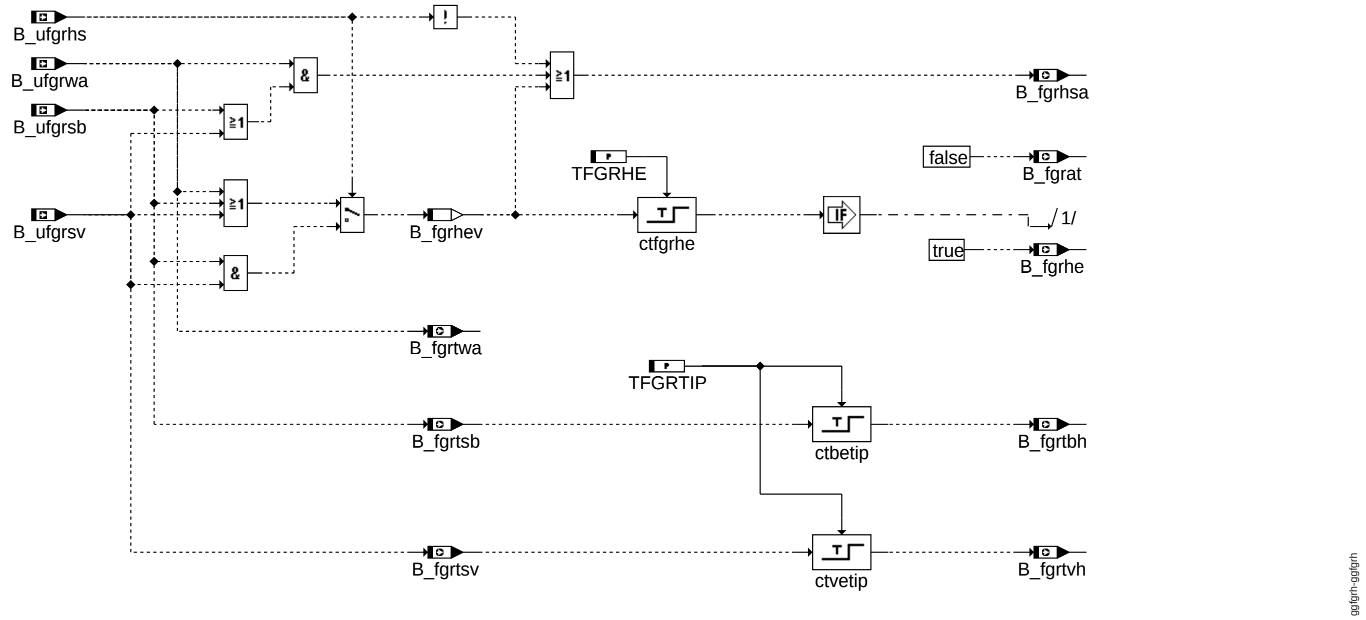
The fault code memory entries FP1P (accelerator 1. poti), FP2P (accelerator 2. poti), BWF (movement detection) and FPP (accelerator poti) are generated in this partial function. The fault path FPP is redundant and can be dropped as soon as E_fpp is no longer scanned in any other function. In case of a synchro fault, for which it cannot be decided which poti is defective (B_upw12e = 1), E_fp1p is set.

APP GGPED 8.30 Application hint

```
The parameters used in this function result from the tolerance calculation.
UPWG12U is to be set less or equal to UPWGUR.

Coding via CWBWEEN
==================

Bit 0
0: Movement detection disabled
1: Movement detection active

Bit 1
0: No limitation of the pedal value at throttle sensor default operation
1: Limitation of the pedal value at throttle sensor default operation (as at PWG default operation)

Bit 2
0: Misuse prevention disabled
1: Misuse prevention active

Bit 3
0: Life detection disabled
1: Life detection active
```

GGFGRH 11.10 Sensor Signals Cruise Control Lever

FDEF GGFGRH 11.10 Function definition



ggfgrh-ggfgrh

ABK GGFGRH 11.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TFGRHE			FW	Delay time for detecting FGR operating-lever fault
TFGRTIP			FW	Time to detect held FGR function key accelerate or decelerate

Variable	Source	Type	Description
B_FGRAT	GGFGRH	AUS	condition: tip-switch off CC lever control
B_FGRHE	GGFGRH	AUS	condition: CC-lever fault
B_FGRHEV	GGFGRH	LOK	Condition: Fault, FGR operating unit (temporary)
B_FGRHSA	GGFGRH	AUS	condition: CC main switch off
B_FGRTBH	GGFGRH	AUS	Condition: FGR switch acceleration held (no Tip)
B_FGRTSB	GGFGRH	AUS	Condition: FGR switch set/accelerate
B_FGRTSV	GGFGRH	AUS	Condition: FGR switch set/decelerate
B_FGRTVH	GGFGRH	AUS	Condition: FGR switch decelerate held (no Tip)
B_FGRTWA	GGFGRH	AUS	condition: Cruise control button RESUME
B_UFGRHS	UFFGRE	EIN	information cruise control level ”main switch ON”
B_UFGRSB	UFFGRE	EIN	information cruise control level ”set / accelerate”
B_UFGRSV	UFFGRE	EIN	information cruise control level ”set / coast”
B_UFGRWA	UFFGRE	EIN	information cruise control level ”resume”
CTBETIP	GGFGRH	LOK	Time counter for Tip detection FGR switch accelerate

Variable	Source	Type	Description
CTFGRHE	GGFGRH	LOK	Time counter to detect FGR operating-lever fault
CTVETIP	GGFGRH	LOK	Time counter for Tip detection FGR switch decelerate

FW GGFGRH 11.10 Fixed Values

Parameter	Value	Description
TFGRHE		Delay time for detecting FGR operating-lever fault
TFGRTIP		Time to detect held FGR function key accelerate or decelerate

FB GGFGRH 11.10 Detailed description of function

The purpose of the function is to process the signals from the vehicle-speed controller (FGR) that are read-in from function monitoring (Level 2) as hardware inputs. The operating lever has the following switches:

o Main switch (indexed)	(B_ufgrhs)
o Tip switch "Set/Accelerate"	(B_ufgrsb)
o Tip switch "Set/Decelerate"	(B_ufgrsv)
o Tip switch "Resumption"	(B_ufgrwa)

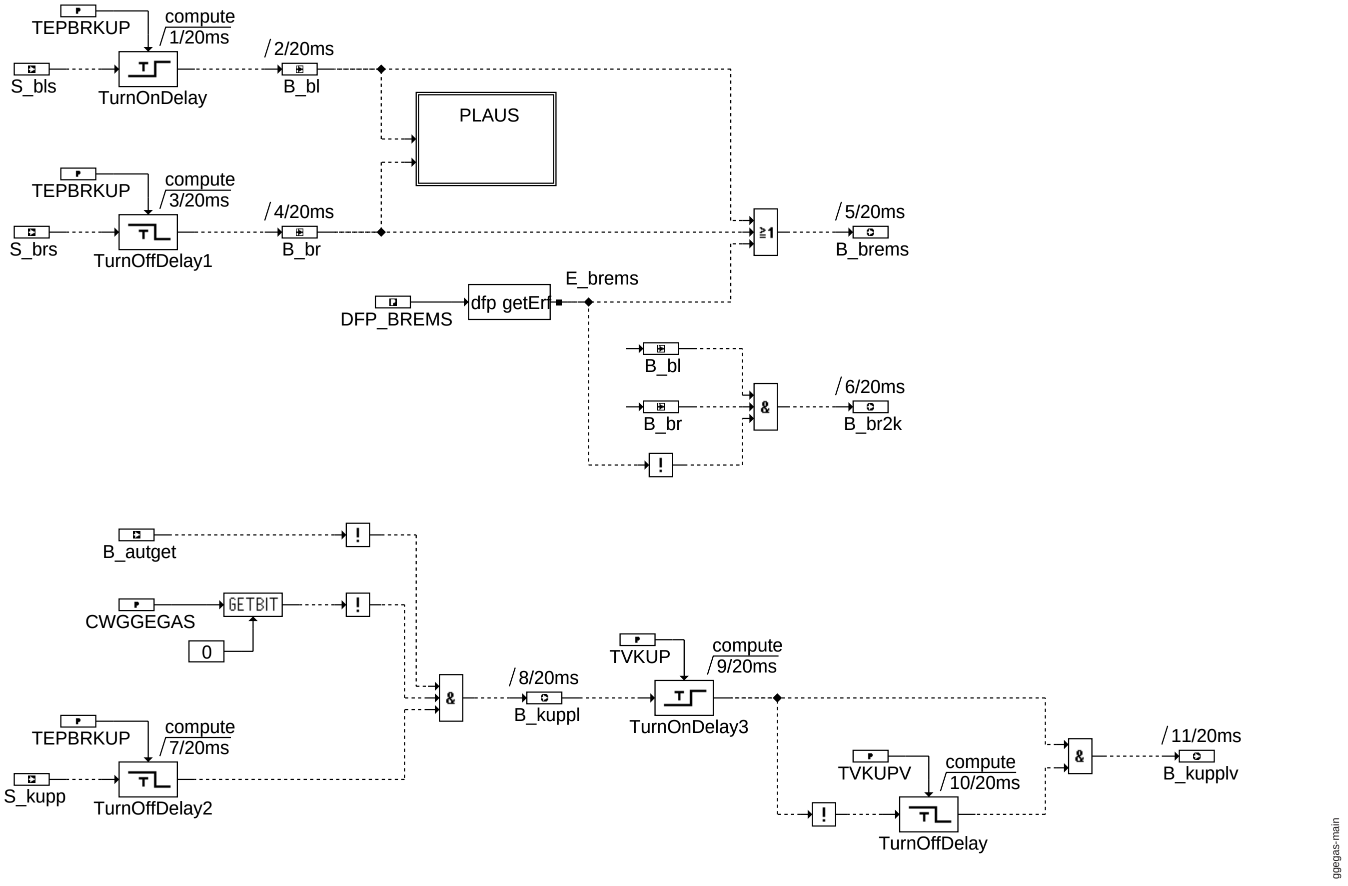
The three tip switches are designed to be in parallel with each other and in series with the main switch.
When the main switch is turned off, there shall therefore be no signal at any of the three tip switches either.
Because of the mechanical configuration of the switches, the tip switch "Set/Accelerate" may not be operate together with the tip switch "Set/Decelerate" when the main switch is activated. The operating-lever fault B_fgrhe is set after elapse of the debounce time TFGRHE in the event of such implausible signals. The vehicle-speed controller is disabled by the main switch if the tip switch "Resumption" is operated at the same time as operating one of the tip switches "Set/Accelerate" or "Set/Decelerate".

The bits B_fgrtbh and B_fgrtvh indicate that the tip switch "Set/Accelerate" or "Set/Decelerate" has been operated for longer than approx. 0.5 s. This leads to a transition in the vehicle-speed controller function control to an acceleration or deceleration ramp, whereas operation for a time less than approx. 0.5 s causes only a one-time increase or decrease of the desired speed. B_fgrtbh and B_fgrtvh are calculated using the time TFGRTIP from B_fgrtsb and B_fgrtsv respectively.

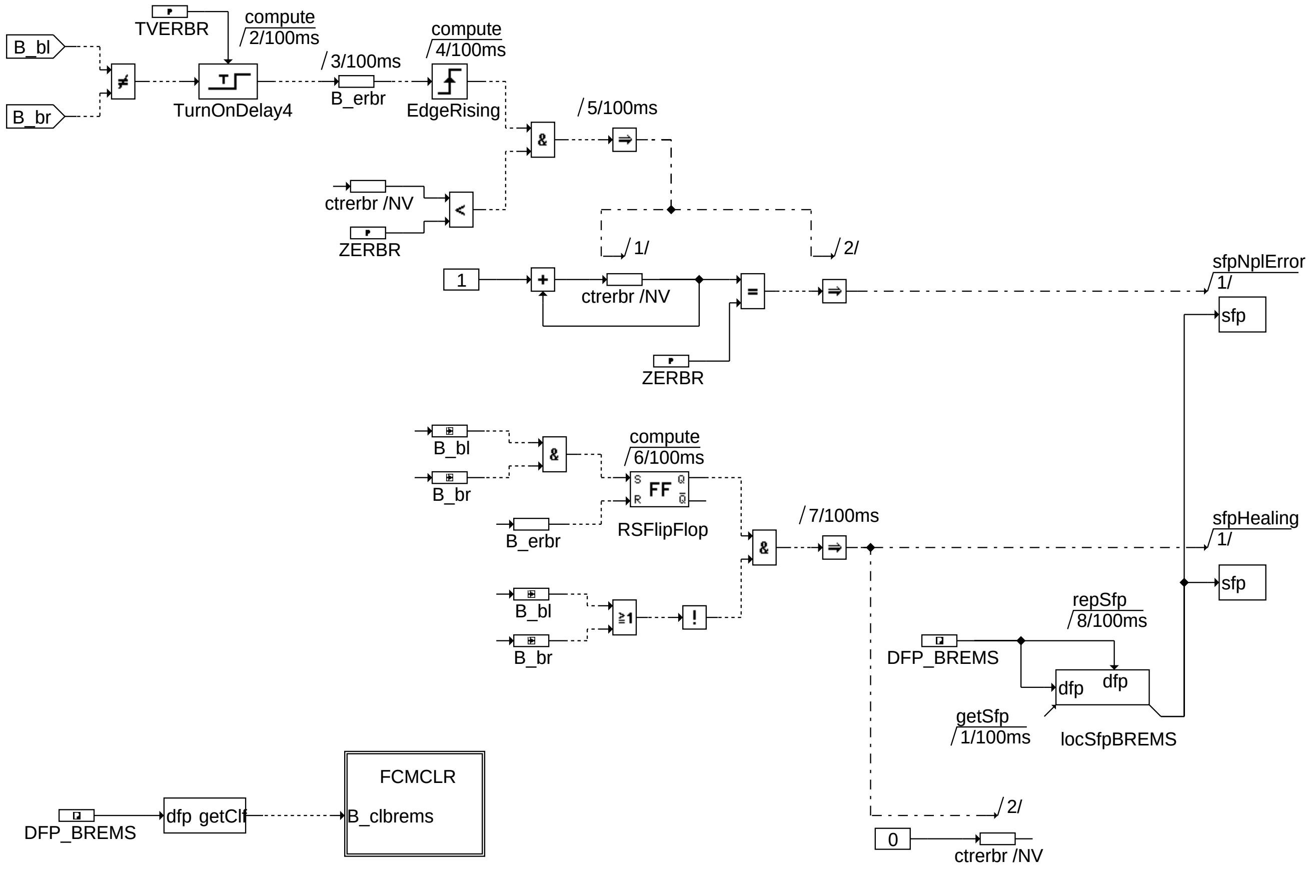
APP GGFGRH 11.10 Application hint

GGEGAS 9.30 Sensor variable for brake and clutch switches

FDEF GGEGAS 9.30 Function definition

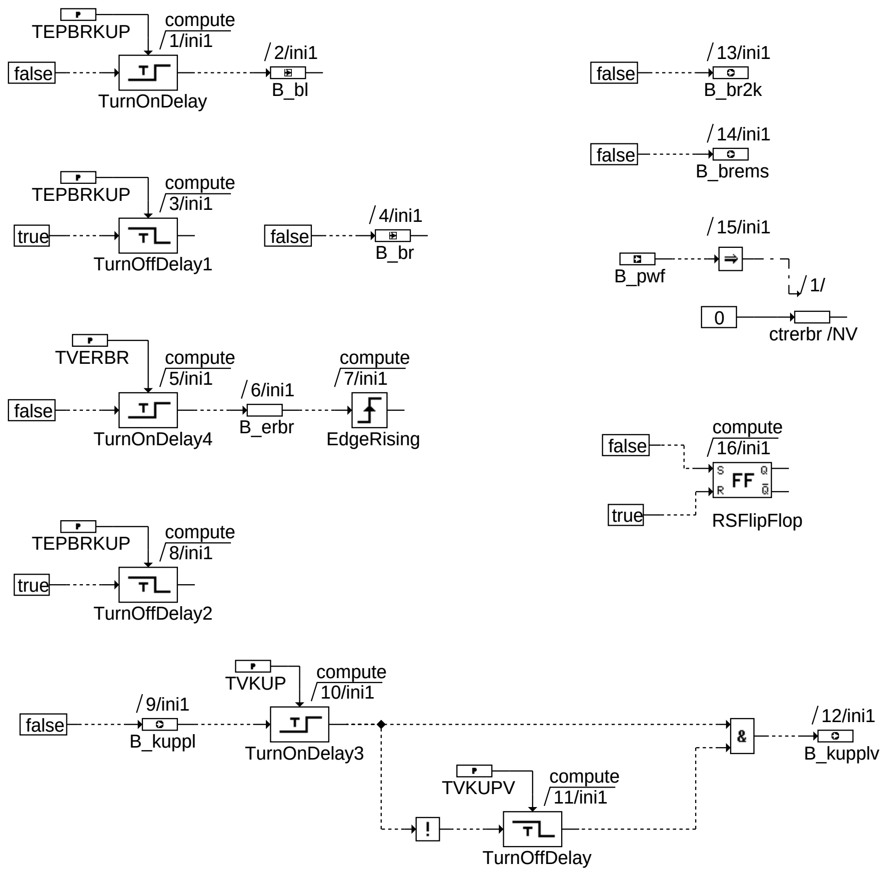


ggegas-main



ggegas-plaus

ggegas-plaus



ggegas-init

ABK GGEGAS 9.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDKBREMS			FW	code word customer: Brake pedal sensor
CDTBREMS			FW	fault path code: brake pedal sensor
CLABREMS			FW	fault class: brake pedal sensor
CWGGEGAS			FW	code word for GGEGAS
TEPBRKUP			FW	debouncing time for brake and clutch switch
TSFBREMS			FW	fault active time: brake pedal sensor
TVERBR			FW	Delay time for brake-switch plausibility check
TVKUP			FW	Delay time for B_kupplv
TVKUPV			FW	delay time for resetting of B_kupplv
ZERBR			FW	Fault counter status for brake-switch implausibility

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_BKBREMS	GGEGAS	LOK	backup value active
B_BL	GGEGAS	LOK	Brake lights switch info: brakes operated
B_BR	GGEGAS	LOK	Brakes switch info: brakes operated
B_BR2K	GGEGAS	AUS	Condition brakes actuated 2-channel detection
B_BREMS	GGEGAS	AUS	condition: brake operated
B_CLBREMS		EIN	condition: clear fault-path BREMS (brake pedal signal)
B_ERBR	GGEGAS	LOK	Condition break switch signals differ
B_KUPPL	GGEGAS	AUS	EGAS Condition cluch is disengaged
B_KUPPLV	GGEGAS	AUS	Condition clutch delayed
B_MNBREMS	GGEGAS	LOK	fault type BREMS (brake):minimum value exceeded
B_MXBREMS	GGEGAS	LOK	fault type BREMS (Bremse): maximum value exceeded
B_NPBREMS	GGEGAS	LOK	fault type BREMS: test result not plausible
B_PWF		EIN	Condition for powerfail
B_SIBREMS	GGEGAS	LOK	fault type BREMS: signal inactiv
CTRERBR	GGEGAS	LOK	Error counter for break switch plausibility check
DFP_BREMS	GGEGAS	DOK	internal fault path number: brake pedal sensor
E_BREMS	GGEGAS	AUS	error flag: brake pedal signal
SFPBREMS	GGEGAS	AUS	status fault path BREMS: brake pedal signal
S_BLS		EIN	brake light switch (true=activated pedal)
S_BRS		EIN	Switch for brake

Variable	Source	Type	Description
S_KUPP		EIN	Clutch switch
Z_BREMS	GGEGAS	AUS	cycle flag: brake pedal signal

FW GGEGAS 9.30 Fixed Values

Parameter	Value	Description
CDKBREMS		code word customer: Brake pedal sensor
CDTBREMS		fault path code: brake pedal sensor
CLABREMS		fault class: brake pedal sensor
CWGGEGAS		code word for GGEGAS
TEPBRKUP		debouncing time for brake and clutch switch
TSFBREMS		fault active time: brake pedal sensor
TVERBR		Delay time for brake-switch plausibility check
TVKUP		Delay time for B_kupplv
TVKUPV		delay time for resetting of B_kupplv
ZERBR		Fault counter status for brake-switch implausibility

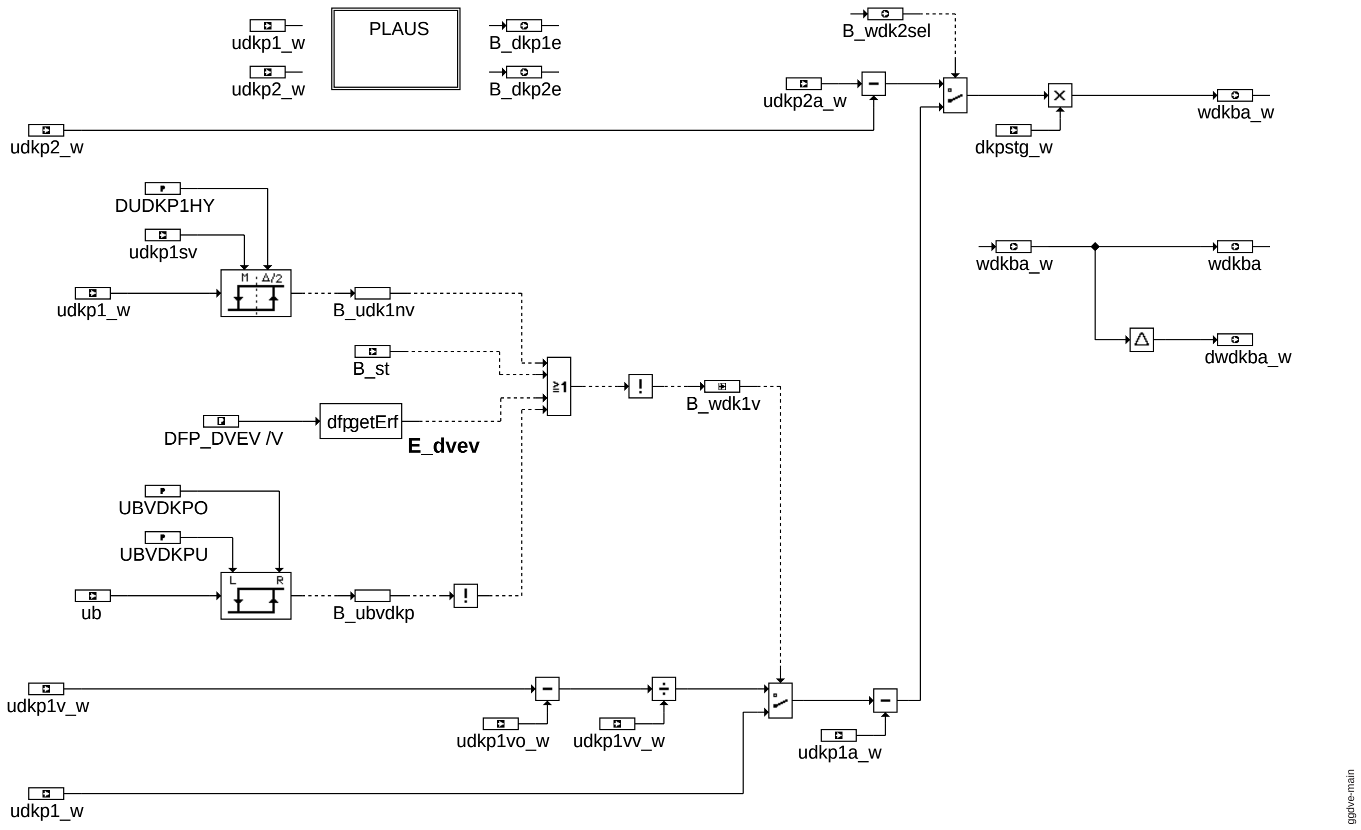
FB GGEGAS 9.30 Detailed description of function

```
 - Connection:
   S_BRS: Switch opens when break is operated. Switch is connected to terminal (KL) 15.
   S_BLS: Switch closes when break is operated. Switch is connected to terminal (KL) 30.

   The operating sequence is not defined

   The input S_kupp does not exist on vehicles with automatic gearbox, the evaluation must then not be calculated.

 - Diagnosis part:
   The two break informations B_br and B_bl may differ for the time TVERBR at the most.
   If this time is exceeded then the error counter is incremented. A break error is set as from the adjustable
   counter state ZERBR.
   The error counter is reset if breaking and non-breaking were successively definitely detected.
```

APP GGEGAS 9.30 Application hint

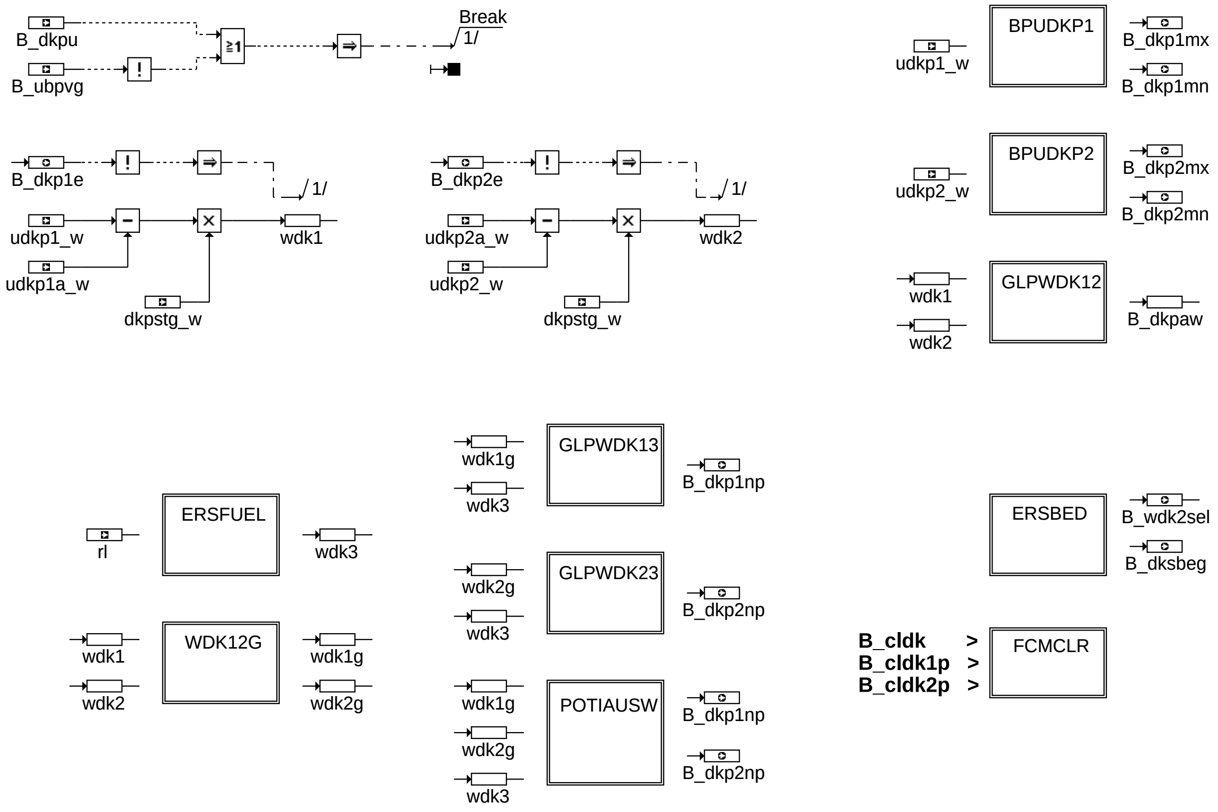
GGDVE 2.40 Sensor variables for throttle-valve actuator

FDEF GGDVE 2.40 Function definition



ggdve-main

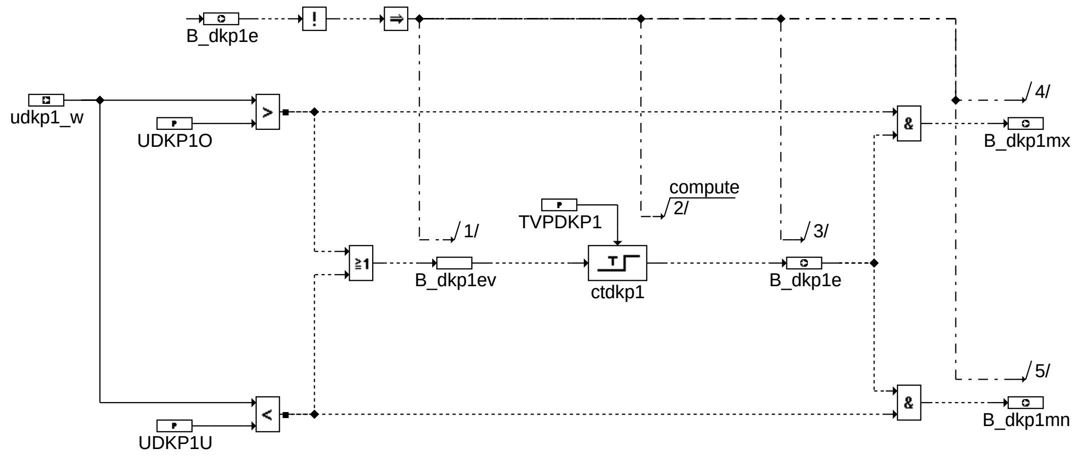
GGDVE: Calculation of the throttle angle



ggdve-plaus

ggdve-plaus

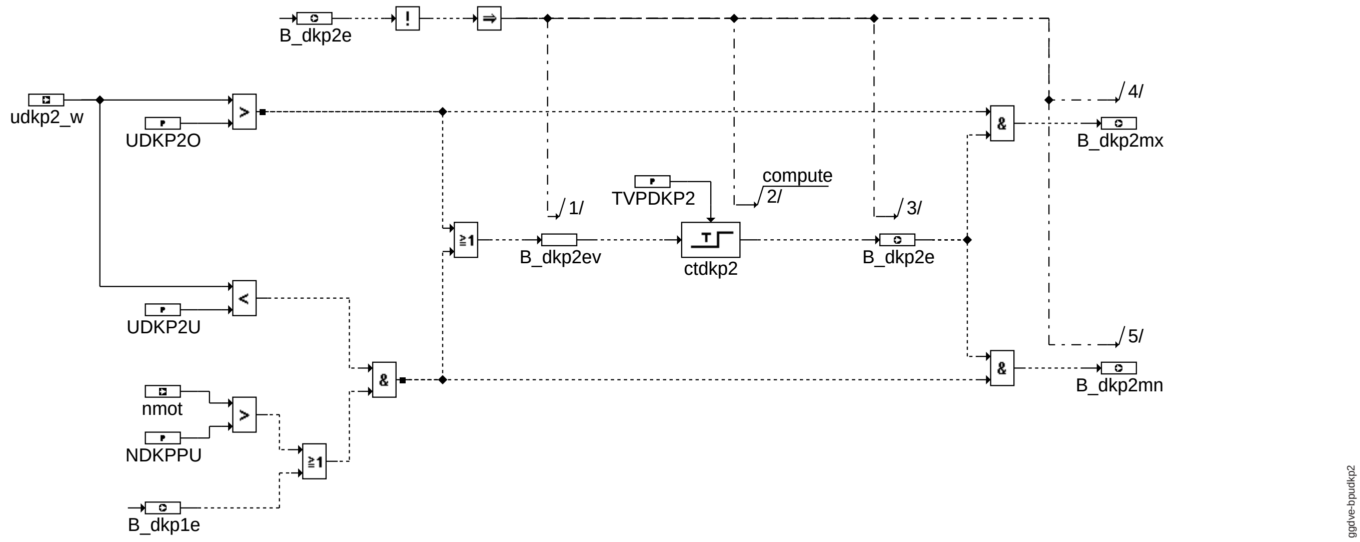
Partial function PLAUS: Overview of the plausibility checks



ggdve-bpudkp1

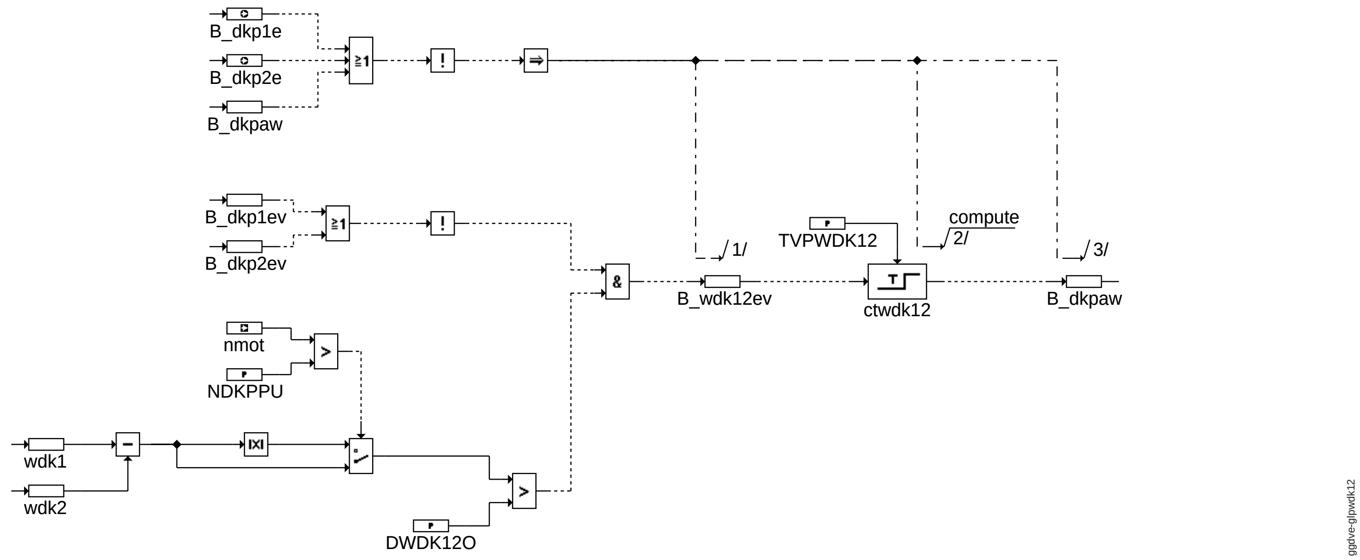
ggdve-bpudkp1

`Partial function BPUDKP1: Range check for throttle poti 1`



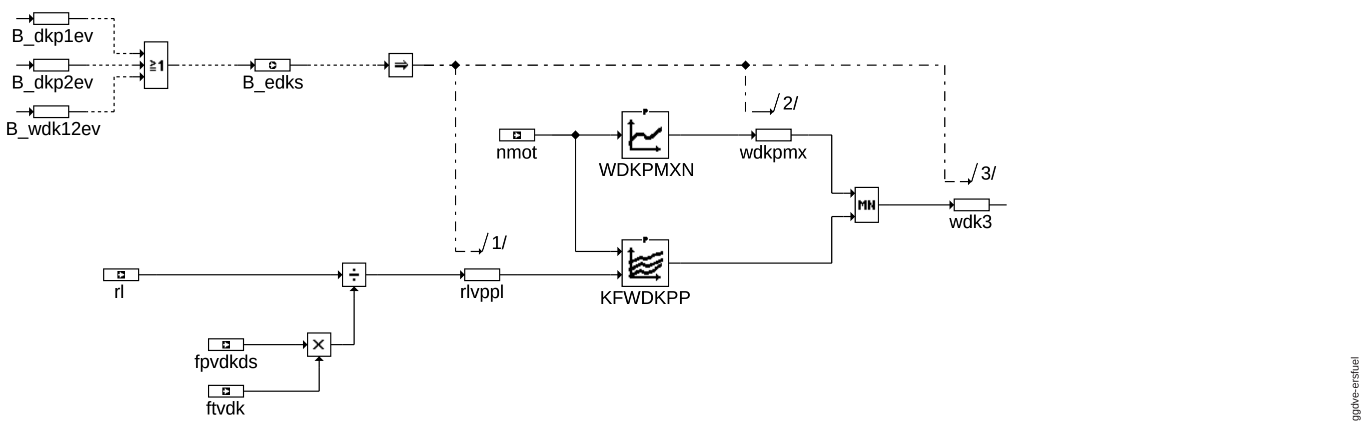
ggdve-bpudkp2

`Partial function BPUDKP2: Range check for throttle poti 2`



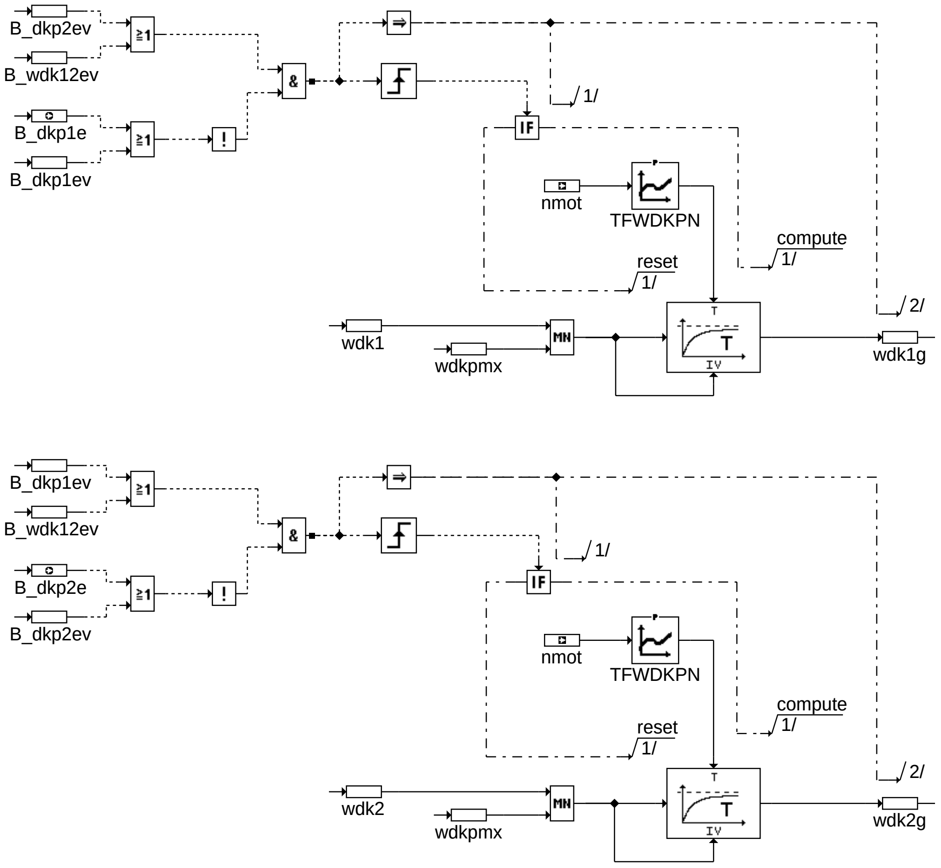
ggdve-glpwdk12

`Partial function GLPWDK12: Synchronization check between throttle poti 1 and 2`



ggdve-ersfuel

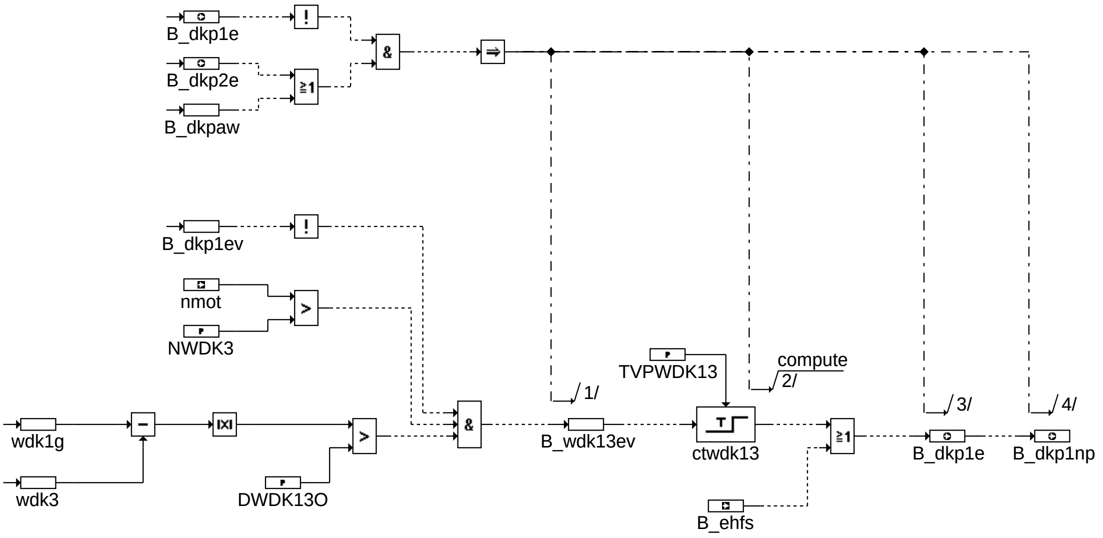
`Partial function ERSFUEL: Calculation of the throttle-angle default value from the charge signal`



ggdve-wdk12g

ggdve-wdk12g

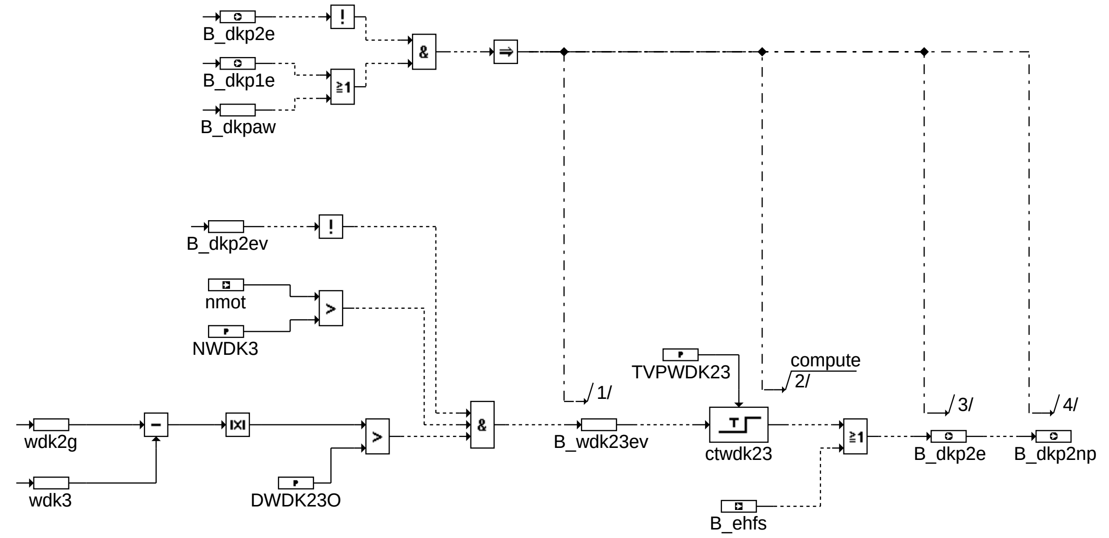
`Partial function WDK12G: Limitation and filtering of the throttle angles for comparison with default value from charge`



ggdve-glpwdk13

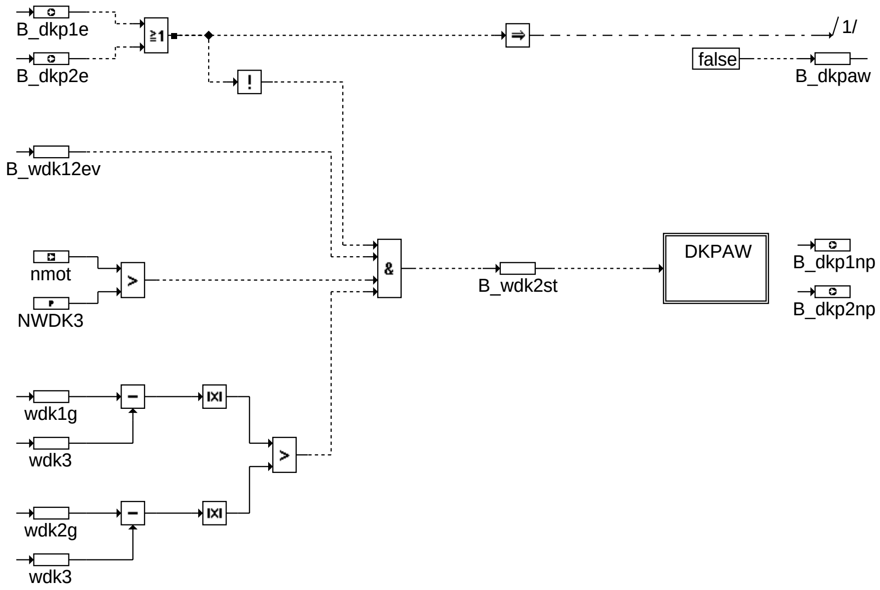
ggdve-glpwdk13

`Partial function GLPWDK13: Synchronization check between throttle poti 1 and default value from charge`



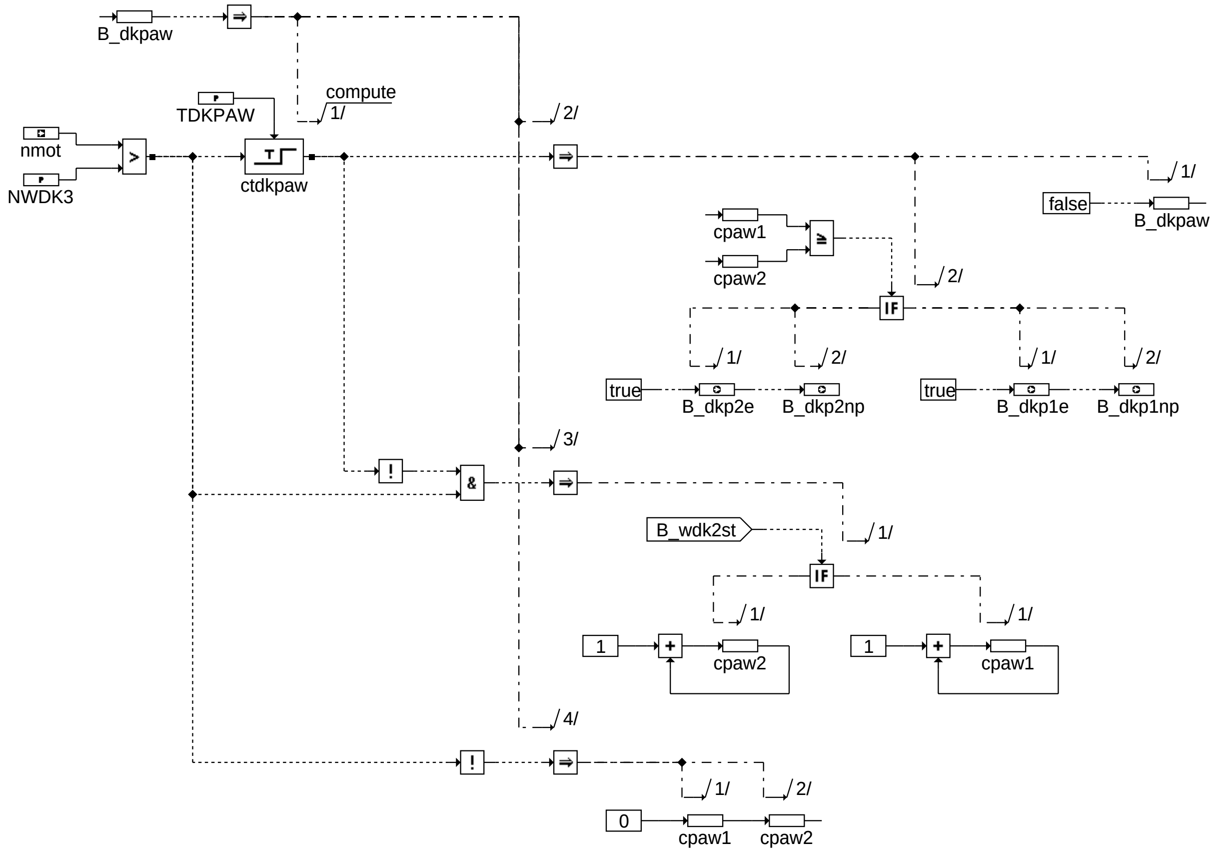
ggdve-glpwdk23

`Partial function GLPWDK23: Synchronization check between throttle poti 2 and default value from charge`



ggdve-potiausw

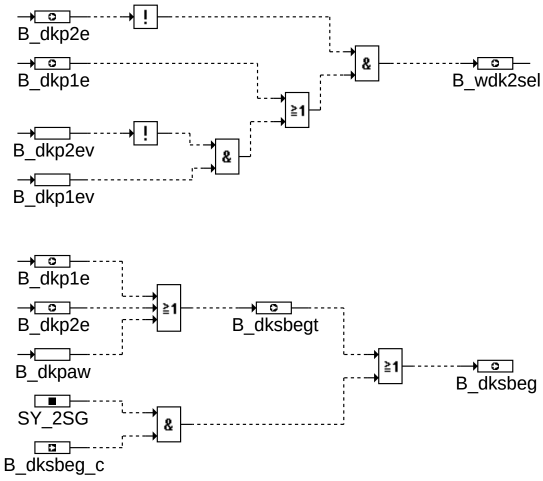
`Partial function POTIAUSW: Selection of the intact throttle poti for TP sensor default operation`



ggdve-dkpaw

ggdve-dkpaw

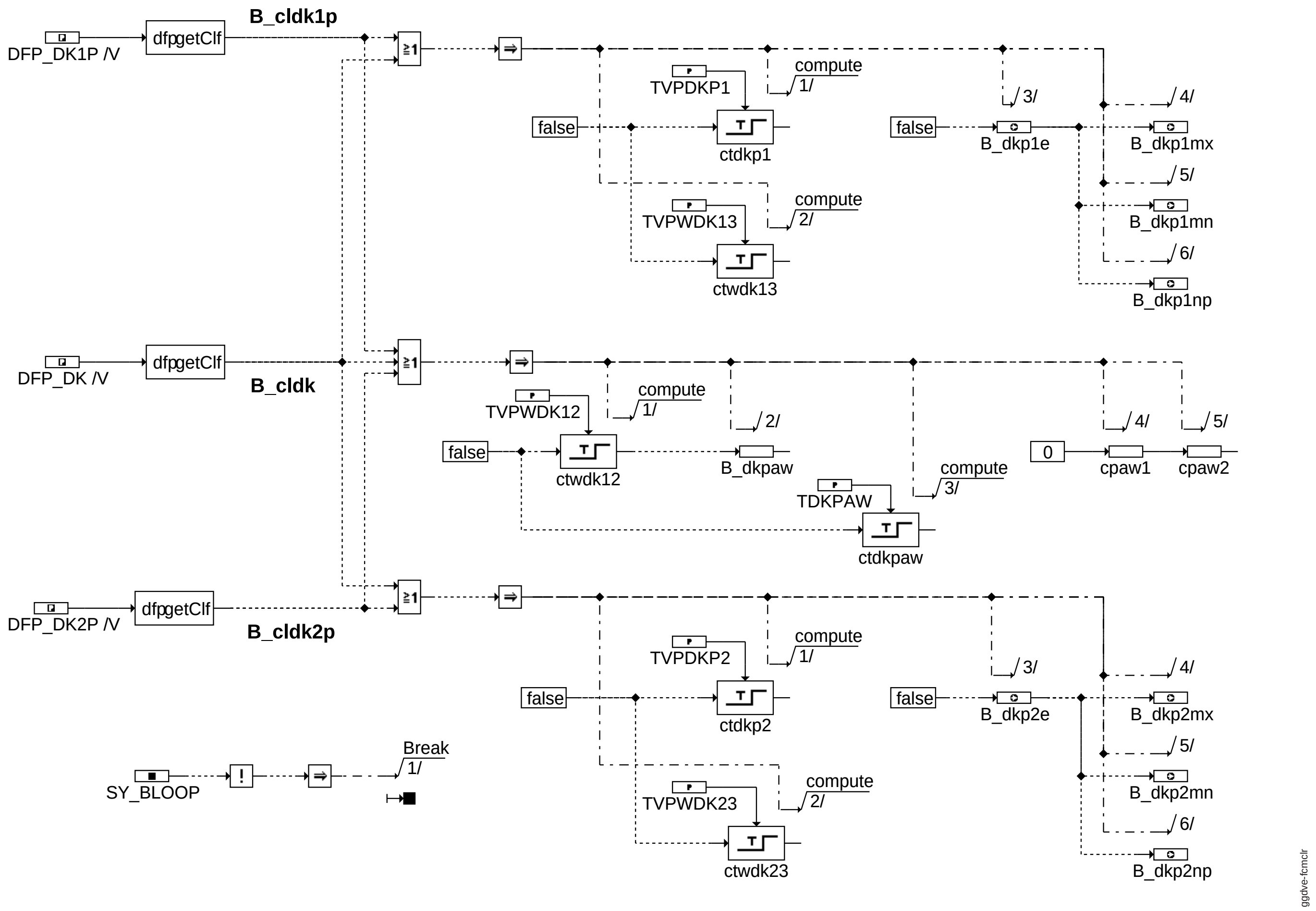
`Partial function DKPAW: Calculation and evaluation of the counters for throttle-poti selection`



ggdve-ersbed

ggdve-ersbed

`Partial function ERSBED: Calculation of the conditions for TP sensor default operation`



ggdve-fcmclr

`Partial function FCMCLR: Measures when clearing the fault code memory`

ABK GGDVE 2.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DUDKP1HY			FW	offset of hysteresis for switching to amplified throttle poti 1 signal
DWDK12O			FW	max. permissible difference between throttle-valve angles from pot's 1 and 2
DWDK13O			FW	max. permissible difference between throttle-valve angles from pot's 1 and 3
DWDK23O			FW	max. permissible difference between throttle-valve angles from pot's 2 and 3
KFWDKPP	NMOT	RLVPPL	KF	throttle blade position dependent on air charge signal
NDKPPU			FW	lower limit of engine speed for throttle poti plausibility check
NWDK3			FW	Minimum engine speed for calculation of throttle angle default value from charge
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_BLOOP			SYS (REF)	sys. con. resetting of irreversible EGAS fault possible during clearing of FCM
TDKPAW			FW	time for throttle-valve potentiometer selection
TFWDKPN	NMOT		KL	time constant for filtering DK angle before comp. with subs. value from charging
TVPDKP1			FW	delay time for recognition of implausible signal from throttle potentiometer 1
TVPDKP2			FW	delay time for recognition of implausible signal from throttle potentiometer 2
TVPWDK12			FW	Fault-tolerance time for checking synchronouso operation of DK potentiometers
TVPWDK13			FW	fault-tol. time checking sync.-operation pot. 1 and subs. value from charging
TVPWDK23			FW	fault-tol. time checking sync. operation DK-pot. 2 and subs. value from charging
UBVDKPO			FW	batt. voltage threshold for using amplified signal from DK-potentiometer 1
UBVDKPU			FW	batt. voltage threshold for using non-amplified signal from DK-potentiometer 1
UDKP1O			FW	maximum permissible voltage from throttle potentiometer 1
UDKP1U			FW	minimum permissible voltage from throttle potentiometer 1
UDKP2O			FW	maximum permissible voltage from throttle potentiometer 2
UDKP2U			FW	minimum permissible voltage from throttle potentiometer 2
WDKPMXN	NMOT		KL	maximum throttle angle for plausibility check with charge signal

Variable	Source	Type	Description
B_CLDK		EIN	condition: clear error throttle potentiometer
B_CLDK1P		EIN	Flag for clearing measures: throttle valve (DK) potentiometer 1
B_CLDK2P		EIN	Flag for clearing measures: throttle valve (DK) potentiometer 2
B_DKP1E	GGDVE	AUS	condition: defect in throttle actuator potentiometer 1
B_DKP1EV	GGDVE	LOK	Condition temporary violation of range, DK potentiometer 1
B_DKP1MN	GGDVE	AUS	Condition lower-range violation DK potentiometer 1

Variable	Source	Type	Description
B_DKP1MX	GGDVE	AUS	Condition upper-range violation DK potentiometer 1
B_DKP1NP	GGDVE	AUS	Condition signal DK potentiometer 1 not plausible
B_DKP2E	GGDVE	AUS	condition: defect in throttle actuator potentiometer 2
B_DKP2EV	GGDVE	LOK	Condition temporary range violation throttle potentiometer 2
B_DKP2MN	GGDVE	AUS	Condition: lower-range violation DK potentiometer 2
B_DKP2MX	GGDVE	AUS	Condition: upper-range violation DK potentiometer 2
B_DKP2NP	GGDVE	AUS	Condition: signal DK potentiometer 2 not plausible
B_DKPAW	GGDVE	LOK	Condition DK-potentiometer selection for DK-sensor standby operation
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKSBEG	GGDVE	AUS	condition: limiting throttle-valve setpoint value
B_DKSBEGT	GGDVE	AUS	condition: limiting DK setpoint value (for CAN for 2-ECU applications)
B_DKSBEG_C		EIN	condition: limiting DK setpoint value from other ECU by CAN
B_EDKS	GGDVE	AUS	Condition fault in throttle-valve sensor
B_EHFS	DHFM	EIN	Condition substitude value main charge sensor
B_ST	SWADAP	EIN	condition for start
B_UBPVG	ADVE	EIN	condition: battery voltage sufficient for 5-V potentiometer supply
B_UBVDKP	GGDVE	LOK	Condition battery voltage sufficient for amplification of DK potentiometer 1
B_UDK1NV	GGDVE	LOK	Condition voltage of DK potentiometer 1 above the amplification range
B_WDK12EV	GGDVE	LOK	Condition temporary synchronization fault in throttle potentiometer
B_WDK13EV	GGDVE	LOK	Condition temporary non-plausibility between throttle poti 1 and default value f
B_WDK1V	GGDVE	LOK	Condition: amplified signal from potentiometer 1 used to calc. throttle angle
B_WDK23EV	GGDVE	LOK	Condition temporary non-plausibility between throttle poti 2 and default value f
B_WDK2SEL	GGDVE	AUS	Condition: DV-E position control is performed with actual-value-poti 2
B_WDK2ST	GGDVE	LOK	Condition throttle-angle calculation for position controller temporary from poti
CPAW1	GGDVE	LOK	Counter for potentiometer 1 for DK potentiometer selection
CPAW2	GGDVE	LOK	Counter for potentiometer 2 for DK potentiometer selection
DFP_DK	GGDVE	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_DK1P	GGDVE	DOK	ECU int. fault path no.:
DFP_DK2P	GGDVE	DOK	ECU int. fault path no.:
DFP_DVEV	GGDVE	DOK	ECU int. fault path no.: DV-E fault in amplifier adjustment
DKPSTG_W	BGDVE	EIN	slope of throttle potentiometer (% DK / V)
DWDKBA_W	GGDVE	AUS	gradient of actual throttle blade position
E_DVEV	DDVE	EIN	Error flag: DV-E cause of failure: amplifier adjustment
FPVDKDS	BGPU	EIN	Factor pressure in front of throttle valve of pressure sensor
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RLVPPL	GGDVE	LOK	relative density-corrected air charge for calc. throttle-angle standby value
UB	SWADAP	EIN	battery voltage
UDKP1A_W	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop (word)
UDKP1SV	BGDVE	EIN	Max. DK potentiometer-1 value for using amplified signal
UDKP1VO_W	BGDVE	EIN	voltage offset of DK potentiometer 1 amplification charcteristic
UDKP1VV_W	BGDVE	EIN	amplification of throttle potentiometer 1
UDKP1V_W		EIN	amplified sensor voltage throttle potentiometer 1
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2A_W	BGDVE	EIN	sensor voltage throttle potentiometer 2 at (lower) mechanical stop
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
WDK1	GGDVE	LOK	Throttle angle from potentiometer 1
WDK1G	GGDVE	LOK	Throttle angle from pot. 1 limited & filtered for comparison with backup value
WDK2	GGDVE	LOK	Throttle angle from potentiometer 2
WDK2G	GGDVE	LOK	Throttle angle from pot. 2 limited & filtered for comparison with backup value
WDK3	GGDVE	LOK	throttle blade position dependent on air charge signal
WDKBA	GGDVE	AUS	throttle angle
WDKBA_W	GGDVE	AUS	throttle angle with respect to lower mechanical stop
WDKPMX	GGDVE	LOK	Maximum throttle angle for plausibility check with charge signal

FW GGDVE 2.40 Fixed Values

Parameter	Value	Description
DUDKP1HY		offset of hysteresis for switching to amplified throttle poti 1 signal
DWDK12O		max. permissible difference between throttle-valve angles from pot’s 1 and 2
DWDK13O		max. permissible difference between throttle-valve angles from pot’s 1 and 3
DWDK23O		max. permissible difference between throttle-valve angles from pot’s 2 and 3
NDKPPU		lower limit of engine speed for throttle poti plausibility check
NWDK3		Minimum engine speed for calculation of throttle angle default value from charge
TDKPAW		time for throttle-valve potentiometer selection
TVPDKP1		delay time for recognition of implausible signal from throttle potentiometer 1
TVPDKP2		delay time for recognition of implausible signal from throttle potentiometer 2
TVPWDK12		Fault-tolerance time for checking synchronouso operation of DK potentiometers
TVPWDK13		fault-tol. time checking sync.-operation pot. 1 and subs. value from charging
TVPWDK23		fault-tol. time checking sync. operation DK-pot. 2 and subs. value from charging
UBVDKPO		batt. voltage threshold for using amplified signal from DK-potentiometer 1
UBVDKPU		batt. voltage threshold for using non-amplified signal from DK-potentiometer 1
UDKP1O		maximum permissible voltage from throttle potentiometer 1
UDKP1U		minimum permissible voltage from throttle potentiometer 1
UDKP2O		maximum permissible voltage from throttle potentiometer 2
UDKP2U		minimum permissible voltage from throttle potentiometer 2

FB GGDVE 2.40 Detailed description of function

The throttle angle is sensed by two potentiometers (poti 1 and poti 2), which are supplied together by the control unit with 5V. By a suitable connection poti 1 possesses a rising characteristic (i.e. larger poti voltage means larger throttle angle) and poti 2 possesses a falling characteristic (i.e. larger poti voltage means smaller throttle angle). One also refers to crossed characteristics. The different characteristics are necessary to possibly be able to detect a short-circuit of the poti signal lines. In case of a line interruption of one of the two signal lines the respective poti signal is taken to a value by the input resistance in the control unit, which signalizes a fully open throttle valve. So poti 1 is drawn towards 5V, poti 2 towards 0. The size of the input resistance resembles a compromise between insensitivity against transition resistance at the poti and the possibility to detect an interruption of the signal line.

So as to be able to adjust the demanded idle speed as exact as possible via the charge a higher resolution of the actual value is necessary in the region of smaller throttle angles. For this purpose the voltage signal of poti 1 is amplified by about factor 4 by means of an analog circuit in the control unit, which makes it possible to increase the resolution of 10 bit given by the A/D converter by 2 bit. When calculating the throttle angle from the amplified signal a resolution of about 0,025 degrees thus results, when using the non-amplified signal in the region of larger throttle angles the resolution will only be about 0,1 degrees. During normal operation always poti 1 servers for the calculation of the throttle angle and poti 2 for the monitoring of poti 1.

In order to prevent a non-desired power increase due to a too far open throttle valve or a stalling of the engine due to an erroneously too far closed throttle valve in case of a single fault, a plausibility check is performed on the two poti signals. During the range check the mechanically not accessible voltage ranges are used for the detection of short-circuits and line interruptions. The upper and lower range check is constantly active for the master poti (poti, from which the throttle angle is calculated, during normal operation poti 1). Signal falsifications by transition resistance are not permanently effective here, since they lead to a movement of the throttle valve due to the closed position control loop. With poti 2 the upper range check is continuously active during normal operation, whereas the lower range check only becomes active outside of the idle range due to possible signal falsifications by transition resistance. The engine speed serves as criterion for the detection of the idle range. With definitely detected faults at a poti the respective range check is no longer performed. If a fault is detected at a poti during the range check a transition into the TP sensor default operation is performed, in the process of which the remaining intact poti is monitored with the charge signal. If a range violation has occurred at both potis, SKA (safety fuel deactivation) is triggered due to the unknown throttle angle.

For the synchronization check each throttle angle is calculated from poti 1 and poti 2 by taking into consideration the learning values at the lower mechanical limit stop. The two calculated throttle angles must lie within a certain tolerance due to the mechanical coupling of both potis. Also the synchronization check is only active one-sided outside of the idle range at poti 2 due to possible signal falsifications by transition resistance. The synchronization check is only performed for as long as no fault is detected at one of the two potis. In case of a synchronization fault the defective poti is determined by comparison of the throttle angle calculated from the two poti signals with the charge signal. Thereafter TP sensor default operation with the intact poti is performed, monitored by the charge signal.

For the selection of the intact poti in case of a synchronization fault and for the monitoring at TP sensor default operation a default value is determined for the throttle angle from the charge signal, which is stored in a map. In the process the pressure and temperature influence is also taken into consideration besides the engine speed. Since a definite relation between charge and throttle angle during unthrottled operation is no longer given, respective limitation is performed. For the comparison with the thus determined default value the throttle angles calculated from the poti signals are not used directly. Instead the dynamic behavior of the intake manifold is approximated by filtering of the throttle angle calculated from the poti signals with an engine speed-dependent time constant. The necessary tolerances and fault tolerance times can be reduced in this way. Monitoring of the throttle angle by the charge signal is no longer possible with a fault of the main load sensor. In this case SKA is triggered as soon as a definite range or synchronization fault occurs at the throttle potis.

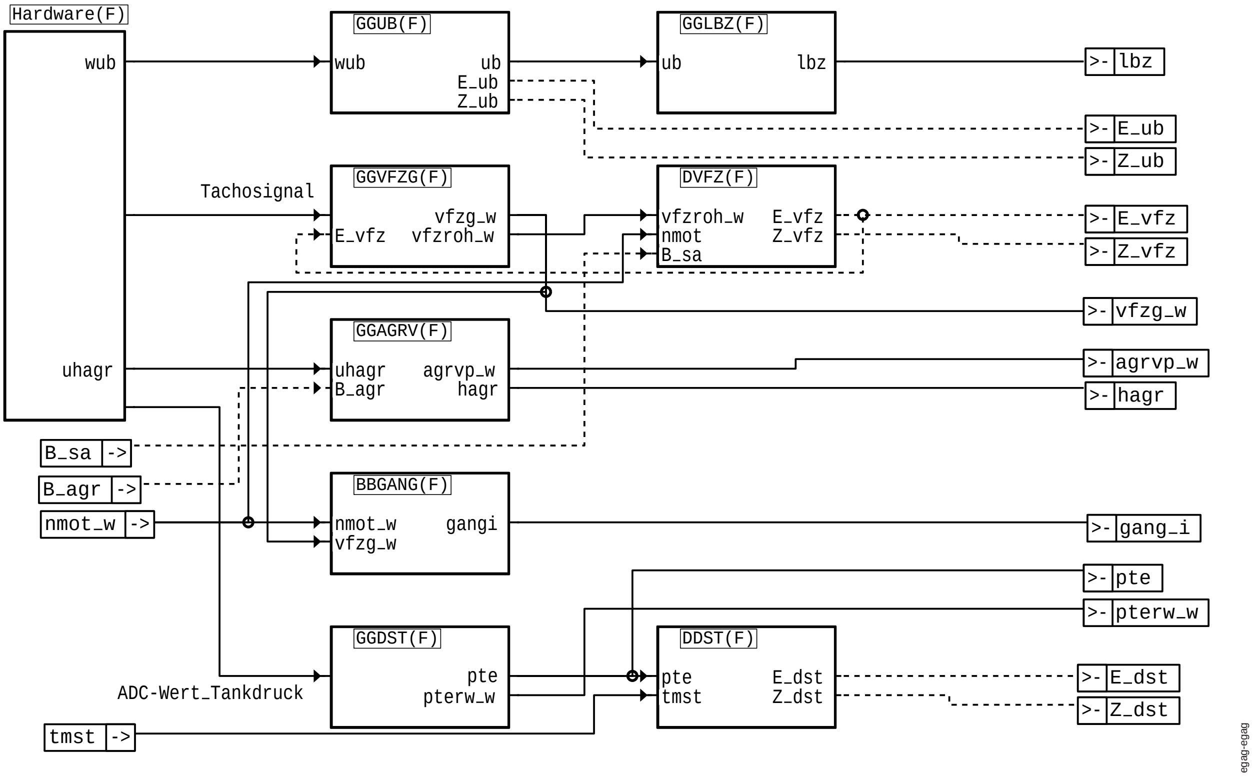
Explanations:

UMA:	Lower mechanical throttle limit stop (leakage air <= 4,8 kg/h)
UEA:	Lower electrical throttle limit stop (leakage air ca. 7,2 kg/h)
UDKPAOFF:	Standard setting 25,6 mV -> 0,538 Grad DK
OEA:	Upper electrical throttle limit stop
OMA:	Upper mechanical throttle limit stop
UIP:	Voltage of actual-value poti % of 5 Volt
udkp1:	Voltage of actual-value poti in Volt
wdkba:	Actual throttle angle in % of the maximum opening, related to the UEA

APP GGDVE 2.40 Application hint

EGAG 2.0 General inputs

FDEF EGAG 2.0 Function definition



egag-egag

Responsible:

ABK EGAG 2.0 Abbreviations

Variable	Source	Type	Description
AGRVP_W	EGAG	AUS	EGR- valve position, 16bit
B_AGR		EIN	Condition AGR active
B_SA	MDRED	EIN	Condition fuel cut-off
DRUCK	EGAG	LOK	fed, unevaluated intake-manifold pressure
E_DST	EGAG	AUS	error flag: tank pressure sensor
E_UB	EGAG	AUS	error flag: power supply voltage UB
E_VFZ	EGAG	AUS	Error flag: vehicle speed signal
GANGI	EGAG	LOK	Engaged gear
GANG_I	EGAG	AUS	current gear
HAGR	EGAG	AUS	Stroke EGR valve
LBZ	EGAG	AUS	charge state of the battery
NMOT	EGAG	LOK	engine speed
NMOT_W	SWADAP	EIN	engine speed
PTE	EGAG	AUS	tank pressure (from ADC)
PTERW_W	EGAG	AUS	tank pressure rough value (16 bit)
TMST	GGTFM	EIN	engine temperature at start
UB	EGAG	LOK	battery voltage
UHAGR	EGAG	LOK	Voltage potentiometer EGR valve after ADC
VFZG_W	EGAG	AUS	Vehicle speed
VFZROH_W	EGAG	LOK	vehicle speed output value to scan tool
WUB	EGAG	LOK	battery voltage; scanned value of ADC
Z_DST	EGAG	AUS	cycle flag: pressure sensor gasoline tank
Z_UB	EGAG	AUS	cycle flag: power supply voltage UB
Z_VFZ	EGAG	AUS	cycle flag: vehicle speed signal

FW EGAG 2.0 Fixed Values

Parameter	Value	Description

FB EGAG 2.0 Detailed description of function

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Description is missing !!!!

Responsible:
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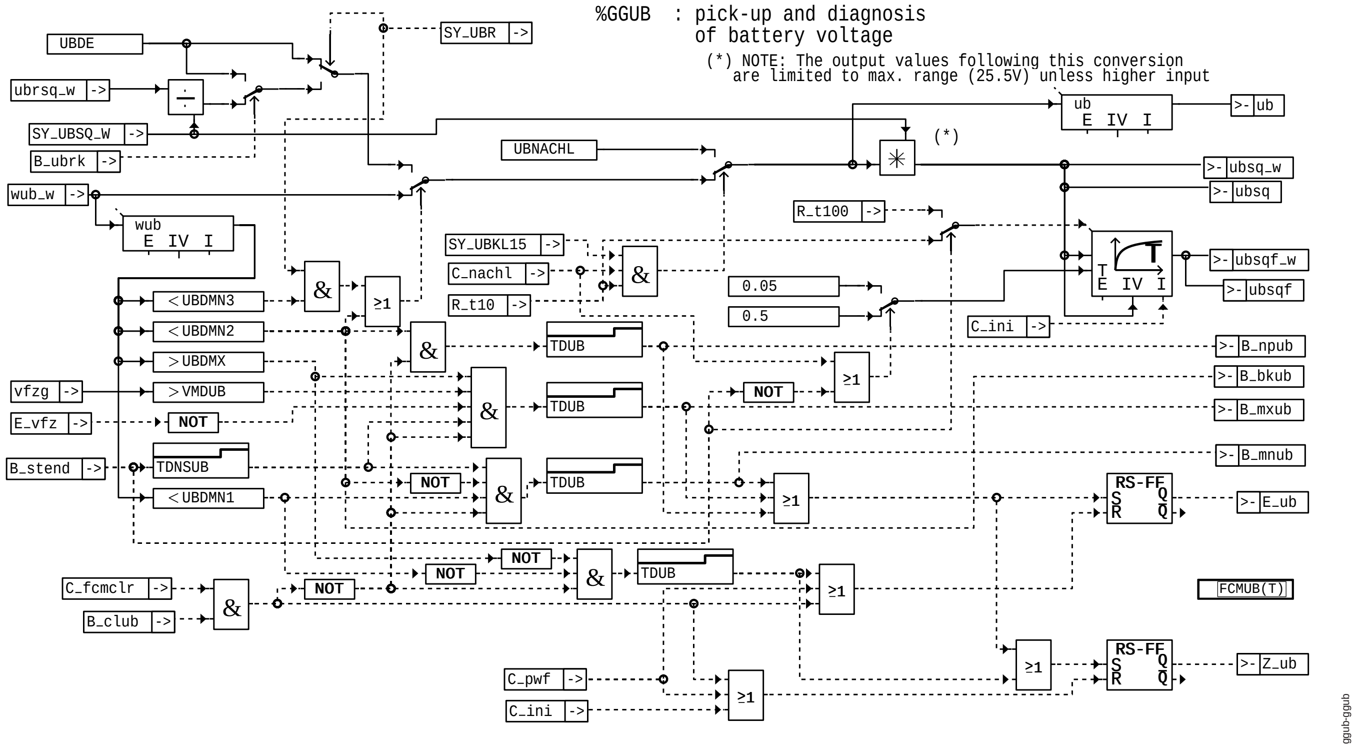
APP EGAG 2.0 Application hint

GGUB 11.30 Sensor variable for battery voltage incl. diagnosis

FDEF GGUB 11.30 Function definition



ggub-ggub

```
Fault memory management:
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Status fault path UB:   SFPUB
Error flag UB:          E_ub
Cycle flag UB:          Z_ub
Fault type UB:          B_mxub
                        B_mnub
                        B_npub
               (B_siub)


Reset fault path:      C_fcmclr & B_club
Fault path UB:                     CDTUB
Fault class UB:                    CLAUB
Fault rate UB:                     TSFUB
Carb Code UB:                      CDCUB
Freeze frame table ub:             FFTUB
```

ABK GGUB 11.30 Abbreviations

ABK GGUB 11.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCUB	BLOKNR		KL	code word CARB: battery voltage UB (onboard)
CDTUB			FW	code word tester: power supply voltage UB
CLAUB			FW	error class: battery voltage UB (onboard)
FFTUB	BLOKNR		KL	freeze frame table: battery voltage UB (onboard)
TDNSUB			FW	time period for battery after start
TDUB			FW	delay time of voltage diagnosis
TSFUB			FW	fault active time: battery voltage UB (onboard)
UBDE			FW	replace value for UBATT at damaged AD-channel
UBDMN1			FW	min. battery voltage (power supply)
UBDMN2			FW	min. battery voltage (ADC)
UBDMN3			FW	battery voltage, lower threshold to take over value for delayed power down

Parameter	Source-X	Source-Y	Type	Description
UBDMX			FW	max. battery voltage
UBNACHL			FW	UB-replace value during ECU afterrun
VMDUB			FW	Lower threshold of vehicle speed for battery voltage diagnosis

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_BKUB	GGUB	AUS	condition backup value for battery voltage (onboard)
B_CLUB		EIN	condition clear fault path battery voltage (onboard)
B_MNUB	GGUB	AUS	fault type: minimum value of battery voltage (onboard)
B_MXUB	GGUB	AUS	fault type: maximum value battery voltage (onboard) exceeded
B_NPUB	GGUB	AUS	Error type: signal of battery voltage not plausible
B_STEND	BBSTT	EIN	condition end of start
B_UBRK		EIN	condition main relay contact fault
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_UB	GGUB	AUS	error flag: power supply voltage UB
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SFPUB	GGUB	AUS	status fault path: battery voltage UB (onboard)
SY_UBKL15		EIN	system constant onboard battery voltage scanned from ignition key on input
SY_UBR	PROKON	EIN	system constant onboard battery voltage scanned from main relay input
SY_UBSQ_W		EIN	System constant conversion factor UB resolution to standard quantization ubsq
UB	GGUB	AUS	battery voltage
UBRSQ_W		EIN	battery voltage (word) via main relay, standard quantization
UBSQ	GGUB	AUS	battery voltage (on board), conversed to standard quantization
UBSQF	GGUB	AUS	battery voltage (on board), conversed to standard quantization and low pass filt
UBSQF_W	GGUB	AUS	battery voltage (on board), conversed to standard quantization and low pass filt
UBSQ_W	GGUB	AUS	battery voltage (on board), conversed to standard quantization
VFZG	SWADAP	EIN	vehicle speed (km/h)
WUB	GGUB	LOK	battery voltage; scanned value of ADC
WUB_W		EIN	battery voltage; scanned value of ADC (16Bit from 10Bit resolution)
Z_UB	GGUB	AUS	cycle flag: power supply voltage UB

FW GGUB 11.30 Fixed Values

Parameter	Value	Description
CDTUB		code word tester: power supply voltage UB
CLAUB		error class: battery voltage UB (onboard)
TDNSUB		time period for battery after start
TDUB		delay time of voltage diagnosis
TSFUB		fault active time: battery voltage UB (onboard)
UBDE		replace value for UBATT at damaged AD-channel
UBDMN1		min. battery voltage (power supply)
UBDMN2		min. battery voltage (ADC)
UBDMN3		battery voltage, lower threshold to take over value for delayed power down
UBDMX		max. battery voltage
UBNACHL		UB-replace value during ECU afterrun
VMDUB		Lower threshold of vehicle speed for battery voltage diagnosis

FB GGUB 11.30 Detailed description of function

If the signal is below the threshold UBDMN2, this points to a fault in the UB determination in the ECU (e.g. ADC), since, if U <= 2.5 V, the processor does not work. The use of a substitute value (UBDE) is only useful and intended of this type of fault.

On the other hand a max. value check is only effective after the delay TDNSUB and only with a rolling vehicle (and with faultless speed signal). This is intended to avoid a faulty diagnosis which could arise, for example in the case of start assistance with a 24 V battery. Conversely, if setting conditions for B_maxflr will disappear, a B_maxflr based error will be reset in case of falling below max. threshold only.

The check of the lower threshold UBDMN1 (fault in board voltage system) is also allowed only after the waiting period TDNSUB from the start end when the board voltage has recovered from the breakdown caused by the start procedure.

As soon as one of the threshold value scans (>UBDMX / <UBDMN1 / <UBDMN2) have been fulfilled, the respectiv bits (B_maxflr /B_minflr /B_plaus) and the error and cycle flags after expiry of the debouncing time TDUB will be set simultaneously. A common debouncing period is provided for the fault detection in order to limit the expenditure of ram cells for the time monitoring. Conversely in I.O. case (B_noflr) the debouncing period TDUB also has to expire before the fault flag is reset.

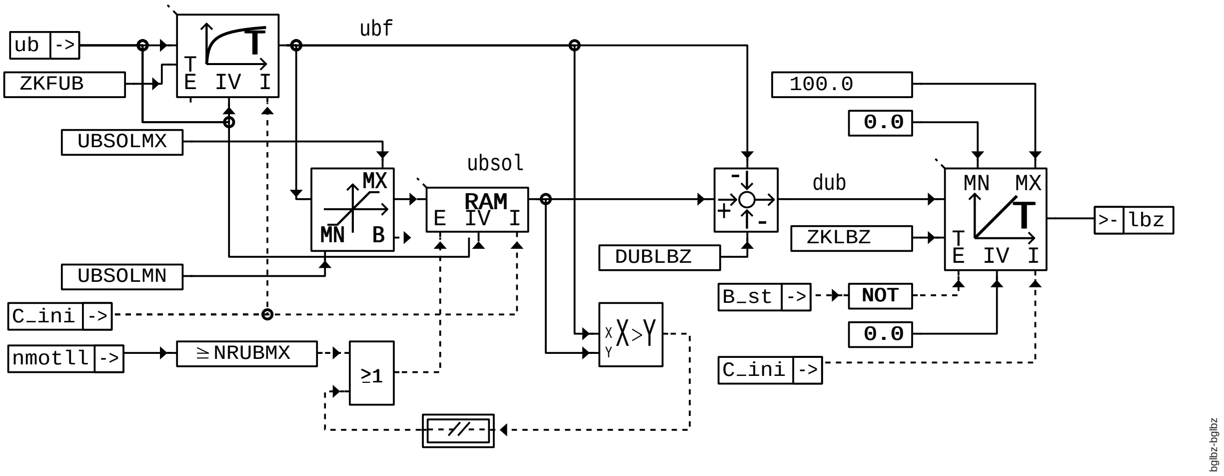
The cycle flag is either set parallel to the fault B_minflr / E_ub, as described above, or, in all other cases, especially when no fault is detected, at the latest when the recovery period TDNSUB expires after the start end.

APP GGUB 11.30 Application hint

Reference values: UBDMX 16 V; UBDMN1 10 V; UBDMN2 2,5 V; TDNSUB ca. 3 min
TDUB ca. 200ms

BGLBZ 4.1 Calculated charge deficit of the battery

FDEF BGLBZ 4.1 Function definition



bglbz-bglbz

ABK BGLBZ 4.1 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DUBLBZ			FW	Voltage offset for battery charce computation
NRUBMX			FW	maximal engine speed for battery voltage control
UBSOLMN			FW	Lower limit for Batterey target voltage
UBSOLMX			FW	Upper limit for Batterey target voltage
ZKFUB			FW	time constant for filtering the battery voltage
ZKLBZ			FW	time constant of the LBZ integrator

Variable	Source	Type	Description
B_ST	SWADAP	EIN	condition for start
C_INI	SWADAP	EIN	ECU-condition for intialisation
DUB	BGLBZ	LOK	difference of battery voltage for voltage control
LBZ	BGLBZ	AUS	charge state of the battery
NMOTLL	BGNMOT	EIN	engine speed
UB	SWADAP	EIN	battery voltage
UBF	BGLBZ	LOK	filtered battery voltage for charge control
UBSOL	BGLBZ	LOK	target battery voltage

FW BGLBZ 4.1 Fixed Values

Parameter	Value	Description
DUBLBZ		Voltage offset for battery charce computation
NRUBMX		maximal engine speed for battery voltage control
UBSOLMN		Lower limit for Batterey target voltage
UBSOLMX		Upper limit for Batterey target voltage
ZKFUB		time constant for filtering the battery voltage
ZKLBZ		time constant of the LBZ integrator

FB BGLBZ 4.1 Detailed description of function

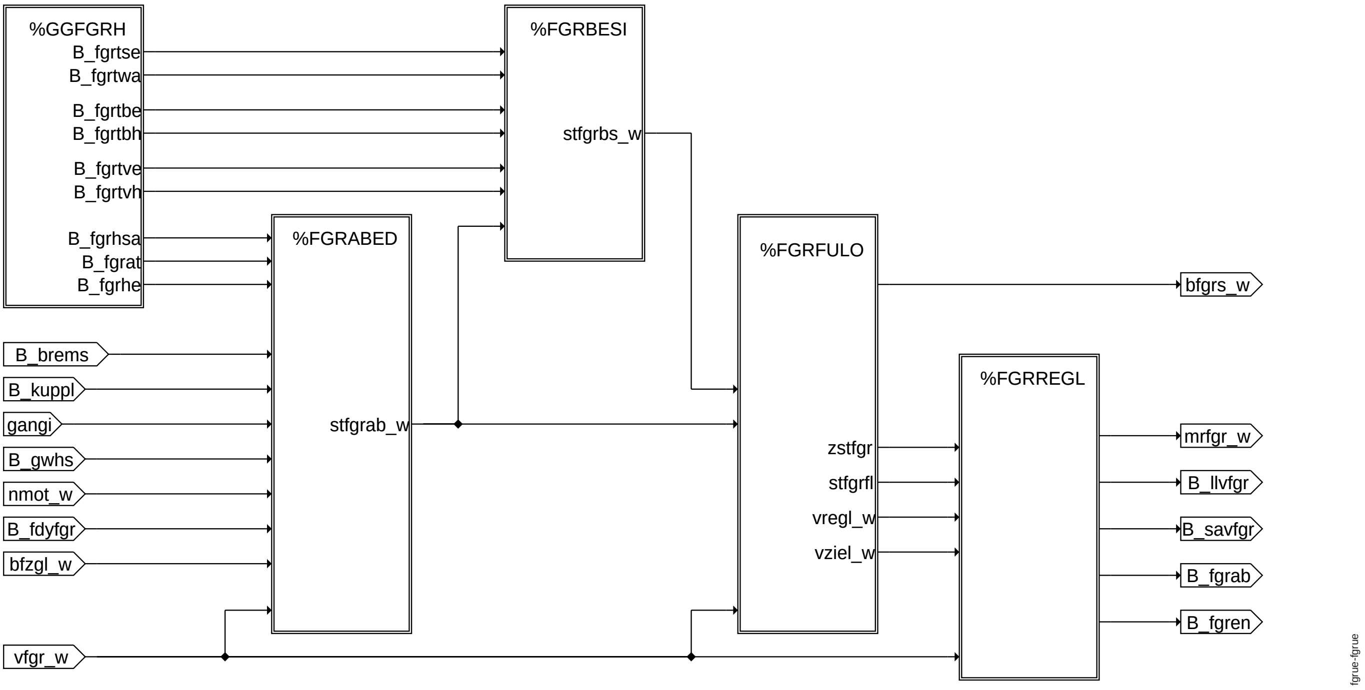
This function deteremines if the actual power of the generator is high enough to avoid a battery discharge.
Therfore the difference dub between a target voltage ubsol and the filtered actual voltage ubf ist calculated. An offset of DUBLBZ (env. 0.5 Volt) is subtracted from dub due to tolerances. The value dub is integrated and represents a value lbz for the charge defficit of the battery. lbz could be used for example in the idle speed control to increase idle speed if the battery is no more charged by the too slowly rotating generator.

The target voltage ubsol is directly measured by the ECU when the actual engine speed garantees the maximal power of the generator or when the actual voltage is higher than the target voltage.
To be shure that there are no erroneous values stored into ubsol, this target voltage is limited between the limits UBSOLMN and UBSOLMX.

APP BGLBZ 4.1 Application hint

FGRUE 6.10 Overview of vehicle-speed controller

FDEF FGRUE 6.10 Function definition



fgrue-fgrue

ABK FGRUE 6.10 Abbreviations

Variable	Source	Type	Description
BFZGL_W	GGVFZG	EIN	Vehicle acceleration in longitudinal direction
B_BREMS	GGEGAS	EIN	condition: brake operated
B_FDYFGR		EIN	Condition: Intervention in driving dynamics function (as cut-out condition: for
B_FGRAB	FGRUE	AUS	CC/ACC shut-off from the function
B_FGRAT	FGRUE	LOK	condition: tip-switch off CC lever control
B_FGREN	FGRUE	AUS	condition: cruise control is active (enable)
B_FGRHE	FGRUE	LOK	condition: CC-lever fault
B_FGRHSA	FGRUE	LOK	condition: CC main switch off
B_FGRTBE	FGRUE	LOK	condition: Cruise control button ACCELERATE
B_FGRTBH	FGRUE	LOK	Condition: FGR switch acceleration held (no Tip)
B_FGRTSE	FGRUE	LOK	condition: CC button (+ or -) set
B_FGRTVE	FGRUE	LOK	condition: Cruise control button DECELERATE
B_FGRTVH	FGRUE	LOK	Condition: FGR switch decelerate held (no Tip)
B_FGRTWA	FGRUE	LOK	condition: Cruise control button RESUME
B_GWHS	BBGANG	EIN	Condition gear change on manual transmission vehicle
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LLVFGR	FGRUE	AUS	Condition: Idling disabled by FGR
B_SAVFGR	FGRUE	AUS	Condition: prohibited trailing throttle fuel cut-off by cruise control
GANGI	SWADAP	EIN	Engaged gear
MRFGR_W	FGRUE	AUS	relative torque demand from cruise control
NMOT_W	SWADAP	EIN	engine speed
STFGRAB_W	FGRUE	LOK	Status word, cut-out conditions, vehicle-speed controller
STFGRBS_W	FGRUE	LOK	Status word operating signals, vehicle-speed controller
STFGRFL	FGRUE	LOK	Status byte FGR function logic
VFGR_W	GGVFZG	EIN	cruise control vehicle speed
VREGL_W	FGRUE	LOK	desired speed for cruise control
VZIEL_W	FGRUE	LOK	target velocity cruise control
ZSTFGR	FGRUE	LOK	Status of vehicle-speed controller

FW FGRUE 6.10 Fixed Values

Parameter	Value	Description

FB FGRUE 6.10 Detailed description of function

Functionality of the vehicle-speed controller

The task of the vehicle-speed controller (FGR) is to keep the speed of the vehicle constant irrespective of the road resistance without the accelerator pedal having to be operated to this end. Besides maintaining the current speed (Constant driving), reaching a previously stored target speed (Resumption), accelerating or decelerating as well as increasing or decreasing in small increments (Tip-up and Tip-down) and accepting the current vehicle speed as the desired speed (Set) are also possible.

Control of the vehicle-speed controller by the driver is by a special operating component, the switch for the functions of Set, Resumption, Accelerate and Decelerate. Depending on the version of the operating component, the switch can have more than one function (e.g. a function button for Set/Decelerate and a button for Resumption/Accelerate) because the function to be executed is given clearly from the status of the vehicle-speed controller and the duration of switch operation. The functions Tip-up and Tip-down are triggered by briefly operating the switch for acceleration or deceleration.

Besides the switches for the functions, the operating component also has an optional main switch and a switch for turning the vehicle-speed controller off. A previously stored target speed is lost when the main switch is turned off. Apart from by the operating component, the vehicle-speed controller can also be turned off by operating the brake or the clutch.

When the vehicle-speed controller is switched on, the driver can set a higher engine performance by operating the accelerator pedal so that the vehicle will accelerate (override). The vehicle-speed controller remains active in the background throughout this and resumes controlling the previously set desired speed when the accelerator pedal is released.

An alternative to the internal vehicle-speed controller can be a control by externally realized vehicle-to-vehicle ranging (ACC = Adaptive Cruise Control). This system communicates with the ME over CAN. The presence of an ACC ECU is indicated B_acc being set. The internal vehicle-speed controller is then deactivated in this case.

The vehicle-speed controller functionality is only calculated in the master in a system where there are 2 ME ECU’s. The output variables are transmitted to the slave via CAN.

Program architecture

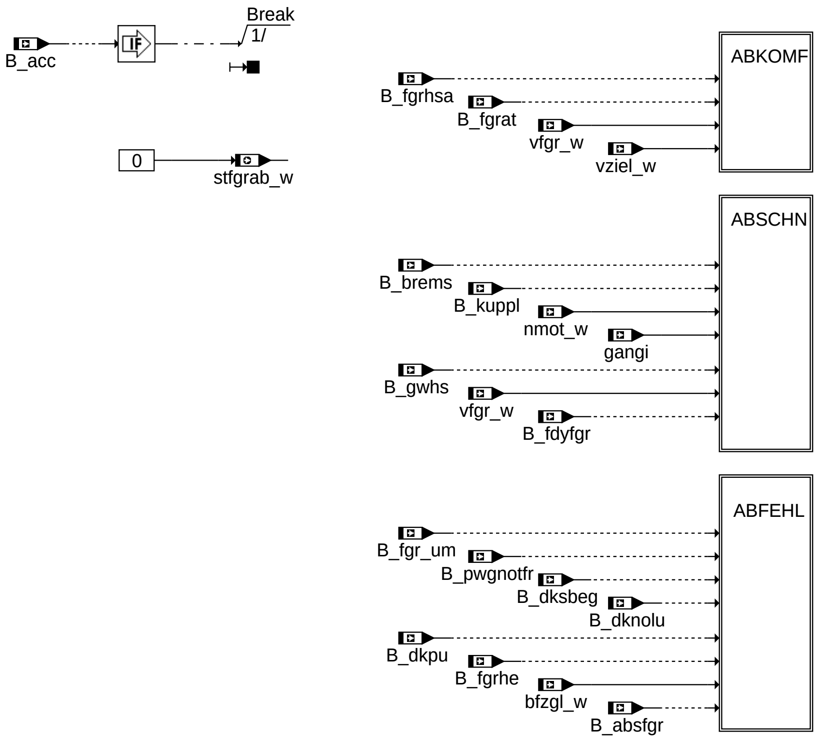
The functionality shown is realized by the functions given in the overview. These functions assume the following tasks:

GGFGRH: Sensing the switch status of the vehicle-speed controller operating component (hardware signals or CAN message)
FGRABED: Monitoring the enable and disable conditions for the vehicle-speed controller
FGRBESI: Evaluating the vehicle-speed controller and calculating the status word "FGR operating signals"
FGRFULO: Function logic and calculating the status of the vehicle-speed controller, target and desired speeds
FGRREGL: Controller calculations, disabling idling and overrun fuel cutoff

APP FGRUE 6.10 Application hint

FGRABED 1.30 Shutdown conditions, vehicle-speed controller

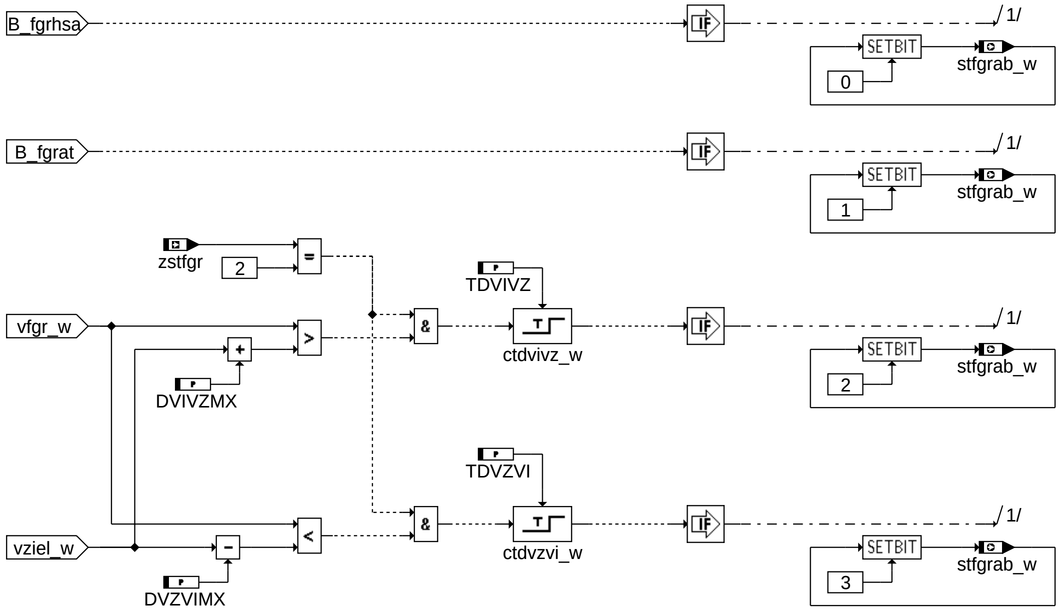
FDEF FGRABED 1.30 Function definition



fgrabed-fgrabed

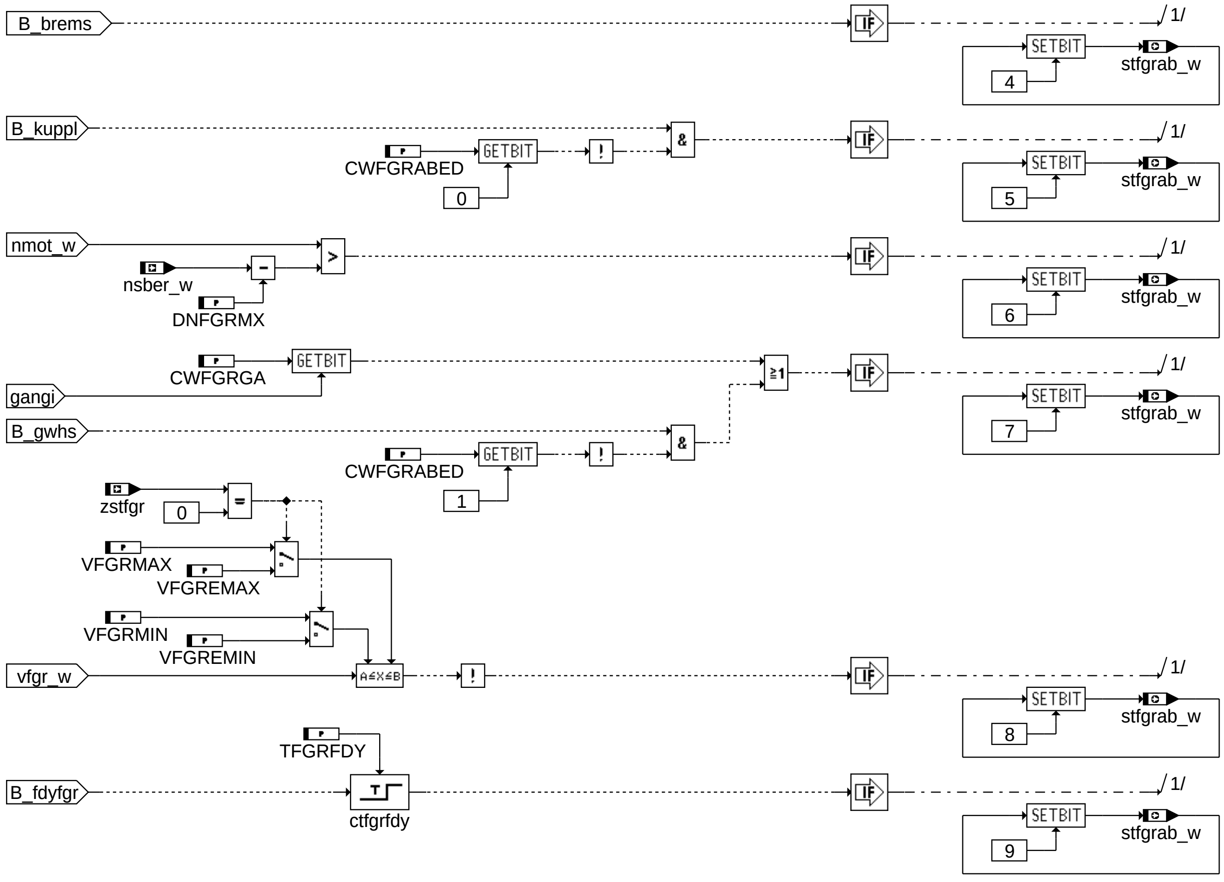
fgrabed-fgrabed

`Sub-function ABKOMF: Conditions for comfortable shutdown`



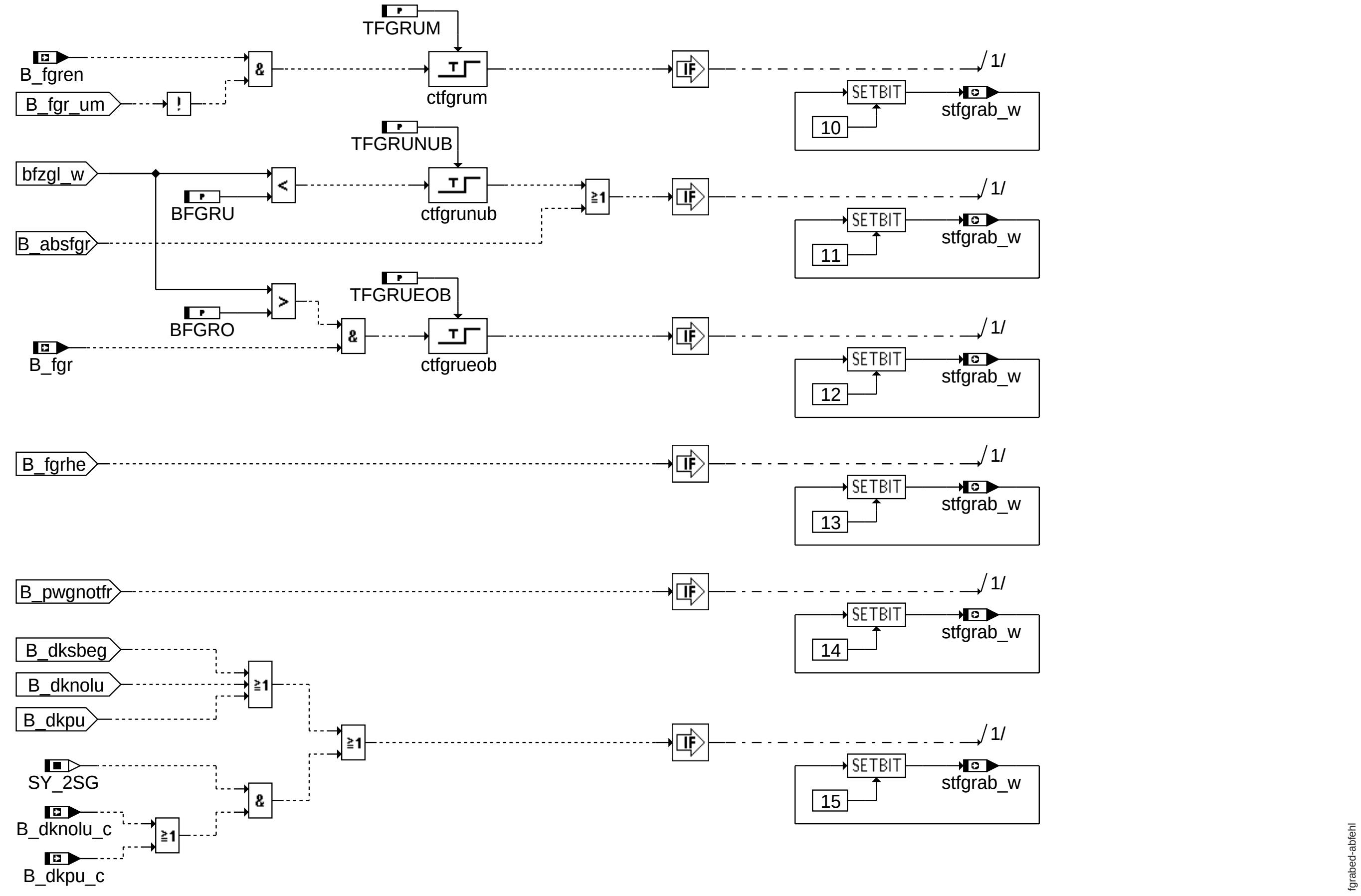
fgrabed-abkomf

`Sub-function ABSCHN: Conditions for quick shutdown`



fgrabed-abschn

Sub-function ABFEHL: Conditions for shutdown in case of a fault



fgrabed-abfehl

ABK FGRABED 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BFGRO			FW	upper limit for acceleration while cruise control is active
BFGRU			FW	lower limit for acceleration while cruise control is active
CWFGRABED			FW	
CWFGRGA			FW	Code word for gear-dependent FGR disable
DNFGRMX			FW	Speed difference from maximum speed for FGR shutdown
DVIVZMX			FW	max. permitted deviation between actual speed and target speed in cruising mode
DVZVIMX			FW	max. permitted deviation between target speed and actual speed in cruising mode
SY_2SG			SYS (REF)	system constant 2 motronic systems
TDVIVZ			FW	tolerance time of high deviation between actual and target velocity
TDVZVI			FW	tolerance time of high deviation between target and actual velocity
TFGRFDY			FW	Tolerance time for interventions by driving dynamics functions during FGR operat
TFGRUEOB			FW	tolerance time for violation of upper acceleration threshold
TFGRUM			FW	Tolerance time for detection of FGR-mode in function monitoring
TFGRUNUB			FW	tolerance time for violation of lower acceleration threshold
VFGREMAX			FW	Maximum FGR switching-on rate
VFGREMIN			FW	Minimum FGR switching-on rate
VFGRMAX			FW	max. permitted velocity during active cruise control
VFGRMIN			FW	Minimum permissible speed during FGR-operation

Variable	Source	Type	Description
BFZGL_W	GGVFZG	EIN	Vehicle acceleration in longitudinal direction
B_ABSFGR		EIN	Condition: ABS braking (as cut-out condition: for FGR)
B_ACC		EIN	Condition: ACC-control unit exists
B_BREMS	GGEGAS	EIN	condition: brake operated
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKNOLU_C		EIN	CAN-Receive-Message: 2.SG has set DK at air limphomeposition
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKPU_C		EIN	CAN: condition: safety fuel cut-off from 2. motronic
B_DKSBEG	GGDVE	EIN	condition: limiting throttle-valve setpoint value
B_FDYFGR		EIN	Condition: Intervention in driving dynamics function (as cut-out condition: for
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGRAT	GGFGRH	EIN	condition: tip-switch off CC lever control
B_FGREN	FGRUE	EIN	condition: cruise control is active (enable)
B_FGRHE	GGFGRH	EIN	condition: CC-lever fault

Variable	Source	Type	Description
B_FGRHSA	GGFGRH	EIN	condition: CC main switch off
B_FGR_UM	UFUE	EIN	CC/ACC torque intervention in function monitoring permitted
B_GWHS	BBGANG	EIN	Condition gear change on manual transmission vehicle
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
CTDVIVZ_W	FGRABED	LOK	Time counter for exceeding the set speed by more than DVIVZMX
CTDVZVI_W	FGRABED	LOK	Time counter when falling below the set speed by more than DVZVIMX
CTFGRFDY	FGRABED	LOK	Time counter for FGR cut-out for intervention by driving dynamics functions
CTFGRUEOB	FGRABED	LOK	Time counter for exceeding the upper accelerations threshold
CTFGRUM	FGRABED	LOK	Time counter to detect FGR operation in function monitoring
CTFGRUNUB	FGRABED	LOK	Time counter when falling below the lower accelerations threshold
GANGI	SWADAP	EIN	Engaged gear
NMOT_W	SWADAP	EIN	engine speed
NSBER_W		EIN	Calculated requested engine speed of the NMAX controller
STFGRAB_W	FGRABED	AUS	Status word, cut-out conditions, vehicle-speed controller
VFGR_W	GGVFZG	EIN	cruise control vehicle speed
VZIEL_W	FGRFULO	EIN	target velocity cruise control
ZSTFGR	FGRFULO	EIN	Status of vehicle-speed controller

FW FGRABED 1.30 Fixed Values

Parameter	Value	Description
BFGRO		upper limit for acceleration while cruise control is active
BFGRU		lower limit for acceleration while cruise control is active
CWFGRABED		
CWFGRGA		Code word for gear-dependent FGR disable
DNFGRMX		Speed difference from maximum speed for FGR shutdown
DVIVZMX		max. permitted deviation between actual speed and target speed in cruising mode
DVZVIMX		max. permitted deviation between target speed and actual speed in cruising mode
TDVIVZ		tolerance time of high deviation between actual and target velocity
TDVZVI		tolerance time of high deviation between target and actual velocity
TFGRFDY		Tolerance time for interventions by driving dynamics functions during FGR operat
TFGRUEOB		tolerance time for violation of upper acceleration threshold
TFGRUM		Tolerance time for detection of FGR-mode in function monitoring
TFGRUNUB		tolerance time for violation of lower acceleration threshold
VFGREMAX		Maximum FGR switching-on rate
VFGREMIN		Minimum FGR switching-on rate
VFGRMAX		max. permitted velocity during active cruise control
VFGRMIN		Minimum permissible speed during FGR-operation

FB FGRABED 1.30 Detailed description of function

The function controls enable and shutdown of the vehicle-speed controller (FGR).

If at least one shutdown condition is fulfilled, then the vehicle-speed controller is deactivated or the controller cannot be activated. There are a number of shutdown conditions that trigger a comfortable shutdown when the vehicle-speed controller is active, whereby the controller output is controlled continuously over a ramp with an applicable running time. The controller output is set immediately to zero for all other shutdown conditions.
Also, certain shutdown conditions trigger the stored target speed. This makes any subsequent resumption impossible.

The different shutdown conditions lead to specific bits being set in the status word "Vehicle-speed controller shutdown conditions", stfgrab_w. The individual shutdown conditions and their assignment to the bits in stfgrab_w are given in the following table:

bit	Reason for shutdown/No-enable of the FGR	Comfort-shutdown (ramp)	Cancel target speed
0	Main switch off	X	X
1	Tip-switch "off" actuated	X	
2	Actual speed exceeds the set speed during constant driving by more than DVIVZMX for longer than TDVIVZ	X	
3	Actual speed falls below the set speed during constant driving by more than DVZVIMX for longer than TDVZVI	X	
4	Brake pedal operated or fault in the brake-switch diagnosis		
5	Clutch operated		
6	Engine speed greater than maximum engine speed minus DNFGRMX		
7	FGR disabled in current gear selection by CWFGRGA or different gear detected during manual gear-shift		
8	Vehicle speed lower than VFGRMIN or higher than VFGRMAX, respectively lower than VFGREMAX or higher than VFGREMAX if cruise control is not active		
9	Intervention by a vehicle-dynamics function (e.g. ASR, MSR, ESP, EDS) for longer than TFGRFDY		
10	No vehicle-speed controller enable from function monitoring for longer than TFGRUM when FGR is active		
11	Vehicle acceleration less than BFGRU for longer than TFGRUNUB or ABS intervention		
12	Vehicle acceleration greater than BFGRO longer than TFGRUEOB as long as FGR is intervening (no overriding by the driver)		
13	Fault at the operating lever		X
14	Pedal-travel sensor limp-home operation		X
15	Throttle-valve actuator limp-home operation		X

The shutdown conditions are not checked in an ACC system (externally realized vehicle-speed controller with vehicle-to-vehicle ranging).

APP FGRABED 1.30 Application hint

Conditions to be fulfilled:

```
  VFGREMIN >= Max(VREGLMIN, VFGRMIN)
  VFGREMAX <= Min(VREGLMAX, VFGRMAX)
```

Configuration with CWFGRABED:

```
  Bit 0   0: Disabling of cruise control if B_kuppl is set
          1: No Disabling of cruise control if B_kuppl is set

  Bit 1   0: Disabling of cruise control if B_gwhs is set
          1: No Disabling of cruise control if B_gwhs is set
```

D2CTR 2.20 Diagnosis; system verification counter

FDEF D2CTR 2.20 Function definition

The fault code memory statuses sfpdfp are searched by means of the selection via the control bits from DFPSLBIT from sfpaaa ##
to sfpzzz (always exclusively) for the following states: ##

1. Number of given sfpdfp is written into 'ctrsfp'.
2. Number of set cycle flags (Z_dfp = 1) is written into 'ctrzyf1'.
3. Number of not set cycle flags (Z_dfp = 0) is written into 'ctrzyf0'.
4. Number of set error flags (E_dfp = 1) is written into 'ctrerf1'.
5. Number of set status-ready bits (sfpdfp.13 = 1) is written into 'ctrrdy1'.

Additionally, the bit B_trip is derived from the number of not checked (Z_dfp = 0) paths for ctrzyf0 > 0.
From the number of stored fault (E_dfp = 1) paths for ctrerf1 > 0, the bit B_syserr is derived.

The counting routine needs to take place once during each initialization (C_ini) after initialization of the sfpdfp.
Thereafter in the 200ms task or more frequently.

```
                        +---------+
sfpaaa to sfpzzz ------>| counting+-- No. of  sfpdfp ------------------------------------------------------------> ctrsfp
with bit in DFPSLBIT=1  | routine +-- No. of Z_dfp = 1 ------------------+---------------------------------------> ctrzyf1     ##
                        |         |                                      |    +-------------+
                        |         |                                      +--->| ctrzyf1 > 0 +---+
                        |         |                                           +-------------+   |
                        |         +-- No. of Z_dfp = 0 ------------------+----------------------|----------------> ctrzyf0
                        |         |                                      |                      |   +-+
                        |         |                                      |    +-------------+   +-->|&+----------> B_trip
                        |         |                                      +--->| ctrzyf0 = 0 +------>| |
                        |         |                                           +-------------+       +-+
                        |         +-- No. of E_dfp = 1 ------------------+---------------------------------------> ctrerf1
                        |         |                                      |    +-------------+
                        |         |                                      +--->| ctrerf1 > 0 +--------------------> B_syserr
                        |         |                                           +-------------+
                        |         +-- No. of ready sfpdfp.13 = 1 ------------------------------------------------> ctrrdy1
                        +---------+
```

ABK D2CTR 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DFPSLBIT			KWB	Section bits for indication of the activated error paths

Variable	Source	Type	Description
B_SYSERR	D2CTR	AUS	condition for detection of at least one fault (E_abc) within the system (coded)
B_TRIP	D2CTR	AUS	flag for fulfilled 'trip'
CTRERF1	D2CTR	AUS	Counter for amount of detected error in the system since pwf (filtered)
CTRRDY1	D2CTR	AUS	Counter of amount of checked error paths in the system since powerfail
CTRSFP	D2CTR	AUS	Counter for amount of error paths in the system
CTRZYF0	D2CTR	AUS	Counter of amount of not checked error paths in the system since engine start
CTRZYF1	D2CTR	AUS	Counter for amount of checked error paths in the system since engine start

FW D2CTR 2.20 Fixed Values

Parameter	Value	Description

FB D2CTR 2.20 Detailed description of function

APP D2CTR 2.20 Application hint

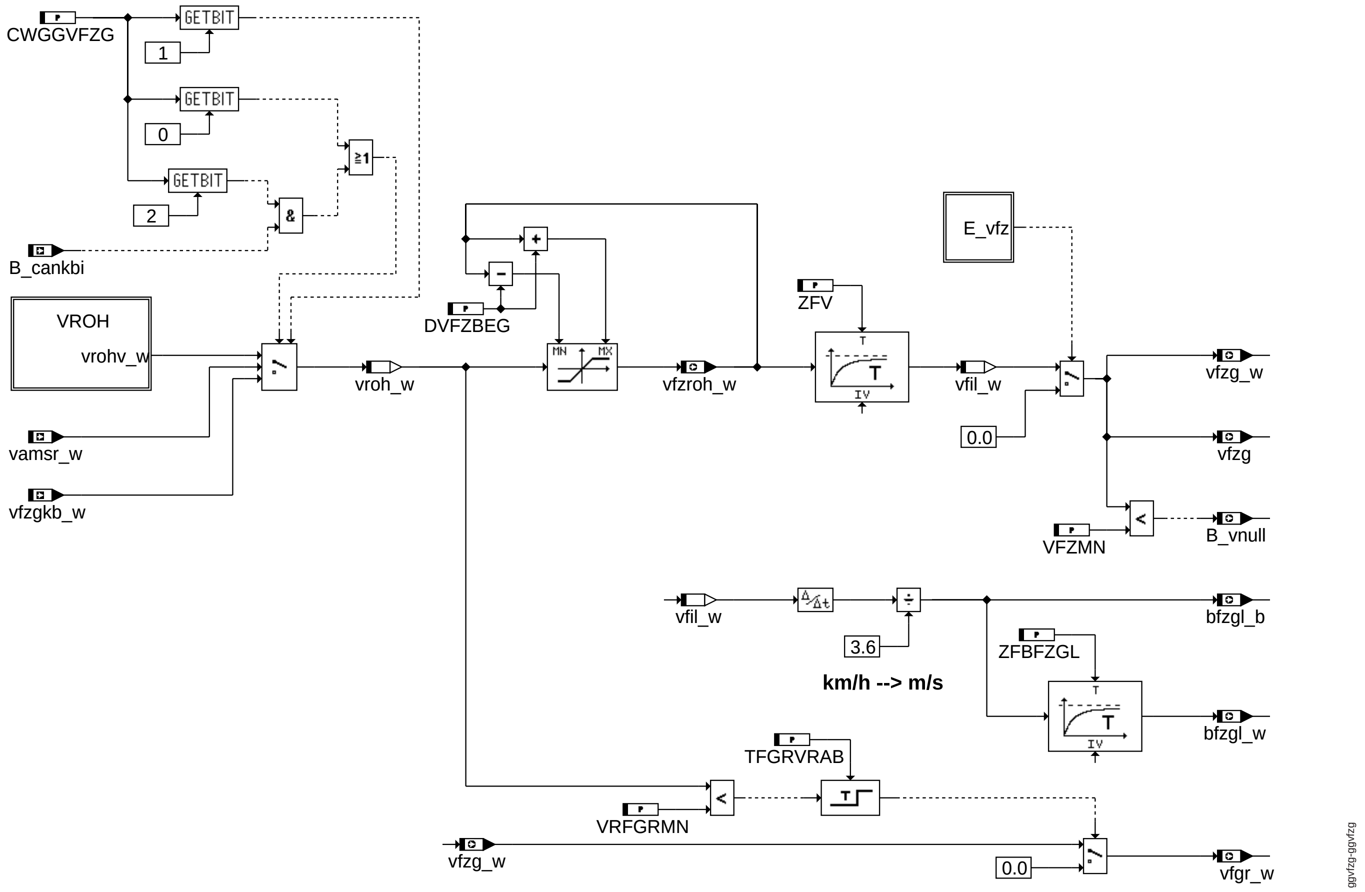
Application of the selected fault paths as follows: ##

The amount of the sfpdfp to be activated or deactivated needs to be determined program-version dependent from VS100. ##
This amount is divided by 16. ##
The integer from the division result declares the block to be changed, the division remainder declares the bit to be changed. ##

Example: Number of the sfptm is to be 87; --> 87 / 16 = 5 remainder 7, so bit 7 in the 5th block needs to be changed. ##

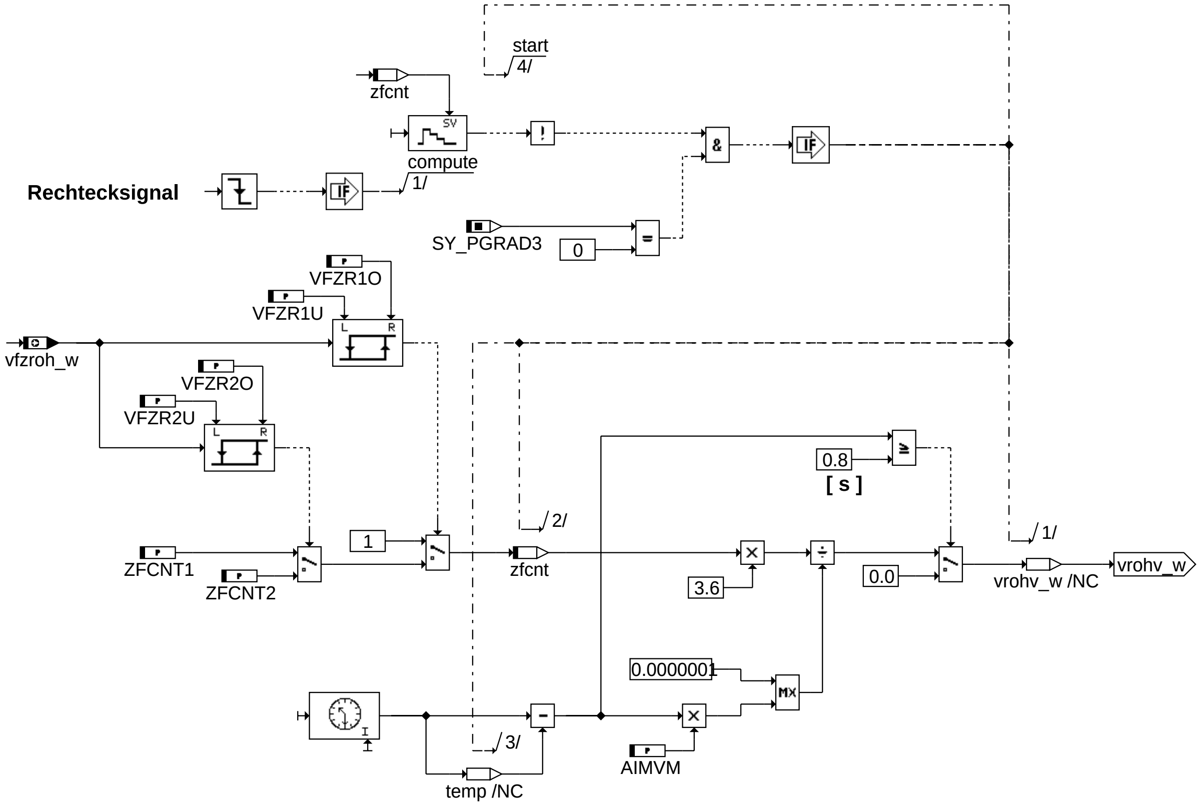
GGVFZG 14.70 Input signal: vehicle speed

FDEF GGVFZG 14.70 Function definition



ggvfzg-ggvfzg

`Sub-function VROH: Calculation of the raw speed`



ggvfzg-vroh

ABK GGVFZG 14.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AIMVM			FW	number of speedpulses for calibration of vehicle speed signal
CWGGVFZG			FW	Code word for %GGVFZG
DVFZBEG			FW	Delta speed for change limitation
SY_PGRAD3			SYS (REF)	system constant: kind of the 3. phase signal
TFGRVRAB			FW	FGR: Time speed shutdown by vroh = 0
VFZMN			FW	Detection of driving-standing
VFZR1O			FW	Threshold vfzroh_w to switch over zfcnt from 1 to ZFCNT1
VFZR1U			FW	Threshold vfzroh_w to switch over zfcnt from ZFCNT1 to 1
VFZR2O			FW	Threshold vfzroh_w to switch over zfcnt from ZFCNT1 to ZFCNT2
VFZR2U			FW	Threshold vfzroh_w to switch over zfcnt from ZFCNT2 to ZFCNT1
VRFGRMN			FW	Lower threshold vroh_w for FGR shutdown by vfzg_w = 0
ZFBFZGL			FW	Filter time constant for 16-bit acceleration signal
ZFCNT1			FW	Number of tooth flanks in the middle speed range
ZFCNT2			FW	Number of tooth flanks in the upper speed range
ZFV			FW	time constant for filter vehicle speed signal

Variable	Source	Type	Description
BFZGL_B	GGVFZG	AUS	Automobile acceleration in the longitudinal direction
BFZGL_W	GGVFZG	AUS	Vehicle acceleration in longitudinal direction
B_CANKBI		EIN	Condition: Combi message detected
B_VNULL	GGVFZG	AUS	condition vehicle at stillstand
DFP_VFZ	GGVFZG	DOK	ECU int. fault path no.: vehicle speed signal
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
VAMSR_W		EIN	Reference speed from ASR/MSR ECU
VFGR_W	GGVFZG	AUS	cruise control vehicle speed
VFIL_W	GGVFZG	LOK	Filtered speed (16-bit)
VFZG	GGVFZG	AUS	vehicle speed (km/h)
VFZGKB_W		EIN	Speed from combi message
VFZG_W	GGVFZG	AUS	Vehicle speed
VFZROH_W	GGVFZG	AUS	vehicle speed output value to scan tool
VROH_W	GGVFZG	LOK	Vehicle speed
ZFCNT	GGVFZG	LOK	Counter of tooth slopes for measurement of vehicle speed

FW GGVFZG 14.70 Fixed Values

Parameter	Value	Description
AIMVM		number of speedpulses for calibration of vehicle speed signal
CWGGVFZG		Code word for %GGVFZG
DVFZBEG		Delta speed for change limitation
TFGRVRAB		FGR: Time speed shutdown by vroh = 0
VFZMN		Detection of driving-standing
VFZR1O		Threshold vfzroh_w to switch over zfcnt from 1 to ZFCNT1
VFZR1U		Threshold vfzroh_w to switch over zfcnt from ZFCNT1 to 1
VFZR2O		Threshold vfzroh_w to switch over zfcnt from ZFCNT1 to ZFCNT2
VFZR2U		Threshold vfzroh_w to switch over zfcnt from ZFCNT2 to ZFCNT1
VRFGRMN		Lower threshold vroh_w for FGR shutdown by vfzg_w = 0
ZFBFZGL		Filter time constant for 16-bit acceleration signal
ZFCNT1		Number of tooth flanks in the middle speed range
ZFCNT2		Number of tooth flanks in the upper speed range
ZFV		time constant for filter vehicle speed signal

FB GGVFZG 14.70 Detailed description of function

Purpose of the function is to make the vehicle speed available. This is needed for amongst others, vehicle speed control (FGR), speed limiting (VMAX) and for gear detection in the case of manual transmissions. The possibility is given depending on the configuration, to use the values supplied by the combined instrument or from CAN or to evaluate an interrupt-controlled rectangular-pulse signal. The raw speed obtained in this way is subsequently filtered by a change limitation and a low-pass filter.

Configuration is by means of the code word CWGGVFZG. If bit 0 in CWGGVFZG is set, then the speed from the CAN message Kombi 1 (vfzgkb_w) is used. The same applies when bit 2 in CWGGVFZG is set and B_cankbi = 1 indicates that the CAN message has been received by the combined instrument. If vfzgkb_w is not used and if bit 1 in CWGGVFZG is set, then the speed from CAN message Bremse 1 (vamsr_w) is used instead. The hardware signal is otherwise evaluated.

To do this, a time entry is generated interrupt-controlled in each case after a certain number of zfcnt from the negative flanks of the rectangular-pulse signal. The current raw speed is calculated in the 20-ms schedule after each new time entry from the difference between the last two time entries. The parameter AIMVM is also included in the calculations besides zfcnt, the number of pulses to which the measured time period refers. AIMVM describes the number of pulses per travel path, i.e. the number of pulses per wheel revolutions divided by the wheel circumference. The raw speed is set to zero if there has been no time entry made for longer than 0.8 s.

It is principally meaningful in order to eliminate inaccuracies due to tooth-pitch errors at the sensor wheel, to always evaluate a full sensor-wheel revolution, i.e. to set zfcnt to the number of pulses per sensor-wheel revolution. An update of the raw signal is then however so seldom at low speeds that an evaluation is made using zfcnt = 1. The computing task is too large at high speeds if a new time entry has to made after each revolution by the sensor wheel. This is why zfcnt is set to a whole-number multiple of the number of pulses per sensor-wheel revolution. Switchover is made between the different values for zfcnt is made depending on the speed while employing a hysteresis:

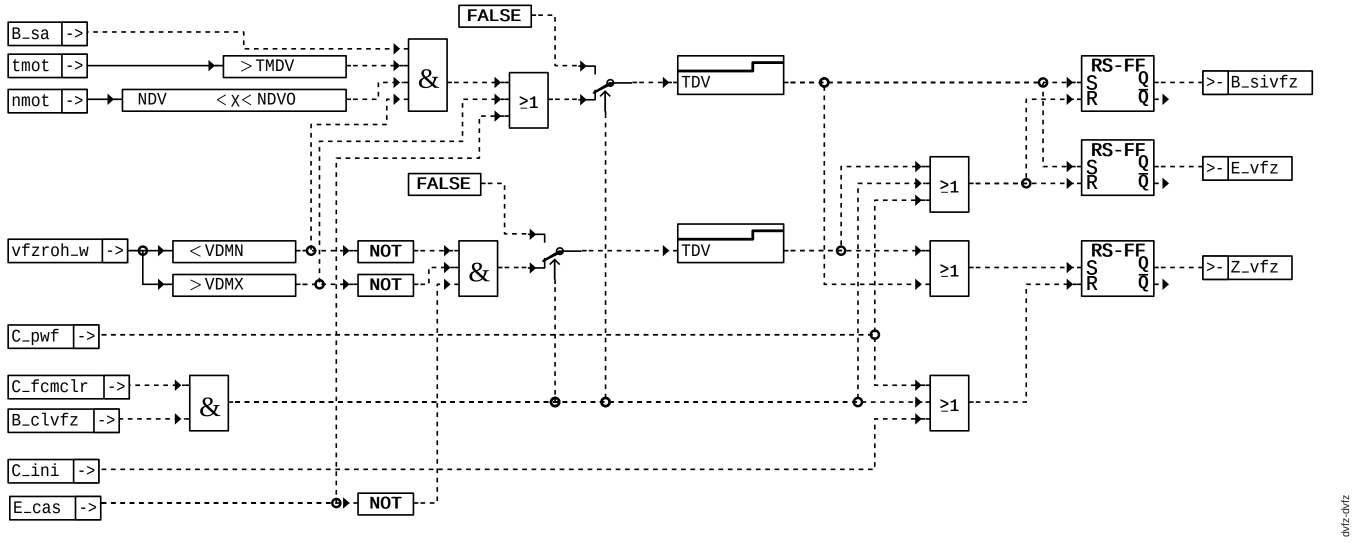
```
zfcnt
              ^
              |
     ZFCNT2  -+                                                               +-----------+------------------------
              |                                                               |           |
              |                                                               |           |
              |                                                               V           ^
              |                                                               |           |
              |                                                               |           |
     ZFCNT1  -+                         +-----------+-------------------------+-----------+
              |                         |           |
              |                         |           |
              |                         V           ^
              |                         |           |
              |                         |           |
          1  -+ ------------------------+-----------+
              |
              |
             -+-------------------------+-----------+-------------------------+-----------+---------------------------->
              |                         |           |                         |           |                              vfzroh_w

              0                       VFZR1U      VFZR1O                    VFZR2U      VFZR2O
```

A separate speed signal, vfgr_w, is made available for the vehicle-speed controller. If the raw signal, vroh_w, falls below the threshold VRFGRMN for the time TFGRVRAB, then a drop in the signal is assumed and vfgr_w is set to zero so that the vehicle-speed controller cuts out as soon as possible and there is no unwanted acceleration until the filter output has reached the minimum vehicle-speed controller speed.

APP GGVFZG 14.70 Application hint

DVFZ 19.10 Diagnosis; plausibility test vehicle speed

FDEF DVFZ 19.10 Function definition



dvfz-dvfz

ABK DVFZ 19.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NDV			FW	error detection vehicle speed signal / minimum threshold for engine speed
NDVO			FW	error detection vehicle speed signal, maximum threshold for engine speed
TDV			FW	error detection tachometer signal / time for interrogation
TMDV			FW	motor temperature threshold for release of vehicle speed diagnosis
VDMN			FW	vehicle speed threshold; fault detection vhehicle speed signal
VDMX			FW	vehicle speed threshold; fault detection vfz-signal

Variable	Source	Type	Description
B_CLVFZ		EIN	condition: delete error path VFZ (Vehicle speed)
B_SA	MDRED	EIN	Condition fuel cut-off
B_SIVFZ	DVFZ	AUS	Condition missing signal vehicle speed
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_CAS	DCAS	EIN	errorflag: CAN-interface, timeout ASC
E_VFZ	DVFZ	AUS	Error flag: vehicle speed signal
NMOT	SWADAP	EIN	engine speed
TMOT	SWADAP	EIN	Engine temperature
VFZROH_W	GGVFZG	EIN	vehicle speed output value to scan tool
Z_VFZ	DVFZ	AUS	cycle flag: vehicle speed signal

FW DVFZ 19.10 Fixed Values

Parameter	Value	Description
NDV		error detection vehicle speed signal / minimum threshold for engine speed
NDVO		error detection vehicle speed signal, maximum threshold for engine speed
TDV		error detection tachometer signal / time for interrogation
TMDV		motor temperature threshold for release of vehicle speed diagnosis
VDMN		vehicle speed threshold; fault detection vhehicle speed signal
VDMX		vehicle speed threshold; fault detection vfz-signal

FB DVFZ 19.10 Detailed description of function

The function shall enable the diagnosis of the V signal during a FTP75 test also on vehicles with automatic gearbox with "soft" converter. For this the SAS-flag is checked within an engine speed range: if it is fulfilled within the range for a certain amount of time the vehicle must be in motion and thus V > VDMN must be fulfilled, otherwise the error is stored.

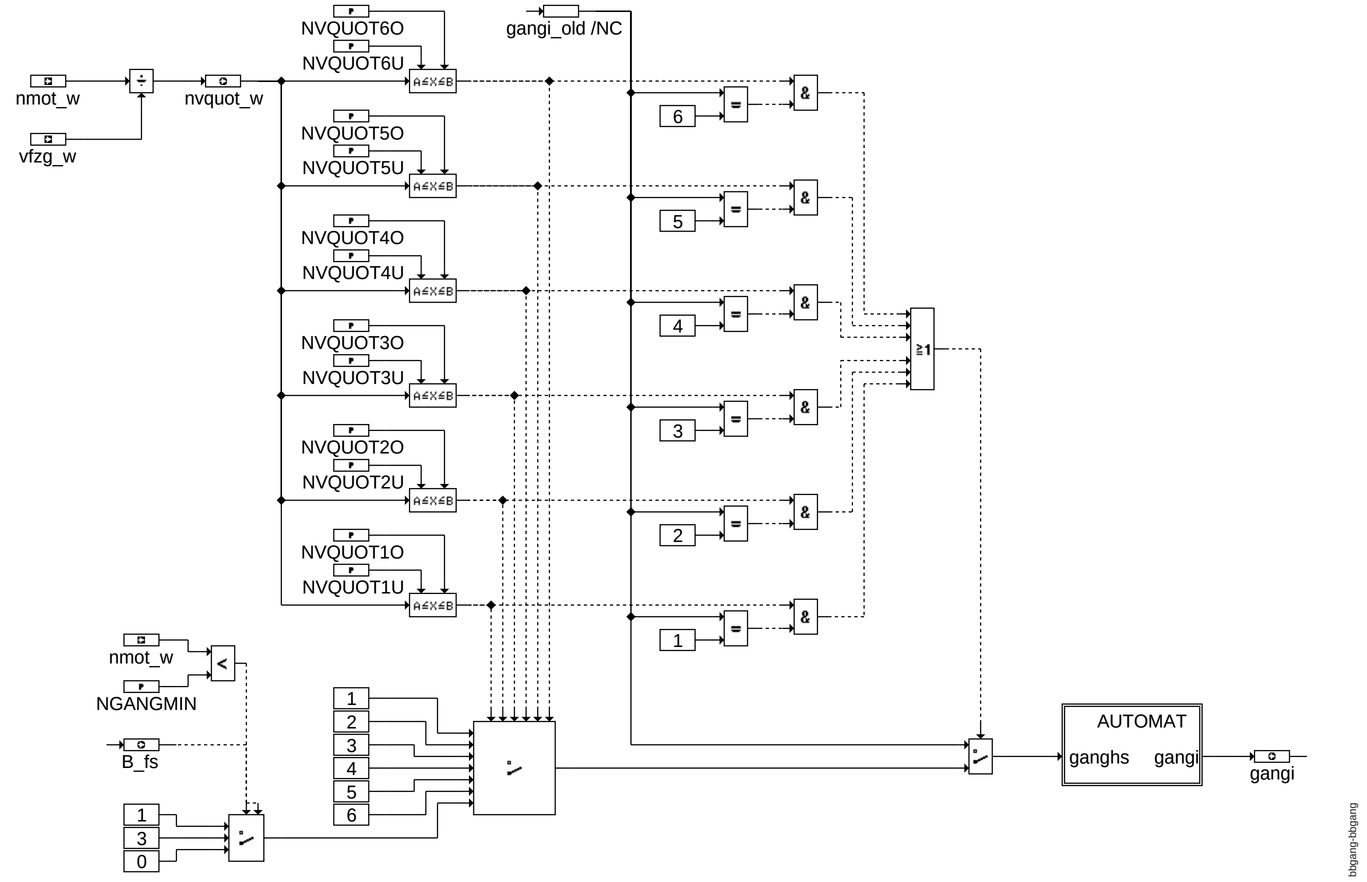
Devault measures: Block the demand adaptation of the LLR
Block gear detection and thus compression control (see %KOS)
LLR active, if B_LL detected
Deactivate the antijerking function

In case BBNMAX exists: switch-over speed limiter/enginge speed limiter.

APP DVFZ 19.10 Application hint

BBGANG 21.10 Detection of actual gear

FDEF BBGANG 21.10 Function definition



bbgang-bbgang

ABK BBGANG 21.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
IGESGA	GANGI		KL	Total transmission ratio
NGANGMIN			FW	minimum engine speed for gear detection
NVQUOT1O			FW	gear detection n/v 1. gear high
NVQUOT1U			FW	gear detection n/v 1. gear low
NVQUOT2O			FW	gear detection n/v 2. gear high
NVQUOT2U			FW	gear detection n/v 2. gear low
NVQUOT3O			FW	gear detection n/v 3. gear high
NVQUOT3U			FW	gear detection n/v 3. gear low
NVQUOT4O			FW	gear detection n/v 4. gear high
NVQUOT4U			FW	gear detection n/v 4. gear low
NVQUOT5O			FW	gear detection n/v 5. gear high
NVQUOT5U			FW	gear detection n/v 5. gear low
NVQUOT6O			FW	gear detection n/v 6. gear high
NVQUOT6U			FW	gear detection n/v 6. gear low

Variable	Source	Type	Description
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_CVT	PROKON	EIN	Condition continuously variable transmission
B_FS	BBGANG	AUS	Condition driving state (automatic gear box)
B_GWHS	BBGANG	AUS	Condition gear change on manual transmission vehicle
B_SELESPED		EIN	condition: car with selespeed
B_TIPPG		EIN	Condition Gear lifter in position ”Tippgasse”
B_VNULL	GGVFZG	EIN	condition vehicle at stillstand
DFP_VFZ	BBGANG	DOK	ECU int. fault path no.: vehicle speed signal
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
GANGAUTI		EIN	current gear of automatic gearbox received by CAN
GANGI	BBGANG	AUS	Engaged gear
GANG_KUP	CAN	EIN	current gear received via CAN for F1 transmission
NMOT_W	SWADAP	EIN	engine speed
NVQUOT_W	BBGANG	AUS	quotient engine speed nmot / vehicle speed vfzg

Variable	Source	Type	Description
S_FS	SWADAP	EIN	Drive position selected
UEFKTGET		EIN	Transfer function (Mrad/Mkurbelwelle) from transmission control
UEVGES	BBGANG	AUS	Transmission ratio total
VFZG_W	GGVFZG	EIN	Vehicle speed

FW BBGANG 21.10 Fixed Values

Parameter	Value	Description
NGANGMIN		minimum engine speed for gear detection
NVQUOT1O		gear detection n/v 1. gear high
NVQUOT1U		gear detection n/v 1. gear low
NVQUOT2O		gear detection n/v 2. gear high
NVQUOT2U		gear detection n/v 2. gear low
NVQUOT3O		gear detection n/v 3. gear high
NVQUOT3U		gear detection n/v 3. gear low
NVQUOT4O		gear detection n/v 4. gear high
NVQUOT4U		gear detection n/v 4. gear low
NVQUOT5O		gear detection n/v 5. gear high
NVQUOT5U		gear detection n/v 5. gear low
NVQUOT6O		gear detection n/v 6. gear high
NVQUOT6U		gear detection n/v 6. gear low

FB BBGANG 21.10 Detailed description of function

APP BBGANG 21.10 Application hint

GGFST 16.10 Sensor variable tank level

FDEF GGFST 16.10 Function definition

```
+-------------------------------------------------------------------------------------------+
| Es gibt 2 Fahrzeugkonfigurationen: Signal tankfst über CAN oder fstl über Analogeingang   |
| Mit dem Codewort CWGGFST kann die Funktion umgeschaltet werden:                           |
|  CWGGFST = 0 --> CAN                                                                      |
|  CWGGFST = 1 --> Analogsignal                                                             |
+-------------------------------------------------------------------------------------------+


Für CWGGFST = 0:
----------------
                 +---------+
tankfst  ------->| < TANKL +----+                 +--------------+
(über CAN)       +---------+    |         +---+   |        +---- |                      +---+----+
                                +-------->|   +-->| TWNTAL |     +-----+--------------->| s |    +-----> B_tal
            +---------------+   |   +---->| & |   | -------+     |     |   +-----+      +---+----+   (Dauerram)
            |         +-----|   |   |     +---+   +--------------+     +-->|     |  +-->| R |    |
B_stend --->|  TWNSTA |     +---|---+                                 +--->| >=1 |  |   +---+----+
            | --------+     |   |   |     +---+   +--------------+    |    +--+--+  |
            +---------------+   |   +---->|   |   |        +---- |    |       +------------------------> B_talval
                                +------->o| & +-->| TWNTAL |     +----+             |
                                          +---+   | -------+     |    |      +---+  |
                                                  +--------------+    +----->|   +--+
B_pwf     ------------------------------------------------------------------>| v |
                                                                             +---+

              +---+
B_talval ---->| & +-------------------------+
B_tal ------->|   |                         |
              +---+                         v
tankfst ----------------------------------o----o--------------------------------------------------------> tfst
                        +------+
                        |   0  +----------o
                        +------+
```

```
Für CWGGFST = 1:
----------------

Analogeingang ----------------------------------------------------------------------------------------> fstl

                Verzögerung nur bei Übergang 1 -> 0
                          +--------------+
           +----------+   | ----+        |
ufst_w --->| < FSTRES +-->|     |TVFSTA  +---+
           +----------+   |     +------- |   |
                          +--------------+   |
                                             |
                                +------------+
                                |                 +--------------+
                                |         +---+   |        +---- |                      +---+----+
                                +-------->|   +-->| TWNTAL |     +-----+--------------->| s |    +-----> B_tal
            +---------------+   |   +---->| & |   | -------+     |     |   +-----+      +---+----+   (Dauerram)
            |         +-----|   |   |     +---+   +--------------+     +-->|     |  +-->| R |    |
B_stend --->|  TWNSTA |     +---|---+                                 +--->| >=1 |  |   +---+----+
            | --------+     |   |   |     +---+   +--------------+    |    +--+--+  |
            +---------------+   |   +---->|   |   |        +---- |    |       +------------------------> B_talval
                                +------->o| & +-->| TWNTAL |     +----+             |
                                          +---+   | -------+     |    |      +---+  |
                                                  +--------------+    +----->|   +--+
B_pwf     ------------------------------------------------------------------>| v |
                                                                             +---+

              +---+
B_talval ---->| & +-------------------------+
B_tal ------->|   |                         |
              +---+     +------+            v
                        | 100  +----------o----o--------------------------------------------------------> tfst
                        +------+
                        |   0  +----------o
                        +------+
```

ABK GGFST 16.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWGGFST			FW	codeword fuel level sensor
FSTRES			FW	”Tank empty” - threshold
TANKL			FW	Threshold tank empty detected
TVFSTA			FW	Delay time for output of tank state
TWNSTA			FW	Waiting time after engine start
TWNTAL			FW	wait period until the signal not-empty-tank is valid

Variable	Source	Type	Description
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_TAL	GGFST	AUS	Condition tank empty or reserve
B_TALVAL	GGFST	AUS	condition ; bit empty tank valid
TANKFST		EIN	Tank liquid level
TFST	GGFST	AUS	fuel level in tank
UFST_W		EIN	A/D Input voltage tank level sensor

FW GGFST 16.10 Fixed Values

Parameter	Value	Description
CWGGFST		codeword fuel level sensor
FSTRES		”Tank empty” - threshold
TANKL		Threshold tank empty detected
TVFSTA		Delay time for output of tank state
TWNSTA		Waiting time after engine start
TWNTAL		wait period until the signal not-empty-tank is valid

FB GGFST 16.10 Detailed description of function

Bei einem fast leeren Tank können z.B. Verbrennungsaussetzer durch die ungenügende Kraftstoffversorgung auftreten. Diese Funktion stellt eine Information über den Tankfüllstand für andere Funktionen zur Verfügung.

Je nach Karosserie steht ein Signal Tankfüllstand tankfst über CAN (Codewort CWGGFST = 0) oder ein anloges Signal fstl (codewort CWGGFST = 1) zur Verfügung. Das Analogsignal hat u.U. nur on/off Funktion.

Bei CAN: Unterschreitet tankfst den Schwellwert TANKL, so wird auf Tank leer erkannt.
Bei Analogsignal: Unterschreitet fstl den Schwellwert FSTRES, so wird auf Tank leer erkannt.

Eine Erste Entprellung kann abhängig von der Zeit nach Motorstart gemacht werden (TWNSTA). Sie ist z.B. nötig, wenn die Reservelampe zu Testzwecken während der Initialisierung angesteuert wird.

Eine zweite Entprellung (TWNTAL) kann ein Toggeln von B_tal bei stark schwappendem Tank und häufig ein und ausgehender Reservelampe verhindern. Die Entprellung gilt sowohl beim Setzen als auch beim Rücksetzen von B_tal.

Einen Sonderfall deckt die Entprellzeit TVFSTA ab. Bei einigen Karosserien wird auf dem Analogsignal ein Blinken von 1 Hz übertragen, wenn das Armaturenbrett einen Fehler am Tankgeber erkennt. Mit TVFSTA = 2 s kann in diesem Fall das Signal "Tank leer" erzeugt werden.

Ein weiteres Bit "B_talval" gibt an, ob B_tal sicher validiert ist. Es wird erst dann gesetzt, wenn beide Entprellungen durchlaufen sind, also das Flip-Flop sicher gesetzt oder rückgesetzt werden soll.

APP GGFST 16.10 Application hint

```
Applikationsvorschlag:
----------------------
TWNTAL:         60 sec
TWNSTA:         30 sec
TVFSTA:          2 sec (sofern Signal im Fehlerfall mit 1 Hz blinkt)
```

GGDST 3.10 pickup tank pressure sensor

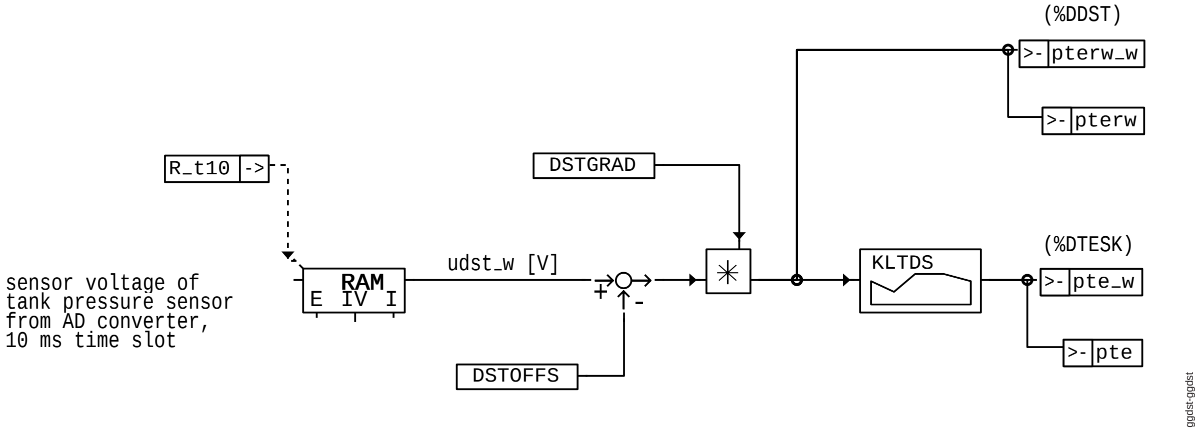
FDEF GGDST 3.10 Function definition

Overview program environement:

```
                               sensor
                        +---+  voltage  +--------+   pte_w   +--------+
pressure sensor ------->|ADC+---------->| %GGDST |----+----->| %DTESK |
                        +---+           +--------+    |      +--------+
                                                      |
                                                      |   pte   +-----+
                                                      --------->| TEB |
                                                                +-----+
```

brief description:

The analog signal of a tank pressure sensor is converted via an ADC (scanned in 10 ms time schedule) into an 10 Bit RAM-Cell. The voltage of the pressure sensor udst is converted by an offset DSTOFFS and and gradient DSTGRAD into the tank pressure rough signal pterw_w (16 Bit) and pterw (8 Bit). The (programmable) characteristic line KLTDS converts the signal into the pressure sensor signal of the DS-T2 (pte, pte_w).



ggdst-ggdst

ABK GGDST 3.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DSTGRAD			FW	gradient for conversion voltage -> pressure of tank pressure sensor
DSTOFFS			FW	offset for conversion voltage -> pressure of tank pressure sensor
KLTDS	PTERW_W		KL	Conversion line for tank pressure sensor DS-T2

Variable	Source	Type	Description
PTE	GGDST	AUS	tank pressure (from ADC)
PTERW	GGDST	AUS	tank pressure rough value (8 bit)
PTERW_W	GGDST	AUS	tank pressure rough value (16 bit)
PTE_W	GGDST	AUS	tank pressure (16 Bit)
R_T10		EIN	Time schedule 10 ms

FW GGDST 3.10 Fixed Values

Parameter	Value	Description
DSTGRAD		gradient for conversion voltage -> pressure of tank pressure sensor
DSTOFFS		offset for conversion voltage -> pressure of tank pressure sensor

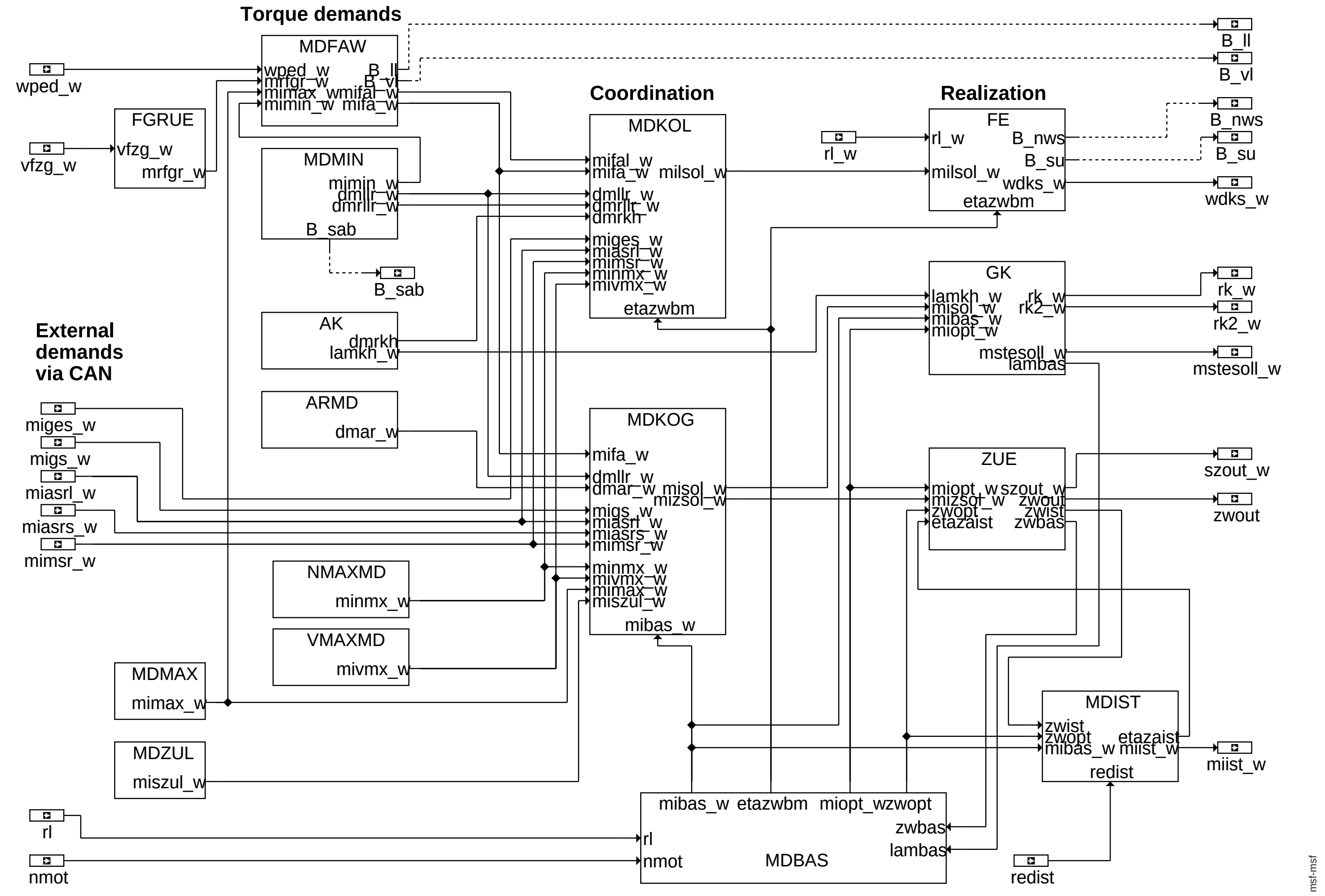
FB GGDST 3.10 Detailed description of function

APP GGDST 3.10 Application hint

```
APPLICATION of the function


The Bosch DS-T2 has got the following physical range: -30.0 hPa...+31.3 hPa (voltage range: 0...5 V). This leads
to the conversion formula:
        U(V) = 2/25*p(hPa) + 5/2

That means for
        - DSTGRAD := 25/2
        - DSTOFFS := 5/2
```

MSF 4.42 Engine control functions

FDEF MSF 4.42 Function definition



msf-msf

ABK MSF 4.42 Abbreviations

Variable	Source	Type	Description
B_LL	MSF	AUS	Condition idle
B_NWS	MSF	AUS	Condition camshaft control
B_SAB	MSF	AUS	Condition fuel cut-off requested
B_SU	MSF	AUS	condition intake manifold switch-over
B_VL	MSF	AUS	Condition for wide open throttle
DMAR_W	MSF	AUS	delta torque anti-jerk
DMLLR_W	LLRRM	EIN	desired torque change from the idle speed control (PD-part)
DMRKH	MSF	AUS	torque reserve for catalyzer heating
DMRLLR_W	LLRMR	EIN	torque reserve for idle speed control
ETAZAIST	MSF	AUS	actual cylinder masking effectiveness
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
LAMBAS	MSF	AUS	basic Lambda
LAMKH_W	MSF	AUS	Lambda engine nominal at catalyst heating (word)
MIASRL_W	SWADAP	EIN	desired indicated torque from ASR for slow intervention
MIASRS_W	SWADAP	EIN	desired indicated torque from ASR for quick intervention
MIBAS_W	MDBAS	EIN	indicated basic torque
MIFAL_W	MSF	AUS	Indicated driver's wish torque for torque coordination cylinder filling
MIFA_W	MSF	AUS	desired indicated engine torque
MIGES_W	SWADAP	EIN	desired indicated torque for transmission protection
MIGS_W	SWADAP	EIN	desired indicated torque form GS for quick intervention
MIIST_W	MSF	AUS	indicated real engine torque
MILSOL_W	MDKOL	EIN	driver torque request for charge
MIMAX_W	MDMAX	EIN	maximum attainable indicated torque
MIMIN_W	MDMIN	EIN	Minimal engine torque
MIMSR_W	SWADAP	EIN	desired indicated torque from MSR
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W	MSF	AUS	indicated resultant nominal torque
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
MIZSOL_W	MSF	AUS	indicated resultant nominal torque for ignition angle intervention
MRFGR_W	MSF	AUS	relative torque demand from cruise control

Variable	Source	Type	Description
MSTESOLL_W	MSF	AUS	desired purge mass flow
NMOT	SWADAP	EIN	engine speed
REDIST	BGEVAB	EIN	real cylinder cut-off step
RK2_W	MSF	AUS	relative fuel mass Bank2
RK_W	MSF	AUS	relative fuel mass
RL	SWADAP	EIN	relative air charge
RL_W	EGFE	EIN	relative air charge (Word)
SZOUT_W	MSF	AUS	dwell time
VFZG_W	GGVFZG	EIN	Vehicle speed
WDKS_W	MSF	AUS	desired throttle angle w.r.t. to lower mechanical stop
WPED_W	SWADAP	EIN	normed angle acceleration pedal
ZWBAS	ZUE	EIN	basic ignition angle
ZWIST	ZUE	EIN	real ignition angle
ZWOPT	MSF	AUS	optimal ignition angle
ZWOUT	MSF	AUS	Ignition angle output value

FW MSF 4.42 Fixed Values

Parameter	Value	Description

FB MSF 4.42 Detailed description of function

The structure of the functions based on the torque comprise a series of function which place requirements on the engine torque: Driver request (MDFAW), minimum torque for start and idling control (MDMIN), exhaust gas/catalyst functions (AK), driving comfort functions such as anti-jerk (ARMD), external requirements from ASR, MSR, transmission control communicated via CAN and limiting functions for engine speed and velocity (NMAXMD, VMAXMD).

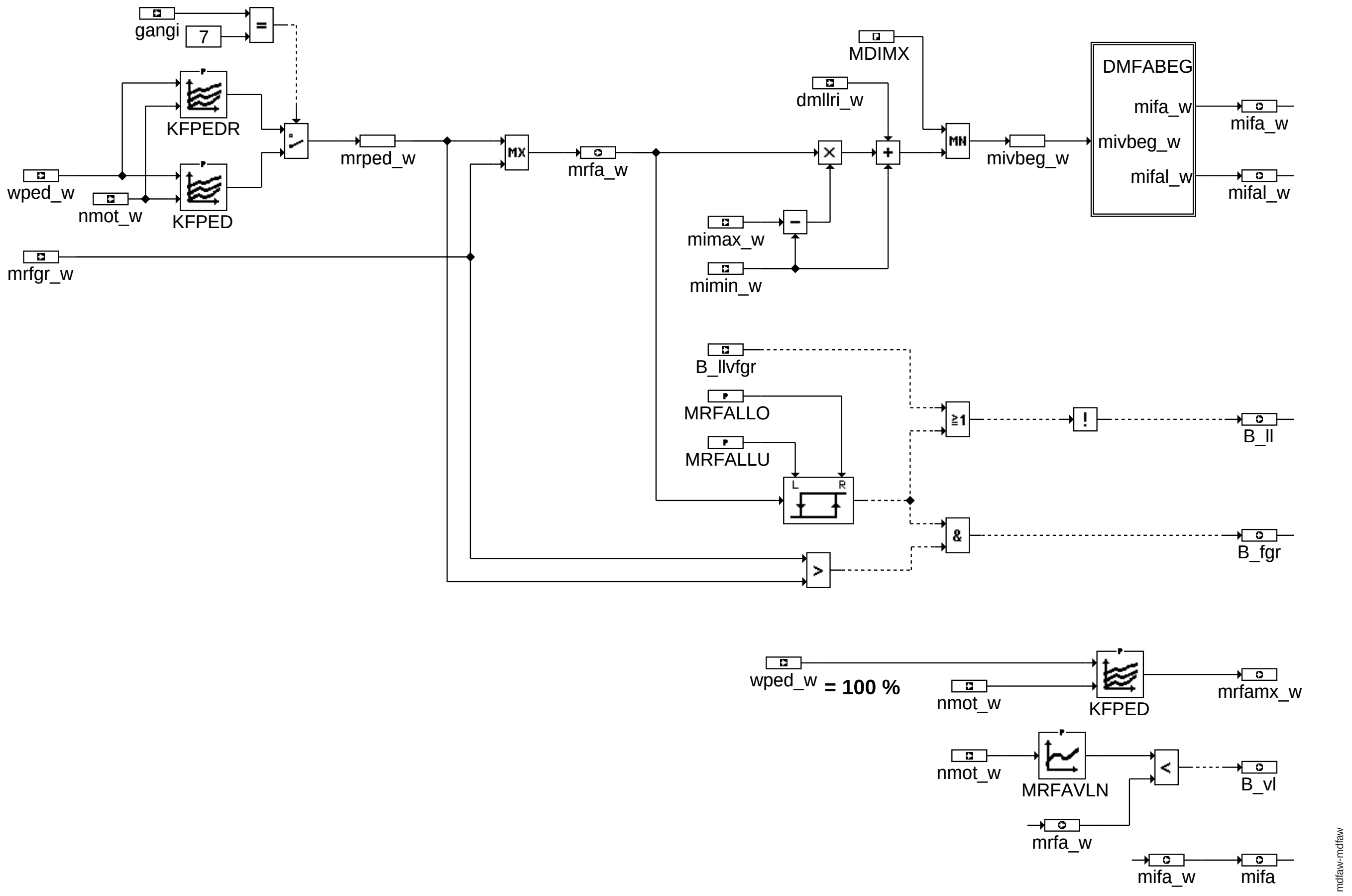
The coordination of these requirements is performed in the functions MDKOL for the air path and in MDKOG as the overall coordination. The selected nominal torques are implemented in the groups FE (filling interventions), GK (mixture control) and ZUE (ignition) in the correcting variables throttle position, injection time and injection angle.

The function MDBAS provides the primary quantities for the torque model, such as optimum torque, optimum ignition angle etc. MDIST calculates the actual internal torque set.

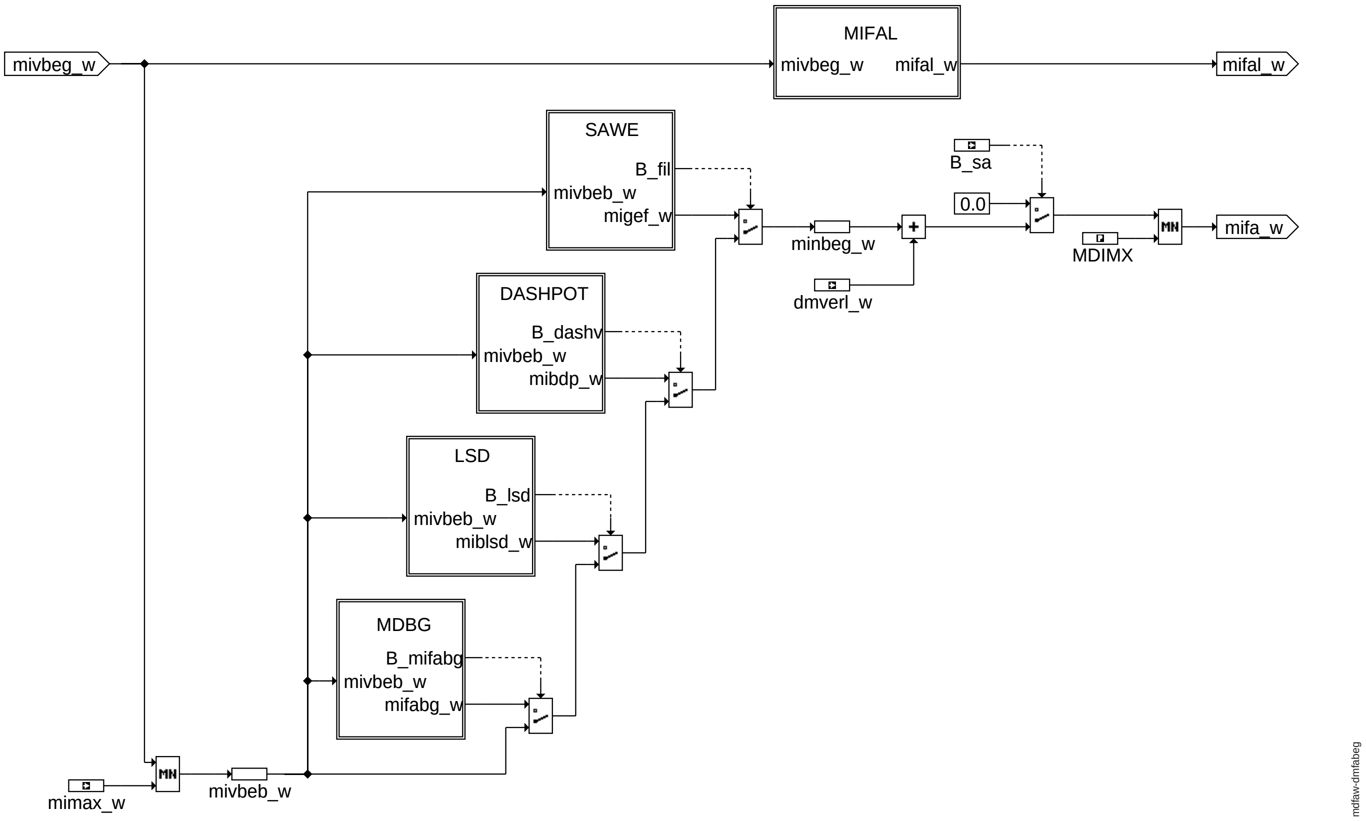
APP MSF 4.42 Application hint

MDFAW 12.120 Calculation of vehicle-operator demand

FDEF MDFAW 12.120 Function definition

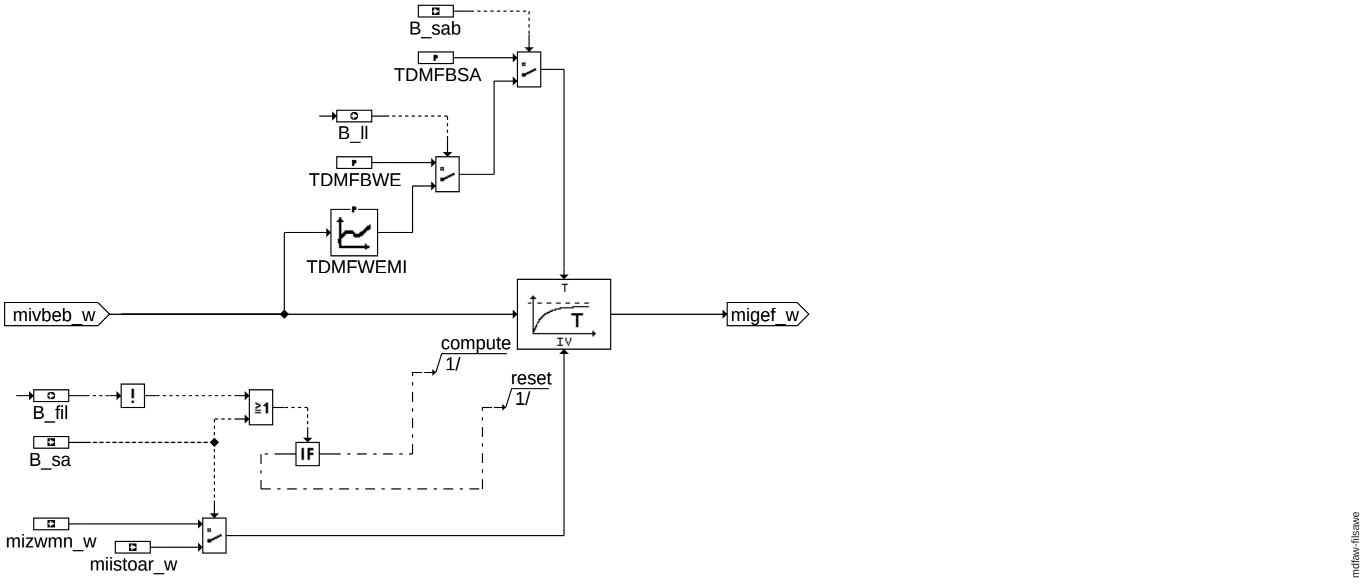


mdfaw-mdfaw



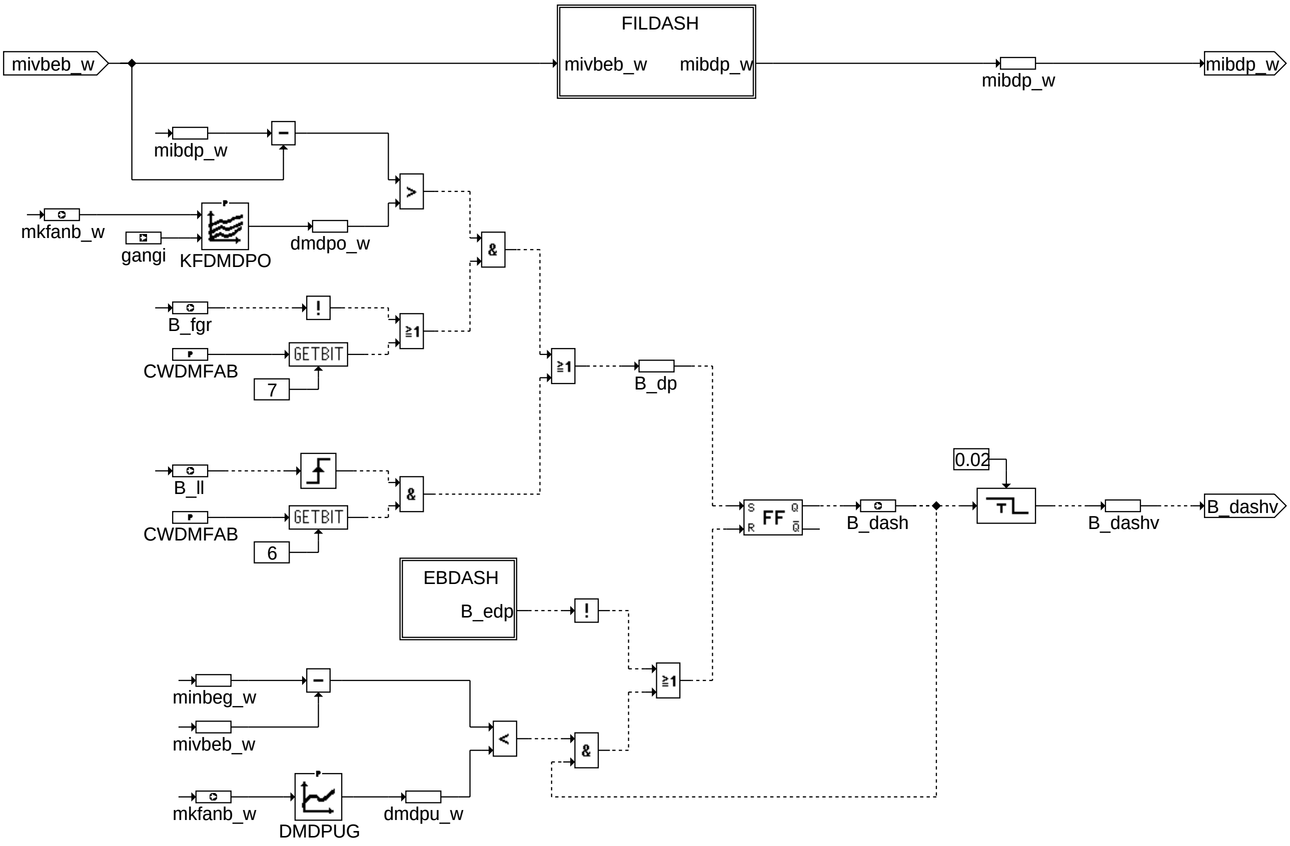
mdfaw-dmfabeg

`Subfunction DMFABEG: Slope limitation of the torque requested by the driver`



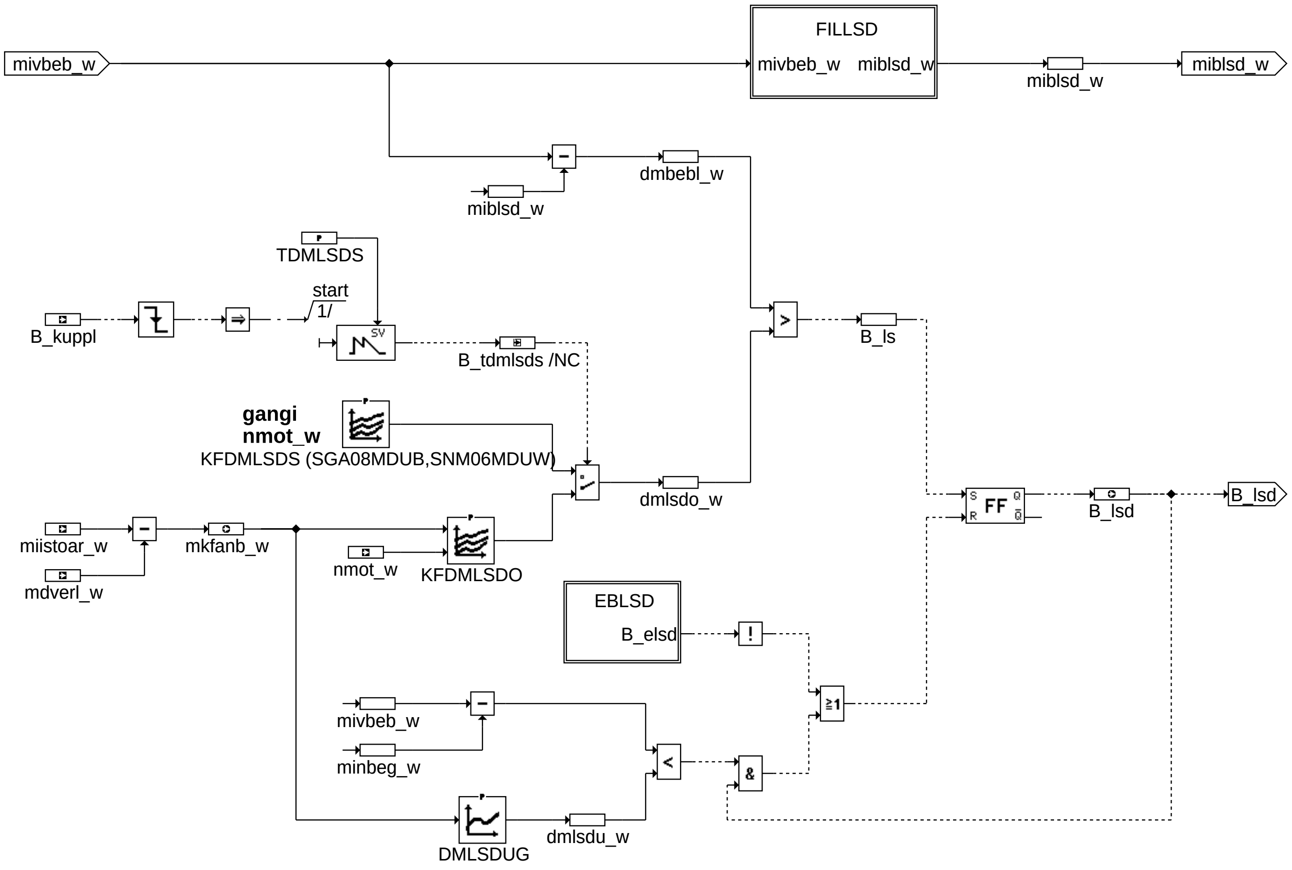
mdfaw-filsawe

`Subfunction FILSAWE: Low pass filter at transition to or from fuel cut off`



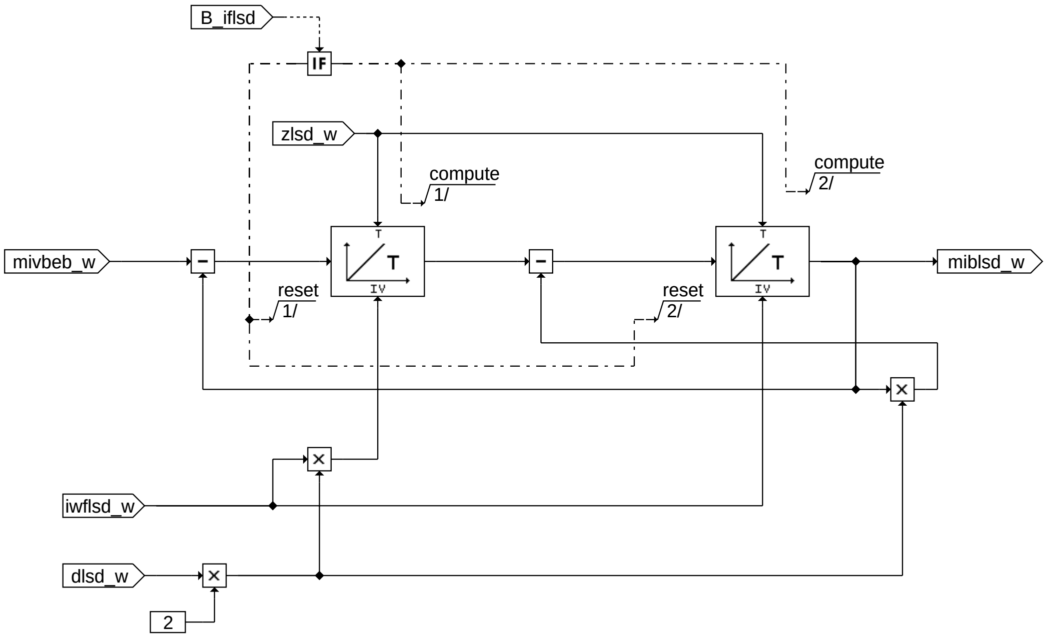
mdfaw-dashpot

`Subfunction DASHPOT: Slope limitation in case of transition from part/full load to coasting`



mdfaw-lsd

`Subfunction LSD: Slope limitation in case of transition from coasting to part/full load`



mdfaw-pt2fil

`Subfunction PT2FIL: PT2 filter for positive slope limitation`

ABK MDFAW 12.120 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDMFAB			FW	code word software switch for slope limitation
DMDPUG	MKFANB_W		KL	delta torque threshold end of dashpot
DMIFLSD			FW	delta torque for initialization of filter load-shock damping
DMLSDUG	MKFANB_W		KL	Delta torque for finishing positive slope limitation
DMRFAWE			FW	Threshold of the mrfa-gradient for deactivation PT1-filter at fuel cut in
DRLMINDP			FW	Offset to rlmin for deactivation of dashpot
FZDASHTM	TMOT		KL	factor for time constant dashpot
KFDLSD	GANGI	NMOT_W	KF	Damping of PT2 filter in positive torque slope limitation
KFDMDPO	MKFANB_W	GANGI	KF	Delta torque for starting negative slope limitation
KFDMLSDO	MKFANB_W	NMOT_W	KF	Delta torque for starting positive slope limitation
KFDMLSDS	GANGI	NMOT_W	KF	delta torque for triggering of load-shock damping after shifting procedure
KFMIFABG	MKFA_W	NMOT_W	KF	delta torque for gradient limitation
KFMIFALS	GANGI	MIFA_W	KF	Indicated driver's request torque for charge path at load-shock damping
KFMILSD	MIVBEB_W	NMOT_W	KF	Initial value for positive torque slope limitation
KFPED	WPED_W	NMOT_W	KF	accelerator pedal characteristic
KFPEDR	WPED_W	NMOT_W	KF	Pedal characteristic for reverse gear (only automatic transmission)
KFZDASH	GANGI	NMOT_W	KF	Time constant for negative torque slope limitation
KFZDASH2	GANGI	NMOT_W	KF	time constant PT1-filter dashpot at low clutch torque
KFZLSD	GANGI	NMOT_W	KF	Time constant for positive torque slope limitation
MDIMX			FW (REF)	maximum limit indicated engine torque
MIFABGMX			FW	maximum value mifa_w for limitation of torque change
MKFADPN	NMOT_W		KL	clutch torque for switch-over dashpot-filter time
MKFADPN1	NMOT_W		KL	clutch torque for switch-over dashpot-fil. time when AC comp. has been enabled
MKMIFABG			FW	clutch torque to activate the torque change limitation
MRFALLO			FW	Upper threshold of relative torque for idle detection
MRFALLU			FW	Lower threshold of relative torque for idle detection
MRFAVLN	NMOT_W		KL	Full load detection threshold of the relative driver request
NGFSAWE			FW	Threshold engine speed gradient for disabling filter for transition fuel cut-off
TDMFBSA			FW	Time constant PT1 filter for transition to fuel cut-off
TDMFBWE			FW	Time constant of PT1 filter for transition from fuel cut-off
TDMFWEMI	MIVBEB_W		KL	filter-time constant at hard fuel cut-in
TDMLSDS			FW	time after clutch was applied with changed LSD triggering
TVFSAWE			FW	Time delay until resetting of B_fil
VDASH			FW	Minimum speed for dashpot
VLSD			FW	Minimum speed for load-shock damping

Variable	Source	Type	Description
B_ASR	MDKOG	EIN	condition for ASR active
B_DASH	MDFAW	AUS	condition: limitation of negative torque gradient active
B_DASHV	MDFAW	LOK	condition dashpot delayed
B_DP	MDFAW	LOK	Condition: Start of negative torque slope limitation
B_EDP	MDFAW	LOK	Condition: activation of negative torque slope limitation possible
B_ELSD	MDFAW	LOK	Condition activation of positive torque slope limitation possible
B_FGR	MDFAW	AUS	condition: driver's set engine torque determined by cruise control
B_FIL	MDFAW	AUS	condition: low pass filter for transition to or from fuel cut-off active
B_GWHS	BBGANG	EIN	Condition gear change on manual transmission vehicle
B_IFLSD	MDFAW	LOK	Condition : Initialisiation of Antijerking filter
B_KO		EIN	condition AC compressor authorised
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_KUPPLV	GGEGAS	EIN	Condition clutch delayed
B_LL	MDFAW	AUS	Condition idle
B_LLVFGR	FGRUE	EIN	Condition: Idling disabled by FGR
B_LS	MDFAW	LOK	Condition: Start of positive torque slope limitation
B_LSD	MDFAW	AUS	condition: limitation of positive torque gradient active
B_MGBGAKT	MDFAW	LOK	condition torque-gradient limitation active
B_MGBGET		EIN	Condition torque gradient limitation active
B_MIFABG	MDFAW	LOK	condition limitation of mifa
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_SA	MDRED	EIN	Condition fuel cut-off
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_SABFG	BBSAWE	EIN	condition fuel cut-off enable or release
B_STEND	BBSTT	EIN	condition end of start
B_VL	MDFAW	AUS	Condition for wide open throttle
B_VNULL	GGVFZG	EIN	condition vehicle at stillstand
DLSD_W	MDFAW	LOK	Damping of PT2 filter in positive torque slope limitation
DMBEBL_W	MDFAW	LOK	delta torque for triggering of load-shock damping
DMDPO_W	MDFAW	LOK	delta torque start of dashpot
DMDPU_W	MDFAW	LOK	delta torque end of dashpot
DMGBEG_W	MDFAW	LOK	delta torque for gradient limitation
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DMLSDO_W	MDFAW	LOK	Delta torque for starting positive torque slope limitation
DMLSDU_W	MDFAW	LOK	Delta torque for finishing positive torque slope limitation
DMVERL_W	MDVER	EIN	Resistant torque after DT1-filter
FZDASH	MDFAW	LOK	factor for time constant dashpot
GANGI	SWADAP	EIN	Engaged gear
IWFLSD_W	MDFAW	LOK	Initial value for filter in positive torque slope limitation
MDGRAD_W		EIN	torque-gradient limitation by transmission
MDVERL_W	MDVER	EIN	Resistant torque of the engine
MIBDP_W	MDFAW	LOK	desired indicated engine torque dashpot
MIBLSD_W	MDFAW	LOK	Limited indicated torque of positive slope limitation
MIFA	MDFAW	AUS	desired indicated engine torque

Variable	Source	Type	Description
MIFABG_W	MDFAW	LOK	gradient-limited desired driver's torque
MIFAL_W	MDFAW	AUS	Indicated driver's wish torque for torque coordination cylinder filling
MIFA_W	MDFAW	AUS	desired indicated engine torque
MIGEF_W	MDFAW	LOK	Filtered indicated torque for transition to or from fuel cut-off
MIISTOAR_W	MDAUTG	EIN	Actual torque without anti-jerk component
MIMAX_W	MDMAX	EIN	maximum attainable indicated torque
MIMIN_W	MDMIN	EIN	Minimal engine torque
MINBEG_W	MDFAW	LOK	Indicated torque requested by driver after slope limitation
MIVBEB_W	MDFAW	LOK	Indicated torque before slope limitation, limited to mimax_w
MIVBEG_W	MDFAW	LOK	Indicated torque requested by driver before slope limitation
MIZWMN_W	MDRED	EIN	indicated engine torque at the latest spark angle
MKFANB_W	MDFAW	AUS	Clutch torque calculated from limited driver's request
MKFA_W	MDFAW	LOK	desired driver's torque (clutch) after change limitation
MRFAMX_W	MDFAW	AUS	Relative torque request by driver maximum value
MRFA_W	MDFAW	AUS	relative driver request torque from cruise control and pedal, =0 in limp-home
MRFGR_W	MSF	EIN	relative torque demand from cruise control
MRPED_W	MDFAW	LOK	Relative torque request by accelerator pedal
NGFIL_W	SWADAP	EIN	filtered engine-speed gradient
NMOT_W	SWADAP	EIN	engine speed
RLMINDP_W	MDFAW	LOK	minimum relative charge for dashpot deactivation
RLMIN_W	MDFUE	EIN	minimum permissible rl
RL_W	EGFE	EIN	relative air charge (Word)
TMOT	SWADAP	EIN	Engine temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)
WPED_W	SWADAP	EIN	normed angle acceleration pedal
ZDASH_W	MDFAW	LOK	time constant for dashpot
ZLSD_W	MDFAW	LOK	Time constant of filter in positive torque slope limitation

FW MDFAW 12.120 Fixed Values

Parameter	Value	Description
CWDMFAB		code word software switch for slope limitation
DMIFLSD		delta torque for initialization of filter load-shock damping
DMRFAWE		Threshold of the mrfa-gradient for deactivation PT1-filter at fuel cut in
DRLMINDP		Offset to rlmin for deactivation of dashpot
MIFABGMX		maximum value mifa_w for limitation of torque change
MKMIFABG		clutch torque to activate the torque change limitation
MRFALLO		Upper threshold of relative torque for idle detection
MRFALLU		Lower threshold of relative torque for idle detection
NGFSAWE		Threshold engine speed gradient for disabling filter for transition fuel cut-off
TDMFBSA		Time constant PT1 filter for transition to fuel cut-off
TDMFBWE		Time constant of PT1 filter for transition from fuel cut-off
TDMLSDS		time after clutch was applied with changed LSD triggering
TVFSAWE		Time delay until resetting of B_fil
VDASH		Minimum speed for dashpot
VLSD		Minimum speed for load-shock damping

FB MDFAW 12.120 Detailed description of function

The function calculates the indicated torque requested by the driver dependent on accelerator pedal position and state of cruise control. The torque coordination air flow and the torque coordination injection/ignition get separate torque requests (mifal_w and mifa_w). Additional important inputs are the minimal necessary indicated torque (depending on engine friction and additional consumers like e.g. the A/C-compressor) and the maximal possible indicated torque (depending on engine speed, boost control and ambient air density).

The pedal characteristic is stored in the map KFPED. From accelerator pedal position and engine speed, a factor (relative torque request) in the range of 0 to 2 is generated (mrped_w). 0 is corresponding to the request of the minimal indicated torque, while 1 is corresponding to the request of the maximal indicated torque. Values between 0 and 1 lead to a linear interpolation. The setting signal of the cruise control is also a relative torque request (mrfgr_w) that becomes important if it is higher than mrped_w. In this case, B_fgr is set.

The condition idle (B_ll) is set if the relative torque request falls below of a threshold (close to 0). For this calculation, a hysteresis is used. The condition full load (B_vl) is set if the relative torque request is higher than the engine speed depending threshold MRFAVLN.

The task of subfunction DMFABEG is the limitation of torque gradient in order to avoid the jerking caused by transitions between coasting and part/full load with high torque gradient. The limitation takes effect only for the area where the gearbox output torque changes its sign. The limitation is especially necessary for vehicles with manual transmission. The function is only active if several conditions are fulfilled. It can be deactivated by a software switch (CWDMFAB). The low pass serves to avoid discontinuous steps of engine torque at transition to or from fuel cut-off.

The I-quota of idle speed control and the differential engine torque loss (DT1 filter) are added after the slope limitation in order to avoid steps of the clutch torque when consumers like the A/C-compressor are switched on or off.

APP MDFAW 12.120 Application hint

- MRFALLO and MRFALLU have to be set close to 0 and with little distance to each other.

- IGEGANG contains at first the transmission ratio for each gear. These values can be slightly changed for a fine application.

- TDMFABEG has to be some seconds (slow filter).

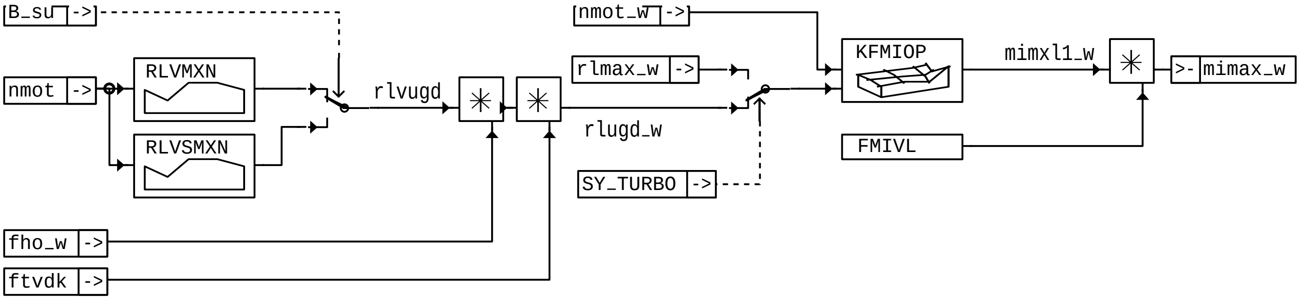
- CWDMFAB serves to switch on or off the slope limitation (bit 0 for positive slope limitation active, bit 1 for negative slope limitation active)

- The slope of the characteristic curves for constant engine speed in KFDMDP must not be higher 1.

- The slope of the characteristic curves for constant engine speed in KFDMLSD must not be less -1.

MDMAX 1.30 Calculation maximum torque

FDEF MDMAX 1.30 Function definition



mdmax-mdmax

ABK MDMAX 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FMIVL			FW	factor correction maximum torque full load
KFMIOP	NMOT_W	RL_W_KGE	KF	map optimum engine torque
RLVMXN	NMOT		KL	maximum volumetric flow with open throttle valve
RLVSMXN	NMOT		KL	maximum volumetric flow with open throttle valve and SU

Variable	Source	Type	Description
B_SU	SU	EIN	condition intake manifold switch-over
FHO_W	BGPU	EIN	correction factor: altitude
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
MIMAX_W	MDMAX	AUS	maximum attainable indicated torque
MIMXL1_W	MDMAX	LOK	maximum optimal torque at lambda = 1
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
RLMAX_W		EIN	maximum attainable charge with turbo
RLUGD_W	MDMAX	LOK	charge under unthrottled condition
RLVUGD	MDMAX	LOK	uncorrected charge in unthrottled condition
SY_TURBO	PROKON	EIN	system constant for turbocharged engine

FW MDMAX 1.30 Fixed Values

Parameter	Value	Description
FMIVL		factor correction maximum torque full load

FB MDMAX 1.30 Detailed description of function

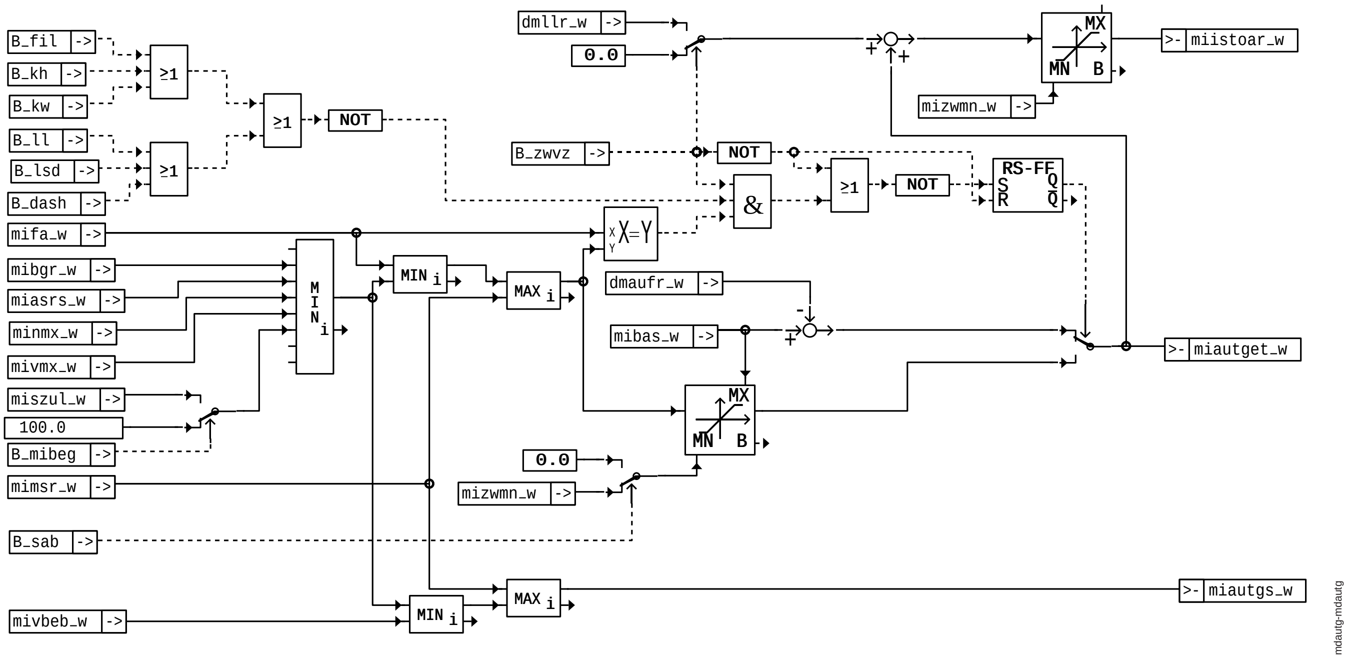
The maximum volumetric charge rlvugd at unthrottled engine operation is taken from the characteristic RLVMXN resp. from the characteristic RLVMXSN dependent on the position of the manifold switch-over. Thereafter the conversion into the charge rlugd_w is performed by altitude- and temperature-correction. For configurations with turbo charger (SY_TURBO=1), the maximum charge rlmax_w is predefined directly. The maximum charge now is input variable for the map KFMIOP, in which the optimum torque is stored over speed and charge. The thus obtained torque mimxl1_w is corrected by the factor FMIVL, which indicates the torque increase at full load and the maximum torque mimax_w is obtained.

APP MDMAX 1.30 Application hint

Determination of the characteristics RLVMXN resp. RLVSMXN: Measurement of rl at speed base points and open throttle valve. Conversion into corresponding rlv by division by the factors ftvdk and fho_w (load sensing must already have been adjusted), entry into the respective characteristic. Application hint for the map KFMIOP cf. %MDBAS.

MDAUTG 2.60 Calculation of torque actual value for gear control

FDEF MDAUTG 2.60 Function definition



mdautg-mdautg

For tuning of the transmission a computed engine torque is calculated, for which the influence of the transmission intervention was not taken into account. A "desired toque" as well as an "actual torque" is calculated for the transmission control in this function.

ABK MDAUTG 2.60 Abbreviations

Variable	Source	Type	Description
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_FIL	MDFAW	EIN	condition: low pass filter for transition to or from fuel cut-off active
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KW	BBKHZ	EIN	Condition catalyst warming
B_LL	MSF	EIN	Condition idle
B_LSD	MDFAW	EIN	condition: limitation of positive torque gradient active
B_MIBEG	MDKOG	EIN	condition torque limit active
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_ZWVZ	MDKOG	EIN	condition for ignition angle intervention of torque interface
DMAUFR_W		EIN	delta torque rise
DMLLR_W	LLRRM	EIN	desired torque change from the idle speed control (PD-part)
MIASRS_W	SWADAP	EIN	desired indicated torque from ASR for quick intervention
MIAUTGET_W	MDAUTG	AUS	Engine torque without torque intervention
MIAUTGS_W	MDAUTG	AUS	Target engine torque without transmission intervention
MIBAS_W	MDBAS	EIN	indicated basic torque
MIBGR_W	MDBGRG	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIFA_W	MSF	EIN	desired indicated engine torque
MIISTOAR_W	MDAUTG	AUS	Actual torque without anti-jerk component
MIMSR_W	SWADAP	EIN	desired indicated torque from MSR
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MIVBEB_W		EIN	Indicated torque before slope limitation, limited to mimax_w
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
MIZWMN_W	MDRED	EIN	indicated engine torque at the latest spark angle

FW MDAUTG 2.60 Fixed Values

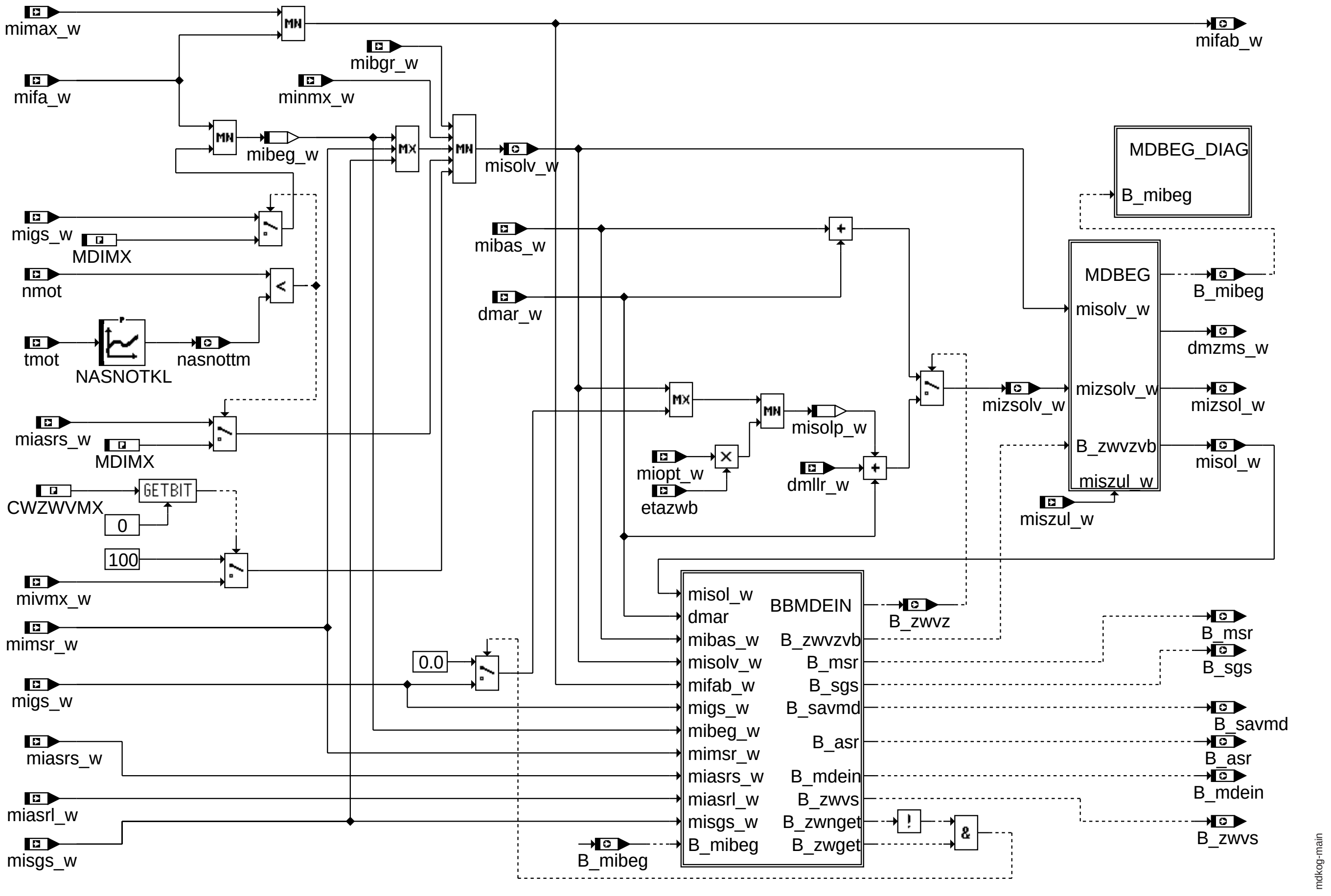
Parameter	Value	Description

FB MDAUTG 2.60 Detailed description of function

APP MDAUTG 2.60 Application hint

MDKOG 1.190 Coordination torque intervention

FDEF MDKOG 1.190 Function definition



mdkog-main

```
Subfunction BBMDEIN: Conditions torque intervention active
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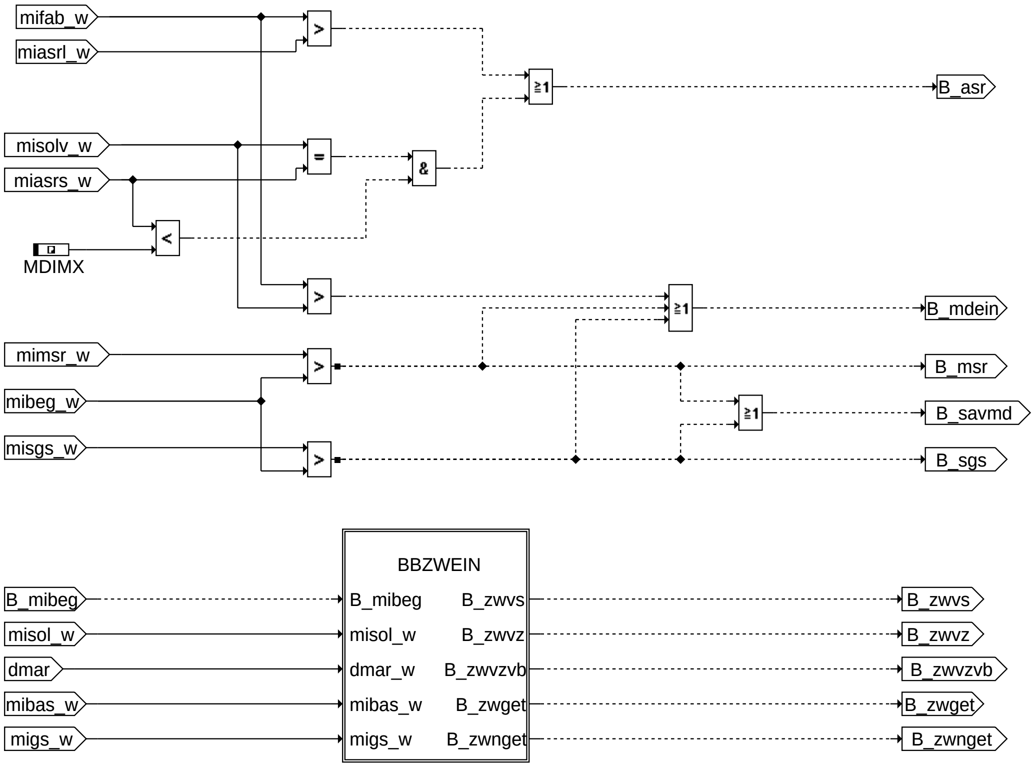
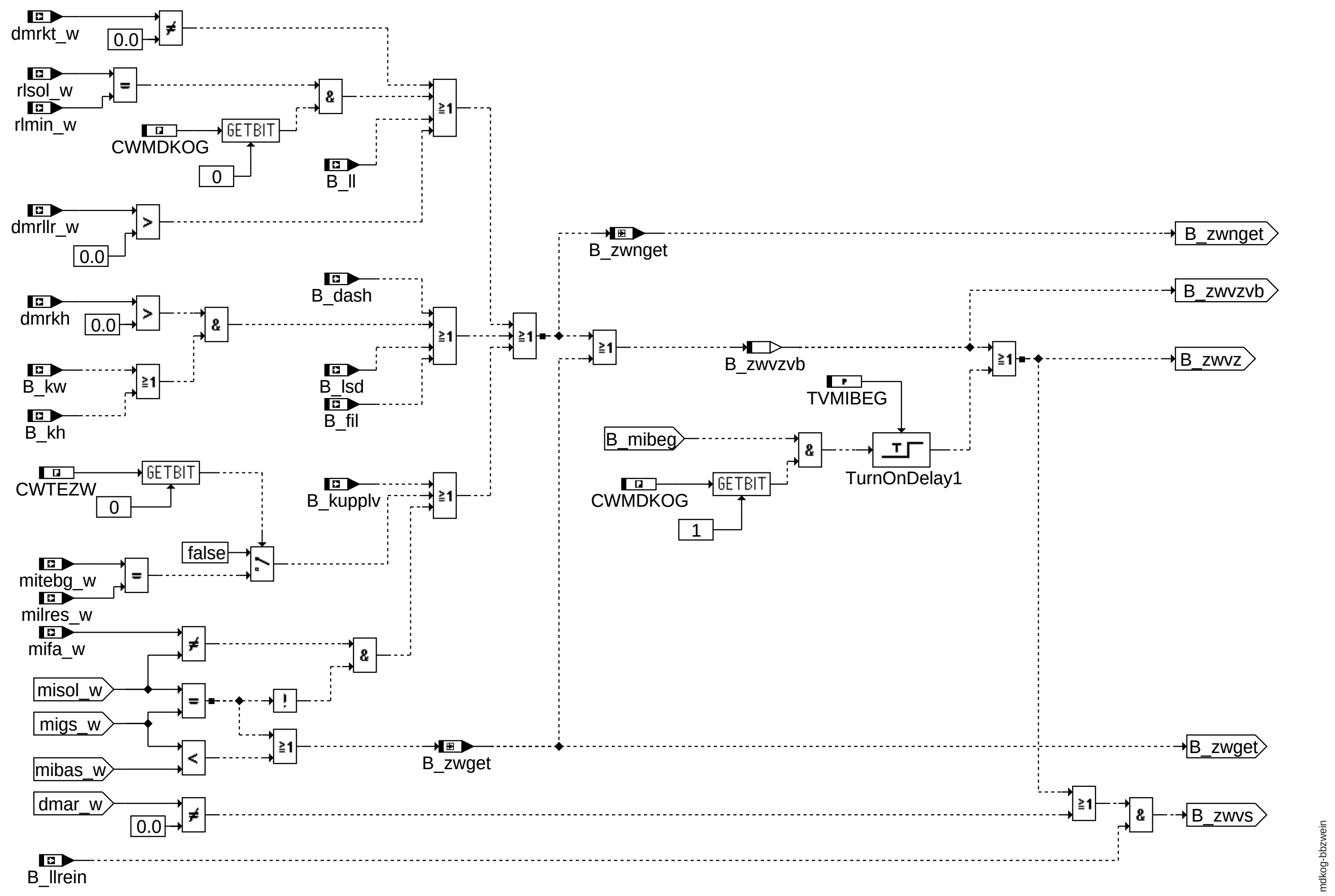


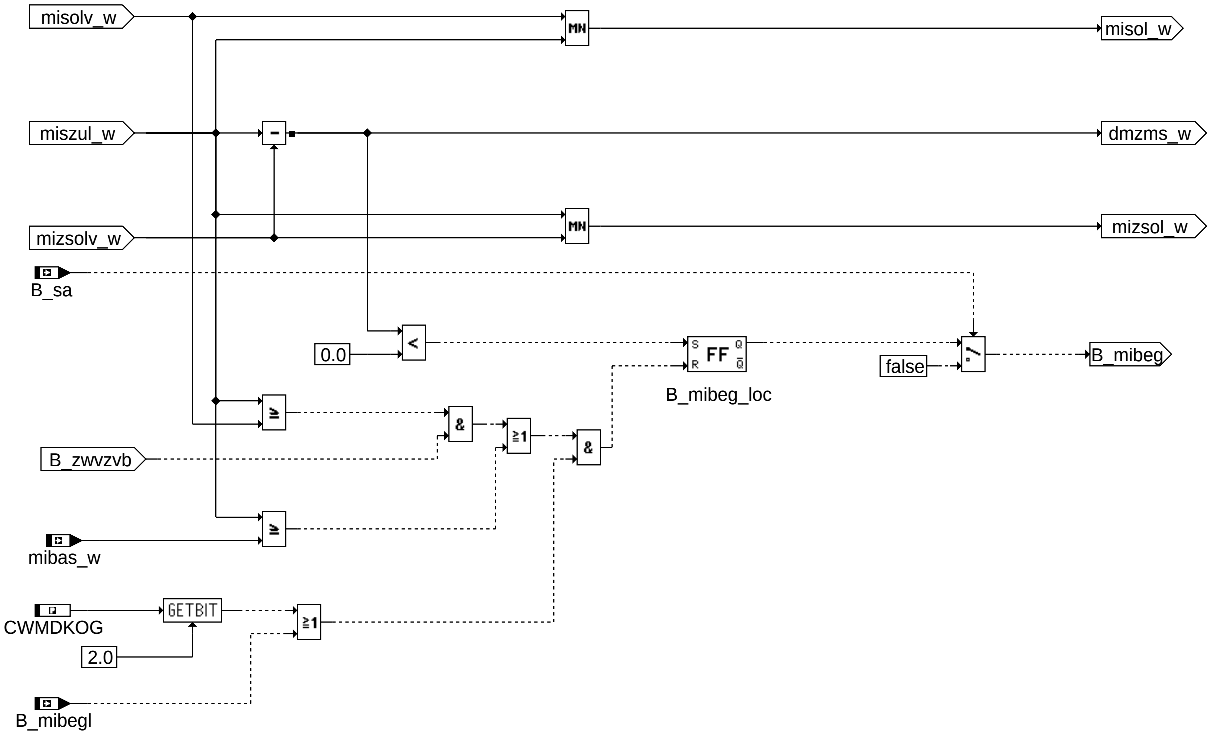
mdkog-bbmdein

`Subfunction BBZWEIN: Conditions for ignition angle intervention active`
`--------------------------------------------------------------------`



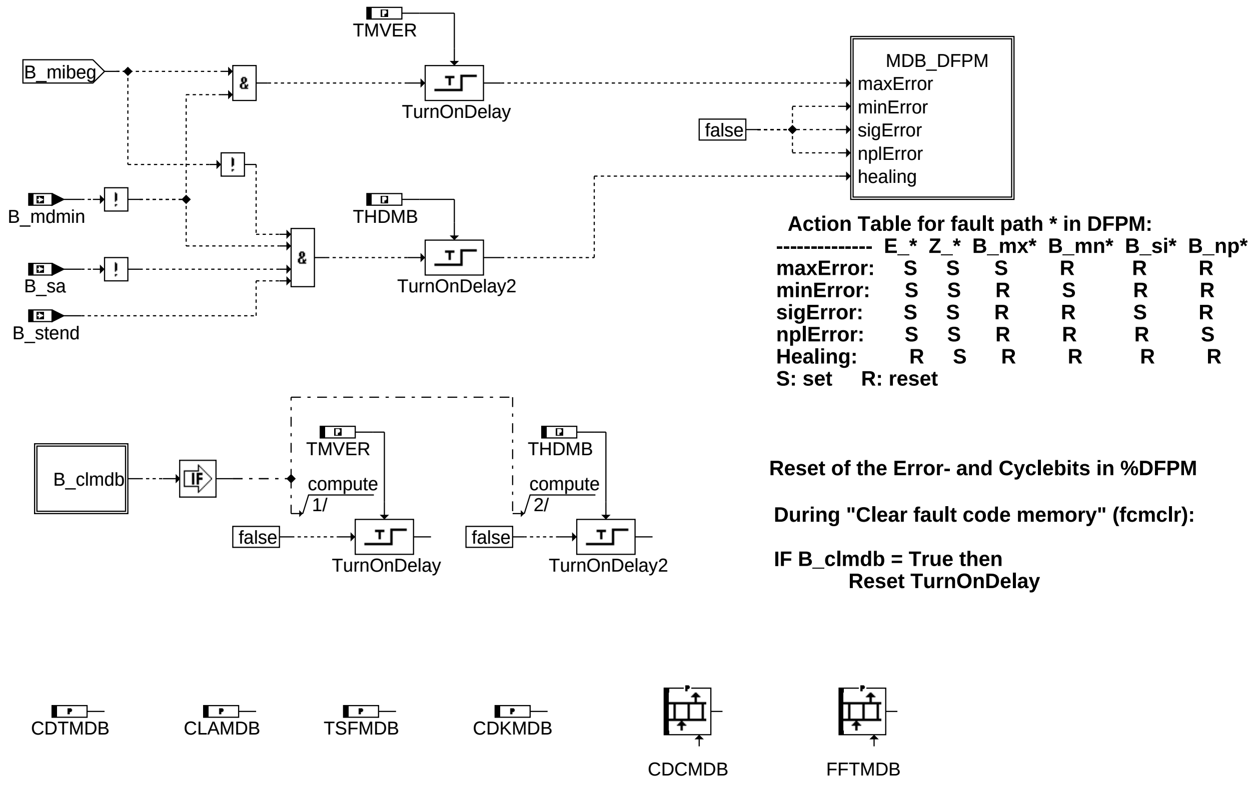
mdkog-bbzwein

`Subfunction MDBEG: Limitation of indicated torque`



mdkog-mdbeg

`Subfunction MDBEG_DIAG: Connection of torque limitation with diagnosis`



Action Table for fault path * in DFPM:

-------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	S	S	S	R	R	R
minError:	S	S	R	S	R	R
sigError:	S	S	R	R	S	R
nplError:	S	S	R	R	R	S
Healing:	R	S	R	R	R	R

S: set R: reset

Reset of the Error- and Cyclebits in %DFPM

During "Clear fault code memory" (fcmclr):

IF B_clmdb = True then
Reset TurnOnDelay

mdkog-mdbeg-diag

ABK MDKOG 1.190 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCMDB	BLOKNR		KL	Code word CARB: Target torque limitter
CDKMDB			FW	code word customer: Target torque limitter
CDTMDB			FW	code word tester: Target torque limitter
CLAMDB			FW	error class: Target torque limitter
CWMDKOG			FW (REF)	code word MDKOG: ignition timing adjusted to retard for limiting vacuum
CWTEZW			FW (REF)	code word: ignition angle intervention at test of canister-purge valve
CWZWVMX			FW (REF)	code word: ignition-timing intervention for VMAX limiting
FFTMDB	BLOKNR		KL	freeze frame table: Target torque limitter
MDIMX			FW (REF)	maximum limit indicated engine torque
NASNOTKL	TMOT		KL	characteristic line rotational speed against engine stall
THDMB			FW (REF)	dwell time, healing for fault path for permanent torque limitation
TMVER			FW (REF)	Debounce time: ETC torque limitation is activ for a longer time
TSFMDB			FW	fault active time: Target torque limitter
TVMIBEG			FW	debounce time for activation of ignition intervention during torque limitation

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_ASR	MDKOG	AUS	condition for ASR active
B_BEMDB	MDKOG	AUS	condition MDB request
B_BKMDB	MDKOG	AUS	Condition: ETC-torque limitation is active
B_CLMDB		EIN	Flag for clearence: ETC torque limitation is activ
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_FIL	MDFAW	EIN	condition: low pass filter for transition to or from fuel cut-off active
B_FTMDB	MDKOG	AUS	Condition fault entry by tester for MDB
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KUPPLV	GGEGAS	EIN	Condition clutch delayed
B_KW	BBKHZ	EIN	Condition catalyst warming
B_LL	MSF	EIN	Condition idle
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LSD	MDFAW	EIN	condition: limitation of positive torque gradient active
B_MDEIN	MDKOG	AUS	Condition actions on the torque are active
B_MDMIN	SWADAP	EIN	Condition minimal possible indicated torque reached
B_MIBEG	MDKOG	AUS	condition torque limit active
B_MIBEGL	MDKOL	EIN	condition torque limitation charge path active
B_MNMDB	MDKOG	AUS	Fault type min.: ETC torque limitation is active
B_MSR	MDKOG	AUS	Condition MSR
B_MXMDB	MDKOG	AUS	Fault type max.: ETC torque limitation is activ for a longer time
B_NPMDB	MDKOG	AUS	not plausible error: ETC torque limitation is activ
B_SA	MDRED	EIN	Condition fuel cut-off
B_SAVMD	MDKOG	AUS	flag: fuel cut-off prohibition because of torque request
B_SGS	MDKOG	AUS	condition: torque intervention for engine speed synchr. during gear shift
B_SIMDB	MDKOG	AUS	error type: ETC torque limitation is active
B_STEND	BBSTT	EIN	condition end of start
B_ZWGET	MDKOG	LOK	ignition angle intervention by gearbox
B_ZWNGET	MDKOG	LOK	ignition angle intervention not by gearbox
B_ZWVS	MDKOG	AUS	condition for fast external ignition angle intervention of torque interface
B_ZWVZ	MDKOG	AUS	condition for ignition angle intervention of torque interface
B_ZWVZVB	MDKOG	LOK	condition for ignition angle intervention of torque interface before limitation
DFP_MDB	MDKOG	DOK	ECU int. fault path no.: ETC torque limitation is active
DMAR_W	MSF	EIN	delta torque anti-jerk
DMLLR_W	LLRRM	EIN	desired torque change from the idle speed control (PD-part)
DMRKH	KHMD	EIN	torque reserve for catalyzer heating
DMRKT_W	MDTRIP	EIN	Torque reserve during quicktest
DMRLLR_W	LLRMR	EIN	torque reserve for idle speed control
DMZMS_W	MDKOG	AUS	difference between internal nominal engine torque and permissible nominal torque
ETAZWB	MDBAS	EIN	ignition angle effectiveness of basic ignition angle
E_MDB	MDKOG	AUS	error flag: ETC torque limitation is active
MIASRL_W	SWADAP	EIN	desired indicated torque from ASR for slow intervention
MIASRS_W	SWADAP	EIN	desired indicated torque from ASR for quick intervention
MIBAS_W	MDBAS	EIN	indicated basic torque
MIBEG_W	MDKOG	LOK	limit torque
MIBGR_W	MDBGRG	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIFAB_W	MDKOG	AUS	limited desired indicated engine torque
MIFA_W	MSF	EIN	desired indicated engine torque
MIGS_W	SWADAP	EIN	desired indicated torque form GS for quick intervention
MILRES_W	MDKOL	EIN	torque request for air path including all torque reserves
MIMAX_W	MDMAX	EIN	maximum attainable indicated torque
MIMSR_W	SWADAP	EIN	desired indicated torque from MSR
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISGS_W	CAN	EIN	desired internal torque for engine speed synchronization during gear shift
MISOLP_W	MDKOG	LOK	indicated nominal torque before limitation, local variable
MISOLV_W	MDKOG	AUS	indicated resultant nominal torque before torque limitation
MISOL_W	MDKOG	AUS	indicated resultant nominal torque
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
MITEBG_W	TEB	EIN	torque value for minimum charge canister purge
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
MIZSOLV_W	MDKOG	AUS	ind. torque for an ignition timing intervention before torque limiting
MIZSOL_W	MDKOG	AUS	indicated resultant nominal torque for ignition angle intervention
NASNOTTM	MDKOG	AUS	Speed threshold due to stalling protection as a function of tmot
NMOT	SWADAP	EIN	engine speed

Variable	Source	Type	Description
RLMIN_W	MDFUE	EIN	minimum permissible rl
RLSOL_W	MDFUE	EIN	desired relative air charge
SFPMDB	MDKOG	AUS	status fault path: ETC torque limitation is active
TMOT	SWADAP	EIN	Engine temperature
Z_MDB	MDKOG	AUS	Cycle flag: ETC torque limitation is active

FW MDKOG 1.190 Fixed Values

Parameter	Value	Description
CDKMDB		code word customer: Target torque limitter
CDTMDB		code word tester: Target torque limitter
CLAMDB		error class: Target torque limitter
TSFMDB		fault active time: Target torque limitter
TVMIBEG		debounce time for activation of ignition intervention during torque limitation

FB MDKOG 1.190 Detailed description of function

```
Coordination of requested engine torque
---------------------------------------
The calculated nominal engine torque misol_w induced by the torque coordination is used for calculation of the suppression
stage and/or for adjusting the ignition angle. The indicated torques requested from outside sources miasrs_w (from ASR, i.e.
traction slip control) and migs_w (from GS, i.e. gear shift) as well as the internal torque requests (e.g. driver torque, n-max
or v-max) are converted either by a minimum or a maximum selection into an indicated nominal engine torque misolv_w. The maximum
selection is performed before the minimum selection due to safety reasons. Thus a torque demand resulting from the maximum
selection can be limited by the minimum selection.

Should the engine speed drop to below NASNOTTM for a torque reduction by ASR or GS, then miext=MDIMX is selected immediately
such that both interventions are prohibited. NASNOTKL is a function of the engine temperature tmot.

The indicated nominal torque for the ignition intervention depends on the activation condition B_zwvz (see BBMDEIN):
 - If the ignition intervention is enabled mizsolv_w is calculated as follows:
   The nominal torque misolv_w is limited above by the product of opt. internal torque (incl. Lambda efficiency) and ignition
   angle efficiency (miopt_w*etazwb). Then the torque requests from the idling control dmllr_w
   (P and D components only) and from the anti-jerk function dmar_w are added.
 - If no ignition intervention is necessary, the basic torque mibas_w is used as nominal torque. It only depends on
   the efficiencies of ignition and mixture. Interventions of the anti-jerk function are also taken into account.


Hint:
-----
An increase of the torque demand can be perfromed via the interface misgs_w for synchronization of the engine speed due to an
intervention of transmission. An establishing of priorities for drag control (MSR), traction slip control (ASR) with misgs_w
is not performed in %MDKOG. If priorities are desired, these have to be defined muß in the function where the desired torque
misgs_w is generated (misgs_w has to be decreased linear to the desired torque demand).
```

Subfunction BBMDEIN: Conditions torque intervention active

The condition B_msr is set in addition to this for MSR intervention, such that trailing throttle cut off is not allowed (see %MDRED). For ASR intervention (traction-slip control), the condition B_asr is set so that a cylinder suppression is possible (see %MDRED). While an increasing torque demand for engine speed synchronization while transmission intervention is active the condition B_sgs is true. Thus overrun fuel cut off is vorbidden (cf. %MDRED). If the conditions B_msr or B_sgs are set, the overrun fuel cut off is vorbidden due to an increased torque demand (B_savmd = true). The condition B_mdein serves to disable the misfire detection (see %DASE) as well as to enable the anti-jerk function and idling control (for B_mdein=0).

For the release of torque adjustment through ignition angle intervention the activation conditions B_zwvz and B_zwvs are responsible.

- B_zwvz is set, if on the level of time schedule the requirement of an intervention is detected. This is the case in all operating conditions that require a torque reserve. These are idling, catalyst heating, short trip and the driveability functions dashpot, load shift damping and filtering before trailing throttle fuel cutoff. With disengaged clutch intervention is also enabled in order to prevent the engine from racing. All external interventions are detected through comparison of mifa_w and misol_w.
- B_zwvs is set, if there is either an intervention on time level or there is a torque request from the anti-jerk function. In this case the nominal value is not switched to misol_w, but in the function %MDZW (torque intervention through ignition) the intervention is activated.

Subfunction BBZWEIN: Conditions for ignition angle intervention active
----
see subfunction BBMDEIN

Subfunction MDBEG: Limitation of indicated torque

Both torques misolv_w and mizsolv_w are limited to the maximum permissible indicated torque miszul_w (from %MDZUL). By this it shall be achieved that the monitoring in the level 2 is only active if the (possibly limited) nominal torque is incorrectly converted into an actual torque. The dating of KFMIZU is matched to the permitted torques in level 2. Undesirable response by the torque surveillance can thus be prevented by this in the application phase in particular. It can be detected by recording B_mibeg whether a limitation of the nominal torques has been performed.

Subfunction MDBEG_DIAG: Connection of torque limitation with diagnosis
----
The function MDBEG_DIAG is part of the ETC monitoring concept (level 1).
The desired torque is limited to a maximum torque miszul_w in MDBEG. If the limitation is active the bit B_mibeg is set.
The level 1 limitation B_mibeg should only be active for a short time, e.g. when the engine is cold and the drivers request is in idle position. If the limitation B_mibeg is active for a longer time (for example 10 min), there may be a fault in the system and a diagnosis entry is made.

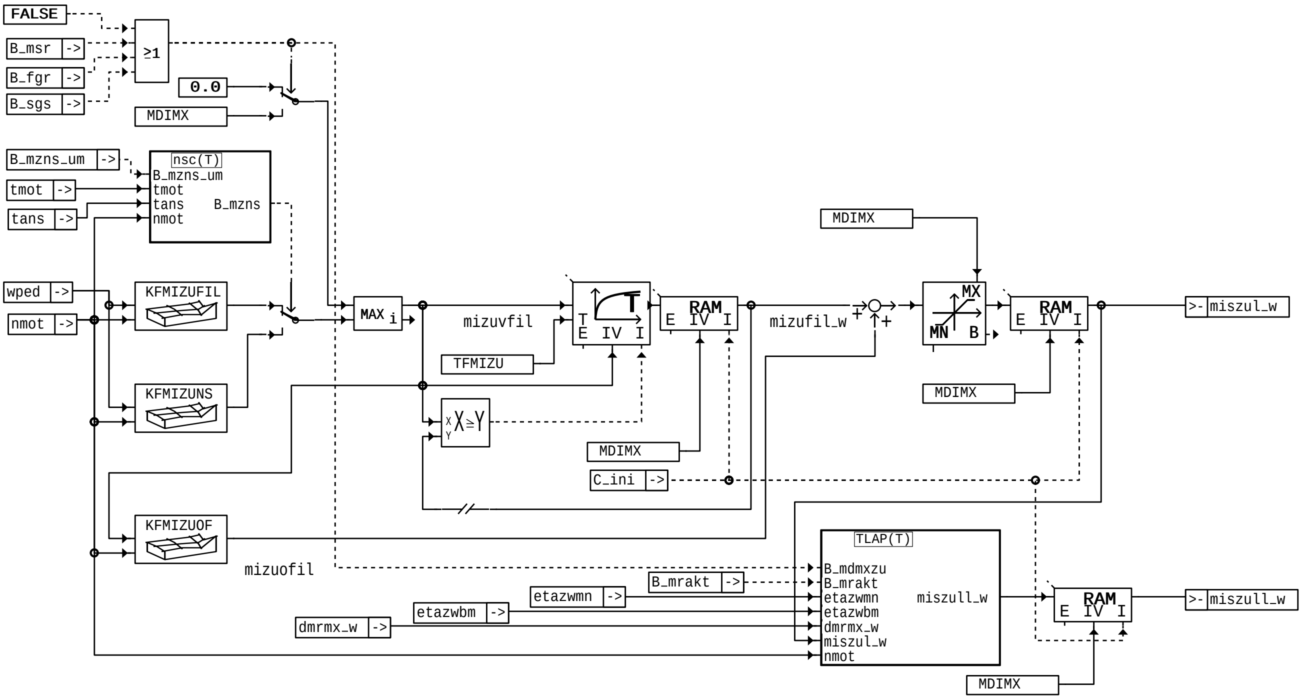
APP MDKOG 1.190 Application hint

Typical value:

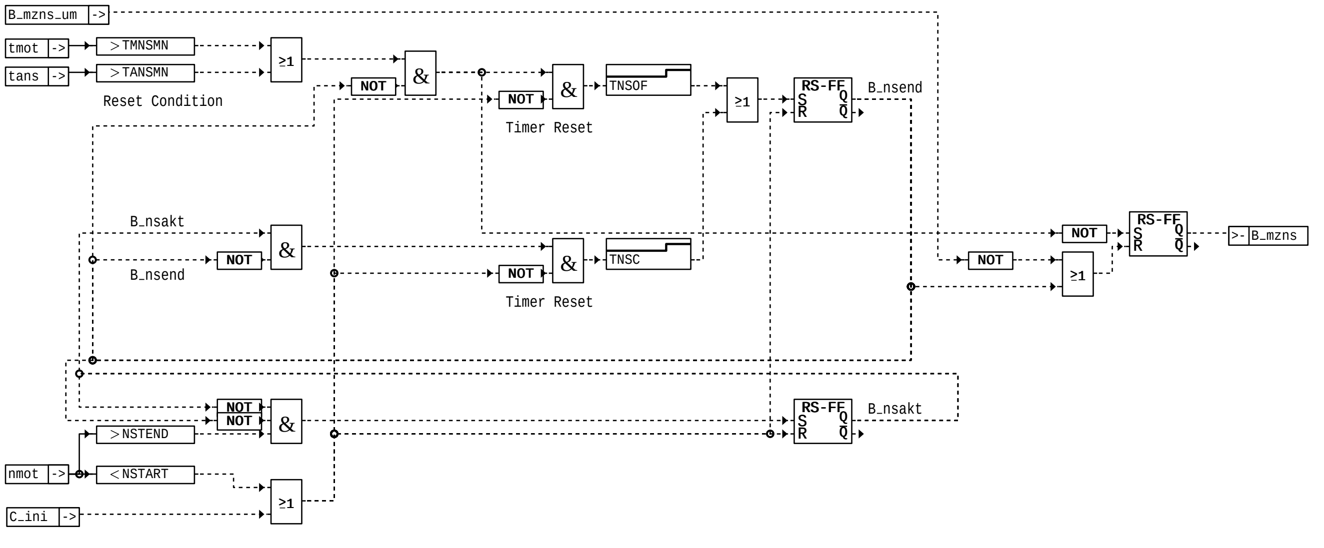
```
MDIMX = 99.6%
CWMDKOG = 6
NASNOTKL   tmot    |  -30  |   0   |   30  |   60  |
           --------+-------+-------+-------+-------+
           NASNOT  |  1500 |  900  |  600  |  600  |
The speed threshold NASNOTTM may not be greater than 2550 rpm.
```

MDZUL 4.21 Calculation of maximum permitted set torque

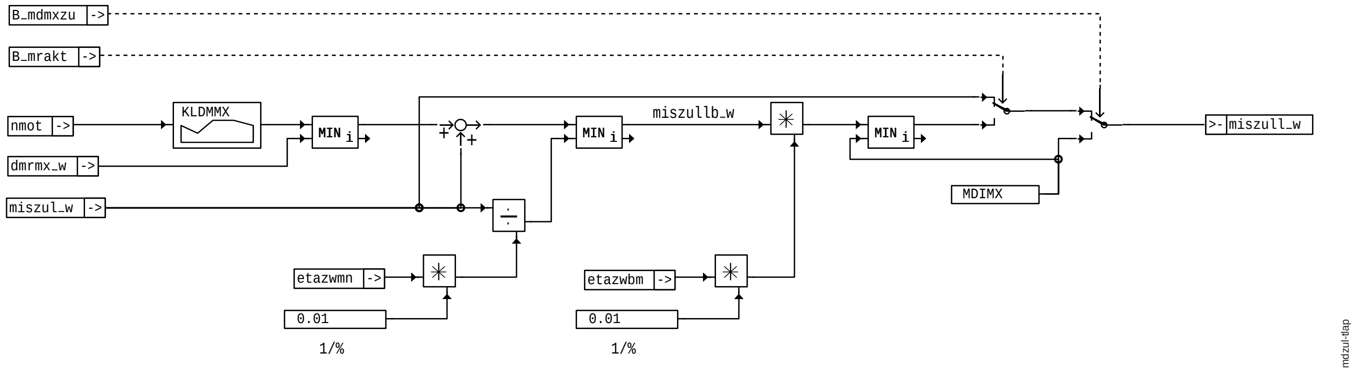
FDEF MDZUL 4.21 Function definition



mdzul-mdzul



mdzul-nsc



mdzul-tlap

ABK MDZUL 4.21 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMIZUFIL	WPED	NMOT	KF	Maximum permitted indicated set torque for torque limitation before Filter
KFMIZUNS	WPED	NMOT	KF	Authorized torque for post-start torque increase
KFMIZUOF	MIZUVFIL	NMOT	KF	Maximum permitted indicated set torque for torque limitation
KLDMMX	NMOT		KL	Maximum delta torque for air path
MDIMX			FW	maximum limit indicated engine torque
NSTART			FW	engine speed limit for low engine speed exit (for post-start torque increase)
NSTEND			FW	engine speed limit for start end (for post-start torque increase)
TANSMN			FW	intake air temperature limit (for post-start torque increase)
TFMIZU			FW	Time constant of low pass filter for permitted set torque
TMNSMN			FW	engine temperature limit (for post-start torque increase)
TNSC			FW	post-start monitoring time
TNSOF			FW	debounce time for turning off the post-start torque increase

Variable	Source	Type	Description
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_MDMXZU	MDZUL	LOK	Condition maximimum torque permitted
B_MRAKT	MDKOL	EIN	condition: torque reserve active
B_MSR	MDKOG	EIN	Condition MSR
B_MZNS	MDZUL	LOK	Post-start torque increase is active
B_MZNS_UM	UFNSC	EIN	afterstart torque increase of ETC-monitoring is active
B_NSAKT	MDZUL	LOK	post-start is active (for post-start torque increase)
B_NSEND	MDZUL	LOK	post-start monitoring time is over (for post-start torque increase)
B_SGS	MDKOG	EIN	condition: torque intervention for engine speed synchr. during gear shift
C_INI	SWADAP	EIN	ECU-condition for intialisation
DMRMX_W	MDKOL	EIN	delta torque for charge by torque reserve
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
MISZULLB_W	MDZUL	DOK	maximum permissible internal torque for charge path (limited)
MISZULL_W	MDZUL	AUS	maximum permissible internal torque for charge path
MISZUL_W	MDZUL	AUS	maximum permissible indicated torque
MIZUFIL_W	MDZUL	LOK	Indicated torque after filtering allowed
MIZUOFIL	MDZUL	LOK	Indicated torque without filtering
MIZUVFIL	MDZUL	LOK	Indicated torque before filtering
NMOT	SWADAP	EIN	engine speed
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW MDZUL 4.21 Fixed Values

Parameter	Value	Description
MDIMX		maximum limit indicated engine torque
NSTART		engine speed limit for low engine speed exit (for post-start torque increase)
NSTEND		engine speed limit for start end (for post-start torque increase)
TANSMN		intake air temperature limit (for post-start torque increase)
TFMIZU		Time constant of low pass filter for permitted set torque
TMNSMN		engine temperature limit (for post-start torque increase)
TNSC		post-start monitoring time
TNSOF		debounce time for turning off the post-start torque increase

FB MDZUL 4.21 Detailed description of function

This function calculates a maximum indicated torque miszul_w for the ignition path and a maximum indicated torque miszull_w for the air path of the torque coordination. These torques are used in the functions %mdkol and %mdkog of the torque coordination to limit the desired torque. Limiting the desired torque shall prevent an unjustified triggering of level 2 of the monitoring concept. In level 2 of the monitoring concept (overview section ufue) a roughly calculated actual torque is compared with a maximum permitted actual torque. A desired torque from the torque coordination, which is calculated too large would lead to a too large actual torque with a response of the actual torque monitoring in level 2.

The calculation of the maximum permitted desired torque miszul_w in the function %mdzul can be described in detail as follows:
The maximum torque request of the pedal, which is permitted at a certain engine speed is stored in two maps (KFMIZUOF = f(nmot, mizuvfil), KFMIZUFIL = f(nmot, wped)). In the process also an offset is taken into consideration, which comes from other torque-increasing functions, which will not be discussed in detail here (e.g. idle control).
The sum of the two maps (referred to as sum map of level 1 in the following) results in the permitted desired torque.
In order to avoid an unjustified limiting of the desired torque (which is e.g. increased due to the dashpot function) in case of quick setpoint changes (due to negative pedal angle gradient) the value obtained from map KFMIZUFIL is filtered in a low pass. This filter, however, is only active in case of a negative gradient of the value obtained from the map.

An after-start extension is performed in level 2 of the torque monitoring in dependency on the engine temperature and on the intake air temperature. The condition for the after-start extension is calculated there in the function %UFNSC. The actual after-start extension is performed in the function %UFMZUL. Level 1 may only perform an after-start extension (subfunction NSC) if an after-start extension is also performed in level 2.
This must be ensured by the entering of data.

APP MDZUL 4.21 Application hint

Starting point for the entering of data into the two maps is the permitted torque in dependency on pedal angle and engine speed. This maximum permitted torque (sum map of level 1) results among other from the idle demand and from the pedal map.

A complete deactivation of the function can be performed by the map KFMIZUOF (KFMIZUOF = 99,6% for all base points).
A deactivation of the after-start extension can take place by entering data into the map KFMIZUNS.
In the process the same data are entered into the map KFMIZUNS as into the map KFMIZUFIL. The value -48 C must be entered for the temperature thresholds TMNSMN and TANSMN.
A deactivation of the function %mdzul with active torque monitoring can lead to a response of the torque monitoring (%ufmzul) in level 2 with the fault reaction safety fuel switch-off.

The counts of TNSOF and TNSC can be looked at in VS100 under tnsofCtr and tnscCtr.

While the offset was so far stored dependent on engine speed and pedal setpoint (KFMIZU) it is now stored dependent on permitted torque and engine speed (KFMIZUOF). The entered data can be changed as follows:
For a fixed engine speed and a fixed pedal setpoint an offset torque is obtained from the map KFMIZU.
This offset is now entered into the map KFMDZOF for the corresponding engine speed base point and the torque base point, which results from the map KFMIUFIL (with same engine speed and same pedal angle).

KFMIZUOF:

The map KFMIZUOF is adjusted in the function %ufmzul following the map KFMDZOF_UM.

KFMIZUFIL:

The map KFMIZUFIL is adjusted in the function %ufmzul following the map KFMPED_UM.

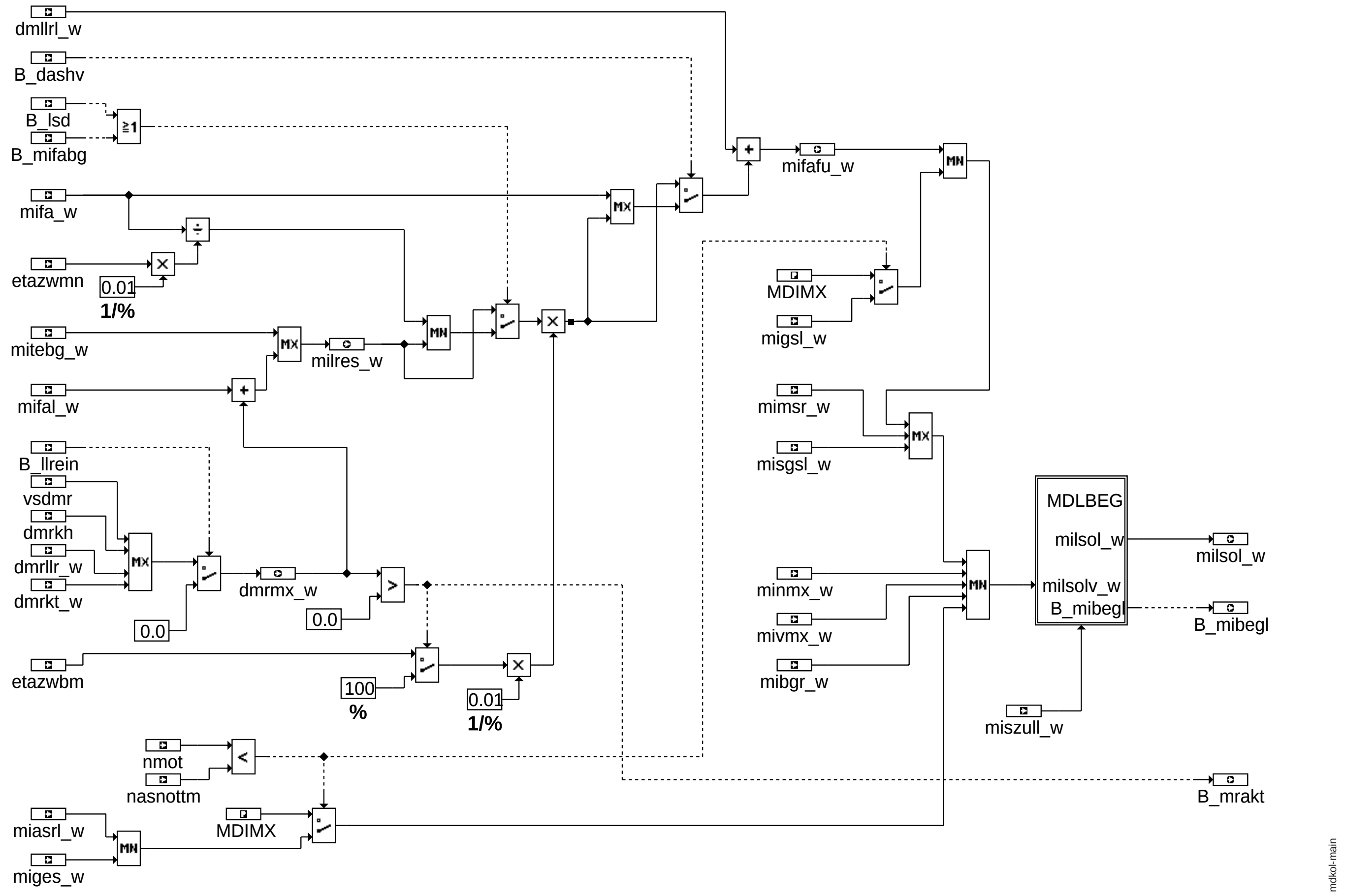
The most important part of this map lies at an accelerator position of 0 and at an engine speed above 1000 rpm.

TFMIZU:

This filter shall take into consideration torque-increasing functions, e.g. dashpot.
The filter time constant of this filter lies between 100 ms and 2 seconds (slow filter). It is to be tuned to the filter in the torque monitoring (section ufmzf). A filter time constant of 0,3s has so far proved to be worthwhile.

MDKOL 10.110 Coordination torque intervention air path

FDEF MDKOL 10.110 Function definition



mdkol-main

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Subfunction MDLBEG: Limitation of desired torque for charge path
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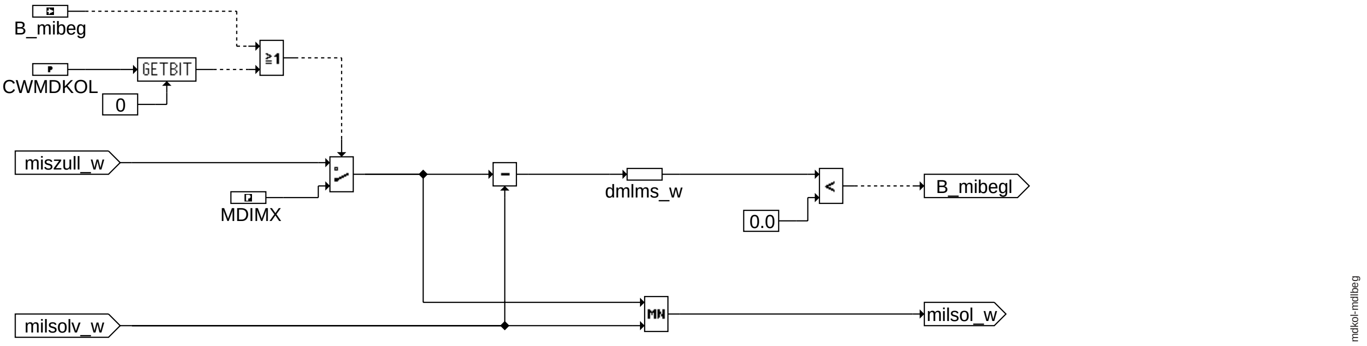


mdkol-mdlbeg

ABK MDKOL 10.110 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWMDKOL			FW	codeword MDKOL: torque limitation
MDIMX			FW (REF)	maximum limit indicated engine torque

Variable	Source	Type	Description
B_DASHV		EIN	condition dashpot delayed
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LSD	MDFAW	EIN	condition: limitation of positive torque gradient active
B_MIBEG	MDKOG	EIN	condition torque limit active
B_MIBEGL	MDKOL	AUS	condition torque limitation charge path active
B_MIFABG		EIN	condition limitation of mifa

Variable	Source	Type	Description
B_MRAKT	MDKOL	AUS	condition: torque reserve active
DMLLRL_W	LLRRM	EIN	desired torque change from the idle speed control (part on the air path)
DMLMS_W	MDKOL	LOK	difference between desired torque and permissible torque for charge path
DMRKH	KHMD	EIN	torque reserve for catalyzer heating
DMRKT_W	MDTRIP	EIN	Torque reserve during quicktest
DMRLLR_W	LLRMR	EIN	torque reserve for idle speed control
DMRMX_W	MDKOL	AUS	delta torque for charge by torque reserve
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
MIASRL_W	SWADAP	EIN	desired indicated torque from ASR for slow intervention
MIBGR_W	MDBGRG	EIN	Indicated desired torque for gear-dependent limiting of the clutch torque
MIFAFU_W	MDKOL	AUS	driver torque request for charge
MIFAL_W	MSF	EIN	Indicated driver's wish torque for torque coordination cylinder filling
MIFA_W	MSF	EIN	desired indicated engine torque
MIGES_W	SWADAP	EIN	desired indicated torque for transmission protection
MIGSL_W	CAN	EIN	desired internal torque for charge limitation during GS.
MILRES_W	MDKOL	AUS	torque request for air path including all torque reserves
MILSOL_W	MDKOL	AUS	driver torque request for charge
MIMSR_W	SWADAP	EIN	desired indicated torque from MSR
MINMX_W	NMAXMD	EIN	indicated nominal torque for NMAX limiting
MISGSL_W	CAN	EIN	desired internal torque (air path) for engine speed synchr. during gear shift
MISZULL_W	MDZUL	EIN	maximum permissible internal torque for charge path
MITEBG_W	TEB	EIN	torque value for minimum charge canister purge
MIVMX_W	VMAXMD	EIN	indicated nominal torque for VMAX control
NASNOTTM	MDKOG	EIN	Speed threshold due to stalling protection as a function of tmot
NMOT	SWADAP	EIN	engine speed
VSDMR	VS_VERST	EIN	adjustable torque reserve via VSxy

FW MDKOL 10.110 Fixed Values

Parameter	Value	Description
CWMDKOL		codeword MDKOL: torque limitation

FB MDKOL 10.110 Detailed description of function

1. Calculation of increased air request milres, mechanism of torque reserve

The maximum torque reserve from catalyst heating, idle speed control and short trip is added to the driver air request mifal.
Further increase for application purpose is possible via VSxy by the interface vsdmr. Another minimum air request is given
by mitebg of the tank ventilation. The resulting air request with all torque reserves is milres.
This increase of the charge torque automatically retards the ignition angle, since the driver request mifa can only be
adjusted by retarding the ignition under an increased charge. The torque reserve always applies to the optimum ignition angle
and not to the basic ignition angle, in order to allow non-ambiguous adjustment of the operating point.

2. Calculation of resulting driver air request mifafu concerning torque reserve and limits of efficiency

The increased driver torque milres is limited to the torque that provides the minimum permissible ignition angle efficiency etazwmn.
This limitation is not performed with active torque gradient limitation (B_lsd) in order to control mifal independently (no influence of
mifa for further calculations in MDKOL).
The value is then multiplied by the basic efficiency in order to arrive at the same reference point as the rest of the coordination
torques. If the torque reserve is greater than the required torque mifa because of the basic effectiveness, then the former is
selected (taking the maximum between the driver request and the driver request with torque reserve). Result is the drivers torque
request for the engine load mifafu.

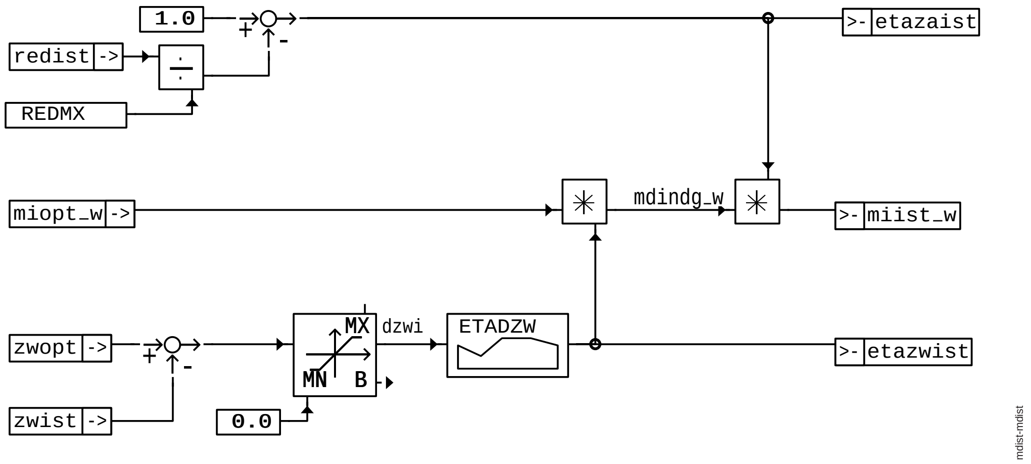
3. Actual torque coordination

Maximum selection with torque request mimsr from MSR, then minimum selection with the torque of the rpm limiter minmx,
the torque of the speed limiter mivmx, the torque from ASR and and the torque request in case of transmission protection.
The last two torques are only considered in case of excceding a low engine speed to prevent engine stalling.

In case of limiting the torque by the safty concept (Level 1), the torque ist limited to miszul_w.

MDIST 10.2 Engine torque calculation

FDEF MDIST 10.2 Function definition



mdist-mdist

ABK MDIST 10.2 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ETADZW	DZWI		KL	ignition efficiency depending on delta ignition angle
REDMX			FW	maximal step number for disabled injectors (f.e. =2*number of cylinder)

Variable	Source	Type	Description
DZWI	MDIST	LOK	difference ignition angle (between zwopt and zwout)
ETAZAIST	MDIST	AUS	actual cylinder masking effectiveness
ETAZWIST	MDIST	AUS	actual ignition angle effectiveness
MDINDG_W	MDIST	LOK	indicated torque in the case of all cylinders firing
MIIST_W	MDIST	AUS	indicated real engine torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
REDIST	BGEVAB	EIN	real cylinder cut-off step
ZWIST	ZUE	EIN	real ignition angle
ZWOPT	MSF	EIN	optimal ignition angle

FW MDIST 10.2 Fixed Values

Parameter	Value	Description
REDMX		maximal step number for disabled injectors (f.e. =2*number of cylinder)

FB MDIST 10.2 Detailed description of function

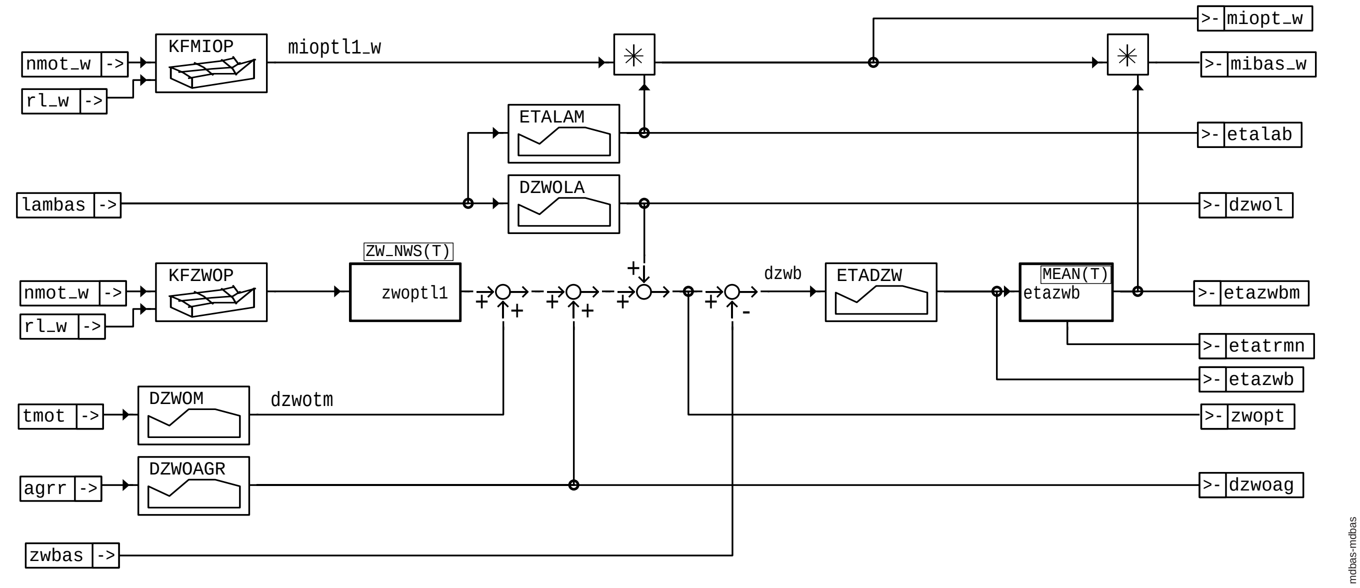
This function supplies an indicated actual torque for all operating states of the engine.
From the difference dzwi between the optimum ignition angle zwopt and the actual ignition angle zwist the actual ignition-angle efficiency etazwist results over the ignition-angle efficiency characteristic ETADZW. The indicated engine torque miopt_w, at given Lambda and optimum ignition angle, is multiplied by the actual ignition-angle efficiency etazwist. The indicated actual engine torque miist_w is the indicated engine torque mdindg_w, which is reduced share-wise by the cut-out cylinders.

APP MDIST 10.2 Application hint

Due to the multiple use of the parameter ETADZW in the functional extent, the working point indication in application aids is of no use for this table. The working point must be determined by a separate indication of the input dzwi.

MDBAS 4.30 Basic calculation for torque interface

FDEF MDBAS 4.30 Function definition



mdbas-mdbas

ABK MDBAS 4.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DZWNWSUE	WNWUE		KL	Delta ignition angle dependent on the camshaft overlap
DZWOAGR	AGRR		KL	AGR-rate-dependent offset of optimum ignition angle
DZWOLA	LAMBAS		KL	Lambda dependency of optimum ignition angle referred to Lambda 1
DZWOM	TMOT		KL	temperature-dependent offset of optimum ignition angle
ETADZW	DZWB		KL	ignition efficiency depending on delta ignition angle
ETALAM	LAMBAS		KL	Lambda effectiveness
KFMIOP	NMOT_W	RL_W	KF	map optimum engine torque
KFZWOP	NMOT_W	RL_W	KF	optimum ignition angle
KFZWOP2	NMOT_W	RL_W	KF	Optimum ignition angle, variant 2

Variable	Source	Type	Description
AGRR	SWADAP	EIN	exhaust gas recirculation rate
DZWOAG	MDBAS	AUS	exhaust recirculation rate-dependent correction of optimum ignition angle
DZWOL	MDBAS	AUS	Lambda-dependent correction of optimum ignition angle
DZWOTM	MDBAS	LOK	temperature-dependent correction of optimum ignition angle
ETALAB	MDBAS	AUS	Lambda effectiveness without intervention w.r.t. to optimum torque at Lambda=1
ETATRMN	MDBAS	AUS	minimum value in effectiveness drum
ETAZWB	MDBAS	AUS	ignition angle effectiveness of basic ignition angle
ETAZWBM	MDBAS	AUS	mean ignition angle effectiveness of basic ignition angle
FNWUE	NWS	EIN	Weighting factor camshaft overlap
LAMBAS	SWADAP	EIN	basic Lambda
MIBAS_W	MDBAS	AUS	indicated basic torque
MIOPTL1_W	MDBAS	LOK	optimal torque at lambda = 1
MIOPT_W	MDBAS	AUS	optimum indicated torque
NMOT_W	SWADAP	EIN	engine speed
RL_W	EGFE	EIN	relative air charge (Word)
R_SYN	GGDPG	EIN	Synchro schedule
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
TMOT	SWADAP	EIN	Engine temperature
WNWUE	NWS	EIN	camshaft overlap angle of inlet and outlet valve opening
ZWBAS	ZUE	EIN	basic ignition angle
ZWOPT	MDBAS	AUS	optimal ignition angle
ZWOPTL1	MDBAS	LOK	optimal ignition angle at lambda=1

FW MDBAS 4.30 Fixed Values

Parameter	Value	Description

FB MDBAS 4.30 Detailed description of function

Calculation of the optimum torque mioptl1 at Lambda=1 with the aid of the map KFMIOP. Correction of this torque by the Lambda influence via multiplication by the Lambda effectiveness etalab. The Lambda effectiveness is calculated from the curve ETALAM. Multiplication by the ignition angle effectiveness gives the basic torque mibas. This corresponds to the indexed torque that stabilises if combustion occurs with the basic Lambda lambas and the basic ignition angle zwbas. Calculation of the optimum ignition angle via the map KFZWOP for Lambda=1. Additive corrections depending on Lambda, the exhaust recirculation rate agrr and the engine temperature, are included. The ignition angle zwopt thus obtained now forms the basis for calculation of the ignition angle effectiveness. The basic ignition angle effectiveness is calculated with the curve ETADZW, and the input variable is formed from the difference between zwopt and zwbas. The basic effectiveness values are then averaged over all cylinders to produce the basic effectiveness etazwbm.

APP MDBAS 4.30 Application hint

Exhaust recirculation inactive for all measurements!

The following measurements must be performed:

1. Lambda=1 operation:
Ignition angle loops on engine test stand at Lambda=1 at the following points with warm engine:
n=500,750,1000,1250,1500,2000,2500,3000,3500,4000,4500,5000,5500,6000,6500 (if possible) rpm
rl=10,20,30,40,50,60,70,80,90,100 %
The ignition angle loops start at the angle at which the maximum torque is obtained (if not driveable at the knock limit).
Ignition is now retarded in steps of 4.5 degrees CA until the latest possible ignition angle is reached.
The following data should be recorded for each measuring point: nmot, rl, lambda, clutch torque, ignition angle.

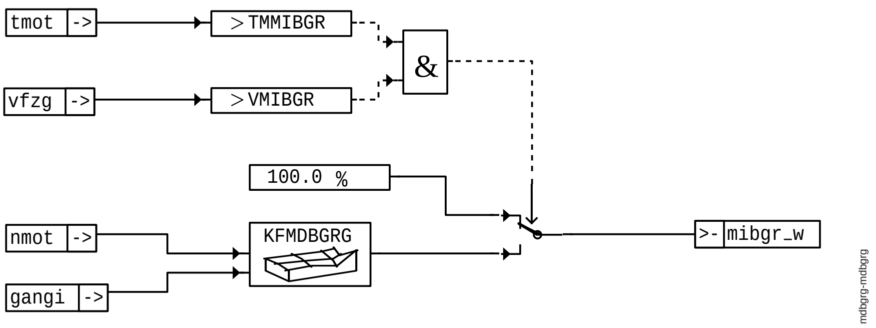
2. Lambda dependency
Ignition angle loops over lambda at measuring points:
n = 1000, 2000, 3000 rpm
rl= 30, 50, 70 %
Lambda= .8,.85,.9,.95,1,1.05,1.1,1.15,1.2
Measurements as above

3. Friction torque
The friction torque must be present for all measurements under 1. Measurement on test stand, engine off but warm.

4. Evaluation
Measurement results evaluated by K3/ESY4-Hes or -Zg.

MDBGRG 4.40 torque limitation mimimum

FDEF MDBGRG 4.40 Function definition



mdbgrg-mdbgrg

Für die Typisierung der Fahrzeuge muß eventuell das Moment in den unteren Gängen in Abhängigkeit vom Gang und von der Drehzahl begrenzt werden.

ABK MDBGRG 4.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMDBGRG	NMOT	GANGI	KF	map with the value of the torque limitation
TMMIBGR			FW	tmot threshold for enabling of torque limitation
VMIBGR			FW	v-threshold for enabling of torque limitation

Variable	Source	Type	Description
GANGI	SWADAP	EIN	Engaged gear
MIBGR_W	MDBGRG	AUS	Indicated desired torque for gear-dependent limiting of the clutch torque
NMOT	SWADAP	EIN	engine speed
TMOT	SWADAP	EIN	Engine temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW MDBGRG 4.40 Fixed Values

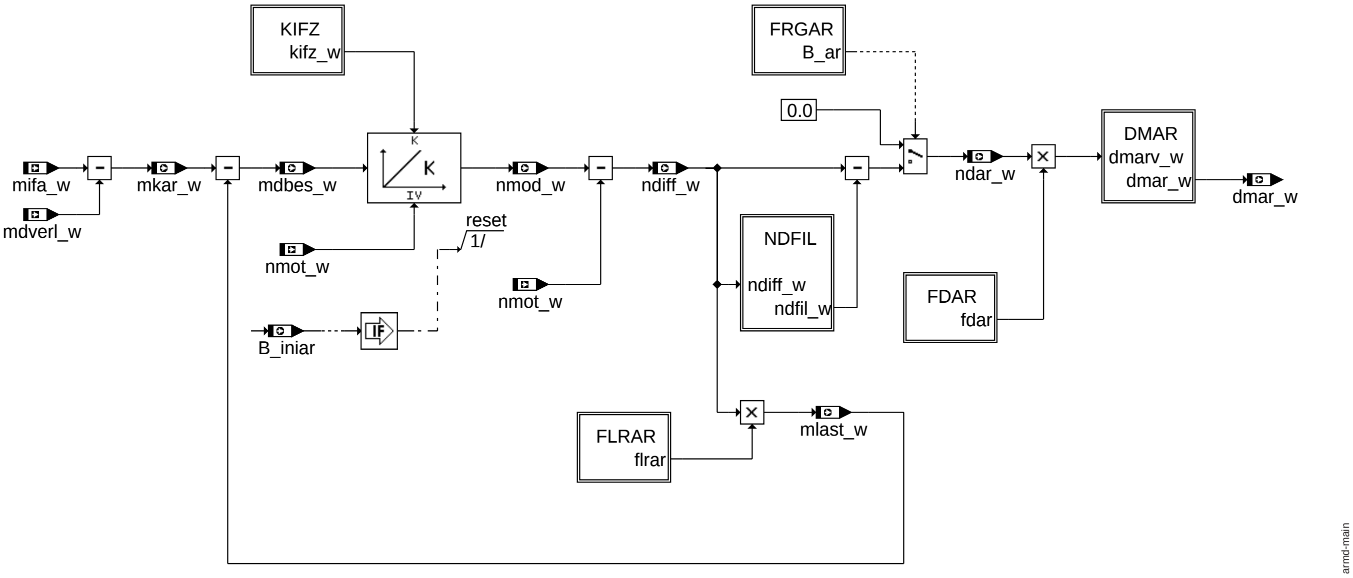
Parameter	Value	Description
TMMIBGR		tmot threshold for enabling of torque limitation
VMIBGR		v-threshold for enabling of torque limitation

FB MDBGRG 4.40 Detailed description of function

APP MDBGRG 4.40 Application hint

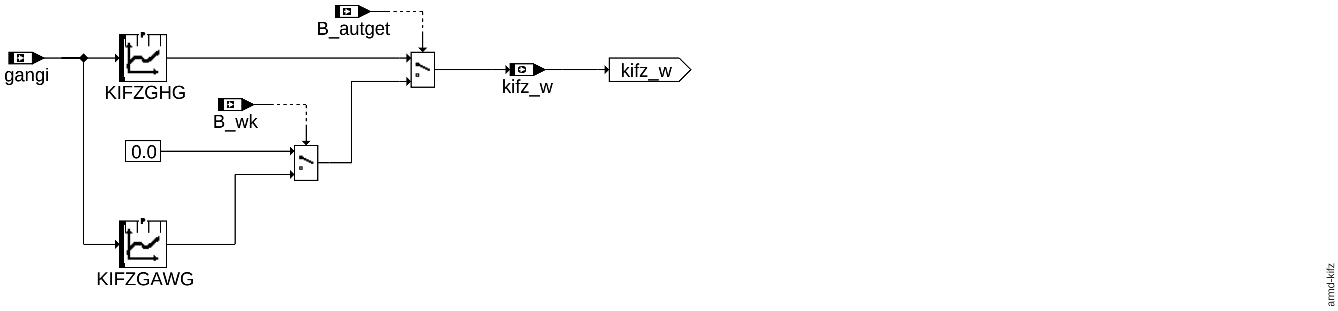
ARMD 14.10 Torque based anti jerk function

FDEF ARMD 14.10 Function definition



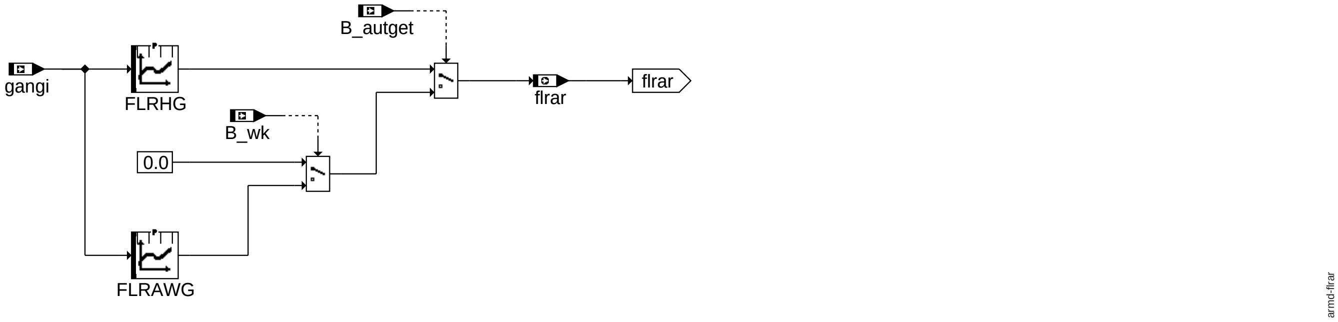
armd-main

`Subfunction KIFZ:`



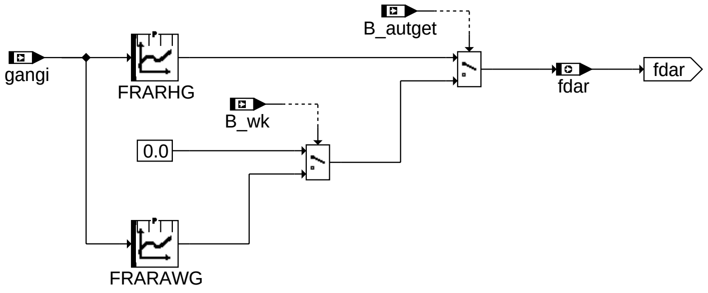
armd-kifz

`Subfunction FLRAR:`



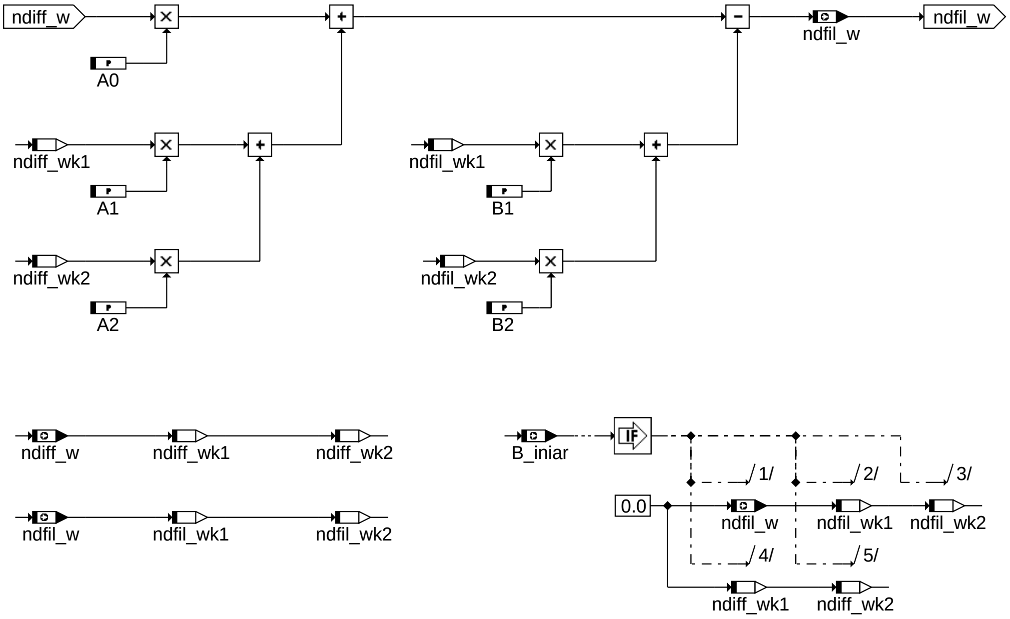
armd-flrar

`Subfunction FDAR:`



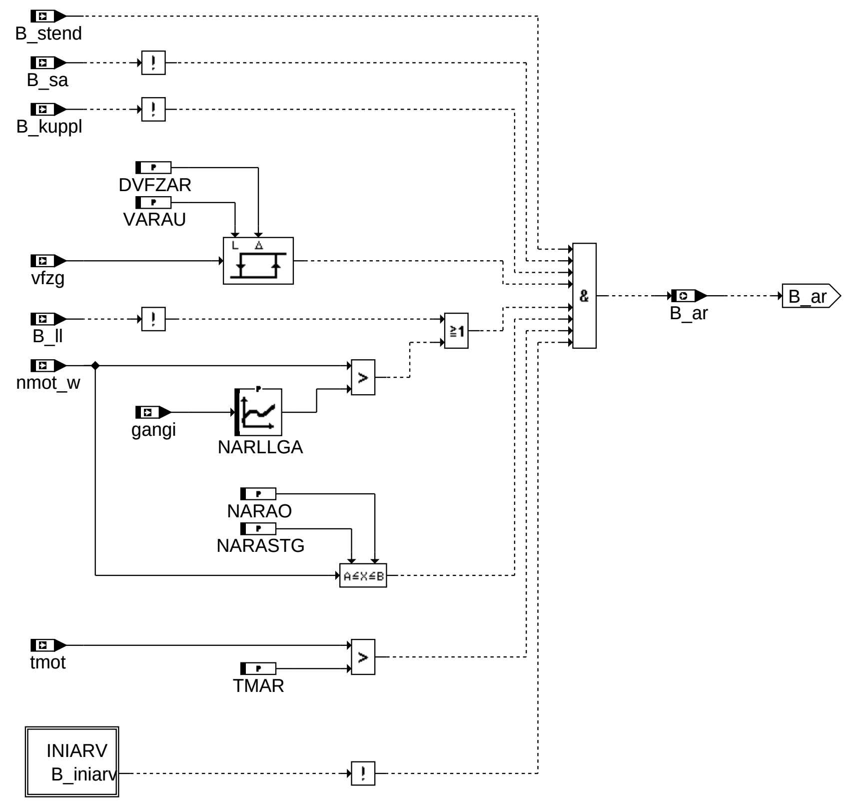
armd-fdar

`Subfunction NDFIL:`



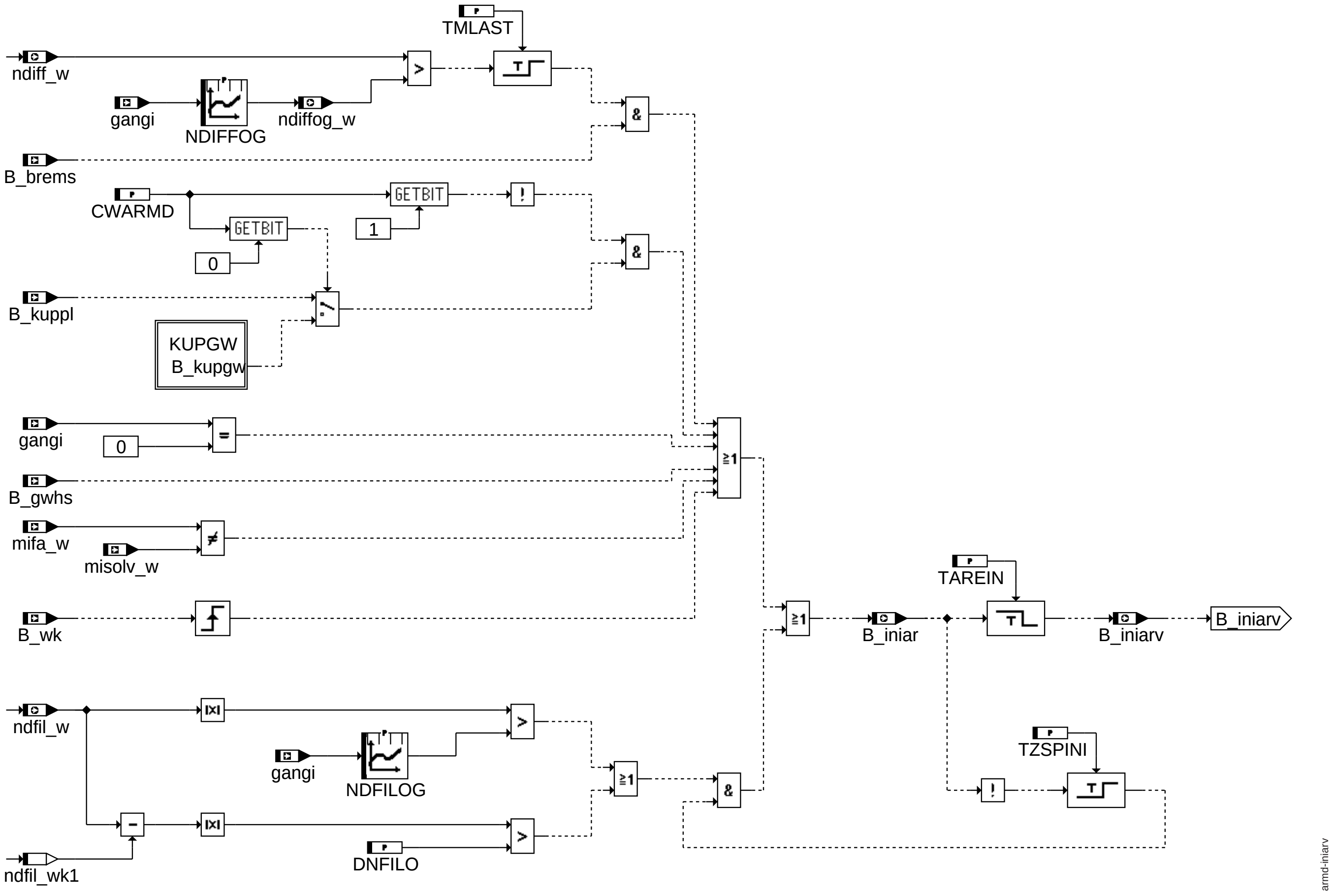
armd-ndfil

`Subfunction FRGAR:`



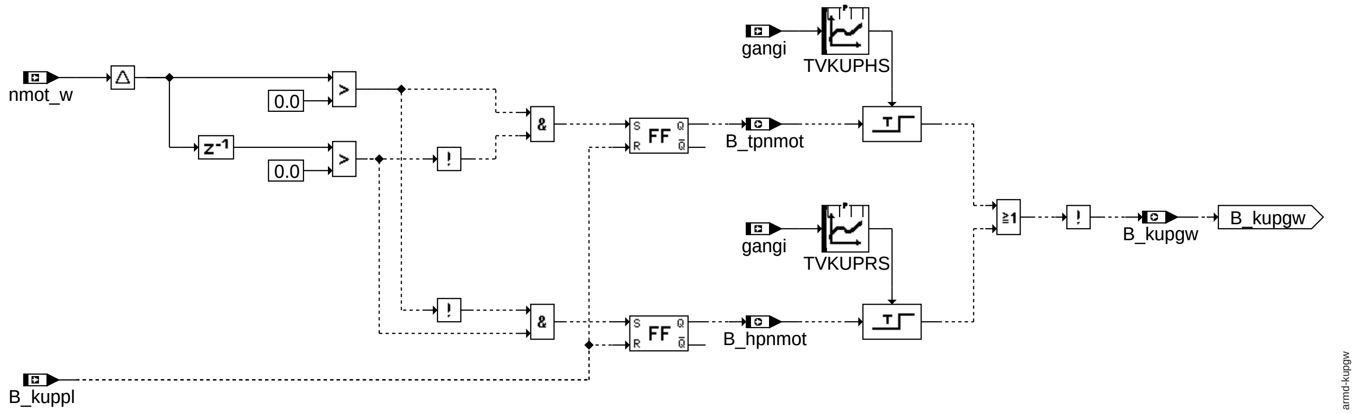
armd-frgar

`Subfunction INIARV:`



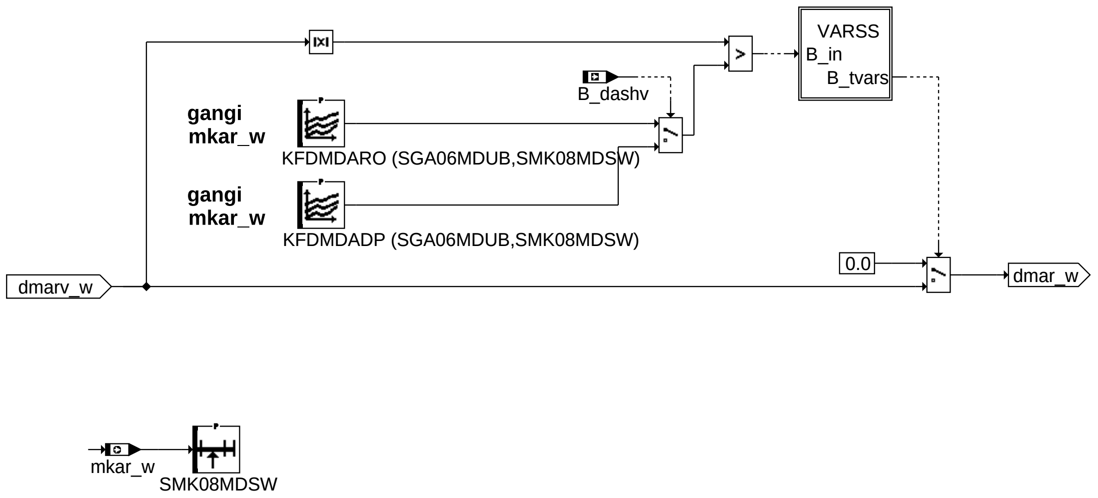
armd-iniarv

`Subfunction KUPGW:`



armd-kupgw

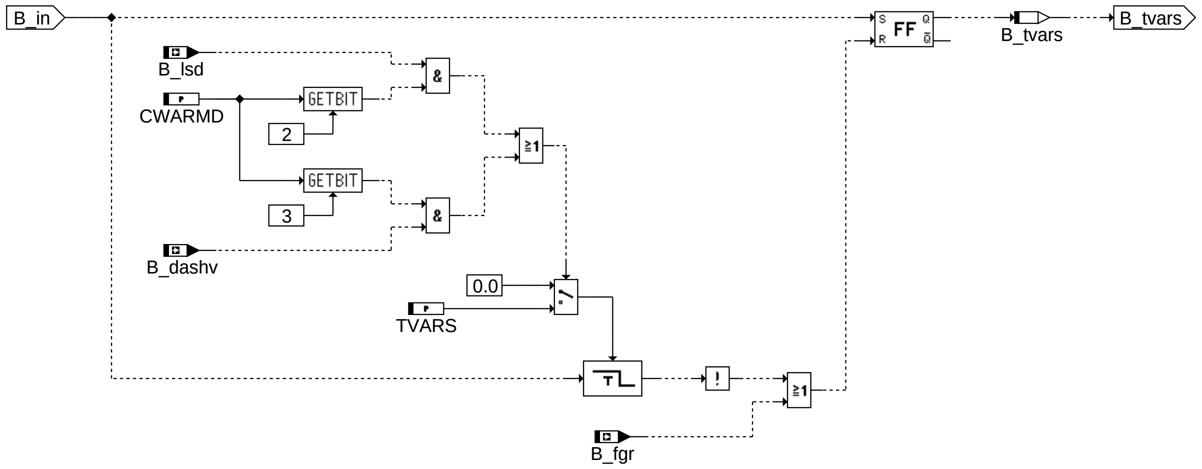
`Subfunction DMAR:`



armd-dmar

armd-dmar

`Subfunction VARSS:`



armd-varss

armd-varss

Parameter	Source-X	Source-Y	Type	Description
A0			FW	transmission coefficient
A1			FW	transmission coefficient
A2			FW	transmission coefficient
B1			FW	transmission coefficient
B2			FW	transmission coefficient
CWARMD			FW	Code word anti jerk function
DNFILO			FW	upper threshold of filter output gradient ndfil
DVFZAR			FW	Hysteresis for vehicle speed limit during AR (Anti jerk)
FLRAWG	GANGI		KL	amplification of load controller
FLRHG	GANGI		KL	amplification of load controller
FRARAWG	GANGI		KL	amplification factor
FRARHG	GANGI		KL	amplification factor
KFDMDADP	GANGI	MKAR_W	KF	upper threshold for torque-intervention during dashpot
KFDMDARO	GANGI	MKAR_W	KF	Upper threshold for torque intervention
KIFZGAWG	GANGI		KL	amplification of vehicle model integrator at AT
KIFZGHG	GANGI		KL	amplification of vehicle model integrator at AT
NARAO			FW	upper engine speed threshold for anti-jerk function active
NARASTG			FW	RPM threshold in higher gear for AR active
NARLLGA	GANGI		KL	speed threshold for AR at idle
NDFILOG	GANGI		KL	Threshold for filter output ndfil
NDIFFOG	GANGI		KL	Threshold engine speed difference for initialization of AR during braking
SMK08MDSW	MKAR_W		SV	Antisurge torque dependent basic point (number =8)
TAREIN			FW	lockup time for anti-jerk function
TMAR			FW	Lower TMOT threshold for AR release
TMLAST			FW	blocking time until the initialization of the AR is triggered at deceleration
TVARS			FW	delay time until antisurge is inactive again
TVKUPHS	GANGI		KL	delay time for clutch switch during shifting in higher gear
TVKUPRS	GANGI		KL	delay time for clutch switch during shifting in lower gear

Parameter	Source-X	Source-Y	Type	Description
TZSPINI			FW	Resting time for filter initialisation
VARAU			FW	vehicle speed for anti-jerk active

Variable	Source	Type	Description
B_AR	ARMD	AUS	condition anti-jerk active
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_BREMS	GGEGAS	EIN	condition: brake operated
B_DASHV		EIN	condition dashpot delayed
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_GWHS	BBGANG	EIN	Condition gear change on manual transmission vehicle
B_HPNMOT	ARMD	AUS	condition high-point speed oscillation
B_INIAR	ARMD	AUS	condition initialization of anti-jerk function
B_INIARV	ARMD	AUS	condition initialization of the filter function is delayed
B_KUPGW	ARMD	AUS	condition clutch applied until shifting of gear is detected
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LSD	MDFAW	EIN	condition: limitation of positive torque gradient active
B_SA	MDRED	EIN	Condition fuel cut-off
B_STEND	BBSTT	EIN	condition end of start
B_TPNMOT	ARMD	AUS	condition low-point speed oscillation
B_TVARS	ARMD	LOK	condition anti-jerking function dynamically active
B_WK		EIN	condition: converter lockup clutch closed
DMAR_W	ARMD	AUS	delta torque anti-jerk
FDAR	ARMD	AUS	amplification factor for anti-jerk intervention
FLRAR	ARMD	AUS	amplification factor for modelling of external load
GANGI	SWADAP	EIN	Engaged gear
KIFZ_W	ARMD	AUS	amplification of vehicle model
MDBES_W	ARMD	AUS	Acceleration torque
MDVERL_W	MDVER	EIN	Resistant torque of the engine
MIFA_W	MSF	EIN	desired indicated engine torque
MISOLV_W	MDKOG	EIN	indicated resultant nominal torque before torque limitation
MKAR_W	ARMD	AUS	calculated clutch torque for anti-jerk function
MLAST_W	ARMD	AUS	Estimated load moment
NDAR_W	ARMD	AUS	Difference RPM for torque control
NDFIL_W	ARMD	AUS	filtered engine speed difference
NDIFFOG_W	ARMD	AUS	Threshold engine speed difference for reset of AR during braking
NDIFF_W	ARMD	AUS	engine speed difference for ISC amplification
NMOD_W	ARMD	AUS	engine speed from model
NMOT_W	SWADAP	EIN	engine speed
TMOT	SWADAP	EIN	Engine temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW ARMD 14.10 Fixed Values

Parameter	Value	Description
A0		transmission coefficient
A1		transmission coefficient
A2		transmission coefficient
B1		transmission coefficient
B2		transmission coefficient
CWARMD		Code word anti jerk function
DNFILO		upper threshold of filter output gradient ndfil
DVFZAR		Hysteresis for vehicle speed limit during AR (Anti jerk)
NARAO		upper engine speed threshold for anti-jerk function active
NARASTG		RPM threshold in higher gear for AR active
TAREIN		lockup time for anti-jerk function
TMAR		Lower TMOT threshold for AR release
TMLAST		blocking time until the initialization of the AR is triggered at deceleration
TVARS		delay time until antisurge is inactive again
TZSPINI		Resting time for filter initialisation
VARAU		vehicle speed for anti-jerk active

FB ARMD 14.10 Detailed description of function

Function purpose

The anti-jerk function detects oscillations of the power train and smoothens them using phase correct torque interventions. The torque intervention is converted into ignition angle offset by the torque interface.

Desired phase position of the torque intervention

In order to smoothen the power train oscillation efficiently, the torque intervention should be counterwise to the engine speed oscillations. Therby the same effect is achieved, as if the attenuation coefficient of the drive shaft is increased.

Operation pattern of anti-jerk function

Basic idea: A reference speed without oscillation and corresponding to the desire of the driver is evaluated. The difference between desired and actual engine speed isolates the oscillation. A delta torque is conterset to this oscillation.
Realization: A simple vehicle model consisting of an integrator with the constant kifz_w. Input of this integrator is the difference between the calculated coupling torque mkar_w and the load torque mlast_w; output is the model engine speed nmod_w. The engine speed difference ndiff_w between model engine speed nmod_w and engine speed nmot_w serves now as basis for the torque intervention as well as for the calculation of the load torque. The load torque is evaluated proportional to the engine speed difference, the factor flrar is taken from the corresponding char. line. The engine speed difference ndiff_w contains besides the oscillation part another offset. This offset is filtered in 50 ms scan rate through a discrete low pass of 2nd order. (Coefficients of the nominator polynomial are denoted A0, A1 and A2, of the denominator polynomial 1, B1 and B2. The filtered offset ndfil_w is substracted from the differential engine speed and gives the engine speed oscillation ndar_w. Proportionally to this engine speed and using the factor fdar, a delta torque as torque intervention is calculated. If this intervention lays between the limits KFDMDARU and KFDMDARO it is set to zero.

Activation conditions

The model is always active, just the intervention can be switched off.

APP ARMD 14.10 Application hint

Conditions for calibration of anti-jerk

The basic calibration of the vehicle must have been done. This includes the compensation for transition (ÜK) and all functions for the torque interface.

1. Evaluation of the integer constant kifz_w and flrar
   Coarse application:
   Drive on the road (flat surface, no hills) with constant speed in respective gear with deactivated anti-jerk function (fdar=0). Then execute a change in load and register the calculated coupling torque mkar_w and the speed nmot_w.
   Evaluation of integrator constant as follows: at a load step the torque jump is approximately delta M (in %) and the speed approximately rises with constant gradient gradn (in RPM/s). kifz_w is then calculated from gradn/(delta M). A typical value for 2nd gear is 4.6*100/MDNORM [RPM/(s*%)].
   Fine application:
   Driving on flat surface. Setting of the product kifz_w*flrar on a fixed value (recommendation: 15). Realization of load jumps with registration of mkar_w, mlast_w, nmot_w, ndiff_w. Variation of the couple kifz_w, flrar (with constant product!) until ndiff_w stays approximately constant at load jump.
   In principle the following is valid for the amplification factor flrar: high factors cause a reduction of the offset ndfil_w, but also a big phase advance of ndiff_w.
2. Evaluation of filter parameters
   Low pass in 50 ms scan rate: transmission function has the form G(z) = Z(z)/N(z) with
   Z(z) = A0 + A1*z^(-1) + A2*z^(-2)   N(z) = 1 + B1*z^(-1) + B2*z^(-2).
   Selection of one of the low pass below, according to the appearing jerk frequency:

TP No.	limit freq.	A0	A1	A2	B1	B2
1	0.67 Hz	.0095	.0191	.0095	-1.7056	.7437
2	0.8 Hz	.0134	.0267	.0134	-1.6475	.7009
3	1.0 Hz	.0201	.0402	.0201	-1.561	.6414

   Recommended is low pass No. 3. The attenuation of the jerk frequency is determined by the distance between jerk frequency and filter cut-off frequency. The bigger the filter cut-off frequency, the smaller the time the filter needs to stabilize.
   Attenuation: any modification of a single coefficient of G(z) is not allowed!
3. Evaluation of fdar
   Recommendation is fdar = .67*100/MDNORM (%/RPM. Increase of attenuation by enlargement of fdar, reduction of fdar decreases the attenuation.
4. Thresholds KFDMDARO and KFDMDARU
   In case the delta torque for the intervention is within these thresholds, it is set to zero. This avoids undesired instabilities
   of the ignition angle. Typical values: KFDMDARU=-5*100/MDNORM [%], KFDMDARO= 5*100/MDNORM [%].

MDTRIP 1.20 Calculation of torque reserve for short trip

FDEF MDTRIP 1.20 Function definition

```
                    +-----+
   dmrdkt_w         |     |
   ---------------->|     |
   dmrlsh_w         |     |
   ---------------->|     |
   dmrlsv_w         |     |
   ---------------->|     |
                    |  M  |         dmrkt_w
                    |  A  +---------------->
   dmrlash_w        |  X  |
   ---------------->|     |
   dmrdsls_w        |     |
   ---------------->|     |
   dmrdagr_w        |     |
   ---------------->|     |
                    |     |
                    +-----+
```

ABK MDTRIP 1.20 Abbreviations

Variable	Source	Type	Description
DMRDAGR_W		EIN	Torque reserve for EGR- diagnosis
DMRDKT_W	DKAT	EIN	torque reserve for catalyst monitoring
DMRDSLS_W	KHMD	EIN	Torque reserve for SAI- diagnosis
DMRKT_W	MDTRIP	AUS	Torque reserve during quicktest
DMRLASH_W	DLSAHK	EIN	torque reserve for lambda sensor ageing diagnosis downstream cat
DMRLSH_W	DLSH	EIN	torque reserve for lambda sensor diagnosis downstream cat
DMRLSV_W		EIN	torque reserve for lambda sensor diagnosis upstream Kat

FW MDTRIP 1.20 Fixed Values

Parameter	Value	Description

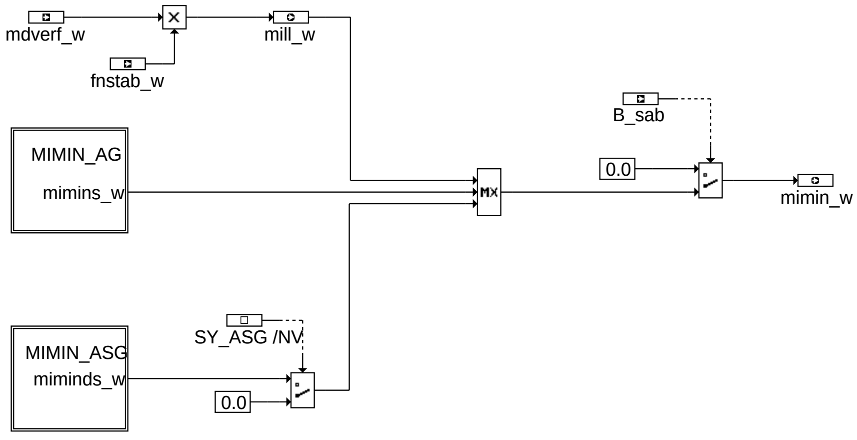
FB MDTRIP 1.20 Detailed description of function

The torque reserve dmrkt_w will be done by maximum choice of each short-trip reserves.

APP MDTRIP 1.20 Application hint

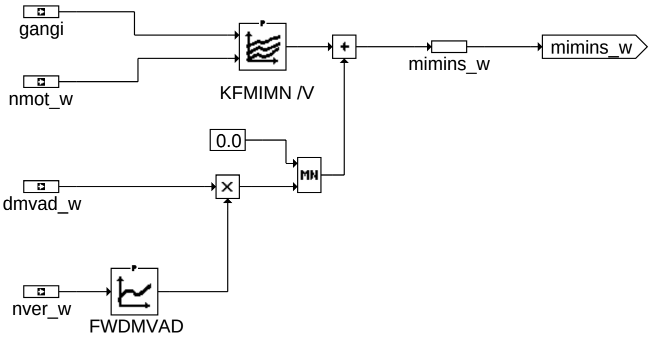
MDMIN 10.30 Minimum engine torque coordination

FDEF MDMIN 10.30 Function definition



mdmin-mdmin

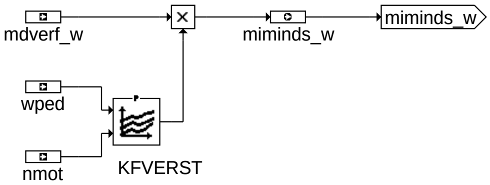
mdmin-mdmin



Kompensation der Momentendifferenz im Schubbetrieb bei Automatikgetriebe

mdmin-mimin-ag

mdmin-mimin-ag



Kompensation der Verlustmomente bei ASG

mdmin-mimin-asg

mdmin-mimin-asg

ABK MDMIN 10.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FWDMVAD	NVER_W		KL	factor for the weighting of dmvad_w in %MDMIN
KFMIMN	GANGI	NMOT_W	KF	minimum drag torque
KFVERST	WPED	NMOT	KF	weighting map for increasing control of friction torque
SY_ASG			SYS	automatic standard transmission

Variable	Source	Type	Description
B_SAB	MSF	EIN	Condition fuel cut-off requested
DMVAD_W	MDVERAD	EIN	Delta resistant torque from resistant torque adaptation
FNSTAB_W	MDNSTAB	EIN	Factor for speed stabilization
GANGI	SWADAP	EIN	Engaged gear
MDVERF_W	MDVER	EIN	Filtered charge torque
MILL_W	MDMIN	AUS	Indicated engine torque at idle
MIMINDS_W	MDMIN	AUS	weighted torque loss in case of AST
MIMINI_W	MDMIN	AUS	text of Mr. Herrmann
MIMINS_W	MDMIN	LOK	minimum drag torque
MIMIN_W	MDMIN	AUS	Minimal engine torque
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
NVER_W		EIN	Quotient of engine speed
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW MDMIN 10.30 Fixed Values

Parameter	Value	Description

FB MDMIN 10.30 Detailed description of function

During fuel cut-off readiness the torque to be indicated at the minimum 0 is outputted. Otherwise the torque to be indicated at the minimum is taken from a maximum selection. To achieve a self-stabilization, the sum from mdverl_w and mdwan_w is weighted with the quotient nstat/nmot_w. After the initialization the sum is weighted with 1 until the actual speed nmot_w has reached the desired speed nstat (MDNSTAB).

MIMIN_AG:

On certain automatic transmission types a noise develops, if the direction of the torque flow changes and if the absolute value of the fuel cut-off torque is greater than that of the indicated torque.
The map KFMIMN serves to limit the indicated torque to an upper value in such cases.
It is thereby possible to suppress the disturbing transmission noises.
The values may not be greater than the minim torque loss (dmvad=0, mds(nstat), mdsm=0, mdko=0, mdgen(nstat), mdsl=0, mdslp=0, mdns=0) at no nmot.
In case of an easily moving transmission, a negative dmvad results. KFMIMN would in this case lie above mimin and thereby contribute to an acceleration. Therefore dmvad is subtracted from KFMIMN in this case.
The weighting factor FWDMVAD is to have the value 1 for all nver_w > 1. FWDMVAD is to travel toward 0 for smaller nver.
If there are no problems with "noisy automatic transmissions", then FWDMVAD and KFMIMN should equal 0.

MIMIN_ASG:

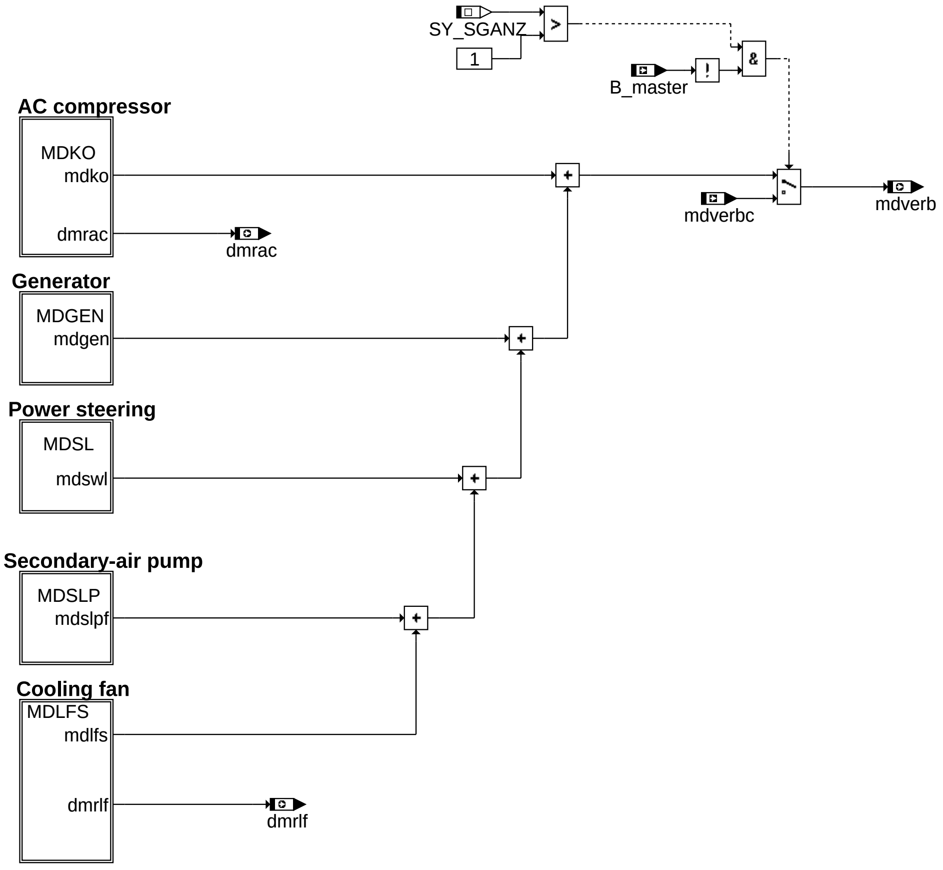
By the factor fnstab_w, the friction torque (mimini_w) is not compensated when nmot is above nstat.
The friction torque compensation with mdverf_w, however, is necessary when the desired wheel torque is preset.
Therefore a switch is performed with the factor {0, <= 1.0} from KFVERST (f(wped_w,nmot_w)) between the conventional calculation mimini_w and the friction torque compensation mdverf_w.
In the range of fuel cut-off monitoring and at idle a switch to mimini_w is performed by entering the value 0 into KFVERST.
With the value KFVERST=1, mimin is set to mdverf_w.

APP MDMIN 10.30 Application hint

Data entry into the maps KFMIMN and KFVERST is safety-relevant. A maximum engine speed of 1500 may not be exceeded, as long as the end of idle range is not detected by both potentiometers. Attention, therefore, need to be paid that that by too large values in the maps KFMIMN and KFVERST no engine torque will result that leads to the speed threshold being exceeded.

MDVERB 12.170 Torque demand by auxiliary systems (e.g. air conditioner, misc. consumers)

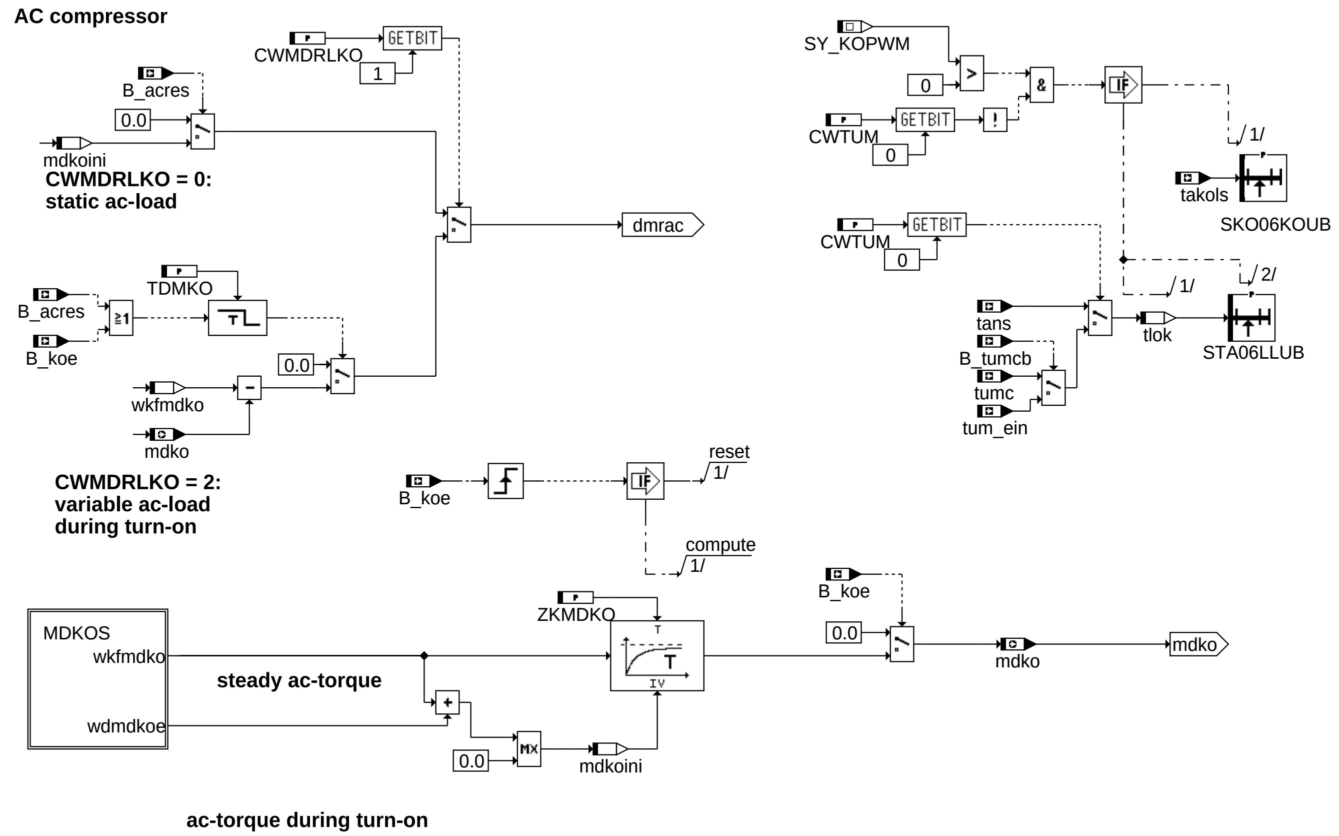
FDEF MDVERB 12.170 Function definition



mdverb-mdverb

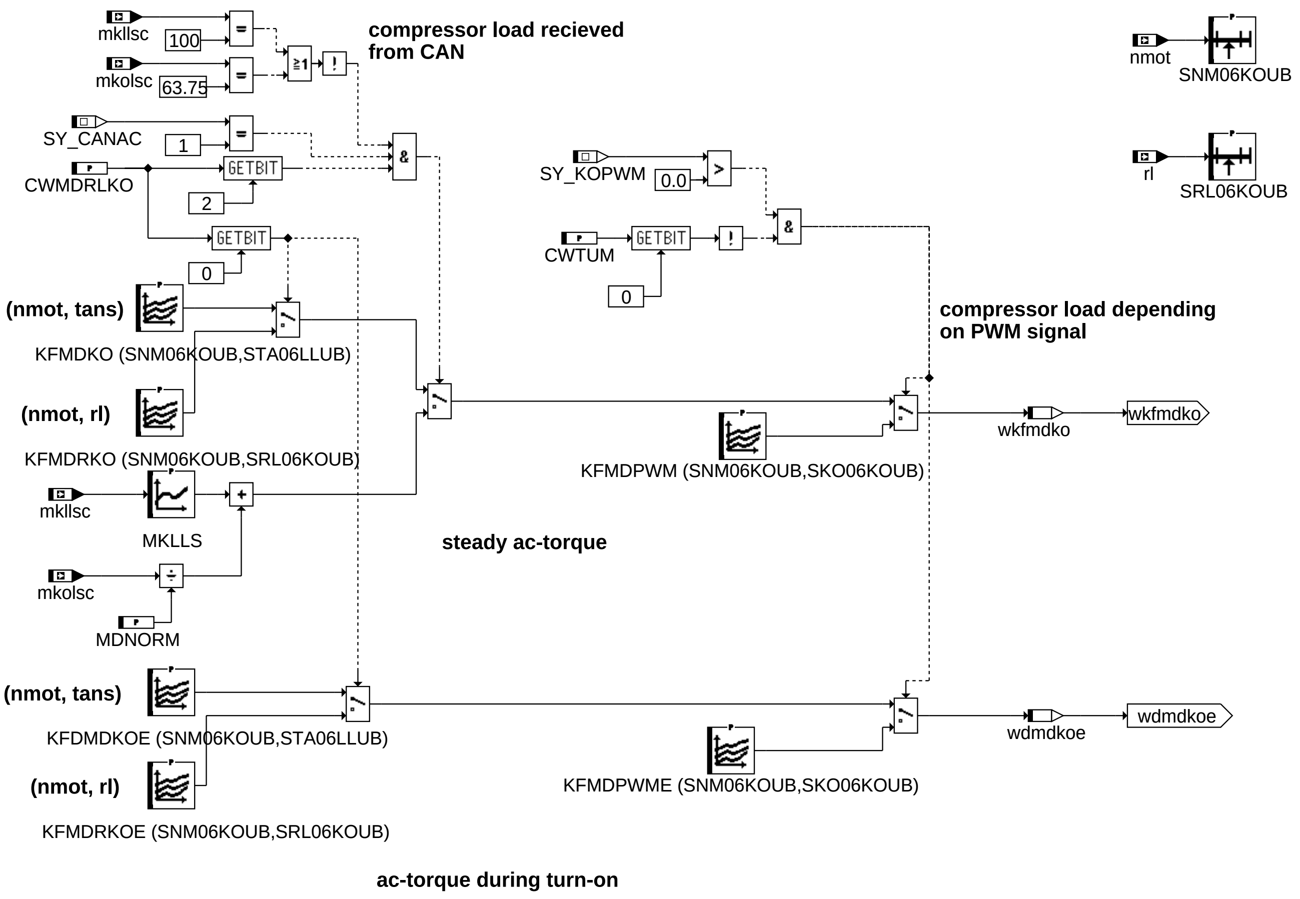
mdverb-mdverb

```
determination of accessory torque demands
-------------------------------------------
```



mdverb-mdko

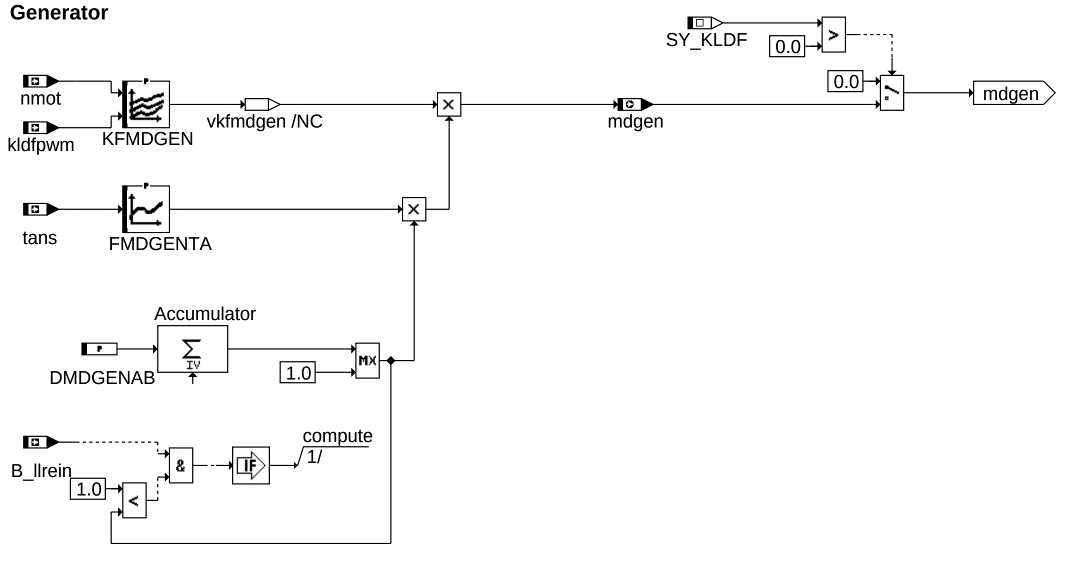
```
AC-compressor torque demand
----------------------------
```



mdverb-mdkos

mdverb-mdkos

```
AC-compressor torque demand: steady state and initial value
------------------------------------------------------------
```

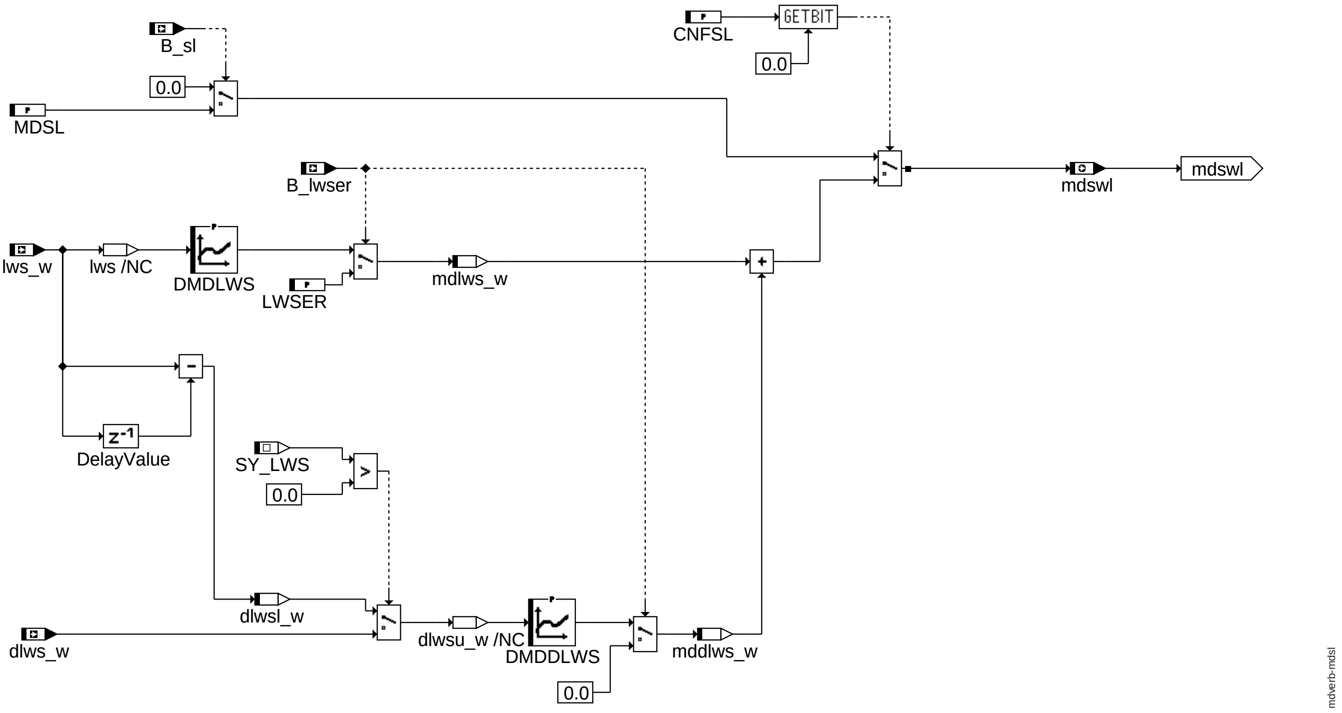


mdverb-mdgen

mdverb-mdgen

```
alternator torque demand
------------------------
```

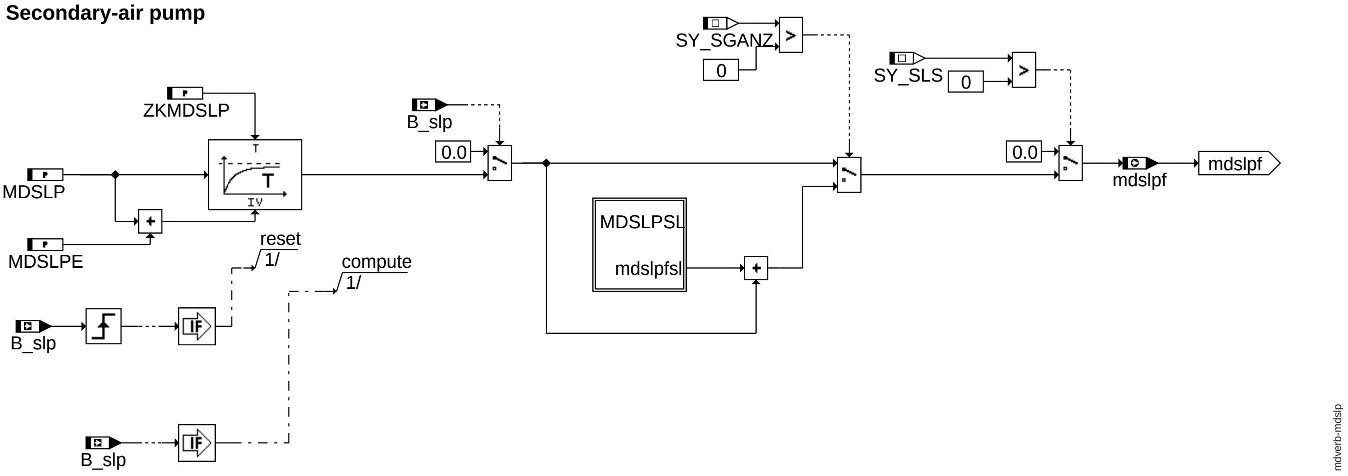
Power steering



mdverb-mdsl

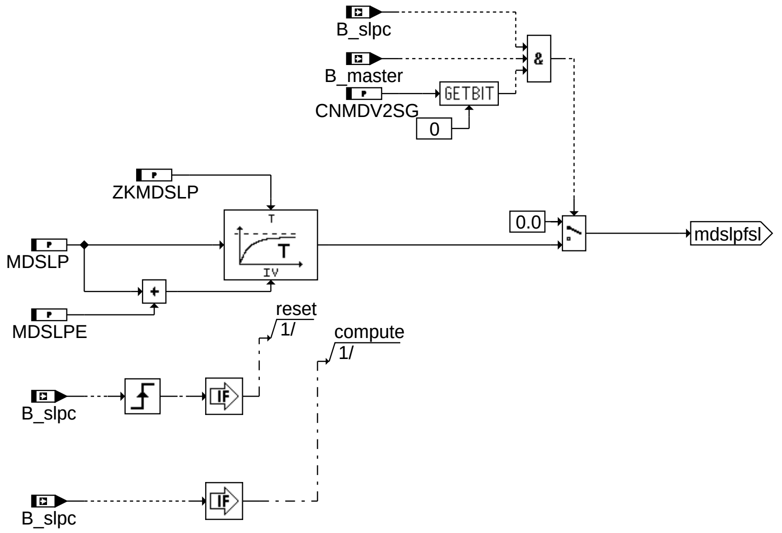
```
torque demand of hydraulic power steering pump
----------------------------------------------
```

Secondary-air pump



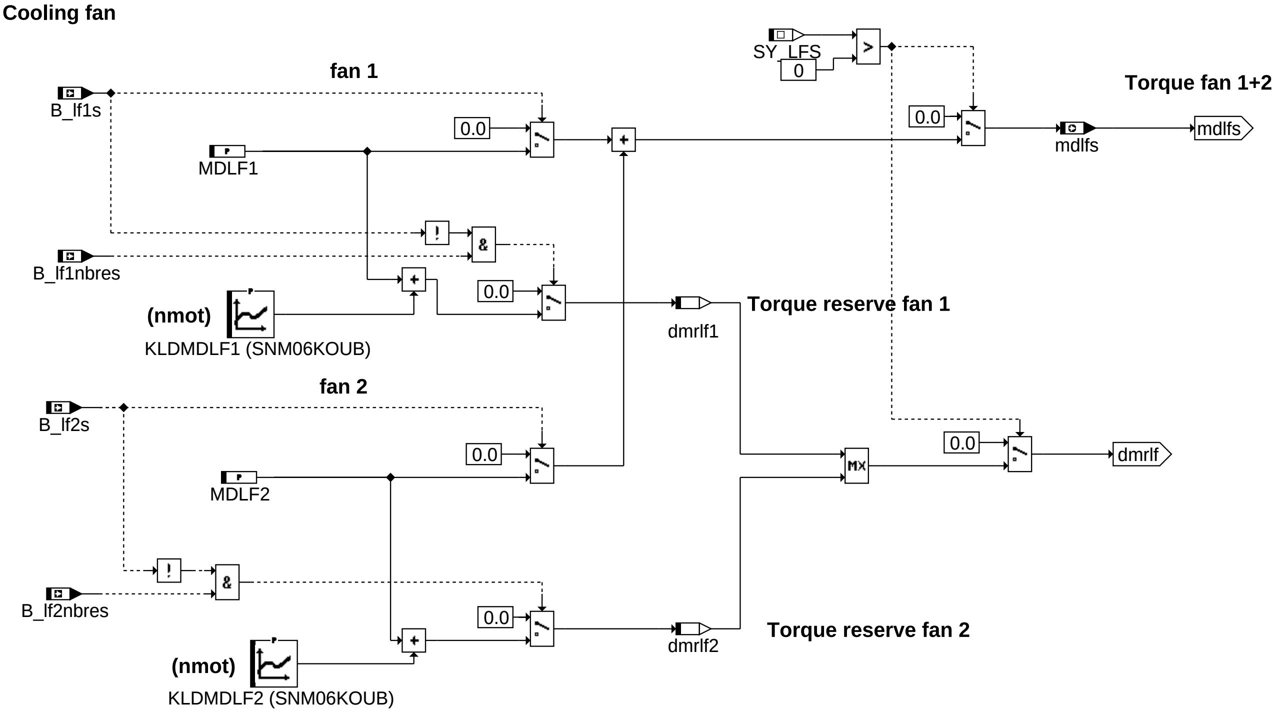
mdverb-mdslp

```
torque demand of secondary air pump
-----------------------------------
```



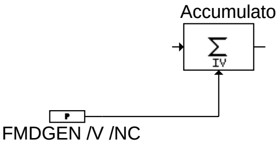
mdverb-mdslpsl

```
torque demand of secondary air pump for slave (multi-ECU system)
---------------------------------------------------------------------------
```



mdverb-mdlfs

```
torque demand of fan
---------------------
```



mdverb-init

```
initialization
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```

ABK MDVERB 12.170 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFSL			FW	Codeword to allow for the steering angle
CNMDV2SG			FW	code word torque request of the accessories for 2-ME-concept
CWMDRLKO			FW	codeword: torque loss ac-compressor dependend of rl, nmot
CWTUM			FW	configuration: ambient temperature for ac-compressor
DMDDLWS	DLWSU_W		KL	Torque for power steering function of the
DMDGENAB			FW	decrement of temperature factor generator torque
DMDLWS	LWS		KL	Torque for power steering
FMDGENTA	TANS		KL	factor: generator torque due to temperature
KFDMDKOE	NMOT	TLOK	KF	Starting value torque filter when air-conditioner compressor is activated
KFMDGEN	NMOT	KLDFPWM	KF	Torque intake generator
KFMDKO	NMOT	TLOK	KF	map for torque needed for air condition
KFMDPWM	NMOT	TAKOLS	KF	steady state load of ac-compressor for PWM-signal of its load
KFMDPWME	NMOT	TAKOLS	KF	initial load of ac-compressor for PWM-signal of its load
KFMDRKO	NMOT	RL	KF	look-up-table: torque loss depended of rl, nmot
KFMDRKOE	NMOT	RL	KF	look-up-table: torque loss dyn. part dependend of rl, nmot
KLDMDLF1	NMOT		KL	Characteristic curve reserve torque fan
KLDMDLF2	NMOT		KL	Characteristic curve reserve torque fan 2
LWSER			FW	Torque for power steering without angle sensor
MDLF1			FW	stationary torque for cooling fan 1
MDLF2			FW	stationary torque for cooling fan 2
MDNORM			FW	maximum limit indicate engine torque
MDSL			FW	Torque request of the power steering
MDSLP			FW	Torque to compensate the secondary air pump (stat.)
MDSLPE			FW	Torque to compensate the secondary air pump (switching on)
MKLLS	MKLLSC		KL	torque needed for air condition fan
SKO06KOUB	TAKOLS		SV	Distribution PWM-signal: load of ac-compressor
SNM06KOUB	NMOT		SV	distribution for ac-compressor torque function
SRL06KOUB	RL		SV	6 air charge set points for A/C-compressor torque loss
STA06LLUB	TLOK		SV	temperature: ambient air, PWM -signal of AC/compressor
SY_CANAC			SYS	systemconstant: AC-compressor signal from CAN
SY_KLDF			SYS	system constant for generator DF-signale
SY_KOPWM			SYS	PWM-compressor-signal enabled
SY_LFS			SYS	System constant Fan Control configuration
SY_LWS			SYS	system constant steering angle via CAN
SY_SGANZ			SYS	system constant number engine control unit
SY_SLS			SYS	system constant for engines with secondary air pump
TDMKO			FW	debounce time after torque reserve: ac-clutch
ZKMDKO			FW	time constant A/C compressor-load decreasing
ZKMDSLP			FW	Time constant to decrease the switching-on torque of the sec. air pump

Variable	Source	Type	Description
B_ACRES	SWADAP	EIN	Condition for increasing the torque reserve by AC-stand-by
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_LF1NBRES	LFS	EIN	Condition for torque reserve for engine cooling fan step 1 normal operation on
B_LF1S	LFS	EIN	fan 1 on condition
B_LF2NBRES	LFS	EIN	Condition for torque-reserve build at engine-fan stage 2, normal operation on
B_LF2S	LFS	EIN	fan 2 on condition
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LWSER		EIN	Error in the path of the steering angle
B_MASTER		EIN	Condition MASTER-ECU
B_SL		EIN	Condition power steering
B_SLP	AK	EIN	condition for secondary air pump
B_SLPC		EIN	condition for secondary air pump via CAN (2-ME-concept)
B_TUMCB		EIN	Condition: Fault in CAN ambient-temperature information
DLWSL_W	MDVERB	LOK	
DLWS_W		EIN	
DMRAC	MDVERB	AUS	Torque reserve for AC-compressor
DMRLF	MDVERB	AUS	Torque reserve for cooling fan
DMRLF1	MDVERB	LOK	Torque reserve, fan level 1
DMRLF2	MDVERB	LOK	Reserve torque, fan level 2
KLDFPWM		EIN	generator signale as PWM-signale filtrated
LWS_W		EIN	Steering angle
MDDLWS_W	MDVERB	LOK	Torque dpending on the steering angle gradient
MDGEN	MDVERB	AUS	Torque consumption generator
MDKO	MDVERB	AUS	torque needed for air condition
MDKOINI	MDVERB	LOK	compressor torque for turn-on
MDLFS	MDVERB	AUS	Torque needed by the engine cooling fan
MDLWS_W	MDVERB	LOK	Torque dpending on the steeing angle
MDSLPF	MDVERB	AUS	Torque needed by the secondary air pump
MDSWL	MDVERB	AUS	torque loss: power steering
MDVERB	MDVERB	AUS	Torque request of the accessories
MDVERBC		EIN	Torque requestt of the accessoires via CAN (2-ME-Concept)
MKLLSC		EIN	Compressor-fan signal from CAN message Clima 1
MKOLSC		EIN	Compressor load signal from CAN message Clima 1
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
TAKOLS		EIN	air-condition information as PWM
TANS	SWADAP	EIN	Intake air temperature
TLOK	MDVERB	LOK	ambient temp. for ac-compressor load
TUMC		EIN	Ambient temperature from CAN combi
TUM_EIN		EIN	ambient temperature for soak time calculation

Variable	Source	Type	Description
WDMDKOE	MDVERB	LOK	torque needed for air condition during turn on
WKFMDKO	MDVERB	LOK	torque needed for air condition before Filter

FW MDVERB 12.170 Fixed Values

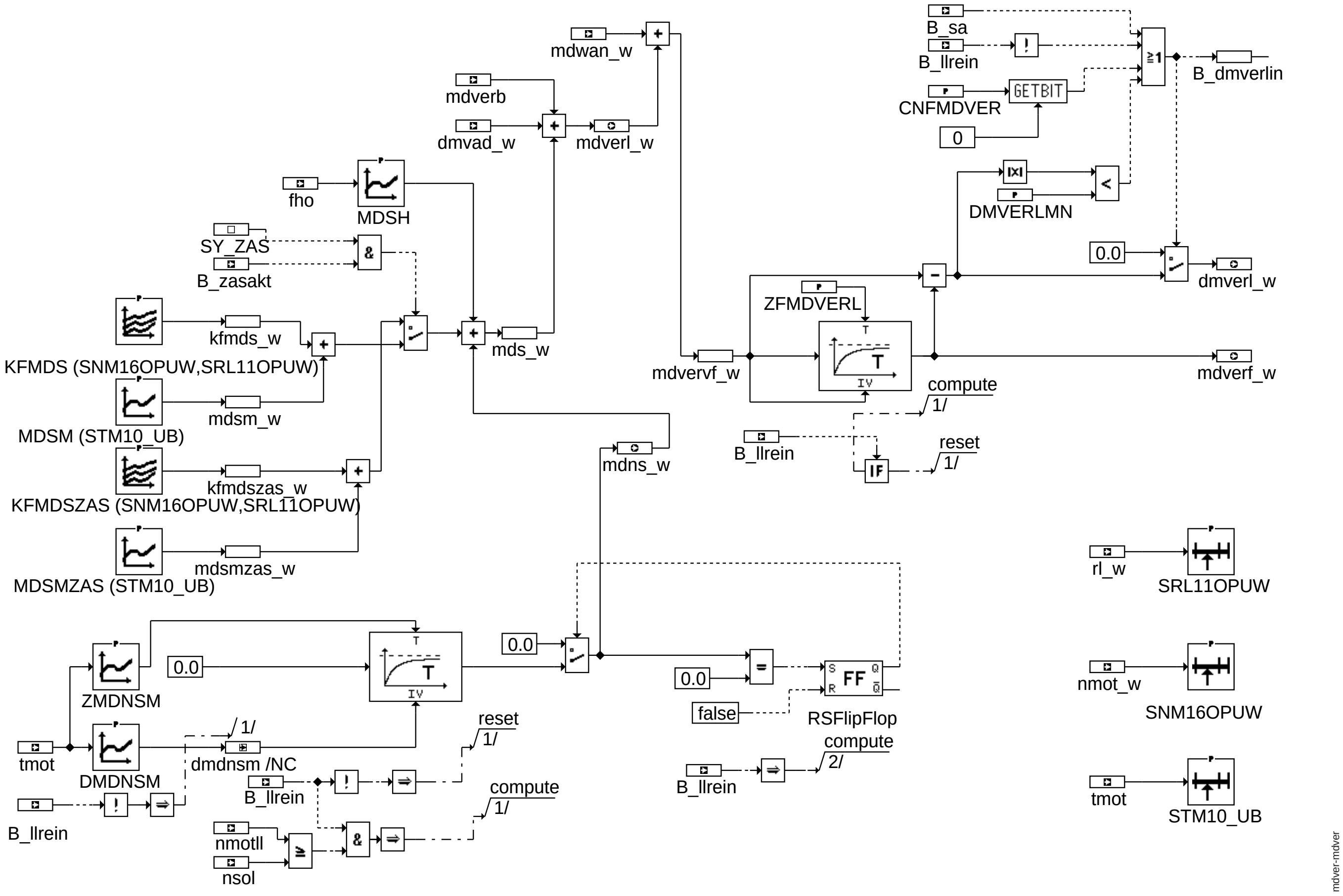
Parameter	Value	Description
CNFSL		Codeword to allow for the steering angle
CNMDV2SG		code word torque request of the accessories for 2-ME-concept
CWMDRLKO		codeword: torque loss ac-compressor dependend of rl, nmot
CWTUM		configuration: ambient temperature for ac-compressor
DMDGENAB		decrement of temperature factor generator torque
LWSER		Torque for power steering without angle sensor
MDLF1		stationary torque for cooling fan 1
MDLF2		stationary torque for cooling fan 2
MDNORM		maximum limit indicate engine torque
MDSL		Torque request of the power steering
MDSLP		Torque to compensate the secondary air pump (stat.)
MDSLPE		Torque to compensate the secondary air pump (switching on)
TDMKO		debounce time after torque reserve: ac-clutch
ZKMDKO		time constant A/C compressor-load decreasing
ZKMDSLP		Time constant to decrease the switching-on torque of the sec. air pump

FB MDVERB 12.170 Detailed description of function

APP MDVERB 12.170 Application hint

MDVER 5.90 Loss in engine torque

FDEF MDVER 5.90 Function definition



mdver-mdver

ABK MDVER 5.90 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFMDVER			FW	Codeword to configure the function MDVER
DMDNSM	TMOT		KL	Torque offset for after cranking compensation
DMVERLMN			FW	Minimum torque-loss threshold
KFMDS	NMOT_W	RL_W	KF	map for engine drag torque
KFMDSZAS	NMOT_W	RL_W	KF	map for engine drag torque during cyclinder cut off
MDSH	FHO		KL	Part of the resistant torque depending on altitude
MDSM	TMOT		KL	temperatuer share of enginie friction torque
MDSMZAS	TMOT		KL	temperatuer share of enginie friction torque during cylinder cut off
SNM16OPUW	NMOT_W		SV	16 speed set points for ?
SRL11OPUW	RL_W		SV	set point distribution relative charge
SY_ZAS			SYS	system constant cylinder deactivation ZAS included
ZFMDVERL			FW	Time constant for filtering the resistant torque
ZMDNSM	TMOT		KL	time constant for decay of torque offset after cranking

Variable	Source	Type	Description
B_DMVERLIN	MDVER	LOK	Condition dmverl = 0
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_SA	MDRED	EIN	Condition fuel cut-off
B_ZASAKT		EIN	Cylinder cut-out active
DMVAD_W	MDVERAD	EIN	Delta resistant torque from resistant torque adaptation
DMVERL_W	MDVER	AUS	Resistant torque after DT1-filter
FHO	BGPU	EIN	Correction factor altitude
KFMDSZAS_W	MDVER	LOK	map for engine drag torque duringcylinder cut off
KFMDS_W	MDVER	LOK	map for engine drag torque
MDNS_W	MDVER	AUS	torque after start
MDSMZAS_W	MDVER	LOK	Drag torque temperature component during cylinder cut off |
MDSM_W	MDVER	LOK	Drag torque temperature component
MDS_W	MDVER	LOK	engine drag torque
MDVERB	MDVERB	EIN	Torque request of the accessories
MDVERF_W	MDVER	AUS	Filtered charge torque
MDVERL_W	MDVER	AUS	Resistant torque of the engine
MDVERVF_W	MDVER	LOK	Unfiltered torque loss
MDWAN_W	MDWAN	EIN	Torque request of the torque converter
NMOTLL	BGNMOT	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
NSOL	LLRNS	EIN	idle reference speed
RL_W	EGFE	EIN	relative air charge (Word)
TMOT	SWADAP	EIN	Engine temperature

FW MDVER 5.90 Fixed Values

Parameter	Value	Description
CNFMDVER		Codeword to configure the function MDVER
DMVERLMN		Minimum torque-loss threshold
ZFMDVERL		Time constant for filtering the resistant torque

FB MDVER 5.90 Detailed description of function

The calculated engine-torque loss, mdverl_w, is made up of the engine drag torque mds, the adapted delta drag torque, dmvad_w, and the torque demand from the auxiliary equipment, mdverb.
The engine drag torque, mds, is made up of the drag torque, KFMDS, dependent on the engine speed, nmot, and the relative load, r, the engine-temperature dependent corrective torque, MDSM, and the altitude-dependent component, MDSH.
In order to meet the higher torque demand from the engine during the post-start phase, an additional torque, DMDNSM, is included in the calculations as of the end of the start-up phase (B_llrein = 1) as a function of the engine's temperature. This additional torque is gradually decreased down to zero again over a filter using the temperature-dependent time constant ZMDNSM. Besides allowing for mdverl_w, the necessary change in the torque loss, dmverl_w, needed to calculated the vehicle-operator demand also takes the change in the converter torque, mdwan_w, into account. The change is calculated and passed over a highpass filter.

APP MDVER 5.90 Application hint

Adaptation of KFMDS: KFMDS constitutes the drag torque of the engine and is determined during non-firing operation of the engine torque at drag test bench. The engine must be warm to do this (min. 80 °C for the oil temperature). The torque is determined for various speed and load points. This is needed to drag the non-firing engine. This map has already been established during basic engine parameterization at the engine test bench.

Adaptation of MDSM: MDSM contains the temperature influence from the engine drag torque (internal friction). The temperature influence is particularly high for the changed oil viscosity and hence by this, to find the thereby associated change in the friction torque of the engines. The influence of the temperature is determined in the climatic chamber. The set speed is kept constant throughout warming-up from lowest possible start-up temperature until the engine is warm. The necessary target torque is then determined over the temperature. The value for the warm engine must correspond to KFMDS for the given operating point of the engine and MDSM forms the difference between mimin and mds for lower temperatures. It is however important to carry out these measurements at differing set speeds, engine and oil qualities (new, used oil, viscosity range). The temperature datapoints of MDSM are run through dynamically, i.e. the engine has already been running for some time and passes through the various temperature datapoints as the engine temperature rises. As this has a very large influence on the oil viscosity, an adjustment is needed immediately after the start-up phase for the temperature compensation.

Adaptation of MDSH: The adaptation of the altitude component is executed with the neutral values of 0 % as part of the basic adaptation. These values then apply for the altitude of the location of the adaptation (e.g. Schwieberdingen is 350 m above sea level). The drag torque decreases as the altitude increases. This is because the resistance falls by the change in the gas (pressure difference between manifold and exhaust sides become less). The drag torque will increase for a falling altitude (compare with the altitude for the basic adaptation). The adaptation is made by transferring the different of the I-component of the idle-speed control (comparison between altitude for the basic application and the current altitude for the same load on the engine).

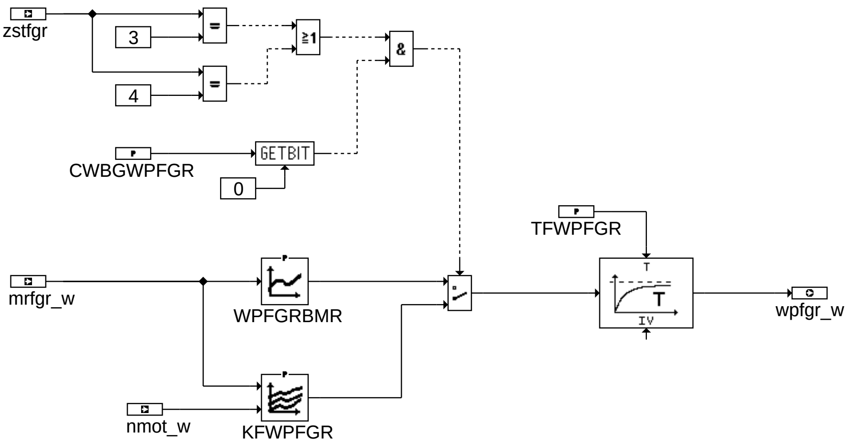
Adaptation of DMDNSM: DMDNSM serve as a correction between the friction torque for a stationary and a dynamic oil viscosity. The stationary oil viscosity is given when the oil is held in a rigid state at a constant temperature over a longer period of time. The oil molecules have increased in length here and hence the viscosity of the oil becomes higher. It is only after the oil has been thoroughly mixed through again by mechanical pumping within the lubrication circuit that it has the viscosity that matches MDSM. This is then the viscosity referred to as the dynamic oil viscosity.

Adaptation of ZMDNSM: This time constant is for gradual decrease of the correction DMDNSM. The interventions by the controller are observed during the post-start phase for several cold and warm start-up's in order to adapt this time constant. The controller will reach a neutral values after a longer period of time. The controller must however apply this correction for such time until this is the case, whereby this correction is not yet part of the characteristic curve DMDNSM. This correction for the controller should no longer occur once adaptation of MDSM and ZMDNSM has finished.

Adaptation of ZFMDVERL: No sudden changes in mimin_w are permitted. This is to prevent sudden changes in the accelerator-pedal characteristics. It is established using the filter ZFMDVERL how quickly the change in the lower limit for the driver torque can take place.

BGWPFGR 2.10 Calculation variable, back-calculated pedal value for FGR

FDEF BGWPFGR 2.10 Function definition



bgwpfgr-main

ABK BGWPFGR 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWBGWPFGR			FW	Code word for %BGWPFGR
KFWPFGR	MRFGR_W	NMOT_W	KF	Inverse pedal characteristic for cruise mode
TFWPFGR			FW	Time constant of the filter for calculation of wpfgr_w
WPFGRBMR	MRFGR_W		KL	Back-calculated pedal value during acceleration with FGR

Variable	Source	Type	Description
MRFGR_W	MSF	EIN	relative torque demand from cruise control
NMOT_W	SWADAP	EIN	engine speed
WPFGR_W	BGWPFGR	AUS	Recalculated accelerator pedal position in cruise mode
ZSTFGR	FGRFULO	EIN	Status of vehicle-speed controller

FW BGWPFGR 2.10 Fixed Values

Parameter	Value	Description
CWBGWPFGR		Code word for %BGWPFGR
TFWPFGR		Time constant of the filter for calculation of wpfgr_w

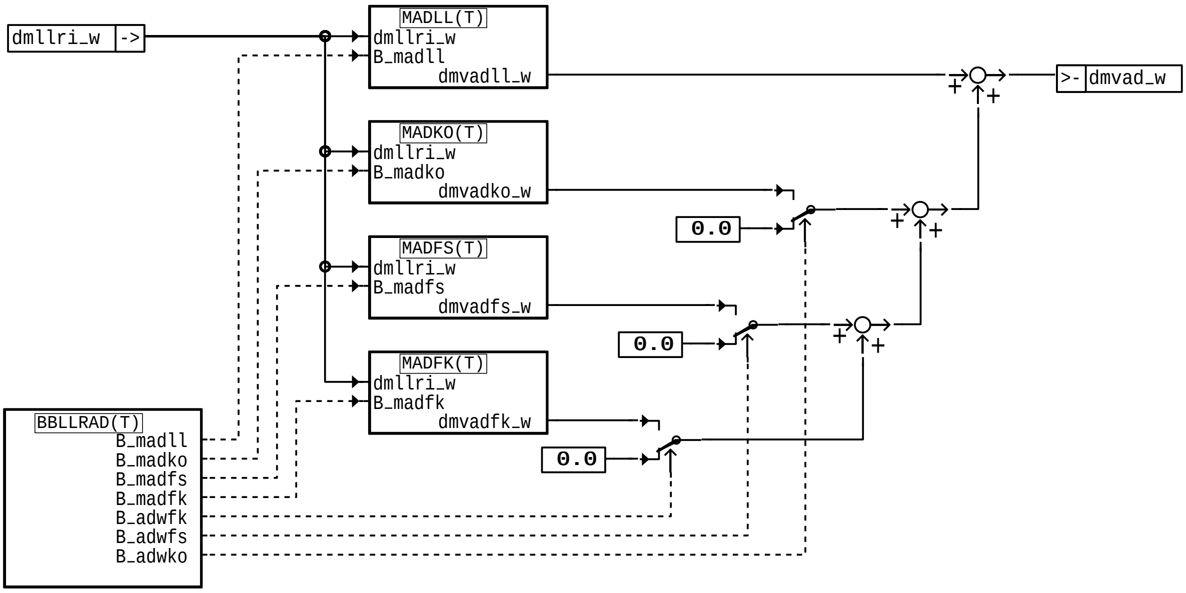
FB BGWPFGR 2.10 Detailed description of function

A value for the pedal travel is calculated back from the relative torque demand of the vehicle-speed controller so as to able to provide transmission control during operation of the vehicle-speed controller (FGR) as well with a parameter equivalent to the pedal-travel value for triggering gear shifting. This usually happens from an inverted pedal map. When appropriately coded, a separate characteristic curve is then used instead of this for accelerations by the vehicle-speed controller.

APP BGWPFGR 2.10 Application hint

MDVERAD 1.50 Adaptation of torque loss

FDEF MDVERAD 1.50 Function definition

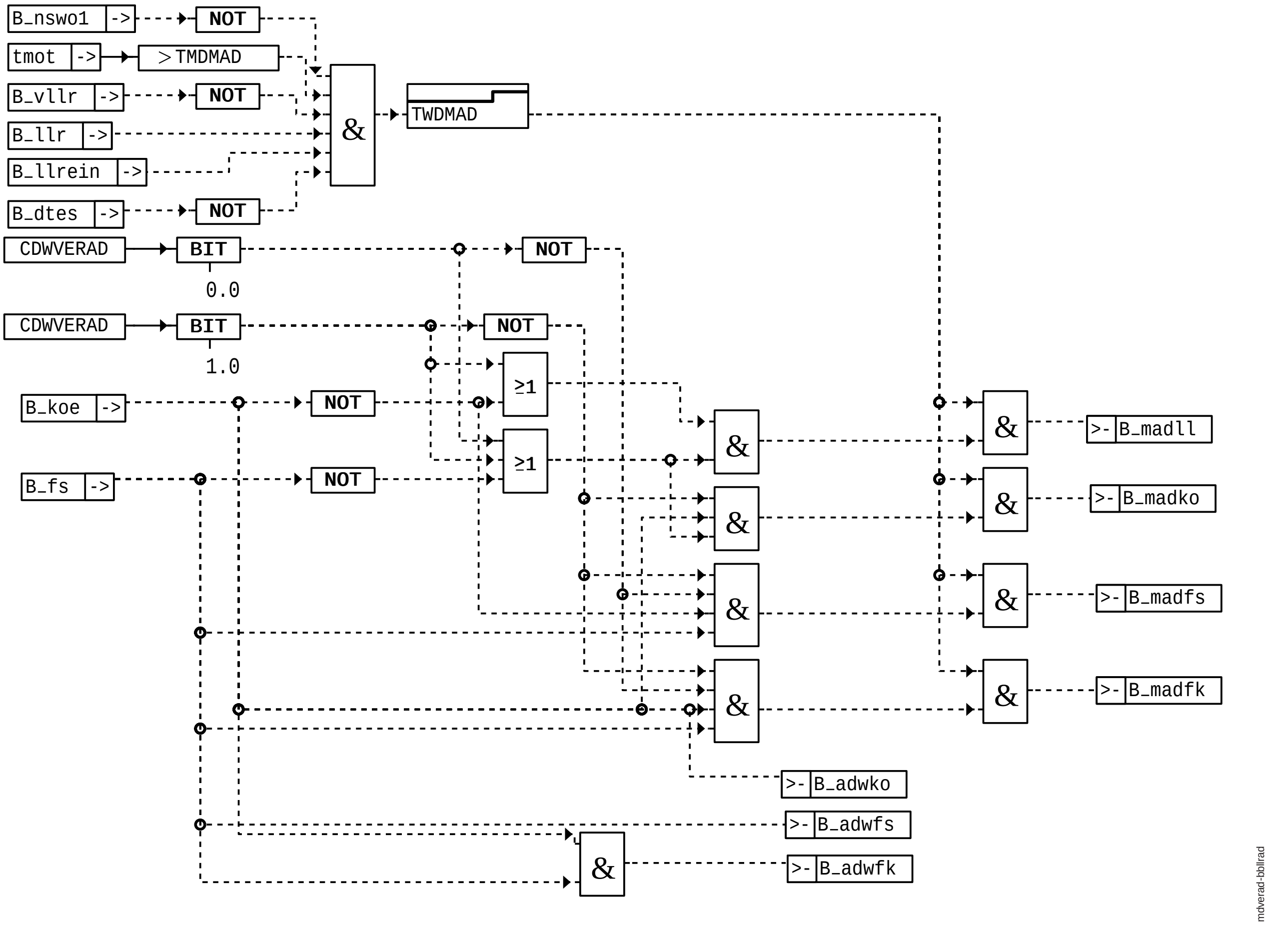


mdverad-mdverad

mdverad-mdverad

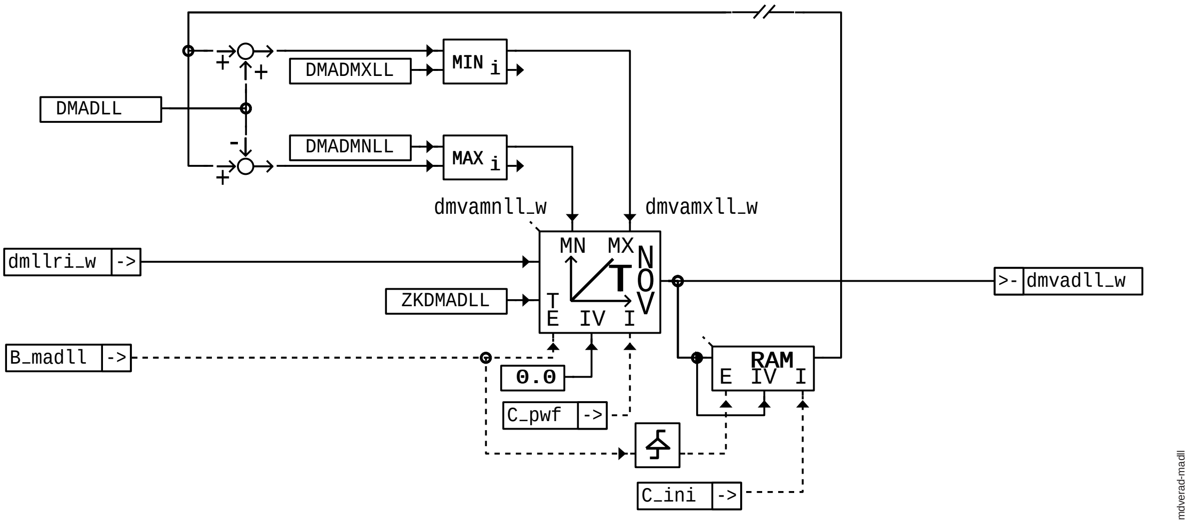
```
Overview of the demand adaptation: The demand adaptation is divided into 4 ranges:
---------------------------------  MADLL : Operation without air-conditioning compressor and without engaged drive driving position
                                   MADKO : Operation with air-conditioning compressor and without engaged driving position
                                   MADFS : Operation without air-conditioning compressor and with engaged driving position
                                   MADFK : Operation with air-conditioning compressor and with engaged driving position

                                   The choice of the current range is made in the BBLLRAD
```



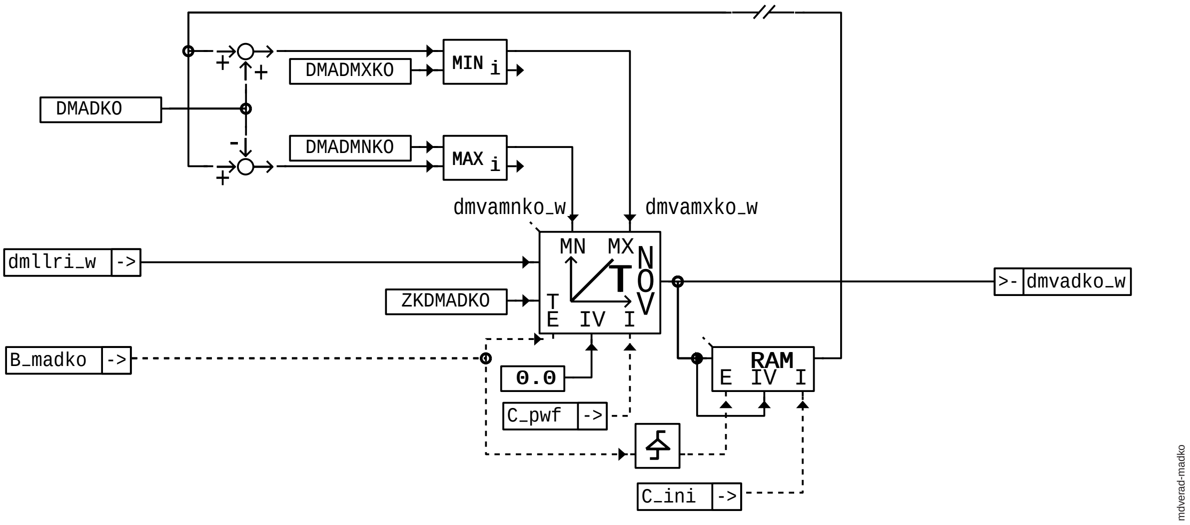
mdverad-bbllrad

```
BBLLRAD:  Determination of the operating range and enabling of the adaptation in these ranges
-------------------------------------------------------------------------------------------
```



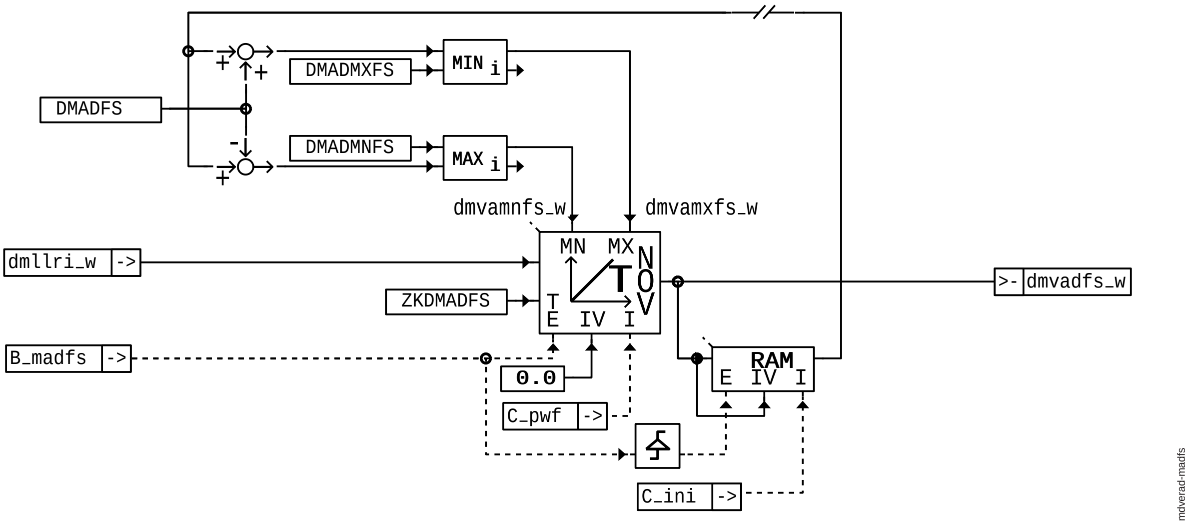
mdverad-madll

```
DMADLL :Adaptation for operation without air-conditioning system and without engaged driving position
-----------------------------------------------------------------------------------------------------
```



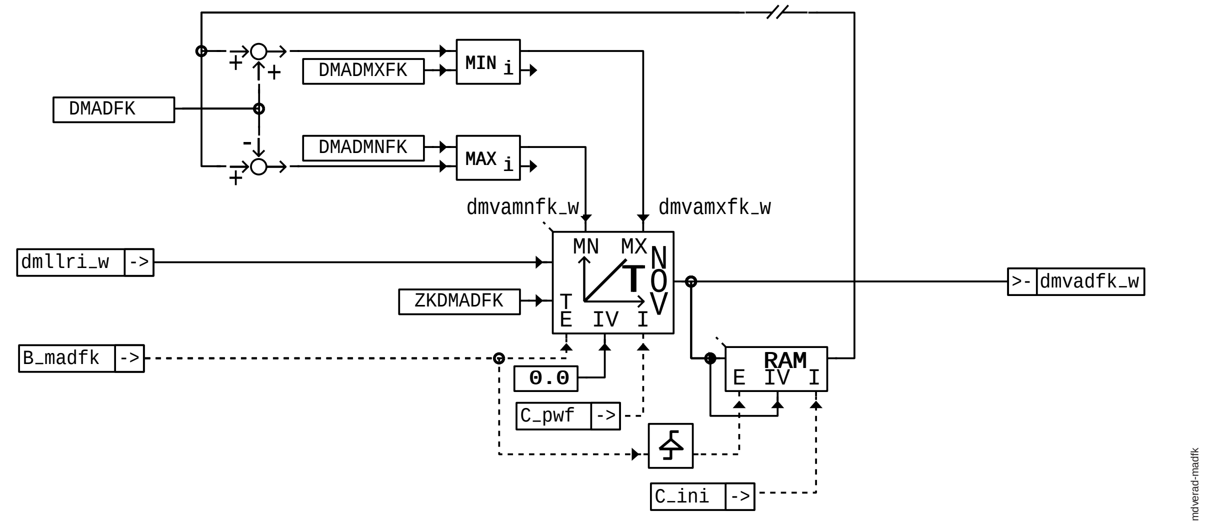
mdverad-madko

```
DMADKO :Adaptation for operation with air-conditioning system and without engaged driving position
----------------------------------------------------------------------------------------------------
```



mdverad-madfs

```
DMADFS :Adaptation for operation without air-conditioning system and with engaged driving position
----------------------------------------------------------------------------------------------------
```



mdverad-madfk

```
DMADFK :Adaptation for operation with air-conditioning system and with engaged driving position
-----------------------------------------------------------------------------------------------
```

ABK MDVERAD 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDWVERAD			FW	Codewort
DMADFK			FW	maximum adaptable change of resistant torque during one idle cycle AT-drvie + AC
DMADFS			FW	maximum adaptable change of resistant torque during one idle cycle AT in drive
DMADKO			FW	maximum adaptable change of resistant torque during one idle cycle compressor on
DMADLL			FW	maximum adaptable change of resistant torque during one idle cycle loadless
DMADMNFK			FW	lower limit for torque adaptation At in drive + AC compressor on
DMADMNFS			FW	lower limit for torque adaptation At in drive
DMADMNKO			FW	lower limit for torque adaptation AC compressor on
DMADMNLL			FW	lower limit for torque adaptation loadless
DMADMXFK			FW	upper limit for torque adaptation AT in drive + AC compressor on
DMADMXFS			FW	upper limit for torque adaptation AT in drive
DMADMXKO			FW	upper limit for torque adaptation AC compresssor on
DMADMXLL			FW	upper limit for torque adaptation loadless
TMDMAD			FW	Engine temperature threshold to enable adaptation of resistant torque
TWDMAD			FW	Waiting time to enable adaptation of resistant torque
ZKDMADFK			FW	time constant for torque adaptation AT in drive and AC compressor on
ZKDMADFS			FW	time constant for torque adaptation AT in drive
ZKDMADKO			FW	time constant for torque adaptation AC compressor on
ZKDMADLL			FW	time constant for torque adaptation loadless

Variable	Source	Type	Description
B_ADWFK	MDVERAD	LOK	condition to use adaptation value for AT in drive and AC compressor on
B_ADWFS	MDVERAD	LOK	condition to use adaptation value for AT in drive
B_ADWKO	MDVERAD	LOK	condition to use adaptation value for AC compressor on
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_LLR	LLRBB	EIN	condition idle speed control
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_MADFK	MDVERAD	LOK	condition for torque adaptation AT in drive and AC compressor on
B_MADFS	MDVERAD	LOK	condition for torque adaptation AT in drive
B_MADKO	MDVERAD	LOK	condition for torque adaptation AC-compressor on
B_MADLL	MDVERAD	LOK	condition for torque adaptation loadless
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_VLLR	LLRBB	EIN	Condition vehicle is moving with engaged gear
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DMVADFK_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_fs=1 & B_ko=1)
DMVADFS_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_fs=1)
DMVADKO_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_ko=1)
DMVADLL_W	MDVERAD	LOK	Delta resistant torque from resistant torque adaptation(B_ll=1)
DMVAD_W	MDVERAD	AUS	Delta resistant torque from resistant torque adaptation
DMVAMNFK_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_fs=1 & B_ko=1)
DMVAMNFS_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_fs=1)
DMVAMNKO_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_ko=1)
DMVAMNLL_W	MDVERAD	DOK	Lower limit of resistant torque adaptation (B_ll=1)
DMVAMXFK_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_fs=1 & B_ko=1)
DMVAMXFS_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_fs=1)

Variable	Source	Type	Description
DMVAMXKO_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_ko=1)
DMVAMXLL_W	MDVERAD	DOK	Upper limit of resistant torque adaptation (B_ll=1)
TMOT	SWADAP	EIN	Engine temperature

FW MDVERAD 1.50 Fixed Values

Parameter	Value	Description
CDWVERAD		Codewort
DMADFK		maximum adaptable change of resistant torque during one idle cycle AT-drvie + AC
DMADFS		maximum adaptable change of resistant torque during one idle cycle AT in drive
DMADKO		maximum adaptable change of resistant torque during one idle cycle compressor on
DMADLL		maximum adaptable change of resistant torque during one idle cycle loadless
DMADMNFK		lower limit for torque adaptation At in drive + AC compressor on
DMADMNFS		lower limit for torque adaptation At in drive
DMADMNKO		lower limit for torque adaptation AC compressor on
DMADMNLL		lower limit for torque adaptation loadless
DMADMXFK		upper limit for torque adaptation AT in drive + AC compressor on
DMADMXFS		upper limit for torque adaptation AT in drive
DMADMXKO		upper limit for torque adaptation AC compresssor on
DMADMXLL		upper limit for torque adaptation loadless
TMDMAD		Engine temperature threshold to enable adaptation of resistant torque
TWDMAD		Waiting time to enable adaptation of resistant torque
ZKDMADFK		time constant for torque adaptation AT in drive and AC compressor on
ZKDMADFS		time constant for torque adaptation AT in drive
ZKDMADKO		time constant for torque adaptation AC compressor on
ZKDMADLL		time constant for torque adaptation loadless

FB MDVERAD 1.50 Detailed description of function

The demand adaptation learns the different friction loss of the system engine+auxiliary aggregates. Included as auxiliary aggregates for the adaptation are only the compressor for the air-conditioning system and the converter for the automatic transmission. Since the engine is sometimes run without the air-conditioning compressor turned on, or with driving positions of the automatic transmission not engaged, the adaptation must take the different load states into account.

The adaptation MADLL is performed when idling without the air-conditioning compressor and without an engaged driving position (only for AT). In dmvadll_w, the change in the load torque of the engine alone is learned (basic change in the engine torque corresponds to a change in the internal friction of the engine by, e.g. wear or differences in viscosity).

The basic load change is retained when the air-conditioning compressor is switched on, new changes in the load are primarily attributable to the air-conditioning compressor. A further factor dmvadko_w is thus adapted to the basic load change dmvadll_w by addition.
This adaptation is as a rule more rapid than the basic load adaptation because the compressor load changes much quicker for regulated compressors (depending on the quality of the check-back signal from the compressor for the load) than the basic load of the engine (given by the mechanical friction and the viscosity).

A similar process takes place when the driving position (automatic transmission) is engaged, as for switching on the compressor.

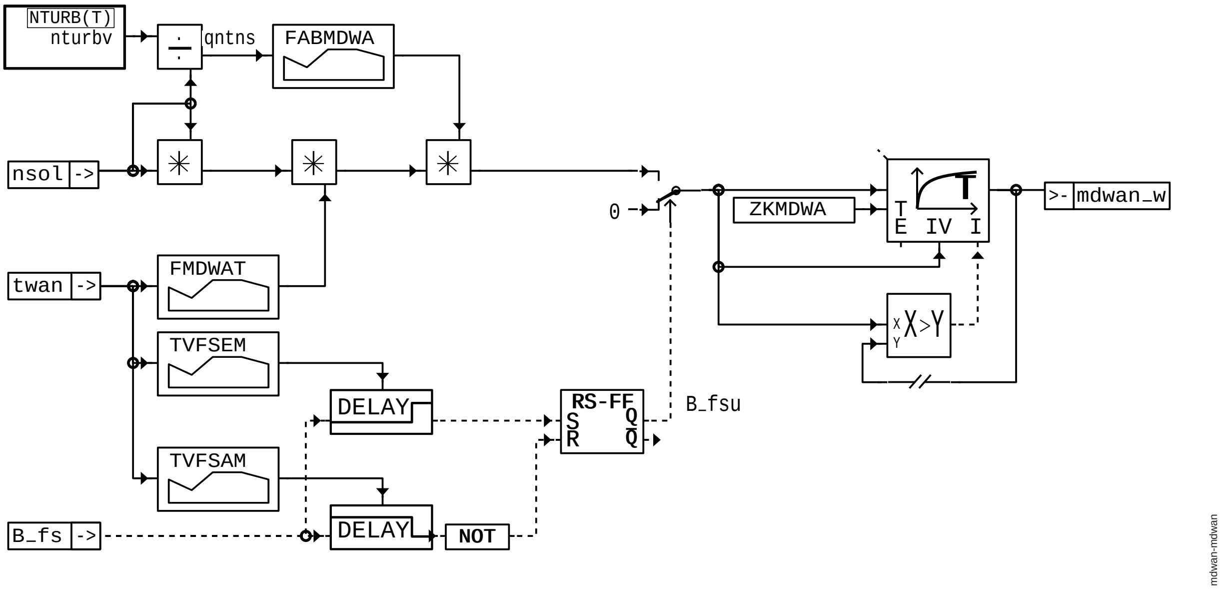
In the event that the compressor and driving position take place as loads at the same time, then the adaptation only sees the sum of changes in load from the compressor and driving position. Hence in this case, the factors already learned for the den air-conditioning compressor and the driving position alone are included in the calculation. A new factor dmvadfk_w is adapted however.

As soon as one of the loads (air-conditioning compressor or driving position) is turned off again, the inclusion of dmvadk_w in the calculation and the corresponding factor dmvadko_w or dmvadfs_w are learned again and included in the computation.

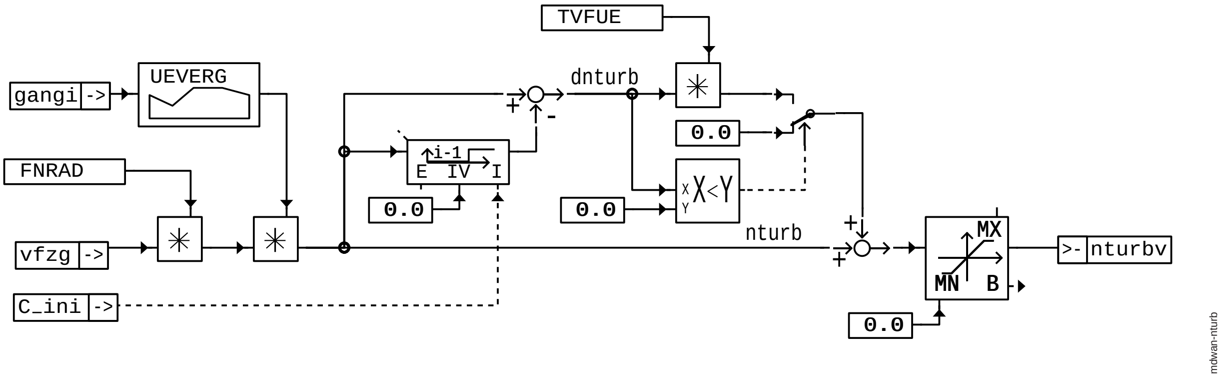
APP MDVERAD 1.50 Application hint

MDWAN 1.30 Torque of the AT-converter

FDEF MDWAN 1.30 Function definition



mdwan-mdwan



mdwan-nturb

ABK MDWAN 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FABMDWA	QNTNS		KL	Factor to decrease the converter torque depending of nturb
FMDWAT	TWAN		KL	Factor to calculate the converter torque depending of oil temperature
FNRAD			FW	Factor between wheel speed and vehicle speed f(circumference)
TVFSAM	TWAN		KL	Delay time after DRIVE-position switch off
TVFSEM	TWAN		KL	delay time after DRIVE-position switch on
TVFUE			FW	Delay for the cylinder filling
UEVERG	GANGI		KL	Gear ratio depending of the gear
ZKMDWA			FW	Time constant for converter torque change

Variable	Source	Type	Description
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_FSU	MDWAN	DOK	Condition: Gear selection, switchover
B_INI		EIN	Condition initialization
C_INI	SWADAP	EIN	ECU-condition for intialisation
DNTURB	MDWAN	LOK	Speed difference of the converter turbine
GANGI	SWADAP	EIN	Engaged gear
MDWAN_W	MDWAN	AUS	Torque request of the torque converter
NSOL	LLRNS	EIN	idle reference speed
NTURB	MDWAN	LOK	Converter turbine speed
NTURBV	MDWAN	LOK	Expected converter turbine speed
QNTNS	MDWAN	LOK	Quotient of turbine speed by target speed at idle
S_FS	SWADAP	EIN	Drive position selected

Variable	Source	Type	Description
TWAN	SWADAP	EIN	Converter oil temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW MDWAN 1.30 Fixed Values

Parameter	Value	Description
FNRAD		Factor between wheel speed and vehicle speed f(circumference)
TVFUE		Delay for the cylinder filling
ZKMDWA		Time constant for converter torque change

FB MDWAN 1.30 Detailed description of function

If the vehicle is at rest with At in ’drive’, the engine must produce a definite torque to compensate the resistance of the torque converter of the AT. This resistant torque can be calculated as follow:

```
                                             2
     md = FMDWAT(twan) * FABMDWA(qntns) * nsol

with  twan = oil temperature of the converter
     qntns = nturbv / nsol, quotient of the expected converter turbine speed and the ensgine target speed at idle.
```

The expected converter turbine speed is calculated as follow:

```
"                      / 0, if the turbine speed is sonstant or increasing"
    nturbv = nturb + <
                      \ dnturb * TVFUE, if the turbine speed is decreasing
```

The converter turbine speed nturb ist calculated as follow:

```
nturb = UEVERG * nrad    with      nrad = FNRAD * vfzg.
```

where UEVERG = f(gangi) is the gear-ratio in the actual gear and FNRAD is a function of the wheel circumference.

If the driver drives away slowly, the turbine is rotated by the wheels. If the turbine speed approches the engine speed, the resistant torque of the converter becomes smaller.

If the wheels are decelerated, the turbine speed decreases and the resistant torque of the converter increases (mdwan_w must increase too). To achieve a quick filling of the intake manifoild in order to compensate the change of converter torque, the torque is predicted by using the turbine speed change (see above).

An increase of the converter torque must be taken into account without filtering (the torque must be present as soon as possible), the reduction of the converter torque can be filtered (comfort).

APP MDWAN 1.30 Application hint

```
FABMDWA:  The factor is 1 if qntns is 0. The factor varies from 0 to 1 if the turbine speed approaches the target speed nsol.
          0 < qntns < 1, the factor is 0 if qntns is 1.

FMDWAT:   With decreasing oil temperature the factor becomes greather because the internal friction of the converter increases.

TVFUE:    Delay time for the filling of the cyclinders at idle and low load.

                                           nTurbine                                   nCardan_Shaft
UEVERG:   example: gear ratio in 5th gear = ------------ = 3.7  und  rear axle ratio  = ------------ = 0.8
                                           nCardan_Shaft                                  nWheel

          The total ration in 5. gear is the given by UEVERG(5) = 3.7 * 0.8 = 2.96.

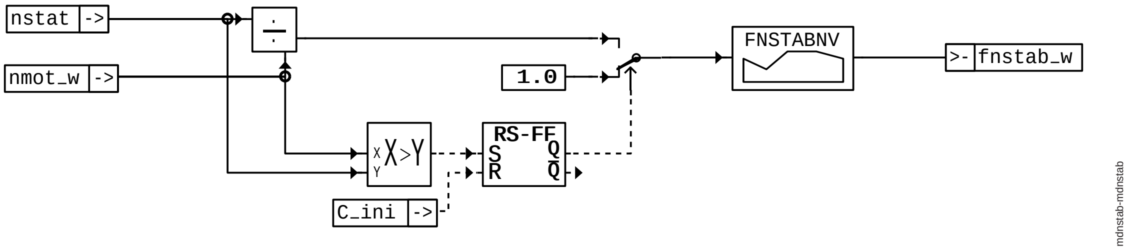
FNRAD:    example: for a circumference of 2m fnrad is given by: nrad = 1 r/min = 2 m/min = 120 m/h = 0.12 km/h = vfzg
                   nWheel     1 rpm           rpm
          FNRAD = ------- = ---------- = 8.33 ----.
                   vfzg      0.12 km/h        km/h
TVFSAM:

TVFSEM:

ZKMDWA:
```

MDNSTAB 1.10 Torque: engine-speed stabilization

FDEF MDNSTAB 1.10 Function definition



mdnstab-mdnstab

ABK MDNSTAB 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FNSTABNV	NVER		KL	Factor for engine speed stabilisation by torque

Variable	Source	Type	Description
C_INI	SWADAP	EIN	ECU-condition for intialisation
FNSTAB_W	MDNSTAB	AUS	Factor for speed stabilization
NMOT_W	SWADAP	EIN	engine speed
NSTAT	LLRNS	EIN	Stationary reference speed

FW MDNSTAB 1.10 Fixed Values

Parameter	Value	Description

FB MDNSTAB 1.10 Detailed description of function

In order to achieve a self-stabilization of the speed, the indicated torque is weighted with the factor fnstab_w. The factor fnstab-w is obtained from the characteristic FNSTABNV.
After the initialization the factor remains at 1 until the actual speed nmot has exceeded the desired speed nsol.

APP MDNSTAB 1.10 Application hint

Adjustment of FNSTABNV: The characteristic FNSTABNV makes it possible to achieve an arbitrary stabilization function for the speed. Dependent on the quotient of the desired speed and on the actual speed of the engine, it is possible to determine a weighting factor for the demanded torque.
The values for speed quotients greater than 1 must also be greater than 1, for quotients less than 1 they must also be less than 1. All characteristics belong to a group and they all intersect the point quotient=1 and fnstab_w=1. When the desired speed is reached, no correction is to be performed.
If the performance output of the engine is to be kept constant (opening cross-section of the throttle valve remains constant at over-critical pressure ratios), then data is to be entered into FNSTABNV as the first bisector. For example:

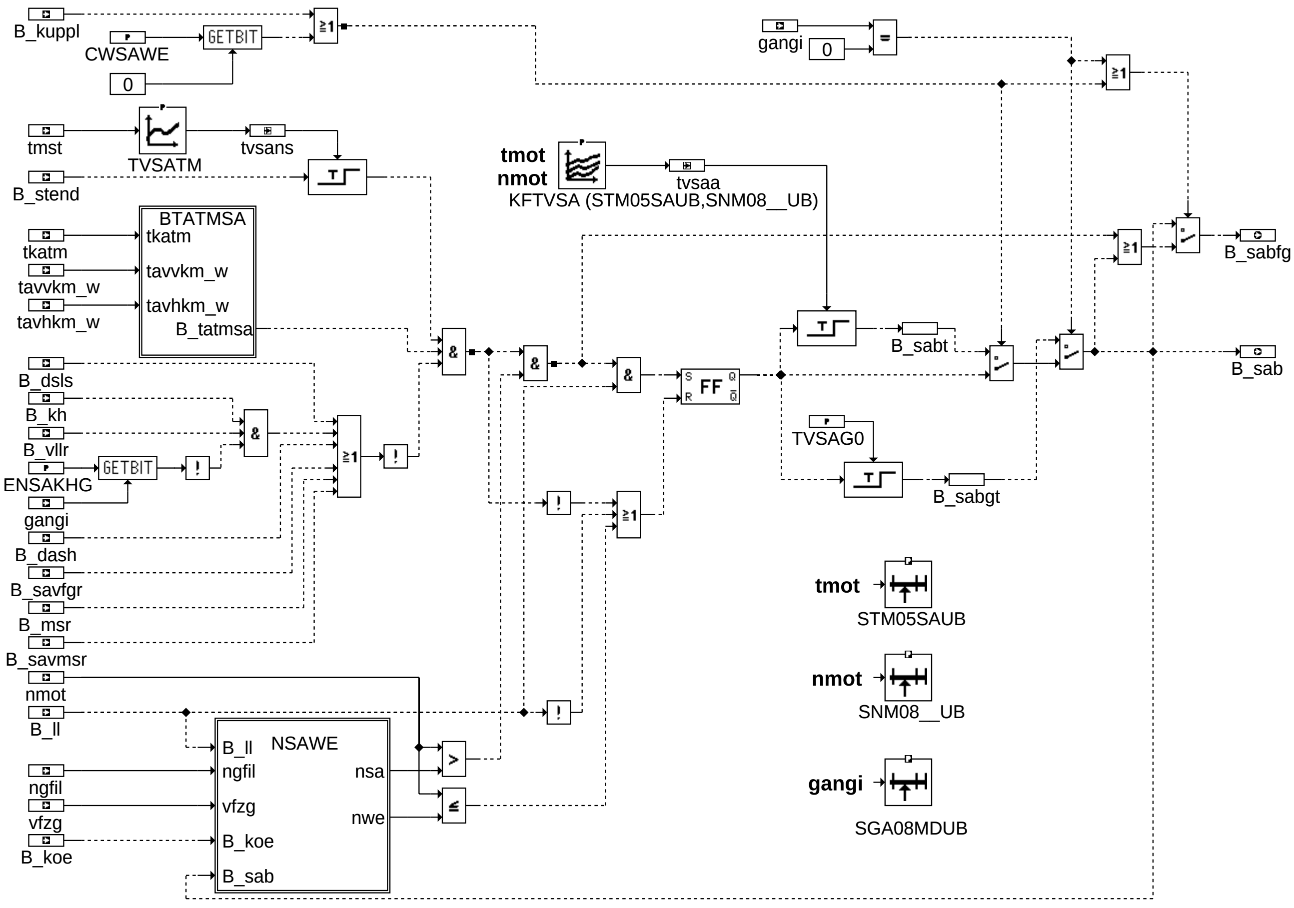
Quotient = 0 1.0 2.0 3.0 4.0 5.0
FNSTABNV = 0 1.0 2.0 3.0 4.0 5.0

By influencing the factors above and below 1, it is possible to improve the speed distribution around the desired speed. For this, however, an exact analysis of the speed distribution should be performed. The above-mentioned characteristic should be used when starting the application.

BBSAWE 18.110 Conditions for fuel cut-off / cut-in

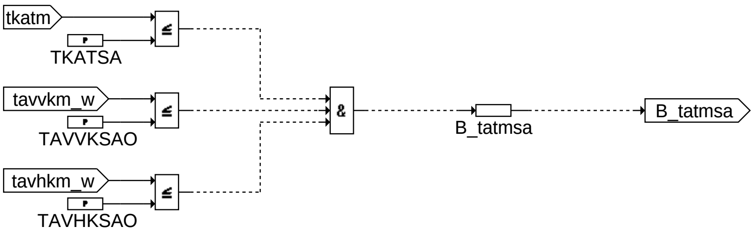
FDEF BBSAWE 18.110 Function definition

`BBSAWE: overview`



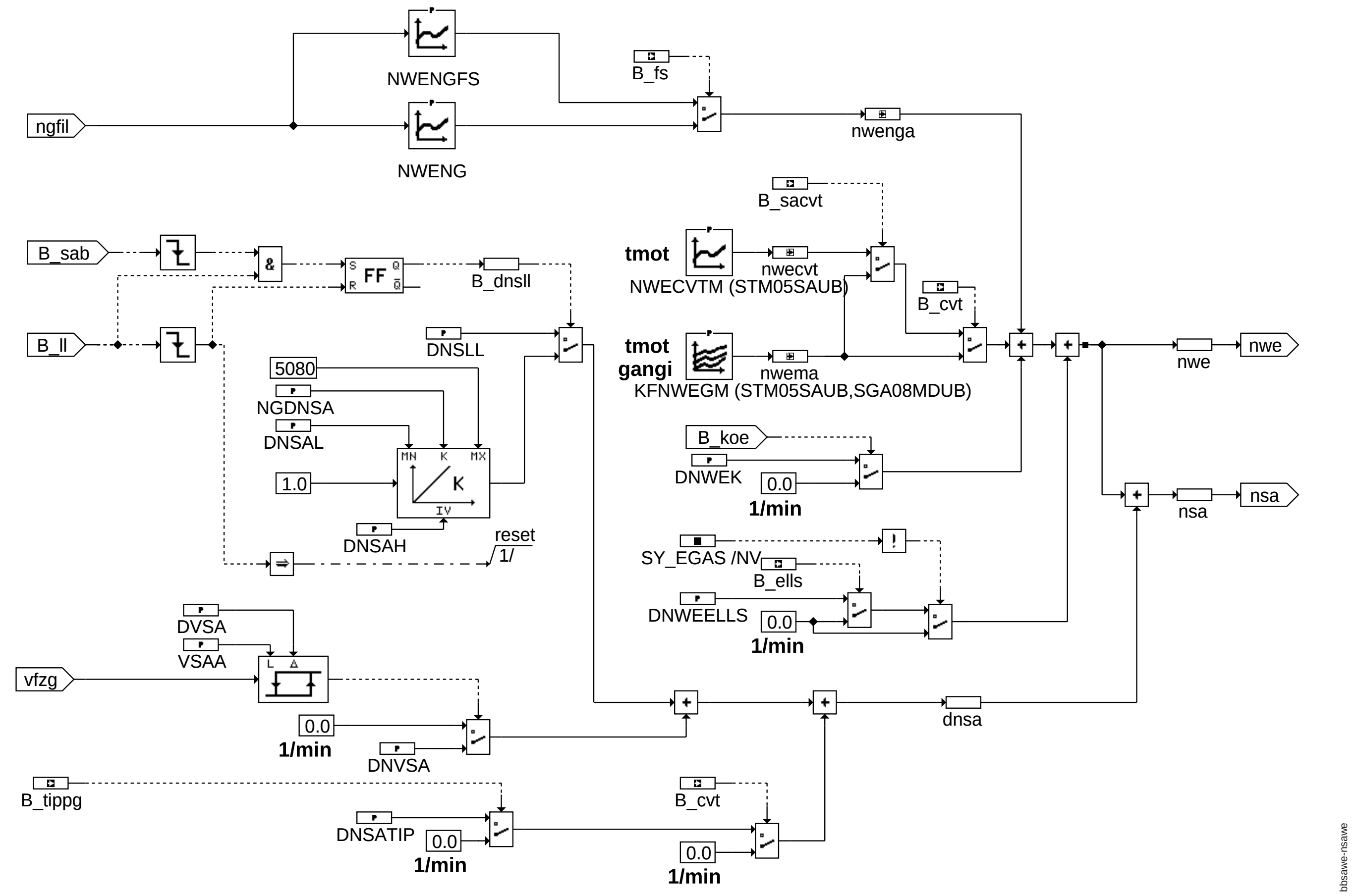
bbsawe-main

`BTATMSA: Release for fuel cut-off by exhaust gas temperature model`



bbsawe-btatmsa

`NSAWE: Calculation of the engine speed thresholds`



bbsawe-nsawe

ABK BBSAWE 18.110 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWSAWE			FW	code word to enable fuel cut off - fuel restart
DNSAH			FW	Delta n overrun cut-off high with reference to n reinstatement
DNSAL			FW	Delta n overrun cut-off low with reference to n reinstatement
DNSATIP			FW	cut off engine speed increase at tip gutter
DNSLL			FW	Overrun cut-off hysteresis for reinstatement at idle
DNVSA			FW	cut off engine speed increase at low vehicle speed
DNWEELLS			FW	delta cut-in speed at error of throttle by-pass valve
DNWEK			FW	Delta n for reinstatement with air conditioning
DVSA			FW	delta vehicle speed for cut off engine speed increase
ENSAKHG			FW	enabling fuel cut off dependent on gear during catalyst heating
KFNWEGM	TMOT	GANGI	KF	Fuel cut in map depending on rpm
KFTVSA	TMOT	NMOT	KF	Retard time for overrun fuel cut-off
NGDNSA			FW	Engine speed gradient during decreasing the cut-off hysteresis
NWECVTM	TMOT		KL	Fuel restart-speed at CVT
NWENG	NGFIL		KL	Fuel cut-in engine speed
NWENGFS	NGFIL		KL	Delta Fuel cut-in engine speed with Drive
SY_EGAS			SYS (REF)	System constant E-GAS present
TAVHKSAO			FW	upper limit exhaust gas temperature before main catalyst
TAVVKSAO			FW	upper limit exhaust gas temperature before pre catalyst
TKATSA			FW	Catalyst temperature threshold for fuel cut-off
TVSAG0			FW	delay fuel cut off at gear 0
TVSATM	TMST		KL	delay time after cranking for fuel cut off
VSAA			FW	vehicle speed threshold for cut off engine speed increase

Variable	Source	Type	Description
B_CVT	PROKON	EIN	Condition continuously variable transmission
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_DNSLL	BBSAWE	LOK	condition fuel cut off engine speed hysteresis DNSLL
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_ELLS		EIN	Condition: error idle speed actuator
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KOE	KOS	EIN	Condition for AC-compressor ON

Variable	Source	Type	Description
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_MSR	MDKOG	EIN	Condition MSR
B_SAB	BBSAWE	AUS	Condition fuel cut-off requested
B_SABFG	BBSAWE	AUS	condition fuel cut-off enable or release
B_SABGT	BBSAWE	LOK	Condition fuel cut-off requested at gear 0
B_SABT	BBSAWE	LOK	Condition fuel cut-off requested
B_SACVT		EIN	condition support of the fuel cut of for CVT-gearbox
B_SAVFGR	FGRUE	EIN	Condition: prohibited trailing throttle fuel cut-off by cruise control
B_SAVMSR		EIN	Condition: Fuel cut off forbidden when MSR request
B_STEND	BBSTT	EIN	condition end of start
B_TATMSA	BBSAWE	LOK	condition: temperatures from ATM permit fuel cut-off
B_TIPPG		EIN	Condition Gear lifter in position ”Tippgasse”
B_VLLR	LLRBB	EIN	Condition vehicle is moving with engaged gear
DNSA	BBSAWE	LOK	time depending overrun hysteresis
GANGI	SWADAP	EIN	Engaged gear
NGFIL	SWADAP	EIN	filtered engine-speed gradient
NMOT	SWADAP	EIN	engine speed
NSA	BBSAWE	LOK	Engine speed for fuel cut-off
NWE	BBSAWE	LOK	engine speed for fuel cut-in
NWECVT	BBSAWE	LOK	engine speed fuel restart at CVT
NWEMA	BBSAWE	LOK	engine speed fuel restart
NWENGA	BBSAWE	LOK	engine speed fuel restart
TAVHKM_W		EIN	Exhaust gas temperature in front of main catalyst out of model
TAVVKM_W		EIN	Exhaust gas temperature in front of pre-catalyst out of model
TKATM	ATM	EIN	catalyst temperature (model)
TMST	GGTFM	EIN	engine temperature at start
TVSAA	BBSAWE	LOK	delay fuel cut-off
TVSANS	BBSAWE	LOK	delay fuel cut-off duriing post cranking
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW BBSAWE 18.110 Fixed Values

Parameter	Value	Description
CWSAWE		code word to enable fuel cut off - fuel restart
DNSAH		Delta n overrun cut-off high with reference to n reinstatement
DNSAL		Delta n overrun cut-off low with reference to n reinstatement
DNSATIP		cut off engine speed increase at tip gutter
DNSLL		Overrun cut-off hysteresis for reinstatement at idle
DNVSA		cut off engine speed increase at low vehicle speed
DNWEELLS		delta cut-in speed at error of throttle by-pass valve
DNWEK		Delta n for reinstatement with air conditioning
DVSA		delta vehicle speed for cut off engine speed increase
ENSAKHG		enabling fuel cut off dependent on gear during catalyst heating
NGDNSA		Engine speed gradient during decreasing the cut-off hysteresis
TAVHKSAO		upper limit exhaust gas temperature before main catalyst
TAVVKSAO		upper limit exhaust gas temperature before pre catalyst
TKATSA		Catalyst temperature threshold for fuel cut-off
TVSAG0		delay fuel cut off at gear 0
VSAA		vehicle speed threshold for cut off engine speed increase

FB BBSAWE 18.110 Detailed description of function

Function:

This function recognizes the speed range where fuel cut-off is admissible. This is signalized by the condition "Ready for fuel cut-off", B_sab = 1. Otherwise, B_sab = 0.

1. Generation of the condition "Ready for fuel cut-off"

The condition "Ready for fuel cut-off" (B_sab = 1) requires the following states and conditions:

engine speed nmot is above the fuel cut-off speed threshold nsa = nwe + dnsa &
after start-up, a time TVSATM has finished which depends on the engine temperature &
the modeled converter temperatures are below the related upper limits (B_tatmsa = true) &
the condition idle operation B_ll is set &
    the condition Dashpot B_dash is not set &
    no fuel cut-off lock by FGR B_savfgr, no SLS diagnosis and no converter heating &
    the condition B_msr is not set.

When the above conditions are met and the clutch switch makes contact, the condition B_sab is only set after an activation delay KFTVSA which depends on temperature and engine speed. This prevents fuel cut-off during gear changes. If the clutch switch brakes contakt and the above conditions are met, the condition B_sab is set immediately. The code word CWSAWE[Bit0] = 1 activates the delay
KFTVSA independently of the clutch switch. This allows to avoid the fuel cut-off during gear changes on projects without clutch switch. In gear 0, the fuel cut-off can be delayed by an applicable time, TVSAG0. If the above conditions are no longer met, or if the engine speed goes below the resume speed nwe, B_sab is reset without delay.

The condition B_sabfg is required as an intermediate value in function %MDFAW.

2. Calculation of the speed thresholds

The resume engine speed nwe and the fuel cut-off hysteresis dnsa are thresholds for fuel cut-off and resume:
- nwe: required if speed goes below resume value.
- nsa = nwe + dnsa: fuel cut-off is admissible if this engine speed is exceeded,

the resume speed nwe depends on engine temperature tmot and on engine speed gradient ngfil (NWENG). The engine speed scarcely drops on cars with automatic transmission if "Drive" is selected. The resume speed needs to be increased only a little in these cases (NWENGFS). The resume speed is furthermore additionally inreased if the compressor of the air conditioner is connected (B_koe).

On systems of the non-E-Gas type, the resume speed can be increased in the event of an error in the LL positioner B_ells(DNWEELLS). This prevents the engine from going out at closed positioner if the filling is too scarce during resume.

On projects with CVT transmission (B_cvt = true), either KFNWEGM or NWECVTM is selected according to the condition B_sacvt.

When the idle operation range is exceeded, the hysteresis is steadily reduced from DNSAH to DNSAL according to a ramp function. NGDNSA states the (negative) gradient used in this reduction.

When the engine resumes in idle operation, the fuel cut-off speed is increased by the value DNSLL. This prevents, in particular on automatic transmissions, that the engine speed overshoot during resume causes another fuel cut-off.

At low vehicle speed (vfzg < VSAA), the hysteresis range is additionally enlarged by DNVSA.
When the vehicle speed exceeds the threshold VSAA+DVSA, this increment is reset.

For projects with CVT transmission (B_cvt = true), the fuel cut-off engine speed can be increased by the value DNSATIP if the vehicle is within the selected target speed range (B_tippg = 1).

```
                ^ n                                                                      Time diagram of the threshold
nwe + DNSAH - - | - - - - - - - - - - *                                                  nsa(t) depending on B_ll
                |                     * *     Incline NGDNSA                             for constant resume
                |                     *   *  /                                           engine speed nwe and without
                |                     *     *                                            increase at low
nwe + DNSAL - - | * * * * * * * * * * *       * * * * * * *  nsa                         vehicle speed.
                |
        nwe     +------------------------------------------  nwe
              1 |        _____________                                   ----->
       B_ll   0 |_______|             |____________________  B_ll        time t
```

APP BBSAWE 18.110 Application hint

```
NOTE:
KFNWEGM(tmot,gangi) offers the possibility to lock the fuel cut-off according to the gear by increasing the resume speed. A general
resume lock is impermissible for gear 0 since otherwise, the vfzg diagnosis is no longer possible !!!
In gear 0, the fuel cut-off can be delayed for an applicable time TVSAG0. This allows to implement a cut-off lock during Tip-In.


The function can be configurated using the code word CWSAWE:

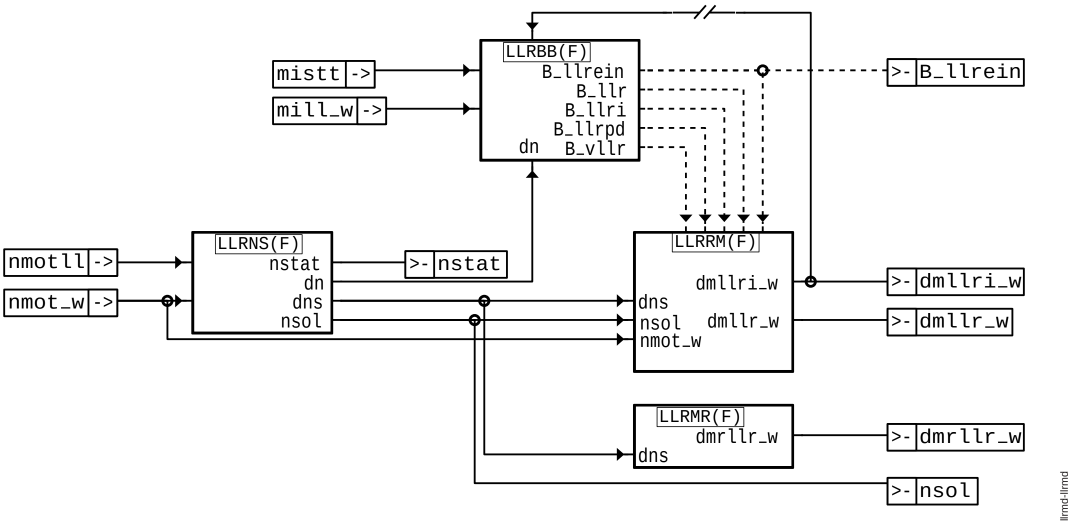
              +---+---+---+---+---+---+---+---+
    Bit-Nr.:  | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
              +---+---+---+---+---+-+-+-+-+-+-+
                                    |   |   |
                                    |   |   +--------> 0 = Fuel cut-off is only delayed for B_kuppl = 1
                                    |   |              1 = Fuel cut-off is always delayed
                                    |   +------------> not implemented
                                    +----------------> not implemented

During converter heating, bitmask ENSAKHG allows to give the release for fuel cut-off only according to the selected gear:

             +---+---+---+---+---+---+---+---+
    Bit-Nr,: | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
             +---+---+-+-+-+-+-+-+-+-+-+-+-+-+
                       |   |   |   |   |   |
                       |   |   |   |   |   +---------> 0 = Fuel cut-off locked during idle operation and converter heating
                       |   |   |   |   |               1 = Fuel cut-off released during during idle operation and converter heating
                       |   |   |   |   +-------------> 0 = Fuel cut-off locked during converter heating in first gear
                       |   |   |   |                   1 = Fuel cut-off released during converter heating in first gear
                       +---+---+---+-----------------> 0 = Fuel cut-off locked during converter heating in gear x
                                                       1 = Fuel cut-off released during converter heating in gear x
```

LLRMD 1.4 Torque-based idle-speed control

FDEF LLRMD 1.4 Function definition



llrmd-llrmd

ABK LLRMD 1.4 Abbreviations

Variable	Source	Type	Description
B_LLR	LLRMD	LOK	condition idle speed control
B_LLREIN	LLRMD	AUS	Condition idle speed control is active
B_LLRI	LLRMD	LOK	Condition activation of I-part of idle speed control
B_LLRPD	LLRMD	LOK	Condition activation of PD-part of idle speed control
B_VLLR	LLRMD	LOK	Condition vehicle is moving with engaged gear
DMLLRI_W	LLRMD	AUS	desired torque change from the idle speed control (I-)
DMLLR_W	LLRMD	AUS	desired torque change from the idle speed control (PD-part)
DMRLLR_W	LLRMD	AUS	torque reserve for idle speed control
DN	LLRMD	LOK	speed deviation at idle speed control
DNS	LLRMD	LOK	LLR: difference of idle speed precontrol
DN_W	LLRMD	LOK	speed deviation at idle speed control
MILL_W	MDMIN	EIN	Indicated engine torque at idle
MISTT		EIN	Starting torque
NMOTLL	BGNMOT	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed

Variable	Source	Type	Description
NSOL	LLRMD	AUS	idle reference speed
NSTAT	LLRMD	AUS	Stationary reference speed

FW LLRMD 1.4 Fixed Values

Parameter	Value	Description

FB LLRMD 1.4 Detailed description of function

The block LLRNS calculates the target speeed nsol, the dynamic speed difference dn_w (dn) ant the stationary speed difference dns.

The block LLRRM contains the idle speed controler.

The block LLRBB determines the operation conditions of the idle speed control.

The block LLRMR calculates the desired torque resverve for the idle speed control.

APP LLRMD 1.4 Application hint

LLRNS 534.10 Idle control; Nominal engine speed for idle speed control

FDEF LLRNS 534.10 Function definition

No text for FDEF available!

ABK LLRNS 534.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFLLRNS			FW	Config.-byte for dtermination of target engine speed at idle
CWNSTAT			FW	Codeword for the Filtration of nstat
DNSNFST			FW	speed threashold of nsol-limitation in start
DNSNFX			FW	Offset to determine the upper limit of target speed
DTAHLL			FW	Delta tans for stopping hot idling
DTMHLL			FW	Delat tmot for stopping hot idling
FNSNF			FW	factor for desired engine-speed correction
FNSSTKM	TMOT		KL	Factor to weight the desired speed at start during catalyst heating
FNSSTM	TMOT		KL	Faktor for taget engine speed during start
KFNLLNST	TNST	TMOT	KF	idle speed after start
KFZNSM	TMOT	DNS	KF	time constant for decay of reference speed
KLDFOFF			FW	Threshold to switch off generator load
KLDFON			FW	Threshold to switch on generator load
KNSNF			FW	Engine speed follow-up inhibition band
LBZO1			FW	Threshold of lbz to increase the target engine speed when leaving idle
LBZO2			FW	Threshold of lbz to increase the target engine during ideling
LBZU			FW	Threshold of lbz to decrease the target engine speed when leaving the idle
NFHZ			FW	Idle speed increase during wind screen heating activ
NFHZFS			FW	Idle speed increase during wind screen heating activ and B_fs=1
NFS2M	TMOT		KL	Target idle speed 2, B_fs = 1
NFSKLDF			FW	Desired speed at generator load active and B_fs=1
NFSKO			FW	desired engine speed with AC-system when B_fs=1
NFSKS			FW	Target engine speed for preventiong boiling (B_fs=1)
NFSLPWG			FW	Desired speed at malfunctioning of PWG-signal when B_fs=1
NFSM	TMOT		KL	desired engine speed DRIVE-position switch on
NFSMIN			FW	Minimal allowed engine speed at idle with AT in drive
NFSNLDG			FW	Target-speed increase for speed-sensor limp-home
NFSSL			FW	Desired speed when power steering switch is active and B_fs=1
NGNSNF			FW	Threshold of speed gradient for starting dynamic taget idle sped calculation
NKLDF			FW	Desired speed when generator load is active
NLL2M	TMOT		KL	Target engine speed 2
NLLCVTMXV	VFZG		KL	Limitation of the target speed (CVT transmission)
NLLM	TMOT		KL	desired engine speed
NLLMIN			FW	Minimal allowed engine speed at idle
NSAC			FW	desired engine speed with air conditioner on (S_AC = 1)
NSACFS			FW	desired engine speed with air conditioner on (S_AC = 1) and AT in Drive (S_fs=1)
NSHLL			FW	Minimal target speed for hot idling
NSKO			FW	desired speed for AC-system
NSKS			FW	Targen speed to prevent boiling
NSL			FW	debit idle-speed at power stearing active
NSLBZFS			FW	desired engine speed when battery is discharged when B_fs=1
NSLBZLL			FW	desired engine speed when battery is discharged when
NSLBZS			FW	Engine speed threshold to switch the target speed due to lbz
NSLPP	PSL		KL	Target speed depending on the pump pressure of power steerung
NSLPPFS	PSL		KL	Target speed depending on the pump pressure of power steering with B_fs=1
NSLPWG			FW	Desired speed when PWG-signals malfunction
NSNLDG			FW	Target-speed increase for speed-sensor limp-home
NSNOT			FW	Target engine speed while B_nnot=1
NZHDTL	RL		KL	Speed threshold for decrementing time counter for hot idling
NZHITL	RL		KL	Speed threshold for incrementing time counter for hot idling
SNS06LLSB	DNS		SV	Datapoint distribution, set-speed deviation, 06 datapoints., idle-speed control.
STM06LLUB	TMOT		SV	Datapoint distribution, engine temperature, 6 datapoints

Parameter	Source-X	Source-Y	Type	Description
STN06LLUB	TNST		SV	distribution: time after start; for determination of idle speed after start
TAHLL			FW	tans threshold for increased target speed at hot idling
TMHLL			FW	tmot threshold for increased target speed at hot idling
TMLLX			FW	Threshold for boiling prevention
TMRZHLL			FW	tmot threshold for resetting the time counter for hot idling
VSL			FW	car speed threshold for compensation power stearing
ZHLLA			FW	Time counter for stopping increased speed in hot idling
ZHLLE			FW	Time counter threshold for increased speed at hot idling
ZKNS			FW	Time constant for target engine speed when changing target
ZNSUB			FW	time constant for desired engine speed at low voltage

Variable	Source	Type	Description
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_FHZ		EIN	Condition flag windshield heating
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_HLL	LLRNS	LOK	Condition hot idling
B_KHN		EIN	condition catalyst heating idle speed
B_KLDF	LLRNS	LOK	Increase speed active for generator load
B_KO		EIN	condition AC compressor authorised
B_LL	MSF	EIN	Condition idle
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LLRST	LLRRM	EIN	speed reaches nstat first time after start
B_NAC	KOS	EIN	condition for increased idle-speed at AC
B_NLDG		EIN	condition limp-home function speed sensor
B_NS2	LLRNS	LOK	Conditon target speed 2 active
B_NS2A	LLRNS	LOK	Condition target speed 2 requested
B_NSKS	LLRNS	LOK	Condition for increasing target speed (prevent from boiling)
B_NSSL	LLRNS	LOK	Condition: Set speed increase for power steering
B_NSWO1	PROKON	EIN	condition engine speed $>$ NSWO1
B_PWF		EIN	Condition for powerfail
B_SL		EIN	Condition power steering
B_SPSMIN	GGPED	EIN	message to SR: '1' = pedal-travel sensor limphome with SPSMIN
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_WKAUF		EIN	Condition for open lock up clutch
DNS	LLRNS	AUS	LLR: difference of idle speed precontrol
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
KLDFPWM		EIN	generator signale as PWM-signale filtrated
LBZ	EGAG	EIN	charge state of the battery
NFSKH	SWADAP	EIN	Idling speed driving level for catalyzer heating
NGFIL	SWADAP	EIN	filtered engine-speed gradient
NLLCVT1		EIN	Target speed from CVT gear box
NLLCVT2	LLRNS	LOK	Target speed from CVT gear box after limitation
NLLKH	BBKHZ	EIN	Idling speed for catalyzer heating
NMOT	SWADAP	EIN	engine speed
NMOTLL	BGNMOT	EIN	engine speed
NSFSMN	LLRNS	LOK	LLR: minimal target speed for AT in drive
NSLBZ	LLRNS	LOK	Target engine speed dependin on lbz
NSLFA	LLRNFA	EIN	Set speed for short trip
NSLLMN	LLRNS	LOK	LLR: minimal target speed during idling
NSNF	LLRNS	LOK	LLR: followed-up target speed
NSOL	LLRNS	AUS	idle reference speed
NSST	LLRNS	AUS	Initialisation value for desired RPM during start
NSTAT	LLRNS	AUS	Stationary reference speed
NSTAT2	LLRNS	AUS	stationary desired idle-speed after limitation
NSTAT3	LLRNS	LOK	Stationary desired idle-speed pre filter
NSTATFIL	LLRNS	AUS	Stationary reference speed filtered
PSL		EIN	Oil pressure of the power steering system
RL	SWADAP	EIN	relative air charge
S_AC		EIN	A/C stand-by position
S_KO	SWADAP	EIN	A/C compressor active
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TNST		EIN	time after end of start
VFZG	SWADAP	EIN	vehicle speed (km/h)
VSNS	VS_VERST	EIN	Change of target engine speed with calibrationg tool VSxy
VSTCNS		EIN	Code-word adaptation, set idle-speed switchover
VSTNLS		EIN	Adjusting idle target speed (tester interface)
ZHLL	LLRNS	LOK	Time counter for hot idling

FW LLRNS 534.10 Fixed Values

Parameter	Value	Description
CNFLLRNS		Config.-byte for dtermination of target engine speed at idle
CWNSTAT		Codeword for the Filtration of nstat
DNSNFST		speed threashold of nsol-limitation in start
DNSNFX		Offset to determine the upper limit of target speed
DTAHLL		Delta tans for stopping hot idling

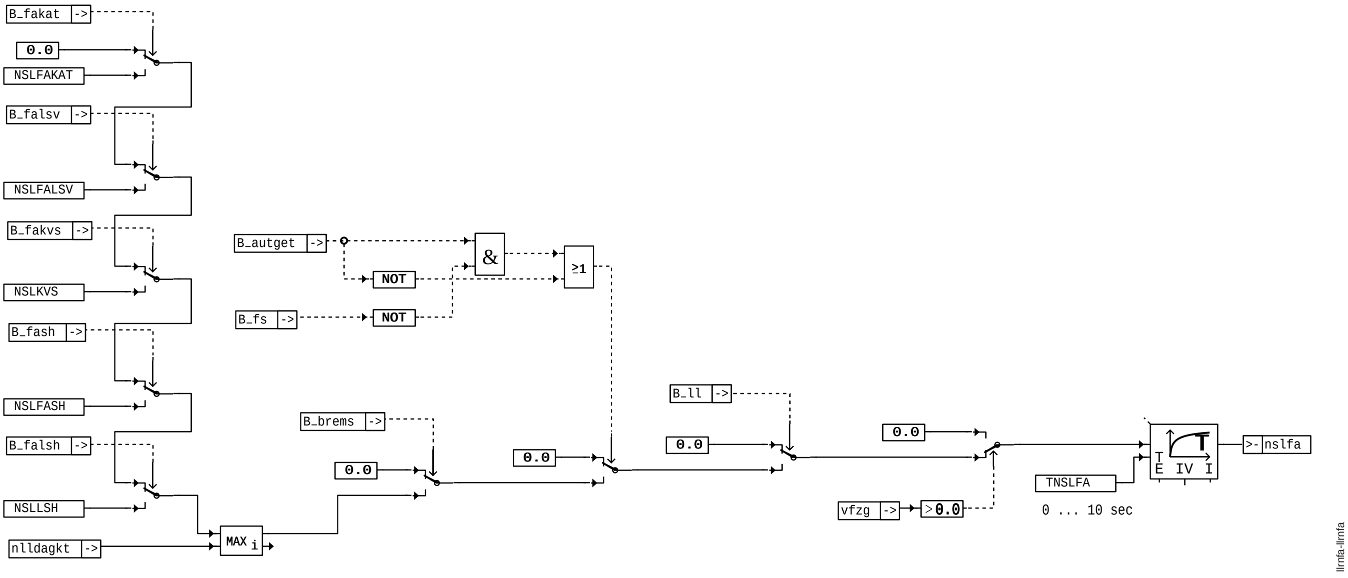
Parameter	Value	Description
DTMHLL		Delat tmot for stopping hot idling
FNSNF		factor for desired engine-speed correction
KLDFOFF		Threshold to switch off generator load
KLDFON		Threshold to switch on generator load
KNSNF		Engine speed follow-up inhibition band
LBZO1		Threshold of lbz to increase the target engine speed when leaving idle
LBZO2		Threshold of lbz to increase the target engine during ideling
LBZU		Threshold of lbz to decrease the target engine speed when leaving the idle
NFHZ		Idle speed increase during wind screen heating activ
NFHZFS		Idle speed increase during wind screen heating activ and B_fs=1
NFSKLDF		Desired speed at generator load active and B_fs=1
NFSKO		desired engine speed with AC-system when B_fs=1
NFSKS		Target engine speed for preventiong boiling (B_fs=1)
NFSLPWG		Desired speed at malfunctioning of PWG-signal when B_fs=1
NFSMIN		Minimal allowed engine speed at idle with AT in drive
NFSNLDG		Target-speed increase for speed-sensor limp-home
NFSSL		Desired speed when power steering switch is active and B_fs=1
NGNSNF		Threshold of speed gradient for starting dynamic taget idle sped calculation
NKLDF		Desired speed when generator load is active
NLLMIN		Minimal allowed engine speed at idle
NSAC		desired engine speed with air conditioner on (S_AC = 1)
NSACFS		desired engine speed with air conditioner on (S_AC = 1) and AT in Drive (S_fs=1)
NSHLL		Minimal target speed for hot idling
NSKO		desired speed for AC-system
NSKS		Targen speed to prevent boiling
NSL		debit idle-speed at power stearing active
NSLBZFS		desired engine speed when battery is discharged when B_fs=1
NSLBZLL		desired engine speed when battery is discharged when
NSLBZS		Engine speed threshold to switch the target speed due to lbz
NSLPWG		Desired speed when PWG-signals malfunction
NSNLDG		Target-speed increase for speed-sensor limp-home
NSNOT		Target engine speed while B_nnot=1
TAHLL		tans threshold for increased target speed at hot idling
TMHLL		tmot threshold for increased target speed at hot idling
TMLLX		Threshold for boiling prevention
TMRZHLL		tmot threshold for resetting the time counter for hot idling
VSL		car speed threshold for compensation power stearing
ZHLLA		Time counter for stopping increased speed in hot idling
ZHLLE		Time counter threshold for increased speed at hot idling
ZKNS		Time constant for target engine speed when changing target
ZNSUB		time constant for desired engine speed at low voltage

FB LLRNS 534.10 Detailed description of function

APP LLRNS 534.10 Application hint

LLRNFA 1.50

FDEF LLRNFA 1.50 Function definition



llrnfa-llrnfa

ABK LLRNFA 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NSLFAKAT			FW	desired speed during quick trip catalyst diagnosis
NSLFALSV			FW	desired speed during quick trip Lambda sensor upstream catalyst
NSLFASH			FW	desired speed during quick trip oscillation test
NSLKVS			FW	desired speed during quick trip diagnosis of fuel supply
NSLLSH			FW	desired speed during quick trip Lambda sensor downstream catalyst
TNSLFA			FW	filter-time constant for nslfa

Variable	Source	Type	Description
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_BREMS	GGEGAS	EIN	condition: brake operated
B_FAKAT		EIN	condition function request catalyst monitoring
B_FAKVS		EIN	condition function request diagnoses fuel supply system
B_FALSH		EIN	condition function request downstream oxygen sensor diagnosis
B_FALSV		EIN	condition function request oxygen sensor diagnosis
B_FASH		EIN	condition diagnosis oxygen sensor aging downstream catalyst function request
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_LL	MSF	EIN	Condition idle
NLLDAGKT		EIN	Speed increase for diagnostic routine in the short test
NSLFA	LLRNFA	AUS	Set speed for short trip
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW LLRNFA 1.50 Fixed Values

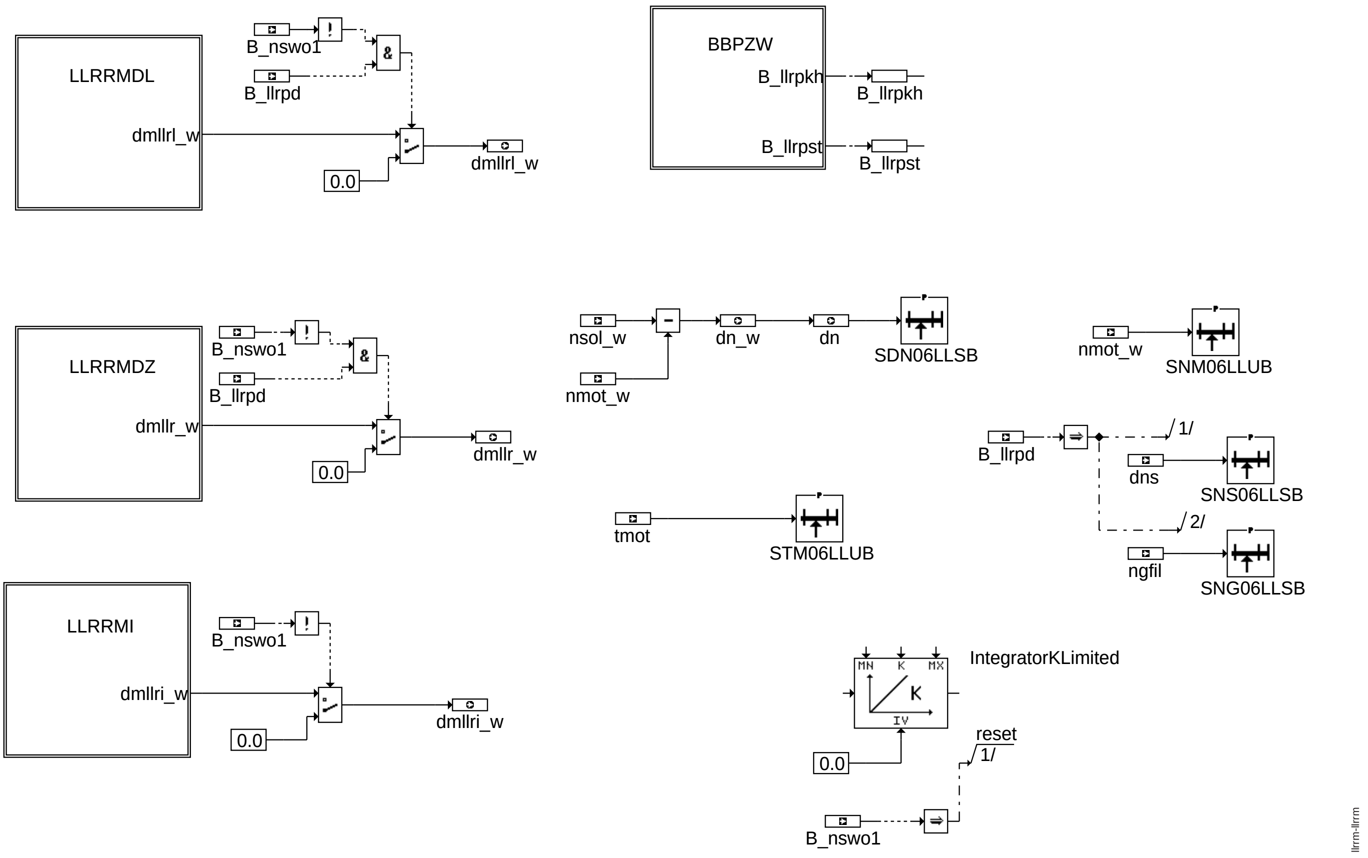
Parameter	Value	Description
NSLFAKAT		desired speed during quick trip catalyst diagnosis
NSLFALSV		desired speed during quick trip Lambda sensor upstream catalyst
NSLFASH		desired speed during quick trip oscillation test
NSLKVS		desired speed during quick trip diagnosis of fuel supply
NSLLSH		desired speed during quick trip Lambda sensor downstream catalyst
TNSLFA		filter-time constant for nslfa

FB LLRNFA 1.50 Detailed description of function

Beim Anreizen eines Kurztrips über B_fa kann die Solldrehzahl auf nslfa erhöht werden. Aus Überwachungsgründen muß diese Drehzahl unter 1500 1/min liegen. Die Drehzahlanhebung ist nur bei getretener Bremse, getrettener Kupplung oder Automatikgetriebe in P/N-Stellung im Stand und im LL zulässig.

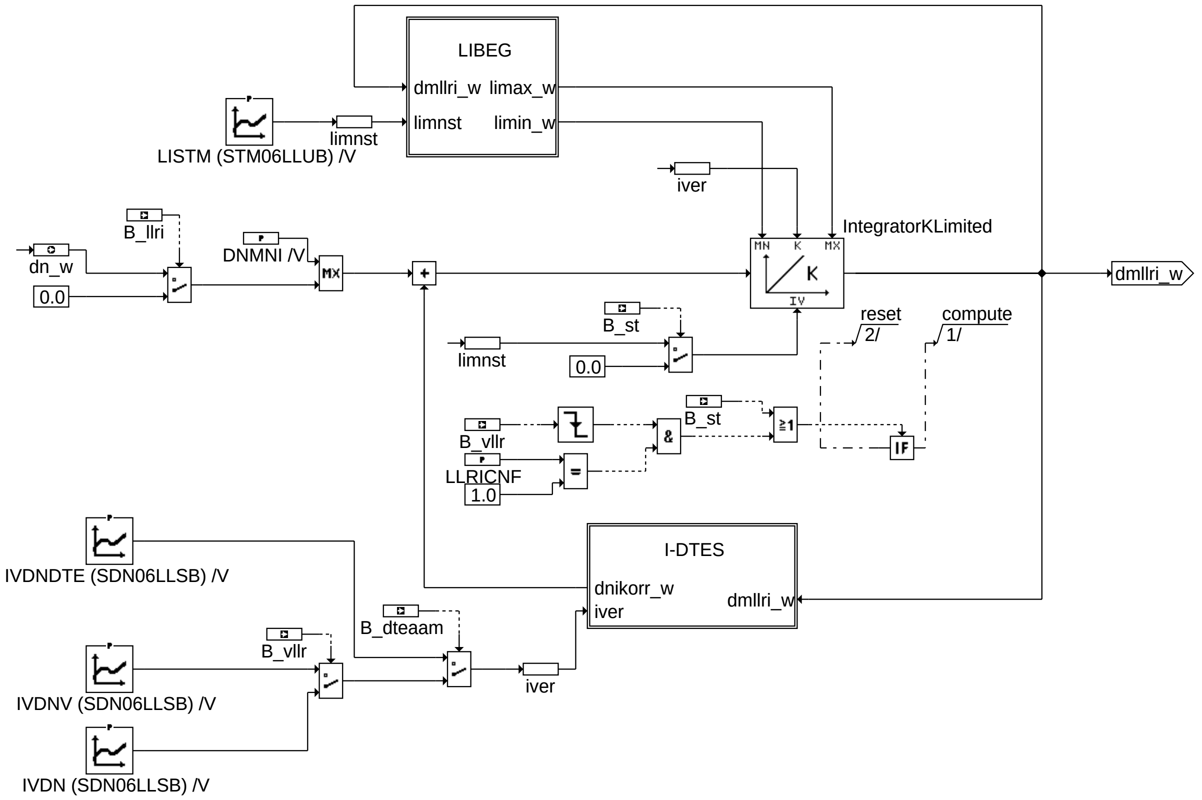
LLRRM 6.110 Idle speed control: torque controller

FDEF LLRRM 6.110 Function definition



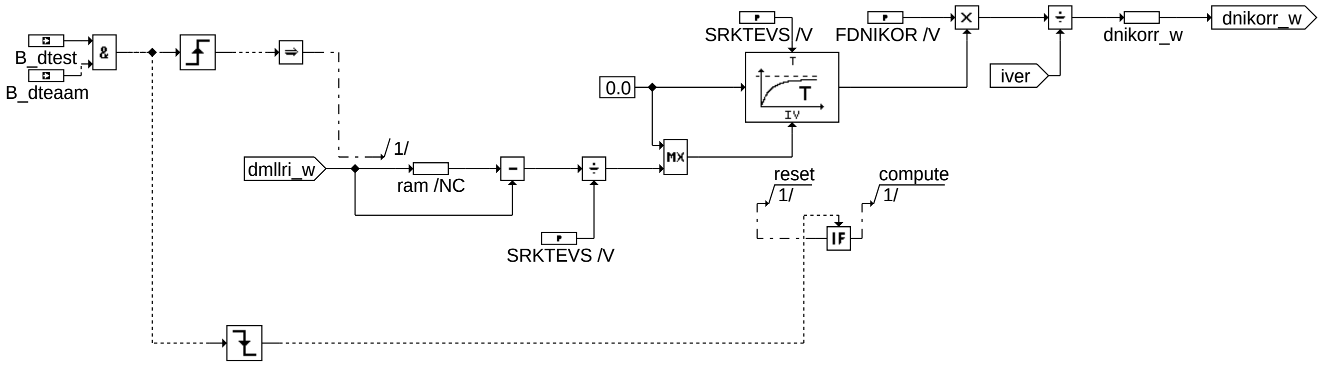
llrrm-llrrm

```
Idle speed controller: PID-controller
-------------------------------------
```



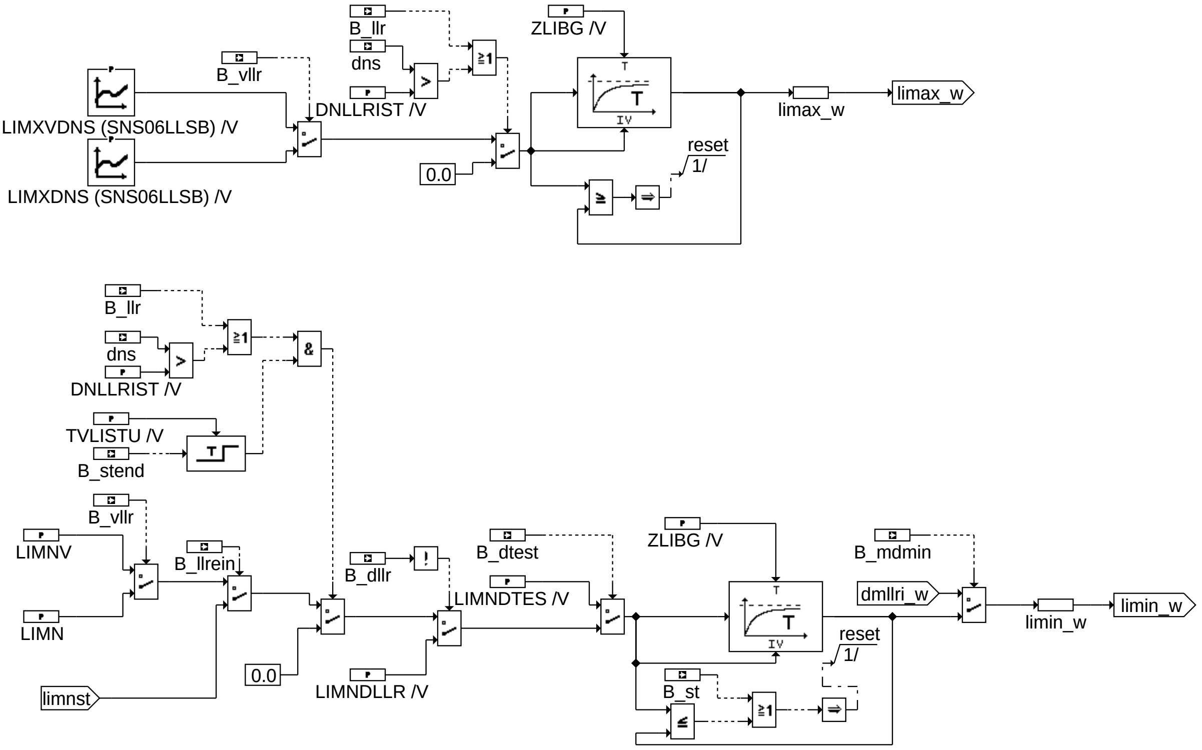
llrrm-llrrmi

```
Subfunction LRRMI: Idle speed controller integral part
------------------------------------------------------
```



llrrm-i-dtes

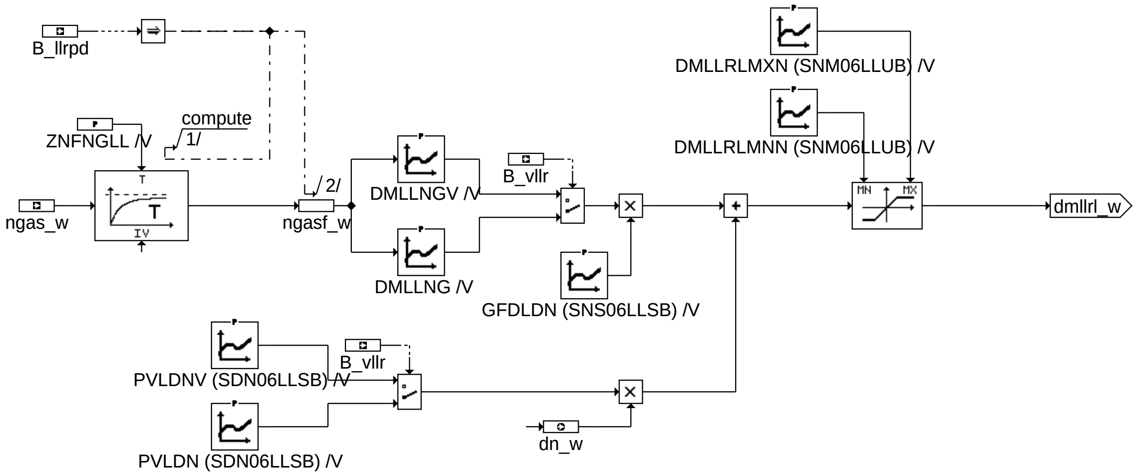
```
Subfunction I-DTES: Reset if the interator at the end of the diagnosis of the canister purge
--------------------------------------------------------------------------------------------
```



llrrm-libeg

```
Subfunction LIBEG: Limitation of the integral part
--------------------------------------------------


Subfunction LLRRMD: Idle speed controler: differential part
-----------------------------------------------------------
```



llrrm-llrrmdl

```
Subfunction LLRRMDL: Idle speed controller: differential part on the air
------------------------------------------------------------------------
```

ABK LLRRM 6.110 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWLLRPA			FW	codeword: selection of idle speed control proportional part
DMLLNG	NGASF_W		KL	LLR: D-gain depending of ngasf for air path
DMLLNGV	NGASF_W		KL	LLR: D-gain depending of ngasf for air path
DMLLRLMNN	NMOT_W		KL	Lower limit for dmllrl
DMLLRLMXN	NMOT_W		KL	Safety concept: upper limit for dmllrl

Parameter	Source-X	Source-Y	Type	Description
DMLLRMNN	NMOT_W		KL	Lower limit for dmllr_w
DMLLRMXN	NMOT_W		KL	Safety concept: upper limit for dmllr
DNLLRIST			FW	Overspeed threshold for integrator reset
DNLLST			FW	speed threashold to disable proportional parameter in start
DNMNI			FW	Lowest possible value for dn for the I-controller
DVNG	NGFIL		KL	LLR: D-gain depending of ngfil for vehicle at rest
DVNGV	NGFIL		KL	LLR: D-gain depending of ngfil for vehicle rolling
FDDN	DNS		KL	LLR: weightning factor for D-amplification
FDNIKOR			FW	Factor for the correction on the I-part by dn
GFDLDN	DNS		KL	LLR: weightning factor for D-amplification on the air path
IVDN	DN		KL	LLR: I-gain for vehicle at rest
IVDNDTE	DN		KL	LLR: I-gain at DTEV
IVDNV	DN		KL	LLR: I-gain for vehicle rolling
LIMN			FW	lower integrator limit for standing car
LIMNDLLR			FW	lower integrator limit for diagnostic of idle speed control
LIMNDTES			FW	lower integrator limit for DTES
LIMNV			FW	lower integrator limit for rolling car
LIMXDNS	DNS		KL	upper integrator limit for standing car
LIMXVDNS	DNS		KL	upper integrator limit for rolling car
LISTM	TMOT		KL	value of idle speed control integrator during start
LLRICNF			FW	Configuration byte for ISC integrator
PVDN	DN		KL	LLR: P-gain for vehicle at rest
PVDNKH	DNS		KL	proportional ISC when secondary air activ
PVDNST	DN		KL	proportional ISC in start
PVDNV	DN		KL	LLR: P-gain for vehicle rolling
PVLDN	DN		KL	LLR: P-gain for vehicle at rest (air path)
PVLDNV	DN		KL	LLR: P-gain for vehicle at rest (air path)
SDN06LLSB	DN		SV	10 Sst.
SNG06LLSB	NGFIL		SV	Datapoint distribution, speed gradient, 6 datapoints
SNM06LLUB	NMOT_W		SV	distribution of engine speed
SNS06LLSB	DNS		SV	Datapoint distribution, set-speed deviation, 06 datapoints., idle-speed control.
SRKTEVS			FW	Manifoild time constant when closing the canister purge valve
STM06LLUB	TMOT		SV	Datapoint distribution, engine temperature, 6 datapoints
TVLISTU			FW	Time during witch a negative integrator value is forbidden
TVLLRPST			FW	delay to disable proportional parameter in start
TVPKH			FW	delay: proportional parameter for kathalyst-heating
ZKLLRD			FW	Time constant for the decrease of the differential part of the controller
ZLIBG			FW	filter time constant for adjusting integrator limits
ZNFNGLL			FW	filter time constant for speed gradient on air path (LLR)

Variable	Source	Type	Description
B_DLLR	SWADAP	EIN	Active diagnostic: ISC-actuator diagnostic
B_DTEAAM	DTEV	EIN	Condition diagnosis CPV by opening the CPV active possible
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_KHA	BBKHZ	EIN	request of activated catalyst heating
B_LLR	LLRBB	EIN	condition idle speed control
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LLRI	LLRBB	EIN	Condition activation of I-part of idle speed control
B_LLRPD	LLRBB	EIN	Condition activation of PD-part of idle speed control
B_LLRPKH	LLRRM	LOK	proportional paramter for cathalyst-heating activ
B_LLRPST	LLRRM	LOK	proportional parameter in start activ
B_LLRST	LLRRM	AUS	speed reaches nstat first time after start
B_MDMIN	SWADAP	EIN	Condition minimal possible indicated torque reached
B_NSWO1	PROKON	EIN	condition engine speed $>$ NSWO1
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TRKH	BBKHZ	EIN	Flag for catalyst fast heating
B_VLLR	LLRBB	EIN	Condition vehicle is moving with engaged gear
DMLLRD_W	LLRRM	AUS	desired torque change from the idle speed control (D-part)
DMLLRI_W	LLRRM	AUS	desired torque change from the idle speed control (I-)
DMLLRL_W	LLRRM	AUS	desired torque change from the idle speed control (part on the air path)
DMLLRP_W	LLRRM	AUS	desired torque change from the idle speed control (P-part)
DMLLR_W	LLRRM	AUS	desired torque change from the idle speed control (PD-part)
DN	LLRRM	AUS	speed deviation at idle speed control
DNIKORR_W	LLRRM	LOK	Correcting value on the integrator after diagnostic
DNS	LLRNS	EIN	LLR: difference of idle speed precontrol
DN_W	LLRRM	AUS	speed deviation at idle speed control
IVER	LLRRM	LOK	Integrator amplification
LIMAX_W	LLRRM	LOK	Idle speed control integrator upper limit
LIMIN_W	LLRRM	LOK	Idle speed control integrator lower limit
LIMNST	LLRRM	LOK	Idle speed control integrator lower limit during after start
NGASF_W	LLRRM	LOK	engine speed gradient during one working cycle (filtered value)
NGAS_W	BGNG	EIN	engine speed gradient during one working cycle
NGFIL	SWADAP	EIN	filtered engine-speed gradient
NMOT_W	SWADAP	EIN	engine speed
NSOL_W		EIN	idle reference speed ,word
NSTAT	LLRNS	EIN	Stationary reference speed
TMOT	SWADAP	EIN	Engine temperature

FW LLRRM 6.110 Fixed Values

Parameter	Value	Description
CWLLRPA		codeword: selection of idle speed control proportional part
DNLLRIST		Overspeed threshold for integrator reset
DNLLST		speed threashold to disable proportional parameter in start
DNMNI		Lowest possible value for dn for the I-controller
FDNIKOR		Factor for the correction on the I-part by dn
LIMN		lower integrator limit for standing car
LIMNDLLR		lower integrator limit for diagnostic of idle speed control
LIMNDTES		lower integrator limit for DTES
LIMNV		lower integrator limit for rolling car
LLRICNF		Configuration byte for ISC integrator
SRKTEVS		Manifoild time constant when closing the canister purge valve
TVLISTU		Time during witch a negative integrator value is forbidden
TVLLRPST		delay to disable proportional parameter in start
TVPKH		delay: proportional parameter for kathalyst-heating
ZKLLRD		Time constant for the decrease of the differential part of the controller
ZLIBG		filter time constant for adjusting integrator limits
ZNFNGLL		filter time constant for speed gradient on air path (LLR)

FB LLRRM 6.110 Detailed description of function

Idle speed controller

The idle speed controller is a controller of PID-type (proportional, integral and differantial controller). The three parts P, I and D are strictly separated from each other.

D-Part: The differential part of the controller is triggered by the input value. The input value is given by the product of the engine speed gradient ngfil, the differential gain DVNG (resp. DVNGV for B_vllr=1) an a weightning factor FDDN depending on the difference of the actual engine speed to the stationary target speed.
This input value is the start value of a low-pass filter. The output of the low-pass filter is the differential part dmllrd_w and the time constant is givent by the fix-value ZKLLRD.
If a new input value, abolutely grather than the actual filter output value is calculated, the filter is initialised to the new input value.

D-part on the air path: to achieve a quicker filling of the empty manifoild, a special D-part in the air-path is generated. The manifoild ist still filled with air when the normal speed controller needs the higher torque. A too large amount of air can not cause a too high output-torque because the torque coordinator will compensate it by retarding the spark advance.

P-part: The proportional part of the controller delivers a torque correction dmllrp_w proportional to the speed difference dn_w. The gain is taken from the caracteristic line FVDN for B_vllr=0 and fromt FVDNV for B_vllr=1. Both lines depend of the speed difference dn.

The controller output is the sum of the P-part dmllrp_w and the D-part dmllrd_w if B_llrpd is true.
If B_llrpd is false, the controller output dmllr_w is zero (for B_llrpd see %LLRBB).

I-part: The input of the integral part is the speed difference dn_w. The integrator ist enabled if B_llri is true.
If B_llri is false, the integrator is stopped (for B_llri see %LLRBB).

The gain of the I-part is taken from the caracteristic lines IVDN for B_vllr=0 and from IVDNV for B_vllr=1. Both lines depend of the speed difference dn.

During start (B_st=1) the integral part is set to the value limst issued from the caracteristic line LISTM depending of the engine coolant temperature.

The integrator is limited between the upper limit limax_w and the lower limit limin_w. These limits can change if necessary. A reduction of the interval is allways filtered, an increase is never filtered. The filter time constant used is ZLIBG.

If the controller is not active (B_llr is false) the integrator limits (upper and lower limit) are filtered towards the end-value zero. The integral part is so disabled.

For active controller (B_llr is true) the limits are issued from the fixed values LIMN and LIMX for B_vllr=0 and from LIMNV and LIMXV for B_vllr=1.

During start and until the controller is enabled (B_llrein=1), the lower limit of the integral part is set to the value limst.

In the special case, when the diagnostic supposes a blocked idle speed control device the lower limit of the integral part is set to LIMNDLLR as long as B_dllr=1.

During the diagnosis of the canister purge system (B_dtes=1) a specific lower integrator limit LIMNDTES is active.

If the minimal possible indicated torque or the maximum limit of the I-Part DMLLRIMXN(nmot) is reached (B_mdmin or B_llrimx is true), the appropriate limit of the integrator is set to the actual integrator value. So the integrator can’t contiue to work in the torque limited direction.

APP LLRRM 6.110 Application hint

Before calibrating the controller for car at rest:

The following precautions have to be taken before calibrating the controller:

- switch off the D-part of the controller: caracteristic DVNG set to zero, caracteristic FDDN set to 1.
- switch off the P-part of the controller: caracteristic PVDN set to zero
- switch off the adaptation of torque requirement: set TMDMAD to a value greather than 120 °C.
- Be shure that the lowest target speed is selected. The engine must be warm, the torque reserve has to be determined. If it is not, set the torque reserve to a value between 3% and 4%.
  ATTENTION: For the calibration of the controller it is important to have a low engine speed with a low load because under these conditions the dead time of the system is at its maximum and the system tends to be instable..
- Calibrate a slow I-part of the controller to enable the system to reah exactly the low target speed.
  IVDN = 0.01 for all points of the caracteristic.
  Then, when the target speed is reached, set the gain of the integral part to zero. The controller is then stopped. The engine should turn with the target speed.

Calibrating the controller:

ATTENTION: The load of the engine mus be as low as possible to have a big dead time in the system. During the calibration resp. the evaluation of the results, no additional load (AC-compressor, electrical load like fans or the power steering) must be switched on. For engines with low internal friction it could be necessary to press the cluth pedal to reduce additionnaly the engine load.

Calibration of the P-part: Increase the proportional gain by increasing the values of PVDN. Make a perturbation by tipping-in or switching on and off a load like the AC-compressor or the power steering. Increase the P-gain until the engine speed oscillates stationnary with a constant amplitude after an exitation.
Now decrease progressivly the P-gain until the engine speed stops oscillating. Verify the behaviour of the engine speed withe a tip-in. The speed shoule reach the target value with at maximaum 2 or 3 oscillations.
The P-again is then calculated from:
PVDN = 0.5 * limit_gain (all values of the caracteristic must be the same).

Calibration of the I-part: The integral part is calibrated after having done the first calibration of the proportional part. The P-part remains active during the calibration of the I-part. The calibration is done in the same way as for the proportinal part. The limit gain where the engine just doen't oscillate is searched.
The P-gain is the given by:
IVDN = 0.5 * limit_gain (all values of the caracteristic must be the same).

With this calibration of the PI-controller the switching on or off of load like the AC-compressor, the power steering or the electrical cooling fan should not result in a engine speed oscillation. The speed drop could of course still be too large. This can be now reduced using the differential part of the controller.

Calibration of the D-part: The differential gain should be kept as small as possible to be shure that the system doesn't become nervous.

- In a dead zone of about ±20 rpm about the target speed, the D-part shoule stay at zero, to avoid a nervous idling. Therefore calibrate the caracteristic FDDN as follows:

dn	.....	-50	-20	20	50	...
FDDN	1.0	1.0	0	0	1.0	1.0

  In a range of 20 rpm above and below the target speed the D-part is zero, between 20 rmp and 50 rpm of deviation the D-part increases and reaches it's maximum for speed deviations of more than 50 rpm.

- Increase slowly the differential gain DVNG of the controller an observe the speed drop when using power steering (keep the steering wheel forced to the right or left buffer to keep the load konstant).
  There should be no speed overshoot. Increase the D-gain until the speed drop is minimal and the speed behaviour is correct.
- If the behaviour of the engine speed after cranking or after a tip-in leeds to an undershoot, ist is necessary to reduce te D-gain for engine speed above the target speed. In the caracteristic FDDN the values for negative dn have to be reduced (for example 0.5 or even less).

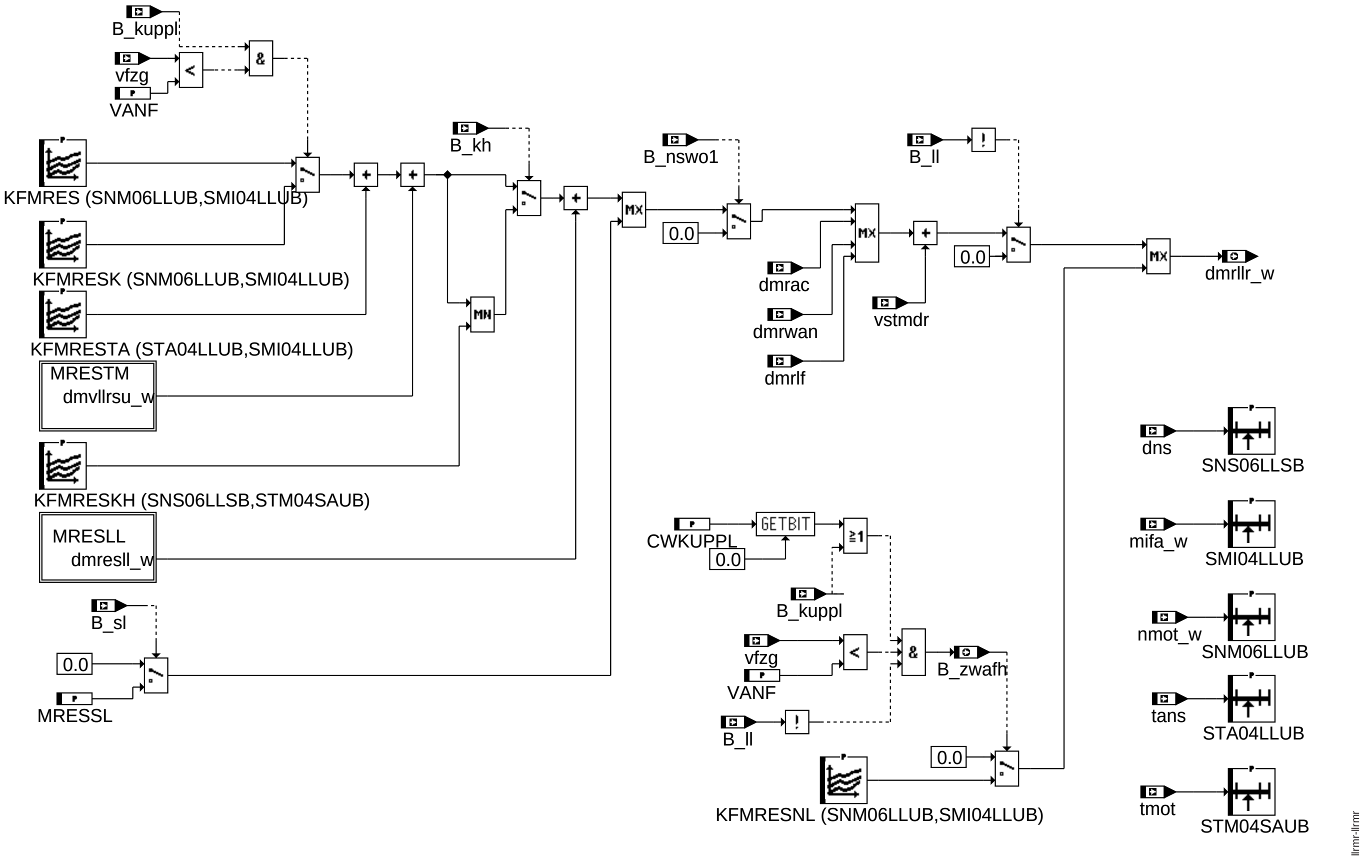
After these calibrations the controller normally gives good results. It is still possible that under specific conditions like driving avay without accelerating the reaction of the controller is insuffisant. The parameter of the controller have the to be optimized. For big speed deviations it is the necessary to increase the P- and I-gain. A limit for the gain is given by 75% of the limit gain mesaured preliminary.For small engines it is possible to increase the gain until the limit gain is reached. For these engines the gain for small speed deviations is more oriented towards the 75% of the limit gain.

The calibration of the gain for driving car have to be smaller like them for car at rest (tendence of stucking). As initial values take the values for car at rest (just calibrated). The gain should not excced 50% of the limit gain. In practice it would either be only 25%.

IMPORTANT REMARK: When judjing the speed behaviour after a tip-in it is important that the dynmical following of the target speed is well calibrated. When an engine returns to it's target speed without any external load the controller should'nt do any corrections. If necessary (I-part becomes too negative) increase the time TVDK to start the controller later after reaching the idle status (B_ll = 1).

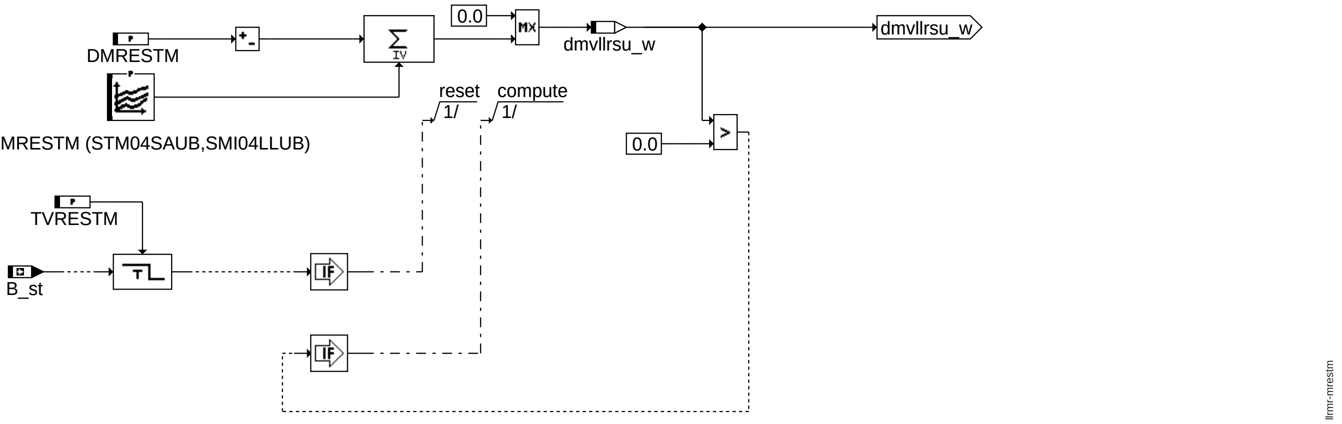
LLRMR 12.40 Torque reserve for idle speed control

FDEF LLRMR 12.40 Function definition



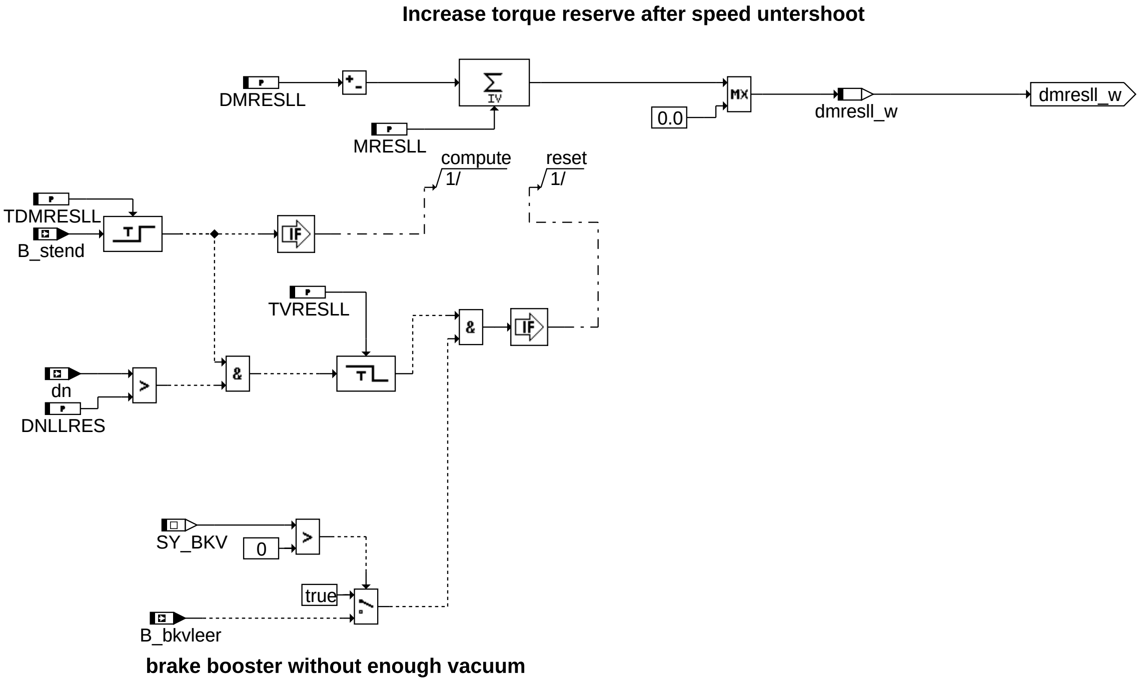
llrmr-llrmr

`Calculation of the torque reserve during idling`



llrmr-mrestm

`Calculation of the torque reserve after the start-up phase`



llrmr-mresll
`Calculation of the torque reserve after a drop in speed`

ABK LLRMR 12.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWKUPPL			FW	Code word for clutch
DMRESLL			FW	LLR: reduction rate for increased torque reserve
DMRESTM			FW	Increment to reduce the torque reserve after start-up
DNLLRES			FW	LLR: dn threshold for increasing the torque reserve at idle
KFMRES	NMOT_W	MIFA_W	KF	LLR: torque reserve at idle and near-idle zone
KFMRESK	NMOT_W	MIFA_W	KF	LLR: torque reserve at idle and near-idle zone clutch disengaged
KFMRESKH	DNS	TMOT	KF	Torque reserve during catalyst heating
KFMRESNL	NMOT_W	MIFA_W	KF	Torque reserve in non idling state
KFMRESTA	TANS	MIFA_W	KF	Torque margin dependent on tans
KFMRESTM	TMOT	MIFA_W	KF	Map temp-dependent limiting of torque reserve
MRESLL			FW	LLR: increased torque reserve at idle after speed undershoot
MRESSL			FW	Torque reserve for power steering
SMI04LLUB	MIFA_W		SV	distribution: ind. torque for torque-reserve
SNM06LLUB	NMOT_W		SV	distribution of engine speed
SNS06LLSB	DNS		SV	Datapoint distribution, set-speed deviation, 06 datapoints., idle-speed control.
STA04LLUB	TANS		SV	distribution: tans for torque resreve
STM04SAUB	TMOT		SV	Datapoint distribution, engine temperature, 4 datapoints
SY_BKV			SYS	system constant: brake booster
TDMRESLL			FW	Inhibition time for the increased torque reserve after engine start
TVRESLL			FW	Hold time for increased torque reserve after engine speed drop
TVRESTM			FW	Initialization period: torque reserve after start-up
VANF			FW	Speed threshold for approach support

Variable	Source	Type	Description
B_BKVLEER		EIN	condition brake booster without enough vacuum
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_SL		EIN	Condition power steering
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_ZWAFH	LLRMR	AUS	enabling spark operation for vehicle drive-up-support
DMRAC	MDVERB	EIN	Torque reserve for AC-compressor
DMRESLL_W	LLRMR	LOK	increased Torque reserve at idle after speed untershoot
DMRLF	MDVERB	EIN	Torque reserve for cooling fan
DMRLLR_W	LLRMR	AUS	torque reserve for idle speed control
DMRWAN		EIN	Torque reserve for torque converter
DMVLLRSU_W	LLRMR	LOK	torque reserve after start
DN	LLRRM	EIN	speed deviation at idle speed control
DNS	LLRNS	EIN	LLR: difference of idle speed precontrol
MIFA_W	MSF	EIN	desired indicated engine torque
NMOT_W	SWADAP	EIN	engine speed

Variable	Source	Type	Description
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)
VSTMDR		EIN	Adjusting the torque reserve (tester interface)

FW LLRMR 12.40 Fixed Values

Parameter	Value	Description
CWKUPPL		Code word for clutch
DMRESLL		LLR: reduction rate for increased torque reserve
DMRESTM		Increment to reduce the torque reserve after start-up
DNLLRES		LLR: dn threshold for increasing the torque reserve at idle
MRESLL		LLR: increased torque reserve at idle after speed undershoot
MRESSL		Torque reserve for power steering
TDMRESLL		Inhibition time for the increased torque reserve after engine start
TVRESLL		Hold time for increased torque reserve after engine speed drop
TVRESTM		Initialization period: torque reserve after start-up
VANF		Speed threshold for approach support

FB LLRMR 12.40 Detailed description of function

The purpose of the torque reserve is to determine the operating point of the engine such that the ignition angle is not at its optimum ignition. It is assured by this that an increase in torque towards the optimum is still possible by a jump in the ignition angle towards the optimum. This function defines how large the possible torque reserve shall be:

In the normal case, the torque reserve is taken from the map KFMRES (dependent on dns and on tmot).
As a rule, it is endeavored to keep this as small as possible so as not to unnecessarily worsen the engine’s efficiency.

So as to be able to provide more torque when driving off if the driver is about to stall the engine, a switchover is made when the clutch has been depressed (B_kuppl = 1) and at low driving speeds (vfzg < VANF) to a torque reserve from the map KFMRESK. This switchover on operating the clutch is made without any filtering, the switch-back on releasing the clutch is however with filtering.

If a drop in speed then occurs because the idle-speed control has not managed to compensate for an additional load during key-ON, then the torque reserve is increased to a higher value MRESLL. The higher torque reserve is retained for the time TVRESLL before being gradually decreased over the ramp DMRESLL to the normal value. DMRESLL is a negative value!
The described functionality is helpful when the steering assistance is stressed. The first stress when the speed drops increases the torque reserve, such that there is only a small drop in speed occurring caused by subsequent stresses (e.g. during parking maneuvers).

A torque reserve, dmrac, is built before air-conditioner compressor cuts in. This is so that the compressor’s cut-in point can be designed to be almost independent of the speed.
The engine is brought to an operating point with a higher torque reserve before the load is switched on.

A lower limit for the torque reserve is set to MRESSL if the information B_sl is received from power steering.

The torque reserve can be adjusted in the workshop using vstmdr (see %TKMWL).

The largest torque reserve demanded is always selected.

Partial shutdown of the function follows in case the bit B_nswo1 is set, whereby only that torque reserve when the air-conditioner compressor cuts in is considered further.

If the vehicle is not at its idle speed, then a torque can also be demanded from the map KFMRESNL when the clutch is depressed. This can be helpful, e.g. if the driver presses only slightly on the accelerator pedal when driving off or if the engine is likely to be stalled by this.

The map KFMRESKH can be used for catalytic-converter heating concepts with thermo-reactors. This constitutes an upper limit during idling for the torque reserve. This can be meaningful in order to limit the adjustment to retarded of the ignition angle.

The map KFMRESTA can be used to realize an additional adjustment to retarded of the ignition angle that is not dependent on the ambient temperature. This can be beneficial for engines where the knocking tendency is high, e.g. turbo-charged engines.

A torque reserve that is dependent on the engine temperature is calculated during the start-up phase in the block MRESTM. This is then gradually decreased after the end of the start-up phase to zero again.

APP LLRMR 12.40 Application hint

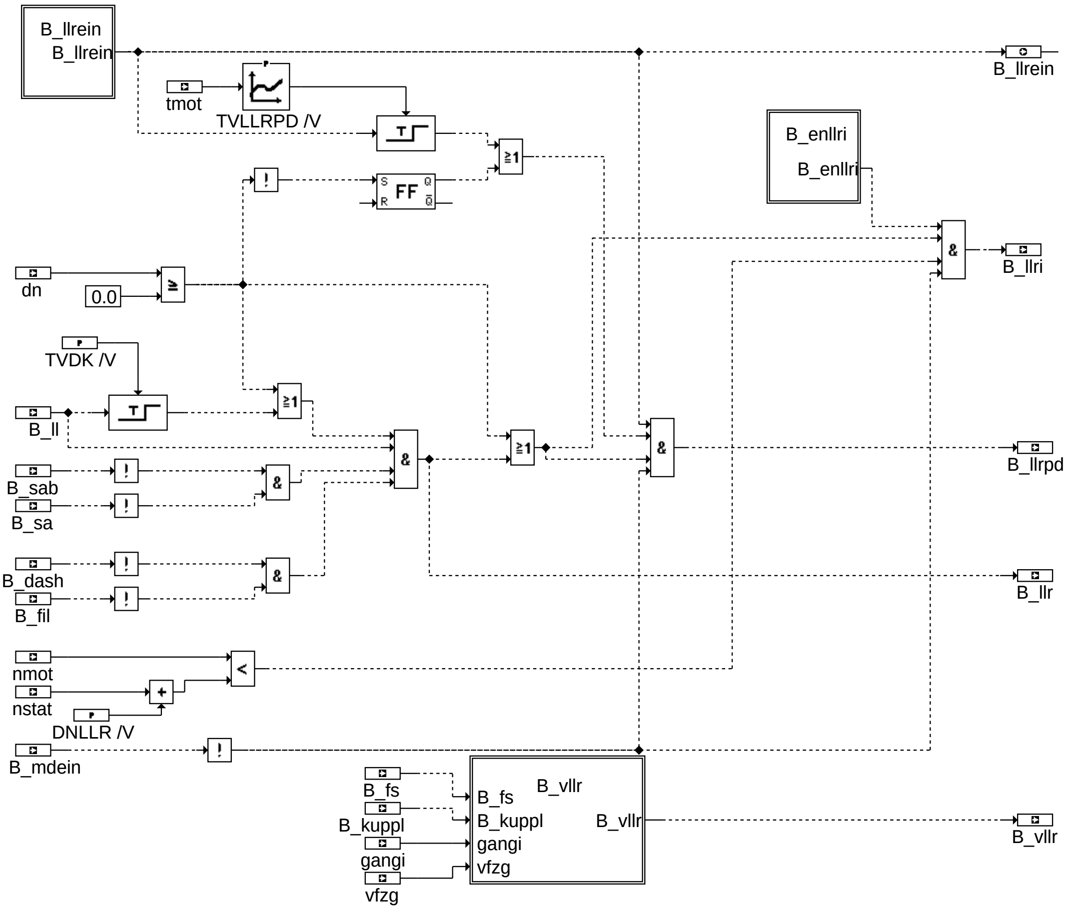
Adaptation of KFMRES: KFMRES constitutes the desired torque reserve in the range close to the idle speed. Since a torque reserve can also mean a deterioration of the engine’s efficiency, the attempt is made to keep this as small as possible. On the other hand, the torque reserve helps to brake a sudden drop in the speed when load torque’s suddenly occur (alternator when the electric fan cuts in, power steering, ...). A minimum torque must however be provided for the ignition over the fast path. The magnitude of this torque has to be determined by carrying out tests with the vehicle by quickly switching on the largest load. The engine engine may not be stalled by this. Neither may the engine speed drop below a set limit. The torque reserve is maintained at a constant value up to speeds of about 300 RPM above the set speed. The torque reserve is quickly reduced to zero at speeds up to 500 RPM.
There shall be no torque reserve demanded by idle-speed control, LLR, at partial loads.
Typical values for the torque reserve are about 3 % to 4 %.

Adaptation of DNLLRES, TVRESLL, MRESLL and DMRESLL:

DNRESLL: Negative differences from the set speed that can just still be tolerated. The torque reserve is increased if the engine speed falls below this threshold. Typical value is approx. 120 RPM
TVRESLL: Time during which the increased torque reserve stays at the higher value. Typically, this time shall be sufficiently long such that a normal driver can park the vehicle (several power-steering maneuvers needed). This time is normally about 30 seconds.
MRESLL: Absolute value for the torque-reserve increase. A additional torque reserve of 4 % is often sufficient here.
DMRESLL: The torque-reserve increase is removed again after elapse of the hold time. This gradual decrease of the torque reserve should be completed within a time period of 10 seconds.
DMRESLL is a negative variable.

LLRBB 505.10 Operating conditions of idle speed control

FDEF LLRBB 505.10 Function definition



llrbb-llrbb

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Formation of the Activation Conditions of the Idle Control
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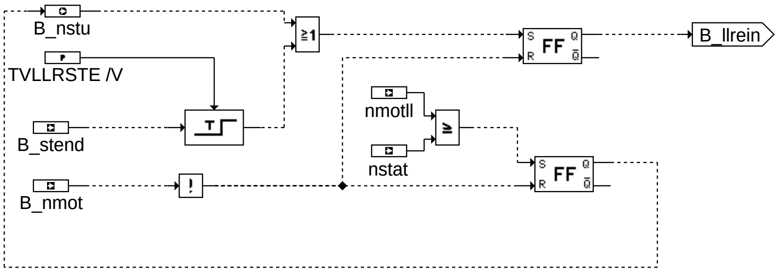

llrbb-b-llrein

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Enabling of the Idle Control after Start:
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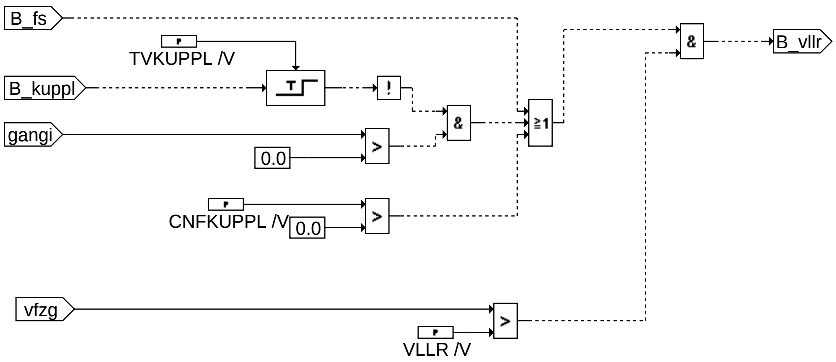

llrbb-b-vllr

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Detection, Whether a Frictional Connection Exists Between Engine and Drive Shaft
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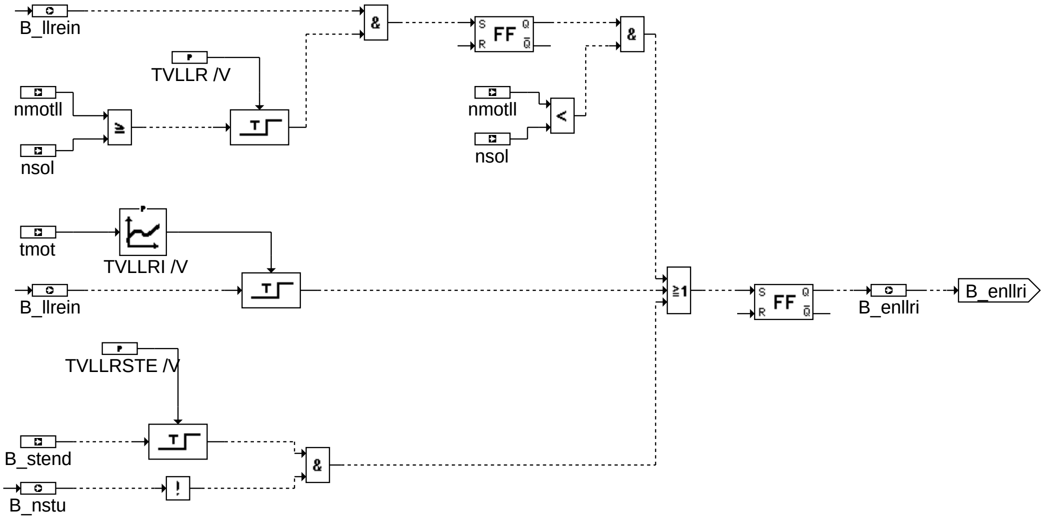

llrbb-b-enllri

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Enabling of the I Component
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ABK LLRBB 505.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFKUPPL			FW	Configuration flag for the evaluation of the cluch switch in the ISC
DNLLR			FW	Engine speed range above nstat to enable the ISC
NMIN			FW	minimum engine speed
TVDK			FW	delay time after closing of the throttle
TVKUPPL			FW	Delay time for the cluch information
TVLLR			FW	turn-on delay: B_llri at engine speed overshoot
TVLLRI	TMOT		KL	delay time to enable I-component after start-up
TVLLRPD	TMOT		KL	Maximal delay time to enable PD components after start-up
TVLLRSTE			FW	enable idle speed control after start
VLLR			FW	vehicle speed limit for idle speed control

Variable	Source	Type	Description
B_DASH	MDFAW	EIN	condition: limitation of negative torque gradient active
B_ENLLRI	LLRBB	AUS	enable integrator: idle speed controller
B_FIL	MDFAW	EIN	condition: low pass filter for transition to or from fuel cut-off active
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_LLR	LLRBB	AUS	condition idle speed control
B_LLREIN	LLRBB	AUS	Condition idle speed control is active
B_LLRI	LLRBB	AUS	Condition activation of I-part of idle speed control
B_LLRPD	LLRBB	AUS	Condition activation of PD-part of idle speed control
B_MDEIN	MDKOG	EIN	Condition actions on the torque are active
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NSTU	LLRBB	AUS	Changeover of rotational speed from nstat to nmot after start
B_SA	MDRED	EIN	Condition fuel cut-off

Variable	Source	Type	Description
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_STEND	BBSTT	EIN	condition end of start
B_VLLR	LLRBB	AUS	Condition vehicle is moving with engaged gear
DN	LLRRM	EIN	speed deviation at idle speed control
GANGI	SWADAP	EIN	Engaged gear
NMOT	SWADAP	EIN	engine speed
NMOTLL	BGNMOT	EIN	engine speed
NSOL	LLRNS	EIN	idle reference speed
NSTAT	LLRNS	EIN	Stationary reference speed
TMOT	SWADAP	EIN	Engine temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)

FW LLRBB 505.10 Fixed Values

Parameter	Value	Description
CNFKUPPL		Configuration flag for the evaluation of the cluch switch in the ISC
DNLLR		Engine speed range above nstat to enable the ISC
NMIN		minimum engine speed
TVDK		delay time after closing of the throttle
TVKUPPL		Delay time for the cluch information
TVLLR		turn-on delay: B_llri at engine speed overshoot
TVLLRSTE		enable idle speed control after start
VLLR		vehicle speed limit for idle speed control

FB LLRBB 505.10 Detailed description of function

The activation conditions for the idle control are formed in this functional block.
Listed, these are:

B_llrein: Enabling of the idle control after start takes place, once the engine speed has reached the steady-state desired nstat for the first time. If the engine is running, but cannot reach nstat, then B_llrein TVLLRSTE is set after end of start. B_llrein is reset, if a software initialization takes place or if the engine speed drops below the threshold NMIN (engine stalled or turned off, but ECU after-run not yet terminated)

B_vllr : Condition vehicle is rolling at engaged gear: If the vehicle speed exceeds the threshold VLLR and if the clutch is not operated, the bit B_vllr is set.
If no gear is engaged, the vehicle is at standstill or the clutch is operated (B_kuppl=1), the bit is cleared.
The bit B_vllr is set, if a frictional connection exists between the engine and the drive shaft.
ATTENTION: Since the clutch switch already activates at the most minor clutch pedal movements on some vehicles, this information is of no use for the LLR. The evaluation of the clutch switch is suppressed via CNFKUPPL > 0.
B_vllr is then only set dependent on the vehicle speed.

B_llr : Condition for idle control: This bit indicates, whether the idle control has been enabled (B_llr = 1) or whether it is still blocked (B_llr = 0).
Enabling of the idle control takes place if: The idle bit has been set (B_ll = 1), no request for fuel cut-off on overrun is given (B_sab = 0), no fuel cut-off is given (B_sa = 0), already TVDK seconds have passed since the idle bit has been reset, underspeed is given (dn > 0), no dashpot is active, no external torque interventions (MSR or ASR) take place (B_mdein=0), no torque filtering for SAWE takes place (B_fil=0) and the engine speed is within a range below of nstat+DNLLR.

B_llrpd : Condition for enabling of the P and D component of the idle controller: The proportional and differential components of the idle controller are enabled, if no external torque intervention takes place and if the LLR is active (B_llrein=1) and if the controller is active (B_llr=1) or if underspeed is given.
The P component is only enabled after engine start, if the engine has made a speed overshoot or if the end of start bit (B_stend) has been set since a time greater than TVLLRPD.

B_llri : Condition for enabling of I component of the idle controller: The integrator of the idle controller is enabled, if the controller has been enabled (B_llr = 1), no torque intervention is active (B_mdein = 0) and B_enllri is set.

B_enllri: This bit ensures that the I component is not active during the start overshoot. The I component is only to be activated, once nmot drops below the desired speed nsol for the first time.
If nmot remains above nsol for longer than TVLLRI, the I component is activated.
If the engine is running, but remains below nsol, the I component is also activated to "pull up" the speed.

APP LLRBB 505.10 Application hint

```
Adjustment of VLLR:   VLLR should be chosen as small as possible, so as to already detect a slowly rolling vehicle as not being at
                      standstill. The state vehicle is rolling at idle in the 1st gear must definitely be detected, also in case
                      of underspeed. The speed threshold necessary for this can be estimated as follows:

                        VLLR =  ( nsol_minimum value - 200) * v1000 / 1000

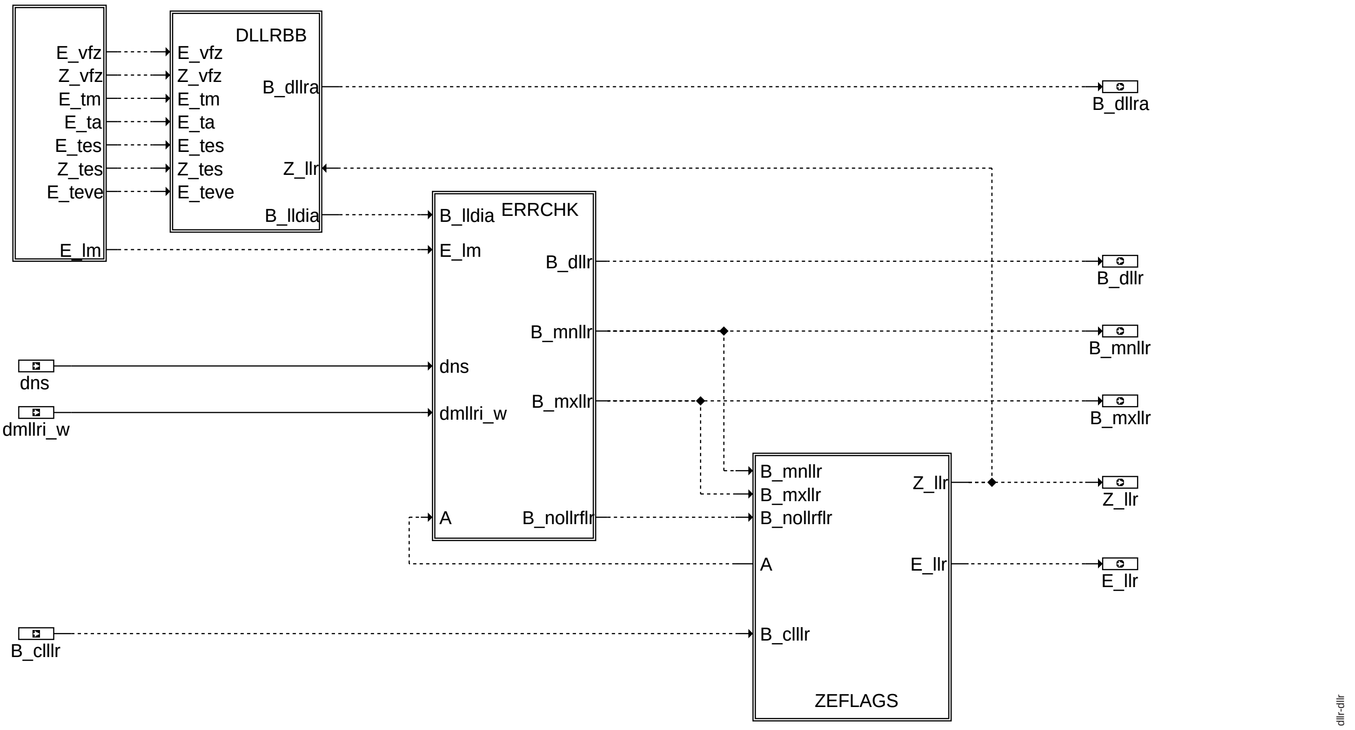
                        where v1000 is the vehicle speed at 1000 rpm in the 1st gear. (This usually lies between 7 km/h and
                        dependent on the fitted tiers and the transmission design).

Adjustment of TVDK:   This controller blocking time is to prevent the controller from already starting to operate immediately
                      after the throttle valve having been closed, but at still high speed. After a tip-in with a final speed
                      close to the maximum speed (about 6000 rpm), TVDK must be chosen that large that the controller only starts
                      operating in the capture range of the desired speed correction. From experience values for TVDK lie between
                      0.5 and 1 second. If TVDK is too small, an undesired underswing of the speed may occur after tip-in, since
                      the too early started controller has already reached a too large negative component, which must now be
                      reduced again.

Adjustment of TVKUPPL: This delay time for the clutch information is necessary, since the clutch switch at the pedal already
                      switches when the pedal is touched, but since the actual disengagement is only reached once the clutch
                      pedal has been nearly completely floored.
                      The time TVKUPPL should lie at about 100 ms.
```

DLLR 28.80 Diagnosis: idle speed control, recognising a blocked actuator

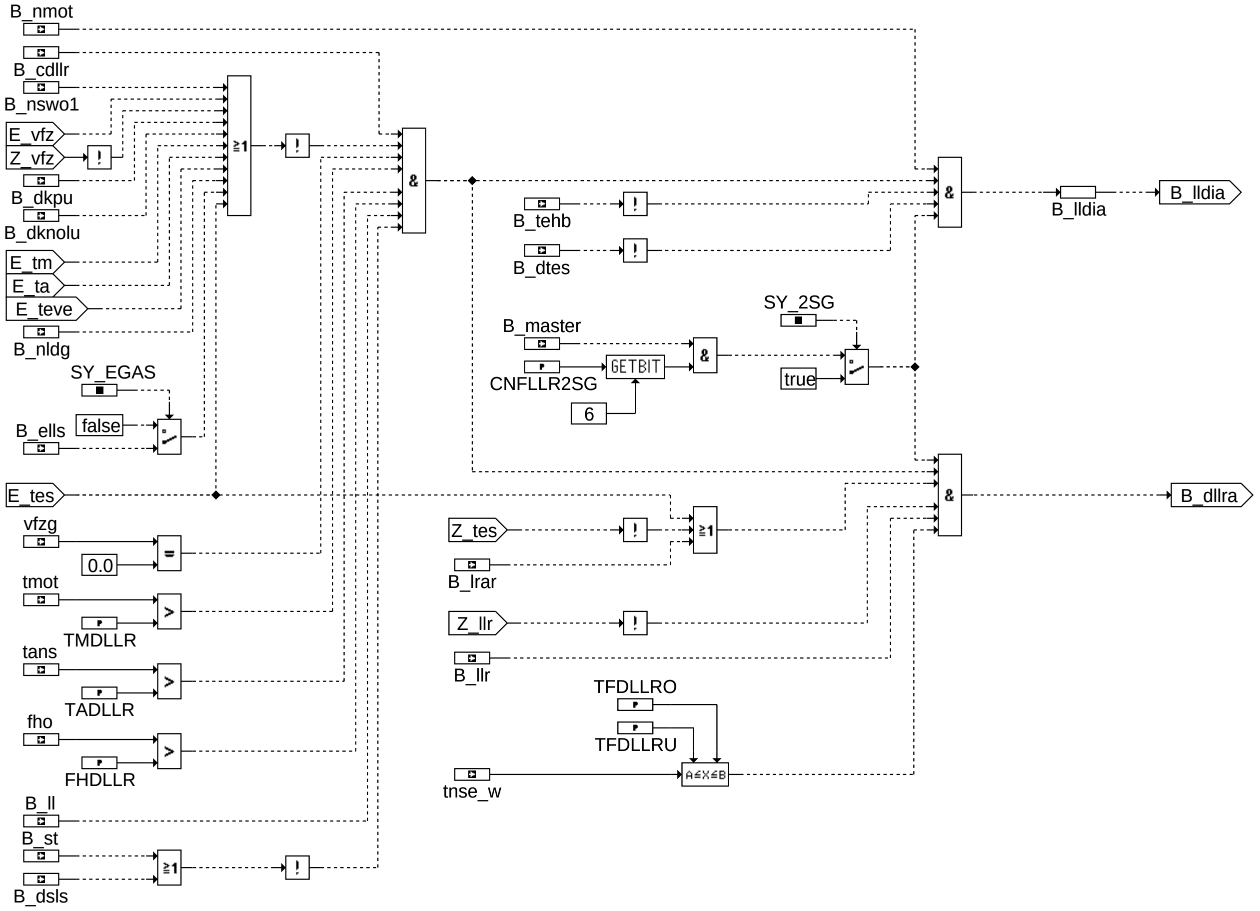
FDEF DLLR 28.80 Function definition



dllr-dllr

```
General view of the idle speed control diagnosis
------------------------------------------------

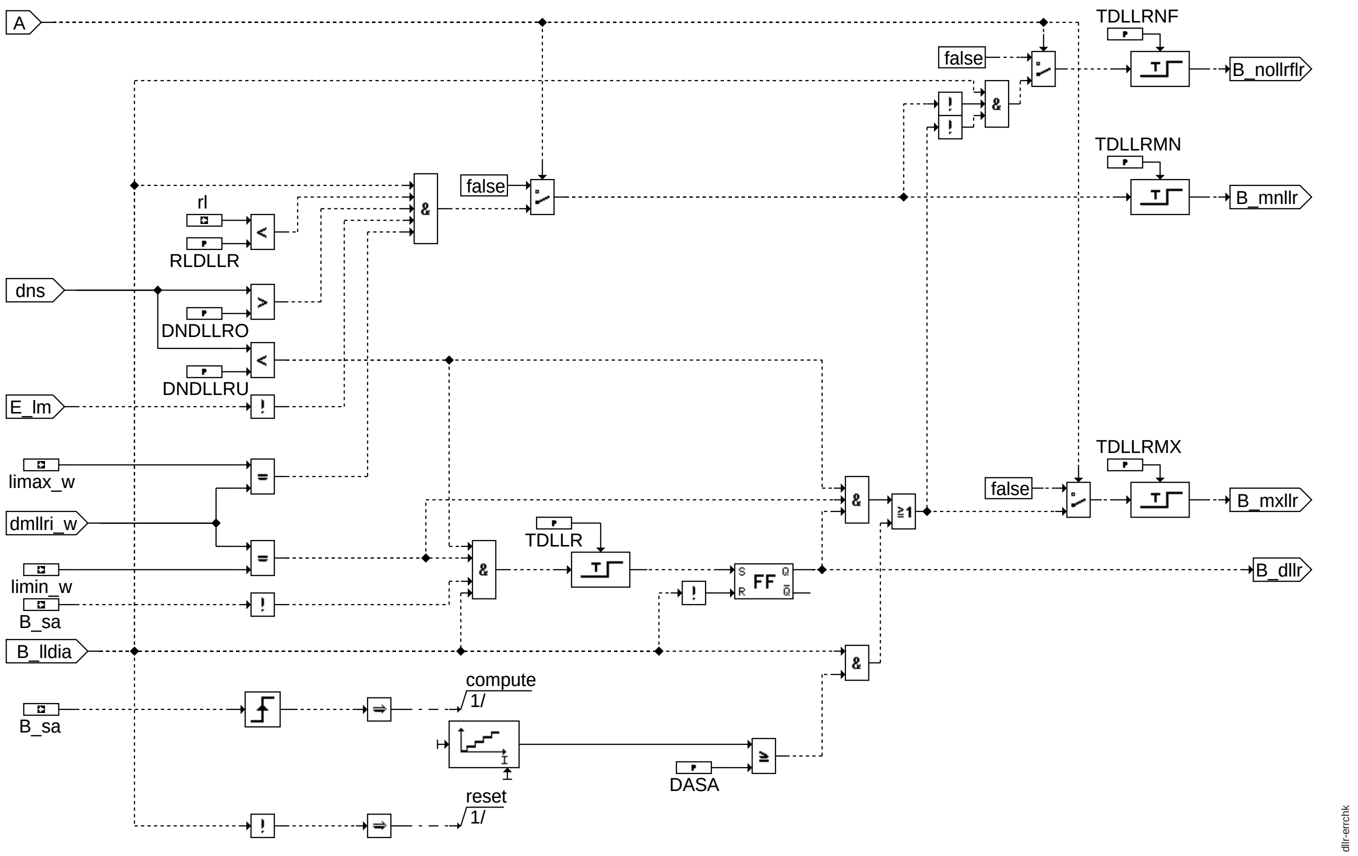
        The diagnosis of the idle speed control is divided into three parts:
        1. DLLRBB : conditions to activate the function
        2. ERRCHK : error check of the idle speed control
        3. ZEFLAG : management of the error and cycle flags
```



dllr-dllrbb

```
DLLRBB: conditions to activate the function
-------------------------------------------

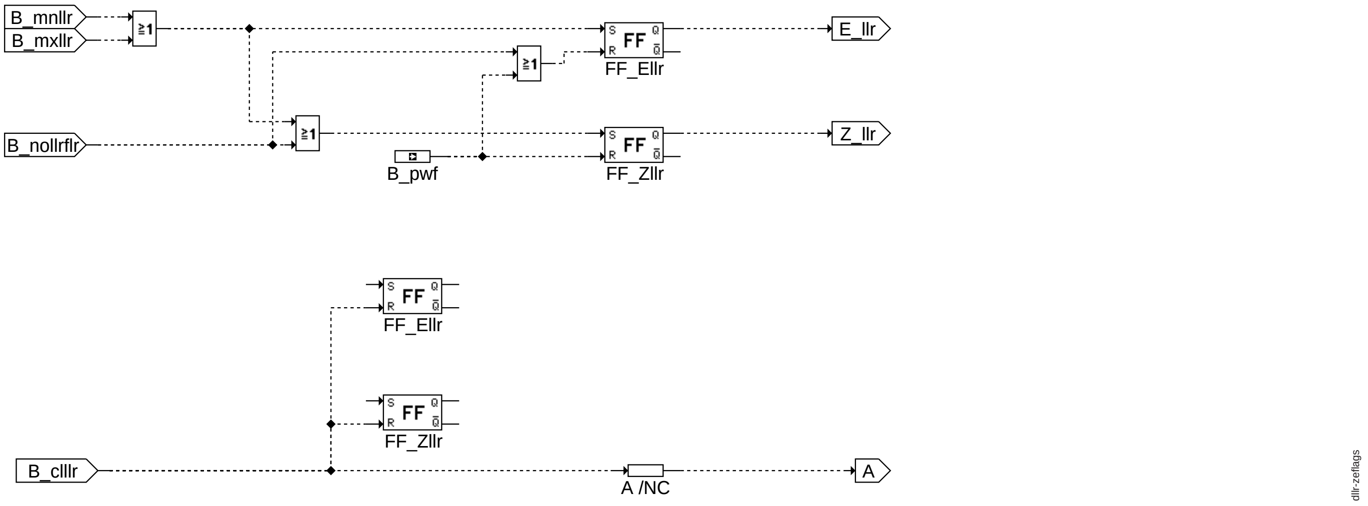
        The function is activated when:
        1. the EURO code sets the flag B_cdllr
        2. other functions have no errors detected (upper OR-gatter)
        3. the engine operates under predefined conditions (lower part of the figure)
        The diagnosis is enabled when the flag B_lldia is true (set to 1).
```



dllr-errchk

```
ERRCHK: error check of the idle speed control
---------------------------------------------

        This part of the function works only if B_lldia is set to 1 (see above).
        In the upper part of the figure (upper AND-gatter) occurs the check for engine speed too low. If the engine speed remains
        more than DNDLLRO rpm under the target speed an the ISC-integrator reaches the upper limit DMLLRIDO for a time longer than
        TDLLRMN, the error-flag B_mnllr is set.
        In the lower part of the figure the check for engine speed to high is made. If the integrator remains at its lower limit
        DMLLRIDU and the engine speed difference ist DNDLLRU the flag B_dllr is set after the time TDLLR. This causes the lower
        limit of the integrator to be changed to LIMNDLLR (see %LLRMD, LIBEG). If now the limit DMLLRIDU2 is reached for more than
        TDLLRMX seconds, the flag B_mxllr is set.
        This flag is also set if during one continuous disgnosis phase (B_lldia set) the flag B_sa is set more than DASA times.
        This is normally impossible vehicle at rest without opening the throttle.
```



dllr-zeflags

```
ZEFLAGS: management of the error and cycle flags
------------------------------------------------

        If the diagnosis worked one time completly, independently if an error occurded, the cycle flag is set.
        If an error occured the error-flag is set additionnaly.
```

ABK DLLR 28.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CNFLLR2SG			FW	Configuration word for idle speed control 2-ECU-concept (slave)
DASA			FW	number of fuel cut-out phases to detect ISC-actuator error
DNDLLRO			FW	Maximal speed deviation (low speed) for diagnosis of idle speed control
DNDLLRU			FW	Maximal speed deviation (high speed) for diagnosis of idle speed control
FHDLLR			FW	altitude threshold for performing of ISC-actuator diagnosis
RLDLLR			FW	Cylinder filling threshold for ISC diagnosis
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_EGAS			SYS (REF)	System constant E-GAS present
TADLLR			FW	intake air temperature threshold for ISC-actuator diagnosis
TDLLR			FW	Time delay for setting the condition diagnosis of ISC-actuator
TDLLRMN			FW	Time delay before storing error of closed ISC-actuator
TDLLRMX			FW	Time delay before storing the error ISC-actuator open
TDLLRNF			FW	Time delay before storing ISC-actuator with no error
TFDLLRO			FW	Upper limit for time window for DLLR
TFDLLRU			FW	Lower limit for time window for DLLR
TMDLLR			FW	Engine temperature threshold for ISC-actuator diagnosis

Variable	Source	Type	Description
B_CDLLR	PROKON	EIN	function active per codeword CDLLR
B_CLLLR		EIN	condition clear failure path DLLR
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DLLR	DLLR	AUS	Active diagnostic: ISC-actuator diagnostic
B_DLLRA	DLLR	AUS	Condition DLLR request
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_ELLS		EIN	Condition: error idle speed actuator
B_LL	MSF	EIN	Condition idle
B_LLDIA	DLLR	LOK	Diagnosis of idle speed control released
B_LLR	LLRBB	EIN	condition idle speed control
B_LRAR	TEB	EIN	condition for reducted correction ranges at LRA
B_MASTER		EIN	Condition MASTER-ECU
B_MNLLR	DLLR	AUS	Error 'Idle speed too low'
B_MXLLR	DLLR	AUS	Error 'Idle speed too high'
B_NLDG		EIN	condition limp-home function speed sensor
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_PWF		EIN	Condition for powerfail
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	SWADAP	EIN	condition for start
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
DFP_LM	DLLR	DOK	ECU-internal fault path no.: main-load sensor
DFP_TA	DLLR	DOK	ECU int fault path no.: air intake temperature TANS
DFP_TES	DLLR	DOK	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE	DLLR	DOK	Internal fault path number: canister purge valve power stage
DFP_TM	DLLR	DOK	Internal fault path number: engine temperature
DFP_VFZ	DLLR	DOK	ECU int. fault path no.: vehicle speed signal
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DNS	LLRNS	EIN	LLR: difference of idle speed precontrol
E_LLR	DLLR	AUS	Error flag: idle speed control
E_LM	EGFE	EIN	Error flag: main load sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
FHO	BGPU	EIN	Correction factor altitude
LIMAX_W		EIN	Idle speed control integrator upper limit
LIMIN_W		EIN	Idle speed control integrator lower limit
RL	SWADAP	EIN	relative air charge
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
VFZG	SWADAP	EIN	vehicle speed (km/h)
Z_LLR	DLLR	AUS	cycle flag: diagnostic ISC-actuator
Z_TES	DTEV	EIN	cycle flag of canister purge system
Z_VFZ	EGAG	EIN	cycle flag: vehicle speed signal

FW DLLR 28.80 Fixed Values

Parameter	Value	Description
CNFLLR2SG		Configuration word for idle speed control 2-ECU-concept (slave)
DASA		number of fuel cut-out phases to detect ISC-actuator error
DNDLLRO		Maximal speed deviation (low speed) for diagnosis of idle speed control
DNDLLRU		Maximal speed deviation (high speed) for diagnosis of idle speed control
FHDLLR		altitude threshold for performing of ISC-actuator diagnosis
RLDLLR		Cylinder filling threshold for ISC diagnosis
TADLLR		intake air temperature threshold for ISC-actuator diagnosis
TDLLR		Time delay for setting the condition diagnosis of ISC-actuator
TDLLRMN		Time delay before storing error of closed ISC-actuator
TDLLRMX		Time delay before storing the error ISC-actuator open
TDLLRNF		Time delay before storing ISC-actuator with no error
TFDLLRO		Upper limit for time window for DLLR
TFDLLRU		Lower limit for time window for DLLR
TMDLLR		Engine temperature threshold for ISC-actuator diagnosis

FB DLLR 28.80 Detailed description of function

The diagnosis of the idle speed control is enabled only if the flag B_lldia is set.

The DLLR-function controls the behaviour of the ISC-integrator dmllri_w in dependence of the engine speed.

If the engine speed difference is greather than DNDLLRO and the integrator is greather than DMLLRIDO the flag B_llrmn is set after waiting the time TDLLRMN.

If the engine speed difference is lower than DNDLLRU and the integrator dmllri_w is lower than DMLLRIDU the lower integrator limit is set to LIMNDLLR after the time TDLLR. If the integrator reaches the new limit DMLLRDIU2 and stays there for more than TDLLRMX seconds, the flag B_llrmx is set.

If the throttle stays too much opened (still with B_ll=1), the engine speed can rise until fuel cut-off occurs.
The speed oscillations and the fuel cut-off phases disable the integrator to reach a lower limit. Therefore the function monitors the times of apprearing of the flag B_sa. If this flag ist set and reset more than DASA times the flag B_mxllr is also set.

APP DLLR 28.80 Application hint

The detection of an idle speed control error has to occure before other functions who need the ISC have theire diagnosis working. The time disponible for the DLLR during the FTP-cycle is only 26 seconds (this is the longest idle phase with warm engine at second 620).

TMDLLR: set to 80°C

RLDLLR: bigger than rl at idle. Is used to detect if the driver tries to hold his car at the hill using the clutch and having an engine speed under the target speed.

DNDLLRO: 100 rpm: engine speed more than 100 rpm under the target speed must be detected as an error.

DMLLRIDO: <= LIMX

DNDLLRU: 200 rpm: engine speed more than 200 rpm above the target speed must be detected as an error.

DMLLRIDU: >= LIMN

DASA: minimum equal to 2

DMDLLIDU2: approx. 5% lower than LIMN = LIMNDLLR

TDLLRNF: max. 20 sec.

TDLLRMX: TDLLRMX and the time needed by the integrator to reach the limit DMLLRIDO when engine speed is 100 rpm too low (depends of the integral gain of the controller) must be less than TDLLRNF.

TDLLRMN: TDLLRMN and the time needed by the integrator to reach its upper limit DMLLRIDU when engine speed is 200 rpm too high and
TDLLR: TDLLR, and the time the integrator needs to reach the new limit DMLLIDU2 when engine speed is still 200 rpm too high must be lower than TDLLRNF.

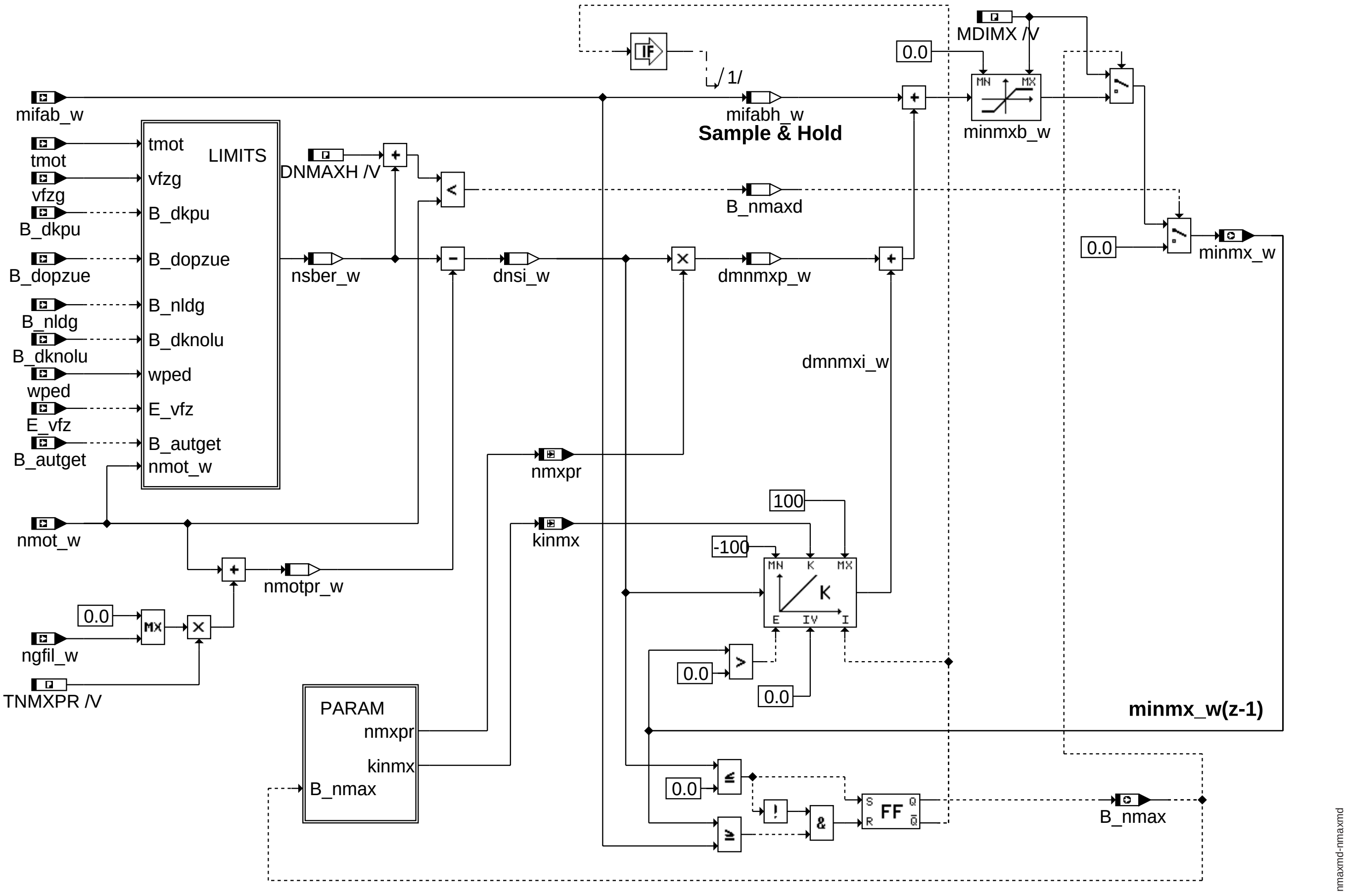
The available time during the FTP cycle is schematically the following:

```
            +-------------------------------------------------------------------------------------------------------+
            |                                                                   .                       .           |
B_lldia ----+                  <<-- maximal time 26 seconds !! ---->>           .                       .           +-----------
            .                                                                   .                       .
            .                                                                   .                       .
1) Case n > nsol (engine speed to high)
=======================================
            .                                                                   .                       .
      1     .                                                                   +-----------------------------------------------
Z_llr 0 ------------------------------------------------------------------------+                       .
            .                                                                   .                       .
            .                                                                   .                       .
      1     .                                                                   +-----------------------------------------------
E_llr 0 ------------------------------------------------------------------------+                       .
            .                                                                   .                       .
            .                                                                   .                       .
dmllri_w ----                                                                   .                       .
             --  .<----------TDLLR----------->.  .<---------TDLLRMN------------>.                       .
            .  --.                            .  .                              .                       .
DMLLRIDU    .    -----------------------------   .                              .                       .
            .    .                             --.                              .                       .
DMLLRIDU2   .                                    -------------------------------------------------------------------------------


            +-------------------------------------------------------------------------------------------------------+
            |                                 .                       .                                             |
B_lldia ----+                          <<-- maximal time 26 seconds !! ---->>                                       +-----------
            .                                 .                       .
            .                                 .                       .
2) Case n < nsol (engine speed too low)
=======================================
            .                                 .                       .
      1     .                                 +---------------------------------------------------------------------------------
Z_llr 0 --------------------------------------+                       .
            .                                 .                       .
            .                                 .                       .
      1     .                                 +---------------------------------------------------------------------------------
E_llr 0 --------------------------------------+                       .
            .                                 .                       .
            .                                 .                       .
            .    .<----------TDLLRMX--------->.                       .
            .    .                            .                       .
DMLLIDO     .    -----------------------------------------------------------------------------------------------------------------
            .  --                                                     .
            .--                                                       .
dmlllri_w ---                                                         .
```

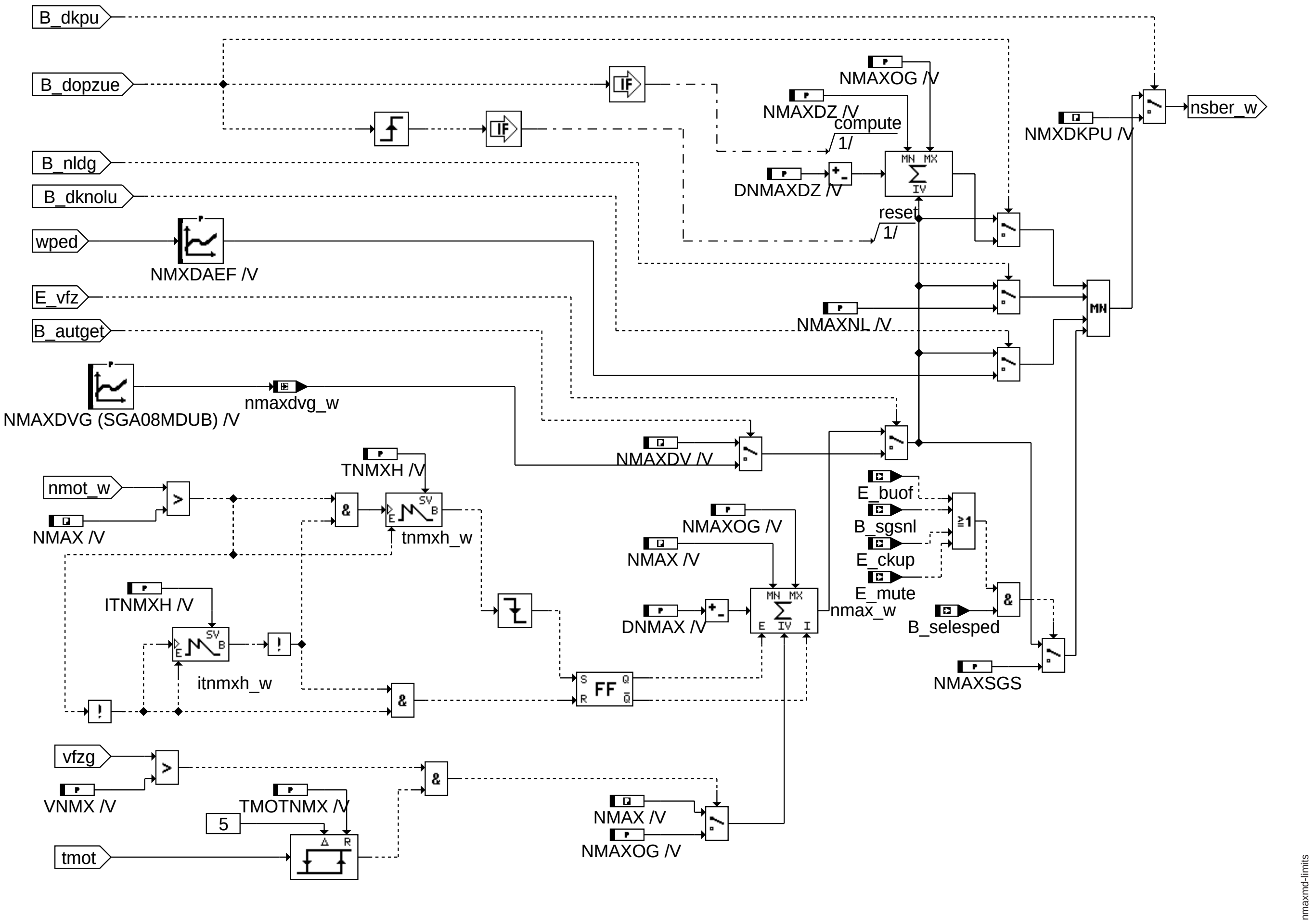
NMAXMD 18.20 Torque calculation during maximum speed control

FDEF NMAXMD 18.20 Function definition



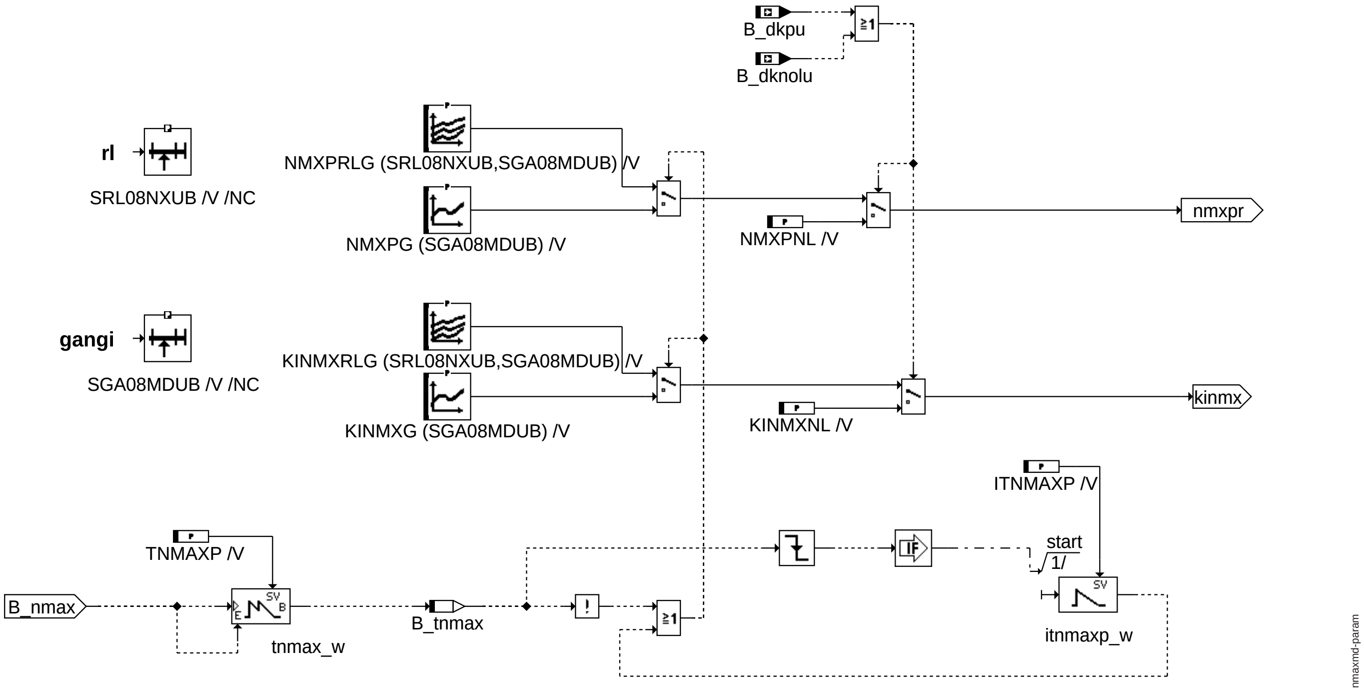
nmaxmd-nmaxmd

```
Subfunction LIMITS: Engine speed limits
---------------------------------------
```



nmaxmd-limits

```
Subfunction PARAM: Controller parameter
---------------------------------------
```



nmaxmd-param

ABK NMAXMD 18.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DNMAX			FW	engine speed threshold for engine speed limitation, transient limit
DNMAXDZ			FW	delta for diminution of engine speed limit
DNMAXH			FW (REF)	hysteresis for hard rpm limiting
ITNMAXP			FW	duration of alternative tuning of engine speed limitation
ITNMXH			FW	dwell time below lower engine speed limit before activation of upper limit
KINMXG	GANGI		KL	gain of integral component for NMAX control
KINMXNL			FW	integrator gain for engine speed limitation in case of throttle actuator error
KINMXRLG	RL	GANGI	KF	gain of integral component for NMAX control
MDIMX			FW (REF)	maximum limit indicated engine torque
NMAX			FW (REF)	engine-speed limitation, transient limit
NMAXDV			FW (REF)	engine speed limit at fault of the vehicle speed signal
NMAXDVG	GANGI		KL	rpm limit in case of fault detection velocity signal
NMAXDZ			FW	engine speed limit for condition double ignition
NMAXNL			FW	engine speed limit for limp-home function speed sensor
NMAXOG			FW	raised engine speed limit
NMAXSGS			FW	
NMXDAEF	WPED		KL	maximum permitted engine speed for throttle actuator substitute function
NMXDKPU			FW (REF)	Maximum permitted engine speed in case of unknown or wrong throttle position
NMXPG	GANGI		KL	P component for NMAX control
NMXPNL			FW	P component for engine speed limitation in case of throttle actuator error
NMXPRLG	RL	GANGI	KF	P component for NMAX control
SGA08MDUB	GANGI		SV (REF)	base point distribution of actual gear 8 b.pt.
SRL08NXUB	RL		SV (REF)	
TMOTNMX			FW	temperature threshold for activation of raised engine speed limitation
TNMAXP			FW	dwell time NMAX limit until activation of alternative tuning
TNMXH			FW	duration of raised engine speed limit
TNMXPR			FW (REF)	rpm prediction horizon for NMAX control
VNMX			FW	vehicle speed threshold for activation of raised engine speed limit

Variable	Source	Type	Description
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DOPZUE	NLPH	EIN	Condition double ignition
B_NLDG		EIN	condition limp-home function speed sensor
B_NMAX	NMAXMD	AUS	1 = maximum engine speed exceeded
B_NMAXD	NMAXMD	LOK	condition rpm limiting with injection masking
B_SELESPED		EIN	condition: car with selespeed
B_SGSNL		EIN	demand for engine speed limitation from SGS
B_TNMAX	NMAXMD	LOK	Bit, timer for parameter switch has run down
DMNMXP_W	NMAXMD	LOK	torque P-component for NMAX control
DNSI_W	NMAXMD	LOK	difference between nominal and actual engine speed
E_BUOF	CAN	EIN	

Variable	Source	Type	Description
E_CKUP		EIN	error flag: CAN-bus, timeout clutch
E_MUTE	CAN	EIN	
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
KINMX	NMAXMD	LOK	gain of integral component for NMAX control
MIFABH_W	NMAXMD	LOK	limited desired indicated engine torque (sample & hold)
MIFAB_W	MDKOG	EIN	limited desired indicated engine torque
MINMX_W	NMAXMD	AUS	indicated nominal torque for NMAX limiting
NGFIL_W	SWADAP	EIN	filtered engine-speed gradient
NMAXDVG_W	NMAXMD	LOK	gear dependant rpm limit in case of fault detection velocity signal
NMOTPR_W	NMAXMD	LOK	engine speed
NMOT_W	SWADAP	EIN	engine speed
NMXPR	NMAXMD	LOK	P component for NMAX control
NSBER_W	NMAXMD	LOK	Calculated requested engine speed of the NMAX controller
TMOT	SWADAP	EIN	Engine temperature
VFZG	SWADAP	EIN	vehicle speed (km/h)
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW NMAXMD 18.20 Fixed Values

Parameter	Value	Description
DNMAX		engine speed threshold for engine speed limitation, transient limit
DNMAXDZ		delta for diminution of engine speed limit
ITNMAXP		duration of alternative tuning of engine speed limitation
ITNMXH		dwell time below lower engine speed limit before activation of upper limit
KINMXNL		integrator gain for engine speed limitation in case of throttle actuator error
NMAXDZ		engine speed limit for condition double ignition
NMAXNL		engine speed limit for limp-home function speed sensor
NMAXOG		raised engine speed limit
NMAXSGS		
NMXPNL		P component for engine speed limitation in case of throttle actuator error
TMOTNMX		temperature threshold for activation of raised engine speed limitation
TNMAXP		dwell time NMAX limit until activation of alternative tuning
TNMXH		duration of raised engine speed limit
VNMX		vehicle speed threshold for activation of raised engine speed limit

FB NMAXMD 18.20 Detailed description of function

A PI controller with rpm prediction is used to limit the engine speed.
The actual engine speed predicted over a time horizon TNMXPR (prediction only with positive engine speed gradient) is compared with the maximum engine speed NMAX. If the predicted actual engine speed nmotpr_w exceeds the maximum permitted value NMAX, then a PI controller is used to calculate the delta torques dmnmxp_w and dmnmxi_w, and add them with the indicated driver torque to minmxb_w so that the actual engine speed is limited to NMAX.
The torque mifabh_w which is used for the limitation is only updated when the permissible torque minmxb_w is greater than the actual limited driver torque mifab_w. This stabilizes the torque minmxb_w and prevents the driver from exciting a torque oscillation with the pedal. The output variable minmxb_w is limited to between the minimum value 0 and the maximum value MDIMX.
If minmx_w(z-1) equals zero, then the integrator of the PI controller is stopped. If the predicted actual engine speed is less than NMAX (dnsi_w < 0) and the torque minmx_w is greater than or equal to the driver torque mifab_w, then the condition B_nmax is revoked and the indicated torque minmx_w is switched to the default value MDIMX, so that no intervention occurs.
If the engine speed exceeds the threshold NMAX, then the condition B_nmax is set. This permits cylinder masking when air and ignition angle intervention is no longer sufficient (see %MDRED).

Subfunction PARAM:

The control parameters can be defined as functions of the relative charge rl and the actual gear gangi. At the end of a retriggerable time interval TNMAXP the controller parameters are switched. This can be used to change the control response from smooth to uncomfortable to signal the driver. The second set of parameters is active for the time ITNMAXP even if B_nmax changes meanwhile.

Subfunction LIMITS:

In case of error velocity signal the engine speed is limited to NMAXDV. With automatic transmission the limitation can be given as a function of the actual gear with the characteristic curve NMAXDVG.
In case of an error of the engine speed sensor the engine speed limit is NMAXNL (limb home function, error engine speed sensor). If B_dknolu = 1 (limb home air position) leads to a smaller engine speed limit the MIN value is chosen.
Raised engine speed limit, valid for a limited time:
If tmot>TMOTNMX and vfzg>VNMX the engine speed limit NMAXOG is activated (initialization of the ramp with NMAXOG), otherwise NMAX is valid. The timer tnmxh_w counts down the time when nmot_w is higher than NMAX. If nmot_w is lower than NMAX only for a short time tnmxh_w is not reinitialised. If tnmxh_w expired (TNMXH) a ramp for nmax_w is started. The variable nmax_w is reduced in steps of DNMAX until it reached its lower limit NMAX.
A reinitialisation of the ramp with NMAXOG and a restart of the timer tnmxh_w is not allowed, until the engine speed is below NMAX for at least the time ITNMXH without interruption. At the time of reinitialisation the engine speed has to be below NMAX.

With double ignition (B_dopzue) a ramp for the diminution of the engine speed limitation is activated. In steps of DNMAXDZ the engine speed is reduced to NMAXDZ.

APP NMAXMD 18.20 Application hint

The control parameters NMXPG, NMXPRLG, KINMXG, KINMXRLG and TNMXPR should be programmed so that the transient recovery time or the overshoot of the engine speed does not exceed the requested values and the system remains stable.
For a basic application all values in the respective characteristic curve (or map) must be the same.

```
Typical values:
NMAX = 6500 rpm,        MDIMX = 99.6%,          DNMAXH = 100 rpm,       NMAXDV <= NMAX
ITNMXH = 3 * TNMXH,     DNMAX = 1 rpm,
TMOTNMX = 80 °C,        VNMX = 20 km/h (raised engine speed not allowed for stationary vehicle)

( Default values:                                                      )
( TMOTNMX = 143.25 °C,  VNMX = 318.75 km/h,     NMAXOG = 5000 rpm,     )
( ITNMXH = 0 s,         TNMXH = 0 s,                                   )
( NMAXNL = 2000 rpm                                                    )
( NMAXDZ = 10000 U/min, DNMAXDZ = 0 U/min                              )
```

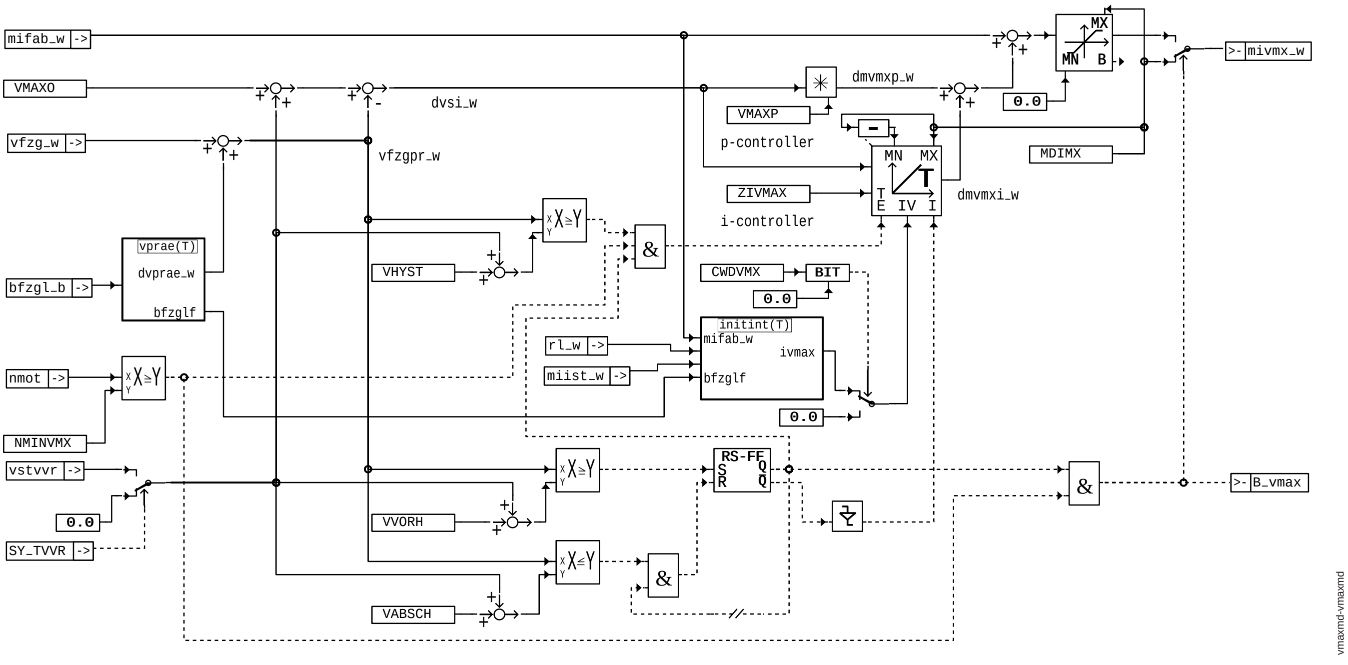
```
                       (NMAXOG-NMAX)/DNMAX*10ms
                                |
                                |
                       TNMXH    |                    ITNMXH
                       |-----|  |                |-------------|
             |               |-----|
     NMAXOG -|-------- *******                                    ***
             |        *         *                                *
       NMAX -|------ * ----------- ******* -- *** ------------- * ---
             |      *                     ****   ***************
             |     *
             |    *
             |   *
             |  *
             | *
             -------------------------------------------------------
```

Choosing NMAXOG = NMAX deactivates the raised engine speed limit.

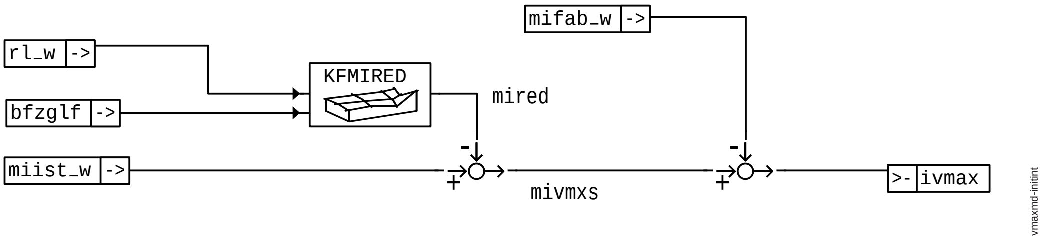
Attention: A high engine speed overshoot activates the hard limit DNMAXH (B_nmaxh=1 => maximum injection suppression).
The maximum engine speed up to B_nmaxd=1 is: nmot_w = NMAXOG + DNMAXH .

VMAXMD 1.30 Torque request of Vmax regulation

FDEF VMAXMD 1.30 Function definition

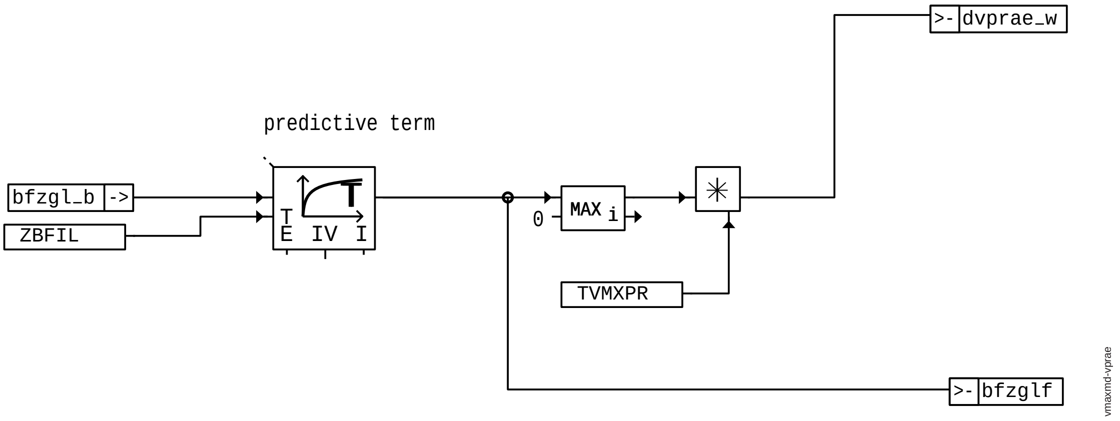


vmaxmd-vmaxmd



vmaxmd-initint

Partial function INITINT: Calculation of the initialization value for the integral action component



vmaxmd-vprae

Partial function VPRAE: Calculation of a predicted speed component

ABK VMAXMD 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDVMX			FW	code word SW-switch for integrator initialization during VMAX control
KFMIRED	RL_W	BFZGLF	KF	Map of decreasing control torque for VMAX control
MDIMX			FW	maximum limit indicated engine torque
NMINVMX			FW	Minimum engine speed threshold for the VMAX control
TVMXPR			FW	Speed prediction horizon for VMAX control
VABSCH			FW	Vmax controller shut-down threshold, variant-coded
VHYST			FW	Vmax hysteresis threshold, variant-coded
VMAXO			FW	Vmax limiting value (line with 16 variants)
VMAXP			FW	P element for VMAX control
VVORH			FW	Vmax guide threshold, variant-coded
ZBFIL			FW	Time constant for acceleration filter
ZIVMAX			FW	I gradient for VMAX control

Variable	Source	Type	Description
BFZGLF	VMAXMD	LOK	Vehicle acceleration , filtered
BFZGL_B	GGVFZG	EIN	Automobile acceleration in the longitudinal direction
B_VMAX	VMAXMD	AUS	flag VMAX limitation active
DMVMXI_W	VMAXMD	LOK	Torque value I-part during VMAX regulation
DMVMXP_W	VMAXMD	LOK	Torque value P-part during VMAX regulation
DVPRAE_W	VMAXMD	LOK	Predicted speed component
DVSI_W	VMAXMD	LOK	Difference between desired and predicted vehicle speed
IVMAX	VMAXMD	LOK	Initial value for integrator for Vmax regulation
MIFAB_W	MDKOG	EIN	limited desired indicated engine torque
MIIST_W	MSF	EIN	indicated real engine torque
MIRED	VMAXMD	LOK	Indicated torque reduction for VMAX regulation
MIVMXS	VMAXMD	LOK	Indicated desired torque for integrator initialisation of VMAX regulation
MIVMX_W	VMAXMD	AUS	indicated nominal torque for VMAX control
NMOT	SWADAP	EIN	engine speed
RL_W	EGFE	EIN	relative air charge (Word)
SY_TVVR	PROKON	EIN	system constant tester connection to vmax-control
VFZGPR_W	VMAXMD	LOK	Predicted vehicle speed
VFZG_W	GGVFZG	EIN	Vehicle speed
VSTVVR		EIN	Speed offset for the VMAX control

FW VMAXMD 1.30 Fixed Values

Parameter	Value	Description
CWDVMX		code word SW-switch for integrator initialization during VMAX control
MDIMX		maximum limit indicated engine torque
NMINVMX		Minimum engine speed threshold for the VMAX control
TVMXPR		Speed prediction horizon for VMAX control
VABSCH		Vmax controller shut-down threshold, variant-coded
VHYST		Vmax hysteresis threshold, variant-coded
VMAXO		Vmax limiting value (line with 16 variants)
VMAXP		P element for VMAX control
VVORH		Vmax guide threshold, variant-coded
ZBFIL		Time constant for acceleration filter
ZIVMAX		I gradient for VMAX control

FB VMAXMD 1.30 Detailed description of function

In order to limit the vehicle speed a PI controller with speed prediction and torque derivation is used.

The basis of this function is the vehicle speed vfzgpr_w, which is predicted in the partial function TVMXPR by a prediction horizon TVMXPR (prediction only with positive vehicle acceleration). If this predicted vehicle speed exceeds the threshold VVORH, then the VMAX control becomes active. The output B_vmax of the RS flip-flop is set to one. The initialization value IVMAX is pre-assigned into the integrator, the delta torques dmvmxp_w and dmvmxi_w are calculated in the controller and added to the indicated torque mifab_w.
If the engine speed falls short of a hysteresis threshold VHYST, then the integrator is stopped. Stopping the integrator shall prevent an escalation of the controller, which may occur due to decelerating and then accelerating again.
So as to prevent the engine from stopping while the clutch is operated and the engine speed having decreased, the VMAX control is is deactivated as from an engine speed threshold.
When the switch-off threshold VABSCH is undershot the controller becomes inactive, the output of the RS flip-flop B_vmax is reset to zero.

The value of the integrator is limited between -MDIMX and MDIMX.
The calculation of the initialization value of the integrator is performed in the partial function INITINT. Dependent on the filtered vehicle acceleration bfzglf and the relative charge rl_w a reduction torque is calculated from a characteristic map. This reduction torque contains the specific torque characteristics of the engine independent of the vehicle mass. By subtracting the reduction torque from the actual torque miist that torque is obtained, which is needed by the engine to maintain the maximum speed.

Via the interface vstvvr a minor change of the control speed is possible.

APP VMAXMD 1.30 Application hint

Hints regarding the initial application:

The controller parameters VMAXP and ZIVMAX are to be adjusted such that the stabilization time resp. the overshoot of the vehicle speed do not exceed the requested values and that the system remains stable.

When starting the control care must be taken at first that the speed signal and the acceleration signal have smooth signal profiles. For this at first the function GGVFZG needs to be adjusted.
For the initial application the prediction horizon TVMXPR should lie at 100 ms and the filter time constant ZBFIL at 500 ms.
The integrator initialization and the speed prediction shall improve the control quality with regard to the stabilization behaviour.
At high limiting speeds and small torque reserve of the engine at that speed an initialization of the integrator is not absolutely necessary.

The map KFMIRED is to be adjusted in the following way:
At first the speed VMAXO is to be reached by driving on a flat stretch of road with the controller being switched off. The actual torque misst (VMAXO, bfzgl=0) measured in the process serves as a basis for the further application. Now the speed threshold VMAXO is exceeded at different accelerations, while the controller is still deactivated. In the process the load rl and the actual torque miist (VMAXO, bfzgl

0) are measured. The reduction value, which corresponds to this rl and to this acceleration results
with regard to
mired (rl,bfzgl) = miist(VMAXO, bfzgl

0) - miist(VMAXO, bfzgl = 0)

For the controller adjustment the controller initialization can be switched off by means of the code word CWDVMX.

Typical application:

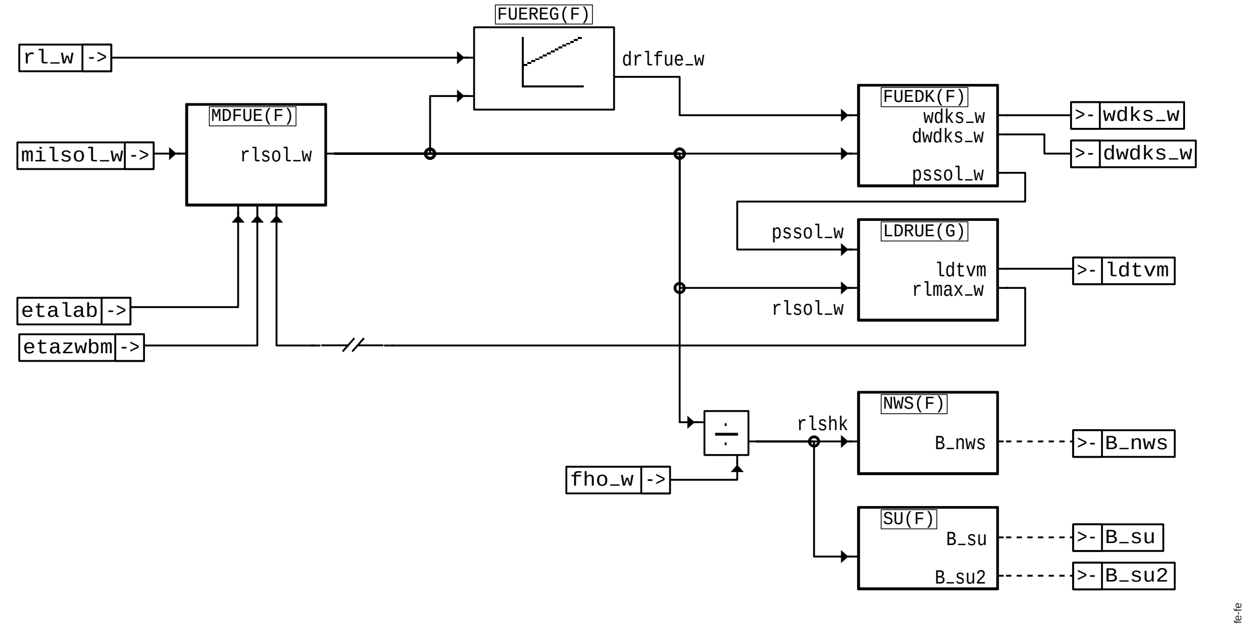
Example for a typical application

Version coding:
In order to obtain different vmax control speeds for different versions the following labels are activated via a version coding:

Vehicle dependency: VMAXO
VHYST
VABSCH
VVORH
VMAXP
ZIVMAX
KFMIRED
NMINVMX

FE 3.10 Charging interventions

FDEF FE 3.10 Function definition



fe-fe

ABK FE 3.10 Abbreviations

Variable	Source	Type	Description
B_NWS	FE	AUS	Condition camshaft control
B_SU	FE	AUS	condition intake manifold switch-over
B_SU2	FE	AUS	condition intake manifold switch over, 2.flap
DRLFUE_W	FE	LOK	correction offset by air mass controller
DWDKS_W	FE	AUS	modification of desired throttle angle
ETALAB	MDBAS	EIN	Lambda effectiveness without intervention w.r.t. to optimum torque at Lambda=1
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
FHO_W	BGPU	EIN	correction factor: altitude
LDTVM	FE	AUS	Boost control duty cycle (endvalue)
MILSOL_W	MDKOL	EIN	driver torque request for charge
PSSOL_W	FE	LOK	Set intake manifold pressure
RLMAX_W	FE	LOK	maximum attainable charge with turbo
RLSHK	FE	LOK	desired relative air charge corrected by altitude
RLSOL_W	FE	LOK	desired relative air charge
RL_W	EGFE	EIN	relative air charge (Word)
WDKS_W	FE	AUS	desired throttle angle w.r.t. to lower mechanical stop

FW FE 3.10 Fixed Values

Parameter	Value	Description

FB FE 3.10 Detailed description of function

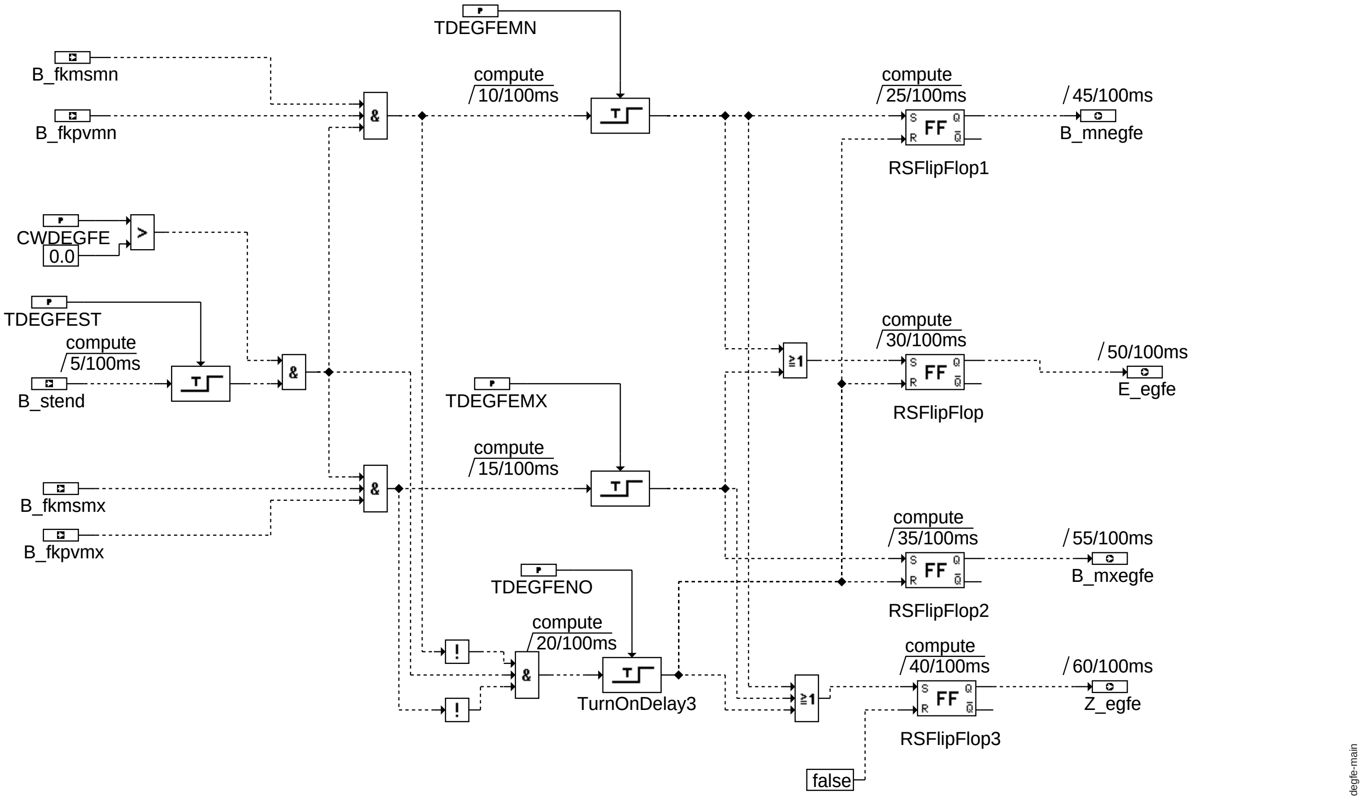
The torque milsol_w, which is to be set via the charge path at the basic ignition angle and effectiveness, is converted in the function MDFEU into the nominal charge rlsol_w, which belongs to the desired working point. The stationary matching between the nominal charge and actual charge rl_w occurs with the aid of the charge controller FUEREG. Both signals are used in the function FUEDK to calculate the corresponding values of intake manifold pressure pssol_w and throttle valve angle wdks_w.

The desired charge rlsol_w and desired intake manifold pressure are the guide variables for charge pressure control. Intake manifold switchover SU and camshaft control NWS use the desired air charge corrected by altitude to determine their switching points.

APP FE 3.10 Application hint

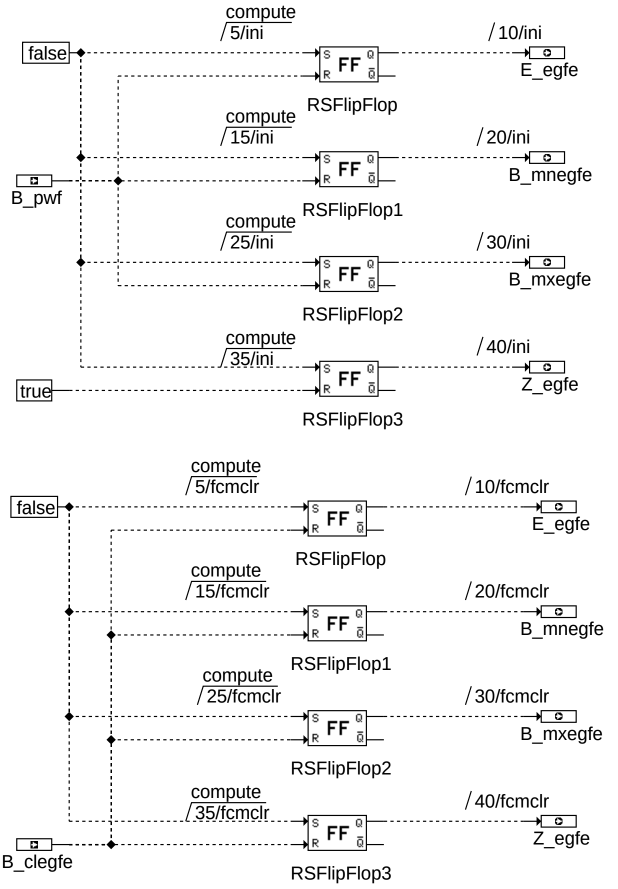
DEGFE 2.10 Diagnosis of input variables for charge detection

FDEF DEGFE 2.10 Function definition



degfe-main

`Initialization block`



degfe-init

degfe-init

ABK DEGFE 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDEGFE			FW	code word for shutdown of the function %DEGFE
TDEGFEMN			FW	Time delay for setting the MIN fault
TDEGFEMX			FW	Time delay for setting the MAX fault
TDEGFENO			FW	Time delay for setting NO fault
TDEGFEST			FW	Time delay after start-up

Variable	Source	Type	Description
B_CLEGFE		EIN	condition clear fault path EGFE
B_FKMSMN	BGMSZS	EIN	Quick adaption of the mass flow fkmsdks at the lower arrester
B_FKMSMX	BGMSZS	EIN	Quick adaption of the mass flow fkmsdks at the upper arrester
B_FKPVMN	BGMSZS	EIN	Slow mass flow adaption fkpvdk at the lower arrester
B_FKPVMX	BGMSZS	EIN	Slow mass flow adaption fkpvdk at the upper arrester
B_MNEGFE	DEGFE	AUS	Condition: MIN fault input parameters charging detection
B_MXEGFE	DEGFE	AUS	Condition: MAX fault input parameters charging detection
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
E_EGFE	DEGFE	AUS	Error flag: input parameters for charging detection
Z_EGFE	DEGFE	AUS	Cycle flag: Input variables for charging detection

FW DEGFE 2.10 Fixed Values

Parameter	Value	Description
CWDEGFE		code word for shutdown of the function %DEGFE
TDEGFEMN		Time delay for setting the MIN fault
TDEGFEMX		Time delay for setting the MAX fault
TDEGFENO		Time delay for setting NO fault
TDEGFEST		Time delay after start-up

FB DEGFE 2.10 Detailed description of function

The function %DEGFE serves the diagnosis of the input variables for the charging detection. The fundamental concept of the function is based on an evaluation of the factors fkmsdks_w (rapid equalization) and fkpvdk_w (slower equalization) from the function %BGMSZS.
The error bit E_egfe is then set if the integrators of the massflow equalization in der %BGMSZS have run either in their lower limits, i.e. the bits B_fkmsmn & B_fkpvmn are TRUE, or if the integrators of the massflow equalization in the %BGMSZS have run in their upper limits, i.e. the bits B_fkmsmx & B_fkpvmx are set.
A shutdown of the function is possible by the code word CWDEGFE. The code word must be assigned the value of 0 for this.
CWDEGFE shall be assigned the value of 1 if the function is to be activated.

APP DEGFE 2.10 Application hint

Prerequisite for putting the function into operation is the correct application of the charging detection.
Particular attention shall be paid to assignment of the correct data for the following labels in the %BGMSZS:

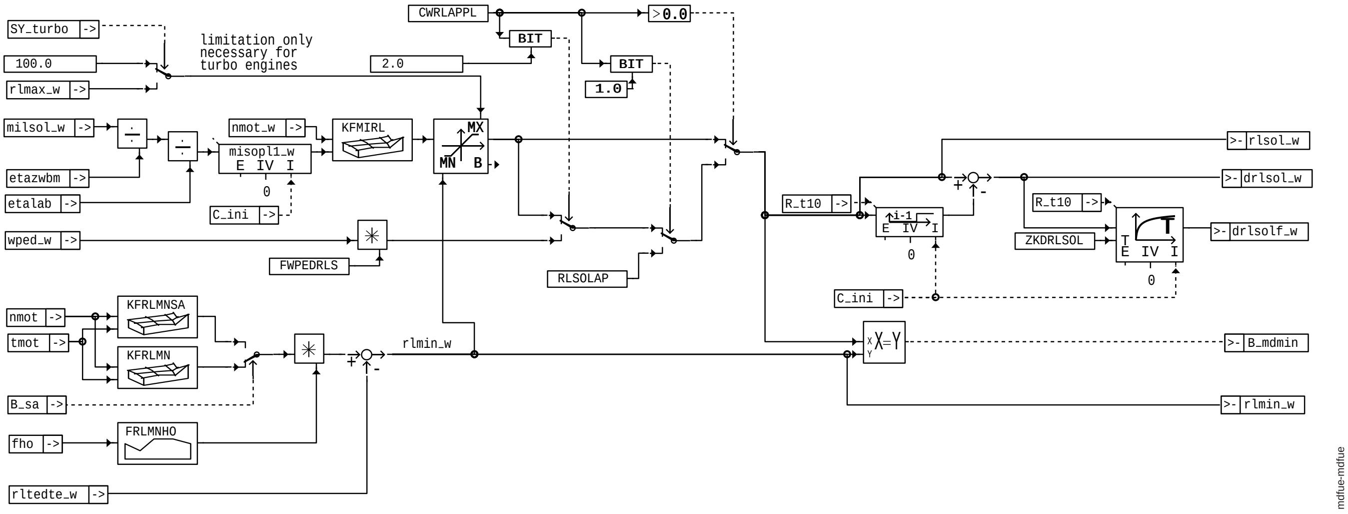
- FKMSDKMX, FKMSDKMN, FKPVDKMX, FKPVDKMN, MSALLMX, MSALLMN, MSLG, ZKMSDK and ZKPVDK
  (Refer to the application in the %BGMSZS for proposed values)

Guiding values for the first application:

```
TDEGFEMN        2 sec.
TDEGFEMX        2 sec.
TDEGFENO        2 sec.
```

MDFUE 8.50 Nominal-value input from nominal torque for airmass

FDEF MDFUE 8.50 Function definition



mdfue-mdfue

ABK MDFUE 8.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWRLAPPL			FW	codeword rlsol_w from Test-bench for Applikation
FRLMNHO	FHO		KL	correction factor rlmin depending on altitude
FWPEDRLS			FW	factor to generate rlsol (application use only)
KFMIRL	NMOT_W	MISOPL1_W	KF	map for calculation of nominal charge
KFRLMN	NMOT	TMOT	KF	Minimum charge during fuel on
KFRLMNSA	NMOT	TMOT	KF	Minimum rl during fuel cut off
RLSOLAP			FW	desired relative air charge (application mode)
ZKDRLSOL			FW	time constant for drlsol-integrator

Variable	Source	Type	Description
B_MDMIN	MDFUE	AUS	Condition minimal possible indicated torque reached
B_SA	MDRED	EIN	Condition fuel cut-off
C_INI	SWADAP	EIN	ECU-condition for intialisation
DRLSOLF_W	MDFUE	AUS	filtered change of desired charge
DRLSOL_W	MDFUE	AUS	change of nominal charge
ETALAB	MDBAS	EIN	Lambda effectiveness without intervention w.r.t. to optimum torque at Lambda=1
ETAZWBM	MDBAS	EIN	mean ignition angle effectiveness of basic ignition angle
FHO	BGPU	EIN	Correction factor altitude
MILSOL_W	MDKOL	EIN	driver torque request for charge
MISOPL1_W	MDFUE	LOK	nominal air torque, recalculated for Lambda=1 and zwopt
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
RLMAX_W		EIN	maximum attainable charge with turbo
RLMIN_W	MDFUE	AUS	minimum permissible rl
RLSOL_W	MDFUE	AUS	desired relative air charge
RLTEDTE_W	DTEV	EIN	from DTEV calculated relative charge through the purge control valve

Variable	Source	Type	Description
R_T10		EIN	Time schedule 10 ms
SY_TURBO	PROKON	EIN	system constant for turbocharged engine
TMOT	SWADAP	EIN	Engine temperature
WPED_W	SWADAP	EIN	normed angle acceleration pedal

FW MDFUE 8.50 Fixed Values

Parameter	Value	Description
CWRLAPPL		codeword rlsol_w from Test-bench for Applikation
FWPEDRLS		factor to generate rlsol (application use only)
RLSOLAP		desired relative air charge (application mode)
ZKDRLSOL		time constant for drlsol-integrator

FB MDFUE 8.50 Detailed description of function

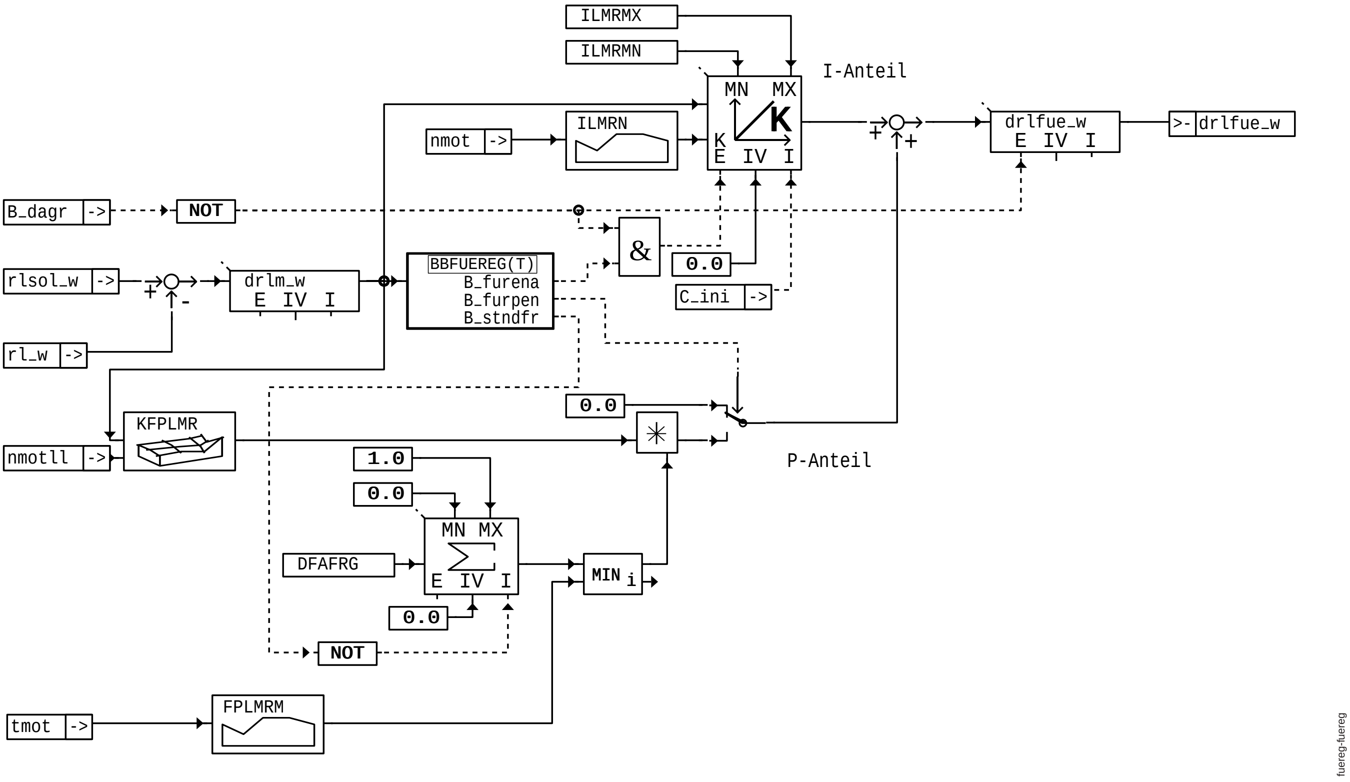
The torque milsol_w, which is to be set via the charge path at the basic ignition angle and effectiveness, is converted into the torque misopl1_w, which corresponds to the optimum torque at Lambda=1. With the aid of the map KFMIRL the charge belonging to this operating point is calculated. This charge is limited to the minimum permissible value rlmin_w. If this limit is reached the Condition B_mdnim stops the integral part of the idle speet controller (cf. LLRRM). In the case of a turbocharger, the charge is limited to the maximum permissible charge rlmax_w. The result is the nominal charge rlsol_w.

APP MDFUE 8.50 Application hint

The map KFMIRL is inverse to the map KFMIOP in the section %MDBAS. Application hint, see %MDBAS.

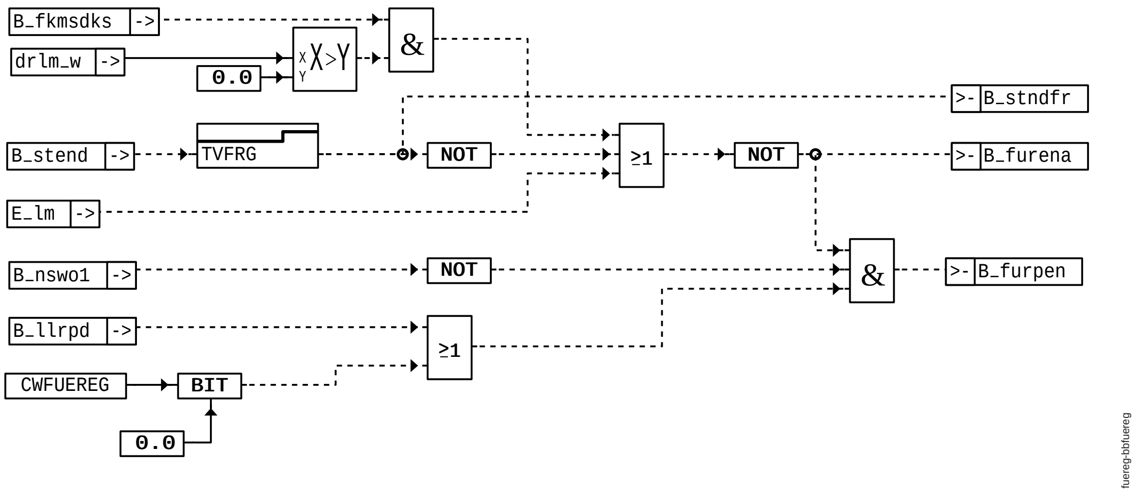
FUEREG 4.30 Charge controller

FDEF FUEREG 4.30 Function definition



fuereg-fuereg

Operating range of the charge controller



fuereg-bbfuereg

ABK FUEREG 4.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWFUEREG			FW	Code word charge controller active outside of idle
DFAFRG			FW	Increasing control factor after the charge controller was activated
FPLMRM	TMOT		KL	weighting factor for P component of air-mass controller
ILMRMN			FW	minimum value of air mass controller
ILMRMX			FW	maximum value of air mass controller
ILMRN	NMOT		KL	integrator gain of air mass controller
KFPLMR	DRLM_W	NMOTLL	KF	P-component of air mass controller
TVFRG			FW	Delay time after end of start until charge controller is enabled

Variable	Source	Type	Description
B_DAGR		EIN	Condition EGR diagnostic routine
B_FKMSDKS	FUEDK	EIN	stop for integration of fkmsdk
B_FURENA	FUEREG	LOK	condition activation of charge controller
B_FURPEN	FUEREG	LOK	condition charge controller P component active
B_LLRPD	LLRBB	EIN	Condition activation of PD-part of idle speed control
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_STEND	BBSTT	EIN	condition end of start
B_STNDFR	FUEREG	LOK	enabling of charge controller after start
C_INI	SWADAP	EIN	ECU-condition for intialisation
DRLFUE_W	FUEREG	AUS	correction offset by air mass controller
DRLM_W	FUEREG	LOK	nominal / actual value difference of air mass controller
E_LM	EGFE	EIN	Error flag: main load sensor
NMOT	SWADAP	EIN	engine speed
NMOTLL	BGNMOT	EIN	engine speed
RLSOL_W	MDFUE	EIN	desired relative air charge
RL_W	EGFE	EIN	relative air charge (Word)
TMOT	SWADAP	EIN	Engine temperature

FW FUEREG 4.30 Fixed Values

Parameter	Value	Description
CWFUEREG		Code word charge controller active outside of idle
DFAFRG		Increasing control factor after the charge controller was activated
ILMRMN		minimum value of air mass controller
ILMRMX		maximum value of air mass controller
TVFRG		Delay time after end of start until charge controller is enabled

FB FUEREG 4.30 Detailed description of function

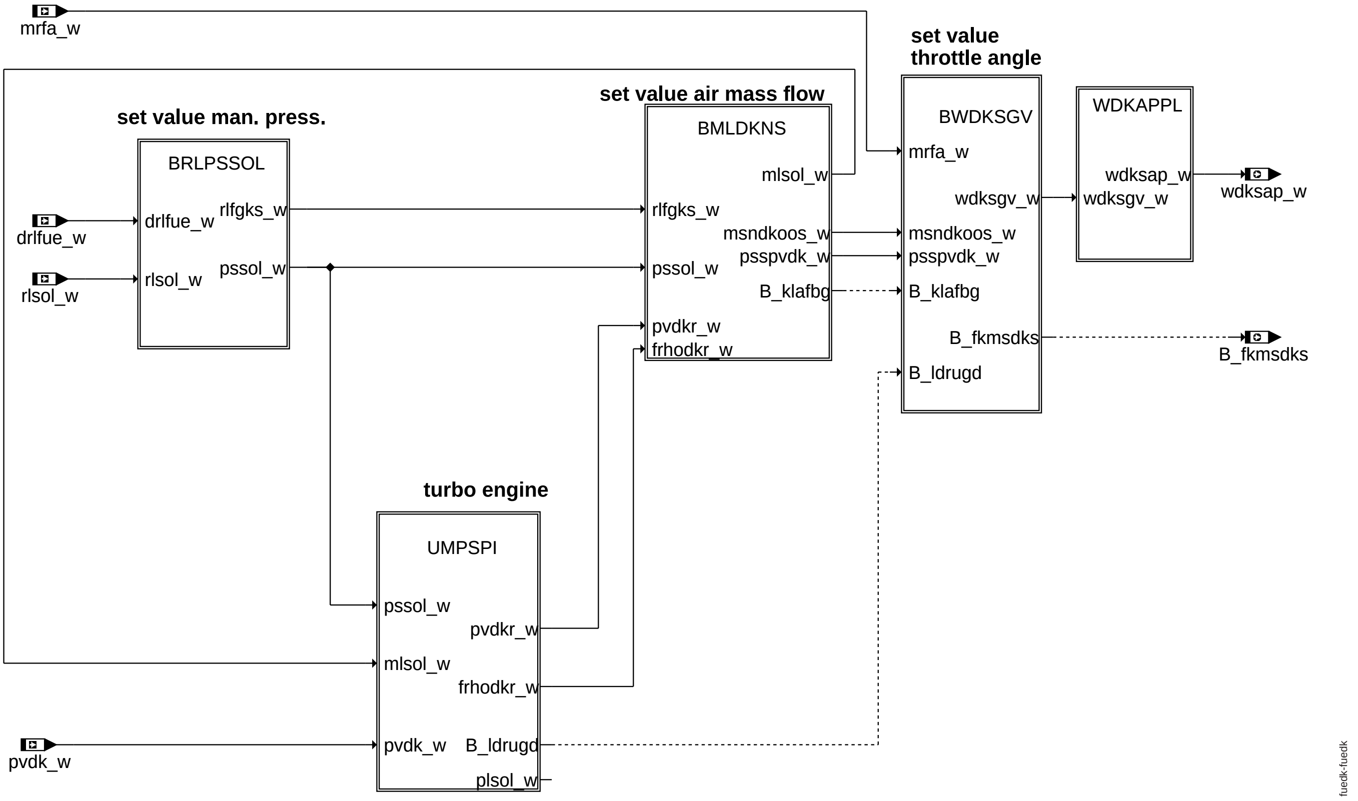
The charge controller takes care of stationary matching of the actual charge rl_w to the nominal charge rlsol_w. The parameters of the P and I components are RPM-dependent. The controller is activated by the condition B_furena (-> sub function BBFUEREG), if the engine is not running in unthrottled mode, and no cranking and no fault in the calculation of the air mass is present.

APP FUEREG 4.30 Application hint

FUEDK 21.30 Charge control (calculation of nominal throttle-valve angle)

FDEF FUEDK 21.30 Function definition

%FUEDK 21.20: Overview

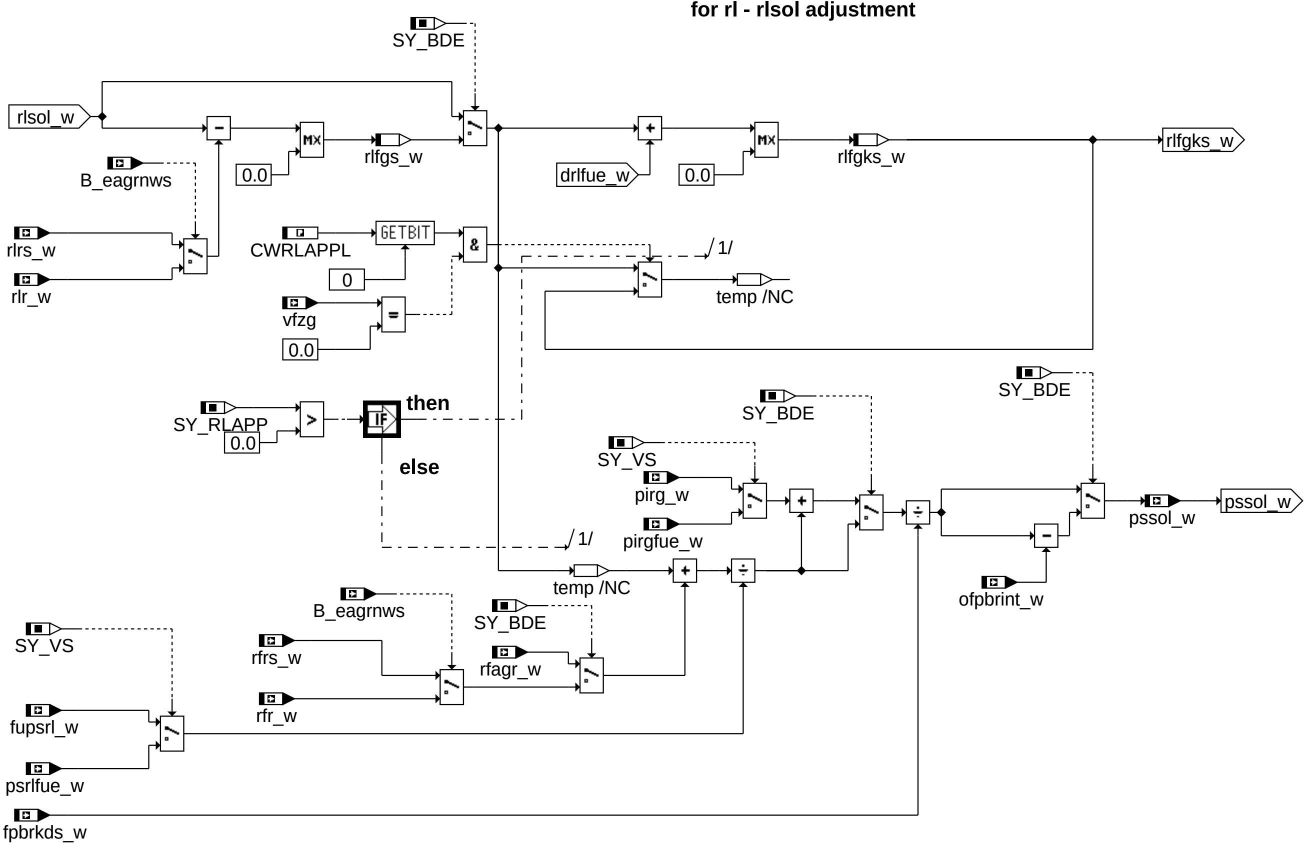


fuedk-fuedk

CWRLAPPL Bit0 = true & SY_RLAPP > 0

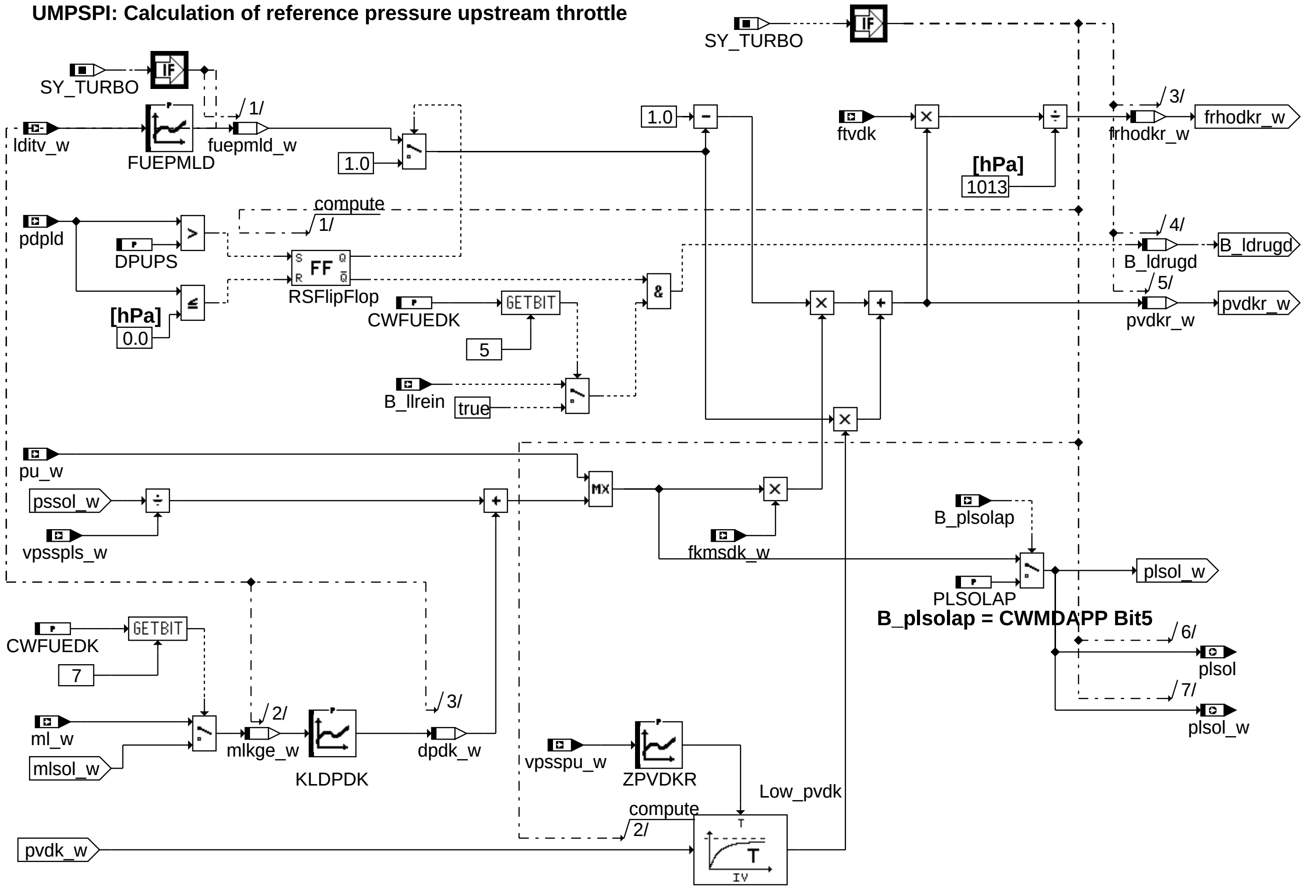
only used for application at test bench
for rl - rlsol adjustment

BDE
BRLPSSOL: Set value manifold pressure



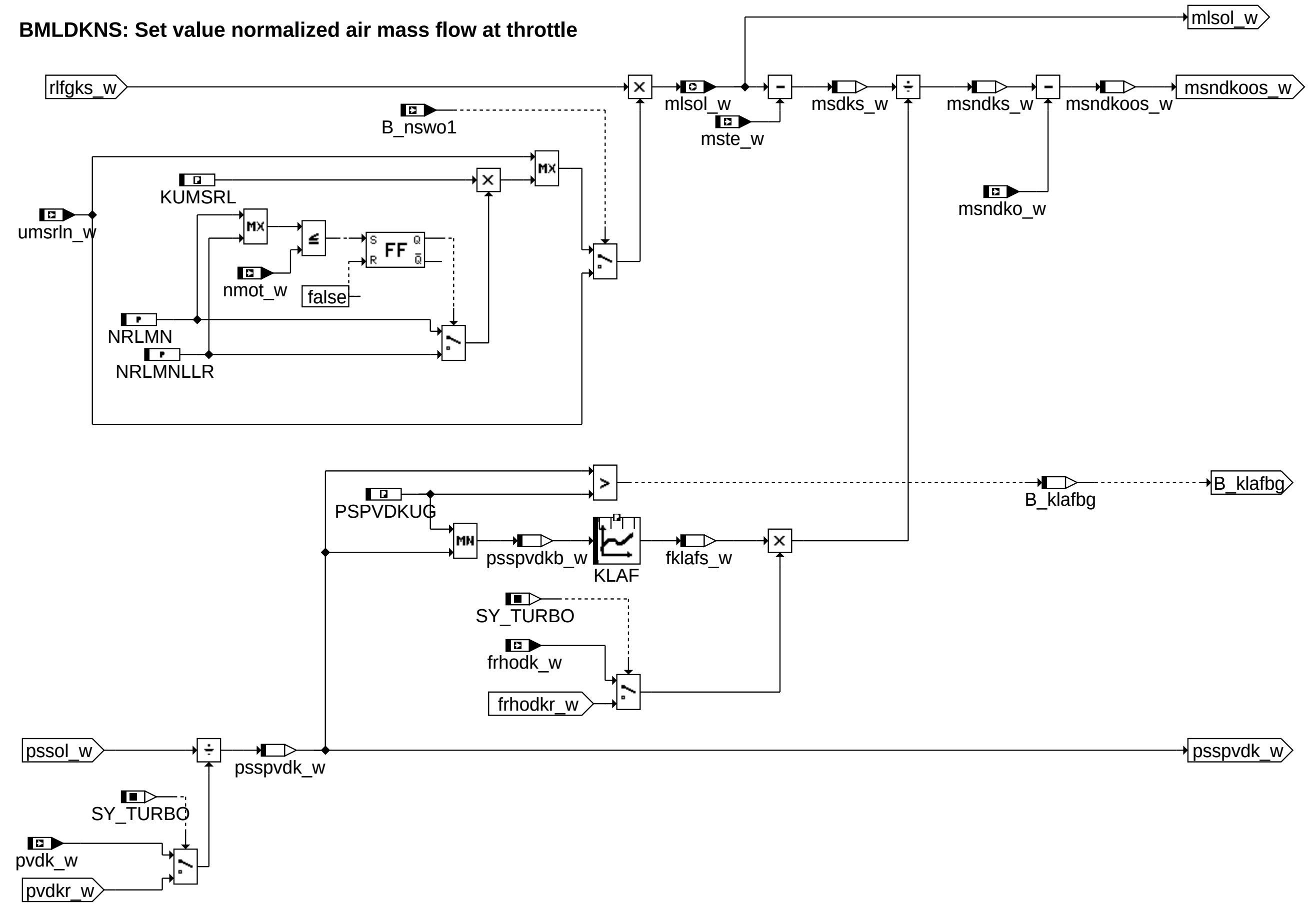
fuedk-brlpssol

UMPSPI: Calculation of reference pressure upstream throttle



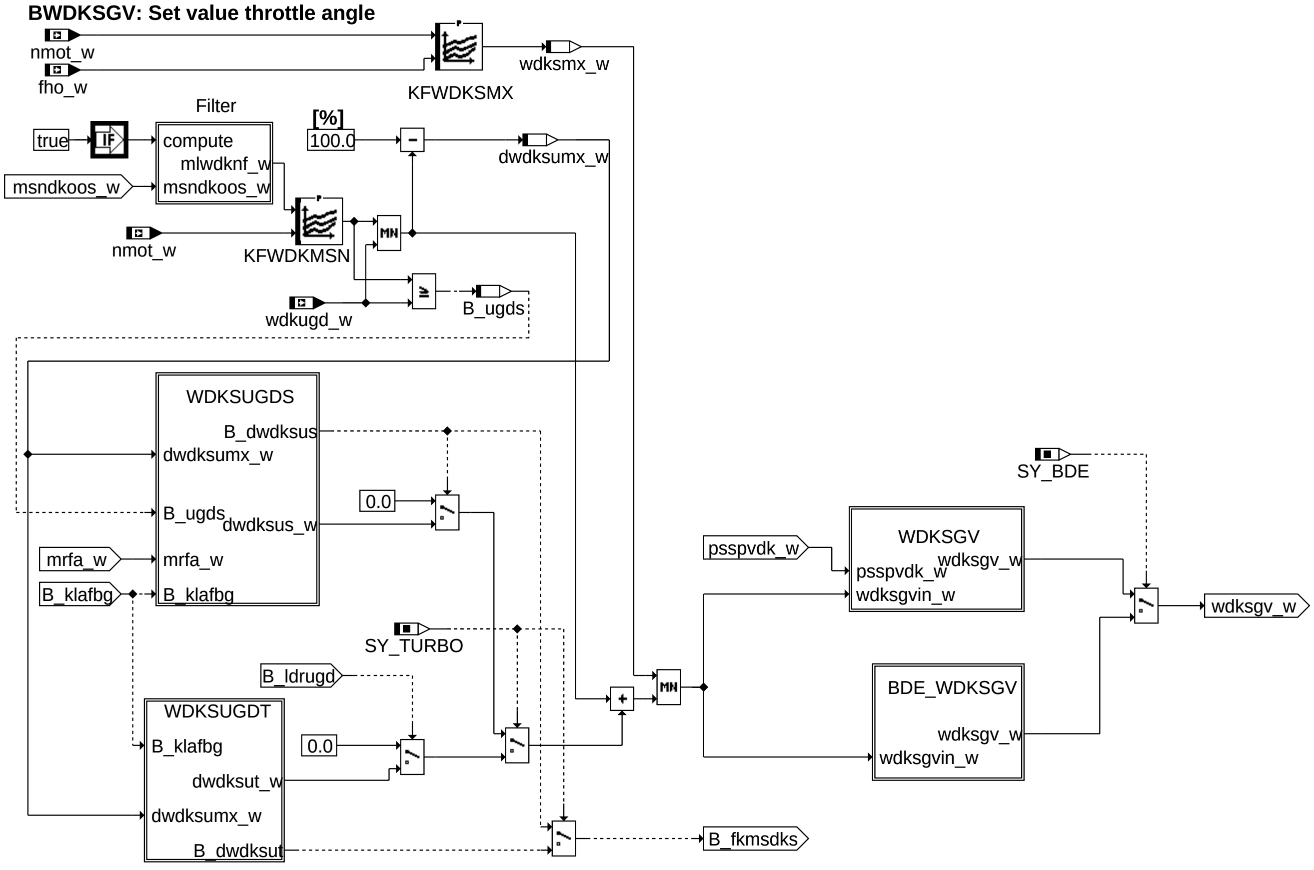
fuedk-umpspi

BMLDKNS: Set value normalized air mass flow at throttle



fuedk-bmldkns

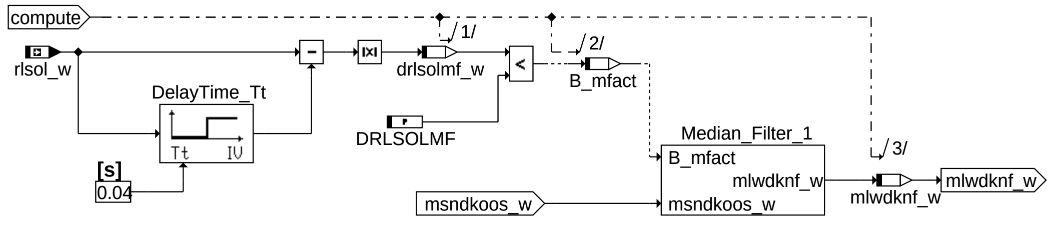
BWDKSGV: Set value throttle angle



fuedk-bwdksgv

fuedk-bwdksgv

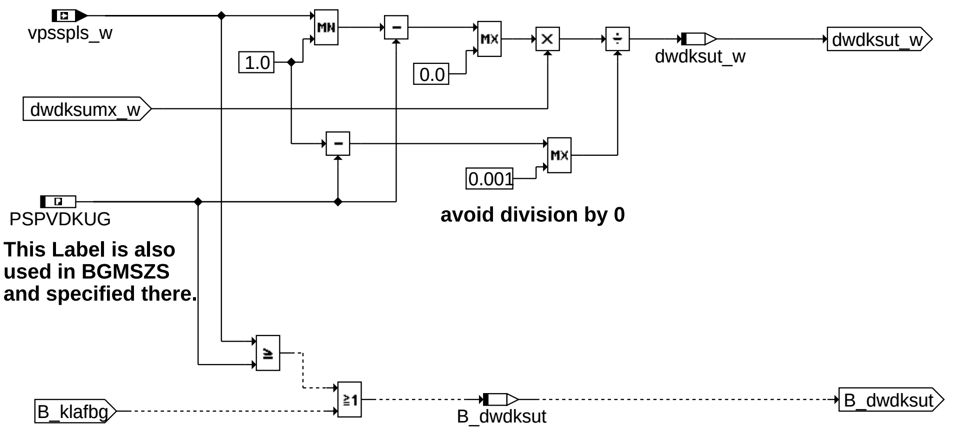
FILTER: Median-Filter



fuedk-filter

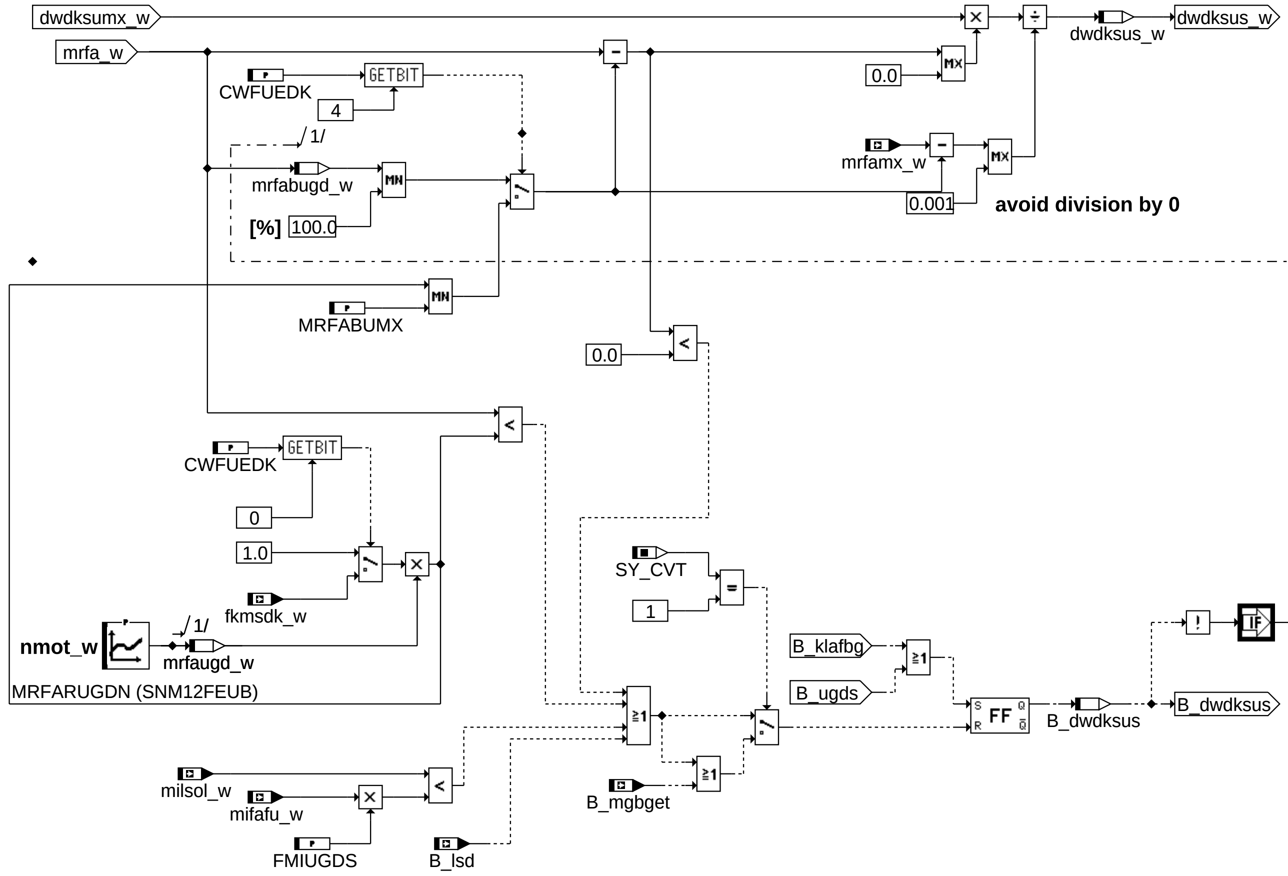
fuedk-filter

WDKSUGDT: difference of desired throttle angle refered to 95% charge at Turbo engine

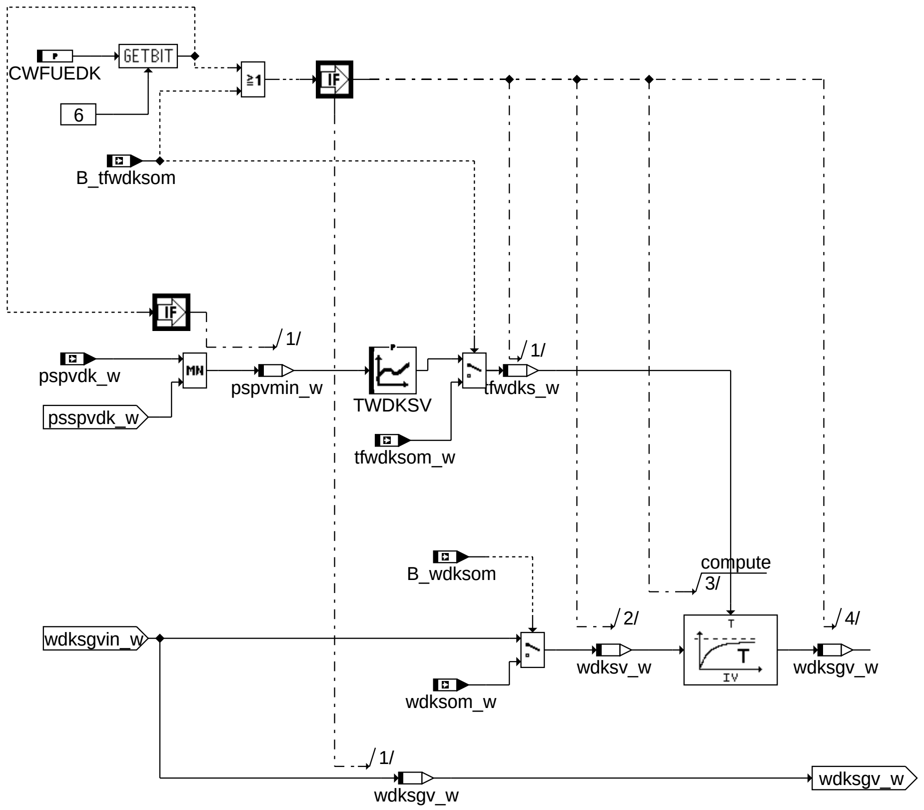


fuedk-wdksugdt

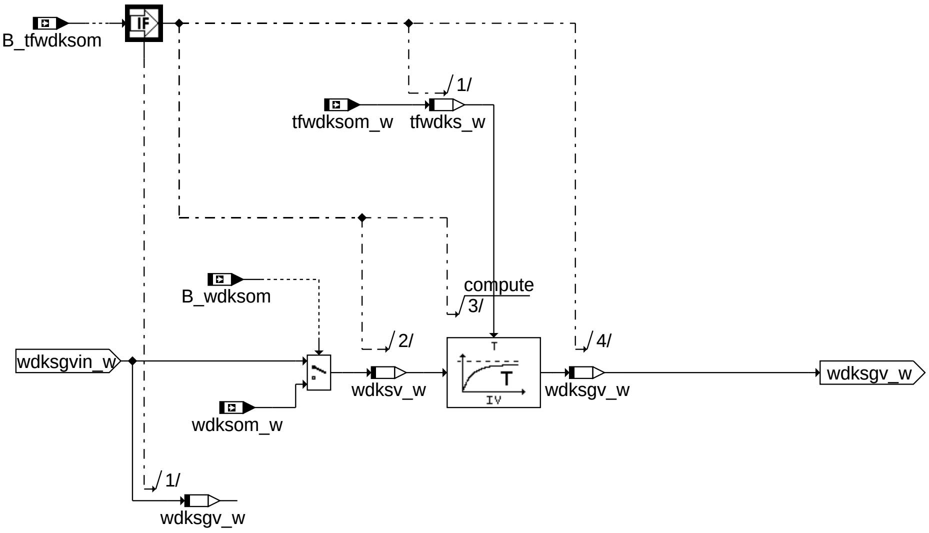
WDKSUGDS: difference of desired throttle angle refered to 95% charge at induction engine



fuedk-wdksugds

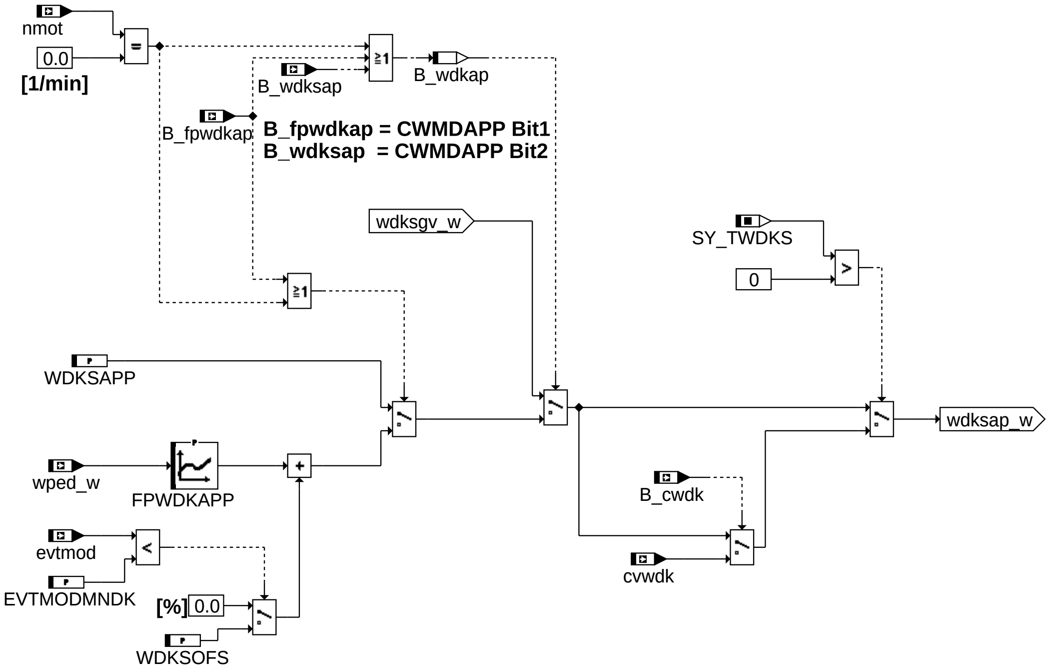


fuedk-wdksgv



fuedk-bde-wdksgv

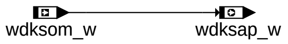
WDKAPPL: Calibration interface



fuedk-wdkappl

fuedk-wdkappl

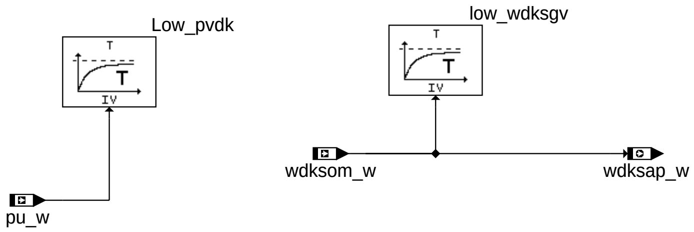
NACHLAUF: calculation of desired throttle angle at SKl15 = off



fuedk-nachlauf

fuedk-nachlauf

INIT: Initialisation of function



fuedk-init

fuedk-init

ABK FUEDK 21.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWFUEDK			FW	codeword FUEDK
CWRLAPPL			FW (REF)	codeword rlsol_w from Test-bench for Applikation
DPUPS			FW	delta pressure threshold for switching of reference pressure upstreams throttle
DRLSOLMF			FW	threshold delta rlsol for Medianfilter
EVTMODMNDK			FW	min. temperature of offset-addition to DK-map (if nmot=0)
FMIUGDS			FW	factor correction maximum torque at full load
FPWDKAPP	WPED_W		KL	throttle angle dependent on accelerator pedal position, only for calibration
FUEPMLD	LDITV_W		KL	Factor for gliding transition average pressure (reference pressure turbo)
KFWDKMSN	MLWDKNF_W	NMOT_W	KF	Map for the desired throttle blade angle
KFWDKSMX	NMOT_W	FHO_W	KF	max. desired throttle angle
KLAF	PSSPVDKB_W		KL (REF)	characteristic of Saint-Venant
KLDPDK	MLKGE_W		KL	pressure drop at throttle blade
KUMSRL			FW (REF)	conversion constant from mass flow to relative air charge

Parameter	Source-X	Source-Y	Type	Description
MRFABUMX			FW	Max. threshold of drivers demand for linear calculation of pedal value at WOT
MRFARUGDN	NMOT_W		KL	Reset threshold for linear pedal travel in the non-reduced DK range
NRLMN			FW	lowest engine speed for calculation of umsrln
NRLMNLLR			FW	lowest engine speed for calculation of umsrln at idle speed
PLSOLAP			FW	calibration value for reference boost pressure
PSPVDKUG			FW (REF)	Ratio pspvdk not reduced
SNM12FEUB	NMOT_W		SV (REF)	set points of WDKSMX, WDKUGDN
SY_BDE			SYS (REF)	system constant GDI
SY_CVT			SYS (REF)	system constant: CVT transmission exists
SY_RLAPP			SYS (REF)	rlsol control during application possible
SY_TURBO			SYS (REF)	system constant for exhaust-gas turbocharger
SY_TWDKS			SYS (REF)	system constant: input of desired angle DVE via tester is possible
SY_VS			SYS (REF)	system constant valve stroke control: no, 2 position
TWDKSV	PSPVMIN_W		KL	time constant for filtering of reference throttle blade position
WDKSAPP			FW	throttle angle for calibration tasks
WDKSOFS			FW	Offset added to appl. value of desired throttle position at low temperature
ZPVDKR	VPSSPU_W		KL	time constant for filtering of pvdkr

Variable	Source	Type	Description
B_CWDK		EIN	device control DCPIDCM
B_DWDKSUS	FUEDK	LOK	difference of desired throttle angle refered at 95% to 100% charge active
B_DWDKSUT	FUEDK	LOK	difference of desired throttle angle refered at 95% to 100% charge active
B_EAGRNWS		EIN	Condition: Error EGR or camshaftcontrol ->use of actual value of EGR-control
B_FKMSDKS	FUEDK	AUS	stop for integration of fkmsdk
B_FPWDKAP	PROKON	EIN	throttle-valve control by accelerator pedal
B_KLAFBG	FUEDK	LOK	input value of KLAF limited
B_LDRUGD	FUEDK	LOK	Condition unthrottled, Eneable from LDR
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_LSD	MDFAW	EIN	condition: limitation of positive torque gradient active
B_MFACT	FUEDK	LOK	condition medianfilter activ
B_MGBGET		EIN	Condition torque gradient limitation active
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_PLSOLAP		EIN	condition: calibration of referece boost pressure
B_TFWDKSOM	WDKSOM	EIN	time constant to filter desired throttle angle without torque structure active
B_UGDS	FUEDK	LOK	set value throttle angle near full load
B_WDKAP	FUEDK	LOK	Condition: desired throttle position from appl. characteristic line or at start
B_WDKSAP	PROKON	EIN	throttle-blade contol by fixed value, bit 1 has priority
B_WDKSOM	WDKSOM	EIN	desired throttle angle without torque structure active
CVWDK		EIN	device control value DCPIDCM
DPDK_W	FUEDK	LOK	pressure drop at throttle blade
DRLFUE_W	FUEREG	EIN	correction offset by air mass controller
DRLSOLMF_W	FUEDK	LOK	delta desired relative air charge for medianfilter
DWDKSUMX_W	FUEDK	LOK	difference of desired throttle angle between 95% and 100% charge
DWDKSUS_W	FUEDK	LOK	difference of desired throttle angle refered to 95% charge induction engine
DWDKSUT_W	FUEDK	LOK	difference of desired throttle angle refered to 95% charge at turbo engine
EVTMOD	BGTEMPK	EIN	modelled temperature at inlet valve
FHO_W	BGPU	EIN	correction factor: altitude
FKLAFS_W	FUEDK	LOK	Factor saint venant (KLAF) for calculation of wdks
FKMSDK_W	BGMSZS	EIN	correction factor for mass-flow substitute load signal
FPBRKDS_W	BGSRM	EIN	factor for determination of combustion chamber pressure
FRHODKR_W	FUEDK	LOK	factor correction air density for throttle blade correction
FRHODK_W	EGFE	EIN	factor correction air density for throttle valve flow f(intake air temp.,altit.)
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
FUEPMLD_W	FUEDK	LOK	factor for gliding transition average pressure (reference pressure) turbo
FUPSRL_W	EGFE	EIN	factor system related transformation pressure to load (16-Bit)
LDITV_W		EIN	I-quota (on/off ratio) for boost control
MIFAFU_W	MDKOL	EIN	driver torque request for charge
MILSOL_W	MDKOL	EIN	driver torque request for charge
MLKGE_W	FUEDK	LOK	Input of characteristic line KLDPDK
MLSOL_W	FUEDK	AUS	set air mass flow
MLWDKNF_W	FUEDK	LOK	filtered normed air mass flow for desired value of throttle blade
ML_W	EGFE	EIN	air mass flow filtered (Word)
MRFABUGD_W	FUEDK	LOK	relative driver request torque at beginn of 95% air charge
MRFAMX_W	MDFAW	EIN	Relative torque request by driver maximum value
MRFAUGD_W	FUEDK	LOK	rel. driver request torque for linear moving accelaration pedal at WOT
MRFA_W	MDFAW	EIN	relative driver request torque from cruise control and pedal, =0 in limp-home
MSDKS_W	FUEDK	LOK	set air mass flow through throttling valve
MSNDKOOS_W	FUEDK	LOK	normed air mass flow for desired value of throttle blade
MSNDKO_W	EGFE	EIN	norm leakage air mass flow through throttle blade
MSNDKS_W	FUEDK	LOK	normed set air mass flow through throttling valve
MSTE_W	BGTEV	EIN	mass flow purge control into the manifold
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
OFPBRINT_W		EIN	Offset correction of pbrintuk_w HFM/DSS adaptation
PDPLD		EIN	predicted delta pressure (overswing pressure)
PIRGFUE_W		EIN	Partial pressure of residual gas in internal AGR (for FUEDK)
PIRG_W	EGFE	EIN	partial pressure residual exhaust gas internal EGR (16-Bit)
PLSOL	FUEDK	AUS	Reference boost pressure
PLSOL_W	FUEDK	AUS	Reference boost pressure
PSPVDK_W	EGFE	EIN	quotient: int.manif.pressure divided by pressure upstream of throttle valve
PSPVMIN_W	FUEDK	LOK	selection (minimum) from pspvdk and psspvdk

Variable	Source	Type	Description
PSRLFUE_W		EIN	Conversion pressure into filling (for FUEDK)
PSSOL_W	FUEDK	AUS	Set intake manifold pressure
PSSPVDKB_W	FUEDK	LOK	ratio of set manifold pressure and pressure upstreams throttle limited
PSSPVDK_W	FUEDK	LOK	ratio of set manifold pressure and pressure upstreams throttle
PU_W	BGPU	EIN	Ambient pressure
PVDKR_W	FUEDK	LOK	reference pressure upstreams throttle
PVDK_W	EGFE	EIN	pressure upstream of throttle valve, 16-bit
RFAGR_W	BGSRM	EIN	relative load by external exhaust gas reduction
RFRS_W		EIN	desired relative charge (residual gas + air) caused by int. and ext. EGR
RFR_W		EIN	Relative filling (inert gas + air) via internal and external EGR
RLFGKS_W	FUEDK	LOK	Corrected rel. desired air charge (air from throttle and EEC)
RLFGS_W	FUEDK	LOK	rel. desired air charge (air from throttle and EEC)
RLRS_W		EIN	desired relative air charge caused by int. and ext. EGR
RLR_W		EIN	relative air-load over int. and ext. EGR
RLSOL_W	MDFUE	EIN	desired relative air charge
TFWDKSOM_W	WDKSOM	EIN	time constant to filter desired throttle angle without torque structure
TFWDKS_W	FUEDK	LOK	time constant of wdks filtering
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
VFZG	SWADAP	EIN	vehicle speed (km/h)
VPSSPLS_W		EIN	ratio of set manifold pressure and boost pressure
VPSSPU_W		EIN	Desired pressure ratio ambient/intake manifold
WDKSAP_W	FUEDK	AUS	desired throttle position from application value
WDKSGV_W	FUEDK	LOK	desired throttle blade before application interface(filtered)
WDKSMX_W	FUEDK	LOK	max. desired throttle angle
WDKSOM_W	WDKSOM	EIN	desired throttle angle without torque structure
WDKSV_W	FUEDK	LOK	desired throttle angle before application interface (unfiltered)
WDKUGD_W	BGMSZS	EIN	Throttle valve angle during which 95% charge is reached
WPED_W	SWADAP	EIN	normed angle acceleration pedal

FW FUEDK 21.30 Fixed Values

Parameter	Value	Description
CWFUEDK		codeword FUEDK
DPUPS		delta pressure threshold for switching of reference pressure upstreams throttle
DRLSOLMF		threshold delta rlsol for Medianfilter
EVTMODMNDK		min. temperature of offset-addition to DK-map (if nmot=0)
FMIUGDS		factor correction maximum torque at full load
MRFABUMX		Max. threshold of drivers demand for linear calculation of pedal value at WOT
NRLMN		lowest engine speed for calculation of umsrln
NRLMNLLR		lowest engine speed for calculation of umsrln at idle speed
PLSOLAP		calibration value for reference boost pressure
WDKSAPP		throttle angle for calibration tasks
WDKSOFS		Offset added to appl. value of desired throttle position at low temperature

FB FUEDK 21.30 Detailed description of function

```
Task of the function is the calculation of the desired throttle valve angle either for a turbo or for an aspirated engine
with intake manifold or direct injection (BDE). The control is performed via the system constant SY_TURBO and SY_BDE.
Main input values are the relative desired charge and the correction requested by the charge controller.
Various other signals such as correction factors for pressure and temperature or informations
about canister purging and exhaust gas recirculation are taken from the manifold model of the charge sensing
or from the predetermined desired values for AGR (in the case of BDE). For this reason,
there is a close connection between the calculation of the throttle valve setpoint and the charge sensing.

Sub function BRLPSSOL: Calculation of the desired manifold pressure (pssol_w) and cor. desired fresh air charge via DK (rlfgks_w)
----------------------------------------------------------------------------------------------------------------------------------
For BDE, the relative desired charge rlsol_w is reduced by the relative air charge of the external and internal AGR. Since
for engines with intake manifold injection no air is contained in the internal or external AGR, the relative AGR-air charge =0
and is thus not considered.
Via the portion drlfue out of the function FUEREG (charge controller),  actual charge rl_w and desired charge rlsol_w
are adjusted. The variable rlfgks_w constitutes the fresh air portion flowing via the throttle valve or the canister purging
system to the engine. The calculation of the desired manifold pressure for BDE includes the desired fresh air charge via throttle
valve and canister purging system and the total charge (air and inert gas) divided by the residual gas of the internal and
external AGR. With the conversion factor fupsrl_w, the manifold pressure related to the total filling is calculated. In the case
of engines with intake manifold injection, the relative desired charge rlsol_w is increased by the relative charge for external
AGR (rfagr_w). Via the conversion factor fupsrl_w, the manifold pressure belonging to this total charge is calculated. By means
of a correction with the internal AGR-partial pressure pirg_w, the desired manifold pressure pssol_w is obtained.

Sub function UMSPI: Calculation of the desired reference pressure upstream the throttle valve for turbo engines (pvdkr_w):
------------------------------------------------------------------------------------------------------------------------------
Turbo engine:
        Desired reference pressure, see description below
        Factor air density correction frhodkr_w = ftvdk * pvdkr_w / 1013 hPa

The desired reference pressure for the pressure upstream the throttle valve pvdkr_w is formed for the turbo from the maximum
selection of ambient pressure pu_w and the desired boost pressure plsol_w or the actual pressure upstr. the throttle valve pvdk_w.
The desired pressure results from pssol_w/vpsspls_w, where vpsspls_w is the pressure ratio requested by the boost pressure control.
As from vpsspls_w > 0.95, the throttle valve is controlled linearly so as to minimize the pressure drop at the throttle valve
at active boost pressure control (see sub function WDKGSUGT). Via the air mass dependent characteristic KLDPDK, the pressure drop
at the throttle valve is taken into account. The result is a higher value for the desired boost pressure which is changed to
the actual boost pressure in the lambda control. Via the characteristic FUEPMLD, it is possible to change ramp-like from the
actual pressure to the desired pressure. If the predicted boost pressure difference pdpld exceeds the threshold DPUPS, then
```

a switch-over to the actual pressure pvdk_w is performed, since here an overcharge fault exists (B_ldrugd = false).
The actual boost pressure is filtered by the TP filter during the transition from pu to basic boost pressure, since pressure pulsations can be triggered in this range due to a wastegate that does not close tightly.

Sub function BMLDKNS: Calculation of the standardized desired air mass flow through the throttle valve (mlwdkns_w)

The desired air mass flow mlsol_w is calculated by a multiplication of the cor. desired charge rlfgks_w with umsrln_w.
Since the charge of the engine is taken from the intake manifold at the beginning of start, at first it would not be necessary to open the throttle valve (umsrln_w = KUMSRL*nmot = 0).
Via the threshold KUMSRL*NRLMN, a minimum amount of air is given (to be adjusted by means of the throttle valve) so that the throttle valve does not close at the beginning of start to open again with beginning engine speed.
In the process, the threshold NRLMN is set to 400 rpm, since a start is assumed up to this threshold.
The threshold NRLMNLLR prevents a closing of the throttle valve in the case of an engine speed drop e.g. due to starting from rest.

The desired air mass flow is reduced by the air mass flow mste_w, which is led into the intake manifold by the canister purging, since this absolute value must not be adjusted by means of the throttle valve . By a division of the desired air mass flow through the throttle valve msdks_w by the density-corrected KLAF, the standardized air mass flow through the throttle valve msndks_w is calculated.
The leakage air of the throttle valve actuator msndko_w, which is learned by an adaptation in the function BGMSZS is subtracted form this air mass flow. The thus remaining standardized air mass flow msndkoos_w is converted to a desired angle for the throttle valve by the characteristic WDKMSN in the sub function BWDKSGV. The outflow characteristic KLAF is addressed to the desired pressure ratio psspvdkb_w. This desired pressure ratio consists of the minimum of psspvdk_w = pssol_w/pvdkr_w (turbo) - psspvdk_w =pssol_w/pvdk_w (for asp.engine) - and PSPVDKUG.
This means that the desired throttle valve angle is only calculated via the KLAF up to the non-reduced range psspvdkb_w = 0.95. The clearance is calculated in the sub function WDKSUGS for the aspirated engine and in WDKSUGT for the turbo engine.

Sub function BWDKSGV: Setpoint DK-angle (wdksgv_w):

The desired angle wdksgv_w for the triggering of the throttle valve is calculated from the standardized desired air mass msndkoos_w in this sub function. The desired angle is determined by the map KFWDKMSN up to the angle for the non-reduced operation wdkugd_w. This is the inverse map of KFMSNWDK and it is adjusted to the mounted throttle valve actuator.
The calculation of the standardized air mass msndkoos_w is described in the sub function BMLDKNS.
The non-reduced angle range of the throttle valve is given by the pressure ratio (pressure downstream the throttle valve) to (pressure upstream the throttle valve) > 0.95 (PSPVDKUG). The throttle valve angle belonging to this pressure ratio is stored in the engine speed dependent characteristic WDKUGDN and is available as wdkugd_w (function BGMSZS). If the angle from WDKMSN calculated via the standardized desired air mass is greater than the angle wdkugd_w, then the condition for non-reduced operation B_ugds = true. Once the condition B_ugds is set, the charge controller is deactivated (see section FUEREG).

If the desired pressure ratio is > 0.95, then it is no longer possible to determine the standardized air mass flow and thus also not the desired angle for the throttle valve by means of the outflow characteristic KLAF for numerical stability reasons. For the remaining desired angle of the throttle valve from wdkugd_w up to 100% a different residual angle determination dwdksus_w resp. dwdksut_w is performed for aspirated and turbo engines. This residual value is added to wdkugd_w in the non-reduced range.
Via the maximum permitted desired throttle valve angle KFWDKSMX, the desired angle is - if necessary - limited and made available as wdksv_w. This can be used for power reduction or for dimming intake noise. In order to increase the lifetime of the DVE-actuator, the standardized air mass flow msndkoos_w is smoothed by means of a median filter for little rlsol_w changes in the sub function FILTER. If delta rlsol (drlsolmf = abs(rlsol_w -rlsol(t-40ms)) ranges below the threshold DRLSOLMF, meaning rather small desired torque changes, the filter is active (B_mfact = true). The actual value of msndkoos_w is intermediately stored in the 5-values large input filter buffer.
The values are stored in a 5-value output filter buffer in decreasing values. If the old filter value mlwdknf_w is not situated within the range of the min. and max. values of this output buffer, it is centered to the mid-value of this buffer.
If the threshold drlsolmf_w > DRLSOLMF, the filter output value mlwdknf_w is directly set to the filter input value msndkoos_w.
In addition, the filter input value is taken over by the filter input buffer.

For special cases, e.g. start and after-run it is required to predetermine an angle that is independent of the torque calculation.
In this case, the input wdksom_w is utilized, when B_wdksom is active. Via the switch B_tfwdksom, a switch-over to the filter time constant tfwdksom can be effected. The TP (LP) filter is needed for the transition between "start angle" and "torque-based" operation. In the case of engines with intake manifold injection, the filter can also be switched on during the operation via the code word CWFUEDK (bit 6) with changing time constant tfwdks_w.

Turbo engine: Sub function WDKSUGT

Since for the turbo engine the charging is performed in the non-reduced range via the boost pressure control, the throttle valve should be completely open in this range to avoid throttle losses. For this the pressure ratio vpsspls_w is given in dependency of desired manifold pressure/ambient pressure in the boost pressure control. If vpsspls_w is > 0.95, i.e. vpsspls_w > PSPVDKUG, the non-reduced range starts. The throttle valve clearance dwdksumx_w = difference between the non-reduced desired angle wdkugd_w and the maximum permitted desired angle WDKSMX is linearly scaled by the ratio (1 - vpsspls_w)/(1 - PSPVDKUG). The value for PSPVDKUG is 0.95 (see function BGMSZS).
The bit B_dwdksut, which is used as B_fkmsdks for the stop of the fkmsdk-integrator in the function BGMSZS, is set with active throttle valve clearance.

Aspirated engine: Sub function WDKSUGDS

Here a so-called pedal overtravel is introduced:

Bit4 of CWFUEDK=false:

If the desired pressure ratio psspvdk_w is > PSPVDKUG (i.e B_klafbg = true), or B_ugds = true, the pedal overtravel begins (B_dwdkugds = true). mrfa_w at the beginning of the overtravel is frozen in mrfabug_w.
The throttle valve clearance dwdksumx_w = difference between the non-reduced desired angle wdkugd_w and the maximum permitted desired angle WDKSMX is linearly scaled between mrfabugd_w and mrfamx_w by the ratio for the pedal overtravel [mrfa_w -min(100%, mrfabugd)]/[mrfamx_w-min(100%, mrfabugd)], as soon as B_dwdksus = true. The value dwdksus_w is added to wdkugd_w and made available as desired angle wdksv_w. wdksv_w can be WDKSMX at the maximum. The end of the pedal overtravel is reached, if e.g. mrfa_w is again < mrfabugd_w or if milsol_w is < FMIUGDS * mifafu_w (0.95 * mifafu_w) or for vehicles with

CVT-transmission B_mgbget=true.
For a positive load change, an excessive increase in torque is predetermined with the air path (mifal) via the function 'driver's demand calculation'for a fast DK-opening. This excess - on the DK-side - has the effect that the non-reduced range is reached via the pressure ratio psspvdk. If the desired driver torque is stored, it is at that particular moment too low, since it does not contain the excess. The storage is therefore prevented by B_lsd until this dynamic precontrol has decreased again.
The map MRFARUGDN prevents that the value 0 is stored in mrfabugd_w during start, if mrfa_w = 0 and psspvdk_w > 0.95.
Thus it is prevented that the pedal overtravel is activated, if wped is close to 0.
The fkmsdk-integrator is stopped in the function BGMSZS via B_fkmsds with active throttle valve clearance
(B_dwdksut = true).

Bit4 CWFUEDK=true:

The pedal overtravel is not calculated depending on mrfabugd_w, but directly depends on the characteristic MRFARUGDN. The point in time at which the pedal overtravel is switched on/off depends on the same conditions as for bit 4 of CWFEUDK=false.

Sub function WDKAPPL: Application management

The application management enables the deactivation of the normal calculation of the desired DK angle, which necessitates the functionality of the torque management (fixed value CWMDAPP). The desired DK angle is instead only dependent on the pedal value or it is even set to a fixed value.
The desired throttle valve angle is directly dependent on the pedal wped in the case of an engine speed = 0 rpm. By this, it is possible to achieve a movement of the throttle valve actuator via the pedal, e.g. in the workshop. Via the system constant SY_TWDKS, a program part can be integrated which enables the triggering of the throttle valve via a tester by means of a predetermined desired angle cvwdk.
For this, the tester must transfer the desired angle in cvwdk and the bit B_cwdk must be set.
!!!! When using this feature, it mus be absolutely ensured that the vehicle is not accelerating. !!!!
!!!! This can e.g. be assured by checking e.g. brake switch, clutch switch, engine speed = 0, vehicle speed = 0 !
!!!! !!!!
If it is switched over to the map FPWDKAPP, an offset WDKSOFS is added to the characteristic for evtmod<EVTMODKMNDK.
Thus a wrong learning of the DK e.g. through ice is avoided.

Sub function NACHLAUF: Calculation of the desired throttle valve angle during after-run

In the after-run an angle is preset independently of the torque structure. This angle wdksom_w is defined in the function WDKSOM.
For systems with integrated main relay and DK-actuator this angle is acutated, if a current supply is guaranteed in the after-run.
This way a smooth engine shut-down is assured.

APP FUEDK 21.30 Application hint

Aspirated engine and turbo:

KLAF: see charge sensing
KFWDKMSN: inverse to KFMSNWDK
KUMSRL: see charge sensing

CWFUEDK: Bit 0: asp. engine, fkmsdk-correction at pedal overtravel
Bit 1: no used in this FDEF (platform development of the start function nstat*KUMSRL)
Bit 2: no used in this FDEF (B_dwdksus before and after flip-flop evaluation)
Bit 3: no used in this FDEF (B_dwdksus before and after flip-flop evaluation)
Bit 4: asp. engine, for pedal overtravel dwdksus_w calculated via mrfabugd_w or mrfaugd
Bit 5: only for turbo: B_ldrugd can be set independently of B_llrein
Bit 6: only for NOT BDE: TP(LP)-filter before wdksgv_w is only switched on during start (or always switched on)
Bit 7: only for turbo: input of the characteristic KLDPDK is switched over by mlsol_w auf ml_w

CWFUEDK=192 (Bit0=false: functionality as %FUEDK 18.20
Bit4=false: functionality as %FUEDK 18.20
Bit5=false: functionality as %FUEDK 18.20
Bit6=true: as %FUEDK 18.20, if Bit6=false --> running time reduction
Bit7=true: then functionality as %FUEDK 18.20)

CWRLAPPL: only for test bench (switch over of pssol_w with or without the influence of the charge controller)

EVTMODMNDK = 5 °C
WDKSOFS = 5 %

FPWDKAPP	wped_w [%]	1.5	6.25	11.0	15.63	23.43	31.25	39.0	46.87	54.69	62.5	70.3	78.13	82 86	85.94	89.84	93.75
	wdksv_w [%]	1.7	7.1	11.16	15.25	20.0	31.0	39.0	47.0	55.0	62.0	70.0	78.0	82.00	86.0	90.0	99.9

WDKSAPP 2 %

TWDKSV: pspvmin_w	0.990	0.992	0.996	0.998	1.0	1.02
	0.01	0.1	0.15	0.2	0.25	0.0

NRLMN: 400 1/min (defined via umsrln_w / the throttle valve opening during start) The throttle valve opening is limited by wdkugd_w.
NRLMNLLR: 100 1/min below low idle speed (700 1/min)

KFWDKSMX: engine speed interpolation points are chosen as for WDKUGDN. It must be observed that at the throttle valve angle limitation for power reduction the interpolation distances in the reduction range are possibly chosen more tightly.
Altitude interpolation points: the upper interpolation point for altitude must be selected such that it corresponds to the altitude for which a power reduction should take place. In the range of the power reduction KFWDKSMX < 100% must be entered in such a way that the max. desired engine power is obtained through the thus effected throtteling.
The lower interpolation point must be selected such that it corresponds to the altitude for which - due to the lower atmospheric density - the natural power reduction corresponds to the desired rated power.

As an orientation, a 10% power reduction for an increase in altitude of 1000 m can be assumed (delta fho_w = -0.1).
At this interpolation point KFWDKSMX = 100% must be entered for the whole speed range.
nmot_w: 240, 760, 1000, 1520, 2000, 2520, 3000, 3520, 4000, 6000 1/min
fho_w: 0.8, 0.9, 1.0
Values: KFWDKSMX = 100% -> angle limitation not active.

Determination of the switch-on threshold for median filters:

1) Median filter switch-off: DRLSOLMF = 0 ;

Determination of the max. drlsolmf_w as value 1 for idling.
Then slow acceleration out of the idle operation (low dynamics), determination of the resulting drlsolmf_w as value 2.
Turning of the power steering up to the limit during idiling, determination of the resulting drlsolmf_w as value 3.
Vehicle acceleration (at load with higher dynamics), determination of the resulting drlsolmf_w as value 4.
From the max. value of value 1 and 2 and the min. value for value 3 and 4, the threshold DRLSOLMF is determined.
This threshold will mostly be situated in the range of value 4.

Suggested value DRLSOLMF: 2%

For the application of the charge sensing at the test bench, engine speed/load interpolation points should be reached automatically. The desired value predetermination in %MDFUE is realized with a fixed rlsol or an accelerator pedal value. So that the preset rlsol is converted in a real rl with the same value, the charge controller is used with a changed parameter set for the adjustment: rl - rlsol. This functionality is only valid, if the systme constant SY_RLAPP in the function PROKON has been set to a value > 0 . With bit 0 of CWRLAPPL, the functionality is then finally activated. The combination with the vehicle speed ensures that the adjustment function can only be activated for a vehicle at rest or at the test bench engine.

Only asp. engine:

MRFABUMX = 100%
MRFAUGDN (SNM12FEUB)
nmot_w
Values all at 80 %
FMIUGDS: 0.95

Only turbo:

FUEPMLD	lditv_w	3	6	10	20
	Values	0.999	0.8	0.2	0

ZPVDKR interpol. points	psspu_w	0.9	1.0	1.1	1.2	1.3	1.4
Values	0	0	0	2	2	0	s

DPUPS: >=250 hPa

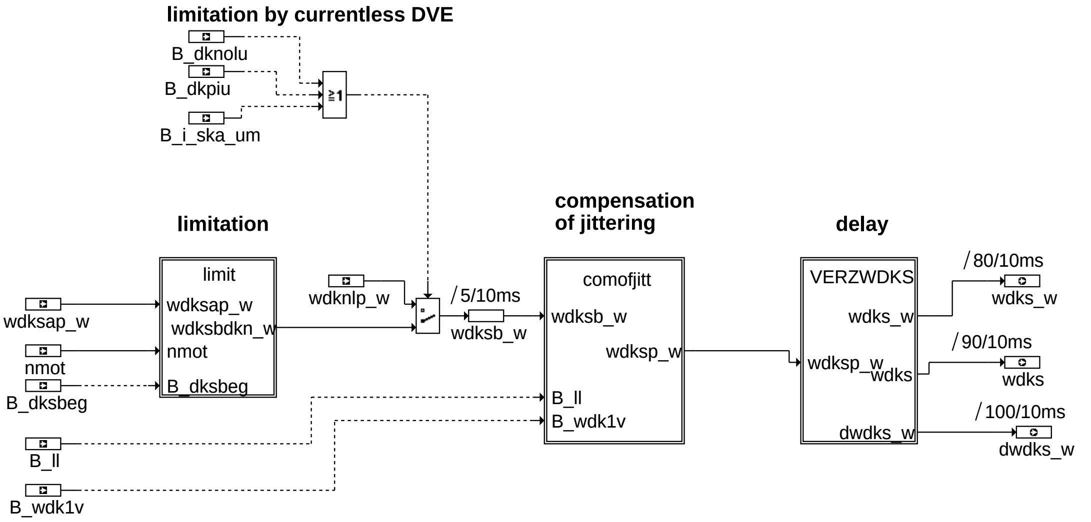
KLDPDK: 0 hPa at all interpolation points
Application: Measurement of pressure drop at throttle valve - esp. for high air mass flows. Then determination of 16 mlkge_w interpolation points and take-over of the respective pressure drop in the characteristic
PLSOLAP: 0 hPa. If during the application phase a desired boost pressure should be preset, B_plsolap = Bit 5 of CWMDAPP must be set to true and the desired boost pressure must be predetermined via PLSOLAP.

PSPVDKUG see function BGMSZS

FUEDKSA 1.20 Influence of air charge by throttle blade, processing throttle-valve angle

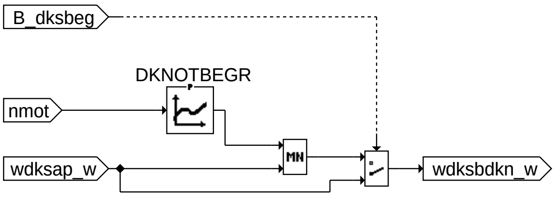
FDEF FUEDKSA 1.20 Function definition

FUEDKSA 1.20



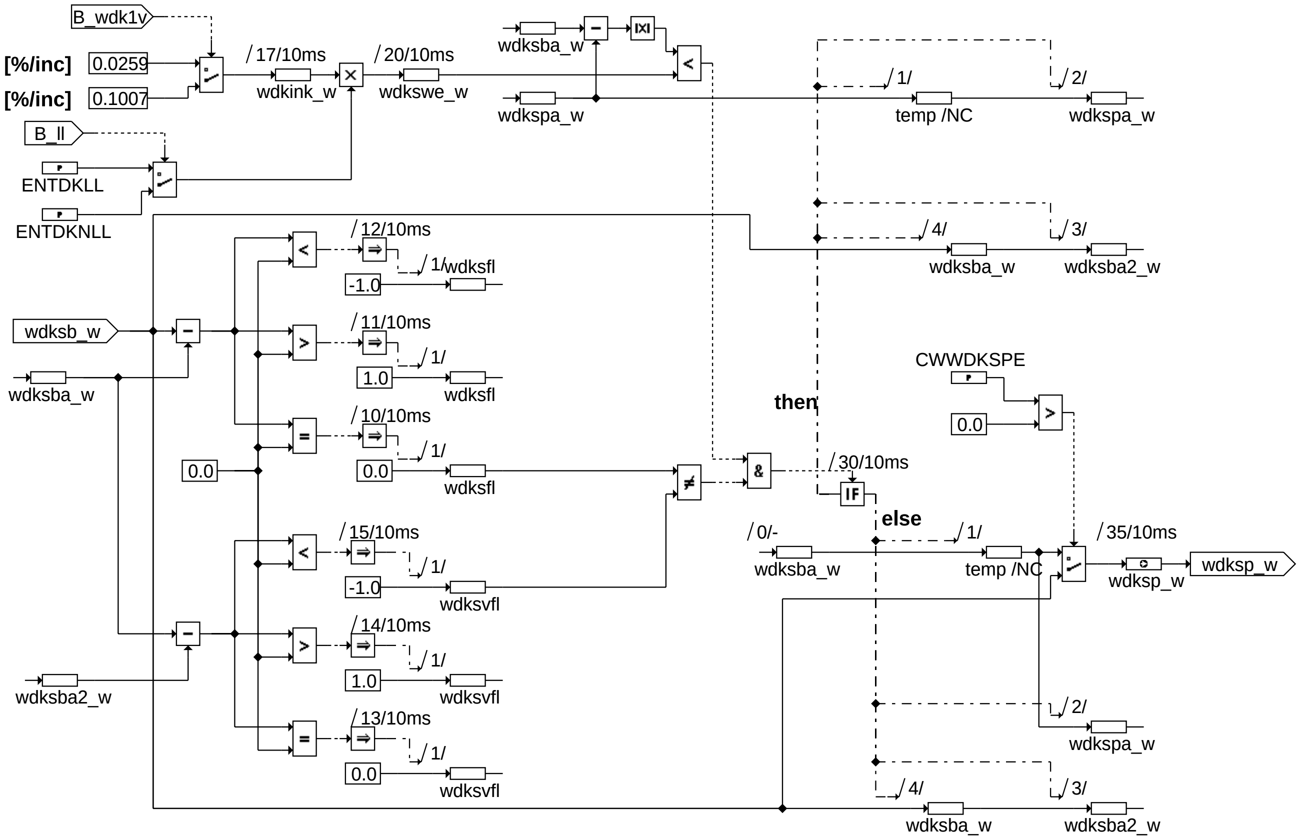
fuedksa-fuedksa

```
Limitation for DK-Poti-limp home:
==============================
```



fuedksa-limit

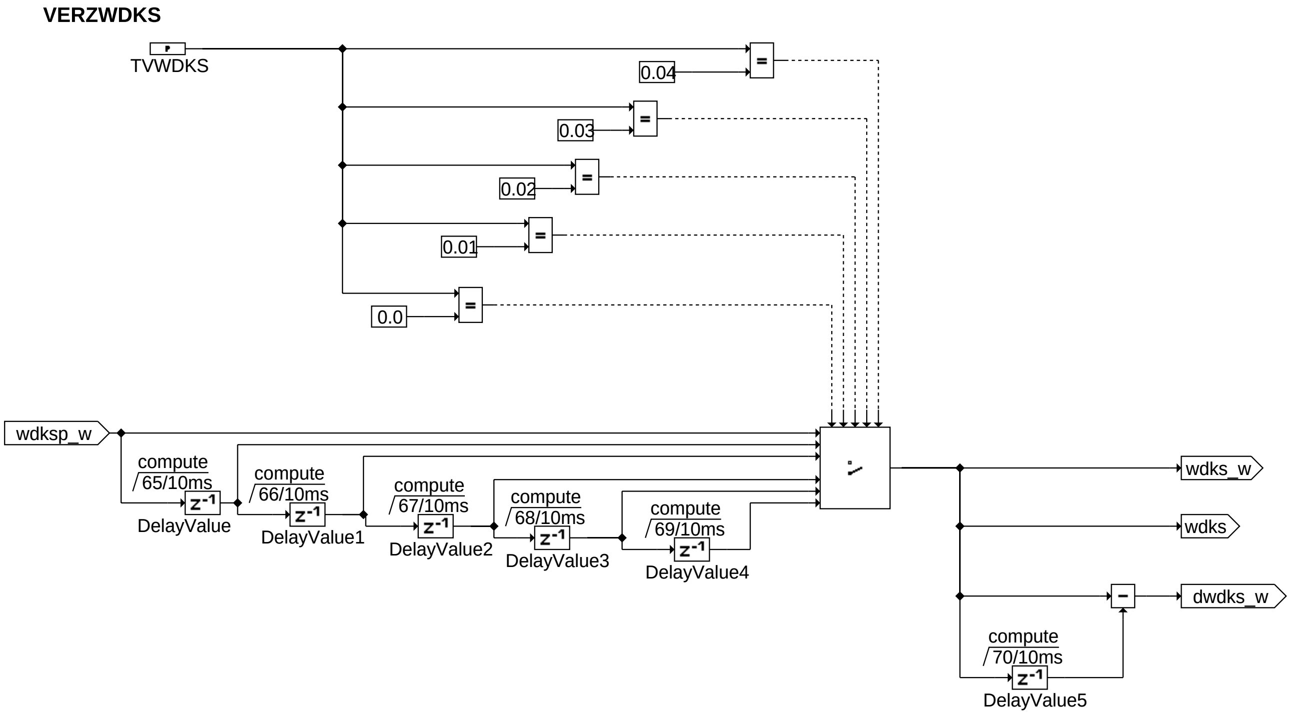
Predictive de-jittering:
===========================



fuedksa-comofjitt

fuedksa-comofjitt

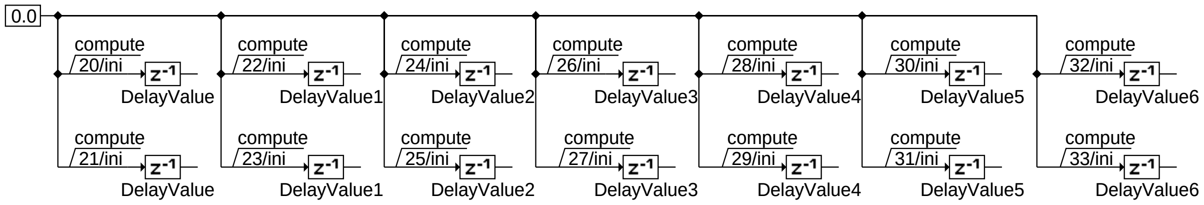
Variable delay time:
==========================



fuedksa-verzwdks

fuedksa-verzwdks

```
Initialization:
================
```



fuedksa-init

fuedksa-init

ABK FUEDKSA 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWWDKSPE			FW	Code word: Predicted throttle-valve target-value de-jittering active
DKNOTBEGR	NMOT		KL	Limtation of set value as f(nmot) if B_dknot = true
ENTDKLL			FW	De-jitter threshold (inc.) for throttle-value target value during idling (B_ll)
ENTDKNLL			FW	De-jitter thresh. (inc.) for throttle-value target value outside idling (!B_ll)
TVWDKS			FW	delay time for desired throttle angle

Variable	Source	Type	Description
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPIU	SREAKT	EIN	Condition: irreversible SKA
B_DKSBEG	GGDVE	EIN	condition: limiting throttle-valve setpoint value
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_LL	MSF	EIN	Condition idle
B_WDK1V		EIN	Condition: amplified signal from potentiometer 1 used to calc. throttle angle
DWDKS_W	FUEDKSA	AUS	modification of desired throttle angle
NMOT	SWADAP	EIN	engine speed
WDKINK_W	FUEDKSA	LOK	Current increment of throttle-valve target value
WDKNLP_W	BGDVE	EIN	throttle angle in the limphome air position
WDKS	FUEDKSA	AUS	desired throttle angle w.r.t. to lower mechanical stop
WDKSAP_W	FUEDK	EIN	desired throttle position from application value
WDKSBA2_W	FUEDKSA	LOK	Throttle-valve target angle after limiting, value from computing schedule n-2
WDKSBA_W	FUEDKSA	LOK	Throttle-valve target angle after limiting, value from computing schedule n-1
WDKSB_W	FUEDKSA	LOK	Throttle-valve target angle after limiting
WDKSFL	FUEDKSA	LOK	Flank-change indicator for throttle-valve target value wdksap_w
WDKSPA_W	FUEDKSA	LOK	Predicted throttle-valve angle, value from computing schedule n-1
WDKSP_W	FUEDKSA	AUS	predicted desired throttle angle
WDKSVFL	FUEDKSA	LOK	Flank-change indicator for throttle-valve target value wdksapa_w
WDKSWE_W	FUEDKSA	LOK	Throttle-valve nominal-value threshold for predicted de-jittering
WDKS_W	FUEDKSA	AUS	desired throttle angle w.r.t. to lower mechanical stop

FW FUEDKSA 1.20 Fixed Values

Parameter	Value	Description
CWWDKSPE		Code word: Predicted throttle-valve target-value de-jittering active
ENTDKLL		De-jitter threshold (inc.) for throttle-value target value during idling (B_ll)
ENTDKNLL		De-jitter thresh. (inc.) for throttle-value target value outside idling (!B_ll)
TVWDKS		delay time for desired throttle angle

FB FUEDKSA 1.20 Detailed description of function

```
1.  Desired value limitation for DK-Poti limp home (sub function limitation):
==================================================================================

        For DVE-actuator operation at zero current ( B_dknolu or B_dkpiu or B_i_ska_um = true), the angle for the limp home
            position (wdknlp_w) is considered as desired angle. That way it is assured that e.g. the load prediction with constant
        desired angle wdksp_w does not predict throttle valve dynamics.

2.  Predictive desired angle de-jittering (sub function comofjitt):
=======================================================================

        The predictive desired angle de-jittering is used for smoothing the desired DK value. The operating cycles for the
        DV-E5 are thus reduced. The desired anlge de-jittering only applies to that extent that no physical effect
        on the whole system occurs.

        The de-jittering thresholds (wdkswe_w) are formed depending on B_ll and B_wdk1v. 4 different de-jittering thresholds
        depending on the dating of ENTDKLL and ENTDKNLL 4 are the result.

        Matrix of resulting de-jittering thresholds wdkswe_w:

                               B_wdk1v
                            0     |    1
                     ---+----------+----------
                        | 0,1007   | 0,0259
                     0  |    *     |    *
                        | ENTDKNLL | ENTDKNLL
               B_ll  ---+----------+----------
                        | 0,1007   | 0,0259
                     1  |    *     |    *
                        | ENTDKLL  | ENTDKLL

/END

BILD /SYM PRINZ-ENTJ
TEXT/ANF

3. Sub function VERZWDKS: Desired DK deadtime:
=================================================

        The desired DK value (wdksp_w) is transferred to the load prediction. For the DK position controller, a delayed value is
        calculated in the sub function VERZWDKS (wdks_w). The deadtime can be adjusted between 0 and 50 ms .
        With the un-delayed desired DK value, the manifold pressure and the relative charge in the function BGRLP are predicted.
        A fuel quantity relative to this charge is calculated. By delaying the throttle valve angle, it is assured that at the
        ignition the advanced fuel quantity fits to the relative cylinder charge.
```

APP FUEDKSA 1.20 Application hint

```
1.  Deactivation of function parts
===================================

    Label       Passive value   deactivated...
    ------------------------------------------------------------
    DKNOTBEGR     100 %DK       desired angle limitation during DK-Poti limp home
    CWWDKSPE        0           predictive desired angle de-jittering
    TVWDKS          0 ms        desired angle delay

2.  Others
=============

    TVWDKS: fixes the deadtime between wdksp_w and wdks_w
            0: no delay; 1: 10 ms; 2: 20 ms; ...; 5 or more: 50 ms delay

3.  Suggested values
======================

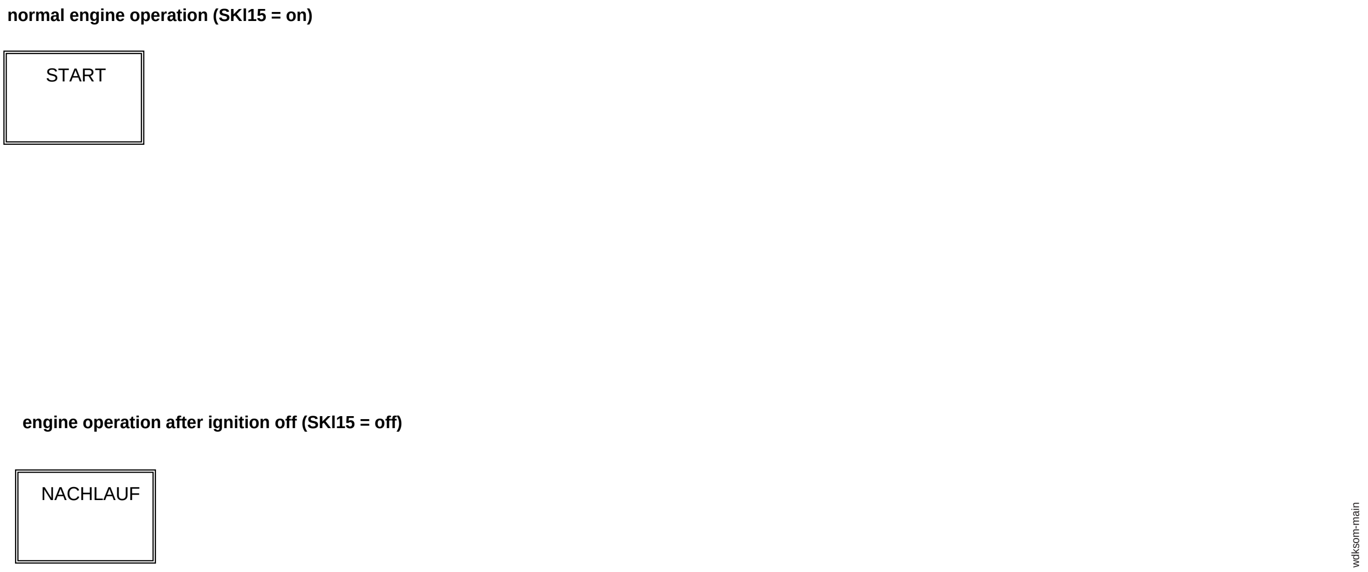
        CWDKSPE = 1
        ENTDKLL = 4
        ENTDKNLL = 6

        TVWDKS_W = 0.01s, application see %BGRLP
        DKNOTBEGR = 100% for interpolation points nmot: 0, 500, 1000, 2000, 2500, 3000, 4000 rpm
```

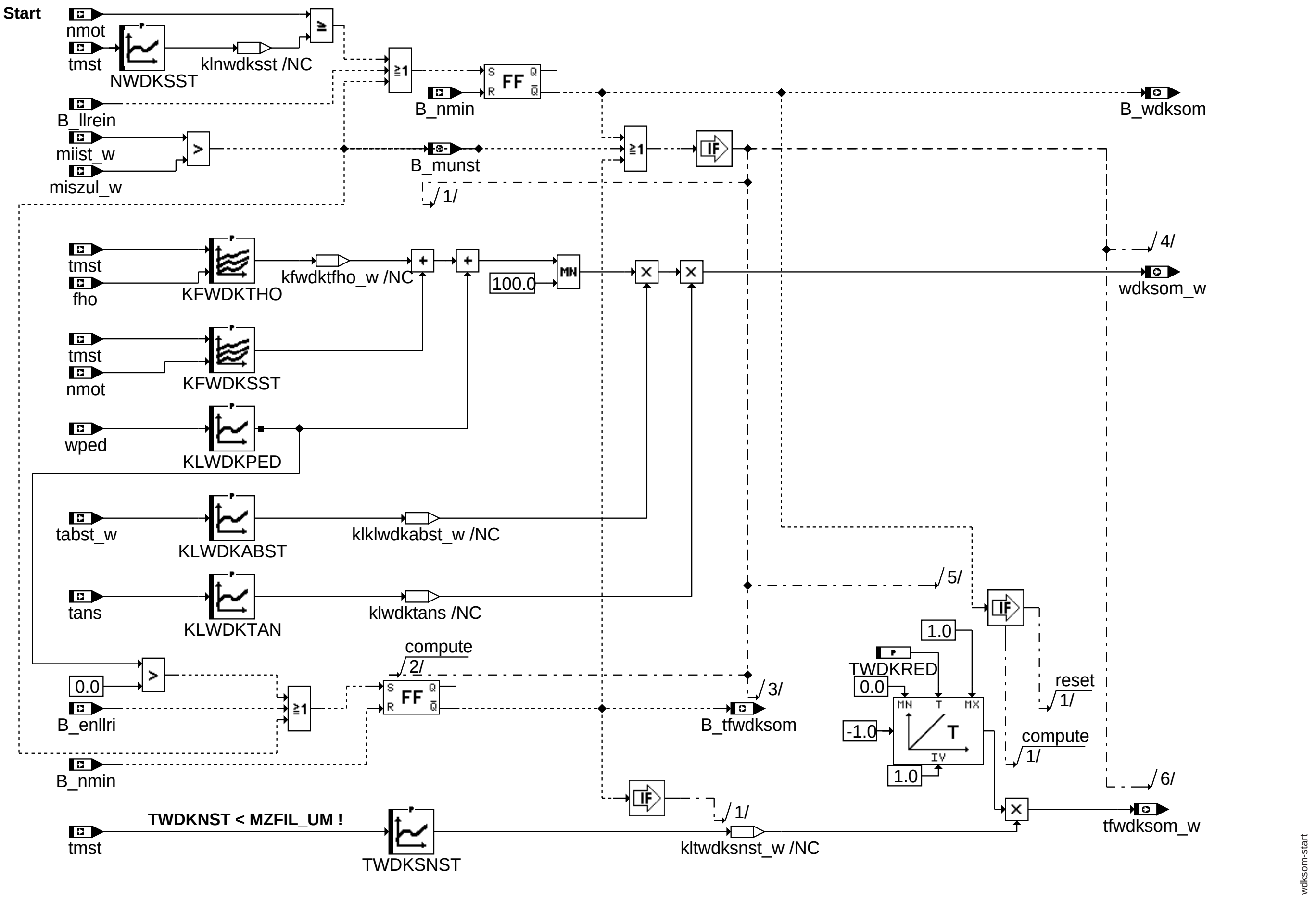
WDKSOM 2.40 calculatiof of desired throttle angle without torque structure

FDEF WDKSOM 2.40 Function definition

WDKSOM 2.20



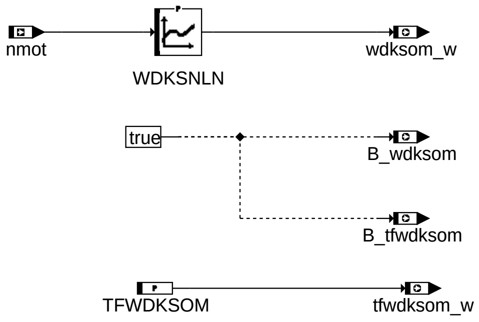
wdksom-main



wdksom-start

```
Subfunction Block 1: Set Value of Throttle Valve during Start
-------------------------------------------------------------
```

Nachlauf



wdksom-nachlauf

```
Subfunction Block 2: Set Value of Throttle Valve during ECU After-Run
---------------------------------------------------------------------
```

ABK WDKSOM 2.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFWDKSST	TMST	NMOT	KF	desired throttle position at start-up
KFWDKTHO	TMST	FHO	KF	desired throttle position at start-up - f (hight, engine start temperatur)
KLWDKABST	TABST_W		KL	Weighting desired throttle position at start-up
KLWDKPED	WPED		KL	Offset desired throttle position at start-up
KLWDKTAN	TANS		KL	weight of throttle position at start up with intake air temperatur
NWDKSST	TMST		KL	threshold for deactivation desired throttle position without torque structur
TFWDKSOM			FW	time constant for filtering desired throttle angle at kl15 off
TWDKRED			FW	Weighting time constant for filtering of reference throttle blade position
TWDKSNST	TMST		KL	time constant for filtering of reference throttle blade position
WDKSNLN	NMOT		KL	desired throttle angle at kl15 off

Variable	Source	Type	Description
B_ENLLRI	LLRBB	EIN	enable integrator: idle speed controller
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_MUNST	WDKSOM	AUS	Condition allow intervention of torque monitoring
B_NMIN	GGDPG	EIN	condition lower speed: n $<$ NMIN
B_TFWDKSOM	WDKSOM	AUS	time constant to filter desired throttle angle without torque structure active
B_WDKSOM	WDKSOM	AUS	desired throttle angle without torque structure active
FHO	BGPU	EIN	Correction factor altitude
MIIST_W	MSF	EIN	indicated real engine torque
MISZUL_W	MDZUL	EIN	maximum permissible indicated torque
NMOT	SWADAP	EIN	engine speed
TABST_W	BGTABST	EIN	soak time
TANS	SWADAP	EIN	Intake air temperature
TFWDKSOM_W	WDKSOM	AUS	time constant to filter desired throttle angle without torque structure
TMST	GGTFM	EIN	engine temperature at start
WDKSOM_W	WDKSOM	AUS	desired throttle angle without torque structure
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW WDKSOM 2.40 Fixed Values

Parameter	Value	Description
TFWDKSOM		time constant for filtering desired throttle angle at kl15 off
TWDKRED		Weighting time constant for filtering of reference throttle blade position

FB WDKSOM 2.40 Detailed description of function

The function WDKSOM calculates a desired angle wdksom_w for the throttle position of the DVE actuator during start and during ECU after-run.

Start:
The set value for the throttle position is mainly dependent on the engine temperature during start.
Since the drag torque of the engine is distinctly higher at cold engine than at warm conditions, the engine is throttled later by a larger opening of the throttle valve during the starting procedure.
The dependence of the throttle position on the engine start temperatue can be combined with the influence of the high (KFWDKTHO) or with the influence of the engine turning speed (KFWDKSST). If both characteristic maps should be used, the values are added.
The influence of high (less air density) is considered with the map KFWDKTHO amongst the influence of the engine start-temperature.
The map dates are taken into account that the factor for high itself is dependent on the temperature (not a linear connection).

As by short soak times the drag torque of the engine is lower, the set value for the throttle position can be reduced (KLWDKABST).
An additional interaction by the driver is possible (KLWDKPED).
The influence of an changed cylinder charge is partially considered with the correction for high (KFWDKTHO). The influence of the intake air temperature on the cylinder charge and with it the influence on the throttle position can additional be wighted with the map KLWDKTAN. This especially is important for hot start-up of the engine.

When the speed threshold NWDKSST is exceeded or the idle control is active (B_llrein) the set value for the throttle position is switched to the set value from the torque structure.
The transition takes place with an adjustable time constant TWDKSNST, which is dependent on the engine starting temperature.
The time constant can be reduced (TWDKRED) during the transitional phase. So a leap of wdks_w by switching to the torque structure can be prevented.
When the integrator component of the idle control (B_enllri) is activated this time constant is switched to the value for normal operation (tfwdks_w).
If the indicated real engine torque miist_w exceeds the maximum permissible indicated torque miszul_w, there is switched immediately to the torque structure. So a intervention of the torque monitoring functionality is possible.

ECU After-run:
During the ECU after-run (at engine run-on, if SKl15 OFF) throttling is generated by closing of the throttle valve.
The transition from normal operation to the value in the ECU after-run WDKSNLN is performed by a filtering with the time constant TFWDKSOM. This makes a faster engine standstill possible.
By the throttling also vibrating of the engine due to higher compression pressures without throttling is prevented.

APP WDKSOM 2.40 Application hint

```
WDKSNLN: Base points nmot_w: 200, 400, 600, 800, 1000, 2000, 3000, 4000 rpm
         Values:              2,   2,   2,   2,    2,  7.5,   15,   20 %

TFWDKSOM: 0.01 s --> no filtering

NWDKSST:  Base points tmst: -30   -20   -10    0    20    90 Grad C
                  Values:           1100  1000  900   800   700   650 rpm
The threshold should be between (B_stend, see NSTNM in %BBSTT) and activation of the idle control (B_llrein, see %LLRBB).
In NWDKSST must not be values greater than 1200 rpm, because then the torque structure is activated to late and an
intervention of the torque monitoring functionality is possible.


KFWDKTHO: Base points tmst     :  -30  -25  -20  -15  -10  -5   0   20  40  60  90   110 Grad C
                      fho      :  0.7  0.8  0.9  1.0
                  values (for all high):   30   25   20   13
                                          (at sea level 1.0, with high increasing)

KFWDKSST: Base points tmst     :   -30  -25  -20  -15  -10  -5   0   20  40  60  90   110 Grad C
                      nmot     :   100  500  750  1000  1/min
                  all values           :    0 %
A constant presetting is recommended by RB via the speed, since otherwise the throttle valve will be moved at speed dynamics
(e.g. by misfiring).

KLWDKABST:Base points : tabst_w:   0   300   3600   18000
          Values               : 0.9   0.95   1.0     1.0

KLWDKTAN  Base points tmst     :   -20    0   30   80   °C
          values               :     1    1    1    1

KLWDKPED: Base points: wped_w  :     0   20   99  %
          Values               :     0    0   99  %
Since the driver should not move the throttle valve at start there will be no reaction to the driver's request up to a
certain pedal value, e.g. 20% and the start is performed purely by control.
Above this value the throttle valve is opened linear up to the maximum value so that, e.g. after flooding the driver can
take measures. As soon as this characteristic becomes effective a simultaneous switch to the fast time constant for the
filtering of the throttle valve set value is performed (normal operation).

TWDKSNST: Base points: tmst: -30  -20  -10   0   20   90 degrees C
                  Values:            0.4  0.4  0.3  0.3  0.2  0.2 sec.
The time constant for the filtering of the throttle valve set value becomes slower, the lower the ambient temperature.
With slow movement of the throttle valve attention has to be paid, however, that in general more dynamics is necessary
at the ignition angle in order to obtain a good speed curve.

Caution:
--------
The values in TWDKNST have to be less than MZFIL_UM (c. 405 msec).
This is claimed by the torque monitoring functionality.

TWDKRED: Value: 5 sec.
The value gives the time after that filtering finished.
```

SU 62.10 Intake manifold switch-over

FDEF SU 62.10 Function definition

No text for FDEF available!

ABK SU 62.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CSU			FW	Codeword for intake manifold switch over
KFSU	NMOT	RLSHK	KF	Load/speed performance characteristics for suction tube switchover
KFSU2	NMOT	RLSHK	KF	map for intake manifold switch over, flap 2
SUMODE0			FW	no activation of intake manifold flaps
SUMODE1			FW	activation of flap 1,no activation of flap 2
SUMODE2			FW	no activation of flap 1,activation of flap 2
SUMODE3			FW	activation of flap 1 and 2
TASUS			FW	intake air temperatur threshold for intake manifold switch over
TMSUS			FW	engine temperature threshold for intake manifold switch over
TMSUSV			FW	temperatur threshold for intake manifold switch over with response delay
TVSU			FW	delay time for intake manifold switch over, flap 1
TVSU2			FW	delay time for intake manifold switch over, flap 2
TVSUM	TMOT		KL	delay time for intake manifold switch over in dependence of engine temperatur
TVSUST			FW	delay time for intake manifold switch over after start

Variable	Source	Type	Description
B_STEND	BBSTT	EIN	condition end of start
B_SU	SU	AUS	condition intake manifold switch-over
B_SU2	SU	AUS	condition intake manifold switch over, 2.flap
B_SUKP	SU	LOK	condition enable manifold intake switch over flap 1
B_SUKP2	SU	LOK	condition enable intake manifold switch over flap 2
E_DK	DDVE	EIN	Error flag: throttle position sensor

Variable	Source	Type	Description
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
NMOT	SWADAP	EIN	engine speed
RLSHK		EIN	desired relative air charge corrected by altitude
SUMODE	SU	AUS	status of the intake manifold switch over
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature

FW SU 62.10 Fixed Values

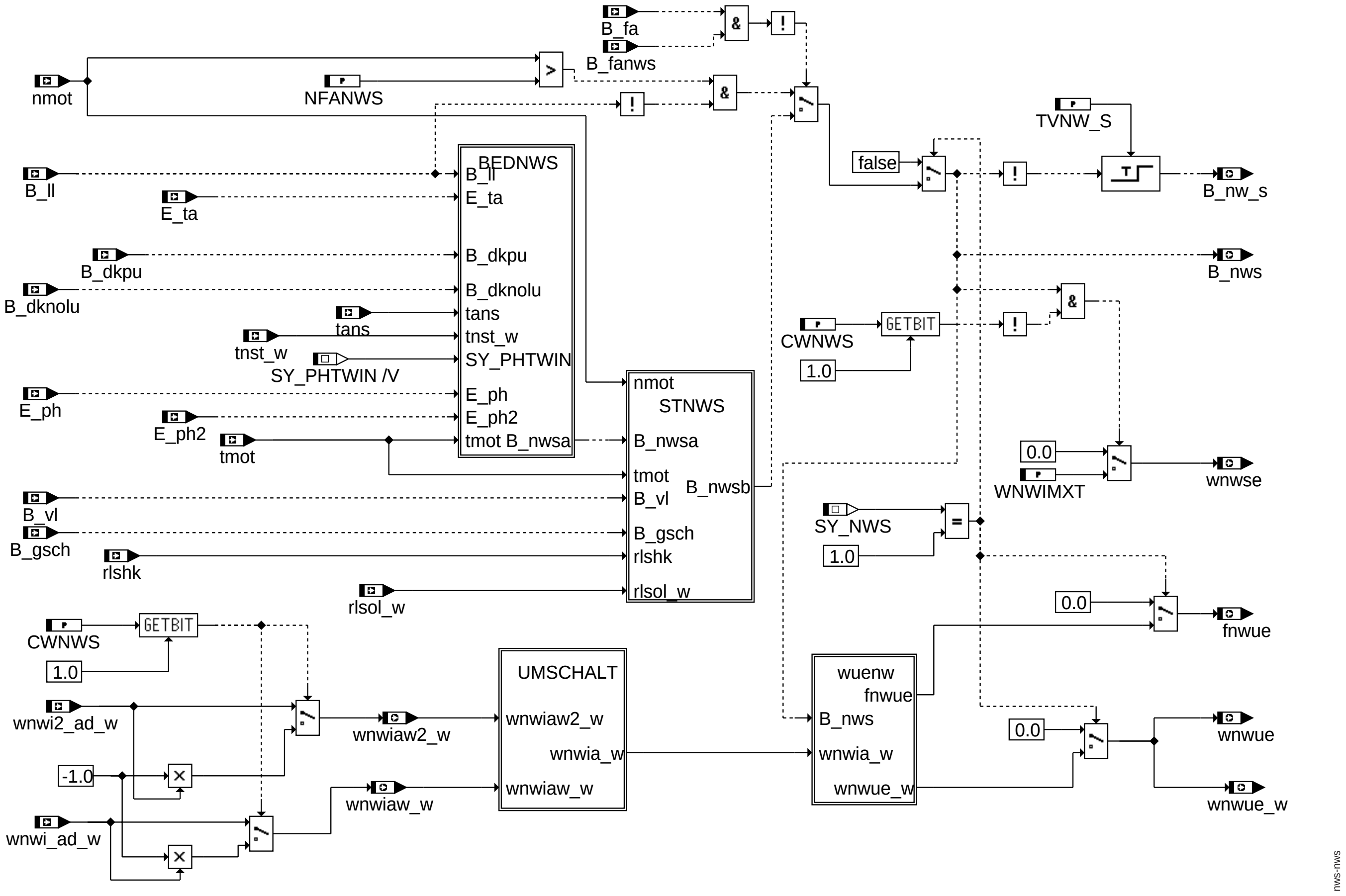
Parameter	Value	Description
CSU		Codeword for intake manifold switch over
SUMODE0		no activation of intake manifold flaps
SUMODE1		activation of flap 1,no activation of flap 2
SUMODE2		no activation of flap 1,activation of flap 2
SUMODE3		activation of flap 1 and 2
TASUS		intake air temperatur threshold for intake manifold switch over
TMSUS		engine temperature threshold for intake manifold switch over
TMSUSV		temperatur threshold for intake manifold switch over with response delay
TVSU		delay time for intake manifold switch over, flap 1
TVSU2		delay time for intake manifold switch over, flap 2
TVSUST		delay time for intake manifold switch over after start

FB SU 62.10 Detailed description of function

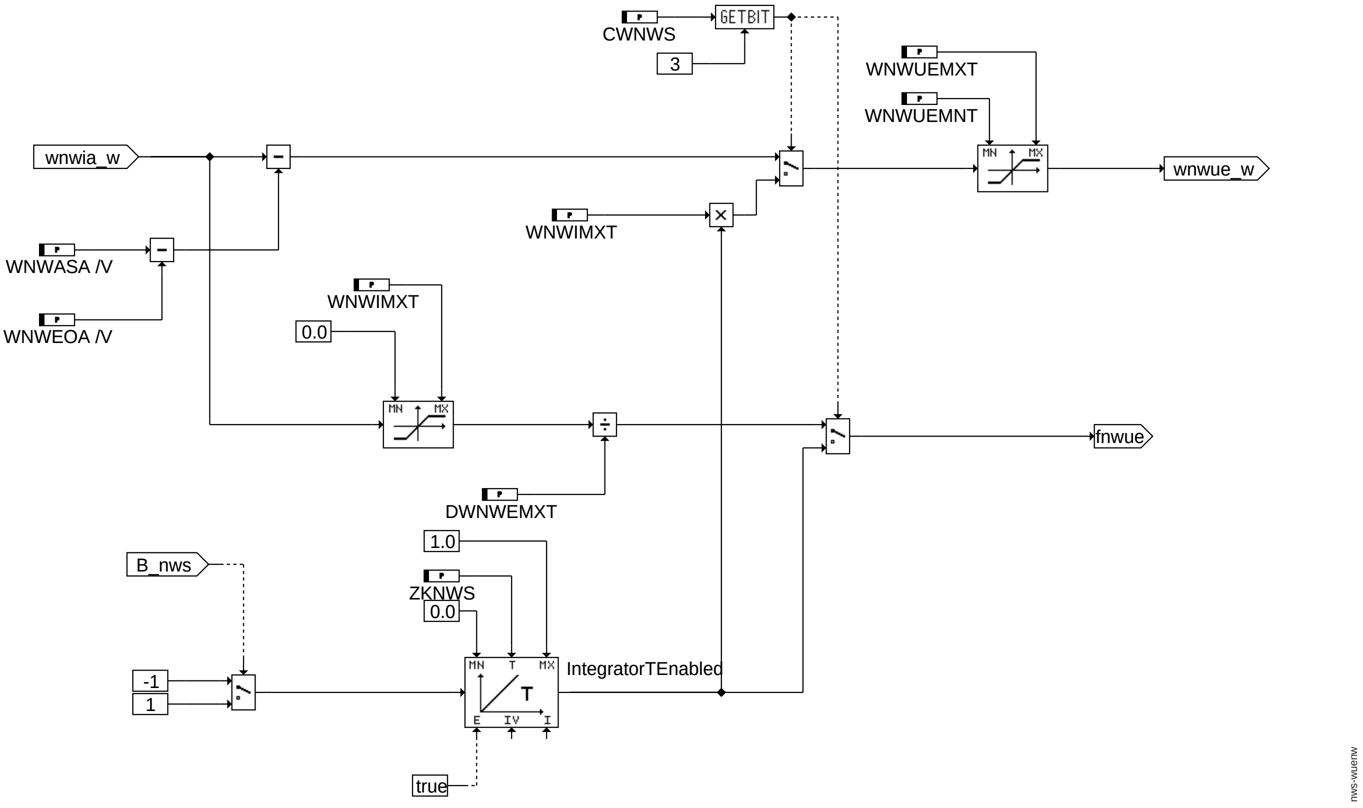
APP SU 62.10 Application hint

NWS 55.60 Camshaft control

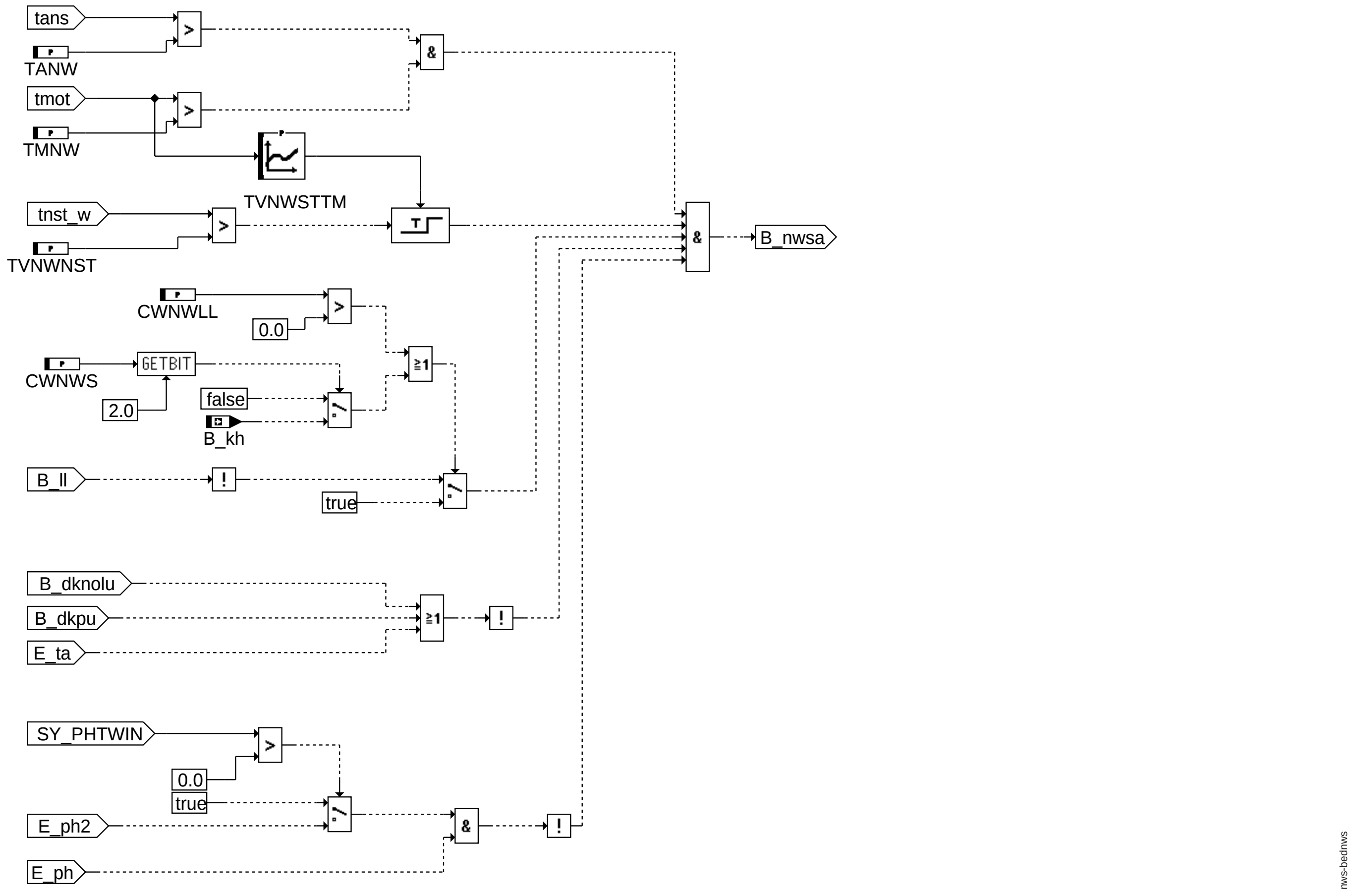
FDEF NWS 55.60 Function definition



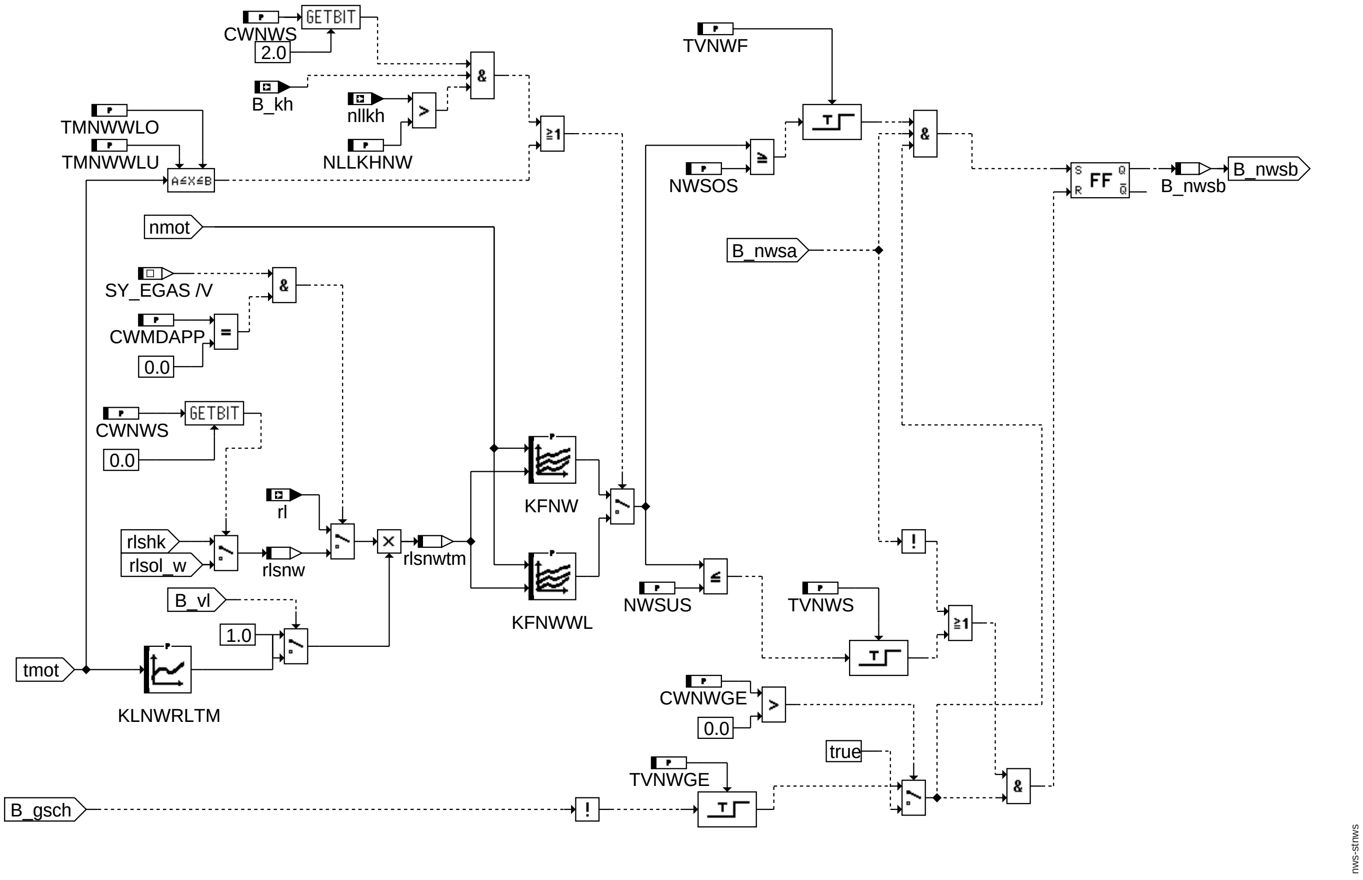
nws-nws



nws-wuenw



nws-bednws



nws-stnws

ABK NWS 55.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWMDAPP			FW	code word for calibration without torque structure
CWNWGE			FW	code word camshaft control at transmission control operation
CWNWLL			FW	code word for deactivation of camshaft-control in idle
CWNWS			FW	code word: camshaft control
DWNWEMXT			FW	Theor. max. delta between retarded and advanced adjustment of the intake valve
KFNW	NMOT	RLSNWTM	KF	characteristic map for variable camshaft spread
KFNWWL	NMOT	RLSNWTM	KF	
KLNWRLTM	TMOT		KL	Weighting of relative nominal filling over engine temp. for addressing KFNWS
NFANWS			FW	Speed threshold for function request NWS
NLLKHNW			FW	engine threshold for catalyst heating during idle position to change over
NWSOS			FW	Camshaft control upper switching threshold
NWSUS			FW	Camshaft control lower switching threshold
SY_EGAS			SYS	System constant E-GAS present
SY_NWS			SYS	system constant camshaft control: none, 2 point, continous
SY_PHTWIN			SYS	system constant 1/2 phase sensing system (sensor, wheel)
TANW			FW	Suction air temperature threshold for camshaft adjustment
TMNW			FW	Engine temperature threshold for camshaft adjustment
TMNWWLO			FW	
TMNWWLU			FW	
TVNWF			FW	Delay time until camshaft switchover enable to advanced
TVNWGE			FW	Delay time until switchover enable following transmission intervention
TVNWNST			FW	delay time : enable condition of camshaft control
TVNWS			FW	Delay time for camshaft adjustment
TVNWSTTM	TMOT		KL	delay time : enable of camshaft control after start, depending on engine temp
TVNW_S			FW	Delay time after the inlet valve is in retarded position with certainty
WNWASA			FW	Angle outlet valve closes at NW limit
WNWEOA			FW	Angle inlet valve opens at NW limit
WNWIMXT			FW	Theoretical maximum wnwi (angle camshaft is)
WNWUEMNT			FW	theoretical minimum camshaft overlapping angle
WNWUEMXT			FW	Theoretical maximum camshaft overlapping angle
ZKNWS			FW	time constant for reproduction of the camshaft control
ZKWNWI			FW	Time constant for filtering wnwi

Variable	Source	Type	Description
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_FA		EIN	condition general function request

Variable	Source	Type	Description
B_FANWS		EIN	condition general function request for diagnosis camshaft control
B_GSCH		EIN	Condition gear-shift in process
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_LL	MSF	EIN	Condition idle
B_NWS	NWS	AUS	Condition camshaft control
B_NWSB	NWS	LOK	Condition camshaft control before B_fa condition |
B_NW_S	NWS	AUS	state information: camshaft control in retarded position
B_VL	MSF	EIN	Condition for wide open throttle
E_PH	DPH	EIN	error flag: phase sensor
E_PH2	DPH	EIN	error flag: phase sensor 2
E_TA	GGTFA	EIN	error flag: TANS
FNWUE	NWS	AUS	Weighting factor camshaft overlap
NLLKH	BBKHZ	EIN	Idling speed for catalyzer heating
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RLSHK		EIN	desired relative air charge corrected by altitude
RLSNW	NWS	LOK	selection between rlsol_w and rlshk for map KFNW
RLSNWTM	NWS	LOK	
RLSOL_W	MDFUE	EIN	desired relative air charge
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start
WNWI2_AD_W	WANWKW	EIN	difference in crank angle between adapted and current 2. phase edge (word)
WNWIAW2_W	NWS	AUS	
WNWIAW_W	NWS	AUS	
WNWIA_W	NWS	AUS	Selection between wnwi_w and wnwi2_w
WNWI_AD_W	WANWKW	EIN	difference in crank angle between adapted and current phase edge (word)
WNWSE	NWS	AUS	Nominal angle for camshaft inlet valve
WNWUE	NWS	AUS	camshaft overlap angle of inlet and outlet valve opening
WNWUE_W	NWS	AUS	camshaft overlap angle of inlet and outlet valve opening

FW NWS 55.60 Fixed Values

Parameter	Value	Description
CWMDAPP		code word for calibration without torque structure
CWNWGE		code word camshaft control at transmission control operation
CWNWLL		code word for deactivation of camshaft-control in idle
CWNWS		code word: camshaft control
DWNWEMXT		Theor. max. delta between retarded and advanced adjustment of the intake valve
NFANWS		Speed threshold for function request NWS
NLLKHNW		engine threshold for catalyst heating during idle position to change over
NWSOS		Camshaft control upper switching threshold
NWSUS		Camshaft control lower switching threshold
TANW		Suction air temperature threshold for camshaft adjustment
TMNW		Engine temperature threshold for camshaft adjustment
TMNWWLO		
TMNWWLU		
TVNWF		Delay time until camshaft switchover enable to advanced
TVNWGE		Delay time until switchover enable following transmission intervention
TVNWNST		delay time : enable condition of camshaft control
TVNWS		Delay time for camshaft adjustment
TVNW_S		Delay time after the inlet valve is in retarded position with certainty
WNWASA		Angle outlet valve closes at NW limit
WNWEOA		Angle inlet valve opens at NW limit
WNWIMXT		Theoretical maximum wnwi (angle camshaft is)
WNWUEMNT		theoretical minimum camshaft overlapping angle
WNWUEMXT		Theoretical maximum camshaft overlapping angle
ZKNWS		time constant for reproduction of the camshaft control
ZKWNWI		Time constant for filtering wnwi

FB NWS 55.60 Detailed description of function

1.Bildung des Freigabebits B_nwsa

Die Bildung des Freigabebits B_nwsa ist Voraussetzung für ein Verstellen der Nockenwelle in Abhängikeit von der Drehzahl nmot und der höhenkorrigierten Sollfüllung rlshk. Das Setzen des Freigabebits erfolgt wenn folgende Bedingungen erfüllt sind:

a.) -Wenn die Motortemperatur tmot größer als eine programmierbare Temperaturschwelle TMNW und die Ansauglufttemperatur tans größer als eine programmierbare Temperaturschwelle TANW sind.
b.) -Wenn die Errorflags für die Drosselklappe E_dk, für den Ansauglufttemperaturfühler E_tans oder für den Motortemperaturfühler E_tm nicht gesetzt sind.
c.) -Wenn nach dem Startende eine programmierbare Zeit TVNWST vergangen ist.
d.) -Wenn die Bedingung B_ll nicht gesetzt ist.
e.) -Wenn das Codewort CWNWS größer 0 ist.

2. Bestromung des Ventils für die Nockenwellensteuerung:

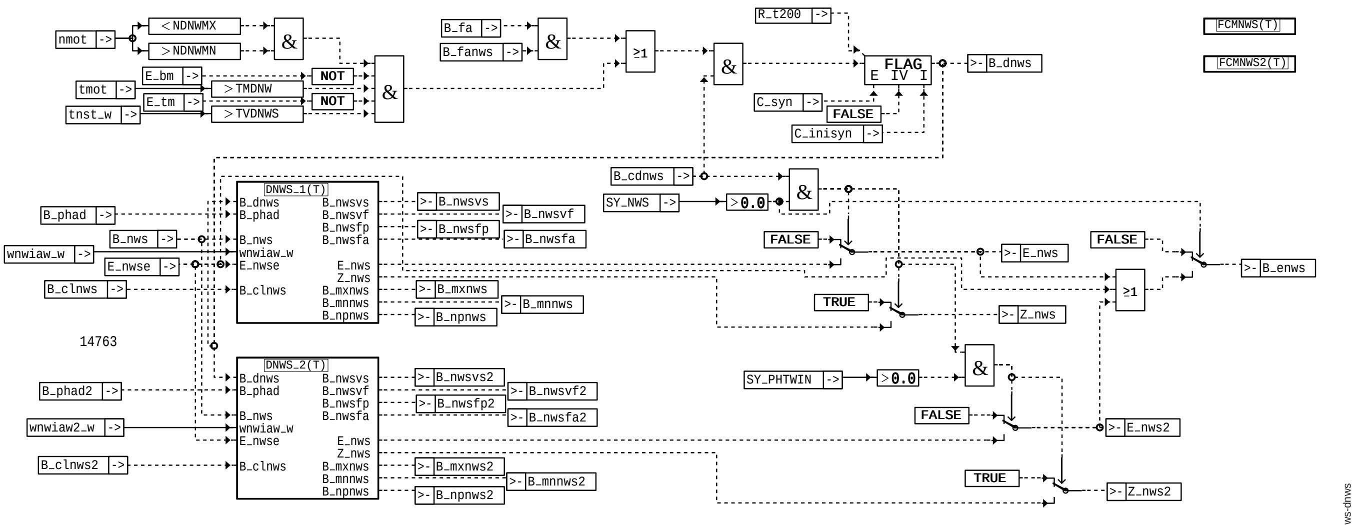
Wenn das Freigabebit für die Nockenwellensteuerung B_nwsa gesetzt ist, wird in Abhängigkeit von der Drehzahl und der höhenkorrigierten Sollfüllung rlshk das Ventil für die Nockenwellensteuerung bestromt oder nicht. Dazu ist ein Kennfeld KFNW, das über die Drehzahl und der höhenkorrigierten Sollfüllung rlshk aufgespannt ist, mit den Zahlenwerten 0, 1 und 2 gefüllt. Der Zahlenwert 0 steht für nicht Bestromen des Ventils, der Wert 2 für ein Bestromen des Ventils und der Wert 1 dient als Hysteresewert. Entsprechend den jeweiligen Zahlenwert des Kennfeldes wird der Ausgang des RS-FF gesetzt oder rückgesetzt. Sollte der Ausgang des Kennfeldes KFNW gleich 2 sein, d.h. bestromen des Ventils, wird dieses erst nach einer programmierbaren Zeit TVNW durchgeschaltet. Dadurch soll verhindert werden, daß bei nur kurzfristigen Anfahren eines Umschaltpunktes ein hin- und herfahren der Nockenwellensteuerung erfolgt.
Sollte vom Kunden gewünscht sein, daß bei der Bedingung B_ge eine Veränderung der Nockenwellenstellung untersagt ist, so muß das Codewort CWNWGE größer Null gesetzt werden. Sollte das Bit B_ge keinen Einfluß auf die Nockenwellenstellung haben, so muß das Codewort CWNWGE gleich Null gesetzt werden.

APP NWS 55.60 Application hint

DNWS 10.60 Diagnosis camshaft control

FDEF DNWS 10.60 Function definition

Die Diagnose der Nockenwellensteuerung erfolgt über eine Prüfung des Verstellwinkels der Nockenwelle. Ein Unter- bzw. Überschreiten von Schwellwerten ist in der jeweiligen Lage der Nockenwelle erforderlich, um die korrekte Funktion der Nockenwellenverstellung anzuzeigen. Die Freigabe der Diagnose Nockenwellensteuerung erfolgt über die Bedingung B_dnws.

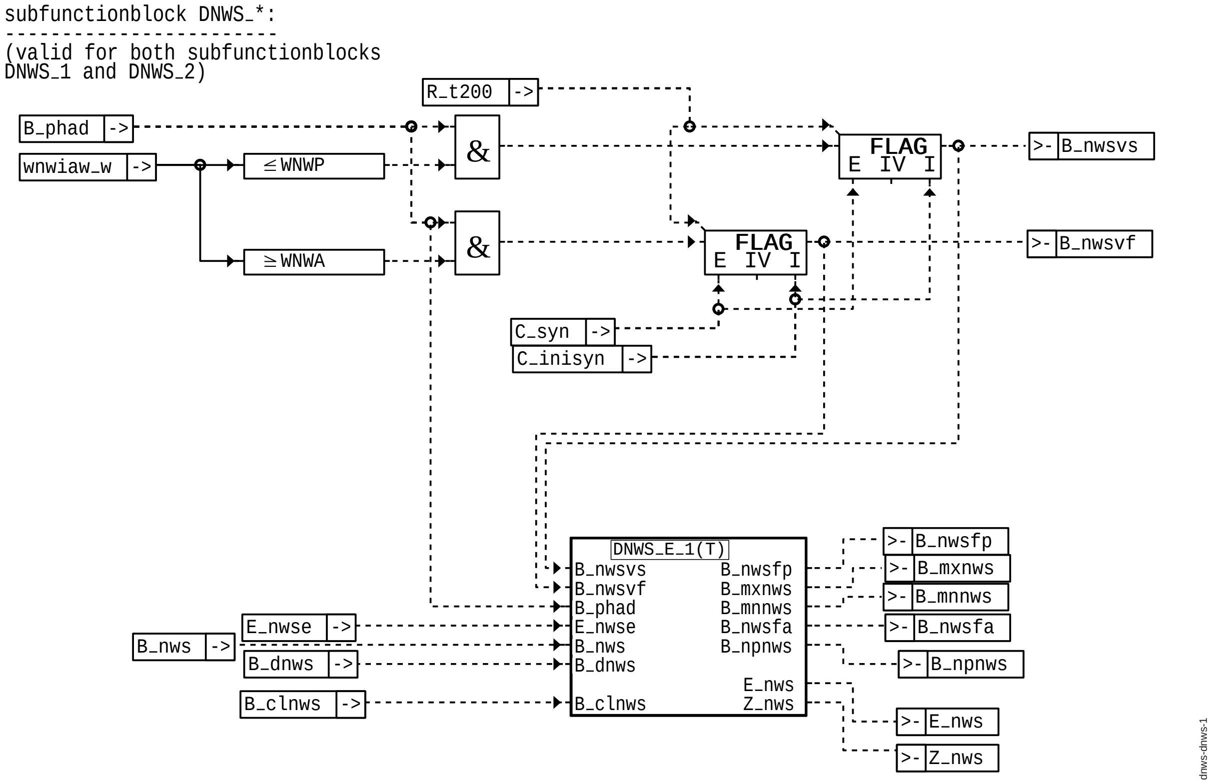


dnws-dnws

Bei Systemen ohne eine Nockenwellenverstellung wird keine Diagnose durchgeführt. Eine Initialisierung der Zyklus- und Fehlerbedingungen erfolgt dann entsprechend dem Schalter mit der Systemkonstanten SY_NWS. Gleiches gilt, wenn die Diagnose über die Bedingung B_cdnws ausgeblendet ist (Definition in %PROKON).

Bei Systemen mit nur einer diagnosefähigen Nockenwelle (z.B. Reihenmotoren, Systeme mit einer gemeinsamen Verstelleinrichtung oder mit nur einem Nockenwellensensor) werden die Bedingungen für die zweite Bank über den Schalter aus der Systemkonstante SY_PHTWIN gesetzt.

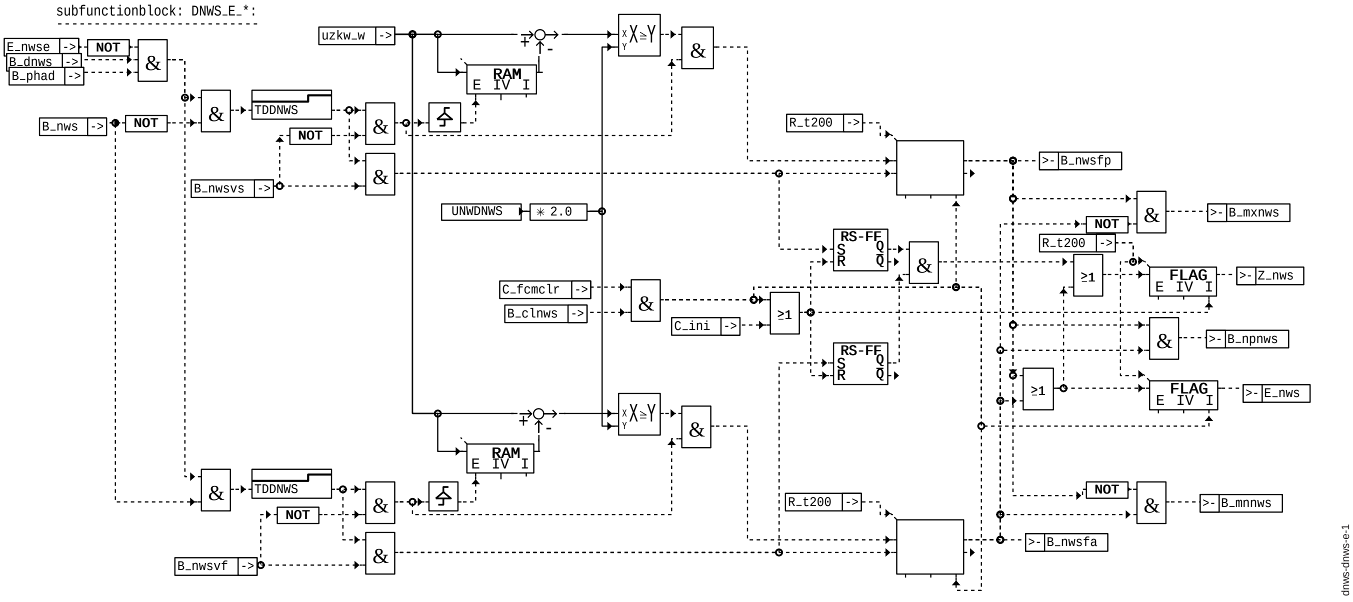
Der Subfunctionblock DNWS_* wird für jede Bank einzeln gerechnet. Im nachfolgenden ist nur die Berechnung einer Bank beschrieben. Die Größen für die zweite Bank sind durch eine 2 am Ende gekennzeichnet, z.B. E_nws2.



dnws-dnws-1

```
Ermittlung der Nockenwellenstellung: aus %NWS:  B_nws = false   -----> Passiv-/Spätstellung: B_nwsvs = true
                                                B_nws = true    -----> Aktiv-/ Frühstellung: B_nwsvf = true
                                                        undefinierte Stellung: (B_nwsvs = false) & (B_nwsvf = false)
                                                                        oder:  (B_nwsvs = true)  & (B_nwsvf = true)
```

Der Verstellwinkel wnwi_w wird in %WANWKW im Phasen-Interrupt (R_ph) gebildet. Die Bedingungen B_nwsvs und B_nwsvf werden im Hintergrund-Programm zur Verfügung gestellt. Die Nockenwellensteuerung kann auf diese Größen zugreifen und abhängig von der Nockenwellenstellung Maßnahmen ergreifen.



dnws-dnws-e-1

Bildung der Fehlerbedingung E_nws* und der Fehlerart:

Fehler:	B_mxnws*	Wenn B_nws=0 anliegt (Passiv- / Spätstellung) und die Sollposition nicht erreicht wird.
	B_mnnws*	Wenn B_nws=1 anliegt (Aktiv- / Frühstellung) und die Sollposition nicht erreicht wird.
	B_npnws	Wenn sowohl die Passiv-/Spätstellung als auch die Aktiv-/Frühstellung nicht erreicht wurde.
	E_nws*=0 & Z_nws*=0	Beide Positionen wurden mindestens einmal angefahren (B_nws=0 und B_nws=1) und und beide Sollpositionen sind erreicht worden.

Die Fehlerbedingung E_nws gibt nur einen Stellerfehler wieder. Wird aufgrund eines Endstufenfehlers nicht verstellt, so führt dies nicht zu einem Fehlereintrag bei E_nws (siehe hierzu auch %DNWSE).

Fehlerspeicherverwaltung:

Status Fehlerpfad NWS:	SFPNWS	Status Fehlerpfad NWS2:	SFPNWS2
Errorflag NWS:	E_nws	Errorflag NWS2:	E_nws2
Zyklusflag NWS:	Z_nws	Zyklusflag NWS2:	Z_nws2
Fehlerart NWS:	B_mxnws B_mnnws B_npnws	Fehlerart NWS2:	B_mxnws2 B_mnnws2 B_npnws2

Löschen Fehlerpfad:	C_fcmclr & B_clnws	Löschen Fehlerpfad:	C_fcmclr & B_clnws2
Fehlerpfad NWS :	CDTNWS	Fehlerpfad NWS2 :	CDTNWS2
Fehlerklasse NWS:	CLANWS	Fehlerklasse NWS2:	CLANWS2
Fehlerschwere NWS:	TSFNWS	Fehlerschwere NWS2:	TSFNWS2
Carb-Code NWS:	CDCNWS	Carb-Code NWS2:	CDCNWS2
Umweltbedingungen NWS:	FFTNWS	Umweltbedingungen NWS2:	FFTNWS2

ABK DNWS 10.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCNWS	BLOKNR		KL	code word CARB: camshaft control
CDCNWS2	BLOKNR		KL	code word CARB: camshaft control bank 2
CDTNWS			FW	code word tester: camshaft control
CDTNWS2			FW	code word tester: camshaft control (bank 2)
CLANWS			FW	fault class: camshaft control
CLANWS2			FW	fault class: camshaft control bank 2
FFTNWS	BLOKNR		KL	freeze frame table: camshaft control
FFTNWS2	BLOKNR		KL	freeze frame table: camshaft control bank 2
NDNWMN			FW	minimum engine speed for diagnosis camshaft control
NDNWMX			FW	maximum engine speed for diagnosis camshaft control
TDDNWS			FW	distortion time for camshaft control diagnosis enable in end positions
TMDNW			FW	minimum engine temperature for camshaft control diagnosis
TSFNWS			FW	fault active time: camshaft contol
TSFNWS2			FW	fault active time: cam shaft control bank 2
TVDNWS			FW	wait time from end of start to DNWS permitted
UNWDNWS			FW	camshaft rotations for debouncing diagnosis NWS
WNWA			FW	limit angle for camshaft actuator active
WNWP			FW	limit angle for camshaft actuator passive

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_CDNWS	PROKON	EIN	function active per codeword CDNWS
B_CLNWS		EIN	condition clear fault path camshaft control
B_CLNWS2		EIN	condition clear fault path camshaft control 2
B_DNWS	DNWS	AUS	active diagnosis: camshaft control
B_ENWS	DNWS	AUS	condition error camshaft control
B_FA		EIN	condition general function request
B_FANWS		EIN	condition general function request for diagnosis camshaft control
B_MNNWS	DNWS	AUS	fault type: camshaft control advanced position not reached
B_MNNWS2	DNWS	AUS	fault type: camshaft control 2 advanced position not reached
B_MXNWS	DNWS	AUS	fault type: camshaft control retarded position not reached
B_MXNWS2	DNWS	AUS	fault type: camshaft control 2 retarded position not reached
B_NPNWS	DNWS	AUS	fault type camshaft control undefined position
B_NPNWS2	DNWS	AUS	fault type camshaft control 2 undefined position
B_NWS	NWS	EIN	Condition camshaft control
B_NWSFA	DNWS	AUS	condition NWS actuator diagnosis fault in active position
B_NWSFA2	DNWS	AUS	condition NWS actuator diagnosis fault in active position of camshaft 2
B_NWSFP	DNWS	AUS	condition NWS actuator diagnosis fault in passive position
B_NWSFP2	DNWS	AUS	condition NWS actuator diagnosis fault in passive position of camshaft 2
B_NWSVF	DNWS	AUS	condition camshaft control in advanced end position
B_NWSVF2	DNWS	AUS	condition camshaft control of bank 2 in advanced end position
B_NWSVS	DNWS	AUS	condition camshaft control in retarded end position
B_NWSVS2	DNWS	AUS	condition camshaft control of bank 2 in retarded end position
B_PHAD	WANWKW	EIN	adaptation crankshaft/camshaft performed
B_PHAD2	WANWKW	EIN	adaptation crankshaft/camshaft 2 performed
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_SYN		EIN	ECU-condition angle synchronization available
E_BM	DDG	EIN	error flag: reference mark sensor
E_NWS	DNWS	AUS	error flag: camshaft control
E_NWS2	DNWS	AUS	error flag: camshaft control bank 2

Variable	Source	Type	Description
E_NWSE	DNWSE	EIN	error flag: power stage of camshaft control valve
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
NMOT	SWADAP	EIN	engine speed
R_T200		EIN	Time schedule 200 ms
SFPNWS	DNWS	AUS	status fault path: camshaft control
SFPNWS2	DNWS	AUS	status fault path: camshaft control bank 2
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
SY_PHTWIN	PROKON	EIN	system constant 1/2 phase sensing system (sensor, wheel)
TMOT	SWADAP	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start
UZKW_W	GGDPG	EIN	revolution counter crankshaft
WNWIAW2_W	NWS	EIN	
WNWIAW_W	NWS	EIN	
Z_NWS	DNWS	AUS	cycle flag: camshaft control
Z_NWS2	DNWS	AUS	cycle flag: camshaft control bank 2

FW DNWS 10.60 Fixed Values

Parameter	Value	Description
CDTNWS		code word tester: camshaft control
CDTNWS2		code word tester: camshaft control (bank 2)
CLANWS		fault class: camshaft control
CLANWS2		fault class: camshaft control bank 2
NDNWMN		minimum engine speed for diagnosis camshaft control
NDNWMX		maximum engine speed for diagnosis camshaft control
TDDNWS		distortion time for camshaft control diagnosis enable in end positions
TMDNW		minimum engine temperature for camshaft control diagnosis
TSFNWS		fault active time: camshaft contol
TSFNWS2		fault active time: cam shaft control bank 2
TVDNWS		wait time from end of start to DNWS permitted
UNWDNWS		camshaft rotations for debouncing diagnosis NWS
WNWA		limit angle for camshaft actuator active
WNWP		limit angle for camshaft actuator passive

FB DNWS 10.60 Detailed description of function

Diese Diagnose berücksichtigt V-Motoren mit 2-Banksystemen mit je einer verstellbaren Einlaßnockenwelle pro Bank. Bei der Verstellung gibt es die 2 Sollzustände "passiv" (B_nws=0) und "aktiv" (B_nws=1). Die Istzustände werden in den Bedingungen B_nwsvs (passiv/spät) bzw. B_nwsvf (aktiv/früh) wiedergegeben.

1. Für NWS : Der Verstellwinkel wnwi_w gibt die Verstellung der Nockenwelle 1 an.
2. Für NWS2: Der Verstellwinkel wnwi2_w gibt die Verstellung der Nockenwelle 2 an.

Darstellung der Eingangssignale wnwi_w, B_nws und der Zeiger über die gemessene Istposition B_nwsvs, B_nwsvf:

```
        Beispielwerte:  Nockenwellenverstellwinkel: wnwi_w = 0 (B_nws=0) bis 20 Grad KW (B_nws=1)

 Stellsignal aus %NWS:  B_nws        true                         false
 Istposition aus %DNWS: B_nwsvs      false                        true
                        B_nwsvf      true                         false
                wnwi_w     ^
                      20°  |  --------------------+
                           |                       \
                           |     WNWA  -----------  \
                           |                         \
                           |                          \
                           |                           \   ------------- WNWP
                           |                            \
                        0° |                             +-------------------------
                           |
                           +----------------------------------------------------------->
                               Frühstellung      Verstellung     Spätstellung
```

```
Ablauf:      Freigabe    spät und          Spätposition    Fehlereintrag        spät
             Diagnose    früh ok           nicht erreicht      spät           wieder ok
                 .         .                    .               .                 .
                 +---------------------------------------------------------------------------------------------
B_dnws ----------+         .                    .               .                 .
                                                +---------------------------------+
B_nwsfp ----------------------------------------+                                 +----------------------------
                          Entprellung in NWU:   .<-- UNWDNWS -->
                           +------------------------------------+                 +----------------------------
kein Fehler ---------------+                                    +-----------------+

                           .                                    +-----------------+
B_mxnws  -------------------------------------------------------+                 +----------------------------
                           .                                                      .
B_mnnws  ------------------------------------------------------------------------------------------------------

                           +-----------------------------------------------------------------------------------
Z_nws ---------------------+                                    .                 .
                                                                +-----------------+
E_nws ----------------------------------------------------------+                 +----------------------------
```

APP DNWS 10.60 Application hint

```
Anhaltswerte für Erstapplikation:
        TVDNWS:         10 sec
        NDNWMX:         4500 U/min
        NDNWMN:         700 U/min  ( < Leerlaufdrehzahl)
        TMDNW:          50°C
        TDDNWS:         1 sec
        UNWDNWS:        4 NWU
        WNWP:           9 °KW   (bei Nockenwellen-Verstellwinkel: 21°)
        WNWA:           12 °KW  (bei Nockenwellen-Verstellwinkel: 21°)
        CDTNWS:         174                     CDTNWS2:        178
        CLANWS*:        3
        TSFNWS*:        255
        CDCNWS:         -                       CDCNWS2:        -
        FFTNWS*:        nmot, ub

Funktionsprüfung:
-----------------
Bei der Funktionsprüfung ist jede Bank getrennt zu untersuchen. Hierzu ist nachfolgende Prüfung durchzuführen:

1. Meßgrößen: Prüfung, ob alle Ramzellen und Labels per VS100 verfügbar.
        digitale Größen:nmot, tmot, E_tm, tnst_w, B_dnws,
                        B_phad*, wnwi*_w, B_nwsvs*, B_nwsvf*,
                        E_nwse, B_nws, uzkw_w, B_nwsfp*, B_nwsfa*, B_mnnws*, B_mxnws*, B_npnws*, E_nws*, Z_nws*
        Labels: alle Labels aus ABK-Liste
        Meßdatenerfassung: Erfassung per VS100 - VSO

2. Meßreihe:
        Um die Nockenwellenverstellung einfach auszulösen, ist das Verstellkennfeld in %NWS im Leerlaufbereich (untere Drehzahl,
        untere Last) auf Frühverstellung zu setzen. Über den Leerlaufschalter (B_ll) kann dann die Nockenwellenverstellung
        einfach per Gaspedal ausgelöst werden.
        Alternativ ist die Verstellung über B_fa und B_fanws möglich, falls diese Größen in der Funktion %NWS zur Ansteuerung
        der Nockenwellenverstellung für Prüfzwecke eingebunden ist.

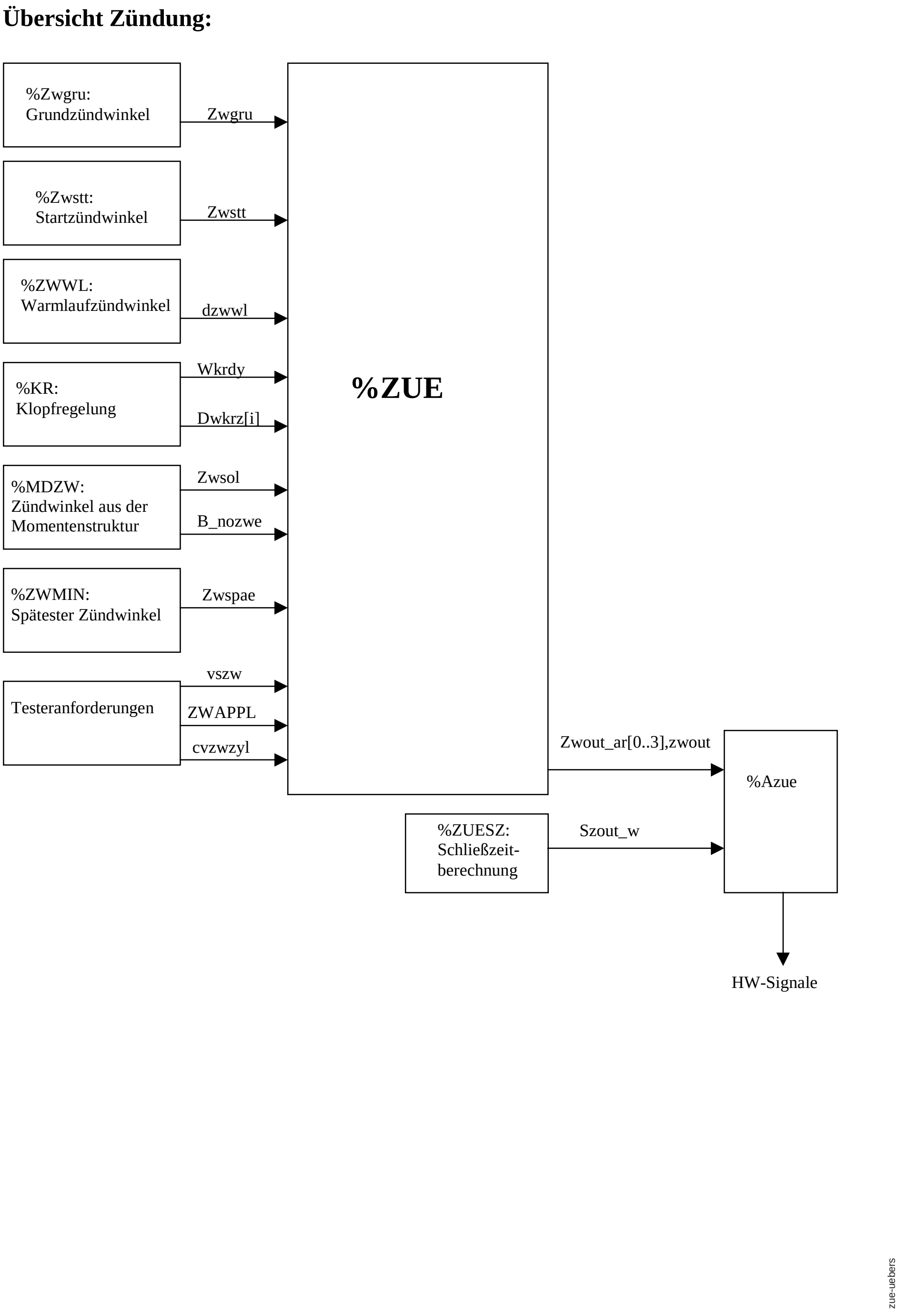
2.1 Prüfung der Diagnose-Freigabe über B_dnws:
        - Änderung der Labels NDNWMX, NDNWMN, TMDNW so, daß das Ein-/Ausschalten von B_dnws bei der aktuellen Drehzahl nmot
          und Temperatur tmot verursacht wird.
        - Prüfung, ob im Nachstart bei Erreichen der Nachstartzeit tnst_w=TVDNWS B_dnws gesetzt wird.
        - Ausschalten B_dnws über E_tm: Ändern der oberen Temperaturschwelle in %GGTFM um E_tm zu setzen.

2.2 Prüfung der Bedingungen für Früh- und Spätverstellung: B_nwsvf, B_nwsvs
        - Plausibilität B_phad (true) und wnwi_w (0...max. Verstellwinkel in °KW) prüfen: sonst %WANWKW überprüfen;
        - Leerlauf (Spätstellung) / Teillast (Frühstellung) führt zur Änderung von wnwi_w und zum abwechselnden
          Setzen von B_nwsvs und B_nwsvf

2.3 Prüfung der Bedingungen für Fehler Aktiv/Früh- und Passiv/Spätverstellung: B_nwsfa, B_nwsfp
        - Wechseln in Spätstellung (Leerlauf) / Frühstellung (Teillast) und WNWP= 9°, WNWA= 12°
                                        -----> B_nwsfp=false, B_nwsfa=false, B_*nws=false, E_nws=false, Z_nws=true;
        - In Spätstellung (Leerlauf) WNWP= -10°, WNWA= 12° setzen
                                        -----> B_nwsfp=true, B_nwsfa=false, B_mxnws=true, E_nws=true, Z_nws=true;
        - In Frühstellung (Teillast) WNWP=  9°, WNWA= 50° setzen
                                        -----> B_nwsfp=false, B_nwsfa=true, B_mnnws=true, E_nws=true, Z_nws=true;
        - Wechseln in Spätstellung (Leerlauf) / Frühstellung (Teillast) und WNWP= -10°, WNWA= 50°
                                        -----> B_nwsfp=true, B_nwsfa=true, B_npnws=true, E_nws=true, Z_nws=true;
```

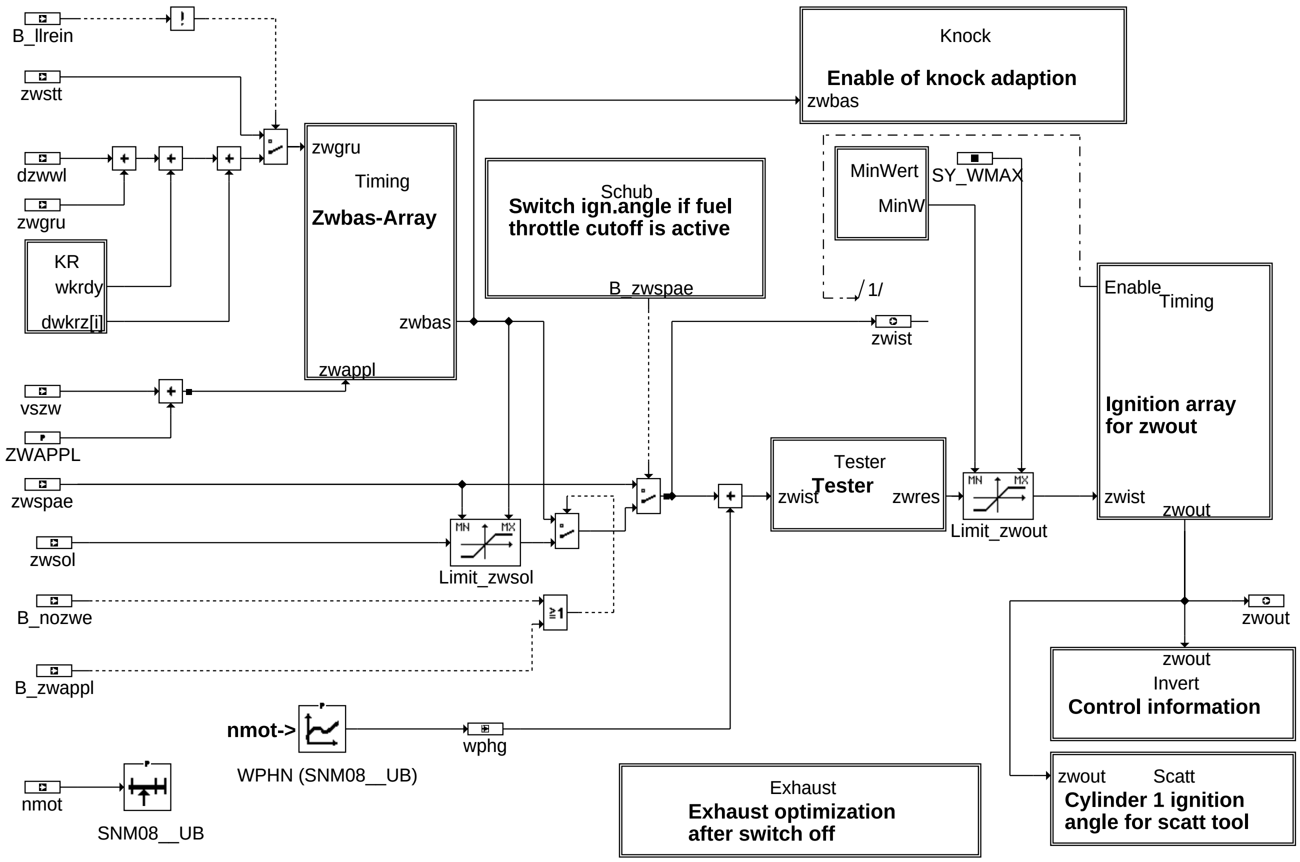
ZUE 258.130 Basic function - ignition

FDEF ZUE 258.130 Function definition

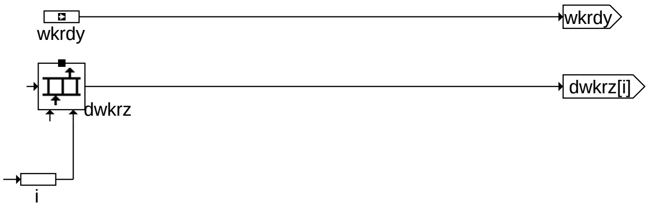


zue-uebers

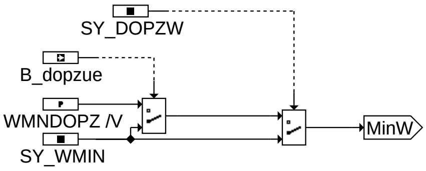
Source: ZUE 258.130



zue-main

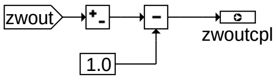


zue-kr



If limp-home function for cylinder-synchronisation is active, the latest possible ignition angle has to be limited to earlier limits.
In case of a limp-home function ignition signals are outputted in a 360° interval instead of 720° this can lead to an ignition into the opened inlet valve if ignition angle is too late during gas exchange.

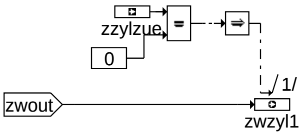
zue-minwert



Complement of zwout is needed for the supervisory module to make a plausibility check

Control information

zue-invert

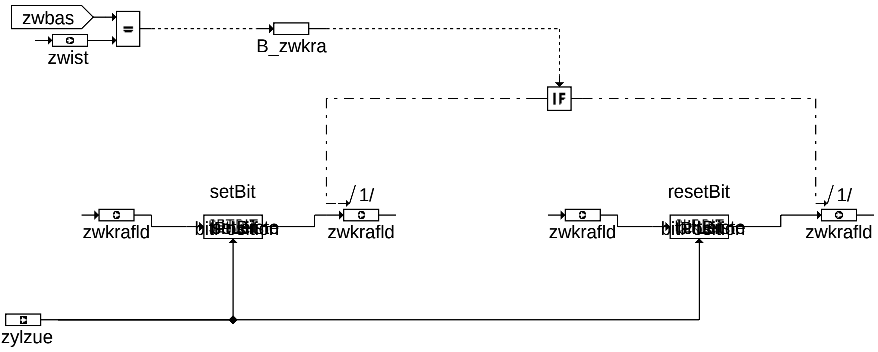


Ignition angle for cylinder 1 is needed for scatt tool

zue-scatt

Cylinder 1 ignition-angle for scatt-tool

zue-scatt

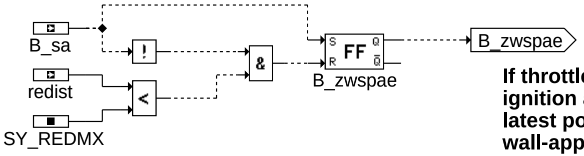


Bit B_zwkra is set if zwist equals zwbas. If B_zwkra is set a cylinderspecific bit inside flag byte zwkrafld is also set. B_zwkra = TRUE means that knock control is able to control the ignition angle.

zue-knock

Enable of knock adaptation

zue-knock



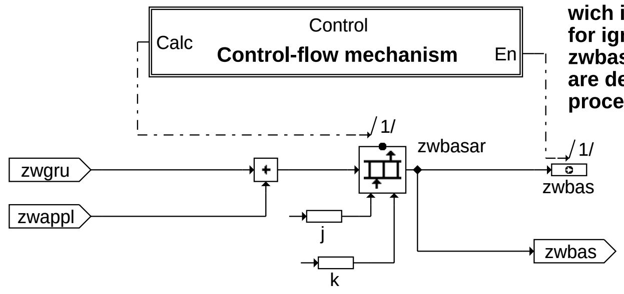
If throttle fuel cutoff is active the ignition angle is switched to the latest possible angle in order to ignite wall-applied fuel film with best burning conditions for the catalyst

zue-schub

Switch ign. angle if fuel throttle cutoff is active

zue-schub

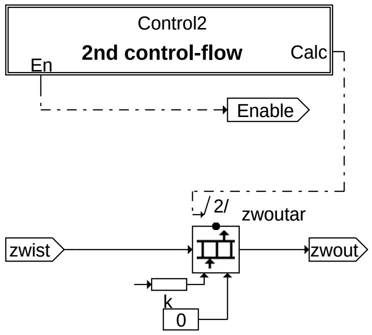
Because of dwell-time overlapping an ignition angle array is needed The zwbas-array is calculated in the synchro-task in a process before calculation of torque-coordination. zwsol is calculated out of torque-coordination wich is based on zwbas as reference for igntion-angle efficiency. zwbas, zwspae zwsol and the phase shift wphn are defining zwout wich is calculated in a synchro process after torque coordination



zwbas-array

zue-timing1

zue-timing1

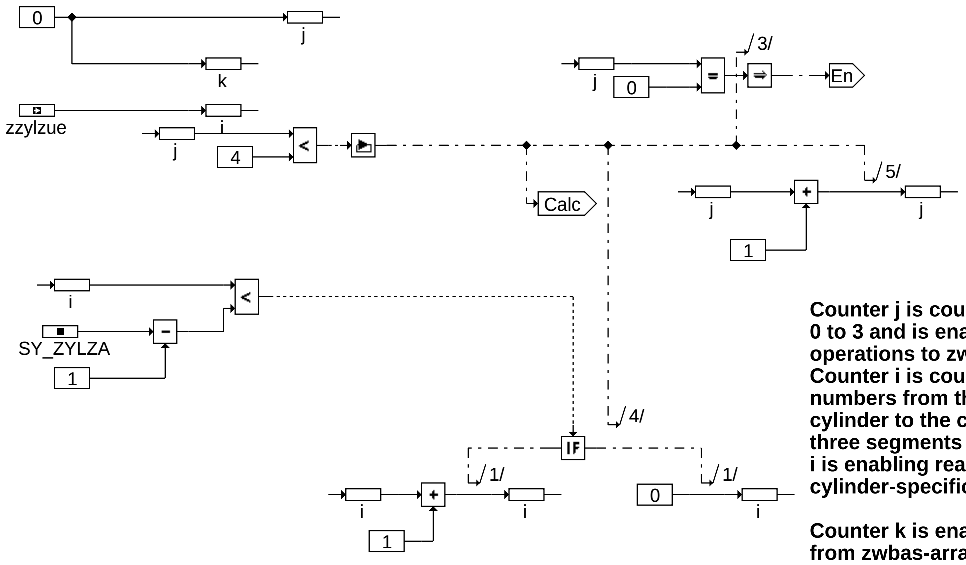


For overlapping mode a four element ignition array is needed. The zwout-array is calculated in a special zwout-sequence after calculation of zwsol out of zwbas.

Ignition array for zwout

zue-timing2

zue-timing2



Counter j is counting from 0 to 3 and is enabling write operations to zwbas-array. Counter i is couting cylinder numbers from the latest cylinder to the cylinder number three segments ahead. Counter i is enabling read-operations from cylinder-specific knock-offsets.

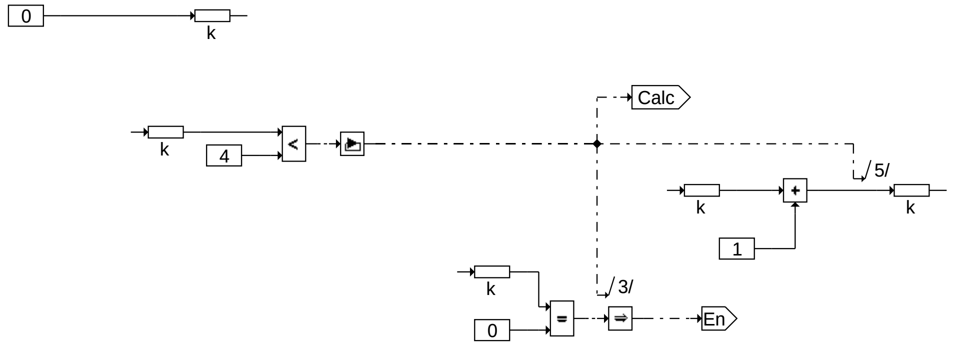
Counter k is enabling read-operations from zwbas-array an is set to 0 in order to start read-operations at element 0.

The control flow sequence is calculated in process syn_zwbas this means that the mentioned counters are active before torque-coordination starts.

Control-flow mechanism

zue-control

zue-control

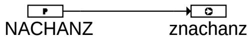


Counter k is calculated in a angle synchronous process after torque-coordination. kth element zwout-array is calculated out of kth element of zwbas-array zwsol and zwspae. If k equals zero zwist and zwout are calculated out of element 0 of zwbasar.

2nd control-flow

zue-control2

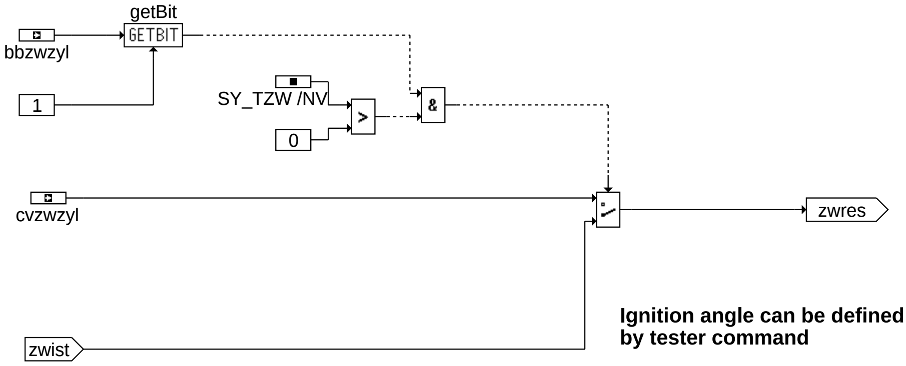
zue-control2



Exhaust optimization after switch off

zue-exhaust

zue-exhaust

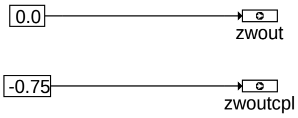


Ignition angle can be defined by tester command

Tester

zue-tester

zue-tester



zue-initialize

zue-initialize

ABK ZUE 258.130 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SNM08_UB	NMOT		SV	Base point distribution engine speed, 8 base points
SY_DOPZW			SYS (REF)	System constant doubled ignition output included
SY_REDMX			SYS (REF)	system constant: max. cylinder cutoff step
SY_TZW			SYS (REF)	System constant tester manipulation of zwist included
SY_WMAX			SYS (REF)	System constant earliest ignition timing that can be outputed
SY_WMIN			SYS (REF)	System constant latest ignition timing that can be outputed
SY_ZYLZA			SYS (REF)	system constant number of cylinders
WMNDOPZ			FW	Latest ignition angle at limp-home mode for phase detection
WPHN	NMOT		KL	phase correction
ZWAPPL			FW	Applications interface ignition angle adjustment

Variable	Source	Type	Description
BBZWZYL		EIN	Condition Flag ingition angle manipulation by tester
B_DOPZUE	NLPH	EIN	Condition double ignition
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_NOZWE	MDZW	EIN	condition no ignition angle intervention of torque structure
B_SA	MDRED	EIN	Condition fuel cut-off
B_ZWAPPL	PROKON	EIN	Condition ignition-timing applications without torque intervention
B_ZWKRA	ZUE	LOK	condition: ignition angle of the KC is active
CVZWZYL		EIN	device control value ignition
DWKRZ	KRRA	EIN	cyl.-spec. ignition-timing retardation with retardation for dynamics
DZWWL	ZWWL	EIN	delta ignition angle from warm-up
NMOT	SWADAP	EIN	engine speed
REDIST	BGEVAB	EIN	real cylinder cut-off step
VSZW	VS_VERST	EIN	Ignition-timing correction by adjusting system
WKRDY	KRDY	EIN	ignition retard during dyn-function of knock control
WPHG	ZUE	LOK	ignition angle DG phase correction
ZNACHANZ	ZUE	AUS	Amount of ignitions after KL15 off
ZWBAS	ZUE	AUS	basic ignition angle
ZWBASAR	ZUE	AUS	basic ignition angle array
ZWGRU	ZWGRU	EIN	basic ignition angle
ZWIST	ZUE	AUS	real ignition angle
ZWKRAFLD	ZUE	AUS	bit pattern of the cylinder-individually stored B_zwkra
ZWOUT	ZUE	AUS	Ignition angle output value
ZWOUTAR	ZUE	AUS	Ignition angle output array
ZWOUTCPL	ZUE	AUS	Single complement of the ignition angle for function monitoring
ZWSOL	MDZW	EIN	desired ignition angle from torque intervention
ZWSPAE	ZWMIN	EIN	retarded ignition angle
ZWSTT	ZWSTT	EIN	Ignition angle during start
ZWZYL1	ZUE	AUS	ignition angle cylinder 1
ZZYLZUE		EIN	SW-zylinder counter for ignition calculation

FW ZUE 258.130 Fixed Values

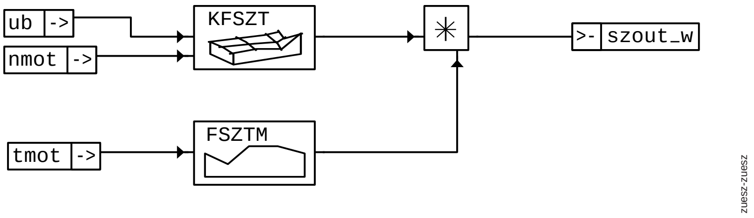
Parameter	Value	Description
WMNDOPZ		Latest ignition angle at limp-home mode for phase detection
ZWAPPL		Applications interface ignition angle adjustment

FB ZUE 258.130 Detailed description of function

APP ZUE 258.130 Application hint

ZUESZ 1.50 Ignition, calculation of coil closing time

FDEF ZUESZ 1.50 Function definition



zuesz-zuesz

ABK ZUESZ 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CW_FUBND			FW	Code word for interval ignition
FFLDZ	UB		KL	Follow-on ignition charging time
FSZTM	TMOT		KL	Factor dwell angle correction tmot depending
FTMFFANZ	TMOT		KL	Follow-on ignition weighting factor
FUBAOF			FW	Opening time for interval ignition
FWNMOT			FW	Turn on limit nmot for interval ignition
KFFFANZ	NMOT	TMOT	KF	Number of sequential sparks
KFFFANZUB	UB	NMOT	KF	Number of sequential sparks
KFSZT	UB	NMOT_W	KF	Dwell angle characteristic map
SY_FFZ			SYS (REF)	system constant interval ignition
SY_ME7			SYS (REF)	system constant ECU
SY_TZW			SYS (REF)	System constant tester manipulation of zwist included
SZOUTMIN			FW	Minimum dwell time

Variable	Source	Type	Description
BBZWZYL		EIN	Condition Flag ingition angle manipulation by tester
B_FF	ZUESZ	AUS	Condition sequential sparks ignition
CVFUBAANZ		EIN	
CVOFFZ_W		EIN	

Variable	Source	Type	Description
CVSZFUBA_W		EIN	
FUBAANZ	ZUESZ	AUS	Amount of ignitions
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
OFFZ_W	ZUESZ	AUS	Opening time
SZFUBA_W	ZUESZ	AUS	dwell time interval ignition
SZOUT_W	ZUESZ	AUS	dwell time
SZTCALC_W	ZUESZ	AUS	Dwell period in timer 1 increments
TMOT	SWADAP	EIN	Engine temperature
UB	SWADAP	EIN	battery voltage

FW ZUESZ 1.50 Fixed Values

Parameter	Value	Description
CW_FUBND		Code word for interval ignition
FUBAOF		Opening time for interval ignition
FWNMOT		Turn on limit nmot for interval ignition
SZOUTMIN		Minimum dwell time

FB ZUESZ 1.50 Detailed description of function

1. Introduction:

Sufficient ignition energy must be made available in order that the sparking plug can ignite the mixture. This is realized by closing the primary circuit of the ignition coil in good time so that the coil can charge up sufficiently.
On the other hand, the closing time shall not be too long as this can otherwise lead to the ignition output stage overheating (particularly critical for internal output stages).
After closing, the primary current i increases exponentially with time. The period of time from the primary circuit closing to opening again (sparking) is referred to as the dwell time.

The energy stored in the magnetic field is given by :

W = 1/2 * L * i^2 (L: inductance, i: current flowing at the point in time that the primary circuit opens)

2. Calculation of the dwell time:

The dwell time szout is calculated from a map that depends on the speed and battery voltage, corrected by a factor depending on the engine temperature (from characteristic FSZTM).

3. Dependency of the dwell time:

ub: The primary current i flows through the primary winding of the ignition coil. This is determined by the battery voltage ub and the resistance of the coil.

nmot: Above an engine-speed threshold, the dwell time is computed as a dwell angle and output at an angle level.
Thus a speed-dependent lead by the dynamics is required here so that a sufficiently long dwell time is still given even in the event of maximum speed dynamics. The dynamics lead is taken into account in the map KFSZT.
The dynamics lead required is lower at higher engine speeds.
No dynamics lead is necessary in the lower engine-speed range (dwell time output).
It can also be meaningful to have a shorter dwell time at higher speeds for thermal reasons.

tmot: The ignition coil temperature changes with the engine temperature.

APP ZUESZ 1.50 Application hint

If the dwell time is too short, then the energy will not suffice to ignite the mixture.
A dwell time that is too long can endanger the ignition output stages.

Application proposal:

Data from a 8-cylinder engine: For KFSZT:

	4.99	6.03	8.01	9.99	11.96	14.04	16.01	17.05
50.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
150.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
450.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
675.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
1000.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
2000.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
3000.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15
6350.	19.97	19.86	7.17	4.81	3.58	2.76	2.25	2.15

BLOCK ANM

TEXT/ANF

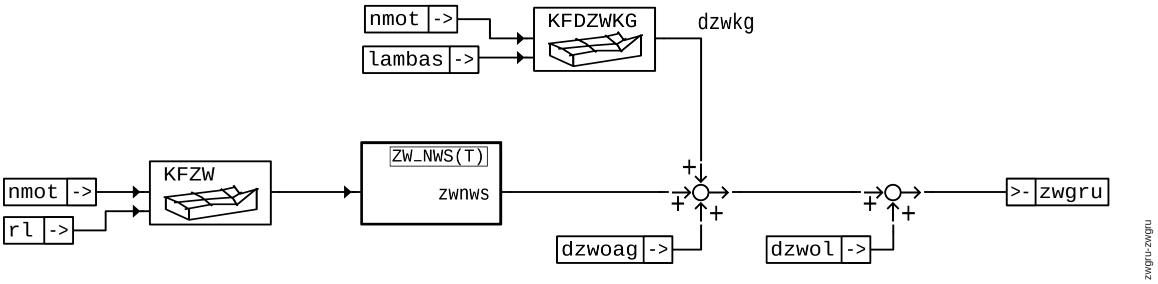
RAM cell	Physical range	Quantization	Calc. freq.	Init value	Remarks
szout_w	0...6553.5 ms	16 bit, 0.1 ms	20 ms	0	

In the SW module szout_w is converted or re-quantized into the corresponding timer quantization.
The minimum value of szout_w is still limited to 0.3 ms, i.e. szout_w is always > 0.3 ms.

Parameter	Physical range	Permiss. range	Quantization	Calc. frequency	Remarks
KFSZT	0...25.5 ms		8 bit, 0.1 ms	20 ms	
FSZTM	0...2		8 bit, 0.0078	20 ms	

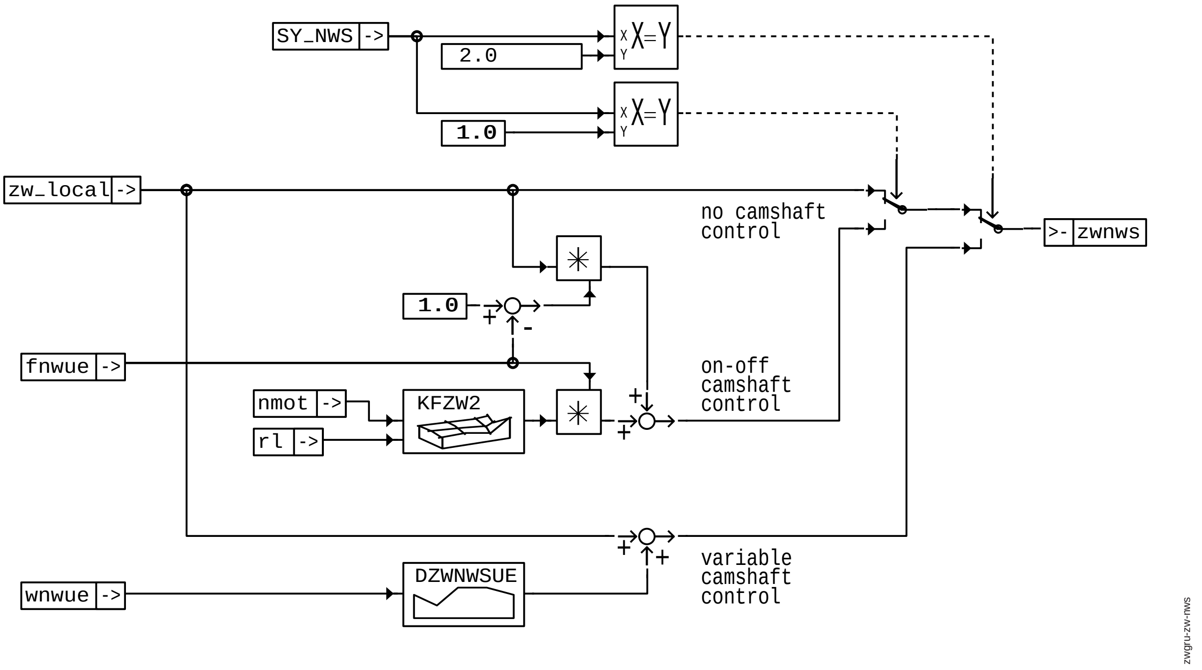
ZWGRU 19.30 Basic ignition angle

FDEF ZWGRU 19.30 Function definition



zwgru-zwgru

Teilfunktion ZW_NWS: Berücksichtigung einer ggf. vorhandenen 2-Punkt- oder stetigen Nockenwellensteuerung



zwgru-zw-nws

ABK ZWGRU 19.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DZWNWSUE	WNWUE		KL	Delta ignition angle dependent on the camshaft overlap
KFDZWKG	NMOT	LAMBAS	KF	ignition angle correction due to knock limit shift
KFZW	NMOT	RL	KF	Ignition advance-angle characteristik map
KFZW2	NMOT	RL	KF	Ignition angle performance characteristics variant 2

Variable	Source	Type	Description
DZWKG	ZWGRU	LOK	delta ignition angle knock limit shift
DZWOAG	MDBAS	EIN	exhaust recirculation rate-dependent correction of optimum ignition angle
DZWOL	MDBAS	EIN	Lambda-dependent correction of optimum ignition angle
FNWUE	NWS	EIN	Weighting factor camshaft overlap
LAMBAS	SWADAP	EIN	basic Lambda
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SY_NWS	PROKON	EIN	system constant camshaft control: none, 2 point or continuous
WNWUE	NWS	EIN	camshaft overlap angle of inlet and outlet valve opening
ZWGRU	ZWGRU	AUS	basic ignition angle
ZWNWS	ZWGRU	LOK	basic ignition angle with camshaft control

FW ZWGRU 19.30 Fixed Values

Parameter	Value	Description

FB ZWGRU 19.30 Detailed description of function

Bereitstellung des Grundzündwinkels aus dem Kennfeld KFZW. Die Teilfunktion ZW_NWS beschreibt die Berücksichtigung einer ggf. vorhandenen Nockenwellensteuerung (NWS). Bei 2-Punkt-NWS wird über den Faktor fnwue stetig zwischen KFZW und dem Kennfeld KFZW2 umgeschaltet. Im Fall einer stetigen NWS wird abhängig vom Überschneidungswinkel wnwue eine Zündwinkelkorrektur DZWNWSUE zu KFZW addiert. Die jeweils gültige NWS-Variante wird über die Systemkonstante SY_NWS bei der SW-Erstellung festgelegt:

```
        SY_NWS  = 0:    keine NWS
                = 1:    2-Punkt-NWS
                = 2:    stetige NWS
                > 2:    nicht definiert.
```

Die SW wird bedingt übersetzt, d.h. es ist immer nur eine Variante im EPROM vorhanden. SY_NWS ist nicht im EPROM nicht applizierbar.

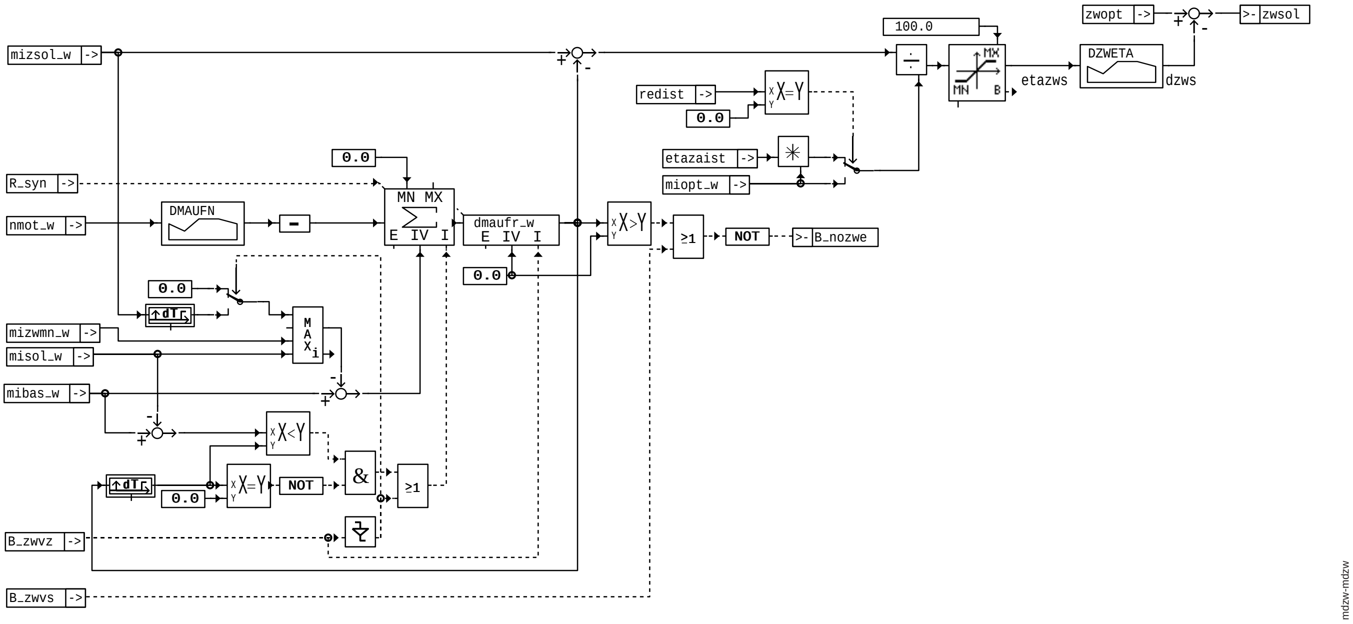
Durchführung der gleichen additiven Zündwinkelkorrektoren wie bei der Berechnung des optimalen Zündwinkels (siehe %MDBAS), d.h. Berücksichtigung von AGR- und Lambdaabhängigkeit. Die Temperaturabhängigkeit wird in einer gesonderten Funktion (%ZWWL) berücksichtigt.

APP ZWGRU 19.30 Application hint

Die Kennfelder KFZW, ˜2 werden bei betriebswarmen Motor für die jeweilige NWS-Position appliziert, AGR inaktiv, Lambda=1. Falls der Motor nicht klopft, Eintrag des optimalen Zündwinkels. Bei klopfendem Motor Eintrag der Klopfgrenze.

MDZW 1.120 Calculation of torque in nominal ignition timing

FDEF MDZW 1.120 Function definition



mdzw-mdzw

ABK MDZW 1.120 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMAUFN	NMOT_W		KL	delta torque rise after torque intervention
DZWETA	ETAZWS		KL	delta ignition angle from efficiency

Variable	Source	Type	Description
B_NOZWE	MDZW	AUS	condition no ignition angle intervention of torque structure
B_ZWVS	MDKOG	EIN	condition for fast external ignition angle intervention of torque interface
B_ZWVZ	MDKOG	EIN	condition for ignition angle intervention of torque interface
DMAUFR_W	MDZW	LOK	delta torque rise
DZWS	MDZW	LOK	difference ignition timing (between zwopt and zwsol)
ETAZAIST	MSF	EIN	actual cylinder masking effectiveness
ETAZWS	MDZW	LOK	nominal ignition angle effectiveness
MIBAS_W	MDBAS	EIN	indicated basic torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W	MSF	EIN	indicated resultant nominal torque
MIZSOL_W	MSF	EIN	indicated resultant nominal torque for ignition angle intervention
MIZWMN_W	MDRED	EIN	indicated engine torque at the latest spark angle
NMOT_W	SWADAP	EIN	engine speed
REDIST	BGEVAB	EIN	real cylinder cut-off step
R_SYN	GGDPG	EIN	Synchro schedule
ZWOPT	MSF	EIN	optimal ignition angle
ZWSOL	MDZW	AUS	desired ignition angle from torque intervention

FW MDZW 1.120 Fixed Values

Parameter	Value	Description

FB MDZW 1.120 Detailed description of function

With the caculation of the desired ignition angle three cases have to be considered:

1. Torque intervention through ignition angle active (B_zwvs=1)
2. Turning-off of torque intervention after being active (B_zwvs=0, dmaufr_w>0)
3. Torque intervention not active (B_nozwe=1)

1. Active torque intervention

The condition B_zwvs is set and the condition for deactivation of ignition angle intervention B_nozwe is false. The desired ignition angle is being calculated from the torque request mizsol_w for the ignition angle path. The contribution of the ramp of torque rise dmaufr_w is zero.

The torque request mizsol_w is converted to the nominal ignition angle effectiveness etazws. This occurs through division by the optimum torque, which is calculated by multiplying miopt_w by the effectiveness etazaist. The nominal ignition angle effectiveness etazws is converted to a delta ignition angle dzws using the inverted characteristic curve DZWETA. From the difference between the optimal ignition angle zwopt and dzws the nominal ignition angle zwsol is calculated.

2. Turning-off of torque intervention

When the torque intervention is turned off (B_zwvz=1 -> 0, see function %MDKOG) the nominal torque mizsol_w can jump to a higher value. This jump has to be prevented because of driveability. For that in the moment B_zwvz turns zero a ramp dmaufr_w is started, which is initialized with the height of the jump and declines with speed dependent velocity until it turns zero. This ramp is substracted from mizsol_w and produces a smooth transition into the state without ignition intervention. In this state B_zwvs is false. However the turn-off condition for ignition intervention B_nozwe is not set until after the ramp is run out.

A special case is the anti-jerk intervention in which B_zwvs, but not B_zwvz is set. If the torque request of the anti-jerk function ceases there is no jump in the input variable mizsol_w. Therefore no turn-off ramp is necessary.

3. Torque intervention not active

In this case no request is active (B_zwvs=0) and the ramp dmaufr_w came to an end. The turn-off condition for the ignition angle intervention B_nozwe is set. The nominal ignition angle zwsol is not considered by the ignition (see %ZUE) and its calculation can therefore be omitted.

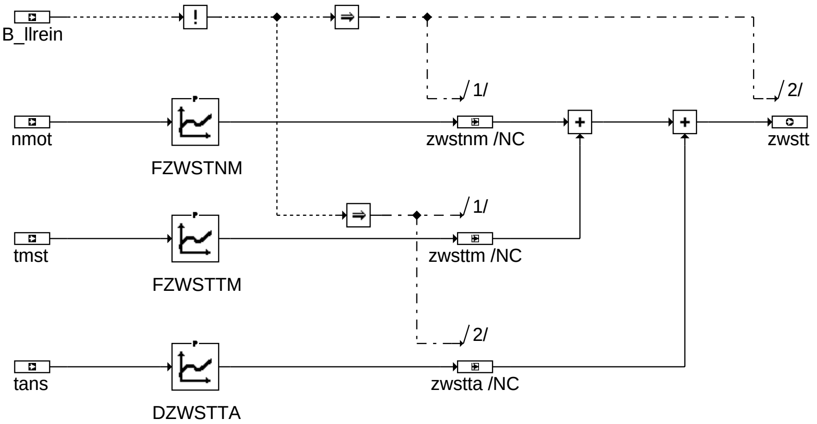
APP MDZW 1.120 Application hint

The characteristic DZWETA is the inverse of the characteristic ETADZW.
The data in DMAUFN have to be chosen preliminary in such a way that there is a gradient of approximately 5%/sec.

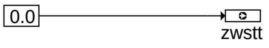
ZWSTT 4.20 Igniton at start

FDEF ZWSTT 4.20 Function definition

Source: ZWSTT 4.20



zwstt-main



zwstt-initialize

ABK ZWSTT 4.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DZWSTTA	TANS		KL	Delta ignition angle during start
FZWSTNM	NMOT		KL	Ignition angle during start
FZWSTTM	TMST		KL	Ignition angle during start

Variable	Source	Type	Description
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
NMOT	SWADAP	EIN	engine speed
TANS	SWADAP	EIN	Intake air temperature
TMST	GGTFM	EIN	engine temperature at start
ZWSTNM	ZWSTT	LOK	ignition angle during start nmot-dependent part
ZWSTT	ZWSTT	AUS	Ignition angle during start
ZWSTTA	ZWSTT	LOK	ignition angle during start tans-dependent part
ZWSTTM	ZWSTT	LOK	ignition angle during start tmst-dependent part

FW ZWSTT 4.20 Fixed Values

Parameter	Value	Description

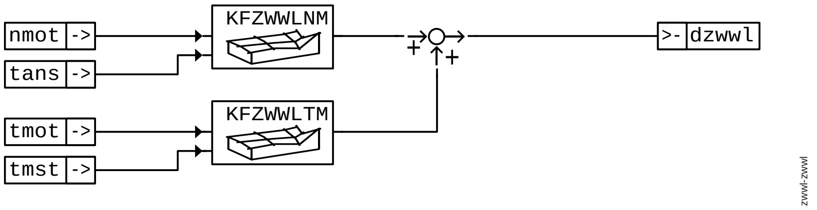
FB ZWSTT 4.20 Detailed description of function

`At start the ignition angle output value zwout is the result of zwstt and the ignition angle DG phase correction wphg (see %ZUE). The ignition angle during start zwstt is calculated until B_llrein is true.`

APP ZWSTT 4.20 Application hint

ZWWL 4.10 Ignition during warm-up

FDEF ZWWL 4.10 Function definition



zwwl-zwwl

ABK ZWWL 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFZWWLNM	NMOT	TANS	KF	Delta ignition sparc advance during engine warm up phase
KFZWWLTM	TMOT	TMST	KF	Delta ignition sparc advance during engine warm up phase

Variable	Source	Type	Description
DZWWL	ZWWL	AUS	delta ignition angle from warm-up
NMOT	SWADAP	EIN	engine speed
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start

FW ZWWL 4.10 Fixed Values

Parameter	Value	Description

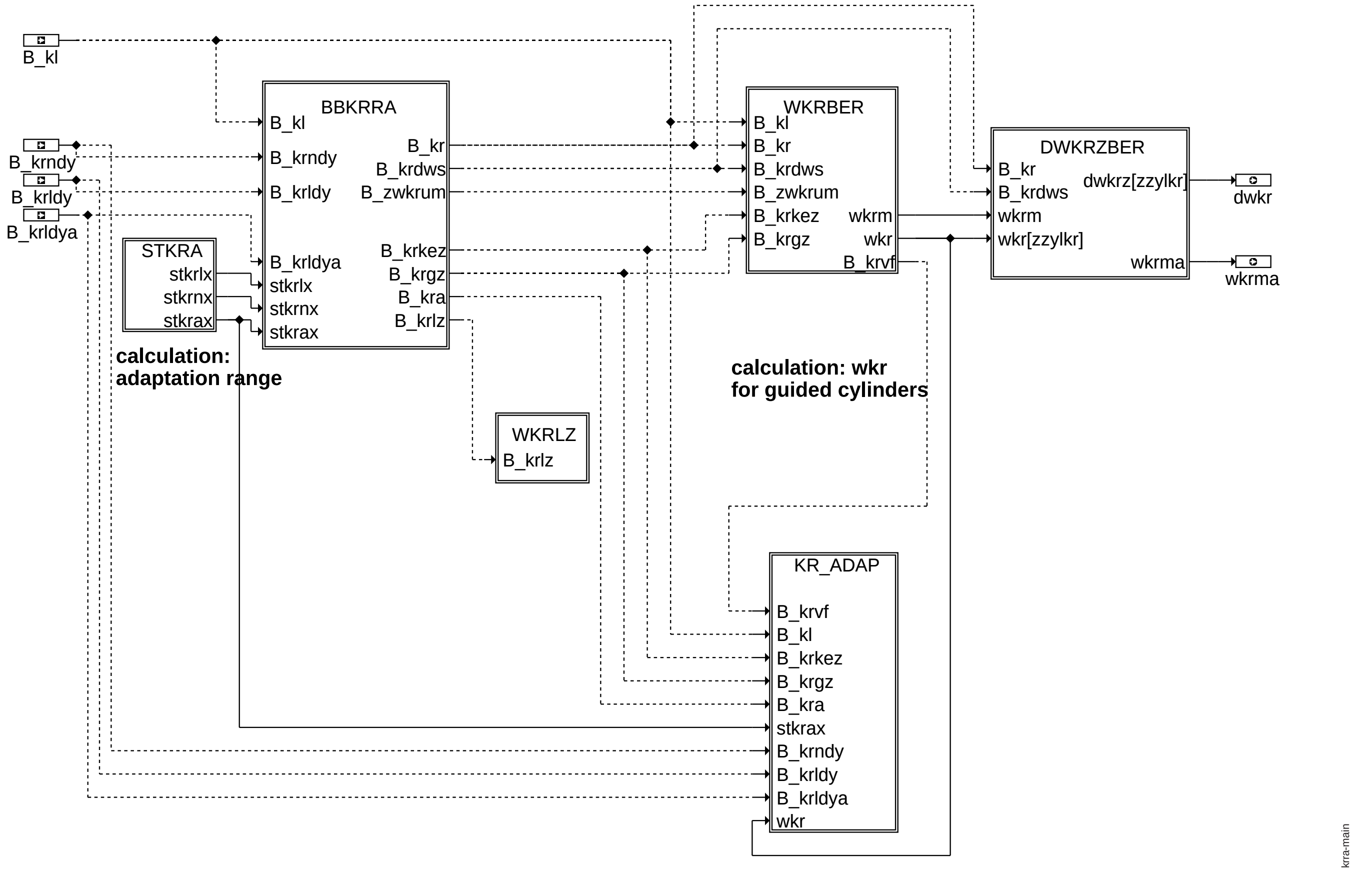
FB ZWWL 4.10 Detailed description of function

`The function offers the possibility to modify the basic ignition sparc advance zwbas by an additive value dzwwl. This offset is dependent on engine start temperature, intake air temperature and engine speed.`

APP ZWWL 4.10 Application hint

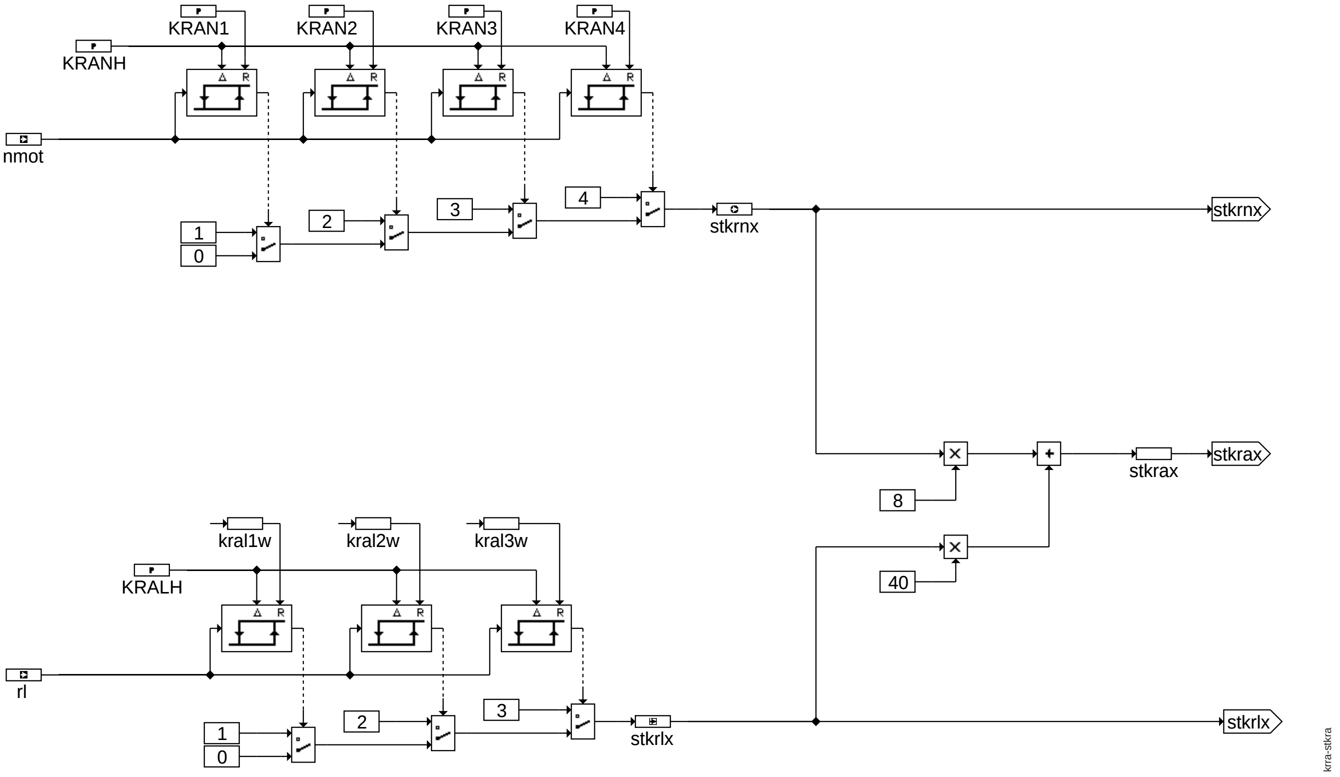
KRRA 18.70 Adaptive knock control

FDEF KRRA 18.70 Function definition



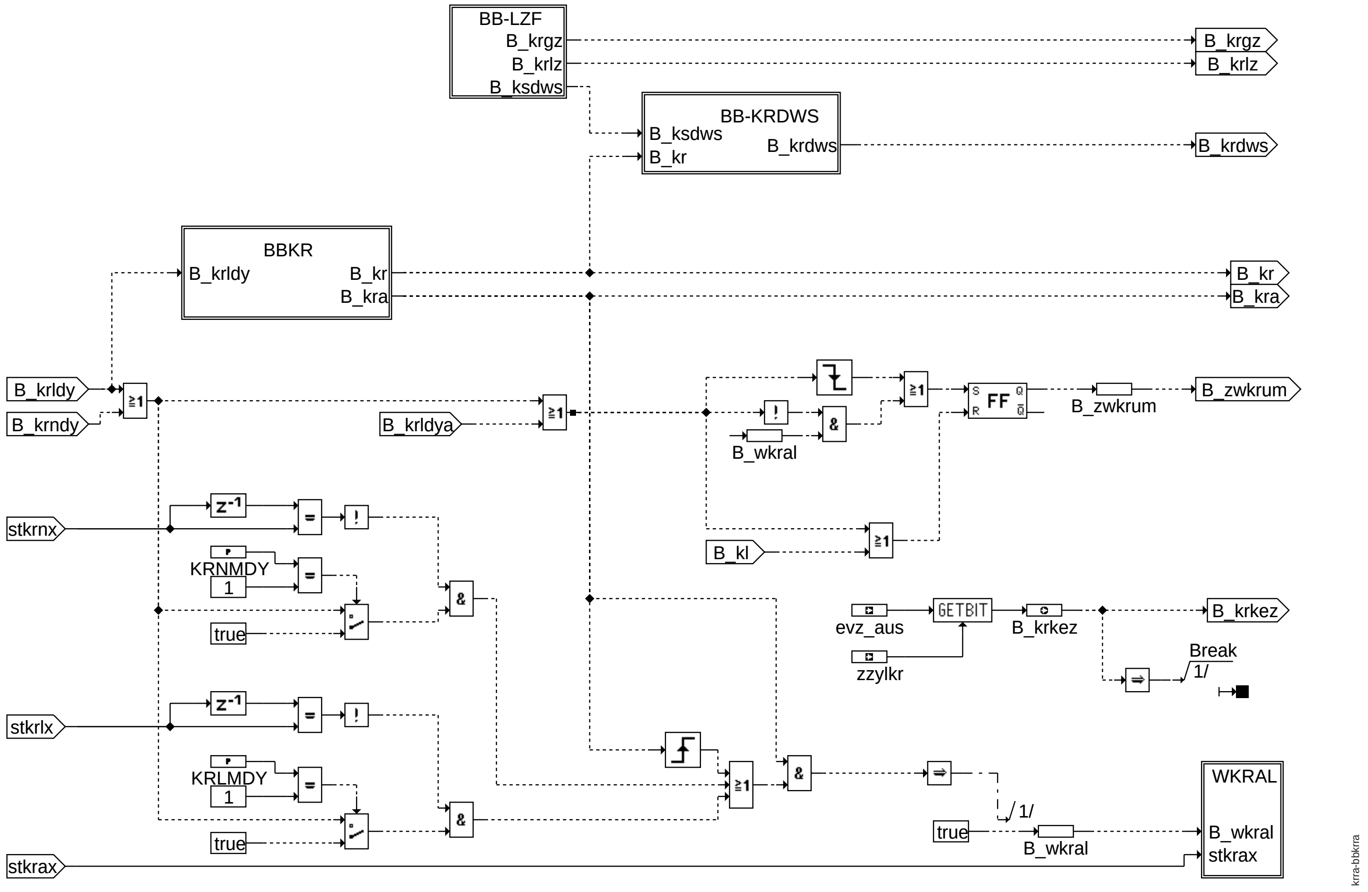
krra-main

STKRA: Detection of load- and speed range



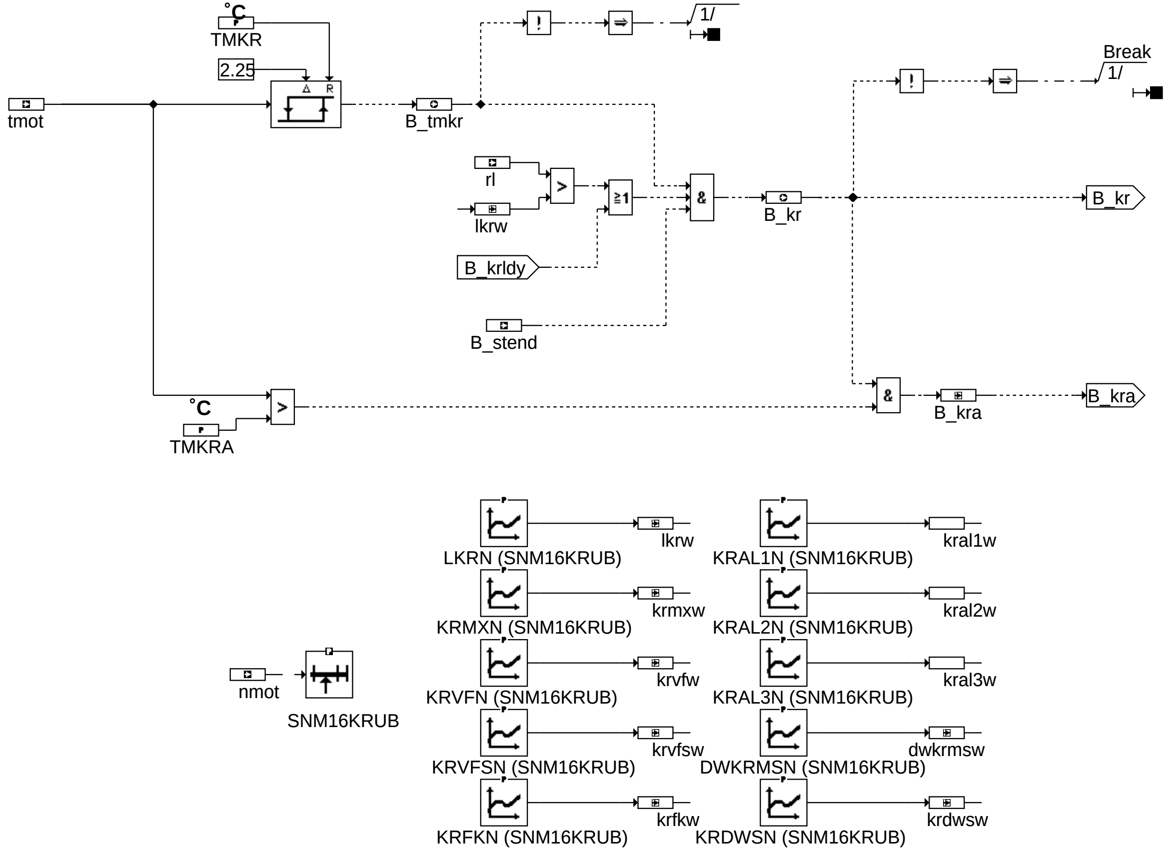
krra-stkra

BBKRRA: release of knock control and adaptation



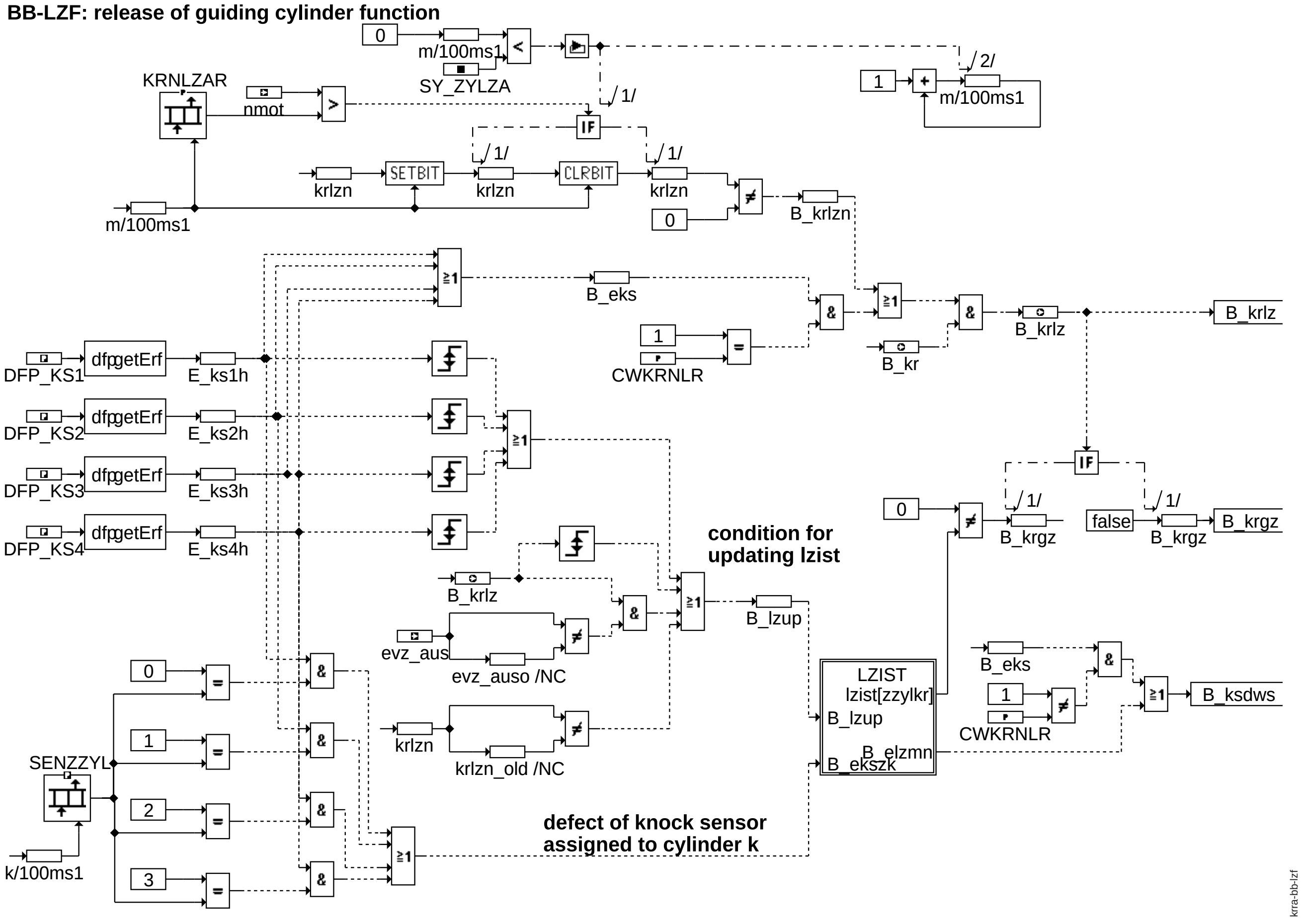
krra-bbkrra

BBKR: release of knock control and adaptation



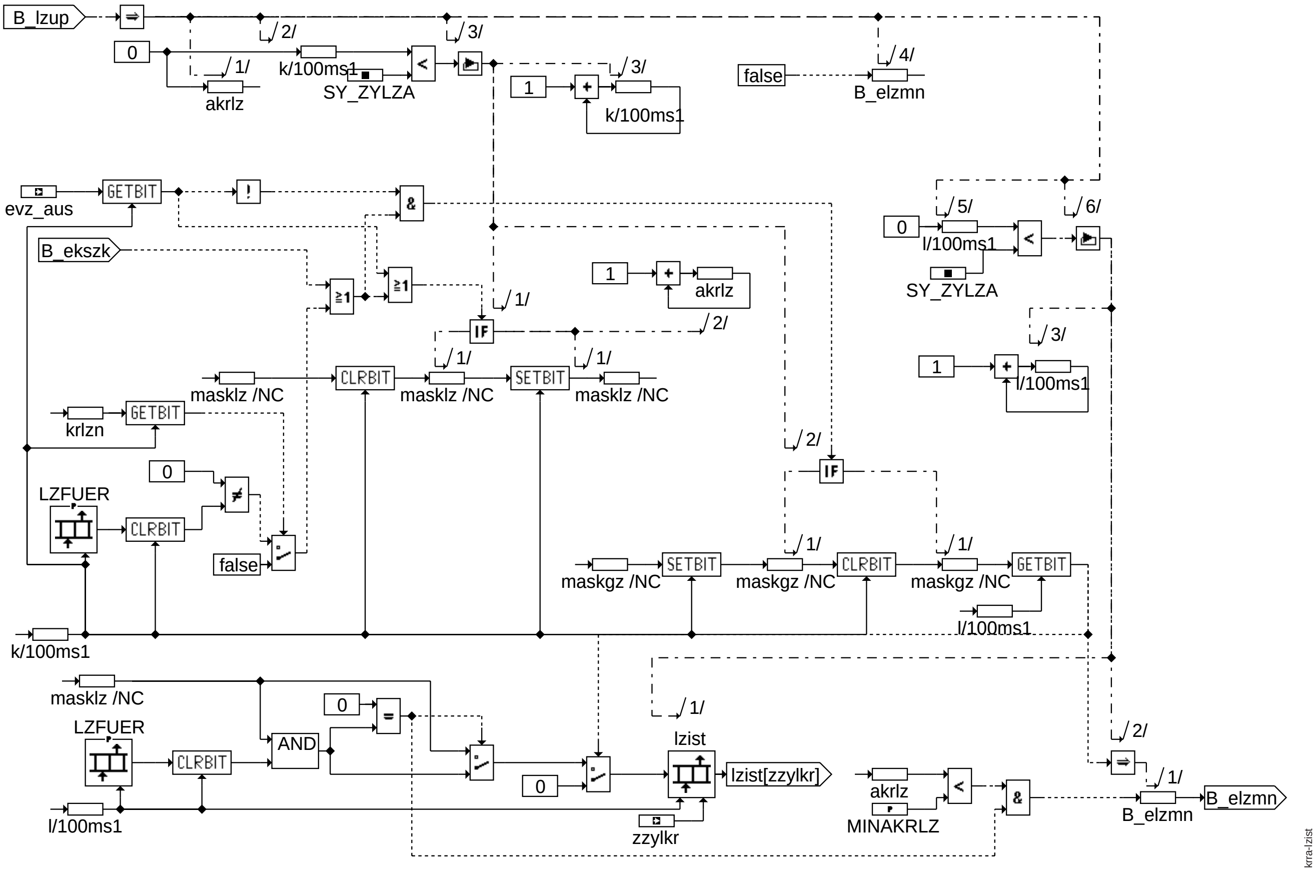
krra-bbkr

BB-LZF: release of guiding cylinder function



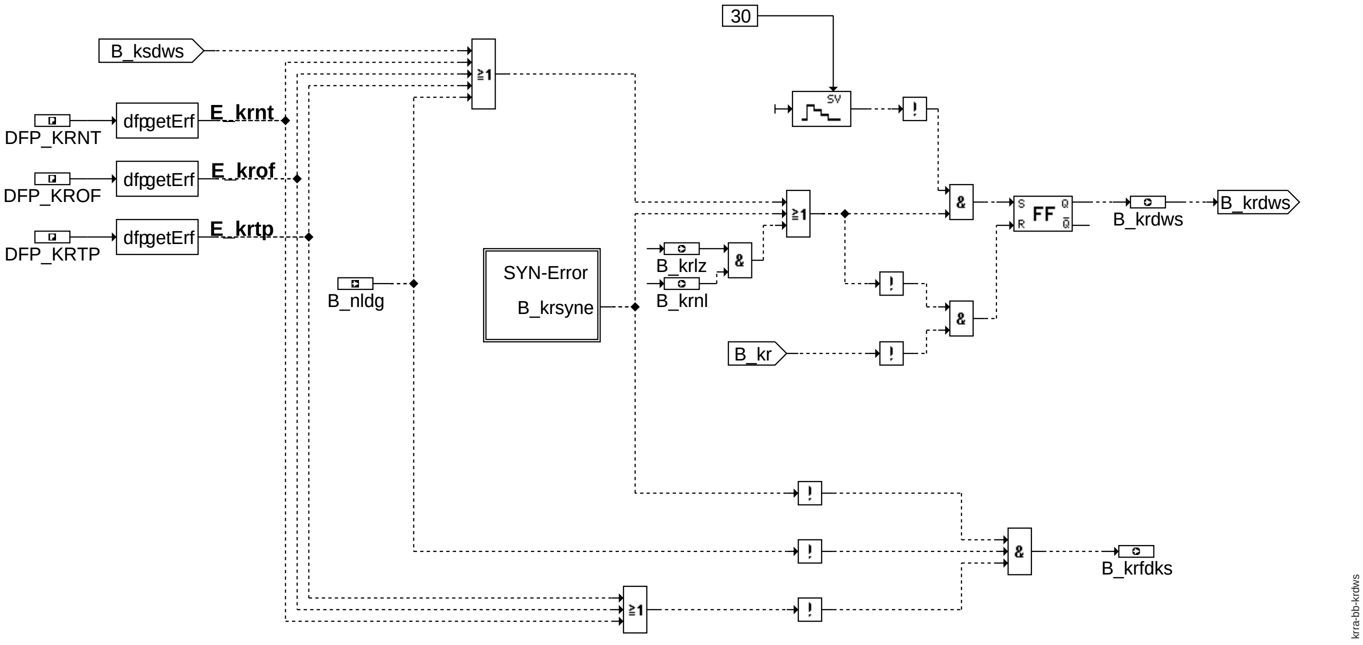
krra-bb-lzf

LZIST: determination of guided and guiding cylinders



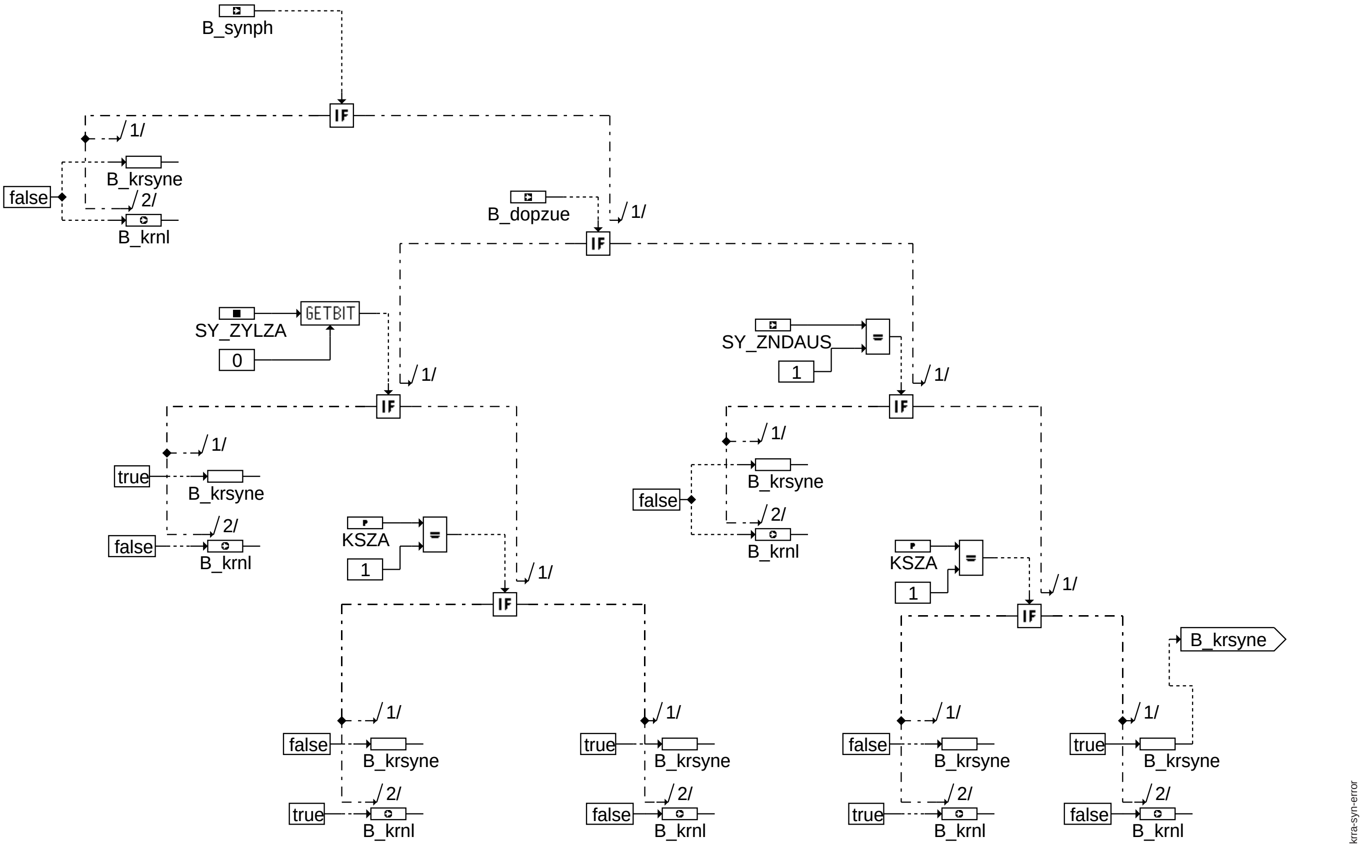
krra-lzist

BB-KRDWS: condition for safety retard of ignition



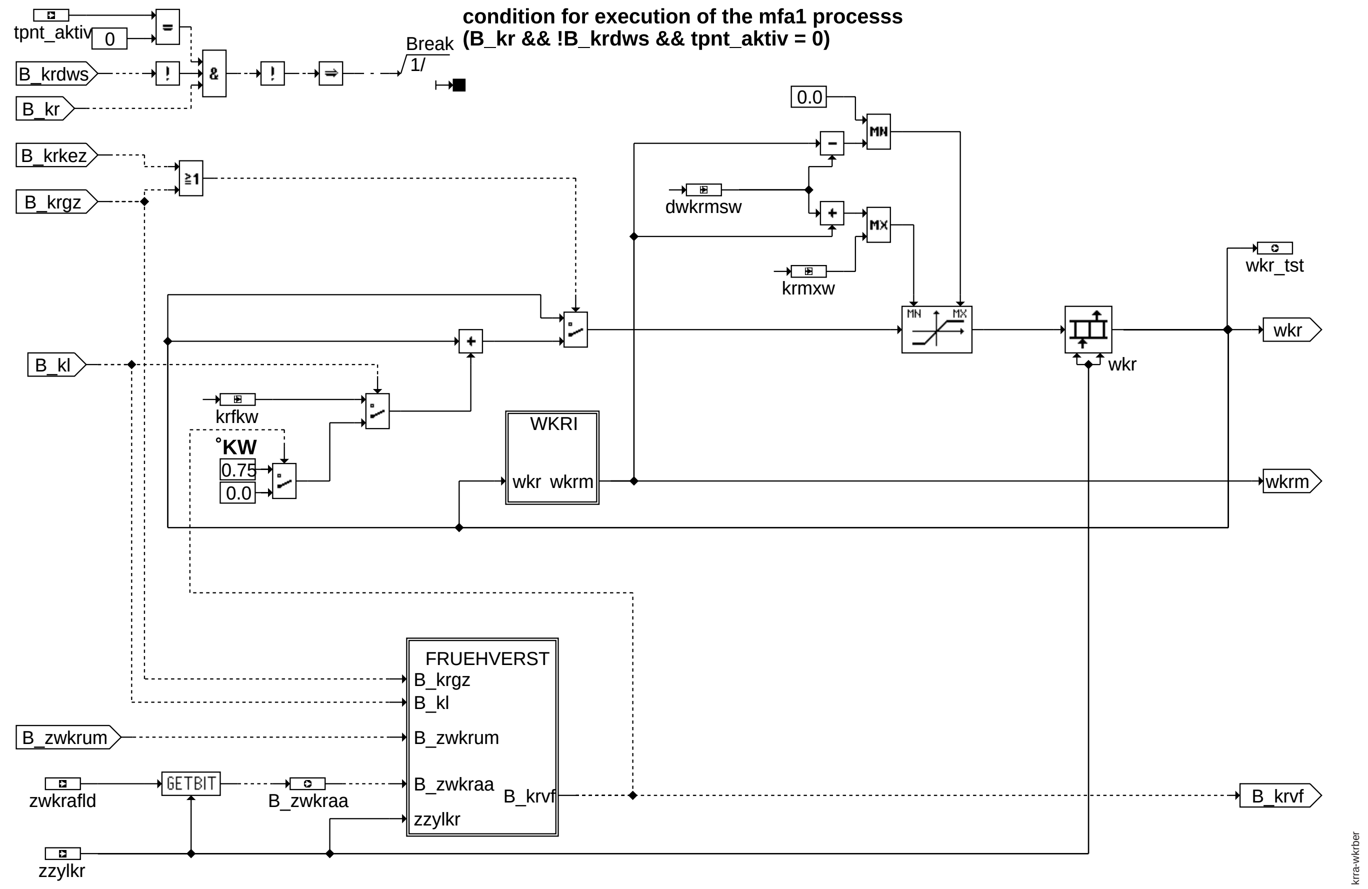
krra-bb-krdws

SYN-ERROR: determination of KC-emergency operation



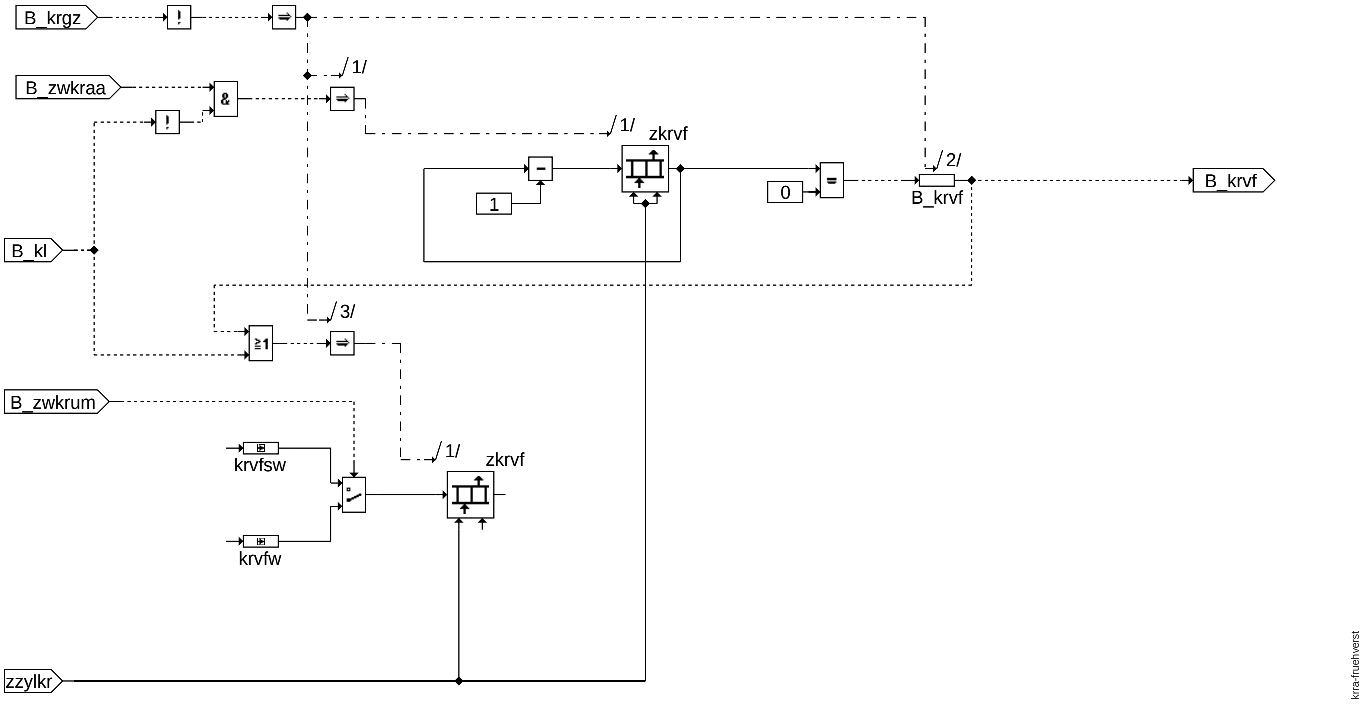
krra-syn-error

WKRBER: Calculation of ignition retard



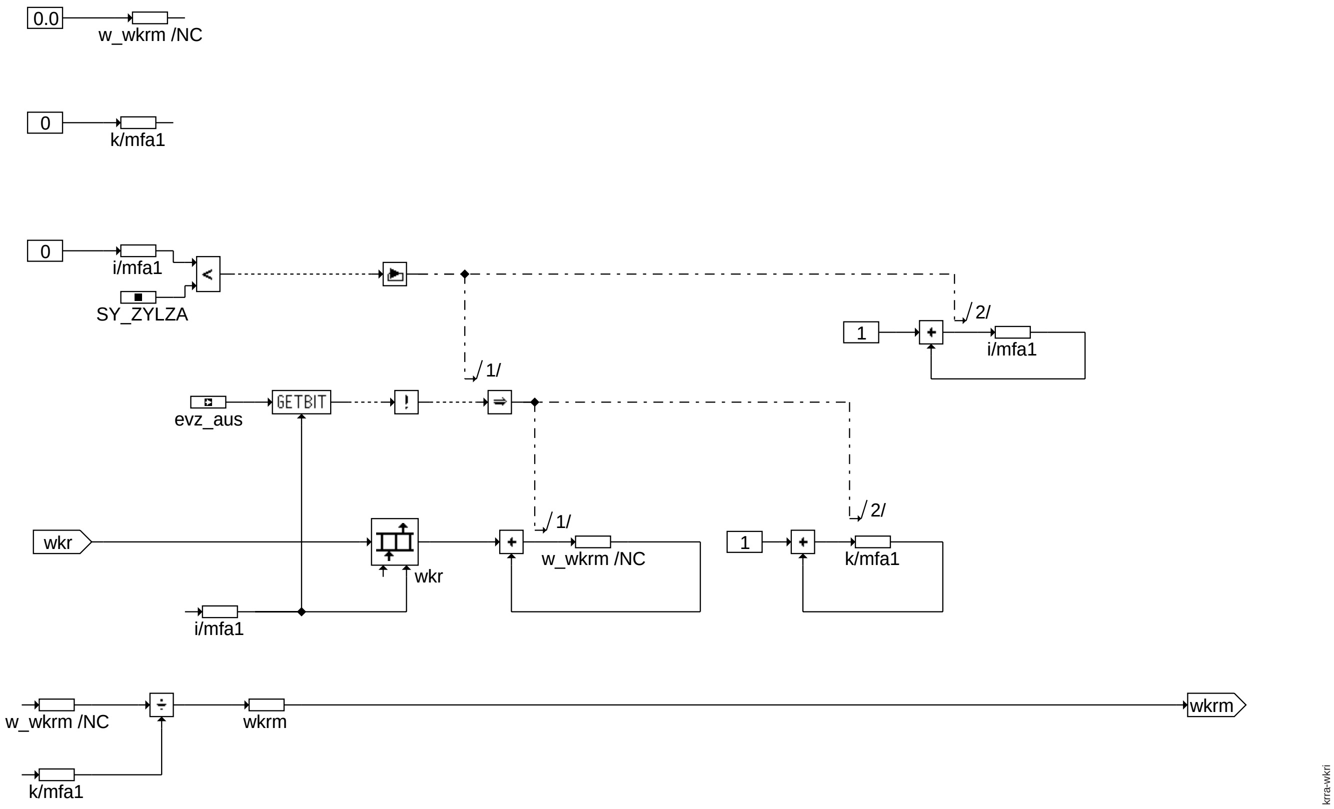
krra-wkrber

FRUEHVERST: Realease of ignition advance adjustment



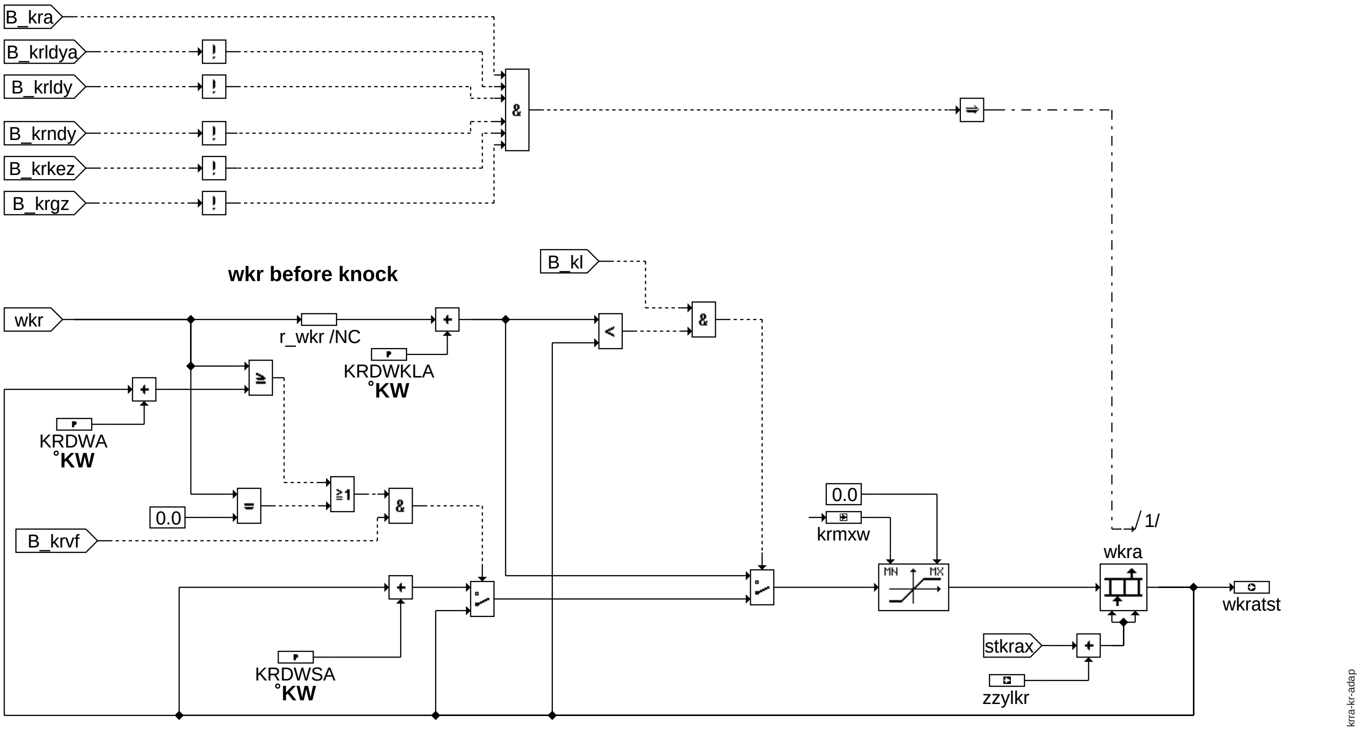
krra-fruehverst

WKRI: Calculation of the average ignition retard



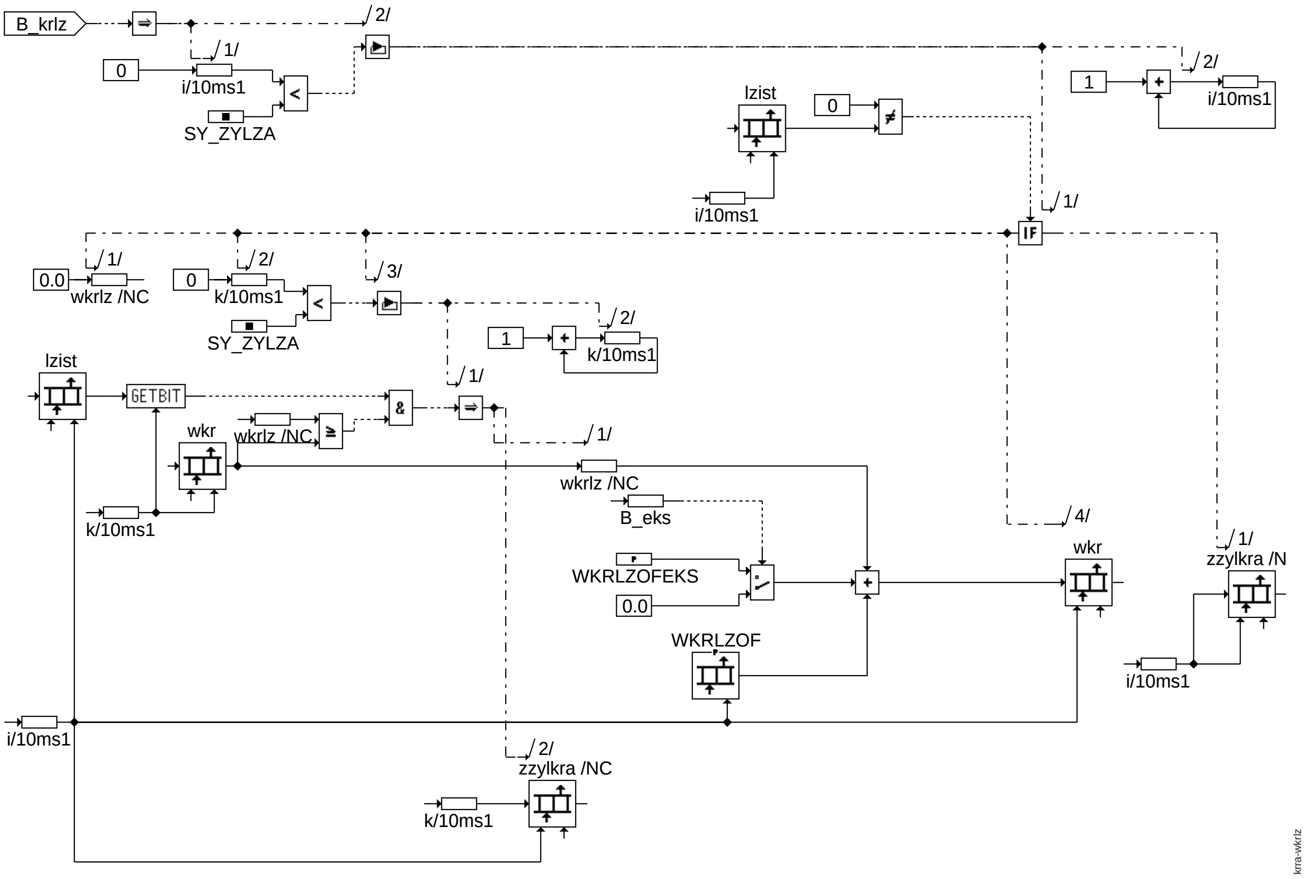
krra-wkri

KR_ADAP: Adaptation of ignition retard



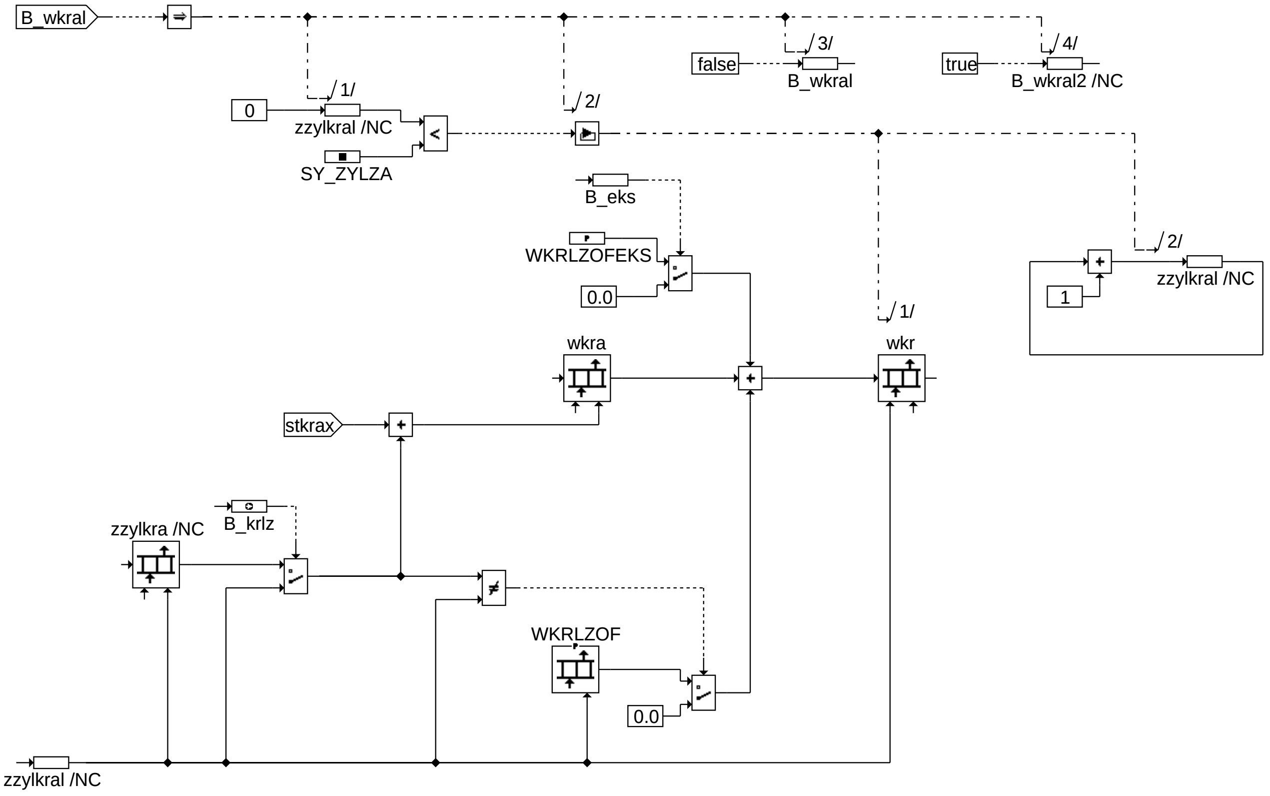
krra-kr-adap

WKRLZ: calculation of wkr for guided cylinders



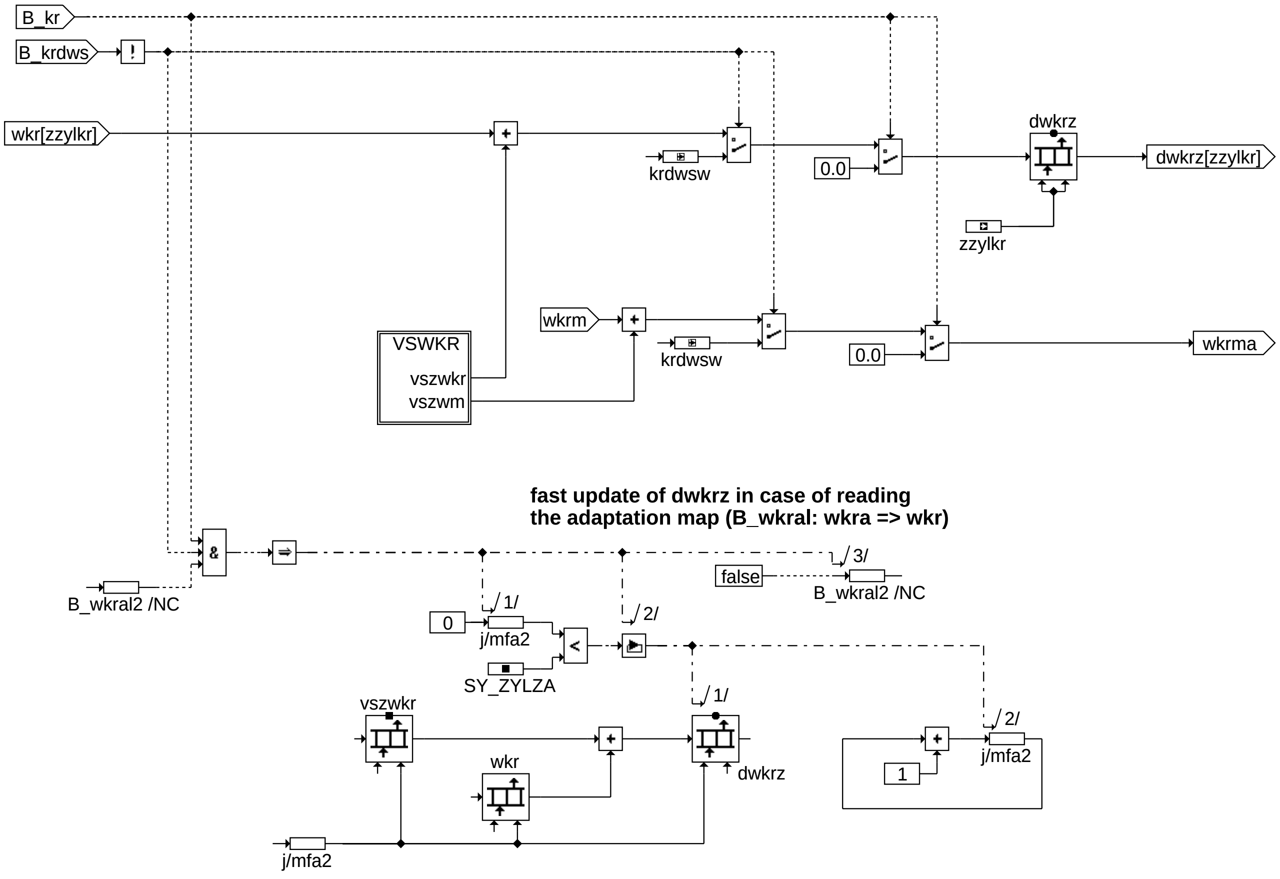
krra-wkrlz

WKRAL: Update of the cylinder selective ignition retard at adaptation area change (wkra --> wkr)



krra-wkral

DWKRZBER: determination of ignition retard dwkrz for different operating conditions

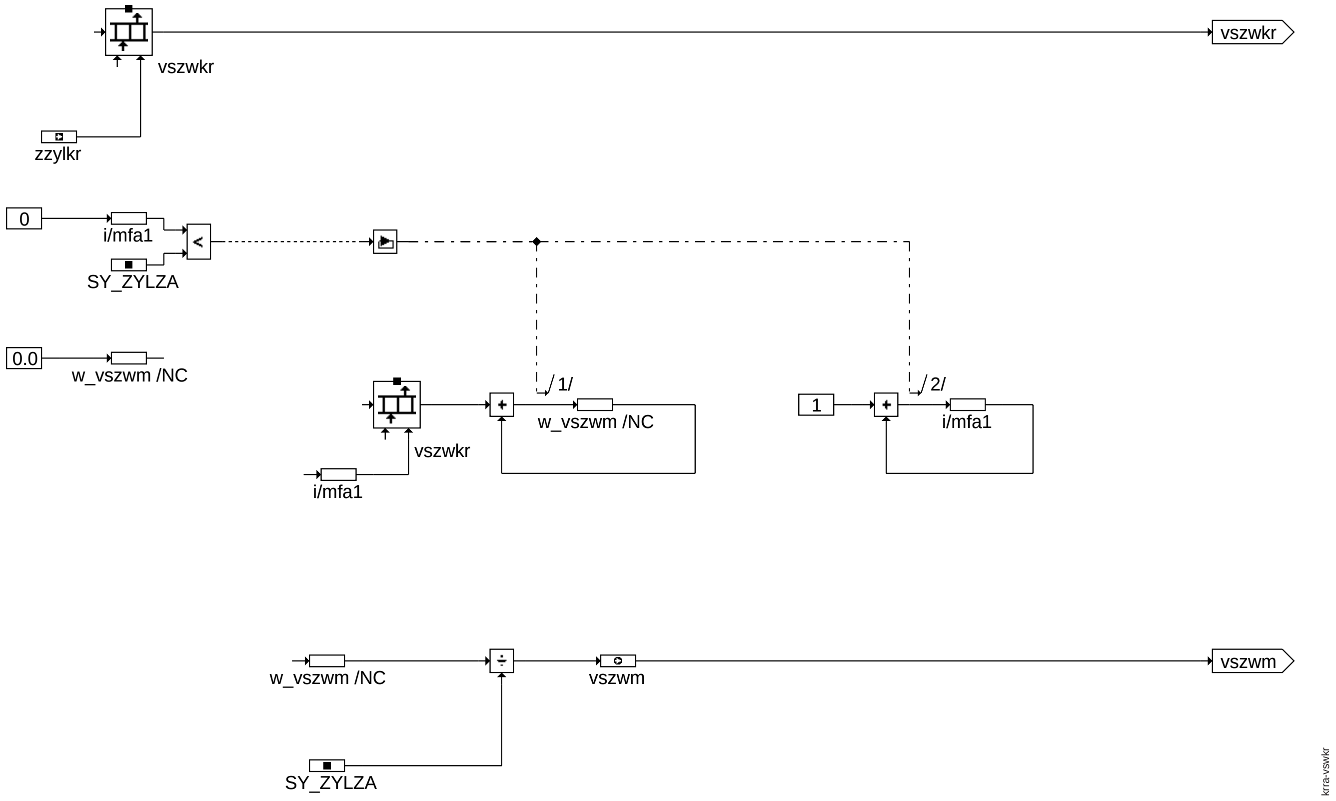


fast update of dwkrz in case of reading
the adaptation map (B_wkral: wkra => wkr)

krra-dwkrzber

krra-dwkrzber

VSWKR: Ignition adjustment with VS2x



krra-vswkr

ABK KRRA 18.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWKRNLR			FW	code word for limp home in case of 1 out of 2 knock sensors fails
DWKRMSN	NMOT		KL	delta ignition angle knock control distance from mean retarding
KRAL1N	NMOT		KL	load range for adaption maps 1
KRAL2N	NMOT		KL	load range dor adaption maps 2
KRAL3N	NMOT		KL	load range for adaption maps 3
KRALH			FW	load hysterisis for adaptation maps
KRAN1			FW	speed range for adaption maps, Stützstelle 1
KRAN2			FW	speed range for adaption maps, Stützstelle 2
KRAN3			FW	speed range for adaption maps, Stützstelle 3
KRAN4			FW	speed range for adaption maps, Stützstelle 4
KRANH			FW	n hysterisis for adaptation maps
KRDWA			FW	knock control difference current ignition angle to adaption map
KRDWKLA			FW	The SV-learning value for KR adaption after knocking detected
KRDWSA			FW	The FV-learning value for KR adation when wkra-wkr > KRDWA
KRDWSN	NMOT		KL	knock control delta angle safety
KRFKN	NMOT		KL	retard step knock occurrence
KRLMDY			FW	Read if change of load range: always or only if dynamic active
KRMXN	NMOT		KL	maximum retard adjustment
KRNLZAR			KWB	cylinder individual rpm limit for lead by leading cylinder
KRNMDY			FW	Read if change of speed range: allways or only if dynamic active
KRVFN	NMOT		KL	number of firings/cyl. or time for ignition advancing
KRVFSN	NMOT		KL	number of firings/cyl. or delay-time during fast ignition advancing of the KC
KSZA			FW	number of knock sensor
LKRN	NMOT		KL	load-signal threshold knock control
LZFUER	ZZYLKR		KL	guide cylinder assignment
MINAKRLZ			FW	minimum number of possible KC guide cylinders
SENZZYL			KWB (REF)	knock sensor for sw-cylinder counter 0-7
SNM16KRUB	NMOT		SV (REF)	datapoint distribution engine speed, 16 datapoints
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TMKR			FW	engine-temperature threshold to enable knock control
TMKRA			FW	engine temperature threshold for adaptive knock control
WKRLZOF	ZZYLKR		KL	Bloc of fixed values: ignition reatard offset for guided cylinder
WKRLZOFEKS			FW	ignition retard offset for guided cylinders in case of knock sensor error

Variable	Source	Type	Description
AKRLZ	KRRA	LOK	number of possible guide cylinders
B_DOPZUE	NLPH	EIN	Condition double ignition
B_EKS	KRRA	LOK	knock sensor defect detected

Variable	Source	Type	Description
B_ELZMN	KRRA	LOK	number of possible KC guide cylinders below minimum
B_KL	KRKE	EIN	condition for knocking
B_KR	KRRA	AUS	condition for knock control active
B_KRA	KRRA	LOK	condition for aktive KR-adaptation
B_KRDWS	KRRA	AUS	condition knock control safety ignition retarding
B_KRFDKS	KRRA	AUS	condition permission for knock sensor diagnosis
B_KRGZ	KRRA	LOK	Filled cylinder
B_KRKEZ	KRRA	AUS	injection valve of current cylinder switched off
B_KRLDY	KRDY	EIN	Condition load dynamics for knock detection active
B_KRLDYA	KRDY	EIN	Condition load dynamics retard and dynamics adaptation active
B_KRLZ	KRRA	AUS	condition for knock control guide-cylinder function active
B_KRLZN	KRRA	LOK	speed threshold for knock control guide-cylinder function exceeded
B_KRNDY	KRDY	EIN	condition speed dynamics for knock detection active
B_KRNL	KRRA	AUS	emergency operation of knock detection for emergency operation of phase sensor
B_KRSYNE	KRRA	LOK	knock control synchronisation error at phase error
B_KRVF	KRRA	LOK	condition for adjustment of kc-ignition timing to a less retarded value
B_LZUP	KRRA	LOK	update of lzist
B_NLDG		EIN	condition limp-home function speed sensor
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_SYNPH	GGDPG	EIN	condition synchronization phase
B_TMKR	KRRA	AUS	Condition temperature (tmot) for knock control achieved
B_WKRAL	KRRA	LOK	condition to read wkr from knock control adaption map
B_ZWKRAA	KRRA	AUS	condition ignition angle of the KC is given
B_ZWKRUM	KRRA	LOK	flag: fast ignition advance KC
DFP_KRNT	KRRA	DOK	internal failure path number: knck control zero test
DFP_KROF	KRRA	DOK	internal failure path number: knock control offset
DFP_KRTP	KRRA	DOK	internal failure path number: knock control test pulse
DFP_KS1	KRRA	DOK	internal failure path number: knock sensor 1
DFP_KS2	KRRA	DOK	internal failure path number: knock sensor 2
DFP_KS3	KRRA	DOK	internal failure path number: kncok sensor 3
DFP_KS4	KRRA	DOK	internal failure path number: knock sensor 4
DWKR	KRRA	AUS	cylinder-specific ignition-timing retardation
DWKRMSW	KRRA	LOK	current value for mean value limitation of the retarding
DWKRZ	KRRA	AUS	cyl.-spec. ignition-timing retardation with retardation for dynamics
EVZ_AUS	AEVAB	EIN	injection cut off pattern
E_KRNT	DKRNT	EIN	error flag: knock control zero test
E_KROF	DKRNT	EIN	Errorflag: knock control offset
E_KRTP	DKRTP	EIN	error flag: knock control test pulse
E_KS1	DKRS	EIN	error flag: knock sensor 1
E_KS1H	KRRA	LOK	auxiliary error flag KS1
E_KS2	DKRS	EIN	error flag: knock sensor 2
E_KS2H	KRRA	LOK	auxiliary error flag KS2
E_KS3	DKRS	EIN	error flag: knock sensor 3
E_KS3H	KRRA	LOK	auxiliary error flag KS3
E_KS4	DKRS	EIN	error flag: knock sensor 4
E_KS4H	KRRA	LOK	auxiliary error flag KS4
KRAL1W	KRRA	LOK	current value load adaptation range 1
KRAL2W	KRRA	LOK	current value load adaptation range 2
KRAL3W	KRRA	LOK	current value load adaption range 3
KRDWSW	KRRA	LOK	momentan characteristic-value for safety retard
KRFKW	KRRA	LOK	current value of KRFKN
KRLZN	KRRA	LOK	cylinder individuel rpm threshold of guide cylinder function exceeded
KRMXW	KRRA	LOK	current value for retard limitation of the retarding
KRVFSW	KRRA	LOK	initialization value for quick advancing
KRVFW	KRRA	LOK	initialization value for normal advancing
LKRW	KRRA	LOK	current value of the load threshold knock control
LZIST	KRRA	LOK	array: momentaneous assignment of guiding and guided cylinders
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
STKRAX	KRRA	LOK	index for kc adaptation map
STKRLX	KRRA	LOK	load range adaption map KC
STKRNX	KRRA	AUS	speed range adaption map KC
SY_ZNDAUS	PROKON	EIN	System constant ignition timing output (single or double fir.)
TMOT	SWADAP	EIN	Engine temperature
TPNT_AKTIV	EGKE	EIN	activation of kc-functions
VSZWKR	VS_VERST	EIN	cylinder individual adjustment of ignition angle by VS2x
VSZWM	KRRA	AUS	mean value of adjustment ignition angle with VS2x
WKR	KRRA	LOK	cylinderindividual ignition retarding value knock control
WKRA	KRRA	LOK	adaption map of wkr, speed- and load-dependent
WKRATST	KRRA	AUS	wkra updated with synchro
WKRM	KRRA	LOK	average value of individual ignition retarting by knocking
WKRMA	KRRA	AUS	Average value of ignition retarding by KC, generally(limpe home with safety)
WKR_TST	KRRA	AUS	cylinder-individual ignition angle retarding, druming
ZKRVF	KRRA	LOK	counter determines the frequency of the cylinder-individual ignition angle adv.
ZWKRAFLD	ZUE	EIN	bit pattern of the cylinder-individually stored B_zwkra
ZZYLKR	GGKS	EIN	cylinder counter KC

```
Hint:   The cylinder-individual values wkr, dwkrz, wkra, zkrvf are indicated in the following description by a control variable (i)
        - like in the ECU-code - for example wkr(i). The corresponding RAM-cell which can be read via VS100 is marked by _i, for
        example wkr_i.
        The KC cylinder counter zzylkr serves as control variable (apart for wkra). The following applies to it:
      s.a. application hints
```

FB KRRA 18.70 Detailed description of function

Function of the knock control

The function KRRA comprises the calculation of the cylinder-individual change of ignition angle of the knock control. It includes the adaptive calculation of the cylinder-individual retarding wkr(i) (WKRBER) and the storage in an adaptation characteristic map wkra(i) (KR_ADAP). The input values of the adaptation map are current cylinder number, engine speed and load (STKRA).
The value of the retarding dwkrz(i) which is passed on to the ignition comes to dependent on the operating condition (BBKC):

```
        1. B_kr & !B_krdws      dwkrz(i) = wkr(i)
        2. B_kr & B_krdws       dwkrz(i) = krdwsw              KRDWS - safety retarding s. %DKRS, %DKRNT, %DKRTP
        3. !B_kr & (!)B_krdws   dwkrz(i) = 0

Condition KC active   :       B_kr         : (( rl > LKRN ) v B_krldy ) & ( tmot > TMKR ) & B_stend
Condition adaptation active : B_kra        : B_kr & ( tmot > TMKRA )
```

Coordination of ignition angle for the torque management

```
In case of active knock control the earliest cylinder-individual ignition angle zwbas results with regard to:
        zwbas = zwgru + dwkrz(i) + wkrdy   s. %ZUE
Two cases of control behaviour are distinguished:
        1. output ignition angle = zwbas        ==> B_zwkraa = 1 ==> knock control algorithm remains unchanged
        2. output ignition angle < zwbas        ==> B_zwkraa = 0 ==> advancing algorithm of wkr(i) is frozen and
                                                                     KC-adaptation is blocked. ( due to exhaust gas
                                                                     reasons, ASR-operation, LL, a.s.o. )

        In %ZUE the bit B_zwkra is formed synchronous to the ignition angle output and it is then stored in correspondent position
        in a bit array zwkrafld. E.g. B_zwkraa is then determined from zwkrafld as follows:

        SW cyl. counter
        (zzylkr)        5  4  3  2  1  0

        B_zwkra         1  1  0  1  0  0  ==> zwkrafld = 2^5 + 2^4 + 2^2 = 52
                              ^
                              |
        B_zwkraa (zzylkr=3)---+   = 0 (= false)

Please note:    Signs of the ignition angle (in deg. crankshaft (° KW)) according to mathematical convention.
                KFZW > 0 ° (with DTC as point of reference, ignition "before" DTC means mathematically positive angles KFZW)
                dwkrz(i) <= 0 ° ("retard"timing with regard to the basis ignition angle means mathematically negative dwkrz(i) )
```

Retarding of the ignition angle without adaptation (WKRBER)

If B_kr and !B_kra are set the knock control operates as follows:
If a knocking combustion (B_kl) is detected in %KRKE then the ignition angle of the corresponding cylinder i is adjusted by retarding it by an amount KRFKN per knocking occurrence. This cylinder-individual retarding is added load- and engine speed-independent in the RAM-area wkr(i).
For engine smoothness reasons and in order to avoid misfire misdetections the retarding is limited in each calculation to a range around the mean value wkrm of the latest given SY_ZYLZA retardings wkr(i), given by wkrm plus/minus a freely selectable threshold.
This threshold DWKRMSN is a characteristic line over the engine speed.
Additionally the retarding is limited in wkr(i) towards retard to KRMXN and towards advance to 0°.

wkr is a RAM-area in which a RAM-cell is reserved for each cylinder.

```
                                   +-----------------+
                                   |^    wkr(i)      |
                                   ||                |
                                   ||  -             |
                                   ||_| |_         _ |
                                   ||_|_|_| . . . |_||
                                   |cylinder         |
                                   | 1 2 3         Z |
                                   +-----------------+
```

If the KC-active operating range of the engine is left (!B_kr) then the latest present retarding remains stored in wkr(i) until the KC-active range is entered again. The same applies for wkrm.
In the KC-not-active range of the engine zero is passed on to %ZUE as adjustment value dwkrz(i).
In case of ignition off the retardings in wkr(i) are set equal to zero.

Advancing of the ignition angle (WKRBER & FRUEHVERST)
===

The retardings from wkr(i) are taken back cylinder-individually if B_kr is set and if a cylinder-individual advancing counter zkrvf(i) has reached zero.
During each knock occurrence B_kl the cylinder-individual counter zkrvf(i) is loaded with the value KRVFN. Each not knocking combustion of the cylinder i for which in addition B_zwkraa = 1 applies (i.e. the given ignition angle was limited by the KC) decrements zkrvf(i) by 1. When zkrvf(i) = 0 is reached the retarding in wkr(i) assigned to the corresponding cylinder is decremented by one quantization step and the counter is again loaded with KRVFN.
During each timing towards advance the wkr(i) are limited to the mean value wkrm of the latest given retarding SY-ZYLZA minus a freely selectable threshold DWKRMSN or to the value zero.

If the KC-active operating range of the engine is left (!B_kr) the latest available counter values remain stored in zkrvf(i) until the KC-active range is entered again.
In case of ignition off the counter values in zkrvf(i) are set equal to zero.

If changed operating conditions of the engine lead to a lesser knock tendency a quicker advancing of the wkr(i) is performed until the first knocking occurs after the beginning of the quick advancing. For this the counters zkrvf(i) are started by means of KRVFSN < KRVFN. Condition for the start of the quick advancing is the transition from !B_kra to B_kra resp. a change of the load or engine speed range in the adaptation characteristic map which leads to the adjusted values wkra(i) being read.

Retarding of the ignition angle with adaptation (KR_ADAP)
===

Besides the above-described retarding the retardings are under certain circumstances written into or read from an adaptation map during active adaptation.
By the adaptation it is ensured that also for strongly map-dependent varying retardings the knock frequency does not increase in case of quick changes of the map ranges.

In the adaptation map wkra a RAM-cell is reserved for each load and engine speed range per cylinder. The range limits for load and engine speed are taken from adjustable labels (KRAL1N, KRAL2N resp. KRAN1 -4). The values which are stored there shall be used as limit values in case of increasing load or engine speed.
In case of decreasing load or engine speed an adjustable hysteresis (KRALH, KRANH) is deducted from these values.
In case of full load (B_ugd) the Vl-line is addressed load-independently.
The current load range is stored in stkrlx, the engine speed range in stkrnx.
After ignition off all values remain stored in wkra. If the supply voltage of the ECU is disconnected the values are lost.
After the supply voltage of the ECU has been reconnected all values are set to 0.

```
                           +----------------+-----------------+-----------------+-----------+-----------+
                           |   wkra(i)      |    ...          |   ...           |  ...      |  ...      |
             stkrlx = 3    |                |                 |                 |           |           |
                    Vl     |                |                 |                 |           |           |
                           |                |                 |                 |           |           |
hysteresis KRALH           +----------------+-----------------+-----------------+-----------+-----------+
  |
  v                                                           +-----------------+
                                            +-----------------+                 +-----------+
                           +----------------+                 |                 |           +-----------+
                           |                |                 |                 |           |           |
             stkrlx = 2    |                |                 |                 |           |           |
                           |                |                 |                 |           |           |
                           |                |                 +-----------------+           |           |
                           |                +-----------------+                 +-----------+           |
                KRAL2N     +----------------+                 |                 |           +-----------+
                           |                | cylinder        |                 |           |           |
            stkrlx = 1     |                | 1 2 3  . . .  Z |                 |           |           |
                           |                |                 +-----------------+           |           |
                           |                +-----------------+                 +-----------+           |
                KRAL1N     +----------------+                 |                 |           +-----------+
                           |                ||              _ |                 |           |           |
                           |                ||             | ||                 |           |           |
      ^     stkrlx = 0     |   wkra(i)      ||_            | ||       ...       |    ...    |    ...    |
      |                    |                ||_|_ _  . . . |_||                 |           |           |
      | load               |                | cylinder        |                 |           |           |
      |                    |                | 1 2 3  . . .  Z |                 |           |           |
      |               LKRN +----------------+-----------------+-----------------+-----------+-----------+
      |                                   KRAN1            KRAN2               -3          -4
      |                    stkrnx = 0              1                  2              3           4
      +------------------------------------->
                                engine speed        <-------- hysteresis KRANH
```

For the indexing of the wkra(i) - RAM-cells the following specification is used in the SW:

```
        i = zzylkr + 8 * stkrnx + 40 * stkrlx    zzylkr = 0...7, so at the max. 8 cylinders can be represented
                                                 stkrnx = 0...4, 5 engine speed ranges
                                                 stkrlx = 0...3, 4 load ranges
```

Storage:
3 conditions for the updating of the adaptation map are distinguished:

1. During each knock occurrence the retarding of the corresponding cylinder is stored in the current load/engine speed range of the adaptation map immediately after knocking has occured if this retarding is later than that stored in wkra. By means of KRWKRUM it is decided whether the retarding which led to the knock occurrence (=knock border) is stored or whether the current retarding after the knock occurrence (retarded by KRFKN) is stored.
   KRWKRUM=0 ignition angle after the knock occurrence; KRWKRUM=1 ignition angle before the knock occurrence.

2. If the current retarding wkr(i) is earlier by at least KRDWA than the latest value stored in the adaptation map and if the advancing counter zkrvf(i) = 0 then the retarding is changed by KRDWA towards advance in the adaptation map.

3. If wkra(i) + KRDWA > 0, if the current retarding wkr(i) = 0 and if the advancing counter zkrvf(i)=0, then wkra(i) is set to wkr(i) = 0.

The adaptation of the characteristic map is only performed during steady-state and during not active safety retarding (B_krdws=0). The adaptation does not take place if the ignition angle is drawn further towards retard by the torque management than would be necessary for the KC (B_zwkraa = 0).

Reading:
During active adaptation the retarding of all cylinders wkr(i) is overwritten by the values from wkra(i) if one of the following conditions is fulfilled:

1. Transition from !B_kra to B_kra

2. Load range changes
   It is possible to choose via label whether during the change of the load adaptation range without dynamic response the value wkr(i) from the just left range is kept or whether it is taken over from the new range wkra(i). The change-over is performed via the fixed value KRLMDY:
   KRLMDY=0 take-over of wkr(i) from wkra(i) always during load range changes
   KRLMDY=1 take-over of wkr(i) from wkra(i) only during load range changes with dynamic response.

3. Engine speed changes
   It is possible to choose via label whether during the change of the engine speed adaptation range without dynamic response the value wkr(i) from the just left range is kept or whether it is taken over from the new range wkra(i). The change-over is performed via the fixed value KRNMDY:
   KRNMDY=0 take-over of wkr(i) from wkra(i) always during engine speed range changes
   KRNMDY=1 take-over of wkr(i) from wkra(i) only during engine speed range changes with dynamic response.

```
Knock control in case of active dynamic response (KRRA, KR_ADAP, BBKR)
======================================================================
In case of active dynamic response ( B_krldy, B_krldya, B_krndy, s. %KRDY ) the further adaptation of the steady-state values
wkra(i) is blocked. A change of the adaptation ranges leads to an updating of wkr(i) with the values adjusted in wkra(i).
Each knocking combustion ( B_kl ), like so far, leads to a retarding by KRFKN and is therefore added to the cylinder-individual
retarding in wkr(i).
For B_krldya additionally an adaptive dynamic response derivation wkrdy (s. %KRDY, %ZUE) is added.


Safety retarding during active knock control (KRRA)
===================================================
If the safety flag of the KC, B_krdws, is set ( see %DKRS, %DKRNT, %DKRTP ), dwkrz(i) and wkrma are overwritten by KRDWS if the
knock control is active.
wkra(i), wkr(i) and wkrm are not updated as long as B_krdws is set.
If B_krdws is again reset dwkrz(i) is overwritten by wkr(i), wkrma by wkrm.
```

APP KRRA 18.70 Application hint

Cylinder-individual and load/engine speed range-dependent values are marked by (i) in the description corresponding to their realization in the ECU-code, e.g. wkr(i). The corresponding RAM-cell which can be read via VS100 is indicated in the ASCET-picture by _i, e.g. wkr_i.
The cylinder counter zzylkr generated in the %GGKS serves as control variable for the index i of the cylinder-individual RAM-cells (wkr(i), dwkrz(i), zkrvf(i), with the exception of wkra(i), s.b.).

The knock control can be switched off via the label TMKR: TMKR > tmot ==> !B_kr

For the application the following typical values are suggested:
==

KRFKN -3 ° KW is a value for the retarding of the ignition angle. Experience shows that it is a sufficient value to safely run the engine at the knock border with stabilized adaptation.

KRMXN -12 ° KW is a value which is sufficient for most applications. When fixing this characteristic line it must be noted though that the engine can be operated absolutely knock-free with the programmed value under worst-case conditions (tmot, tans, fuel with lowest octane number).
In the process attention must be paid to the maximum permitted exhaust gas temperature.

KRVFN approx. 4 sec/°KW advancing is a typical value. The control speed of the KC during quasi-steady-state engine running results from this characteristic line in connection with KRFKN. The aim here is to determine a time constant which is larger than the thermic time constant of the engine so as to avoid a thermic strain.
When adjusting KRVFN it must be taken into consideration that the thermic strain of the engine increases with increasing engine speed so that a larger period should be chosen for higher engine speeds.
KRVFN = 1 Inc. * n / (120 * x) with 1 Inc. in ° KW
n in rpm
x in ° KW / sec - "speed" for the advance adjustment

KRVFSN to be adjusted dependent of KRDWKLA in order to enable a quick advancing of the adaptation map values in case of changed operating conditions without provoking an increased knock frequency.
KRDWKLA = -3 °KW: approx. 1 sec/°KW advancing or approx. 1/4 * KRVFN
KRDWKLA = 0 °KW: approx. 2 sec/°KW advancing or approx. 1/2 * KRVFN

TMKR approx. 40 °C is the value during which on many engines knocking combustions can already occur.

TMKRA: Below an engine temperature threshold TMKRA it is not useful to update wkra since experience has shown that within this operating range the knock tendency of the engine is very low. If adaptation would be permitted the necessary values learned in the normal operating range would be lost which means that the knock frequency is again increased when this operating range is reached again.
Usually this engine temperature threshold lies at TMKRA = 80 ° C.

LKRN approx. 30% rl is a typical value. The lowest load threshold during which knocking combustions can occur is stored in this characteristic line.

KRDWKLA 0 °KW <= |KRDWKLA| <= |KRFKN|

KRDWA |KRDWA| >= |KRDWKLA|

KRDWSA 0 °KW < |KRDWSA| und |KRDWSA| <= |KRDWA| - |KRDWKLA|

the following set of parameters is recommended:

KRDWKLA	KRDWA	KRDWSA	
°KW	°KW	°KW	
0	2.25	2.25	=> Adaptation of the knock border
-1.5	3	1.5	=> Adaptation of the knock border + safety retarding of 1.5 °KW
-3	4.5	1.5	=> Adaptation of the knock border + safety retarding of 3 °KW

DWKRMSN approx. -3 ° KW is a typical value to maintain the engine smoothness and to avoid misfire misdetection; if the values get smaller the cylinder-individual character of the knock control is increasingly lost.

KRLMDY = 0: reading of the adaptation map in case of load range changes is always performed (independent of dynamic response)

KRNMDY = 1: reading of the adaptation map in case of engine speed range changes is only perfomed during simultanious dynamic response

KRDWSN approx. -12 ° KW, knocking must definitely be avoided under worst-case conditions

KRALH In order to avoid a jitter at the range limits a hysteresis was introduced for decreasing load.
Typical value for KRALH 3 %.

KRANH In order to avoid a jitter at the range limits a hysteresis was introduced for decreasing engine speed.
Typical value for KRANH 120 RPM.

When determining the ignition characteristic map special attention must be paid to the knowledge in which range an enrichment function (lambda < 1)) is active since the knock border shifts due to the enrichment.
So as not to endanger a stable knock control the determination of the ignition angles and the enrichment function must be adjusted such that in the entire operating range of the engine a constant distance is kept to the knock border(<3 ° KW).

Hints regarding load

The load is given in percent.

Needed measured values:

- B_kl
- B_kr
- B_kra
- B_krldy _krldya _krndy
- B_zwkraa
- B_zwkrum
- stkrlx
- stkrnx
- wkr_0 - x
- wkra_0 - x
- wkrdy_0 - x
- zkrvf_0 - x

The existence of some values/RAMs is determined by the representation in ASCET (block hierarchy, course of control). They are not realized in the SW resp. they cannot be measured definitely by means of VS100 due to their special realization:

- B_wkral	cannot be measured definitely
- B_krvf	not realized
- zkrvf(i)=0	cannot be measured, this state can only be detected indirectly via the performed RESET of the counter from zkrvf(i) = 1 to zkrvf(i) = KRVF(S)N
- zzylkral	not realized

Distinction wkrm/wkrma
----

wkrm represents the mean value of the each time SY_ZYLZA latest calculated wkr(i) (possibly incl. mean value vswzm) while wkrma represents the mean value of the dwkrz(i) (without wkrdy) which was passed on to the ignition during the SY_ZYLZA latest combustions.

Adaptation characteristic map wkra

When choosing the map values a compromise has to be found between the possibly varying knock tendency of the engine at different load and engine speed ranges and the time by which the characteristic map is updated during normal driving.
If the adaptation map wkra is chosen to large (i.e. many rl-nmot-ranges) a longer period is needed in order to update all ranges. Thus in case of changed operating conditions which lead to a larger knock tendency it is inevitable that the knock frequency increases.

Generally a characteristic map with 3 load and 5 engine speed ranges is sufficient for wkra. In this map a RAM-cell is provided for each load/ engine speed range per cylinder.
(Example 4-cylinder-engine: 3 x 5 x 4 = 60 RAM-cells for wkra)
For the indexing of the wkra(i) - RAM-cells the following specification is used in the SW:
i = zzylkr + 8 * stkrnx + 40 * stkrlx   (zzylkr = 0...7, so at the max. 8 cylinders can be represented)

In case of special customers need the number of adaptation ranges can be varied but at the maximum to 4 x 8 load/engine speed ranges (change of above-mentioned indexing may possibly be necessary).

Cylinder-individual ignition angle timing with VS20

By means of VS20 a cylinder-individual additional timing vszw(i) can be performed (s.a. %VS_VERST) so that the following applies:
dwkrz(i) = wkr(i) + wkrdy + vszwkr(i)   if B_kr & !B_krdws

Label	timing range	quantization	initialization/neutral value
vszwkr_i	see %VS_VERST	0.75 °KW	0 °KW

i = 0 ... SY_ZYLZA - 1

==

Attention: 1. No automatic limitation of vszwkr(i) is performed - please observe engine and catalyst protection during the timing!

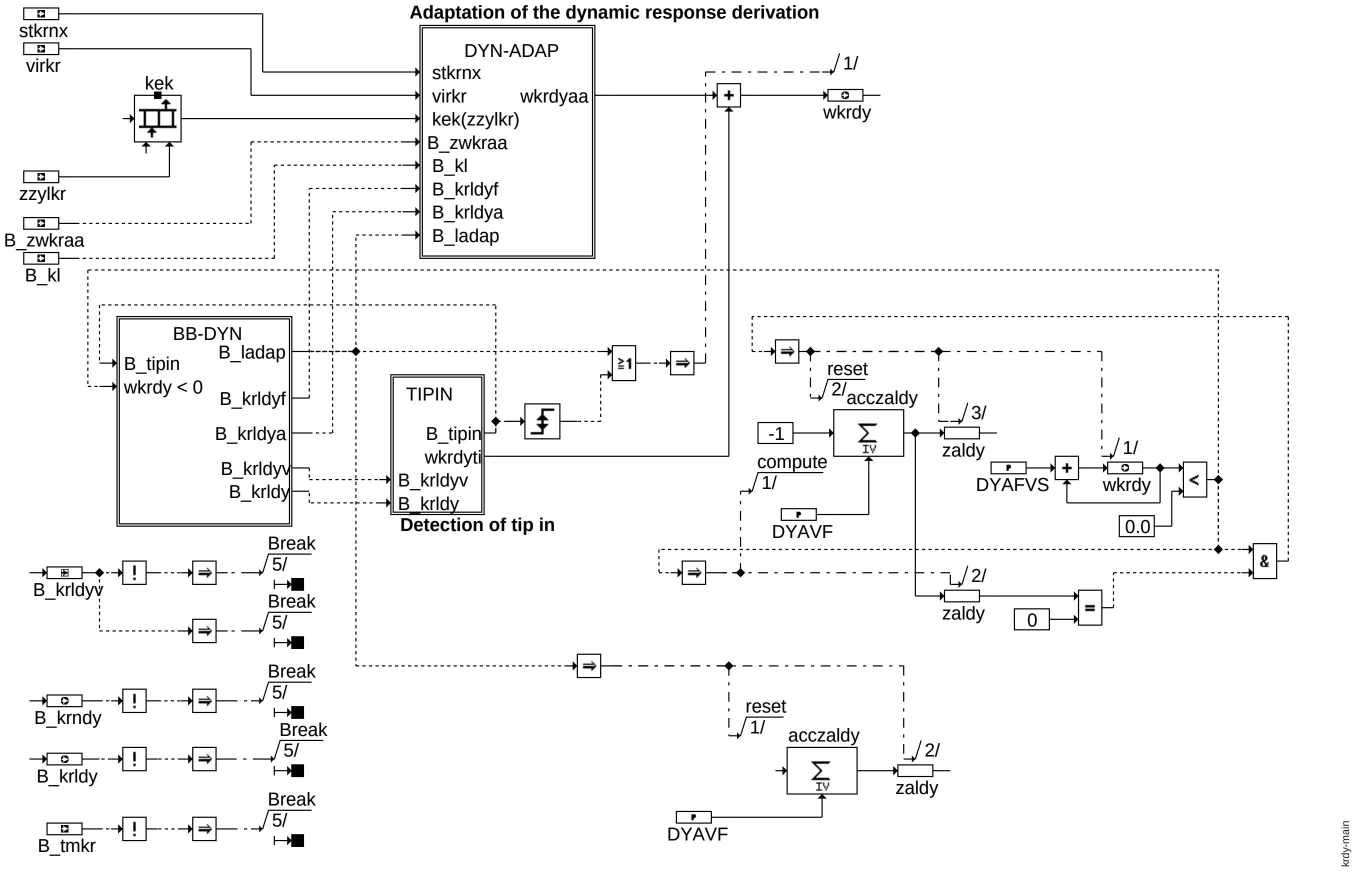
2. The earliest possible ignition angle is under all circumstance determined by the knock control, i.e. it is possible that the minimum permitted (due to temperature reasons) ignition angle may be undershot (s. %ZUE, %ZWMIN). Please observe engine and catalyst protection !

==

KRDY 10.90 Knock control for load dynamics

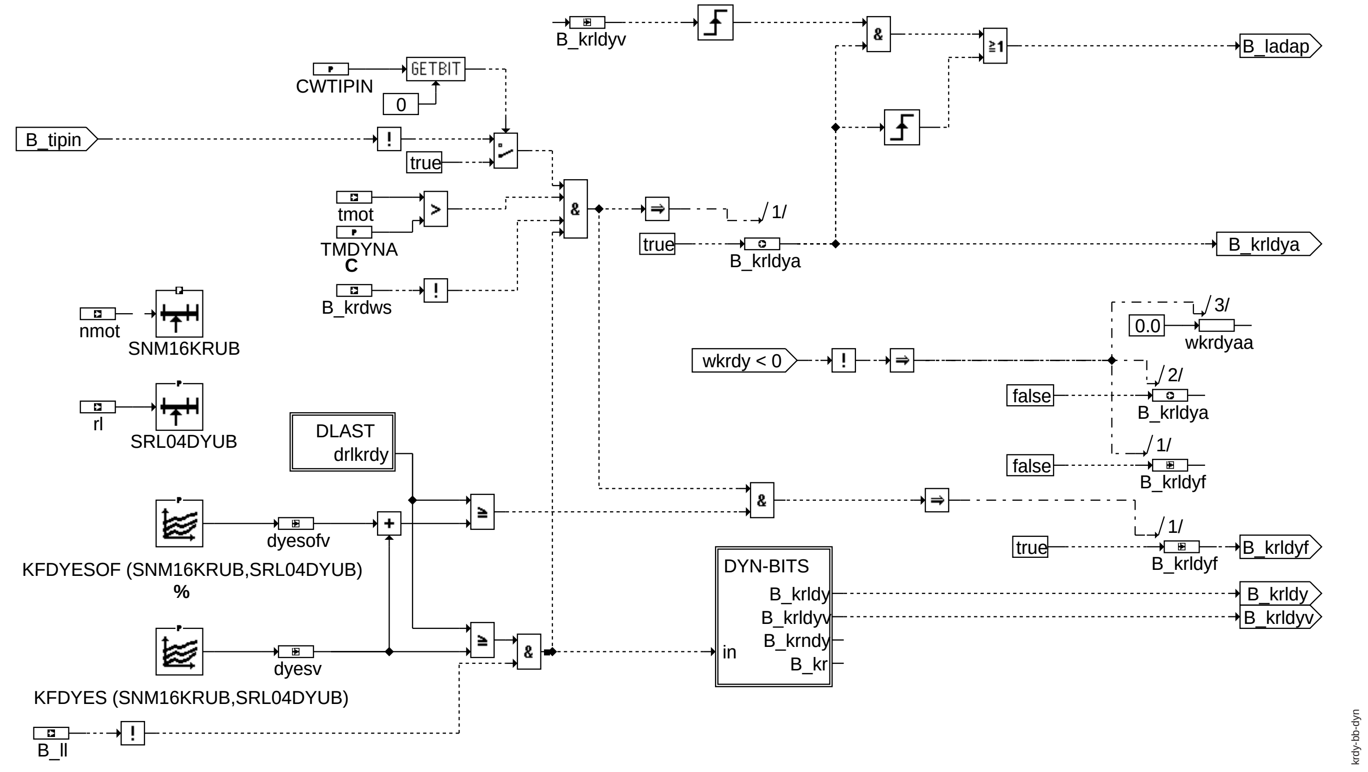
FDEF KRDY 10.90 Function definition

KRDY: Overview KC-dynamic response



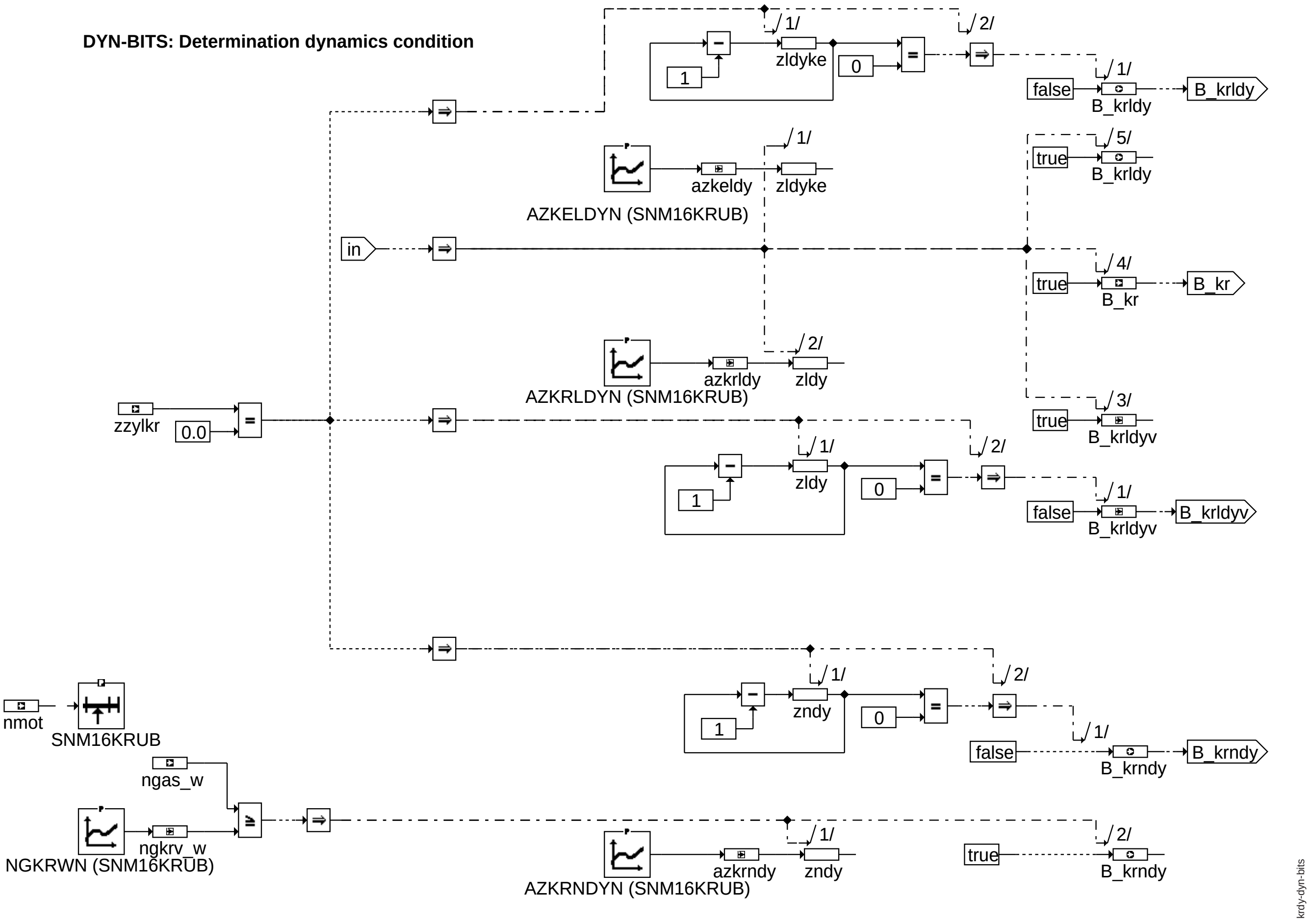
krdy-main

BB-DYN: Detection load and engine speed dynamic response, enabling adaptation



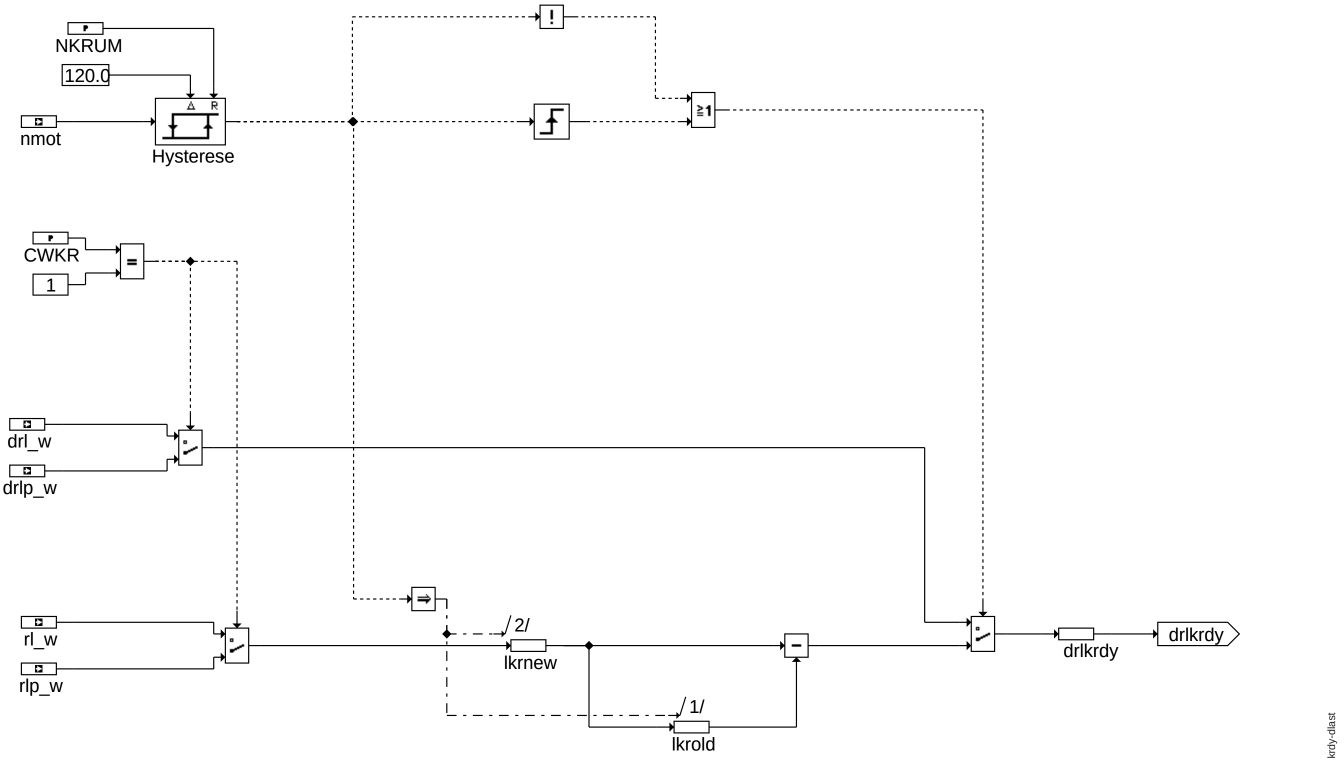
krdy-bb-dyn

DYN-BITS: Determination dynamics condition



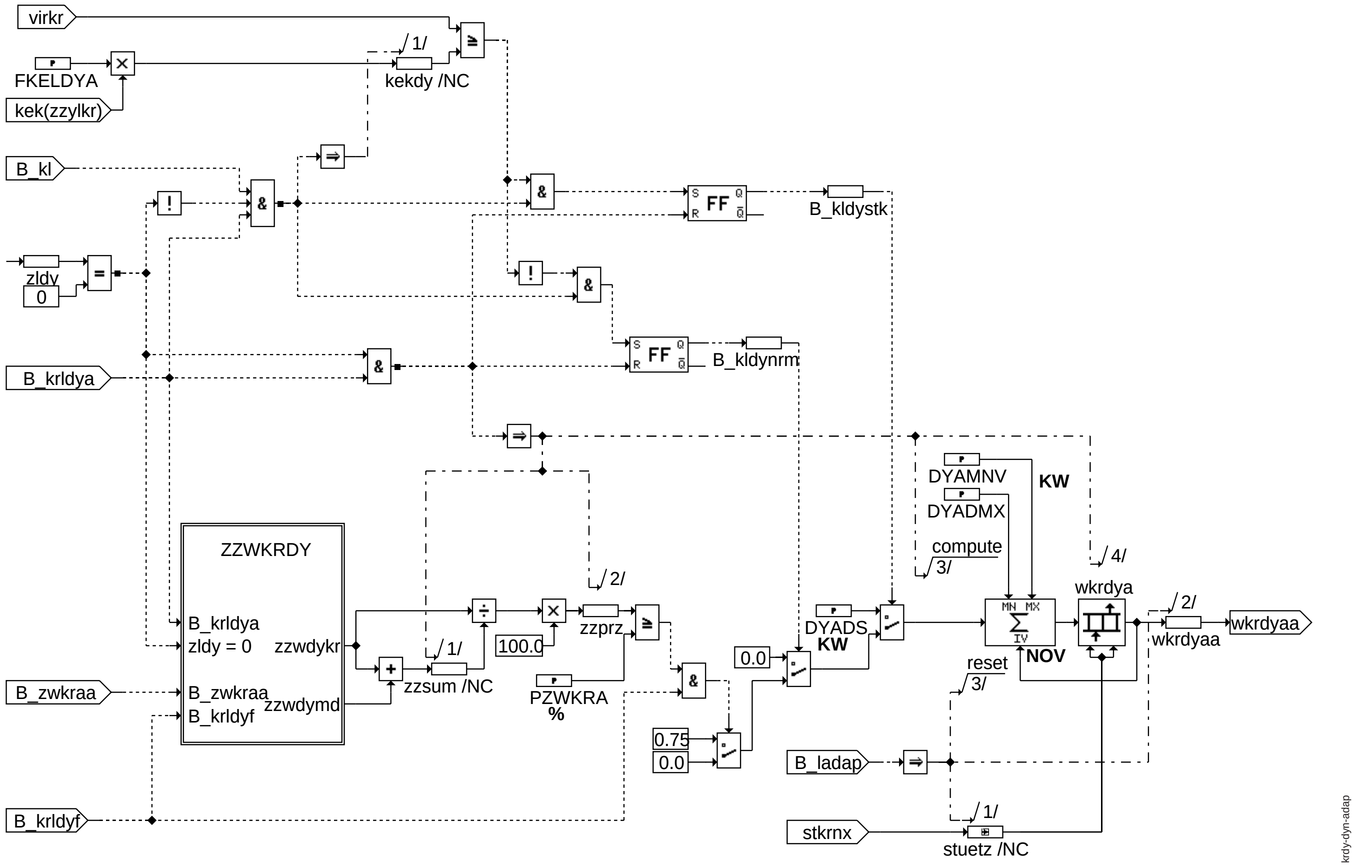
krdy-dyn-bits

DLAST: Determination load gradient



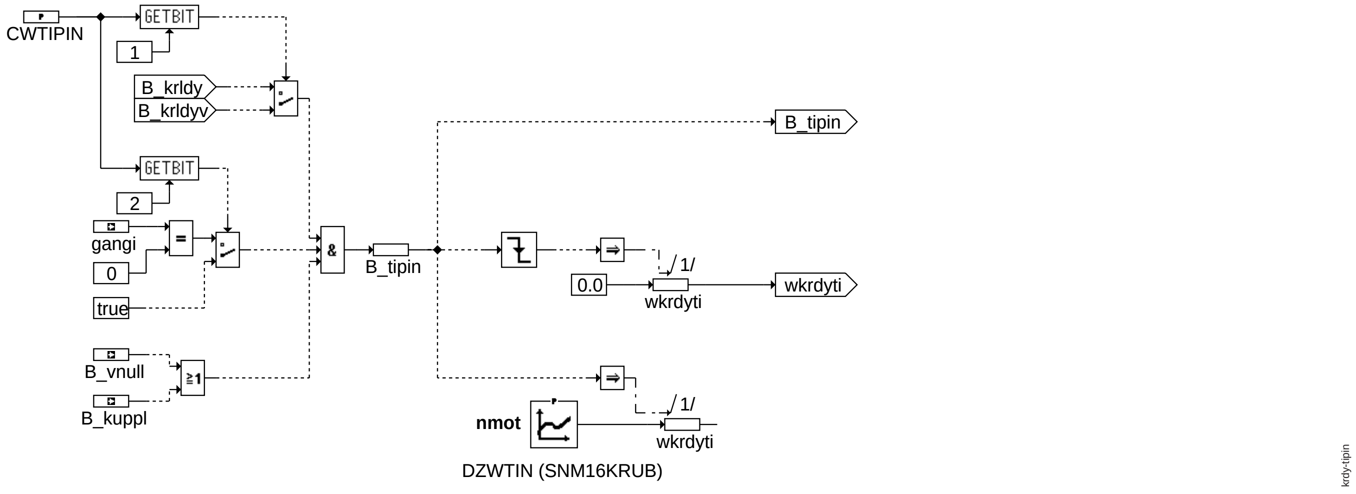
krdy-dlast

DYN-ADAP: Adaptation of the dynamic response derivation



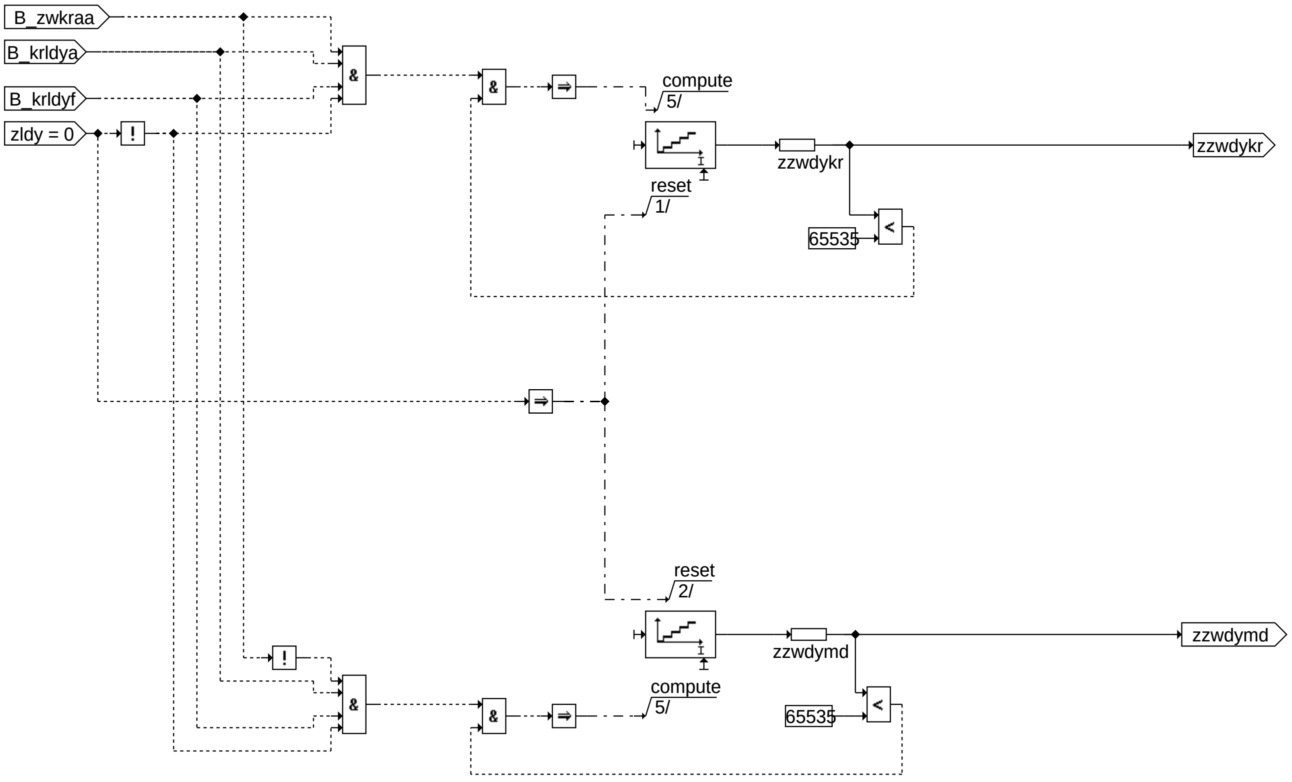
krdy-dyn-adap

TIPIN: Detection of tip ins



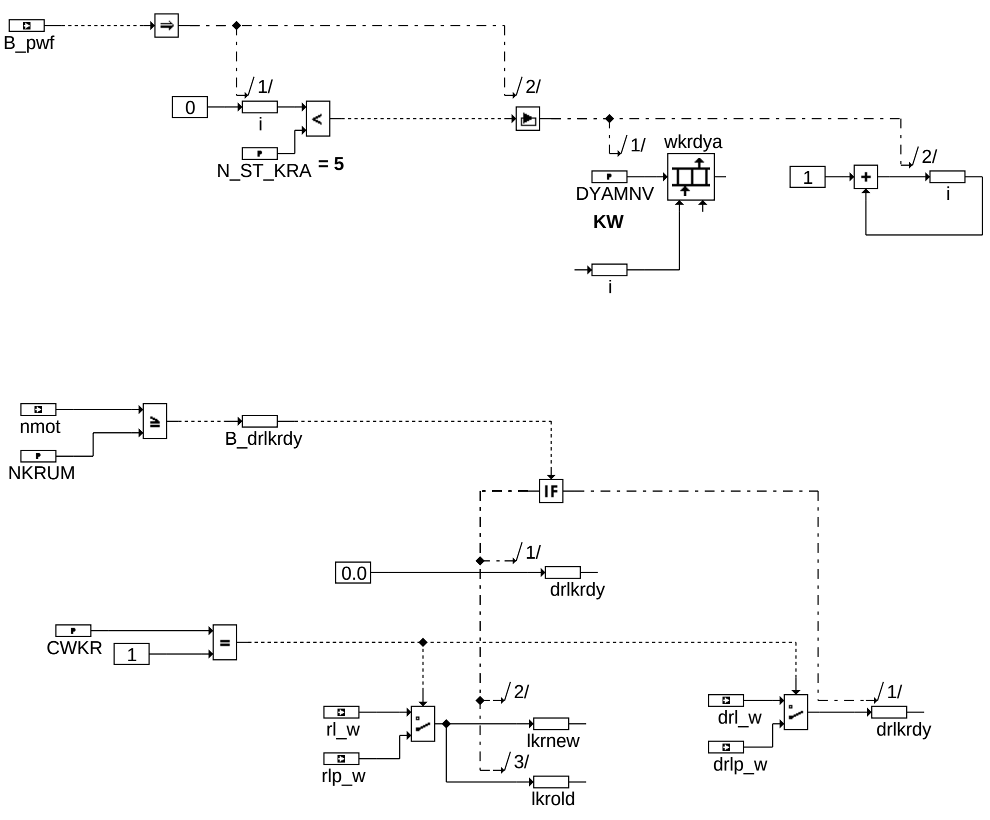
krdy-tipin

ZZWKRDY: percentage of ignition retard adjustment caused by KC



krdy-zzwkrdy

Initialization



krdy-initialize

ABK KRDY 10.90 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AZKELDYN	NMOT		KL (REF)	ignition per cylinder for load dynamics => knock detection
AZKRLDYN	NMOT		KL (REF)	number of ignition per cyl. during knock control load dynamic
AZKRNDYN	NMOT		KL (REF)	number of ignition for knock control engine speed dynamic
CWKR			FW	code word knock control
CWTIPIN			FW	Codeword for tip in function
DYADMX			FW	max. value of dynamic response derivation
DYADS			FW	add. retarding per cycle through adapt. dynamics
DYAFVS			FW	advance step for deactivation of dynamic response
DYAMNV			FW	min. value of dynamic response derivation
DYAVF			FW	deactivation period for dynamics retardation
DZWTIN	NMOT		KL (REF)	delta ignition angle at tip-in
FKELDYA			FW	Corrective factor for knock detection threshold for adaptation of load dynamic
KFDYES	NMOT	RL	KF	Threshold for dynamic presetting values
KFDYESOF	NMOT	RL	KF	Offset threshold for dynamic presetting values
NGKRWN	NMOT		KL (REF)	threshold revolution gradient for dynamics detection
NKRUM			FW	revolution threshold for change of delta load signal for load dynamics
N_ST_KRA			FW	number of speed ranges in kc adaptation map
PZWKRA			FW	percentage frequency of ignition angle output by KC during dyn. adaption
SNM16KRUB	NMOT		SV (REF)	datapoint distribution engine speed, 16 datapoints
SRL04DYUB	RL		SV	basepoint distribution of rl, 4 basepoints
TMDYNA			FW	engine temperature threshold to enable load dynamic adaptation

Variable	Source	Type	Description
AZKELDY	KRDY	LOK	value of cl AZKELDYN
AZKRLDY	KRDY	LOK	value of cl AZKRLDYN
AZKRNDY	KRDY	LOK	value of cl AZKRNDYN
B_DRLKRDY	KRDY	LOK	Flag for n > NKRUM
B_KL	KRKE	EIN	condition for knocking
B_KLDYNRM	KRDY	LOK	Condition normal knocking with adapted load dynamic
B_KLDYSTK	KRDY	LOK	Condition heavy knocking with adapted load dynamic
B_KR	KRDY	AUS	condition for knock control active
B_KRDWS	KRRA	EIN	condition knock control safety ignition retarding
B_KRLDY	KRDY	AUS	Condition load dynamics for knock detection active
B_KRLDYA	KRDY	AUS	Condition load dynamics retard and dynamics adaptation active
B_KRLDYF	KRDY	LOK	condition adaptation load dynamics retard towards advance released
B_KRLDYV	KRDY	LOK	condition threshold for additional load dynamics retard exceeded
B_KRNDY	KRDY	AUS	condition speed dynamics for knock detection active
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_PWF		EIN	Condition for powerfail
B_TIPIN	KRDY	LOK	Tip-in detected
B_TMKR	KRRA	EIN	Condition temperature (tmot) for knock control achieved
B_VNULL	GGVFZG	EIN	condition vehicle at stillstand
B_ZWKRAA	KRRA	EIN	condition ignition angle of the KC is given
DRLKRDY	KRDY	LOK	load gradient for activating kc load dynamics
DRLP_W	BGRLP	EIN	delta predicted load for injection time calculation (word)
DRL_W	SWADAP	EIN	charge change (Word)
DYESOFV	KRDY	LOK	current value offset for load dynamic response detection threshold
DYESV	KRDY	LOK	current value of load dynamic response detection threshold
GANGI	SWADAP	EIN	Engaged gear
I	KRDY	LOK	Vector for initialization flags (ECU model only)
KEK	KRKE	EIN	knock detection threshold corrected
LKRNEW	KRDY	LOK	value of load at time t
LKROLD	KRDY	LOK	value of load at time t-dt
NGAS_W	BGNG	EIN	engine speed gradient during one working cycle
NGKRV_W	KRDY	LOK	instantaneous value of threshold speed dynamics
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RLP_W	BGRLP	EIN	rel. air charge predicted for injection calculation (Word)
RL_W	EGFE	EIN	relative air charge (Word)
STKRNX	KRRA	EIN	speed range adaption map KC
TMOT	SWADAP	EIN	Engine temperature
VIRKR	KRKE	EIN	Ratio: integrator / reference level knock control
WKRDY	KRDY	AUS	ignition retard during dyn-function of knock control
WKRDYA	KRDY	LOK	Adapted ignition timing for KC dynamic
WKRDYAA	KRDY	LOK	adaptation part of dynamic ignition retard
WKRDYTI	KRDY	LOK	tip in part of dynamic ignition retard
ZALDY	KRDY	LOK	Ignition counter for deactivation of load dynamics
ZLDY	KRDY	LOK	Ignition counter for load dynamic
ZLDYKE	KRDY	LOK	ignition counter for load dynamics => knock detection
ZNDY	KRDY	LOK	ignition counter for rpm-dynamics
ZZPRZ	KRDY	LOK	percentage of ignitions with kc determined ignition angle during dynamics
ZZWDYKR	KRDY	LOK	ignition counter for KC with bit B_zwkra=1 set during KC dynamic
ZZWDYMD	KRDY	LOK	ignition counter for KC with bit B_zwkra=0 not set during KC dynamic
ZZYLKR	GGKS	EIN	cylinder counter KC

FB KRDY 10.90 Detailed description of function

```
Load dynamic response
=====================
The load dynamic response is marked by two phenomena:
        - increased knock tendency (in case of corresponding temperature)
        - quick noise increase
which are responded to by an additional ignition retarding (dynamic response derivation wkrdy) resp. by a quicker following-up of
the reference level and increased knock detection threshold (s. %KRKE).


Detection load dynamic response and enabling of the dynamic response adaptation (BB_DYN)
=========================================================================================
When introducing countermeasures two temperature ranges are distinguished:
Temperature range 1: (TMKR < tmot < TMDYNA): knock control load dynamic response without adaptation of ignition angle --->
                                             B_krldy & !B_krldya
Temperature range 2: (tmot > TMDYNA):        knock control load dynamic response with adaptation of ignition angle --->
                                             B_krldy & B_krldya

In both ranges the load dynamic response B_krldy is triggered via the positive load difference between equidistant instants (=load
gradient). If during an acceleration the difference drlkrdy of the nominal load signal between two consecutive scannings in the
10ms-grid is larger than the 1. dynamic response detection threshold DYESN then the timer zldy is set to the starting value
AZKRLDYN. As soon as drlkrdy < DYESN,  zldy is decremented by 1 increment per working cycle until zldy = 0 is reached. As long as
zldy > 0 and TMKR < tmot <= TMDYNA, only the condition B_krldy=1 applies. For zldy > 0 and tmot > TMDYNA the condition B_krldya=1
additionally applies and this is done until wkrdy is completely controlled back to 0. The dynamic response detection threshold
DYESN and the starting value for the timer AZKRLDYN are engine speed-dependent and each taken from a fixed characteristic line.
During idling (B_ll) no dynamic response may be detected (e.g. due to LLR). In additon zldy=0 leads to the
dynamic phase being stopped.

Triggering conditions for load dynamic response:  Temperature range 1 --->  (TMKR < tmot < TMDYNA) & (drlkrdy > DYESN) & !B_ll
                                                  Temperature range 2 --->  (tmot > TMDYNA) & (drlkrdy > DYESN) & !B_ll


           ^                                                     *---*   *   *   *   *   *   *   *   *
     rlsol |                           drlkrdy < DYESN   --->*---+
           |                                             *---+ - - - - - - - - -
           |                                             |   .
           |                                             |   .
           |                                         *---+   .
           |         drlkrdy > DYESN + DYESOFN  ---> |       .
           |                                         |       .
           |                                     *---+       .
           |                                     |           .
           |                                     |           .
           |                                 *---+ - - - - - - - - - - - - - - -
           |          drlkrdy < DYESN -->*---+   .           .
           |                         *---+ - - - - - - - - - - - - - - - - - - -
           |                         |   .       .           .
           |                     *---+   .       .           .
           | drlkrdy > DYESN -> |        .       .           .
           |                 *---+ - - - - - - - - - - - - - - - - - - - - - - -
           |     *   *   *---+           .       .           .
           |                     .       .       .           .                                                 10 ms
           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->

           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
           |             ^       |       .       .           .           +---+                            ignitions cyl.1
           |             |       |       .       .           .       +---+   .    |
           |          AZKRLDYN   |       .   +---+           .   +---+       .    v
    zldy   |             v       |       +---+   |           +---+- - - - - - - - -
           |           - - - - - +-------+       +-----------+- - - - - - - - - - - 1 Inkr.
           v                                                                      ^
                                                                                  |
```

for temperature range 1 without adaptation of the ignition angle as long as zldy > 0: B_krldy & !B_krldya applies

```
                                 .                                           .
  B_krldy  ^                     .                                           .
           |                     +-------------------------------------------+
           |                     |                                           |
           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
  B_krldya ^                     .                                           .                            ignitions cyl.1
           |                     .                                           .
           |                     .                                           .
           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
                                 .                                           .                            ignitions cyl.1
                                 .                                           .
                                 .                                           .
```

for temperature range 2 with adaptation of the ignition angle as long as zldy > 0: B_krldy & B_krldya applies

```
                                 .                                           .
  B_krldy  ^                     .<-- DYESN+DYESOFN > drlkrdy > DYESN        .<-- zldy=0
           |                     +-------------------------------------------+
           |                     |                                           |
           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
                                 .        .                                  .
  B_krldyf ^                     .        .<-- drlkrdy > DYESN+DYESOFN       .
           |                     .        +----------------------------------+
           |                     .        |                                  |
           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
                                 .                                           .
  B_krldya ^                     .  tmot > TMDYNA                            .<-- wkrdy < 0                 ignitions cyl.1
           |                     +---------------------------------------------------------------+
           |                     |                                                               | <-- wkrdy = 0
           --+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
                                                                                                          ignitions cyl.1
                                 .                                           .
   DYAMNV  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+--->
           |             ^       |                                           .               +---+        ignitions cyl.1
           |             |       |                                           .           +---+   .
  wkrdy    |             |       |                                           .       +---+       .  |
           |             |       |                                           .   +---+           .  v
           |             v       |                                           +---+ - - - - - - - - - -
           |    wkrdya   - - - - +-------------------------------------------+ - - - - - - - - - - - - 1 incr.
   DYADMX  |---------------------------------------------------------------------------------------------------
           v
```

Influence of load dynamic response on knock detection and control

When triggering load dynamic response the following functions become effective independent of the temperature range (TMKR < tmot <= TMDYNA or tmot > TMDYNA):

1. The cylinder-selective reference level calculations are performed by means of the label KRFTP3 (see %KRKE) => quicker following-up of reference level.

2. The knock detection thresholds ke(i)w are increased by the factor FKELDY. Corrected knock detection thresholds kek(i) result (see %KRKE).

3. For each detected knocking combustion the ignition angle is retarded by the value KRFKN cylinder-selectively (see % KRRA). For enabled steady-state adaptation the stored retardings are read from the each time current adaptation map range in case of range changes. Writing access to the characteristic map of the steady-state adaptation is, however, forbidden (see %KRRA).

In temperature range 1 (TMKR < tmot <= TMDYNA) n o additional dynamic response retarding of the ignition angle is performed !!

Load dynamic response adaptation (DYN_ADAP)
===
If load dynamic response is triggered in temperature range 2 (tmot > TMDYNA ==> B_krldya) the following functions additionally become effective:

4. Adaptive dynamic response retarding of the ignition angle for all cylinders (KRDY and %KRRA).
In addition to the steady-state cylinder-selective KC retarding the ignition angle for all cylinders is retarded by wkrdy for the time zldy > 0 if dynamic response was detected. Here wkrdy is read engine speed-dependent from the RAM-area wkrdya. If zldy = 0 this additional dynamic response retarding wkrdy is reduced by 1 increment per DYAVF combustions.

5.1 If load dynamic response is triggered without exceeding of the 2. dynamic response threshold (DYESN < drlkrdy < DYESN+DYESOFN ==> B_krldy & B_krldya), then the enabling of the adaptation to retard (BB_DYN)is performed for the starting value of the dynamic response retarding wkrdy. That means that by strong knocking B_kldystk a new adaptation of wkrdya is performed for the next dynamic procedure (wkrdya(new) = wkrdya(old) + krfkw, limited to DYADMX).
In case of exclusively normal knocking B_kldynrm the adaptation value remains unchanged and also if no knocking occurs (DYN_ADAP).

5.2 If the 2. dynamic response threshold is also exceeded (drlkrdy > DYESN + DYESOFN ==> B_krldyf) then in additon to the measures from 4 and 5.1 also the adaptation of the dynamic response retarding is enabled to advance (BB_DYN).
During the active dynamic phase (B_krldyf = 1) two counters zzwdykr and zzwdymd are started. For each set bit B_zwkraa = 1 (i.e. ignition angle of the KC was given out) zzwdykr is incremented, for each not set bit B_zwkraa = 0 (i.e. ignition angle of the torque management was given out) zzwdymd is incremented. At the end of the dynamic phase (B_krldyf = 0) the ratio zzwdykr / (zzwdykr + zzwdymd) is determined, the two counters zzwdykr and zzwdymd are thereafter reset to 0 (DYN_ADAP).
If no knocking combustion occurs during the active dynamic phase (B_krldyf = 1) which is detected by the knock detection threshold kek (s. %KRKE) and if zzwdykr / (zzwdykr + zzwdymd) >= PZWKRA (adjustable fixed value) then the adaptive dynamic response derivation starting value wkrdya is adjusted towards advance by 1 increment, however, in the process it is limited to the value DYAMNV.

The RAM-area wkrdya is subdivided into 5 engine speed ranges stkrnx.

```
stkrnx =    0            1           2           3           4
               +-----------+-----------+-----------+-----------+-----------+
        wkrdya |           |           |           |           |           |
               +-----------+-----------+-----------+-----------+-----------+
engine speed base points KRAN1       KRAN2       KRAN3       KRAN4
                             <---------+            ---------> nmot (rpm)
                            hysteresis KRANH
```

The engine speed ranges are identical to those of the steady-state adaptation map (s. %KRRA). The engine speed limits apply directly with rising engine speed. The engine speed hysteresis KRANH is only deducted with decreasing engine speed (identical to %KRRA).

The dynamic response derivation calculated again each time is written into the RAM-area wkrdya and there into the engine speed range which is valid at the time of the triggering of the dynamic response (!B_krldya ==> B_krldya). It is then available as wkrdy for the next dynamic procedure which starts in this engine speed range.

With ’ignition off’ all retardings are preserved in the RAM-area wkrdya until the engine is started again.

Tip in (TIPIN)
==============
Tipin is an increase of engine speed at almost zero load while the engine is declutched. This results in a mximum of engine speed-

and load dynamics which leads to a increased knocking tendency. On the other side the torque requested by the driver is not used to acclerate the vehicle. Therefore it is allowed to retard the ignition timing later as knock borderline. The reduced torque due to the ignition retard is irrelevant. Therfore a tipin ignition retard wkrdyti = DZWTIN(nmot) is added to the actual ignition angle.
A tipin is detected if load dynamics (B_krldyv) is detected and the relation of engine speed to vehicle speed results in gangi=0 and the the engine is declutched.

The tipin function can be configurated by CWTIPIN:

Bit 0 = 0 => wkrdy = wkrdyaa + wkrdyti, ignition retard during dynamics is the sum of adative and pre-controlled share
Bit 0 = 1 => wkrdy = wkrdyti, dynamics adaptation is disabled, only the pre-controlled tip in-share is ausgegeben

Bit 1 = 0 => max. duration of tip in is determined by AZKRLDYN (B_krldyv)
Bit 1 = 1 => max. duration of tip in is determined by AZKELDYN (B_krldy)   with AZKRLDYN < = AZKELDYN

Bit 2 = 0 => tip in detection is enabled even if gangi=0 is not detected, then tip in can be detected during the gearshift process
Bit 2 = 1 => tip in detection is enabled by gangi = 0, tip in can not be detected during the gearshift process

Engine speed dynamic response
=============================

If the engine temperature tmot > TMKR and the engine speed gradient ngas_w are lager than the engine speed dynamic response detection threshold DNKRDYSN then the timer zndy is set to the starting value AZKRNDYN.
If ngas_w < DNKRDYSN, zndy is decremented up to zero for each ignition of cylinder 1. The condition B_krndy=1 applies until zndy > 0.

As long as B_krndy=1 the following applies:

1. The cylinder-selective reference level calculations are performed with the label KRFTP2 (see %KRKE) => quicker following-up of reference level.

2. The knock detection thresholds ke(i)w are increased by the factor FKENDY. Corrected knock detection thresholds kek(i) result (see %KRKE).

3. For each detected knocking combustion the ignition angle is retarded by the value KRFKN cylinder-selectively (see % KRRA). For enabled steady-state adaptation the stored retardings are read from the each time current adaptation map range in case of range changes. Writing access to the characteristic map of the steady-state adaptation is, however, forbidden (see %KRRA).

The triggering of the load dynamic response may also take place during engine speed dynamic response active and vice versa. It is decided in %KRKE resp. %KRRA which of the then introduced measures takes priority.

APP KRDY 10.90 Application hint

Application aim load dynamic response: Adjustment so that perfomance is optimized but no audible "dynamic knocking" in the vehicle. The adjustment should be performed resp. checked under "worst-case conditions" (summer test, fuel with lowest enabled octane number).
The following values taken from experience can be used for a rough adjustment:

TMKR	approx. 40 degrees C
TMDYNA	approx. 80 degrees C
DYESN	no values have yet been gained
DYESOFN	no values have yet been gained, tough demand: DYESN + DYESOFN <= 767 % for all base points nmot !
AZKRLDYN	should be chosen in such a way that the dynamic conditon approx. 300-600 ms applies. Guidance values are: 2-5 working cycles (AS) at 1000 rpm and 15-25 working cycles at 6000 rpm.
DYADMX	approx. -8 ... -10 degrees crankshaft (°KW)
FKELDYA	1.2 - 1.3
DYAVF	should be chosen such that during each working cycle adjustment to advance is perfomed by approx. 4 increments at most (so DYAVF must be equal to or exceed no. of cylinders / 4, DYAVF is an integer and DYAVF > 0 is demanded!)

Application aim engine speed dynamic response: Avoiding of misdetections due to a very fast increase in engine speed and a thus resulting abrupt noise increase (especially critical: gear shifting on powerful vehicles with automatic gearbox)

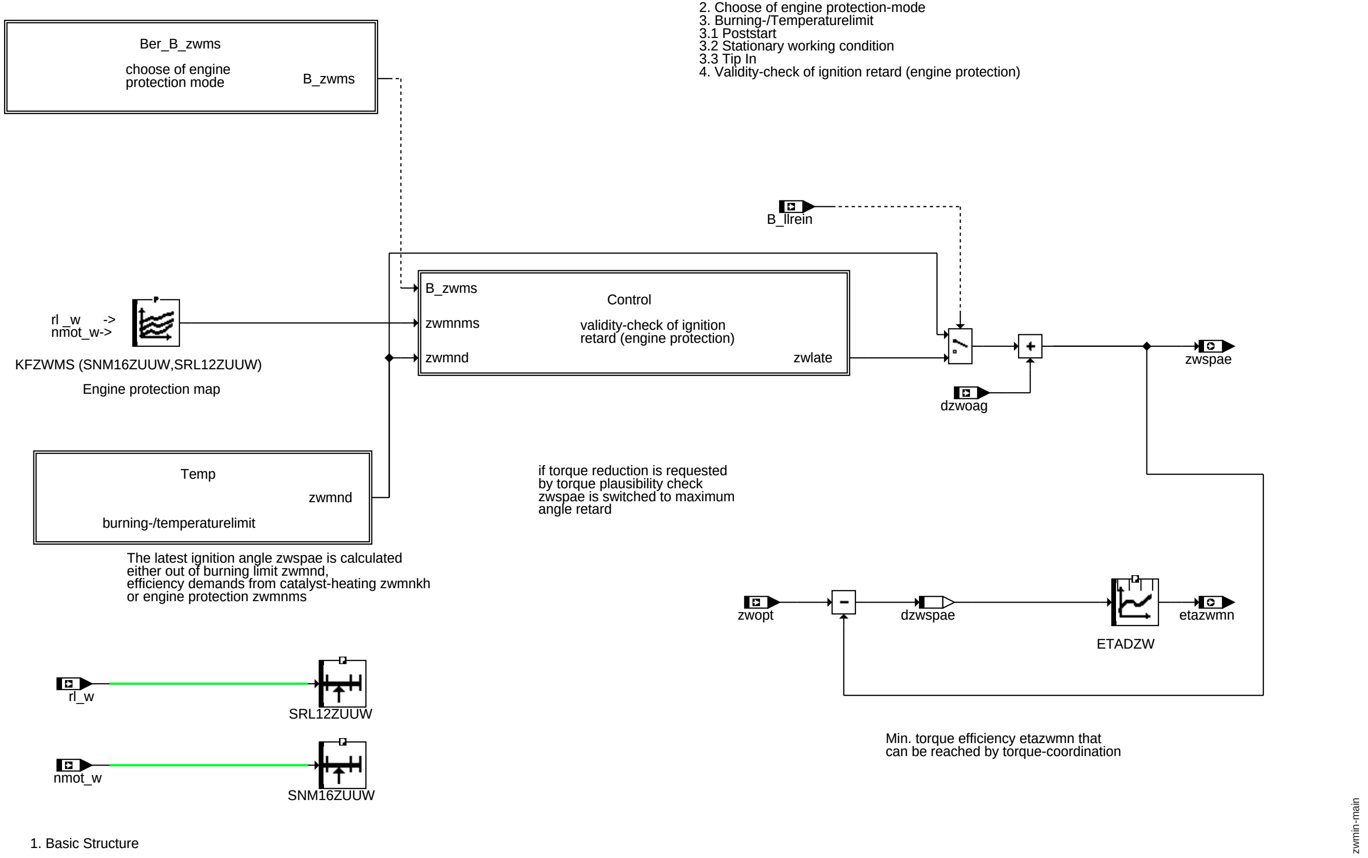
DNKRDYSN	approx. 500 - 1000 rpm/s;
AZKRNDYN	should be chosen such that the dynamic response condition approx. 300-600 ms applies. Guidance values are: 2-5 working cycles at 1000 rpm and 15-25 working cycles at 6000 rpm.

ZWMIN 3.140 Calculation of maximum retarded spark limitation

FDEF ZWMIN 3.140 Function definition

Source: ZWMIN 3.140

Contents:
1. Basic Structure
2. Choose of engine protection-mode
3. Burning-/Temperaturelimit
3.1 Poststart
3.2 Stationary working condition
3.3 Tip In
4. Validity-check of ignition retard (engine protection)



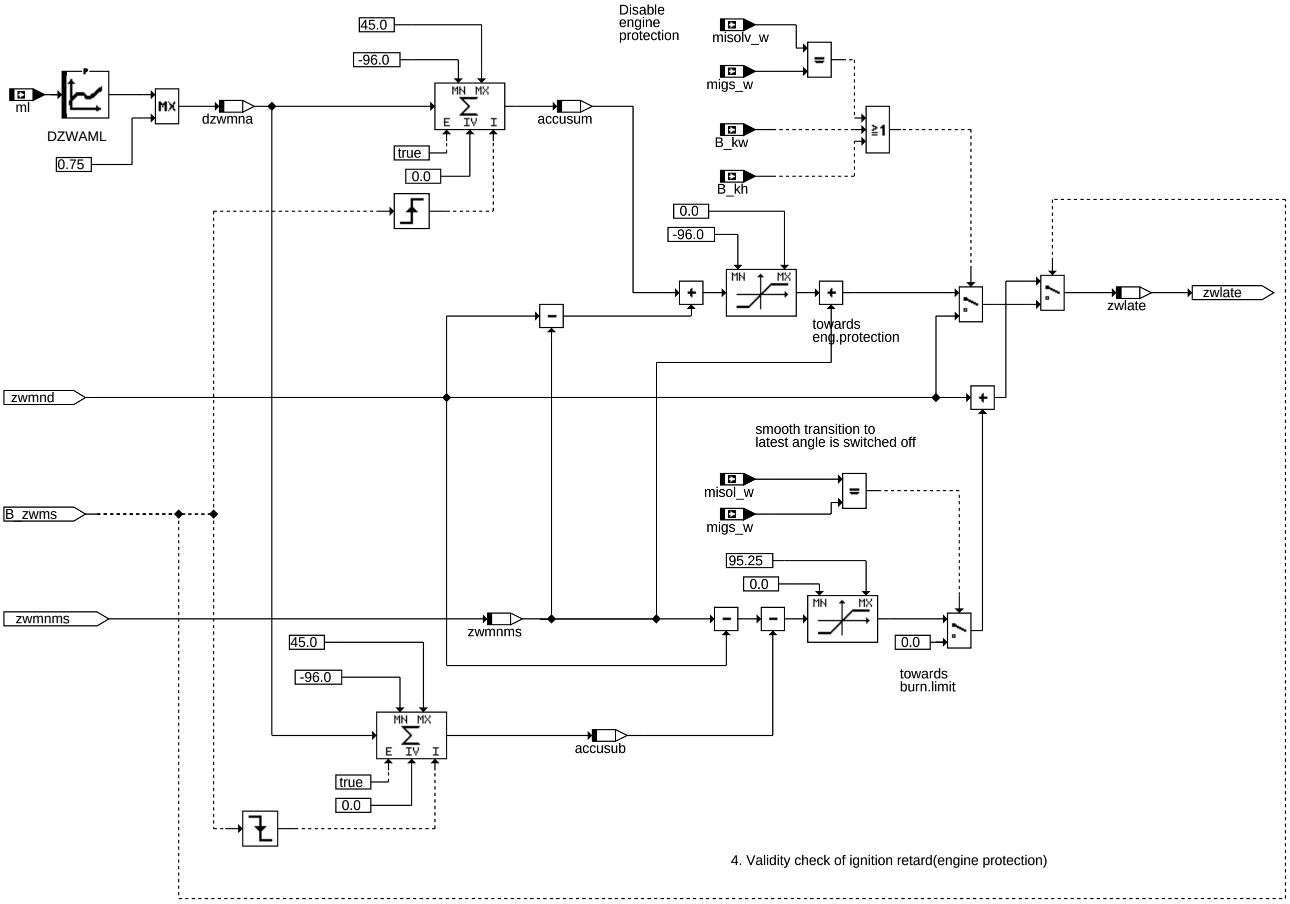
if torque reduction is requested by torque plausibility check zwspae is switched to maximum angle retard

The latest ignition angle zwspae is calculated either out of burning limit zwmnd, efficiency demands from catalyst-heating zwmnkh or engine protection zwmnms

Min. torque efficiency etazwmn that can be reached by torque-coordination

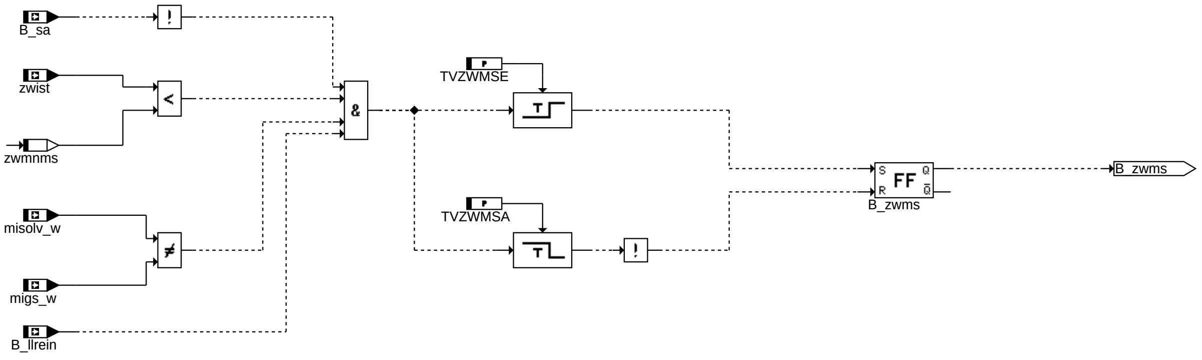
1. Basic Structure

zwmin-main



4. Validity check of ignition retard(engine protection)

zwmin-control

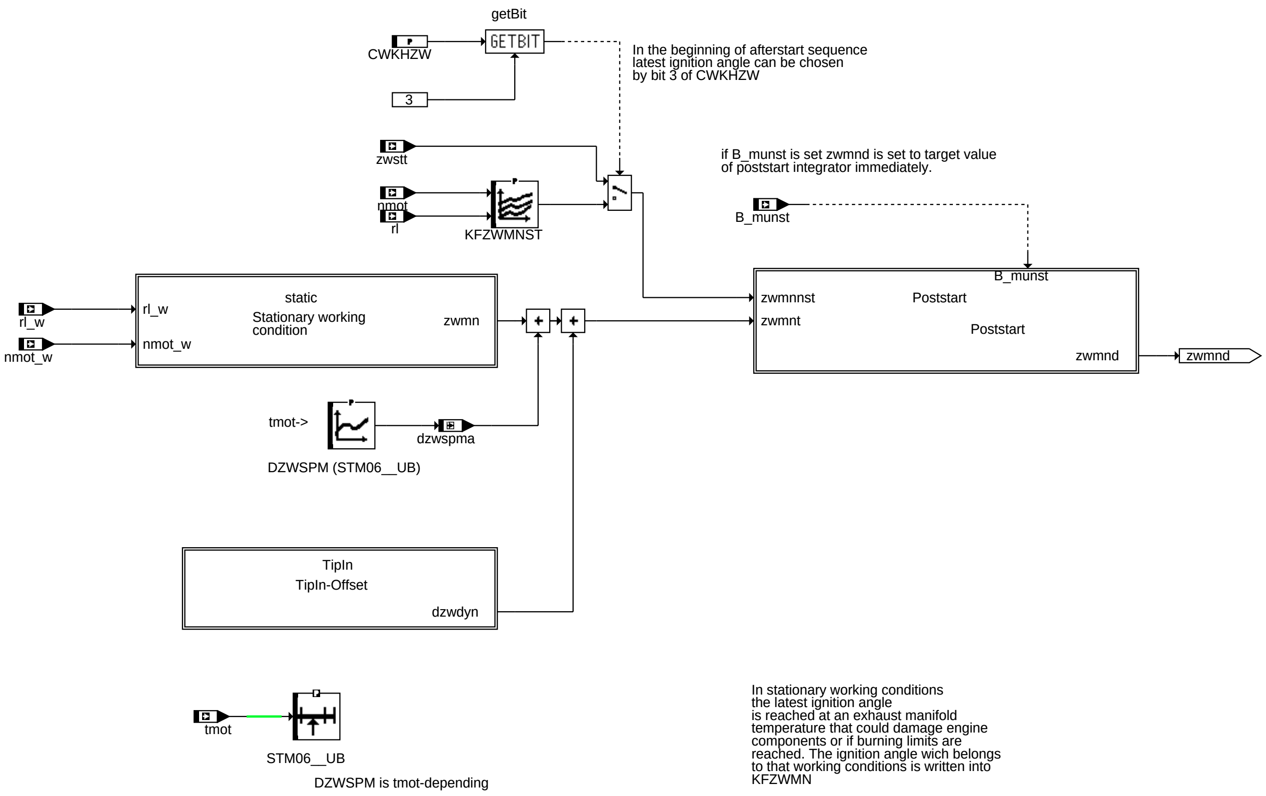


Engine protection B_zwms is switched on if zwist is retarded to angles smaller than zwnms (engine protection ingnition angle) and no trailing throttle fuel cutoff (B_sa) is on and no torque reduction from the automatic gear box is demanded

If B_zwmns is TRUE then the latest ignition angle is advanced from zwmnd to zwmnms. If catalyst warm-up or hold of catalyst temperature is active or automatic gear box is demanding torque reduction then the ignition angle is switched to zwmnd immediately.

2. Choose of engine protection mode

zwmin-ber-b-zwms



In the beginning of afterstart sequence
latest ignition angle can be chosen
by bit 3 of CWKHZW

if B_munst is set zwmnd is set to target value
of poststart integrator immediately.

DZWSPM is tmot-depending

In stationary working conditions
the latest ignition angle
is reached at an exhaust manifold
temperature that could damage engine
components or if burning limits are
reached. The ignition angle wich belongs
to that working conditions is written into
KFZWMN

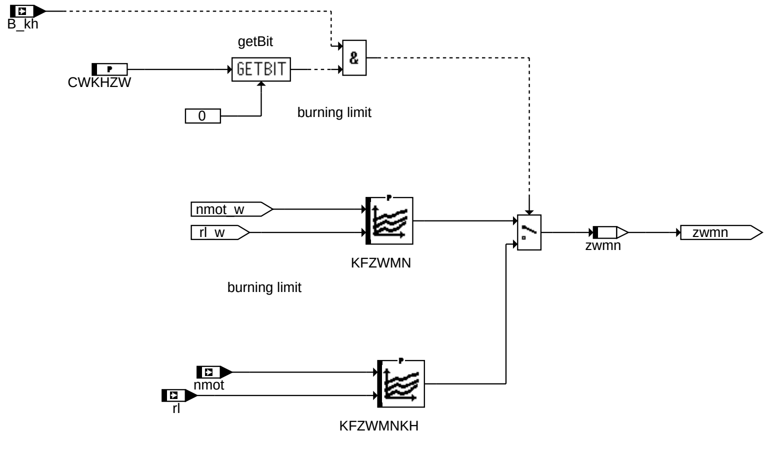
DZWSPM is the temperature-correction
of the two mentioned principles

3. Burning-/temperatur condition

zwmin-temp

zwmin-temp

If catalyst warm-up is active,
a extended limit for the latest
ignition angle could be necessary.
This area is only active in a
small low dynamic rl/nmot-window.

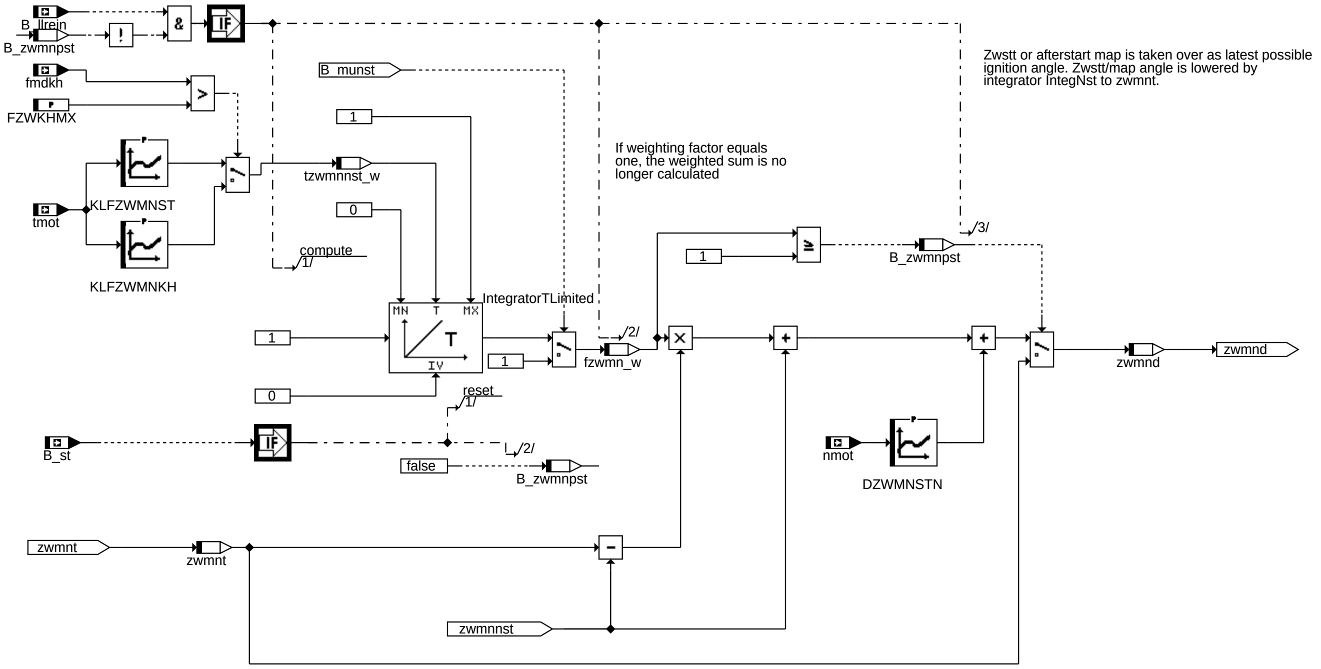


catalyst heating

3.2 Stationary working condition

zwmin-static

zwmin-static



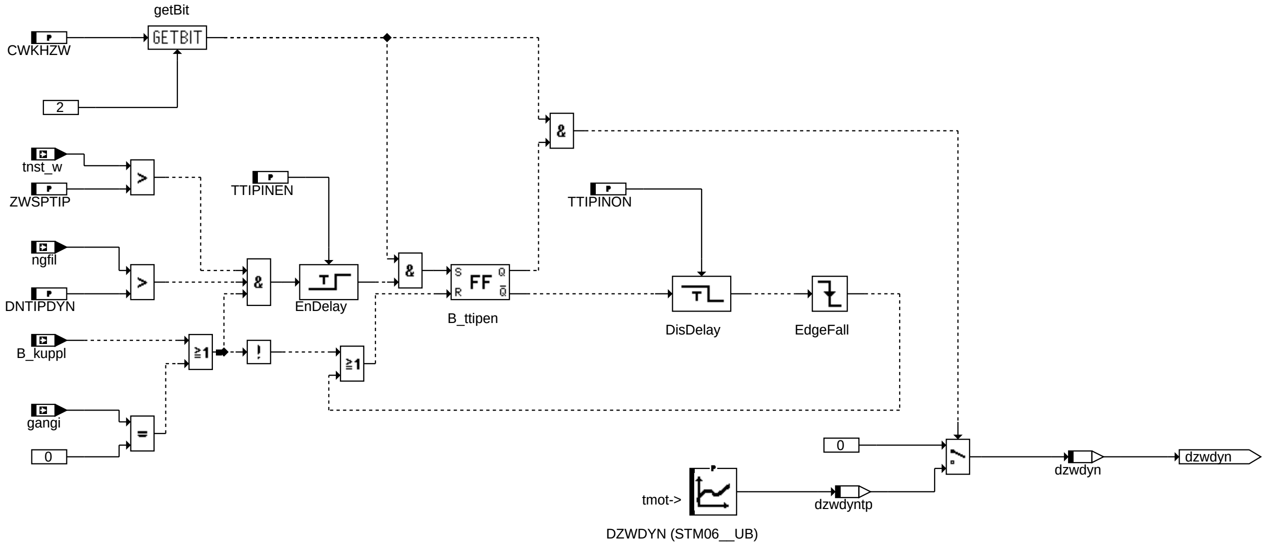
If weighting factor equals one, the weighted sum is no longer calculated

Zwstt or afterstart map is taken over as latest possible ignition angle. Zwstt/map angle is lowered by integrator IntegNst to zwmnt.

zwmin-poststart

3.1 poststart

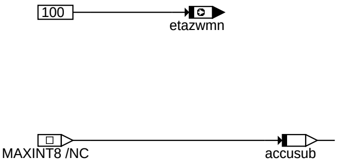
zwmin-poststart



zwmin-tipin

3.3 Tip In

zwmin-tipin



zwmin-initialize

zwmin-initialize

ABK ZWMIN 3.140 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWKHZW			FW	Codeword for calculation of latest ign.angle out of catalyst warm-up
DNTIPDYN			FW	Turn on limit for Tip-In offset on max. spark retard
DZWAML	ML		KL	Up/down regulation speed between the maps of limitation
DZWDYN	TMOT		KL	Spark advance for burning-limit angle at tip-in
DZWMNSTN	NMOT		KL	nmot dependent offset on latest ign. angle during start
DZWSPM	TMOT		KL	delta latest ignition angle relative to engine temperature
ETADZW	DZWSPAE		KL (REF)	ignition efficiency depending on delta ignition angle
FZWKHMX			FW	Normalization factor torque reserve for catalyst heating
KFZWMN	NMOT_W	RL_W	KF	Map for minimal ignition angle
KFZWMNKH	NMOT	RL	KF	Map for minimal ignition angle catalyst warm-up
KFZWMNST	NMOT	RL	KF	minimal ignition spark advance for engine start and after start
KFZWMS	NMOT	RL	KF	Map for ignition value as latest possible value
KLFZWMNKH	TMOT		KL	Spark retard gradient of burning limit during after-start at cat.heating
KLFZWMNST	TMOT		KL	Spark retard gradient of burning limit during after-start
SNM16ZUUW	NMOT_W		SV (REF)	break point distribution engine speed, 16 base pts.
SRL12ZUUW	RL_W		SV (REF)	break point distribution of relative air charge, 12 base points
STM06__UB	TMOT		SV (REF)	Datapoint distribution, engine temperature, 6 datapoints
TTIPINEN			FW	Time delay for consideration of torque transmition after nmot-dynamik
TTIPINON			FW	On-Time for tip-in offset on max. spark retard
TVZWMSA			FW	Time until transition to continuously retarded limiting
TVZWMSE			FW	Time until transition to dynamic retarded limiting
ZWSPTIP			FW	Enable time for tipin offset on latest ignition angle

Variable	Source	Type	Description
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_KW	BBKHZ	EIN	Condition catalyst warming
B_LLREIN	LLRMD	EIN	Condition idle speed control is active
B_MUNST	WDKSOM	EIN	Condition allow intervention of torque monitoring
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	SWADAP	EIN	condition for start
B_ZWMNPST	ZWMIN	LOK	condition afterstart referring latest ignition angle is reached
DZWDYNTP	ZWMIN	LOK	tip-in correction latest ignition angle
DZWMNA	ZWMIN	LOK	delta ignition angle minimum
DZWOAG	MDBAS	EIN	exhaust recirculation rate-dependent correction of optimum ignition angle
DZWSPAE	ZWMIN	LOK	correction ignition angle for latest permissible ignition angle
ETAZWMN	ZWMIN	AUS	minimum ignition angle effectiveness
FMDKH	BBKHZ	EIN	Weighting factor torque reserve for catalyst heating
FZWMN_W	ZWMIN	LOK	fade out factor for latest ignition angle during afterstart
GANGI	SWADAP	EIN	Engaged gear
MIGS_W	SWADAP	EIN	desired indicated torque form GS for quick intervention
MISOLV_W	MDKOG	EIN	indicated resultant nominal torque before torque limitation
MISOL_W	MSF	EIN	indicated resultant nominal torque
ML	SWADAP	EIN	air mass flow
NGFIL	SWADAP	EIN	filtered engine-speed gradient
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RL_W	EGFE	EIN	relative air charge (Word)
TMOT	SWADAP	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start
TZWMNNST_W	ZWMIN	LOK	time constant for fade out ramp latest ignition angle
ZWIST	ZUE	EIN	real ignition angle
ZWLATE	ZWMIN	LOK	Latest ignition angle after engine protection plausibilisation
ZWMN	ZWMIN	LOK	retarded ignition timing
ZWMND	ZWMIN	LOK	Latest possible dynamic sparc retard
ZWMNMS	ZWMIN	LOK	Latest possible continous sparc retard
ZWMNT	ZWMIN	LOK	ingnition angle at burning limit plus temperature and dynamic-correction
ZWOPT	MSF	EIN	optimal ignition angle
ZWSPAE	ZWMIN	AUS	retarded ignition angle
ZWSTT	ZWSTT	EIN	Ignition angle during start

FW ZWMIN 3.140 Fixed Values

Parameter	Value	Description
CWKHZW		Codeword for calculation of latest ign.angle out of catalyst warm-up
DNTIPDYN		Turn on limit for Tip-In offset on max. spark retard
FZWKHMX		Normalization factor torque reserve for catalyst heating
TTIPINEN		Time delay for consideration of torque transmition after nmot-dynamik
TTIPINON		On-Time for tip-in offset on max. spark retard
TVZWMSA		Time until transition to continuously retarded limiting
TVZWMSE		Time until transition to dynamic retarded limiting
ZWSPTIP		Enable time for tipin offset on latest ignition angle

FB ZWMIN 3.140 Detailed description of function

This function supplies the ignition angle retarded as much as possible zwspae and the most retarded ignition-angle efficiency etazwmn for the ignition-angle limitation.

The ignition angle retarded as much as possible is either calculated from the combustion limit KFZWMN, a special catalyst heating map or from the engine protection map. The catalyst heating map is activated optionally via the code word CWKHZW dependent on the catalyst heating concept and on the combustion behavior of the engine.

The map KFZWMN contains the absolutely most retarded ignition angle, at which the engine still combusts. The ignition angles result, if the permissible temperature in the exhaust manifold is being exceeded or if combustion misses occur in the engine due to the retarded position of the ignition angle.

Clearly audible combustions can be observed in the exhaust-system branch during start and during post-start with the ignition angles in KFZWMN. This longer afterburning at cold engine and bad carburation is compensated by the ignition angle at start resp. by the map KFZWMNST. KFZWMNST resp. the ignition angle at start zwstt is controlled down via a ramp to KFZWMN during the post-start. Via the characteristics KLFZWMNST resp. KLFZWMNKH the duration in seconds is set, which is needed by the ramp to travel from a factor zero to 100%. If the catalyst heating reserve fmdkh has been completely built-up, the control duration is set via a catalyst heating characteristic.
KFZWMNST/ZWSTT limits the lift of the torque control into the direction retarded in the speed overshoot during the transition from start to idle.

Afterburning occurs more often in the exhaust-system branch at cold temperatures, therefore it is often useful to perform a timing advance on the most retarded ignition angle at cold engine. The shift of the retarding limit via tmot is performed in DZWSPM.

If retarded ignition angles are needed for the catalyst heating function immediately after the start, then these can often only be driven in an rl,nmot-window. In case of load change e.g. such a catalyst heating angle can lead to distinct noise in the exhaust-system branch. A special catalyst heating limitation of the ignition angle can for this reason be performed via KFZWMNKH.

The engine protection map is activated, if the ignition angle was more retarded than the engine protection ignition angle for longer than a debouncing time.

The most retarded ignition angles calculated from the maps are checked for long-term compatibility in another calculation step. That means, an angle KFZWMS that in the long-term does not lead to the engine being damaged may not be exceeded. If fuel cut-off is active or if the automatic transmission requests a torque reduction, the engine protection check is deactivated.
Activation and deactivation of the engine protection check are delayed via time constants to prevent jittering of the ignition angle, when the most retarded ignition angle is reached.

If the engine protection check is active, then the ignition angle is controlled via a ramp to the value in KFZWMS, provided it is less than the value in KFZWMS. The increasing control is performed during the post-start phase. If catalyst heating, keeping catalyst warm or torque reduction is performed there by transmission intervention, then immediately branching to the most retarded ignition angle from the combustion criteria is performed in this phase.

The ignition angle is controlled down to zwmnd again, if the engine protection check is deactivated. If transmission intervention occurs during the decreasing control phase, an immediate jump to zwmnd takes place.

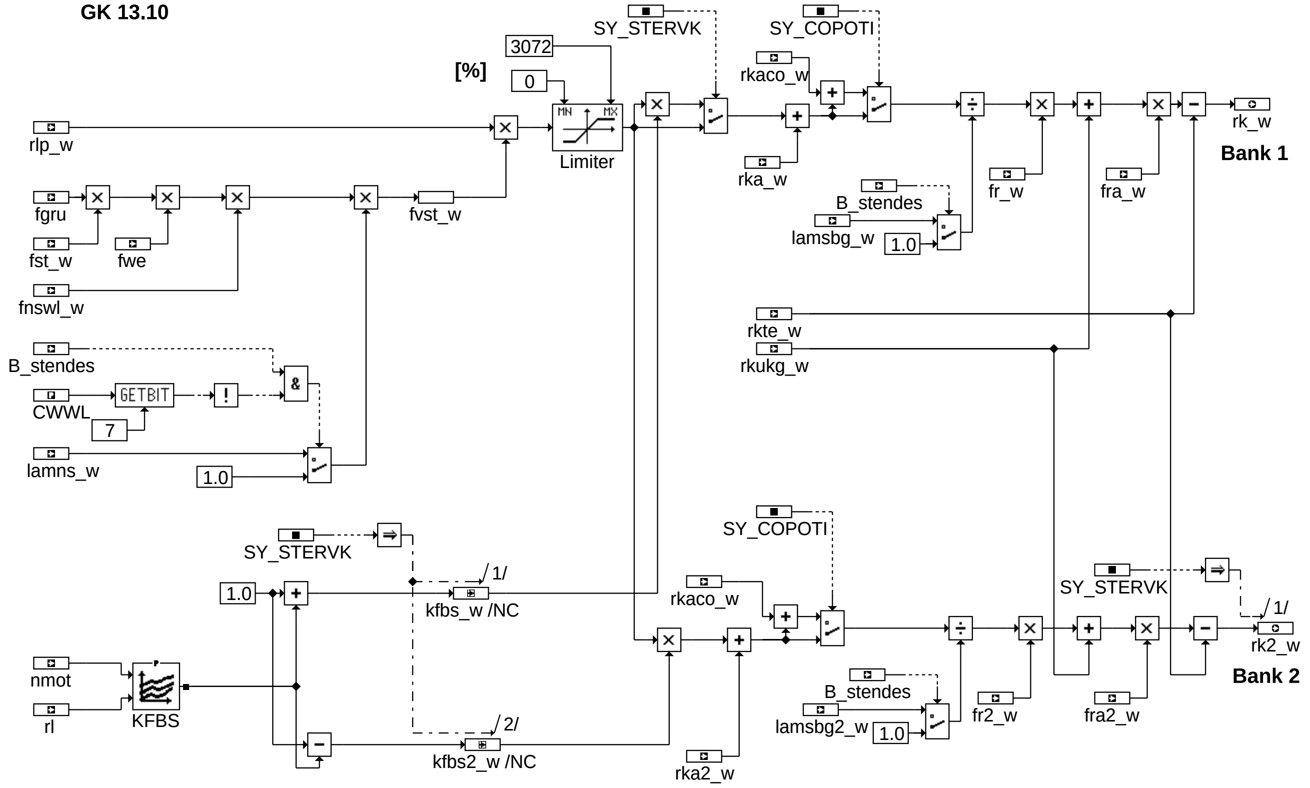
APP ZWMIN 3.140 Application hint

The map KFZWSP and the characteristic DZWSPM are to be adjusted such that no misfiring will occur at the respective operating point with the ignition angle retarded as much as possible.

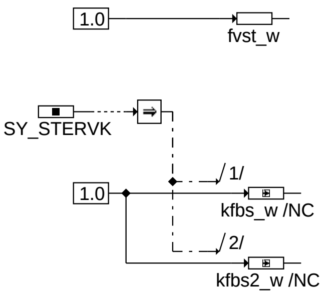
GK 13.10 mixture control

FDEF GK 13.10 Function definition

GK 13.10



gk-main



gk-init

ABK GK 13.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWWL			FW (REF)	code word for warm-up control
KFBS	NMOT	RL	KF	bank-selective mixture factor
SY_COPOTI			SYS (REF)	System constant CO-Poti present
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat

Variable	Source	Type	Description
B_STENDES	ESSTT	EIN	Condition end of start injection
FGRU	ESVST	EIN	factor: basic pilot control
FNSWL_W	ESNSWL	EIN	Factor afterstart and warm-up
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FR_W	LR	EIN	Lambda controller output (word)
FST_W	ESVST	EIN	start-injection factor
FVST_W	GK	LOK	factor: pilot control
FWE	ESWE	EIN	reinjection factor
KFBS2_W	GK	LOK	Distribution factor bank selective (bank2)
KFBS_W	GK	LOK	Distribution factor bank selective (bank1)
LAMNS_W	ESVST	EIN	lambda engine nominal during afterstart
LAMSBG2_W	LAMSOLL	EIN	required lambda limitation Bank2

Variable	Source	Type	Description
LAMSBG_W	LAMSOLL	EIN	Desired Lambda limitation (word)
NMOT	SWADAP	EIN	engine speed
RK2_W	GK	AUS	relative fuel mass Bank2
RKA2_W	LRA	EIN	additive adaptive correction of the relative fuel amount bank 2
RKACO_W		EIN	Additive correction of the rel. fuel mass for setting idle-speed CO
RKA_W	LRA	EIN	additive adaptive correction of the relative fuel amount
RKTE_W	TEB	EIN	relative fuel part of the purge control
RKUKG_W	ESVST	EIN	rel. fuel mass transition compensation
RK_W	GK	AUS	relative fuel mass
RL	SWADAP	EIN	relative air charge
RLP_W	BGRLP	EIN	rel. air charge predicted for injection calculation (Word)

FW GK 13.10 Fixed Values

Parameter	Value	Description

FB GK 13.10 Detailed description of function

The function GK calculates the relative fuel mass rk_w necessary for the predicted relative air charge rlp_w of a cylinder, for combustion at Lambda = 1.0. The standardisation of the two variables rlp_w and rk_w was chosen such that, at 100% air charge 100% fuel is also required for combustion with the engine at operating temperature and where Lambda = 1.0.
The stochiometric ratio of air mass to fuel mass in the cylinder is designated here as lambda combustion chamber,
as opposed to lambda sensor, which is measured on the lambda sensor and may deviate from lambda combustion chamber due to the introduction of secondary air. In normal engine operation lambda-combustion chamber = lambda-sensor.

The function ESVST delivers the pre control values fgru, fst_w, fnswl_w, fwe for lambda-combustion chamber = 1.0.

This lambda combustion chamber can be shifted to "rich" or "lean" by way of the desired value of lambda LAMSOLL to improve engine running (engine protection, lean running limit) or to comply with exhaust specifications.

The function GKRA includes mixture adaptation (rka_w, fra_w), canister purge (rkte_w), canister purge diagnosis and lambda control (fr_w).
The continuous lambda controller controls each bank to the required lambda (lamsbg_w, lamsbg2_w), which is formed in the function overview LAMSOLL.
During secondary air the input for lambda controller is lamsbg_w =lamsons_w,lamsbg2_w=lamsons2_w, lambda-combustion chamber is # 1.0.

At Systems with a two-point lambda controller, the lambda controller is stopped during lamsbg_w, lamsbg2_w # 1.0.

The desired value of lambda at lambda sensor deviates from lambda combustion chamber during secondary air mode.

Calculation of the relative fuel mass rk_w:

The factors fgru, fst_w fnswl, fwe are multiplied together and are available for the application as a RAM cell pre-control factor (fvst_w). Multiplication of this pre-control factor by the relative air charge rlp produces the pre-control value of the relative fuel mass rk for lambda-combustion chamber = 1.0.
A difference in charge in two-bank systems is corrected by multiplication by means of the bank-selective correction KFBS. Positive values in KFBS signify "enrichment" of Bank1 with simultaneous "enleanment" of Bank2 by the same amount, because the charges of the two banks are composed of the total charge measured by the HFM.

The additive portion rka_w from the mixture control GKRA is intended to correct any leakage air which may be present, so that pre-control is also to lambda-combustion chamber = 1.0 in this case.

These pre-control values are then corrected bank-selectively to the lambda (lamsbg_w,lamsbg2_w) specified by the desired value of lambda infunction LAMSOLL.
The continuous lambda controller controls to this specified lambda and corrects any deviation by the controller factor fr_w, fr2_w bank-selectively.
In two-point lambda control, the controller is stopped (fr_w = 1.0) at a required lambda # 1.0, and
pre-control defines lambda # 1.0.

The transition compensation corrects dynamic effects in the intake manifold wall-applied film by way of the additive intervention rkukg_w.

Long-term deviations (errors in the fuel path dominant) from the required lambda are adapted as factors fra_w, fra2_w.

Finally, the fuel portion directed into the intake manifold by the canister purge is subtracted from this relative fuel demand calculated for the required lambda (lamsbg_w), and is delivered for output as rk_w,rk2_w.

At systems without lambda controller, the pre-control can be correctet by Tester via RAM-cell rkaco_w. This fearture is only available if SY_COPOTI is true.

Switch B_stendes separates the influence between fst and lamsbg during Start. It means: if B-stendes = false -> pre-control is defined by fst.

APP GK 13.10 Application hint

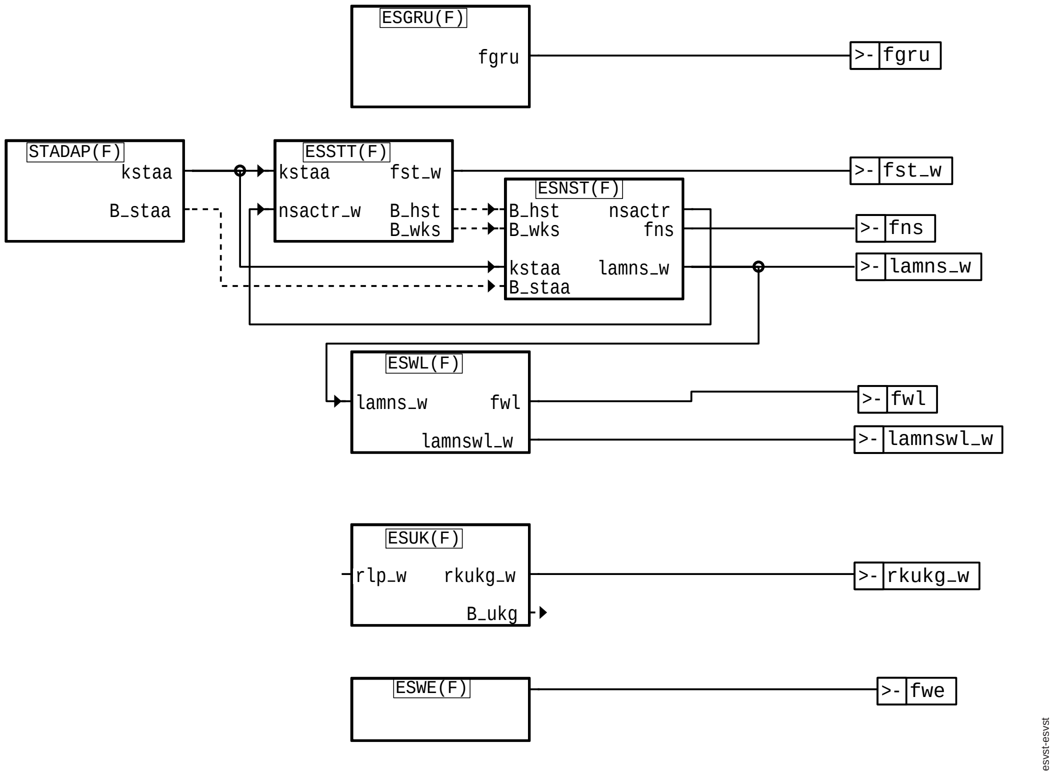
```
Line KFBS is only available if SY_STERVK = true

KFBS:   Values at Axis-Points:  800, 1200, 1600, 2000, 2500, 3000, 4000, 5000 1/min
        Values of Line:         Neutral value is 0.
      Factor 0.1 corresponds to 10% enrichment on Bank1 with simultaneous 10% enleanment on Bank2

CWWL Bit 7: 0 -> lamns_w is calculated
CWWL Bit 7: 1 -> lamns_w has no influence
```

ESVST 4.20 Fuel injection pre-control

FDEF ESVST 4.20 Function definition



esvst-esvst

ABK ESVST 4.20 Abbreviations

Variable	Source	Type	Description
B_HST	ESVST	LOK	condition hot start
B_STAA	ESVST	LOK	starting fuel adaptation active at afterstart
B_UKG	ESVST	LOK	condition transient control activated
B_WKS	ESVST	LOK	Condition cold restart
FGRU	ESVST	AUS	factor: basic pilot control
FNS	ESVST	AUS	afterstart factor
FST_W	ESVST	AUS	start-injection factor
FWE	ESVST	AUS	reinjection factor
FWL	ESVST	AUS	warm up factor
KSTAA	ESVST	LOK	currently used start mixture adaptation factor
LAMNSWL_W	ESVST	AUS	lambda engine nominal at afterstart and warming up
LAMNS_W	ESVST	AUS	lambda engine nominal during afterstart
NSACTR	ESVST	LOK	afterstart counter/filter
NSACTR_W	ESVST	LOK	afterstart counter 16-bit
RKUKG_W	ESVST	AUS	rel. fuel mass transition compensation
RLP_W	ESVST	LOK	rel. air charge predicted for injection calculation (Word)

FW ESVST 4.20 Fixed Values

Parameter	Value	Description

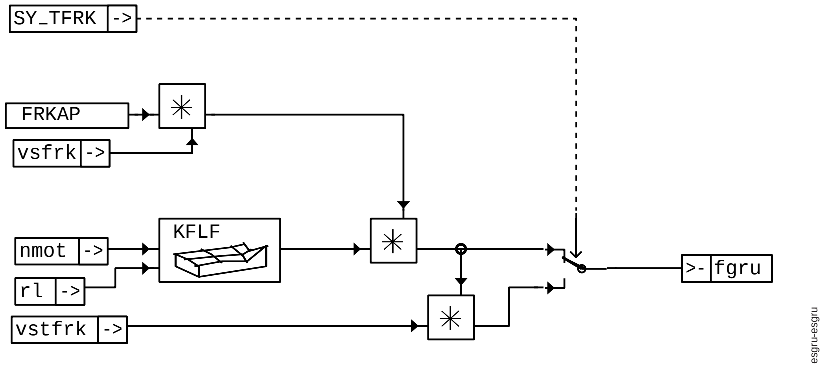
FB ESVST 4.20 Detailed description of function

The function ESVST provides an overview of the injection pre-control for a combustion chamber Lambda of 1.0, and is composed of the basic injection factor fgru, the start injection factor fst_w, the post-start factor fns and the warm-up factor fwl.
The transition compensation ESUK corrects wall-applied film effects in case of dynamics above the additional or reduced quantity rkukg_w. The additional quantity after cutin of cylinders is calculated as fwe in function ESWE.

APP ESVST 4.20 Application hint

ESGRU 23.30 Basic function injection

FDEF ESGRU 23.30 Function definition



esgru-esgru

ABK ESGRU 23.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FRKAP			FW	factor, relative fuel mass for application
KFLF	NMOT	RL	KF	lambda characteristic map at part load

Variable	Source	Type	Description
FGRU	ESGRU	AUS	factor: basic pilot control
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SY_TFRK	PROKON	EIN	system constant service device correction of relative fuel mass rk
VSFRK	VS_VERST	EIN	Correction of the relative fuel mass by adjusting systems
VSTFRK		EIN	Correction of the relative fuel mass by tester

FW ESGRU 23.30 Fixed Values

Parameter	Value	Description
FRKAP		factor, relative fuel mass for application

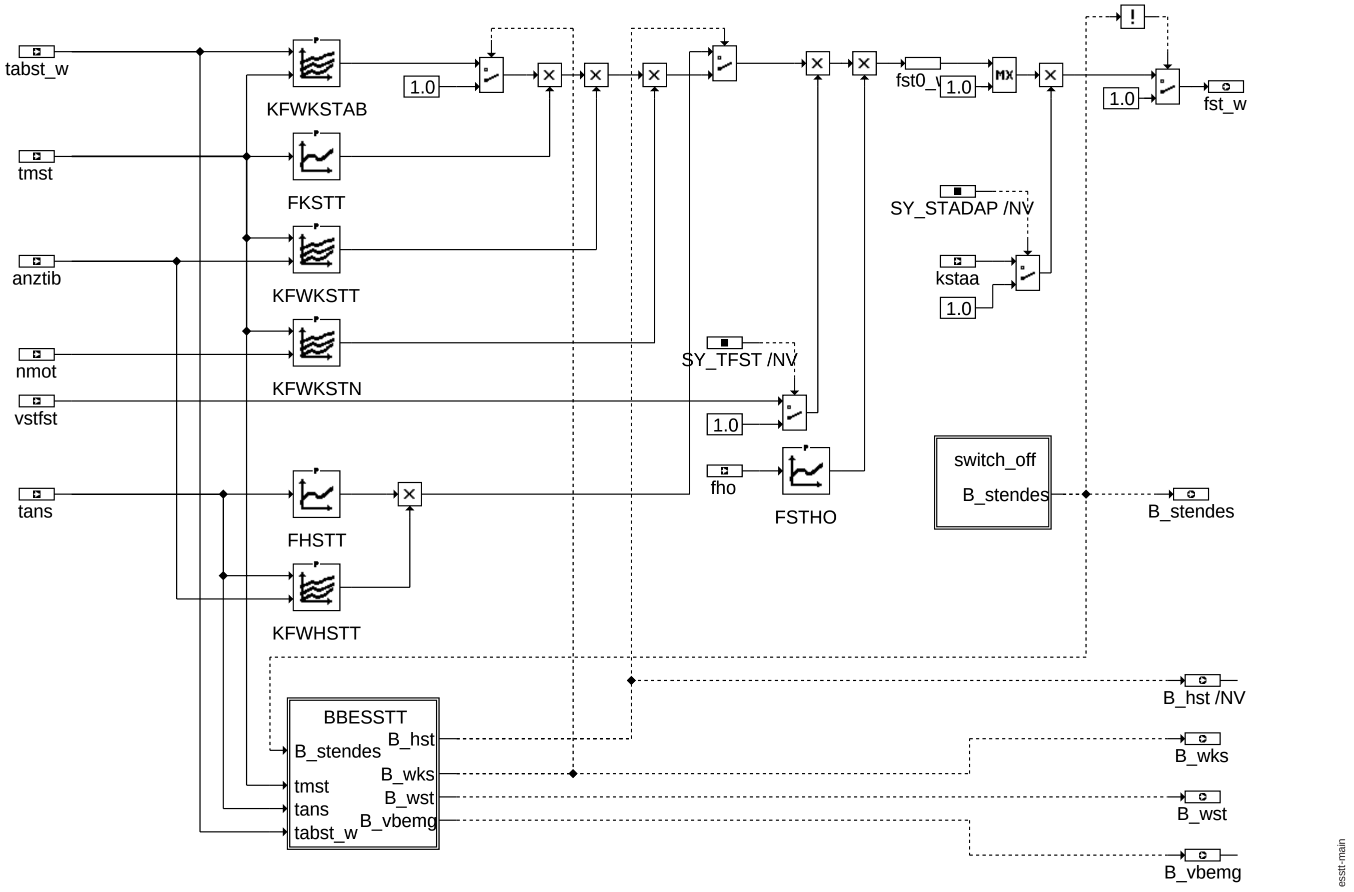
FB ESGRU 23.30 Detailed description of function

The KFLF map should not be used for intervening in the mixture, because the relative air charge rl must be balanced to the engine demand via the pulsation map KFPU. If rl is corrected by KFPU faktor fgru has to be 1.0
The two interventions vsfrk and FRKAP are multiplying interventions via application devices. FRKAP is changed by VS100 adjustment; vsfrk by VS20 or via the serial interface. These two interventions must be set to neutral during definition after start of production

APP ESGRU 23.30 Application hint

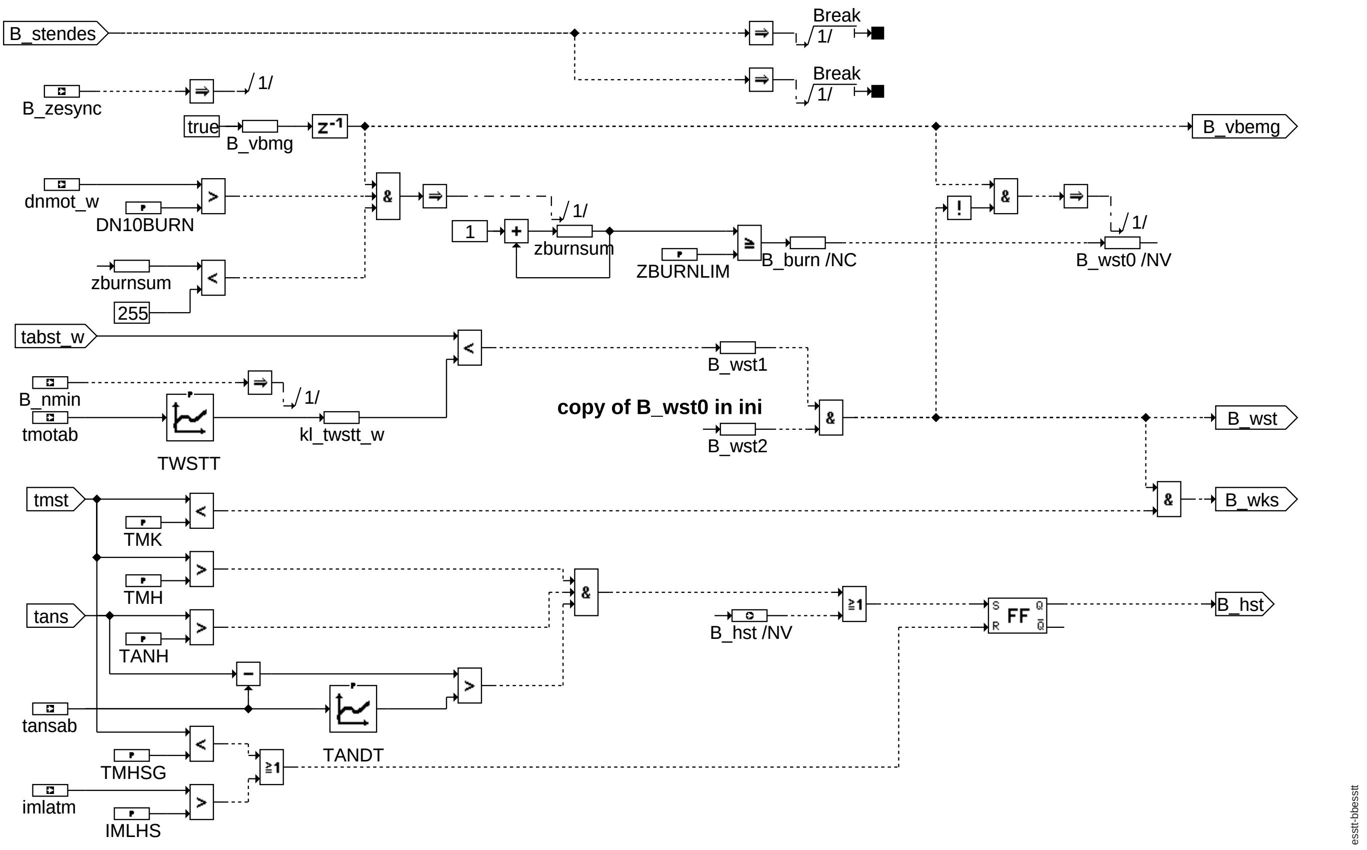
ESSTT 22.10 Injection duration at start

FDEF ESSTT 22.10 Function definition



esstt-main

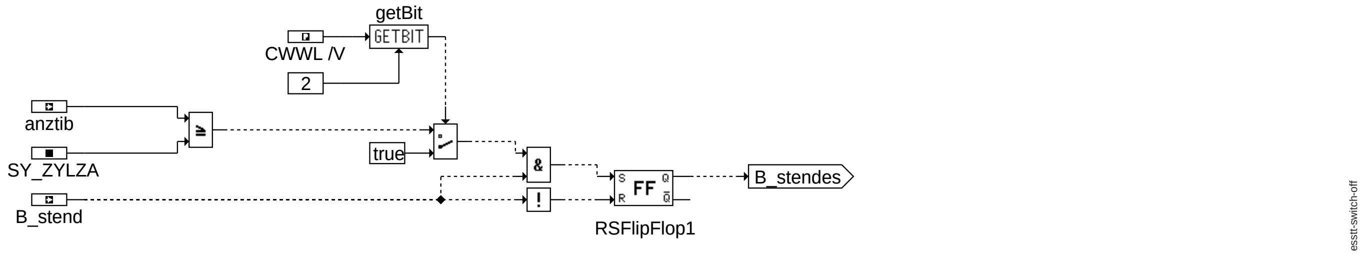
Subfunctionblock 1: Conditions



esstt-bbesstt

Subfunctionblock 2: Switch off of start injection

switch off start-up injection



esstt-switch-off

Injection during start-up:

The function is broken down into cold/warm start-up and hot start-up. In the hot start-up, effects from hot gasoline (enleanments) from increased precontrol can be compensated for to a certain degree.
The function permits an adaptation of the start-up specific to the temperature for the start-up factor and the controlled decrease of the quantity of fuel during start-up.
A uniform wall build-up and a uniform start-up mixture can be realized for all cylinders by the anzti-dependent weighting/controlled decrease.
The states of hot and repeated cold start-up are also transferred to the afterstart and warm up function %ESNSWL.
It shall be assured for those projects where there is no tester intervention required in the start-up enrichment for the constant describing the system that SY_TFST = false.
With Codeword CWWL(bit 2) it is possible to decide wether this function is switched off when B_stend = true or to wait until in each cylinder was injected at least one start injection. Especially with engines with many cylinders and a fast rewing up it is possible that B_stend is set before each cylinder got a start injection. In order to ensure that each cylinder gets a start injection CWWL(bit 2) can be set to 1.

Hot start-up:

The aim is the certain detection of a hot start-up. Hot start-up conditions are given when the engine temperature is high for a start-up and the fuel system could heat up (detection by means of the temperature increase in the intake air between shutdown and repeated start). A reset is only then meaningful when the engine has accordingly cooled down again or a certain time has elapsed (flow of a certain air mass) and such that the fuel supply system has been purged. The reset path must therefore also be computed outside of the start-up when there was a hot start-up given. If the hot start-up conditions are still prevailing after the engine has been turned off, then B_hst is set again during the subsequent start-up if the engine start-up temperature tmst is greater than or equal to TMHSG.

Restart:

After engine has been switched off, the temperature in the combustion chamber is the same as the engine temperature (cooling water) only after elapse of a certain period of time. If the engine is started again during this time (restart), then the mixture shall be leaned in order make allowance for the higher temperature conditions in the combustion chamber in comparison with tmot.

Two independent criteria play a role for the condition restart. For a restart, both the saved shutdown time tabst_w must lie below the threshold TWSTT (B_wst1=1) and the number detected firings in the previous start/running or attempted start-up zburnsum must have exceeded the threshold ZBURNLIM, i.e., it shall apply that B_wst2 = 1 (warming up of the combustion chamber). B_wst2 is calculated during initialization from B_wst0. B_wst0 is calculated in the current start-up for the next cycle and is set by zburnsum exceeding the threshold ZBURNLIM. At restart conditions B_wst0 is not calculated. So by an unsuccessful start another restart is possible.

If the shutdown time tabst_w is only determined by means of a control-unit afterrun, then attention shall be paid to conformity of the characteristic curves TWSTT and TNLSGM (refer to %BGTABST). B_wst1 is formed between the start of the initialization and the detection of start-up (B_st = 1) since the shutdown time tabst_w is formed during this time. B_wst1 remains fixed for a running engine when B_st is set.

The condition combustion possible B_vbmg is formed by B_zesync (ignition is synchron to injection). A combustion detection is possible one synchro later. This is expressed by the condition combustion detection possible B_vbemg. As soon as B_vbemg is set, the combustion counter is clocked in every syncro process. Firing is detected when an increase in the speed dnmot_w greater than DN10BURN is given. The condition B_vbemg is also used for adaptation of the start-up quantity.

If during start-up, B_wst = 1 and tmst < TMK, i.e. B_wks = 1, then the start-up factor is weighted with KFWKSTAB. KFWKSTAB depends on the shutdown time tabst_w and the engine temperature tmst. The conditions B_wks and B_hst are also used for the repeated afterstart-up.

ABK ESSTT 22.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWWL			FW (REF)	code word for warm-up control
DN10BURN			FW	minimum engine-speed difference for acckn. combustion
FHSTT	TANS		KL	factor hot start
FKSTT	TMST		KL	factor cold start
FSTHO	FHO		KL	weighting of factor start
IMLHS			FW	integrated flow of air-mass at hot start
KFWHSTT	TANS	ANZTIB	KF	map weighting of hot start factor
KFWKSTAB	TABST_W	TMST	KF	factor cold re-start for reduction of starting fuel
KFWKSTN	TMST	NMOT	KF	map weighting of factor cold start
KFWKSTT	TMST	ANZTIB	KF	map weighting of factor cold start
SY_STADAP			SYS (REF)	system constant start adaptation
SY_TFST			SYS (REF)	system constant service device intervention start factor
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TANDT	TANSAB		KL	threshold difference intake air temperature for hot start
TANH			FW	intake air temperature - threshold warm
TMH			FW	engine-temperature - threshold warm
TMHSG			FW	engine temp. hot-start limit
TMK			FW	engine-temperature - threshold cold
TWSTT	TMOTAB		KL	threshold soak time for re-start
ZBURNLIM			FW	threshold detected combustions for re-start

Variable	Source	Type	Description
ANZTIB	ACIFI	EIN	injection counter limited
B_HST	ESSTT	AUS	condition hot start
B_NMIN	GGDPG	EIN	condition lower speed: n < NMIN
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_STENDES	ESSTT	AUS	Condition end of start injection
B_VBEMG	ESSTT	AUS	condition detection of combustion possible
B_VBMG	ESSTT	LOK	condition combustion possible
B_WKS	ESSTT	AUS	Condition cold restart
B_WST	ESSTT	AUS	condition for re-start
B_WST0	ESSTT	LOK	Condition restart (part 1: combustions detected)
B_WST1	ESSTT	LOK	Condition restart (part 2: soak time)
B_WST2	ESSTT	LOK	Condition restart (part1: combustions detected in last cycle)
B_ZESYNC	AZUE	EIN	Condition ignition synchronized
DNMOT_W	BGNG	EIN	engine speed difference between two following segments
FHO	BGPU	EIN	Correction factor altitude
FST0_W	ESSTT	LOK	precontrolled start factor 16 bit
FST_W	ESSTT	AUS	start-injection factor
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value

Variable	Source	Type	Description
KL_TWSTT_W	ESSTT	LOK	output characteristic line TWSTT
KSTAA	STADAP	EIN	currently used start mixture adaptation factor
NMOT	SWADAP	EIN	engine speed
TABST_W	BGTABST	EIN	soak time
TANS	SWADAP	EIN	Intake air temperature
TANSAB	GGTFA	EIN	Intake air temperature when engine is shut-off
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TMST	GGTFM	EIN	engine temperature at start
VSTFST		EIN	adjustment factor start (service device interface)
ZBURNSUM	ESSTT	LOK	sum of detected combustions during start

FW ESSTT 22.10 Fixed Values

Parameter	Value	Description
DN10BURN		minimum engine-speed difference for acckn. combustion
IMLHS		integrated flow of air-mass at hot start
TANH		intake air temperature - threshold warm
TMH		engine-temperature - threshold warm
TMHSG		engine temp. hot-start limit
TMK		engine-temperature - threshold cold
ZBURNLIM		threshold detected combustions for re-start

FB ESSTT 22.10 Detailed description of function

APP ESSTT 22.10 Application hint

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Prerequisites:
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 - Torque coordination applied, in particular the frictional losses.

 - Basic adaptation for warm engine applied.

 - Total filling detection applied.

 - Idle-speed control adapted for a warm engine.

 - Basic ignition timing, ignition timing during start-up and afterstart as well as torque reserve defined.

 - Desired throttle blade position ( with torque structue not active, see %WDKSOM) adapted to a warm engine.

Preparatory work:
-----------------------
 - Specify fuel and engine oil to be used for the application.

 - Shut down start-quantity adaptation %STADAP ( --> kstaa = 1.0).

 - Disconnect tank ventilation valve and shut down the tank ventilation function.

 - Shut down lambda control and lambda adaptation.

 - Shut down the catalyzer heating function.

 - Shut down torque loss adaptation.

 - For absolutely lambda nominal at afterstart and warm up (CWWL Bit 7 = 1), define lambda nominal for afterstart
   and warm up in %LANSWL.
   By using a lambda description (CWWL Bit 7 = 0) set lamns_w to 1.0.

 - Check the running limits (lalgm > 1, lalgf < 1).

 - Define advanced position and type of injection (%ESVW).

 - Execute powerfail to reset the values learned.
```

Cold / warm start-up:

The start-up factor is stored in FKSTT and weighted with the values from KFWKSTT and KFWKSTN (controlled decrease). Interpolation is not in KFWKSTT but rather the value of the first datapoint is included in the calculations until the next datapoint has been reached. The anzti datapoints shall be selected as whole-number multiples of the number of cylinders. A uniform wall film build-up over all cylinders is thus possible by this. The rl dependency is however to be observed when considering the injection times (ti).

Example.: 4-cylinder --> Datapoints: 0, 4, 8, 12, 16, 20
6-cylinder --> Datapoints: 0, 6, 12, 18, 24, 30

Proposal for tmst datapoints:
-30 / -25 / -20 / -15 / -7 / 0 / 15 / 20 / 25 / 40 / 60 / 90 degrees C

Adjustment of the first injection per cylinder: The quantity of fuel for the first injections should already be sufficiently large that a firing is achieved following ignition (to be detected by an increase in the speed after each ignition). To do this, the value 1.0 is entered in KFWKSTT for anzti = 0 for all temperature datapoints and the necessary enrichment factor is described in FKSTT.

The start-up quantity can be (greatly) reduced after the first major injection per cylinder because a wall film has already been built up and heating has thus occurred because of the first firing. It is advisable to make the controlled decrease so steep such that, after approximately 3 injections per cylinder, a "flooding" of the engine is ruled out. It is thus assured by this that the engine can also be started again with certainty even for a restart. The corresponding values are to be entered in KFWKSTT on a temperature-specific basis to do this.
An evaluation of the selected data can be performed using the course for the engine speed.

A correction may be necessary for a start-up at high altitude because of the changed wall-film behavior during the transition from start-up to afterstart. This can be realized by means of the characteristic FSTHO.

In addition to a controlled decrease in the start-up enrichment via anztib, reduction of the start-up factor can be realized with KFWKSTN = f(tmst, nmot).
This map can simplify the transfer of data from earlier projects with a start-up factor for a controlled decrease in the speed. Wherever possible for new applications, the data shall be assigned such that KFWKSTN = 1.0.

Repeated cold start-up:

The condition repeated cold start-up B_wks is then fulfilled when the condition B_wst is fulfilled and the engine temperature during start-up tmst is less than the threshold TMK (e.g. 20°C). The condition restart B_wst is in turn made up of the partial conditions B_wst2 and B_wst1. B_wst2 is then fulfilled when more than one minimum number of firings (e.g. 2) have been detected in the previous start-up or attempted start-up and hence it can be assumed that the combustion chamber have warmed up in comparison with the coolant temperature. The condition B_wst0 is stored non-volatile and is written to B_wst2 in the following initialization. So the information is hence always available in B_wst2 for the next start-up or attempted start-up.
B_wst1 is then fulfilled when the shutdown of the engine has not yet exceeded the threshold TWSTT = f(tmotab) (refer also to %BGTABST). The duration shall be entered in TWSTT, as for how long the restart conditions are given after shutting down or stalling the engine.

In the event of repeated cold start-up the precontrol factor can be reduced by means of the map KFWKSTAB = f(tabst_w, tmst). Values < 1.0 are to entered in KFWSTAB to do this so that a course for the speed will still be achieved as for a normal start-up at the same start-up temperature tmst.

Hot start-up:

Hot start-up conditions are present when the fuel supply system (in particular in the region of the injection valves) has heated up considerably.
Injection valves shall be installed with a temperature-measuring point near to the tips of the injection valves for clear detection of the hot start-up conditions.

The threshold of the engine temperature tmot, as of which hot start-up conditions can occur, shall be entered in TMH. The threshold of the intake air temperature, as of which hot start-up conditions can occur, shall be entered in TANH. A heating-up
of the fuel supply system is deduced by observing the increase in the intake-air temperature tans since shutting down the engine (tansab).
If the increase exceeds the threshold TANDT = f(tansab), then hot start-up conditions can be present.

Hot start-up conditions are no longer present if

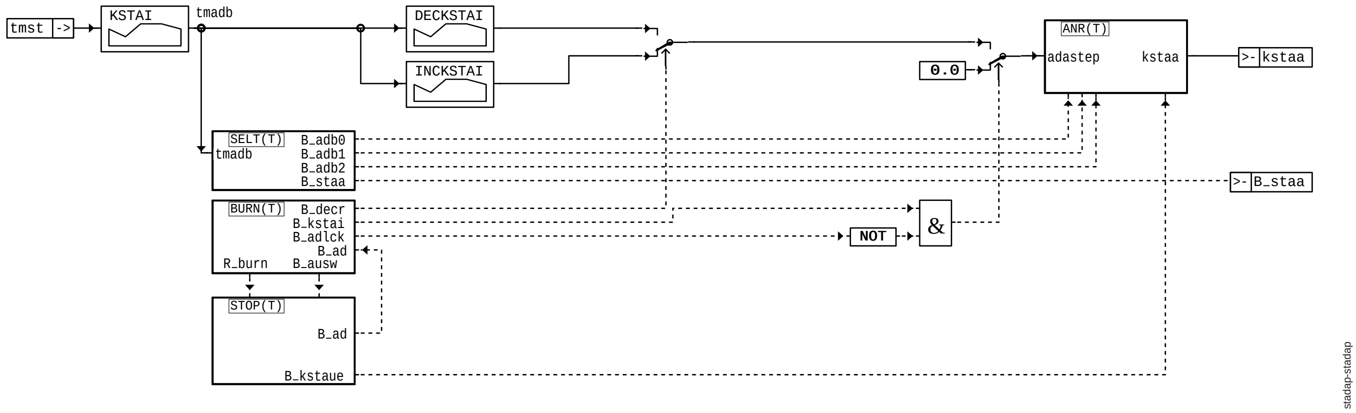
a) The engine has been shut down for a certain length of time and hence the fuel supply system has been purged. This is detected by an assessment of the air mass integral imlatm. That value for the integrated air mass shall be entered in IMLHS, as of which a sufficient purging has been carried out. B_hst is then reset while the engine is still running. The following start-up can again be hot start-up if the conditions for setting have been fulfilled.

b) The engine has been shut down under hot start-up conditions (B_hst set) for such a time that the fuel supply has been able to cool down again.
The corresponding engine temperature for this shall be entered in TMHSG. For the start-up, B_hst is reset prior to the first output of ti.

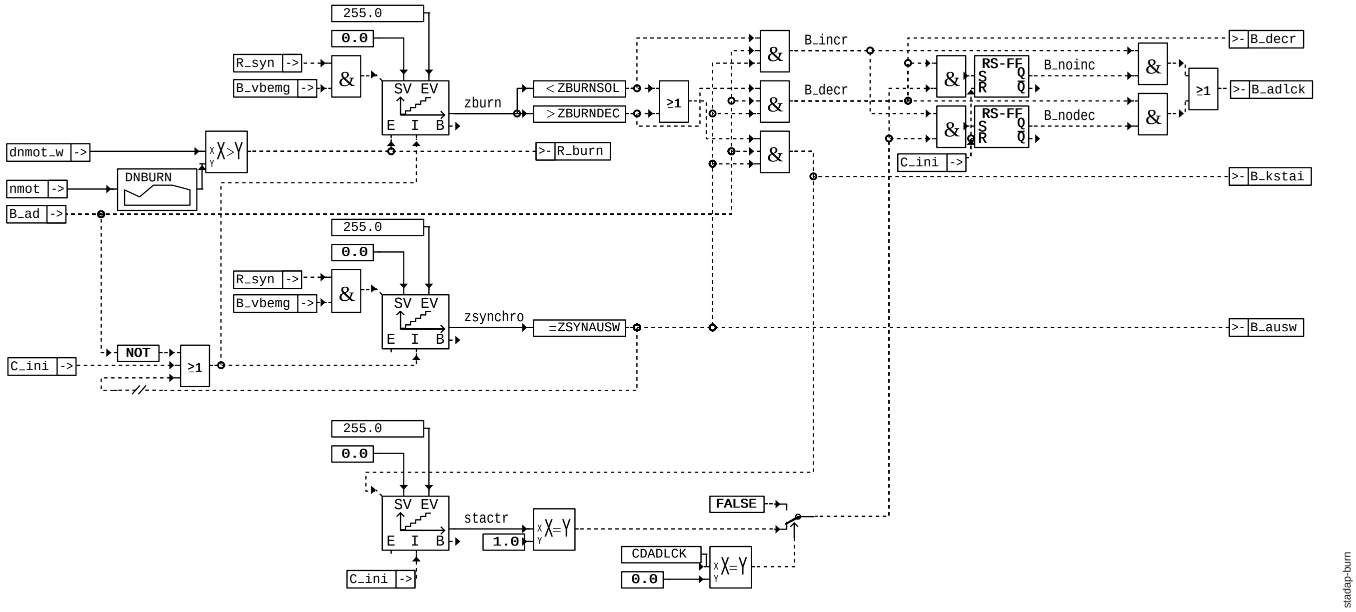
If there are hot start-up conditions prevailing (B_hst set), then in analogy to a cold start-up adaptation, FHSTT and KFWHSTT shall be applied, though as a dependency on the intake-air temperature tans instead of on the engine temperature tmst. For the application, first the start-up data for tmst = tans shall be taken from the warm adaptation from FKSTT and KFWKSTT (e.g. tmst = 90°C). B_hst shall be blocked by TMH = 143.25°C.
The next step is to check as of which tmst, tans, tansab and injection-valve peak temperatures, the hot start-up problems occur (amongst others, to be detected by using the course for the speed and for lambda). The conditions for setting can be specified by this and the start-up data can be corrected in FHSTT and KFWHSTT on the basis of the lambda course (LSU, pre-heated).

STADAP 6.30 Starting fuel adaptation

FDEF STADAP 6.30 Function definition

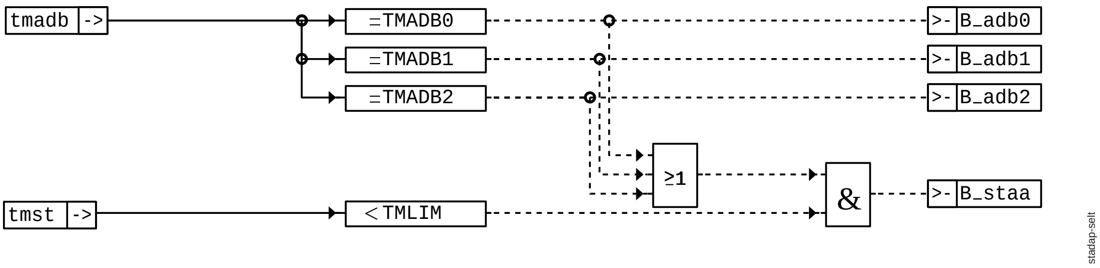


stadap-stadap



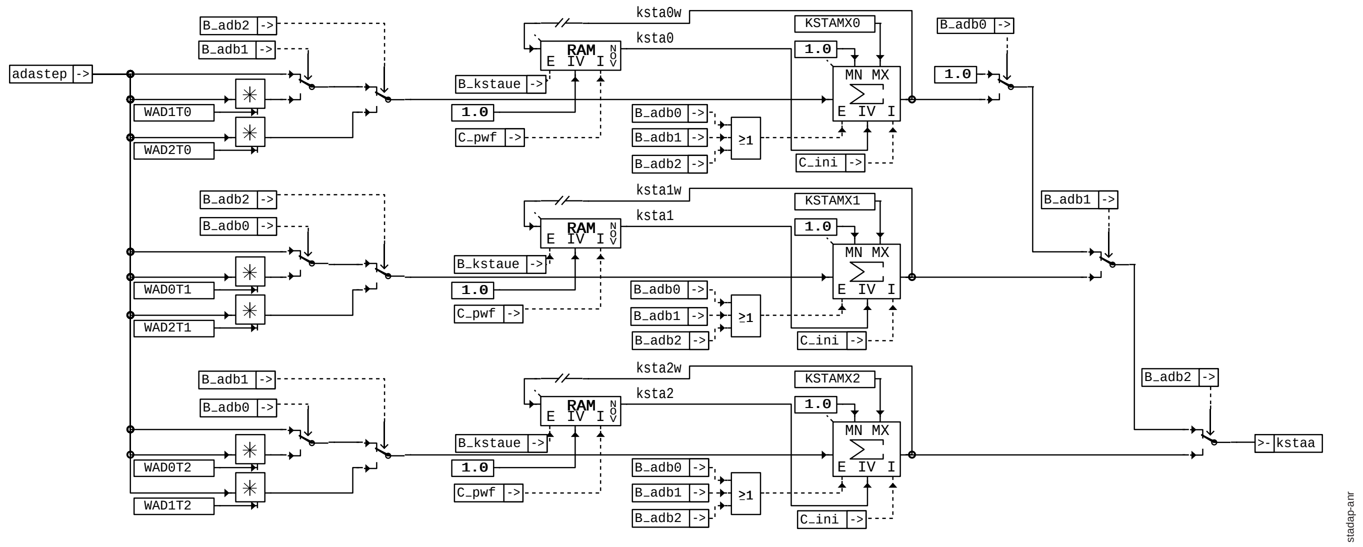
stadap-burn

Sub-function BURN(T): Evaluation after detected combustion



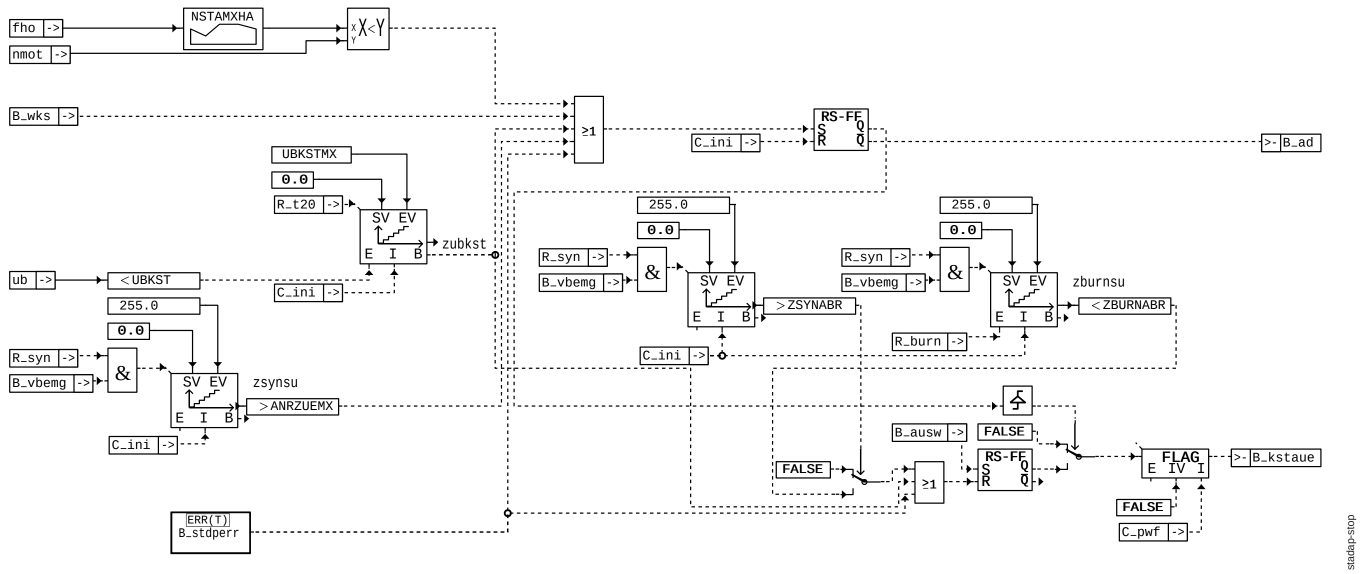
stadap-selt

Sub-function SELT(T): Choice of temperature range



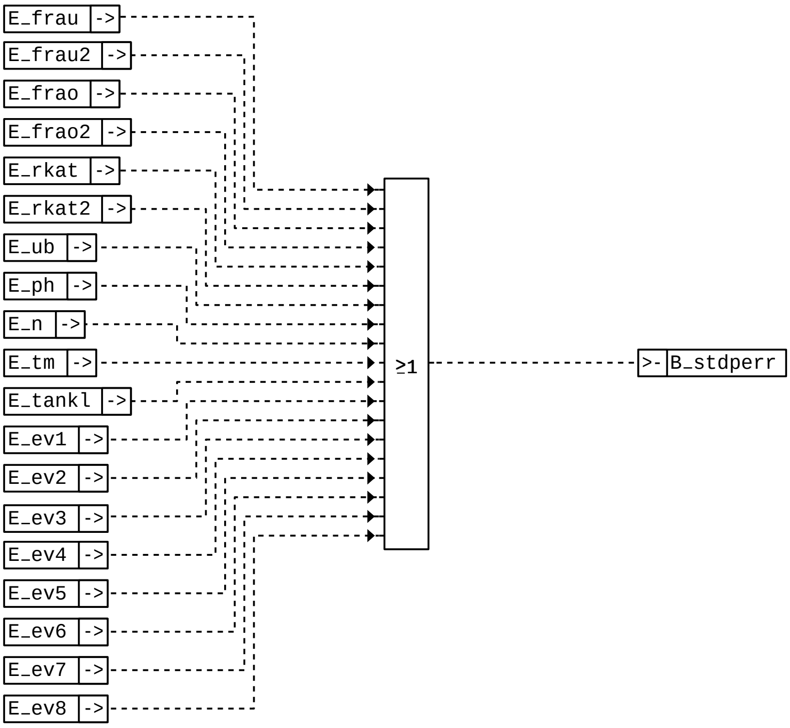
stadap-anr

Sub-function ANR(T): Determination of enrichment factor kstaa



stadap-stop

Sub-function STOP(T): Determination of adaption aborting



stadap-err

stadap-err

Sub-function ERR(T): Errorflags for adaption aborting

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            |                                        Incr.-Step INCKSTAI     |                  | Decr.-Step DECKSTAI
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        1  -+------------------------+----------------------------------------------------------------------------------------->
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                                     |                   |                   |                   |
                                Adap.factor           Adap.factor       Adap.factor           Adap.factor
                                increase              no change         increase              decrease



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           |                     +---+               +---+               +---+               +---+--ignition counter
           |                     |   |               |   |               |   |               |   |
           |                 +---+   |           +---+   |           +---+   |           +---+****--combustion counter
           |                 |       |           |       |           |       |           |    |  |
           |             +---+       |       +---+********       +---+       |       +---+*****  |
           |             |           |       |    |      |       |           |       |    |      |
           |         +---+************   +---+*****      |   +---+           |   +---+*****      |
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        -------------+----*----------+---+----*----------+---+---------------+---+----*----------+------------------------------>
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                                     |                   |                   |                   |
                The number of combustions is compared to the limits ZBURNSOL and ZBURNDEC after ZSYNAUSW ignitions.
                Depending on the result, the adaptation factor is increased, decreased or no change is made.
```

General:

There is a great variety of fuel qualities in the field. Bad fuel qualities can lead to major starting problems, which only can be compensated by enrichment. With the starting fuel adaptation it is possible to adapt an emission-optimized start without any security-offsets.
Fill-up of "bad" fuel results in mixture enrichment with STADAP. After re-fill with "good" fuel the function is learning back to the initial value.

ABK STADAP 6.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANRZUEMX			FW	ignition counter limit until STADAP is active
CDADLCK			FW	Code word: Adaptation only in one direction
DECKSTAI	TMADB		KL	decrement-step for STADAP-factor
DNBURN	NMOT		KL	Minimum difference in engine-speed for detected combustion
INCKSTAI	TMADB		KL	increment-step for STADAP factor
KSTAI	TMST		KL	workingrange for STADAP factor
KSTAMX0			FW	Maximum limit of STADAP factor in range 0
KSTAMX1			FW	Maximum limit of STADAP factor in range 1
KSTAMX2			FW	Maximum limit of STADAP factor in range 2
NSTAMXHA	FHO		KL	engine speed limit until STADAP is active depend. on altitude
TMADB0			FW	Range 0 of engine temperature for STADAP calculation
TMADB1			FW	Range 1 of engine temperature for STADAP calculation
TMADB2			FW	Range 3 of engine temperature for STADAP calculation
TMLIM			FW	TMOT threshold for KSTAA active at after start
UBKST			FW	battery-voltage limit for ZUBKSTMX
UBKSTMX			FW	Threshold number of Ubat measurements lower than UBKST for adaptation blocking
WAD0T1			FW	Factor weighting range 0 to 1
WAD0T2			FW	Factor weighting range 0 to 2
WAD1T0			FW	Factor weighting range 1 to 0
WAD1T2			FW	Factor weighting range 1 to 2
WAD2T0			FW	Factor weighting range 2 to 0
WAD2T1			FW	Factor weighting range 2 to 1
ZBURNABR			FW	number of combustions for decision adaptation stop
ZBURNDEC			FW	number of combustions for decrease factor
ZBURNSOL			FW	number of combustions for no change of factor

Parameter	Source-X	Source-Y	Type	Description
ZSYNABR			FW	number of ignitions for stop of STADAP
ZSYNAUSW			FW	number of ignitions until evaluation

Variable	Source	Type	Description
ADASTEP	STADAP	LOK	Adaptation step for STADAP factor
B_AD	STADAP	LOK	Condition adaptation permitted
B_ADB0	STADAP	LOK	Condition adaptation range 0
B_ADB1	STADAP	LOK	Condition adaptation range 1
B_ADB2	STADAP	LOK	Condition adaptation range 2
B_ADLCK	STADAP	LOK	Blocking of an adaptation-step depending on its direction
B_AUSW	STADAP	LOK	Condition evaluation of combustions
B_DECR	STADAP	LOK	Condition decrementation of STADAP factor
B_INCR	STADAP	LOK	Condition incrementation of STADAP factor
B_KSTAI	STADAP	LOK	Condition incrementation/decrementation of STADAP factor
B_KSTAUE	STADAP	LOK	adaption value of start quantity valid at next start
B_NODEC	STADAP	LOK	Condition no decrementation of STADAP factor during current start
B_NOINC	STADAP	LOK	Condition no incrementation of STADAP factor during current start
B_STAA	STADAP	AUS	starting fuel adaptation active at afterstart
B_STDPERR	STADAP	LOK	condition adaptation stopped due to detected error
B_VBEMG	ESSTT	EIN	condition detection of combustion possible
B_WKS	ESSTT	EIN	Condition cold restart
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DNMOT_W	BGNG	EIN	engine speed difference between two following segments
E_EV1	DEVE	EIN	error flag: injection valve of cyl. 1
E_EV2	DEVE	EIN	error flag: injection valve of cyl. 2
E_EV3	DEVE	EIN	error flag: injection valve of cyl. 3
E_EV4	DEVE	EIN	error flag: injection valve of cyl. 4
E_EV5	DEVE	EIN	error flag: injection valve of cyl. 5
E_EV6	DEVE	EIN	error flag: injection valve of cyl. 6
E_EV7	DEVE	EIN	error flag: injection valve of cyl. 7
E_EV8	DEVE	EIN	error flag: injection valve of cyl. 8
E_FRAO	DKVS	EIN	error flag: upper multiplicative mixture adaption factor frao
E_FRAO2	DKVS	EIN	error flag: upper multiplicative mixture adaption factor frao2
E_FRAU	DKVS	EIN	error flag: lower multiplicative mixture adaption factor frao
E_FRAU2	DKVS	EIN	error flag: lower multiplicative mixture adaption factor frao2
E_N	DDG	EIN	error flag: engine speed sensor
E_PH	DPH	EIN	error flag: phase sensor
E_RKAT	DKVS	EIN	error flag DKVS (additive correction per unit of time)
E_RKAT2	DKVS	EIN	error flag DKVS (additive correction per unit of time, bank 2)
E_TANKL		EIN	Error flag: OBDII error due to an empty canister
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
FHO	BGPU	EIN	Correction factor altitude
KSTA0	STADAP	LOK	coldstart enrichment range 0, buffered
KSTA0W	STADAP	LOK	coldstart enrichment range 0, currently used
KSTA1	STADAP	LOK	coldstart enrichment range 1, buffered
KSTA1W	STADAP	LOK	coldstart enrichment range 1, currently used
KSTA2	STADAP	LOK	coldstart enrichment range 2, buffered
KSTA2W	STADAP	LOK	coldstart enrichment range 2, currently used
KSTAA	STADAP	AUS	currently used start mixture adaptation factor
NMOT	SWADAP	EIN	engine speed
R_BURN	STADAP	DOK	Schedule of detected combustions for starting fuel adaptation
R_SYN	GGDPG	EIN	Synchro schedule
R_T20		EIN	Time schedule 20 ms
STACTR	STADAP	LOK	STADAP counter
TMADB	STADAP	LOK	Range of engine temperature for starting fuel adaptation
TMST	GGTFM	EIN	engine temperature at start
UB	SWADAP	EIN	battery voltage
ZBURN	STADAP	LOK	number of combustions
ZBURNSU	STADAP	LOK	number of all combustions while ZSYNABR
ZSYNCHRO	STADAP	LOK	number of ignitions till combustion evaluation
ZSYNSU	STADAP	LOK	Counter of ignitions for limitation of STADAP factor
ZUBKST	STADAP	LOK	counter: Ub $<$ UBKST

FW STADAP 6.30 Fixed Values

Parameter	Value	Description
ANRZUEMX		ignition counter limit until STADAP is active
CDADLCK		Code word: Adaptation only in one direction
KSTAMX0		Maximum limit of STADAP factor in range 0
KSTAMX1		Maximum limit of STADAP factor in range 1
KSTAMX2		Maximum limit of STADAP factor in range 2
TMADB0		Range 0 of engine temperature for STADAP calculation
TMADB1		Range 1 of engine temperature for STADAP calculation
TMADB2		Range 3 of engine temperature for STADAP calculation
TMLIM		TMOT threshold for KSTAA active at after start
UBKST		battery-voltage limit for ZUBKSTMX
UBKSTMX		Threshold number of Ubat measurements lower than UBKST for adaptation blocking
WAD0T1		Factor weighting range 0 to 1
WAD0T2		Factor weighting range 0 to 2

Parameter	Value	Description
WAD1T0		Factor weighting range 1 to 0
WAD1T2		Factor weighting range 1 to 2
WAD2T0		Factor weighting range 2 to 0
WAD2T1		Factor weighting range 2 to 1
ZBURNABR		number of combustions for decision adaptation stop
ZBURNDEC		number of combustions for decrease factor
ZBURNSOL		number of combustions for no change of factor
ZSYNABR		number of ignitions for stop of STADAP
ZSYNAUSW		number of ignitions until evaluation

FB STADAP 6.30 Detailed description of function

Function definition:

Main issue of the function is the evaluation of combustions. A combustion is detected when the difference in engine-speed from one segment to the next is higher than DNBURN.
After B_vbemg is set an ignition- and a combustion-counter are activated. If the number of ignitions equals ZSYNAUSW a check is made if the number of combustions is lower than ZBURNSOL or higher than ZBURNDEC. Mixture was too lean when the number of combustions is lower than ZBURNSOL, the start-adaptation factor is incremented by INCKSTAI.
The enrichment can be limited to the values KSTAMXi.
No change to the adaptation factor is done if the number of combustions is between ZBURNSOL and ZBURNDEC. Exceeding of ZBURNDEC results in decrementing the adaptation-factor by DECKSTAI because the mixture seems just right. After this verification ignition- and combustion-counter are reset.

With CDADLCK it can be decided if learning is allowed only in one direction during a single start. If CDADLCK = 1 the first learning appoints in which direction the adaptation is permitted. For example B_nodec is set if it is an incrementation.
If zburn >ZBURNDEC (decrementation) appears later during this start, B_nodec prevents a decrementation with B_adlck blocking the adaptation. If CDADLCK = 0, adaptation is permitted in both directions during a single start.

The start-adaptation factor is only used during start (B_st = 1). Parts of the mixture result in wall-wetting from the first start-ti, therefore it‘s necessary to continue with the adaptation until engine-speed NSTAMXHA is reached. The information about fuel quality can also be considered in afterstart (see %ESNST).

Applications with long starting times and steep start-ti-regulation can lead to maximum enrichment KSTAMXi at the first start attempt. To prevent this, the adaptation is stopped after ANRZUEMX ignitions.

For better consideration of different fuel characteristics an adaptation factor can be calculated for three different temperature ranges. Beyond these ranges the function can be blocked. INCKSTAI, DECKSTAI and KSTAMXi can also be pretended individually for each temperature range. It is also possible to consider adaptation values learned in range x in the other adaptation ranges by pretention of weighting factors WADxTy.
Example: An increase of the adaptation factor in range 1 of 0.1 is calculated during one start. WAD1T0 = 0.5 leads to an increase of the adaptation factor in range 0 of 0.05.
A strict separation of adaptation ranges is possible if all weighting factors WADxTy = 0.

STADAP not allowed

A successfull start is uncertain if the battery voltage at start is lower than UBKST for ZUBKSTMX times.
The start adaptation is then blocked, a learned adaptation factor is not stored in kstai.

No adaptation is done if cold re-start is detected (B_wks = 0).

Detection of errors (E_* = 1) leads to no adaptation; the adaptation factor already learned during this start or start-attempt is not stored in kstai, the last regular adaptation value is used for the following start.

If an engine start is impossible or not required (reason: compression test, empty tank, defects in loom etc.) a wrong adaptation of mixture is prevented by:
After ZSYNABR ignitions the number of detected combustions zburnsu is lower than ZBURNABR and kstaiw is not stored in kstai because B_kstaue = 0. The last regular (error-free) value is used for the following start.

APP STADAP 6.30 Application hint

Data recommendation

	From 1. test suitable for 6 cylinder:	From 6 cylinder test derived for 4 cylinder:
ANRZUEMX	42	36
DNBURN	30 rpm	30 rpm
UBKST	8.5 V	8.5 V
ZBURNDEC	3	2
ZBURNSOL	3	2
ZSYNAUSW	6	4
ZUBKSTMX	6	4
ZSYNABR	36	28
ZBURNABR	2	2

NSTAMXHA : This speed threshold must be selected in the way that the engine speed can reach it during speed increase or overshoot (e.g. for sealevel 900 rpm). In high altitude tests are necessary to find out what speed level can be reached depending on engine temperature. For a certain altitude the minimum must be selected.In most cases the lowest engine temperature where STADAP is active determines this speed threshold.

The adaptation can be controlled variable by choice of data.
Exampes: High values of DNBURN lead to fast enrichment in the adaptation range, low values result in low adaptation-increase and fast adaptation decrease of start enrichment.

At cold re-start the function is not active.

Recommendation for definition of adaptation ranges:

adaptation range 0: -10 ... 0 °C
adaptation range 1: 0 ... 15 °C
adaptation range 2: 15 ... 30 °C

KSTAI = 0 within temperature limits for adaptation range 0
KSTAI = 1 within temperature limits for adaptation range 1
KSTAI = 2 within temperature limits for adaptation range 2

TMADB0 = 0 for adaptation range 0
TMADB1 = 1 for adaptation range 1
TMADB2 = 2 for adaptation range 2

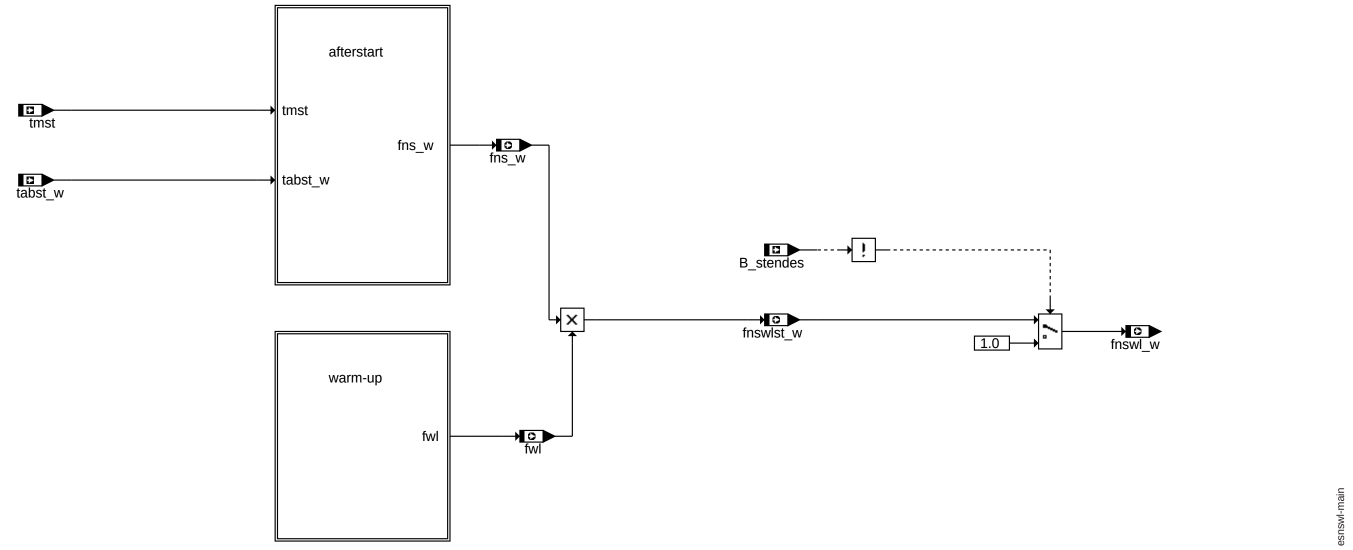
DECKSTAI setpoint = 0 for adaptation range 0
DECKSTAI setpoint = 1 for adaptation range 1
DECKSTAI setpoint = 2 for adaptation range 2

INCKSTAI setpoint = 0 for adaptation range 0
INCKSTAI setpoint = 1 for adaptation range 1
INCKSTAI setpoint = 2 for adaptation range 2

With application TMLIM = -48 °C the adaptation factor kstaa is not considered in afterstart.

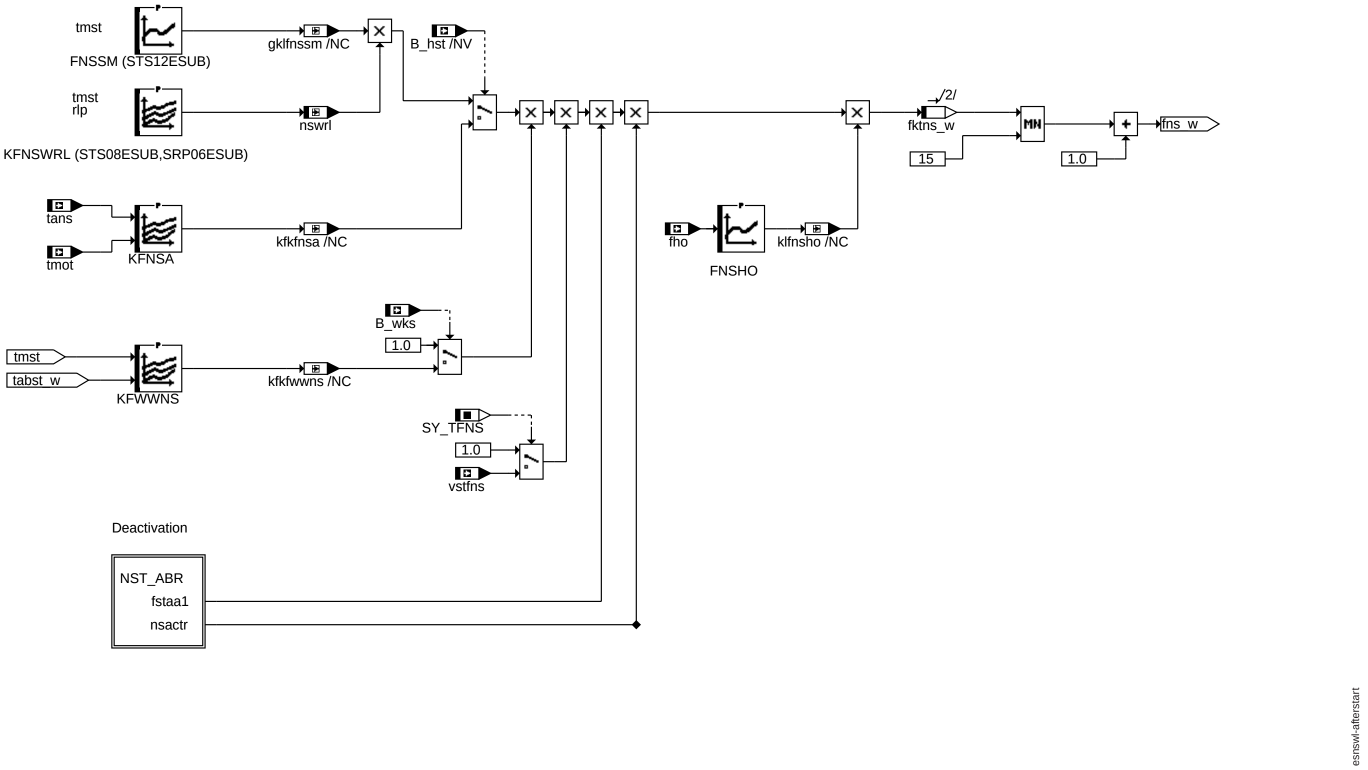
ESNSWL 2.30 injection during afterstart and warm-up

FDEF ESNSWL 2.30 Function definition



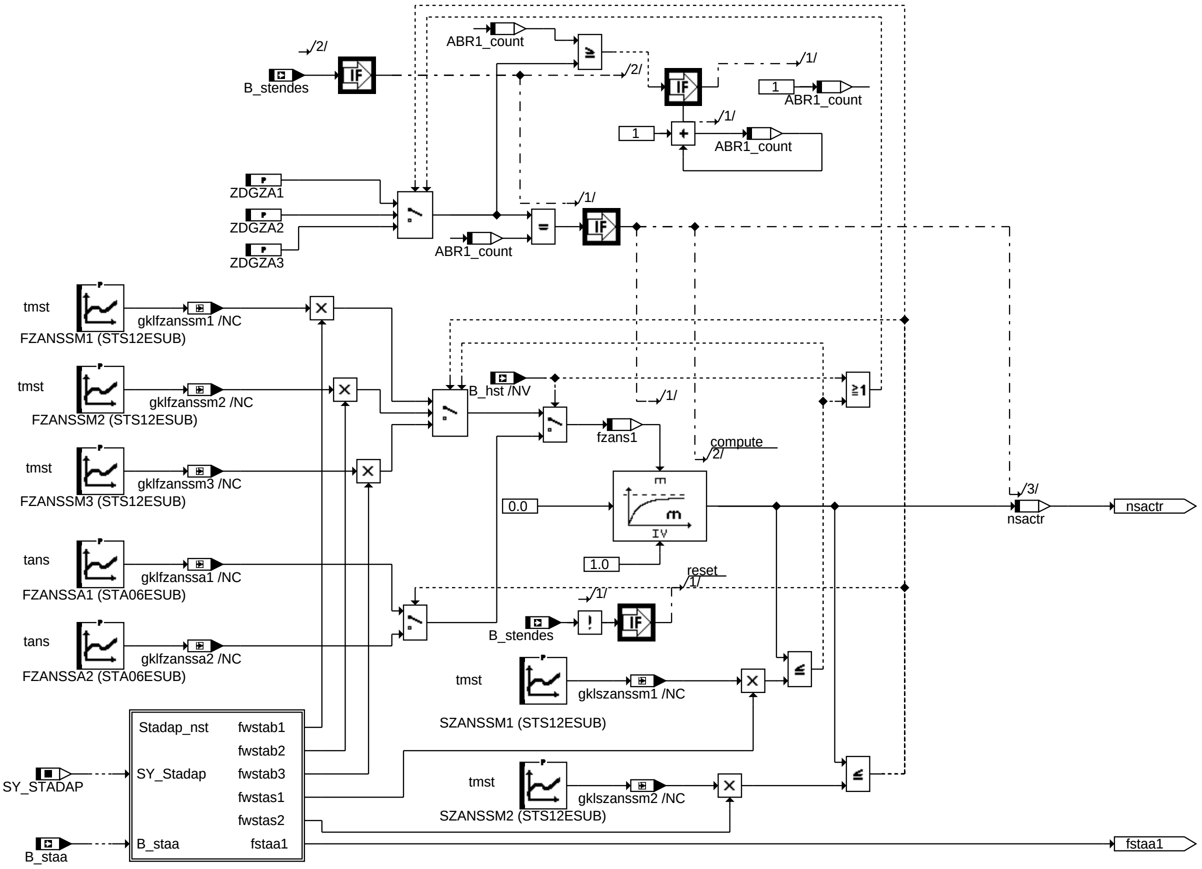
esnswl-main

```
Subfunctionblock 1: Afterstart
------------------------------
```



esnswl-afterstart

```
Subfunctionblock 2: Controlled decrease function
------------------------------------------------
```

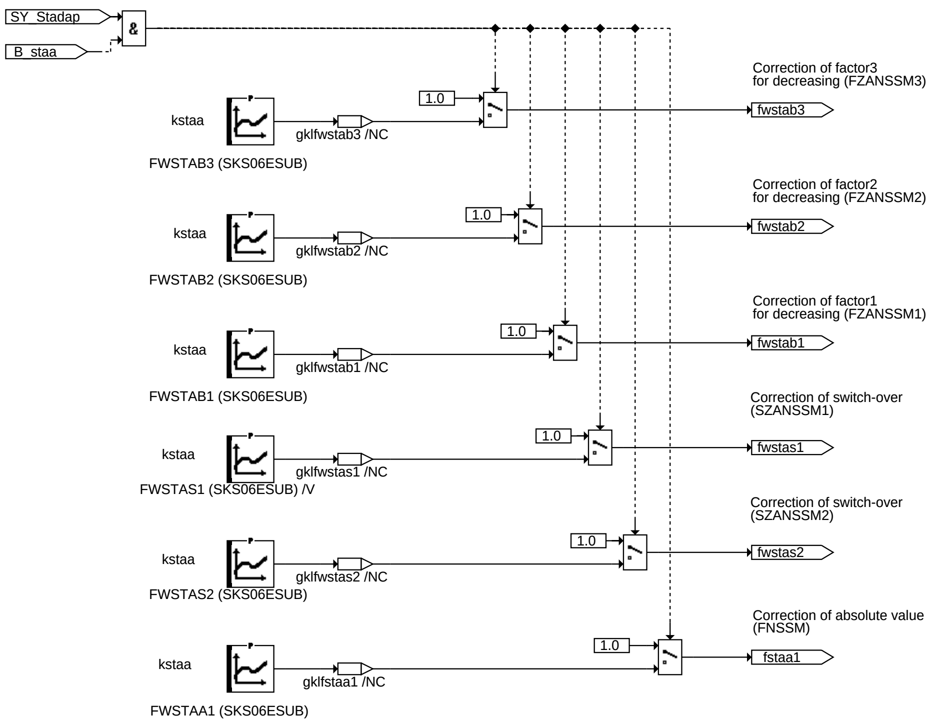


esnswl-nst-abr

esnswl-nst-abr

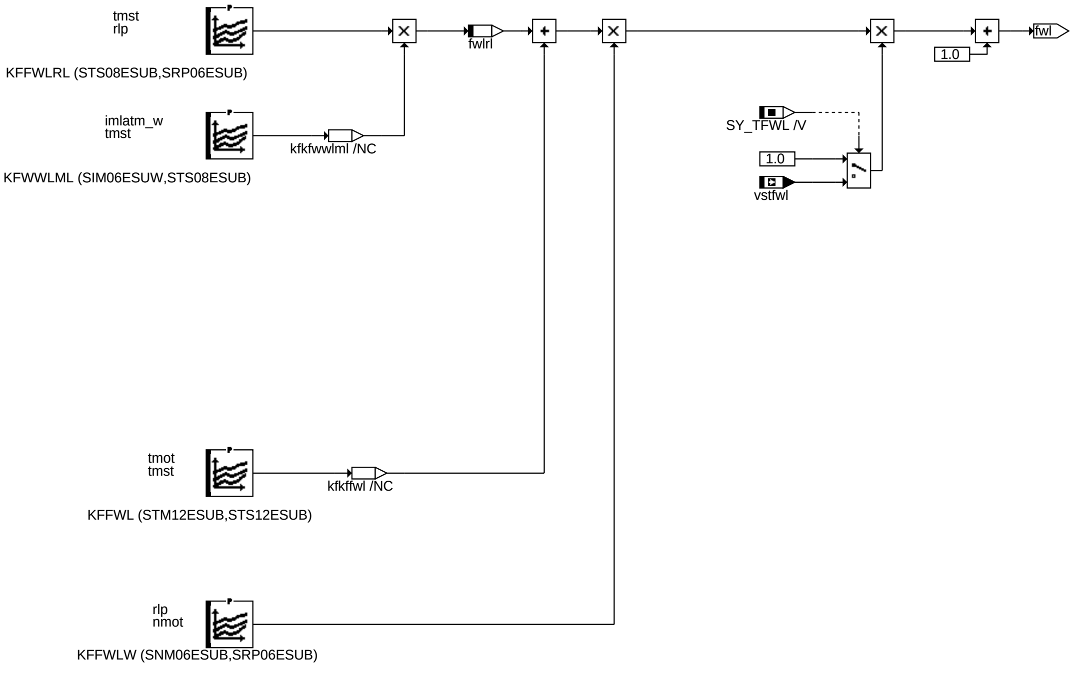
Subfunctionblock 3: Correction of decrease function with active start adaptation function

Afterstart deactivation as function of start adaptation factor kstaa



esnswl-stadap-nst

Subfunctionblock 4: Warm-up



Map KFFWLW is implemented for
downward compatibility.
For new calibration use KFFWLW
as characteristic line = f (nmot)

esnswl-warm-up

ABK ESNSWL 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FNSHO	FHO		KL	weighting of afterstart enrichment
FNSSM	TMST		KL	after start increase
FWSTAA1	KSTAA		KL	afterstart correction
FWSTAB1	KSTAA		KL	weighting afterstart decrease range 1
FWSTAB2	KSTAA		KL	weighting afterstart decrease range 2
FWSTAB3	KSTAA		KL	weighting afterstart decrease range 3
FWSTAS1	KSTAA		KL	correction of threshold 1 for afterstart
FWSTAS2	KSTAA		KL	correction of threshold 2 for afterstart
FZANSSA1	TANS		KL	factor for ign. sync. decreasing of afterstart enrichment at hot start range 1
FZANSSA2	TANS		KL	factor for ign. sync. decreasing of afterstart enrichment at hot start range 2
FZANSSM1	TMST		KL	factor for ign. sync. decreasing of afterstart enrichment above SZANSSM
FZANSSM2	TMST		KL	factor for ign. sync. decreasing of afterstart enrichment below SZANSSM
FZANSSM3	TMST		KL	factor for ign. sync. decreasing of afterstart enrichment in range 3
KFFWL	TMOT	TMST	KF	map warm-up factor
KFFWLRL	TMST	RLP	KF	map warm-up factor load dependent fraction
KFFWLW	NMOT	RLP	KF	map weighting warm-up factor
KFNSA	TANS	TMOT	KF	after start increase
KFNSWRL	TMST	RLP	KF	weighting of afterstart enrichment
KFWWLML	IMLATM_W	TMST	KF	map weighting warm-up factor
KFWWNS	TMST	TABST_W	KF	repeated start time factor
SIM06ESUW	IMLATM_W		SV (REF)	Distribution for integrated air massflow since end of start
SKS06ESUB	KSTAA		SV (REF)	Distribution for the start adaption factor kstaa
SNM06ESUB	NMOT		SV (REF)	Distribution for engine speed
SRP06ESUB	RLP		SV (REF)	Distribution for relative air charge
STA06ESUB	TANS		SV (REF)	Distribution for the air temperature in the intake manifold
STM12ESUB	TMOT		SV (REF)	Distribution for the engine coolant temperature tmot
STS08ESUB	TMST		SV (REF)	Distribution for engine coolant temperature at start
STS12ESUB	TMST		SV (REF)	Distribution for engine coolant temperature at start
SY_STADAP			SYS (REF)	system constant start adaptation
SY_TFNS			SYS (REF)	system constant service device intervention afterstart factor
SY_TFWL			SYS (REF)	system constant service device intervention warm-up factor
SZANSSM1	TMST		KL	switching level 1 of afterstart enrichment
SZANSSM2	TMST		KL	switching level 2 of afterstart enrichment
ZDGZA1			FW	Number of ignitions for decrease in range 1
ZDGZA2			FW	Number of ignitions for decrease in range 2
ZDGZA3			FW	Number of ignitions for decrease in range 3

Variable	Source	Type	Description
ABR1_COUNT	ESNSWL	LOK	afterstart deactivation counter 1
B_FNSOFF	ESNSWL	LOK	Condition switch off calculation of afterstart
B_HST	ESSTT	EIN	condition hot start
B_STAA	STADAP	EIN	starting fuel adaptation active at afterstart
B_STENDES	ESSTT	EIN	Condition end of start injection
B_WKS	ESSTT	EIN	Condition cold restart
FHO	BGPU	EIN	Correction factor altitude
FKTNS_W	ESNSWL	LOK	after start enrichment
FNSWLST_W	ESNSWL	AUS	Factor afterstart and warm-up for max. selection at start
FNSWL_W	ESNSWL	AUS	Factor afterstart and warm-up
FNS_W	ESNSWL	AUS	after start factor
FWL	ESNSWL	AUS	warm up factor
FWLRL	ESNSWL	LOK	Factor warm-up load dependend fraction
FZANS1	ESNSWL	LOK	factor decrease of afterstart
GKLFNSSM	ESNSWL	LOK	output of characteristic line FNSSM (afterstart enrichment depending on tmst)
KFKFWWNS	ESNSWL	LOK	output of map KFWWNS (decrease of afterstart enrichment in case of cold restart)
NSACTR	ESNSWL	LOK	afterstart counter/filter
NSWRL	ESNSWL	LOK	Output KF KFNSWRL weighting of afterstart enrichment
TABST_W	BGTABST	EIN	soak time
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VSTFNS		EIN	adjustment factor afterstart (service device interface)
VSTFWL		EIN	adjustment factor warm-up (service device interface)

FW ESNSWL 2.30 Fixed Values

Parameter	Value	Description
ZDGZA1		Number of ignitions for decrease in range 1
ZDGZA2		Number of ignitions for decrease in range 2
ZDGZA3		Number of ignitions for decrease in range 3

FB ESNSWL 2.30 Detailed description of function

General description:

During cold start it must be considered that there are mixture losses from blowby, wall-applied film etc. The required fuel mass to compensate these mixture losses decreases rapidly during afterstart. The mixture losses depend mainly from the temperature in the combustion chamber. In subfunction afterstart the mixture losses are compensated by enrichment depending on starting temperature tmst.

Long time mixture losses depend mainly on the engine coolant temperature tmot. The compensation of these mixture losses occurs in subfunction warm up. The compensation depends mainly on the engine coolant temperature tmot.
The subfunctions afterstart and warm up compensation are working together complementary.

The required compensation depends on the injection timing and on the rail pressure.
For this reason it is necessary to regard the injection timing described in function %ESVW too.

Since the engine, as defined in %LAMKO, shall always be precontrolled to lambda combustion compartment = 1, the deviation is given towards "rich" by means of a lambda setpoint defined by lamnswl_w in function %LANSWL.
This lambda setpoints enables to precontrol a burnable mixture during cold start.
In %ESNSWL there should be only a compensation of the mixture losses. But the shift of the lambda setpoint value has do be done in function %LANSWL.

Subfunction afterstart

The function enables compensation by means of an enrichment of the mixture depending on the start-up temperature. The enrichment is gradually decreased by the number of ignitions. The controlled-decrease factor can be selected as a dependency on the engine start-up temperature and on the adaptation factor for the start-up quantity.

The afterstart enrichment can be weighted individually as a dependency of the load for a better allowance of the wall film behavior.

The afterstart mixture can be reduced during a cold restart. The restart detection B_wks originates from the start-up function %ESSTT.

Enleanments in a hot restart from the formation of bubbles can also be compensated for up to a certain degree by an enrichment of the mixture.
The hot start-up detection B_hst originates from the start-up function %ESSTT.

Critical fuel qualities also require a change in the afterstart adaptation. The possibility exists to modify the afterstart quantity as a dependency of the adaptation values of the start-up adaptation (%STADAP) learned in the start-up.
Details:
The factors FWSTAB1..3, FWSTAS1..2 and FWSTAA1 can be specified as a dependency on the start-up adaptation values kstaa.
The course for the afterstart factor fns can be influenced by this.
B_staa comes from %STADAP. The functional branch with influence on the fuel quality can be disabled here with TMLIM. TMLIM is the engine temperature threshold, above which there is no influence on the afterstart factor by the learned adaptation value kstaa.

For Projects without %STADAP it must be ensured, that SY_STADAP = false.

Subfunction warm up

In subfunction warm up there are two main parts. Depending on the engine temperature at start up and the current engine temperature in map KFFWL there is the enrichment for the operation range near to idle.
When the load is higher an additional enrichment depending on the load is possible to compensate worse mixture preparation and different behaviour in wall wetting at the combustion chamber-wall and the piston top. Therefore an additional offset can be calibrated as function of engine temperature at start and relative air charge.
This additional enrichment can be decreased with an increase of the integrated mass of intake air since end of start.
This considers the heat up of the combustion chamber and the components near to the combustion chamber by an increasing number of combustions. A weighting of the enrichment as function of the engine speed is possible, because the conditions for mixture preparation can change at higher engine speed.

Tester intervention:

It shall be assured for projects where there is no tester intervention in the warm-up enrichment that the constant describing the system SY_TFWL and SY_TFNS = false. Tester intervention is to be prevented for those projects with continuous lambda control since the tester intervention only acts on the precontrol factor. The variable lamns_w acting on the lambda setpoint continues however to be based on the original application, such that the tester manipulation when turning on the lambda control can lead to an offset of the lambda control factor.

APP ESNSWL 2.30 Application hint

Prerequisities:

- Refer to %ESSTT

Preparatory work:

- Refer to %ESSTT
- Lambda setpoint must be defined in %LANSWL

Notes:

- %ESSTT, %ESNSWL and %LANSWL cannot be applied independently of one another. Therefore approach the nominal lambda from the "rich" side.

- The influence of the the start adaptation (%STADAP) on the afterstart can only be applicated, when the application of the start adaptation occurs or is already done.

Afterstart adaptation in cold / warm start-up:

- Set KFNSWRL(.../...) temporarily to 1.0. The map can subsequently serve to compensate for changes in the load for the transition from start-up into afterstart.
  If afterstart factors greater than 4 are required for low temperatures tmst, this can be realized by values in KFNSWRL between 1.0 and 2.0 (FNSSM already assigned data with the maximum value 4).

- Select FNSSM on the basis of the lambda course in the range of permissible measurement values such that jumps will be avoided and an approximation to the desired lambda lamnswl_w = lamsbg_w will be realized from the slightly "richer" side.

- The controlled decrease of the afterstart factor fns is performed by multiplication with the afterstart counter nsactr. This is calculated from:
  nsactr_new = nsactr_old * (1-fzans).

- The controlled decrease can occur in three ranges.
  The first controlled range for decrease serves to calibrate the transition start-up -> afterstart individual (FZANSSM1).
  The second range serves to compensate for the "fuel losses" during the warm-up phase of the components near to the combustion compartment and hence to take the faster effects into account compared to the cooling water warming up (FZANSSM2).
  The third range of controlled decrease is required in the fine application for a smooth transition into the pure warming-up phase. Should the range of values of FZANSSM3 not suffice in order to reach the desired slow controlled decrease, then a compensation for this can be made by a correction of ZDGZA3 to larger values.

- The level of the controlled afterstart decrease at which changeover to the second range shall take place is specified in the characteristic SZANSSM1 = f(tmst). SZANSSM1 = 0.7 for example, leads to changeover into the second range as soon as the afterstart counter has fallen below the value nsactr = 0.7. The changeover in the third range is defined in SZANSSM2=f(tmst). SZANSSM2 = 0.3 for example, leads to changeover into the third range as soon as the afterstart counter has fallen below the value nsactr = 0.3.
  The values in SZANSSM2 should be smaller than in SZANSSM1.

- The synchro interval can be defined individually for each range of controlled decrease at which the afterstart counter shall be calculated.
  The corresponding values shall be entered in ZDGZA1, ZDGZA2 and ZDGZA3 to do this. ZDGZA1, ZDGZA2 = cylinder number and ZDGZA3 = 2*cylinder number are proposed as the basis for starting.

- By calibration the afterstart deactivation can be done in two ranges as in previous afterstart functions.
  Then the first deactivation range should be deactivated (SZANSSM1 = max. value, ZDGZA1 = ZDGZA2).

- For a start-up at higher altitudes, a correction of the afterstart factor may be necessary for the transition from the start-up into afterstart because of the changes in the applied evaporation behavior of the fuel. As the influence of a higher altitude is considered in the relative air charge rl, at start-up at higher altitudes an enrichement may be necessary. This can be realized values greater than 1.0 in the characteristic FNSHO.

- Termination of Subfunction afterstart:
  Calculation of afterstart factor is terminated, when the factor nsactr = 0.

Afterstart adaptation in the restart:

- Only a low quantity of fuel is required in a restart because of the higher combustion-compartment temperatures in comparison to the cooling-water temperature.
  The afterstart enrichment can be reduced by means of KFWWNS = f(tmst/tabst_w) to do this.

Afterstart adaptation in the hot start-up:

- The afterstart factor FNSA = f(tans) shall be adjusted such that lambda = 1.0 is given again if possible. A different controlled decrease can also be specified than in the normal case by means of the tans-dependent characteristics FZANSSA1 and FZANSSA2. The changeover from range1 to range 2 is given by SZANSSM2.
  (SZANSSM1 and FZANSSM1 are not active by hot start condition)
  It shall be assured that an adaptation of the start-up quantity is not active in the case of a hot start-up and hence that B_staa = false.
  Refer also to %STADAP.

Afterstart adjustment for critical fuel qualities (with activated %STADAP):

- Fuel qualities are to be defined for the entire cold adjustment. RB recommends the following:

  A fuel A that lies approximately in the center of the DIN standard. Orientation on the winter specification for low temperatures (<10°C), and on the summer specification for temperatures above this.
  A fuel B to represent the "worst case" possible in the field, e.g. Reformulated Gasoline (RFG).

  The adjustment for start-up, afterstart and warming-up is performed with fuel A. An optimum adjustment does not include any margin of safety. The adaptation of the start-up quantity must now learn during a start-up when using fuel B. Depending on the factor for start-up adaptation, the afterstart enrichment is now modified such that lambda = 1.0 is given again when using fuel B.

- For application it is necessary to enable start adaptation for the desired temperature range via TMLIM in %STADAP (B_staa set).

- The basic application can now be influenced by the factors FWSTAA1, FWSTAS1 and FWSTAS2, and FWSTAB1 to FWSTAB3 = f(kstaa).
  As the basis, these characteristics shall first be assigned with data of the value 1.0 at all datapoints.
  Hence the course for the afterstart enrichment is identical to that without any allowance made for the fuel quality.

- Attention shall be paid when defining the datapoint distribution for the Characteristic lines FWSTAA1, FWSTAS1..2 and FWSTAB1..3 (SKS06ESUB) that kstaa can only assume values between KSTAMN and KSTAMX of %STADAP.
  A datapoint at kstaa = 1.0 is required under all circumstances.

- In order in turn to obtain the afterstart enrichment of an unchanged fuel quality in comparison to the basic application, the value 1.0 must be entered in the characteristics FWSTAA1, FWSTAS1..2 and FWSTAB1..3 under all circumstances for kstaa = 1.0 !

- For FWSTAA1, the afterstart enrichment can in general be changed, i.e. without any influence on the decreasing control function.
  Values > 1.0 are to also to be applied for kstaa > 1.0 for an increase in the afterstart enrichment.

- FWSTAS1 and FWSTAS2 have an influence on the switchover in the range. Should the switchover into the second range only be at a later point in time for kstaa > 1.0, then values < 1.0 shall be applied in FWSTAS1.

- FWSTAB1, FWSTAB2 and FWSTAB3 influence the controlled decrease in the speed. A faster controlled decrease for kstaa > 1.0 is possible by using values > 1.0, whereas a slower controlled decrease can be realized for kstaa > 1.0 by using values < 1.0.

Proposal for tmot/tmst datapoints:

  -30 / -25 / -20 / -15 / -7 / 0 / 15 / 20 / 25 / 40 / 60 / 90 deg. C

Application of warm up

- KFFWL has to be calibrated for the operating range near to idle. The aim is that the actual lambda is equal to the lambda setpoint defined in %LANSWL. Now the calibration at "basic load" is done and should not be changed when the calibration at higher loads occurs. So there is less influence between the cold start calibration (e.g. at the cold start test bench) and the calibration at higher load.

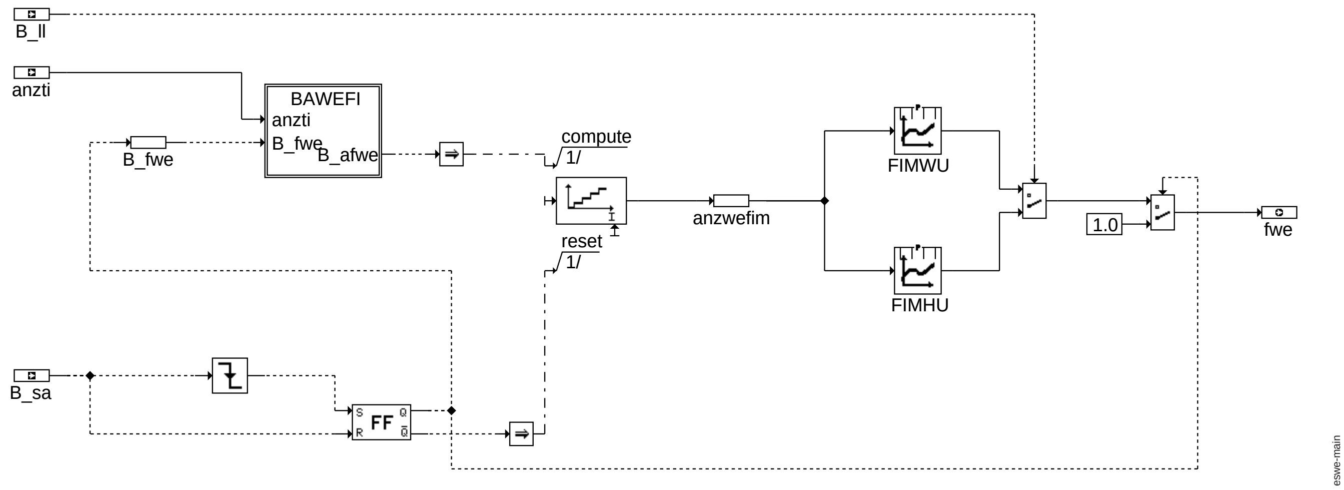
- The following calibration at higher load requires a roller test bench with an own drive. With this roller test bench it is possible to set the wheels and transmission system of the car to the desired speed before starting the engine (at idle). So the desired engine speed (setpint of KFFWLW) is reached very fast after the start-up, by closing the power transmission (engaged gear). With an external potentiometer it is possible to set the accelerator-pedal position to the desired value in order to have a relative constant load during warm up. There should be several warm ups at the same temperature with different loads. The necessary enrichment can be written in the map KFFWLRL. It should be paid attention to the calculation of fwl:
  fwl = (KFFWL + KFFWLRL * KFWWLML) * KFFWLW
  This part of the warm up (fwlrl) is decreased by the increasing integrated mass of the intake air (map KFWWLML).
  This Map is function of the integrated air mass since end of start and the engine temperature at start.

  Remark to KFFWLW:
  The engine speed dependent weighting is done with KFFWLW.
  For that, in a transitional phase, KFFWLW is f (nmot, rlp) to offer the possibility to use already existing calibration data from %ESWL. In this case KFFWLRL should be zero.
  For new calibration KFFWLW should be used as characteristic line = f(nmot). The enrichment at high load should then be calibrated in KFFWLRL.

ESWE 1.60 Injection, resumption of overrun fuel cut-off

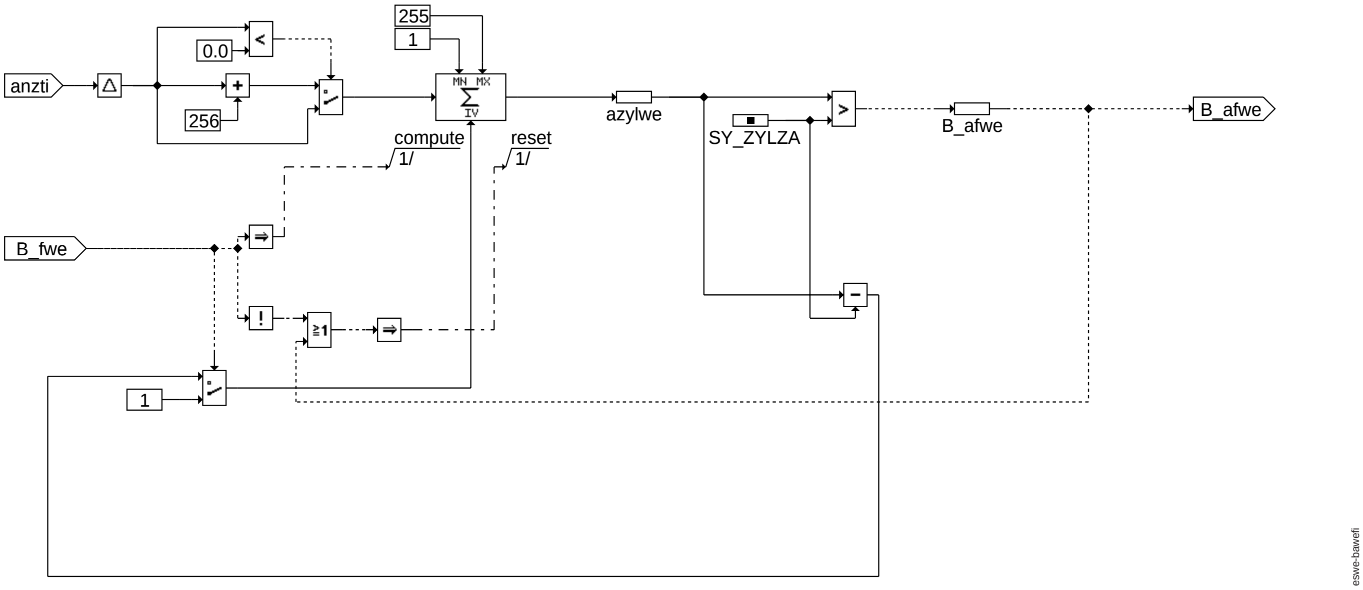
FDEF ESWE 1.60 Function definition

`Overview ESWE`



eswe-main

`Overview BAWEFI`



eswe-bawefi

eswe-initialize

ABK ESWE 1.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FIMHU	ANZWEFIM		KL	Factor pulse abrupt
FIMWU	ANZWEFIM		KL	Factor pulse smooth
SY_ZYLZA			SYS (REF)	system constant number of cylinders

Variable	Source	Type	Description
ANZTI	ACIFI	EIN	injection counter
ANZWEFIM	ESWE	LOK	number of processed fuel cut-in factors
AZYLWE	ESWE	LOK	number of processed cut-in cylinders
B_AFWE	ESWE	LOK	flag number of restart fuel feed factors
B_FWE	ESWE	LOK	condition factor restart fuel feed
B_LL	MSF	EIN	Condition idle
B_SA	MDRED	EIN	Condition fuel cut-off
FWE	ESWE	AUS	reinjection factor

FW ESWE 1.60 Fixed Values

Parameter	Value	Description

FB ESWE 1.60 Detailed description of function

```
Calculation of overrun - reinjection factor

Principle:
=======
During overrun conditions possibly the fuel wall layer is completely removed.
To counteract a mixture leaning during restart fuel feed it sprays in supplementary fuel to rebuild the fuel
wall layer when the injection resumes.

ESWE: Overview
===============
During restart fuel feed (B_sa changes from 1 --> 0) the first injection pulses can be enriched via a characteristic in relation
to the number of released injections after the restart.
When the number of injections is changing the counter which counts the restarted cylinders (azylwe) is enable.
It considers the possibility of more then one injetions during one segment.
The condition B_ll is used to select between 2 characteristics
For soft restarts (B_ll = 1 ) the characteristic FIMWU applies
For hard restarts (B_ll = 0 ) the characteristic FIMHU applies
```

APP ESWE 1.60 Application hint

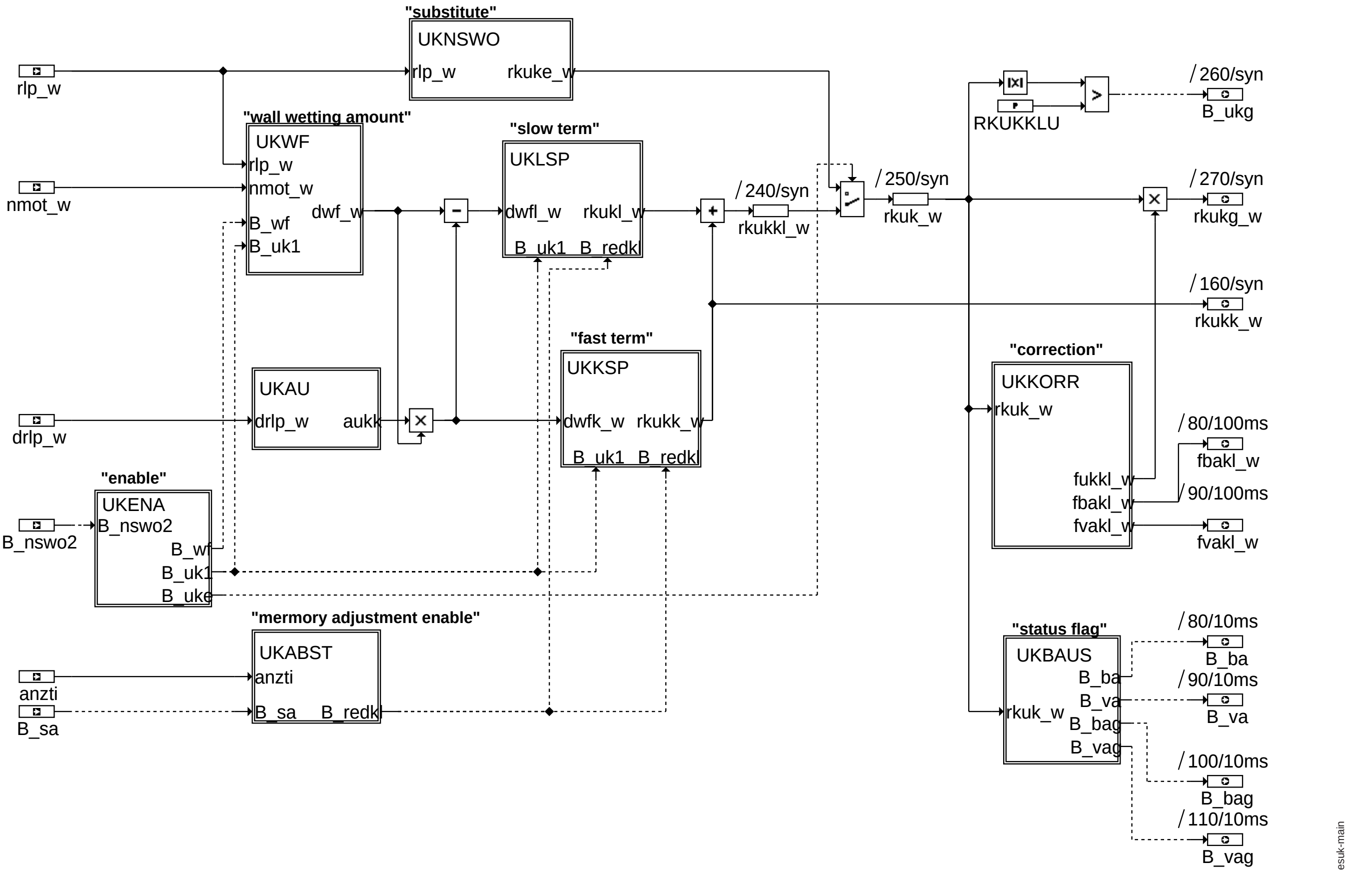
```
Pre setting of Parameter:
========================
FIMHU: fixed characteristic with 16 points, first point about 1.6, exponential relaxation
FIMWU: fixed characteristic with 16 points, first point about 1.2, exponential relaxation
no interpolation

Link to other functions:
=======================
%GK :(fwe)
```

ESUK 4.50 Injection: transient compensation

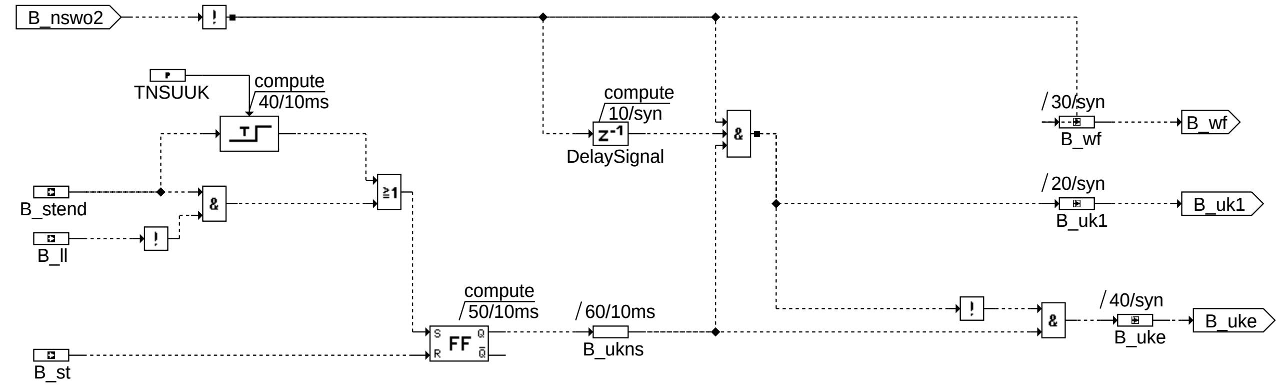
FDEF ESUK 4.50 Function definition

```
Overview Transient Compensation
```



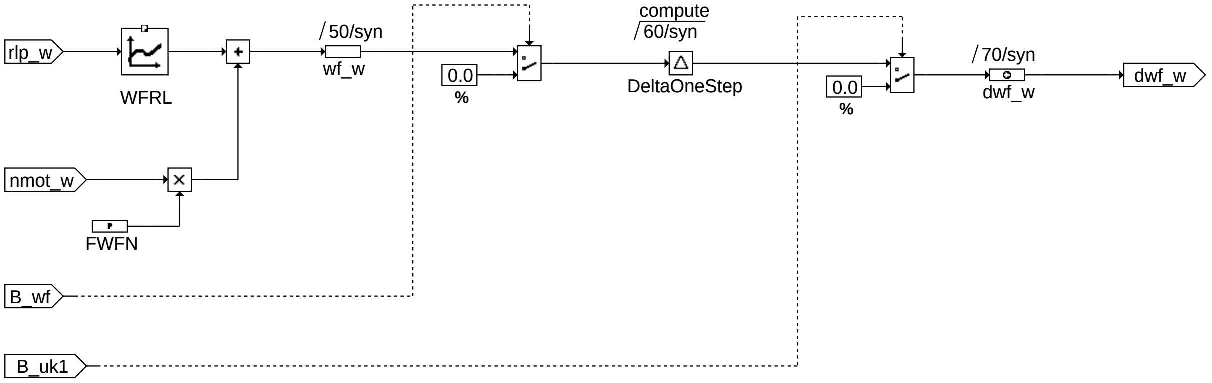
esuk-main

UKENA: transient compensation enable



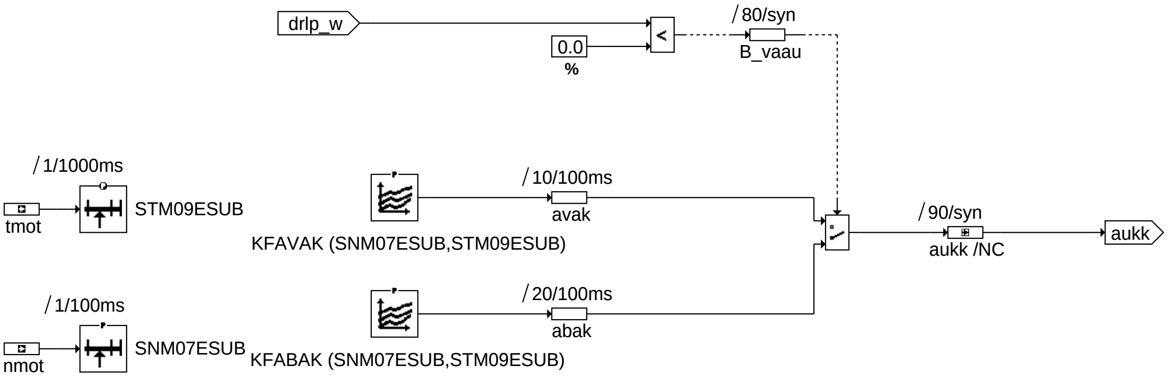
esuk-ukena

UKWF: calculation of wall wetting amount



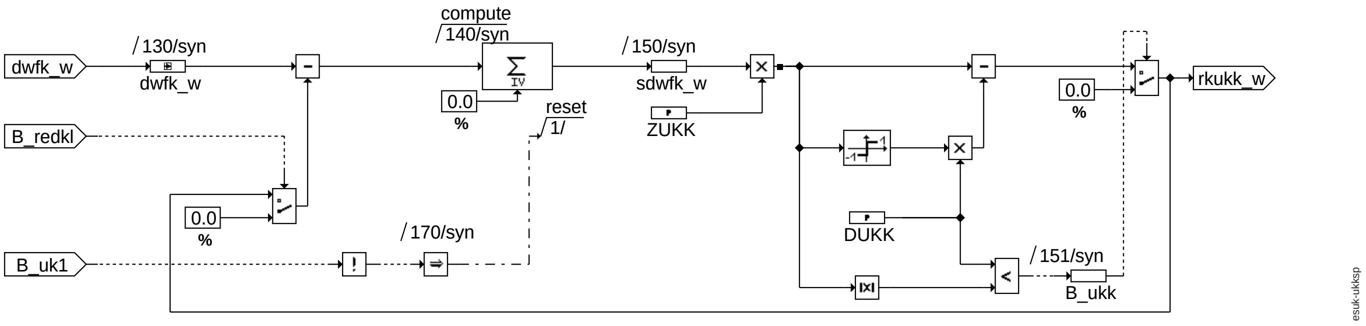
esuk-ukwf

UKAU: wall wetting share factor



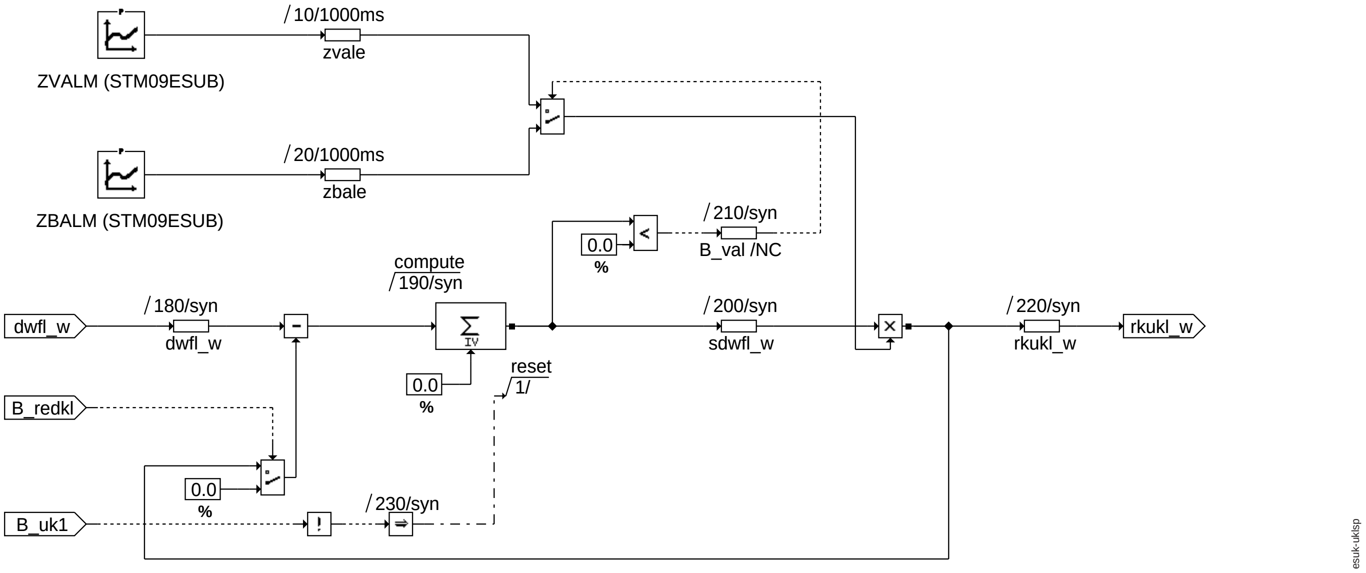
esuk-ukau

`UKKSP: short term memory`



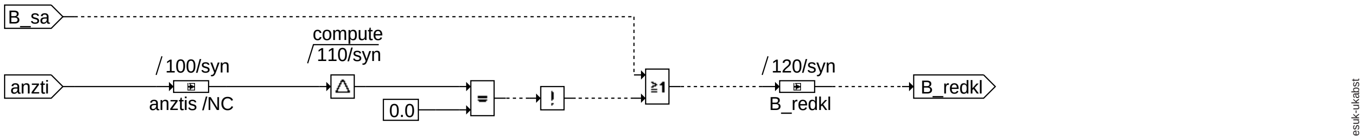
esuk-ukksp

`UKLSP: long term memory`



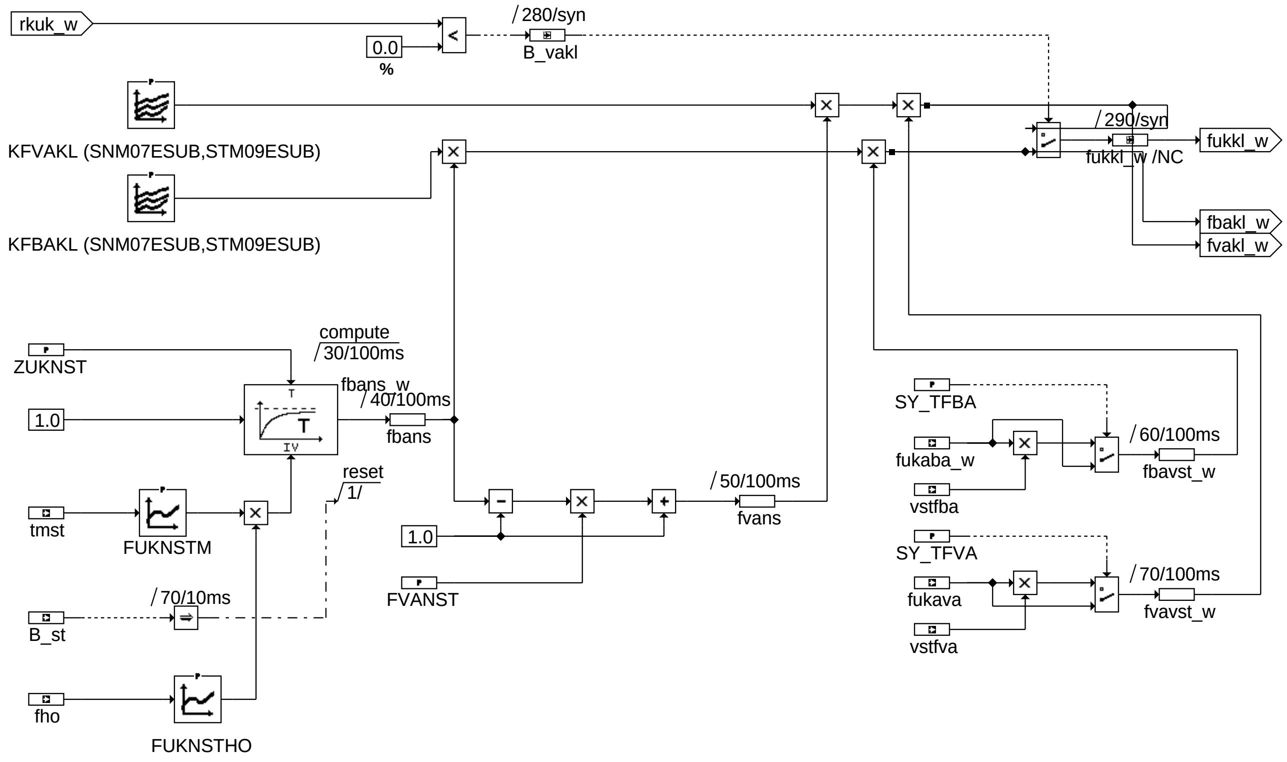
esuk-uklsp

`UKABST: memory adjustment enable`



esuk-ukabst

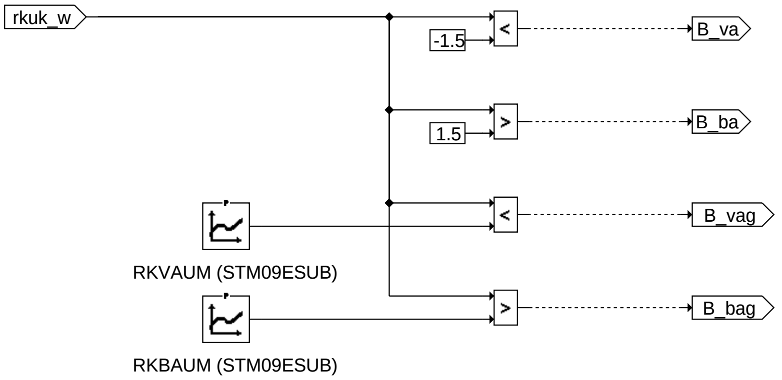
`UKKORR: short+long term correction, post cranking, transient compensation adaptation`



esuk-ukkorr

esuk-ukkorr

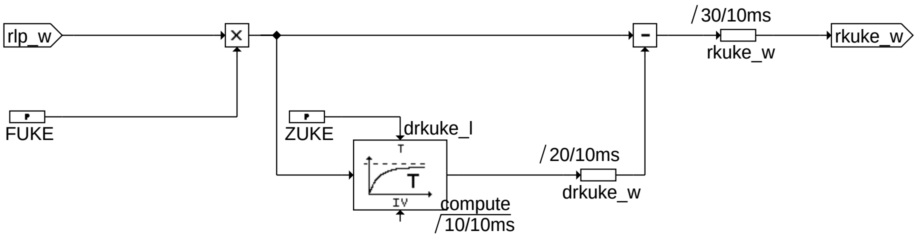
`UKBAUS: state bits`



esuk-ukbaus

esuk-ukbaus

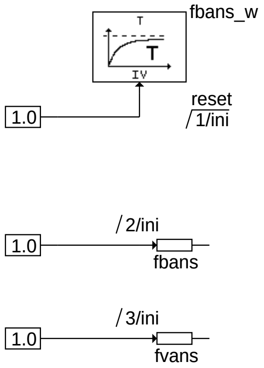
`UKNSWO: substitute value for partial function switch off`



esuk-uknswo

esuk-uknswo

`INITIALIZE: Initialize`



esuk-initialize

ABK ESUK 4.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DUKK			FW	threshold for short term portion
FUKE			FW	Factor transient contol substitute value
FUKNSTHO	FHO		KL	altitude dependent transient control post cranking factor
FUKNSTM	TMST		KL	initial value of transient control post cranking factor
FVANST			FW	weighting factor of deceleration during post-cranking
FWFN			FW	wall wetting factor influence of rpm
KFABAK	NMOT	TMOT	KF	share factor wall wetting for acceleration enrichment
KFAVAK	NMOT	TMOT	KF	share factor wall wetting for deceleration enleanment
KFBAKL	NMOT	TMOT	KF	factor accel. enrichment (short- and long-time part)
KFVAKL	NMOT	TMOT	KF	factor decel. enleanment (short- and long-time part)
RKBAUM	TMOT		KL	rk-threshold for acceleration enrichment display
RKUKKLU			FW	threshold sum of long-/short term
RKVAUM	TMOT		KL	rk-threshold for deceleration enleanment display
SY_TFBA			SYS	system constant service device intervention accel. enrichment
SY_TFVA			SYS	system constant service device intervention decel. enleanment
TNSUUK			FW	disabling time of transient control during post-cranking
WFRL	RLP_W		KL	fuel wall hang.up
ZBALM	TMOT		KL	reduction factor L-memory (tmot) for accel. enrichment
ZUKE			FW	Time constant transient contol substitute value
ZUKK			FW	reduction factor K-memory
ZUKNST			FW	time constant of transient control post cranking factor
ZVALM	TMOT		KL	reduction factor L-memory (tmot) for decel. enleanment

Variable	Source	Type	Description
ABAK	ESUK	LOK	share factor wall wetting for acceleration enrichment
ANZTI	ACIFI	EIN	injection counter
AVAK	ESUK	LOK	share factor wall wetting for deceleration enleanment
B_BA	ESUK	AUS	Condition acceleration enrichment (display)
B_BAG	ESUK	AUS	Condition large accel. enrichment
B_LL	MSF	EIN	Condition idle
B_NSWO2	PROKON	EIN	condition engine speed > NSWO2
B_REDKL	ESUK	LOK	Enable reduction of K- and L-Memory
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_UK1	ESUK	LOK	Enable condition for transient control
B_UKE	ESUK	LOK	Enable condition for substitute value of transient control
B_UKG	ESUK	AUS	condition transient control activated
B_UKNS	ESUK	LOK	Enable condition transient contr. after cranking
B_VA	ESUK	AUS	Condition deceleration enleanment (display)
B_VAAU	ESUK	LOK	Condition decel. enleanment for partition of fuel film
B_VAG	ESUK	AUS	Condition large deceleration enleanment
B_VAKL	ESUK	LOK	Condition decel. enleanment L- and K-part
B_WF	ESUK	LOK	Condition wall wetting calculation
DRKUKE_L	ESUK	LOK	Delta of the relative fuel mass (default value)
DRKUKE_W	ESUK	LOK	Delta of the relative fuel mass (default value)
DRLP_W	BGRLP	EIN	delta predicted load for injection time calculation (word)
DWFK_W	ESUK	LOK	delta wall wetting quantity short term
DWFL_W	ESUK	LOK	delta wall wetting quantity long term
DWF_W	ESUK	AUS	Delta wall hang-up quantity
FBAKL_W	ESUK	AUS	factor short/long time part of trans.control during acceleration
FBANS	ESUK	LOK	post cranking factor of transient control during acceleration
FBANS_W	ESUK	LOK	post cranking factor of transient control during acceleration
FBAVST_W	ESUK	LOK	factor ÜK-adjustment at acceleration enrichment
FHO	BGPU	EIN	Correction factor altitude
FUKABA_W	ESUKA	EIN	factor adaptive transient control BA

Variable	Source	Type	Description
FUKAVA		EIN	factor adaptive transient control VA
FVAKL_W	ESUK	AUS	factor short/long-time part of trans.control at deceleration
FVANS	ESUK	LOK	post cranking factor of transient control during deceleration
FVAVST_W	ESUK	LOK	factor ÜK-adjustment at deceleration enleanment
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
RKUKE_W	ESUK	LOK	rel. fuel mass transition compensation substitute value
RKUKG_W	ESUK	AUS	rel. fuel mass transition compensation
RKUKKL_W	ESUK	LOK	sum of short and long term parts of transient control
RKUKK_W	ESUK	AUS	rk short term part of transient control
RKUKL_W	ESUK	LOK	rk long term part of transient control
RKUK_W	ESUK	LOK	rel. fuel mass transition compensation without adjustment
RLP	BGRLP	EIN	rel. air charge predicted for injection calculation
RLP_W	ESUK	LOK	rel. air charge predicted for injection calculation (Word)
SDWFK_W	ESUK	LOK	memory content of the wall wetting difference for short term portion
SDWFL_W	ESUK	LOK	memory content of the wall wetting difference for long term portion
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VSTFBA		EIN	factor acceleration enrichment (service device interface)
VSTFVA		EIN	factor deceleration enleanment (service device interface)
WF_W	ESUK	LOK	wall wetting quantity
ZBALE	ESUK	LOK	reduction factor during acceleration
ZVALE	ESUK	LOK	reduction factor during deceleration enleanment

FW ESUK 4.50 Fixed Values

Parameter	Value	Description
DUKK		threshold for short term portion
FUKE		Factor transient contol substitute value
FVANST		weighting factor of deceleration during post-cranking
FWFN		wall wetting factor influence of rpm
RKUKKLU		threshold sum of long-/short term
TNSUUK		disabling time of transient control during post-cranking
ZUKE		Time constant transient contol substitute value
ZUKK		reduction factor K-memory
ZUKNST		time constant of transient control post cranking factor

FB ESUK 4.50 Detailed description of function

The transient control determines the required additional or reduced injected fuel during a change in load to compensate for wall wetting.

The transient control consists of three different portions:

- Long term portion rkukl_w
  serves to compensate slow wall wetting effects. Based on predicted load signal rlp_w and engine speed. Calculation is performed segment synchroneously.

- Short term portion rkukk_w
  serves to compensate fast wall wetting effects. Based on predicted load signal rlp_w and engine speed. Calculation is performed segment synchroneously.

The wall wetting characteristic line WFRL contains that fuel quantity, which is stored in the wall wetting for the appropriate load at steady-state conditions. If the load is changing during one segment by the value drlp_w = rlp_w(s) - rlp_w(s-1), then the wall wetting difference dwf_w = WFRL(rlp_w(s)) - WFRL(rlp_w(s-1)) has to be injected as additional fuel amount, in order to compensate the increase of wall wetting.

This additional quantity has to be distributed over time, so that Lambda remains constant during the transient. For this, the additional quantity is divided into a short time and a long time portion by means of the partition factor aukk and accumulated in the corresponding memorys (sdwfl_w, long term memory resp. sdwfk_w, short term memory).

For each segment the fuel quantity sdwfl_w * ZBALM (for acceleration) resp. sdwfl_w * ZVALM (for deceleration) is taken from the long term memory. It represents the long time portion rkukl_w of rkukkl_w. Afterwards the long term memory is decremented by the same value rkukl_w, if the current value of rlukl_w has been used at least for one injection (B_redkl = 1). The reduction factors ZBALM and ZVALM depend on engine temperature, since the evaporation of fuel film is much slower during warm up than at hot engine.
Equivalently, the fuel quantity sdwfk_w * ZUKK - DUKK, i.e. the amount that exceeds the threshold DUKK, is taken from the short term memory as short term portion rkukk_w. The reduction factor of the short term portion ZUKK is equal for both increasing and decreasing load. The short term memory is decremented by rkukk_w as soon as the current value rkukk_w has been used at least for one injection (B_redkl = 1).
By means of this it is ensured, that the additionally injected fuel amount (due to the load change drlp_w = rlp_w(s) - rlp_w(s-1)) corresponds exactly to the difference of the wall wetting quantities dwf_w = WFRL(rlp_w(s)) - WFRL(rlp_w(s-1)).

The sum rkukkl_w of the two portions rkukl_w (from long term memory) and rkukk_w (from short term memory) is weighted by the factor KFBAKL (for acceleration) resp. KFVAKL (for deceleration), a post cranking factor and the correction factor from adaptation of transient control (see later).

During cranking at a determined coolant temperature the wall of intake manifold is much cooler as if it would be during warming at the same coolant temperature (cranking at a lower temperature). That is the reason why the transient control is weighted with the factor fbans resp. fvans during post cranking. This factor is initialized with FUKNSTM during cranking and then reduced exponentially towards 1. At deceleration an additional factor FVANST is used.

The differentiation between acceleration and deceleration for the segment synchroneous portions is realized as dependence on drlp_w (share factor aukk) resp. on sdwfl_w (reduction factor zukl).
For the change over between fbakl/fvakl the sum of the short term/long term portion rkukkl_w is used.

The transient control is not determined during cranking and for engine speeds above a speed limit (B_nswo=1).
Besides the calculation of the segment synchronous part of the transient control is turned off for an additional cycle after the the engine speed falls short of the treshold again, since the value WFRL(s-1) which is required for the calculation of the change dwf_w is not yet defined.

After transition from cranking to post cranking the transient control can be disabled during the time TNSUUK in order to prevent that errors in measured load do trigger an acceleration enrichment or a deceleration enleanment;
so it is possible to calibrate the post cranking phase independent of transient control. This time will be finished at once, when idling status is left.

If the absolute value of rkukkl_w exceeds RKUKKLU, bit B_ukg will be set to indicate high dynamics;
this information as well as Bits B_bag/B_vag are used to disable other functions.
B_ba and B_va are used to show the acceleration or decelaration state, e.g. on a calibration tool like VS20.

APP ESUK 4.50 Application hint

Requirements:

- steady state calibration to Lambda = 1
- injection advance angle calibrated, so that the fuel is just not yet injected into the open inlet valve (flight time of fuel (approx. 8 ms considered), i.e. the ti-end must advance for increasing engine speed; this results in a minimized actualization error and low HC-emission
- creation of load signal rl_w proportional to intake manifold pressure
- load prediction calibrated

Application aids:

- Lambda-test procedure with a sample rate of < 20 ms. If a sensor LSM11 and a Lambda display LA1/LA2 is employed, the engine can be tuned for steady state condition to a Lambda value of 1.05. With it, the more accurate "lean"-branch of the LSM11 characteristic is used and the problems during rich-lean transients at Lambda = 1.0 are avoided.
- throttle actuator for defined load jumps during constant engine speed

Presetting of the parameters:

- preset of all setpoints of n resp. tmot-dependent characteristic lines or maps to identical values

- wall wetting characteristic line WFRL: lower base point: WFRL = 0.0 %, upper base point: WFRL = 1300 %;
gradient around idle area approx. 1/3 of the gradient for WOT
- factor wall wetting influence of engine speed FWFN = 0.0 %/(1/min)
- reduction factor ZUKK = 0.25
- threshold short time part DUKK = 0.0 ms
- reduction factors ZBALM = ZVALM = 0.015 (4-cylinder engine) for temperatures between 100 °C .. 40 °C
= 0.008 (6-cylinder)
= 0.006 (8-cylinder)
should be reduced at lower temperatures
- share factors KFABAK = KFAVAK = 0.25 (for all engine speeds)
- engine temperature factors KFBAKL, KFVAKL = 0.8 for tmot = 100°C and all engine speeds
KFBAKL, KFVAKL = 1.0 for tmot = 90 °C and all engine speeds
KFBAKL, KFVAKL = 1.2 for tmot = 80 °C and all engine speeds
KFBAKL, KFVAKL = 6.0 for tmot = 20 °C und N = 1500 rpm,
KFBAKL, KFVAKL = 2.0 for tmot = 20 °C und N = 4000 rpm

- time Uk disabled after cranking TNSUUK = 2 s
- threshold disable of other functions RKUKKLU = 30 %, RKBAUM = 300 %, RKVAUM = -300 %
- transient control post cranking factor FUKNSTM = 2.0 (for tmot < 80 °C, neutral value = 1.0), FVANST = 1.0
- time constant of transient control post cranking factor ZUKNST = 22 s
- Factor substitute value for transient control FUKE = 1.1
- Time constant for substitute value ZUKE = 0.03 s

Switch off transient control:
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switch off load dependent part: KFBAKL = 0; KFVAKL = 0

Procedure:

For calibration of the transient control, the Lambda closed loop control must be turned off. Transient control adaptation (see %ESUKA resp. %ESUKAS) must be disabled and the correction factor of transient control must be set to its initial value of 1.0 .

1) Calibration of the hot engine at low engine speed

Prefereably, the calibration should be carried out on an externally driven chassis dynamometer or engine dyno. In case the calibration is carried out with the vehicle, then a manual transmission is required. If not available, the torque converter of the automatic transmission must be locked, so that the engine can be operated with variable load at constant engine speed. For vehicle calibration, the fuel evaporation must be sucked off. Appropriate tire equipment must be provided (the stress on tires is comparable to engine mapping).

At first the wall wetting characteristic line WFRL, the share of KFABAK, KFAVAK and the reduction factors ZUKK, ZBALM, and ZVALM are determined for the short and long term portion at a relatively low engine speed (approx. 1400 RPM). For this, fast load changes at constant speed are performed between neighbouring rlp_w setpoints of the wall wetting characteristic WFRL (throttle plate adjustment within approx. 100 ... 200 ms). For practical reasons, the engine load and Lambda characteristic during the load change is simultaneously displayed (with oscilloscope) and recorded. Waiting time between two consecutive load steps: approx. 10 ... 20 s.

In the following the procedure, recommended for correcting the transient parameters, is explained, based on various Lambda traces occuring during acceleration.
The following load setpoints of the wall wetting characteristic are assumed:

rlp_w = ... 24 % / 36 & / 48 % / 60 % .....

At first the calibration is carried out at low load, e.g., with a load step from rlp_w = 24 % --> 36 % --> 24 %.

```
   rlp  ^
        |
  36 %  + - - - - - - -  **************************************************************************
        |              **
        |            **
        |           *
  24 %  + **********
        |
        +----------|----------|----------|----------|----------|----------|----------|----------|--->  Time / ms
                   0         500       1000       1500       2000       2500       3000       3500


        ^
 Lambda |              **            Characteristic A:
  1.1   + - - - - - -  **   - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |             *  *
        |             *  *
  1.0   + *************   ******     **************************************************************
        |                       *****
        |
  0.9   + - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |
        +----------|----------|----------|----------|----------|----------|----------|----------|--->  Time / ms
                   0         500       1000       1500       2000       2500       3000       3500


        ^
 Lambda |                            Characteristic B:
  1.1   + - - - - - -  **  ***  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |             *  **   **********
        |             *                 ***********************
  1.0   + *************   - - - - - - - - - - - - - - - - - -  ************************************
        |
        |
  0.9   + - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |
        +----------|----------|----------|----------|----------|----------|----------|----------|--->  Time / ms
                   0         500       1000       1500       2000       2500       3000       3500


        ^
 Lambda |                            Characteristic C:
  1.1   + - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |                           ***********
        |             **          **           *****************
  1.0   + ************  *       **    - - - - - - - - - - - -   ***********************************
        |                *    **
        |                 *  *
  0.9   + - - - - - - - -  **   - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |
        +----------|----------|----------|----------|----------|----------|----------|----------|--->  Time/ ms
                   0         500       1000       1500       2000       2500       3000       3500
```

The Lambda characteristic B indicates insufficient transient compensation for all portions. In this case the wall wetting amount WFRL should be increased. Since only the differences between consecutive calculations are used for evaluation of the wall wetting characteristic WFRL, the gradient of the wall wetting characteristic between the setpoints rlp_w = 24 % and rlp_w = 36 % must be increased. In this case the total characteristic WFRL for rlp_w = 36 % must be upshifted in a parallel direction (therefore, the characteristic of the function in the load range rlp_w > 36 % remains constant).

On an average, line C shows a desired Lambda characteristic. However, the split-up into short term and long term portion is considered insufficient. By reducing the split factor KFABAK, the total injected additional amount of fuel is shifted from the short term to the long term portion. By this, both the mixture deviation to the rich at t = 400 ms and the following lean-out is reduced.

For negative load steps above procedure is applied accordingly. In this case, however, the opposite reaction of the transient compensation parameters must be obeyed:
  Mixture lean-out after load reduction is caused by excessive deceleration lean-out, i.e., in contrary to the acceleration lean-out, the transient compensation must be reduced.

Since the wall wetting characteristic WFRL is applied to increasing and decreasing load, the acceleration as well as the deceleration parameters for a specific load range must always be optimized. In below example a significant enrichment occurs during deceleration. Accordingly, the gradient of the wall wetting characteristic WFRL for the range 24 % < rlp_w < 36 % must be significantly increased. This change can be implemented, although there is no significant lean-out during acceleration.

An insufficient amount of wall wetting results in significantly less mixture deviation during increasing load, since this insufficient additional amount of fuel is related to a higher load, compared to the appropriate deceleration. Therefore, it is expected that, by applying a steeper wall wetting characteristic WFRL in the range 24 % < rlp_w < 36 %, at first only the deceleration enrichment will be compensated, not necessarily resulting in mixture enrichment during acceleration.

```
   rl   ^
        |
  36 %  + - - -  ******************************************
        |       *                                          *
        |      *                                            *
        |     *                                              *
  24 %  + ****    - - - - - - - - - - - - - - - - - - - - -   *****************************************
        |
        +-----|---------------------|---------------------|---------------------|---------------------|------>  Time / s
              0                     5                     10                    15                    20
```

```
        ^
 Lambda |
  1.1   + - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |
        |         **************
  1.0   + ********              ************************** - - - - - -  **************************
        |                                                 *      *******
        |                                                  *   ***
  0.9   + - - - - - - - - - - - - - - - - - - - - - - - - - *** - - - - - - - - - - - - - - - - - -
        |
        +-----|---------------------|---------------------|---------------------|---------------------|------>  Time / s
              0                     5                     10                    15                    20
```

For the "decrease factors" ZUKK, ZBALM and ZVALM for the short and long term portion, generally the given pilot values are sufficient. Possible indicators for improperly chosen "decrease factors" are:

- remaining Lambda deviation after the long term portion has elapsed (in this case the long term portion must be increased, i.e., ZBALM or ZVALM must be reduced). This effect is frequently experienced with cold engine.

- short lean-out during acceleration (approx. 1 s) after load step, in the case when an increased short term portion results in an enrichment prior to the lean-out, and increased long term portion leads to an enrichment after the lean-out. In this case there is obviously a gap between the short term and long term portion.

When varying the "decrease factors", the ratio ZUKK/ZBALM or ZUKK/ZVALM should not fall short of 8 ... 10. Otherwise, both portions are dynamically too similar in order to influence the mixture characteristic by means of the short and long term portion.

Note: When calibrating the wall wetting characteristic WFRL, make sure to obtain a "plausible" characteristic (flat parabolic curve, no edges!).
As soon as all load intervals 24 % <--> 36 %, 36 % <--> 48 %, 48 % <--> 60 % etc. have been calibrated, larger load changes are applied and the Lambda characteristic is then evaluated. In case there are unacceptable Lambda deviations, at first the "small" load steps should be again verified at the appropriate area. Frequently, the deviations, occuring at large load steps, are also experienced with small load steps (smaller magnitude), however, they were yet accepted in these areas.
Short term portions KFABAK or KFAVAK exceeding 60 % are frequently caused by a dynamic error in load signal (too slow).
In this case both the rl and the manifold pressure characteristic during load variation should again be compared.

Remaining Lambda deviations for load steps close to full load may indicate insufficient steady state calibration in this area. In this case the pulsation compensation and the psmax-limitation must again be verified.

2. Calibration with hot engine for the entire engine speed range

Initial calibration is performed at the speed setpoint of approx. 1400 rpm. Then, the remaining speed setpoints are calibrated as well. At first the setpoints in the idle area should be calibrated, since, in some cases, improperly chosen "decrease factors" ZUKK, ZBALM, ZVALM may be discovered, resulting in verification of the speeds which have already been calibrated. If possible, neither the "decrease factors" nor the wall wetting characteristic WFRL should be changed, because there is no degree-of-freedom for different engine speed.
For significant deviations of the entire wall wetting amount, the correction should be carried out via the speed dependency in the look-up tables KFBAKL and KFVAKL.

Note: The time for build-up and reduction of wall wetting decreases at higher engine speed. This effect must be considered when choosing the parameters, compensating for Lambda deviations. At 1000 rpm, the Lambda deviation, occuring approx. 1 s after a load step, is rather allocated to the short term portion, at 3000rpm, however, the deviation is mainly influenced by the long term portion.

Time for calibration: Approx. 1 day for each speed setpoint.

3. Conversion engine dyno --> vehicle

If the calibration of the hot engine is performed on the engine dyno, all transient compensation data must be reduced by 10 - 20 %, since the manifold temperatures for vehicle installation are slightly increased.
In order to obtain proper conversion to the vehicle, the configuration of all engine components (manifold design, camshaft, etc.) must be identical for dyno and vehicle testing. Aging conditions (intake valve deposits) should be comparable as well.
If not ensured, the conversion of data must be verified, after one or two speed setpoints have been calibrated.

4. Warm-up calibration

The correspondence between engine dyno and vehicle is not ensured for the cold engine. Therefore, the warm-up calibration of the transients (accel, decel) should be performed on the chassis dyno. For this purpose, alternating acceleration and deceleration events are carried out at a constant engine speed (lower load point corresponding to approx. 400 mbar, upper load point at approx. 800 - 900 mbar manifold pressure) and the parameters: load, injection time, coolant temperature and Lambda are recorded (on-line calibration not possible!). Then, the factors KFBAKL and KFVAKL for the appropriate speed and temperature range are increased or decreased, depending on the Lambda characteristic (10 %-steps each, based on the previous value, e.g., increase KFBAKL from 5.0 to 5.5, if there is an accel lean-out in the relevant temperature range).

In order to minimize the time required for adjusting the desired speed and load points (undesired engine heat-up), the chassis dyno adjustment, and the variation of the throttle angle are determined prior to testing (with hot engine).
Note: With cold engine (coolant 20 deg C), the air flow for the same throttle position is approx. 10 - 15 % higher than with hot engine (increased desired idle airflow and cylinder charge with cold engine). Prior to testing, the Lambda sensor must be pre-heated (approx. 5 min).

For the temperature range > 0 deg C, a soak time of 7 to 8 hours (if possible in the cold chamber) is sufficient, allowing two measurements daily. Cooling down the engine by means of a blower (2 ..3 hours) is not recommended. In this case, the manifold would have cooled down, however, the coolant temperature, used for determining the transient compensation (TC) maps, would increase quickly due to the relatively warm engine block, causing insufficient TC calibration.
Time for calibration: Three to four warm-up cycles required for each speed setpoint.
Since the speed dependency shows a smooth characteristic, it is considered sufficient to calibrate 3 to 4 setpoints in the range 800 to 4000 rpm.

In many cases the long term portion must be increased at <= 20 deg C (ZBALM and ZVALM to be reduced at the appropriate temperature range). When increasing the temperature dependent factors during load reduction, it must be ensured that the injection time during transients exceeds the te-minimum value. With cold engine, in general a significant speed dependency of the wall wetting is experienced (wall wetting decreasing with increasing speed).

5. Calibration of the post cranking factor

In case the calibration of the TC is performed according to section 4, e.g., TC at 20 deg C with a start temperature of 0 deg C, then a significant undercompensation is experienced, when the engine is started at 20 deg C (poor acceleration immediately after cranking, partly misfiring at fast acceleration).
Cause: Shortly after coldstart the temperatures of the manifold and intake valves are significantly lower compared to the temperatures occuring based on a significantly lower start temperature. This temperature effect can be compensated with the post cranking factors FUKNSTM and FVANST. In this case the post cranking factor FUKNSTM at the appropriate start temperature is increased (starting at 1.0) until satisfactory driving conditions for the warm-up stage have been obtained.

Due to high HC concentrations, Lambda measurements are very critical if carried out right after start.
If fast gas analyzers are available, then "Lambda = constant" can also be calibrated during post cranking conditions.

Influenced functions:

- Idle speed control: The wall wetting compensation, which is also effective during idle condition, leads to a faster increase of engine torque for opening of the idle speed actuator. This could result in cyclic speed oscillations ("sawing").

ESUKA 13.30 Wall wetting adaptation based on ZPR

FDEF ESUKA 13.30 Function definition

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ESUKA: Overview
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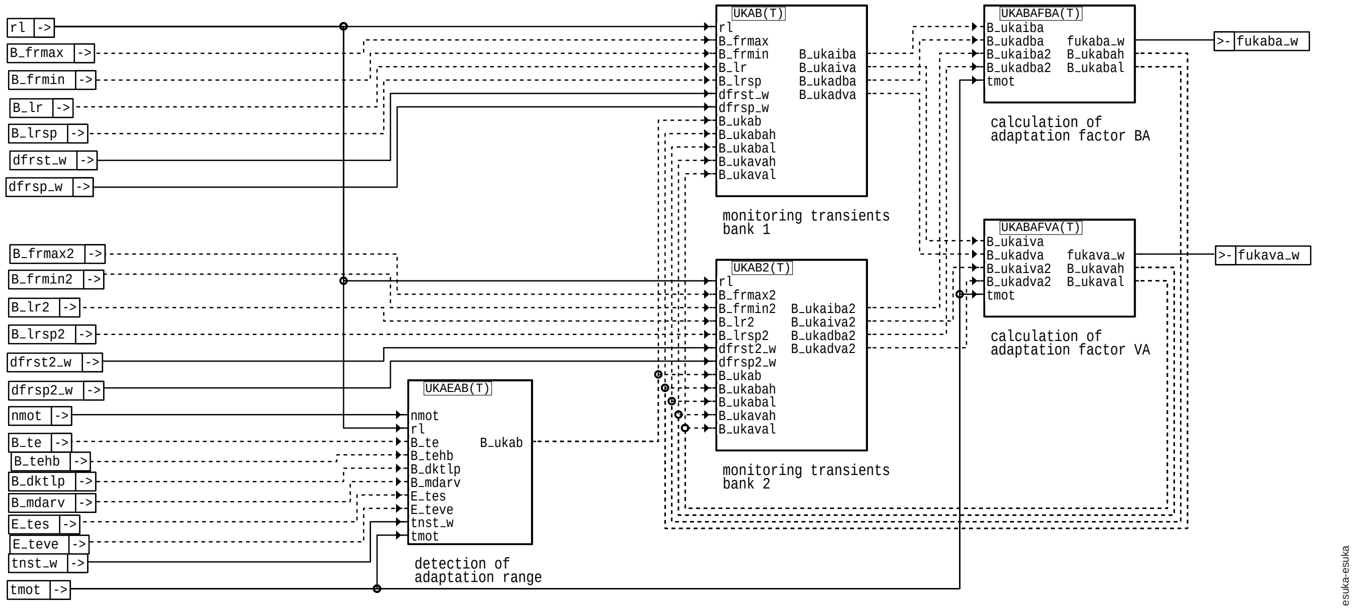

esuka-esuka

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UKAB: Monitoring of transients bank 1
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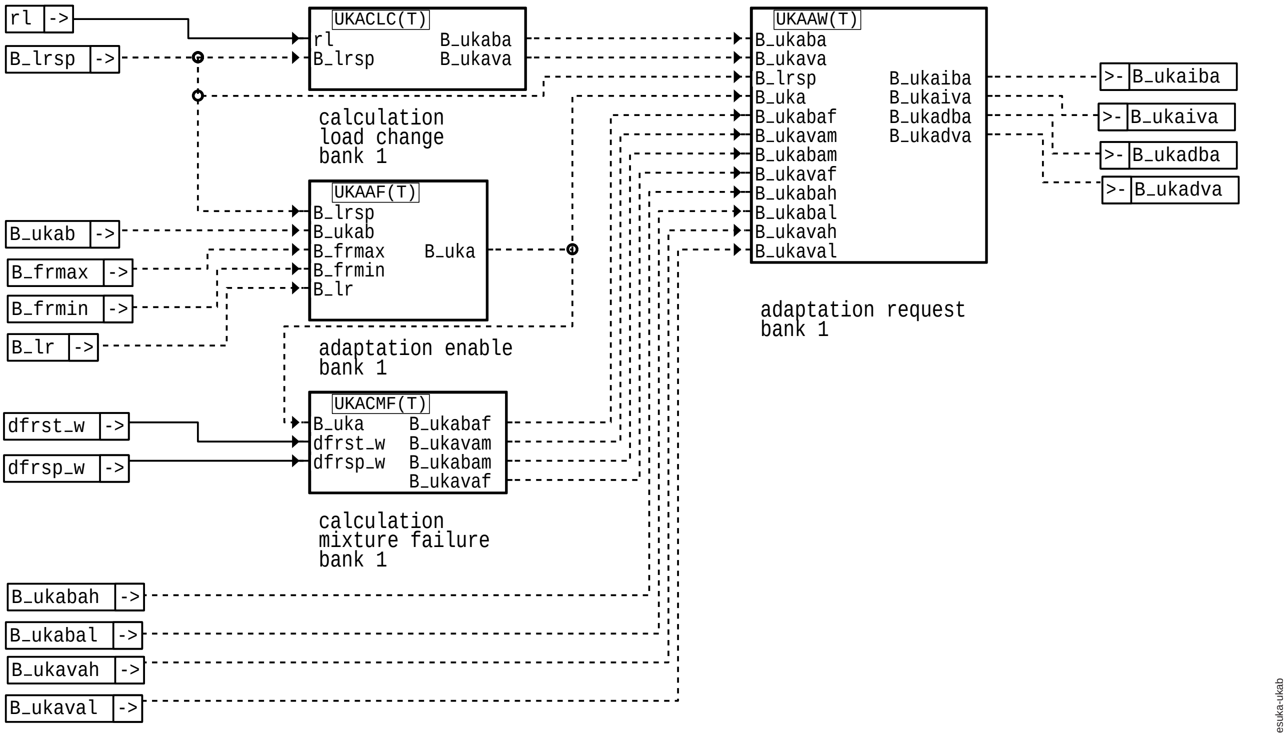

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UKACLC: Calculation of load change bank 1
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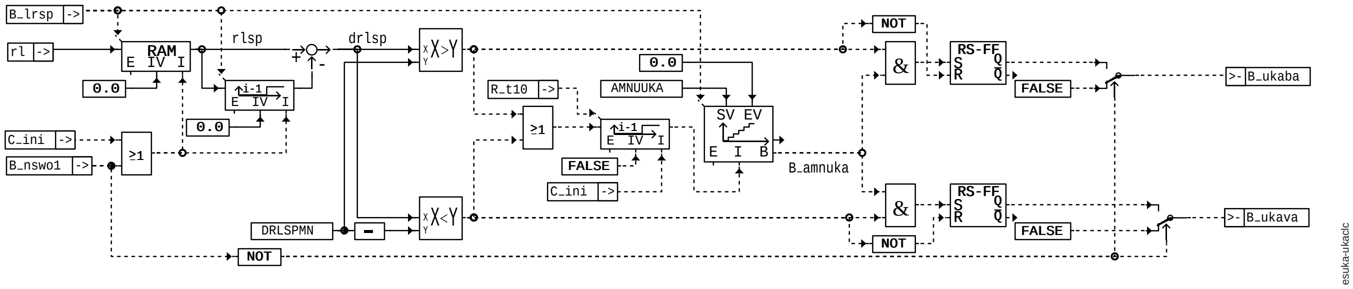

esuka-ukaclc

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UKACMF: Calculation of mixture deviation bank 1
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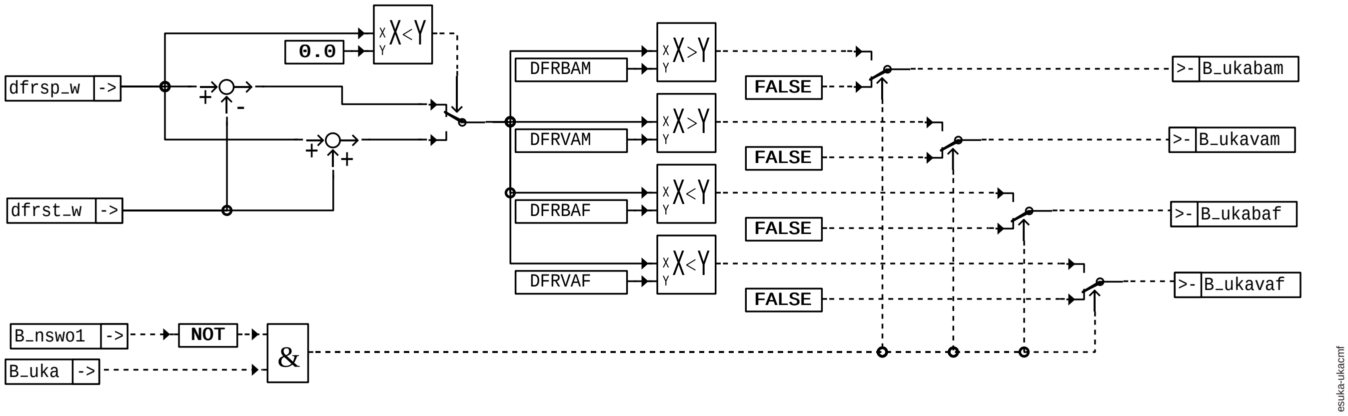
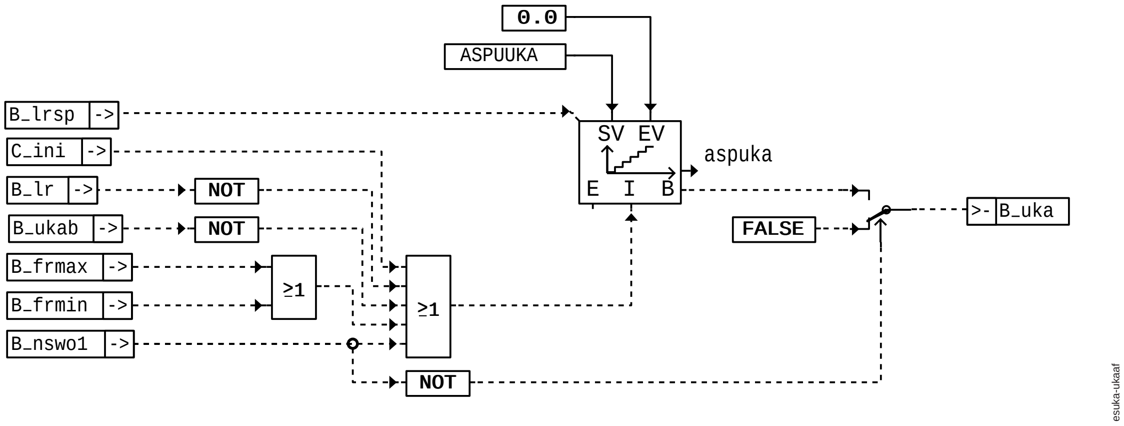


esuka-ukacmf

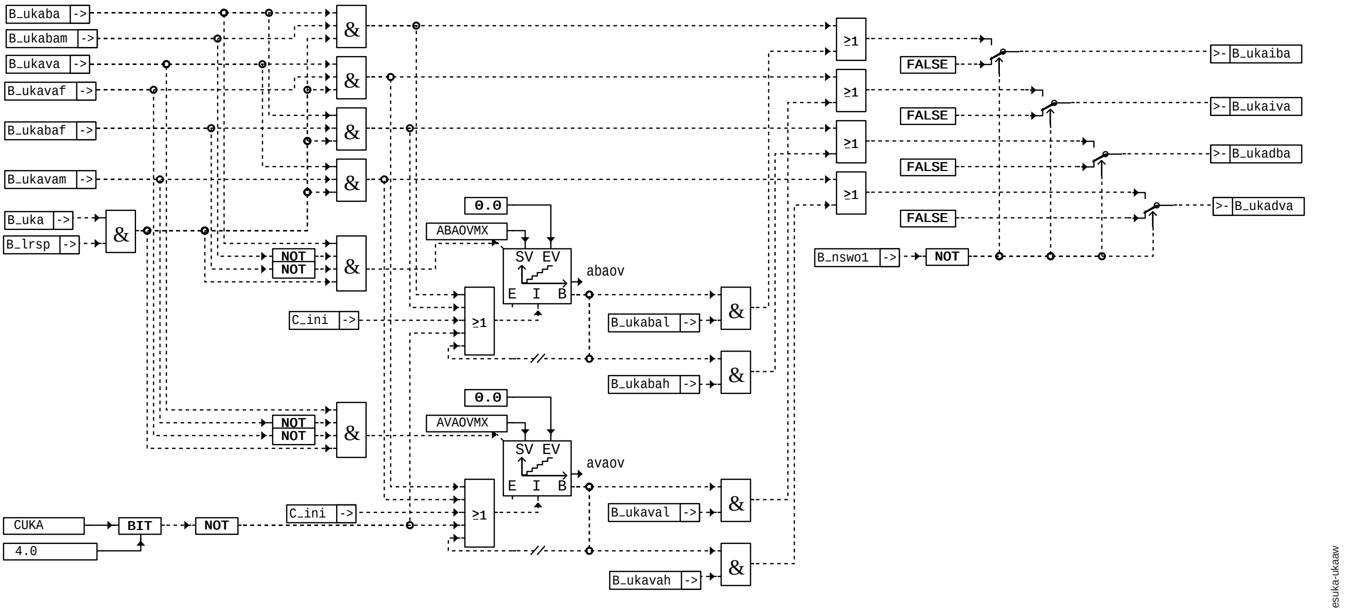
```
Processing in the 10-ms-cycle.
 UKAAF: Adaptation release bank 1
 ================================
```



esuka-ukaaf

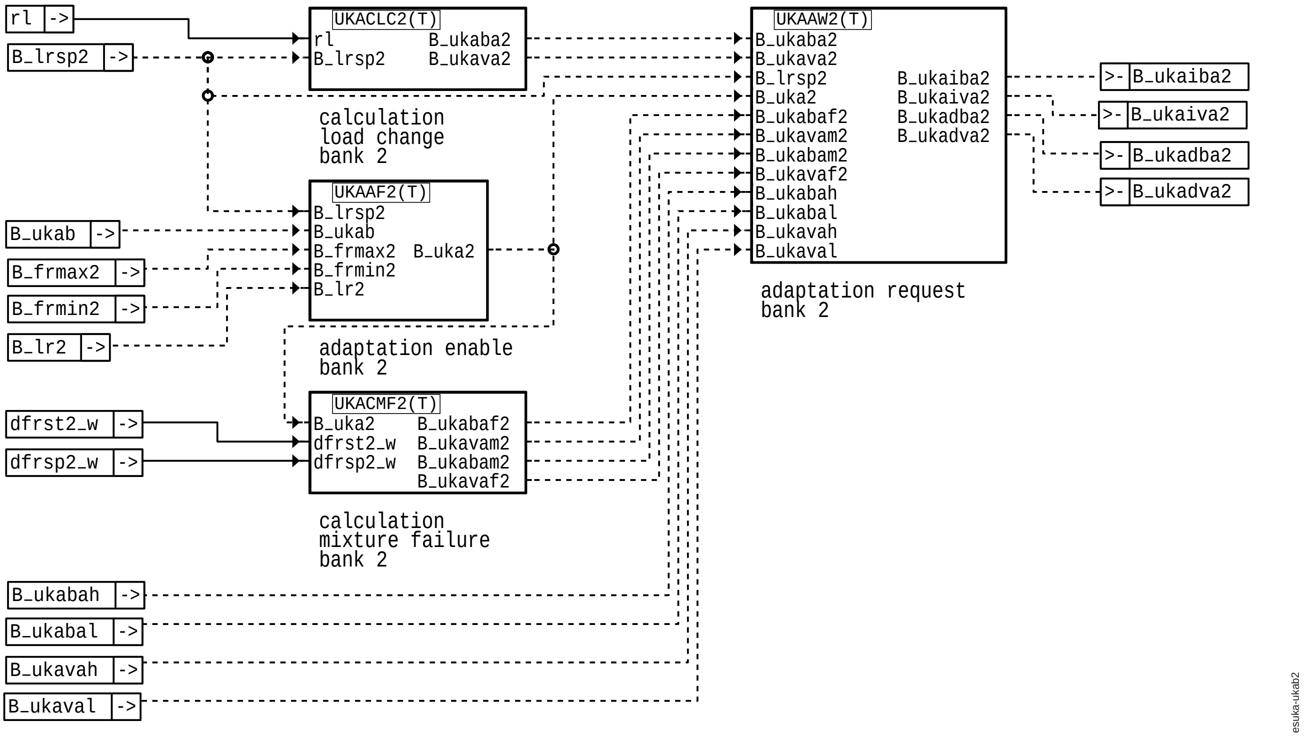
```
Processing in the 10-ms-cycle.
```

```
UKAAW: Adaptation request bank 1
================================
```



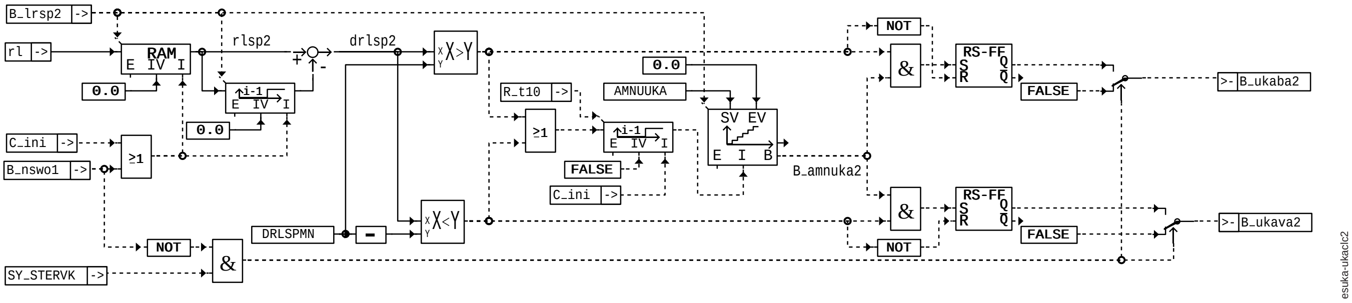
esuka-ukaaw

```
Processing in the 10-ms-cycle.
 UKAB2: Monitoring of transients bank 2
 =====================================
```



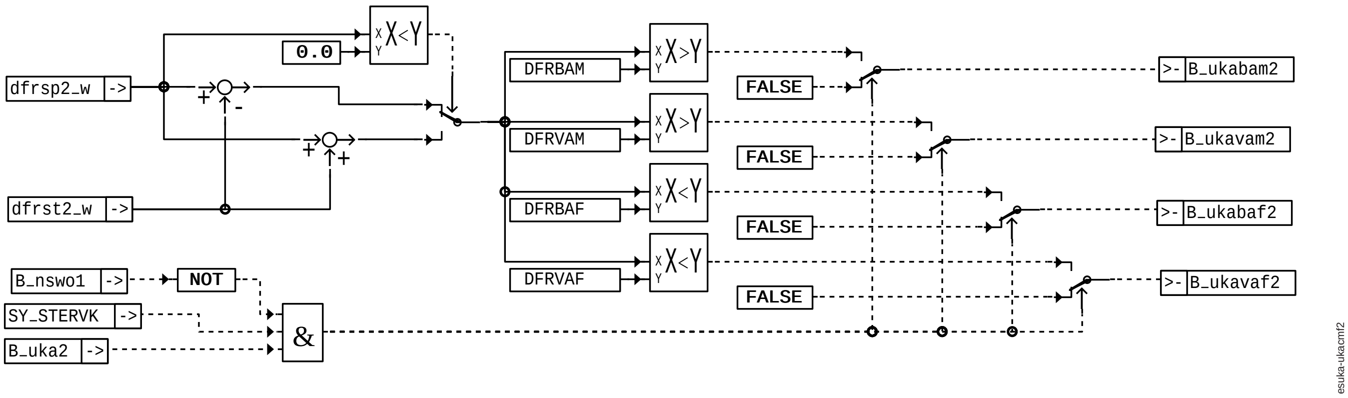
esuka-ukab2

UKACLC2: Calculation of load change bank 2
==



esuka-ukaclc2

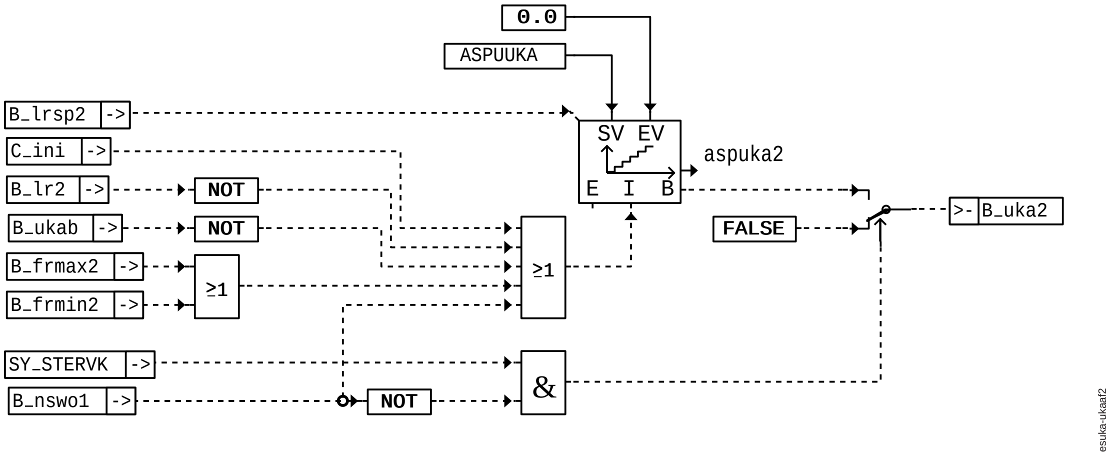
UKACMF2: Calculation of mixture deviation bank 2
==



esuka-ukacmf2

Processing in the 10-ms-cycle.

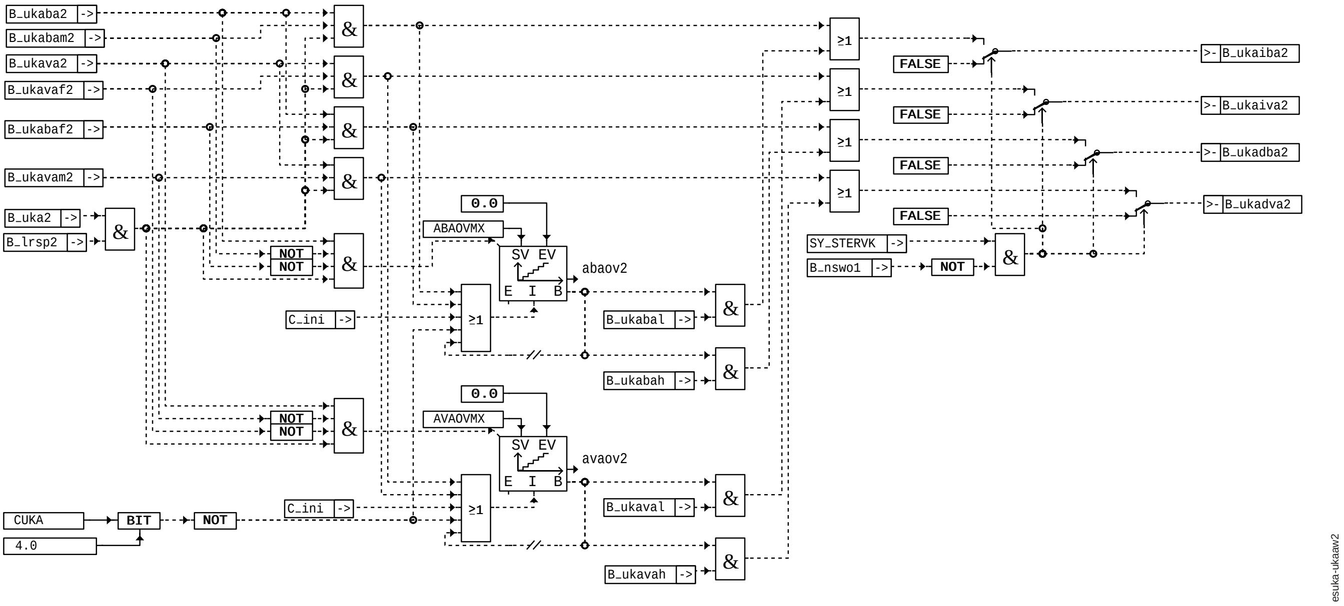
UKAAF2: Adaptation release bank 2
=================================



esuka-ukaaf2

Processing in the 10-ms-cycle.

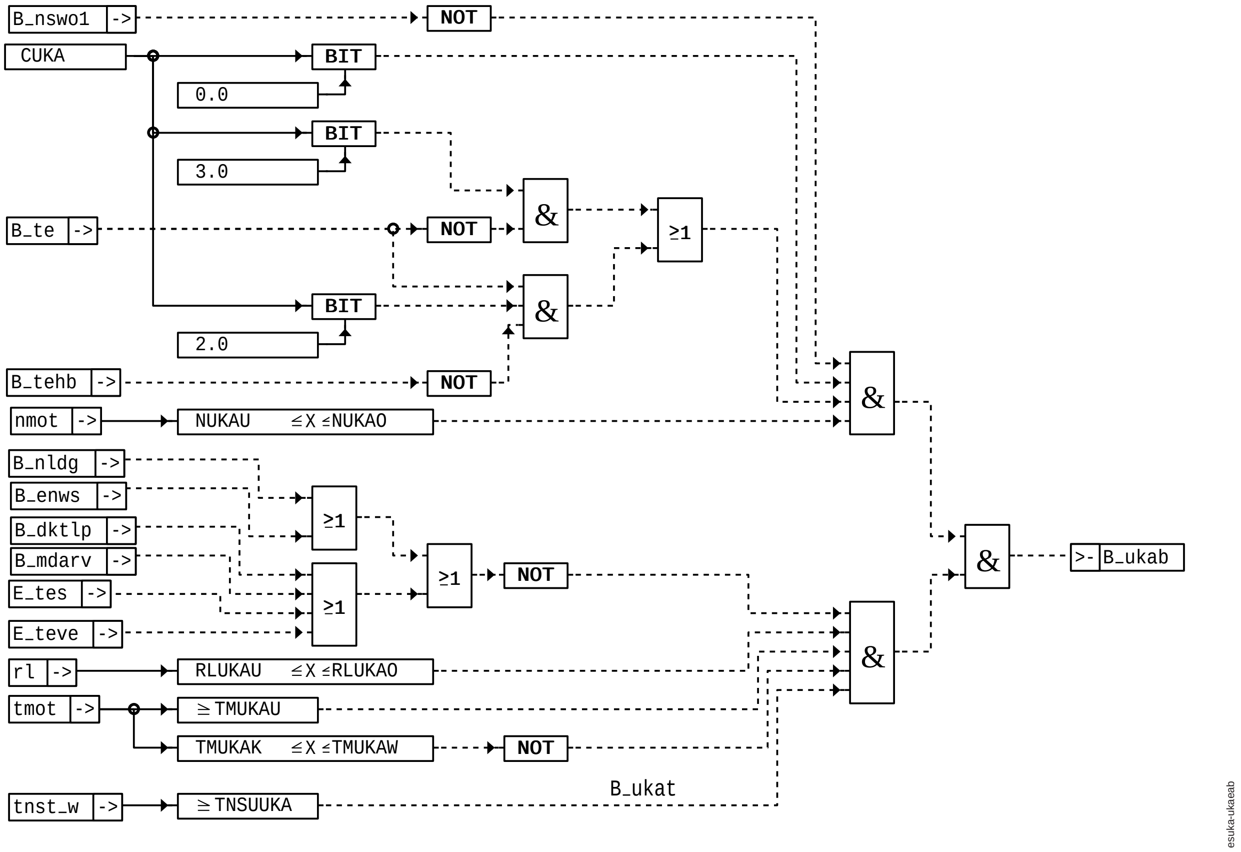
UKAAW2: Adaptation request bank 2



esuka-ukaaw2

Processing in the 10-ms-cycle.

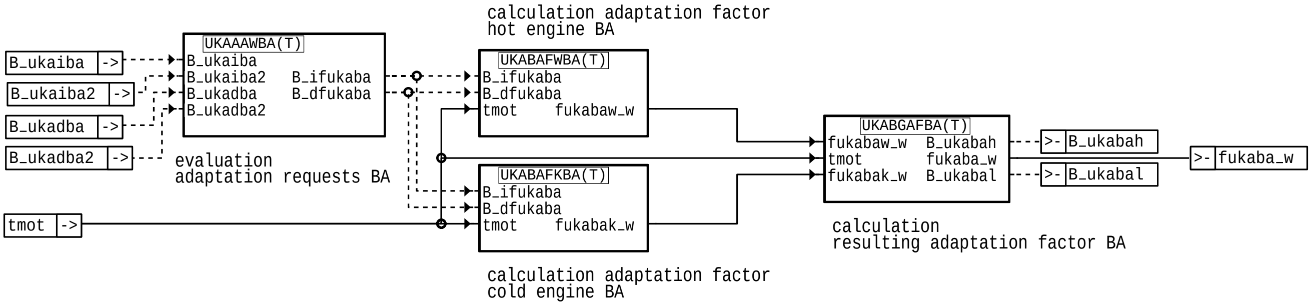
UKAEAB: Detection of adaptation range



esuka-ukaeab

Limiting value comparison of engine speed and engine temperature, as well as scanning of the bit B_tehb in the 100-ms-cycle.
Remaining function in the 10-ms-cycle.

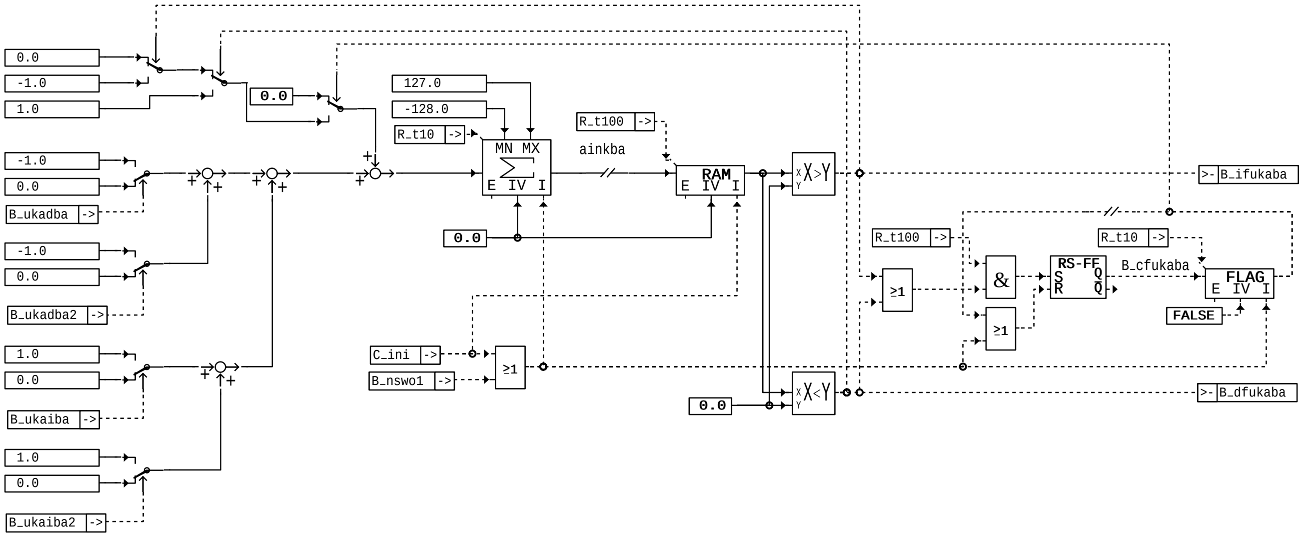
UKABAFBA: Calculation of correction factor BA



esuka-ukabafba

esuka-ukabafba

UKAAAWBA: Evaluation of adaptation requests BA

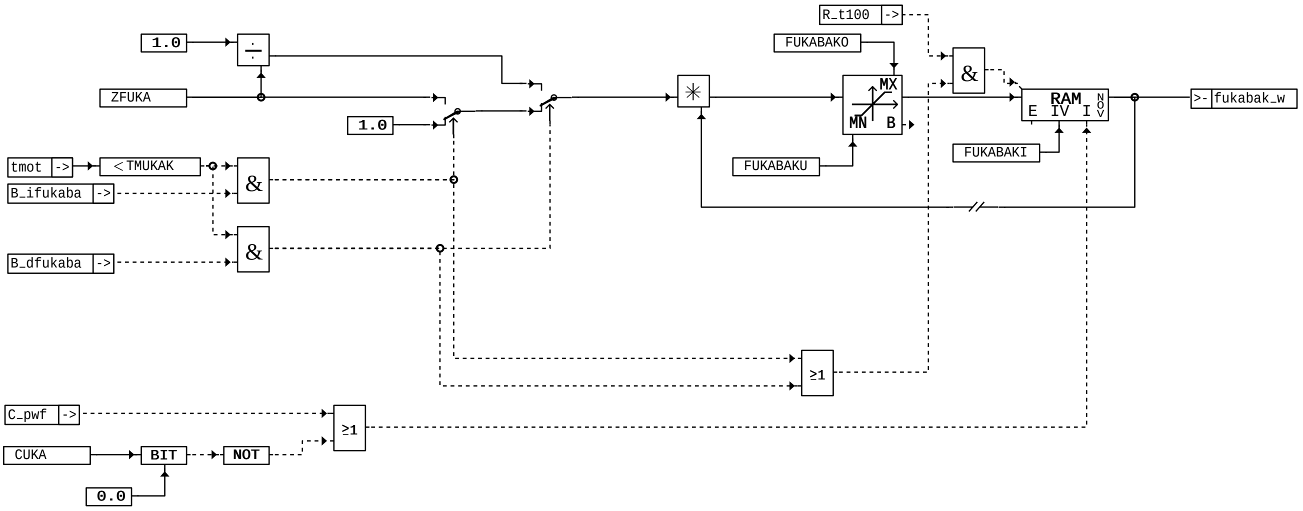


esuka-ukaaawba

esuka-ukaaawba

Scanning of B_ukaiba and B_ukadba and corresponding incrementing/decrementing of ainkba in the 10-ms-cycle.
Remaining partial function in the 100-ms-cycle

UKABAFKBA: Calculation of correction factor BA cold engine

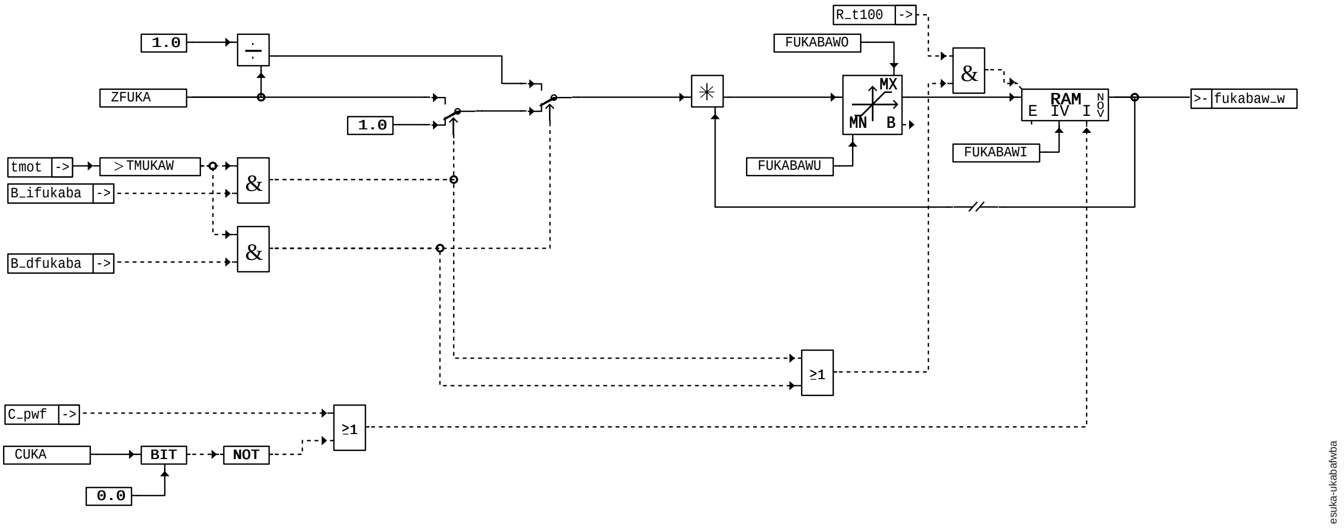


esuka-ukabafkba

esuka-ukabafkba

Processing in the 100-ms-cycle.

```
UKABAFWBA: Calculation of correction factor BA hot engine
=========================================================
```

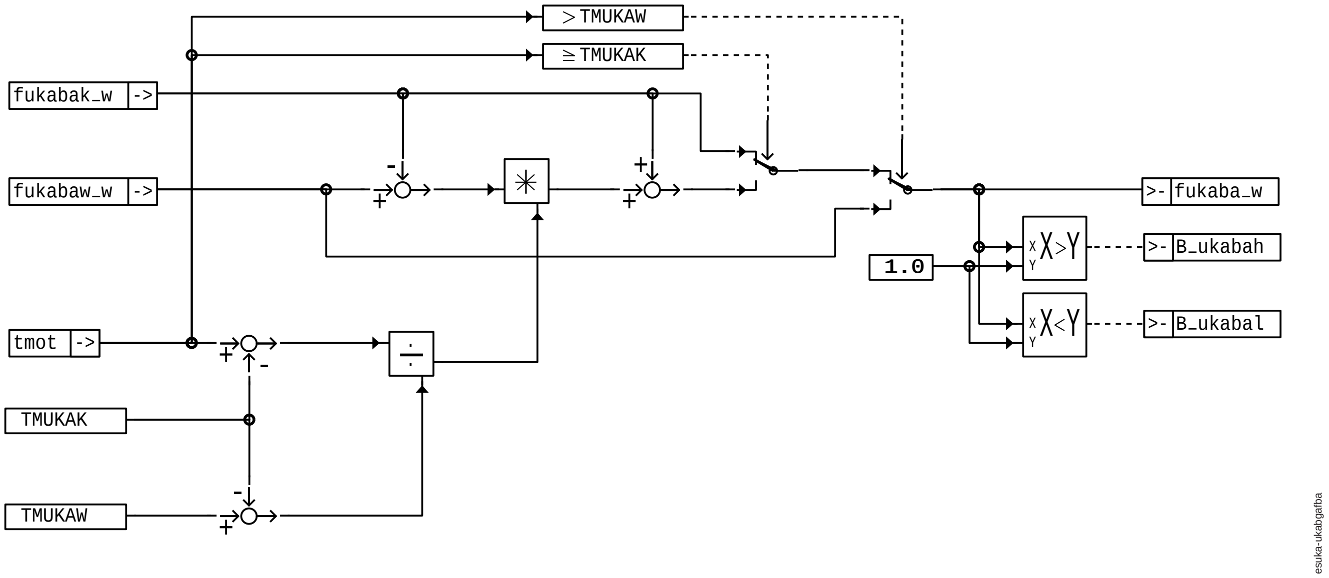


esuka-ukabafwba

```
Processing in the 100-ms-cycle.
```

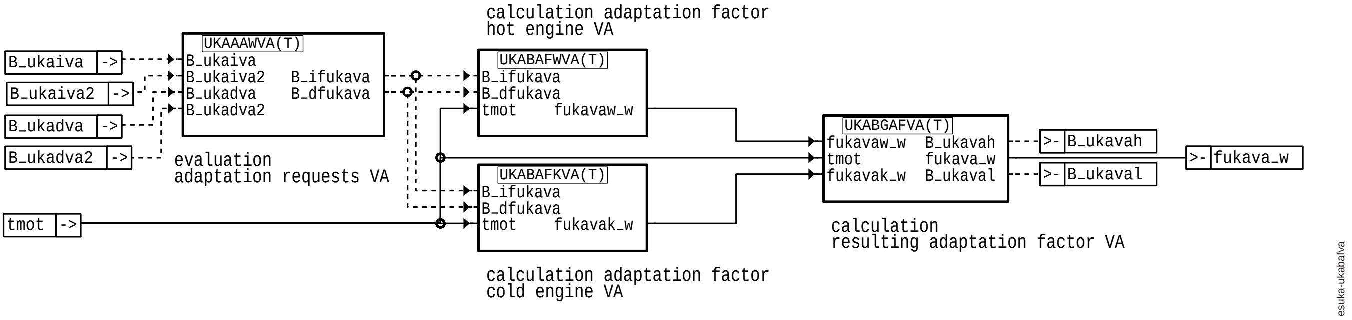
```
UKABGAFBA: Calculation of total correction factor BA
====================================================

Interpolation cold/hot
```



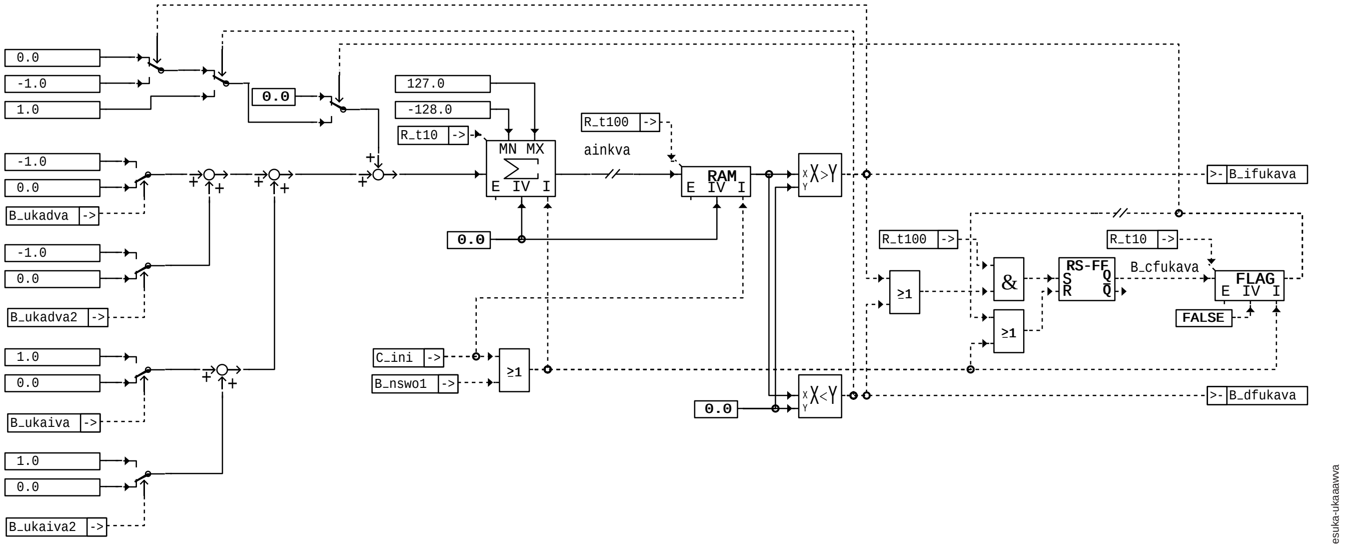
esuka-ukabgafba

```
Processing in the 100-ms-cycle.
 UKABAFVA: Calculation of correction factor VA
 =============================================
```



esuka-ukabafva

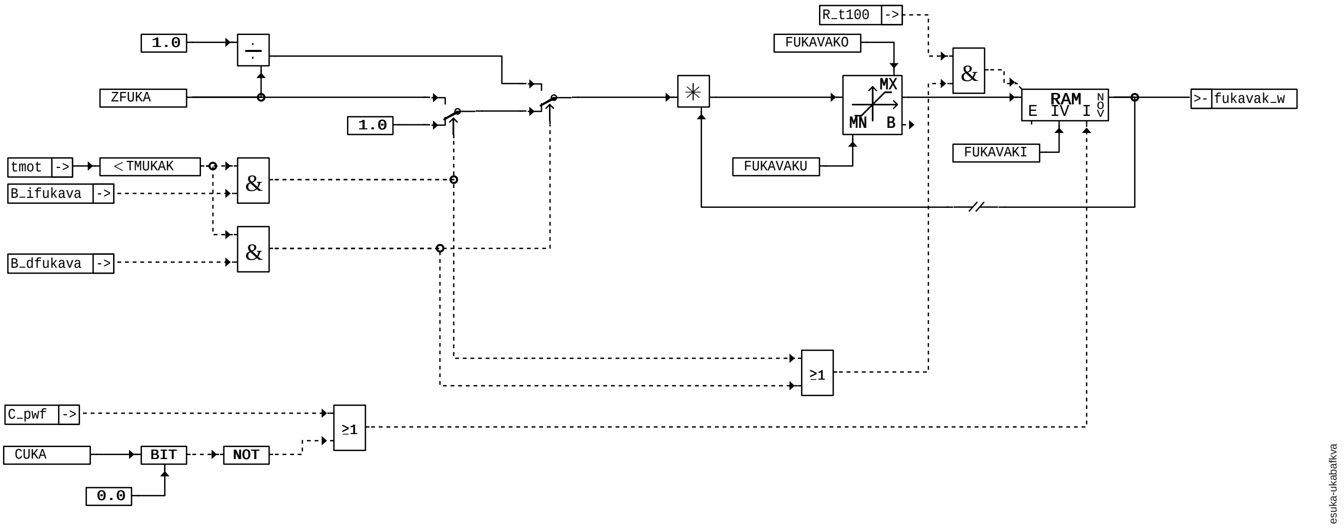
UKAAAWVA: Evaluation of adaptation requests VA
==



esuka-ukaaawva

Scanning of B_ukaiva and B_ukadva and corresponding incrementing/decrementing of ainkva in the 10-ms-cycel. Remaining partial function in the 100-ms-cycle.

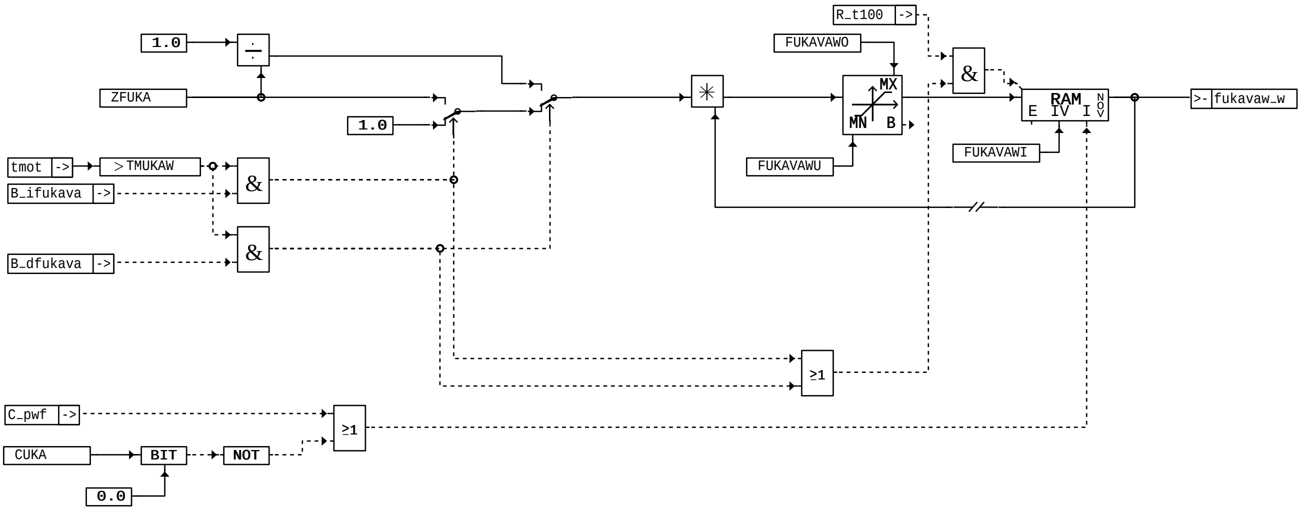
UKABAFKVA: Calculation of correction factor VA cold engine
==



esuka-ukabafkva

Processing in the 100-ms-cycle.

```
UKABAFWVA: Calculation of correction factor VA hot engine
==========================================================
```

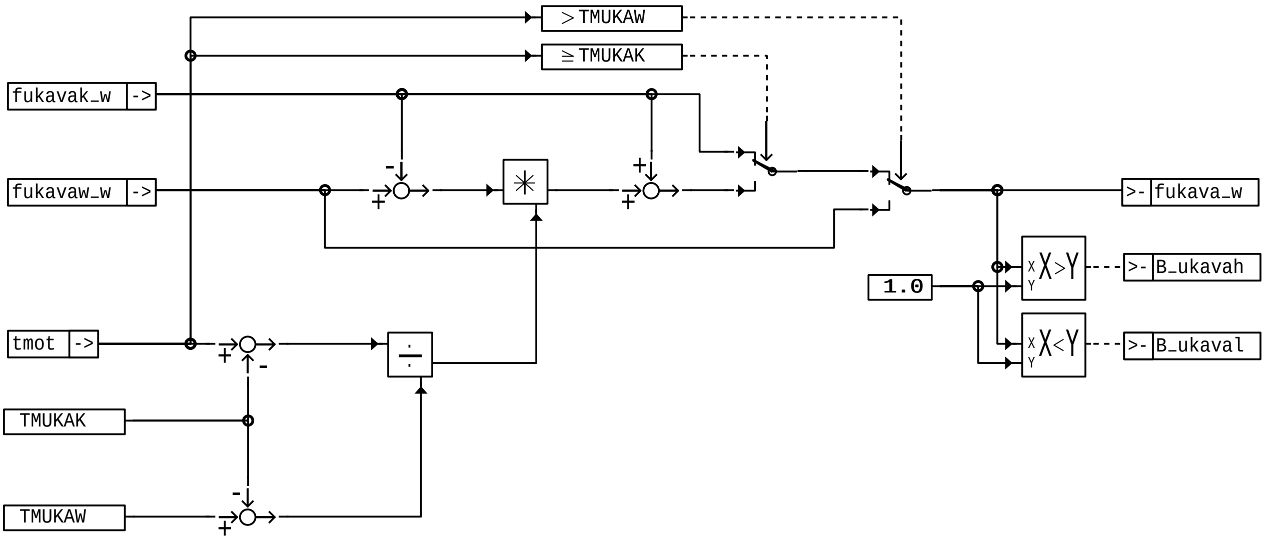


esuka-ukabafwva

`Processing in the 100-ms-cycle.`

```
UKABGAFVA: Calculation of total correction factor VA
====================================================

Interpolation cold/hot
```



esuka-ukabgafva

`Processing in the 100-ms-cycle.`

ABK ESUKA 13.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABAOVMX			FW	max. number accelerations without adaptation value return
AMNUUKA			FW	minimum number sensor bounces between 2 adapt. steps (trans. contr. adaptation)
ASPUUKA			FW	No. of O2 sensor signal bounces to disable adaptation of trans.contr.
AVAOVMX			FW	max. number decelerations without adaptation value return
CUKA			FW	code word for adaptation of transient control
DFRBAF			FW	delta lambda controller for detection BA rich
DFRBAM			FW	delta lambda controller for detection BA lean
DFRVAF			FW	delta lambda controller for detection VA rich
DFRVAM			FW	delta lambda controller for detection VA lean
DRLSPMN			FW	min. load change between O2 sensor sign. bounces for adaptation
FUKABAKI			FW	init.-value adaptive transient control correction factor BA (cold engine)
FUKABAKO			FW	upper limit adaptive transient control correction faktor BA (cold engine)
FUKABAKU			FW	lower limit adaptive transient control correction factor BA (cold engine)
FUKABAWI			FW	init.-value adaptive transient control correction factor BA (hot engine)

Parameter	Source-X	Source-Y	Type	Description
FUKABAWO			FW	upper limit adaptive transient control correction factor BA (hot engine)
FUKABAWU			FW	lower limit adaptive transient control correction factor BA (hot engine)
FUKAVAKI			FW	init.-value adaptive transient control correction factor VA (cold engine)
FUKAVAKO			FW	upper limit adaptive transient control correction faktor VA (cold engine)
FUKAVAKU			FW	lower limit adaptive transient control correction factor VA (cold engine)
FUKAVAWI			FW	init.-value adaptive transient control correction factor VA (hot engine)
FUKAVAWO			FW	upper limit adaptive transient control correction factor VA (hot engine)
FUKAVAWU			FW	lower limit adaptive transient control correction factor VA (hot engine)
NUKAO			FW	upper engine speed limit for adaptation of transient control
NUKAU			FW	lower engine speed limit for adaptation of transient control
RLUKAO			FW	upper load limit for adaptation of transient control
RLUKAU			FW	lower load limit for adaptation of transient control
TMUKAK			FW	temperature range cold engine for adaption of transient control
TMUKAU			FW	lower engine temperature limit for adaptiation of trans.contr.
TMUKAW			FW	temperature range hot engine for adaptation of transient control
TNSUUKA			FW	disabling time of trans. contr. adaptation during post-cranking
ZFUKA			FW	changing rate of adaptive transient control correction factor

Variable	Source	Type	Description
ABAOV	ESUKA	LOK	number accelerations without adaptation adjustment
ABAOV2	ESUKA	LOK	number accelerations without adaptation adjustment bank 2
AINKBA	ESUKA	LOK	number of increment-wishes BA
AINKVA	ESUKA	LOK	number of increment-wishes VA
ASPUKA	ESUKA	LOK	counter sensor signal bounces at prohibition of transient control adaptation
ASPUKA2	ESUKA	LOK	counter for sensor signal bounces at prohibition of TC-adaptation (bank 2)
AVAOV	ESUKA	LOK	number decelerations without adaptation adjustment
AVAOV2	ESUKA	LOK	number decelerations without adaptation adjustment bank 2
B_AMNUKA	ESUKA	LOK	Condition: minimum number of sensor bounces between adaptation steps occured
B_AMNUKA2	ESUKA	LOK	Condition: minimum number of sensor bounces between adapt. steps occured bank 2
B_CFUKABA	ESUKA	LOK	calculation of adaptation-factor (transient control adaptation) BA
B_CFUKAVA	ESUKA	LOK	calculation of adaptation-factor (transient control adaptation) VA
B_DFUKABA	ESUKA	LOK	condition: decrement adaptation factor BA
B_DFUKAVA	ESUKA	LOK	condition: decrement adaptation factor VA
B_DKTLP	DKAT	EIN	Request of parameter switch over in lambda control
B_ENWS	DNWS	EIN	condition error camshaft control
B_FRMAX	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMAX
B_FRMAX2	LR	EIN	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_FRMIN	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMIN
B_FRMIN2	LR	EIN	lambda control sets bit when lambda control reaches its limit FRMIN,bank2
B_IFUKABA	ESUKA	LOK	condition: increment adaptation factor BA
B_IFUKAVA	ESUKA	LOK	condition: increment adaptation factor VA
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRSP	LR	EIN	Flag 'O2 sensor voltage crosses threshold detected'
B_LRSP2	LR	EIN	condition for sensor signal bounce cylinderbench 2
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_NLDG		EIN	condition limp-home function speed sensor
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_TE	TEBEB	EIN	Condition canister purge active
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
B_UKA	ESUKA	LOK	Enable flag adaptation of transient control
B_UKA2	ESUKA	LOK	enable flag for transient control adaptation bank 2
B_UKAB	ESUKA	LOK	condition valid operation range for transient control adaptation
B_UKABA	ESUKA	LOK	condition acceleration (transient control adaptation)
B_UKABA2	ESUKA	LOK	condition acceleration (transient control adaptation) bank 2
B_UKABAF	ESUKA	LOK	condition: BA fett
B_UKABAF2	ESUKA	LOK	condition: BA fett Bank 2
B_UKABAH	ESUKA	LOK	Flag BA increased by transient control adaptation
B_UKABAL	ESUKA	LOK	Flag BA decreased by transient control adaptation
B_UKABAM	ESUKA	LOK	condition: BA lean
B_UKABAM2	ESUKA	LOK	condition: BA lean bank 2
B_UKADBA	ESUKA	LOK	decrement-wish transient control adaptation BA
B_UKADBA2	ESUKA	LOK	decrement-wish transient control adaptation at BA cylinderbench 2
B_UKADVA	ESUKA	LOK	decrement-wish transient control adaptation VA
B_UKADVA2	ESUKA	LOK	decrement-wish transient control adaptation at VA cylinderbench 2
B_UKAIBA	ESUKA	LOK	increment-wish BA transient control adaptation
B_UKAIBA2	ESUKA	LOK	increment-wish BA transient control adaptation cylinderbench 2
B_UKAIVA	ESUKA	LOK	increment-wish VA transient control adaptation
B_UKAIVA2	ESUKA	LOK	increment-wish VA transient control adaptation cylinderbench 2
B_UKAT	ESUKA	LOK	timer for prohibition of transient control adaptation expired
B_UKAVA	ESUKA	LOK	deceleration condition (transient control adaptation)
B_UKAVA2	ESUKA	LOK	deceleration condition (transient control adaptation) cylinderbench 2
B_UKAVAF	ESUKA	LOK	condition: VA rich
B_UKAVAF2	ESUKA	LOK	condition: VA rich bank 2
B_UKAVAH	ESUKA	LOK	Flag VA increased by transient control adaptation
B_UKAVAL	ESUKA	LOK	Flag VA decreased by transient control adaptation
B_UKAVAM	ESUKA	LOK	condition: VA lean
B_UKAVAM2	ESUKA	LOK	condition: VA lean bank 2
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DFRSP2_W	LR	EIN	delta peak value lambda control factor frsp bank 2
DFRSP_W	LR	EIN	delta peak value lambda control factor frsp

Variable	Source	Type	Description
DFRST2_W	LR	EIN	A/F ratio controller output stroke in steady-state condition (cylinderbench 2)
DFRST_W	LR	EIN	A/F ratio controller output stroke (steady-state condition)
DRLSP	ESUKA	LOK	load change between 2 consecutive sensor signal bounces
DRLSP2	ESUKA	LOK	load change between 2 sensor signal bounces (bench 2)
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
FUKABAK_W	ESUKA	LOK	factor adaptive transient control (cold engine) BA
FUKABAW_W	ESUKA	LOK	actor adaptive transient control (hot engine) BA
FUKABA_W	ESUKA	AUS	factor adaptive transient control BA
FUKAVAK_W	ESUKA	LOK	factor adaptive transient control (cold engine) VA
FUKAVAW_W	ESUKA	LOK	actor adaptive transient control (hot engine) VA
FUKAVA_W	ESUKA	AUS	factor adaptive transient control VA
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
RLSP	ESUKA	LOK	load signal value at O2 sensor signal bounce
RLSP2	ESUKA	LOK	laod signal at O2 sensor signal bounce (bench 2)
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TMOT	SWADAP	EIN	Engine temperature
TNST_W	BBSTT	EIN	time after end of start

FW ESUKA 13.30 Fixed Values

Parameter	Value	Description
ABAOVMX		max. number accelerations without adaptation value return
AMNUUKA		minimum number sensor bounces between 2 adapt. steps (trans. contr. adaptation)
ASPUUKA		No. of O2 sensor signal bounces to disable adaptation of trans.contr.
AVAOVMX		max. number decelerations without adaptation value return
CUKA		code word for adaptation of transient control
DFRBAF		delta lambda controller for detection BA rich
DFRBAM		delta lambda controller for detection BA lean
DFRVAF		delta lambda controller for detection VA rich
DFRVAM		delta lambda controller for detection VA lean
DRLSPMN		min. load change between O2 sensor sign. bounces for adaptation
FUKABAKI		init.-value adaptive transient control correction factor BA (cold engine)
FUKABAKO		upper limit adaptive transient control correction faktor BA (cold engine)
FUKABAKU		lower limit adaptive transient control correction factor BA (cold engine)
FUKABAWI		init.-value adaptive transient control correction factor BA (hot engine)
FUKABAWO		upper limit adaptive transient control correction factor BA (hot engine)
FUKABAWU		lower limit adaptive transient control correction factor BA (hot engine)
FUKAVAKI		init.-value adaptive transient control correction factor VA (cold engine)
FUKAVAKO		upper limit adaptive transient control correction faktor VA (cold engine)
FUKAVAKU		lower limit adaptive transient control correction factor VA (cold engine)
FUKAVAWI		init.-value adaptive transient control correction factor VA (hot engine)
FUKAVAWO		upper limit adaptive transient control correction factor VA (hot engine)
FUKAVAWU		lower limit adaptive transient control correction factor VA (hot engine)
NUKAO		upper engine speed limit for adaptation of transient control
NUKAU		lower engine speed limit for adaptation of transient control
RLUKAO		upper load limit for adaptation of transient control
RLUKAU		lower load limit for adaptation of transient control
TMUKAK		temperature range cold engine for adaption of transient control
TMUKAU		lower engine temperature limit for adaptiation of trans.contr.
TMUKAW		temperature range hot engine for adaptation of transient control
TNSUUKA		disabling time of trans. contr. adaptation during post-cranking
ZFUKA		changing rate of adaptive transient control correction factor

FB ESUKA 13.30 Detailed description of function

Task:
=====

On-line correction of the transient control in case of coking of the intake valves, manufacturing tolerances, changed fuel characteristics etc.

Principle:
==========

The transient control (ÜK) is corrected by an amplitude factor, which acts on all parts of the ÜK, if in case of load changes larger deviations in the air / fuel ratio are detected. For this, the amplitude of the control oscillation is evaluated by the two-step Lambda control.

The adaptation factor is realized separately for BA (fukaba) and VA (fukava). For simplification reasons, however, only the factor fuka is mentioned in the following function description.

If there is no fault in the air / fuel ratio, then the typical control amplitude of the Lambda control is 6% (application instructions for Lambda control). If the change of the control factor deviates considerably from this value between two sensor step changes and if simultaneously a distinct load change occurs between the corresponding sensor step changes, then it is assumed that the wall wetting behaviour has changed with regard to the initial state and the correction factors fukaba with acceleration and fukava with deceleration are changed accordingly.

Example: In the course illustrated below, the control amplitude between the sensor step changes (A) and (B) is 6%, i.e. this fr-course corresponds to the application state. There is no Lambda deviation.

From sensor step (B) to (C) the control factor, however, rises by 4 %, i.e. the Lambda control does not enrich as much as was expected. In this case, therefore, there must be a rich fault. Since the load rises simultaneously in the range (B) to (C), it is obvious that the acceleration enrichment is too strong. --> The factor fuka is decremented at point (C).

The position of the fr-mean value is of no significance. By this the procedure becomes independent of the basic adaptation.

```
        ˆ fr
        |
        + - - - - - - - - - -  ********* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        |                  *** .       *                                                          ˆ
        |               ***    .       *                                                          |
        |            ***       .       *                                 *******  - - - - - - -   |
        |         ***          .        ***                           ***      *              ˆ   |
        |      ***             .           ***                     ***   .     *              |   |
        |   ***                .              ***               ***      .     *              |  6 %
        |***                   .                 ***           *         .     *             4 %  |
        |                      .                    ***        *         .      ***           |   |
        |                      .                       ***     *         .         ***        |   |
        |                      .                          ***  *         .            ***     v   v
        + - - - - - - - - - - -.- - - - - - - - - - - - - -  *** - - - - . - - - - - - - *** - - - -
        |                      .                               .         .                  ***
        +----------------------+-------------------------------+---------+---------------------------------->
                               A                               B         C                             time
```

```
        ˆ rl
        |
        |                                                                        ***************
        |                                                               *********
        |                                                             ** .
        |                                                           **   .
        |                                                      *****     .
        |                                                ******.         .
        |                                   *************      .         .
        |***********************************                   .         .
        |                      .                               .         .
        |                      .                               .         .
        |                      .                               .         .
        +----------------------+-------------------------------+---------+---------------------------------->
                               A                               B         C                             time
```

On systems with stereo Lambda control the control oscillations of the two cylinder banks are evaluated independent of one another according to the above principle. However, only a common factor fuka is made available for both cylinder banks, i.e. the incrementing resp. decrementing steps determined from the fr-courses of the two cylinder banks act on the same factor fuka.

Dependent on the cause of the change of the wall wetting behaviour a different correction of the transient control needs to be performed with hot resp. cold engine. Valve coking for example necessitates about the same correction factors for the ÜK with hot and with cold engine. On the other hand some fuel types can reduce the build-up of the wall wetting as regards the application state with a hot engine and increase it with a cold engine. For the adaptive ÜK the correction factor is therefore composed of the factors fukak and fukaw for cold and for hot engine dependent on the engine temperature:

```
  fuka
        ^
        |          fukak
        |**********************
        |                       *****
        |                      .     *****
        |                      .          *****
        |                      .               *****
        |   cold engine:       .                    *****                   fukaw
        |   fuka = fukak.      .                          *************************************
        |   only fukak is      .   transition range:      .
        |   adapted            .   linear interpola-      .     hot engine:
        |                      .   tion between           .     fuka = fukaw.
        |                      .   fukak and fukaw.       .     only fukaw is adapted
        |                      .   Adaptation prohibited   .
        |                      .                          .
        +----------------------|--------------------------|--------------------------------------> tmot
                            TMUKAK                     TMUKAW
```

According to the validity range of the factors fukak and fukaw the adaptation of fukak is only performed with cold engine, whereas fukaw is determined with hot engine. In the transition temperature range no adaptation of the ÜK is performed.

Overview code word CUKA:
========================

```
              +---+---+---+---+---+---+---+---+
   bit-no.:   | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
              +---+---+---+---+---+---+---+---+
                            |   |   |   |   |
                            |   |   |   |   +-----------> 1 = ÜK adaptation released
                            |   |   |   +--------------->     not occupied
                            |   |   +-------------------> 1 = ÜK adaptation released during canister purging phase
                            |   +-----------------------> 1 = ÜK adaptation released during basic adaptation phase
                            +---------------------------> 1 = Return mechanism for adaptation factor enabled
```

Calculation of load change bank 1 (bank 2):
===

Determination of the load change between two sensor steps by scanning the load signal rl at each sensor step (B_lrsp = 1). If the absolute value of the load change between two sensor steps drlsp exceeds the adjustable threshold DRLSPMN, then either the condition "VA" (B_ukava = 1, deceleration) or the condition "BA" (B_ukaba = 1, acceleration) is set dependent on the direction of the load change. So that only load changes out of steady-state condition are evaluated, a minimum amount of sensor step changes AMNUUKA must occur after each transient detection prior to a new transient process being evaluated. The scanning and evaluation of the load signal for sensor steps on cylinder bank 2 takes place accordingly (B_lrsp2 = 1).
So as to save calculation time this partial function is switched off at high engine speed (B_nswo1 = 1).

Calculation of mixture fault bank 1 (bank 2):
===

For the detection of a mixture fault the current control amplitude dfrsp is compared to the long-term averaged control amplitude dfrst. If the deviation is greater than for BA, VA, rich and lean separately adjustable thresholds, this is indicated by the corresponding bit:
B_ukabam = BA lean
B_ukavam = VA lean
B_ukabaf = BA rich
B_ukavaf = VA rich.

Adaptation release bank 1 (bank 2):
===================================

The adaptation of the ÜK is switched off in some operating ranges. After the prohibited ranges have been left, a certain number of sensor step changes needs to be waited for until the Lambda control has stabilized again.

With the following prohibitive conditions the adjustable number ASPUUKA of sensor step changes is subsequently waited for until the adaptation is switched on:

- Non-permissible operating range for the ÜK adaptation (engine speed, load, temperature, high charge of the activated carbon filter, strong dynamics). A permissible operating range is reported via the flag B_ukab=1.
- Lambda control for the respective cylinder bank is out of operation (B_lr = 0 resp. B_lr2 = 0).
- Control factor fr resp. fr2 is at the limit stop (B_frmax(2) = 1 or B_frmin(2) = 1)

If the adaptation is blocked for a cylinder bank (e.g. due to a failure of the Lambda sensor of a cylinder bank), then the ÜK adaptation keeps on being active for the other cylinder bank. The correction factor fuka is then determined only on the basis of the non-steady mixture deviation of this cylinder bank.
So as to save calculation time this partial function is switched off at high engine speed (B_nswo1 = 1).

Adaptation request bank 1 (bank 2):
===================================

The conditions acceleration (B_ukaba) and deceleration (B_ukava) determined in the partial function "determination of load change" described above as well as the conditions enrichment and enleanment are checked at each sensor step, as long as the adaptation has generally been released (B_uka=1).

The adjustment requests for the factor fuka are determined according to the combination of the input conditions:

Acceleration and enleanment -----> increase fuka (B_ukai = 1)
Acceleration and enrichment -----> decrease fuka (B_ukad = 1)
Deceleration and enleanment -----> decrease fuka (B_ukad = 1)
Deceleration and enrichment -----> increase fuka (B_ukai = 1).

The two counters abaov resp. avaov accumulate the number of accelerations resp. decelerations where no mixture deviations were detected. If an applicable number ABAOVMX resp. AVAOVMX is exceeded, the corresponding adaptation factor is adjusted back in direction of its neutral value 1.0 by one increment.

An adjustment request may generally only be set if the ÜK adaptation is released for this cylinder bank.

The adjustment requests B_ukai2 and B_ukad2 for cylinder bank 2 are determined in the same way on the basis of the fr and rl evaluation. The adjustment requests of both cylinder banks need to be coordinated and transferred to the 100-ms-cycle, which performs the new calculation of the factor fuka (see partial function "Evaluation of adaptation requests" described below).
So as to save calculation time this partial function is switched off at high engine speed (B_nswo1 = 1).

Detection of adaptation range:

This partial function checks the prohibition ranges for the ÜK adaptation, in as far as they mutually apply to both cylinder banks.

The flag B_ukab (permissible operating range for adaptation) is set, if the following conditions are fulfilled:

- Adaptation released via code word CUKA[bit 0] = 1
- B_te = 1 and ÜK adaptation is released in the canister purging phase (CUKA(bit 2)=1) as well as no high charge of the canister purge flow: B_tehb = 0 .
- B_te = 0 and ÜK adaptation is released in the basic adaptation phase (CUKA(bit 3)=1)
- Engine speed within permissible range: NUKAU <= nmot <= NUKAO .
- No increase of contoller excursion at catalyst diagnosis
- No critical misfire rate
- No error of tank vent valve
- No error of tank vent valve output stage
- Load within permissible range: RLUKAU <= rl <= RLUKAO.
- Engine temperature is above a minimum value: TMUKAU <= tmot .
- Engine temperature is not in the tmot transition range TMUKAK <= tmot <= TMUKAW
- The prohibition time TNSUUKA has elapsed after end of start

The flag B_ukat=1 indicates that the prohibition time for the ÜK adaptation during after-start has elapsed. (Only relevant for hot start. In case of cold start is must be waited anyhow until the engine temperature threshold TMUKAU and the operating readiness of the Lambda control is reached).
So as to save calculation time this partial function is switched off at high engine speed (B_nswo1 = 1).

Evaluation of adaptation requests (BA/VA):

This function serves for the transfer of adjustment requests determined in the 10-ms-cycle to the 100-ms-cycle. If an increment request is detected in the 10-ms-cycle, it leads to an increase of the counter aink. In case of a decrement request the count is decreased. The adjustment requests stored in aink are processed in the subsequent runs of the 100-ms-cycle. The bit B_ifuka indicates that the count aink is positive, i.e. the adaptation factor fuka is to be incremented. The bit B_dfuka indicates that the count aink is negative, i.e. the adaptation factor fuka is to be decremented.
So as to save calculation time this partial function (only parts in the 10-ms-cycle) is switched off at high engine speed (B_nswo1 = 1).

Calculation of correction factor cold engine (BA/VA):

If the engine temperature lies below the threshold TMUKAK, the factor fukak for cold engine is changed dependent on the adjustment requests indicated by the bits B_ifuka resp. B_dfuka. If the transient control is too weak, the old value of the factor fukak is multiplied by ZFUKA. With too strong transient control, fukak is divided by ZFUKA. The calculated new value is limited to the adjustment range FUKAKU < fukak < FUKAKO. For quantization reasons the value of fukak shall furthermore not become less than approx. 0.1. The newly calculated value of fukak is stored in the battery-backed RAM area.

In the event of powerfail as well as in case of prohibited adaptation by the code word CUKA, fukak is set to the adjustable initialization value FUKAKI. The application engineer is responsible himself that the initialization value FUKAKI is within the permissible limits for fukak. No check is performed during the initialization.

Calculation of correction factor hot engine (BA/VA):

If the engine temperature lies above the threshold TMUKAW, the factor fukaw for hot engine is changed dependent on the adjustment requests indicated by the bits B_ifuka resp. B_dfuka. If the transient control is too weak, the old value of the factor fukaw is multiplied by ZFUKA. With too strong transient control, fukaw is divided by ZFUKA. The calculated new value is limited to the adjustment range FUKAWU < fukaw < FUKAWO. For quantization reasons the value of fukaw shall furthermore not become less than approx. 0.1. The newly calculated value of fukaw is stored in the battery-backed RAM area.

In the event of powerfail as well as in case of prohibited adaptation by the code word CUKA, fukaw is set to the adjustable initialization value FUKAWI. The application engineer is responsible himself that the initialization value FUKAKI is within the permissible limits for fukak. No check is performed during the initialization.

Calculation of total correction factor (BA/VA):

With cold engine (tmot < TMUKAK) resp. with hot engine (tmot > TMUKAW) the factors fukak resp. fukaw chosen for the corresponding temperature range are selected and passed on to the ÜK as total correction factor fuka. In the transition temperature range a tmot-dependent linear interpolation between fukak and fukaw is performed.
The flags B_ukabah, B_ukavah, B_ukabal and B_ukaval show the actual position of the adaptation factors.

APP ESUKA 13.30 Application hint

Preconditions:

- Steady-state basic application
- Application of the charge sensing
- Application of the load prediction
- Application of the transient control
- Application of the Lambda control
- Application of the canister purge control, if ÜK adaptation is released in the canister purging phase

Please adhere to the order!

Application aiding devices:

VS100

Entry of the parameter:

General:
- Code word CUKA = FF (hex.) = 255 (dec.) (adaptation released, adaptation released in canister purging and basic adaptation phase)
- Control amplitude adaptation released in Lambda control: CFRA = 1

Calculation of load change:
- min. load change for adaptation: DRLSPMN = 5 %
- min. no. of sensor step changes between two adaptation processes: AMNUUKA = 4

Calculation of mixture deviation:
- Threshold for detection BA lean: DFRBAM = 0.03
- Threshold for detection VA lean: DFRVAM = 0.03
- Threshold for detection BA rich: DFRBAF = -0.04
- Threshold for detection VA rich: DFRVAF = -0.05

Adaptation release:
- No. of sensor steps prior to the adaptation being switched on again: ASPUUKA = 4 (especially critical here is the no. of control periods after fuel cut-in).

Adaptation request:
- Maximum number of accelerations without adjustment of adaptation factor: ABAOVMX = 10
- Maximum number of decelerations without adjustment of adaptation factor: AVAOVMX = 10
- Return mechanism of adaptation factors enabled: CUKA[Bit(4)] = 1

Detection of adaptation range:
- Engine speed range: lower limit: NUKAU = 900 rpm
  upper limit: NUKAO = switch-off engine speed of the ÜK, (project-dependent, typically 4520 rpm)
- Load range: lower limit RLUKAU = 20 %
  upper limit RLUKAO = 80 %
- Engine temperature range: TMUKAU = switch-on threshold of the Lambda control. Typically >= 20°C
  TMUKAK > TMUKAU + approx. 20 °C, typically TMUKAK = 40 °C
  TMUKAW = 70 °C
  TMUKAK must be chosen with sufficient pos. clearance to the switch-on temperature TMUKAU since otherwise no adaptation of the cold factor fukak will take place !
  TMUKAW may not be chosen greater than the operating temperature of the hot engine, since otherwise no adaptation of the hot factor fukaw will take place !
  It must apply: TMUKAU + 20 °C < TMUKAK < TMUKAW < operating temperature hot engine
- Waiting time after end of start: TNSUUKA = 20 sec

Calculation of correction factor:

- Increment for fuka-adjustment: ZFUKA = 1.015 for stereo LC
  ZFUKA = 1.03 for mono LC
- Initialization values FUKABAKI = FUKABAWI = FUKAVAKI = FUKAVAWI = 1.0
- Min. and max. limits for correction factor: FUKABAKU = 0.9, FUKABAKO = 2.0
  FUKABAWU = 0.9, FUKABAWO = 2.0
  FUKAVAKU = 0.7, FUKAVAKO = 1.1
  FUKAVAWU = 0.7, FUKAVAWO = 1.1
- Temperature ranges: TMUKAK > TMUKAU + approx. 20 °C, typically TMUKAK = 40 °C
  TMUKAW = 70 °C
  TMUKAK must be chosen with sufficient pos. clearance to the switch-on temperature TMUKAU, since otherwise no adaptation of the cold factor fukak will take place !
  TMUKAW may not be chosen greater than the operating temperature of the hot engine, since otherwise no adaptation of the hot factor fukaw will take place !
  It must apply: TMUKAU + 20 °C < TMUKAK < TMUKAW < operating temperature hot engine

Procedure:
==========

1.) Determine the adaptation range ("Detection of adaptation range ").
The permissible adaptation range (n, rl, ps, tmot) should cover that range, in which a satisfactory application of the transient control was possible. Problematic ranges must be deactivated. Especially the ranges idling and full load need to be deactivated. Suggested data to be entered see above.

2.) By selecting the thresholds DFRBAF, DFRBAM, DFRVAF and DFRVAM the tolerance range for the detection of a mixture deviation is determined. The thresholds must be chosen such that with ideal conditions (no coking, good fuel quality) no correction of the ÜK takes place. With usual "rich derivation" the thresholds for the detection of enrichment DFRBAF and DFRVAF must therefore be chosen with a greater absolute value than the thresholds for the detection of enleanment DFRBAM and DFRVAM.

Switch-off of the function:
===========================

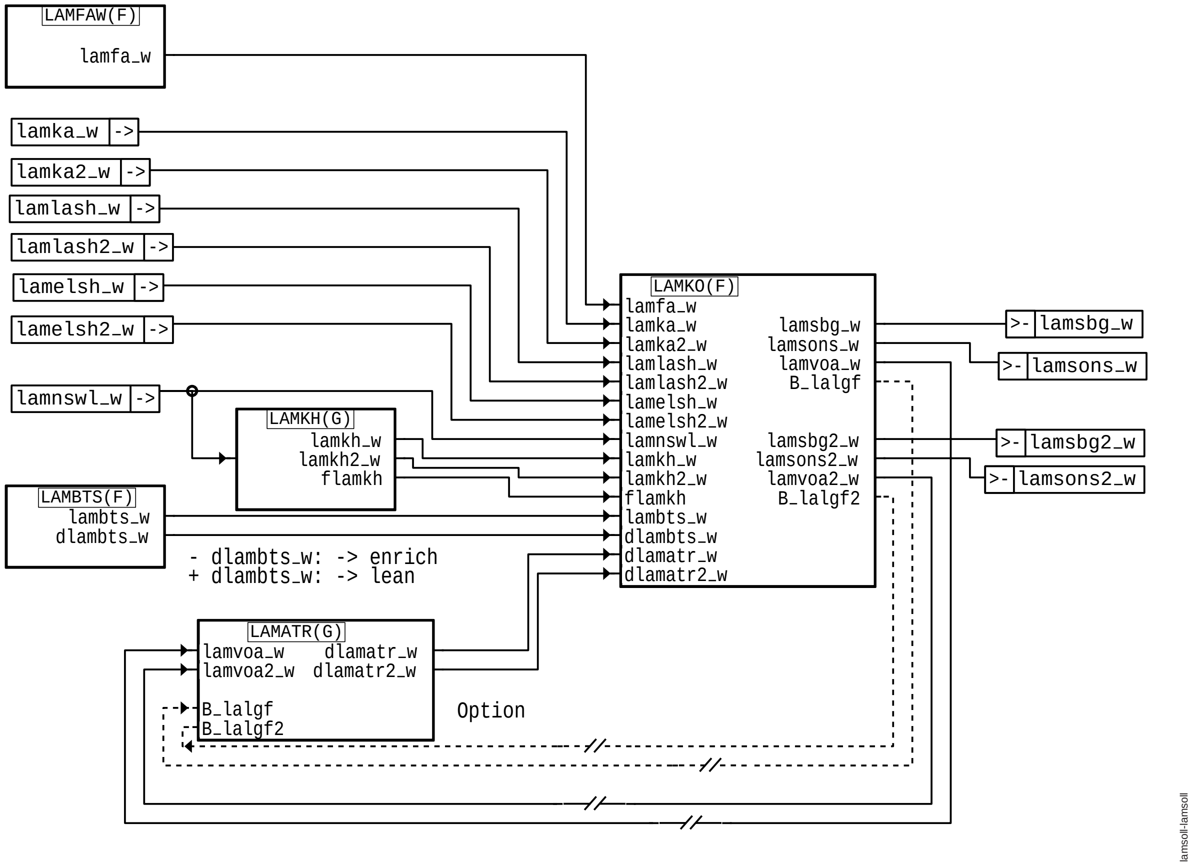
Prohibition of the ÜK adaptation: Set code word CUKA, bit 0 = 0. Adjustment of the desired values for fukaba, fukava:
Set FUKABAKI, FUKABAWI, FUKAVAKI, FUKAVAWI to desired values

Influenced functions:
=====================

%ESUK

LAMSOLL 1.30 Lambda setpoint input

FDEF LAMSOLL 1.30 Function definition



lamsoll-lamsoll

The overview LAMSOLL shows the formation of the nominal values for Lambda in the combustion chamber lamsbg_w, lamsbg2_w and Lambda at the sensor lamsons_w, lamsons2_w. A nominal Lambda limited lamsbg is calculated for the advance control of a combustion chamber Lambda from the different absolute Lambda requests lamfa_w, lamnswl_w, lambts_w lamkh_w by a minimum selection as well as the additive delta Lambda requests in the function Lambda coordination LAMKO. The limitation is set by the running limit of the engine for rich (lalgf) and lean (lalgm) mixtures in the respective running state.
The incorporation of the nominal lambda value lamsbg in the computation is shown in the function Mixture Control GK.
All interventions for Lambda which are not equal to Lambda 1.0 are realized by means of this intervention.

Lambda post start warm up lamnswl is active for the start and during engine warm up.
This is 1.0 at the end of the engine warm up cycle.

The nominal requirement for the Lambda control is lamsons = lamsbg. Regulation is to this nominal Lambda if continuous Lambda control is present, and even if Lambda is not equal to 1.0.

If secondary air is injected during the warm up, then the transition is made by the factor flamkh from lamnswl_w to lamkh_w. The return to lamnswl_w is made following termination of secondary air injection. During this time, lamsbg and lamsons are different because the Lambda sensor detects "thinner" exhaust emissions due to the secondary air.

For a large charge and high speeds, the engine must be run with a Lambda < 1.0 for thermal reasons. The intervention foreseen for this is lambts_w and is generated in the function LAMBTS (Lambda component protection). lambts_w is an absolute Lambda, i.e Lambda < 1.0 leads to enrichment.
An additive enrichment is realized by means of dlambts_w (Function LAMBTS) as a function of the change in the ignition-timing efficiency so as not to give any thermal damage from exhaust emission temperatures which are high and attributable to poor gasoline quality and knock combustion resulting from this.
This additive Lambda nominal shift is taken into the computation with correct observance of the sign, i.e. negative values lead to a more enriched mixture.
A further enrichment additive dlamatr_w,dlamatr2_w is also realized for a given exhaust emission temperature control ATR by the exhaust emission temperature controller.

By the function LAMFAW, an additional engine torque request can be realized by the driver by a Lambda < 1.0.

Switchover is made to the fixed value LASOAB at the respective bank which is independent of the nominal Lambda for Ev cutoff's by the function AEVAB.
A nominal Lambda > 1.0 is given by this fixed value to ensure with certainty that no overheating of the catalyzer occurs.

ABK LAMSOLL 1.30 Abbreviations

Variable	Source	Type	Description
B_LALGF	LAMSOLL	LOK	condition lambda limit ”rich” active
B_LALGF2	LAMSOLL	LOK	condition lambda limit ”rich” active
DLAMATR2_W	LAMSOLL	LOK	desired delta lambda of exhaust temperature control bank 2
DLAMATR_W	LAMSOLL	LOK	desired delta lambda of exhaust temperature control
DLAMBTS_W	LAMSOLL	LOK	delta lambda for component protection
FLAMKH	LAMSOLL	LOK	factor setting up lambda engine nominal at catalyst heating
LAMBTS_W	LAMSOLL	LOK	lambda for component protection
LAMELSH2_W	DLSH	EIN	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMELSH_W	DLSH	EIN	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMFA_W	LAMSOLL	LOK	required lambda, driver request
LAMKA2_W	LRKA	EIN	Lambdasetpoint catalyst clean out, bank2
LAMKA_W	LRKA	EIN	Lambdasetpoint catalyst o2 purge function
LAMKH2_W	LAMSOLL	LOK	Lambda engine nominal at catalyst heating, bank 2 (word)
LAMKH_W	LAMSOLL	LOK	Lambda engine nominal at catalyst heating (word)
LAMLASH2_W	DLSAHK	EIN	Desired Lambda for test oscillation check downstream catalyst bank2
LAMLASH_W	DLSAHK	EIN	Desired Lambda for test oscillation check downstream catalyst
LAMNSWL_W	ESVST	EIN	lambda engine nominal at afterstart and warming up
LAMSBG2_W	LAMSOLL	AUS	required lambda limitation Bank2
LAMSBG_W	LAMSOLL	AUS	Desired Lambda limitation (word)
LAMSONS2_W	LAMSOLL	AUS	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	AUS	required lambda referred to lambda sensor fitting location
LAMVOA2_W	LAMSOLL	LOK	lambda pilot control without additive parts
LAMVOA_W	LAMSOLL	LOK	lambda pilot control without additive parts

FW LAMSOLL 1.30 Fixed Values

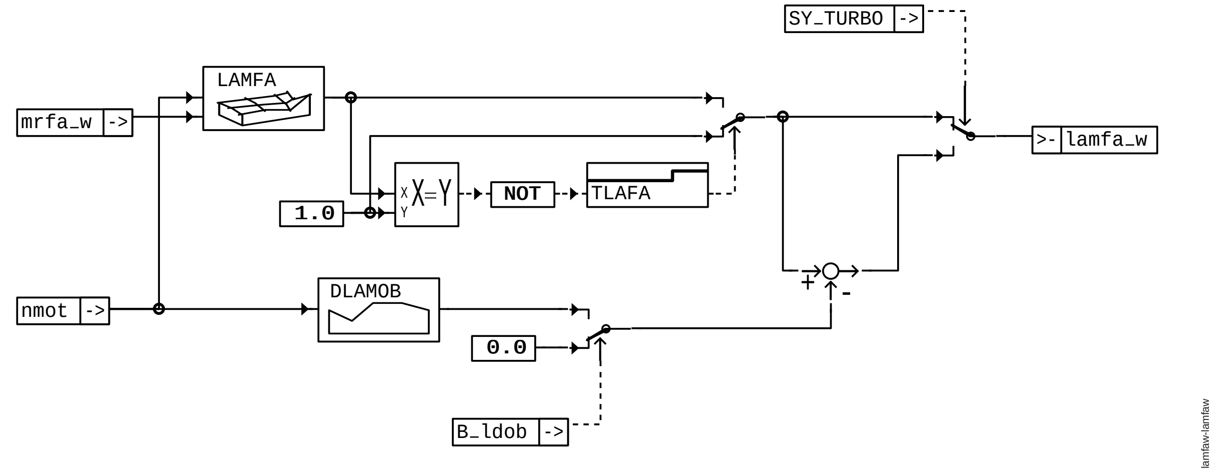
Parameter	Value	Description

FB LAMSOLL 1.30 Detailed description of function

APP LAMSOLL 1.30 Application hint

LAMFAW 2.20 Lambda vehicle-operator demand

FDEF LAMFAW 2.20 Function definition



lamfaw-lamfaw

ABK LAMFAW 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DLAMOB	NMOT		KL	delta lamda at overboost
LAMFA	NMOT	MRFA_W	KF	Lamda driver demand
TLAFA			FW	delay time for activation of lambda demand by driver

Variable	Source	Type	Description
B_LDOB		EIN	Condition overboost active
LAMFA_W	LAMFAW	AUS	required lambda, driver request
MRFA_W	MDFAW	EIN	relative driver request torque from cruise control and pedal, =0 in limp-home
NMOT	SWADAP	EIN	engine speed
SY_TURBO	PROKON	EIN	system constant for turbocharged engine

FW LAMFAW 2.20 Fixed Values

Parameter	Value	Description
TLAFA		delay time for activation of lambda demand by driver

FB LAMFAW 2.20 Detailed description of function

```
The function LAMFAW makes an enrichment if the driver wants to drive with max torque. The enrichment is made bei
changing the Lambda ( lamfaw_w ) and replace the old function ' enrichment at full load '.
A delay of the begin of enrichment is applicable with TLAFA.
During overboost an additional enrichment is possible by the characteristic DLAMOB.
```

APP LAMFAW 2.20 Application hint

```
TLAFA > 0 --> delay of the activation for enrichment
TLAFA = 0  no delay  of the activation for enrichment

MAP LAMFA:

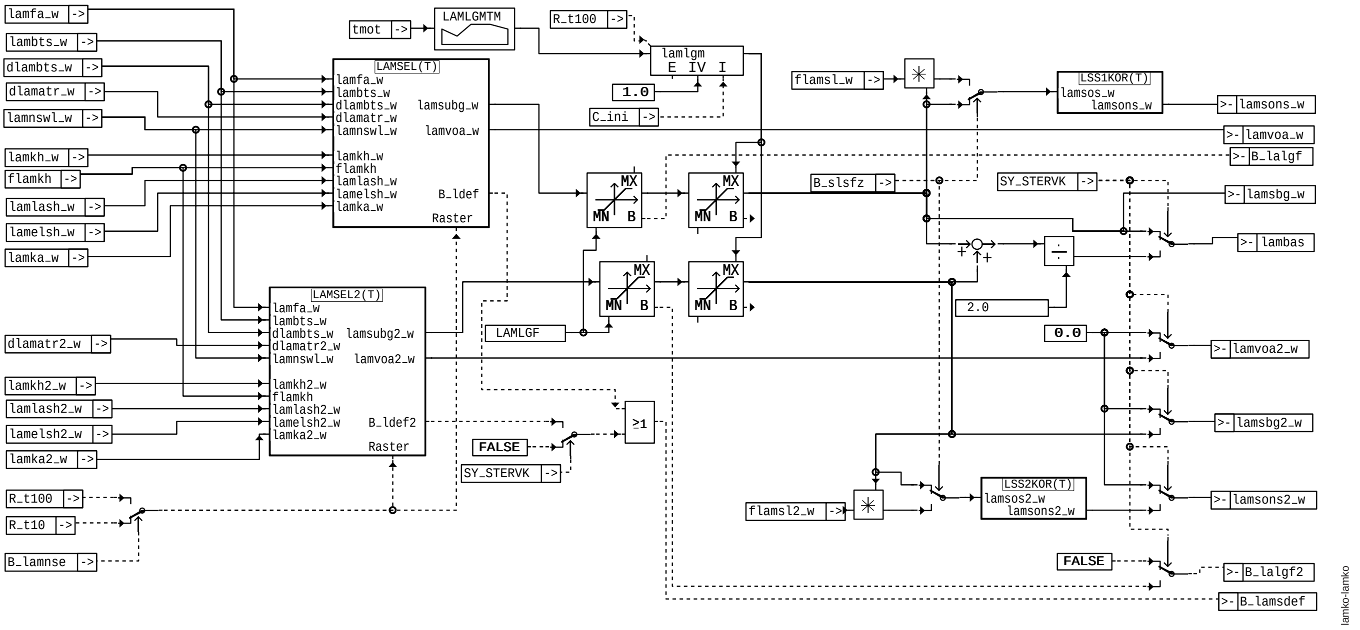
         nmot:    1000, 2000, 3000, 4000, 5000, 6000 1/min
        mrfa_w :   70, 80, 90, 100, 110, 120 %
Values of MAP            1.0                          --> disable of enrichment;  values < 1.0 --> enrichment aktiv


With line DLAMOB an additional enrichment may be realized at turbo engines during overboost.

Line DLAMOB:
         nmot:  1500, 2500, 3500, 4500, 5500, 6000
        Values  0                                     0: disable of enrichment; e.q. 0.1 enrichment of 10 %
```

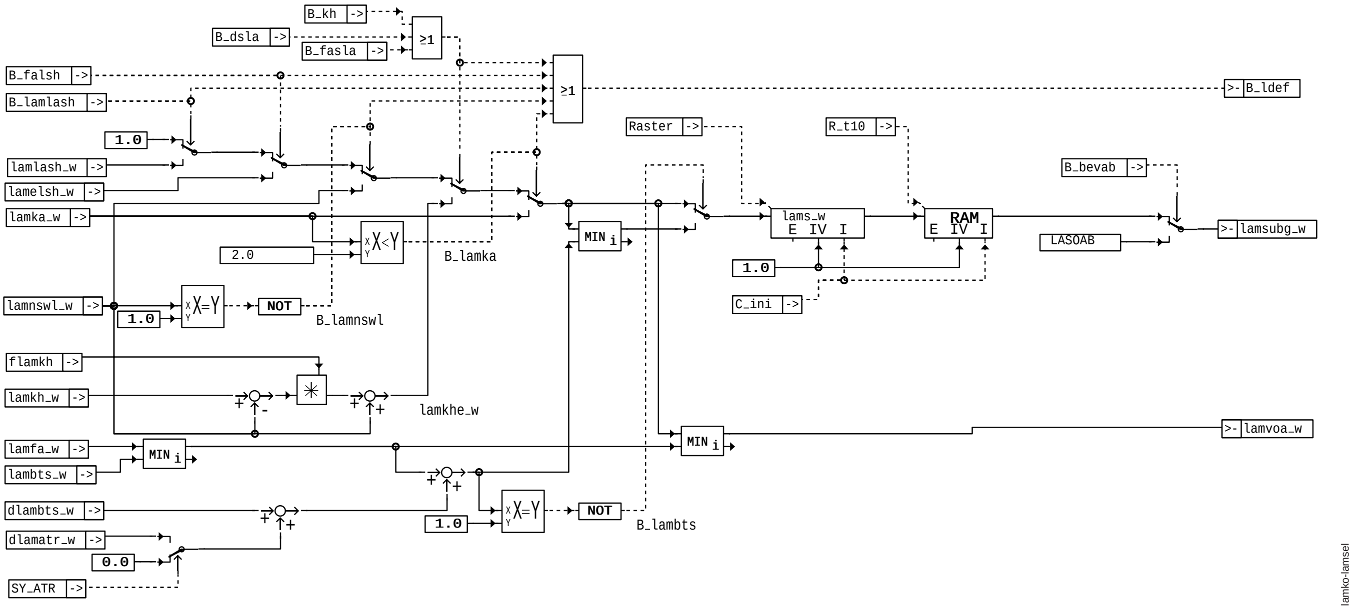
LAMKO 3.120 Lambda coordination

FDEF LAMKO 3.120 Function definition



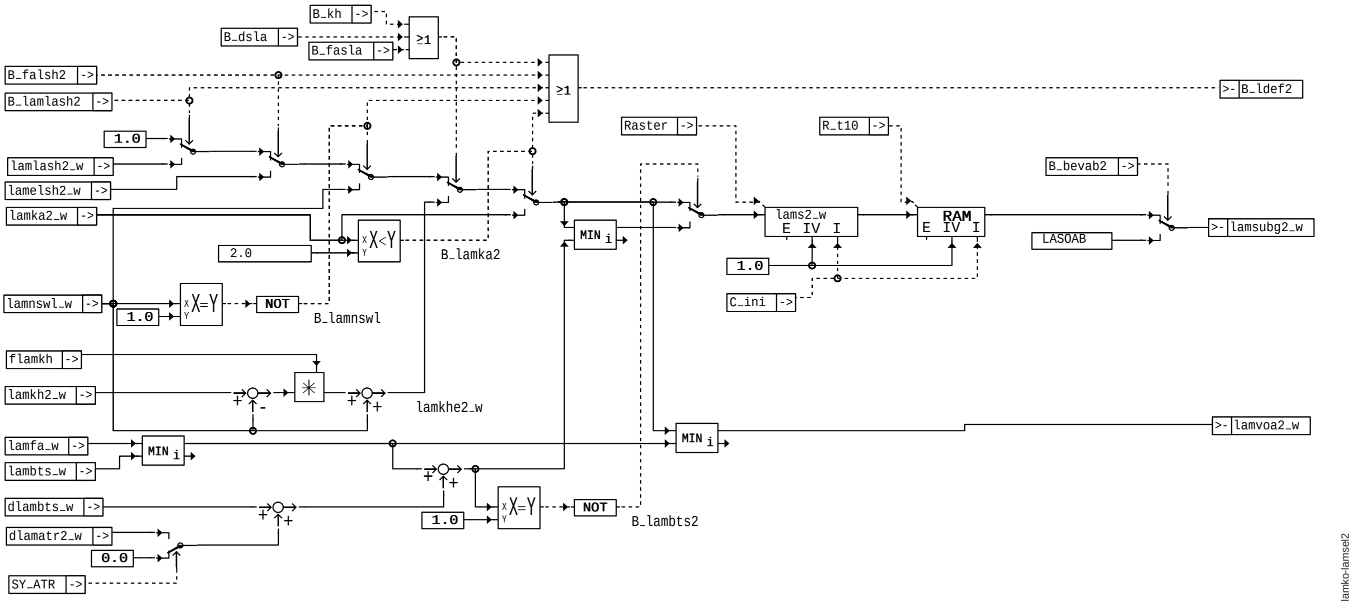
lamko-lamko

`subfunction selection of lambda at bank1: LAMSEL`



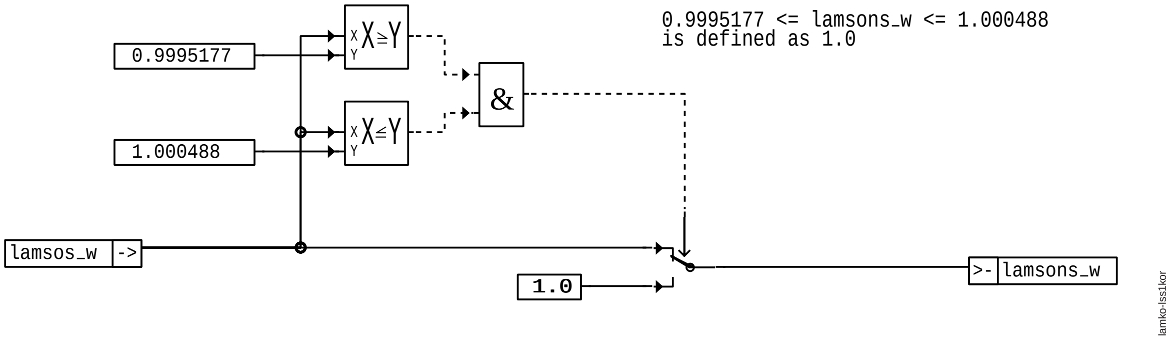
lamko-lamsel

`subfunction selection of lambda at bank2: LAMSEL2`



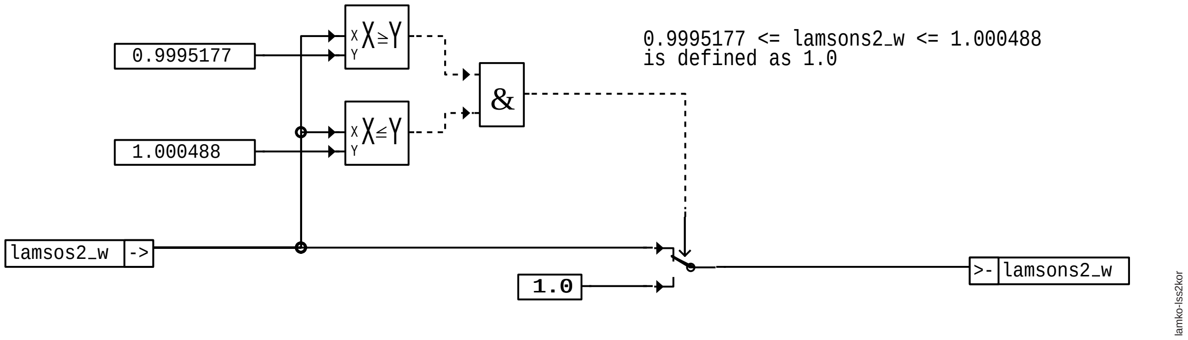
lamko-lamsel2

`subfunction correction of nominal Lambda for lambdasensor bank1: LSS1KOR`



lamko-lss1kor

`subfunction correction of nominal Lambda for lambdasensor bank2: LSS2KOR`



lamko-lss2kor

ABK LAMKO 3.120 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
LAMLGF			FW	lambda limit ”rich”
LAMLGMTM	TMOT		KL	lambda limit ”lean”
LASOAB			FW	target lambda value for bank shutdown

Variable	Source	Type	Description
B_BEVAB	BGEVAB	EIN	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	BGEVAB	EIN	condition: Inj. valve cut off on Bank2
B_DSLA		EIN	adaption phase: calculation of secondary air mass

Variable	Source	Type	Description
B_FALSH		EIN	condition function request downstream oxygen sensor diagnosis
B_FALSH2		EIN	condition function request downstream oxygen sensor diagnosis bank2
B_FASLA		EIN	Condition: external request of SAI system aktiv
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_LALGF	LAMKO	AUS	condition lambda limit ”rich” active
B_LALGF2	LAMKO	AUS	condition lambda limit ”rich” active
B_LAMBTS	LAMKO	LOK	lambda for component protection is active
B_LAMBTS2	LAMKO	LOK	lambda for component protection is active (bank 2)
B_LAMKA	LAMKO	LOK	lambda for Katalyst oxygen purge is active
B_LAMKA2	LAMKO	LOK	lambda for Katalyst oxygen purge is active
B_LAMLASH		EIN	Condition for enleanment in %LAMKO
B_LAMLASH2		EIN	Condition for enleanment in %LAMKO bank2
B_LAMNSE		EIN	condition end of lamns_w calculation
B_LAMNSWL	LAMKO	LOK	lambda engine nominal at post start and warming up active
B_LAMSDEF	LAMKO	AUS	Condition: defined desired air/fuel ratio value
B_LDEF	LAMKO	LOK	Condition: defined desired value of the lambda (bank1)
B_LDEF2	LAMKO	LOK	Condition: defined desired value of the lambda (bank2)
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
C_INI	SWADAP	EIN	ECU-condition for intialisation
DLAMATR2_W		EIN	desired delta lambda of exhaust temperature control bank 2
DLAMATR_W		EIN	desired delta lambda of exhaust temperature control
DLAMBTS_W	LAMBTS	EIN	delta lambda for component protection
FLAMKH	BBKHZ	EIN	factor setting up lambda engine nominal at catalyst heating
FLAMSL2_W		EIN	Factor lambda change by secondary air, bank 2
FLAMSL_W		EIN	Factor lambda change by secondary air
LAMBAS	LAMKO	AUS	basic Lambda
LAMBTS_W	LAMBTS	EIN	lambda for component protection
LAMELSH2_W	DLSH	EIN	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMELSH_W	DLSH	EIN	desired lambda for electrical sensor diagnosis behind catalyst (short trip)
LAMFA_W	LAMFAW	EIN	required lambda, driver request
LAMKA2_W	LRKA	EIN	Lambdasetpoint catalyst clean out, bank2
LAMKA_W	LRKA	EIN	Lambdasetpoint catalyst o2 purge function
LAMKH2_W	LAKH	EIN	Lambda engine nominal at catalyst heating, bank 2 (word)
LAMKHE2_W	LAMKO	LOK	lambda engine nominal at catalyst heating, actual, bank 2
LAMKHE_W	LAMKO	LOK	lambda engine nominal at catalyst heating, actual
LAMKH_W	MSF	EIN	Lambda engine nominal at catalyst heating (word)
LAMLASH2_W	DLSAHK	EIN	Desired Lambda for test oscillation check downstream catalyst bank2
LAMLASH_W	DLSAHK	EIN	Desired Lambda for test oscillation check downstream catalyst
LAMLGM	LAMKO	LOK	lambda limit ”lean”
LAMNSWL_W	ESVST	EIN	lambda engine nominal at afterstart and warming up
LAMS2_W	LAMKO	LOK	Lambda nominal (word)
LAMSBG2_W	LAMKO	AUS	required lambda limitation Bank2
LAMSBG_W	LAMKO	AUS	Desired Lambda limitation (word)
LAMSONS2_W	LAMKO	AUS	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMKO	AUS	required lambda referred to lambda sensor fitting location
LAMSOS2_W	LAMKO	LOK	required lambda referred to lambda sensor fitting location bank2
LAMSOS_W	LAMKO	LOK	required lambda referred to lambda sensor fitting location
LAMSUBG2_W	LAMKO	LOK	Lambda nominal unlimited (word)
LAMSUBG_W	LAMKO	LOK	Lambda nominal unlimited (word)
LAMS_W	LAMKO	LOK	Lambda nominal (word)
LAMVOA2_W	LAMKO	AUS	lambda pilot control without additive parts
LAMVOA_W	LAMKO	AUS	lambda pilot control without additive parts
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_ATR	PROKON	EIN	system constant exhaust-gas temperatur controller built in
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TMOT	SWADAP	EIN	Engine temperature

FW LAMKO 3.120 Fixed Values

Parameter	Value	Description
LAMLGF		lambda limit ”rich”
LASOAB		target lambda value for bank shutdown

FB LAMKO 3.120 Detailed description of function

Lambda = 1.0 is set in the combustion chamber by the precontrol of the injection ESVST.

The function Lambda coordination LAMKO defines that operating point of the engine at which the engine is run at combustion chamber Lambda # 1.0.

The position of the switches is a dimension for the selection priority of lambda.

The priorities of lambdaselection are catalyst protection, component protection, catalyst heating by secondary air.

Lambda for catalyst protection is LASOAB.

Component protection for manifold, exhaust valves, supercharger, catalyzer is realized by means of the two inputs lambts_w and dlambts_w.

By this, lambts_w is an intervention for an absolute Lambda, to which other protection interventions can be added.

lambts_w is thereby influenced by the protection for engine and exhaust manifold (full-load enrichment for engine protection), turbine protection for supercharger.

dlambts_w is included as an additive component in the computation for knock-protection injection, catalyst overheating prevention.

For projects with exhaust emission temperature control by exhaust emission sensors, the control correction is included in the computation by the additive component dlamatr_w.

From post-start until end of warm up of the engine lamnswl_w is active, if there is no katalyst heating.

The transition is made at the beginning of catalyzer heating from Lambda post-start/warm up (lamnswl_w) by means of the factor flakh from %LAKH to Lambda for catalyzer heating lamnswl_w. Return to lamnswl_w is made by means of flakh for an abort of the catalyzer heating. For systems with secondary air injection (B_slsfz), the nominal lambda given at the Lambda sensor lamsons_w is calculated from the Lambda engine (lamsbg_w) by dilution of the secondary air by multiplication with the auxiliary air dilution factor flamsl_w.

The Lambda requirements is given by the fixed value LASOB for injection valve cut off (B_evab,Bevab2 = true). It can realized by this, that there is no excess HC occuring in the corresponding exhaust emission train for cylinders which have been cut off if the entire bank is operated at "lean", e.g. with LASOAB = 1.05.

The average value from both banks is provided as the basic Lambda lambas for calculation of the engine torque.

If there is no further need for higher Lambda dynamics outside of the warm up, catalyzer heating range (B_lamnswle = true), then a switchover is made from the 10 ms to the 100 ms computation frame.

The lambda set by the driver request, engine protection or catalyzer heating is limited by both of the Lambda thresholds for the engine-running limit "rich" (lalgf_w) and "lean" (lalgm_w).

APP LAMKO 3.120 Application hint

Initialisation Parameters for Applikation:
LASOAB = 1.05
LAMLGF = 0.77
LAMLGMTM: tmot interpolation points are the same one as the tmot points in function ESWL.
values of LAMLGMTM = 1.2

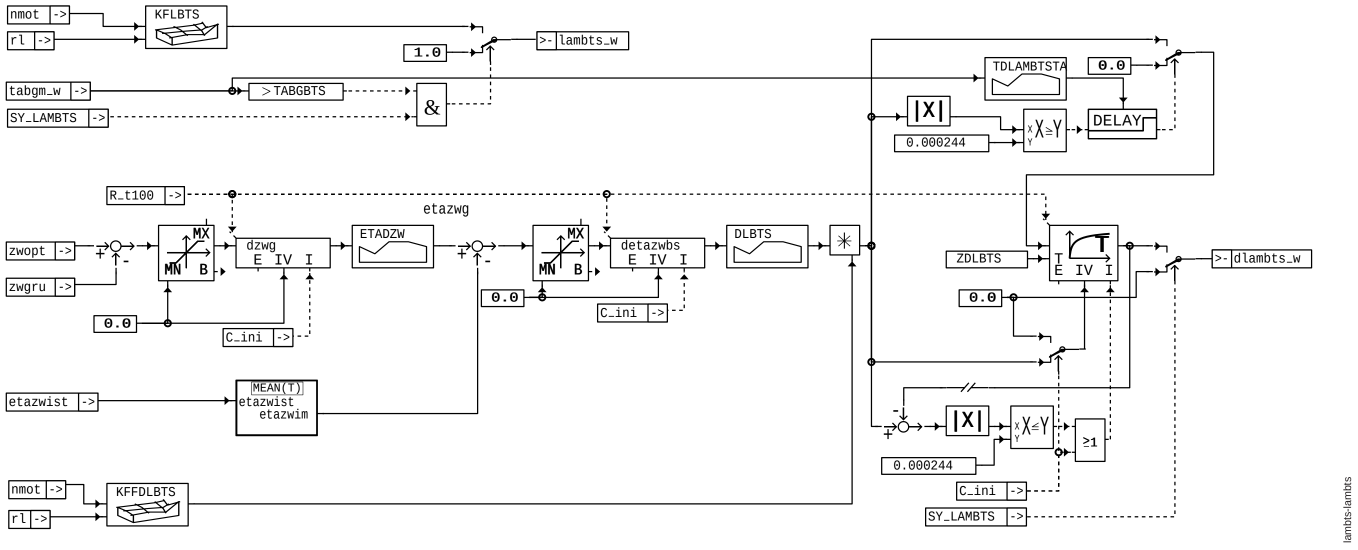
The inputs lamka_w , lamka2_w are inactive if its value is >= 2.0. The Function katalyst purge set this value to 8.0 if there is no activity.

Outside warm-up and catalyst heating, at reduced lambda dynamic requirement (B_lamnswle = true), the calculation timing is switched from 10 ms to 100 ms.

LAMBTS 1.60 Lambda component protection

FDEF LAMBTS 1.60 Function definition

LAMBTS: Overview
=================



lambts-lambts

ABK LAMBTS 1.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DLBTS	DETAZWBS		KL	Delta nominal Lambda for component protection
ETADZW	DZWG		KL	ignition efficiency depending on delta ignition angle
KFFDLBTS	NMOT	RL	KF	Factor delta nominal Lambda for component protection
KFLBTS	NMOT	RL	KF	Nominal Lambda for component protection
TABGBTS			FW	Exhaust temperature threshold for component protection
TDLAMBTSTA	TABGM_W		KL	delay time to enable nominal Lambda component protection
ZDLBTS			FW	Time constant delta lambda component protection

Variable	Source	Type	Description
C_INI	SWADAP	EIN	ECU-condition for intialisation
DETAZWBS	LAMBTS	LOK	Delta ignition angle efficiency for component protection
DLAMBTS_W	LAMBTS	AUS	delta lambda for component protection
DZWG	LAMBTS	LOK	Delta ignition timing, basis ZW to optimum ZW
ETAZWG	LAMBTS	LOK	Efficiency at basic ignition angle
ETAZWIM	LAMBTS	LOK	Mean efficiency at actual ignition angle
ETAZWIST	MDIST	EIN	actual ignition angle effectiveness
LAMBTS_W	LAMBTS	AUS	lambda for component protection
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_LAMBTS	PROKON	EIN	system constant component protection present
TABGM_W	ATM	EIN	Exhaust gas temperature in front of the catalyzer from model (Word)
ZWGRU	ZWGRU	EIN	basic ignition angle
ZWOPT	MSF	EIN	optimal ignition angle

FW LAMBTS 1.60 Fixed Values

Parameter	Value	Description
TABGBTS		Exhaust temperature threshold for component protection
ZDLBTS		Time constant delta lambda component protection

FB LAMBTS 1.60 Detailed description of function

```
Task:
========
Protection of components (manifold, supercharger etc.) by mixture enrichment.


Principle:
========
An exhaust emission temperature which is too high can be lowered by an enrichment of the air-fuel mixture.  By this enrichment,
more fuel reaches the cylinder than would be required for a stoichiometric combustion of the fuel. The fuel not burned
vaporizes at the cylinder walls and thereby cools these down whereby the exhaust emission temperature also drops.


LAMBTS: Overview
=================
By means of the mapping KFLBTS, a lambda nominal shift towards rich can be performed as a function of the speed nmot and the
cylinder fill rl.
The enrichment is active only, if the modelized exhaust temperature exceeds the applicable threshold TABGBTS.

An increase in the exhaust emission temperature can occur for a deterioration in the ignition-timing efficiency. This increase can
be counteracted by an enrichment of the mixture.
In addition to this, the ignition-timing efficiency etazwg is calculated for the basic timing zwgru and the ignition-timing
efficiency etazwim for the averaged actual ignition timing.
The difference between etazwg and etazwim gives the deterioration in the efficiency detazwbs. Depending on detazwbs, a additive
enrichment can now be performed by means of the characteristic DLBTS. The enrichment can be reduced or shut off in desired regions
by the mapping KFFDLBTS (nmot, rl).  The efficiency of the enrichment can be filtered by the PT1-Block.

MEAN: Calculation mean value of efficiency at actual ignition angle
===================================================================
Here the mean value of the ignition angle efficiencies (10ms-frame) is calculated over one 100ms-frame.
```

APP LAMBTS 1.60 Application hint

```
Prerequisites:
================
 * Application of basic ignition angle (see %ZWGRU)
 * Stationary lambda-application
 * Application of exhaust gas temperature model (%ATM)


Pre-assignment of the parameters:
=================================
Shutoff of enrichment by nominal lambda value: KFLBTS = 1.0 (all nmot, all rl)
Critical exhaust temperature: TABGBTS = 900 °C
Shutoff of enrichment by delta nominal lambda value: DLBTS = 0.0 (all detazwbs)
Deactivate low pass for delta enrichment: ZDLBTS = 0.2 s
Neutralize weighting factor for delta nominal lambda value: KFFDLBTS = 1.0 (all nmot, all rl)


Method of proceeding:
=====================
1.) Application of general enrichment
-------------------------------------
First set low threshold for enrichment: TABGBTS = -50 grad C. Measure modelized exhaust temperature tabgm for later application of
TABGBTS at every operation point of the following maps.
The Application of the map KFLBTS must be done at basic ignition angle. For this use the following data:
 * Neutralize warm up ignition angle shift: KFZWWLNM = KFZWWLTM = 0
 * Switch off knock control: TMKR > tmot
 * Disable shift of ignition angle by application constant: ZWAPPL = 0
 * Set condition ignition angle application without torque control (B_zwappl): CWMDAPP[Bit0] = 1

At application of the map KFLBTS the exhaust gas temperature must be measured at every operation point and must be limited by
enrichment (KFLBTS values < 1) to an uncritical value.

The exhaust temperature threshold for enrichment TABGBTS must be set to the value at which an enrichment was neccessary.

2.) Application of enrichment at shift of ignition angle
--------------------------------------------------------
At application of the time constant ZDLBTS steps of ignition angle must be done without delta-enrichment (with ZWAPPL):
 * Make a step of ignition angle and measure the exhaust gas temperature
 * Verify time constant and write it in ZDLBTS

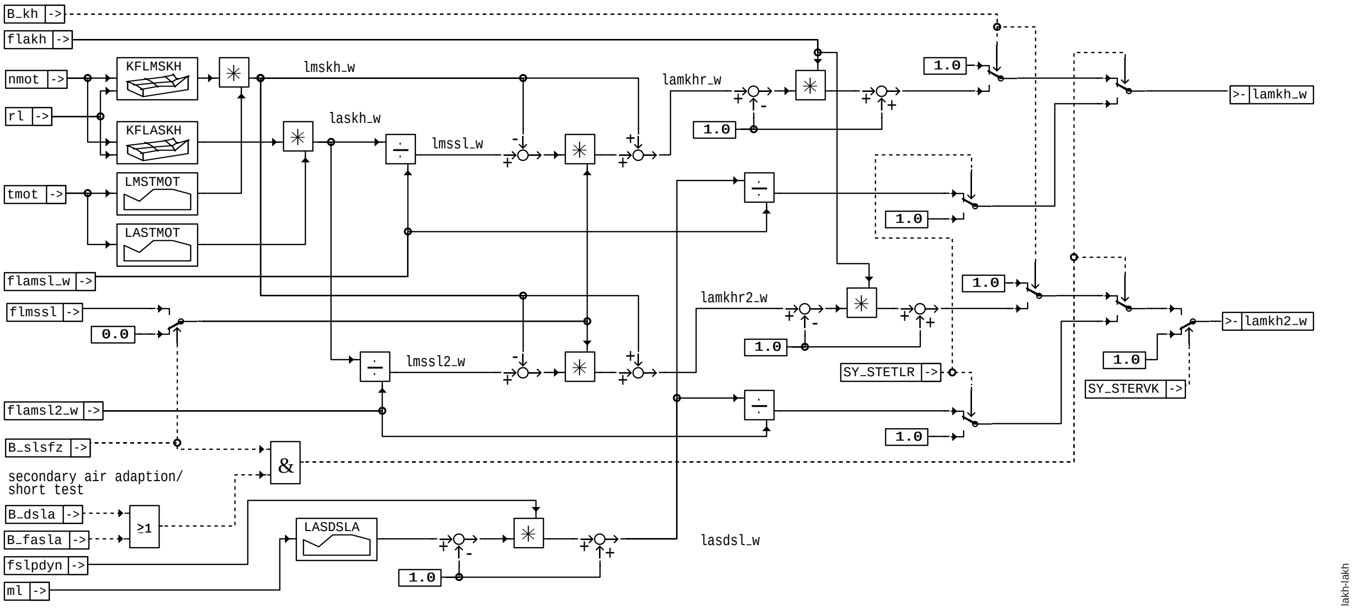
Application of enrichment characteristic DLBTS:
 * Operate engine at the operation point where the highest generel enrichment was neccessary
 * Adjust ignition angle by ZWAPPL in direction "late" and enrich by DLBTS, if the exhaust gas temperature is too high
The characteristic DLBTS should stay constant for further application.

The map KFFDLBTS must be applicated at maximum ignition angle shift in direction late (by ZWAPPL):
 * Operate engine at every operation point of KFFDLBTS and measure exhaust gas temperature. Reduce or swith off enrichment if
   neccessary.

Functions influenced:
=======================
 %LAMKO by lambts_w, dlambts_w
```

LAKH 2.30 Lambda coordination for catalyst heating

FDEF LAKH 2.30 Function definition



lakh-lakh

ABK LAKH 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFLASKH	NMOT	RL	KF	Performance characteristics lambda exhaust nominal at catalyst heating
KFLMSKH	NMOT	RL	KF	Performance characteristics lambda engine nominal at catalyst heating
LASDSLA	ML		KL	Lambda exhaust nominal at secondary air adaption/short test
LASTMOT	TMOT		KL	tmot-correction of lambda exhaust nominal
LMSTMOT	TMOT		KL	tmot-correction of lambda engine nominal

Variable	Source	Type	Description
B_DSLA		EIN	adaption phase: calculation of secondary air mass
B_FASLA		EIN	Condition: external request of SAI system aktiv
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
FLAKH	BBKHZ	EIN	Factor control lambda at catalyst heating
FLAMSL2_W		EIN	Factor lambda change by secondary air, bank 2
FLAMSL_W		EIN	Factor lambda change by secondary air
FLMSSL		EIN	Factor lambda engine by secondary air
FSLPDYN		EIN	Factor dynamic behavior secondary air pump
LAMKH2_W	LAKH	AUS	Lambda engine nominal at catalyst heating, bank 2 (word)
LAMKHR2_W	LAKH	LOK	Lambda engine result at catalyst heating, bank 2 (word)
LAMKHR_W	LAKH	LOK	Lambda engine result at catalyst heating (word)
LAMKH_W	LAKH	AUS	Lambda engine nominal at catalyst heating (word)
LASDSL_W	LAKH	LOK	Lambda exhaust nominal at secondary air diagnosis
LASKH_W	LAKH	LOK	Lambda exhaust nominal at catalyst heating (word)
LMSKH_W	LAKH	LOK	Lambda engine nominal at catalyst heating (word)
LMSSL2_W	LAKH	LOK	Lambda engine nominal caused by secondary air, bank 2
LMSSL_W	LAKH	LOK	Lambda engine nominal caused by secondary air (word)
ML	SWADAP	EIN	air mass flow
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
TMOT	SWADAP	EIN	Engine temperature

FW LAKH 2.30 Fixed Values

Parameter	Value	Description

FB LAKH 2.30 Detailed description of function

For exhaust gas reasons the engine is operated after cold start in such a way that an accelerated catalyst warm-up takes place. The quantity of heat necessary for this can be mainly supplied by thermal exhaust gas energy (exhaust gas temperature, exhaust gas mass flow), during which the engine must be operated as lean as possible, in order to minimize the raw emissions ("lean warm-up"). A further possible catalyst heating source uses thermal exhaust gas energy ("rich warm-up"). For this, the engine is operated with an excess of fuel. In combination with secondary air the rich exhaust gas reacts inside the manifold or inside the catalyst. The heat produced by this oxidation process is used for the heating of the catalyst.

An excess of air in the exhaust gas is necessary for both catalyst heating concepts.

For concepts with lean warm-up the lean Lambda engine set point lmskh (due to flmssl = 0) from the characteristic map KFLMSKH is preassigned and made available as Lambda set point lamkh. The "control" is performed by the evaluation to Lambda = 1 by flakh from %BBKHZ. In the Lambda coordination %LAMKO the transition from lamnswl (Lambda after-start warm-up) to lamkh and the limitation to the actual Lambda combustion chamber lamsbg is performed by the evaluation factor flamkh from %BBKHZ. In addition the Lambda set point lamsons for the Lambda control is calculated.

For concepts with secondary air injection (B_slsfz = 1, code word CWKONABG from %PROKON) the setpoint for Lambda engine is determined for flmssl = 0.9961 from the setpoint for Lambda exhaust gas laskh by the relation of lmssl = laskh / flamsl with the secondary air dilution factor flamsl = (1 + msl / ml) from %SLS.

By the weight factor flmssl from the secondary air control %SLS the resulting Lambda setpoint lamkhr is then obtained from:

lamkhr = lmskh + flmssl * (lmssl - lmskh).

Here flmssl = 0 - in spite of secondary air - complies to the setpoint input for Lambda engine of a concept with lean warm-up. The limit flmssl = 0.9961 then complies to the setpoint default selection with thermal reaction in combination with secondary air. The default selection of fmssl takes place in the secondary air control %SLS.

The setpoint for Lambda catalyst heating lamkhr resulting from this, also evaluated by flakh, is controlled by flamkh in %LAMKO and is made available as actual Lambda combustion chamber lamsbg. In %LAMKO the correspondent Lambda setpoint lamsons for the Lambda control is calculated by:

lamsons = lamsbg * flamsl.

Both catalyst heating concepts ("lean warm-up", "secondary air injection") have in common, that the starting procedure must be performed with minimum raw emissions and minimum exhaust gas mass flow, that means idling of the engine must be adjusted such that maximum heat is produced in the exhaust pipe, whilst the starting procedure must take place at the lean warm-up limit with an ignition angle of optimum efficiency. As a result, the Lambda in the engine is defined by the lean limit "lalgm" from %ESWL, especially at start of driving. For concepts with a large excess of secondary air during idling Lambda engine is additionally determined by the rich limit lalgf from %WL. For this also see %LAMKO.

Secondary air adaptation/quick test:
For the secondary air diagnosis (%DLSLR or %DSLSLRS) it is possible to again activate the secondary air by B_dsla or also by the quick test request B_fasla. The Lambda input selection is performed dependent on the secondary air diagnosis, based on the used Lambda control:
Two-state controller -> secondary air diagnosis DSLSLR:
Control to Lambda exhaust gas = 1 with input selection of the necessary engine enrichment due to the secondary air dilution factor flamsl_w.
At engine operation points, at which a too rich engine operation would be reached due to the little intake air mass, the Lambda exhaust gas input selection lasdsl_w can be corrected in the direction lean depending on the intake air mass. An adaptation of the secondary air mass then, however, is no longer possible due to lamsons_w, since the "measuring window" has been left. (Regarding this see %DSLSLR.)

Continuous Lambda control -> secondary air diagnosis DSLSLRS:
Input selection of Lambda engine = 1 and calculation of the desired Lambda exhaust gas (lamsons_w) from the secondary air dilution factor. In case of quicktrip request (B_fasla) the diagnosis is performed in combination with active control analogous to the secondary air diagnosis during catalyst heating. During the adaptation phase (B_dsla) the secondary air diagnosis in comparison is performed by measuring and evaluating the Lambda sensor voltage lamsoni_w at controlled operation. (Regarding this see %DSLSLRS.)

APP LAKH 2.30 Application hint

Precondition: Application mixture check (%GK), injection pilot control (%ESVST), secondary air control (%SLS), Application %WL in combination with catalyst heating.

Default selection:
By the bit B_slsfz from CWKONABG the catalyst heating concept without / with secondary air system becomes compatible:

B_slsfz = | 0: no secondary air system, lean catalyst heating operation of the engine
| 1: with secondary air system, rich catalyst heating operation of the engine
Further possible secondary air variations are described in %SLS.

Lean warm-up: Default selection KFLMSKH with 1,05, transition to 1,0 resp. richer dependent on load (rl) when starting from rest and adjustment to the lean performance limit (lalgm) from %ESWL, as described in %LAMKO.

Rich warm-up : Default selection KFLASKH with 1,1 to 1,2, transition to > 1,3 when starting from rest and adjustment to the lean performance limit (lalgm) from %ESWL, as described in %LAMKO. Also see %BBKHZ.

or Lambda engine default selection by code word CWSLS in %SLS analogues to lean warm-up.

The base point distribution of KFLMSKH, KFLASKH is to be chosen such that the "catalyst heating idle range" is sufficiently covered with regard to engine speed and load at idle and that a steady transition by interpolation to partial load can be performed.

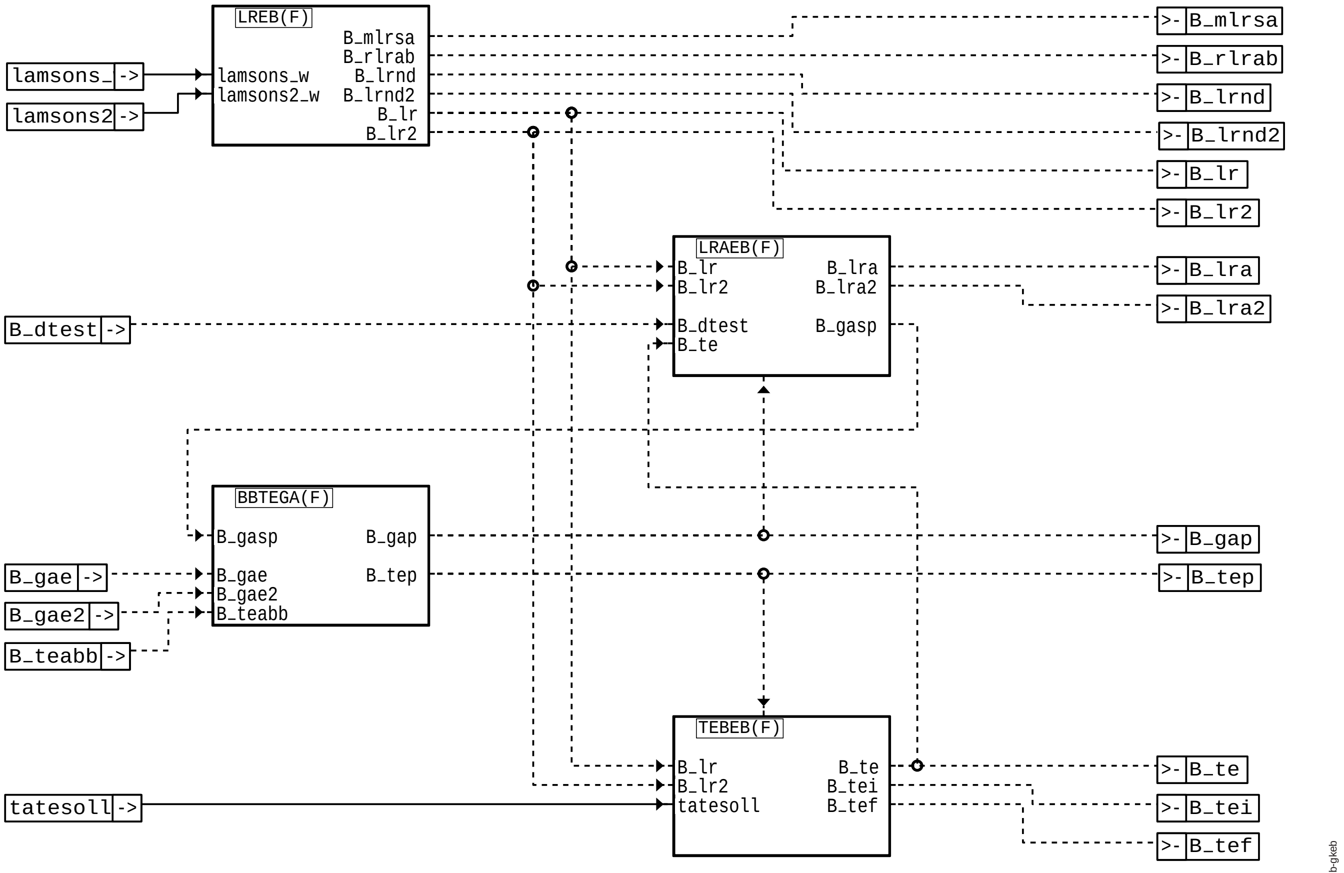
Default selection in %ESWL such that "lalgm" does not limit lalgf during catalyst heating.

Switching off:
No catalyst heating with MLSUS = 0 in %BBKHZ
No Lambda action during lean warm-up: KFLMSKH = 1
with secondary air: MSLUB = 0 in %SLS and KFLASKH = 1.0

GKEB 3.0 Operating condition mixture control overview

FDEF GKEB 3.0 Function definition

Mixture Control, Adaptation - Activation Conditions:



gkeb-gkeb

ABK GKEB 3.0 Abbreviations

Variable	Source	Type	Description
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_GAE	DKVS	EIN	condition for adaptive Lambda pilot control successful
B_GAE2		EIN	condition for adaptive lambda pilot control 2 successful
B_GAP	GKEB	AUS	condition mixture adaptation phase active
B_GASP	GKEB	LOK	condition for basic mixture adaptation disabled
B_LR	GKEB	AUS	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	GKEB	AUS	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	GKEB	AUS	condition for basic mixture adaptation enabled
B_LRA2	GKEB	AUS	condition for basic mixture adaption 2 enabled
B_LRND	GKEB	AUS	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	GKEB	AUS	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_MLRSA	GKEB	AUS	LRSEB: Air mass based switch off Lambda Control during and after fuel cut off
B_RLRAB	GKEB	AUS	condition LR off due to high load
B_TE	GKEB	AUS	Condition canister purge active
B_TEABB	TEB	EIN	Condition purge canister function ready to finish
B_TEF	GKEB	AUS	Condition canister purge function principally released
B_TEI	GKEB	AUS	Internal condition: canister purge function active
B_TEP	GKEB	AUS	Condition canister purge phase active
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
TATESOLL	GKRA	EIN	desired duty cycle of the PCV

FW GKEB 3.0 Fixed Values

Parameter	Value	Description

FB GKEB 3.0 Detailed description of function

Functional group, mixture control, switch-on conditions (%GKEB)

Only for 2-point lambda control !!!!!!!

This functional group includes the following functions:

%LREB - Switch-on conditions for 2-point lambda control
%LRAEB - Switch-on conditions for mixture adaptation
%TEBEB - Switch-on conditions for the loading-dependent tank venting
%BBTEGA - Phase control tank venting / mixture adaptation
(The term "phase control" designates a device which actuates the change between a mixture adaptation phase and a tank venting phase)

Remark: the switch-on conditions for the control after the catalyzer are described in the function "Control after the catalyzer" and not in %LREB.

%LREB - Switch-on conditions for 2-point lambda control

- A number of conditions must be fulfilled for activation of the lambda control.
- The lambda control must remain disabled (B_lr = FALSE) in particular for OBDII faults which have a strong influence on the mixture at the probe
- Specific conditions must also be fulfilled however. The most important of these are, e.g.
  - B_sbbvk (readiness for operation by the probe in front of the catalyzer)
  - B_evloc (all EV’s triggered)

%LRAEB - Switch-on conditions for mixture adaptation

- The mixture adaptation has specific switch-on conditions. A number of OBDII faults thereby disable the mixture adaptation.
- A prerequisite for activation of the mixture adaptation is B_lr
- The mixture adaptation is furthermore only then activated when there is no tank venting active (B_gap = 1)

%TEBEB - Switch-on conditions for the loading-dependent tank venting

- The tank venting valve is opened during a tank venting phase (B_tep)
- Furthermore, certain conditions must be fulfilled in order that the tank venting can be activated. (e.g. engine temp. > threshold). The TEV can only be opened if the bit B_tef (condition for release of tank venting) is TRUE.
- Furthermore, it is differentiated between controlled tank venting (e.g. the probe is defective) and regulated tank venting. A regulated tank venting (loading-dependent) is only activated for B_tei. To the extent that B_tef = TRUE, the TEV can also be opened for B_tei = FALSE by controlled performance characteristics (emergency run TE).
- The bit B_te indicates that the TEV is still opened for "normal TEB" (regulated TE). B_te is only the reset if the TEV is completely closed, e.g. following a TE phase.

%BBTEGA - Phase control tank venting / mixture adaptation

The phase control brings about the change mixture adaptation / tank venting and shall meet OBDII requirements in particular. Hence switchover to long tank venting phase is only then made after an established mixture adaptation (B_gae = TRUE). Tank venting can be terminated intentionally by means of a customer servicing tester and the mixture adaptation activated for diagnosis purposes.

APP GKEB 3.0 Application hint

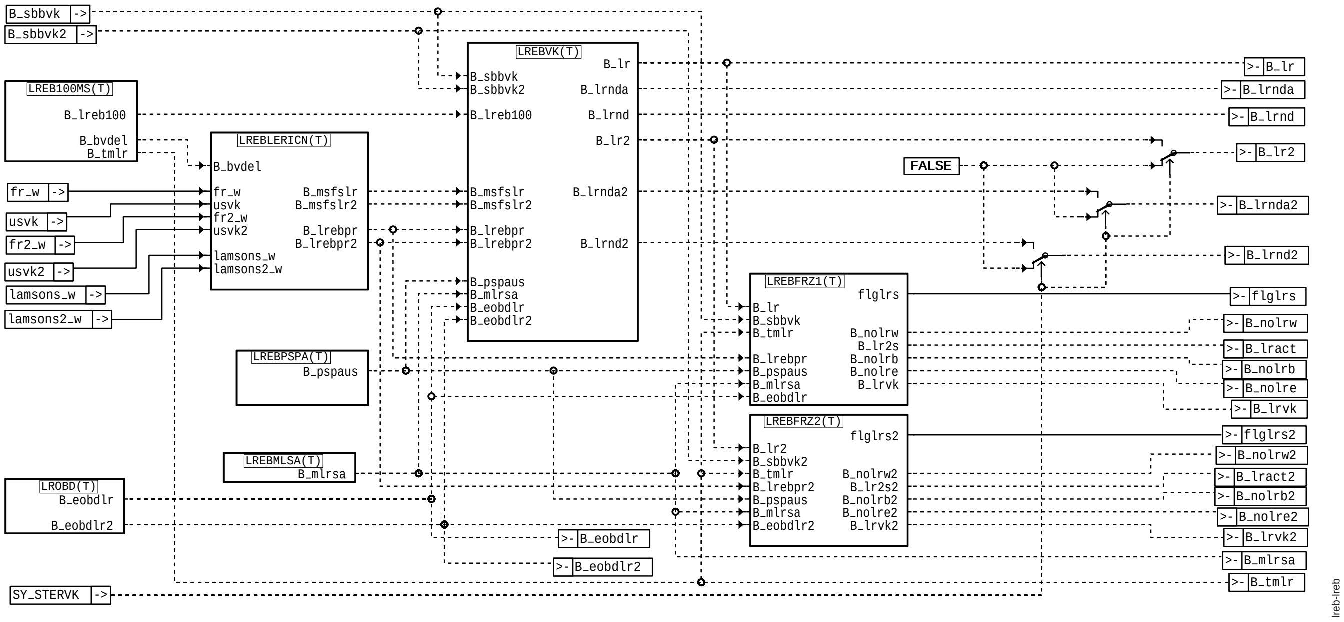
Not applicable here as all parameters are described in the appropriate functions.

LREB 141.10 Activation conditions for lambda closed loop control

FDEF LREB 141.10 Function definition

LREB: Switch-on conditions Lambda control upstream catalyst total overview

==



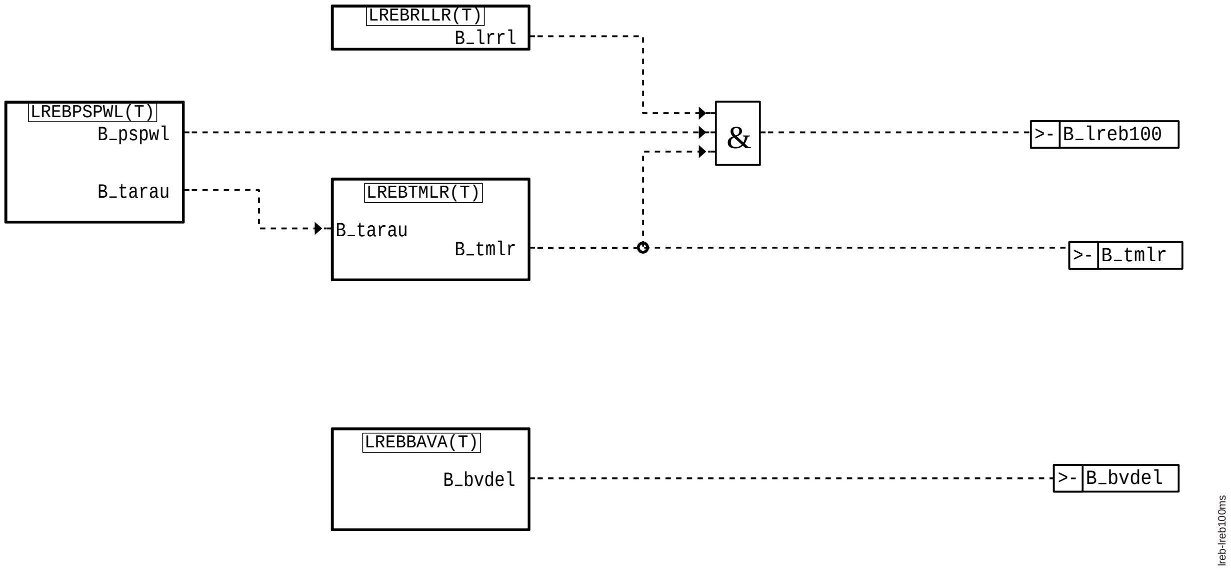
lreb-lreb

B_lr shows for all sections, which evaluate this bit, the state of the Lambda control (B_lr = TRUE means Lambda control is active).
B_lrnd is activated in addition to B_lr as soon as the Lambda control is necessary e.g. for diagnostic purposes, the controller factor fr_w, however, would lie in not plausible ranges or in case a lean engine operation is to be prevented for lamsons < 1 or a rich engine operation is to prevented for lamsons > 1.
This is ensured by two paths during the formation of B_lr and B_lrnd:

- For lamsons <> 1 B_lr is set to FALSE, lean/rich protection is activated by B_lrnd = TRUE.
- LC is blocked during SLS/DSLS, with lamsons >1 rich protection is activated if necessary
- By B_vag = TRUE OR B_bag = TRUE (from UKSEFI) B_lr is set to FALSE for an adjustable time. Lean protection is activated via B_lrnd = TRUE if necessary.

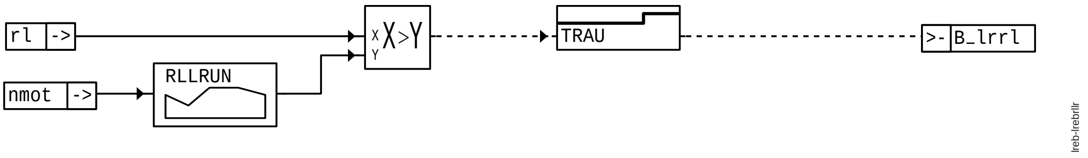
LREB100MS: Switch-on conditions for control upstream catalyst determined in the 100 ms cycle

===



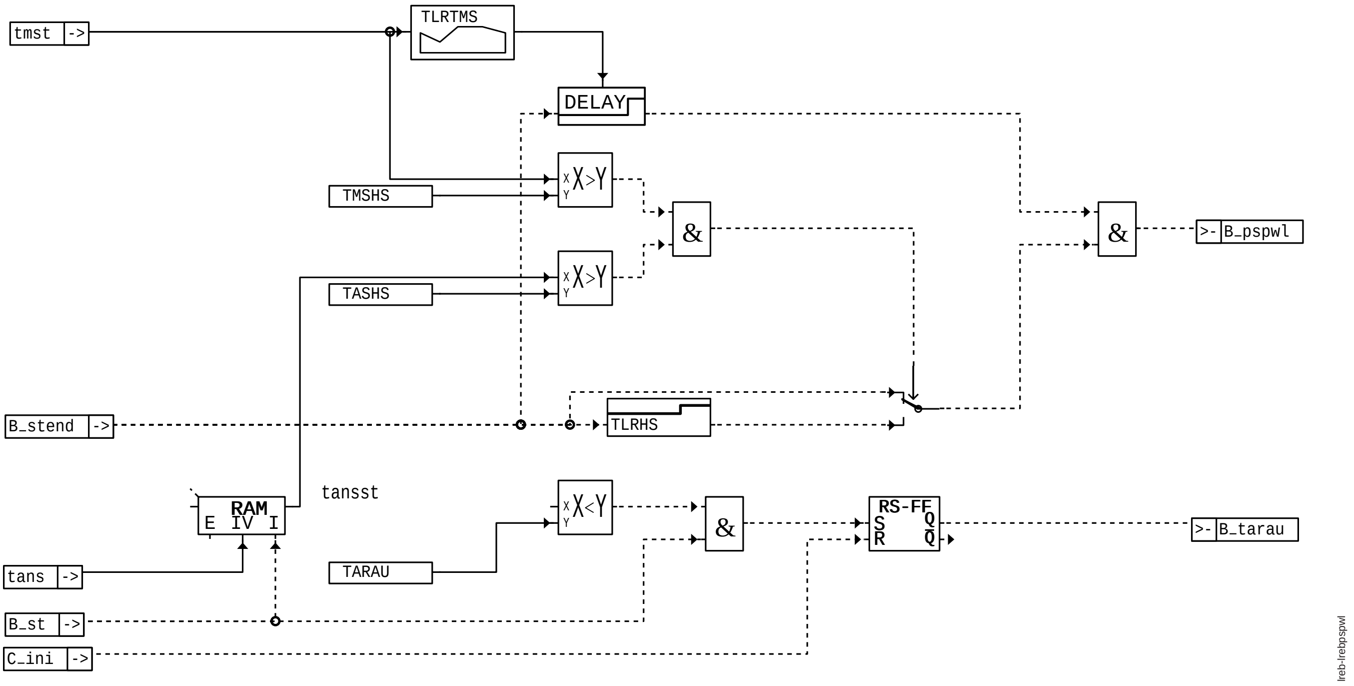
lreb-lreb100ms

LREBRLLR: Evaluation of load threshold



lreb-lrebrllr

LREBPSPWL: Warm-up specific switch-on conditions for control upstream catalyst

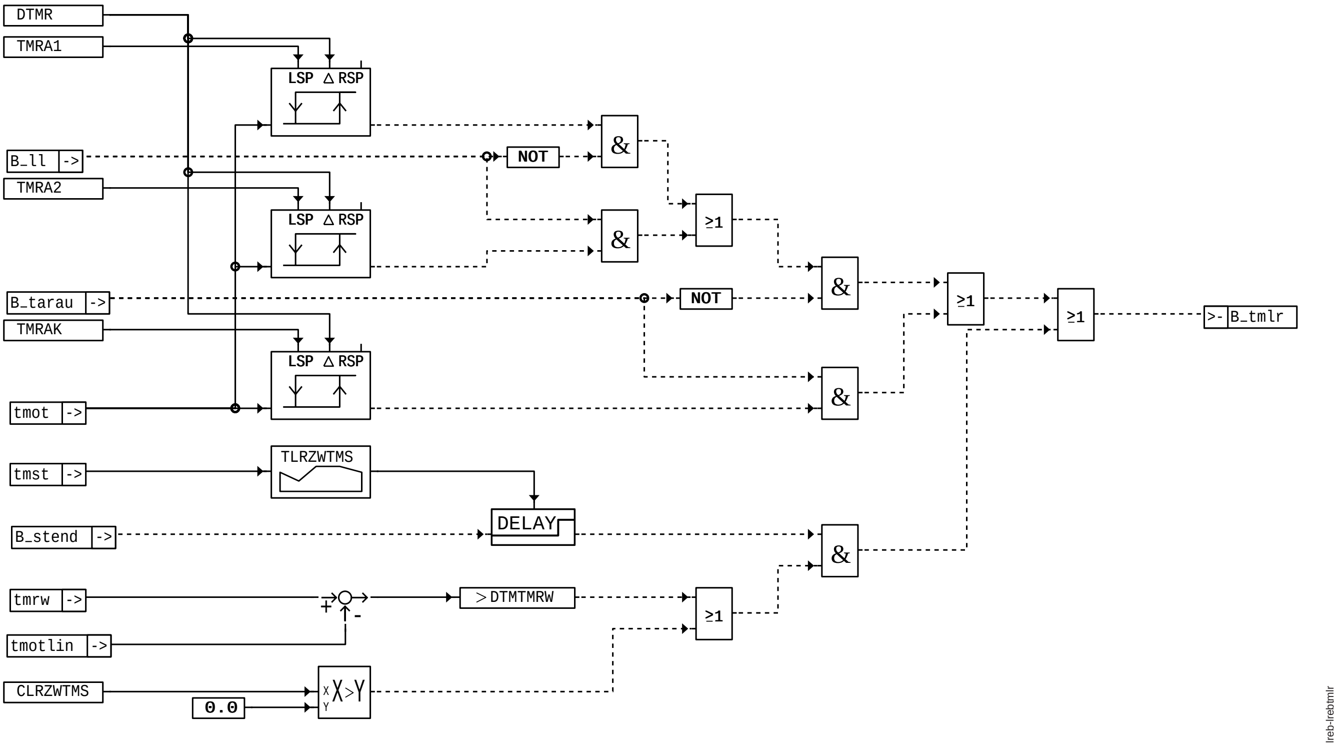


lreb-lrebpspwl

Switch-on / switch-off: - If the hot start condition tmst > TMSHS and tansst > TASHS is fulfilled during start, the delay time TLRHS is set. TLRHS runs as of end of start and accordingly delays the start of the Lambda control upstream catalyst.

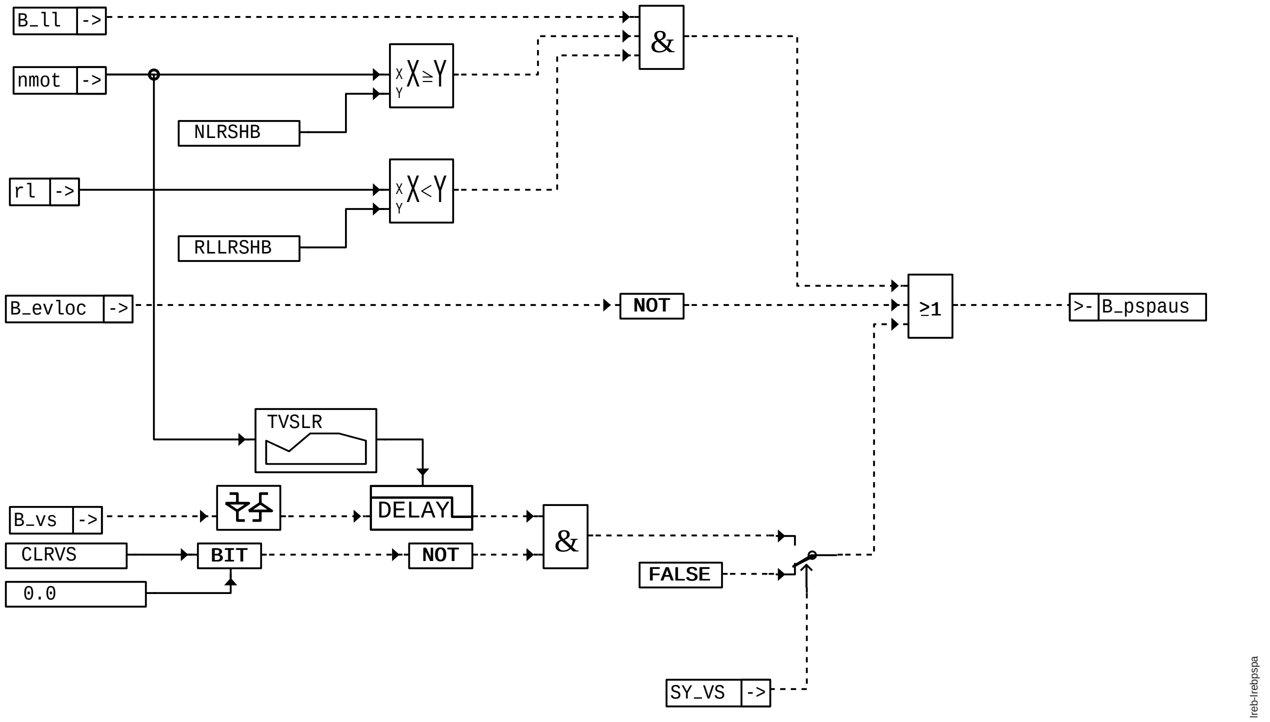
Via the local bit B_tarau it is possible to alternatively define another temperature threshold for the switch-on of the Lambda control. This may e.g. be necessary on systems with an evaluation of the intake air temperature.

```
LREBTMLR: TMOT- and TANS-dependent switch-on conditions for control upstream catalyst
==========================================================================================
```



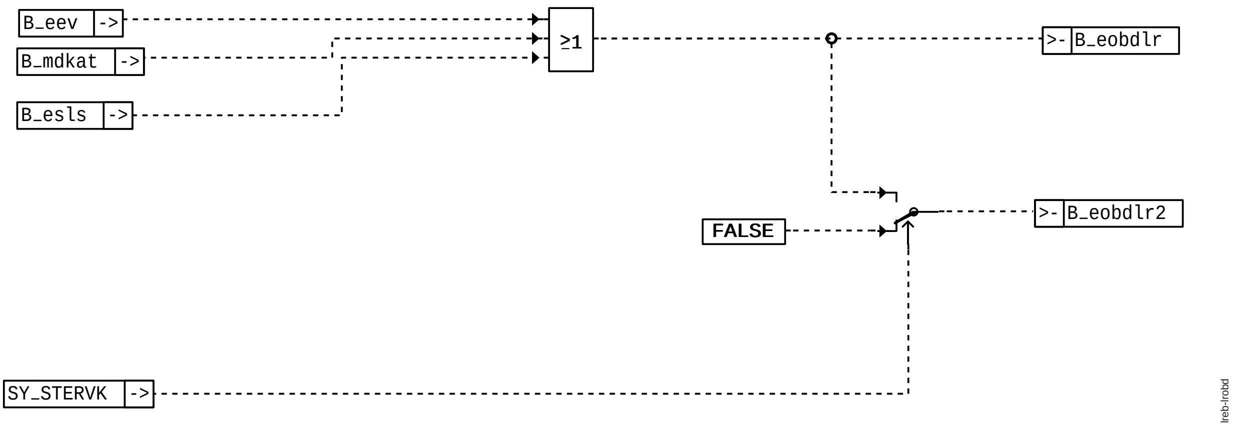
lreb-lrebtmlr

```
LREBPSPA: Project-specific switch-off conditions for control upstream catalyst
================================================================================
```



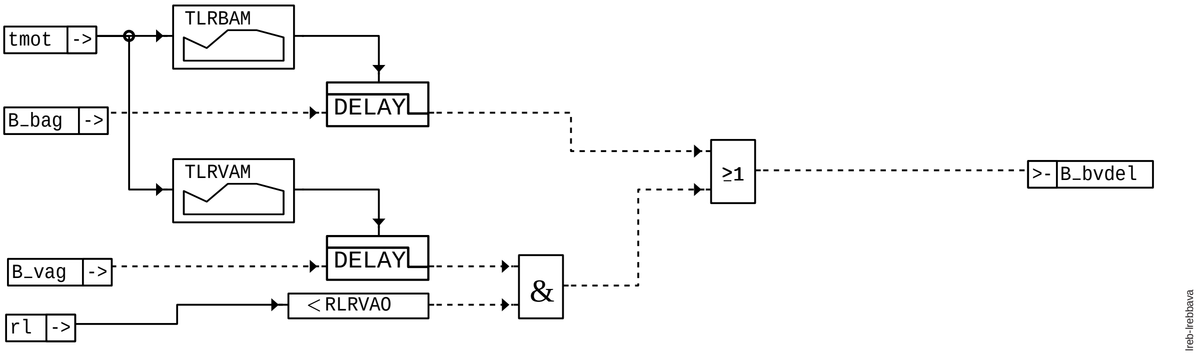
lreb-lrebpspa

```
LROBD: OBDII switch-off conditions
==================================
```



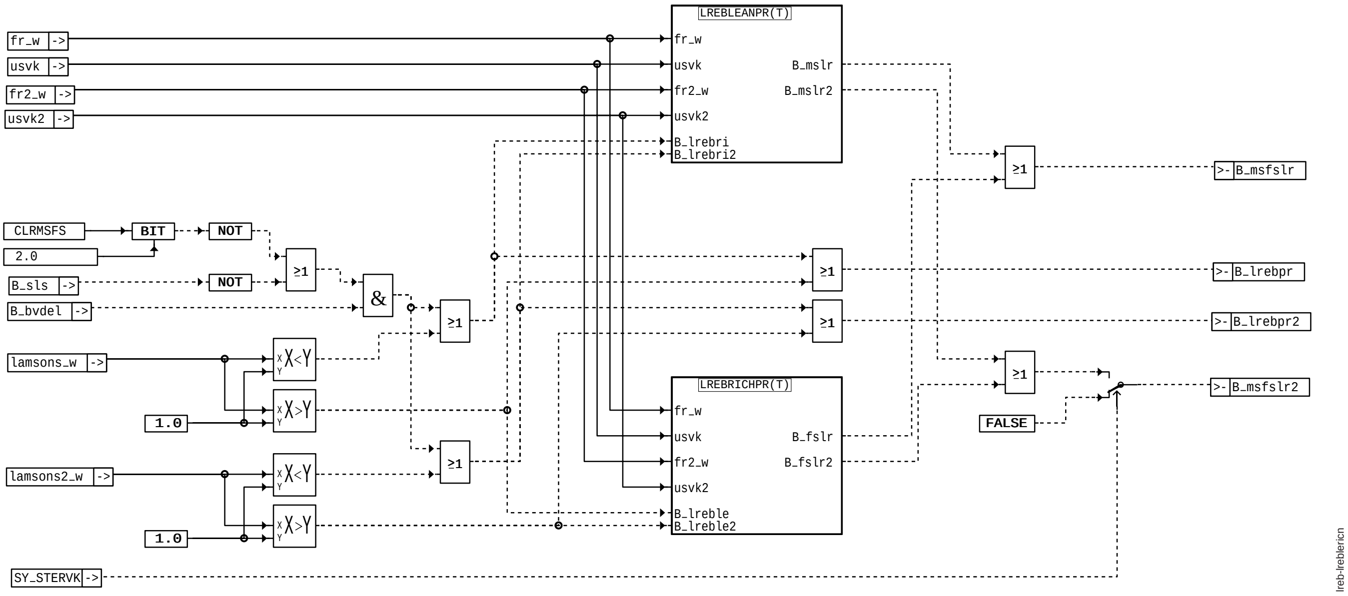
lreb-lrobd

```
LREBBAVA: Evaluation of lean and rich protection condition and of transient control bits B_vag/B_bag
====================================================================================================
```



lreb-lrebbava

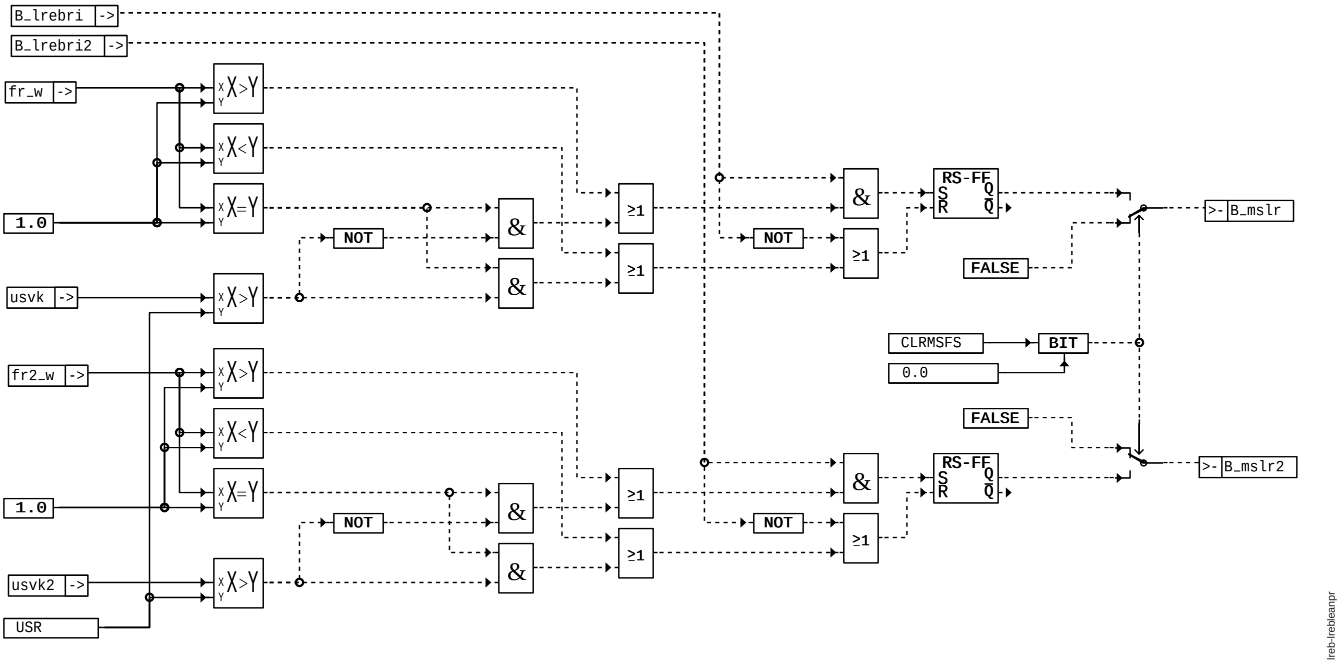
```
LREBLERICN: Evaluation of lean and rich protection condition
============================================================
```



lreb-lreblericn

LREBLEANPR: Subfunction lean protection

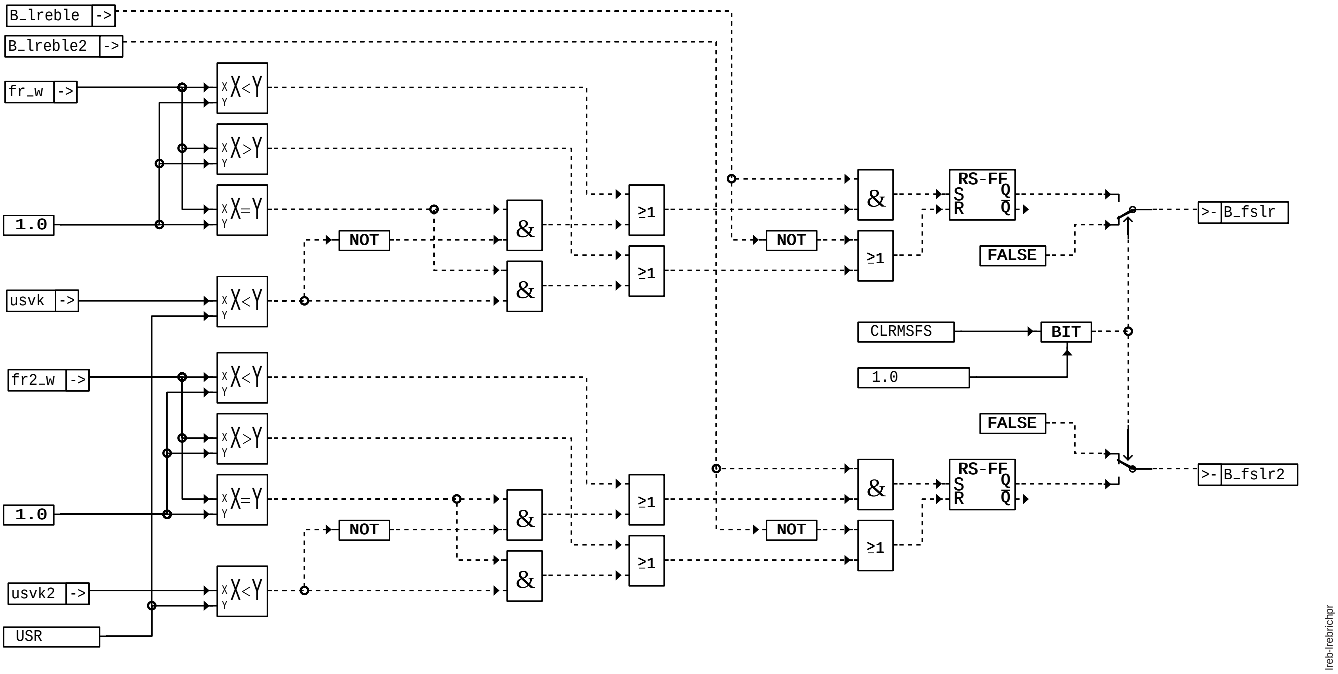
=====================================



lreb-lrebleanpr

LREBRICHPR: Subfunction rich protection

=====================================



lreb-lrebrichpr

Conditions for lean / rich protection

The lean protection monitoring is activated by lamsons_w < 1.

The lean protection function is triggered by the condition

((usvk = "lean") AND (fr_w = 1)) OR (fr_w > 1)

The lean protection function is reset by the condition

((usvk = "rich") AND (fr_w = 1))

((B_mslr = TRUE & blocking conditions = FALSE) ---> B_lrnd = TRUE and B_lr = FALSE)

The rich protection monitoring is activated by lamsons_w > 1.

The rich protection function is triggered by the condition

((usvk = "rich") AND (fr_w = 1)) OR (fr_w < 1)

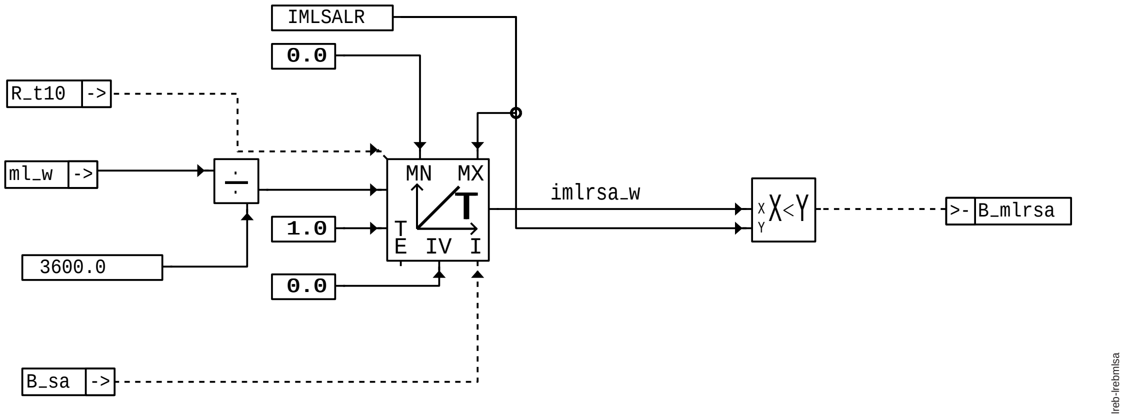
The rich protection function is reset by the condition

((usvk = "lean") AND (fr_w = 1))

((B_fslr = TRUE & blocking conditions = FALSE) ---> B_lrnd = TRUE and B_lr = FALSE)

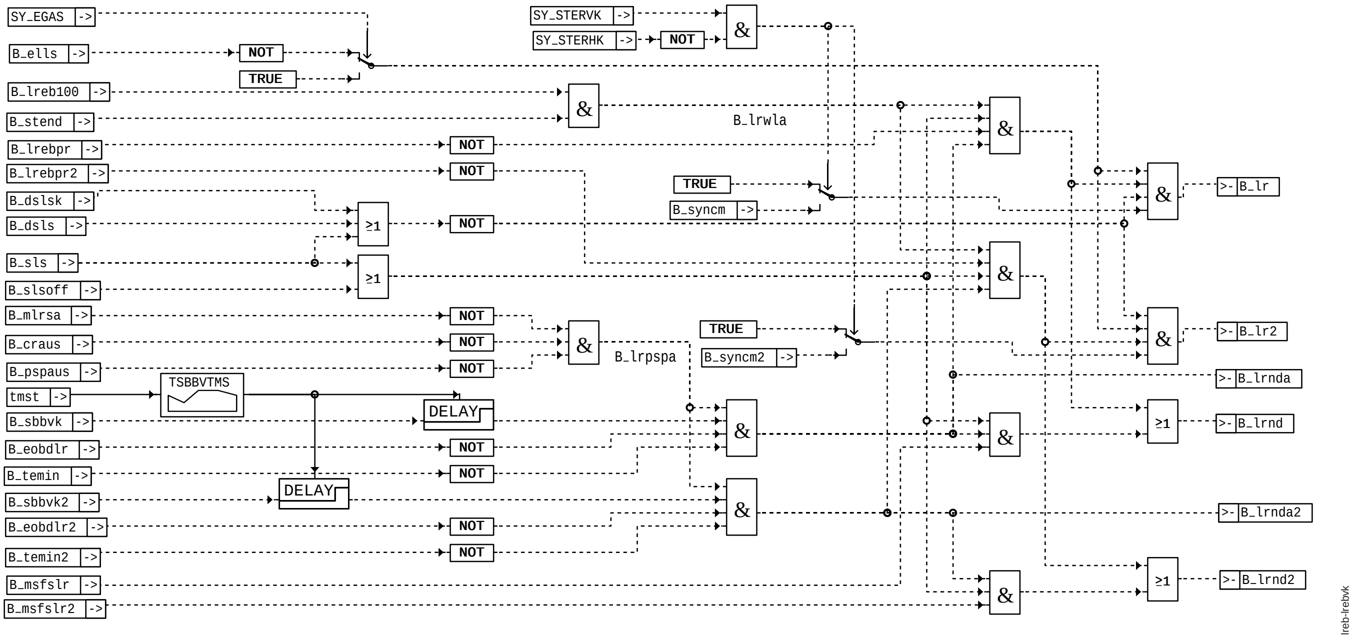
The lean protection monitoring is activated by lamsons_w < 1.

LREBMLSA: Checking on air mass integral after fuel cut-off on overrun



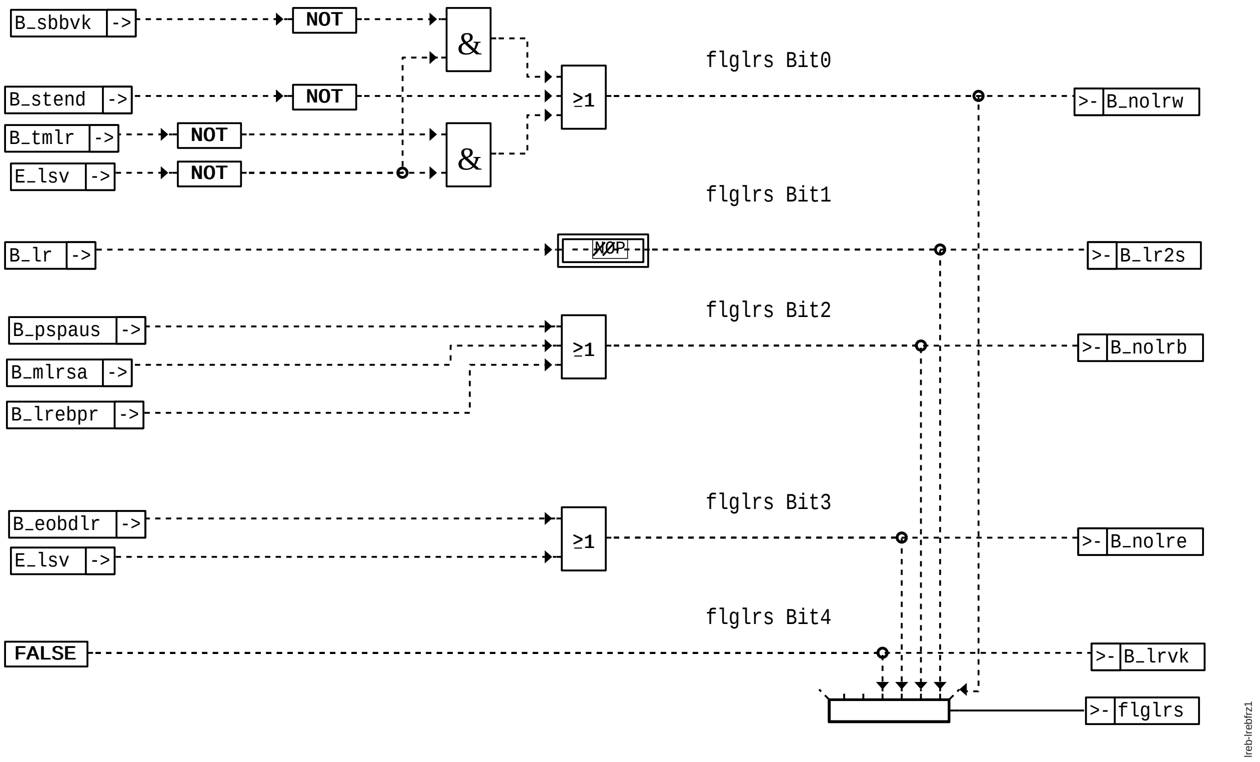
lreb-lrebmlsa

LREBVK: Formation of the bits B_lr and B_lrnd



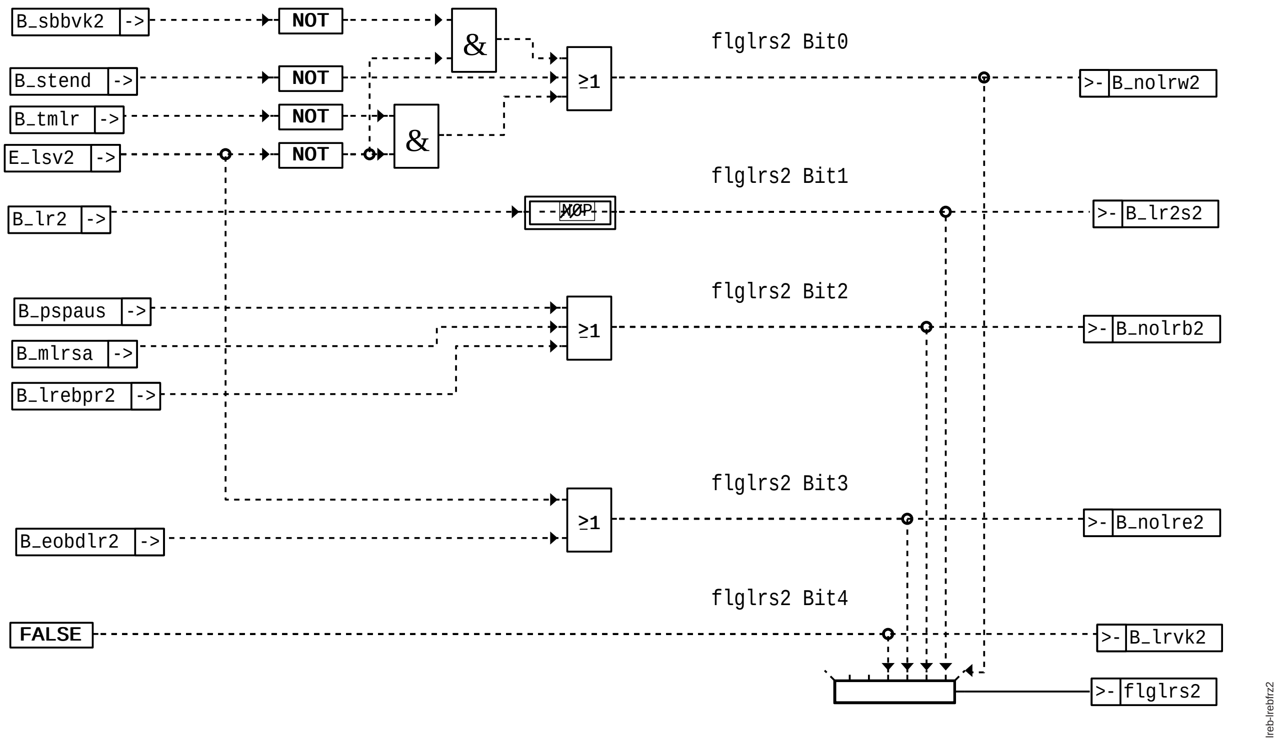
lreb-lrebvk

```
LREBFRZ1: CARB Freeze Frame - status byte of the LC, at stereo LC for bank 1 (flglrs)
=========================================================================================
```



lreb-lrebfrz1

```
LREBFRZ2: CARB Freeze Frame - status byte of the LC, at stereo LC for bank 2 (flglrs2)
==========================================================================================
```



lreb-lrebfrz2

```
Remark: The bits should be checked upon in above-mentioned order. If one of the bits
        Bit0, Bit1, Bit2 or Bit3 is set to TRUE, no further checking is to be performed.
        By the thus given priority of the evaluation it is ensured that 2 bits cannot
        be set simultaneously in the freeze frame byte.
```

ABK LREB 141.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CLRMSFS			FW	code word for lambda closed-loop control lean/rich protection on/off
CLRVS			FW	code word for lambda closed-loop control on/off at changing of valve stroke
CLRZWTMS			FW	Codeword for hard activation of LR according to CARB
DTMR			FW	hysteresis for cut-in threshold
DTMTMRW			FW	temperature difference thresh. for detection of hard LC-switch on
IMLSALR			FW	thresh.value integr.air mass for activ.delay of lambda contr.after fuel cut-off
NLRSHB			FW	eng.speed thesh.,turn-off lamb.cont.during overrun,in connec.with idle a.TLLRSHB
RLLRSHB			FW	load thresh.,turn-off lambda contr.during sec. air,in connect.with idle a.NLRSHB
RLLRUN	NMOT		KL	char.line above nmot,lower rL control limit for controller in front of catalyst
RLRVAO			FW	Upper rl-threshold for trigger of LR stopped during transient VA
TARAU			FW	air temperature threshold for closed loop lambda - control switching on
TASHS			FW	threshold intake air temp.for trigg.of TLRHS-blocking time LC during hot start
TLRBAM	TMOT		KL	blocking time for activation LC after BA
TLRHS			FW	blocking time LC during hot start, triggered via thresholds TASHS and TMSHS
TLRTMS	TMST		KL	lock time for CL lambda control after start, depending on engine start temperatu
TLRVAM	TMOT		KL	blocking time for activation LC after VA
TLRZWTMS	TMST		KL	Time until hard LC switch on after start (CARB)
TMRA1			FW	cut-out condition (idle-speed switch = 0)
TMRA2			FW	cut-out condition (idle-speed switch = 1)
TMRAK			FW	cut-out threshold of lambda closed-loop control at low starting temperature
TMSHS			FW	threshold engine temp.for triggering of TLRHS-blocking time LC during hot start
TRAU			FW	monitoring time for lower load limit of lambda closed-loop control
TSBBVTMS	TMST		KL	time delay control readiness after sensor readiness
TVSLR	NMOT		KL	Duration of LRS downtime commanded via valve stroke control
USR			FW	controller theshold for lambda control upstream catalyst

Variable	Source	Type	Description
B_BAG	ESUK	EIN	Condition large accel. enrichment
B_BVDEL	LREB	LOK	OR-logic interconnection for the stop condition B_bag / B_vag
B_CRAUS		EIN	Tested by LREB: Workshop bit to stop LR
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DSLSK		EIN	COndition secondary air diagnosis short trip
B_EEV	DEVE	EIN	condition injector fault (power stage)
B_ELLS		EIN	Condition: error idle speed actuator
B_EOBDLR	LREB	AUS	error flag:ˆOBDII summary fault, disables lambda control
B_EOBDLR2	LREB	AUS	error flag:ˆOBDII summary fault, disables lambda control, bank 2
B_ESLS		EIN	Condition secondary air fault by wrong air mass flow
B_EVLOC	BGEVAB	EIN	Status: all injection valves are activated
B_FSLR	LREB	LOK	Condition LR activ/inactiv during rich open loop (lamsons_w $<$ 1.0)
B_FSLR2	LREB	LOK	Condition LR activ/inactiv during rich open loop (lamsons_w $<$ 1.0) bank 2
B_LL	MSF	EIN	Condition idle
B_LR	LREB	AUS	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	AUS	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LR2S	LREB	LOK	CARB freeze frame, cyl.row 1 bit 1, LR:closed loop operating with two sensors
B_LR2S2	LREB	LOK	CARB freeze frame, cyl.row 2 bit 1, LR:closed loop operating with two sensors
B_LRACT	LREB	AUS	CARB freeze frame, cyl.row 1 bit 1, LR:normal closed loop operation
B_LRACT2	LREB	AUS	CARB freeze frame, cyl.row 2 bit 1, LR:normal closed loop operation
B_LREB100	LREB	LOK	Collection bit of stop condition during a 100ms-slot
B_LREBLE	LREB	LOK	Condition LR inactiv during lean out and lambda sensor indicates ”rich”
B_LREBLE2	LREB	LOK	Condition LR inactiv during lean out and lambda sensor indicats ”rich” bank 2
B_LREBPR	LREB	LOK	Condition LR inactiv during enrichment and lambda sensor indicates ”lean”
B_LREBPR2	LREB	LOK	Condition LR inactiv during enrichment and lambda sensor indicates ”lean”
B_LREBRI	LREB	LOK	cond. lambda control inact. while open loop: lamsons_w $<$ 1, B_vl, B_vag or B_bag
B_LREBRI2	LREB	LOK	cond. lambda control inact. while open loop: lamsons_w $<$ 1, B_vl, B_vag or B_bag
B_LRND	LREB	AUS	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	LREB	AUS	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_LRNDA	LREB	AUS	lambda control bank 1 active by conditions : B_lrpspa & B_lrkasn & !E_obdlr
B_LRNDA2	LREB	AUS	lambda control bank 2 active by conditions : B_lrpspa & B_lrkasn & !E_obdlr
B_LRPSPA	LREB	DOK	LREB: Project specific condition for lambda closed loop control upstream cat.
B_LRRL	LREB	LOK	LREB: Load dependend condition for lambda closed loop control upstream catalyst
B_LRVK	LREB	AUS	CARB freeze frame,cyl.row 1 bit 4,LR:closed loop contr. with one sensor (upstr.)
B_LRVK2	LREB	AUS	CARB freeze frame,cyl.row 2 bit 4,LR:closed loop contr. with one sensor (upstr.)
B_LRWLA	LREB	DOK	lambda control active by conditions : B_lrrl & B_tmlr & B_pspwl & B_stend
B_MDKAT	DMDMIL	EIN	cat. damaging misfire rate exceeded (for deactivation of other functions)
B_MLRSA	LREB	AUS	LRSEB: Air mass based switch off Lambda Control during and after fuel cut off
B_MSFSLR	LREB	LOK	Condition LR activ/ inactivduring rich/lean protection
B_MSFSLR2	LREB	LOK	Condition LR activ/ inactivduring rich/lean protection, bank 2
B_MSLR	LREB	LOK	Condition LR activ/inactiv during rich/lean protection
B_MSLR2	LREB	LOK	Condition LR activ/ inactiv during rich/lean protection
B_NOLRB	LREB	AUS	CARB freeze frame, cyl.row 1 bit 2, LR:open loop operating by operating condit.
B_NOLRB2	LREB	AUS	CARB FREEZE FRAME, bank2 Bit 2, LR: open loop control by operation condition
B_NOLRE	LREB	AUS	CARB freeze frame, cyl.row 1 bit 3, LR:open loop operating by system fault
B_NOLRE2	LREB	AUS	CARB FREEZE FRAME, bank2 bit 3, LR: open loop after system error
B_NOLRW	LREB	AUS	CARB freeze frame,cyl.row 1 bit 0,LR:open loop opera.,start cond.not yet fulfil.
B_NOLRW2	LREB	AUS	CARB FREEZE FRAME, bank2 bit 0, LR: open loop,start condition not fullfilled
B_PSPAUS	LREB	LOK	condition lambda control inactive by project spezific off-condition
B_PSPWL	LREB	LOK	condition lambda control inactive by project spezific warmup condition
B_SA	MDRED	EIN	Condition fuel cut-off
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_SLS	AK	EIN	Condition for active secondary air

Variable	Source	Type	Description
B_SLSOFF	AK	EIN	Condition end of secondary air after removing secondary air
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_SYNCM	LR	EIN	Condition fr_w-/fr2_w-synchronization active, fr_w is used as master
B_SYNCM2	LR	EIN	Condition fr-synchronization active,bank 2 is used as master
B_TARAU	LREB	LOK	LREB: condition start for low intake air temperatures
B_TEMIN	RKTI	EIN	Condition: TEMIN-limitation active, bench 1
B_TEMIN2	RKTI	EIN	Condition: TEMIN-limitation active, bench 2
B_TMLR	LREB	AUS	LREB: Engine Temperature dependend condition for lambda closed loop control u.C.
B_VAG	ESUK	EIN	Condition large deceleration enleanment
B_VS		EIN	Condition valve lift high
C_INI	SWADAP	EIN	ECU-condition for intialisation
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
FLGLRS	LREB	AUS	CARB FREEZE FRAME byte, bank 1, for lambda control
FLGLRS2	LREB	AUS	CARB FREEZE FRAME byte, bank 2, for lambda control
FR2_W	LR	EIN	Lambda controller output (word)
FR_W	LR	EIN	Lambda controller output (word)
IMLRSA_W	LREB	LOK	air mass after fuel cut-off for continuous lambda control
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
SY_EGAS	PROKON	EIN	system constant E-GAS present
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_VS		EIN	system constant valve stroke control: no, 2 position
TANS	SWADAP	EIN	Intake air temperature
TANSST	LREB	LOK	Intake air temperature at cranking
TMOT	SWADAP	EIN	Engine temperature
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
TMRW	GGTFM	EIN	model-based reference value for plausibility check of engine temperature signal
TMST	GGTFM	EIN	engine temperature at start
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2

`Label for stereo LC`

FW LREB 141.10 Fixed Values

Parameter	Value	Description
CLRMSFS		code word for lambda closed-loop control lean/rich protection on/off
CLRVS		code word for lambda closed-loop control on/off at changing of valve stroke
CLRZWTMS		Codeword for hard activation of LR according to CARB
DTMR		hysteresis for cut-in threshold
DTMTMRW		temperature difference thresh. for detection of hard LC-switch on
IMLSALR		thresh.value integr.air mass for activ.delay of lambda contr.after fuel cut-off
NLRSHB		eng.speed thesh.,turn-off lamb.cont.during overrun,in connec.with idle a.TLLRSHB
RLLRSHB		load thresh.,turn-off lambda contr.during sec. air,in connect.with idle a.NLRSHB
RLRVAO		Upper rl-threshold for trigger of LR stopped during transient VA
TARAU		air temperature threshold for closed loop lambda - control switching on
TASHS		threshold intake air temp.for trigg.of TLRHS-blocking time LC during hot start
TLRHS		blocking time LC during hot start, triggered via thresholds TASHS and TMSHS
TMRA1		cut-out condition (idle-speed switch = 0)
TMRA2		cut-out condition (idle-speed switch = 1)
TMRAK		cut-out threshold of lambda closed-loop control at low starting temperature
TMSHS		threshold engine temp.for triggering of TLRHS-blocking time LC during hot start
TRAU		monitoring time for lower load limit of lambda closed-loop control
USR		controller theshold for lambda control upstream catalyst

FB LREB 141.10 Detailed description of function

1.1 Switch-on / switch-off via temperature thresholds TMRA1 (partial load) TMRA2 (idling) TMRAK (no emission test)

1.1.1 Switch-on at Tmot > TMRAx + DTMR
Switch-off at Tmot < TMRAx
1.1.2 If the condition Tmot > TMSHS and Tans > TASHS is fulfilled at start, then switch-on as from end of start after a delay time t > TLRHS.
1.1.3 Switch on as from end of start after a delay time TLRTMS dependent on the engine temperature at start.

1.2 Sensor operating readiness

1.1.1 Switch on, if flag B_sbbvk from %DLSV is set with the switch-on delay TSBBVTMS = f(tmst).
1.1.2 Switch off, if flag B_sbbvk from %DLSV is not set.

1.3 Switch-over to open-loop control under certain conditions, hence switch-over to close-loop control

Switch-over to open-loop control:

1.3.1 at start
1.3.2 at fuel cut-off on overrun (B_sa = 1); until throughput of air mass IMLSALR after transition from (B_sa : 1 --> 0)
1.3.3 while UKSEFI status B_bag = 1 OR while UKSEFI status B_vag = 1
1.3.4 when exceeding a load threshold rl > RLLRUN(nmot) after a delay time t > TRAB
1.3.5 Lambda setpoint lamsons_w <> 1.0
1.3.6 at idling, if (B_ll = 1) & tl >= TLLRSHB & n >= NLRSHB
1.3.7 while function secondary air is active, is achieved indirectly by lamsons_w > 1
1.3.8 Lambda control is blocked after function secondary air until the bit B_slsoff (from %DSLS) has been set
Check of Bit B_slsoff is blocked as long as bit B_sls is TRUE

Switch-over to close-loop control:

1.3.10 with lamsons_w < 1.0 (e.g. at full load) and ready control sensor OR while UKSEFI status B_bag = 1
OR while UKSEFI status B_vag = 1,
and under the following conditions:
((lean mixture, usvk < USR) AND (fr >= 1.0)) OR ((rich mixture, i.e. usvk) > (USR fr > 1.0)
independent of temperature-dependent switch-on conditions

1.4 Switch-over to open-loop control during OBDII fault detection

Switch-over to open-loop control:

1.4.1 with fault injector power stage, B_eev from %DEVE
1.4.2 with fault catalyst damaging misfires (B_mdkat by DMDMIL4.10)
1.4.3 with fault secondary air system B_esls (only with spurious air due to open secondary air valve or running secondary air pump)

1.5 Switch-over to open-loop control under further project-specific switch-off conditions

Switch-over to open-loop control project-specifically:

1.5.1 as soon as B_evloc := 0; the following applies to the following conditions

- 1.5.1.1 at active engine speed limitation
- 1.5.1.3 at speed limitation

1.5.2 As soon as bit B_craus is set; mode basic setting:
Permits open-loop controlled operating of the engine by the workshop
for diagnostic purposes

2.1 Switch-over to close-loop control at compulsory switch-on (according to CARB requirement)

2.1.1 CLRZWTMS > 0
Switch-over to close-loop control at compulsory switch-on after tmot-fault was suspected
As soon as the difference between the model engine temperature tmrw and the engine temperature raw value is greater than the threshold DTMTMRW, the LC is switched on compulsorily after the time TLRZWTMS = f(tms).

2.1.2 CLRZWTMS = 0
Switch-over to close-loop control at compulsory switch-on
The LC is switched on compulsorily after the time TLRZWTMS = f(tms)

APP LREB 141.10 Application hint

LRINI 1.0 Coordination initializing lambda controller

FDEF LRINI 1.0 Function definition

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Funktion LRINI: Koordinationn der Initialisierung der Lambdaregelung
====================================================================
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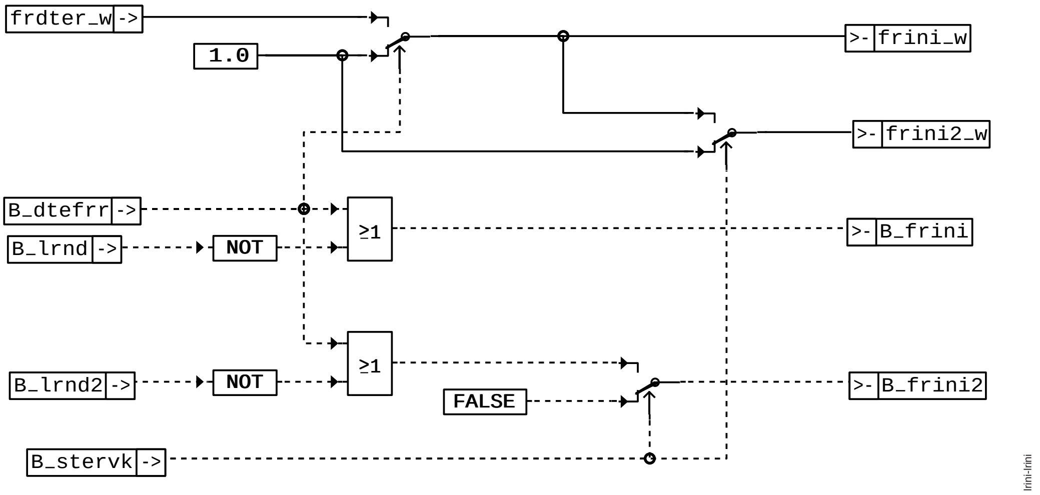


lrini-lrini

ABK LRINI 1.0 Abbreviations

Variable	Source	Type	Description
B_DTEFRR	GKRA	EIN	condition of lambda controller reset
B_FRINI	LRINI	AUS	Condition control factor fr initialize
B_FRINI2	LRINI	AUS	Condition control factor fr initialize, bank 2
B_LRND	LREB	EIN	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	LREB	EIN	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_STERVK		EIN	condition Stereo Lambda control before catalyst
FRDTER_W	DTEV	EIN	lambda control factor as reference value for CPV diagnosis
FRINI2_W	LRINI	AUS	Initialisation value for control factor lambda control, bank 2
FRINI_W	LRINI	AUS	Initialisation value for control factor lambda control

FW LRINI 1.0 Fixed Values

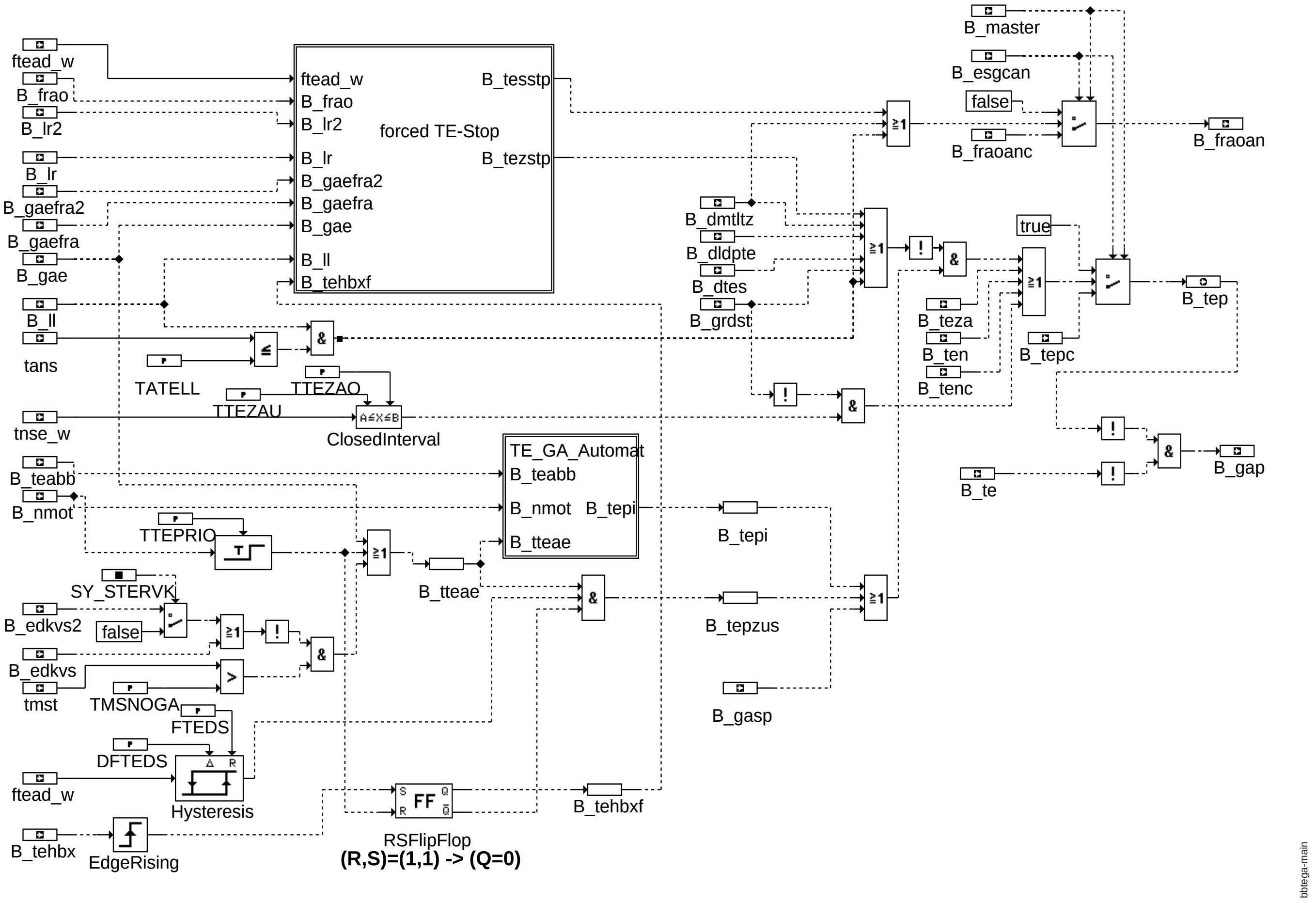
Parameter	Value	Description

FB LRINI 1.0 Detailed description of function

APP LRINI 1.0 Application hint

BBTEGA 4.20 Operating contitions for purge canister control / fuel adaption

FDEF BBTEGA 4.20 Function definition



bbtega-main

```
forced TE-Stop:
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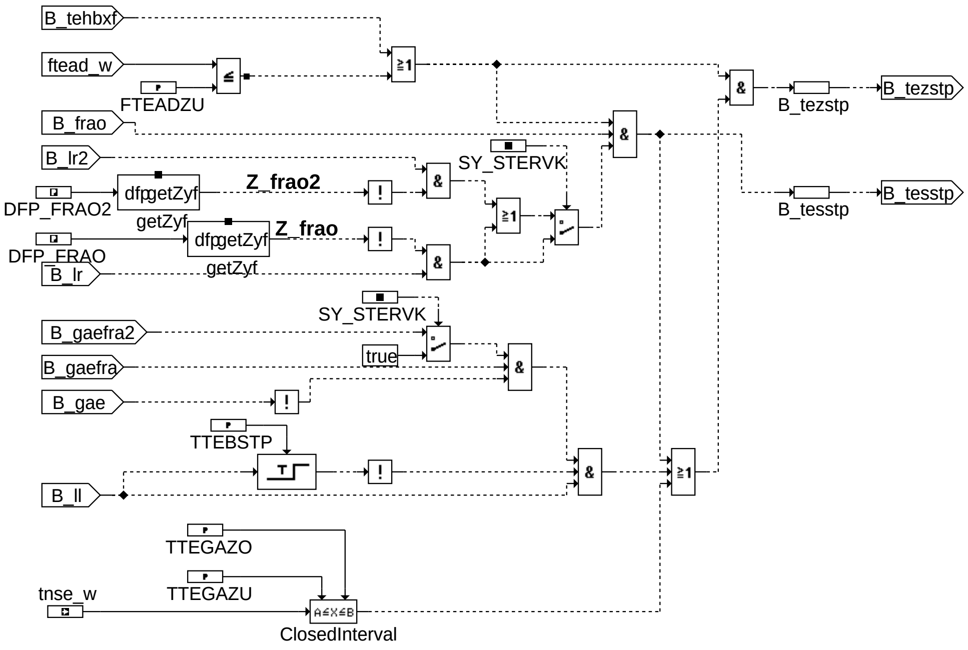

bbtega-forcedte-s

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TE-GA-AUTO: Statemachine for phase control between canister purge (TE) and mixture adaptation (GA)
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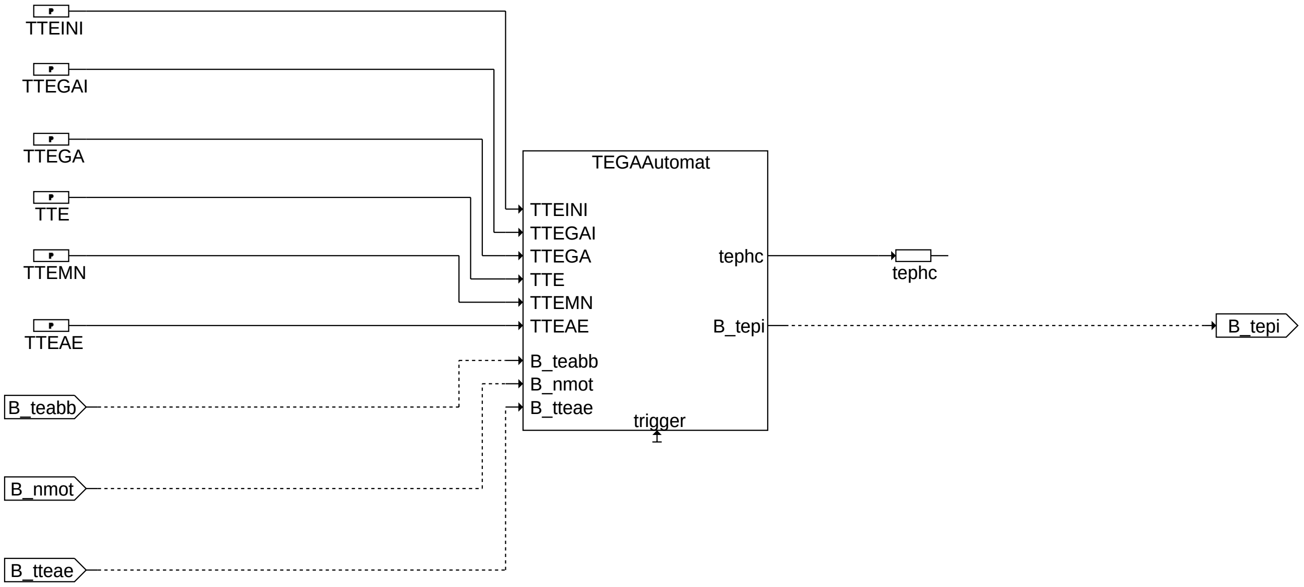
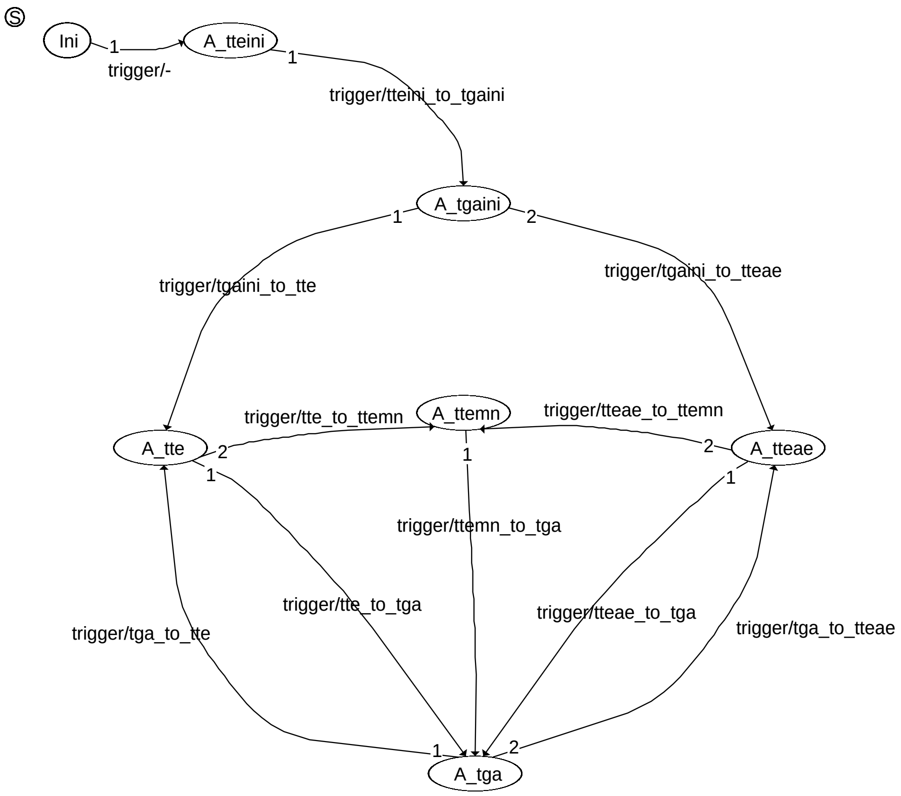
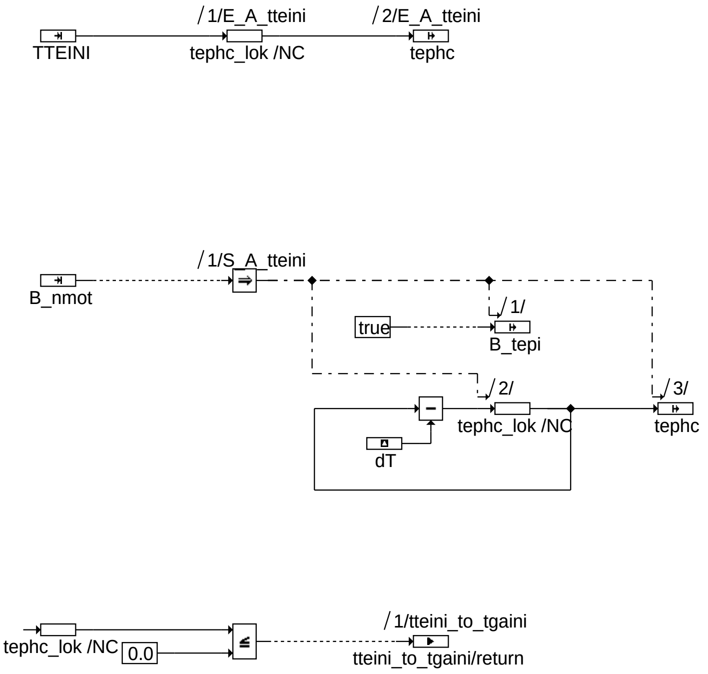


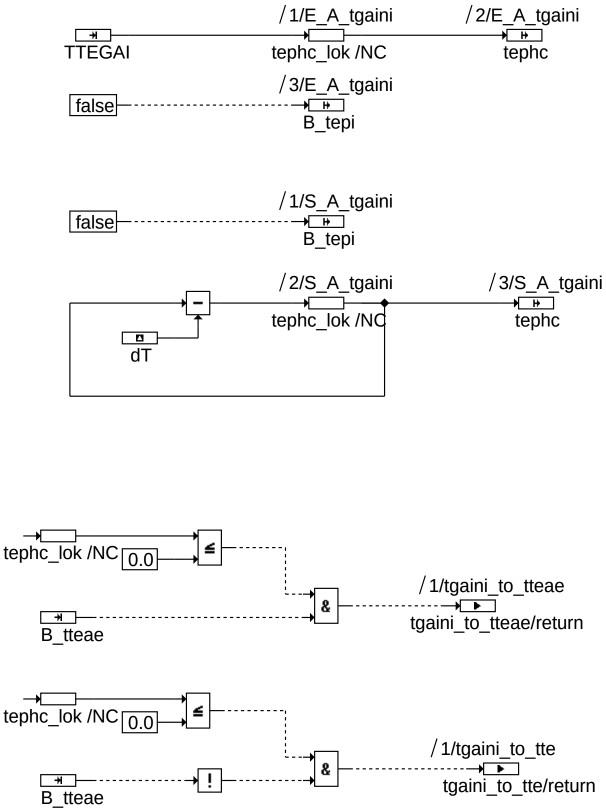
bbtega-te-ga-auto



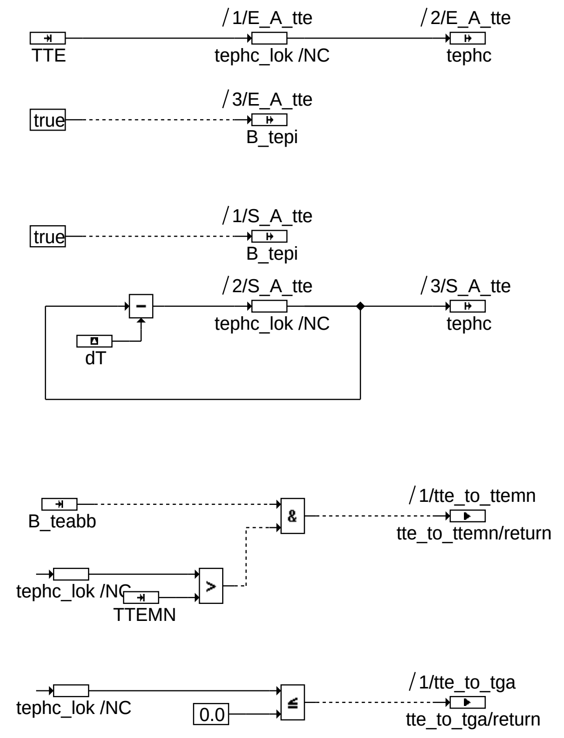
bbtega-statemachi



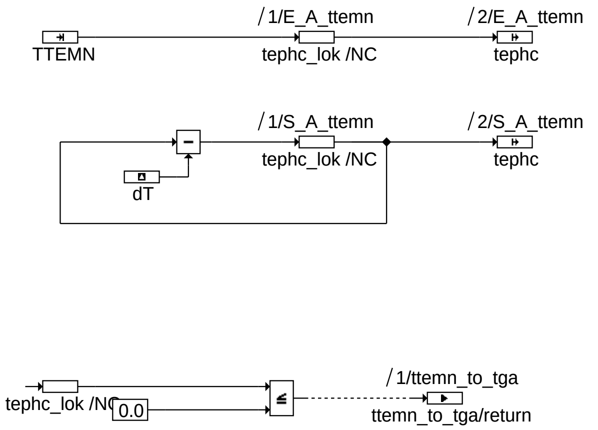
bbtega-a-tteini



bbtega-a-tgaini

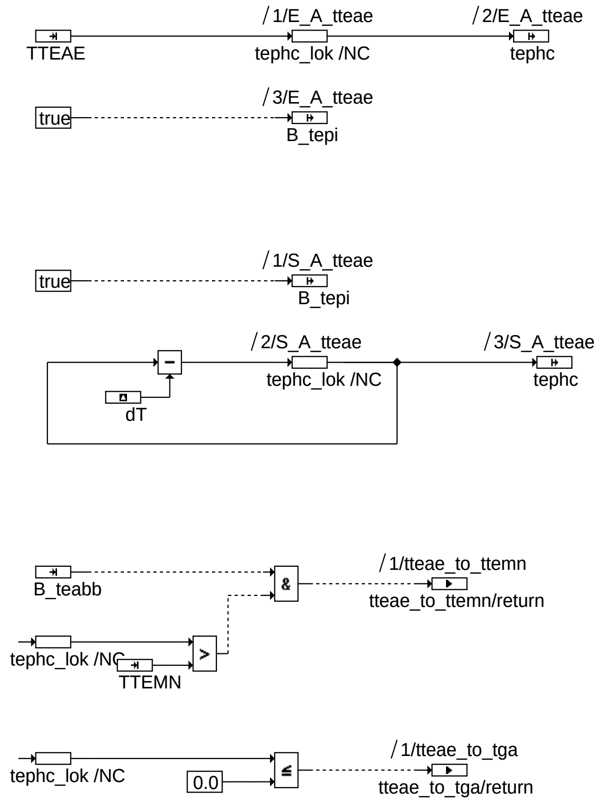


bbtega-a-tte



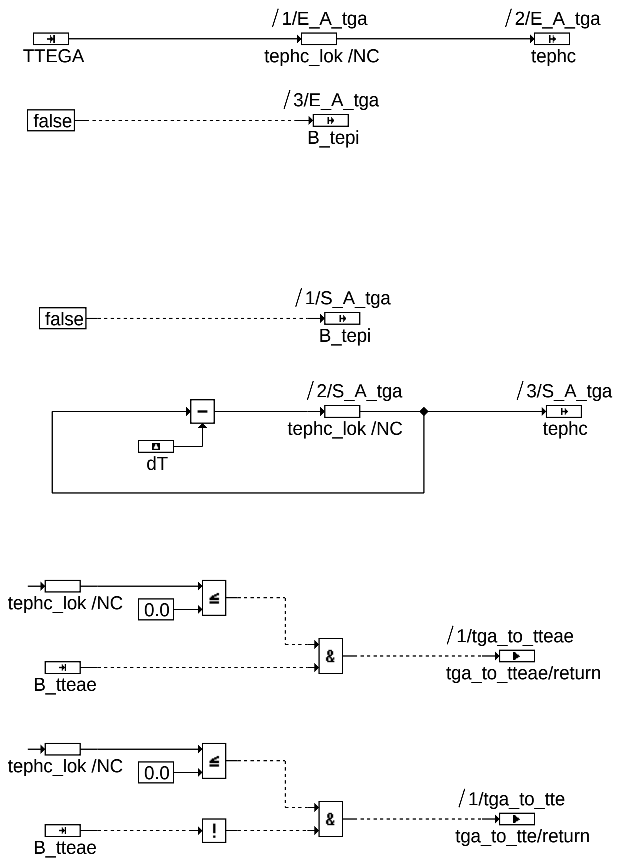
bbtega-a-ttemn

bbtega-a-ttemn



bbtega-a-tteae

bbtega-a-tteae



bbtega-a-tga

ABK BBTEGA 4.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DFTEDS			FW	hysteresis width on canister charge for switching to endless purging
FTEADZU			FW	threshold canister charge for interruption of the purge phase
FTEDS			FW	threshold canister charge for switching to endless purging
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TATELL			FW	tans-threshold for canister purge control with B_ll = 1
TMSNOGA			FW	threshold tms for endless purge control, if mixture adaptation without error
TTE			FW	time for canister purge phase
TTEAE			FW	duration of canister purge phase with completed mixture adaptation
TTEBSTP			FW	maximum time for purge stop at idle if the cycle flags are not set
TTEGA			FW	time during canister purge for basic adaptation
TTEGAI			FW	Duration of the first mixture adaptation phase
TTEGAZO			FW	Time for canister purge stop for lambda adaptation, upper threshold
TTEGAZU			FW	Time for canister purge stop for lambda adaptation, lower threshold
TTEINI			FW	Duration of the first purge phase
TTEMN			FW	time for canister purge phase minimum
TTEPRIO			FW	time after start for switching to endless purging
TTEZAO			FW	Time for permanent canister purge, upper threshold
TTEZAU			FW	Time for permanent canister purge, lower threshold

Variable	Source	Type	Description
B_DLDPTE	GKRA	EIN	request from evap system monitoring to shut down PCV
B_DMTLTZ		EIN	Condition TEV should be closed
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ESGCAN		EIN	Condition error ecu-CAN for 2 ME-ecu's
B_FRAO	LRA	EIN	condition for enabling adaption of frao
B_FRAOAN	BBTEGA	AUS	demand CPV quickly closing for activtion of mixture adaptation
B_FRAOANC		EIN	demand CPV quickly closing for mixture adaptation, signal from CAN
B_GAE	DKVS	EIN	condition for adaptive Lambda pilot control successful
B_GAEFRA	DKVS	EIN	condition for fra portion of adaptive Lambda pilot control successful
B_GAEFRA2	DKVS	EIN	condition for fra2 portion of adaptive lambda pilot control successful
B_GAP	BBTEGA	AUS	condition mixture adaptation phase active
B_GASP	LRAEB	EIN	condition for basic mixture adaptation disabled
B_GRDST		EIN	condition basic attitude
B_LL	MSF	EIN	Condition idle
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2

Variable	Source	Type	Description
B_MASTER		EIN	Condition MASTER-ECU
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_TE	TEBEB	EIN	Condition canister purge active
B_TEABB	TEB	EIN	Condition purge canister function ready to finish
B_TEHBX	TEB	EIN	Condition load integrator ftead at max. limit
B_TEHBXF	BBTEGA	LOK	Condition load integrator ftead at max. limit, filtered
B_TEN	TEBEB	EIN	condition open loop purging
B_TENC		EIN	condition open loop purging, input from CAN
B_TEP	BBTEGA	AUS	Condition canister purge phase active
B_TEPC		EIN	Condition canister purge phase active from CAN
B_TEPI	BBTEGA	LOK	Condition canister purge phase active internal
B_TEPZUS	BBTEGA	LOK	condition additional canister purge phase
B_TESSTP	BBTEGA	LOK	condition canister purge fast stop
B_TEZA		EIN	Condition forced activation of the purge control function
B_TEZSTP	BBTEGA	LOK	condition canister purge forced stop
B_TTEAE	BBTEGA	LOK	condition switch over to long purge phase
FTEAD_W	TEB	EIN	charcoal canister charge
TANS	SWADAP	EIN	Intake air temperature
TEPHC	BBTEGA	LOK	phase counter mixture adaptation / canister purge
TMST	GGTFM	EIN	engine temperature at start
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
Z_FRAO	DKVS	EIN	cycle flag of mixture adaption factor frao
Z_FRAO2	DKVS	EIN	cycle flag of mixture adaption factor frao2 (bank 2)

FW BBTEGA 4.20 Fixed Values

Parameter	Value	Description
DFTEDS		hysteresis width on canister charge for switching to endless purging
FTEADZU		threshold canister charge for interruption of the purge phase
FTEDS		threshold canister charge for switching to endless purging
TATELL		tans-threshold for canister purge control with B_ll = 1
TMSNOGA		threshold tms for endless purge control, if mixture adaptation without error
TTE		time for canister purge phase
TTEAE		duration of canister purge phase with completed mixture adaptation
TTEBSTP		maximum time for purge stop at idle if the cycle flags are not set
TTEGA		time during canister purge for basic adaptation
TTEGAI		Duration of the first mixture adaptation phase
TTEGAZO		Time for canister purge stop for lambda adaptation, upper threshold
TTEGAZU		Time for canister purge stop for lambda adaptation, lower threshold
TTEINI		Duration of the first purge phase
TTEMN		time for canister purge phase minimum
TTEPRIO		time after start for switching to endless purging
TTEZAO		Time for permanent canister purge, upper threshold
TTEZAU		Time for permanent canister purge, lower threshold

FB BBTEGA 4.20 Detailed description of function

```
Remark on engine assembly: concept with 2 control units
-------------------------------------------------------
- two identical engine control units (same code, same data)
- PIN-information B_master tells the control unit if it is used as a master or as a slave control unit
- 1 canister purge valve on each side. The inlet pipes are relied down stream the 2 canister purge valves. This means that the
  canister purge on one side has an impact on the other side.
- Therefore canister purge must be simultaneous in both control units --> synchronization of the control units
- Calculation of BBTEGA in master control unit only. The results B_tep and B_fraoan are reported to the slave                  ##


                       Master           Slave

                       |   |            |   |
                       |   |            |   |
      +----------------+   |   inlet    |   |
      | canister purge     |   pipe     |   |
      |   +------------+   |            |   |
      |   |            |   |            |   |
                       |   +------------+   |
                       | pressure compens.  |
                       |   +------------+   |
                       |   |            |   |
                     +-+   +-+        +-+   +-+
                     |       |        |       |
                     |       | enigne |       |
                     |       |        |       |
                     +-+   +-+        +-+   +-+
                       |   |   exhaust  |   |
                       |   |   system   |   |                                                                               ##


Remarks on stereo lambda control:
---------------------------------
- The FDEF below is intended for systems with stereo and mono lambda control but there is no stereo variable necessary because
  in DKVS B_gae represents the both sides.
```

Description of phase control, mixture adaptation / canister purge (function BBTEGA):

Output variables:

- Mixture adaptation phase active: B_gap (B_gap = TRUE does not necessarily mean that LRA is really active)
- Canister purge phase active: B_tep (B_tep = TRUE does not necessarily mean that TEB is really active)
  Remark: With inactive lambda control (e.g. defective probe), the system switches to controlled purge operation. The canister purge valve is opened even in a "mixture phase". The LRA is then disabled.

Input variables:

- Load ftead for PCV closing, if
  - in idle speed the mixture adaptation has not stablizied (B_gae = FALSE) and multiplicative adaptation has stablized (B_gaefra=TRUE).
  - upper multiplicative range is active, the cycle bit Z_frao(2) = FALSE and the lambda control is active (B_lr(2) = TRUE).
- Flags of the DKVS (B_gae, B_gaefra/2). The flag B_gae corresponds to the cycle bit of DKVS. When LRA is not complete, there is greater need of adaptation at idle.
- Request bits of the diagnosis functions that can only run at idle speed (B_dldpte, B_dtes, B_dmtltz)
- Request bits for a quickly test: B_grdst
- The bit B_nmot (engine speed plausible) for initialisation of counters in the phase control
- The bits B_teabb (purge ready to finish), B_gasp (mixture adaptation disabled) and B_tehbx (load at max. limit) for influencing the phase control
- The Bit B_te from the TEBEB for detecting whether the purge valve is closed.
- tans : No canister purge control in idle speed, if manifold air temperature less then threshold TATELL
- time since end of start tnse_w for time controlled canister purge and mixture adaptation
- Bits B_ten and B_tenc (= B_ten via CAN from the other control unit): canister purge at open loop (no lambda control)
- PIN-information B_master shows, which of the 2 control units is the master that calculates the phase control.
- The bit B_esgcan tells, if the CAN-communication between the master and the slave is OK. ##

Purpose of phase control:

- Coordination of the changeover between mixture adaptation and canister purge with the following aims:
  - a) Maximising the flush volume (in emission test and in the field) especially at high loads => activate TEB
  - b) Quickest possible detection of a DKVS fault (sufficiently long and frequent activation of mixture adaptation on faults) => activate LRA
  - c) Quickly closing of the purge valve and LRA (activate upper multiplicative range) at low load
  - d) Quickest possible activation of diagnosis functions that only run at idle speed => Initiation of reset of the purge valve at B_ll (idle switch only) and low load
  - e) Reset of the purge valve on request by DKVS (B_gae = FALSE and multiplicative adaptation correction is completed), DLDP (B_dldpte) and tester (B_grdst)
  - f) Activation of TEB, if from DLDP desired (B_teza)
  - g) Long canister purge, if the time after start greater then TTEPRIO or B_gae = TRUE or a hotstart without a fault in fuel supply system (starttempeture higher then TMSNOGA and B_edkvs(2) = FALSE).
  - h) Endless canister purge at high load of canister purge (ftead >= FTEDS), B_tehbx = FALSE and long caniter purge is activated (B_tteae = TRUE).
  - i) No canister purge control in idle speed, if manifold air temperature less then threshold TATELL

Implementation of phase control:
If the CAN doesn't work (B_esgcan = 1) both control units acitvate the canister purge. If the CAN does word, the master and the slave control unit have their respective tasks:
B_master = 0 means that in this control unit no phase control is calculated. The information "canister purge phase active" B_tepc and "quick closing of canister calve" B_fraoanc are read via CAN from the other control unit and according to it the condition "mixture adaptation phase active" B_gap is calculated.
When B_master = 1 the following phase control plays. The results B_tep and B_fraoan are an output to the CAN.

- The core is a statemachine. The output of this statemachine is the bit B_tepi (internal purge phase). The main internal variable is the RAM cell tephc - phase counter for canister purge/mixture adaptation. It is set to an initial value at the start of each phase. The phase counter is decremented in each state. At zero the system generally switches to the other state.

  The following process control is integrated into this statemachine:
  - Start with a purge phase (B_tepi = TRUE) of length TTEINI, which cannot be aborted (state A_tteini)
  - Switching to state A_tgaini: first mixture adaptation phase -> B_tepi = FALSE
  - Depending on bit B_tteae (long purge phase) transition to state A_tteae (long purge phase with TTEAE) if B_tteae = TRUE, else short purge phase with TTE if B_tteae = FALSE. Both states may be exited prematurely if the remaining time is greater than TTEMN (tephc < TTEMN) and the bit B_teabb (purge ready to finish) is set. => Transition to state A_ttemn. Otherwise when the phase counter has elapsed, transition to mixture adaptation (A_tga).
  - After the adaptation phase, transition to either long or short purge phase.

- Two conditions result in switching to endless canister purge (OR condition with B_tepi):
  - A) B_gasp - mixture adaptation disabled
  - B) Load greater than threshold FTEDS (hysteresis to prevent toggeling of activation of endless canister purge) and load was not at maximum limit (this condition is reset once when time TTEPRIO after start ist elapsed) and
    - time TTEPRIO after start elapsed, or
    - mixture adaptation complete or
    - the starttemperature is higher then threshold TMSNOTGA and any faults are in diagnosis fuel supply system.

- However, some conditions produce a "dominant" switching (activation) of mixture adaptation:
  A) If the DKVS (additive correction) that is active at idle speed" has not yet finished running (B_gae = FALSE) while already B_gaefra(2) = TRUE and the canister load is less than a threshold (FTEADZU) with the idle switch closed.
  After the time TTEBSTP the adaptation is stopped and TEB is started again in order to avoid long adaptation times in long idle phases.
  B) At active lambda control, if B_frao = TRUE, and Z_frao is not set, the system also switches to a mixture adaptation phase at low canister load. In this case the purge valve is closed quickly.
  C) A "diagnosis function active at idle speed" forces a purge phase: B_dldpte, B_dtes, B_dmtltz
  D) Short test via tester: B_grdst = TRUE
  E) at low manifold air temperature in idle speed for a quiet operation the canister purge control is switched off.
  F) time controled mixture adaptation phase starting at time TTEGAZU and ending at time TTEGAZO

- Actiavation of TE-phase with highest priority at the following conditions.
  A) activation from the DLDP by B_teza
  B) time controlled canister purge phase starting at time TTEZAU and ending at Time TTEZAO
  C) There is canister purge at open loop (no lambda control) in one of the control units: B_ten and B_tenc

APP BBTEGA 4.20 Application hint

TTEINI : 220 s
TTEMN : 30 s
TTEGAI : 130 s
TTE : 60 s
TTEAE : 300 s
TTEGA : 60 s
TTEPRIO : 700 s
TTEBSTP : 40 s

TTEGAZU : 250 s for FTP75 the values lay within the TTEGAI-phase: this supplementary feature is not used ##
TTEGAZO : 260 s

TTEGAZU : 1000 s for ECE a adaptation phase can be forced in the high load phase and the following idle time
High engine capacity: propably the 4th range is not reached: late time TTEGAZU is enough
Low engine capacity: eventually TTEGAZU a bit earlier to guarantee that there is enough time for the FRAU-range. ##
TTEGAZO : 1230 s

TTEZAU : FTP: 900s DTEV assured in idle phase at 1000 s after start
TTEZAO : FTP: 1020s

TTEZAU : ECE: 610 s DTEV has 3 chances; if only one chance needed: TTEZAU = 750 s
TTEZAO : ECE: 840 s

TMSNOGA : 50 °C

FTEDS : 20
DFTEDS : 5
FTEADZU : 5 kg/m^3
MSTEOZU : 0.1 kg/h

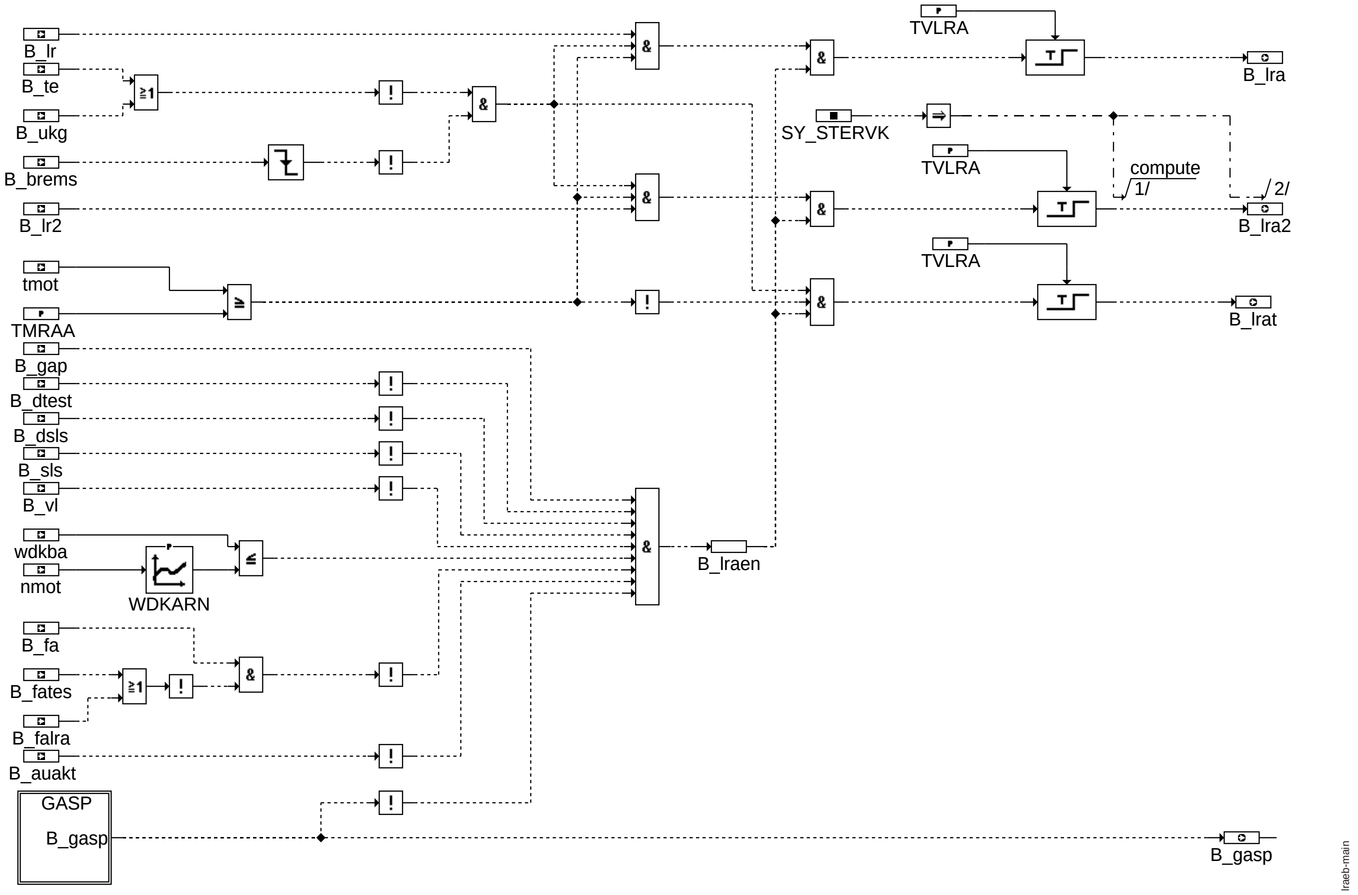
Remarks on the BBTEGA concept for 2 control units

This BBTEGA was optimazed for small changing cost and few communication via CAN. Therefore bear in mind to the following please:
Only the functions of the master control unit can influence the phase control. It therefore may happen that the phase control is not optimal for the slave. Though there is garantie that the functions are undisturbed when activated:

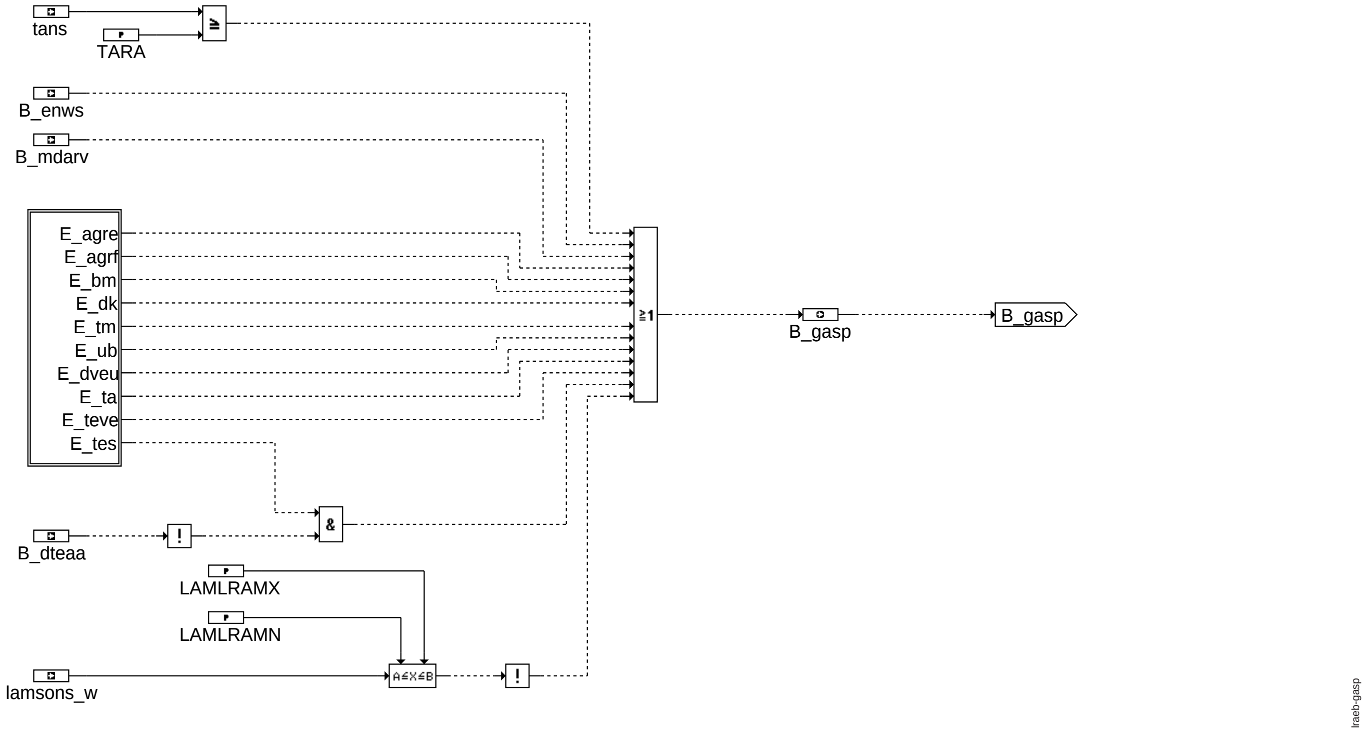
- inhibit of the LRA in both control units, if there is no lambda control in one of the control units and the canister purge is running in open loop.
- The condition B_tep exists in both control units. Each function that requests a canister purge phase must check whether B_tep is set before starting.

LRAEB 4.90 Conditions adaptive pilot control

FDEF LRAEB 4.90 Function definition



lraeb-main



lraeb-gasp

ABK LRAEB 4.90 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
LAMLRAMN			FW	minimum of lambda threshold for mixture adaptation active
LAMLRAMX			FW	maximum of lambda threshold for mixture adaptation active
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TARA			FW	temperature threshold intake air
TMRAA			FW	cut-in temperature adaptive precontrol for lambda closed-loop control
TVLRA			FW	delay time for activation of the lambda adaption after lambda control active
WDKARN	NMOT		KL	threshold throttle angle for activation of the mixture adaptation

Variable	Source	Type	Description
B_AUAKT		EIN	condition emission check active
B_BREMS	GGEGAS	EIN	condition: brake operated
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTEAA	DTEV	EIN	Condition diagnosis CPV by opening the CPV active
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_ENWS	DNWS	EIN	condition error camshaft control
B_FA		EIN	condition general function request
B_FALRA		EIN	condition: requirement adaption open loop
B_FATES		EIN	condition leak detection request
B_GAP	GKEB	EIN	condition mixture adaptation phase active
B_GASP	LRAEB	AUS	condition for basic mixture adaptation disabled
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	LRAEB	AUS	condition for basic mixture adaptation enabled
B_LRA2	LRAEB	AUS	condition for basic mixture adaption 2 enabled
B_LRAEN	LRAEB	LOK	Condition mixture adaptation is enabled
B_LRAT	LRAEB	AUS	condition for basic mixture adaptation temperature dependet enabled
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_SLS	AK	EIN	Condition for active secondary air
B_TE	TEBEB	EIN	Condition canister purge active
B_UKG	ESUK	EIN	condition transient control activated
B_VL	MSF	EIN	Condition for wide open throttle
DFP_AGRE	LRAEB	DOK	ECU int. fault path no.: EKR power stage
DFP_AGRF	LRAEB	DOK	ECU int. fault path no.: partial pressure EGR
DFP_BM	LRAEB	DOK	ECU int. fault path no.: reference mark
DFP_DK	LRAEB	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_DVEU	LRAEB	DOK	ECU-internal fault-path no.: DV-E failure during UMA learning
DFP_TA	LRAEB	DOK	ECU int fault path no.: air intake temperature TANS
DFP_TES	LRAEB	DOK	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE	LRAEB	DOK	Internal fault path number: canister purge valve power stage
DFP_TM	LRAEB	DOK	Internal fault path number: engine temperature
DFP_UB	LRAEB	DOK	Internal fault path number: ambient conditions
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_BM	DDG	EIN	error flag: reference mark sensor
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_DVEU	DDVE	EIN	Error flag: DV-E cause of failure: UMA-learning
E_TA	GGTFA	EIN	error flag: TANS
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
NMOT	SWADAP	EIN	engine speed
TANS	SWADAP	EIN	Intake air temperature
TMOT	SWADAP	EIN	Engine temperature
WDKBA	GGDVE	EIN	throttle angle

FW LRAEB 4.90 Fixed Values

Parameter	Value	Description
LAMLRAMN		minimum of lambda threshold for mixture adaptation active
LAMLRAMX		maximum of lambda threshold for mixture adaptation active
TARA		temperature threshold intake air
TMRAA		cut-in temperature adaptive precontrol for lambda closed-loop control
TVLRA		delay time for activation of the lambda adaption after lambda control active

FB LRAEB 4.90 Detailed description of function

Remarks concerning stereo lambda control:

- This FDEF is intended for systems with stereo lambda control.
- The stereo variables are identified by the suffix 2 (e.g. B_lra -> B_lra2).
- The FDEF is also fully applicable for mono systems. In this case B_lr2 = FALSE. And thus B_LRA2 = FALSE.
- At a Mono system (SY_STERVK) = FALSE B_lra2 is automatically set to FALSE.

Description of the function LRAEB:

- The function LRAEB provides the cut-in conditions for adaptations and the bit "mixture adaptation disabled" (B_gasp).
- For stereo systems the cut-in conditions are separate for each bank (B_lra, B_lra2).

Bit B_gasp:
A series of OBDII errors prohibit mixture adaptation (E_...) . Adaptation is also prohibited at high intake air temperatures (tans>=TARA) . These disable conditions are compiled in the flag B_gasp. When B_gasp = true the system should switch to permanent purging. This is taken into account in the relevant phase control or canister purge module.

Other cut-in conditions:
As long as B_gasp = false, mixture adaptation is only ever enabled if for the time TVLRA the engine temperature was above the threshold TMRAA; lambda control with closed TEV (B_te = FASLE) was uninterrputed active, (B_lr/B_lr2 = true & NOT B_te); the basic adaptation phase was there (B_gap = true); no full load (B_vl = false) and no function / diagnosis function was running to prohibit adaptation (e.g. secondary air injection (B_sls), secondary air diagnosis (B_dsls) or canister purge diagnosis (B_dtest)). The LRA is also stopped for the time TVLRA an activation of the break, so that leakage air can not disturbe rkat_w.

The learning of the mixture adaptation is prohibited by B_ukg = TRUE at least for the time TVLRA in order to avoid an error in diagnosis %DKVS due to a strong effect from transient control.

If an off-bord tuning of the exhaust emission occur, the LRA should be stopped.

If the throttle valve is fully, or almost fully open, no adaptation may occur. In this case the load signal may be falsified by pulsations. Above the throttle valve threshold WDKARN adaptation is disabled for this reason. WDKARN is an engine-speed-dependent characteristic.

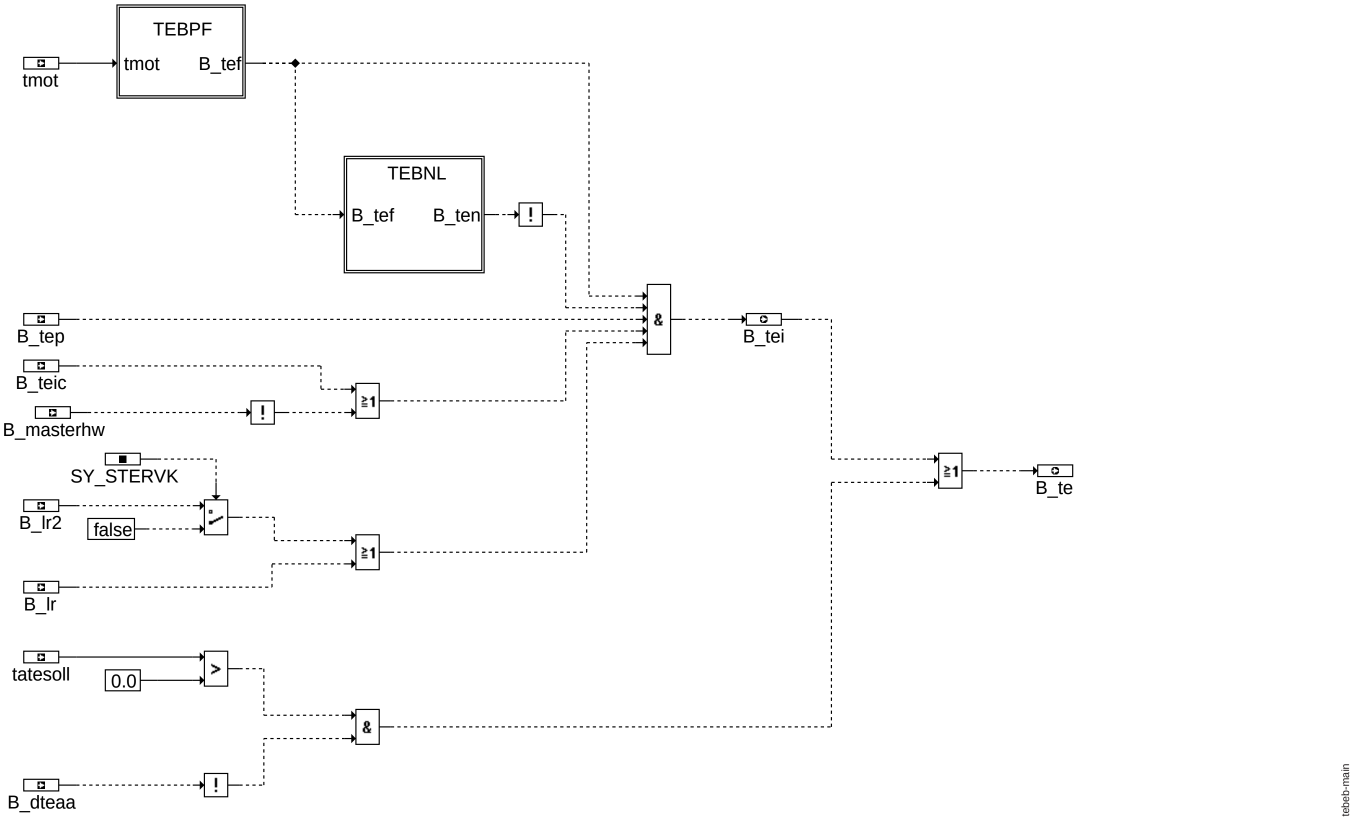
By a function request B_fa = TRUE the LRA is stopped unless B_fates or B_falra are true.
The mixture adaptation is stopped, if desire lambda is more rich then LAMLRAMN or more lear then LRMLRAMX.
For temperature dependent adaptation factor is formed the bit B_frat. It is only active, if the engine temperature is less then the switch on temperature of mixture adaptation.

APP LRAEB 4.90 Application hint

TMRAA: Cut-in threshold for engine temperature. LRA must always be able to be active in the large peak (FTP75). Warm running must be controlled. TMRAA: 50 - 70 ° C
TARA: Cut-off threshold for high intake air temperatures: project-specific: above 60 - 100 °C
TVLRA: Cut-in delay after tatei = 0 and B_lr (B_lr2) = TRUE. Avoids erroneous adaptations when idle control not yet stabilised, e.g. after purge operation or deceleration cut-off. Value: 1 - 4 s
WDKARN: Erroneous adaptations in the pulsation range must be avoided at all costs. Set WDKARN a few percent below the pulsation range.
Remark: The threshold TLWARN (or TLARN) familiar from earlier FDEFs can be converted into WDKARN.
LAMLRAMN : for continue control take greater then value in LALIUSMN [0,8...0,85...0,9] and für two point control take equal 0,95
LAMLRAMX : for continue control [1,2..1,1..1,3] and for two point control take equal 1.05

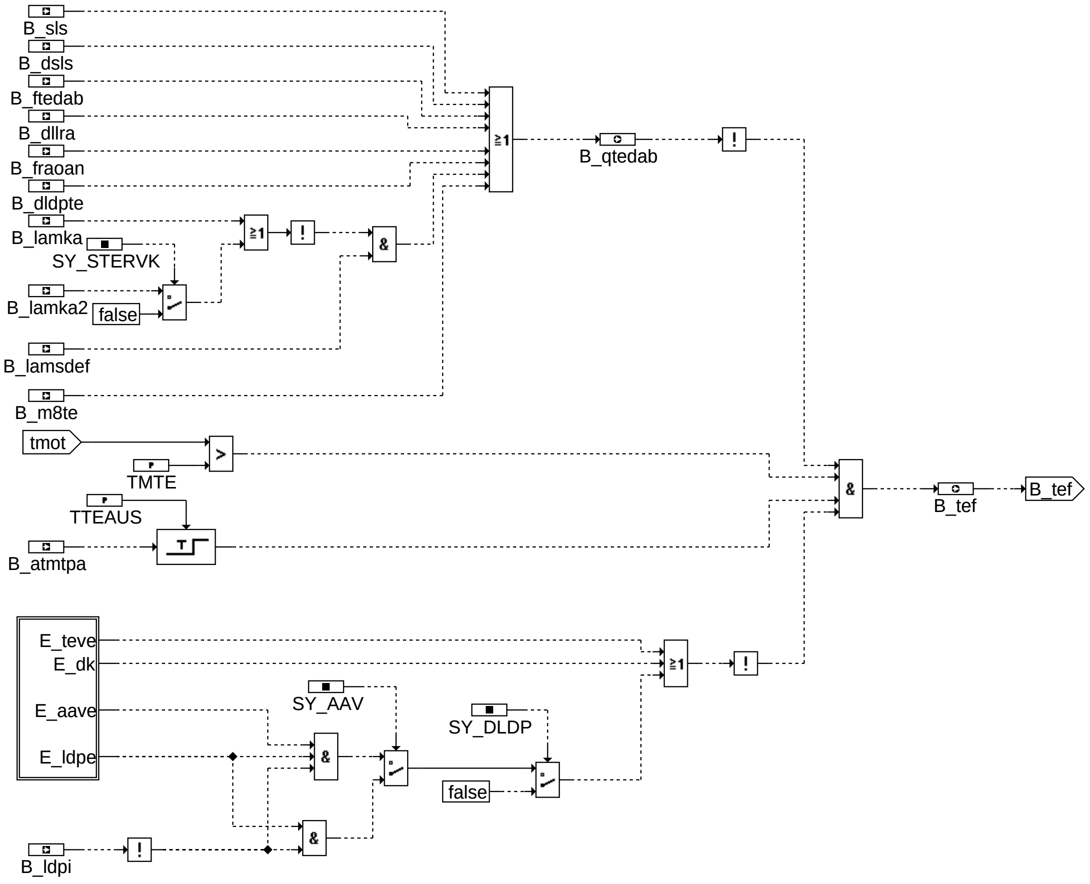
TEBEB 6.20 Switch-on conditions for purge control

FDEF TEBEB 6.20 Function definition



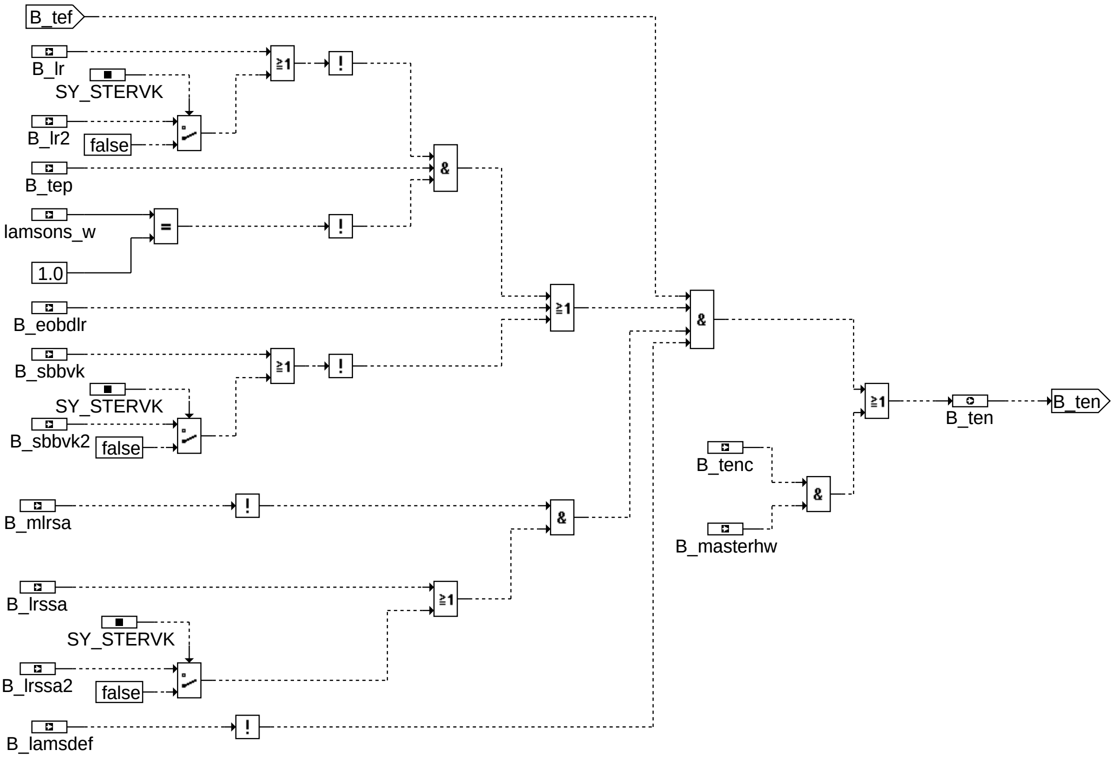
tebeb-main

TEBPF: Purge Control Principally Enabled



tebeb-tebpf

TEBNL: Purge Control at Limp-Home Operation



tebeb-tebnl

ABK TEBEB 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_DLDP			SYS (REF)	SY_DLDP = 1 there ist a DLDP in system
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TMTE			FW	engine-temperature threshold for canister purge
TTEAUS			FW	Delay time after engine start for activating the purge control valve

Variable	Source	Type	Description
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_DLDPTE	GKRA	EIN	request from evap system monitoring to shut down PCV
B_DLLRA	DLLR	EIN	Condition DLLR request
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTEAA	DTEV	EIN	Condition diagnosis CPV by opening the CPV active
B_EOBDLR	LREB	EIN	error flag:ˆOBDII summary fault, disables lambda control
B_FRAOAN	BBTEGA	EIN	demand CPV quickly closing for activtion of mixture adaptation
B_FTEDAB	DTEV	EIN	Condition decrease purge rate for diagnosis CPV
B_LAMKA		EIN	lambda for Katalyst oxygen purge is active
B_LAMKA2		EIN	lambda for Katalyst oxygen purge is active
B_LAMSDEF	LAMKO	EIN	Condition: defined desired air/fuel ratio value
B_LDPI		EIN	condition reed contact leakage diagnosis pump
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRSSA		EIN	LRSEB: switch onLambda after fuel cut off with slow sensor
B_LRSSA2		EIN	switch onLambda after fuel cut off with slow sensor, bank2
B_M8TE	TC8MOD	EIN	condition to enable function evap system by SAE J1879 Mode 8 TID $01
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_MLRSA	LREB	EIN	LRSEB: Air mass based switch off Lambda Control during and after fuel cut off
B_QTEDAB	TEBEB	AUS	condition fast decrementation of purge rate
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_SLS	AK	EIN	Condition for active secondary air
B_TE	TEBEB	AUS	Condition canister purge active
B_TEF	TEBEB	AUS	Condition canister purge function principally released
B_TEI	TEBEB	AUS	Internal condition: canister purge function active
B_TEIC		EIN	Internal condition: canister purge function active (CAN-variable)
B_TEN	TEBEB	AUS	condition open loop purging
B_TENC		EIN	condition open loop purging, input from CAN
B_TEP	GKEB	EIN	Condition canister purge phase active
DFP_AAVE	TEBEB	DOK	ECU int. fault path no.: diagnosis AAVE valve power stage
DFP_DK	TEBEB	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_LDPE	TEBEB	DOK	ECU int. fault path no.: leakage detection pump power stage
DFP_TEVE	TEBEB	DOK	Internal fault path number: canister purge valve power stage
E_AAVE		EIN	error flag: canister ventilation valve (power stage)
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_LDPE		EIN	error flag: leakage detection pump power stage
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
SY_AAV	TEBEB	DOK	system constant condition : shut-off-valve available
TATESOLL	GKRA	EIN	desired duty cycle of the PCV
TMOT	SWADAP	EIN	Engine temperature

FW TEBEB 6.20 Fixed Values

Parameter	Value	Description
TMTE		engine-temperature threshold for canister purge
TTEAUS		Delay time after engine start for activating the purge control valve

FB TEBEB 6.20 Detailed description of function

Concept of purge control with 2 control units:

- This TEBEB is designed for a 2 ECU concept. It will operate identically in the master ECU as well as in the slave ECU. So that the operating mode can be distinguished the bit B_masterhw was introduced. If it is TRUE, then it is the master TEBEB.

- The purge control of both ECUs is to be synchronized so that both PCVs always supply the same quantity of scavenge gas.
  => Result: The TEB in the master ECU must orient itself according to the activation conditions of the slave.

    B_ten in the master is always set if B_ten is set in the slave (reading of the CAN signal B_tenc)
    B_tei is only set in the master if B_teic is set

Description of the Overview:

The function TEBEB contains the enable conditions for purge control. A distinction is made between controlled purge control (Lambda control active - B_tei = TRUE) and limp-home purge control (Lambda control OFF B_ten = TRUE).

The TEBEB has the following output values for other functions:
- B_tef: Principle enabling of the purge control (closed-loop controlled, open-loop controlled)
- B_tei: Enabling of controlled purge control for opening control
- B_te : PCV is (still) open due to triggering by TEB
- B_ten: Limp-home purge control (Lambda control of both banks OFF)
- B_qtedab : Quick closing control of the PCV for diagnostic functions

There are 2 partial functions: TEBPF (principle enabling) and TEBNL (enabling of limp-home). The bits B_tei and B_te are defined in the overview:

- B_tei: B_tei can only be set to TRUE if simultaneously B_tep, B_tef and either B_lr or B_lr2 (with stereo LC) is active. Furthermore B_teic (B_tei of the slave) must set in the master ECU.

  Remark: B_tep also already contains the inquiry for B_dldpte, B_dtes and B_dllr
  In order to be able to perform deactivation at controlled purge control it must be possible to set B_tef separately to FALSE when one of the diagnostic functions is requested.

- In contrast to B_tei, B_te is also TRUE if tatesoll > 0. => B_te indicates that the PCV is open during normal purge control operation. At open PCV due to DTEV, B_te = FALSE. This is achieved by inquiry of B_dteaa. This is necessary so that the learning of the saturation is prohibited in TEB.

Description of the Partial Function TEBPF (Principal Enabling of Purge Control):

Purge control is principally enabled if
- the engine temperature is above the threshold TMTE and if
- no condensed water exists in the exhaust-system branch (B_atmtpa = TRUE) and if the time TTEAUS has elapsed.
- the following faults and conditions are not given:
  - B_sls : Secondary air active
  - B_dsls : Diagnosis secondary air active
  - B_ftedab : Diagnosis purge control system
  - B_dllra : Condition for request close PCV by idle controller diagnosis
  - B_fraoan : With not learned adaptation in FRAO region
  - B_dldpte : Condition for request close PCV by diagnostic function leak diagnosis pump
  - B_lamsdef : Active diagnosis Lambda sensor operates. If the bit B_lamsdef is set due to catalyst deoxidation, the PCV is not controlled close during normal running.
  - E_teve : Fault diagnosis PCV output stage, if B_ldpi = False and LDP output stage fault
  - E_dk : Fault throttle valve sensor
  - E_ldpe : Fault output stage LDP, if B_ldpi = False and no AAV exists
  - B_m8te : Mode 8 active

Description of the Partial Function TEBNL (Enabling of Purge Control, Limp-home Purge Control):

B_ten is only TRUE if the purge control is principally enabled and if the following conditions are fulfilled:
- Neither sensor bank 1 nor sensor bank 2 is ready for operation!(B_sbbvk V B_sbbvk), or if no Lambda control (bank1 or bank2) is active and if the purge control phase is active and lamsons_w is unequal to 1.0, or if an OBDII total fault is given, which prohibits the Lambda control (e.g. secondary air fault)
- Sufficient air mass was put through after fuel cut-off so that the Lambda control is activated again. Thereby it is prevented that e.g. during a purge control phase the PCV opens shortly after fuel cut-off.
- B_lrssa(2): Activation condition of the Lambda controller after fuel cut-off with slow sensor
- The Lambda controller is blocked for an active diagnosis of Lambda sensor and a testing function is started. In this case LIMP-HOME purge control is to be prohibited.
- B_eobdlr: OBDII total fault Lambda controller is blocked
- B_lamsdef = FALSE: Thereby it is prevented that e.g. the purge rate is strongly reduced at controlled catalyst deoxidation
- The bit B_ten is set in the master even if the bit B_tenc has been set.

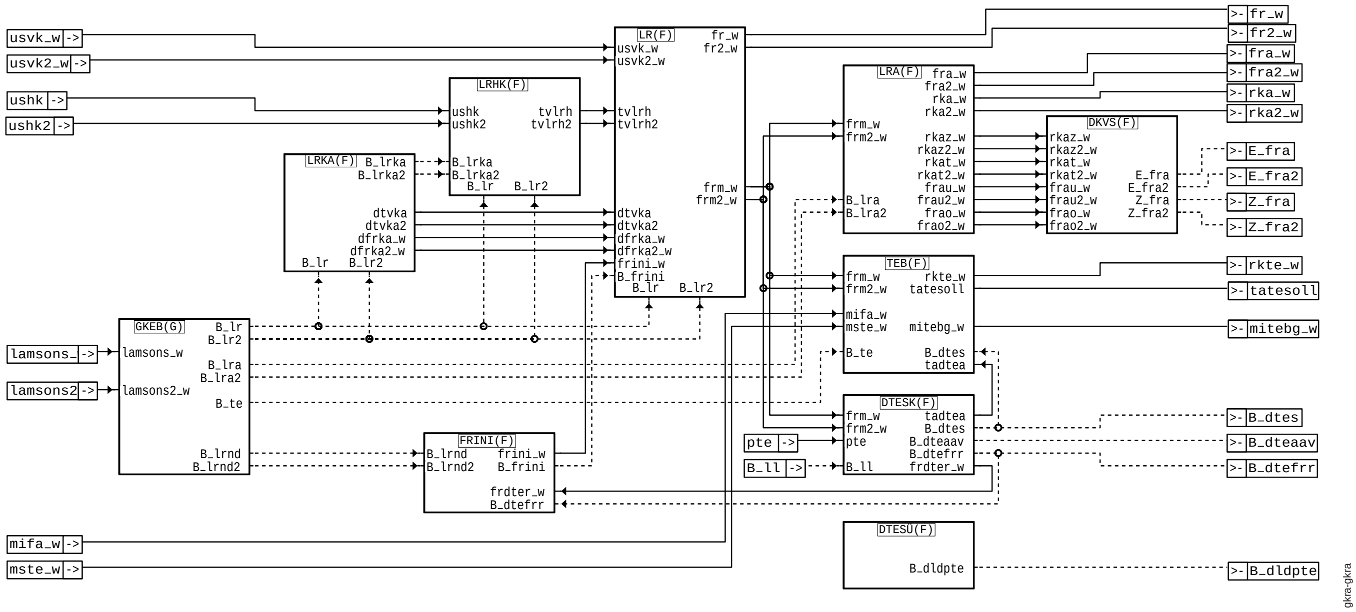
APP TEBEB 6.20 Application hint

```
Engine temperature - activation threshold: TMTE
 * the lower, the earlier the TEB becomes active, the more purging can be performed
 * the higher, the less are the exhaust-gas influences of the TEB at cold catalyst
 => Compromise: TMTE about 40 - 50 degrees

Off-time for purge control after start: TTEAUS
 * Reason: During a hot start the pre-control may at first be too lean, fr must enrich
           so that the saturation ftead does not unlearn itself the purge control is not enabled
           immediately after start.
 => Guidance value: TTEAUS about 10s - 20s
```

GKRA 3.0 Mixture control and adaptive pilot control

FDEF GKRA 3.0 Function definition

Overview Mixture Control and Adaptation:



gkra-gkra

ABK GKRA 3.0 Abbreviations

Variable	Source	Type	Description
B_DLDPTE	GKRA	AUS	request from evap system monitoring to shut down PCV
B_DTEAAV	GKRA	AUS	canister vent valve closed
B_DTEFRR	GKRA	AUS	condition of lambda controller reset
B_DTES	GKRA	AUS	Condition for active diagnosis of canister purge system
B_FRINI	GKRA	LOK	Condition control factor fr initialize
B_LL	MSF	EIN	Condition idle
B_LR	GKRA	LOK	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	GKRA	LOK	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	GKRA	LOK	condition for basic mixture adaptation enabled
B_LRA2	GKRA	LOK	condition for basic mixture adaption 2 enabled
B_LRKA	GKRA	LOK	condition for neutralization of catalyst oxygen storage
B_LRKA2	GKRA	LOK	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRND	GKRA	LOK	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	GKRA	LOK	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_TE	GKRA	LOK	Condition canister purge active
DFRKA2_W	GKRA	LOK	delta-fr for open loop catalyst oxygen neutralization, bank 2
DFRKA_W	GKRA	LOK	delta-fr for open loop catalyst oxygen neutralization
DTVKA	GKRA	LOK	delta-tv for catalyst oxygen neutralization
DTVKA2	GKRA	LOK	delta-tv for catalyst oxygen neutralization for 2nd bank of stereo lambda contr.
E_FRA	GKRA	AUS	error flag: multiplicative mixture adaptation factor fra
E_FRA2	GKRA	AUS	error flag: multiplicative mixture adaption factor fra2
FR	GKRA	LOK	Lambda controller output
FR2_W	GKRA	AUS	Lambda controller output (word)
FRA	GKRA	LOK	multiplicative mixture adaptation factor
FRA2_W	GKRA	AUS	multiplicative correction of the mixture adaptation (word)
FRAO2_W	GKRA	LOK	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	GKRA	LOK	multipl. mixture adaptation factor higher load (word)
FRAU2_W	GKRA	LOK	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAU_W	GKRA	LOK	multipl. mixture adaptation factor of the lower mult. section (Word)

Variable	Source	Type	Description
FRA_W	GKRA	AUS	multiplicative correction of the mixture adaptation (word)
FRDTER_W	GKRA	LOK	lambda control factor as reference value for CPV diagnosis
FRINI_W	GKRA	LOK	Initialisation value for control factor lambda control
FRM2_W	GKRA	LOK	fast mean value of lambda control factor bank 2(word)
FRM_W	GKRA	LOK	fast mean value of lambda control factor (word)
FR_W	GKRA	AUS	Lambda controller output (word)
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
MIFA_W	MSF	EIN	desired indicated engine torque
MITEBG_W	GKRA	AUS	torque value for minimum charge canister purge
MSTE_W	BGTEV	EIN	mass flow purge control into the manifold
PTE	GGDST	EIN	tank pressure (from ADC)
RKA2_W	GKRA	AUS	additive adaptive correction of the relative fuel amount bank 2
RKAT2_W	GKRA	LOK	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	GKRA	LOK	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	GKRA	LOK	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)
RKAZ_W	GKRA	LOK	additive correction (per ignition) of the mixture adaptation
RKA_W	GKRA	AUS	additive adaptive correction of the relative fuel amount
RKTE_W	GKRA	AUS	relative fuel part of the purge control
TADTEA	GKRA	LOK	TEV duty cycle from canister purge diagnosis
TATESOLL	GKRA	AUS	desired duty cycle of the PCV
TVLRH	GKRA	LOK	LRHK: correction value for delayed controller switch tv
TVLRH2	GKRA	LOK	LRHK: correction value for delayed controller switch tv 2
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK2_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVK_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
Z_FRA	GKRA	AUS	cycle flag of mixture adaption factor fra
Z_FRA2	GKRA	AUS	cycle flag:ˆLambda adaptation multiplicative (bank 2)

FW GKRA 3.0 Fixed Values

Parameter	Value	Description

FB GKRA 3.0 Detailed description of function

```
Only for 2-step Lambda control !!!

Overview of Lambda control, mixture adaptation, purge control, tank diagnosis including the activation conditions.
Also contains the phase control mixture adaptation / purge control (%BBTEGA in %GKEB).
```

APP GKRA 3.0 Application hint

LR 89.20 Lambda closed loop control

FDEF LR 89.20 Function definition

Im Abschnitt FDEF wird der Funktionsumfang der Lambdaregelung beschrieben. Die Darstellung erfolgt mittels hyrarchisch strukturierter Blockdiagramme:

Bank 1 und Bank 2

1.   Lambdaregler Bank1 und Bank2 mit globalen Funktionen I-/P-Auswahl und tv-Berechnung

1.1   Lambdaregler Bildung Gesamt-tv-Zeit für Bank1 und Bank2
1.2   Lambdaregler Bildung funktionsspezifische Integratorsteigung,
       P-Sprungwert und fr-Begrenzung für Bank1 und Bank2
1.2.1 Lambdaregler Bildung bankspezifische Integratorsteigung, P-Sprungwert
1.3   Lambdaregler Auswertung Mono/Stereo und Symmetrisch/Unsymmetrisch

Bank 1

2.   Lambdaregler Basisstruktur mit Automat, fr-Integrator und Monitor-Block

2.1   Lambdaregler Automat zur Steuerung von Integrieren, P-Sprung und tv-Zeit
2.2   Lambdaregler Bildung des internen Reglerfaktors frint_w

Bank 2

3.   Lambdaregler Basisstruktur mit Automat, fr-Integrator und Monitor-Block

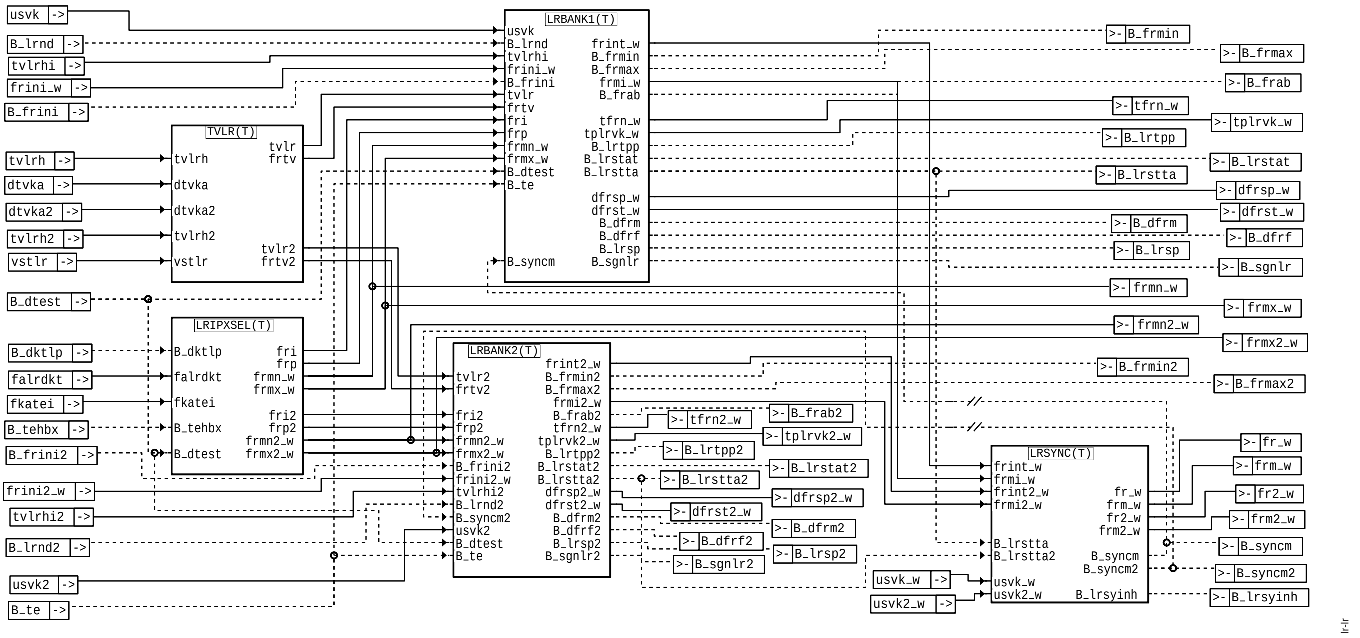
Monitorfunktionen zu Lambdaregelung Bank 1

4.   Lambdaregler Übersicht Basisblöcke zur Ermittlung Stationärbedingung,
      fr-Mittelwert frm_w und Periodendauer

4.1   Lambdaregler Ermittlung zeitbasierte Stationärbedingung
4.2   Lambdaregler Berechnung Periodendauer von fr
4.3   Lambdaregler Bildung aktueller Regelhub dfrps_W
4.4   Lambdaregler Bildung fr-Mittelwert frm_w
4.4.1 Lambdaregler Bildung fr-Mittelwert, Zustandsautomat
4.5   Lambdaregler Ermittlung amplitudenbasierte Statinärbedingung, Adaption Reglerhub
4.6   Lambdaregler Erkennung Amplitudenüberschreitung
4.7   Lambdaregler Ausgabe Status gültige Periodendauer und
      Stationärbedingung Zeit/Amplitude

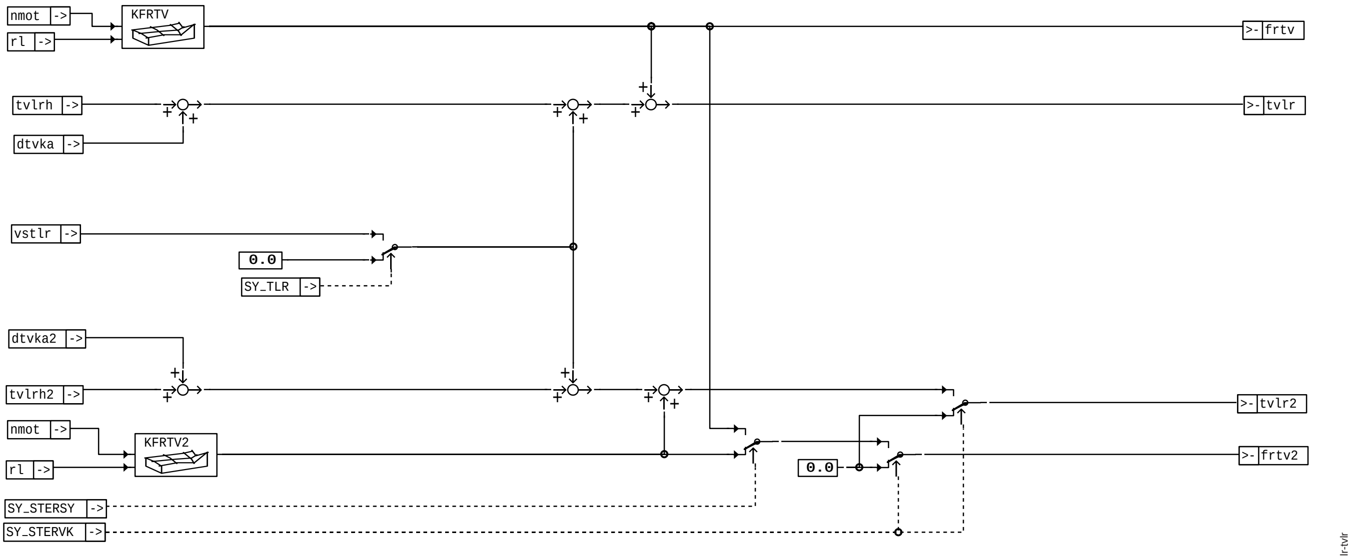
1.   Lambdaregler Bank1 und Bank2 mit globalen Funktionen I-/P-Auswahl und tv-Berechnung

---



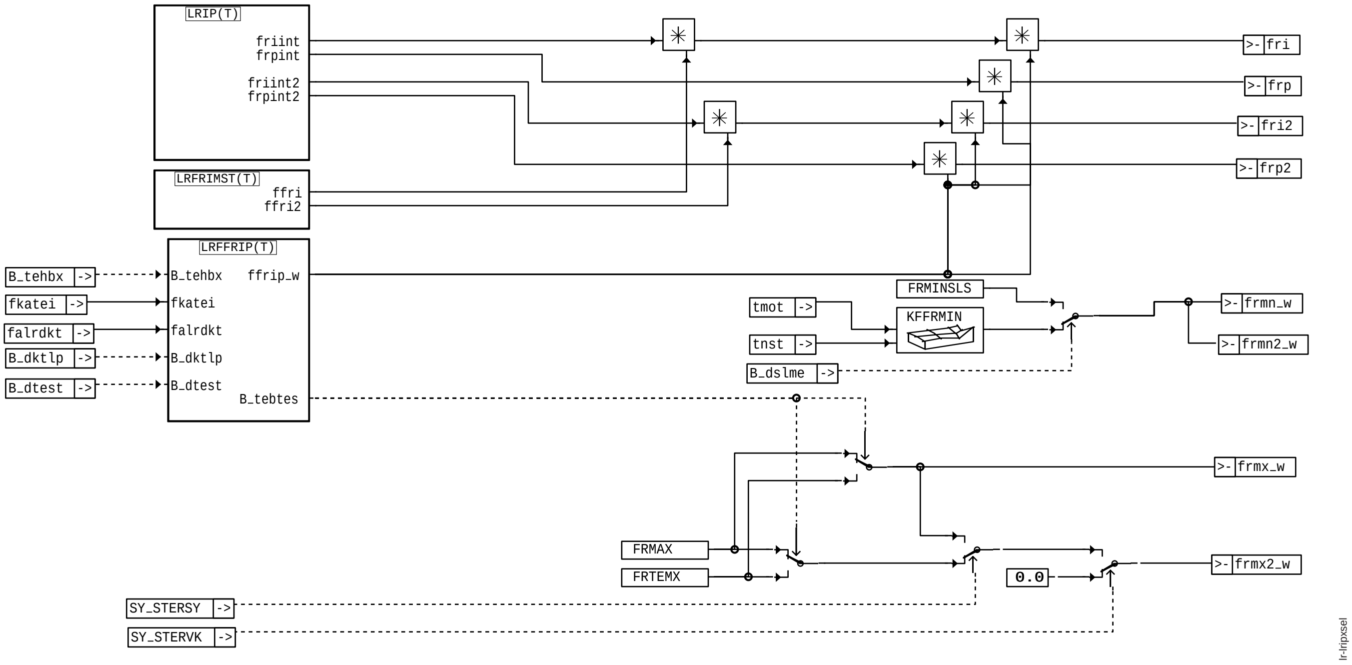
lr-lr

1.1 Lambdaregler Bildung Gesamt-tv-Zeit



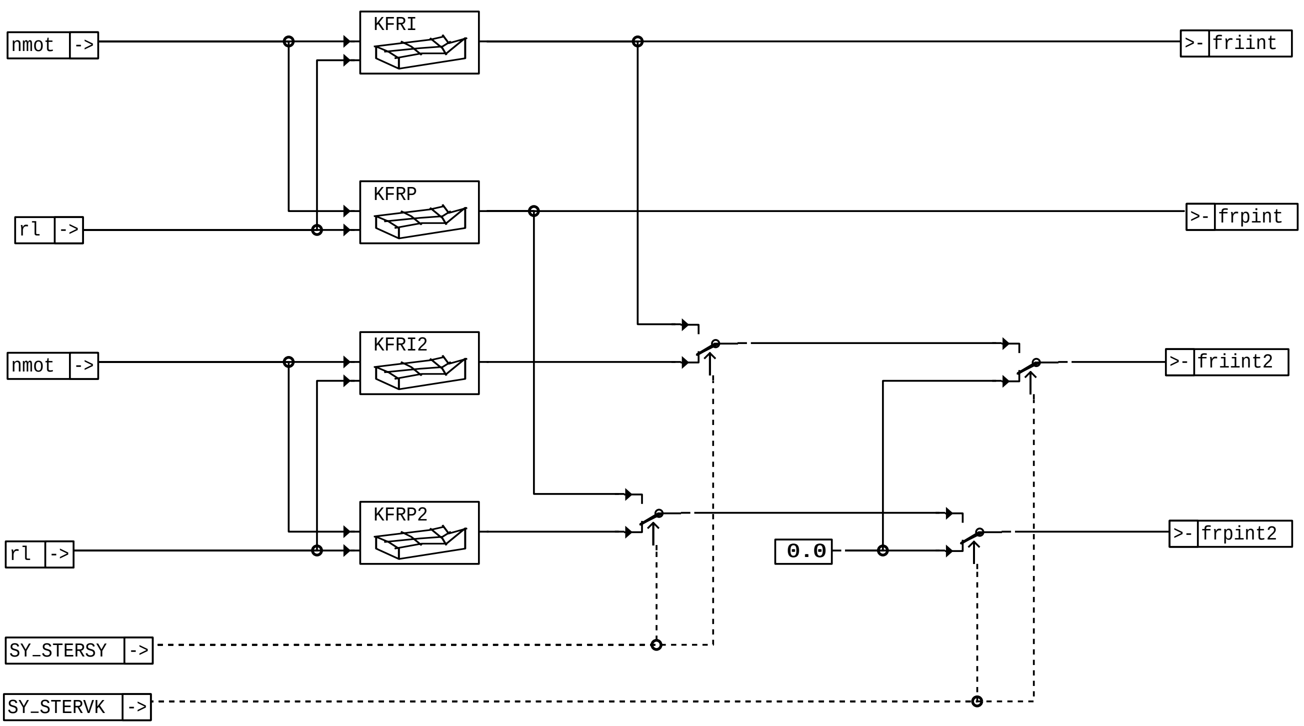
lr-tvlr

1.2 Lambdaregler Bildung funktionsspezifische Integratorsteigung, P-Sprungwert und fr-Begrenzung



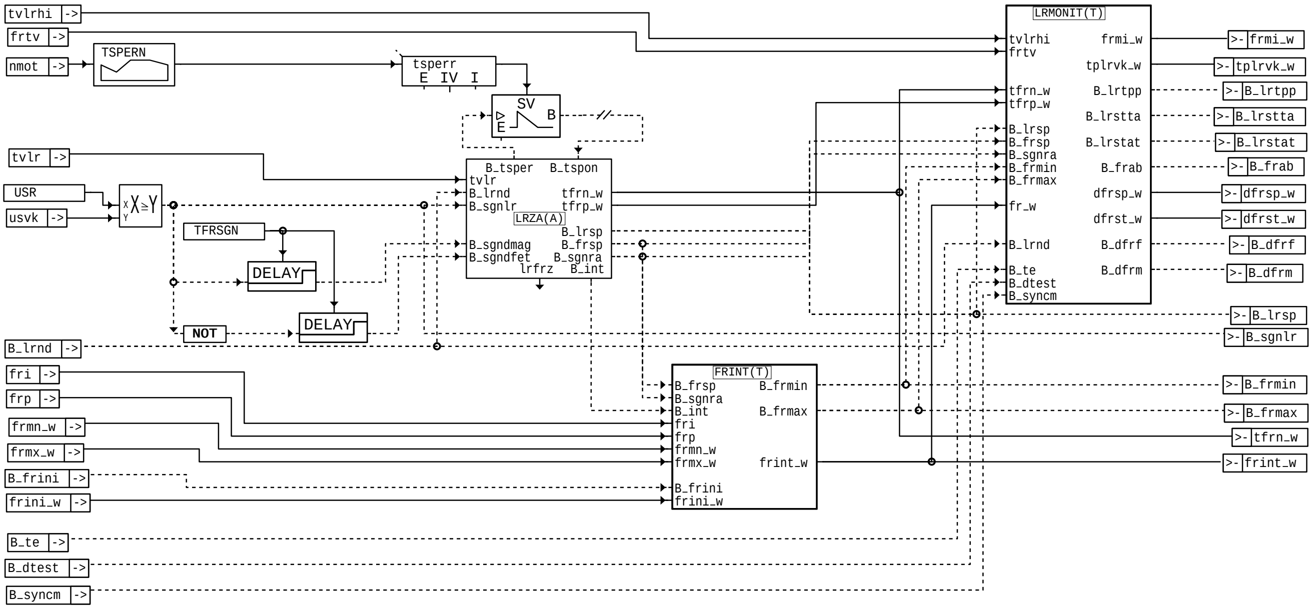
lr-lripxsel

1.2.1 Lambdaregler Bildung bankspezifische Integratorsteigung, P-Sprungwert



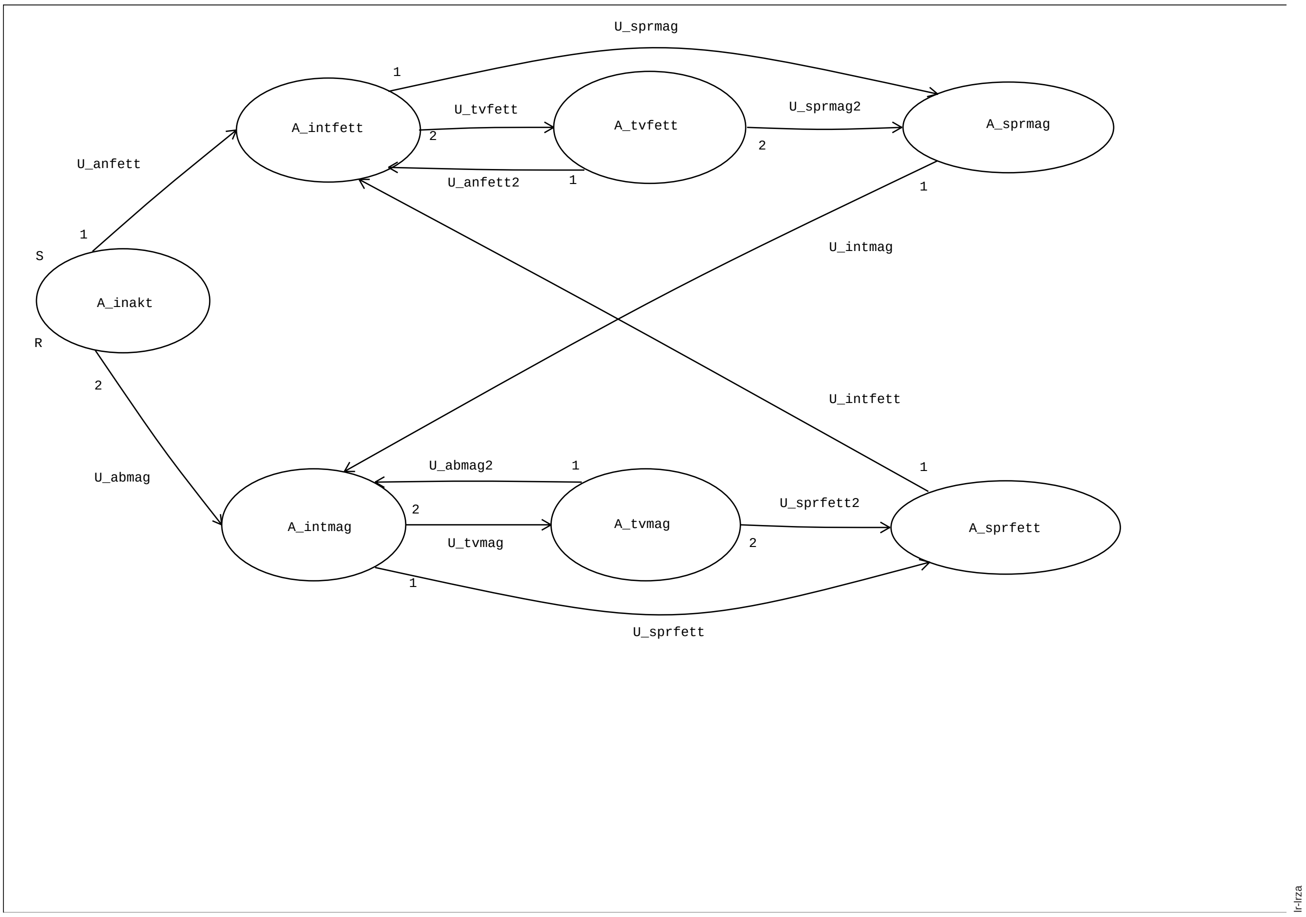
lr-lrip

2. Lambdaregler Basisstruktur Bank 1



lr-lrbank1

2.1 Lambdaregler Automat zur Steuerung von Integrieren, P-Sprung und tv-Zeit



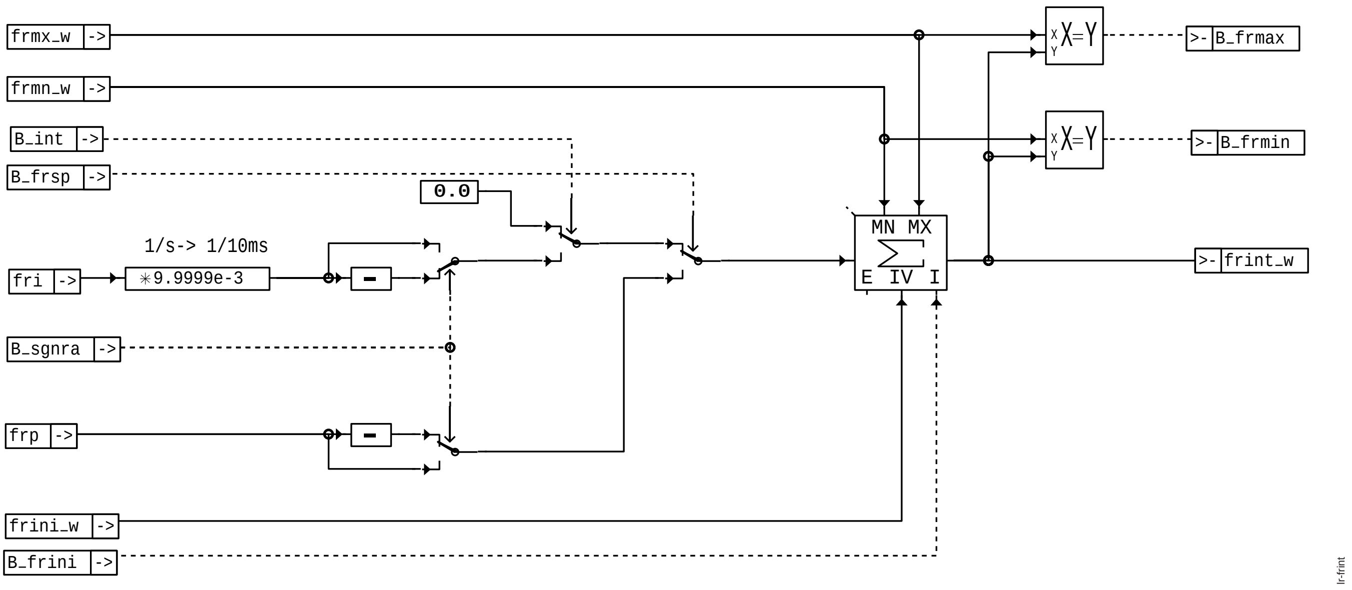
lr-lrza

```
 Zustand
 |    Übergangsname    +- Übergangsbedingung
 |    |    Aktionen    +- Aktions-Code
 |    |    |           |
 V    V    V           V
------------------------------------------------------------------------------------------------------------------------
 A_inakt               Reset-Bedingung: B_lrnd = false                    -- Dies ist der Reset-Zustand, er wird aus allen
                                                                             Zuständen angesprungen, wenn die Reset-Bedingung
                                                                             erfüllt ist.

           Entry:      lrfrz := 0;
           Exit:       tv := 0.0;
                       B_sgnra := B_sgnlr;
                                                                          -- Initialisierung von Variablen,
                                                                          -- damit Division durch Null vermieden wird
                       tfrnint_w := 1.0;
                       tfrpint_w := 1.0;
                       tfrn_w  := 1.0;
                       tfrp_w := 1.0;
      U_anfett:        -- Lambdaregelung freigegeben, Sonde erkennt mageres Gemisch
                       B_lrnd and B_sgnlr
           Action:                                                        -- Sondensprung bei Start
                       B_lrsp := true;
      U_abmag:         -- Lambdaregelung freigegeben, Sonde erkennt fettes Gemisch
                       B_lrnd and not B_sgnlr
           Action:                                                        -- Sondensprung bei Start
                       B_lrsp := true;
------------------------------------------------------------------------------------------------------------------------
 A_intfett
           Entry:                                                         -- Beginn des Integrierens
                       B_int := true;
                                                                          -- Reset der positiven Integrierzeit
                                       tv := 0;                                                                        -
- Reset tv-Zeit
                      tfrpint_w := 0;
                       lrfrz := 1;
           Action:                                                        -- Flag-Bit Sondensprung rücksetzen
                       B_lrsp := false;
                                                                          -- Berechnung der Integrierzeit
```

```
                  tfrpint_w := tfrpint_w + dT;
          Exit:                                                         -- Integrieren beendet
                  B_int := false;
                                                                        -- Ausgabe der positiven Integrierzeit
                  tfrp_w := tfrpint_w;
                                                                        -- Setzen der Sperrzeit
                  B_tsper := true;
                  B_sgnalt := B_sgnlr;
     U_sprmag:    -- Signal fett, Sperrzeit abgelaufen, keine Fettverschiebung:
                  (B_sgnlr = false) and (B_tspon = false) and (tvlr <= 0)

          Action:                                                       -- Sondensprung erkannt
                  B_lrsp := true;
     U_tvfett:    -- Signal fett,  Fettverschiebung gewünscht:
                  (B_sgnlr = false) and (B_tspon = false) and (tvlr > 0)

          Action:                                                       -- Sondensprung erkannt
                  B_lrsp := true;
------------------------------------------------------------------------------------------------------------------------------------
 A_tvfett
          Entry:                                                        -- Setzen der Verzögerungszeit
                  tv := tvlr - dT;
                  lrfrz := 2;
          Action:                                                       -- Flag-Bit Sondensprung rücksetzen
                  B_lrsp := false;
                                                                        -- Abregelung der tv-Zeit:
                  tv := tv - dT;
                                                                        -- Setzen der Sperrzeit, wenn Vorzeichenwechel
                  IF (B_sgnalt <> B_sgnlr) THEN
                          B_tsper := true;
                     ELSE
                          B_tsper := false;
                     ENDIF;
                  B_sgnalt := B_sgnlr;
     U_anfett2:   -- Verzögerungszeit abgelaufen, aber Sonde sieht wieder mager
                  (tv <= 0) and (B_sgnlr) or B_sgndmag
     U_sprmag2:   -- Verzögerungszeit abgelaufen:
                  (tv <= 0)
          Action: B_lrsp := FALSE;
------------------------------------------------------------------------------------------------------------------------------------
 A_sprmag
          Entry:                                                        -- fr-Sprung erlaubt
                  B_frsp := true;
                                                                        -- Vorzeichen für Sprung und Integration setzen
                  B_sgnra := false;
                  lrfrz := 3;
          Exit:                                                         -- fr-Sprung durchgeführt
                  B_frsp := false;
                                                                        -- Flag-Bit Sondensprung rücksetzen
                  B_lrsp := false;
                                                                        -- Bedingung Starten der Sperrzeit zurücksetzen
                  B_tsper := false;
     U_intmag:    true
------------------------------------------------------------------------------------------------------------------------------------
 A_intmag
          Entry:                                                        -- Beginn des Integrierens
                  B_int := true;
                                                                        -- Reset der negativen Integrierzeit
                                  tv := 0;                                                                                         -
- Reset tv-Zeit
                 tfrnint_w := 0;
                  lrfrz := 4;
          Action:                                                       -- Flag-Bit Sondensprung rücksetzen
                  B_lrsp := false;

                  tfrnint_w := tfrnint_w + dT;                          -- Berechnung der Integrierzeit
          Exit:                                                         -- Integrieren beendet
                  B_int := false;
                                                                        -- Ausgabe der negativen Integrierzeit
                  tfrn_w := tfrnint_w;
                                                                        -- Setzen der Sperrzeit
                  B_tsper := true;
                  B_sgnalt := B_sgnlr;
     U_sprfett:   -- Signal mager, Sperrzeit abgelaufen, keine Magerverschiebung:
                  (B_sgnlr = true) and (B_tspon = false) and (tvlr >= 0)

          Action:                                                       -- Sondensprung erkannt
                  B_lrsp := true;
     U_tvmag:     -- Signal mager, Magerverschiebung gewünscht:
                  (B_sgnlr = true) and (B_tspon = false) and (tvlr < 0)

          Action:                                                       -- Sondensprung erkannt
                  B_lrsp := true;
------------------------------------------------------------------------------------------------------------------------------------
 A_tvmag
          Entry:                                                        -- Setzen der Verzögerungszeit
```

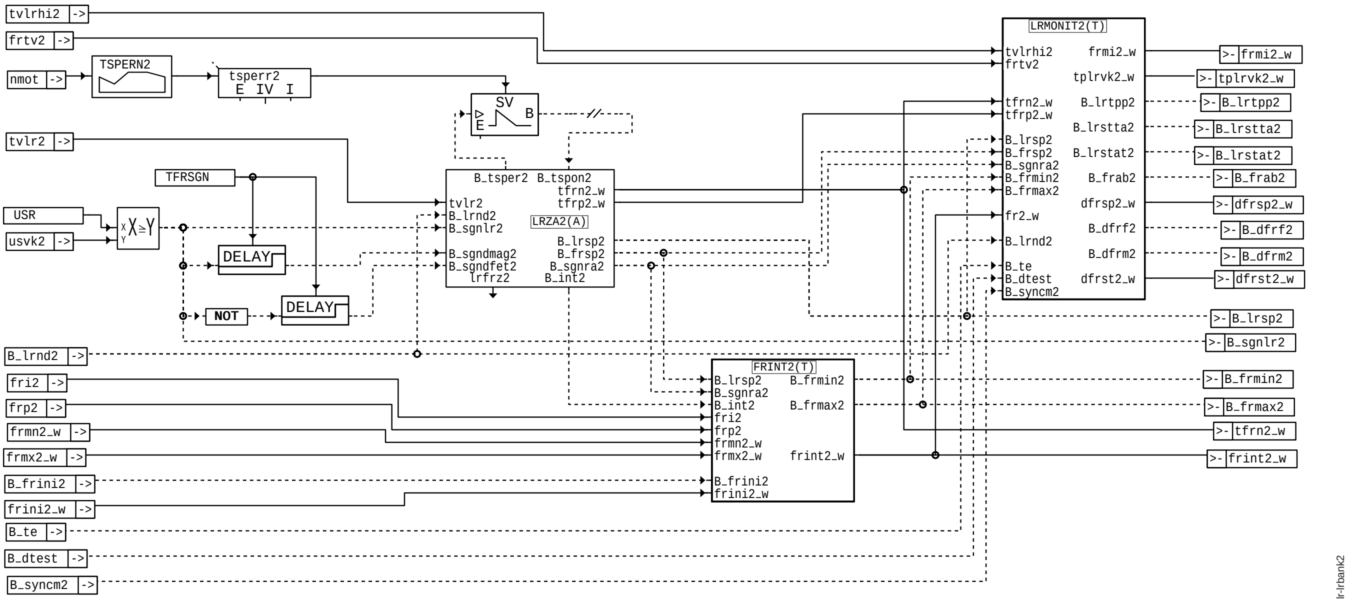
```
                     tv := -(tvlr + dT);
                     lrfrz := 5;
          Action:                                                    -- Flag-Bit Sondensprung rücksetzen
                     B_lrsp := false;
                                                                     -- Abregelung der tv-Zeit:
                     tv := tv - dT;
                                                                     -- Setzen der Sperrzeit, wenn Vorzeichenwechel
                     IF (B_sgnalt <> B_sgnlr) THEN
                             B_tsper := true;
                        ELSE
                             B_tsper := false;
                        ENDIF;
                     B_sgnalt := B_sgnlr;
     U_abmag2:       -- Verzögerungszeit abgelaufen, aber Sonde sieht wieder fett
                     (tv <= 0) and (not B_sgnlr) or B_sgndfet
     U_sprfett2:     -- Verzögerungszeit abgelaufen:
                     (tv <= 0)
          Action:    B_lrsp := FALSE;
-----------------------------------------------------------------------------------------------------------------------------------
 A_sprfett
          Entry:                                                     -- Sprung erlaubt
                     B_frsp := true;
                                                                     -- Vorzeichen für Sprung und Integration setzen
                     B_sgnra := true;
                     lrfrz := 6;
          Exit:                                                      -- Sprung durchgeführt
                     B_frsp := false;
                                                                     -- Flag-Bit Sondensprung rücksetzen
                     B_lrsp := false;
                                                                     -- Bedingung Starten der Sperrzeit zurücksetzen
                     B_tsper := false;
     U_intfett:      true
===================================================================================================================================
 Lokale Variablen:
     Float tv := 0.0;        -- [s]
     Float tfrpint_w := 0.0;

     Float tfrnint_w := 0.0;

     Bool B_sgnalt := false;
```

2.2 Lambdaregler Bildung des internen Reglerfaktors frint_w



lr-frint

3. Lambdaregler Basisstruktur Bank 2



lr-lrbank2

4. Lambdaregler Übersicht Basisblöcke zur Ermittlung Stationärbedingung, fr-Mittelwert frm_w und Periodendauer

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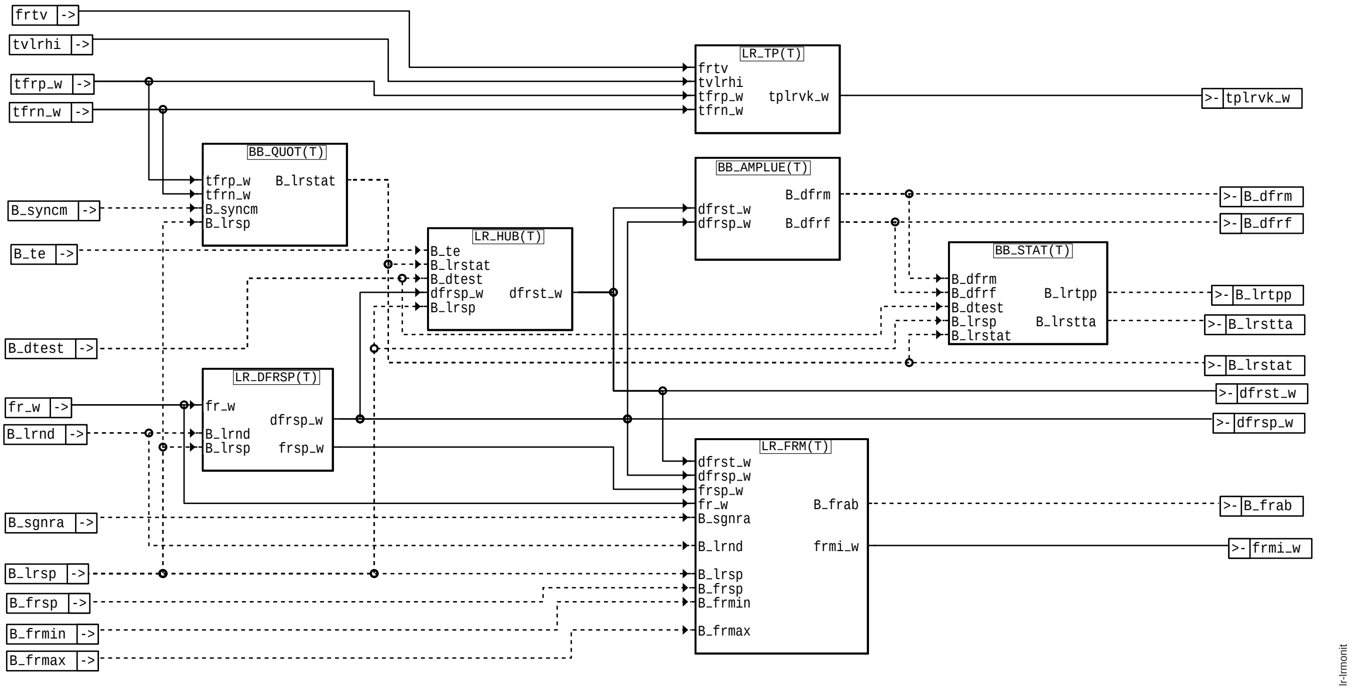
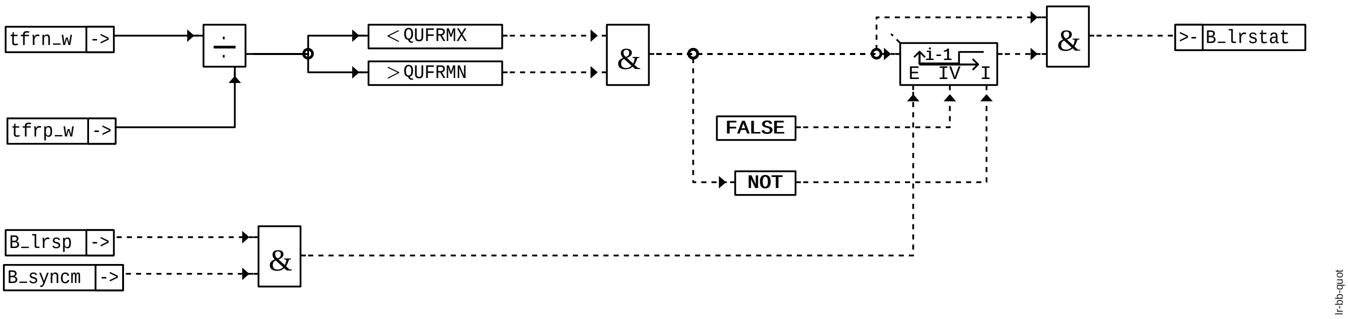


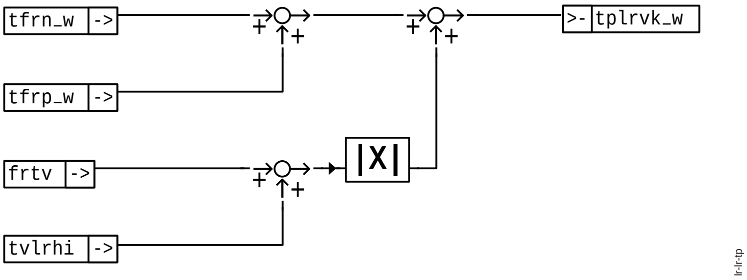
lr-lrmonit

4.1 Lambdaregler Ermittlung zeitbasierte Stationärbedingung



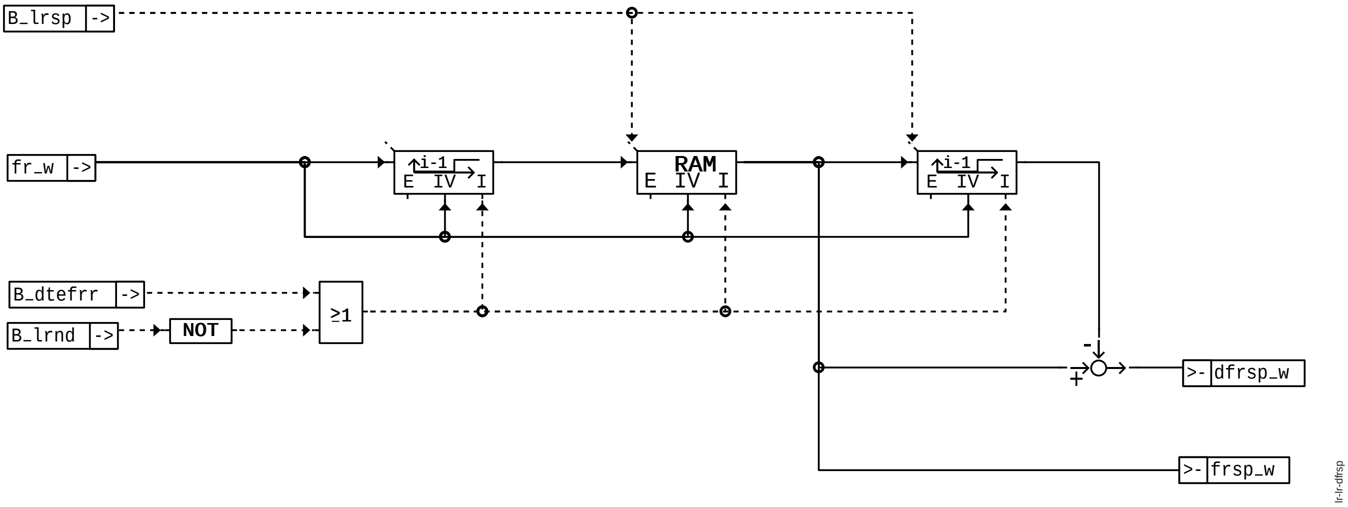
lr-bb-quot

4.2 Lambdaregler Berechnung Periodendauer von fr



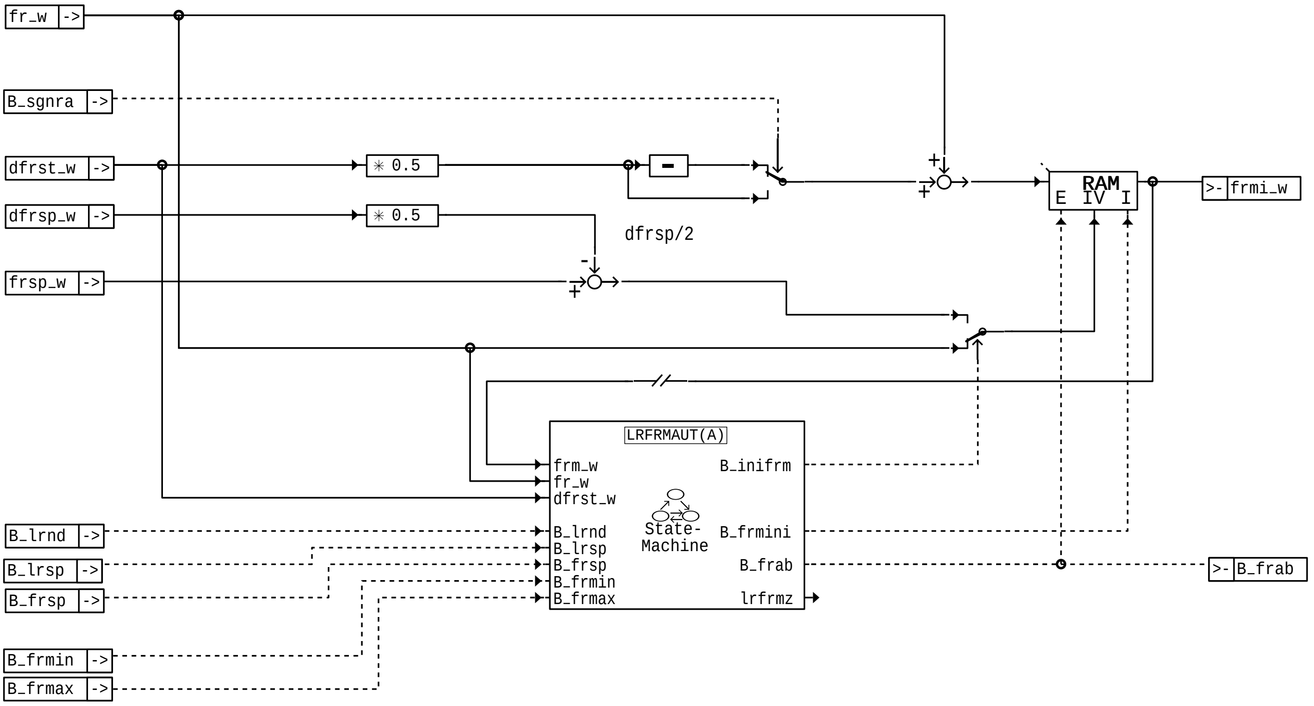
lr-lr-tp

4.3 Lambdaregler Bildung aktueller Regelhub dfrps_W



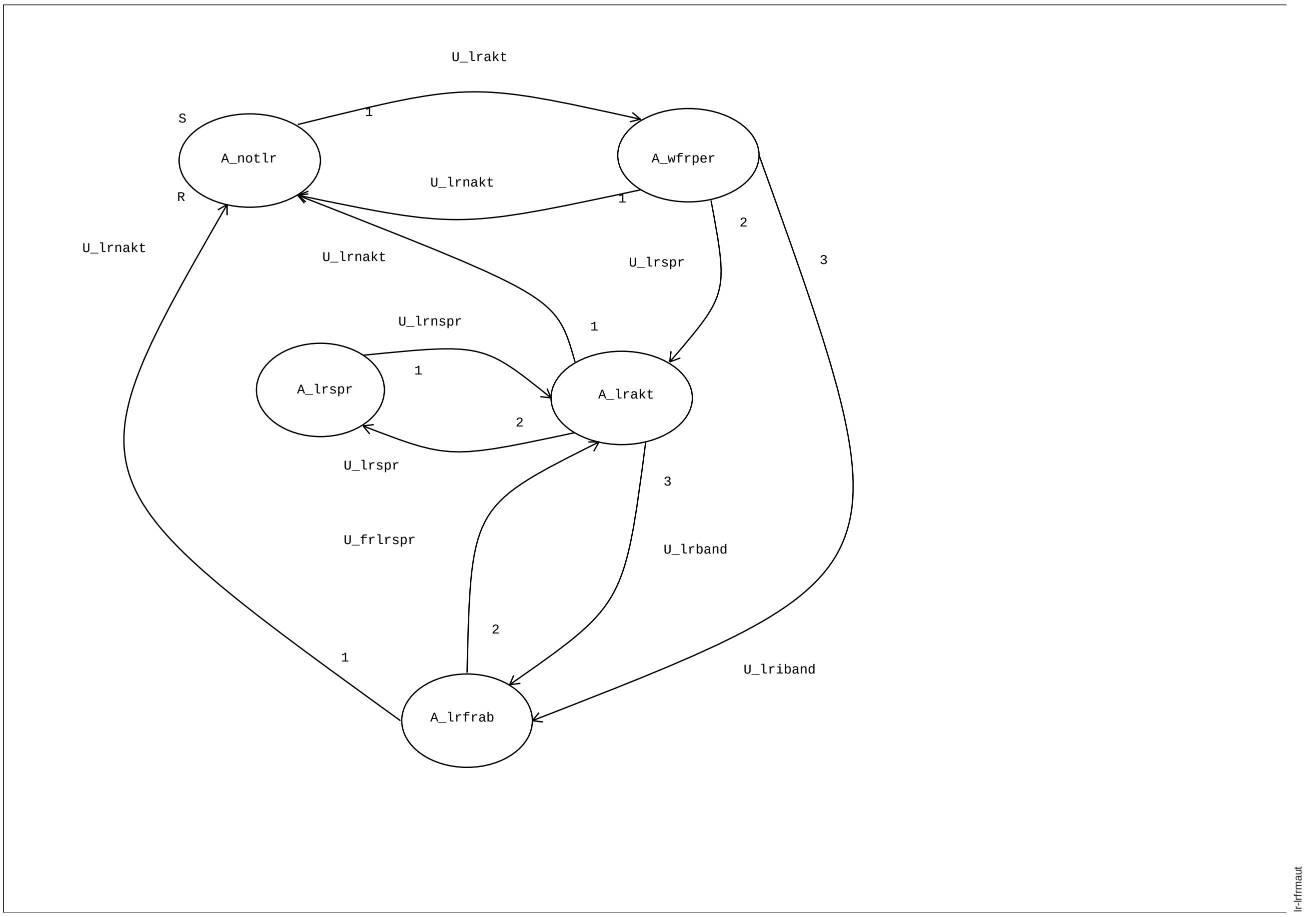
lr-lr-dfrsp

4.4 Lambdaregler Bildung fr-Mittelwert frm_w



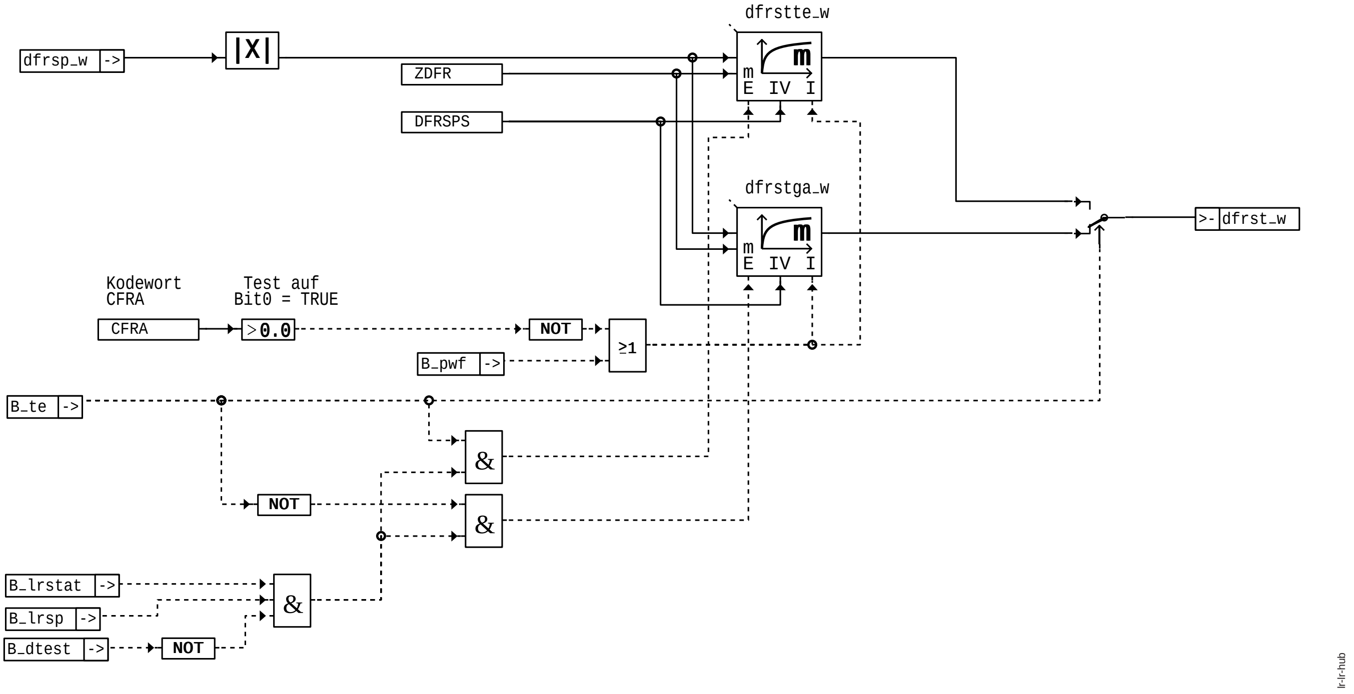
lr-lr-frm

4.4.1 Lambdaregler Bildung fr-Mittelwert, Zustandsautomat



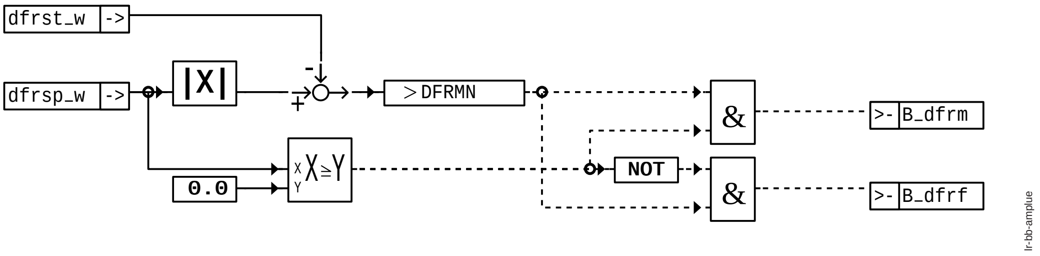
lr-lrfrmaut

4.5 Lambdaregler Ermittlung amplitudenbasierte Statinärbedingung, Adaption Reglerhub



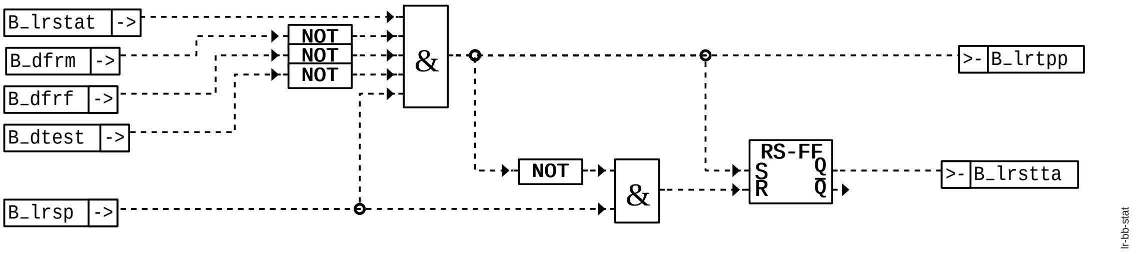
lr-lr-hub

4.6 Lambdaregler Erkennung Amplitudenüberschreitung



lr-bb-amplue

4.7 Lambdaregler Ausgabe Status gültige Periodendauer und Stationärbedingung Zeit/Amplitude



lr-bb-stat

ABK LR 89.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CFRA			FW	code word for adaptation of control amplitude
CWLRSYNC			FW	Code word: Selects bank1 or bank2 as master during fr-synchronization
DFRMN			FW	min. lambda deviation for steady state cond. and adaptation of transient contrl.
DFRSPS			FW	stroke of A/F ratio controller signal (standard value)
DLRPERIMN			FW	
DLRPERIMX			FW	

Parameter	Source-X	Source-Y	Type	Description
FFRITMS	TMST		KL	tmst dependent factor to modify I-dynamic of lambda control
FLRFKATE	FKATEI		KL	Rating of factor fkatei from %TEB to optimize the regulation parameter
FLRM	TMOT		KL	Engine temperature dependent factor to modify I-dynamic of lambda control
FRIPDSL1			FW	Factor adjustment of fri and frp during active phase 1 of DSLSLR
FRIPDSL4			FW	Factor adjustment of fri and frp during active phase 4 of DSLSLR
FRIPDTES			FW	Factor adjustment of fri and frp during active DTEV
FRIPTES			FW	Factor adjustment of fri and frp at fault ”open TEV pinch”
FRMAX			FW	upper limit of control range
FRMINSLS			FW	lower control range limit during phas1 of secondary air system diagnosis
FRTEMX			FW	upper limit of control range on error ”cannister purge valve open”
KFFRMIN	TMOT	TNST	KF	lower limit of control range
KFRI	NMOT	RL	KF	I characteristic map
KFRI2	NMOT	RL	KF	LR-I-Map for bank 2
KFRP	NMOT	RL	KF	P characteristic map
KFRP2	NMOT	RL	KF	LR-P MAP for bank 2
KFRTV	NMOT	RL	KF	delay time characteristic map
KFRTV2	NMOT	RL	KF	delay time characteristic map
KLRSYNIN	NMOT		KL	
KLRSYNPN	NMOT		KL	
QUFRMN			FW	lower limit for static condition of lambda controller
QUFRMX			FW	upper limit for static condition of lambda controller
TFRSGN			FW	
TSPERN	NMOT		KL	lock time for p-offset after lambda sensor voltage jump
TSPERN2	NMOT		KL	lock time for p-offset after lambda sensor voltage jump, bank 2
USR			FW	controller theshold for lambda control upstream catalyst
ZDFR			FW	filter constant for calc. of A/F ratio contr. stroke mean value
ZLRFRI			FW	Time constant for ingreasing of tmst depending weighting factor FFRITMS

Variable	Source	Type	Description
B_ATMTPA	ATM	EIN	condition temperature upstream catalyst exceeds dew-point
B_ATMTPA2	ATM	EIN	condition temperature upstream catalyst exceeds dew-point2
B_DFRF	LR	AUS	rich deviation by %LR detected
B_DFRF2	LR	AUS	rich deviation by %LR detected, bank2
B_DFRM	LR	AUS	lean deviation by %LR detected
B_DFRM2	LR	AUS	lean deviation by %LR detected, bank2
B_DKTLP	DKAT	EIN	Request of parameter switch over in lambda control
B_DSL1		EIN	Diagnosis phase 1: secondary air mass
B_DSL4		EIN	Condition phase 4: secondary air mass adaptation/ add. diagnosis
B_DSLME		EIN	diagnostis secondary air mass, enable measurement
B_DTEFRR	GKRA	EIN	condition of lambda controller reset
B_DTEST	DTEV	EIN	condition for start of TEV opening
B_FRAB	LR	AUS	condition fr outside adapted controller range
B_FRAB2	LR	AUS	condition fr outside adapted controller range, bank 2
B_FRINI	LRINI	EIN	Condition control factor fr initialize
B_FRINI2	LRINI	EIN	Condition control factor fr initialize, bank 2
B_FRMAX	LR	AUS	lambda control sets bit when lambda controller reaches its limit FRMAX
B_FRMAX2	LR	AUS	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_FRMIN	LR	AUS	lambda control sets bit when lambda controller reaches its limit FRMIN
B_FRMIN2	LR	AUS	lambda control sets bit when lambda control reaches its limit FRMIN,bank2
B_FRMINI	LR	LOK	condition for initialize frm
B_FRMINI2	LR	LOK	condition for initialize frm bank 2
B_FRSP	LR	LOK	Flag controller factor fr is jumping
B_FRSP2	LR	LOK	Flag controller factor fr is jumping, Bank 2
B_INIFRM	LR	LOK	Condition for the choixe of initial value of frm_w
B_INIFRM2	LR	LOK	Condition for the choixe of initial value of frm_w , bank 2
B_INT	LR	LOK	LR: Condition Intregation allowed
B_INT2	LR	LOK	LR: Condition Intregation allowed , bank 2
B_LL	MSF	EIN	Condition idle
B_LRND	LREB	EIN	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_LRND2	LREB	EIN	set control bit LR activ; request for ”NORMAL” or ”DIAGNOSIS”
B_LRPERF	LR	LOK	Averaging of rich period terminated
B_LRPERM	LR	LOK	Averaging of lean period terminated
B_LRSP	LR	AUS	Flag ’O2 sensor voltage crosses threshold detected’
B_LRSP2	LR	AUS	condition for sensor signal bounce cylinderbench 2
B_LRSTAT	LR	AUS	static condition for lambda controller
B_LRSTAT2	LR	AUS	static condition for lambda controller, bank2
B_LRSTTA	LR	AUS	static condition for lambda controller, time and amplitude
B_LRSTTA2	LR	AUS	static condition for lambda controller, time and amplitude, bank2
B_LRSTTAMA	LR	LOK	static condition for lambda controller master, time and amplitude
B_LRSYINH	LR	AUS	Condition fr_b1-/fr_b2-synchronization due to min/max limiter disabled
B_LRSYNB1	LR	LOK	Condition fr_b1-/fr_b2-synchronization active, bank 1 is master
B_LRSYNC	DKAT	EIN	Condition fr_b1-/fr_b2-synchronization requested
B_LRSYNI	LR	LOK	Condition fr_b1-/fr_b2-synchronization active, local
B_LRTPP	LR	AUS	Periodic time valid, static cond. for %LR (amplitude/periodic time) = TRUE
B_LRTPP2	LR	AUS	static condition for lambda controller (amplitude/periodic time) bank2
B_PWF		EIN	Condition for powerfail
B_SBBVK	DLSV	EIN	condition for lambda sensor upstream cat ready for operation
B_SBBVK2	DLSV	EIN	condition oxygen sensor upstream cat. bank2 ready for operation
B_SBBVKSL	LR	LOK	condition for lambda sensor upstream cat ready for operation, slave bank
B_SGNALT	LR	LOK	Indication of rich / lean mixture pre cat, 1 slot retarded
B_SGNALT2	LR	LOK	Indication of rich / lean mixture pre cat, 1 slot retarded

Variable	Source	Type	Description
B_SGNDFET	LR	LOK	
B_SGNDFET2	LR	LOK	
B_SGNDMAG	LR	LOK	
B_SGNDMAG2	LR	LOK	
B_SGNLR	LR	AUS	calculation sign for mixture upsteam cat (Bool)
B_SGNLR2	LR	AUS	calculation sign for mixture upsteam cat (Bool), bank 2
B_SGNRA	LR	LOK	Indication of rich / lean mixture pre cat due to delay time control
B_SGNRA2	LR	LOK	Indication of rich / lean mixture pre cat due to delay time control bank2
B_SYNCM	LR	AUS	Condition fr_w-/fr2_w-synchronization active, fr_w is used as master
B_SYNCM2	LR	AUS	Condition fr-synchronization active,bank 2 is used as master
B_TE	TEBEB	EIN	Condition canister purge active
B_TEBTES	LR	LOK	Dynamic manipulation of i and p part activated by B_tehbx or B_dtes
B_TEHBX	TEB	EIN	Condition load integrator ftead at max. limit
B_TSPER	LR	LOK	LR: Condition Start of delay time
B_TSPER2	LR	LOK	LR: Condition Start of delay time, bank 2
B_TSPON	LR	LOK	Condition of start of delay time in LR for signal interference elimination
B_TSPON2	LR	LOK	Condition of start of delay time in LR for signal interference elimination,bank2
C_INI	SWADAP	EIN	ECU-condition for intialisation
DFRSP2_W	LR	AUS	delta peak value lambda control factor frsp bank 2
DFRSP_W	LR	AUS	delta peak value lambda control factor frsp
DFRST2_W	LR	AUS	A/F ratio controller output stroke in steady-state condition (cylinderbench 2)
DFRSTGA2_W	LR	DOK	controller output stroke in steady-state condition (basic adaptation), bank 2
DFRSTGA_W	LR	DOK	controller output stroke in steady-state condition (basic adaptation)
DFRSTTE2_W	LR	DOK	controller output stroke in steady-state condition (canister purge), bank 2
DFRSTTE_W	LR	DOK	controller output stroke in steady-state condition (canister purge)
DFRST_W	LR	AUS	A/F ratio controller output stroke (steady-state condition)
DLRPERI_W	LR	LOK	
DLRPERP_W	LR	LOK	
DLRPER_W	LR	LOK	
DPERMF_W	LR	LOK	
DTVKA	LRKA	EIN	delta-tv for catalyst oxygen neutralization
DTVKA2	LRKA	EIN	delta-tv for catalyst oxygen neutralization for 2nd bank of stereo lambda contr.
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
FALRDKT	DKAT	EIN	Request form cat monitoring: modify lambda controller amplitude
FFRI	LR	LOK	LR with integrator stop: weighing factor I-Slope to compensate slow sensor
FFRI2	LR	LOK	LR with integrator stop: weighing factor I-Slope to compensate slow sensor,bank2
FFRIP_W	LR	LOK	LR with integrator stop: weighing factor I-Slope to compensate slow sensor
FKATEI	TEB	EIN	factor fuel part purge control (actuel value)
FR2_W	LR	AUS	Lambda controller output (word)
FRBAND2_W	LR	LOK	Close loop regulation frm calculation local variable Bank2
FRBAND_W	LR	LOK	Close loop regulation frm calculation local variable Bank2
FRI	LR	LOK	LR with integrator stop: gradient from KFRI(n,tL) or corresp. to DSLS
FRI2	LR	LOK	bank2: LR with integrator stop: gradient from KFRI(n,tL) or corresp. to DSLS
FRIBAND2_W	LR	LOK	Close loop regulation frm calculation local variable Bank2
FRIBAND_W	LR	LOK	Close loop regulation frm calculation local variable
FRIINT	LR	LOK	gradient from KFRI(nmot,rL) or corresp. to DSLS, local use
FRIINT2	LR	LOK	gradient from KFRI(nmot,rL) or corresp. to DSLS, local use, bank 2
FRINI2_W	LRINI	EIN	Initialisation value for control factor lambda control, bank 2
FRINI_W	LRINI	EIN	Initialisation value for control factor lambda control
FRINT2_W	LR	LOK	Close loop lambda coltrol regulation factor Bank 2 Integrator value
FRINT_W	LR	LOK	Close loop lambda coltrol regulation factor Integrator value
FRM2_W	LR	AUS	fast mean value of lambda control factor bank 2(word)
FRMA_W	LR	LOK	Lambda controller output (word), master during syncronisation
FRMI2_W	LR	LOK	Bypass: fast mean value of lambda control factor bank 2(word)
FRMI_W	LR	LOK	Bypass: fast mean value of lambda control factor (word)
FRMMA_W	LR	LOK	fast mean value of lambda control factor (word), master during synchronisation
FRMN2_W	LR	AUS	lambda regulator output min., bank 2
FRMN_W	LR	AUS	lambda regulator output min.
FRMSL_W	LR	LOK	fast mean value of lambda contr. factor (word), for slave during synchronisation
FRMX2_W	LR	AUS	LR bank 2: Maximum limit. of integrator fr;FRMAX increased by DSLS
FRMX_W	LR	AUS	LR with integrator stop:Maximum limit. of integrator fr;FRMAX increased by DSLS
FRM_W	LR	AUS	fast mean value of lambda control factor (word)
FRP	LR	LOK	LR with integrator stop; P-jump from KFRP(n,tL), or DSLS enabled
FRP2	LR	LOK	bank2: LR with integrator stop; P-jump from KFRP(n,tL), or DSLS enabled
FRPINT	LR	LOK	P-part from KFRP(nmot,rL) or corresp. to DSLS, local use
FRPINT2	LR	LOK	P-part from KFRP(nmot,rL) or corresp. to DSLS, local use, bank 2
FRSL_W	LR	LOK	Lambda controller output (word), slave during syncronisation
FRSP2_W	LR	LOK	Lambda close loop control: Regulation factor fr before p-jump bank2/min-value)
FRSP_W	LR	LOK	Lambda close loop control: Regulation factor fr before p-jump
FRTV	LR	LOK	integrator stop from KFRTV(nmot,rL) or corresp. to DSLS
FRTV2	LR	LOK	integrator stop from KFRTV(nmot,rL) or corresp. to DSLS, bank 2
FR_W	LR	AUS	Lambda controller output (word)
LRFRMZ	LR	LOK	Condition byte, Creation of fr-mean value frm_w
LRFRMZ2	LR	LOK	Condition byte of calculation Fr-meam value frm_w, Bank2
LRFRZ	LR	LOK	Condition byte of LR-machine
LRFRZ2	LR	LOK	Condition byte of LR-machine , bank2
NMOT	SWADAP	EIN	engine speed
PERMFMA_W	LR	LOK	
PERMFSL_W	LR	LOK	
RL	SWADAP	EIN	relative air charge
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical

Variable	Source	Type	Description
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_TLR	PROKON	EIN	system constant service device intervention LR, modif. of integrator stop time
TFETTIF_W	LR	LOK	
TFETTIMA_W	LR	LOK	
TFETTIM_W	LR	LOK	
TFETTMA_W	LR	LOK	
TFETTSL_W	LR	LOK	
TFRN2_W	LR	AUS	time duration lambda controller negativ slope, bank 2
TFRNINT2_W	LR	LOK	counter to measure time duration lambda controller negativ slope, bank 2
TFRNINT_W	LR	LOK	counter to measure time duration lambda controller negativ slope
TFRN_W	LR	AUS	time duration lambda controller negativ slope
TFRP2_W	LR	LOK	time duration lambda controller positiv slope, bank 2
TFRPINT2_W	LR	LOK	counter to measure the time duration lambda controller positiv slope, bank 2
TFRPINT_W	LR	LOK	counter to measure the time duration lambda controller positiv slope
TFRP_W	LR	LOK	time duration lambda controller positiv slope
TMAGERMA_W	LR	LOK	
TMAGERSL_W	LR	LOK	
TMAGRIF_W	LR	LOK	
TMAGRIMA_W	LR	LOK	
TMAGRIM_W	LR	LOK	
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TNST		EIN	time after end of start
TPLRVK2_W	LR	AUS	cycle duration of sensor upstream cat, calculated by %LR, bank 2
TPLRVK_W	LR	AUS	cycle duration of sensor upstream cat, calculated by %LR
TSPERR	LR	LOK	Stop time for lambda close loop system
TSPERR2	LR	LOK	Stop time for lambda close loop system, bank2
TV	LR	LOK	LR: counter for delayed controller switch tv / ES: supply of voltage correction
TV2	LR	LOK	LR bank2: count. for delayed contr. switch tv / ES: supply of voltage correction
TVLR	LR	LOK	LR: total value for delayed controller switch tv
TVLR2	LR	LOK	LR: total value for delayed controller switch tv 2
TVLRH	LRHK	EIN	LRHK: correction value for delayed controller switch tv
TVLRH2	LRHK	EIN	LRHK: correction value for delayed controller switch tv 2
TVLRHI	LRHK	EIN	weighted I-part for delayed controller switching tv
TVLRHI2	LRHK	EIN	Bank2: weighted I-part for delayed controller switching tv
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
USVK2_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst 2
USVKMA_W	LR	LOK	output voltage master oxygen sensor upstream catalyst
USVKSL_W	LR	LOK	output voltage slave oxygen sensor upstream catalyst
USVK_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) upstream catalyst
VSTLR		EIN	adjustment integrator stop time tv (service device interface)

FW LR 89.20 Fixed Values

Parameter	Value	Description
CFRA		code word for adaptation of control amplitude
CWLRSYNC		Code word: Selects bank1 or bank2 as master during fr-synchronization
DFRMN		min. lambda deviation for steady state cond. and adaptation of transient contrl.
DFRSPS		stroke of A/F ratio controller signal (standard value)
DLRPERIMN		
DLRPERIMX		
FRIPDSL1		Factor adjustment of fri and frp during active phase 1 of DSLSLR
FRIPDSL4		Factor adjustment of fri and frp during active phase 4 of DSLSLR
FRIPDTES		Factor adjustment of fri and frp during active DTEV
FRIPTES		Factor adjustment of fri and frp at fault ”open TEV pinch”
FRMAX		upper limit of control range
FRMINSLS		lower control range limit during phas1 of secondary air system diagnosis
FRTEMX		upper limit of control range on error ”cannister purge valve open”
QUFRMN		lower limit for static condition of lambda controller
QUFRMX		upper limit for static condition of lambda controller
TFRSGN		
USR		controller theshold for lambda control upstream catalyst
ZDFR		filter constant for calc. of A/F ratio contr. stroke mean value
ZLRFRI		Time constant for ingreasing of tmst depending weighting factor FFRITMS

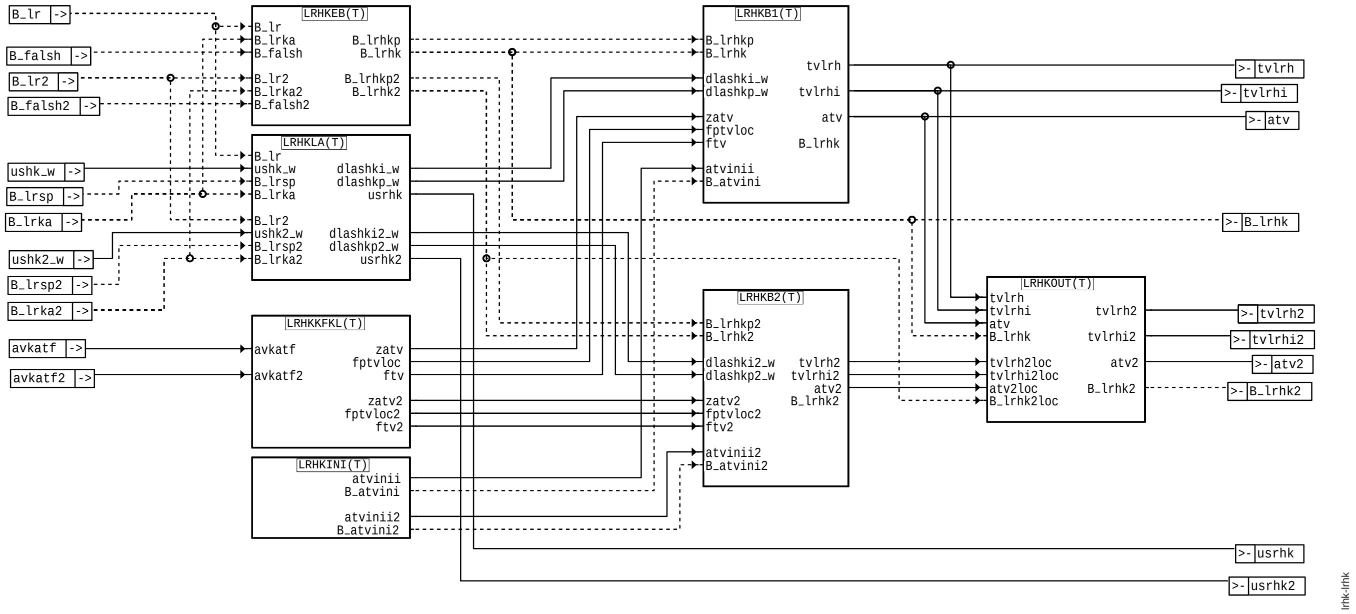
FB LR 89.20 Detailed description of function

APP LR 89.20 Application hint

LRHK 33.70 Lambda closed loop control downstream catalyst (OBDII)

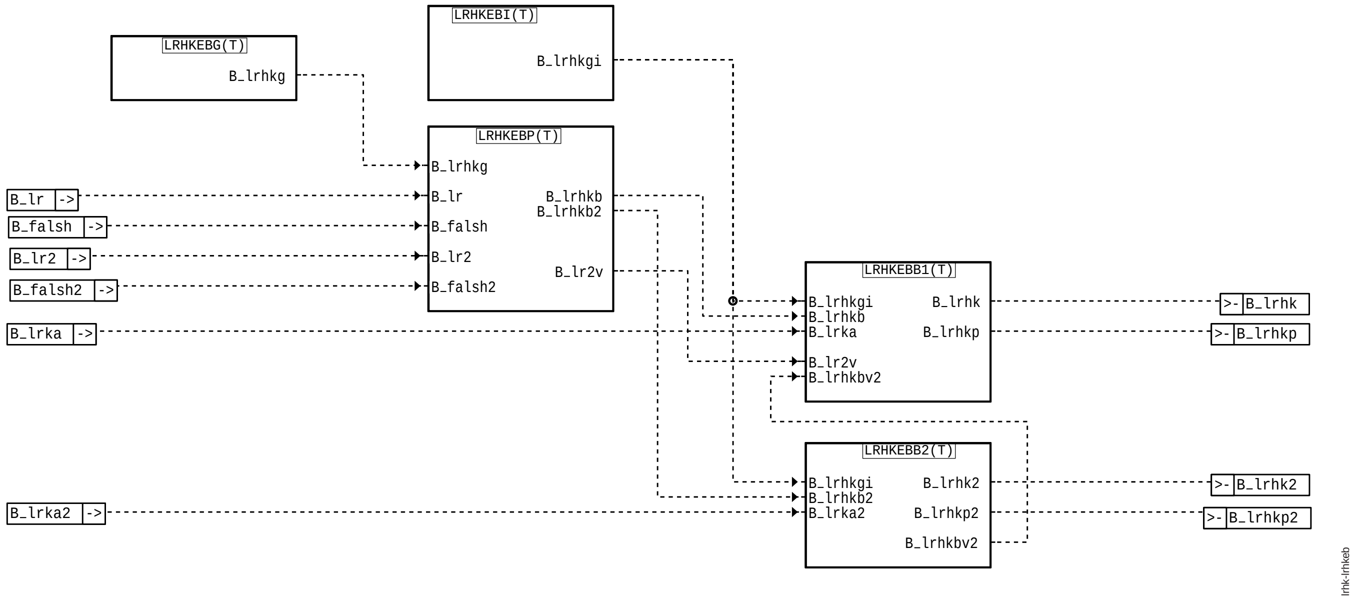
FDEF LRHK 33.70 Function definition

```
Function LRHK: Overview of control downstream of the catalyzer with the sub-blocks
-----------------------------------------------------------------------------------
```



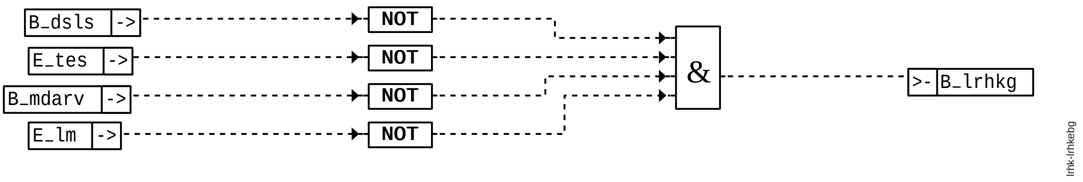
lrhk-lrhk

```
Subfunction LRHKEB: Turn-on conditions for control downstream of the catalyzer
==============================================================================
```



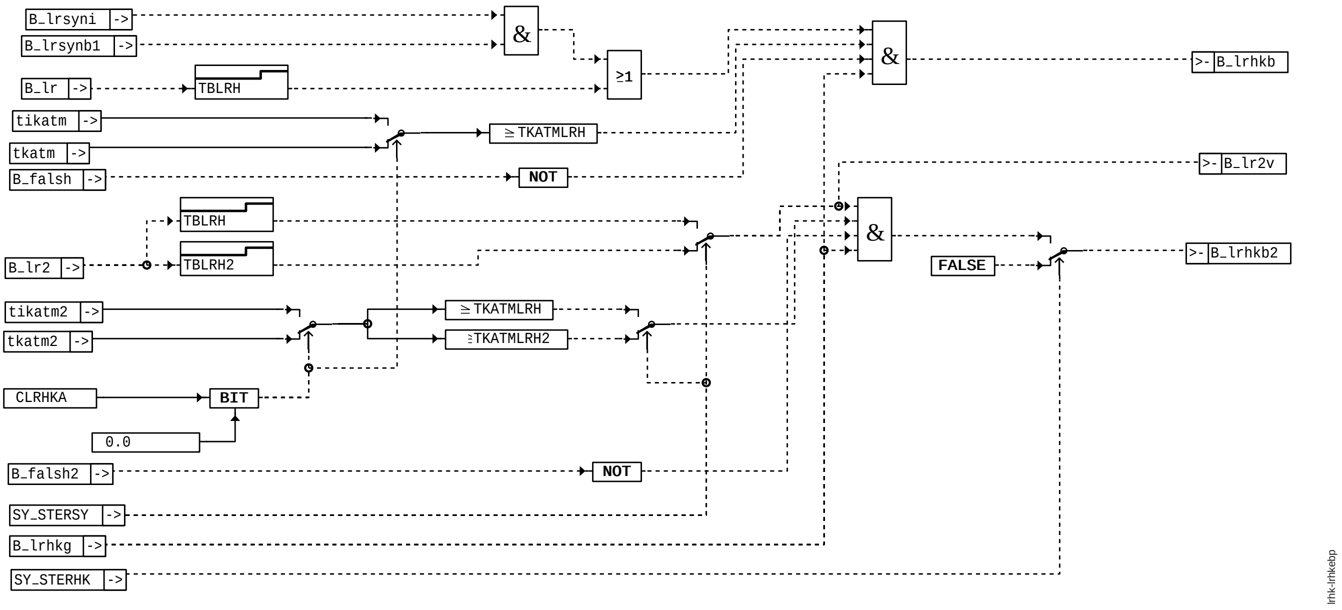
lrhk-lrhkeb

Subfunction LRHKEBG: Global turn-on conditions for control downstream of the catalyzer



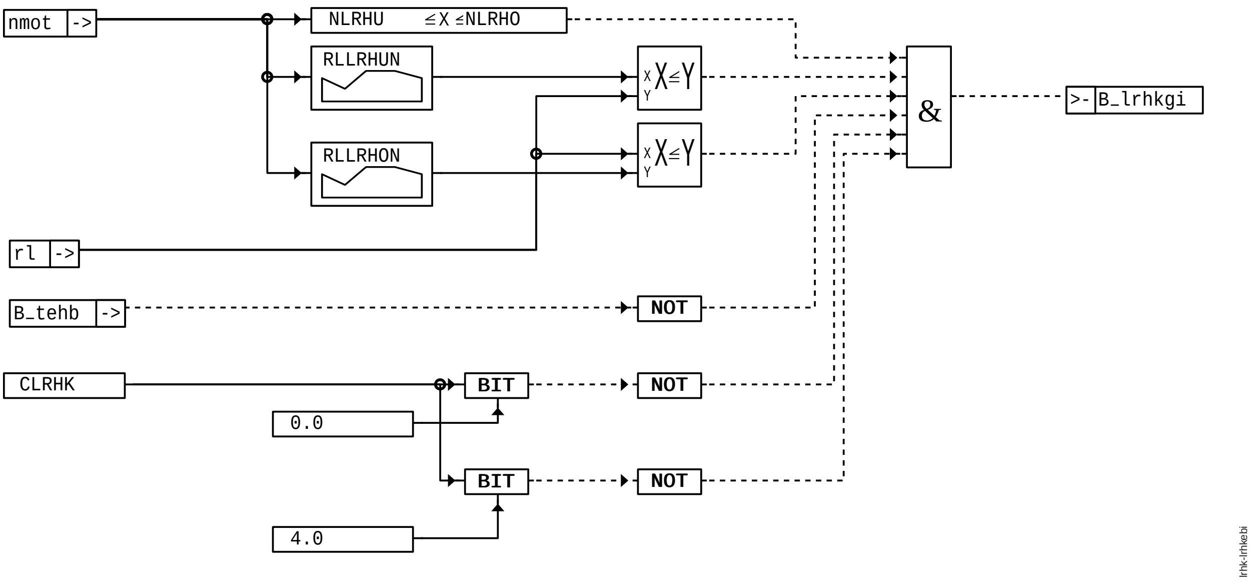
lrhk-lrhkebg

Subfunction LRHKEBP: Parameterizable turn-on conditions for control downstream of the catalyzer for bank 1 and bank 2



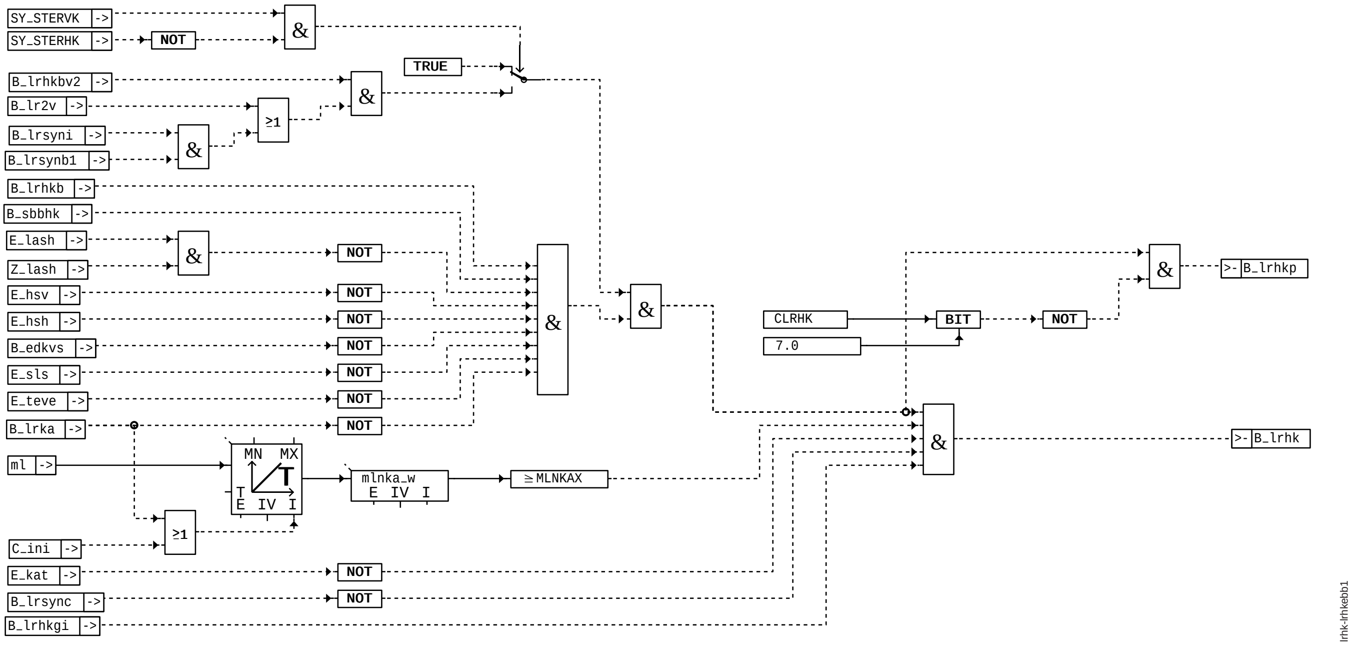
lrhk-lrhkebp

Subfunction LRHKEBI: Turn-on conditions for I-component of the downstream control



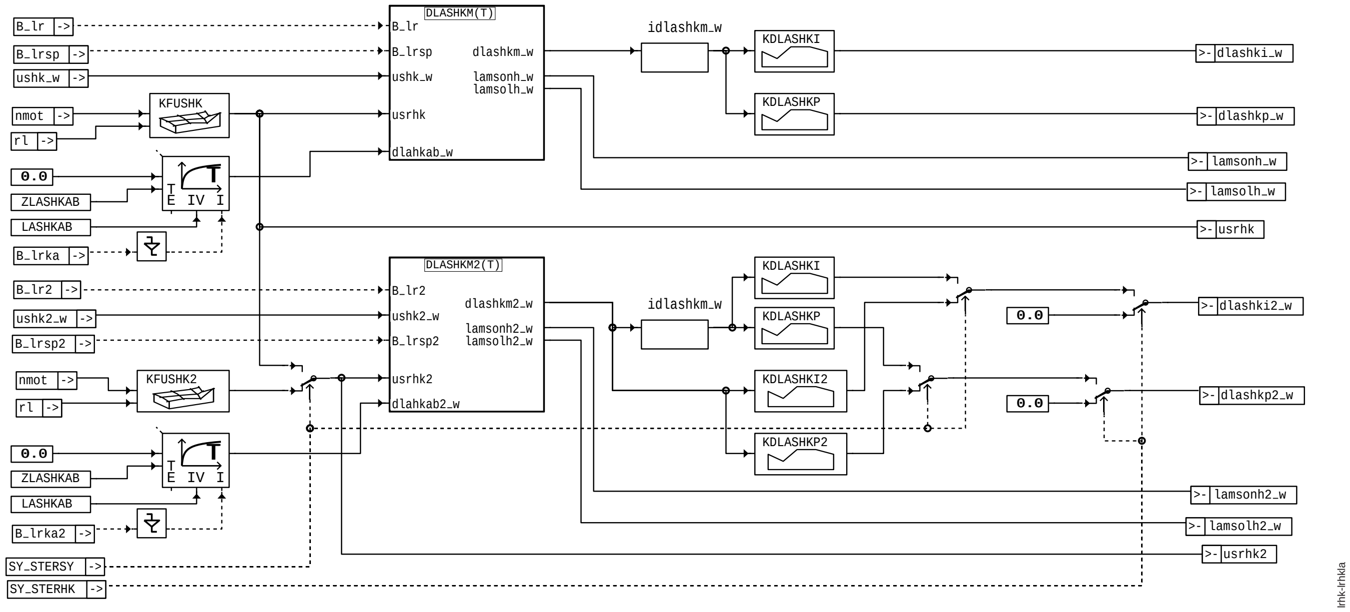
lrhk-lrhkebi

Subfunction LRHKEBB1: bank-specific turn-on conditions for control downstream of the catalyzer, bank 1



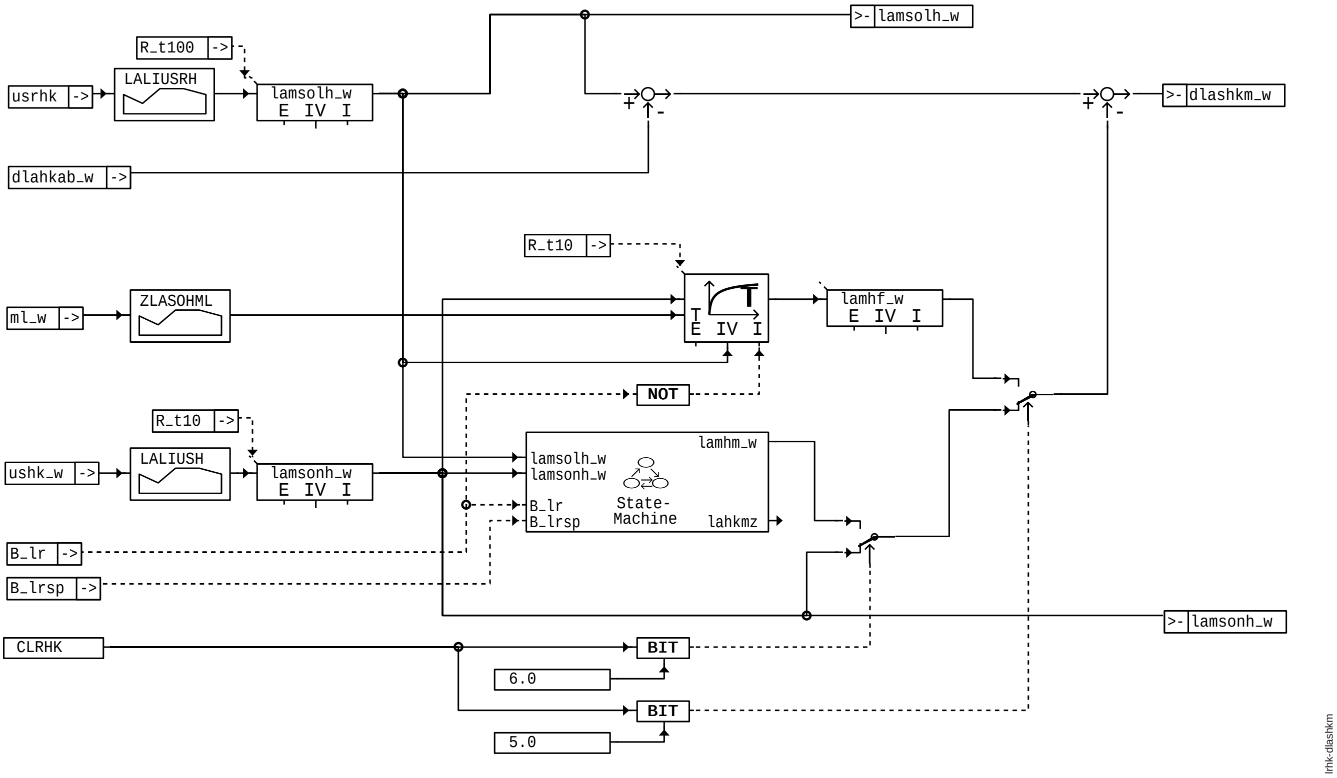
lrhk-lrhkebb1

Subfunction LRHKLA: Evaluation of the sensor voltage



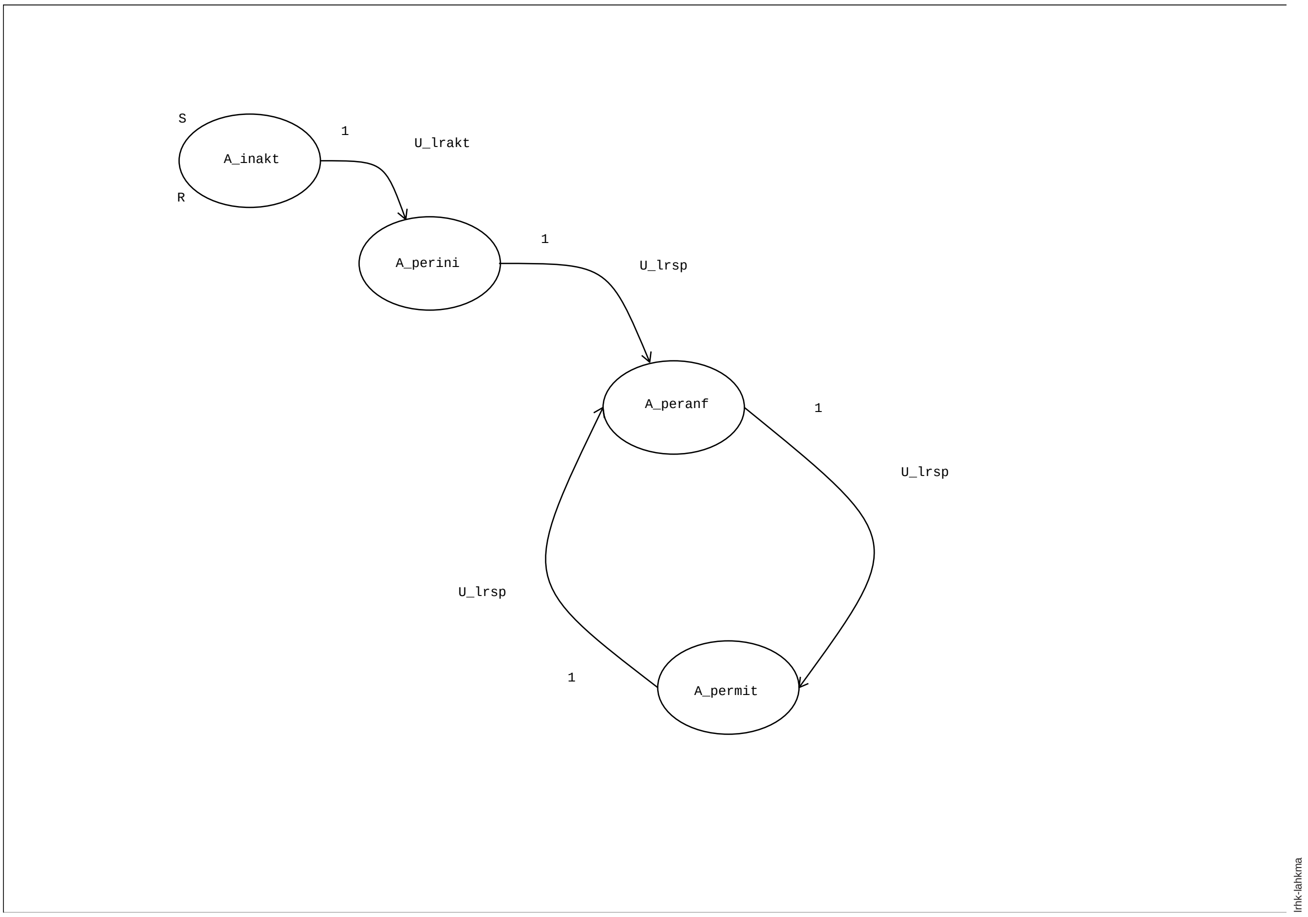
lrhk-lrhkla

Subfunction DLASHKM: Pseudo-linearization of the sensor downstream of the catalyzer, Block of mean values formed DLASHKM and determination of the nominal value



lrhk-dlashkm

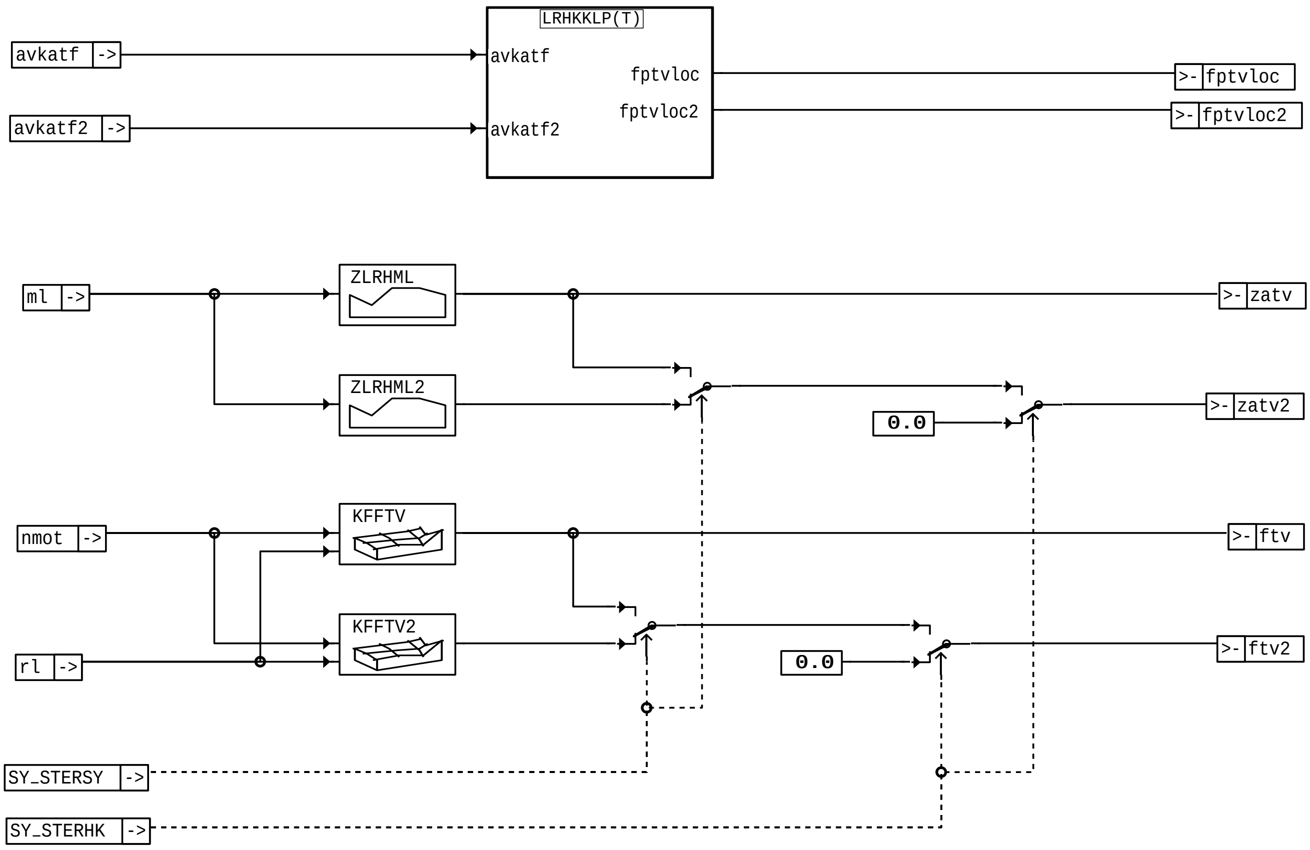
```
Subfunction LRHKMA: State machine for forming a fr-synchronous mean value for pseudo-lambda downstream of the catalyzer
========================================================================================================================
```



lrhk-lahkma

```
State machine code LAHKMAR: Formation of a fr-synchronous mean value for pseudo-lambda downstream of the catalyzer
=========================================================================================================

 State

 |    Transition name    +- Transition condition

 |    |    Action    +- Action code

 |    |    |           |

 V    V    V           V

---------------------------------------------------------------------------------------------------------------------------------

 A_inakt               Reset condition: NOT B_lr                             -- This is reset state and is initiated from all
                                                                                states when the reset condition
                                                                                is fulfilled.

           Entry:      lahkmz := 0;

           Action:     lamhm_w := lamsolh_w;
                       percnt_w := 0;
                       lahksum_l := 0.0;

      U_lrakt:         B_lr

---------------------------------------------------------------------------------------------------------------------------------

 A_perini

           Entry:      lahkmz := 1;

      U_lrsp:          B_lrsp

---------------------------------------------------------------------------------------------------------------------------------

 A_peranf

           Entry:      lahkmz := 2;
                       percnt_w := percnt_w + 1;
                       lahksum_l := lahksum_l + lamsonh_w;
                       lamhm_w := lahksum_l/percnt_w;
                       percnt_w := 0;
                       lahksum_l := 0;

           Action:     percnt_w := percnt_w + 1;
                       lahksum_l := lahksum_l + lamsonh_w;

      U_lrsp:          B_lrsp

---------------------------------------------------------------------------------------------------------------------------------

 A_permit

           Entry:      lahkmz := 3;

                       percnt_w := percnt_w + 1;

                       lahksum_l := lahksum_l + lamsonh_w;

           Action:     percnt_w := percnt_w + 1;

                       lahksum_l := lahksum_l + lamsonh_w;

      U_lrsp:          B_lrsp

=================================================================================================================================

 Local variables:

      Float percnt_w;
      Float lahksum_l;
```

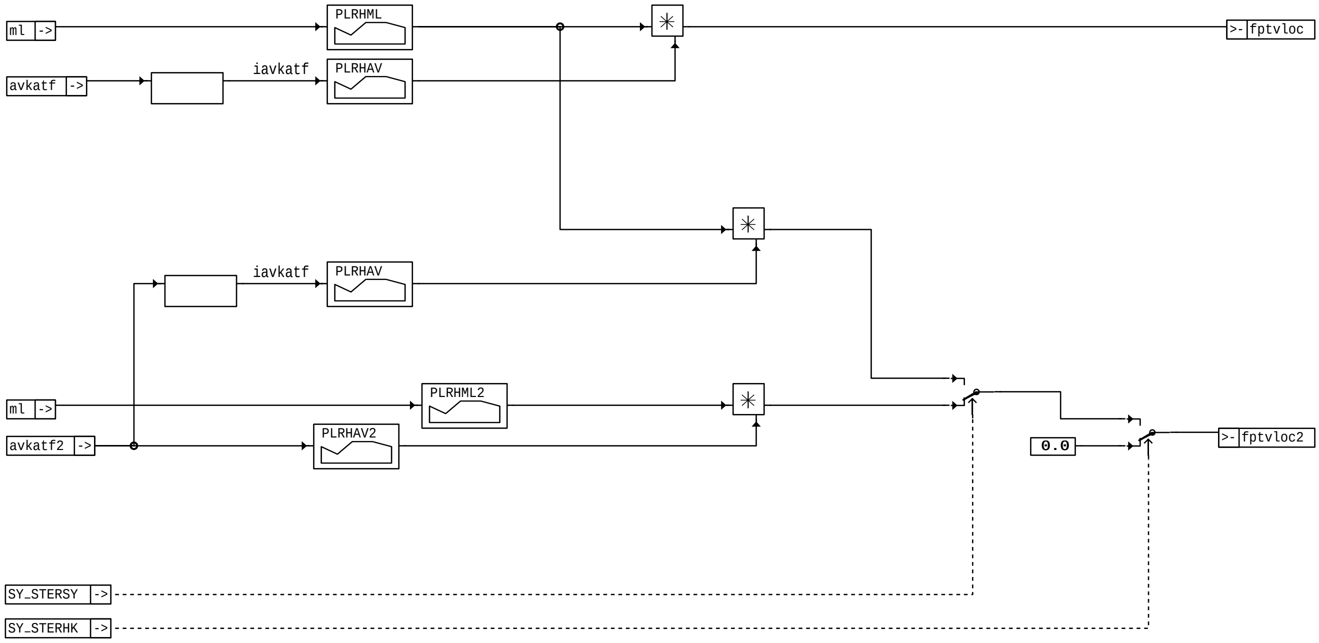
Subfunction LRHKKFKL: Parameter selection for bank 1 and bank 2



lrhk-lrhkkfkl

lrhk-lrhkkfkl

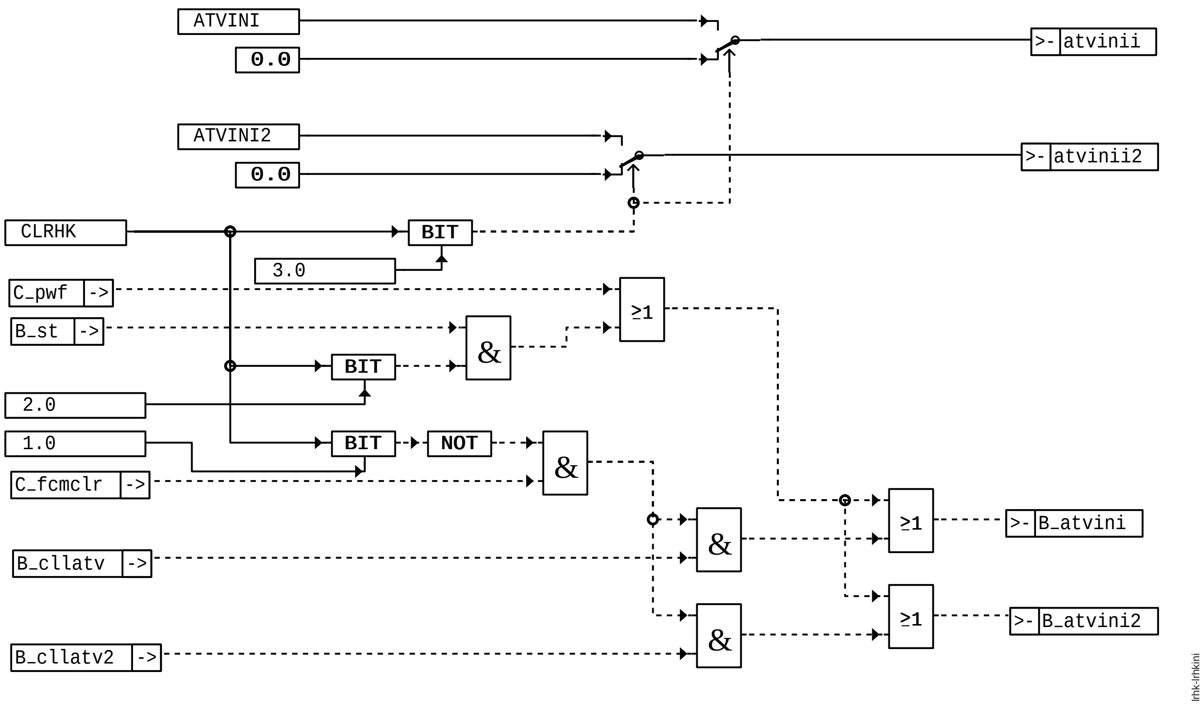
Subfunction LRHKKFKL: Parameter selection P-component for bank 1 and bank 2



lrhk-lrhkklp

lrhk-lrhkklp

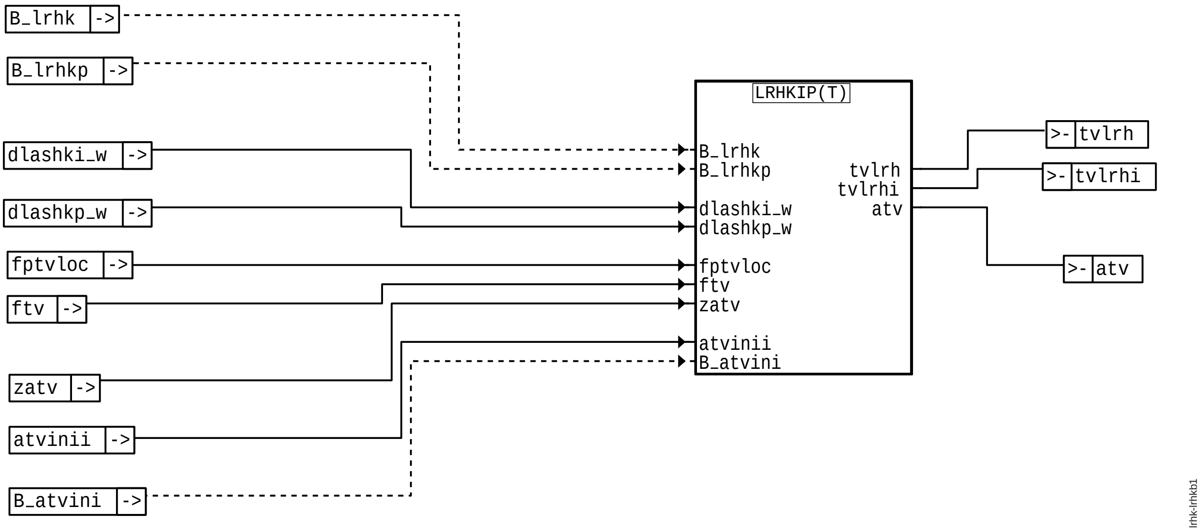
Subfunction LRHKINI: Initialization condition and Initialization value for LRHK integrators



lrhk-lrhkini

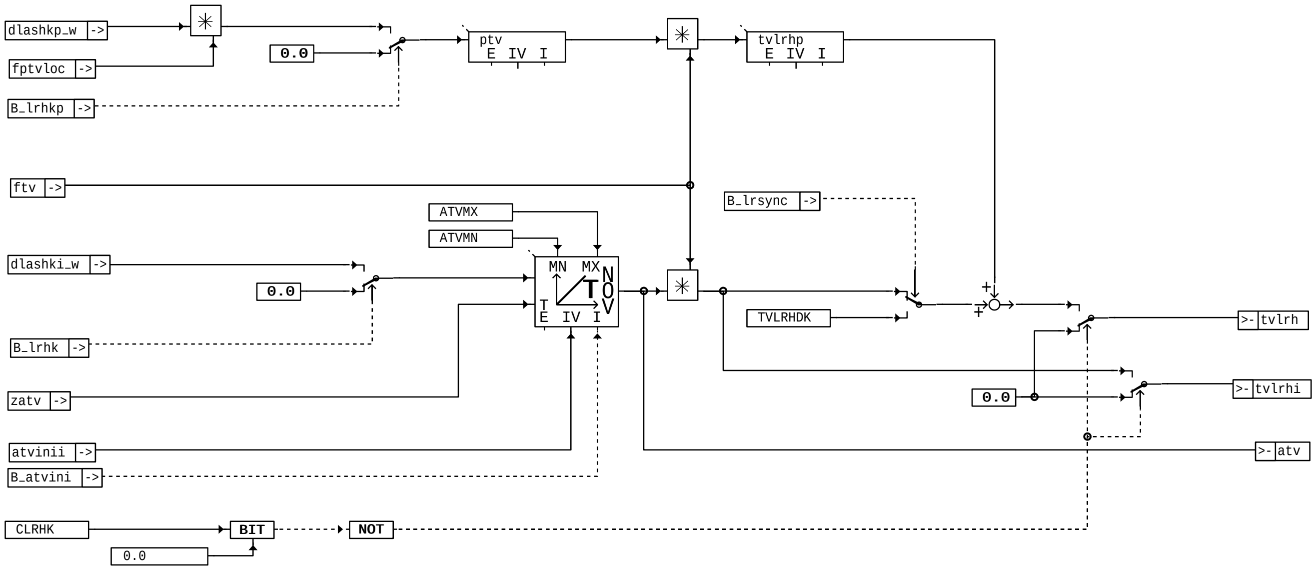
Subfunction LRHKB1: Control downstream of the catalyzer, bank 1

turn-on conditions LRHKEB and the actual control I and P-component LRHKIP



lrhk-lrhkb1

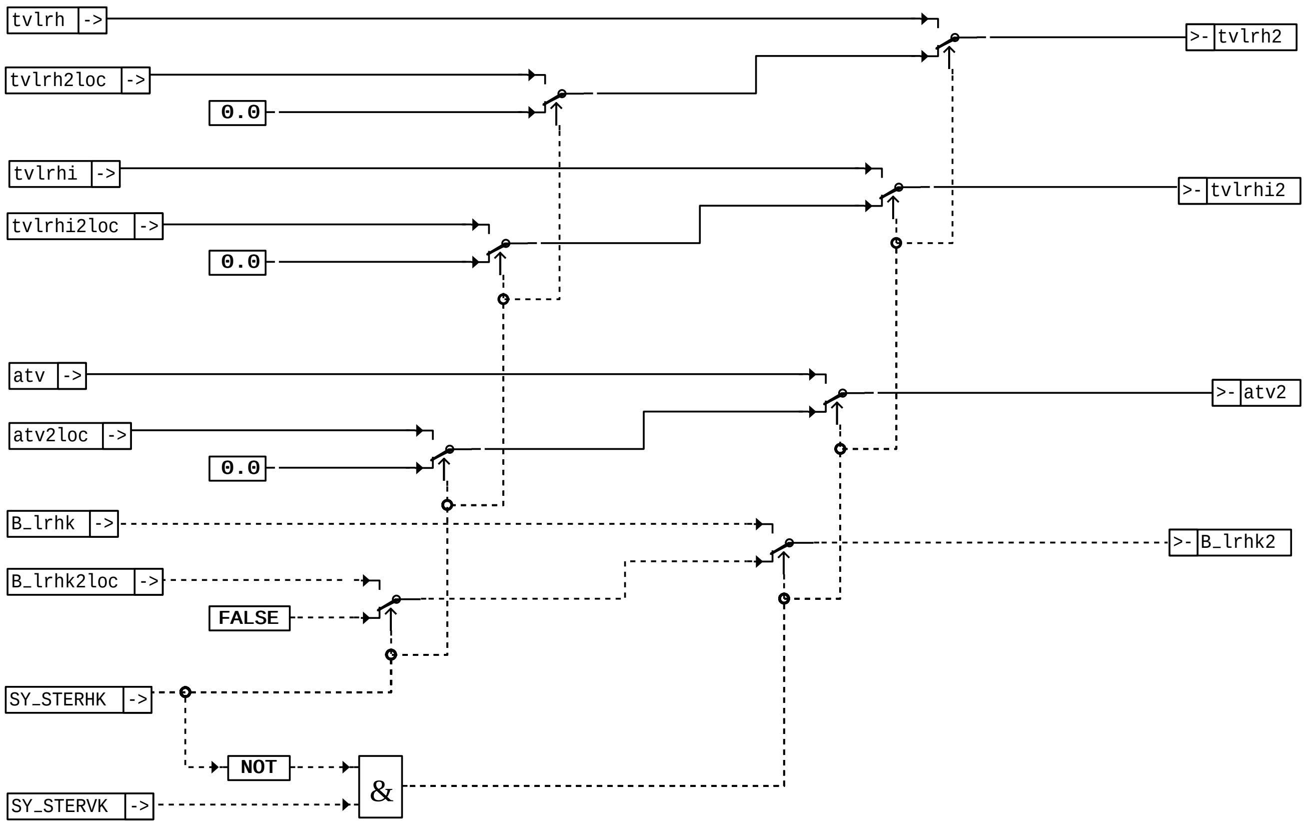
Subfunction block LRHKIP: Control downstream of the catalyzer - controller structure with I/P-component
===



lrhk-lrhkip

lrhk-lrhkip

Subfunction block LRHKOUT: Output for bank 2 according to stereo/mono/symmetry
===



lrhk-lrhkout

lrhk-lrhkout

The labels to be carried twice for stereo-lambda control are identified accordingly.
Defining the lower control limits by NLRHU and the characteristic RLRHUN.
The upper control limits are to be established by NLRHO and the characteristic RLRHON.

ABK LRHK 33.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ATVINI			FW	Initial value for control factor atv, set according to code word NOATV
ATVINI2			FW	Initial value for control factor atv, bank 2, set according to code word NOATV
ATVMN			FW	lower limit of control range of factor atv
ATVMX			FW	upper limit of control range of factor atv
CLRHK			FW	code word for lambda closed-loop control downstream catalyst on/off
CLRHKA			FW	code word for lambda closed-loop control downstream catalyst
KDLASHKI	IDLASHKM_W		KL	evaluation factor of I-part of LRHK, f(dlashkm)
KDLASHKI2	DLASHKM2_W		KL	evaluation factor of I-part of LRHK, f(dlashkm), bank 2
KDLASHKP	IDLASHKM_W		KL	evaluation factor of P-part of LRHK, f(dlashkm)
KDLASHKP2	DLASHKM2_W		KL	evaluation factor of P-part of LRHK, f(dlashkm), bank 2
KFFTV	NMOT	RL	KF	weighting map for TVLRH
KFFTV2	NMOT	RL	KF	weighting map for TVLRH bank 2
KFUSHK	NMOT	RL	KF	lambda sensor reference value for lambda control downstream of catalyst
KFUSHK2	NMOT	RL	KF	lambda sensor reference value for lambda control downstream of catalyst bank2
LALIUSH	USHK_W		KL	lambda linearization, sensor behind catalyst
LALIUSH2	USHK2_W		KL	lambda linearization, sensor behind catalyst, bank 2
LALIUSRH	USRHK		KL	lambda linearization, sensor behind catalyst
LALIUSRH2	USRHK2		KL	lambda linearization, sensor behind catalyst
LASHKAB			FW	initial value for dynamic increase of desired value (lamsolh) in the LRHK
MLNKAX			FW	air mass threshold for activation readiness LRSHK I-part
NLRHO			FW	upper engine speed threshold for lambda control downstream cat
NLRHU			FW	lower engine speed threshold for lambda control downstream cat
PLRHAV	IAVKATF		KL	Weighting factor of P-part LRHK depending on catalyst age
PLRHAV2	AVKATF2		KL	Weighting factor of P-part LRHK depending on catalyst age range 2
PLRHML	ML		KL	p-part of LRHK, f(dushk)
PLRHML2	ML		KL	Partie p. dans LRHK, agit avec la difference de tension de sonde aval cata banc2
RLLRHON	NMOT		KL	char. line on nmot, upper rl control threshold for downstream lambda control
RLLRHUN	NMOT		KL	char. line on nmot, lower control threshold rl for downstream lambda control
TBLRH			FW	lock per. f. c.-loop contr.downstr.cat after rel.by c.-loop contr.upstr.cat
TBLRH2			FW	lock per. f. c.-loop contr.downstr.cat after rel.by c.-loop contr.upstr.cat b2
TKATMLRH			FW	lower catalyst temperature threshold for lambda control downstream cat
TKATMLRH2			FW	lower catalyst temperature threshold for lambda control downstream cat, bank 2
TVLRHDK			FW	delay time used while catalyst diagnosis is active
ZLASHKAB			FW	time const.for decrease of the dynamic set point increase (dlasohkab)in the LRHK
ZLASOHML	ML_W		KL	time constant for PT1-filter of the pseude lambda behind catalyst
ZLASOHML2	ML_W		KL	Time constant for PT1-filter of pseudo lambda post cat, bank 2
ZLRHML	ML		KL	time constant of lambda control integrator downstream catalyst
ZLRHML2	ML		KL	time constant of lambda control integrator downstream catalyst bank 2

Variable	Source	Type	Description
ATV	LRHK	AUS	current integrator value of lambda control downstream cat
ATV2	LRHK	AUS	current integrator value of lambda control downstream cat 2
ATVINII	LRHK	LOK	Initialisation value for integrator atv
ATVINII2	LRHK	LOK	Initialisation value for integrator atv, bank 2
AVKATF	DKAT	EIN	amplitude ratio laafh/laafv strained
AVKATF2	DKAT	EIN	amplitude ratio laafh/laafv strained bank2
B_ATVINI	LRHK	LOK	Condition integrator atv be initialized
B_ATVINI2	LRHK	LOK	Condition integrator atv be initialized, Bank 2
B_CLLATV		EIN	Clear fault path in DLSA.
B_CLLATV2		EIN	Clear fault path in DLSA. Bank2
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_FALSH		EIN	condition function request downstream oxygen sensor diagnosis
B_FALSH2		EIN	condition function request downstream oxygen sensor diagnosis bank2
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LR2V	LRHK	LOK	condition for lambda closed loop control upstr. cat. delayed by TBLRH(2); bank 2
B_LRHK	LRHK	AUS	condition for lambda closed loop control downstream cat
B_LRHK2	LRHK	AUS	condition for lambda closed loop control downstream cat (bank 2)
B_LRHKB	LRHK	LOK	LRHK: condition lambda control behind catalyst, bank-specific parameter bank 1
B_LRHKB2	LRHK	LOK	LRHK: condition lambda control behind catalyst, bank-specific parameter bank 2
B_LRHKBV2	LRHK	LOK	Bank 2 related condition based on lambda control upstream catalyst
B_LRHKG	LRHK	LOK	LRHK: bank-independent condition lambda control behind catalyst
B_LRHKGI	LRHK	LOK	LRHK: bank-independent condition I-part lambda control behind catalyst
B_LRHKP	LRHK	LOK	LRHK: condition for P-part lambda closed loop control downstream cat (bank 1)
B_LRHKP2	LRHK	LOK	LRHK bank2: condition for P-part lambda closed loop control downstream cat
B_LRKA	LRKA	EIN	condition for neutralization of catalyst oxygen storage
B_LRKA2	LRKA	EIN	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRSP	LR	EIN	Flag 'O2 sensor voltage crosses threshold detected'
B_LRSP2	LR	EIN	condition for sensor signal bounce cylinderbench 2
B_LRSYNB1		EIN	Condition fr_b1-/fr_b2-synchronization active, bank 1 is master
B_LRSYNC	DKAT	EIN	Condition fr_b1-/fr_b2-synchronization requested
B_LRSYNI		EIN	Condition fr_b1-/fr_b2-synchronization active, local
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_ST	SWADAP	EIN	condition for start
B_TEHB	TEB	EIN	condition for canister purge system with high canister load
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation

Variable	Source	Type	Description
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DLAHKAB2_W	LRHK	LOK	dynamic overshoot of the pseudo lambda set point value behind catalyst, bank2
DLAHKAB_W	LRHK	LOK	dynamic overshoot of the pseudo lambda set point value behind catalyst
DLASHKI2_W	LRHK	LOK	delta lambda weighted for I-component LRSHK, bank2
DLASHKI_W	LRHK	LOK	delta lambda weighted for I-component LRSHK
DLASHKM2_W	LRHK	LOK	delta lambda of lambda contr.behind cat.(actual value averaged fr-synchr.),bank2
DLASHKM_W	LRHK	LOK	delta lambda of lambda contr.behind cat.(actual value averaged fr-synchr.)
DLASHKP2_W	LRHK	LOK	delta lambda weighted for P-component LRSHK5.30, Bank2
DLASHKP_W	LRHK	LOK	delta lambda weighted for P-component LRSHK5.30
E_HSH	DHLSHK	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLSHK	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLSVK	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLSVK	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	EIN	error flag: catalyst conversion
E_KAT2	DKAT	EIN	error flag: catalyst conversion (cylinder row 2)
E_LASH	DLSAHK	EIN	error flag: lambda sensor aging downstream cat
E_LASH2	DLSAHK	EIN	error flag: lambda sensor aging downstream cat (cylinder row 2)
E_LM	EGFE	EIN	Error flag: main load sensor
E_SLS		EIN	error flag: secondary air system
E_SLS2		EIN	error flag: secondary air system, cylinder row 2
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TEVE2		EIN	error flag: canister purge valve power stage
FTV	LRHK	LOK	factor weighting tv-correction of downstream lambda control
FTV2	LRHK	LOK	factor weighting tv-correction of downstream lambda control, bank 2
IAVKATF	LRHK	DOK	Char. Line source: amplitude relatio of catalyst downstream/upstream
IDLASHKM_W	LRHK	DOK	KL-Source: Delta-lambda from close loop regulation post cat,(actuell value of fr
LAHKMZ	LRHK	LOK	status byte of the machine: avera.of pseudo-lambda beh.cat. fr-synchr.
LAHKMZ2	LRHK	LOK	status byte of the machine: avera.of pseudo-lambda beh.cat. fr-synchr.; bank 2
LAMHF2_W	LRHK	LOK	pseudo-linearized lambda downstream, filtered by PT1, bank2
LAMHF_W	LRHK	LOK	pseudo-linearized lambda downstream, filtered with PT1
LAMHM2_W	LRHK	LOK	fr-synchronized mean-value of pseudo-lambda downstream, bank2
LAMHM_W	LRHK	LOK	fr-synchronized mean-value of pseudo-lambda downstream
LAMSOLH2_W	LRHK	AUS	pseudo lambda set point behind catalyst, bank2
LAMSOLH_W	LRHK	AUS	pseudo lambda set point behind catalyst
LAMSONH2_W	LRHK	AUS	pseudo-lambda, measured with Nernst-sensor downstream
LAMSONH_W	LRHK	AUS	pseudo-lambda,measured with Nernst-sensor downstream
ML	SWADAP	EIN	air mass flow
MLNKA2_W	LRHK	LOK	air mass after catalyst oxygen neutralization, bank 2
MLNKA_W	LRHK	LOK	air mass after catalyst oxygen neutralization
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	SWADAP	EIN	engine speed
PERCNT2_W	LRHK	LOK	counter 10-ms-steps for fr-synchronous lamsolh averaging, bank 2
PERCNT_W	LRHK	LOK	counter 10-ms-steps for fr-synchronous lamsolh averaging
PTV	LRHK	LOK	LRHK: unweighted p-part for delayed controller switching tv
PTV2	LRHK	LOK	Bank2: unweighted p-part for delayed controller switching tv
RL	SWADAP	EIN	relative air charge
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
SY_2SLS		EIN	System constant fault E_sls2 is defined and evaluated
SY_2TEV		EIN	System constant fault E_teve2 is defined and evaluated
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TIKATM	ATM	EIN	exhaust gas temperature in catalyst (modelled)
TIKATM2	ATM	EIN	exhaust gas temperature in catalyst (modelled) bank2
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TVLRH	LRHK	AUS	LRHK: correction value for delayed controller switch tv
TVLRH2	LRHK	AUS	LRHK: correction value for delayed controller switch tv 2
TVLRHI	LRHK	AUS	weighted I-part for delayed controller switching tv
TVLRHI2	LRHK	AUS	Bank2: weighted I-part for delayed controller switching tv
TVLRHP	LRHK	LOK	weighted P-part for delayed controller switching tv
TVLRHP2	LRHK	LOK	Bank2: weighted p-part for delayed controller switching tv
USHK2_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst 2
USHK_W	SWADAP	EIN	output voltage oxygen sensor (4.88mV/LSB) downstream catalyst
USRHK	LRHK	AUS	momentary control threshold for downstream lambda control
USRHK2	LRHK	AUS	momentary control threshold for downstream lambda control, bank2
ZATV	LRHK	LOK	Integration speed I-part, close loop regulation post cat.
ZATV2	LRHK	LOK	Integration speed I-part, close loop regulation post cat, Bank2
Z_LASH	DLSAHK	EIN	cycle flag of lambda sensor aging downstream cat
Z_LASH2	DLSAHK	EIN	cycle flag of lambda sensor aging downstream cat, cylinder row 2

FW LRHK 33.70 Fixed Values

Parameter	Value	Description
ATVINI		Initial value for control factor atv, set according to code word NOATV
ATVINI2		Initial value for control factor atv, bank 2, set according to code word NOATV
ATVMN		lower limit of control range of factor atv
ATVMX		upper limit of control range of factor atv
CLRHK		code word for lambda closed-loop control downstream catalyst on/off

Parameter	Value	Description
CLRHKA		code word for lambda closed-loop control downstream catalyst
LASHKAB		initial value for dynamic increase of desired value (lamsolh) in the LRHK
MLNKAX		air mass threshold for activation readiness LRSHK I-part
NLRHO		upper engine speed threshold for lambda control downstream cat
NLRHU		lower engine speed threshold for lambda control downstream cat
TBLRH		lock per. f. c.-loop contr.downstr.cat after rel.by c.-loop contr.upstr.cat
TBLRH2		lock per. f. c.-loop contr.downstr.cat after rel.by c.-loop contr.upstr.cat b2
TKATMLRH		lower catalyst temperature threshold for lambda control downstream cat
TKATMLRH2		lower catalyst temperature threshold for lambda control downstream cat, bank 2
TVLRHDK		delay time used while catalyst diagnosis is active
ZLASHKAB		time const.for decrease of the dynamic set point increase (dlasohkab)in the LRHK

FB LRHK 33.70 Detailed description of function

The control by the sensor downstream of the catalyzer is superimposed on the lambda control with the sensor upstream of the catalyzer.
The only control intervention in the control upstream of the catalyzer is by the tv correction variable tvlrh.

Control downstream of the catalyzer:

Set bit 0 to shutdown in code word CLRHK to 1 (TRUE).

P/I control action

The control downstream of the catalyzer, as described in this FDEF, is a slow-acting two-point control with I characteristics.
The purely I-control used in previous versions for catalytic converters with a small to medium-size O2 storage capacity has been an adequate function. The larger O2 storage capacity of the new types of catalytic converters led to a greater tendency to errors by the integrator atv due to the function because following a change in the sensor voltage downstream of the catalyzer from rich to lean or from lean to rich, the integrator had first to learn back the exceissively learned value before it could act correctly according to the sign. By the P-component and because it "has no memory", enrichment or enleanment is immediate following a change in the sensor voltage by the tv penetration.

The LRKH is in the position by the I-component of the control downstream of the catalyzer to largely compensate for deteriorations in the exhaust emissions that are accentuated by a shift in the static sensor characteristic attributable to non-symetrical extensions in the response time of the front control sensor.

The P-component and I-component of the control downstream of the catalyzer is formed by an evaluation of the difference of the current voltage threshold depending on the operating point from the map KFUSHK and the sensor voltage. Prior to formation of the control difference, the output usrhk of the map KFUSHK is converted by the characteristic LALIUSRH to the pseudo-lambda nominal value lamsolh_w. The sensor voltage downstream of the catalyzer ushk is converted by the characteristic LALIUSH into a pseudo-lambda nominal value lamsonh_w. Because the control oscillation of the upstream control affects the course of the sensor voltage downstream of the catalyzer for older types of catalytic converters, an unchanged P-part would lead to oscillations in the control downstream of the catalyzer.
Thus lamsonsh_w in the 10-ms time frame is determined in synchronization to the control oscillations and the state machine LRHKMA is responsible for this averaging. In the state machine, lamsonsh_w is determined from one sensor jump of a control period to the next-but-one sensor jump. The difference in control, dlashkm_w, is formed by subtracting the pseudo-lambda actual value lamsonsh_w from the control threshold lamsolh_w. The weighting factor dlashki is then determined by means of the characteristic KDLASHKI = f(dlashkm_w). The factor is then used for weighting the input of the atv integrator by multiplication. The weighting factor dlashkp_w for den P-component is determined by means of the characteristic KDLASHKP = f(dlashkm_w) and hence the P-component PLRHML=f(ml) is applied by multiplication. This means that both the P-component as well as the integrator rate are proportional to the difference dlashkm_w determined above, and hence also tend towards zero for a difference in the control close to 0.

Because for older types of catalytic converters, the control oscillation of the pre-catalyzer control penetrates through to the course of the sensor voltage downstream of the catalyzer, an unchanged P-penetration would lead to oscillations in the control downstream of the catalyzer. It is for this reason that the P-component of the rear control is cancelled for older catalytic converters in a further multiplication with the evaluation factor from the characteristic PLRHAV = f(avkatf). In addition to this for older types of catalytic converters that are associated with a lower oxygen storage capacity, the necessity for a P-component in the control downstream of the catalyzer is of lesser importance.

Effect of the LRHK on the sensor diagnostic routine

The control downstream of the catalyzer intervenes solely by an additional tv shift (tvlrh = tvlrhi + tvlrhp) in the front control. The magnitude of the intervention is a measure for the aging of the sensor and is needed in the diagnostic routine for the upstream lambda-sensor aging. A symmetrical increase of the sensor-response time cannot be detected via tvlrh.

Compensation for the influence of the control frequency on the effects of tv

The current integrator value for control downstream of the catalyzer (atv) and the proportional component PLRHML = f(ml) are generally weighted with a factor from the map KFFTV and this thus gives the effective tv shift tvlrh.
The weighting map KFFTV was introduced in order to be able to describe the influence of the period duration TP of the control upstream of the catalyzer on the effect of the integrator stop time tv in delta lambda. This effect can be described - for the condition that P-jump is identical to the control amplitude - that is given according to the application procedure, by the following equation:

Amplitude * Delta tv

```
                       Delta lambda =  ---------------------
                                           Period duration
```

According to this, delta lambda is proportional to the amplitude, to delta-tv and to 1/period duration.
A load / speed-dependent weighting of the controller correction is thus possible in the entire load-speed range by multiplication of the integrator value with the weighting factor from the map KFFTV.
The product (tvlrhi) from the integrator content and the KFFTV value totaled with the product (tvlrhp) from the P-component and KFFTV value gives the tv correction variable for the control downstream of the catalyzer (tvlrh). This is then added in the lambda control %LR to each value from the tv precontrol map KFRTV.

Control threshold from map KFUSHK
=================================

If the sensor downstream of the catalyzer, signals e.g. a mixture that is too lean, then the integrator value increases and by this the entire tv shift as well,and the mixture is enriched until the actual value lamsons_w and hence ushk, surpasses the control threshold downstream of the catalyzer again.
Unlike control upstream of the catalyzer, a map is foreseen for the control threshold downstream of the catalyzer. A minor load-dependent shift in lambda can be attained by the selection made for the threshold.
The limitations shall be observed thereby, that are given by the specification for the sensor (temperature dependency of the enrichment branch).

LRHK control dynamics
=====================

The superimposed control is to be applied considerably slower than for a control upstream of the catalyzer. Since the voltage downstream of the catalyzer has, as a rule, a more irregular course for a lower air-mass throughput (lower load-speed point) and hence oscillations following lower sensor voltages should not be evaluated to the same extent here, the time constant for the rear control shall be chosen to be independent of the air-mass throughput rate ml - (characteristic ZLRHML). The integrator rate can, as a rule, be selected to be higher for a higher air flow.

Turn-on conditions
==================

If the control downstream of the catalyzer LRHK is disabled, then the output of the controller downstream of the catalyzer is still the integrator value atv learned up to that point in time, except that it is frozen.
The evaluation of atv depending on the operating point continues however to be active because of the map KFFTV. This means that the output tvlrhi = atv * KFFTV(nmot,rl) will indicate this dependency even for a control downstream of the catalyzer that is disabled.

The turn-on conditions for the P and the I-components are defined differently and are indicated by the bits B_lrhkp and B_lrhk.
The following conditions apply for the P-component:

If the readiness for control upstream of the catalyzer(B_lr = 1) is detected, then the LRHK is enabled after elapse of the delay time TBLRH.
The control downstream of the catalyzer is only to be activated above a certain temperature of the catalytic converter threshold (tkatm > TKATMLRH) and for a detected readiness for operation by the sensor downstream of the catalyzer (B_sbbhk).

In addition to this, a number of faults in the diagnostic routine disables the control downstream of the catalyzer.

Remark: Provided there is secondary air, B_lrhk must be disabled during the secondary-air diagnostic routine (B_dsls = 1).
In addition to this, B_lrhk is disabled by B_lr = 0 (section LREB) for an active secondary air system (B_sls = 1).

The following additional conditions apply for the I-component:

Thus the integrator is only disabled in the nmot-rl range (NLRHU <= nmot <= NLRHO and RLRHUN(nmot) <= rl <= RLRHON(nmot)).
The characteristics RLRHUN and RLRHON make the selection possible of the rl limits of the control range as a dependency of the speed. By this, the control range that in earlier FDEF versions formed a rectangle in the rl-/nmot area, can be defined such that the operating range can be limited that lead to an incorrect adaptation of the control downstream of the catalyzer. This can for example occur for operating points where the air-mass throughputs are too low.

The catalytic converter is saturated with oxygen following trailing-throttle fuel cutoff. The sensor voltage downstream of the catalyzer remains at small "lean" values for a certain length of time.
In this phase, the section LRKA disables the control downstream of the catalyzer by the bit B_lrka.
Following completion of clearing O2 out of the catalyzer, the control downstream of the catalyzer is prohibited for such a time until the air mass MLLRH has flowed through the catalytic converter.

If the bit B_tehb, "purge canister high load" is set, then the I-component of the LRHK is disabled since the integrator would otherwise learn incorrectly here. The P-component remains active in this case because this helps to reduce problems with exhaust emissions.

Dynamics increase in the control threshold following clearing out of the catalytic converter
==

Following completion of clearing O2 out of the catalytic converter, the sensor downstream of the catalyzer oscillates for typically 5 to 30 s above the threshold value of 600 mV. The sensor voltage thereby reaches values of between 750 and 800 mV. The overshoot depends on the characteristics of the catalytic converter.
The increase can be disabled for those types of catalytic converters that do not exhibit this behavior.

```
  ushk      ˆ                                               v
   mV       |    :         :                              --- :     *:* * *
            |    :         :                            USHKAB:    * :      * * *
     600  ..|.*.*:*.*......:...............................___:...*..:............*.*.*. . .*.*. .*.*........
```

```
             |    :   *      :                                 ^  :  *   :                  * *     *
             |    :    *     :                                    :      :
             |    :    *     :                                    :*     :
             |    :    *     :                                   *:      :
             |    :    *     :   * * * * * * * * * * * * * * * *  :      :
             |    :    *     :*                                   :      :
         0   -----:----*-*-*-*------------------------------------:------:-------------------------------------->
                  :          :                                    :      :                                      t
                  :          :                                    :      :                                      t
                  :          :                                    :      :
                  :          :                                    :      :
  lamhm_w    ^    :          :                                    :      :
             |    :          :                                    :      :
             |    :          :                                    :      :
      1.05 ..|    :    *     :*                                   :      :
             |    :    *     :*                                   :      :
             |    :    *     :*                                   :      :
             |    :    *     : *                                  :      :
             |    :   *      :   * * * * * * * * * * * * * * * * *:      :
      1.00 ..|.......*.......:....................................:..*...:.......................................
             | * * *         :                                    :    * :         *  * * * * * * * * * * * * * --> KFLASOHK
             |    :          :                      LASHKAB ----->:      *   *  *                                  threshold
             |    :          :                                    :      :                                        downstream
             |    :          :                                    :      :                                          control
       0.95  -----:----------:------------------------------------:------:-------------------------------------->
                  :          :                                    :      :                                      t
                  :          :                                    :      :                                      t
   B_sa    1 |    :----------:                                    :      :
           0 |----:          :------------------------------------:------:-------------------------------------
             -----:----------:------------------------------------:------:-------------------------------------->
                  :          :                                    :      :                                      t
   B_lrka  1 |    :          :------------------------------------:      :
           0 |----:----------:                                    :------:-------------------------------------
             -----:----------:------------------------------------:------:-------------------------------------->
                                                                  |<    >|                                      t
                                                                   MLLRH
```

The course of the sensor voltage ushk, the pseudo-lambda lahkm_w and the status bits B_sa (trailing-throttle cutoff) and B_lrka (clear-out catalyzer) is shown schematically in the diagram given above.
In order that "Time" (air mass MLLRH), in which the control downstream of the catalyzer is prohibited, can be kept as short a possible, the response of the sensor voltage following clearing out of the catalyzer is described over the time by dynamically raising the nominal value. To do this, the input of a PT1 filter is occupied for a short period by LASHKAB and gradually decreased to 0 with the time constant ZLASHKAB. The time constant is derived from the course determined for the sensor voltage.
It is possible by means of this function in those cases where clearing out O2 was not successful or where the control position upstream of the catalyzer leads to a more lean sensor voltage downstream of the catalyzer, to raise the sensor voltage downstream of the catalyzer by the LRHK.

APP LRHK 33.70 Application hint

Method of proceeding for application of the %LRHK:

Code word CLRHK

The code word CLRHK has been introduced in order to be able to influence the handling of the adaptation value atv during the application.
The significance of the individual control bits in CLRHK is described under Remarks.
Meaningful combinations - presented in decimal - are listed in the following:

CLRHK = 0 Normal course for the function
CLRHK = 1 LRHK disabled I and P-component disabled
CLRHK = 2 atv is not reset for delete error memory
CLRHK = 4 atv is reset for engine start-up
CLRHK = 8 atv is reset with the value ATVINI for delete error memory
CLRHK = 12 atv is reset with the value ATVINI for engine start-up

LRHK parameters

- The application of the %LR must be completed
- Select the datapoints KFFTV exactly as for the datapoints KFRI (7*nmot, 6*rl), provisionally set all values KFFTV = 1. It is found that a weighting is necessary outside of the control range, then this can be performed with the map KFFTV. If values other than 1 are selected, the integration rate varies for the downstream controller.
- 4 * 4 datapoints are foreseen for the map KFUSHK:
  Proposal: nmot: 1000, 1800, 2400, 3000 / min
  rL: 20 35 45 60 / %
- Lower control limit e.g. NLRHU = 1200/min
  characteristic RLRHUN dependent on n
- Upper control limit e.g. NLRHO = 3000/min
  characteristic RLRHON dependent on n
  The characteristics RLRHUN and RLRHON depend greatly on the project. A characteristic with 4 datapoints lying between NLRHU and NLRHO should however suffice.
- Select TKATMLRH such that control is at a catalyzer temperature > 300 ° C. There is a catalyzer-temperature model (%ATM), by which the catalyzer temperature tkatm is formed.

- TBLRH is dependent on the characteristics of the catalytic converter should be selected as a minimum to be 1 s. The time is defined by this label that elapse until the control upstream of the catalyzer correlates with the sensor signal downstream of the catalyzer after the lambda control has switched on.
- ZLRHML characteristic that describes the integration rate via the air mass in ms/s.
  Datapoints for an engine with ml full load for example: 450 kg/h

ml:	9.6	28.8	86.4	200	400	kg/h
ZLRHML:	0.6	1.2	1.8	2.4	3.0	ms/s

Application of the P-component in the LRHK:

The effective action of the P-component on the control downstream of the catalyzer is calculated as follows. The following conditions thereby apply:

A numerical range of ±1.0 is permissible for dlashkp_w.
The pseudo-difference in lambda is transformed into a dimensionless factor by the maps KDLASHKI/KDLASHKP, and is standardized such that it can take values between -2 and 2. The value from the characteristic PLRHML = f(ml) is then multiplied by this factor. PLRHML has the dimension of seconds as is quantized with 0.01 s/incr., like the tv time. With a further factor from the characteristic PLRHAV, the influence of the age of the catalytic converter is included in the calculation by multiplication (RAM cell ptv), as described above.
PLRHAV is occupied with 1.0 for a new catalytic converter (avkatf at 0.0). PLRHAV is returned to 0.0 for an increasing amplitude ratio (the catalytic converter has aged).
The result is then weighted with the output of the map KFFTV that describes the influence of the control frequency of the control upstream of the catalyzer on the lambda implementation by atv and ptv tvlrh.

The following formula for the calculation is thus given:

tvlrhp = dlashkp_w * PLRHML * PLRHAV (avkatf) * KFFTV (nmot,rl)

where
usrhk = KFUSHK (nmot,rl)
dlashkm_w = LALIUSRH (usrhk) - LALIUSH (ushk)
dlashkp_w = f(dlashkm_w) = KDLASHKP (dlashkm_w)

The effect of the difference in sensor voltage on the I / P component can be weighted by the characteristics KDLASHKI and KDLASHKP.
The characteristic is normally defined such that for a decreasing difference in the voltage, the amplification of the I / P-component is also reduced.

KDLASHK could be applied for example as follows:

KDUSHKP Characteristic via dlashkm_w
Evaluation factor for I/P-component in the LRHK

	dlashkm_w	KDLASHKI/KDLASHKP
0 !	-0.297	1.000
1 !	-0.198	0.500
2 !	-.0991	0.500
3 !	0.000	0.00
4 !	0.198	-1.000
5 !	0.402	-1.000
6 !	0.495	-1.500
7 !	0.600	-1.703

The selection of parameters is essentially determined by the characteristics of the catalytic converter. In the event of queries, please inquire the application at the department developing the function.

Application of the parameter MLLRH:

The overshoot of the sensor voltage following completion of the function LRKA after clearing out O2 converter is a phenomenon specific to the project that disturbs the LRHK.
It is for this reason that the LRHK shall be disabled for such a time until the air mass MLLRH has been put through.
Since there is no experience available (above all with the new types of catalytic converters), those responsible for the LRKA or LRSKA should be consulted when specifying the parameter.

Application of the parameters ZLRHML:

For the application of the map KFRTV in the lambda control LR, the integration rate for control downstream of the catalyzer should be adjusted using the characteristic ZLRHML such that a control excursion of the integrator atv of between ±0.03 to ±0.04 s is given for the measurement at a datapoint.
The air mass at each operating point is noted during the measurement.
Following completion of the application of the map KFRTV, the values set from ZLRHML are plotted versus the air mass.
A cloud of points above the air mass is thus obtained in the plot by this. The actual characteristic ZLRHML in the LRHK is obtained by averaging the cloud of points.

LRKA 15.20 Two Sensor Lambda Control: Oxygen Clear Out Function

FDEF LRKA 15.20 Function definition

`No text for FDEF available!`

ABK LRKA 15.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CLRKA			FW	code word for catalyst O2 purge funktion
DTVKAML	ML		KL	delta-tv for cat oxygen neutralization (air mass dependent)
DTVKAML2	ML		KL	delta-tv for cat oxygen neutralization (air mass dependent) bank2
FFWEKA			FW	Weighting factor for inclusion of resumption factor fwe in calc.of enriched area
FKAXAVKAT	AVKATF		KL	weighting factor for oxygen capacity depending on avkatf
FLMLKAMA			FW	Factor for evaluation of threshold of richness to interrupt cat evacuation
FLMLKAPR			FW	Factor for weighing of the measured stored oxygen
FMLKAMA			FW	factor for threshold correc. of integrated air mass for stop of cat clear out
ILMLKAXTK	TKATM_W		KL	Threshold of richness area of O2 purging after fuel cat off, funct. of cat-temp
ILMLKAXTK2	TKATM2_W		KL	Thresh. of richness area of O2 purging after fuel cut off, funct. of cat-temp.
IMLKAMN			FW	integrated air mass threshold for minimum duration of cat oxygen neutralization
IMLKAMN2			FW	integrated air mass threshold for minimum duration of cat oxygen neutralization2
IMLKAXTK	TKATM_W		KL	integr. air mass threshold f(tkatm) for cancelation of cat oxygen neutralization
IMLKAXTK2	TKATM2_W		KL	integr. air mass threshold f(tkatm2) for cancelation of cat oxygen neutral.
LAMKAML	ML		KL	lambda setpoint for catylyst deoxidation (dependent on air mass)
LAMKAML2	ML		KL	lambdasetpoint for catalyst deoxidation (air mass dependent), bank 2
NLRKA			FW	Speed threshold for suppression of controlling emptying of the catalyzer
TDFRKAD			FW	Control-down time for controlled emptying of the catalyzer
TDFRKAU			FW	Control-up time for controlled emptying of the catalyzer
TSAKAMN			FW	minimum duration of fuel cut-off for catalyst oxygen neutralization
USHKAMN			FW	downstream sensor voltage for detection of cat has compl. stored oxygen
USHKAMX			FW	downstream sensor voltage for cancelation of cat oxygen neutralization
USVKAMX			FW	upstream sensor voltage for detection of lean cond. of cat oxygen neutralization

Variable	Source	Type	Description
AVKATF	DKAT	EIN	amplitude ratio laafh/laafv strained
B_BEVAB	BGEVAB	EIN	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	BGEVAB	EIN	condition: Inj. valve cut off on Bank2
B_BLRKA	LRKA	LOK	Condition controlled oxygen purging of catalyzer requested
B_BLRKA2	LRKA	LOK	Condition controlled oxygen purging of catalyzer requested, bank 2
B_ILMLKAT	LRKA	AUS	Condition: valid measurement of oxygen storage
B_ILMLKAT2	LRKA	AUS	Condition: valid measurement of oxygen storage, bank 2
B_KAWE	LRKA	LOK	Factor fwe active during catalyzer clear-out, Bank 1
B_KAWE2	LRKA	LOK	Factor fwe active during catalyzer clear-out, Bank 2
B_LRKA	LRKA	AUS	condition for neutralization of catalyst oxygen storage
B_LRKA2	LRKA	AUS	condition for neutralization of catalyst oxygen storage, cylinder row 2
B_LRKAA	LRKA	LOK	condition for turning on/ turning off the neutralization of cat. oxygen storage
B_LRKAA2	LRKA	LOK	condition for turning on/off the neutralization of cat. oxygen storage, bank 2
B_LRKAE	LRKA	LOK	Condition open loop oxygen purging of catalyst possible
B_LRKAE2	LRKA	LOK	Condition open loop oxygen purging of catalyst possible
B_LRKAEI	LRKA	LOK	Condition open loop oxygen purging of catalyist possible (ALRKAGST)
B_LRKAEI2	LRKA	LOK	Condition open loop oxygen purging of catalyst possible (ALRKAGST2), bank 2
B_LRKAON	LRKA	LOK	status catalyst clearing stopped due to new trigger of function
B_LRKARG	LRKA	LOK	condition for neutralization of catalyst oxygen storage, closed loop
B_LRKARG2	LRKA	LOK	condition for neutralization of catalyst oxygen storage, closed loop, bank 2
B_LRKAST	LRKA	LOK	condition for neutralization of catalyst oxygen storage, open loop
B_LRKAST2	LRKA	LOK	condition for neutralization of catalyst oxygen storage,open loop,bank 2
B_SA	MDRED	EIN	Condition fuel cut-off
B_SBBHK	DLSH	EIN	condition for lambda sensor downstream cat ready for operation
B_SBBHK2	DLSH	EIN	condition for lambda sensor downstream cat ready for operation bank2
B_SLS	AK	EIN	Condition for active secondary air
C_INI	SWADAP	EIN	ECU-condition for intialisation
DTVKA	LRKA	AUS	delta-tv for catalyst oxygen neutralization
DTVKA2	LRKA	AUS	delta-tv for catalyst oxygen neutralization for 2nd bank of stereo lambda contr.
DTVKAI	LRKA	LOK	delta-tv for catalyst oxygen neutralization, internal use
DTVKAI2	LRKA	LOK	delta-tv for catalyst oxygen neutralization, internal use, bank 2
FAVKATMX	LRKA	LOK	Evaluation factor for oxigen capacity of avkatf
FWE	ESWE	EIN	reinjection factor
ILMLKA2_W	LRKA	LOK	(air mass times delta fr)-integrator for cat oxygen neutralization, bank 2
ILMLKAH2_W	LRKA	LOK	Integrator, rich area for catalyst purging of main cat, bank 2
ILMLKAH_W	LRKA	LOK	Integrator, rich area for catalyst purging of main cat,
ILMLKAM_W	LRKA	LOK	weighted integrator of oxygen input in main catalyst
ILMLKAT2_W	LRKA	AUS	Valid value of oxygen storage, bank 2
ILMLKAT_W	LRKA	AUS	Valid value of oxygen storage
ILMLKAV2_W	LRKA	LOK	Integrator, rich area after catalyst purge pre cat, Bank2
ILMLKAV_W	LRKA	LOK	Integrator, rich area after catalyst purge pre cat,
ILMLKAX2_W	LRKA	LOK	Rich area limit for controlled catalyst purge f(tkatm2), bank 2
ILMLKAX_W	LRKA	LOK	Rich area limit for controlled catalyst purge f(tkatm2), bank 1 |
ILMLKA_W	LRKA	LOK	(air mass times delta fr)-integrator for cat oxygen neutralization
IMLKA2_W	LRKA	LOK	air mass integrator for cat oxygen neutralization for 2nd bank of stereo control
IMLKAV2_W	LRKA	LOK	weighted integrator air-mass at end of deoxidation of precatalyst, bank2
IMLKAV_W	LRKA	LOK	weighted integrator air-mass at end of deoxidation of precatalyst
IMLKAX2_W	LRKA	LOK	Air mass threshold for regulated (KAT ausräumen) f(tkatm2), bank 2
IMLKAX_W	LRKA	LOK	Air mass threshold for regulated (KAT ausräumen) f(tkatm), bank 1
IMLKA_W	LRKA	LOK	air mass integrator for cat oxygen neutralization

Variable	Source	Type	Description
LAMKA2_W	LRKA	AUS	Lambdasetpoint catalyst clean out, bank2
LAMKAI2_W	LRKA	LOK	Lambdasetpoint catalyst O2 purge function, bank 2
LAMKAII2_W	LRKA	LOK	Lambdasetpoint catalyst o2 purge function, local intermediate value, bank 2
LAMKAII_W	LRKA	LOK	Lambdasetpoint catalyst o2 purge function, local intermediate value
LAMKAI_W	LRKA	LOK	Lambdasetpoint catalyst O2 purge function
LAMKA_W	LRKA	AUS	Lambdasetpoint catalyst o2 purge function
LAMSNKA2_W	LRKA	LOK	required lambda for internal use by function LRKA, bank 2
LAMSNKA_W	LRKA	LOK	required lambda for internal use by function LRKA
LAMSONS2_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location bank2
LAMSONS_W	LAMSOLL	EIN	required lambda referred to lambda sensor fitting location
LRKAZ	LRKA	LOK	flagbyte of the catalyst oxygen neutralization
LRKAZ2	LRKA	LOK	status byte of the cat O2 neutralization for 2nd bank of stereo lambda control
ML	SWADAP	EIN	air mass flow
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	SWADAP	EIN	engine speed
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERSY	PROKON	EIN	system constant condition stereo lambda control symmetrical
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TKATM2_W	ATM	EIN	catalyst temperature modelled (word) bank2
TKATM_W	ATM	EIN	catalyst temperature modelled (word)
TSAKA	LRKA	LOK	timer fuel cut-off duration for cat oxygen neutralization
TSAKA2	LRKA	LOK	timer fuel cut-off duration for cat O2 neutralization 2nd bank stereo control
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2

FW LRKA 15.20 Fixed Values

Parameter	Value	Description
CLRKA		code word for catalyst O2 purge funktion
FFWEKA		Weighting factor for inclusion of resumption factor fwe in calc.of enriched area
FLMLKAMA		Factor for evaluation of threshold of richness to interrupt cat evacuation
FLMLKAPR		Factor for weighing of the measured stored oxygen
FMLKAMA		factor for threshold correc. of integrated air mass for stop of cat clear out
IMLKAMN		integrated air mass threshold for minimum duration of cat oxygen neutralization
IMLKAMN2		integrated air mass threshold for minimum duration of cat oxygen neutralization2
NLRKA		Speed threshold for suppression of controlling emptying of the catalyzer
TDFRKAD		Control-down time for controlled emptying of the catalyzer
TDFRKAU		Control-up time for controlled emptying of the catalyzer
TSAKAMN		minimum duration of fuel cut-off for catalyst oxygen neutralization
USHKAMN		downstream sensor voltage for detection of cat has compl. stored oxygen
USHKAMX		downstream sensor voltage for cancelation of cat oxygen neutralization
USVKAMX		upstream sensor voltage for detection of lean cond. of cat oxygen neutralization

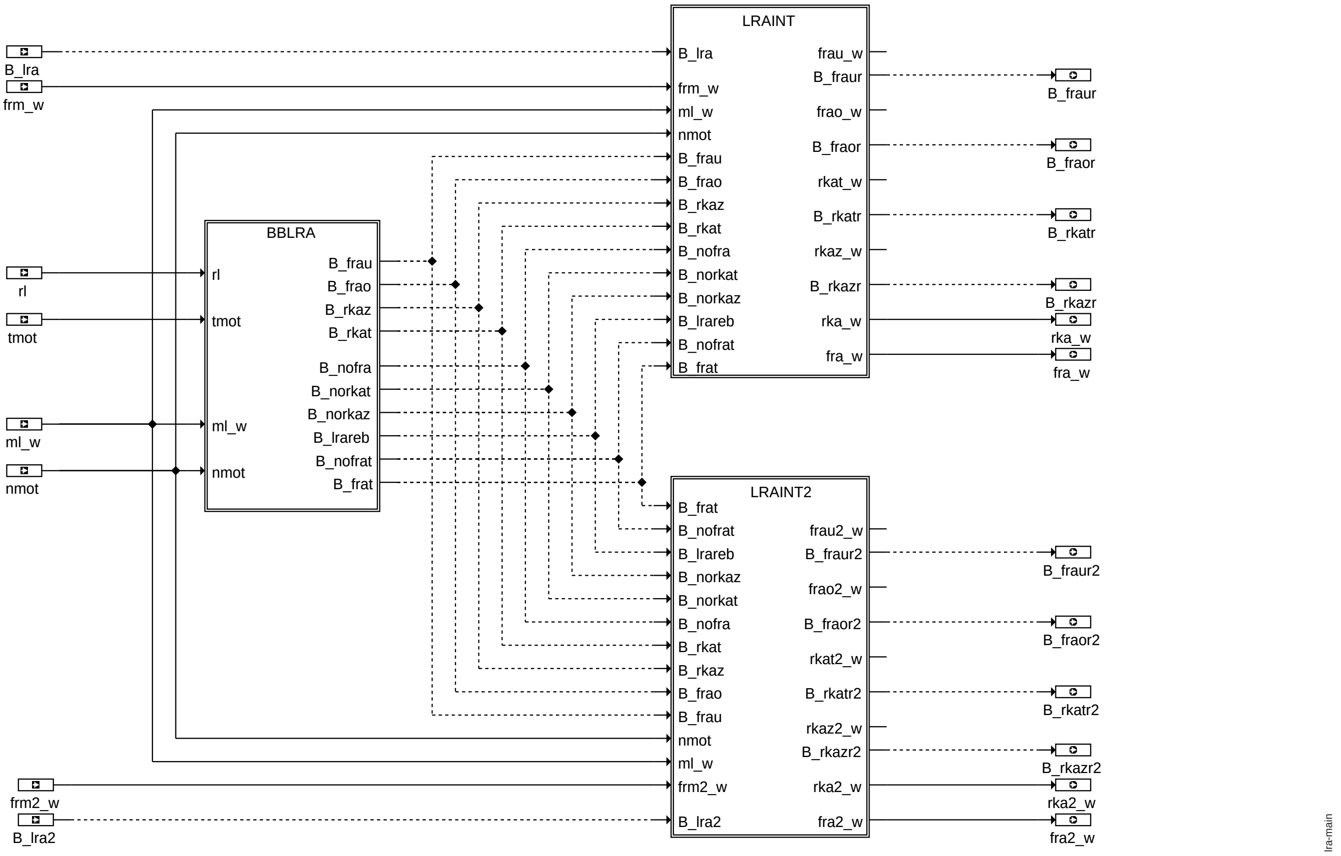
FB LRKA 15.20 Detailed description of function

APP LRKA 15.20 Application hint

LRA 93.60 Lambda closed loop control; Adaptive pilot control

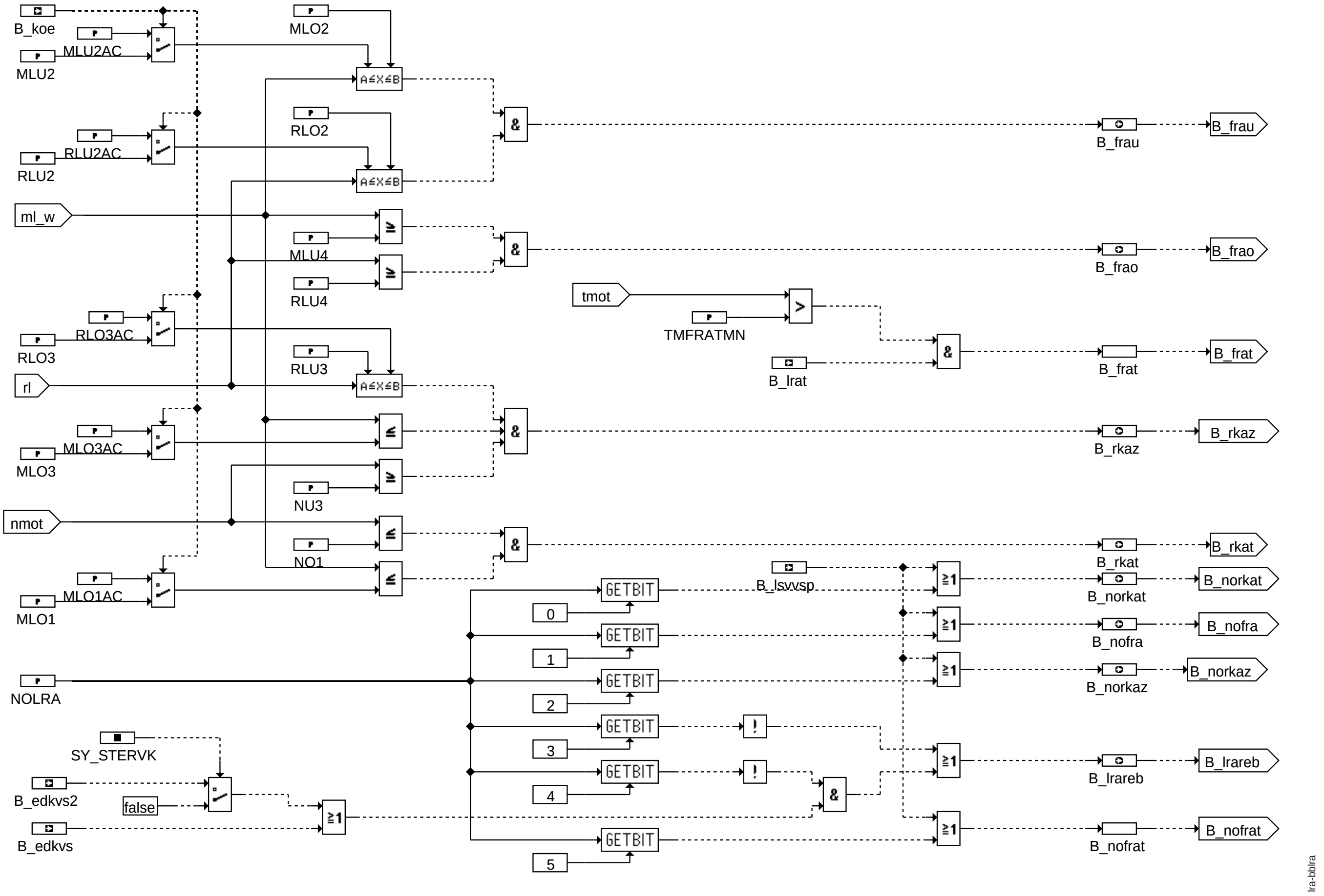
FDEF LRA 93.60 Function definition

`LRA : calculation of adaptation variables and their reset-, deactivation conditions (Bank 1 und 2)`



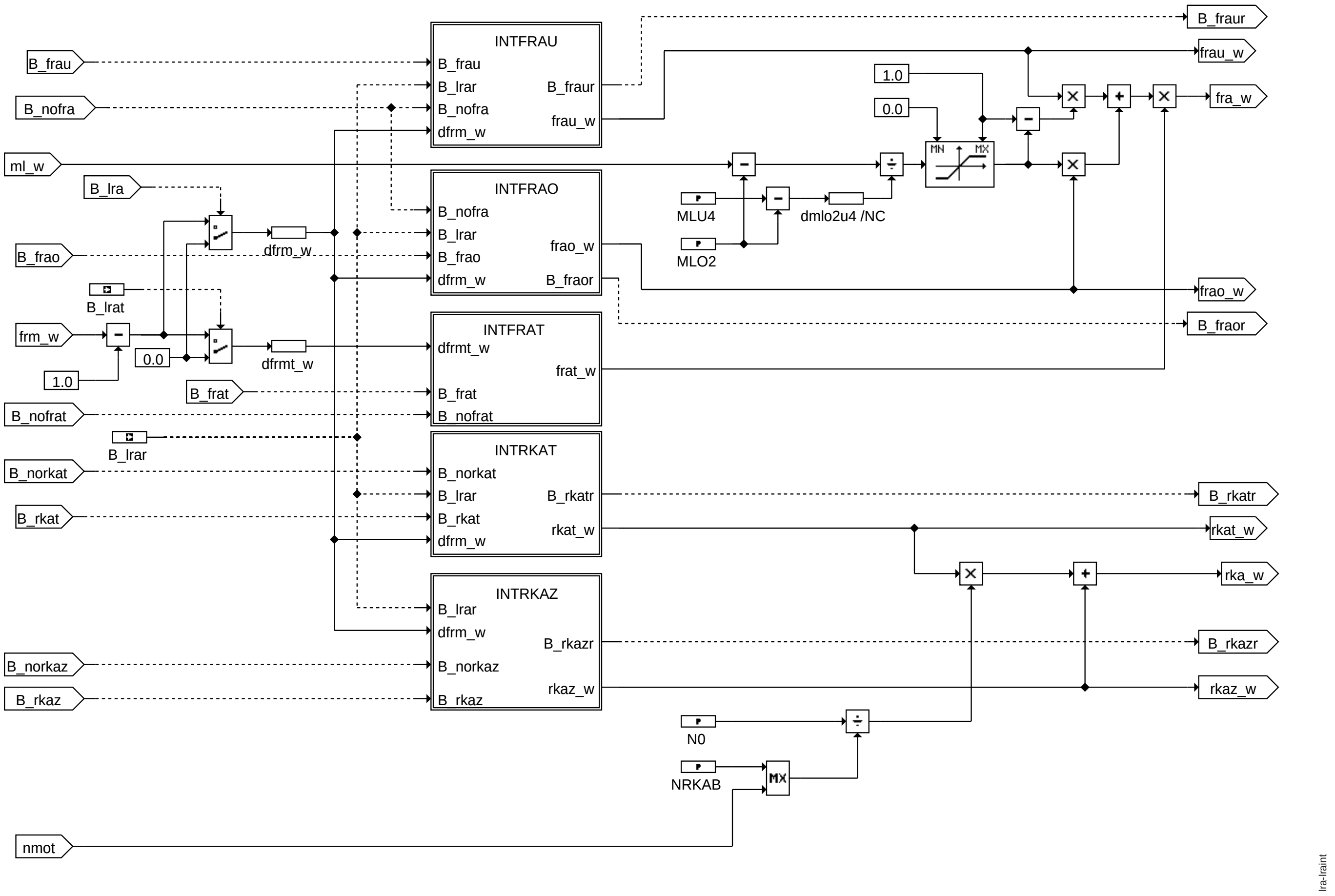
lra-main

BBLRA : commitment of learning ranges, calculation of reset and deaktivation conditions



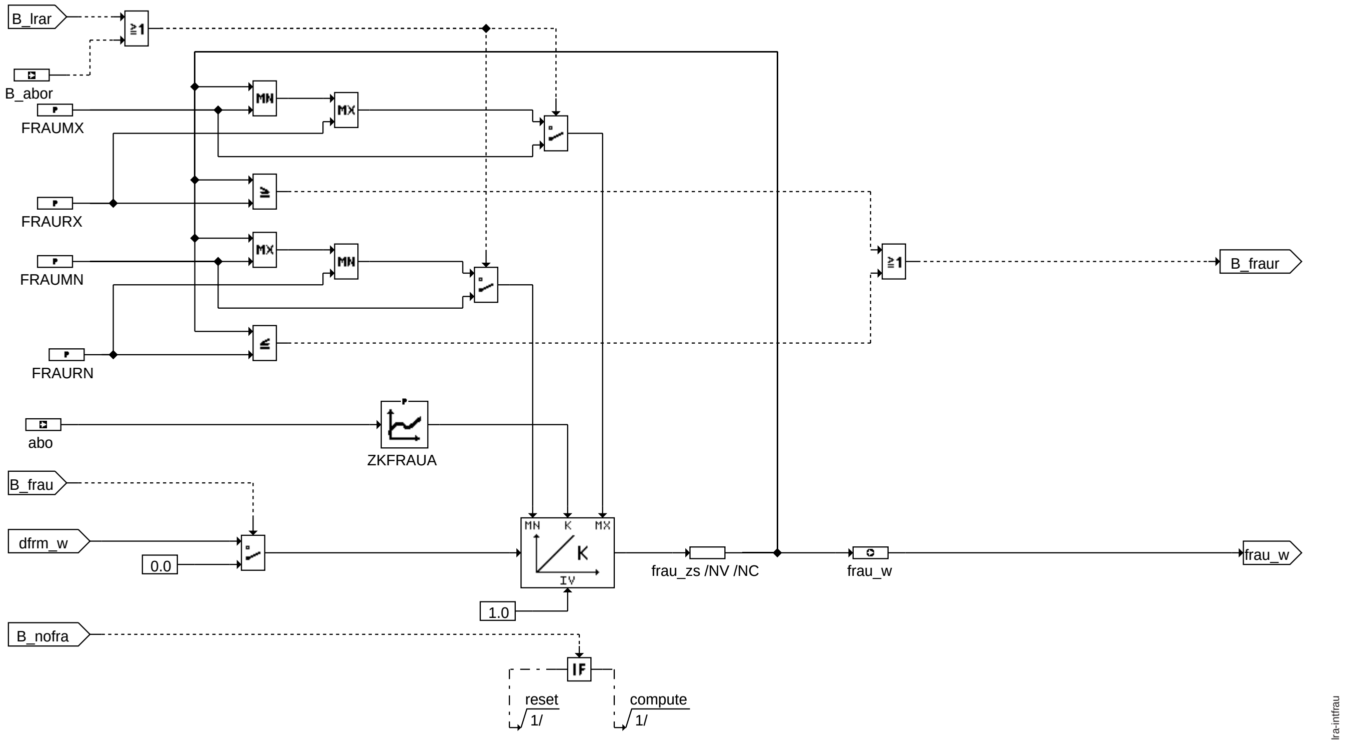
lra-bblra

`LRAINT : calculation of adaptation variables frao_w, frau_w, rkat_w und rkaz_w`



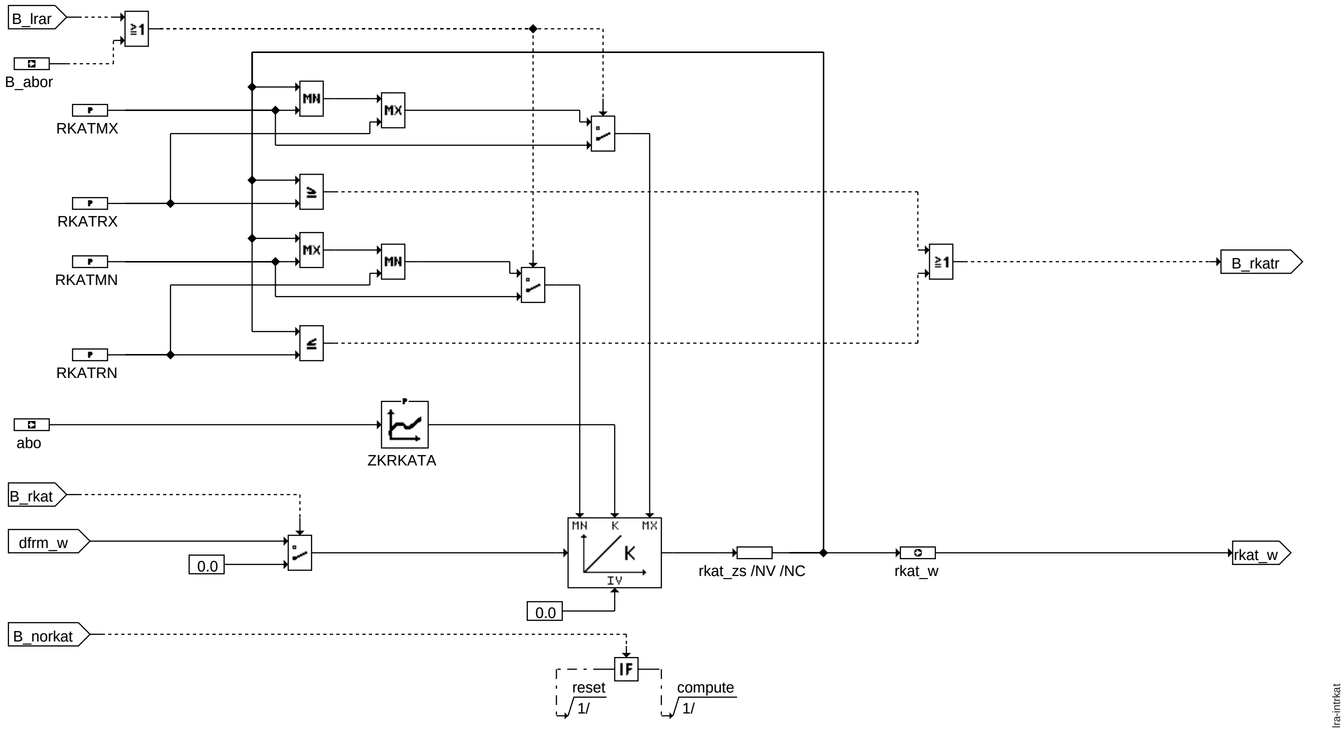
lra-lraint

`INTFRAU : calculation of lower multiplicative adaptation variable frau_w`



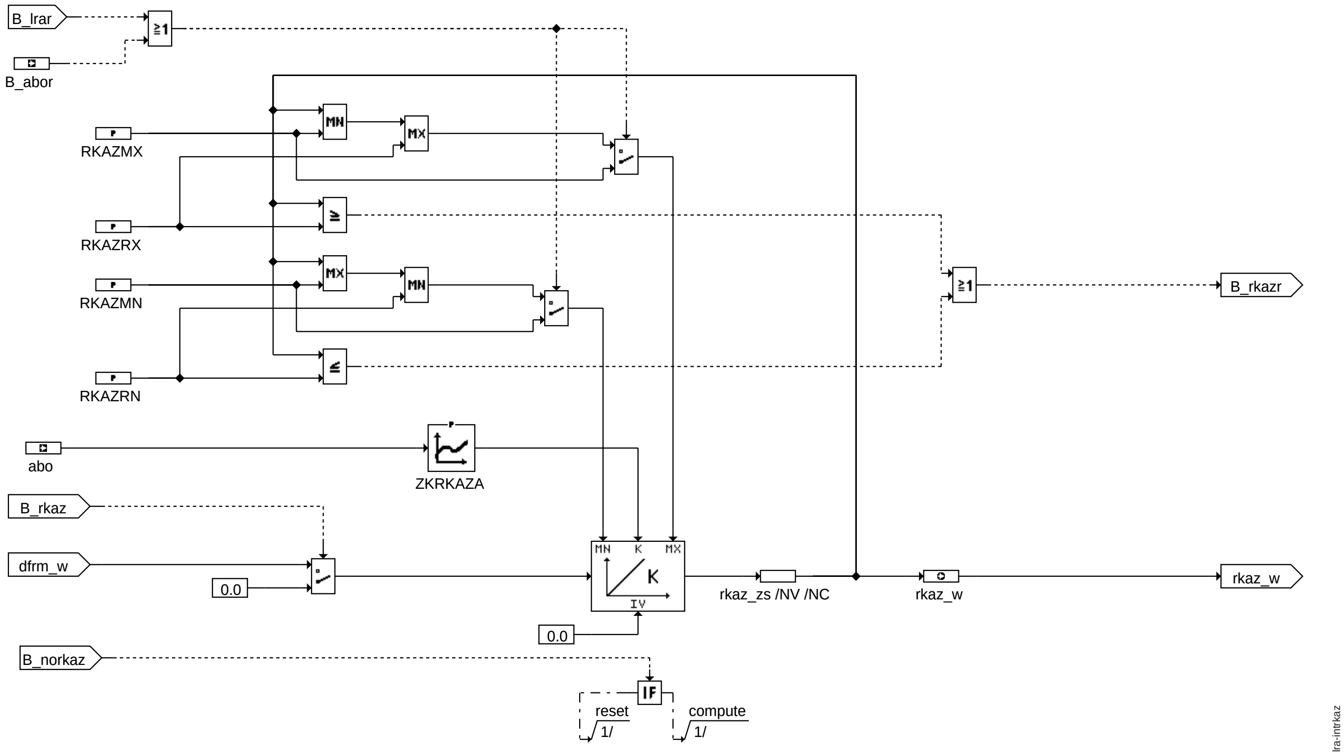
lra-intfrau

`INTRKAT : calculation of additive adaptation variable per time unit rkat_w`



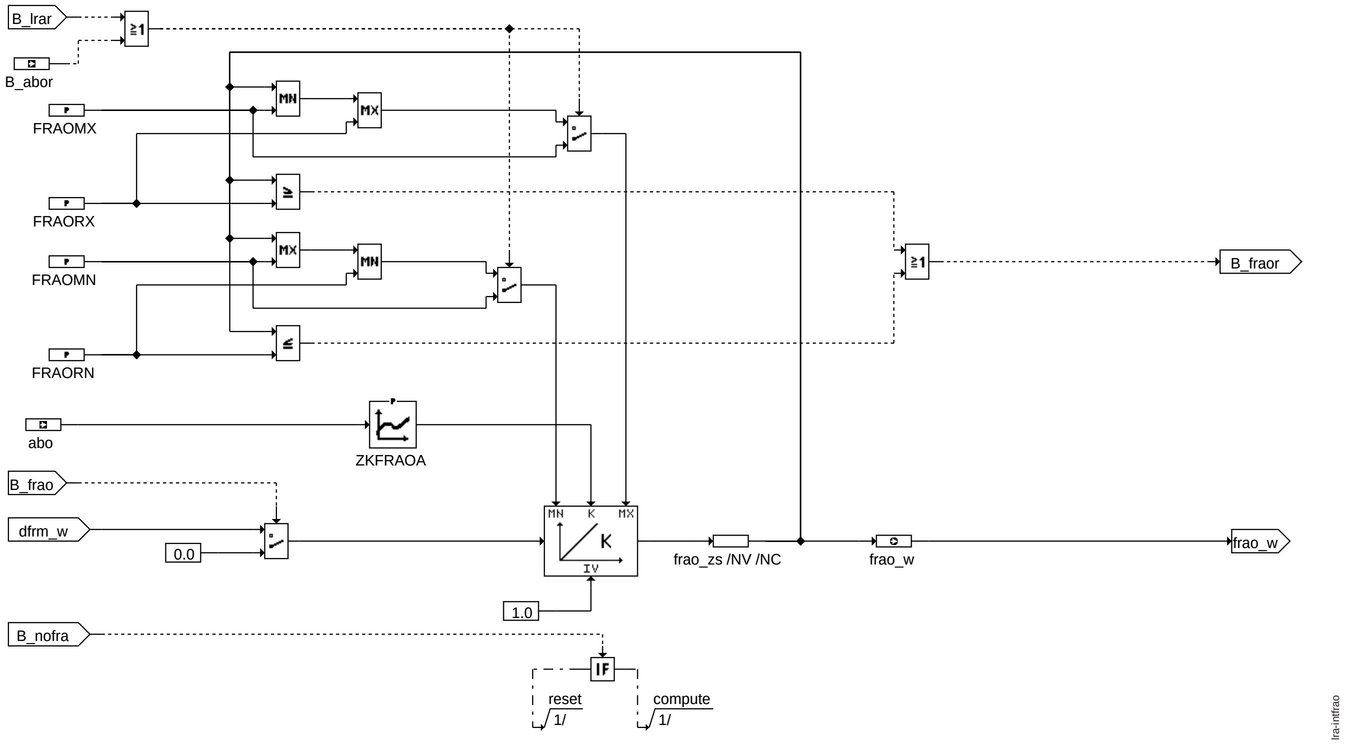
lra-intrkat

`INTRKAZ : calculation of additive adaptation variable per ignition rkaz_w`



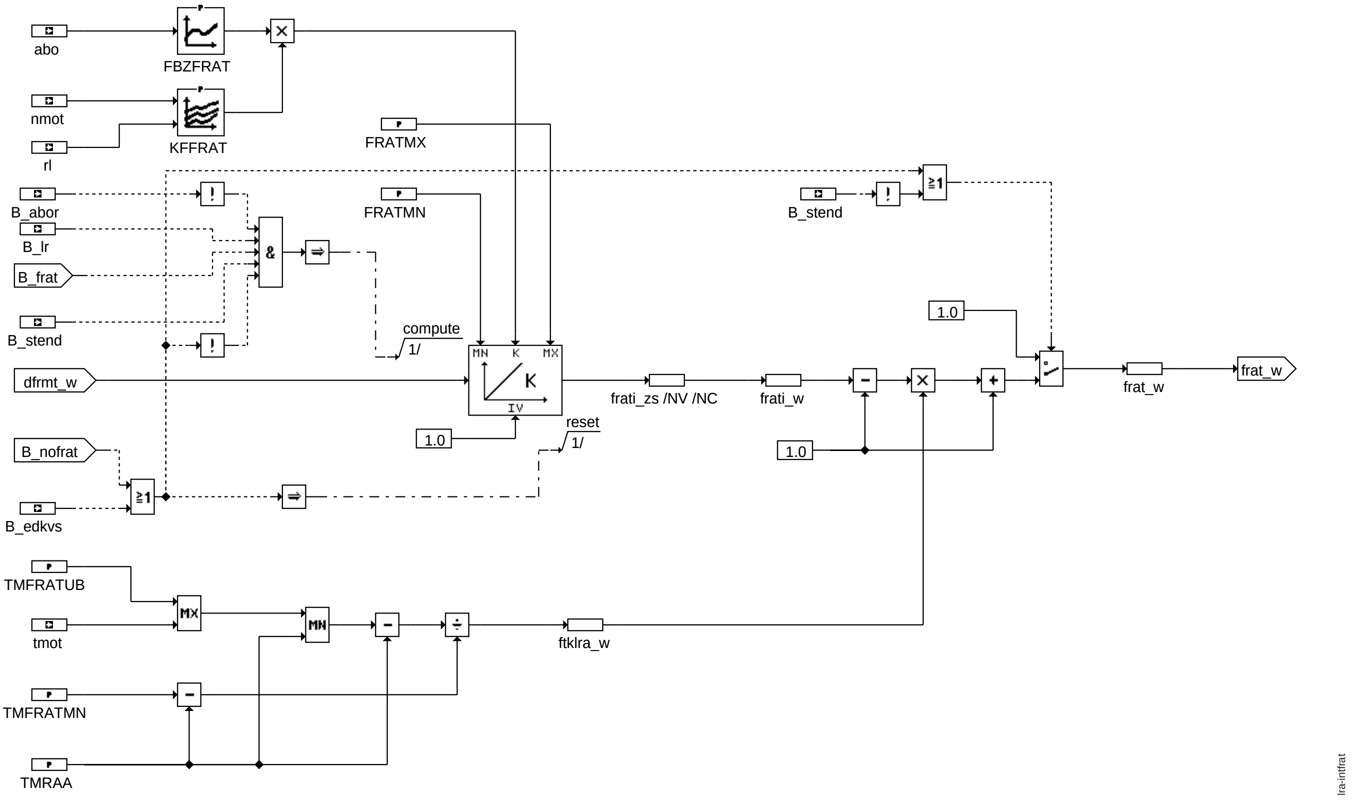
lra-intrkaz

`INTFRAO : calculation of upper multiplicative adaptation variable frao_w`



lra-intfrao

`INTFRAT :  calculation of temperature dependent adaptation variable frat_w`



lra-intfrat

ABK LRA 93.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FBZFRAT	ABO		KL	weighting factor for integration speed KFFRAT as f(abo)
FRAOMN			FW	lower limit of correction factor frao
FRAOMX			FW	upper limit of correction factor frao
FRAORN			FW	reduced lower threshold for frao correction
FRAORX			FW	reduced upper threshold for trao correction
FRATMN			FW	lower limit of correction factor frat
FRATMX			FW	upper limit of correction factor frat
FRAUMN			FW	lower limit of correction factor frau
FRAUMX			FW	upper limit of correction factor frau
FRAURN			FW	reduced lower threshold for frau correction
FRAURX			FW	reduced upper threshold fpr frau correction
KFFRAT	NMOT	RL	KF	load and speed dependent gradient of FRAT integrator
MLO1			FW	upper air-quantity threshold range 1
MLO1AC			FW	upper air-quantity threshold range 1 with compressor
MLO2			FW	upper air-quantity threshold range 2
MLO3			FW	upper air-quantity threshold range 3
MLO3AC			FW	upper air-quantity threshold range 3 with compressor
MLU2			FW	lower air-quantity threshold range 2
MLU2AC			FW	lower air-quantity threshold range 2 with compressor
MLU4			FW	lower air-quantity threshold range 4
N0			FW	conversion constant for calculation the mixture correction rkat
NO1			FW	upper engine-speed threshold range 1
NOLRA			FW	codeword for release of adaptation
NRKAB			FW	minumum engine speed for limitation rkat correction
NU3			FW	lower engine-speed threshold range 3
RKATMN			FW	lower threshold of additive correction per time
RKATMX			FW	upper threshold of additive correction per time
RKATRN			FW	reduced lower threshold of additive correction per time
RKATRX			FW	reduced upper threshold of additive correction per time
RKAZMN			FW	lower threshold of additive correction per ignition
RKAZMX			FW	upper threshold of additive correction per ignition
RKAZRN			FW	reduced lower threshold of additive correction per ignition
RKAZRX			FW	reduced upper threshold of additive correction per ignition
RLO2			FW	upper load threshold of range 2
RLO3			FW	upper load-signal threshold range 3
RLO3AC			FW	upper load-signal threshold range 3 with compressor
RLU2			FW	lower load-signal threshold range 2
RLU2AC			FW	lower load-signal threshold range 2 with compressor
RLU3			FW	lower load-signal threshold range 3
RLU4			FW	lower load threshold of the upper multiplicative section
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TMFRATMN			FW	minimum temperature at it ftklra_w is one
TMFRATUB			FW	upper temperature threshold at it ftklra_w is constant
TMRAA			FW	cut-in temperature adaptive precontrol for lambda closed-loop control
ZKFRAOA	ABO		KL	time constant for frao-integrator, f(number of starts with fuel in oil)
ZKFRAUA	ABO		KL	time constant for frau-integrator, f(number of starts with
ZKRKATA	ABO		KL	integration speed integrator rkat, f(abo)
ZKRKAZA	ABO		KL	integration speed integrator rkaz, f(abo)

Variable	Source	Type	Description
ABO	BBBO	EIN	numbers of starts with fuel in oil
B_ABOR	BBBO	EIN	condition numbers of starts with fuel in oil for reduced adaptive lambda control
B_CLFRAO		EIN	condition clear failure path FRAO (upper multipl. section)
B_CLFRAO2		EIN	condition clear failure path FRAO2 (stereo)
B_CLFRAU		EIN	condition clear failure path FRAU (lower multipl. section)
B_CLFRAU2		EIN	condition clear failure path FRAU2 (stereo)
B_CLRKAT		EIN	condition clear failure path RKAT (add. per time)
B_CLRKAT2		EIN	condition clear failure RKAT2 (stereo)
B_CLRKAZ		EIN	condition clear failure RKATZ (add. per ingnition)
B_CLRKAZ2		EIN	condition clear failure path RKAZ2 (stereo)
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_FA		EIN	condition general function request
B_FAKVS		EIN	condition function request diagnoses fuel supply system
B_FRAO	LRA	AUS	condition for enabling adaption of frao
B_FRAOR	LRA	AUS	condition frao-integrator outside reduced thresholds
B_FRAOR2	LRA	AUS	condition frao2-integrator outside reduced thresholds
B_FRAT	LRA	LOK	condition enable adaptation of frat
B_FRAU	LRA	AUS	condition enable adaptation of frau
B_FRAUR	LRA	AUS	condition frau-integrator outside reduced thresholds
B_FRAUR2	LRA	AUS	condition frau2-integrator outside reduced thresholds
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	LRAEB	EIN	condition for basic mixture adaptation enabled
B_LRA2	LRAEB	EIN	condition for basic mixture adaption 2 enabled
B_LRAR	TEB	EIN	condition for reducted correction ranges at LRA
B_LRARE	LRA	AUS	condition reset of mixture adaptation
B_LRARE2	LRA	AUS	condition reset of mixture adaptation bank 2
B_LRAREB	LRA	AUS	condition reset readiness of mixture adaptation
B_LRAT	LRAEB	EIN	condition for basic mixture adaptation temperature dependet enabled

Variable	Source	Type	Description
B_LSVVSP		EIN	condition for exchange lambda sensor; lambda control stopped
B_NOFRA	LRA	AUS	condition no fra adaptation active
B_NOFRAT	LRA	LOK	condition no frat adaptation active
B_NORKAT	LRA	AUS	condition additive correction of the mixture adaptation switched off
B_NORKAZ	LRA	AUS	condition additive correction of the mixture adaptation switched off
B_PWF		EIN	Condition for powerfail
B_RKAT	LRA	AUS	condition adaptation area rkat active
B_RKATR	LRA	AUS	condition rkat-integrator outside reduced thresholds
B_RKATR2	LRA	AUS	condition rkat2-integrator outside reduced thresholds
B_RKAZ	LRA	AUS	condition adaptation area rkaz active
B_RKAZR	LRA	AUS	condition rkaz-integrator outside reduced thresholds
B_RKAZR2	LRA	AUS	condition rkaz2-integrator outside reduced thresholds
B_STEND	BBSTT	EIN	condition end of start
DFP_DPL	LRA	DOK	ECU int. fault path no.: power fail
DFP_FRAO	LRA	DOK	internal failure path number mixture adaptation FRAO
DFP_FRAO2	LRA	DOK	internal failure path number mixture adaptation FRAO bank 2
DFP_FRAU	LRA	DOK	ECU int. fault path no.: upper multiplicative mixture adaptation factor
DFP_FRAU2	LRA	DOK	internal failure path number mixture adaptation FRAU bank 2
DFP_RKAT	LRA	DOK	internal failure path number mixture adaptation RKAT
DFP_RKAT2	LRA	DOK	internal failure path number mixture adaptation RKAT bank 2
DFP_RKAZ	LRA	DOK	internal failure path number mixture adaptation RKAZ
DFP_RKAZ2	LRA	DOK	internal failure path number mixture adaptation RKAZ bank 2
DFRM2_W	LRA	LOK	deviation of fast lambda controller mean value from 1.0 (Word), bank 2
DFRMT2_W	LRA	LOK	deviation of fast lambda controller mean value from 1.0 (Word), bank 2
DFRMT_W	LRA	LOK	deviation of fast lambda controller mean value from 1.0 (Word)
DFRM_W	LRA	LOK	deviation of fast lambda controller mean value from 1.0 (Word)
E_DPL		EIN	error condition: power fail
FRA2_W	LRA	AUS	multiplicative correction of the mixture adaptation (word)
FRAO2_W	LRA	AUS	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	LRA	AUS	multipl. mixture adaptation factor higher load (word)
FRAT2_W	LRA	LOK	temperature dependent mixture adaptation factor (2. bank)
FRATI2_W	LRA	LOK	temperature dependent mixture adaptation factor integral value (2. bank)
FRATI_W	LRA	LOK	temperature dependent mixture adaptation factor integral value
FRAT_W	LRA	LOK	temperature dependent mixture adaptation factor
FRAU2_W	LRA	AUS	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAU_W	LRA	AUS	multipl. mixture adaptation factor of the lower mult. section (Word)
FRA_W	LRA	AUS	multiplicative correction of the mixture adaptation (word)
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
FTKLRA_W	LRA	LOK	correction factor for temperature dependent adaptation factor
ML_W	EGFE	EIN	air mass flow filtered (Word)
NMOT	SWADAP	EIN	engine speed
RKA2_W	LRA	AUS	additive adaptive correction of the relative fuel amount bank 2
RKAT2_W	LRA	AUS	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	LRA	AUS	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	LRA	AUS	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)
RKAZ_W	LRA	AUS	additive correction (per ignition) of the mixture adaptation
RKA_W	LRA	AUS	additive adaptive correction of the relative fuel amount
RL	SWADAP	EIN	relative air charge
TMOT	SWADAP	EIN	Engine temperature

FW LRA 93.60 Fixed Values

Parameter	Value	Description
FRAOMN		lower limit of correction factor frao
FRAOMX		upper limit of correction factor frao
FRAORN		reduced lower threshold for frao correction
FRAORX		reduced upper threshold for trao correction
FRATMN		lower limit of correction factor frat
FRATMX		upper limit of correction factor frat
FRAUMN		lower limit of correction factor frau
FRAUMX		upper limit of correction factor frau
FRAURN		reduced lower threshold for frau correction
FRAURX		reduced upper threshold fpr frau correction
MLO1		upper air-quantity threshold range 1
MLO1AC		upper air-quantity threshold range 1 with compressor
MLO2		upper air-quantity threshold range 2
MLO3		upper air-quantity threshold range 3
MLO3AC		upper air-quantity threshold range 3 with compressor
MLU2		lower air-quantity threshold range 2
MLU2AC		lower air-quantity threshold range 2 with compressor
MLU4		lower air-quantity threshold range 4
N0		conversion constant for calculation the mixture correction rkat
NO1		upper engine-speed threshold range 1
NOLRA		codeword for release of adaptation
NRKAB		minumum engine speed for limitation rkat correction
NU3		lower engine-speed threshold range 3
RKATMN		lower threshold of additive correction per time
RKATMX		upper threshold of additive correction per time
RKATRN		reduced lower threshold of additive correction per time
RKATRX		reduced upper threshold of additive correction per time
RKAZMN		lower threshold of additive correction per ignition

Parameter	Value	Description
RKAZMX		upper threshold of additive correction per ignition
RKAZRN		reduced lower threshold of additive correction per ignition
RKAZRX		reduced upper threshold of additive correction per ignition
RLO2		upper load threshold of range 2
RLO3		upper load-signal threshold range 3
RLO3AC		upper load-signal threshold range 3 with compressor
RLU2		lower load-signal threshold range 2
RLU2AC		lower load-signal threshold range 2 with compressor
RLU3		lower load-signal threshold range 3
RLU4		lower load threshold of the upper multiplicative section
TMFRATMN		minimum temperature at it ftklra_w is one
TMFRATUB		upper temperature threshold at it ftklra_w is constant
TMRAA		cut-in temperature adaptive precontrol for lambda closed-loop control

FB LRA 93.60 Detailed description of function

```
Principle:
==========
The fuel pilot control is adjusted by the mixture adaptation multiplicative and additive such that the Lambda controller corrections
become minimal and that the desired Lambda is also obtained during open-loop controlled operation (e.g. B_vl = 1 or
tmot < activation temperature threshold of the Lambda control). The correction variables multiplicative (fra_w) and additive (rka_w)
are included in the calculation on the mixture side, i.e. the load signal rl is not corrected (see %GK).

The method of the LRA is based on the following assumptions:
1. Due to the service life and by manufacturing tolerances mainly three fault types occur:
   multiplicative faults, additive faults per time unit (leakage air) and additive faults per injection (injector pickup delay).
2. During idling the leakage air fault dominates (low air throughput, low engine speed), with high air throughput the multiplicative
   fault dominates and at high engine speed and low load the injector fault dominates.
3. An arbitrary fault combination of multiplicative and additive kind is correctly compensated if a correction variable each is
   adapted in its corresponding dominating range. Precondition is a repeated switching from one range to another during the
   driving cycle.
   Learning ranges are defined for individual adaptation variables. Only during engine operation within a learning range is the
   corresponding integrator activated. The adaptation variables are however included global in the calculation according to their
   physical effect (fra_w multiplicative - everywhere equally strong, rkat_w additive per time decreases according to the engine
   speed nmot).

Remark:  In addition to the above-mentioned fault types the mixture adaptation should also correct characteristic deviations of
         the HFM. In order to adapt "a curved HFM fault characteristic" the multiplicative range was subdivided into two ranges
         (FRAU and FRAO).


Remarks regarding Stereo Lambda control:
========================================
 - This FDEF is designed for a system with stereo Lambda control.
 - The stereo variables are distinguished by attaching a (2) (fra_w(2) means fra_w for bank 1 and fra2_w for Bank 2).
 - The FDEF is, however, also completely suitable for a mono-system. In this case B_lra2 = FALSE.
   Additionally B_lrare2  = TRUE (reset of the integrators), so that the integrators of bank 2 are set to their neutral
   values.
 - In so far as they exist in duplicate the ASCET pictures only show the function of bank 1.

Description of the overview representation:
===========================================
The LRA is part of the %GKRA (mixture check, controls, adaptations). It makes available the multiplicative and additive adaptation
variables of the DKVS (for the diagnosis of the fuel supply system) and the mixture check GK (for the ti calculation).
The LRA contains the following subfunctions:
 - BBLRA (determination of the learning ranges of the adaptation variables and calculation of the reset and deactivation
   conditions for the integrators)
   Remark: The learning ranges (over nmot, rl and ml) of the two banks are identical.
 - LRAINT (calculation of the adaptation variables for bank 1 resp mono Lambda control)
 - LRAINT2 (calculation of the adaptation variables for bank 2 with stereo Lambda control)
```

a) Description of the subfunction BBLRA:

Four learning ranges are defined, in each of which a learning integrator is active.

1. FRAU : lower multiplicative learning range for the adaptation of muliplicativ faults and HFM deviations with mean air masses

2. FRAO : upper multiplicative learning range for the adaptation of muliplicative faults and HFM deviations with large air masses

3. RKAZ : additive adaptation variable for the learning of faults additive per ignition

4. RKAT : additive adaptation variable for the learning of faults additive per time

The learning ranges should each time be counted such that the effect of the assigned fault is at its maximum.
Die temperaturabhängige Gmischadption FRAT wird unabhängig von der Last, Drehzahl sondern von einem Temperaturbereich nämlich TMFRATMN <= tmot <= TMRAA aktivert.

Limitation of the ranges:

The lower multiplicative learning range is limited by a lower air mass threshold (ml >= MLU2) and a lower relative load threshold (rl >= RLU2) as well as by an upper air mass threshold (ml <= MLO2) and an upper load threshold (rl <= RLO2) (range 2).

The upper multiplicative learning range (range 4) is limited by a lower air mass threshold (ml >= MLU4) and a lower relative load threshold (rl >= RLU4).

The learning range for additive adaptation correction per injection (range 3) is limited by the air mass ml <= MLO3, by the engine speed nmot >= NU3 and by the relative load between RLU3 and RLO3.

The learning range for the additive adaptation variable per time unit (range 1) is limited by the engine speed nmot <= NO1 and by the air mass ml <= MLO1.

Remark: If the throttle valve is completely open (HFM pulsations) learning must be prohibited: -> see threshold WDKARN in %LRAEB. The general activation condition B_lra(2) is reset here. The above-mentioned learning conditions remain unchanged from this.

Calculation of the reset conditions for the integrators in LRAINT(2):

There are several conditions, for which the adaptation integrators should be set to neutral values.

They are furthermore generally reset:

a) After detected powerfail (C_pwf)
   If the voltage supply is interrupted, then this is detected by a powerfail test. (A stored test word then no longer corresponds to the value, which is also stored in the EPROM). In this case the adaptation is started with neutral values.
b) During the initialization C_ini = TRUE,
   1. If one of the integrator values (frau_w, frau2_w or frao_w, frao2_w) is outside of the absolute limit
   2. With detected fault E_dpl

Deactivation of individual integrators:

The status byte NOLRA is a simple possibility to deactivate individual adaptation ranges.
This should also then happen if the respective range is not entered.

a) Bit 0 in NOLRA resets the RKAT-integrator in LRAINT(2)	B_norkat
b) Bit 1 in NOLRA resets the FRAU and the FRAO-integrator in LRAINT(2)	B_nofra
c) Bit 2 in NOLRA resets the RKAZ-integrator in LRAINT(2)	B_norkaz
d) Bit 5 in NOLRA resets the FRAT-integratot in LRAINT(2)	B_nofrat

Remark: It is not useful to only deactivate one of the two multiplicative integrators. Therefore a separate reset of FRAO and FRAU was abstained from.

For the clearing of the individual fault path the bit reset readiness B_lrareb is made available. The bit B_lrareb is set to TRUE,
a) if bit 3 of NOLRA = FALSE or
b) if bit 4 of NOLRA = FALSE and B_edkvs or B_edkvs2 = TRUE.

B_edkvs(2) is set as soon as a fault threshold of the DKVS is exceeded. If bit 3 was set to TRUE and bit 4 was set to FALSE then the individual adaptation variables are only reset in case of clear fault path if a fault of the DKVS occurred.

Attention:
==========
In the series production version the adaptation must at least then be reset with clear fault memory if a fault of the DKVS occurred.
A general resetting is, however, recommended.
==> NOLRA bit 4 must be FALSE in any case, it is also recommendable to set NORLA bit 3 to FALSE.

NOLRA bit 3 and NOLRA bit 4 may only both be TRUE during the application phase.

If SY_STERVK = FALSE all integrators in LRAINT2 are reset (B_lrare2 = TRUE). Thus all integrators of the LRAINT2 are at their neutral values with a mono-system. In the software bank 2 is not processed and no program codes are generated.

b) Description of the subfunctions LRAINT(2):

Since the two subfunctions LRAINT and LRAINT2 (for 2. bank) are designed similarly, the description of LRAINT2 is abstained from here.
Wherever no stereo labels exists, this will be mentioned explicitly (e.g. frm_w(2) means frm_w for bank 1 and frm2_w for bank 2).

LRAINT(2) consists of:

- Calculation of dfrm_w(2): The frm_w(2) (mean value of the Lambda controller from continuous or 2-step Lambda control) serves as input value
- Calculation of fra_w: Interpolation between frau_w(2) and frao_w(2) over the air mass ml_w
- Calculation of rka_w(2) from rkat_w(2), rkaz_w(2) and nmot
- The following subfunctions:
  - INTFRAU(2): Integrating of the frm_w(2) deviation for the lower multiplicative fault correction and for the calculation of the condition "frau_w(2) outside the reduced range" B_fraur(2)
  - INTFRAO(2): Integrating of the frm_w(2) deviation for the upper multiplicative fault correction and for the calculation of the condition "frao_w(2) outside the reduced range" B_fraor(2)
  - INTRKAT(2): Integrating of the frm_w(2) deviation for the additive fault correction per time and for the calculation of the condition "rkat_w(2) outside the reduced range" B_rkatr(2)
  - INTRKAZ(2): Integrating of the frm_w(2) deviation for the additive fault correction per ignition and for the calculation of the condition "rkaz_w(2) outside the reduced range" B_rkazr(2)

Calculation of fra_w(2): Interpolation between frau_w(2) and frao_w(2) over the air mass ml_w

Between the learning ranges a linear interpolation over ml_w from frau_w(2) and frao_w(2) is to be performed for the multiplicative correction variable. If ml_w has a value within one of the learning ranges FRAU resp. FRAO, then fra_w(2) to frau_w(2) resp. frao_w(2) shall be chosen.

The interpolation takes place as follows:

- Formation of the difference from the current ml and the upper threshold of the lower multplicative range (MLO2).
- Formation of the difference from the lower ML threshold of the upper multiplicative range (MLU4) and of the upper ml threshold multiplicative range (MLO2)
- Formation of the ratio of both values calculated above -> Norm_Wert_ml = (ml - MLO2)/ (MLU4-MLO2) thus a normalized value between 0 and 1 is obtained for the current air mass ml_w. For air masses less than MLO2 an extrapolation to frau_w is performed and for air masses greater than MLU4 an extrapolation to frao_w is performed. For air masses between MLO2 and MLU4 a linear interpolation between frau_w and frao_w is performed.

  fra_w = frau_w * (1 - Norm_Wert_ml) + frao_w * Norm_Wert_ml = Norm_Wert_ml * (frao_w - frau_w) + frau_w

Calculation of rka_w(2):

The additive correction per time rkat_w(2) calculated by the subfunction INTRKAT(2) is multiplied by the factor N0/nmot (value N0=640 rpm) and added to the additive correction per injection calculated by the subfunction INTRKAZ(2) and then it is passed on to the injection calculation (see mixture check %GK) as additive correction rka_w(2).
By a maximum selection of nmot with NRKAB it is ensured that the additive correction per time, which was included in the calculation does not become too large in case of very low engine speeds (stalling).

Description of the subfunctions INTFRAU(2), INTFRAO(2), INTRKAT(2) and INTRKAZ(2)

Subfunction INTFRAU(2):

The lower multiplicative adaptation factor frau_w(2) is adjusted with the integration speed ZKFRAU, if the condition B_frau(2) is fulfilled. If this condition is not fulfilled, then the integration input is set to zero.

The integrator is initialized with the value 1.0, if one of the following conditions is fulfilled: B_nofra (deactivate FRA range by bit 1 in NOLRA = TRUE), B_lrare(2) (reset mixture adaptation during the initialization phase) or clear fault path FRAU (if B_lrareb=TRUE reset readiness). The output of the integrator is set to 1.0, if the functional request is signalized to be equal to TRUE by B_fa and B_fakvs. The output of the integrator is limited by the absolute threshold FRAUMX resp. FRAUMN, which may by no means be exceeded. In order to rule out the incorrect messages of the DKVS (see diagnosis; fuel supply system) due to hot gasoline problems, additionally the reduced threshold FRAURX resp. FRAURN were introduced. The reduced thresholds apply, if the condition B_lrar was set to TRUE by the subfunction HOHE BEL. (high charge in TEB). In case the integrator value is already outside of the reduced thresholds with B_lrar = TRUE, only a reversed integral-action to the neutral position is still possible otherwise the integrator will be held at the present value. This comportment is forced by MINi-, MAXi-operators (resp. MAXi, MINi with lower limit), which are connected in series.

If frau_w(2) is greater than or equal to FRAURX or less than or equal to FRAURN, the condition B_fraur(2) = TRUE is set. B_fraur(2) is needed in the DKVS to prevent an erroneous setting of the bit B_gaefra(2) (multiplicative adaptation factor stabilized) and of B_gaeing(2) (mixture adaptation bank 1 resp. bank 2 stabilized).

Subfunction INTFRAO(2) :

The facts mentioned regarding INTFRAU(2) apply analogous with the following differences:
- The thresholds can be adjusted separately (labels FRAOMX, FRAOMN, FRAORX, FRAORN)
- The time constant can be adjusted separately ZKFRAO
- B_fraor(2) is not needed for the formation of B_gaefra(2)
- The FRAO integrator is reset to the neutral value by clear fault path FRAO (if reset readiness is given).

Subfunction INTFRAT(2) :

The adaptation value dependent on temperature will be active at temperature which is lower then switch on temperature of mixture adaptation TMRAA. The feul density is dependent on temperature and at high common rail temperature learns the fra_w (frau_w resp. frao_w) the mixture fault which describes the density of feul. Since the adaptation values is calculated at every temperature in mixture control, the adaptation values are not right at low temperature anymore. The frat_w learns this faults und corrects the fra_w so that the mixture is excatly again. If the engine temperature converges against the switch on temperature of mixture adaptation (TMRAA), the frat_w converges against one and thus it is not relevant anymore. With the factor TMFRATMN can be varies the gradient of temerature dependent correction frat_w so that integrator FRAT learns not too much. With FRATMX and FRATMN the integrator FRAT can be limited. The geradient of Integrator FRAT is dependent on load and speed. This isnecessray, because at low temperature the frm_w deviation, which e.g. are caused by transient control, do not interpret as density fault. The correction factor ftklra_w is limited down by TMFRATUB. In start and by mixture fault the adaptation corrction is neutral.

Subfunction INTRKAT(2):

The additive adaptation variable per time rkat_w(2) is adjusted with the integration speed ZKRKAT, if the condition B_rkat(2) is fulfilled.

The integrator is initialized with the value 0.0, if one of the following conditions is fulfilled: B_norkat (bit no. 0 in NOLRA), B_lrare(2) or clear fault path RKAT. The output of the integrator is set to 0.0 if the functional request is signalized to be equal to TRUE by B_fa and B_fakvs. The integrator is limited by the absolute thresholds (RKATMX, RKATMN).

Analogous to the FRAU and the FRAO integrator there are also reduced thresholds (RKATRN and RKATRX). These thresholds apply as soon as B_lrar(2) is set. If, however, rkat_w(2) has exceeded or undershot these thresholds then only a reversed integral-action resp. a hold at instantaneous value is possible.
If rkat_w(2) is outside of the reduced thresholds, then the condition B_rkatr(2) = TRUE is set. B_rkatr(2) is needed in the DKVS to prevent an erroneous setting of the bit B_gaeing(2) (mixture adaptation bank 1 resp. bank 2 stabilized).

Subfunction INTRKAZ(2):

The additive adaptation factor per ignition rkaz_w(2) is adjusted with the integration speed ZKRKAZ, if the condition B_rkaz(2) is fulfilled. If this condition is not fulfilled, then the integration input is set to zero. The integrator is initialized with the value 0.0, if one of the following conditions is fulfilled: B_norkaz (bit no. 2 in NOLRA),B_lrare(2) or clear fault path RKAZ. The output of the integrator is set to 0.0 if the functional request is signalized to be equal to TRUE by B_fa and B_fakvs. The integrator is limited by the absolute thresholds RKAZMX resp. RKAZMN.

Analogous to the RKAT integrator there are also reduced thresholds(RKAZRN and RKAZRX). These thresholds apply as soon as B_lrar is set. If, however, rkaz_w(2) has exceeded or undershot these thresholds then only a reversed integral-action resp. a hold at instantaneous value is possible.
If rkaz_w(2) is outside of the reduced thresholds, then the condition B_rkazr(2) = TRUE is set. B_rkazr(2) is needed in the DKVS to prevent an erroneous setting of the bit B_gaeing(2) (mixture adaptation bank 1 resp. bank 2 stabilized).
It must be taken into account that only one of the two integrators RKAT resp. RKAZ is checked for stabilization in the DKVS (see %DKVS code word CPLRA). It is recommendable, here, to stop that integrator, which is not needed via the code word NORLA.

Remark:
The adaptive corrections are included in the injection calculation during all operating states outside of the start and they are stored in the RAM with permanent voltage supply (permanent RAM), so that they are not lost when the engine is turned off.

APP LRA 93.60 Application hint

Procedure:

The application of the LRA should usefully only be started once the application of the following functions has been terminated: Lambda controller, transient control, charge sensing, torque structure and idle controller. The characteristic WDKARN in LRAEB should be adjusted.

```
 Application of the subfunction BBLRA:
 -------------------------------------

 A p p l i c a t i o n   v a r i a b l e s

        NO1     upper engine speed threshold range 1    (RKAT)    rl                                    WDKRAN
        MLO1    upper air mass threshold range 1        (RKAT)    ^                         *------------------------+
                                                                  |   *------------*RLO2     *           FRAO        |
        MLU2    lower air mass threshold range 2        (FRAU)    |    *  (B 2)     *         *                      |
        MLO2    upper air mass threshold range 2        (FRAU)    |      *   FRAU    *           *       (B 4)       |
        RLU2    lower rl-threshold range 2              (FRAU)    |        *          *        MLU4*                 |
        RLO2    upper rl-threshold range 2              (FRAU)    |      MLU2*          *             *              |
                                                                  |             *          *MLO2        *------------+RLU4
        NU3     lower engine speed threshold 3          (RKAZ)    *                 *          *
        MLO3    upper air mass threshold range 3        (RKAZ)    |  *MLO1              *--------*RLU2
        RLU3    lower rl-threshold range 3              (RKAZ)    |      *           RLO3
        RLO3    upper rl-threshold range 3              (RKAZ)    |          *     +---v---*
                                                                  | RKAT     |     | RKAZ        *MLO3
        MLU4    lower air mass threshold range 4        (FRAO)    | (B 1)    |     +------------------* RLU3
        RLU4    upper rl-threshold range 4              (FRAO)    +----------+---------------------------------------|-----> nmot
                                                                            NO1   NU3                               NMAX

        NOLRA   Code word deactivate adaptation ranges
```

```
Selection of the adaptation ranges:
-----------------------------------
  1) Leakage air during idling: choose N01 about 1000 rpm.
                                choose ML01 to air needed at idling in case all consumers are connected (air conditioner,
                                rear window, fan, lights).

  2) Multiplicative fault     : choose MLU2 about twice as large as MLO1.
                                choose MLO2 about 1/3 of the max. possible air mass (120 kg/h).
     (lower range)              choose RLU2 to that rl, which results at nmot = 2000 rpm with the air need ml = MLU2.
                                choose RLO2 such that adaptation is blocked in pulsation range. Possibly enough if only WDKARN acts.
                                Remarks: The deactivation threshold WDKARN is defined in LRAEB. The adaptation can be blocked
                                         in the pulsation range by this.
                                         Selection of MLO2 together with MLU4 (see below) according to HFM fault characteristic.

  3) Injector fault           : For the quicker stabilization of the two other ranges it is recommended to shut this range down
                                by means of NOLRA (bit no. 2 equal to TRUE e.g. NOLRA = 4 HFM systems).
                                For P-systems and for test purposes:
                              : choose ML03 between MLO1 and MLU2
                                choose NU3 about 1600 rpm
                                choose RLU3 about 16 %
                                choose RLO3 about 32 %

  4) Multiplicative fault     : choose MLU4 about 40-60 kg/h above MLO2.
     (upper range)              choose RLU4 about 20 -30% above RLU2
                                Remarks: The deactivation threshold WDKARN is defined in LRAEB. The adaptation can be blocked
                                         in the pulsation range by this.
                                         Selection of MLO2 together with MLU4 (see below) according to HFM fault characteristic.
 - NOLRA: For OBDII series with HFM : NOLRA = 4 (bit 2 is the only one which is set)  -> shut down RKAZ range, reset in case of
   clear fault memory active. For Europe also recommended: NOLRA: 4

by small car with high demanded air in idle, if air-conditioner is switch on, following threshold are modification
MLO1 without air conditioner and MLO1AC the threshold with air-contioner (HFM-System)
MLU2 without air conditioner and MLU2AC the threshold with air-contioner
MLO3 without air conditioner and MLO3AC the threshold with air-contioner (P-System)
RLU2 without air conditioner and RLU2AC the threshold with air-contioner
RLO3 without air conditioner and RLU3AC the threshold with air-contioner (P-System)
```

if the demanded air with put on compresser in idle is not to great so that the error detection (multiplicative and additive) is possible, then applay the MLO1 with air-condition and set MLxxAc to MLxx, RLxxAC to RLxx.

Important:

Attention must be paid that the ranges do not overlap each other!!

Application of the subfunction INTFRAU and INTFRAO:

Application variables

FRAUMX	upper limitation of the correction factor FRAU	[1,2....1,25....1,3]
FRAUMN	lower limitation of the correction factor FRAU	[0,7....0,75....0,8]
FRAURX	upper reduced limitation of the correction factor FRAU	[1,2....1,25....1,3]
FRAURN	lower reduced limitation of the correction factor FRAU	[0,7....0,75....0,8]
FRAOMX	upper limitation of the correction factor FRAO	[1,2....1,25....1,3]
FRAOMN	lower limitation of the correction factor FRAO	[0,7....0,75....0,8]
FRAORX	upper reduced limitation of the correction factor FRAO	[1,2....1,25....1,3]
FRAORN	lower reduced limitation of the correction factor FRAO	[0,7....0,75....0,8]

ZKFRAUA Integration speed Integrator FRAU [0,025..0,025..0,0125] 1/Sec 3 * abo

abo	0	3	8
ZKFRAUA [1/Sec]	0,02	0,02	0,015

ZKFRAOA Integrations speed Integrator FRAO [0,025..0,025..0,0125] 1/Sec 3 * abo

abo	0	3	8
ZKFRAOA [1/Sec]	0,15	0,075	0,03

The values indicated in the middle are reference values.

Time constants, which result with feedback (via engine and Lambda control):
Time constant for FRAU/FRAO integrator : 40 to 80 s (integration gradient ZKFRAU: 0.025/s to 0.0125/s)

Example for fra integration gradient ZKFRAU:
A frm deviation of 0.1 (step change from 1.0 to 1.1) causes a ti increase of 10 percent. The output of the integrator must therefore increase from 1.0 to 1.1, so that the frm will fall back to 1.0. If the integrator output shall reach the value 1.1 after 40 s, the integration gradient then has the value ZKFRAU = 1/40s = 0.025/s .

Adaptation limits: FRAURX = FRAORX = FRAUMX; no reduction of the fra range, so that DKVS is successful also with high charge
(restricted) FRAURN = FRAORN = FRAUMN; no reduction of the fra range

Application of the subfunction INTFRAT:

Application variables

FRATMX	upper limitation of the correction factor FRAT	[1,0....1,05....1,07]
FRATMN	lower limitation of the correction factor FRAT	[0,93....0,95....1,0]
TMFRATMN	lower temperature, at this ftklra = 1	[-48....20..< TMRAA] °C
TMFRATUB	lower temperature, at this ftklra = constant	[-48...0,0..< TMRAA] °C

KFFRAT [0,01...0,2] 1/sec

nmot[1/min]	600	1000	2000	4000
rl [%]				
0	0.1	0.1	0.02	0.0125
20	0.1	0.05	0.02	0.0125
60	0.02	0.02	0.02	0.0125
100	0.0125	0.0125	0.0125	0.0125

FBZFRAT [0,0....0,99]

abo	0	1	3	5	8
FBZFRAT	0,99	0,99	0,5	0,0	0,0

The values indicated in the middle are reference values.

The fault should be learnt in Ca. 10 Second. On the one hand this is dependent on the gradient of intergrator and on the other hand on the lower temperature threshold, at this the factor ftklra is equal one. If the lower temperature threshold is chosen very low, the integrator gradient can be made faster.

Let have learnt the mixture adapation so that the precontrol is at 100% all right at the temperature greater then TMRAA. TMFRATMN set to 20 ° C. At tmot = 20 °C and with switched on lambda control let have learnt the FRAT correction until the the precontrol is all right again.

Application of the subfunction INTRKAT and INTRKAZ:

Application variables

RKATMX	upper limitation of the correction factor RKAT	[7,0....9,0...11,0] %
RKATMN	lower limitation of the correction factor RKAT	[-11,0..-9,0..-7,0] %
RKATRX	upper reduced limitation of the correction factor RKAT	[7,0....9,0...11,0] %
RKATRN	lower reduced limitation of the correction factor RKAT	[-9,0..-7,0...-5,0] %
RKAZMX	upper limitation of the correction factor RKAZ	[7,0....9,0...11,0] %
RKAZMN	lower limitation of the correction factor RKAZ	[-11,0..-9,0..-7,0] %
RKAZRX	upper reduced limitation of the correction factor RKAZ	[7,0....9,0...11,0] %
RKAZRN	lower reduced limitation of the correction factor RKAZ	[-11,0..-9,0..-7,0] %

ZKRKATA	Integrationsgeschwindigkeit Integrator RKAT	[0,1...0,5...0,5] %/Sec

abo	0	3	8
ZKRKATA [1/Sec]	0,38	0,38	0,293

ZKRKAZA	Integrationsgeschwindigkeit Integrator RKAZ	[0,1...0,5...0,5] %/Sec

abo	0	3	8
ZKRKAZA [1/Sec]	0,38	0,38	0,293

The values indicated in the middle are reference values.

Background of the above values -> a rl of 30% was assumed during idling.
Choose RKATMX such that during idling 25% to 30% rk-correction is possible
Choose RKATMN such that during idling -25% to -30% rk-correction is possible
(Choose RKAZMX such that with typ. rl in range three +25% rk- correction is possible
Choose RKAZMN such that with typ. rl in range three -25% rk- correction is possible)

RKATRX =RKATMX; no upward reduction of the rkat
RKATRN : about 2% to 3% (related to idle rl) above diagnostic threshold RKATDN
Remark: For OBDII with running losses no reduction at all RKATRX = RKATMX
(RKAZRX : about 2% to 3% (related to typ. rl in RKAZ range) below diagnostic threshold RKAZDX
RKAZRN : about 2% to 3% (related to typ. rl in rkaz range) above diagnostic threshold RKAZDN)

Time constants, which result with feedback (via engine and Lambda control):

Time constant for RKAT integrator : 40 to 80 s (ZKRKAT 0.5 %/s to 0.25 %/s) Att.: oscillation tendency with frm!!
Time constant for RKAZ integrator : 40 to 80 s (ZKRKAZ 0.5 %/s to 0.25 %/s)

Example for rkat integration gradient ZKRAKT:
A frm deviation of 0.1 causes a ti increase of 10 percent. This constitutes a 2% rl change as related to rl = 20%.
The engine speed is to be 800 rpm during idling. If these 2% have to be controlled within 50s, so that the frm reaches the value 1.0, then the integration gradient for RKAT integrator is the same ZKRKAT = (800 rpm * 2%)/(640 rpm * 0.1 * 50 s) = 0.5 %/s .

Example for rkaz integration gradient ZKRAKZ:
A frm deviation of 0.1 causes a ti increase of 10 percent. This constitutes a 2% rl change as related to rl = 20%.
If these 2% have to be controlled within 40s, so that the frm deviation of one becomes zero again, then the integration gradient is the same
ZKRKAZ = 2% /(40 s * 0.1) = 0.5 %/s .

An oscillation tendency of the LRA with the frm is definitely to be ruled out during the application of the time constants. The most critical case is given here during idling without consumers. The integrator gradient of the frm is at its lowest here. The integration speed of the rkat must be chosen distinctly slower than that speed, at which an oscillation tendency could be provoked. Otherwise the system will oscillate after excitation (large frm deviations).

Application of the subfunction LRAINT:

Application variables

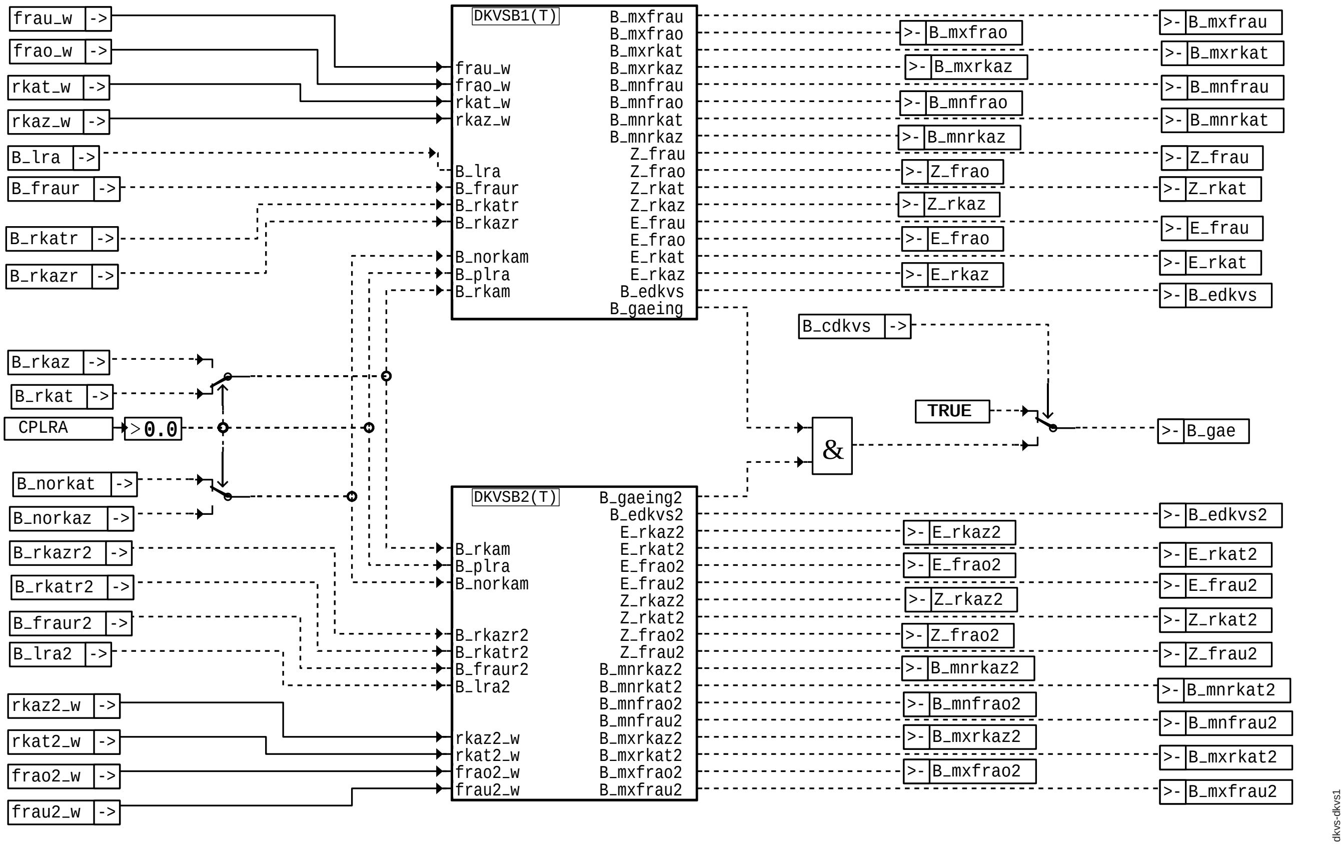
NRKEB	minimum engine speed for limitation control action rkat	[400...400...500] rpm
N0	conversion constant for inclusion mixture correction rkat	[640...640...800] rpm

The values indicated in the middle are reference values.

DKVS 17.60 Diagnosis; plausibility test fuel supply system

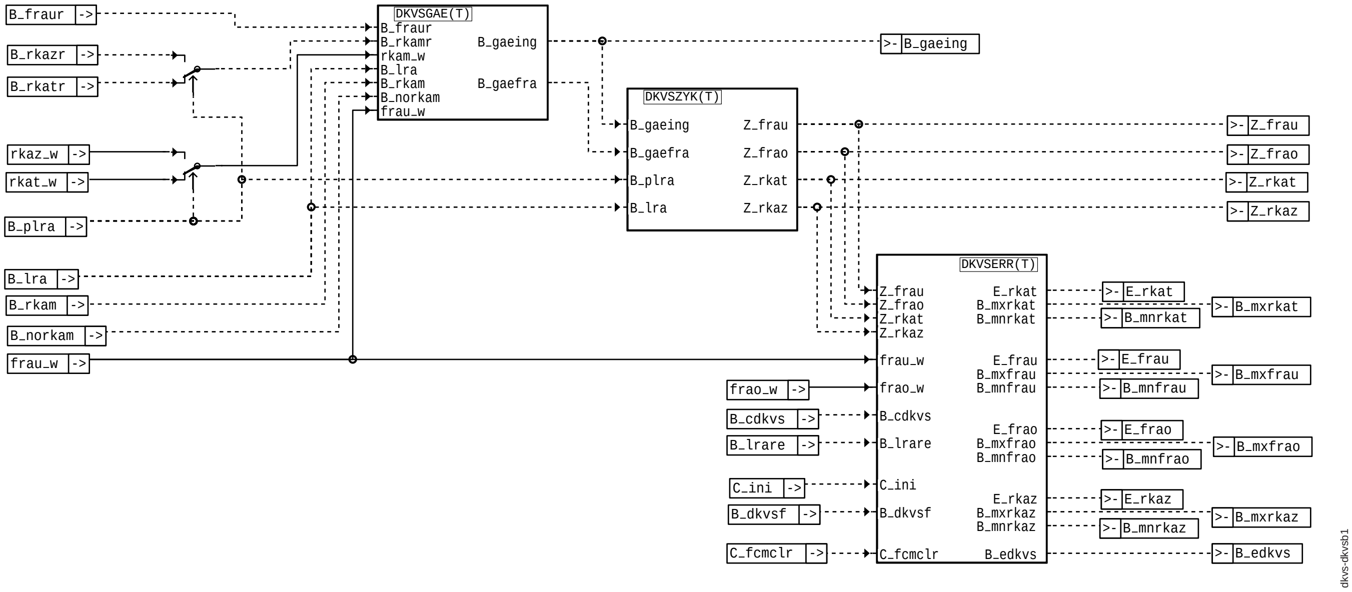
FDEF DKVS 17.60 Function definition

DKVS : Plausibility test fuel supply systems



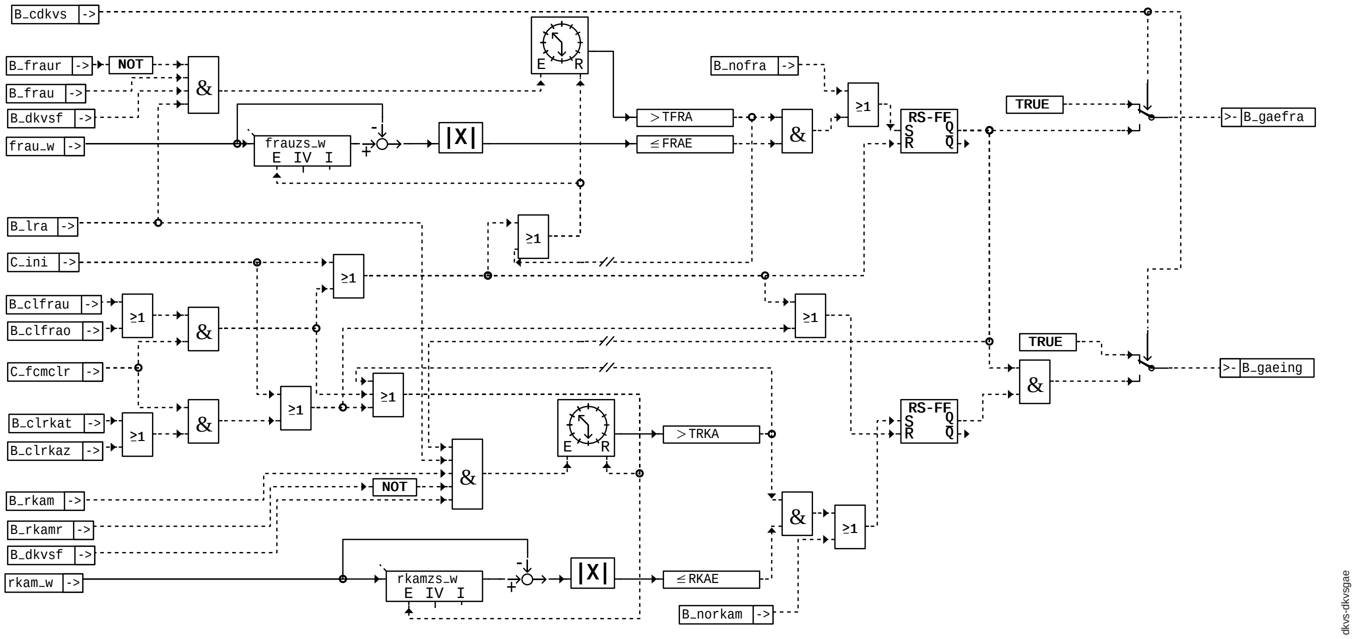
dkvs-dkvs1

DKVSB1 :Formation of the cycle and error flags and checking on whether the basic adaptation stabilizes



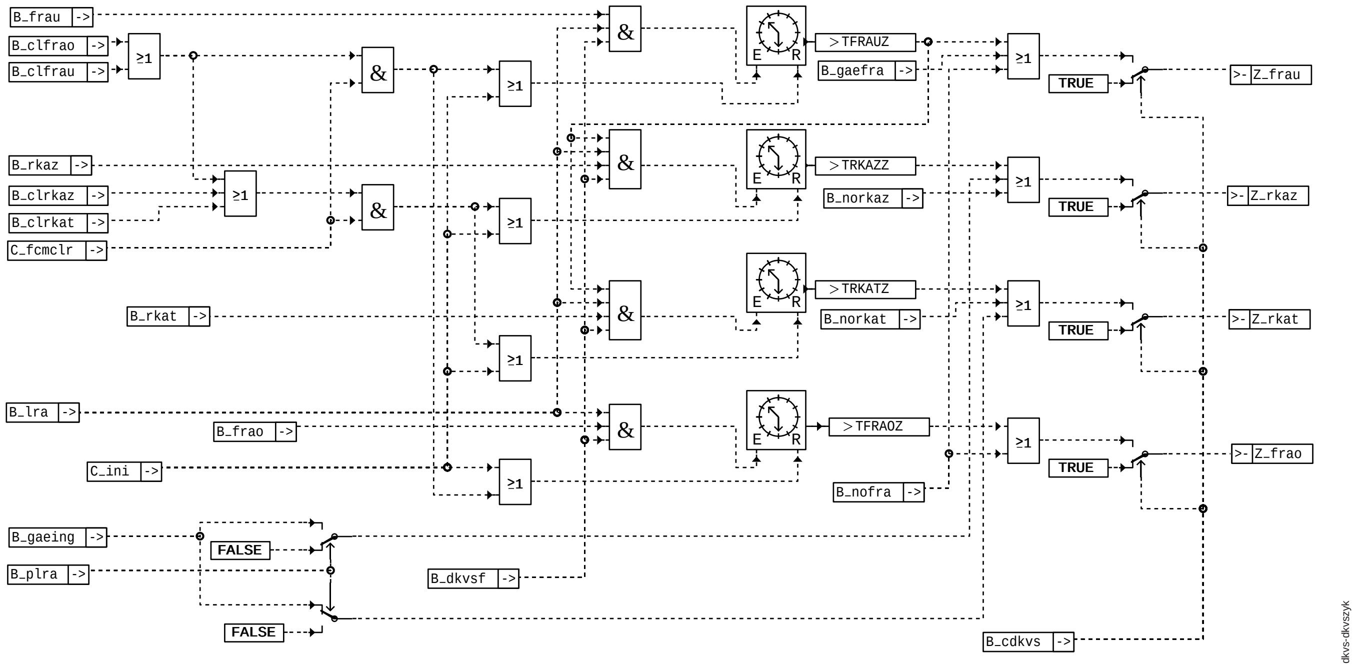
dkvs-dkvsb1

DKVSGAE :Checking on whether the basic adaptation stabilizes



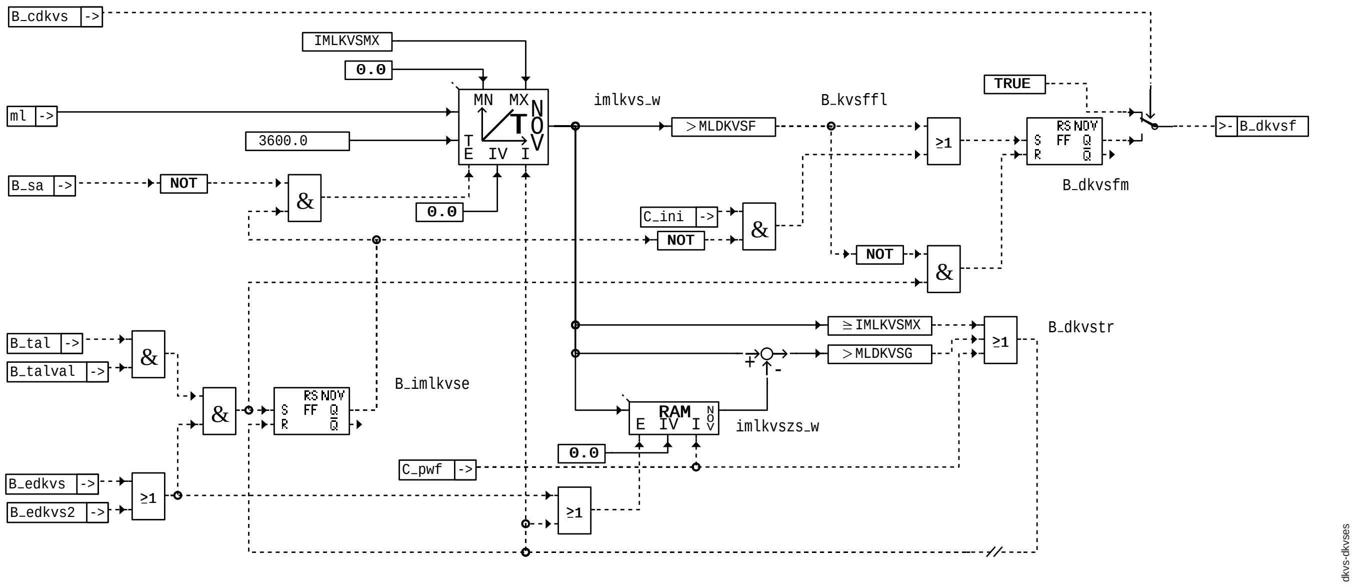
dkvs-dkvsgae

DKVSZYK : Setting of the cycle flag and checking on whether it is active for a minimum time



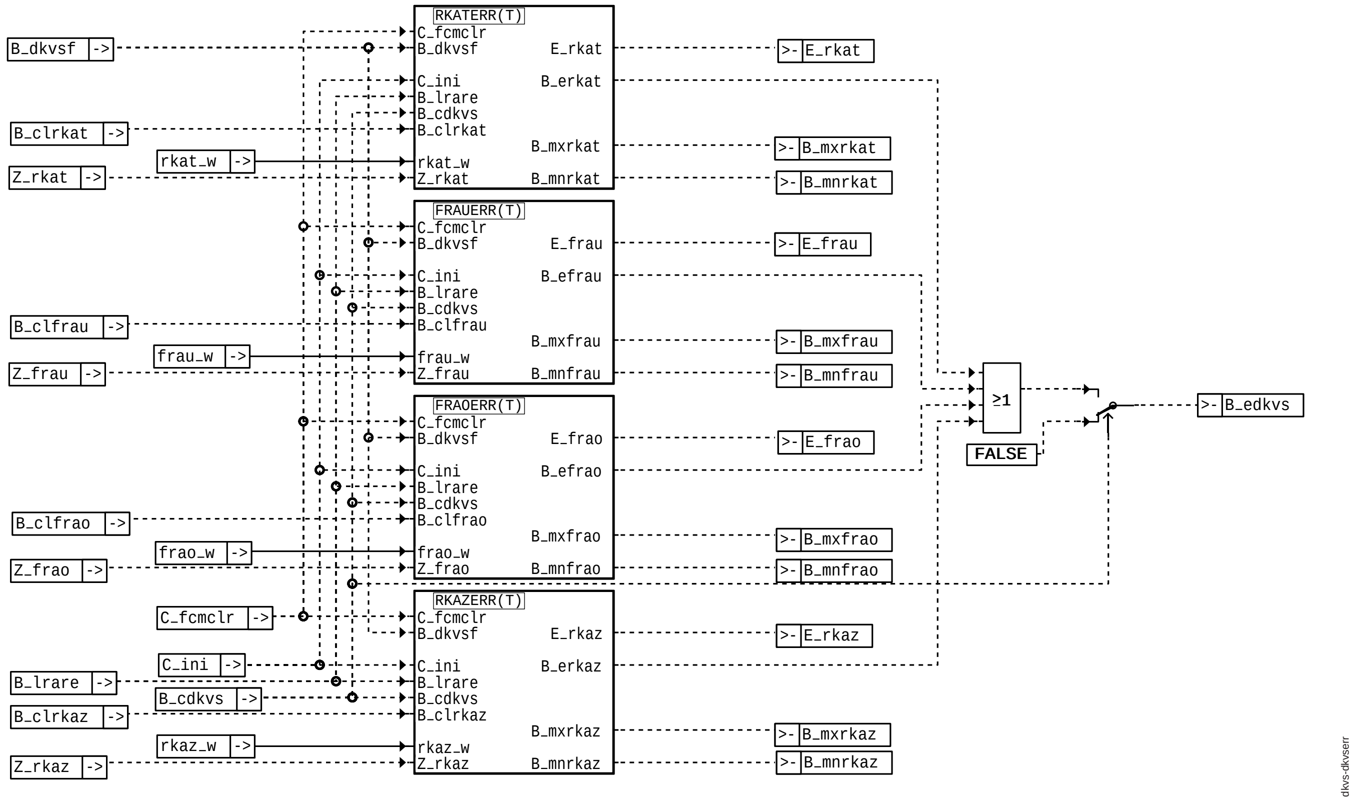
dkvs-dkvszyk

DKVSES : By tank empty error disenable



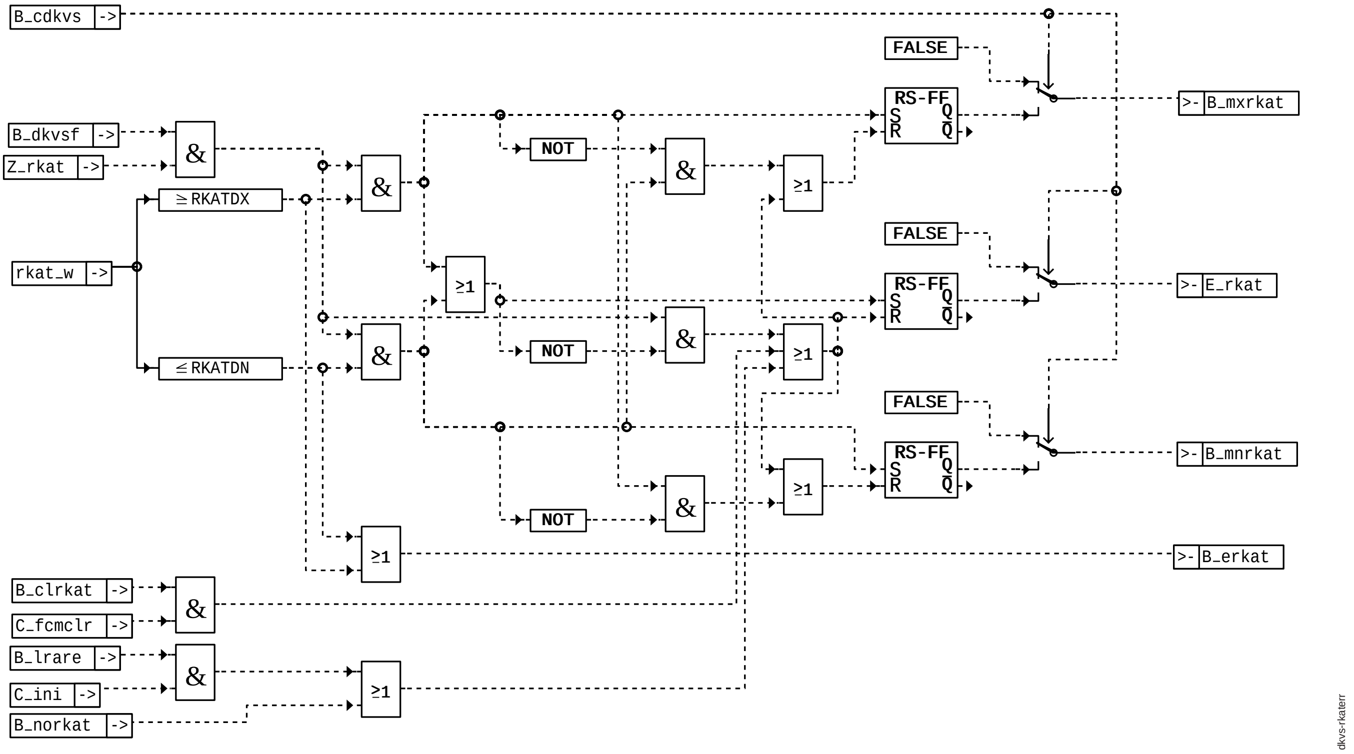
dkvs-dkvses

DKVSERR :Formation of the error flag for FRAO, FRAO, RKAT and RKAZ



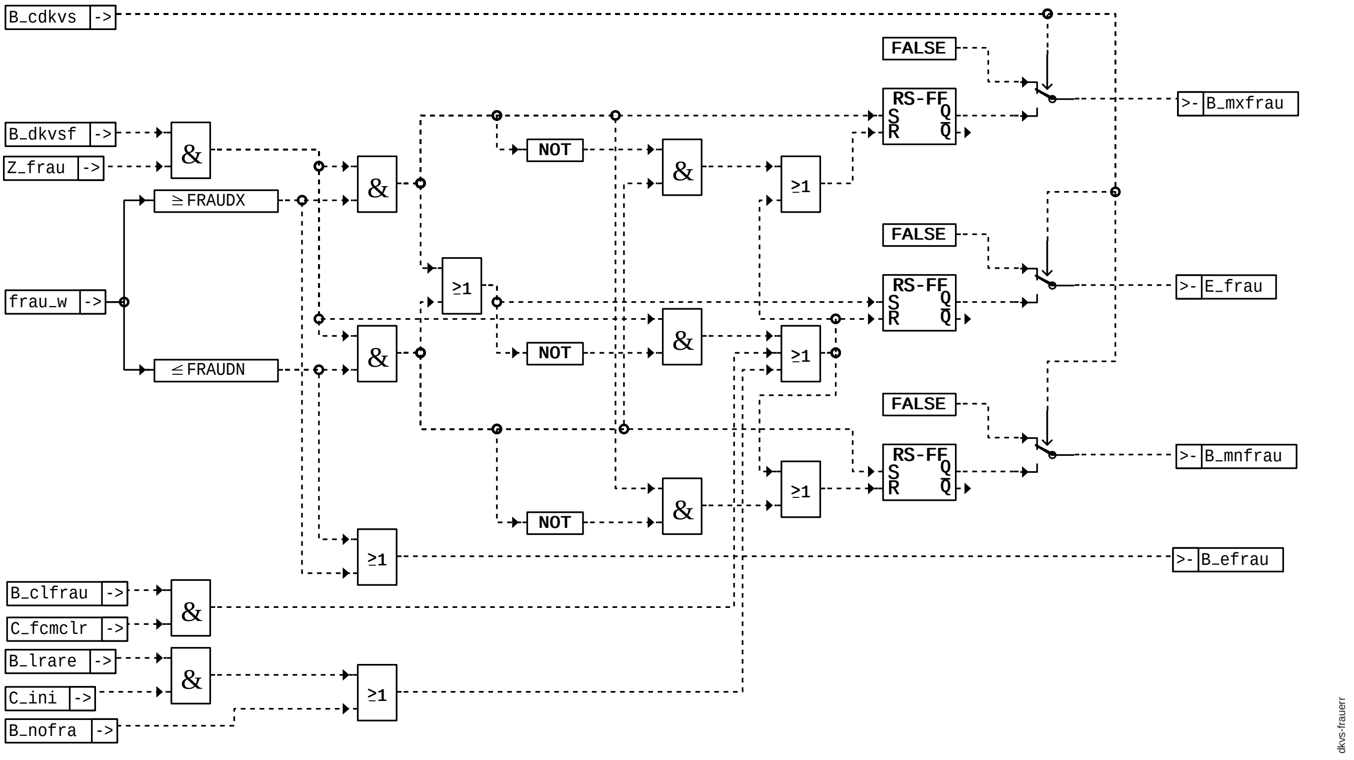
dkvs-dkvserr

RKATERR : Checking of the additive adaptation correction per time RKAT for error



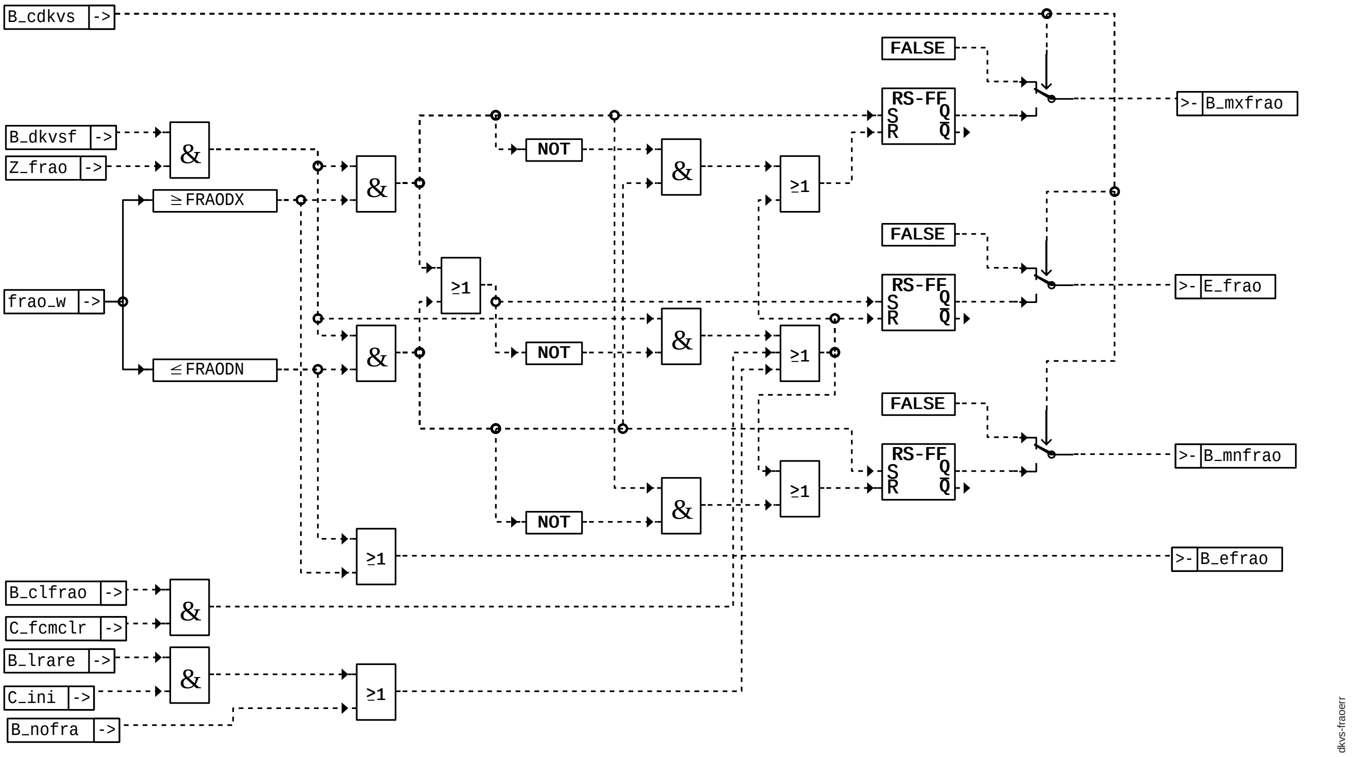
dkvs-rkaterr

FRAUERR : Checking of the lower multiplicative adaptation correction FRAU for error



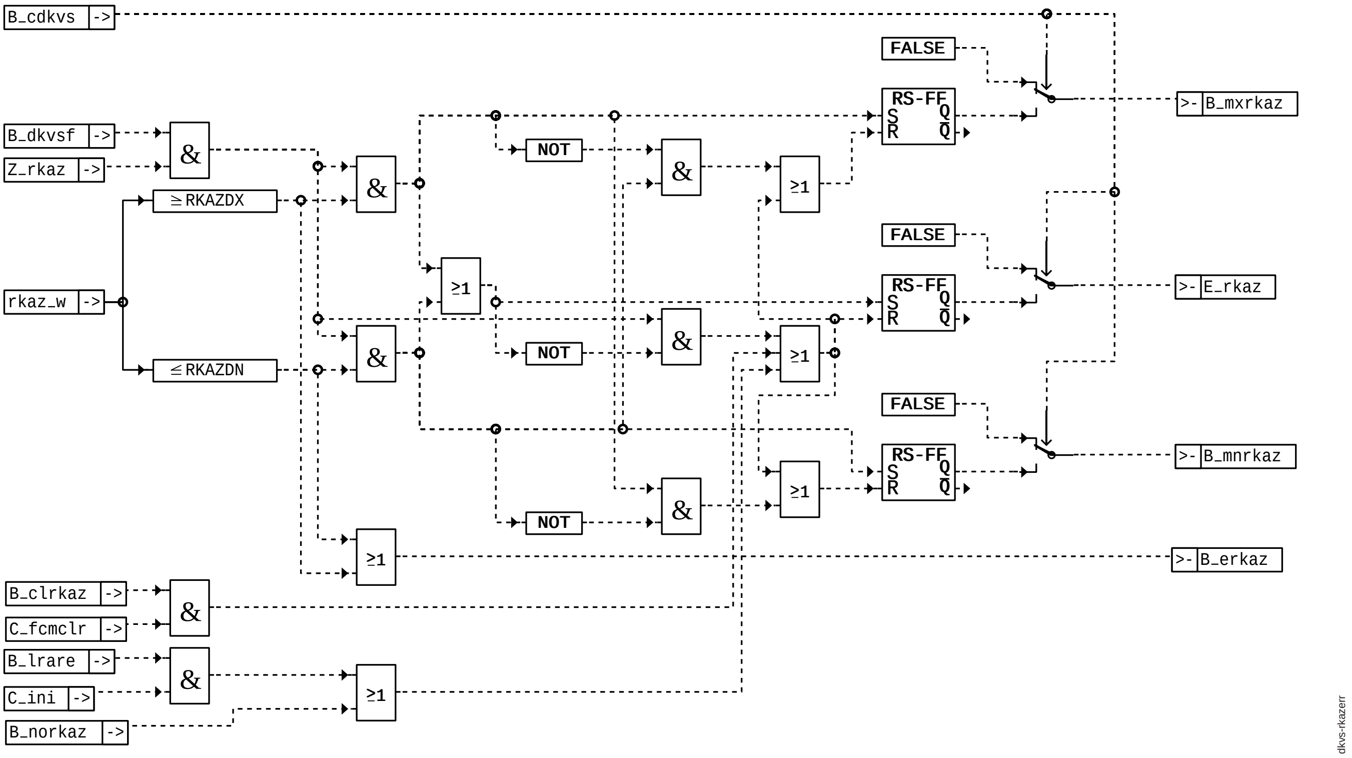
dkvs-frauerr

FRAOERR : Checking of the upper multiplicative adaptation correction FRAO for error



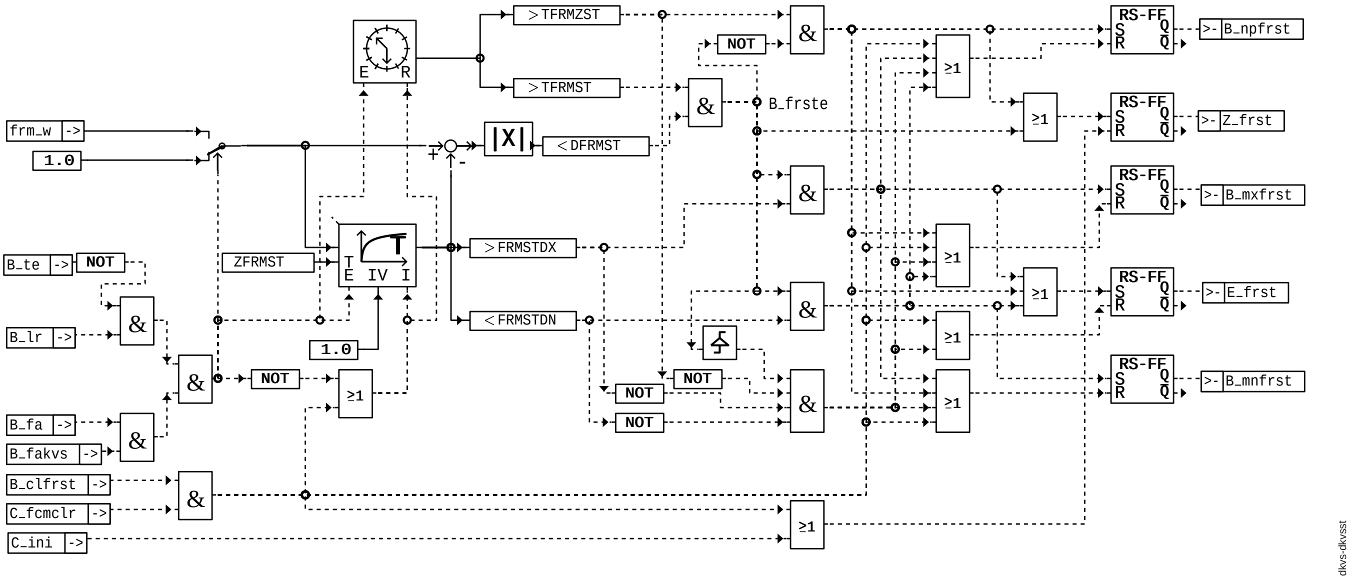
dkvs-fraoerr

RKAZERR : Checking of the additive adaptation correction per ignition RKAZ for error



dkvs-rkazerr

DKVSST : Short Test



dkvs-dkvsst
In block diagrams error type informations as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the error path xyz back into the central diagnosis management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external error paths which occur as inputs access methods are available which read these informations directly from the error path status managed in the DFPM.

For each error path xyz of this diagnosis function the following values are defined:

Status error path xyz	sfpxyz
Error flag xyz :	E_xyz
Cycle flag xyz :	Z_xyz
Error type xyz :	TYP_xyz :(B_mxxyz, B_mnxyz, B_sixyz, B_npxyz)
Delete error path:	B_clxyz
Substitution value active :	B_bkxyz (optional)
Error path code xyz:	CDTxyz
Error class xyz:	CLAxyz
Error intensity xyz:	TSFxyz
CARB code xyz:	CDCxyz
Table of environm. cond.xyz:	FFTxyz

In this function definition (FDEF) the following error paths xyz are treated:

Error path name	used abbreviation (substitutes ,,xyz‘‘)
upper multiplicative correction FRAO	frao
upper multiplicative correction FRAO2	frao2
lower multiplicative correction FRAU	frau
lower multiplicative correction FRAU2	frau2
additive correction per time RKAT	rkat
additive correction per time RKAT2	rkat2
additive correction per ignition RKAZ	rkaz
additive correction per ignition RKAZ2	rkaz2

Error path name for short test	used abbreviation (substitutes ,,xyz‘‘)
short test Lambda control deviation	frst
short test Lambda control deviation	frst2

ABK DKVS 17.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCFRAO	BLOKNR		KL	code word CARB: mixture adaptation factor frao
CDCFRAO2	BLOKNR		KL	code word CARB: mixture adaptation factor frao bank 2
CDCFRAU	BLOKNR		KL	code word CARB: mixture adaptation factor frau
CDCFRAU2	BLOKNR		KL	code word CARB: mixture adaptation factor frau bank 2
CDCFRST	BLOKNR		KL	code word CARB: deviation of lambda closed loop control
CDCFRST2	BLOKNR		KL	code word CARB : deviation of lambda closed loop control bank 2
CDCRKAT	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkat
CDCRKAT2	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkat bank 2
CDCRKAZ	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkaz
CDCRKAZ2	BLOKNR		KL	code word CARB: additive adaptive mixture correction rkaz bank 2
CDLFRAO	BLOKNR		KL	code word lamp : LR-Adaptation multiplicative upper threshold
CDLFRAO2	BLOKNR		KL	code word lamp : LR-Adaptation multiplicative upper threshold bank 2

Parameter	Source-X	Source-Y	Type	Description
CDLFRAU	BLOKNR		KL	code word lamp: LR-Adaptation multiplicative lower threshold
CDLFRAU2	BLOKNR		KL	code word lamp: LR-Adaptation multiplicative lower threshold bank 2
CDLFRST	BLOKNR		KL	code word lamp: feul supply system short test
CDLFRST2	BLOKNR		KL	code word lamp: feul supply system short test bank 2
CDLRKAT	BLOKNR		KL	code word lamp : LR-Adaptation additive per time
CDLRKAT2	BLOKNR		KL	code word lamp : LR-Adaptation additive per time bank 2
CDLRKAZ	BLOKNR		KL	code word lamp : LR-Adaptation additive per ingnition
CDLRKAZ2	BLOKNR		KL	code word lamp : LR-Adaptation additive per ingnition bank 2
CPLRA			FW	Code word for switching DKVS from HFM- to pressure controlled system
DFRMST			FW	delta frm threshold for detection of successful basic mixt. adaptation
FRAE			FW	delta-fra-threshold for detection of successful basic mixture adaptation
FRAODN			FW	lower diagnostic threshold of frao correction
FRAODX			FW	upper diagnostic threshold of frao correction
FRAUDN			FW	lower diagnostic threshold of correction frau
FRAUDX			FW	upper diagnostic threshold of correction frau
FRMSTDN			FW	lower threshold for diagnosis (short test)
FRMSTDX			FW	upper threshold for diagnosis (short test)
IMLKVSMX			FW	maximum integration threshold for error enabled in DKVS (empty tank)
MLDKVSF			FW	Air mass threshold for error enable in DKVS (empty tank)
MLDKVSG			FW	air mass threshold for error enable empty tank
RKAE			FW	delta rkat- rkaz threshold for detection of successful basic mixt. adaptation
RKATDN			FW	lower threshold for diagnosis of additive correction per time
RKATDX			FW	upper threshold for diagnosis of additive correction per time
RKAZDN			FW	lower threshold for diagnosis of additive correction per ignition
RKAZDX			FW	upper threshold for diagnosis of additive correction per ignition
TFRA			FW	monitoring duration FRA
TFRAOZ			FW	duration of stay in FRAO for cycle flag with not successful adaptation
TFRAUZ			FW	duration of stay in FRAU for cycle flag with not successful adaptation
TFRMST			FW	monitoring duration frm sufficient
TFRMZST			FW	duration of stay for unplausible frm-signal (short test)
TRKA			FW	monitoring duration rkat, rkaz sufficient
TRKATZ			FW	activation duration rkat for setting the cycle-flag if B_gae = FALSE
TRKAZZ			FW	activation duration rkaz for setting the cycle-flag if B_gae = FALSE
ZFRMST			FW	time constant for frm-filter (short test)

Variable	Source	Type	Description
B_CDKVS	PROKON	EIN	function active per codeword CDKVS
B_CLFRAO		EIN	condition clear failure path FRAO (upper multipl. section)
B_CLFRAO2		EIN	condition clear failure path FRAO2 (stereo)
B_CLFRAU		EIN	condition clear failure path FRAU (lower multipl. section)
B_CLFRAU2		EIN	condition clear failure path FRAU2 (stereo)
B_CLFRST		EIN	condition clear failure path FRST (short test)
B_CLFRST2		EIN	condition clear failure path FRST (short test bank 2)
B_CLRKAT		EIN	condition clear failure path RKAT (add. per time)
B_CLRKAT2		EIN	condition clear failure RKAT2 (stereo)
B_CLRKAZ		EIN	condition clear failure RKATZ (add. per ingnition)
B_CLRKAZ2		EIN	condition clear failure path RKAZ2 (stereo)
B_DKVSF	DKVS	AUS	condition: enabled of error
B_DKVSFM	DKVS	LOK	condition: enabled of error (filpflop output)
B_DKVSTR	DKVS	AUS	condition: integrator reset by tank empty
B_EDKVS	DKVS	AUS	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	AUS	condition for adaption fault thresholds bank 2 momentarily exceeded
B_EFRAO	DKVS	LOK	Condition: diagnostic thresholds of upper multipl. correction actually exceeded
B_EFRAO2	DKVS	LOK	Condition: diagnostic thresholds (bank 2) of upper multipl. correction exceeded
B_EFRAU	DKVS	LOK	Condition diagnostic thresholds of lower multipl. correction actually exceeded
B_EFRAU2	DKVS	LOK	Condition diagnostic thresholds (bank 2) of lower multipl. correction exceeded
B_ERKAT	DKVS	LOK	Condition diagnostic thresholds of additive correction per time actually exeeded
B_ERKAT2	DKVS	LOK	Condition diagnostic thresholds (bank2) of additive correction per time exceeded
B_ERKAZ	DKVS	LOK	Condition: diagnostic thresholds of add. correction per inj. actually exceeded
B_ERKAZ2	DKVS	LOK	Condition: diagnostic thresholds (bank2) of add. correction per inj. exceeded
B_FA		EIN	condition general function request
B_FAKVS		EIN	condition function request diagnoses fuel supply system
B_FRAO	LRA	EIN	condition for enabling adaption of frao
B_FRAU	LRA	EIN	condition enable adaptation of frau
B_FRAUR	LRA	EIN	condition frau-integrator outside reduced thresholds
B_FRAUR2	LRA	EIN	condition frau2-integrator outside reduced thresholds
B_FRSTE	DKVS	LOK	condition frm stabilized (short test)
B_FRSTE2	DKVS	LOK	condition frm2_w stabilized (short test 2. bank)
B_GAE	DKVS	AUS	condition for adaptive Lambda pilot control successful
B_GAEFRA	DKVS	AUS	condition for fra portion of adaptive Lambda pilot control successful
B_GAEFRA2	DKVS	AUS	condition for fra2 portion of adaptive lambda pilot control successful
B_GAEING	DKVS	LOK	condition basic adaption Bank 1 steady state
B_GAEING2	DKVS	LOK	condition for adaptive lambda pilot control 2 successful
B_IMLKVSE	DKVS	LOK	condition air mass integrator reset
B_KVSFFL	DKVS	LOK	condition: enable of error in spite of empty tank
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRA	LRAEB	EIN	condition for basic mixture adaptation enabled
B_LRA2	LRAEB	EIN	condition for basic mixture adaption 2 enabled
B_LRARE	LRA	EIN	condition reset of mixture adaptation
B_LRARE2	LRA	EIN	condition reset of mixture adaptation bank 2

Variable	Source	Type	Description
B_MNFRAO	DKVS	LOK	condition below low plausibility threshold (upper multipl. section)
B_MNFRAO2	DKVS	LOK	condition below low plausibility threshold (stereo)
B_MNFRAU	DKVS	LOK	condition below low plausibility threshold (lower multipl. section)
B_MNFRAU2	DKVS	LOK	condition below low plausibility threshold (stereo)
B_MNFRST	DKVS	LOK	condition below low plausibility threshold (short test)
B_MNFRST2	DKVS	LOK	condition below low plausibility threshold (short test stereo
B_MNRKAT	DKVS	LOK	condition below low plausibility threshold (add. per time)
B_MNRKAT2	DKVS	LOK	condition below low plausibilitiy threshold (stereo)
B_MNRKAZ	DKVS	LOK	condition below low plausibility threshold (add. per ingnition)
B_MNRKAZ2	DKVS	LOK	condition below low plausibility threshold (stereo)
B_MXFRAO	DKVS	LOK	Condition: upper plausible value exceeded (frao)
B_MXFRAO2	DKVS	LOK	Condition: upper plausible value exceeded (bank 2) (frao2)
B_MXFRAU	DKVS	LOK	Condition: upper plausible value exceeded (frau)
B_MXFRAU2	DKVS	LOK	Condition: upper plausible value exceeded (multiplicative 2. bank)
B_MXFRST	DKVS	LOK	Condition: upper plausible value exceeded (short test)
B_MXFRST2	DKVS	LOK	Condition: upper plausible value exceeded (short test stereo)
B_MXRKAT	DKVS	LOK	Condition: upper plausible value exceeded (rkat)
B_MXRKAT2	DKVS	LOK	Condition: upper plausible value exceeded (Bank 2) (rkat2)
B_MXRKAZ	DKVS	LOK	Condition: upper plausible value exceeded (rkaz)
B_MXRKAZ2	DKVS	LOK	Condition: upper plausible value exceeded (bank 2) (rkaz)
B_NOFRA	LRA	EIN	condition no fra adaptation active
B_NORKAM	DKVS	LOK	condition additive correction of the mixture adaptation switched off
B_NORKAT	LRA	EIN	condition additive correction of the mixture adaptation switched off
B_NORKAZ	LRA	EIN	condition additive correction of the mixture adaptation switched off
B_NPFRST	DKVS	LOK	condition for fault type ”unplausible signal” detected (DKVS short test)
B_NPFRST2	DKVS	LOK	condition for fault type ”unplausible signal” detected (DKVS short test bank 2)
B_PLRA	DKVS	LOK	Condition: Switch over from HFM to pressure controlled system
B_RKAM	DKVS	LOK	Condition: One of both additive LRA sections is active
B_RKAMR	DKVS	LOK	Condition: rkaz or rkat has exceeded it's thresholds
B_RKAMR2	DKVS	LOK	Condition: rkaz2 or rkat2 has exceeded it's thresholds
B_RKAT	LRA	EIN	condition adaptation area rkat active
B_RKATR	LRA	EIN	condition rkat-integrator outside reduced thresholds
B_RKATR2	LRA	EIN	condition rkat2-integrator outside reduced thresholds
B_RKAZ	LRA	EIN	condition adaptation area rkaz active
B_RKAZR	LRA	EIN	condition rkaz-integrator outside reduced thresholds
B_RKAZR2	LRA	EIN	condition rkaz2-integrator outside reduced thresholds
B_SA	MDRED	EIN	Condition fuel cut-off
B_TAL	GGFST	EIN	Condition tank empty or reserve
B_TALVAL	GGFST	EIN	condition ; bit empty tank valid
B_TE	TEBEB	EIN	Condition canister purge active
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_FRAO	DKVS	AUS	error flag: upper multiplicative mixture adaption factor frao
E_FRAO2	DKVS	AUS	error flag: upper multiplicative mixture adaption factor frao2
E_FRAU	DKVS	AUS	error flag: lower multiplicative mixture adaption factor frao
E_FRAU2	DKVS	AUS	error flag: lower multiplicative mixture adaption factor frao2
E_FRST	DKVS	AUS	error flag: fuel supply system (short test)
E_FRST2	DKVS	AUS	error flag: fuel supply system (short test bank 2)
E_RKAT	DKVS	AUS	error flag DKVS (additive correction per unit of time)
E_RKAT2	DKVS	AUS	error flag DKVS (additive correction per unit of time, bank 2)
E_RKAZ	DKVS	AUS	error flag DKVS (additive correction per ignition)
E_RKAZ2	DKVS	AUS	error flag DKVS (additive correction per ignition, bank 2)
FRAO2_W	LRA	EIN	multipl. mixture adaptation factor higher load bank 2 (Word)
FRAO_W	LRA	EIN	multipl. mixture adaptation factor higher load (word)
FRAU2_W	LRA	EIN	multipl. mixture adaptation factor of the lower mult. section of bank 2 (Word)
FRAUZS2_W	DKVS	LOK	multipl. mixture adaptation factor of the lower mult. section (stereo)
FRAUZS_W	DKVS	LOK	multipl. mixture adaptation factor of the lower section (old value)
FRAU_W	LRA	EIN	multipl. mixture adaptation factor of the lower mult. section (Word)
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
IMLKVSZS_W	DKVS	LOK	strored value:air mass after DKVS fault with empty fuel tank
IMLKVS_W	DKVS	LOK	air mass after DKVS fault with empty fuel tank
ML	SWADAP	EIN	air mass flow
RKAM2_W	DKVS	LOK	Selection of additive correction of the mixture adaptation for calc. of B_gae2
RKAMZS2_W	DKVS	LOK	correction additive (per time or ingnition) bank 2 (old value)
RKAMZS_W	DKVS	LOK	correction additive (per time or ingnition); old value
RKAM_W	DKVS	LOK	Selection of additive correction of the mixture adaptation for calc. of B_gae
RKAT2_W	LRA	EIN	additive correction (per time) of the mixture adaptation bank 2 (Word)
RKAT_W	LRA	EIN	additive correction (per time) of the mixture adaptation (Word)
RKAZ2_W	LRA	EIN	additive corretion (per ignition) of the mixture adaptatition Bank 2 (Word)
RKAZ_W	LRA	EIN	additive correction (per ignition) of the mixture adaptation
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
Z_FRAO	DKVS	AUS	cycle flag of mixture adaption factor frao
Z_FRAO2	DKVS	AUS	cycle flag of mixture adaption factor frao2 (bank 2)
Z_FRAU	DKVS	AUS	cycle flag of mixture adaption factor frau
Z_FRAU2	DKVS	AUS	cycle flag of mixture adaption factor frau2 (bank 2)
Z_FRST	DKVS	AUS	cycle flag: fuel supply system (short test)
Z_FRST2	DKVS	AUS	cycle flag: fuel supply system (short test bank 2)
Z_RKAT	DKVS	AUS	cycle flag of additive adaptive mixture correction per time
Z_RKAT2	DKVS	AUS	cycle flag of additive adaptive mixture correction per time (bank 2)

Variable	Source	Type	Description
Z_RKAZ	DKVS	AUS	cycle flag of additive adaptive mixture correction rkaz
Z_RKAZ2	DKVS	AUS	cycle flag of additive adaptive mixture correction rkaz (bank 2)

FW DKVS 17.60 Fixed Values

Parameter	Value	Description
CPLRA		Code word for switching DKVS from HFM- to pressure controlled system
DFRMST		delta frm threshold for detection of successful basic mixt. adaptation
FRAE		delta-fra-threshold for detection of successful basic mixture adaptation
FRAODN		lower diagnostic threshold of frao correction
FRAODX		upper diagnostic threshold of frao correction
FRAUDN		lower diagnostic threshold of correction frau
FRAUDX		upper diagnostic threshold of correction frau
FRMSTDN		lower threshold for diagnosis (short test)
FRMSTDX		upper threshold for diagnosis (short test)
IMLKVSMX		maximum integration threshold for error enabled in DKVS (empty tank)
MLDKVSF		Air mass threshold for error enable in DKVS (empty tank)
MLDKVSG		air mass threshold for error enable empty tank
RKAE		delta rkat- rkaz threshold for detection of successful basic mixt. adaptation
RKATDN		lower threshold for diagnosis of additive correction per time
RKATDX		upper threshold for diagnosis of additive correction per time
RKAZDN		lower threshold for diagnosis of additive correction per ignition
RKAZDX		upper threshold for diagnosis of additive correction per ignition
TFRA		monitoring duration FRA
TFRAOZ		duration of stay in FRAO for cycle flag with not successful adaptation
TFRAUZ		duration of stay in FRAU for cycle flag with not successful adaptation
TFRMST		monitoring duration frm sufficient
TFRMZST		duration of stay for unplausible frm-signal (short test)
TRKA		monitoring duration rkat, rkaz sufficient
TRKATZ		activation duration rkat for setting the cycle-flag if B_gae = FALSE
TRKAZZ		activation duration rkaz for setting the cycle-flag if B_gae = FALSE
ZFRMST		time constant for frm-filter (short test)

FB DKVS 17.60 Detailed description of function

Introduction:

The OBD II legislation requires monitoring of the fuel supply system. A defective fuel supply system leads to deviations in the pilot mixture control. As a result, the average control factor (frm) will deviate from factor 1.0.

The mixture adaptation (LRA) will try to "learn" such errors in order to correct the error even during dynamic engine operation in the best possible way. The best result is obtained for errors with a specifically assigned LRA integrator. Examples are:
- rkat in case of an additive error per time (leakage air)
- frau, frao in case of a multiplicative error (pressure controller tolerance or fluctuating fuel density)
- rkaz in case of an additive error per ignition (injection valve-delay time TVUB wrong)

Within certain limits (+/- 25% multiplicative and +/- 25% additive) the mixture adaptation is capable of correcting such an error with only little impact on emissions. Errors, however, which deviate from the above-mentioned characteristics cause continuously activated integrators. In this case only part of the error can be compensated and a residual error remains which must constantely be compensated by the Lambda controller dependent on the load and engine speed point. In this case the legal emission limits may be exceeded by factor 1.5 even in case of small deviations of the LRA integrators from the neutral value. This must be taken into consideration when selecting the diagnosis thresholds.

The diagnosis thresholds of the LRA adaptation values are to be determined such that the emissions do not exceed the defined limits with respect to the factor 1.5 (see block APP).

The DKVS is closely connected to the mixture adaptation (LRA) and it evaluates the following integrators of the mixture adaptation:

- RKAT...: additive error per time (e.g. leakage air)
- FRAU...: multiplicative error (at average air masses - lower mulitplicative range)
- FRAO...: multiplicative error (at high air masses - upper multiplicative range)
- RKAZ...: additive error per ignition (e.g. wrongly adjusted valve delay time TVUB)

Apart from the error flags (E_xyz) and the corresponding cycle flags (Z_xyz) the DKVS also provides the information "basic adaptation stabilized" (B_gae). Once the adaptation has stabilized an early switch-over to long canister purge phases can be performed (see phase control %BBTEGA).

Apart from the integrator values (rkat_w, frau_w, frao_w and rkaz_w) and the conditions B_rkat, B_frau, B_rkaz and B_frao, the DKVS also needs the information from the mixture adaptation whether the corresponding integrator has reached resp. exceeded one of the reduced thresholds.

- B_rkatr: a reduced threshold of rkat reached resp. exceeded
- B_fraur: a reduced threshold of frau reached resp. exceeded
- B_fraor: is not needed since frao is not checked for stabilization
- B_rkazr: a reduced threshold of rkaz reached resp. exceeded

As soon as the reduced thresholds are reached resp. exceeded the bit "mixture adaptation stabilized" (B_gae) can no longer be set.

The reduced thresholds were introduced in order to avoid possible error messages which mistakenly occur under certain conditions (e.g. high charge of the activated carbon filter).

The banks 1 and 2 have the same structure. Where bank-specific signals occur an index (2) is given for the second bank. Example: frau_w(2) means frau_w for bank 1 and frau2_w for bank 2.

The diagnosis fuel supply systems (DKVS) consists of the following partial functions :

Partial function block DKVSGAE(2) :

In this partial function it is checked whether the basic adaptation has stabilized (B_gaeing(2) = TRUE). It only monitores the adaptation stabilization of 2 LRA integrators. One of these integrators is the FRAU. The other is either the RKAT (HFM-systems) or the RKAZ (P-load acquisition). The switch-over is performed outside of this partial function via the code word CPLRA. If CPLRA > 0 then the RKAZ (adaptive correction per ignition) is monitored for stabilization and if CPLRA = 0 the RKAT (adaptive correction per time) is monitored. It is recommendable to always deactivate the integrator not needed in the LRA (B_norkaz = TRUE with HFM load acquisition or B_norkat = TRUE with P-load acquisition) => see %LRA - partial function BBLRA.

If frau, frao ist stopped by B_nofra, B_gaefra is set.
If rkat ist stopped by B_norkat and CPLRA = 0 the Flip-Flop for B_gaeing is set.
If rkaz ist stopped by B_norkaz and CPLRA = 1 the Flip-Flop for B_gaeing is set.
With this method "B_gae can be set TRUE" also if one range is stopped!

The bit "basic adaptation stabilized" is needed:

- for a quick switch-over to long canister purge phases (TTE -> TTEAE) in the function %BBTEGA
- for a quick setting of the cycle flags of the DKVS (Z_rkat(2), Z_frau(2), Z_frao(2) and Z_rkaz(2)).
- as an information for other diagnosis functions

Generally it can be assumed that an integrator of the LRA has stabilized if the corresponding integrator changed only little during the time in which it was active.

However, if only a fixed load / engine speed point (e.g. idle speed) is entered an intergrator (e.g. RKAT) may stabilize even though it falsely learned a mixture error (e.g. multiplicative error) which does not belong in this range. In order to avoid a too early setting of the bit B_gaeing(2) the check on stabilization in the additive range (RKAM = RKAT resp. RKAZ) is only performed after FRAU has stabilized (B_gaefra(2) = TRUE). The basic adaptation stabilizes only once both monitored integrators have stabilized (B_gaeing(2) = TRUE).

The check in detail:
At the beginning of the check (e.g. from start for FRAU, resp. after FRAU has stabilized for RKAM) the adaptation value frau_w is temporarily stored in frauzs_w resp. rkam_w in rkamzs_w. Then the time during which the condition for the adaptation of the variables FRAU resp. RKAM were fulfilled is measured starting from the beginning.
The time counter is only active if frau_w (rkam_w) has not already reached or undershot resp. exceeded one of the reduced thresholds FRAURX resp. FRAURN(RKATRX resp. RKATRN or RKAZRX resp. RKAZRN) and the Bit B_dkvsf is set to TRUE.
Reason: A forced limitation on the reduced threshold may not be interpreted as stabilized state.

After the time TFRA (TRKA) has passed an inquiry is made whether the adapation has deviated by more than FRAE (RKAE) from the starting value. If this is not so then the FRAU- resp. the RKAM-adaptation has stabilized and the flags B_gaefra(2) and B_gaeing(2) are set.

The flags B_gaefra(2) and B_gaeing(2) are set to FALSE under the following conditions :

- in case of start (C_ini = TRUE)
- reset of all integrators of the LRA during the initialization phase (B_lrare(2) = TRUE, this bit is formed in %LRA)
- individual error path deletion:
  - deleting of the error path FRAO(2) or FRAU(2) i.e.. B_clfrao(2) or B_clfrau(2) equal TRUE and C_fcmclr = TRUE
    => B_gaefra(2) and B_gaeing(2) = FALSE
  - deleting of the error path RKAT(2) or RKAZ(2) => only B_gaeing(2) = FALSE is set.
- the additive corrections of the mixture adaptation RKAT or RKAZ are switched off with B_norkat resp. B_norkaz (selecting via codeword CPLRA => B_norkam = TRUE)

B_gaefra(2) and B_gaeing(2) are set to TRUE if B_cdkvs was set to FALSE by the bit no. ZERO of the code word CDKVS (in %PROKON). In this case this block is not calculated. They are also set TRUE, if the range, that is needed for a TRUE is stopped by B_noxxx.

On the stereo version the adaptation has stabilized once both banks have stabilized (B_gaeing and B_gaeing2 equal TRUE).

Partial function block DKVSZYK(2) :

The task of this partial function is the formation of the cycle flags (Z_rkat(2), Z_rkaz(2), Z_frau(2) and Z_frao(2)).

- The cycle flag Z_frau(2) is set if
  - a) the accompanying integrator has stabilized in LRA. The stabilization of the FRAU(2)-integrators is signaled by the bit B_gaefra(2) from the partial function DKVSGAE.
  - b) the time during which the adaptation is active in the FRAU range is larger than a defined threshold (TFRAUZ). This setting of the cycle flag is described as "forced setting".

- The cycle flag Z_frao(2) is set if the passed time during active Lambda control in the FRAO range is larger than the adjustable threshold TFRAOZ.

- The cycle flag Z_rkaz(2) is set if
  - a) in case of the set bit B_plra the accompanying integrator RKAZ(2) has stabilized in the LRA. The stabilization of the RKAZ(2) integrator is signaled by the bit B_gaeing(2) = TRUE from the partial function DKVSGAE.
  - b) in case of the not set bit B_plra the time during which the adaptation is active in the RKAZ range is larger than TKRAZZ. In this case the cycle flag Z_frau must be set beforehand.

- The cycle flag Z_rkat(2) is set if
  - a) in case of the not set bit B_plra the accompanying integrator has stabilized in the LRA. The stabilization of the RKAT(2) integrator is signaled by the bit B_gaeing(2) = TRUE from the partial function DKVSGAE.
  - b) in case of the set bit B_plra the time during which the adaptation is active in the RKAT range is larger than TKRATZ. In this case the cycle flag Z_frau must be set beforehand.

The cycle flags Z_frau(2), Z_frao(2), Z_rkaz(2) and Z_rkat(2) are set to TRUE if B_cdkvs = FALSE. In this case the function is not calculated. They are also set TRUE, if the range is stopped by B_noxxx.

The timers and thus the cycle flags are reset under the following conditions:
a) in case of start (C_ini = TRUE)
b) in case of delete error path FRAO(2) or delete FRAU(2)
c) in case of delete error path RKAT(2) or RKAZ(2) only the cycle flags Z_rkat(2) and Z_rkaz(2) are set to FALSE by the resetting of the accompanying timers.

The resetting of all cycle flags in case of condition b) is necessary because the stabilization of the integrators RKAZ resp. RKAT is only checked for after the FRAU integrator has stabilized. The condition c) is permitted because after the RKAT resp. the RKAZ integrators were deleted only the stabilization behaviour of the RKAT resp. the RKAZ integrator is observed for the setting of the bit B_gaeing(2).

Partial function block DKVSES :

In order to avoid an error diagnosis in DKVS (fuel supply system) due to an empty tank, the sitting of error flag is prohibited for a difinite time (if one of the threshold diagnosis is exceeded or undershot). Because for the reasion the air mass throughput is integrated so much that, the threshold MLDKVSF is exceeded. In fuel cut off the integrator is stopped. The Integrator is initializated with the value Zero and then stopped, if after enable in next driving,
a) the air mass integrator is integrated at least MLDKVSG (imlkvs - imlkvszs > MLDKVSG)
b) The integrator has reached his maximum. Remark: The integrator is limited to maximal value IMLKVSMX.

The bit B_dkvsf by the make ones debut of error with an empty tank is set to FALSE und as a result, the DKVS is deactived against the error diagnosis.

The bit B_dkvsf is set to TRUE und so error identify is enabled, if
a) the integrator is exceeded the value MLDKVSF(B_kvsffl=TRUE).
b) in case of start (C_ini=TRUE) if the bit B_imlkvse is set to FALSE

Partial function block DKVSERR(2) :

This partial function consists of four further partial functions (RKATERR(2), FRAUERR(2), FRAOERR(2), RKAZERR(2)). The task of each partial function is the formation of the error bit E_xyz(2) and the formation of the flag error type (B_mnxyz(2), B_mxxyz(2)). Since these partial functions all show the same structure here only the partial function FRAUERR is described.

Description of the partial function FRAUERR:

- Formation of the flags E_frau, B_mxfrau and B_mnfrau

If in case of set cycle flag the adaptation value frau_w reaches resp. exceeds the upper diagnosis threshold FRAUDX resp. the lower diagnosis threshold FRAUDN and the bit tank empty is enabled then E_frau is set to TRUE. When the cycle flag Z-frau is set the error type B_mxfrau is detected if frau_w is greater than or equal to the diagnosis threshold FRAUDX and the errors B_mnfrau are detected if the adapation value frau_w is less than or equal to the diagnosis threshold FRAUDN.

In addition to the error flag E_frau a quick error message for the blocking of other diagnosis functions in case of an error is needed. In this case the error bit B_efrau is set to TRUE when an error threshold is exceeded. The bit B_efrau is not directly available to other diagnosis functions but the bit B_edkvs(2) is formed by an OR operation of the four error bits B_efrau(2), B_efrao(2), B_erkat(2) and B_erkaz(2).

The error flag is again reset during a drive while the cycle flag is set if frau_w is in the permitted diagnosis range. This means that the error flag can be set and again reset as often as desired during a drive.
The error flag (E_xyz) and the fault type (B_mnxyz, B_mxxyz) are set to FALSE with B_noxyz = TRUE.

Partial function block DKVSST(2) :

This subfunction is needed for a short test. If low pass filtered frm_w(2)-signal has stabilized, the error flags E_frst(2), B_mxfrst(2) (max. permissible frm_w(2)-value) oder B_mnfrst(2) (min permissible frm_w(2)-value) are set in relatet of diagnosis thershold FRMSTDX resp. FRMSTDN.
The frm_w(2) signal has stabilized, if the time TFRMST is passed and the change of frm_w(2) is less then DFRMST. If the time TFRMZST is passed and the change of frm_w(2) ist not less then DFRMST, the error flags E_frst(2), B_npfrst(2) (für unplausible signal) and the cycle flag Z_frst are set of TRUE.

The time counter and the low pass filter are enabled, if
- canister purge is not active (B_te = FALSE).
- lambda closed loop control is active (B_lr(2) = TRUE).
- the function request will be actived by the tester (B_fa and B_fakvs are TRUE).
- condition clear failure path FRST (B_clfrst(2) = TRUE and C_fcmclr) are not set

With cancel of the function request the cycle flag, the error flag, und the error type flags are unchanged (Z_frst(2), E_frst(2), B_mxfrst(2), B_mnfrst(2) and B_npfrst(2)). A reset of the cycle flag is done at engine start (C_ini).

If there is no error detected a Reset of the error flag is possible if the thresholds are not exceeded while the positive slope of B_frste is detected.

APP DKVS 17.60 Application hint

Application process:

It is sensible to start the application of the DKVS only once the application of the Lambda controller, of the transient control, of the charge acquistion, of the torque management and of the idle speed control has been terminated. In the mixture adaptation especially adapation speeds (ZKFRAU,...) and the adaptation ranges (MLU2,...) shall be determined. In the LRA reduced thresholds shall be set to maximum thresholds (FRAURX = FRAUMX, FRAURN = FRAUMN, RKATRX = RKATMX, RKAZRN = RKAZMN, a.s.o.).

An exception is RKATRN.

Application of the partial function DKVSGAE :

Application values

TFRA	Detection time for stabilized basic adaptation of FRAU	[8..10..12] sec
TRKA	Detection time for stabilized basic adaptation of RKAT or RKAZ	[4...6...8] sec
FRAE	Delta-FRAU for detection of the stabilized adaptation value FRAU	[0,01..0,03..0,05]
RKAE	Delta-RKAT resp. RKAZ for detection of the stabilized adaptation value RKAT resp. RKAZ	[0,2..0,6..1,0] %

The values indicated in the middle are reference values

By means of the partial function DKVSGAE the adaptation values FRAU and alternative RKAT (HFM system) or RKAZ (P-load acquistion) are checked for stabilization.

Frau_w is the lower multiplicative adaptation correction. A multiplicative error only differs significantely from an additive error if air masses >> idle speed air mass. For this reason the application values TFRA and FRAE should be chosen such that the bit B_gaefra can be set in the FTP75 in the large hill.

The choice of the value FRAE is directly dependent on the adaptation speed ZKFRAU. It should be chosen such that in case of a frm_w deviation from the neutral value 1.0 by 3% to 7% B_gaefra(2) is just not set. A multiplicative error can be simulated e.g. by an adjustable pressure controller. It should be possible to adjust the pressure between 1 and 6 bar so that a delta Lambda of +- 25 % can be adjusted. In future the CARB also allows an error simulation by manipulation of the ECU (e.g. multiplication of the injection time by a factor).

RKAZ resp. RKAT are the additive adaptation correction values and they act significantely in the low load range respectively load / engine speed range. The application values TRKA and RKAE should be chosen such that the bit B_gaeing(2) can be set in the FTP75 during idling after the big hill. Here again the value RKAE depends on the adaptation speed ZKRKAZ resp. ZKRKAT. It should be chosen in such a way that in case of a frm deviation by more than 3% - 7% no stabilization is detected.
Via the code word CPLRA it is possible to switch from the detection of RKAT having stabilized to RKAZ having stabilized. It is recommendable to deactivate the integrator in %LRA which was not checked for stabilization via the code word NOLRA. An additive error can be simulated by a leakage after the HFM in the intake manifold. A leakage of 3-4 mm diameter proofed itself useful for a certification on a 2.4 l engine. With lager holes it may happen that the engine no longer starts. Leakage air can also be simulated by a drop-off of the crankcase purge pipe (if there is one).

Application of the partial function DKVSZYK :

Application values

TFRAUZ	Waiting time for the forced setting of the adaption correction FRAU	[20..30..50] sec
TFRAOZ	Waiting time for the forced setting of the adaption correction FRAO	[20..30..50] sec
TRKATZ	Waiting time for the forced setting of the adaption correction RKAT	[20..30..50] sec
TRKAZZ	Waiting time for the forced setting of the adaption correction RKAZ	[20..30..50] sec

The values indicated in the middle are reference values

By means of the partial function DKVSZYK the cycle flags for all adaptation ranges are set. The cycle flag is either set by the bit B_gaefra for FRAU and B_gaeing for RKAT resp. RKAZ or after an adjustable time has passed.

The cycle flags Z_rkat and Z_rkaz may only be set during a drive once a mixture error can reliably be detected by the integrator (RKAT resp. RKAZ) assigned to it. It must for example be definately ruled out that a multiplicative error after engine start and long idling leads to an error message in the additive range.
Such false messages can be ruled out if the demand is made that the adaptation first must be active in the frau range for a certain time (TFRAUZ) before it then is active for another time in the RKAT resp. RKAZ range (TRKATZ,TRKAZZ).
For the FTP-72 test without error in the fuel supply system the times TRKATZ and TFRAUZ are too long. A quicker setting is necessary. For this the information basic adaptation stabilized (B_gaefra resp. B_gaeing) can be used.

Application of block DKVS enable:

Application values :

MLDKVSF : Air mass threshold for fault enable [8....10....15] Kg
MLDKVSF is to choose graeter then the air mas value, which could be sucked in only after first low fat e.g. by not straight standing auto until finally auto standstill by e.g. straight auto position.

MLDKVSG : air mas threshold for intergrator to set of zero [10....20....30] Kg
MLDKVSG is the air mas, which must flow in motor for verification of fil up. After this the DKVS is free for closing by repeated fault with empty tank. MLDKVSG must be not to less, so that by a real error DKVS with toggelbehavior of bit B_edkvs it dose not occur an erroneously closing.

IMLKVSMX: air mas threshold for integrator to set of zero [50....80...100] Kg
IMLKVSMX is introduced, with them a reset of integrator occurs anyway. IMLKVSMX is to choose higher then air mass, which in 2 FTP75 tests could be sucked in.

Remark : The Values indicated in the middle are recommend reference values.

Application of the partial function DKVSERR :

Application values

FRAUDX	upper diagnosis threshold FRAU	[1,2...1,23...1,25]
FRAUDN	lower diagnosis threshold FRAU	[0,75..0,77...0,80]
FRAODX	upper diagnosis threshold FRAO	[1,2...1,23...1,25]
FRAODN	lower diagnosis threshold FRAO	[0,75..0,77...0,80]
RKATDX	upper diagnosis threshold RKAT	[7.....8,5....10,0] %
RKATDN	lower diagnosis threshold RKAT	[-10..-8,5....-7,0] %
RKAZDX	upper diagnosis threshold RKAZ	[7.....8,5....10,0] %
RKAZDN	lower diagnosis threshold RKAZ	[-10..-8,5....-7,0] %

The values indicated in the middle are reference values.

The diagnosis thresholds must be entered into the permissible adaptation range (lift). The thresholds are to be determined such that an error fitted in the fuel supply system which results in the emission limit being exceeded by more than factor 1.5 definitely causes the error threshold to be reached in the FTP72 test. The diagnosis threshold should be adjusted in such a way that if the crankcase purge pipe drops off a leakage air error is detected (new CARB requirement).

In order to avoid undesired error messages under certain conditions (hot fuel, very high intake air temperature) reduced adaptation limits were introduced in the LRA, of which, however, only RKATRN shall be used.
These adaptation limits are to be adjusted to the determined diagnosis thresholds. The following conditions shall apply:

set FRAURX = FRAUMX and FRAURN = FRAUMN; i.e. no reduced threshold for FRAU
set FRAORX = FRAOMX and FRAORN = FRAOMN; i.e. no reduced threshold for FRAO

set RKATRX = RKATMX.
RKATRN approx. 2% - 3% Delta Lambda (related to rl during idling) above diagnosis threshold RKATDN

The 2% - 3% Delta Lambda must be maintained, so that "further adaptation into the wrong direction" for a short time after the next cranking (where the extended correction thresholds are again released) cannot lead to an error message.

set RKAZRX = RKAZMX and RKAZRN = RKAZMN; i.e. no reduced threshold for RKAZ

Maximum resp. minimum limits (FRAUMX,...,FRAOMN,...) should lie approx. 2% - 3% Delta-Lambda above resp. below the diagnosis thresholds.

```
            _____________ FRAUMX = FRAURX (upper adaptation limit)
            ------------- FRAUDX          (upper diagnosis threshold)

            -.-.-.-.-.-.- FRAUDN          (lower diagnosis threshold)
            _._._._._._._ FRAUMN = FRAURN (lower adaptation limit)
```

Application of the partial function DKVSST :

Application values

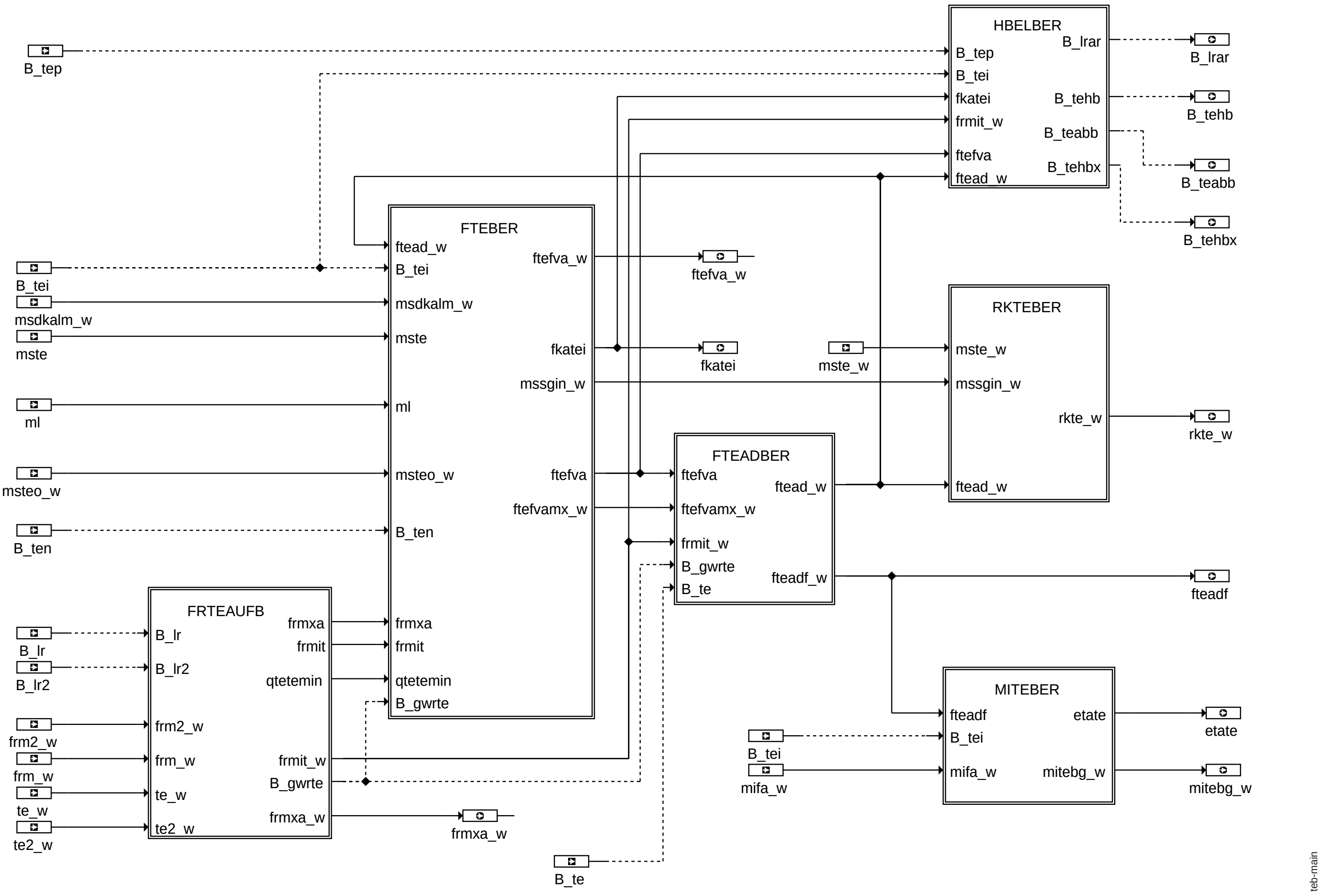
ZFRMST	Low pass time constant für frm_w(2)-signal	[3,0...5,0....10,0] sec
TFRMST	Detection time for stabilized of frm_w(2)-signal	[3,0...15,0...30,0] sec
TFRMZST	Waiting time for the unplausible frm_w(2)-signal	[20,0..50,0...50,0] sec
DFRMST	Delta-frm for detection of the stabilized frm_w(2)-signal	[0,01..0,03...0,05]
FRMSTDX	upper diagnosis threshold for frm_w(2)-signal short test	[1,2...1,23...1,25]
FRMSTDN	lower diagnosis threshold for frm_w(2)-signal short test	[0,75..0,77...0,80]

The values indicated in the middle are reference values.

The detection time for stabilized frm_w(2)-signal TFRMST should be choosen laset 3 time of low pass time constans.
The diagnositc thresholds (FRMSTDX and FRMSTDN) must be entered into the permissible control range (lift) and less then diagnositc threshold of FRAU. The thresholds are so to define, such that a fitted error in the fuel supply system, which in stationary state exceeds the error threshold of FRAU, with certainty reachs the error threshold (FRMSTDX resp. FRMSTDN).
The time threshold TFRMZST should be greater then time threshold TFRMST.

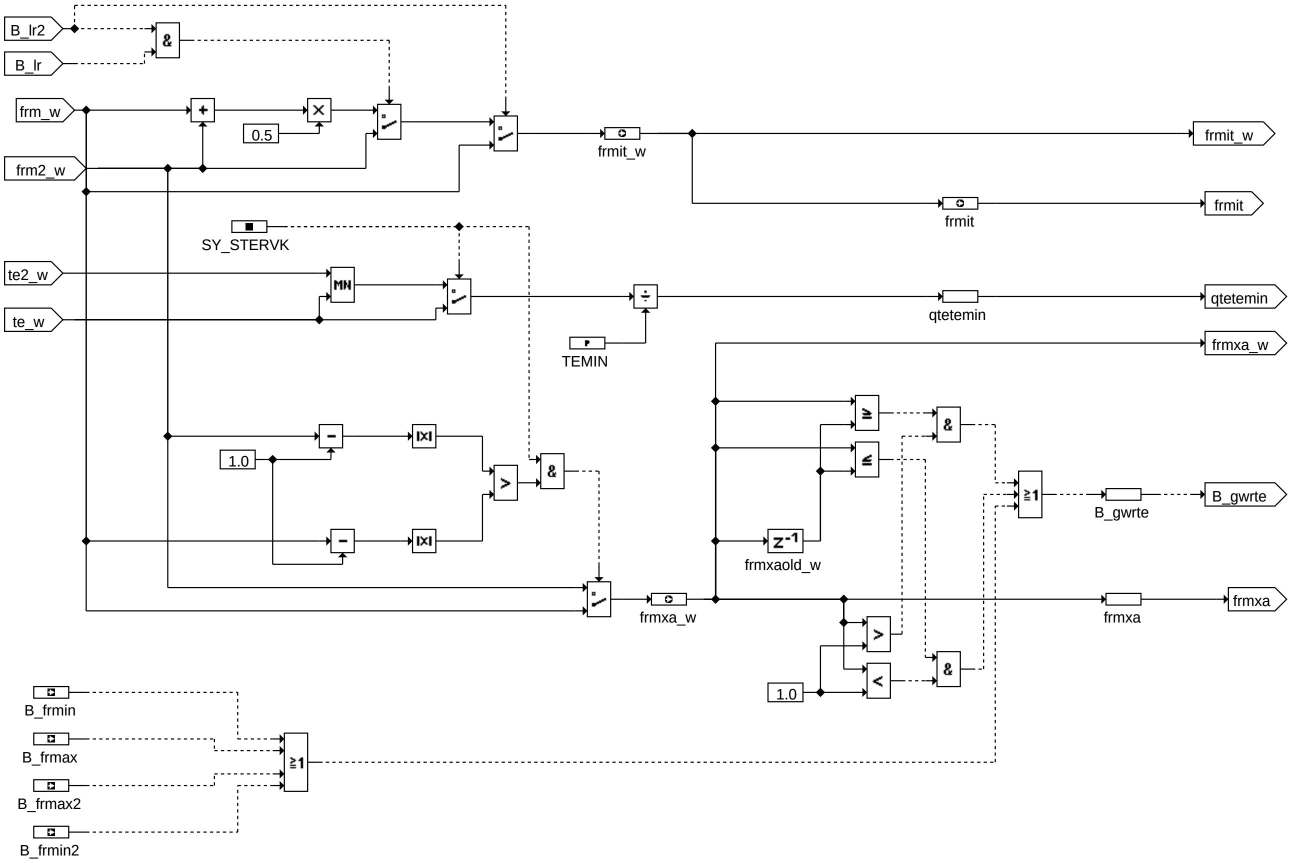
TEB 95.80 Purge canister function

FDEF TEB 95.80 Function definition



teb-main

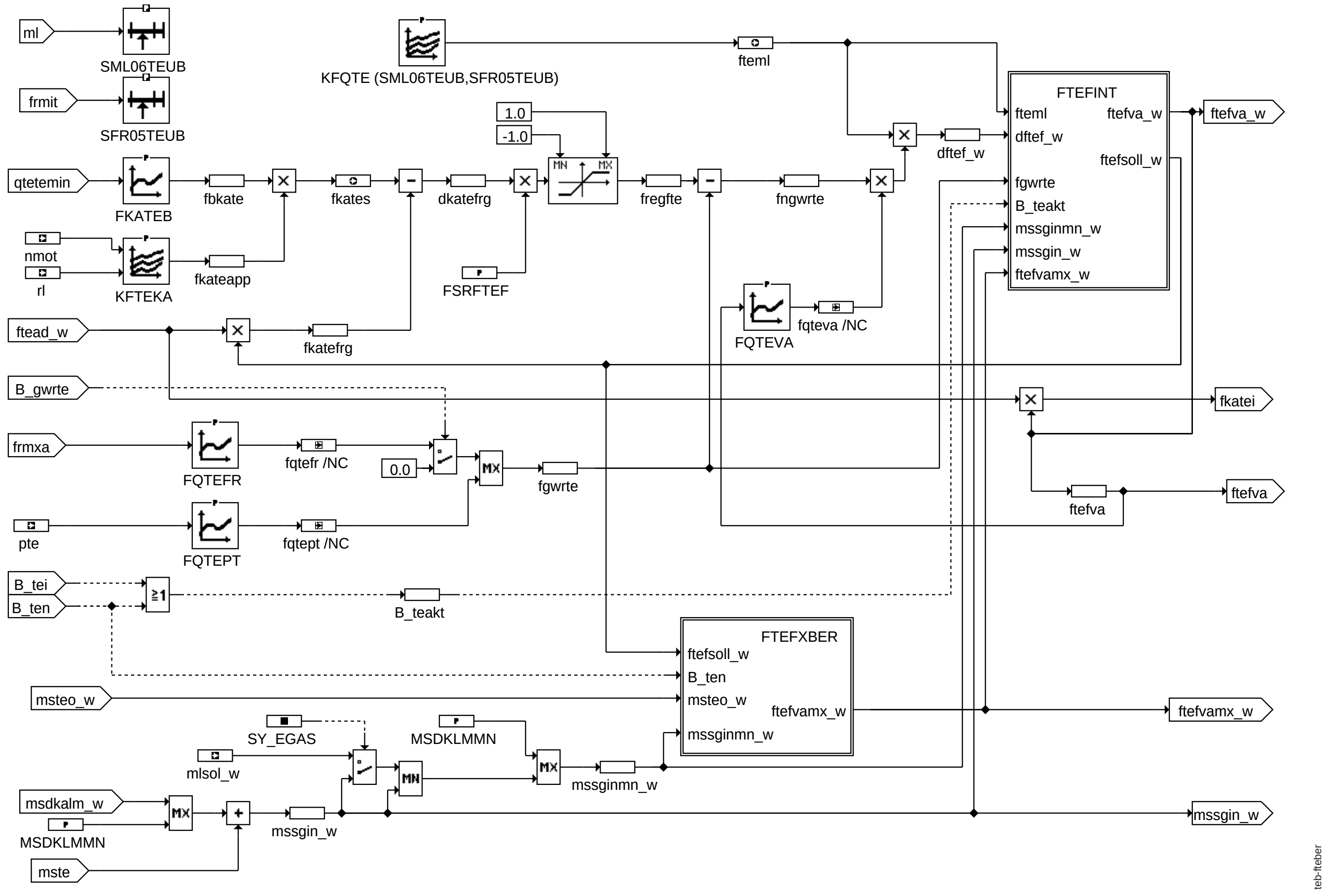
```
Calculation of Lambda control signals (frmxa, frmit_w and B_gwrte) and of the quotient: qtetemin = MIN(te_w, te2_w) / TEMIN:
-----------------------------------------------------------------------------------------------------------------------------
```



teb-frteaufb

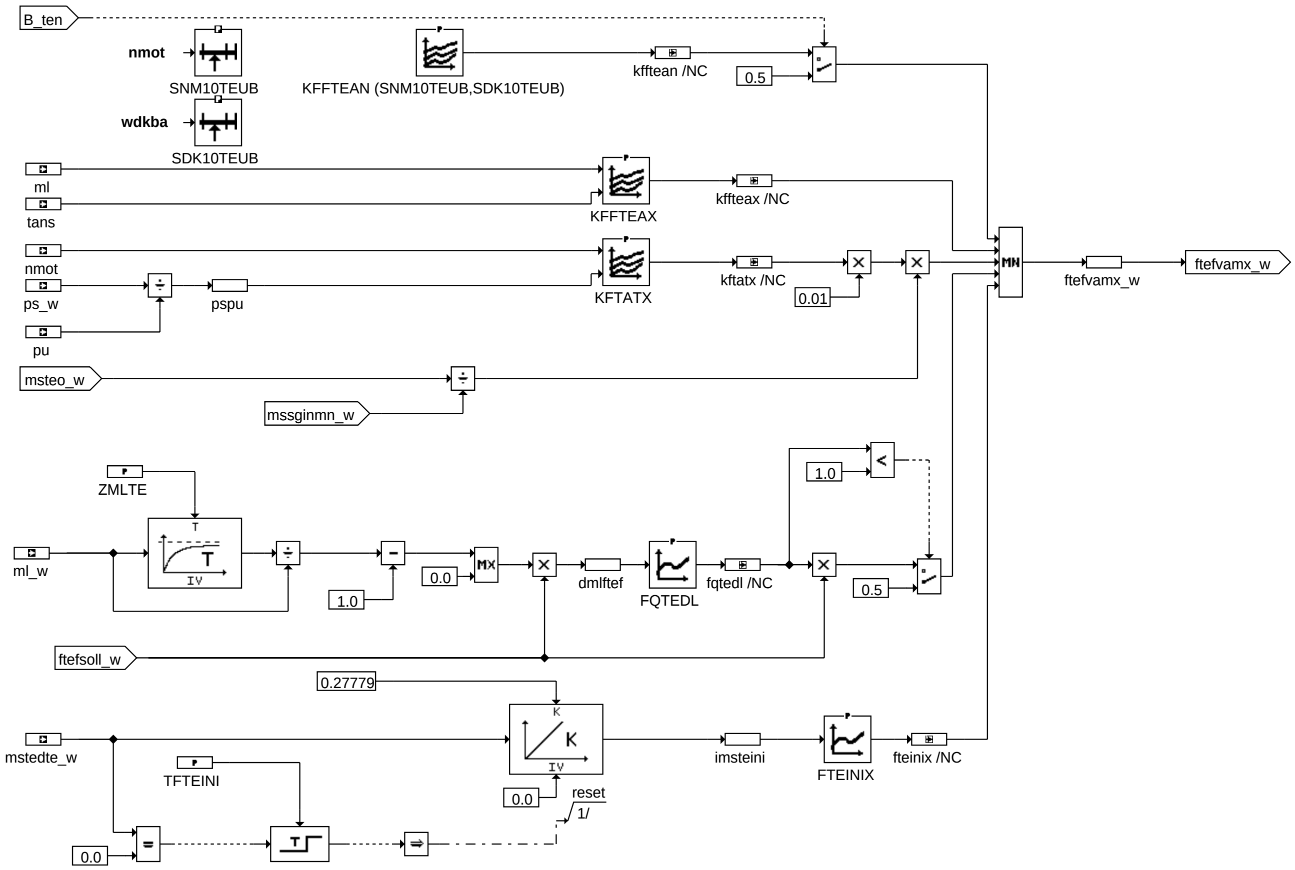
teb-frteaufb

`Calculation of the desired value of purge mass flow  (mstesoll_w) and of the purge rate (ftefva_w):`



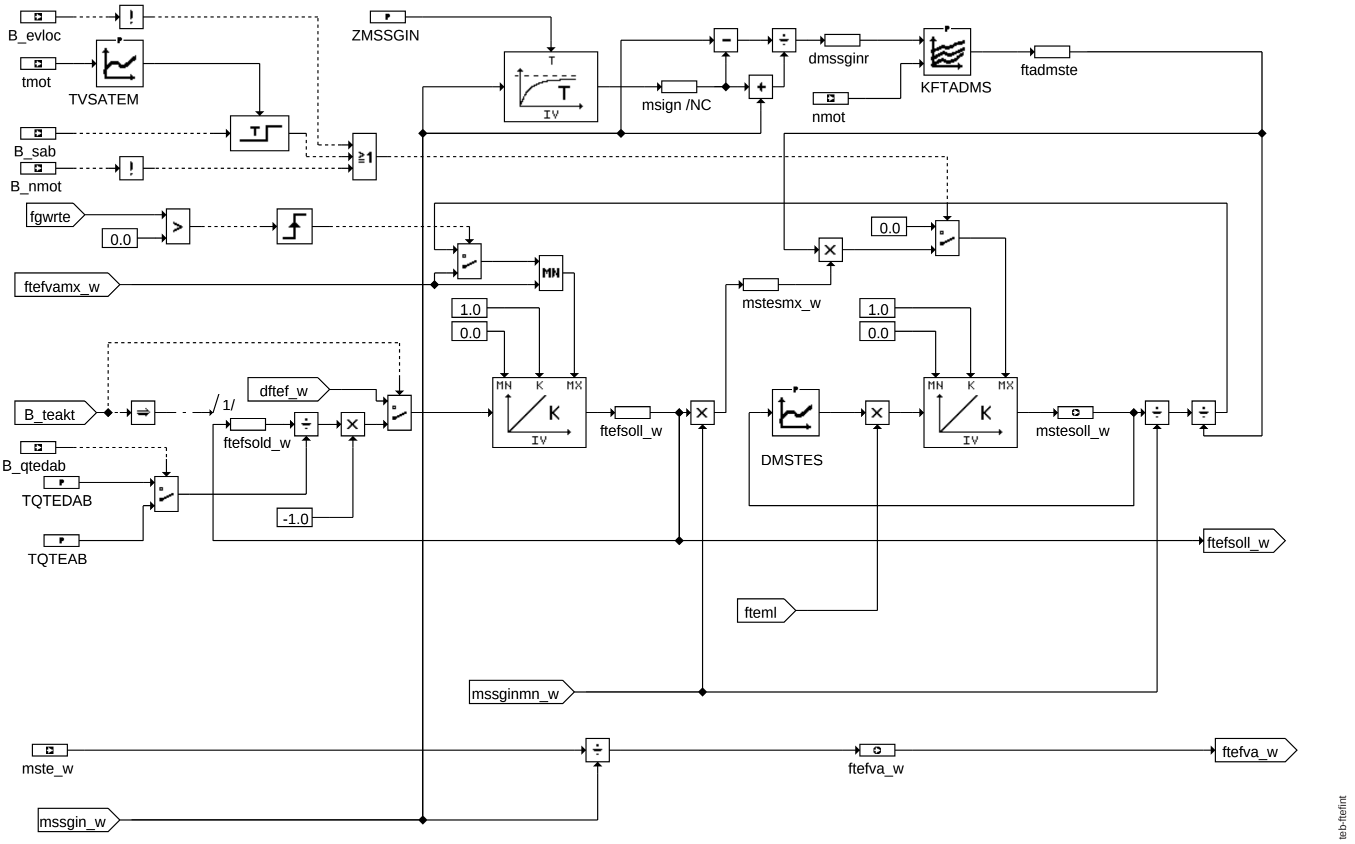
teb-fteber

`Limitation of the purge rate (signal ftefvamx_w):`



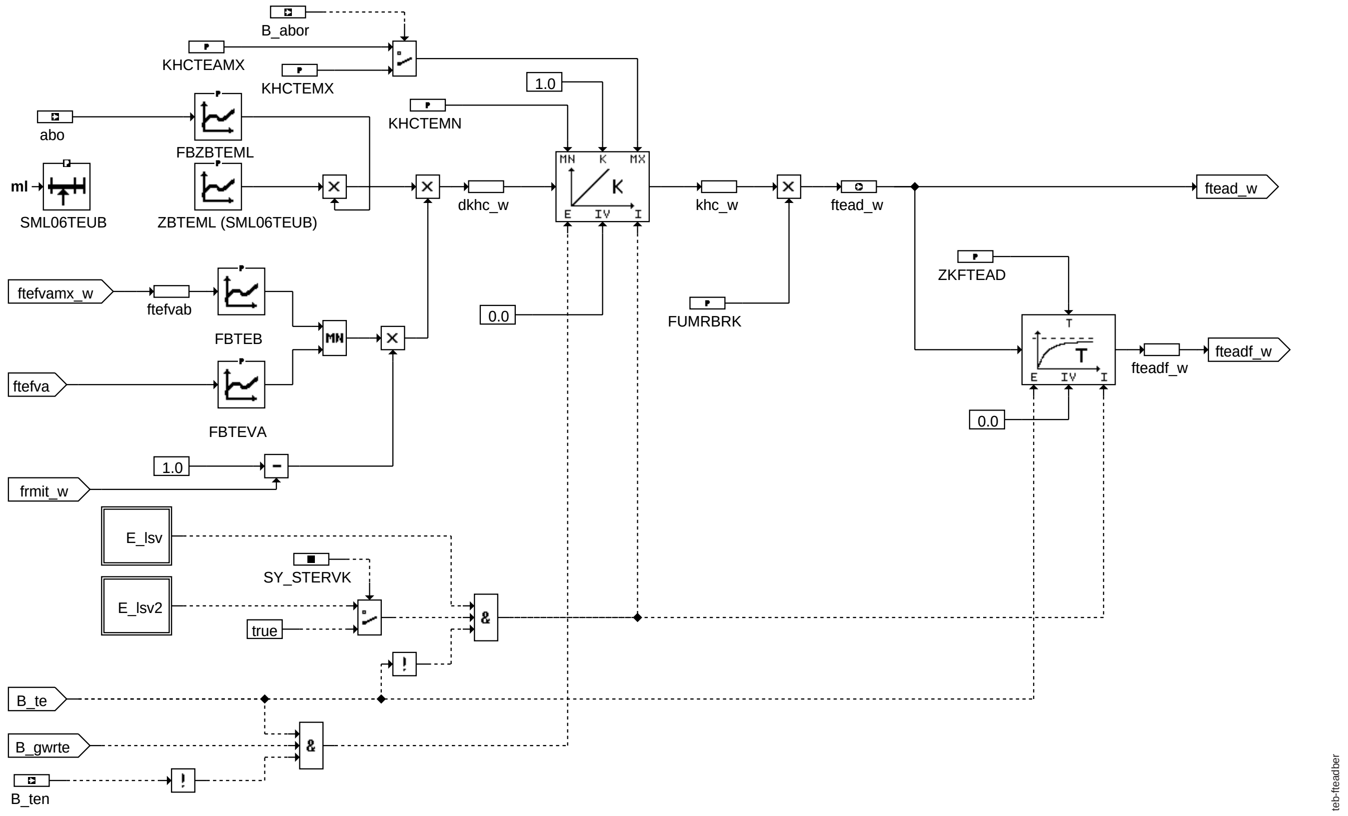
teb-ftefxber

`The two integrators: ftefsoll_w and mstesoll_w:`
`-----------------------------------------------`



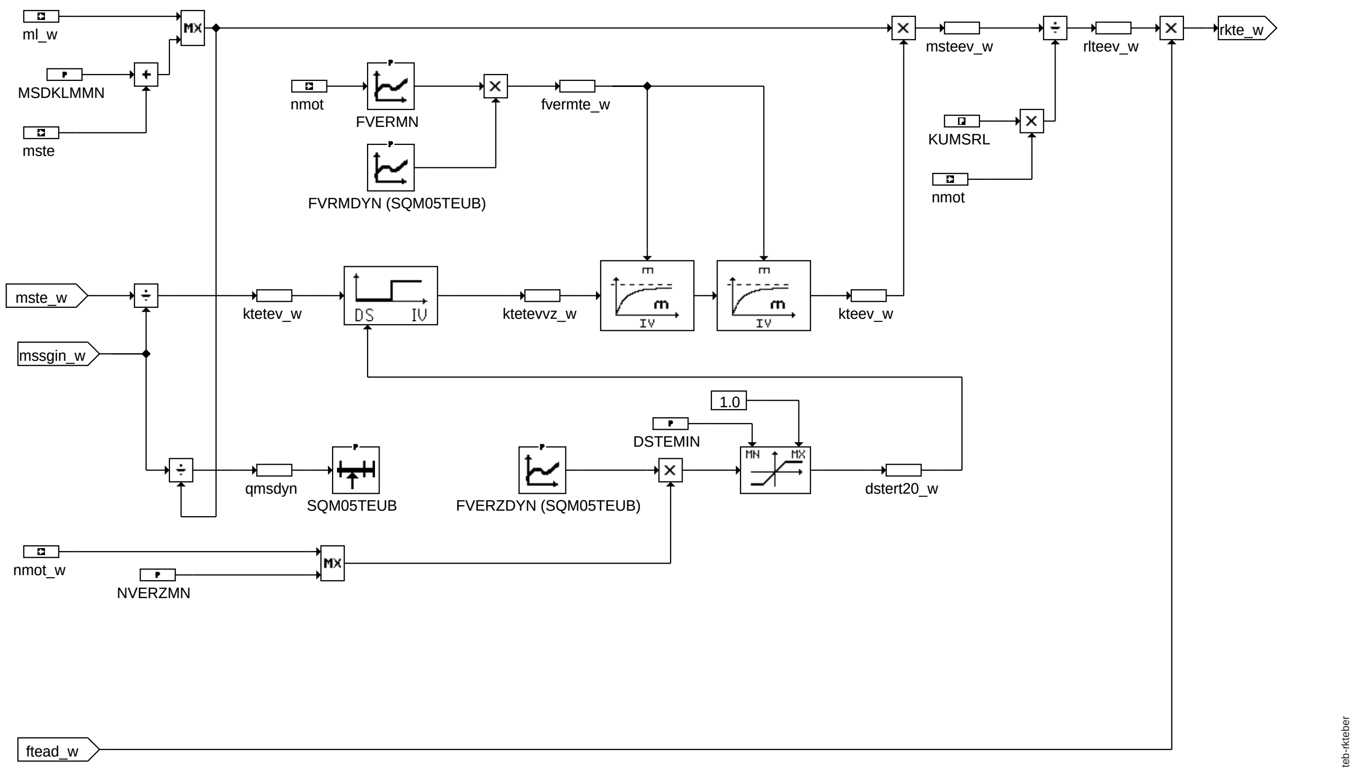
teb-ftefint

Adaptation of the HC-concentration of the purge flow:



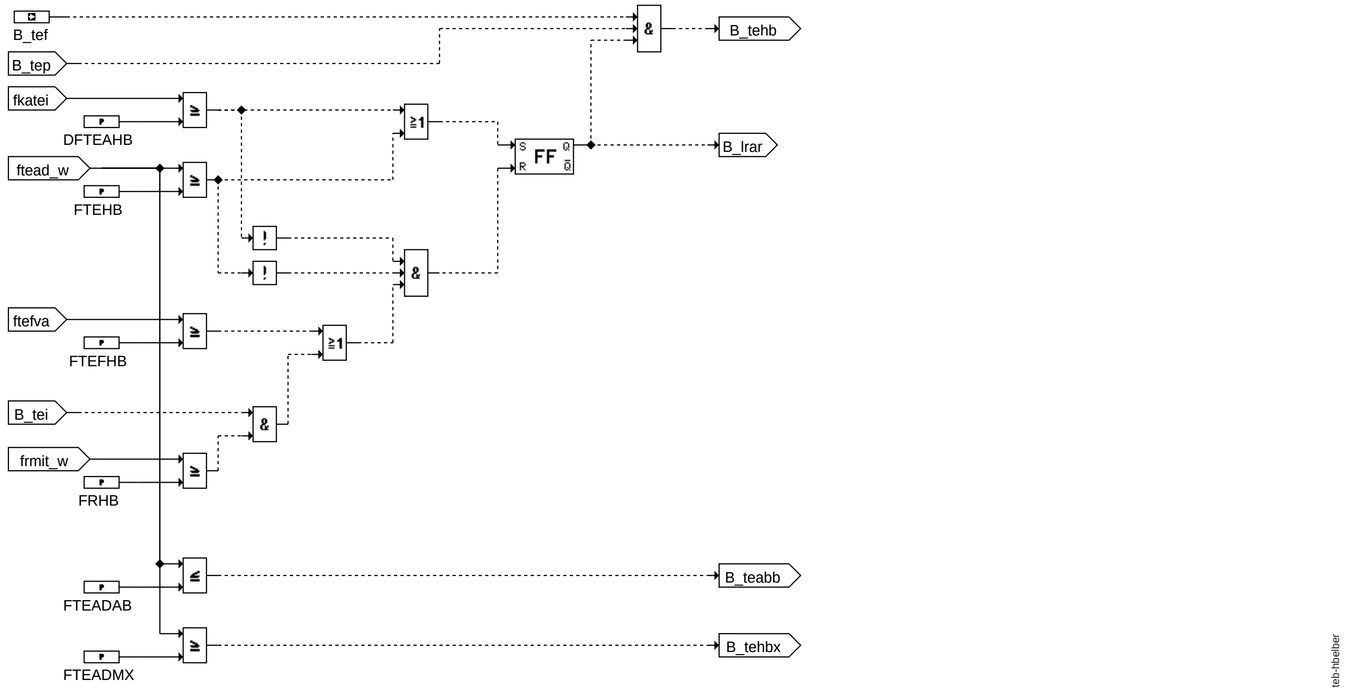
teb-fteadber

Calculation of the mixture correction signal "rkte_w":



teb-rkteber

```
Calculation of the Bits derived from "Canister Charge - ftead_w":
-----------------------------------------------------------------
```



teb-hbelber

```
Interaction on engine torque:
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```
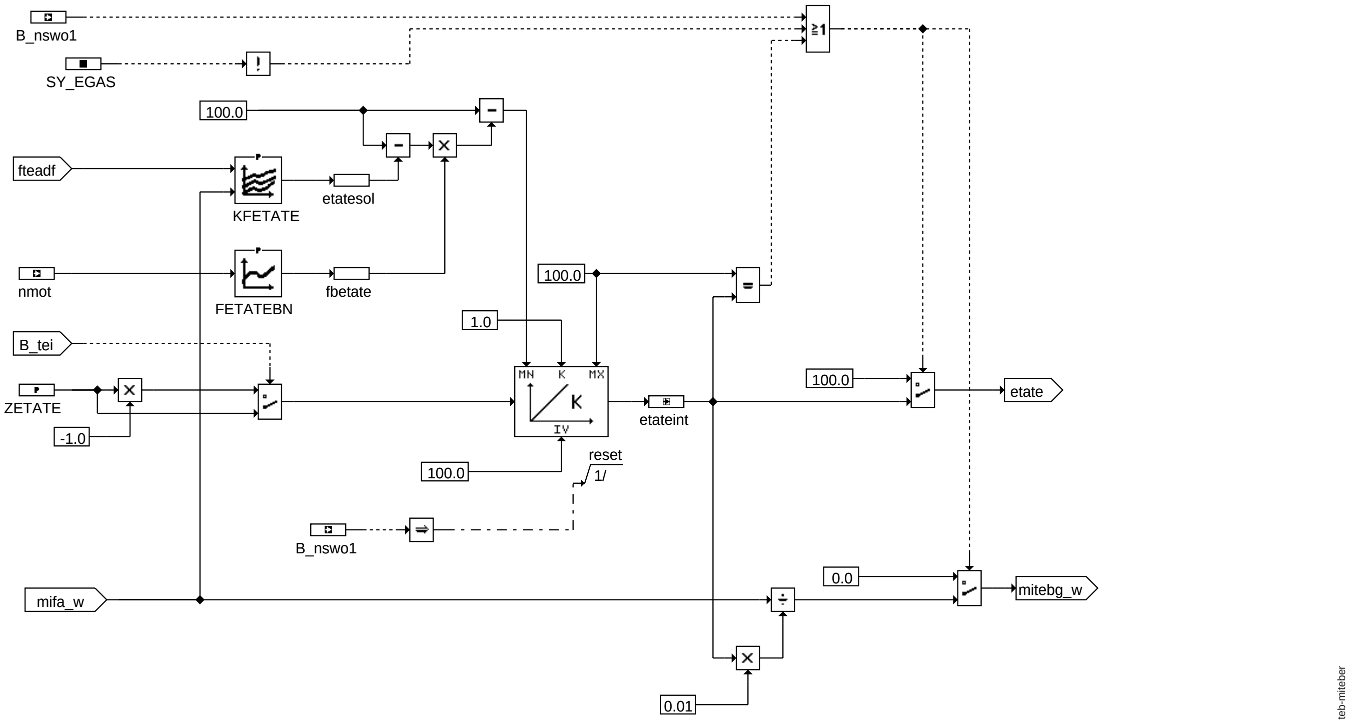



teb-miteber

ABK TEB 95.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DFTEAHB			FW	threshold fuel rate for switching the bit B_tebh to TRUE
DMSTES	MSTESOLL_W		KL	characteristic line maximum increase of purge mass flow
DSTEMIN			FW	minimum value for transportation distance in delay-time block
FBTEB	FTEFVAB		KL	factor ftefvab-depending limitation of the canister charge adaptation speed
FBTEVA	FTEFVA		KL	factor ftefva-depending canister charge adaptation speed

Parameter	Source-X	Source-Y	Type	Description
FBZBTEML	ABO		KL	Weighting factor integration speed for canister charge adaptation
FETATEBN	NMOT		KL	characteristic line: reduction of engine efficiency as f(nmot)
FKATEB	QTETEMIN		KL	Characteristic line fuel portion depending on te / TEMIN
FQTEDL	DMLFTEF		KL	Factor for exponential decrease of flow rate
FQTEFR	FRMXA		KL	characteristic line: purge rate reduction with big frm-deviation
FQTEPT	PTE		KL	characteristic line: for fuel-tank underpressure limitation
FQTEVA	FTEFVA		KL	progression of purge rate controller
FRHB			FW	limit for lambda controller to reset Bit "High HC-canister charge"
FSRFTEF			FW	factor: control speed of purge rate controller
FTEADAB			FW	Canister charge threshold for interruption of the purge phase
FTEADMX			FW	Maximum value of the canister charge (ftead)
FTEFHB			FW	Limit for flow rate of purge system to detect high concentration
FTEHB			FW	Limit for purge factor to detect high concentration
FTEINIX	IMSTEINI		KL	characteristic line for max. purge rate = F(integral purge flow after TE-Stop)
FUMRBRK			FW	factor calculation of canister charge (ftead) from HC-concentration
FVERMN	NMOT		KL	characteristic line: filter factor for purge flow in the manifold with fresh air
FVERZDYN	QMSDYN		KL	dynamic factor delay of purge flow in the manifold
FVRMDYN	QMSDYN		KL	dynamic factor for purge flow in the manifold with fresh air
KFETATE	FTEADF_W	MIFA_W	KF	characteristic map for efficency at active purging when te is near TEMIN
KFFTEAN	NMOT	WDKBA	KF	characteristic map for limitation of the purge rate with no Lambda control
KFFTEAX	ML	TANS	KF	Characteristic map for limitation of the purge rate
KFQTE	ML	FRMIT	KF	Map for purge rate increase / decrease
KFTADMS	DMSSGINR	NMOT	KF	dynamic evaluation factor for close off of PCV
KFTATX	NMOT	PSPU	KF	map for max. duty cycle
KFTEKA	NMOT	RL	KF	characteristic map of desired fuel portion purge control
KHCTEAMX			FW	maximum value of HC concentration in purge flow (by B_abor)
KHCTEMN			FW	minimum value of HC concentration in purge flow
KHCTEMX			FW	maximum value of HC concentration in purge flow
KUMSRL			FW (REF)	conversion constant from mass flow to relative air charge
MSDKLMMN			FW	minimum mass flow over throttle in canister purge control
NVERZMN			FW	minimal engine speed for dealy time
SDK10TEUB	WDKBA		SV (REF)	wdkba dependet basic point (number 10)
SFR05TEUB	FRMIT		SV (REF)	frmit dependet basic point (number 5)
SML06TEUB	ML		SV (REF)	ml dependet basic point (number 6)
SNM10TEUB	NMOT		SV (REF)	nmot dependet basic point (number 10)
SQM05TEUB	QMSDYN		SV	air mass quotient dependet basic point (number =5)
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TEMIN			FW	minimum effective injection time
TFTEINI			FW	Time for detection of purge stop
TQTEAB			FW	time for decrementation of the purge rate
TQTEDAB			FW	time for fast decrementation of the purge rate
TVSATEM	TMOT		KL	delay time for closing of the PCV after readyness for fuel cut off
ZBTEML	ML		KL	integration speed for canister charge adaptation
ZETATE			FW	changing speed of engine efficiency because of purge control
ZKFTEAD			FW	time constant filtered factor load scavening air at tank ventilation
ZMLTE			FW	Time constant for ml-filter
ZMSSGIN			FW	filter time constant for calculation of relative evalution mssgin_w

Variable	Source	Type	Description
ABO	BBBO	EIN	numbers of starts with fuel in oil
B_ABOR	BBBO	EIN	condition numbers of starts with fuel in oil for reduced adaptive lambda control
B_EVLOC	BGEVAB	EIN	Status: all injection valves are activated
B_FRMAX	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMAX
B_FRMAX2	LR	EIN	lambda control sets bit when lambda control reaches it limit FRMAX, bank2
B_FRMIN	LR	EIN	lambda control sets bit when lambda controller reaches its limit FRMIN
B_FRMIN2	LR	EIN	lambda control sets bit when lambda control reaches its limit FRMIN,bank2
B_GWRTE	TEB	LOK	condition: purge rate reduction because of fr-controller deviations
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_LRAR	TEB	AUS	condition for reducted correction ranges at LRA
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_QTEDAB	TEBEB	EIN	condition fast decrementation of purge rate
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_TE	TEBEB	EIN	Condition canister purge active
B_TEABB	TEB	AUS	Condition purge canister function ready to finish
B_TEAKT	TEB	LOK	condition purge control active (open loop or closed loop)
B_TEF	TEBEB	EIN	Condition canister purge function principally released
B_TEHB	TEB	AUS	condition for canister purge system with high canister load
B_TEHBX	TEB	AUS	Condition load integrator ftead at max. limit
B_TEI	TEBEB	EIN	Internal condition: canister purge function active
B_TEN	TEBEB	EIN	condition open loop purging
B_TEP	GKEB	EIN	Condition canister purge phase active
DFP_LSV	TEB	DOK	ECU int. fault path no.: electrical diagnosis for lambda sensor upstream cat.
DFP_LSV2	TEB	DOK	ECU int. fault path no.: electr. diagnos. for lambda sensor upstream cat. bank 2
DFTEF_W	TEB	LOK	input purge rate integrator
DKATEFRG	TEB	LOK	deviation actual fuel rate purge control from desired value
DKHC_W	TEB	LOK	input integrator for learning HC-concentration of purge control
DMLFTEF	TEB	LOK	product of percentual air flow change with purge rate
DMSSGINR	TEB	LOK	relative variation of mass flow mssgin_w

Variable	Source	Type	Description
DSTERT20_W	TEB	LOK	normalised transportation amount of purge flow in the manifold
ETATE	TEB	AUS	engine efficiency when purging with high vapour concentration
ETATEINT	TEB	LOK	integrator engine efficiency while purging
ETATESOL	TEB	LOK	desired engine efficiency when purging (depending on HC-vapor concentration)
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
FBETATE	TEB	LOK	desired engine efficiency as f(nmot) at purge control to avoid te/TEMIN<=1
FBKATE	TEB	LOK	factor fuel portion of purge flow depending on te / TEMIN
FGWRTE	TEB	LOK	value: purge rate reduction because of fr-controller deviations
FKATEAPP	TEB	LOK	factor calibrated fuel portion of purge flow
FKATEFRG	TEB	LOK	factor fuel rate purge control at desired purge rate
FKATEI	TEB	AUS	factor fuel part purge control (actuel value)
FKATES	TEB	AUS	factor fuel part purge control (desired value)
FNGWRTE	TEB	LOK	factor purge rate control after fr-controller reduction
FREGFTE	TEB	LOK	factor purge rate control before fr-controller reduction
FRM2_W	LR	EIN	fast mean value of lambda control factor bank 2(word)
FRMIT	TEB	AUS	Mean value of fr and fr2
FRMIT_W	TEB	AUS	mean value of fr and fr2 (16 bit)
FRMXA	TEB	LOK	fr value (out of fr and fr2) which is the farest away from 1.0
FRMXA_W	TEB	AUS	fr value (out of fr aund fr2) wich is the farest away from 1 (16bit)
FRM_W	LR	EIN	fast mean value of lambda control factor (word)
FTADMSTE	TEB	LOK	evaluation factor for close off of PCV when dynamic case
FTEADF	TEB	AUS	filtered factor load scavening air at tank ventilation
FTEADF_W	TEB	LOK	filtered factor load scavening air at tank ventilation (16 bit)
FTEAD_W	TEB	AUS	charcoal canister charge
FTEFSOLD_W	TEB	LOK	last desired canister purge rate before closing the PCV
FTEFSOLL_W	TEB	LOK	desired canister purge rate
FTEFVA	TEB	LOK	canister purge rate
FTEFVAB	TEB	LOK	actual limit of the purge rate
FTEFVAMX_W	TEB	LOK	max. purge rate (16 bit value)
FTEFVA_W	TEB	AUS	purge rate of the purge control function
FTEML	TEB	AUS	input purge rate integrator
FVERMTE_W	TEB	LOK	factor filtering purge low in the manifold
IMSTEINI	TEB	LOK	integral of purge mass flow after a longer purge stop
KHC_W	TEB	LOK	adapted HC-concentration of the purge flow
KTEEV_W	TEB	LOK	concentration purge flow in the manifold at the injection valve
KTETEVVZ_W	TEB	LOK	concentration purge flow in the manifold (with delay)
KTETEV_W	TEB	LOK	concentration purge flow in the manifold at the PCV
MIFA_W	MSF	EIN	desired indicated engine torque
MITEBG_W	TEB	AUS	torque value for minimum charge canister purge
ML	SWADAP	EIN	air mass flow
MLSOL_W	FUEDK	EIN	set air mass flow
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSDKALM_W	BGMSZS	EIN	Mass flow over throttle (balance with HFM signal)
MSSGINMN_W	TEB	LOK	mimmum of mass flow into manifold (through throttle and PCV)
MSSGIN_W	TEB	LOK	mass flow into manifold (through throttle and PCV)
MSTE	BGTEV	EIN	mass flow purge control into the manifold
MSTEDTE_W	BGTEV	EIN	purge mass flow for DTEV (word)
MSTEEV_W	TEB	LOK	purge mass flow at the injection valve
MSTEO_W	BGTEV	EIN	Mass flow the 100 % opened TEV
MSTESMX_W	TEB	LOK	max. possible desired purge mass flow
MSTESOLL_W	TEB	AUS	desired purge mass flow
MSTE_W	BGTEV	EIN	mass flow purge control into the manifold
NMOT	SWADAP	EIN	engine speed
NMOT_W	SWADAP	EIN	engine speed
PSPU	TEB	LOK	quotient: manifold pressure / ambient pressure
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PTE	GGDST	EIN	tank pressure (from ADC)
PU	BGPU	EIN	Ambient pressure
QMSDYN	TEB	LOK	quotient from ml_w und mmssgin_w
QTETEMIN	TEB	LOK	quotient: te / TEMIN for BDE teh_w/teminh_w resp. tes_w/temins_w
RKTE_W	TEB	AUS	relative fuel part of the purge control
RL	SWADAP	EIN	relative air charge
RLTEEV_W	TEB	LOK	relative cylinder air amount because of purging
TANS	SWADAP	EIN	Intake air temperature
TE2_W		EIN	effective injection time bank 2 (word)
TE_W		EIN	effective injection time (word)
TMOT	SWADAP	EIN	Engine temperature

FW TEB 95.80 Fixed Values

Parameter	Value	Description
DFTEAHB		threshold fuel rate for switching the bit B_tebh to TRUE
DSTEMIN		minimum value for transportation distance in delay-time block
FRHB		limit for lambda controller to reset Bit "High HC-canister charge"
FSRFTEF		factor: control speed of purge rate controller
FTEADAB		Canister charge threshold for interruption of the purge phase
FTEADMX		Maximum value of the canister charge (ftead)
FTEFHB		Limit for flow rate of purge system to detect high concentration
FTEHB		Limit for purge factor to detect high concentration
FUMRBRK		factor calculation of canister charge (ftead) from HC-concentration

Parameter	**Value**	**Description**
KHCTEAMX		maximum value of HC concentration in purge flow (by B_abor)
KHCTEMN		minimum value of HC concentration in purge flow
KHCTEMX		maximum value of HC concentration in purge flow
MSDKLMMN		minimum mass flow over throttle in canister purge control
NVERZMN		minimal engine speed for dealy time
TEMIN		minimum effective injection time
TFTEINI		Time for detection of purge stop
TQTEAB		time for decrementation of the purge rate
TQTEDAB		time for fast decrementation of the purge rate
ZETATE		changing speed of engine efficiency because of purge control
ZKFTEAD		time constant filtered factor load scavening air at tank ventilation
ZMLTE		Time constant for ml-filter
ZMSSGIN		filter time constant for calculation of relative evalution mssgin_w

FB TEB 95.80 Detailed description of function

```
Introduction:
=============
The new "loading-dependent purge control" is subdivided into several functions:
> %TEB     - core of the function
> %TEBEB   - activation conditions
> %ATEV    - output of the duty cycle to the PCV
> %BGTEV   - calculation of the mass flows PCV (separate functions for aspirating engines and for turbo charger engines)


Short description of the function purge control:
================================================
> A desired mass flow scavenge gas is determined  (mstesoll_w)
> From this the pulse duty cycle PCV is calculated (tateout)
> The actual scavenging flow purge control into intake manifold is calculated (mste_w)
> The concentration of scavenge gas in the intake manifold at the level of the PCV is calculated (ktetev_w)
> The transport and mixing through the intake manifold are taken into consideration (ktetev_w -> kteev_w)
> The mass flow of scavenge gas at the level of the intake valve of the engine (msteev_w) is calculated
> The relative charge in the cylinder due to scavenge gas (rlteev_w) is calculated.
> From the deviations of the Lambda controller from 1.0 the HC concentration directly upstream the PCV (khc_w)
  is adapted and directly from this the variable loading (ftead_w) is calculated.
> The needed relative fuel correction is calculated (rkte_w = relative charge * loading).

Remark: All mass flows (so also scavenging flows) refer to pure air. A possible "loading" with hydrocarbons (HC) is only taken
        into consideration during the mixture correction (rkte_w).
        The system constant SY_EGAS distinguishes the system-specific versions with/without electronic accelerator (EGAS)

List of the most important values for purge control (turbo charge engine + aspirating engine):
==============================================================================================
Mass flows:
-----------
> Air masses flowing into and out of the intake manifold (msdkalm_w, ml_w)
> Scavenge gas masses flowing into and out of the intake manifold (mste_w, msteev_w)
=> thus resulting scavenge gas concentrations (ktetev_w - at the level of throttle valve, kteev_w)

Physical values (only for description):
---------------------------------------
> HC concentrations (mass of HC particles / mass of air particles) in the monitored gas flow
  - khc_tev: directly upstream PCV
    (no motronic value, however, adapted value "HC conc. upstream PCV" exists in motronic: khc_w )
  - khc_einl.: at the level of the intake valve of the engine (no motronic value)

Special motronic values for PCV triggering and mixture correction:
------------------------------------------------------------------
> tateout  : Output duty cycle PCV (contains pickup delay PCV)
> rkte_w   : Mixture correction for injection (is subtracted from the injection volume needed without purge control)
> khc_w    : Adapted HC concentration of the scavenge gas flow directly upstream the PCV
> rlteev_w : Relative charge in the cylinder due to scavenge gas
> ftead_w  : Value obtained from khc_w only by conversion (re-normalization) (rkte_w = ftead_w * rlteev_w)
```

Intake manifold models (separate for aspirating engines and turbo charger engines), complete list of all values:
==

```
Aspirating engine:
==================                                    | |
                                                      |X| PCV
                                                      | | mstetev_w
                                                      | | khc_tev
                                                      | |                                                     intake    exhaust
    +------+         +-----+                          | | mste_w                                           injector
----|      |---------|     |--------------------------| |----------------------------------------------------||-----+  +-----------
    | air  |         |     |                        /                                                 khc_einl.  || |  |
pu  |      |         | HFM |         pvdk = pu    *    =>  asp. engine: mste_w (total flow)  ps_w         =>     || |  | ||   pu
    |filter|         |     |                     /                                                 => msteev_w   -- |  | ||
----|      |---------|-----|-----------------------------------------------------------------------------------+=  =+==+=--=+------
    +------+         +-----+                                                                                   |            |
                     ------->                --------->                                             ------->   |            |
                      mshfm_w                asp.engine: msdkalm = mshfm                                  ml_w     |+----------+|
                                                                                                               ||          ||
                                                                                                               ||          ||
```

Mass flows:
mshfm_w.........: Mass flow of air flowing through HFM
msdkalm_w.......: Mass flow through throttle valve equalized with air mass meter signal
(on the aspirating engine msdkalm_w = mshfm_w, on the turbo charger engine the balance air mass turbo charger is added)
mstetev_w.......: On the aspirating engine: mass flow PCV (intake downstream throttle valve)
mste_w..........: Total flow purge control ("currently flowing at the level of the throttle valve")
msteev_w........: Total (compared to throttle valve) timewise delayed and "smoothed out mass flow purge control"
msteev_w is only used for the mixture correction (the charge sensing calculates with mste).
mssgin_w........: mssgin_w = msdkalm_w + mste_w: total gas mass flow flowing into intake manifold
(air throttle valve + TE scavenge gas). EGR is not taken into consideration
ml_w............: Total air mass flow siphoned from the engine (in ml_w also scavenge gas is contained)

Pressures:
ps_w............: Manifold pressure in hPa
pu..............: Ambient pressure in hPa
pvdk............: Pressure upstream throttle valve

HC concentrations:
khc_tev.........: Concentration HC at PCV
khc_einl........: Concentration HC at the level of the intake valves

Concentrations of scavenge gas in air, which is taken in through the throttle valve (not illustrated in above diagrams) :
ktetev..........: Concentration of scavenge gas in the intake manifold immediately after scavenge gas has mixed with air
kteev...........: Concentration of scavenge gas at intake valve
Remark: Conc. of scavenge gas is not equal to concentration of HC but only indicates how many gas particles from the TE-system have currently mixed with the gas particles of the air.
ktetev = mste / (msdkalm + mste) ktete
kteev = msteev / ml

```
Turbo engine:
=============                          | |
                                       |X| PCV
                                       | | khc_tev
                           <--mstevl_w | | mstetev_w -->
                        +--------/|----+ +-----|\--------+
                        | +------\|------------|/------+ |                                                    intake    exhaust
    +------+   +-----+  | |  +-------+                 | | mstesg_w                                       injector
----|      |---|     |--| |--|       |-----------------| |---------------------------------------------------||-----+  +-----------
    | air  |   |     |       | Turbo |  pvdk          /                                               khc_einl.  || |  |
 pu |      |   | HFM |  pvl  |       |               *  => Turbo: mste_w = mstesg_w + mstehl_w    ps_w    =>     || |  | ||   pu
    |filter|   |     |       |       | => mstehl_w /                                               => msteev_w   -- |  | ||
----|      |---|     |-------|       |-------------------------------------------------------------------------+=  =+==+=--=+------
    +------+   +-----+       +-------+                                                                         |            |
               ------->                      --------->                                             ------->   |            |
               mshfm_w                       Turbo:                                                   ml_w     |+----------+|
                                             msdkalm-w = mshfm_w + change of air mass in turbo                 ||          ||
                                                                                                               ||          ||
```

Mass flows:
mshfm_w.........: Air mass flow flowing through HFM
msdkalm_w.......: Mass flow through throttle valve equalized by air mass meter signal
(on the aspirating engine msdkalm_w = mshfm_w, on the turbo charger engine the balance air mass turbo charger is added)
mstevl_w........: Only turbo engine: portion of mass flow PCV which is led in upstream of the turbo charger
mstehl_w........: Only turbo engine: mass flow purge control currently flowing into the intake manifold from the turbo charger
mstesg_w........: Only turbo engine: the mass flow purge control currently flowing into the manifold via the intake position of the manifold
mstetev_w.......: On the turbo engine: the mass flow PCV which is led in upstream throttle valve
mste_w..........: Total flow purge control ("currently flowing at the level of the throttle valve")
msteev_w........: Total (compared to throttle valve) timewise delayed and "smoothed out mass flow purge control"
msteev_w is only used for the mixture correction (the charge sensing calculates with mste).
mssgin_w........: mssgin_w = msdkalm_w + mste_w: total gas mass flow flowing into intake manifold
(air throttle valve + TE scavenge gas). EGR is not taken into consideration
ml_w............: Total air mass flow siphoned from the engine (in ml_w also scavenge gas is contained)

Pressures:
ps_w............: Manifold pressure in hPa
pu..............: Ambient pressure in hPa
pvl.............: Only turbo engine: Pressure upstream the turbo charger (little below external pressure due to flow resistance)
pvdk............: Pressure upstream throttle valve

HC concentrations:
khc_tev.........: Concentration HC at PCV
khc_einl........: Concentration HC at the level of the intake valves

Concentrations of scavenge gas in air, which is sucked in through the throttle valve (not illustrated in above diagrams) :
ktetev..........: Concentration of scavenge gas in the intake manifold immediately after scavenge gas has mixed with air
kteev...........: Concentration of scavenge gas at intake valve
Remark: Conc. of scavenge gas is not equal to concentration of HC but only indicates how many gas particles from the TE-system have currently mixed with the gas particles of the air.
ktetev = mste / (msdkalm + mste) ktete
kteev = msteev / ml

Statements and physical regularities:
=====================================

> For the purge control at first the entire mass flow of scavenge gas which flows in at the level of the throttle valve is of interest (mste_w). On the aspirating engine there is only one intake downstream throttle valve. Due to the intake manifold vacuum, regenerating gas flows into the intake manifold. On the turbo charger two intake positions are to be provided
(1. downstream throttle valve, 2. upstream the turbo charger) In case of low manifold pressure the scavenging flow will flow in downstream throttle valve. In the charging area the flow resistance of the air filter causes a minor vacuum upstream the turbo charger. Then the scavenge gas will flow upstream the turbo charger. A check valve prevents that air from the intake manifold will flow upstream the turbo charger.

> On the aspirating engine and also on the turbo charger engine the entire purge flow at throttle valve is calculated (mste_w) - important common intermediate value.
=> Mste_w is thus then the input value for %TEB. Mste_w calculation for aspirating engines and for turbo engines, however, in separate versions %BGTEV
Remarks: Mste_w at first does not take into consideration that also HC particles are contained in the flow. Additionally also a HC concentration must be learned (adapted) (khc_w resp. ftead_w). Mste_w is related to pure air !
Storage effects in the pipe PCV-intake manifold and in the turbo charger can (in later versions) be taken into consideration in mste_w. For this the values mstetev_w (aspirating engine, turbo engine) and mstevl_w, mstehl_w (additionally only for turbo engine) were introduced.

> The HC flow led in at the PCV needs a certain time until it reaches the intake valve (position of the intake valve).

> Steep edges of concentration differences at the position of the PCV are smoothed by diffusion in the intake manifold. Generally it can be said that the longer a gas particle is in the intake manifold the more diffused become the concentration jumps.
A concentration progress in form of a rectangle (0->1 jump) smoothes out and results in a concentration progress in form of a -S- at the intake valve of the engine.

> The time spend by a particle in the intake manifold is approx. inversely proportional to the engine speed during steady-state engine operation.

> If the PCV does not open resp. close at exactly the same time or to exactly the same degree as the throttle valve then load changes cause strong HC concentration changes in the intake manifold. For example in case of a constantly open PCV the opening of the throttle valve will result in a temporarily very low scavenge gas concentration (air shoots into the intake manifold, PCV flow remains the same or reduces).

> However, if the PCV is opened resp. closed at exactly the same time as the throttle valve then the scavenge gas concentration in the intake manifold remains at a constant level. Unfortunately this mode of operation is not possible. As a rule the PCV timer enables the closing of the PCV only 50 ms after the throttle valve has closed. A throttle valve synchronous opening is also only to be passed on to the PCV delayed by the same time.
In order to obtain an as constant as possible HC concentration of the scavenge gas flow it is furthermore recommendable to open the PCV only slowly also in case of quick positive load changes (e.g. double the opening within 5 s to 10 s). This prohibits a throttle valve synchronous activation of the PCV.

=> With load changes the dilution of the scavenge gas flow in the intake manifold changes very quickly with the inflowing air. This must be taken into consideration for the injection correction.

Advantages of the new charge sensing for the purge control function:
==

> The new charge sensing performs a "particle balance" in the intake manifold. All gas particles flowing in are determined and from this the outflowing particles are calculated. Thus an exact knowledge of the manifold pressure is obtained. By means of the manifold pressure and of the external pressure the gas particles flowing in can then again be calculated in the next step.
The only factors which must be known are the opening areas (resp. the mass flow led off from them in the over-critical under standard conditions) to the intake manifold.

> The consequences for the purge control are:

The following values are known:

a) Aspirating engine (see e.g. BGTEV1.20):
- one intake position downstream throttle valve
    ps_w - manifold pressure
    pu_w - ambient pressure
    => from this the current mass flow through the PCV (mste_w = KLAFTE(ps_w/pu_w)) and the mass flow with open PCV (msteo_w) can be derived.
    Remark: Additional characteristic KLAFTE (and not KLAF) to take into consideration the flow resistance of the pipe ACF-PCV or the flow characteristic of a Laval PCV changed with regard to the throttle valve.

    Exceptions: close to full load and full load. Here a map value (KFAFTE = f(nmot, wdkba)) instead of the HFM-signal is used due to steady-state accuracy reasons.

b) Turbo engine (see e.g. BGTEV2.10):
- as shown above as a rule two intake positions are provided here
    - The quotient ps_w/pu is taken from the charge sensin for the intake downstream throttle valve.
    - For the intake upstream the turbo charger the characteristic DPVLMS (pressure drop upstream turbo charger due to air filter) is used.
    - Also an own outflow characteristic is defined (KLAFTE). Deviations from the normal characteristic may be necessary in order to:
      a) take into consideration the flow resistance of a long pipe ACF-PCV.
      b) take into consideration another PCV characteristic (Laval nozzle)

Summary for application compared to previous TEB:

> On the aspirating engine the map "factor outflow (KFAFTE)" instead of the map "volume flow open PCV (KFVOBL)" is adjusted
> The PCV mass flow (vacuum side) over the outflow characteristic (KLAF) is calculated for the turbo and for the aspirating engine.
  The mass flow in the loading range is adjusted via the differential pressure characteristic (DPVLMS).
  Remark: The map KFVOBL used for the previous purge control was very inaccurate for the turbo engine.
> In case of long pipes ACF-PCV an engine-specific correction characteristic MSNTATE (previously KORTATE) is still needed.
  So as to take into consideration the different flow rate characteristics (throttle valve <-> PCV + pipe, resp. flow rate
  characteristic Laval-PCV) an own flow rate characteristic (KLAFTE) is provided.

Remarks to dynamic response:
> With the new functions %BGTEV an exact temporal course of the mass flow (mste_w) flowing into the intake manifold in case of
   load changes can be calculated for the aspirating engine as well as for the turbo engine !!
> The vrego used so far was only dependent on nmot and wdkba !!! The dynamic response was not taken into consideration.
> With the new purge control the mixture correction during dynamic engine operation can be calculated much better than before.

```
           ^
 3.8 m^3/h |         +   +   +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 900 mbar  -***** +                                                                   *****   ps_w
           |    + *                                                                   +++++   mste_w
           |   +      *
           |  +             *
           |                         *
 300 mbar  - +                                    *    *    *    *    *    *    *
 1.3 m^3/h +
           |
           +---------|-----------------|------------------------------------------------>
                  200 ms             500 ms
```

Example: Course of the mass flow (mste_w) through the open PCV after a negative load change at nmot = 1000 rpm:

Subdivision of the new purge control into subfunctions %TEBEB, %BGTEV, %ATEV and %TEB (rough block diagram):

```
                                        +----- % TEBEB --------+
                                        | activation conditions|
                                        +----------------------+
                                                  |  B_te
+--- % BGTEV ---+                      +-----------v---------------+                 +------------------+
| calculation   |---> mste_w  ------->| calculation : calculation |   mstesoll_w    | calculation pulse|----------> tateout
| mass flows    |                      | transport   : desired mass|---------------->| duty cycles      |----------> tevper
| PC into manif.|---> msteo_w ------->| and mixing  : flow         |            +--->| cycle duration   |------+---> tatesoll
|               |                      | intake      :.............|            |    +---- % ATEV ------+      |
|    msntevo_w  |--+  msdkalm_w ----->| manifold    : calculation  |   rkte_w   |                              |
|...............|  |  ml_w ---------->| ->msteev_w :  mixture     |------------|------------------------------|---> rkte_w
| intermediate  |  |                   |....................  corr-|            |                              |
| value tateist |  |  frm_w (frm2_w)->| adaptation loading : ect. |            |                              |
+------^--------+  |                   +------- % TEB -------------+            |                              |
       |           |                                                             |                              |
       |           +------------------------------->----------------------------+                              |
       +-------------------------------------------<-----------------------------------------------------------+
```

Basic ideas and consequences of the new "loading-dependent purge control" especially in comparison to the previous function are:

> Volume flows (in previous TEB) are substituted by mass flows. When calculating the mass flows through the PCV it is assumed that
  pure air is coming.

  Remark: Consequence of the calculation of mass flows compared to volume flows of the previous TEB:
          => The values "loading" (ftead_w) and "purge rate" (ftefva_w) no longer have units !!

> A distinction is made between a desired pulse duty cycle (tatesoll) and the actual pulse duty cycle (tateist).
  Tatesoll is calculated in %ATEV from mstesoll_w for the activation of the PCV (activation value tateout), tateist is used for
  the calculation of the scavenge gas flow flowing into the intake manifold (%BGTEV). Thus the simultaneous use of the purge rate
  ftefva_w for the calculation of the pulse duty cycle and of the mixture correction was dropped for the first time !! The
  splitting-up into tatesoll and tateist is also important so as to take into consideration the delayed activation of the PCV.

> The PCV volume flow (mste) is taken into consideration in the charge sensing. Here too, it is assumed that pure air is coming.
  The thus made fault is (for 50% fuel portion and highest loading) at the maximum 50% / 21 = 2.4%.
  The division by 21 indicates that with HC vapor the Lambda deviation is approx. 21-times greater than with air.
  Remark: Factor 21 = 15 * root(2) ! According to the theory, the mass flow HC through a valve is only root 2-times greater than
          the mass flow air due to the density of HC gas being approx. double. In addition the maximum of the flow rate function
          for HC gas differs slightly from the maximum for air. This is to be neglected here.
          Even though it showed: At 100 % HC concentration, HC vapor causes a 30-times greater Lambda deviation than air!

> Attention new value, re-normalization: A value "concentration HC in the scavenge gas" (khc_w) was introduced.
                                          The value range lies between 0.. 1.
                                          The old value "loading - ftead_w", however, was maintained. It is generated by
                                          multiplication by 30 (FUMRBRK). The loading thus has the physically plausible value range
                                          [0... 30] !!
                                          By taking the ambient pressure and the ambient temperature into consideration during the
                                          calculation of mste the maximum value of the loading is in future no longer altitude- and
                                          temperature-dependent !!!

Several other statements and calculations follow, some of which were also valid for the previous TEB:

> Dependent on the total air mass currently flowing into the intake manifold and on the HC concentration of the gas flow (also called loading in the following) the purge control valve is triggered by the activated carbon filter. The aim is to obtain a certain fuel portion from the purge control.

> For the calculation of the pulse duty cycle it is important to know the maximum possible air mass flow through the PCV (msteo_w). It can be calculated from the corresponding load state of the engine and from ambient conditions (pressure, temperature).
> Remark: msteo_w is the gas mass flowing into the intake manifold at fully opened PCV provided pure air is coming.
> In case of an air-fuel mixture the actual gas mass flow is greater (since fuel vapor is denser), the air mass flow, however, is less, since the HC particles reduce the cross section of the valve, which is effective for air.

> Mste_w is the gas mass flow PCV currently flowing into the intake manifold (related to air). In mste (calculated in %BGTEV) the delay of the PCV timer is already taken into consideration.

> The quotient from: "gas mass flow PCV (related to air) / total air mass flowing into the intake manifold" is called purge rate.
> Remark: In the purge rate control a distinction is made between desired purge rate (ftefsoll_w) and the currently realized purge rate ftefva_w. Reason for the splitting-up into two values: It must be possible to limit the change of the desired volume flow through the PCV (mstesoll).

> The purge control function adapts the HC concentration of the scavenge gas flow (khc_w) flowing through the PCV. This concentration is multiplied by FUMRBRK and the value loading ftead_w is obtained. By this conversion it is achieved that khc_w has the plausible value range [0..1].

> The additive mixture correction (ti-correction with rkte_w) is obtained from the relative charge with scavenge gas particles currently flowing into the cylinders (rlteev_w) multiplied by the loading ftead_w. Rlteev_w is a value related to pure air. Transport and mixing in the intake manifold are already taken into consideration in rlteev_w.

> For the calculation of rlteev_w at first the desired pulse duty cycle, by which the PCV power stage is activated, is transferred to a simulation of the PCV timer. Here a pulse duty cycle course is calculated which comes quite close to the actual mechanical pulse duty cycle by which the PCV adjusts (as delay of the PCV timer approx. half of the current cycle duration is assumed).

> With the pulse duty cycle "tateist" calculated from this, the mass flow (mste_w) currently flowing through the PCV into the intake manifold is calculated without temporal cycle offset (important!!!) from the actual pulse duty cycle, from the ambient temperature, from the ambient pressure as well as from the manifold pressure. This is done in %BGTEV. Mste_w is the mass flow, provided pure air would come from the PCV.

> In the TEB the transport time and the mixing in the intake manifold to which the scavenge gas particles are subject to is then taken into consideration. The mass flow scavenge gas msteev_w currently being siphoned from the intake manifold is obtained (still provided pure air is coming). Finally the relative charge purge control rlteev_w, i.e. the relative charge in the cylinder which was caused by regenerating gas is obtained by a division by nmot_w and by a re-normalization (KUMSRL).

> With rlteev_w on its own no mixture correction can be performed. The needed mixture correction is dependent on the HC concentration in the scavenging flow. In case of pure air the mixture correction is zero since the mass flow flowing through the PCV is already included in the calculation in the charge sensing.
> The necessary mixture correction rkte_w is obtained from the product of the loading (ftead_w) by rlteev_w.
> The loading ftead_w is calculated from the HC concentration khc_w which in turn is continuously learned from the deviations of the mean value of the Lambda controller. The re-normalization factor khc_w
> -> ftead_w is calculated related to 20,7 = 14.7 * 1.4142 :
> * 14,7.....: stoichiometric ratio "air mass / fuel mass"
> * 1.4142...: = root (roh_fuel / roh_air) assuming that fuel vapor is double as dense as air
>
> It was neglected that the maximum of the flow rate function PSI for HC gas is slightly different to the maximum of air.
> Remark: Law for mass flow flowing through restrictor dependent on ambient temperature and ambient pressure:
> mp(rohu, pu) = mp = u * Aa * PSI * SQRT (2 * pu * rohu)
> In practice a factor 30 results!! => FUMRBRK = 30 !

```
Block diagram of all functions assigned to the purge control (without adhering to the function subdivision in the ASCET pictures)
-----------------------------------------------------------------------------------------------------------------------------------
```

The following block diagrams describe the function principle. Here the term desired purge rate (ftefsoll_w) appears.
The desired purge rate is the quotient: Desired mass flow through the PCV (mstesoll_w) / mass flow currently flowing into the intake manifold (mssgin). During the mass balance at first it is assumed that pure air goes through the PCV.
The purge rate does not have a unit. Ftefsoll_w = 0.01 means e.g. that per taken in mass flow (msdkalm_w + mste_w) of 1 kg/h a scavenge gas mass flow (mstesoll_w) of 10 g/h should get into the intake manifold via the PCV (provided pure air is coming).

```
Calculation of desired mass flow, desired cycle duty cycle                                                         consideration of
----------------------------------------------------------                                characteristic TATEMSN   delay time
                                                                            msntevo_w  +--------------------------+    |
                       +---+                  R_t20         mstesoll_w          |      |     ^                    |    v
mlsol_w -------------->|MIN|     R_t20      +-+  +--------------+     +---+     v      | 100%-       ++++++++++   | +->o-> tateout
msdkalm_w + mste_w --->|   +--------------->|*+->|inc.contr.lim.+---->|a  |    +-+     |     |      +             | |      [%]
R_syn    R_t20         +---+   [kg/h]  +--->| |  |dec.con.unlim.|R_t20|a/b+--->|X+---->|  50%-    +               +-+----> tatesoll
                                       |    +-+  +--------------+  +->|b  |    +-+     |     |  +                 |        [%]
                                       |    mstesmx_w              |  +---+            |   0 +-------|-------|>   |
msteo_w -------------------------------|---------------------------+                   |     0     5 kg/h  10kg/h |
R_t20                [kg/h]            |                                               +--------------------------+
                                       |
                  +----------+  []     |
frm_w, ftead_w -->|purge rate+---------+       - mstesoll_w is the desired gas mass flow through the PCV
Op-l. cont.,contr.| ftefsoll | ftefsoll_w      - provided pure air is coming: msdkalm_w + mste_w is the total
                  +----------+                   air mass flow currently flowing into the intake manifold.
                                               - mlsol_w desired air mass flow from the throttle valve
                                                 triggering (%FUEDK). The MIN- selection causes an as fast
                                                 as possible closing of the PCV with a negative load change.
```

```
Calculation of actual mass flow purge control into the intake manifold, mixture correction:
-------------------------------------------------------------------------------------------

                                               msteo_w          (R_t20)       mste included in the charge sensing
                                                  ^            +---------------------------------------------------------> mste
                                                  |            |
            +-----------------------+ tateist  +--+------------+--+ mste_w   +---------------+ msteev_w           +---+
tatesoll -->| consideration         +--------->| flow into manif. +--------->| transport time+------------------->|a  |
R_t20       | PCV timer delay       |  R_t20   | in same R_t20    |  R_t20   | mixing        | R_t20              |a/b+--> rlteev_w
            +-----------------------+          +------------------+          +---------------+                 +->|b  |    R_t20
                                                                                                    +-+        |  +---+
nmot_w -------------------------------------------------------------------------------------------->|x|--------+
R_syn                                                                                               +-+  R_t20
                                                                                                     |
                                                                                                   +-+----+
                                                                                                   |KUMSRL|
                                                                                                   +------+
```

Remarks to diagram shown above:

1) In %BGTEV (calculation of mste_w) a "re-correction" of the characteristic rotation of the PCV adjusted in TATEMSN is performed (MSNTATE). The characteristic TATEMSN in %ATEV is the inverse characteristic to MSNTATE => please pay attention during application !!

2) rlteev_w is the current relative charge of the cylinder with scavenge gas particles (pure air through the PCV provided). Transport and mixing in the intake manifold have already been taken into consideration.

```
 rlteev_w ------------------------------------------------------+
 R_t20                                                          |
                      +----------+   R_t100                     |    +-+ R_t20
       -    R_t100    |integrator|   khc_w     +-+  ftead_w    +--->|*+--------> rkte_w    rkte_w is included in the
 frm_w ->o------------>| HC conc. +------------>|*|----------------->| |          [%]       ti calculation in the R_syn
 R_t10   ^ +          | khc_w    |   []        +-+   R_t100         +-+
         |            +----------+              ^
        +-+           value range:              |
        |1|         0 with pure air          +--+------+
        +-+         1 with pure fuel         | FUMRBRK |
                                             +---------+         nominal value FUMRRK:  30
```

Formulas:

Volume flow and mass flow through the PCV in dependency on ambient pressure and temperature:
Siphoned volume flow (thus with pu and Tu)
vp = u * Aa * PSI * SQRT(2 * pu/rohu)

Siphoned mass flow:
mp = u * Aa * PSI * SQRT (2 * pu * rohu)

Ratio mass / volume:
mp = vp * rohu

Normalization to temperature T_o and pressure p_o:
rohu = roh_o * pu/p_o * T_o/Tu

=> vp = vp_o * PSI * SQRT (Tu / T_o)
=> mp = mp_o * PSI + pu/p_o * SQRT (T_o/Tu)

Fuel mass flow through a PCV (pure fuel vapor provided) at known mass flow air:
mktev = mltev * SQRT (roh_Kraftst./roh_Luft) = mltev * 1.4142

Through a PCV the 1.4142-fold fuel mass passes referred to air !!!
Reason: Stoichometric ratio mass portions air / mass portions fuel = 14.7
        Density fuel / density air = 2 (assumed to be constant for the sake of simplification)
        Mass flow through PCV, however, only SQRT(2) times that of air

        => If the PCV is open so wide that in ml 1% air flow through PCV is contained this PCV opening at the same load-/engine speed point would cause a Lambda deviation of 20.7% with fuel vapor.

       This value is independent of the altitude and the temperature since mste_w is supplied density- and altitude-corrected from %BGTEV.

Description of the ASCET block diagram of the function %TEB:
==

The function is subdivided into the following subfunctions:
> FRTEAUFB - Processing of the Lambda controller values and formation of quotient qtetemin
> FTEBER - Calculation purge rate and desired mass flow
> FTEFXBER - Subfunction for the calculation of the maximum of the purge rate
> FTEFINT - Integrator purge rate and integrator mass flow purge control valve
> FTEADBER - Calculation of HC concentration of the scavenge gas flow, of the loading and of a filtered value of the loading
> RKTEBER - Calculation of the relative fuel portion purge control
> HBELBER - Calculation of the bit B_lrar at high loading and of other bits
> MITEBER - Calculation of requested minimum torque purge control

> FRTEAUFB - Formation quotient: qtetemin and processing of the Lambda controller values
----

> Formation of the quotient qtetemin
  - The minimum value of te_w and te2_w is used
  - With mono Lambda control (SY_STERVK = FALSE) automatically te_w is used.
  - After division by TEMIN the variable qtetemin is formed. It indicates how far the smallest te is still away from the minimum value TEMIN. Qtetemin is needed in the purge rate control FTEBER.

> Formation of frmxa_w (frmxa) (maximum deflection of fr_w and fr2_w)
  - the absolute value of the deviation of frm_w and frm2_w from 1.0 is formed.
  - via a transfer switch frmxa_w is determined with respect to the value frm_w or frm2_w, which has the greater absolute value of the deviation from 1.0
  - For mono Lambda control (SY_STERVK = FALSE) automatically frmxa_w = frm_w.

> Formation of frmit_w (mean value related to fr_w and fr2_w)
  - if B_lr and B_lr2 = TRUE the mean value frmit_w is formed with respect to (frm_w + frm2_w) / 2
  - if only B_lr2 = FALSE the frm_w is used for the mean value frmit_w
  - if only B_lr2 = TRUE, but B_lr = FALSE the frm2_w is used for the mean value

```
> Formation of the bit B_gwrte (limiting value control in operation)
  - The limiting value control shall only be in operation if
    a) the frmxa_w has a sufficient distance to its neutral position
    b) the frmxa_w keeps on moving away from the neutral position. If frmxa returns, the limiting value control shall immediately
       become inactive. In order to detect this the bit B_gwrte is needed.
       For the formation of B_gwrte the last value of frmxa_w (frmxaold_w) is stored.
       B_gwrte is set if
       - the new value frmxa_w is greater than or equal to the old value frmxaold_w and if frmxa_w is greater than 1.0
       - the new value frmxa_w is less than or equal to the old value frmxaold_w and if frmxa_w is less than 1.0
       - one of the two Lambda controllers fr_w or fr2_w is at the minimum or maximum limit.

> FTEBER - Calculation purge rate and desired mass flow
-------------------------------------------------------
> Contains characteristics and maps for the calculation of the increasing and decreasing control speed of
  the desired purge rate (ftefsoll_w) as well as the limiting value control via Lambda controller and canister pressure
> Contains the subfunction FTEINIX for the limitation of the purge rate
> Contains the subfunction FTEFINT with the integrators desired purge rate (ftefsoll_w) and desired mass flow PCV (mstesoll_w)

           +-------------------------------------<--------------------------------------------------------+
           v                   FQTEFR  FQTEPT, B_gwrte                                                    |
          +-+                  frmxa  | pte                   +--------------------------+   ftefsoll_w   |
ftead_w ->|*|--+                      |                       | B_teakt   subfunction    |----------------+
          +-+  |       +---------+    +---------------------->| fgwrte       FTEFINT     |   mstesoll_w
             - v  +-+  |     -- 1|  - v   +-+     +-+         |                          |---------------------------->
fkates ------->o->|*|->|    /    |--->o-->|*|---->|*|-------->| dftef_w                  |   ftefva_w
             +    +-+  |-1--     |  +     +-+     +-+    +--->| ftefamx_w                |---------------------------->
                   ^   +---------+         ^       ^     | +->| mssgin_w                 |
                FSRFTEF                    |       |     | |  +--------------------------+
                                           |       |     | |
B_ten ----------------------+            FQTEVA  KFQTE   | |
                            |            ftefva ml,frmit | |
             +---------+    v                 +---+      | |
nmot, wdkba  | KFFTEAN |--o \ o-------------->|   |      | |             Formation of desired fuel portion purge control:
             +---------+                      |   |      | |             ------------------------------------------------
             +---------+                      |   |      | |             +------+ fkateapp
tans, ml     | KFFTEAX |--------------------->|MIN|------+ |             |KFTEKA|---------+
             +---------+   %->Faktor          |   |        |             +------+         |
             +---------+  +-----+  +-+        |   |        |              nmot,rl         |    +---+
nmot, ps/pu  | KFTATX  |->|*0.01|->|*|------->|   |        |             +------+         +--->| * |-----> fkates
             +---------+  +-----+  +-+        |   |        |             |FKATEB|------------->|   |
                                    ^         |   |        |             +------+ fbkate       +---+
                         +---+      |     +-->|   |        |             qtetemin
msteo_w ---------------->|a  |      |     |   +---+        |
            +-+          |a/b|------+     |                |
msdkalm_w ->|M|--+   +-->|b  |    +-------|-------------+  |
            |A|  |   |   +---+    |  initial limitat.   |  |
MSDKLMMN  ->|X|  |   |            |lim. neg. load grad. |  |
            +-+  v   |            +---------------------+  |
mste ----------->o---+-------------------------------------+
```

Description of the subfunction FTEBER:

- The purge rate (ftefsoll_w) is controlled such that a fuel portion defined in KFTEKA should be reached.
  The fuel portion is calculated with respect to: ftead_w * ftefsoll_w. However, if the injection time te lies close to TEMIN only a small fuel portion can be realized.
  Via the controller amplification FSRFTEF the control behaviour at ftead_w * ftefsoll_w can be adjusted approx. equal to KFTEKA.
  The smaller FSRFTEF, the "softer" the control characteristic.
- Via the limiting value action (FQTEFR (frmxa) as well as FQTEPT (pte)) the purge rate is controlled down in case of large fr-deviations and in case of an unpermissibly high canister vacuum.
- Via the characteristic FQTEVA the increasing control can be made increasingly quicker with increasing purge rate.
- The speed of the increasing control is given in the map KFQTE dependent on ml and on the deviation of the frmit from 1.
- Subfunction FTEFXBER:
  - The max. purge rate is limited by a number of characteristics / maps:
    - FQTEDL: Decreas of purge rate if a negative load gradient is detected
    - KFFTEAN: Purge rate in case of TEB without Lambda control (limp-home purge rate)
    - KFFTEAX: Limitation of purge rate in dependency on ml and tans
    - KFTATX: Max. PCV volume flow reduced by map in percent to the maximum flow rate through the open PCV
    - FTEINIX: Characteristic purge rate limitation dependent on the integral mass flow PCV after purge break

Remarks to the initial limitation of the purge rate (FTEINIX):
On vehicles on which the ACF is "engine distant" the pipe ACF-PCV often has a length of over 3 m.
If now, e.g. in case of a fully loaded ACF, the purge rate is activated after a long deactivation phase at first pure air flows through the PCV into the intake manifold. Only once this air has completely been siphoned the HC concentration suddenly increases immensely. So that the purge rate cannot increase too much until then and so that no too strong enrichment occurs the purge rate can be limited dependent on the integral of the air taken in after a purge break. Only once more scavenge gas was taken in than can remain in the the pipe ACF-PCV, shall the purge rate be able to increase to higher values.

Remarks to the limitation at a neg. load gradient (FQTEDL):

- unbuffered charcoal canisters can cause fast HC-concentration change
- the desired purge rate should then be decreased
- For this mlsol_w is low pass filtered (PT1). The filtered signal is diveded through mlsol_w. One ist substracted.
  You get the procentual load change. The value ist positive, if a negative load chnage is detected.
- This procentual load change is multiplied with the desired purge rate. You get dmlftef.
- Dmlftef is source for FQTEDL. FQTEDL contains factors in the Range [0 ... 1.0]. This factor is a degree for purge rate decrease.
- The derease is realised by a limitation of the purge rate: Limit = Factor * Old desired Purge rate
- This causes an exponentiel decrease of ftefsoll_w.

Example for FQTEDL:

```
     0       0.01     0.02      0.05     0.1
     ----------------------------------------
     1         1      0.9        0.9     0.5

- Start purge rate = 0.05
- procentual load change = 10 = const.
                                                              Start           ftefsoll_w = 0.05
  0.05 * 10 => 0.5 =>  * 0.5                               => after 20 ms     ftefsoll_w = 0.025
  0.025 * 10 => 0.25 => * 0.5                              => after 40 ms     ftefsoll_w = 0.0125
  0.0125 * 10 => 0.125 =>  * 0.5                           => after 60 ms     ftefsoll_w = 0.00625
  0.00625* 10 => 0.0625 => * 0.8                           => after 80 ms     ftefsoll_w = 0.005
  0.005 * 10  => 0.05   => * 0.9                           => after 100 ms    ftefsoll_w = 0.0045
```

and so on. The purge rate ist first fast, then slower dereased.

The following principle diagram is for the understanding of the purge rate and desired mass flow calculation by means of the subfunction FTEFINT:

```
                   +-------+
          +-----+  |    -- |      When the limiting value control sets in
fgwrte -->| > 0 |->| --^   |-+    the factor mstesoll_w/MIN(mssgin_w, mlsol_w) / KFTADMS is used and
          +-----+  +-------+ |    => thus the limiting value control can have an immediately effect
                             |                              +---+
             +---------------|------------------------------|a  |<---------------------------------------------+
             |               |                              |a/b|    +-------+                                 |
             |               v         +---+                |b  |<---|KFTADMS|                                 |
             +------------>o / o------>|   |                +---+    +-------+                                 |
                       +-->o           |MIN|-----+                        |                                    |
ftefmax_w -------------+-------------->|   |     |                        v                                    |
                                       +---+     |         mstesmx_w     +-+                                   |
                       +---------<---------------+       +---------->--->|*|----+                              |
                       |                                 |               +-+    |                              |
           +-----------v--+ ftefsoll_w       +-+         |        +-------------v---+  mstesoll_w   +---+      |
dftef_w -->| calculation  |----------------->|*|---------+        | des. mass flow  |-------------->|a  |      |
           |des.purge rate|                  +-+                  | inc. contr. lim.|               |a/b|------+
           +--------------+                   ^                   +-----------------+       +------>|b  |
                            +---+             |                                             |       +---+
mssgin_w  -------------+--->|MIN|-------------+---------------------------------------------+
mlsol_w   - - - - - - -|- ->|   |
            f(SY_EGAS) |    +---+                  +----+
                       +-------------------------->| a  |                                     current purge rate
                                                   | a/b|--------------------------------------> ftefva_w
mste_w  ------------------------------------------>| b  |
                                                   +----+
```

The integrators for desired purge rate and for desired air mass are in the subfunction FTEFINT. This separation was made in order to be able to adjust a maximum increase of the mass flow PCV separately from the purge rate control. Via DMSTES the mass flow increase can be chosen dependent on the current mass flow purge control. Choosing the minimum (mssgin_w / mlsol_w * fafteptk_w) has the effect that just before the throttle valve is closed already the new smaller pulse duty cycle is passed on to the PCV timer. This prevents mixture faults in case of neg. load changes.
The system constant SY_EGAS decides whether mlsol_w is to be used for the comparison or whether mssgin_w is used directly.
A quickly closing of CPV for diagnosis function can be make with B_qtedab = TRUE. In this case is switched of closing time TQTEDAB
With KFTADMS ist is possible to reduce the PCV mass flow at dynamic engine conditions. With KFTADMS ist is possible to reduce Lambda deviations at load changes.

> FTEADBER - Calculation of the HC concentration of the scavenge gas flow (loading) and of a filtered value of the loading

- The HC concentration is calculated from the integral of the deviation of the frmit_w (mean value from frm and frm2) if B_te = TRUE.
- Apart from depending on ml (ZBTEML) the integration speed also depends on a value from the characteristics FBTEB and FBTEVA determined by the chosen minimum.
  - FBTEB serves for the reduction of the integration speed in case of a limitation to very small purge rates.
  - FBTEVA servers to avoid an oscillation tendency fr (resp. frm) towards rkte.

- From the HC concentration the loading ftead_w is calculated (multiplication by FUMRBRK = 30)
- The TEB also provides a filtered value of the loading (fteadf). The low pass filter is necessary so that short-termed oscillations of ftead_w are not taken into account. This value is needed e.g. to reduce the engine performance in case of long-termed high loading (see below) and so as to increase the idle speed.

> RKTEBER - Calculation of the relative fuel portion purge control

This subfunction at first calculates the mass flow purge control (msteev_w) flowing to the combustion chamber from the mass flow purge control (mste_w) which flows into the intake manifold at the level of the throttle valve.
After a division by nmot_w and by the conversion constant KUMSRL the relative charge purge control at the level of the intake valve (rlteev_w) is obtained. After a multiplication by the loading ftead_w the relative fuel portion purge control rkte_w is obtained. In order to maintain the injection time at the intake valve, rkte_w is subtracted from the value rk_w without purge control during the injection calculation => "additive action in the TEB" .

```
               +---------------------------+   msteev_w                    +---+
mste_w ------->|      delay + mixing       |------------------------------>|a  |    rlteev_w
               +---------------------------+                  +-+          |a/b|-------------+
nmot_w ------------------------------------------------------>|*|--------->|b  |             |
                                                              +-+          +---+             |
                                         +------+              ^                             |
                                         |KUMSRL|--------------+                             v
                                         +------+                                           +-+
ftead_w ----------------------------------------------------------------------------------->|*|---------> rkte_w
                                                                                            +-+
```

So in the subfunction RKTEBER the transport and the mixing in the intake manifold are also described.

> The mass flow mste_w led in at the PCV is at first converted to a concentration "scavenge gas purge control in air" (ktetev_w).

> After delay (variable lag element) and after mixing (filtering 2 * PT1 with the same time constant) the concentration of scavenge gas purge control at the intake valve (kteev_w) is calculated.

> By a multiplication by ml_w the mass flow purge control at the intake valve of the engine (msteev_w) is obtained. Attention: msteev_w refers to pure air as scavenge gas !

```
                +---+
ml_w ---------->|MAX|-----------------------------------------------------------------------------------------------+
mste ------>o-->|   |                          ktetevvz_w       PT1                       PT1                       |
MSDKLMMN  --+   +---+          ktetev_w                 +------------------+     +-------------------+             |
                         +---+        +------------+     | ^           *    |     |^              *   |             v
mste_w  ---------------->|a  |        | T-dead     |     | |     *          |     | |      *          |  kteev_w   +-+
                         |a/b+------->| variable   +---->| | *              +---->| | *               +----------->|*|----> msteev_w
mssgin_w --------------->|b  |     +->| dstert20_w |  +->|T| ------------>  |  +->|T| --------------> |            +-+
                         +---+     |  +------------+  |  +-----IV------I----+  |  +------IV------I----+
mssgin    +----------+       +-+   |                  |      C_ini     0       |         C_ini   0
------ -->| FVERZDYN |------>|x|---+                  |                        |
  ml      +----------+       +-+                      +------------------------+
                              ^                                                |     - Not considered are:
                              |                              +--------+   +-+  |       - Changes of the mixing characteristic due
                              |                nmot -------->| FVERMN |-->|*|--+         to pulsations
                              |                              +--------+   +-+        - There is considered:
                              |                mssgin     +--------+       ^           - Changes of transport und mixing at dynamic
nmot_w -----------------------+                ------  -->|FVERMDYN|-------+             driving (FVERMDYN, FVERZDYN)
                                                 ml       +--------+
```

Calculation of delay and mixing in the intake manifold

> HBELBER - Calculation of the bit B_lrar "mixture adaptation reduced range" at high loading as well as of the bit loading at maximum limit stop (B_tehbx).

> In case of a high fuel concentration in the scavenging flow the Lambda controller frequency may possibly change due to an uneven distribution of the scavenge gas to the individual cylinders. OBDII functions which evaluate the Lambda controller (DLSA, DKAT) must be blocked. - A high loading is an indication for hot fuel. There is a risk of vapor blisters occurring in the intake valve. The diagnostic fuel supply system evaluates the adaptation factors of the LRA. They are limited via B_lrar to a lift lower than the fault thresholds.

> In case of C_ini the flip-flop is always set: If the purge rate exceeds the value FTEHB or if the frmit_w exceeds the threshold FRHB (if B_tei = 1) and if at the same time the loading is less or greater than FTEHB, then the flip-flop is reset. If ftead_w rises above FTEHB or if ftea falls below FTEAHB, then the flip-flop is set again.

> If the loading undershoots the value FTEADAB an error in the fuel supply system is assumed and the flag " canister purge control ready for abort" (B_teabb) is set.

> An indication for a pilot control fault (pilot control too rich) or for a leaking PCV is the dead stop of the loading integrator at the maximum value FTEADMX. The bit B_tehbx can be used e.g. for the switch-over of the controller speed of the fr and of the maximum fr-lift.

> MITEBER - Calculation of the demanded minimum torque purge control
  ----

Calculation of a minimum torque (mitebg) for the torque management for the increase of the purge rate at high loading.

From the filtered value of the loading fteadf (see above) and from the driver’s request torque mifa_w a desired engine performance for engine operation with purge control is derived, which is corrected by an engine speed dependent evaluation factor fbetate.
It is e.g. possible to increase the air charge of the engine with long-lasting high loading and with a low induced driver’s request torque, so as to increase the purged quantity. The torque coordination ensures that the driver will not notice this while at the same time the ignition angle is retarded and thus the engine performance is worsened.

For the determination of the torque mifafu_w (torque driver’s request for charge) the value mitebg is included in a maximum selection.

- etate is the desired engine performance with purge control. A desired low engine performance is only reached if mitebg_w is not high-limited to zero by etate = 100%.
- mifa is the torque requested by the driver. The charge resulting from it assumes an engine performance of 100%.

The calculation of etate:
> The desired engine performance is stored in the map KFETATE dependent on fteadf and on mifa_w. By means of this map very small injection times te with high fuel portions purge control can be avoided. By reducing the engine performance the small te-values are no longer reached.
> In the characteristic FETATEBN an evaluation factor is stored dependent on nmot, which corrects the etatesoll change of 100%.
> The core of this subfunction is an integrator whose output gives the currently desired engine performance. At the beginning of the purge control phase the input value is adjusted to - ZETATE, so that the integrator integrates down to 0 starting from 100%. Once the integrator reaches its minimum, it is stopped.
> For non E-Gas systems the performance etate is set to 100% by means of the system constant SY_EGAS.

APP TEB 95.80 Application hint

Instruction for the application of the entire purge control:
==

Concerns sections: TEBEB, BGTEV, ATEV, TEB, (BBTEGA)

Preliminary remark: Apart from this APP. hint also a detailed APP. standard with measurement reports and diagrams exists. This APP. hint can be obtained until the end of 1996 only directly from Mr. Mallebrein, dep. K3/ESY4. Later on (approx. from beginning of 1997) it will also be available in the APS. In case of differences the data should be taken from the detailed APP. hint. If necessary call Tel.: 811/8432

The following must be dealt with prior to an application:
> Throttle valve activation (%FUEDK): The throttle valve may have no considerable over-, undershoot, it may not flutter.
> The charge sensing must have been adjusted (adjustment of the pilot control (rl) to +/- 3%-4%, so that the adaptation of the HC concentration is not performed incorrectly, adjustment of ps_w on the turbo charger stationary as exact as possible).
> Application of all time constants of the charge sensing, of all temperature models especially on the turbo charger so that the intermediate value manifold pressure (ps_w) is sufficiently accurate. The manifold pressure is needed in BGTEV for the turbo charger in order to calculate the mass flow PCV.
> Application of the engine warm-up so that the HC-concentration does not stop learning itself there.
> The transient control must be adjusted in order to be reliably able to learn a HC-concentration from the fr-course and so as to avoid the limiting value control being erroneously activated.
> Application of the Lambda control (incl. all activation conditions). If no exhaust gas test has yet been performed the control downstream catalyst must not necessarily be adjusted (resp. active).

Application of the BBTEGA and of the TEBEB:
> In BBTEGA the time for the purge control can be adjusted. Make TTEINI, TTE, TTEAE as long as possible, make TTEGAI, TTEGA as short as possible (only for application phase, for FTP-test see values in BBTEGA).
> Adjust TEBEB according to specifications in the section

Application of the sections BGTEV, ATEV:
> The main work of a purge control application will have to be done in BGTEV (turbo resp. aspirating engine version) !!! BGTEV must definitely be adjusted prior to a test on the engine test bench reps. chassis test bench ! See in BGTEV !
> ATEV is also to be adjusted according to the suggestion in the section ATEV.

Actual core function TEB:
> Most of the data are general and not vehicle-specific !! - The values shown below are to be used.
> However, KFQTE, ZBTEML, KFTATX, FVERZTE, FVERMN and DMSTES are engine-specific ! For the initial entering of data the data given below can be used.
  - KFQTE, ZBTEML depend on the delay time of the Lambda control - the larger the delay time the smaller the values.
  - KFTATX must especially be adjusted on the turbo engine, so that in the range where the turbo charger sets in (ps_w/pu around 1.0) the PCV is opened less especially at low engine speeds.
  - FVERZTE and FVERMN depend on the design of the intake manifold, on the PCV intake position and on the ratio of intake manifold volume to lift volume. The variables are to be determined by performing jumps while scavenge gas is taken in.
  - DMSTES is to be determined after the application of KFQTE and ZBTEML. For a not buffered ACF the increasing control speed (PCV mass flow increase) must be distinctly smaller than for a buffered ACF.
  - With KFTADMS Lambda deviations can be reduced. Output values smaller than one reduce the purge mass flow at dynamic driving.

The data, which follow now, are for an initial entry. Depending on the engine size possibly ml base points need to be shifted a little. The data are only guidance values and were thought up by the function developer without having been tested on the vehicle. They do not represent an application state on an actually existing vehicle.

Data for the initial entry of all parameters of the TEB:

Subfunction FRTEAUFB:

> TEMIN: see injection calculation

Subfunction FTEBER:

FQTEPT: Limiting value control for the limitation of canister vacuum unit [-]

- 32.00	-28.00	-25.00	-20.00	-15.00	0	pte [hPa]
15.75	4	2	1	0	0	factor

FQTEFR: Limiting value control to avoid uncontrolled Lambda controller deviations unit [-]

0.75	0.80	0.86	0.92	1.08	1.14	1.20	1.25	fr
12	4	2	0	0	2	4	12	factor

KFFTEAN: Map maximum purge rate for limp-home purge control unit purge rate [-]

nmot[rpm] wdkba[%]	600	800	1000	1400	1800	2400	3000	3500	4000	5000
4	0.005	0.005	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007
10	0.005	0.005	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
16	0.005	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
24	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
34	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
45	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
55	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
65	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
80	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
100	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007

FQTEDL: Purge rate decrease factor at neg. load change

0	0.01	0.02	0.05	0.1
1	1	0.9	0.9	0.5

ZMLTE: 1 s

KFFTEAX : Map maximum purge rate for normal operating unit purge rate [-]

ml [kg/h] tans [°C]	10	20	50	100	500
-30	0.02	0.02	0.03	0.03	0.03
0	0.04	0.04	0.06	0.06	0.08
20	0.10	0.10	0.10	0.10	0.10
80	0.10	0.10	0.10	0.10	0.10

KFTATX: Map maximum pulse duty cycle unit pulse duty cycle [%]
(Recommendation for turbo engine - pspu around 1.0 the pulse duty cycle is reduced especially at low engine speeds - on an aspirating engine here no reduction needs to be performed)

nmot[rpm] pspu	600	800	1000	1400	1800	2400	3000	3500	4000	5000
0.30	60.00	60.00	70.00	80.00	80.00	99.61	99.61	99.61	99.61	99.61
0.90	60.00	60.00	70.00	80.00	80.00	99.61	99.61	99.61	99.61	99.61
0.95	10.00	15.00	20.00	25.00	30.00	40.00	50.00	65.00	80.00	99.61
1.05	10.00	15.00	20.00	25.00	30.00	40.00	50.00	65.00	80.00	99.61
1.10	80.00	80.00	80.00	90.00	99.61	99.61	99.61	99.61	99.61	99.61
1.70	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61

KFTEKA : Map maximum fuel portion purge control unit fuel portion [-]

nmot [1/min] rl [%]	800	1400	2000	3000	5000
20	0.4	0.45	0.5	0.5	0.5
50	0.5	0.5	0.5	0.5	0.5
70	0.5	0.5	0.5	0.5	0.5
90	0.5	0.5	0.5	0.5	0.5
120	0.5	0.5	0.5	0.5	0.5

Please note that te_w each time remains greater than TEMIN.

FKATEB : Characteristic evaluation factor for fuel portion in dependency on qtemin

qtetemin []	1.0	1.1	1.2	1.5	2
fbkate	0.0	0.5	1.0	1.0	1.0

FTEINIX : Characteristic maximum purge rate in dependency on the integral air mass after purge break unit purge rate [-]
The example data apply for a pipe ACF-PCV of 4 m length with an internal diameter of 6 mm.
V = 4 m * Pi * 0.006 m * 0.006 m / 4 = 113 E-6 m^3 = 113 cm^3 => 150 E-6 kg
Application recommendation: At first (for small values of imsteini) the purge rate may rise to high values. However, after exactly that mass scavenge gas was taken in, which was in the pipe as a precaution the purge rate is at first reduced to 0.01. Then it can be increased to 0.1.
For application data: Let the purge rate at low values for a longer time (until e.g. 1g).

imsteini [g]	0.1	0.20	0.5	1.0	2.0
Output	0.02	0.02	0.01	0.02	0.1

TFTEINI [s]: Time for detection of purge break: 30 s (in any case shorter than TTEGA)

KFQTE: Increasing control speed desired purge rate unit [1/s]

ml [kg/h] frmit	10	20	50	100	200	500
0.7	0.0006	0.0010	0.0020	0.0040	0.0060	0.0100
0.9	0.0002	0.0003	0.0005	0.0010	0.0016	0.0026
1.0	0.0006	0.0010	0.0020	0.0040	0.0060	0.0100
1.1	0.0002	0.0003	0.0005	0.0010	0.0016	0.0026
1.3	0.0006	0.0010	0.0020	0.0040	0.0060	0.0100

FSRFTEF: Factor steepness purge rate controller 20 [-]

FQTEVA: Increasing control progression desired purge rate unit [-]

0.002	0.006	0.012	0.020	0.040	0.100	ftefva [-]
1.00	2.00	3.00	4.00	6.00	8.00	factor progression [-]

TVSATEM: Delay time for PCV closed after fuel cut-off readiness unit [s]

-30	-10	20	40	70	90	tmot [°C]
3	2	1.5	1.0	0.8	0.8	delay time [s]

TQTEAB: Decreasing control time PCV at the end of a purge control phase TQTEAB: 10 s

TQTEDAB: Quickly decreasing control time PCV at the end of a purge control phase TQTEDAB: 2 s

DMSTES: Increase of mass flow PCV

0.005	0.02	0.08	0.32	1.28	5.12	mstesoll_w [kg/h]
25.6	51.2	204.8	819. 2	2048	5120	output DMSTES [kg/h]

ZMSSGIN: Filter time constant for mssgin_w: 0.6 s

KFTADMS: Map for reduction of the purge mass flow at dynamic engine driving

dmssginr	-1	-0.4	0	0,4	1
nmot					
600	0.4	0.6	1.03	0.6	0.4
1000	0.5	0.7	1.03	0.7	0.5
2000	0.7	0.8	1.03	0.8	0.7
5000	1.0	1.0	1.03	1.0	1.0

MSDKLMMN: Lower limit of msdkalm_w: max. 75% of the air mass flow at idle: 8 kg/h
MSDKLMMN prevents too high values of ktetev_w if mshfm is near zero at neg. load change !!!

Subfunction FTEABER:

ZBTEML: Learning speed loading unit [1/s]

10	20	50	100	200	500	ml [kg/h]
0.30	0.50	0.80	1.2	2.0	3.0	learning speed [1/s]

FBTEB: Unlearning brake loading with limitation to small purge rates unit [-]

0.00024	0.00061	0.00122	0.00244	0.00610	0.0122	ftefvab [-]
0	0.0	0.1	0.2	0.5	0.9961	factor learning speed [-]

FBTEVA: Purge rate dependent learning speed of the loading unit [-]

0.000	0.005	0.01	0.020	0.050	0.100	ftefva [-]
0.4	0.9961	0.9961	0.5	0.2	0.1	factor learning speed [-]

KHCTEMX: Maximum fuel concentration scavenge gas: 1.25 [-]

KHCTEMN: Minimum fuel concentration scavenge gas: -0.25 [-]

FUMRBRK: Factor conversion loading / HC conc.: 30 [-]

ZKFTEAD: Time constant filtering of the loading: 100 [s]

Subfunction RKTEBER:

FVERZDYN: Factor delay time scavenge gas in the intake manifold: 1.6.E-4 [min]
=> continued transport at 1000 rpm: 1000 rpm * 1.6E-4 min = 0.160 => delay = 20 ms / 0.16 = 125 ms

0	0.4	1	2	10	qmsdyn
0.0001	0.00014	0.00016	0.0003	0.0005	Faktor transportation / time slot [-]

FVERMN: Characteristic factor mixing in the intake manifold []

800	1200	1800	2600	3600	5000	nmot [1/min]
0.25	0.30	0.35	0.40	0.45	0.50	Faktor Vermischung [-]

FVERMDYN: characteristic line dynamic part gas mixing in manifold []

0	0.4	1	2	10	qmsdyn
1.5	1.2	1	1.4	2.5	Faktor dyn. part in mixing [-]

NVERZMN: 800/min (idle speed)

KUMSRL: see charge sensing: V_Hub [l] / 2578

DSTEMIN 0.01 []

Subfunction MITEBER:

KFETATE : Map desired performance with te close to TEMIN unit performance [%]

mifa [%]	8	16	32	60	100
fteadf					
12	90	100	100	100	100
20	80	90	95	100	100
30	70	80	90	95	100

FETATEBN: Characteristic evaluation factor for desired engine performance dependent on the engine speed

600	1200	2000	3000	5000	nmot [rpm]
1	1	0.5	0	0	evaluation factor

ZETATE: Ramp steepness change of engine performance 1 [%/s]

Subfunction HBELBER:

DFTEAHB: Fuel portion detection high loading: 0.3 [-]

FTEHB: Loading threshold for detection high loading: 5 [-]

FTEFHB: Minimum purge rate for resetting high loading: 0.01 [-]

FRHB: fr threshold to prevent resetting high loading 1.24 [-]

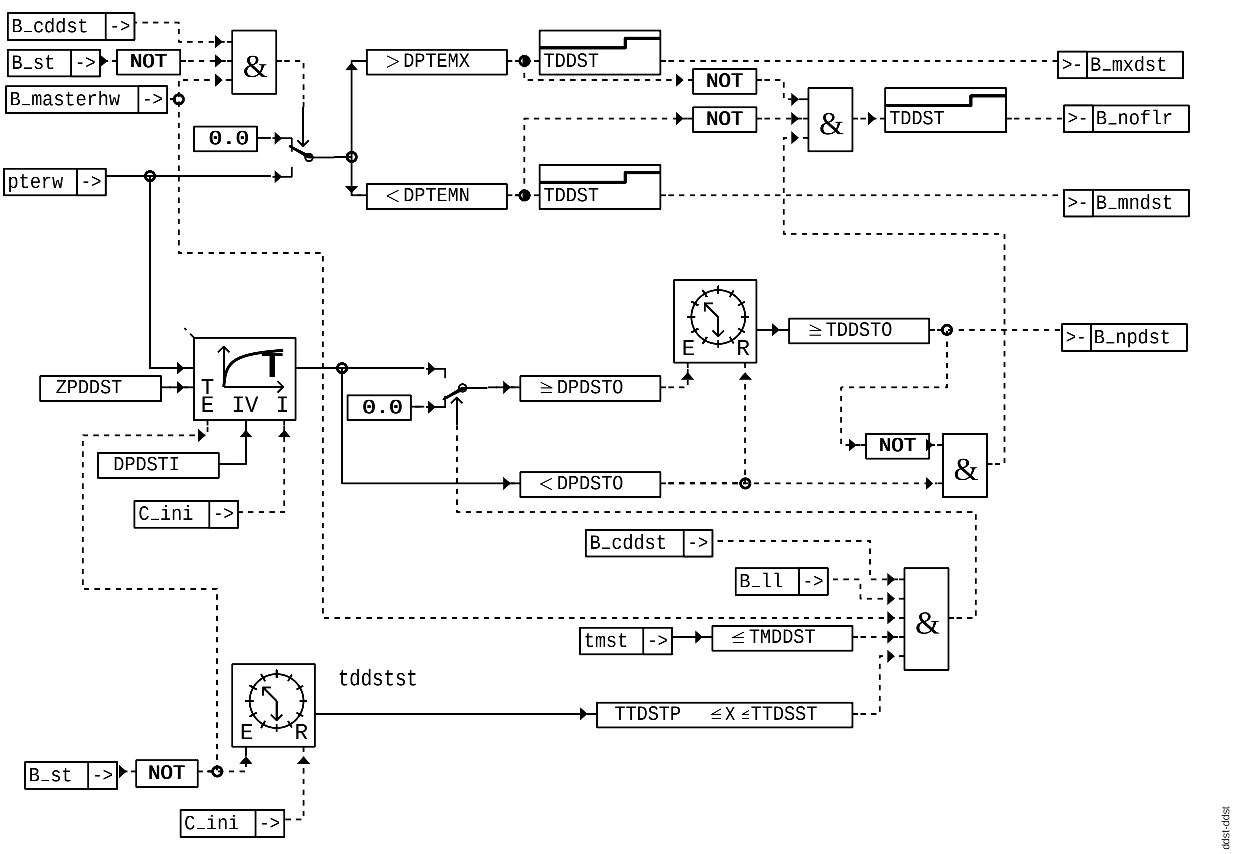
FTEADAB: Threshold for setting B_teabb -4 [-]

FTEADMX: Threshold for setting B_tebhx 37.5 = KHCTEMX * FUMBRRK [-]

DDST 7.30 diagnosis of tank pressure sensor

FDEF DDST 7.30 Function definition

The tank pressure sensor provides information on the tank differential pressure to the ambient. The tank pressure sensor is required for the diagnosis of the purge control system (leakage detection).
The sensor signal is monitored concerning electronic plausibility (B_mndst, B_mxdst) as well as functional plausibility (B_npdst).



ddst-ddst

Interaction with other modules:

In fault management module:

```
                                      +--+
        B_npdst -----------------+--->|  |
        B_mndst --------+--------]--->|V |             +-+-----+
        B_mxdst --------]--+-----]--->|  +------------>|S|Flip +----> E_dst
                        |  |     |    +--+             +-+-----+
              +--+      |  |     |               +---->|R|Flop |
B_noflr ----->|  +------]--]---+-]---------------+     +-+-----+
CDDST ------>0|  |      |  |   | |
B_cldst ----->|  |      |  |   | |    +--+
              +--+      |  |   | +--->|  |
                        |  |   +----->|V |              +-+-----+
                        |  +--------->|  +------------->|S|Flip +----> Z_dst
                        +------------>|  |              +-+-----+
                                      +--+       +----->|R|Flop |
          C_ini ---------------------------------+      +-+-----+
```

```
Fault code storage with: CDTDST ; LDDST ; FLCDST ; HLCDST ; U1DST ; U2DSt ;  B_mndst \ B_npdst \ B_noflr
                                                          U1=   ; U2=
```

ABK DDST 7.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DPDSTI			FW	Initialization pressure for low pass filtered tank pressure
DPDSTO			FW	upper pressure threshold for detection of press.sensor. error
DPTEMN			FW	min. plausible differential pressure
DPTEMX			FW	max. plausible differential pressure
TDDST			FW	debouncing time for fault detection tank pressure sensor
TDDSTO			FW	delay time for press. sensor rationality error
TMDDST			FW	eng. temp. thrseshold for pressure sensor rationality check
TTDSST			FW	time period after start for enabled press. sensor rationality check
TTDSTP			FW	time period for stabilization of low pass
ZPDDST			FW	time constant for tank pressure sensor rationality check

Variable	Source	Type	Description
B_CDDST	PROKON	EIN	function active per codeword CDDST
B_LL	MSF	EIN	Condition idle
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_MNDST	DDST	AUS	condition fault type ”minimum value” detected: tank pressure sensor

Variable	Source	Type	Description
B_MXDST	DDST	AUS	condition fault type ”maximum value” detected: tank pressure sensor
B_NOFLR	DDST	AUS	Condition diagnosis finished with o.k. report
B_NPDST	DDST	AUS	condition for fault type ”unplausible DS-T signal”
B_ST	SWADAP	EIN	condition for start
C_INI	SWADAP	EIN	ECU-condition for intialisation
PTERW	GGDST	EIN	tank pressure rough value (8 bit)
TDDSTST	DDST	DOK	time after start for press. sensor rationality check
TMST	GGTFM	EIN	engine temperature at start

FB DDST 7.30 Detailed description of function

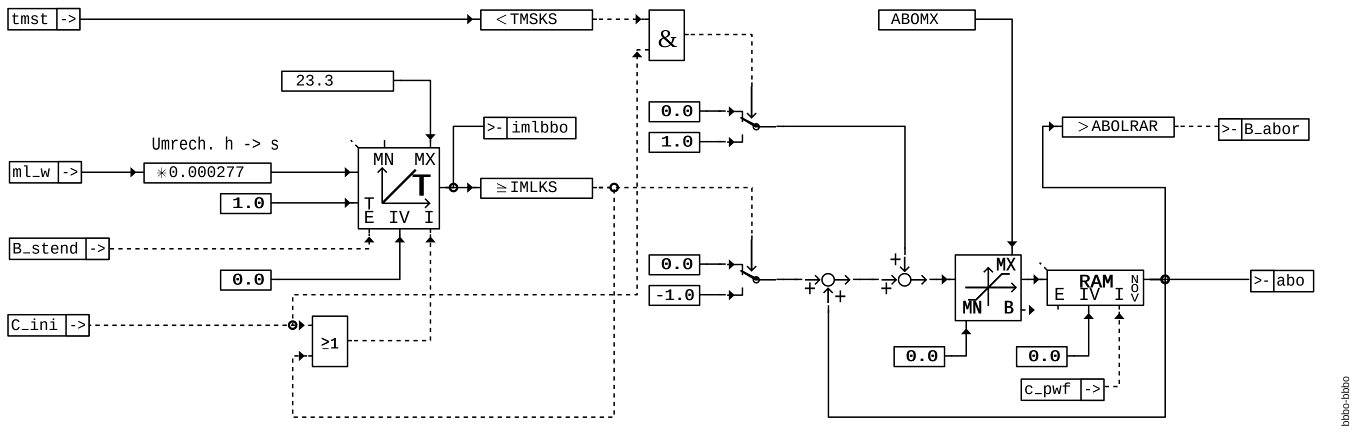
```
Plausibility check of the tank pressure sensor
        This check is permanently performed, independently on the regeneration function or the purge control
        system diagnosis.
        The pressure signal may be falsified, caused by wiring interruption or short circuit.
        The pressure signal is limited to its minimum and maximum value by the sensor itself.
        If the sensor signal exceeds or falls short of the limits DPTEMX (DPTEMN), then a wiring fault has occured.

Functional plausibility check of the tank pressure sensor.
        In case of the sensor prioviding a constant overpressure signal, the leakage diagnosis (%DTES) will be disabled.
        Hence this case must be checked. It will be done at idle condition and after a cold start of the engine. If the lowpass
        filtered pressure "ptedstp" exceeds DPDSTO for a period longer than TDDSTO, a defective pressure sensor will be
        notified (B_npdst).

2 SG:   Durch B_masterhw wird beim 2SG-System die Diagnose im Slave-Steuergerät abgeschaltet.
```

APP DDST 7.30 Application hint

```
1. Characteristic values

DPTEMX  29.5 hPa  (RB pressure sensor DS-T1 and DS-T2)
DPTEMN  -28.2 hPa (RB pressure sensor DS-T1 and DS-T2)
TDDST   3...5 s

Functional plausibility check

TMDDST: Max. enginge temp. threshold for detection of a cold start (35 °C) (Not to be exceeded in an FTP)
TTDSST: Max. time after start for conducting of the funktional plausibility check (10 s)
TTDSTP: Time after initialisation for stabilization of the low pass
ZPDDST: time constant for low pass filter. It must be assured that low pass ZPDDST is stabilized lon gbefore TDDST has elapsed, else
        B_noflr will irraneously be set before B_plaus is set.
DPDSTI: Initialision value of tank pressure low pass (0 hPa)
DPDSTO: pressure threshold for detection of inplausibel sensor
        This threshold to be applied identically as DPTEBO (in %DTES) only if the vehicle has no excessive tank overpressures
        during plausibility check. Otherwise the check can be disabled by setting DPDSTO = max. value.
        In any case DPDSTO to be significantly higher than the specified sensor offset.
TDDSTO: Delay time for notification of B_plaus-error. (3 s)
```

BBBO 2.10 Start operating range with fuel in oil

FDEF BBBO 2.10 Function definition



bbbo-bbbo

ABK BBBO 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ABOLRAR			FW	threshold numbers of starts with fuel in oil for reduction LRA
ABOMX			FW	max. numbers of starts for recognation of fuel in oil
IMLKS			FW	threshold integrated air mass for detection fuel in oil
TMSKS			FW	engine temperature threshold for detection fuel in oil

Variable	Source	Type	Description
ABO	BBBO	AUS	numbers of starts with fuel in oil
B_ABOR	BBBO	AUS	condition numbers of starts with fuel in oil for reduced adaptive lambda control
B_STEND	BBSTT	EIN	condition end of start
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
IMLBBO	BBBO	AUS	integration air mass for recognizing fuel in oil
ML_W	EGFE	EIN	air mass flow filtered (Word)
TMST	GGTFM	EIN	engine temperature at start

FW BBBO 2.10 Fixed Values

Parameter	Value	Description
ABOLRAR		threshold numbers of starts with fuel in oil for reduction LRA
ABOMX		max. numbers of starts for recognation of fuel in oil
IMLKS		threshold integrated air mass for detection fuel in oil
TMSKS		engine temperature threshold for detection fuel in oil

FB BBBO 2.10 Detailed description of function

Fuel can get into the engine oil during cold start. The engine oil gets warm during continued driving. The fuel evaporates. The fuel vapor is delivered to the combustion via the crankcase ventilation. The mixture deviation occurring in the process can amount to up to 30% at idle. The Lambda control corrects this. The mixture adaptation stores this correction as long-term effect. If the values of the mixture adaptation exceed certain values, the error lamp may be triggered. Furthermore the subsequent start may fail, since the starting mixture has become too lean, however, during the start no degassing of the fuel in the oil takes place.

By means of a counter abo the feeding of fuel into oil is simulated. The counter is incremented by one if a start below the temperature threshold TMSKS takes place. This can be the engine and or the intake or the transmission oil temperature of the vehicle.
The counter is decremented if it is ensured that the oil temperature has remained above a threshold for long enough. Then it is ensured that the fuel has degassed again. The air mass flow integrated during a drive or the transmission oil temperature can serve as measure for high oil temperature. When this variable exceeds a threshold the counter is decremented again. In the process zero may not be undershot.

Realization: The air mass ml is integrated in imlbbo. If the integrator value imlbbo is greater than IMLKS the counter abo is decremented and the integrator value imlbbo is reset.
Thereby the counter can be decremented several times during an engine run. The counter abo is stored in the permanent RAM.

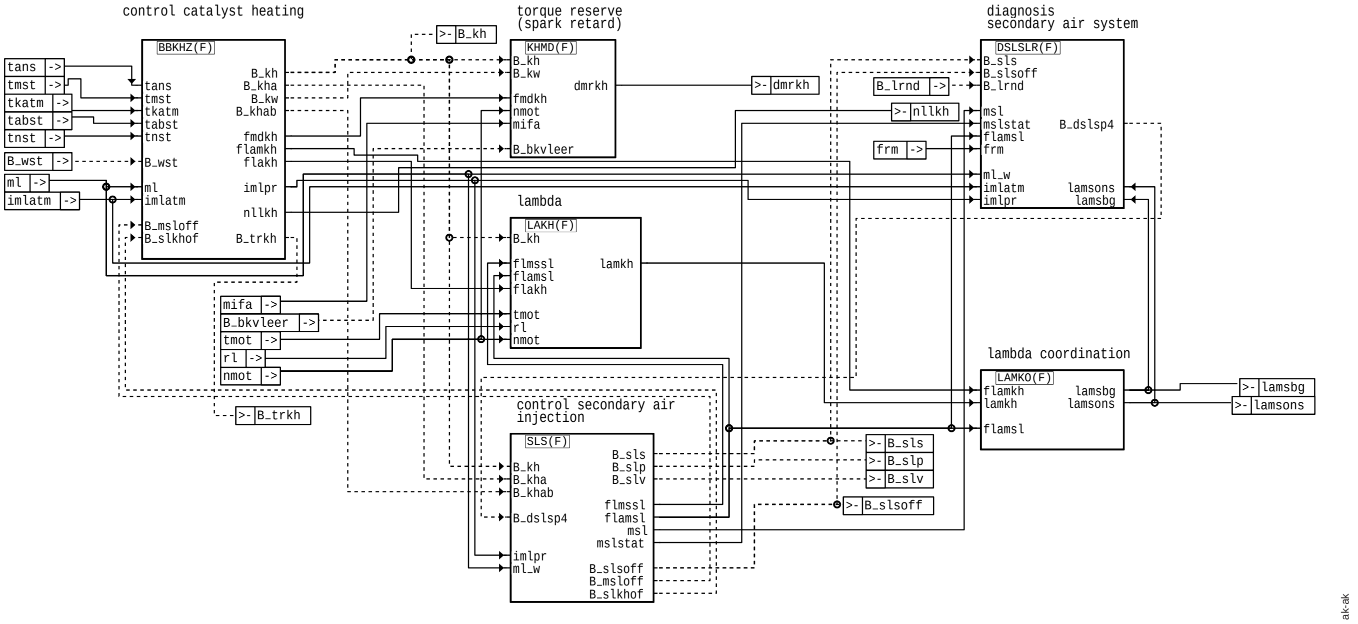
By the count of the counter abo, which can be limited to a maximum value, the learning speed of the mixture adaptation is varied.

If the counter is greater than the threshold ABOLRAR the condition B_abor is set, which enables the reduced adaptation ranges in the function %LRA.

APP BBBO 2.10 Application hint

AK 1.20 Overview Emission reduction / catalyst

FDEF AK 1.20 Function definition



ak-ak

ABK AK 1.20 Abbreviations

Variable	Source	Type	Description
B_BKVLEER		EIN	condition brake booster without enough vacuum
B_DSLSP4	AK	LOK	Condition: Request start of SAI for adaptation/additional diagnosis
B_KH	AK	AUS	condition catalyst heating activated
B_KHA	AK	LOK	request of activated catalyst heating
B_KHAB	AK	LOK	condition catalyst heating terminating
B_KW	AK	LOK	Condition catalyst warming
B_LRND	LREB	EIN	set control bit LR active; request for ”NORMAL” or ”DIAGNOSIS”
B_MSLOFF	AK	LOK	Condition secondary air mass flow removed after switch off
B_SLKHOF	AK	LOK	condition shut down secondary air pump caused by imlpr threshold
B_SLP	AK	AUS	condition for secondary air pump
B_SLS	AK	AUS	Condition for active secondary air
B_SLSOFF	AK	AUS	Condition end of secondary air after removing secondary air
B_SLV	AK	AUS	condition for secondary air valve
B_TRKH	AK	AUS	Flag for catalyst fast heating
B_WST	ESSTT	EIN	condition for re-start
DMRKH	AK	AUS	torque reserve for catalyzer heating
FLAKH	AK	LOK	Factor control lambda at catalyst heating
FLAMKH	AK	LOK	factor setting up lambda engine nominal at catalyst heating
FLAMSL	AK	LOK	Factor lambda change by secondary air
FLMSSL	AK	LOK	Factor lambda engine by secondary air
FMDKH	AK	LOK	Weighting factor torque reserve for catalyst heating
FRM		EIN	mean value of lambda control factor
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value
IMLPR	AK	LOK	relative amount of integrated air mass flow at catalyst heating
LAMKH	AK	LOK	Weighted lambda nominal for catalyzer heating
LAMSBG	AK	AUS	Desired Lambda limitation
LAMSONS	AK	AUS	lambda setpoint value w.r.t. to location of lambda-sensor installation
MIFA	MDFAW	EIN	desired indicated engine torque
ML	SWADAP	EIN	air mass flow
ML_W	AK	LOK	air mass flow filtered (Word)
MSL	AK	LOK	secondary air mass flow
MSLSTAT	AK	LOK	static secondary air mass flow
NLLKH	AK	AUS	Idling speed for catalyzer heating
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
TABST		EIN	Soak Time
TANS	SWADAP	EIN	Intake air temperature
TKATM	ATM	EIN	catalyst temperature (model)
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TNST		EIN	time after end of start

FW AK 1.20 Fixed Values

Parameter	Value	Description

FB AK 1.20 Detailed description of function

Caused by emission legislations the engine has to be controlled after cold start to reach accelerated catalyst light off.

The required heating energy is mainly provided by thermal exhaust power (exhaust temperature and exhaust mass flow), running the engine with maximum spark retard and increased idle speed. To reduce engine out emissions it is possibly necessary to run the engine lean (lambda = 0,95 ... 1,05).

Another catalyst heating source uses chemical exhaust energy ("rich warming up") by running the engine rich (lambda = 0.6 .. 0.95). In combination with secondary air injection the rich exhaust gas reacts inside exhaust manifold or catalyst. The heat of this oxidation process heats the catalyst and reduces simultaneously HC- and CO- emissions.

The catalyst heating function %BBKHZ coordinates the sub-functions:

* nominal idle speed at catalyst heating inside %BBKHZ,

* torque reserve to increase the exhaust temperature by spark retard, combined with increased load inside %KHMD,

* mixture control at catalyst heating and lambda - limitation for driveability inside %LAKH and %LAMKO,

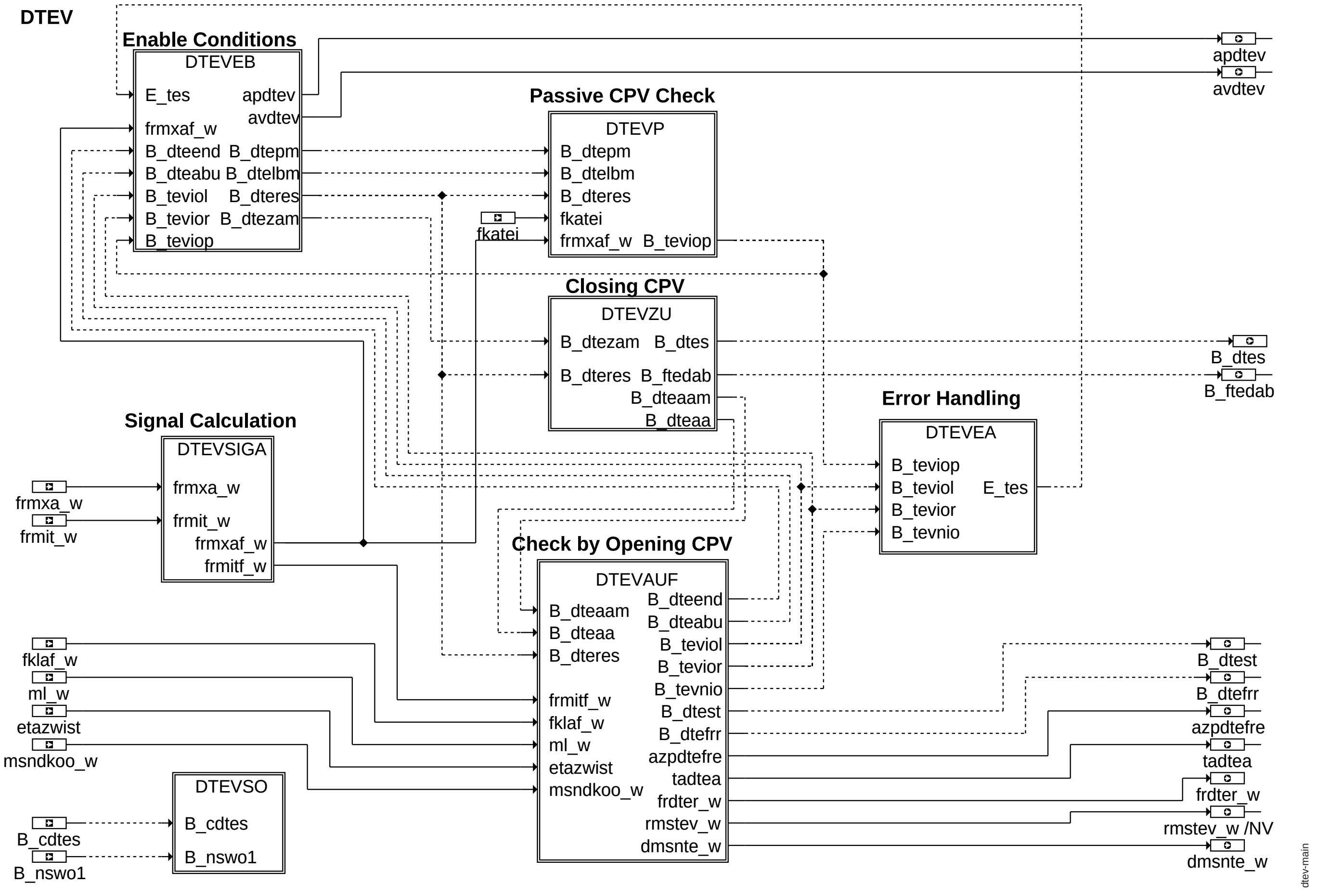
* secondary air control inside %SLS and OBDII- diagnosis inside %DSLSLR with conventional lambda - control or %DSLSLRS with continuous lambda - control.

For detailed information, see description in each sub-function.

APP AK 1.20 Application hint

DTEV 32.90 Diagnosis; canister purge valve (OBDII)

FDEF DTEV 32.90 Function definition



dtev-main

```
DTEVSIGA: Signal Calculation
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```
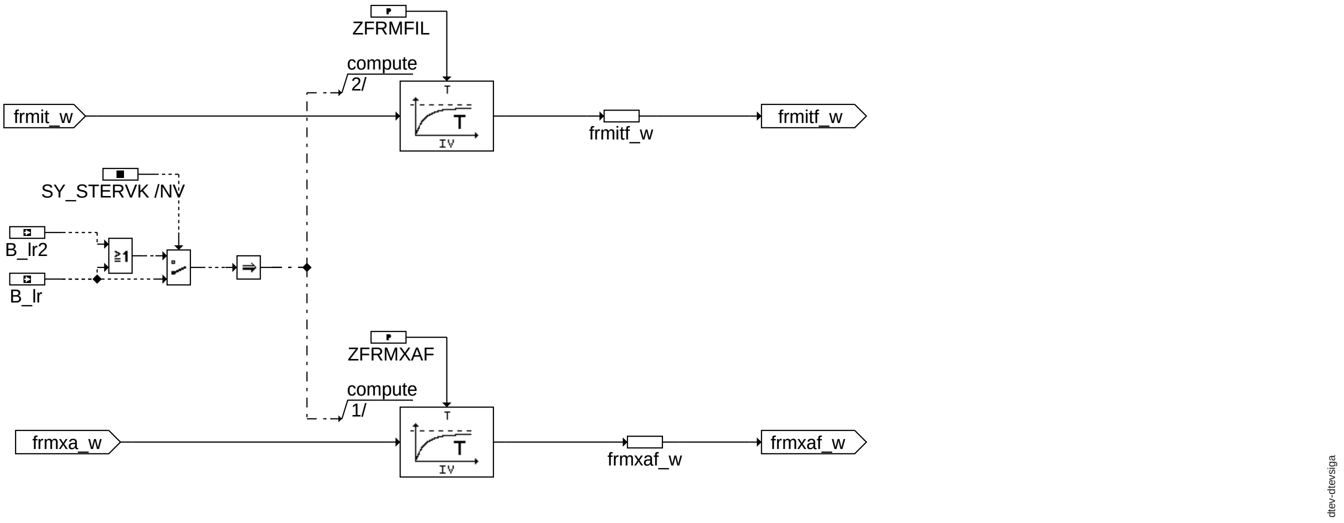

DTEVSIGA: Signal Caclulation



dtev-dtevsiga

```
DTEVEB: Enable Conditions
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```
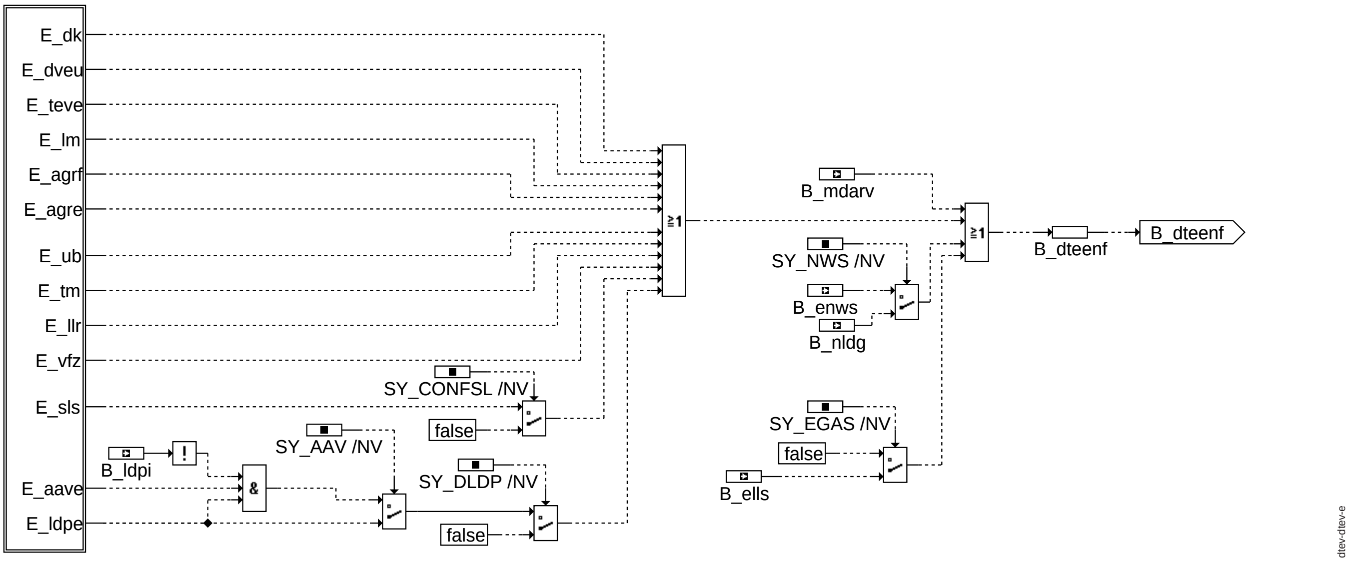
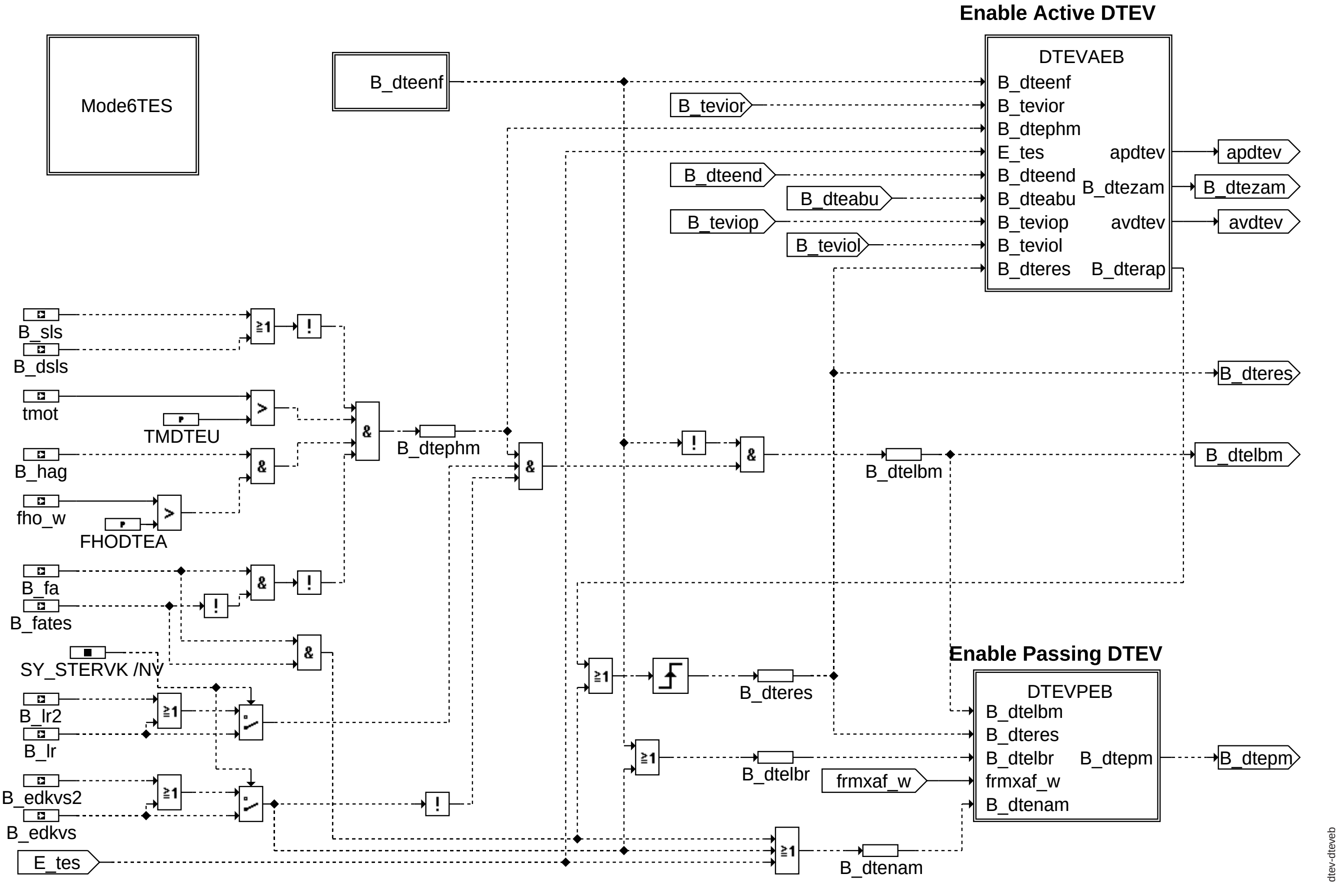

Reading Errorflags



dtev-dtev-e

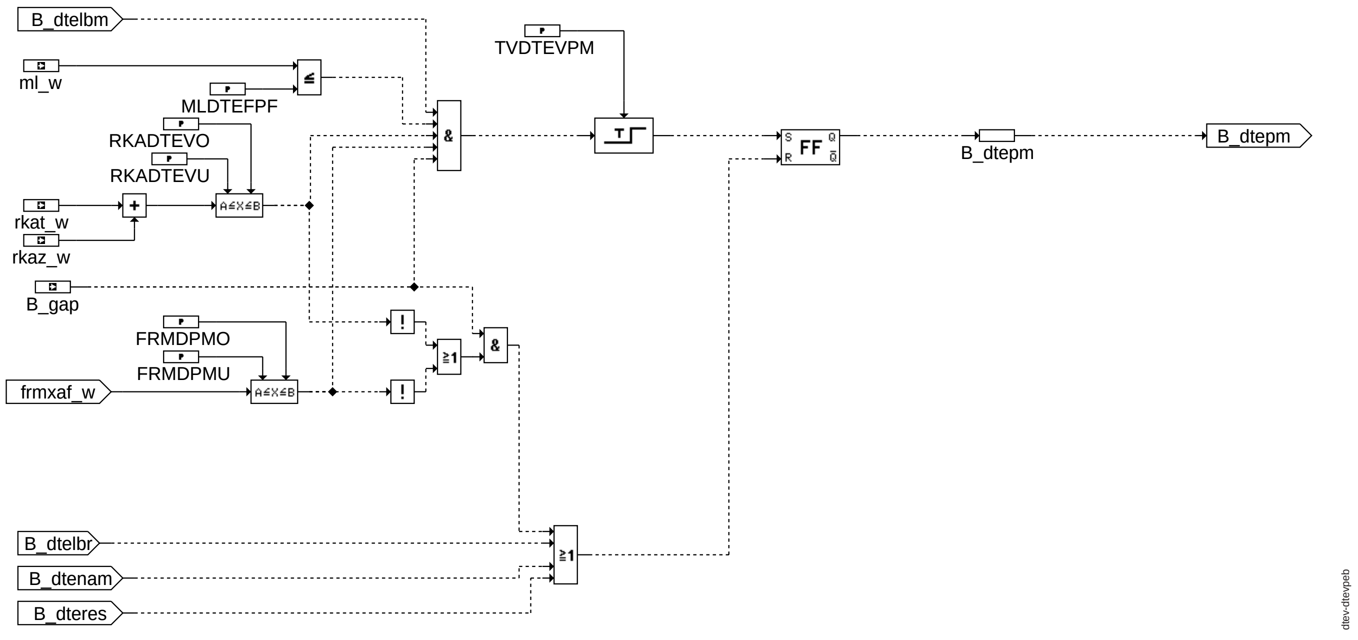
DTEVEB: Enable Conditions



dtev-dteveb

```
DTEVPEB: Enable Conditions of Passive Check
-------------------------------------------
```

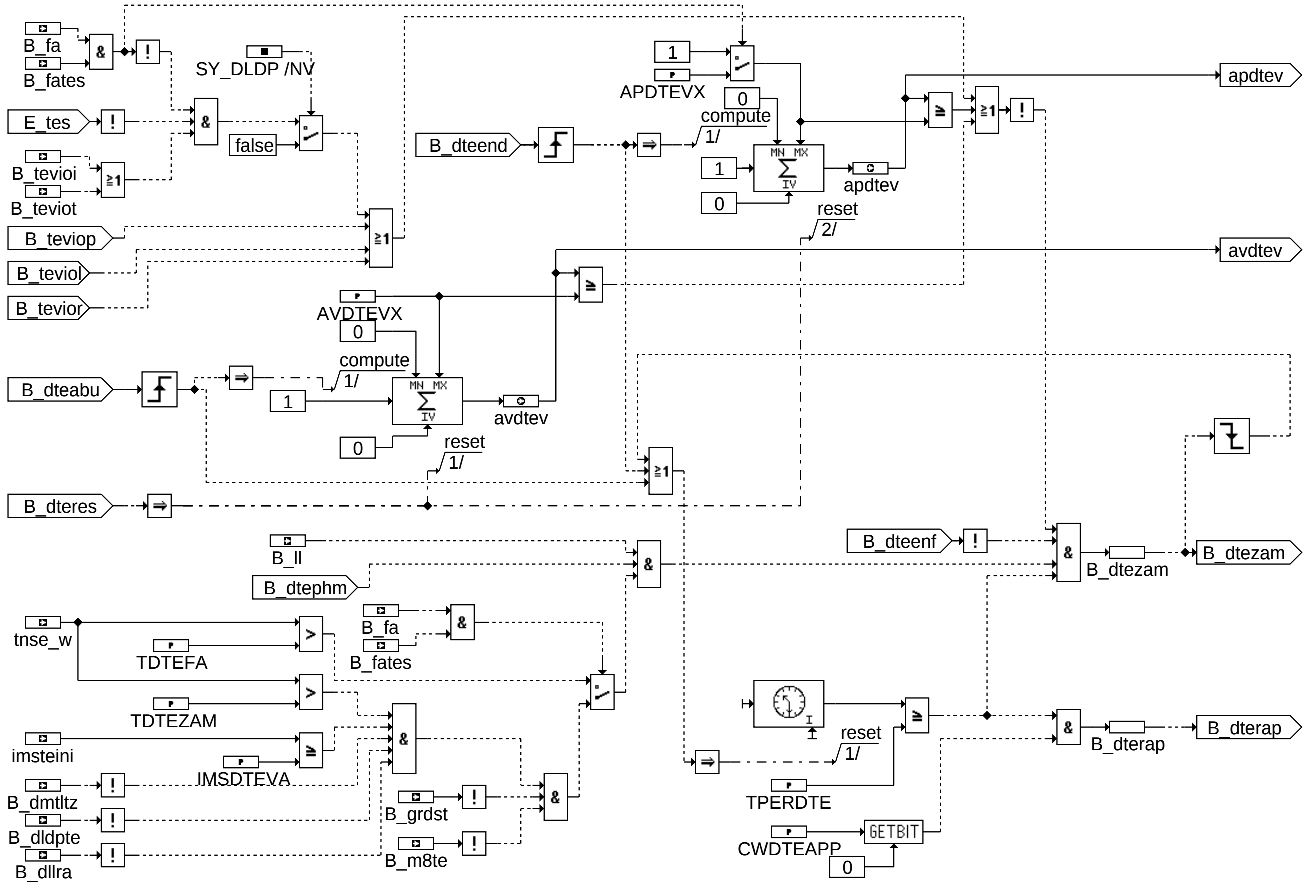
DTEVPEB: Enable Conditions of Passive Check



dtev-dtevpeb

```
DTEVAEB: Enable Conditions of Active Check
------------------------------------------
```

DTEVAEB: Enable Condition of Active Check



dtev-dtevaeb

```
DTEVP: Passive Check
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```
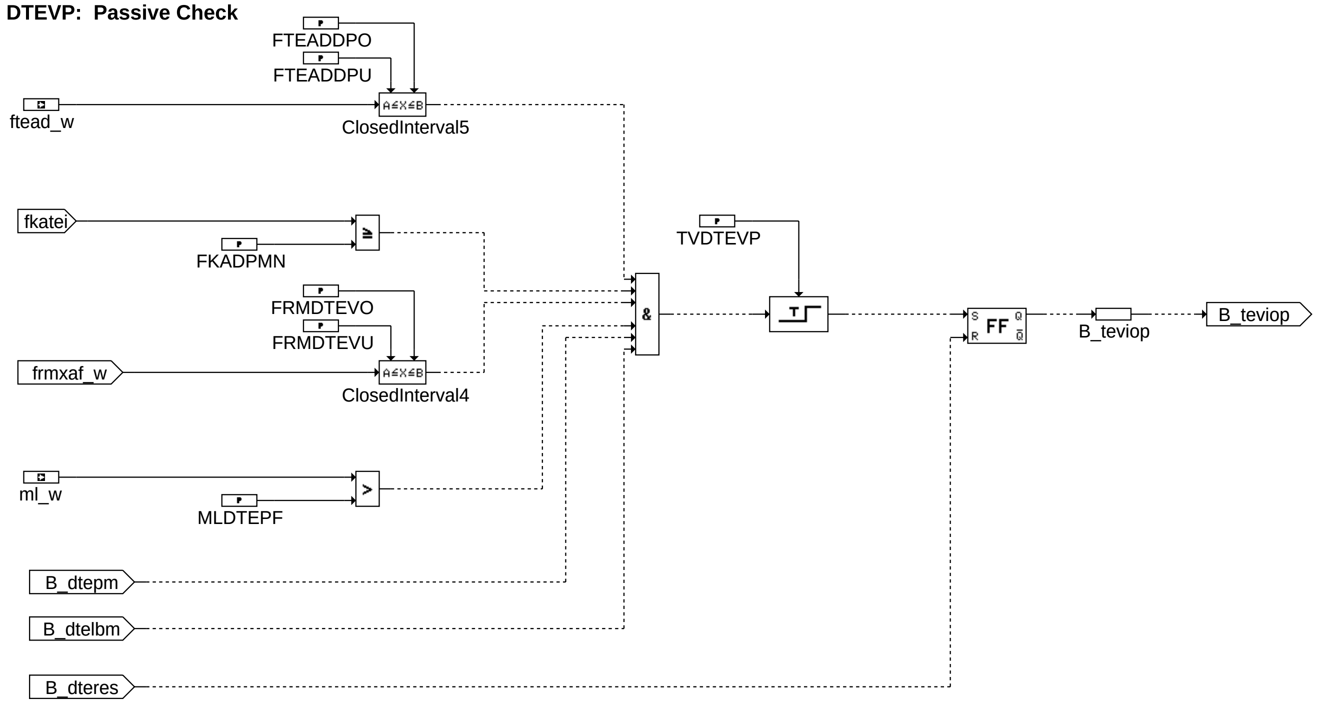
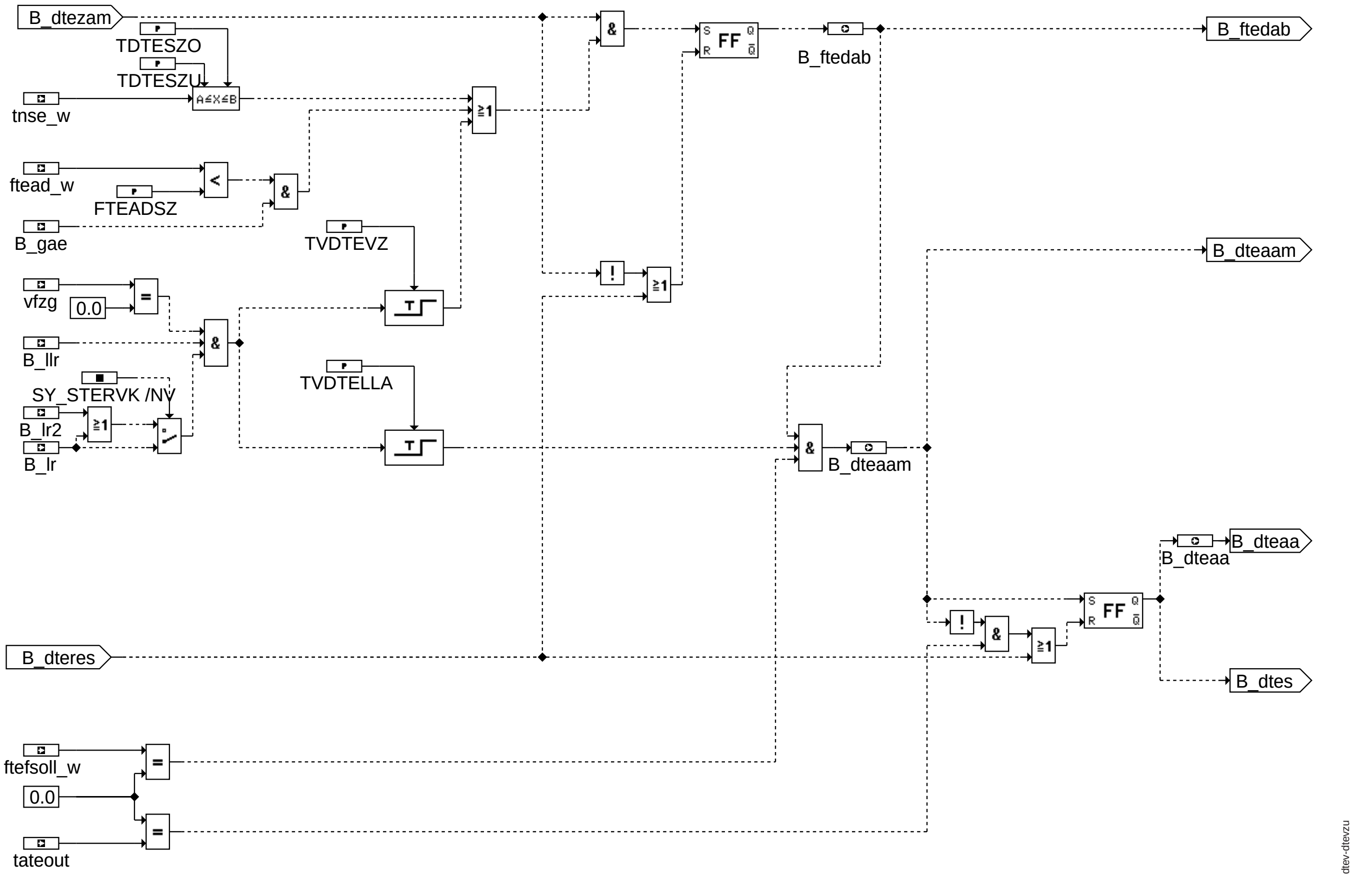

DTEVP: Passive Check



dtev-dtevp

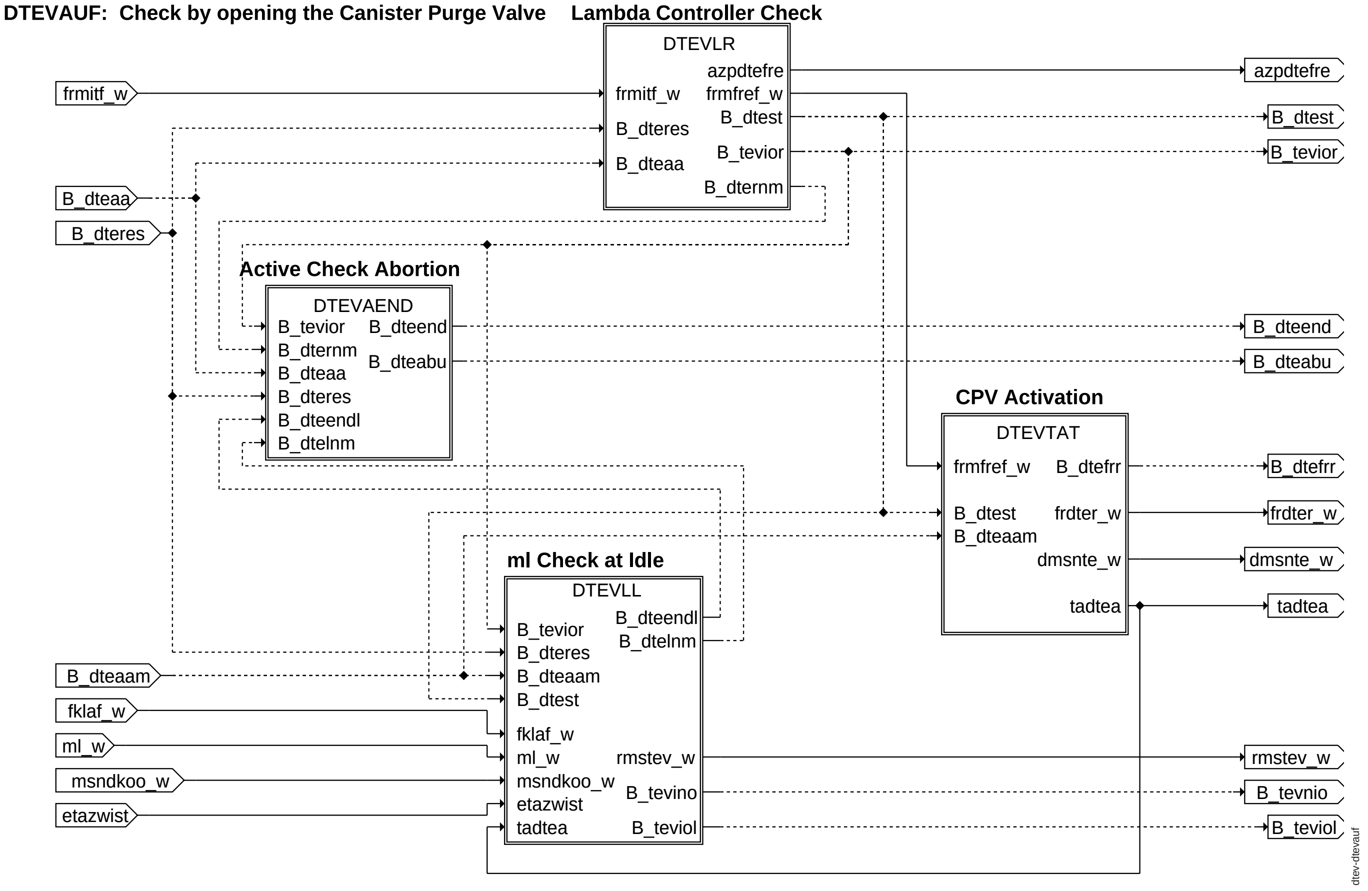
DTEVZU: Closing the Canister Purge Valve (CPV)

DTEVZU: Closing the Canister Purge Valve (CPV)



dtev-dtevzu

```
DTEVAUF: Check by opening the Canister Purge Valve
--------------------------------------------------
```



dtev-dtevauf

```
DTEVLR: Lambda Controller Check
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```
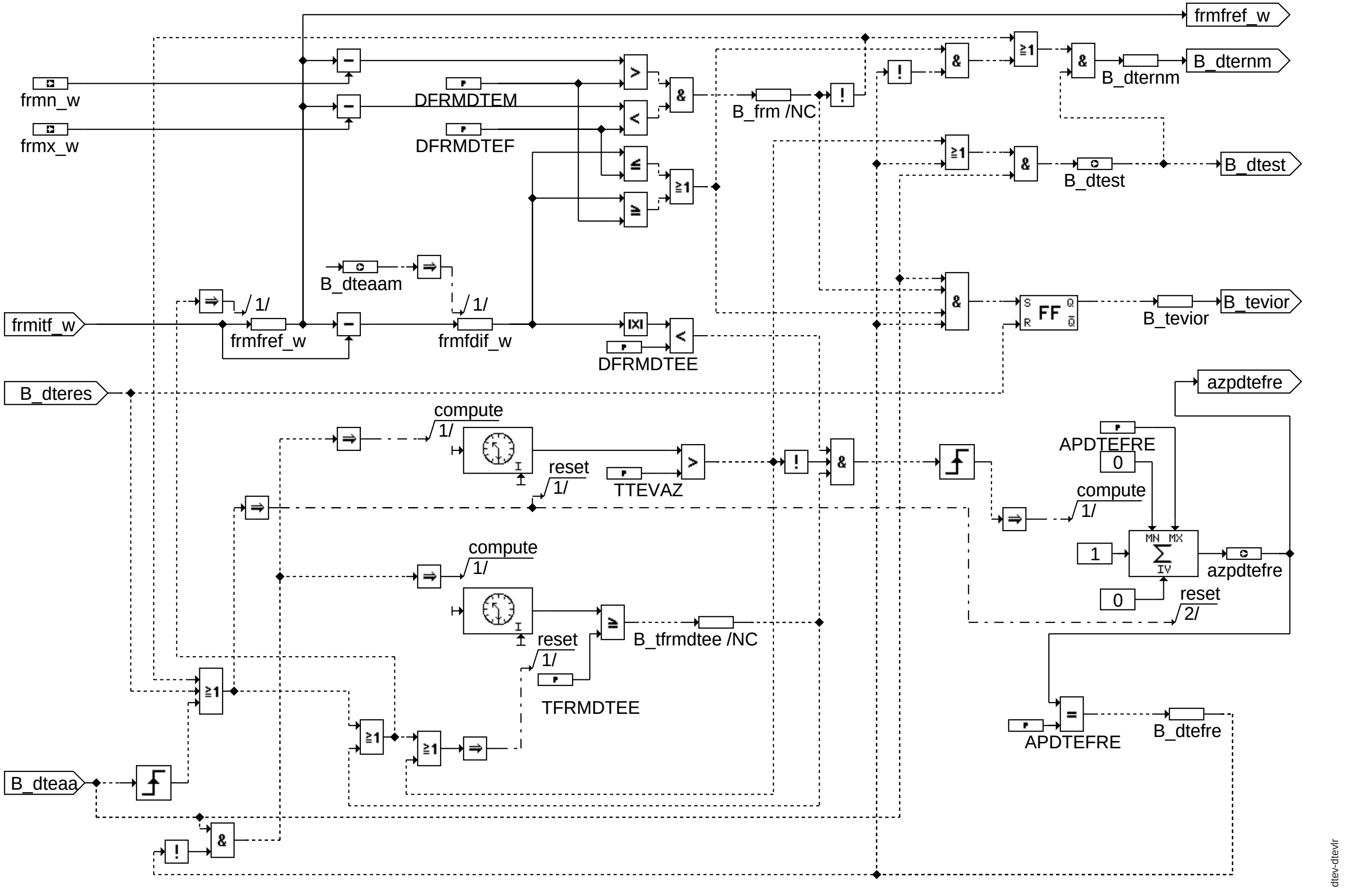

DTEVLR: Lambda Controller Check



dtev-dtevlr

```
DTEVLL: ml Check at Idle
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```
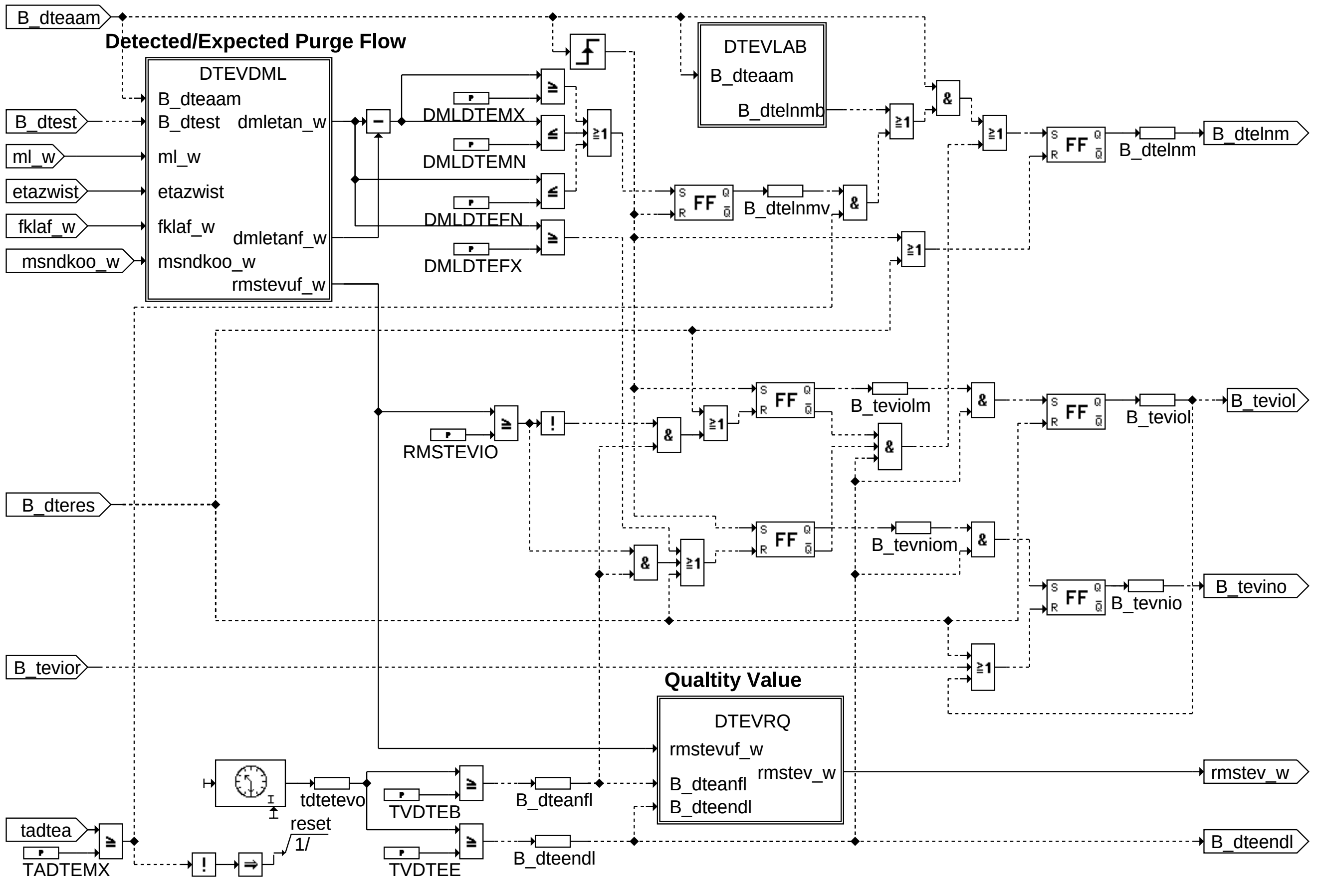
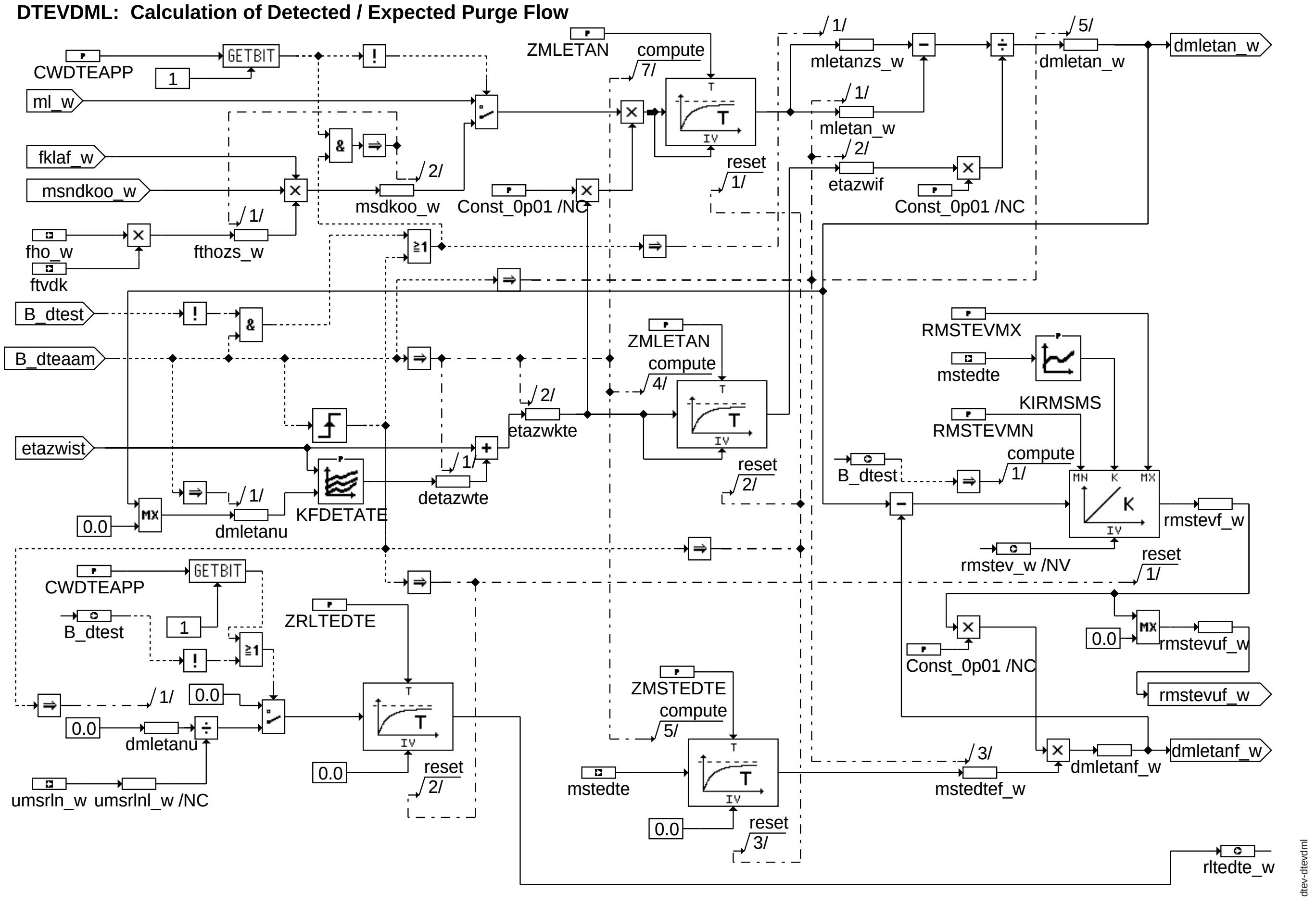

DTEVLL: ml Check at Idle



dtev-dtevll

`DTEVDML: Calculation of Detected / Expected Purge Flow`

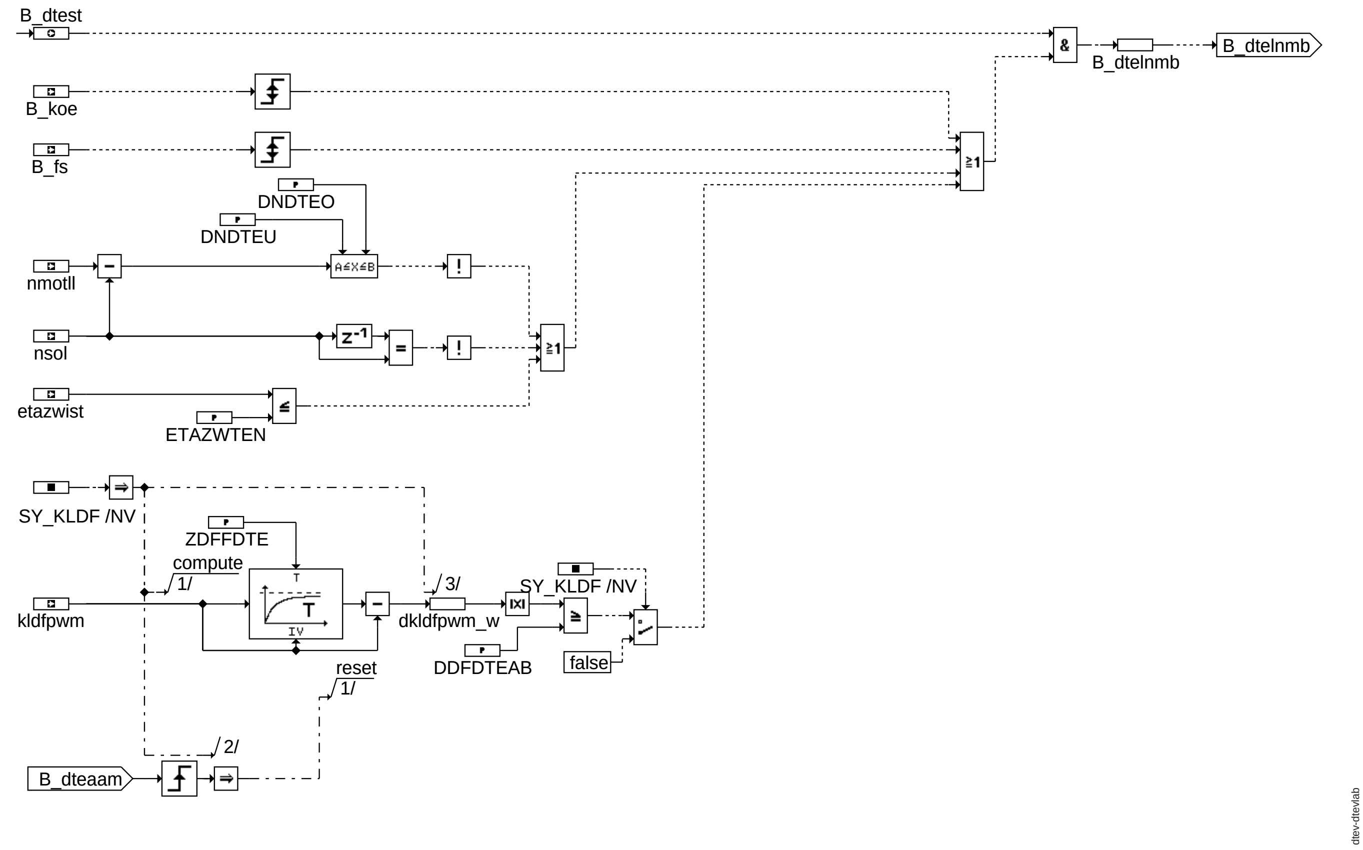
DTEVDML: Calculation of Detected / Expected Purge Flow



dtev-dtevdml

`DTEVLAB : Bearing out of Abort`

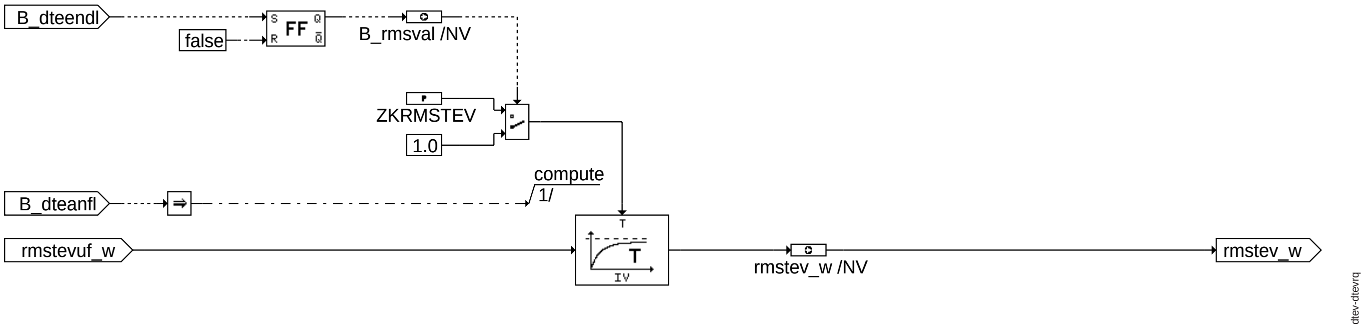
DTEVLAB: bearing out of abort



dtev-dtevlab

`DTEVRQ: Quality value`

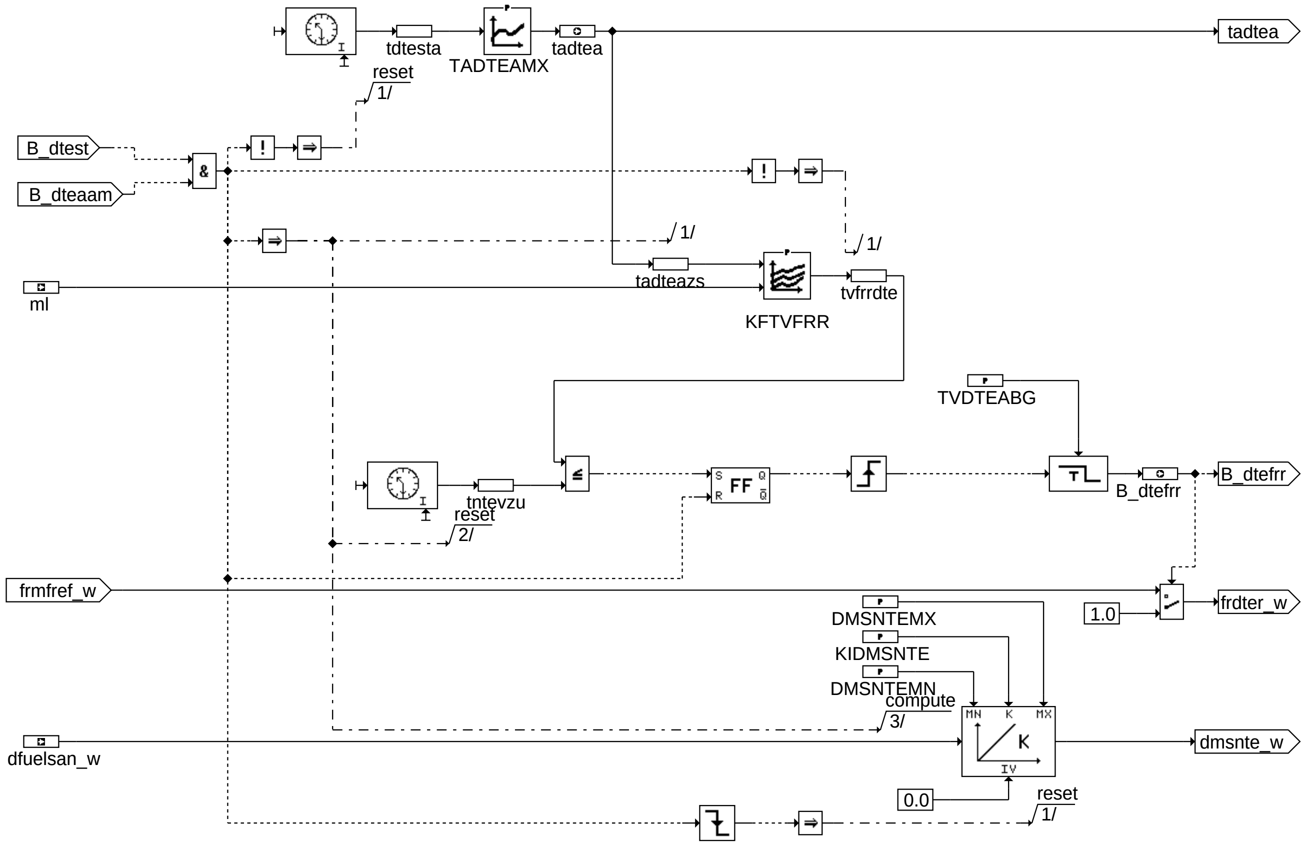
DTEVRQ: Quality Value



dtev-dtevrq

`DTEVTAT: Canister Purge Valve Activation, Lambda Controller Reset, Learning Purge Valve Air Flow for %BGMSZS`
`--------------------------------------------------------------------------------------------------------`

DTEVTAT: Canister Purge Valve Activation, Lamda Controllerreset, Lerning Purge Valve Air Flow for %BGMSZS



dtev-dtevtat

```
DTEVAEND: Active Check Abortion
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```
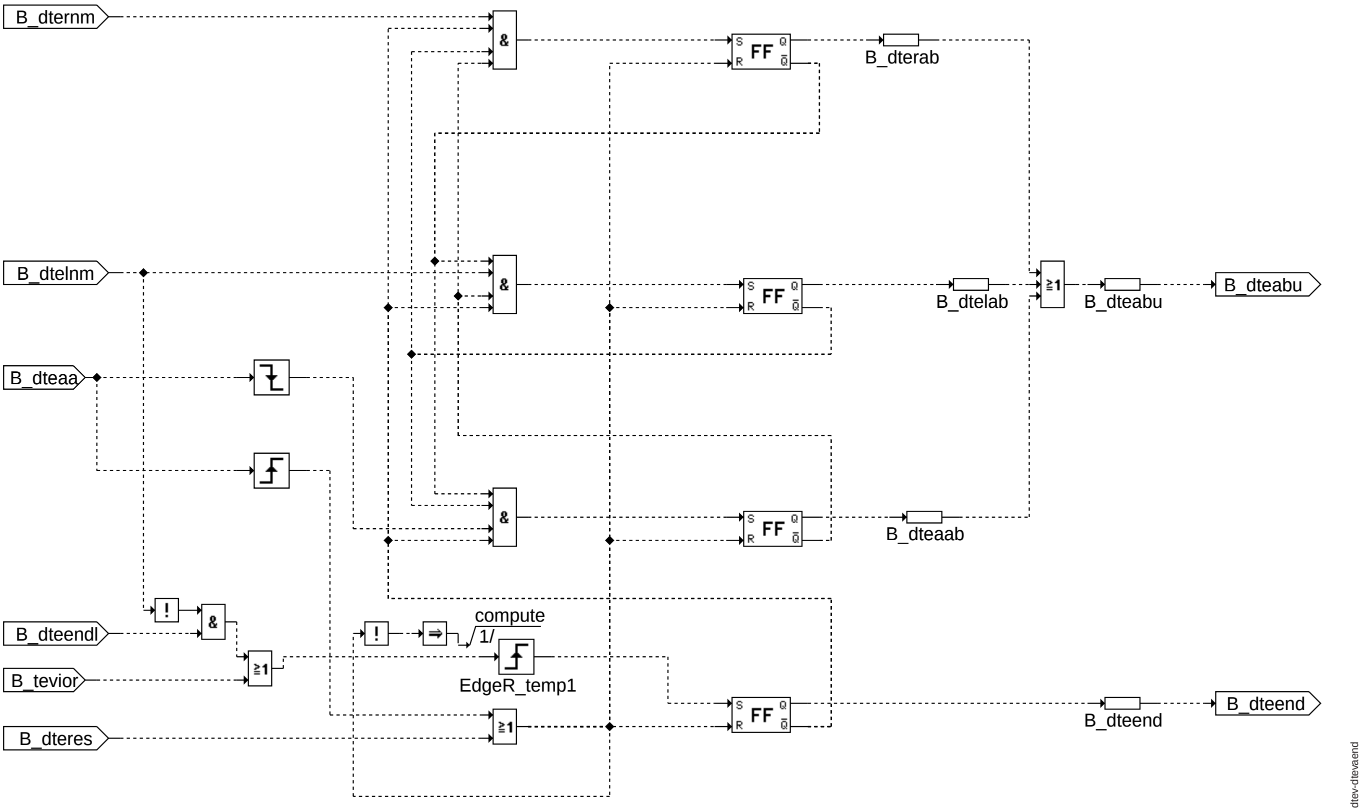
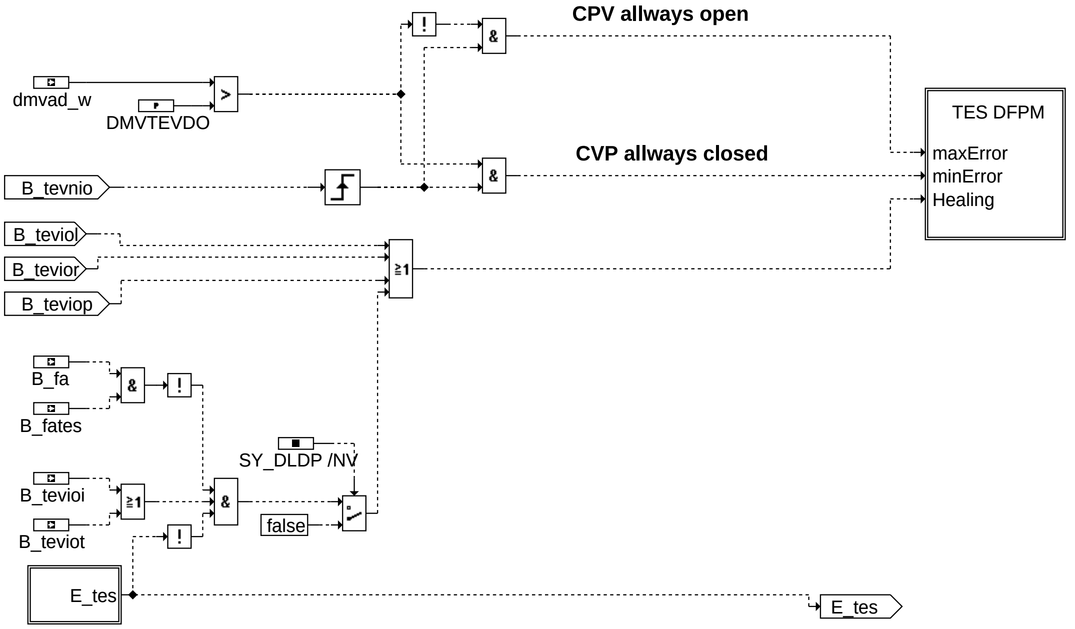

DTEVAEND: Active Check Abortion



dtev-dtevaend

DTEVEA: Error Handling

DTEVEA: Error Handling



Action Table for fault path * in DFPM:

--------------	E_*	Z_*	B_mx*	B_mn*	B_si*	B_np*
maxError:	S	S	S	R	R	R
minError:	S	S	R	S	R	R
sigError:	S	S	R	R	S	R
nplError:	S	S	R	R	R	S
Healing:	R	S	R	R	R	R

S: set R: reset * = tes

dtev-dtevea

dtev-dtevea

In block diagrams fault type information as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnostic management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these information directly from the fault path status managed in the DFPM.

The following values are defined for the fault path of this diagnostic function:

Status fault path DTEV	sfptes
Error flag DTEV :	E_tes
Cycle flag DTEV :	Z_tes
Fault type DTEV :	TYP_tes :(B_mxtes, B_mntes, B_sites, B_nptes)
Clear fault path:	B_cltes
Default value active:	B_bktes (optional)
Fault path code DTEV:	CDTTES
Fault class DTEV:	CLATES
Fault severity DTEV:	TSFTES
CARB Code DTEV:	CDCTES
Table of ambient cond. DTEV:	FFTTES

Fault path entry with: LDTES; FLCTES; HLCTES; U1TES= nmot_w; U2abc=ml_w

ABK DTEV 32.90 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
APDTEFRE			FW	number of tests to set flag fr stabilized for DTEV
APDTEVX			FW	maximum number of checks at detected fault
AVDTEVX			FW	maximum number of DTEV checks
CDCTES	BLOKNR		KL	code word CARB: canister purge system
CDKTES			FW	code word customer: canister purge system
CDTTES			FW	code word tester: canister purge system
CLATES			FW	fault class: evap system monitoring, PCV stuck open
CWDTEAPP			FW	Application code word for DTEV always active and swiching between HFM and P-sys.
DDFDTEAB			FW	Threshold for abort of diagnosis because change of genarator signale is high
DFRMDTEE			FW	delta-frm-threshold for detection of successful mixture correction
DFRMDTEF			FW	delta Fr threshold 'rich correction' for check o.k.
DFRMDTEM			FW	delta Fr threshold 'lean correction' for check o.k.
DMLDTEFN			FW	Threshold air mass flow not plausible for detection fault in DTEV
DMLDTEFX			FW	Air mass threshold for detection PCV defective no longer necessary

Parameter	Source-X	Source-Y	Type	Description
DMLDTEMN			FW	Lower threshold for detection air mass flow not plausible for evaluation in DTEV
DMLDTEMX			FW	Upper threshold for detection air mass flow not plausible for evaluation in DTEV
DMSNTEMN			FW	Minimum standardized mass flow change PCV
DMSNTEMX			FW	Maximum standardized mass flow change PCV
DMVTEVDO			FW	Threshold loss adaptation to distinguish min, max faults in DTEV
DNDTEO			FW	upper Nsoll-Nist threshold for abortion diagnosis CPV
DNDTEU			FW	lower Nsoll-Nist threshold for abortion diagnosis CPV
ETAZWTEN			FW	minimum threschold of ignition angle efficiency for diagnosis of PCV
FFTTES	BLOKNR		KL	freeze freme table: canister purge valve
FHODTEA			FW	lower altitude threshold for diagnosis CPV active
FKADPMN			FW	minimum feul part via CPV for passive O.K. testing.
FRMDPMO			FW	upper frm threshold for passive switch on condition of diagnosis CPV
FRMDPMU			FW	lower frm threshold for passive switch on condition of diagnosis CPV
FRMDTEVO			FW	upper frm threshold for passive O.K. testing of diagnosis CPV
FRMDTEVU			FW	lower frm threshold for passive O.K. testing of diagnosis CPV
FTEADDPO			FW	upper load threshold for passive O.K. testing.
FTEADDPU			FW	lower load threshold for passive O.K. testing.
FTEADSZ			FW	threshold for immediate closing of CPV from DTEV
IMSDTEVA			FW	thershold for integral of purge mass flow after a long purge stop
KFDETATE	ETAZWIST	DMLETANU	KF	correction of ignition angle effectiveness for diagnosis of PCV
KFTVFRR	TADTEAZS	ML	KF	Map: Lambda controll after this time reset at reference value
KIDMSNTE			FW	Integration speed for the calculation of the mass flow change PCV
KIRMSMS	MSTEDTE		KL	Integration speed matching of mass flow PCV with calculated mass flow
MLDTEFPF			FW	threshold ml for possible Check passive diagnosis DTEV possible
MLDTEPF			FW	threshold ml for possible Check passive diagnosis DTEV
RKADTEVO			FW	upper rka threshold for passive switch on condition of diagnosis CPV
RKADTEVU			FW	lower rka threshold for passive switch on condition of diagnosis CPV
RMSTEVIO			FW	Threshold relative mass flow for O.K. detection
RMSTEVMN			FW	Minimum value relative mass flow PCV
RMSTEVMX			FW	Maximum value relative mass flow PCV
SY_CONFSL			SYS (REF)	System constant: secondary air present vorhanden
SY_DLDP			SYS	SY_DLDP = 1 there ist a DLDP in system
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_KLDF			SYS	system constant for generator DF-signale
SY_NWS			SYS (REF)	system constant camshaft control: none, 2 point, continous
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
TADTEAMX	TDTESTA		KL	characteristic line for max. duty cycle = F(integral purge flow after TE-Stop)
TADTEMX			FW	duty cycle threshold for active testing
TC6TECI			FW	mode 6 code word for O.K. check of CPV form DLDP
TC6TECL			FW	mode 6 code word for O.K. check of CPV from air-test
TC6TECNL			FW	mode 6 code word for NOT O.K. check of CPV from air-test
TC6TECP			FW	mode 6 code word for passive O.K. check of CPV
TC6TECRF			FW	mode 6 code word for O.K. check of CPV from FR-deviation dircetion rich
TC6TECRM			FW	mode 6 code word for O.K. check of CPV from FR-deviation dircetion lean
TC6TECT			FW	mode 6 code word for O.K. check of CPV form DLDP
TDTEFA			FW	Time for blocking of DTEV as of start with tester request
TDTESZO			FW	time after start for desactivation fast purge rate decrease DTEV at B_ll= TRUE
TDTESZU			FW	time after start for activation purge rate decrease DTEV at B_ll= TRUE
TDTEZAM			FW	time after engine start for possible activation of active DTEV
TFRMDTEE			FW	monitoring duration frm
TMDTEU			FW	lowest engine temperature threshold for diagnose
TPERDTE			FW	time for repeating DTEV at non stop idle
TSFTES			FW	fault active time: canister purge system
TTEVAZ			FW	duration of stay for CPV opening with not successful frm
TVDTEABG			FW	delay time between engine and Lambda- sensor
TVDTEB			FW	delay time for statement TEV o.k./defect in diagnosis DTEV
TVDTEE			FW	Duration as of PCV open for checking of DTEV
TVDTELLA			FW	min. time for activation conditions DTEV at idle fullfilled
TVDTEVP			FW	delay time for setting of the flip flop ”Passive Diagnosis CPV o.k.”
TVDTEVPM			FW	delay time for setting of the flip flop ”Diagnosis passive possible”
TVDTEVZ			FW	delay time for closing CPV for active DTEV
ZDFFDTE			FW	Time constant for highpas filter of genarator signale
ZFRMFIL			FW	filter timeconstant for lambda controller
ZFRMXAF			FW	filter time constant for frmxa_w signal
ZKRMSTEV			FW	time constante low pass filter for mode 6 DTEV
ZMLETAN			FW	Time cons. for filtering for the calc. of the energy needed for idling for DTEV
ZMSTEDTE			FW	Time constant for filtering of the calculated mass flow PCV
ZRLTEDTE			FW	Time constant for filtering of the calculated charge PCV

Variable	Source	Type	Description
APDTEV	DTEV	AUS	Number of DTEV Tests with success
AVDTEV	DTEV	AUS	Number of DTEV Tests without success
AZPDTEFRE	DTEV	AUS	number of tests for lambda controller stabilized
BLOKNR		EIN	DAMOS source for block number
B_BETES	DTEV	AUS	condition leak detection request
B_BKTES	DTEV	AUS	condition backup value evap system monitoring, PCV stuck open
B_CDTES	PROKON	EIN	function active per codeword CDTES
B_CLTES		EIN	condition: clear error ”evaporation control system open”
B_DLDPTE	GKRA	EIN	request from evap system monitoring to shut down PCV
B_DLLRA	DLLR	EIN	Condition DLLR request
B_DMTLTZ		EIN	Condition TEV should be closed

Variable	**Source**	**Type**	**Description**
B_DSLS		EIN	condition for active diagnosis of secondary air system
B_DTEAA	DTEV	AUS	Condition diagnosis CPV by opening the CPV active
B_DTEAAB	DTEV	LOK	condition DTEV abortion because of activation conditions no more fullfilled
B_DTEAAM	DTEV	AUS	Condition diagnosis CPV by opening the CPV active possible
B_DTEABU	DTEV	LOK	Condition interruption of TE diagnosis without result
B_DTEANFL	DTEV	LOK	terminated time from this the CPV duty-cyle over threshold
B_DTEEND	DTEV	LOK	Condition TEV check was successful
B_DTEENDL	DTEV	LOK	Condition TEV check was successful by idle speed air check
B_DTEENF	DTEV	LOK	Condition CPV diagnosis not allowed because of an error of the system
B_DTEFRE	DTEV	LOK	Condition fr for diagnosis CPV stabilized.
B_DTEFRR	DTEV	AUS	condition of lambda controller reset
B_DTELAB	DTEV	LOK	condition DTEV abortion because of destorption idle speed air check
B_DTELBM	DTEV	LOK	Condition detection of Lambda controller possible for diagnosis CPV
B_DTELBR	DTEV	LOK	condition reset of flip flop ”Passive DTEV” possible
B_DTELNM	DTEV	LOK	Condition diagnosis CPV not possible
B_DTELNMB	DTEV	LOK	bear out : Condition diagnosis CPV not possible
B_DTELNMV	DTEV	LOK	Reservation: Condition diagnosis CPV not possible
B_DTENAM	DTEV	LOK	Condition diagnosis CPV only possible by opening the CPV
B_DTEPHM	DTEV	LOK	condition pysical enable of DTEV
B_DTEPM	DTEV	LOK	Condition passive CPV diagnosis possible
B_DTERAB	DTEV	LOK	condition DTEV abortion because of too much fr deviation
B_DTERAP	DTEV	LOK	condition DTEV reset by application
B_DTERES	DTEV	LOK	Condition reset for CPV diagnosis
B_DTERNM	DTEV	LOK	Condition no fr-lift for diagnosis CPV available
B_DTES	DTEV	AUS	Condition for active diagnosis of canister purge system
B_DTEST	DTEV	AUS	condition for start of TEV opening
B_DTEZAM	DTEV	LOK	Condition Diagnosis CPV is released for active test (CPV - close/open)
B_EDKVS	DKVS	EIN	condition for adaption fault thresholds momentarily exceeded
B_EDKVS2	DKVS	EIN	condition for adaption fault thresholds bank 2 momentarily exceeded
B_ELLS		EIN	Condition: error idle speed actuator
B_ENWS	DNWS	EIN	condition error camshaft control
B_FA		EIN	condition general function request
B_FATES		EIN	condition leak detection request
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_FTEDAB	DTEV	AUS	Condition decrease purge rate for diagnosis CPV
B_FTTES	DTEV	AUS	Condition fault entry by tester for TEV
B_GAE	DKVS	EIN	condition for adaptive Lambda pilot control successful
B_GAP	GKEB	EIN	condition mixture adaptation phase active
B_GRDST		EIN	condition basic attitude
B_HAG	BGPU	EIN	condition altitude adaptation valid
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_LDPI		EIN	condition reed contact leakage diagnosis pump
B_LL	MSF	EIN	Condition idle
B_LLR	LLRBB	EIN	condition idle speed control
B_LR	LREB	EIN	LREB: condition for Lambda closed loop control upstream catalyst; bank 1
B_LR2	LREB	EIN	LREB: condition for lambda closed loop control upstream catalyst; bank 2
B_M8TE	TC8MOD	EIN	condition to enable function evap system by SAE J1879 Mode 8 TID $01
B_MDARV	DMDMIL	EIN	critical misfire rate detected
B_MNTES	DTEV	AUS	condition for fault type ”minimum value” detected
B_MXTES	DTEV	AUS	condition for fault type ”maximum value” detected (tank vent valve)
B_NLDG		EIN	condition limp-home function speed sensor
B_NPTES	DTEV	AUS	condition for fault type ”unplausible signal” detected (PCV stuck open)
B_NSWO1	PROKON	EIN	condition engine speed > NSWO1
B_PWF		EIN	Condition for powerfail
B_RMSVAL	DTEV	AUS	Condition relative mass flow PCV valid
B_SITES	DTEV	AUS	error type: PCV stuck open
B_SLS	AK	EIN	Condition for active secondary air
B_TEVIOI		EIN	Condition CPV detected as o.k. by DLDP check (initial purge)
B_TEVIOL	DTEV	LOK	Condition CPV detected o.k. from idle speed control
B_TEVIOLM	DTEV	LOK	condition CPV o.k. test by idle speed air consumption possible
B_TEVIOP	DTEV	LOK	Condition CPV in passive test detected as o.k.
B_TEVIOR	DTEV	LOK	Condition CPV from fr-deviation detected as o.k.
B_TEVIOT		EIN	Condition CPV detected as o.k. by DLDP check (increase of period)
B_TEVNIO	DTEV	LOK	Condition CPV in active test detected as defect
B_TEVNIOM	DTEV	LOK	condition CPV o.k. test by idke speed air consumption not possible
DETAZWTE	DTEV	LOK	correction factor of ignition angle effectiveness for diagnosis of PCV
DFP_AAVE	DTEV	DOK	ECU int. fault path no.: diagnosis AAVE valve power stage
DFP_AGRE	DTEV	DOK	ECU int. fault path no.: EKR power stage
DFP_AGRF	DTEV	DOK	ECU int. fault path no.: partial pressure EGR
DFP_DK	DTEV	DOK	ECU int. fault path no.: clear error throttle potentiometer
DFP_DVEU	DTEV	DOK	ECU-internal fault-path no.: DV-E failure during UMA learning
DFP_LDPE	DTEV	DOK	ECU int. fault path no.: leakage detection pump power stage
DFP_LLR	DTEV	DOK	ECU int. fault path no.: idle speed control
DFP_LM	DTEV	DOK	ECU-internal fault path no.: main-load sensor
DFP_SLS	DTEV	DOK	Internal fault path number: secondary air-system
DFP_TES	DTEV	DOK	Internal error path number evap system monitoring, pcv Struck open
DFP_TEVE	DTEV	DOK	Internal fault path number: canister purge valve power stage
DFP_TM	DTEV	DOK	Internal fault path number: engine temperature
DFP_UB	DTEV	DOK	Internal fault path number: ambient conditions
DFP_VFZ	DTEV	DOK	ECU int. fault path no.: vehicle speed signal
DFUELSAN_W	BGMSZS	EIN	Delta charge sensor to alpha/n-systems
DKLDFPWM_W	DTEV	LOK	variation of generator signale as PWM-signale

Variable	Source	Type	Description
DMLETANF_W	DTEV	LOK	Filtered value for deviation energy needed for idling during DTEV
DMLETANU	DTEV	LOK	Delta: airflow * ignition efficiency at DTEV unsigned
DMLETAN_W	DTEV	LOK	Delta: airflow * ignition efficiency at DTEV 16 bit
DMSNTE_W	DTEV	AUS	Standardized mass flow change through PCV
DMVAD_W	MDVERAD	EIN	Delta resistant torque from resistant torque adaptation
ETAZWIF	DTEV	LOK	value of ignition efficiency: filtered value for DTEV
ETAZWIST	MDIST	EIN	actual ignition angle effectiveness
ETAZWKTE	DTEV	LOK	correction ignition angle effectiveness for diagnosis of PCV
E_AAVE		EIN	error flag: canister ventilation valve (power stage)
E_AGRE		EIN	error flag: EGR power stage monitoring
E_AGRF		EIN	error flag: EGR flow monitoring
E_DK	DDVE	EIN	Error flag: throttle position sensor
E_DVEU	DDVE	EIN	Error flag: DV-E cause of failure: UMA-learning
E_LDPE		EIN	error flag: leakage detection pump power stage
E_LLR	DLLR	EIN	Error flag: idle speed control
E_LM	EGFE	EIN	Error flag: main load sensor
E_SLS		EIN	error flag: secondary air system
E_TES	DTEV	AUS	error flag: canister purge system diagnosis
E_TEVE	DTEVE	EIN	error flag: canister purge valve power stage
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_UB	GGUB	EIN	error flag: power supply voltage UB
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
FHO_W	BGPU	EIN	correction factor: altitude
FKATEI	TEB	EIN	factor fuel part purge control (actuel value)
FKLAF_W	BGMSZS	EIN	Factor saint venant (KLAF)
FRDTER_W	DTEV	AUS	lambda control factor as reference value for CPV diagnosis
FRMFDIF_W	DTEV	LOK	difference value between trail value and momentary value
FRMFREF_W	DTEV	LOK	filtered reference value of fr for DTEV active check
FRMITF_W	DTEV	LOK	filtered value of fr for DTEV
FRMIT_W	TEB	EIN	mean value of fr and fr2 (16 bit)
FRMN_W	LR	EIN	lambda regulator output min.
FRMXAF_W	DTEV	LOK	fr value (out of fr or fr2) which is the farest away from 1 (filtered)
FRMXA_W	TEB	EIN	fr value (out of fr aund fr2) wich is the farest away from 1 (16bit)
FRMX_W	LR	EIN	LR with integrator stop:Maximum limit. of integrator fr;FRMAX increased by DSLS
FTEAD_W	TEB	EIN	charcoal canister charge
FTEFSOLL_W		EIN	desired canister purge rate
FTHOZS_W	DTEV	LOK	factor temperature and altitude depending correction of mass flow
FTVDK	SWADAP	EIN	correction factor for temperature upstream of throttle valve
IMSTEINI		EIN	integral of purge mass flow after a longer purge stop
KLDFPWM		EIN	generator signale as PWM-signale filtrated
ML	SWADAP	EIN	air mass flow
MLETANZS_W	DTEV	LOK	safed value: at ignition efficiency = 100% normalised air amount
MLETAN_W	DTEV	LOK	At ignition efficiency = 100% normalised air amount
ML_W	EGFE	EIN	air mass flow filtered (Word)
MSDKOO_W	DTEV	LOK	Mass flow throttle valve without offset
MSNDKOO_W	BGMSZS	EIN	Normalized mass flow over throttle without offset (word)
MSTEDTE	BGTEV	EIN	purge mass flow for DTEV
MSTEDTEF_W	DTEV	LOK	purge massflow für DTEV (filtered value)
NMOTLL	BGNMOT	EIN	engine speed
NSOL	LLRNS	EIN	idle reference speed
RKAT_W	LRA	EIN	additive correction (per time) of the mixture adaptation (Word)
RKAZ_W	LRA	EIN	additive correction (per ignition) of the mixture adaptation
RLTEDTE_W	DTEV	AUS	from DTEV calculated relative charge through the purge control valve
RMSTEVF_W	DTEV	LOK	Current measured value for relative PCV quality
RMSTEVUF_W	DTEV	LOK	Current, unsigned measured value for relative PCV quality
RMSTEV_W	DTEV	AUS	Long-time stored measured value for value of relative PCV quality
SFPTES	DTEV	AUS	status fault path: evap system monitoring, PCV defective open
SY_AAV	DTEV	DOK	system constant condition : shut-off-valve available
TADTEA	DTEV	AUS	TEV duty cycle from canister purge diagnosis
TADTEAZS	DTEV	LOK	last duty cycle value from canister purge diagnosis
TATEOUT	ATEV	EIN	output duty cycle for canister purge valve
TC6TESC	DTEV	AUS	Output code SCAN tool mode 6 from purge control diagnosis
TC6TESS	DTEV	AUS	Output threshold SCAN tool mode 6 from purge control diagnosis
TC6TESW	DTEV	AUS	Output check value SCAN tool mode 6 from purge control diagnosis
TDTESTA	DTEV	LOK	time for DTEV check by CPV opening active
TDTETEVO	DTEV	LOK	time for CPV duty-cyle over threshold
TISPLDPX_W		EIN	Threshold for time for initial purging until LDP switch switches
TISPLDP_W		EIN	time for initial purging until LDP switch switches
TMOT	SWADAP	EIN	Engine temperature
TNSE_W	BBSTT	EIN	time counter at end of start (16 bit)
TNTEVZU	DTEV	LOK	time after PCV closing
TPLDPTCX_W		EIN	threshold time until LDP switch switches if CVP is open
TPLDPTC_W		EIN	time until LDP switch switches if CVP is open
TVFRRDTE	DTEV	LOK	delay time for Lambda controll reset after PCV closing
UMSRLN_W	BGMSZS	EIN	calculation factor load to mass flow
VFZG	SWADAP	EIN	vehicle speed (km/h)
Z_TES	DTEV	AUS	cycle flag of canister purge system

FW DTEV 32.90 Fixed Values

Parameter	Value	Description
APDTEFRE		number of tests to set flag fr stabilized for DTEV
APDTEVX		maximum number of checks at detected fault
AVDTEVX		maximum number of DTEV checks
CDKTES		code word customer: canister purge system
CDTTES		code word tester: canister purge system
CLATES		fault class: evap system monitoring, PCV stuck open
CWDTEAPP		Application code word for DTEV always active and swiching between HFM and P-sys.
DDFDTEAB		Threshold for abort of diagnosis because change of genarator signale is high
DFRMDTEE		delta-frm-threshold for detection of successful mixture correction
DFRMDTEF		delta Fr threshold 'rich correction' for check o.k.
DFRMDTEM		delta Fr threshold 'lean correction' for check o.k.
DMLDTEFN		Threshold air mass flow not plausible for detection fault in DTEV
DMLDTEFX		Air mass threshold for detection PCV defective no longer necessary
DMLDTEMN		Lower threshold for detection air mass flow not plausible for evaluation in DTEV
DMLDTEMX		Upper threshold for detection air mass flow not plausible for evaluation in DTEV
DMSNTEMN		Minimum standardized mass flow change PCV
DMSNTEMX		Maximum standardized mass flow change PCV
DMVTEVDO		Threshold loss adaptation to distinguish min, max faults in DTEV
DNDTEO		upper Nsoll-Nist threshold for abortion diagnosis CPV
DNDTEU		lower Nsoll-Nist threshold for abortion diagnosis CPV
ETAZWTEN		minimum threschold of ignition angle efficiency for diagnosis of PCV
FHODTEA		lower altitude threshold for diagnosis CPV active
FKADPMN		minimum feul part via CPV for passive O.K. testing.
FRMDPMO		upper frm threshold for passive switch on condition of diagnosis CPV
FRMDPMU		lower frm threshold for passive switch on condition of diagnosis CPV
FRMDTEVO		upper frm threshold for passive O.K. testing of diagnosis CPV
FRMDTEVU		lower frm threshold for passive O.K. testing of diagnosis CPV
FTEADDPO		upper load threshold for passive O.K. testing.
FTEADDPU		lower load threshold for passive O.K. testing.
FTEADSZ		threshold for immediate closing of CPV from DTEV
IMSDTEVA		thershold for integral of purge mass flow after a long purge stop
KIDMSNTE		Integration speed for the calculation of the mass flow change PCV
MLDTEFPF		threshold ml for possible Check passive diagnosis DTEV possible
MLDTEPF		threshold ml for possible Check passive diagnosis DTEV
RKADTEVO		upper rka threshold for passive switch on condition of diagnosis CPV
RKADTEVU		lower rka threshold for passive switch on condition of diagnosis CPV
RMSTEVIO		Threshold relative mass flow for O.K. detection
RMSTEVMN		Minimum value relative mass flow PCV
RMSTEVMX		Maximum value relative mass flow PCV
TADTEMX		duty cycle threshold for active testing
TC6TECI		mode 6 code word for O.K. check of CPV form DLDP
TC6TECL		mode 6 code word for O.K. check of CPV from air-test
TC6TECNL		mode 6 code word for NOT O.K. check of CPV from air-test
TC6TECP		mode 6 code word for passive O.K. check of CPV
TC6TECRF		mode 6 code word for O.K. check of CPV from FR-deviation dircetion rich
TC6TECRM		mode 6 code word for O.K. check of CPV from FR-deviation dircetion lean
TC6TECT		mode 6 code word for O.K. check of CPV form DLDP
TDTEFA		Time for blocking of DTEV as of start with tester request
TDTESZO		time after start for desactivation fast purge rate decrease DTEV at B_ll= TRUE
TDTESZU		time after start for activation purge rate decrease DTEV at B_ll= TRUE
TDTEZAM		time after engine start for possible activation of active DTEV
TFRMDTEE		monitoring duration frm
TMDTEU		lowest engine temperature threshold for diagnose
TPERDTE		time for repeating DTEV at non stop idle
TSFTES		fault active time: canister purge system
TTEVAZ		duration of stay for CPV opening with not successful frm
TVDTEABG		delay time between engine and Lambda- sensor
TVDTEB		delay time for statement TEV o.k./defect in diagnosis DTEV
TVDTEE		Duration as of PCV open for checking of DTEV
TVDTELLA		min. time for activation conditions DTEV at idle fullfilled
TVDTEVP		delay time for setting of the flip flop "Passive Diagnosis CPV o.k."
TVDTEVPM		delay time for setting of the flip flop "Diagnosis passive possible"
TVDTEVZ		delay time for closing CPV for active DTEV
ZDFFDTE		Time constant for highpas filter of genarator signale
ZFRMFIL		filter timeconstant for lambda controller
ZFRMXAF		filter time constant for frmxa_w signal
ZKRMSTEV		time constante low pass filter for mode 6 DTEV
ZMLETAN		Time cons. for filtering for the calc. of the energy needed for idling for DTEV
ZMSTEDTE		Time constant for filtering of the calculated mass flow PCV
ZRLTEDTE		Time constant for filtering of the calculated charge PCV

FB DTEV 32.90 Detailed description of function

```
Essentials of the DTEV for quick readers and crash course beginners
---------------------------------------------------------------------
"- Task of:     Check of the PCV with regard to controllability of the flow rate => permanently open as well as permanently closed"
  the DTEV      PCV is detected.

"- Checking        5 possibilities for O.K. - check "
principle:      1.) O.K.: DLDP reports PCV being O.K. from initial purging - only on projects with according DLDP
                2.) O.K.: DLDP reports PCV being O.K. from compulsory purging after canister pressure check - only on projects
                    with according DLDP
                3.) O.K.: From passive check. In a purge control phase high saturation is detected, which can only be caused by
                    an O.K. PCV. No previous problems of the mixture control => PCV can be controlled thus is O.K.
                4.) O.K.: From active check at idle. A deviation of the Lambda controller from its value prior to opening the PCV
                    indicates that the PCV can be controlled. => PCV O.K.
                5.) O.K.: If a stoichiometric mixture is coming there is no deviation of the Lambda controller
                   => Only the reaction of the idle control, which closes the throttle valve can be evaluated
                   => Indication for an O.K. check is the decrease of the air mass flowing through the throttle valve
                   => If the valve cannot close any further the ignition angle efficiency is worsened. This is also detected.
                1 possibility for defective PCV check
                1.) defective: If neither a reaction of the Lambda controller nor of the idle controller can be observed during
                    the active check by controlling the PCV open, then the PCV can no longer be controlled (jammed at closed or
                    open position) => defective

"- Preconditions: Precondition is a reasonably satisfactory application of the labels in %BGTEV and %ATEV especially at"
                  idle. => MSNTATE, KLAFTE !
                - Equally important is an application of the idle control incl. torque margin (KFMRES). If the parameters of the
                  idle control are changed later on, this may affect the result of the DTEV.
                - An adequately adjusted mixture pilot control and Lambda control is also a precondition for the DTEV.

"- Application:   - Now we can get started:"
                  - Set important codes and customer-specific labels correctly!!!
                    CWDTEAPP: Via Bit 0 a "continuous operation" of the DTEV can be activated, so that one open-control check
                              after the other results without the result being considered => very recommendable !
                              By means of the time TPERDTE it can be determined how fast the DTEVs follow one another!
                              Do not set TPERDTE to zero !!!
                    CWDTEAPP: By means of Bit 1 a distinction between a system with HFM and a system with P-charge sensing can
                              be made. On a P-system bit 1 is set => CWDTEAPP = 2 or 3!!!
                              On an HFM-system bit 1 of CWDTEAPP = FALSE => CWDTEAPP = 0 or 1!!!
                              In any case, please make sure that this bit is set correctly!!!
                    AVDTEVX:  Number of trials per driving cycle, until the DTEV "retreats unsatisfied"
                              Depends on the customer's request!  AVDTEVX: minimal 5
                    APDTEVX:  After a terminated check with negative result (E_tes = TRUE) the authorities only allow
                              for one repeated check within the same driving cycle. => APDTEVX = 2 !!!
                    TDTEZAM:  Time after the start as from when the DTEV tries an active check for the first time.
                              In the application phase the time can (should) be lowered to e.g. 10 s, otherwise it is
                              to be set to 590s for the FTP. Values for the Euro-Test are not yet known.
                - After this introduction of the most important labels for the initial start-up the DTEV should start
                  acting at idle (CWDTEAPP Bit 0 = TRUE, TDTEZAM = 10 s).

"- For more details refer to the following function description or to the block APP hint!"


Contents:
---------
 - Essentials of the DTEV for quick readers (see above)
 - Task and environment of the DTEV
 - Features of the PCV check
 - Comparison of the DTEV in ME7 in contrast to M4- and M5-systems
 - Functional principle, functional sequence, sequential control (timing in the exhaust test and in the field)
 - Connection of the DTEV to other functions
 - Detailed description of the FDEF figures and explanation of the bits and RAM-cells
```

Task, efficiency and environment of the DTEV:

"- The task of the DTEV is to detect a defective purge control valve. It is used in addition to the electrical diagnosis."
Provided the electrical diagnosis (%DTEVE) has already detected a fault, the DTEV remains inactive.
If the electrical diagnosis should not yet have detected a fault it will be detected by the DTEV.

"- Provided a leak diagnosis pump (LDP) is mounted in the system a PCV can also be checked for being O.K. by means of the" diagnostic function DLDP. The DTEV obtains the input signals (B_tevioi and B_teviot) from the DLDP. The active check DTEV is then switched off and the cycle flag is set. If no O.K. is obtained from the DLDP or if no LDP is mounted then the DTEV will perform the check.

"- The DTEV, however, at long last only gives a defect-statement by a comparison of"
a) through throttle valve (DK) "flowing performance" of the engine at idle (air mass DK* ignition angle efficiency) at closed PCV
b) through throttle valve (DK) "flowing performance" of the engine at idle (air mass DK* ign. angle efficiency) at 100% open PCV
If the PCV opens the performance flowing in through the throttle valve must decrease. The performance also decreases if the PCV as from a certain opening will distinctly open even further. Therefore a PCV leak up to about 40% of the maximum flow rate cannot definitely be detected, since the flow increases by 60% of the maximum flow rate when opening completely.
When the activated carbon filter is highly saturated, such a leakage, however, will trigger a fault in the diagnosis of the fuel supply (rkat or rkaz at the min. limit stop) and in the DLDP it will in any case produce a fault message "canister leaks".
A reduced maximum quantity through the PCV (lesser blockage) is also not definitely detected.
a) During the saturation test a PCV with about half of the maximum flow rate can already be tested as being O.K.
a) During the test by means of detection of an fr-deviation at idle already 10% of the maximum flow rate suffices if the activated carbon filter is highly saturated to arrive at an O.K. message.
b) During the air test on the other hand a PCV is only tested as being O.K. if the flow rate is higher than 50% - 60% of the nominal flow rate, otherwise an abort without result takes place. A defect-check will only be successful with a PCV with less than about 40% of the nominal flow rate.

"- The DTEV is suitable for Mono and Stereo Lambda control with continuous as well as two-step Lambda control."

'- The DTEV needs the "saturation-dependent purge control" (TEB) as well as the functions BGTEV (calculation of mass flow TEV) and' ATEV (output pulse duty cycle).

"- The DTEV is suitable for P-charge sensing (B_hfmv=FALSE) as well as for HFM-charge sensing."
- With the P-charge sensing the air mass flow through the throttle valve is derived from the throttle valve angle
- With the HFM-charge sensing this flow is obtained from the signal ml_w based on the HFM-signal.
- Via the code word CWDTEAPP (Bit 1) this can be coded.

Features of the PCV Check

* 2-stage Check:
  1) In a mixture adaptation phase it must be detected that there is no fault of the pilot control and that the factor Lambda control fluctuates stable round 1.0. If now - in a successive purge control phase - a high degree of saturation of the activated carbon filter is detected and regenerated by means of a high fuel rate, then this is an obvious sign that the PCV is okay (O.K.).
  2) The following test only needs to be performed if up to the time TDTEZAM after engine start no O.K. detection via high fuel rate from purge control (or via the DLDP) exists:
     - Progressive opening control of the PCV (comparable to DTEV on M4, M5).
     - O.K. check, if a deviation of the Lambda controller (toward rich or lean) or a distinct reaction of the idle control (negative torque action) is observed.
     - Defect-check, if no considerable Lambda controller deviation can be observed and if also the idle controller does not perform any considerable action (explanation see section: Comparison of DTEV in ME7 in contrast to M4, M5).

Comparison of the DTEV in ME7 in contrast to M4- and M5-systems / Differences between HFM-charge sensing / P-charge sensing:

Especially for the opening check mste = 0 is set, although the PCV is controlled open. Thus the relations in the system change at a few places in contrast to normal operation with purge control (TEB) as defined in ME7:

1) The air mass flow through the purge control valve is taken into consideration in the charge sensing.
The mass flow PCV (mste) is taken into consideration in the function %EGFE => rl_w comprises mste !

```
mshfm --------->O---------> mlroh (air flowing into the intake manifold)
              + ^
                |
mste -----------+                      With DTEV controlled opening check mste = 0 is set !!
                                       => this switches off the consideration of the PCV air
                                          in the charge sensing !
                                       Remark for P-system: The P-sensor also measures the charge rate of the PCV !!!
                                       Thus it is always taken into consideration in ml_w and rl_w (also with DTEV) !!!
```

2) During the calculation of the desired throttle valve angle mste is taken into consideration => at open PCV the throttle valve opens accordingly less !

```
             +
mlsol -------->O----------> mldks (setpoint for air mass through throttle valve)
               ^-
               |
mste ----------+                       With DTEV controlled opening check mste = 0 is set !!
                                       => thereby the position of the throttle valve will at first
                                          not change when the PCV is opened.
                                          Only if the idle control and mifa_w decrease,
                                          is the throttle valve e.g. closed.
```

3) The mixture correction of the purge control takes place additive in the ME7 (rkte_w instead of ftea on M4 and M5).
The relative fuel rate is calculated from: Degree of saturation (ftead_w) * relative charge purge control (rlte_w)

```
                                     +-+
ftead_w ---------------------------->| |                      During the active controlled opening by the DTEV (B_dteaa = true)
                                     |x|--------> rkte_w      mste remains = 0 ! Thereby also rlteev_w remains = 0.
rlteev_w --------------------------->| |                      Thus no mixture correction via rkte_w is performed.
                                     +-+
```

Conclusion:
- When the PCV is opened by the DTEV (controlled opening check) all above-mentioned actions are switched off (mste_w = 0).
- Thereby the relations of the M4 and M5 are re-established.
- One of the features of an O.K. PCV is that either the Lambda control or the idle control shows a reaction.
- Only if both control types show no reactions is the PCV defective (either incorrectly open or incorrectly connected).

Further exceptional features of the ME7 as compared to M4 and M5:
- A further difference of the ME7 is the torque-based idle control.
  Actions of the idle control take place on basis of the torque (dmllr...) and not as in M4, M5 on basis of air only (qsol)!
  The idle control takes action via the throttle valve as well as via the ignition angle.

Special features of HFM charge sensing as compared to P charge sensing:
- The ignition angle efficiency effective at active DTEV (PCV open) is not etazwist, since the additional charge through the PCV is not taken into consideration on the HFM-system when the optimum ignition angle KFZWOB (nmot, rl) is calculated.
  The actual efficiency is usually greater since the charge is greater and thus zwopt is less advanced.
  => Correction map KFDETATE. With the P charge sensing the PCV air mass flow is in any case contained in rl_w.
- Since rl_w becomes very small on the HFM-system during DTEV and in the process does not correspond to the actual charge it could happen that the lower rl threshold RLMNN would be reached. So that this will not happen the threshold is lowered by the amount of the already detected rl_w decrease (rltedte_w).
- During HFM charge sensing the Lambda controller will show no reaction when the PCV is opened, only in case of stoichiometric mixture. During P charge sensing this will be the case with pure air since here the additional PCV charge is measured in rl_w.
- During the HFM charge sensing the charge sensor (HFM) only sees that air, which flows through the throttle valve. Provided overcritical pressure ratios exist the equalizing HFM / Alfa-n (msndko_w, fkmsdk_w) is not influenced when the PCV is opened by DTEV.
- During the P charge sensing the charge sensor (P-sensor) sees the PCV air, the Alpha-n system does not see this mass flow. This leads to a mismatch and to adaptation demand with msndko_w. This Delta (dmsnte_w) is learned in the DTEV and transferred to the BGMSZS. When the PCV is abruptly closed at the end of the DTEV, dmsnte_w is reset to zero.

4) There is an ME7 for the continuous as well as for the two-step Lambda control. Therefore the PCV check should work with both Lambda controls. The fast mean value of the Lambda controller (frm_w) serves as input value for the DTEV.
On Stereo-systems either the mean value from both banks (frmit_w) calculated in the TEB or that frm_w, which is further away from the neutral value 1.0 (frmxa) is used. By means of a low-pass filtering (of frmxaf_w) it is in addition possible to achieve an approximately equal dynamics for continuous or two-step control. Thereby the DTEV is suitable for both controls.
Frmitf_w should be filtered with a distinctly smaller time constant.

Functional principle, functional sequence, sequential control (timing in the exhaust test and in the field):

By means of the 2-stage check (passive, active) the DTEV tries to come to a diagnostic result as soon as possible after the engine start.

a) Passive check (can only be terminated if the PCV is O.K):

- During a mixture adaptation phase with low engine air mass flow it is determined whether the pilot control is O.K.
  An indication for this is: Mixture adaptation needs to perform minor corrections only, the Lambda controller is not far off the neutral value.
  The flip-flop "diagnosis passive possible" (B_dtepm) is set.
  The passive diagnosis is only enabled if a fault was not already detected (E-tes = TRUE). Thereby a healing at detected fault is only possible via the controlled opening check.

- In one of the successive purge control phases the O.K. check can already take place with medium to high but plausible degrees of saturation of the activated carbon filter. As soon as it is discovered that purging is performed at high fuel rate at an air mass greater than a threshold and that in the process the Lambda controller fluctuates relatively stable round 1.0, an O.K. detection is triggered (B_teviop). The PCV check is terminated for this driving cycle.

  Remark: In the US FTP75 Test - during the actual exhaust test with saturated activated carbon filter - this check will in all probability be successfully terminated already on the 3rd or 4th hill if the PCV is O.K.

b) Active check (check by means of active PCV opening control by the DTEV):

- Enabling of the active diagnosis:
  - After the time TDTEZAM has elapsed (e.g. TDTEZAM = 590s in the FTP75 prior to long idling at 600 s) the active check is permitted (B_dtezam), if so far no other check was completed with O.K. and if in addition the integral of the currently purged air mass (imsteini) has exceeded the threshold IMSDTEVA. Other diagnostic functions can furthermore block the DTEV (DDMTL, DLDP, DLLR).
  - The active check is only attempted for a limited number of times per driving cycle. In case of an abort (diagnosis can make neither an O.K. nor a defective statement), the counter is increased by "number of trials DTEV" (avdtev). If it reaches the value AVDTEVX then the active DTEV is no longer activated during this driving cycle.
  - After a defect-check (no O.K. but B_dteend = TRUE) only one repeated test is possible (APDTEVX=2) - CARB requirement! During the quick test (B_fa, B_fates) no repeated test is possible.

- Decreasing control of the purge rate in TEB (B_ftedab)
  - As soon as the flag B_ll is set (driver steps off the accelerator) a decision is made on whether the decreasing control shall be effected immediately or only once idling is stable. The following is achieved by means of this distinction:
    a) An immediate decreasing control in case of "snap off throttle" (B_ll = TRUE) in order to be able to use the limited time during the exhaust test at idling solely for the controlled opening of the PCV. No valuable idle time shall be wasted for a controlled decrease of the PCV from a purging phase. A decreasing control is then performed during fuel cut-off on overrun (manual transmission) or already prior to the stopping of the vehicle (automatic transmission). This quick decreasing control of the purge rate (B_ftedab) reduces the necessity of an adaptation phase prior to the DTEV as compared to the M4 or the M5.
    b) With high saturation it would not be sensible to each time request a quick decreasing control of the purge rate whenever the driver steps off the accelerator (B_ll = TRUE). The purge quantity would be distinctly reduced. The decreasing control is only activated here if the vehicle is at rest for a certain time (delay time: TVDTEVZ) during idle (vfzg = 0).

- Request of the active check:
  - The partial function DTEVZU checks the performed decreasing control of the purge rate by an inquiry of ftefsoll_w = 0 ! If ftefsoll_w = 0, the bits "active check active" (B_dteaam and B_dteaa) are set. B_dteaa switches mste_w and mste = 0 in BGTEV!! B_dteaam is reset one calculation cycle earlier than B_dteaa and is needed as function-internal control bit.
  - Simultaneously the "global bit" B_dtes is set, which indicates in the motronic system that the DTEV now actively opens the PCV. B_dtes and B_dteaa remain set in case of an abort of the DTEV or when the DTEV has terminated until the PCV is truly closed (tateout = 0)! Only then is the flip-flop reset. Thus this bit constitutes "the bracket" round the active PCV opening control by DTEV.

- Mode of operation of the active check:
  - The inclusion of the mass flow PCV is switched off in the motronic system (B_dteaa = TRUE => mste_w = 0).
  - The PCV is controlled open progressively (at first slowly then increasingly faster).
  - The deviation of the Lambda control factor is watched. A deviation of more than 5% - 10% suggests an O.K. PCV.
  - Apart from the Lambda controller also the needed air mass is evaluated with the current ignition angle efficiency (so to speak the performance flowing through the throttle valve needed at idle) is watched. If this performance drops as expected when the PCV is opened then it can be assumed that the PCV is O.K.; if it drops less than expected then the PCV is partially blocked (the PCV quality is less); if the performance flowing through the throttle valve remains constant then the PCV is defective.

c) Interaction of the DTEV with the canister diagnosis DLDP (if existing)

- The canister diagnosis DLDP can have the PCV checked as being O.K. already prior to the passive or active check (B_tevioi or B_teviot is set). The active check of the DTEV then no longer needs to be performed, the passive check (B_teviop), however, is not blocked. B_teviop being set then, however, has no effect on the fault memory since Z_tes = TRUE and E_tes = FALSE were already set prior to the DLDP.

- In DLDP there is a code word, which distinguish here

  1) LDP without external AAV (LDP is near the charcoal canister (AKF)). The LDP ist the only connection between tank system and ambient air. The membrane e.g. is closed by the shor circuit to mass and the tank system is not aerated.

  2) LDP with extrenal AAV (LDP is near the engine, at chacole canister is a electiric shut-off-valve). The tank is not aerated, if the electric shut-off-valve can not open and the DLDP membrane is closed too.

  SY_AAV =
  TRUE: AAV is installed ==> DTEV stop only, if E_aave&E_ldpe&!B_ldpi
  FALSE: without AAV ==> DTEV stop only, if E_ldpe = TRUE

Summary Timing: DLDP-PCV-Check / Passive check / Active check / immediate and delayed decreasing control of the purge rate in TEB for active check:

- In the first mixture adaptation phase the DLPD (about: Second 200 - 350 after start) can become active, if its input conditions are fulfilled. With O.K. system (PCV O.K., canister O.K., LDP O.K.) either B_tevioi or B_teviot is set. The active check of the DTEV will in this case be switched off otherwise, or if a fault PCV is already given (E_tes = TRUE) the DTEV will check itself. If no DLDP exists B_tevioi and B_teviot remain set to FALSE.
- For a certain time as from engine start at first only the passive check is possible (TDTEZAM). Provided it cannot be terminated successfully by then the active check becomes possible (B_dtezam). As from second 590 in the FTP.
- A quick decreasing control of the purge rate was defined for the DTEV in TEB and TEBEB. With the bit B_ftedab it is possible to control the purge rate down within e.g. 2 seconds. Thus a preliminary mixture adaptation phase is not necessarily needed in the exhaust test.
- This decreasing control usually only becomes active at considerable saturation if all conditions for the DTEV are given for a certain time (vehicle at rest during idle, idle control active ...).
- With low saturation and if the time after start lies within a time window (e.g. for long idling in the FTP75: 990 s - 1030 s), the quick decreasing control is already started with B_ll = TRUE. By this the DTEV has a guaranteed maximum of checking time in this idle phase.

Connection of the DTEV to other functions:
----

a) Charge sensing and calculation of ignition angle efficiency => provision of a variable for the energy demand of the engine
  - The charge sensing supplies the air flowing through the throttle valve:
    i) HFM-charge sensing: Air mass flow ml_w (does not include the PCV air mass flow mste_w since mste_w = 0 !)
       The DTEV evaluates the air mass flow with the accuracy of the HFM !
    ii) P-charge sensing: msndkoo_w * fho_w * ftvdk_w * fklaf_w (msndkoo_w => standardized air mass DK (characteristic MSNWDK))
       Attention: The application of MSNWDK is relevant for DTEV !!! Do not change after the application of DTEV !!!
  - With the P-system a learning of the PCV leakage air is necessary: dfuelsan_w => dmsnte_w (inclusion in BGMSZS in msndko_w).
  - The ignition angle efficiency is etazwist ! Provided the ignition angle does not correspond to the optimum ignition angle it becomes less than 100%. Attention: The ignition angle efficiency is only accurate if the charge rl_w is correct. This is not the case for an open PCV on an HFM-system!! => refer to application correction map KFDETATE !

b) Lambda Control:
  - Input values from the Lambda control:
    - From frm_w and frm2_w the variables frmxa_w and frmit_w are formed in %TEB. Refer to TEB.
    - B_lr, B_lr2 indicate, that the Lambda control of the respective bank is active. For DTEV it is sufficient only if one bank operates.
  - Output values for the Lambda control:
    - B_dtefrr: Condition setting of the control factors to the value frdter_w
    - frdter_w: Value for control factors for B_dtefrr

c) Idle Control
  - B_llr : Idle control active
  -> although the idle control is decisive for the DTEV, no analogous variable of the idle control is directly inquired upon.
     The following variables, however, are evaluated indirectly:
     ml_w: measured HFM air mass flow, which indicates the air mass flow through the throttle valve
     etazwist: current ignition angle efficiency. This value is influenced by the idle control.
     Remark: The product from air mass flow ml_w and ignition angle efficiency is a variable, which corresponds to the needed and measured performance of the engine during idling. If the PCV now opens the measured performance becomes less since the PCV introduces "not measured" performance (air mass PCV * ignition angle efficiency at open PCV). At constant idling the measured performance needs to drop with an O.K. PCV.
  - Actions taken by the DTEV in the idle control and in the demand adaptation are:
    - at active DTEV the demand adaptation is blocked
    - the I component of the idle controller is expanded
    - at the end of the DTEV the I component is reset by that absolute value, which it has "learned down" during the check. Thereby it is possible to prevent a drop of the idle speed.

d) Purge Control (TEB):

- Input values from TEB:

Desired purge rate (ftefsoll_w):	The desired purge rate is the output of an integrator in the TEB.
Currently learned ACF saturation (ftead_w):	The saturation is no longer learned during DTEV
Current fuel rate purge control (fkatei):	The fuel rate is calculated from fteva_w * ftead_w
Max-deviation of the Lambda controllers (frmxa_w):	Serves as a measure for a system without mixture fault
Mean value of the Lambda controllers (frmit_w):	
Integral of just purged mass flow (imsteini):	Enables the active check

- Output values for TEB:
  B_ftedab: Condition quick decreasing control of purge rate: controls ftefsoll_w down to zero within a short time and holds the purge rate at zero during the DTEV controlled opening check.

- Output values for TEBEB:
  B_dtes: Disables the TEB

e) Decrease of the RL-Min-limitation in MDFUE => Variable from DTEV: rltedte_w:
Only significant on HFM-systems. Here, the variable rl_w does not contain the charge flowing through the PCV into the intake manifold. Thus the limit RLMNN would be reached in many cases and the throttle valve would thereby be stopped against further closing. However, since the actual charge at open PCV is higher, the MIN-threshold for rl_w can be decreased by that absolute value, as was already detected as decrease of the air flowing through the throttle valve into the intake manifold (dmletan_w resp. dmletanu).

f) Calculation of mass flow PCV (BGTEV):

- BGTEV supplies that mass flow mstedte_w, which is also calculated if the DTEV is active.
  The bit B_dteaa is also included in BGTEV and it switches the mass flow mste and mste_w to zero for the other motronic functions (charge sensing, throttle valve triggering) when B_dteaa = TRUE.

g) Switch on condition mixture adaptation (LRAEB): The LRA is only blocked once the DTEV truly performs an opening control of the PCV (B_dtest = TRUE).

h) Sequential control (BBTEGA):

- B_dtes forces the decreasing control of the purge rate and triggers a mixture adaptation phase. The LRA is active until B_dtest is set. (refer to point f)

i) Diagnosis canister leak with pressure pump (DLDP):

- B_tevioi (PCV detected as O.K. by DLDP-PCV-Check by means of initial purging)
- B_teviot (PCV detected as O.K. by DLDP-PCV-Check by means of a decrease of the dropout time after leak test)
- For Mode 6: tispldp_w and tispldpx_w from DLDP for B_tevioi
- For Mode 6: tpldptc_w, tpldptcx_w form DLDP for B_teviot

j) Diagnosis idle control

- The DLLR must be able to block the active check of the DTEV: B_dllra blocks B_dtezam
  Thereby priority can be given to the DLLR (=> see DLLR).

k) Other input values:

- Vehicle speed: vfzg
- Factor altitude: fho_w
- Condition factor altitude is valid: B_hag
- Detection driving position engaged/disengaged: B_fs
- Detection air conditioner on/off: B_koe
- Deactivation due to fault:
- Deactivation in case of SLS and DSLS
- nsol, nmotll: to check on whether a constant idle speed is maintained and for the abort in case of engine speed increase
- B_dldpte: Diagnosis DLDP can block DTEV
- B_dmtltz: Diagnosis leak diagnosis pump can block DTEV
- kldfpwm: PWM-signal of the generator excitation

l) Tester interface

- B_fa
- B_fates
- The DTEV switches off as soon as another function is to be tested
- The opening control check is activated by B_fa & B_fates. Prior to that quick decreasing control DTEV. Other blocks (B_dllra, tnse_w < TDTEZAM) are canceled.
- When the quick trip is activated a DTEV internal reset is triggered, so that the check will be performed in any case. The fault memory, however, is not cleared. At the end of the quick trip the result is maintained!

Detailed description of the FDEF figures and explanation of the bits and RAM-cells:

The function is subdivided into 6 partial functions:

1) Creating of some signals (DTEVSIGA)
2) General switch-on conditions (DTEVEB) / subdivided into partial functions: DTEVPEB and DTEVAEB
3) Passive check PCV (DTEVP)
4) Request of quick closing control (DTEVZU)
5) PCV check by active opening control (DTEVAUF) / subdivided into partial functions: DTEVLR, DTEVLL, DTEVTAT, DTEVAEND
   - 5.1) Partial function DTEVAUF / DTEVLR:
   - 5.2) Partial functions DTEVAUF / DTEVLL and DTEVAUF / DTEVLL / DTEVDML:
   - 5.3) Partial function DTEVAUF / DTEVLL / DTEVRQ:
   - 5.4) Partial function DTEVAUF / DTEVTAT:
6) Formation of the signals for the fault management (DTEVEA - "Error-treatment")

1) Partial function DTEVSIGA:
The signals of the Lambda control (frmit_w and frmxa_w - conditioned in %TEB) are filtered in this partial function. Varying time constants should be chosen.

2) Partial function DTEVEB:
General switch-on conditions - The partial function DTEVEB has the subfunctions DTEVAEB (switch-on conditions for DTEV active check) and DTEVPEB (switch-on conditions for DTEV passive check).

Local bits from DTEVEB:
- B_dteenf: all functional parts of DTEV blocked, since other error was detected, which interacts with DTEV
  - blocks the active check by an opening control of the PCV (B_dtezam)
  - blocks the Lambda evaluation at any one check (B_dtelbm)
  - resets the flip-flop: Passive check possible (B_dtepm)
- B_dtelbr: resets the flip-flop: Passive check possible (B_dtepm)
- B_dtephm: DTEV checks are physically possible (exception: the readiness of the Lambda control, this is executed separately). Important here: Altitude deactivation via fho_w and switch-off if engine temperature < threshold.
- B_dtenam: Diagnosis only possible by an opening control of the PCV !
  - PCV already detected as defective (E_tes)
  - fault in the fuel supply system assumed
  - DTEV is activated by the tester
- B_dterap: Reset after aborted or successful check in the application phase so that another check can be enabled
  This continuous periodically returning reset is activated via the code word: CWDTEAPP (Bit 0)

Output values of the partial function DTEVEB:
- B_dtezam: Diagnosis by an opening control possible
  - Conditions for B_dtezam = TRUE:
    - PCV not already checked as being O.K. by the passive check
    - PCV not already checked as being O.K. by the idle control
    - PCV not already checked as being O.K. by the Lambda control
    - PCV not already checked as being O.K. from the DLDP (B_tevioi or B_teviot) if error bit E_tes = FALSE and no function demand DTEV (B_fates)
    - Max. number of trials by active action (avdtev) not yet reached
    - Max. number of checks with detection of a fault (apdtev) not yet reached
    - no other fault blocks the DTEV
    - bit idling (B_ll) is set
    - active checks of the DTEV are physically possible (B_dtephm)
    - time as from start has exceeded the value TDTEZAM (time for DTEV closing/opening check elapsed) (For FTP-Test: TDTEZAM: 590 s) or with function demand (B_fates) time TDTEFA exceeded.
    - counter for cyclic repeat (CWDTEAPP Bit0=TRUE) has reached the value TPERDTE.
    - B_dldpte, B_dmtltz and B_dllra, B_grdst and B_m8te can block the active check
    - imsteini must be greater or equal to a threshold: Thereby the DTEV active check is only started if a purging phase was performed immediately beforehand.

- B_dtelbm: Lambda evaluation possible: Diagnosis via fr evaluation possible, system O.K.

- B_dtepm: flip-flop - condition passive diagnosis possible

  - Setting conditions for B_dtepm (must be given for longer than TVDTEVPM for the flip-flop to be set):
    a) B_dtelbm = TRUE (Lambda evaluation possible)
    b) additive correction (rkat_w + rkaz_w) of the mixture adaptation small
    c) air mass less than threshold (ml < MLDTEFPF), so that a PCV jamming at the open position does not lead to B_dtepm being set erroneously.
    d) filtered Lambda controller frmxaf_w in range round 1.0
    e) an adaptation phase must be active (B_gap = TRUE)

  - Reset conditions for B_dtepm:
    a) additive correction of the mixture adaptation during an adaptation phase large
    b) filtered Lambda controller outside of range round 1.0 during an adaptation phase
    c) fault, which blocks the diagnosis or fault in the fuel supply system detected
    d) only active check possible (B_dtenam = TRUE)
    e) Reset DTEV desired (B_dteres = TRUE)

- B_dteres: Condition reset diagnosis DTEV: resets all memories of the function to initial values (also error and cycle flags).

3) Partial function DTEVP:

Passive check - O.K. detection with reliably detected high degree of saturation of the activated carbon filter while simultaneously there is a high fuel rate from the purge control during purge control operation.

- saturation medium or high, however, plausible: FTEADDPU <= ftead_w <= FTEADDPO
- fuel rate purge control high: fkatei = ftead_w * ftefva_w > FKADPMN
- filtered Lambda controller within the range round 1.0: FRMDTEVU <= frmxaf_w <= FRMDTEVO
- engine air mass greater than threshold: ml_w > MLDTEPF (so that PCV with only minor throughput is not erroneously detected as being O.K.)
- in partial function DTEVEB it was determined that the diagnosis passive is possible: B_dtepm = TRUE.
- Lambda evaluation for diagnosis DTEV is possible (B_dtelbm)

=> All conditions must be fulfilled for a minimum time (TVDTEVP), only then will the flip-flop B_teviop be set.

4) Partial function DTEVZU:

Request of a quick decreasing control of the purge rate, activation of the opening control check

As soon as the bit B_dtezam (active check possible) is set a decreasing control of the purge rate is either immediately effected or it is still waited until the activation condition of the DTEV are stable (B_llr, vfzg = 0, at least the Lambda control on one bank is active for longer than TVDTEVZ). The bit B_ftedab goes to the TEB and demands a quick decreasing control of ftefsoll_w there.
Immediate decreasing control:
- in case degree of saturation (ftead_w) is less than threshold (FTEADSZ) or
- time as from end of start within window: TDTESZU <= tnse_w <= TDTESZO.

The opening control of the PCV can be enabled (B_dteaam = TRUE) as soon as the purge rate was controlled down and at the earliest once the time TVDTELLA after stable idling has elapsed.

The bits B_dtes and B_dteaa inform the motronic that the PCV may be open due to the opening control from the DTEV. These bits are only reset once tateout = 0. Two bits are necessary so that in the same system also a DTESK can be used (B_dteaa sets in BGTEV mste and mste_w = 0; mste_w is to be calculated in case of DTESK) !

5) Partial function DTEVAUF:

Check by means of an opening control of the PCV during idling

The opening control check is only activated, if so far no O.K. detection is given: The test is performed by a progressive PCV opening control (comparable to DTEV with M4, M5).
An O.K. check takes place if a deviation of the Lambda controller is observed or if the idle actuator performs a considerable action (product from air through throttle valve * ignition angle efficiency decreases)!
A defect-check takes place if no considerable Lambda controller deviation can be observed and if in addition the idle controller does not need to perform any considerable action. (Explanation also refer to section: Changes of ME7 as compared to M4, M5).

The opening control check is again subdivided into 4 further partial functions
- DTEVLR: Check of PCV by an evaluation of the factor Lambda control
- DTEVLL: Check of PCV by an evaluation of the determined power demand
- DTEVTAT: Calculation of the pulse duty cycle tadtea, as well as of the resetting value and of the reset condition for the Lambda controller in case of end or abort of the opening control check DTEV
- DTEVAEND: Combination of all abort and end conditions of the opening control check DTEV

5.1) Partial function DTEVAUF / DTEVLR:

The partial function (DTEVLR) evaluates the filtered mean value of the Lambda controller (frmitf_w) and forms the bit for the start of the PCV opening control (B_dtest).

Start of the PCV opening control:
i) If frmitf_w has changed only little (change < DFRMDTEE) for several times in succession (no. of times: APDTEFRE) within a predefined time (TFRMDTEE) then the bit "frmitf_w stabilized" is set (B_dtere = TRUE). Now an opening control is possible and the Lambda controller can be evaluated.
ii) If the time as from the beginning of the enabling (B_dteaa) has exceeded the value TTEVAZ, an opening control is also performed. Without the detection "frmitf_w stabilized", however, the O.K. detection via the evaluation of the Lambda controller is refrained from.
Remark: If the frmitf_w is close to the limits frmn_w resp. frmx_w, then neither the PCV is controlled open nor is the DTEV terminated until either idling is exited or until the mixture adaptation has learned the deviation.

The RAM-cell frmfref_w is updated each time a "sample" of frmitf_w is taken.
Frmfref_w is also continuously updated if frmitf_w lies close to the lift limits of the Lambda control (frmn_w, frmx_w).
Frmfref_w serves as reset value for the Lambda controller after the end resp. in case of an abort of the DTEV.

The function is successfully terminated (B_tevior - O.K. detection via the factor Lambda control):
- if B_dteaa is set
- if frmitf_w was detected as having stabilized
- if frmitf_w was still far enough away from the control limit stop
- if frmitf_w rose by more than DFRMDTEF after the beginning of the PCV opening control or if it dropped by more than DFRMDTEM

Remark: A successful termination via B_tevior also leads to a resetting of the bit B_dtezam, which in turn resets the active bit B_dteaam. Thus tadtea = 0 results (partial function DTEVTAT), which in turn resets B_dteaa, B_dtes and B_dtest in the partial functions DTEVZU and DTEVLR.

The function is aborted (B_dternm):
- if B_dteaa is reset, because e.g. idling is stopped. Then also B_dtes and B_dtest are reset.
- if the control limits (frmn_w resp. frmw_w are narrowed during the diagnosis and therefore not enough control lift remains for an O.K. diagnosis.
- if with "not stabilized" Lambda controller - B_dtefre = FALSE

Prior to the opening of the PCV the function waits for a stabilization of the mixture adaptation (rkat_w) if frmitf_w has no sufficient distance to the control limits.

The evaluation of the measured engine performance (air mass flow throttle valve * ignition angle efficiency) is performed simultaneously for as long as the function was neither successfully terminated with B_tevior nor that it was aborted.

=> see partial function DTEVLL:

5.2) Partial functions DTEVAUF / DTEVLL and DTEVAUF / DTEVLL / DTEVDML:

This part of the check evaluates the "performance flowing in through the throttle valve". If the O.K. PCV is opened then the engine speed and thus the idle engine performance is kept constant by means of the idle control; ignition angle efficiency and /or air mass flow through the throttle valve are reduced by that absolute value of unmeasured performance, which the PCV brings in (mass flow PCV * ignition angle efficiency), provided the Lambda control corrects the mixture to Lambda = 1.
On the HFM charge sensing the signal "ml_w" is used as airflow through the throttle valve!
On the P charge sensing this airflow can be calculated from the characteristic MSNWDK as well as from the KLAF and the altitude and temperature correction. Since the intake air temperature (especially with a sensor in the intake manifold) can change fho_w * ftvdk is "held" during the check.

On HFM-systems, however, the following problem results:
- By a feed-in of not measured additional charge through the PCV the source rl of the map KFZWOP becomes incorrect. A smaller value is for example outputted for zwopt (more advance ignition angle) than the actual current physically correct value at completely open PCV (e.g. zwopt = 35° (rl = 12%) although the actual charge is 17% and zwopt would be 30° for this).
- If zwist lies in the region of zwopt, this is not dramatic. This only becomes a problem if simultaneously a considerable torque margin (resp. ignition angle timing of the idle control) is active.
  The dependency of the engine torque on an incorrect optimal ignition angle is then high. The ECU value etazwist is then extremely incorrect.
  The following diagram shows two ignition angle efficiency parabolas next to each other:
  1) +++ engine efficiency calculated in the ECU (calculation is performed with etazwist)
  2) *** current physically acting engine efficiency

```
  Characteristic ETADZW:
                                +
                                *                     +
                                                      *           +                                             |
      zw = zwopt_SG                                               *    +  etazwist = 100%                       |
   c) zw = zwopt_SG - 10°                                         +    *  phys. best efficiency             retarding
   b) zw = zwopt_SG - 20°                             +           *                                             |
   a) zw = zwopt_SG - 30°        +                    *           |    |                                        |
                                 *                    |           |    |                                        v
                                 |                    |           |    |
                                60%                  80%         95%  100%
```

CONCLUSION: The angle for the physically best efficiency lies by 10° later than the angle assumed in the ECU. Thus the following faults result:
a) Control Unit (ECU) shows etazwist = 60% => due to a higher charge, however, the engine runs with 80% efficiency! 20% error
b) Control Unit (ECU) shows etazwist = 80% => due to a higher charge, however, the engine runs with 95% efficiency! 15% error
c) Control Unit (ECU) shows etazwist = 95% => due to a higher charge, however, the engine runs with 100% efficiency! 5% error

This must be taken into consideration in DTEV ! => Formation of etazwkte in DTEV for the performance balance.

The above representation shows: The smaller etazwist, the larger is the fault between the value of the ignition angle efficiency in the ECU (etazwist: curve with +) and the physical efficiency acting in the engine (curve with *).

Solution: etazwist is increased by detazwte. Detazwte is again output of the map KFDETATE (etazwist, dmletanu)
Thereby - dependent on the current ignition angle efficiency (etazwist) and on the already detected decrease of the HFM mass flow at idling (dmletan) - it is possible to add a delta efficiency to etazwist in order to obtain the actual engine efficiency.
Application of KFDETATE refer to APP.
Remark: The charge rl_w is always correctly sensed with the P charge sensing => KFDETATE = 0 !

Calculation of the detected PCV air mass flow (mste_ber = dmletan_w):

The PCV air mass mste_ber calculated from the decrease of the "performance flow through the throttle valve" is:

```
                        (msdk_vor  * etazwkte_vor)  - (msdk_wäh * etazwkte_wäh)
mste_ber = dmletan_wäh = ------------------------------------------------------
                                              etazwkte_wäh
```

Abbreviations:

mste_ber:	calculated effect of the air mass flow PCV
dmletan_wäh:	decrease of the measured engine performance / ignition angle efficiency during the check
msdk_vor:	air mass flow throttle valve prior to the check - from ml_w with an HFM-system - from MSNDK, fklaf_w and fho_w and ftvdk with a P-system
etazwkte_vor:	ignition angle efficiency prior to the check
msdk_wäh:	air mass flow throttle valve during the check (calculation of msdk_w see above)
etazwkte_wäh:	ignition angle efficiency during the check

The RL-fault of the HFM-system necessitates a further connection:
DTEV -> MDFUE. The RL-Min-limitation must be lowered in MDFUE => variable from DTEV: rltedte_w:
Otherwise the limit RLMN would be reached in many cases and the throttle valve would thereby be held against further closing. The MIN-threshold for rl_w can be lowered by that absolute value, which was detected as decrease of the air flowing into the intake manifold through the throttle valve, since the actual charge at open PCV is higher.

Check of the idle energy demand:

Preliminary remark: Since this check at long last decides on "defective", O.K. or function abort it is the most important and "unfortunately" also the most complicated part of the DTEV. For the basic understanding, here are a few important statements to start with:

- Quite a few "disturbances known or not known to the motronic" influence the check.
- For one the air conditioner must be mentioned. Its energy demand distorts the balance extremely. As a rule at least one switch on / off is known (edge of B_koe). In this case an immediate abort is performed.
- The same applies to the driving position switch on the automatic transmission (B_fs)
- The generator excitation (kldfpwm) is known for some projects. A change leads to an abort.
- Unknown large disturbance variables are power steering and slipping clutch!!
- Just as, it is possible that electric consumers can but must not have a disturbing effect. A switch-on and off only disturbs, if the energy absorbed by the generator changes. If it was already at "its end" prior to the current output, then the supply voltage will break down, the engine is not put under more stress.
- Further effects are surely also the engine friction, which can change immediately after engine start or after a high-load phase during idling.

  If now - with an O.K. PCV - an unknown consumer "sets in" while the PCV opens then this leads to a minor decrease of the "performance flow through the throttle valve". There is a risk of an erroneous defect-detection. Analogous the reversed case (defective PCV and O.K. detection) is possible.

Conclusion:
- An as reliable as possible detection of such disturbances must be realized.

Solution:
- The basic idea of the solution is as follows.
  - The temporal course of the expected decrease of the air mass flow through the throttle valve is known (mstedtef_w)
  - The currently "measured" value of this decrease is dmletan_w. In case of an e.g. partially blocked PCV this decrease is only a percentage of the expected value. This percentage will be described as PCV quality in the following description. This percentage can also be greater than 100% with a MAX-PCV.

  - This percentage can be determined in a control loop directly from mstedtef_w and dmletan_w (integrator for PCV quality rmstevf_w). For that the product from the determined PCV quality rmstevf_w is multiplied by mstedtef_w and subtracted from dmletan_w and the result is passed on to the input of the integrator.

After this introduction for the basic understanding, now further details of the function:

- The current value of mletan_w (ml_w * etazwkte) is stored temporarily in the RAM-cell mletanzs_w when the PCV is opened for the opening control check.
- From then on the deviation between the current and the temporarily stored value is formed.
- This difference is divided by the current, filtered ignition angle efficiency etazwif. The calculation value for the PCV air mass flow "dmletan_w" of the currently mounted PCV is thus obtained.
- This calculated value must approximately correspond to the expected value mstedte with an O.K. PCV. With a defective PCV, dmletan_w hardly changes. With a partially blocked PCV the value is only a percentage of mstedte.
- The respective input values are filtered by the three low-pass filters "mletan_w, etazwif and mstedtef_w", so that very short-termed fluctuations (especially of etazwist) do not disturb the diagnosis. Just like the measuring signals also the reference signal (mstedte) needs to be filtered. Here it is possible to choose a different time constant (ZMSTEDTE) in order to straight away take the delayed stabilization of the idle control, which after all causes a delay at dmletan_w, into consideration.
- The integration speed of the PCV quality integrator can be chosen dependent on mstedte (KIRMSMS). If e.g. a high integration speed with small mstedte and a low integration speed with large mstedte values is chosen then it is possible to keep the difference "dmletan_w - dmletanf_w" largely independent of mstedte in case of disturbances.
  => constant disturbance deactivation.
- The "unsigned" variable of the PCV quality is rmstevuf_w. Provided the PCV was already open for a certain time (B_dteanfl) rmstevuf_w approximately corresponds to the quotient: Air mass flow of currently mounted PCV/air mass flow of standard PCV * 100%.

- The formation of the bits B_teviol (O.K. detection by "air check") and B_tevnio (PCV defective) is described in the partial function DTEVAUF / DTEVLL.
- An O.K. detection is only possible, if rmstevuf_w is constantly greater than RMSTEVIO after B_dteanfl was set.
- A defect-detection is only possible, if rmstefuf_w is constantly less than RMSTEVIO after B_dteanfl was set.
- If rmsteuf_w fluctuates round RMSTEVIO the check is terminated (B_dteendl), however, B_teviol and B_tevnio cannot be set.
- The function is capable of two ways of abort:
  - immediate abort
  - delayed abort (the fr-evaluation should still have a chance to perform the "good" check). An evaluation of the decrease of the performance demand at idling is no longer possible.
- The immediate abort is performed in case of engine speed fluctuations > threshold, switch-on and off of known consumers, changes of the desired engine speed and when a minimum ignition angle efficiency (ETAZWTEN) is undershot.
- The delayed abort is triggered in case of a not plausible course of the air mass decrease |dmletan_w - dmletanf_w| > threshhold or if mletan_w <= threshold. The delay has the advantage that a possible good-check is still possible via the control factor.

The following diagram shows the thresholds for an O.K. check, for the defect-check and for an abort of the evaluation of the air:

```
                                                                                                -> abort
                                                       oooooooooooooooooooooooooooo| difference: dmletan_w - dmletanf_w >= DMLDTEMX
                                                     o                             |
      dmletan_w                                     o  ****************************|  *** course dmletan_w and dmletanf_w
                                                  o  *                             |
           ˆ                                   o    *  ooooooooooooooooooooooooooo | difference: dmletan_w - dmletanf_w <= DMLDTEMN
           |                            o o       *  o                             |            -> abort
           |              o   o   o            *    o                              |
           |+ o + o + o +   +   +   +   * *   +   o   +   +   + | +   +   +   +   +|  dmletan_w >= DMLDTEFX -> no defect-check
           |  defective  ************          o                |     defective    |
         --+***********-----------------o-o---------------------|------------------|********************---> check time t
           |  defective   o   o   o        defective            |     defective    |
           |# o # o # o #   #   #   #   #   #   #   #   #   #   # | #   #   #   #  |  dmletan_w <= DMLDTEFN -> abort
           |                                                    |                  |
           |                                                    |                  |
           |                                           tdtetevo > TVDTEB    tdtetevo > TVDTEE
           |                                                    |-> from here PCV is evaluated: rmstevuf_w
           |                                                    |
           |-> from here defective PCV is evaluated. When the range round 0 is exceeded no defect-check is possible, when the
           |   range is exceeded an abort is performed. A fault is only set if the defect-range is not exited until end of
           |   the test.
           |-> from here also a not plausible dmletan_w course is evaluated. In case of larger deviations of dmletan_w from
           |   dmletanf_w an abort is performed. An O.K. is only set, if the deviations are less than thresholds until end of test.
           |
           |
```

5.3) Partial function DTEVAUF / DTEVLL / DTEVRQ:

Calculation of a value for the relative PCV quality (rmstev_w):

- The variable rmstevuf_w is low-pass filtered. Thus a reliable value for the PCV quality is obtained after several checks.
- During the first check after a reset or power-fail the time constant is reduced to 2s. The value initialized with 100% can thereby stabilize quickly. The time constant can otherwise be chosen as desired.
- The setting of the bit B_dteanfl (start of air check) activates the low-pass filtering.
- Initialize with 100% for C_pwf and C_fcmclr & B_cltes
- The RAM-cell rmstev_w is a permanent RAM. Thereby a once stored value is preserved for reading.

5.4) Partial function DTEVAUF / DTEVTAT:

- The PCV is triggered via the characteristic TADTEAMX. The PCV is abruptly controlled closed once the check has ended (B_dtest & B_dteaam are no longer fulfilled).
- The Lambda control factor must be reset to the reference value by the delay time of the purge gas in the intake manifold (tvfrrdte) time-variant after the closing of the PCV (bit: B_dtefrr, value: frdter_w).
  The delay time can be stored in the map KFTVFRR (tadteazu, ml).
  - Via the dependency of tadteazs (max. pulse duty cycle at abort) it can be taken into consideration that dependent on the HC concentration a different delay time is necessary.
  - Via the dependency of ml it can be taken into consideration that the time will strongly reduce itself when staring to drive.

  The reset signal is given for the time TVDTEABG. Thus it is possible to take into consideration the run-time engine -> sensor.
- The deviation "P charge / Alpha-n - system" must be learned on a P-system. dfuelsan_w (deviation), output: dmsnte_w.
  The output is added to the learned throttle valve leakage air in BGMSZS. The sum is msndko_w !

6) Partial function DTEVEA:

- Formation of the signals for the fault management (DTEVEA - "error treatment")
  The error and cycle flags B_mntes and B_mxtes are set here.
  Deactivation and purposeful setting of the flip-flops in case of B_cdtes.
  The flip-flops B_nmtes, B_mxtes and E_tes are in the permanent RAM.
  A Min-fault exists if during the fault detection dmvad_w > DMVTEVDO   (does not work on the P-system)
  A Max-fault exists if during the fault detection dmvad_w <= DMVTEVDO   "
  The bits B_tevioi and B_teviot are ignored in case a quick test or a fault (E_tes) is given.

APP DTEV 32.90 Application hint

Introduction:

The DTEV is a diagnostic function demanded by the legislator, which can trigger the error lamp. Erroneous fault messages as well as not detected faults need to be classified as being critical.

The most important points (very critical) to be checked are:
- Avoiding of an erroneous fault detection in case of an O.K. PCV under all practically conceivable driving situations and ambient conditions
- Reliable detection of faults during the certification test (no abort of the function so that cycle flag is set, no O.K. message in case of a defective PCV).

Aims of "secondary order" (not quite as critical) are:
- An as frequent as possible setting of the cycle flag (Z-tes) during normal driving operation in the field
- No O.K. message in case of a defective PCV under all practically conceivable driving situations and ambient conditions

What is a defective PCV?
- A PCV, which is completely closed or which is blocked
- A PCV, which is jammed while fully open and which allows for no or only a minimum controllability of the flow rate
- A PCV with an increased leakage (e.g. also up to 40% of the max. flow rate) is not reliably detected.
- A PCV, which shows a minor to medium blockage (open quantity only 60% of the max-value), is not reliably detected.

* Certification possibilities at the authority: 1) PCV totally blocked resp. defective 2) PCV continuously fully open (jammed at open position)

The DTEV requires very intensive testing. The application requires a very good knowledge of the vehicle (especially knowledge of the "disturbing factors of the performance demand at idling"), of the purge control system and of the idle control.

The application phase will most probably at least take one man week. During all tests the DTEV should be "one topic".
During the certification the DTEV should be watched in the exhaust test (fault simulation with open or blocked PCV).
Is the setting of the cycle flag guaranteed in all cases?

Preconditions for a DTEV application:

Later changes of one of the mentioned functions can have an effect on the application of the DTEV!!!

- Charge sensing, idle control, torque structure, Lambda control and adaptation and all other important basic functions of the engine.
- Especially: Purge control function (%TEB) with the partial functions %BGTEV and %ATEV
- The canister system must be final (with possibly canister pressure valve, PCV, pipes...)
- Sequential control of the diagnostic functions (BBTEGA)

Important cross-couplings to other functions:

- DLDP: Input into DTEV are the bits B_tevioi and B_teviot (see DLDP)
- Idle control: The limits LIMNDTES and LIMN (LIMNV) and the time constant ZLIBG and the integration speed (IVDN resp. IVDNV), torque margin (KFMRES) !!!, resetting of the integrator dmllri_w !!
- BGTEV: Entire function
- ATEV: Entire function
- TEB: Max. fuel rate, quick opening control time for DTEV
- On P-system: Characteristic MSNWDK, WDKMSN (or comparable maps) as well as interaction with BGMSZS dfuelsan_w => dmsnte_w
- On systems without ambient pressure sensor: Altitude adaptation fho_w
- With Lambda control 2-step: The control parameters (P and I component of the Lambda control can be increased at active DTEV)

Timing around the DTEV:

The DTEV possesses a passive part and an active part

"- The passive part is again subdivided into the parts:"
- a) Determination of mixture pilot control with closed PCV O.K. (during a mixture adaptation phase at idling) => B_dtepm
- b) Check whether purge control purges with high fuel rate outside of idling (in one of the successive purge control phases)

  => Condition DTEV passive possible during first mixture adaptation phase (TTEGAINI)
  => Condition PCV O.K. passive in successive purge control phase, once the ACF has a certain HC charge.

- The active part is blocked for the time TDTEZAM (typical value for FTP = 590 s) after start.
  The active check is furthermore only allowed if sufficient purging was performed immediately before the DTEV (imsteini > threshold). This is necessary since it must be ensured that there is always a continuous HC concentration in the pipe PCV-ACF when the PCV is controlled open. Other diagnostic functions can also block the opening control check (DLDP, DDMTL, DLLR).
- When the active check is enabled (B_dtezam) at first an idle phase is waited for. Only once the vehicle is at rest while idling for longer than TVDTEVZ (e.g. 2 s) is the quick PCV closing control requested.
- The request for the opening control check (B_dteaa) starts only once the vehicle is at rest during idling for longer than the time TVDTELLA (e.g. 2 s). With a low degree of saturation and if e.g. a typically long idle phase lies in the exhaust test (TDTESZU <= time after start <= TDTESZO) the purge rate is immediately controlled down with "snap off throttle". Then no valuable time is lost for the PCV closing control.
  Remark: In M4, M5 systems an additional mixture adaptation phase was necessary prior to the DTEV, this no longer applies here.
- The actual PCV opening control only takes place once it is detected that the idle control has stabilized or once a maximum time has elapsed (TTEVAZ).

- So as to be able to make an O.K. or defect-statement also in case of stoichiometric mixture, the PCV check needs at least 12 s - 15 s. Together with waiting time at idling and stabilization time of the controller the total check needs an idle phase of 15 s - 20 s ! Due to the reduced control speed in the two-step control the opening control can be performed slower only. The control parameters (P and I component of the Lambda control) can be increased here at active DTEV => %LR.

The individual labels separated according to partial functions:

A detailed description is attached to the data suggestion for critical labels and for labels to be adjusted project-specifically. Where no additional remarks are mentioned the suggestion should only be deviated from after querying.

Always three values are mentioned:
[sensible lower value ..... value recommended according to current level of knowledge ... sensible upper value]

"- Partial function DTEVSIGA: Signal conditioning"
- Filter time constant for frmit_w: Variable: ZFRMFIL [0.2s ... 0.5s ... 1s] continuous Lambda control
- Filter time constant for frmit_w: Variable: ZFRMFIL [0.4s ... 0.8s ... 1.5s] 2-step Lambda control
- Filter time constant for frmxa_w: Variable: ZFRMXAF [5s ... 8s ... 10s] continuous Lambda control
- Filter time constant for frmxa_w: Variable: ZFRMXAF [4s ... 6s ... 8s] 2-step Lambda control
  ZFRMXAF is not much larger than TVDTEVPM, but not too small so that a short-termed frm deviation does not cause a resetting of B_dtepm. Also adjust in connection with thresholds FRMDPMU, FRMDPMO.

"- Partial function DTEVEB: Switch-on conditions"
- TMDTEU: Engine temperature threshold DTEV: [60°C ... 70C°... 80°C]
  Activation during warm-up is not permitted since the engine friction steadily decreases here. It would impede the detection of a defective PCV or it would lead to an erroneous O.K. message. This threshold also applies during the quick test !!!
- Introduction of a threshold for engine start temperature was refrained from! During cold tests it must be ensured that when activating the DTEV as from TDTEZAM after engine start a PCV, which was possibly at first iced, has "defrosted" by means of current input during TEB operation !!!
- FHODTEA: Deactivation threshold when driving at high altitude: [0.70 ....0.72 ....0.74]: With mounted altitude sensor (diagnosis must work reliably at 2440 m above sea-level!!!) [0.65 ... 0.68 ... 0.70]: At altitudes above altitude adaptation tolerance!!!

"- Partial function DTEVPEB: Passive check switch-on condition"
- Lower rkat-threshold for enabling of passive diagnosis possible: RKADTEVU [RKATRN ...-5% ...-3%] remark: RKATRN comes from %LRA
- Upper rkat-threshold for enabling of passive diagnosis possible: RKADTEVO [3% ... 5% ...-RKATMX] remark: RKATMX comes from %LRA
- Air mass threshold for enabling of diagnosis passive possible: MLDTEFPF [15 kg/h .... 30 kg/h ....40 kg/h]
  Basic idea: The check should be performed at idling with all possible consumers.
  The expansion of the check to the "range close to idle" => MLDTEFPF up to max. 60 kg/h is in principle also conceivable.
  Here, however, it is quite possible that a PCV jamming at the open position is erroneously detected as being O.K when the ACF is at first not saturated but then becomes increasingly saturated!
  Attention: Threshold should in any case be higher than the highest idle air demand !!! Otherwise there is no passive O.K. !!!
- Lower frm-threshold for enabling of diagnosis passive possible: FRMDPMU [0.85 ... 0.88 ... 0.93]
- Upper frm-threshold for enabling of diagnosis passive possible: FRMDPMO [1.07 ... 1.12 ... 1.15]
- Debounce time for setting of flip-flop B_dtepm: TVDTEVPM [5 s ... 8 s.... 10 s]

"- Partial function DTEVAEB: Active check switch-on condition"
- * Important label for application phase / Series production: CWDTEAPP [Bit 0] - Code word for permanent DTEV
  In the series production bit 0 of CWDTEAPP must be = FALSE !!!!!!!
  In the application phase it is possible to request a continuously repeated activation of the DTEV: Bit 0 = TRUE
  Thereby the system is immediately active again after an O.K. check, without the engine having to be turned off!!!
- Time from engine start, as from when the opening control check DTEV can become active for the first time: TDTEZAM:
  For FTP 75: [590s]
  For ECE: [?]
  For application phase: [5s ... 10s] so that DTEV can become active immediately after engine start.
- Time from engine start for diagnosis active with quick trip: TDTEFA [30s... 45s...60s]:
  Attention: Set TDTEFA to that value, where the course of ml_w is stable after an engine start. It can be observed that the air mass at first decreases also after a warm start.
- Cycle duration for repeated operation: TPERDTE: [2s ... 5s .... 25.5s]: Only important for application phase !!
- Number of terminated opening control checks DTEV: APDTEVX [2]
  Remark: By the law max. 2 trials for series production, for application purposes it can be chosen much greater. When mounting a defective PCV it can be checked, whether erroneous O.K. detections occur and how often !!! => then APDTEVX = 255 !
- Number of aborted opening control checks DTEV: AVDTEVX: [3 ...5...20]
  The number of trials are limited so that with according driving (only very short idle phases) the mixture adaptation or the purge control is not interrupted "for ages". During the application phase much larger values are possible.
- Threshold integral purge flow for enabling of (IMSDTEVA): On systems with a short pipe ACF-PCV it can be adjusted to zero.
  On systems where the pipe ACF-PCV is longer than 70 cm a purging phase should take place immediately before the DTEV.
  The variable imsteini (integral purge mass flow since last purge break) is scanned from the TEB for this. Only once this integral has exceeded a certain value (e.g. volume of the pipe ACF-PCV) may the active check DTEV be started.
  Reason: An HC front could just be reaching the PCV after a longer purge break when it is completely opened by the DTEV.
  Suggestion IMSDTEVA: [0.5g < 1 g < 4g]

"- Partial function DTEVP: Passive DTEV"
- Lower ftead-threshold for passive diagnosis: FTEADDPU:[3 .... 5 .... 7]
- Upper ftead-threshold for passive diagnosis: FTEADDPO:[30 .... 32 .... 35]
  The scanning of an upper threshold shall prevent that a PCV jamming at the open position can cause an O.K. A PCV jamming at the open position leads as from certain saturation and at low and medium air masses to a MAX limit stop of the saturation [37.5].
- Fuel rate purge control for passive diagnosis: FKADPMN:[0.15 ... 0.20 ... 0.25] : 0.15 only if MLDTEPF > idle air mass
- Lower frm-threshold for passive diagnosis: FRMDTEVU [0.9 ... 0.92 ... 0.94]
- Upper frm-threshold for passive diagnosis: FRMDTEVO [1.06 ... 1.08 ... 1.10]
  By these fr-thresholds all those cases are excluded, during which the PCV is not controllable (e.g. because it jams at the open position), so that a fr-course round 1.0 will practically not occur for a certain time at high saturation.
- Air mass threshold for diagnosis passive: MLDTEPF [30 kg/h .... 40 kg/h ....50 kg/h]
  A higher air mass flow than idle air mass is in principle demanded for O.K. detection.
  The expansion of the check to idling (MLDTEPF = 5 kg/h] is in principle also possible. Then, however, FKADPMN > 0.20 should be chosen. There is, however, a larger possibility that at activated O.K. detection during idling, a PCV jamming at the open position is erroneously detected as being O.K. with lesser saturated ACF.

"- Partial function DTEVZU: Closing control PCV for active diagnosis"
- Time from end of start for start of time window for immediate closing of PCV when B_ll = TRUE: TDTESZU: [990s] for FTP
- Time from end of start for end of time window for immediate closing of PCV when B_ll = TRUE: TDTESZO: [1050s] for FTP
- ECE-window: 650 s - 850 s (2 DTEV trials) or if no DLLR: 570s - 850 s (3 trials DTEV)
- Threshold saturation for immediate closing of PCV when B_ll = TRUE, if B_gae = TRUE: FTEADSZ: [1...3...5]
- Delay time for closing of PCV as from idle at stand-still active: TVDTEVZ: [3s...5s...10s]
- Delay time for earliest start of active DTEV after idle at stand-still: TVDTELLA: [2 s... 3s ... 5s]

"- Partial function DTEVLR: Check of PCV via the Lambda control"
- Threshold fr-deviation toward lean for O.K detection: DFRMDTEM: [0.06 ...0.07... 0.10]
- Threshold fr-deviation toward rich for O.K detection: DFRMDTEF: [-0.10 ...-0.07... -0.06]
- Delta fr-threshold for detection "fr - stabilized": DFRMDTEE:[0.004 ....0.005...0.01]
- Time for check "fr - stabilized": TFRMDTEE:[0.3 s ...0.4 s .... 1s]
- Number of checks for stabilized: APDTEFRE: [3...5...8]
- Time for "compulsory stabilization": TTEVAZ: [4... 5...8]
  => defined such that DTEV can definitely be successful via the "air check" during the longest idle phase of the test
  also if fr does not stabilize !

"- Partial functions DTEVLL and DTEVDML together: Check of PCV via the performance balance"

- Code word for switch-over HFM-system / P-system: CWDTEAPP Bit 1
  - Bit1 = 0 => HFM-system   !!!   Pay attention, an incorrect application is not necessarily noticed !!!
  - Bit1 = 1 => P-system

  Remark: The evaluation can also take place via the throttle valve on an HFM-system (bit 1 = 1). This, however, is by no means recommended for the series production. Except maybe for the "trying out during the start-up". The tolerance with throttle valve evaluation (msndkoo_w, fklaf_w, fho_w, and ftvdk) is distinctly higher !!!

- Threshold pulse duty cycle as from which the open-time of the PCV is counted. Simultaneously threshold for abort possible: TADTEMX: [30%..... 80% ....98%]
- Time threshold for the start of the evaluation of the performance balance: TVDTEB [1s ... 3s ....5s]
- Time threshold for the end of the evaluation of the performance balance: TVDTEE [TVDTEB + 1 s ... 5s ....8s]
  => Checking time should at least be one second!!!
- Threshold ignition angle efficiency for abort DTEV: ETAZWTEN: [40% .. 50% ...60%]
  => definitely lower than each etazwist measured under normal conditions during DTEV!!
  => no abort during test !!
- Lower engine speed deviation for abort: DNDTEU [-100 rpm... -80 rpm... -50 rpm]: The more stable the idle, the narrower
- Upper engine speed deviation for abort: DNDTE0 [50 rpm... 80 rpm... 100 rpm]: The more stable the idle, the narrower
- Abort when the generator excitation is changed: High-pass filter time constant ZDFFDTE: [1 s... 1.5 s... 3s]
  Delta % for abort DDFDTEAB: [5%...10%...20%]
- RMSTEVIO: Diagnostic threshold for defective / O.K.
- To be adjusted together with DMLDTEFX (threshold for defect-check no longer possible) !
  The following facts result:
  Setting of B_tevnio is no longer possible in case of an air mass decrease through the throttle valve by more than DMLDTEFX (e.g. 0.8 kg/h). Simultaneously RMSTEVIO decides on defective or O.K. RMSTEVIO is a relative value, so e.g. independent of altitude and temperature.
  A "dead range" between good and bad check develops. RMSTEVIO and DMLDTEFX should be matched to one another, in order to prevent this dead range from becoming wider than a certain width. This is to be calculated at standard pressure and temperature conditions.

"- Partial functions DTEVLL and DTEVDML together: Check of PCV via the performance balance"

Example: Small PCV: PCV max. flow rate 3.2 kg/h [at 1013 mbar and 0 °C]
Threshold for defect-check: 0.8 kg/h => that means no defect above 25.00 %
Threshold RMSTEVIO: 35% => no O.K below 35%
=> Dead range: from 25.00% to 35.00%
At 3000 m altitude: => Maximum flow rate: 2.24 kg/h
Defect-detection only possible within 35.7% = 100% * 0.8 / 2.24
O.K. detection via RMSTEVIO as from 35%
=> No more dead range !!

Large PCV: PCV max. flow rate 4.8 kg/h [at 1013 mbar and 0 °C]
Threshold for defect-check: 1.0 kg/h => that means no defect above 20.08 %
Threshold RMSTEVIO: 35% => no O.K below 35%
=> Dead range: from 20.08% to 35%
At 3000 m altitude: => Maximum flow rate: 3.36 kg/h
Defect-detection only possible below 29.76% = 100% * 1.0 / 3.36
O.K. detection via RMSTEVIO as from 35%
=> Dead range now only 5.24 % wide so between 29.76% and 35%

OBD-durability test: If a durability test is made for this test RMSTEVIO can be set to higher values to receive information about "tests with a low rmstevf result". Proposal: RMSTEVIO 45% - 55%

"- Map for correction of ignition angle efficiency: Default values map KFDETATE: "
Important: To be adjusted only on an HFM-system ! The PCV air is measured in any case on a P-system !
=> no fault with etazwist on P-system !!! => fill map with zero on P-system !!!

etazwist		0%	50%	75%	100%
dmletanu	0.0 kg/h	0	0	0	0
	1.5 kg/h	0	0	0	0
	3.0 kg/h	30%	20%	10%	0
	4.5 kg/h	40%	25%	13%	0
	6.0 kg/h	45%	30%	16%	0
	7.5 kg/h	50%	35%	20%	0

Values for HFM-system !!!

"- Time constant for rltedte_w formation: Default value ZRLTEDTE = 1s   "

"- Partial functions DTEVLL and DTEVDML together: Check of PCV via performance balance"

- Application of the map KFDTEATE:
  - Stage I
    - The map KFMRES is at first to be set to zero (no torque margin).
    - So that the throttle valve does not bottom at least one large as constant as possible consumer is to be activated (e.g. drive with automatic transmission). For the manual transmission this can possibly be the A/C.
    - The time TVDTEE is to be set to a high value (e.g. 25s), so that the PCV stays open for a long time.
    - Small quantities of HC are to be led from a butane bottle into a well-buffered ACF (if not given in the project, find a foreign ACF), so that at the output of the ACF a roughly stoichiometric mixture is obtained! In this way it can be achieved that no O.K. is obtained via the fr. To support this ZFRMFIL can be set to a high value (> 20 s).
    - The DTEV is to be switched to permanently active. An O.K. standard PCV is to be mounted. Monitor rmstevf_w. Is a PCV quality of about 100% reached during the individual checks, (which after all take a long time now)?
    - Etazwist should at first be about 100% during the entire measuring period.
    - If rmstevf_w considerably deviates from 100%, TATEMSN and MSNTATE are to be adjusted accordingly.

    => Target of this first stage: During each measurement rmstevf_w reliably reaches about 100% +/- 15% !!!
  - Stage II
    - Now a torque margin KFMRES is set, which results in an efficiency etazwist of about 75% (e.g. 3% - 4% in KFMRES).
    - Consumers should be maintained (Drive still engaged)
    - The DTEV is again activated. How large is rmstevf_w ? Are 100% still reached, is it more or less? If less, decrease the values in the third column of above-mentioned map. If more than 100% is indicated, the values must be increased accordingly.
    - The same needs to be performed for the higher torque margin (etwazwist = 50%). The lowest base point of the source etazwist is to be extrapolated!

    - Repetition for "partially blocked PCV": The values for dmletanu = 3.0 kg/h can be repeated with a small PCV (e.g. 3.0 kg/h instead of e.g. 4.8 kg/h) for a very exact application. Now e.g. 62% rmstevf_w must be reached consistently.
  - Stage III
    - Checking: Now all consumers are to be switched off and the usual torque margin is to be adjusted.
    - The checking time DTEV is still to be kept high (25 s PCV completely open)
    - If 100% are still reached with O.K. PCV, then the application is correct. The above measurements should be repeated in case of deviations of more than 20%. A 3 kg/h PCV should now too come to about rmstevf_w = 62%.

- Filter time constants: ZMSTEDTE and ZMLETAN:
  - ZMSTEDTE should be chosen slightly greater than ZMLETAN, so that the time delay of the "answer" of the idle control is more or less taken into consideration in the filtered expectation value "mstedtef_w".
  - ZMLETAN [1 s.....1.5 s.....3 s]
  - ZMSTEDTE [1.5 s...2.0 s....4 s]

- Upper threshold relative PCV quality: RMSTEVMX: [150% ... 170% .... 199%]
- Lower threshold relative PCV quality: RMSTEVMN [-80% ... -50% .... -30%]

  This expansion beyond the plausible value range [0... 120%] is necessary, so that the deactivation of disturbances will also work with small values of mstedtef. If the range is too narrow, an abort will frequently terminate the function!!!

- DTEVLL and DTEVDML together: Check of PCV via the performance balance

  The air mass thresholds for "defect-check no longer possible" and for "abort" should now be adjusted in form of a package together with the integrator speed KIRMSMS:

- Threshold for defect-check no longer possible: DMLDTEFX: [0.5 kg/h ...0.7 kg/h ...0.8 kg/h]
- Threshold for defect-check no longer possible => abort: DMLDTEFN: [-0.8 kg/h ...-0.7 kg/h ...-0.5 kg/h]
- Upper threshold for abort due to disturbing factors: DMLDTEMX: [0.4 kg/h ...0.6 kg/h ...1.0 kg/h]
- Lower threshold for abort due to disturbing factors: DMLDTEFN: [-1.0 kg/h ...-0.6 kg/h ...-0.4 kg/h]

- Integrator speed for re-adjustment rmstevf_w : Default values characteristic KIRMSMS:

mstedte	0	0.5 kg/h	2 kg/h	5 kg/h	
Value	1000	200	60	30	%/ [kg/h*s]

=> The following applies here:
- The faster the integrator, the smaller the deviations of dmletan_w and dmletanf_w and thus the lower the abort tendency of the DTEV (also with small disturbing factors)
- The higher the absolute value of the thresholds, the lower the abort tendency but also the lower the protection against disturbing factors.

=> Intensive testing by simulation of all possible disturbing factors is demanded!
- Abort with disturbing factors, which influence the PCV quality by more than +/- 25% -> +/- 30 %
- Reliable passing of the exhaust test ! No abort allowed without "self-inflicted" disturbing factors (e.g. power steering, power-window control)!!!

"- Partial function DTEVRQ: Calculation of PCV quality"

- Time constant for filtering of PCV quality: [10 s... 20 s....40s]

  The higher, the better is the PCV quality filtered and less noticeable do deviations become. Since, however, only a few checks are successful via an evaluation of the performance balance, this value should not be set too high.

"- Partial function DTEVTAT: Output of pulse duty cycle and reset of Lambda controller"
Default values characteristic TADTEAMX:

- This is dependent on whether a continuous or a two-step Lambda control exists. The opening control characteristic TADTEAMX is to be adjusted correspondingly faster or slower. In the process the highest ACF saturation must be taken as orientation. The Lambda deviation should not exceed more than 15%!
- Very important, however, is that the entire checking time of the DTEV does not exceed the time available in the exhaust test!
  FTP: approx. 24 s
  ECE: approx. 20 s
  It must be assumed that "only" stoichiometric mixture comes. Also the detection of a defective PCV needs the longest time.
  => Application of TVDTEE !!

- Suggestion for continuous control:

tdtesta	0	1	2	3	4	5	6	7	8	9	10	12	18	25.5	s
TADTEAMX	0	3	4	5	10	15	25	40	65	100	100	100	100	100	%

Default values map KFTVFRR: Delay for fr reset!

tadteazs			10%	30%	60%	100%
ml	12	kg/h	1.0	0.9	0.8	0.7 Sec
	20	kg/h	0.9	0.8	0.7	0.5 Sec
	60	kg/h	0.4	0.3	0.2	0.1 Sec

=> If the PCV could be opened up to higher pulse duty cycles without this process being terminated by fr, then the saturation was not high. It has shown that the fr-reset then needs to be delayed less.
If the PCV closes already at small pulse duty cycles a high saturation existed, the fr must then only be reset later.
=> The reset is distinctly shortened with high air masses, since the throttle valve was opened, this resulting in the intake manifold being free of HC more quickly.

TVDTEABG: Period for fr-reset !
=> The fr can be held at its reset value for some 100 ms [100 ms ... 300 ms ... 600 ms]

=> Checking of the reset delay and of the reset duration with Lambda measurement! Target being to keep Lambda deviations low at all degrees of saturation.

KIDMSNTE: Integration speed for output variable dmsnte_w from dfuelsan_w = (1 - rlmod_w/rl_w):
[0.5kg/h / s ... 2kg/h / s ... 4 kg/h / s]
The PCV air mass flow should be learned fast enough when the PCV is controlled open.
DMSNTEMX: Maximum value for adapted PCV air mass flow: for Bosch PCV2 [5 kg/h ... 6 kg/h....8 kg/h]
DMSNTEMN: Minimum value for adapted PCV air mass flow: for Bosch PCV2 [-3 kg/h ... -2 kg/h....-1 kg/h]
Negative values are permissible since even with a defective PCV a residual adaptation of the throttle valve leakage must still be possible.

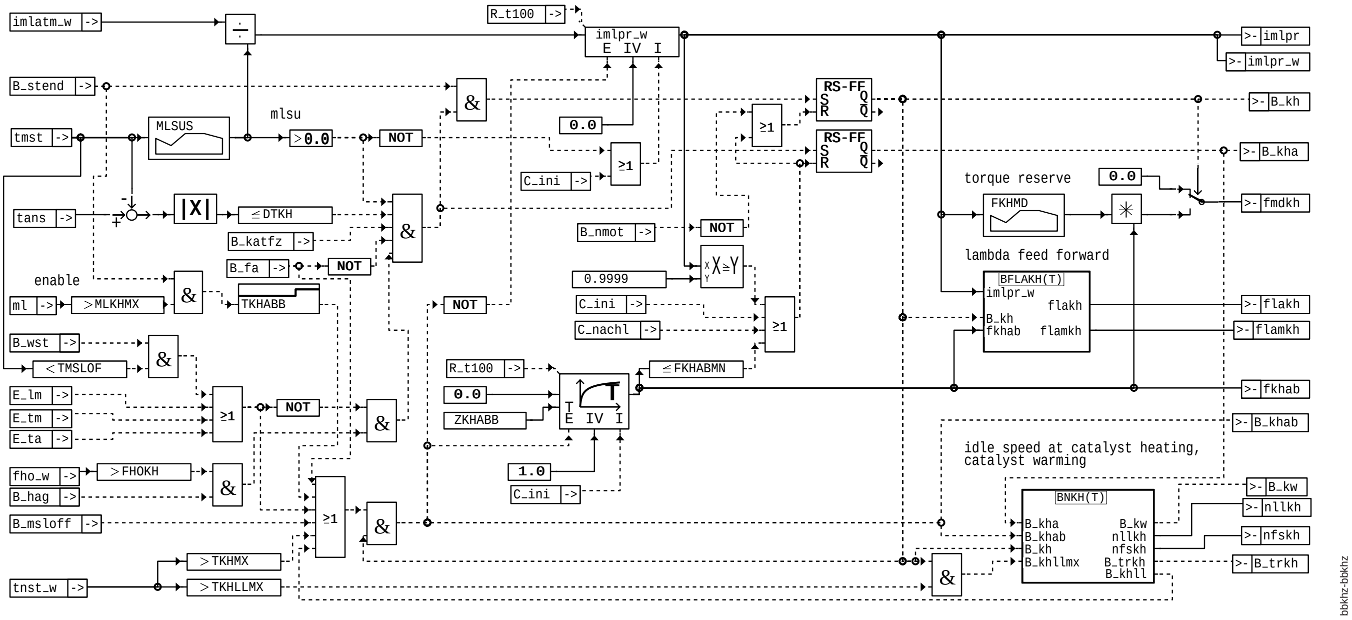
"- Partial function DTEVAEND: Setting of the abort flag DTEV"
-> no label

"- Partial function DTEVEA: Fault treatment of DTEV"
- Threshold for detection defective open /defective closed: DMVTEVDO: [- 5% ... - 3% ..-2%]
  The current value of the loss adaptation is taken as indication, whether
  A) the PCV defectively jams at the open position
  B) the PCV defectively jams at the closed position
  With a PCV jamming at the open position the loss adaptation has learned the PCV leakage; dmvad_w then has a distinctly negative value. This distinction does not work on a P-system, since dmvad_w basically does not react if the PCV jams at the open position. The information can be found in msndko_w on a P-system.

  Remark: Also on an HFM-system it must be accepted that the information max-fault / min-fault is not very reliable in case of a torque loss pilot control that was not adjusted optimal.

BBKHZ 11.130 Control of catalyst heating

FDEF BBKHZ 11.130 Function definition



bbkhz-bbkhz

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BFLAKH: Calculation Lambda control
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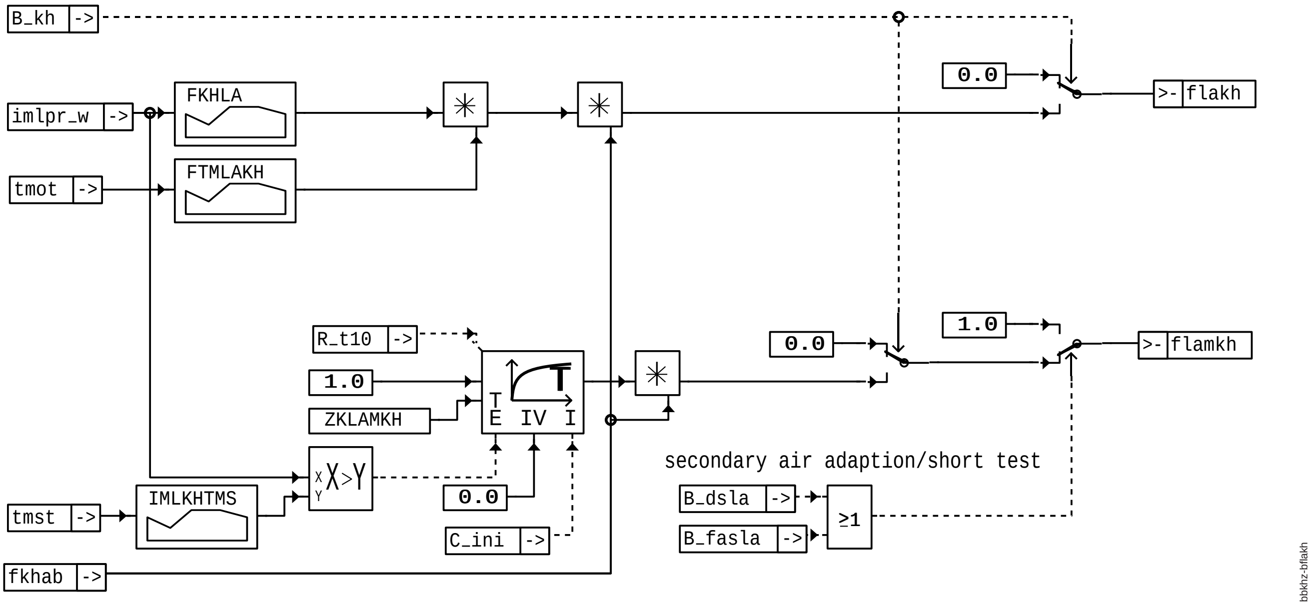

bbkhz-bflakh

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BNKH: Calculation idle speed and keeping the catalyst warm
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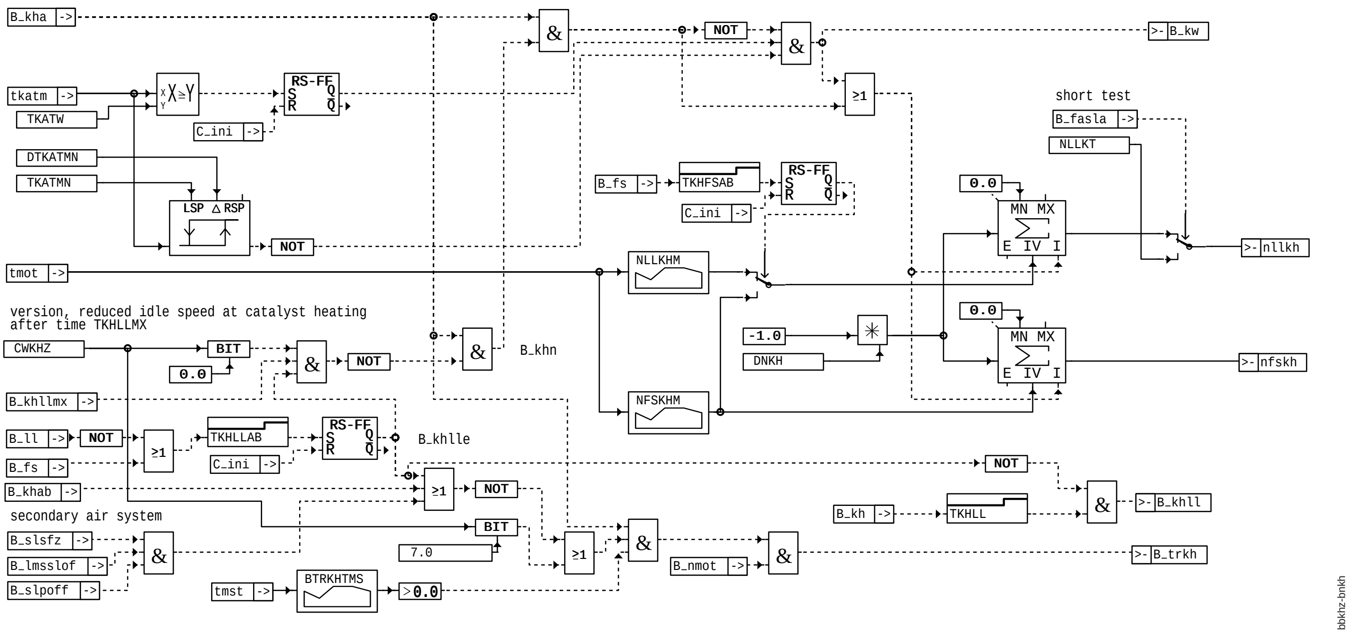


bbkhz-bnkh

ABK BBKHZ 11.130 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BTRKHTMS	TMST		KL	Characteristic enabling flag B_trkh
CWKHZ			FW	code word for catalyzer heating control
DNKH			FW	
DTKATMN			FW	Hysteresis catalyst temperature control threshold for catalyst warming
DTKH			FW	absolute value difference (tans -tmst) for catalyst heating
FHOKH			FW	minimum altitude threshold to enable catalyst heating
FKHABMN			FW	threshold terminating factor catalyst heating
FKHLA	IMLPR_W		KL	Weighting factor Lambda nominal for catalyzer heating
FKHMD	IMLPR_W		KL	Weighting factor torque reserve for catalyzer heating
FTMLAKH	TMOT		KL	tmot-correction of lambda-weighting at catalyst heating
IMLKHTMS	TMST		KL	imlpr-threshold, changing to lambda catalyst heating
MLKHMX			FW	max. air flow for catalyst heating
MLSUS	TMST		KL	reference of air mass flow integral
NFSKHM	TMOT		KL	LL nominal speed with driving graduations and catalyzer heating
NLLKHM	TMOT		KL	Nominal idling speed during catalyzer heating
NLLKT			FW	Nominal idle speed at short test of SAI-system
TKATMN			FW	Catalyst temperature control threshold for catalyst warming
TKATW			FW	Catalyst temperature threshold for catalyst warming
TKHABB			FW	delay time switching off catalyst heating
TKHFSAB			FW	delay time switching to idle speed at drive at catalyst heating
TKHLL			FW	cancelling time catalyst heating idle speed
TKHLLAB			FW	delay time switching off increased idle speed at catalyst heating
TKHLLMX			FW	Maximum time for increased catalyst heating idle speed
TKHMX			FW	maximum time for active catalyst heating
TMSLOF			FW	threshold of engine temperature for disabled secondary air
ZKHABB			FW	Time constant for abort low-pass catalyzer heating
ZKLAMKH			FW	time constant lambda engine nominal at catalyst heating

Variable	Source	Type	Description
B_DSLA		EIN	adaption phase: calculation of secondary air mass
B_FA		EIN	condition general function request
B_FASLA		EIN	Condition: external request of SAI system aktiv
B_FS	BBGANG	EIN	Condition driving state (automatic gear box)
B_HAG	BGPU	EIN	condition altitude adaptation valid
B_KATFZ	PROKON	EIN	condition: cat fitted in vehicle
B_KH	BBKHZ	AUS	condition catalyst heating activated
B_KHA	BBKHZ	AUS	request of activated catalyst heating
B_KHAB	BBKHZ	AUS	condition catalyst heating terminating
B_KHLL	BBKHZ	LOK	condition catalyst heating idle speed (cancelling condition)
B_KHLLE	BBKHZ	LOK	condition idle at cactalyst heating quitted
B_KHLLMX	BBKHZ	LOK	condition max. catalyst heating time reached
B_KHN	BBKHZ	LOK	condition catalyst heating idle speed
B_KW	BBKHZ	AUS	Condition catalyst warming
B_LL	MSF	EIN	Condition idle
B_LMSSLOF		EIN	condition lambda engine by secondary air, off
B_MSLOFF		EIN	Condition secondary air mass flow removed after switch off
B_NMOT	GGDPG	EIN	condition engine speed: n $>$ NMIN
B_SLPOFF		EIN	Condition secondary air pump switched of

Variable	Source	Type	Description
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
B_STEND	BBSTT	EIN	condition end of start
B_TRKH	BBKHZ	AUS	Flag for catalyst fast heating
B_WST	ESSTT	EIN	condition for re-start
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
E_LM	EGFE	EIN	Error flag: main load sensor
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
FHO_W	BGPU	EIN	correction factor: altitude
FKHAB	BBKHZ	AUS	terminating factor catalyst heating
FLAKH	BBKHZ	AUS	Factor control lambda at catalyst heating
FLAMKH	BBKHZ	AUS	factor setting up lambda engine nominal at catalyst heating
FMDKH	BBKHZ	AUS	Weighting factor torque reserve for catalyst heating
IMLATM_W	ATM	EIN	integrated air mass flow from engine start to max. value (word)
IMLPR	BBKHZ	AUS	relative amount of integrated air mass flow at catalyst heating
IMLPR_W	BBKHZ	AUS	relative amount of integrated air mass at catalyst heating (word)
ML	SWADAP	EIN	air mass flow
MLSU	BBKHZ	LOK	nominal air mass for catalyst heating
NFSKH	BBKHZ	AUS	Idling speed driving level for catalyzer heating
NLLKH	BBKHZ	AUS	Idling speed for catalyzer heating
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
TANS	SWADAP	EIN	Intake air temperature
TKATM	ATM	EIN	catalyst temperature (model)
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
TNST_W	BBSTT	EIN	time after end of start

FW BBKHZ 11.130 Fixed Values

Parameter	Value	Description
CWKHZ		code word for catalyzer heating control
DNKH		
DTKATMN		Hysteresis catalyst temperature control threshold for catalyst warming
DTKH		absolute value difference (tans -tmst) for catalyst heating
FHOKH		minimum altitude threshold to enable catalyst heating
FKHABMN		threshold terminating factor catalyst heating
MLKHMX		max. air flow for catalyst heating
NLLKT		Nominal idle speed at short test of SAI-system
TKATMN		Catalyst temperature control threshold for catalyst warming
TKATW		Catalyst temperature threshold for catalyst warming
TKHABB		delay time switching off catalyst heating
TKHFSAB		delay time switching to idle speed at drive at catalyst heating
TKHLL		cancelling time catalyst heating idle speed
TKHLLAB		delay time switching off increased idle speed at catalyst heating
TKHLLMX		Maximum time for increased catalyst heating idle speed
TKHMX		maximum time for active catalyst heating
TMSLOF		threshold of engine temperature for disabled secondary air
ZKHABB		Time constant for abort low-pass catalyzer heating
ZKLAMKH		time constant lambda engine nominal at catalyst heating

FB BBKHZ 11.130 Detailed description of function

The catalyst heating function coordinates the actions:

* KHMD: Torque margin for the specific increase of the exhaust gas temperature by retarded ignition,
* LAKH, LAMKO: mixture control,
* desired idle speed and
* SLS: Secondary air injection

for the faster heating of the catalyst after start.

Switch-on, switch-off condition:
The catalyst heating function is only released by the condition B_katfz = 1 from %Prokon and activated by default selection of the desired intake air mass mlsu > 0 dependent on the engine temperature at start tmst as from end of start (B_kh = 1). Here the intake air mass describes the quantity of heat in the exhaust pipe, which is necessary to warm up the catalyst.
The control is performed by the heating progress in percent imlpr by relating the air mass put through since end of start (B_stend) imlatm_w to the desired air mass mlsu from the characteristic MLSUS = f(tmst).
Additionally the intake air temperature tans must lie close to the engine temperature at start due to (tmst - tans) < DTKH.
The quantity of heat necessary for the warming-up of the catalyst is reached if the desired air mass was put through the engine and if imlpr = 0.9999 is reached.
In case of repeated start (B_wst =1) at an engine temperature at start tmst < TMLOF catalyst heating is blocked, in order to avoid an undesired switching on of the possibly still frozen secondary air system.
Catalyst heating is only activated if the altitude factor fho_w exceeds the threshold FHOKH and if the altitude information (B_hag=1) is valid.

Torque margin:
Dependent on imlpr the torque margin is assessed by fmdkh from the characteristic line FKHMD. The increasing control from 0 to 0.9961 is performed dependent on imlpr. By a delayed decreasing control of the torque margin after end of start by means of a suitable definition of the imlpr base points and of the assessment factor it is possibly to ensure that a sufficient vacuum of the vacuum system, the power brake unit is obtained. The decreasing control is performed by an assessment by the value 0 at the base point imlpr = 0.9999.

Mixture control:
The mixture control takes place by the assessment factor flakh from the characteristic line FKHLA by an increasing control from 0 -> 0.9961 and a decreasing control to 0 dependent on imlpr, analogous to the torque margin. Additionally it is possible to assess the Lambda catalyst heating weight flakh tmot-dependent by FTMLAKH. The filtered increasing control with the time constant ZKLAMKH to lamkh takes place in %LAMKO by the factor flamkh after the imlpr threshold value from IMLKHTMS, which is dependent on tmst (without interpolation!), so as to achieve a coupling to the after-start mixture control. An abort of the catalyst heating leads back to the Lambda after-start warm-up input lamnswl.

Desired idle speed:
The desired idle speed is obtained by an entry into the tmot-dependent characteristic lines NLLKHM and NFSKHM when the automatic gear box is in gear. For comfort reasons an irreversible switch-over to the input from NFSKHM is performed by shifting into gear. In addition the increased catalyst heating speed after start and after the time TKHLLMX was exceeded can be terminated by means of the code word CWKHZ.0.

Secondary air control:
The secondary air control is performed by the evaluation of imlpr in the separate secondary air control. By means of the bit B_kha the secondary air can, dependent on the electrical system, be activated already during start, as is described in the secondary air control. An abort of the secondary air B_slpoff = 1 also leads to an abort of the catalyst heating. The abort can optionally be stopped by B_lpoff =1 by the setting of CWKHZ.6.

Abort of catalyst heating:
The abort of the catalyst heating (B_khab = 1) is performed by a debounced exceeding of the max. intake air mass MLKHMX in case of an error of the main load signal E_lm, in case of an error of the engine or intake air temperature sensor E_tm, E_ta, or if the permitted catalyst heating time TKHMX is exceeded. (On secondary air systems this complies to the permitted switch-on duration of the secondary air pump). The abort condition B_slpoff = 1 from %SLS also aborts the catalyst heating (optional: dependent on CWKHZ.6). With abort of catalyst heating the heating progress in percent imlpr is frozen. The catalyst heating actions are controlled down with the time constant ZKHABB by the decreasing control factor fkhab. The catalyst heating function is stopped (B_kh = 0) once the threshold FKHABMN is reached. With uninterrupted idling since engine start the catalyst heating is also stopped after the time TKHLL was reached.

Keeping the catalyst warm:
With a warm catalyst it is possible to adjust the mode "keep catalyst warm, temporary" (B_kw = 1) dependent on the catalyst temperature tkatm after the temperature threshold TKATW was exceeded once. For this the desired engine speed nllkh from NLLKHM is increased between TKATMN and TKATMN + DTKATMN also in case of higher engine temperatures. The increase in engine speed, when the vehicle is in gear nfskh, is determined by the characteristic line NFSKHM. (Attention: On vehicles with automatic gear box the increase in engine speed in NFSKHM must be adjusted carefully in order to avoid an undesired rolling away of the vehicle, e.g. with insufficient operating of the parking brake.) To increase the performance loss in the exhaust pipe additionally an own torque margin can be activated from KFKWTMP.

Secondary air adaptation/quicktrip:
By B_dsla from the secondary air diagnosis or by B_fasla from %SLS the secondary air adaptation phase resp. the quicktest is requested. In the Lambda input selection BFLAKH the evaluation factor flamkh is then switched to 1, i.e. Lambda catalyst heating input lamkh in %LAKH. By B_fasla from the tester request the engine speed input NLLKT is additionally activated.

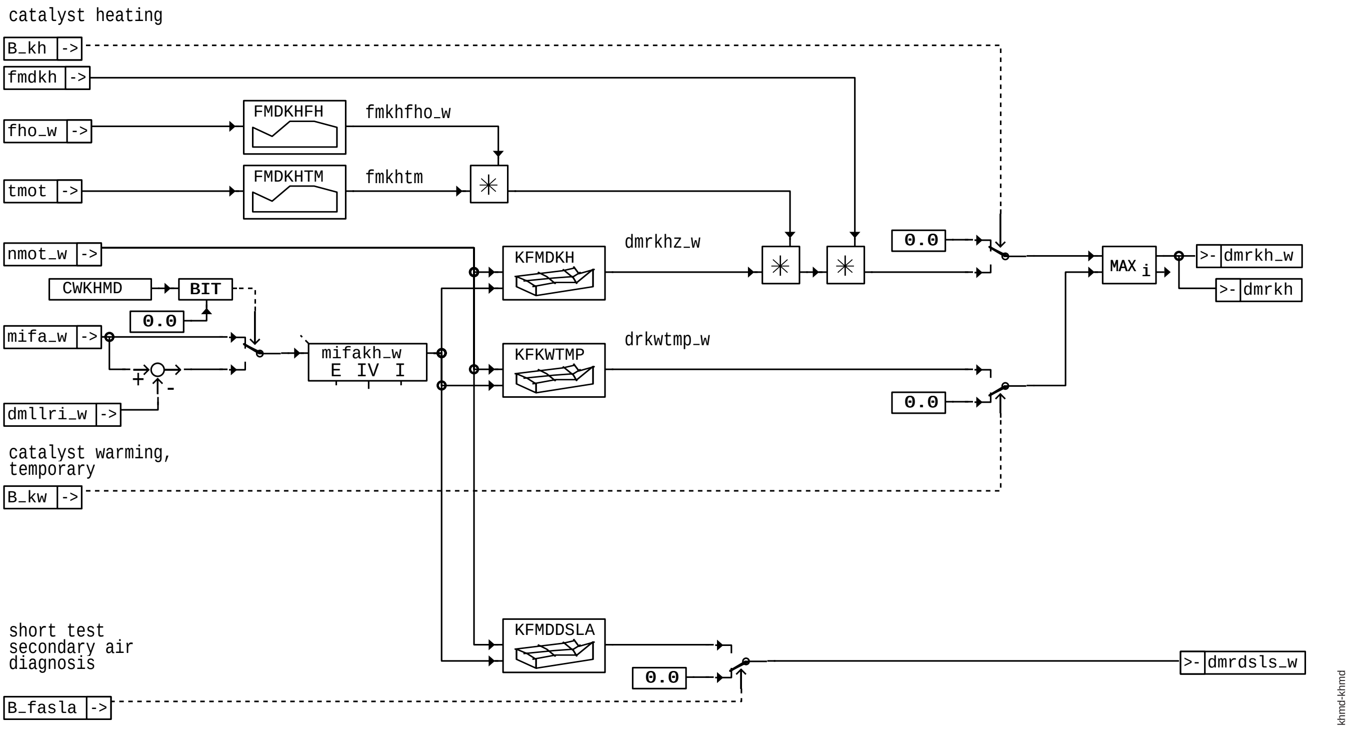
Note:
The bit B_khlle is also generated outside of catalyst heating, however, it is only of significance during catalyst heating (B_kh = 1). The bit B_trkh serves to request the accelerated Lambda sensor heating. Dependent on the sensor mounting position and on the amount of condensate it is possible to couple the bit B_trkh to catalyst heating by CWKHZ.0, otherwise a reset will be performed when idling is left, when the drive is shifted to and so on.

APP BBKHZ 11.130 Application hint

```
Preconditions:  Application mixture check(%GK), torque coordination(%MDUE)

Suggestion for the default selection:
BBKHZ*****************************************************************************************************
MLSUS:   2 .. 5 kg in the desired engine temperature range at start, =0 kg to switch off the catalyst heating
DTKH:    10 deg C
MLKHMX:  200 kg/h
TKHABB:  1 s, debouncing time for abort of catalyst heating
TKHLL:   120 s, maximum catalyst heating duration with uninterrupted idling as from engine start
TKHMX:   180 s, e.g. permitted max. turn-on duration of the secondary air pump
TKHMW:   255 s, idle speed decrease after 255 s
ZKHABB:  2 s
FKHABMN: 0,2
FKHMD:   from 0 to 0.9961 to 0 dependent on 0, continuous decreasing control close to imlpr = 0.9961
(The base point distribution of imlpr is to be chosen such that a continuous decreasing control to 0 is achieved.)
TMSLOF:  -10 deg C
FHOKH:   0.8
BFLAKH****************************************************************************************************
FKHLA:   analogous to FKHMD
FTMLAKH: 0.9961, at first no tmot-dependency, since catalyst heating duration =f(tmst) in MLSUS
IMLKHTMS:0, transition to lamkh already as from B_stend
ZKLAMKH: 0,01 s, quick transition to imlpr_w- control
BNKH******************************************************************************************************
TKATW:   1000 deg C, no mode keep catalyst warm
TKATMN:  300 deg C,
DTKATMN: 100 K
TKHFSAB: 0,3 s, debouncing time to shift into gear
TKHLLAB: 1 s, debouncing time to exit idling
NLLKHM:  1200 rpm at tmot 20 ... 40 deg C, normal desired engine speed with warm engine
NFSKHM:  800 rpm        "               , normal desired engine speed with warm engine
BTRKHTMS: = 0, -> decreased sensor heating performance with minor catalyst heating measures,
          > 0  -> maximum sensor heating performance only in conjunction with major catalyst heating measures (thermal reactor)
 CWKHZ:  0, no engine speed decrease after the time TKHLLMX, B_trkh is reset in case of interference
 Attention: Bit 7 set only for application purposes!
            Bit 7 sets B_trkh hard -> no decrease of the sensor heating performance -> sensor may be endangered.
KT*******************************************************************************************************
TDDSLA:  10s
TDSLKT:  5s
```

KHMD 1.50 Calculation of torque reserve for heating catalytic converter

FDEF KHMD 1.50 Function definition



khmd-khmd

ABK KHMD 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWKHMD			FW	code word for torque reserve in catalyzer heating
FMDKHFH	FHO_W		KL	altitude correction of torque reserve for catalyst heating
FMDKHTM	TMOT		KL	tmot-correction of torque reserve for catalyst heating
KFKWTMP	NMOT_W	MIFAKH_W	KF	Characteristic torque reserve for keeping catalyst warm, temporary
KFMDDSLA	NMOT_W	MIFAKH_W	KF	Map torque reserve at tester demand of SAI-diagnosis short test
KFMDKH	NMOT_W	MIFAKH_W	KF	Characteristic torque reserve for catalyst heating

Variable	Source	Type	Description
B_FASLA		EIN	Condition: external request of SAI system aktiv
B_KH	BBKHZ	EIN	condition catalyst heating activated
B_KW	BBKHZ	EIN	Condition catalyst warming
DMLLRI_W	LLRRM	EIN	desired torque change from the idle speed control (I-)
DMRDSLS_W	KHMD	AUS	Torque reserve for SAI- diagnosis
DMRKH	KHMD	AUS	torque reserve for catalyzer heating
DMRKHZ_W	KHMD	LOK	Torque reserve for catalyst heating
DMRKH_W	KHMD	AUS	Torque reserve for catalyst heating
DRKWTMP_W	KHMD	LOK	Torque for keeping catalyst warm, temporary
FHO_W	BGPU	EIN	correction factor: altitude
FMDKH	BBKHZ	EIN	Weighting factor torque reserve for catalyst heating
FMKHFHO_W	KHMD	LOK	Altitude correction of torque reserve at catalyst heating
FMKHTM	KHMD	LOK	tmot-correction of torque reserve at catalyst heating
MIFAKH_W	KHMD	LOK	desired indicated engine torque at catalyst heating
MIFA_W	MSF	EIN	desired indicated engine torque
NMOT_W	SWADAP	EIN	engine speed
TMOT	SWADAP	EIN	Engine temperature

FW KHMD 1.50 Fixed Values

Parameter	Value	Description
CWKHMD		code word for torque reserve in catalyzer heating

FB KHMD 1.50 Detailed description of function

So as to heat up the catalyst quicker resp. to keep it warm, the engine performance is deliberately reduced and therewith the exhaust-gas temperature is increased.
For this, the torque margin dmrkh is taken into account in the function %MDKOL, which causes the charge to be increased and the ignition angle to be retarded.

A distinction is made between "catalyst heating" dmrkhz and "keeping catalyst warm, temporarily" drkwtmp:

Catalyst heating:
The torque margin dmrkhz only has an effect while catalyst heating (B_kh = 1) is active. The control is performed from %BBKHZ by fmdkh. In order to ensure the performance at altitudes and the build-up of a vacuum for the brake, the torque margin can be evaluated altitude-dependent (FMDKHFH). The build-up of a vacuum when starting the engine is to be ensured by an increasing control of fmdkh 0 -> 1 in %BBKHZ. So as to expand the catalyst heating range, a tmot-dependent evaluation of the torque margin is possible.

Keeping the catalyst warm:
A temporary "keeping catalyst warm, temporarily" (B_kw) can be realized by the temporary torque margin drkwtmp from the map KFKWTMP dependent on the catalyst temperature tkatm from %ATM.

The resulting torque margin dmrkh_w is obtained by a max-selection from dmrkhz_w and drkwtmp.

By the code word CWKHMD, bit 0 it is possible to optionally deactivate the idle intervention dmllri_w in the addressing of the torque margin by mifakh_w = (mifa_w - dmrllri_w), e.g. in case of steep gradients in KFMDKH in the idling region.

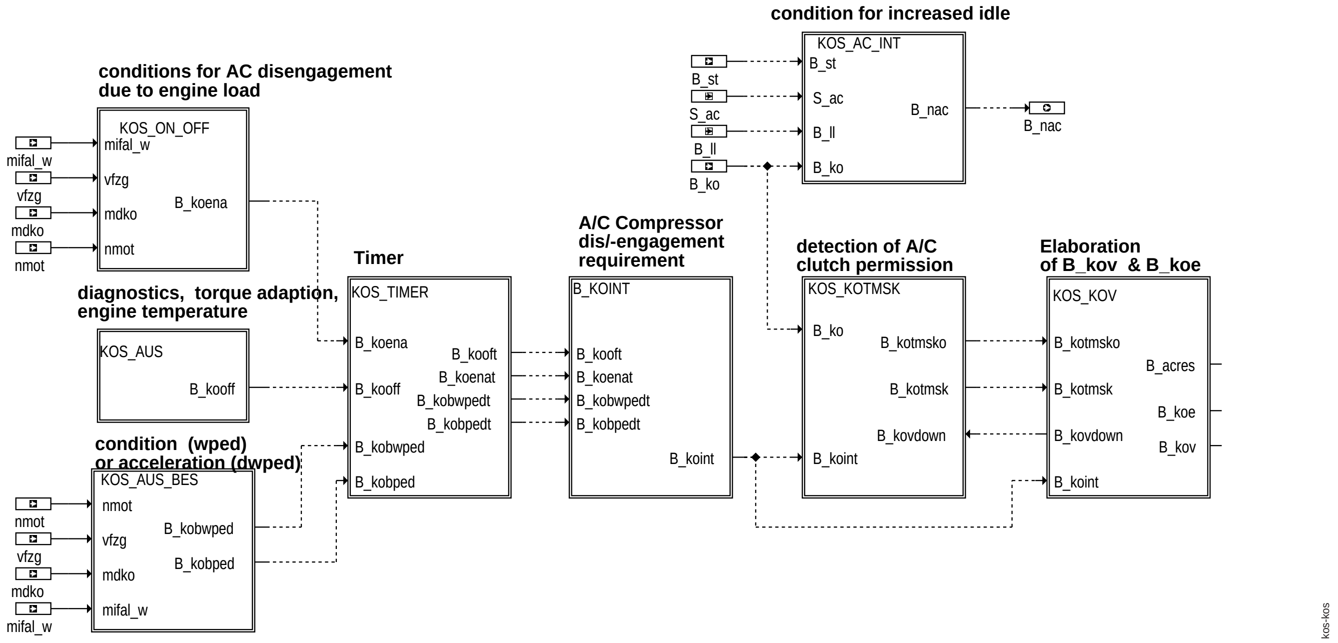
Quick-trip for the secondary air diagnosis:
By an input selection of the torque margin KFMDDSLA at tester intervention (B_fasla), it is possible to adjust the desired intake air mass for the secondary air diagnosis. (Also refer to %SLS.) For this, the necessary torque margin dmrdsls_w is transferred to %MDTRIP from the map KFMDDSLA.

APP KHMD 1.50 Application hint

Preconditions: Application of torque margin coordination (%MDUE)
Suggestion for presetting:
KFMDKH: Base point distribution for intended catalyst heating operating range, decreasing control of the torque margin with increasing driver's request mifa to start from rest most efficiently. Preset with 0, application of the torque margin e.g. from the necessary performance loss for catalyst heating.
FMDKHFH: Altitude-dependent evaluation of the torque margin, preset with 1.0
FMDKHTM: tmot- dependent evaluation of the torque margin, preset with 1.0
KFKWTMP: Base point distribution for idle and for operating ranges close to idle, in which the catalyst cools down when being in these ranges for longer. Preset with 0.
KFMDDSLA: Base point distribution for secondary air diagnosis at tester intervention. Preset with 0.
CWKHMD: 0

KOS 113.140 Control of A/C compressor

FDEF KOS 113.140 Function definition



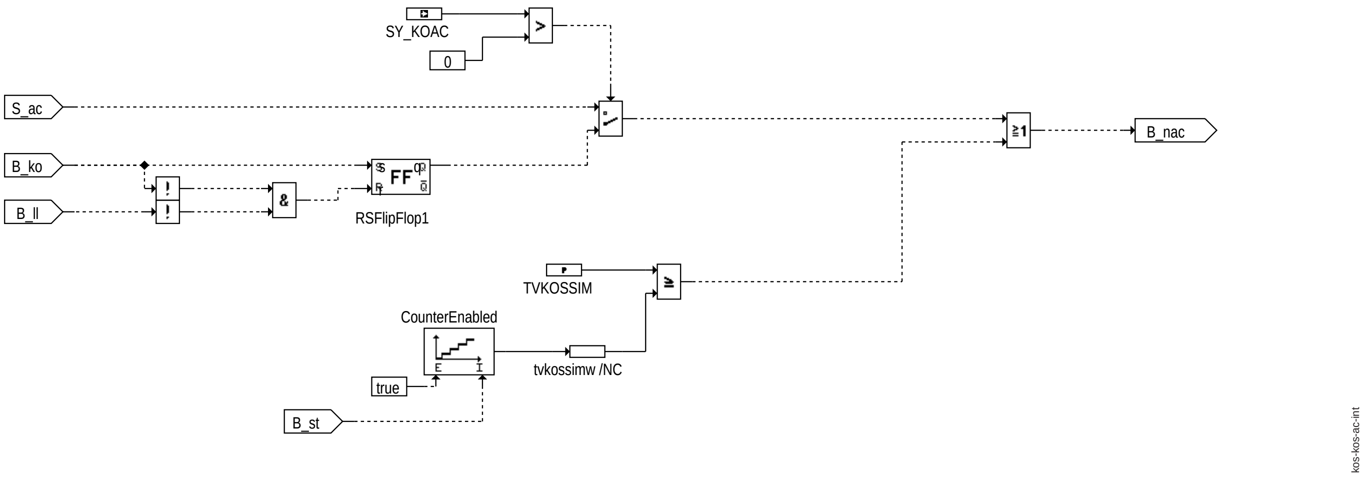
kos-kos

Genaral view of the AC-compressor control

The AC-compressor control is divided into four parts. These parts are:

- KOS_AC_INTERF : Software interface between the external signals from the AC-control and the Motronic
- KOS_ON_OFF : Conditions for swiching the compressor on or off depending of the engine operating conditions
- KOS_TIMER : Scheduler for the swiching-on and -off times of the compressor
- KOS_MANAGER : Controller for the compressor, decides if the compressor has to be swiched on or off in dependence of the informations from the above listed functions

Condition for increased idle-speed



kos-kos-ac-int

Software interface between the external signals of the AC-control and the Motronic:

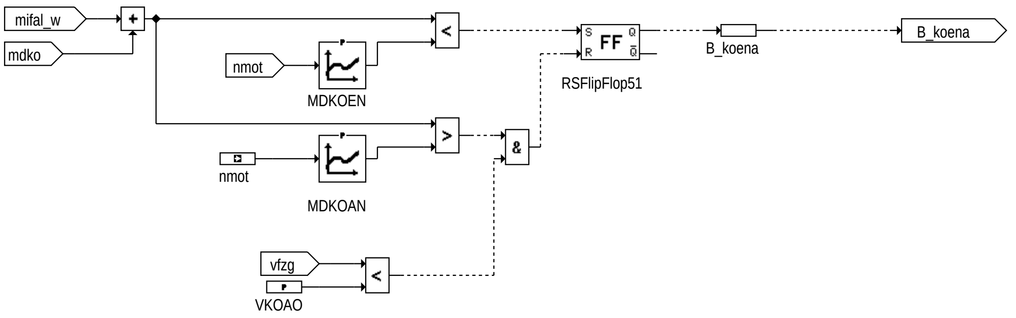
(This subfunction is specific for each project)

The AC-control delivers two informations in the form of an on/off-signal:

Inputs from the AC-control:
- S_ac : Swich AC-stand-by, is equal to the wish of an accelerated idling
- S_ko : Swich AC-compressor, is equal to the wish of having the compresor on

Outputs of the inerface:
- B_nac : Condition for an accelerated idling, see %LLRNS
- B_ko : Condition AC needs the compressor

A/C Clutch disengagement due to torque



kos-kos-on-off

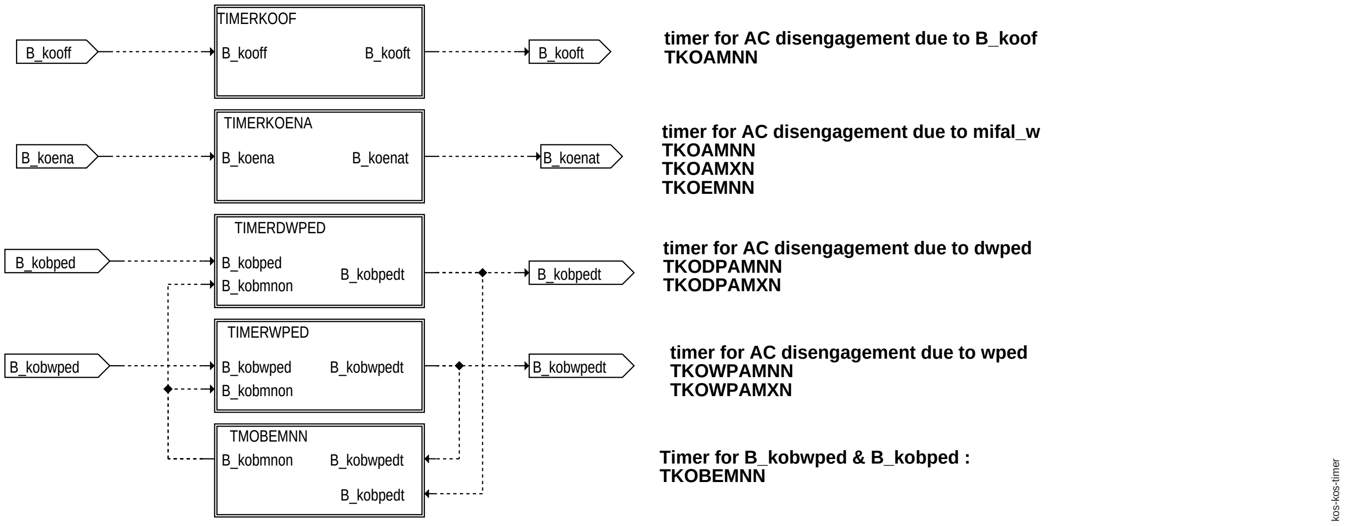
Engine dependant conditions to swich the AC-compressor on or off:

The compressor remains in any way swiched off for the time TNSTKO after engine start.
In normal use the compressor is disabled or swiched off only if he is the reason for an insuffisant torque at the clutch.
This is the case if the sum of the desired torque by the driver mifal and the compressor load-torque mdko is geather than the maximal torque that the engine can deliver. This limit sum is stored into the caracteristic line MDKOAN.
The compressor is enabled again if the sum mifal+mdko becomes less than the limit MDKOEN.

If the engine coolant temperature excceds the limit TMKOAO or is less than TMKOAU, the compressor is swiched off.
The output B_kooff diables the compressor time independantly.

For several diagnostic functions it is important that the compressor state remains unchanged for the time this functions are active because they need the reactions of the torque controller. Therefore torque jumps have to be avoided.
The output B_kosta freezes the actual compressor state. It is actually unused and therefore set to false.

Timer for for B_koof, B_koena, B_kopped & B_kobwped



kos-kos-timer

Sheduling the minimal an maximal compressor state times:

In dependance of the engine speed, the following compressor state times can be determined:

"- TKOAMNN : Minimal compressor off time; the compressor remains swiched off at least for this time before he could be swiched" on again.

"- TKOEMNN : Minimal compressor on time; the compressor remains swiched on at least for this time before he could be swiched" off again.

"- TKOAMXN : Maximal compressor off time; the compressor is swiched on again if he has been swiched off for a time greather" then TKOAMXN

The times TKOAMNN and TKOEMNN are used to prevent the compressor cluch from to often changing the swich state.
The time TKOAMXN avoids a permanent swich off of the compressor if the engine ist permanently used in an point where the compressor is disabled. It assures that the AC could work.
If the time TKOAMXN is set above the limit LIMTKOA, the compressor will never be swiched on by the time scheduler.

Compressor-control - manager of the different informations:

The manager decides in dependance of the input signals if the compressor will be swiched on or off.
Additionally the manager controles the swiching on and off of the compressor.
The condition B_ko has the highest priority. The compressor control enables or disables the compressor.
The compressor is enabled if the engine allowes the compressor load (B_koena = 1) or the compressor has been swiched off for a too long time (B_komxoff = 1) and an minimal off time has elapsed (B_komnoff = 1)
The compressor is diabled if if the engine doesn't allow the compressor (B_koena = 0) and the compressor is operating since at least a minimal time (B_komnon = 1).

The input B_kooff swiches the compressor allways off independly of minimal or maximal on or off times.

The input B_kosta frezzes the actual compressor state.

The compressor is swiched on in two steps:

first step: B_acres = 1, B_koe = 0: the compressor remains still swiched off, the engine torque reserve is increased.

after the time TKOE:

second step: B_acres = 0, B_koe = 1: the compressor is swiched on, the torque reserve is reduced to the normal lower value.

The compressor is swiched off in one step:

B_acres = 0 and B_koe = 0: the compressor is swiched off.

Paralelly to the swiching on and off of the compressor the load torque is increased or decreased.

ABK KOS 113.140 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDWGANG			FW	Gear detection for compressor shutdown at full throttle
CDWGANGB			FW	Gear detection during acceleration
CDWKOB			FW	Code word: Selection for gear detection for compr. shutdown (gangi or nmot/vfzw)
CWKOGANG			FW	configuration for transmission
DWPEDKOB			FW	gradient of the standardized accelerator pedal for the compressor
FHOKOB			FW	altitude threshold to enable the compressor
MDKOAB	NMOT		KL	Torque threshold to shut down the compressor during acceleration
MDKOAN	NMOT		KL	Torque threshold to switch the AC-compressor off
MDKOEN	NMOT		KL	Torque threshold to switch the AC-compressor on
SNM08KOUB	NMOT		SV	Datapoint distribution for air-conditioner compressor control 8 nmot
SY_GGGTS			SYS	system constant: sensor variable exact temperature signal
SY_KOBIDIR			SYS	AC- with bidirect. connection
TANSKOB			FW	Intake-air temperature threshold for compressor shutdown
TKOAMAD			FW	Inhibition time for AC compressor during adaptation of requirement
TKOAMNN	NMOT		KL	minimum shutdown time for air-conditioning compressor
TKOAMXN	NMOT		KL	maximum shutdown time for air-conditioning compressor
TKOBEMNN	NMOT		KL	Minimum switch-on time for compres. after triggering by B_kobped or B_kobwped
TKODPAMNN	NMOT		KL	Minimum cut-out time of the air-conditioner compressors during acceleration (dwp
TKODPAMXN	NMOT		KL	Maximum cut-out time for compressor cut-out by dwped
TKOEMNN	NMOT		KL	minimal time of air-condition compressor beeing swiched on
TKOMBKOA			FW	Engine temperature thresholt from panel board for switching the compressor off
TKOMBKOE			FW	Engine temperature threshold from panel board for switching on the compressor
TKOVKO			FW	Monitoring time for air-cond. key detection after reset of B_kov (bidirect. inte
TKOWPAMNN	NMOT		KL	Minimum cut-out time at full load (by wped)
TKOWPAMXN	NMOT		KL	Maximum cut-out time at full load (by wped)
TMKOAO			FW	Upper coolant temperature for swichting off the AC-compressor
TMKOAU			FW	Lower coolant temperature for swichting off the AC-compressor
TMSTMAD			FW	Threshold for engine temperature at start for adaptation of requirement
TNSTKO			FW	AC OFF time after engine start

Parameter	Source-X	Source-Y	Type	Description
TVKOE1			FW	delay time for compressor ON
TVKOEV			FW	delay time for compressor ON
TVKOSSIM			FW	Delay time for simulation of an air conditioner switched-on during start-up
VKO			FW	vehicle speed threshold for AC-control
VKOAO			FW	Upper vehicle speed threshold to inhibit the AC-compressor
VKOB			FW	Speed threshold for compr. control during acceleration
VNVKO			FW	Gear detection threshold for compr. shutdown at full load
VNVKOB			FW	Gear detection threshold for compr. shutdown at full load
WPEDKO	NMOT		KL	Accelerator position treshold for the A/C cut off

Variable	Source	Type	Description
B_ACRES	KOS	AUS	Condition for increasing the torque reserve by AC-stand-by
B_AUTGET	PROKON	EIN	condition automatic gearbox
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_GEKOA		EIN	Condition for switching off the compressor due to transmission actions
B_GRDST		EIN	condition basic attitude
B_GSCH		EIN	Condition gear-shift in process
B_GWHS	BBGANG	EIN	Condition gear change on manual transmission vehicle
B_KO		EIN	condition AC compressor authorised
B_KOA	KOS	LOK	Condition for AC-compressor OFF
B_KOBAUS	KOS	LOK	Condition for compressor during acceleration or at load
B_KOBMNON	KOS	LOK	Minimum Switch-on time after switching off during acceleration or full load
B_KOBPED	KOS	LOK	Condition for compressor off during acceleration by dwped
B_KOBPEDT	KOS	LOK	Condition for compressor switch-off by dwped acc. to timer
B_KOBWPEDT	KOS	LOK	Condition: A/C cut off over wped after timer
B_KOE	KOS	AUS	Condition for AC-compressor ON
B_KOENA	KOS	LOK	Condition AC-compressor is enabled
B_KOENAT	KOS	LOK	Condition AC-compressor is enabled after timer
B_KOINT	KOS	LOK	Condition for compressor switch-off from engine management
B_KOMNOFF	KOS	LOK	Condtion AC-compressor is swiched off for more mor than an minimal time
B_KOMNON	KOS	LOK	Condtion AC-compressor is swiched on for more mor than an minimal time
B_KOMXOFF	KOS	LOK	Condtion AC-compressor is swiched off for more than a maximal time
B_KOOFF	KOS	LOK	Condition for immediate swiching off the AC-compressor
B_KOOFFT	KOS	LOK	Condition for immediate swiching off the AC-compressor after timer
B_KOTMSK	KOS	LOK	Condition for air-conditioning switch-on
B_KOTMSKO	KOS	LOK	Condition for air-conditioning switch-on acc. to timer
B_KOV	KOS	AUS	Condition AC compressor forbidden
B_KOVDOWN	KOS	LOK	Monitoring time of B_ko after reset B_kov to B_kotmsko (bidirect. interface)
B_KOWPED	KOS	LOK	condition for A/C compressor cut off over wped
B_KUPPL	SWADAP	EIN	EGAS Condition cluch is disengaged
B_LL	MSF	EIN	Condition idle
B_MADFK		EIN	condition for torque adaptation AT in drive and AC compressor on
B_MADFS		EIN	condition for torque adaptation AT in drive
B_MADKO		EIN	condition for torque adaptation AC-compressor on
B_MADLL		EIN	condition for torque adaptation loadless
B_NAC	KOS	AUS	condition for increased idle-speed at AC
B_SA	MDRED	EIN	Condition fuel cut-off
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
DWPED	GGPED	EIN	gradient of the standardized accelerator pedal angle
FHO	BGPU	EIN	Correction factor altitude
GANGI	SWADAP	EIN	Engaged gear
MDKO	MDVERB	EIN	torque needed for air condition
MIFAL_W	MSF	EIN	Indicated driver's wish torque for torque coordination cylinder filling
NMOT	SWADAP	EIN	engine speed
SY_KOAC		EIN	system constant : commutation for S_ko and S_ac
S_AC		EIN	A/C stand-by position
TANS	SWADAP	EIN	Intake air temperature
TMKI		EIN	Coolant temperature of instrument panel
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
VFZG	SWADAP	EIN	vehicle speed (km/h)
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW KOS 113.140 Fixed Values

Parameter	Value	Description
CDWGANG		Gear detection for compressor shutdown at full throttle
CDWGANGB		Gear detection during acceleration
CDWKOB		Code word: Selection for gear detection for compr. shutdown (gangi or nmot/vfzw)
CWKOGANG		configuration for transmission
DWPEDKOB		gradient of the standardized accelerator pedal for the compressor
FHOKOB		altitude threshold to enable the compressor
TANSKOB		Intake-air temperature threshold for compressor shutdown
TKOAMAD		Inhibition time for AC compressor during adaptation of requirement
TKOMBKOA		Engine temperature thresholt from panel board for switching the compressor off
TKOMBKOE		Engine temperature threshold from panel board for switching on the compressor
TKOVKO		Monitoring time for air-cond. key detection after reset of B_kov (bidirect. inte
TMKOAO		Upper coolant temperature for swichting off the AC-compressor
TMKOAU		Lower coolant temperature for swichting off the AC-compressor

Parameter	Value	Description
TMSTMAD		Threshold for engine temperature at start for adaptation of requirement
TNSTKO		AC OFF time after engine start
TVKOE1		delay time for compressor ON
TVKOEV		delay time for compressor ON
TVKOSSIM		Delay time for simulation of an air conditioner switched-on during start-up
VKO		vehicle speed threshold for AC-control
VKOAO		Upper vehicle speed threshold to inhibit the AC-compressor
VKOB		Speed threshold for compr. control during acceleration
VNVKO		Gear detection threshold for compr. shutdown at full load
VNVKOB		Gear detection threshold for compr. shutdown at full load

FB KOS 113.140 Detailed description of function

APP KOS 113.140 Application hint

The following picture shows an example of calibration for the AC-compressor control parameters:

Swiching off threshold MDKOAN: Far under the idle speed the threshold is equal to zero. Immediatly if the engine speed drops into this speed region, the compressor is swiched off to avoid engine stalling.
The time TKOEMNN is set to zero to permit allways the immediate swiching off.
The time TKOAMXN is greater than LIMTKOA to avoid a swiching on as long as the engine remains in this speed region.

For normal engine speeds the swich-off threshold is nearly equalt ot the maximum of engine torque.
The disponibility of the compressor becomes here maximal.
For very high engine speeds it could be necessary for preventing the compressor from damage to swich him off. Therefore the threshold MDKOANN is here again set to zero. Here the same time conditions are used as for very low engine speeds.

Swiching on threshold MDKOEN: The swiching on threshold is typically lower than the swiching off threshold. At constant engine speed there is a torque hysteresis for the swiching of the compressor.

For high engine speeds the two thresholds MDKOEN and MDKOAN are speed shifted to each other.
So a speed hysteresis for the compressor swiching can be obatained.

Minimal on time TKOEMNN: For low and high engine speed, the minimal on time is set to zero to permit an immediate swiching of of the compressor an any time.
Between this speed limits the car manufacturer decides of the minimal on time.

Minimal off time TKOAMNN: The minimal off time is not important for the compressor control. This time is only a request of the manufacturer of the compressor-clutch.

Maximal off time TKOAMXN: The maximal off time must be greater than LIMTKOA for low and high engine speeds to avoid a a compressor swiching on in this engine speed regions.
Between this speed limits the maximal off time is determined by the car manufacturer depending of the requested AC disponibility.

DKOSE 5.10 Diagnosis of power stage for AC compressor

FDEF DKOSE 5.10 Function definition

`Diagnosis CJ400, resp. CJ 920  see %DECJ`

```
+-----------+------------+
| CJ400     |  B_mxkose  +-----------------------------+
| resp.     |            |                             |
| CJ920     |  B_sikose  +---------------------------+ |
|           |            |                           | |
| pow.stage |            |                           | |
|           |  B_mnkose  +-------------------------+ | |
|   A/C     |            |                         | | |
| control   |            |                         | | |   +-+
|           |            |                         | | +-->| |       (#)                             +-+---+
|           |            |                         | +---->|v+------+--------------------+---------->|S|   +-------> E_kose (*)
|           |            |                         +------>| |      |                    |    +-+    +-+---+
|           |            |                                 +-+      |               +-+  +-->o|v+--->|R|   |
|           |  B_desee   +---+                                      |    C_pwf ---->|v+------>| |    +-+---+
+-----------+------------+   |                                      |            +->| |  (*)  +-+
                 +-----------+                                      |            |  +-+
                 |   +-+                                            |    +-+     |
                 +-->|&|      +-+---+       +-+    +------------+   +--->| |     |
B_koe --------+--|-->| +----->|S|   +------>| |    | 500 ms +-  |        |v|     |                   +-+---+
              |  |   +-+      +-+---+       |&+--->| -------+-> +------->| +-----|------------------>|S|   +-------> Z_kose (*)
              |  |         +->|R|   |   +-->| |    +------------+        +-+     |                   +-+---+
              |  |         |  +-+---+   |   +-+                                  |            +----->|R|   |
              |  |   +-+   |            |                                +-+     |            |      +-+---+
              |  +-->|&|   |  +-+---+   |             B_clkose  -------->|&|     |     +-+    |
              +---->o| +---|->|S|   +---+             C_fcmclr --------->| +-----+---->| |    |
                     +-+   |  +-+---+                                    +-+           |v+----+ (*)
              +------------+->|R|   |                 C_ini -------------------------->| |    |
              |               +-+---+                                                  +-+    |
              |                                                                               |
              +-------------------------------------------------------------------------------+
```

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Substitution measures: non

```
Error memory management:
------------------------

Status error path kose:         SFPKOSE
Error flag :                    E_kose
Cycle flag :                    Z_kose
Error type :                    B_mnkose
                                B_mxkose
                                B_sikose
Delete error path:              C_fcmclr & B_clkose
Error path :                    CDTKOSE
Error class :                   CLAKOSE
Error intensity :               TSFKOSE
Carb code :                     CDCKOSE
Environmental conditions :      FFTKOSE
```

ABK DKOSE 5.10 Abbreviations

Variable	Source	Type	Description
B_CLKOSE		EIN	condition: clear fault path A/C power stage
B_DESEE	DKOSE	AUS	Diagnosis power stage: entry conditions fulfilled
B_KOE	KOS	EIN	Condition for AC-compressor ON
B_MNKOSE	DKOSE	AUS	Error type: short circuit to ground air cond. power stage
B_MXKOSE	DKOSE	AUS	error type: short circuit to Ubat A/C power stage
B_SIKOSE	DKOSE	AUS	error type: cable disconnection of A/C power stage
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_KOSE	DKOSE	AUS	Error flag: AC compressor activation , power stage
Z_KOSE	DKOSE	AUS	Cycle flag: AC compressor activation, power stage

FW DKOSE 5.10 Fixed Values

Parameter	Value	Description

FB DKOSE 5.10 Detailed description of function

Together with the CJ400/CJ920 diagnosis %DECJ the air condition power stage diagnosis forms a function unit. The diagnosis describes the forming of the error bit E_kose and of the cycle bit Z_kose.

The setting of the cycle flag is performed for one via an error entry and for the other via a definitely checked not to be due error. This definitate check is given if both switch states of the power stage, i.e. an on-state and an off-state were reached once. If an error is detected an error verification is activated in %DECJ which is performed independent of the external power stage request and which is definitely terminated after approx. 500 ms. Thereafter the the cycle flag is set in case no error occured.

APP DKOSE 5.10 Application hint

DHLSVKE 2.20

FDEF DHLSVKE 2.20 Function definition

Diagnosis CJ 400, resp. CJ 920 see %DECJ

```
+----------+------------+                                  +-+
|  CJ400   | B_mxhsve/2 +--------------------------------->| |        (#)                                  +-+----+
|  resp.   |            |                                  |V+--------+--------------------+-------------->|S|Flip|
|  CJ920   | B_sihsve/2 +--------------------------------->| |        |                    |         +-+   +-+----+--> E_hsve/2 (*)
|          |            |                                  | |        |               +-+  +------->o|V+-->|R|Flop|
|  HLSHK   | B_mnhsve/2 +--------------------------------->| |        |  C_pwf ------>|V+----------->| |   +-+----+
|  power   |            |                                  +-+        |           +-->| |(*)  +---->O| |
|  stage   | B_desee    +-+                                           | (#) +-+   |   +-+     |      +-+
+----------+------------+ |                          +-------------+  +---->| |   |           |
                 +--------+                          | 500 ms +--- |        |V|   |           |       +-+----+
                 |    +-+    +-+----+           +--->| -------+->t +------->| +---|-----------|------>|S|Flip|
                 +--->| +--->|S|Flip|      +-+  |    +-------------+   +-->O| |   |           |       +-+----+-------> Z_hsve/2 (*)
               +-|--->|&|    +-+----+----->| |  |                      |    +-+   |           | +---->|R|Flop|
               | |    +-+ +->|R|Flop|  +-->|&+--+    B_cdhsve ---------+----------|-----------+ |     +-+----+
               | |   +-+  |  +-+----+  |   +-+                               +-+  |             |
               | +-->| |  |   +-+----+ |                 C_fcmclr ---------->|&|  |      +-+    | (*)
B_hsve/2 ------+--->O|&+--|-->|S|Flip| |                 B_clhsve/2 -------->| +--+----->| |    |
                     +-+  |   +-+----+-+                                     +-+         |V+----+
                          +-->|R|Flop|                                           C_ini-->| |    |
                          |   +-+----+                                                   +-+    |
                          +---------------------------------------------------------------------+
+---------------------------------------------------------------------------------------------------------------+
|  The outputs E_hsve2, and Z_hsve2 on a 1-bank system are set defined by SY_STERHK=0:                          |
|  E_hsve2 = 0; Z_hsve2 = 1; the fault type is set = 0                                                          |
+---------------------------------------------------------------------------------------------------------------+
```

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

ABK DHLSVKE 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCHSVE	BLOKNR		KL	code word CARB: lambda sensor heating power stage upstream cat
CDCHSVE2	BLOKNR		KL	code word CARB: lambda sensor heating2 power stage upstream cat
CDTHSVE			FW	code word tester: oxygen sensor heater upstream catalyst power stage
CDTHSVE2			FW	code word tester: power stage oxygen sensor heater2 upstream catalyst
CLAHSVE			FW	fault class: O2 Sensor Heater power stage bank 1
CLAHSVE2			FW	fault class: O2 Sensor Heater power stage bank 2
FFTHSVE	BLOKNR		KL	Freeze frame table: 02 Sensor Heater power stage
FFTHSVE2	BLOKNR		KL	Freeze frame table: 02 Sensor Heater power stage bank 2
TSFHSVE			FW	fault active time: lambda sensor heating catalyst upstream (driver stage)
TSFHSVE2			FW	fault active time: power stage lambda sensor heating catalyst upstream, bank 2

Variable	Source	Type	Description
B_CDHSVE	PROKON	EIN	function active per codeword CDHSVE
B_CLHSVE		EIN	condition clear failure path DHLSVK (power stage)
B_CLHSVE2		EIN	condition clear failure path DHLSVK2 (power stage)
B_DESEE	DKOSE	EIN	Diagnosis power stage: entry conditions fulfilled
B_HSVE	HLS	EIN	condition for lambda sensor heating-switch upstream cat on
B_HSVE2	HLS	EIN	condition for lambda sensor2 heating-switch upstream cat on
B_MNHSVE	DHLSVKE	AUS	Short-circuit of heating of Lambda sensor upstream catalyst to ground
B_MNHSVE2	DHLSVKE	AUS	Short-circuit of heating of Lambda sensor 2 upstream catalyst to ground
B_MXHSVE	DHLSVKE	AUS	Short-circuit of heating of Lambda sensor upstream catalyst to UB
B_MXHSVE2	DHLSVKE	AUS	Short-circuit of heating of Lambda sensor 2 upstream catalyst to UB
B_SIHSVE	DHLSVKE	AUS	Load drop of sensor heating upstream catalyst
B_SIHSVE2	DHLSVKE	AUS	Load drop of sensor heating 2 upstream catalyst
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_HSVE	DHLSVKE	AUS	error flag: lambda sensor heating upstream cat (Endstufe)

Variable	Source	Type	Description
E_HSVE2	DHLSVKE	AUS	error flag: lambda sensor heating upstream cat on the right (Endstufe)
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
Z_HSVE	DHLSVKE	AUS	cycle flag of lambda sensor heating upstream cat (Endstufe)
Z_HSVE2	DHLSVKE	AUS	cycle flag of lambda sensor heating upstream cat, cylinder row 2 (Endstufe)

FW DHLSVKE 2.20 Fixed Values

Parameter	Value	Description
CDTHSVE		code word tester: oxygen sensor heater upstream catalyst power stage
CDTHSVE2		code word tester: power stage oxygen sensor heater2 upstream catalyst
CLAHSVE		fault class: O2 Sensor Heater power stage bank 1
CLAHSVE2		fault class: O2 Sensor Heater power stage bank 2
TSFHSVE		fault active time: lambda sensor heating catalyst upstream (driver stage)
TSFHSVE2		fault active time: power stage lambda sensor heating catalyst upstream, bank 2

FB DHLSVKE 2.20 Detailed description of function

The precondition for the diagnosis "power stage heating Lambda sensor" is the use of a power stage of the type CJ400/CJ920. The detection of a non-plausible state at the power stage and the reading of the fault type from the IC is described in the section %DECJ.

The fault types from the CJ400 diagnosis are combined according to their effect on the HLS for the further processing in other ECU functions. Short-circuit to UBat or wiring interruption lead to the Lambda sensor not being heated.
In case of a short-circuit to ground the sensor is heated with maximum performance.

The cycle flag is set by the CJ400 diagnosis in case of detected power stage fault. The cycle flag is also set, if via the condition B_desee it is indicated that a CJ400 diagnosis can be performed and if the heater power stage was switched on and off once without fault.

APP DHLSVKE 2.20 Application hint

AS 5.0 Output signal adaption

FDEF AS 5.0 Function definition

Responsible:

ABK AS 5.0 Abbreviations

FW AS 5.0 Fixed Values

Parameter	Value	Description

FB AS 5.0 Detailed description of function

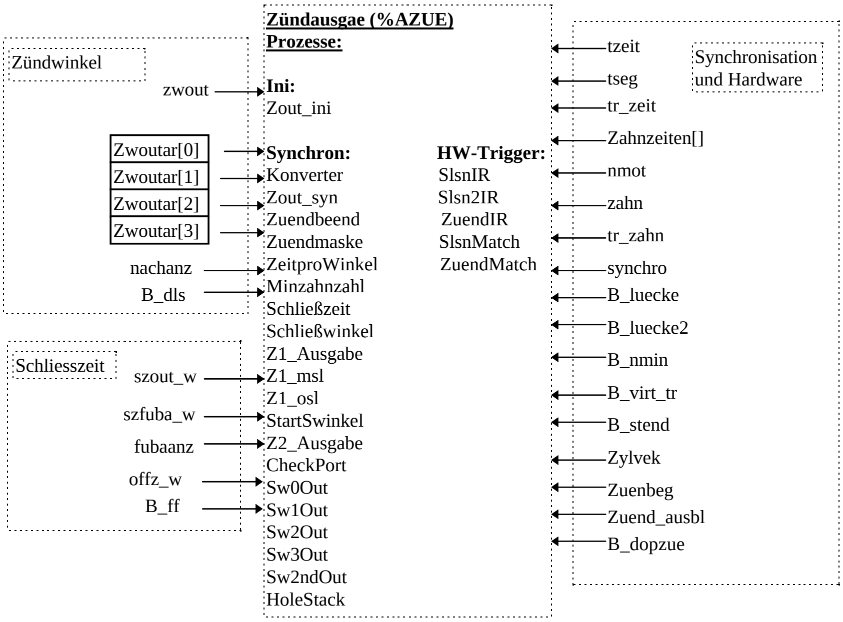
Description is missing !!!!

Responsible:

APP AS 5.0 Application hint

AZUE 5.40 Output ignition

FDEF AZUE 5.40 Function definition



azue-syn

`Fig. 1.0    Overview interfaces %AZUE:`

ABK AZUE 5.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CW_AZUE			FW	configuration code word ignition output
SY_DLS			SYS (REF)	system constant digital idle speed control
SY_DOPZW			SYS (REF)	System constant doubled ignition output included
SY_FFZ			SYS (REF)	system constant interval ignition
SY_FREQ_CP			SYS (REF)	system constant cpu frequency
SY_GAP			SYS (REF)	system constant: number of missing teeth in the gap
SY_GRNDWRT			SYS (REF)	system constant basis angle ref. tr-mark
SY_NACH			SYS (REF)	System constant ignition output after KL15 off included
SY_NZUEB			SYS (REF)	system constant engine speed threshold for switching between ignition modes 1+2
SY_TEETH			SYS (REF)	system constant: number of teeth at the crankshaft wheel (gapteeth included)
SY_WMIN			SYS (REF)	System constant latest ignition timing that can be outputed
SY_ZNDAUS			SYS (REF)	System constant ignition timing output (single or double fir.), 1: single,2: d.
SY_ZYLZA			SYS (REF)	system constant number of cylinders
TMZUB2MX			FW	temperature limit for angular priority during cold-start
ZWFUBAMN			FW	end angle of multiple strike ignition if configurated

Variable	Source	Type	Description
B_LUECKE	GGDPG	EIN	current segment covers the reference gap
B_LUECKE2		EIN	condition tooth gap at odd number of cylinders in the center of the segment
B_NMIN	GGDPG	EIN	condition lower speed: n < NMIN
B_SLSN2	AZUE	AUS	Condition overlapping dwell-time after cylinderspecific ignition-timing retard
B_STEND	BBSTT	EIN	condition end of start
B_SW0	AZUE	AUS	Condition no overlapping of dwell-time
B_SW1	AZUE	AUS	Condition overlapping of dwell-time
B_VIRT_TR		EIN	Condition virtuel calculation of tr marking is active
B_Z1	AZUE	AUS	Condition ignition section 1 is active
B_ZESYNC	AZUE	AUS	Condition ignition synchronized
B_ZWS0	AZUE	AUS	Condition change to single dwell-time overlapping - dwell time is outputed
MINZAHN	AZUE	AUS	Minimum number of teeth for earliest ignition event
NMOT	SWADAP	EIN	engine speed
OVLCTR	AZUE	AUS	Overlap counter dwell-event
SLSNINKR	AZUE	AUS	Rest of dwell-begin angle in 0.75 degree quantisation
SLSNINKR2	AZUE	AUS	Rest of dwell-begin angle in 0.75 degree quantisation overlapping after knocking
SLSNZAHN	AZUE	AUS	Dwell-begin angle in tooth quantisation 6 degree
SLSNZAHN2	AZUE	AUS	Dwell-begin angle in tooth quantisation 6 degree
SN2ZKVEK	AZUE	AUS	Next ignition circuit to close for 2nd event

Variable	Source	Type	Description
SNZKVEK	AZUE	AUS	Next ignition circuit to close
SWOUT	AZUE	AUS	dwell angle
SZOUT_W	ZUESZ	EIN	dwell time
TINKR	AZUE	AUS	time per ignition angle incrementation
TR_ZAHN		EIN	teeth counter
TR_ZEIT		EIN	Timer-value at TR-event
TSEG_W	BGNMOT	EIN	segment cycle time
TZND	AZUE	AUS	Real controlled dwell-time
WOUTA0	AZUE	AUS	Ignition angle array referring angle basis element 0
WOUTA1	AZUE	AUS	Ignition angle referring to TR event plus zylinderspecific correct. of foll. cyl
WOUTA2	AZUE	AUS	Ignition angle referring to TR event plus zylinderspec. correct. of act. cyl+ 2
WOUTA3	AZUE	AUS	Ignition angle referring to TR event plus zylinderspec. correct. of act. cyl+ 3
WOUTST0	AZUE	AUS	Lowest ram-cell of ignition angle stack
WOUTST1	AZUE	AUS	Ram-cell 1 of four element ignition angle stack
WOUTST2	AZUE	AUS	Ram-cell 2 of four element ignition angle stack
WOUTST3	AZUE	AUS	Ram-cell 3 of four element ignition angle stack
ZKVEK	AZUE	AUS	Shifting value for calculation of ignition mask
ZNZKVEK	AZUE	AUS	Next ignition circuit to fire
ZOUTTMX	AZUE	AUS	Max. time from TR event till end of AZUE
ZUENBEG		EIN	Value of cylinder counter at wich an injection has taken place
ZUENINKR	AZUE	AUS	Rest angle from last tooth till ignition
ZUENTMX	AZUE	AUS	Max. time from TR event till final calculation of ignition values
ZUENZAHN	AZUE	AUS	Ignition angle in tooth quantisation
ZWOUT	ZUE	EIN	Ignition angle output value
ZWOUTAR0		EIN	Ignition angle output array Element 0
ZWOUTAR1		EIN	Ignition angle output array Element 1
ZWOUTAR2		EIN	Ignition angle output array Element 2
ZWOUTAR3		EIN	Ignition angle output array Element 3
ZYLVEK		EIN	cylinder vector

FW AZUE 5.40 Fixed Values

Parameter	Value	Description
CW_AZUE		configuration code word ignition output
TMZUB2MX		temperature limit for angular priority during cold-start
ZWFUBAMN		end angle of multiple strike ignition if configurated

FDEF AZUE 5.40 Function definition

```
1. Ignition concept:

The ignition concept of the ME7 has been conceived for single spark and double spark coils.
The coils are triggered by ignition power stages, which can either be located inside
of the ECU or outside. The triggering of the ignition power stages
is performed via port outputs of the processor.  ASIC-concepts
for the ignition output do not exist. Some of the power stages include a current limitation.

For external power stages diagnosis-capable small signal drivers (ex. CK110) can be integrated
in the power stage diagnosis according to %DECJ. The state machine described in %DECJ
is manipulated in such a way that a diagnosis logic according to %DZUEET is obtained.

For internal power stages, a diagnosis does not exist.

The task of the ignition is to reliably initiate a combustion. For this, it must be ensured,
that a sufficiently high amount of energy is present at the ignition coils in all operating points of
the engine. This means that the voltage at the spark plug must be sufficiently high and a minimum spark
duration must not be undershot. This is realized by the control of the ignition coil dwell
periods (szout). The coil dwell periods are stored in characteristic maps and are applied through
ub and nmot (KFSZT) in such a manner that the coil current is situated within the range of the
nominal current (see %ZUEZ) for all engine load points. Normal spark durations hover around 1 ms,
which corresponds to an angle range of 18 degrees for 3000 rpm. The voltage at the plug is possibly
applied to 30KV.

In order to optimize the combustion process (exhaust gas reduction, optimum torque), the dwell end (i.e. the
ignition point) is controlled such that a spark beginning corresponds as exactly as possible to the
preset ignition point zwout.

Angle information is available through the counting of teeth of the engine speed sensor. During an engine speed
sensor limp-home, this information must be artificially generated. The remaining residual angle, which
cannot be measured by referring to the teeth, is added as a waiting period to the last counted tooth.
Time-controlled events, like e.g. the output of the dwell period during start, are realized via a special timer.
It should be observed that the time interval output is not longer than one timer cycle. This is 52.4ms
for a resolution of 800ns. The ignition event is limited to one synchro. The dwell event in ignition range 2
can be realized as an output for up to 3 synchronization rasters after the calculation of the event
(return of the 3-fold overlap to an overlap-free operation).

1.1 Block diagram:
===================
Assignment: engine speed signal (nBM), phase signal and ignition signal (Example 4-cyl.-engine, firing order 1 3 4 2):
```

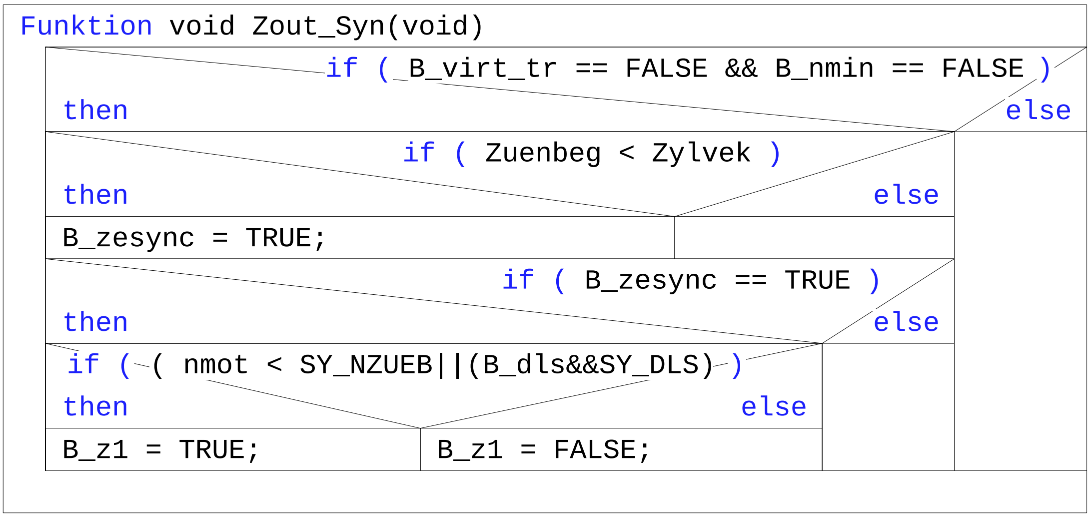
```
   60-2-tooth wheel
                tooth space
          ++++++++    ++++++++++                    ++++++++    ++++++++++                    ++++++++    ++++++++++
 nBM  ...-++++++++----++++++++++-...            ...-++++++++----++++++++++-...            ...-++++++++----++++++++++-... .

 tr-mark
 --|------------------|--------------------|--------------------|--------------------|--------------------|-------------
   |<--Segment time-->|                    |                    |                    |                    |
                      |                    |                    |                    |                    |
                      |                    |                    |                    |                    |
 Camshaft signal(NWS):|                    |                    |                    |                    |
       ------------+  |         +----------|--------------------|--------------------|-----------------+  |         +--
 standard sensor      |--|---------|..........|                    |                    |                 |--|---------|
 wheel                   |             mit NWS|                    |                    |                    |
                      |                    |                    |                    |                    |
                     +-+                  +-+                  +-+                  +-+                  +-+
synchron. raster ----+ +------------------+ +------------------+ +------------------+ +------------------+ +------------
                      |                    |                    |                    |                    |
 Single ignition output (without overlap)  |                    |                    |                    |
                      |                    |                    |                    |                    |
ts cyl.1 -------------|------------+ +-----|--------------------|--------------------|--------------------|----+ +-------
                      |            +-+     |                    |                    |                    |    +-+
ts cyl.3 -------------|--------------------|----------+ +-------|--------------------|--------------------|--------------
                      |                    |          +-+       |                    |                    |
ts cyl.4 -------------|--------------------|--------------------|--------+ +---------|--------------------|--------------
                      |                    |                    |        +-+         |                    |
ts cyl.2 -------+ +---|--------------------|--------------------|--------------------|------+ +-----------|--------------
                +-+   |                    |                    |                    |      +-+           |
                      |                    |                    |                    |                    |
Single ignition output (with overlap)      |                    |                    |                    |
                      |                    |                    |                    |                    |
ts cyl.1 -------------|------------+                      +-----|--------------------|--------------------|----+
                      |            +-------|--------------+     |                    |                    |    +---------
ts cyl.3 -------------|--------------------|----------+         |            +-------|--------------------|--------------
                      |                    |          +---------|------------+       |                    |
ts cyl.4 -------------|--------------------|--------------------|--------+           |          +---------|--------------
                      |                    |                    |        +-----------|----------+         |
ts cyl.2 -------+     |               +----|--------------------|--------------------|------+             |        +-----
                +-----|---------------+    |                    |                    |      +-------------|--------+
                      |                    |                    |                    |                    |
                      |                    |                    |                    |   -->|             |<--
                                                                                              overlap
```

Figure 1.1 shows in principle the course of ignition signals at the controller. Via engine speed sensor and camshaft sensor the controller HW generates the synchronization raster by counting a determined number of teeth. The first synchronization raster is established immediately after the detection of the tooth space. By requesting the level of the camshaft sensor directly after the tooth space has been detected, the synchronization raster is assigned to the corresponding cylinders.
At the beginning of the synchronization raster the segment time - i.e. the time between the tr-marks - is calculated. Afterwards the synchronous processes of the user SW (applicable SW) - containing among others the calculation of the output ignition angle zwout(see %ZUE) - are called.
The dwell period szout (see %ZUESZ), the segment time tseg_w and the ignition angle zwout are used to calculate a dwell beginning angle (Slsnzahn,Slsninkr). The dwell beginning is set by the controller HW by counting sensor teeth (Slsnzahn) including a waiting period for the increment refinement (Slsninkr*Tinkr).

The ME7 uses two different output methods, called ignition range 1 and 2 in the following.
Basically, the ignition output is provided with the information about ignition angle and dwell period. The synchronisation SW transmits the segment time tseg.
Via the segment time, the dwell period szout is converted into a dwell angle swout. Ignition angles of few dwell angles result in the dwell beginning angle.
In both of the ignition ranges, the output of the dwell beginning angle is performed by counting sensor teeth plus added increment refinment. Is the dwell beginning angle reached, the dwell event is released.
In ignition range 1, the dwell period is defined as a timer-comparative value at the release of the dwell event. This means, the ignition coil remains closed until the dwell period szout is reached with a max. timer precision (800ns for 20 Mhz). When the comparative value is reached, the controller HW opens the coil circuit, and an ignition is triggered. In ignition range 2, no further actions are started anymore in the release routine of the dwell event. In this operating mode, the output of dwell beginning angle and ignition angle is carried out parallely and independently of each other. This means, the ignition angle in ignition range 2 is released in the same way as the dwell beginning angle (counting of sensor teeth plus increment refinement).

Principle of function: synchronisation and switch-over between the ignition ranges:

Zout_Syn



```
Funktion void Zout_Syn(void)
  if ( B_virt_tr == FALSE && B_nmin == FALSE )
  then
    if ( Zuenbeg < Zylvek )
    then
      B_zesync = TRUE;
    else
    if ( B_zesync == TRUE )
    then
      if ( ( nmot < SY_NZUEB||(B_dls&&SY_DLS) )
      then
        B_z1 = TRUE;
      else
        B_z1 = FALSE;
    else
  else
```

azue-umsch

azue-umsch

Figure AZUE-5-UMSCH-1 shows the synchronisation mechanism as well as the range switch-over in a structogram. It should be noticed that the structogram constitutes only an abstraction of the assembler SW in the ECU. The used names as well as the position of the request elements differs from the real SW.
Is the minimum engine speed exceeded (B_nmin == FALSE), a real synchronisation has been carried out (B_virt_tr == FALSE). If the cylinder counter exceeds the cylinder value of the first injection (Zylvek > Zuenbeg), the ignition output routine is started.
The synchronisation with the injection effects an ignition at a defined Motronic-mixture.
That way, the assymetries (jerk during start) are reduced.

The switch-over between the ignition ranges happens via the flag B_Z1 (visible in the application system).
Below the speed SY_NZUEB B_Z1 = TRUE is set, the ignition range 1 thus being activated. By means of a code word intervention, it is also possible to select another switch-over mechanism (see chapters later on).
Above the threshold B_Z1 = FALSE, i.e. ignition range 2 is activated.
In some single projects a so-called "digital low idle stabilisation" is used, for which the output of dwell beginning and ignition event is performed by a timer-comparison. The DLS-function is utilized in VW-projects and requires various frame conditions for a correct functionning.
If the DLS-functionality is integrated in the ECU via the system constant SY_DLS, ignition range 1 is activated, in the case of an active DLS (B_dls = TRUE).

1.2 Signal sequence in ignition range 1

===

Overview : calculation of the dwell time:

```
   nBM -----------------------------------------------------------------------+
                                                                              |
   output of ignition                                                         |
   angle                                                                      |
   zwout     --------------+                                                  |
                           |                                              +---V------------+  angle A
                         - V     wout            wout          wbegin     |   tooth        |--------->
   SY_GRDWRT ------------->O------------------------------>O------------->|   refinement   |  time B
                                                         - ^              |             2) |--------->
                                                           |              +----------------+
   SY_ZYLZA, Segment time----------+                       |
                      +------------V---+                   |
   dwell period       | time/          | dwell angle       |
   szout_w   ----+--->| angle -        |-------------------+
                 |    | conversion  1) |
                 |    +----------------+
                 |                                                                            time D
                 +----------------------------------------------------------------------------------->
```

1) and 2) as for the "calculation of the dwell angle"

Calculation of dwell beginning and dwell end:
Calculation of the dwell beginning and the dwell end:
The dwell beginning is calculated, just like in the ignition range 2, with tooth refinement.
The dwell end results directly from the dwell period szout_w. The exact output of the dwell period uninfluenced by the engine speed dynamics takes place.

Output: fixed dwell period (ignition range 1, B_z1 = 1):

Overview:

```
                                                                                    <----- advance (+) ---------- | -- retard (-) --
->

                                                                                        |<---- zwout ---------|
                                                                                        |                     |
                                                                                                            TDC cyl.
                      Software-ref. mark                    A  B                                  D                     |
     60-2-tooth wheel          |                   |  |                                  |                     |
       -+ +-+ +-+       +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+
        +-+ +-+ +-------+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +
         tooth space----->|   |               |TzB|  |                                  |
                              |               |<->|  |                                  |
          tr-mark ----------> |               |   |  |                                  |
                              |                   |  |                                  |
                              |   angle    A      |  |                                  |
                              |==================>|  |                                  |
                              |                      |                                  |
                              |                time B|                                  |
                              |                   |<>|                                  |
                              |                      |          time  D                 |
                              |                      |=================================>|
                              | dwell begin. , wbegin|                                  |
                              +--------------------->|                                  |
                              |                      |                                  |
                              | dwell end, wout                                         |
                              +-------------------------------------------------------->|
                              |                                                         |
                                                     +----------------------------------+
                                                     |<------- dwell period------------>|
                                                     +----------------------------------+
```

In ignition range 1, the dwell period szout is re-quantized after the triggering of the dwell beginning and is loaded into a comparative register of the ignition timer. That way, exactly (800ns) after the dwell period has elapsed, an ignition pulse is generated.

Ignition range 1 has only been conceived for lower engine speeds. An operation with overlapping dwell periods is not supported.

1.3 Signal sequence in ignition range 2

Overview: calculation of the dwell angle:

```
   nBM -----------------------------------------------------------------------+
                                                                          +---V------------+  angle C
                                                                          |   tooth        |--------->
                                        +-------------------------------->|   refinement   |  time D
                                        |                                 |             2) |--------->
                                        |                                 +----------------+
   Output of the ignition               |
   angle                                |                                     |
   zwout     --------------+            |                                     |
                           |            |                                 +---V------------+  angle A
                         - V     wout   |        wout          wbegin     |   tooth        |--------->
   SY_GRDWRT ------------->O------------+----------------->O------------->|   refinement   |  time B
                                                         - ^              |             2) |--------->
                                                           |              +----------------+
   SY_ZYLZA, Segment time ---------+                       |
                      +-----------V----+                   |
   dwell period       | time /         | dwell angle                |
   szout_w   -------->| angle   -      |-------------------+
                      | conversion 1)  |
                      +----------------+
```

```
    1):                         720°/SY_ZYLZA
        Dwell angle     =    ------------------------------  * szout_w
                              segment time (tseg_w, tseghi)
```

```
   2):
        Tooth refinement:
                                        tooth angle           6°
        Factor tooth refinement  =    -----------------  =  ------ =  8
                                       angle increment       0.75°
```

Sequence:
1. Determine angle A for 1. interrupt:
   Angle A [no. of teeth]   = wbegin[°] / 6   ; with rest [no. of teeth]
2. Determine the last tooth time TzB
3. Residual angle [°] = rest[no. of teeth] * 6°
4. No. of increments = residual angle[°] / 0.75
5. Determine timeB for 2. interrupt:
   TimeB = (TzB/8) * no. of increments

;accordingly for the time D

Output: Fixed dwell angle (ignition range 2, B_z1 = 0):

Overview:

```
                                                                                    <----- advance (+) ---------- | -- retard (-) --
->
                                                                                        |<---- zwout ---------|
                                                                                        |                     |
                              |<--------------------  SY_GRDWRT --------------------------------------------->|
                              |                                                                             TDC cyl.
                      Software ref. mark          A  B                                C D                     |
     60-2-tooth wheel         |                   |  |                                | |                     |
       -+ +-+ +-+       +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+
        +-+ +-+ +-------+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-
         tooth space----->|   |               |TzB|  |                            |TzD| |
                              |               |<->|  |                            |<->| |
          tr-mark  ---------->|               |   |  |                            |   | |
                              |                   |  |                                | |
                              |   angle A         |  |                                | |
                              |==================>|  |                                | |
                              |                      |                                  |
                              |                 timeB|                             timeD|
                              |                   |<>|                                <>|
                              |                               angle  C                | |
                              |======================================================>| |
                              | dwell begin. , wbegin|                                | |
                              +--------------------->|                                | |
                              |                      |                                | |
                              | dwell end, wout                                         |
                              +-------------------------------------------------------->|
                              |                                                         |
                                                     +----------------------------------+
                                                     |<------- dwell angle   ---------->|
                                                     +----------------------------------+
```

In igniton range 2, dwell beginning angle and ignition angle are used independently of each other for the output of dwell beginning and dwell end by counting the angle values at the sensor wheel teeth.

Ignition range 2 permits dwell period overlaps. This means, that the dwell beginning of a charging time can be situated max. three segments before the ignition event. Since the charging times must be kept as exactly as possible, the ignition angle related to the dwell beginning in the segment of the dwell beginning is frozen, and the ignition angle calculated during the charging time is not taken into account anymore.

2. Ignition output methods

2.1 Ignition range 1

The ignition output is divided into two ignition methods between which a hard switch-over is performed during stationary operation at an engine speed of SY_NZUEB, as soon as the start phase ends.

Summary of the advantages and the disadvantages of the two methods:

	Advantages:	Disadvantages:
Dwell period output (ZB1):	minor power dissipation, sufficient ignition energy also in case of dynamics (start, time output not influenced by dynamics)	engine speed dynamics causes a deviation of zwout compared to the real angle position of the ignition output pulse. The deviation strongly depends on the length of the dwell period.
dwell angle output(ZB2):	more accurate ignition angle	inaccurate ignition energy (too high: power dissipation, too low: misfire)

It should be noticed that at a stable engine speed no difference between the immediate output of the dwell periods and the angle accurate output of the dwell beginning and the ignition angle (ignition range 2) can be observed.
The division into two ignition ranges has the major aim to avoid an affection of the dwell periods through pre-emptive dynamics during start. In the old Motronic-Systems a hyperbolically increasing dynamic value must be added to the dwell periods to obtain an angle accurate output of dwell beginning and ignition point.
This is due to the fact, that the engine speed information in the synchro is only determined rather rarely, with the effect, that the extreme accelerations during start result into an extreme reduction of the real dwell period.
In this case, a sufficiently high dynamic value must be considered during the application phase so that even at the highest acceleration within a segment the output of the charging time remains correct.

In practice, the charging times sometimes take on such high values, that coil/power stage are in danger during warm starts. For ignition systems with current limitation, it has been observed that the considered dynamic value at start is so high, that the primary current clearly reaches the current limitation range at normal dynamic influences.
This means that during normal operation the power dissipation increases with increasing dynamic value.

Since the dwell period application is optimized regarding power loss/plug wear, it is of a major importance to realize a dynamically correct output of the dwell period to ensure that an ignition spark is established.
With increasing engine speed the frequency used for the detection of the speed signal in the ECU increases too. Thus dynamic changes can more easily be determined. Therefore it is advisable to realize an output of dwell periods at low engine speeds. The higher the engine speed, the higher the dynamic resolution. Due to this fact, it is no more necessary to proceed to an immediate output of the dwell periods from a particular engine speed threshold onwards.
Since with increasing engine speed and load also the fuel management is improved, it becomes more and more probable that already at spark beginning a combustion is caused.
The ignition angle resolution therefore increases.

In the current ignition no dynamic value must be applied during start. The disadvantage of the very exact control of the dwell periods is that the ignition angle deviates under dynamic influences from the applied ignition angle zwout.
This deviation, however, only occurs for dynamic influences and decreases with reduced dwell periods.
Since the output of the dwell period enables a very exact control, the dwell periods in ignition range 1 should be selected as small as possible.

2.2 Ignition range 2

Starting with the threshold SY_NZUEB, dwell beginning and dwell end (ignition) are realized as an output via an angle comparison. This ignition mode is designated as ignition range 2.

The output of the ignition related dwell beginning in ignition range 2 can be realized up to 3 segments in advance.
The output of the dwell beginning one or more segments before the ignition segment is called overlap.
The overlap can comprise 3 segments at max..
In the case of double spark coils for cylinder numbers lower than 6 and in the case of single spark plugs for cylinder numbers lower than 3, the max. degree of the overlap is less than three segments.

Possible overlap in segment	Cylinder number	Used coil concept
3	8	single and double spark
3	6	single spark
2	6	double spark
3	5	single spark
3	4	single spark
1	4	double spark
2	3	single spark

E.g. single and double spark coils (4 cylinder)

```
Single spark :
Zyl.OT        1             2             3              4              1              2
            +--+            |             |              |            +--+
            |  |            |             |              |            |  | Coil 1
------------+  +------------+-------------+--------------+------------+  +-----------------
               |   3-fold   |  2-fold     |   1          |               |
               |<-----------+-------------+--------------+---------------|
                            |
Double spark  :             |
                            |
            +--+            |           +--+                          +--+
            |  |            |           |  |                          |  | Coil  1
------------+  +------------+-----------+  +--------------------------+  +-----------------
               |   1        |                                            |
               |<-----------+--------------------------------------------|
```

One single coil can be closed for almost 4 segments, as long as the power dissipation permits it.
This means, the dwell period can overlap for max. 3 segments.
For ideal, loss-free components only a residual open time must be kept during the spark duration.
The last possible ignition angle is in this case determined by the system variable SY_WMIN.

For the double spark plug, already 2 segments after the last ignition, the ignition of the complementary cylinder is carried out with the same coil. This means, the dwell beginning can be at max. one segment in advance of the ignition segment.

Dwell beginning angle and ignition angle in ignition range 2 define the dwell angle and thus the energy of the coil. If between dwell beginning and ignition angle a synchronization raster is active, the calculated new ignition angle has no effect on the current ignition, since otherwise the coil energy could change too gravely.

2.1.1 Overlap operation - ignition array/ignition angle stack

As described above, the dwell beginning is placed one or two segments before the ignition during the overlap operation. Since the calculation of the ignition events takes place in the general synchro-program, a possibility must be created to enable an access of the synchro-program to an ignition angle that is part of a dwell beginning resulting from several synchros in advance. For this, the SW uses a 4-element (0..3) deep ignition angle stack. If the SW is in overlap operation, the ignition angle is not taken directly from zwout, but from the 0-element of the ignition angle stack.
If a 3-fold overlap is detected, zwout is written on the third element of the ignition angle stack and the dwell beginning angle belonging to zwout is realized as an output in the current synchro. At the end of this synchro, the elements of the ignition angle stack are shifted downwards by one element.
As a result, the zwout written into the third element of the stack occurs 3 synchros later at the zero position of the stack. The output SW takes over the corresponding output ignition angle.

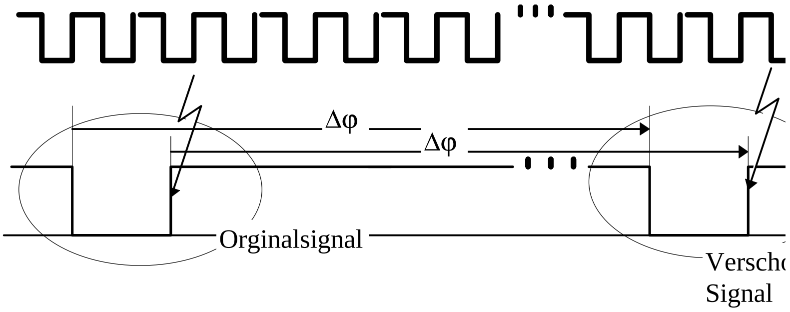
```
+-------------------+   +-------------------+   +-------------------+   +-------------------+
| ZWOUTST3=ZWOUTAR3 |   |ZWOUTST3= xx       |   | ZWOUTST3= xx      |   |ZWOUTST3= xx       |
+-------------------+   +-------------------+   +-------------------+   +-------------------+
| ZWOUTST2= xx      |   |ZWOUTST2=ZWOUTAR3  |   | ZWOUTST2= xx      |   |ZWOUTST2=xx        |
+-------------------+   +-------------------+   +-------------------+   +-------------------+
| ZWOUTST1= xx      |   |ZWOUTST1=xx        |   | ZWOUTST1=ZWOUTAR3 |   |ZWOUTST1=xx        |
+-------------------+   +-------------------+   +-------------------+   +-------------------+
| ZWOUTST0= xx      |   |ZWOUTST0=xx        |   | ZWOUTST0= xx      |   |ZWOUTST0=ZWOUTAR3  |
+-------------------+   +-------------------+   +-------------------+   +-------------------+
   0   segment            1 st  segment            2 nd segment           3 rd segment
```

The figure shows the principle of the ignition angle stack at a 3-fold overlap. In the zero segment, the dwell beginning of an ignition which should be triggered in the 3rd segment is started.
For this, the output ignition angle is copied to the 3rd element of the ignition stack. It then moves one element downwards per synchro, so that it accesses the ignition output in the third segment at zero position.

The ignition angle written into the stack in the zero segment could belong to a knocking cylinder, whereas the cylinder which is fired in segment 0 does not knock. The ignition angle zwout is calculated in the synchro for the cylinder which should be fired in the current synchro.
In the example, the firing of the cylinder has already been initialized 3 segments in advance.
This means, the output ignition angle is also placed in the zero element of the ignition angle stack.

For the described ignition angle stack zwout can not be used. For this, an ignition angle array zwoutar[0...3] is defined in %ZUE. This array increases zwout in the zero element. In the elements 1 to 3 the same value is used, if no cylinder-individual offsets are added to the ignition angle.
If a knocking occurs or if other cylinder-individual proportions are added to the basic ignition angle, zwoutar1...zwoutar3 contains that value, which would result for zwout in the following cylinder, and also the next two cylinders. This means, the ignition angle array includes the basic ignition angle of the current cylinder plus the cylinder-individual offset for the following cylinders, for the case that the ignition output must shift to the overlap mode, to realize after all the output of the applied dwell period.
The ignition thus works during the overlap operation with the ignition angle of the previous segment (single overlap) or with the ignition angle of the third advanced segment (3-fold overlap).

2.2 Dual-spark ignition output (DZA)



Doppelte Zündausgabe bei ungeradzahligen Zylinderzahlen:
Schließ-und Zündereignis werden ein halbes Segment später nochmals ausgegeben

azue-dza1

azue-dza1

The dual spark ignition output is activated, if no cylinder synchronisation of the segments is reached and the synchronisation SW requests this mode via the bit B_dopzue.

At the DZA, the cylinders are always fired again after 360 degree. This means that each cylinder is fired at working TDC and gas exchange TDC. For even-numbered cylinders, a complementary cylinder is at gas exchange TDC, if the considered cylinder is at working TDC. The DZA for even-numbered cylinders and single coil systems can thus be realized by a corresponding masking of the output register.
For ignition systems with doule spark coils, a special DZA-operation is not required.
For single coil ignition systems and uneven cylinder number, no complementary cylinder exists.
However, it exists an offset of 1/2 segments between a cylinder at working TDC and the next cylinder which is heading for the gas exchange TDC. For this reason, two further interrupts are placed for the DZA-operation with uneven cylinder number. The two IR are added to the dwell event and the ignition event of an "original ignition"in a 1/2 segment-distance. This means, the thus activated ignition is independent of the synchro, new calculation results of the synchro-program cannot be taken into account in the mirrored event.

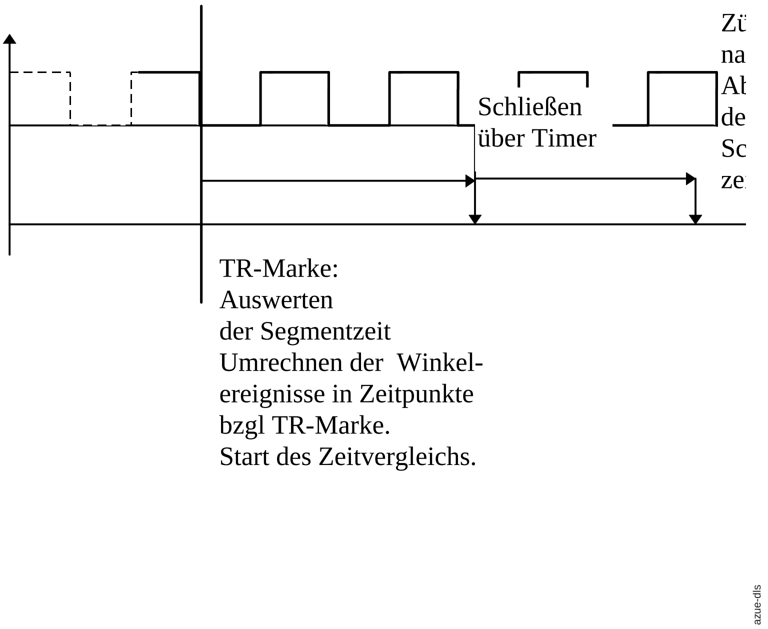
Attention ! The DZA could provoke an intake manifold explosion. The customer must be informed about these risks.
A single spark ignition during DZA-operation cannot be compared to a double spark ignition.
A double spark ignition has two spark gaps in series, i.e. the working spark needing a high voltage quickly consumes the energy provided by the coil.
For the secondary spark only a small amount of energy is available.
The burning duration is equal to the burning duration of the working spark at a lower burning voltage.
If the single spark coil is ignited during charge change, the burning durations are longer, since the voltage requirement at the plug and the burning voltage are much smaller than at working TDC.

2.3 Spark band ignition
======================

At the spark band ignition sparks derived from the original spark are added through a kind of mirror effect.
The original spark is in this case conventionally defined over the ignition angle zwout and the ignition angle array zwoutar[0..3] as well as the dwell period szout. The following ignitions are started after an open time (offzt) succeeding the last ignition. The dwell period of the following ignitions is described in szfuba.
The number of added sparks is determined in fubaanz.

Via the code word ZWFUBAMN, the last permissible angle position of a recharge pulse of a partial spark of the spark band can be applied.
In this case, the actual teeth number at the ignition of a partial spark is compared to the teeth number of the tr-mark. If the distance between the last released ignition spark and tr-mark is smaller than the value described by ZWFUBAMN, a further charge process is triggered, if the applied spark number has not been reached yet. If the last possible ignition angle coincides with a space, a distinction is made whether the end mark is situated behind or in front of the middle of the segment.
If the last possible ignition angle is placed before the middle of the space, the preceeding tooth is used as an end mark. If the ignition angle is placed behind the middle of the space, the following tooth is used as an end mark.

2.4 Digital low-idle stabilisation (DLS-function)
==


Zü
na
Ab
de
Sc
ze
Schließen
über Timer
TR-Marke:
Auswerten
der Segmentzeit
Umrechnen der Winkel-
ereignisse in Zeitpunkte
bzgl TR-Marke.
Start des Zeitvergleichs.
azue-dls

azue-dls

The DLS-function can be classified as an extension of the ignition range 1. In ignition range 1, the dwell period is added to the dwell beginning angle, which is effected by counting of the sensor teeth. In contrast to ignition range 1, also the dwell beginning angle is controlled via a timer-comparison.

2.5 Ignition during after-run

In single systems, the ignition coil is permanently set to plus in the after-run phase via a relay in the ECU. For this, the ignition is also kept during the after-run. So that the motor stops after a definite time, the revolutions during the after-run are counted and after reaching the threshold nachanz, the ignition is suppressed.

2.6 Configuration word ignition output

At a high acceleration or for a drastic change of the dwell period, it can occur that it is detected in the synchro interrupt that the current supply to reach the desired primary current should have been already initialized in the past.

In such a case, the primary current will not reach the desired value, if the desired ignition angle zwoutar(overlap wheel) is kept. For this reason, the standard configuration of the ME7 ignition will move the ignition angle to ’retard’, to ensure, that the desired primary current will still be reached.

If, however, long dwell periods are applied in a system, and do high dynamic influences occur, it can happen, that the retarded ignition angles are not permitted anymore.

In such cases, the ignition angle correction can be switched off via the code word CW_AZUE on behalf of the dwell period. The Bit 0 code word is usually in the correction mode. If a correction should not be carried out, Bit 0 of CW_AZUE must be set to 1.

2.7 Different switch-over mechanisms

By setting the Bit 1 of the code word CW_AZUE, it can be switched between the conventional and the power loss contioned switch-over mechanism between the ignition ranges. This means, that for engine speeds below SY_NZUEB it is not automatically switched over to time output and for engine speeds above SY_NZUEB it is not automatically switched to angle output. If bit 1 of the code word is set, at tmot<TMZUB2MX the angle output is activated an at tmot>TMZUB2MX, the switch-over mechanism is activated via a fixed engine speed threshold (800Upm).

Tmot dependent range selection:

1. CW_AZUE xxxx xx1x : TMOT dependent activation of the time output
2. tmot<TMZUB2MX : angle output
3. tmot>TMZUB2MX : time output

2.8 Turn-back detection

At a detected turn-back, a service of the ignition output is called by the turn-back detection which directly causes an ignition and blocks the ignition interrupt.

The turn-back detection sets the Bit B_motstop which is called at the beginning at the ignition output. The ignition event calculation is then no longer carried out, at the same time, the ignition is once more forcibly released and the IR-releases are taken back.

2.9 The actual ignition angle

If the ECU is in the overlap mode, the ignition angle of the current segment is taken over from a previous segment. This means, the ignition angle calculated in the current synchro does not occur as an output in the same segment. The ignition angle passed over to the output HW in the current synchro is described by the RAM-cell zwoutakt.

3. Detailed functions of the ignition output

Figure 1.0 shows an interface overview of the AZUE and the processes in which the model of the AZUE is split under ASCET-SD.
It should be noticed that the AZUE as a whole takes place in the HW of the ME7 and thus only occurs in the SW as an HW partial process. The process structure is first of all a logic representation of the functionalities occuring in the ignition output . Parts of the ASCET-SD processes are behaviour descriptions of HW functions which have been transferred to ASCET-SD for ignition timing simulation reasons. The processes are described in the programming language C. This representation is however not to be confused with the source code of the ME7. It is rather a model of the timing behaviour for the simulation environment ASCET-SD.

In the following table the functional principle of the logic function groups of the ME7-ignition is described by means of the ASCET-SD processes:

Process	Time shedule	Functional description
1. Zout_ini	Ini	Initialization of the control information of the ignition
2. Converter	Synchro	Re-quantisation and re-formatting of the values visible for the application into values which can be processed by the HW-components of the controller.

```
                  |                | e.g.. szout in 0,1ms/Ink is restored
                  |                | in sztcalc_w (800ns/Ink -> Timer 1 quantisation).
                |             |
3. Zout_syn       |   Synchro      | Request for the start conditions of the ignition:
                  |                | - a first ignition has been triggered
                  |                | - a successful synchronisation
                  |                |   of the SW with the camshaft and the crankshaft has taken place
                  |                | - the min. engine speed has been exceeded
                  |                | Adjustment of the ignition range :
                  |                | If nmot < SY_NZUEB
                  |              | then  -> ignition range 1 active
                  |                | otherwise -> ignition range 2 active
                  |                |
4. Zuendbeend     |   Synchro      | If the release of the ignition output SW to the timer-comparison
                  |                | unit of the last segment does still exist, for realizing an output
                  |                | of an ignition pulse at the actual comparative value,
                  |                | the release is taken back and an ignition is effected immediately.
                  |               |
                  |                |
5. Zuendmaske     |   Synchro      | Calculation of the output mask for the ignition port
                  |                | preparation for actual ignition
                  |               |
6. ZeitProWinkel|   Synchro        | Time for the calculation of an angle increment
                  |                |
7. Minzahnzahl  |   Synchro        | Min. tooth distance concerning the segment start
                  |                | at which an event can still be triggered.
                  |                | Depending on the engine speed, the SW calculation of the ignition events
                  |               | takes more or less time. This means, the output signals
                  |                | are only available for an angle that is not zero.
                  |                | It thus exists an earliest possible ignition angle
                  |                | set by the program running time and the engine speed.
                  |                |
                  |                |
8. Schliesszeit |   Synchro    | Re-storage of the dwell period in internal registers
                  |                |
9. Schliesswinkel|   Synchro  | Conversion of the dwell period via the angle time calculated
                  |                | in process 6 in a dwell angle.
-------------------------------------------------------------------------------------------------
Ignition range 1
-------------------------------------------------------------------------------------------------
10. Z1_Ausgabe  |   Synchro        | Initialize Controller HW  for dwell period output,
                  |              | check, if already a current flows through the coils (return
                  |                | from overlap operation in ignition range 2 to ignition range 1),
                  |              | depending on this, a dwell event or
                |                  | an ignition signal is initialized.
                  |                |
11. Z1_msl      |   Synchro   | Calculation of a port mask for the dwell beginning release
                  |                | by the controller.
                  |                | Calculate dwell beginning angle out of ignition angle
                  |                | minus dwell angle.
                  |                | If the dwell beginning angle is negative, then switch-over of
                  |              | the controller from angle comparision to time comparision.
                  |                | Immediate switch on of the coil current.
                |                  | The charging time is limited in such a way, that a last
                  |                | possible ignition angle WMAX is not exceeded.
                  |                | If the dwell beginning angle is positive, then check,
                  |                | if it can still be realized as an output by a tooth count.
                  |                | If the dwell beginning angle is so early that it can still be
                  |                | triggered after the elapsed program-time by a tooth count,
                  |                | a switch over to time comparion  is carried out.
                  |                | If the program has already passed the comparative point
                  |                | of the timer, at which the dwell beginning should have been
                  |                | released, a forced closure is provoked and the charging time
                  |                | up to the ignition has to be awaited,
                  |                | the charging time being limited to a last possible ignition
                  |                | angle WMAX.
                  |                | If the dwell beginning can be calculated by measuring the tooth
                  |                | distance, the output is effected according to the above
                  |                | sketch.
                  |                |
12. StartSwinkel|   Synchro        | Conversion of the dwell beginning angle in comparative values
                  |                | for the Timer/comparison unit of the controller.
                  |                | Check, if the angle event is situated in a space,
                  |                | if this is the case, missing teeth are substracted from
                  |                | the comparison value and are added to the residual increment.
                |                  | If the angle event is situated behind the space, only
                  |                | the missing teeth must be substracted.
                  |                |
-------------------------------------------------------------------------------------------------
Ignition range 2
-------------------------------------------------------------------------------------------------
13. Z2_Ausgabe  |   Synchro        | In that way the dwell beginning has been treated in processes 10-12,
                  |                | the ignition angle is processed in this case.
                  |                | As for the dwell event, the ignition event is connected
                  |                | to an angle event (tooth interrupt).
                  |              | The ignition is not released by awaiting the end of a charging time
```

```
                 |                 | after the dwell beginning. In this case dwell beginning and
                  |                | ignition are individual, independent events.
                  |                | The ignition angle in the overlap-free range is directly taken
                  |                | out of the synchronous zwout-calcualtion (s.%ZUE).
                  |                | In the overlap range, the ignition angle is taken from
                  |                | the ignition angle stack (zwoutst0...zwoutst3).
                  |                | The ignition angle stack contains always the ignition angle
                  |                | belonging to the dwell beginning of the coil of the actual segment,
                  |                | already flown through by a current. The number of the described
                  |                | stack element is equal to the degree of overlapping. At a 3-fold overlap,
                  |                | the dwell beginning is situated 3 segments in advance of the ignition.
                  |                | The currently calculated ignition angle is written to zwoutst3.
                  |                | In the following segment, the ignition angle shifts to
                  |                | zwoutst2, after that to zwoutst1, and finally to
                  |                | zwoutst0. At a signalized overlap, The process Z2_output
                  |                | takes over the the ignition angle of zwoutst0.
                  |                |
14. CheckPort     |   Synchro      | Checking of the output port. If a current is flowing through all of
                  |                | the coils, a dwell beginning has been triggered in the past.
                  |                | The particular number of such coils defines the
                  |                | overlap degree. Depending on the detected overlap degree,
                  |                | the processes Sw0_out, Sw1_out, Sw2_out, Sw3_out
                  |                | are called for the dwell masks and dwell event calculation,
                  |                | for no overlap up to a 3-fold overlap.
15. Sw0_out       |    Synchro   | Calculation of the port mask for the dwell event release
                  |              | 0 overlaps.
                  |                | Check, if  Sw2nd_out must be called.
                  |                | Calculation of the dwell angle. If the dwell beginning angle
                  |                | is situated in the past, a forced closure is effected and
                  |                | the call of Sw1_out. Limp-home/emergency measures and
                  |                | plausibility checks, as well as the signal processing
                  |                | correspond to those of the dwell beginning output in ignition range 1.
16. Sw1_out       |    Synchro   | Calculation of the port mask for the dwell event output
                  |              | 1-fold overlap.
                  |                | Check, if Sw2nd_out must be called.
                  |                | Calculation of the dwell angle. If the dwell beginning angle
                  |                | is situated in the past, a forced closure is effected and
                  |                | call of Sw2_out. Limp-home/emergency measures and plausibility checks,
                  |                | as well as the signal processing correspond to those
                  |                | of the dwell beginning output in ignition range 1.
17. Sw2_out       |    Synchro   | Calculation of the port mask for the dwell event output
                  |              | 2-fold overlap.
                  |                | Check, if Sw2nd_out must be called.
                  |                | Calculation of the dwell angle. If the dwell beginning angle
                  |                | is situated in the past, a forced closure is effected and
                  |                | and the call of Sw3_out. Limp-home/emergency measures
                  |                | and plausibility checks,as well as the signal processing
                  |                | correspond to those of the dwell beginning output in ignition range 1.
18. Sw3_out       |    Synchro   | Calculation of the port mask for the dwell event output
                  |              | 3-fold overlap.
                  |                | No call of  Sw2nd_out, since the max. overlap degree
                |                  | has been reached.
                  |                | Calculation of the dwell angle. If the dwell beginning angle
                  |                | is situated in the past, a forced closure is effected.
                  |                | Limp-home/emergency measures and plausibility checks and
                  |                | the signal processing correspond to those
                  |                | of the dwell beginning output in ignition range 1.
19. Sw2nd_out     |    Synchro   | Calculation of the port mask for the dwell event output
                  |              | for the next higher degree of overlap, from which the function has
                |                  | been started.
                  |                | Calculation of the dwell angle. If the dwell beginning angle
                  |                | is situated in the past, a forced closure is effected.
                  |                | Limp-home/emergency measures and plausibility checks
                  |                | and the signal processing correspond to those of the
                  |                | dwell beginning output in ignition range 1. For the second
                  |              | dwell event a separate dwell interruptis used which also writes
                  |              | on the ignition port. This has the result, that the conventional
                |                  | dwell event calculation detects a correspondingly higher overlap
                |                  | degree in the next synchro.
20. SlsnIR      |  HW-Trigger | Dwell beginning interrupt: is called for the first time by the
                  |                | timer-comparison unit, when the tooth is reached behind which
                  |                | according to the calculation in the synchro, the dwell event is situated.
                |                  | In this case the duration of the last tooth period is measured and the
                  |                | residual angle up to the dwell beginning is converted into a time value.
                  |               | Afterwards the timer-comparion unit is switched from tooth comparison
                  |              | to angle comparison  and the residual time up to the dwelll beginning
                  |                | is loaded into a register of the timer comparison unit.
                 |              | If the residual time has elapsed, the timer comparison unit
                  |                | carries out the same interrupt a second time. This time, the ignition
                  |              | output mask calculated in the synchro is written in the port latch
                  |                | of the ignition port and is available as an output of the controller-periphery.
                  |                | In ignition range 1 or at the transition between no overlap/single overlap
                  |                | in ignition range 2, the timer-comparison unit is additionally switched to
                 |                 | time comparison, the coil dwell period is loaded into the comparison
                  |              | register of the ignition interrupt and the ignition interrupt is released.
                  |                |
```

```
21. Slsn2IR       |  HW-Trigger  | Interrupt of the second dwell event in the case of an overlap operation
                  |                | after knocking. Functional principle as SlsnIR without functionality
                  |              | for ignition range 1 with  dwell time output.
22. ZuendIR       |  HW-Trigger  | Ignition interrupt: Is effected by the timer-comparison unit, if
                  |               | the tooth counter and the tooth calculated by the synchro behind which the
                  |                | ignition should start are identical.
23. SlsnMatch   |                  | Auxiliary processes for the ASCET-SD Simulation
24. Slsn2Match  |                  | Auxiliary processes for the ASCET-SD Simulation
25. ZuenMatch   |                  | Auxiliary processes for the ASCET-SD Simulation
22. HoleStack   |  Synchro         | Stack shifted downwards by one element
```

APP AZUE 5.40 Application hint

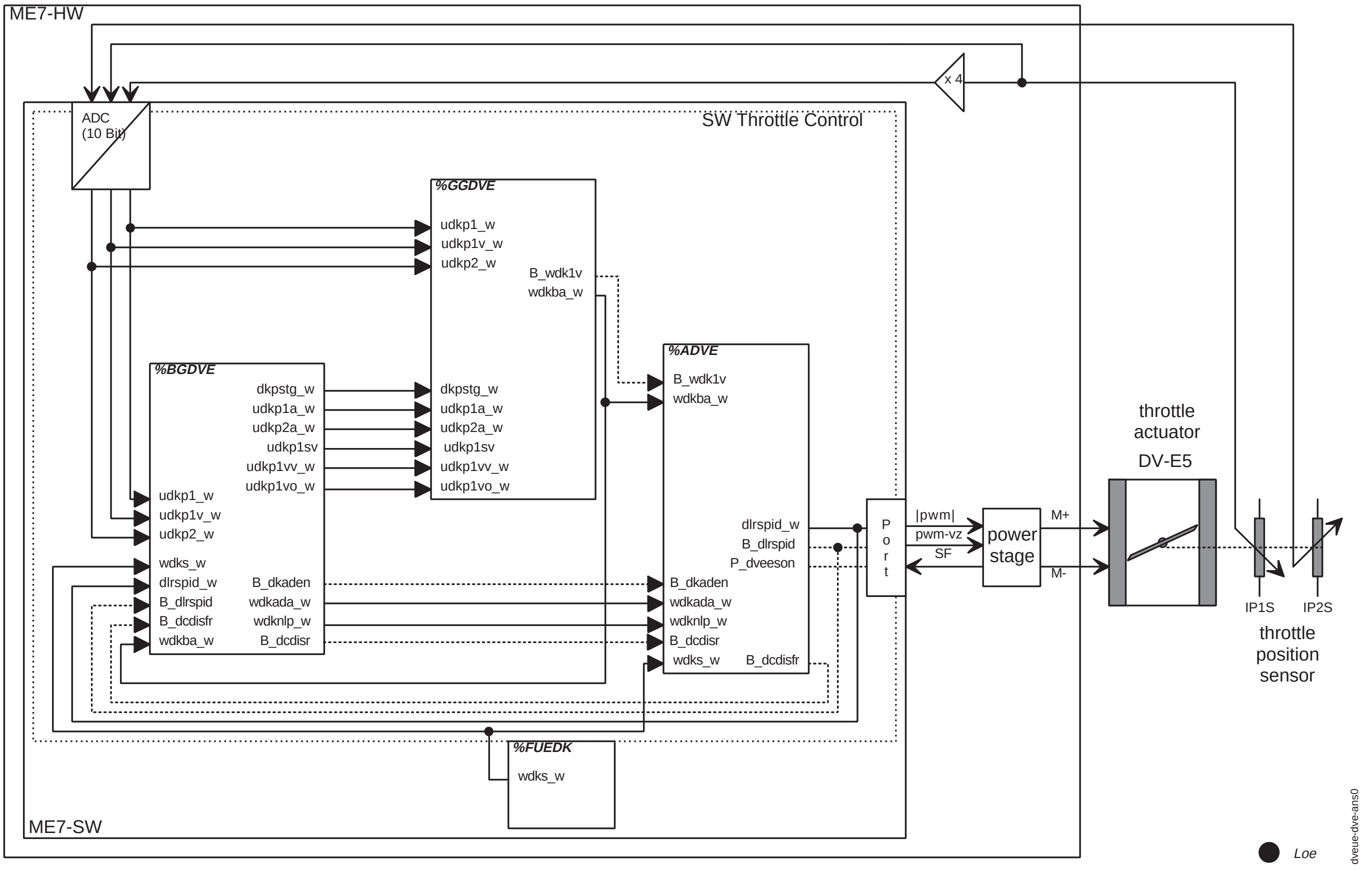
`Switch-over of the ignition ranges by means of a program-constant:`

`NIST_Z2 = 800/min`

DVEUE 1.0 Overview of DV-E-control

FDEF DVEUE 1.0 Function definition

overview
throttle control, command signals



dveue-dve-ans0

ABK DVEUE 1.0 Abbreviations

FW DVEUE 1.0 Fixed Values

Parameter	Value	Description

FB DVEUE 1.0 Detailed description of function

The trigger of the throttle adjustment device is sectionalized in following parts:

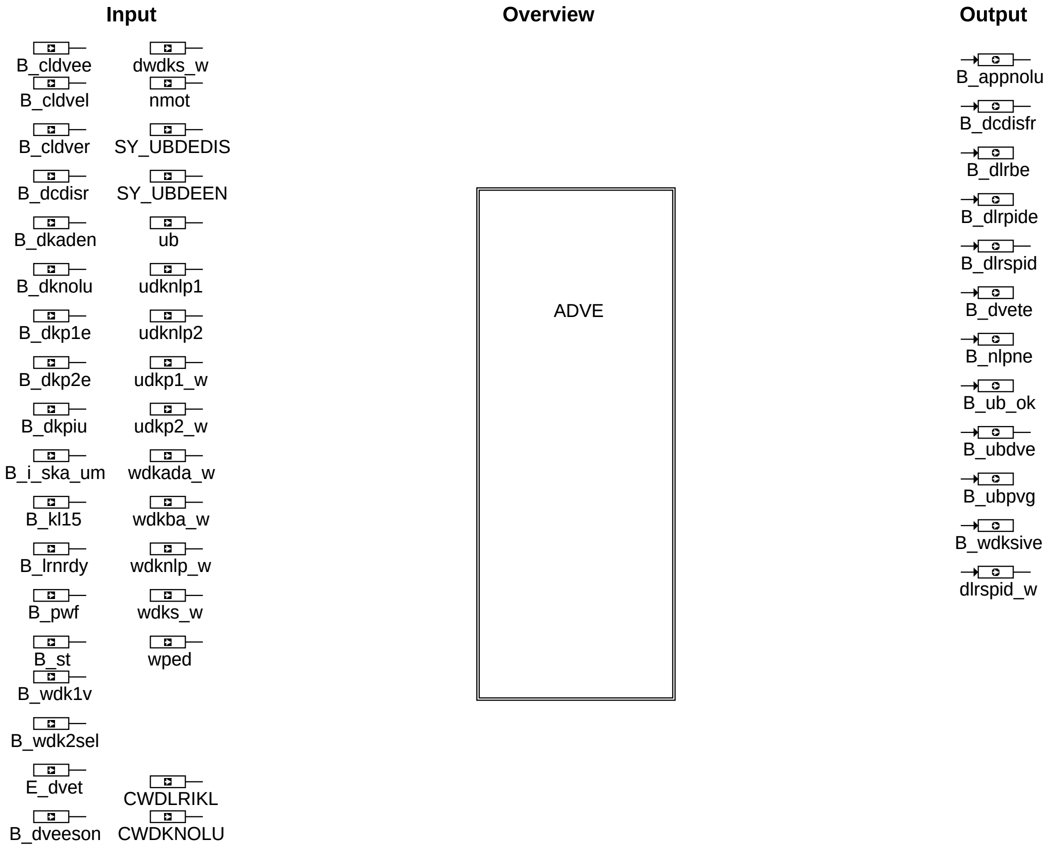
block ADC:	actual value with 10 Bit analog-digital converter
FDEF GGDVE:	standardization and check of actual value diagnosis
FDEF BGDVE:	learning of the lower mechanical DK limit stop (UMA learning) gain adjustment, offset and gradient learning and checking of the DV-E air at limphome position (NLP learning) DV-E return spring check diagnosis
FDEF ADVE:	digital position controller (DLR) coordination of the DV-E power stage release (disable/enable) monitoring of the DK position (DK at air in limphome position and DK setpoint/actual value) monitoring of the DLR setting range monitoring of battery voltage diagnosis

Parts of above-mentioned functions are implemented in the initialization or run after of the control device.

APP DVEUE 1.0 Application hint

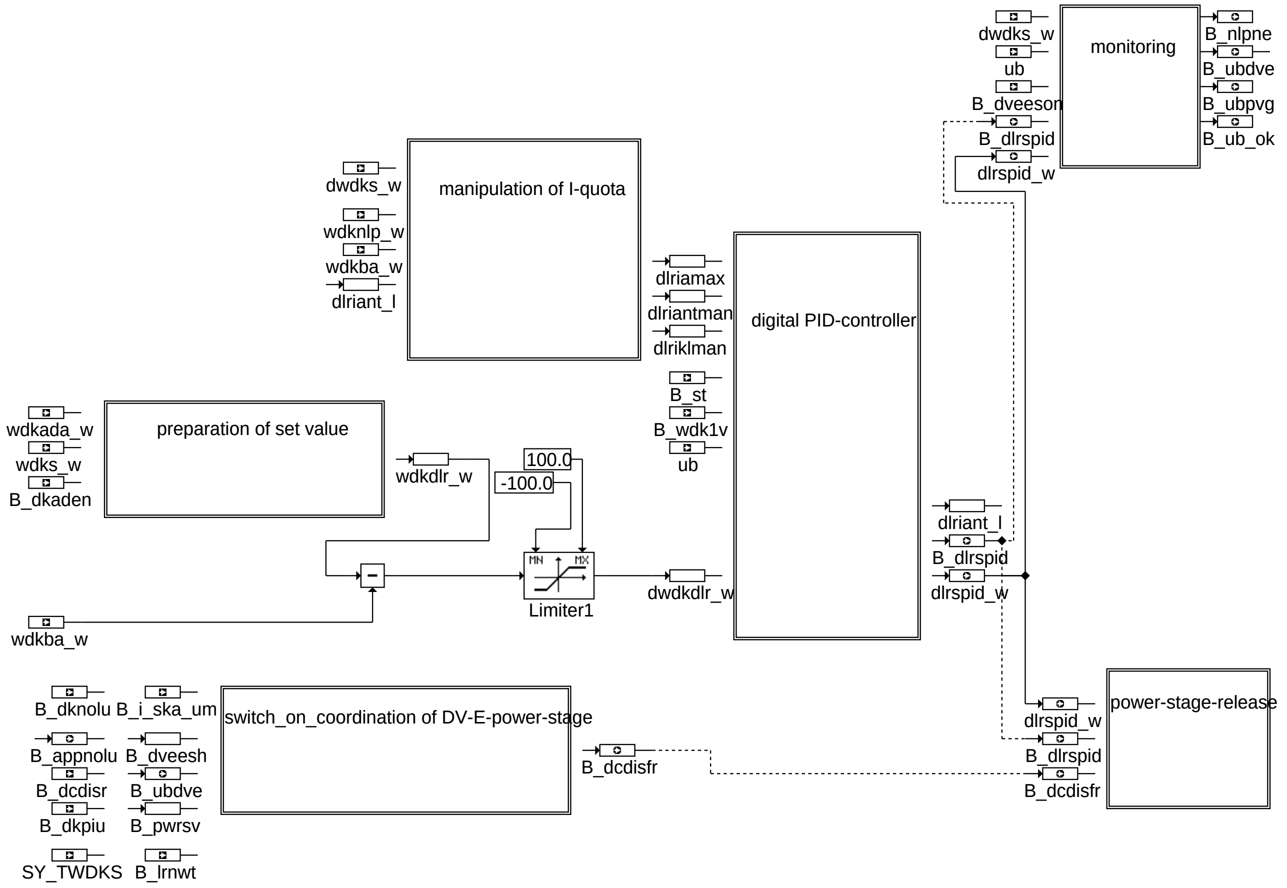
ADVE 3.70 Activation of the DV-E by means of the DLR

FDEF ADVE 3.70 Function definition



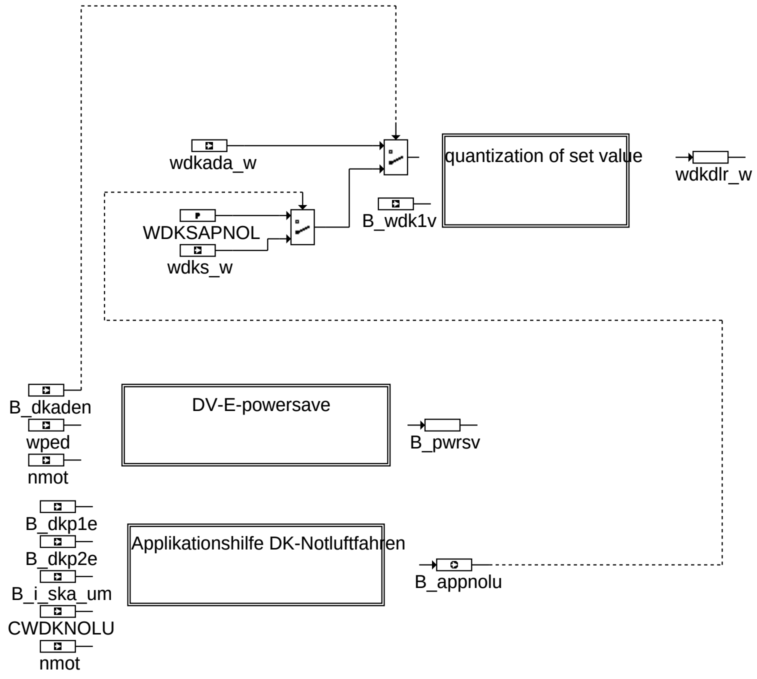
adve-main

adve-main



adve-adve

adve-adve

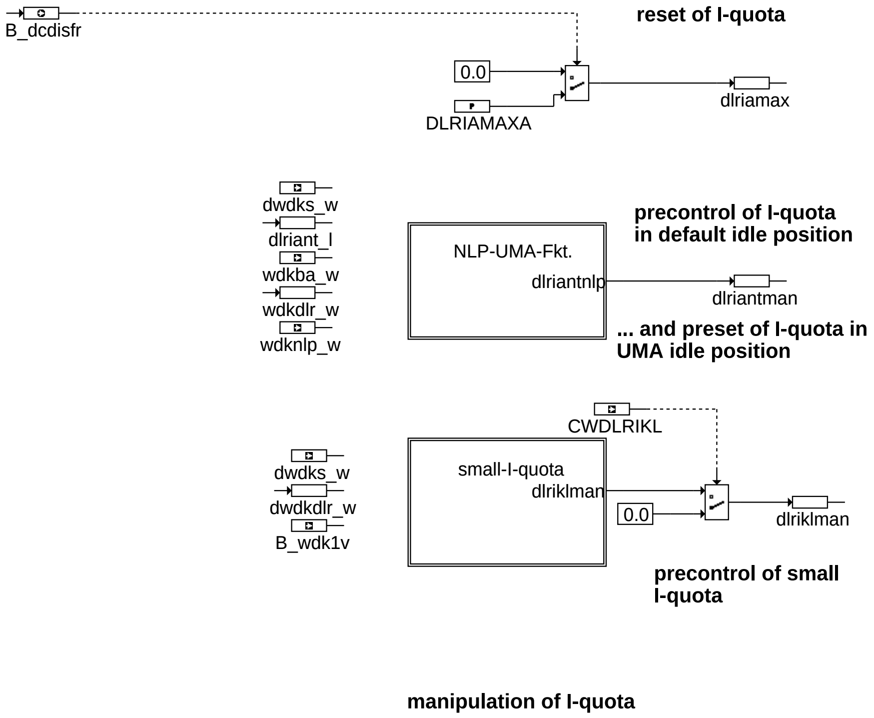


preparation of set value

adve-preparation-of-set-value

adve-preparation-of-set-value

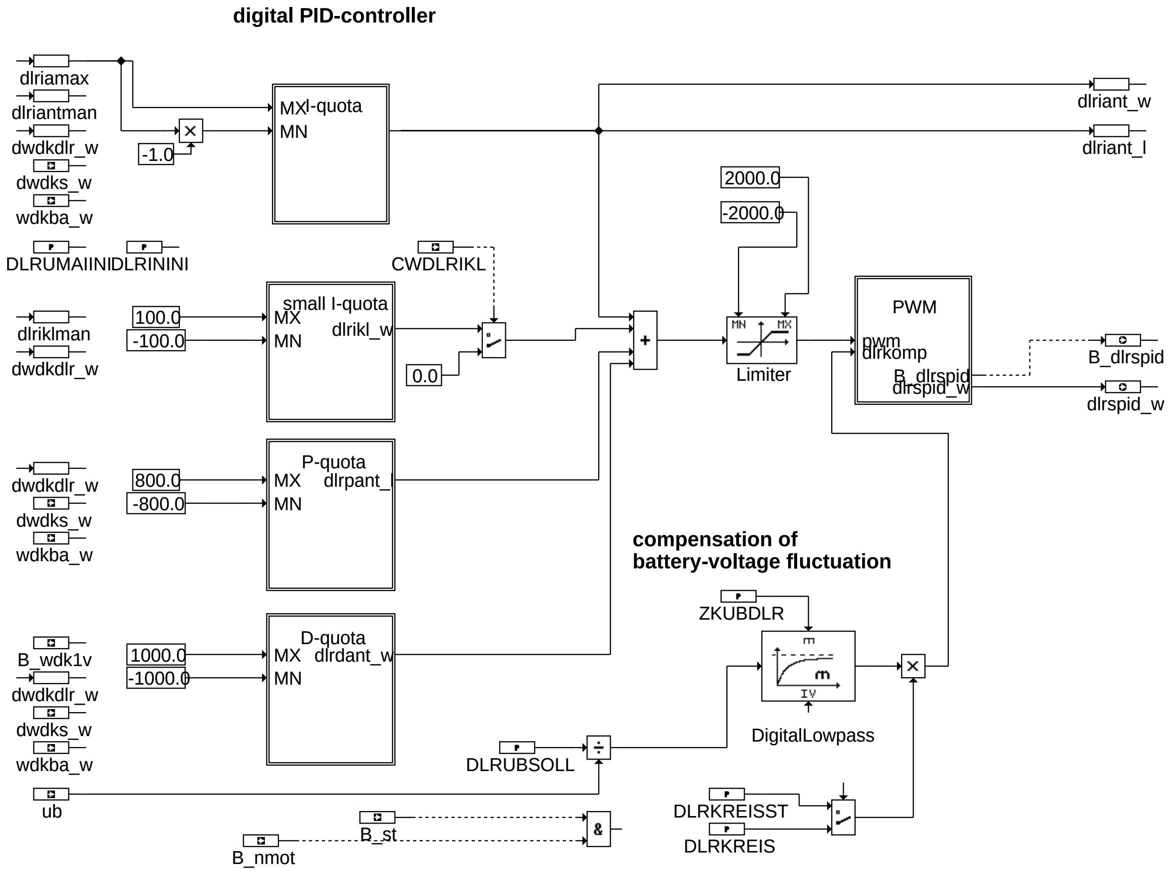
```
Code of block DV-E powersave:
=============================

   -- task rate 10 ms

    if ((( B_dkaden = false ) AND (wped = 0)
        AND (nmot = 0) #if (SY_TWDKS) then
        AND (B_cwdk = false) #endif))
    then
       if ((dpwrsvc < TPWRSV))
       then
       -- Increment time counter for powersave
          dpwrsvc := dpwrsvc + 10 ms;
       else
       -- Demand DV-E power stage shutdown
          B_pwrsv := true;
       endif;
    else
    -- Cancel time counter for powersave
    -- and DV-E power stage shutdown
       dpwrsvc := 0;
       B_pwrsv := false;
    endif;

  -- code of application help for DK limp-home operation
  -- task rate 1000 ms

   if (CWDKNOLU AND (nmot > 0))
   then
      if (B_apnoluv = false)
      then
         B_appnolu := true;
         B_apnoluv := true;
      endif;
   else
         B_appnolu := false;
         B_apnoluv := false;
   endif;
```



please note: dlriantnlp, dlriklman only serve for documentation purpose and do not exist as labels in ADVE 3.10

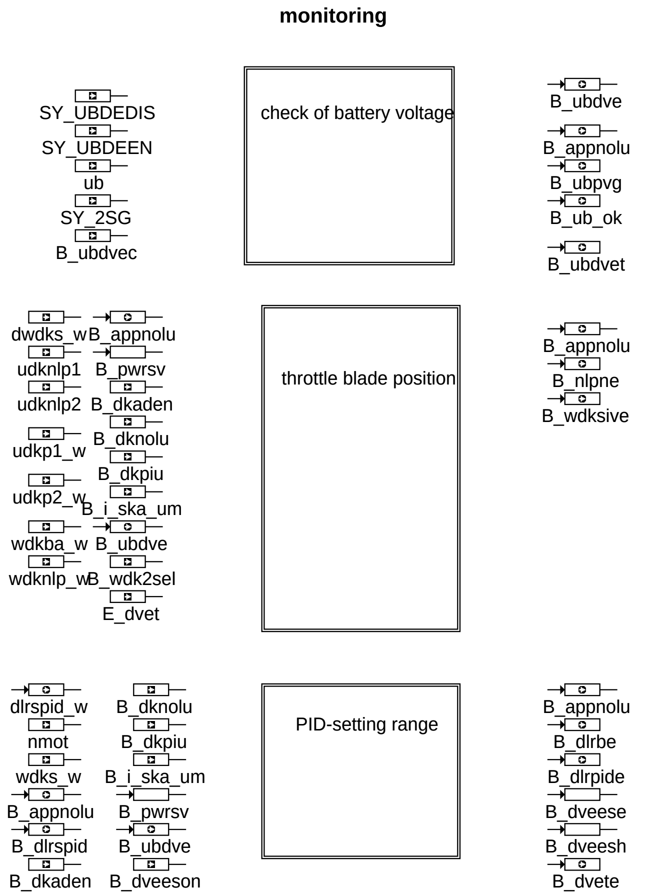
adve-manipulation-of-i-quota

adve-manipulation-of-i-quota



adve-digital-pid-controller

adve-digital-pid-controller



adve-monitoring

adve-monitoring

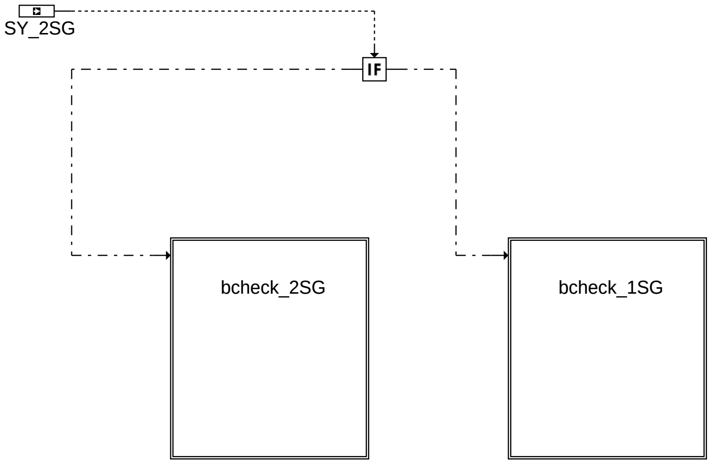
Code of block throttle blade position:
=====================================

```
-- monitoring of position from throttle blade
-- task rate: 20 ms
if ((B_dkpiu = false) AND (B_i_ska_um = false) AND B_ubdve
   # if (SY_2SG) then AND (B_dcdiscan = false) endif #)
then
   if ((B_dknolu) AND (B_appnolu = false))
   then
      -- monitoring DK-NLP dueing DK limp-home operation with application help
      if (E_dvet)
      then
      -- actuator replacement without adaptation, UMA not known, only the absolute
      -- potentiometer-voltage values at the limp-home can be monitored
         if ( (B_wdk2sel = false))
         then
            if ((udkp1_w > (udknlp1 + UDKNLPTOL))
            then
            -- demand reversible SKA
               B_nlpne := true;
            else
            -- cancel reversible SKA
            endif;
         else
            if ((udkp2_w < (udknlp2 - UDKNLPTOL))
            then
            -- demand reversible SKA
               B_nlpne := true;
            else
            -- cancel reversible SKA
               B_nlpne := false;
            endif;
         endif;
      else
      -- UMA known, relative NLP can be monitored
         if (wdkba_w > (wdknlp_w + WDKNLPTOL))
         then
         -- demand reversible SKA
            B_nlpne := true;
         else
         -- cancel reversible SKA
```

```
               B_nlpne := false;
               endif;
            endif;
         else
            -- monitoring DK tareget/actual values
            if (B_dkaden = false)
            then
               -- transfer change in target value from FUEDK übernehmen and
               -- form the absolute value.
               -- ATTENTION: Range gwdk_w from -50 .. 0 .. +50 % DK
               gwdk_kge := abs(gwdkdlr_w);
               -- determine permissble difference
               -- determine the value from a table, without interpolation
               dwdksimx := DWDKSBAMX(gwdk_kge);
               if (abs(wdksfi_w - wdkba_w) > dwdksimx)
               then
                  if (dklagerc > DKLAGERT)
                  then
                     -- fault-reaction time has elapsed, i.e.
                     -- set error flag to demand limp-home operation
                     -- without application help
                     B_appnolu := false;
                     B_wdksive := true;
                  else
                     -- increment fault counter
                     dklagerc := dklagerc + 20 ms;
                  endif;
               else
                  -- decrement fault counter
                  dklagerc := dklagerc - TDKLAGDE;
                  -- and limit in the ECU to min 0
                  dklagerc := limit(0, dklagerc, DKLAGERT+20 ms);
               endif;
               -- filter DK target value with PT1 to predict
               -- the DK actual value. Only use the filter value in the
               -- next calculation schedule so that DK start-up
               -- behavior will be considered (PT2)
               wdksfi_w := wdksfi_w + (wdkdlr_w - wdksfi_w) * ZKWDKSPT1;
            endif;
         endif;
      endif;

Code of block PID-setting range:
================================

      -- monitoring of PID-setting range
      -- task rate: 10 ms
      if ((B_dknolu = false) OR (B_dknolu AND B_appnolu)
         # if (SY_2SG) then AND (B_dcdiscan = false) endif #)
           AND (B_dkpiu = false)
           AND (B_i_ska_um = false))
      then
         if (B_ubdve AND (B_dkaden = false)
             AND (B_pwrsv = false))
         then
            if ((dlrspid_w > DLRPIDMAX) AND B_dlrspid)
            then
               -- range exceeded
               FKT_DLRBER-Test();
            else
               if ((dlrspid_w > DLRPIDMIN) AND (B_dlrspid = false))
               then
                  -- range exceeded
                  FKT_DLRBER-Test();
               else
                  -- Cancel reversible SKA
                  B_dlrbe := false;
                  -- decrement fault counter
                  dlrpidc := dlrpidc - TDLRPIDDEC;
                  dlrpidc := limit (0, dlrpidc, DLRPID2T + 10 ms);
                  -- cancel debounce counter and shutdown demand
                  dveesc := 0;
                  B_dveesh := false;
               endif;
            endif;
         endif;
      else
         -- decrement fault counter
         dlrpidc := dlrpidc - TDLRPIDDEC;
         dlrpidc := limit (0, dlrpidc, DLRPID2T + 10 ms);
         -- reset debounce counter
         dveesc := 0;
         -- cancel extended actuator-exchange detection
         B_dvete := 0;
      endif;
```

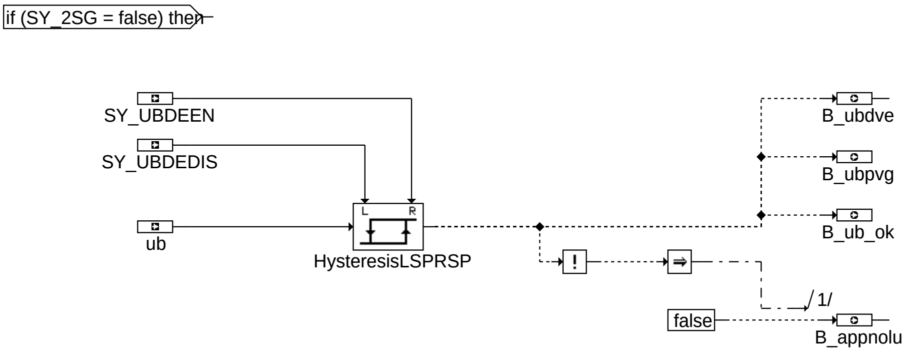
```
  -- function FKT_DLRBER-Test()

      if (dlrpidc > DLRPID2T)
      then
         -- the HW port, B_dveeson, to be inquired
         -- in the following, constitutes the status
         -- flags for the DV-E power-stage port.
         -- e.g. status flag at P3.15,
         -- it applies for DV-E-ES CJ220 that status = ok,
         -- when the line is on 'high'.
         -- i.e. it applies that P_dveeson = P3.15
         if (B_dveeson = false)
         then
            -- set DV-E power-stage fault
            B_dveese := true;
         endif;
         -- set fault 'DLR control range at limit', and
         -- by this, signal DK limp-home operation without
         -- application help as the desired reaction
         B_dlrpide := true;
         B_appnolu := false;
      else
         if (dlrpidc > DLRPID1T)
         then
            -- demand reversible SKA
            B_dlrbe := true;
            B_appnolu := false
         else
            if ((dlrpidc > DLRPID0T) AND (wdkdlr_w < WDKETE)
                 AND (nmot = 0) AND (B_dlrspid = false) )
            then
            -- extended actuator-exchange detection
               B_dvete := treu;
            endif;
         endif;
      endif;
endif;

         -- increment fault counter
         dlrpidc := dlrpidc + 10 ms;
         if (P_dveeson = false)
         then
            -- DV-E power-stage restart test
            if (dveesc >= DVEEST)
            then
               -- cancel shutdown demand for DV-E power stage.
               -- A negative flank is generated by this. This
               -- flank can activate the power stage again.
               B_dveesh := false;
            else
               -- increment debounce counter
               dveesc := dveesc + 10 ms;
               if (dveesc >= DVEEST)
               then
                  -- set shutdown demand for DV-E power stage,
                  -- to be able to generate a negative flank
                  -- for activating the power stage by subsequently
                  -- canceling the demand for shutdown.
                  B_dveesh := true;
               endif;
            endif;
         else
            -- reset debounce counter
            dveesc := 0;
         endif;
      endif;
```

If a fault occurs it will be analyzed in the function SREAKT7.xx. Depending on what kind of fault has been detected SREAKT7.xx will switch the system to (DK limp-home operation, DK potentiometer limp-home, SKA).



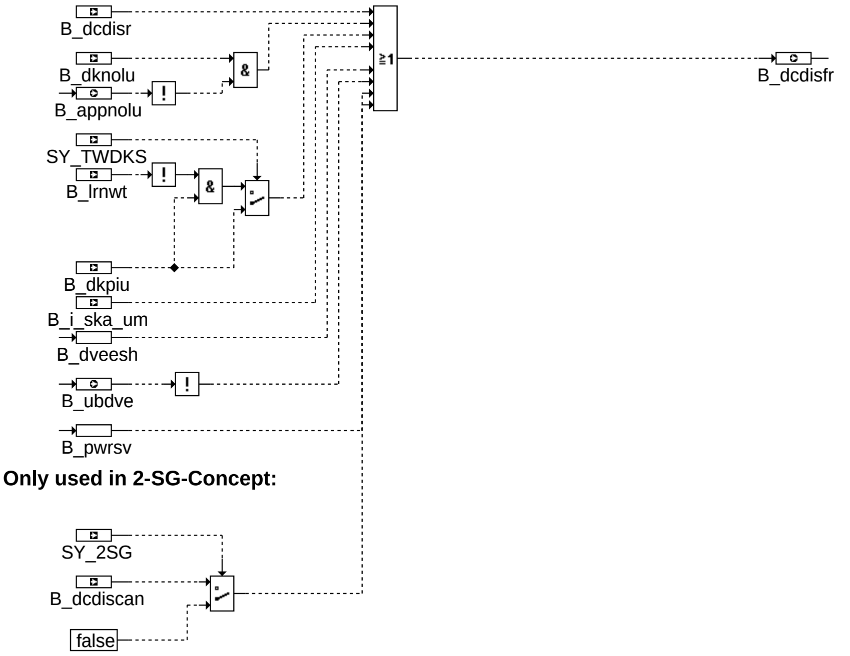
check of battery voltage

adve-check-of-battery-voltage



check of battery-voltage in 1_SG_Concept

adve-bcheck-1sg



switch on coordination of DV-E-power-stage

adve-switch-on-coordination-of-dv-e-

ABK ADVE 3.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DANTGESWNV			FW	Threshold for activation of D component (speed) in the non-amplified range
DANTGESWV			FW	Threshold for activation of D component (speed) in the amplified range
DANTSCHWNV			FW	Threshold for activation of D component (deviation) in the non-amplified range
DANTSCHWV			FW	Threshold for activation of D component (deviation) in the amplified range
DKLAGERT			FW	Permissible fault time for DK setpoint/actual comparison
DLRDWDKSS1			FW	DLR, upper limit for the parameter switch-over
DLRDWDKSS2			FW	DLR, lower limit for the parameter switch-over
DLRIAMAXA			FW	Maximum permissible I-component
DLRIKLPAR			FW	DLR, I small parameter
DLRININI			FW	I-component during init for ramp passing through NLP
DLRKDONLP0			FW	DLR, D parameter above NLP
DLRKDUNLP0			FW	DLR, D parameter below NLP (weak)
DLRKDUNLP1			FW	DLR, D parameter below NLP (medium)
DLRKDUNLP2			FW	DLR, D parameter below NLP (strong)
DLRKIONLP0	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), above NLP
DLRKIUNLP0	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), below NLP (weak)
DLRKIUNLP1	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), below NLP (medium)
DLRKIUNLP2	DWDKDLR_W		KL	I component as f(abs(dwdkdlr_w)), below NLP (strong)
DLRKPONLP0			FW	DLR, P parameter above NLP
DLRKPUNLP0			FW	DLR, P parameter below NLP (weak)
DLRKPUNLP1			FW	DLR, P parameter below NLP (medium)
DLRKPUNLP2			FW	DLR, P parameter below NLP (strong)
DLRKREIS			FW	DLR, factor loop gain
DLRKREISST			FW	DLR, factor loop gain at the time of the engine start
DLRNLPD			FW	Fuzzy range of DK in limphome air position
DLRPID0T			FW	Timecounter for extended DV-E-exchange detection
DLRPID1T			FW	Permissible fault time 1 for DLR setting range at the limit stop
DLRPID2T			FW	Permissible fault time 2 for DLR setting range at the limit stop
DLRPIDMAX			FW	Max. permissible PWM pulse duty factor for DLR
DLRPIDMIN			FW	Min. permissible PWM pulse duty factor for DLR
DLRUBSOLL			FW	DLR, battery standard voltage
DLRUMABAND			FW	Range of uncertainty during the step change out of the UMA range
DLRUMAIINI			FW	Default value of the I component during the step change out of the UMA range
DVEEST			FW	Time for the healing attempt of the DV-E-power stage
DWDKSIKLS			FW	Threshold for the activation of the I small component
KDLRIDDVE			FW	Identification of the DLR parameter block regarding DV-E type
TDKLAGDE			FW	Time delta for clearing of fault counter with DK setpoint/actual comparison
TDLRPIDC			FW	Timestep for decrementing of dlrpidc
TPWRSV			FW	Waiting time before DV-E Powersave becomes active
UDKNLPTOL			FW	Tolerance of DK-potentiometer signal in limphome position
WDKBEWS			FW	Threshold for the DK movement detection (I-small)
WDKETE			FW	Upper limit of DK-set value with DV-E extended exchange detection active
WDKNLPTOL			FW	Permissible DK angle tolerance of the NLP
WDKREIB			FW	Frictional component of the DK I small
WDKSAPNOL			FW	DK-set value used with apllication supply DK at air in limphome position
WDKSTFEIN			FW	Threshold for detection of steady-state (amplified range)

Parameter	Source-X	Source-Y	Type	Description
WDKSTGROB			FW	Threshold for detection of steady-state (non-amplified range)
ZKUBDLR			FW	DLR, time constant for filtering of Ubatt
ZKWDKSPT1			FW	Time constant for prediction of DK angle from setpoint

Variable	Source	Type	Description
B_APNOLUV	ADVE	LOK	Latch: Application supply DK at air in limphome position
B_APPNOLU	ADVE	AUS	Condition: Throttle limp-home air driving requested by application
B_CLDVEE		EIN	Flag for clearing measures: DV-E power stage
B_CLDVEL		EIN	Flag for clearing measures: DV-E position deviation
B_CLDVER		EIN	Flag for clearing measures: DV-E deviation
B_DCDISCAN	SREAKT	EIN	Condition: DV-E power-stage-switch-off because of CAN-ERROR
B_DCDISFR	ADVE	AUS	Condition: Disable DV-E power stage by means of the funct. processor
B_DCDISR	BGDVE	EIN	Condition: DV-E power stage deactivation is requested
B_DKADEN	BGDVE	EIN	Condition: Use DK setpoint from DK adaptation and DK check
B_DKBEW	ADVE	LOK	Condition: Throttle valve has moved
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKP1E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 1
B_DKP2E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 2
B_DKPIU	SREAKT	EIN	Condition: irreversible SKA
B_DLRBE	ADVE	AUS	Condition: DLR correction range exceeded
B_DLRIKLA	ADVE	LOK	Condition: DLR, I-small active
B_DLRIKLST	ADVE	LOK	Condition: First run of I-small after start
B_DLRPARC	ADVE	LOK	Condition: desired value step change is about to happen
B_DLRPIDE	ADVE	AUS	Condition: Fault, DLR correction range at limit
B_DLRSPID	ADVE	AUS	Condition: DLR, sign of sum of the PID-components, = 1: positiv, =0: negative
B_DLRUMZU	ADVE	LOK	Condition: NLP reloading is permitted
B_DVEESE	ADVE	LOK	Condition: DV-E power stage fault
B_DVEESH	ADVE	LOK	Condition: DV-E power stage healing
B_DVEESON		EIN	Condition: DV-E-poe-stage is switches on (= P_dveeson)
B_DVETE	ADVE	AUS	Condition: Extended DV-E-exchange detection
B_IKLREST	ADVE	LOK	Condition: Re-triggering of I-small
B_IKLSTAR	ADVE	LOK	Condition: I-small shall start
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_KL15		EIN	condition ignition switch on
B_LRNRDY	BGDVE	EIN	learning complete
B_LRNWT		EIN	Condition: DV-E adaptions activated by tester at end of intake-module-production
B_NLPNE	ADVE	AUS	Condition: NLP not reached for DK standby trip
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
B_PWRSV	ADVE	LOK	Condition: DV-E-powersave active
B_ST	SWADAP	EIN	condition for start
B_UBDVE	ADVE	AUS	Condition: Battery voltage for DV-E control OK
B_UBDVEC		EIN	CAN-Receive-Message: 2.SG has low voltage
B_UBDVET	ADVE	AUS	CAN-Send-Message:1.SG has low voltage and sends this information to 2.SG
B_UBPVG	ADVE	AUS	condition: battery voltage sufficient for 5-V potentiometer supply
B_UB_OK	ADVE	AUS	Battery voltage o.k.
B_WDK1V		EIN	Condition: amplified signal from potentiometer 1 used to calc. throttle angle
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
B_WDKSIVE	ADVE	AUS	Condition: Fault in comparing DK angle nominal value/actual value
CWDKNOLU		EIN	Codeword: Application supply DK at air in limphome position
CWDLRIKL		EIN	Codeword: DLR-small-I-quota is activ
DKLAGERC	ADVE	LOK	Fault counter DK position monitoring
DLRBATKP_W	ADVE	LOK	Compensation factor for fluctuation UBatt
DLRD	ADVE	LOK	DLR, D-parameter
DLRDANT_W	ADVE	LOK	D component
DLRDSV_W	ADVE	LOK	Threshold for activation of D component (speed)
DLRDSW_W	ADVE	LOK	Threshold for activation of D component (deviation)
DLRI	ADVE	LOK	DLR, I-parameter
DLRIAMAX	ADVE	LOK	DLR, maximum possible I-component
DLRIANTMAN	ADVE	LOK	For documentation only: precontrol of I-quota in default idle position
DLRIANT_L	ADVE	LOK	DLR, I component
DLRIANT_W	ADVE	LOK	DLR, I-component, high word of dlriant_l
DLRIKLMAN	ADVE	LOK	
DLRIKLST_W	ADVE	LOK	Input value i small component
DLRIKL_W	ADVE	LOK	DLR, I small component
DLRKOMP	ADVE	LOK	DLR, factor loop gain
DLRP	ADVE	LOK	DLR, P-parameter
DLRPANT_L	ADVE	LOK	DLR, P component
DLRPIDC	ADVE	LOK	Fault counter DLR setting range monitoring
DLRRAST	ADVE	LOK	DLR task counter
DLRSPID_W	ADVE	AUS	DLR for DV-E: Sum of the PID-components
DPWRSVC	ADVE	LOK	Timecounter for DV-E power stage
DWDKDLR_W	ADVE	LOK	Difference-DK-angle setpoint - act. value (wdkdlr_w - wdkba_w)
DWDKS_KGE	ADVE	LOK	Change of the throttle valve setpoint angle,absol.value for charact.line input
DWDKS_W	FUEDKSA	EIN	modification of desired throttle angle
E_DVET	DDVE	EIN	Errorflag: DV-E-exchange detection
NMOT	SWADAP	EIN	engine speed
SY_2SG	PROKON	EIN	system constant 2 motronic systems
SY_TWDKS		EIN	system constant: input of desired angle DVE via tester is possible
SY_UBDEDIS	PROKON	EIN	Ubatt threshold for disabling the DV-E output stage
SY_UBDEEN	PROKON	EIN	Ubatt threshold for enabling the DV-E output stage

Variable	Source	Type	Description
UB	SWADAP	EIN	battery voltage
UDKNLP1		EIN	Voltage DK-Poti 1 at the NLP
UDKNLP2		EIN	Voltage DK-Poti 2 at the NLP
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
WDKADA_W	BGDVE	EIN	Setpoint DK-angle, from DV-E adaptation function and check function
WDKBAALT_W	ADVE	LOK	Old Throttle valve actual value to determine the D component
WDKBAS_W	ADVE	LOK	Throttle valve actual value for the movement detection for I-small
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
WDKDLR_W	ADVE	LOK	Setpoint DK-Angle in 12 Bit-Resolution
WDKNLP_W	BGDVE	EIN	throttle angle in the limphome air position
WDKSFI_W	ADVE	LOK	Predicted DK angle from wdks_w
WDKSSTSW_W	ADVE	LOK	Threshold for steady-state detection for I-small
WDKS_W	MSF	EIN	desired throttle angle w.r.t. to lower mechanical stop
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW ADVE 3.70 Fixed Values

Parameter	Value	Description
DANTGESWNV		Threshold for activation of D component (speed) in the non-amplified range
DANTGESWV		Threshold for activation of D component (speed) in the amplified range
DANTSCHWNV		Threshold for activation of D component (deviation) in the non-amplified range
DANTSCHWV		Threshold for activation of D component (deviation) in the amplified range
DKLAGERT		Permissible fault time for DK setpoint/actual comparison
DLRDWDKSS1		DLR, upper limit for the parameter switch-over
DLRDWDKSS2		DLR, lower limit for the parameter switch-over
DLRIAMAXA		Maximum permissible I-component
DLRIKLPAR		DLR, I small parameter
DLRININI		I-component during init for ramp passing through NLP
DLRKDONLP0		DLR, D parameter above NLP
DLRKDUNLP0		DLR, D parameter below NLP (weak)
DLRKDUNLP1		DLR, D parameter below NLP (medium)
DLRKDUNLP2		DLR, D parameter below NLP (strong)
DLRKPONLP0		DLR, P parameter above NLP
DLRKPUNLP0		DLR, P parameter below NLP (weak)
DLRKPUNLP1		DLR, P parameter below NLP (medium)
DLRKPUNLP2		DLR, P parameter below NLP (strong)
DLRKREIS		DLR, factor loop gain
DLRKREISST		DLR, factor loop gain at the time of the engine start
DLRNLPD		Fuzzy range of DK in limphome air position
DLRPID0T		Timecounter for extended DV-E-exchange detection
DLRPID1T		Permissible fault time 1 for DLR setting range at the limit stop
DLRPID2T		Permissible fault time 2 for DLR setting range at the limit stop
DLRPIDMAX		Max. permissible PWM pulse duty factor for DLR
DLRPIDMIN		Min. permissible PWM pulse duty factor for DLR
DLRUBSOLL		DLR, battery standard voltage
DLRUMABAND		Range of uncertainty during the step change out of the UMA range
DLRUMAIINI		Default value of the I component during the step change out of the UMA range
DVEEST		Time for the healing attempt of the DV-E-power stage
DWDKSIKLS		Threshold for the activation of the I small component
KDLRIDDVE		Identification of the DLR parameter block regarding DV-E type
TDKLAGDE		Time delta for clearing of fault counter with DK setpoint/actual comparison
TDLRPIDC		Timestep for decrementing of dlrpidc
TPWRSV		Waiting time before DV-E Powersave becomes active
UDKNLPTOL		Tolerance of DK-potentiometer signal in limphome position
WDKBEWS		Threshold for the DK movement detection (I-small)
WDKETE		Upper limit of DK-set value with DV-E extended exchange detection active
WDKNLPTOL		Permissible DK angle tolerance of the NLP
WDKREIB		Frictional component of the DK I small
WDKSAPNOL		DK-set value used with apllication supply DK at air in limphome position
WDKSTFEIN		Threshold for detection of steady-state (amplified range)
WDKSTGROB		Threshold for detection of steady-state (non-amplified range)
ZKUBDLR		DLR, time constant for filtering of Ubatt
ZKWDKSPT1		Time constant for prediction of DK angle from setpoint

FB ADVE 3.70 Detailed description of function

```
0.   Overview
=============

     1.   Introduction
     2.   Initialization
     3.   DK position control
     3.1     DK setpoint and DK actual value
     3.2     DV-E power-save
     3.3     Application supply ’DK at air in limphome position’
     3.4     Pre-control of the I component
     3.5     Compensating the battery voltage fluctuations
     3.6     Digital PID controller
     4.   DV-E power stage triggering
     5.   Coordination of the DV-E power stage release
     6.   Monitoring of battery voltage
```

7. Monitoring of the DK position
7.1 Monitoring of the DK at air in limphome position
7.2 Monitoring of the DK setpoint/actual value
8. Monitoring of the DLR setting range
9. Protection of DV-E power stage from overheating during hot idling
10. Diagnosis
11. Function to suppress shutdown rattling

1. Introduction

The task of the function is to trigger the throttle adjustment device (DV-E) and to diagnose faults in the triggering circuit. The position of the throttle blade (DK) is controlled by a digital position controller (DLR), which transfers a PMW pulse duty factor and a directional bit to the DV-E power stage (DV-E-ES). The DV-E-ES is designed as an integrated H-bridge with internal current limitation. The input values are for one the DK setpoint (wdks_w), which is generated in the function FUEDK and for the other the DK actual value (wdkba_w), which is formed in the function GGDVE.

Furthermore the position control loop is monitored for non-permissible desired / actual deviations (wdks_w to wdkba_w), for the setting signal exceeding the range (dlrspid_w with B_dlrspid) and for the operating state of the DV-E-ES (B_dveeson).

2. Initialization

During the initialization fixed values are written into the following RAM cells:

```
B_dlrparc  := true
B_dlrumzu  := true
B_ubdve    := true
B_ubpvg    := true
B_ub_ok    := true
dlrbatkp_w := 1.0
dlrkomp    := DLRKREIS
dlrd       := DLRKDONLP0
dlri       := 1.0
dlrp       := DLRKPONLP0
dlrhaftak  := DLRHAFTMN/DLRKREIS
dlrini_w   := DLRININI/DLRKREIS
```

Additionally in systems with main relay for supply
of DV-E5 during SG-run after with Kl.15 OFF
(only if SY_UBR = true) adaption of quantization:

```
ubdedis  := SY_UBDEDIS * SY_UBSQ_W
ubdeen   := SY_UBDEEN  * SY_UBSQ_W
dlrubrsq := DLRUBSOLL  * SY_UBSQ_W
```

3. DK position control

3.1 DK setpoint and DK actual value

The setpoint for the DK position control is supplied by the FUEDK as a 16 bit value (wdks_w). Since the DK actual value (wdkba_w) is given with a maximum resolution of 0,0244 %DK (100 %DK / (2e12 - 1)) in the amplified and of 0,0978 %DK (100 %DK / (2e10 - 1)) in the remaining (non-amplified) range, the setpoint must be matched to the actual value. At first the setpoint is shifted to the right by 4 bit positions, this complies with a resolution of 12 bit. For the non-amplified range (B_wdk1v = false) the setpoint is additionally combined by an AND with the bit mask 0x0FFCh so that the resolution is 10 bit.

During adaptation- and UMA-learning the set value for DK comes from function BGDVE, this is enabled by (B_dkaden = true). If 'application supply DK in air limphome position is active' (B_appnolu = true) set value can be adjusted via the Label WDKSAPNOLU.

If (B_dksbeg = true) DK-Setvalue will be limited according to DKNOTBEGR(nmot).

The DK actual value wdkba_w must have been updated by the GGDVE for the 1 ms - cycle of the DLR prior to the call-up of the DLR. The max. dead time between AD conversion and output of the DLR pulse duty factor may not exceed 0,2 ms. The shorter this dead time, the better it is for the control behaviour.

3.2 DV-E powersave

To avoid unnecessary load of the car-battery the DV-E power stage is switched off automatically after a waiting time TPWRSV. This is only done if the engine does not turn (nmot = 0) and if the driver does not move the accelerator (wped = 0). Then the bit B_pwrsv := true is set to request a switch off of the DV-E powerstage. If the driver starts the engine (nmot != 0) or moves the accelerator B_pwrsv will be reset and the DV-E power stage can be switched on immediately.

In OPEL-Projects powersave-function does not become active when test of position system is performed when tester sends B_cwdk = true. (only when SY_TWDKS = 1).

3.3 Application supply DK at air in limphome position
===

This function shall support the application engineer when driving with DK at air in limphome position. Setting the codeword CWDKNOLU triggers the bit B_appnolu and this bit activates driving with DK at air in limphome postition in the function SREAKT (B_dknolu is set in SREAKT). When triggered this way driving with DK at air in limphome position will not be done with DV-E powers stage switched off. DV-E powerstage remains switched on and set value for the DK can be adjusted via WDKSAPNOLU. Monitoring of the DK at air in limphome position (see 7.1) is not active. If an error occurs (B_dkp1e OR B_dkp2e OR B_i_ska_um OR !B_ubdve OR B_wdksive OR B_dlrpide OR B_dlrbe) bit B_appnolu will be reset immediately. This garantees that a real error has priority. B_appnolu can only be retriggered when C_wdknolu is set true -- > false -- > true.

3.4 Reset iof the I-component in the static-friction case
==

If an untypically high static-friction component occurs during a DV-E at high temperatures below the NLP in addition to the torque from the opening spring, then the I-component will be drawn to an unncessarily large value during control of the nominal-actual deviation. This is drawn to such an extent that the maximum permissible continuous current of the DV-E will be exceeded. The current I-component is reset in this case to the minimum I-component necessary with the help of the criteria listed in the following.

Code of block reduction of I-quota in case of static friction

```
 -- task rate: 50 ms

if (B_dlrien)
then
    if ((highword)dlriant_l < dlrhaftak) AND
        (abs(dwdks_w) <= DLRHAFTST)
    then
        if (dlrihaftc > TDLRHAFTMX)
        then
            (highword)dlriant_l := dlrhaftak;
            dlrihaftc := 0;
        else
            dlrihaftc := dlrihaftc + 50 ms;
        endif;
    else
        dlrihaftc := dlrihaftc - 50 ms;
        dlrihaftc := lilmit(0,dlrihaftc, TDLRHAFTMX);
    endif;
endif;
```

3.5 Pre-control of the I component
====================================

Due to the strongly non-linear control system the I component is manipulated by a pre-control in case of a DK movement through the limphome air point (NLP) and out of the UMA range.

If the DK is in the vicinity of the UMA then the I component will increase to large negative values due to the strongly increased friction. For this reason the I component is set to the smaller default value DLRUMAIINI, if the DK setpoint rises above the threshold DLRUMABAND and if the I component has increased to more than DLRUMAIINI.

In case of a movement of the DK through the NLP a torque step change with a reversal of direction of movement takes place there. This step change is compensated with a delta I component DLRININI. The sequence of this pre-control is described below:

Code of block pre-control of I component at air in the limphome position:

```
-- for closing direction
if (wdkdlr_w < (wdknlp_w - DLRNLPD) AND B_dlrumzu)
then
   if (abs(wdkba_w - wdknlp_w) > DLRNLPD)
   then
      (highword)dlriant_l := (highword)dlriant_l - DLRININI
   endif
   -- turn reversal of movement of direction
   B_dlrumzu = false
endif
-- for opening direction
if (wdkdlr_w > (wdknlp_w + DLRNLPD) AND (B_dlrumzu = false))
then
   if (abs(wdkba_w - wdknlp_w) > DLRNLPD)
   then
      (highword)dlriant_l := (highword)dlriant_l + DLRININI
   endif
   -- turn reversal of movement of direction
```

```
       B_dlrumzu = true
     endif
```

The highword of dlriant_l is available in dlriant_w for measurements with the VS100.

3.6 Compensation of the battery voltage fluctuation

Since a fluctuation of the battery voltage has a direct proportional effect on the loop gain of the DLR, this effect was compensated via a function. The battery voltage ub is filtered via a PT1 with the constant ZKUBDLR. The compensation, however, does have its limits in case of start. The starter can lower the battery voltage with a weak battery so far that in spite of compensation the DK can be stimulated to vibrate. In order to diffuse this case, a switch-over to an individual loop gain DLRKREISST is performed during the start (B_st = true). The therefore a little slower DK movement does not influence the starting behaviour.

3.7 Digital PID controller

The control structure consists of a PID controller, however, here the D component is only formed with the actual value. The non-linearities of the system are taken into consideration in the characteristic lines for the I component as well as in the range-dependent parameters. A moving of the DK through the NLP of the DV-E is supported by reloading the I component, see chapter 3.2.

The controller is processed in a 1 ms basic cycle and in a 1 ms cycle transposed 3 times (corresponds to a 3 ms cycle).

The control deviation dwdkdlr_w, the D component, the sum of all control components (dlriant_l, dlrikl_w, dlrpant_l and dlrdant_w) and the PWM signal (absolute value dlrspid_w and sign B_dlrspid) are calculated in the 1 ms cycle (see picture DLR in the block FDEF). The D component is limited to +/- 1000 %PWM. In addition the value (dlrkomp) resulting from the compensation and from the changed loop gain is included in the calculation prior to the PMW signal being made available. The PMW signal is limited to +/- 100 %PWM.

In the 3 ms cycle the individual cycles are processed in the counting mode 2 1 0 2 1
In cycle 2 the I small component dlrikl_w is calculated. The I small component is used to tear away the DK from the static friction. This I small component is limited to +/- 100 %PWM. In cycle 1 the control parameters in dependency on the DK position (above/below NLP with wdkba_w) and below the NLP (wdkba_w < wdknlp_w) in dependency on the steepness of the step change of the DK setpoint (gwdkdlr_w) are determined. Furthermore, here the I component dlriant_l is calculated and limited to +/- dlriamax. In cycle 0 the P component is calculated and limited to +/- 1000 %PWM.

The I small component can be switched off with codeword CWDLRIKL = false.

A separate set of parameters is available for operating the DV-E5 with a no-gain potentiometer (B_wdk1v = false) below the NLP.

4. DV-E power stage triggering

The setting signal given by the DLR is converted into a PWM signal with absolute value (dlrspid_w) and direction signal (B_dlrspid) and transferred to the DV-E power stage (DV-E-ES) via the functional processor (FR). The PWM frequency is 2000 Hz.

5. Coordination of the DV-E power stage release

Here the deactivation requests from various functions are combined in a resulting bit B_dcdisfr. This bit supplies the port of the FR, which supplies the disable line of the DV-E-ES. Representation in the block FDEF in the overview diagram part coordination of the DV-E power stage release

6. Monitoring of the battery voltage

For a faultless operation of the DV-E with the DV-E-ES a minimum supply voltage is required. So that the DV-E-ES does not constantly switch ON / OFF in case of undervoltage, the ES is therefore switched by means of a hysteresis (SY_UBDEEN and SY_UBDEDIS) via the bit B_ubdve. Furthermore a bit Bit B_ubpvg is supplied with this undervoltage detection, which blocks resp. enables the plausibility check of the potentiometer actual values of the PWG and the DV-E. See picture check of battery voltage in the block FDEF.

The differentiation in battery-voltage monitoring is made for systems with an additional measuring path for the DV-E5 ubrsq supply voltage after the main relay only for conditional compiling SY_UBR = true):
Plausibility check of the DV-E5 voltage, ubrsq, by comparison with the hysteresis thresholds ubdedis and ubdeen. (Refer also to: 2nd initialization.)
Plausibility check of the HFM and DV-E potentiometer supply voltage at terminal 15, wub, using the hysteresis thresholds SY_UBDEDIS and SY_UBDEEN.

7. Monitoring of DK position

Representation in the block FDEF in the picture monitoring of position of throttle blade.

7.1 Monitoring of the DK with air at limphome position

In case of the DK drive default function (B_dknolu = 1) it is checked whether the DK is not further above the DK-NLP than the range permits (wdkba_w <= (wdknlp_w + WDKNLPTOL)). As long as the DK has not reached the DK-NLP during the transition from normal operating to the DK drive default function, reversible safety fuel deactivation (rev. SKA) is requested.

If ’application support DK with air at limphome position’ is used (B_appnolu = true) monitoring of the DK with air at limphome position is not active.

7.2 Monitoring of DK setpoint and DK actual value

During normal operating the deviation between DK setpoint and DK actual value is compared with a permissible deviation and if it is exceeded the DK drive default function is requested. The deviation is calculated from the difference between the DK setpoint filtered with a PT1 and delayed by one calculation cycle (wdksfi_w, rough prediction) and the DK actual value. The permissible deviation is given in a characteristic line (DWDKSBAMX) as a function of the DK setpoint gradient (gwdk_kge).

If the permissible deviation is violated a fault counter (dklagerc) is incremented, which can be counted back again by TDKLAGDE in case of healing.

8. Monitoring of the DLR setting range

In order to avoid overheating of the DV-E or of the DV-E-ES due to a tight DK the DLR setting range is monitored. Additionally an attempt is made to switch the ES on again, if the DV-E-ES has switched off automatically for hardware reasons. This switch-on attempt is performed via 2 cycles (2 x 10 ms).

In case of a fault the rev. SKA resp. the DK drive default function is requested.

Representation in the block FDEF in the picture monitoring of PID setting range and monitoring of DV-E power stage status.

9. Protection of DV-E power stage from overheating during hot idling (only when SY_ESTZ = 1)

Provided certain prerequisites are fulfulled, the triggering duty cycle for the power stage is limited in the short term to protect the DV-E power stage from overheating during hot idling in extreme environmental conditions. This is to let the power stage cool down.

The conditions for this are: Stationary vehicle (vfzg < VFZERH) and a high ambient temperature (tans > TANERH). If the duty cycle dlrspid_w then exceeds a threshold DLRPIDERH for a time terhc >= TERHMX, then for a negative duty cycle at the controller output, limiting is to dlrspid_w = PIDERHBEG and a negative sign (B_dlrspid = false). This limitation is maintained for the time terholc = TERHOL so that the power stage can cool down. The controller-output duty cyle is applied at the power stage again after elapse of this time.

If the driver operates the accelerator pedal during this protective measure (B_ll = false), the vehicle is set in motion, the actual value for flap starts to drift, the idle speed fluctuates by more than DNMOTERH, the engine speed, nmot, exceeds the threshold NMOTERH or the nominal-actual difference, dwdkdlr_w > DWDKERH, then the duty-cycle limitation is aborted immediately and the controller output duty cycle is applied at the power stage again.

Refer to the function DVEUE for the criteria to use the system constant SY_ESTZ.

10. Diagnosis

For the workshop and CARB diagnosis 3 fault paths were defined.

- Path ’DVEL’: indicates that the DK of the DV-E will not reach the desired position any more
- Path ’DVEE’: indicates that the DV-E power stage has switched off, e.g. due to too high temperature, too high current or too low voltage.
- Path ’DVER’: indicates that the DLR lies outside the valid control range.

11. Function to suppress shutdown rattling

For projects with the possibity to supply the DV-E5 during after-run as well from a main relayafter key OFF, position control also remains active during the after-run by conditional compiling (SY_UBR = true). The flap is driven to wdkba = 0 by a speed-dependent DK nominal value from the function FUEDK. If the engine has stopped turning (B_nmin = true), then the DV-E5 is switched to currentless after elapse of the waiting time TWDKNL.

APP ADVE 3.70 Application hint

1. Identification of the DLR version

For the identification of the DLR parameter records the following identification byte is used:

KDLRIDDVE = 1: DV-E5 longitudinal construction and double-entry
2: Standard DV-E5
x: ...

2. Switch-off of function parts

Label	passive value	deactivated ...
DLRININI	0 %PWM	Reload I component via NLP in case of step change
WDKNLPTOL	100 %DK	Monitoring of the DK drive default function (driving with DK at limphome air)
SY_UBDEDIS	0 Volt	Monitoring of the battery voltage
DLRUMAIINI	0 %PWM	Default selection of the I component in case of a step change out of the UMA range
CWDLRIKL	false	I small component
DWDKSBAMX	100 %DK	Monitoring DK setpoint / actual value
DLRPIDMAX	100 %PWM	Monitoring of DLR setting range
DLRPIDMIN	-100 %PWM	’ ’ ’

3. DK position control

An adjustment of the PID controller directly in the vehicle by means of a VS100 is not possible. The adjustment must be performed in the corresponding ASCET-model and HW in the loop at the labor desk (also see block ANM chapter 4.). Only via the loop gain DLRKREIS can an adjustment be performed in the vehicle with regard to special conditions. For the start (B_st = true) the loop gain factor DLRKREISST applies (also see block FB chapter 3.3). During the adjustment via the loop gain DLRKREIS for a certain project the parameter KDLRIDDVE is to be adjusted according to above-mentioned table resp. a value is to be completed for a quicker identification.

4. Monitoring of the battery voltage

The smaller the deactivation threshold SY_UBDEDIS is chosen, the greater the hysteresis must be chosen, since the performance curve of a car battery drops off at a steeper angle with decreasing voltage upon stress. That means the activation threshold SY_UBDEEN = SY_UBDEDIS + hysteresis. The chosen settings are to be checked in the vehicle with an according battery or at the labor desk with a suitable simulation. The DV-E-ES may not wobble between activation and deactivation.

5. Monitoring

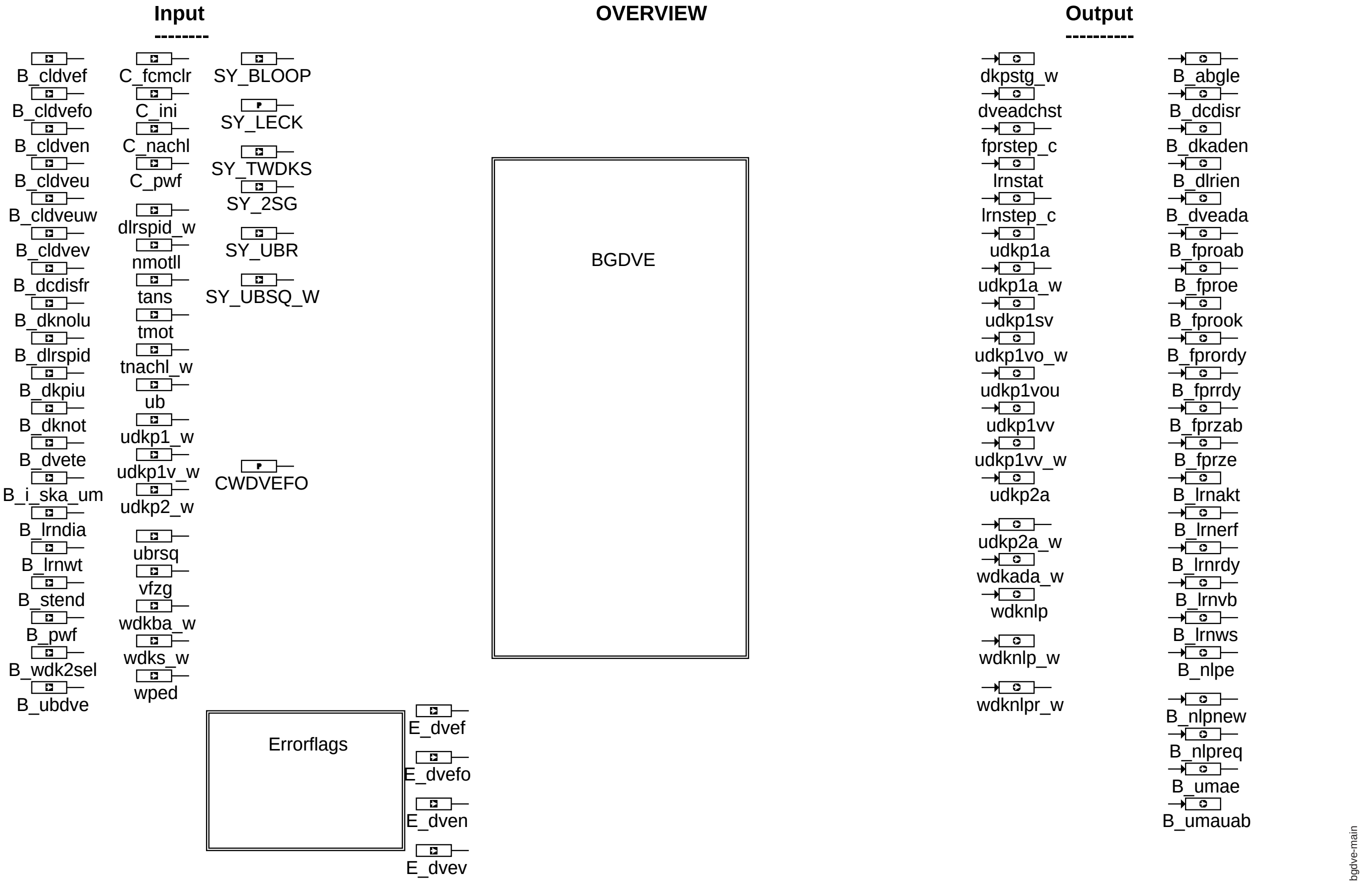
If the DLR is adjusted anew, then the filter time constant ZKWDKSPT1 is to be adjusted to the DK position monitoring. For the determination the Excel document DKNBPT20.XLS can be used.

6. Saving the maximum DV-E5 stroke number over the service life

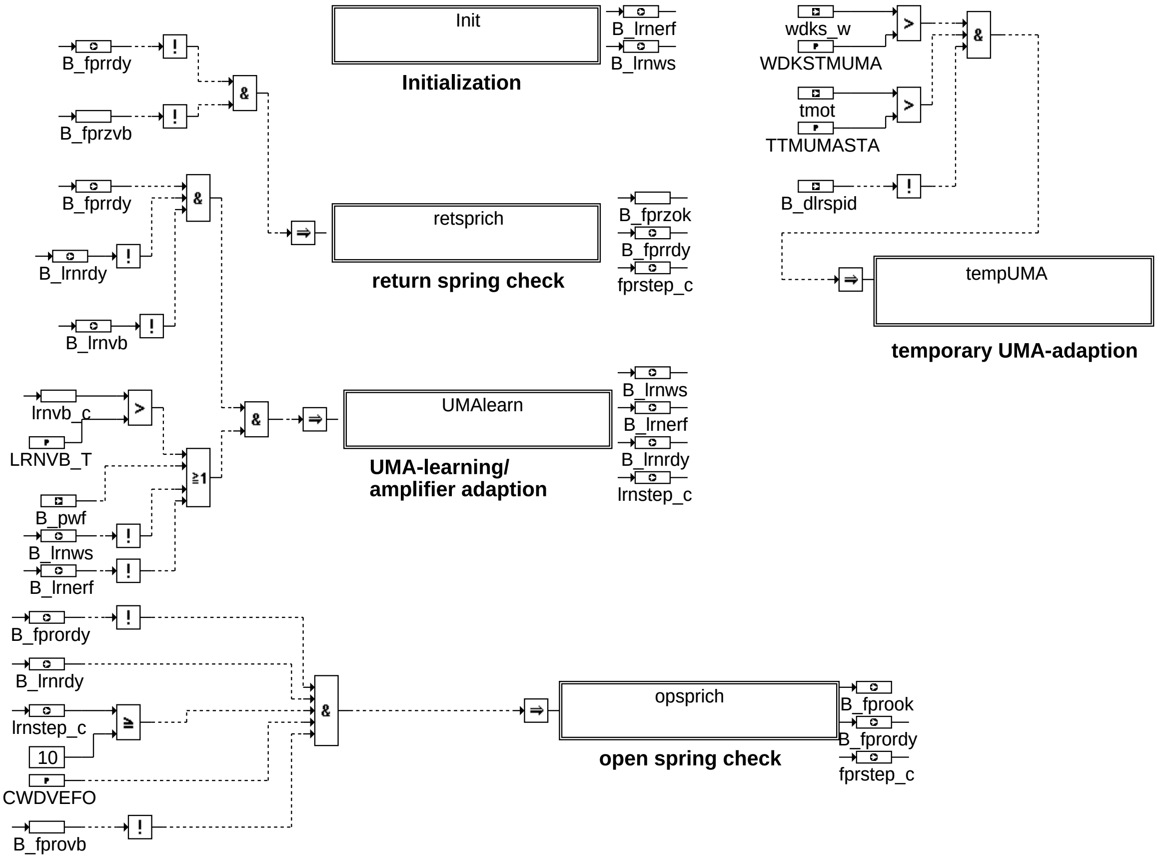
The parameters wdkba_w, wdkdlr_w, dlrspid_w, B_dlrspid shall be measured during a FTP cycle and the results forwarded to K3/ESI 1 for evaluation to ensure that the maximum number of actual-value strokes by the DV-E5 its not exceeded over its service life. Procedure in accordance with the document k3appdat\Functions\DV-E control\saving the servive-life data assignment DV-E5.doc.

BGDVE 3.110 Values for DV-E control from the learning and checking routines

FDEF BGDVE 3.110 Function definition



bgdve-main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Initialization
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&
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retsprich
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fprstep_c
return spring check
B_lrnrdy
B_lrnvb
UMAlearn
B_lrnws
B_lrnerf
B_lrnrdy
lrnstep_c
UMA-learning/
amplifier adaption
lrnvb_c
LRNVB_T
B_pwf
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B_fprordy
lrnstep_c
≥
10
CWDVEFO
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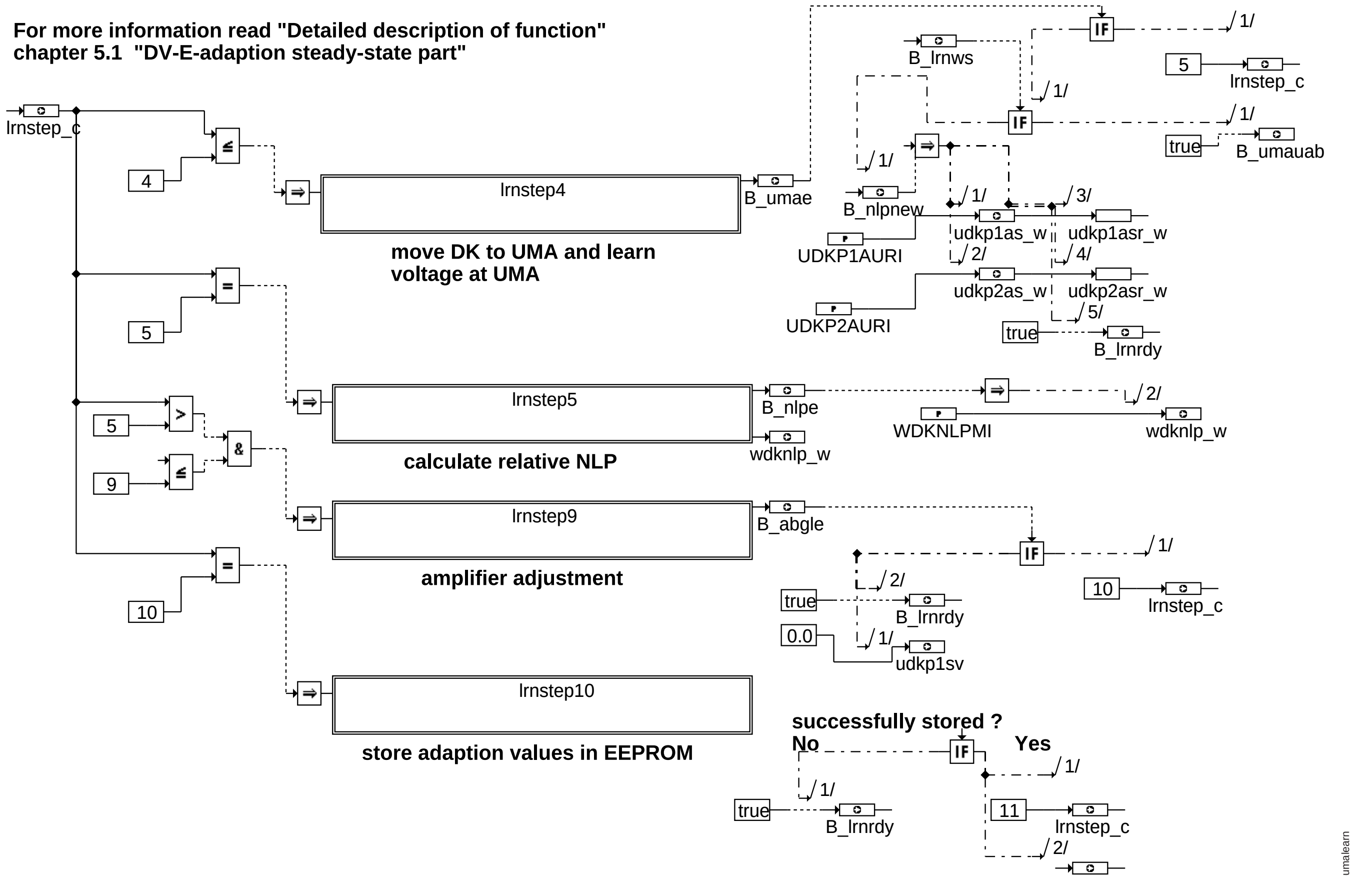
opsprich
B_fprook
B_fprordy
fprstep_c
open spring check
wdks_w
WDKSTMUMA
tmot
TTMUMASTA
B_dlrspid
tempUMA
temporary UMA-adaption
⇒
bgdve-bgdve

bgdve-bgdve

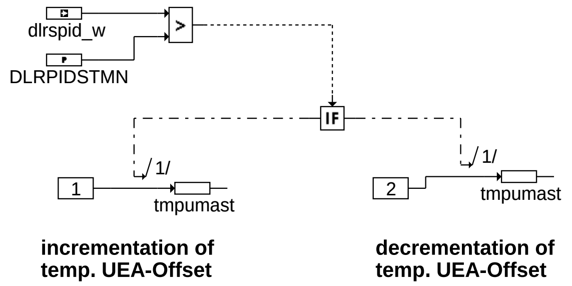
For more information read "Detailed description of function" chapter 5.1 "DV-E-adaption steady-state part"

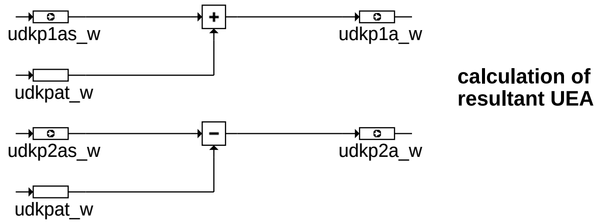


UMA-learning and amplifier adjustment

bgdve-umalearn

For more information read "Detailed description of function" chapter 5 "DV-E-adaption" part 5.2 "temporary part"



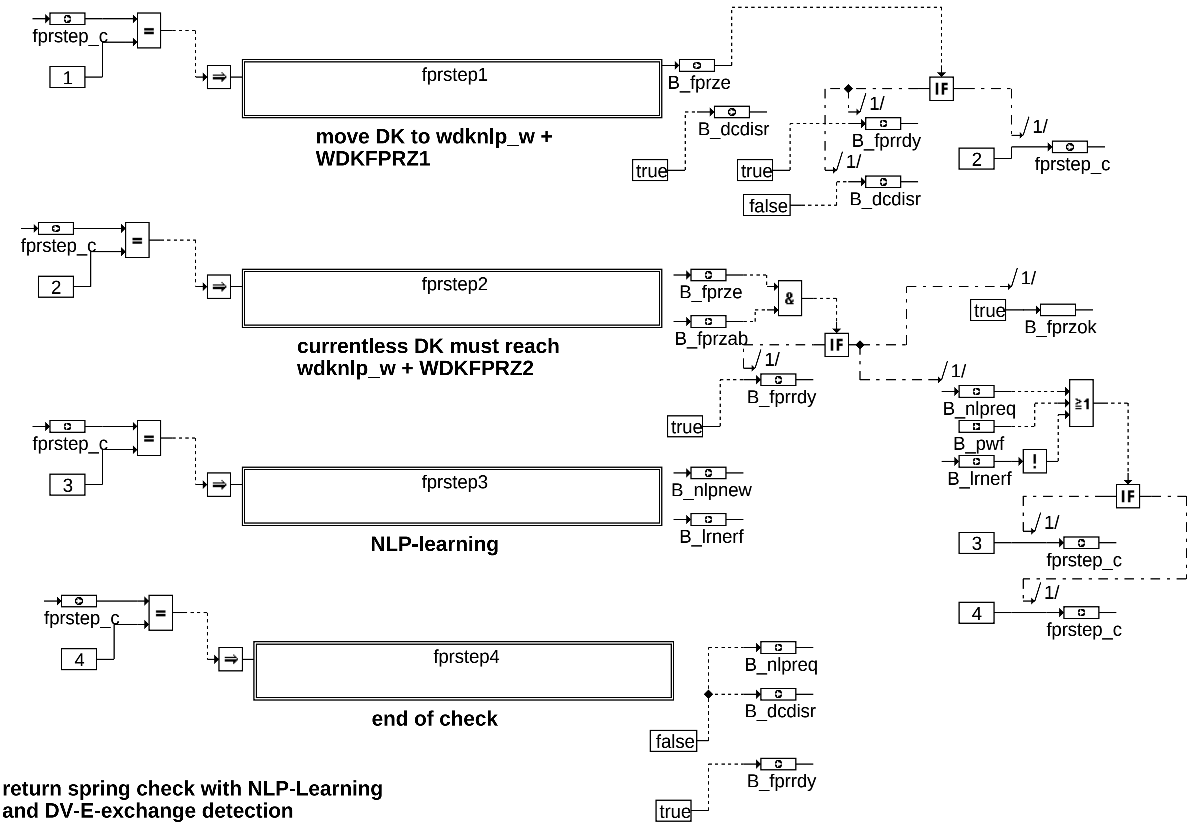


temporary UMA-adaption

bgdve-tempuma

bgdve-tempuma

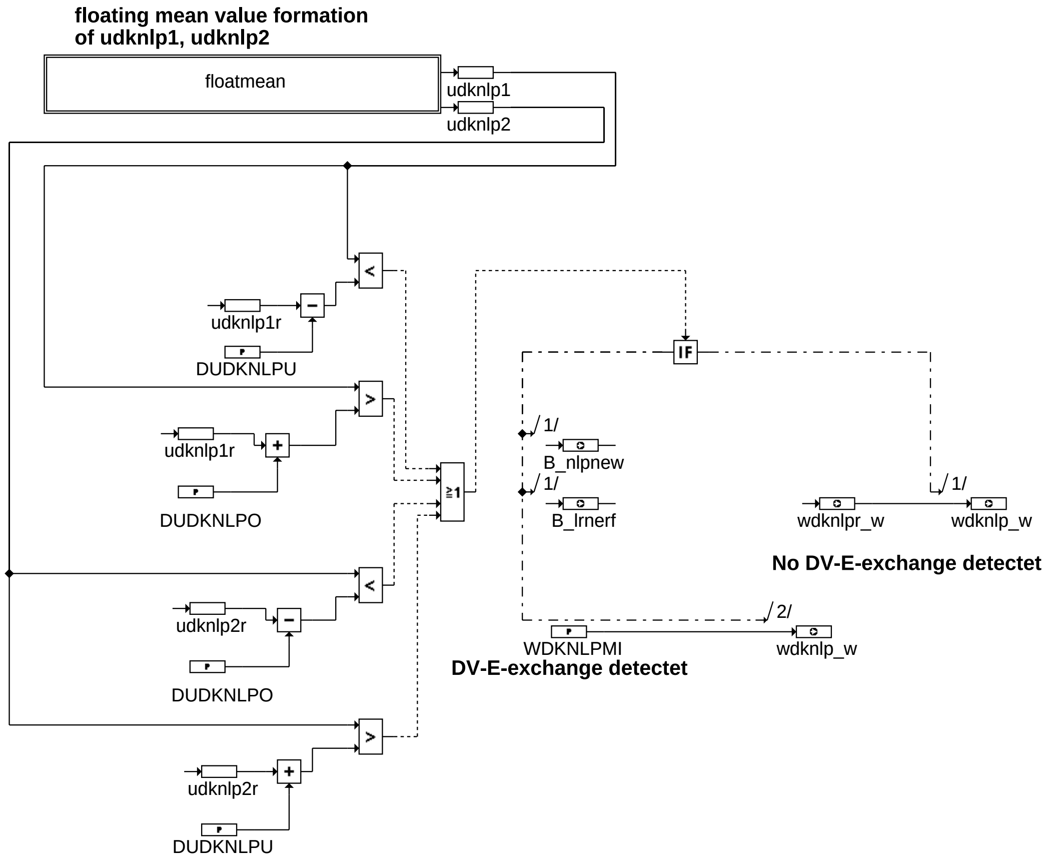
For more information read "Detailed description of function" chapter 4 "DV-E-spring check"



return spring check with NLP-Learning and DV-E-exchange detection

bgdve-retsprich

bgdve-retsprich

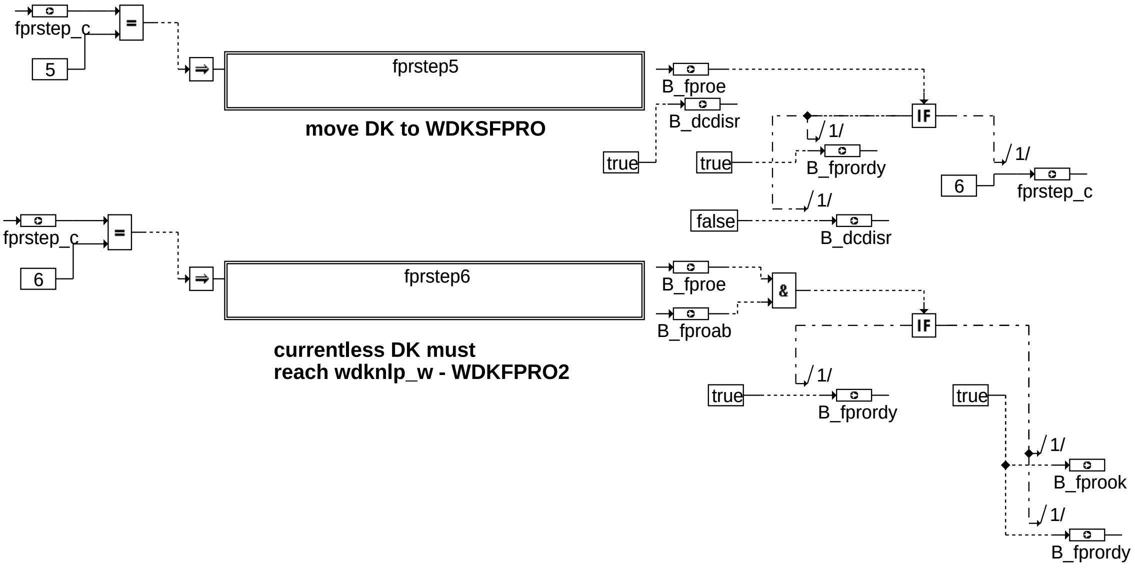


NLP-learning and DV-E-exchange detection

bgdve-fprstep3

bgdve-fprstep3

For more information read "Detailed description of function" chapter 4 "DV-E-spring check"



DV-E-Open spring check

bgdve-opsprich

bgdve-opsprich

ABK BGDVE 3.110 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWDVEFO			FW	Codeword DV-E opening spring-check
DKPSTGMIN			FW	Min. gradient of the DK poti for conversion abs. to rel. angle in the worst case
DLRPIDSTMN			FW	Min. threshold for PWM pulse duty factor of the DLR with temp. UMA adapt.
DUDKNLPO			FW	Tolerance range for NLP upward (incl. Rü)
DUDKNLPU			FW	Tolerance range for NLP downward
DUDKP1HY			FW	offset of hysteresis for switching to amplified throttle poti 1 signal
DUDKPTMP			FW	Delta of a ramp-step during the temp. UMA adaptation
FPRAT			FW	Inlet air temperature threshold for DV-E spring check
FPRMT			FW	Engine temperature threshold for DV-E spring check
FPRNMAX			FW	Engine speed threshold for DV-E spring check
FPRTIM1_T			FW	DV-E spring check, waiting time in check step 1
FPRTIM2_T			FW	DV-E spring check, waiting time in check step 2
FPRTIM3_T			FW	DV-E spring check, waiting time in check step 5
FPRTIM4_T			FW	DV-E spring check, waiting time in check step 6
LRNST1_T			FW	Waiting time during learning step 1
LRNST3_T			FW	Waiting time during learning step 3
LRNST7_T			FW	Waiting time during learning step 7
LRNST9_T			FW	Waiting time during learning step 9
LRNVB_T			FW	Time during which learning is forbidden for 'normal learning'
NLPST1T			FW	Waiting time 1 in the NLP learning
NLPST2T			FW	Waiting time 2 in the NLP learning
SY_LECK			FW	Leckluft im Steller
TCIDIS			FW	Max. time for CAN-Kommunikation to be stopped when B_stend
TDKNACH			FW	time during run after untol zero current DK stabilizes in NLP
TDLRPIDMX			FW	Max. time for PWM pulse duty factor of the DLR at temp. UMA adapt.
TMSUTMUMA			FW	Lower Tmot threshold for temporary UMA adapation
TTMUMASTA			FW	Time for steady-state during temp. UMA adaptation
UANAUFRP			FW	Step width for OPEN ramp
UANNMAX			FW	Engine speed threshold for the release of the UMA learning and gain adjustment
UANPEDMAX			FW	Pedal threshold for UMA learning allowed
UANPIDMIN			FW	Abort threshold PID-sum for CLOSE ramp
UANPIDMINA			FW	Abort threshold PID-sum for OPEN ramp
UANUATS			FW	Lower inlet air temperature threshold for release of learning
UANVFZG			FW	Car velocity threshold for DV-E check/adaption
UANZURP			FW	Step width for CLOSE ramp
UAN_O_MT			FW	upper engine temperature threshold for stop limit
UAN_STORE			FW	Threshold for storage of new learning values
UAN_U_MT			FW	lower engine temperature threshold for stop limit
UB_UANL			FW	Battery voltage threshold for release of learning
UDKNLP1N			FW	Nominal value voltage DK-Poti 1 in NLP-position
UDKNLP2N			FW	Nominal value voltage DK-Poti 2 in NLP-position
UDKP1AMAX			FW	Max. voltage DK-Poti 1 at lower DK limit stop
UDKP1AMIN			FW	Min. voltage DK-Poti 1 at lower DK limit stop
UDKP1AURI			FW	Voltage DK-poti 1 at the lower DK limit stop, initial. value
UDKP1DUS			FW	Nominal switch-over threshold for DK-Poti-1 switch-over
UDKP1NHUB			FW	Rated travel of the throttle valve in the DV-E, (poti 1)
UDKP1VID			FW	Nominal amplification for DK-Poti 1
UDKP1VOMA			FW	Max. offset error for DK-Poti-1-amplifier
UDKP1VOMI			FW	Min. offset error for DK-Poti-1-amplifier
UDKP1VOSC			FW	Lower limit for upper adjust.pt. DK-Poti 1
UDKP1VUSC			FW	Upper limit for lower adjust.pt. DK-Poti 1
UDKP1VVMA			FW	Upper value amplification error for amplifier
UDKP1VVMI			FW	Lower value amplification error for amplifier
UDKP2AMAX			FW	Max. voltage DK-Poti 2 at lower DK limit stop
UDKP2AMIN			FW	Min. voltage DK-Poti 2 at lower DK limit stop
UDKP2AURI			FW	Voltage DK-poti 2 at the lower DK limit stop, initial. value
UDKPALOS			FW	Voltage offset for detection of the breakaway
UDKPAOFF			FW	Voltage offset at lower limit stop
UDKPATMX			FW	Max. possible offset of the temp. UMA adaptation
UPVGNENN			FW	Nominal value for DV-E poti supply voltage
WDKFPRO1			FW	Shutdown actual throttle-valve value for opening DV-E spring check
WDKFPRO2			FW	Test threshold actual throttle-valve value for opening DV-E spring check
WDKFPRZ1			FW	Deactivation threshold DK actual value for DV-E return spring check
WDKFPRZ2			FW	Checking threshold DK actual value for DV-E return spring check
WDKNLPMA			FW	Upper allowed setpoint for NLP-position
WDKNLPMI			FW	Lower allowed setpoint for NLP-position
WDKNSTORE			FW	Threshold for storage of new learning values rel. limp home position
WDKSFPR			FW	DK setpoint for DV-E return spring check
WDKSFPRO			FW	Nominal throttle-valve value for opening DV-E spring check
WDKSTMUMA			FW	DK angle threshold for temporary UMA adaptation

Variable	Source	Type	Description
B_2WART	BGDVE	LOK	condition: Wait for "injection enabled" from 2.ECU
B_ABGLE	BGDVE	AUS	Condition: Error during amplifier adjustment
B_CIDIS	BGDVE	LOK	condition: Stop of CAN-Kommunikation when B_stend
B_CLDVEF		EIN	Flag for clearance: DV-E cause of failure: spring check
B_CLDVEFO		EIN	Flag for detection: Fault in spring test "Open"
B_CLDVEN		EIN	Flag for clearance: DV-E cause of failure: limphome air position
B_CLDVEU		EIN	Flag for clearance: DV-E cause of failure: UMA-learning
B_CLDVEUW		EIN	Flag for deletion: Fault during UMA re-learning
B_CLDVEV		EIN	Flag for clearance: DV-E cause of failure: amplifier adjustment

Variable	Source	Type	Description
B_DCDISFR	ADVE	EIN	Condition: Disable DV-E power stage by means of the funct. processor
B_DCDISR	BGDVE	AUS	Condition: DV-E power stage deactivation is requested
B_DKADEN	BGDVE	AUS	Condition: Use DK setpoint from DK adaptation and DK check
B_DKNACH	BGDVE	LOK	Non-volatile RAM, Condition: DK currentless and in NLP in run after
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKNOT	SREAKT	EIN	condition: continued operation with a single remaining throttle actuator poti
B_DKP1E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 1
B_DKP2E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 2
B_DKPIU	SREAKT	EIN	Condition: irreversible SKA
B_DLRIEN	BGDVE	AUS	Condition: Perform no temp. limitation of I-component in the DLR
B_DLRSPID	ADVE	EIN	Condition: DLR, sign of sum of the PID-components, = 1: positiv, =0: negative
B_DVEADA	BGDVE	AUS	condition: disabling injection during DV-E-adaptation
B_DVEADAMC		EIN	CAN-Receive-Message: injection prohibited by master-ECU during DV-E-adaption
B_DVEADASC		EIN	CAN-Receive-Message: injection prohibited by slave-ECU during DV-E-adaption
B_DVEADAT	BGDVE	AUS	CAN-Send-Message: injection prohibites by slave- or master-ECU during DV-E-adapt
B_DVETE	ADVE	EIN	Condition: Extended DV-E-exchange detection
B_DVETV	BGDVE	LOK	Condition: Locking bit extended controller replacement detection
B_FPRAKT	BGDVE	LOK	Throttle return spring check active
B_FPROAB	BGDVE	AUS	Condition: Abort of DV-E open spring check, spring does not open
B_FPROE	BGDVE	AUS	Condition: Opening spring test fault
B_FPROOK	BGDVE	AUS	Condition: Opening spring test OK
B_FPRORDY	BGDVE	AUS	Condition: Opening spring test completed
B_FPROVB	BGDVE	LOK	Condition: Opening spring test prohibited
B_FPRRDY	BGDVE	AUS	throttle return spring check ended
B_FPRZAB	BGDVE	AUS	Condition: Abort of DV-E return spring check, spring does not close
B_FPRZE	BGDVE	AUS	Condition: Error in the DV-E return spring check
B_FPRZOK	BGDVE	LOK	Condition: DV-E return spring check o.k.
B_FPRZVB	BGDVE	LOK	Condition: DV-E return spring check forbidden
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_LRNAKT	BGDVE	AUS	learning active bit
B_LRNDIA		EIN	Condition: DV-E adaptations and checks activated by means of diagnosis tester
B_LRNERF	BGDVE	AUS	learning success bit
B_LRNFG	BGDVE	LOK	learning enable bit
B_LRNRDY	BGDVE	AUS	learning complete
B_LRNTESA	BGDVE	LOK	Condition: UMA learning a.gain adj. activated due to tester request
B_LRNVB	BGDVE	AUS	learning prohibition bit
B_LRNWS	BGDVE	AUS	learned value save bit
B_LRNWT		EIN	Condition: DV-E adaptions activated by tester at end of intake-module-production
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_NLPE	BGDVE	AUS	Condition: Error in NLP-check and learning
B_NLPERF	BGDVE	AUS	Permanent RAM, condition: NLP acquisition successful
B_NLPNEW	BGDVE	AUS	Condition: NLP position not yet known
B_NLPREQ	BGDVE	AUS	Condition: Request NLP learning
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_UBDVE	ADVE	EIN	Condition: Battery voltage for DV-E control OK
B_UMAE	BGDVE	AUS	Condition: Error during UMA learning
B_UMAUAB	BGDVE	AUS	Condition: UMA learning stopped during first initialization (SKA)
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
CIDISTIM	BGDVE	LOK	time-counter to stop CAN-Kommunikation after B_stend
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DKPSTG_W	BGDVE	AUS	slope of throttle potentiometer (% DK / V)
DLRMXT	BGDVE	LOK	Timer for DLR in the UMA within the limit
DLRSPID_W	ADVE	EIN	DLR for DV-E: Sum of the PID-components
DVEADCHST	BGDVE	AUS	DV-E adaptation: Status test conditions
E_DVEF	DDVE	EIN	Error flag: DV-E cause of failure: spring check
E_DVEFO	DDVE	EIN	errror flag: DV-E cause of failure: spring check ”open”
E_DVEN	DDVE	EIN	Error flag: DV-E cause of failure: limphome air position
E_DVEV	DDVE	EIN	Error flag: DV-E cause of failure: amplifier adjustment
FPRSTEP_C	BGDVE	AUS	step counter throttle return spring check
FPRTIM_C	BGDVE	LOK	time counter throttle return spring check
LRNSTAT	BGDVE	AUS	statusbyte DV-E-adaption routine for tester-communication
LRNSTEP_C	BGDVE	AUS	counter for learning time for a learning step
LRNTIM_C	BGDVE	LOK	Time counter for the waiting time in the learning steps
LRNVB_C	BGDVE	LOK	Learning prohibition counter (wait time)
NLP1TIM	BGDVE	LOK	Time counter for the waiting time 1 in the NLP learning
NMOTLL	BGNMOT	EIN	engine speed
SY_2SG	PROKON	EIN	system constant 2 motronic systems
SY_BLOOP		EIN	1=resetting of irrev. EGAS fault possible during clearing of FCM
SY_TWDKS		EIN	system constant: input of desired angle DVE via tester is possible
SY_UBR	PROKON	EIN	system constant onboard battery voltage scanned from main relay input
SY_UBSQ_W		EIN	System constant conversion factor UB resolution to standard quantization ubsq
TANS	SWADAP	EIN	Intake air temperature
TDKNACH_W	BGDVE	LOK	time counter during run after until curentless DK reaches NLP
TLOOP	BGDVE	LOK	Ring counter for time difference measurement
TMOT	SWADAP	EIN	Engine temperature
TMPUMAST	BGDVE	LOK	Status for temporary UMA adaptation
TNACHL_W	MOTAUS	EIN	time of ECU switch off delay
TTMUMAD	BGDVE	LOK	time difference for temporary UMA adaptation

Variable	Source	Type	Description
UB	SWADAP	EIN	battery voltage
UBRSQ		EIN	battery voltage via main relay, standard quantization
UBUANLR	BGDVE	LOK	min.voltage for UMA-Learning in Quantization of ubrsq
UDKNLP1	BGDVE	LOK	Voltage DK-Poti 1 at the NLP
UDKNLP1R	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 1 at the NLP
UDKNLP2	BGDVE	LOK	Voltage DK-Poti 2 at the NLP
UDKNLP2R	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 2 at the NLP
UDKP1A	BGDVE	AUS	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop
UDKP1AALT	BGDVE	LOK	Temp. voltage DK-poti 1 at the lower DK limit stop
UDKP1ASR_W	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 1 at lower DK limit stop, stationary value
UDKP1AS_W	BGDVE	AUS	Voltage DK-poti 1 at the lower limit stop, steady-state part
UDKP1A_W	BGDVE	AUS	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop (word)
UDKP1ROB	BGDVE	LOK	Real DK-poti-1-value at the upper adjustment point
UDKP1RUN	BGDVE	LOK	Real DK-poti-1-value at the lower adjustment point
UDKP1SV	BGDVE	AUS	Max. DK potentiometer-1 value for using amplified signal
UDKP1VOR	BGDVE	LOK	Permanent RAM: Voltage offset at DK-Poti-1-amplification
UDKP1VOU	BGDVE	AUS	Diagnosis: 8 bit copy of udkp1vo_w as ambient value
UDKP1VO_W	BGDVE	AUS	voltage offset of DK potentiometer 1 amplification charcteristic
UDKP1VROB	BGDVE	LOK	Real amplified DK-poti-1-value at the upper adjustment point
UDKP1VRUN	BGDVE	LOK	Real amplified DK-poti-1-value at the lower adjustment point
UDKP1VV	BGDVE	AUS	Diagnosis: 8 bit copy of udkp1vv_w as ambient value
UDKP1VVR	BGDVE	LOK	Permanent RAM: Amplification at DK-Poti-1-amplification
UDKP1VV_W	BGDVE	AUS	amplification of throttle potentiometer 1
UDKP1V_W		EIN	amplified sensor voltage throttle potentiometer 1
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2A	BGDVE	AUS	sensor voltage poti 2 of throttle actuator at (lower) mechanical stop
UDKP2AALT	BGDVE	LOK	Temp. voltage DK-poti 2 at the lower DK limit stop
UDKP2ASR_W	BGDVE	LOK	Permanent RAM: Voltage DK-Poti 2 at lower DK limit stop, stationary value
UDKP2AS_W	BGDVE	AUS	voltage DK-poti 2 at the lower limit stop, steady-state part
UDKP2A_W	BGDVE	AUS	sensor voltage throttle potentiometer 2 at (lower) mechanical stop
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKPATR_W	BGDVE	LOK	Static-RAM: temporary UEA offset of the DK-poti
UDKPAT_W	BGDVE	LOK	Temporary UEA offset of the DK-poti
VFZG	SWADAP	EIN	vehicle speed (km/h)
WDKADA_W	BGDVE	AUS	Setpoint DK-angle, from DV-E adaptation function and check function
WDKBA_W	GGDVE	EIN	throttle angle with respect to lower mechanical stop
WDKNLP	BGDVE	AUS	Diagnosis: 8 bit copy of wdknlp_w as ambient value
WDKNLPR	BGDVE	AUS	Diagnosis: 8 bit copy of wdknlpr_w as ambient value
WDKNLPR_W	BGDVE	AUS	Permanent RAM: Setpoint throttle angle in NLP-position, related to UMA
WDKNLP_W	BGDVE	AUS	throttle angle in the limphome air position
WDKS_W	MSF	EIN	desired throttle angle w.r.t. to lower mechanical stop
WDKVABOB	BGDVE	LOK	DK setpoint for upper adjustment point
WDKVABUB	BGDVE	LOK	DK setpoint for lower adjustment point
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW BGDVE 3.110 Fixed Values

Parameter	Value	Description
CWDVEFO		Codeword DV-E opening spring-check
DKPSTGMIN		Min. gradient of the DK poti for conversion abs. to rel. angle in the worst case
DLRPIDSTMN		Min. threshold for PWM pulse duty factor of the DLR with temp. UMA adapt.
DUDKNLPO		Tolerance range for NLP upward (incl. Rü)
DUDKNLPU		Tolerance range for NLP downward
DUDKP1HY		offset of hysteresis for switching to amplified throttle poti 1 signal
DUDKPTMP		Delta of a ramp-step during the temp. UMA adaptation
FPRAT		Inlet air temperature threshold for DV-E spring check
FPRMT		Engine temperature threshold for DV-E spring check
FPRNMAX		Engine speed threshold for DV-E spring check
FPRTIM1_T		DV-E spring check, waiting time in check step 1
FPRTIM2_T		DV-E spring check, waiting time in check step 2
FPRTIM3_T		DV-E spring check, waiting time in check step 5
FPRTIM4_T		DV-E spring check, waiting time in check step 6
LRNST1_T		Waiting time during learning step 1
LRNST3_T		Waiting time during learning step 3
LRNST7_T		Waiting time during learning step 7
LRNST9_T		Waiting time during learning step 9
LRNVB_T		Time during which learning is forbidden for 'normal learning'
NLPST1T		Waiting time 1 in the NLP learning
NLPST2T		Waiting time 2 in the NLP learning
SY_LECK		Leckluft im Steller
TCIDIS		Max. time for CAN-Kommunikation to be stopped when B_stend
TDKNACH		time during run after untol zero current DK stabilizes in NLP
TDLRPIDMX		Max. time for PWM pulse duty factor of the DLR at temp. UMA adapt.
TMSUTMUMA		Lower Tmot threshold for temporary UMA adapation
TTMUMASTA		Time for steady-state during temp. UMA adaptation
UANAUFRP		Step width for OPEN ramp
UANNMAX		Engine speed threshold for the release of the UMA learning and gain adjustment
UANPEDMAX		Pedal threshold for UMA learning allowed
UANPIDMIN		Abort threshold PID-sum for CLOSE ramp
UANPIDMINA		Abort threshold PID-sum for OPEN ramp
UANUATS		Lower inlet air temperature threshold for release of learning
UANVFZG		Car velocity threshold for DV-E check/adaption

Parameter	Value	Description
UANZURP		Step width for CLOSE ramp
UAN_O_MT		upper engine temperature threshold for stop limit
UAN_STORE		Threshold for storage of new learning values
UAN_U_MT		lower engine temperature threshold for stop limit
UB_UANL		Battery voltage threshold for release of learning
UDKNLP1N		Nominal value voltage DK-Poti 1 in NLP-position
UDKNLP2N		Nominal value voltage DK-Poti 2 in NLP-position
UDKP1AMAX		Max. voltage DK-Poti 1 at lower DK limit stop
UDKP1AMIN		Min. voltage DK-Poti 1 at lower DK limit stop
UDKP1AURI		Voltage DK-poti 1 at the lower DK limit stop, initial. value
UDKP1DUS		Nominal switch-over threshold for DK-Poti-1 switch-over
UDKP1NHUB		Rated travel of the throttle valve in the DV-E, (poti 1)
UDKP1VID		Nominal amplification for DK-Poti 1
UDKP1VOMA		Max. offset error for DK-Poti-1-amplifier
UDKP1VOMI		Min. offset error for DK-Poti-1-amplifier
UDKP1VOSC		Lower limit for upper adjust.pt. DK-Poti 1
UDKP1VUSC		Upper limit for lower adjust.pt. DK-Poti 1
UDKP1VVMA		Upper value amplification error for amplifier
UDKP1VVMI		Lower value amplification error for amplifier
UDKP2AMAX		Max. voltage DK-Poti 2 at lower DK limit stop
UDKP2AMIN		Min. voltage DK-Poti 2 at lower DK limit stop
UDKP2AURI		Voltage DK-poti 2 at the lower DK limit stop, initial. value
UDKPALOS		Voltage offset for detection of the breakaway
UDKPAOFF		Voltage offset at lower limit stop
UDKPATMX		Max. possible offset of the temp. UMA adaptation
UPVGNENN		Nominal value for DV-E poti supply voltage
WDKFPRO1		Shutdown actual throttle-valve value for opening DV-E spring check
WDKFPRO2		Test threshold actual throttle-valve value for opening DV-E spring check
WDKFPRZ1		Deactivation threshold DK actual value for DV-E return spring check
WDKFPRZ2		Checking threshold DK actual value for DV-E return spring check
WDKNLPMA		Upper allowed setpoint for NLP-position
WDKNLPMI		Lower allowed setpoint for NLP-position
WDKNSTORE		Threshold for storage of new learning values rel. limp home position
WDKSFPR		DK setpoint for DV-E return spring check
WDKSFPRO		Nominal throttle-valve value for opening DV-E spring check
WDKSTMUMA		DK angle threshold for temporary UMA adaptation

FB BGDVE 3.110 Detailed description of function

0.   Overview

==============

1.   Introduction

====================

Since there is no adjustment between the actual value acquisition by the potentiometer and the mechanical throttle valve position (DK) for the throttle adjustment device DV-E5, an adaptation needs to be performed in the ME. During the adaptation, the lower mechanical DK limit stop (UMA) and the air in the limp home position (NLP) of the DV-E5 are learned, and an adjustment of the actual value potentiometer gain is performed. The learned values are stored in the permanent RAM resp. in the EEPROM. In addition, the springs of the DV-E5 are checked. With ignition ON, this adaptation may under certain input conditions take place again.

Therefore, the following sub functions are realized in the BGDVE:

- Learning and checking of the DV-E air at limp home position (NLP learning) with DV-E exchange detection
- DV-E spring check (open spring, return spring)

- Learning of the lower mechanical DK limit stop (UMA learning)
- Gain adjustment, offset and gradient

A ’first initialization’ was performed only, if all of the mentioned sub functions are successfully executed during an initial start. The variables must then be given the following values:

B_lrnws = 1, B_lrnerf = 1, B_fprzok = 1, (B_fprook = 1 only for CWDVEFO = 1)
and lrnstep_c = 11.

(B_nlperf is not needed anymore for event control purposes from BGDVE3.110 onwards, thus being reduced to a Dummy - Function. B_nlperf = 1 is cyclically refreshed and is of no importance anymore)

2. Initialization

The initialization phase consists of three parts.

```
"- Part 1: Copy EEPROM values into the permanent RAM"
          B_lrnerf, B_lrnws, udknlp1r, udknlp2r, udkp1asr_w,
          udkp2asr_w, udkp1vor, udkp1vvr and wdknlpr_w
"- Part 2: Copy permanent RAM values into the RAM"
          udkp1asr -> udkp1as_w, udkp1asr_w -> udkp1a
          udkp2asr -> udkp2as_w, udkp2asr_w -> udkp2a
          udkpatr_w -> udkpat_w
          udkp1vor -> udkp1vo_w, udkp1vvr -> udkp1vv_w
          wdknlpr_w -> wdknlp_w
"- Part 3: Calculate ini-values and write them into RAM"
          Poti gradient dkpstg_w := 100.0 %DK / UDKP1NHUB
          Switch-over threshold udkp1sv := UPVGNENN / udkp1vv_w - UDKP1DUS
```

If the EEPROM was cleared or if it is defective, fixed values are written into the permanent RAM in part 1. The assignment is as follows:

```
          udkp1asr_w := UDKP1AURI
          udkp2asr_w := UDIP2AURI
          udkp1vor   := 0.0
          udkp1vvr   := UDKP1VID
          B_lrnws    := false
          B_lrnerf   := false
          udknlp1r   := UDKNLP1N
          udknlp2r   := UDKNLP2N
          wdknlpr_w  := WDKNLPMA
```

Furthermore the following plausibility checks are performed in part 3:

```
             if (udkp1asr_w < UDKP1AMIN)  OR  (udkp1asr_w > UDKP1AMAX + UDKPAOFF)
             OR (udkp2asr_w < UDKP2AMIN - UDKPAOFF)  OR  (udkp2asr_w > UDKP2AMAX)
          then
              B_lrnws    := false
              B_lrnerf   := false
              udkp1asr_w := UDKP1AURI
              udkp2asr_w := UDKP2AURI
              udkp1as_w  := UDKP1AURI
              udkp1a     := UDKP1AURI
              udkp2as_w  := UDKP2AURI
              udkp2a     := UDKP2AURI
          endif

          if (udkp1vo_w < UDKP1VOMI)  OR  (udkp1vo_w > UDKP1VOMA)  OR
             (udkp1vv_w < UDKP1VVMI)  OR  (udkp1vv_w > UDKP1VVMA)
          then
              B_lrnerf  := false
              udkp1vo_w := 0.0
              udkp1vv_w := UDKP1VID
          endif

          if ((wdknlp_w < WDKNLPMI) OR (wdknlp_w > WDKNLPMA)
          then
              B_lrnerf := false
              wdknlp_w := WDKNLPMA
          endif
```

For projects with additional measurement path for the voltage ubrsq downstream the main relay (conditional compilation, SY_UBR = true), a re-quantisation of the voltage threshold UB_UANL to the resolution of ubrsq is required. In this case ubuanlr replaces the environmental condition UB_UANL. (see 5.1.2 Detailed order of events/Starting conditions).

```
if (SY_UBR)
then
   ubuanlr := UB_UANL * SY_UBSQ_W
endif
```

3. NLP learning (DV-E exchange detection)

The NLP is needed for the digital position controller (DLR) and for the detection of a DV-E adaptation need, e.g. in the case of an actuator exchange. At ignition ON, the NLP is read via the actual value potentiometers, as long as the DV-E is still at zero current (result in udknlp1 and ukdnlp2) and it is then checked for plausibility with the values stored in the memory (udknlp1r and udknlp2r). If the values differ, adaptation need is detected and after the return spring was checked in checking step 3 (fprstep_c = 3), the NLP is learned. The NLP is made available to the DLR in the ADVE as wdknlp_w.

In order to avoid an incorrect DV-E exchange detection in the case of a quick change from ignition ON -> OFF -> ON the DV-E exchange detection is only permitted in the ECU initialization, if the DK in the previous ECU-after-run has been at zero current for at least a time tdknach_w >= TDKNACH (then B_dknach = true). Thus it is ensured that the DK can definitely stabilize into the NLP while it is at zero current.

In the case of an actuator exchange without adaption by service-tester, it might be possible that udknlp1 and udknlp2 are still inside of the tolerance limit. Therefore at first the exchange detection is not active and no adaption will be made.If the UMA of the new actuator is above UMA of the old one, it could be possible that with ignition ON and no operation of the accelerator the current limitation in the ADVE will become active. In this case, the extended DV-E exchange detection reacts with blocking of the injection and a DV-E adaption. The extended DV-E exchange detection is only active with nmot = 0, wdks_w < (UDKP1AURI - udkp1as_w)* dkpstg_w und B_stend = false. After the start, the extended DV-E exchange detection is stopped with B_dvetv = true and can only become active again when the ignition was turned OFF --> ON again.

Also see chapter 6, blocking of the injection.

4. DV-E spring check

4.1 Return spring check

4.1.1 Overview

By an opening of the DK from the NLP into the direction DK OPEN and by a subsequent switch-off of the DV-E power stage (DV-E-ES), the return motion forced by the return spring is checked. In the case of a fault, the DK drive default function (previously driving with DK limp home air) is requested via B_fprzab = 1.
The course of events can be observed by means of the checking step counter fprstep_c.
The check is only performed once by it being locked via the check ready bit B_fprrdy.

The check is performed only if the following preconditions are fulfilled - if not, the check will be prohibited (B_fprzvb = true) and the counter dveadchst will be set. dveadchst indicates which precondition was not fulfilled.

		Counter dveadchst:	
((B_dkpiu = 0)	AND	I	
(B_dknolu = 0)	AND	I	
(B_i_ska_um = 0)	AND	I	1
		I	
(vfzg < UANVFZG)	AND	I	5
(nmotll <= FPRNMAX)	AND	I	6
(B_wdk2sel = false)	AND	I	4
(B_ubdve = true)	AND	I	9
(tmot >= FPRMT)	AND	I	7
(tans >= FPRAT)		I	8

In the case of a conditional compilation with SY_TWDKS = 1, in the intake manifold module test at the end of line of test request B_lrnwt = 1, the environmental conditions 5,6,7,8 are left out, and in condition 1 B_dkpiu = 0 is replaced by B_dkunb = 0.
(B_lrnwt = 1 only exists for SY_TWDKS = 1).

4.1.2 Detailed order of events

Spring check step 0 (B_fprakt = 0 -> 1 AND fprstep_c = 0):

Entry of the desired angle WDKSFPR for original position, starting of the spring check timer fprtim_c and switching over of the DV-E triggering to ’setpoint selection by adaptation’ (B_dkaden = 1).

Spring check step 1 (fprstep_c = 1):

If the actual DK angle reaches the threshold of the original position (wdkba_w >= (wdknlp_w + WDKFPRZ1)) within a max. time (fprtim_c <= FPRTIM1_T), a DV-E power stage switch-off is requested by B_dcdisr = 1. If the max. time is exceeded or if the check threshold is not reached, then the internal check fault B_fprze = 1 is set and the DV-E return spring check is aborted.

Spring check step 2 (fprstep_c = 2):

As a result of the DV-E power stage switch-off, the DK returns into the direction NLP due to the return spring. If the actual DK angle reaches the threshold of the original position (wdkba_w <= (wdknlp_w + WDKFPRZ2)) within a max. time (fprtim_c <= FPRTIM2_T), the check is detected to be O.K., the check bit B_fprzok = 1 is set and ’spring check active’ is reset (B_fprakt = 0). If the max. time is exceeded or if the lower check threshold is not reached, it means that the return spring has not set the DK back within the necessary time or that the return spring can no longer perform a return. In case this fault occurs, the DK drive default function (previously driving with DK limphome air) is requested via B_fprzab = 1.
Furthermore it is checked whether a learning of the NLP was requested (B_nlpreq = 1).
In the case of B_nlpreq = B_nlperft and no power fail, the check step counter is set to 4, otherwise the check step counter is set to 3.

Spring check step 3 (fprstep_c = 3):

Learning of the DK-NLP while the DK is in a zero current state. After a waiting time (nlp1tim > NLPST1T), during which the DK has stabilized into the NLP, both actual DK value potentiometers udkp1_w and udkp2_w are read until a certain time nlp1tim >= (NLPST1T + NLPST2T) has elapsed. During this measuring time the absolute NLP of the DK (udknlp1 and udknlp2) is determined by means of a floating mean value formation.

Spring check step 4 (fprstep_c = 4):

Check is terminated; request of the DV-E power stage switch-off is taken back (B_dcdisr = 0), check terminated is set (B_fprrdy = 1) and DV-E triggering is enabled for the normal operation (B_dkaden = 0).

4.2   Open spring check
========================

4.1.1 Overview
==============

By closing the DK from the NLP into the direction DK CLOSE and by a subsequent switch-off of the DV-E power stage (DV-E-ES), the open motion forced by the open spring is checked. In case of a fault, the DK drive default function (previously driving with DK limphome air) is requested. The course of events can be observed by means of the checking step counter fprstep_c.
The check is only performed once by it being locked via the check ready bit B_fprordy.

The check is performed only if the following preconditions are fulfilled, if not the check will be prohibited (B_fprovb = true) and the counter dveadchst will be set. dveadchst indicates which precondition was not fulfilled.

The open spring check can be shut-off with the code word CWDVEFO = 0

			Counter dveadchst:
((B_dkpiu = 0)	AND	I	
(B_dknolu = 0)	AND	I	
(B_i_ska_um = 0)	AND	I	
(B_wdk2sel = 0))	AND	I	40
(vfzg < UANVFZG)	AND	I	44
(nmotll <= FPRNMAX)	AND	I	45
(tmot >= FPRMT)	AND	I	46
(tans >= FPRAT)		I	47

In the case of a conditional compilation with SY_TWDKS = 1, in the intake manifold module test at the end of line of test request B_lrnwt = 1, the environmental conditions 44-47 are left out, and in condition 40 B_dkpiu = 0 is replaced by B_dkunb = 0.
(B_lrnwt = 1 only exists for SY_TWDKS = 1).

4.1.2 Detailed order of events
==============================

Spring check step 4 (B_fprakt = 0 -> 1 AND fprstep_c = 4):

Entry of the desired angle WDKAFPRO for original position, starting of the spring check timer fprtim_c and switching over of the DV-E triggering to ’setpoint selection by adaptation’ (B_dkaden = 1).

Spring check step 5 (fprstep_c = 5):

If the actual DK angle reaches the threshold of the original position (wdkba_w <= WDKFPRO1) within a max. time (fprtim_c <= FPRTIM3_T) a DV-E power stage switch-off is requested by B_dcdisr = 1. If the max. time is exceeded or if the check threshold is not reached, then the internal check fault B_fproe = 1 is set and the DV-E return spring check is aborted.

Spring check step 6 (fprstep_c = 6):

As a result of the DV-E power stage switch-off, the DK returns into the direction NLP due to the open spring. If the actual DK angle reaches the threshold of the original position (wdkba_w >= (wdknlp_w - WDKFPRO2)) within a max. time (fprtim_c <=

FPRTIM4_T), the check is detected to be O.K., the check bit B_fprook = 1 is set and 'spring check active' is reset (B_fprakt = 0), the request of the DV-E power stage switch-off is taken back (B_dcdisr = 0) and end of check is set ((B_fprordy = 1)..

If the max. time is exceeded or if the check threshold is not reached, it means that the open spring has not set the DK back within the necessary time or that the open spring can no longer perform a return. In case this fault occurs, the DK drive default function (previously driving with DK limp home air) is requested via B_fproab = 1 and check error B_fproe = 1 is set.

5. DV-E adaptation

5.1 Steady-state part

5.1.1 Overview

The steady-state part of the DV-E adaptation includes the UMA learning and the adjustment of the actual value potentiometer gain. In principle the steady-state part only needs to be performed once during the start-up of a new control unit resp. when exchanging a DV-E. The possibility of a renewed adaptation at ignition ON can be controlled by means of the prohibition time for learning LRNVB_T. The shorter this time is, the more likely it becomes that the adaptation is performed once more.

During the learning of the UMA the DK is moved in steps from the max. possible UMA to the UMA. By monitoring the actual value potentiometer it is detected, that the DK no longer moves. The corresponding value is read and increased by an offset UDKPAOFF, it is checked for plausibility as lower electrical DK limit stop (UEA) and stored in the permanent RAM resp. EEPROM. The UEA udkp1as_w and udkp2as_w are made available to the function GGDVE. When adjusting the gain, the offset and the gains of the OP loop are determined by taking up two measuring positions with the DK. The calculated values udkp1vo_w and udkp1vv_w are made available to the function GGDVE. The adjustment is performed after the UMA learning.

If a fault occurs during the first initialization resp. with not set learning value memory bit (B_lrnws = 0), an irreversible safety fuel deactivation (SKA) is requested via B_umauab = 1. The course of the adaptaption can be observed by means of the learning step counter lrnstep_c.

The adaptation can also be started by a tester. See chapter 7.

```
In adaptation step  0 ... 4 the UMA is learned
                    5       the rel. NLP is calculated
                    6 ... 9 the gain is adjusted
```

5.1.2 Detailed order of events

Starting conditions:

The adaptation will only take place, if the return spring check has been terminated (B_fprrdy = 1) and if the following input conditions are fulfilled, if not the learning will be prohibited (B_lrnvb = true) and the counter dveadchst will be set. dveadchst indicates which input condition was not fulfilled.

```
                                                                  Counter dveadchst:
                                                         ==================


    ((B_dkpiu = 0)        AND               I
    (B_i_ska_um = 0)      AND               I
    (B_dknolu = 0)        AND               I
    (B_dknot = 0))        AND               I                         20
    (nmotll <= UANNMAX)   AND               I                         24
    *)                                      I
    (vfzg <= UANVFZG)     AND               I                         25
    (wped < UANPEDMAX)    AND               I                         26
    (ub > UB_UANL)        AND               I                         27
    ((tmot >= UAN_U_MT)   AND               I
    (tmot <= UAN_O_MT))   AND               I                         28
    (tans >= UANUATS)                       I                         30

    *): The conditions to follow are only tested, if
                         (lrnvb_c > LRNVB_T)   OR
                         (B_pwf = 1)           OR
                         (B_lrnws = 0)         OR
                         (B_lrnerf = 0)
```

When the engine is turning lrnvb_c is stopped.

In the case of a conditional compilation with SY_TWDKS = 1, in the intake manifold module test at the end of line of test request B_lrnwt = 1 the environmental conditions 24-26,28,30 are left out, and in condition 20 B_dkpiu = 0 is replaced by B_dkunb = 0.
(B_lrnwt = 1 only exists for SY_TWDKS = 1).

For projects with additional measurement path for the voltage ubrsq downstream the main relay (conditional compilation, SY_UBR = true), a re-quantisation of the voltage threshold UB_UANL to the resolution of ubrsq is required. In this case ubuanlr replaces the environmental condition UB_UANL. (see 5.1.2 Detailed order of events/Starting conditions).

In the case that all input condtions are fulfilled, the adaption is enabled (B_lrnfg = 1), if not, the adaption is prohibited (B_lrnvb = 1).

Adaptation step 0 (B_lrnfg = 0 -> 1 AND lrnstep_c = 0):

Initialization of the DV-E adaptation. Switch-over of the DV-E triggering to 'setpoint of the BGDVE' (B_dkaden = 1) and entering the worst case values into the UMA values (udkp1as_w = UDKP1AMAX and udkp2as_w = UDKP2AMIN).

Adaptation step 1 (lrnstep_c = 1):

The DK is made to approach the UMA via a ramp by reducing udkp1as_w (step width UANZURP). As soon as the position controller output undershoots a min-threshold (conditon: B_dlrspid = 0 AND dlrspid_w > UANPIDMIN) a waiting time counter (lrntim_c) is started. During this time, the learning value is formed by means of a floating mean value formation in udkp1aalt and udkp2aalt. After the waiting time (lrntim_c >= LRNST1_T), the determined values udkp1as_w and udkp2as_w are checked for the permitted value range (UDKP1AMIN and UDKP2AMAX). In case of a fault, the learning fault is set (B_umae = 1) and the UMA abort function is executed.

Adaptation step 2 (lrnstep_c = 2):

The learned UMA, stored in the previous step in udkp1as_w and udkp2as_w, is increased by the offset (UDKPAOFF) and it thus becomes UEA. The UEA values are subsequently checked for the permitted value range (UDKP1AMAX and UDKP2AMIN). In case of a fault, the learning fault is set (B_umae = 1) and the UMA abort function is executed.

Adaptation step 3 (lrnstep_c = 3):

In this step, a ramp with the step width UANAUFRP is passed to the DK via the setpoint wdkada_w until the position controller output again exceeds the min-threshold (condition: B_dlrspid = 0 AND dlrspid_w <= UANPIDMINA). As soon as the threshold was exceeded, it is checked - after a waiting time (lrntim_c >= LRNST3_T) - whether the DK has detached from the UMA (udkp1_w > udkp1aalt) resp. whether it is not more than one delta away from UEA (udkp1_w <= udkp1as_w + UDKPALOS). In case of a fault, the learning fault is set (B_umae = 1) and the UMA abort function is executed.

Adaptation step 4 (lrnstep_c = 4):

Part 1 of the adaptation, the UMA learning has successfully been terminated; the bit learning value storage is set (B_lrnws = 1). If the following conditions are fulfilled, the currently learned UEA are entered into the permanent RAM (udkp1asr_w and udkp2asr_w).

Conditions: (|udkp1as_w - udkp1asr_w| > UAN_STORE) OR
(B_pwf = 1) OR
(B_lrnerf = 0) OR
(B_lrntesa = 1)

Adaptation step 5 (lrnstep_c = 5):

The value for the absolute NLP determined during the spring check is converted to a relative value (wdknlp_w). The calculated value is checked for plausibility with the NLP tolerance range permitted for the DV-E (WDKNLPMI and WDKNLPMA). If the tolerance range is adhered to, NLP-new is reset (B_nlpnew = 0). If the value is not within the tolerance range, the NLP-abort function is executed and NLP-fault (B_nlpe = 1) is set. The correct NLP values are also passed on to the permanent RAM (udknlp1r, udknlp2r and wdknlpr_w), if the following conditions are fulfilled:

(|udknlp1 - udknlp1r| > UANSTORE) OR
(|wdknlp_w - wdknlpr_w| > WDKN_STORE) OR
B_pwf = 1 OR
(B_lrnerf = false) OR
B_lrntesa

Adaptation step 6 (lrnstep_c = 6):

Initialization for the gain adjustment (gain adj.). Calculation of the adjustment points (wdkvabub and wdkvabob), change control to non-amplified poti (udkp1sv = 0) and enter setpoint for upper adjustment point (wdkada_w = wdkvabob).

Adaptation step 7 (lrnstep_c = 7):

After a waiting time (lrntim_c >= LRNST7_T), the actual values are read in the upper adjustment point (udkp1rob and udkp1vrob). The amplified actual value is checked for plausibility (UDKP1VOSC). In case of a fault the gain adj. abort function is executed.

Adaptation step 8 (lrnstep_c = 8):

Enter setpoint for lower adjustment point (wdkada_w = wdkvabub).

Adaptation step 9 (lrnstep_c = 9):

After a waiting time (lrntim_c >= LRNST9_T) the actual values are read in the lower adjustment point (udkp1run and udkp1vrun). The amplified actual value is checked for plausibility (UDKP1VUSC). Thereafter, the gain and the offset are calculated (udkp1vo_w and udkp1vv_w) and checked for plausibility (UDKP1VOMI, UDKP1VOMA, UDKP1VVMI and UDKP1VVMA). To finish off, the switch-over threshold was updated (udkp1sv), gain and offset were written into the permanent RAM (udkp1vor and ukdp1vvr) and the learning success was set. In case of a fault the gain adj. abort function is executed.

Adaptation step 10 (lrnstep_c = 10):

In lrnstep_c = 10, the adapted values are stored in the EEPROM.
If the storage has been successuful lrnstep_c = 11 is set. Has the storage not been successful, the DV-E-Adaption is stopped with lrnstep_c = 10 and the adapted values are then written in the EEPROM during the ECU-after-run. The DV-E-drive is enabled for normal operation (B_dkaden = 0), the injection is enabled (B_dveada = 0) and end of learning is set (B_lrnrdy = 1 und B_lrnakt = 0).

Adaptation step (lrnstep_c = 11):

The storage of the adapted values in the EEPROM has been successful.
The DV-E-drive is enabled for normal operation (B_dkaden = 0),the injection is enabled (B_dveada = 0) and end of learning is set (B_lrnrdy = 1 und B_lrnakt = 0).

UMA abort function:

If no 'initial adaptation' has yet been performed(B_lrnws = 0), irreversible SKA is realized as an output (B_umauab = 1). If an initial adaptation was performed, a basic initialization is performed (udkp1asr_w = UDKP1AURI, udkp2asr_w = UDKP2AURI and dkpstg_w = DKPSTGMIN) in the case of a detected actuator exchange (B_nlpnew = 1) and B_lrnerf = false is set. The permanent RAM values are continued to be transferred to the RAM (udkp1asr_w and ukdp2ar_w) and the settings for the adaptation are reset (B_dkaden, B_dveada, B_lrnrdy and B_lrnakt).

NLP-abort function:

Setting of the NLP-fault (B_nlpe = 1) and settings of adaption reset (B_dkaden, B_dveada,B_lrnrdy und B_lrnakt).

Gain adj. abort function:

Setting of the adjustment fault (B_abgle = 1), prohibit operation with amplified poti signal (udkp1sv = 0) and reset the settings for the adaptation (B_dkaden, B_dveada, B_lrnrdy and B_lrnakt).

5.2   Temporary part
====================

On the DV-E on which the DK enters the bore, the UMA is influenced by the temperature. That means that in case of a setpoint entry << 1 %DK the DK can reach the UMA and that it can therefore be switched to zero current via the DLR range monitoring of the DV-E and the idle control (LLR) can no longer control the idling speed.
For this reason, the UMA is increased in steps resp. decreased again to the learned value.

The offset formation is only permitted, if the engine temperature (tmot) has exceeded a threshold TMSUTMUMA and if the setpoint entry (wdks_w) has undershot a threshold WDKSTMUMA.

A temp. offset is built up, if the DLR output (dlrspid_w with B_dlrspid) exceeds the value DLRPIDSTMN for a time (dlrmxt >= TDLRPIDMX). The offset (udkpat_w) is increased by a delta (DUDKPTMP) in each calculation cycle (50 ms).The offset is stored in the permanent RAM (udkpatr_w).The maximum possible offset is UDKPATMX. As soon as the offset is so large that the DLR is no longer at the limit stop (DLRPIDSTMN), a time difference measurement is started (ttmumad).

If the offset is no longer built up for at least a time (TTMUMASTA), the temporary offset is reduced again. The delta per calculation cycle is DUDKPTMP/4.

As soon as the temp. offset is > 0, the gradient of the actual value potentiometer (dkpstg_w) is corrected, in order to avoid the DK from reaching the upper mechanical limit stop (OMA) when entering a setpoint of 100 %DK. The maximum position the DK reaches, is the upper electrical DK limit stop (OEA).

The state of the temp. offset is indicated in tmpumast.

```
      tmpumast = 0:  no offset formation, resp. offset (udkpat_w) = 0
                 1:  offset for UEA is increased, resp. is > 0
                 2:  offset for UEA is decreased
```

5.3   Resulting part
====================

The resulting UEA is formed from the steady-state UEA and the temporary UEA offset.

The following applies:

```
udkp1a_w := ukdp1as_w + udkpat_w
udkp2a_w := udkp2as_w - udkpat_w
udkp1a   := udkp1a_w
udkp2a   := udkp2a_w
```

6. Blocking of the injection

By means of the system constant SY_DVEADA, it is possible to adjust whether the injection in case the of an adaptation need can be blocked or not by the BGDVE. If blocking is desired, then B_dveada = 1. Via the blocking request (B_dveada = 1) it can be ensured that an adaptation requested via the DV-E exchange detection can definitely be performed by the system in spite of a starting attempt.

7. DV-E adaptation by tester request

The learning of the NLP, UMA and of the gain adjustment can in addition be triggered by a tester request. For this, the B_lrndia must be set to 1. The adaption can only be activated again by the tester, if a transition B_lrndia = true -> false -> true has been executed. During a SG-cycle ON it is allowed, that the DV-E adaption can be started repeatedly. To ensure that, if a currently running adaption is interrupted by tester request, adaption will run again correctly udkp1sv = UPVGNENN / UDKPVID - UDKP1DUS is initialized.

In the case of a conditional compilation with SY_TWDKS = 1 for adaption, at the end of the intake manifold module test, the environmental conditions for the adaption by tester request are left out if B_lrnwt = 1.(B_lrnwt = 1 only exists for SY_TWDKS = 1).

Also see chapter 6 . ’Blocking of the injection’.

8. Permanent RAM and EEPROM storage

The following RAM-cells are stored in the permanent RAM and in the EEPROM:

RAM	Permanent RAM	EEPROM
B_lrnerf	B_lrnerf	yes
B_lrnws	B_lrnws	yes
tnachl_w	tnachl_w	--
udknlp1	udknlp1r	yes
udknlp2	udknlp2r	yes
udkpat_w	udkpatr_w	--
udkp1as_w	udkp1asr_w	yes
udkp1vo_w	udkp1vor	yes
udkp1vv_w	udkp1vvr	yes
udkp2as_w	udkp2asr_w	yes
wdknlp_w	wdknlpr_w	yes

APP BGDVE 3.110 Application hint

1. Deactivation of parts of the function

When switching off the following parts of the functions, it must be noted that an initial adaptation cannot be performed correctly.

Label	Passive value	deactivated ...
CWDVEFO	0	Open spring check
DUDKNLPO	5 V	NLP check and learning (DV-E exchange detection)
DUDKNLPU	5 V	dto.
FPRAT	143.25 °C	DV-E spring check (open,return)
LRNVB_T	FFFF (=1310.72 s)	UMA-learning in case of repetition
UAN_U_MT	143.25 °C	UMA learning and gain adjustment
TMSUTMUMA	143.25 °C	temp. UMA adaptation
WDKSTMUMA	0 %DK	dto.

2. Check of the DV-E return spring

The engine speed threshold FPRNMAX should be adjusted such that when turning the starter, the threshold is not exceeded without injection. Thus it is ensured that in the case of DV-E exchange detection and simultaneous prohibition of the injection, see chapter 6 of the function description, the DV-E adaptation is performed correctly.

3. Learning of the UMA and gain adj.

The engine speed threshold UANNMAX should be adjusted such that when turning the starter, the threshold is not exceeded without injection. Thus it is ensured that in the case of DV-E exchange detection and simultaneous prohibition of the injection, see chapter 6 of the function description, the DV-E adaptation is performed correctly.

4. Temporary UEA adaptation
============================

An increase of the offset must take place so quickly that the DV-E-ES does not come into the temperature deactivation. The decrease of the offset is performed slower by a factor of 4. This value cannot be adjusted. That means, that the ramp-step may not be less than 4 increments, corresponds to 4,884 mV. The maximum permitted offset is determined by means of the parameter calculation program (see ANM). The time, after which a decrease of the offset is permitted (TTMUMASTA), should be roughly adjusted to the cooling behaviour of the DV-E. The value is preset to 2 minutes.

5. DV-E exchange detection
===========================

The time TDKNACH to avoid an incorrect DV-E exchange detection in case of a quick change of the ignition ON -> OFF -> ON should be adjusted such that during this time the throttle valve can definitely stabilize in the NLP. When using a DV-E5, this time should not be less than 2 s. It must be ensured that the min. ECU after-run time TNLSGMN in the function MOTAUS is greater than TDKNACH.

For the extended DV-E exchange detection, a DK-setpoint of wdks_w < 4.7%DK should be fixed in characteristic map FPWDKAPP for wped = 0.

6. Air for the limphome position (NLP) of the DV-E
===

The data made available by the DCM file assume a DV-E with a standard NLP of 5 DK over UMA. If the NLP diameter is changed, the parameters DUDKNLPU, DUDKNLPO, WDKPFPRZ1, WDKPFPRZ2, WDKNLPMI and WDKNLPMA need to be adjusted. For the adjustment the K3/ESI1-tolerance calculation should be used.

7. Blocking of the injection
=============================

So that a complete DV-E adaptation is performed when a DV-E exchange is detected with the ignition ON, the system constant SY_DVEADA should generally be set = 1. If the injection is not prohibited with detected DV-E exchange, no DV-E basic adaptation is performed when the engine is started and therefore initialization values are loaded for the continued trip. --> idle speed fluctuations are possible.

8. Selection of the DK-diameter for a good idle behaviour/
==
Consideration of additional air leakage in the system
==

It generally applies: the larger the DK-diameter, the smaller are the desired DK-angles for the idle control. Possibly occuring addtional air leakage sources in the system must be considered. Therefore the DK-diameter should not be too large compared to the displacement.

With this strategy variations between 0 %DK and 1 %DK during idling can be avoided. (this is acceptable from the point of view of the DV-E-control, however, some customers do not accept it.)

A reduction of the offset UDKPAOFF between UMA and UEA to minimize air leakage is not permitted!

9. Other
=========

With changes of the DV-E dynamics, such as e.g. shortened setting times, the functions DV-E spring check, UMA learning and the gain adjustment need to be checked. Please also pay attention to the block ANM!

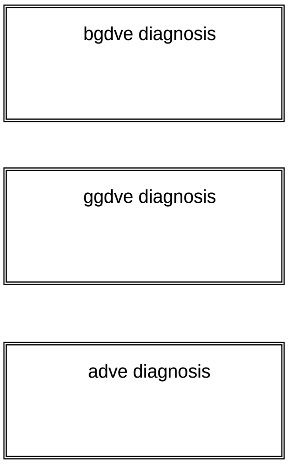
DDVE 7.30 Diagnosis: EGAS-Actuator DV-E

FDEF DDVE 7.30 Function definition

1. Introduction
================

In block diagrams fault type information as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path XYZ back into the central diagnostic management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths, which occur as inputs, access methods are available, which read these pieces of information directly from the fault path status managed in the DFPM.

2. Fault paths
===============

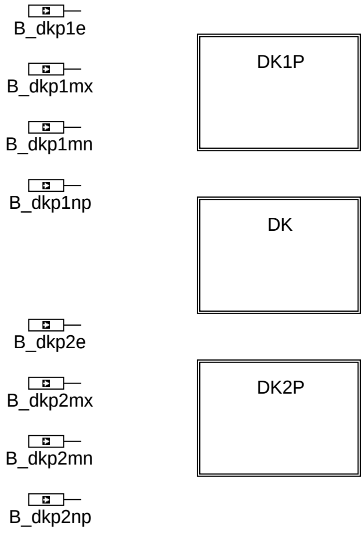


ddve-main

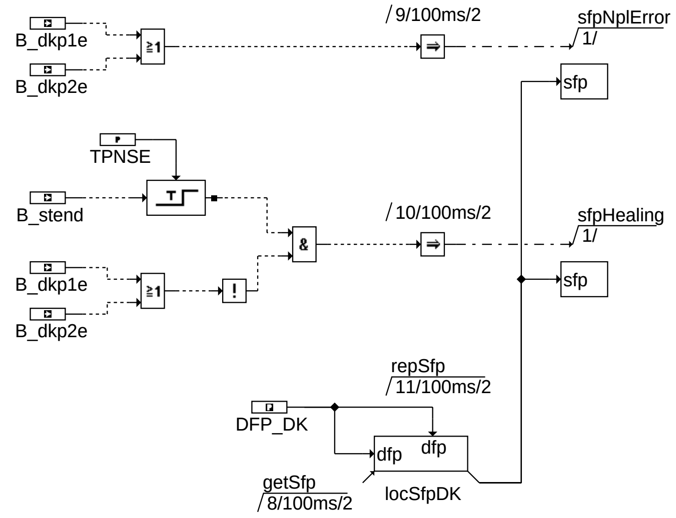
```
2.1 Function GGDVE
==================

For each fault path x = DK, DK1P or DK2P of this diagnostic function the following
variables have been defined:

    Status fault path x:          sfpx
       Error flag x:                E_x
       Cycle flag x:                Z_x
       Fault type x:                TYP_x: (B_mxx, B_mnx, B_six, B_npx)
       Clear fault path:              B_clx
       Default value active:          B_bkx (optional)
    Fault path code x:            CDTX
    Fault class x:                CLAX
    Fault severity x:             TSFX
    CARB code x:                  CDCX
    Table of ambient cond. x:     FFTX
```

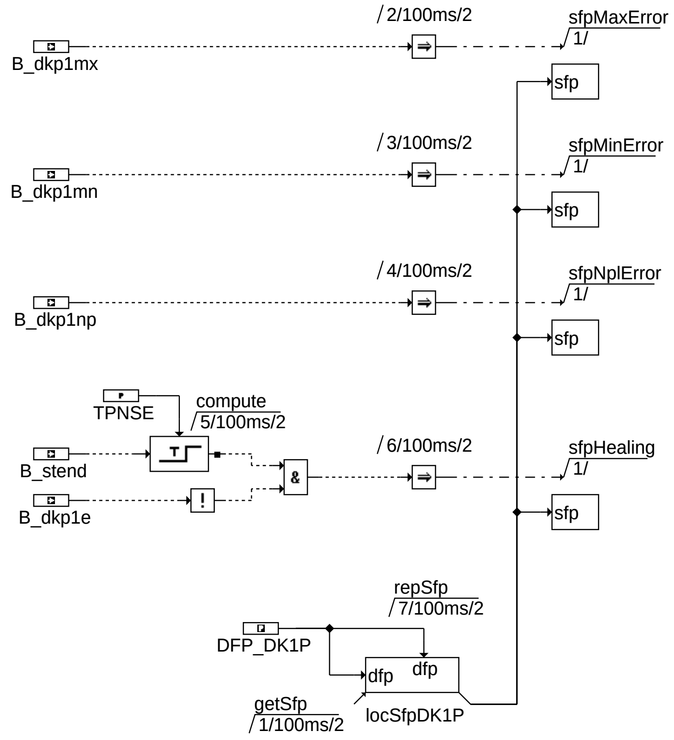


ddve-ggdve-diag



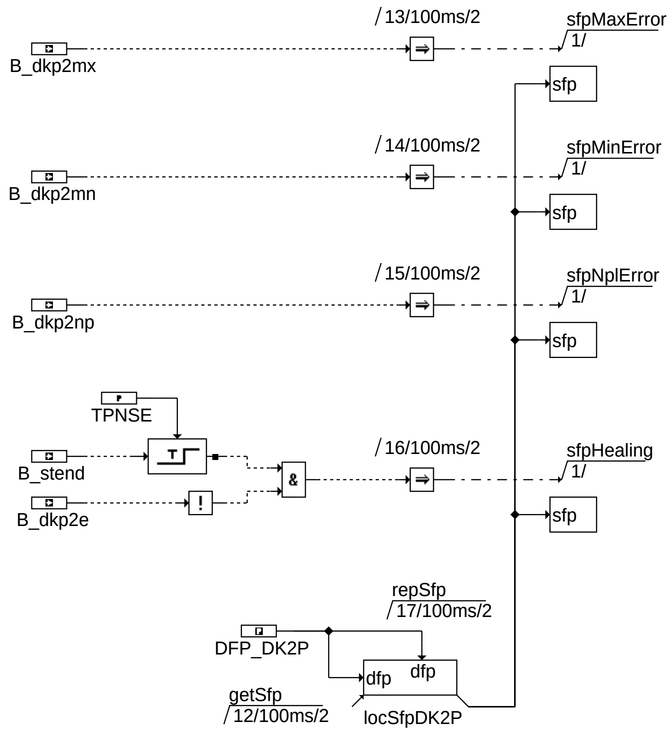
ddve-dk

ddve-dk



ddve-dk1p

ddve-dk1p

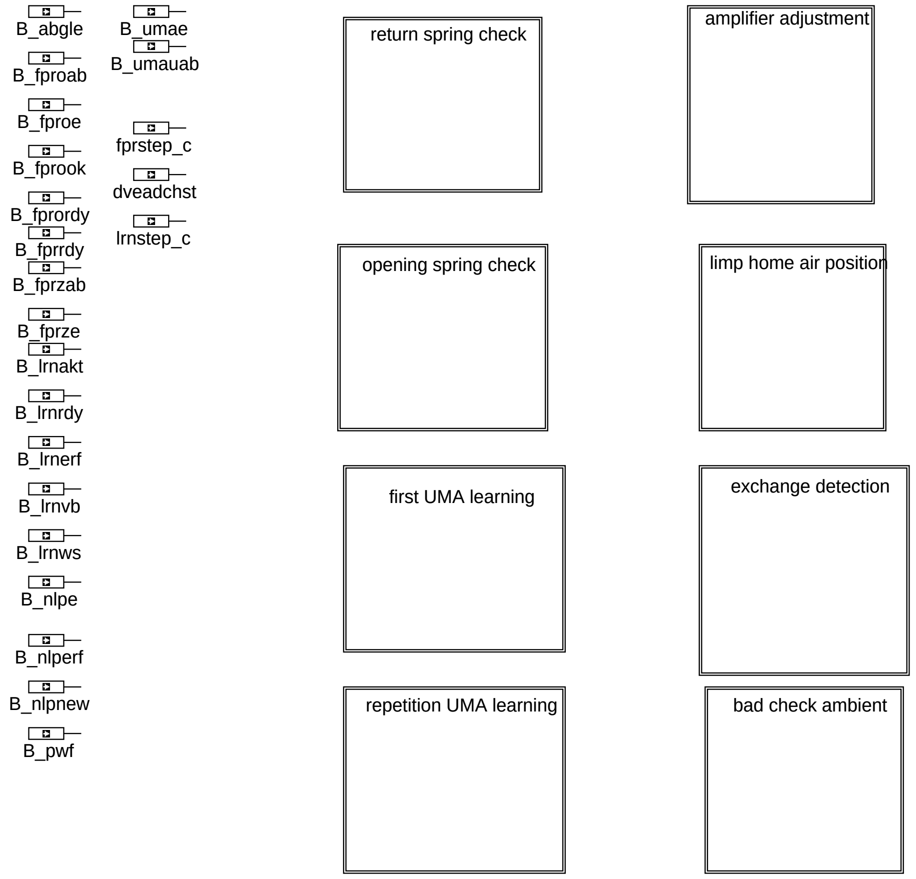


ddve-dk2p

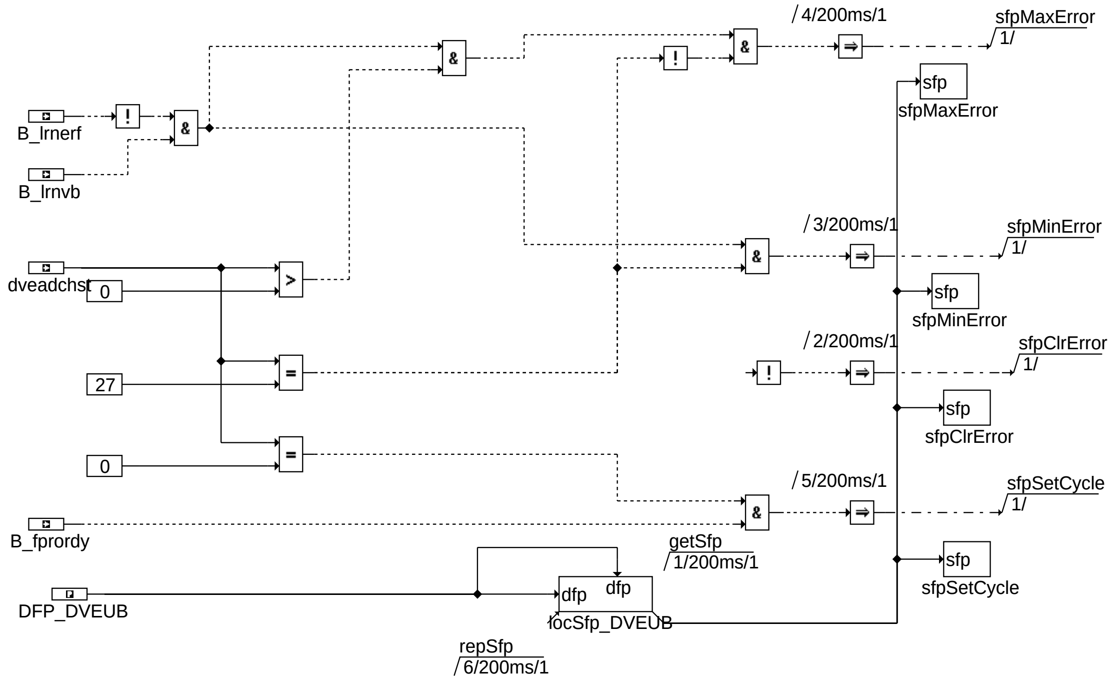
```
2.2 Function BGDVE
==================

For each fault path x = DVEF, DVEFO, DVEN, DVET, DVEV, DVEU, DVEUW or DVEUB of this
diagnostic function the following variables have been defined:

    Status fault path x:          sfpx
       Error flag x:                E_x
       Cycle flag x:                Z_x
       Fault type x:                TYP_x: (B_mxx, B_mnx, B_six, B_npx)
       Clear fault path:              B_clx
       Default value active:          B_bkx (optional)
    Fault path code x:            CDTX
    Fault class x:                CLAX
    Fault severity x:             TSFX
    CARB code x:                  CDCX
    Table of ambient cond. x:     FFTX
```

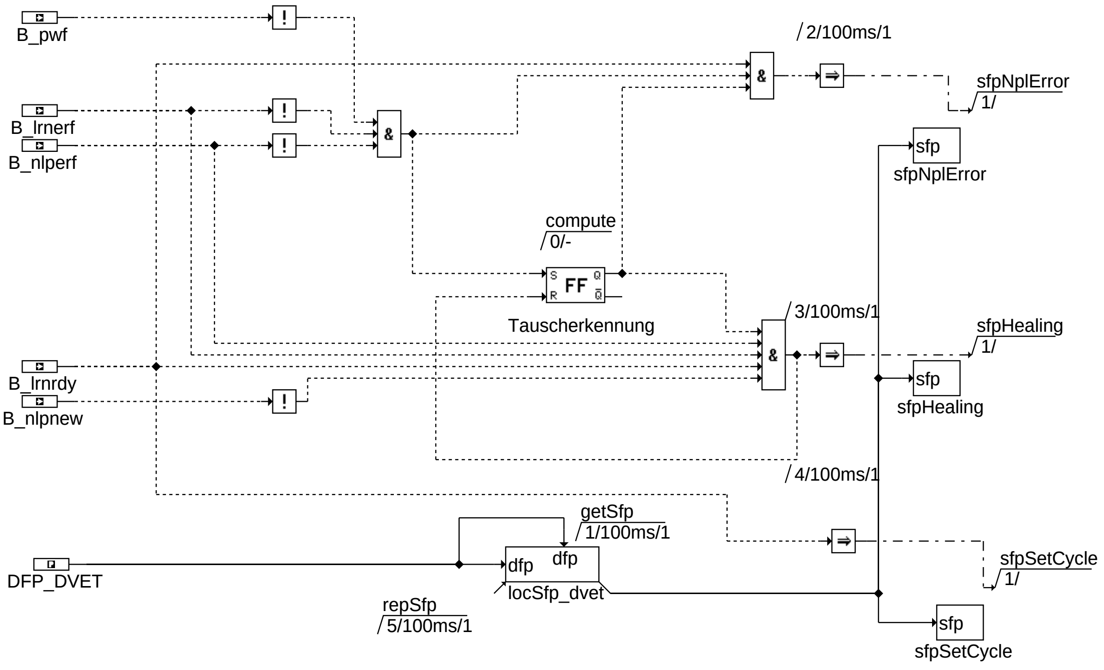


ddve-bgdve-diag



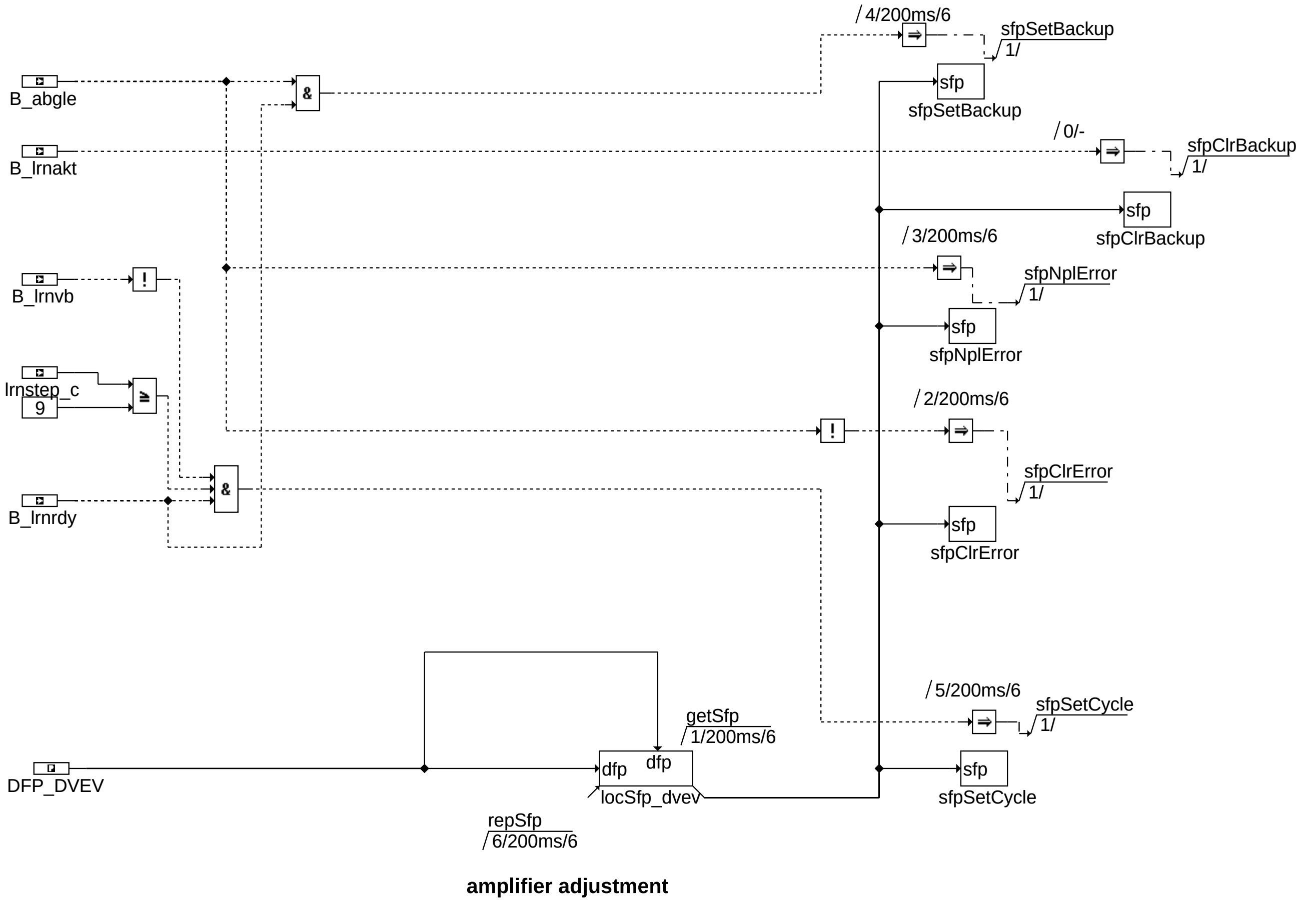
bad check ambient

ddve-bad-check-



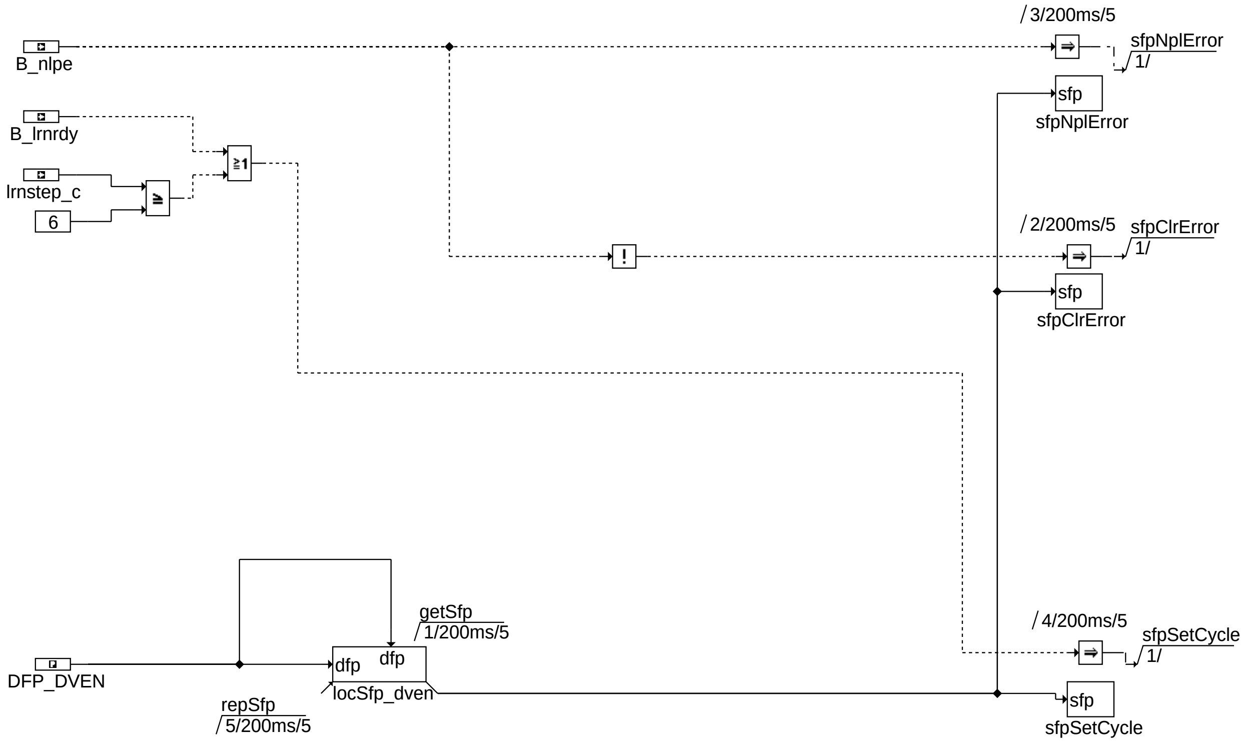
exchange detection

ddve-exchange-d



amplifier adjustment

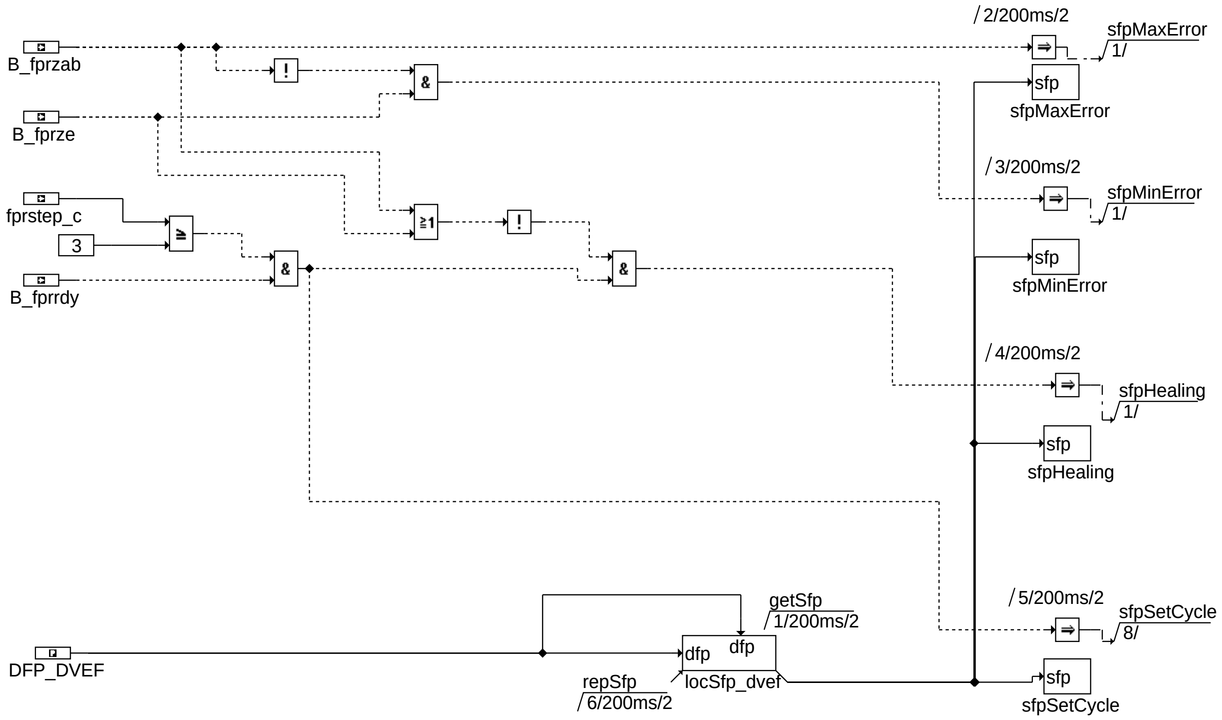
ddve-amplifier-



limp home air position

ddve-limp-home-

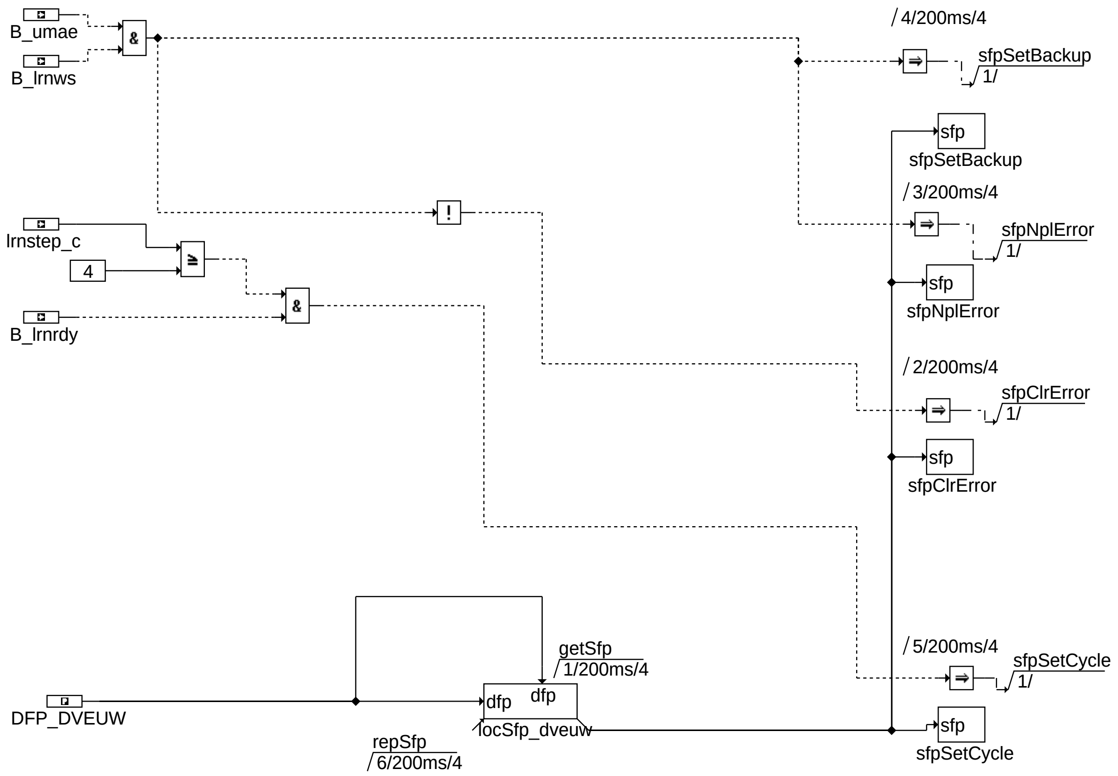
ddve-limp-home-



return spring check

ddve-return-spr

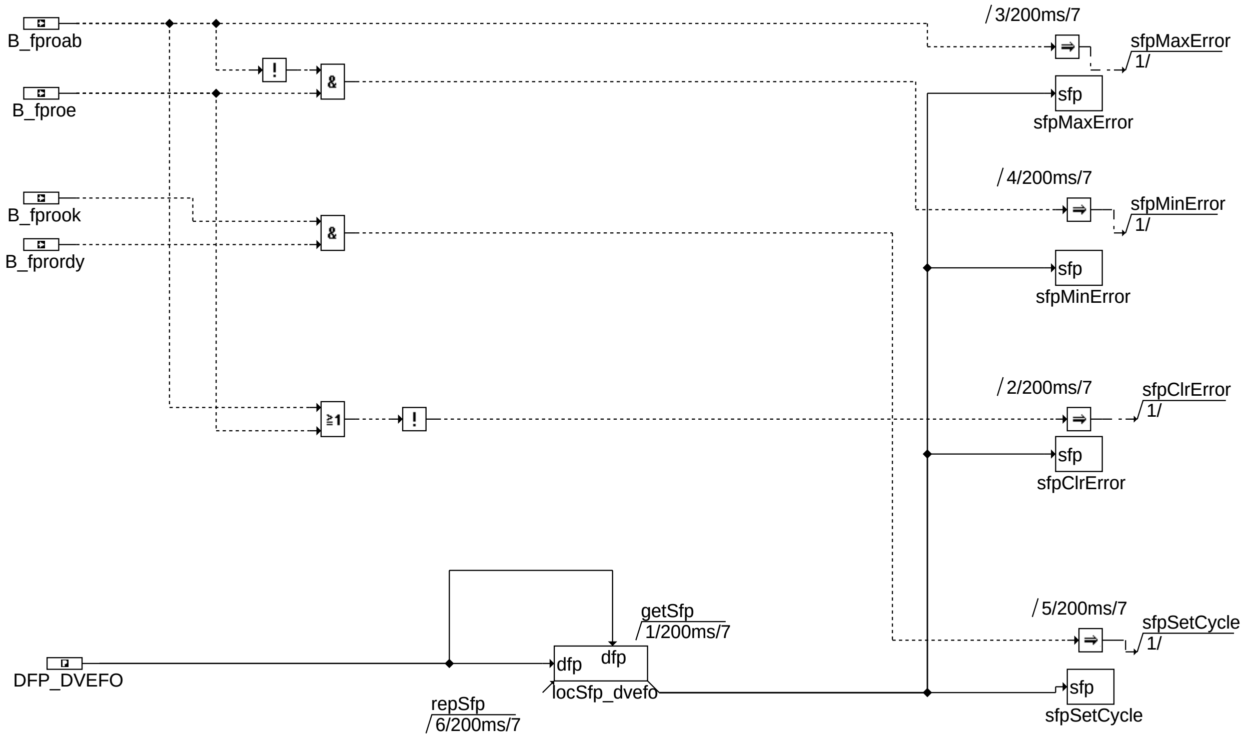
ddve-return-spr



repetition UMA learning

ddve-repetition

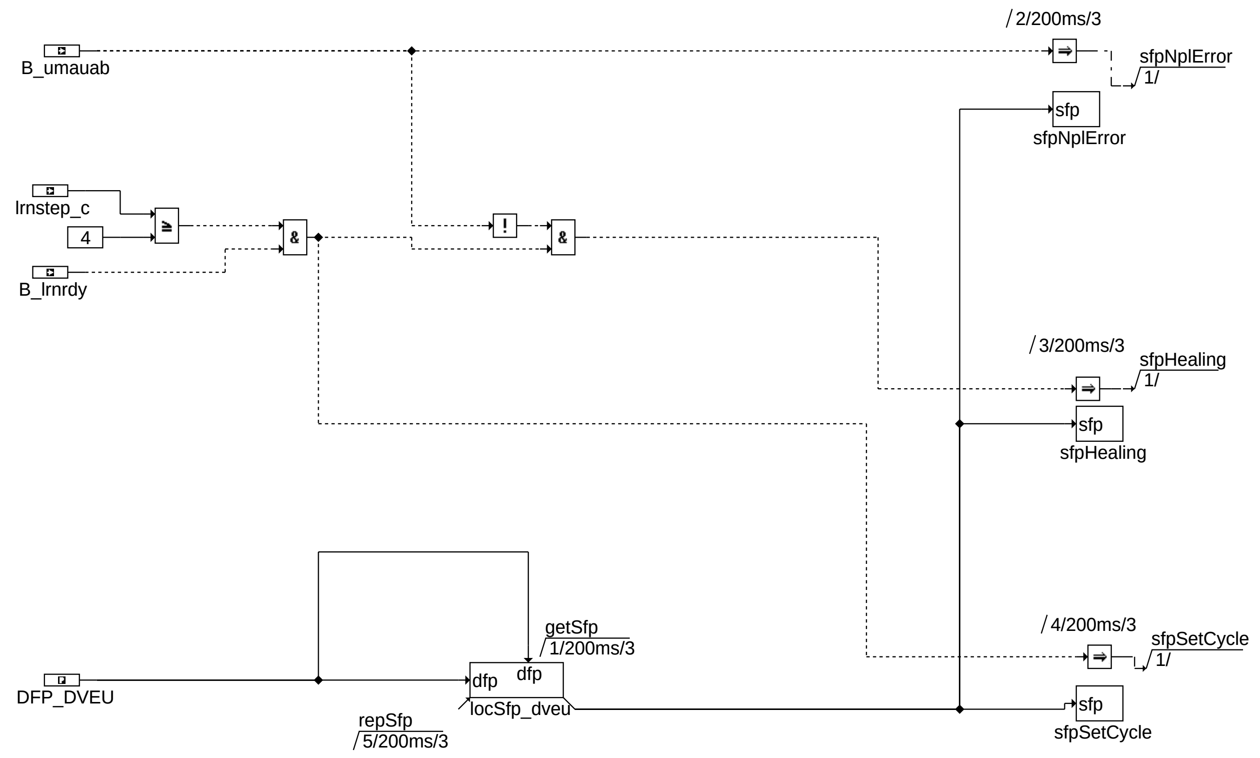
ddve-repetition



opening spring check

ddve-opening-sp

ddve-opening-sp



first UMA learning

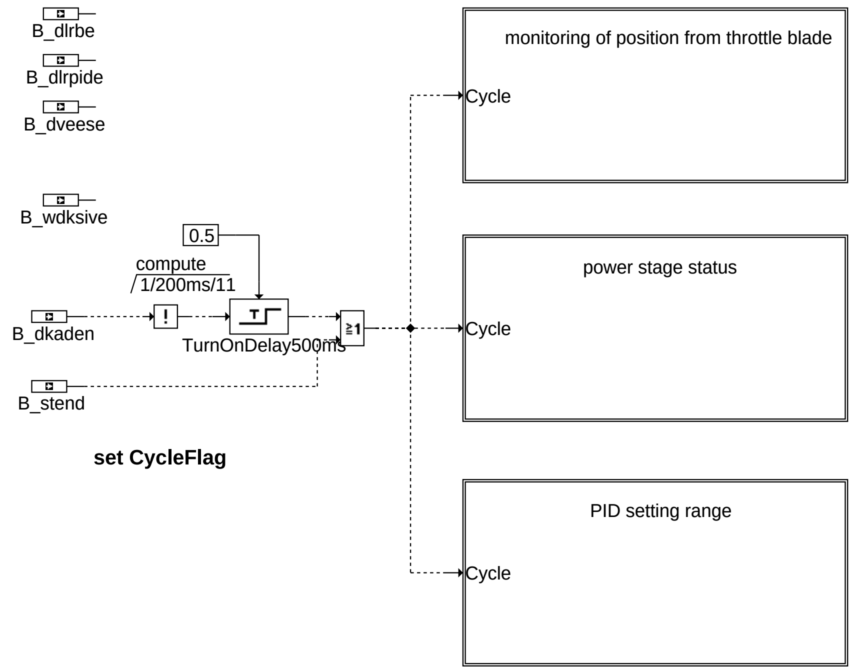
ddve-first-uma-

ddve-first-uma-

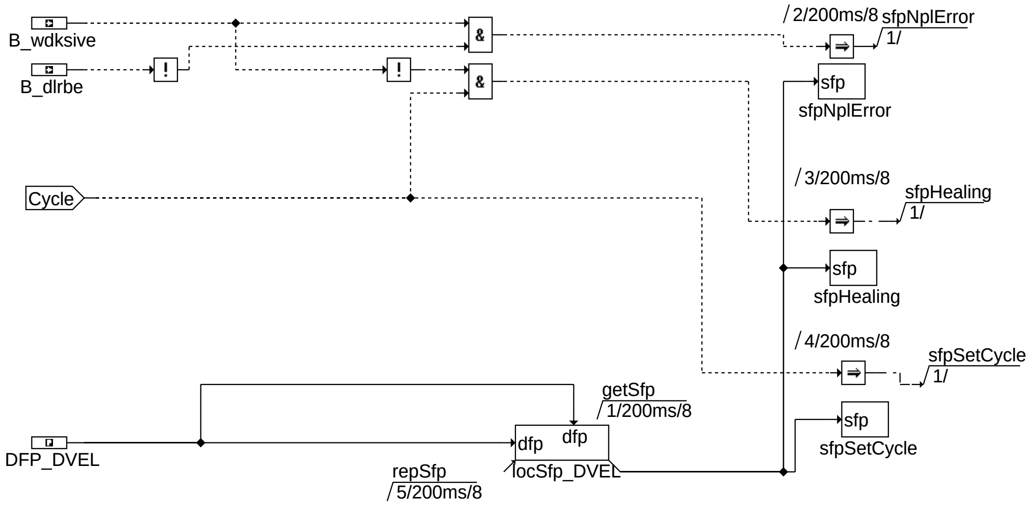
```
2.3 Function ADVE
=================

For each fault path x = DVEL, DVEE or DVER of this diagnostic function the following
variables have been defined:

    Status fault path x:          sfpx
       Error flag x:                E_x
       Cycle flag x:                Z_x
       Fault type x:                TYP_x: (B_mxx, B_mnx, B_six, B_npx)
       Clear fault path:              B_clx
       Default value active:          B_bkx (optional)
    Fault path code x:            CDTX
    Fault class x:                CLAX
    Fault severity x:             TSFX
    CARB code x:                  CDCX
    Table of ambient cond. x:     FFTX
```

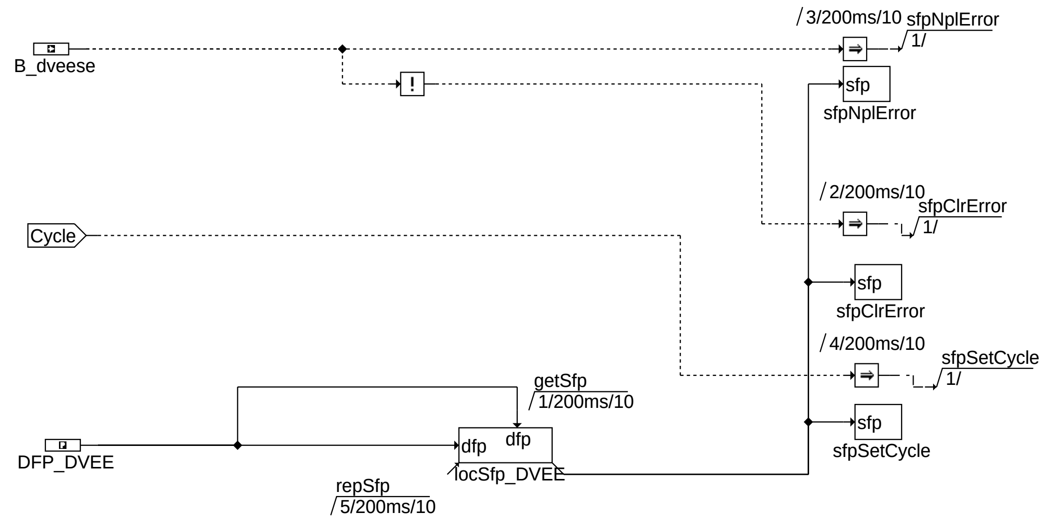


ddve-adve-diagn



monitoring of position from throttle blade

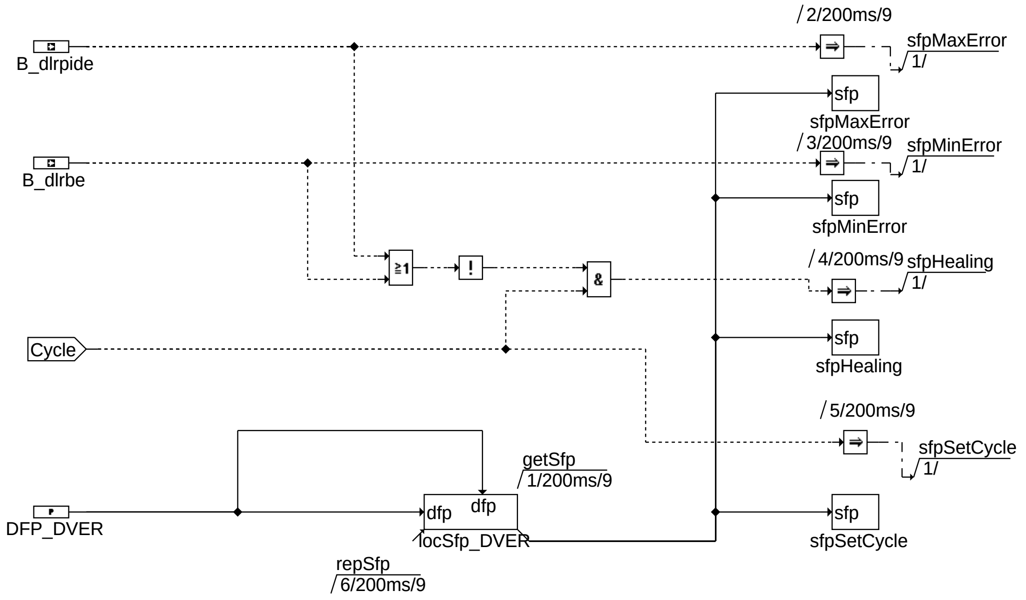
ddve-monitoring



ddve-power-stag

power stage status

ddve-power-stag

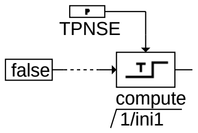


ddve-pid-settin

PID setting range

ddve-pid-settin

```
3.  Initialization
=================
3.1 Function GGDVE
=================
```



ddve-init

ddve-init

ABK DDVE 7.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TPNSE			FW	Test time after start end for DVE diagnostic routine

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_ABGLE	BGDVE	EIN	Condition: Error during amplifier adjustment
B_BKDVEN	DDVE	LOK	Backup value activated: DV-E limphome air position
B_BKDVEU	DDVE	LOK	Backup value activated: DV-E UMA-learning
B_BKDVEUW	DDVE	AUS	Condition default value active: Fault during relearning of UMA
B_BKDVEV	DDVE	AUS	Backup value activated: DV-E amplifier adjustment
B_CLDVEF		EIN	Flag for clearance: DV-E cause of failure: spring check
B_CLDVEFO		EIN	Flag for detection: Fault in spring test ”Open”
B_CLDVEN		EIN	Flag for clearance: DV-E cause of failure: limphome air position
B_CLDVEU		EIN	Flag for clearance: DV-E cause of failure: UMA-learning
B_CLDVEUW		EIN	Flag for deletion: Fault during UMA re-learning
B_CLDVEV		EIN	Flag for clearance: DV-E cause of failure: amplifier adjustment
B_DKADEN	BGDVE	EIN	Condition: Use DK setpoint from DK adaptation and DK check
B_DKP1E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 1
B_DKP1MN	GGDVE	EIN	Condition lower-range violation DK potentiometer 1
B_DKP1MX	GGDVE	EIN	Condition upper-range violation DK potentiometer 1
B_DKP1NP	GGDVE	EIN	Condition signal DK potentiometer 1 not plausible
B_DKP2E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 2
B_DKP2MN	GGDVE	EIN	Condition: lower-range violation DK potentiometer 2
B_DKP2MX	GGDVE	EIN	Condition: upper-range violation DK potentiometer 2
B_DKP2NP	GGDVE	EIN	Condition: signal DK potentiometer 2 not plausible
B_DLRBE	ADVE	EIN	Condition: DLR correction range exceeded
B_DLRPIDE	ADVE	EIN	Condition: Fault, DLR correction range at limit
B_DVEESE		EIN	Condition: DV-E power stage fault
B_FPROAB	BGDVE	EIN	Condition: Abort of DV-E open spring check, spring does not open
B_FPROE	BGDVE	EIN	Condition: Opening spring test fault
B_FPROOK	BGDVE	EIN	Condition: Opening spring test OK
B_FPRORDY	BGDVE	EIN	Condition: Opening spring test completed
B_FPRRDY	BGDVE	EIN	throttle return spring check ended
B_FPRZAB	BGDVE	EIN	Condition: Abort of DV-E return spring check, spring does not close
B_FPRZE	BGDVE	EIN	Condition: Error in the DV-E return spring check
B_LRNAKT	BGDVE	EIN	learning active bit
B_LRNERF	BGDVE	EIN	learning success bit
B_LRNRDY	BGDVE	EIN	learning complete
B_LRNVB	BGDVE	EIN	learning prohibition bit
B_LRNWS	BGDVE	EIN	learned value save bit
B_MNDK	DDVE	LOK	error type: short circuit to ground throttle potentiometer
B_MNDK1P	DDVE	LOK	Fault type min.: Throttle valve 1. Poti
B_MNDK2P	DDVE	LOK	Fault type min.: Throttle valve 2. Poti
B_MNDVEE	DDVE	LOK	error typ min.: DV-E power stage
B_MNDVEF	DDVE	AUS	Fault typ min.: DV-E cause of failure: spring open check
B_MNDVEFO	DDVE	AUS	error typ min.: cause of failure: spring check ”open”
B_MNDVEL	DDVE	LOK	error typ min.: DV-E position deviation
B_MNDVEN	DDVE	LOK	Fault typ min.: DV-E cause of failure: limphome air position
B_MNDVER	DDVE	LOK	Fault type min.: DV-E control range, exceeded for a short time
B_MNDVEU	DDVE	LOK	Fault typ min.: DV-E cause of failure: UMA-learning
B_MNDVEUB	DDVE	LOK	error typ min.: end of DV-E adaption because of ambient conditions
B_MNDVEV	DDVE	LOK	Fault typ min.: DV-E cause of failure: amplifier adjustment
B_MXDK	DDVE	LOK	error type: short circuit to Ubat throttle potentiometer
B_MXDK1P	DDVE	LOK	Fault type max.: Throttle valve 1. Poti
B_MXDK2P	DDVE	LOK	Fault type max.: Throttle valve 2. Poti
B_MXDVEE	DDVE	LOK	error type max.: DV-E power stage
B_MXDVEF	DDVE	AUS	Fault typ max.: DV-E cause of failure: spring return check
B_MXDVEFO	DDVE	AUS	error type max.: cause of failure:spring check ”open”
B_MXDVEL	DDVE	LOK	error type max.: DV-E position deviation
B_MXDVEN	DDVE	LOK	Fault typ max.: DV-E cause of failure: limphome air position
B_MXDVER	DDVE	LOK	Fault type max.: DV-E control range, violation for a long time
B_MXDVEU	DDVE	LOK	Fault typ max.: DV-E cause of failure: UMA-learning
B_MXDVEUB	DDVE	LOK	Fault type max.: Abort of DV-E-adaptation due to ambient condition
B_MXDVEV	DDVE	LOK	Fault typ max.: DV-E cause of failure: amplifier adjustment
B_NLPE	BGDVE	EIN	Condition: Error in NLP-check and learning
B_NLPERF	BGDVE	EIN	Permanent RAM, condition: NLP acquisition successful
B_NLPNEW	BGDVE	EIN	Condition: NLP position not yet known
B_NPDK	DDVE	LOK	Condition potentiometer signals from throttle valve not plausible
B_NPDK1P	DDVE	LOK	Fault type not plausible: Throttle valve 1. Poti
B_NPDK2P	DDVE	LOK	Fault type not plausible: Throttle valve 2. Poti
B_NPDVEE	DDVE	LOK	Fault type not plausible: DV-E power stage
B_NPDVEF	DDVE	LOK	Fault type not plausible: DV-E failure during spring check

Variable	Source	Type	Description
B_NPDVEL	DDVE	LOK	Fault type not plausible: DV-E position deviation
B_NPDVEN	DDVE	AUS	Fault type npt plausible: DV-E fault in checking the limp-home air position
B_NPDVER	DDVE	LOK	Fault type not plausible: DV-E control range
B_NPDVET	DDVE	LOK	Fault type ”not plausible”: DV-E exchange detection without adaptation
B_NPDVEU	DDVE	AUS	Fault type not plausible: DV-E failure during UMA learning
B_NPDVEUW	DDVE	AUS	Fault type ”not plausible” during relearning of UMA
B_NPDVEV	DDVE	AUS	Fault type not plausible: DV-E failure during amplifier adjustment
B_PWF		EIN	Condition for powerfail
B_SIDK1P	DDVE	LOK	error type: throttle valve potentiometer 1
B_SIDVEE	DDVE	LOK	error type: DV-E power stage
B_SIDVEF	DDVE	LOK	Fault type sig.: DV-E failure during spring check
B_SIDVEL	DDVE	LOK	error type: DV-E position deviation
B_SIDVEN	DDVE	LOK	Fault type sig.: DV-E failure during check of limp-home air position
B_SIDVER	DDVE	LOK	error type: DV-E control range
B_SIDVEU	DDVE	LOK	Fault type sig.: DV-E failure during UMA-learning
B_SIDVEV	DDVE	LOK	Fault type sig.: DV-E failure during amplifier adjustment
B_STEND	BBSTT	EIN	condition end of start
B_UMAE	BGDVE	EIN	Condition: Error during UMA learning
B_UMAUAB	BGDVE	EIN	Condition: UMA learning stopped during first initialization (SKA)
B_WDKSIVE	ADVE	EIN	Condition: Fault in comparing DK angle nominal value/actual value
DFP_DVEE	DDVE	DOK	ECU internal fault-path no.: DV-E output stage
DFP_DVEF	DDVE	DOK	ECU-int. fault-path no.: DV-E failure during spring check
DFP_DVEFO	DDVE	DOK	Fault path: DV-E fault in spring check ”Open”
DFP_DVEL	DDVE	DOK	ECU internal fault-path no.: DV-E position deviation
DFP_DVEN	DDVE	DOK	ECU-internal fault-path no.: DV-E failure during check of limp-home air position
DFP_DVER	DDVE	DOK	ECU-internal fault-path no.: DV-E control range
DFP_DVET	DDVE	DOK	Fault path: DV-E exchange detection without adaptation
DFP_DVEU	DDVE	DOK	ECU-internal fault-path no.: DV-E failure during UMA learning
DFP_DVEUB	DDVE	DOK	Fault path: DV-E adaptation abort because of environmental conditions
DFP_DVEUW	DDVE	DOK	Fault path: UMA re-learning
DFP_DVEV	DDVE	DOK	ECU int. fault path no.: DV-E fault in amplifier adjustment
DVEADCHST	BGDVE	EIN	DV-E adaptation: Status test conditions
E_DK	DDVE	AUS	Error flag: throttle position sensor
E_DK1P	DDVE	AUS	Error flag: Throttle valve 1. Poti
E_DK2P	DDVE	AUS	Error flag: Throttle valve 2. Poti
E_DVEE	DDVE	AUS	Error flag: DV-E power stage
E_DVEF	DDVE	AUS	Error flag: DV-E cause of failure: spring check
E_DVEFO	DDVE	AUS	errror flag: DV-E cause of failure: spring check ”open”
E_DVEL	DDVE	AUS	Error flag: DV-E position deviation
E_DVEN	DDVE	AUS	Error flag: DV-E cause of failure: limphome air position
E_DVER	DDVE	AUS	Error flag: DV-E control range
E_DVET	DDVE	AUS	Errorflag: DV-E-exchange detection
E_DVEU	DDVE	AUS	Error flag: DV-E cause of failure: UMA-learning
E_DVEUB	DDVE	AUS	Error flag: Abort of DV-E adaptation due to ambient condition
E_DVEUW	DDVE	AUS	Error flag: Fault during relearning of UMA
E_DVEV	DDVE	AUS	Error flag: DV-E cause of failure: amplifier adjustment
FPRSTEP_C	BGDVE	EIN	step counter throttle return spring check
LRNSTEP_C	BGDVE	EIN	counter for learning time for a learning step
SFPDK		EIN	Status fault path DK: Throttle valve
SFPDK1P		EIN	Status fault path DK1P: Throttle valve potentiometer 1
SFPDK2P		EIN	Status fault path DK2P: Throttle valve potentiometer 2
SFPDVEE		EIN	Status word: DV-E power stage
SFPDVEF		EIN	Status word: DV-E cause of failure: spring check
SFPDVEFO		EIN	status fault path: DV-E-open spring check
SFPDVEL		EIN	Status word: DV-E position deviation
SFPDVEN		EIN	Status word: DV-E cause of failure: limphome air position
SFPDVER		EIN	Status word: DV-E control range
SFPDVET		EIN	Status fault path: DV-E exchange detection without adaptation
SFPDVEU		EIN	Status word: DV-E cause of failure: UMA-learning
SFPDVEUB		EIN	Status fault path: Abort of DV-E adaptation due to ambient condition
SFPDVEUW		EIN	Status fault path: UMA relearning
SFPDVEV		EIN	Status word: DV-E cause of failure: amplifier adjustment
Z_DK	DDVE	AUS	cycle flag: throttle position potentiometer
Z_DK1P	DDVE	AUS	Cycle flag: Throttle valve 1. Poti
Z_DK2P	DDVE	AUS	Cycle flag: Throttle valve 2. Poti
Z_DVEE	DDVE	AUS	Cycle flag: DV-E power stage
Z_DVEF	DDVE	AUS	Cycle flag: DV-E cause of failure: spring check
Z_DVEFO	DDVE	AUS	Cycle flag: DV-E fault for spring test ”Open”
Z_DVEL	DDVE	AUS	Cycle flag: DV-E position deviation
Z_DVEN	DDVE	AUS	Cycle flag: DV-E cause of failure: limphome air position
Z_DVER	DDVE	AUS	Cycle flag: DV-E control range
Z_DVET	DDVE	AUS	Cycle flag: DV-E exchange detection without adaptation
Z_DVEU	DDVE	AUS	Cycle flag: DV-E cause of failure: UMA-learning
Z_DVEUB	DDVE	AUS	Cycle flag: Abort of DV-E adaptation due to ambient condition
Z_DVEUW	DDVE	AUS	Cycle flag: Fault during relearning of UMA
Z_DVEV	DDVE	AUS	Cycle flag: DV-E cause of failure: amplifier adjustment

FW DDVE 7.30 Fixed Values

Parameter	Value	Description
TPNSE		Test time after start end for DVE diagnostic routine

FB DDVE 7.30 Detailed description of function

```
1.  Diagnosis
=============

1.1 Function GGDVE
==================

Three fault paths were defined for the workshop and CARB diagnosis.

    - Path ’DK’:   Indicates that one poti is faulty and that the other poti is plausible to the
                   default signal from load and speed
                   or that both potentiometers are not plausible.
    - Path ’DK1P:  Indicates that poti 1 is faulty.
    - Path ’DK2P:  Indicates that poti 2 is faulty.

1.2 Function BGDVE
==================

Eight fault paths were defined for the workshop and CARB diagnosis.

    - Path ’DVEF’:  Indicates that the DV-E return spring check was performed incorrectly.
    - Path ’DVEFO’: Indicates that the check of the just opening DV-E spring was performed incorrectly.
    - Path ’DVEN’:  Indicates that the detected limp-home air position is incorrect.
    - Path ’DVET’:  Indicates that at detected DV-E exchange no new adaptation was performed.
    - Path ’DVEV’:  Indicates that the gain adjustment was performed incorrectly.
    - Path ’DVEU’:  Indicates that UMA-learning was performed incorrectly during the initial initialization.
    - Path ’DVEUW’: Indicates that UMA-learning was performed incorrectly during repetition.
    - Path ’DVEUB’: Indicates that UMA-learning was aborted due to violated input conditions.

1.3 Function ADVE
=================

Three fault paths were defined for the workshop and CARB diagnosis.

    - Path ’DVEL’: Indicates that the throttle valve of the DV-E does not reach the desired position any longer
    - Path ’DVEE’: Indicates that the DV-E output stage has deactivated, e.g. due to excess temperature, excess
                   current or undervoltage
    - Path ’DVER’: Indicates that the DLR lies outside of the valid control range.
```

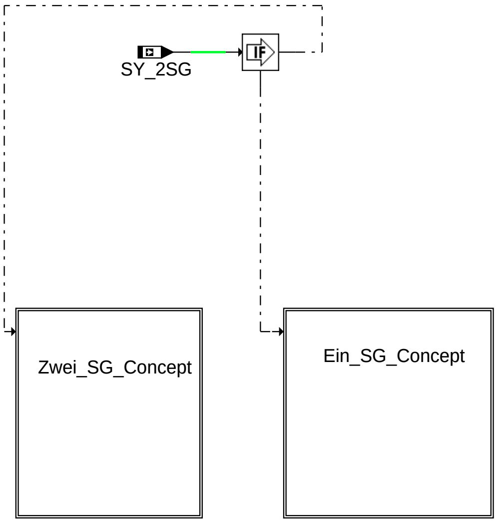
APP DDVE 7.30 Application hint

SREAKT 10.10 EGAS: safety concept, failure reactions

FDEF SREAKT 10.10 Function definition

```
1.  Fault Coordination of the DV-E Triggering
=============================================

1.1 During Operation
====================
```

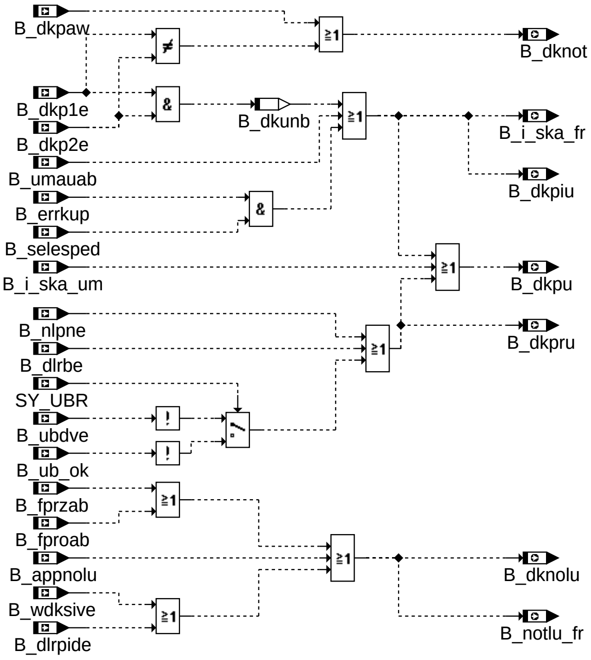


sreakt-sreakt

Fehlerreaktion

sreakt-sreakt

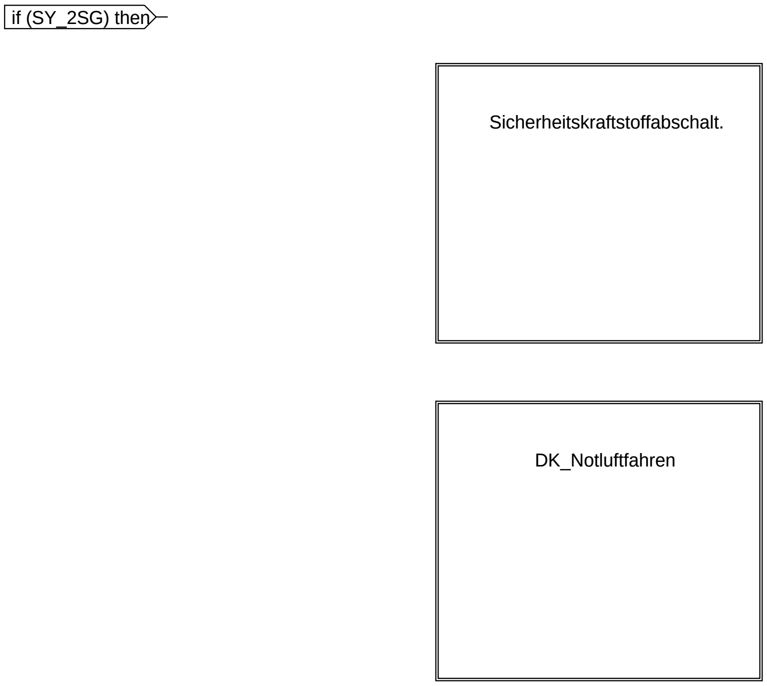
if (SY_2SG = false) then



Fehlerreaktion 1_SG_Concept

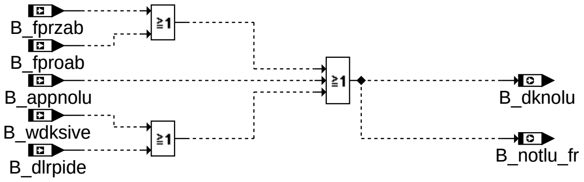
sreakt-ein-sg-concept

sreakt-ein-sg-concept



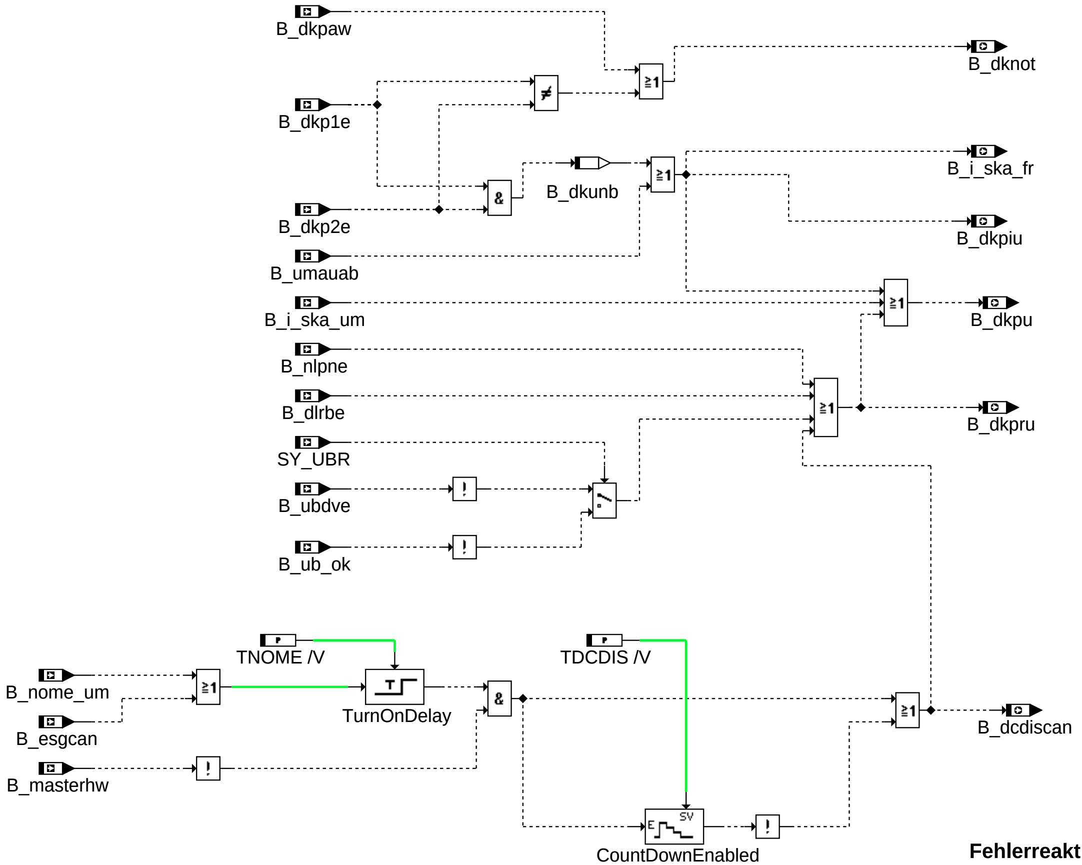
Fehlerreaktion_2_SG_Concept

sreakt-zwei-sg-concept



Fehlerreaktion 2_SG_Concept DK-Notluftfahren

sreakt-dk-notluftfahren

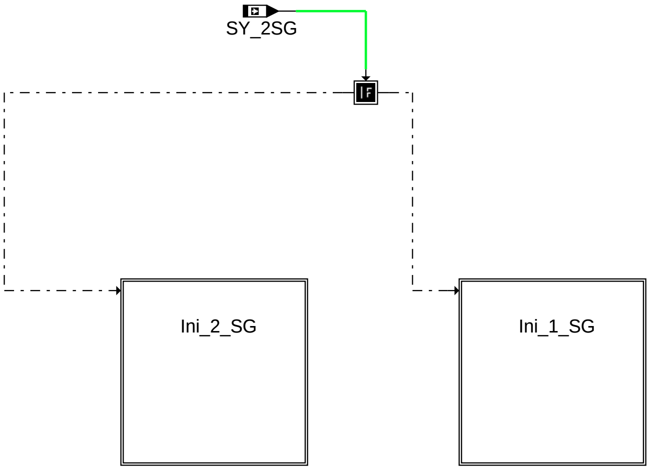


Fehlerreaktion 2_SG_Concept
Sicherheitskraftstoffabschaltung

sreakt-sicherheitskraftstoffabschalt.

sreakt-sicherheitskraftstoffabschalt.

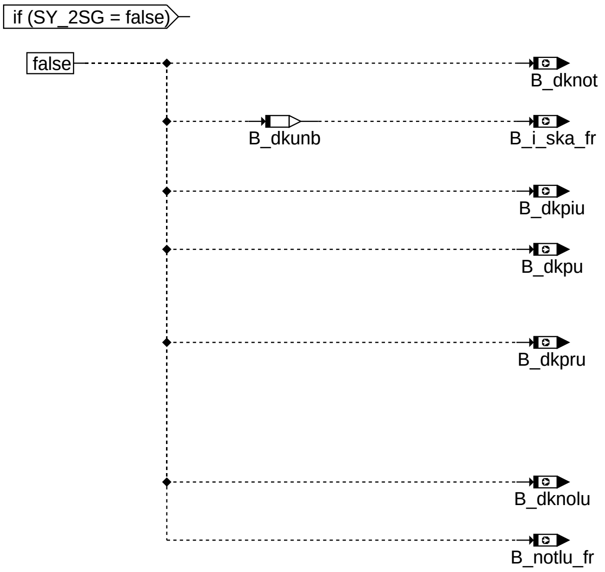
```
1.1 Initialization
==================
```



Initialisierung

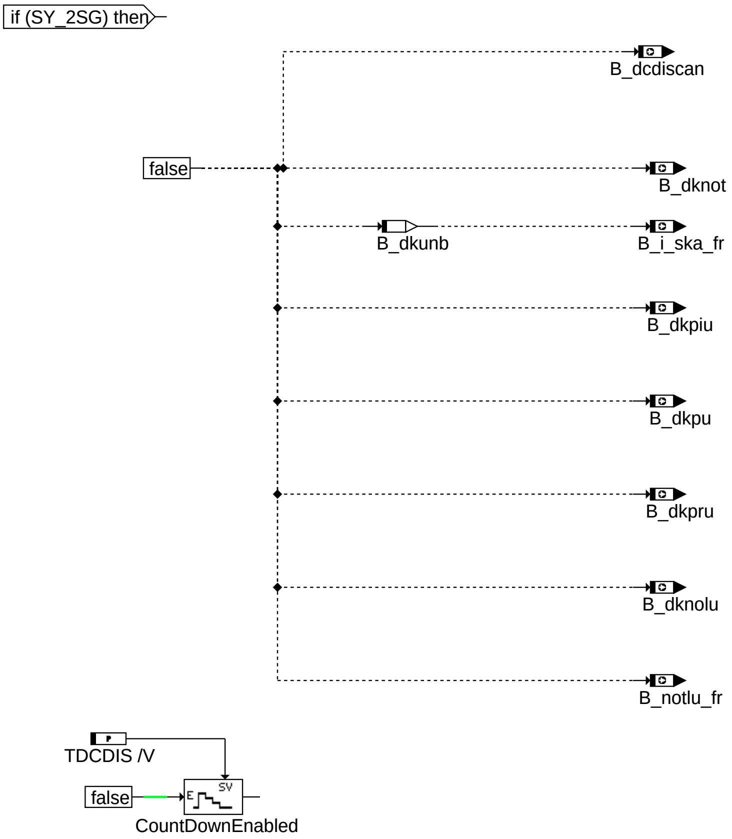
sreakt-init

sreakt-init



Initialisierung für 1_SG

sreakt-ini-1-sg



Initialisierung für 2_SG

sreakt-ini-2-sg

```
2. Fault of the Pedal Sensor
============================

    cf. GGPEDx.y
```

ABK SREAKT 10.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TDCDIS			FW	Debouncing time for irreversible SKA in case of CAN fault
TNOME			FW	Debouncing time for idle presetting value in case of CAN fault

Variable	Source	Type	Description
B_APPNOLU	ADVE	EIN	Condition: Throttle limp-home air driving requested by application
B_DCDISCAN	SREAKT	AUS	Condition: DV-E power-stage-switch-off because of CAN-ERROR
B_DKNOLU	SREAKT	AUS	condition: power supply of throttle actuator cut off
B_DKNOT	SREAKT	AUS	condition: continued operation with a single remaining throttle actuator poti
B_DKP1E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 1
B_DKP2E	GGDVE	EIN	condition: defect in throttle actuator potentiometer 2
B_DKPAW		EIN	Condition DK-potentiometer selection for DK-sensor standby operation
B_DKPIU	SREAKT	AUS	Condition: irreversible SKA
B_DKPRU	SREAKT	AUS	Condition: reversible SKA
B_DKPU	SREAKT	AUS	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKUNB	SREAKT	LOK	condition: unknown throttle blade position
B_DLRBE	ADVE	EIN	Condition: DLR correction range exceeded
B_DLRPIDE	ADVE	EIN	Condition: Fault, DLR correction range at limit
B_ERRKUP	DVKUP	EIN	Condition: engine switch-off cansed by electronic clutch
B_ESGCAN		EIN	Condition error ecu-CAN for 2 ME-ecu's
B_FPROAB	BGDVE	EIN	Condition: Abort of DV-E open spring check, spring does not open
B_FPRZAB	BGDVE	EIN	Condition: Abort of DV-E return spring check, spring does not close
B_I_SKA_FR	SREAKT	AUS	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_NLPNE	ADVE	EIN	Condition: NLP not reached for DK standby trip
B_NOME_UM	UFMER	EIN	Condition replacement values are used caused by failures in the recieved massage
B_NOTLU_FR	SREAKT	AUS	Request for NFB from Function controller
B_SELESPED		EIN	condition: car with selespeed
B_UBDVE	ADVE	EIN	Condition: Battery voltage for DV-E control OK
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_UMAUAB	BGDVE	EIN	Condition: UMA learning stopped during first initialization (SKA)
B_WDKSIVE	ADVE	EIN	Condition: Fault in comparing DK angle nominal value/actual value
SY_2SG	PROKON	EIN	system constant 2 motronic systems
SY_UBR	PROKON	EIN	system constant onboard battery voltage scanned from main relay input

FW SREAKT 10.10 Fixed Values

Parameter	Value	Description
TDCDIS		Debouncing time for irreversible SKA in case of CAN fault
TNOME		Debouncing time for idle presetting value in case of CAN fault

FB SREAKT 10.10 Detailed description of function

Task of the function is the evaluation of the fault states, which are generated in the modules of the DV-E triggering (cf. DVEUE2.x). These resulting faults start appropriate default functions dependent on the detected fault (throttle poti limp-home driving, throttle limp-home air driving or safety fuel deactivation).

For the application of the throttle limp-home air driving, the throttle limp-home air driving can be triggered in the function ADVE3.x via a code word. The bit B_appnolu is then set.

Faults and fault reactions of the pedal sensor are treated in the function GGPED.

APP SREAKT 10.10 Application hint

1-ECU-Concept:
==============

No application is necessary.

2-ECU-Concept:
==============

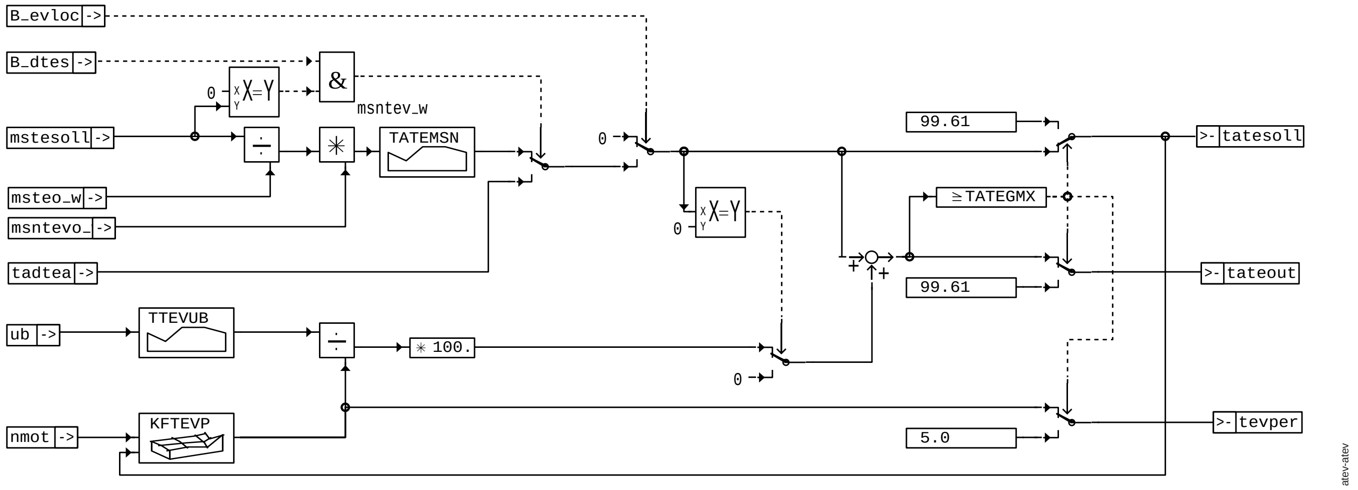
The time TNOME must be chosen distinctly smaller than MVER_T_UM from the torque monitoring.
For example: TNOME = 200 ms. When used for the 2-ECU concept the system constant SY_2SG must be set to true.

Systems with Main Relay for the Separate Voltage Supply of the DV-E After Terminal 15 OFF:
==

On systems with a main relay for the voltage supply of the DV-E5 with an additional measuring path for the voltage after the main relay, the system constant SY_UBR must be set to true for conditional compiling to realize the cutoff chatter function.

ATEV 2.0 Purge valve drive (duty cycle)

FDEF ATEV 2.0 Function definition



atev-atev

ABK ATEV 2.0 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFTEVP	NMOT	TATESOLL	KF	Characteristic map for period time of the PCV
TATEGMX			FW	Maximum PCV duty cycle for pulsed PCV activation
TATEMSN	MSNTEV_W		KL	characteristic line of the PCV duty-cycle depending on the desired mass-flow
TTEVUB	UB		KL	Battery-voltage depending delay time of canister purge valve

Variable	Source	Type	Description
B_DTES	GKRA	EIN	Condition for active diagnosis of canister purge system
B_EVLOC	BGEVAB	EIN	Status: all injection valves are activated
MSNTEVO_W	BGTEV	EIN	normalized mass flow through the complete open PCV
MSTEO_W	BGTEV	EIN	Mass flow the 100 % opened TEV
MSTESOLL_W	TEB	EIN	desired purge mass flow
NMOT	SWADAP	EIN	engine speed
TADTEA	DTEV	EIN	TEV duty cycle from canister purge diagnosis
TATEOUT	ATEV	AUS	output duty cycle for canister purge valve
TATESOLL	ATEV	AUS	desired duty cycle of the PCV
TEVPER	ATEV	AUS	periode time of purge control valve
UB	SWADAP	EIN	battery voltage

FW ATEV 2.0 Fixed Values

Parameter	Value	Description
TATEGMX		Maximum PCV duty cycle for pulsed PCV activation

FB ATEV 2.0 Detailed description of function

The function ATEV calculates the desired duty-cycle of the PCV (tatesoll) for further treatment in BGTEV and also the output sources for the PCV-timer tateout (duty cycle) and tevper (period time).

Tatesoll is calculated from the folowing sources:

mstesoll_w = desired purge mass flow through the PCV
msteo_w = purge mass flow through the complete open PCV
msntevo_w = normalized overcritical purge mass flow through the complete open PCV
Kennlinie TATEMSN = characteristic line for the PCV duty-cycle depending on the desired normalized overcritical purge mass flow

Normalized overcritical purge mass flow PCV: msntev_w = mstesoll_w / msteo_w * msntevo

Output PCV duty-cycle: Tateout = tatesoll + delay time of PCV / Period time * 100%
Remarks:
- As tatesoll = 0%, tateout = 0% too.
- Tateout ist limited to 99.61 % begrenzt (max. value HEX is FF => PCV timer should activate the PCV all the time.

Further features:
- Switching tateout to 99.61% if tateout >= TATEGMX
- As tateout = 99.61% tevper is set to 5 ms => a fast closing of the PCV is possible, because the PCV timer can change it’s duty-cycle every 5 ms.

APP ATEV 2.0 Application hint

TTEVUB: Delay time of the PCV depending on the battery voltage
----

7 V	9 V	11 V	13 V	15 V	17 V
11 ms	9.5 ms	7 ms	5.5 ms	4.5 ms	3.5 ms

KFTEVP: Characteristic map for the period time of the PCV

Values in ms:

	800	1200	2000	3000	4500	1/min
0%	128	110	100	80	60	
10%	110	100	80	70	50	
20%	80	80	60	50	40	
30%	70	60	50	40	30	
50%	60	40	30	30	30	
70%	60	40	40	40	40	
80%	80	80	80	80	80	<= if TEV delay is higher than 7 ms (at ubat > 11V)
90%	120	120	120	120	120	choose higher period times to avoid tateout = 99.61% at tatesoll < 90%
100%	120	120	120	120	120	

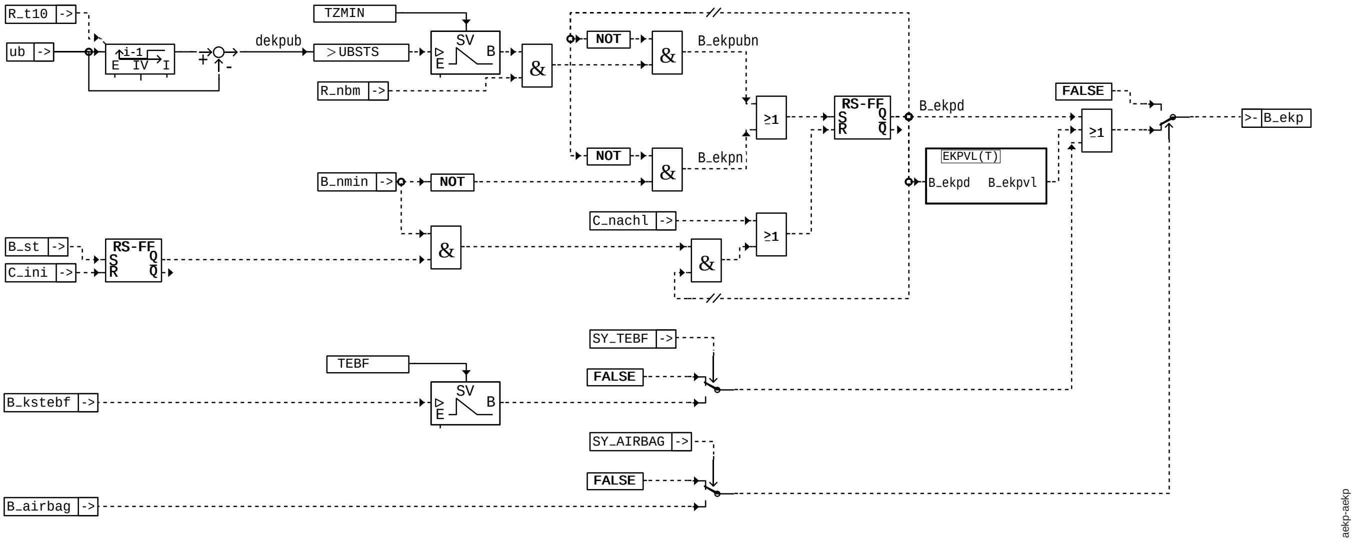
TATEGMX: 97% - Explanation: up to tateout = 97% there is continuous dosing. Then tateout and tatesoll jump to 99.61% !
Reason: Above a max. duty cycle the purge control valve current does not fall to zero.

TATEMSN: Characteristic line for the PCV duty-cycle depending on the desired normalized overcritical purge mass flow
----
TATEMSN ist exactly the inverse characteristic line to MSNTATE ! Please consider when calibrating !

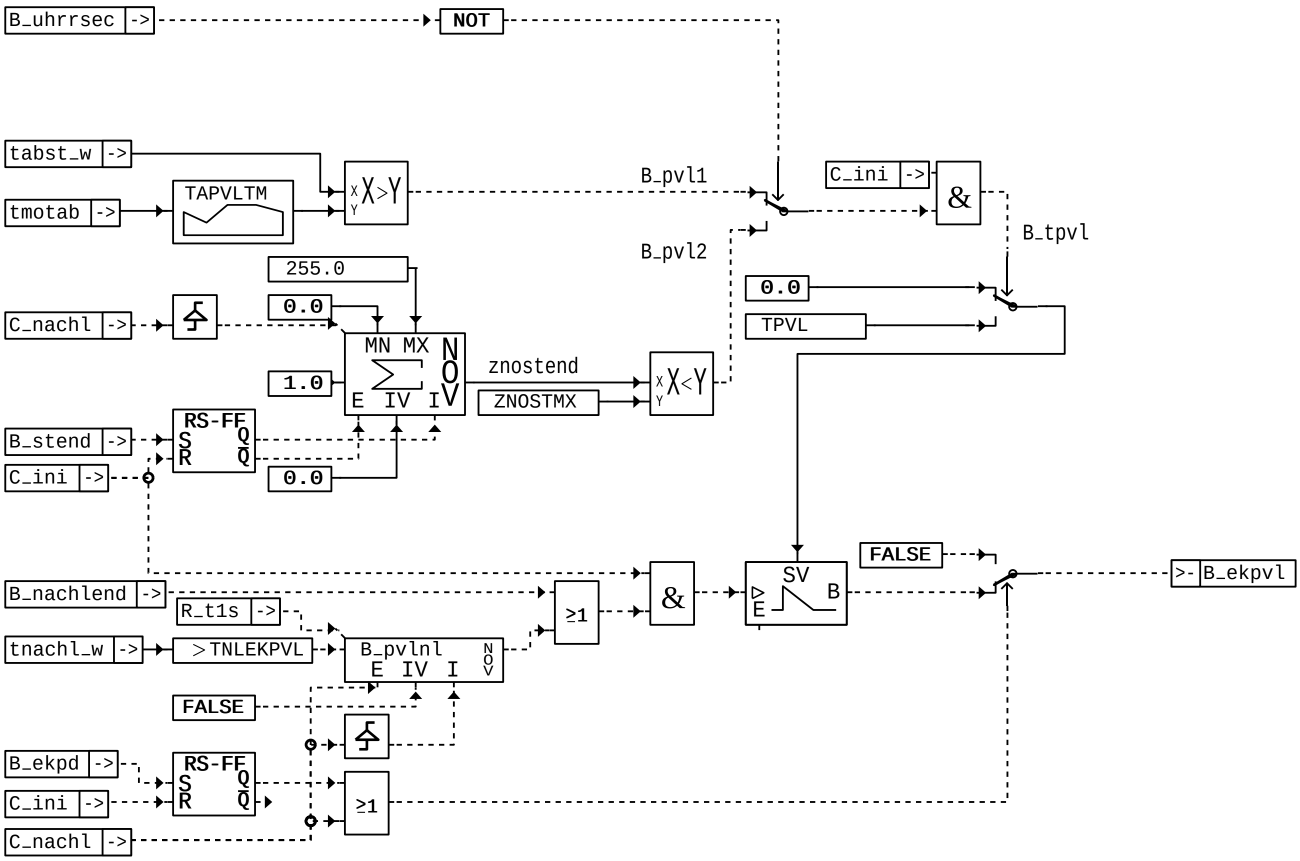
Example for first calibration: (small TEV2)	0	0.488	0.976	1.464	1.952	2.440	2.928	3.416	3.904	4.400	[kg/h]
	0	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	100	[%]
(big TEV2)	0	0.634	0.1.27	1.903	2.5375	3.172	3.8066	4.441	5.075	5.72	[kg/h]
	0	11.1	22.2	33.3	44.4	55.5	66.6	77.7	88.8	100	[%]

AEKP 4.10 EKP control

FDEF AEKP 4.10 Function definition



aekp-aekp



aekp-ekpvl

aekp-ekpvl

Subfunction EKPVL(T)

Electric fuel pump (EKP) control with lead time and suppression of interference during start
----

Signals may interfere the speed sensor (DG) line caused by operation of electric consumers during engine stop. These signals can exceed the switching threshold of the DG-preparation circuit and might be recognized as toothed disk pulses. This can lead to a false switch-on of the EKP. Monitoring of tooth speed and battery voltage during start can prevent this.

1. B_ekpubn: Monitoring of battery voltage, EKP-start control

```
speed signal:       -------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---

battery voltage:                                                     |<-------TZMIN  ---->|
 -schedule         ------------|--------------------|----------------|---|---|---|---|---|------------------------------------

 -course          ------------------------------------------------|          __/----------------------------------------------
                                                                   |       __/
                                                                   |     _/
                                                                   |   _/
                                                                   |__/

test of condition:     dekpub = ub_old - ub_act > UBSTS and next tooth signal within TZMIN

                   1 : On                                                ----------------------------------------------------
        B_ekpubn:  0 : Off_______________________________________________|
```

2. B_ekpn: Speed calculation, EKP-start control (if 1. not recognized)

B_ekpn is set if B_nmin is not set.

3. B_ekpvl: EKP-lead time

The decision if EKP-lead time is necessary or desired can be reached in two different manners. If precise information about soak time is available EKP-lead time is released only when tabst_w > TAPVLTM. The characteristic line TAPVLTM contains the maximum soak time in minutes up to that no lead time is necessary depending on the engine temperature when the engine is stopped. If no precise information about soak time is available (B_uhrrsec = 0) EKP-lead time is released when number of ignition=on-->off without reaching end of start is less than ZNOSTMX. No lead time if ignition is switched on during ECM-afterrun (B_nachlend=0) and when tnachl_w <TNLEKPVL. This ensures that lead time is available at the next start even when the ignition is switched on once again after the engine is stopped i.e. to close windows (power-windows).

4. B_kstebf: Initial fuelling

If SY_TEBF=true the EKP can be activated for TEBF seconds for initial fuelling of the fuel system. For further information see %TKMWL if available.

ABK AEKP 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TAPVLTM	TMOTAB		KL	threshold soak time for EKP-lead time
TEBF			FW	EKP operation for initial fuelling
TNLEKPVL			FW	threshold ECM-afterrun for EKP-lead time
TPVL			FW	time for fuel pump precontrol
TZMIN			FW	timeframe for recognition of teeth after battery voltage drop
UBSTS			FW	threshold for recognition of battery voltage drop
ZNOSTMX			FW	number of ignition=on without reaching end of start for no EKP-lead time

Variable	Source	Type	Description
B_AIRBAG		EIN	condition airbag activated
B_EKP	AEKP	AUS	Release of EKP-supply
B_EKPD	AEKP	LOK	condition EKP continuos duty
B_EKPN	AEKP	LOK	EKP starting condition engine speed
B_EKPUBN	AEKP	LOK	EKP starting condition speed sensor signal within TZMIN
B_EKPVL	AEKP	LOK	condition EKP lead time
B_KSTEBF		EIN	condition initial fuelling
B_NACHLEND	MOTAUS	EIN	conditon ECU switch off delay regularly finished
B_NMIN	GGDPG	EIN	condition lower speed: n $<$ NMIN
B_PVL1	AEKP	LOK	condition EKP-lead time for systems with clock
B_PVL2	AEKP	LOK	condition EKP-lead time for systems without clock
B_PVLNL	AEKP	LOK	condition EKP-lead time from ECM-afterrun duration
B_ST	SWADAP	EIN	condition for start
B_STEND	BBSTT	EIN	condition end of start
B_TPVL	AEKP	LOK	condition EKP-lead time for TPVL seconds
B_UHRRSEC	PROKON	EIN	Condition clock with a relative counter of seconds
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
DEKPUB	AEKP	LOK	change in battery voltage between two following measurements
R_NBM	GGDPG	EIN	Schedule of tooth signal
R_T10		EIN	Time schedule 10 ms
R_T1S		EIN	Time schedule 1 s
SY_AIRBAG	PROKON	EIN	system constant airbag-signal present
SY_TEBF	PROKON	EIN	system constant initial filling fuel system (service device)
TABST_W	BGTABST	EIN	soak time

Variable	Source	Type	Description
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TNACHL_W	MOTAUS	EIN	time of ECU switch off delay
UB	SWADAP	EIN	battery voltage
ZNOSTEND	AEKP	LOK	Number ignition on without reaching end of start

FW AEKP 4.10 Fixed Values

Parameter	Value	Description
TEBF		EKP operation for initial fuelling
TNLEKPVL		threshold ECM-afterrun for EKP-lead time
TPVL		time for fuel pump precontrol
TZMIN		timeframe for recognition of teeth after battery voltage drop
UBSTS		threshold for recognition of battery voltage drop
ZNOSTMX		number of ignition=on without reaching end of start for no EKP-lead time

FB AEKP 4.10 Detailed description of function

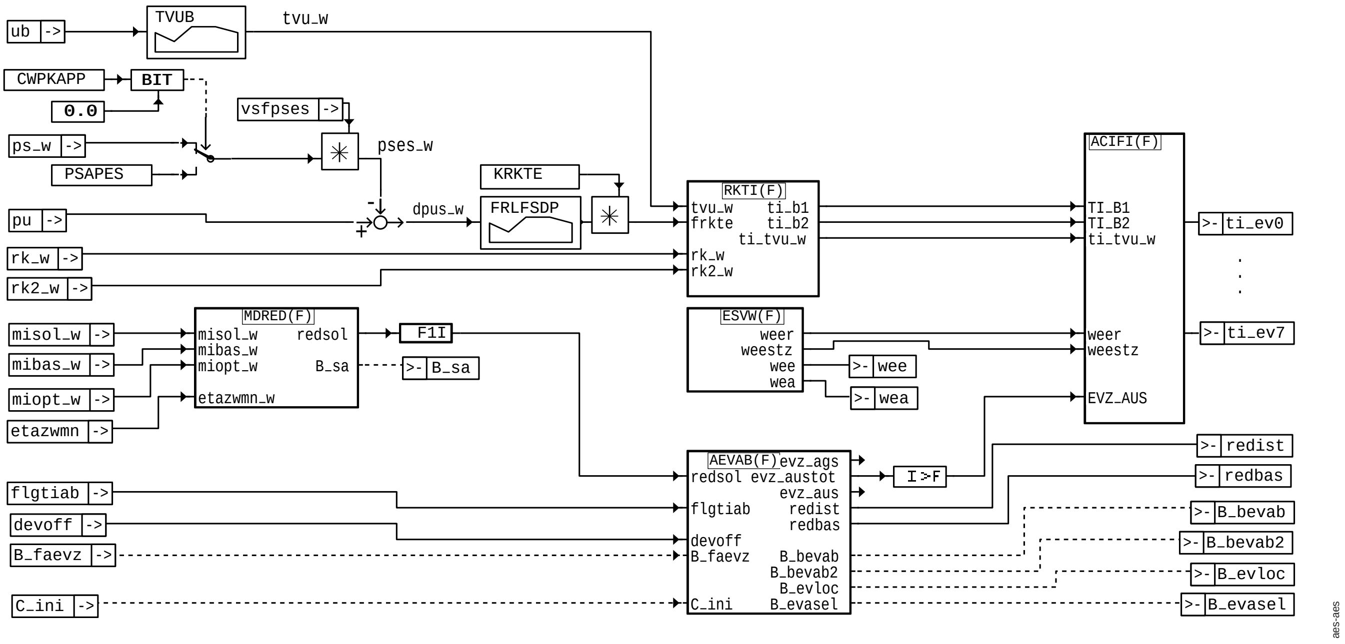
`EKP-supply may not be released with B_ekp = 0. For additional security, the EKP-supply may be locked by crash-sensor or signal from airbag-ECU.`

APP AEKP 4.10 Application hint

`EKP-lead time is essential to obtain short starting time. TNLEKPVL should always be less than TNLSGMX (%MOTAUS).`

AES 1.50 Overview calculation of injection time

FDEF AES 1.50 Function definition



aes-aes

ABK AES 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWPKAPP			FW	code word application of reference pressure for fuel-pressure controller
FRLFSDP	DPUS_W		KL	injection correction for RLFS
KRKTE			FW	conversion from relative fuel mass rk into effective injection time te
PSAPES			FW	intake manifold pressure to applicate injection
TVUB	UB		KL	voltage correction

Variable	Source	Type	Description
B_BEVAB	AES	AUS	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	AES	AUS	condition: Inj. valve cut off on Bank2
B_EVASEL	AES	AUS	Status:all local injector relevant to DASE are switched on
B_EVLOC	AES	AUS	Status: all injection valves are activated
B_FAEVZ		EIN	condition cylinder fade out by tester
B_SA	AES	AUS	Condition fuel cut-off
C_INI	SWADAP	EIN	ECU-condition for intialisation
DEVOFF		EIN	injector fade out pattern at tester requirement
DPUS_W	AES	AUS	delta between ambient and intake manifold pressure

Variable	Source	Type	Description
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
ETAZWMN_W	AES	LOK	minimum ignition angle effectiveness
EVZ_AGS	AES	LOK	injection cut off pattern total of one or two ECU
EVZ_AUS	AES	LOK	injection cut off pattern
EVZ_AUSTOT	AES	LOK	injection cut off pattern total
FLGTIAB	DMDMIL	EIN	state flag ti turn-of by catalyst damaging misfiring rates
FRKTE	AES	LOK	factor: conversion rel. fuel mass rk into effect. injection time te
MIBAS_W	MDBAS	EIN	indicated basic torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W	MSF	EIN	indicated resultant nominal torque
PSES_W	AES	LOK	intake manifold pressure corrected bei application system
PS_W	EGFE	EIN	intake manifold pressure (absolute) (Word)
PU	BGPU	EIN	Ambient pressure
REDBAS	AES	AUS	Base cut-off step
REDIST	AES	AUS	real cylinder cut-off step
REDSOL	AES	LOK	calculated desired cylinder cut-off step
RK2_W	MSF	EIN	relative fuel mass Bank2
RK_W	MSF	EIN	relative fuel mass
TI_B1	AES	LOK	injection time for valves on bank1
TI_B2	AES	LOK	injection time for valves on Bank2
TI_EV0	AES	AUS	injection time 1. cylinder in firing sequence
TI_EV1	AES	LOK	injection time 2. cylinder in firing sequence
TI_EV7	AES	AUS	injection time 8th cylinder in firing sequence
TI_EV8	AES	LOK	injection time 9th cylinder in firing sequence
TI_TVU_W	AES	LOK	injection time correction as function of battery voltage ECU-quantization
TVU_W	AES	LOK	supply of voltage correction
UB	SWADAP	EIN	battery voltage
VSFPSES	VS_VERST	EIN	factor for modifying intake manifold pressure during Application injection
WEA	AES	AUS	anglemark injection break off
WEE	AES	AUS	angle injection-end in normal operation
WEER	AES	LOK	resulting crankshaft angle for end of injection
WEESTZ	AES	LOK	angle injection-end for triggering simultanious injection at start

FW AES 1.50 Fixed Values

Parameter	Value	Description
CWPKAPP		code word application of reference pressure for fuel-pressure controller
KRKTE		conversion from relative fuel mass rk into effective injection time te
PSAPES		intake manifold pressure to applicate injection

FB AES 1.50 Detailed description of function

The function AES shows the calculation of the injection time (injection valve control time) from the relative fuel mass rk_w, rk2_w.
The injection time is calculated bank-selectively and results as:

ti_b1 = rk_w *frkte + tvu_w
ti_b2 = rk2_w *frkte + tvu_w

wherein

ti_b1, ti_b2	bank-selective injection time
rk_w, rk2_w	relative fuel mass, bank-selective
frkte	correction for returnless fuel systems (FRLSDP) and translation of relative fuel mass rk into effective injection time te (KRKTE).
tvu_w	battery voltage compensation of the injection valves (response delay with differing battery voltage)
FRLFSDP	correction of injection fuel mass at returnless fuel systems

In the AEVAB function, a valve cutoff pattern ev_zaustot is formed from the fixed valve cutoff patterns of the misfire flag DASE (flgtiab), the tester specification for cutoff of an injection valve for tests at the end of line assembly (devoff) where B_faevz = true, the error of injection valves E_ev and from the reduction stage redsol specified by the torque reduction.

Based on the valve cutoff pattern the information bits B_bevab, B_bevab2 are formed, indicating the bank on which injection valves are shut off.

APP AES 1.50 Application hint

Calculation of constant KRKTE:

$$KRKTE\ [ms/\%] = \frac{rho0Air\ [g/dm^3] * Vhzyl[dm^3]}{100[\%] * Lst * Normmk[min/ms] * 1.05 * Qstat[g/min]}$$

KRKTE = 50.2624 * Vh / Qstat

where

rho0Air	= 1.293 g/dm^3	(0°C and 1013hPa)
Vhzyl	= dm^3	Displacement of a cylinder in dm^3
Qstat	= g/min	Valve constant with n-Heptane
	1.05	Valve correction for petrol/n-Heptane
Lst	= 14.7	Air/fuel ratio for Lambda = 1.0
Normmk	= 0.00001667 min/ms	Adaptation of units

Calculation of the correction for returnless fuel systems:

$$FRLFSDP = \sqrt{pdr\_evmes/(pdr\_akt+(pu-ps))}$$

Wherein pdr_evmes = absolute pressure in the fuel circulation upstream of the injection valve at measuring Qstat (3000 hPa)
pdr_akt = actuell system pressure in fuel circulation
pu = ambient pressure
ps = intake manifold pressure

At systems with reference pressure at intake manifold pu - ps = 0.
The correction for the complete characteristic a this one is:

$$FRLFSDP = \sqrt{pdr\_evmes/pdr\_akt}$$

For a fuel pressure of 3000 hPa the result for FRLFSDP is:
Wherein dpus = pu - ps

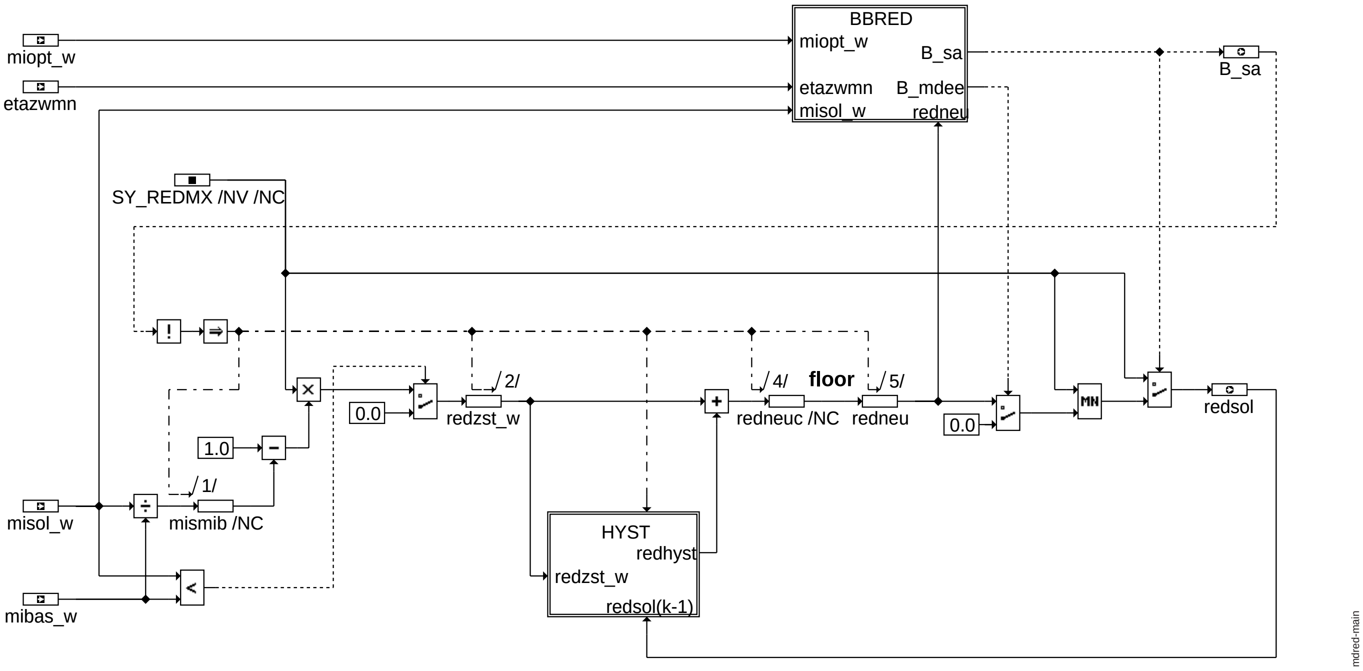
Induction engine 3000 hPa /3500 hPa			Turbo engine:		
dpus [hPa]	FRLFSDP		dpus [hPa]	FRLFSDP	
0	1.0	1.0	-1200	1.299	pBoostPress = 1800 hPa, pu = 600 hPa
100	0.9837	0.9860	-1000	1.2247	
200	0.9682	0.9726	-800	1.1678	
300	0.9535	0.9597	-600	1.1180	
400	0.9393	0.9473	-400	1.0742	
500	0.9258	0.9354	-200	1.0351	
600	0.9129	0.9240	0	1.0	
700	0.9005	0.9129	200	0.9682	
800	0.8885	0.9022	400	0.9393	
			600	0.9129	
			800	0.8885	

There are 11 interpolation points implemented for induction and turbo engine.

during application air charge measuring, the modelled intake manifold pressure is not correct.
At returnless fuel systems the intake manifold pressure can be set by
the application system VS100 with parameter PSAPES. Therefore bit 0 at CWPKAPP must be set.
The init value for PSAPES is 1013 hPa. The VS20 application System can correct the pressure PSAPES by the factor vsfpses
with a range of 0 ... 2. The corrected pressure for calculation dpus_w is pses_w.

MDRED 1.50 Calculation reduction step from torque demand

FDEF MDRED 1.50 Function definition



mdred-main

```
Sub-function HYST: Hysteresis to prevent bouncing of the masking stage:
---------------------------------------------------------------------
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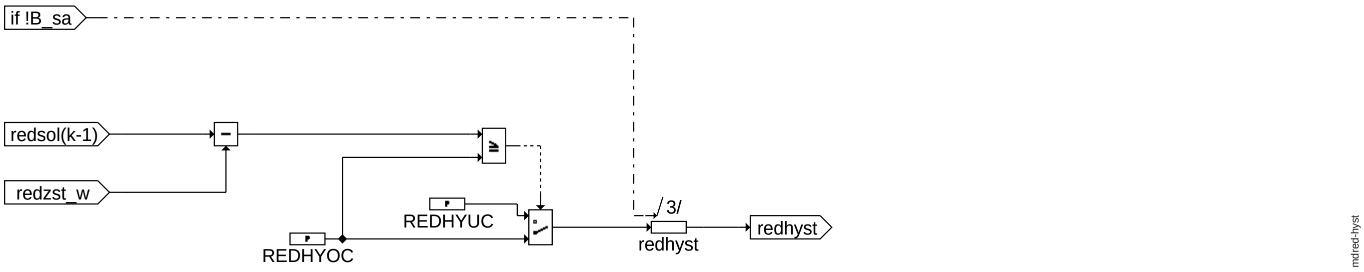

mdred-hyst

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Sub-function BBRED: Operating conditions of torque intervention over injection masking:
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```
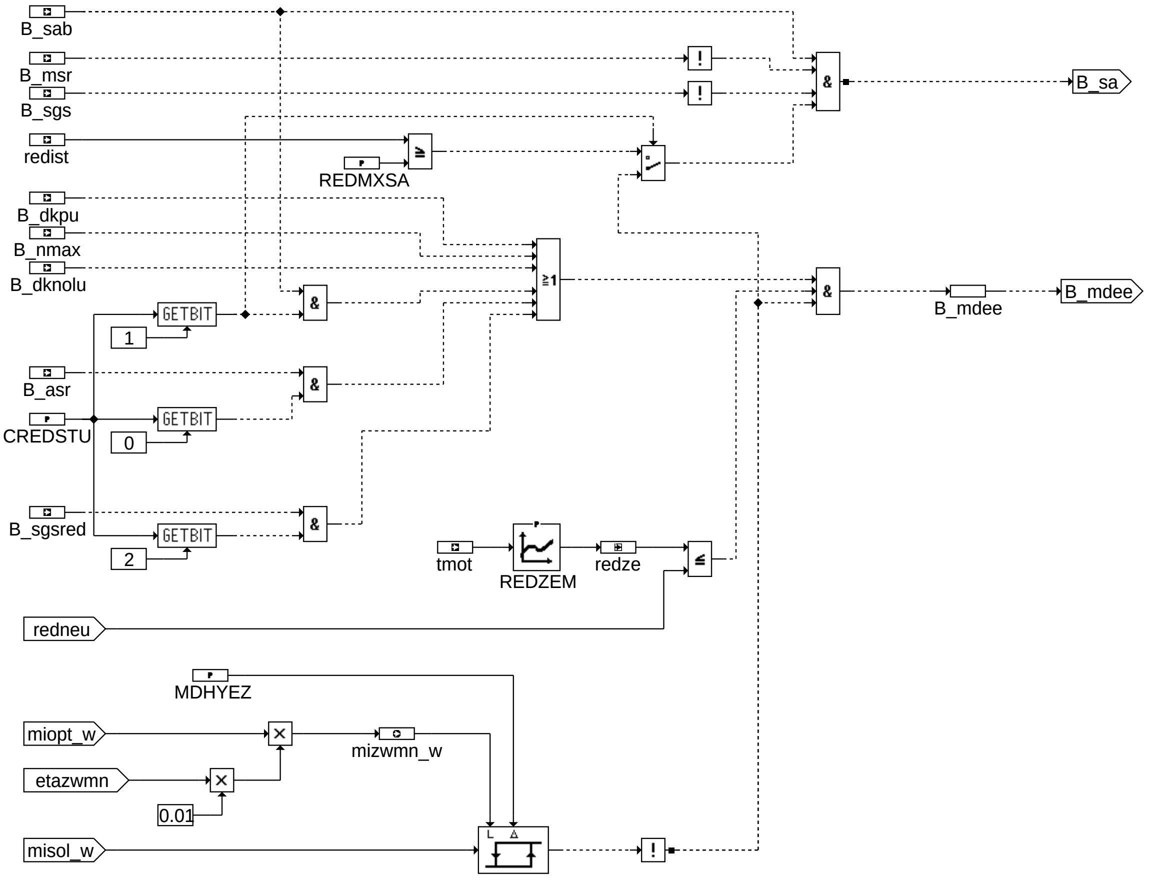



mdred-bbred

ABK MDRED 1.50 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CREDSTU			FW	code word for reduction step on/off
MDHYEZ			FW	torque-hysteresis for decision cylinder fuel cut-off
REDHYOC			FW	hysteresis of reduction step at bigger desired red. step than actual value
REDHYUC			FW	hysteresis of reduction step at smaller desired red. step than actual value
REDMXSA			FW	maximum reduction step for sequential fuel cutoff
REDZEM	TMOT		KL	threshold between ignition intervention and injector disabling
SY_REDMX			SYS (REF)	system constant: max. cylinder cutoff step

Variable	Source	Type	Description
B_ASR	MDKOG	EIN	condition for ASR active
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_MDEE	MDRED	LOK	condition: torgue reduction by injection fade out is permited
B_MSR	MDKOG	EIN	Condition MSR
B_NMAX	NMAXMD	EIN	1 = maximum engine speed exceeded
B_SA	MDRED	AUS	Condition fuel cut-off
B_SAB	MSF	EIN	Condition fuel cut-off requested
B_SGS	MDKOG	EIN	condition: torque intervention for engine speed synchr. during gear shift
B_SGSRED	CAN	EIN	condition: reducing torque intervention for eng. speed synchr. during gear shift
ETAZWMN	ZWMIN	EIN	minimum ignition angle effectiveness
MIBAS_W	MDBAS	EIN	indicated basic torque
MIOPT_W	MDBAS	EIN	optimum indicated torque
MISOL_W	MSF	EIN	indicated resultant nominal torque
MIZWMN_W	MDRED	AUS	indicated engine torque at the latest spark angle
REDHYST	MDRED	LOK	hysteresis for cylinder cut-off step
REDIST	BGEVAB	EIN	real cylinder cut-off step
REDNEU	MDRED	LOK	new calculated cylinder cut-off step
REDSOL	MDRED	AUS	calculated desired cylinder cut-off step
REDZE	MDRED	LOK	threshold of cylinder cut-off step between two interventions
REDZST_W	MDRED	LOK	cylinder cut-off step without hysteresis and roundness
TMOT	SWADAP	EIN	Engine temperature

FW MDRED 1.50 Fixed Values

Parameter	Value	Description
CREDSTU		code word for reduction step on/off
MDHYEZ		torque-hysteresis for decision cylinder fuel cut-off
REDHYOC		hysteresis of reduction step at bigger desired red. step than actual value
REDHYUC		hysteresis of reduction step at smaller desired red. step than actual value
REDMXSA		maximum reduction step for sequential fuel cutoff

FB MDRED 1.50 Detailed description of function

This function provides the injection masking stages corresponding to the nominal torque request misol_w (referred to the indexed engine torque mibas_w, which results at the static ignition angle zwbase and basic Lambda lambas).
A hysteresis is used to ensure that no "bouncing" occurs in the selection of the reduction stages (cf. sub-function "HYST"). Cutting the decimal places ("Floor function") results in the new reduction stage. The sub-function "BBRED" determines whether injection masking is permitted (B_mdee) and whether deceleration cut-off occurs (B_sa).

The actual reduction stage redist results from a max selection between redbas (basic reduction stage due to bank shut-off or due to misfire detection) and the reduction stage redsol calculated from misol.

Sub-function HYST: Hysteresis to prevent bouncing of the masking stage
----

The hysteresis is determined by the difference between REDHYUC and REDHYOC and the offset of the hysteresis referred to the old value of redsol, divided by (1-REDHYOC). REDHYUC must always be greater than REDHYOC. If the calculated masking stage redzst exceeds the current value of redsol by more than 1-REDHYOC (if redzst_w>redsol(k-1)-REDHYOC)
or REDHYUC (if redzst_w <= redsol(k-1)-REDHYOC) stages,
then the next masking stage must be selected.

Sub-function BBRED: Operating conditions of torque intervention over injection masking
----

The characteristic REDZEM in relation to the engine temperature can be used to establish the reduction stage redze from which injection masking is actually permitted. If the calculated reduction stage redneu is less than the value specified in the characteristic REDZEM, ignition angle intervention is activated. Injection masking is only possible when redsol>=redze
(see above) or when the requested torque misol_w is less than the possible torque mizwnm at the latest ignition angle and the condition such as B_ska, B_dknolu or B_nmax is set. At B_asr =1 cylinder masking is possible if in addition the 0th bit of CREDSTU is set to 1. Otherwise the injection angle intervention is limited to zwmin and no cylinder masking is possible.
If misol_w is less than mizwmn_w and B_sab is set, the condition B_sa is set and the nominal reduction stage redsol equals REDMX, so that deceleration cut-off occurs. In MSR intervention (B_msr = 1), deceleration cut-off is prohibited.

APP MDRED 1.50 Application hint

Typical value:

REDMX = No. of cylinders
REDHYOC = 0.5   (for simultaneous injection and ignition interventions)
REDHYUC = 0.6   (for simultaneous injection and ignition interventions)
MDHYEZ = 5 Nm
CREDSTU[0] = 0 (cylinder masking during ASR not possible)

Characteristic REDZEM (typical value, see diagram below)
This characteristic determines the threshold between injection masking and ignition intervention. According to the engine temperature it can be used to program the reduction stage from which injection masking no longer results in overheating of the catalytic converter.

```
                           REDZEM ^
                                2 |----------------+
                                  |                |
                                  |                |
                                  |                |
                                1 |                +-------------------------
                                  +-------------------------------------------->  tmot
                                                 TMOTASR
```

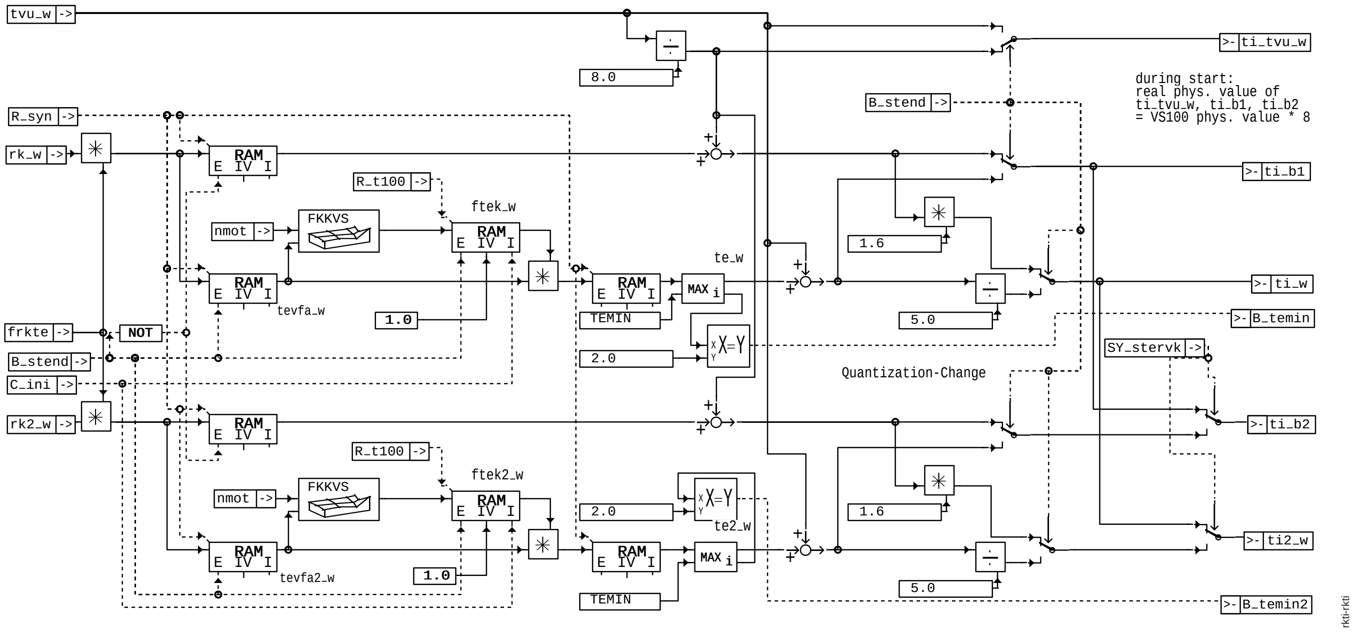
Example for the calculation of REDHYUC, REDHYOC :

Target is a hysteresis of 0.1, at delta=(redzst-redsol(k-1)) >=0.5 a higher stage should be selected. From the equations
REDHYUC - REDHYOC = 0.1
delta = 1 - REDHYOC

we get:
REDHYOC = 0.5;   REDHYUC = 0.6;

RKTI 1.60 Calculation of injection time ti from relative fuel mass rk

FDEF RKTI 1.60 Function definition



rkti-rkti

ABK RKTI 1.60 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FKKVS	NMOT	TEVFA2_W	KF	Factor to correct fuel delivery system
TEMIN			FW	minimum effective injection time

Variable	Source	Type	Description
B_STEND	BBSTT	EIN	condition end of start
B_TEMIN	RKTI	AUS	Condition: TEMIN-limitation active, bench 1
B_TEMIN2	RKTI	AUS	Condition: TEMIN-limitation active, bench 2
C_INI	SWADAP	EIN	ECU-condition for intialisation
FRKTE		EIN	factor: conversion rel. fuel mass rk into effect. injection time te
NMOT	SWADAP	EIN	engine speed
RK2_W	MSF	EIN	relative fuel mass Bank2
RK_W	MSF	EIN	relative fuel mass
R_SYN	GGDPG	EIN	Synchro schedule
R_T100		EIN	Time schedule 100 ms
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TI2_W	RKTI	AUS	injection time cylinder 2 (word)
TI_B1	RKTI	AUS	injection time for valves on bank1
TI_B2	RKTI	AUS	injection time for valves on Bank2
TI_TVU_W	RKTI	AUS	injection time correction as function of battery voltage ECU-quantization
TI_W	RKTI	AUS	injection time
TVU_W		EIN	supply of voltage correction

FW RKTI 1.60 Fixed Values

Parameter	Value	Description
TEMIN		minimum effective injection time

FB RKTI 1.60 Detailed description of function

The function calculates the effective injection time tevfa from the relative fuel mass rk_w,rk2_w and the factor frkte.
At an ideal fuel system there will be Lambda combustion chamber 1.0 with ti = tefva + tvu. A real fuel system has to be corrected by the map FKKVS for pulsations in returnless fuel systems, nonlinearitis of injection valves ... .
The injection time ti_b1, ti_b2 is calculated by addition of the battery voltage correction and the corrected effective injection time te_w, te2_w.
The CIFI controls the relevant injection valves with times ti_b1 and ti_b2.

In a single-bank system (SY_stervk = false) the injection time of Bank1 is passed as ti_b1 and ti_b2 to the CIFI.

To implement the large injection times occurring during starting, the ti_b1, ti_b2, ti_tvu_w quantisation is increased by a factor of 8 during starting, and the values range thus extended to 1677.696ms. The interface to cifi is so realized by a 16-Bit RAM, also during start.

ti_w is calculated selective to cylinder bank and shows the correct VS100-measured value during start and normal operating with constant resolution of 16 us.

APP RKTI 1.60 Application hint

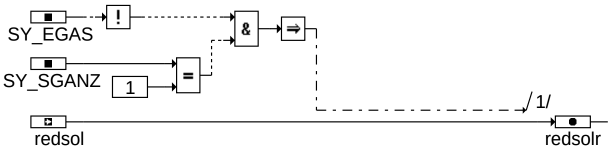
```
Init values:

        FKKVS: Interpol. points nmot_w   800  1400 2000 2600 3200 3800 4400 5000 5600 6200 1/min
                                tevfa_w  1.5   2.5  3.5  4.5  5.5  6.5  7.5  8.5  9.5 10.5 ms
               Values                    1.0   1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
the map FKKVS corrects errors in fuel system, especially pulsation at returnless fuel systems.
        TEMIN: 1 ms

ti-resolution:  start:  ti_b1, ti_b2            25.6 us         real value = VS100-measured value * 8 during start
                        ti_tvu_w                25.6 us           "
                        ti_w, ti2_w             16 us
                        te_w, te2_w             not available

                normal: ti_b1, ti_b2            3.2 us
                        ti_tvu_w                3.2 us
                        ti_w, ti2_w             16 us
                        te_w, te2_w             3.2 us
```

AEVAB 6.20 Output injection valve cut off

FDEF AEVAB 6.20 Function definition

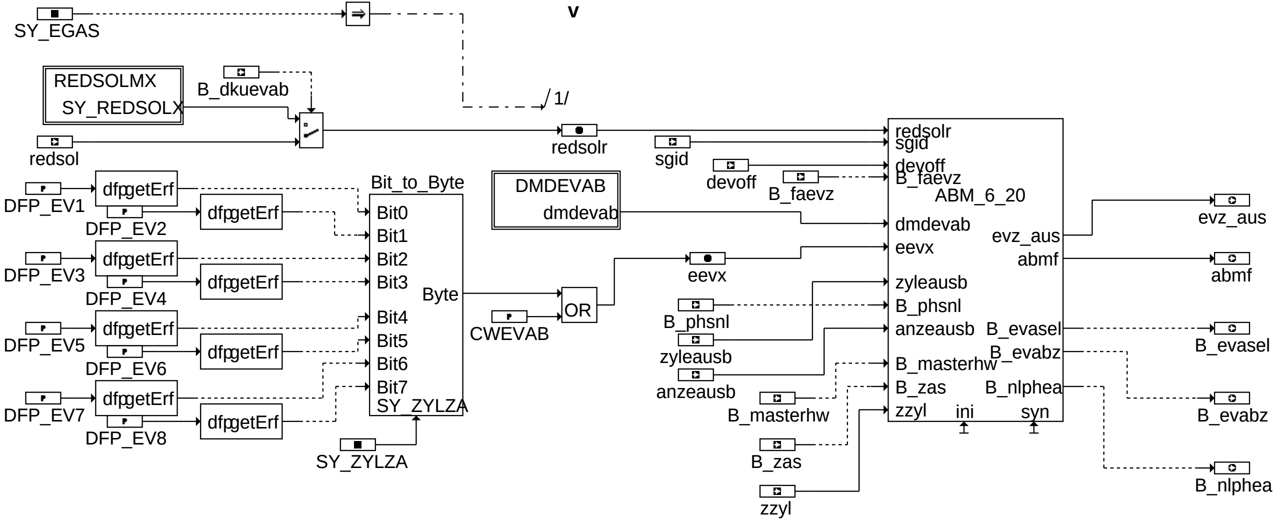
AEVAB 6.20

System without DVE and 1 ECU

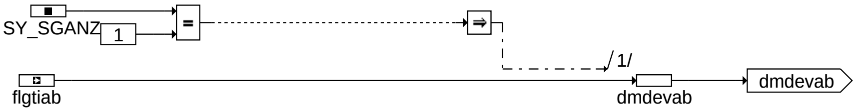


v alternative Code
|
+ for calculation of redsolr
|
v

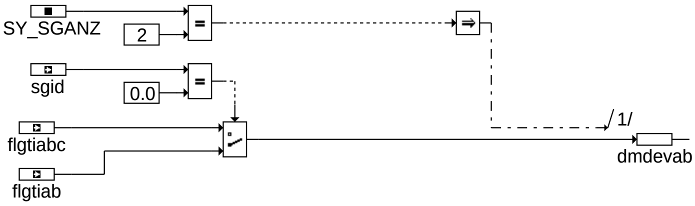
System with DVE and one or more ECU



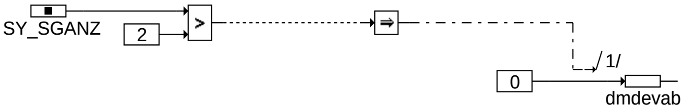
aevab-main



one ecu --> dmdevab = flgtiab



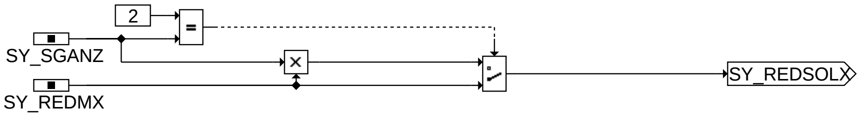
two ecu --> master ecu : dmdevab = flgtiabc
. slave ecu: if communication is ok dmdevab = flgtiab
. else dmdevab = 0



more then 2 ecu's: misfire detection is not implemented in this function

aevab-dmdevab

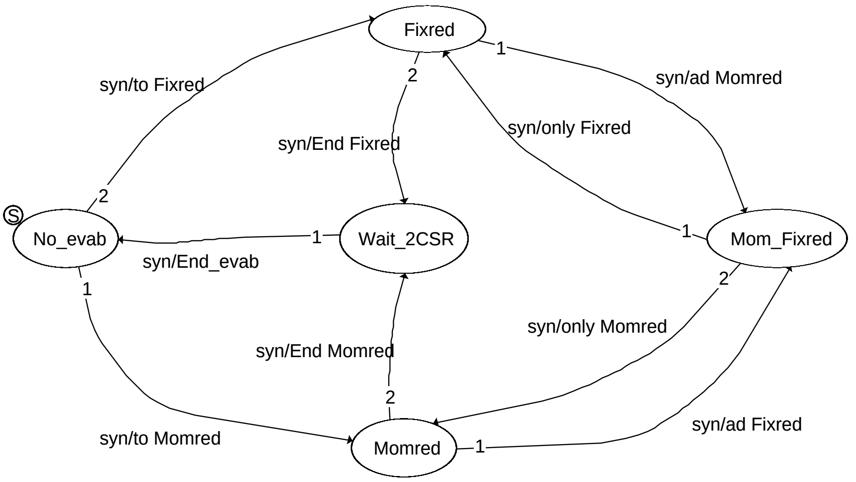
aevab-dmdevab



1 ecu: SY_REDSOLX = SY_REDMX --> 1 cylinder at 1 step of redsol
2 ecu: SY_REDSOLX = 2* SY_REDMX --> 1 cylinder at 1 step of redsol
3 ecu: SY_REDSOLX = SY_REDMX --> 3 cylinder at 1 step of redsol

aevab-redsolmx

aevab-redsolmx



stateevab: No_evab = 0; Fixred = 1; Mom_Fixred = 2; Momred = 3; Wait_2CSR = 4;

No_evab:no inj. valve cutoff active
Fixred:inj. valve cutoff by fixed inj. valve active
Momred:inj. valve cutoff begins with inj.valve = zzyl + SY_ZYLZA/2 active
Momfixred: combination of Fixred and Momred active
Wait_2CSR: waiting for 2 camshaft revolutions with activated injection,
Lambda controller ind misfire detection are deactivated

aevab-abm

aevab-abm

state: Noevab

Cond No_evab

specification of transitions from state No_evab to other states

Act No_evab

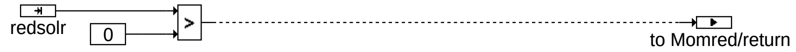
specification of actions in state No_evab

aevab-no-evab

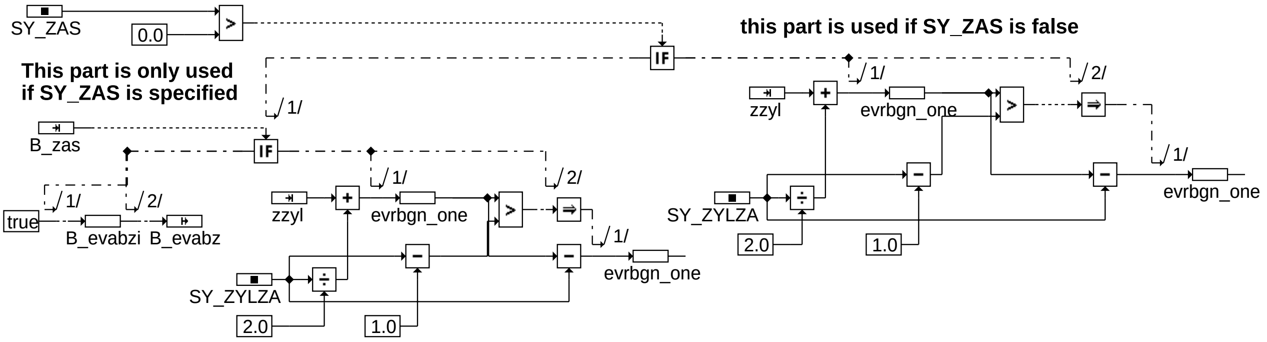
aevab-no-evab

state No_evab

condition code for transition: to Momred



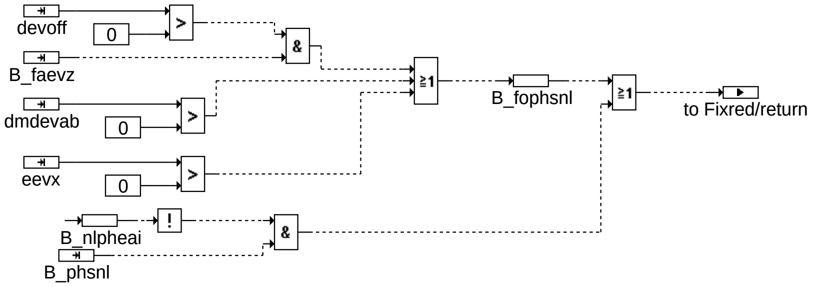
action code for transition: to Momred



This part is only used
if SY_ZAS is specified

this part is used if SY_ZAS is false

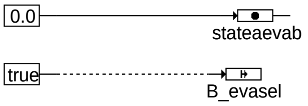
condition code for transition: toFixred



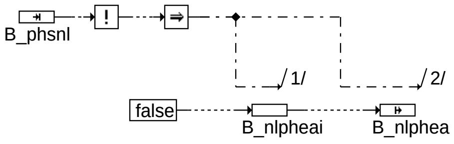
aevab-cond-no-evab

aevab-cond-no-evab

entry Code in state: No_evab



action code in state: No_evab



end of PHSNL

aevab-act-no-evab

aevab-act-no-evab

state Fixred

Cond Fixred — **specification of transitions from state Fixred to other states**

Entr Fixred — **specification of entry code into state Fixred**

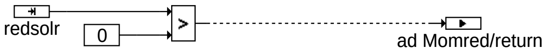
Act Fixred — **specification of action code in state Fixred**

aevab-fixred

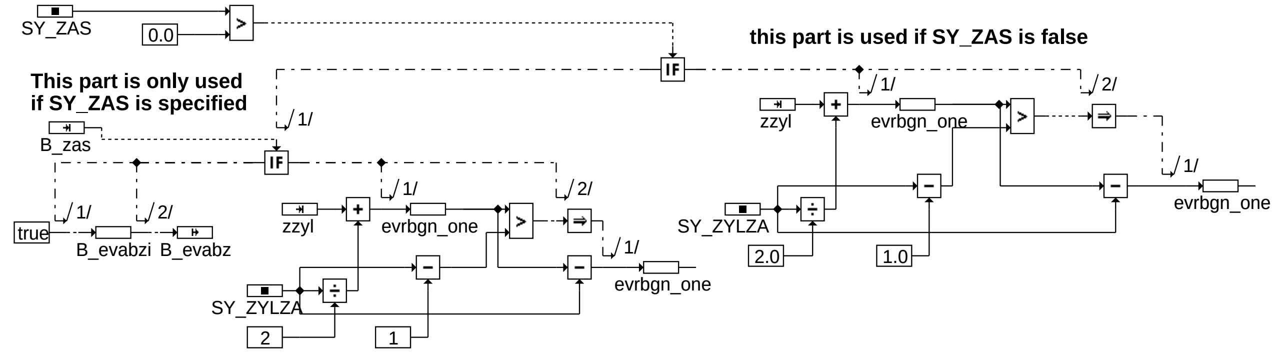
aevab-fixred

state Fixred

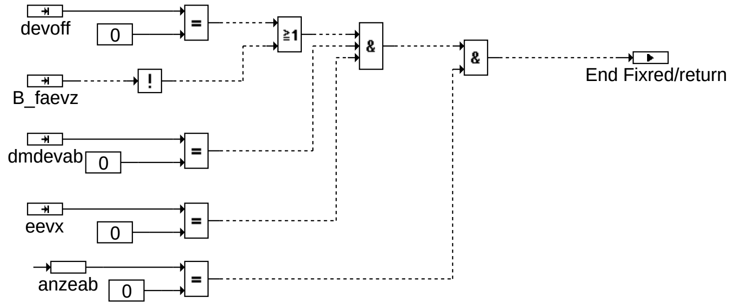
condition code for transition: ad Momred



action code in transition: ad Momred



condition code for transition: End Fixred

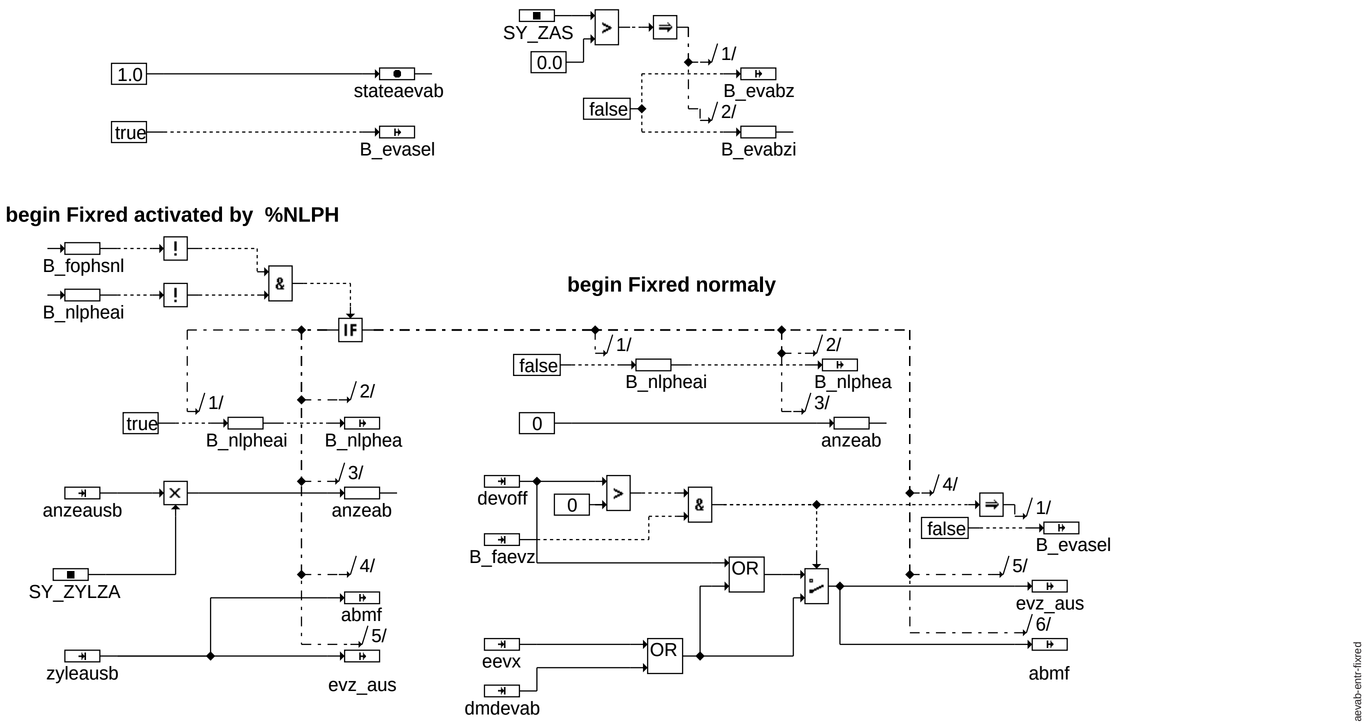


aevab-cond-fixred

aevab-cond-fixred

- -

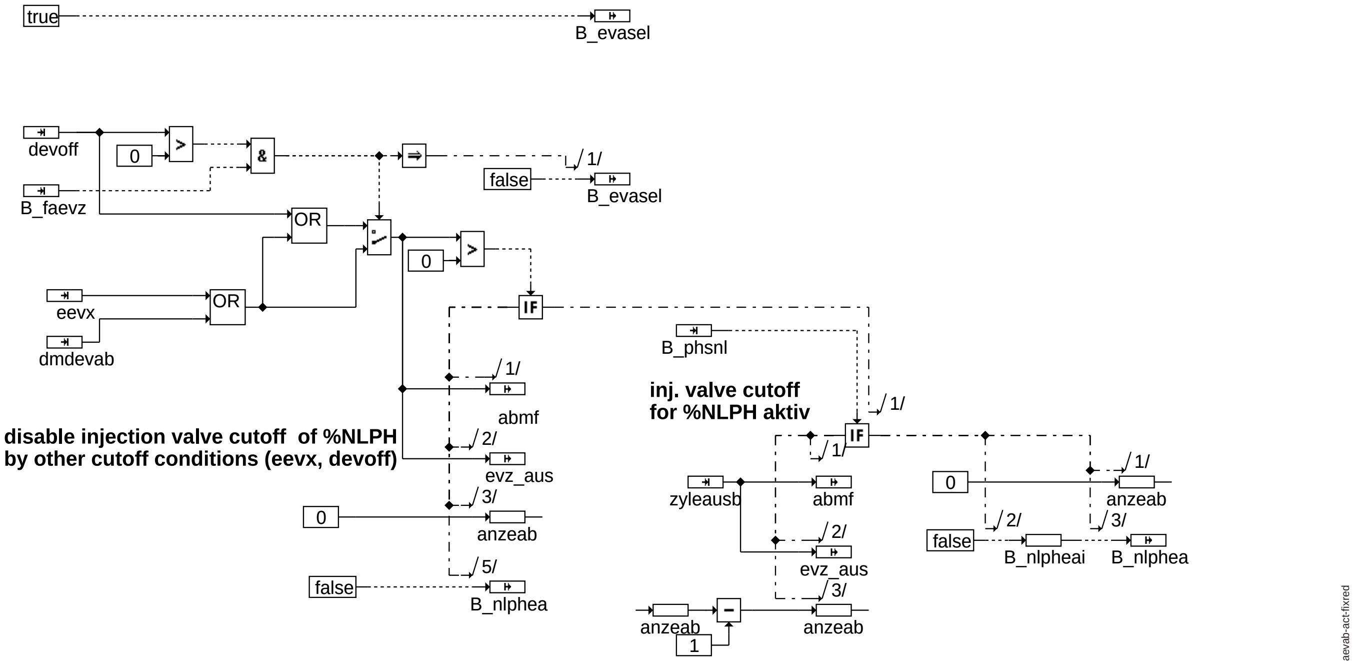
entry code in state: Fixred



aevab-entr-fixred

- -

action code in state: Fixred



aevab-act-fixred

state Momred

Cond Momred

specification of transitions from state Momred to other states

Entr Momred

specification of entry code into stateMomred

Act Momred

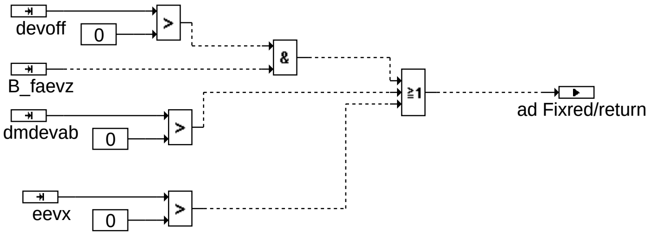
specification of action code in state Momred

aevab-momred

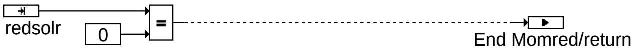
aevab-momred

state : Momred

condition code in transition: ad Fixred



condition code in transition: End Momred



aevab-cond-momred

aevab-cond-momred

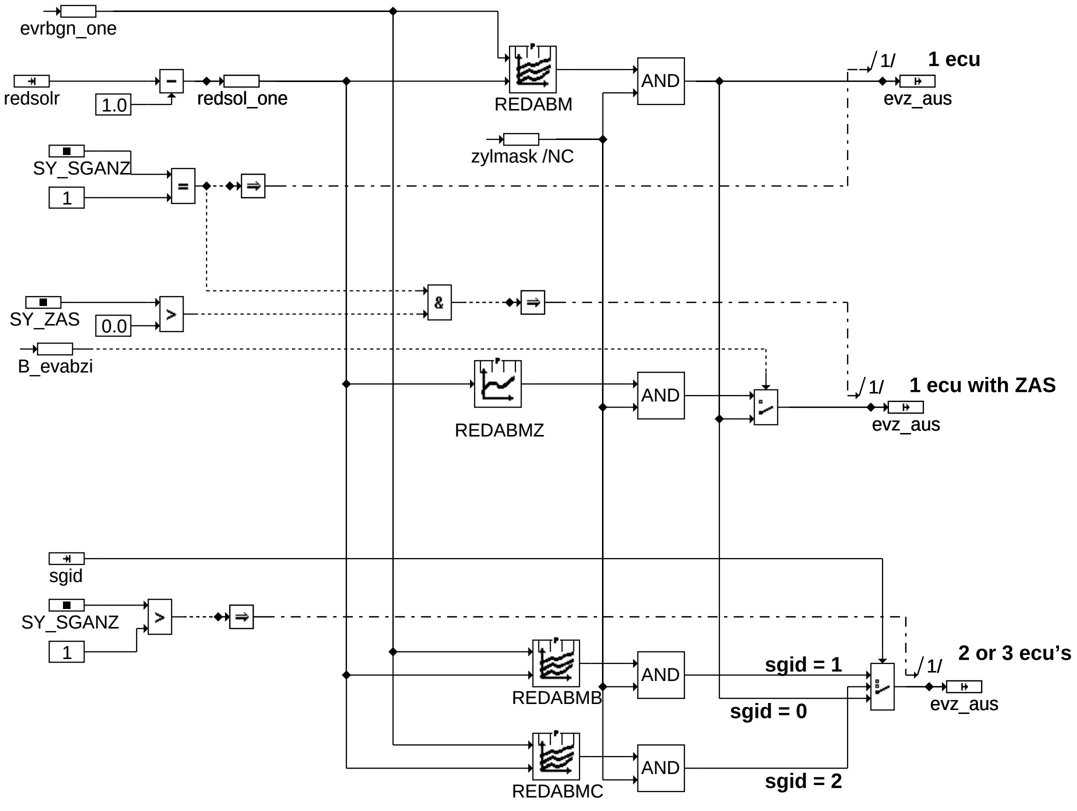
entry code into state: Momred

there is additional calculated complete action code of state Momred
see in specification of action code in state Momred

aevab-entr-momred

aevab-entr-momred

action code in state: Momred **also calculated as entry code into state Momred**



aevab-act-momred

aevab-act-momred

state Mom_Fixred

Cond Mom_Fixred

specifications of transitions from state Mom_fixred to other states

Entr Mom_Fixred

specification of entry code into state Mom_Fixred

Act Mom_Fixred

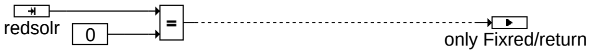
specification of action code in state Mom_Fixred

aevab-mom-fixred

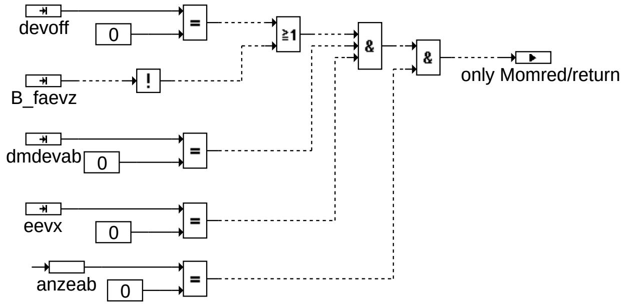
aevab-mom-fixred

state Mom_Fixred

condition code in transition: only Fixred



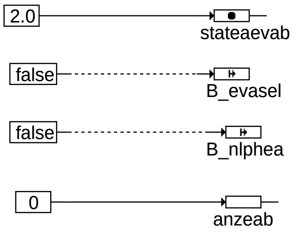
condition code in transition : only Momred



aevab-cond-mom-fixred

aevab-cond-mom-fixred

entry code in state: Mom_Fixred



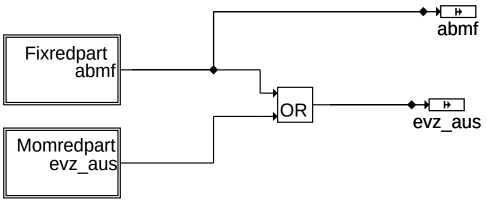
there is also calculated complete action code of state Mom_Fixred see in specification of action code in state Mom_Fixred

aevab-entr-mom-fixred

aevab-entr-mom-fixred

- -

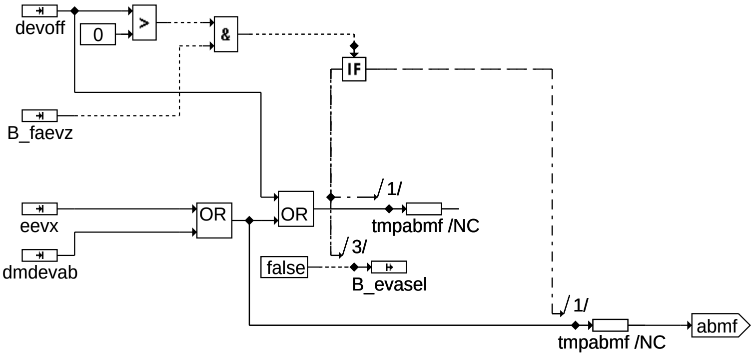
action code in state: Mom_Fixred



aevab-act-mom-fixred

- -

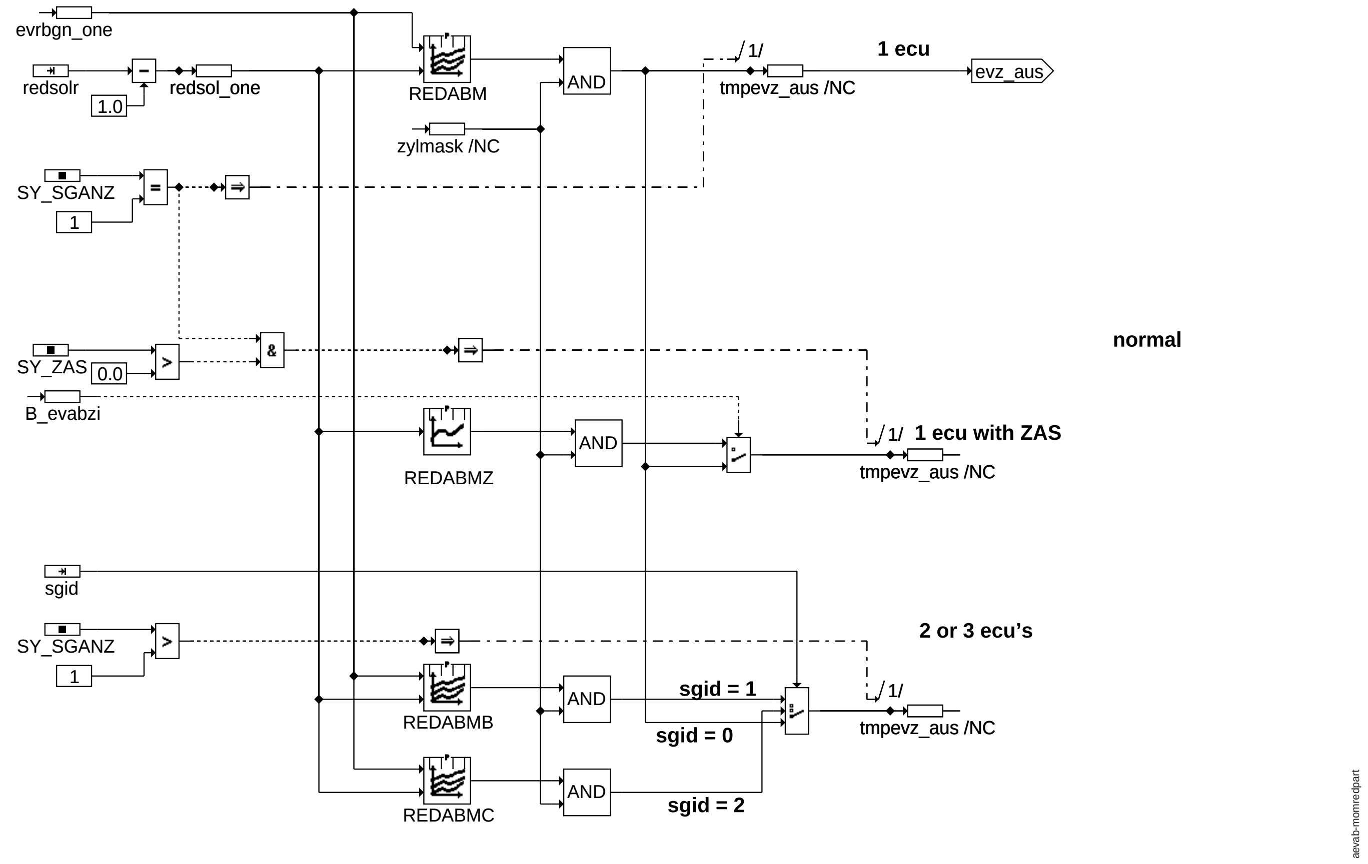
action code in state Mom_Fixred: Fixredpart is also calculated as entry code into state Mom_Fixred



aevab-fixredpart

- -

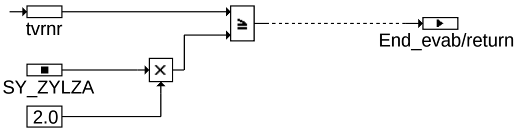
action code in state Mom_Fixred: Momredpart
is also calculated in entry into state Mom_Fixred



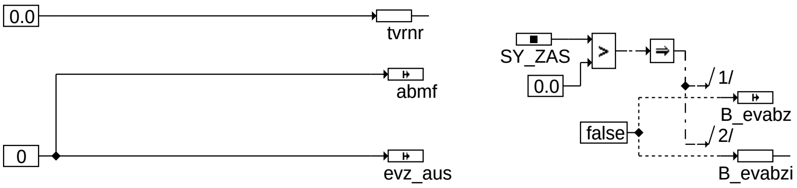
aevab-momredpart

state: Wait_2CSR

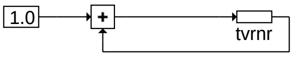
condition in transition: End_evab



entry code into state: Wait_2CSR

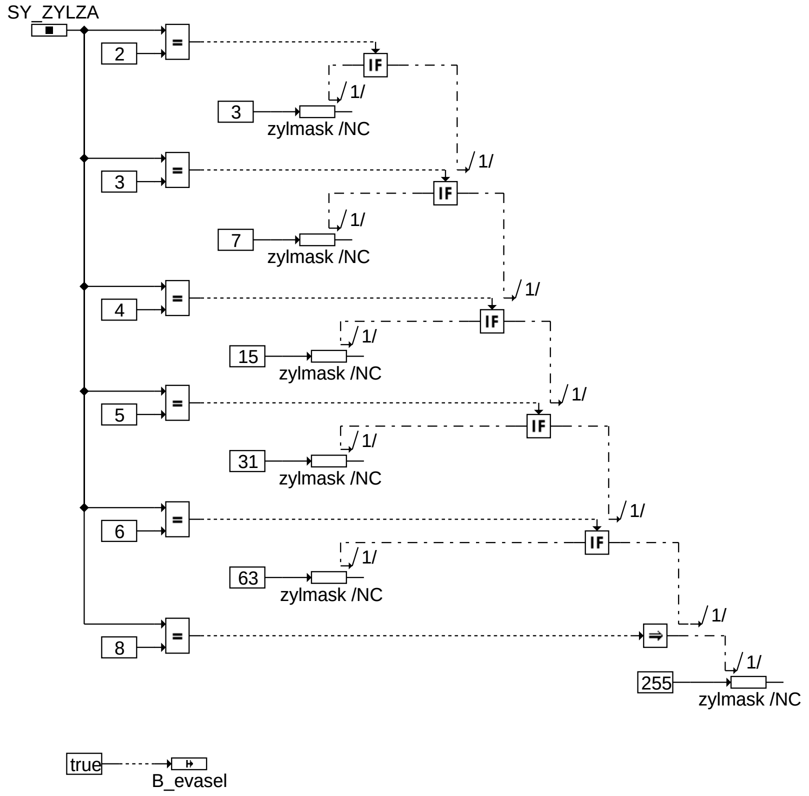


action code in state: Wait _2CSR



aevab-wait-2csr

initialization



aevab-initstatemachine

ABK AEVAB 6.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWEVAB			FW	codeword injection valve cutoff
REDABM	EVRBGN_ONE	REDSOL_ONE	KF	fuel cut-off table for torque reduction
REDABMB	EVRBGN_ONE	REDSOL_ONE	KF	fuel cut-off table for torque reduction slave1 or ecu B (SGB)
REDABMC	EVRBGN_ONE	REDSOL_ONE	KF	fuel cut-off table for torque reduction slave 2 or ecu C
REDABMZ	REDSOL_ONE		KL	fuel cut-off table for torque reduction during ZAS
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_REDMX			SYS (REF)	system constant: max. cylinder cutoff step
SY_SGANZ			SYS (REF)	system constant number engine control unit
SY_ZAS			SYS (REF)	system constant cylinder deactivation ZAS included
SY_ZYLZA			SYS (REF)	system constant number of cylinders

Variable	Source	Type	Description
ABMF	AEVAB	AUS	injection cut off pattern at fixed position
ANZEAB	AEVAB	LOK	Number of segments EV deactivation for emergency operation phase synchronisation
ANZEAUSB	NLPH	EIN	number of injections to fade out; limited between 4 and 7
B_DKUEVAB	AEVABU	EIN	Injection valve cut off by throttle blade uncorrect
B_EVABZ	AEVAB	AUS	Injection valve cutoff activated by ZAS
B_EVABZI	AEVAB	LOK	Injection valve cutoff activated by ZAS AEVAB internal
B_EVASEL	AEVAB	AUS	Status:all local injector relevant to DASE are switched on
B_FAEVZ		EIN	condition cylinder fade out by tester
B_FOPHSNL	AEVAB	LOK	injection valve cutoff by fixed pattern without .....
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_NLPHEA	AEVAB	AUS	Injector deactivation for limp-home phase synchronization active
B_NLPHEAI	AEVAB	LOK	Ev Deactivation for emergency operation phase synchronization active AEVAB inter
B_PHSNL	NLPH	EIN	Condition phase search during phase sensor limp-home
B_ZAS		EIN	condition: beginning of cylinder shutdown
DEVOFF		EIN	injector fade out pattern at tester requirement
DFP_EV1	AEVAB	DOK	ECU int. fault path no.: injector 1
DFP_EV2	AEVAB	DOK	ECU int. fault path no.: injector 2
DFP_EV3	AEVAB	DOK	ECU int. fault path no.: injector 3
DFP_EV4	AEVAB	DOK	ECU int. fault path no.: injector 4
DFP_EV5	AEVAB	DOK	ECU int. fault path no.: injector 5
DFP_EV6	AEVAB	DOK	ECU int. fault path no.: injector 6
DFP_EV7	AEVAB	DOK	ECU int. fault path no.: injector 7
DFP_EV8	AEVAB	DOK	ECU int. fault path no.: injector 8
DMDEVAB	AEVAB	LOK	inject. valve cutoff pattern of misfire detection for the aktual ecu
DUMMY	AEVAB	LOK	
EEVX	AEVAB	AUS	Injection valve Errorbyte

Variable	Source	Type	Description
EVRBGN_ONE	AEVAB	LOK	ev.nr. -1 at begin of cylinder cut-off for REDABM
EVZ_AUS	AEVAB	AUS	injection cut off pattern
E_EV1	DEVE	EIN	error flag: injection valve of cyl. 1
E_EV2	DEVE	EIN	error flag: injection valve of cyl. 2
E_EV3	DEVE	EIN	error flag: injection valve of cyl. 3
E_EV4	DEVE	EIN	error flag: injection valve of cyl. 4
E_EV5	DEVE	EIN	error flag: injection valve of cyl. 5
E_EV6	DEVE	EIN	error flag: injection valve of cyl. 6
E_EV7	DEVE	EIN	error flag: injection valve of cyl. 7
E_EV8	DEVE	EIN	error flag: injection valve of cyl. 8
FLGTIAB	DMDMIL	EIN	state flag ti turn-of by catalyst damaging misfiring rates
FLGTIABC		EIN	state flag ti turn-of by catalyst damaging misfiring rates CAN
REDSOL	SWADAP	EIN	calculated desired cylinder cut-off step
REDSOLR	AEVAB	AUS	realized cylinder cut-off step
REDSOL_ONE	AEVAB	LOK	calculated desired cylinder cut-off step -1 for REDABM
SGID		EIN	ECU-ID
STATEAEVAB	AEVAB	AUS	No. of the active state in AEVAB
TVRNR	AEVAB	LOK	delay time from end of fuel cut of to normal combustion
ZYLEAUSB	NLPH	EIN	cylinder to fade out; binary description
ZZYL	GGDPG	EIN	SW-cylinder counter

FW AEVAB 6.20 Fixed Values

Parameter	Value	Description
CWEVAB		codeword injection valve cutoff

FB AEVAB 6.20 Detailed description of function

The function Output Injection Valve cutoff, AEVAB, determines which of the injection valves must be disconnected. This decision is made according to the fix injection valve cutoff patterns established by the misfire detection, %DMD... (flgtiab, flgtiabc bei SY_SGANZ =2), according to the disconnection of an injection valve commanded by the garage testing engineer (devoff), or the injection valve final amplifier errors, or the injection valve cutoff pattern established by means of code word CWEVAB, or according to the engine torque reduction via the reduction ratio redsol.
The functioning is described by means of a state machine (see diagram aevab-abm).
The function is always in one of the states represented graphically during any logical decision. Any change-over from one state to another always follows the sense of the arrows drawn in the diagram/text.
Invariable (fix) injection valve cutoff patterns are such patterns where e determined individual injection valve must be disconnected, e.g. in the event of a final amplifier error or if the misfire detection has written an error into the RAM cell flgtiab.
In contrast to this, a reduction in the engine torque requires the next possible injection valve to be disconnected.

Any injection valve cutoff via invariable cutoff patterns is indicated in the RAM cell abmf. This cell is used to calculate the base reduction, redbas.

The I.V. cutoff pattern from the mapping REDABM (Master), or from REDABMB, REDABMC (Slave1, 2 in the event of more than 2 ecu's) is respectively indicated in RAM cell evz_aus.
See also the application information in this FDEF.
In order to achieve the functionality of injection valve cutoff during a cylinder disconnection (SY_ZAS = true), the same mechanism is used as for torque reduction. This is, redsol is used as an "interface" to pass over the number of injection valves which require to be disconnected. This reduction is used to address the characteristic line REDABMZ. In this case, the disconnection does not start out with any injection valve whatever but according to the invariable pattern from the characteristic curve REDABMZ. Therefore, evrbgn_one is not used as RAM address.
The function AEVAB is also used to do the synchronizing during emergency phase loop search.
To do so, the injection valve zyleausb (Bit Nr. 0 = 1 corresponds to I.V.1, ...) is disconnected for anzeausb times. Now, the misfire detection determines the cylinder associated to this injection valve which equals to the synchronizing for ignition purposes.

Description of the individual states:

Initialization: Condition Init

This condition is run once at S_kl15 = 1 to initialize the RAM cells.

No injection valve disconnection active: Condition No_evab

The function is in this state if no injection valve cutoff is requested.

Torque reduction: Condition Momred

If only the torque reduction is active, redsol establishes the number of injection valves to be disconnected.
On systems with two ecu's (2SG), there are different disconnection strategies:
disconnection only on the Master control device first; only when the Master is completely disconnected, the injection valve disconnection starts out on the Slave control device or disconnection, one by one, sequentially and mutually on Master and Slave, i.e. M,S,M,S,...
The injection valve disconnection starts out with the valve which has the number evrbgn_one = zzylabm+SY_ZYLZA/2; counting mode of zzylabm: (0 ... SY_ZYLZA-1), counting mode of evrbgn_one: (Ev1 =0... Ev8 = 7).
Here, zzylabm represents the cylinder which is about to be fired. However, fuel has already been injected also into the successive cylinder which will be fired next because of the injection advance angle; this means the injection valve of the successive cylinder cannot be disconnected but only the next injection valve but one. This next-plus-one injection is determined by the offset SY_ZYLZA/2. This rule is a compromise because the number of the next injection valve to be activated does not exist in the present CIFI version. In this way, an injection valve is disconnected after one camshaft revolution at the latest.
For 1 ecu (1SG) or for the Master (>1SG), the injection valve cutoff pattern evz_aus is determined according to the invariable mapping REDABM using the value evrbgn_one and value redsol_one = redsol-1. The I.V. cutoff pattern for the 2SG Slave device is described by the mapping REDABMS.
If SY_GRDWOF = 0, the variable zzylabm is generated from zzyl, else from zzylbi.
In the event of a cylinder disconnection (SY_ZAS = true), evrbgn_one is not considered because the injection valves to be disconnected follow an invariable association scheme. The disconnection patterns are contained in the characteristic curve REDABMZ.
B_evabz = true indicates that an injection valve disconnection has been activated via B_zas.

During DV substitution operation (B_dknolu, B_dkpu), a complete injection valve disconnection is requested by redsol = SY_REDMX above the engine speed threshold NMXSKA. If B_dkuevab = true, the above request is fed back to the torque calculation via the regular injection valve disconnection by setting redsolr = SY_REDMX.

Disconnection by means of invariable injection valve cutoff patterns: Condition Fixred
----

The invariable injection valve cutoff patterns flgtiab, devoff, eevx are linked by a logical OR operation and are available for the disconnection of the injection valves in the form of the bit pattern abmf.
On concepts for 2 control devices (2SG), abmf contains the injection valves which are respectively to be disconnected on Master and Slave.
Since the injection valves are only disconnected according to invariable cutoff patterns in this condition, evz_aus is set = abmf.
The condition Fixred is also used in the exceptional case of synchronizing during phase generator emergency operation, i.e. in the event that the injection valve indicated by zyleausb is disconnected for anzeausb injection cycles while B_phsnl = true; Fixred is however only used in these conditions if no other invariable-pattern disconnection is active.
While the synchrony is being searched, the bit B_nlphea is = true.This bit is usually reset to the state No_evab when the request condition, B_nlph, assumes the value false. If another invariable-pattern disconnection or a torque reduction is requested by redsol during phase synchronizing, the invariable-pattern I.V. disconnection used to search the phase synchrony is terminated and B_nlphea is set to the value false. The search for phase synchrony remains locked until B_nlphea = false is detected in condition No_evab.

Disconnection by means of invariable disconnection patterns and torque reduction: condition Mom_Fixred
----

The I.V. cutoff pattern evz_aus which is to be executed is formed by means of a logical OR operation from the invariable cutoff patterns devoff, flgtiab, eevx and the cutoff pattern of the torque reduction, REDABM or REDABMS.
abmf = devoff OR flgtiab OR eevx
evz_aus = abmf OR REDABM (or respectively REDABMS)

In the event that the disconnection is induced by a torque reduction, the explanation given for condition Momred applies.

Condition Wait_2CSR:

This condition causes a delay of two camshaft revolutions (2CSR) before via B_evasel = true unlocks the misfire detection and B_evloc = true causes, for example, the labmda control to be released again.

The cutoff patterns evz_austot which at the end must really be carried out via function the AEVABZK is analyzed in function BGEVAB:
Here, the bank where one or more injection valves are disconnected is determined.
B_bevab = true: at least 1 I.V. on Bank1 is disconnected.
B_bevab2 = true: at least 1 I.V. on Bank2 is disconnected.
The disconnection of any injection valve in general and of any final amplifier error is indicated by B_evloc.
B_evloc = false means: an injection valve is disconnected or a final amplifier error is present.

The function AEVAB locks the misfire recognition by setting B_evasel = false if either a change-over towards condition Momevab or towards condition Fest_evab occurs, of if a testing engineer intervention is active via devoff.

Request for disconnection	cutoff conditions	cutoff information	Misfire recognition	
Tester intervention	devoff > 0 & B_faevz = TRUE	-> B_evloc = false	-> B_evasel = false	Misfire recognition locked
Torque reduction	redsol > 0	-> B_evloc = false	-> B_evasel = false	Misfire recognition locked
Final amplifier error diagnosis	eevx > 0	-> B_evloc = false	-> B_evasel = true	Misfire recognition active
Misfire recognition	flgtiab > 0	-> B_evloc = false	-> B_evasel = true	Misfire recognition active, Search for further errors
Cylinder disconnection	B_zas	-> B_evloc = false	-> B_evasel = false	Misfire recognition locked

During cylinder disconnection (ZAS, disconnection of a bank), this functionality is implemented by means of a torque reduction (redsol intervention).
However, the injection valve disconnection pattern from characteristic curve REDABMZ is used if B_zas =true since in this case, the first disconnected injection valve is a determined individual valve. All torque interventions use the I.V. disconnection pattern of this characteristic curve until the torque reduction is reset (redsol = 0).
Any I.V. disconnection during ZAS (cylinder disconnection) is indicated via B_evabz.

During application on the test bench, it is often necessary to operate the engine without injection. Code word CWEVAB allows to disconnect the individual injection valves. Here, Bit 0 corresponds to I.V.1 (Ev1). By default, all injection valves are active: CWEVAB = 0

```
Description of the change-over conditions of function AEVAB:
------------------------------------------------------------

Condition: Init ----------------------------------------------------------------------------------------------------

Transition:-------------------------------------------------------------------------------------------------
      End Init:        ---
                       C_ini = FALSE
                       ---                                          -- End of Initialization
Condition: No_evab -------------------------------------------------------------------------------------------------

Transition:---------------------------------------------------------------------------------------------------------
      to Fixred:
                       ---
                       ((devoff >0) and (B_faevz = TRUE)) or (flgtiab > 0 ) or (eevx > 0) or ((B_nlpheai = FALSE)&B_phsnl=TRUE)
                       ---                                               -- Start of an I.V. cutoff by means of an
                                                                            invariable I.V. cutoff pattern by misfire
                                                                            detection flgtiab, I.V. final amplifier error
                                                                            eevx,  Tester request
                                                                            devoff or phase generator emergency operation.
Transition:---------------------------------------------------------------------------------------------------------
      to Momred:
                       ---
                       redsolr > 0
                       ---                                          -- --- Start of an I.V. cutoff by torque reduction
                                                                       --- via the reduction ratio redsol
Condition: Momred -------------------------------------------------------------------------------------------------
Transition:---------------------------------------------------------------------------------------------------------
      ad Fixred:
                       ---
                       ((devoff >0) and (B_faevz = TRUE)) or (flgtiab > 0) or (eevx > 0)
                       ---                                          ----- Tester, I.V. final amplifier diagnosis or
                                                                          misfire detection request the disconnection of
                                                                          further I.V.'s in addition to the torque reduction
Transition: --------------------------------------------------------------------------------------------------------
      End Momred:   ---
                       (redsolr = 0 )
                       ---                                          -- --- From here on, no more I.V. cutoff
                                                                       --- is commanded via the torque reduction
Condition:  Fixred ------------------------------------------------------------------------------------------------
Transition:---------------------------------------------------------------------------------------------------------
      ad Momred:   ---
                       redsolr > 0
                       ---                                          -- --- Torque reduction requests further
                                                                       --- I.V. cutoff in addition to the I.V.
                                                                           disconnectuions commanded by misfire recognition,
                                                                           I.V. final amplifier diagnosis or tester
Transition:---------------------------------------------------------------------------------------------------------
      End Fixred:
                       ---
                       ((devoff=0) and (B_faevz = FALSE)) and (flgtiab = 0) and (eevx = 0) and (anzeab = 0)
                       ---                                          -- --- From here on, no request for I.V. disconnection
                                                                           by Tester, I.V. diagnosis, detection or phase
                                                                           generator emergency operation is present any more
```

```
Condition:  Mom_Fixred -----------------------------------------------------------------------------------------------------------
Transition:----------------------------------------------------------------------------------------------------------------------
      Only Momred:                                                       --- End of the disconnection
                                                                         --- by misfire detecttion, tester request or
                                                                         --- phase generator emergency operation.

                       ((devoff=0) and (B_faevz = FALSE)) and (flgtiab = 0) and (eevx = 0) and (anzeab = 0)
                       ---
Transition:----------------------------------------------------------------------------------------------------------------------
      Only Fixred:                                                       --- End of the I.V. cutoff by
                                                                         --- Torque reduction
                       redsolr = 0
                       ---
Condition: Wait_2CSR ------------------------------------------------------------------------------------------------------------
Transition:----------------------------------------------------------------------------------------------------------------------
      End evab:       ---
                       tvrnr >= (2*SY_ZYLZA)                                -- --- End of the I.V. cutoff, each cylinder has
                                                                               ---  been fired once, i.e. normal operation is.
                                                                               --- ensured
```

APP AEVAB 6.20 Application hint

```
System constant values for the functionality injection valve cutoff
Definition in %PROKON
=====================================================

SY_SGANZ:       Number of control devices (SG) used in the project
                                        1: 1SG (one device used)
                                        2: 2SG (two devices used)
                                        3: 3SG (three devices used)

SY_ZZBANK:      Injection valves associated to the exhaust gas bank of the Master control device (SGA)

SY_ZZBANKB:     Injection valves associated to the exhaust gas bank of the Slave1 control device (SGB)

SY_ZZBANKC:     Injection valves associated to the exhaust gas bank of the Slave2 control device (SGC)

Meaning of SY_ZZBANKx: (applies to all above system constant values)

        Bit position    7 6 5 4 3 2 1 0
        Inj.Valve Nr.   8 7 6 5 4 3 2 1 Counted on the Engine: 1 ... SY_ZYLZA
        Association     x x x x x x 1 0 0: I.V. belongs to exhaust gas bank 1 of control device x
                                        1: I.V. belongs to exhaust gas bank 2 of control device x

SY_ZAS:         Project implements cylinder disconnection

SY_EGAS:        Project with EGAS system

SY_ZYLZA:       Number of cylinders of one control device with respect to injection and ignition

SY_REDMX:       Number of cylinders of one control device with respect to injection and ignition

Meaning of other input values:

Only present if SY_2SG = true

Identification code for Master/Slave : is specified in %SGA

B_masterhw = true       --> control device (SG) is MasterSG

B_masterhw = false      --> control device (SG) is SlaveSG; whether it is Slave1 or Slave2 is determined by sgid

sgid:                   0: MasterSG or SGA
                        1: Slave1 control device, called SGB in the further text
                        2: Slave2 control device, called SGC in the further text

Only present during cylinder disconnection (SY_ZAS = true):

B_zas = true            -> Request for disconnection of the cylinders which are governed by ZAS
```

```
Possible functional features via injection valve disconnection:
===============================================================

Projects with one control device (SG):
--------------------------------------

SY_SGANZ = 1                    ( 1 control device used)

redsol  0 ...  SY_REDMX         --> reduction ratio = 1 Cylinder / SG --> 1 cyl. per reduction stage

Functional features:

Cylinder disconnection ZAS              Input: B_zas,
                                cutoff pattern: evz_aus = f(REDABMZ
n
Misfire detection DMD*          Input: flgtiab
                                cutoff pattern: evz_aus = f(flgtiab)

Torque reduction MDRED  Input: redsol
                                cutoff pattern: evz_aus = f(REDABM)

Phase generator emergency operation NLPH                Input: B_phsnl, zyleausb, anzeausb
                                cutoff pattern: evz_aus = f(zyleausb)

I.V. disconnection by testing engineer  Input: B_faevz, devoff
                                cutoff pattern: evz_aus = f(devoff)

I.V. disconnection by VS100     Code word CWEVAB Bit 0  = Ev1 .... Default value = 0


Projects with two control devices (2SG):
------------------------------------

SY_SGANZ = 2  ( 2 control devices used, Master/SGA, Slave/SGB)

redsol 0 ... SY_SGNR * SY_REDMX --> Reduction ratio = 0.5 cylinders / per SG --> 1 cyl. / reduction stage


Functional features:

Cylinder disconnection ZAS              not implemented

Misfire recognition DMD*                Input: flgtiab, flgtiabc
Program runs on SGB             cutoff pattern: evz_aus = f(flgtiabc) for Master/ SGA
                                                evz_aus = f(flgtiab) for Slave/SGB

Torque reduction MDRED  Input: redsol
                                cutoff pattern: evz_aus = f(REDABM) for Master/SGA
                                                evz_aus = f(REDABMB) for Slave/SGB

Phase generator emergency operation NLPH        not implemented

I.V. cutoff by testing engineer Input: B_faevz, devoff
                                cutoff pattern: evz_aus = f(devoff)

I.V. cutoff by VS100    Code word CWEVAB Bit 0  = Ev1 .... Default value = 0
```

Projects with three control devices (3SG):

SY_SGANZ = 3 (3 control devices used)

redsol 0 ... SY_REDMX   --> reduction level = 1 cylinder per SG --> 3 cyl. per reduction stage

Functional features:

```
Cylinder disconnection ZAS              not implemented

Misfire detection DMD*          Input: ??       Method not yet specified
                                cutoff pattern:  no effect

Torque reduction MDRED  Input: redsol
                                cutoff pattern: evz_aus = f(REDABM) for Master/SGA
                                                evz_aus = f(REDABMB) for Slave1/SGB
                                                evz_aus = f(REDABMC) for Slave2/SGC
Phase generator emergency operation NLPH        not implemented

I.V. cutoff by testing engineer Input: B_faevz, devoff
                                cutoff pattern: evz_aus = f(devoff)

I.V. cutoff by VS100    Code word CWEVAB Bit 0  = Ev1 .... Default value = 0
```

Example for the configuration of a 8-cylinder engine: the engine can be operated using one control device (1SG) or two control devices (2SG)

1SG:	2SG:
SY_SGANZ = 1	SY_SGANZ = 2
SY_ZYLZA = 8	SY_ZYLZA = 4
sgid not present	sgid = 1/0
SY_REDMX = 8	SY_REDMX = 4

The cutoff pattern itself is memorized in the constant mapping REDABM = f(evrbgn_one, redsol_one) or in REDABMB, REDABMC for the Slave control device (SGB). The access to this mapping depends on the cylinder which is about to be fired, zzylabm, and the torque reduction ratio redsol requested by the torque reduction.

The first injection valve to be disconnected is determined by evrbgn_one = zzylabm + SY_ZYLZA/2 because the injection valves which follow next after the cylinder which is about to be fired have already completed their injection cycle and a disconnection is no longer possible.
The characteristic curve REDABM starts out with index 0. Therefore, a conversion is carried out for any indexed access:
        redsol_one = redsol - 1   Only these two variables are present in the system.

The associations between injection valves and ignition order, injection order, the bank association of the injection valves and the association between the disconnection pattern REDABM and the I.V.s are described in the following section.

```
Example 8-cylinder engine 1SG (one control device):
===================================================
                        Axially-mounted front engine cylinder scheme
                                    ^
                                    | Vehicle front side
                                5       1
                Bank2           6       2       Bank1
                                7       3
                                8       4
                                    XX
                                Clutch side

Cylinder Nr.                    1 5 4 8 6 3 7 2 <--- Firing order in direction of the arrow,
                                                     cylinder nr. according to above cylinder scheme
I.V. Nr.                        8 7 6 5 4 3 2 1 <--- Injection order in direction of the arrow, user counting scheme 1 ... SY_ZYLZA
I.V. Nr.                        7 6 5 4 3 2 1 0 <--- Injection order in direction of the arrow,
                                | | | | | | | |      SG internal counting mode 0 ... SY_ZYLZA-1corresponds to counting mode of zzyl
SY_ZZBANK = zzbank = 90 dec     0 1 0 1 1 0 1 0      Cylinder-Bank association  Bit = false (0): I.V. belongs to Bank1,
                                | | | | | | | |                                 Bit = true (1): I.V. belongs to Bank 2
REDABM-Bit position             7 6 5 4 3 2 1 0
cutoff pattern  REDABM                                  evrbgn_one: 0
        redsol_one:     0       0 0 0 0 0 0 0 1         01 dec  redsol_one = redsol -1, if redsol  > 0
                      | 1       0 0 0 1 0 0 0 1         17
                      | 2       0 0 0 1 0 1 0 1         21
                      | 3       0 1 0 1 0 1 0 1         85
                      | 4       0 1 0 1 0 1 1 1         87
                      | 5       0 1 1 1 0 1 1 1         119
                      | 6       0 1 1 1 1 1 1 1         127
                      v 7       1 1 1 1 1 1 1 1         255
```

The pattern with evrbgn_one = 1 is generated by a logical shift to the left side by one position, i.e. any "1" which goes out of the matrix on the left side is inserted on the left side.

```
                                                        evrbgn_one: 1
        redsol_one:     0       0 0 0 0 0 0 1 0         02 dec
                        1       0 0 1 0 0 0 1 0         34
                        2       0 0 1 0 1 0 1 0         42
                        3       1 0 1 0 1 0 1 0         170
                        4       1 0 1 0 1 0 1 1         171
                        5       1 0 1 1 1 0 1 1         187
                        6       1 0 1 1 1 1 1 1         191
                        7       1 1 1 1 1 1 1 1         255

        .
        .               Rotation/shifting of the respective preceding pattern
        .
                                                        evrbgn_one = SY_ZYLZA-1 last pattern
```

Here, another time an explanation of the way how injection valves and cylinders are counted:
Injection valve 1 (Ev1) according to the user counting mode is identical to injection valve 0 (Ev0) according to the internal control device counting mode. This injection valve is opened for the time ti_ev0 and provides the fuel mass required for cylinder zzyl = 0 according to the SG-internal counting mode, i.e. cylinder 2 according to the firing order of the engine from the above example.
Injection valve 1 and the cylinder nr. 2 according to the firing order are associated one to another by the wiring (harness).
This injection valve 1 is disconnected if the value of REDABM-Bit0 or correspondingly evz_aus-Bit0 has the value 1.

```
Example 8-cylinder engine 2SG (two control devices):
====================================================

Disconnection of the cylinders first on Master and then on Slave:
        The applicable redsol resolution is one engine cylinder on projects with two control devices (2SG),
        i.e. maximum redsol = 2*SY_ZYLZA = 8
                        Axially-mounted rear engine cylinder scheme
                                    ^
                                    | Vehicle front end
                                8       1
                Bank2           7       2       Bank1
                                6       3
                                5       4
                                    XX
                                Clutch side
                        Slave (SGB)   Master (SGA)
Cylinder Nr.            6 2 8 4       7 3 5 1 <--- Firing order in direction of the arrow,
                                                   cyl.nr. according to above engine counting scheme
I.V..Nr.                8 7 6 5       4 3 2 1 <--- Injection order in direction of the arrow,
                                                   counting mode 1 ... SY_ZYLZA of entire engine
I.V..Nr.                4 3 2 1       4 3 2 1 <--- Injection order in direction of the arrow,
                                                   counting mode 1 ... SY_ZYLZA Slave/Master
I.V..Nr.                3 2 1 0       3 2 1 0 <--- Injection order in direction of the arrow,
                                                   SG-internal counting mode 0 ... SY_ZYLZA-1
                | | | | | | | |   | | | | | | | |  which corresponds to the counting mode of zzyl Slave/Master
SY_ZZBANKB      0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0  SY_ZZBANK  Cylinder association always with respect to Bank1: Bit = false (0)
                                                   means the injection valve belongs to Bank1,
                |             |   | | | | | | | |  Bit = true (1) means the injection valve belongs to Bank 2
REDABM Bit pos.                   7 6 5 4 3 2 1 0
REDABMB Bit pos.7 6 5 4 3 2 1 0
                REDABMB:          REDABM:               evrbgn_one: 0
redsol_one: 0   0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 1       redsol_one = redsol -1 if redsol  > 0
        |   1   0 0 0 0 0 0 0 0   0 0 0 0 0 0 1 1
        |   2   0 0 0 0 0 0 0 0   0 0 0 0 0 1 1 1
        |   3   0 0 0 0 0 0 0 0   0 0 0 0 1 1 1 1
        |   4   0 0 0 0 0 0 0 1   0 0 0 0 1 1 1 1
        |   5   0 0 0 0 0 0 1 1   0 0 0 0 1 1 1 1
        |   6   0 0 0 0 0 1 1 1   0 0 0 0 1 1 1 1
        |   7   0 0 0 0 1 1 1 1   0 0 0 0 1 1 1 1
                \------ ------/   \------ ------/
                       V                 V
                   Slave (SGB)      Master (SGA)
        .
        .               Rotation/shift of the respective preceding matrix: see above in section 1SG concept
        .
```

Example 8-cylinder engine with one control device (1SG):
==

Disconnection of the cylinders mutually on Bank1 and on Bank2:

```
                        Axially-mounted rear engine cylinder scheme
                                    ^
                                    | Vehicle front end
                                8       1
                Bank2           7       2       Bank1
                                6       3
                                5       4
                                    XX
                                Clutch side
                Slave (SGB)   Master (SGA)
Cylinder Nr.    6 2 8 4       7 3 5 1 <--- Firing order in direction of the arrow, cylinder nr. according to engine counting scheme
I.V..Nr.        8 7 6 5       4 3 2 1 <--- Inj. order in direction of the arrow, counting mode 1 ... SY_ZYLZA for the entire engine
I.V..Nr.        4 3 2 1       4 3 2 1 <--- Injection order in direction of the arrow, counting mode 1 ... SY_ZYLZA Slave/Master
I.V..Nr.        3 2 1 0       3 2 1 0 <--- Injection mode in direction of the arrow, SG internal counting mode 0 ... SY_ZYLZA-1
                | | | | | | | |   | | | | | | | |      which corresponds to the zzyl counting mode Slave/Master
SY_ZZBANKB      0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0   SY_ZZBANK The cylinder association is always stated with respect to Bank1:
                                                              Bit = false (0) means the injection valve belongs to Bank1
                |             |   | | | | | | | |             Bit = true (1) means the injection valve belongs to Bank 2
REDABM-Bit pos.                   7 6 5 4 3 2 1 0
REDABMB-Bit pos. 7 6 5 4 3 2 1 0
                REDABMB:          REDABM:               evrbgn_one: 0
redsol_one: 0   0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 1       redsol_one = redsol -1 if redsol  > 0
        |   1   0 0 0 0 0 0 0 1   0 0 0 0 0 0 0 1
        |   2   0 0 0 0 0 0 0 1   0 0 0 0 0 0 1 1
        |   3   0 0 0 0 0 0 1 1   0 0 0 0 0 0 1 1
        |   4   0 0 0 0 0 0 1 1   0 0 0 0 0 1 1 1
        |   5   0 0 0 0 0 1 1 1   0 0 0 0 0 1 1 1
        |   6   0 0 0 0 0 1 1 1   0 0 0 0 1 1 1 1
        |   7   0 0 0 0 1 1 1 1   0 0 0 0 1 1 1 1
                \------ ------/   \------ ------/
                       V                 V
                   Slave (SGB)       Master (SGA)
        .
        .               Rotation/shifting of the respective preceding pattern: see above in the section on 1SG concept
        .
```

Cylinder disconnection (ZAS):

To the characteristic curve REDABMZ (= injection valve cutoff pattern) applies the same as applies to REDABM. However, the parameter evrbgn_one does not exist.

For redsol_one = 0 to SY_ZYLZA/2, the I.V. cutoff pattern must be drawn in for the ZAS cylinders. For higher redsol_one values, more and more injection valves are disconnected.

The cutoff pattern which is finally applied is generated by means of a logical OR operation from the invariable cutoff patterns and the I.V. cutoff patterns selected by the torque reduction (REDABM, REDABMB, REDABMC, REDABMZ).

Invariable cutoff patterns:	eevx	final amplifier error
	flgtiab	Cylinders with irregular misfire which is detected by the function misfire detection
	devoff	injection valves to be disconnected by the tester

Entire invariable cutoff pattern:
abmf = eevx OR flgtiab OR devoff

Entire injection valve cutoff pattern:

If no cylinder disconnection is active:
evz_aus = abmf OR [REDABM (evr_bgn_one, redsol_one)] If 2 control devices are used (2SG), the mapping REDABMB or REDABMC is used on the Slave side instead of REDABM.

If a cylinder disconnection is active:
evz_aus = abmf OR [REDABMZ (redsol_one)] Not possible if two control devices are used (2SG)

On EGAS systems, it is the function AEVABZK which establishes whether an injection valve cutoff has been caused by the torque reduction (redsol) or by interventions of a monitoring function; on systems without EGAS, only the torque reduction is active.
If a torque intervention is active, evz_austot = evz_aus; during interventions by monitoring functions, evz_austot = 255. During torque interventions, only those bits in evz_aus are set which correspond to physically installed injection valves. This means that evz_aus is always < 255 on control devices where SY_ZYLZA < 8.
This allows to distinguish whether a torque intervention or a monitoring is active when evz_aus is measured.

The calculation of the actually performed reduction (redist = number of the disconnected I.V.'s in evz_austot, or redbas = number of the disconnected I.V.'s in abmf) is performed in function BGEVAB.
The physical injection valve disconnection is governed by function %ACIFI. If a disconnection is performed, the corresponding final amplifier does not receive any input although the associated ti_evx is > 0.

There are different criteria for the definition of the injection valve cutoff pattern:

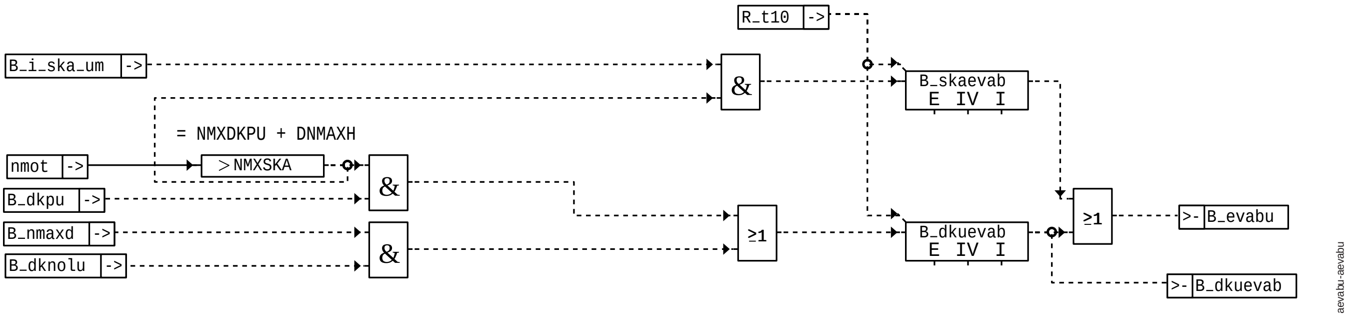
-- on projects with one control device (1SG), the injection valves are disconnected mutually: first one valve on one bank, then a second on the other bank, and so on according to the increase in the reduction ratio;
-- it is possible to implement the disconnection either in a way that always the respective next injection valve according to the firing order is disconnected, or in a way that an injection valve with a constant "firing order distance" with respect to the actually fired cylinder is disconnected which reduces the engine roughness if two successive injection valves are disconnected.
-- on projects with two control devices (2SG), first all injection valves on one engine side (Master side) are disconnected and only as the reduction continues, the valves on the other side are disconnected.

In normal conditions, the cutoff patterns which are shifted via evrbgn_one are generated by rotating/shifting the matrix of evrbn_one - 1 towards the left side.

The beginning of the I.V. cutoff is synchronized to the cylinder which is about to be fired when the function is activated, i.e. the first injection valve would be disconnected no sooner than 2 camshaft revolutions later.
If the invariable offset SY_ZYLZA/2 is applied, this beginning can be shifted to an earlier point of time so that the first injection valve is disconnected after 1 camshaft revolution.

AEVABU 1.10 Output injection-valve cut-off by monitoring functions (EGAS)

FDEF AEVABU 1.10 Function definition



aevabu-aevabu

ABK AEVABU 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NMXSKA			FW	Maximum permitted engine speed in case of unknown throttle position -> cut off

Variable	Source	Type	Description
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_DKUEVAB	AEVABU	AUS	Injection valve cut off by throttle blade uncorrect
B_EVABU	AEVABU	AUS	Fuel cutoff by .....
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NMAXD		EIN	condition rpm limiting with injection masking
B_SKAEVAB	AEVABU	LOK	Fuel cutoff by safety fuel shut-down
NMOT	SWADAP	EIN	engine speed
R_T10		EIN	Time schedule 10 ms

FW AEVABU 1.10 Fixed Values

Parameter	Value	Description
NMXSKA		Maximum permitted engine speed in case of unknown throttle position -> cut off

FB AEVABU 1.10 Detailed description of function

This function realizes the interventions of the monitioring functions for the injection valve shut-off.
Via the condition B_i_ska_um a so-called safety fuel deactivation is requested, when the engine speed is > NMXSKA.
For non-plausible poti values of the EGAS-actuator and engine speed > NMXSKA, a complete injection valve shut-off is requested. If the EGAS-actuator is at zero current, a complete injection valve shut-off is requested at B_nmaxd.
The injection valve shut-off pattern for a complete fuel shut-off is realized in the function AEVABZK in the RAM-cell evz_austot.

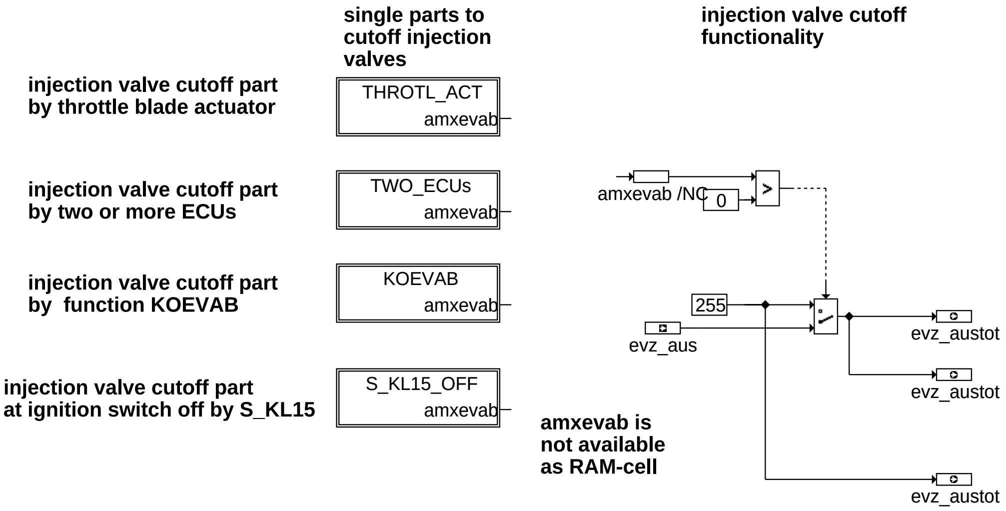
APP AEVABU 1.10 Application hint

```
        NMXSKA = NMXDKPU + DNMAXH
```

AEVABZK 1.20 Output injection-valve cut-off %MDRED + total shutdown by monitioring functions

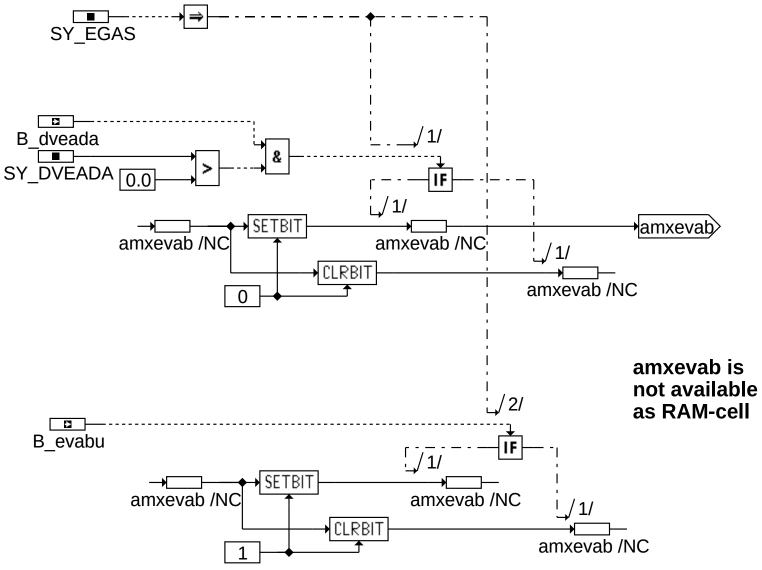
FDEF AEVABZK 1.20 Function definition

AEVABZK 1.20

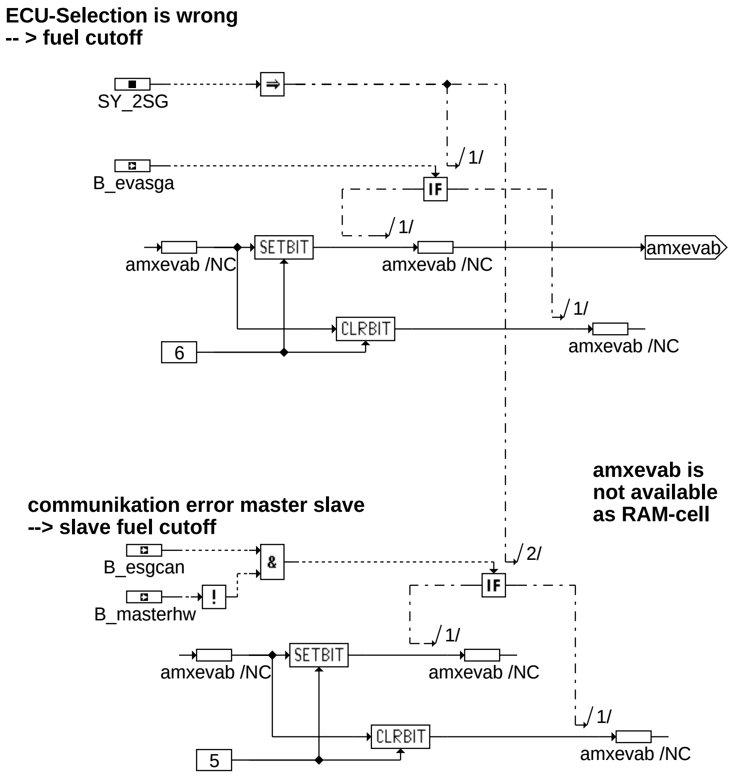


injection may also be disabled if immobilizer is active

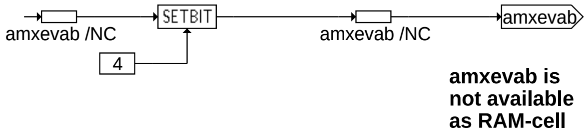
aevabzk-main



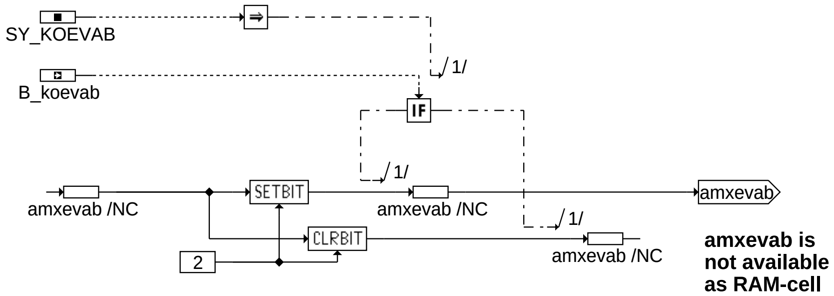
aevabzk-throtl-act



aevabzk-two-ecus



aevabzk-s-kl15-off



aevabzk-koevab

ABK AEVABZK 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_DVEADA			SYS (REF)	system constant BGVE: disabling injection and ignition during DV-E-adaptation
SY_EGAS			SYS (REF)	System constant E-GAS present
SY_KOEVAB			SYS (REF)	coordination injection valve cutoff by function KOEVAB

Variable	Source	Type	Description
B_DVEADA	BGDVE	EIN	condition: disabling injection during DV-E-adaptation
B_ECULOCK		EIN	Locking request immobilyzer
B_ESGCAN		EIN	Condition error ecu-CAN for 2 ME-ecu's
B_EVABU	AEVABU	EIN	Fuel cutoff by .....
B_EVASGA		EIN	condition fuel cutoff by ECU-ID selection
B_KOEVAB	KOEVAB	EIN	injection valve cutoff active by function KOEVAB
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)

Variable	Source	Type	Description
EVZ_AUS	AEVAB	EIN	injection cut off pattern
EVZ_AUSTOT	AEVABZK	AUS	injection cut off pattern total

FW AEVABZK 1.20 Fixed Values

Parameter	Value	Description

FB AEVABZK 1.20 Detailed description of function

The function transmits the injection valve cutoff pattern, evz_aus, via the RAM cell evz_austot to the function ACIFI on non-EGAS systems. The fuel cutoff itself is performed in function ACIFI.
During ecu after-running, the cutoff pattern 255 is sent. (Subfunction S_KL_15_OFF)
On EGAS systems (Subfunction THROTL_ACT), the injection valve cutoff pattern evz_aus is usually as well sent via evz_austot to the function ACIFI.
However, if monitoring functions request an injection valve cutoff via the input B_evabu, then evz_austot = 255 is transmitted to the function ACIFI which is equal to a request for a complete injection cutoff.
If the EGAS actuator is exchanged, the lower mechanical end position must be learned again by adaptation. During this period, no engine speed > starter motor speed may occur. B_dveada prevents that the engine can be started up before the EGAS actuator position has been adapted after an exchange of the EGAS actuator has been recognized; i.e. if SY_DVEADA > 0, then evz_austot = 255 (complete injection valve cutoff).
The subfunction TWO_ECUS shows the additional functional features of the injection valve disconnection on systems with more than one ecu's.

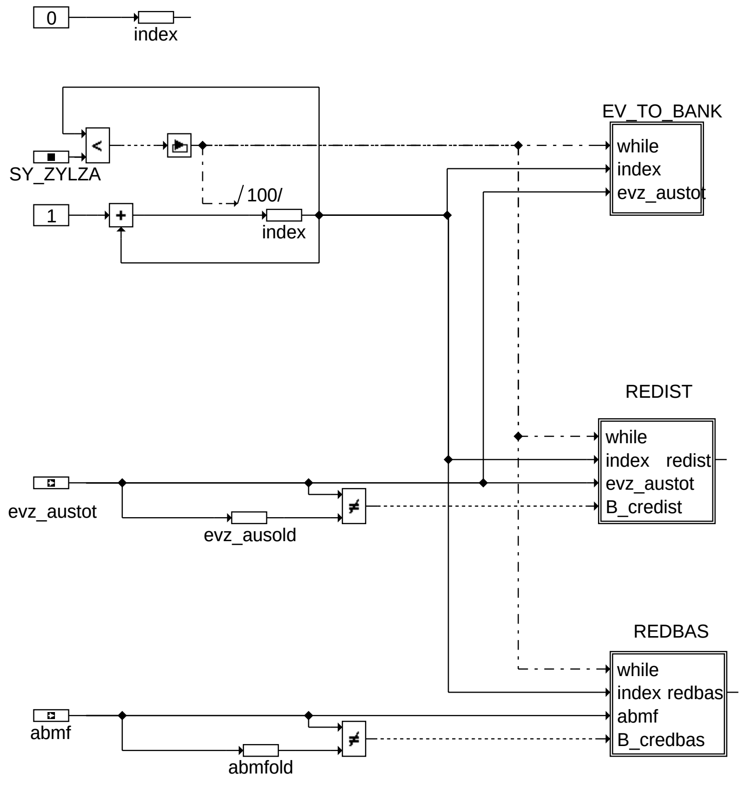
The subfunction KOEVAB allows to implement injection valve cutoff types specific to a project, e.g. injection valve cutoff in the event of errors by the automatic gearbox, recognized engine backward movement, engine stalling etc.
To release the diagnosis "misfire detection", the bit B_evasel is generated as follows: B_dmdstop (locks the misfire detection via function AEVAB during torque interventions) is linked by means of an OR operation to the other types of injection valve cutoff of function AEVABZK. If B_evasel = true --> misfire detection is released.

APP AEVABZK 1.20 Application hint

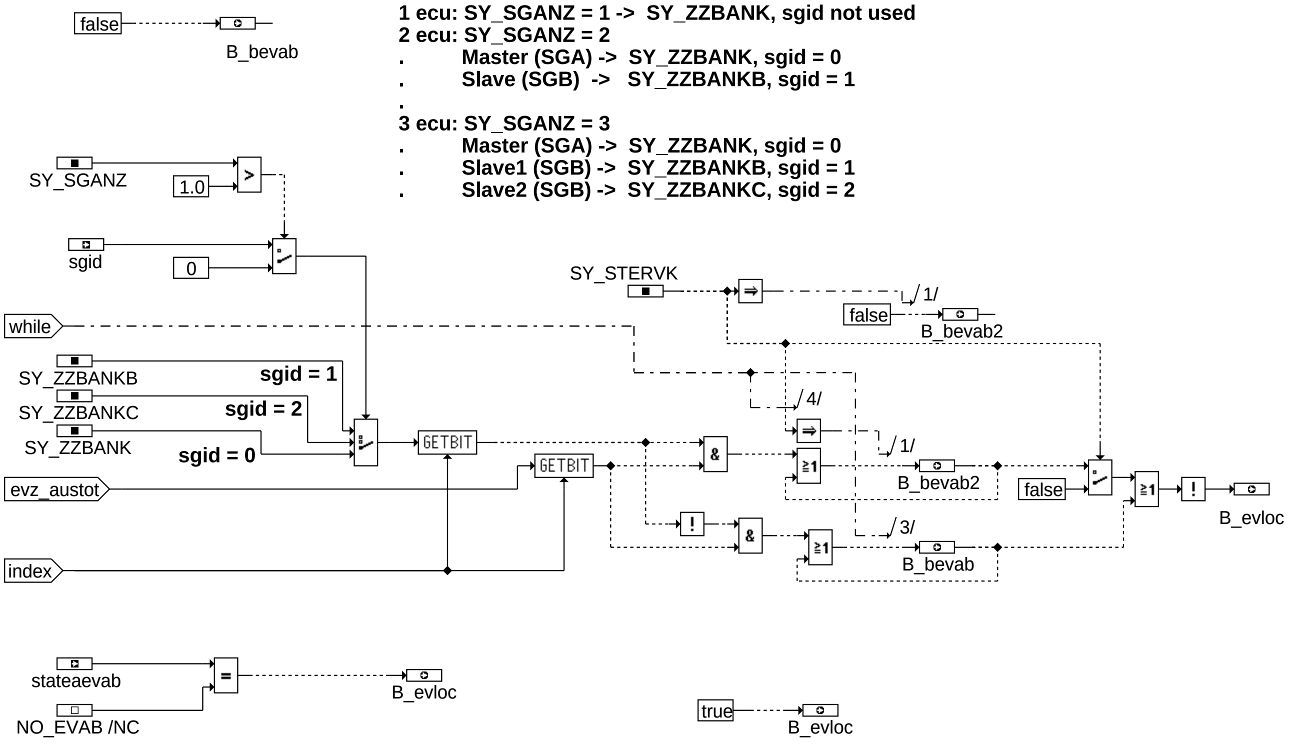
BGEVAB 1.20 Calculation of the actual reduction stage by ignition-valve cut-off

FDEF BGEVAB 1.20 Function definition

BGEVAB 1.20

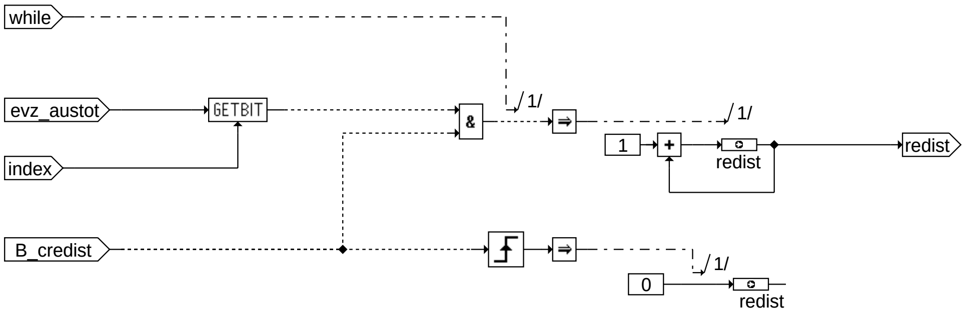


bgevab-main

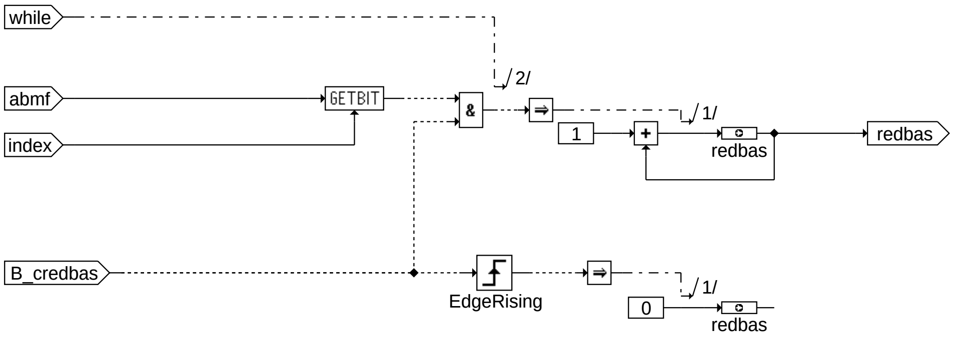


1 ecu: SY_SGANZ = 1 -> SY_ZZBANK, sgid not used
2 ecu: SY_SGANZ = 2
. Master (SGA) -> SY_ZZBANK, sgid = 0
. Slave (SGB) -> SY_ZZBANKB, sgid = 1
.
3 ecu: SY_SGANZ = 3
. Master (SGA) -> SY_ZZBANK, sgid = 0
. Slave1 (SGB) -> SY_ZZBANKB, sgid = 1
. Slave2 (SGB) -> SY_ZZBANKC, sgid = 2

bgevab-ev-to-bank



bgevab-redist



bgevab-redbas

ABK BGEVAB 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_SGANZ			SYS (REF)	system constant number engine control unit
SY_STERVK			SYS (REF)	system constant condition: stereo exhaust system upstream of cat
SY_ZYLZA			SYS (REF)	system constant number of cylinders
SY_ZZBANK			SYS (REF)	system constant assignment of cyl. to bank1/bank2, 0 bank1, 1 b.2, binary value
SY_ZZBANKB			SYS (REF)	system const. ass. of cyl. to exhaust bank1/2 for slave1/SGB; 0 b1, 1 b2 bynary
SY_ZZBANKC			SYS (REF)	system const. ass. of cyl. to exhaust bank1/2 for slave2/SGC; 0 b1, 1 b2 bynary

Variable	Source	Type	Description
ABMF	AEVAB	EIN	injection cut off pattern at fixed position
ABMFOLD	BGEVAB	LOK	injection cut off pattern at fixed position at time t-1
B_BEVAB	BGEVAB	AUS	condition: Inj. valve cut off on Bank/Bank1
B_BEVAB2	BGEVAB	AUS	condition: Inj. valve cut off on Bank2
B_EVLOC	BGEVAB	AUS	Status: all injection valves are activated
EVZ_AUSOLD	BGEVAB	LOK	injection cut off pattern total at time t-1
EVZ_AUSTOT	AEVABZK	EIN	injection cut off pattern total
REDBAS	BGEVAB	AUS	Base cut-off step
REDIST	BGEVAB	AUS	real cylinder cut-off step
SGID		EIN	ECU-ID
STATEAEVAB	AEVAB	EIN	No. of the active state in AEVAB

FW BGEVAB 1.20 Fixed Values

Parameter	Value	Description

FB BGEVAB 1.20 Detailed description of function

The function uses the injection valve cutoff pattern evz_austot to calculate the true reduction ratio redist, and the conditions B_bevab, 2, which state on which exhaust gas bank an Ev is disconnected.
Since the function is also applicable to projects with multiple control devices, a distinction must be made between cylinder banks and exhaust gas banks.
One control device (ecu) does always control one cylinder bank which may include either one exhaust gas bank (SY_STERVK = false) or 2 exhaust gas banks (SY_STERVK = true).

B_bevab = true: at least one Ev of exhaust gas Bank1 is disconnected.
B_bevab2 = true: at least one Ev of exhaust gas Bank2 is disconnected.

Any final amplifier fault and any disconnection of an injection valve is displayed in B_evloc.
In the event of a disconnected Ev or a faulty final applies: B_evloc = false
If a cylinder is disconnected, the misfire detection is locked by the tester; in the event of a torque reduction, the bit B_evasel = false. This bit is calculated in %AEVAB.

Disconnection request Disconnection condition Disconnection information Misfire recognition

Tester devoff > 0 -> B_evloc = false -> B_evasel = false
fire detection locked
& B_faevz = TRUE
Torque reduction redsol > 0 -> B_evloc = false -> B_evasel = false Misfire detection locked
amplifier diagnosis eevx > 0 -> B_evloc = false -> B_evasel = true Misfire detection active
Misfire recognition flgtiab > 0 -> B_evloc = false -> B_evasel = true Misfire detection active,

ther errors.

Cylinder disconnection B_zas = true -> B_evloc = false -> B_evasel = false Misfire detection locked

Determination of the true resulting reduction ratio, redist:
Each injection valve (Ev) which is to be disconnected corresponds to a reduction of 1. Accordingly, redist results from the number of bits set in the function evz_austot (which is equal to the number of Ev's to be disconnected). For reasons of running time, the counting is done only SY_ZYLZA times. The calculation is done only if the value of evz_austot has changed
(evz_austot <> evz_ausold). Here, evzausold is the value of evz_austot from the preceding calculation.
The bits B_bevab and B_evloc (B_bevab2 applies only if SY_STERVK = true) are derived from the injection valve cutoff pattern, evz_austot.
B_evloc = false means that at least one injection valve is disconnected (independently of the Bank where this occurs).
B_beavb = true means that an Ev of Bank1 is disconnected.

Example:

SY_ZZBANK: 0 1 0 0 1 0 1 1 Bit = 0 --> injection valve associated to Bank1

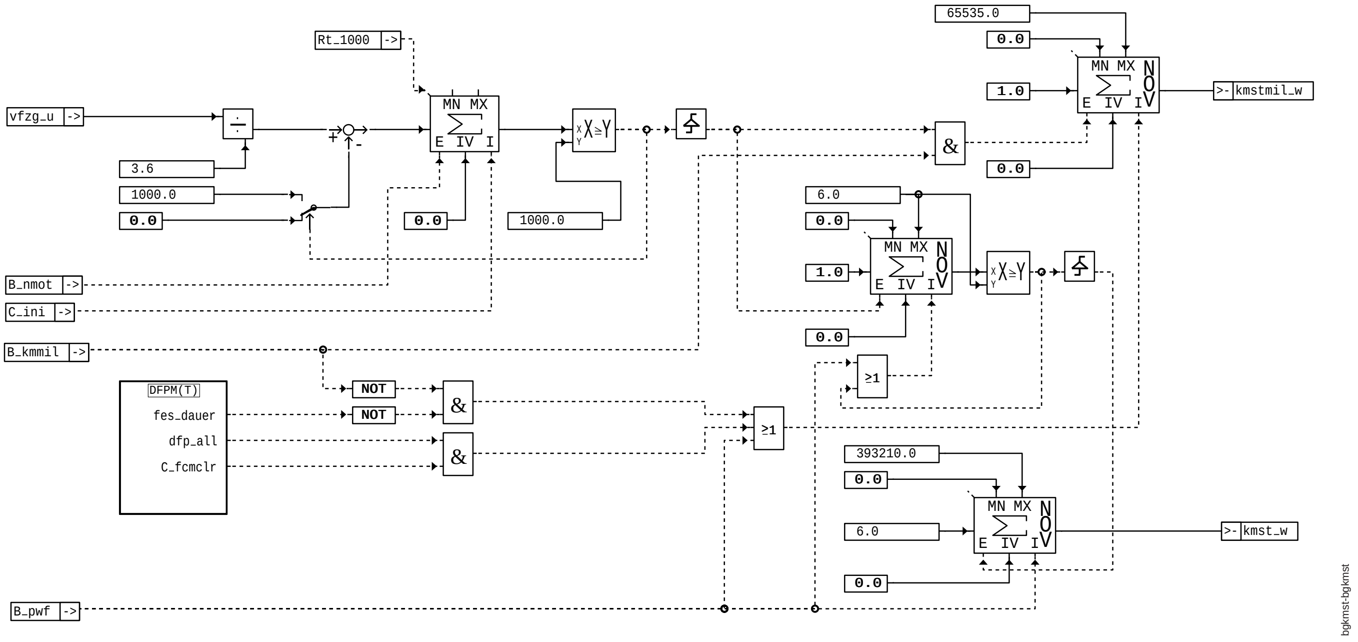
evz_austot: 0 0 0 0 0 1 0 0 1 inj. valve disconnected, inj.valve associated to Bank1 --> B_bevab = true

The base reduction redbas is calculated from the number of Ev's to be disconnected according to the fixed inj.valve cutoff patterns flgtiab, devoff, eevx. They all are memorized in the RAM cell abmf. The calculation is only done if the content of the cell abmf changes.
The method is the same as for the calculation of redist.
In this case, the injection valves do not need to be assigned to a bank since abmf is a subset of evz_austot and are accounted for earlier when
redist is calculated.

APP BGEVAB 1.20 Application hint

BGKMST 2.10 Calculation of odometer value (Km)

FDEF BGKMST 2.10 Function definition



bgkmst-bgkmst

ABK BGKMST 2.10 Abbreviations

Variable	Source	Type	Description
B_KMMIL	DMIL	EIN	MIL turn-on related to mileage
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_PWF		EIN	Condition for powerfail
C_FCMCLR	BGKMST	LOK	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
KMSTMIL_W	BGKMST	AUS	Drive distance with MIL on
KMST_W	BGKMST	AUS	Drive distance since last power fail
R_T1000		EIN	Time schedule 1000 ms
VFZG_U	DFFTCNV	EIN	Vehicle speed

FW BGKMST 2.10 Fixed Values

Parameter	Value	Description

FB BGKMST 2.10 Detailed description of function

EOBD fordert die Erfassung der mit aktivierter MIL zurückgelegten Fahrstrecke.
Diese wird in kmstmil_w aus der Fahrgeschwindigkeit vfzg_u aufintegriert.
Die Quantisierung und Ausgabe von kmstmil_w erfolgt gemäß SAE J1979, Mode 1, PID$21. ->%TC1MODx.y

Für Kundendiensttester wird zusätzlich die Fahrstrecke kmst_w seit powerfail ermittelt.

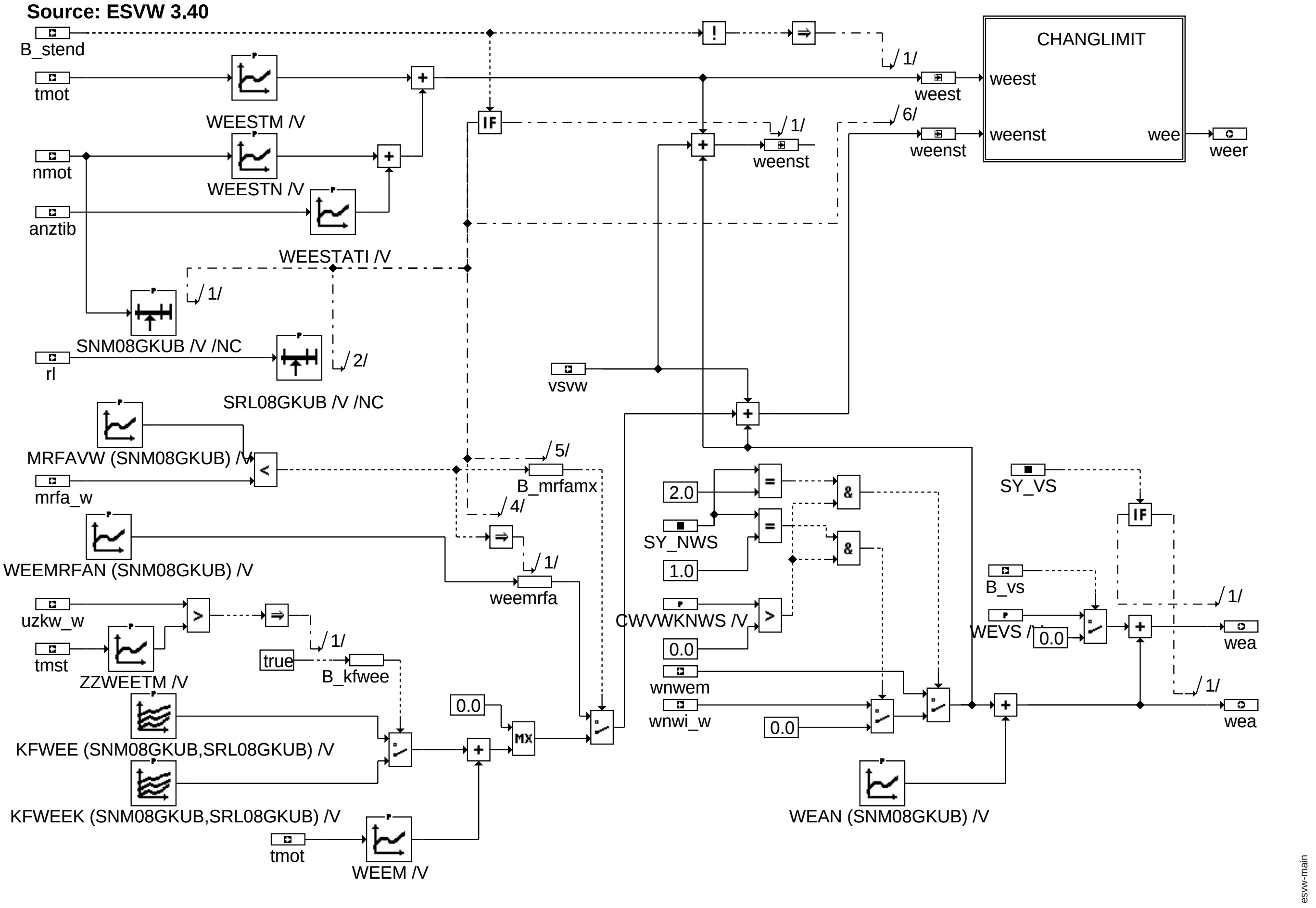
APP BGKMST 2.10 Application hint

Zur Steuerung der Funktion über B_kmmil wird eine entsprechend angepasste DMIL benötigt. ->%DMIL
Achtung: B_kmmil ermittelt nur den MIL-Status der Motorsteuerung, andere Systeme müssen eine entsprechende Funktion aufweisen.
Zur Werteausgabe ist eine entsprechend angepasste SCAN-TOOL-Kommunikation nötig: ->%TC1MOD

ESVW 3.40 Injection : calculation of injection angle

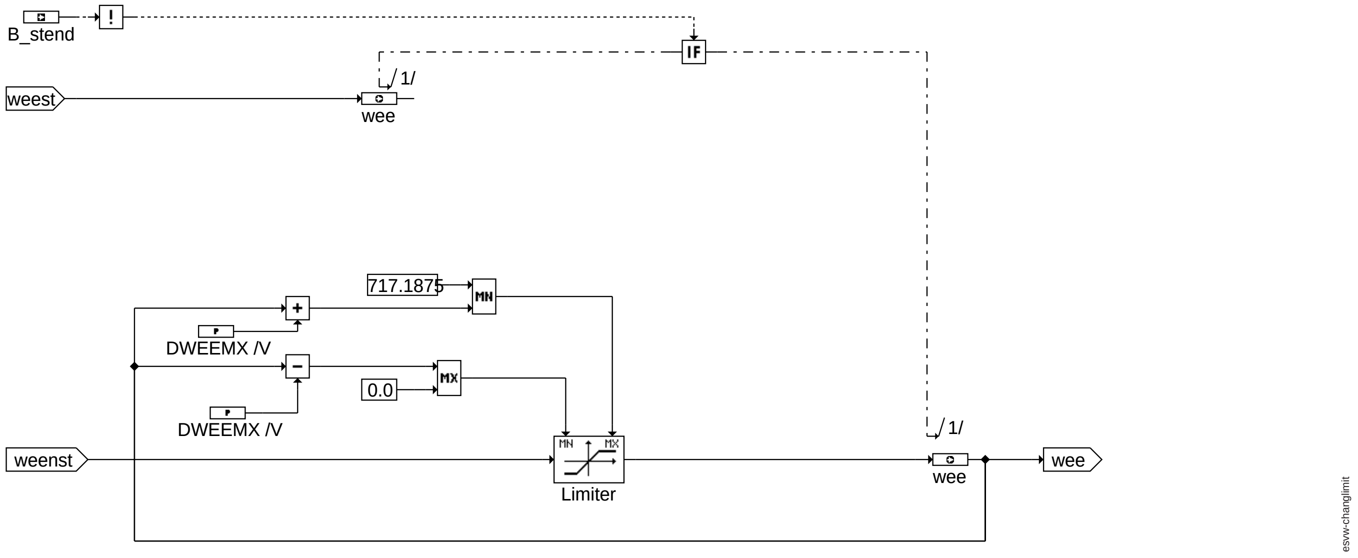
FDEF ESVW 3.40 Function definition

Source: ESVW 3.40



esvw-main

CHANLIMIT (T) limitation of wee change



esvw-changlimit

ABK ESVW 3.40 Abbreviations

```
WESBM           Angle Intake valve closure (Es) before reference mark (BM)

Es          Control time for intake valve closure
LWOT        Charge Changing Upper Dead Center
ZOT         Ignition Upper DC, IUDC
UTH         Compression Bottom DC
```

Parameter	Source-X	Source-Y	Type	Description
CWVWKNWS			FW	code word: correction of injection angle for active cam control
DWEEMX			FW	max. change of ”angle end of injection” per ignition
KFWEE	NMOT	RL	KF	characteristic map angle end of injection
KFWEEK	NMOT	RL	KF	map for end of injection angle (cold parameters)
MRFAVW	NMOT		KL	threshold to switch end of injection angle at max. driver request
SY_NWS			SYS (REF)	system constant camshaft control: none, 2 point, continous
SY_VS			SYS (REF)	system constant valve stroke control: no, 2 position
WEAN	NMOT		KL	angle injection break off
WEEM	TMOT		KL	correction of prestorage angle
WEEMRFAN	NMOT		KL	end of injection angle at max relative driver request
WEESTATI	ANZTIB		KL	Offset for injection end angle towards early
WEESTM	TMOT		KL	correction of pretiming of injection during start
WEESTN	NMOT		KL	end of injection angle during start
WEVS			FW	Angle correction for valve stroke adaptation
ZZWEETM	TMST		KL	Switchover threshold pattern angle

Variable	Source	Type	Description
ANZTIB	ACIFI	EIN	injection counter limited
B_KFWEE	ESVW	LOK	condition map KFWEE activ
B_MRFAMX	ESVW	LOK	angle injection-end activated by maximum desired driver request torque
B_STEND	BBSTT	EIN	condition end of start
B_VS		EIN	Condition valve lift high
MRFA_W	MDFAW	EIN	relative driver request torque from cruise control and pedal, =0 in limp-home
NMOT	SWADAP	EIN	engine speed
RL	SWADAP	EIN	relative air charge
TMOT	SWADAP	EIN	Engine temperature
TMST	GGTFM	EIN	engine temperature at start
UZKW_W	GGDPG	EIN	revolution counter crankshaft
VSVW	VS_VERST	EIN	change in the phase injection angle by the application system
WEA	ESVW	AUS	anglemark injection break off
WEE	ESVW	AUS	angle injection-end in normal operation
WEEMRFA	ESVW	LOK	angle injection-end at maximum of desired driver request torque
WEENST	ESVW	LOK	angle injection-end after end of start
WEER	ESVW	AUS	resulting crankshaft angle for end of injection
WEEST	ESVW	LOK	angle injection-end at start
WNWEM		EIN	Camshaft angle intake (average value)
WNWI_W		EIN	actual shifting angle of the camshaft (word)

FW ESVW 3.40 Fixed Values

Parameter	Value	Description
CWVWKNWS		code word: correction of injection angle for active cam control
DWEEMX		max. change of ”angle end of injection” per ignition
WEVS		Angle correction for valve stroke adaptation

FB ESVW 3.40 Detailed description of function

Formation of the advance angle:

The advance angles defined in the characteristic curves and mappings refer to the intake valve closure (at a valve stroke of 0 mm). On systems with intake camshaft shifting (2-point or continuous), they refer to the late position of the camshaft. When calculating the end of the injection interval after engine start, any angular difference towards earlier in the camshaft position is accounted for, i.e. if the intake valve closes earlier, the injection interval is also terminated earlier. The end of the injection interval is calculated as follows: wee = KFWEE + WEEM +wnwi (2-point CS shifting), or wee = KFWEE + WEEM + wnwem (continuous CS shifting). wee and weer differ only with respect to the quantization. The variable vsvw allows to achieve a change the advance angle using the VS20 adjustment system.

During engine start applies: wee = weest = WEESTM + WEESTN.
During engine start, the camshaft shifting is not considered. The camshaft is considered to be in the late end position until the engine start has finished.
The speed dynamic during engine start requires weest to be calculated in the Synchro-Raster.
During normal operation, the advance angle is calculated as follows: wee = weenst = KFWEE + WEEM. The sudden changes in the advance angles which occur during the switch-over, especially when switching over to the mapping WEEMRFAN, are limited by the transient limitation of the function CHANGLIMIT.

ti triggering:

The function ACIFI calculates the angle where the injection must start, using duration of ti, engine speed and advance angle, and starts the ti output when the associated negative tooth slope passes. Both length of the injection interval, ti, and starting point of the injection are calculated for any tR mark.

Output of a termination angle wea:

The characteristic curve WEAN f(nmot) transmits a termination angle, wea, in order to avoid that after-dashes are injected into a closing intake valve. Here, the time of flight needed by the fuel, which is approx. 6...10ms, must be considered (see the description in the APP section of the present function). This angle also considers the intake valve shifting angle. The termination angle is used in function %BRGLP to release after-dashes whereas the physical after-dashes are calculated and sent by the function ACIFI.

Specification of the advance angle:

```
                                                          CCUDC Cyl.1        CBDC             IUDC Cyl.1
                                                              |                |             GDWRT|
                                                              |                |            |<--->|
                    | BM                                | BM                                | BM                 (Ref. marks)
   |4               |1                |2                |3                |4                |1                |2         tR Marks
 -+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------
  .                 .                 .                 .                 .            WESBM                  .
  .                 .            <--------------- wee --------------------------------|<--->|                 .
 --------------+    .                 .                 .  +--------------------------+     .     *           .
  .            |    . |SSSSSSSSS|     .                 .  |              .           |     .     *         |SSSSSS|        EV 1
 --------------+    .                 .                 .  +--------------------------+     .     *           .
```

```
    *            Ignition output
    |SSSSS|      Sequential Injection
```

Position of the upper reference mark:

```
                                                                        Ref. mark                            IUDC
                                                                         |                                   |
                                        +--+  +--+              +--+  +--+  +--+                             |
                            ....        |  |  |  |  +--+  +--+  |  |  |  |  |  |  ........                   |
                                       -+  +--+  +--+  +--+  +--+  +--+  +--+  +--                           |
                                                                         |                                   |
                                  |<------------- WESBM  --------------->|<------------ GDWRT -------------->|old denominations
                                  |                                      |
           Intake valve closes -->|                                      |<-------- SY_GRUNDWERT------------>| new denominations
                                  |<----------------------WESSOT ------------------------------------------->|
                                                Angle between "Intake valve closes, in late position" and UDC
```

APP ESVW 3.40 Application hint

Start of injection interval during engine start:
On many engines, it is favourable to inject onto the closed intake valve to prevent the spark plug from being wetted directly.
On engines where the spark plug is located in an uncritical position, especially on 4-valve engines, it makes sense to inject when the intake valve is about to open so that the air flow helps to achieve a better mixture preparation.

Note: the valve control timing apply to the beginning of aperture and to the end of closure of the intake valve, i.e. they apply to a valve stroke of 0 mm. The distance WESBM which ranges from the reference mark to the closure of the intake valve must be referred to this point.

Since in practice, the point where the intake valve closes is often defined as 1 mm valve stroke (and WESBM is in this case increased with respect to a valve stroke of 0mm), it is important to check which definition is in use when data is exchanged between different projects.

WESBM:

WESBM is the angle between intake valve closure and the reference mark or the tR mark of the respective cylinder.
Here, the associated tR mark is the last mark before the respective IUDC (=ZOT). The distance between tR mark and IUDC is memorized as the value of SY_GRUNDWERT.
Accordingly, WESBM must be adapted if the intake control timing or the position of the reference mark are changed.
In such a case, values in (CS are stated in the advance angle mappings and characteristic curves which express a pre-positioning with respect to the intake valve closure (Es).

WESBM is calculated according to the control time "intake valve closes" (Es) and the distance GDWRT between the BM reference mark and the IUDC (=ZOT) as follows:

WESBM (°CS) = 180 (°CS) - Es (°CS after CBDC (=UTH)) - SY_GRUNDWERT (°KW)

!!! If WESBM should assume negative values according to this formula, the point "intake valve closes" must be defined as 1 mm valve stroke. Once defined, the value of WESBM may no longer be changed during the application process.

Position of the injection interval:

When the end of the injection interval is implemented, the following aspects should be considered:

- the injection interval should not start before the angle "intake valve closes" of the preceding cycle.

- as the advance angle increases, the ti calculation may suit the actual conditions lesser (dynamics, bucking, lambda control)

- the fuel time-of-flight must be considered (according to the fuel pressure, to the air speed in the suction pipe and to the specific distance between injection valve and intake valve. A typical fuel time-of-flight may be e.g. 7ms.

Calculation of the time-of-flight:
The time-of-flight [ms] results from the distance spanned by the fuel droplets (which is the distance between injection valve and intake valve) divided by the mean flight speed of the fuel droplets. The distance is typically about 100mm, the average speed is about 15m/s. -->flighttime = 6,67ms.
This time allows to derive a camshaft angle which varies according to the engine speed.
-->flightangle[°] = {360° * n [1/min] * flighttime [ms]} / 60000[ms/min]
For example: flighttime 7ms --> 1000 1/min: 42°; 6000 1/min: 252°. The camshaft angle for the time of flight is 252°.
Experience shows that the flight angle varies up to an engine speed of 4000 RPM; above this speed, the flight angle may assumed to be constant. (The value for 4000 RPM is 160°CS in the above example.)

Start of injection interval during normal operation:

In order to ensure a sufficient injection advance angle even in the event of extreme engine speed dynamic, and to avoid that fuel is injected into the open intake valve, the injection interval is shifted according to engine speed, considering a dynamic advance. Injection should start only when the angle "Intake valve closes" (Es) of the preceding intake cycle has passed by. An excessive injection advance angle should be avoided also to keep the ti calculation as up-to-date as possible (see also the application information for %UKSEFI, %ESUK, %BGRLP).

Advance angle mapping KFWEE/KFWEEK:
After the end of engine start, the advance angle is formed from KFWEEK + WEEM. The switch-over to KFWEE is done after ZZWEETM crankshaft revolutions.
ZZWEETM depends on the engine temperature tmst during engine start. If engine and suction pipe are cold, this path implements a reduction in the advance angle.
If engine and suction pipe are warm, an increase in the injection advance angle is used to enhance the mixture preparation inside the suction pipe.

Characteristic curve WEEMRFAN:
This mapping is used to adjust the injection advance angle so that the fuel is injected into the open intake valve if the driver commands full power. The intention is to have the components cooled down by the vaporization inside the cylinder, which yields also an increase in the filling ratio. The threshold which determines from when onwards to apply this characteristic curve is defined in the characteristic curve MRFAVW.

Change limitation DWEEMX:

The partial function CHANGE LIMITATION represents a transient limitation for wee or weer.
If fuel is injected into the open intake valve for long time, the wall film present in the suction pipe reduces to zero.
When the switch-back to injection in advance is performed in these conditions, the wall film forms again and causes the mixture to be lean for short time.
Limitation of this injection advance angle distributes the loss caused by wall film formation over several injection intervals and therefore, reduces the leaning-down effect. However, it is not possible to prevent the leaning-down completely using this primitive method.
The change limitation applies to sudden changes towards wider and smaller injection advance angles after the end of engine start.

Group base points are used for the characteristic curves and mappings:

```
Suggested values of the base points:
--------------------------------------
WEESTM,WEEM: Source tmot : -30, -10, 10, 30, 50, 75, 100, 130 degrees

KFWEE, KFWEEK, WEAN, WEEMRFAN, MRFAVW: Source nmot: 500, 1000, 1500, 2000, 3000, 4000, 5000, 6000 1/min
KFWEE, KFWEEK: Source rl : 20, 40, 60, 80, 100, 125, 150, 175 %
MRFAVW: Values 200% --> B_mrfamx is always false
WEESTN: Source nmot:     125, 300, 700, 1200 1/min
        Values:           0    0              degrees
DWEEMX: 6 degrees/Ignition     Resolution is 6 degr.
        720 degr. -> no change limitation active

ZZWEETM: Source tmst:   -30, -20, -10, 0, 10, 20, 40, 70 degr.
         Values:                                          0   0  CS Revolutions        0: KFWEE is active directly after engine start
                                                                                    >0: KFWEEK is active for this number of
                                                                                    CS revolutions
WEESTATI:       Source anztib_w 2, 4, 5, 6, 7, 8
                Values          0 degr. CS
```

The characteristic curve can be used to achieve a sudden change in the injection advance angle towards early for a determined injection interval during engine start at high engine speed dynamic. This sudden change depends directly on the counter for already performed injections, anztib_w. This counter starts to count only after the injection has been activated which must be

accounted for when determining the injection advance angle.
This means the sudden change in the injection advance angle needs to be triggered off one or two ti's earlier.

SY_NWS = 1.0 -> Accounts for wnwi according to CWVWKNWS on two-point CS shifting systems
SY_NWS = 2.0 -> Accounts for wnwem according to CWVWKNWS on systems with continuous CS shifting

CWVWKNWS = 0: CS shifting towards earlier is not accounted for in the advance angle
CWVWKNWS > 0: SH shifting towards earlier is accounted for in the advance angle

WEVS: On systems with variable valve stroke (SY_VS = true), the termination angle wea is shifted by the value WEVS towards earlier
Initial data assignment: WEVS = 0.

Further information on how to apply the advance angle is included in the application information for application of the transition compensation %UKSEFI, %ESUK, load prediction %BGRLP.

ACIFI 9.70 Output for cylinder-individual injection

FDEF ACIFI 9.70 Function definition

No text for FDEF available!

ABK ACIFI 9.70 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWESWEZ			FW	enable codeword restart fuel feed
FWEAB			FW	recursion constant for fuel cut-in factor decreasing
FWEAUF			FW	recursion constant for fuel cut-in factor increasing
FWEMXT	TMOT		KL	maximum factor for fuel cut-in temperature characteristic
FZN1	NMOT		KL	Cylinder individual factor at neutral camshaft position EV 1
FZNWN1	NMOT		KL	Cylinder individual factor at active camshaft position EV 1
TMESP			FW	Engine temperature threshold quick start
TVFZNW			FW	Delay time for activation of CIFI factors after camshaft phasing
WEESTS			FW	limit for end of injection angle during start

Variable	Source	Type	Description
ANZTI	ACIFI	AUS	injection counter
ANZTIB	ACIFI	AUS	injection counter limited
ANZTIB_W	ACIFI	AUS	injection counter with limit
ANZTI_W	ACIFI	AUS	injection counter
B_CWESAKT	ACIFI	AUS	Codeword CWESWEZ bit 3 true
B_NWS	NWS	EIN	Condition camshaft control
B_SA	MDRED	EIN	Condition fuel cut-off
EVZ_AUSTOT	AEVABZK	EIN	injection cut off pattern total
FWEG	ACIFI	AUS	
FWEZ0	ACIFI	AUS	
NMOT	SWADAP	EIN	engine speed
TI_B1	RKTI	EIN	injection time for valves on bank1
TI_B2	RKTI	EIN	injection time for valves on Bank2
TI_EV0	ACIFI	AUS	injection time 1. cylinder in firing sequence
TI_TVU_W	RKTI	EIN	injection time correction as function of battery voltage ECU-quantization
TMOT	SWADAP	EIN	Engine temperature
ZZBANK		EIN	cylinder allocation to injection banks

FW ACIFI 9.70 Fixed Values

Parameter	Value	Description
CWESWEZ		enable codeword restart fuel feed
FWEAB		recursion constant for fuel cut-in factor decreasing
FWEAUF		recursion constant for fuel cut-in factor increasing
TMESP		Engine temperature threshold quick start
TVFZNW		Delay time for activation of CIFI factors after camshaft phasing
WEESTS		limit for end of injection angle during start

FB ACIFI 9.70 Detailed description of function

APP ACIFI 9.70 Application hint

DECJ 14.30 Diagnosis; Power stage CJ9x

FDEF DECJ 14.30 Function definition

The following presentation of the output stage diagnostics applies in its entirety for the types CJ450 (with excess temperature shut-off): Restrictions for the other versions: effects (*) and "Special 450-supplement" block not applicable

```
 B_dhrnio >---------------------+   +-+                 +--------+
 B_ubrmax >---------------------|-->| |     +-+   +-+   |CWBBDECJ+-+------------------+
 B_ubrk >-----------------------|-->|v+---->| |   | |   +--------+ |  +---+           |  +---+
                           +-+  +-->| |  +->|&+->o| |              +->|Bit+->B_bbubr  +->|Bit+->B_bbdecj
 B_bbdecj ---------------->| |      +-+  |  +-+   | |                 +-+-+              +-+-+
 B_nmin >--------+  +--+   |&|  B_bbubr--+        | |          +-+      |          +-+     |
             +-+ +->|>1+-->| +------------------>o| |          |1+------+          |0+-----+
 B_airbag -->| |--->|- |   | |                    | |          +-+                 +-+
 SY_AIRBAG-->|&|    +--+   +-+   +--------+       |&+---+------------------------------------------------------------------> B_desee
             +-+ +-------------->+ > NDECJ+------>| |   |                  +------------------------------+
 nmot >----------+ +----------+  +--------+       | |   |     +----------->| CJxxx Fehlerzwischenspeicher |
                 +-+ < UBCJMX +------------------>| |   |     |            |    Fehlerart (i,j)           |
                 | +----------+ +----------+      | |   |     O            +-------------+----------------+
 ub >------------+--------------+ > UBCJMN |----->| |   +--->\                            V
                                +----------+      +-+         O     +------------------+-----------------------+
                                                              |     | +-------------------+   +-------------+  |
100ms-Raster: R_t100 >----------------------------------------|---->| | Verifikation      |   |             |  |
                                                              |     | | ES-Fehlerart (i,j)|-->|             |  |
10ms Zeitraster: R_t10 >--------------------------------------|---->| +---------+---------+   |CJxxx Fehler |--|---> B_mxxyz (i.j)
                                                              |     |           |             |  speicher   |  |
                            +---+         (*)                 O     |           V             | Fehlerart   |--|---> B_mnxyz (i,j)
CJ450_TJ_ZEIT >----------->0|   |--------------------------->\      | +---------+---------+   |   (i,j)     |  |
                            +---+                             O     | | Prüfung           |   |verifiziert  |--|---> B_sixyz (i,j)
                                                              |     | | Fehlerheilung für |-->|             |  |
+----------+                  CJxxx(i); CJxxx(i)              |     | | ES-Fehlerart (i,j)|   |             |  |
|ES-       +--+                +--------------+               |     | +-------------------+   +-------------+  |
|Schaltfkt.|  +--0  \      e(j)|  +--------+  |a(j)           |     +---+-------+------+---------+-------------+
+----------+          0------->|  | e # a  |  |---->          |         |       |      |         |
 +----------+ +--0  ^          |  ++++++++++  |               |         |       |      +---------|-----------------> B_esdia
 |ES-Ansteu | |     |          |   ||||||||   |               |         |       |      |         |
 |erung :   +-+     |   DA(i-1)| +-++++++++-+ |DA(i)          |         |       |      |         |           Spez. "450-Zusatz":
 |Verif/ Hei|       |  ------->|-|   SR     |-|---------------+         |       |      |         |        +-----------------------+
 |      lung|       |    DE(i) | |          |-|<------------Takt--------+       |      |         |        |   CJxxx :             |
 +----------+       |          | |    :     |-|<------------SY -----------------+      |         |        |   ub > UBCJTJ         |
      ^             |          +-+----:-----+-+                                        |         |        |                       |
      |             |     +-----------:------------------+                             |         0  0-----| CJ450_TJ_Zeit :       |
      |             |     |Bit1(j) Bit2(j) Fehlerart(i,j)|                             |         |<-------|   ES-Ansteuerung bei  |
      |             |     |------------------------------|                             |         0        |       B_mxxyz         |
      |             |     | 0        0     KS_Masse (i,j)| --->  B_mnxyz               |         |        |                       |
      |             |     | 1        0     KS_UBat  (i,j)| --->  B_mxxyz               0  0------|--------| TPHL: Heilungsprüfung |
      |             |     | 0        1    Ltg.abfall(i,j)| --->  B_sixyz               |<--------|--------|       B_mxxyz         |
      |             |     | 1        1     Anst. OK (i,j)|                             0         |        +-----------------------+
      |             |     +------------------------------+                             |         |
      |             +-----Fehler-Verifikation/ - Heilung  -----------------------------+         |
      +-------------------ES Ansteuerung aus 10 ms Zeitraster -----------------------------------+
```

Bit1(j), bit2(j) in CJxxx fault shift register SR is set for an unplausible comparison of e(j) with a(j)
Assignment : i = variable for output stage IC ; j = varialble for output stage / IC (see %DEKON for ES assignment)

For the case of output stages of the type CJ405, CJ420, CJ920 (with display for excess temperature):
The same bit pattern is used to detect excess temperature as for detection of a line drop. Differentiation for diagnostics and verification by means of control : ES off --> line drop , ES on --> display of excess temperature (not implemented in ME7)

Scan CJxxx fault shift register SR with control SY and clock pulse
Initiate fault healing check according to { THP } - run through of 100 ms time base

For output stages of the type CJ450 (with shut-off for excess temperature):
Call the CJxxx fault healing check for B_mxxyz according to { THP } * { THPL }-run through of 100 ms time base.

The output stage faults stored in the CJxxx fault memory as verified fault types (i,j) are transferred into the OBDII fault memory, except for output stages of the types CJ405, CJ420, CJ920 (with display of excess temperature).
Organization of the fault memory in accordance with the functional description %DFPM.

ABK DECJ 14.30 Abbreviations

ES	Output stage
SR	CJxxx fault shift register
DE	Data input (serial) in CJxxx fault shift register
DA	Data output (serial) from CJxxx fault shift register
B_mnxyz	Fault type: less than minimum value fault path "xyz" (wildcard)
B_mxxyz	Fault type: greater than maximum value fault path "xyz" (wildcard)
B_sixyz	Fault type: signal inactive fault path "xyz" (wildcard)

UBCJMN	Immediate constant	Minimum battery voltage for enabling CJxxx output stage diagnostics
UBCJMX	Immediate constant	Maximum battery voltage for enabling CJxxx output stage diagnostics
UBCJTJ	Immediate constant	Battery voltage threshold for CJ450 KS_UBat healing check
NDECJ	Immediate constant	Engine speed threshold for CJxxx output stage diagnostics
THP	Immediate constant	Number of time base run through for fault healing check
THPL	Immediate constant	CJ450 KS_UBat healing check after THP * THPL runs

For output stages of the type CJ450 (with shut-off for excess temperature):

CJ450_TJ_ZEIT	Immediate constant	Turn-on time of the CJ450 ES for KS_UBat healing check

Variable	Source	Type	Description
B_AIRBAG		EIN	condition airbag activated
B_BBDECJ	DECJ	AUS	condition stall protection DECJ
B_BBUBR	DECJ	AUS	condition operation mode f. powerst. diagn. to be disabled by supply voltage err
B_DESEE	DECJ	AUS	Diagnosis power stage: entry conditions fulfilled
B_ESDIA	DECJ	AUS	Power stage diagnosis active
B_NMIN	GGDPG	EIN	condition lower speed: n $<$ NMIN
B_UBRK		EIN	condition main relay contact fault
B_UBRMAX		EIN	condition onboard battery voltage via main relay higher than UBRDMX
NMOT	SWADAP	EIN	engine speed
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
UB	SWADAP	EIN	battery voltage

FW DECJ 14.30 Fixed Values

```
UBCJMN          {        UBCJMN        }        Minimum battery voltage for enabling CJxxx output stage diagnostics
UBCJMX          {        UBCJMX        }        Maximum battery voltage for enabling CJxxx output stage diagnostics
UBCJTJ          {        UBCJTJ        }        Battery voltage threshold for CJ450 KS_UBat healing check
NDECJ           {        NDECJ         }        Engine speed threshold for CJxxx output stage diagnostics
THP             {        THP           }        Fault healing check after (THP * 100 ms-[time base]) seconds

        For output stages of the type CJ450 (with shut-off for excess temperature):
THPL            {        THPL          }        CJ450 KS_UBat healing check after THP * THPL run through
CJ450_TJ_ZEIT   {        CJ450_TJ_ZEIT }        Turn-on time of the CJ450 ES for KS_UBat healing check
```

Parameter	Value	Description

FB DECJ 14.30 Detailed description of function

Output stage diagnostics in IC hardware:

The output stage component includes 4 output stages (ES) resp. 14 ES (on CJ920). The input level and the output level are checked in each ES for plausibility by monitoring the hardware. Any detected fault is stored in a shift register (SR) as 2-bit information for each ES (see Table FDEF for coding) and can be read out from here via a serial interface.

Short-circuit to ground and (KS_Masse) and line drop (Ltg.abfall) are detected when the ES are in the disabled state; whereas a short circuit to UBat (KS_Bat) is detected for a conducting ES. The defective ES is switched off to protect the ES IC in the case of KS_UBat. Reactivation is possible following a change in the flank from high --> low at the input or by reset.

Special feature of the CJ450:
The output stages have a limiting maximum current. KS_UBat can only be detected by a shut-off for excess temperature.

The serial transfer shift register -> CPU is controlled by 3 CPU ports (SY = low : changeover of fault set parallelly to shift serially, SY: low -> high : shift register deleted upon completion of the transfer; clock pulse: the information is shifted by a positive clock pulse flank, DA: serial data output shift register). The interface is extended without additional CPU ports by cascading the shift register (connection of DA to DE of the next IC). The level of the DA line is set to low for an entry of a fault in the shift register.

Realization of the software interface for ES diagnostics:

The assignment of the output stage IC's is described in terms of configuration bytes in %DEKON. At the same time, the diagnostic routine can be determined by assigning 2 bits to each output stage.

bit 1	bit 0	
0	0	Diagnostics active with OBDII fault storage and with healing check
0	1	Diagnostics active without OBDII fault storage, with healing check
1	0	Diagnostics active without OBDII fault storage and without healing check
1	1	Diagnostics inactive

Read-out of the IC shift register is only permissible in a programmable UBat and speed range.
The UBat thresholds UBCJMN and UBCJMX are determined by the functional limit of the IC. The computation base must already be started in the system in which operation of the CJxxx diagnostics is performed. The diagnostics routine is disabled until the programmable speed threshold NDECJ is exceeded. It is possible to suppress the start range by means of the speed threshold NDECJ.
The index >i< is assigned to the power stage IC's and the index >j< to the individual output stages.

The level of the DA line is sampled in each 100 ms time base run through for the condition B_desee = true. For a low level of the DA line, there is an ES fault present as detected by the hardware which must now be selected according to output stage and fault type by reading out the interface. The level of the line SY is pulled down to low in order to start the read-out process and one bit of information is subsequently shifted on the DA line out of the shift register and stored in a buffer memory in the CPU as a "fault to be verified" with each positive flank on the clock pulse line. Allocation of the fault type and the corresponding output stage is now possible from the position of the set bit information.

The diagnostics software takes over control of an output stage with a detected fault for verification of the fault (B_esdia = true). The output stage detected as being out of order is disabled. The shift register is deleted by setting and resetting the SY line in the ES IC. The output stage is controlled in the 10 ms time base such that the fault types KS_Masse, line drop and KS_UBat can be generated. The fault status in the shift register is "frozen" by setting the SY line to low. The ES control is returned to the pertinent ES driver software (B_esdia = false).
The CJxxx shift register cascade is read out during the subsequent run through the 100 ms time base. If fault type and output stage can now be verified, there then follows a transfer into a fault memory for verified output stage faults and the transfer into the OBDII fault memory. Following readout, the shift register in the CJxxx is enabled again by setting the SY level to high.

A time counter is started at the same time as fault verification. A check for healing of those output stages detected as being defective is performed after elapse of this counter. The time THP is set by a defined number of program runs.
The healing check of the output stages is carried out in the same manner as described for fault verification. During the healing check, those output stages are controlled which are stored with a verified fault type.

For output stages of the type CJ450 (with shut-off for excess temperature):
Fault verification and healing check for KS_UBat:
A short circuit to UBat cannot be detected with certainty by the standard control procedure for KS_UBat during the check for verification and healing because of the thermal time constant. The fault KS_UBat is therefore considered as being verified when it has occurred twice.

The fault healing check switches over to its own time control. The healing check is performed following a time period is formed as the product of the run times THP * THPL. Control of the defective ES is then for longer than 1 sec (specified in CJ450_TJ_ZEIT), if the UBat threshold (UBCJTJ) is exceeded. The possibility of transferring the fault from the ES IC is disabled throughout the control time CJ450_TJ_ZEIT.

APP DECJ 14.30 Application hint

DEVE 6.40 Diagnosis; power stage of injector valve

FDEF DEVE 6.40 Function definition

```
 Diagnosis CJ 400, resp. CJ 920  see %DECJ

+----------+-----------------+
|  CJ400   | B_mxev (1...8)  +----------------------------+
|  bzw.    |                 |                            |
|  CJ920   |                 |                            |
|          | B_siev (1...8)  +---------------------+      |
|  EV-     |                 |                     |      |
|  End-    |                 |                     |      |
|  stufe   | B_mnev (1...8)  +--------------+      |      |
|          |                 |              |      |      |
|          |                 |              |      |      |     +-+
|          |                 |              |      |      +---->| |             (#)                            +---+-----+
|          | B_desee         +---------+    |      +----------->|V+-------------+-------------------+--------->| S |     |
+----------+-----------------+         |    +------------------>| |             |                   |    +-+   +---+     +-> E_ev
                                       |                        +-+             |              +-+  +-->o|V+-->| R |     |  (1..8)
                                       |                                        |  C_pwf ----->|V+------>| |   +---+-----+     (*)
                                       |                                        |          +-->| |  (*)  +-+
                                       |             +-+                        | (#) +-+  |   +-+
                                       +------------>| |     +-------------+    +---->| |  |
                    B_stend ------------------------>| |     | 500 ms +--- |          |V|  |                   +---+-----+
                       B_sa ----------------------->o|&+---->| -------+->t +---------->| +--|------------------>| S |     |
                    Bit i (i=0...7) --------------->o| |     +-------------+          +-+  |                   +---+     +-> Z_ev
                    from evz_austot            +--->o| |                                   |             +---->| R |     |  (1...8)
                                               |     +-+                                   |             |     +---+-----+     (*)
                                               +-------------------------------------------+             |
                                                                                      +-+  |             |
              +---+---+---+---+---+---+---+---+                   B_clev (1...8)----->|&|  |      +-+    |
  evz_austot  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |                   C_fcmclr ---------->| +--+----->| |    |
              +---+---+---+---+---+---+---+---+                                       +-+         |V+----+ (*)
                ^   ^   ^   ^   ^   ^   ^   ^                       C_ini ----------------------->| |
                |   |   |   |   |   |   |   |                                                     +-+
EV8 (Bit 7) ----+   |   |   |   |   |   |   |
EV7 (Bit 6) --------+   |   |   |   |   |   |
EV6 (Bit 5) ------------+   |   |   |   |   |
EV5 (Bit 4) ----------------+   |   |   |   |
EV4 (Bit 3) --------------------+   |   |   |
EV3 (Bit 2) ------------------------+   |   |
EV2 (Bit 1) ----------------------------+   |
EV1 (Bit 0) --------------------------------+
```

Bits (E_evi, Z_evi), that do not exist because of ZYLZA<8, are set per definition:

E_evi (i>ZYLZA) = false
Z_evi (i>ZYLZA) = true

Example: For a 6-zylinder engine E_ev7 = E_ev8 = false and Z_ev7 = Z_ev8 = true.

```
                   +---+
E_ev (i=n) ------> |   |
   ...             | V |---------> B_eev
E_ev (i=1) ------> |   |
                   +---+
```

(*) deviant from the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

```
 Error memory management:
 ------------------------

Status error path EV:    sfpev
Error flag  EV:          E_ev
Cycle flag EV:           Z_ev
Error type EV:           Typ_ev
Kind of error EV:        B_mxev
                         B_mnev
                         B_siev


Clear error path:        C_fcmclr & B_clev
Error path EV:                      CDTEV
Error class EV:                     CLAEV
Error intensity EV:                 TSFEV
Carb code EV:                       CDCEV
Ambient conditions EV:              FFTEV
```

ABK DEVE 6.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCEV1	BLOKNR		KL	code word CARB: injector 1
CDCEV2	BLOKNR		KL	code word CARB: injector 2
CDCEV3	BLOKNR		KL	code word CARB: injector 3
CDCEV4	BLOKNR		KL	code word CARB: injector 4
CDCEV5	BLOKNR		KL	code word CARB: injector 5
CDCEV6	BLOKNR		KL	code word CARB: injector 6
CDCEV7	BLOKNR		KL	code word CARB: injector 7
CDCEV8	BLOKNR		KL	code word CARB: injector 8
CDTEV1			FW	code word tester: injection valve of cyl. 1
CDTEV2			FW	code word tester: injection valve of cyl. 2
CDTEV3			FW	code word tester: injection valve of cyl. 3
CDTEV4			FW	code word tester: injection valve of cyl. 4
CDTEV5			FW	code word tester: injection valve of cyl. 5
CDTEV6			FW	code word tester: injection valve of cyl. 6
CDTEV7			FW	code word tester: injection valve of cyl. 7
CDTEV8			FW	code word tester: injection valve of cyl. 8
CLAEV1			FW	error class: injector power stage 1
CLAEV2			FW	error class: injector power stage 2
CLAEV3			FW	error class: injector power stage 3
CLAEV4			FW	error class: injector power stage 4
CLAEV5			FW	error class: injector power stage 5
CLAEV6			FW	error class: injector power stage 6
CLAEV7			FW	error class: injector power stage 7
CLAEV8			FW	error class: injector power stage 8
FFTEV1	BLOKNR		KL	freeze frame table: injector power stage 1
FFTEV2	BLOKNR		KL	freeze frame table: injector power stage 2
FFTEV3	BLOKNR		KL	freeze frame table: injector power stage 3
FFTEV4	BLOKNR		KL	freeze frame table: injector power stage 4
FFTEV5	BLOKNR		KL	freeze frame table: injector power stage 5
FFTEV6	BLOKNR		KL	freeze frame table: injector power stage 6
FFTEV7	BLOKNR		KL	freeze frame table: injector power stage 7
FFTEV8	BLOKNR		KL	freeze frame table: injector power stage 8
TSFEV1			FW	fault active time: injector of cyl 1
TSFEV2			FW	fault active time: injector of cyl 2
TSFEV3			FW	fault active time: injector of cyl 3
TSFEV4			FW	fault active time: injector of cyl 4
TSFEV5			FW	fault active time: injector of cyl 5
TSFEV6			FW	fault active time: injector of cyl 6
TSFEV7			FW	fault active time: injector of cyl 7
TSFEV8			FW	fault active time: injector of cyl 8
ZYLZA			FW	number of cylinders

Variable	Source	Type	Description
B_CLEV		EIN	condition clear fault path injector power stage
B_DESEE	DKOSE	EIN	Diagnosis power stage: entry conditions fulfilled
B_EEV	DEVE	AUS	condition injector fault (power stage)
B_MNEV1		EIN	Error type: short circuit to ground at power stage injector 1
B_MNEV2		EIN	Error type: short circuit to ground at power stage injector 2
B_MNEV3		EIN	Error type: short circuit to ground at power stage injector 3
B_MNEV4		EIN	Error type: short circuit to ground at power stage injector 4
B_MNEV5		EIN	Error type: short circuit to ground at power stage injector 5
B_MNEV6		EIN	Error type: short circuit to ground at power stage injector 6
B_MNEV7		EIN	Error type: short circuit to ground at power stage injector 7
B_MNEV8		EIN	Error type: short circuit to ground at power stage injector 8
B_MXEV1		EIN	Error type: short circuit to B+ at power stage injector 1
B_MXEV2		EIN	Error type: short circuit to B+ at power stage injector 2
B_MXEV3		EIN	Error type: short circuit to B+ at power stage injector 3
B_MXEV4		EIN	Error type: short circuit to B+ at power stage injector 4
B_MXEV5		EIN	Error type: short circuit to B+ at power stage injector 5
B_MXEV6		EIN	Error type: short circuit to B+ at power stage injector 6
B_MXEV7		EIN	Error type: short circuit to B+ at power stage injector 7
B_MXEV8		EIN	Error type: short circuit to B+ at power stage injector 8
B_SA	MDRED	EIN	Condition fuel cut-off
B_SIEV1		EIN	Error type: interruption at power stage injector 1
B_SIEV2		EIN	Error type: interruption at power stage injector 2
B_SIEV3		EIN	Error type: interruption at power stage injector 3
B_SIEV4		EIN	Error type: interruption at power stage injector 4
B_SIEV5		EIN	Error type: interruption at power stage injector 5
B_SIEV6		EIN	Error type: interruption at power stage injector 6
B_SIEV7		EIN	Error type: interruption at power stage injector 7
B_SIEV8		EIN	Error type: interruption at power stage injector 8
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
EVZ_AUSTOT	AEVABZK	EIN	injection cut off pattern total
E_EV1	DEVE	AUS	error flag: injection valve of cyl. 1
E_EV2	DEVE	AUS	error flag: injection valve of cyl. 2
E_EV3	DEVE	AUS	error flag: injection valve of cyl. 3
E_EV4	DEVE	AUS	error flag: injection valve of cyl. 4
E_EV5	DEVE	AUS	error flag: injection valve of cyl. 5

Variable	Source	Type	Description
E_EV6	DEVE	AUS	error flag: injection valve of cyl. 6
E_EV7	DEVE	AUS	error flag: injection valve of cyl. 7
E_EV8	DEVE	AUS	error flag: injection valve of cyl. 8
Z_EV1	DEVE	AUS	cycle flag: injection valve of cyl. 1
Z_EV2	DEVE	AUS	cycle flag: injection valve of cyl. 2
Z_EV3	DEVE	AUS	cycle flag: injection valve of cyl. 3
Z_EV4	DEVE	AUS	cycle flag: injection valve of cyl. 4
Z_EV5	DEVE	AUS	cycle flag: injection valve of cyl. 5
Z_EV6	DEVE	AUS	cycle flag: injection valve of cyl. 6
Z_EV7	DEVE	AUS	cycle flag: injection valve of cyl. 7
Z_EV8	DEVE	AUS	cycle flag: injection valve of cyl. 8

FW DEVE 6.40 Fixed Values

Parameter	Value	Description
CDTEV1		code word tester: injection valve of cyl. 1
CDTEV2		code word tester: injection valve of cyl. 2
CDTEV3		code word tester: injection valve of cyl. 3
CDTEV4		code word tester: injection valve of cyl. 4
CDTEV5		code word tester: injection valve of cyl. 5
CDTEV6		code word tester: injection valve of cyl. 6
CDTEV7		code word tester: injection valve of cyl. 7
CDTEV8		code word tester: injection valve of cyl. 8
CLAEV1		error class: injector power stage 1
CLAEV2		error class: injector power stage 2
CLAEV3		error class: injector power stage 3
CLAEV4		error class: injector power stage 4
CLAEV5		error class: injector power stage 5
CLAEV6		error class: injector power stage 6
CLAEV7		error class: injector power stage 7
CLAEV8		error class: injector power stage 8
TSFEV1		fault active time: injector of cyl 1
TSFEV2		fault active time: injector of cyl 2
TSFEV3		fault active time: injector of cyl 3
TSFEV4		fault active time: injector of cyl 4
TSFEV5		fault active time: injector of cyl 5
TSFEV6		fault active time: injector of cyl 6
TSFEV7		fault active time: injector of cyl 7
TSFEV8		fault active time: injector of cyl 8
ZYLZA		number of cylinders

FB DEVE 6.40 Detailed description of function

The precondition for the diagnosis of the EV power stage is the use of a power stage of the type CJ400/CJ920. The detection of a non-plausible state at the power stage and the reading of the kind of error from the IC is described in the section %DECJ.

The kinds of errors from the CJ400-diagnosis are combined according to their effect on the EV for the further processing in other ECU functions. Short circuit to UBat (B_mxev) or wire disconnection (B_siev) lead to the EV permanently being closed.
With a short circuit to ground (B_mnev), however, the EV is permanently open.

The cycle flag Z_ev is set by the CJ400-diagnosis in case of a detected power stage error. The cycle flag is set by this function if it is indicated by the condition B_desee that a CJ400-diagnosis can be performed and if the EV power stage was active for a certain time. This is ensured by the conditions B_stend and B_sa. In addition it is ensured by the byte evz_austot that no EV power stage was switched off by the cylinder cutout.

--> no powerstage-diagnosis during ECU after-run

APP DEVE 6.40 Application hint

DEKPE 11.11 Diagnosis; power stage of fuel pump relay

FDEF DEKPE 11.11 Function definition

```
Diagnosis-CJ400 : see %DECJ
+---------+---------+
| CJ400   | B_mxkpe |----------------+   (#)
| resp.   |         |                |
| CJ920   | B_sikpe |---------+      |
|         |         |         |      |   +-+    +------------------------------+
| EKP-    | B_mnkpe |-------+ |      +-->| +--->| delete HW-interlock in ES-IC +-----+
| power   |         |       | |          |&|    |10 microsec. impulse          |     |
| stage   | B_desee |----+--|-|--------->| |    +------------------------------+     |
+---------+---------+    |  | |          +-+               +---------+               |
             +-+         |  | |                       O----| EKPFA   |               |
 C_ini ----->| |---------|--|-|----------------------->\    +---------+               |
          +->|v|         |  | |   +-+                 O                              |
          |  +-+         |  | +-->| |  +-+            | Preset                       |    +-+
          |              |  +---->|V+->| |   +--------V------------+                 +--->| |                +---+---+
          |              |        +-+  |&| Cl| ---\ counter: EKPFZ |  ekpfz +------+  +-->|V+-----+--------->| S |   +--> E_kpe (*)
          |           +--|------------>| +-->|  0  \---------      +------->| <= 0 +--+   +-+     |   +-+    +---+---+
          |           |  |             +-+   +---------------------+        +------+            +-+->o| | +->| R |   |
          |           |  |                                                                  +-+ |     |V|-+  +---+---+
          |           |  |                                                  C_pwf --------->| | | +-->| |
          |           |  |                                                             +--->|V|-|-+   +-+
          |           |  |                                                             |    +-+ |
          +-----------|--|-------------------------------------------------------------+        |
          |           |  |                                                             |        |
          |  +-+      |  |                                 +---------+                 |        |
          +->| |      |  |                            O----| EKPPA   |                 | (*)    |  +-+
 C_ini ----->|v|------|--|-------------------------->\     +---------+             +-+ |  C_ini-|->|V|   (*)
             +-+      |  |                            O               B_clkpe ---->| | |  +-----|->| |--+
                      |  |    +-+                     | Preset        C_fcmclr --->|&|-+--+     |  +-+  |
                      |  +--->| |            +--------V------------+               +-+          |       |
 R_100 millisec ------|------>|&|          Cl| ---\ counter: EKPPZ |   ekppz      +------+      |  +-+  |    +---+---+
                   +--|------>| |----------->|  0  \---------      +-------+----->| <= 0 +--+   +->| |--|--->| S |   +--> Z_kpe (*)
                   |  |       +-+            +---------------------+       |      +------+  +----->|v|  |    +---+---+
                   |  |      +--------------------+                        |                |      +-+  +--->| R |   |
                   |  +------|     ekppz > 0      +<-----------------------+                +-------+        +---+---+
                   |  |      +--------------------+            +------------------------+           |
                   |  |                  +-+                   | EKP-relay triggering   |           |
                   |  +----------------->| |                   | with test pulse        |           V              CJ400 - KPE
                   |                     |&+------------------->| 250 microsec.          +-------O ---- O---------> EKP-relay
+----------------+ |             +------>| |                   +------------------------+   +---O                  triggering
|CJ400-Dia-module+-+-------------+       +-+                  +-----------------------+     |
|in state OK     |                                            |EKP-triggering: %AEKP  +-----+
+----------------+                                            +-----------------------+
```

(*) deviant from the description this path is served in the module %DFPM, resp. the flags are managed in %DFPM;
(#) deviant from the description this path is served in the module %DECJ;

Error memory management:

```
Status error path KPE:     SFPKPE
Error flag KPE       :     E_KPE
Cycle flag KPE       :     Z_KPE
Error type  KPE      :     Typ_kpe
Kind of error KPE    :     B_mxkpe
                           B_mnkpe
                           B_sikpe

Clear error path:          C_fcmclr & B_clkpe
Error path KPE:            CDTKPE
Error class:               CLAKPE
Error intensity KPE:       TSFKPE
Carb code KPE:             CDCKPE
Ambient conditions KPE:    FFTKPE
```

ABK DEKPE 11.11 Abbreviations

CJ400		fourfold power stage of the type CJ400
ES		power stage
EKP		electric fuel pump
KPE		power stage fuel pump relay
EKPFZ		counter for error debouncing of the EKP relay power stage
EKPPZ		counter of the test pulse output
EKPFA = 3	Immediate constant	counter starting value of the error debouncing EKP relay power stage
EKPPA =10	Immediate constant	counter starting value of the test pulse output

Parameter	Source-X	Source-Y	Type	Description
CDCKPE	BLOKNR		KL	Code word CARB: fuel pump relay power stage
CDTKPE			FW	Code word tester: fuel pump relay power stage
CLAKPE			FW	Error class: fuel pump relay power stage
FFTKPE	BLOKNR		KL	Freeze frame table: fuel pump relay power stage
TSFKPE			FW	Fault active time: fuel pump relay power stage

Variable	Source	Type	Description
B_CLKPE		EIN	Condition clear fault path fuel pump relay power stage
B_DESEE	DKOSE	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNKPE		EIN	Condition fault type short circuit to ground of fuel pump power stage detected
B_MXKPE		EIN	fault type short circuit to Ubat of fuel pump power stage detected
B_SIKPE		EIN	Condition for fault type open circuit of fuel pump power stage detected
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
EKPFZ	DEKPE	LOK	Power stage diagnostic EKP relais: counter for dejettering of error
EKPPZ	DEKPE	LOK	Power stage diagnostic EKP relais: counter test puls trigger
E_KPE	DEKPE	AUS	Error flag: fuel pump relay power stage
Z_KPE	DEKPE	AUS	Cycle flag: fuel pump relay power stage

FW DEKPE 11.11 Fixed Values

Parameter	Value	Description
CDTKPE		Code word tester: fuel pump relay power stage
CLAKPE		Error class: fuel pump relay power stage
TSFKPE		Fault active time: fuel pump relay power stage

FB DEKPE 11.11 Detailed description of function

The EKP power stage is switched on as soon as the engine speed impulses are detected. When switching the ignition off via terminal 15 or in case of engine stop the relay power stage is switched off (see description operating modes EKP: AEKP). With this kind of triggering it is not possible to detect a short circuit to ground or a wire disconnection during normal operating, since the ES is not operated in a control state which allows this error detection.

So that the power stage diagnosis can be performed the power stage is switched off by means of a test pulse of max. 250 microsec. duration (this switching time does not yet lead to an opening of the relay contacts). It must be ensured that the 250 microsec. duration is not prolonged unpermissibly by interrupts thus leading to the EKP relay being switched off. The generation of test pulse and the triggering of the EKP-relay power stage is performed in the 100 ms grid; thereafter the EKP-relay triggering follows as is defined in the section %AEKP.

After an engine start (C_ini =1: engine speed pulses are detected, program changes to normal operting) the counter (EKPPZ) is preset with the starting value EKPPA. The counter is decremented in the 100 ms grid (R_100), if the condition B_desee indicates that an error detection is possible from the ES-IC.
Until the counter reaches the value 0 the EKP-relay power stage is triggered via a 250 microsec. pulse. The output of the impulse is always performed once the CJ400-diagnosis module is in the state OK so that a detected error can be read immediately in the ES-IC.

Setting of the cycle bit Z_kpe:

The cycle bit can be set as soon as test pulses were transmitted to the power stage and if it was indicated by the condition B_desee that an error diagnosis was possible on the power stage IC. After the output of the test pulse the switching possiblities of the power stage have been checked. Once the debouncing counter EKPPZ reaches the value 0 the cycle bit is set. With the setting of the error bit also the cycle bit is set, if a power stage error is detected with the output sequence of the test pulses.

Setting of the error bit E_kpe in case of wire disconnection or short circuit to ground:

If these errors are given at the power stage, it can be detected during the output sequence of the test pulses. For the error debouncing the error bit is not set until the counter EKPFZ was decremented to the value 0. The error type detected last is then entered into the error memory.

Setting of the error bit E_kpe in case of short circuit to UBat:

A short circuit to Ubat can be detected during normal operating. The special error treatment (verification, check of healing) of the EKP-relay power stage takes place in the CJ400-diagnosis module. For the protection of the power stage there is a switch-off of the switching transistor on the IC. This switch-off becomes active if the error type short circuit to Ubat is entered into the CJ400-shift register. The interlock is released by means of an edge change at the power stage input for a another triggering. For error verification and for check of healing this HW-interlock is removed with a pulse lasting for 10 microsec. The ECU software then immediately enables the power stage again.

Error verification, error healing check wire disconnection and short circuit to ground:

It must be ensured that the relay contacts do not open during an error verification or a healing check. For this reason it is not possible to use the standard CJ400-verification or -healing check.

For the error verification of the power stage error short circuit to ground the power stage is triggered by the test pulse.
If following this an error can be read via the CJ400-diagnosis, this error detection is debounced by means of the counter EKPFZ. Once the counter reaches the count 0 the error bit is set and the detected error type is entered into the error memory.

A healing check can then no longer be performed during the following engine operation. If the power stage is triggered again by the output of the test pulse sequence after a new start and no power stage is detected, then this is considered as a criterion for an error healing. The error bit E_kpe is reset.

Setting of the error bit E_kpe in case of short circuit to UBat:

A short circuit to Ubat can be detected during normal operating. The special error treatment (verification, check of healing) of the EKP-relay power stage takes place in the CJ400-diagnosis module. For the protection of the power stage there is a switch-off of the switching transistor on the IC. This switch-off becomes active if the error type short circuit to Ubat is entered into the CJ400-shift register. The interlock is released by means of an edge change at the power stage input for a another triggering. For error verification and for check of healing this HW-interlock is removed with a pulse lasting for 10 microsec. The ECU software then immediately enables the power stage again.

APP DEKPE 11.11 Application hint

Filter time in the CJ400 for the setting of the flip-flop in the shift register: 60 to 200 μsec

Estimation of the max. capacitance at the power stage output: < 1nF --> then with LA the max. voltage threshold 12 V is reached in 120 usec.

DTEVE 9.31 Diagnosis; power stage of canister purge valve

FDEF DTEVE 9.31 Function definition

Diagnostic function for CJ 400 , CJ 920 see %DECJ

```
+-----------+------------+
| CJ400     |  B_mxteve  +-----------------------------+
| bzw.      |            |                             |
| CJ920     |  B_siteve  +---------------------------+ |
|           |            |                           | |
| powerstage|            |                           | |
|           |  B_mnteve  +-------------------------+ | |
|   PCV     |            |                         | | |
|           |            |                         | | |   +-+
|           |            |                         | | +-->| |       (#)                             +-+---+
|           |            |                         | +---->|v+------+--------------------+---------->|S|   +-------> E_teve (*)
|           |            |                         +------>| |      |                    |    +-+    +-+---+
|           |            |                               +-+      |               +-+  +-->o|v+--->|R|   |
|           |  B_desee   +---+                                    |    C_pwf ---->|v+------>| |    +-+---+
+-----------+------------+   |                                    |            +->| |  (*)  +-+
                 +-----------+                                    |            |  +-+
                 |   +-+                                          |    +-+     |
 tateout         +-->|&|      +-+---+       +-+    +------------+   +--->| |     |
  zwischen ---+--|-->| +----->|S|   +------>| |    | 500 ms +-  |        |v|     |                   +-+---+
 0% und 100%  |  |   +-+      +-+---+       |&+--->| -------+-> +-------->| +-----|------------------>|S|   +-------> Z_teve (*)
              |  |         +->|R|   |   +-->| |    +------------+        +-+     |                   +-+---+
              |  |         |  +-+---+   |   +-+                                  |            +----->|R|   |
              |  |   +-+   |            |                                +-+     |            |      +-+---+
              |  +-->|&|   |  +-+---+   |             B_clteve --------->|&|     |     +-+    |
              +---->o| +---|->|S|   +---+             C_fcmclr --------->| +-----+---->| |    |
                     +-+   |  +-+---+                                    +-+           |v+----+ (*)
                 +---------+->|R|   |                 C_ini -------------------------->| |    |
                 |            +-+---+                                                  +-+    |
                 |                                                                            |
                 +----------------------------------------------------------------------------+
```

```
(*) this path is calculated in %DFPM and the flags are flags of the status register
(#) this path is calculated in % DECJ

In case of fault:
 - B_atev: B_gasp = TRUE     (see   %LRA)

Fault code management:
----------------------

status fault-path TEVE: SFPTEVE
Errorflag TEVE:                E_teve
Cycleflag TEVE:                Z_teve
possible kinds of fault TEVE:  B_mxteve
                               B_mnteve
                               B_siteve


Reset fault path                   C_fcmclr & B_clteve
Fault path TEVE  :                 CDTTEVE
Fault class  TEVE:                 CLATEVE
Fault rate TEVE:                   TSFTEVE
CARB Code TEVE:                    CDCTEVE
Freeze frame Table TEVE:           FFTTEVE
```

ABK DTEVE 9.31 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCTEVE	BLOKNR		KL	code word CARB: canister purge valve power stage
CDTTEVE			FW	code word tester: canister purge valve (power stage)
CLATEVE			FW	fault class: canister purge valve power stage
FFTTEVE	BLOKNR		KL	freeze frame table: canister purge valve (power stage)
TSFTEVE			FW	fault active time: canister purge valve driver stage

Variable	Source	Type	Description
B_ATEV	DTEVE	AUS	condition power stage diagnostic TEV on
B_CLTEVE		EIN	condition clear fault path TEVE
B_DESEE	DKOSE	EIN	Diagnosis power stage: entry conditions fulfilled
B_MNTEVE	DTEVE	AUS	fault type: short circuit ground canister purge valve power stage
B_MXTEVE	DTEVE	AUS	fault type: short circuit Ubat canister purge valve power stage
B_SITEVE	DTEVE	AUS	fault type: cable disconnection of canister purge valve power stage
B_ZTEV	DTEVE	AUS	condition power stage diagnostic TEV closed
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_TEVE	DTEVE	AUS	error flag: canister purge valve power stage
TATEOUT	ATEV	EIN	output duty cycle for canister purge valve
Z_TEVE	DTEVE	AUS	cycle flag: canister purge valve power stage

FW DTEVE 9.31 Fixed Values

Parameter	Value	Description
CDTTEVE		code word tester: canister purge valve (power stage)
CLATEVE		fault class: canister purge valve power stage
TSFTEVE		fault active time: canister purge valve driver stage

FB DTEVE 9.31 Detailed description of function

APP DTEVE 9.31 Application hint

```
See general application of diagnostic parameters of power stages
```

DSUE 7.20 Diagnosis; driver for intake manifold flap

FDEF DSUE 7.20 Function definition

```
 Diagnosis CJ 400, resp. CJ 920  see %DECJ


+----------+----------+
|  CJ400   | B_mxsue  +-------------------------------+
|  resp.   |          |                               |
|  CJ920   | B_sisue  +--------------------------+    |
|          |          |                          |    |
|  SU-     |          |                          |    |
|  power   |          |                          |    |
|  stage   | B_mnsue  +---------------------+    |    |
|          |          |                     |    |    |
|          |          |                     |    |    |    +-+
|          |          |                     |    |    +--->| |       (#)                            +---+-----+
|          | B_desee  +-------+             |    +-------->|V+--------+--------------------+--------->| S |     |
+----------+----------+       |             +------------->| |        |                    |    +-+   +---+     +----> E_sue (*)
                              |                            +-+        |               +-+  +-->o|V+-->| R |     |
                 +------------+                                       |  C_pwf ------>|V+------>| |   +---+-----+
                 |   +-+                                              |           +-->| |  (*)  +-+
                 +-->| |     +---+----+                               | (#) +-+   |   +-+
B_su  ------+----|-->|&+---->| S |    |       +-+    +-------------+  +---->| |   |
            |    |   +-+     +---+    +------>| |    | 500 ms +--- |        |V|   |                   +---+-----+
            |    |        +->| R |    |   +-->|&+--->| -------+->t +------->| +---|------------------>| S |     |
            |    |        |  +---+----+   |   +-+    +-------------+        +-+   |                   +---+     +----> Z_sue (*)
            |    |   +-+  |               |                                  +-+  |             +---->| R |     |
            |    +-->| |  |  +---+----+   |              B_clsue  ---------->|&|  |      +-+    |     +---+-----+
            +------>o|&+--|->| S |    |   |              C_fcmclr ---------->| +--+----->| |    |
                     +-+  |  +---+    +---+                                  +-+         |V+----+ (*)
                          +->| R |    |                    C_ini ----------------------->| |    |
                          |  +---+----+                                                  +-+    |
                          |                                                                     |
                          +---------------------------------------------------------------------+


(*) deviant to the description this path is served in the module %DFPM resp. the flags are managed in %DFPM;
(#) deviant to the description this path is served in the module %DECJ;

Fault Code Memory Management:
-----------------------------

Status fault path SUE:   sfpsue
Error flag SUE:          E_sue
Cycle flag SUE:          Z_sue
Fault type SUE:          B_mxsue
                         B_mnsue
                         B_sisue


Clear fault path:       C_fcmclr & B_clsue
Fault path SUE:                   CDTSUE
Fault class SUE:                  CLASUE
Fault severity SUE:               TSFSUE
Carb-Code SUE:                    CDCSUE
Ambient conditions SUE:           FFTSUE
```

ABK DSUE 7.20 Abbreviations

FW DSUE 7.20 Fixed Values

Parameter	Value	Description

FB DSUE 7.20 Detailed description of function

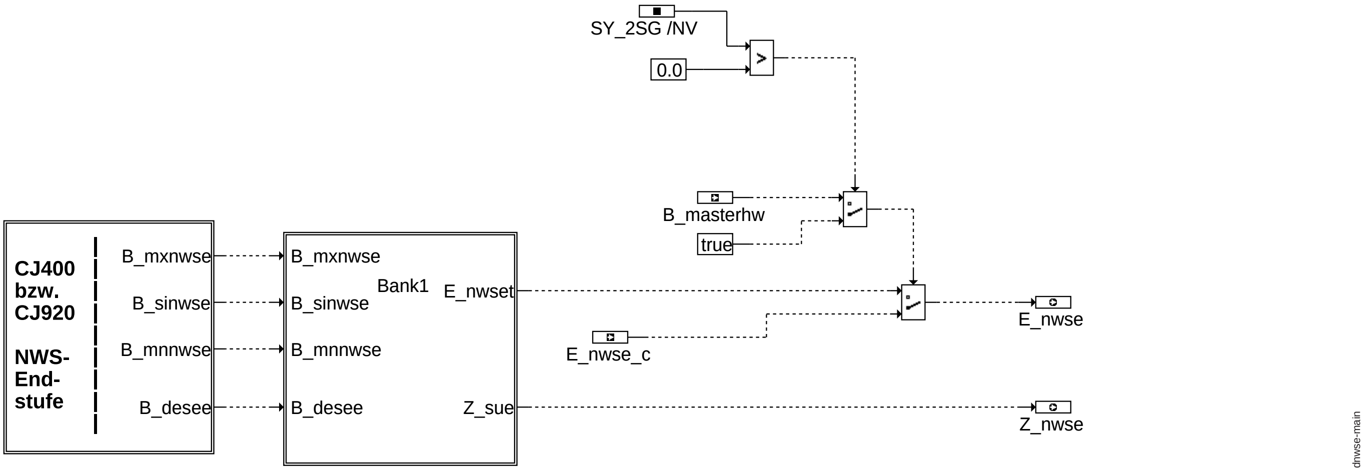
Precondition for the diagnosis of the SU power stage is the use of a power stage of the type CJ401.
The detection of not plausible states at the power stage and the reading of the fault type is described in the section %DECJ.

Setting of the Cycle Flag:
The setting of the cycle flag is performed for one via a fault entry and for the other via a securely tested not due fault. This secure test is given, if both switch-states of the power stage, so switched on and switched off, were reached once.
If a fault is detected in one of the states fault verification is activated in %DECJ, which is performed independent of the external power-stage request and which is definitely terminated after approx. 500 ms. Thereafter the cycle bit is set.

APP DSUE 7.20 Application hint

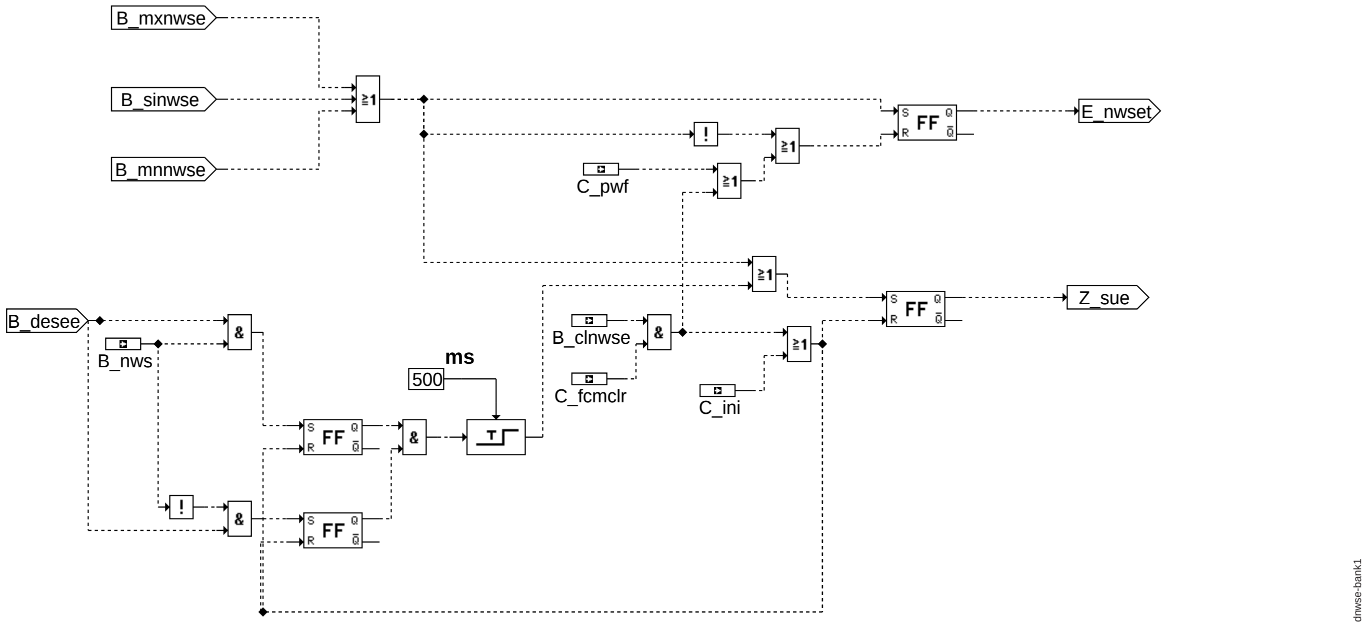
DNWSE 5.40 Diagnosis; camshaft control power stage

FDEF DNWSE 5.40 Function definition



dnwse-main

dnwse-dnwse



dnwse-bank1

Diagnosis CJ 400, or. CJ 920 see %DECJ

(*) Contrary to the description, this path is served by the module %DFPM and the flags are handled in %DFPM;
(#) Contrary to the description, this path is served by the module %DECJ;

Fault memory management:

```
Status fault path NWSE: SFPNWSE
Error flag NWSE:        E_nwse
Cycle flag NWSE:        Z_nwse
Fault type NWSE:        B_mxnwse
                        B_mnnwse
                        B_sinwse


Reset fault path:      C_fcmclr & B_clnwse
Fault path NWSE  :                CDTNWSE
Fault class NWSE:                 CLANWSE
Fault rate NWSE:                  TSFNWSE
Carb Code NWSE:                   CDCNWSE
Freeze frame table NWSE:          FFTNWSE
```

ABK DNWSE 5.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_2SG			SYS (REF)	system constant 2 motronic systems

Variable	Source	Type	Description
B_CLNWSE		EIN	condition clear fault path camshaft control power stage
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_NWS	NWS	EIN	Condition camshaft control
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_NWSE	DNWSE	AUS	error flag: power stage of camshaft control valve
E_NWSE_C		EIN	
Z_NWSE	DNWSE	AUS	cycle flag: power stage of camshaft control valve

FW DNWSE 5.40 Fixed Values

Parameter	Value	Description

FB DNWSE 5.40 Detailed description of function

The requirement for diagnosis of the camshaft control (NWS) power stage is the use of a CJ400 or CJ920 type power stage. Recognition of an implausible state at the power stage and retrieval of the fault type from the IC is described in the section %DECJ.

The fault types from the CJ400 diagnosis are compiled for further processing in other ECU functions according to their effects on the camshaft control. Short circuit to UBat or cable failure result in the camshaft control moving to the retarded end position. In contrast, a short circuit to ground (B_mnnwse) results in the NWS being constantly at the advanced end position.

The cycle flag Z_nwse is set in the event of a power stage fault in the CJ400 diagnosis. The cycle flag is set by this function if the condition B_desee indicates that a CJ400 diagnosis can be performed and if the NWS power stage has been actuated to both states via the condition B_nws.

APP DNWSE 5.40 Application hint

DVKUP 4.30 Diagnosis; Switch-off engine by electronic clutch control (KUP)

FDEF DVKUP 4.30 Function definition

```
Check criteria:        B_motaus = 1 & vfzg_w < VDKUP & B_kup1new = 1 & B_selesped = 1 & B_anf_kup = 1 & misgs_c = 0
                       & E_vfz
Fault cure criteria:   C_pwf = 1 or clear fault memory (C_fcmclr = 1 & B_clvkup = 1)
Measures:              Switch-off injection pulses (see %MDRED)
```

```
                               +-----+
   B_kup1new ----------------->|     |
                               |     |
   B_selesped ---------------->|     |
               +---------+     |     |                                +---+-------+
   vfzg_w ---->| < VDKUP +---->|     |          +---+---------------->| S |       +-------------+--------> B_errkup
               +---------+     |     |          |   |     +---+       +---+-------+             |
   B_motaus ------------------>|     |          |   +--->O| V +------>| R |       |             +--------> B_asgab
                               |     |   +------|-------->|   |       +---+-------+
   B_anf_kup ----------------->|     |   |      |         +---+
                               |  &  +---|------+-----------------------+-------------------------------> B_sivkup
                  +-----+      |     |   |                              |
   misgs_c ------>| = 0 +----->|     |   |                              |
                  +-----+      |     |   |                              |
                               |     |   |                              |
   E_vfz -------------------->o|     |   |                              |
                               |     |   |                              |            +-----------+
                               +-----+   |                     +---+    +----------->| S |       +-------> E_vkup
   C_pwf --------------------------------|-------------------->|   |                 +---+-------+
                                         |                     | V +---------------->| R |       |
                                +---+    |   +---------------->|   |                 +---+-------+
   B_clvkup ------------------->|   |    |   |                 +---+
                                | & +----|---+
   C_fcmclr ------------------->|   |    |   |
                                +---+    |   |
                 +-----------------+     |   |
                 |        +------- |     |   |                                       +---+------+
   timmot_w ---->| TDVKUP |        +-----|---|-------------------------------------->| S |      +--------> Z_vkup
                 | -------+        |     |   |           +---+                       +---+------+
                 +-----------------+     |   +---------->| V +---------------------->| R |      |
   C_ini --------------------------------+-------------->|   |                       +---+------+
                                                         +---+
```

```
Fault management:
-----------------
status fault path:         SFPVKUP                clear fault path:          C_fcmclr & B_clvkup
error flag:                E_vkup                 fault path:                CDTVKUP
cycle flag:                Z_vkup                 fault class:               CLAVKUP
fault type:                B_sivkup               fault active time:         TSFVKUP
                                                  CARB-code:                 CDCVKUP
                                                  ambient conditions:        FFTVKUP
```

ABK DVKUP 4.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCVKUP	BLOKNR		KL	code word CARB: electr. clutch, speed dependent
CDTVKUP			FW	code word tester: electr. clutch, speed dependent
CLAVKUP			FW	fault class: ”Engine off”-request from F1-gearbox (KUP)
FFTVKUP	BLOKNR		KL	freeze frame tabele: ”Engine OFF”-request from F1-gearbox (KUP)
TDVKUP			FW	bounce free time for diagnosis electronic clutch control vehicle speed depending
TSFVKUP			FW	fault active time: electr. clutch, speed dependent
VDKUP			FW	vehicle speed threshold for diagn. electr. clutch contr. (engine switch-off)

Variable	Source	Type	Description
B_ANF_KUP		EIN	CAN-signal: bit shift phase (B_ANF_KUP) from el. clutch
B_ASGAB	DVKUP	AUS	Engine shut off by ASG
B_CLVKUP	DVKUP	LOK	condition clear fault path VKUP

Variable	Source	Type	Description
B_ERRKUP	DVKUP	AUS	Condition: engine switch-off cansed by electronic clutch
B_KUP1NEW		EIN	condition CAN-KUP1-message received
B_MOTAUS		EIN	CAN-signal: "Engine off"-request from F1-gearbox (KUP)
B_SELESPED		EIN	condition: car with selespeed
B_SGSRED	CAN	EIN	condition: reducing torque intervention for eng. speed synchr. during gear shift
B_SIVKUP	DVKUP	LOK	signal fault: "Engine off"-request from F1-gearbox (KUP)
C_FCMCLR	DVKUP	LOK	system state: reset fault memory
C_INI	DVKUP	LOK	ECU-condition for intialisation
C_PWF	DVKUP	LOK	ECU-condition powerfail initialisation
E_VFZ	EGAG	EIN	Error flag: vehicle speed signal
E_VKUP	DVKUP	LOK	error flag: electr. clutch, speed dependent
MISGS_C		EIN	indicated torque request from SGS
SFPVKUP	DVKUP	LOK	status fault path: "Engine off"-request from F1-gearbox (KUP)
TIMMOT_W	DVKUP	LOK	Timer:time after engine start n>NINI (word)
VFZG_W	GGVFZG	EIN	Vehicle speed
Z_VKUP	DVKUP	LOK	cycle flag: electr. clutch, speed dependent

FW DVKUP 4.30 Fixed Values

Parameter	Value	Description
CDTVKUP		code word tester: electr. clutch, speed dependent
CLAVKUP		fault class: "Engine off"-request from F1-gearbox (KUP)
TDVKUP		bounce free time for diagnosis electronic clutch control vehicle speed depending
TSFVKUP		fault active time: electr. clutch, speed dependent
VDKUP		vehicle speed threshold for diagn. electr. clutch contr. (engine switch-off)

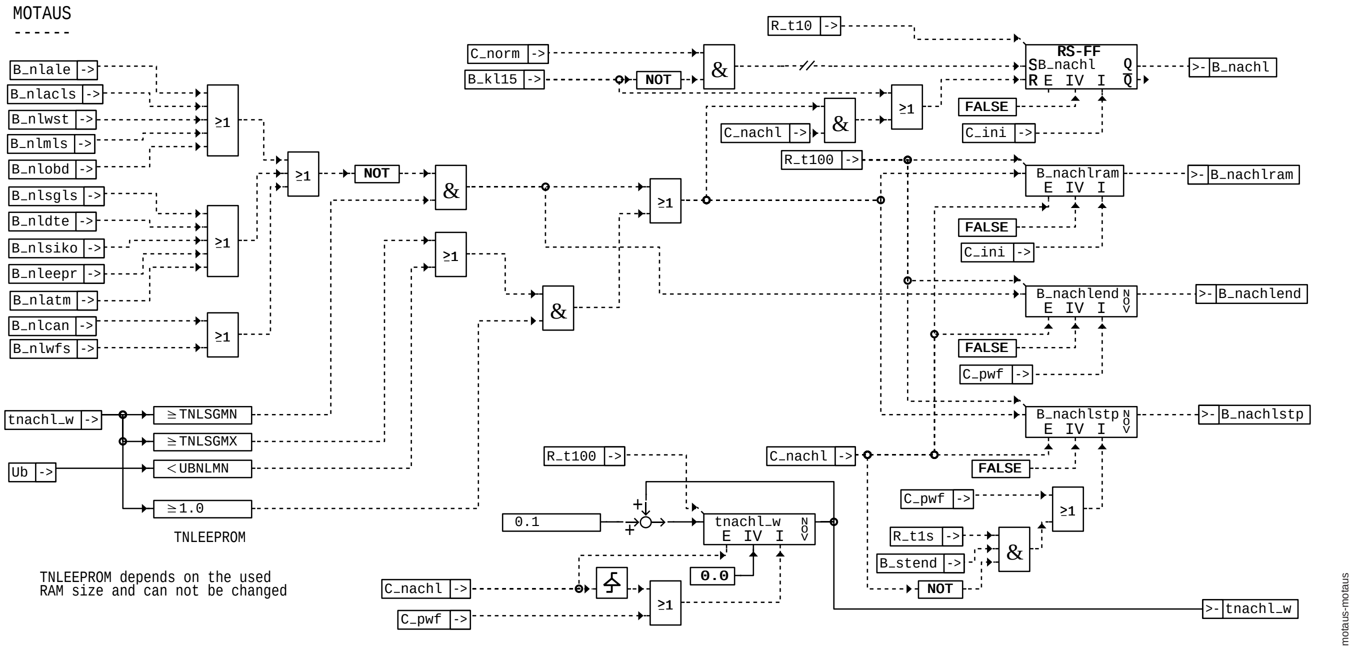
FB DVKUP 4.30 Detailed description of function

APP DVKUP 4.30 Application hint

MOTAUS 5.30 Engine switch-off

FDEF MOTAUS 5.30 Function definition

The function %MOTAUS describes the switch-off behaviour of the engine electronic control unit which is activated via S_KL15 (see %SYSCON) once the driver's desire to switch off the engine was detected and which is initiated by the setting of the condition B_kl15:



motaus-motaus

ABK MOTAUS 5.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TNLSGMN			FW	minimum time for ECM-switch-off delay
TNLSGMX			FW	maximum time for ECM-switch-off delay
UBNLMN			FW	Lower limit for Batterey target voltage

Variable	Source	Type	Description
B_KL15		EIN	condition ignition switch on
B_NACHL	MOTAUS	AUS	ECU control for ECU switch off delay
B_NACHLEND	MOTAUS	AUS	conditon ECU switch off delay regularly finished
B_NACHLRAM	MOTAUS	AUS	Condition ECU switch off with system check
B_NACHLSTP	MOTAUS	AUS	condition ECU switch off delay finished
B_NLACLS		EIN	request for ECM afterrun from the AC-fan-control
B_NLALE	ALE	EIN	request for ECM afterrun from the function ALE
B_NLATM	ATM	EIN	request for ECM exhaust-temp.modell ATM
B_NLCAN		EIN	Condition for ECU switch off delay by demand of CAN
B_NLDTE		EIN	request for ECM afterrun from leak detection
B_NLEEPR		EIN	Condition write of EEPROM during afterrun
B_NLMLS	LFS	EIN	request for ECM afterrun from the engine-fan-control
B_NLOBD		EIN	request for ECM afterrun from OBD
B_NLSGLS		EIN	request for ECM afterrun from the ECM-fan-control
B_NLSIKO		EIN	Condition monitoring of EGAS during afterrun
B_NLWFS		EIN	ECU condition for ECU switch off delay by the immobilizer ECU
B_NLWST	BGTABST	EIN	Request for ECM afterrun for recognition of re-start
B_STEND	BBSTT	EIN	condition end of start
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NACHL		EIN	ECU condition for ECU switch off delay
C_NORM		EIN	ECU-condition normal engine management operation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
R_T10		EIN	Time schedule 10 ms
R_T100		EIN	Time schedule 100 ms
R_T1S		EIN	Time schedule 1 s
TNACHL_W	MOTAUS	AUS	time of ECU switch off delay
UB	SWADAP	EIN	battery voltage

FW MOTAUS 5.30 Fixed Values

Parameter	Value	Description
TNLSGMN		minimum time for ECM-switch-off delay
TNLSGMX		maximum time for ECM-switch-off delay
UBNLMN		Lower limit for Batterey target voltage

FB MOTAUS 5.30 Detailed description of function

After the ignition key (B_kl15=0) was switched off the condition B_nachl is set during normal operation for the transition to the ECU-switch-off delay. Once the ECU-switch-off delay is terminated the condition B_nachl is reset. Via this the end of the ECU-switch-off delay is started in the system state control. By setting the Bit B_nachlram the RAM is released for the RAM test (this effects a loss of the RAM data). After this the ECU is switched off.

With the beginn of switch-off delay the time tnachl_w is started which gives the current time of the ECU-switch-off delay.

The switching off of the ECU-switch-off delay is activated,

- if no further requests come from the different functions during the switch-off delay, i.e. all B_nl* = false, and if the minimum switch-off delay time (TNLSGMN) has passed,

or

- if the maximum switch-off delay time (TNLSGMX) was reached or the battery voltage is under a lower threshold and the minimum switch-off delay time (TNLEEPROM - time to store for EEPROM) has passed.

Is the ECU-switch-off delay executed correctly that means the ECU will be switched off once all requests were taken back- then this is documented in the condition B_nachlend (permanent RAM) by true. If the condition B_nachlend is false this indicates an abort of the ECU-switch-off delay by reset, by the ignition key being switched on again or by the maximum switch-off delay time TNSGLMX being reached.

When reseting the bit B_nachl the bit B_nachlstp is stored at permanent flag. This bit indicates if the ECU-switch-off was stopped right (this is the case if no demands exist anymore or TNCEEPROM is gone and maximum ECU-switch-off time TNLSGMX is gone or battery voltage is at a lower threshold). Is B_nachlstp = FALSE that means it might be KL15 was switched on again.

For the condition of the ECU-switch-off a redundat switch-off track is existing. At the transition of the ECU-switch-off an extern timer is set in the ASIC, which stops the ECU-switch-off after the time is finished.

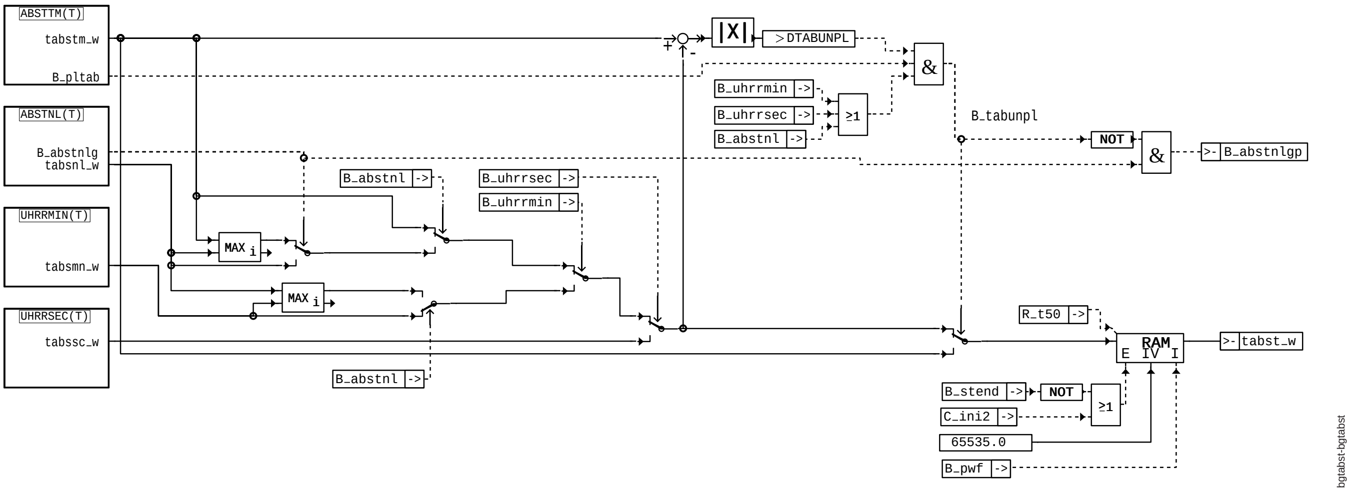
APP MOTAUS 5.30 Application hint

Data for initial application:

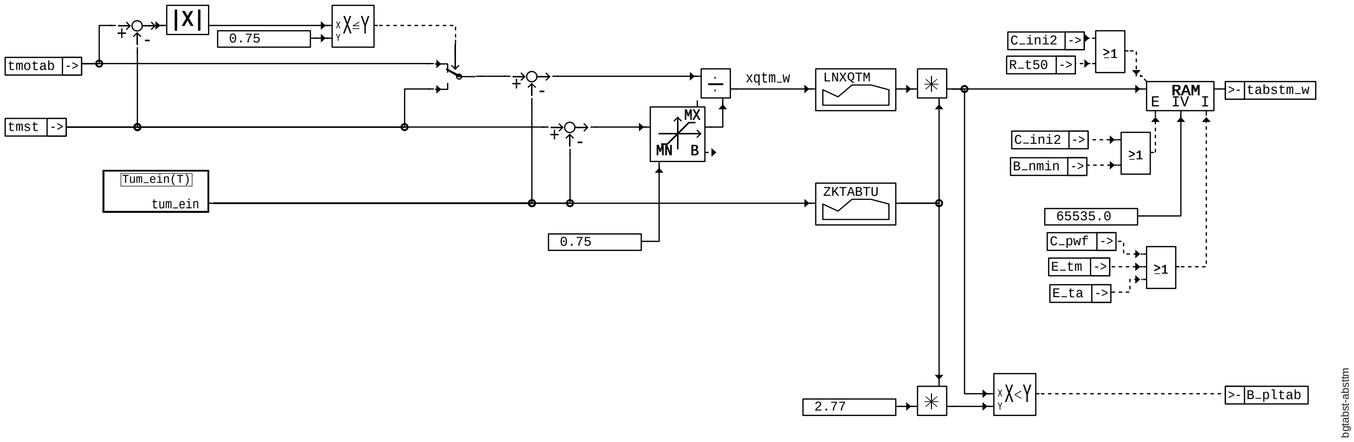
TNLSGMN = 5 sec
TNLSGMX = 25.6 sec
UBNLMN = 7 V

BGTABST 7.10 Calculated variable: cut-off time

FDEF BGTABST 7.10 Function definition

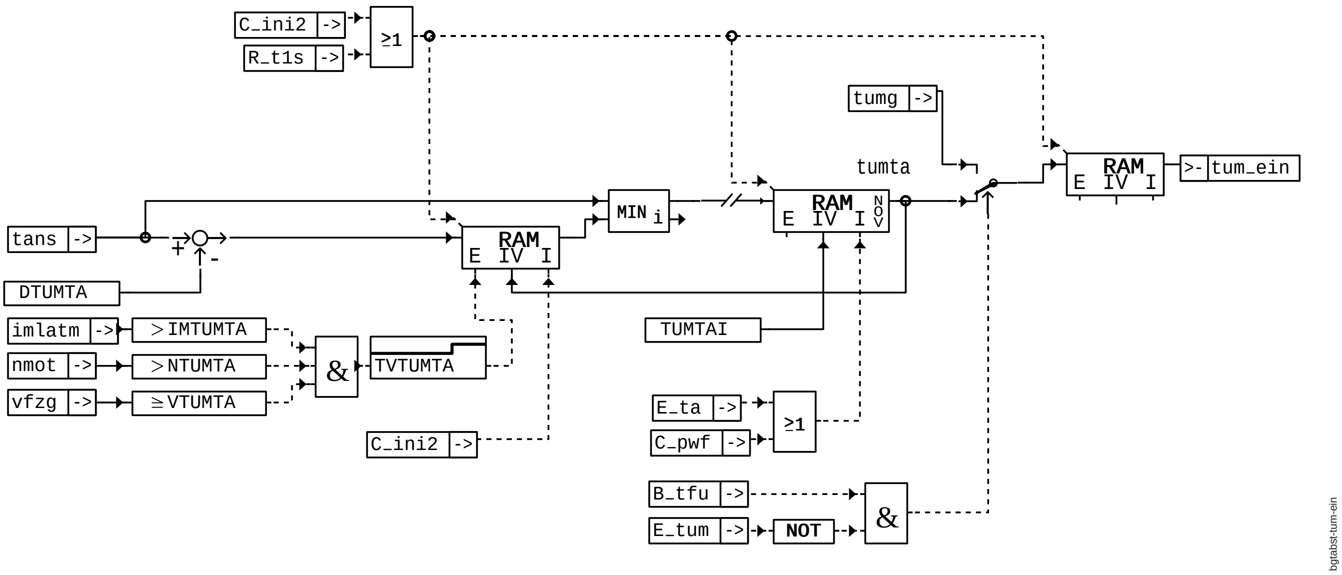


bgtabst-bgtabst



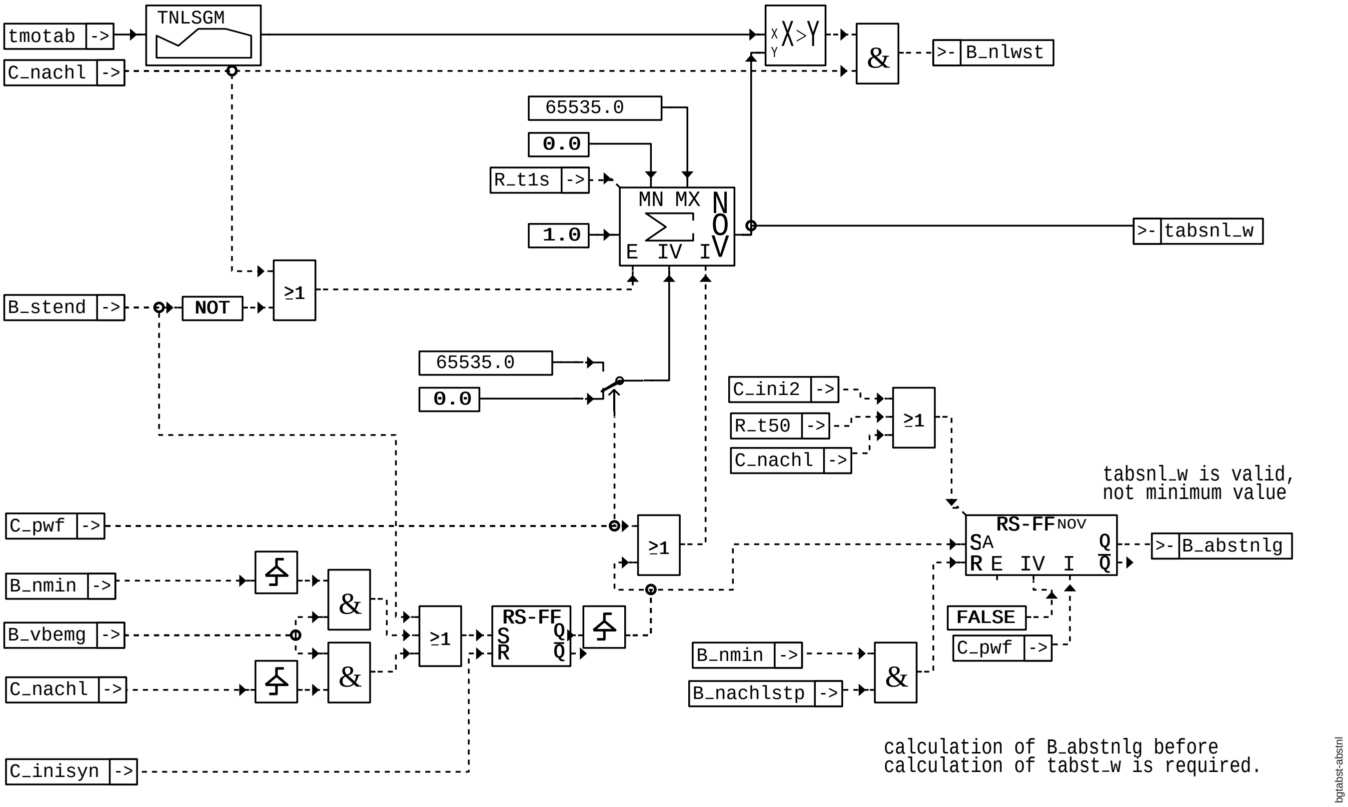
bgtabst-absttm

`Subfunction ABSTTM: Soak time determination from engine cooling`



bgtabst-tum-ein

Subfunction TUM_EIN: Calculation of the ambient temperature

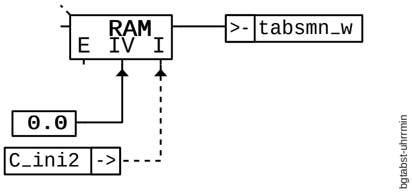


tabsnl_w is valid,
not minimum value

calculation of B_abstnlg before
calculation of tabst_w is required.

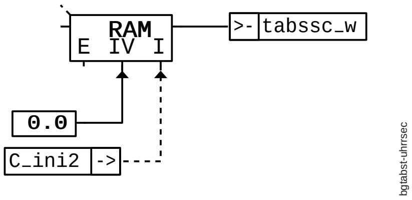
bgtabst-abstnl

Subfunction ABSTNL: Soak time determination with ECM-afterrunning



bgtabst-uhrrmin

Subfunction UHRRMIN: Soak time determination with relative minute counter



bgtabst-uhrrsec

Subfunction UHRRSEC: Soak time determination with relative second counter

ABK BGTABST 7.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTABUNPL			FW	threshold soak time unplausible
DTUMTA			FW	offset intake-air temperature -> ambient temperature
IMTUMTA			FW	threshold integrated air mass for determination ambient temperature
LNXQTM	XQTM		KL	natural logarithm from temperature quotient
NTUMTA			FW	threshold engine speed for determination ambient temperature
TNLSGM	TMOTAB		KL	Delay time for ECU shut-off
TUMTAI			FW	initial value of ambient temperature
TVTUMTA			FW	delay for threshold velocity for determination ambient temperature

Parameter	Source-X	Source-Y	Type	Description
VTUMTA			FW	threshold velocity for determination ambient temperature
ZKTABTU	TUM_EIN		KL	time constant for engine cooling

Variable	Source	Type	Description
B_ABSTNL	PROKON	EIN	condition soak time calculation via ECM-afterrun
B_ABSTNLG	BGTABST	LOK	condition soak time calculation via ECM-afterrun is valid
B_ABSTNLGP	BGTABST	AUS	condition soak time calculation via ECM-afterrun is valid and plausible
B_NACHLSTP	MOTAUS	EIN	condition ECU switch off delay finished
B_NLWST	BGTABST	AUS	Request for ECM afterrun for recognition of re-start
B_NMIN	GGDPG	EIN	condition lower speed: n $<$ NMIN
B_PLTAB	BGTABST	LOK	condition plausibility check soak time possible
B_PWF		EIN	Condition for powerfail
B_STEND	BBSTT	EIN	condition end of start
B_TABUNPL	BGTABST	LOK	condition soak time unplausible
B_TFU	PROKON	EIN	condition ambient temperature sensor exists
B_UHRRMIN	PROKON	EIN	Condition clock with a relative counter of minutes
B_UHRRSEC	PROKON	EIN	Condition clock with a relative counter of seconds
B_VBEMG	ESSTT	EIN	condition detection of combustion possible
C_INI2		EIN	ECU-condition for initialisation phase 2
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NACHL		EIN	ECU condition for ECU switch off delay
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_TA	GGTFA	EIN	error flag: TANS
E_TM	GGTFM	EIN	Error flag: engine temperature tmot
E_TUM		EIN	Error Flag: ambient (air) temperature tumg
IMLATM	ATM	EIN	integrated air mass flow from engine start to maximum value
NMOT	SWADAP	EIN	engine speed
R_T1S		EIN	Time schedule 1 s
R_T50		EIN	Time schedule 50 ms
TABSMN_W	BGTABST	LOK	soak time from relative counter of minutes
TABSNL_W	BGTABST	LOK	soak time from ECM-afterrunning
TABSSC_W	BGTABST	LOK	soak time from relative counter of seconds
TABSTM_W	BGTABST	LOK	soak time from engine cooling
TABST_W	BGTABST	AUS	soak time
TANS	SWADAP	EIN	Intake air temperature
TMOTAB	GGTFM	EIN	engine coolant temperature at engine stop or cut-off cranking
TMST	GGTFM	EIN	engine temperature at start
TUMG		EIN	Ambient air temperature
TUMTA	BGTABST	LOK	ambient temperature from intake-air temperature
TUM_EIN	BGTABST	LOK	ambient temperature for soak time calculation
VFZG	SWADAP	EIN	vehicle speed (km/h)
XQTM_W	BGTABST	LOK	temperature quotient

FW BGTABST 7.10 Fixed Values

Parameter	Value	Description
DTABUNPL		threshold soak time unplausible
DTUMTA		offset intake-air temperature -$>$ ambient temperature
IMTUMTA		threshold integrated air mass for determination ambient temperature
NTUMTA		threshold engine speed for determination ambient temperature
TUMTAI		initial value of ambient temperature
TVTUMTA		delay for threshold velocity for determination ambient temperature
VTUMTA		threshold velocity for determination ambient temperature

FB BGTABST 7.10 Detailed description of function

The soak time tabst_w can be determined by different methods depending on the given surroundings. These are defined by the codeword CWUHR. The following methods are distinguished:

1. Soak time determination with relative second counter: A relative second counter is required, that is available either ECM-internal and works permanent, or ECM-external, which works permanent and communication between ECM and counter is possible throughout ECM operation (i.e. via CAN). If these requirements are fulfilled B_uhrrsec = 1 (bit 1 of CWUHR).

2. Soak time determination with relative minute counter: A relative minute counter is required, that is available either ECM-internal and works permanent, or ECM-external, which works permanent and communication between ECM and counter is possible throughout ECM operation (i.e. via CAN). If these requirements are fulfilled B_uhrrmin = 1 (bit 0 of CWUHR).

3. Soak time determination with ECM-afterrunning:
   B_abstnl = 1 (bit 2 of CWUHR) if ECM-afterrunning is available for determination of short soak times.
   After the engine is stalled or shut-off a time counter is started at the beginning of ECM-afterrunning.
   The necessary (permissible) duration of ECM-afterrunning for re-start detection is given in characteristic TNLSGM depending on engine temperature. If the engine is not started within the duration of ECM-afterrunning the time counting will be stopped at the end of afterrunning and the minimum soak time stored in tabsnl_w. Longer soak time is then detected as described in 5. .
   If ignition is switched on again within the duration of afterrunning tabsnl_w is stored and updated until end of start.

4. Soak time determination with relative minute counter and ECM-afterrunning:
   Combination of 2. and 3.: B_uhrrmin = 1 and B_abstnl = 1 (bits 0 and 2 of CWUHR).

5. Soak time determination from engine cooling:
   If neither relative second counter nor relative minute counter are available for soak time determination longer soak times are determined from engine cooling. Therefor xqtm_w = (tmotab - tumta)/(tmst - tumta) is calculated. Characteristic LNXQTM contains values for the natural logarithm ln(xqtm_w). Soak time tabstm_w is then obtained by multiplication of ln(xqtm_w) and time constant ZKTABTU = f(tumta). The ambient temperature tumta is the difference between tans and DTUMTA. If a sensor for ambient temperature is available, tumg is used instead of tumta.

APP BGTABST 7.10 Application hint

1. Soak time determination with relative second counter:
   This method of soak time determination is the most precise and therefor should be preferred. If plausibility test is desired subfunction ABSTTM and threshold for plausibility check DTABUNPL must be applicated (see 5.). If no plausibility check within %BGTABST is desired DTABUNPL must be set on its maximum value 65535.
   This way of soak time determination is not realized in the actual version.

2. Soak time determination with relative minute counter:
   Application like 1. . If ECM-afterrunning is available, see 4. .
   This way of soak time determination is not realized in the actual version.

3. Soak time determination with ECM-afterrunning:
   This method of soak time determination is suitable for detecting short soak times. A combination with a relative minute counter (see 4.) or evaluation of engine cooling (see 5.) is necessary to detect longer soak time.
   Characteristic TNLSGM in subfunction ABSTNL must contain the desired or permitted duration of ECM-afterrunning in seconds for re-start detection depending on engine temperature.

4. Soak time determination with combination of relative minute counter and ECM-afterrunning:
   With this method it is possible to determine soak time with a resolution of 1 s during afterrunning and with a resolution of 1 min after that. For application of subfunction ABSTNL see 3. .

5. Soak time determination from engine cooling:
   This method is less precise than the above described and should be used only if the hardware requirements for these are not fulfilled. Soak time is calculated as multiplication of time constant (depending on ambient temperature) ZKTABTU and natural logarithm of xqtm_w. The logarithm is calculated via characteristic LNXQTM.

data for LNXQTM:

xqtm	1,000	1,102	1,199	1,352	1,551	1,750	2,000	2,801	4,200	6,000	9,999	16,00
LNXQTM	0,0000	0,0967	0,1816	0,3012	0,4387	0,5596	0,6931	1,0298	1,4348	1,7917	2,3025	2,7725

Time constant ZKTABTU must be applicated for four ambient temperatures, i.e. Tu = -20°C, 0°C, 20°C und 40°C. Therefor measurements of engine temperature after engine is stalled at T1 = tmotab = 80°C are required. The second temperature T2 = tmot must be determined after soak time dt for that highest accuracy is desired (i.e. 1800 s).

ZKTABTU = dt / ln((T1 - Tu)/(T2 - Tu)) .

B_tfu = 1 (bit 0 of CWTF, see %PROKON) if ambient temperature can be measured directly with a separate sensor. In this case the measured ambient temperature is used for the calculation of soak time. If no sensor for measurement of ambient temperature is available ambient temperature tumta is calculated from intake-air temperature. For initialization of tumta TUMTAI = 20°C is suggested.

UMFSEL 1.10 ETS monitoring concept: inquiry selection in the monitoring module(UM)

FDEF UMFSEL 1.10 Function definition

```
               +--+--+--+--+--+--+--+--+
FrReg          |b7|b6|b5|b4|b3|b2|b1|b0|------------>+-------+
               +--+--+--+--+--+--+--+--+             |  MAX  |-----+
01 (Constant)  ------------------------------------->+-------+     |
                                                                   |
                           +---------------------------------------+
                           |
                           v
               +--+--+--+--+--+--+--+--+
               |b7|b6|b5|b4|b3|b2|b1|b0|<-------------+
               +--+--+--+--+--+--+--+--+              |
                 |  |     |     |                     |
                 |  |     |     |  +---+       +---+  |
                 |  |     |     +->|EOR|------>|EOR|--+
                 |  |     +------->|   |    +->|   |
                 |  |              +---+    |  +---+
                 |  |  +---+                |
                 |  +->|EOR|----------------+
                 +---->|   |
                       +---+
```

`FrReg = MAX(1,FrReg) * 2 + ((b7 EOR b6) EOR (b4 EOR b2))`

`Inquiry = LowNibble (FrReg)`

ABK UMFSEL 1.10 Abbreviations

FW UMFSEL 1.10 Fixed Values

Parameter	Value	Description

FB UMFSEL 1.10 Detailed description of function

Random Inquiry Selection in the Supervisor Module for the Inquiry/Response Communication in the Functional Processor

The supervisor module (UM) poses 16 different inquiries via a random generator and expects an unambiguous response to each inquiry from the functional processor (FR). If the FR does not find a correct response, it sends a defined 17th response, which is in any case detected as being incorrect by the UM, since it is incorrect for each possibly posed inquiry.

The inquiries posed to the FR are determined by means of a pseudo-random generator.
The random generator is based on an 8-bit shift register with 4 feedback connections, which are connected by an exclusive OR operation. The pseudo-random sequence repeats itself after 255 shift operations. The content of the shift register provides the new inquiry selection in the low-nibble.

If an inquiry is incorrectly responded to, then this inquiry is repeated and the content of the shift register is maintained.

APP UMFSEL 1.10 Application hint

UMFPW 2.10 ETS monitoring concept: flash programming request in the monitoring module (UM)

FDEF UMFPW 2.10 Function definition

ABK UMFPW 2.10 Abbreviations

FW UMFPW 2.10 Fixed Values

Parameter	Value	Description

FB UMFPW 2.10 Detailed description of function

Transition of the monitoring module (UM) into flash programming mode

The output stages may be shut down during flash programming. This state is not critical from the technical safety viewpoint. Consequently it is permissible that the interface between the function controller (FR) and the monitoring module is not served for an active flash programming.

The following occurs via the evaluation of a defined incorrect response operating as flash programming request information:
In this case the inquiry/response communication is interrupted following this defined response for flash programming request.
The UM finds itself in an eternal loop in which it disables the output stages.
If the flash programming process is completed, a software reset is triggered by the function controller.

Reaction to valid response for normal operation:
UM in normal operation, enable output stages, error counter - 1

Reaction to another defined response for flash programming:
UM in flash programming mode, eternal loop until reset with disabled output stages

Reaction to invalid response:
error counter + 1, at final status reset with disabled output stages

Due to the communication between function controller and monitoring module via a synchronous serial interface which the functions computer controls as master, the switchover to flash programming mode in the monitoring module cannot be detected by the missing operation of the interface in the function controller. A defined flash programming request acknowledgement QFPW having the value 0FFh is transmitted for this.

For a correct selection in normal operation, the possibility of a flash programming request AFPW from the function controller is not given. Neither shall the monitoring module erroneously detect a flash programming request AFPW as response from the function controller via the serial interface. It is for this reason that safeguarding the response by additional information at a defined position in the data block as complement of the flash programming request is meaningful.

If the monitoring module is found to be erroneously in the flash programming mode, the function controller triggers a reset after having detected a flash programming request acknowledgement instead of a valid inquiry.
If a transmission error leads to the monitoring module not accepting the flash programming request, then there is a normal inquiry in place of the flash programming request acknowledgement. The function controller can, on the basis of this, re-generate the request to go over onto flash programming mode. This delay must be accepted from a possible external flash programming device.

```
                                                                                                                    | Flash
                                                                                                                    | programming
                                                                                                                    | active

           +---------------------------------------------------------------------------------------------------------------------
POR     ---+

------       +-------------------------------------------------------------------------------------------------------------------
RSTOUT  --//-+

               +-+                   +------------------------------------------------------------------+
ESENUM  -----+-+ +--//---------------+                                                                  +------------------------

                             ASync1      F1          ASync2      F2          A1           Fn          AFPW        QFPW
        -----+------//-+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +-//-+ +---+ +---+ +---+ +---+ +------------
SPI     -----+         +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+    +-+   +-+   +-+   +-+   +-+

10-ms time frame
for data transfer      |     |     |     |     |     |     |     |     |     |     |      |     |     |     |     |

40-ms time frame for
the inquiry sequence                     |                       |                        |                       |

40-ms time frame for
the response sequence        |                       |                       |                        |

POR = Power on reset

------
RSTOUT = Reset output from the function controller, reset input at the monitoring module

ESENUM = Output stage enable of the monitoring module

SPI    = Synchronous serial interface between function controller and monitoring module


ASync1 = First synchronization response from the function controller
ASync2 = Second synchronization response from the function controller

AFPW   = Flash programming request from the function controller
QFPW   = Flash programming acknowledgement from the monitoring module
F1     = first inquiry from the monitoring module
F2     = second inquiry from the monitoring module
Fn     = nth inquiry from the monitoring module
```

APP UMFPW 2.10 Application hint

UMAUSC 1.11 ETS monitoring concept: test of the shut-down path of the monitoring module

FDEF UMAUSC 1.11 Function definition

ABK UMAUSC 1.11 Abbreviations

FW UMAUSC 1.11 Fixed Values

Parameter	Value	Description

FB UMAUSC 1.11 Detailed description of function

```
Testing of the shut-down path from the supervising module
---------------------------------------------------------
```

The shut-down path by means of the supervising module (UM) is tested by the function controller (FR) within its supervising function of the supervising module (UM).

Following completion of its initialization, the UM switches the output stages on for a short time and then off again in order that the FR is able to test the shut-down functions of the output stages. This occurs during a defined time window following release of the UM reset.

The status message from an output stage module is checked after the FR has switched on the output stages. The output stage shut-down is thereby evaluated before the FR sends the first information to the UM and the UM enables the output stages.

Following the reset, the communications is established between the function controller and the supervising module as follows:

- the FR terminates it initialization and releases the RSTOUT
- the UM runs through its initialization
- the UM switches the output stages on and off again
- the FR checks the shut-down of the output stages by the UM
- the inquiry/response communication begins (see %UMTOUT)

```
           +----------------------------------------------------------------
POR     ---+
                +-----------------------------------------------------------
RSTOUT  -----//-+

                  t1   t2
        --------+     +-+                   +-------------------------------
ESENUM  --------+--//-+ +--//-------//------+

                                       |   inquiry/response communication
        -----+------//--------------+ +---+ +---+ +---+ +---+ +---+ +---+ +-
SPI     -----+                      +-+   +-+   +-+   +-+   +-+   +-+   +-+
                                       |
                |                      |
                +<-----t4------------->+


t1:     time for UM initialization
t2:     time for enable of the output stages
t4:     minimum time for requesting the shut-down status message
```

POR = Power on reset

```
------
RSTOUT = Reset output from the function controller, reset input at the monitoring module

ESENUM = Output stage enable of the monitoring module

SPI    = Synchronous serial interface between function controller and monitoring module
```

It is thereby of importance that the initialization sequences are kept short in order to maintain a short period of time prior to enable of the output stages.

APP UMAUSC 1.11 Application hint

UMKOM 2.10 ETS monitoring concept: Inquiry/response communication between UM/FR

FDEF UMKOM 2.10 Function definition

ABK UMKOM 2.10 Abbreviations

FW UMKOM 2.10 Fixed Values

Parameter	Value	Description

FB UMKOM 2.10 Detailed description of function

Inquiry/response communication between the monitoring module and the function controller

The main flow of information for the monitoring function comprises
a1) Forwarding the inquiries from the monitoring module (UM) to the function controller (FR)
a2) The feedback of the fault counter status from the monitoring module to the function controller
b) The response from the function controller to the monitoring module

It is meaningful that 16 valid inquiry/response pairs are established for response by the fault reaction in the monitoring module following 5 incorrect responses in succession.
It is hereby important that the 16 valid inquiries from the monitoring module can be detected exactly by the function controller.

Furthermore, it is meaningful that the response is formed at the 16-bit level at least, in order to obtain a minimum of 65520 impossible responses, i.e. irrespective of the inquiry, as well as the 16 possible responses.
The responses expected from the inquiries raised shall be defined, i.e. shall not depend on the number of the modules interfacing with the program process control in the FR.
This means that a conversion of the program process control contents is performed in a meaningful way in the FR.
In order to do this, a 17th invalid response must be specified at the interface to the monitoring module in addition to the 16 valid responses.

The expectation of a correct response assigned to the inquiry thereby set does not allow an uncontrolled behaviour that performs a cyclic operation of the monitoring module without any appropriate processing in the function controller.

It is meaningful for an optimum utilization of the interface to interleave the inquiries set and the responses outputted, i.e. to obtain the response to the preceding inquiry following the setting of an inquiry and to output the current response in the function controller after setting the subsequent inquiry.
The provision of an inquiry just received is not possible without a time delay
as the monitoring software in the FR is included in evaluation the response.

The FR outputs the response to the preceding inquiry during the processing of the last inquiry. Hence there is regular data transmission and synchronization taking place between the FR and the UM (refer also to %UMTOUT).

```
10 ms time slot
for data transmission  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |    |     |

40 ms time slot for
the inquiry sequence                     |                       |                       |                       |

40 ms time slot for
the response sequence        |                       |                       |                       |                      |

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A(n-2)      F(n)        A(n-1)      F(n+1)      A(n)        F(n+2)      A(n+1)      F(n+3)
                             correct                 incorrect              correct                 correct
Fault counter                         0                       3                       2                 1
transmitted by UM

                                               A(n-1) hand over         A(n) hand over           A(n+1) hand over
                                               fault counter and        fault counter and        fault counter and
                                               F(n) take over           F(n+1) take over         F(n+2) take over
                                               +-+                      +-+                      +-+
                         ----------------------+ +----------------------+ +----------------------+ +-------------------------
Function controller:     evaluate fault counter   evaluate fault counter   evaluate fault counter   evaluate fault counter
                         and process F(n-1)       and process F(n)         and process F(n+1)       and process F(n+2)

                                         fault counter           fault counter           fault counter           fault counter
                                         and F(n)    A(n-1)      and F(n+1)  A(n)        and F(n+2)  A(n+1)      and F(n+3)
                                         hand over   take over   hand over   take over   hand over   take over   take over
                         ------+         +-+         +-+         +-+         +-+         +-+         +-+         +-+
                               +---------+ +---------+ +---------+ +---------+ +---------+ +---------+ +---------+ +---------
Monitoring module:             A(n-2) check            A(n-1) check            A(n) check              A(n+1) check
                               fault counter and       fault counter and       fault counter and       fault counter and
                               F(n) preparation        F(n+1) preparation      F(n+2) preparation      F(n+3) preparation
```

The inquiries shall not correspond to the expected responses, i.e. if the UM sets the 00, then the response to this should not be 00. The following assignment shall be complied with:

Inquiry	Response
00	12
01	03
02	08
03	04
04	14
05	13
06	15
07	09
08	02
09	00
10	07
11	10
12	05
13	11
14	06
15	01

An internal counter is increased by 3 if the monitoring module receives an incorrect response and which, for a final status of >= 13, triggers a defined fault reaction. This fault reaction definitely shuts all output stages down under all circumstances and leads to a transfer to the safe state by this. In addition to this, the monitoring module triggers a software reset at the function controller in parallel to shutting down the output stages, in order to permit a correct restart for limited incorrect response with respect to time.

For errors in the content of the responses, the fault counter in the monitoring module is raised in increments of 3 up to a final status of >= 13, or is decremented to 0 for responses which are correct.

In order to keep the time for enabled output stages as short as possible (long off, short on) for permanently present faults and the fault reaction defined by software reset, the fault counters in the function controller and monitoring module are pre-assigned with the status 11 (11 = final status -3 +1, i.e. -3 for increase at fault and +1 for lowering at OK).

An output stage is only then enabled if the communication starts up correctly and the fault counter in the monitoring module is decremented to 10.
In addition to this, the FR must correctly supply the first permanently defined synchronization response in order that the UM gives the output stage release.
If the second permanently defined synchronization response is incorrect, the monitoring module runs immediately from 10 back to its final status of 13 and thereby into the fault reaction.
The first fault counter values transmitted by UM must be correct as well in order that the FR does not run into a fault reaction but rather to decrementing its fault counter.

If the monitoring module receives an incorrect response then it repeats the incorrectly responded inquiry such that inquiry-specific faults lead to a fault reaction.

The inquiry which the monitoring module sends to the function controller is expected again within the defined time slot.
For a detection of the correct value for the fault counter transmitted by the UM, it is permissible to conclude that the UM is working correctly.

The targeted put in of the 17th response which is intentionally and definitely incorrect, the function controller tests the monitoring module by comparing the fault counter of the monitoring module with its own expected value for the fault counter.
The function controller thereby then gives a incorrect response in normal operation if the fault counter transmitted by UM of the UM is exactly 0.
If the fault counter of the monitoring module deviates from the expected value from the function controller, then the last response form (correct or incorrect) is repeated. This occurs automatically by inclusion of an incorrect response at a fault counter value of 0 transmitted by the UM. In addition to this, the value expected for the fault counter on the basis of the fault counter transmitted by UM and the expected treatment (+3 for an incorrect or -1 for a correct response) is defined again.

If the fault counter of the monitoring module deviates from the value expected from the function controller, then the FR increases a fault counter by 3, for a final status of 13 of which will also trigger a software reset.
If the expected fault counter status arrives at the function controller then the fault counter is decremented to 0.

The monitoring module information is thereby transferred in one byte:
High-nibble = fault counter status (range of values 0 to 12=0Dh, for flash program acknowledgement 15=0Fh)
Low-nibble = inquiry (range of values 0 to 0Fh)

The RAM cell for the inquiry setting is thereby also assured by the transfer in a common byte with the evaluation of the fault counter information.

Sequence at the beginning with transition to the normal operation state:

```
10 ms time slot for
data transfer          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

40 ms time slot for
the inquiry sequence                     |                       |                       |                       |

40 ms time slot for
the response sequence        |                       |                       |                       |                       |

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             ASync1      F1          ASync2      F2          A1          F3          A2          F4          A3
                             correct                 correct                 correct                 correct                 corr.
fault counter                            10                      9                       8                       7
transmitted by UM


Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A3          F5          A4          F6          A5          F7          A6          F8          A7
                             correct                 correct                 correct                 correct                 corr.
fault counter                            6                       5                       4                       3
transmitted by UM

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A7          F9          A8          F10         A9          F11         A10         F12         A11
                             correct                 correct                 correct                 incorrect              corr.
fault counter                            2                       1                       0                       3
transmitted by UM

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A11         F13         A12         F14         A13         F15         A14         F16         A15
                             correct                 correct                 correct                 incorrect              corr.
fault counter                            2                       1                       0                        3
transmitted by UM
```

A10 is then the first incorrect response which the function controller introduces. From this point onwards, every fourth response introduced is incorrect, provided there is no fault otherwise present. The inquiries F10 and F12 as well as F16 and F14 are identical by doing this as those inquiries with incorrect responses are repeated.

Sequence for faults independent of the inquiry:

```
10 ms time slot for
the data transfer      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

40 ms time slot for
the inquiry sequence                     |                       |                       |                       |

40 ms time slot for
response sequence            |                       |                       |                       |                       |

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A1          F3          A2          F4          A3          F5          A4          F6          A5
                             correct                 incorrect              incorrect                incorrect               incorr.
fault counter                            0                       3                       6                       9
transmitted by UM

Data transfer via         ---+ +---+ +---+ +---+ +---+ +-
the interface:               +-+   +-+   +-+   +-+   +-+
                             A5          F7          A6
                             incorrect               incorrect
fault counter                            12             15 >= 13 --> fault reaction
transmitted by UM
```

The fault is thus active following five incorrect responses.
The fault reaction time is thus for faults which are independent of the inquiries 5*40 ms = 200 ms.

Sequence for inquiry-specific faults:

```
10 ms time slot for
data transfer          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

40 ms time slot for
the inquiry sequence                     |                       |                       |                       |

40 ms time slot for
response sequence            |                       |                       |                       |                       |

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A1          F3=x        A2          F4          A3          F5=x        A4          F6          A5
                             correct                 correct                 incorrect              correct                 incorr.
fault counter                            1                       0                       3                       2
transmitted by UM

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A5          F7=x        A6          F8          A7          F9=x        A8          F10         A9
                             incorrect               correct                 incorrect               correct                 incorr.
fault counter                            5                       4                       7                       6
transmitted by UM

Data transfer via         ---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---
the interface:               +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+
                             A9          F11=x       A10         F12         A11         F13=x       A12         F14         A13
                             incorrect               correct                 incorrect               correct                 incorr.
fault counter                            9                       8                       11                       10
transmitted by UM

Data transfer via         ---+ +-
the interface:               +-+
                             A13
                             incorrect
fault counter                   13 >= 13 --> fault reaction
transmitted by UM
```

The fault reaction is active by this for inquiry-specific fault reactions after six incorrect responses at the latest (with correct responses between).
The fault reaction time is thus for inquiry-specific faults 11*40 ms = 440 ms.

APP UMKOM 2.10 Application hint

UMTOUT 2.10 ETS monitoring concept: time-out for UM/FR-communication

FDEF UMTOUT 2.10 Function definition

ABK UMTOUT 2.10 Abbreviations

FW UMTOUT 2.10 Fixed Values

Parameter	Value	Description

FB UMTOUT 2.10 Detailed description of function

Testing of the timing between monitoring module and function controller

----

The monitoring module (UM) is hardware which is independent of the function controller (FR) and has its own clock.

The UM makes different inquiries to the FR in an arbitrary sequence which require a correct response within a defined time period. The window watchdog function of the monitoring module is to wait for the response at the right point in time.

Operation is no longer permissible in the event of defective communication between the function controller and monitoring module. This is assured by cyclic triggering of error reactions by the monitoring module as reaction to timing errors.

The error reaction is defined as disabled output stages and software reset, thereby enabling the system to be restarted. This reaction is active immediately for time-out errors.

The time monitoring is to be executed as follows:
- The monitoring module checks the timing of synchronization by means of the interface operating controlled from the function controller. To do this, time information from the operating system of the monitoring module shall be made available which check for limiting values. This can take place in 10ms, 20ms or 40ms time slot.
- The function controller cannot directly watch the timing via the coupling because of its master function at the interface. The function controller thus tests the contents of the monitoring module inquiry and error counter for plausibility (see %UMKOM)

The communication is established between the function controller and the monitoring module after the reset as follows:

- the FR terminates its initialization and releases the RSTOUT
- the UM runs through its initialization
- the UM switches the output stages on and off again (see %UMAUSC)
- the FR checks the shut-down of the output stages by the UM (see %UMAUSC)
- the FR sends an initial defined response ASync1
- the UM synchronizes automatically to the first response from the FR
- the UM sends its first inquiry following a defined period of time after the response
- the FR sends its second defined response ASync2
- the UM sends its second inquiry
- the FR sends its response to the first inquiry from UM

- The cyclic interlock sequence of inquiry/response is continued

```
           +------------------------------------------------------------------------------------
POR     ---+

------          +-------------------------------------------------------------------------------
RSTOUT  -----//-+

                  t1   t2
        --------+     +-+                   +---------------------------------------------------
ESENUM  --------+--//-+ +--//-------//------+

                                          ASync1      F1          ASync2      F2          A1
        -----+------//--------------+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +--
SPI     -----+                      +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+   +-+

                |                      |   |
                +<-----t4------------->+   |
                |                          |
                +<-----TOSynch------------>+

10-ms time slot
for data transfer                   |     |     |     |     |     |     |     |     |     |

40-ms time slot for
the inquiry sequence                                  |                       |

40-ms time slot for
the response sequence                     |                       |                       |
```

t1:   time used to initialize the UM
t2:   time for release of the output stages
t4:   max. time for requesting the shut-down status message
TOSynch: Synchronization time-out

POR = Power on reset

RSTOUT = Reset output from the function controller, reset input at the monitoring module

ESENUM = Output stage enable of the monitoring module

SPI   = Synchronous serial interface between function controller and monitoring module

ASync1 = First synchronization response from the function controller
ASync2 = Second synchronization response from the function controller
A1   = Response from the function controller to the first inquiry from the monitoring module
F1   = First inquiry from the monitoring module
F2   = Second inquiry from the monitoring module

APP UMTOUT 2.10 Application hint

URROM 2.20 ETS monitoring concept: ROM-test

FDEF URROM 2.20 Function definition

ABK URROM 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ROMRSTA_UM			FW	Max. number of resets for error detection in the ROM check during initialization

Variable	Source	Type	Description
ROMRSTC_UM	URROM	LOK	Counter for resets for error detection in the ROM check during initialization

FW URROM 2.20 Fixed Values

Parameter	Value	Description
ROMRSTA_UM		Max. number of resets for error detection in the ROM check during initialization

FB URROM 2.20 Detailed description of function

ROM test

Procedure:
- Wordwise checksum over the entire ROM range in blocks with assigned check word.

Frequency:
- In each driving cycle

Errors that can be detected:
- Losses / falsifications of data in memory cells
- Readability of memory cells
- Faults on address / data lines
- Bus faults

ROM test in the function computer

Secondary condition:
- Permanent RAM available
- Computer afterrunning defined
- Time required for ROM test during initialization not acceptable (ROM code e.g. larger than 64 Kbyte)

Point in time:
- During a standard initialization prior to enabling the surveillance module
  - Repeat check of the discrepant block or all the blocks in the event of several discrepant blocks in case the corresponding information in the permanent RAM contains the identifier "Discrepant ROM test".
- During computer afterrunning
  - All blocks of the entire ROM range

Error reaction from possible repeated checks:
- Output stages become or remain suppressed,
- Software reset by transfer of the reset path "SUPERVISOR_RESET_ROM",
- Repeat of the ROM test,
- Engine start-up possible if the ROM has been detected as being error-free

In the event that a checksum error is detected in the ROM test during initialization, then an error counter in the permanent RAM is incremented before a software reset is triggered.
This error counter is deleted again when an error-free condition is detected during the ROM test, or the final status has been reached for the error counter.
Deleting the error counter when the final status has been reached shall also ensure that the foreseen number of ROM tests is carried out again for "Ignition off/on".
This is meaningful in order to make a transition possible into the normal operating mode in case the error is no longer present the next time the ignition is switched on.
A return to the boot block or into the internal ROM when the final status of the error counter is reached enables the Flash content to be programmed again.
This is above all then important if a status that has been programmed by mistake remains in the reset ROM-test loop because of an error in the checksum.
If it is only that a checksum has been incorrectly entered, then although typical by triggering a powerfail, the transition into the normal operating mode is possible by programming the Flash. This does not apply for checksum errors in the range to be cyclically checked (refer to %URMEM).

Error reaction from computer afterrunning:
- Repeat of the check during the next standard initialization
- Transfer of the identifier "Discrepant ROM test" to the subsequent driving cycle as information in the permanent RAM
  With the allocation of the block detected as being discrepant, or the information "Several ROM blocks discrepant"

ROM test in the surveillance module

Secondary condition:
- Time required for the ROM test during initialization is acceptable (ROM code e.g., not larger than 64 Kbyte)

Point in time:
- During standard initialization
  - All blocks of the entire ROM range

Error reaction:
- Output stages become or remain shutdown,
- Output of software reset to the function computer (i.e. system reset),
- Repeat of the ROM test,
- Engine start-up possible if the ROM is detected as being error-free,
- No operation of data transfer to the function computer

APP URROM 2.20 Application hint

URRAM 2.10 ETS monitoring concept: RAM-test

FDEF URRAM 2.10 Function definition

ABK URRAM 2.10 Abbreviations

Variable	Source	Type	Description
RST_TV	URMEM	EIN	Variable in the permanent RAM for reset pulse control factor from funct. monito.

FW URRAM 2.10 Fixed Values

Parameter	Value	Description

FB URRAM 2.10 Detailed description of function

```
RAM test
--------

Procedure:
* Write the complement of the addresses in the RAM cells to be tested, subsequently test the contents and write the value of the
  addresses in the RAM cells to be tested, read out, check and clear as the check result is OK.

Frequency:
* in each driving cycle

Detectable errors:
* setability/clearability of all bits
* writability/readability of the memory cells
* errors on address/data lines
* address decoder errors


RAM test in the function controller
-----------------------------------

Marginal conditions:
* permanent RAM present
* controller afterrun defined
* time required for RAM test in the initialization is not acceptable (external RAM e.g. larger than 8 Kbyte)

RAM cells to be tested:
* CPU RAM (internal RAM and onchip XRAM)
* external RAM

Point in time:
* in the standard initialization prior to release of the monitoring module
    * external RAM only permanent RAM (without OBP RAM) in the initial initialization, i.e. prior to first use
    * repeated test for external RAM without permanent RAM in case the information in the permanent RAM does not contain the
      identifier "RAM test error-free".
    * Writability test of the permanent RAM cell for the information "RAM test error-free" by the chess board pattern with the
      following sequence: save contents, write 55H, test for 55H, write AAH, test for AAH, save back contents.
* in the standard initialization following release of the monitoring module and prior to enable of the interrupts
    * CPU RAM (internal RAM and onchip XRAM)
* in the afterrun following run-down of the operating system and disabling of the interrupts
    * external RAM without permanent RAM

Error reaction from initial or standard initialization or repeated testing or writability test:
* output stages will be or remain shut down,
* software reset,
* repetition of the RAM test,
* engine start possible if RAM is detected as being error-free,
* no serving of the data transfer to the monitoring module

Error reaction from computer afterrun:
* repeat test in the next standard initialization
* destruction of the identifier "RAM test error-free" at the following drive cycle as information in the permanent RAM

RAM test in the monitoring module
---------------------------------

Marginal condition:
* time required for RAM test in the initialization acceptable (only internal RAM)

RAM cells to be tested:
* CPU RAM (internal RAM and onchip XRAM)

Point in time:
* in the standard initialization
    * CPU RAM (internal RAM and onchip XRAM)
```

```
Error reaction:
* output stages will be or remain shut down,
* software reset at the function controller (i.e. system reset),
* repetition of the RAM test,
* engine start possible if RAM is detected as being error-free,
* no serving of the data transfer to the function controller
```

APP URRAM 2.10 Application hint

URMEM 3.10 ETS monitoring concept: cyclic memory test

FDEF URMEM 3.10 Function definition

```
Zyklischer Speichertest: Auswertung der Fehlerreaktionsanforderungen im Modul URAUSG
------------------------------------------------------------------------------------

b_srst_um --------------+-------------------------------------------------------------------+
                        |                                                                   |
                        |                          +------------+                         o\v
                        |          +-----+         + AUSGH_T_UM +                    0 -->o \o---------------------> b_srst_um
                        |       +->+ > 0 +-------->+      +---- +-------+--------------------------+
                        |       |  +-----+         + -----+     +       |                          |
                        |       |                  +------------+       |                          |
                        |       |                   Reset ^             |                          |
                        |       |                         |             |                          |
ausg_c_um --+-------->o\v       |                         +-------------+                          v
            +--->o--->o \o----+-+--------------------------------------------------+------------>o--o--------------> ausg_c_um
               + ^+           |    +--------------+                                +---->o------>o
    1 -->o\      |            +--->+ >= AUSG_T_UM +---+                                + ^-
    0 -->o^\o----+                 +--------------+   |                                  |
          |                                           |     +---+                    1 --+
          +-------------------------------------------+-----+ v +---------------------------------+
                                                            +   +                                 |
                                                      +-----+   +    rst_tv  ------------------>o\v
                                                      |     +---+    RST_TV_UM ---------------->o \o------------------> rst_tv
                                                      |                                           |
                                                      |              srst_c_um  ---+----------->o\v
                                                      |                            +---->o----->o \o---------------> srst_c_um
                                                      |                                + ^+       |
          +-------------------------------------------+                                  |        |
          |                                           |                              1 --+      o\v
   1 -->o\v                                           |              Fehlerreaktion ----------->o \o----------> Software-Reset
   0 -->o \o----+                  +--------------+   |
                |             +--->+ >= AUSZ_T_UM +---+
              + v+            |    +--------------+
            +-->o---->o /o----+-+--------------------------------------------------+------------>o--o--------------> ausz_c_um
ausz_c_um --+-------->o/^       |                  +------------+                  +---->o----->o ^
                        |       |  +-----+         + AUSZH_T_UM +                      + ^-       |
                        |       +->+ > 0 +-------->+      +---- +-------+                |        |
                        |          +-----+         + -----+     +       |            1 --+        |
                        |                          +------------+       |                         |
                        |                           Reset ^             |                         |
                        |                                 |             |                         |
                        |                                 +-------------+-------------------------+
b_srstz_um -------------+------------------------------------------------------------------+
                                                                                           |
                                                                                         o\v
                                                                                    0 -->o \o--------------------> b_srstz_um
```

ABK URMEM 3.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
AUSGH_T_UM			FW	Rectification time for faults in cyclic RAM check of watchdog function
AUSG_T_UM			FW	Fault tolerance threshold for the cyclic RAM check in the watchdog function
AUSZH_T_UM			FW	rectification time for faults in cyclic ROM check of watchdog function
AUSZ_T_UM			FW	Fault tolerance threshold for the cyclic ROM check in the watchdog function
RST_TV_UM			FW	Identifier for requesting a reset pulse control factor from function monitoring
WAIT_T_UM			FW	Waiting time for reset pulse duty cycle from the watchdog function

Variable	Source	Type	Description
AUSGH_C_UM	URMEM	LOK	rectification counter for faults in cyclic RAM check of watchdog function
AUSG_C_UM	URMEM	LOK	Fault counter for cyclic RAM check in the watchdog function
AUSZH_C_UM	URMEM	LOK	rectification counter for faults in cyclic ROM check of watchdog function
AUSZ_C_UM	URMEM	LOK	Fault counter for cyclic ROM check in the watchdog function
B_SRSTZ_UM	URMEM	LOK	Software-reset request from the cyclic ROM securing of the watchdog function
B_SRST_UM	URMEM	LOK	Software-reset request from the cyclic RAM securing of the watchdog function
RAM_C_UM	URMEM	LOK	Fault counter in the permanent RAM for RAM-consistency check (diagnosis) in the
ROMZ_C_UM	URMEM	LOK	Fault counter in the permanent RAM for ROM check (diagnosis) in the watchdog fun
RST_TV	URMEM	AUS	Variable in the permanent RAM for reset pulse control factor from funct. monito.
SRST_C_UM	URMEM	LOK	Counter in the permanent RAM for Software-reset (diagnosis) from the watchdog fu
URMCKSCO	URMEM	LOK	checksum over function-monitoring code in cyclic ROM test
URMCKSDA	URMEM	LOK	checksum over function-monitoring data in cyclic ROM test

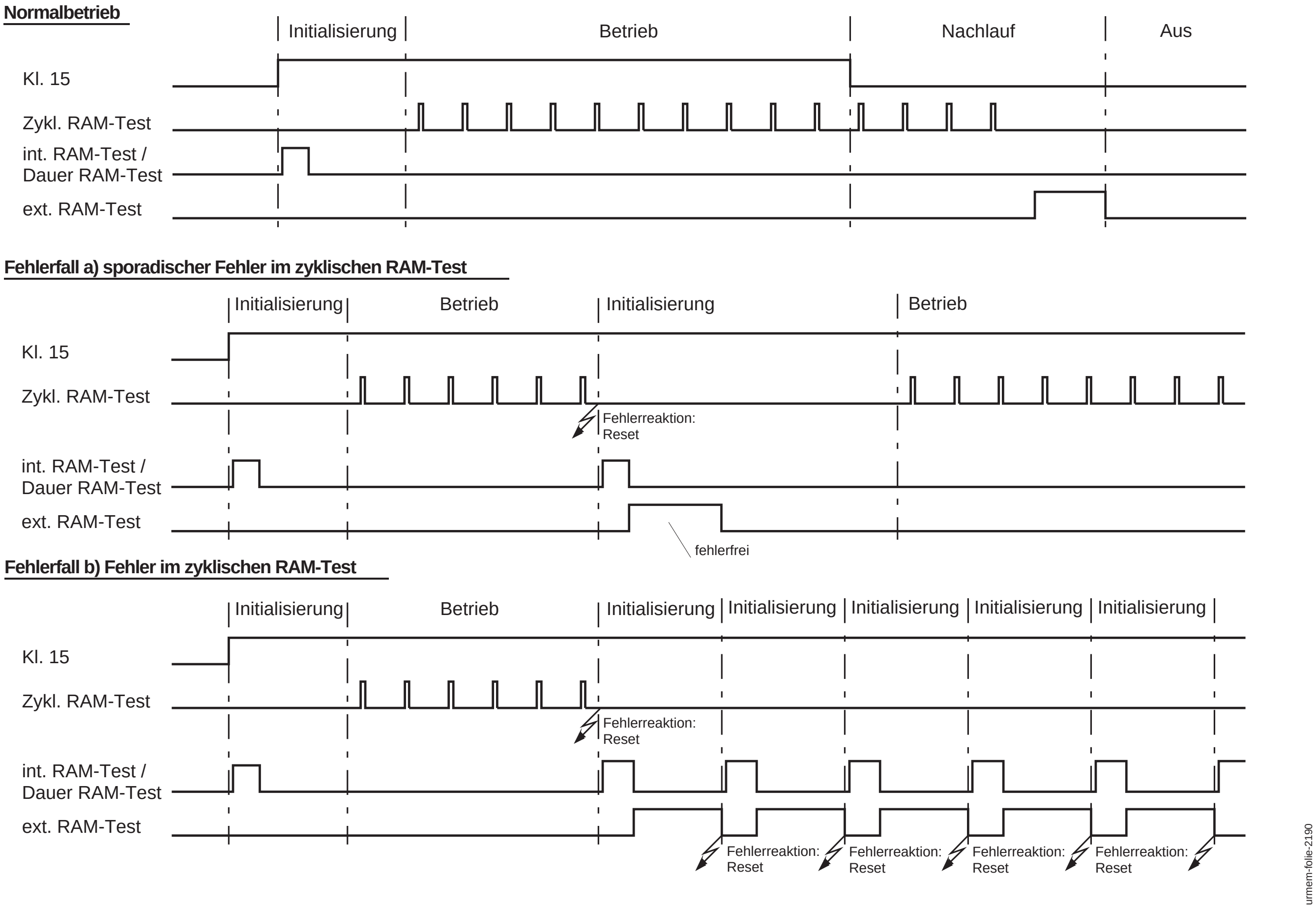
Variable	Source	Type	Description
URMPATCO	URMEM	LOK	patch address in function-monitoring code for checking cyclic ROM test
WRI_C_UM	URMEM	LOK	Fault counter in the permanent RAM for RAM-writability check (diagnosis) in the

FW URMEM 3.10 Fixed Values

Parameter	Value	Description
AUSGH_T_UM		Rectification time for faults in cyclic RAM check of watchdog function
AUSG_T_UM		Fault tolerance threshold for the cyclic RAM check in the watchdog function
AUSZH_T_UM		rectification time for faults in cyclic ROM check of watchdog function
AUSZ_T_UM		Fault tolerance threshold for the cyclic ROM check in the watchdog function
RST_TV_UM		Identifier for requesting a reset pulse control factor from function monitoring
WAIT_T_UM		Waiting time for reset pulse duty cycle from the watchdog function

FB URMEM 3.10 Detailed description of function

```
Cyclic memory test
------------------

Das Modul muß zur Programm-Ablauf-Kontrolle (siehe %URPAK) beitragen.

Innerhalb dieser Funktion dürfen für Zwischengrößen nur die Temporärvariablen verwendet werden. Diese werden im
Befehlstests (siehe %URCPU) ebenso verwendet und sind somit auf Beschreibbarkeit geprüft.

Die Funktion soll im 40ms-Raster abgearbeitet werden.


Cyclic RAM safeguarding
-----------------------

A cyclic safeguarding must be performed in the RAM of the monitoring functionality.

A cyclic partial RAM test must therefore take place in the function controller and in the monitoring module via UM functionality,
i.e. the RAM cells which are used in the monitoring outside of their generation. Excluded from this can be those RAM cells which
are detected as being incorrect on account of their evaluation in the other controller in case of error and without self-
diagnosis, or which are safeguarded by other inherent test mechanisms. One example of this is the response from the function
controller to the monitoring module.  The response will determine the error, irrespective of whether the contents of the RAM
cell are incorrect for the response in the function controller or in the monitoring module.

The RAM contents are stored as values together with one’s complement during their generation and one of the two values tested for
writability.
Test for writability by cyclic RAM test using chess board pattern works in the following way:
           - save contents,
           - write 55h resp. 5555h, test for 55h resp. 5555h,
           - write AAh resp. AAAAh, test for AAh resp. AAAAh,
           - save back contents.
A system reset is demanded if the values do not agree.

The double storage as value and complement is tested for consistency prior to further use. The RAM cell in question must
therefore also be initialized as value and complement if these are already used in the first run and are tested beforehand. Bit
information is thereby supervised by means of a byte variable, whereby the bit information 0 and 1 correspond to defined constants,
the values of which are tested for consistency with the bit prior to the bit being used.
Die Variablen für das 1-er Komplement sind unsichtbar, d.h. sie werden nicht über DAMOS bekannt gemacht. Sie tauchen deshalb
auch nicht in anderen FDEFs für die Funktionsüberwachung auf.

The error reaction is defined as a system reset in all paths of the cyclic RAM safeguarding, i.e. trigger disable output stages and
software reset (function controller) respectively disable output stages and software reset at the function controller (monitoring
module).
This enables a restart of the system in the event of interferences.
Triggering a software reset in the function controller takes place in the module URAUSG by means of a software reset demand
(safeguarded by a double storage) from the cyclic RAM safeguarding. This software reset demand enables a debouncing and a healing
(adjusted to the fault identification) to be choosen. An identifier for "Reset duty cycle" is stored in the permanent RAM before
the debounced trigger of a software reset. In the following initialization the ROM- and RAM-check and a defined waiting time before
releasing the power stages (resp. the end of the initialization) is activated by this identifier.

In case of a permanent defect in the RAM which no longer permit a writing, or which inhibit a consistency of the data in
question, a new system reset is always triggered and the system remains in the error reaction.

Bei jeder Erkennung eines Beschreibbarkeits-Fehlers wird im Dauer-RAM ein Fehlerzähler (wri_c_um) inkrementiert.
Bei jeder Erkennung eines Konsistenz-Fehlers wird im Dauer-RAM ein Fehlerzähler (ram_c_um) inkrementiert.
Diese beiden Fehlerzähler im Dauer-RAM werden nur in dieser FDEF genannt, sie sind jedoch Ausgangsgröße für jedes Modul der
Funktionsüberwachung, welches der zyklischen RAM-Absicherung unterliegt.
```



urmem-folie-2190

Cyclic partial ROM check

A cyclic partial check must be performed in the ROM for safeguarding of the monitoring functionality.

A cyclic partial ROM test must therefore take place in the function controller via monitoring functions, i.e. the ROM area which is used by the monitoring and is not otherwise supervised.

Excluded from this can thus be the operation of the interface as well as the compilation of the information for the other controller, as an error here will be found in the other controller whatever the case.

Furthermore, those ROM areas can be excluded which are exclusively used for monitoring the second controller. It is sufficient to test these ROM contents once during the driving cycle in order to prevent sleeping errors in the monitoring.

The monitoring controller can thus be designed to be without cyclic ROM check.

A cyclic ROM check in the monitoring module will only be helpful in the event of double errors, i.e. if, in addition to the error in the monitoring module, a second error occurs that has to be detected from the monitoring module in the function controller.

For the cyclic partial ROM test, the ROM area in question (code and data) are stored either as a whole or in parts with a respective check-sum. The ROM area is cyclically summed word-wise and compared with the applicable check-sum in the ROM.

Ist die Checksumme fehlerhaft, so wird der betroffene ROM-Bereich wiederholt geprüft, damit eine Entprellung der Fehlerreaktion über den fehlerhaften ROM-Breich erfolgt und nicht durch den anderen eventuell fehlerfreien Bereich zeitlich verlängert wird.

Bei der Bildung der Checksummen wird der betroffene ROM-Bereich unterteilt, so daß im Raster der Überwachungssoftware (40ms) jeweils ein Teil abgearbeitet wird. Hierbei ist zu beachten daß bei einer Fehlererkennung die Drosselklappe nach spätestens 3s (einschließlich Entprellzeit und Rücklaufzeit der Drosselklappe) geschlossen sein muß. Bei einer Drosselklappen-Schließzeit von 0.4s bei -40°C und einer Entprellung in URAUSG mit 2 muß deshalb ein einzelner ROM-Bereich innerhalb von 1.3s geprüft sein.

Falsifications of the RAM contents used (in particular of the ROM pointer) lead to an error not being detected with certainty and must therefore be supervised separately in the RAM (see cyclic RAM safeguarding).

Zur Überprüfung des zyklischen ROM-Tests kann folgendermaßen Code innerhalb der Funktionsüberwachung abgeändert werden :

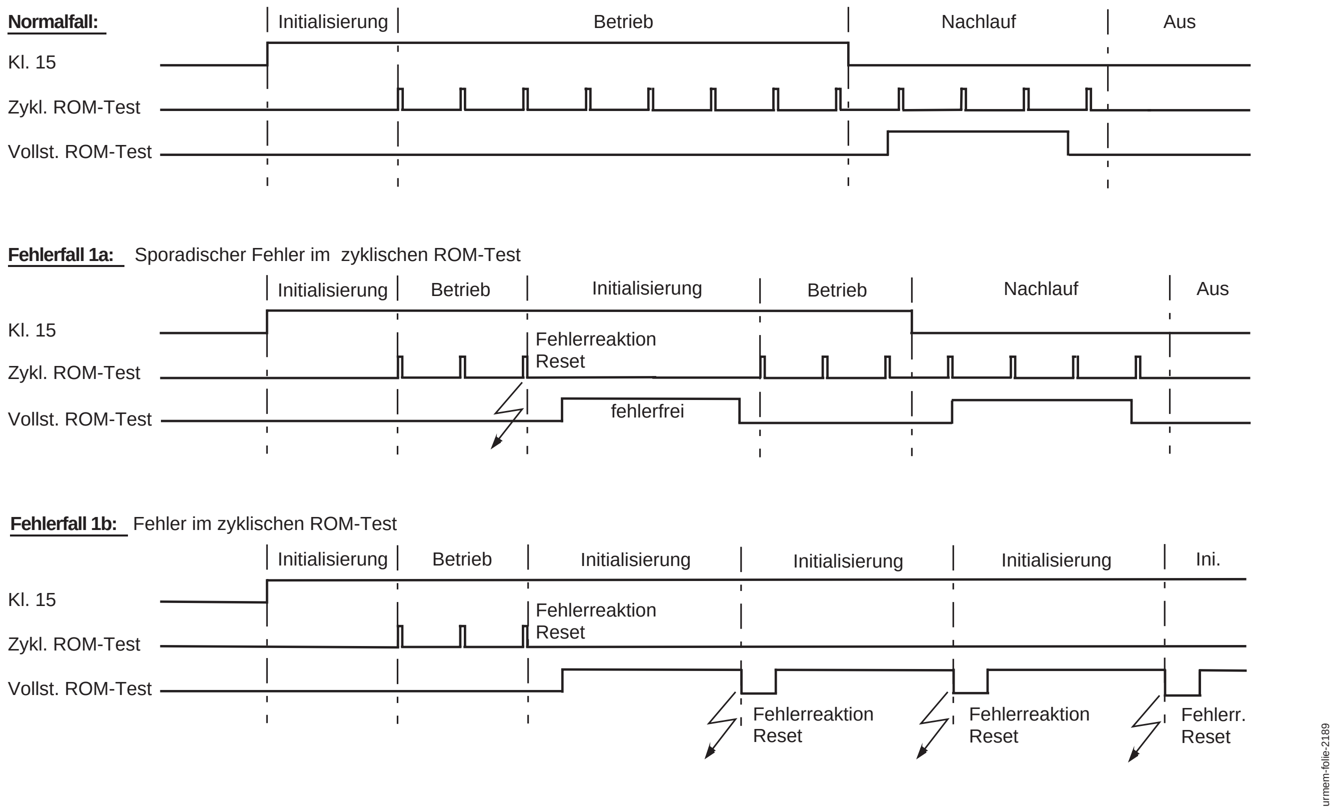
Die durch den zyklischen ROM-Test berechnete Checksumme über die Daten der Funktionsüberwachung wird in der RAM-Zelle urmcksda und die Checksumme über das Programm der Funktionsüberwachung in der RAM-Zelle urmcksco angezeigt. Ferner wird die Adresse eines sog. Dummy-Codes im Programm der Funktionsüberwachung in der RAM-Zelle urmpatco angegeben. An dieser Adresse steht der 2-Byte Befehl 0xE105 (C16x-Maschinenbefehl). Dieser Befehl darf nur in folgende 2-Byte Befehle abgeändert werden : 0xCC00, 0xE005, 0xE104 oder 0xE106 (C16x-Maschinenbefehl). Dadurch ergibt sich eine veränderte Checksumme, die in urmcksco angezeigt wird, bevor dann die Fehlereaktion ausgelöst wird. Durch Änderungen an Daten der Funktionsüberwachung kann ebenfalls ein Ansprechen des zyklischen ROM-Tests erzwungen werden.

The error reaction is - unlike the complete ROM test in the afterrun - defined as disable output stages and software reset. It enables the system to be restarted in the event of any interferences.
Triggering a software reset in the function controller takes place in the module URAUSG by means of a software reset demand (safeguarded by a double storage) from the cyclic ROM safeguarding. This software reset demand enables a debouncing and a healing (adjusted to the fault identification) to be choosen.
Zusätzlich wird im Dauer-RAM bei jedem erkannten Fehler ein Fehlerzähler (romz_c_um) inkrementiert.

An identifier for "Reset duty cycle" is stored in the permanent RAM before the debounced trigger of a software reset. In the following initialization the ROM- and RAM-check and a defined waiting time before releasing the power stages (resp. the end of the initialization) is activated by this identifier.
In case of a permanent defect in the ROM of the monitoring function, a software reset is repeatedly triggered in an attempt to successfully conclude the ROM test in order to resume a normal driving mode.

Zyklischer ROM-Test: Checksumme über Ebene 2 mit Beitrag zur Programmablaufkontrolle (PAK). Block 1: Programm ; Block 2: Daten

Vollständiger ROM-Test: Checksumme über Programm und Daten in 16K - Blöcken



urmem-folie-2189

APP URMEM 3.10 Application hint

Die Daten der Funktionsüberwachung sind Bestandteil des Überwachungskonzepts und dürfen nicht beliebig verändert werden.

Die Start-, Endadressen und Checksummen des zyklischen RAM- bzw. ROM-Tests müssen zur Serie festgeschrieben und dokumentiert werden.
Bei Folge-Programmständen müssen die Start-, Endadressen und Checksummen kontrolliert bzw. angepaßt werden. Bei veränderter Checksumme müssen die Änderungen in der Funktionsüberwachung bekannt sein - bei gleicher Checksumme gegenüber dem Vorgänger-Programmstand wird die Codegleichheit der Funktionsüberwachung sichergestellt.

URPAK 1.11 ETS monitoring concept: program flow check

FDEF URPAK 1.11 Function definition

```
               Query                                                                                               Response
                                           Surveillance module                                                         ^
                 |                                                                                                    |
-----------------|----------------------------------------------------------------------------------------------------|--------
                 |                          Function computer                                                         |
                 v                                                                                                    |
               UMFRG                                                                                                UMANT
                 |                                                                                                    ^
Module UM        |                                                                           Module UM                |
+----------------------------+                                                        +---------------------------------------+
|                |           |                                                        |                               |       |
|                v           |                |                          |            |                               |       |
|             UMF_PTR        |    Module 001  v          ...   Module n  v            |                               |       |
|                |           |     +-----------------+ MBEG_C +-----------------+     |                               |       |
|                +-----------|---->| MBEG_C - 0FFFFh |------->| MBEG_C - 0FFFFh |-----|----+                  +-------------+ |
|                |           |     +-----------------+        +-----------------+     |    |                  |   Response  | |
|                v           |     |                 |        |                 |     |    |                  |    decoder  | |
|           +--------------+ |     |                 |        |                 |     |    | MBEG_C           +-------------+ |
| UMF_MUL ->|Multiplication| |     |                 |        |                 |     |    |  6 Bit                           |
|           +--------------+ |     |                 |        |                 |     |    v                       ^     ^    |
|                |           |     |                 |  ...   |                 |     |  +-+-+-   -+-+-+-+-+-+     |     |    |
|                v           |     |                 |        |                 |     |  | | | ... | | | | | | ->UMA_RES |    |
|           +--------------+ |     |                 |        |                 |     |  +-+-+-   -+-+-+-+-+-+           |    |
| UMF_DIF ->|   Division   | |     |                 |        |                 |     |                                  |    |
|           +--------------+ |     |                 |        |                 |     |                ^                 |    |
|                |           |     +-----------------+ MEND_C +-----------------+     |                | MEND_C          |    |
|                +-----------|---->| MEND_C + M001_K |------->| MEND_C + Mn_K   |-----|----------------+  10 Bit         |    |
|                            |     +-----------------+        +-----------------+     |                                  |    |
|                            |              |                           |             |                                  |    |
+----------------------------+              v                           v             +--------------------------------------+
                                                                                                                         |
                                                                                                                         |
                                                                                                                     UMA2_RES
                                                                                                                  (see %URCPU)
```

ABK URPAK 1.11 Abbreviations

FW URPAK 1.11 Fixed Values

Parameter	Value	Description

FB URPAK 1.11 Detailed description of function

Program process control

Function

Process control ensures cyclic execution of major sections of the program in a defined time frame.

In addition to this, errors shall be detected when working through the command sequences by an application of CPU commands used both at the functional level as well as in functional surveillance for working through the process control.
The following processing is executed for this:
a) Defined query recognition from a given input information complex
b) Defined arithmetical operations at the beginning after receipt of the query in the major program sections and at the end prior to allocation of the response
c) Allocation of the results from the program process control to a defined, correct or incorrect response to the surveillance module

Secondary conditions

A program module is detected of being processed when this has been correctly begun and completed.
This module frame in the form of an initial and final processing must satisfy the following conditions:
a) Each pertinent module must be processed within the prescribed time frame. Processing of program process control must be active at all times so as not to permit any error in the processing matrix.
b) Any processing not performed for a module may not be substituted by the singular or multiple processing of another module.
c) Errors in the program flow of these major program sections must result in a defined error response.
d) The program process control must lead to different responses for differing queries, in order to prevent that a unique correctly executed process control will always lead to a correct response.
e) Protection of the ROM in defined area must be separate in order to ensure that the program code between initial and final processing is correct (see %URMEM).

The requirements a), b) and c) can be fulfilled by the module-specific definition of individual primary numbers and the continuous cyclic processing of these for formation of a response to a query from the separate HW surveillance module.
The inclusion into program process control of the query raised fulfils the requirement d).

Realization example

The processing of query, response and the program process control are active in afterrunning and normal operation because the surveillance module (UM) cannot differentiate between afterrunning and normal operation. This applies in the same manner for those modules with a cyclic contribution to the program process control.

The query UMFRG set by the surveillance module is checked for validity of the range of values and standardized into a range of values (UMF_PTR) that can be processed by the program process control. In the event of a violation of the range of values, the incorrectly set query leads to a false response.
The current query UMF_PTR is looped through all the modules associated with the safety-relevant program and is included in the program process control.

The start-counter module (MBEG_C) is initialized by the current query (UMF_PTR) and incremented in each function surveillance module to do this.
The finish-count module (MEND_C) is initialized with the result from a multiplication and division routine with the current query (UMF_PTR) as well as constant contributions for process control and increased in each function surveillance module by a module-specific value.

The result UMA_RES is determined (UMA_RES = 1024 * MBEG_C + MEND_C) from both of these counters at the end of the program process control. This result is compared with 16 valid results in the response decoder prior to transfer of a new query. There are two constants from function surveillance for each module to do this:
1. Number of recalls in the 40-ms time frame
2. Module-specific code
The correct response is provided for a valid result, otherwise a response defined in UMANT as being incorrect.

The transfer of the response determined as well as the query set are transferred every 40 ms during operation.
This ensures continuous program process control that is meaningful. A processing cycle is started when a new query is received.
This processing is terminated after 40 ms by receipt of the next query.

APP URPAK 1.11 Application hint

URADCC 2.20 ETS monitoring concept: test of the AD-converter

FDEF URADCC 2.20 Function definition

```
                  +---------+                    +----+
iuspoti1   ------>+ & 03FFh +------------------->+ :4 +-------+-----------------------------------------------------> sp1s_r
                  +---------+                    +----+       |
                                                              +-------o /o------------------------------------------> sp1s_a_um
                                                                      o/^
                  +---------+                    +----+                 |
iasp1plaus ------>+ & 03FFh +------------------->+ :4 +-------+-----------------------------------------------------> sp1p_r
                  +---------+                    +----+       |         |
                                                              +----o /o---------------------------------------------> sp1p_a_um
                                                                   o/^  |
                                                                     |  |                +---+
                                                                     |  |             +->+   +o-+
sp1p_r  ----+                                                        +--+             |  +---+  |
            |                                                           |             |         V Reset
            v-  +---+   +--------------+                                |       +---+ |    +-----------+
sp1s_r  -+->o-->+|x|+-->+ > SP1ADC_DIF +--+-----------------------------+------>+   + |    + ADCC_T_UM +    +-+--+
         | +    +---+   +--------------+  |                                     + & +-+--->+      +--- +--->+S+  +--> ei_adcc_um
         |                                |                                  +->+   +      + -----+    +    +-+--+    b_dcdis_um
         |                                |                                  |  +---+      +-----------+ +->+R+  +    b_i_ska_um
         |                                |    +---+                         |                           |  +-+--+   b_pwgnot_um
         |                                +--->+   +                         |                           |
         |                                |    + & +o------+                 |                           |
         |                                | +->+   +       |                 |                           |
         |                                | |  +---+       V Reset           |                           |
         | +    +---+   +--------------+  | |        +------------+          |                           |
         +->o-->+|x|+-->+ <= SP1_STAT  +----+------->+ SP1_STAT_T +    +---+ |                           |
            ^-  +---+   +--------------+  |          +     +----- +--->+   + |                           |
            |                             |          + ----+      +    + v +-+                           |
sp1s_a_um --+                             |          +------------+ +->+   +                             |
                                          |    +---+                |  +---+                             |
                                          +--->+   +                |                                    |
                                               + & +o------+        |                                    |
                                            +->+   +       |        |                                    |
                                            |  +---+       V Reset  |                                    |
           +    +---+   +--------------+    |        +------------+ |                                    |
sp1p_r  --->o-->+|x|+-->+ <= SP1_STAT  +----+------->+ SP1_STAT_T + |                                    |
            ^-  +---+   +--------------+             +     +----- +-+                                    |
            |                                        + ----+      +                                      |
sp1p_a_um --+                                        +------------+                                      |
                                                                                                         |
C_ini ---------------------------------------------------------------------------------------------------+
```

ABK URADCC 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ADCC_T_UM			FW	Error time for ADC values for sp1s that become increasingly less mutually plaus.
SP1ADC_DIF			FW	Max. Diff. bet. setp.-val.poti1 & setp.-val.poti1 from surv. module in sta. case

Parameter	Source-X	Source-Y	Type	Description
SP1_STAT			FW	Bandwidth for detection of sp1s stationary
SP1_STAT_T			FW	Time for detection of sp1s stationary

Variable	Source	Type	Description
ADCC_C_UM	URADCC	LOK	Error counter ADC values for sp1s that become increasingly less mutually plaus.
B_DCDIS_UM	URADCC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	URADCC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_PWGNOTUM	URADCC	AUS	= b_pwgnot_um function monitoring fault response PWG idling (= b_pwgnot_sr)
EI_ADCC_UM	URADCC	AUS	Irreversible error bit for the AD converter surveillance
IASP1PLAUS		EIN	ADC value incl. channel no. setpoint value for poti 1 loop (PWG) from second ADC
IUSPOTI1		EIN	ADC value incl. channel number nominal value potentiometer 1 loop (PWG)
SP1P_A_UM	URADCC	LOK	Old 10-ms value for setpoint value poti 1 (PWG) from surveillance module for ADC
SP1P_ST_UM	URADCC	LOK	Stationary counter for setpoint value potentiometer 1 from surveillance module
SP1S_A_UM	URADCC	LOK	Old 10-ms value for setpoint value poti 1 (PWG) for the function surveillance
SP1S_ST_UM	URADCC	LOK	Stationary counter for setpoint value potentiometer 1

FW URADCC 2.20 Fixed Values

Parameter	Value	Description
ADCC_T_UM		Error time for ADC values for sp1s that become increasingly less mutually plaus.
SP1ADC_DIF		Max. Diff. bet. setp.-val.poti1 & setp.-val.poti1 from surv. module in sta. case
SP1_STAT		Bandwidth for detection of sp1s stationary
SP1_STAT_T		Time for detection of sp1s stationary

FB URADCC 2.20 Detailed description of function

AD-converter test

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

The ADC value for the reference variable from the pedal value sensor is read in on the function computer by means of the on-chip ADC and a second AD converter that is on a second and different component in the surveillance modulator.
In the case of large pedal dynamics, these values cannot be compared for a bandwidth that is meaningful and it is for this reason, or the difference in threshold is exceeded, that a check is made whether at least one of the two comparison values lies in a defined stationary bandwidth. An error counter only runs when at least one of the two AD values is stationary, the final status of which sets the error information, the error-reaction information as well as the error-reaction idle-speed requirement and the SKA safety fuel shutdown.

The current pedal value is saved at exactly that time as the age for the subsequent processing cycle if a stationary consideration must follow because of the deviation in both AD conversion results.
If both AD-conversion results lie in the permissible bandwidth, then the counter for the stationary consideration and the error-tolerance counter as well, are deleted for the AD-converter error.
The detection for a stationary value is only meaningful and possible when scanning is in the 10-ms time frame.

APP URADCC 2.20 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
b_dcdis_um		VAR/AUS	Error-reaction info from func. surveillance (shutdown of throttle-valve actuator output stage)
b_i_ska_um		VAR/AUS	Function surveillance error-reaction irreversible SKA (safety fuel shutdown)
b_pwgnot_um		VAR/AUS	Function surveillance error-reaction: PWG idle-speed requirement active
ei_adcc_um		VAR/AUS	Irreversible error bit for monitoring AD converter
iuspoti1		VAR/EIN	ADC value incl. channel number setpoint-value potentiometer 1
iasp1plaus		VAR/EIN	ADC value incl. channel number setpoint-value potentiometer 1 from surveillance module
sp1s_r		VAR/TMP	Temporary current setpoint-value potentiometer 1-value for the function surveillance
sp1p_r		VAR/TMP	Temporary current setpoint-value potentiometer 1-value from surveillance module for the ADC test
sp1s_a_um		VAR/LOK	Old value for setpoint-value potentiometer 1 for function surveillance
sp1p_a_um		VAR/LOK	Old Value for setpoint-value potentiometer 1 from the surveillance module for the ADC test
adcc_c_um		VAR/LOK	Error counter ADC values that are not mutually plausible for sp1s
sp1s_st_um		VAR/LOK	Stationary counter for sp1s_r
sp1p_st_um		VAR/LOK	Stationary counter for sp1p_r

Label	Dependency	Type	Designation
ADCC_T_UM		FW	Error time for ADC values for sp1s that are not mutually plausible
SP1_STAT		FW	Bandwidth for detection of sp1s stationary
SP1_STAT_T		FW	Time for detection of sp1s stationary
SP1ADC_DIF		FW	Maximum difference between sp1s_r and sp1p_r in the stationary case

URCPU 4.11 ETS monitoring concept: Instruction test by means of level 2’

FDEF URCPU 4.11 Function definition

```
                                         Level 2'

+----------------------------------+
+ Test data requirement for        +
+                                  +
+ mzf_uc, mzf_low_uc, pt_mzf_uc    +--------------------------------------+
+ sr_mzf_uc [3]                    +                                      |                                        +------------+
+                                  +                                      |                                        +            +
+ mifa_uc                          +           +---------+                |                                        +            +
+ b_fgren_uc, b_brems_uc,          +---------->+ %UFFGRC'+---+            |                                        +            +
+ vfzg_uc, b_fgrfr_uc              +           +---------+   |            |                                        +            +
+                                  +                         |            |                                        +            +
+ mimsr_uc, bz_msr_uc, bzmsr_a_uc  +           +---------+   |            |                                        +            +
+ miasrl_uc, miasrs_uc             +---------->+ %UFMSRC'+   |            |                                        +            +
+ b_asr_uc, b_msr_uc               +           +--+------+   |            |                                        +            +
+ msrc_c_uc, (b_nomsrfr_uc)        +              | mmsr_uc  |            |                                        +            +
+                                  +              |   +------+            |                                        +            +
+                                  +              |   | mfgr_uc           |                                        +            +
+ spsn_uc, b_mzns_um               + spsn_uc      V   V                   V                                        + determine  +
+ nmot_uc                          + nmot_uc   +----------+ mz_uc     +----------+ mzf_uc    +----------+          + of the     +
+ milsol_uc                        + milsol_uc +          +---------->+ %UFMZF'  +---------->+          +          +            +
+                                  +---------->+ %UFMZUL' +           +----------+ mzo_uc    + %UFMVER' +          +response    +
+                                  +           +          +--------------------------------->+          +          +contribution+
+ mver_c_uc                        +           +----+-----+                                  +          + mzfo_uc  +with        +
+                                  +                | mped_uc                                +          + mver_c_uc+            +
+ rl_uc                            + rl_uc          +---->                                   +          +--------->+ mzfo_uc    +
+ zwout_uc                         + zwout_uc                                                +          +          + mi_uc      +
+                                  + nmot_uc                          +----------+ mi_uc     +          +          + mped_uc    +
+                                  +--------------------------------->+ %UFMIST' +---------->+          +          + mmsr_uc    +
+                                  +                                  +----------+           +          +          + mfgr_uc    +
+                                  + r_flags_uc (m_ub_ska, m_i_ska, m_notlu)                 +          +          +            +
+ r_flags_uc                       +---------------------------------------------+---------->+          +          + mver_c_uc  +
+                                  + b_i_ska_uc                                  +           +----------+          +            +
+                                  +                                             +             |                   + reac_c1_uc +
+                                  +                                             +             V b_dcdis_uc        + reac_c2_uc +
+ reac_c1_uc                       + reac_c1_uc                                  +           +----------+          + b_i_ska_uc +
+ reac_c2_uc                       + reac_c2_uc                                  +---------->+ %UFREAC' +          +            +
+ evz_aus_uc                       + Evz_aus_uc                                              +          +--------->+            +
+                                  +-------------------------------------------------------->+          +          +            +
+----------------------------------+                                                         +----------+          +------------+
```

ABK URCPU 4.11 Abbreviations

FW URCPU 4.11 Fixed Values

Parameter	Value	Description

FB URCPU 4.11 Detailed description of function

Instruction test with Level 2’

This section describes the instruction test with the help of Level 2’. Level 2’ is a image of Level 2, which is formed from the following components:

%UFFGRC	Cruise control monitoring for function monitoring
%UFMSRC	MSR monitoring for function monitoring
%UFMZUL	Permissible torque for function monitoring
%UFMZF	Torque filter for function monitoring
%UFMIST	Actual torque for function monitoring
%UFMVER	Torque comparison for function monitoring
%UFREAC	Fault reaction monitoring for function monitoring

The reason for introducing this transparent instruction test by means of the safety-relevant torque comparison in Level 2 is, to detect an incorrect processing at Level 2. Without the instruction test in Level 2’, a incorrect processing of the monitoring function, as executed in Level 2, cannot be detected with certainty. It would thereby be problematical if the function monitoring is active without being detected as such. An active function monitoring which is incorrect becomes apparent in the fault reaction and is thereby detected.

It is assured by the instruction test over the monitoring function that the instructions used here are processed correctly in the test case. Through the inclusion of the performed test results in forming the response for the monitoring module, i.e. in the monitoring module, the test is performed for the instruction test running correctly in a separate intelligent component.
Inquiry-specific test data are thereby selected (refer also to %UMKOM, %UMFSEL), which act as input signals for the Level 2’.
The execution of the instruction test in its own RAM and ROM areas thereby lead to the function monitoring running without being influenced by the instruction test itself. A utilization of the sub-programs from Level 2 (setpoint search, interpolation) is thereby meaningful.

Dependent on the inquiry set from the monitoring module, a permanently defined set of test data is specified for the Level 2’.

All variables used in the instruction test, i.e. those local variables are superimposed with test data as well, in order to reach a defined result.
The test data are chosen such that the differing torque interventions will be effective as a function of the inquiries set.
Taking the nominal torque into account in the response contribution thereby leads to each nominal torque formation path being included in the response regardless of the inquiry set, and hence to a fault detection in the event of a fault which is independent of the inquiry.

The 16-bit response contribution uma2_res is determined as follows:

uma2_res = word (mped_uc) + word (mmsr_uc) + word (mfgr_uc) + word (mzfo_uc) - word (mi_uc) + word (mver_c_uc)
+ 256* reac_c1_uc + 2048* reac_c2_uc + 16384 (in case b_i_ska_uc=1)
and
uma2_res = word (mped_uc) + word (mmsr_uc) + word (mfgr_uc) + word (mzfo_uc) - word (mi_uc) + word (mver_c_uc)
+ 256* reac_c1_uc + 2048* reac_c2_uc + 0 (in case b_i_ska_uc=0)

This response contribution must vary according to the specific inquiry. It is requested in addition for the conversion into a valid response.
By this, the 16-bit contribution of the program flow check uma_res and the 16-bit contribution of the instruction test uma2_res are required with exact bit correctness as 32-bit information for decoding into a correct response.

APP URCPU 4.11 Application hint

The selection of the test data is made such that fault states are set.

Each monitoring path must be operated as often as possible at intervals which are as short as possible and the result must flow into the formation of the response.

After freezing the data in Level 2, the data from Level 2’ shall follow as required.

DUR 1.22 Diagnosis from computer monitoring

FDEF DUR 1.22 Function definition

```
Last reset reason or, if this is SUPERVISOR_RESET_TV,
last reset reason prior to SUPERVISOR_RESET_TV ---------------------------------> rstpfad
```

```
                +-------------------------+   +---+
rstpfad --+---->+ = SUPERVISOR_RESET_ROM  +-->+   +              (*1)
          |     +-------------------------+   + v +--------+         +---+---+
          +---->+ = SUPERVISOR_RESET_ROMZ +-->+   +        +-------->+ S +   +----> E_urrom
                +-------------------------+   +---+                  +---+---+      B_npurrom
                                                            +------->+ R +   +
                                                            |        +---+---+
                  +---+                                     |    (*1)
(*2) C_fcmclr --->+   +     +---+                           |        +---+---+
                  + & +---->+   +                           |  +---->+ S +   +----> Z_urrom
     B_clurrom -->+   +     +   +                           |  |     +---+---+
                  +---+     + v +---------------------------+------->+ R +   +
(*2) C_pwf ---------------->+   +                              |     +---+---+
(*2) C_ini -------------+-->+   +                              |
                        |   +---+                              |
                        +--------------------------------------+
```

```
                +-------------------------+   +---+
rstpfad --+---->+ = SUPERVISOR_RESET_RAM  +-->+   +              (*1)
          |     +-------------------------+   +   +                  +---+---+
          +---->+ = SUPERVISOR_RESET_RAMI +-->+ v +----------------->+ S +   +----> E_urram
          |     +-------------------------+   +   +                  +---+---+      B_npurram
          +---->+ = SUPERVISOR_RESET_RAMZ +-->+   +         +------->+ R +   +
                +-------------------------+   +---+         |        +---+---+
                  +---+                                     |    (*1)
(*2) C_fcmclr --->+   +     +---+                           |        +---+---+
                  + & +---->+   +                           |  +---->+ S +   +----> Z_urram
     B_clurram -->+   +     +   +                           |  |     +---+---+
                  +---+     + v +---------------------------+------->+ R +   +
(*2) C_pwf ---------------->+   +                              |     +---+---+
(*2) C_ini -------------+-->+   +                              |
                        |   +---+                              |
                        +--------------------------------------+
```

```
                +----------------------------+   +---+
rstpfad --+---->+ = SUPERVISOR_RESET_FU      +-->+   +
          |     +----------------------------+   +   +
          +---->+ = SUPERVISOR_RESET_UM      +-->+   +           (*1)
          |     +----------------------------+   + v +-----+         +---+---+
          +---->+ = SUPERVISOR_DISPS_RESET   +-->+   +    +---------->+ S +   +----> E_urrst
          |     +----------------------------+   +   +               +---+---+      B_npurrst
          +---->+ = SUPERVISOR_NOQUEST_RESET +-->+   +      +------->+ R +   +
                +----------------------------+   +---+      |        +---+---+
                  +---+                                     |    (*1)
(*2) C_fcmclr --->+   +     +---+                           |        +---+---+
                  + & +---->+   +                           |  +---->+ S +   +----> Z_urrst
     B_clurrst -->+   +     +   +                           |  |     +---+---+
                  +---+     + v +---------------------------+------->+ R +   +
(*2) C_pwf ---------------->+   +                              |     +---+---+
(*2) C_ini -------------+-->+   +                              |
                        |   +---+                              |
                        +--------------------------------------+
```

(*1): Deviant to the description this part is realized in the module %DFPM
(*2): The actions triggered by C_(*) are implemented in the SW in separate processes

E_urrom:

Ambient condition 1: rstpfad   Ambient condition 2: -

E_urram:

Ambient condition 1: rstpfad   Ambient condition 2: -

E_urrst:

Ambient condition 1: rstpfad   Ambient condition 2: -

ABK DUR 1.22 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCURRAM	BLOKNR		KL	Code word CARB: monitoring of the controller: RAM
CDCURROM	BLOKNR		KL	Code word CARB: monitoring of the controller: ROM
CDCURRST	BLOKNR		KL	Code word CARB: monitoring of the controller: Reset
CDKURRAM			FW	Code word customer: monitoring of the controller: RAM
CDKURROM			FW	Code word customer: monitoring of the controller: ROM
CDKURRST			FW	Code word customer: monitoring of the controller: Reset
CDTURRAM			FW	Code word tester: monitoring of the controller: RAM
CDTURROM			FW	Code word tester: monitoring of the controller: ROM
CDTURRST			FW	Code word tester: monitoring of the controller: Reset
CLAURRAM			FW	Fault class: monitoring of the controller: RAM
CLAURROM			FW	Fault class: monitoring of the controller: ROM
CLAURRST			FW	Fault class: monitoring of the controller: Reset
FFTURRAM	BLOKNR		KL	Freeze frame tabele: monitoring of the controller: RAM
FFTURROM	BLOKNR		KL	Freeze frame tabele: monitoring of the controller: ROM
FFTURRST	BLOKNR		KL	Freeze frame tabele: monitoring of the controller: Reset
TSFURRAM			FW	Fault active time: monitoring of the controller: RAM
TSFURROM			FW	Fault active time: monitoring of the controller: ROM
TSFURRST			FW	Fault active time: monitoring of the controller: Reset

Variable	Source	Type	Description
B_CLURRAM		EIN	Flag for clearance: monitoring of the controller: RAM
B_CLURROM		EIN	Flag for clearance: monitoring of the controller: ROM
B_CLURRST		EIN	Flag for clearance: monitoring of the controller: Reset
B_NPURRAM	DUR	AUS	fault type not plaus.: monitoring of the controller: RAM
B_NPURROM	DUR	AUS	fault type not plaus.: monitoring of the controller: ROM
B_NPURRST	DUR	AUS	fault type not plaus.: monitoring of the controller: Reset
E_URRAM	DUR	AUS	error flag: monitoring of the controller: RAM
E_URROM	DUR	AUS	error flag: monitoring of the controller: ROM
E_URRST	DUR	AUS	Error flag: monitoring of the controller: Reset
RSTPFAD	DUR	AUS	Reset-path as environment condition for the diagnosis of processor monitoring
SFPURRAM	DUR	AUS	status word: monitoring of the controller: RAM
SFPURROM	DUR	AUS	status word: monitoring of the controller: ROM
SFPURRST	DUR	AUS	status word: monitoring of the controller: Reset
Z_URRAM	DUR	AUS	cycle flag: monitoring of the controller: RAM
Z_URROM	DUR	AUS	cycle flag: monitoring of the controller: ROM
Z_URRST	DUR	AUS	cycle flag: monitoring of the controller: Reset

FW DUR 1.22 Fixed Values

Parameter	Value	Description
CDKURRAM		Code word customer: monitoring of the controller: RAM
CDKURROM		Code word customer: monitoring of the controller: ROM
CDKURRST		Code word customer: monitoring of the controller: Reset
CDTURRAM		Code word tester: monitoring of the controller: RAM
CDTURROM		Code word tester: monitoring of the controller: ROM
CDTURRST		Code word tester: monitoring of the controller: Reset
CLAURRAM		Fault class: monitoring of the controller: RAM
CLAURROM		Fault class: monitoring of the controller: ROM
CLAURRST		Fault class: monitoring of the controller: Reset
TSFURRAM		Fault active time: monitoring of the controller: RAM
TSFURROM		Fault active time: monitoring of the controller: ROM
TSFURRST		Fault active time: monitoring of the controller: Reset

FB DUR 1.22 Detailed description of function

Diagnosis from the Processor Monitoring

The diagnostic function must be processed during the initialization after the initialization section for the reset duty cycle and after the DFPM initialization, since all cycle bits are cleared during the DFPM initialization.

Also cyclic processing during operation is possible, e.g. in the 100 ms task should inclusion in the initialization be problematic.

Separation is performed into faults from the RAM test, from the ROM test and into other faults with the defined fault reaction Reset.

In the process, the following assignment applies:

SUPERVISOR_RESET_TV = Reset to generate a duty cycle between reset and operation (cf. %URMEM, %UFREAC)

SUPERVISOR_RESET_ROM = Reset from the ROM test during the initialization (cf. %URROM)
=> rstpfad = 01
SUPERVISOR_RESET_ROMZ = Reset from the cyclic partial ROM test via the monitoring components (cf. %URMEM)
=> rstpfad = 02

SUPERVISOR_RESET_RAM = Reset from the RAM test during the initialization via the external RAM (cf. %URRAM)
=> rstpfad = 03
SUPERVISOR_RESET_RAMI = Reset from the RAM test during the initialization via the internal RAM (cf. %URRAM)
=> rstpfad = 04
SUPERVISOR_RESET_RAMZ = Reset from the cyclic partial RAM securing of the monitoring variables (cf. %URMEM)
=> rstpfad = 05

SUPERVISOR_RESET_FU = Reset from the fault-reaction monitoring of the watchdog function (cf. %UFREAC)
=> rstpfad = 06
SUPERVISOR_RESET_UM = Reset from the incorrect fault-counter feedback of the supervisor module (cf. %UMKOM)
=> rstpfad = 07
SUPERVISOR_DISPS_RESET = Reset from the deactivation-path test (cf. %UMAUSC)
=> rstpfad = 08
SUPERVISOR_NOQUEST_RESET= Reset from missing inquiry by the supervisor module (cf. %UMTOUT/%UMKOM),
at communication via SPI with the functional processor as master not possible
=> rstpfad = 09

The assignment of the code rstpfad is fixed for the evaluation in the diagnosis. In case of symbolic inquiry for a reset cause to be entered, this assignment then needs to be corrected according to above-mentioned list.

The entry into the fault memory can, however, only take place, if no static fault is given, which prevents reset with its fault reaction that the entry takes place resp. can be read.
Thereby the entries into the fault memory defined above are possible for faults, which are no longer given at the moment of the entry.
Thus a sequence is conceivable, in which e.g. a storage fault is detected during the initialization, which leads to the reset.
If this storage fault is no longer given during the initialization in one of the following checking sequences, then normal operation is resumed without functional limitation and the no longer given fault is entered into the fault memory.

In block diagrams fault type information as well as cycle and error flags are illustrated as outputs. The output, however, is not performed by the transmission of individual bits but by writing the entire status word sfpxyz of the fault path xyz back into the central diagnostic management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are contents of this status word. For error and cycle flags of external fault paths which occur as inputs, access methods are available which read these information directly from the fault path status managed in the DFPM.

The following variables are defined for each fault path XYZ of this diagnostic function:

Status fault path XYZ:	sfpxyz
Error flag xyz:	E_xyz
Cycle flag xyz:	Z_xyz
Fault type xyz:	TYP_xyz: (B_mxxyz, B_mnxyz, B_sixyz, B_npxyz)
Clear fault path:	B_clxyz
Default value active:	B_bkxyz (optional)
Fault path code xyz:	CDTXYZ
Fault class xyz:	CLAXYZ
Fault severity xyz:	TSFXYZ
CARB code xyz:	CDCXYZ
Table of ambient cond. xyz:	FFTXYZ

The following fault paths xyz are treated in this function definition:

Fault path name	Used abbreviation (substitutes "xyz")
Processor monitoring: ROM	URROM
Processor monitoring: RAM	URRAM
Processor monitoring: Reset	URRST

APP DUR 1.22 Application hint

UFUE 4.11 ETS monitoring concept: function monitoring overview

FDEF UFUE 4.11 Function definition

```
                                         Function surveillance (UF)
+----------+ b_fgr                                                            +---------+                             +----------+
+          +----------------------------------------------------------------->+         +                             +          +
+          + vfzg_w     +----------+ vfzg_um, mifa_um                         +         +                             +          +
+          +----------->+ %UFEING  +----------------------------------------->+         +                             +          +
+          +            +----------+        +----------+ b_brems_um           + %UFFGRC +--> b_fgr_um                 +          +
+          + Brake signals                  +          +--------------------->+         +                             +          +
+          + b_fgr_ab                   +-->+ %UFFGRE  + b_fgren_um           +         +                             +          +
+          + FGR operating lever signals+   +          +--------------------->+         +                             +          +
+          +----------------------------+   +----------+                      +-----+---+                             +          +
+          + MSR-CAN message, MSR intervention                     +---------+      | mfgr_um                         +          +
+          +------------------------------------------------------>+ %UFMSRC +------|-------> b_nomsr_um              +          +
+ Operating +                                                      +-----+---+      |                                 +          +
+          + nmot, timer0, system_time_low  +----------+         mmsr_um |          |                                 +          +
+          +------------------------------->+  %UFNC   +-+               | +--------+                                 +          +
+          +                                +-------+--+ |               | |                            b_dcdis_um    +          +
+          + B_pwgnot_fr, B_spsmin, B_sp1s, B_sp2s, +----|---> b_dcdis_um| |                            ------------->+          +
+ system   +-------------------------------------+       |               V V                                          +          +
+          +              b_ub_ska,  b_brems_um  |       | nmot_um    +--------+                                      +          +
+          + iuspoti1                            V       +---------+->+        + mz_um +-------+ mzf_um +---------+   +          +
+          + iuspoti2                        +---------+ spsn_um   |  + %UFMZUL+------>+ %UFMZF+------->+         +   +          +
+          +-------------------------------->+ %UFSPSC +------------->+        +       +-------+        + %UFMVER +   +          +
+          + milsol_w   +----------+         +----+----+ milsol_um |  +        +                 mzo_um +         +   +          +
+          +----------->+ %UFEING  +--------------|------------------>+        +----------------------->+         +   +          +
+          + tans       +          + tans_um      |                |  +--------+                        +         +   +          +
+          +----------->+          +-----------+  +---> b_dcdis_um |        ^                           +         +   +          +
+          + tmot       +          +           |                   |        |b_mzns_um                  +         +   +          +
+ function +----------->+          +--+        |                   |   +----------+                     +         +   +          +
+          +  C_ini     +----------+  |        |                   +-->| %UFNSC   |                     +         +   +          +
+          +---------------------+    |tmot_um +---------------------->|          |                     +         +   +          +
+          + rl,  rl_w           |    +------------------------------->|          |                     +         +   +          +
+          + iuipoti1, udkp1a    +------------------------------------>|          |                     +         +   +          +
+          + iuipoti2, udkp2a                +---------+  rl_um        +----------+                     +         +   +          +
+          + b_hfm, b_dkp1e   +------------->+ %UFRLC  +-----------+     +----------+                   +         +-->+          +
+          +------------------+       +----->+---+-----+           +---->+          +                   +         +   + Error-  +
+          +                 b_ub_ska |          +----> b_dcdis_um       +          + mi_um             +         +   +          +
+          + zwout                    |      nmot_um ------------------->+ %UFMIST  +------------------>+         +   + reaction +
+          + zwoutcpl                 |      +---------+ zwout_um        +          +                   +         +   +          +
+          +-------------------------------->+ %UFZWC  +---------------->+          +                   +         +   +b_i_ska_um+
+          +            +----------+  |      +---+-----+                 +----------+            +----->+         +   +          +
+          + b_ub_ok    +          +  |          +----> b_dcdis_um                               |      +---------+   +          +
+          +----------->+ %UFEING  +  |                                                          |       | b_dcdis_um +          +
+          + b_notlu_fr +          +  | b_ub_ska, b_i_ska, b_notlu                               |       V            +          +
+          +----------->+          +--+----------------------------------------------------------+      +---------+   +          +
+          + b_i_ska_fr +          +                                                             +----->+         |   +          +
+          +----------->+          +                         spsn_um, nmot_um ------------------------->+ %UFREAC +-->+ Soft-    +
+          +            +          +                                                +------------------>+         +   + ware-    +
+          + evz_aus    +          + evz_aus_um                                     +                   ++--------+   + reset    +
+          +----------->+          +------------------------------------------------+                    + b_dcdis_um +          +
+----------+            +----------+                                                                     +-------->   +----------+
```

ABK UFUE 4.11 Abbreviations

Variable	Source	Type	Description
B_DCDIS_UM	UFUE	LOK	Fault reaction information of the function monitoring
B_FGR	MDFAW	EIN	condition: driver’s set engine torque determined by cruise control
B_FGR_UM	UFUE	AUS	CC/ACC torque intervention in function monitoring permitted
B_I_SKA	UFUE	LOK	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_FR	SREAKT	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFUE	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_MZNS_UM	UFUE	LOK	afterstart torque increase of ETC-monitoring is active
B_NOMSR_UM	UFUE	AUS	MSR moment required not used in function monitoring
B_NOTLU	UFUE	LOK	Request standby air driving from the function
B_NOTLU_FR	SREAKT	EIN	Request for NFB from Function controller
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_UB_SKA	UFUE	LOK	Battery voltage not OK, undervoltage shut-off active
C_INI	SWADAP	EIN	ECU-condition for intialisation
EVZ_AUS	AEVAB	EIN	injection cut off pattern
EVZ_AUS_UM	UFUE	LOK	Injection cut off pattern in function monitoring
IUIPOTI1		EIN	ADC value incl. channel number throttle valve actual value potentiometer 1 loop
IUIPOTI2		EIN	ADC value incl. channel number throttle valve actual value potentiometer 2 loop
IUSPOTI1		EIN	ADC value incl. channel number nominal value potentiometer 1 loop (PWG)
IUSPOTI2		EIN	ADC value incl. channel number nominal value potentiometer 2 loop (PWG)
MFGR_UM	UFUE	LOK	Torque request from cruise control for function monitoring
MIFA_UM	UFUE	LOK	FGR-/ACC- or driver requested torque of function for function monitoring
MILSOL_UM	UFUE	LOK	driver torque request for charge used in function monitoring
MILSOL_W	MDKOL	EIN	driver torque request for charge
MI_UM	UFUE	LOK	Calculated actual torque in function monitoring
MMSR_UM	UFUE	LOK	Permissible MSR torque request for function monitoring

Variable	Source	Type	Description
MZF_UM	UFUE	LOK	Filtered permissible torque of function monitoring
MZO_UM	UFUE	LOK	Tolerance offset for permissible torque in function monitoring
MZ_UM	UFUE	LOK	Permissible torque resulting from the coordination of function monitoring
NMOT	SWADAP	EIN	engine speed
NMOT_UM	UFUE	LOK	engine speed in function monitoring
RL	SWADAP	EIN	relative air charge
RL_UM	UFUE	LOK	Relative air charge in function monitoring
RL_W	EGFE	EIN	relative air charge (Word)
SPSN_UM	UFUE	LOK	Pedal value (8-bit) with lower limit to idling in function monitoring
TANS	SWADAP	EIN	Intake air temperature
TANS_UM	UFUE	LOK	Intake air temperature of the watchdog function
TMOT	SWADAP	EIN	Engine temperature
TMOT_UM	UFUE	LOK	Engine temperature in the watchdog function
UDKP1A	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop
UDKP2A	BGDVE	EIN	sensor voltage poti 2 of throttle actuator at (lower) mechanical stop
VFZG_UM	UFUE	LOK	engine speed in function monitoring
VFZG_W	GGVFZG	EIN	Vehicle speed
ZWOUT	ZUE	EIN	Ignition angle output value
ZWOUTCPL	ZUE	EIN	Single complement of the ignition angle for function monitoring
ZWOUT_UM	UFUE	LOK	Ignition angle in function monitoring

FW UFUE 4.11 Fixed Values

Parameter	Value	Description

FB UFUE 4.11 Detailed description of function

This section is an overview of der function surveillance at the torque level.

The sections are active in the 10-ms, 20-ms or 40-ms time frame. The allocation to the respectively valid frame is executed on a module-specific basis.

These are thereby called up in the 10-ms time frame in the following sequence:

%UFEING	Transfer of input signal for function surveillance
%UFFGRE	FGR input information for function surveillance
%UFNC	Speed monitoring for function surveillance
%UFNSC	Afterstart-monitoring for function surveillance
%UFZWC	Ignition-timing monitoring for function surveillance
%UFRLC	Load signal monitoring for function surveillance
%UFSPSC	Pedal setpoint value monitoring for function surveillance
%UFFGRC	FGR monitoring for function surveillance
%UFMSRC	Monitoring MSR torque interventions for function surveillance
%UFMIST	Actual torque in function surveillance
%UFMZUL	Permissible torque in function surveillance
%UFMZF	Torque filter for function surveillance
%UFMVER	Torque comparison in function surveillance
%UFNSC	Afterstart-monitoring for function surveillance
%UFREAC	Error-reaction monitoring in function surveillance

APP UFUE 4.11 Application hint

UFOBP 1.10 ETS monitoring concept: OBP operation of function monitoring

FDEF UFOBP 1.10 Function definition

ABK UFOBP 1.10 Abbreviations

FW UFOBP 1.10 Fixed Values

Parameter	Value	Description

FB UFOBP 1.10 Detailed description of function

```
OBP operation of the function surveillance
-------------------------------------

The module must contribute to control of the program sequence (refer to %URPAK).


Requirement:
The surveillance module (UM) may not be shut down during the on-board check (OBP), such that its monitoring function is
continuously active in normal operation as well, and cannot be shut down either.
It is for this reason that the function computer (FR) in the OBP has to serve the surveillance module (UM) as in normal operation.
In normal operation, the query initiated by the surveillance module (UM) is iterated through the function surveillance modules
with the help of the process sequencing control, and valid response is formed from this for the surveillance module (UM).

A special program section that iterates through a special OBP module of the program sequencing control and forms a valid response
for the surveillance module (UM) is used in OBP operation so that order effects on the OBP are excluded for changes in function
surveillance.

Definition:
This special OBP module of function surveillance monitors the ignition and injection outputs in the Capture Compare Unit for
a shutdown capture-compare mode.
A software reset is triggered in the case of a fault.
```

APP UFOBP 1.10 Application hint

UFEING 13.10 ETS monitoring concept: Input signal transfer used in function monitoring

FDEF UFEING 13.10 Function definition

```
Transfer of the Input Signals for the Watchdog function
-------------------------------------------------------
                                                           +---+
b_ub_ok -------------------------------------------------->+   +o----------------------------------> b_ub_ska
                                                           +---+
b_i_ska_fr ----------------------------------------------------------------------------------------> b_i_ska
b_notlu_fr ----------------------------------------------------------------------------------------> b_notlu

evz_austot ----------------------------------------------------------------------------------------> evz_aus_um

tmot ----------------------------------------------------------------------------------------------> tmot_um
tans ----------------------------------------------------------------------------------------------> tans_um
```

ABK UFEING 13.10 Abbreviations

Variable	Source	Type	Description
B_I_SKA	UFEING	AUS	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_FR	SREAKT	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_NOTLU	UFEING	AUS	Request standby air driving from the function
B_NOTLU_FR	SREAKT	EIN	Request for NFB from Function controller
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_UB_SKA	UFEING	AUS	Battery voltage not OK, undervoltage shut-off active
EVZ_AUSTOT	AEVABZK	EIN	injection cut off pattern total
EVZ_AUS_UM	UFEING	AUS	Injection cut off pattern in function monitoring
MILSOL_UM	UFEING	AUS	driver torque request for charge used in function monitoring
MILSOL_W	MDKOL	EIN	driver torque request for charge
TANS	SWADAP	EIN	Intake air temperature
TANS_UM	UFEING	AUS	Intake air temperature of the watchdog function
TMOT	SWADAP	EIN	Engine temperature
TMOT_UM	UFEING	AUS	Engine temperature in the watchdog function

FW UFEING 13.10 Fixed Values

Parameter	Value	Description

FB UFEING 13.10 Detailed description of function

Input signal transfer for watchdog function

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The input signals needed for the watchdog function must be transferred cyclically to the watchdog function.

The following informations are input signals for %URADCC:

iuspoti1	ADC-value incl. channel number setpoint poti 1
iasp1plaus	ADC-value incl. channel number setpoint poti 1 from the supervisor module

The following informations are input signals for %UFRLC:

b_wdk2sel	Fault at throttle valve (DK) poti 1, throttle sensor default function with DK poti 2
b_hfm	Condition HFM ready for measurement, i.e. load signal from HFM and not from DK info
rl	Relative air charge, i.e. load information rl from the function
rl_w	Relative air charge, i.e. load information rl_w from the function
iuipoti1	ADC-value incl. channel number for throttle valve poti 1
iuipoti2	ADC-value incl. channel number for throttle valve poti 2
udkp1a	Voltage throttle valve poti 1 at the (lower) limit stop
udkp2a	Voltage throttle valve poti 2 at the (lower) limit stop

The following informations are input signals for %UFZWC:

zwout	Ignition angle for the function
zwoutcpl	Complement of the ignition angle to make the ignition angle plausible in the watchdog function

The following informations are input signals for %UFSPSC:

iuspoti1	ADC-value incl. channel number setpoint poti 1
iuspoti2	ADC value incl. channel number setpoint poti 2
b_sp1s	SP1S is reference variable in the pedal sensor default function
b_sp2s	SP2S is reference variable in the pedal sensor default function
b_spsmin	In the pedal sensor default function the idle input applies
b_pwgnotfr	Pedal sensor default function from the function is active

The following informations are input signals for %UFFGRE:

S_bls	Stop-light switch information: Brake is applied
S_brs	Stop-light switch information: Brake is not applied
b_fgrab	FGR/ACC deactivation conditions active in the function
S_fgrwb	Switch resume/accelerate on the FGR stalk
S_fgrsv	Switch set/decelerate on the FGR stalk
S_fgrat	Switch OFF-TIP on the FGR stalk
S_fgrhs	Main switch on the FGR stalk

The following information is input signals for %UFNC:

nmot	Engine speed

The ASR/MSR data arrive in the function processor via CAN and are made available unprocessed to the watchdog function for the evaluation in %UFMSRC.

APP UFEING 13.10 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_i_ska_fr		VAR/EIN	functional fault reaction irrev. SKA (safety fuel deactivation)
b_i_ska		VAR/AUS	functional fault reaction irrev. SKA (safety fuel deactivation)
b_notlu_fr		VAR/EIN	functional fault reaction throttle actuator power stage at zero current
b_notlu		VAR/AUS	functional fault reaction throttle actuator power stage at zero current
b_ub_ok		VAR/EIN	battery voltage O.K., no undervoltage deactiv. of DK actuator power stage active
b_ub_ska		VAR/AUS	undervoltage deactivation of DK actuator power stage active
evz_austot		VAR/EIN	cylinder cutout mask for injection cutout as input info for the CIFI
evz_aus_um		VAR/AUS	cylinder cutout mask for injection cutout for the watchdog function
tans		VAR/EIN	intake air temperature
tans_um		VAR/AUS	intake air temperature in the watchdog function
tmot		VAR/EIN	engine temperature
tmot_um		VAR/AUS	engine temperature in the watchdog function

UFMER 1.10

FDEF UFMER 1.10 Function definition

`No text for FDEF available!`

ABK UFMER 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DMEBZ_MX			FW	
MEBZ_M			FW	
MER_T1_UM			FW	
MER_T2_UM			FW	
SPSC_MINUM			FW	= SPSC_MIN_UM Pedal idling gas limit for function monitoring

Variable	Source	Type	Description
B_DCDIS_C	UFMER	AUS	
B_MSTHW_UM		EIN	
B_MZNS_C	UFMER	AUS	
B_NOME_C	UFMER	AUS	Condition default values in watchdog function (via CAN)
B_NOME_UM	UFMER	AUS	Condition replacement values are used caused by failures in the recieved massage
B_UB_SKA_C	UFMER	AUS	
MEBZA_UM_C	UFMER	LOK	
MEBZ_UM_C	UFMER	LOK	
MECS_UM_C	UFMER	LOK	
MEST_UM_C	UFMER	LOK	
MFGR_UM_C	UFMER	AUS	
SPSN_UM_C	UFMER	AUS	Pedal value (8-bit) from master-ECU via CAN in the monitoring function

FW UFMER 1.10 Fixed Values

Parameter	Value	Description
DMEBZ_MX		
MEBZ_M		
MER_T1_UM		
MER_T2_UM		
SPSC_MINUM		= SPSC_MIN_UM Pedal idling gas limit for function monitoring

FB UFMER 1.10 Detailed description of function

APP UFMER 1.10 Application hint

UFMET 1.10

UFSPSC 2.30 ETS monitoring concept: Monitoring of accelerator pedal value for function m.

FDEF UFSPSC 2.30 Function definition

```
                +---------+                    +----+
iuspoti1 ------>+ & 03FFh +------------------->+ :4 +---------------------------------------------> sp1s_um
                +---------+                    +----+

255 --------------------------------------------------------------------------------+
                  +---------+                    +----+                             +-->o
iuspoti2 -------->+ & 03FFh +------------------->+ :2 +---+-----------------------------o--o------> sp2s_um
                  +---------+                    +----+   |                                ^
                                                          |    +-------+                   |
                                                          +--->+ > 255 +-------------------+
                                                               +-------+
```

```
SP12LL_UM ---------------------------------------o\   Tolerance
                                                  ^\
SP12VG_UM ---------------------------------------o| o---------------------------+
              +---------------+      +-------+    |                             |
          +-->+  >  SPSVG_UM  +----->+       +    |                             |
          |   +---------------+      +   &   +----+                             |
          |                      +-->+       +                                  |
          |   +---------------+  |   +-------+                                  |
          |   | SPSC_MIN_UM / |  | sp1sn_um    +-----------------------+        V            o    +----------------+
sp1s_um --+-->+ ------------  +-------------+->+                       +  +------------+          + SPSC_T_UM      +
              +---------------+  | sp2sn_um |  + |sp1sn_um - sp2sn_um| +->+ > Tolerance +-+-o--o-->+           +--- +--+--> 1)
                                 |   +------|->+                       +  +------------+ |   ^    + -----------+   +   |
              +---------------+  |   |      |  +-----------------------+                 |   |    +----------------+   |
              | SPSC_MIN_UM / |  |   |      |     +-------+                              |   |     +-------------------+
          +-->+ ------------  +------+      +---->+       +                              |   |     |   +-----+-----+
          |   +---------------+  |   |      |     +  MIN  +--+                           |   |     +-->+  S  +     +-> ei_spsc_um
          |                      |   +------|---->+       +  |                           |   |         +-----+-----+   b_dcdis_um
          |   +---------------+  |   |      |     +-------+  |                           |   |     +-->+  R  +     +   b_i_ska_um
sp2s_um --+-->+  >  SPSVG_UM  +--+   |      +--o\            +--o                        |   |     |   +-----+-----+  b_pwgnot_um
              +---------------+      |          ^\                                       |   |     |
               +-------+             +---------o| o-------------o--o-+                   |   |     |
b_pwgnot_fr -->+       +                        |                ^   |                   |   |     |
               +   &   +------------------------+                |   |                   |   |     |
b_sp2s   ----->+       +                                         |   |                   |   |     |
               +-------+                                         |   |                   |   |     |
C_ini -----------------------------------------------------------|---|-------------------|---|-----+
               +-------+                                         |   |                   |   |
b_pwgnot_fr -->+       +                                         |   |                   |   |
b_sp1s   ---->o+   &   +-----------------------------------------+   |      spsn_um(t-1) |   |
b_sp2s   ---->o+       +                                             +--o\  ----o        |   |
               +-------+                                                 ^\              |   |
SPSC_MIN_UM ------------------------------------------------------------o| o----o--o---------------------------------> spsn_um
                                                  +-------+              |       ^       |   |
     1)  ---------------------------------------->+       +              |       |       |   |
                                +-------+         +   v   +--------------+       |       |   |
b_pwgnot_fr ------------------->+       +   +---->+       +                      |       |   |
               +-------+        +   &   +---+     +-------+                      |       |   |
b_brems_um --->+       +   +--->+       +     +----------------------------------|-------+   |
               +   v   +---+    +-------+     |   +-------+                      |           |
b_spsmin ----->+       +                      +-->+       +                      |           |
               +-------+                          +   &   +---+    +-------+     |           |
b_pwgnot_fr ------------------------------------>o+       +   +--->+       +     |           |
                                                  +-------+        +   v   +-----+           |
                                              +------------------->+       +                 |
                                              |   +-------+        +-------+                 |
b_ub_ska -------------------------------------+-->+       +                                  |
                                                  +   v   +----------------------------------+
b_pwgnot_fr ------------------------------------->+       +
                                                  +-------+
```

ABK UFSPSC 2.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SP12LL_UM			FW	maximum difference between SP1S and SP2S below full load
SP12VG_UM			FW	maximum difference between SP1S and SP2S above full load range
SPSC_MINUM			FW	= SPSC_MIN_UM Pedal idling gas limit for function monitoring
SPSC_T_UM			FW	Fault time for nominal values in func. monitor. which are mutually not plaus.
SPSVG_UM			FW	Threshold full load for switch over of max. tolerance

Variable	Source	Type	Description
B_BREMS_UM	UFFGRE	EIN	condition of function monitoring: brake pedal pressed
B_DCDIS_UM	UFSPSC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	UFSPSC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
B_PWGNOTUM	UFSPSC	AUS	= b_pwgnot_um function monitoring fault response PWG idling (= b_pwgnot_sr)
B_SP1S	GGPED	EIN	message to SR: SP1S is command variable
B_SP2S	GGPED	EIN	SP2S is valid set value for PWG failure driving
B_SPSMIN	GGPED	EIN	message to SR: '1' = pedal-travel sensor limphome with SPSMIN
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
EI_SPSC_UM	UFSPSC	AUS	irrevers. error bit for pedal value plausibility check in function monitoring
IUSPOTI1		EIN	ADC value incl. channel number nominal value potentiometer 1 loop (PWG)
IUSPOTI2		EIN	ADC value incl. channel number nominal value potentiometer 2 loop (PWG)
SP1SN_UM	UFSPSC	LOK	Value from SP1S with lower limit to idling for function monitoring
SP1S_UM	UFSPSC	LOK	Current value for nominal value potentiometer 1 (PWG) for function monitoring
SP2SN_UM	UFSPSC	LOK	Value from SP2S with lower limit to idling for function monitoring
SP2S_UM	UFSPSC	LOK	Current value for nominal value potentiometer 2 (PWG) for function monitoring
SPSC_C_UM	UFSPSC	LOK	Error counter for mutually non-plausible values in function monitoring
SPSN_UM	UFSPSC	AUS	Pedal value (8-bit) with lower limit to idling in function monitoring

FW UFSPSC 2.30 Fixed Values

Parameter	Value	Description
SP12LL_UM		maximum difference between SP1S and SP2S below full load
SP12VG_UM		maximum difference between SP1S and SP2S above full load range
SPSC_MINUM		= SPSC_MIN_UM Pedal idling gas limit for function monitoring
SPSC_T_UM		Fault time for nominal values in func. monitor. which are mutually not plaus.
SPSVG_UM		Threshold full load for switch over of max. tolerance

FB UFSPSC 2.30 Detailed description of function

Pedal setpoint monitoring for the function surveillance

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

The pedal setpoint value must be monitored on the basis of redundant information.

Monitoring the pedal setpoint value cannot be executed if the power supply to the sensors is no longer assured. Accordingly, monitoring the pedal setpoint value is not carried out if the throttle-valve actuator output stage is shut down by an undervoltage. A check is then made in the error-reaction monitoring of function surveillance (%UFREAC) whether the undervoltage shutdown has actually been executed and is not just being indicated.

For pedal setpoint monitoring, the lower values for both sets of input information are limited to the idle-speed value.

Both pedal setpoints limited to the lower values are then compared with a permissible tolerance range. This tolerance is extended if both pedal setpoint values are in the full-gas range.

If the pedal setpoint values are matching, then the error counter for monitoring the pedal setpoint value is deleted and the reference variable sp1s_um is taken as the valid value for the pedal setpoint, sps_um for the subsequent processing.

If, in the event of a fault, there is no switchover to the PWG standby function (pedal-value variable), then the valid pedal setpoint value is not updated and, following elapse of an error time that is longer than that in the function, a set of error information, the error reaction and the error-reaction information are set. In addition to this, the pedal setpoint value is then set to the idle-speed requirement.

If the PWG standby function is active, then the valid pedal setpoint value is set to the idle-speed requirement when the brake is operated.
If the brake is not operated, then the valid pedal setpoint value is updated for an active PWG standby function with the help of the information from the reference variable for component monitoring in the function. In case neither the idle-speed requirement nor a defined reference variable (SP1S or SP2S) is signaled, then the minimum-value selection from SP1S and SP2S is continued to be used as the pedal setpoint value requirement.

APP UFSPSC 2.30 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
b_brems_um		VAR/EIN	Resulting brake information for function surveillance (operated in case of doubt)
b_dcdis_um		VAR/AUS	Error-reaction info. (shutdown of throttle-valve actuator output stage) of function surveillance
b_sp1s		VAR/EIN	SP1S is the reference variable in the PWG standby function
b_sp2s		VAR/EIN	SP2S is the reference variable in the PWG standby function
b_spsmin		VAR/EIN	The idle-speed requirement applies in the PWG standby function
b_i_ska_um		VAR/AUS	Function-surveillance error reaction irrev. SKA (safety fuel shutdown)
b_pwgnot_fr		VAR/EIN	Message to function surveillance: PWG standby function active
b_pwgnot_um		VAR/AUS	Function-surveillance error reaction: PWG idle-speed requirement active
b_ub_ska		VAR/EIN	Battery voltage not OK, undervoltage shutdown of the throttle-valve actuator output stage active
ei_spsc_um		VAR/AUS	Irreversible error bit for plausibility of setpoint value in function surveillance
iuspoti1		VAR/EIN	ADC value incl. channel number setpoint-value potentiometer 1
iuspoti2		VAR/EIN	ADC value incl. channel number setpoint-value potentiometer 2
sp1s_um		VAR/LOK	Setpoint-value potentiometer 1 for function surveillance
sp2s_um		VAR/LOK	Setpoint-value potentiometer 2 for function surveillance
sp1sn_um		VAR/LOK	Value limited to lower idle-speed limit by setpoint-value poti 1 for function surveillance
sp2sn_um		VAR/LOK	Value limited to idle-speed limit by setpoint-value potentiometer 2 for function surveillance
spsn_um		VAR/AUS	Valid pedal setpoint value for function surveillance
spsc_c_um		VAR/LOK	Error counter setpoint values not mutually plausible in function surveillance

Label	Dependency	Type	Designation
SP12LL_UM		FW	Maximum difference between SP1S and SP2S below the full-gas threshold
SP12VG_UM		FW	Maximum difference between SP1S and SP2S above the full-gas threshold
SPSVG_UM		FW	Full-gas setpoint-value threshold for switching over the max. diff. in function surve.
SPSC_MIN_UM		FW	Pedal idle-speed limit for function surveillance
SPSC_T_UM		FW	Error time for setpoint values not mutually plausible in function surveillance

UFNC 3.20 ETS monitoring concept: Monitoring of engine speed for function monitoring

FDEF UFNC 3.20 Function definition

```
Monitoring of engine speed for watchdog function
------------------------------------------------

Values from the SYNC-cycle --> | <-------------------------   %UFNC - engine speed monitoring --------------------------------> |
reps. the operating system     |       zalt_um -----------------+
                                                                |
                                       +-------------+ zcap_um  V- zdif_um  +------------+    +-----------+
Tooth counter (Timer0) --------------->+ Consistency +--------->o---------->+ * NZMUL_UM +--->+ : tdif_um +-------+--> nz_um
                                       +             + tcap_um              +------------+    +-----------+       |
Time counter (SYSTEM_TIME_LOW) ------->+ Check       +----------+                                   ^             |
                                       +-------------+          |                          tdif_um  |             |
                                                                V+   +------------------------------+             |
                                       talt_um ---------------->o----+   +----------------------------------------+
                                                              -          |      nz_um  +-----+
                                    +------------------------------------+------------>+ MAX +----+
                                    |                                           +----->+     +    +
                                    |                                  nmot     +      +-----+    +---->o\
                                 +--|-------------------------------------------+---------------------->o^\o---------> nmot_um
                                 |  |         +-----------------+                          +-+           |
                                 |  |      +->+  = ~ZSYNC_I_UM  +---+    +-+ +------------>+ +           |
                                 |  |      |  +-----------------+   +--->+ + |             +v+-----------+
                                 |  |      |    +-----------------+      +&+-+  +-------->o+ +
                                 |  |      | +->+  = ZSYNC_I_UM   +----->+ + |  |   +-+    +-+
                                 |  |      | |  +-----------------+      +-+ +--|-->+ +
                                 |  |      | |                        +---------+   +v+-----+
                                 |  |      | |         +-----------+  |  +-+  +--->o+ +     |
                                 |  +----------------->+ > NMIN_UM +---->+ +  |     +-+     V Reset
                                 |  |      | |         +-----------+  |  +&+--+      +------------+
                                 |  V+     | | +-----+  +-----------+ +->+ +  |      + NC_T_UM    +    +---+---+
nmot ----------------------------+->o--------->+ |x| +->+ > NDIF_UM +-+  +-+  +----->+     +----- +--->+ S +   +-----> b_dcdis_um
                                   -       | | +-----+  +-----------+                + ----+      +    +---+---+       b_i_ska_um
                                           | |                                       +------------+ +->+ R +   +       ei_nc_um
C_ini ----------------------------------------------------------------------------------------------+  +---+---+
       +---------+                         | |
       +   ~0    +--> zsync_ur   zsync_ur -+------------------------------------------------------------->o
       +---------+                           |    +-------------------+                                    \
                                             |    +    ~ZSYNC_I_UM    +----------------------------------->o^\o-------> zsync_ur
                                             |    +-------------------+        +-------------------+       |
                                             |                                 +     ZSYNC_I_UM    +----->o|/o-------> zsync_um
       +---------+                           |                                 +-------------------+       /
       +    0    +--> zsync_um   zsync_um ---+----------------------------------------------------------->o^
       +---------+                            +-----------------------+    +-----------------------+       |
                                 r10msCtr --->+ & xxxx xxxx xxxx x111 +--->+ = xxxx xxxx xxxx x110 +-------+
                                              +-----------------------+    +-----------------------+
                                 zcap_um ----------------------------------------------------------------------------> zalt_um
                                 tcap_um ----------------------------------------------------------------------------> talt_um
```

ABK UFNC 3.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NC_T_UM			FW	Fault tolerance time for engine speed monitoring in function monitoring
NDIF_UM			FW	Permissible difference between nmot and nz_um in function monitoring
NMIN_UM			FW	Minimum speed for engine speed surveillance in function monitoring
NZMUL_UM			FW	Multiplier for conv. of the number of teeth in engine speed for func. monitor.
TZTOL_UM			FW	Tolerance between time and tooth counter detection in timer increments
ZSYNC_I_UM			FW	Initialization value for missing synchronization in the watchdog function

Variable	Source	Type	Description
B_DCDIS_UM	UFNC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	UFNC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
EI_NC_UM	UFNC	AUS	irreversible error bit for engine speed comparison from function monitoring
NC_C_UM	UFNC	LOK	Error counter for engine speed for function monitoring
NMOT	SWADAP	EIN	engine speed
NMOT_UM	UFNC	AUS	engine speed in function monitoring
NZ_UM	UFNC	LOK	engine speed resulting from tooth-counter difference per time in function mon.
TALT_UM	UFNC	LOK	Timer value of previous point for computation in 40 ms time slot
TCAP_UM	UFNC	LOK	Timer value of current point for computation in 40 ms time slot
TDIF_UM	UFNC	LOK	Difference between current and previous computation point in time
ZALT_UM	UFNC	LOK	Tooth counter value from previous point for computation in 40 ms time slot
ZCAP_UM	UFNC	LOK	Tooth counter value of current point for computation in 40 ms time slot
ZDIF_UM	UFNC	LOK	Difference between current and previous tooth counter value
ZSYNC_UM	UFNC	LOK	Identifier for synchronization in the watchdog function
ZSYNC_UR	UFNC	LOK	One's complement for identifier for synchronization in the watchdog function

FW UFNC 3.20 Fixed Values

Parameter	Value	Description
NC_T_UM		Fault tolerance time for engine speed monitoring in function monitoring
NDIF_UM		Permissible difference between nmot and nz_um in function monitoring
NMIN_UM		Minimum speed for engine speed surveillance in function monitoring
NZMUL_UM		Multiplier for conv. of the number of teeth in engine speed for func. monitor.
TZTOL_UM		Tolerance between time and tooth counter detection in timer increments
ZSYNC_I_UM		Initialization value for missing synchronization in the watchdog function

FB UFNC 3.20 Detailed description of function

```
Monitoring of engine speed for watchdog function
------------------------------------------------

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by this function must be stored cyclically (see %URMEM).
Only the temporary variables may be used as intermediate variables within this function. These are used just as in the command
tests (see %URCPU) and they are thus checked for writability.

This function shall be processed in the 40ms cycle.


The engine speed must be monitored on the basis of redundant information.
For this purpose the engine speed is secured for the watchdog function with a variable of the engine speed sensing, which is also
relevant for the ignition output.
Usage of the tooth counter is useful for this.
The counter for the tooth edges serves as compare-setting for the ignition and it is evaluated in the 40ms cycle as number of
increments per measuring cycle, i.e. as number of teeth during the measuring period.
In the process a time matching the current tooth counter value is also taken over, in order to be able to take into account
deviations from the standard cycle time due to floating processing in the 10ms cycle.

In the process the following sequence is executed in the 40ms cycle, which is generated from the 10ms cycle:

1) Read timer count from operating-system timer being executed with fixed quantization (SYSTEM_TIME_LOW)
2) Read tooth count from event counter being executed
3) Consistency check:
   Read timer count again and in case of too high temporal offset rsatz (> TZTOL_UM) to the first read timer count read the tooth
   count again so that a possibly triggered synchro between reading of timer and tooth counter does not prevent the unity.
4) Take over timer count into tcap_um and event counter into zcap_um
5) Form the difference between current and previous timer count:      tdif_um = tcap_um - talt_um
6) Form the difference between current and previous tooth count:      zdif_um = zcap_um - zalt_um
7) Convert number of teeth zdif_um to accompanying engine speed nz_um:

   The number of teeth is converted to an engine speed, as is used in the watchdog function, by the following conversion formula:

                       zdif_um
   nz_um = NZMUL_UM *  -------
                       tdif_um


8) Check calculated and functional engine speed for maximum allowed offset:
   |nz_um - nmot| > NDIF_UM means too high deviation

   In case the engine speed values match each other the fault counter is cleared and nmot is transferred to nmot_um for further
   use.
   The maximum value from nmot and nz_um is transferred to nmot_um as valid engine speed value in case of fault.
   If the minimum engine speed for the watchdog function NMIN_UM is exceeded even with the calculated engine speed nz_um, then the
   fault counter nc_c_um is incremented until it reaches its final value of NC_T_UM, otherwise the fault counter nc_c_um is
   cleared.
   In case the final value is reached a fault information ei_nc_um is set and the fault reaction irreversible safety fuel
   deactivation is triggered (b_i_ska_um=1, b_dcdis_um=1).

9) Store the current timer and tooth count as previous one:
   talt_um = tcap_um
   zalt_um = zcap_um

The missing valid values in talt_um and zalt_um can lead to the fault counter nc_c_um starting to count up to 1 when the program
is called up for the first time.
Dynamic sequences at high engine speeds, which can lead to differing engine speed information in nmot and zdif_um, are taken into
consideration in the permissible tolerance NDIF_UM during the comparison.
Low engine speeds are possibly updated less frequently in nmot than in zdif_um.
This must be permitted by the fault tolerance time NC_T_UM and the tolerance NDIF_UM during the comparison.
```

A malfunction at the speed sensor input can lead to a synchronization loss with the phase sensor signal. Thereby no SYNC-cycle is processed, in which ignition and injection are served.

Such a malfunction can last for longer than the fault tolerance time NC_T_UM and may not lead to the fault detection of the engine speed monitoring.
Deshalb werden die Drehzahlaufbereitung und -überwachung während dieser Zeit ausgeblendet, d.h. der Fehlerzähler nc_c_um wird gelöscht und nmot in nmot_um zur Weiterverwendung übernommen, damit für diesen Fall die Drehzahl in der Funktionsüberwachung mit der in der Funktion konsistent ist. Dies erfolgt aufgrund der beiden Kennungen zsync_um = Initialisierungswert (ZSYNC_I_UM) und zsync_ur = 1-er Komplement des Initialisierungswertes (~ZSYNC_I_UM).

Die Kennungen zsync_um und zsync_ur werden alle 80 ms mit dem Initialisierungswert beschrieben. Sobald eine Synchronisation erfolgt und das SYNC-Raster abgearbeitet wird, werden beide Kennungen zerstört (zsync_um = 0 und zsync_ur = ~0). Dann setzen auch Einspritzung und Zündung wieder ein. Damit erfolgen die Drehzahlaufbereitung und -überwachung, sobald die Kennungen zsync_um und zsync_ur zerstört werden.
Hierbei muß garantiert werden, daß innerhalb 80 ms mindestens ein SYNC-Raster abgearbeitet wird. Bei einer Zylinderanzahl von minimal 3 und einem Inkrementgeber mit 58 Zähnen entspricht das einer Drehzahl von maximal 483,3 U/min und wird als Erstbedatung für NMIN_UM zugrundegelegt. Eine höhere Zylinderanzahl ist unkritischer, da die entsprechende Segmentzeit bei gleicher Drehzahl bzw. die entsprechende Drehzahl bei gleicher Segmentzeit kleiner werden.

Durch die Abfrage zweier Bedingungen wird vermieden, daß eine Fehlinformation den Zustand "nicht synchronisiert" simuliert. Eine Beschreibbarkeitsprüfung (siehe %URMEM) darf für beide Kennungen nicht erfolgen, weil diese ungerechtfertigt einen Fehler erkennen kann, wenn im höherpriorisierten SYNC-Raster die Kennungen zerstört werden. Aus dem gleichen Grund darf keine Komplementprüfung durchgeführt werden.
Das ist zulässig, weil ein schlafender Fehler in der Beschreibbarkeit oder im richtigen Wert einmal pro Fahrzyklus in der RAM-Prüfung (%URRAM) erkannt wird.

APP UFNC 3.20 Application hint

The data of the watchdog function are part of the monitoring concept and may therefor not be changed arbitrarily.

Label	Source	Type	Description
b_dcdis_um		VAR/AUS	Fault-reaction info (deactivation of throttle actuator output stage) of watchdog function
b_i_ska_um		VAR/AUS	Watchdog function fault reaction irrev. SKA (safety fuel deactivation)
ei_nc_um		VAR/AUS	irreversible fault bit during the speed plausibility check of the watchdog function
nc_c_um		VAR/LOK	Fault counter for engine speed comparison of the watchdog function
nmot		VAR/EIN	Engine speed for the function
nmot_um		VAR/AUS	Engine speed for the watchdog function
nz_um		VAR/LOK	Engine speed from the cycle-time-corrected number of teeth
r10msCtr		VAR/EIN	Counter of the 10ms cycle
talt_um		VAR/LOK	Timer value of the previous calculation instant in the 40ms cycle
tcap_um		VAR/LOK	Timer value of the current calculation instant in the 40ms cycle
tdif_um		VAR/LOK	Difference between current and previous calculation instant in timer steps
zalt_um		VAR/LOK	Tooth counter value of the previous calculation instant in the 40ms cycle
zcap_um		VAR/LOK	Tooth counter value of the current calculation instant in the 40ms cycle
zdif_um		VAR/LOK	Difference between current and previous tooth counter value
zsync_um		VAR/LOK	Identifier for synchronization in the watchdog function
zsync_ur		VAR/LOK	one's complement to the identifier 1-er for synchronization in the watchdog function

Label	Dependency	Type	Description
NC_T_UM		FW	Fault tolerance time for engine speed comparison in the watchdog function
NDIF_UM		FW	permitted difference between nmot and from no. of teeth calculated speed nz_um
NMIN_UM		FW	minimum engine speed for watchdog function
NZMUL_UM	En, Esystim	FW	Multiplier for conversion of the no. of teeth into engine speed
TZTOL_UM	Esystim	FW	Tolerance between time and tooth counter sensing in timer increments
ZSYNC_I_UM		FW	Initialization value for missing synchronization in the watchdog function

The determination of the engine speed is performed by means of the following conversion from the number of measured teeth zdif_um during the measuring period tdif_um:

```
                  n [rpm]     f58z [teeth/s]  teeth/s * 60 s/min      f58z [teeth/s]      60
nz_um [En rpm] = ----------- = ------------------------------------ = ---------------- * ----
                  En [rpm]    En [rpm] rpm *  z  teeth/rev.           En [rpm]             z


                      zdif_um [teeth]                       1        60     zdif_um
               = ----------------------------------- * ---------- * ---- = --------- * NZMUL_UM
                  tdif_um [steps] * Esystim [s/step]    En [rpm]      z     tdif_um


                  60         1                   1
with  NZMUL_UM = ---- * ------------------ * ------------
                   z     Esystim [s/step]     En [rpm]
```

```
n       = engine speed
En      = resolution of the engine speed nz_um in rpm
z       = 58 = no. of teeth per revolution
f58z    = average tooth frequency
Esystim = resolution of the system timer used for the time measurements for the calculation of tdif_um in s/timer steps
```

The low-byte of the ERCOS-system time SYSTEM_TIME_LOW with 12,8 us/step is used as time information.

For a resolution En [rpm] = 40 for NMOT resp. NZ_UM and Esystim [s/timer step] = 12,8 / 1000 000 the following applies:

```
            60          1                   1         60       1                  1    60 * 1000 000
NZMUL_UM = ---- * ------------------ * ------------ = -- * ------------------- * -- = ------------------ = 2021
             z     Esystim [s/step]     En [rpm]      58     12,8 / 1000 000     40    58 * 12,8 * 40
```

UFRLC 5.10 ETS monitoring concept: Monitoring of load signal for function monitoring

FDEF UFRLC 5.10 Function definition

Load signal surveillance through plausibility check with the load information from the function

```
-----------------------------------------------------------------------------------------------

                        +---------------+
rl -------------------->+  consistency  +---------------------------------------------------------> rl_um
                        +  check      +
rl_w ------------------>+               +---------------------------------------------------------> rl_w_um
                        +---------------+


                                             +--------------------+
rl_um ---------------------------+           |                    |
                                 |           |                    V Reset
                    +--------+   |           |            +----------------+
          +-----+   +  ----- +   V-  +----+  |   +--+     + RLC_T_UM       +     +---+-----+
rl_w_um ->+ :32 +-->+ /255   +-->o-->+ =0 +--+-->+  +o--->+        +------ +---->+ S +     +----> b_dcdis_um
          +-----+   +--------+       +----+      +--+     + -------+       +     +---+-----+      b_i_ska_um
                                                          +----------------+  +->+ R +     +      ei_rlc_um
                                                                              |  +---+-----+
C_ini ------------------------------------------------------------------------+
```

```
Load signal surveillance through plausibility check with the throttle valve information
---------------------------------------------------------------------------------------

                       +-------------------------------------------------------+
                       |                   +----------+                        |
           +---------+ |  +----+   +       +   0    / +                        V
iuipoti1 ->+ & 03FFh +--->+ :4 +--->o----->+ -------  +---------------------->o--o----------------------------------> ipsn_um
           +---------+ |  +----+    ^-     +----------+                    +->o
                       |            |    +--------------+  +---+           |
udkp1a -----------------------------+--->+ > IP1A_MX_UM +->+   +           |
                       |                 +--------------+  + & +-+         |
                 +-+   +--------------------------------->o+   + |  +---+  |  +----------------+
b_ehfs --------->+ +   |                                   +---+ +->+   +  |  + IPA_T_UM       +     +---+-----+
                 +v+---+                                            + v +---->+        +------ +---->+ S +     +----> b_dcdis_um
b_wdk2sel ------>+ +   |                                   +---+ +->+   +  |  + -------+       +     +---+-----+      b_i_ska_um
                 +-+   +---------------------------------->+   + |  +---+  |  +----------------+ +-->+ R +     +      ei_ipa_um
                                         +--------------+  + & +-+         |                     |   +---+-----+
udkp2a -----------------------------+--->+ < IP2A_MN_UM +->+   +           |                     |
                                    |    +--------------+  +---+           |                     |
                                    |      +----------+                    |                     |
           +---------+    +----+    v +    +   0    / +                    |                     |
iuipoti2 ->+ & 03FFh +--->+ :4 +--->o----->+ -------  +--------------------+                     |
           +---------+    +----+   -       +----------+                                          |
C_ini -------------------------------------------------------------------------------------------+
                                                                                                  +---+
b_ehfs ------------------------------------------------------------------------------------------>+   +
                                                                      +---------------------+     + v +----+
                                              rlipf_um -------------->+ rlip_um <= rlipf_um +---->+   +    |
                                                            +-------->+---------------------+     +---+    |
                                                            |  rlip_um                                     |
                                        +-----+-----------+ |     +-----------+   +-----------------+      |
ipsn_um  ------------------------------>+ SST +           + |     + RLIPTV_UM +   + ^      *        +      V    rlipf_um
                                        +-----+ KFRLIP_UM +-+-+-->+     +---- +-->+ |  * RLIPFIL_UM +---->o--o-+
nmot_um -------------------+----------->+ SST +           +   |   + ----+     +   + *------------>t +  +->o    |
                           |            +-----+-----------+   |   +-----------+   +-----------------+  |       |
                           |                                  |                               rlip_um  |       |
                           |                                  +----------------------------------------+       |
                       +---|-----------------------------------------------------------------------------------+
                +---+  |   |       +------------+   +---+
b_i_ska ------->+   +  |   +------>+ > NRLIP_UM +-->+   +
b_notlu ------->+   +  |           +------------+   + & +--------+    +---+
                + v +----------------------------->o+   +        +--->+   +
b_ub_ska ------>+   +  |   +--------------------+   +---+        |    + & +-------+
b_dcdis_um ---->+   +  +-->+ rlipf_um > rlzo_um +------+---------|-->o+   +       |
                +---+      +--------------------+      |         |    +---+       |
                                   rlzo_um ^           |         |                V Reset
           +------------+       +--------+ |           |         |  +---+  +----------------+
rl_um  --->+ * RL_MO_UM +--->o--+  ----- +-+           |         +->+   +  + RLIP_T_UM      +     +---+-----+
           +------------+    ^+ + / 255  +             |            + & +->+        +------ +---->+ S +     +----> b_dcdis_um
                             |  +--------+             +----------->+   +  + -------+       +     +---+-----+      b_i_ska_um
RL_BO_UM --------------------+                                      +---+  +----------------+ +-->+ R +     +      ei_rlip_um
                                                                                              |   +---+-----+
C_ini ----------------------------------------------------------------------------------------+
```

ABK UFRLC 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
IP1A_MX_UM			FW	Max. voltage for DK actual value pot. 1 at lower limit for function monitoring
IP2A_MN_UM			FW	Min. voltage for DK actual value pot. 2 at lower limit for function monitoring
IPA_T_UM			FW	Fault tolerance time for lower DK limit in invalid range for func. monitoring
KFRLIP_UM	IPSN_UM	NMOT_UM	KF	characteristic map for load signal calculation on throttle angle
NRLIP_UM			FW	Engine speed threshold for the rl/rlip comparison in function monitoring
RLC_T_UM			FW	Fault tolerance time for rl comparison with the function in function monitoring
RLIPFIL_UM			FW	Filter time constant for delayed load information rlipt_um in function monitor.
RLIPTV_UM			FW	Delay time for load information rlip_um in functioning monitoring
RLIP_T_UM			FW	Fault tolerance time for the rl/rlip comparison in function monitoring
RL_BO_UM			FW	Offset for tolerance straight line f(rl_um) for rlipf_um in function monitoring
RL_MO_UM			FW	Increase for tolerance straight line f(rl_um) for rlipf_um in function monitor.

Variable	Source	Type	Description
B_DCDIS_UM	UFRLC	AUS	Fault reaction information of the function monitoring
B_EHFS	DHFM	EIN	Condition substitude value main charge sensor
B_HFM	DHFM	EIN	Condition: HFM ready to measure
B_I_SKA	UFEING	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFRLC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NOTLU	UFEING	EIN	Request standby air driving from the function
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
C_INI	SWADAP	EIN	ECU-condition for intialisation
EI_IPA_UM	UFRLC	AUS	Irrevers. error bit for lower DK limit in invalid range of function monitoring
EI_RLC_UM	UFRLC	AUS	Irrevers. error bit for comparison of rl with the function in function monitor.
EI_RLIP_UM	UFRLC	AUS	Irreversible error bit for rl/rlip comparison in function monitoring
IPA_C_UM	UFRLC	LOK	Fault counter for lower DK limit in invalid range for function monitoring
IPSN_UM	UFRLC	LOK	Active DK actual-value potenti. info. without lower limit for function monitor.

Variable	Source	Type	Description
IUIPOTI1		EIN	ADC value incl. channel number throttle valve actual value potentiometer 1 loop
IUIPOTI2		EIN	ADC value incl. channel number throttle valve actual value potentiometer 2 loop
NMOT_UM	UFNC	EIN	engine speed in function monitoring
RL	SWADAP	EIN	relative air charge
RLC_C_UM	UFRLC	LOK	Error counter for rl comparison with the function in function monitoring
RLIPF_UM	UFRLC	LOK	Relative air charge from secondary load signal after low pass in funct. monito.
RLIP_UM	UFRLC	LOK	relative air charge from auxiliary load signal
RLZO_UM	UFRLC	LOK	Upper tolerance limit for rl from secondary load signal in function monitoring
RL_UM	UFRLC	LOK	Relative air charge in function monitoring
RL_W	EGFE	EIN	relative air charge (Word)
RL_W_UM	UFRLC	LOK	relative air charge (Word)
UDKP1A	BGDVE	EIN	sensor voltage poti 1 of throttle actuator at (lower) mechanical stop
UDKP2A	BGDVE	EIN	sensor voltage poti 2 of throttle actuator at (lower) mechanical stop

FW UFRLC 5.10 Fixed Values

Parameter	Value	Description
IP1A_MX_UM		Max. voltage for DK actual value pot. 1 at lower limit for function monitoring
IP2A_MN_UM		Min. voltage for DK actual value pot. 2 at lower limit for function monitoring
IPA_T_UM		Fault tolerance time for lower DK limit in invalid range for func. monitoring
NRLIP_UM		Engine speed threshold for the rl/rlip comparison in function monitoring
RLC_T_UM		Fault tolerance time for rl comparison with the function in function monitoring
RLIPFIL_UM		Filter time constant for delayed load information rlipt_um in function monitor.
RLIPTV_UM		Delay time for load information rlip_um in functioning monitoring
RLIP_T_UM		Fault tolerance time for the rl/rlip comparison in function monitoring
RL_BO_UM		Offset for tolerance straight line f(rl_um) for rlipf_um in function monitoring
RL_MO_UM		Increase for tolerance straight line f(rl_um) for rlipf_um in function monitor.

FB UFRLC 5.10 Detailed description of function

```
Load signal surveillance for function monitoring
-------------------------------------------------

The module must contribute to the control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40 ms time frame.


The load signal must be checked on the basis of redundant information.

Load signal surveillance through plausibility check of the load information from the function
---------------------------------------------------------------------------------------------

The consistency of the variables rl and rl_w generated in the SYNC frame is assured in that both variables are read out twice in
succession.
In the event that rl_w from the 1st read-out is identical to the rl_w from the 2nd read-out, then rl and rl_w from the 1st
read-out are transferred as the current variables, otherwise the rl and rl_w values from the 2nd read-out are taken as the current
variables.

It is detected by means of the RL comparison between the word variable used in the function and the 8-bit variable whether
a transfer of the load information has been performed such that the same load information
is used in the function as in function monitoring.
The load information in the function thereby serves as the basis for computing the injection time and the load information in
function monitoring for calculating the actual moment.
If the signals rl_w and rl converted to rl are not identical, then a fault tolerance time is run the elapse of which into the
final state will set the fault information, the fault response as well as the fault response information.
```

Load signal surveillance through plausibility check using throttle valve information

For the transfer of the input signals for determination of the load information from the DK, a check is made for the valid voltage range at the lower limit of the selected DK sensor.
Exceeding the threshold for the lower limit of the DK sensor 1 for DK sensor 2 not selected, or falling below the threshold for the lower limit of DK sensor 2 for DK sensor 2 selected will lead to initiation of a fault tolerance time.
The fault tolerance time is deleted if there is no evidence of the threshold having been violated.
The final status of the fault tolerance time sets the fault information, the fault response as well as the fault response information.

The throttle valve position can be converted into rl information by using the speed information.
As the throttle valve information is faster than the load information from the load sensor, the load information determined from the DK position for the check of an upper tolerance limit is delayed over a low pass for increasing load information from the DK.
The comparison of both sets of load information is performed with the help of an upper limit for the load information from the DK, which is calculated as a dependency of the currently effective load information.
The currently effective load information rl_um is thereby determined from the main load sensor or, if this has been detected as being discrepant, from the first DK sensor.
Therefore the comparison variable rlip_um from ipsn_um is switched over to the second DK sensor for a load sensor detected as being defective or for a DK sensor standby function.
If the load information is generated from the auxiliary load signal DK sensor 1, then the lag element and the low pass are shut down because the comparison of both sets of DK information and their load information is present at the same time.
If the deviation is greater than the permissible tolerance, which is determined by possible influences which cannot be eliminated, then a fault tolerance time is initiated.
The fault tolerance time is deleted if the load information from the DK is within permissible tolerances.
One restriction for the upper limit straight line rlzo_um = f(rl_um) for rlipf_um, i.e. the rl from the DK actual value information, is permissible, as a discrepantly high load signal leads to a response by the moment comparison and thus does not have to be taken into consideration.
In addition to this, the filter settings would be critical for a comparison of the lower values.

The fault counter is halted if the engine speed falls below a defined fixed threshold, until this threshold is surpassed again.
The load information is not significant below this speed threshold from a technical safety viewpoint and the computation from the throttle valve information can include errors under certain circumstances.
Furthermore, the fault counter is halted for an active undervoltage shut-off because the DK information can no longer be evaluated with reliability.

The final status of the fault tolerance time sets the fault information, the fault response as well as the fault response information.

If the filter is active, the drum storage for the dead time as well as the starting value for the low-pass filter must be occupied beforehand with the currently determined load value.

APP UFRLC 5.10 Application hint

The data in function monitoring are part of the surveillance concept and therefore may not be arbitrarily changed.

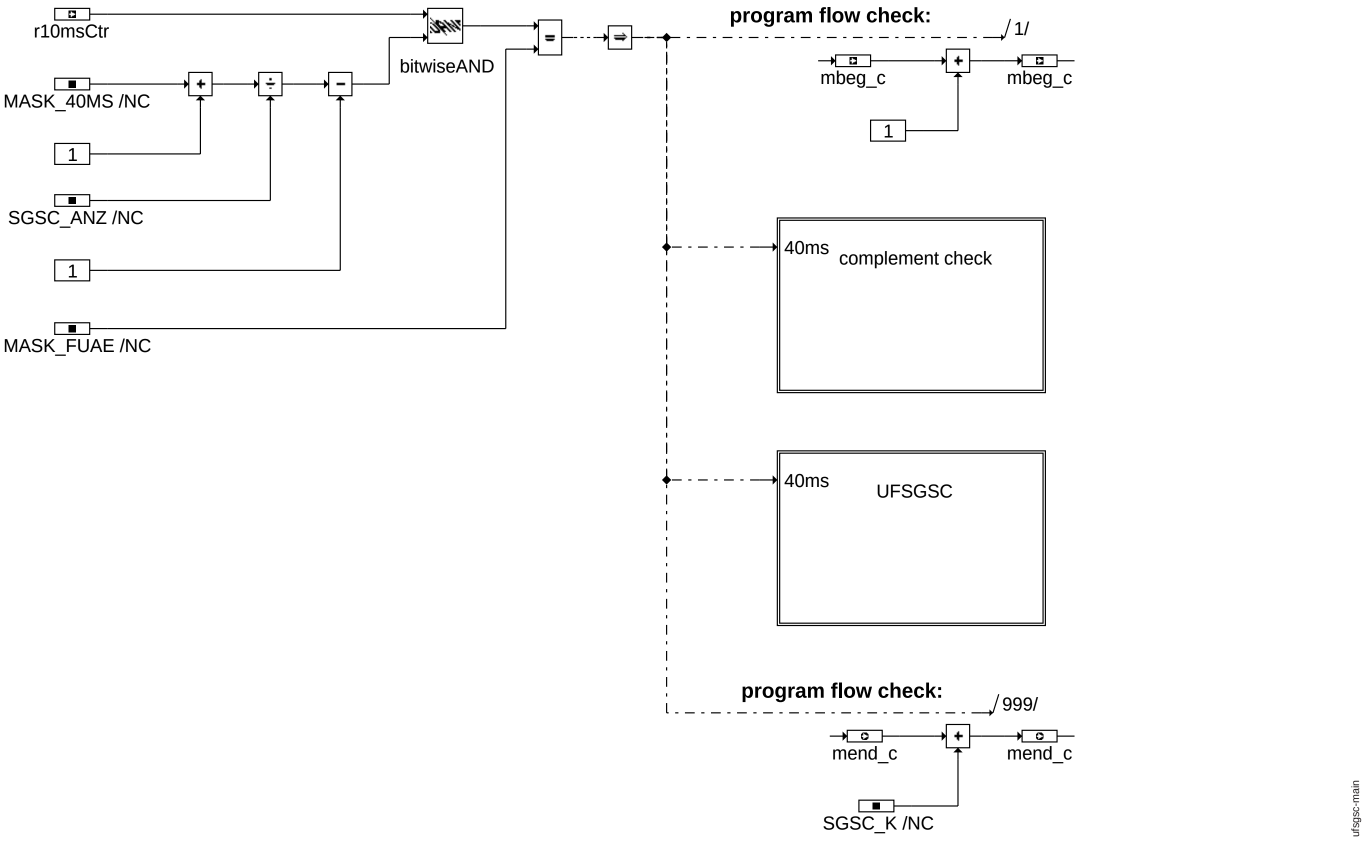
Label	Source	Type	Designation
b_dcdis_um		VAR/AUS	Fault response information (shut-off of the DK actuator output stage) of function monitoring
b_wdk2sel		VAR/EIN	Fault at DK potentiometer 1, DK sensor standby function with DK potentiometer 2
b_i_ska_um		VAR/AUS	Function monitoring fault response irrev. SKA (safety fuel shut-off)
b_ehfs		VAR/EIN	Condition substitude value main charge sensor
b_ub_ska		VAR/EIN	Battery voltage not OK, undervoltage shut-off of the DK actuator output stage active
ei_ipa_um		VAR/AUS	Irrev. fault bit for lower DK limit in invalid range in function monitoring
ei_rlc_um		VAR/AUS	Irreversible fault bit for rl comparison with the function
ei_rlip_um		VAR/AUS	Irreversible fault bit for rl/rlip comparison
ipa_c_um		VAR/LOK	Fault counter for lower DK limit in invalid range for function monitoring
ipsn_um		VAR/LOK	Active DK actual value potentiometer information converted to rising straight line without lower limit
iuipoti1		VAR/EIN	ADC value incl. channel number for throttle valve potentiometer 1
iuipoti2		VAR/EIN	ADC value incl. channel number for throttle valve potentiometer 2
nmot_um		VAR/EIN	Engine speed for function monitoring
rlc_c_um		VAR/LOK	Fault counter for rl comparison with the function
rlip_um		VAR/LOK	rl information from the DK actual value potentiometer information for function monitoring
rlip_c_um		VAR/LOK	Fault counter for plausibility check between rl_um and rlipf_um
rlipf_um		VAR/LOK	rl from DK actual value potentiometer after the low-pass filter for function monitoring
rlipf_low_um		VAR/LOK	Fine adjustment of rl from DK actual value potentiometer after TP for function monitoring
rlzo_um		VAR/LOK	Tolerance limit for rl from DK actual value potentiometer as a function of valid rl_um
rl		VAR/EIN	Relative air charge, i.e. load information rl from the function
rl_w		VAR/EIN	Relative air charge, i.e. load information rl_w from the function
rl_um		VAR/LOK	Load information rl from the function for function monitoring
rl_w_um		VAR/LOK	load information rl_w from the function for function monitoring
udkp1a		VAR/EIN	Voltage throttle valve potentiometer 1 at the (lower) limit
udkp2a		VAR/EIN	Voltage throttle valve potentiometer 2 at the (lower) limit

Label	Dependency	Type	Designation
IPA_T_UM		FW	Fault tolerance time for lower DK limit in the invalid range for function monitoring
IP1A_MX_UM		FW	Max. voltage for DK actual value potentiometer 1 at the lower limit for function monitoring
IP2A_MN_UM		FW	Min. voltage for DK actual value potentiometer 2 at the lower limit for function monitoring
KFRLIP_UM	ipsn_um, nmot_um	KF	Performance characteristics for rl information
NRLIP_UM		FW	Engine speed threshold for the rl comparison
RLC_T_UM		FW	Fault tolerance time for rl comparison with the function
RLIP_T_UM		FW	Fault tolerance time for plausibility check between rl_um and rlipf_um
RLIPTV_UM		FW	Delay time for load information rlip_um
RLIPFIL_UM		FW	Filter time constant for delayed load information rlipt_um
RL_MO_UM		FW	Inclination for tolerance straight line for rlipf_um as a dependency of rl_um
RL_BO_UM		FW	Offset for tolerance straight line for rlipf_um as a dependency of rl_um

UFSGSC 4.10 EGAS-monitoring concept: SGS-intervention-monitoring for the function overview

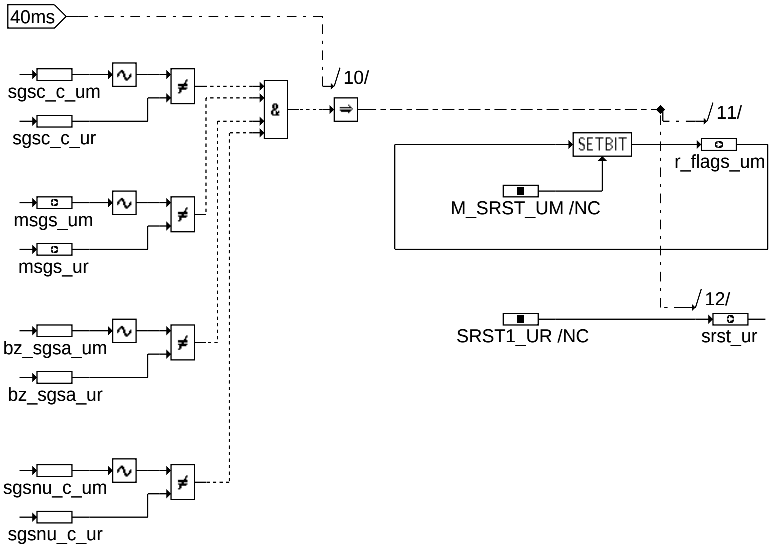
FDEF UFSGSC 4.10 Function definition

Overview:



ufsgsc-main

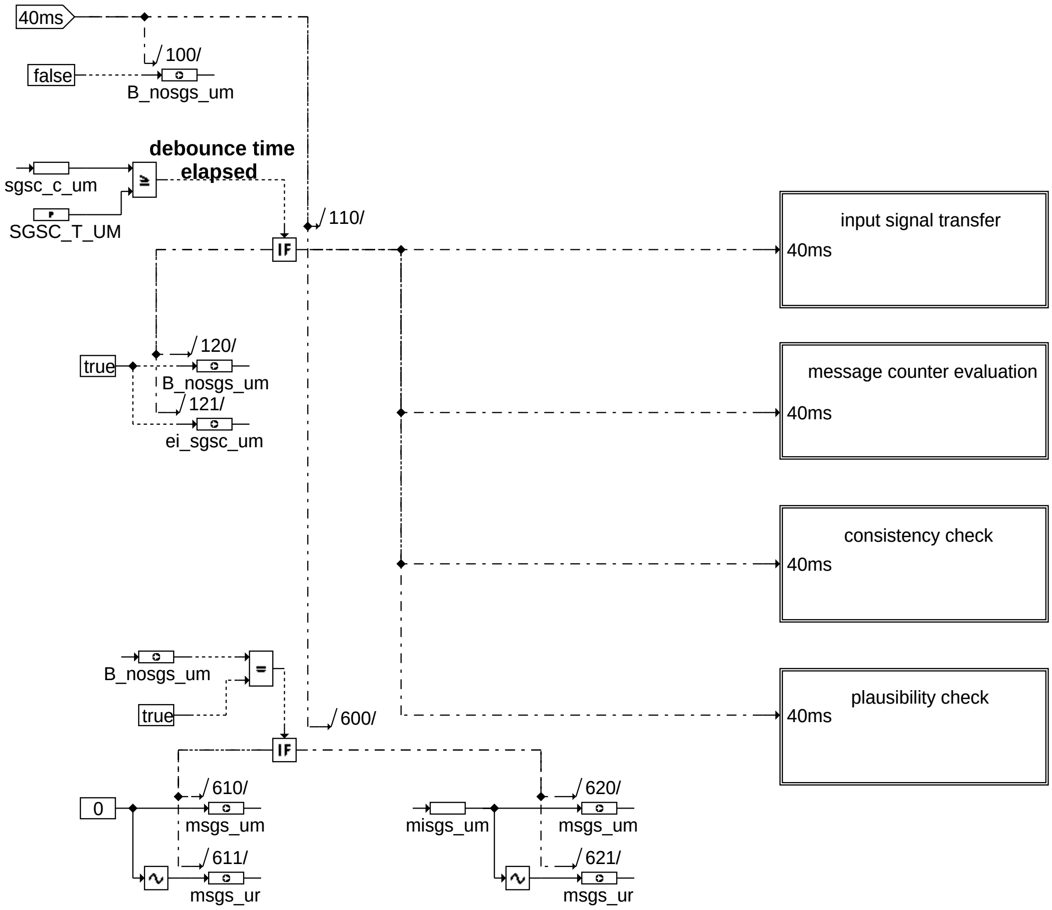
```
Complement check:
-----------------
```



ufsgsc-complement-check

ufsgsc-complement-check

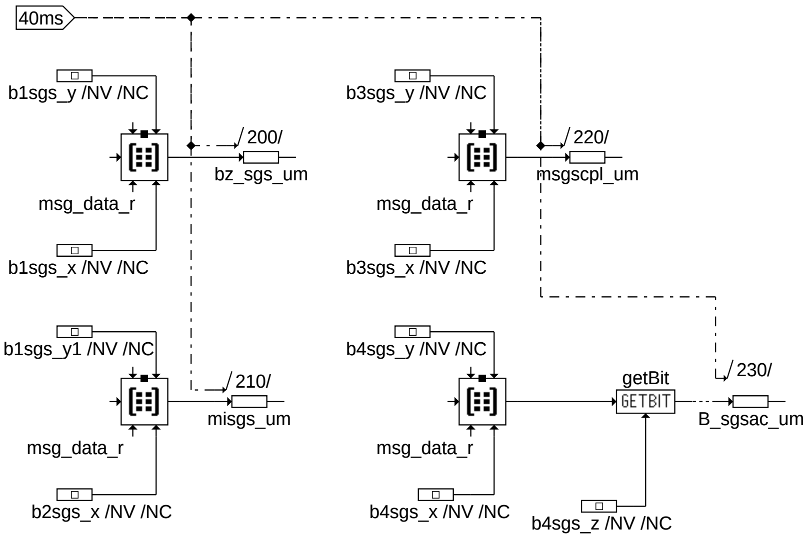
```
SGS-Monitoring:
----------------
```



ufsgsc-ufsgsc

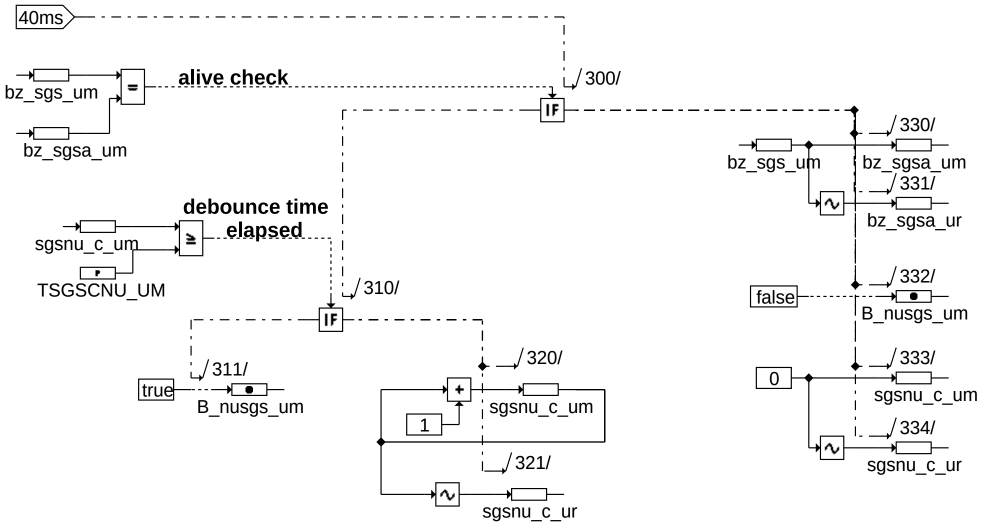
ufsgsc-ufsgsc

```
Input signal transfer:
----------------------
```



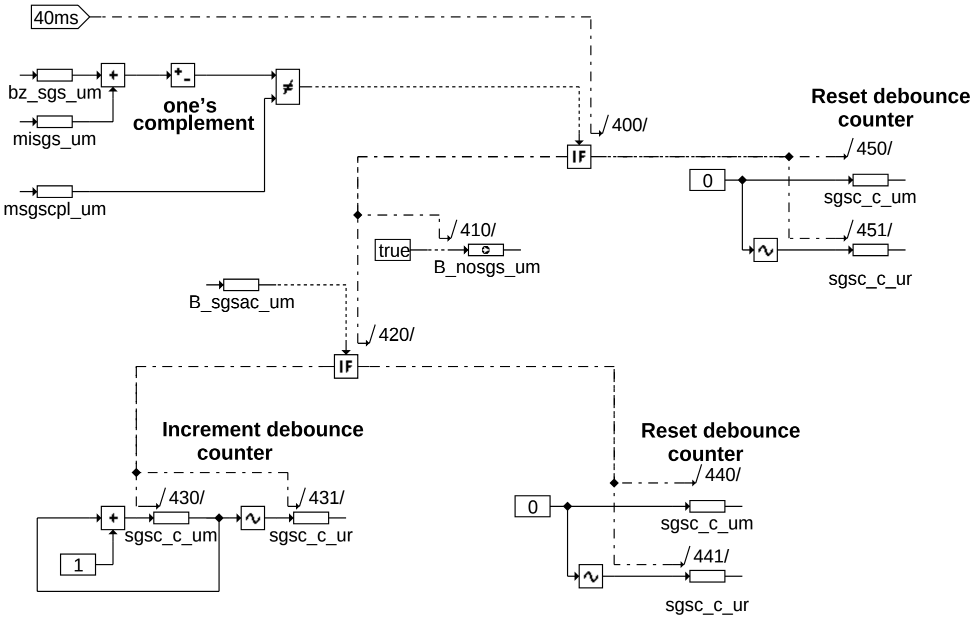
ufsgsc-input-signal-transfer

```
Alive check:
------------
```



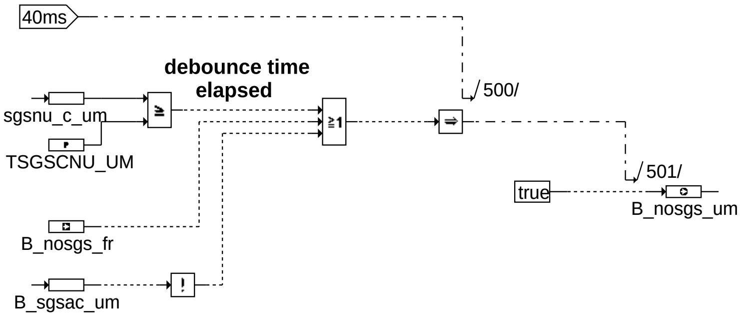
ufsgsc-message-counter-evaluation

```
Consistency check:
------------------
```



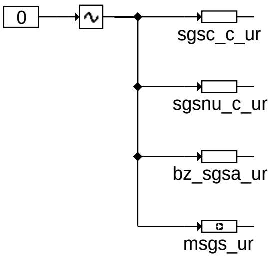
ufsgsc-consistency-check

```
Plausibility check:
-------------------
```



ufsgsc-plausibility-check

```
Initialization phase:
---------------------
```



ufsgsc-ini

FB UFSGSC 4.10 Detailed description of function

SGS-intervention-monitoring of function surveillance

The module must contribute to program flow check (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

The transmission data arrive via CAN in the functions computer and are made available for function surveillance.
The data are read out directly from the CAN buffer.

b1sgs_x Constant for CAN-buffer for SGS-message conter
b1sgs_y Constant for CAN-buffer for SGS-message conter
b2sgs_x Constant for CAN-buffer for SGS-intervention
b2sgs_y Constant for CAN-buffer for SGS-intervention
b3sgs_x Constant for CAN-buffer for SGS-surveillance
b3sgs_y Constant for CAN-buffer for SGS-surveillance
b4sgs_x Constant for CAN-buffer for SGS-Intervention activ
b4sgs_y Constant for CAN-buffer for SGS-Intervention activ
b4sgs_z Constant for CAN-buffer for SGS-Intervention activ (bitposition)

The torque msgs_um ist calculated by value and complement.

The SGS-Intervention is allowed, if
1. the SGS-Intervention is also valid in Level I
2. the message-counter is updated in the right way
3. there is a valid SGS-Request (torque request by the transmission)
4. the message is consistent
5. the SGS-Intervention is not irreversible vorbidden in Level II

The flag B_nosgs_um is deleted, if all these points are true. The value misgs_um is coppied to msgs_um.
Otherwise, the value msgs_um is set to 0.

If the message is inconsistent, the torque msgs_um remains to 0.
The identifier ei_sgsc_um is set following elapse of the error tolerance time.

Monitoring for updatedness

- The message counter bz_sgs is incremented from the transmitting control unit. If the message counter is incremented every 20 ms, then the old and the new message counters differ by at least one and by a maximum of two in each 40-ms test cycle.

For detection of discrepant updating, i.e. in case the old and the new message countesr do not differ, there is only one reversible error reaction active since an interruption in the CAN message shall not lead to a ban of the function until "Ignition off".

Monitoring for plausibility and message consistency

The Message counter is added to the torque Request and compared with the complement of the value mksgscpl.
This value is clculated by the transmitting ECU by the same way. If there is a inconsistence,the SGS-Intervention is vorbidden by Level II.
If the SGS-Intervention (intervention by the transmission) is not carried out by Level I, the SGS-Torque request will not be monitored in Level II.

ABK UFSGSC 4.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MASK_40MS			SYS (REF)	40ms mask for function monitoring
MASK_FUAE			SYS (REF)	Mask for task splitting in monitoring functions (part 1: inputs)
M_SRST_UM			SYS (REF)	Mask B_srst_um - information SW-reset from cyclic RAM-check
SGSC_ANZ			SYS (REF)	number of module calls of %UFSGSC (refer to %URPAK) in the monitoring function
SGSC_K			SYS (REF)	Constant for module %UFSGSC (see %URPAK)
SGSC_T_UM			FW	Fault time for SGS intervention surveillance in function monitoring
SRST1_UR			SYS (REF)	value for RAM data redundancy of bit B_SRST_UM = 1
TSGSCNU_UM			FW	Debounce time for information interuption

Variable	Source	Type	Description
BZ_SGSA_UM	UFSGSC	LOK	SGS-message counter from former calculation
BZ_SGSA_UR	UFSGSC	LOK	RAM data redundancy for bz_sgsa_um
BZ_SGS_UM	UFSGSC	LOK	SGS-message counter for function monitoring
B_NOSGS_FR		EIN	No SGS intervention from FR
B_NOSGS_UM	UFSGSC	AUS	SGS moment required not transferred to function monitoring
B_NUSGS_UM	UFSGSC	AUS	Condition for discrepant updating
B_SGSAC_UM	UFSGSC	LOK	Condition SGS intervention activ for function monitoring
EI_SGSC_UM	UFSGSC	AUS	Irreversible error bit for SGS surveillance function monitoring
MBEG_C	UFSGSC	AUS	module-beginning counter for check of the program run (%URPAK)

Variable	Source	Type	Description
MEND_C	UFSGSC	AUS	module-end counter for check of program run (%URPAK)
MISGS_UM	UFSGSC	LOK	indicated torque request from SGS for monitoring system
MSGSCPL_UM	UFSGSC	LOK	One's complement of sum of torque demand and message counter
MSGS_UM	UFSGSC	AUS	desired torque of gear box control at monitoring function
MSGS_UR	UFSGSC	AUS	double storage: msgs_um
MSG_DATA_R		EIN	can message buffer
R10MSCTR		EIN	10ms task-counter of the function
R_FLAGS_UM	UFSGSC	AUS	byte for fault reactions of function monitoring
SGSC_C_UM	UFSGSC	LOK	debounce counter for transmission monitoring in function monitoring
SGSC_C_UR	UFSGSC	LOK	Double storage: sgsc_c_um
SGSNU_C_UM	UFSGSC	LOK	Debounce counter for detected information interuption in level 2
SGSNU_C_UR	UFSGSC	LOK	Double storage: Debounce counter for detected information interuption in level 2
SRST_UR	UFSGSC	AUS	RAM data redundancy for Bit B_srst_um

FW UFSGSC 4.10 Fixed Values

Parameter	Value	Description
SGSC_T_UM		Fault time for SGS intervention surveillance in function monitoring
TSGSCNU_UM		Debounce time for information interuption

APP UFSGSC 4.10 Application hint

```
The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

It is important that monitoring in the function (e.g. DCAN, CAN, DCAS) and the monitoring in function surveillance are mutually
compatible so that the function does not execute the MSR torque request if a message error has been detected in the function or
during function surveillance.
```

UFZWC 2.20 ETS monitoring concept: Monitoring of ignition angle for function monitoring

FDEF UFZWC 2.20 Function definition

```
Variable from the SYNC matrix  ---> | <-------------------------   %UFZWC - Ignition-timing monitoring   -----------------------> |



                                                           zwout_um (t-1) ---------o\
                                                                                    |\
        +-------------------------------------------------------------------------o | o---------------------------> zwout_um
        |                                                                           |
zwout   |                               +---------+                         +-----+ |   +----------+
------+-+------------------------------>| Consis- |------------------------>|     | |   | ZWC_T_UM |   +-+-----+
      |  +-------------------+ zwoutcpl | tency   |  +-------------------+  |  =  |-+->o|     +--- |-->|S|     |--> ei_zwc_um
      +->| Single complement |--------->| check   |->| Single complement |->|     |     | ----+    |   | |     |    b_dcdis_um
         +-------------------+          +---------+  +-------------------+  +-----+     +----------+   +-+-----+    b_i_ska_um
                                C_ini                                                                  | |     |
                                ---------------------------------------------------------------------->|R|     |
                                                                                                       +-+-----+
```

ABK UFZWC 2.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ZWC_T_UM			FW	Fault tolerance time for ignition angle monitoring in function monitoring.
ZYLANZ_UM			FW	Cylinder number for ignition angle monitoring in function monitoring

Variable	Source	Type	Description
B_DCDIS_UM	UFZWC	AUS	Fault reaction information of the function monitoring
B_I_SKA_UM	UFZWC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
EI_ZWC_UM	UFZWC	AUS	irrevers. error bit for ignition angle monitoring from function monitoring
ZWC_C_UM	UFZWC	LOK	Error counter for ignition angle monitoring in function monitoring
ZWOUT	ZUE	EIN	Ignition angle output value
ZWOUTCPL	ZUE	EIN	Single complement of the ignition angle for function monitoring
ZWOUT_UM	UFZWC	AUS	Ignition angle in function monitoring

FW UFZWC 2.20 Fixed Values

Parameter	Value	Description
ZWC_T_UM		Fault tolerance time for ignition angle monitoring in function monitoring.
ZYLANZ_UM		Cylinder number for ignition angle monitoring in function monitoring

FB UFZWC 2.20 Detailed description of function

Ignition-timing monitoring for function surveillance

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

Statistically, there is an adjustment of the ignition timing to retardation in certain operating states. Such ignition-timing adjustments reduce the engine torque given as an efficiency of 100 %, to e.g. 70 %.

The efficiency or ignition timing must also be taken into account as an input variable of function surveillance because function surveillance executes a torque comparison.

In the event that the ignition timing is acting in function surveillance with an efficiency of e.g. 70 %, and in function surveillance a discrepant ignition timing is taken for an efficiency of e.g. 50 % (value is incorrect from overwriting from another position), then there is a dormant error present. For function surveillance, this means a detected actual torque that is too low for the torque comparison.
If an additional error then occurs in the function that leads to an increase in performance, then function surveillance would not detect this error.
Monitoring the ignition timing is necessary for this reason.
This cannot be interpreted as a double error because without being able to detect the dormant error that can exist over many driving cycles, the performance-increasing error applies in the function as the prime error.

Requirement

Double storage of the ignition timing is implemented in the SYNC matrix, in that the complement of the current ignition timing zwout (refer to %ZUE) is saved as well after zwoutcpl. A writability check (according to %URMEM) is not necessary because the ignition timing is acting directly as an output variable and the absence of writability does not cause an update of the ignition timing.

Ignition-timing monitoring by plausibility of the double storage

Consistency check:

Consistency is assured for the variables zwout and zwoutcpl generated in the SYNC matrix in that both variables are read out twice in succession.
In case zwout from the 1st reading is identical with zwout from the 2nd reading, then zwout, zwoutcpl from the first reading are transferred as the currently applicable variables; otherwise zwout and zwoutcpl from the 2nd reading are taken as the current variables.

Double-storage check:

Both of the current variables are compared with one another, whereby the one variable must be the complement of the other variable.
In the event of an error, the ignition timing zwout_um is not updated for function surveillance and the error counter is incremented by ZYLANZ_UM (number of cylinders). An incrementation by ZYLANZ_UM is necessary in order that a cylinder-specific error will lead to a detection of the error.
The ignition timing zwout_um is otherwise transferred from the current Variable zwout for function surveillance and the error counter is decremented by 1 to the error-counter status of 0.

APP UFZWC 2.20 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
b_dcdis_um		VAR/AUS	Error-reaction information (shutdown of the throttle-valve actuator output stage) of function surveillance
b_i_ska_um		VAR/AUS	Function surveillance error reaction irrev. SKA (safety fuel shutdown)
ei_zwc_um		VAR/AUS	Irreversible error bit by ignition-timing plausibility of function surveillance
zwout		VAR/EIN	Ignition timing for the function
zwoutcpl		VAR/EIN	Ignition-timimg complement for plausibility of the ignition timing in functional surveillance
zwout_um		VAR/AUS	Ignition timing for function surveillance
zwc_c_um		VAR/LOK	Error counter in ignition-timing monitoring

Label	Dependency	Type	Designation
ZYLANZ_UM		FW	Number of cylinders for monitoring the ignition timing in function surveillance
ZWC_T_UM		FW	Error tolerance time in ignition-timing monitoring

UFNSC 2.10 ETS monitoring concept: Afterstart monitoring for function monitoring

FDEF UFNSC 2.10 Function definition

```
                                        +---+
              +--------------+          +   +     +---+       +----------------+
tmot_um ----->+ > TMNSMN_UM  +--------->+   +---->+   +       + NSOF_T_UM      +    +---+
              +--------------+          +   +     + & +-+---->+           +--- +--->+   +    +---+-----+
                                        + v + +->o+   + |     + ----------+    +    + v +--->+ S +     +---> b_nsend_um
              +--------------+          +   + |   +---+ |     +----------------+ +->+   +    +---+-----+
tans_um ----->+ > TANSMN_UM  +--------->+   + |         |             ^ Reset    |  +---+ +->+ R +     +
              +--------------+          +   + |         |     +---+   |          |        |  +---+-----+
                                        +---+ |         +--->o+   +   |          |        |
                                              |         |     + v +---+          |        |
                                              |         | +-->+   +              |        |
                                              |         | |   +---+              |        |              +---+-----+
                                              |         +----------------------------------------------->o+ S +     +--> b_mzns_um
                                              |           |                      |        |              +---+-----+
                                    +---------+--------------------------------------------------------->+ R +     +
                                    |   +---+             |   +----------------+ |        |              +---+-----+
                                  +---->+   +             |   + NSC_T_UM       + |        |
                                  | |   + & +---------------->+           +--- +-+        |
                                  | +->o+   +             |   + ----------+    +          |
                                  | |   +---+             |   +----------------+          |
                                  | |                     |           ^ Reset             |
                                  | |   +---+             |           |                   |
           b_nsakt_um ------------+--->o+   +             +-----------+                   |
                                    |   +   +             |                               |  +---+-----+
           b_nsend_um --------------+->o+ & +----------------------------------------------->+ S +     +---> b_nsakt_um
              +--------------+          +   +             |                               |  +---+-----+
           +->+ > N_STEND_UM +--------->+   +             +-------------------------------+->+ R +     +
           +  +--------------+          +---+             |                                  +---+-----+
nmot_um ---+                                              |
           +  +--------------+          +---+             |
           +->+ < N_START_UM +--------->+   +             |
              +--------------+          + v +-------------+
C_ini --------------------------------->+   +
                                        +---+
```

ABK UFNSC 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
NSC_T_UM			FW	After-start monitoring time for the watchdog function
NSOF_T_UM			FW	Debouncing time for the switch-off of the after-start expansion
N_START_UM			FW	Engine speed threshold for underspeed exit for the watchdog function
N_STEND_UM			FW	Engine speed threshold for end of start in the watchdog function
TANSMN_UM			FW	Intake air temp. threshold for after-start expansion in the watchdog function
TMNSMN_UM			FW	Engine temp. threshold for the after-start expansion in the watchdog function

Variable	Source	Type	Description
B_MZNS_UM	UFNSC	AUS	afterstart torque increase of ETC-monitoring is active
B_NSAKT_UM	UFNSC	LOK	After-start active for the watchdog function
B_NSEND_UM	UFNSC	LOK	After-time monitoring time elapsed for the watchdog function
C_INI	SWADAP	EIN	ECU-condition for intialisation
NMOT_UM	UFNC	EIN	engine speed in function monitoring
TANS_UM	UFEING	EIN	Intake air temperature of the watchdog function
TMOT_UM	UFEING	EIN	Engine temperature in the watchdog function

FW UFNSC 2.10 Fixed Values

Parameter	Value	Description
NSC_T_UM		After-start monitoring time for the watchdog function
NSOF_T_UM		Debouncing time for the switch-off of the after-start expansion
N_START_UM		Engine speed threshold for underspeed exit for the watchdog function
N_STEND_UM		Engine speed threshold for end of start in the watchdog function
TANSMN_UM		Intake air temp. threshold for after-start expansion in the watchdog function
TMNSMN_UM		Engine temp. threshold for the after-start expansion in the watchdog function

FB UFNSC 2.10 Detailed description of function

After-start monitoring for the watchdog function

The module must be of assistance in the check of the program run (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The function is to be processed in the 40ms grid.

In order to improve the monitoring quality it is possible to switch to an increased permissible torque (see %UFMZUL) during the after-start dependent on the engine and intake air temperature.

The after-start expansion becomes active, as soon as the conditions for B_mzns_um are fulfilled, that means as soon as
* the identifier after-start monitoring times elapsed B_nsend_um is not set (B_nsakt_um is set) and
* the engine temperature is less than the threshold TMNSMN_UM and
* the air temperature is less than the threshold TANSMN_UM.
The after-start monitoring time (NSC_T_UM) is started, if the identifier after-start active (b_nsakt_um) is being set.

The irreversible switchover from after-start to normal operation is performed with the resetting of the condition B_mzns_um after a debouncing time NSOF_T_UM, if
* the engine temperature is greater than the threshold TMNSMN_UM or
* the air temperature is greater than the threshold TANSMN_UM.
Furthermore the switchover is performed compulsorily after the setting of the identifier after-start monitoring time elapsed (b_nsend_um).
The transition at the end of the after-start is filtered (see %UFMZF).

In case of an underspeed exit, i.e. engine speed < threshold for start N_START_UM, the following actions are performed:
  - Clearing of the debouncing time
  - Clearing of the after-start monitoring time
  - Clearing of the identifier after-start monitoring time elapsed
  - Clearing of the identifier after-start active

Cross-reference: This function of the watchdog function corresponds to the after-start detection on the functional level in %MDZUL.

APP UFNSC 2.10 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_mzns_um		VAR/AUS	After-start expansion of the perm. torque active for watchdog function
b_nsakt_um		VAR/LOK	After-start active for the watchdog function
b_nsend_um		VAR/LOK	After-start monitoring time elapsed for the watchdog function
tans_um		VAR/EIN	Intake air temperature in the watchdog function
tmot_um		VAR/EIN	Engine temperature in the watchdog function
nmot_um		VAR/EIN	Engine speed for the watchdog function

Label	Dependency	Type	Description
NSOF_T_UM		FW	Debouncing time for switch-off of after-start expansion in the watchdog function
NSC_T_UM		FW	After-start monitoring time for the watchdog function
N_START_UM		FW	Engine speed threshold for underspeed exit for the watchdog function
N_STEND_UM		FW	Engine speed threshold for end of start for the watchdog function

UFFGRC 1.30 ETS monitoring concept: Monitoring of Cruise Control of function monitoring

FDEF UFFGRC 1.30 Function definition

```
                                            +---+
b_fgren_um -------------------------------->+   +
                                            +   +
b_brems_um ------------------------------->o+   +                             b_fgr_um
                                            + & +--+---------------------------------->
                                            +   +  |
             +-----------+                  +   +  |
vfzg_um  --->+ > VMIN_UM +----------------->+   +  |
             +-----------+                  +---+  |   +---+
                                                   +-->+   +
                                                       + & +-----+
b_fgr ------------------------------------------------>+   +     |
                                                       +---+     |
                                                                 V            mfgr_um
00 -------------------------------------------------------------o--o------------------>
mifa_um --------------------------------------------------------o
```

ABK UFFGRC 1.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
VMIN_UM			FW	Minimum speed for FGR operation in function monitoring

Variable	Source	Type	Description
B_BREMS_UM	UFFGRE	EIN	condition of function monitoring: brake pedal pressed
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGREN_UM	UFFGRE	EIN	CC/ACC turn-on from control lever valid in function monitoring
B_FGR_UM	UFFGRC	AUS	CC/ACC torque intervention in function monitoring permitted
MFGR_UM	UFFGRC	AUS	Torque request from cruise control for function monitoring
MIFA_UM		EIN	FGR-/ACC- or driver requested torque of function for function monitoring
VFZG_UM		EIN	engine speed in function monitoring

FW UFFGRC 1.30 Fixed Values

Parameter	Value	Description
VMIN_UM		Minimum speed for FGR operation in function monitoring

FB UFFGRC 1.30 Detailed description of function

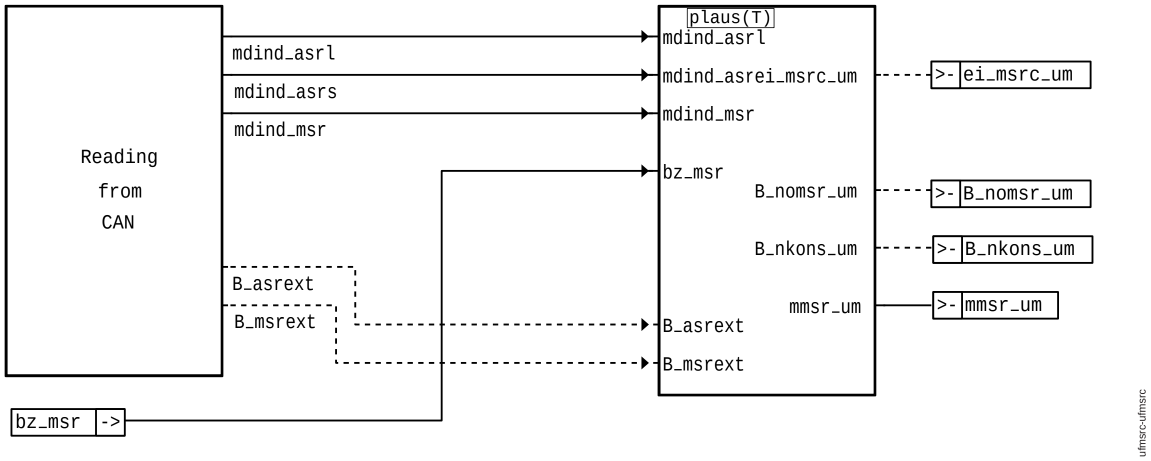
```
Monitoring an increasing intervention in the function surveillance
------------------------------------------------------------------

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.


The increasing torque intervention is only then transferred from the function when this has been detected as being permissible on
the basis on an independent assessment.
A check is made in order to enable an FGR-/ACC intervention as to whether a valid turn-on condition was present and that no
shutdown is pending.
A check is made in addition to this whether the brake information is inactive and the minimum speed has been surpassed.
Furthermore, the FGR/ACC torque request is only then transferred into the torque coordination of function surveillance
when FGR/ACC torque intervention is active in the function.
```

APP UFFGRC 1.30 Application hint

```
The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.


Label           Source                  Art     Designation
-----------------------------------------------------------
b_fgr                                   VAR/EIN FGR/ACC torque intervention active
b_fgren_um                              VAR/EIN FGR turn-on condition from operating lever valid
                                                without FGR shutdown being present from the function
b_fgr_um                                VAR/AUS FGR/ACC torque intervention permitted in function surveillance
b_brems_um                              VAR/EIN Redundant brake information active in function surveillance
mifa_um                                 VAR/EIN FGR-/ACC or driver-requested torque from function in function surveillance
mfgr_um                                 VAR/AUS Permissible FGR torque for function surveillance
vfzg_um                                 VAR/EIN Vehicle speed in function surveillance

Label           Dependency              Art     Designation
-----------------------------------------------------------
VMIN_UM                                 FW      Minimum speed for FGR operation in function surveillance
```

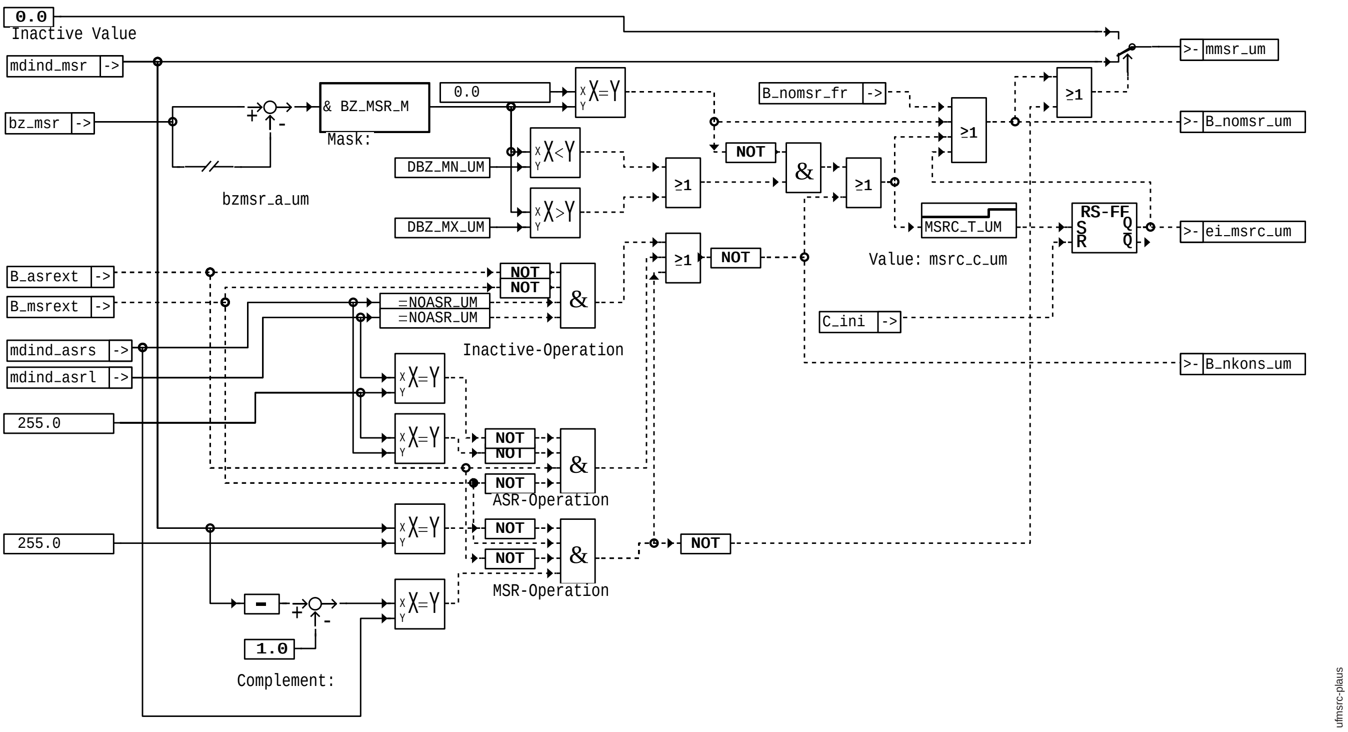
UFMSRC 5.10 ETS monitoring concept: MSR intervention surveillance for function monitoring

FDEF UFMSRC 5.10 Function definition



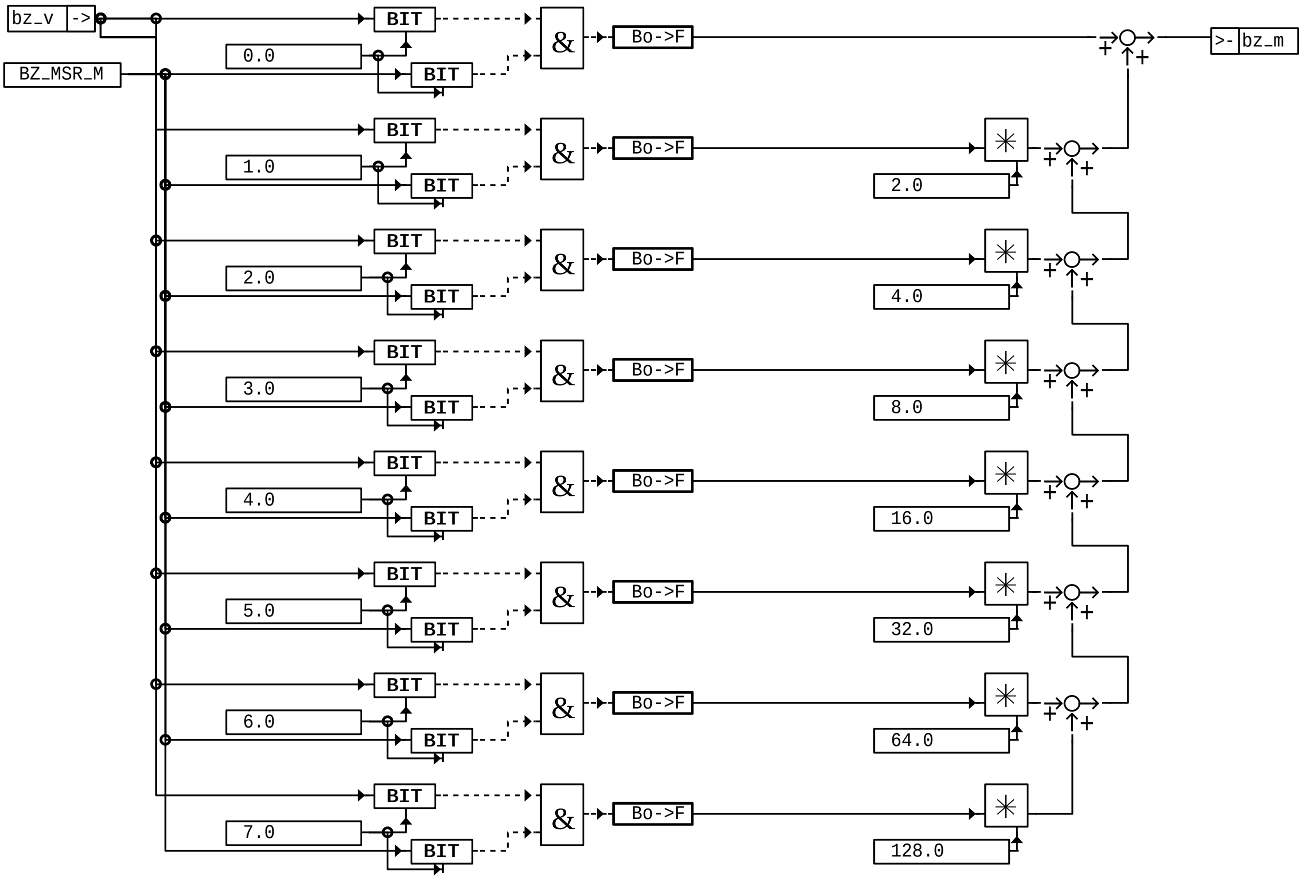
ufmsrc-ufmsrc

```
Overview
--------
```



ufmsrc-plaus

Plausibility Check



ufmsrc-mask

ufmsrc-mask

Mask (Operation Bit by Bit And)

FB UFMSRC 5.10 Detailed description of function

MSR intervention-monitoring of function surveillance

The module must contribute to program-flow control (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

The ASR/MSR data arrive via CAN in the functions computer and are made available for function surveillance without further processing. The data are read out directly from the CAN buffer.

The identifier ei_msrc_um is set following elapse of the error tolerance time.

The bit b_nomsr_um is deleted if the ASR/MSR data are error-free. The MSR value specified for the torque, md_ind_msr, is then transferred into the incrementation value mmsr_um for 'MSR-intervention plausible'. The MSR torque-increase request mmsr_um is otherwise set to 0.

Monitoring for updatedness

- The 4-bit message counter bz_msr is incremented from the transmitting control unit. If the message counter is incremented every 10 ms, then the old and the new message counters differ by at least three and by a maximum of five in each 40-ms test cycle. If the message counter is incremented by the control unit every 20 ms, then the old and the new message counter differs by at least one and by a maximum of three in each 40-ms test cycle.

For detection of discrepant updating, i.e. in case the old and the new message counters do not differ, there is only one reversible error reaction active since an interruption in the CAN message shall not lead to a ban of the function until 'Ignition off'.

Monitoring for plausibility and message consistency

1) ASR active message (b_asrext=1)
   - MSR inactive (b_msrext=0)
   - miasrl_can

255
   - miasrs_can

255

2) MSR active message (b_msrext=1)
   - ASR inactive (b_asrext=0)
   - ASR torque requirement for rapid intervention for assurance of the MSR values mdind_asrs = CPL (mdind_msr)
   - mimsr_can

255

3) Inactive message (b_asrext=0 and b_msrext=0)
   - ASR torque requirement for rapid intervention inactive, i.e. mdind_asrs = NOASR_UM
   - ASR torque requirement for intervention via air path inactive, i.e. mdind_asrl = NOASR_UM

ABK UFMSRC 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BZ_MSR_M			FW	MSR message counter mask (0Fh for 4-bit message counter)
DBZ_MN_UM			FW	Smallest permissible delta of the message counter
DBZ_MX_UM			FW	Largest permissible delta of the message counter
MSRC_T_UM			FW	Error tolerance time for monitoring of MSR intervention in function monitoring
NOASR_UM			FW	Inactive mask for ASR

Variable	Source	Type	Description
BZMSR_A_UM	UFMSRC	LOK	Old MSR message counter
BZ_M	UFMSRC	DOK	CAN message counter after masking
BZ_MSR		EIN	MSR message counter
BZ_V	UFMSRC	DOK	message counter prior to the masking
B_ASREXT	UFMSRC	LOK	condition for externe ASR
B_MSREXT	UFMSRC	LOK	Condition external MSR demand
B_NKONS_UM	UFMSRC	AUS	Condition MSR message is not consistent
B_NOMSR_FR	CAN	EIN	No ASR-/MSR intervention from FR
B_NOMSR_UM	UFMSRC	AUS	MSR moment required not used in function monitoring
C_INI	SWADAP	EIN	ECU-condition for intialisation
EI_MSRC_UM	UFMSRC	AUS	Irreversible error bit for monitoring of MSR in function monitoring
MDIND_ASRL	UFMSRC	LOK	ASR moment requirement for intervention over air path
MDIND_ASRS	UFMSRC	LOK	ASR moment requirement for rapid intervention
MDIND_MSR	UFMSRC	LOK	MSR moment requirement
MMSR_UM	UFMSRC	AUS	Permissible MSR torque request for function monitoring
MSRC_C_UM	UFMSRC	LOK	Error counter for monitoring of MSR intervention of function monitoring

FW UFMSRC 5.10 Fixed Values

Parameter	Value	Description
BZ_MSR_M		MSR message counter mask (0Fh for 4-bit message counter)
DBZ_MN_UM		Smallest permissible delta of the message counter
DBZ_MX_UM		Largest permissible delta of the message counter
MSRC_T_UM		Error tolerance time for monitoring of MSR intervention in function monitoring
NOASR_UM		Inactive mask for ASR

APP UFMSRC 5.10 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Art	Designation
b_asrext		VAR/EIN	ASR torque requirement active
b_msrext		VAR/EIN	MSR torque requirement active
b_nomsr_um		VAR/AUS	MSR torque requirement in the function surveillance not transferred
b_nkons_um		VAR/LOK	condition MSR message inconsistent
bz_msr		VAR/EIN	MSR message counter
bzmsr_a_um		VAR/LOK	Old MSR message counter
ei_msrc_um		VAR/AUS	Irreversible error bit for MSR-monitoring of function surveillance
mdind_msr		VAR/EIN	MSR torque requirement or complement (ASR requirement - message counter)
mdind_asrs		VAR/EIN	ASR torque requirement or complement (MSR requirement + message counter)
mdind_asrl		VAR/EIN	ASR torque requirement for air path
mmsr_um		VAR/AUS	Torque permitted by the MSR requirement
msrc_c_um		VAR/LOK	Error counter for MSR-intervention monitoring of function surveillance

Label	Dependency	Type	Designation
BZ_MSR_UM		FW	MSR message counter mask (0Fh for 4-bit message counter)
MSRC_T_UM		FW	Error time for MSR-intervention monitoring of function surveillance
DBZ_MX_UM		FW	Largest permissible delta for the message counters
DBZ_MN_UM		FW	Smallest permissible delta for the message counters
NOASR_UM		FW	Inactive mask for ASR

UFMZF 1.10 ETS monitoring concept: Torque filter for function monitoring

FDEF UFMZF 1.10 Function definition

```
mzf_um ------------>+----------------+
                    + mz_um > mzf_um +-------------------------------------------+
            +------>+----------------+                                           |
            |                                                                    |
            |       +-----------------+            +-----------------+           |
            |       + MZFTV_UM        +            + ^ *   MZFFIL_UM +           V     mzf_um
mz_um ------+-+---->+       +-------- +----------->+ |    *          +----------o--o---------->
              |     + ------+         +            + +-----------*-> +          o
              |     +-----------------+            +-----------------+          |
              |                                                                 |
              +-----------------------------------------------------------------+
```

ABK UFMZF 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MZFFIL_UM			FW	Filter time constant for delayed moment in function monitoring
MZFTV_UM			FW	Delay time for permissible moment mz_um in function monitoring

Variable	Source	Type	Description
MZF_LOW_UM	UFMZF	LOK	Fine adjustment for filtered permissible moment from function monitoring
MZF_UM	UFMZF	AUS	Filtered permissible torque of function monitoring
MZ_UM	UFMZUL	EIN	Permissible torque resulting from the coordination of function monitoring

FW UFMZF 1.10 Fixed Values

Parameter	Value	Description
MZFFIL_UM		Filter time constant for delayed moment in function monitoring
MZFTV_UM		Delay time for permissible moment mz_um in function monitoring

FB UFMZF 1.10 Detailed description of function

Torque filter for the function surveillance

The module must contribute to control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40-ms time frame.

Delays occur for jumps from full load to idle-speed for the air mass measured in the manifold and are converted into a load signal. This means a lower value for the permissible torque. The actual torque that essentially depends on the load signal and the engine speed supplies higher values however during this delay.

In order that the function surveillance does not respond on account of an actual-torque value that is too high compared with the permissible torque, the permissible torque is delayed over a dead time and filtered by a low-pass filter of the first order, i.e. clearing the manifold pipe for a falling driver-requested torque is simulated by this.

The dead time and the low-pass filter do not act for jumps in the torque from idle-speed to full load because functional monitoring allows an actual torque that is too low compared with the permissible torque.

APP UFMZF 1.10 Application hint

The data of function surveillance are part of the monitoring concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
mz_um		VAR/EIN	Permissible torque from the driver request
mzf_um		VAR/AUS	Filtered permissible torque
mzf_low_um		VAR/LOK	Filtered permissible torque carried to after the decimal point

Label	Dependency	Type	Designation
MZFTV_UM		FW	Delay time for permissible torque MZ_UM
MZFFIL_UM		FW	Filter time constant for delayed torque

UFMZUL 5.10 ETS monitoring concept: Calculation of permissible torque in UF

FDEF UFMZUL 5.10 Function definition

```
milsol_um --------------------------------------------------------------------+
                                                                              |
                                     +-----+                                  |
0 ---------------------------------->|     |                                  |
                               .     |     |                                  |
                               .     | Max +-----------------+                |
mfgr_um ---------------------------->|     |                 |                |
mmsr_um ---------------------------->|     |                 |                |
                                     +-----+                 |                |      +-----+
b_mzns_um -----------------------------------------------+   |                +----->|     |
                                                         |   |      +-----+          |     |
            +-----+      nmst08_um   +-----------+       |   +----->|     | mzmax_um | MIN +----> mz_um
nmot_um --->+ SST +----+------------>|           |       v  mped_um | Max +---+----->|     |
            +-----+    | spsnst08_um | KFMPED_UM +---->o --o------->|     |   |      |     |
spsn_um --->+ SST +--+-------------->|           |                  +-----+   |      +-----+
            +-----+  | |             +-----------+     o                      |
                     | |                               ^                      |
                     | |             +-----------+     |                      |
                     | +------------>|           |     |                      |
                     | |             | KFMPNS_UM +-----+                      |
                     +-------------->|           |                            |
                       |             +-----------+                            |
                       |                                                      |
                       |             +------------+                           |
                       +------------>|            |    mzo_um                 |
            +-----+  mdst08_um       | KFMDZOF_UM +--------->                 |
         +--+ SST +----------------->|            |                           |
         |  +-----+                  +------------+                           |
         +--------------------------------------------------------------------+
```

ABK UFMZUL 5.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMDZOF_UM	MZ_UM	NMOT_UM	KF	map for offset tolerance depending on permissible torque
KFMPED_UM	SPSN_UM	NMOT_UM	KF	map for permissible torque from the pedal position in function monitoring
KFMPNS_UM	SPSN_UM	NMOT_UM	KF	map for permissible torque from pedal position for a cold engine

Variable	Source	Type	Description
B_MZNS_UM	UFNSC	EIN	afterstart torque increase of ETC-monitoring is active
MFGR_UM	UFFGRC	EIN	Torque request from cruise control for function monitoring
MMSR_UM	UFMSRC	EIN	Permissible MSR torque request for function monitoring

Variable	Source	Type	Description
MPED_UM	UFMZUL	LOK	Permissible indicated torque from accelerator pedal in function monitoring
MZMAX_UM	UFMZUL	LOK	Permissible torque from the maximum selection in function monitoring
MZO_UM	UFMZUL	AUS	Tolerance offset for permissible torque in function monitoring
MZ_UM	UFMZUL	AUS	Permissible torque resulting from the coordination of function monitoring

FW UFMZUL 5.10 Fixed Values

Parameter	Value	Description

FB UFMZUL 5.10 Detailed description of function

Permissible Torque of the Watchdog Function

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).

The function shall be processed in the 40ms cycle.

The torque KFMPED_UM permissible due to the accelerator position is calculated (and filtered, cf. %UFMZF) via a map interpolation dependent on the pedal set point and the engine speed. The offset is stored in the map KFMDZOF in dependency on the permissible torque mz_um and on the engine speed. The offset torque mzo_um is not filtered. Due to the addressing of the offset over engine speed and permissible desired torque a high offset can be used for high permissible torque.

As long as the bit B_mzns_um is active during post-start (cf. %UFNSC), the map KFMPNS_UM (instead of KFPED_UM) is used with cold engine. This map is also filtered and the same offset is taken into account.
Thereby the increased drag torque at cold engine can on one hand be taken into consideration, on the other hand it is possible to reduce the permissible torque at warm engine so as to achieve a controllable reaction in case of a fault.

With permitted increasing torque intervention by the road speed controller mfgr_um from %UFFGRC or with permitted increasing torque intervention of the MSR mmsr_um from %UFMSRC the permissible torque becomes valid by the maximum selection between mped_um, mfgr_um and mmsr_um. Future external interventions, which must additionally be secured, are taken into account in the maximum selection between mfgr_um and mmsr_um. This is expressed in the function definition by the points and the input with 0.

Thereafter the minimum selection between the mzmax_um determined by the coordination of the permissible torque and the currently valid desired torque for the air path milsol_um is formed.
The resulting permissible torque can thereby pass through the subsequent torque filter for the elimination of the manifold time constant.
In addition the watchdog function is thus - with correct milsol - used for the fact that no higher torque than desired is allowed for.

Cross reference: This function of the watchdog function corresponds to the function %MDZUL in the functional plane.

APP UFMZUL 5.10 Application hint

The data of the watchdog function are part of the monitoring concept and they may therefore not be changed arbitrarily.

Label	Source	Type	Description
b_mzns_um		VAR/EIN	Condition for permissible torque during post-start
mped_um		VAR/LOK	permissible torque from the pedal position
mfgr_um		VAR/EIN	permissible torque from the road speed control
mmsr_um		VAR/EIN	permissible torque from the MSR setting
mzo_um		VAR/AUS	tolerance offset for the permissible torque
mz_um		VAR/AUS	resulting permissible torque
mzmax_um		VAR/LOK	permissible torque from the maximum selection in the coordination

Label	Dependency	Type	Description
SPSNV08_UM	spsn_um	KL	pedal set point base points
NMV08_UM	nmot_um	KL	engine speed base points for torque
MDST 08_UM	mz_um	KL	torque base points
KFMPED_UM	spsnst08_um, nmst08_um	KF	map for permissible torque from the pedal position
KFMPNS_UM	spsnst08_um, nmst08_um	KF	map for permissible torque from the pedal position during post-start
KFMDZOF_UM	mdst08_um, nmst08_um	KF	map for offset tolerance in dependency on the permissible torque

While the offset so far was stored dependent on engine speed and pedal set point (KFMZOF_UM) it is now stored dependent on permissible torque and engine speed (KFMDZOF). Changing the data is possible as follows:
For a fixed engine speed and a fixed pedal set point an offset torque is obtained from the map KFMZOF. This offset is now entered into the map KFMDZOF for the respective engine speed base points and the torque base point, which results from the map KFMPED_UM (at same engine speed and same pedal angle).

UFMIST 2.10 ETS monitoring concept: Calculation of the actual torque in UF

FDEF UFMIST 2.10 Function definition

```
            +-----+ nzwst08_um  +---------+
nmot_um --->+ SST +-+---------->|         | miopt_um                                                   +---+ mi_um
            +-----+ | rlst08_um | KFMI_UM +----------------------------------------------------------->| * +------>
rl_um ----->+ SST +--------+--->|         |                                                            +---+
            +-----+ |      |    +---------+                                                              ^
                    |      |                                                                             |
                    |      |    +---------+                                                              |
                    |      +--->|         | zwopt_um                                                     |
                    |           | KFZW_UM +------+                                                       |
                    +---------->|         |      |                                                       |
                                +---------+      |                                                       |
                                               + v  dzw_um   +---------+ dzwst08_um     +------------+   | etazw_um
                                                 o---------->|   SST   +--------------->| KLETAZW_UM +---+
                                               - ^           +---------+                +------------+
                                                 |
                                                 |
zwout_um   --------------------------------------+
```

ABK UFMIST 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KFMI_UM	RL_UM	NMOT_UM	KF	map of optimum engine torque
KFZW_UM	RL_UM	NMOT_UM	KF	map of optimum ignition angle
KLETAZW_UM	DZW_UM		KL	ignition efficiency depending on delta ignition angle

Variable	Source	Type	Description
DZW_UM	UFMIST	LOK	Delta ignition angle between zwopt and zwout in function monitoring
ETAZW_UM	UFMIST	LOK	Efficiency of actual ignition angle in function monitoring
MIOPT_UM	UFMIST	LOK	Optimum indicated torque in function monitoring
MI_UM	UFMIST	AUS	Calculated actual torque in function monitoring
NMOT_UM	UFNC	EIN	engine speed in function monitoring
RL_UM		EIN	Relative air charge in function monitoring
ZWOPT_UM	UFMIST	LOK	Optimum ignition angle in function monitoring
ZWOUT_UM	UFZWC	EIN	Ignition angle in function monitoring

FW UFMIST 2.10 Fixed Values

Parameter	Value	Description

FB UFMIST 2.10 Detailed description of function

```
Actual moment of function monitoring
-----------------------------------

The module must contribute to the control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processed in the 40 ms time frame.


The actual moment is calculated as a function of the speed, load and ignition timing.
The ignition timing is thereby defined as positive in front of OT and negative after OT.
```

APP UFMIST 2.10 Application hint

```
The data from function monitoring are part of the surveillance concept and therefore may not be arbitrarily changed.
```

Label	Source	Type	Designation
rl_um		VAR/EIN	Relative air charge in function monitoring
zwout_um		VAR/EIN	Actual ignition timing in function monitoring
nmot_um		VAR/EIN	Engine speed in function monitoring
miopt_um		VAR/LOK	Optimum induced moment in function monitoring
zwopt_um		VAR/LOK	Optimum ignition timing in function monitoring
dzw_um		VAR/LOK	Difference in ignition timing in function monitoring
etazw_um		VAR/LOK	Ignition timing in function monitoring
mi_um		VAR/AUS	Actual moment in function monitoring

Label	Dependency	Load	Designation
RLV08_UM	rl_um	KL	Load signal setpoints in function monitoring
NZWV08_UM	nmot_um	KL	Speed setpoints for determining the actual moment in function monitoring
DZWV08_UM	dzw_um	KL	Speed setpoints for difference in ignition timing
KFMI_UM	rlst08_um, nzwst08_um	KF	Performance characteristics for optimum induced moment in function monitoring
KFZW_UM	rlst08_um, nzwst08_um	KF	Performance characteristics for optimum ignition timing in function monitoring
KLETAZW_UM	dzwst08_um	KL	Characteristic for ignition timing efficiency in function monitoring

UFMVER 2.10 ETS monitoring concept: Torque comparison of function monitoring

FDEF UFMVER 2.10 Function definition

```
                             +
                          +-->o--------------------------------------------------------------------> mdif_w_um
                          |   ^-
                          |   |
                          |   |
                          |   |      +---------------------+           +-----------------------+
mi_um ------------------------+----->+                     +       o   +             +------   +
               +--------+ |  mzfo_um +  mi_um  >  mzfo_um  +---o---o-->+  MVER_T_UM  |         +--+
mzf_um --->o-->+  ----- +-+--------->+                     +     ^     +  -----------+         +  |
           ^+  + / 255  +            +---------------------+     |     +-----------------------+  |
           |   +--------+                                        |                                |
mzo_um ----+                                                     |                                |
                                                                 |                                |
                    +-------+                                    |                                |
b_i_ska ----------->+       +                                    |                                |
b_notlu ----------->+       +                                    |                                |
b_ub_ska ---------->+   v   +------------------------------------+                                |
                    +       +                                                                     |
b_dcdis_um -------->+       +                                                                     |      +-----+-----+
                    +-------+                                                                     +----->+  S  +     +-- ei_mver_um
                                                                                                         +-----+-----+   b_dcdis_um
C_ini -------------------------------------------------------------------------------------------------->+  R  +     +   b_i_ska_um
                                                                                                         +-----+-----+
```

ABK UFMVER 2.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
MVER_T_UM			FW	Fault time for moment comparison in function monitoring

Variable	Source	Type	Description
B_DCDIS_UM	UFMVER	AUS	Fault reaction information of the function monitoring
B_I_SKA	UFEING	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFMVER	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NOTLU	UFEING	EIN	Request standby air driving from the function
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
EI_MVER_UM	UFMVER	AUS	Irreversible error bit for torque comparison from function monitoring
MDIF_W_UM	UFMVER	AUS	Difference between permissible and actual torque in function monitoring
MI_UM	UFMIST	EIN	Calculated actual torque in function monitoring
MVER_C_UM	UFMVER	LOK	Error counter for torque comparison of function monitoring
MZFO_UM	UFMVER	LOK	Filtered permissible moment including offset in function monitoring
MZF_UM	UFMZF	EIN	Filtered permissible torque of function monitoring
MZO_UM	UFMZUL	EIN	Tolerance offset for permissible torque in function monitoring

FW UFMVER 2.10 Fixed Values

Parameter	Value	Description
MVER_T_UM		Fault time for moment comparison in function monitoring

FB UFMVER 2.10 Detailed description of function

Moment comparison in function monitoring

The module must contribute to the control of the program sequence (refer to %URPAK).

The RAM and ROM ranges affected by the function must be cyclically safeguarded (refer to %URMEM).

The function shall be processing in the 40 ms time frame.

During moment comparison, the actual moment (refer to %UFMIST) is checked if this has exceeded the permissible moment (refer to %UFMZUL).
A comparison of the moment cannot be performed if the nominal pedal value has not been updated because the supply to the pickup is no longer assured.
Thus the moment comparison is not executed for an undervoltage shut-off of the DK actuator output stage.
If the fault response "DK actuator output stage currentless" is effective because of other faults, there shall be no detection of faults in the moment comparison in addition to these.
It is for this reason that the moment comparison is no longer executed in this case either.
In this case a check is then made in the fault response surveillance of function monitoring (%UFREAC) as to whether the undervoltage shut-off or the fault response "DK actuator output stage currentless" is in fact executed and not just indicated.

If the actual moment exceeds the permissible moment for longer than an applicable fault time MVER_T_UM, then the fault bit ei_mver_um, the fault response information b_dcdis_um (shut-down of the DK actuator output stage) and the function monitoring fault response b_i_ska_um (irreversible SKA) are set.
If the actual moment mi_um is not greater than the permissible moment mzfo_um which is given by adding the filtered permissible moment mzf_um to the tolerance offset mzo_um, then the fault counter mver_c_um is deleted.

APP UFMVER 2.10 Application hint

The data in function monitoring are part of the surveillance concept and therefore may not be arbitrarily changed.

Label	Source	Type	Designation
mzf_um		VAR/EIN	Filtered permissible moment
mzfo_um		VAR/EIN	Filtered permissible moment with offset
mzo_um		VAR/EIN	Offset for permissible moment
mi_um		VAR/EIN	Actual moment
mdif_w_um		VAR/AUS	Difference between permissible and actual moment
mver_c_um		VAR/LOK	Fault counter for moment comparison in function monitoring
ei_mver_um		VAR/AUS	Irreversible fault bit for moment comparison in function monitoring
b_dcdis_um		VAR/AUS	Fault response information (shut-down of the DK actuator output stage) in function monitoring
b_i_ska_um		VAR/AUS	Function surveillance fault response irrev. SKA (safety fuel shut-off)
b_i_ska		VAR/EIN	Function fault response irreversible SKA (safety fuel shut-off)
b_notlu		VAR/EIN	Function fault response DK actuator ES currentless
b_ub_ska		VAR/EIN	Undervoltage shut-off of the DK actuator output stage active

Label	Dependency	Type	Designation
MVER_T_UM		FW	Fault time for moment comparison in function monitoring

UFREAC 4.30 ETS monitoring concept: Monitoring of fault reaction of function monitoring

FDEF UFREAC 4.30 Function definition

```
b_notlu ---------------------------------------------------+
                                                           |
SKA_DRHZ_UM -------------------------------------+         |
                                                 |         |
                           +-----+-----------+   +-------o\V
spsn_um ------------------>+ SST + KLNPED_UM +-----------o \o-+ nska_um
                           +-----+-----------+                |
            +-------------------------------------------------+
            |                                          +---+                   +---------------+
b_dcdis_um ------------------------------------+------>+   +                   + REAC_T2_UM    +
            |                                  |       + & +------------------>+      +------- +-------> Software-Reset
            +-->+-------------------+    +---+ | +---->+   +                   + -----+        +
                + nmot_um > nska_um +--->+   + | |     +---+                   +---------------+
nmot_um ------->+-------------------+    + & +---+          SY_EGAS -----+
                 +-----------------+ +->o+   + | |          TRUE --+     |
evz_aus_um ----->+ = M_ALLEVAUS_UM +-+   +---+ | |     +---+       |     |     +---------------+
                 +-----------------+           | +---->+   +       +---o\V     + REAC_T1_UM    +       +---+-----+
                                         +---+ +----->o+ & +-----------o \o--->+       +------ +------>+ S +     +----> ei_reac_um
b_i_ska -------------------------------->+   +-------->+   +                   + ------+       +       +---+-----+      b_i_ska_um
b_notlu -------------------------------->+ v +         +---+                   +---------------+   +-->+ R +     +      b_dcdis_um
b_ub_ska ------------------------------->+   +                                                     |   +---+-----+
                                         +---+                                                     |
C_ini ---------------------------------------------------------------------------------------------+
```

ABK UFREAC 4.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
KLNPED_UM	SPSN_UM		KL	Speed lim. as func. of nominal pedal value, in DK drive standby func.,func.mon.
NOREA_UM			FW	ident. to request no engine operation possible from %UFREAC of watchdog function
REAC_T1_UM			FW	Fault time for functional-fault reaction monitoring in UF
REAC_T2_UM			FW	Fault time for function monitoring - fault reaction monitoring in UF
RST_TV_UM			FW	Identifier for requesting a reset pulse control factor from function monitoring
SKADRHZ_UM			FW	Engine limiting speed for entire fuel cut-off SKA
SY_EGAS			SYS	System constant E-GAS present
WAIT_T_UM			FW	Waiting time for reset pulse duty cycle from the watchdog function

Variable	Source	Type	Description
B_DCDIS_UM	UFREAC	AUS	Fault reaction information of the function monitoring
B_I_SKA	UFEING	EIN	FR error reaction irreversible SKA (safety fuel shut-down)
B_I_SKA_UM	UFREAC	AUS	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_NOTLU	UFEING	EIN	Request standby air driving from the function
B_UB_SKA	UFEING	EIN	Battery voltage not OK, undervoltage shut-off active
C_INI	SWADAP	EIN	ECU-condition for intialisation
EI_REAC_UM	UFREAC	AUS	irreversible error bit of fault reaction monitoring from function monitoring
EVZ_AUS_UM	UFEING	EIN	Injection cut off pattern in function monitoring
NMOT_UM	UFNC	EIN	engine speed in function monitoring
NSKA_UM	UFREAC	LOK	Limiting speed for active fault response in function monitoring
REAC_C1_UM	UFREAC	LOK	error counter 1 for fault reaction monitoring in function monitoring response
REAC_C2_UM	UFREAC	LOK	error counter 2 for fault reaction monitoring in function monitoring
REAC_C_UM	UFREAC	LOK	Fault counter in perm. RAM for monitor. of fault react. (diag.) in watchdog func
RST_TV	UFREAC	AUS	Variable in the permanent RAM for reset pulse control factor from funct. monito.
SPSN_UM	UFSPSC	EIN	Pedal value (8-bit) with lower limit to idling in function monitoring

FW UFREAC 4.30 Fixed Values

Parameter	Value	Description
NOREA_UM		ident. to request no engine operation possible from %UFREAC of watchdog function
REAC_T1_UM		Fault time for functional-fault reaction monitoring in UF
REAC_T2_UM		Fault time for function monitoring - fault reaction monitoring in UF
RST_TV_UM		Identifier for requesting a reset pulse control factor from function monitoring
SKADRHZ_UM		Engine limiting speed for entire fuel cut-off SKA
WAIT_T_UM		Waiting time for reset pulse duty cycle from the watchdog function

FB UFREAC 4.30 Detailed description of function

Fault Reaction Monitoring of the Watchdog Function

The module must be of assistance in the check of the program execution (see %URPAK).

The RAM and ROM areas affected by the function must be stored cyclically (see %URMEM).
Within this function only the temporary variables may be used for intermediate variables. These are used in the command test (cf. %URCPU) in the same way and they have therefore been checked for writability.

Within this function separate routines of the watchdog function of the software module UFIUP (no FDEF) need to be used for interpolations.

The function is to be processed in the 40ms cycle.

The functionality of the fault reactions needs to be monitored.
This is important, since the fault reaction needs to be definitely performed for the watchdog function.
This applies to fault reactions from the function on the basis of which the watchdog function is either totally or partially deactivated and also to the fault reactions from the watchdog function, without which it would not reach its target of performance reduction in case of fault.

If a desired deactivation of the throttle actuator output stage with the accompanying speed limitation via injection cut-out does not take place, then in case of deactivation request from the function an attempt is made after a defined fault-tolerance time to activate on an additional path by means of the fault-reaction request and information in the watchdog function.

If the deactivation of the throttle actuator output stage was initiated by the watchdog function, then in case of a fault, i.e. if the speed limitation via injection cut-out does not become active, a software reset is triggered after a defined fault-tolerance time. In this case, the identifier is loaded into the permanent RAM for reset duty cycle prior to the software reset being triggered.
Via this identifier the RAM and ROM check (usually taking place during the after-run) as well as a defined waiting time prior to output stage enabling resp. to end of initialization is activated during the subsequent initialization.
(Interim solution beginning)
If the adjustable identifier NOREA_UM has not been set or if the software reset was not triggered from here (%UFREAC).
If the adjustable identifier NOREA_UM has been set and if the software reset was triggered from here (%UFREAC), the identifier reset duty cycle is cleared and a jump to the boot block resp. to the internal ROM is performed. In this operating mode no engine operating is any longer possible but only the possibility exists to program the flash content anew. This operating mode can only be exited, if terminal 15 is switches off and hence on again.
After terminal 15 = on, normal operation is resumed. Should a permanent fault trigger this fault reaction again, this again leads to engine operation any longer possible. The driver therefore decides by himself, whether or how long he wants to keep engine operation off, if a permanent fault is given.
(Interim solution end)
Remark regarding the described Interim solution:
Demand made by Audi, VW for a quicker conversion for series production

If the system constant SY_EGAS is false in an EGAS-system, then the function UFREAC requests a safety fuel deactivation. Since the EGAS-relevant parts are not compiled at not set system constant SY_EGAS in the function AEVAB, it is not possible for the function AEVAB to translate the safety fuel deactivation.
The system constant SY_EGAS is checked already during the compiling procedure. If it is not defined in EGAS-systems, the fault message is made that it needs to be defined. A fault message is also made, if the system constant exists but if it has been set to false. No code is generated in either case. This is illustrated in the diagram by the reset.

APP UFREAC 4.30 Application hint

The data of the watchdog function are part of the monitoring concept and may not be changed arbitrarily.

DUF 6.30 Diagnostic interface of the function monitoring

FDEF DUF 6.30 Function definition

```
                       +---+
SY_UBR --------------->+   +     +---+
              +---+    + & +---->+   +
ei_ubr_um --->+   +o-->+   +     +   +
              +---+    +---+     +   +
                    +---+        + & +----------------+    (*1)
ei_mver_um -------->+   +o------>+   +                |         +---+---+
                    +---+        +   +                +-------->+ S +   +----> E_ufska
b_i_ska_um --------------------->+   +                |         +---+---+      B_npufska
                                 +---+           +------------->+ R +   +
                 +---+                           |    |         +---+---+
(*2) C_fcmclr -->+   +      +---+                |    |
                 + & +----->+   +                |    |
     B_clufska ->+   +      +   +                |    |
                 +---+      + v +-------------+--+    |
(*2) C_pwf ---------------->+   +             |       |
(*2) C_ini --------+------->+   +             |       |
                   |        +---+             |       |
                   |                          |       |
                   +------------+             |       |
                                |             |       |
                                V Reset       |       |          +---+  (*1)
                            +---------+       |       +--------->+   +      +---+---+
            +-----------+   + DUF_T   +       |                  + v +----->+ S +   +---> Z_ufska
nmot_um --->+ > NMN_DUF +-->+     +-- +--+---------------------->+   +      +---+---+
            +-----------+   + ----+   +  |    |                  +---+  +-->+ R +   +
                            +---------+  |    +-------------------------+   +---+---+
                                         |
                                         |
                                         |                  (*1)
                                         |                      +---+---+
ei_mver_um -------------------------------------------+-------->+ S +   +----> E_ufmv
                                         |            |         +---+---+      B_npufmv
                                         |    +---------------->+ R +   +
                 +---+                   |    |       |         +---+---+
(*2) C_fcmclr -->+   +  +---+            |    |       |
                 + & +->+   +            |    |       |          +---+  (*1)
     B_clufmv -->+   +  +   +            |    |       +--------->+   +      +---+---+
                 +---+  + v +----+       |    |                  + v +----->+ S +   +---> Z_ufmv
(*2) C_pwf ------------>+   +    |       +---------------------->+   +      +---+---+
(*2) C_ini ------------>+   +    |            |                  +---+  +-->+ R +   +
                        +---+    +------------+-------------------------+   +---+---+
```

(*1):   Contrary to the description, this part is realized in the module %DFPM
(*2):   The activities triggered by C_(*) are implemented in separate processes in the SW

```
                           +---+
      SY_2SG-------------->|   |
                           |   |    +------------+
      B_nome_um ---------->| & |    |        +-- |                  (*1)  +---+---+
                    +-+    |   |--->| NOME_T |   |-------+--------------->| S |   |---> E_uf2sg
      B_esgcan ---->|!|--->|   |    | -------+   |       |                +---+---+     B_npuf2sg
                    +-+    +---+    +------------+     +----------------->| R |   |
                                        nome_c         | |                +---+---+
                      +---+                            | |
       SY_2SG-------->|   |                            | |
                      |   |                            | |
  (*2) C_fcmclr ----->| & |    +---+                   | |
                      |   |--->|   |                   | |
       B_cluf2sg ---->|   |    |   |                   | |
                      +---+    | v |-------------------+ |
  (*2) C_pwf ----------------->|   |                   | |
  (*2) C_ini -------+--------->|   |                   | |
                    |          +---+                   | |
                    +---------------------+            | |
                                          |            | |
                                          V Reset      | |    +---+
                                    +------------+     | +--->|   |  (*1)
                   +-----------+    |        +-- |     |      | v |---+
       nmot_um --->| > NMN_DUF |--->| DUF_T  |   |----------->|   |   |   +---+---+
                   +-----------+    | -------+   |     |      +---+   +-->| S |   |---> Z_uf2sg
                                    +------------+     |                  +---+---+
                                        duf_c          +----------------->| R |   |
                                                                          +---+---+
```

        The code is only produced, if SY_2SG is set.
(*1):   Contrary to the description, this part is realized in the module %DFPM
(*2):   The activities triggered by C_(*) are implemented in separate processes in the SW

```
                                                        o\
0 ---------o--o--o--o--o--o--o--o-----------------------o \o-----------------> skapfad
           ^+ ^+ ^+ ^+ ^+ ^+ ^+ ^+                       ^
0 ------o\ |  |  |  |  |  |  |  |                        |
128 ----o o+  |  |  |  |  |  |  |                        |
         ^    |  |  |  |  |  |  |                        |
0 ---------o\ |  |  |  |  |  |  |                        |
64 --------o o+  |  |  |  |  |  |                        |
         |  ^    |  |  |  |  |  |                        |
0 ------------o\ |  |  |  |  |  |                        |
32 -----------o o+  |  |  |  |  |                        |
         |  |  ^    |  |  |  |  |                        |
0 ---------------o\ |  |  |  |  |                        |
16 --------------o o+  |  |  |  |                        |
         |  |  |  ^    |  |  |  |                        |
0 ------------------o\ |  |  |  |                        |
8 ------------------o o+  |  |  |                        |
         |  |  |  |  ^    |  |  |                        |
0 ---------------------o\ |  |  |                        |
4 ---------------------o o+  |  |                        |
         |  |  |  |  |  ^    |  |                        |
0 ------------------------o\ |  |                        |
2 ------------------------o o+  |                        |
         |  |  |  |  |  |  ^    |                        |
0 ---------------------------o\ |                        |
1 ---------------------------o o+                        |
         |  |  |  |  |  |  |  ^                          |
         +-+|  |  |  |  |  |  |                          |
           ||  |  |  |  |  |  |                          |
ei_adcc_um-+|  |  |  |  |  |  |                          |
ei_reac_um -+  |  |  |  |  |  |                          |
ei_spsc_um ----+  |  |  |  |  |                          |
ei_rlip_um -------+  |  |  |  |                          |
ei_ipa_um -----------+  |  |  |                          |
ei_rlc_um --------------+  |  |                          |
ei_zwc_um -----------------+  |                          |
ei_nc_um ---------------------+   +-----+                |
                                  |  +- |                |
                                  |  |  |                |
E_ufska --------------------------+  ^  +----------------+
(internal intermediate parameter) |  |  |
                                  | -+  |
                                  +-----+
```

```
egaspfad (t-1) -----------------------------------------o
0 ---------o--o--o--o--o--o--o--o-----------------------o--o-----------------> egaspfad
           ^+ ^+ ^+ ^+ ^+ ^+ ^+ ^+                       ^
0 ------o\ |  |  |  |  |  |  |  |                        |
128 ----o o+  |  |  |  |  |  |  |                        |
         ^    |  |  |  |  |  |  |                        |
0 ---------o\ |  |  |  |  |  |  |                        |
64 --------o o+  |  |  |  |  |  |                        |
         |  ^    |  |  |  |  |  |                        |
0 ------------o\ |  |  |  |  |  |                        |
32 -----------o o+  |  |  |  |  |                        |
         |  |  ^    |  |  |  |  |                        |
0 ---------------o\ |  |  |  |  |                        |
16 --------------o o+  |  |  |  |                        |
         |  |  |  ^    |  |  |  |                        |
0 ------------------o\ |  |  |  |                        |
8 ------------------o o+  |  |  |                        |
         |  |  |  |  ^    |  |  |                        |
0 ---------------------o\ |  |  |                        |
4 ---------------------o o+  |  |                        |
         |  |  |  |  |  ^    |  |                        |
0 ------------------------o\ |  |                        |
2 ------------------------o o+  |                        |
         |  |  |  |  |  |  ^    |                        |
0 ---------------------------o\ |                        |
1 ---------------------------o o+                        |
         |  |  |  |  |  |  |  ^                          |
         |  |  |  |  |  |  |  |                          |
         |  |  |  |  |  |  |  |                          |
b_ub_ok -+  |  |  |  |  |  |  |                          |
b_notlu_fr -+  |  |  |  |  |  |                          |
b_sp2s --------+  |  |  |  |  |                          |
b_sp1s -----------+  |  |  |  |                          |
b_spsmin ------------+  |  |  |                          |
b_pwgnotfr -------------+  |  |                          |
b_wdk2sel ----------------+  |                          |
b_ehfs -----------------------+                          |
                                                         |
E_ufska -------------------------------------------------+
(internal intermediate parameter)
```

```
mpfad (t-1) ----------------------------------------------------------o
0 -----------------------o--o--o--o--o--o--o--o-----------------------o--o---> mpfad
                         ^+ ^+ ^+ ^+ ^+ ^+ ^+ ^+                       ^
0 --------------------o\ |  |  |  |  |  |  |  |                        |
128 ------------------o o+  |  |  |  |  |  |  |                        |
                       ^    |  |  |  |  |  |  |                        |
0 -----------------------o\ |  |  |  |  |  |  |                        |
64 ----------------------o o+  |  |  |  |  |  |                        |
                       |  ^    |  |  |  |  |  |                        |
0 --------------------------o  |  |  |  |  |  |                        |
32 -------------------------o-o+  |  |  |  |  |                        |
                       |  |  ^    |  |  |  |  |                        |
0 -----------------------------o\ |  |  |  |  |                        |
16 ----------------------------o o+  |  |  |  |                        |
                       |  |  |  ^    |  |  |  |                        |
0 --------------------------------o\ |  |  |  |                        |
8 --------------------------------o o+  |  |  |                        |
                       |  |  |  |  ^    |  |  |                        |
0 -----------------------------------o\ |  |  |                        |
4 -----------------------------------o o+  |  |                        |
                       |  |  |  |  |  ^    |  |                        |
0 --------------------------------------o\ |  |                        |
2 --------------------------------------o o+  |                        |
                       |  |  |  |  |  |  ^    |                        |
0 -----------------------------------------o\ |                        |
1 -----------------------------------------o o+                        |
                       |  |  |  |  |  |  |  ^                          |
              +---+    |  |  |  |  |  |  |  |                          |
              |   |    |  |  |  |  |  |  |  |                          |
SY_2SG ------>| & |----+  |  |  |  |  |  |  |                          |
b_nome_um --->|   |       |  |  |  |  |  |  |                          |
              +---+       |  |  |  |  |  |  |                          |
                          |  |  |  |  |  |  |                          |
                          |  |  |  |  |  |  |                          |
                          |  |  |  |  |  |  |                          |
b_nosgs_um ---------------+  |  |  |  |  |  |                          |
                             |  |  |  |  |  |                          |
                             |  |  |  |  |  |                          |
b_nomsr_um ------------------+  |  |  |  |  |                          |
b_fgr_um -----------------------+  |  |  |  |                          |
b_sgs -----------------------------+  |  |  |                          |
b_mibeg ------------------------------+  |  |                          |
b_msr -----------------------------------+  |                          |
b_fgr --------------------------------------+                          |
                                                                       |
E_ufmv ----------------------------------------------------------------+
(internal intermediate parameter)
```

```
mi_duf (t-1) ------------------------------------o
mi_um -------------------------------------------o--o------------------------> mi_duf
                                                  ^
                                                  |
E_ufmv -------------------------------------------+
(internal intermediate parameter)
```

E_ufska:

Environmental condition 1 : skapfad   Environmental condition 2 : egaspfad

E_ufmv:

Environmental condition 1 : mpfad   Environmental condition 2 : mi_duf

E_uf2sg:

Environmental condition 1: mer_c1_um   Environmental condition 2 : mer_c2_um

ABK DUF 6.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCUF2SG	BLOKNR		KL	Code word CARB: monitoring of the function: data from other ECU
CDCUFMV	BLOKNR		KL	Code word CARB: monitoring of the function: torque comparison
CDCUFSKA	BLOKNR		KL	Code word CARB: monitoring of the function: safety fuel cut-off
CDKUF2SG			FW	Code word customer: monitoring of the function: data from o ther ECU
CDKUFMV			FW	Code word customer: monitoring of the function: torque comparison
CDKUFSKA			FW	Code word customer: monitoring of the function: safety fuel cut-off
CDTUF2SG			FW	Code word tester: monitoring of the function: data from other ECU
CDTUFMV			FW	Code word tester: monitoring of the function: torque comparison

Parameter	Source-X	Source-Y	Type	Description
CDTUFSKA			FW	Code word tester: monitoring of the function: safety fuel cut-off
CLAUF2SG			FW	Fault class: monitoring of the function: data from other ECU
CLAUFMV			FW	Fault class: monitoring of the function: torque comparison
CLAUFSKA			FW	Fault class: monitoring of the function: safety fuel cut-off
DUF_T			FW	time for setting the cycle flags of function monitoring diagnosis
FFTUF2SG	BLOKNR		KL	Freeze frame table: monitoring of the function: data from other ECU
FFTUFMV	BLOKNR		KL	Freeze frame table: monitoring of the function: torque comparison
FFTUFSKA	BLOKNR		KL	Freeze frame table: monitoring of the function: safety fuel cut-off
NMN_DUF			FW	engine speed threshold for setting the cycle flag of the function monitoring dia
NOME_T			FW	Time for fault detection UF2SG
SY_2SG			SYS	system constant 2 motronic systems
SY_UBR			SYS	system constant: Voltage behind main relay ubr exists
TSFUF2SG			FW	Fault active time: monitoring of the function: data from other ECU
TSFUFMV			FW	Fault active time: monitoring of the function: torque comparison
TSFUFSKA			FW	Fault active time: monitoring of the function: safety fuel cut-off

Variable	Source	Type	Description
B_CLUF2SG		EIN	flag for clearing measures: watchdog function: data of the other ME
B_CLUFMV		EIN	Flag for clearance: monitoring of the function: torque comparison
B_CLUFSKA		EIN	Flag for clearance: monitoring of the function: safety fuel cut-off
B_EHFS	DHFM	EIN	Condition substitude value main charge sensor
B_ESGCAN		EIN	Condition error ecu-CAN for 2 ME-ecu’s
B_FGR	MDFAW	EIN	condition: driver’s set engine torque determined by cruise control
B_FGR_UM	UFUE	EIN	CC/ACC torque intervention in function monitoring permitted
B_I_SKA_UM	UFREAC	EIN	Fault reaction demand from function monitoring: irrev.SKA (safety fuel cut-off)
B_MIBEG	MDKOG	EIN	condition torque limit active
B_MSR	MDKOG	EIN	Condition MSR
B_NOME_UM	UFMER	EIN	Condition replacement values are used caused by failures in the recieved massage
B_NOMSR_UM	UFUE	EIN	MSR moment required not used in function monitoring
B_NOSGS_UM	UFSGSC	EIN	SGS moment required not transferred to function monitoring
B_NOTLU_FR	SREAKT	EIN	Request for NFB from Function controller
B_NPUF2SG	DUF	AUS	failure type unplausible: Function monitoring: Data from other ECU
B_NPUFMV	DUF	AUS	fault type not plaus.: monitoring of the function: torque comparison
B_NPUFSKA	DUF	AUS	fault type not plaus.: monitoring of the function: safety fuel cut-off
B_PWGNOTFR	GGPED	EIN	FR error reaction pedal-travel sensor limphome
B_SGS	MDKOG	EIN	condition: torque intervention for engine speed synchr. during gear shift
B_SP1S	GGPED	EIN	message to SR: SP1S is command variable
B_SP2S	GGPED	EIN	SP2S is valid set value for PWG failure driving
B_SPSMIN	GGPED	EIN	message to SR: ’1’ = pedal-travel sensor limphome with SPSMIN
B_UB_OK	ADVE	EIN	Battery voltage o.k.
B_WDK2SEL	GGDVE	EIN	Condition: DV-E position control is performed with actual-value-poti 2
DUF_C	DUF	AUS	Time counter for setting cycle flags of the function surveillance diag. routine
EGASPFAD	DUF	AUS	ETS-path as environmental condition for diagnosis of function monitoring
EI_ADCC_UM	URADCC	EIN	Irreversible error bit for the AD converter surveillance
EI_IPA_UM	UFRLC	EIN	Irrevers. error bit for lower DK limit in invalid range of function monitoring
EI_MVER_UM	UFMVER	EIN	Irreversible error bit for torque comparison from function monitoring
EI_NC_UM	UFNC	EIN	irreversible error bit for engine speed comparison from function monitoring
EI_REAC_UM	UFREAC	EIN	irreversible error bit of fault reaction monitoring from function monitoring
EI_RLC_UM	UFRLC	EIN	Irrevers. error bit for comparison of rl with the function in function monitor.
EI_RLIP_UM	UFRLC	EIN	Irreversible error bit for rl/rlip comparison in function monitoring
EI_SPSC_UM	UFSPSC	EIN	irrevers. error bit for pedal value plausibility check in function monitoring
EI_UBR_UM		EIN	Irreversibloe error bit for fault entry main relay
EI_ZWC_UM	UFZWC	EIN	irrevers. error bit for ignition angle monitoring from function monitoring
E_UF2SG	DUF	AUS	Error flag:function monitoring: Data from other ECU
E_UFMV	DUF	AUS	Error flag: monitoring of the function: torque comparison
E_UFSKA	DUF	AUS	Error flag: monitoring of the function: safety fuel cut-off
MER_C1_UM		EIN	fault counter 1 for message counter in function monitoring
MER_C2_UM		EIN	fault counter 2 for message counter in function monitoring
MI_DUF	DUF	AUS	actual torque at response of torque comparison in the function monitoring
MI_UM	UFMIST	EIN	Calculated actual torque in function monitoring
MPFAD	DUF	AUS	Torque path in function and function monitoring as environmental cond. of diag.
NMOT_UM	UFNC	EIN	engine speed in function monitoring
NOME_C	DUF	AUS	fault counter for UF2SG
SFPUFMV	DUF	AUS	status word: monitoring of the function: torque comparison
SFPUFSKA	DUF	AUS	status word: monitoring of the function: safety fuel cut-off
SKAPFAD	DUF	AUS	freeze frame information for SKA
Z_UF2SG	DUF	AUS	cycle flag: function mo0nitoring: Data from other ECU
Z_UFMV	DUF	AUS	cycle flag: monitoring of the function: torque comparison
Z_UFSKA	DUF	AUS	cycle flag: monitoring of the function: safety fuel cut-off

FW DUF 6.30 Fixed Values

Parameter	Value	Description
CDKUF2SG		Code word customer: monitoring of the function: data from o ther ECU
CDKUFMV		Code word customer: monitoring of the function: torque comparison
CDKUFSKA		Code word customer: monitoring of the function: safety fuel cut-off
CDTUF2SG		Code word tester: monitoring of the function: data from other ECU
CDTUFMV		Code word tester: monitoring of the function: torque comparison
CDTUFSKA		Code word tester: monitoring of the function: safety fuel cut-off
CLAUF2SG		Fault class: monitoring of the function: data from other ECU
CLAUFMV		Fault class: monitoring of the function: torque comparison

Parameter	Value	Description
CLAUFSKA		Fault class: monitoring of the function: safety fuel cut-off
DUF_T		time for setting the cycle flags of function monitoring diagnosis
NMN_DUF		engine speed threshold for setting the cycle flag of the function monitoring dia
NOME_T		Time for fault detection UF2SG
TSFUF2SG		Fault active time: monitoring of the function: data from other ECU
TSFUFMV		Fault active time: monitoring of the function: torque comparison
TSFUFSKA		Fault active time: monitoring of the function: safety fuel cut-off

FB DUF 6.30 Detailed description of function

Diagnosis from functional surveillance

As a minimum, the diagnostic function shall be processed in the 100-ms time frame.

It is not active during afterrunning.

In this function, three different fault pathes are served:
- Faults by the torque monitoring, that can also be due to a fault by the load monitoring
- Faults by the monitoring with the fault reaction safty-fuel-cut-off, which only can result by an intern fault of the ECU (UFSKA).
- Faults caused by a bad communication between two ECU's (UF2SG).

The distinction is made between faults from the torque comparison that can also be due to faults in load signals, and other faults from the surveillance with the fault response SKA that can only arise from internal fault responses in the computer.
Both fault entries from functional surveillance are mutually excluding, i.e. if the fault response SKA comes from the one of the fault cases defined in skapfad, then the torque comparison can no longer respond, and if the fault response comes first from the torque comparison, then there is no longer a fault E_ufska stored from the complex skapfad.
Apart from that, there will be no fault E_ufska from the Path skapfad, if there is a main relay (SY_UBR = true) and the fault ei_ubr_um results in an fault mnemory entry by the function %GGUBR.

The time for setting the cycle flags in the error-free case will always run then when a defined engine-speed threshold has been exceeded.

The following environment conditions are provided at this function specification, because the
Bit-Information had to be united.
The RAM cell skapfad is only filled in the case of a fault, i.e with a positive flank to E_ufska.
The RAM cell egaspfad is no longer filled as soon as a fault, i.e. E_ufska, has been detected.
The RAM cell mpfad is no longer filled as soon as a fault, i.e. E_ufmv, has been detected.
The following environment condition are provided at this function specification, because
the information is changed by the fault reaction b_i_ska_um. The fault reaction closes the throttle, therefore the load and the torque decreases
The RAM cell mi_duf is no longer filled as soon as a fault, i.e. E_ufmv, has been detected.
The following environment conditions are not provided in this function, they aere providet in the
fault managment system.
The RAM cell mer_c1_um
The RAM cell mer_c2_um

Fault-type information as well as the cycle and error flags are shown as outputs in the block diagrams. The output is not however by transfer of single bits, but rather by writing back the entire status word sfpxyz of the fault path XYZ into the centralized diagnostics management DFPM. The bits E_xyz, Z_xyz, B_mnxyz etc. are the contents of this status words. Access methods are available for those error and cycle flags from other fault paths, that occur as inputs. These methods read in the information directly from the fault path status managed by the DFPM.

The following variables are defined for each fault path XYZ of this diagnostic function:

Status Fault path XYZ: sfpxyz
  Fault flag xyz: E_xyz
  Cycle flag xyz: Z_xyz
  Fault type xyz: TYP_xyz: (B_mxxyz, B_mnxyz, B_sixyz, B_npxyz)
  Delete fault path: B_clxyz
  Standby value active: B_bkxyz (optional)
Fault path code xyz: CDTXYZ
Fault class xyz: CLAXYZ
Fault severity xyz: TSFXYZ
CARB Code xyz: CDCXYZ
Table of environmental conditions xyz: FFTXYZ

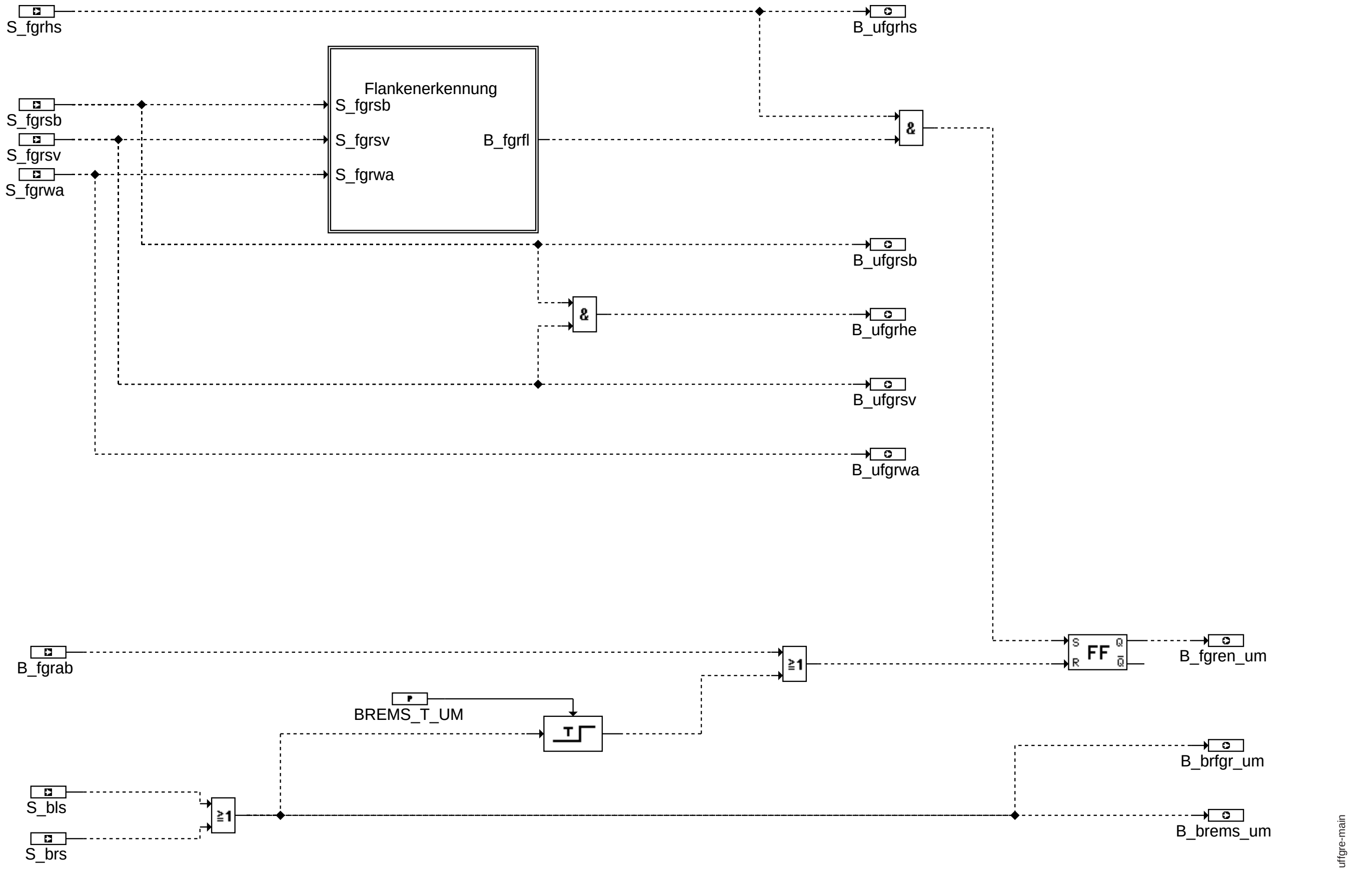
The following fault paths xyz are covered in this FDEF:

Fault path name	Abbreviation used (replaces "xyz")
Function monitoring: Torque comparison	UFMV
Function monitoring: SKA	UFSKA
Function monitoring: communication 2 ECU's	UF2SG

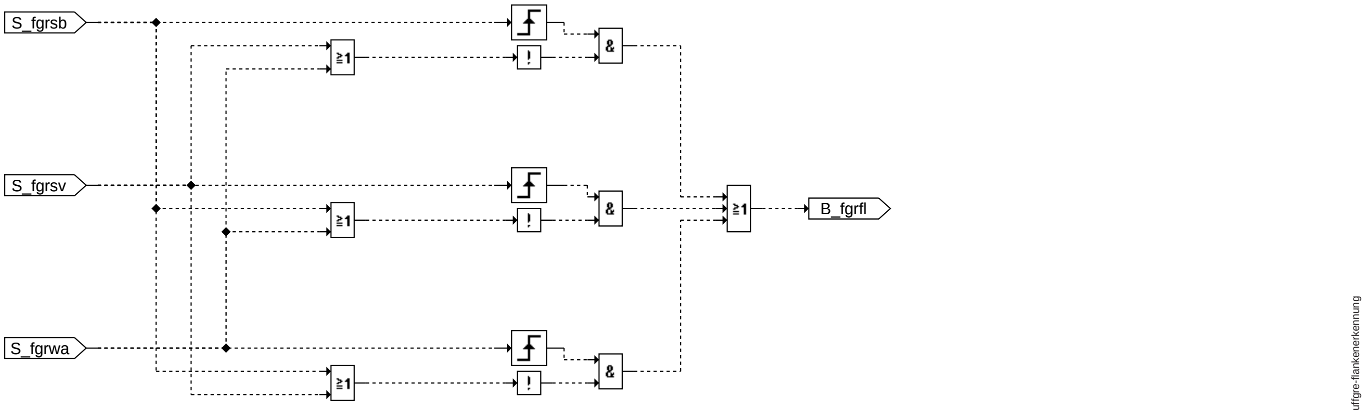
APP DUF 6.30 Application hint

UFFGRE 17.10 ETS monitoring concept: CC input information used in function monitoring

FDEF UFFGRE 17.10 Function definition



uffgre-main



uffgre-flankenerkennung

```
No text for FDEF available!
```

ABK UFFGRE 17.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BREMS_T_UM			FW	Debounce time for operated brake in function monitoring

Variable	Source	Type	Description
B_BREMS_UM	UFFGRE	AUS	condition of function monitoring: brake pedal pressed
B_BRFGR_UM	UFFGRE	AUS	condition of function monitoring: brake pedal pressed

Variable	Source	Type	Description
B_FGRAB	FGRUE	EIN	CC/ACC shut-off from the function
B_FGREN_UM	UFFGRE	AUS	CC/ACC turn-on from control lever valid in function monitoring
B_UFGRHE	UFFGRE	AUS	voltage from cruise control level too high or faulty signal
B_UFGRHS	UFFGRE	AUS	information cruise control level ”main switch ON”
B_UFGRSB	UFFGRE	AUS	information cruise control level ”set / accelerate”
B_UFGRSV	UFFGRE	AUS	information cruise control level ”set / coast”
B_UFGRWA	UFFGRE	AUS	information cruise control level ”resume”
S_BLS		EIN	brake light switch (true=activated pedal)
S_BRS		EIN	Switch for brake
S_FGRHS		EIN	Main switch on FGR control lever
S_FGRSB		EIN	
S_FGRSV		EIN	Switch set/delay on FGR control lever
S_FGRWA		EIN	

FW UFFGRE 17.10 Fixed Values

Parameter	Value	Description
BREMS_T_UM		Debounce time for operated brake in function monitoring

FB UFFGRE 17.10 Detailed description of function

APP UFFGRE 17.10 Application hint

SCATT 20.70 SCAN TOOL-tester interface

FDEF SCATT 20.70 Function definition

```
Allgemeine Hinweise:
Die Funktionskenntnis der Funktion %DFPM ist für die Arbeit mit dieser Funktion hilfreich!

I n t e r f a c e   a n d   P r o t o c o l

        The protokoll driver verifies the transfer protocol and sets the Bit B_isoprot as follows:

        B_isoprot = 0   communication according to ISO 9141-2
        B_isoprot = 1   communication according to ISO 14230-4



B_isoprot = 0 (communication according to ISO 9141-2):
        Only those PID's are responded to, which are reported as being supported by PID $00.

B_isoprot = 1 (communication according to ISO 14230-4):
        When a not supported mode is requested a message (negative response) is created:

        No.     Mnemonic        Description
        ---     --------        -----------
        11h     SNS             requested mode is not supported (serviceNotSupported)



Message Structure
Mode $01 - $09 as well as the respective PID's are defined in SAE J1979.

Mode $01: Request Current Powertrain Diagnostic Data                                      ---> See %TC1MOD
Mode $02: Request Current Powertrain Freeze Frame Data                                    ---> See %TC2MOD
Mode $03: Request Emission-Related Powertrain Diagnostic Trouble Codes (DTC)              ---> See %SCATT
Mode $04: Clear/Reset Emission-Related Diagnostic Information                             ---> See %SCATT
Mode $05: Request Oxygen Sensor Monitoring Test Results                                   ---> See %TC5MOD
Mode $06: Request On-Board Monitoring Test Results for Non-Cotinuously Monitored Systems  ---> See %TC6MOD
Mode $07: Request On-Board Monitoring Test Results for Cotinuously Monitored Systems      ---> See %SCATT

Mode $08: Request Control of On-Board System, Test or Component                           ---> See %TC8MOD
```

```
               +----+
 SY_M8I00B --->| >0 +-----+
               +----+     |           +---+
                +----+    +---------->|   |           +---+
 SY_M8I00C ---->| >0 +--------------->| V +---------->| & +---+-------------> Mode $08 support
                +----+   +----------->|   | +-------->|   |   |
               +----+    | +--------->|   | |         +---+   |
 SY_M8I00D --->| >0 +----+ |          +---+ |                 |
               +----+      |                |                 |
                +----+     |                |                 |
 SY_M8I00E ---->| >0 +-----+                |                 |
                +----+                      |                 |
 B_mde8e -----------------------------------+                 |      +---+
                                                              +---->o| & +--> neg. Response (SNS)
 B_isoprot --------------------------------------------------------->|   |
                                                                     +---+
```

In connection with Mode $08 the following applies:
The condition B_m8te (see TC8MOD) is always set to false by the function %SCATT, when a another Mode is requested.
When Mode $08 is requested the condition B_m8te is hence treated as described in %TC8MOD.

Mode $09: Vehicle Information ---> See %TC9MOD

```
               +----+
 SY_M9I00A --->| >0 +-----+
               +----+     |           +---+
                +----+    +---------->|   |           +---+
 SY_M9I00B ---->| >0 +--------------->| V +---------->| & +---+-------------> Mode $09 support
                +----+   +----------->|   | +-------->|   |   |
               +----+    | +--------->|   | |         +---+   |
 SY_M9I00C --->| >0 +----+ |          +---+ |                 |
               +----+      |                |                 |
                +----+     |                |                 |
 SY_M9I00D ---->| >0 +-----+                |                 |
                +----+                      |                 |
 B_mde9e -----------------------------------+                 |      +---+
                                                              +---->o| & +--> neg. Response (SNS)
 B_isoprot --------------------------------------------------------->|   |
                                                                     +---+
```

This description contains details regarding SAE J1979 Mode $03, $04 a. $07.
The realization of the SAE J1979 Modes $01, $02, $05, $06, $08 and %09 is described in the independent FDEF’s %TC*MOD
(* = 1, 2, 5, 6, 8 or 9).

Mode $03

Basis is SAE J1979 Mode $03:
Mode $03 enables the access to the OBDII - relevant debounced fault codes stored in case of fault detection.
Only OBDII - relevant faults and MIL-debounced faults with (fes.scatt = 1) & (fes.dauer = 1) are outputted.
Furthermore it is possible to filter fault paths of the misfire monitoring via %TCSORT.

Output

The output is performed chronological, i.e. in the order of their entry.
The output is performed in blocks of three fault codes, i.e. per response block always three words are transferred.
In case of more than 3 fault codes, the ECU have to send multiple messages.
If the amount of faults is not equal to 3 or not divisible by 3, the remaining bytes are outputted with $00.
Description of the fault code structure see -->%DFPM.
With empty fault code memory 3 times 0000 is outputted.

Mode $04

Basis is SAE J1979 Mode $04:
By Mode $04 the fault memory is cleared dependent on the system constant SY_DELFCMS.

The selection of the clearing routine is performed prior to the compiler run via the system constant SY_DELFCMS.
SY_DELFCMS = 0 (=Default): with Mode $04 all fault-code memory entries are cleared
SY_DELFCMS = 1 : with Mode $04 only the SCAN TOOL relevant fault-code memory entries (s. %DCLA) are cleared

With a tester request for MODE $04 stored faults are cleared in dependency on SY_DELFCMS.
In addition to the clearing of the fault memory the following actions still need to be performed by the functions, which serve Modes $01, $05 a. $06:
- Reset basic data for Mode $01 PID $01 (reset readiness in DIMC)
- Clear sensor measured values for Mode $05 (%DLSSA)
- Clear on-board monitoring test results (Mode $06)

Mode $07

Basis is SAE J1979 Mode $07:
Für den Mode $07 gibt es 2 Varianten um behördenrelevante Fehlerpfade anzuzeigen.
Mit der Systemkonstante SY_M7VAR ist die Anzeigevariante auswählbar:
SY_M7VAR = 0: Es werden nur vorhandene und nicht entprellte Fehlerpfade (pending) angezeigt.
SY_M7VAR = 1: Es wird immer das letzte Prüfergebnis angezeigt, auch für entprellte (Mode $03) Fehlerpfade.

if SY_M7VAR = 0

Mode $07 indicates fault paths, which are OBDII - relevant & currently exist & not yet debounced & do not belong to the diagnostic function (fault paths) supported by Mode $06.

FCM-entries with ((fes.scatt =1) & (fes.dauer = 0) & (dfp not in Mode $06)) are outputted to the Scan Tool.

endif

if SY_M7VAR = 1

Mode $07 indicates fault paths, which are OBDII - relevant & currently exist & do not belong to the diagnostic function (fault paths) supported by Mode $06.

FCM-entries with ((fps.erfact = 1) & (fes.scatt = 1) & (dfp not in Mode $06)) are outputted to the Scan Tool.

endif

In addition it is possible to filter fault paths of the misfire detection via %TCSORT.

Output see above Mode $03.

ABK SCATT 20.70 Abbreviations

ISO: International Organization for Standardization
SAE: Society of Automotive Engineers, Inc.
PID: Parameter Identification
TID: Test Identification
fes.scatt and fes.dauer: see %DFPM
>dfp not in Mode $06<: Verweis auf Ausblendtabelle in %TC6MOD

Parameter	Source-X	Source-Y	Type	Description
CWSCTMDE			FW	Code word f. switch-off of certain Scan Tool Modes/Services (Bit=0 -> mode off)

Variable	Source	Type	Description
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
B_M8TE	TC8MOD	EIN	condition to enable function evap system by SAE J1879 Mode 8 TID $01
B_MDE8E		EIN	Condition: mode $08 permitted
B_MDE9E		EIN	Condition: mode $09 permitted
SY_DELFCMS	PROKON	EIN	system constant: selection of the reset routine for scan tool mode $04
SY_M7VAR		EIN	System constant for Mode $07 DTC - output
SY_M8I00B	PROKON	EIN	System constant coding from DATA B in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00C	PROKON	EIN	System constant coding from DATA C in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00D	PROKON	EIN	System constant coding from DATA D in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00E	PROKON	EIN	System constant coding from DATA E in mode 8 PID $00 according to SAE J1979
SY_M9I00A		EIN	System constant coding from DATA A in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00B		EIN	System constant coding from DATA B in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00C		EIN	System constant coding from DATA C in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00D		EIN	System constant coding from DATA D in Mode $09 VIT $00 acc. to SAE J1979

FW SCATT 20.70 Fixed Values

Parameter	Value	Description
CWSCTMDE		Code word f. switch-off of certain Scan Tool Modes/Services (Bit=0 -> mode off)

FB SCATT 20.70 Detailed description of function

The operating of the interface is described by the above-mentioned standards:
ISO9141-2 resp. ISO 14230-4: Description of the hardware requirements, of the diagnostic initialization and of the timing
SAE J1979: Description of the protocol and of the contents, also refers to a few other SAE-standards, in which further
information is given.

APP SCATT 20.70 Application hint

Fehlerspeicher lesen (Mode §03 und Mode $07) und Fehlerspeicher löschen (Mode $04) erfolgen nach den Vorschriften der SAE J1979.
Die Ausgabe der Fehlercodes in Mode $07 wird mit der Systemkonstante SY_M7VAR auf eine Variante eingestellt.
Diese Varianteneinstellung erfolgt vor der Erzeugung des Hexfiles und ist nicht applizierbar!

Mode $08 und Mode $09 über CWSCTMDE abschalten:
Das Codewort CWSCTMDE ist in der projektspezifischen KONCW oder PROKON definiert.
CWSCTMDE.Bit 0: B_mde8e
CWSCTMDE.Bit 1: B_mde9e

TC1MOD 20.120 Tester communication CARB; Mode 1

FDEF TC1MOD 20.120 Function definition

General:

Basis of this description is SAE J1979 Mode $01:
Mode $01 shall enable access to the momentary resp. most current exhaust gas relevant data.
In the process only the original measured values (so e.g. no default values) are permitted.

The protokoll driver verifies the transfer protocol and sets the Bit B_isoprot as follows:

B_isoprot = 0   communication according to ISO 9141-2
B_isoprot = 1   communication according to ISO 14230-4

B_isoprot = 0 (communication according to ISO 9141-2):
Only those PID's are responded to, which are reported as being supported by PID $00.

B_isoprot = 1 (communication according to ISO 14230-4):
When a not supported PID is requested the following message (negative response) is created:

No.	Mnemonic	Description
12h	SFNS-IF	subFunctionNotSupported-invalidFormat

PID $00: Bit-coded transfer of the PID's supported by the ECU (PID $00 must by all means be contained in Mode 1).

On a tester request (Mode $01 PID $00), the calculation begins and the result shows DATA Byte #5 (DATA C) as register.

```
if  (SY_M1I00C.Bit 6 = 1) & (B_slsfz = 1)  or   (SY_M1I00C.Bit 6 = 0):

     SY_M1I00C -----------------------------------------------> register

else
     SY_M1I00C.Bit 0 -----------------------------------------> register.Bit 0
     SY_M1I00C.Bit 1 -----------------------------------------> register.Bit 1
     SY_M1I00C.Bit 2 -----------------------------------------> register.Bit 2
     SY_M1I00C.Bit 3 -----------------------------------------> register.Bit 3
     SY_M1I00C.Bit 4 -----------------------------------------> register.Bit 4
     SY_M1I00C.Bit 5 -----------------------------------------> register.Bit 5

     %SLS (PID $12) supported (yes / no)
     B_slsfz -------------------------+
     +---+                            |
     | 0 +----------------+           v
     +---+                +---------o --- o--------------------> register.Bit 6
     SY_M1I00C.Bit 6 ---------------o

     SY_M1I00C.Bit 7 -----------------------------------------> register.Bit 7

endif
```

Der Registerinhalt für DATA Byte #6 (DATA D) ist auf Testeranfrage (Mode $01 PID $00) zu berechnen:

```
   if  (SY_M1I00D.Bit 0 = 0)

        SY_M1I00D -----------------------------------------------> register_B

   else
        SY_M1I00D.Bit 0 --------------------------------------+
                                            +---+             |
        SY_M1I20A.Bit 7 ------------------->| & +--+          |
        B_kmmilsct ------------------------>|   |  |          |
        +---------------------+             +---+  |   +---+  |   +---+
        | SY_M1I20A  & 7F hex |   +-----+          +-->|   |  +-->| & +----> register_B.Bit 0
        |(nur Bit 0 bis Bit 6)+-->| > 0 +------------->| V +----->|   |
        +---------------------+   +-----+    +-------->|   |      +---+
                      +-----+                |  +----->|   |
        SY_M1I20B --->| > 0 +----------------+  |  +-->|   |
                      +-----+                   |  |   +---+
                        +-----+                 |  |
        SY_M1I20C ----->| > 0 +-----------------+  |
                        +-----+                    |
                          +-----+                  |
        SY_M1I20D ------->| > 0 +------------------+
                          +-----+

        SY_M1I00D.Bit 1 -----------------------------------------> register_B.Bit 1
        SY_M1I00D.Bit 2 -----------------------------------------> register_B.Bit 2
        SY_M1I00D.Bit 3 -----------------------------------------> register_B.Bit 3
        SY_M1I00D.Bit 4 -----------------------------------------> register_B.Bit 4
        SY_M1I00D.Bit 5 -----------------------------------------> register_B.Bit 5
        SY_M1I00D.Bit 6 -----------------------------------------> register_B.Bit 6
        SY_M1I00D.Bit 7 -----------------------------------------> register_B.Bit 7

   endif
```

The following table shows the allocation Bit and PID:

	SY_M1I00A	SY_M1I00B	register	register_B
DATA:	A	B	C	D
DATA Byte #:	3	4	5	6
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
PID in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

The PID’s $20; $40; $60; $80; $A0; $C0 and $E0 are dealt with analogous.
DATA A - D (SY_M1I00A - SY_M1I00D): Is entered by the SW developer.

0 = PID n is not supported in Mode 1 (not supported)
1 = PID n is supported in Mode 1 (supported)

PID $01: Status Information
DATA A: Number of emission-related powertrain Trouble codes and MIL status
Bit 0 to 6: Number of codes stored in this module
The fault code memory is searched for entered, debounced and CARB-relevant faults.
Stored misfire faults are filtered via the function %TCSORTx.y, thereafter the amount of faults is adjusted.
This amount is entered into DATA A bit 0 to 6 (this corresponds to 0 ... 127 dec).

Bit 7: MIL status with 1 = MIL on, 0 = MIL off):
The %DMIL calculates the MIL - status and sets the Bit B_milstat.
--> Output B_milstat

DATA B: Bit-coded identification of the supported continuously active diagnostic routines and of their state:
(0 = not supported, 1 = supported)
Bit 0 = Misfire detection (comes from B_cdmd %PROKONx.y)
Bit 1 = Fuel system (comes from B_cdkvs from %PROKONx.y)
Bit 2 = Comprehensive Component (set to 1 , since always present)
Bit 3 to 7 set to 0, since not used resp. not necessary in this constellation.
--> Output AKKU - contents in case of request
(AKKU-contents is only given in the request buffer and therefore not readable by VS100)

DATA C: Bit-coded identification of the supported sporadically active diagnostic routines:
(0 = not supported, 1 = supported)
Bit 0 = Catalyst monitoring
Bit 1 = Heated catalyst monitoring
Bit 2 = Evaporative system monitoring
Bit 3 = Secondary air system monitoring
Bit 4 = A/C system refrigerant monitoring
Bit 5 = Oxygen sensor monitoring
Bit 6 = Oxygen sensor heater monitoring
Bit 7 = EGR system monitoring
--> output evsup1 (comes from DIMC)

DATA D: Bit-coded identification of the test status of the respective function.
(0 = not supported or test is performed, 1 = test not yet performed). Assignment just as with DATA C.
--> Output of the RAM-cell ready from --> %DIMCx.y

PID $02: Is not supported in Mode 1.

PID $03: Output Status Fuel Supply System Bank 1 + 2
DATA A: Bit-coded output of status of fuel-supply system bank 1
Only one of the following bits each may be set to 1:
Bit 0 = Open loop - has not yet satisfied conditions to go closed loop
Bit 1 = Closed loop - using oxygen sensor(s) as feedback for fuel control
Bit 2 = Open loop due to driving conditions (fuel cut-off etc.)
Bit 3 = Open loop due to detected system fault
Bit 4 = Control active with limitations
Bit 5 to 7 = not used (are set to 0)
--> Output flglrs, corresponds to the SAE-quantization

DATA B: Bit-coded output of status of fuel-supply system bank 2
Coding like on the 1-bank system (DATA A)
On a 1-bank system (SY_STERVK = false) is set to $00.

```
        SY_STERVK ------------+
                              |
                              v
        00 hex ------------o ---- o---------------------------------------> output
        flglrs2 -----------o
        (flglrs2 corresponds to the SAE-quantization)
```

PID $04 DATA A: Calculated load value in percent of the max. load.
SAE-quantization: (Quant = 100%/256)
--> Output rml, corresponds to the SAE-quantization

PID $05 DATA A: Engine coolant temperature
SAE-quantization: ($00 = -40 deg. C, $FF = 215 deg. C, quant = 1 deg. C)
--> convert tmotlin to the SAE-quantization and output

PID $06 DATA A: Short term fuel trim - Bank 1
SAE-quantization: ($00 = -100%, $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% at 128)

```
        Calculate output:
                     +-------------+-----------+
                 +-->| = xxxx xxxx   1xxx xxxx |------+
                 |   +-------------+-----------+      |
                 |         (MSB)       (LSB)          v            +-----------+
        fr_w ----+----------------------------------o-----o------->| : 100 hex |----------> register
                 |           +-----------+   +------o              +-----------+
                 +---------->| + 100 hex |---+
                             +-----------+
        --> output register;  corresponds to the SAE-quantization
```

PID $07 DATA A: Long term fuel trim - Bank 1
SAE-quantization: ($00 = -100%, $80 = 0%, $FF = +99,22%, quant = 100%/128)

```
Calculate output:
             +-------------+-----------+
         +-->| = xxxx xxxx   1xxx xxxx |------+
         |   +-------------+-----------+      |
         |         (MSB)       (LSB)          v            +-----------+
fra_w ---+----------------------------------o-----o------->| : 100 hex |----------> register
         |           +-----------+   +------o              +-----------+
         +---------->| + 100 hex |---+
                     +-----------+
--> output register;  corresponds to the SAE-quantization
```

PID $08 DATA A: Short term fuel trim - Bank 2
SAE-quantization: ($00 = -100%, $80 = 0%, $FF = +99,22%, quant = 100%/128)

```
Calculate output:
             +-------------+-----------+
         +-->| = xxxx xxxx   1xxx xxxx |------+
         |   +-------------+-----------+      |
         |         (MSB)       (LSB)          v            +-----------+
fr2_w ---+----------------------------------o-----o------->| : 100 hex |----------> register
         |           +-----------+   +------o              +-----------+
         +---------->| + 100 hex |---+
                     +-----------+
--> output register;  corresponds to the SAE-quantization
```

PID $09 DATA A: Long term fuel trim - Bank 2
SAE-quantization: ($00 = -100%, $80 = 0%, $FF = +99,22%, quant = 100%/128)

```
Calculate output:
             +-------------+-----------+
         +-->| = xxxx xxxx   1xxx xxxx |------+
         |   +-------------+-----------+      |
         |         (MSB)       (LSB)          v            +-----------+
fra2_w --+----------------------------------o-----o------->| : 100 hex |----------> register
         |           +-----------+   +------o              +-----------+
         +---------->| + 100 hex |---+
                     +-----------+
--> output register;  corresponds to the SAE-quantization
```

PID $0A is not supported.

PID $0B DATA A: Intake manifold absolute pressure
SAE-quantization: ($00 = 0 kPa, $FF = 255 kPa, quant = 1 kPa)
--> output psdss_u corresponds to the SAE-quantization

PID $0C DATA A: Engine speed high-Byte
DATA B: Engine speed low-Byte
SAE-quantization: ($0000 ... $FFFF = 0 ... 16383,75 rpm; 1 incr = 0,25 rpm)
--> output nmot_w, corresponds to the SAE-quantization

PID $0D DATA A: Vehicle speed
SAE-quantization: ($00 = 0 km/h, $FF = 255 km/h, quant = 1 km/h)
--> vfzg (comes from %GGVFZGx.y with the quantization: 0 ... 318,75 km/h, 1 incr. = 1,25 km/h),
output after conversion to SAE-quantization.

PID $0E DATA A: Ignition timing advance for #1 cylinder
SAE-quantization: ($00 = -64,0 deg., $80 = 0 deg., $FF = +63,5 deg., quant = 0,5 deg.)
--> zwzyl1 (comes from %ZUE with the quantization: 0,75 deg. KW/incr, -96 - +95,25 deg. KW),
output after conversion to SAE-quantization.

PID $0F DATA A: Intake air temperature
SAE-quantization: ($00 = -40 deg. C, $FF = 215 deg. C, quant = 1 deg. C)
--> convert tanslin to SAE-quantization and output

PID $10 DATA A: Air flow rate from MAF sensor (high-Byte)
DATA B: Air flow rate from MAF sensor (low-Byte)
SAE-quantization: ($0000 = 0 g/sec, $FFFF = 655.35 g/sec, quant = 0,01 g/sec)
--> mshfm_w (comes from BGSRMx.y with the quantization: 0 ... 6553,5 kg/h, 0,1 kg/h per incr.)
output after conversion to SAE-quantization.

```
PID $11 DATA A: Absolute throttle position sensor
        SAE-quantization: ( $00 = 0 %, $FF = 100 %, quant = 100%/255 )
        --> output wdkba, corresponds to the SAE-quantization


PID $12 DATA A: Commanded secondary air status
        Presently only this constellation is known. If secondary air system is given then injection of air upstream 1st catalyst
        of each bank.
        B_slsfz = 0; no answer (ISO 9141-2) resp. SFNS-IF = $12 (ISO 14230-4)
        (B_slsfz = 1) & (B_sls = 1) corresponds in the AKKU bit 0 = 1,
        (B_slsfz = 1) & (B_sls = 0) corresponds in the AKKU bit 2 = 1, remaining bits are to be set to 0.
        --> output AKKU - contents in case of request
        (AKKU-contents is only given in the request buffer and therefore not readable by VS100)


PID $13 DATA A: Location of oxygen sensors installed in the vehicle, where sensor 1 is closest to the engine
        (Bit = 1: sensor mounted)
        PID $13 is an alternative to PID $1D.

        B_lsv   -->  Bit 0: Bank 1, sensor 1 (RB = upstream catalyst bank 1) mounted
        B_lsh   -->  Bit 1: Bank 1, sensor 2 (RB = downstream catalyst bank 1) mounted
        0       -->  Bit 2: Bank 1, sensor 3 (not RB-typical)
        0       -->  Bit 3: Bank 1, sensor 4 (not RB-typical)
        B_lsv2  -->  Bit 4: Bank 2, sensor 1 (RB = upstream catalyst bank 2) mounted
        B_lsh2  -->  Bit 5: Bank 2, sensor 2 (RB = downstream catalyst bank 2) mounted
        0       -->  Bit 6: Bank 2, sensor 3 (not RB-typical)
        0       -->  Bit 7: Bank 2, sensor 4 (not RB-typical)

        --> output AKKU, bit composition corresponds to the SAE-requirement.

        The bits 2, 3, 6 a. 7 are set to "0" during the output, since this constellation is not RB-typical.



PID $14 DATA A: Oxygen sensor output voltage of sensor upstream catalyst, bank 1  ( $00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
        Is only supported on systems with 2-step Lambda control!
        --> usvkj (comes from DLSSAx.y and corresponds to the SAE-quantization)

   DATA B: short term fuel trim of sensor upstr. cat, bank 1  ( $00 = -100%,  $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
        Is only supported on systems with 2-step Lambda control!
        Calculate output:
                     +-------------+-----------+
                 +-->| = xxxx xxxx   1xxx xxxx |------+
                 |   +-------------+-----------+      |
                 |         (MSB)       (LSB)          v            +-----------+
        fr_w ----+----------------------------------o-----o------->| : 100 hex |----------> register
                 |           +-----------+   +------o              +-----------+
                 +---------->| + 100 hex |---+
                             +-----------+
        --> output register;  corresponds to the SAE-quantization



PID $15 DATA A: Oxygen sensor output voltage of sensor downstream catalyst, bank 1  ( $00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
        --> output ushkj (comes from DLSSAx.y), conversion corresponds to the SAE-quantization

   DATA B: short term fuel trim of sensor downstr. cat, bank 1
        ( $00 = -100%,  $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
        --> output $FF, since sensor is not used for the control.


PID $16 + $17:  Sensor 3 + 4 of bank 1; not used here.



PID $18 DATA A: Oxygen sensor output voltage of sensor upstream catalyst, bank 2  ( $00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
        Is only supported on systems with 2-step Lambda control!
        --> usvkj2 (comes from DLSSAx.y and corresponds to the SAE-quantization)

   DATA B: short term fuel trim of sensor upstr. cat, bank 2  ( $00 = -100%,  $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128)
        Is only supported on systems with 2-step Lambda control!
        Calculate output:
                     +-------------+-----------+
                 +-->| = xxxx xxxx   1xxx xxxx |------+
                 |   +-------------+-----------+      |
                 |         (MSB)       (LSB)          v            +-----------+
        fr2_w ---+----------------------------------o-----o------->| : 100 hex |----------> register
                 |           +-----------+   +------o              +-----------+
                 +---------->| + 100 hex |---+
                             +-----------+
        --> output register;  corresponds to the SAE-quantization
```

```
PID $19 DATA A: Oxygen sensor output voltage of sensor downstream catalyst, bank 2  ( $00 = 0 V, $FF = 1,275 V, quant = 0,005 V)
        --> output ushkj2 (comes from DLSSAx.y), conversion corresponds to the SAE-quantization

   DATA B: short term fuel trim of sensor downstr. cat, bank 2
        ( $00 = -100%,  $80 = 0%, %FF = +99,22%, quant = 100%/128, 0% at 128 )
        --> output $FF, since sensor is not used for the control.


PID $1A + $1B:  Sensor 3 + 4 of bank 2; not used here.



PID $1C DATA A: OBD requirements
        --> output CWOBD
```

CWOBD in dec:	Certification according to:
01	OBDII-CARB
02	OBD-EPA
03	OBDII-CARB + OBD-EPA
04	OBDI
05	no OBD-requirements
06	EOBD

```
        Data are entered into CWOBD after an investigation of the project-specifically-used certification.


PID $1D DATA A: Location of oxygen sensors (Bit = 1: Sensor mounted )
        (PID $1D is only enabled if PID $13 is not activated.)

        B_lsv   -->   Bit 0: Bank 1, sensor 1
        B_lsh   -->   Bit 1: Bank 1, sensor 2
        B_lsv2  -->   Bit 2: Bank 2, sensor 1
        B_lsh2  -->   Bit 3: Bank 2, sensor 2
        0       -->   Bit 4: Bank 3, sensor 1
        0       -->   Bit 5: Bank 3, sensor 2
        0       -->   Bit 6: Bank 4, sensor 1
        0       -->   Bit 7: Bank 4, sensor 2

        --> output AKKU - contents in case of request
        (AKKU-contents is only given in the request buffer and therefore not readable by VS100)


if  (SY_M1I00D.Bit 0 = 1)

PID $20 Bit-coded transfer of the PID's >$20 supported by the ECU
        PID $20 must always be included in case of an activation of PID's >$20.


        Der Registerinhalt für DATA Byte #3 (DATA A) ist auf Testeranfrage (Mode $01 PID $20) zu berechnen:

   if  (SY_M1I20A.Bit 7 = 0)

        SY_M1I20A ------------------------------------------------> register_2A

   else
        SY_M1I20A.Bit 0 ------------------------------------------> register_2A.Bit 0
        SY_M1I20A.Bit 1 ------------------------------------------> register_2A.Bit 1
        SY_M1I20A.Bit 2 ------------------------------------------> register_2A.Bit 2
        SY_M1I20A.Bit 3 ------------------------------------------> register_2A.Bit 3
        SY_M1I20A.Bit 4 ------------------------------------------> register_2A.Bit 4
        SY_M1I20A.Bit 5 ------------------------------------------> register_2A.Bit 5
        SY_M1I20A.Bit 6 ------------------------------------------> register_2A.Bit 6
                                             +---+
        SY_M1I20A.Bit 7 -------------------->| & +----------------> register_2A.Bit 7
        B_kmmilsct ------------------------->|   |
                                             +---+

   endif
```

The following table shows the allocation Bit and PID:

	register_2A	SY_M1I20B	SY_M1I20C	SY_M1I20D
DATA:	A	B	C	D
DATA Byte #:	3	4	5	6
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
PID in hex:	21 22 23 24 25 26 27 28	29 2A 2B 2C 2D 2E 2F 30	31 32 33 34 35 36 37 38	39 3A 3B 3C 3D 3E 3F 40

The structure of PID $20 is similar to PID $00, however, for the PID's $21 - $40 and so on.
For further details refer to PID $00.

```
PID $21 Trip with "MIL on"


        B_kmmilsct ----------------------------+
        B_isoprot -------------+               |
                               |               |
        +-----------+          V               V
        | no Answer +---------o---o-----------o---o----------------> output
        +-----------+   +-----o        +------o
        | neg. Resp.+---+              |
        +-----------+                  |
                                       |
        +---------------+              |
        | kmstmil_w     +--------------+
        +---------------+

    DATA A: kmstmil_w high-Byte
    DATA B: kmstmil_w low-Byte
        SAE-quantization: ( Quant = 1km / incr, 0 ... 65535)


PID $34 Equivalence ratio (Lambda) and oxygen sensor current Bank 1 - Sensor 1
        Is only supported on systems with wide range oxygen sensor (LSU)!

    DATA A: Lambda high-Byte
    DATA B: Lambda low-Byte
        SAE-quantization: 1 Incr. = 0,0000305; Inkr; Range: 0 ... 1,999
        --> output  lalsuvj_w,  corresponds to the SAE-quantization

    DATA C: oxygen sensor current high-Byte
    DATA D: oxygen sensor current low-Byte
        SAE-quantization: 1 Inkr. = 0,0000305 ma; Range: -128 ma - 127,996 ma; $8000 = 0 ma
        --> output  iplsuvj_w,  corresponds to the SAE-quantization


PID $38 Equivalence ratio (Lambda) and oxygen sensor current Bank 2 - Sensor 1
        Is only supported on systems with wide range oxygen sensor (LSU)!

    DATA A: Lambda high-Byte
    DATA B: Lambda low-Byte
        SAE-quantization: 1 Incr. = 0,0000305; Inkr; Range: 0 ... 1,999
        --> output  lalsuvj2_w,  corresponds to the SAE-quantization

    DATA C: oxygen sensor current high-Byte
    DATA D: oxygen sensor current low-Byte
        SAE-quantization: 1 Incr. = 0,0000305 ma; Range: -128 ma - 127,996 ma; $8000 = 0 ma
        --> output  iplsuvj2_w,  corresponds to the SAE-quantization

endif
```

ABK TC1MOD 20.120 Abbreviations

ISO: International Organization for Standardization
SAE: Society of Automotive Engineers, Inc.
PID: Parameter Identification

Parameter	Source-X	Source-Y	Type	Description
CWKMMILSCT			FW	Output:"Km at MIL on" for Scan Tool switch-off (0 = no output in PID $21)
CWOBD			FW	code word for configuration OBD certifikation

Variable	Source	Type	Description
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
B_KMMILSCT		EIN	Output:"km at MIL on" for Scan Tool switch-off (0 = no output in PID $21)""
B_MILSTAT	DMIL	EIN	MIL-Status for Scan-Tool Mode $01 PID $01
B_SLS	AK	EIN	Condition for active secondary air
B_SLSFZ	PROKON	EIN	condition: SLS fitted in vehicle
FLGLRS	LREB	EIN	CARB FREEZE FRAME byte, bank 1, for lambda control
FLGLRS2	LREB	EIN	CARB FREEZE FRAME byte, bank 2, for lambda control
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FR_W	LR	EIN	Lambda controller output (word)
IPLSUVJ2_W		EIN	sensor current IP LSU2
IPLSUVJ_W		EIN	sensor current IP LSU
KMSTMIL_W	BGKMST	EIN	Drive distance with MIL on
LALSUVJ2_W		EIN	Lambda actual value
LALSUVJ_W		EIN	Lambda actual value
MSHFM_W	GGHFM	EIN	air-mass flow HFM
NMOT_W	SWADAP	EIN	engine speed
PSDSS_U	DFFTCNV	EIN	Intake manifold pressure from pressure sensor (DS-S) with SAE quantisation
SY_M1I00A	PROKON	EIN	System constant coding from DATA A in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00B	PROKON	EIN	System constant coding from DATA B in Mode 1 PID $00 acc. to SAE J1979
SY_M1I00C	PROKON	EIN	System constant coding from DATA C in Mode 1 PID $00 acc. to SAE J1979

Variable	Source	Type	Description
SY_M1I00D	PROKON	EIN	System constant coding from DATA D in Mode 1 PID $00 acc. to SAE J1979
SY_M1I20A		EIN	System constant coding from DATA A in Mode 1 PID $20 acc. to SAE J1979
SY_M1I20B		EIN	System constant coding from DATA B in Mode 1 PID $20 acc. to SAE J1979
SY_M1I20C		EIN	System constant coding from DATA C in Mode 1 PID $20 acc. to SAE J1979
SY_M1I20D		EIN	System constant coding from DATA D in Mode 1 PID $20 acc. to SAE J1979
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
TANSLIN	GGTFA	EIN	intake air temperature, linearised and calculated
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
VFZG	SWADAP	EIN	vehicle speed (km/h)
WDKBA	GGDVE	EIN	throttle angle
ZWZYL1	ZUE	EIN	ignition angle cylinder 1

FW TC1MOD 20.120 Fixed Values

Parameter	Value	Description
CWKMMILSCT		Output:"Km at MIL on" for Scan Tool switch-off (0 = no output in PID $21)
CWOBD		code word for configuration OBD certifikation

FB TC1MOD 20.120 Detailed description of function

APP TC1MOD 20.120 Application hint

```
The variable CWOBD must by all means be adjusted according to below-mentioned table in correspondence to the certification degree:

 Certification according to          CWOBD in dec:
  OBDII-CARB                         01
  OBD-EPA                            02
  OBDII-CARB + OBD-EPA               03
  OBDI                               04
  no OBD-requirements                05
  EOBD                               06

PID $21 über Codewort abschalten:
        CWKMMILSCT.Bit 0: B_kmmilsct
```

TC2MOD 20.70 Tester communication CARB; Mode 2

FDEF TC2MOD 20.70 Function definition

```
M o d e  $ 0 2

General:
        Basis of this description is SAE J1979 Mode 2:
        Mode 2 shall enable access to freeze-frame data stored in case of fault detection.
        In the process only original measured values (so e.g. no default values) are permitted.


Communication Protocol:

        The protocol driver detects the type of transfer protocol and describes the bit B_isoprot:
        B_isoprot = 0   communication according to ISO 9141-2
        B_isoprot = 1   communication according to ISO 14230-4

   B_isoprot = 0 (communication according to ISO 9141-2):
        Only those PID's are responded to, which are reported as being supported by PID $00.
        If no Freeze Frame is enabled (ffzdfp = 00), the inquiry for Mode $02 freeze frame "00"  is answered by those
        PID's, which are marked as being supported in the PID $00.


   B_isoprot = 1  (communication according to ISO 14230-4):
        When a not supported PID or freeze frame is requested, the following message (negative response) is created:

        No.     Mnemonic        Description
        ---     --------        -----------
        12h     SFNS-IF         requested PID/TID is not supported (subFunctionNotSupported-invalidFormat)
        22h     CNCORSE         no Freeze Frame #00 stored for Mode $02 (conditionsNotCorrect or requestSequenceError)
```

Freeze Frame:

Description of freeze frame see --->%DFFT, %DTIP and %DFPM x.y.

Only once the fault was confirmed is the freeze frame with the number 00 stipulated by CARB formed and released for the output.
The content of the RAM-cell ffzdfp points to the dfp with the Freeze Frame 00.
The memory cell from the Freeze Frame table in the FCM for the Freeze Frame 00 is marked by the contraction frzx_ffzdfp (x stands for 0 to n; n is an internal FCM no.) in this description.

PID $00: Bit-coded transfer of the PID's supported by the ECU (PID $00 must by all means be contained in Mode 2).

DATA Bytes #4 - #7

The software modules of the respective PID are included in the program dependent on the system constants SY_M2I00A, SY_M2I00B, SY_M2I00C and SY_M2I00D.
The support of the PID's > PID $02 is only performed, if a freeze frame 0 is available, i.e. if ffzdfp > 00.
The PID's to be supported are determined and displayed at request by PID $00.

Determining of Support

The buffer content for DATA byte #4 to #7 (DATA A to DATA D) is to be calculated at tester request (Mode $02 PID $00) in dependency on the content of the RAM - cell ffzdfp:

```
B_isoprot --------------+   +-+
             +-------+  +-->| |
ffzdfp ----->| > 00h +----->|V+--+
             +-------+      +-+  |
     +------+                    v
     | 40 h +------------------o --- o--------------------> buffer.DATA A
     +------+        +---------o |
SY_ M2I00A ----------+           |
     +------+                    v
     | 00 h +------------------o --- o--------------------> buffer.DATA B
     +------+        +---------o |
SY_ M2I00B ----------+           |
     +------+                    v
     | 00 h +------------------o --- o--------------------> buffer.DATA C
     +------+        +---------o |
SY_ M2I00C ----------+           |
     +------+                    v
     | 00 h +------------------o --- o--------------------> buffer.DATA D
     +------+        +---------o
SY_ M2I00D ----------+
```

Support is performed dependent on the buffer contents for DATA A to DATA D.

DATA A - D:

	Buffer	Buffer	Buffer	Buffer
DATA:	A	B	C	D
DATA Byte #:	4	5	6	7
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
PID in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

0 = PID n is not supported in Mode 2
1 = PID n is supported in Mode 2

PID $01: not used in Mode 2

PID $02 Output of the fault code, which belongs to the freeze frame 00

With fault detection via the combustion miss detection the outputted fault paths are filtered with the function %TCSORT for the output to the tester.

A fault code consists of 2 bytes, which are transferred to Data A and Data B.
Data A is composed of the BCD-coded high-byte of the SAE-code incl. the letter P, e.g. P01xx.
Data B is composed of the BCD-coded low-byte of the SAE-code, e.g. Pxx37.
In case no freeze frame is stored, DATA A = 00 and DATA B = 00 is outputted.

```
PID $03: Output Status Fuel Supply System Bank 1 + 2
   DATA A: Bit-coded output of status of fuel-supply system bank 1
        Only one of the following bits each may be set to 1:
        Bit 0 = Controller readiness not yet reached
        Bit 1 = Control active without limitation
        Bit 2 = Open loop due to driving condition (fuel cut-off etc.)
        Bit 3 = Open loop due to fault
        Bit 4 = Control active with limitations
        Bit 5 to 7 = not used (must be set to 0)
        --> Output  frz0_ffzdfp

DATA B: Bit-coded output of status of fuel-supply system bank 2
        The codes are the same as with DATA A.
        For 1-bank systems (SY_STERVK = false), 00 hex needs to be sent.


        SY_STERVK ------------+
                              |
                              v
        00 hex ------------o ---- o--------------------------------------> output
        frz1_ffzdfp -------o



PID $04 DATA A: Calculated load in percent of the max. load.
        --> Output frz2_ffzdfp
        The content of frz2_ffzdfp corresponds to the SAE-quantization.


PID $05 DATA A: Engine temperature
        The content of frz3_ffzdfp corresponds to the SAE-quantization.



PID $06 DATA A: Controller value of the Lambda control bank 1
        --> Output frz4_ffzdfp
        In frz4_ffzdfp the value of the high-byte of fr_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% for 128)



PID $07 DATA A: Adaptation value of the Lambda control bank 1
        --> Output frz5_ffzdfp
        In frz5_ffzdfp the value of the high-byte of fra_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% for 128)



PID $08 DATA A: Controller value of the Lambda control bank 2
        --> Output frz6_ffzdfp
        In frz6_ffzdfp the value of the high-byte of fr2_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% for 128)



PID $09 DATA A: Adaptation value of the Lambda control bank 2
        --> Output frz7_ffzdfp
        In frz7_ffzdfp the value of the high-byte of fra2_w is given. The content corresponds to the SAE-quantization
        SAE-quantization: ( $00 = -100%,  $80 = 0%, $FF = +99,22%, quant = 100%/128, 0% for 128)


PID $0B DATA A: Manifold pressure (absolute)
        --> Output frz8_ffzdfp


PID $0C DATA A: Engine speed high-Byte
        DATA B: Engine speed low-Byte
        convert frz9_ffzdfp to SAE-quantization.
        The RAM-cell frz9_ffzdfp contains the engine speed as 8-bit value with the quantization of 40 rpm per increment.
        For the output this variable is to be converted to a 2-byte value with the SAE-quantization
        SAE-quantization: ($0000 ... $FFFF = 0 ... 16383,75 rpm; 1 incr = 0,25 rpm)
        Conversion: frz9_ffzdfp * 160
        --> output result.


PID $0D DATA A: Vehicle speed
        The content of frz10_ffzdfp corresponds to the SAE-quantization.
```

ABK TC2MOD 20.70 Abbreviations

```
frz0_ffzdfp ... frz10_ffzdfp: Name of the cells, in which the freeze frame data for the freeze frame 00 are given
ISO:  International Organization for Standardization
SAE:  Society of Automotive Engineers, Inc.
```

Variable	Source	Type	Description
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
FFZDFP		EIN	fault path identification number (dfp) of freeze frame zero
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FR_W	LR	EIN	Lambda controller output (word)
SY_M2I00A	PROKON	EIN	System constant coding from DATA A in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00B	PROKON	EIN	System constant coding from DATA B in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00C	PROKON	EIN	System constant coding from DATA C in Mode 2 PID $00 acc. to SAE J1979
SY_M2I00D	PROKON	EIN	System constant coding from DATA D in Mode 2 PID $00 acc. to SAE J1979
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat

FW TC2MOD 20.70 Fixed Values

Parameter	Value	Description

FB TC2MOD 20.70 Detailed description of function

APP TC2MOD 20.70 Application hint

```
Attention: frz0_ffzdfp ... frz10_ffzdfp cannot be assigned a fixed address, since all faults are entered chronologically
           and since the assignment to the freeze frame 00 to any arbitrary fault memory line is performed dependent on the
           priority control.
```

TC5MOD 20.30 Tester communikation CARB; Mode 5

FDEF TC5MOD 20.30 Function definition

```
Mode 5
        Basis is SAE J1979 Mode $05:
        Mode $05 shall enable the output of Lambda sensor values.

Interface and Protocol

        The protokoll driver verifies the transfer protocol and sets the Bit B_isoprot as follows:

        B_isoprot = 0   communication according to ISO 9141-2
        B_isoprot = 1   communication according to ISO 14230-4



B_isoprot = 0  (communication according to ISO 9141-2):
        Only those TID's are responded to, which are reported as being supported by TID $00.

B_isoprot = 1  (communication according to ISO 14230-4):
        When a not supported TID or an incorrect sensor number is requested a message (negative response)
        is generated:

        No.     Mnemonic        Description
        ---     --------        ------------
        12h     SFNS-IF         requested TID is not supported (subFunctionNotSupported-invalidFormat)
        22h     CNCORSE         incorrect sensor-no. in Mode $05 (conditionsNotCorrect or requestSequenceError)
```

TID $00: Bit-coded transfer of the TIDs supported by the ECU.
Must by all means be contained in Mode $05.

Lambda sensor upstream catalyst:
The system constants SY_M5IV00A, SY_M5IV00B SY_M5IV00C a. SY_M5IV00D apply to TID $00.
For the TID $20, $40 to $80 the system constants SY_M5V20A - D, resp. SY_M5V40A - D and so on apply.

Lambda sensor downstream catalyst:
The system constants SY_M5IH00A, SY_M5IH00B SY_M5IH00C a. SY_M5IH00D apply to TID $00.
For the TID $20, $40 to $80 the system constants SY_M5H20A - D, resp. SY_M5H40A - D and so on apply.

```
+--------------+-------------------------+-------------------------+-------------------------+-------------------------+
|O2S upst. cat |    SY_M5IV00A           |    SY_M5IV00B           |    SY_M5IV00C           |   SY_M5IV00D            |
+--------------+-------------------------+-------------------------+-------------------------+-------------------------+
|O2S d.-st cat |    SY_M5IH00A           |    SY_M5IH00B           |    SY_M5IH00C           |   SY_M5IH00D            |
+--------------+-------------------------+-------------------------+-------------------------+-------------------------+
|DATA Byte #:  |           4             |           5             |           6             |           7             |
+--------------+-------------------------+-------------------------+-------------------------+-------------------------+
|Bit:          |  7  6  5  4  3  2  1  0 |  7  6  5  4  3  2  1  0 |  7  6  5  4  3  2  1  0 |  7  6  5  4  3  2  1  0 |
+--------------+-------------------------+-------------------------+-------------------------+-------------------------+
|TID in hex:   | 01 02 03 04 05 06 07 08 | 09 0A 0B 0C 0D 0E 0F 10 | 11 12 13 14 15 16 17 18 | 19 1A 1B 1C 1D 1E 1F 20 |
+--------------+-------------------------+-------------------------+-------------------------+-------------------------+
```

0 = TID n is not supported in Mode $05 (not supported)
1 = TID n is supported in Mode $05 (supported)
The TID’s $20; $40; $60; $80; $A0; $C0 and $E0 are dealt with analogous.
The structure of TID $20 is similar to TID $00, however, only for the TID’s $21 - $40 and so on..

Only values of those Lambda sensors are supported, which were reported in Mode $01 at PID $13 or PID $1D.
If neither PID $13 nor PID $1D is active in Mode $01, then Mode $05 is not supported.

TID $01 and following according to TID $00:
The transfer values are made available by the function "Signal Output Lambda Sensors" (%DLSSA).

ABK TC5MOD 20.30 Abbreviations

ISO: International Organization for Standardization
SAE: Society of Automotive Engineers, Inc.

Variable	**Source**	**Type**	**Description**
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
SY_M5IH00A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH00D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. downst. cat.
SY_M5IH20A	PROKON	EIN	Sys. con. cod. DATA A in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20B	PROKON	EIN	Sys. con. cod. DATA B in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20C	PROKON	EIN	Sys. con. cod. DATA C in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IH20D	PROKON	EIN	Sys. con. cod. DATA D in mode 5 PID $20 acc. to SAE J1979 sen. downstream cat.
SY_M5IV00A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV00D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $00 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV20D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $20 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV40D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $40 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV60D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $60 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80A	PROKON	EIN	Sys. const. cod. DATA A Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80B	PROKON	EIN	Sys. const. cod. DATA B Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80C	PROKON	EIN	Sys. const. cod. DATA C Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.
SY_M5IV80D	PROKON	EIN	Sys. const. cod. DATA D Mode 5 PID $80 acc. to SAE J1979 for sen. upstr. cat.

FW TC5MOD 20.30 Fixed Values

Parameter	**Value**	**Description**

FB TC5MOD 20.30 Detailed description of function

APP TC5MOD 20.30 Application hint

TC6MOD 20.80 Tester communikation CARB; Mode 6

FDEF TC6MOD 20.80 Function definition

Mode $06

Basis of this description is SAE J1979 Mode $06:
Mode $06 enables access to the most current test results and test thresholds of already tested functions. The functions were named by the authority. The misfire detection, the diagnosis of the fuel supply system (DKVS) and of comprehensive components are not taken into consideration.

Communication Protocol:

The protocol driver detects the type of transfer protocol and describes the bit B_isoprot:

B_isoprot = 0   communication according to ISO 9141-2
B_isoprot = 1   communication according to ISO 14230-4

B_isoprot = 0 (communication according to ISO 9141-2):
Only those TID’s are responded to, which are reported as being supported by TID $00.

B_isoprot = 1 (communication according to ISO 14230-4):
When a not supported TID is requested a message (negative response) is created:

No.	Mnemonic	Description
12h	SFNS-IF	requested TID is not supported (subFunctionNotSupported-invalidFormat)

Fault path table for the deactivation in Mode $07
The following configuration table shows, which functions are served by Mode $06, fault codes of these functions are not outputted (masked) in Mode $07.

Functions	Compiler - Conditions	Masked Fault Paths	Fault Code
DKAT(LRS)	(SY_STERHK = false) & (SY_BDE = false) & (SY_M6I00A.Bit 7 = 1)	dfpkat,	CDCKAT
	(SY_STERHK = true) & (SY_BDE = false) & (SY_M6I00A.Bit 7 = 1)	dfpkat, dfpkat2	CDCKAT, CDCKAT2
DKATTH	(SY_STERVK = false) & (SY_BDE = true) & (SY_M6I00A.Bit 7 = 1)	dfpvtk,	CDCVTK
	(SY_STERVK = true) & (SY_BDE = true) & (SY_M6I00A.Bit 7 = 1)	dfpvtk, dfpvtk2	CDCVTK, CDCVTK2
DKATNO	(SY_STERHK = false) & (SY_BDE = true) & (SY_M6I00A.Bit 7 = 1)	dfpkatno	CDCKATNO
	(SY_STERHK = true) & (SY_BDE = true) & (SY_M6I00A.Bit 7 = 1)	dfpkatno, dfpkatno2	CDCKATNO, CDCKATNO2
DLSAHK	(SY_STERHK = false) & (SY_M6I00A.Bit 6 = 1)	dfplash	CDCLASH
	(SY_STERHK = true) & (SY_M6I00A.Bit 6 = 1)	dfplash, dfplash2	CDCLASH, CDCLASH2
DLSA	(SY_STETLR = false) & (SY_STERHK = false) & (SY_M6I00A.Bit 6 = 1)	dfplatv	CDCLATV
	(SY_STETLR = false) & (SY_STERHK = true) & (SY_M6I00A.Bit 6 = 1)	dfplatv, dfplatv2	CDCLATV, CDCLATV2
	(SY_STETLR = false) & (SY_STERVK = false) & (SY_M6I00A.Bit 6 = 1)	dfplatp	CDCLATP
	(SY_STETLR = false) & (SY_STERVK = true) & (SY_M6I00A.Bit 6 = 1)	dfplatp, dfplatp2	CDCLATP, CDCLATP2
DSLSLR(S)	(SY_STERVK = false) & (SY_M6I00A.Bit 5 = 1)	dfpsls, dfpslv	CDCSLS, CDCSLV
	(SY_STERVK = true) & (SY_M6I00A.Bit 5 = 1)	dfpsls, dfpsls2, dfpslv, dfpslv2	CDCSLS, CDCSLS2, CDCSLV, CDCSLV2
DAGRFC(S)	(SY_M6I00A.Bit 4 = 1)	dfpagrf	CDCAGRF
DLDP	(SY_DLDP = 1) & (SY_M6I00A.Bit 3 = 1)	dfpldp, dfptesf, dfptesg,	CDCLDP, CDCTESF, CDCTESG
DTEV	(SY_DTES.Bit 1 = 1) & (SY_M6I00A.Bit 3 = 1)	dfptes	CDCTES

Availability of Data

The data to be transferred are made available by diagnostic functions. The function descriptions of these diagnostic functions are mentioned in the corresponding TID's.

As long as the names of the transfer variables and of the fault paths do not change, this description always refers to the current project-specific version of the diagnostic function.

Diagnostic Functions

The diagnostic functions must store the Mode $06 - values from the last test in the permanent RAM!

In case of initial start, after power-fail or clearing of fault memory, 00 hex must be entered into CID and 0000 hex must be entered into value and threshold as starting value.

```
Data
 Transfer
        When a TID supported by Mode $06 is requested, response is made by 7 DATA bytes.
        DATA #1: 46 hex (= Mode $06)
        DATA #2: Test ID (TID)
        DATA #3: FF hex with TID $00 or Component ID
        DATA #4: MSB of the measured value
        DATA #5: LSB of the measured value
        DATA #6: MSB of the threshold value (Limit)
        DATA #7: LSB of the threshold value (Limit)

        Component ID (CID):
        CID: identifies the individual value blocks,


        a) CID Bit 7 = 0: fault if value > threshold;  example:      ###########  fault range
                                                                     ----------------  threshold
                                                                      xxxxxxxxxxx  o.k. range

           CID Bit 7 = 1: fault if value < threshold;  example:      xxxxxxxxxxx  o.k. range
                                                                     ----------------  threshold
                                                                      ###########  fault range

        b) CID Bit 0 ..6: number of the value block (max 127 possible)


TID $00: Bit-coded transfer of the TID's supported by the ECU.
        TID $00 always needs to be included in mode $06.

   DATA Byte #3: --> $FF

   DATA Bytes #4 - #7
        The SW-modules of the corresponding TID are included in the program dependent on the system constants
        SY_M6I00A, SY_M6I00B, SY_M6I00C and SY_M6I00D.
        It is only possible to decide via an inquiry of the system constants and of the respective bit (B_cd...) whether a TID
        is being supported, since many diagnostic functions have a deactivation possibility via the bit B_cdxyz from CDXYZ.

   The register contents for DATA byte #4 (DATA A) is to be calculated upon tester request (mode $06 TID $00) from SY_M6I00A
   and B_cd...:


   if  (SY_ M6I00A.Bit 7 = 1) & (SY_BDE = false):
        support %DKAT(LRS)

        B_cdkat -------------------------+
        +---+                            |
        | 0 +----------------+           v
        +---+                +---------o --- o--------------------> Register.Bit 7
        SY_ M6I00A.Bit 7 -------------o



   else if  (SY_ M6I00A.Bit 7 = 1) & (SY_BDE = true):
        support %DKATTH and/or %DKATNO

                       +---+
        B_cdkatno ----->| V +------------+
        B_cdvkt ------->|   |            |
        +---+           +---+            v
        | 0 +--------------------------o --- o--------------------> Register.Bit 7
        +---+                +---------o
        SY_ M6I00A.Bit 7 ----+


   else  Register.Bit 7 = 0




   if  (SY_ M6I00A.Bit 6 = 1) & (SY_STETLR = true):
        support %DLSAHK in case of continuous LR

        B_cdlash ------------------------+
        +---+                            |
        | 0 +----------------+           v
        +---+                +---------o --- o--------------------> Register.Bit 6
        SY_ M6I00A.Bit 6 -------------o
```

```
   else if  (SY_ M6I00A.Bit 6 = 1) & (SY_STETLR = false):
        support %DLSAHK and/or DLSA in case of 2-step LR

                     +---+
        B_cdlatp --->|   |
        B_cdlatv --->| v +---------------+
        B_cdlash --->|   |               |
        +---+        +---+               |
        | 0 +----------------+           v
        +---+                +---------o --- o--------------------> Register.Bit 6
        SY_ M6I00A.Bit 6 --------------o

   else  Register.Bit 6 = 0




   if  (SY_ M6I00A.Bit 5 = 1):
        support %DSLSLR(S)

        B_cdsls -------------------------+
        +---+                            |
        | 0 +----------------+           v
        +---+                +---------o --- o--------------------> Register.Bit 5
        SY_ M6I00A.Bit 5 --------------o

   else  Register.Bit 5 = 0




   if  (SY_ M6I00A.Bit 4 = 1):
        support %DAGR*

        B_cdagr -------------------------+
        +---+                            |
        | 0 +----------------+           v
        +---+                +---------o --- o--------------------> Register.Bit 4
        SY_ M6I00A.Bit 4 --------------o

   else  Register.Bit 4 = 0




   if  (SY_ M6I00A.Bit 3 = 1):
        support %DTEV and %DLDP

                               +-+
        SY_DLDP -------------->| |
        B_cdldp -------------->|&+--+   +-+
                         +-+   +-+  +-->|V+--+
        B_cdtes -------->|&+----------->| |  |
        SY_DTES.Bit 1 -->| |            +-+  |
        +---+            +-+                 v
        | 0 +------------------------------o --- o--------------------> Register.Bit 3
        +---+              +---------------o
        SY_ M6I00A.Bit 3 --+

   else  Register.Bit 3 = 0
```

By the following table it is possible to determine, which of the following TID's is being supported:

	Register	SY_M6I00B	SY_M6I00C	SY_M6I00D
DATA Byte #:	4	5	6	7
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
TID in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

Each bit is assigned to a certain TID.
If a bit has the value "0", the accompanying TID is not supported in mode $06.
In case of a bit value of "1", the accompanying TID is supported in mode $06.

If SY_M6I00A.Bit 7 = 1:

TID $01: Catalyst conversion

The values tc6kat* resp. m6* are made available in the project-specific function(s) %DKAT(LRS) resp. %DKATNO and %DKATTH.

The data must have the following structure for the transfer:

```
        | Component ID     |    Measured Value *)        |         Threshold *)        |
        | DATA Byte #3     | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
        |                  |     MSB      |     LSB      |       MSB    |    LSB       |
        +------------------+--------------+--------------+--------------+--------------+
```

When (SY_BDE = false) & (B_cdkat = 1), the following value block is to be transferred:

```
        | tc6katc          |    00 hex    |  tc6katw     |     00 hex   |  tc6kats     |  %DKAT(LRS)
        +------------------+--------------+--------------+--------------+--------------+
```

When (SY_BDE = true) & (B_cdvkt = 1), the following value block is to be transferred:

```
        | m6ckth           |          m6wkth_w           |          m6skth_w           |  %DKATTH
        +------------------+-----------------------------+-----------------------------+
```

When (SY_BDE = true) & (B_cdkatno = 1), the following value block is to be transferred:

```
        | m6katnc          |          m6katnw_w          |          m6katns_w          |  %DKATNO
        +------------------+-----------------------------+-----------------------------+
```

Only 2-bank systems need additionally:

When (SY_BDE = false) & (SY_STERHK = true) & (B_cdkat = 1), the following value block is to be transferred additionally:

```
        | tc6katc2         |    00 hex    |  tc6katw2    |     00 hex   |  tc6kats2    |  %DKAT(LRS)
        +------------------+--------------+--------------+--------------+--------------+
```

When (SY_BDE = true) & (SY_STERVK = true) & (B_cdvkt = 1), the following value block is to be transferred additionally:

```
        | m6ckth2          |         m6wkth2_w           |         m6skth2_w           |  %DKATTH
        +------------------+-----------------------------+-----------------------------+
```

When (SY_BDE = true) & (SY_STERHK = true) & (B_cdkatno = 1), the following value block is to be transferred additionally:

```
        | m6katnc2         |         m6katnw2_w          |         m6katns2_w          |  %DKATNO
        +------------------+-----------------------------+-----------------------------+
```

*) Die values tc6tkatw and tc6kats are made available as 8-bit variables and the value m6*_w as 16-bit variables.
The available 8 bit variables for value and threshold must be expanded to 16 bit variables.
That means: 00hex must be entered into the MSB.
The sequence MSB LSB (see table) must by all means be adhered to during the transfer to the tester!

Endif

If SY_M6I00A.Bit 6 = 1:

TID $02: Lambda sensor monitoring
The values for mode $06 are made available in the project-specific functions %DLSA and %DLSAHK.

The data must have the following structure for the transfer:

```
| Component ID   |    Measured Value *)        |         Threshold *)        |
| DATA Byte #3   | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
|                |     MSB      |     LSB      |      MSB     |     LSB      |
+----------------+--------------+--------------+--------------+--------------+
```

When (B_cdlash = 1), the following 2 value blocks are to be transferred:

```
| m6cshkf        |     00       |    m6wshkf   |      00      |    m6sshkf   |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
| m6cshkm        |     00       |    m6wshkm   |      00      |    m6sshkm   |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
```

When (B_cwlshdyn = 1), the following value block is to be transferred:

```
| m6clsdy        |     00       |    m6wlsdy   |      00      |    m6slsdy   |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
```

When (B_cwlshsch = 1), the following value block is to be transferred additionally:

```
| m6clsch        |     00       |    m6wlsch   |      00      |    m6slsch   |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
```

When (SY_STETLR = false) & (B_cdlatp = 1), the following value block is to be transferred:

```
| m6ctp          |           m6wtp_w           |           m6stp_w           |   %DLSA
+----------------+--------------+--------------+--------------+--------------+
```

When (SY_STETLR = false) & (B_cdlatv = 1), the following value block is to be transferred:

```
| m6catv         |     00       |    m6watv    |      00      |    m6satv    |   %DLSA
+----------------+--------------+--------------+--------------+--------------+
```

For 2-bank systems the following value blocks in dependency on the accompanying enable bits are to be transferred additionally:

```
| Component ID   |    Measured Value *)        |         Threshold *)        |
| DATA Byte #3   | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
|                |     MSB      |     LSB      |      MSB     |     LSB      |
+----------------+--------------+--------------+--------------+--------------+
```

When (SY_STERHK = true) & (B_cdlash = 1), the following 2 value blocks are to be transferred additionally:

```
| m6cshkf2       |     00       |    m6wshkf2  |      00      |    m6sshkf2  |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
| m6cshkm2       |     00       |    m6wshkm2  |      00      |    m6sshkm2  |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
```

When (SY_STERHK = true) & (B_cwlshdyn = 1), the following value block is to be transferred additionally:

```
| m6clsdy2       |     00       |    m6wlsdy2  |      00      |    m6slsdy2  |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
```

When (SY_STERHK = true) & (B_cwlshsch = 1), the following value block is to be transferred additionally:

```
| m6clsch2       |     00       |    m6wlsch2  |      00      |    m6slsch2  |   %DLSAHK
+----------------+--------------+--------------+--------------+--------------+
```

When (SY_STETLR = false) & (SY_STERVK = true) & (B_cdlatp = 1), the following value block is to be transferred additionally:

```
| m6ctp2         |           m6wtp2_w          |            m6stp2_w         |   %DLSA
+----------------+-----------------------------+-----------------------------+
```

When (SY_STETLR = false) & (SY_STERHK = true) & (B_cdlatv = 1), the following value block is to be transferred additionally:

```
| m6catv2        |       00     |    m6watv2   |      00      |    m6satv2   |   %DLSA
+----------------+--------------+--------------+--------------+--------------+
```

*) The variables m6w*_w and m6s*_w are made available as 16-bit variables.
The available 8 bit variables for value and threshold must be expanded to 16 bit variables.
That means: 00hex must be entered into the MSB.
The sequence MSB LSB (see table) must by all means be adhered to during the transfer to the tester!

Endif

If SY_M6I00A.Bit 5 = 1:

TID $03 Secondary-air system
The values for m6*msl* are made available in the project-specific function %DSLSLR(S).

The data must have the following structure for the transfer:

```
        | Component ID     |    Measured Value *)        |         Threshold *)        |
        | DATA Byte #3     | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
        |                  |     MSB      |    LSB       |       MSB    |    LSB       |
        +------------------+--------------+--------------+--------------+--------------+
```

TID $03 is only to be supported when (B_cdsls = 1):

```
        | m6cmsl           |          m6wmsl_w           |          m6smsl_w           |
        +------------------+-----------------------------+-----------------------------+
```

When (B_cwdslt = 1), the following value block is to be transferred additionally:

```
        | m6cmslv          |         m6wmslv_w           |          m6smslv_w          |
        +------------------+-----------------------------+-----------------------------+
```

For 2-bank systems where(SY_STERVK = true) the following applies additionally:

```
        | Component ID     |    Measured Value *)        |         Threshold *)        |
        | DATA Byte #3     | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
        |                  |     MSB      |    LSB       |       MSB    |    LSB       |
        +------------------+--------------+--------------+--------------+--------------+
```

When (SY_STERVK = true)& (B_cdsls = 1), the following value block is to be transferred additionally:

```
        | m6cmsl2          |         m6wmsl2_w           |          m6smsl2_w          |
        +------------------+-----------------------------+-----------------------------+
```

When (SY_STERVK = true) & (B_cwdslt = 1) the following value block is to be transferred additionally:

```
        | m6cmslv2         |         m6wmslv2_w          |          m6smslv2_w         |
        +------------------+-----------------------------+-----------------------------+
```

*) The variables m6wmsl*_w and m6smsl*_w are made available as 16-bit variables.
The sequence MSB LSB (see table) must by all means be adhered to during the transfer to the tester!

Endif

If SY_M6I00A.Bit 4 = 1:

TID $04 Exhaust-gas recirculation system
The values m6*agrf are made available by the project-specific function %DAGRFC(S).

The data must have the following structure for the transfer:

```
        | Component ID     |    Measured Value *)        |         Threshold *)        |
        | DATA Byte #3     | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
        |                  |     MSB      |    LSB       |       MSB    |    LSB       |
        +------------------+--------------+--------------+--------------+--------------+
```

TID $04 is only to be supported when (B_cdagr = 1):

```
        | m6cagrf          |           m6wagrf_w         |           m6sagrf_w         |
        +------------------+-----------------------------+-----------------------------+
```

*) The variables m6wagrf_w and m6sagrf_w are made available as 16-bit variables.
The sequence MSB LSB (see table) must by all means be adhered to during the transfer to the tester!

Endif

If SY_M6I00A.Bit 3 = 1:

TID $05 Purge control system
The values tc6ldp* and tc6tes* are made available by the project-specific functions %DLDP and %DTEV.

The data must have the following structure for the transfer:

```
        | Component ID     |    Measured Value *)        |         Threshold *)        |
        | DATA Byte #3     | Data Byte #4 | Data Byte #5 | Data Byte #6 | Data Byte #7 |
        |                  |     MSB      |     LSB      |      MSB     |     LSB      |
        +------------------+-------------+-------------+-------------+-------------+

When (SY_DTES.Bit 1 = 1) & (B_cdtes = 1), the following value block is to be transferred:

        | tc6tesc          |          tc6tesw            |          tc6tess            |   %DTEV
        +------------------+----------------------------+----------------------------+

When (SY_DLDP = 1) & (B_cdldp = 1), the following value block is to be transferred:

        | tc6ldpc          |          tc6ldpw            |          tc6ldps            |   %DLDP
        +------------------+----------------------------+----------------------------+

        *) The variables tc6tes* and tc6ldp* are made available as 16-bit variables.
           The sequence MSB LSB (see table) must by all means be adhered to during the transfer to the tester!

Endif
```

ABK TC6MOD 20.80 Abbreviations

```
ISO:  International Organization for Standardization
SAE:  Society of Automotive Engineers, Inc.
ID:   Identification
CID:  Component ID
TID:  Test ID
MSB:  Most Significant Byte
LSB:  Least Significant Byte

dfpxyz: Diagnostic fault path of the function xyz
```

Parameter	**Source-X**	**Source-Y**	**Type**	**Description**
SY_BDE			SYS	system constant GDI
SY_DLDP			SYS	SY_DLDP = 1 there ist a DLDP in system
SY_DTES			SYS	system constant diagnosis evap system

Variable	**Source**	**Type**	**Description**
B_CDAGR	PROKON	EIN	function active per codeword CDAGR
B_CDKAT	PROKON	EIN	function active per codeword CDKAT
B_CDKATNO		EIN	function active via codeword CWDKATNO
B_CDLASH	PROKON	EIN	function active per codeword CDLASH
B_CDLATP	PROKON	EIN	function active per codeword CDLATP
B_CDLATV	PROKON	EIN	function active per codeword CDLATV
B_CDLDP	PROKON	EIN	function active per codeword CDLDP
B_CDSLS	PROKON	EIN	function active per codeword CDSLS
B_CDTES	PROKON	EIN	function active per codeword CDTES
B_CDVKT		EIN	function DKATTH active per euro switch
B_CWDSLT		EIN	Condition: enable valve tightness
B_CWLSHDYN		EIN	cond. disabling of partial func. dynmics check of sensor downstream cat. %DLSAHK
B_CWLSHSCH		EIN	cond. disabling of partial func. fuel cut-off for sensor downstream cat. %DLSAHK
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
M6CATV	DLSA	EIN	Mode 6-Memory: Comp. ID for check Lambda sensor aging TV
M6CATV2	DLSA	EIN	Mode 6-Memory: Comp. ID for check Lambda sensor aging TV on bank 2
M6CKTH		EIN	Mode 6-Memory: Comp. ID for thermal catalyst monitoring
M6CKTH2		EIN	Mode 6-Memory: Comp. ID for thermal catalyst monitoring bank 2
M6CLSCH	DLSAHK	EIN	Mode 6-Memory: Comp. ID sensor voltage during fuel cut-off downstream cat.
M6CLSCH2	DLSAHK	EIN	Mode 6-Memory: Comp. ID sensor voltage during fuel cut-off downstream cat. bank2
M6CLSDY	DLSAHK	EIN	Mode 6-Memory: Comp. ID dynamic response measurement for sensor downstream cat
M6CLSDY2	DLSAHK	EIN	Mode 6-Memory: Comp. ID dyn. resp. measurement for sensor downstream cat. bank2
M6CMSL		EIN	Mode 6 - memory: Component ID for SAI- mass test
M6CMSL2		EIN	Mode 6 - memory: Component ID for SAI- mass test, bank 2
M6CMSLV		EIN	Mode 6 - memory: Component ID for SAI- tightness test
M6CMSLV2		EIN	Mode 6 - memory: Component ID for SAI- tightness test, bank 2
M6CSHKF	DLSAHK	EIN	Mode 6-Memory: Comp. ID rich volt. for sensor downstream cat.(osci. test)
M6CSHKF2	DLSAHK	EIN	Mode 6-Memory: Comp. ID rich volt. for sensor downstream cat.(osci. test) bank2
M6CSHKM	DLSAHK	EIN	Mode 6-Memory: Comp. ID lean volt. for sensor downstream cat.(osci. test)
M6CSHKM2	DLSAHK	EIN	Mode 6-Memory: Comp. ID lean volt. for sensor downstream cat.(osci. test) bank2
M6CTP	DLSA	EIN	Mode 6-Memory: Comp. ID for check Lambda sensor aging TP
M6CTP2	DLSA	EIN	Mode 6-Memory: Comp. ID for check Lambda sensor aging TP on bank 2
M6KATNC		EIN	output code SCAN-tool mode 6 from NOx cat. diagnosis
M6KATNS_W		EIN	output threshold SCAN-tool mode 6 from NOx cat. diagnosis
M6SATV	DLSA	EIN	Mode 6-Memory: Threshold value with Lambda sensor aging TV
M6SATV2	DLSA	EIN	Mode 6-Memory: Threshold value with Lambda sensor aging TV on bank 2
M6SKTH2_W		EIN	Mode 6 - memory: Threshold value for thermal catalyst monitoring bank 2
M6SKTH_W		EIN	Mode 6 - memory: Threshold value for thermal catalyst monitoring
M6SLSCH	DLSAHK	EIN	Mode 6-Memory: Threshold sensor voltage during fuel cut-off downstream cat.
M6SLSCH2	DLSAHK	EIN	Mode 6-Memory: Threshold sensor volt. during fuel cut-off downstream cat. bank2
M6SLSDY	DLSAHK	EIN	Mode 6-Memory: Threshold dynamic response measurement for sensor downstream cat.
M6SLSDY2	DLSAHK	EIN	Mode 6-Memory: Threshold dyn. resp. measurement for sensor downstream cat. bank2
M6SMSL2_W		EIN	Mode 6 - memory: Threshold value for test of auxiliary air mass, Bank 2
M6SMSLV2_W		EIN	Mode 6 - memory: Threshold value for valve tightness testing, Bank 2
M6SMSLV_W		EIN	Mode 6 - memory: Threshold value for valve tightness testing

Variable	Source	Type	Description
M6SMSL_W		EIN	Mode 6 - memory: Threshold value for test of auxiliary air mass
M6SSHKF	DLSAHK	EIN	Mode 6-Memory: Threshold rich volt. for sensor downstream cat.(osci. test)
M6SSHKF2	DLSAHK	EIN	Mode 6-Memory: Threshold rich volt. for sensor downstream cat.(osci. test) bank2
M6SSHKM	DLSAHK	EIN	Mode 6-Memory: Threshold lean volt. for sensor downstream cat.(osci. test)
M6SSHKM2	DLSAHK	EIN	Mode 6-Memory: Threshold lean volt. for sensor downstream cat.(osci. test) bank2
M6STP2_W	DLSA	EIN	Mode 6-Memory: Threshold value with Lambda sensor aging TP on bank 2
M6STP_W	DLSA	EIN	Mode 6-Memory: Threshold value with Lambda sensor aging TP
M6VKANW_W		EIN	verified mode6 result from NOx-catalyst monitoring for SCAN-Tool
M6WATV	DLSA	EIN	Mode 6-Memory: Measured value Lambda sensor aging TV
M6WATV2	DLSA	EIN	Mode 6-Memory: Measured value Lambda sensor aging TV on bank 2
M6WKTH2_W		EIN	Mode 6 - memory: Measured value of relative faults therm. catalyst monit. bank 2
M6WKTH_W		EIN	Mode 6 - memory: Measured value of relative faults thermal catalyst monitoring
M6WLSCH	DLSAHK	EIN	Mode 6-Memory: Measured value sensor voltage during fuel cut-off downstream cat.
M6WLSCH2	DLSAHK	EIN	Mode 6-Mem.: Measured value sensor volt. during fuel cut-off downst. cat. bank2
M6WLSDY	DLSAHK	EIN	Mode 6-Mem.: Measured value dyn. resp. measurement for sensor downst. cat.
M6WLSDY2	DLSAHK	EIN	Mode 6-Mem.: Measured value dyn. resp. measurement for sensor downst. cat. bank2
M6WMSL2_W		EIN	Mode 6 - memory: Measurement value of SAI- mass flow, bank 2
M6WMSLV2_W		EIN	Mode 6 - memory: Measurement value tightness, bank 2
M6WMSLV_W		EIN	Mode 6 - memory: Measurement value valve tightness
M6WMSL_W		EIN	Mode 6 - memory: Measurement value of SAI- mass flow
M6WSHKF	DLSAHK	EIN	Mode 6-Mem.: Measured value rich volt. for sensor downst. cat.(osci.test)
M6WSHKF2	DLSAHK	EIN	Mode 6-Mem.: Measured value rich volt. for sensor downst. cat.(osci.test) bank2
M6WSHKM	DLSAHK	EIN	Mode 6-Mem.: Measured value lean volt. for sensor downstr. cat.(osci.test)
M6WSHKM2	DLSAHK	EIN	Mode 6-Mem.: Measured value lean volt. for sensor downstr. cat.(osci.test) bank2
M6WTP2_W	DLSA	EIN	Mode 6-Mem.: Measured value Lambda sensor aging TP on bank 2
M6WTP_W	DLSA	EIN	Mode 6-Mem.: Measured value Lambda sensor aging TP
SY_M6I00A	PROKON	EIN	System constant coding from DATA A in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00B	PROKON	EIN	System constant coding from DATA B in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00C	PROKON	EIN	System constant coding from DATA C in Mode $06 PID $00 acc. to SAE J1979
SY_M6I00D	PROKON	EIN	System constant coding from DATA D in Mode $06 PID $00 acc. to SAE J1979
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
SY_STERVK	PROKON	EIN	system constant condition: stereo exhaust system upstream of cat
SY_STETLR	PROKON	EIN	System constant condition continuous Lambda control present
TC6KATC	DKAT	EIN	output code SCAN-tool mode 6 from catalyst diagnosis
TC6KATC2	DKAT	EIN	output code SCAN-tool mode 6 from catalyst diagnosis, bank 2
TC6KATS	DKAT	EIN	output threshold SCAN-tool mode 6 from catalyst diagnosis
TC6KATS2	DKAT	EIN	output threshold SCAN-tool mode 6 from catalyst diagnosis
TC6KATW	DKAT	EIN	output test threshold SCAN-tool mode 6 from catalyst diagnosis
TC6KATW2	DKAT	EIN	output test threshold SCAN-tool mode 6 from catalyst diagnosis, bank 2
TC6LDPC		EIN	Output of code SCAN-Tool Mode 6 from LDP-diagnosis
TC6LDPS		EIN	Output of threshold value SCAN-Tool Mode 6 from LDP-diagnosis
TC6LDPW		EIN	Output of test value SCAN-Tool Mode 6 from LDP-diagnosis
TC6TESC	DTEV	EIN	Output code SCAN tool mode 6 from purge control diagnosis
TC6TESS	DTEV	EIN	Output threshold SCAN tool mode 6 from purge control diagnosis
TC6TESW	DTEV	EIN	Output check value SCAN tool mode 6 from purge control diagnosis

FW TC6MOD 20.80 Fixed Values

Parameter	Value	Description

FB TC6MOD 20.80 Detailed description of function

APP TC6MOD 20.80 Application hint

Application of the diagnostic thresholds is performed in the respective diagnostic functions.

TC8MOD 20.20 Tester communikation CARB; Mode 8

FDEF TC8MOD 20.20 Function definition

```
Mode $08

        Basis of this section is SAE J1979 Mode 8 (as at June 95):
        Mode 8 makes it possible to activate component and system tests.
        Each request of various actions (e.g. close and open valves, test duration etc.) is performed out of the project-specific
        basic and diagnostic functions.

Communication
        The protokoll driver verifies the transfer protocol and sets the Bit B_isoprot as follows:

        B_isoprot = 0   communication according to ISO 9141-2
        B_isoprot = 1   communication according to ISO 14230-4
```

B_isoprot = 0 (communication according to ISO 9141-2):
Only those TID's are responded to, which are reported as being supported by TID $00.

B_isoprot = 1 (communication according to ISO 14230-4):
When a not supported TID is requested a message (negative response) is created:

No.	Mnemonic	Description
12h	SFNS-IF	requested TID is not supported (subFunctionNotSupported-invalidFormat)

Data Transfer
When a TID supported by Mode $08 is requested, response is made by 7 DATA bytes.
DATA #1: 48 hex (= Mode $08)
DATA #2: Test ID (TID)
DATA #3 to DATA #7: see respective TID

TID $00:Bit-coded transfer of the TIDs supported by the ECU.
TID $00 must always be contained in Mode $08.

The DATA - bytes #3 - #7 are also called DATA A - E.
DATA A must be dated to $00 hex

DATA B - E correspond to the system constants SY_M8I00B - SY_M1I00E.
Utilization of the system constants SY_M8I00B, SY_M8I00C, SY_M8I00D a. SY_M8I00E:

	SY_M8I00B	SY_M8I00C	SY_M8I00D	SY_M8I00E
DATA:	B	C	D	E
Bit:	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
TID in hex:	01 02 03 04 05 06 07 08	09 0A 0B 0C 0D 0E 0F 10	11 12 13 14 15 16 17 18	19 1A 1B 1C 1D 1E 1F 20

0 = TID n is not supported in Mode 8
1 = TID n is supported in Mode 8
The TID's $20; $40; $60; $80; $A0; $C0 and $E0 are dealt with analogous.
The structure of TID $20 is similar to TID $00, however, for the TID's $21 - $40 and so on.

TID $01:Purge Control System; Leak Test
Bit B_m8te is set when Mode 8 and TID $01 are requested.
The bit B_m8te must remain set until the triggered test function resets it again.

The Control Unit answers the tester with:
DATA #1 + DATA #2: as described in chapter data transfer,
DATA #3 - Data #7: 5 times 00 hex

ABK TC8MOD 20.20 Abbreviations

ISO: International Organization for Standardization
SAE: Society of Automotive Engineers, Inc.

Variable	Source	Type	Description
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
B_M8TE	TC8MOD	AUS	condition to enable function evap system by SAE J1879 Mode 8 TID $01
SY_M8I00B	PROKON	EIN	System constant coding from DATA B in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00C	PROKON	EIN	System constant coding from DATA C in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00D	PROKON	EIN	System constant coding from DATA D in Mode 8 PID $00 acc. to SAE J1979
SY_M8I00E	PROKON	EIN	System constant coding from DATA E in mode 8 PID $00 according to SAE J1979

FW TC8MOD 20.20 Fixed Values

Parameter	Value	Description

FB TC8MOD 20.20 Detailed description of function

APP TC8MOD 20.20 Application hint

TC9MOD 10.10 Tester communication CARB; Mode 9, Request vehicle information

FDEF TC9MOD 10.10 Function definition

No text for FDEF available!

ABK TC9MOD 10.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
FA_CALID			TX	

Variable	Source	Type	Description
B_ISOPROT		EIN	tester protocol by ISO-standards ISO 14230-4
SY_M9I00A		EIN	System constant coding from DATA A in Mode $09 VIT $00 acc. to SAE J1979

Variable	Source	Type	Description
SY_M9I00B		EIN	System constant coding from DATA B in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00C		EIN	System constant coding from DATA C in Mode $09 VIT $00 acc. to SAE J1979
SY_M9I00D		EIN	System constant coding from DATA D in Mode $09 VIT $00 acc. to SAE J1979

FW TC9MOD 10.10 Fixed Values

Parameter	Value	Description

FB TC9MOD 10.10 Detailed description of function

APP TC9MOD 10.10 Application hint

TCSORT 3.30 Tester communicstion CARB; sort function

FDEF TCSORT 3.30 Function definition

Due to function-specific features the fault code memory (FCM) contains too much information for the user of a SCAN TOOL.

The method of misfire detection can be taken as example here:
Due to the detection strategy as a rule total faults (dfpmd) and single faults (dfpmd0x, x = event number (Zündereignisnummer ZEN)) are stored.
The ZEN shows the cylinder number via the firing order.
The CARB, however, explicitly prohibits the output of 'multiple misfire' to the SCAN-TOOL for misfire on only one cylinder.
The output of fault codes to the SCAN-TOOL can therefore not take place 1:1 from the fault memory in case of misfire detection.

Via the code word CWERFIL it is possible to chose 1 of 2 sorting versions. The result of the sorting can be seen in the following table (example for 3 cylinders).

CWERFIL = 0 dec; version A: Indicates only the multiple code for misfire on several cylinders and for 1 cylinder with misfire it indicates the code for this cylinder.
CWERFIL = 1 dec; version B: Indicates the multiple code for misfire on several cylinders and the code for the individual cylinders.

Generally the following applies to both versions for the fault output:
If only a single cylinder has misfire then only the code for this cylinder may be outputted to the SCAN TOOL with regard to misfire fault code.

Below a distinction between version A and B is made.

Version A (CWERFIL = 0):
As soon as misfires were detected on more than 1 cylinder and these were stored as fault paths in the FCM, a distinction must be made according to Mode 3 and Mode 7 dependent on the fault entry status fes.dauer.
Example: (dfpmd: (fes.dauer = 1)) & (dfpmd0a: (fes.dauer = 0)) & (dfpmd0b: (fes.dauer = 0))
That corresponds to case 3 in the table below: During the 1st driving cycle cylinder a has misfires and during the 2nd driving cycle cylinder b, without a fault healing detection being performed in the meantime.
==> Mode 3 and Mode 1 PID $01 point to dfpmd. In Mode 7 no indication takes place.

Otherwise the following applies to version A:
If more than 1 misfire fault is given for the individual modes then only the SAE-code (CDCMD) for the multible faultcode is to be outputted in the respective mode instead of the SAE-code (CDCMD01-n) for the single cylinders.

Version B (CWERFIL = 1):
In contrast to version A, version B outputs the multiple (CDCMD) code for misfires on several cylinders and the codes of the misfiring single cylinders (CDCMD00 - CDCMDnn).

Table: Example for 3 cylinders (cyl. a, cyl. b + cyl. c)

	Misfire fault stored in the FCM				Version A CWERFIL = 0		Version B CWERFIL = 1	
case	mult.	cyl. a	cyl. b	cyl. c	GST_M7	GST_M3	GST_M7	GST_M3
1	dfpmd_u	dfpmd0a_u	---	---	30a	---	30a	---
2	dfpmd_u	dfpmd0a_u	dfpmd0b_u	---	300	---	300, 30a, 30b	---
3	dfpmd_e	dfpmd0a_u	dfpmd0b_u	---	---	300_f	30a, 30b	300_f
4	dfpmd_e	dfpmd0a_e	dfpmd0b_u	---	---	300_f	30b	300_f, 30a
5	dfpmd_e	dfpmd0a_e	---	---	---	30a_f	---	30a_f
6	dfpmd_e	dfpmd0a_e	dfpmd0b_e	---	---	300_f	---	300_f, 30a, 30b
7	dfpmd_u	---	---	---	300	---	300	---
8	dfpmd_e	---	---	---	---	300_f	---	300_f
9	dfpmd_e	dfpmd0a_u	dfpmd0b_u	dfpmd0c_e	---	300_f	30a, 30b	300_f, 30c

```
Explanations:
GST_M7      = Display Generic Scan Tool Mode 7
GST_M3      = Display Generic Scan Tool Mode 3
dfpmd_u     = Misfire not debounced detected (pending)
dfpmd_e     = Misfire debounced detected (MIL on)
dfpmda/b/c = Misfire on cyl. a, b or c detected
300         = Multiple code
30a         = Code for cylinder a
30b         = Code for cylinder b
***_f       = code to the freeze frame 00   (e.g. 30b_f)
```

Effects on other functions

The result of this sorting function affects the following modes when outputted to the SCAN TOOL:

```
Mode 1  PID $01 DATA A: Output of the number of faults                                  -->%TC1MODx.y
Mode 2                  Output 'Freeze frame'                                           -->%TC2MODx.y
Mode 3                  Output of the debounced faults                                  -->%SCATTx.y
Mode 7                  Output of the not debounced faults                              -->%SCATTx.y
```

ABK TCSORT 3.30 Abbreviations

fes.dauer = 1: Fault has resp. had switched on the MIL
fes.scatt = 1: Fault entry is visible for SCAN TOOL only
fes.dauer and fes.scatt are described in more detail in the DFPM x.y.

Parameter	Source-X	Source-Y	Type	Description
CWERFIL			FW	Codeword for selection of misfire fault codes for output to scan tool

Variable	Source	Type	Description
CW_ERFIL	PROKON	EIN	Status codeword for selection of misfire fault codes for output to scan tool

FW TCSORT 3.30 Fixed Values

Parameter	Value	Description
CWERFIL		Codeword for selection of misfire fault codes for output to scan tool

FB TCSORT 3.30 Detailed description of function

APP TCSORT 3.30 Application hint

Appl.- Tools: VS100 and Generic Scan tool

Version selection
Via the code word CWERFIL (see %PROKONx.y) it is possible to select a sorting version.
CWERFIL = 0 dec: Version A
CWERFIL = 1 dec: Version B
Which version is active can be seen by means of the RAM-cell cw_erfil.
When data of CWERFIL are changed they are only accepted if B_ini = 1, that means a change of version is only possible if ignition on/off (INI).

Attention!
After a change from version A to B and vice versa, the fault code memory needs to be cleared and the misfire/s must be generated again.

TCKOMUE 1.20 Tester communication CARB; Communication structure overview

FDEF TCKOMUE 1.20 Function definition

Für die Kommunikation mit einem Generic Scan Tool sind mehrere Reizungsarten freigegeben. Die Steuergeräte von RB unterstützen die Kommunikation entsprechend den Normen ISO 9141-2 und ISO 14230-4.

ISO 9141-2: ist seit Einführung der OBDII - Bestimmungen bei RB - Steuergeräten im Einsatz,
ISO 14230-4 per WUP (fast Ini.) bzw. per 5Baud (slow Ini.): Scan Tool Kommunikation über KWP2000

Ein Generic Scan Tool darf mit verschiedenen Reizungsarten versuchen, eine Kommunikation mit den im Fahrzeug verbauten Steuergeräten aufzubauen.
Die behördenrelevanten Steuergeräte müssen mindestens auf eine Reizungsart (Kommunikationsprotokoll) antworten.

Abhängig von der Systemkonstante SY_INI_OBD kann die jeweilige Reizungsart in die SG - Software implementiert werden.

```
+-----------+--------------------------------------------------------+
|SY_INI_OBD | unterstützte Reizungsarten (Protokolle)                |
+-----------+--------------------------------------------------------+
|   0       | ISO 14230-4 per WUP (fast Ini) und ISO 9141-2 per 5Baud |
+-----------+--------------------------------------------------------+
|   1       | ISO 14230-4 per 5Baud                                  |
+-----------+--------------------------------------------------------+
|   2       | ISO 9141-2 per 5Baud                                   |
+-----------+--------------------------------------------------------+
|   3       | ISO 14230-4 per WUP (fast Ini.)                        |
+-----------+--------------------------------------------------------+
|   4       | kein CARB-Protokoll                                    |
+-----------+--------------------------------------------------------+
```

Wichtiger Hinweis:

Antwortet ein Steuergerät eine bestimmte Reizungsart, so müssen alle behördenrelevanten Steuergeräte in diesem Fahrzeug dieses Protokoll unterstützen!

ABK TCKOMUE 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_INI_OBD			SYS	system constant to select the communication protocols for scan tool operation

FW TCKOMUE 1.20 Fixed Values

Parameter	Value	Description

FB TCKOMUE 1.20 Detailed description of function

APP TCKOMUE 1.20 Application hint

CAN 89.80 CAN signal list

FDEF CAN 89.80 Function definition

No text for FDEF available!

ABK CAN 89.80 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
BOLATZ			FW	
CANINDLY			FW	
CBUSOFF			FW	
CMUTE			FW	
CWCAN			FW	
DMIGSL			FW	offset to SGS reduced torque demand for air path
DMIVW			FW	Wichtung Verlustmoment Offset Luftpfad
MDIMX			FW	maximum limit indicated engine torque
MSRMX			FW	
NGANGMIN			FW	minimum engine speed for gear detection
RAMDASR			FW	ramp steepness during advancement of ASR torque request
RAMPASR			FW	ramp steepness during advancement of ASR torque request
RAMPKUP			FW	ramp steepness during advancement of KUP torque request
TDCAN			FW	
TOCKUP			FW	Selespeed message. switch to default-values
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
B_ANF_KUP		EIN	CAN-signal: bit shift phase (B_ANF_KUP) from el. clutch
B_ASC1NEW		EIN	condition CAN-ASC1 message current receive
B_ASRFZ	PROKON	EIN	Condition for ASR in the automobile
B_ASR_C		EIN	CAN-signal: condition for external ASR-request
B_AUTGET	PROKON	EIN	condition automatic gearbox

Variable	Source	Type	Description
B_BUSOFF		EIN	
B_CASRLVAL		EIN	CAN message from ASR is valid
B_CASRSVAL		EIN	CAN message from ASR is valid
B_CMSRVAL		EIN	CAN message from MSR is valid
B_CMUTE	CAN	AUS	
B_CVT	PROKON	EIN	Condition continuously variable transmission
B_DKNOLU	SWADAP	EIN	condition: power supply of throttle actuator cut off
B_DKPU	SWADAP	EIN	condition: safety fuel cut-off due to unknown or wrong throttle blade position
B_KL15		EIN	condition ignition switch on
B_KUP1NEW		EIN	condition CAN-KUP1-message received
B_MSR_C		EIN	CAN-signal: condition for external MSR-request
B_NOMSR_FR	CAN	AUS	No ASR-/MSR intervention from FR
B_NOMSR_UM	UFUE	EIN	MSR moment required not used in function monitoring
B_NOSGS_FR	CAN	LOK	No SGS intervention from FR
B_NOSGS_UM	UFSGSC	EIN	SGS moment required not transferred to function monitoring
B_NPBUOF	CAN	AUS	
B_SELESPED		EIN	condition: car with selespeed
B_SGSERH_C		EIN	condition: increased torque intervention f. eng. speed synchr. during gear shift
B_SGSKON_C		EIN	condition: constant torque intervention for eng. speed synchr. during gear shift
B_SGSRED	CAN	AUS	condition: reducing torque intervention for eng. speed synchr. during gear shift
B_SGSRED_C		EIN	condition: reducing torque intervention for eng. speed synchr. during gear shift
B_SIMUTE	CAN	AUS	
B_TDCAN	CAN	AUS	
B_TOCASR1	CAN	LOK	ASR1 message timeout - default values used
B_TOCKUP	CAN	LOK	Selespeed message timeout - default values used
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_NOSERE		EIN	
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_BUOF	CAN	AUS	
E_BUSOFF	CAN	AUS	
E_CAS	DCAS	EIN	errorflag: CAN-interface, timeout ASC
E_CKUP		EIN	error flag: CAN-bus, timeout clutch
E_MUTE	CAN	AUS	
GANG_KUP	CAN	AUS	current gear received via CAN for F1 transmission
MDVERL_W	MDVER	EIN	Resistant torque of the engine
MIASRL_C		EIN	CAN-signal: request ”slow ASR intervention”
MIASRL_W	CAN	AUS	desired indicated torque from ASR for slow intervention
MIASRS_C		EIN	CAN-signal: request ”fast ASR intervention”
MIASRS_W	CAN	AUS	desired indicated torque from ASR for quick intervention
MIGSL_W	CAN	AUS	desired internal torque for charge limitation during GS.
MIGS_W	CAN	AUS	desired indicated torque form GS for quick intervention
MIMSR_C		EIN	CAN-signal: request ”MSR intervention”
MIMSR_W	CAN	AUS	desired indicated torque from MSR
MISGSL_W	CAN	AUS	desired internal torque (air path) for engine speed synchr. during gear shift
MISGS_C		EIN	indicated torque request from SGS
MISGS_W	CAN	AUS	desired internal torque for engine speed synchronization during gear shift
NMOT_W	SWADAP	EIN	engine speed
STAT_MD_E	CAN	AUS	CAN signal: Status torque intervention
S_ASR	CAN	AUS	status ASR-active via CAN
S_MSR	CAN	AUS	input signal MSR
UB	SWADAP	EIN	battery voltage
ZWOUT	ZUE	EIN	Ignition angle output value
ZWSPAE	ZWMIN	EIN	retarded ignition angle
Z_BUOF	CAN	AUS	
Z_MUTE	CAN	AUS	

FW CAN 89.80 Fixed Values

Parameter	Value	Description
BOLATZ		
CANINDLY		
CBUSOFF		
CMUTE		
CWCAN		
DMIGSL		offset to SGS reduced torque demand for air path
DMIVW		Wichtung Verlustmoment Offset Luftpfad
MDIMX		maximum limit indicated engine torque
MSRMX		
NGANGMIN		minimum engine speed for gear detection
RAMDASR		ramp steepness during advancement of ASR torque request
RAMPASR		ramp steepness during advancement of ASR torque request
RAMPKUP		ramp steepness during advancement of KUP torque request
TDCAN		
TOCKUP		Selespeed message. switch to default-values
UBDCAN		battery voltage threshold for diagnosis of CAN-Timeout

FB CAN 89.80 Detailed description of function

APP CAN 89.80 Application hint

DCINS 8.30 Diagnostics; CAN timeout instrument (Combi)

FDEF DCINS 8.30 Function definition

```
             Prüfkriterien:  Keine CAN-Botschaft INSTR1: B_ins1new = 0
                             für t > TDCINS und Ub > UBDCAN und B_kl15 = EIN und kein Busoff und kein Mute

             Fehlerheilkriterien:  Bedingungen sind nicht erfüllt

             Ersatzgrößen: S_fst = 0 ;
```

```
            +--------+          +-+
E_busoff -->|        |          | |
            |  > 1   |o--+----->| |
B_cmute --->|  -     |   |      | |
            +--------+   |      | |
                         |      | |
B_flbc ------------------|----->|&|
          +----------+   |      | |
ub ------>| > UBDCAN +---|--+-->| |     retrigger
          +----------+   |  |   | |   +-------------+
B_kl15 ------------------|--|-->| +-->| t > TDCINS  +---------------------------------------------------+------------> B_sicins
                         |  |   | |   +-------------+                                                   |
B_ins1new ------------+--|--|->O| |                                                                     |
                      |  |  |   | |                                                                     |
B_tdcan --------------|--|--|-->| |                                                                     |
                      |  |  |   | |                                                                     |
                      |  |  |   +-+                                  +-+                                |
                      |  |  +--------------------------------------->| |                                |
                      |  |                                           | |    +-------------+      +-+    |
                      |  +------------------------------------------>|&+--->| t > TDHCINS +----->| |    |   +-+----+
                      |                                              | |    +-------------+      | |    +-->|S|    +---> E_cins
                      +--------------------------------------------->| |                         | |        +-+----+
                                                                     +-+                         |V+------->|R|    |
C_pwf ------------------------------------------------------------------------------------------>| |        +------+
                            (*)                                                         +------->| |
                                      +-+                                               |        +-+
B_clcins ---------------------------->| |                                               |
                                      |&+-----------------------------------------------+
Fsp_cl ------------------------------>| |                                               |
                                      +-+                                               |
                  +-----------+                                                         |                   +-+----+
timmot_w -------->| >  TDCINS +---------------------------------------------------------|------------------>|S|    +---> Z_cins
                  +-----------+                                                         |   +-+             +-+----+
                                                                                        +-->|V+------------>|R|    |
C_ini ------------------------------------------------------------------------------------->| |             +-+----+
                                                                                            +-+


(*)  abweichend zur Beschreibung wird dieser Pfad im Modul %DFPM bedient bzw. die Flags in %DFPM verwaltet;
```

```
Fehlerspeicherverwaltung:
-------------------------

Status Fehlerpfad :       SFPCINS               Löschen Fehlerpfad:       C_fcmclr & B_clcins
Errorflag :               E_cins                Fehlerpfad :              CDTCINS
Zyklusflag :              Z_cins                Fehlerklasse :            CLACINS
Fehlerart :               B_sicins              Fehlerschwere :           TSFCINS
                                                Carb-Code :               CDCCINS
                                                Umweltbedingungen :       FFTCINS
```

ABK DCINS 8.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCINS	BLOKNR		KL	code word CARB: CAN interface, timeout instrument
CDTCINS			FW	code word tester: CAN-Timeout, Instruments
CLACINS			FW	fault class: CAN interface, timeout instruments
FFTCINS	BLOKNR		KL	Freeze frame table: CAN-Timeout, instrument panel
FLCCINS			FW	fault set debouncing: CAN interface, timeout instrument
HLCCINS			FW	fault reset debouncing: CAN interface, timeout instrument
TDCINS			FW	Time for timeout detection CAN interface combi-instrument
TDHCINS			FW	Time for fault rectification CAN timeout combined instrument
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
B_CLCINS		EIN	condition clear fault path CINS
B_CMUTE	CAN	EIN	

Variable	Source	Type	Description
B_FLBC		EIN	condition: car with Florence Body Computer
B_INS1NEW		EIN	Condition: CAN-message INSTR1 received
B_KL15		EIN	condition ignition switch on
B_SICINS	DCINS	AUS	signal error CAN interface instruments
B_TDCAN	CAN	EIN	
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_BUSOFF	CAN	EIN	
E_CINS	DCINS	AUS	Error flag: CAN interface, timeout instrument
FSP_CL		EIN	clear fault memory
SFPCINS	DCINS	AUS	status fault path: timeout CAN interface instruments
TIMMOT_W		EIN	Timer:time after engine start n>NINI (word)
UB	SWADAP	EIN	battery voltage
Z_CINS	DCINS	AUS	Cycle flag: CAN interface, timeout instrument

FW DCINS 8.30 Fixed Values

Parameter	Value	Description
CDTCINS		code word tester: CAN-Timeout, Instruments
CLACINS		fault class: CAN interface, timeout instruments
FLCCINS		fault set debouncing: CAN interface, timeout instrument
HLCCINS		fault reset debouncing: CAN interface, timeout instrument
TDCINS		Time for timeout detection CAN interface combi-instrument
TDHCINS		Time for fault rectification CAN timeout combined instrument
UBDCAN		battery voltage threshold for diagnosis of CAN-Timeout

FB DCINS 8.30 Detailed description of function

Die Funktion überwacht die CAN-Botschaft INSTR1, (B_ins1new) auf Timeout.
Sender der Botschaft ist das Kombiinstrument.
Die Timeoutüberwachung ist aktiv, wenn die Batteriespannung größer UBDCAN und Kl.15 ein und kein Busoff und kein Mute aktiv ist (In der Haltephase keine Überwachung). Die Abtastrate ist 10 ms. Auf Fehler E_cins wird erkannt, wenn für t > TDCINS B_ins1new = 0.
Wird während der Überwachungszeit wieder eine Instr-Botschaft emfangen, wird der interne Überwachungszeitzähler zurückgesetzt.
Fehlerheilung und Rücksetzen des Fehlerflags E_cins, wenn Instr-Botschaften für t > TDHCINS wieder empfangen wurden und kein Busoff und kein Mute aktiv ist.
Das Zyklusflag Z_cins wird immer nach timmot_w > TDCINS (Zeitzähler ab Motorlauf) gesetzt.
Mit Befehl 'Löschen Fehlerspeicher' werden E_cins und Z_cins zurückgesetzt.

APP DCINS 8.30 Application hint

FDEF DCINS 8.30 Function definition

No text for FDEF available!

ABK DCINS 8.30 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCINS	BLOKNR		KL	code word CARB: CAN interface, timeout instrument
CDTCINS			FW	code word tester: CAN-Timeout, Instruments
CLACINS			FW	fault class: CAN interface, timeout instruments
FFTCINS	BLOKNR		KL	Freeze frame table: CAN-Timeout, instrument panel
FLCCINS			FW	fault set debouncing: CAN interface, timeout instrument
HLCCINS			FW	fault reset debouncing: CAN interface, timeout instrument
TDCINS			FW	Time for timeout detection CAN interface combi-instrument
TDHCINS			FW	Time for fault rectification CAN timeout combined instrument
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
B_CLCINS		EIN	condition clear fault path CINS
B_CMUTE	CAN	EIN	
B_FLBC		EIN	condition: car with Florence Body Computer
B_INS1NEW		EIN	Condition: CAN-message INSTR1 received
B_KL15		EIN	condition ignition switch on
B_SICINS	DCINS	AUS	signal error CAN interface instruments
B_TDCAN	CAN	EIN	
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_BUSOFF	CAN	EIN	
E_CINS	DCINS	AUS	Error flag: CAN interface, timeout instrument
FSP_CL		EIN	clear fault memory
SFPCINS	DCINS	AUS	status fault path: timeout CAN interface instruments
TIMMOT_W		EIN	Timer:time after engine start n>NINI (word)
UB	SWADAP	EIN	battery voltage
Z_CINS	DCINS	AUS	Cycle flag: CAN interface, timeout instrument

FW DCINS 8.30 Fixed Values

Parameter	Value	Description
CDTCINS		code word tester: CAN-Timeout, Instruments
CLACINS		fault class: CAN interface, timeout instruments
FLCCINS		fault set debouncing: CAN interface, timeout instrument
HLCCINS		fault reset debouncing: CAN interface, timeout instrument
TDCINS		Time for timeout detection CAN interface combi-instrument
TDHCINS		Time for fault rectification CAN timeout combined instrument
UBDCAN		battery voltage threshold for diagnosis of CAN-Timeout

FB DCINS 8.30 Detailed description of function

APP DCINS 8.30 Application hint

DCAS 14.20 Diagnosis CAN timeout ASC interface

FDEF DCAS 14.20 Function definition

`No text for FDEF available!`

ABK DCAS 14.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCAS	BLOKNR		KL	code word CARB: CAN interface, timeout ASC
CDTCAS			FW	code word tester: CAN interface, time out ASC [216]
CLACAS			FW	fault class: timeout asc-message
FFTCAS	BLOKNR		KL	Freeze Frame table: CAN, timeout ASC
FLCCAS			FW	fault set debouncing: CAN interface, timeout ASC
HLCCAS			FW	fault reset debouncing: CAN interface, timeout ASC
TDCAS			FW	Time for timeout detection CAN interface ASC
TDHCAS			FW	
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
B_ASC1NEW		EIN	condition CAN-ASC1 message current receive
B_ASC2NEW		EIN	condition CAN-ASC2 interface with o.k. status
B_CLCAS		EIN	condition clear fault path CAS
B_CMUTE	CAN	EIN	
B_KL15		EIN	condition ignition switch on
B_SICAS	DCAS	AUS	signal error CAN interface ASC
B_TDCAN	CAN	EIN	
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_BUSOFF	CAN	EIN	
E_CAS	DCAS	AUS	errorflag: CAN-interface, timeout ASC
SFPCAS	DCAS	AUS	status fault path: timeout CAN interface ASC
TIMMOT_W		EIN	Timer:time after engine start n>NINI (word)
UB	SWADAP	EIN	battery voltage
Z_CAS	DCAS	AUS	cyclus flag: CAN interface, timeout ASC

FW DCAS 14.20 Fixed Values

Parameter	Value	Description
CDTCAS		code word tester: CAN interface, time out ASC [216]
CLACAS		fault class: timeout asc-message
FLCCAS		fault set debouncing: CAN interface, timeout ASC
HLCCAS		fault reset debouncing: CAN interface, timeout ASC
TDCAS		Time for timeout detection CAN interface ASC
TDHCAS		
UBDCAN		battery voltage threshold for diagnosis of CAN-Timeout

FB DCAS 14.20 Detailed description of function

APP DCAS 14.20 Application hint

DCKUP 3.20 Diagnosis; CAN-Timeout interface electronic clutch control (KUP)

FDEF DCKUP 3.20 Function definition

`No text for FDEF available!`

ABK DCKUP 3.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCCKUP	BLOKNR		KL	code word CARB: CAN-bus, timeout clutch
CDTCKUP			FW	code word tester: CAN-bus, timeout clutch
CLACKUP			FW	fault class: CAN-timeout KUP-message
FFTCKUP	BLOKNR		KL	freeze frame table: CAN-timeout KUP-message
FLCCKUP			FW	fault set debouncing: CAN-bus, timeout clutch

Parameter	Source-X	Source-Y	Type	Description
HLCCKUP			FW	fault reset debouncing: CAN-bus, timeout clutch
TDCINS			FW	Time for timeout detection CAN interface combi-instrument
TDCKUP			FW	time for CAN-timeout recognition KUP-message
TDHCKUP			FW	
UBDCAN			FW	battery voltage threshold for diagnosis of CAN-Timeout

Variable	Source	Type	Description
B_CLCKUP		EIN	condition clear fault path CKUP
B_CMUTE	CAN	EIN	
B_KL15		EIN	condition ignition switch on
B_KUP1NEW		EIN	condition CAN-KUP1-message received
B_SELESPEE		EIN	
B_SICKUP	DCKUP	LOK	signal error: CAN-timeout Kup-message
C_FCMCLR	DCKUP	LOK	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_BUSOFF	CAN	EIN	
E_CKUP		EIN	error flag: CAN-bus, timeout clutch
SFPCKUP	DCKUP	LOK	status fault path: CAN-timeout Kup-message
TIMMOT		EIN	Timer:time after engine start n>NINI
UB	SWADAP	EIN	battery voltage
Z_CKUP		EIN	cycle flag: CAN-bus, timeout clutch

FW DCKUP 3.20 Fixed Values

Parameter	Value	Description
CDTCKUP		code word tester: CAN-bus, timeout clutch
CLACKUP		fault class: CAN-timeout KUP-message
FLCCKUP		fault set debouncing: CAN-bus, timeout clutch
HLCCKUP		fault reset debouncing: CAN-bus, timeout clutch
TDCINS		Time for timeout detection CAN interface combi-instrument
TDCKUP		time for CAN-timeout recognition KUP-message
TDHCKUP		
UBDCAN		battery voltage threshold for diagnosis of CAN-Timeout

FB DCKUP 3.20 Detailed description of function

APP DCKUP 3.20 Application hint

TN 3.10 Output of engine speed signal

FDEF TN 3.10 Function definition

```
Initialisierung :   Nach S_Kl.15 = "EIN" und Initialisierung der Endstufe beginnend  mit High-Pegel.

  Signalausgabe :   1.Signal-Ausgabe nach der 1. erkannten Lücke.
                    Signal wird Segmentsynchron als symmetrischer Low/High-Impuls mit jeweils 90 grad KW Länge ausgegeben.

     Haltephase :   In der Haltephase wird bis n < NMIN (Drehzahlimpulse werden noch erkannt) das tN-Signal weiter ausgegeben.

  Diagnose      :   Falls die Drehzahlerfassung nicht in Ordnung ist (Fehlerflag = E_n gesetzt), wird ein Low-Pegel ausgegeben.


                               +---------- Hardware-Bezugsmarke {GDWRT           }[grad KW] vor OT
                               |
                               |   +------ Software-
                               |   |       Bezugsmarke
   SG interne                  V   V
   Zahnimpulse         Lücke   1   2                            9.5                           17
        +-+ +-+ +-+ +-+      +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+
        | | | | | | | |      | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
      +-+ +-+ +-+ +-+ +------+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-+ +-
                                   |                             .                             |
        <--- Drehrichtung          |<-------------------  Segmentbreite =  180 grad KW  ------>|
             Inkrementenrad        |                             .                             |
                                   |                             .                             |
tN - Signal                        |                             .                             |
                                   V                             .                             V
      U High ----------------------+                             +-----------------------------+
                                   |                             |                             |
                                   |                             |                             |
                         U Low     +-----------------------------+                             +-------------------------
                                   |<-------- 90 grad KW ------->|<-------- 90 grad KW ------->|
```

ABK TN 3.10 Abbreviations

{GDWRT	}	Immediate Konstante
{NMIN	}	Immediate Konstante

FB TN 3.10 Detailed description of function

APP TN 3.10 Application hint

EEPROM 11.30 EEPROM treatment

FDEF EEPROM 11.30 Function definition

ABK EEPROM 11.30 Abbreviations

FW EEPROM 11.30 Fixed Values

Parameter	Value	Description

FB EEPROM 11.30 Detailed description of function

EEPROM treatment

Data which are to be maintained also in the event of powerfail are stored in the EEPROM.

Partitioning of the EEPROM

The project-specific structure and partition as well as the contents of the EEPROM are determined in a header file.
The area of the EEPROM is divided into blocks and pages. A block may consist of one or several pages.
Blocks have version numbers in order to be able to detect a changed EEPROM assignment and the consistency of EEPROM and program version. These blocks are used for the logical structuring and it is possible to to initialize them individually.
The version number and the length of the block are stored in the first two bytes of the first page of a block.

Structure of a page

```
 byte 0                                                                                    byte 15
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

The typical length of a page is 16 bytes (for presently used EEPROMs). For the configuration of the page a page descriptor exist in the flash-EPROM.

```
+----------------------+       configurated            +--------------------------+
|    page 0            |<------------------------------|  page descriptor 0       |
+----------------------+      storage mode             +--------------------------+
|    page 1            |<------------------------------|  page descriptor 1       |
+----------------------+                               +--------------------------+
|    page 2            |<------------------------------|  page descriptor 2       |
+----------------------+                               +--------------------------+
|    page .            |<------------------------------|  page descriptor .       |
+----------------------+                               +--------------------------+
|    page .            |<------------------------------|  page descriptor .       |
+----------------------+                               +--------------------------+
|    page .            |<------------------------------|  page descriptor .       |
+----------------------+                               +--------------------------+
|    page 31           |<------------------------------|  page descriptor 31      |
+----------------------+                               +--------------------------+
```

The following is specified in the page descriptor:
- Is the check sum stored in the last two bytes of the page ?
- Is the page mirror-imaged in the RAM ?
- Is the page the first page in the block or the double storage of the first page ?
- Is external writing into the page allowed ?
- Is external reading of the page allowed ?
- Is the initialization of the data on detection of non-correctable errors (check sum test) allowed ?
- Is the page the first or the second page of a double storage ?

In the individual pages and blocks the data are to be divided such that the chosen integrity strategy, described below, is sufficient for all data and that the configuration of the page and of the block suits all data of the page.
It is useful to store the first page of a block twice, so that in case of incorrect data in this page not the entire block is going to be initialized.

Access mode

In the permanent RAM a mirror-image of the EEPROM pages can be stored. This is configurated in the page descriptor for each page.
During the initialization of the ECU program the EEPROM pages (as far as they are configurated as page with mirror-image in the permanent RAM and as far as it was determined by means of check sum test that the contents is correct) are copied into the corresponding mirror-image pages in the the permanent RAM. In case of changed data the contents of the mirror-imaged pages is written into the the corresponding pages in the EEPROM during the ECU after-run. Furthermore, it is possible to write event-triggered data into an EEPROM page and, as far as configurated, into the corresponding mirror-image page.

The functions only have access to the data of the mirror and not to the EEPROM directly. An exception here, is the reading via external services (e.g. tester). Since the data in the mirror cannot be entered into the DAMOS (they are addressed by a structure) and since they are thus not available to application tools, it is necessary to use an additional RAM-cell for application relevant values, and to copy their contents cyclic or during the ECU

after-run into the mirror. During the copying procedure the check sum is updated via a routine (subtraction of the value to be overwritten and summing of the value to be written).

In the process the following must be paid attention to:

- When only copying during the ECU after-run there is a risk that the RAM-cell was corrupted since the latest writing procedure (program error or inverted bit).
  Data which were changed in such a way are then interpreted as correct data and they may possibly be stored in the EEPROM for a long time.
- Since the above-mentioned routine must be used for the copying into the mirror, it is run-time relevant in case of cyclic call-up in small time cycles.
- It is recommendable to perform a plausibilty check on the value to be written, just prior to the writing procedure !

The EEPROM can be cleared completely (in future) and it can then be initialized again.

Data integrity

After each writing procedure into the EEPROM the correctness is checked by another reading and by comparing the transmitted data.
Incorrect writing procedures are repeated up to two times..
The external reading and writing access (e.g. tester) can, as already mentioned above, be configurated via the page descriptor.
Dependent on the demand made on the data integrity of a page it is possible to choose between different storage modes and combinations of them.

- Single storage
- Multiple storage (presently only double storage is realized)
- Check sum in the page in the EEPROM and in the mirror.

With multiple storage, however, only one mirror-image of the page is stored in the permament RAM.
During the reading of a page the data contents is checked for correctness by means of the check sum.
If a loss of data is detected during the reading of the EEPROM pages in the ECU program initialization, then the redundant storage modes are used in the following order so as to determine the correct data:

1. Multiple storage (s) in the EEPROM
2. Mirror page in the permanent RAM
3. Default values from the flash EPROM

The correction for the mirror is performed immediately, i.e. during the reading in the ECU program initialization. For the EEPROM pages it is performed only during the after-run by overwriting them with the corrected mirror pages.

The contents of the EEPROM is project-specific and it is defined in the section EEDAT.

APP EEPROM 11.30 Application hint

DCDACC 1.10 Diagnosis; access to tester data

FDEF DCDACC 1.10 Function definition

```
The scope of data per fault path and the access by the tester to the output data
are set in this function using system constants.

The following data are set:

CDTdfp: SY_CDTSIZE = SY_SGANZ,
          Available per fault path dfp is
             either a CDT characteristic value (for SY_SGANZ = 1)
             or a block of CDT characteriatic values (length = SY_SGANZ).
    Data assignment: Value in block no. 0 assigned here to ECU no. 1 and
                     value in block no. 1 to ECU no. 2, etc.

CDCdfp: SY_CDCSIZE = 4 * SY_SGANZ,
          Available per fault path dfp is
             either a block of CDC characteristic values of length 4 (for SY_SGANZ = 1)
             or a block of CDC characteristic values of length 8 (for SY_SGANZ = 2) etc.
    Data assignment: Values in block nos. 0 - 3 assigned here to ECU no. 1 and
                     values in block nos. 4 - 7 to ECU no. 2, etc.

CDKdfp: SY_CDKSIZE = SY_SGANZ,
          Available per fault path dfp is
             either a CDK characteristic value (for SY_SGANZ = 1)
             or a block of CDK characteristic values (of length = SY_SGANZ).
    Data assignment: Value in block no. 0 assigned here to ECU no. 1 and
                     vakue in block no. 2 to ECU no. 2, etc.

CLAdfp: SY_CLASIZE = SY_SGANZ,
          Available per fault path dfp is
             either a CLA characteristic value (for SY_SGANZ = 1)
             or a block of CLA characteristic values (of length = SY_SGANZ).
    Data assignment: Value in block no. 0 assigned here to ECU no. 1 and
                     value in block no. 1 to ECU no. 2, etc.

TSFdfp: SY_TSFSIZE = 1, a TSF chracteristic value is avilable per fault path.
                        Variation by e.g. SY_SGANZ is not required here.

FFTdfp: SY_FFTSIZE = SY_DFPMENV, a block of length SY_DFPMENV of FFT characteristic values is available.
                                 Variation by e.g. SY_SGANZ is not required here.
```

ABK DCDACC 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
SY_CDCSIZE			SYS	System constant: Number of values CDC to each fault path
SY_CDKSIZE			SYS	System constant: Number of values CDK to each fault path
SY_CDTSIZE			SYS	System constant: Number of values CDT to each fault path
SY_CLASIZE			SYS	System constant: Number of values CLA to each fault path
SY_DFPMENV			SYS	system constant: environmental conditions in fault code memory
SY_FFTSIZE			SYS	System constant: Number of values FFT to each fault path
SY_SGANZ			SYS	system constant number engine control unit
SY_TSFSIZE			SYS	System constant: Number of values TSF to each fault path

FW DCDACC 1.10 Fixed Values

Parameter	Value	Description

FB DCDACC 1.10 Detailed description of function

APP DCDACC 1.10 Application hint

DFPM 3.10 OBDII; Fault path manager

FDEF DFPM 3.10 Function definition

```
Overview:  Diagnostic fault path manager whithin the system
```

```
                                         +--fcmTrig()   methods for event trigger
                                         |              from e.g. %DDCY, %DWUC, etc.
                                         v
+--------------------------------------------------------+
|  status                                                |
|  array (sfp)          fault code Memory FCM            |
|  +-------+            +----------------------------+   |<--getErrCnt()----     methods for
|  |       +-fcmErr()-->|                            |   |<--getErrLine()---     tester interface
|  |       +-fcmZyf()-->|                            |   |<--getErrDfp()----
|  |       +-fcmOk()--->|                            |   |<--delFCM()-------     e.g. %SCATT, KWP2000
|  |       +-fcmTyp()-->|                            |   |<--delErrDfp()----          etc.
|  |       |            +----------------------------+   |<--getInfoLine()--
|  |       |                                             |
|  |       |                                             |<-getMil()- method for MIL activation in %DMILx.y
|  |       |                                             |
|  +-------+                                             |<-getEpcl()-meth. for EPCL activation in %DEPCLx.y
|                                                        |
|                                                        |
+--------------------------------------------------------+
  ^  ^  ^  ^  ^                                ^ ^ ^ ^ ^
  |  |  |  |  |                                | | | | |
  |  |  |  |  +--getErf()                      | | | | +--dfpm_nl
  |  |  |  +--getZyf()                         | | | +--dfpm_clr
  |  |  +--repSfp()                            | | +--dfpm_ini
  |  +--getSfp()                               | +--dfpm_time
  +--getClf()                                  +--dfpm_check

    methods for actions of                     internal processes
    the diagnostic functions
```

ABK DFPM 3.10 Abbreviations

```
abbr.   type            description
----    ---             -----------
DFPM    module          Diagnosis, fault path management
FCM     module          Fault Code Memory
sfp     place holder    Status fault path
dfp     place holder    Diagnosis fault path
EPCL            Electronic Powertrain Control Lamp
```

Variable	Source	Type	Description
B_DCY	DDCY	EIN	condition for 'driving cycle' fulfilled
B_WUC	DWUC	EIN	condition for detected 'warm up cycle'
SY_DFPMENV		EIN	system constant: environmental conditions in fault code memory
SY_DFPMTIM	PROKON	EIN	system constant: Time info in fault code memory
SY_DFPMVAR	PROKON	EIN	system constant: Version of DFPM
SY_ENVBLOK		EIN	system constant; no. of blocks ambient conditions in fault code memory
SY_FCMSIZE	PROKON	EIN	system constant: Maximum number of fault entries
SY_FFESIZE	PROKON	EIN	system constant: Size of Freeze Frame-extension

FB DFPM 3.10 Detailed description of function

Overview:

1. Memory areas of the DFPM
1.1 Status array (sfp)
1.2 Fault code memory (fcm)

2. Methods
2.1 Methods for actions of the diagnostic functions
2.2 Methods for actions within DFPM
2.3 Methods for event trigger
2.4 Methods for MIL activation
2.5 Methods for tester interface

3. DFPM processes

4. Used data

5. Description of the function

5.1	Fault recognition; change of error flag E_abc 0->1;	call method fcmErr()
5.2	Fault recognition; change of fault type;	call method fcmTyp()
5.3	o.k. recognition; change of error flag E_abc 1->0;	call method fcmOk()
5.4	Test recognition; change of cycle flag Z_abc 0->1;	call method fcmZyf()
5.5	Trigger recogn.; e.g. change of B_dcy 0->1;	call method fcmTrig()
5.6	Time trigger for fault active time	within process dfpm_time
5.7	After-run	within process dfpm_nl
5.8	Short overview of the strategy for MIL activation	

6. References

Description:

1. Memory areas of the DFPM
The both memory areas status array (sfp) and fault code memory (fcm) are located within the buffered RAM.
Data loss with power fail is possible.

1.1 Status array (sfpdfp); each fault path dfp has ecaxtly one status word sfpdfp (16bit) with the following content:

1.1.0	bit0	E_dfp	fault flag; test result of the latest test	
1.1.1	bit1	Z_dfp	cycle flag; confirmation for min. one successfull test during the current driving cycle.	
1.1.2	bit2		reserved	
1.1.3	bit3		reserved	
1.1.4	bit4		reserved	
1.1.5	bit5		reserved	
1.1.6	bit6	B_bkdfp	flag for backup value; active whenever dfp uses backup values.	
1.1.7	bit7	B_cldfp	clear flag; interface for fault path specific actions during erasure of the fault code memory	
1.1.8	bit8	B_mxdfp	fault type flag; 'value higher than high limit' with latest test	
1.1.9	bit9	B_mndfp	fault type flag; 'value lower than low limit' with latest test	
1.1.10	bit10	B_sidfp	fault type flag; 'no signal' with latest test	
1.1.11	bit11	B_npdfp	fault type flag; 'result not plausible' with latest test	
1.1.12	bit12	sfpdfp.12	fault exists and is stored within FCM	##
1.1.13	bit13	sfpdfp.13	fault path at minimum once tested since power fail / FCM clear (dfp-ready)	##
1.1.14	bit14		reserved	
1.1.15	bit15		reserved	

1.2 fault code memory (fcm); only contains information of faulty tests with the following content (bytes):

Maximum SY_fcmsize fault path entries are possible. ##

1.2.1byte1 dfp fault path identifier; programm status-specific number from 1...n.

1.2.2 byte2 tsf counter for fault active time; each stored fault has a value with the measured time during the fault was active (E-dfp = 1). During after-run each fault path with tsf > TSFdfp and E_dfp=0 is set to emission related (like E_dfp=1). With first storage of the fault, the tsf is set to 0. With engine start and n > nmin tsf is set to 0, this is to allow measuring of tsf from last driving cycle during ign. on and engine not running. With tsf = 255 the counter is stopped without overflow.

1.2.3 byte3 fps status of fault path with latest entry (E_dfp, etc.)

bit3.0	fps.erfact	copy of the latest E_dfp out of status array sfpdfp
bit3.1	fps.zyf	copy of the latest Z_dfp out of status array sfpdfp
bit3.2	fps.ekd	reserved, not used yet
bit3.3	fps.zkd	reserved, not used yet
bit3.4	fps.fa	entry of fault code during activity of service test equipment
bit3.5	fps.be	entry of fault code during activity of end of line test equipment
bit3.6	fps.nn1	reserved, not used yet
bit3.7	fps.nn2	reserved, not used yet

1.2.4 byte4 typ type of fault at first and latest entry.

bit4.0	typ.actmax	’value was higher than high limit’ with latest entry
bit4.1	typ.actmin	’value was lower than low limit’ with latest entry
bit4.2	typ.actsig	’no signal’ with latest entry
bit4.3	typ.actnpl	’result not plausible’ with latest entry
bit4.4	typ.inimax	’value was higher than high limit’ with first entry
bit4.5	typ.inimin	’value was lower than low limit’ with first entry
bit4.6	typ.inisig	’no signal’ with first entry
bit4.7	typ.ininpl	’result not plausible’ with first entry

1.2.5 byte5 fes status of fault entry; dynamical evaluation of CARB relation

bit5.0	fes.erfprl	error flag debounced
bit5.1	fes.dauer	FLC was min. one time at zero, FCM deletion due to CARB
bit5.2	fes.scatt	fault entry is visible for scan tool (dynamic) see ->%TCSORT ##
bit5.3	fes.mil	fault entry is relevant for MIL
bit5.4	fes.blink	fault entry with MIL blinking
bit5.5	fes.multi	sporadic fault
bit5.6	fes.epcl	fault entry is relevant for EPCL (see ->%DEPCLx.y)
bit5.7	fes.nn2	reserved

1.2.6 byte6 cla class of fault path; entry from class table (see ->%DCLAx.y)

1.2.7 byte7 flc MIL-on - counter; trigger due to class table

1.2.8 byte8 hlc MIL-off - counter; trigger due to class table

1.2.9 byte9 dlc delete counter; For each detected fault an individual fault delete counter (DLCabc) is used. It determines the duration of storage of the corresponding fault. At each first detection (not yet debounced, ’probable fault’) dlcdfp is set due to class table CLAdfp to DLCPRL (e.g. 80 dec).
If this fault is neither confirmed nor detected as healed within these DLCPRL dcy/wuc, it will be deleted.
As soon as a ’probable’ fault is detected as healed, the dlcdfp is set to the value ADSTKD acc. CLAdfp.
As soon as a ’probable’ fault is confirmed, the dlcdfp is set to the value ADSTFD (40dez) acc. CARB.
This value is fixed up to recognized healing (MIL off acc. this fault).
As long as a ’probable fault’ is not yet ’confirmed’, or as soon as a fault is detected as healed, the corresponding dlcdfp is decremented by 1 in the stop phase of each cycle where ’warm-up cycle’ was detected (B_wuc=1). --> %DWUC.
If dlcdfp reaches here the value 0, the fault (and if necessary its corresponding freeze frame) will be erased completely out of the memory.

1.2.10 byte10 First freeze frame value according to -->%DFRZx.y ##

1.2.11 Byte21 + SY_ffesize First value of environmental conditions ##
Entry of SY_envblok blocks of ambient conditions out of FFTdfp ext. ambient conditions -->%DUMWEXx.y ##
Structure of the block of ambient cond.: First top_w, then FFTdfp with length SY_dfpmenv ##

1.2.12 Byte21 + SY_ffesize + SY_envblok * (SY_dfpmenv + SY_dfpmtim): hz frequency counter ##
At the first detection of a fault, the frequency counter is set to the initial value 01.
At each ’new detection’ after detected healing, (e.g. at loose contacts) the frequency counter is increased by 1.
Max. value 255 limits the frequency counter to the top; no overflow active.

1.2.13 Byte21 + SY_ffesize + SY_envblok * (SY_dfpmenv + SY_dfpmtim) + 1: cks check sum ##
check sum for this fault path entry

Depending on the overall length of the entry, one additional byte with value 00 is used to keep the entry within word-structure. ##

2. Methods

2.1 Methods for actions of the diagnostic functions

2.1.1	getSfp()	read-out of the status word sfpdfp of a fault path dfp out of the status array
2.1.2	repSfp()	write the statusword sfpdfp of a fault path dfp into the status array
2.1.3	getErf()	read-out of the error flag E_dfp of a fault path dfp out of the status array
2.1.4	getZyf()	read-out of the cycle flag Z_dfp of a fault path dfp out of the status array
2.1.5	getClf()	read-out of the clear flag B_cldfp of a fault path dfp out of the status array

2.2 Methods for actions within DFPM

2.2.1	fcmErr()	fault path sends message: fault detected
2.2.2	fcmZyf()	fault path sends message: cycle flag is set, test fulfilled
2.2.3	fcmOk()	fault path sends message: fault healing or o.k. detected
2.2.4	fcmTyp()	fault path sends message: change of fault type

2.3 Methods for trigger events

2.3.1	fcmTrig()	call of a specific trigger event (B_dcy, B_wuc etc.)

2.4 Methods for activation of MIL or EPCL

2.4.1	getMil()	search for MIL-related state within the fault code memory
2.4.2	getEpcl()	search for EPCL-related state within the fault code memory

2.5 Methods for tester interface

2.5.1	getErrCnt	read-out of the number of emission related fault entries
2.5.2	getErrLine()	read-out of the specific line of the fault code memory
2.5.3	getErrDfp()	read-out of the specific fault path of the fault code memory
2.5.4	delFCM	deletion of the complete fault code memory with status array and possibly parts of diagnostic function.
2.5.5	delErrDfp()	deletion of this specific fault path entry
2.5.6	getInfoLine()	read-out of short information out of selected FCM line

3. Processes inside DFPM

3.1	dfpm_nl	generates the DFPM-specific actions within the after-run
3.2	dfpm_clr	generates the DFPM specific actions within the FCM deletion
3.3	dfpm_ini	generates the DFPM-specific actions within the initialisation task
3.4	dfpm_time	generates the DFPM-specific actions within the time task (0.5 s)
3.5	dfpm_check	verification of the FCM for plausible entries.

4. Used data

4.1 Overall data

4.1.1	CLA	table with different data as described in ->%DCLAx.y
4.1.2	FFT	table with the selectable ambient conditions; described in ->%DFFTx.y

4.2 Fault path specific data

4.2.1	CLAdfp	fixed value; management class for selection out of CLA
4.2.2	TSFdfp	fixed value; threshold value for fault active time decision
4.2.3	FFTdfp	block of fixed values with length SY_dfpmenv; selection of the value out of FFT-table. ->%DFFTx.y ##

4.2.4 CDTdfp fixed value(16bit); fault path specific number for response to the service tester with RB-K3 standard.
The CDTdfp numbers are RB-K3 standardized by K3/EKS3-My, -Fk in chronological order.
attention: no. 00 is not allowed, sign for empty memory
no. >=65280 dez (FF00h) are stop criteria for fault memorisation.

4.2.5 CDCdfp block of fixed values (4*16bit); SAE-fault codes for output to the OBD scan tool. -->%DCDCx.y ##
The fault path identifier dfp has to be converted to the format of the SAE standard J2012.
For each of the four possible fault types there is a specific code.
Data application due to customer requirements.

5. Description of functional details

Entry, update and verification of the entries in the fault code memory are carried out only by one of the following trigger:

5.1 fault detection; change in errorflag E_dfp 0->1; call of method fcmErr()

Whenever an error flag E_dfp inside status word sfpdfp is set by a diagnostic function, the method fcmErr() is active.

Firstly it is searched within the fault code memory for an existing entry of the fault path dfp.

- If dfp is not yet stored, a new entry is generated. ---> 5.1.1
- If dfp is stored, an update is generated. ---> 5.1.2

5.1.1 New entry: the following values are stored at the end of the fault code memory

dfp	fault path identifier
fps	fault path status
typ.ini	fault path type at first entry (B_mxdfp, etc.)
fes	fault path status of entry; dynamical evaluation of the CARB-related status
cla	class of the fault path; CLAdfp
flc	MIL on - counter; is set to initial value due to the class table and is decremented by 1, only if the trigger event and the cycle flag Z_dfp are true.
tsf	fault active time; set to 0
hlc	MIL off - counter; is set to initial value due to CLAdfp
dlc	delete counter; is set to initial value due to fault path status fes.
hz	frequency counter; set to 1
frz0....	freeze frame; stored due to FFT, see -->%DFRZx.y
ini_env...	ambient conditions due to FFTdfp and -->%DUMWEXx.y at initial detection ##
cks	write check sum

5.1.2 Update: the following values are updated:

fps	fault path status; new value
typ.act	fault path type at the current entry (B_mxdfp, etc.)
fes	fault path status of entry; dynamical evaluation of the CARB-related status
flc	MIL on - counter; decremented by 1, only if the trigger event and the cycle flag Z_dfp are true.
hlc	MIL off - counter; is set to initial value due to CLAdfp
dlc	delete counter; is set to initial value due to fault path status fes.
hz	frequency counter; increment by 1
act_env(x)	ambient conditions due to FFTdfp stored to place X at this detection (->%DUMWEXx.y) ## X = minimum out of frequency counter HZ and SY_envblok ## Not yet used blocks of ambient conditions are set to FFhex ##
cks	write new check sum

5.2 Fault detection; change of fault type, call method fcmTyp()

Whenever a fault type flag B_xxdfp inside status word sfpdfp is changed by a diagnostic function, method fcmTyp() is active.

The following values are updated inside the FCM:

typ.act	fault path type at the current entry (B_mxdfp, etc.)
cks	write new check sum

5.3 Detection of healing; change of error flag E_abc 1->0; call method fcmOk()

Whenever the error flag E_dfp inside status word sfpdfp is reset by a diagnostic function, method fcmOk() is active. The following values are updated inside the FCM:

With pending, not yet CARB-debounced fault path status:

fps	fault path status; new value
fes	fault path status of entry; dynamical evaluation of the CARB-related status
dlc	delete counter; is set to ADSTKD
cks	write new check sum

With CARB-debounced fault path status:

fps	fault path status; new value
fes	fault path status of entry; dynamical evaluation of the CARB-related status
flc	MIL on - counter; incremented by 1, only if the trigger event and the cycle flag Z_dfp are true.
hlc	MIL off - counter; decremented by 1, only if the trigger event and the cycle flag Z_dfp are true.
cks	write new check sum

5.4 Test recognition; change of cycle flag Z_abc 0->1; call method fcmZyf()

Whenever the cycle flag Z_dfp inside status word sfpdfp is set by a diagnostic function, method fcmZyf() is active. The following values are updated inside the FCM (only if fault code entry is existing):

fps	fault path status; new value
fes	fault path status of entry; dynamic evaluation of the CARB-related status
cks	write new check sum

Whenever this E_dfp = 1 the following values are updated additionally:

flc	MIL on - counter; decremented by 1, only if the trigger event (e.g. B_dcy) is true.
hlc	MIL off - counter; set to initial value due to CLAdfp

or, if this E_dfp = 0, the following values are updated aditionally:

hlc	MIL off - counter; decremented by 1, only if the trigger event is true.

5.5 Trigger recogn.; e.g. change of B_dcy 0->1; call method fcmTrig()

Whenever one of the trigger functions is fulfilled, method fcmTrig() is active. The following values are updated inside the FCM:

fes	fault path status of entry; dynamic evaluation of the CARB-related status
flc	MIL on - counter; filtered to trigger according to CLAdfp and decremented by 1, only if a fault currently exists but is not debounced.
hlc	MIL off - counter; filtered to trigger according to CLAdfp and decremented by 1, only if a current fault is healed but not debounced.
cks	write new check sum

5.6 Time trigger for fault active time within process dfpm_time

The following values are updated inside the FCM (only if fault code entry is existing):

tsf	fault active time; incremented by 1, if a fault currently exists
cks	write new check sum

5.7 Afterrun within process dfpm_nl

flc	MIL on - counter; decremented by 1, only if Z_dfp=1, E_dfp=0 and tsf > TSPdfp. Set to initial value due to CLAdfp, only if Z_dfp=1, E_dfp=0 und tsf <= TSPdfp.
dlc	delete counter; only if B_wuc = 1, each dlc of the stored and healed entries is decremented by 1.
cks	write new check sum

5.8 Short overview of the strategie for MIL activation

Description is based on change of states, only in the following 5 cases the fault code manager gets active:

Case 1: Change within the cycle status (e.g. B_dcy 0 -> 1)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0 -> 1	0	0/1	FLC = FLC	HLC = HLC	waiting for cycle flag
0 -> 1	1	0	FLC = FLC	HLC = HLC-1	o.k.- recognition
0 -> 1	1	1	FLC = FLC-1	HLC = HLC	fault recognition

Case 2: fault path test is fulfilled (Z_xyz 0 -> 1)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0 -> 1	0/1	FLC = FLC	HLC = HLC	waiting for cycle status
1	0 -> 1	0	FLC = FLC	HLC = HLC-1	o.k.- recognition
1	0 -> 1	1	FLC = FLC-1	HLC = HLC	fault recognition

Case 3: fault is detected (E_xyz 0 -> 1)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0/1	0 -> 1	FLC = FLC	HLC = HLC	waiting for cycle status
1	0	0 -> 1	FLC = FLC	HLC = max.	stopped healing
1	1	0 -> 1	FLC = FLC-1	HLC = max.	fault recognition

Case 4: healing is detected (E_xyz 1 -> 0)

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0/1	1 -> 0	FLC = FLC	HLC = HLC	waiting for cycle status
1	0	1 -> 0	FLC = FLC	HLC = HLC	waiting for cycle flag
1	1	1 -> 0	FLC = FLC+1	HLC = HLC-1	active debouncing for healing

Case 5: actions during after-run

Cycle status (e.g. B_dcy)	cycle flag Z_xyz	error flag E_xyz	MIL on counter FLC	MIL off counter HLC	comment
0	0/1	0/1	FLC = FLC	HLC = HLC	driving cycle too short
1	0	0/1	FLC = FLC	HLC = HLC	cycle flag missing
1	1	0 & TSF<limit	FLC = max.	HLC = HLC	driving cycle not MIL rel.
1	1	0 & TSF>limit	FLC = FLC-1	HLC = HLC	driving cycle with sporadic fault
1	1	1	FLC = FLC	HLC = HLC	actions during driving cycle fulfilled

6. References

To complete the description of the whole fault code manager the following sections have to be included:

description of class table CLA	-->%DCLA1.y	
description of selectable trigger events	-->%DTRIGx.y	##
description of the selectable ambient conditions / freeze frame values	-->%DFFT1.y	
description of the used freeze frame values	-->%DFRZx.y	
description of the used extended ambient condition values /-strategy	-->%DUMWEXx.y, -->%DTOPx.y	##
description of SAE fault codes	-->%DCDCx.y	##
description of the evaluation ’driving cycle’	-->%DDCYx.y	
description of the evaluation ’warm up cycle’	-->%DWUCx.y	
activation of the MIL	-->%DMILx.y	
activation of the EPCL	-->%DEPCLx.y	
Inspection/Maintenance-readiness code	-->%DIMCx.y	
read-out of the fault code memory by generic scan tool	-->%SCATTx.y	
or servive tester e.g. KTS300	-->%TK...x.y	

APP DFPM 3.10 Application hint

For function specific label selection within VS100, etc. the DFPM-related fault path data are available with DFPM_<function>.

Class table CLA::
Default table is prepared by K3/EKS3-Mayer, -Frank.
The storage of a fault - but not its recognition with output of the replacement functions and error flags, can be suppressed by dating the class CLAdfp correspondingly.

Fault active time TSFdfp:
Attention ! With low TSFdfp, decrementation of FLC is going faster -> MIL activation very soon!
With TSFdfp = 127,5 sec (255dez) the evaluation is switched off due to tsf > TSFdfp.
Debouncing then corresponds to the version preceeding the introduction of the fault active counter TSF.

Fault codes CDTdfp:
Following strictly the RB standard for CDTabc-Codes supports the use of application facilities and systems with a SW that is conceived one time regardless of specific customers or projects.

For measurement and application purposes, the RAM cell dfp_ap is established. At each fault detection, the identifier dfp of the triggering fault is stored in this cell so that the information of the last detected fault is always available.
If the currently stored fault is detected as "healed" or deleted, the dfp_ap will be set to 00h.

delete counter dlc (initial value due to CLAdfp)
Stand MAIL OUT 91-57: CARB-debounced = 40 dez; CARB-pending (only special faults) = 80 dez.;
only service related faults = approx. 10 dez.

SAE fault codes CDCdfp: see -->%DCDCx.y ##

Quality:
To assure a correct DFPM-function due to the CARB regulations, it is very important to observe the correctness of the fault recognition and the information-exchange with the DFPM via status array.
CARB-related diagnostic evaluations have to be fullfilled within a FTP72 cycle.

DFPMPWF 1.10 Diagnosis fault path management; detection of powerfail

FDEF DFPMPWF 1.10 Function definition

Statusarray und Fehlerspeicher werden am Beginn der INI auf folgende Zusammenhänge durchsucht:

1. Steht zu jedem sfpxxx mit mem-flag = 1 der entsprechende Fehlerspeichereintrag im Fehlerspeicher ?
2. Steht zu jedem sfpxxx mit mem-flag = 0 der entsprechende Fehlerspeichereintrag nicht im Fehlerspeicher ?
3. Entspricht die Anzahl der ermittelten mem-flags der Anzahl im Fehlerspeicherzähler fcmend ?

Wird einer der o.g. Zusammenhänge verletzt, so wird auf (zumindest teilweisen) Informationsverlust geschlossen
und über die powerfail-Routine aktiviert.

ABK DFPMPWF 1.10 Abbreviations

FW DFPMPWF 1.10 Fixed Values

Parameter	Value	Description

FB DFPMPWF 1.10 Detailed description of function

APP DFPMPWF 1.10 Application hint

DTRIG 1.10 OBDII; Selectable trigger for fault path management

FDEF DTRIG 1.10 Function definition

```
The following trigger events are selectable by the shown number:           for more info see -->%DCLA

number          trigger         comment
---------------------------------------------------------------------------------------------------------------
0               B_no            no trigger selected
1               B_tim           timetrigger, Quantification according -->%DFPMx.y
2               B_dcy           Driving Cycle,                  see -->%DDCYx.y
3               B_wuc           Warm Up Cycle,                  see -->%DWUCx.y
4               B_sp1           special trigger 1               see -->%DMDMILx.y
5               B_sp2           special trigger 2               see -->%DMDMILx.y
6               B_sp3           special trigger 3               see -->%DKVSx.y
```

ABK DTRIG 1.10 Abbreviations

Variable	Source	Type	Description
B_DCY	DDCY	EIN	condition for 'driving cycle' fulfilled
B_NO	DTRIG	LOK	Infinite-trigger of the fault path manager
B_SP1	DMDMIL	EIN	FLC-trigger of misfire detection
B_SP2	DMDMIL	EIN	HLC-trigger of misfire detection
B_SP3		EIN	special cycle trigger diagnosis fuel supply system
B_TIM	DTRIG	LOK	time trigger for fault path management
B_WUC	DWUC	EIN	condition for detected 'warm up cycle'

FW DTRIG 1.10 Fixed Values

Parameter	Value	Description

FB DTRIG 1.10 Detailed description of function

APP DTRIG 1.10 Application hint

DFFT 1.40 Diagnostics; Freeze frame selection table

FDEF DFFT 1.40 Function definition

Reference table of the measurement values in FFTdfp available for selection: (max. 99 !)
Quantisation of the fault code memory entry is due to the according label or the additionally described calculation
For 'not supported' values (FF) is used (eg. values for bank #2 within single bank-system) ##
Values with xxx_u are not shure existing as byte. Maybe they are created within %DFFTCNVx.y as xxx_u ! ##

```
Structure:   No.   0            Substitute for 'not_used'
             No.   1 to  15     Reserved for CARB-Freeze Frame (lt. SAE J1979)
             No.  16 to  99     Reserved for common values out of platform
             No. 100 to 255     Reserved for project- / customerspecific add-ons;     see -->%DFFTKx.y
```

No.	Value	Description	
0		not_used	
1	flglrs	Control status Bank 1	
2	flglrs2	Control status Bank 2	
3	rml	relative air mass	##
4	tmot_u	Engine temperature acc. SAE J1979	##
5	fr_u	Control factor bank1 (byte)	##
6	fra_u	Adaptation factor bank1 (byte)	##
7	fr2_u	Control factor bank2 (byte); if single bank system (SY_stervk=0) 'not supported' is used	##
8	fra2_u	Adaptation factor bank2 (byte); if single bank system (SY_stervk=0) 'not supported' is used	##
9	not supported	reserved for Intake-manifold pressure Q: 1kPA SAE J1979 Mode2,PID$0B	##
10	nmot	Engine speed; Quantization is recalculated with output. ->%TC2MOD	##
11	vfzg_u	Vehicle speed acc. SAE J1979	##
12-16	not used	Reserved for extension SAE	
17	ml	Mass air flow	
18	tmot	Engine coolant temperature quantification systemspecific	##
19	tans	Intake-air temperature	
20	ub	Battery voltage	
21	wdkba	throttle angle	
22	usvk	Sensor voltage upstream catalyst bank 1	
23	ushk	Sensor voltage downstream catalyst bank 1	
24	usvk2	Sensor voltage upstream catalyst bank 2 if single bank system (SY_stervk = 0) 'not supported' is used	##
25	ushk2	Sensor voltage downstream catalyst bank 2 if single bank system (SY_stervk = 0) 'not supported' is used	##
26	rl	relative air charge	##
27	upwg1_u	voltage of pedal sensor poti 1 (byte)	
28	upwg2_u	voltage of pedal sensor poti 2 (byte)	
29	upwg2d_u	double voltage of pedal sensor poti 2 (byte)	
30	skapfad	Pathidentifier out of SKA	
31	egaspfad	Pathidentifier out of EGAS	
32	mpfad	Pathidentifier out of torque calculation	
33	mi_duf	Pathidentifier out of torque comparison	
34	rstpfad	Pathidentifier out of reset	
35	wped	standardized angle of accellerator pedal	

```
        No.     Value           Description
-----------------------------------------------------------------------------------------------------------------------------
        36      tumg            Ambient temperature
        37      tmew            engine temperature, backup value out of model
        38      udkp1_u         Voltage throttle poti 1 (byte)
        39      udkp2_u         Voltage throttle poti 2 (byte)
        40      wdks            desired throttle angle, refering to lower mechanical stop
        41      tabgm           Exhaust temperature upstream catalyst, out of model
        42      tabgm2          Exhaust temperature upstream catalyst bank 2, out of model
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        43      tkatm           Catalyst temperature, out of model
        44      tkatm2          Catalyst temperature, bank 2, out of model
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        45      uhsv            Voltage at the heater output stage upstream of the catalyst
        46      uhsv2           Voltage at the heater output stage upstream of the catalyst bank 2
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        47      uhsh            Voltage at the heater output stage downstream of the catalyst
        48      uhsh2           Voltage at the heater output stage downstream of the catalyst bank 2
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        49      rinv_u          Internal resistance oxygen sensor upstream catalyst (byte)
        50      rinv2_u         Internal resistance oxygen sensor upstream catalyst bank 2 (byte)
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        51      rinh_u          Internal resistance oxygen sensor downstream catalyst (byte)
        52      rinh2_u         Internal resistance oxygen sensor downstream catalyst bank 2 (byte)
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        53      pu              Ambient pressure
        54      tpsvkmf_u       filtered cycle duration of sensor signal upstream cat. (byte)
        55      tpsvkmf2_u      filtered cycle duration of sensor signal upstream cat. bank 2 (byte)
                                                               if single bank system (SY_stervk = 0) 'not supported' is used ##
        56      (fr_u)          replaced by no. 5                                                                             ##
        57      (fra_u)         replaced by no. 6                                                                             ##
        58      (fr2_u)         replaced by no. 7                                                                             ##
        59      (fra2_u)        replaced by no. 8                                                                             ##
        60      tfst            fuel level       1l/inc
        61      (rl)            replaced by no. 26                                                                            ##
        62-99   not used        add-ons up to max. #99 tbd only by the responsable for %DFPM !!
        100-255 not used        Reserved for project- / customerspecific add-ons
```

ABK DFFT 1.40 Abbreviations

Variable	Source	Type	Description
EGASPFAD	DUF	EIN	ETS-path as environmental condition for diagnosis of function monitoring
FLGLRS	LREB	EIN	CARB FREEZE FRAME byte, bank 1, for lambda control
FLGLRS2	LREB	EIN	CARB FREEZE FRAME byte, bank 2, for lambda control
FR2_U	DFFTCNV	EIN	Lambda controller output (byte)
FRA2_U	DFFTCNV	EIN	multiplicative correction of the mixture adaptation (byte)
FRA_U	DFFTCNV	EIN	multiplicative correction of the mixture adaptation (byte)
FR_U	DFFTCNV	EIN	Lambda controller output (byte)
MI_DUF	DUF	EIN	actual torque at response of torque comparison in the function monitoring
ML	SWADAP	EIN	air mass flow
MPFAD	DUF	EIN	Torque path in function and function monitoring as environmental cond. of diag.
NMOT	SWADAP	EIN	engine speed
PU	BGPU	EIN	Ambient pressure
RINH2_U	DFFTCNV	EIN	Act. value (byte) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_U	DFFTCNV	EIN	Actual value (byte) internal res. Ri-Nernst cell lambda sensor downstream cat
RINV2_U	DFFTCNV	EIN	Actuel value of internal resistance of lambda sensor 2, pre cat (byte)
RINV_U	DFFTCNV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (byte)
RL	SWADAP	EIN	relative air charge
RML	BGRML	EIN	relative air mass (calc. load value) acc. to SAE J1979
RSTPFAD	DUR	EIN	Reset-path as environment condition for the diagnosis of processor monitoring
SKAPFAD	DUF	EIN	freeze frame information for SKA
TABGM	ATM	EIN	exhaust gas temperature upstream cat from exhaust temperature model
TABGM2	ATM	EIN	exhaust gas temperature2 upstream cat from exhaust temperature model bank2
TANS	SWADAP	EIN	Intake air temperature
TFST	GGFST	EIN	fuel level in tank
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TMEW	GGTFM	EIN	model-based substitute value for engine temperature signal in case of error
TMOT	SWADAP	EIN	Engine temperature
TMOT_U	DFFTCNV	EIN	Engine temperature with defined quantisation for FSP-freese frame
TPSVKMF2_U	DFFTCNV	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (byte)
TPSVKMF_U	DFFTCNV	EIN	filtered cycle duration of sensor signal upstream cat. (byte)
TUMG		EIN	Ambient air temperature
UB	SWADAP	EIN	battery voltage
UDKP1_U	DFFTCNV	EIN	sensor voltage from throttle-valve potentiometer 1 (byte)
UDKP2_U	DFFTCNV	EIN	sensor voltage from throttle-valve potentiometer 2 (byte)
UHSH		EIN	Voltage at ECU heating power stage, post cat
UHSH2		EIN	Voltage at ECU heating power stage 2, post cat
UHSV		EIN	Voltage at the heater output stage upstream of the catalyzer
UHSV2		EIN	Voltage at the heater output stage 2 upstream of the catalyzer
UPWG1_U	DFFTCNV	EIN	Voltage PWG potentiometer 1 (byte)
UPWG2D_U	DFFTCNV	EIN	Doubled PWG potentiometer-2 voltage (byte)
UPWG2_U	DFFTCNV	EIN	Voltage PWG potentiometer 2 (byte)
USHK	GGLSH	EIN	output voltage oxygen sensor downstream catalyst

Variable	Source	Type	Description
USHK2	GGLSH	EIN	output voltage oxygen sensor downstream catalyst 2
USVK	GGLSV	EIN	output voltage oxygen sensor upstream catalyst
USVK2	GGLSV	EIN	output voltage oxygen sensor upstream catalyst 2
VFZG_U	DFFTCNV	EIN	Vehicle speed
WDKBA	GGDVE	EIN	throttle angle
WDKS	FUEDKSA	EIN	desired throttle angle w.r.t. to lower mechanical stop
WPED	GGPED	EIN	Standardized accelerator pedal angle

FW DFFT 1.40 Fixed Values

Parameter	Value	Description

FB DFFT 1.40 Detailed description of function

APP DFFT 1.40 Application hint

```
Achtung, bei Änderung, Applikation von FFTdfp müssen zwingend auch die Testerservices entsprechend angepasst werden.
Z.B. muß bei Anwendung von DIAS auf das neue .hex-File referenziert werden.
```

DFFTK 1.10 Diagnosis; customer-specific list for selection of freeze-frame values

FDEF DFFTK 1.10 Function definition

```
Reference table of the measurement values in FFTdfp available for selection: ( max. 255 !  No. 100 to 255 )
Quantisation of the fault code memory entry is due to the according label or the additionally described calculation
For not supported values 00 is used (eg. values for bank #2 within single bank-system)

Structure:   No. 100 to 255       Reserved for project- / customerspecific add-ons, no structure for the moment

        No.     Value           Description
-----------------------------------------------------------------------------------------------------------------------------
        100     tbd
        .       .
        255     tbd
```

ABK DFFTK 1.10 Abbreviations

Variable	Source	Type	Description
NMOT	SWADAP	EIN	engine speed
TMOT	SWADAP	EIN	Engine temperature

FW DFFTK 1.10 Fixed Values

Parameter	Value	Description

FB DFFTK 1.10 Detailed description of function

APP DFFTK 1.10 Application hint

DFFTCNV 3.30 Diagnosis; freeze frame table, conversion to bytes

FDEF DFFTCNV 3.30 Function definition

```
Ambient condition values which are not available in the system in byte-quantization are converted to the correct quantization
e.g. word-values xxx_w are converted to byte-values xxx_u for use within %DFFTx.y and %DFFTKx.y.

The following calculations are supported by this module:

Basic value and calc.   byte value      quantization            type of data
===================================================================================
rl_w            *1)     rl_u                                    unsigned byte
upwg1_w / 4             upwg1_u         spg_ub_b5               unsigned byte
upwg2_w / 4             upwg2_u         spg_ub_b5               unsigned byte
upwg2d_w / 4            upwg2d_u        spg_ub_b5               unsigned byte
udkp1_w / 16            udkp1_u         spg_ub_b5               unsigned byte
udkp2_w / 16            udkp2_u         spg_ub_b5               unsigned byte
rinv_w / 32             rinv_u          r_ub_q64                unsigned byte
rinv2_w / 32            rinv2_u         r_ub_q64                unsigned byte
rinh_w / 32             rinh_u          r_ub_q64                unsigned byte
rinh2_w / 32            rinh2_u         r_ub_q64                unsigned byte
tpsvkmf_w / 4           tpsvkmf_u       t10msxs_ub_b10p2        unsigned byte
tpsvkmf2_w / 4          tpsvkmf2_u      t10msxs_ub_b10p2        unsigned byte
fr_w / 256              fr_u            fak_ub_b2               unsigned byte
fra_w / 256             fra_u           fak_ub_b2               unsigned byte
fr2_w / 256             fr2_u           fak_ub_b2               unsigned byte
fra2_w / 256            fra2_u          fak_ub_b2               unsigned byte
tmotlin                 tmot_u          temp_ub_q1_040          acc. SAE-Quantization
vfzg                    vfzg_u          vfzg_q1p0               acc. SAE-Quantization
psdss_w / 256           psdss_u                                                                                           ##

"*1) ( 255 * rl_w / rlugd_w) * ( nmot_w / NMAX )"
```

ABK DFFTCNV 3.30 Abbreviations

Variable	Source	Type	Description
FR2_U	DFFTCNV	AUS	Lambda controller output (byte)
FR2_W	LR	EIN	Lambda controller output (word)
FRA2_U	DFFTCNV	AUS	multiplicative correction of the mixture adaptation (byte)
FRA2_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FRA_U	DFFTCNV	AUS	multiplicative correction of the mixture adaptation (byte)
FRA_W	LRA	EIN	multiplicative correction of the mixture adaptation (word)
FR_U	DFFTCNV	AUS	Lambda controller output (byte)
FR_W	LR	EIN	Lambda controller output (word)
PSDSS_U	DFFTCNV	AUS	Intake manifold pressure from pressure sensor (DS-S) with SAE quantisation
PSDSS_W		EIN	Intake manifold pressure measured with pressure sensor at manifold (DS-S)
RINH2_U	DFFTCNV	AUS	Act. value (byte) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH2_W	GGLSH	EIN	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_U	DFFTCNV	AUS	Actual value (byte) internal res. Ri-Nernst cell lambda sensor downstream cat
RINH_W	GGLSH	EIN	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
RINV2_U	DFFTCNV	AUS	Actuel value of internal resistance of lambda sensor 2, pre cat (byte)
RINV2_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor 2, pre ca
RINV_U	DFFTCNV	AUS	Actuel value of internal resistance of lambda sensor,pre cat (byte)
RINV_W	GGLSV	EIN	Actuel value of internal resistance of lambda sensor,pre cat (word)
RL_U	DFFTCNV	AUS	relative air charge (byte) for ambient cond. of fault code memory
RL_W	EGFE	EIN	relative air charge (Word)
TMOTLIN	GGTFM	EIN	Engine coolant temperature, linearised and calculated
TMOT_U	DFFTCNV	AUS	Engine temperature with defined quantisation for FSP-freese frame
TPSVKMF2_U	DFFTCNV	AUS	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (byte)
TPSVKMF2_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat (cylinder row 2) (word)
TPSVKMF_U	DFFTCNV	AUS	filtered cycle duration of sensor signal upstream cat. (byte)
TPSVKMF_W	DLSA	EIN	filtered cycle duration of sensor signal upstream cat. (word)
UDKP1_U	DFFTCNV	AUS	sensor voltage from throttle-valve potentiometer 1 (byte)
UDKP1_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UDKP2_U	DFFTCNV	AUS	sensor voltage from throttle-valve potentiometer 2 (byte)
UDKP2_W		EIN	sensor voltage from throttle potentiometer 2 (word)
UPWG1_U	DFFTCNV	AUS	Voltage PWG potentiometer 1 (byte)
UPWG1_W		EIN	Voltage PWG potentiometer 1 (word)
UPWG2D_U	DFFTCNV	AUS	Doubled PWG potentiometer-2 voltage (byte)
UPWG2D_W		EIN	Doubled PWG potentiometer-2 voltage (word)
UPWG2_U	DFFTCNV	AUS	Voltage PWG potentiometer 2 (byte)
UPWG2_W		EIN	Voltage PWG potentiometer 2 (word)
VFZG	SWADAP	EIN	vehicle speed (km/h)
VFZG_U	DFFTCNV	AUS	Vehicle speed

FW DFFTCNV 3.30 Fixed Values

Parameter	Value	Description

FB DFFTCNV 3.30 Detailed description of function

APP DFFTCNV 3.30 Application hint

DFRZ 20.20 OBDII; description ’freeze frame’

FDEF DFRZ 20.20 Function definition

```
With new fault entry the following freeze frame values are stored within the fault code memory:

CARB-freeze frame according to the values 1 to 11 out of the basic freeze frame table                   see -->%DFFTx.y      ##
Extended freeze frame values according data EFFDFPM with length SY_ffesize out of the basic freeze frame table               ##
```

ABK DFRZ 20.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
EFFDFPM	BLOKNR		KL	Declaration of freeze frame extension out of table DFFT
SY_FFESIZE			SYS	system constant: Size of Freeze Frame-extension

FB DFRZ 20.20 Detailed description of function

APP DFRZ 20.20 Application hint

```
Selection of the extended freeze frame values is possible by data EFFDFPM out of data FFT                 -->%DFFTx.y
```

DTIP 1.30 OBDII; tester interface package

FDEF DTIP 1.30 Function definition

```
The following methods to get interaction with an external scan tool via according interface are supported:

getErrCnt       readout of the number of stored fault entries

getErrLine()    readout of the specific line of the fault code memory
                content of the line see -->%DFCMx.y

getErrDfp()     readout of the specific fault path of the fault code memory
                content of the line see -->%DFCMx.y

delFCM          deletion of the complete fault code memory FCM with status words sfpdfp and possibly parts of diagnostic functions

delErrDfp()     deletion of this specific fault path entry with status word sfpdfp and possibly parts of the diagnostic function.

getInfoLine()   readout of short info out of selected FCM line (Byte 0  to  Byte 5); see -->%DFCMx.y

getInfoDfp()    readout of short info out of this specific fault path entry (Byte 0  to  Byte 5); see -->%DFCMx.y

delFcmScatt     deletion only of the scatt-related fault path entries with their status word sfpdfp.

    readout of the fault code memory by OBDII scan tool                                 -->%SCATTx.y
                                    or servive tester e.g. KTS500                       -->%T2...x.v; %TK...x.y

Additionally the CARB freeze frame no.0 is selected for output to scan tool according SAE J1972 mode 2.
```

ABK DTIP 1.30 Abbreviations

FB DTIP 1.30 Detailed description of function

APP DTIP 1.30 Application hint

DFPMEEP 1.11 Diagnosic; Fault Path Manager, EEPROM storage

FDEF DFPMEEP 1.11 Function definition

Im EEPROM werden folgende Fehlerspeicherinhalte gesichert und für eine Restaurierung von max. 10 Einträgen des Fehlerspeichers nach Powerfail bereitgehalten:

Fehlerpfadstatus	fps	(byte)
Fehlerpfadtyp	typ	(byte)
Fehlerpfad-Testercode	CDTdfp	(word)
Fehlerpfadidentifier	dfp	(byte)
Fehlereintragsstatus	fes	(byte)

Nach Powerfail wird der Fehlerspeichereintrag wie folgt restauriert:
(Nur dann, wenn dfp und CDTdfp im aktuell vorliegenden Programmstand noch mit den gespeicherten Werten übereinstimmen.)

dfp	aus EEPROM übernehmen
tsf	auf 00 dez setzen
fps	aus EEPROM übernehmen
typ	aus EEPROM übernehmen
fes.erfprl	auf 0 setzen
fes.dauer	auf 0 setzen
fes.scatt	entsprechend CLAdfp setzen
fes.mil	auf 0 setzen
fes.blink	auf 0 setzen
fes.multi	auf 0 setzen
fes.epcl	auf 0 setzen
fes.nn2	auf 0 setzen
cla	entsprechend CLAdfp setzen
flc	entsprechend Class auf INI-Wert setzen
hlc	entsprechend Class auf Kundendienstwert setzen
dlc	entsprechend Class auf INI-Wert setzen
frz 0 - 10	auf FF hex setzen
initim	auf 0 setzen, da top_w nach powerfail auch 0 ist
inifft 1 + 2	auf FF hex setzen
acttim	auf 0 setzen, da top_w nach powerfail auch 0 ist
actfft 1 + 2	auf FF hex setzen
hz	auf 1 dez setzen

Weitere Info z.B. auch zur Ablagesystematik im EEPROM: siehe ->%EEPROMx.y und %EEDATx.y

ABK DFPMEEP 1.11 Abbreviations

Abk.	Art	Beschreibung

FB DFPMEEP 1.11 Detailed description of function

Der Fehlerspeicher wird zu Beginn des Nachlaufs auf aktuelle Fehlerspeichereinträge durchsucht und über den EEPROM-Spiegel aktualisiert. Auch ein evtl. Löschen des Fehlerspeichers wird erst im Nachlauf in das EEPROM übernommen. -->%EEPROMx.y
Falls mehr als 10 Einträge im Fehlerspeicher eingetragen sind, werden nur diese ersten 10 Einträge im EEPROM gespeichert.

Nach Powerfail wird der Fehlerspeicher aus dem EEPROM heraus restauriert. Hierbei wird jeder betroffene Fehlerpfad auf den Zustand -geheilt nach einmaligem, nicht CARB-entprelltem Erkennen- gesetzt. Stimmt hierbei der CDTdfp aus dem EEPROM nicht mit dem CDTdfp aus dem ROM überein, so wird dieser Fehlereintrag nicht restauriert. (Datenkonsistenz bei Flash-Prog.)

Nicht restaurierbare Werte wie Freeze Frame, Umwelten etc. werden auf FF gesetzt.

APP DFPMEEP 1.11 Application hint

DTOP 1.0 Diagnosis; operating time

FDEF DTOP 1.0 Function definition

```
C_pwf ------------------------------------+
                                          |
                                          | reset to 0
            +------------+  6min timer +--v-------------+
timer ----->| ./.  to    +------------>| increment      +------> top_w
            | 6 minutes  |  topsec_w   +----------------+
            +------------+
```

ABK DTOP 1.0 Abbreviations

Variable	Source	Type	Description
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
TOP_W	DTOP	AUS	operating time since powerfail

FW DTOP 1.0 Fixed Values

Parameter	Value	Description

FB DTOP 1.0 Detailed description of function

```
During engine running tow_w is incremented every 6 minutes.
```

APP DTOP 1.0 Application hint

DDCY 15.10 OBDII; fulfillment condition ’driving cycle’

FDEF DDCY 15.10 Function definition

```
                                                              +-----+
                                                              |  +- |
                                                         +--->|  |  +----> fcmTrig (B_dcy) in %DFPM
                                                         |    | -+  |
               reset +----------------+                  |    +-----+
                     |                |                  |
            +--------v---+            |         +-+---+  |
B_stend --->| t > TWBDCY +----------- | ------->|S|   +--+-----------------+------> B_dcy
            +------------+    +-+     |         +-+---+                    |
C_ini ----------------------->|v+-----+-------->|R|   |                    |
C_fcmclr -+------------------>| |               +-+---+                    |
          |                   +-+                                          |
          |                                                                |
          |            +-----------<----------------------<----------------+
          |            |                                                                                               ##
          |            |                                        +--------------+                                       ##
          |            |               +-------------+          | ˆ counter+-- |               +----------+                    ##
          |            |               |      +--- 1 |          | |     +--+   |               |   ------ |                    ##
          |            +-------------->| 0 ---+      +--------->| |  +--+      +-------------->|  / 65535 +------> dcycnt      ##
          |                            +-------------+          | +--+-------> |               +----------+                    ##
          |     +-+                                             +--------------+                                               ##
          +---->| |                                                 ˆ                                                          ##
                |v|                                         Reset   |                                                          ##
C_pwf --------->| +-------------------------------------------------+                                                          ##
                +-+                                                                                                            ##
```

ABK DDCY 15.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TWBDCY			FW	waiting time for condition ’driving cycle’

Variable	Source	Type	Description
BBDCY	DDCY	AUS	Byte for condition B_dcy as trigger relevant in DCLA
B_DCY	DDCY	AUS	condition for ’driving cycle’ fulfilled
B_STEND	BBSTT	EIN	condition end of start
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
DCYCNT	DDCY	AUS	driving cycle - counter

FW DDCY 15.10 Fixed Values

Parameter	Value	Description
TWBDCY		waiting time for condition ’driving cycle’

FB DDCY 15.10 Detailed description of function

```
TWBDCY seconds after engine start the ’driving cycle’ condition B_dcy is set and stored untill end of cycle.
With change of B_dcy  0 -> 1  inside the fault path manager all dcy-actions are run by method ’fcmTrig(B_dcy) once per cycle.

With deletion of the fault code memory via C_fcmclr (even with running engine) B_dcy is reset and TWBDCY is started again.
```

APP DDCY 15.10 Application hint

```
Default value for TWBDCY:  5 sec; this for sure running of the engine in advance of ’sharpness’ of the system.
TWBDCY >> 5 sec gives more security, has to be CARB declared case by case.
```

DWUC 14.20 OBDII; fulfillment condition ’warm up cycle’

FDEF DWUC 14.20 Function definition

```
               +-+
B_stend ----->o|V+------+                                                          +---+                                       ##
          +--->| |      | Trigger for                    +----------------------->o|   +----------------------------> B_nowuc  ##
          |    +-+      v update                         |                         +---+                                       ##
          |       +-------------+   tmstem +----------+  |   +-+     +-+---+
          |   +-->|tmstem = tmot+-+------->| <TMWUCST +--+-->|&+---->|S|   +-+---------------------------------+----> B_wuc
          |   |   +-------------+ |        +----------+ +--->| |     +-+---+ |                                 |
          |   |                   |                     | +->| |  +->|R|   | |                                 |
          |   |                  -V  dtmste+----------+ | |  +-+  |  +-+---+ |  +-----+                        |
tmot -----|---+------------------>O------->| >=DTMWUC +-+ |       |          |  |  +- |                        |
          |   |                  +         +----------+   |       |          +->|  |  +-> fcmTrig(B_wuc)       |
          |   |                                           |       |             | -+  |    in %DFPM            |
          |   |                            +----------+   |       |             +-----+                        |
          |   +--------------------------->|  >TMWUC  +---+       |                                            |
          |                                +----------+       +-+ |                                            |
C_fcmclr -+-------------------------------------------------->|v+-+                                            |
C_ini --- | ------------------------------------------------->| |                                              |
          |                                                   +-+                                              |
          |            +-----------<----------------------<--------------------------<------------------<------+
          |            |
          |            |                                        +--------------+
          |            |               +-------------+          | ^Counter +-- |               +----------+
          |            |               |      +--- 1 |          | |     +--+   |               |   ------ |
          |            +-------------->| 0 ---+      +--------->| |  +--+      +-------------->|  /  255  +-----> wuccnt
          |                            +-------------+          | +--+-------> |               +----------+
          |     +-+                                             +--------------+
          +---->|v|                                         Reset   ^
C_pwf --------->| +-------------------------------------------------+
                +-+
```

ABK DWUC 14.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
DTMWUC			FW	delta engine temperture threshold for fulfilment ”warm up cycle”
TMWUC			FW	engine temperture threshold for fulfilment ”warm up cycle”
TMWUCST			FW	engine temperture threshold during cranking for fulfilment ”warm up cycle”

Variable	Source	Type	Description
BBWUC	DWUC	AUS	Byte for condition B_wuc as trigger relevant in DCLA
B_NOWUC	DWUC	AUS	condition for ’no warm up cycle’ detected
B_STEND	BBSTT	EIN	condition end of start
B_WUC	DWUC	AUS	condition for detected ’warm up cycle’
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
TMOT	SWADAP	EIN	Engine temperature
TMSTEM	DWUC	LOK	engine temperature at end of start memorized
WUCCNT	DWUC	AUS	Warm-up cycle - counter

FW DWUC 14.20 Fixed Values

Parameter	Value	Description
DTMWUC		delta engine temperture threshold for fulfilment ”warm up cycle”
TMWUC		engine temperture threshold for fulfilment ”warm up cycle”
TMWUCST		engine temperture threshold during cranking for fulfilment ”warm up cycle”

FB DWUC 14.20 Detailed description of function

Following an engine start below the start temperature TMWUCST with subsequent heating by min. DTMWUC and reaching the upper temperature threshold TMWUC, the operating cycle is assigned the status ’warm-up cycle’ with B_wuc = 1.
If the engine start is effected above the start temperature TMWUCST, it is signaled via B_nowuc that no B_wuc can be realized anymore during the actual driving cycle.

During the start (B_st = 1), tmstem is continuously updated and remains stored at the start end (B_st 1->0) for the engine run.
An update for tmstem is performed once for deletion of the fault memory (e.g. as well for a running engine).
Amongst others, B_wuc is also reset by the command ’delete fault memory’ in C_fcmclr.

The corresponding debouncing measures are executed by initiating with fcmTrig(B_wuc), when the ’warm up cycle’ is fulfilled. -> %DFPM

APP DWUC 14.20 Application hint

```
Recommended values:   DTMWUC  =   21.00 deg. C
                      TMWUC   =   71.25 deg. C
                      TMWUCST = < 69.75 deg. C
```

DIMC 41.10 OBDII; inspection/maintenance-ready

FDEF DIMC 41.10 Function definition

If the fault memory has been deleted (by a possible tester command or a power failure), it may be necessary to first output a code 'ready' to the tester upon request which indicates that not all of the required tests for faults from the OBD system have been performed.

This means that each fault test for faults relevant to the exhaust emission given in 'evsup1' must reset a permanently stored preset bit as soon as the test has been completed in accordance with procedures (regardless of whether the result is 'acceptable' or 'discrepant').

As CARB couples the number of tests for reaching readiness with the MIL on - debounce (e.g. 2 driving cycles), the number of the previous driving cycles since a power failure or a deletion of the memory must be included in the assessment, at least in for the first suspected fault. To do this, a corresponding counter is cry... is run with each 'ready' function.

Structure of the path identifier 'evsup1' and the readiness byte 'ready' due to SAE J1979 (Mode 1 PID 1 Data C + D):

```
+--------+--------+--------+--------+--------+--------+--------+--------+
|B_cdagr |B_cdhsv |B_cdlsv |    0   |B_cdsls |B_cdtes |B_kath  |B_katfz |
+------7-+------6-+------5-+------4-+------3-+------2-+------1-+------0-+
       |        |        |        |        |        |        |        |
       |        |        |        |        |        |        |        |
       |        |        |        |        |        |        |        |
       v        v        v        v        v        v        v        v
+--------+--------+--------+--------+--------+--------+--------+--------+
|B_agrrdy|B_hsrdy |B_lsrdy |    0   |B_slsrdy|B_tesrdy|    0   |B_katrdy|
+------7-+------6-+------5-+------4-+------3-+------2-+------1-+------0-+
```

Byte 'evsup1' includes the designation of the currently installed test paths as required in SAE J1979 Mode 1 PID 1 Data C.

Following fault memory deletion or power fail, 'ready' is described with 'evsup1'.

Byte 'ready' includes the momentary test status of the installed test paths as required in SAE J1979 Mode 1 PID 1 Data C.

The bits for faults not present in the respective system are left as '0' during initialization.
(e.g. Bit 1: catalyzer heating system; Bit 4: air-conditioner coolant)

Each fully completed fault check of a path, irrespective of whether 'fault' or 'no fault' has been detected, increments the ready counter cry... until the maximum value of each is reached (255) and are maintained there without overflow.

The 'ready' condition is fulfilled when all B_...rdy - flags in the flag byte 'ready' = 0.

Formation of the 'evsup' byte:

```
                        +-+
C_ini -----------+----->|&+----------------------------> evsup1 bit 0
B_katfz ---------| ---->| |
                 |      +-+
0 ---------------|-------------------------------------> evsup1 bit 1
                 |
          +-+    |      +-+
B_cdtes ->| |    +----->|&+----------------------------> evsup1 bit 2
B_cdldp ->|v+----| ---->| |
          +-+    |      +-+  +-+
                 +---------->|&+-----------------------> ecsup1 bit 3
B_cdsls ---------| --------->| |
                 |           +-+
0 ---------------|-------------------------------------> evsup1 bit 4
                 |
                 |      +-+
                 +----->|&+----------------------------> evsup1 bit 5
B_cdlsv ---------| ---->| |
                 |      +-+  +-+
                 +---------->|&+-----------------------> evsup1 bit 6
B_cdhsv ---------| --------->| |
                 |           +-+  +-+
                 +--------------->|&+------------------> evsup1 bit 7
B_cdagr ------------------------->| |
                                  +-+
```

Formation of the 'ready' byte:

```
         +-+                +-+                                                                         +----------------+
B_pwf -->| |  C_fcmclr ---->|v+----------------+-------------------------------------------------------->| ready = evsup1 |
C_ini -->|&+--------------->| |                |                                                        +----------------+
         +-+    +-+         +-+                |
E_kat --------->|v+----------------------------|------------------------+           +-----+      +-+
E_kat2 -------->| |            +-+             +--------+               |       +-->| >=1 +----->| |
                +-+   Z_kat -->| |             |        | Reset auf 00  v o-----+   +-----+      | |
                      Z_kat2 ->| |             |   +----v----------+    /      +--------------+  | |
                 crykat# ---->0|&+-------------|-->| crykat + 1    +---o  o--->| >= SRYKAT ?  +->|v+o-------> B_katrdy
           +-+                 +-+             |   +---------------+           +--------------+  +-+
E_tesf --->|v+---------------------------------|------------------------+           +-----+           +-+
E_tes ---->| |                 +-+             +--------+               |       +-->| >=1 +---------->| |
           +-+   crytes# ---->0| |             |        | Reset auf 00  v o-----+   +-----+           | |
                    Z_tes ---->| |             |   +----v----------+    /      +--------------+       | |
                    Z_tesf --->|&+-------------|-->| crytes + 1    +---o  o--->| >= SRYTES ?  +------>|v+o--> B_tesrdy
                               +-+             |   +---------------+           +--------------+       +-+
E_sls -----------------------------------------|------------------------+           +-----+      +-+
                                               +--------+               |       +-->| >=1 +----->| |
                               +-+             |        | Reset auf 00  v o-----+   +-----+      | |
                 crysls# ---->0| |             |   +----v----------+    /      +--------------+  | |
                    Z_sls ---->|&+-------------|-->| crysls + 1    +---o  o--->| >= SRYSLS ?  +->|v+o-------> B_slsrdy
           +-+                 +-+             |   +---------------+           +--------------+  +-+
E_lsv ---->|v+---------------------------------|------------------------+
E_lsv2 --->| |                 +-+             |                        |
E_lsh ---->| |       Z_lsv --->| |             |                        |           +-----+           +-+
E_lsh2 --->| |       Z_lsv2 -->| |             +--------+               |       +-->| >=1 +---------->| |
E_latp  -->| |       Z_lsh --->| |             |        | Reset auf 00  v o-----+   +-----+           | |
E_latp2 -->| |       Z_lsh2 -->| |             |   +----v----------+    /      +--------------+       | |
           +-+       Z_latp -->|&+-------------|-->| cryls + 1     +---o  o--->+ >= SRYLS ?   +------>|v+o--> B_lsrdy
                     Z_latp2 ->| |             |   +---------------+           +--------------+       +-+
                    cryls# -->0| |             |
                               +-+             |
           +-+                                 |
E_hsv ---->|v+---------------------------------|------------------------+
E_hsv2 --->| |                 +-+             |                        |           +-----+      +-+
E_hsh ---->| |       Z_hsv --->| |             +--------+               |       +-->| >=1 +----->| |
E_hsh2 --->| |       Z_hsv2 -->| |             |        | Reset auf 00  v  o----+   +-----+      | |
           +-+       Z_hsh --->| |             |   +----v----------+     /     +--------------+  | |
                     Z_hsh2 -->|&+-------------|-->| cryhs + 1     +---o   o-->| >= SRYHS ?   +->|v+o-------> B_hsrdy
                    cryhs# -->0| |             |   +---------------+           +--------------+  +-+
                               +-+             |
E_agr -----------------------------------------|------------------------+           +-----+           +-+
                                               +--------+               |       +-->| >=1 +---------->| |
                               +-+                      | Reset auf 00  v  o----+   +-----+           | |
                 cryagr# ---->0| |                 +----v----------+     /     +--------------+       | |
                    Z_agr ---->|&+---------------->| cryagr + 1    +---o   o-->| >= SRYAGR ?  +------>|v+o--> B_agrrdy
                               +-+                 +---------------+           +--------------+       +-+
```

ABK DIMC 41.10 Abbreviations

Variable	Source	Type	Description
B_AGRRDY	DIMC	AUS	status EGR tested for ”ready byte”
B_CDAGR	PROKON	EIN	function active per codeword CDAGR
B_CDHSV	PROKON	EIN	function active per codeword CDHSV
B_CDLDP	PROKON	EIN	function active per codeword CDLDP
B_CDLSV	PROKON	EIN	function active per codeword CDLSV
B_CDSLS	PROKON	EIN	function active per codeword CDSLS
B_CDTES	PROKON	EIN	function active per codeword CDTES
B_HSRDY	DIMC	AUS	status O2 sensor heater tested for ”ready byte”
B_KATFZ	PROKON	EIN	condition: cat fitted in vehicle
B_KATH	PROKON	EIN	Condition cat-heater installed in vehicle
B_KATHRDY	DIMC	AUS	status catalyst heater tested for ”ready byte”
B_KATRDY	DIMC	AUS	status catalyst tested for ”ready byte”
B_LSRDY	DIMC	AUS	status O2 sensors tested for ”ready byte”
B_PWF		EIN	Condition for powerfail
B_SLSRDY	DIMC	AUS	status SAI system tested for ”ready byte”
B_TESRDY	DIMC	AUS	status purge system tested for ”ready byte”
CRYAGR		EIN	counter for setting readyness flag - EGR diagnosis
CRYHS		EIN	counter for setting readyness flag - oxygen sensor heater diagnosis
CRYKAT		EIN	counter for setting readyness flag - catlyst monitoring diagnosis
CRYLS		EIN	counter for setting readyness flag - oxygen sensor diagnosis
CRYSLS		EIN	counter for setting readyness flag - secondary air system diagnosis
CRYTES		EIN	counter for setting readyness flag - canister purge diagnosis
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
EVSUP1	DIMC	AUS	function identifier for support SAE J1979 mode 2
E_AGRF		EIN	error flag: EGR flow monitoring
E_HSH	DHLSHK	EIN	error flag: lambda sensor heating downstream cat
E_HSH2	DHLSHK	EIN	error flag: lambda sensor heating downstream cat on the right
E_HSV	DHLSVK	EIN	error flag: lambda sensor heating upstream cat
E_HSV2	DHLSVK	EIN	error flag: lambda sensor heating upstream cat on the right
E_KAT	DKAT	EIN	error flag: catalyst conversion
E_KAT2	DKAT	EIN	error flag: catalyst conversion (cylinder row 2)
E_LATP	DLSA	EIN	error flag: lambda sensor aging tp

Variable	Source	Type	Description
E_LATP2	DLSA	EIN	error flag: lambda sensor aging tp (cylinder row 2)
E_LSH	DLSH	EIN	error flag: lambda sensor downstream cat
E_LSH2	DLSH	EIN	Errorflag: Lambda-Sensor downstream bank2
E_LSV	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_LSV2	DLSV	EIN	error flag: lambda sensor upstream catalyst
E_SLS		EIN	error flag: secondary air system
E_TES	DTEV	EIN	error flag: canister purge system diagnosis
READY	DIMC	AUS	readiness byte for support SAE J1979 mode 2
Z_AGRF		EIN	cycle flag: monitoring of EGR flow
Z_HSH	DHLSHK	EIN	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLSHK	EIN	cycle flag of lambda sensor heating downstream cat, cylinder row 2
Z_HSV	DHLSVK	EIN	cycle flag of lambda sensor heating upstream cat
Z_HSV2	DHLSVK	EIN	cycle flag of lambda sensor heating upstream cat, cylinder row 2
Z_KAT	DKAT	EIN	cycle flag of catalyst conversion
Z_KAT2	DKAT	EIN	cycle flag: catalyst conversion (2nd bank)
Z_LATP	DLSA	EIN	cycle flag of lambda sensor aging tp
Z_LATP2	DLSA	EIN	cycle flag of lambda sensor aging tp (cylinder row 2)
Z_LSH	DLSH	EIN	cycle-flag: lambda sensor downstream cat
Z_LSH2	DLSH	EIN	cycle-Flag: Lambda-sensor downstream cat bank2
Z_LSV	DLSV	EIN	cycle flag: lambda sensor upstream of catalyst
Z_LSV2	DLSV	EIN	cycle flag: 2nd lambda sensor upstream of catalyst
Z_SLS		EIN	cycle flag: secondary air system
Z_TES	DTEV	EIN	cycle flag of canister purge system

FW DIMC 41.10 Fixed Values

Parameter	Value	Description

FB DIMC 41.10 Detailed description of function

APP DIMC 41.10 Application hint

The values of for the counter SRY.. are derived from the dating of the corr. FLC.., refer to Classtab (Standard MY97 is 2)

DMIL 26.40 OBDII; MIL control

FDEF DMIL 26.40 Function definition

```
        +-+-+-+-+-+-+-+-+
CWNOMIL |7|6|5|4|3|2|1|0|                                                                                    +-+
        +-+-+-+-+-+-+-+++                                                                B_kl15 ------------>| |
                       +------------+------------------------------------- B_nomil ------------------------>o| |
                                    |       +-+----+                                                  +-+    | |
C_inisyn ---------------------------|------>|S|    +--------------------------------------- B_milst ->|v+--->|&+--->B_mil
             +----------+           |       +-+----+                                              +-->| |    +-+
             | TLAED +- +-----------|-+---->|R|    |                                              |   +-+
B_nmot ----->| ------+  |           | |     +-+----+                                              |
             +----------+           | |                                                           |
                                    | |                                                 +-+       |
                +-----+             | |                              +-+----+           | |       |
getDfpmMil() -->|   on+-------+-----|-|----------------------------->|S|    +-B_mileb ->| |       |
von %DFPM       |  off+-------|-----|-|-----------+   +-+     +-+    +-+----+           | |       |
(auch bei INI)  |blink+-------|-+---|-|--------+  +-->|&+---->|v+--->|R|    |           |v+--O-O--+
                +-----+       | |   | |        |      | |  +->| |    +-+----+           | |   ^
C_nachl ----------------------|-|---|-|--------|----->| |  |  +-+                       | |   |
                              | |   | |        |      +-+  |                            | |   |
C_fcmclr ---------------------|-|---|-|--------|-----------+                            | |   |
B_milmd --------------------+-|-|---|-|--------|--------------------------------------->| |   |
B_milfb --------------------|-|-|---|-|--------|--------------------------------------->| |   |
                            | | |   | |        |                                        | |   |
                            | | |   | |        |              +-+                       | |   |
                            | | |   | |        +--- B_blkeb-->|v+-- B_milblk ---+------>| |   |
B_blkfb --------------------|-|-|---|-|---------------------->| |               |       +-+   |
B_blkmd --------------------|-|-|-+-|-|---------------------->| |               v             |
                            | | | | | |                       +-+           +-------+         |
                            | | | | | |                            +-+      | 1 Hz  +---------+
                            | | | | | +--------------------------->| |      +-------+
                            | | | | +---------------------+------>o| |
                            | | | |             +-+       |        | |
                            | | | +------------>|v+--+----|------->|&+---------------------> B_kmmil
                            | | +-------------->| |  |    |   +-+  +-+
                            | +---------------->| |  |    +->o| |
                            +------------------>| |  +------->|&+---------------> B_milstat
                      B_mileb ----------------->| |           +-+
                                                +-+
```

Faults which the MIL shall not control, can be dated accordingly (--> Classification table %DFPM)

ABK DMIL 26.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWNOMIL			FW	code word MIL-control not active

Variable	Source	Type	Description
B_BLKEB	DMIL	LOK	MIL activation blinking by own module
B_BLKFB		EIN	MIL-trigger blinking controlled by external ECU
B_BLKMD	DMDMIL	EIN	MIL-trigger blinking controlled by misfire detection
B_KL15		EIN	condition ignition switch on
B_KMMIL	DMIL	AUS	MIL turn-on related to mileage
B_MILBLK	DMIL	LOK	MIL turn-on blinking
B_MILEB	DMIL	LOK	MIL turn-on, self-controlled
B_MILFB		EIN	MIL controlled by external ECU
B_MILST	DMIL	LOK	MIL turn-on, test function during start
B_MILSTAT	DMIL	AUS	MIL-Status for Scan-Tool Mode $01 PID $01
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NOMIL	DMIL	LOK	MIL turn-on blocked
C_FCMCLR		EIN	system state: reset fault memory
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization
C_NACHL		EIN	ECU condition for ECU switch off delay

FW DMIL 26.40 Fixed Values

Parameter	Value	Description
CWNOMIL		code word MIL-control not active

FB DMIL 26.40 Detailed description of function

Legislation requires the display of faults relevant to exhaust emission by a fault lamp (MIL) in the instrumentation board.
The fault lamp may not be used for other purposes.
It shall display one of the following signs when triggered:
      -Check Engine-;   -Service Engine Soon-;   -Check Powertrain-   or   -Service Powertrain Soon-

The MIL must illuminate for Ignition ON and standing engine for functional control.

For detected faults which are relevant to exhaust emission, the MIL must illuminate at latest following debounce of the legally permissible fault detection.

For special faults (e.g. detection of misfire rates damaging to the catalyzer), the MIL must blink immediately with 1 Hz.

The MIL may extinguish at the earliest after the legally permissible rectification debounce following detected rectification of all faults.

The MIL may only be controlled by one master SG on account of the checking function for ignition ON and the output stage diagnostics. Other SG’s send requests for lamp control to this master SG, e.g. via CAN.

APP DMIL 26.40 Application hint

Set TLAED to 3 seconds.

DEPCL 1.20 Diagnosis; electronic powertrain control lamp

FDEF DEPCL 1.20 Function definition

```
                                                                      +-+                     +-+----+
C_inisyn ------+----------------------------------------------------->|v+-------------------->|S|    +----->B_epcl
               |                                                  +-->| |                     +-+----+
               |                                                  |   +-+     +-------------->|R|    |
getDfpmEpcl()  |                               /    +-----+       |           |               +-+----+
out of %DFPM --|------------------------------o o-->|   on+-------+   +-+     |
               |                               ˆ    |  off+---------->|&+-----+
               |                               |    +-----+  +------->| |
               |                               |             |        +-+
               |  +---------------+     +-+    |             |
               |  |   TEPCLI +--- +---->|v+----+-------------+
               +->| ---------+    |  +->| | TEPCLI is inactive if dated to max. value, then only TEPCL is active.
                  +---------------+  |  +-+
                                     |
                  +---------------+  |
                  |   TEPCL +---- +--+
B_nmot ---------->| --------+     |
                  +---------------+
```

Whithin the class table there is data CLAdfp defining which faults activate the EPCL. (--> see class table %DCLA)

ABK DEPCL 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
TEPCL			FW	Time after engine start for end of EPCL test
TEPCLI			FW	Time after INI for end of EPCL test

Variable	Source	Type	Description
B_EPCL	DEPCL	AUS	Condition for activation of electronic powertrain control lamp
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
C_INISYN		EIN	ECU-condition for intialisation of angle synchronization

FW DEPCL 1.20 Fixed Values

Parameter	Value	Description
TEPCL		Time after engine start for end of EPCL test
TEPCLI		Time after INI for end of EPCL test

FB DEPCL 1.20 Detailed description of function

The EPCL has to be activated for min. a view seconds for visual control with ignition on and engine not running.

After the detection of a fault which has a strong impact to the driveability, the EPCL has to be activated immediately.

After healing of all relevant faults the EPCL may be switched off immediately.

To ensure the selftest of the power stage the EPCL has to be activated by only ECU.
Other ECU’s have to send a request to activate and deactivate the EPCL (e.g. via CAN).

APP DEPCL 1.20 Application hint

```
For deactivation of EPCL with delaytime TEPCL after engine is running:
             TEPCLI set to max. value; Default data for TEPCL is 3 sec.
For deactivation of EPCL with delaytime TEPCLI after INI:
             TEPCLI auf z.B. 3 sec setzen; TEPCL >= TEPCLI setzen, sonst überwiegt TEPCL bei Schnellstart.
```

RSTMON 2.10 Reset monitor

FDEF RSTMON 2.10 Function definition

1. Reset monitor
1.1 Background:

In the ME7.0-Software there are a lot of reasons to Resets. In the development-phase there could be e.g. certain kind of errors, and wrong application data settings, which makes the ECU μC Reset itself. But there are also normal Reset-causes e.g. as the ignition switch is turned ON. To find the errors in the development-phase, one must be able to track the previous Reset-causes, preferably via the application tools VS-100 or VAT-2000.

1.2 Functional description:

The Reset-monitor is a SW-part which keeps track of the previous Reset-causes in the System. This is a cyclical buffer placed in Non-Volatile RAM, which is able to log the last 12 Reset-causes.

Before the SW causes a Reset, the variable resetIndication is set to match the appropriate cause. E.g. if a SW-Reset should be forced by the trap function handling Stack underflows, the resetIndication is set to "System stack underflow"-Reset (04h).

The resetIndication is read out in the ini-phase which follows the Reset. This takes place in a subroutine, which compares resetIndication with the last Reset-cause placed in the Reset-monitor. As long as the resetIndication is the same, no new entry is done in the Reset-monitor. Only a counter associated to the entry is then incremented.

An example of how the Reset-Monitor could look like is made in the following table:

```
Variable        Number of Resets (High Byte)    Reset-cause(Low Byte)
rstMon[0]       20h     O6h
rstMon[1]       01h     03h
rstMon[2]       02h     06h
:       :       :
```

resetMonIdx = 2

The example should be read out in the following way:
At 1st took the 06-Reset place 20h times. Then the 03-Reset took place once, and after that the 06-Reset took place twice (which also was the previous Reset-cause, as the resetMonIdx is = 2).

The Reset-causes are to be read out according to the following table:

```
Name of Reset-cause             No:     Explanation

EXTERNAL_RESET                  =       0,      reset due to RSTIN=low
WATCHDOG_RESET                  =       1,      reset due to CPU-on-chip-Watchdog
DEADLINE_RESET                  =       2,      reset due to deadline overrun
ILLBUS_TRAP_RESET               =       3,      reset due to ILLegal BUS Access         ||don't insert any line here as all these
ILLINA_TRAP_RESET               =       4,      reset due to ILLegal INstruction Access ||resets corresponds to Class B type reset
ILLOPA_TRAP_RESET               =       5,      reset due to ILLegal word OPerand Access||which are querried in rstmonX.c and
                                                startufX.c
PRTFLT_TRAP_RESET               =       6,      reset due to PRoTection FauLT Flag      ||if( 3[ILLBUS] <= reset Indication <=
                                                7[UNOPC]
UNDOPC_TRAP_RESET               =       7,      reset due to UNdefined OPCode           ||then reset Indication is Class B type
STKUN_TRAP_RESET                =       8,      reset due to Stackunderflow
STKOV_TRAP_RESET                =       9,      reset due to Stack-overflow
NMI_TRAP_RESET                  =       10,     reset due to Non-Maskable Interrupt and KL15-off Reset
KWP2000_RESET                   =       11,     reset forced by KWP2000-service
AD_SCAN_ERROR_RESET             =       12,     reset due to AD scan error
SUPERVISOR_RESET_UM             =       13,     reset forced by supervisor modul (umkom)
SUPERVISOR_RESET_FU             =       14,     reset forced by safety monitoring moduls (ufxxxx, ufreac)
SUPERVISOR_RESET_RAMI           =       15,     reset forced by safety monitoring by internal ram-check (reservation)
SUPERVISOR_RESET_RAM            =       16,     reset forced by safety monitoring by ram-check in Init (urram)
SUPERVISOR_RESET_ROM            =       17,     reset forced by safety monitoring by rom-check in Init (urrom)
SUPERVISOR_RESET_RAMZ           =       18,     reset forced by safety monitoring by cyclic ram-check (urmem, urausg)
SUPERVISOR_RESET_ROMZ           =       19,     reset forced by safety monitoring by cyclic rom-check in Init (urmem)
SUPERVISOR_RESET_TV             =       20,     reset forced by safety monitoring to delay startup (urdelay)
SUPERVISOR_NOQUEST_RESET        =       21,     reset due to wrong question from
SUPERVISOR_DISPS_RESET          =       22,     reset due to failure in disabling power stage from UM
SUPERVISOR_RESET_UM_OBP         =       23,     reset forced by supervisor module ufobp)
SUPERVISOR_RESET_CCM_OBP        =       24,     reset forced by supervisor module (ufobp), CCM supervision
SUPERVISOR_NOQUEST_RESET_OBP    =       25,     reset forced by supervisor module (ufobp), wrong question
SUPERVISOR_RESET_RAMTAB         =       26,     reset forced due to illegal ramTableEntry
EEPROM_RESET                    =       27,     reset forced by EEPROM module
ADDR_NOT_IN_SEG                 =       28,     reset forced by powerfail-module (caused by addr. in diff. segments)
UNDEF_RESET                     =       29      specifies end of enumeration
```

2. Trap functions

2.1 Background:

Trap functions are activated in response to special conditions that occur during the execution of instructions. Several hardware trap functions are provided by the C167 for handling erroneous conditions and exceptions that arise during the execution of an instruction.

2.2 Functional description:

The C167 is capable of detecting the following kind of exceptional HW events:
1. Illegal External Bus Access
An external access has been attempted with no external bus defined. (Not an issue in ME7)
2. Illegal Instruction Access
A branch to an odd address has been attempted.
3. Illegal Word Operand Access
A word operand access (read or write) to an odd address has been attempted.
4. Protection fault
A protect instruction with an illegal format has been detected.
5. Undefined Opcode
The currently decoded instruction has no valid C167 opcode. (Used for the so called "error capturing instructions" in ME7.0)

All of the 5 faults listed above, lead to the execution of the interrupt service routine (isr) for the so called "class B traps". To be able to search for the the possible SW error which triggers the class B trap, there are two values which could be interesting. One of these is to know exactly which cause the class B trap has (one of those 5), and the second is to know at which program address the fault is triggered. This is solved via three variables, placed in non volatile RAM area, and visible for e.g. VS-100.

2.3 Execution example:

```
   +---------- enter class B trap isr
   | +-------- save value of Instruction Pointer (IP) -> mirrorIP
   | | +------ save value of Code Segment Pointer (CSP) -> mirrorCSP
   | | | +---- save value of Trap Flag Register (TFR) -> mirrorTFR
   | | | | +-- Software Reset
   | | | | |   CLASS_B_TRAP as indication (for reset monitor)
   | | | | |
---+-+-+-+-+---> time
             |
             +--- start from Reset Vector (0x00000h)
```

2.4 Variables:

The following 3 variables are visible for the application tool:

2.4.1 mirrorTFR, Word

each fault sets one flag, which is decoded according to the following scheme:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|F|E|D|C|B|A|9|8|7|6|5|4|3|2|1|0| mirrorTFR, Bits
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | |           |       | | | |
   | |           |       | | | +- Illegal External Bus Access Flag
   | |           |       | | +--- Illegal Instruction Access Flag
   | |           |       | +----- Illegal Word Operand Access Flag
   | |           |       +------- Protection Fault Flag
   | |           +--------------- Undefined Opcode Flag
   | +--------------------------- Stack Underflow Flag (class A trap)
   +----------------------------- Stack Overflow Flag (class A trap)
```

2.4.2 mirrorIP, Word

2.4.3 mirrorCSP, Word

CSP:IP (32 bits) is the address of the instruction currently executed as the class B trap was injected
(e.g. mirrorIP = 0xf406h, mirrorCSP = 0x0004h -> address: 4f406h)

As the class B trap, and the class A traps stack underflow/overflow are quite related, the 3 variables are also beeing used by the two stack traps.
The exact cause of the trap is to be read out of the mirrorTFR.

ABK RSTMON 2.10 Abbreviations

Variable	Source	Type	Description
MIRRORCSP	RSTMON	LOK	flagregister mirror CSP
MIRRORIP	RSTMON	LOK	flagregister mirror IP
MIRRORTFR	RSTMON	LOK	flagregister mirror TFR
RSTMON_0	RSTMON	LOK	reset monitor 0
RSTMON_1	RSTMON	LOK	reset monitor 1
RSTMON_10	RSTMON	LOK	reset monitor 10
RSTMON_11	RSTMON	LOK	reset monitor 11
RSTMON_2	RSTMON	LOK	reset monitor 2
RSTMON_3	RSTMON	LOK	reset monitor 3
RSTMON_4	RSTMON	LOK	reset monitor 4
RSTMON_5	RSTMON	LOK	reset monitor 5
RSTMON_6	RSTMON	LOK	reset monitor 6
RSTMON_7	RSTMON	LOK	reset monitor 7
RSTMON_8	RSTMON	LOK	reset monitor 8
RSTMON_9	RSTMON	LOK	reset monitor 9

FW RSTMON 2.10 Fixed Values

Parameter	Value	Description

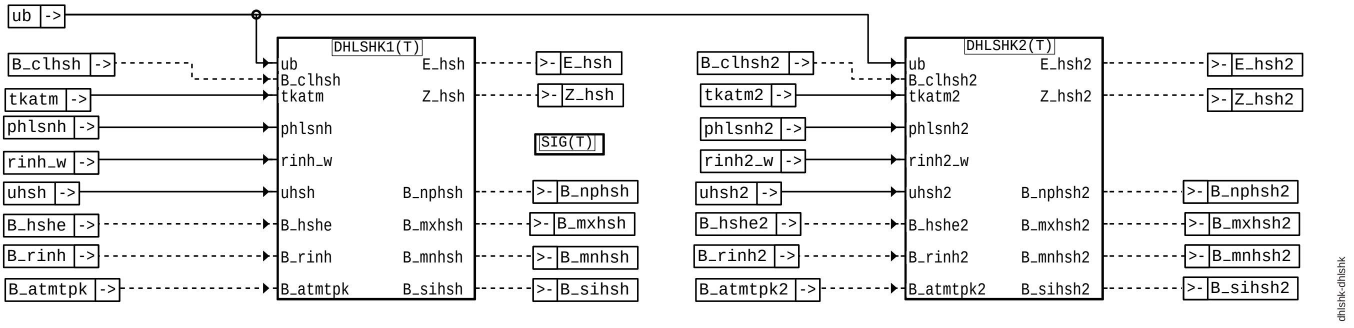
FB RSTMON 2.10 Detailed description of function

APP RSTMON 2.10 Application hint

DHLSHK 2.40 Diagnosis: sensor heating downstream of catalytic converter

FDEF DHLSHK 2.40 Function definition

Overview heater diagnosis downstream catalyst

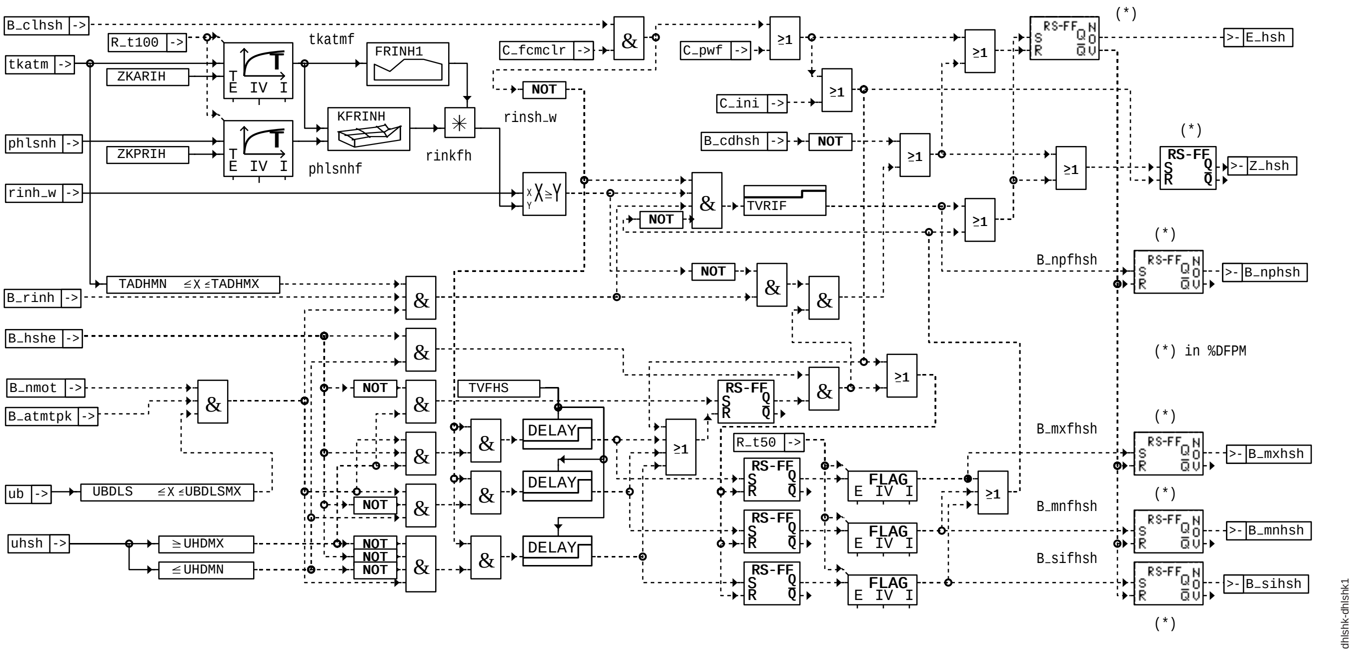


dhlshk-dhlshk

Status fault path: sfphsh
Error flag: E_hsh
Cycle flag: Z_hsh
Fault type: TYP_hsh:
(B_mxhsh, B_mnhsh, B_sihsh, B_nphsh)
Clear fault path: B_clhsh

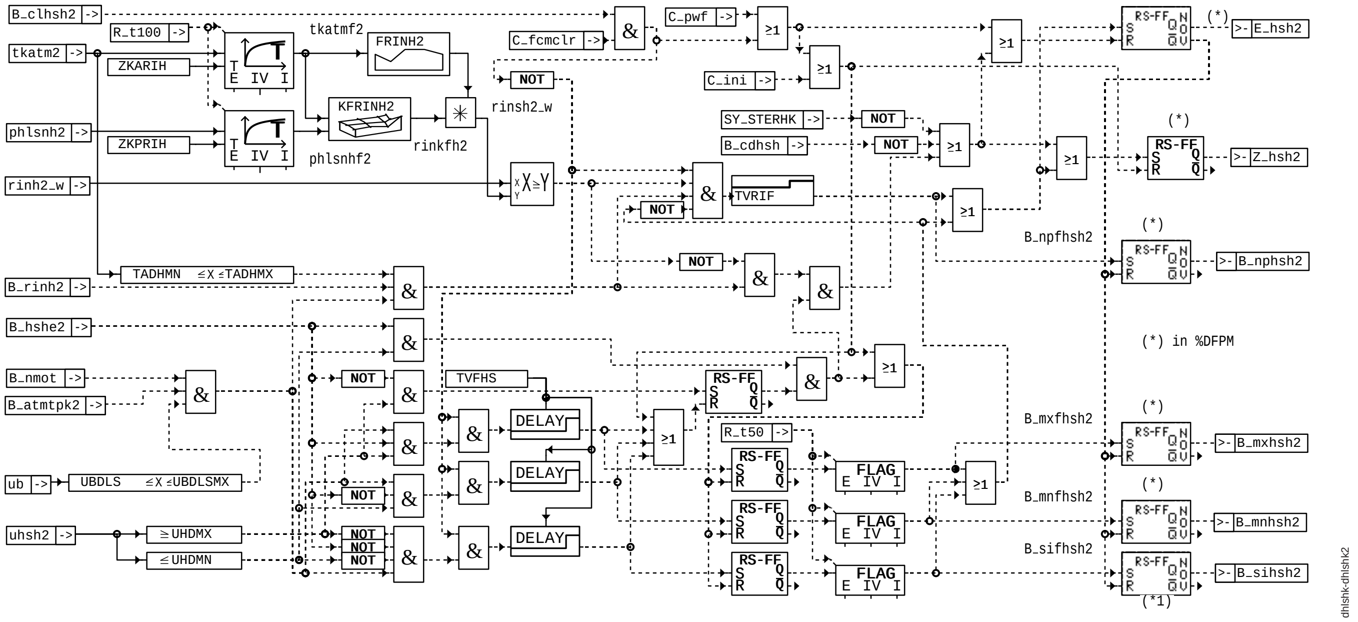
Default value active: B_bkhsh (optional)
Fault path code: CDTHSH
Fault class: CLAHSH
Fault intensity: TSFHSH
CARB CODE: CDCHSH
Table of ambient cond.: FFTHSH

Heater diagnosis downstream catalyst bank1



dhlshk-dhlshk1

Heater diagnosis downstream catalyst bank2



dhlshk-dhlshk2

ABK DHLSHK 2.40 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CDCHSH	BLOKNR		KL	code word CARB: lambda sensor heating downstream cat
CDCHSH2	BLOKNR		KL	code word CARB: lambda sensor heating downstream cat
CDTHSH			FW	code word tester: oxygen sensor heater downstream catalyst
CDTHSH2			FW	code word tester: oxygen sensor heater downstream catalyst, cyl. row 2
CLAHSH			FW	Fault class: Heating, lambda sensor downstream of catalytic converter
CLAHSH2			FW	Fault class: Heating, lambda sensor 2 downstream of catalytic converter
FFTHSH	BLOKNR		KL	Table of ambient condition for heating O2-sensor post cat
FFTHSH2	BLOKNR		KL	Table ambient conditions heating lambda sensor downstream catalyst bank2
FRINH1	TKATMF		KL	Multiplication factor for RIN nominal value downstream of the catalyzer

Parameter	Source-X	Source-Y	Type	Description
FRINH2	TKATMF2		KL	Multiplication factor for RIN nominal value downstream of the catalyzer
KFRINH	TKATMF	PHLSNHF	KF	MAP for Nernst resistor post cat
KFRINH2	TKATMF2	PHLSNHF2	KF	MAP for Nernst resistor post cat bank 2
TADHMN			FW	lower Temperature threshold for die heater diagnostic routine
TADHMX			FW	upper Temperature threshold for die heater diagnostic routine
TSFHSH			FW	fault active time: lambda sensor heating catalyst downstream
TSFHSH2			FW	fault active time: lambda sensor heating catalyst downstream, bank2
TVFHS			FW	Dejettering time for heater power stage
TVRIF			FW	Delay time for Ri fault
UBDLS			FW	battery voltage threshold for release the sensor diagnosis
UBDLSMX			FW	upper battery voltage threshold for the sensor diagnosis
UHDMN			FW	Threshold for powered heater power stage
UHDMX			FW	Threshold for not powerded heater power stage
ZKARIH			FW	Filter time const. sim. dyn. ceramic temp. for exhaust emis. temp. downstr. cat.
ZKPRIH			FW	Filter for sim. of dynamics for ceramic temp. from elec. heat. downstr.of cat.

Variable	Source	Type	Description
BLOKNR		EIN	DAMOS source for block number
B_ATMTPK	ATM	EIN	condition temperature downstream catalyst exceeds dew-point
B_ATMTPK2	ATM	EIN	condition temperature downstream catalyst exceeds dew-point2
B_CDHSH	PROKON	EIN	function active per codeword CDHSH
B_CLHSH		EIN	condition clear failure path DHLSHK
B_CLHSH2		EIN	condition clear failure path DHLSHK2
B_HSHE	HLS	EIN	condition for lambda sensor heating-switch downstream cat on
B_HSHE2	HLS	EIN	condition for lambda sensor2 heating-switch downstream cat on
B_MNFHSH	DHLSHK	LOK	Short circuit of heating O2 sensor post cat to ground
B_MNFHSH2	DHLSHK	LOK	Short circuit of heating O2 sensor post cat to ground
B_MNHSH	DHLSHK	AUS	Short circuit of heating O2 sensor post cat to ground
B_MNHSH2	DHLSHK	AUS	Short circuit of heating O2 sensor post cat to ground
B_MXFHSH	DHLSHK	LOK	Short circuit of heating O2 sensor post cat to Ubatt
B_MXFHSH2	DHLSHK	LOK	Short circuit of heating O2 sensor2 post cat to Ubatt
B_MXHSH	DHLSHK	AUS	Short circuit of heating O2 sensor post cat to Ubatt
B_MXHSH2	DHLSHK	AUS	Short circuit of heating O2 sensor 2 post cat to Ubatt
B_NMOT	GGDPG	EIN	condition engine speed: n > NMIN
B_NPFHSH	DHLSHK	LOK	Nernst resistance sensor downstream of the catalyzer too large
B_NPFHSH2	DHLSHK	LOK	Nernst resistance sensor 2 downstream of the catalyzer too large
B_NPHSH	DHLSHK	AUS	Nernst resistance sensor downstream of the catalyzer too large
B_NPHSH2	DHLSHK	AUS	Nernst resistance sensor 2 downstream of the catalyzer too large
B_RINH	GGLSH	EIN	Condition internal resistance of Ri-measur. of sensor active downstream cat.
B_RINH2	GGLSH	EIN	Condition internal resist. of Ri-meas. sensor active downstream cat. bank2
B_SIFHSH	DHLSHK	LOK	Load disconnection lambda sensor heating downstrean cat.
B_SIFHSH2	DHLSHK	LOK	Load disconnection lambda sensor heating downstrean cat. bank 2
B_SIHSH	DHLSHK	AUS	Load disconnection lambda sensor heating downstrean cat.
B_SIHSH2	DHLSHK	AUS	Load disconnection lambda sensor heating downstrean cat. bank 2
C_FCMCLR		EIN	system state: reset fault memory
C_INI	SWADAP	EIN	ECU-condition for intialisation
C_PWF	SWADAP	EIN	ECU-condition powerfail initialisation
E_HSH	DHLSHK	AUS	error flag: lambda sensor heating downstream cat
E_HSH2	DHLSHK	AUS	error flag: lambda sensor heating downstream cat on the right
PHLSNH	HLS	EIN	Standardized heating power of the Lambda sensor downstream of the catalyzer
PHLSNH2	HLS	EIN	Standardized heating power of the Lambda sensor 2 downstream of the catalyzer
PHLSNHF	DHLSHK	LOK	Standardized heating power of Lambda sensor downstream of catalyzer, filtered
PHLSNHF2	DHLSHK	LOK	Standardized heating power of Lambda sensor 2 downstream of catalyzer, filtered
RINH2_W	GGLSH	EIN	Act. value (word) int. res. Ri-Nernst cell lambda sensor downstream cat bank2
RINH_W	GGLSH	EIN	Actual value (word) internal res. Ri-Nernst cell lambda sensor downstream cat
RINKFH	DHLSHK	LOK	Internal resistance Nernst cell of Lambda sensor from mapping upstream of cat.
RINKFH2	DHLSHK	LOK	Internal resistance Nernst cell of Lambda sensor 2 from mapping upstream of cat.
RINSH2_W	DHLSHK	LOK	Lim. value internal resistance Nernst cell of Lambda sensor 2 downstream of cat.
RINSH_W	DHLSHK	LOK	Lim. value internal resistance Nernst cell of Lambda sensor downstream of cat.
R_T100		EIN	Time schedule 100 ms
R_T50		EIN	Time schedule 50 ms
SFPHSH	DHLSHK	AUS	status fault path:
SFPHSH2	DHLSHK	AUS	status fault path:
SY_STERHK	PROKON	EIN	system parameter condition stereo downstream catalyst
TKATM	ATM	EIN	catalyst temperature (model)
TKATM2	ATM	EIN	catalyst temperature (model), bank2
TKATMF	DHLSHK	LOK	Filtered catalyzer temperature from model
TKATMF2	DHLSHK	LOK	Filtered catalyzer temperature from model, Bank2
UB	SWADAP	EIN	battery voltage
UHSH		EIN	Voltage at ECU heating power stage, post cat
UHSH2		EIN	Voltage at ECU heating power stage 2, post cat
Z_HSH	DHLSHK	AUS	cycle flag of lambda sensor heating downstream cat
Z_HSH2	DHLSHK	AUS	cycle flag of lambda sensor heating downstream cat, cylinder row 2

FW DHLSHK 2.40 Fixed Values

Parameter	Value	Description
CDTHSH		code word tester: oxygen sensor heater downstream catalyst
CDTHSH2		code word tester: oxygen sensor heater downstream catalyst, cyl. row 2
CLAHSH		Fault class: Heating, lambda sensor downstream of catalytic converter
CLAHSH2		Fault class: Heating, lambda sensor 2 downstream of catalytic converter

Parameter	Value	Description
TADHMN		lower Temperature threshold for die heater diagnostic routine
TADHMX		upper Temperature threshold for die heater diagnostic routine
TSFHSH		fault active time: lambda sensor heating catalyst downstream
TSFHSH2		fault active time: lambda sensor heating catalyst downstream, bank2
TVFHS		Dejettering time for heater power stage
TVRIF		Delay time for Ri fault
UBDLS		battery voltage threshold for release the sensor diagnosis
UBDLSMX		upper battery voltage threshold for the sensor diagnosis
UHDMN		Threshold for powered heater power stage
UHDMX		Threshold for not powerded heater power stage
ZKARIH		Filter time const. sim. dyn. ceramic temp. for exhaust emis. temp. downstr. cat.
ZKPRIH		Filter for sim. of dynamics for ceramic temp. from elec. heat. downstr.of cat.

FB DHLSHK 2.40 Detailed description of function

With this DHLSHK an indirect check is performed on whether the heating of the Lambda sensor is operational, i.e. the measurement of the heater current by means of a shunt performed so far is abandoned.
As criterion for the diagnosis the internal resistance of the Nernst cell of the Lambda sensor is used. With defective sensor heating the internal resistance (rinh_w) is essentially larger. For the determination of rinh_w the sensor voltage must be periodically connected to load with 0,5mA for 10ms (%GGLSH).
In addition the switching behaviour of the heater power stage is monitored. For this an ADC-channel with a circuit per power stage is necessary, which is scanned in the 10ms grid. This circuit is necessary for the detection of "load drop".
Circuit: 10 kOhm to ground, 10 kOhm to 5 Volt and connection ADC to power stage output via 22 kOhm.

Diagnosis internal resistance of the Nernst cell

Since the internal resistance rinh_w is also dependent on the exhaust gas temperature and on the el. heating performance (phlsnh), the typical value of rinh_w is stored in a map from tkatm and phlsnh.
tkatm and phlsnh are filtered, since a change only affects rinh_w after a delay.

Preconditions:
1. rinh_w is updated (B_rinh = 1)
2. The exhaust gas temperature is greater than the threshold TADHMN and lower than TADHMX
3. UB is within the diagnosis range

Diagnosis:
If rinh_w is less than rinsh_w, then B_hsokh is set if additionally the switching behaviour of the power stage is OK.
If rinh_w is greater, then B_nphsh is set.

Diagnosis switching behaviour of the heater power stage

For diagnosis purposes the power stage is switched off every 10s for 100ms (in %HLSHK). Then a check on whether the power stage is operational and whether the heater is connected to the battery voltage is performed.

Preconditions:
1. The power stage is switched on and off
2. UB must lie within the diagnosis range
3. The switch-off capability of the power stage (heater connected to UB) is stored

Diagnosis:
By a logic combination of the input and output of the power stage the power stage operation is checked.
The faults are delayed by the time TVFHS in order to take into consideration fault reports, which are caused by calculation execution times between B_hshe and uhsh.

Fault management

The debouncing of the heater faults is performed during two drives. If a heater fault is detected the fault lamp is only triggered if a fault is again detected during the second drive.

APP DHLSHK 2.40 Application hint

Fault memory relevant values of the %DHLSHK are assigned to the %DFPM_hsh in the function-orientated selection.
To be adjusted:

```
TADHMN   = 200°C      UBDLSMX = 15.5V      UHSN = 13V (%HLS)            Filter values    LSH25P  LSH25PL LSF4.7
TVFHS    = 0.04s      UHDMN   = 2.34V      TADHMX = 600°C                      ZKARIH  = 20s     46s     21s
UBDLS    = 10.7V      UHDMX   = 3.6V                                           ZKPRIH  = 35s     35s     10s
```

TVRIF = 3s

KFRINH

The map values are determined by a measuring sensor with typical Nernst and heater internal resistance (Type "PM" from K3-LS/ESV). The measuring sensor must be of the same type as the intended control sensor.
Adjust exhaust gas temperature to a base point value by an according selection of load and engine speed. It is possible to adjust phlsnh (performance) to a base point value by changing THSHKTA (in %HLSHK). Enter the value of rinh_w into the map after approx. 60s.

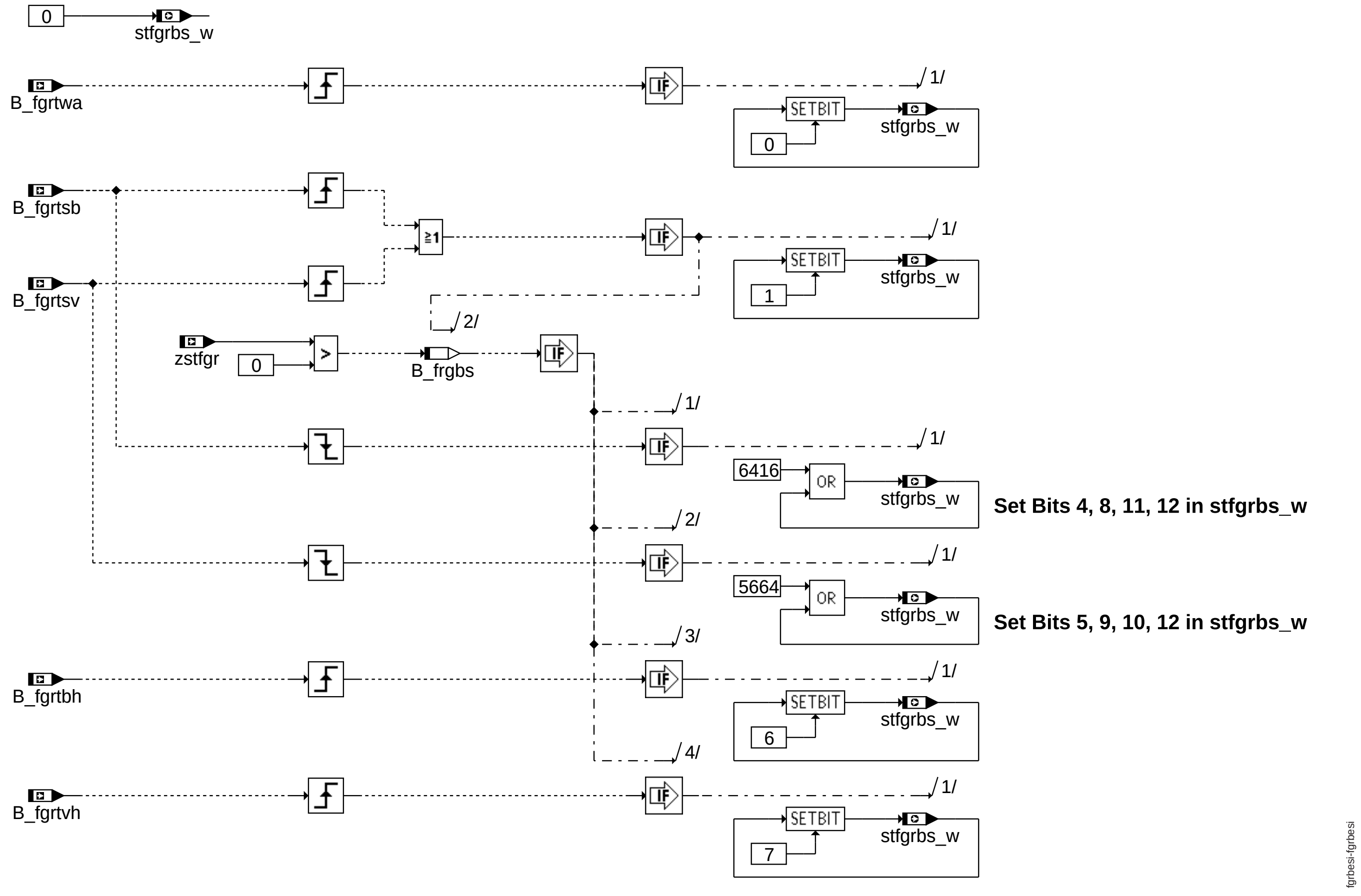
```
        |              LSF4.7                  |           |              LSH25PL                 |
 phlsnh |  E X .  G A S  T E M P E R A T U R E  |    phlsnh |  E X .  G A S  T E M P E R A T U R E  |
P       |  200  |  300  |  400  |  500  |  600  |   P       |  200  |  300  |  400  |  500  |  600  |
E ------+-------+-------+-------+-------+-------+   E ------+-------+-------+-------+-------+-------+
R   1.0 |  288  |  256  |  224  |  192  |  160  |   R   1.0 |       |       |       |       |       |
F ------+-------+-------+-------+-------+-------+   F ------+-------+-------+-------+-------+-------+
O   0.8 |  448  |  384  |  352  |  320  |  224  |   O   0.8 |       |       |       |       |       |
R ------+-------+-------+-------+-------+-------+   R ------+-------+-------+-------+-------+-------+
M   0.7 |  704  |  608  |  544  |  384  |  320  |   M   0.7 |       |       |       |       |       |
  ------+-------+-------+-------+-------+-------+     ------+-------+-------+-------+-------+-------+
```

```
FRINH1/2   tkatmf/FRINH  200/63   300/50   400/30  500/10  600/5
-------
```

The larger the factor FRINH is adjusted the more "inaccurate" the diagnosis of the internal resistance of the Nernst cell becomes.
The map KFRINH , %ATM and the %HLSHK must already have been adjusted.
The faults E_hsh and B_nphsh should be entered, if the sensor heating operates with little heating performance only. This can be achieved by connecting a resistor in series to the heater and if FRINH is changed accordingly.
Necessary resistor: LSF4.7 ˜ 11 Ohm, LSH25 ˜ 5 Ohm.
Approach:
Connecting the resistor in series to the heater, then do the same as description for KFRINH (only for phlsnh = 1).
FRINH = rinh_w with series-resistor / rinh_w without series_resistor.

FGRBESI 2.10 Operating signals, vehicle-speed controller

FDEF FGRBESI 2.10 Function definition



fgrbesi-fgrbesi

ABK FGRBESI 2.10 Abbreviations

Variable	Source	Type	Description
B_FGRTBH	GGFGRH	EIN	Condition: FGR switch acceleration held (no Tip)
B_FGRTSB	GGFGRH	EIN	Condition: FGR switch set/accelerate
B_FGRTSV	GGFGRH	EIN	Condition: FGR switch set/decelerate
B_FGRTVH	GGFGRH	EIN	Condition: FGR switch decelerate held (no Tip)
B_FGRTWA	GGFGRH	EIN	condition: Cruise control button RESUME
B_FRGBS	FGRBESI	LOK	Condition: Enable operating signals vehicle-speed controller

Variable	Source	Type	Description
STFGRBS_W	FGRBESI	AUS	Status word operating signals, vehicle-speed controller
ZSTFGR	FGRFULO	EIN	Status of vehicle-speed controller

FW FGRBESI 2.10 Fixed Values

Parameter	Value	Description

FB FGRBESI 2.10 Detailed description of function

The function evaluates the signals from the operating lever of the vehicle-speed controller (FGR) and converts these to the status word "FGR operating signals" stfgrbs_w. This then constitutes the interface for controlling the vehicle-speed controller states in the function %FGRFULO. Depending on the actual vehicle-speed controller state, certain activities are then triggered here by inquiring individual bits from stfgrbs_w. These are summarized in the following table:

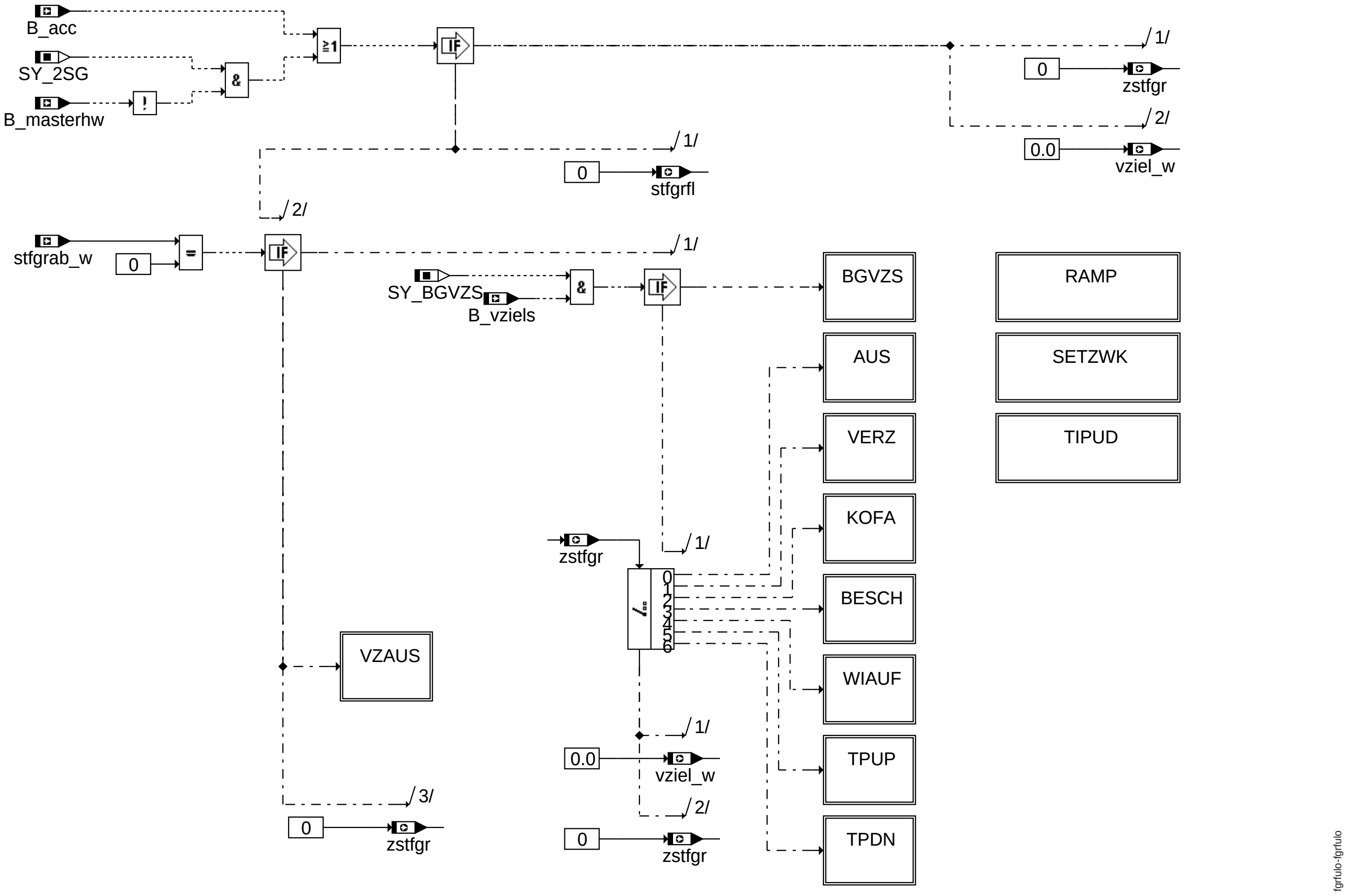
bit	Vehicle-speed controller state	Activity
0	Off	Switch-on with resumption
1	Off	Switch-on with setting
2	Off	Switch-on with acceleration
3	Off	Switch-on with deceleration
4	Constant driving	Tip-up
5	Constant driving	Tip-down
6	Constant driving, resumption, Tip-up, Tip-down	Acceleration off, control mode
7	Constant driving, resumption, Tip-up, Tip-down	Deceleration off, control mode
8	Accelerate	End acceleration
9	Decelerate	End deceleration
10	Tip-up	Set
11	Tip-down	Set
12	Constant driving, resumption	Set
13	Not assigned	
14		
15		

This variant is suitable for the vehicle-speed controller operating lever of the Fiat concern. This comprises three tip-type switches with the functions "Set/Accelerate", "Set/Decelerate" and "Resumption" as well as an indexed main switch that is evaluated as a vehicle-speed controller shutdown condition in the function %FGRABED.

APP FGRBESI 2.10 Application hint

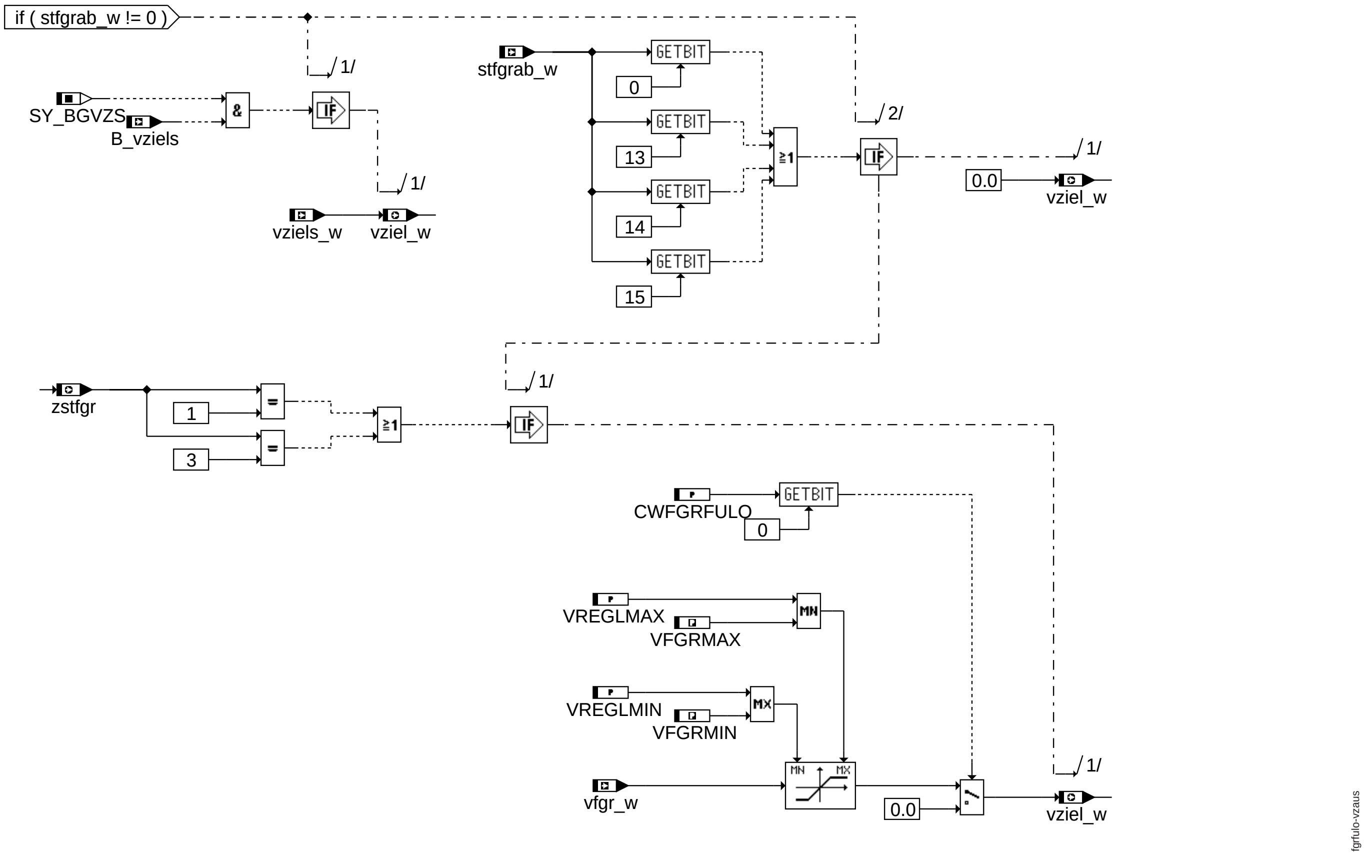
FGRFULO 1.20 Function logic, vehicle-speed controller

FDEF FGRFULO 1.20 Function definition



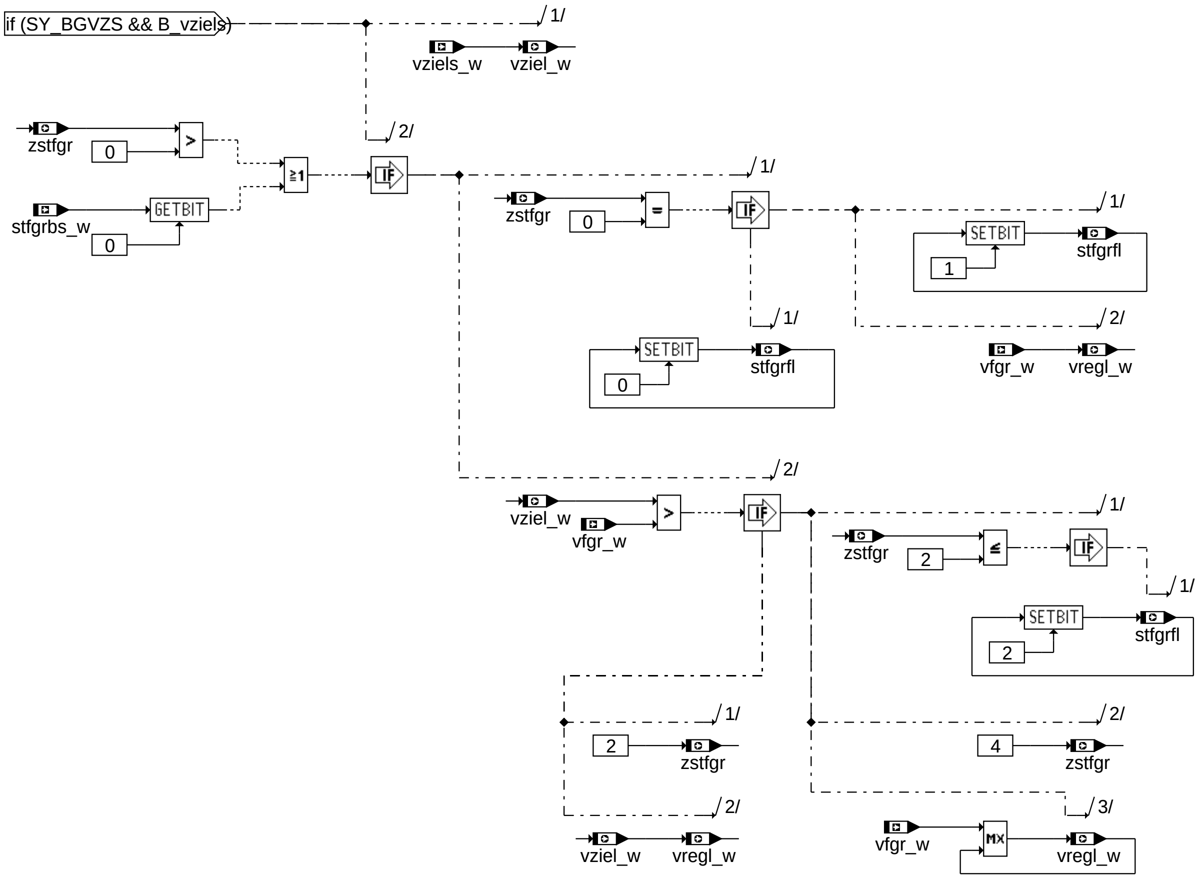
fgrfulo-fgrfulo

`Sub-function VZAUS: Modifying the target speed for active shutdown conditions`



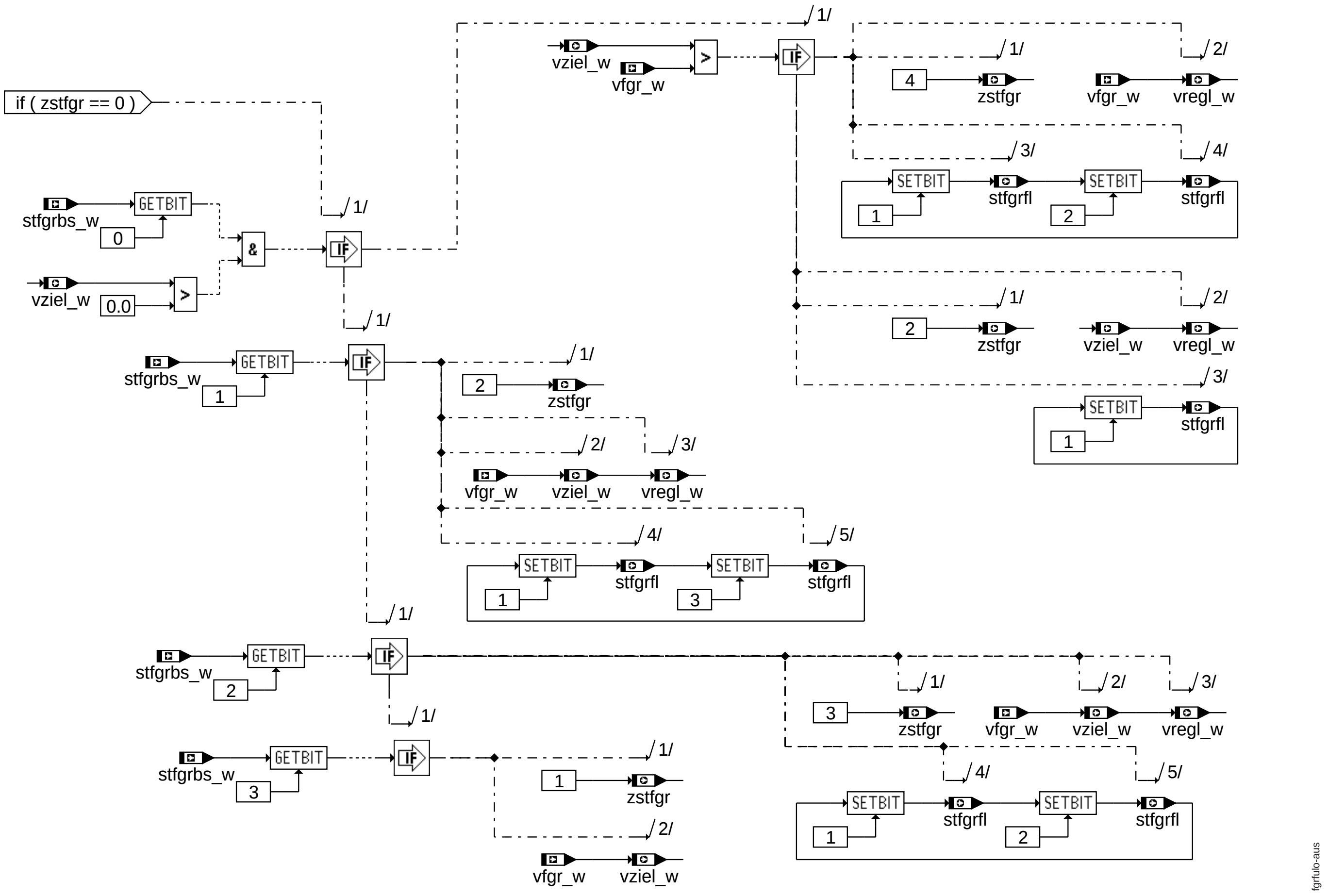
fgrfulo-vzaus

Sub-function BGVZS: Status transitions when transferring calculated set desired target speed



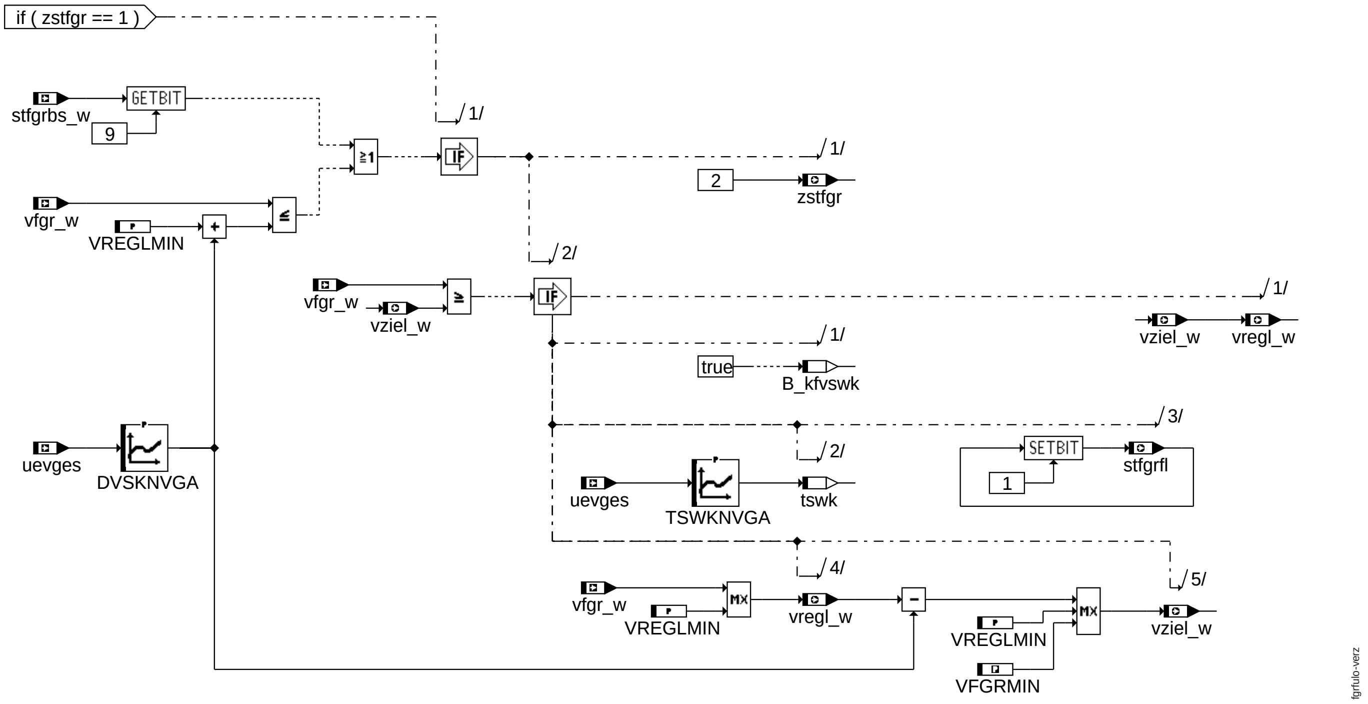
fgrfulo-bgvzs

`Sub-function AUS: Transitions from the state "Off"`



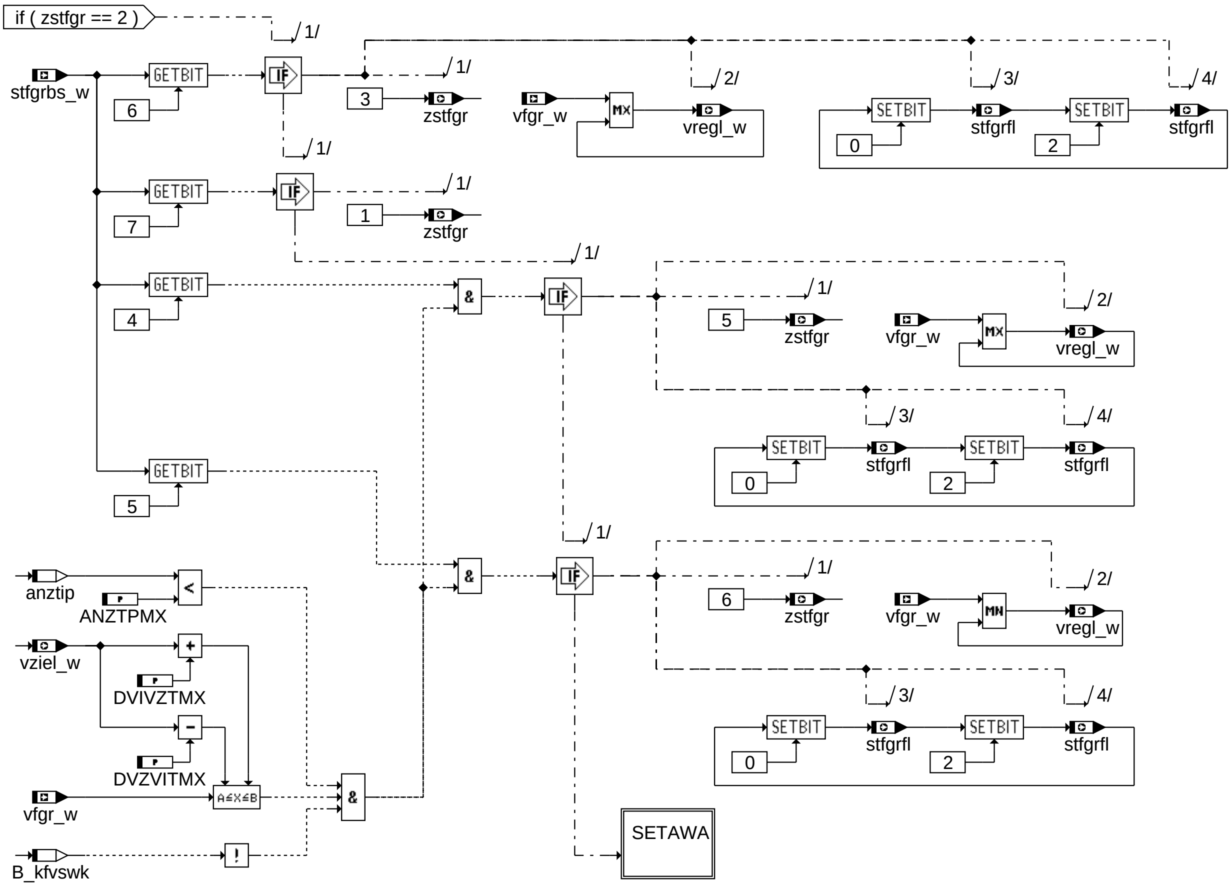
fgrfulo-aus

`Sub-function VERZ: Transitions from the state "Decelerate"`



fgrfulo-verz

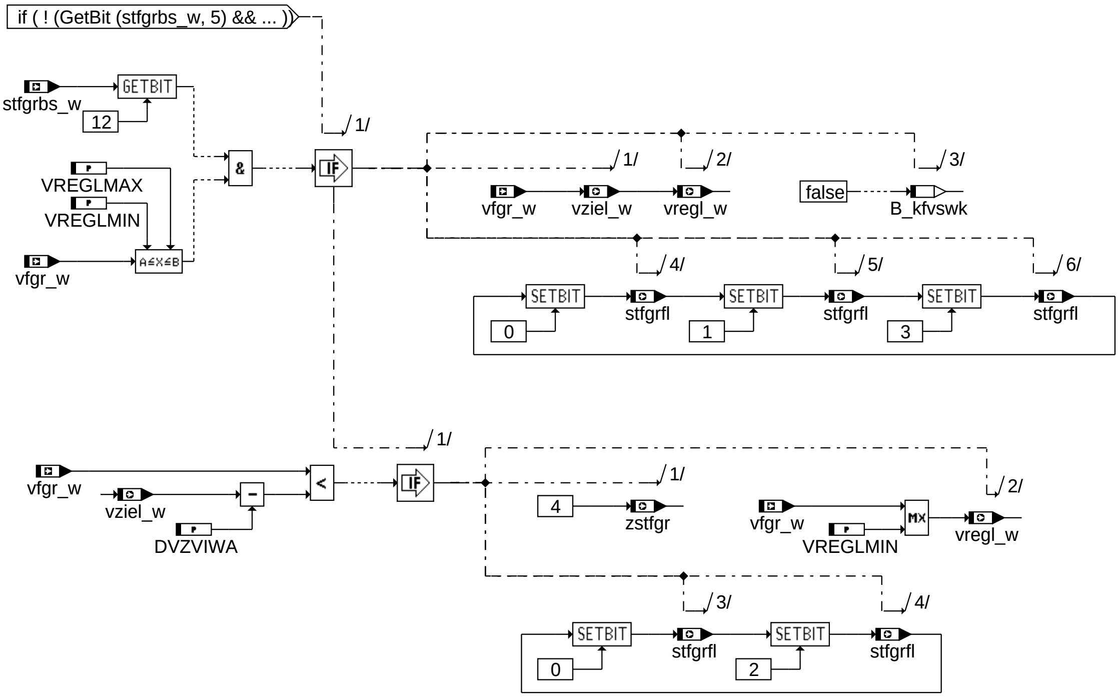
Sub-function KOFA: Transitions from the state "Constant driving"



fgrfulo-kofa

fgrfulo-kofa

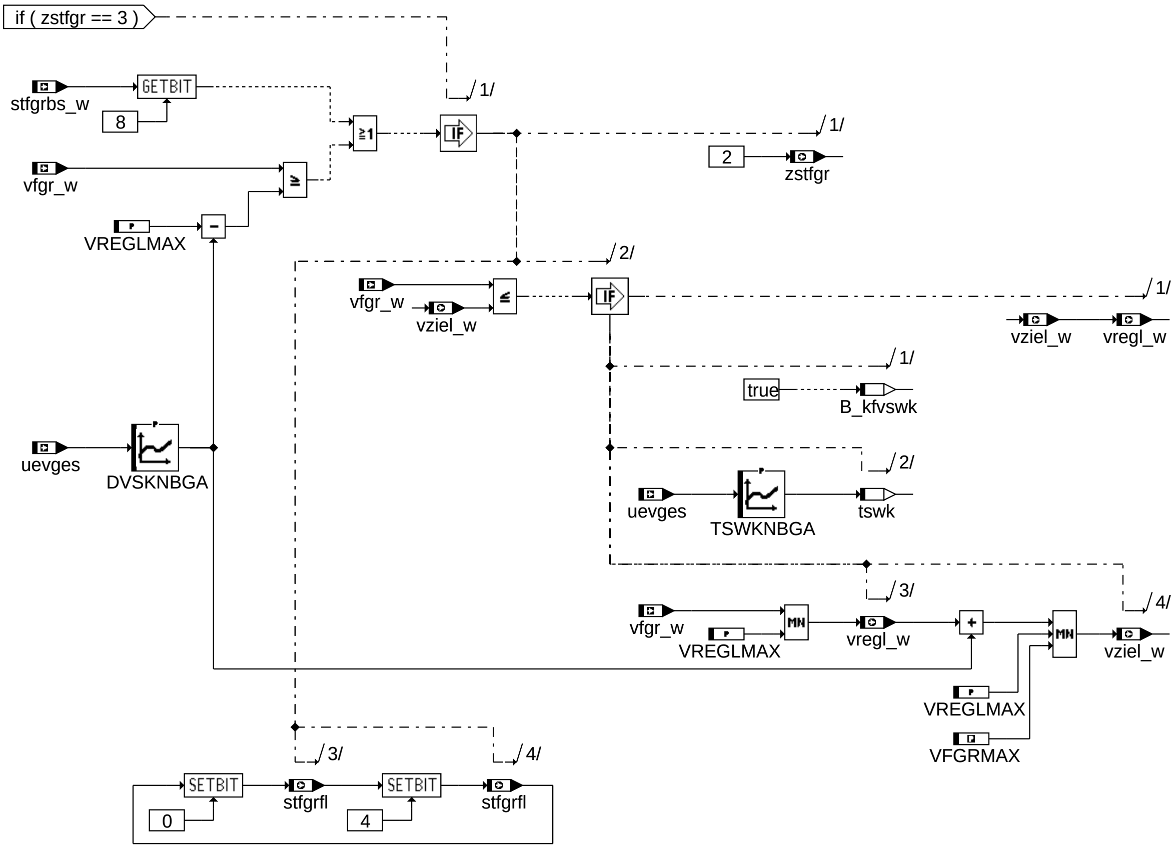
Sub-function SETAWA: Set and automatic resumption during constant driving



fgrfulo-setawa

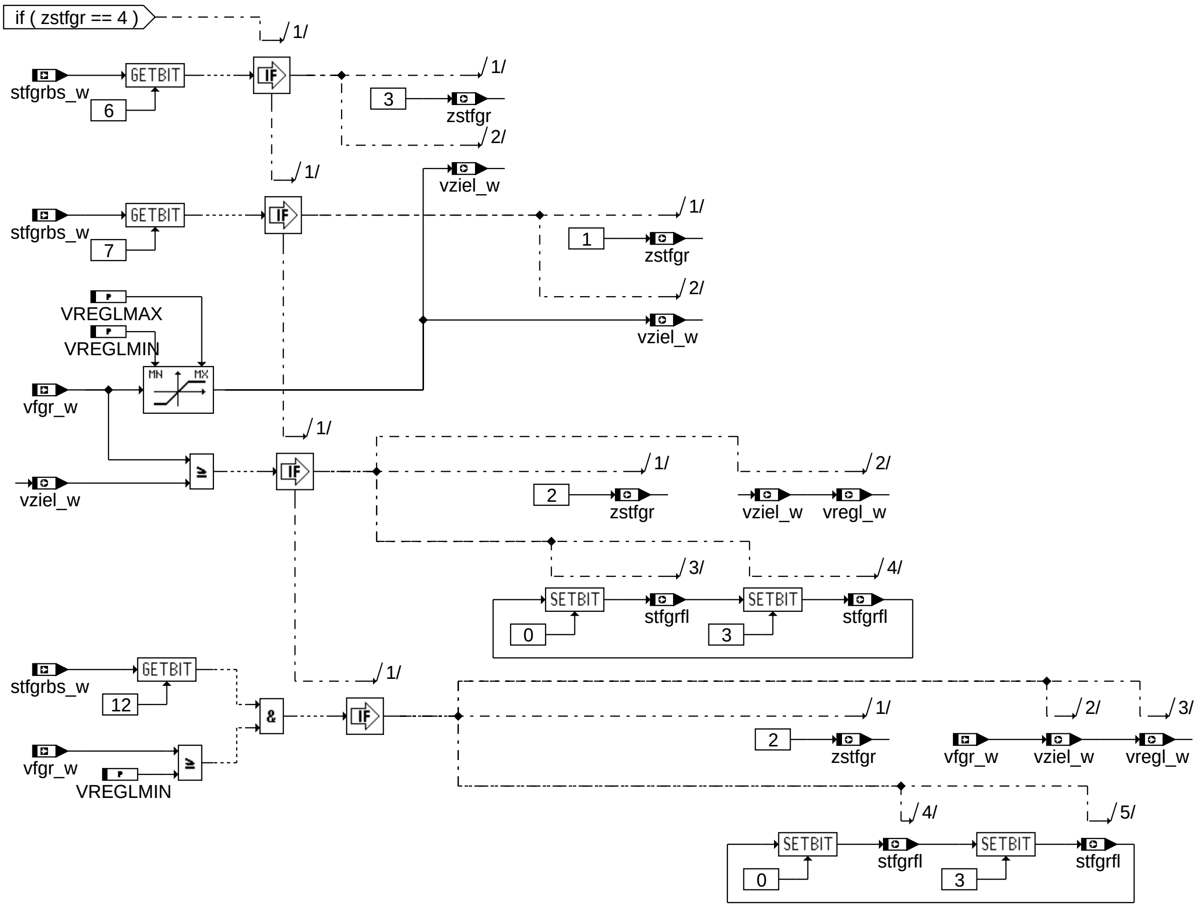
fgrfulo-setawa

`Sub-function BESCH: Transitions from the state "Accelerate"`



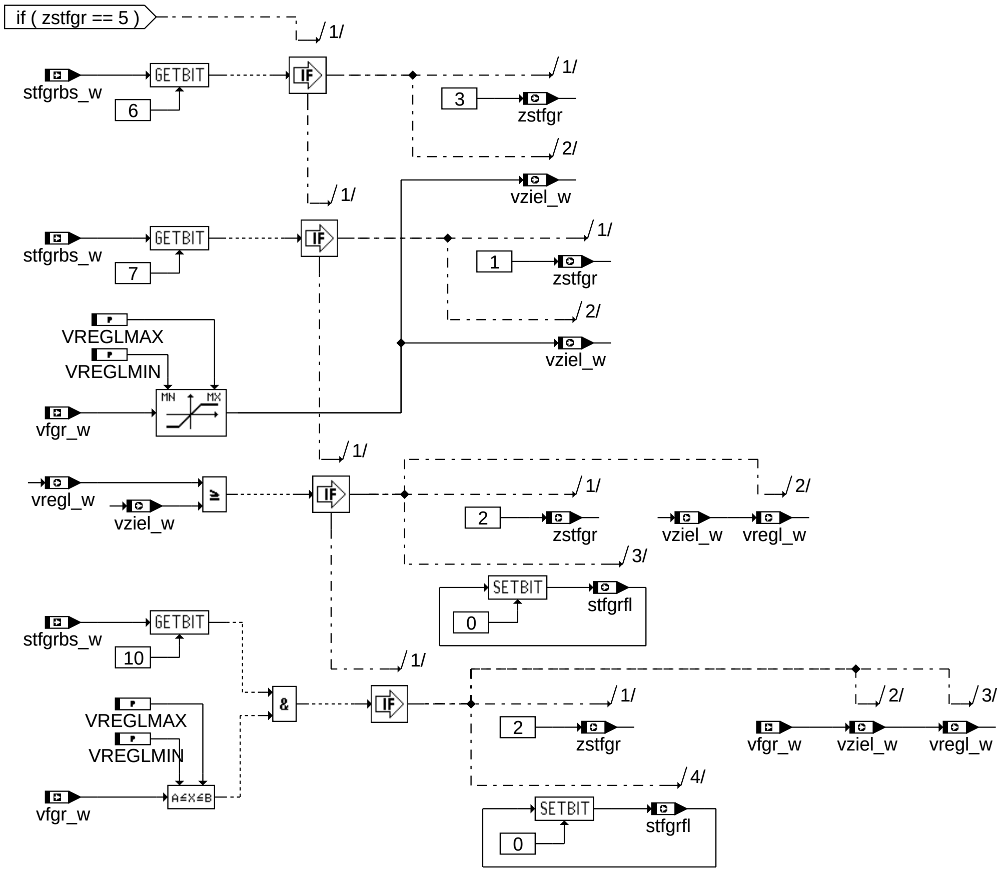
fgrfulo-besch

`Sub-function WIAUF: Transitions from the state "Resumption"`



fgrfulo-wiauf

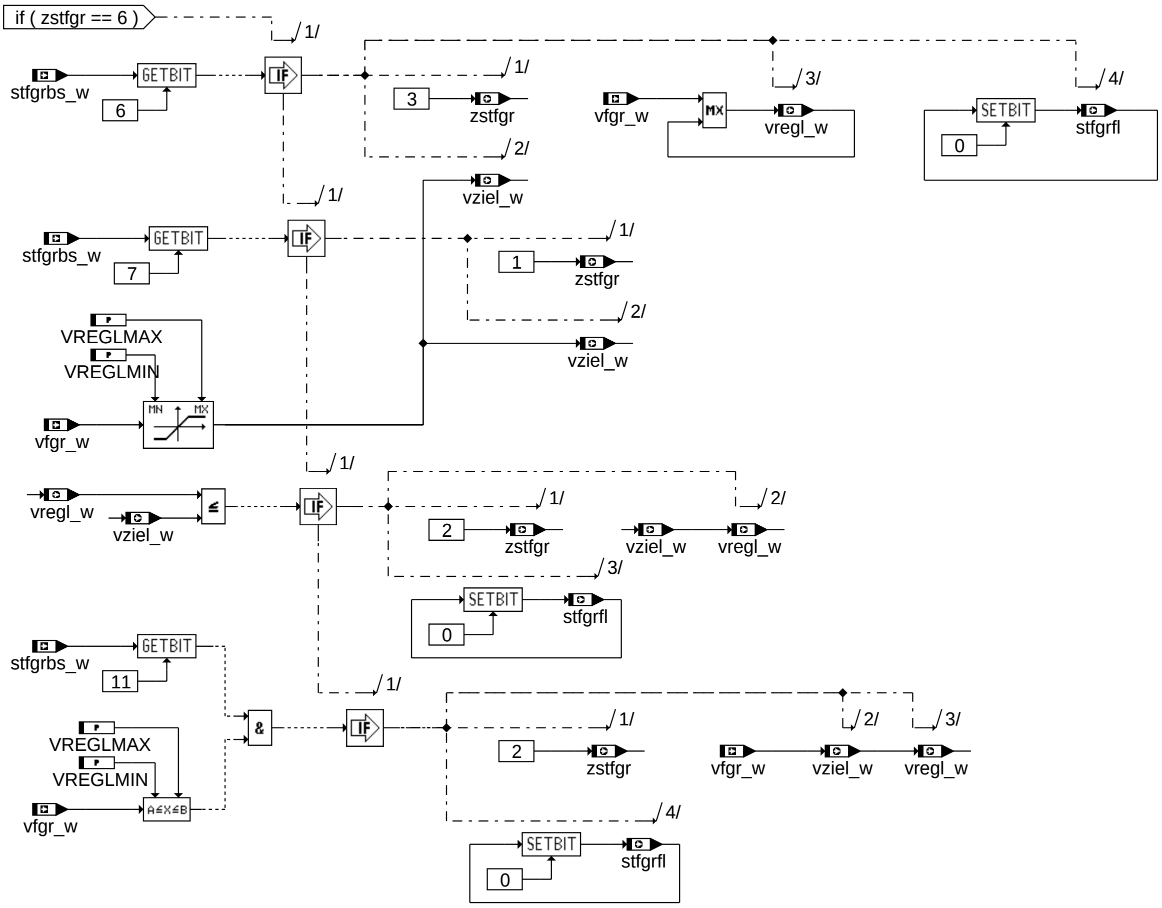
`Sub-function TPUP: Transitions from the state "Tip-up"`



fgrfulo-tpup

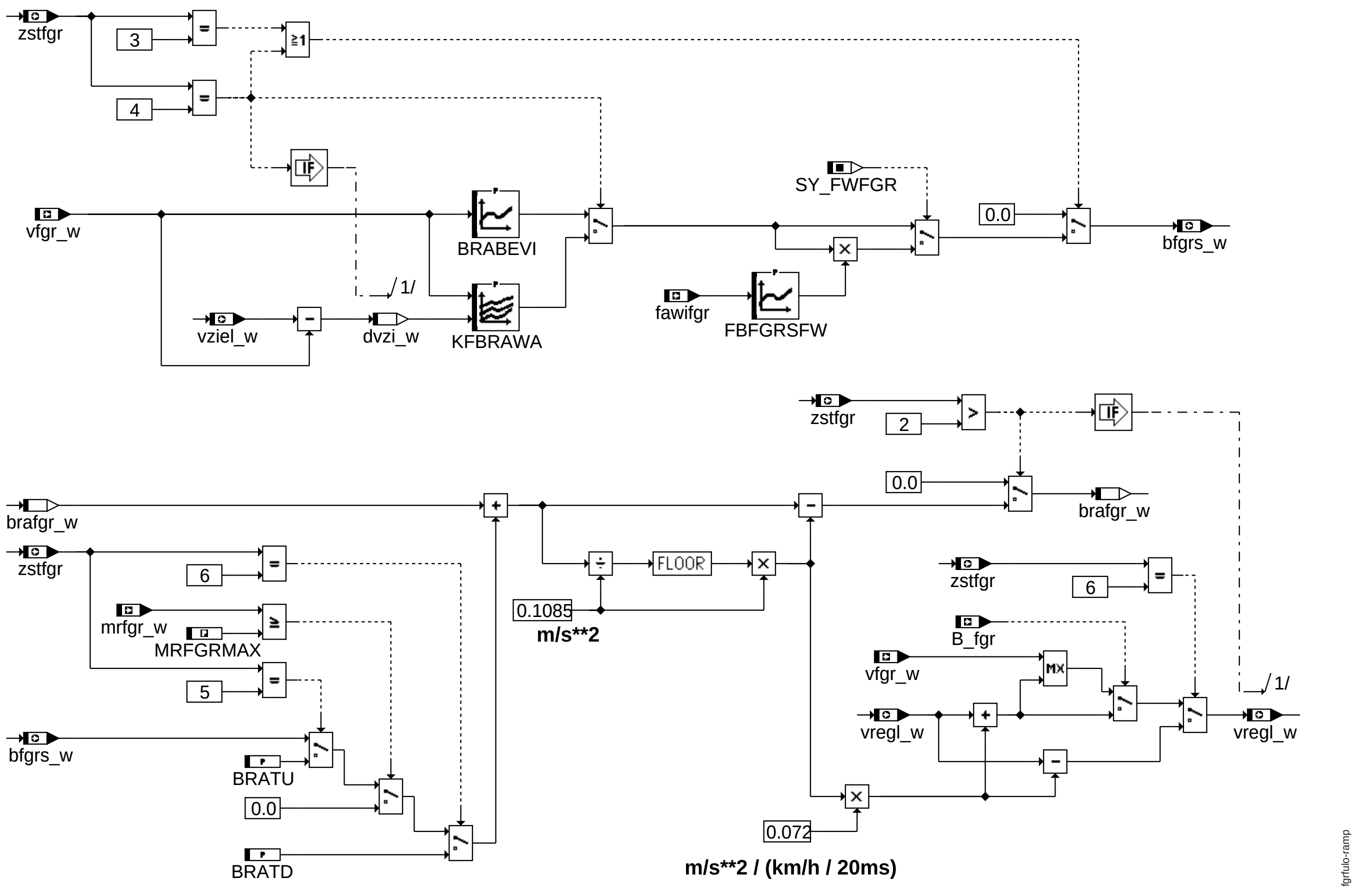
fgrfulo-tpup

`Sub-function TPDN: Transitions from the state "Tip-down"`



fgrfulo-tpdn

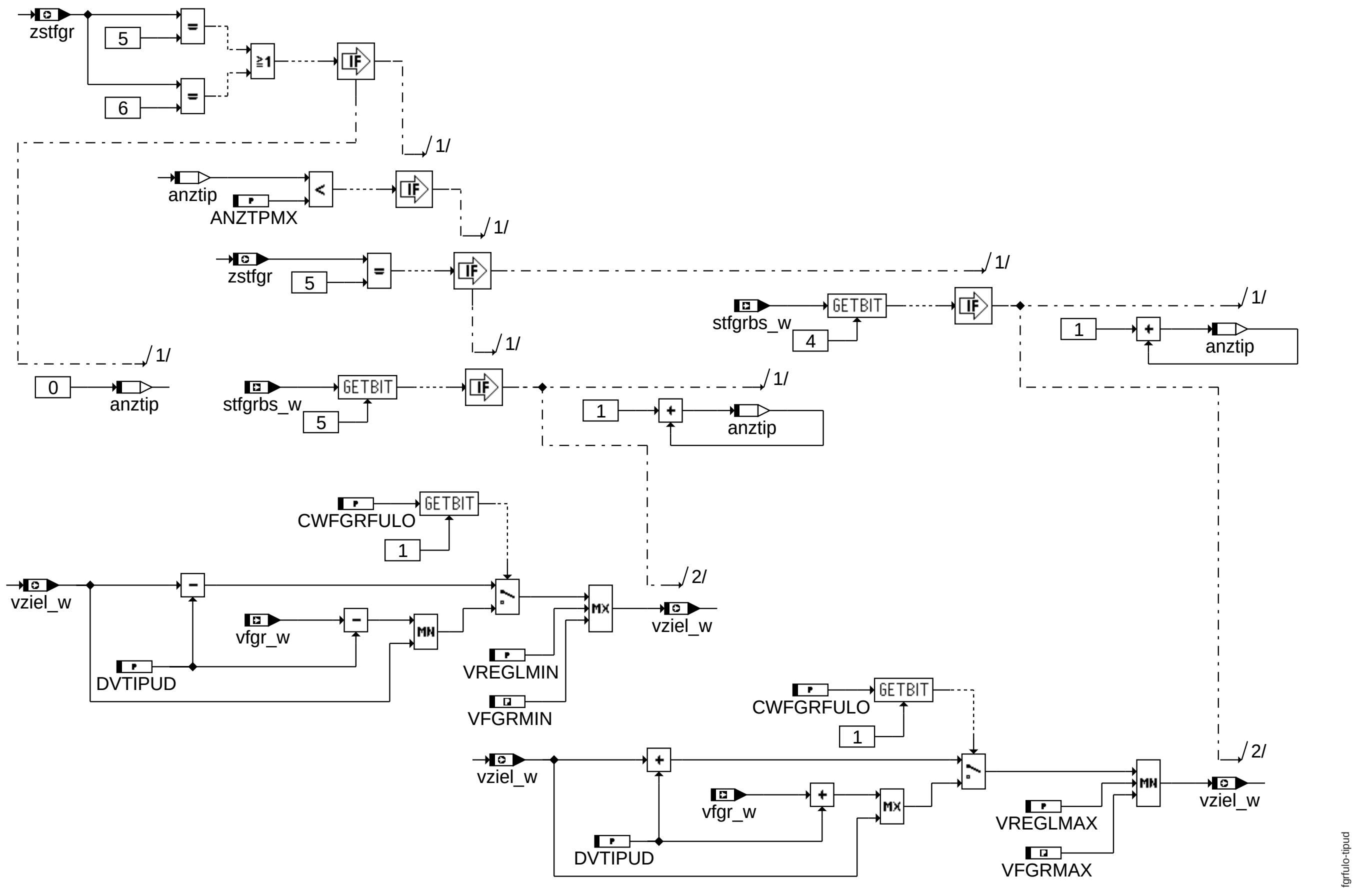
Sub-function RAMP: Target acceleration for ramps



fgrfulo-ramp

Sub-function SETZWK: Set-value adjustment after acceleration and decelaration
BILD /SYM SETZWK

TEXT/ANF
Sub-function TIPUD: Modifying the target speed for Tip-up and Tip-down



fgrfulo-tipud

ABK FGRFULO 1.20 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
ANZTPMX			FW	maximum number of tips (one after the other)
BRABEVI	VFGR_W		KL	acceleration at accelerating ramp
BRATD			FW	acceleration (amount) at tip-down ramp
BRATU			FW	acceleration at tip-up ramp
CWFGRFULO			FW	Code word FGRFULO
DVIVZTMX			FW	maximum delta between actual and target speed for tip permission
DVSKNBGA	UEVGES		KL	delta velocity for set value correction after acceleration
DVSKNVGA	UEVGES		KL	delta velocity for set value correction after deceleration
DVTIPUD			FW	changing actual speed at tip-up or tip-down
DVZVITMX			FW	maximum delta between target and actual speed for tip permission
DVZVIWA			FW	delta between target and actual speed for transition cruising to resuming
FBFGRSFW	FAWIFGR		KL	Correction factor for FGR target acceleration
KFBRAWA	VFGR_W	DVZI_W	KF	Target acceleration for resumption
MRFGRMAX			FW (REF)	maximum value for relative torque request from cruise control
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_BGVZS			SYS (REF)	
SY_FWFGR			SYS (REF)	
TSWKNBGA	UEVGES		KL	time to set value correction after acceleration finished
TSWKNVGA	UEVGES		KL	time to set value correction after deceleration finished
VFGRMAX			FW (REF)	max. permitted velocity during active cruise control
VFGRMIN			FW (REF)	Minimum permissible speed during FGR-operation
VREGLMAX			FW	max. permitted desired speed for cruise control
VREGLMIN			FW	min. permitted desired speed for cruise control

Variable	Source	Type	Description
ANZTIP	FGRFULO	LOK	Number of consecutive successful Tip-Up's or Tip-Down's
BFGRS_W	FGRFULO	AUS	FGR target acceleration
BRAFGR_W	FGRFULO	LOK	Ramp acceleration FGR
B_ACC		EIN	Condition: ACC-control unit exists
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_KFVSWK	FGRFULO	LOK	Condition: Constant driving before set-value correction
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_VZIELS		EIN	Condition: Transfer calculated target speed
CTSWK	FGRFULO	LOK	Time counter for set value correction
DVZI_W	FGRFULO	LOK	Difference between target and actual speed
FAWIFGR		EIN	Driving resistance for FGR

Variable	Source	Type	Description
MRFGR_W	MSF	EIN	relative torque demand from cruise control
STFGRAB_W	FGRABED	EIN	Status word, cut-out conditions, vehicle-speed controller
STFGRBS_W	FGRBESI	EIN	Status word operating signals, vehicle-speed controller
STFGRFL	FGRFULO	AUS	Status byte FGR function logic
TSWK	FGRFULO	LOK	Time for set-value correction
UEVGES	BBGANG	EIN	Transmission ratio total
VFGR_W	GGVFZG	EIN	cruise control vehicle speed
VREGL_W	FGRFULO	AUS	desired speed for cruise control
VZIELS_W		EIN	Calculated nominal target for FGR
VZIEL_W	FGRFULO	AUS	target velocity cruise control
ZSTFGR	FGRFULO	AUS	Status of vehicle-speed controller

FW FGRFULO 1.20 Fixed Values

Parameter	Value	Description
ANZTPMX		maximum number of tips (one after the other)
BRATD		acceleration (amount) at tip-down ramp
BRATU		acceleration at tip-up ramp
CWFGRFULO		Code word FGRFULO
DVIVZTMX		maximum delta between actual and target speed for tip permission
DVTIPUD		changing actual speed at tip-up or tip-down
DVZVITMX		maximum delta between target and actual speed for tip permission
DVZVIWA		delta between target and actual speed for transition cruising to resuming
VREGLMAX		max. permitted desired speed for cruise control
VREGLMIN		min. permitted desired speed for cruise control

FB FGRFULO 1.20 Detailed description of function

The function controls the states of the vehicle-speed controller (FGR) depending on the operating signals (stfgrbs_w from %FGRBESI) and the shutdown conditions (stfgrab_w from %FGRABED). The meaning of the vehicle-speed controller state, zstfgr, is given in the following table:

zstfgr	FGR state
0	Off
1	Decelerate
2	Constant driving
3	Accelerate
4	Resumption
5	Tip-up
6	Tip-down
7-255	Not assigned

The target speed vziel_w and desired speed, vregl_w, for the controller, as well as the status byte "FGR function logic", stfgrfl, are also made available. Certain activities are triggered by inquiring specific bits in stfgrfl in %FGRREGL. These activities are summarized in the following table:

bit	Activity
0	Initialization of the stored control difference from the last computing step
1	Initialization of the stored controller output from the last computing step
2	Initialization of the offset speed voffs_w during ramp start
3	Initialization of the load-dependent offset speed vlast_w
4	Limitation of the controller output during transition from the state "Accelerate" to "Constant driving"
5-7	Not assigned

The vehicle-speed controller state is set to "Off" and the target speed cancelled in an ACC system (externally realized vehicle-speed controller with vehicle-to-vehicle ranging) or in the slave of a system where there are two ME ECU’s. Otherwise the shutdown conditions are first checked. The vehicle-speed controller state is set to "Off" if a shutdown condition is fulfilled. The target speed is cancelled as well depending on the type of shutdown condition. Aborting the states "Accelerate" or "Decelerate" causes the actual speed to be taken as the new target speed. The target speed can also be canceled as an alternative in this case.

If none of the shutdown conditions is fulfilled, then different conditions are checked depending on the vehicle-speed controller state. This can lead to a change in the vehicle-speed controller state as well to a modification of the desired or target speed.

o Off

The vehicle-speed controller only then cuts in when the actual speed, vfgr_w, lies within the range between VFGREMIN and VFGREMAX.

- o Resumption to the stored target speed:
  The target speed is approached again if bit 0 in stfgrbs_w is set and there is a stored target speed available (vziel_w greater than 0). If the actual speed is less than the target speed, then the vehicle-speed controller state is set to "Resumption" and the nominal-speed ramps is started commencing at the actual speed. On the other hand, if the actual speed is greater than the target speed, then the vehicle-speed controller state is set to "Constant driving" and the desired speed set to the target speed.

- o Taking the current actual speed as the target speed:
  If bit 1 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Constant driving" and actual speed is taken as the target and as the desired speed.

- o Accelerate from non-controlled driving:
  If bit 2 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Accelerate" and the desired-speed ramp started commencing at the actual speed.

- o Decelerate from non-controlled driving:
  If bit 3 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Decelerate". The controller is however only activated after deceleration has finished (when the decelerate button has been released).

o Decelerate

- o End of deceleration:
  If bit 9 in stfgrbs_w is set or the actual speed reached the lower limit of the range permitted for the desired speed, then deceleration is terminated and the vehicle-speed controller state is set to "Constant driving". If the actual speed has fallen compared to the stored target speed, then this is taken as the new desired speed. The target speed is set to just below the actual speed is set so as to make the transition to stabilization more comfortable. The target speed is then set to the target speed (set-value adjustment) following elapse of defined period of time.
  Refer to the sub-function SETZWK.

o Constant driving

- o Accelerate:
  If bit 6 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Accelerate". The desired speed ramp then starts commencing at the maximum of the target and actual speed.

- o Decelerate:
  If bit 7 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Decelerate". The controller remains deactivated until deceleration has finished and the vehicle is decelerated by the drag torque from the engine.

- o Tip-up:
  If bit 4 in stfgrbs_w is set and the actual speed lies within a certain range about the target speed, then the vehicle-speed controller state is set to "Tip-up" is set. The desired-speed ramp is started commencing from the maximum of the target and actual speed. The target speed is increased by a small value in jumps (refer to sub-function TIPUD).

- o Tip-down:
  If bit 5 in stfgrbs_w is set and the actual speed lies within a certain range about the target speed, then the vehicle-speed controller state is set to "Tip-down". The desired-speed ramp is started commencing from the minimum of the target and actual speed. The target speed is decreased by a small amounts in jumps (refer to sub-function TIPUD).

- o Set:
  If bit 12 in stfgrbs_w is set and the actual speed lies within a range permissible for the desired speed, then the actual speed is taken as the target and as the desired speed.

- o Automatic resumption:
  If the actual speed falls below the target speed by a certain amount, then the vehicle-speed controller state is set to "Resumption" and the desired-speed ramp is started commencing from the actual speed. Uncontrolled acceleration by the vehicle is prevented in this way.

o Accelerate

- o End of acceleration:
  If bit 8 in stfgrbs_w is set or the actual speed reaches the upper limit permitted for the desired speed, then acceleration is terminated and the vehicle-speed controller state is set to "Constant driving". If the actual speed has increased compared to the stored target speed, then this is taken as the new desired speed. The target speed is set to just above the actual speed is set so as to make reaching stabilization comfortable. The target speed is then set to the target speed (set-value adjustment) following elapse of defined period of time.
  Refer to the sub-function SETZWK.

o Resumption

- o Accelerate:
  If bit 6 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Accelerate". The desired-speed ramp continues to run.

- o Decelerate:

If bit 7 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Decelerate". The controller remains deactivated until deceleration has finished and the vehicle is decelerated by the engine's drag torque.

- o Reaching the target speed:
  If the actual speed reaches the target speed, then the vehicle-speed controller state is set to "Constant driving" and the desired speed is set to the target speed.

- o Set:
  If bit 12 in stfgrbs_w is set and the actual speed lies within a range permitted for the desired speed then the vehicle-speed controller state is set to "Constant driving" and the actual speed is taken as the target and as the desired speed.

o Tip-up

- o Accelerate:
  If bit 6 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Accelerate". The desired-speed ramp continues to run.

- o Decelerate:
  If bit 7 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Decelerate" is set. The controller remains deactivated until deceleration has finished and the vehicle is decelerated by the engine's drag torque.

- o Reaching the target speed:
  If the actual speed reaches the target speed, then the vehicle-speed controller state is set to "Constant driving" and the desired speed is set to the target speed.

- o Set:
  If bit 10 in stfgrbs_w is set and the actual speed lies within a range permitted for the desired speed then the vehicle-speed controller state is set to "Constant driving" and the actual speed is taken as the target and as the desired speed.

o Tip-down

- o Accelerate:
  If bit 6 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Accelerate". the desired-speed ramp runs upwards commencing at the actual speed.

- o Decelerate:
  If bit 7 in stfgrbs_w is set, then the vehicle-speed controller state is set to "Decelerate". The controller remains deactivated until deceleration has finished and the vehicle is decelerated by the engine's drag torque.

- o Reaching the target speed:
  If the actual speed reaches the target speed, then the vehicle-speed controller state is set to "Constant driving" and the desired speed is set to the target speed.

- o Set:
  If bit 11 in stfgrbs_w is set and the actual speed lies within a range permitted for the desired speed then the vehicle-speed controller state is set to "Constant driving" and the actual speed is taken as the target and as the desired speed.

In the states "Accelerate", "Resumption", "Tip-up" and "Tip-down", the desired speed vregl_w is modified depending on the applied target-acceleration values. When the states "Accelerate" and "Decelerate" has finished, the desired speed vregl_w is set to the target speed vziel_w after elapse of a certain time. The target speed is increased or decreased further in the states "Tip-up" and "Tip-down" if the appropriate operating signals are given (bit 4 or bit 5 in stfgrbs_w) and the maximum number of successive permissible tip-routines has not yet been exceeded.

APP FGRFULO 1.20 Application hint

CWFGRFULO:

Bit 0
0: vziel_w = vfgr_w for shutdown condition during acceleration or deceleration 1: vziel_w = 0 for shutdown condition during acceleration or deceleration

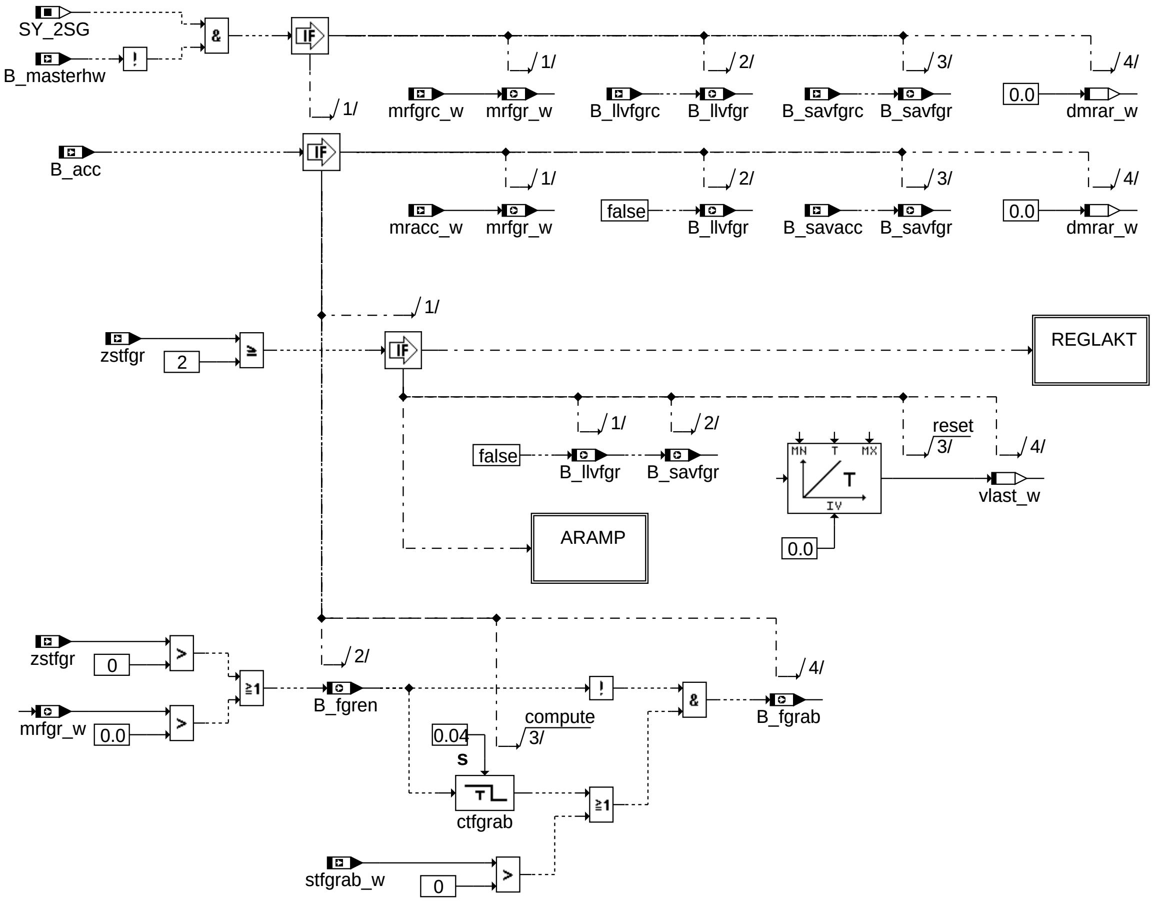
Bit 1
0: Set Tip-up and Tip-down to target speed up
1: Set Tip-up and Tip-down Set to actual speed up

It must apply that:

VFGREMIN >= Max (VREGLMIN, VFGRMIN)
VFGREMAX <= VREGLMAX

FGRREGL 1.10 Control algorithm, vehicle-speed controller

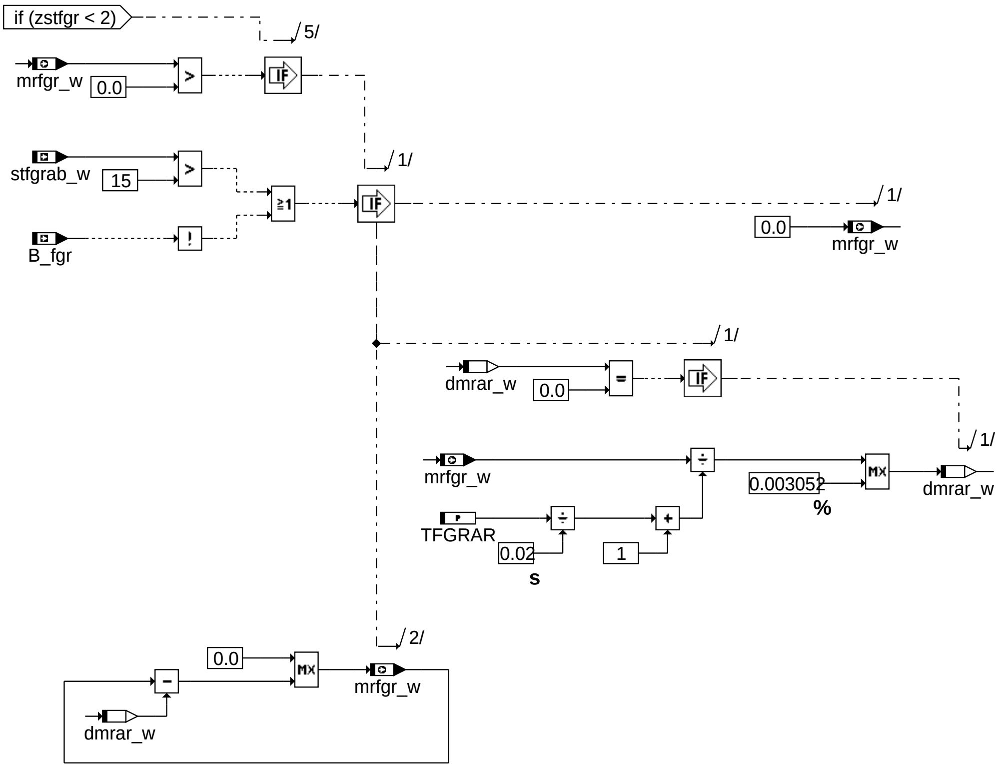
FDEF FGRREGL 1.10 Function definition



fgrregl-fgrregl

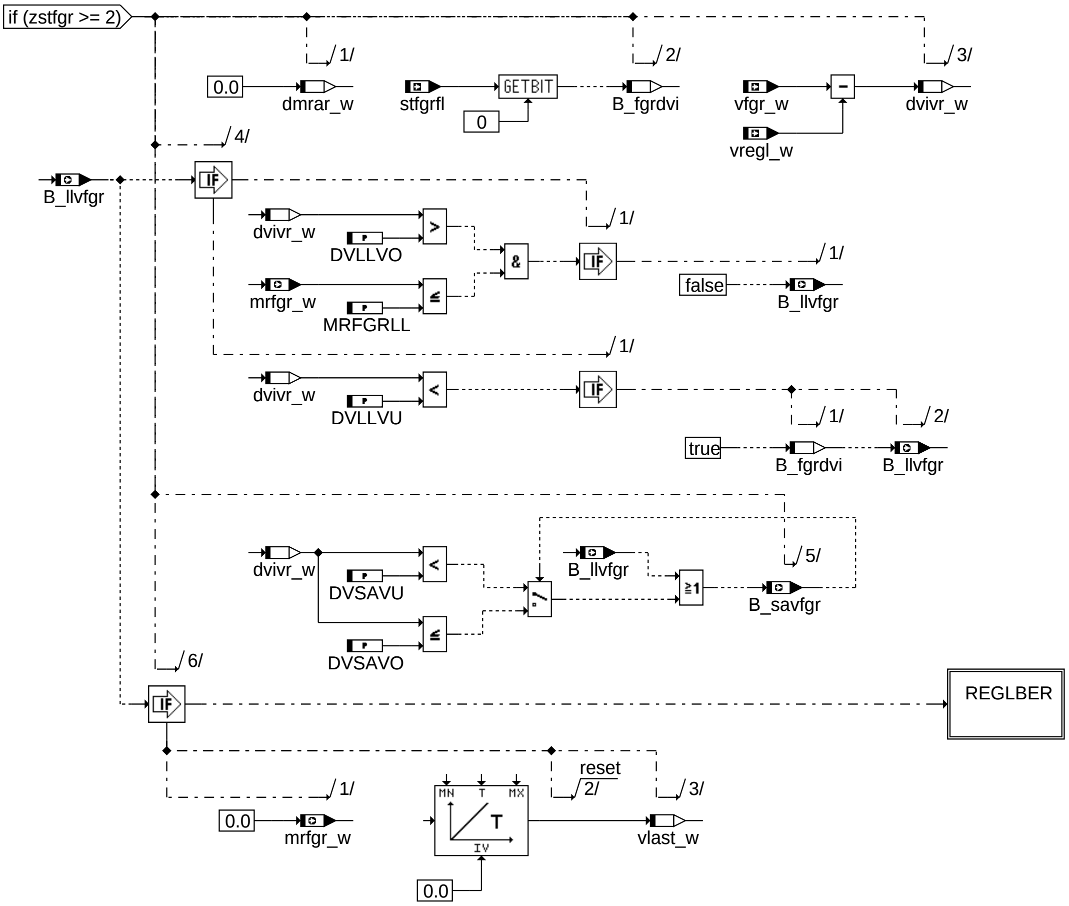
fgrregl-fgrregl

Sub-function ARAMP: Shutdown ramp for comfortable shutdown



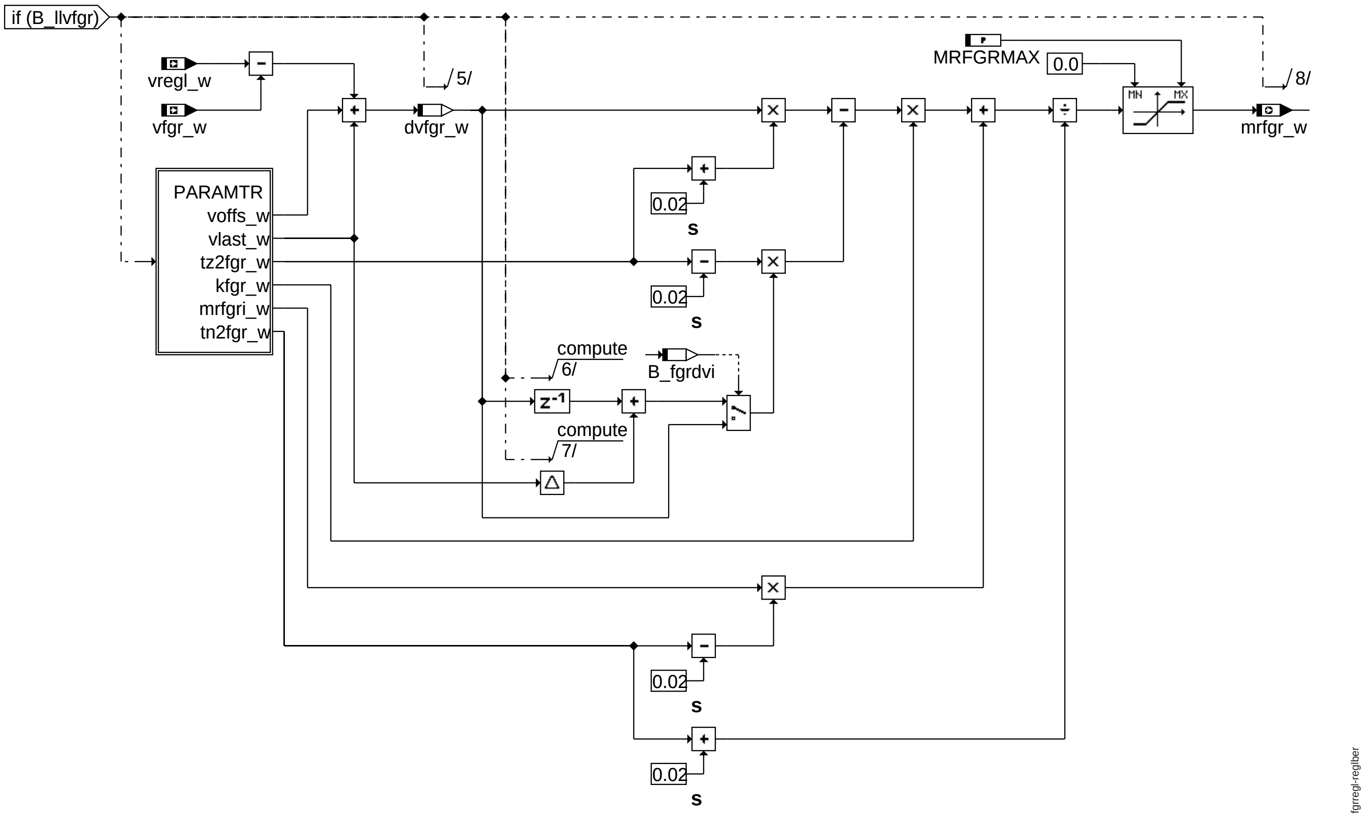
fgrregl-aramp

Sub-function REGLAKT: Control active



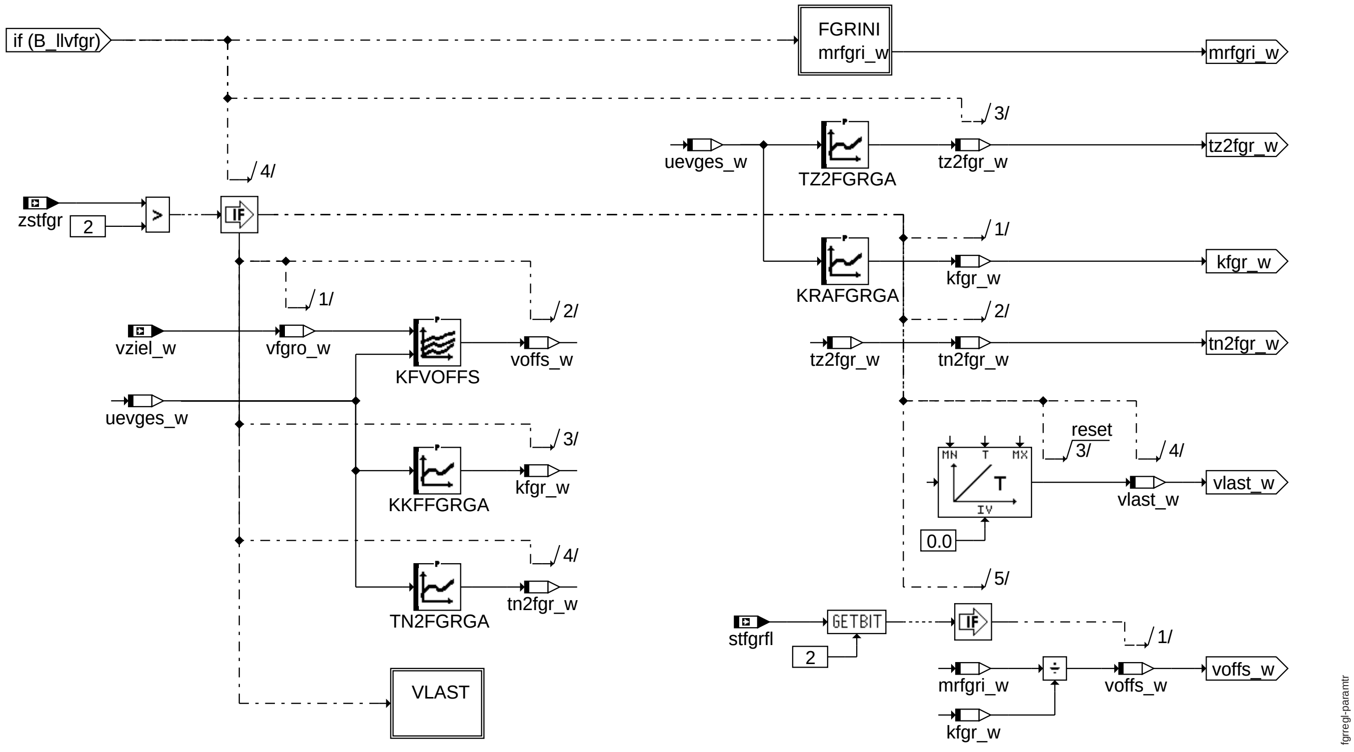
fgrregl-reglakt

`Sub-function REGLBER: Controller calculation with recursion formula`



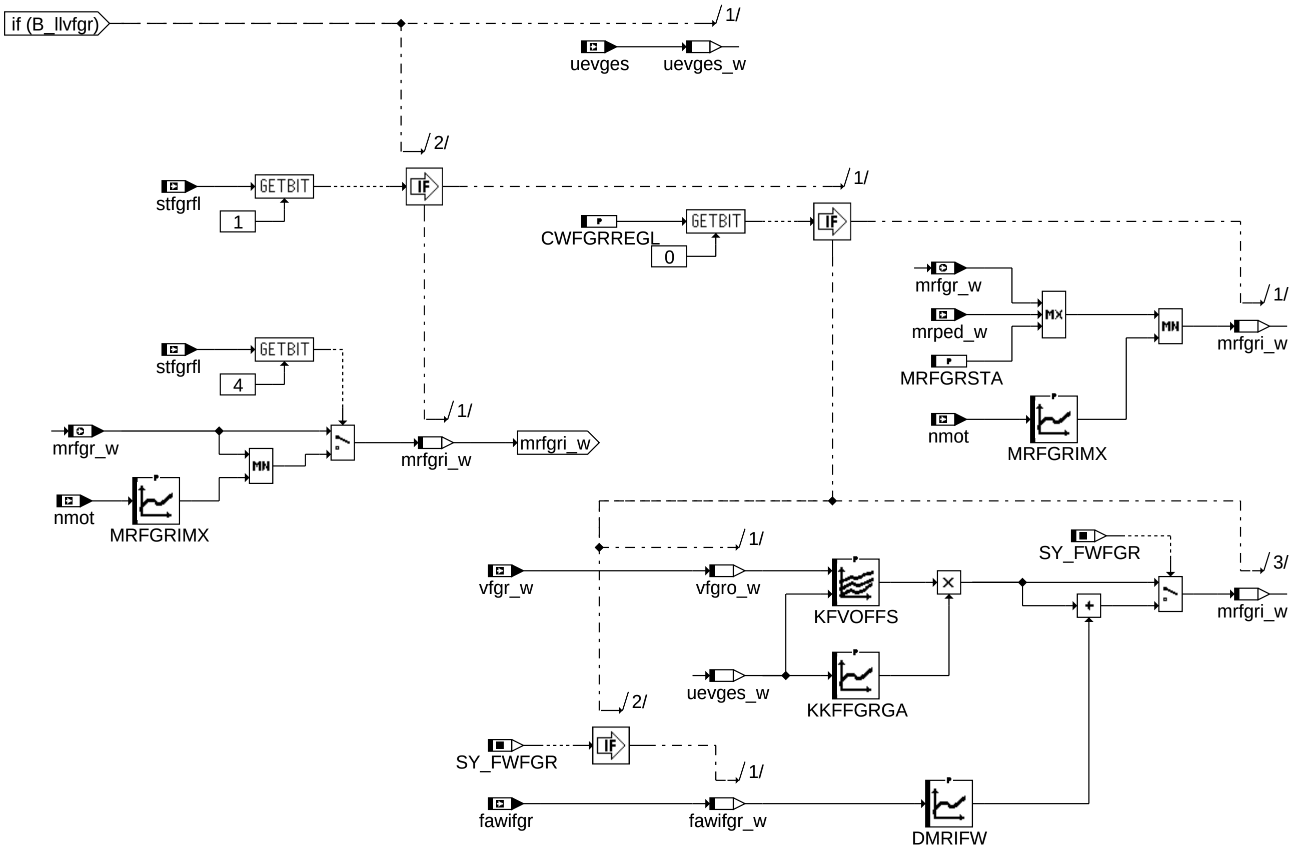
fgrregl-reglber

`Sub-function PARAMTR: Controller parameters`



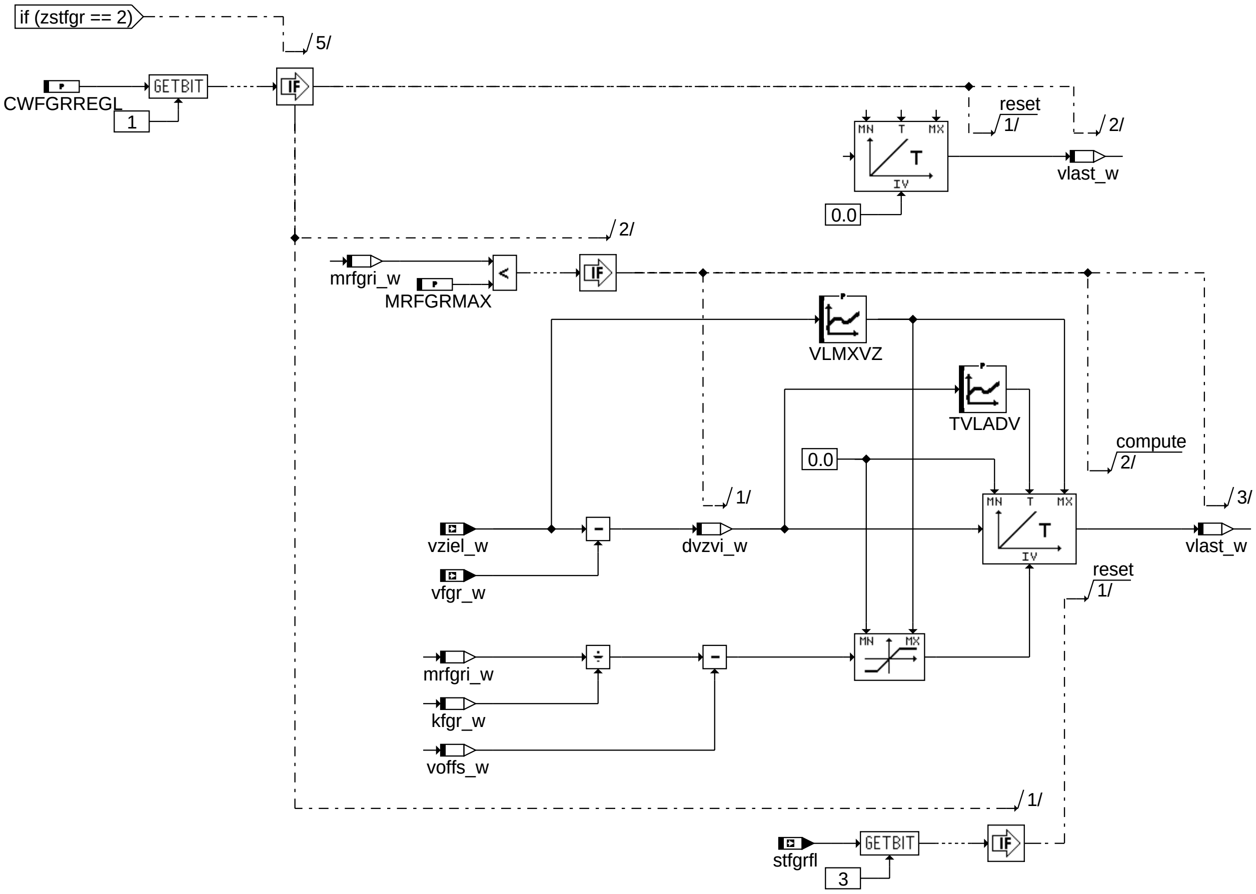
fgrregl-paramtr

Sub-function FGRINI: Controller initialization



fgrregl-fgrini

`Sub-function VLAST: Load-dependent offset rate`



fgrregl-vlast

ABK FGRREGL 1.10 Abbreviations

Parameter	Source-X	Source-Y	Type	Description
CWFGRREGL			FW	Code word FGRREGL
DMRIFW	FAWIFGR_W		KL	Delta relative torque for FGR initialization
DVLLVO			FW	Delta speed to reset idle-speed disable from the FGR
DVLLVU			FW	Delta speed to set idle-speed disable from the FGR
DVSAVO			FW	delta velocity to set prohibited trailing throttle fuel cutoff
DVSAVU			FW	delta velocity to remove prohibited trailing throttle fuel cutoff
KFVOFFS	VFGRO_W	UEVGES_W	KF	velocity offset for cruise control
KKFFGRGA	UEVGES_W		KL	amplification rate during cruising for cruise control
KRAFGRGA	UEVGES_W		KL	amplification rate at ramp for cruise control
MRFGRIMX	NMOT		KL	Maximum FGR initialization value
MRFGRLL			FW	Relative-torque threshold from FGR for idle-speed detection
MRFGRMAX			FW	maximum value for relative torque request from cruise control
MRFGRSTA			FW	starting value for relativ torque at active cruise control
SY_2SG			SYS (REF)	system constant 2 motronic systems
SY_FWFGR			SYS (REF)	
TFGRAR			FW	Ramp running time comfort shutdown of the FGR
TN2FGRGA	UEVGES_W		KL	double denominator time constant for cruise control
TVLADV	DVZVI_W		KL	Integrator time constant at vlast-calculation
TZ2FGRGA	UEVGES_W		KL	double numerator time constant for cruise control
VLMXVZ	VZIEL_W		KL	Max. value for vlast_w

Variable	Source	Type	Description
B_ACC		EIN	Condition: ACC-control unit exists
B_FGR	MDFAW	EIN	condition: driver's set engine torque determined by cruise control
B_FGRAB	FGRREGL	AUS	CC/ACC shut-off from the function
B_FGRDVI	FGRREGL	LOK	condition: CC initialization of the saved system deviation
B_FGREN	FGRREGL	AUS	condition: cruise control is active (enable)
B_LLVFGR	FGRREGL	AUS	Condition: Idling disabled by FGR
B_LLVFGRC		EIN	CAN-Signal: Idling disabled by FGR
B_MASTERHW		EIN	Condition Master-SG corresponding with code-pin (plausible)
B_SAVACC		EIN	Condition: overrun fuel cut-off forbidden by ACC
B_SAVFGR	FGRREGL	AUS	Condition: prohibited trailing throttle fuel cut-off by cruise control
B_SAVFGRC		EIN	CAN-signal: prohibited trailing throttle fuel cut-off by cruise control
CTFGRAB	FGRREGL	LOK	Time counter to transfer the FGR cut-out to function monitoring
DMRAR_W	FGRREGL	LOK	relative delta torque at cruise control deactivation ramp

Variable	Source	Type	Description
DVFGR_W	FGRREGL	LOK	Control deviation of the FGR
DVIVR_W	FGRREGL	LOK	Difference between actual and set speed for FGR
DVZVI_W	FGRREGL	LOK	Difference between target- and actual velocity
FAWIFGR		EIN	Driving resistance for FGR
FAWIFGR_W	FGRREGL	LOK	Driving resistance for FGR
KFGR_W	FGRREGL	LOK	Amplification factor FGR-controller
MRACC_W		EIN	Relative torque request by ACC
MRFGRC_W		EIN	CAN-signal: relative torque request from cruise control
MRFGRI_W	FGRREGL	LOK	Relative torque initialization value for FGR-controller
MRFGR_W	FGRREGL	AUS	relative torque demand from cruise control
MRPED_W		EIN	Relative torque request by accelerator pedal
NMOT	SWADAP	EIN	engine speed
STFGRAB_W	FGRABED	EIN	Status word, cut-out conditions, vehicle-speed controller
STFGRFL	FGRFULO	EIN	Status byte FGR function logic
TN2FGR_W	FGRREGL	LOK	double denominator time constant cruise control
TZ2FGR_W	FGRREGL	LOK	double numerator time constant cruise control
UEVGES	BBGANG	EIN	Transmission ratio total
UEVGES_W	FGRREGL	LOK	Total transmission ratio
VFGRO_W	FGRREGL	LOK	Rate for addressing KFVOFFS
VFGR_W	GGVFZG	EIN	cruise control vehicle speed
VLAST_W	FGRREGL	LOK	Additional offset of the velocity for FGR-controller at higher load
VOFFS_W	FGRREGL	LOK	offset velocity for cruise control
VREGL_W	FGRFULO	EIN	desired speed for cruise control
VZIEL_W	FGRFULO	EIN	target velocity cruise control
ZSTFGR	FGRFULO	EIN	Status of vehicle-speed controller

FW FGRREGL 1.10 Fixed Values

Parameter	Value	Description
CWFGRREGL		Code word FGRREGL
DVLLVO		Delta speed to reset idle-speed disable from the FGR
DVLLVU		Delta speed to set idle-speed disable from the FGR
DVSAVO		delta velocity to set prohibited trailing throttle fuel cutoff
DVSAVU		delta velocity to remove prohibited trailing throttle fuel cutoff
MRFGRLL		Relative-torque threshold from FGR for idle-speed detection
MRFGRMAX		maximum value for relative torque request from cruise control
MRFGRSTA		starting value for relativ torque at active cruise control
TFGRAR		Ramp running time comfort shutdown of the FGR

FB FGRREGL 1.10 Detailed description of function

The function calculates the relative torque demand, mrfgr_w, of the vehicle-speed controller (FGR) as a function of the target speed and the actual speed. A PDT1 controller is used to do this. This controller has the following transfer function:

$$G(s) = K \; \frac{1 + T_Z\, s}{1 + T_N\, s}$$

The following recursion formula is given for discrete realization:

$$y(i) = \frac{1}{2\,T_N + dT} \left(K \left((2\,T_Z + dT)\, x(i) - (2\,T_Z - dT)\, x(i-1) \right) + (2\,T_N - dT)\, y(i-1) \right)$$

x: Control deviation (delta speed)
y: Controller output (relative torque)
dT: Sampling time (20 ms)
i: Computing step

Only the vehicle-speed controller in the master runs in a system where there are two ME ECU’s. The relative torque demand, mrfgr_w, is set in the slave to the value mrfgrc_w received from the master via CAN. In the case of an ACC system (externally realized vehicle-speed controller with vehicle-to-vehicle ranging), mrfgr_w is set to the value mracc_w demanded by the ACC control unit.

The controller is not active in the FGR states "Off" and "Decelerate". As long as the controller is intervening and there is no demand for a quick shutdown, then for comfort reasons, the relative torque demand is controlled to zero over a ramp with an applicable running time.

By the conditions idle speed disabled (B_llvfgr) and overrun fuel cutoff disabled (B_savfgr), the vehicle-speed controller has the option of preventing idling or overrun shutdown from being triggered. Both conditions are calculated depending on the target and the actual speed and includes hysteresis. If the actual speed exceeds the target speed by a certain delta, then idling is first enabled. A larger delta then causes overrun fuel cutoff to be enabled. mrfgr_w is always at zero if idling disabled is not set.

The PDT1 controller that is used is not very accurate when the vehicle is stationary. It is for this reason that in the state "Constant driving" the control deviation is increased further by an offset, voffs_w. This offset depends on the speed and step-up ratio. As soon as a ramp is started, voffs_w is initialized to a value where the controller output does not drop. voffs_w then remains constant throughout the subsequent course of the ramp. By using an integrator with an adjustable time constant, vlast_w is calculated as an additional offset for the control deviation in order to prevent control deviations that are too large when in the "Constant driving" state. During the ramps, the PDT1 controller changes to a P-controller by setting the counter constant to equal the nominal-time constant. The controller gain is calibrated separately for constant driving and the ramps.

APP FGRREGL 1.10 Application hint

```
CWFGRREGL:

Bit 0
 0: Controller initialization depending on the pre-control map and the gain
 1: Controller initialization depending on the accelerator pedal and a fixed starting value

Bit 1
 0: vlast_w calculated for constant driving from an integrator
 1: vlast_w always equals zero
```

AINTKAN number of interval misfire frequency at which ti- cutoff

ANALUN number of combustions for deactivation after detected misfire

ATMABKA factor reduction of exhaust gas temperature = f(soak time)

ATMABKK factor reduction for catalyst temperature = f(soak time)

ATMTANS temperature correction of the exhaust model temperature

AZKELDYN ignition per cylinder for load dynamics => knock detection

AZKRLDYN number of ignition per cyl. during knock control load dynamic

AZKRNDYN number of ignition for knock control engine speed dynamic

BRABEVI acceleration at accelerating ramp

BTRKHTMS Characteristic enabling flag B_trkh

CDCCAS code word CARB: CAN interface, timeout ASC

CDCCINS code word CARB: CAN interface, timeout instrument

CDCCKUP code word CARB: CAN-bus, timeout clutch

CDCEV1 code word CARB: injector 1

CDCEV2 code word CARB: injector 2

CDCEV3 code word CARB: injector 3

CDCEV4 code word CARB: injector 4

CDCEV5 code word CARB: injector 5

CDCEV6 code word CARB: injector 6

CDCEV7 code word CARB: injector 7

CDCEV8 code word CARB: injector 8

CDCFRAO code word CARB: mixture adaptation factor frao

CDCFRAO2 code word CARB: mixture adaptation factor frao bank 2

CDCFRAU code word CARB: mixture adaptation factor frau

CDCFRAU2 code word CARB: mixture adaptation factor frau bank 2

CDCFRST code word CARB: deviation of lambda closed loop control

CDCFRST2 code word CARB : deviation of lambda closed loop control bank 2

CDCHSH code word CARB: lambda sensor heating downstream cat

CDCHSH2 code word CARB: lambda sensor heating downstream cat

CDCHSV code word CARB: lambda sensor heating upstream cat

CDCHSV2 code word CARB: lambda sensor heating upstream cat; (bank2)

CDCHSVE code word CARB: lambda sensor heating power stage upstream cat

CDCHSVE2 code word CARB: lambda sensor heating2 power stage upstream cat

CDCKAT code word CARB: catalyst conversion

CDCKAT2 code word CARB: catalyst conversion, cyl.row 2

CDCKPE Code word CARB: fuel pump relay power stage

CDCKRNT code word CARB: knock control zero test pulse

CDCKROF code word CARB: knock control offset

CDCKRTP code word CARB: knock control test pulse

CDCKS1 code word CARB: knock sensor 1

CDCKS2 code word CARB: knock sensor 2

CDCKS3 code word CARB: knock sensor 3

CDCKS4 code word CARB: knock sensor 4

CDCLASH code word CARB: lambda sensor aging downstream cat

CDCLASH2 code word CARB: lambda sensor aging downstream cat, Cyl.row 2

CDCLATP code word CARB: lambda sensor aging tp

CDCLATP2 code word CARB: lambda sensor aging tp, cyl. row 2

CDCLATV code word CARB: lambda sensor aging tv

CDCLATV2 code word CARB: lambda sensor aging tv, cyl.row 2

CDCLSH code word CARB: lambda sensor downstream catalyst

CDCLSH2 code word CARB: lambda sensor downstream catalyst

CDCLUEA code word CARB: Power stage engine fan A

CDCLUEB Code word CARB: Power stage engine fan B

CDCMD Code word CARB: misfire, multiple

CDCMD00 Code word CARB: misfire cyl. 0

CDCMD01 Code word CARB: misfire cyl. 1

CDCMD02 Code word CARB: misfire cylinder 2

CDCMD03 Code word CARB: misfire cylinder 3

CDCMD04 Code word CARB: misfire cylinder 4

CDCMD05 Code word CARB: misfire cylinder 5

CDCMD06 Code word CARB: misfire cylinder 6

CDCMD07 Code word CARB: misfire cylinder 7

CDCMD08 Code word CARB: misfire cylinder 8

CDCMD09 Code word CARB: misfire cylinder 9

CDCMD10 Code word CARB: misfire cylinder 10

CDCMD11 Code word CARB: misfire cylinder 11

CDCMDB Code word CARB: Target torque limitter

CDCMILE Code word CARB: MIL power stage

CDCNWKW code word CARB: alignment between camshaft and crankshaft

CDCNWKW2 code word CARB: alignment between camshaft 2 and crankshaft

CDCNWS code word CARB: camshaft control

CDCNWS2 code word CARB: camshaft control bank 2

CDCPH code word CARB: phase sensor

CDCPH2 code word CARB: phase sensor 2

CDCRKAT code word CARB: additive adaptive mixture correction rkat

CDCRKAT2 code word CARB: additive adaptive mixture correction rkat bank 2

CDCRKAZ code word CARB: additive adaptive mixture correction rkaz

CDCRKAZ2 code word CARB: additive adaptive mixture correction rkaz bank 2

CDCTA code word CARB: intake air temperature

CDCTES code word CARB: canister purge system

CDCTEVE code word CARB: canister purge valve power stage

CDCTM code word CARB: engine coolant temperature TMOT

CDCUB code word CARB: battery voltage UB (onboard)

CDCUF2SG Code word CARB: monitoring of the function: data from other ECU

CDCUFMV Code word CARB: monitoring of the function: torque comparison

CDCUFSKA Code word CARB: monitoring of the function: safety fuel cut-off

CDCURRAM Code word CARB: monitoring of the controller: RAM

CDCURROM Code word CARB: monitoring of the controller: ROM

CDCURRST Code word CARB: monitoring of the controller: Reset

CDCVKUP code word CARB: electr. clutch, speed dependent

CDLFRAO code word lamp : LR-Adaptation multiplicative upper threshold

CDLFRAO2 code word lamp : LR-Adaptation multiplicative upper threshold bank 2

CDLFRAU code word lamp: LR-Adaptation multiplicative lower threshold

CDLFRAU2 code word lamp: LR-Adaptation multiplicative lower threshold bank 2

CDLFRST code word lamp: feul supply system short test

CDLFRST2 code word lamp: feul supply system short test bank 2

CDLRKAT code word lamp : LR-Adaptation additive per time

CDLRKAT2 code word lamp : LR-Adaptation additive per time bank 2

CDLRKAZ code word lamp : LR-Adaptation additive per ingnition

CDLRKAZ2 code word lamp : LR-Adaptation additive per ingnition bank 2

DECKSTAI decrement-step for STADAP-factor

DEVTMAGR offset for evtmod depending on tsges_w at high tans caused by EGR

DFPSLBIT Section bits for indication of the activated error paths

DFSEFO2N max. plausible speed-dependent variance of FSE values

DFSEFON max. plausible speed-dependent variance of FSE values

DKNOTBEGR Limtation of set value as f(nmot) if B_dknot = true

DKROFN limit of integrator rise for zero test

DLAMOB delta lamda at overboost

DLBTS Delta nominal Lambda for component protection

DLRKIONLP0 I component as f(abs(dwdkdlr_w)), above NLP

DLRKIUNLP0 I component as f(abs(dwdkdlr_w)), below NLP (weak)

DLRKIUNLP1 I component as f(abs(dwdkdlr_w)), below NLP (medium)

DLRKIUNLP2 I component as f(abs(dwdkdlr_w)), below NLP (strong)

DLURMIN speed dependensy of engine roughness referenz minimum value 1

DMAUFN delta torque rise after torque intervention

DMDDLWS Torque for power steering function of the

DMDLWS Torque for power steering

DMDNSM Torque offset for after cranking compensation

DMDPUG delta torque threshold end of dashpot

DMLLNG LLR: D-gain depending of ngasf for air path

DMLLNGV LLR: D-gain depending of ngasf for air path

DMLLRLMNN Lower limit for dmllrl

DMLLRLMXN Safety concept: upper limit for dmllrl

DMLLRMNN Lower limit for dmllr_w

DMLLRMXN Safety concept: upper limit for dmllr

DMLSDUG Delta torque for finishing positive slope limitation

DMRIFW Delta relative torque for FGR initialization

DMSTES characteristic line maximum increase of purge mass flow

DNBURN Minimum difference in engine-speed for detected combustion

DPUPVDK pressure difference pu-pvdk

DRLSOLA Misfire Detection : load-dynamic treshold for deactivation

DTLRTML proportion factor to decrease waiting time up to tmot-threshold for closed loop

DTVKAML delta-tv for cat oxygen neutralization (air mass dependent)

DTVKAML2 delta-tv for cat oxygen neutralization (air mass dependent) bank2

DVNG LLR: D-gain depending of ngfil for vehicle at rest

DVNGV LLR: D-gain depending of ngfil for vehicle rolling

DVSKNBGA delta velocity for set value correction after acceleration

DVSKNVGA delta velocity for set value correction after deceleration

DWKRMSN delta ignition angle knock control distance from mean retarding

DZWAML Up/down regulation speed between the maps of limitation

DZWDYN Spark advance for burning-limit angle at tip-in

DZWETA delta ignition angle from efficiency

DZWMNSTN nmot dependent offset on latest ign. angle during start

DZWNWSUE Delta ignition angle dependent on the camshaft overlap

DZWOAGR AGR-rate-dependent offset of optimum ignition angle

DZWOLA Lambda dependency of optimum ignition angle referred to Lambda 1

DZWOM temperature-dependent offset of optimum ignition angle

DZWSPM delta latest ignition angle relative to engine temperature

DZWSTTA Delta ignition angle during start

DZWTIN delta ignition angle at tip-in

EFFDFPM Declaration of freeze frame extension out of table DFFT

ETADZW ignition efficiency depending on delta ignition angle

ETALAM Lambda effectiveness

EVTMODO offset for evtmod depending on filtered engine temperature

FABMDWA Factor to decrease the converter torque depending of nturb

FABSTT Factor parking time for model temperature

FATMRML divide factor exhaust-/exhaust-pipe temperature

FATMRML2 divide factor exhaust-/exhaust-pipe temperature bank2

FA_CALID

FBFGRSFW Correction factor for FGR target acceleration

FBTEB factor ftefvab-depending limitation of the canister charge adaptation speed

FBTEVA factor ftefva-depending canister charge adaptation speed

FBZBTEML Weighting factor integration speed for canister charge adaptation

FBZFRAT weighting factor for integration speed KFFRAT as f(abo)

FDDN LLR: weightning factor for D-amplification

FDVAGR factor temperature for flow through EGR valve

FDVANS Temperature factor for air at throttle valve

FETATEBN characteristic line: reduction of engine efficiency as f(nmot)

FFLDZ Follow-on ignition charging time

FFRITMS tmst dependent factor to modify I-dynamic of lambda control

FFTCAS Freeze Frame table: CAN, timeout ASC

FFTCINS Freeze frame table: CAN-Timeout, instrument panel

FFTCKUP freeze frame table: CAN-timeout KUP-message

FFTEV1 freeze frame table: injector power stage 1

FFTEV2 freeze frame table: injector power stage 2

FFTEV3 freeze frame table: injector power stage 3

FFTEV4 freeze frame table: injector power stage 4

FFTEV5 freeze frame table: injector power stage 5

FFTEV6 freeze frame table: injector power stage 6

FFTEV7 freeze frame table: injector power stage 7

FFTEV8 freeze frame table: injector power stage 8

FFTHSH Table of ambient condition for heating O2-sensor post cat

FFTHSH2 Table ambient conditions heating lambda sensor downstream catalyst bank2

FFTHSV Table of ambient condition for heating O2-sensor pre cat

FFTHSV2 Table of ambient condition for heating O2-sensor post cat bank 2

FFTHSVE Freeze frame table: 02 Sensor Heater power stage

FFTHSVE2 Freeze frame table: 02 Sensor Heater power stage bank 2

FFTKPE Freeze frame table: fuel pump relay power stage

FFTKRNT freeze frame table: knock control zero test

FFTKROF freeze frame table: knock control offset

FFTKRTP freeze frame table: knock control test pulse

FFTKS1 freeze frame table: knock sensor 1

FFTKS2 freeze frame table: knock sensor 2

FFTKS3 freeze frame table: knock sensor 3

FFTKS4 freeze frame table: knock sensor 4

FFTLASH Table ambient conditions for Lambda sensor downstream catalyst

FFTLASH2 Table ambient conditions Lambda sensor downstream catalyst bank2

FFTLATP Table ambient conditions Lambda sensor aging Tp upstream catalyst

FFTLATP2 Table ambient conditions Lambda sensor aging Tp upstream catalyst bank2

FFTLATV Table ambient conditions Lambda sensor aging Tv upstream catalyst

FFTLATV2 Table ambient conditions Lambda sensor aging Tv upstream catalyst bank2

FFTLSH Table of ambient conditions Lambda sensor downstream catalyst

FFTLSH2 Table of ambient conditions Lambda sensor downstream catalyst bank 2

FFTMDB freeze frame table: Target torque limitter

FFTMILE freeze frame table: MIL power stage

FFTNWKW freeze frame table: alignment between camshaft and crankshaft

FFTNWKW2 freeze frame table: alignment between camshaft 2 and crankshaft

FFTNWS freeze frame table: camshaft control

FFTNWS2 freeze frame table: camshaft control bank 2

FFTPH freeze frame table: phase sensor

FFTPH2 freeze frame table: phase sensor

FFTTA freeze frame table: air intake temperature TANS

FFTTES freeze freme table: canister purge valve

FFTTEVE freeze frame table: canister purge valve (power stage)

FFTTM freeze frame table: engine temperature TMOT

FFTUB freeze frame table: battery voltage UB (onboard)

FFTUF2SG Freeze frame table: monitoring of the function: data from other ECU

FFTUFMV Freeze frame table: monitoring of the function: torque comparison

FFTUFSKA Freeze frame table: monitoring of the function: safety fuel cut-off

FFTURRAM Freeze frame tabele: monitoring of the controller: RAM

FFTURROM Freeze frame tabele: monitoring of the controller: ROM

FFTURRST Freeze frame tabele: monitoring of the controller: Reset

FFTVKUP freeze frame tabele: ”Engine OFF”-request from F1-gearbox (KUP)

FHSTT factor hot start

FIMHU Factor pulse abrupt

FIMWU Factor pulse smooth

FKATEB Characteristic line fuel portion depending on te / TEMIN

FKAXAVKAT weighting factor for oxygen capacity depending on avkatf

FKDISA faktor difference for integrator ambient pressure during fuel cut off

FKHLA Weighting factor Lambda nominal for catalyzer heating

FKHMD Weighting factor torque reserve for catalyzer heating

FKKVS Factor to correct fuel delivery system

FKSTT factor cold start

FLRAWG amplification of load controller

FLRFKATE Rating of factor fkatei from %TEB to optimize the regulation parameter

FLRHG amplification of load controller

FLRM Engine temperature dependent factor to modify I-dynamic of lambda control

FLUTN filter factor running irregularity

FMDGENTA factor: generator torque due to temperature

FMDKHFH altitude correction of torque reserve for catalyst heating

FMDKHTM tmot-correction of torque reserve for catalyst heating

FMDWAT Factor to calculate the converter torque depending of oil temperature

FNSHO weighting of afterstart enrichment

FNSSM after start increase

FNSSTKM Factor to weight the desired speed at start during catalyst heating

FNSSTM Faktor for taget engine speed during start

FNSTABNV Factor for engine speed stabilisation by torque

FPLMRM weighting factor for P component of air-mass controller

FPVMXN2 factor for pressure ratio maximum with secondary last sensor

FPWDKAPP throttle angle dependent on accelerator pedal position, only for calibration

FQTEDL Factor for exponential decrease of flow rate

FQTEFR characteristic line: purge rate reduction with big frm-deviation

FQTEPT characteristic line: for fuel-tank underpressure limitation

FQTEVA progression of purge rate controller

FRARAWG amplification factor

FRARHG amplification factor

FRINH1 Multiplication factor for RIN nominal value downstream of the catalyzer

FRINH2 Multiplication factor for RIN nominal value downstream of the catalyzer

FRINV1 Multiplicativ factor for RIN desired value pre cat

FRINV2 Multiplicativ factor for RIN desired value pre cat

FRLFSDP injection correction for RLFS

FRLMNHO correction factor rlmin depending on altitude

FSTHO weighting of factor start

FSWALUV rough road detection threshold = f (vehicle speed)

FSWALUV1 rough road detection threshold = f (vehicle speed)

FSZTM Factor dwell angle correction tmot depending

FTAGRV Factor for temperature drop from EGR_pipe to EGR_valve

FTDAG factor for temperature drop on EGR line

FTEINIX characteristic line for max. purge rate = F(integral purge flow after TE-Stop)

FTMFFANZ Follow-on ignition weighting factor

FTMLAKH tmot-correction of lambda-weighting at catalyst heating

FUEPMLD Factor for gliding transition average pressure (reference pressure turbo)

FUKNSTHO altitude dependent transient control post cranking factor

FUKNSTM initial value of transient control post cranking factor

FVERMN characteristic line: filter factor for purge flow in the manifold with fresh air

FVERZDYN dynamic factor delay of purge flow in the manifold

FVRMDYN dynamic factor for purge flow in the manifold with fresh air

FWDMVAD factor for the weighting of dmvad_w in %MDMIN

FWEMXT maximum factor for fuel cut-in temperature characteristic

FWFTBRTA Weighting for ftbr as a function of tans

FWLKFTBR warm up correction for combustion chamber model

FWMLHFMMN Weighting factor for min. HFM air-mass threshold as a function of the altitude

FWSTAA1 afterstart correction

FWSTAB1 weighting afterstart decrease range 1

FWSTAB2 weighting afterstart decrease range 2

FWSTAB3 weighting afterstart decrease range 3

FWSTAS1 correction of threshold 1 for afterstart

FWSTAS2 correction of threshold 2 for afterstart

FZANSSA1 factor for ign. sync. decreasing of afterstart enrichment at hot start range 1

FZANSSA2 factor for ign. sync. decreasing of afterstart enrichment at hot start range 2

FZANSSM1 factor for ign. sync. decreasing of afterstart enrichment above SZANSSM

FZANSSM2 factor for ign. sync. decreasing of afterstart enrichment below SZANSSM

FZANSSM3 factor for ign. sync. decreasing of afterstart enrichment in range 3

FZDASHTM factor for time constant dashpot

FZN1 Cylinder individual factor at neutral camshaft position EV 1

FZNWN1 Cylinder individual factor at active camshaft position EV 1

FZPUSA correction faktor time constant ambient pressure adaptation during fuel cut-off

FZWSTNM Ignition angle during start

FZWSTTM Ignition angle during start

GFDLDN LLR: weightning factor for D-amplification on the air path

IGESGA Total transmission ratio

ILMLKAXTK Threshold of richness area of O2 purging after fuel cat off, funct. of cat-temp

ILMLKAXTK2 Thresh. of richness area of O2 purging after fuel cut off, funct. of cat-temp.

ILMRN integrator gain of air mass controller

IMLKAXTK integr. air mass threshold f(tkatm) for cancelation of cat oxygen neutralization

IMLKAXTK2 integr. air mass threshold f(tkatm2) for cancelation of cat oxygen neutral.

IMLKHTMS imlpr-threshold, changing to lambda catalyst heating

INCKSTAI increment-step for STADAP factor

IVDN LLR: I-gain for vehicle at rest

IVDNDTE LLR: I-gain at DTEV

IVDNV LLR: I-gain for vehicle rolling

KATBFML filter time constant for signal attenuation in catalyst stress

KATBFML2 filter-time constant for signal attenuation in catalyst stress (assymmetrical)

KATBFXM max. catalyst load threshold for stop condition

KATMEXML Temperature of the exotherme in the catalyst tkatm

KATMEXML2 Temperature of the exotherme in the catalyst , bank 2

KATMIEXML Temperature of the exotherme in the catalyst tikatm

KATMIEXML2 Temperature of the exotherme in the catalyst tikatm, bank 2

KDLASHKI evaluation factor of I-part of LRHK, f(dlashkm)

KDLASHKI2 evaluation factor of I-part of LRHK, f(dlashkm), bank 2

KDLASHKP evaluation factor of P-part of LRHK, f(dlashkm)

KDLASHKP2 evaluation factor of P-part of LRHK, f(dlashkm), bank 2

KE1N knock detection threshold at cylindertimer 1

KE2N knock detection threshold at cylindertimer 2

KE3N knock detection threshold at cylindertimer 3

KE4N knock detection threshold at cylindertimer 4

KE5N knock detection threshold at cylindertimer 5

KE6N knock detection threshold at cylindertimer 6

KE7N knock detection threshold at cylindertimer 7

KE8N knock detection threshold at cylindertimer 8

KEMLN length of the sampling window for knock control

KFABAK share factor wall wetting for acceleration enrichment

KFAFTE map flow-characteristic of PCV (incl. PCV carcoal-canister line)

KFAMAL map reduction factor of the engine roughness reference value at multiple misfire

KFAMAL1 map reduction factor of the engine roughness reference value at multiple misfire

KFATMLA map exhaust gas temperature correction = f(lambda)

KFATMLA2 map exhaust gas temperature correction = f(lambda) bank2

KFATMZW map exhaust gas temperature correktion = f(ignition-variation)

KFATMZW2 map exhaust gas temperature correktion = f(ignition) bank2

KFAVAK share factor wall wetting for deceleration enleanment

KFBAKL factor accel. enrichment (short- and long-time part)

KFBRAWA Target acceleration for resumption

KFBS bank-selective mixture factor

KFCFO map for definition of range characteristics (dominant..)

KFCFO2 map for definition of range characteristics (dominant..)

KFDETATE correction of ignition angle effectiveness for diagnosis of PCV

KFDFBTMN dynamic factor for combustion chamber temperatur model negativ gradient

KFDFBTMP dynamic factor for combustion chamber temperatur model positiv gradient

KFDLSD Damping of PT2 filter in positive torque slope limitation

KFDLUR map engine roughness difference dluts referenz value

KFDLUR1 map engine roughness difference dluts referenz value

KFDLUR2 map engine roughness difference dluts referenz value

KFDLURZ map engine roughness difference dluts referenz value at ZAS (cylinder cut-off)

KFDMDADP upper threshold for torque-intervention during dashpot

KFDMDARO Upper threshold for torque intervension

KFDMDKOE Starting value torque filter when air-conditioner compressor is activated

KFDMDPO Delta torque for starting negative slope limitation

KFDMLSDO Delta torque for starting positive slope limitation

KFDMLSDS delta torque for triggering of load-shock damping after shifting procedure

KFDTMRS char.line for gradient of engine coolant temp. during cutoff for reference model

KFDTMTE char. map for gradient of engine coolant temperature in substitute temp. model

KFDTMTR char. map for gradient of engine coolant temperature in reference model

KFDTMTU char. map for correction gradient of engine coolant temp. at low warming up

KFDYES Threshold for dynamic presetting values

KFDYESOF Offset threshold for dynamic presetting values

KFDZWKG ignition angle correction due to knock limit shift

KFETATE characteristic map for efficency at active purging when te is near TEMIN

KFFDLBTS Factor delta nominal Lambda for component protection

KFFFANZ Number of sequential sparks

KFFFANZUB Number of sequential sparks

KFFRAT load and speed dependent gradient of FRAT integrator

KFFRMIN lower limit of control range

KFFTEAN characteristic map for limitation of the purge rate with no Lambda control

KFFTEAX Characteristic map for limitation of the purge rate

KFFTV weighting map for TVLRH

KFFTV2 weighting map for TVLRH bank 2

KFFWL map warm-up factor

KFFWLRL map warm-up factor load dependent fraction

KFFWLW map weighting warm-up factor

KFFWTBR Weighting factor for combustion chamber temperature model

KFFWTBRA Weighting factor for combustion chamber temperature model B_agr=true

KFKABMT Map for correction of calculated amplitude, dependent on ml and cat. temperature

KFKHFM HFM-correction characteristic map

KFKSWF map for catalyst protection, weighting factors

KFKWTMP Characteristic torque reserve for keeping catalyst warm, temporary

KFLASKH Performance characteristics lambda exhaust nominal at catalyst heating

KFLBTS Nominal Lambda for component protection

KFLF lambda characteristic map at part load

KFLMSKH Performance characteristics lambda engine nominal at catalyst heating

KFLUAR map for engine roughness distance reference value

KFLUAR1 map for engine roughness distance reference value

KFLUAR2 map for engine roughness distance reference value

KFLUARZ map for engine roughness distance reference value at ZAS (cylinder cut-off)

KFLURB map for engine roughness - reference base value

KFLURB1 map for engine roughness - reference base value

KFLURB2 map for engine roughness - reference base value

KFLURBZ map for engine roughness base value, in case of ZAS

KFLURM reference base value map for engine roughness for misfire detection

KFLURM1 reference base value map for engine roughness for misfire detection

KFMAKR map for starting measuring window knock control

KFMDBGRG map with the value of the torque limitation

KFMDDSLA Map torque reserve at tester demand of SAI-diagnosis short test

KFMDGEN Torque intake generator

KFMDKH Characteristic torque reserve for catalyst heating

KFMDKO map for torque needed for air condition

KFMDPWM steady state load of ac-compressor for PWM-signal of its load

KFMDPWME initial load of ac-compressor for PWM-signal of its load

KFMDRKO look-up-table: torque loss depended of rl, nmot

KFMDRKOE look-up-table: torque loss dyn. part dependend of rl, nmot

KFMDS map for engine drag torque

KFMDSZAS map for engine drag torque during cyclinder cut off

KFMDZOF_UM map for offset tolerance depending on permissible torque

KFMIFABG delta torque for gradient limitation

KFMIFALS Indicated driver’s request torque for charge path at load-shock damping

KFMILSD Initial value for positive torque slope limitation

KFMIMN minimum drag torque

KFMIOP map optimum engine torque

KFMIRED Map of decreasing control torque for VMAX control

KFMIRL map for calculation of nominal charge

KFMIZUFIL Maximum permitted indicated set torque for torque limitation before Filter

KFMIZUNS Authorized torque for post-start torque increase

KFMIZUOF Maximum permitted indicated set torque for torque limitation

KFMI_UM map of optimum engine torque

KFMLDMN air mass flow threshold for min. failure

KFMLDMX air mass flow threshold for max. failure

KFMPED_UM map for permissible torque from the pedal position in function monitoring

KFMPNS_UM map for permissible torque from pedal position for a cold engine

KFMRES LLR: torque reserve at idle and near-idle zone

KFMRESK LLR: torque reserve at idle and near-idle zone clutch disengaged

KFMRESKH Torque reserve during catalyst heating

KFMRESNL Torque reserve in non idling state

KFMRESTA Torque margin dependent on tans

KFMRESTM Map temp-dependent limiting of torque reserve

KFMSNWDK Map for scaled mass flow over throttle valve

KFNLLNST idle speed after start

KFNSA after start increase

KFNSWRL weighting of afterstart enrichment

KFNW characteristic map for variable camshaft spread

KFNWEGM Fuel cut in map depending on rpm

KFNWWL

KFPBRK factor to correct pressure at combustion chamber

KFPBRKNW factor to correct pressure at combustion chamber by active Camshaft control

KFPED accelerator pedal characteristic

KFPEDR Pedal characteristic for reverse gear (only automatic transmission)

KFPLMR P-component of air mass controller

KFPRG internal partial exhaust gas pressure dependent on camshaft adjustment sumode=0

KFPRG2SU internal partial exhaust gas pressure depent on camshaft adjustment sumode=2

KFPRG3SU internal partial exhaust gas pressure dpent on camshaft adjustment sumode=3

KFPRGSU internal partial exhaust gas pressure dependent on camshaft adjustment sumode=1

KFPU pulsation characteristic map

KFPUNW pulsation map for camshaft control switch over

KFPUSU pulsation characteristic map at active variable intake system by sumode=1

KFPUSUNW pulsation characteristic map at active variable intake system and camshaft cont.

KFQTE Map for purge rate increase / decrease

KFRI I characteristic map

KFRI2 LR-I-Map for bank 2

KFRINH MAP for Nernst resistor post cat

KFRINH2 MAP for Nernst resistor post cat bank 2

KFRINV MAP for Nernst resistor pre cat

KFRINV2 MAP for Nernst resistor post cat , bank 2

KFRLIP_UM characteristic map for load signal calculation on throttle angle

KFRLMN Minimum charge during fuel on

KFRLMNSA Minimum rl during fuel cut off

KFRLW rlw-map from throttle valve angle

KFRLWNW rlw-map from throttle valve angle during variable camshaft

KFRLWSU rlw-map from throttle valve angle during manifold switch over

KFRLWSUNW rlw-map from throttle valve angle during manifold switch over and aktive var. ch

KFRP P characteristic map

KFRP2 LR-P MAP for bank 2

KFRTV delay time characteristic map

KFRTV2 delay time characteristic map

KFSU Load/speed performance characteristics for suction tube switchover

KFSU2 map for intake manifold switch over, flap 2

KFSZT Dwell angle characteristic map

KFTADMS dynamic evaluation factor for close off of PCV

KFTAGAV EGR temperature at outlet valve

KFTATM map exhaust gas temperature f(nmot,rl)

KFTATM2 map exhaus gas temperature f(nmot,rl) bank2

KFTATX map for max. duty cycle

KFTEKA characteristic map of desired fuel portion purge control

KFTEVP Characteristic map for period time of the PCV

KFTPKOR correction map for the measured cycle duration TP (tpsvkof)

KFTVFRR Map: Lambda controll after this time reset at reference value

KFTVSA Retard time for overrun fuel cut-off

KFURL conversion factor from ps->rl dependent on camshaft adjustment sumode=0

KFURL2SU conversion factor from ps->rl dependent on camshaft adjustment sumode=2

KFURL3SU conversion factor from ps->rl dependent on camshaft adjustment sumode=3

KFURLSU conversion factor from ps->rl dependent on camshaft adjustment sumode=1

KFUSHK lambda sensor reference value for lambda control downstream of catalyst

KFUSHK2 lambda sensor reference value for lambda control downstream of catalyst bank2

KFVAKL factor decel. enleanment (short- and long-time part)

KFVERST weighting map for increasing control of friction torque

KFVOFFS velocity offset for cruise control

KFWDKMSN Map for the desired throttle blade angle

KFWDKPP throttle blade position dependent on air charge signal

KFWDKSMX max. desired throttle angle

KFWDKSST desired throttle position at start-up

KFWDKTHO desired throttle position at start-up - f (hight, engine start temperatur)

KFWEE characteristic map angle end of injection

KFWEEK map for end of injection angle (cold parameters)

KFWHSTT map weighting of hot start factor

KFWKSTAB factor cold re-start for reduction of starting fuel

KFWKSTN map weighting of factor cold start

KFWKSTT map weighting of factor cold start

KFWMABG map for heat-quantity threshold dew-point end upstream bank1

KFWMABG2 map for heat-quantity threshold dew-point end upstream bank2

KFWMKAT map for heat quantity threshold dew-point end downstream

KFWMKAT2 map for heat quantity threshold dew-point end downstream bank 2

KFWPFGR Inverse pedal characteristic for cruise mode

KFWTBR Weighting factor Tans/Tmot for combustion chamber temperature model

KFWTBRA Weighting factor Tans/Tmot for combustion chamber temperature model B_agr=true

KFWWLML map weighting warm-up factor

KFWWNS repeated start time factor

KFZDASH Time constant for negative torque slope limitation

KFZDASH2 time constant PT1-filter dashpot at low clutch torque

KFZKPUA time constant for ambient pressure

KFZLSD Time constant for positive torque slope limitation

KFZNSM time constant for decay of reference speed

KFZW Ignition advance-angle characteristik map

KFZW2 Ignition angle performance characteristics variant 2

KFZWMN Map for minimal ignition angle

KFZWMNKH Map for minimal ignition angle catalyst warm-up

KFZWMNST minimal ignition spark advance for engine start and after start

KFZWMS Map for ignition value as latest possible value

KFZWOP optimum ignition angle

KFZWOP2 Optimum ignition angle, variant 2

KFZWWLNM Delta ignition sparc advance during engine warm up phase

KFZWWLTM Delta ignition sparc advance during engine warm up phase

KFZW_UM map of optimum ignition angle

KIFZGAWG amplification of vehicle model integrator at AT

KIFZGHG amplification of vehicle model integrator at AT

KINMXG gain of integral component for NMAX control

KINMXRLG gain of integral component for NMAX control

KIRMSMS Integration speed matching of mass flow PCV with calculated mass flow

KKFFGRGA amplification rate during cruising for cruise control

KLAF characteristic of Saint-Venant

KLAFTE characteristic of Saint-Venant of purge control valve an line AKF-TEV

KLATMILAE Temperature of the exotherme decrease during enrichment tikatm

KLATMILAE2 Temperature of the exotherme decrease during enrichment tikatm, bank2

KLATMIZWE Temperature of the exotherme decrease in cat during ignition retard tikatm

KLATMIZWE2 Temperature of the exotherme decrease in cat during ignition retard tikatm, bank

KLATMLAE Temperature of the exotherme decrease during enrichment

KLATMLAE2 Temperature of the exotherme decrease during enrichment, bank 2

KLATMZWE Temperature of the exotherme decrease in cat during ignition retard tkatm

KLATMZWE2 Temperature of the exotherme decrease in cat during ignition retard, bank2

KLDMDLF1 Characteristic curve reserve torque fan

KLDMDLF2 Characteristic curve reserve torque fan 2

KLDMMX Maximum delta torque for air path

KLDPDK pressure drop at throttle blade

KLDTPH Fixed value characteristic for weighting the engine dynamic

KLDTPHST Fixed value characteristic for the engine start

KLDYNCOR Value for the dynamic correction after the first ignition

KLETAZW_UM ignition efficiency depending on delta ignition angle

KLFZWMNKH Spark retard gradient of burning limit during after-start at cat.heating

KLFZWMNST Spark retard gradient of burning limit during after-start

KLNLPHN Correction of the phase frequency characteristic of the sensor

KLNPED_UM Speed lim. as func. of nominal pedal value, in DK drive standby func.,func.mon.

KLNWRLTM Weighting of relative nominal filling over engine temp. for addressing KFNWS

KLRSYNIN

KLRSYNPN

KLTDS Conversion line for tank pressure sensor DS-T2

KLTNRDE characterisitic for tooth times at reverse rotation

KLWDKABST Weighting desired throttle position at start-up

KLWDKPED Offset desired throttle position at start-up

KLWDKTAN weight of throttle position at start up with intake air temperatur

KLWNWI Fixed value characteristic for weighting the angular displacement

KRAFGRGA amplification rate at ramp for cruise control

KRAL1N load range for adaption maps 1

KRAL2N load range dor adaption maps 2

KRAL3N load range for adaption maps 3

KRDWSN knock control delta angle safety

KRFKN retard step knock occurrence

KRMXN maximum retard adjustment

KRNLZAR cylinder individual rpm limit for lead by leading cylinder

KRVFN number of firings/cyl. or time for ignition advancing

KRVFSN number of firings/cyl. or delay-time during fast ignition advancing of the KC

KSTAI workingrange for STADAP factor

LALIUSH lambda linearization, sensor behind catalyst

LALIUSH2 lambda linearization, sensor behind catalyst, bank 2

LALIUSRH lambda linearization, sensor behind catalyst

LALIUSRH2 lambda linearization, sensor behind catalyst

LAMFA Lamda driver demand

LAMKAML lambda setpoint for catylyst deoxidation (dependent on air mass)

LAMKAML2 lambdasetpoint for catalyst deoxidation (air mass dependent), bank 2

LAMLGMTM lambda limit ”lean”

LASDSLA Lambda exhaust nominal at secondary air adaption/short test

LASTMOT tmot-correction of lambda exhaust nominal

LIMXDNS upper integrator limit for standing car

LIMXVDNS upper integrator limit for rolling car

LISTM value of idle speed control integrator during start

LKRN load-signal threshold knock control

LMSTMOT tmot-correction of lambda engine nominal

LNXQTM natural logarithm from temperature quotient

LSAKTD Impact of slow front sensor on cat. monitoring

LURBRL8 reference value for engine roughness, vehicle speed zero

LURKH dmrkh-depen. engine roughness reference correction value, during cat heating

LURKTM Tmot-dependent engine roughness reference correcting value

LURMIN1 speed dependensy of engine roughness referenz minimum value 1

LURMIN2 speed dependensy of engine roughness referenz minimum value 2

LURMIN3 speed dependensy of engine roughness referenz minimum value 3

LZFUER guide cylinder assignment

MASK_40MS 40ms mask for function monitoring

MASK_FUAE Mask for task splitting in monitoring functions (part 1: inputs)

MDKOAB Torque threshold to shut down the compressor during acceleration

MDKOAN Torque threshold to switch the AC-compressor off

MDKOEN Torque threshold to switch the AC-compressor on

MDSH Part of the resistant torque depending on altitude

MDSM temperatuer share of enginie friction torque

MDSMZAS temperatuer share of enginie friction torque during cylinder cut off

MIFAMXNOT maximum indicated engine torque at limp home

MKFADPN clutch torque for switch-over dashpot-filter time

MKFADPN1 clutch torque for switch-over dashpot-fil. time when AC comp. has been enabled

MKLLS torque needed for air condition fan

MLHFM air-mass meter characteristic line

MLSUS reference of air mass flow integral

MRFARUGDN Reset threshold for linear pedal travel in the non-reduced DK range

MRFAVLN Full load detection threshold of the relative driver request

MRFAVW threshold to switch end of injection angle at max. driver request

MRFGRIMX Maximum FGR initialization value

MSNTAG EGR mass flow standardised

MSNTATE Characteristic standardized mass flow through TEV

M_SRST_UM Mask B_srst_um - information SW-reset from cyclic RAM-check

NARLLGA speed threshold for AR at idle

NASNOTKL characteristic line rotational speed against engine stall

NDFILOG Threshold for filter output ndfil

NDIFFOG Threshold engine speed difference for initialization of AR during braking

NFS2M Target idle speed 2, B_fs = 1

NFSKHM LL nominal speed with driving graduations and catalyzer heating

NFSM desired engine speed DRIVE-position switch on

NGALUN Misfire Detection : treshold for gradient of engine speed

NGKRWN threshold revolution gradient for dynamics detection

NLL2M Target engine speed 2

NLLCVTMXV Limitation of the target speed (CVT transmission)

NLLKHM Nominal idling speed during catalyzer heating

NLLM desired engine speed

NMAXDVG rpm limit in case of fault detection velocity signal

NMXDAEF maximum permitted engine speed for throttle actuator substitute function

NMXPG P component for NMAX control

NMXPRLG P component for NMAX control

NNSTA engine-speed transition normal -> start

NSLPP Target speed depending on the pump pressure of power steerung

NSLPPFS Target speed depending on the pump pressure of power steering with B_fs=1

NSTAMXHA engine speed limit until STADAP is active depend. on altitude

NSTNM transition start -> normal

NWDKSST threshold for deactivation desired throttle position without torque structur

NWECVTM Fuel restart-speed at CVT

NWENG Fuel cut-in engine speed

NWENGFS Delta Fuel cut-in engine speed with Drive

NZHDTL Speed threshold for decrementing time counter for hot idling

NZHITL Speed threshold for incrementing time counter for hot idling

PAGAVML exhaust gas pressure at outlet valve

PLRHAV Weighting factor of P-part LRHK depending on catalyst age

PLRHAV2 Weighting factor of P-part LRHK depending on catalyst age range 2

PLRHML p-part of LRHK, f(dushk)

PLRHML2 Partie p. dans LRHK, agit avec la difference de tension de sonde aval cata banc2

PRG2SUNM internal exhaust-gas part. press. dependent on the speed at active SU (2nd flap)

PRG3SUNM inter. exhaust-gas part. press. dependent on speed at active SU (1st + 2nd flap)

PRGNM internal exhaust-gas partial pressure dependent on the speed

PRGSUNM inter. exhaust-gas partial press. dep. on speed in case of active SU (1st flap)

PUKANS correction of pulsation depending on intake air temperature

PVDN LLR: P-gain for vehicle at rest

PVDNKH proportional ISC when secondary air activ

PVDNST proportional ISC in start

PVDNV LLR: P-gain for vehicle rolling

PVLDN LLR: P-gain for vehicle at rest (air path)

PVLDNV LLR: P-gain for vehicle at rest (air path)

REDABM fuel cut-off table for torque reduction

REDABMB fuel cut-off table for torque reduction slave1 or ecu B (SGB)

REDABMC fuel cut-off table for torque reduction slave 2 or ecu C

REDABMZ fuel cut-off table for torque reduction during ZAS

REDZEM threshold between ignition intervention and injector disabling

RKBAUM rk-threshold for acceleration enrichment display

RKRMX1N Maximum of reference level for knock detection threshold cylinder group 1

RKRMX2N maximum of reference level for knock detection threshold cylinder group 2

RKVAUM rk-threshold for deceleration enleanment display

RLDKTSO upper load characteristic line for DKAT-active

RLDKTSU lower load characteristic line for DKAT-active

RLLRHON char. line on nmot, upper rl control threshold for downstream lambda control

RLLRHUN char. line on nmot, lower control threshold rl for downstream lambda control

RLLRUN char.line above nmot,lower rL control limit for controller in front of catalyst

RLNOT limp-home relative air charge rl in case of E_DK and E_LM

RLSALUN threshold load fuel cut-off detection for deactivating misfire detection

RLVMXN maximum volumetric flow with open throttle valve

RLVSMXN maximum volumetric flow with open throttle valve and SU

SDK10TEUB wdkba dependet basic point (number 10)

SDN06LLSB 10 Sst.

SENZZYL knock sensor for sw-cylinder counter 0-7

SFR05TEUB frmit dependet basic point (number 5)

SGA08MDUB base point distribution of actual gear 8 b.pt.

SGSC_ANZ number of module calls of %UFSGSC (refer to %URPAK) in the monitoring function

SGSC_K Constant for module %UFSGSC (see %URPAK)

SIM06ESUW Distribution for integrated air massflow since end of start

SKO06KOUB Distribution PWM-signal: load of ac-compressor

SKS06ESUB Distribution for the start adaption factor kstaa

SLFOO2N speed dep. upper threshold for learning filter value at fuel-on/-off adaptation

SLFOON speed dep. upper threshold for learning filter value at fuel-on/-off adaptation

SMI04LLUB distribution: ind. torque for torque-reserve

SMK08MDSW Antisurge torque dependent basic point (number =8)

SML05DKUB base point distribution air mass

SML06TEUB ml dependet basic point (number 6)

SNG06LLSB Datapoint distribution, speed gradient, 6 datapoints

SNM05DKUB base point distribution nmot

SNM06ESUB Distribution for engine speed

SNM06KOUB distribution for ac-compressor torque function

SNM06LLUB distribution of engine speed

SNM08DMUB Datapoint distribution in DMD, 8 speed datapoints

SNM08KOUB Datapoint distribution for air-conditioner compressor control 8 nmot

SNM08__UB Base point distribution engine speed, 8 base points

SNM10TEUB nmot dependet basic point (number 10)

SNM12FEUB set points of WDKSMX, WDKUGDN

SNM16KRUB datapoint distribution engine speed, 16 datapoints

SNM16OPUW 16 speed set points for ?

SNM16ZUUW break point distribution engine speed, 16 base pts.

SNS06LLSB Datapoint distribution, set-speed deviation, 06 datapoints., idle-speed control.

SQM05TEUB air mass quotient dependet basic point (number =5)

SRL04DYUB basepoint distribution of rl, 4 basepoints

SRL04KRUB datapoint distribution relative charge, 4 datapoints

SRL06KOUB 6 air charge set points for A/C-compressor torque loss

SRL08DMUB Datapoint distribution in DMD, 8 load datapoints

SRL08NXUB

SRL11OPUW set point distribution relative charge

SRL12ZUUW break point distribution of relative air charge, 12 base points

SRP06ESUB Distribution for relative air charge

SRST1_UR value for RAM data redundancy of bit B_SRST_UM = 1

STA04LLUB distribution: tans for torque resreve

STA06ESUB Distribution for the air temperature in the intake manifold

STA06LLUB temperature: ambient air, PWM -signal of AC/compressor

STM04SAUB Datapoint distribution, engine temperature, 4 datapoints

STM06LLUB Datapoint distribution, engine temperature, 6 datapoints

STM06__UB Datapoint distribution, engine temperature, 6 datapoints

STM12ESUB Distribution for the engine coolant temperature tmot

STN06LLUB distribution: time after start; for determination of idle speed after start

STS08ESUB Distribution for engine coolant temperature at start

STS12ESUB Distribution for engine coolant temperature at start

SY_2SG system constant 2 motronic systems

SY_650ICLK system constant: external clock frequency of CC650

SY_AGR System constant AGR present

SY_ASG automatic standard transmission

SY_ASR system constant ASR present

SY_AWUE injection valve cutoff possible by function AWUE

SY_BDE system constant GDI

SY_BGVZS

SY_BKV system constant: brake booster

SY_BLOOP sys. con. resetting of irreversible EGAS fault possible during clearing of FCM

SY_CANAC systemconstant: AC-compressor signal from CAN

SY_CDCSIZE System constant: Number of values CDC to each fault path

SY_CDKSIZE System constant: Number of values CDK to each fault path

SY_CDTSIZE System constant: Number of values CDT to each fault path

SY_CLASIZE System constant: Number of values CLA to each fault path

SY_CONFSL System constant: secondary air present vorhanden

SY_COPOTI System constant CO-Poti present

SY_CVT system constant: CVT transmission exists

SY_DEGFE system constant diagnosis input values load monitoring

SY_DFPMENV system constant: environmental conditions in fault code memory

SY_DGANZ system constant number rotational-speed sensor

SY_DLDP SY_DLDP = 1 there ist a DLDP in system

SY_DLS system constant digital idle speed control

SY_DLSHV Sys. constant condition %DLSHV (sensor exchange behind KAT) existent

SY_DOPZW System constant doubled ignition output included

SY_DTES system constant diagnosis evap system

SY_DVEADA system constant BGVE: disabling injection and ignition during DV-E-adaptation

SY_EGAS System constant E-GAS present

SY_EGFE system constant input variable for charge detection

SY_FANT system constant increase of the fuel cut-off speed at tester intervention

SY_FFESIZE system constant: Size of Freeze Frame-extension

SY_FFTSIZE System constant: Number of values FFT to each fault path

SY_FFZ system constant interval ignition

SY_FREQ_CP system constant cpu frequency

SY_FWFGR

SY_GAP system constant: number of missing teeth in the gap

SY_GGGTS system constant: sensor variable exact temperature signal

SY_GRDWRT System constant basic value, space between SW reference mark to OT in ° KW

SY_GRDWRTB system constant basic value 2.ECU, space between SW reference mark to OT in °KW

SY_GRNDWRT system constant basis angle ref. tr-mark

SY_INI_OBD system constant to select the communication protocols for scan tool operation

SY_KL50 System constant: information available in the ECU if starter is cranking

SY_KLDF system constant for generator DF-signale

SY_KOBIDIR AC- with bidirect. connection

SY_KOEVAB coordination injection valve cutoff by function KOEVAB

SY_KOPWM PWM-compressor-signal enabled

SY_KR_INT system constant: CC650 present

SY_KS1 system constant: input of the CC195 onto which knock sensor 1 is connected

SY_KS2 system constant: input of the CC195 onto which knock sensor 2 is connected

SY_KS3 system constant: input of the CC195 onto which knock sensor 3 is connected

SY_KS4 system constant: input of the CC195 onto which knock sensor 4 is connected

SY_KSDIFF system constant: connection type of knock sensor(s)

SY_LFS System constant Fan Control configuration

SY_LWS system constant steering angle via CAN

SY_ME7 system constant ECU

SY_NACH System constant ignition output after KL15 off included

SY_NWS system constant camshaft control: none, 2 point, continous

SY_NWSA system constant camshaft control outlet

SY_NWVAR system constant for camshaft configuration

SY_NZUEB system constant engine speed threshold for switching between ignition modes 1+2

SY_PBRPW system constant plausibility check brake/PWG

SY_PGRAD system constant: kind of the phase signal

SY_PGRAD2 system constant: kind of the 2. phase signal

SY_PGRAD3 system constant: kind of the 3. phase signal

SY_PH2OFST system const. offset in syncros between the 2 active phase signals,2 PGs only

SY_PHTWIN system constant 1/2 phase sensing system (sensor, wheel)

SY_RDE detection of reverse rotation of the engine in project included

SY_REDMX system constant: max. cylinder cutoff step

SY_RLAPP rlsol control during application possible

SY_SGANZ system constant number engine control unit

SY_SLS system constant for engines with secondary air pump

SY_STADAP system constant start adaptation

SY_STERHK system parameter condition stereo downstream catalyst

SY_STERSY System constant Condition stereo Lambda control symmetrical

SY_STERVK system constant condition: stereo exhaust system upstream of cat

SY_SU system constant: version of intake runner length adjuster

SY_SWE_B system constant for rough road detection using PWM signal from ABS

SY_SWE_C system constant for rough road detection using CAN

SY_SWE_S system constant for rough road detection using engine roughness statistics

SY_TEETH system constant: number of teeth at the crankshaft wheel (gapteeth included)

SY_TFA configuration for installtion position for intake-air sensor

SY_TFBA system constant service device intervention accel. enrichment

SY_TFNS system constant service device intervention afterstart factor

SY_TFST system constant service device intervention start factor

SY_TFVA system constant service device intervention decel. enleanment

SY_TFWL system constant service device intervention warm-up factor

SY_TSFSIZE System constant: Number of values TSF to each fault path

SY_TURBO system constant for exhaust-gas turbocharger

SY_TWDKS system constant: input of desired angle DVE via tester is possible

SY_TZW System constant tester manipulation of zwist included

SY_UBR system constant: Voltage behind main relay ubr exists

SY_VS system constant valve stroke control: no, 2 position

SY_WMAX System constant earliest ignition timing that can be outputed

SY_WMIN System constant latest ignition timing that can be outputed

SY_ZAS system constant cylinder deactivation ZAS included

SY_ZNDAUS System constant ignition timing output (single or double fir.), 1: single,2: d.

SY_ZYLZA system constant number of cylinders

SY_ZZBANK system constant assignment of cyl. to bank1/bank2, 0 bank1, 1 b.2, binary value

SY_ZZBANKB system const. ass. of cyl. to exhaust bank1/2 for slave1/SGB; 0 b1, 1 b2 bynary

SY_ZZBANKC system const. ass. of cyl. to exhaust bank1/2 for slave2/SGC; 0 b1, 1 b2 bynary

SZANSSM1 switching level 1 of afterstart enrichment

SZANSSM2 switching level 2 of afterstart enrichment

TADTEAMX characteristic line for max. duty cycle = F(integral purge flow after TE-Stop)

TANDT threshold difference intake air temperature for hot start

TANDT1 delta threshold intake air temperature for hot start

TANSELI intake air temperature calculation, inverse function

TAPVLTM threshold soak time for EKP-lead time

TATEMSN characteristic line of the PCV duty-cycle depending on the desired mass-flow

TDLAMBTSTA delay time to enable nominal Lambda component protection

TDMFWEMI filter-time constant at hard fuel cut-in

TFWDKPN time constant for filtering DK angle before comp. with subs. value from charging

THSHKTK Line for switch off time of lambda sensor heating post cat dep. on temp

THSHKTK2 ine for switch off time of lambda sensor heating 2 post cat dep. on temp

THSVKTA Line of switching off time for lambda sensor heating depending on exh.gas temp

THSVKTA2 Line of switching off time for lambda sensor heating depending on exh.gas temp 2

TKOAMNN minimum shutdown time for air-conditioning compressor

TKOAMXN maximum shutdown time for air-conditioning compressor

TKOBEMNN Minimum switch-on time for compres. after triggering by B_kobped or B_kobwped

TKODPAMNN Minimum cut-out time of the air-conditioner compressors during acceleration (dwp

TKODPAMXN Maximum cut-out time for compressor cut-out by dwped

TKOEMNN minimal time of air-condition compressor beeing swiched on

TKOWPAMNN Minimum cut-out time at full load (by wped)

TKOWPAMXN Maximum cut-out time at full load (by wped)

TLRBAM blocking time for activation LC after BA

TLRTMS lock time for CL lambda control after start, depending on engine start temperatu

TLRVAM blocking time for activation LC after VA

TLRZWTMS Time until hard LC switch on after start (CARB)

TMDMMAT Default temperature dependent on parking time during TDTMMA

TMLFAROF Engine coolant temperature below which After run is termined

TMLRTMS engine temp. threshold for lambda control depending on cranking temp. tmst

TMOTELI engine temperature calculation, inverse function

TN2FGRGA double denominator time constant for cruise control

TNLSGM Delay time for ECU shut-off

TSBBVTMS time delay control readiness after sensor readiness

TSPERN lock time for p-offset after lambda sensor voltage jump

TSPERN2 lock time for p-offset after lambda sensor voltage jump, bank 2

TSWKNBGA time to set value correction after acceleration finished

TSWKNVGA time to set value correction after deceleration finished

TTEVUB Battery-voltage depending delay time of canister purge valve

TVFSAM Delay time after DRIVE-position switch off

TVFSEM delay time after DRIVE-position switch on

TVKTDTK temperature dependant delay time for catalyst monitoring

TVKUPHS delay time for clutch switch during shifting in higher gear

TVKUPRS delay time for clutch switch during shifting in lower gear

TVLADV Integrator time constant at vlast-calculation

TVLLRI delay time to enable I-component after start-up

TVLLRPD Maximal delay time to enable PD components after start-up

TVNWSTTM delay time : enable of camshaft control after start, depending on engine temp

TVSATEM delay time for closing of the PCV after readyness for fuel cut off

TVSATM delay time after cranking for fuel cut off

TVSLR Duration of LRS downtime commanded via valve stroke control

TVSUM delay time for intake manifold switch over in dependence of engine temperatur

TVUB voltage correction

TWDKSNST time constant for filtering of reference throttle blade position

TWDKSV time constant for filtering of reference throttle blade position

TWLRTMS waiting time up to check engine temp. signal exceeding threshold for closed loop

TWSTT threshold soak time for re-start

TZ2FGRGA double numerator time constant for cruise control

UDKSNO upper reference voltage threshold for diagnosis knock sensors

UDKSNU lower reference voltage threshold for diagnosis knock sensors

UEVERG Gear ratio depending of the gear

URL2SUNM conversion factor from ps->rl dependent on nmot_w for active SU (2nd flap)

URL3SUNM conversion factor from ps->rl dependent on nmot_w for active SU (1st + 2nd flap)

URLNM conversion factor from ps->rl dependent on nmot_w

URLSUNM conversion factor from ps->rl dependent on nmot_w for active SU (1st flap)

VLMXVZ Max. value for vlast_w

WDKARN threshold throttle angle for activation of the mixture adaptation

WDKHKDN High threshold throttle plate for altitude adaptation

WDKHKN Low threshold throttle plate for altitude adaptation

WDKPMXN maximum throttle angle for plausibility check with charge signal

WDKSNLN desired throttle angle at kl15 off

WDKUGDN throttle angle necessary for 95 % of the maximum possible air charge

WEAN angle injection break off

WEEM correction of prestorage angle

WEEMRFAN end of injection angle at max relative driver request

WEESTATI Offset for injection end angle towards early

WEESTM correction of pretiming of injection during start

WEESTN end of injection angle during start

WFRL fuel wall hang.up

WKRLZOF Bloc of fixed values: ignition reatard offset for guided cylinder

WPEDKO Accelerator position treshold for the A/C cut off

WPFGRBMR Back-calculated pedal value during acceleration with FGR

WPHN phase correction

WPUAVLN Throttle valve angle as of which VL ambient pressure adaptation is active

WPUAVLSN Throttle valve angle as of which VL ambient pressure adaptation is blocked

ZATMAML time constant for exhaust gas temperature model

ZATMAML2 time constant for exhaust gas temperature model bank2

ZATMIKML time constant for modelled temperature in catayst tikatm

ZATMIKML2 time constant for modelled temperature in catayst bank 2

ZATMKML time constant for catalyst temperature model tkatm

ZATMKML2 time constant for catalyst temperature model bank2

ZATMRML time constant for exhaust model temperature - pipe temperature

ZATMRML2 time constant for exhaust model temperature - pipe temperature bank2

ZBALM reduction factor L-memory (tmot) for accel. enrichment

ZBTEML integration speed for canister charge adaptation

ZDBTMN time constant combustion chamber temperatur model for negativ gradient

ZDBTMP time constant combustion chamber temperatur model for positiv gradient

ZKFRAOA time constant for frao-integrator, f(number of starts with fuel in oil)

ZKFRAUA time constant for frau-integrator, f(number of starts with

ZKMSDKT integrator speed for fast constant mass-flow adaption

ZKPVDKT integrator speed for slow constant mass-flow adaption

ZKRKATA integration speed integrator rkat, f(abo)

ZKRKAZA integration speed integrator rkaz, f(abo)

ZKTABTU time constant for engine cooling

ZLASOHML time constant for PT1-filter of the pseude lambda behind catalyst

ZLASOHML2 Time constant for PT1-filter of pseudo lambda post cat, bank 2

ZLRHML time constant of lambda control integrator downstream catalyst

ZLRHML2 time constant of lambda control integrator downstream catalyst bank 2

ZMDNSM time constant for decay of torque offset after cranking

ZPVDKR time constant for filtering of pvdkr

ZVALM reduction factor L-memory (tmot) for decel. enleanment

ZZWEETM Switchover threshold pattern angle

Cross reference list

Symbol	Type	Created within	Used within
A0	FW	ARMD (531)	
A1	FW	ARMD (531)	
A2	FW	ARMD (531)	
ABAOVMX	FW	ESUKA (711)	
ABGMSIGH	FW	DLSH (330)	
ABGMSIGV	FW	DLSV (301)	
ABOLRAR	FW	BBBO (853)	
ABOMX	FW	BBBO (853)	
ADCC_T_UM	FW	URADCC (1049)	
ADKATNF	FW	DKAT (361)	
AFNTOL	FW	DMDMIL (216)	
AGRPMN	FW	BGAGR (263)	
AGRPMX	FW	BGAGR (263)	
AHEAGW	FW	DMDMIL (216)	
AHEAGWS	FW	DMDMIL (216)	
AHEARV	FW	DMDMIL (216)	
AHEKA	FW	DMDMIL (216)	
AHEKS	FW	DMDMIL (216)	
AHEKS1	FW	DMDMIL (216)	
AHKATMN	FW	DKAT (361)	
AHKATMX	FW	DKAT (361)	
AHKATS	FW	DKAT (361)	
AHKATSB	FW	DKAT (361)	
AHKTMXT	FW	DKAT (361)	
AHKTTSW	FW	DKAT (361)	
AIMVM	FW	GGVFZG (497)	
AINTKAN	KL	DMDMIL (216)	
ALFO	FW	DMDFON (161)	
AMNUUKA	FW	ESUKA (711)	
ANALUN	KL	DMDLU (193)	
ANRZUEMX	FW	STADAP (684)	
ANWFOHE	FW	DMDFON (161)	
ANWFOST	FW	DMDFON (161)	
ANZDPVK	FW	DLSA (398)	
ANZDYNSH	FW	DLSAHK (339)	
ANZEAUS	FW	NLPH (150)	
ANZERDYH	FW	DLSAHK (339)	
ANZERSCH	FW	DLSAHK (339)	
ANZERTV	FW	DLSA (398)	
ANZGEM	FW	DLSV (301)	
ANZRIBEH	FW	GGLSH (318)	
ANZRIBEV	FW	GGLSV (382)	
ANZTP	FW	DLSA (398)	
ANZTPMX	FW	FGRFULO (1160)	
APDTEFRE	FW	DTEV (856)	
APDTEVX	FW	DTEV (856)	
APEKTDX	FW	DKAT (361)	
ASPUUKA	FW	ESUKA (711)	
ATMABKA	KL	ATM (20)	
ATMABKK	KL	ATM (20)	
ATMTANS	KL	ATM (20)	
ATVFETTO	FW	DLSSA (350)	
ATVFETTU	FW	DLSSA (350)	
ATVINI	FW	LRHK (781)	
ATVINI2	FW	LRHK (781)	
ATVMAGO	FW	DLSSA (350)	
ATVMAGU	FW	DLSSA (350)	
ATVMN	FW	LRHK (781)	
ATVMX	FW	LRHK (781)	
AUSGH_T_UM	FW	URMEM (1044)	
AUSG_T_UM	FW	URMEM (1044)	
AUSZH_T_UM	FW	URMEM (1044)	
AUSZ_T_UM	FW	URMEM (1044)	
AVAOVMX	FW	ESUKA (711)	
AVDTEVX	FW	DTEV (856)	
AVKATFS	FW	DKAT (361)	
AVRALU	FW	DMDSTP (205)	
AZKELDYN	KL		KRDY (659)
AZKRLDYN	KL		KRDY (659)
AZKRNDYN	KL		KRDY (659)
AZYTIAB	FW	DMDMIL (216)	
B1	FW	ARMD (531)	
B2	FW	ARMD (531)	
BFGRO	FW	FGRABED (491)	
BFGRU	FW	FGRABED (491)	
BMFA	FW	DDG (141)	
BMFMX	FW	DDG (141)	
BOLATZ	FW	CAN (1124)	
BRABEVI	KL	FGRFULO (1160)	
BRATD	FW	FGRFULO (1160)	
BRATU	FW	FGRFULO (1160)	

Symbol	Type	Created within	Used within
BREMS_T_UM	FW	UFFGRE (1096)	
BTRKHTMS	KL	BBKHZ (890)	
BZ_MSR_M	FW	UFMSRC (1080)	
CANINDLY	FW	CAN (1124)	
CBGRLP	FW	BGRLP (266)	
CBUSOFF	FW	CAN (1124)	
CDADLCK	FW	STADAP (684)	
CDAGR	FW	PROKON (53)	
CDAGRL	FW	PROKON (53)	
CDATR	FW	PROKON (53)	
CDATS	FW	PROKON (53)	
CDCCAS	KL	DCAS (1128)	
CDCCINS	KL	DCINS (1126)	
CDCCKUP	KL	DCKUP (1128)	
CDCEV1	KL	DEVE (1017)	
CDCEV2	KL	DEVE (1017)	
CDCEV3	KL	DEVE (1017)	
CDCEV4	KL	DEVE (1017)	
CDCEV5	KL	DEVE (1017)	
CDCEV6	KL	DEVE (1017)	
CDCEV7	KL	DEVE (1017)	
CDCEV8	KL	DEVE (1017)	
CDCFRAO	KL	DKVS (811)	
CDCFRAO2	KL	DKVS (811)	
CDCFRAU	KL	DKVS (811)	
CDCFRAU2	KL	DKVS (811)	
CDCFRST	KL	DKVS (811)	
CDCFRST2	KL	DKVS (811)	
CDCHSH	KL	DHLSHK (1154)	
CDCHSH2	KL	DHLSHK (1154)	
CDCHSV	KL	DHLSVK (29)	
CDCHSV2	KL	DHLSVK (29)	
CDCHSVE	KL	DHLSVKE (902)	
CDCHSVE2	KL	DHLSVKE (902)	
CDCKAT	KL	DKAT (361)	
CDCKAT2	KL	DKAT (361)	
CDCKPE	KL	DEKPE (1020)	
CDCKRNT	KL	DKRNT (445)	
CDCKROF	KL	DKRNT (445)	
CDCKRTP	KL	DKRTP (451)	
CDCKS1	KL	DKRS (437)	
CDCKS2	KL	DKRS (437)	
CDCKS3	KL	DKRS (437)	
CDCKS4	KL	DKRS (437)	
CDCLASH	KL	DLSAHK (339)	
CDCLASH2	KL	DLSAHK (339)	
CDCLATP	KL	DLSA (398)	
CDCLATP2	KL	DLSA (398)	
CDCLATV	KL	DLSA (398)	
CDCLATV2	KL	DLSA (398)	
CDCLSH	KL	DLSH (330)	
CDCLSH2	KL	DLSH (330)	
CDCLUEA	KL	DMLSE (34)	
CDCLUEB	KL	DMLSE (34)	
CDCMD	KL	DMDMIL (216)	
CDCMD00	KL	DMDMIL (216)	
CDCMD01	KL	DMDMIL (216)	
CDCMD02	KL	DMDMIL (216)	
CDCMD03	KL	DMDMIL (216)	
CDCMD04	KL	DMDMIL (216)	
CDCMD05	KL	DMDMIL (216)	
CDCMD06	KL	DMDMIL (216)	
CDCMD07	KL	DMDMIL (216)	
CDCMD08	KL	DMDMIL (216)	
CDCMD09	KL	DMDMIL (216)	
CDCMD10	KL	DMDMIL (216)	
CDCMD11	KL	DMDMIL (216)	
CDCMDB	KL	MDKOG (516)	
CDCMILE	KL	DMILE (36)	
CDCNWKW	KL	DNWKW (134)	
CDCNWKW2	KL	DNWKW (134)	
CDCNWS	KL	DNWS (622)	
CDCNWS2	KL	DNWS (622)	
CDCPH	KL	DPH (144)	
CDCPH2	KL	DPH (144)	
CDCRKAT	KL	DKVS (811)	
CDCRKAT2	KL	DKVS (811)	
CDCRKAZ	KL	DKVS (811)	
CDCRKAZ2	KL	DKVS (811)	
CDCTA	KL	GGTFA (298)	
CDCTES	KL	DTEV (856)	
CDCTEVE	KL	DTEVE (1022)	

Symbol	Type	Created within	Used within
CDCTM	KL	GGTFM (289)	
CDCUB	KL	GGUB (487)	
CDCUF2SG	KL	DUF (1089)	
CDCUFMV	KL	DUF (1089)	
CDCUFSKA	KL	DUF (1089)	
CDCURRAM	KL	DUR (1052)	
CDCURROM	KL	DUR (1052)	
CDCURRST	KL	DUR (1052)	
CDCVKUP	KL	DVKUP (1027)	
CDDST	FW	PROKON (53)	
CDFO	FW	DMDFON (161)	
CDHSH	FW	PROKON (53)	
CDHSHE	FW	PROKON (53)	
CDHSV	FW	PROKON (53)	
CDHSVE	FW	PROKON (53)	
CDKAT	FW	PROKON (53)	
CDKATLK	FW	DKAT (361)	
CDKBREMS	FW	GGEGAS (474)	
CDKKAT	FW	DKAT (361)	
CDKKAT2	FW	DKAT (361)	
CDKKS1	FW	DKRS (437)	
CDKKS2	FW	DKRS (437)	
CDKKS3	FW	DKRS (437)	
CDKKS4	FW	DKRS (437)	
CDKLSV2	FW	DLSV (301)	
CDKMDB	FW	MDKOG (516)	
CDKTES	FW	DTEV (856)	
CDKUF2SG	FW	DUF (1089)	
CDKUFMV	FW	DUF (1089)	
CDKUFSKA	FW	DUF (1089)	
CDKURRAM	FW	DUR (1052)	
CDKURROM	FW	DUR (1052)	
CDKURRST	FW	DUR (1052)	
CDKVS	FW	PROKON (53)	
CDLASH	FW	DLSAHK (339), PROKON (53)	
CDLATP	FW	DLSA (398), PROKON (53)	
CDLATV	FW	DLSA (398), PROKON (53)	
CDLDP	FW	PROKON (53)	
CDLFRAO	KL	DKVS (811)	
CDLFRAO2	KL	DKVS (811)	
CDLFRAU	KL	DKVS (811)	
CDLFRAU2	KL	DKVS (811)	
CDLFRST	KL	DKVS (811)	
CDLFRST2	KL	DKVS (811)	
CDLLR	FW	PROKON (53)	
CDLRKAT	KL	DKVS (811)	
CDLRKAT2	KL	DKVS (811)	
CDLRKAZ	KL	DKVS (811)	
CDLRKAZ2	KL	DKVS (811)	
CDLSA	FW	PROKON (53)	
CDLSH	FW	PROKON (53)	
CDLSV	FW	PROKON (53)	
CDMD	FW	DMDUE (158), PROKON (53)	
CDNWS	FW	PROKON (53)	
CDSLS	FW	PROKON (53)	
CDSLSE	FW	PROKON (53)	
CDSWE	FW	PROKON (53)	
CDTANKL	FW	PROKON (53)	
CDTBREMS	FW	GGEGAS (474)	
CDTCAS	FW	DCAS (1128)	
CDTCINS	FW	DCINS (1126)	
CDTCKUP	FW	DCKUP (1128)	
CDTES	FW	PROKON (53)	
CDTEV1	FW	DEVE (1017)	
CDTEV2	FW	DEVE (1017)	
CDTEV3	FW	DEVE (1017)	
CDTEV4	FW	DEVE (1017)	
CDTEV5	FW	DEVE (1017)	
CDTEV6	FW	DEVE (1017)	
CDTEV7	FW	DEVE (1017)	
CDTEV8	FW	DEVE (1017)	
CDTHSH	FW	DHLSHK (1154)	
CDTHSH2	FW	DHLSHK (1154)	
CDTHSV	FW	DHLSVK (29)	
CDTHSV2	FW	DHLSVK (29)	
CDTHSVE	FW	DHLSVKE (902)	
CDTHSVE2	FW	DHLSVKE (902)	
CDTKAT	FW	DKAT (361)	
CDTKAT2	FW	DKAT (361)	
CDTKPE	FW	DEKPE (1020)	
CDTKRNT	FW	DKRNT (445)	
CDTKROF	FW	DKRNT (445)	

Symbol	Type	Created within	Used within
CDTKRTP	FW	DKRTP (451)	
CDTKS1	FW	DKRS (437)	
CDTKS2	FW	DKRS (437)	
CDTKS3	FW	DKRS (437)	
CDTKS4	FW	DKRS (437)	
CDTLASH	FW	DLSAHK (339)	
CDTLASH2	FW	DLSAHK (339)	
CDTLATP	FW	DLSA (398)	
CDTLATP2	FW	DLSA (398)	
CDTLATV	FW	DLSA (398)	
CDTLATV2	FW	DLSA (398)	
CDTLSH	FW	DLSH (330)	
CDTLSH2	FW	DLSH (330)	
CDTLSV2	FW	DLSV (301)	
CDTLUEA	FW	DMLSE (34)	
CDTLUEB	FW	DMLSE (34)	
CDTMD	FW	DMDMIL (216)	
CDTMD00	FW	DMDMIL (216)	
CDTMD01	FW	DMDMIL (216)	
CDTMD02	FW	DMDMIL (216)	
CDTMD03	FW	DMDMIL (216)	
CDTMD04	FW	DMDMIL (216)	
CDTMD05	FW	DMDMIL (216)	
CDTMD06	FW	DMDMIL (216)	
CDTMD07	FW	DMDMIL (216)	
CDTMD08	FW	DMDMIL (216)	
CDTMD09	FW	DMDMIL (216)	
CDTMD10	FW	DMDMIL (216)	
CDTMD11	FW	DMDMIL (216)	
CDTMDB	FW	MDKOG (516)	
CDTMILE	FW	DMILE (36)	
CDTNWKW	FW	DNWKW (134)	
CDTNWKW2	FW	DNWKW (134)	
CDTNWS	FW	DNWS (622)	
CDTNWS2	FW	DNWS (622)	
CDTPH	FW	DPH (144)	
CDTPH2	FW	DPH (144)	
CDTTA	FW	GGTFA (298)	
CDTTES	FW	DTEV (856)	
CDTTEVE	FW	DTEVE (1022)	
CDTTM	FW	GGTFM (289)	
CDTUB	FW	GGUB (487)	
CDTUF2SG	FW	DUF (1089)	
CDTUFMV	FW	DUF (1089)	
CDTUFSKA	FW	DUF (1089)	
CDTURRAM	FW	DUR (1052)	
CDTURROM	FW	DUR (1052)	
CDTURRST	FW	DUR (1052)	
CDTVKUP	FW	DVKUP (1027)	
CDWGANG	FW	KOS (896)	
CDWGANGB	FW	KOS (896)	
CDWKOB	FW	KOS (896)	
CDWVERAD	FW	MDVERAD (549)	
CFRA	FW	LR (768)	
CIDATV	FW	DLSA (398)	
CIDATV2	FW	DLSA (398)	
CIDLSCH	FW	DLSAHK (339)	
CIDLSCH2	FW	DLSAHK (339)	
CIDLSDY	FW	DLSAHK (339)	
CIDLSDY2	FW	DLSAHK (339)	
CIDSHKF	FW	DLSAHK (339)	
CIDSHKF2	FW	DLSAHK (339)	
CIDSHKM	FW	DLSAHK (339)	
CIDSHKM2	FW	DLSAHK (339)	
CIDTP	FW	DLSA (398)	
CIDTP2	FW	DLSA (398)	
CLABREMS	FW	GGEGAS (474)	
CLACAS	FW	DCAS (1128)	
CLACINS	FW	DCINS (1126)	
CLACKUP	FW	DCKUP (1128)	
CLAEV1	FW	DEVE (1017)	
CLAEV2	FW	DEVE (1017)	
CLAEV3	FW	DEVE (1017)	
CLAEV4	FW	DEVE (1017)	
CLAEV5	FW	DEVE (1017)	
CLAEV6	FW	DEVE (1017)	
CLAEV7	FW	DEVE (1017)	
CLAEV8	FW	DEVE (1017)	
CLAHSH	FW	DHLSHK (1154)	
CLAHSH2	FW	DHLSHK (1154)	
CLAHSV	FW	DHLSVK (29)	
CLAHSV2	FW	DHLSVK (29)	

Symbol	Type	Created within	Used within
CLAHSVE	FW	DHLSVKE (902)	
CLAHSVE2	FW	DHLSVKE (902)	
CLAKAT	FW	DKAT (361)	
CLAKAT2	FW	DKAT (361)	
CLAKPE	FW	DEKPE (1020)	
CLAKRNT	FW	DKRNT (445)	
CLAKROF	FW	DKRNT (445)	
CLAKRTP	FW	DKRTP (451)	
CLAKS1	FW	DKRS (437)	
CLAKS2	FW	DKRS (437)	
CLAKS3	FW	DKRS (437)	
CLAKS4	FW	DKRS (437)	
CLALASH	FW	DLSAHK (339)	
CLALASH2	FW	DLSAHK (339)	
CLALATP	FW	DLSA (398)	
CLALATP2	FW	DLSA (398)	
CLALATV	FW	DLSA (398)	
CLALATV2	FW	DLSA (398)	
CLALSH	FW	DLSH (330)	
CLALSH2	FW	DLSH (330)	
CLALSV2	FW	DLSV (301)	
CLAMDB	FW	MDKOG (516)	
CLAMILE	FW	DMILE (36)	
CLANWKW	FW	DNWKW (134)	
CLANWKW2	FW	DNWKW (134)	
CLANWS	FW	DNWS (622)	
CLANWS2	FW	DNWS (622)	
CLAPH	FW	DPH (144)	
CLAPH2	FW	DPH (144)	
CLATA	FW	GGTFA (298)	
CLATES	FW	DTEV (856)	
CLATEVE	FW	DTEVE (1022)	
CLATM	FW	GGTFM (289)	
CLAUB	FW	GGUB (487)	
CLAUF2SG	FW	DUF (1089)	
CLAUFMV	FW	DUF (1089)	
CLAUFSKA	FW	DUF (1089)	
CLAURRAM	FW	DUR (1052)	
CLAURROM	FW	DUR (1052)	
CLAURRST	FW	DUR (1052)	
CLAVKUP	FW	DVKUP (1027)	
CLRHK	FW	LRHK (781)	
CLRHKA	FW	LRHK (781)	
CLRKA	FW	LRKA (795)	
CLRMSFS	FW	LREB (739)	
CLRVS	FW	LREB (739)	
CLRZWTMS	FW	LREB (739)	
CMUTE	FW	CAN (1124)	
CNFKUPPL	FW	LLRBB (575)	
CNFLLR2SG	FW	DLLR (578)	
CNFLLRNS	FW	LLRNS (562)	
CNFMDVER	FW	MDVER (546)	
CNFSL	FW	MDVERB (540)	
CNMDV2SG	FW	MDVERB (540)	
CPLRA	FW	DKVS (811)	
CREDSTU	FW	MDRED (976)	
CSCATT	FW	PROKON (53)	
CSU	FW	SU (617)	
CUKA	FW	ESUKA (711)	
CWALE	FW	ALE (136)	
CWARMD	FW	ARMD (531)	
CWBGSRM	FW	BGSRM (245)	
CWBGWPFGR	FW	BGWPFGR (548)	
CWBWEEN	FW	GGPED (454)	
CWCAN	FW	CAN (1124)	
CWDEGFE	FW	DEGFE (592)	
CWDHFM	FW	DHFM (233)	
CWDKRNT	FW	DKRNT (445)	
CWDKROF	FW	DKRNT (445)	
CWDKRTP	FW	DKRTP (451)	GGKS (412)
CWDKS1	FW	DKRS (437)	
CWDKS2	FW	DKRS (437)	
CWDKS3	FW	DKRS (437)	
CWDKS4	FW	DKRS (437)	
CWDLSA	FW	DLSA (398)	
CWDLSAHK	FW	DLSAHK (339)	
CWDMDE	FW	DMDMIL (216)	
CWDMFAB	FW	MDFAW (508)	
CWDSS	FW	BGPU (276)	
CWDTEAPP	FW	DTEV (856)	
CWDVEFO	FW	BGDVE (934)	
CWDVMX	FW	VMAXMD (588)	

Symbol	Type	Created within	Used within
CWERFIL	FW	PROKON (53), TCSORT (1122)	
CWESWEZ	FW	ACIFI (1013)	
CWEVAB	FW	AEVAB (980)	
CWFGRABED	FW	FGRABED (491)	
CWFGRFULO	FW	FGRFULO (1160)	
CWFGRGA	FW	FGRABED (491)	
CWFGRREGL	FW	FGRREGL (1174)	
CWFKMSDKA	FW	BGMSZS (239)	
CWFUEDK	FW	FUEDK (597)	
CWFUEREG	FW	FUEREG (595)	
CWGGEGAS	FW	GGEGAS (474)	
CWGGFST	FW	GGFST (502)	
CWGGLSH	FW	GGLSH (318)	
CWGGLSV	FW	GGLSV (382)	
CWGGVFZG	FW	GGVFZG (497)	
CWKATUM	FW	DKAT (361)	
CWKHMD	FW	KHMD (894)	
CWKHZ	FW	BBKHZ (890)	
CWKHZW	FW	ZWMIN (669)	
CWKLIMA	FW	PROKON (53)	
CWKMMILSCT	FW	TC1MOD (1100)	
CWKOGANG	FW	KOS (896)	
CWKONABG	FW	PROKON (53)	
CWKONFZ1	FW	PROKON (53)	
CWKONLS	FW	PROKON (53)	
CWKR	FW	KRDY (659)	
CWKRAPP	FW	GGKS (412)	
CWKRNLR	FW	KRRA (639)	
CWKRREF	FW	KRKE (427)	
CWKUPPL	FW	LLRMR (572)	
CWLFD	FW	LFS (69)	
CWLLRPA	FW	LLRRM (566)	
CWLRSYNC	FW	LR (768)	
CWLSHA	FW	DLSAHK (339)	
CWMDAPP	FW	NWS (618), PROKON (53)	
CWMDKOG	FW		MDKOG (516)
CWMDKOL	FW	MDKOL (526)	
CWMDRLKO	FW	MDVERB (540)	
CWNLPH	FW	NLPH (150)	
CWNOMIL	FW	DMIL (1150)	
CWNSTAT	FW	LLRNS (562)	
CWNWGE	FW	NWS (618)	
CWNWLL	FW	NWS (618)	
CWNWREF	FW	GGDPG (74)	
CWNWS	FW	NWS (618)	
CWOBD	FW	PROKON (53), TC1MOD (1100)	
CWPKAPP	FW	AES (973)	
CWPUA	FW	BGPU (276)	
CWREFI	FW	KRKE (427)	
CWRLAPPL	FW	MDFUE (594)	FUEDK (597)
CWSAWE	FW	BBSAWE (557)	
CWSCTMDE	FW	SCATT (1097)	
CWSTPCNF	FW	DMDSTP (205)	
CWTEMPK	FW	BGTEMPK (252)	
CWTEZW	FW		MDKOG (516)
CWTF	FW	PROKON (53)	
CWTIPIN	FW	KRDY (659)	
CWTUM	FW	MDVERB (540)	
CWUHR	FW	PROKON (53)	
CWVSV	FW	VS_VERST (67)	
CWVWKNWS	FW	ESVW (1009)	
CWWDKSPE	FW	FUEDKSA (610)	
CWWL	FW		ESSTT (679), GK (675)
CWZWVMX	FW		MDKOG (516)
CW_AZUE	FW	AZUE (904)	
CW_FUBND	FW	ZUESZ (632)	
DANTGESWNV	FW	ADVE (918)	
DANTGESWV	FW	ADVE (918)	
DANTSCHWNV	FW	ADVE (918)	
DANTSCHWV	FW	ADVE (918)	
DASA	FW	DLLR (578)	
DBZ_MN_UM	FW	UFMSRC (1080)	
DBZ_MX_UM	FW	UFMSRC (1080)	
DDFDTEAB	FW	DTEV (856)	
DECKSTAI	KL	STADAP (684)	
DEVTMAGR	KL	BGTEMPK (252)	
DFAFRG	FW	FUEREG (595)	
DFKMSMN	FW	BGMSZS (239)	
DFKMSMX	FW	BGMSZS (239)	
DFKPVMN	FW	BGMSZS (239)	
DFKPVMX	FW	BGMSZS (239)	
DFPSLBIT	KWB	D2CTR (496)	

Symbol	Type	Created within	Used within
DFRBAF	FW	ESUKA (711)	
DFRBAM	FW	ESUKA (711)	
DFRMDTEE	FW	DTEV (856)	
DFRMDTEF	FW	DTEV (856)	
DFRMDTEM	FW	DTEV (856)	
DFRMN	FW	LR (768)	
DFRMST	FW	DKVS (811)	
DFRSPS	FW	LR (768)	
DFRVAF	FW	ESUKA (711)	
DFRVAM	FW	ESUKA (711)	
DFSEFO2N	KL	DMDFON (161)	
DFSEFON	KL	DMDFON (161)	
DFSERES	FW	DMDFON (161)	
DFTEAHB	FW	TEB (826)	
DFTEDS	FW	BBTEGA (750)	
DKATCW	FW	DKAT (361)	
DKLAGERT	FW	ADVE (918)	
DKNOTBEGR	KL	FUEDKSA (610)	
DKPSTGMIN	FW	BGDVE (934)	
DKROFN	KL	DKRNT (445)	
DKROKD	FW	DKRNT (445), GGKS (412)	
DKROKMX	FW	GGKS (412)	
DKROKO	FW	GGKS (412)	
DKROKU	FW	DKRNT (445)	
DLAHISATO	FW	DLSSA (350)	
DLAHISATU	FW	DLSSA (350)	
DLAMELSH	FW	DLSH (330)	
DLAMLASHF	FW	DLSAHK (339)	
DLAMLASHM	FW	DLSAHK (339)	
DLAMOB	KL	LAMFAW (728)	
DLBTS	KL	LAMBTS (732)	
DLRDWDKSS1	FW	ADVE (918)	
DLRDWDKSS2	FW	ADVE (918)	
DLRIAMAXA	FW	ADVE (918)	
DLRIKLPAR	FW	ADVE (918)	
DLRININI	FW	ADVE (918)	
DLRKDONLP0	FW	ADVE (918)	
DLRKDUNLP0	FW	ADVE (918)	
DLRKDUNLP1	FW	ADVE (918)	
DLRKDUNLP2	FW	ADVE (918)	
DLRKIONLP0	KL	ADVE (918)	
DLRKIUNLP0	KL	ADVE (918)	
DLRKIUNLP1	KL	ADVE (918)	
DLRKIUNLP2	KL	ADVE (918)	
DLRKPONLP0	FW	ADVE (918)	
DLRKPUNLP0	FW	ADVE (918)	
DLRKPUNLP1	FW	ADVE (918)	
DLRKPUNLP2	FW	ADVE (918)	
DLRKREIS	FW	ADVE (918)	
DLRKREISST	FW	ADVE (918)	
DLRNLPD	FW	ADVE (918)	
DLRPERIMN	FW	LR (768)	
DLRPERIMX	FW	LR (768)	
DLRPID0T	FW	ADVE (918)	
DLRPID1T	FW	ADVE (918)	
DLRPID2T	FW	ADVE (918)	
DLRPIDMAX	FW	ADVE (918)	
DLRPIDMIN	FW	ADVE (918)	
DLRPIDSTMN	FW	BGDVE (934)	
DLRUBSOLL	FW	ADVE (918)	
DLRUMABAND	FW	ADVE (918)	
DLRUMAIINI	FW	ADVE (918)	
DLURMIN	KL	DMDDLU (199)	
DMADFK	FW	MDVERAD (549)	
DMADFS	FW	MDVERAD (549)	
DMADKO	FW	MDVERAD (549)	
DMADLL	FW	MDVERAD (549)	
DMADMNFK	FW	MDVERAD (549)	
DMADMNFS	FW	MDVERAD (549)	
DMADMNKO	FW	MDVERAD (549)	
DMADMNLL	FW	MDVERAD (549)	
DMADMXFK	FW	MDVERAD (549)	
DMADMXFS	FW	MDVERAD (549)	
DMADMXKO	FW	MDVERAD (549)	
DMADMXLL	FW	MDVERAD (549)	
DMAUFN	KL	MDZW (636)	
DMDDLWS	KL	MDVERB (540)	
DMDGENAB	FW	MDVERB (540)	
DMDLWS	KL	MDVERB (540)	
DMDNSM	KL	MDVER (546)	
DMDPUG	KL	MDFAW (508)	
DMEBZ_MX	FW	UFMER (1060)	

Symbol	Type	Created within	Used within
DMIFLSD	FW	MDFAW (508)	
DMIGSL	FW	CAN (1124)	
DMIVW	FW	CAN (1124)	
DMLDTEFN	FW	DTEV (856)	
DMLDTEFX	FW	DTEV (856)	
DMLDTEMN	FW	DTEV (856)	
DMLDTEMX	FW	DTEV (856)	
DMLLNG	KL	LLRRM (566)	
DMLLNGV	KL	LLRRM (566)	
DMLLRLMNN	KL	LLRRM (566)	
DMLLRLMXN	KL	LLRRM (566)	
DMLLRMNN	KL	LLRRM (566)	
DMLLRMXN	KL	LLRRM (566)	
DMLSDUG	KL	MDFAW (508)	
DMRESLL	FW	LLRMR (572)	
DMRESTM	FW	LLRMR (572)	
DMRFAWE	FW	MDFAW (508)	
DMRIFW	KL	FGRREGL (1174)	
DMRKTD	FW	DKAT (361)	
DMRLASH	FW	DLSAHK (339)	
DMRLSH	FW	DLSH (330)	
DMSNTEMN	FW	DTEV (856)	
DMSNTEMX	FW	DTEV (856)	
DMSTES	KL	TEB (826)	
DMVERLMN	FW	MDVER (546)	
DMVTEVDO	FW	DTEV (856)	
DMXRDL	FW	DMDDLU (199)	
DMXRFL	FW	DMDLUA (202)	
DMXRLU	FW	DMDLU (193)	
DN10BURN	FW	ESSTT (679)	
DNABW	FW	RDE (112)	
DNBURN	KL	STADAP (684)	
DNDLLRO	FW	DLLR (578)	
DNDLLRU	FW	DLLR (578)	
DNDTEO	FW	DTEV (856)	
DNDTEU	FW	DTEV (856)	
DNFGRMX	FW	FGRABED (491)	
DNFILO	FW	ARMD (531)	
DNKH	FW	BBKHZ (890)	
DNLLR	FW	LLRBB (575)	
DNLLRES	FW	LLRMR (572)	
DNLLRIST	FW	LLRRM (566)	
DNLLST	FW	LLRRM (566)	
DNMAX	FW	NMAXMD (584)	
DNMAXDZ	FW	NMAXMD (584)	
DNMAXH	FW		NMAXMD (584)
DNMNI	FW	LLRRM (566)	
DNSAH	FW	BBSAWE (557)	
DNSAL	FW	BBSAWE (557)	
DNSATIP	FW	BBSAWE (557)	
DNSLL	FW	BBSAWE (557)	
DNSNFST	FW	LLRNS (562)	
DNSNFX	FW	LLRNS (562)	
DNTIPDYN	FW	ZWMIN (669)	
DNVSA	FW	BBSAWE (557)	
DNWEELLS	FW	BBSAWE (557)	
DNWEK	FW	BBSAWE (557)	
DPDSTI	FW	DDST (851)	
DPDSTO	FW	DDST (851)	
DPTEMN	FW	DDST (851)	
DPTEMX	FW	DDST (851)	
DPUPS	FW	FUEDK (597)	
DPUPVDK	KL	BGPU (276)	
DRISIGH	FW	DLSH (330)	
DRISIGV	FW	DLSV (301)	
DRLDYNU	FW	BGRLP (266)	
DRLKTDP	FW	DKAT (361)	
DRLKTDPT	FW	DKAT (361)	
DRLMIN	FW	BGRLP (266)	
DRLMINDP	FW	MDFAW (508)	
DRLSOLA	KL	DMDSTP (205)	
DRLSOLMF	FW	FUEDK (597)	
DRLSPMN	FW	ESUKA (711)	
DSTEMIN	FW	TEB (826)	
DSTGRAD	FW	GGDST (504)	
DSTOFFS	FW	GGDST (504)	
DTABUNPL	FW	BGTABST (1030)	
DTAHLL	FW	LLRNS (562)	
DTEPRU	FW	BGRLP (266)	
DTKATMN	FW	BBKHZ (890)	
DTKH	FW	BBKHZ (890)	
DTLRTML	KL	GGTFM (289)	

Symbol	Type	Created within	Used within
DTMDMA	FW	GGTFM (289)	
DTMDNPO	FW	GGTFM (289)	
DTMHLL	FW	LLRNS (562)	
DTMLF	FW	LFS (69)	
DTMR	FW	LREB (739)	
DTMSRT	FW	GGTFM (289)	
DTMTMRW	FW	LREB (739)	
DTMWUC	FW	DWUC (1147)	
DTUMTA	FW	BGTABST (1030)	
DTUMTAT	FW	ATM (20)	
DTVKAML	KL	LRKA (795)	
DTVKAML2	KL	LRKA (795)	
DUBLBZ	FW	BGLBZ (489)	
DUDKNLPO	FW	BGDVE (934)	
DUDKNLPU	FW	BGDVE (934)	
DUDKP1HY	FW	BGDVE (934), GGDVE (477)	
DUDKPTMP	FW	BGDVE (934)	
DUF_T	FW	DUF (1089)	
DUKK	FW	ESUK (699)	
DUPW12	FW	GGPED (454)	
DUPW12BE	FW	GGPED (454)	
DUPW12TG	FW	GGPED (454)	
DUPW12VG	FW	GGPED (454)	
DUPWGHY	FW	GGPED (454)	
DUSRIH	FW	GGLSH (318)	
DUSRIV	FW	GGLSV (382)	
DUSSPH	FW	GGLSH (318)	
DUSSPV	FW	GGLSV (382)	
DVEEST	FW	ADVE (918)	
DVFZAR	FW	ARMD (531)	
DVFZBEG	FW	GGVFZG (497)	
DVIVZMX	FW	FGRABED (491)	
DVIVZTMX	FW	FGRFULO (1160)	
DVLLVO	FW	FGRREGL (1174)	
DVLLVU	FW	FGRREGL (1174)	
DVNG	KL	LLRRM (566)	
DVNGV	KL	LLRRM (566)	
DVSA	FW	BBSAWE (557)	
DVSAVO	FW	FGRREGL (1174)	
DVSAVU	FW	FGRREGL (1174)	
DVSKNBGA	KL	FGRFULO (1160)	
DVSKNVGA	KL	FGRFULO (1160)	
DVTIPUD	FW	FGRFULO (1160)	
DVZVIMX	FW	FGRABED (491)	
DVZVITMX	FW	FGRFULO (1160)	
DVZVIWA	FW	FGRFULO (1160)	
DWDK12O	FW	GGDVE (477)	
DWDK13O	FW	GGDVE (477)	
DWDK23O	FW	GGDVE (477)	
DWDKSIKLS	FW	ADVE (918)	
DWEEMX	FW	ESVW (1009)	
DWKRMSN	KL	KRRA (639)	
DWNWEMXT	FW	NWS (618)	
DWPEDKOB	FW	KOS (896)	
DWPMXNB	FW	GGPED (454)	
DWPMXNOT	FW	GGPED (454)	
DWPR	FW	BGRLP (266)	
DWPRNSP	FW	BGRLP (266)	
DYADMX	FW	KRDY (659)	
DYADS	FW	KRDY (659)	
DYAFVS	FW	KRDY (659)	
DYAMNV	FW	KRDY (659)	
DYAVF	FW	KRDY (659)	
DYNLSUTO	FW	DLSSA (350)	
DYNLSUTU	FW	DLSSA (350)	
DYNMXNL	FW	NLDG (157)	
DZWAML	KL	ZWMIN (669)	
DZWDYN	KL	ZWMIN (669)	
DZWETA	KL	MDZW (636)	
DZWMNSTN	KL	ZWMIN (669)	
DZWNWSUE	KL	MDBAS (529), ZWGRU (634)	
DZWOAGR	KL	MDBAS (529)	
DZWOLA	KL	MDBAS (529)	
DZWOM	KL	MDBAS (529)	
DZWSPM	KL	ZWMIN (669)	
DZWSTTA	KL	ZWSTT (637)	
DZWTIN	KL		KRDY (659)
DZZST	FW	GGDPG (74)	
DZZST2	FW	GGDPG (74)	
DZZSTNLP	FW	GGDPG (74)	
EFFDFPM	KL	DFRZ (1144)	
ENSAKHG	FW	BBSAWE (557)	

Symbol	Type	Created within	Used within
ENTDKLL	FW	FUEDKSA (610)	
ENTDKNLL	FW	FUEDKSA (610)	
ESKONF	FW	DEKON (64)	
ETADZW	KL	LAMBTS (732), MDIST (528), MDBAS (529)	ZWMIN (669)
ETALAM	KL	MDBAS (529)	
ETAZWTEN	FW	DTEV (856)	
EVTMODMNDK	FW	FUEDK (597)	
EVTMODO	KL	BGTEMPK (252)	
FABMDWA	KL	MDWAN (554)	
FABSALU	FW	DSWEC (32)	
FABSTT	KL	GGTFM (289)	
FAINTEN	FW	DMDMIL (216)	
FAKTABGM	FW	BGTEMPK (252)	
FALRKTD	FW	DKAT (361)	
FALRKTT	FW	DKAT (361)	
FASKIV1	FW	DMDMIL (216)	
FATMRML	KL	ATM (20)	
FATMRML2	KL	ATM (20)	
FA_CALID	TX	TC9MOD (1121)	
FBFGRSFW	KL	FGRFULO (1160)	
FBTEB	KL	TEB (826)	
FBTEVA	KL	TEB (826)	
FBZBTEML	KL	TEB (826)	
FBZFRAT	KL	LRA (797)	
FDDN	KL	LLRRM (566)	
FDNIKOR	FW	LLRRM (566)	
FDVAGR	KL	BGAGR (263)	
FDVANS	KL	BGTEMPK (252)	
FETATEBN	KL	TEB (826)	
FFLDZ	KL	ZUESZ (632)	
FFRITMS	KL	LR (768)	
FFTCAS	KL	DCAS (1128)	
FFTCINS	KL	DCINS (1126)	
FFTCKUP	KL	DCKUP (1128)	
FFTEV1	KL	DEVE (1017)	
FFTEV2	KL	DEVE (1017)	
FFTEV3	KL	DEVE (1017)	
FFTEV4	KL	DEVE (1017)	
FFTEV5	KL	DEVE (1017)	
FFTEV6	KL	DEVE (1017)	
FFTEV7	KL	DEVE (1017)	
FFTEV8	KL	DEVE (1017)	
FFTHSH	KL	DHLSHK (1154)	
FFTHSH2	KL	DHLSHK (1154)	
FFTHSV	KL	DHLSVK (29)	
FFTHSV2	KL	DHLSVK (29)	
FFTHSVE	KL	DHLSVKE (902)	
FFTHSVE2	KL	DHLSVKE (902)	
FFTKPE	KL	DEKPE (1020)	
FFTKRNT	KL	DKRNT (445)	
FFTKROF	KL	DKRNT (445)	
FFTKRTP	KL	DKRTP (451)	
FFTKS1	KL	DKRS (437)	
FFTKS2	KL	DKRS (437)	
FFTKS3	KL	DKRS (437)	
FFTKS4	KL	DKRS (437)	
FFTLASH	KL	DLSAHK (339)	
FFTLASH2	KL	DLSAHK (339)	
FFTLATP	KL	DLSA (398)	
FFTLATP2	KL	DLSA (398)	
FFTLATV	KL	DLSA (398)	
FFTLATV2	KL	DLSA (398)	
FFTLSH	KL	DLSH (330)	
FFTLSH2	KL	DLSH (330)	
FFTMDB	KL	MDKOG (516)	
FFTMILE	KL	DMILE (36)	
FFTNWKW	KL	DNWKW (134)	
FFTNWKW2	KL	DNWKW (134)	
FFTNWS	KL	DNWS (622)	
FFTNWS2	KL	DNWS (622)	
FFTPH	KL	DPH (144)	
FFTPH2	KL	DPH (144)	
FFTTA	KL	GGTFA (298)	
FFTTES	KL	DTEV (856)	
FFTTEVE	KL	DTEVE (1022)	
FFTTM	KL	GGTFM (289)	
FFTUB	KL	GGUB (487)	
FFTUF2SG	KL	DUF (1089)	
FFTUFMV	KL	DUF (1089)	
FFTUFSKA	KL	DUF (1089)	
FFTURRAM	KL	DUR (1052)	
FFTURROM	KL	DUR (1052)	

Symbol	Type	Created within	Used within
FFTURRST	KL	DUR (1052)	
FFTVKUP	KL	DVKUP (1027)	
FFWEKA	FW	LRKA (795)	
FHDLLR	FW	DLLR (578)	
FHODTEA	FW	DTEV (856)	
FHOKH	FW	BBKHZ (890)	
FHOKOB	FW	KOS (896)	
FHOMN	FW	BGPU (276)	
FHOMX	FW	BGPU (276)	
FHSTT	KL	ESSTT (679)	
FIAMALU	FW	DMDLU (193)	
FIBSALU	FW	DSWEC (32)	
FIMALU	FW	DMDLU (193)	
FIMHU	KL	ESWE (698)	
FIMWU	KL	ESWE (698)	
FIRNLIGN	FW	NLDG (157)	
FKADPMN	FW	DTEV (856)	
FKATEB	KL	TEB (826)	
FKAXAVKAT	KL	LRKA (795)	
FKDISA	KL	BGPU (276)	
FKEFMC	FW	KRKE (427)	
FKELDY	FW	KRKE (427)	
FKELDYA	FW	KRDY (659)	
FKENDY	FW	KRKE (427)	
FKHABMN	FW	BBKHZ (890)	
FKHLA	KL	BBKHZ (890)	
FKHMD	KL	BBKHZ (890)	
FKKVS	KF	RKTI (979)	
FKMSDKMN	FW	BGMSZS (239)	
FKMSDKMX	FW	BGMSZS (239)	
FKMSHFM	FW	GGHFM (230)	
FKPVDKMN	FW	BGMSZS (239)	
FKPVDKMX	FW	BGMSZS (239)	
FKRFTPFMC	FW	KRKE (427)	
FKSTT	KL	ESSTT (679)	
FLCCAS	FW	DCAS (1128)	
FLCCINS	FW	DCINS (1126)	
FLCCKUP	FW	DCKUP (1128)	
FLCLUEA	FW	DMLSE (34)	
FLCLUEB	FW	DMLSE (34)	
FLFO	FW	DMDFON (161)	
FLMLKAMA	FW	LRKA (795)	
FLMLKAPR	FW	LRKA (795)	
FLRAWG	KL	ARMD (531)	
FLRFKATE	KL	LR (768)	
FLRHG	KL	ARMD (531)	
FLRM	KL	LR (768)	
FLUTN	KL	DMDLUA (202)	
FLUV1	FW	DMDLU (193)	
FLUV2	FW	DMDLU (193)	
FMDGENTA	KL	MDVERB (540)	
FMDKHFH	KL	KHMD (894)	
FMDKHTM	KL	KHMD (894)	
FMDWAT	KL	MDWAN (554)	
FMFKRB0	FW	GGKS (412)	
FMFKRB1	FW	GGKS (412)	
FMFKRB2	FW	GGKS (412)	
FMFKRB3	FW	GGKS (412)	
FMIUGDS	FW	FUEDK (597)	
FMIVL	FW	MDMAX (514)	
FMLKAMA	FW	LRKA (795)	
FNLMI0	FW	NLDG (157)	
FNLMI1	FW	NLDG (157)	
FNLMI2	FW	NLDG (157)	
FNRAD	FW	MDWAN (554)	
FNSHO	KL	ESNSWL (691)	
FNSNF	FW	LLRNS (562)	
FNSSM	KL	ESNSWL (691)	
FNSSTKM	KL	LLRNS (562)	
FNSSTM	KL	LLRNS (562)	
FNSTABNV	KL	MDNSTAB (556)	
FPLMRM	KL	FUEREG (595)	
FPRAT	FW	BGDVE (934)	
FPRMT	FW	BGDVE (934)	
FPRNMAX	FW	BGDVE (934)	
FPRTIM1_T	FW	BGDVE (934)	
FPRTIM2_T	FW	BGDVE (934)	
FPRTIM3_T	FW	BGDVE (934)	
FPRTIM4_T	FW	BGDVE (934)	
FPVDKE	FW	BGPU (276)	
FPVDKMN	FW	BGPU (276)	
FPVDKMX	FW	BGPU (276)	

Symbol	Type	Created within	Used within
FPVMXN2	KL	BGSRM (245)	
FPVMXP	FW	BGRLP (266)	
FPWDKAPP	KL	FUEDK (597)	
FQTEDL	KL	TEB (826)	
FQTEFR	KL	TEB (826)	
FQTEPT	KL	TEB (826)	
FQTEVA	KL	TEB (826)	
FRAE	FW	DKVS (811)	
FRAODN	FW	DKVS (811)	
FRAODX	FW	DKVS (811)	
FRAOMN	FW	LRA (797)	
FRAOMX	FW	LRA (797)	
FRAORN	FW	LRA (797)	
FRAORX	FW	LRA (797)	
FRARAWG	KL	ARMD (531)	
FRARHG	KL	ARMD (531)	
FRATMN	FW	LRA (797)	
FRATMX	FW	LRA (797)	
FRAUDN	FW	DKVS (811)	
FRAUDX	FW	DKVS (811)	
FRAUMN	FW	LRA (797)	
FRAUMX	FW	LRA (797)	
FRAURN	FW	LRA (797)	
FRAURX	FW	LRA (797)	
FRHB	FW	TEB (826)	
FRINH1	KL	DHLSHK (1154)	
FRINH2	KL	DHLSHK (1154)	
FRINOF	FW	GGLSH (318), GGLSV (382)	
FRINV1	KL	DHLSVK (29)	
FRINV2	KL	DHLSVK (29)	
FRIPDSL1	FW	LR (768)	
FRIPDSL4	FW	LR (768)	
FRIPDTES	FW	LR (768)	
FRIPTES	FW	LR (768)	
FRKAP	FW	ESGRU (678)	
FRLFSDP	KL	AES (973)	
FRLMNHO	KL	MDFUE (594)	
FRMAX	FW	LR (768)	
FRMDPMO	FW	DTEV (856)	
FRMDPMU	FW	DTEV (856)	
FRMDTEVO	FW	DTEV (856)	
FRMDTEVU	FW	DTEV (856)	
FRMINSLS	FW	LR (768)	
FRMLASHO	FW	DLSAHK (339)	
FRMLASHU	FW	DLSAHK (339)	
FRMSTDN	FW	DKVS (811)	
FRMSTDX	FW	DKVS (811)	
FRTEMX	FW	LR (768)	
FS1FO	FW	DMDFON (161)	
FS2FO	FW	DMDFON (161)	
FSRFTEF	FW	TEB (826)	
FSTHO	KL	ESSTT (679)	
FSTRES	FW	GGFST (502)	
FSTTMX	FW	BGKV (71)	
FSWALUV	KL	DSWEC (32)	
FSWALUV1	KL	DSWEC (32)	
FSZTM	KL	ZUESZ (632)	
FTAGRV	KL	BGAGR (263)	
FTDAG	KL	BGAGR (263)	
FTEADAB	FW	TEB (826)	
FTEADDPO	FW	DTEV (856)	
FTEADDPU	FW	DTEV (856)	
FTEADMX	FW	TEB (826)	
FTEADSZ	FW	DTEV (856)	
FTEADZU	FW	BBTEGA (750)	
FTEDS	FW	BBTEGA (750)	
FTEFHB	FW	TEB (826)	
FTEHB	FW	TEB (826)	
FTEINIX	KL	TEB (826)	
FTMFFANZ	KL	ZUESZ (632)	
FTMLAKH	KL	BBKHZ (890)	
FUBAOF	FW	ZUESZ (632)	
FUEPMLD	KL	FUEDK (597)	
FUKABAKI	FW	ESUKA (711)	
FUKABAKO	FW	ESUKA (711)	
FUKABAKU	FW	ESUKA (711)	
FUKABAWI	FW	ESUKA (711)	
FUKABAWO	FW	ESUKA (711)	
FUKABAWU	FW	ESUKA (711)	
FUKAVAKI	FW	ESUKA (711)	
FUKAVAKO	FW	ESUKA (711)	
FUKAVAKU	FW	ESUKA (711)	

Symbol	Type	Created within	Used within
FUKAVAWI	FW	ESUKA (711)	
FUKAVAWO	FW	ESUKA (711)	
FUKAVAWU	FW	ESUKA (711)	
FUKE	FW	ESUK (699)	
FUKNSTHO	KL	ESUK (699)	
FUKNSTM	KL	ESUK (699)	
FUMRBRK	FW	TEB (826)	
FUMRMV	FW	BGTEV (257)	
FUMSTEK	FW	BGTEV (257)	
FVANST	FW	ESUK (699)	
FVERMN	KL	TEB (826)	
FVERZDYN	KL	TEB (826)	
FVRMDYN	KL	TEB (826)	
FWDMVAD	KL	MDMIN (538)	
FWEAB	FW	ACIFI (1013)	
FWEAUF	FW	ACIFI (1013)	
FWEMXT	KL	ACIFI (1013)	
FWFN	FW	ESUK (699)	
FWFTBRTA	KL	BGTEMPK (252)	
FWLKFTBR	KL	BGTEMPK (252)	
FWMABGW	FW	ATM (20)	
FWMABGW2	FW	ATM (20)	
FWMKATW	FW	ATM (20)	
FWMKATW2	FW	ATM (20)	
FWMLHFMMN	KL	DHFM (233)	
FWNMOT	FW	ZUESZ (632)	
FWPEDRLS	FW	MDFUE (594)	
FWSTAA1	KL	ESNSWL (691)	
FWSTAB1	KL	ESNSWL (691)	
FWSTAB2	KL	ESNSWL (691)	
FWSTAB3	KL	ESNSWL (691)	
FWSTAS1	KL	ESNSWL (691)	
FWSTAS2	KL	ESNSWL (691)	
FZANSSA1	KL	ESNSWL (691)	
FZANSSA2	KL	ESNSWL (691)	
FZANSSM1	KL	ESNSWL (691)	
FZANSSM2	KL	ESNSWL (691)	
FZANSSM3	KL	ESNSWL (691)	
FZDASHTM	KL	MDFAW (508)	
FZN1	KL	ACIFI (1013)	
FZNWN1	KL	ACIFI (1013)	
FZPUSA	KL	BGPU (276)	
FZWKHMX	FW	ZWMIN (669)	
FZWSTNM	KL	ZWSTT (637)	
FZWSTTM	KL	ZWSTT (637)	
GFDLDN	KL	LLRRM (566)	
HLCCAS	FW	DCAS (1128)	
HLCCINS	FW	DCINS (1126)	
HLCCKUP	FW	DCKUP (1128)	
HLCLUEA	FW	DMLSE (34)	
HLCLUEB	FW	DMLSE (34)	
HYKATA	FW	DKAT (361)	
HYKATR	FW	DKAT (361)	
IGESGA	KL	BBGANG (501)	
ILMLKAXTK	KL	LRKA (795)	
ILMLKAXTK2	KL	LRKA (795)	
ILMRMN	FW	FUEREG (595)	
ILMRMX	FW	FUEREG (595)	
ILMRN	KL	FUEREG (595)	
IMLHS	FW	ESSTT (679)	
IMLKAMN	FW	LRKA (795)	
IMLKAMN2	FW	LRKA (795)	
IMLKAXTK	KL	LRKA (795)	
IMLKAXTK2	KL	LRKA (795)	
IMLKHTMS	KL	BBKHZ (890)	
IMLKS	FW	BBBO (853)	
IMLKVSMX	FW	DKVS (811)	
IMLSALR	FW	LREB (739)	
IMSDTEVA	FW	DTEV (856)	
IMTUMTA	FW	BGTABST (1030)	
IMTUMTAT	FW	ATM (20)	
INCKSTAI	KL	STADAP (684)	
IP1A_MX_UM	FW	UFRLC (1066)	
IP2A_MN_UM	FW	UFRLC (1066)	
IPA_T_UM	FW	UFRLC (1066)	
ITNMAXP	FW	NMAXMD (584)	
ITNMXH	FW	NMAXMD (584)	
IVDN	KL	LLRRM (566)	
IVDNDTE	KL	LLRRM (566)	
IVDNV	KL	LLRRM (566)	
KAMFZ	FW	DMDTSB (159)	
KATBFML	KL	DKAT (361)	

Symbol	Type	Created within	Used within
KATBFML2	KL	DKAT (361)	
KATBFMN	FW	DKAT (361)	
KATBFMNT	FW	DKAT (361)	
KATBFN	FW	DKAT (361)	
KATBFNM	FW	DKAT (361)	
KATBFNP	FW	DKAT (361)	
KATBFSX	FW	DKAT (361)	
KATBFXM	KL	DKAT (361)	
KATBFXT	FW	DKAT (361)	
KATBSG	FW	DKAT (361)	
KATBSH	FW	DKAT (361)	
KATBSHF	FW	DKAT (361)	
KATBSHG	FW	DKAT (361)	
KATMEXML	KL	ATM (20)	
KATMEXML2	KL	ATM (20)	
KATMIEXML	KL	ATM (20)	
KATMIEXML2	KL	ATM (20)	
KDLASHKI	KL	LRHK (781)	
KDLASHKI2	KL	LRHK (781)	
KDLASHKP	KL	LRHK (781)	
KDLASHKP2	KL	LRHK (781)	
KDLRIDDVE	FW	ADVE (918)	
KE1N	KL	KRKE (427)	
KE2N	KL	KRKE (427)	
KE3N	KL	KRKE (427)	
KE4N	KL	KRKE (427)	
KE5N	KL	KRKE (427)	
KE6N	KL	KRKE (427)	
KE7N	KL	KRKE (427)	
KE8N	KL	KRKE (427)	
KEMLN	KL	GGKS (412)	
KFABAK	KF	ESUK (699)	
KFAFTE	KF	BGTEV (257)	
KFAMAL	KF	DMDLU (193)	
KFAMAL1	KF	DMDLU (193)	
KFATMLA	KF	ATM (20)	
KFATMLA2	KF	ATM (20)	
KFATMZW	KF	ATM (20)	
KFATMZW2	KF	ATM (20)	
KFAVAK	KF	ESUK (699)	
KFBAKL	KF	ESUK (699)	
KFBRAWA	KF	FGRFULO (1160)	
KFBS	KF	GK (675)	
KFCFO	KF	DMDFON (161)	
KFCFO2	KF	DMDFON (161)	
KFDETATE	KF	DTEV (856)	
KFDFBTMN	KF	BGTEMPK (252)	
KFDFBTMP	KF	BGTEMPK (252)	
KFDLSD	KF	MDFAW (508)	
KFDLUR	KF	DMDDLU (199)	
KFDLUR1	KF	DMDDLU (199)	
KFDLUR2	KF	DMDDLU (199)	
KFDLURZ	KF	DMDDLU (199)	
KFDMDADP	KF	ARMD (531)	
KFDMDARO	KF	ARMD (531)	
KFDMDKOE	KF	MDVERB (540)	
KFDMDPO	KF	MDFAW (508)	
KFDMLSDO	KF	MDFAW (508)	
KFDMLSDS	KF	MDFAW (508)	
KFDTMRS	KF	GGTFM (289)	
KFDTMTE	KF	GGTFM (289)	
KFDTMTR	KF	GGTFM (289)	
KFDTMTU	KF	GGTFM (289)	
KFDYES	KF	KRDY (659)	
KFDYESOF	KF	KRDY (659)	
KFDZWKG	KF	ZWGRU (634)	
KFETATE	KF	TEB (826)	
KFFDLBTS	KF	LAMBTS (732)	
KFFFANZ	KF	ZUESZ (632)	
KFFFANZUB	KF	ZUESZ (632)	
KFFRAT	KF	LRA (797)	
KFFRMIN	KF	LR (768)	
KFFTEAN	KF	TEB (826)	
KFFTEAX	KF	TEB (826)	
KFFTV	KF	LRHK (781)	
KFFTV2	KF	LRHK (781)	
KFFWL	KF	ESNSWL (691)	
KFFWLRL	KF	ESNSWL (691)	
KFFWLW	KF	ESNSWL (691)	
KFFWTBR	KF	BGTEMPK (252)	
KFFWTBRA	KF	BGTEMPK (252)	
KFKABMT	KF	DKAT (361)	

Symbol	**Type**	**Created within**	**Used within**
KFKHFM	KF	GGHFM (230)	
KFKSWF	KF	DMDMIL (216)	
KFKWTMP	KF	KHMD (894)	
KFLASKH	KF	LAKH (735)	
KFLBTS	KF	LAMBTS (732)	
KFLF	KF	ESGRU (678)	
KFLMSKH	KF	LAKH (735)	
KFLUAR	KF	DMDLUA (202)	
KFLUAR1	KF	DMDLUA (202)	
KFLUAR2	KF	DMDLUA (202)	
KFLUARZ	KF	DMDLUA (202)	
KFLURB	KF	DMDLU (193)	
KFLURB1	KF	DMDLU (193)	
KFLURB2	KF	DMDLU (193)	
KFLURBZ	KF	DMDLU (193)	
KFLURM	KF	DMDLU (193)	
KFLURM1	KF	DMDLU (193)	
KFMAKR	KF	GGKS (412)	
KFMDBGRG	KF	MDBGRG (530)	
KFMDDSLA	KF	KHMD (894)	
KFMDGEN	KF	MDVERB (540)	
KFMDKH	KF	KHMD (894)	
KFMDKO	KF	MDVERB (540)	
KFMDPWM	KF	MDVERB (540)	
KFMDPWME	KF	MDVERB (540)	
KFMDRKO	KF	MDVERB (540)	
KFMDRKOE	KF	MDVERB (540)	
KFMDS	KF	MDVER (546)	
KFMDSZAS	KF	MDVER (546)	
KFMDZOF_UM	KF	UFMZUL (1084)	
KFMIFABG	KF	MDFAW (508)	
KFMIFALS	KF	MDFAW (508)	
KFMILSD	KF	MDFAW (508)	
KFMIMN	KF	MDMIN (538)	
KFMIOP	KF	MDBAS (529), MDMAX (514)	
KFMIRED	KF	VMAXMD (588)	
KFMIRL	KF	MDFUE (594)	
KFMIZUFIL	KF	MDZUL (523)	
KFMIZUNS	KF	MDZUL (523)	
KFMIZUOF	KF	MDZUL (523)	
KFMI_UM	KF	UFMIST (1086)	
KFMLDMN	KF	DHFM (233)	
KFMLDMX	KF	DHFM (233)	
KFMPED_UM	KF	UFMZUL (1084)	
KFMPNS_UM	KF	UFMZUL (1084)	
KFMRES	KF	LLRMR (572)	
KFMRESK	KF	LLRMR (572)	
KFMRESKH	KF	LLRMR (572)	
KFMRESNL	KF	LLRMR (572)	
KFMRESTA	KF	LLRMR (572)	
KFMRESTM	KF	LLRMR (572)	
KFMSNWDK	KF	BGMSZS (239), BGRLP (266)	
KFNLLNST	KF	LLRNS (562)	
KFNSA	KF	ESNSWL (691)	
KFNSWRL	KF	ESNSWL (691)	
KFNW	KF	NWS (618)	
KFNWEGM	KF	BBSAWE (557)	
KFNWWL	KF	NWS (618)	
KFPBRK	KF	BGSRM (245)	
KFPBRKNW	KF	BGSRM (245)	
KFPED	KF	MDFAW (508)	
KFPEDR	KF	MDFAW (508)	
KFPLMR	KF	FUEREG (595)	
KFPRG	KF	BGSRM (245)	
KFPRG2SU	KF	BGSRM (245)	
KFPRG3SU	KF	BGSRM (245)	
KFPRGSU	KF	BGSRM (245)	
KFPU	KF	GGHFM (230)	
KFPUNW	KF	GGHFM (230)	
KFPUSU	KF	GGHFM (230)	
KFPUSUNW	KF	GGHFM (230)	
KFQTE	KF	TEB (826)	
KFRI	KF	LR (768)	
KFRI2	KF	LR (768)	
KFRINH	KF	DHLSHK (1154)	
KFRINH2	KF	DHLSHK (1154)	
KFRINV	KF	DHLSVK (29)	
KFRINV2	KF	DHLSVK (29)	
KFRLIP_UM	KF	UFRLC (1066)	
KFRLMN	KF	MDFUE (594)	
KFRLMNSA	KF	MDFUE (594)	
KFRLW	KF	BGPU (276)	

Symbol	Type	Created within	Used within
KFRLWNW	KF	BGPU (276)	
KFRLWSU	KF	BGPU (276)	
KFRLWSUNW	KF	BGPU (276)	
KFRP	KF	LR (768)	
KFRP2	KF	LR (768)	
KFRTV	KF	LR (768)	
KFRTV2	KF	LR (768)	
KFSU	KF	SU (617)	
KFSU2	KF	SU (617)	
KFSZT	KF	ZUESZ (632)	
KFTADMS	KF	TEB (826)	
KFTAGAV	KF	BGAGR (263)	
KFTATM	KF	ATM (20)	
KFTATM2	KF	ATM (20)	
KFTATX	KF	TEB (826)	
KFTEKA	KF	TEB (826)	
KFTEVP	KF	ATEV (969)	
KFTPKOR	KF	DLSA (398)	
KFTVFRR	KF	DTEV (856)	
KFTVSA	KF	BBSAWE (557)	
KFURL	KF	BGSRM (245)	
KFURL2SU	KF	BGSRM (245)	
KFURL3SU	KF	BGSRM (245)	
KFURLSU	KF	BGSRM (245)	
KFUSHK	KF	LRHK (781)	
KFUSHK2	KF	LRHK (781)	
KFVAKL	KF	ESUK (699)	
KFVERST	KF	MDMIN (538)	
KFVOFFS	KF	FGRREGL (1174)	
KFWDKMSN	KF	FUEDK (597)	
KFWDKPP	KF	GGDVE (477)	
KFWDKSMX	KF	FUEDK (597)	
KFWDKSST	KF	WDKSOM (614)	
KFWDKTHO	KF	WDKSOM (614)	
KFWEE	KF	ESVW (1009)	
KFWEEK	KF	ESVW (1009)	
KFWHSTT	KF	ESSTT (679)	
KFWKSTAB	KF	ESSTT (679)	
KFWKSTN	KF	ESSTT (679)	
KFWKSTT	KF	ESSTT (679)	
KFWMABG	KF	ATM (20)	
KFWMABG2	KF	ATM (20)	
KFWMKAT	KF	ATM (20)	
KFWMKAT2	KF	ATM (20)	
KFWPFGR	KF	BGWPFGR (548)	
KFWTBR	KF	BGTEMPK (252)	
KFWTBRA	KF	BGTEMPK (252)	
KFWWLML	KF	ESNSWL (691)	
KFWWNS	KF	ESNSWL (691)	
KFZDASH	KF	MDFAW (508)	
KFZDASH2	KF	MDFAW (508)	
KFZKPUA	KF	BGPU (276)	
KFZLSD	KF	MDFAW (508)	
KFZNSM	KF	LLRNS (562)	
KFZW	KF	ZWGRU (634)	
KFZW2	KF	ZWGRU (634)	
KFZWMN	KF	ZWMIN (669)	
KFZWMNKH	KF	ZWMIN (669)	
KFZWMNST	KF	ZWMIN (669)	
KFZWMS	KF	ZWMIN (669)	
KFZWOP	KF	MDBAS (529)	
KFZWOP2	KF	MDBAS (529)	
KFZWWLNM	KF	ZWWL (638)	
KFZWWLTM	KF	ZWWL (638)	
KFZW_UM	KF	UFMIST (1086)	
KHCTEAMX	FW	TEB (826)	
KHCTEMN	FW	TEB (826)	
KHCTEMX	FW	TEB (826)	
KIDMSNTE	FW	DTEV (856)	
KIELM	FW	BGPU (276)	
KIFZGAWG	KL	ARMD (531)	
KIFZGHG	KL	ARMD (531)	
KIMSALL	FW	BGMSZS (239)	
KINMXG	KL	NMAXMD (584)	
KINMXNL	FW	NMAXMD (584)	
KINMXRLG	KF	NMAXMD (584)	
KIRMSMS	KL	DTEV (856)	
KISA	FW	BGPU (276)	
KISRM	FW	BGSRM (245)	
KISRM2SU	FW	BGSRM (245)	
KISRM3SU	FW	BGSRM (245)	
KISRMSU	FW	BGSRM (245)	

Symbol	Type	Created within	Used within
KKFFGRGA	KL	FGRREGL (1174)	
KLAF	KL	BGAGR (263), BGMSZS (239)	FUEDK (597), BGRLP (266)
KLAFTE	KL	BGTEV (257)	
KLATMILAE	KL	ATM (20)	
KLATMILAE2	KL	ATM (20)	
KLATMIZWE	KL	ATM (20)	
KLATMIZWE2	KL	ATM (20)	
KLATMLAE	KL	ATM (20)	
KLATMLAE2	KL	ATM (20)	
KLATMZWE	KL	ATM (20)	
KLATMZWE2	KL	ATM (20)	
KLDFOFF	FW	LLRNS (562)	
KLDFON	FW	LLRNS (562)	
KLDMDLF1	KL	MDVERB (540)	
KLDMDLF2	KL	MDVERB (540)	
KLDMMX	KL	MDZUL (523)	
KLDPDK	KL	FUEDK (597)	
KLDTPH	KL	NLDG (157)	
KLDTPHST	KL	NLDG (157)	
KLDYNCOR	KL	NLDG (157)	
KLETAZW_UM	KL	UFMIST (1086)	
KLFZWMNKH	KL	ZWMIN (669)	
KLFZWMNST	KL	ZWMIN (669)	
KLNLPHN	KL	NLDG (157)	
KLNPED_UM	KL	UFREAC (1088)	
KLNWRLTM	KL	NWS (618)	
KLRSYNIN	KL	LR (768)	
KLRSYNPN	KL	LR (768)	
KLTDS	KL	GGDST (504)	
KLTNRDE	KL	RDE (112)	
KLWDKABST	KL	WDKSOM (614)	
KLWDKPED	KL	WDKSOM (614)	
KLWDKTAN	KL	WDKSOM (614)	
KLWNWI	KL	NLDG (157)	
KMXSTG	FW	DLSAHK (339)	
KNLSYN	FW	NLDG (157)	
KNSNF	FW	LLRNS (562)	
KRAFGRGA	KL	FGRREGL (1174)	
KRAL1N	KL	KRRA (639)	
KRAL2N	KL	KRRA (639)	
KRAL3N	KL	KRRA (639)	
KRALH	FW	KRRA (639)	
KRAN1	FW	KRRA (639)	
KRAN2	FW	KRRA (639)	
KRAN3	FW	KRRA (639)	
KRAN4	FW	KRRA (639)	
KRANH	FW	KRRA (639)	GGKS (412)
KRDWA	FW	KRRA (639)	
KRDWKLA	FW	KRRA (639)	
KRDWSA	FW	KRRA (639)	
KRDWSN	KL	KRRA (639)	
KRFHKS	FW	DKRS (437)	
KRFHT	FW	DKRNT (445), DKRTP (451), GGKS (412)	
KRFKN	KL	KRRA (639)	
KRFTP1	FW	KRKE (427)	
KRFTP2	FW	KRKE (427)	
KRFTP3	FW	KRKE (427)	
KRKFKS	FW	KRKE (427)	
KRKTE	FW	AES (973)	
KRLMDY	FW	KRRA (639)	
KRMXN	KL	KRRA (639)	
KRNLZAR	KWB	KRRA (639)	
KRNMDY	FW	KRRA (639)	
KRVFN	KL	KRRA (639)	
KRVFSN	KL	KRRA (639)	
KRVST	FW	KRKE (427)	
KSTAI	KL	STADAP (684)	
KSTAMX0	FW	STADAP (684)	
KSTAMX1	FW	STADAP (684)	
KSTAMX2	FW	STADAP (684)	
KSZA	FW	KRKE (427), KRRA (639)	
KUMSRL	FW	BGKV (71), BGMSZS (239)	TEB (826), FUEDK (597)
KVLAD	FW	BGMSZS (239)	
LADFIL	FW	BGMSZS (239)	
LALIUSH	KL	LRHK (781)	
LALIUSH2	KL	LRHK (781)	
LALIUSRH	KL	LRHK (781)	
LALIUSRH2	KL	LRHK (781)	
LAMFA	KF	LAMFAW (728)	
LAMKAML	KL	LRKA (795)	
LAMKAML2	KL	LRKA (795)	
LAMLGF	FW	LAMKO (729)	

Symbol	Type	Created within	Used within
LAMLGMTM	KL	LAMKO (729)	
LAMLRAMN	FW	LRAEB (759)	
LAMLRAMX	FW	LRAEB (759)	
LAMSSAMN	FW	DLSSA (350)	
LAMSSAMX	FW	DLSSA (350)	
LASDSLA	KL	LAKH (735)	
LASHKAB	FW	LRHK (781)	
LASOAB	FW	LAMKO (729)	
LASTMOT	KL	LAKH (735)	
LBZO1	FW	LLRNS (562)	
LBZO2	FW	LLRNS (562)	
LBZU	FW	LLRNS (562)	
LIMN	FW	LLRRM (566)	
LIMNDLLR	FW	LLRRM (566)	
LIMNDTES	FW	LLRRM (566)	
LIMNV	FW	LLRRM (566)	
LIMXDNS	KL	LLRRM (566)	
LIMXVDNS	KL	LLRRM (566)	
LISTM	KL	LLRRM (566)	
LKRN	KL	KRRA (639)	
LLRICNF	FW	LLRRM (566)	
LMSTMOT	KL	LAKH (735)	
LNXQTM	KL	BGTABST (1030)	
LRNST1_T	FW	BGDVE (934)	
LRNST3_T	FW	BGDVE (934)	
LRNST7_T	FW	BGDVE (934)	
LRNST9_T	FW	BGDVE (934)	
LRNVB_T	FW	BGDVE (934)	
LSAKTD	KL	DKAT (361)	
LURBRL8	KL	DMDLU (193)	
LURFOST	FW	DMDFON (161)	
LURKH	KL	DMDLU (193)	
LURKTM	KL	DMDLU (193)	
LURMIN1	KL	DMDLU (193)	
LURMIN2	KL	DMDLU (193)	
LURMIN3	KL	DMDLU (193)	
LWSER	FW	MDVERB (540)	
LZFUER	KL	KRRA (639)	
MASK_40MS	SYS		UFSGSC (1070)
MASK_FUAE	SYS		UFSGSC (1070)
MDERFOKH	FW	DMDFON (161)	
MDERKFON	FW	DMDFON (161)	
MDHYEZ	FW	MDRED (976)	
MDIMX	FW	CAN (1124), VMAXMD (588), MDZUL (523)	NMAXMD (584), MDKOL (526), MDKOG (516), MDFAW (508)
MDKOAB	KL	KOS (896)	
MDKOAN	KL	KOS (896)	
MDKOEN	KL	KOS (896)	
MDLF1	FW	MDVERB (540)	
MDLF2	FW	MDVERB (540)	
MDNORM	FW	MDVERB (540)	
MDSH	KL	MDVER (546)	
MDSL	FW	MDVERB (540)	
MDSLP	FW	MDVERB (540)	
MDSLPE	FW	MDVERB (540)	
MDSM	KL	MDVER (546)	
MDSMZAS	KL	MDVER (546)	
MEBZ_M	FW	UFMER (1060)	
MER_T1_UM	FW	UFMER (1060)	
MER_T2_UM	FW	UFMER (1060)	
MIFABGMX	FW	MDFAW (508)	
MIFAMXNOT	KL	GGPED (454)	
MILANTI	FW	DMDMIL (216)	
MINAKRLZ	FW	KRRA (639)	
MKFADPN	KL	MDFAW (508)	
MKFADPN1	KL	MDFAW (508)	
MKLLS	KL	MDVERB (540)	
MKMIFABG	FW	MDFAW (508)	
MLDKVSF	FW	DKVS (811)	
MLDKVSG	FW	DKVS (811)	
MLDTEFPF	FW	DTEV (856)	
MLDTEPF	FW	DTEV (856)	
MLFKMSDK	FW	BGMSZS (239)	
MLHFM	KL	GGHFM (230)	
MLHFMMN	FW	DHFM (233)	
MLKHMX	FW	BBKHZ (890)	
MLLASH	FW	DLSAHK (339)	
MLMAX	FW	BGRML (287)	
MLMIN	FW	GGHFM (230)	
MLNKAX	FW	LRHK (781)	
MLO1	FW	LRA (797)	
MLO1AC	FW	LRA (797)	
MLO2	FW	LRA (797)	

Symbol	Type	Created within	Used within
MLO3	FW	LRA (797)	
MLO3AC	FW	LRA (797)	
MLOFS	FW		DHFM (233), GGHFM (230)
MLOSTEST	FW	DLSAHK (339)	
MLSUS	KL	BBKHZ (890)	
MLU2	FW	LRA (797)	
MLU2AC	FW	LRA (797)	
MLU4	FW	LRA (797)	
MLUSSTG	FW	DLSAHK (339)	
MLUSTEST	FW	DLSAHK (339)	
MRESLL	FW	LLRMR (572)	
MRESSL	FW	LLRMR (572)	
MRFABUMX	FW	FUEDK (597)	
MRFALLO	FW	MDFAW (508)	
MRFALLU	FW	MDFAW (508)	
MRFARUGDN	KL	FUEDK (597)	
MRFAVLN	KL	MDFAW (508)	
MRFAVW	KL	ESVW (1009)	
MRFGRIMX	KL	FGRREGL (1174)	
MRFGRLL	FW	FGRREGL (1174)	
MRFGRMAX	FW	FGRREGL (1174)	FGRFULO (1160)
MRFGRSTA	FW	FGRREGL (1174)	
MSALLMN	FW	BGMSZS (239)	
MSALLMX	FW	BGMSZS (239)	
MSDKLMMN	FW	TEB (826)	
MSLG	FW	BGMSZS (239)	
MSNTAG	KL	BGAGR (263)	
MSNTATE	KL	BGTEV (257)	
MSRC_T_UM	FW	UFMSRC (1080)	
MSRMX	FW	CAN (1124)	
MVER_T_UM	FW	UFMVER (1087)	
MXNLFEHL	FW	NLDG (157)	
MZFFIL_UM	FW	UFMZF (1083)	
MZFTV_UM	FW	UFMZF (1083)	
M_SRST_UM	SYS		UFSGSC (1070)
N0	FW	LRA (797)	
NARAO	FW	ARMD (531)	
NARASTG	FW	ARMD (531)	
NARLLGA	KL	ARMD (531)	
NASNOTKL	KL	MDKOG (516)	
NC_T_UM	FW	UFNC (1063)	
NDFILOG	KL	ARMD (531)	
NDIFFOG	KL	ARMD (531)	
NDIF_UM	FW	UFNC (1063)	
NDKPPU	FW	GGDVE (477)	
NDKS	FW	DKRS (437)	
NDKTSO	FW	DKAT (361)	
NDKTSOT	FW	DKAT (361)	
NDKTSU	FW	DKAT (361)	
NDKTSUT	FW	DKAT (361)	
NDNWMN	FW	DNWS (622)	
NDNWMX	FW	DNWS (622)	
NDV	FW	DVFZ (500)	
NDVO	FW	DVFZ (500)	
NFANWS	FW	NWS (618)	
NFHZ	FW	LLRNS (562)	
NFHZFS	FW	LLRNS (562)	
NFLUV	FW	DMDLU (193)	
NFS2M	KL	LLRNS (562)	
NFSKHM	KL	BBKHZ (890)	
NFSKLDF	FW	LLRNS (562)	
NFSKO	FW	LLRNS (562)	
NFSKS	FW	LLRNS (562)	
NFSLPWG	FW	LLRNS (562)	
NFSM	KL	LLRNS (562)	
NFSMIN	FW	LLRNS (562)	
NFSNLDG	FW	LLRNS (562)	
NFSSL	FW	LLRNS (562)	
NGALUN	KL	DMDSTP (205)	
NGANGMIN	FW	BBGANG (501), CAN (1124)	
NGDNSA	FW	BBSAWE (557)	
NGFSAWE	FW	MDFAW (508)	
NGKRWN	KL		KRDY (659)
NGNSNF	FW	LLRNS (562)	
NKLDF	FW	LLRNS (562)	
NKRFM1	FW	GGKS (412)	
NKRFM2	FW	GGKS (412)	
NKRFM3	FW	GGKS (412)	
NKRUM	FW	KRDY (659)	
NKTDX	FW	DKAT (361)	
NLL2M	KL	LLRNS (562)	
NLLCVTMXV	KL	LLRNS (562)	

Symbol	Type	Created within	Used within
NLLKHM	KL	BBKHZ (890)	
NLLKHNW	FW	NWS (618)	
NLLKT	FW	BBKHZ (890)	
NLLM	KL	DMDMIL (216), LLRNS (562)	
NLLMIN	FW	LLRNS (562)	
NLPST1T	FW	BGDVE (934)	
NLPST2T	FW	BGDVE (934)	
NLRHO	FW	LRHK (781)	
NLRHU	FW	LRHK (781)	
NLRKA	FW	LRKA (795)	
NLRSHB	FW	LREB (739)	
NMAX	FW		NMAXMD (584)
NMAXDV	FW		NMAXMD (584)
NMAXDVG	KL	NMAXMD (584)	
NMAXDZ	FW	NMAXMD (584)	
NMAXNL	FW	NMAXMD (584)	
NMAXOG	FW	NMAXMD (584)	
NMAXSGS	FW	NMAXMD (584)	
NMAXU	FW	BGBSZ (73)	
NMIALU	FW	DMDSTP (205)	
NMIDLU	FW	DMDDLU (199)	
NMIN	FW	GGDPG (74), LLRBB (575)	
NMINVMX	FW	VMAXMD (588)	
NMIN_UM	FW	UFNC (1063)	
NMN_DUF	FW	DUF (1089)	
NMOTQSYN	FW	GGDPG (74)	
NMOTRDE	FW	RDE (112)	
NMXALU	FW	DMDSTP (205)	
NMXDAEF	KL	NMAXMD (584)	
NMXDKPU	FW		NMAXMD (584)
NMXPG	KL	NMAXMD (584)	
NMXPNL	FW	NMAXMD (584)	
NMXPRLG	KF	NMAXMD (584)	
NMXSKA	FW	AEVABU (1002)	
NNSTA	KL	BBSTT (148)	
NO1	FW	LRA (797)	
NOASR_UM	FW	UFMSRC (1080)	
NOLRA	FW	LRA (797)	
NOME_T	FW	DUF (1089)	
NOREA_UM	FW	UFREAC (1088)	
NOVZTE	FW	BGTEV (257)	
NPHERKMN	FW	NLPH (150)	
NPHERKMX	FW	NLPH (150)	
NPHINVMN	FW	NLPH (150)	
NPHINVMX	FW	NLPH (150)	
NPMOL1	FW	GGPOEL (296)	
NPUS	FW	BGPU (276)	
NRKAB	FW	LRA (797)	
NRLIP_UM	FW	UFRLC (1066)	
NRLMN	FW	FUEDK (597)	
NRLMNLLR	FW	FUEDK (597)	
NRUBMX	FW	BGLBZ (489)	
NSAC	FW	LLRNS (562)	
NSACFS	FW	LLRNS (562)	
NSC_T_UM	FW	UFNSC (1077)	
NSHLL	FW	LLRNS (562)	
NSKO	FW	LLRNS (562)	
NSKS	FW	LLRNS (562)	
NSL	FW	LLRNS (562)	
NSLBZFS	FW	LLRNS (562)	
NSLBZLL	FW	LLRNS (562)	
NSLBZS	FW	LLRNS (562)	
NSLFAKAT	FW	LLRNFA (564)	
NSLFALSV	FW	LLRNFA (564)	
NSLFASH	FW	LLRNFA (564)	
NSLKVS	FW	LLRNFA (564)	
NSLLSH	FW	LLRNFA (564)	
NSLPP	KL	LLRNS (562)	
NSLPPFS	KL	LLRNS (562)	
NSLPWG	FW	LLRNS (562)	
NSNLDG	FW	LLRNS (562)	
NSNOT	FW	LLRNS (562)	
NSOF_T_UM	FW	UFNSC (1077)	
NSTAMXHA	KL	STADAP (684)	
NSTART	FW	MDZUL (523)	
NSTEND	FW	MDZUL (523)	
NSTNM	KL	BBSTT (148)	
NSWO1	FW	PROKON (53)	
NSWO2	FW	PROKON (53)	
NSYN2SG	FW	GGDPG (74)	
NTPKTO	FW	DLSA (398)	
NTPKTU	FW	DLSA (398)	

Symbol	Type	Created within	Used within
NTPVKO	FW	DLSA (398)	
NTPVKU	FW	DLSA (398)	
NTUMTA	FW	BGTABST (1030)	
NTUMTAT	FW	ATM (20)	
NU3	FW	LRA (797)	
NUKAO	FW	ESUKA (711)	
NUKAU	FW	ESUKA (711)	
NVERZMN	FW	TEB (826)	
NVQUOT1O	FW	BBGANG (501)	
NVQUOT1U	FW	BBGANG (501)	
NVQUOT2O	FW	BBGANG (501)	
NVQUOT2U	FW	BBGANG (501)	
NVQUOT3O	FW	BBGANG (501)	
NVQUOT3U	FW	BBGANG (501)	
NVQUOT4O	FW	BBGANG (501)	
NVQUOT4U	FW	BBGANG (501)	
NVQUOT5O	FW	BBGANG (501)	
NVQUOT5U	FW	BBGANG (501)	
NVQUOT6O	FW	BBGANG (501)	
NVQUOT6U	FW	BBGANG (501)	
NWAFMN	FW	WANWKW (125)	
NWAFMX	FW	WANWKW (125)	
NWDK3	FW	GGDVE (477)	
NWDKSST	KL	WDKSOM (614)	
NWECVTM	KL	BBSAWE (557)	
NWENG	KL	BBSAWE (557)	
NWENGFS	KL	BBSAWE (557)	
NWPMBBR	FW	GGPED (454)	
NWSOS	FW	NWS (618)	
NWSUS	FW	NWS (618)	
NZHDTL	KL	LLRNS (562)	
NZHITL	KL	LLRNS (562)	
NZMUL_UM	FW	UFNC (1063)	
N_START_UM	FW	UFNSC (1077)	
N_STEND_UM	FW	UFNSC (1077)	
N_ST_KRA	FW	KRDY (659)	
OFQSYNADAP	FW	GGDPG (74)	
PAGAVML	KL	BGAGR (263)	
PGFLWA	FW	DDG (141)	
PHLSNVMN	FW	DLSV (301)	
PHNOKA	FW	DPH (144)	
PH_MINSEG	FW	GGDPG (74)	
PLRHAV	KL	LRHK (781)	
PLRHAV2	KL	LRHK (781)	
PLRHML	KL	LRHK (781)	
PLRHML2	KL	LRHK (781)	
PLSOLAP	FW	FUEDK (597)	
PRG2SUNM	KL	BGSRM (245)	
PRG3SUNM	KL	BGSRM (245)	
PRGNM	KL	BGSRM (245)	
PRGSUNM	KL	BGSRM (245)	
PSAPES	FW	AES (973)	
PSPVDKUG	FW	BGMSZS (239), BGRLP (266)	FUEDK (597)
PUE	FW	BGPU (276)	
PUKANS	KL	GGHFM (230)	
PUMN	FW	BGPU (276)	
PUMX	FW	BGPU (276)	
PVDN	KL	LLRRM (566)	
PVDNKH	KL	LLRRM (566)	
PVDNST	KL	LLRRM (566)	
PVDNV	KL	LLRRM (566)	
PVLDN	KL	LLRRM (566)	
PVLDNV	KL	LLRRM (566)	
PZWKRA	FW	KRDY (659)	
P_ZYL	FW	DMDLU (193)	
QUFRMN	FW	LR (768)	
QUFRMX	FW	LR (768)	
RALEZMAX	FW	ALE (136)	
RAMDASR	FW	CAN (1124)	
RAMPASR	FW	CAN (1124)	
RAMPKUP	FW	CAN (1124)	
RBEL	FW	GGLSH (318)	
RDUNDEF	FW	RDE (112)	
REAC_T1_UM	FW	UFREAC (1088)	
REAC_T2_UM	FW	UFREAC (1088)	
REDABM	KF	AEVAB (980)	
REDABMB	KF	AEVAB (980)	
REDABMC	KF	AEVAB (980)	
REDABMZ	KL	AEVAB (980)	
REDHYOC	FW	MDRED (976)	
REDHYUC	FW	MDRED (976)	
REDMX	FW	MDIST (528)	

Symbol	Type	Created within	Used within
REDMXSA	FW	MDRED (976)	
REDZEM	KL	MDRED (976)	
REFINI	FW	KRKE (427)	
RINHMX	FW	GGLSH (318)	
RINVMX	FW	GGLSV (382)	
RISIGRESH	FW	DLSH (330)	
RISIGRESV	FW	DLSV (301)	
RKADTEVO	FW	DTEV (856)	
RKADTEVU	FW	DTEV (856)	
RKAE	FW	DKVS (811)	
RKATDN	FW	DKVS (811)	
RKATDX	FW	DKVS (811)	
RKATMN	FW	LRA (797)	
RKATMX	FW	LRA (797)	
RKATRN	FW	LRA (797)	
RKATRX	FW	LRA (797)	
RKAZDN	FW	DKVS (811)	
RKAZDX	FW	DKVS (811)	
RKAZMN	FW	LRA (797)	
RKAZMX	FW	LRA (797)	
RKAZRN	FW	LRA (797)	
RKAZRX	FW	LRA (797)	
RKBAUM	KL	ESUK (699)	
RKRMX1N	KL	KRKE (427)	
RKRMX2N	KL	KRKE (427)	
RKSP	FW	GGLSH (318)	
RKUKKLU	FW	ESUK (699)	
RKVAUM	KL	ESUK (699)	
RLC_T_UM	FW	UFRLC (1066)	
RLDKTOT	FW	DKAT (361)	
RLDKTSO	KL	DKAT (361)	
RLDKTSU	KL	DKAT (361)	
RLDKTUT	FW	DKAT (361)	
RLDLLR	FW	DLLR (578)	
RLIPFIL_UM	FW	UFRLC (1066)	
RLIPTV_UM	FW	UFRLC (1066)	
RLIP_T_UM	FW	UFRLC (1066)	
RLLRHON	KL	LRHK (781)	
RLLRHUN	KL	LRHK (781)	
RLLRSHB	FW	LREB (739)	
RLLRUN	KL	LREB (739)	
RLNOT	KL	BGMSZS (239)	
RLO2	FW	LRA (797)	
RLO3	FW	LRA (797)	
RLO3AC	FW	LRA (797)	
RLPHERKMN	FW	NLPH (150)	
RLPHERKMX	FW	NLPH (150)	
RLRVAO	FW	LREB (739)	
RLSALULL	FW	DMDSTP (205)	
RLSALUN	KL	DMDSTP (205)	
RLSOLAP	FW	MDFUE (594)	
RLTPKTO	FW	DLSA (398)	
RLTPKTU	FW	DLSA (398)	
RLTPVKO	FW	DLSA (398)	
RLTPVKU	FW	DLSA (398)	
RLU2	FW	LRA (797)	
RLU2AC	FW	LRA (797)	
RLU3	FW	LRA (797)	
RLU4	FW	LRA (797)	
RLUKAO	FW	ESUKA (711)	
RLUKAU	FW	ESUKA (711)	
RLVMXN	KL	MDMAX (514)	
RLVSMXN	KL	MDMAX (514)	
RL_BO_UM	FW	UFRLC (1066)	
RL_MO_UM	FW	UFRLC (1066)	
RMSTEVIO	FW	DTEV (856)	
RMSTEVMN	FW	DTEV (856)	
RMSTEVMX	FW	DTEV (856)	
ROMRSTA_UM	FW	URROM (1041)	
RST_TV_UM	FW	UFREAC (1088), URMEM (1044)	
SAFK1	FW	DLSSA (350)	
SAFK2	FW	DLSSA (350)	
SDK10TEUB	SV		TEB (826)
SDN06LLSB	SV	LLRRM (566)	
SENZZYL	KWB	GGKS (412)	DKRS (437), KRRA (639)
SFONTM	FW	DMDSTP (205)	
SFR05TEUB	SV		TEB (826)
SGA08MDUB	SV		NMAXMD (584)
SGSC_ANZ	SYS		UFSGSC (1070)
SGSC_K	SYS		UFSGSC (1070)
SGSC_T_UM	FW	UFSGSC (1070)	
SIM06ESUW	SV		ESNSWL (691)

Symbol	Type	Created within	Used within
SKADRHZ_UM	FW	UFREAC (1088)	
SKO06KOUB	SV	MDVERB (540)	
SKS06ESUB	SV		ESNSWL (691)
SLFOO2N	KL	DMDFON (161)	
SLFOON	KL	DMDFON (161)	
SLFOU	FW	DMDFON (161)	
SMI04LLUB	SV	LLRMR (572)	
SMK08MDSW	SV	ARMD (531)	
SML05DKUB	SV		DKAT (361)
SML06TEUB	SV		TEB (826)
SMLDYN	FW	DLSAHK (339)	
SNG06LLSB	SV	LLRRM (566)	
SNM05DKUB	SV		DKAT (361)
SNM06ESUB	SV		ESNSWL (691)
SNM06KOUB	SV	MDVERB (540)	
SNM06LLUB	SV	LLRMR (572), LLRRM (566)	
SNM08DMUB	SV		DMDSTP (205)
SNM08KOUB	SV	KOS (896)	
SNM08__UB	SV	ZUE (627)	
SNM10TEUB	SV		TEB (826)
SNM12FEUB	SV	BGMSZS (239)	FUEDK (597)
SNM16KRUB	SV		DKRS (437), KRDY (659), GGKS (412), KRRA (639), KRKE (427)
SNM16OPUW	SV	MDVER (546)	
SNM16ZUUW	SV		ZWMIN (669)
SNS06LLSB	SV	LLRMR (572), LLRNS (562), LLRRM (566)	
SP12LL_UM	FW	UFSPSC (1060)	
SP12VG_UM	FW	UFSPSC (1060)	
SP1ADC_DIF	FW	URADCC (1049)	
SP1_STAT	FW	URADCC (1049)	
SP1_STAT_T	FW	URADCC (1049)	
SPSC_MINUM	FW	UFMER (1060), UFSPSC (1060)	
SPSC_T_UM	FW	UFSPSC (1060)	
SPSVG_UM	FW	UFSPSC (1060)	
SQM05TEUB	SV	TEB (826)	
SRKTEVS	FW	LLRRM (566)	
SRL04DYUB	SV	KRDY (659)	
SRL04KRUB	SV		GGKS (412)
SRL06KOUB	SV	MDVERB (540)	
SRL08DMUB	SV		DMDSTP (205)
SRL08NXUB	SV		NMAXMD (584)
SRL11OPUW	SV	MDVER (546)	
SRL12ZUUW	SV		ZWMIN (669)
SRP06ESUB	SV		ESNSWL (691)
SRST1_UR	SYS		UFSGSC (1070)
STA04LLUB	SV	LLRMR (572)	
STA06ESUB	SV		ESNSWL (691)
STA06LLUB	SV	MDVERB (540)	
STM04SAUB	SV	LLRMR (572)	
STM06LLUB	SV	LLRNS (562), LLRRM (566)	
STM06__UB	SV		ZWMIN (669)
STM12ESUB	SV		ESNSWL (691)
STN06LLUB	SV	LLRNS (562)	
STS08ESUB	SV		ESNSWL (691)
STS12ESUB	SV		ESNSWL (691)
SUMODE0	FW	SU (617)	
SUMODE1	FW	SU (617)	
SUMODE2	FW	SU (617)	
SUMODE3	FW	SU (617)	
SY_2SG	SYS	DUF (1089)	AEVABZK (1003), FGRREGL (1174), GGDVE (477), GGPED (454), FGRFULO (1160), DNWSE (1025), FGRABED (491), DMDSTP (205), DLLR (578)
SY_650ICLK	SYS		GGKS (412)
SY_AGR	SYS		BGPU (276), DMDSTP (205), BGTEMPK (252)
SY_ASG	SYS	MDMIN (538)	KOEVAB (124)
SY_ASR	SYS		DMDSTP (205)
SY_AWUE	SYS		KOEVAB (124)
SY_BDE	SYS	TC6MOD (1112)	BGPU (276), FUEDK (597), KOEVAB (124), BGTEMPK (252)
SY_BGVZS	SYS		FGRFULO (1160)
SY_BKV	SYS	LLRMR (572)	
SY_BLOOP	SYS		GGDVE (477), GGPED (454)
SY_CANAC	SYS	MDVERB (540)	
SY_CDCSIZE	SYS	DCDACC (1132)	
SY_CDKSIZE	SYS	DCDACC (1132)	
SY_CDTSIZE	SYS	DCDACC (1132)	
SY_CLASIZE	SYS	DCDACC (1132)	
SY_CONFSL	SYS		DTEV (856)
SY_COPOTI	SYS		GK (675)
SY_CVT	SYS		FUEDK (597)
SY_DEGFE	SYS		BGPU (276)
SY_DFPMENV	SYS	DCDACC (1132)	
SY_DGANZ	SYS		GGKS (412)
SY_DLDP	SYS	DTEV (856), TC6MOD (1112)	TEBEB (762)

Symbol	Type	Created within	Used within
SY_DLS	SYS		AZUE (904)
SY_DLSHV	SYS		DKAT (361)
SY_DOPZW	SYS		AZUE (904), ZUE (627)
SY_DTES	SYS	TC6MOD (1112)	
SY_DVEADA	SYS		AEVABZK (1003)
SY_EGAS	SYS	NWS (618), UFREAC (1088)	AEVAB (980), AEVABZK (1003), BBSAWE (557), BGRLP (266), BGPU (276), DLLR (578), DTEV (856), TEB (826), BGMSZS (239)
SY_EGFE	SYS		BGPU (276), BGTEMPK (252)
SY_FANT	SYS		DMDSTP (205)
SY_FFESIZE	SYS	DFRZ (1144)	
SY_FFTSIZE	SYS	DCDACC (1132)	
SY_FFZ	SYS		AZUE (904), ZUESZ (632)
SY_FREQ_CP	SYS		AZUE (904)
SY_FWFGR	SYS		FGRFULO (1160), FGRREGL (1174)
SY_GAP	SYS		AZUE (904), RDE (112)
SY_GGGTS	SYS	KOS (896)	
SY_GRDWRT	SYS		GGKS (412), RDE (112)
SY_GRDWRTB	SYS		GGKS (412)
SY_GRNDWRT	SYS		AZUE (904)
SY_INI_OBD	SYS	TCKOMUE (1124)	
SY_KL50	SYS		RDE (112)
SY_KLDF	SYS	DTEV (856), MDVERB (540)	
SY_KOBIDIR	SYS	KOS (896)	
SY_KOEVAB	SYS		AEVABZK (1003)
SY_KOPWM	SYS	MDVERB (540)	
SY_KR_INT	SYS		GGKS (412)
SY_KS1	SYS		GGKS (412)
SY_KS2	SYS		GGKS (412)
SY_KS3	SYS		GGKS (412)
SY_KS4	SYS		GGKS (412)
SY_KSDIFF	SYS		GGKS (412)
SY_LECK	FW	BGDVE (934)	
SY_LFS	SYS	MDVERB (540)	
SY_LWS	SYS	MDVERB (540)	
SY_ME7	SYS		ZUESZ (632)
SY_NACH	SYS		AZUE (904)
SY_NWS	SYS	NWS (618)	BGSRM (245), DMDSTP (205), ESVW (1009), DTEV (856)
SY_NWSA	SYS		BGSRM (245)
SY_NWVAR	SYS		DMDSTP (205)
SY_NZUEB	SYS		AZUE (904)
SY_PBRPW	SYS		GGPED (454)
SY_PGRAD	SYS		NLPH (150)
SY_PGRAD2	SYS		DMDSTP (205), NLPH (150)
SY_PGRAD3	SYS		GGVFZG (497)
SY_PH2OFST	SYS		NLPH (150)
SY_PHTWIN	SYS	NWS (618)	
SY_RDE	SYS		KOEVAB (124)
SY_REDMX	SYS		AEVAB (980), ZUE (627), MDRED (976)
SY_RLAPP	SYS		FUEDK (597)
SY_SGANZ	SYS	DCDACC (1132), MDVERB (540)	AEVAB (980), GGKS (412), BGEVAB (1005)
SY_SLS	SYS	MDVERB (540)	DKAT (361)
SY_STADAP	SYS		ESNSWL (691), ESSTT (679)
SY_STERHK	SYS		DKAT (361)
SY_STERSY	SYS		DKAT (361)
SY_STERVK	SYS	BGKV (71)	BBTEGA (750), BGEVAB (1005), TEBEB (762), TEB (826), LRAEB (759), LRA (797), GK (675), DTEV (856), DLSV (301), DKAT (361)
SY_SU	SYS		DMDSTP (205)
SY_SWE_B	SYS		DMDSTP (205)
SY_SWE_C	SYS		DMDSTP (205)
SY_SWE_S	SYS		DMDSTP (205)
SY_TEETH	SYS		AZUE (904), RDE (112)
SY_TFA	SYS		BGTEMPK (252)
SY_TFBA	SYS	ESUK (699)	
SY_TFNS	SYS		ESNSWL (691)
SY_TFST	SYS		ESSTT (679)
SY_TFVA	SYS	ESUK (699)	
SY_TFWL	SYS		ESNSWL (691)
SY_TSFSIZE	SYS	DCDACC (1132)	
SY_TURBO	SYS	BGRML (287)	BGMSZS (239), GGHFM (230), FUEDK (597), DMDSTP (205), DHFM (233)
SY_TWDKS	SYS		FUEDK (597)
SY_TZW	SYS		ZUE (627), ZUESZ (632)
SY_UBR	SYS	DUF (1089)	KOEVAB (124)
SY_VS	SYS		ESVW (1009), FUEDK (597)
SY_WMAX	SYS		ZUE (627)
SY_WMIN	SYS		AZUE (904), ZUE (627)
SY_ZAS	SYS	MDVER (546)	AEVAB (980)
SY_ZNDAUS	SYS		AZUE (904)
SY_ZYLZA	SYS	BGKV (71), DKRS (437)	AEVAB (980), BGEVAB (1005), BGRLP (266), DMDSTP (205), ESWE (698), KRKE (427), NLPH (150), KRRA (639), ZUE (627), RDE (112), GGKS (412), ESSTT (679), AZUE (904)
SY_ZZBANK	SYS		BGEVAB (1005)

Symbol	Type	Created within	Used within
SY_ZZBANKB	SYS		BGEVAB (1005)
SY_ZZBANKC	SYS		BGEVAB (1005)
SZANSSM1	KL	ESNSWL (691)	
SZANSSM2	KL	ESNSWL (691)	
SZOUTMIN	FW	ZUESZ (632)	
TABGBTS	FW	LAMBTS (732)	
TABGMCSD	FW	DLSH (330)	DLSV (301)
TABGMEX	FW	ATM (20)	
TABGMSVU	FW	DLSV (301)	
TABGSTG	FW	DLSAHK (339)	
TADE	FW	GGTFA (298)	
TADHMN	FW	DHLSHK (1154), DHLSVK (29)	
TADHMX	FW	DHLSHK (1154), DHLSVK (29)	
TADLLR	FW	DLLR (578)	
TADMM	FW	GGTFM (289)	
TADMN	FW	GGTFA (298)	
TADMX	FW	GGTFA (298)	
TADTEAMX	KL	DTEV (856)	
TADTEMX	FW	DTEV (856)	
TAHLL	FW	LLRNS (562)	
TALUST	FW	DMDSTP (205)	
TAMIALU	FW	DMDSTP (205)	
TANDT	KL	ESSTT (679)	
TANDT1	KL	GGTFM (289)	
TANH	FW	ESSTT (679)	
TANH1	FW	GGTFM (289)	
TANKL	FW	GGFST (502)	
TANSELI	KL	GGTFA (298)	
TANSKOB	FW	KOS (896)	
TANSMN	FW	MDZUL (523)	
TANSMN_UM	FW	UFNSC (1077)	
TANW	FW	NWS (618)	
TAPVLTM	KL	AEKP (970)	
TARA	FW	LRAEB (759)	
TARAU	FW	LREB (739)	
TAREIN	FW	ARMD (531)	
TASHS	FW	LREB (739)	
TASIG	FW	DLSH (330)	DLSV (301)
TASTBFA	FW	ATM (20)	
TASUS	FW	SU (617)	
TATEGMX	FW	ATEV (969)	
TATELL	FW	BBTEGA (750)	
TATEMSN	KL	ATEV (969)	
TATMKH	FW	ATM (20)	
TATMKH2	FW	ATM (20)	
TATMKW	FW	ATM (20)	
TATMSA	FW	ATM (20)	
TATMSAE	FW	ATM (20)	
TATMSAE2	FW	ATM (20)	
TATMSTI	FW	ATM (20)	
TATMTMOT	FW	ATM (20)	
TATMTP	FW	ATM (20)	
TATMTRKH	FW	ATM (20)	
TATMTRKH2	FW	ATM (20)	
TATMWMK	FW	ATM (20)	
TAVHKSAO	FW	BBSAWE (557)	
TAVVKSAO	FW	BBSAWE (557)	
TBLRH	FW	LRHK (781)	
TBLRH2	FW	LRHK (781)	
TC6TECI	FW	DTEV (856)	
TC6TECL	FW	DTEV (856)	
TC6TECNL	FW	DTEV (856)	
TC6TECP	FW	DTEV (856)	
TC6TECRF	FW	DTEV (856)	
TC6TECRM	FW	DTEV (856)	
TC6TECT	FW	DTEV (856)	
TCIDIS	FW	BGDVE (934)	
TDCAN	FW	CAN (1124)	
TDCAS	FW	DCAS (1128)	
TDCDIS	FW	SREAKT (963)	
TDCINS	FW	DCINS (1126), DCKUP (1128)	
TDCKUP	FW	DCKUP (1128)	
TDDNWS	FW	DNWS (622)	
TDDST	FW	DDST (851)	
TDDSTO	FW	DDST (851)	
TDEGFEMN	FW	DEGFE (592)	
TDEGFEMX	FW	DEGFE (592)	
TDEGFENO	FW	DEGFE (592)	
TDEGFEST	FW	DEGFE (592)	
TDEPOEL	FW	GGPOEL (296)	
TDFRKAD	FW	LRKA (795)	
TDFRKAU	FW	LRKA (795)	

Symbol	**Type**	**Created within**	**Used within**
TDHCAS	FW	DCAS (1128)	
TDHCINS	FW	DCINS (1126)	
TDHCKUP	FW	DCKUP (1128)	
TDKATAKT	FW	DKAT (361)	
TDKATATT	FW	DKAT (361)	
TDKLAGDE	FW	ADVE (918)	
TDKNACH	FW	BGDVE (934)	
TDKPAW	FW	GGDVE (477)	
TDLAMBTSTA	KL	LAMBTS (732)	
TDLLR	FW	DLLR (578)	
TDLLRMN	FW	DLLR (578)	
TDLLRMX	FW	DLLR (578)	
TDLLRNF	FW	DLLR (578)	
TDLRPIDC	FW	ADVE (918)	
TDLRPIDMX	FW	BGDVE (934)	
TDMFBSA	FW	MDFAW (508)	
TDMFBWE	FW	MDFAW (508)	
TDMFWEMI	KL	MDFAW (508)	
TDMKO	FW	MDVERB (540)	
TDMLHFM	FW	DHFM (233)	
TDMLMN	FW	DHFM (233)	
TDMLMX	FW	DHFM (233)	
TDMLNF	FW	DHFM (233)	
TDMLSDS	FW	MDFAW (508)	
TDMLST	FW	DHFM (233)	
TDMRESLL	FW	LLRMR (572)	
TDMSDKS	FW	BGMSZS (239)	
TDNSTA	FW	GGTFA (298)	
TDNSUB	FW	GGUB (487)	
TDNWSP	FW	DNWKW (134)	
TDPUA	FW	BGPU (276)	
TDRLQNWS	FW	BGPU (276)	
TDRLQSU	FW	BGPU (276)	
TDTA	FW	GGTFA (298)	
TDTAL	FW	GGTFA (298)	
TDTEFA	FW	DTEV (856)	
TDTESZO	FW	DTEV (856)	
TDTESZU	FW	DTEV (856)	
TDTEZAM	FW	DTEV (856)	
TDTM	FW	GGTFM (289)	
TDTMMA	FW	GGTFM (289)	
TDTMNP	FW	GGTFM (289)	
TDUB	FW	GGUB (487)	
TDUBHFM	FW	DHFM (233)	
TDV	FW	DVFZ (500)	
TDVIVZ	FW	FGRABED (491)	
TDVKUP	FW	DVKUP (1027)	
TDVZVI	FW	FGRABED (491)	
TDZFPUA	FW	BGPU (276)	
TEBF	FW	AEKP (970)	
TEMIN	FW	RKTI (979), TEB (826)	
TEPBRKUP	FW	GGEGAS (474)	
TEPCL	FW	DEPCL (1151)	
TEPCLI	FW	DEPCL (1151)	
TFDLLRO	FW	DLLR (578)	
TFDLLRU	FW	DLLR (578)	
TFGRAR	FW	FGRREGL (1174)	
TFGRFDY	FW	FGRABED (491)	
TFGRHE	FW	GGFGRH (473)	
TFGRTIP	FW	GGFGRH (473)	
TFGRUEOB	FW	FGRABED (491)	
TFGRUM	FW	FGRABED (491)	
TFGRUNUB	FW	FGRABED (491)	
TFGRVRAB	FW	GGVFZG (497)	
TFMIZU	FW	MDZUL (523)	
TFPWG2	FW	GGPED (454)	
TFRA	FW	DKVS (811)	
TFRAOZ	FW	DKVS (811)	
TFRAUZ	FW	DKVS (811)	
TFRMB	FW	DLSAHK (339)	
TFRMDTEE	FW	DTEV (856)	
TFRMST	FW	DKVS (811)	
TFRMZST	FW	DKVS (811)	
TFRSGN	FW	LR (768)	
TFTEINI	FW	TEB (826)	
TFWDKPN	KL	GGDVE (477)	
TFWDKSOM	FW	WDKSOM (614)	
TFWPFGR	FW	BGWPFGR (548)	
TGGLS	FW	GGLSH (318), GGLSV (382)	
THDMB	FW		MDKOG (516)
THEH	FW	HLS (392)	
THEV	FW	HLS (392)	

Symbol	Type	Created within	Used within
THHA	FW	HLS (392)	
THHA2	FW	HLS (392)	
THHAWU	FW	HLS (392)	
THOPP1	FW	GGPED (454)	
THOPP2	FW	GGPED (454)	
THSHKTK	KL	HLS (392)	
THSHKTK2	KL	HLS (392)	
THSRIH	FW	GGLSH (318)	
THSRIV	FW	GGLSV (382)	
THSVKTA	KL	HLS (392)	
THSVKTA2	KL	HLS (392)	
THVA	FW	HLS (392)	
THVA2	FW	HLS (392)	
THVAWU	FW	HLS (392)	
TIKATMOE	FW	ATM (20)	
TKATMLRH	FW	LRHK (781)	
TKATMLRH2	FW	LRHK (781)	
TKATMN	FW	BBKHZ (890)	
TKATMOE	FW	ATM (20)	
TKATSA	FW	BBSAWE (557)	
TKATW	FW	BBKHZ (890)	
TKHABB	FW	BBKHZ (890)	
TKHFSAB	FW	BBKHZ (890)	
TKHLL	FW	BBKHZ (890)	
TKHLLAB	FW	BBKHZ (890)	
TKHLLMX	FW	BBKHZ (890)	
TKHMX	FW	BBKHZ (890)	
TKOAMAD	FW	KOS (896)	
TKOAMNN	KL	KOS (896)	
TKOAMXN	KL	KOS (896)	
TKOBEMNN	KL	KOS (896)	
TKODPAMNN	KL	KOS (896)	
TKODPAMXN	KL	KOS (896)	
TKOEMNN	KL	KOS (896)	
TKOMBKOA	FW	KOS (896)	
TKOMBKOE	FW	KOS (896)	
TKOVKO	FW	KOS (896)	
TKOWPAMNN	KL	KOS (896)	
TKOWPAMXN	KL	KOS (896)	
TKSTBFA	FW	ATM (20)	
TKTPVK	FW	DLSA (398)	
TLAFA	FW	LAMFAW (728)	
TLFRES	FW	LFS (69)	
TLFSARMX	FW	LFS (69)	
TLFSART	FW	LFS (69)	
TLLASH	FW	DLSAHK (339)	
TLRBAM	KL	LREB (739)	
TLRHS	FW	LREB (739)	
TLRTMS	KL	LREB (739)	
TLRVAM	KL	LREB (739)	
TLRZWTMS	KL	LREB (739)	
TM1LF	FW	LFS (69)	
TM6LF	FW	LFS (69)	
TMADB0	FW	STADAP (684)	
TMADB1	FW	STADAP (684)	
TMADB2	FW	STADAP (684)	
TMAR	FW	ARMD (531)	
TMASKIV1	FW	DMDMIL (216)	
TMASO	FW	DLSV (301)	
TMAXKAT	FW	DKAT (361)	
TMBVH	FW	GGPED (454)	
TMCC650	FW	GGKS (412)	
TMDDST	FW	DDST (851)	
TMDLLR	FW	DLLR (578)	
TMDMAD	FW	MDVERAD (549)	
TMDMMA	FW	GGTFM (289)	
TMDMMAT	KL	GGTFM (289)	
TMDMMAU	FW	GGTFM (289)	
TMDMMEE	FW	GGTFM (289)	
TMDMMER	FW	GGTFM (289)	
TMDMN	FW	GGTFM (289)	
TMDMX	FW	GGTFM (289)	
TMDNW	FW	DNWS (622)	
TMDTEU	FW	DTEV (856)	
TMDV	FW	DVFZ (500)	
TMDYNA	FW	KRDY (659)	
TMESP	FW	ACIFI (1013)	
TMFRATMN	FW	LRA (797)	
TMFRATUB	FW	LRA (797)	
TMH	FW	ESSTT (679)	
TMHLL	FW	LLRNS (562)	
TMHSG	FW	ESSTT (679)	

Symbol	Type	Created within	Used within
TMINKAT	FW	DKAT (361)	
TMK	FW	ESSTT (679)	
TMKOAO	FW	KOS (896)	
TMKOAU	FW	KOS (896)	
TMKR	FW	GGKS (412), KRRA (639)	
TMKRA	FW	KRRA (639)	
TMLAST	FW	ARMD (531)	
TMLFAFO	FW	LFS (69)	
TMLFAFU	FW	LFS (69)	
TMLFAROF	KL	LFS (69)	
TMLIM	FW	STADAP (684)	
TMLLX	FW	LLRNS (562)	
TMLRTMS	KL	GGTFM (289)	
TMMIBGR	FW	MDBGRG (530)	
TMMXRT	FW	GGTFM (289)	
TMNEB	FW	DLSV (301)	
TMNKATT	FW	DKAT (361)	
TMNSMN	FW	MDZUL (523)	
TMNSMN_UM	FW	UFNSC (1077)	
TMNW	FW	NWS (618)	
TMNWWLO	FW	NWS (618)	
TMNWWLU	FW	NWS (618)	
TMOHSMN	FW	HLS (392)	
TMOTELI	KL	GGTFM (289)	
TMOTNMX	FW	NMAXMD (584)	
TMOTWRM	FW	BGTEMPK (252)	
TMQSYN	FW	GGDPG (74)	
TMRA1	FW	LREB (739)	
TMRA2	FW	LREB (739)	
TMRAA	FW	LRA (797), LRAEB (759)	
TMRAK	FW	LREB (739)	
TMRZHLL	FW	LLRNS (562)	
TMSH	FW	DLSH (330)	
TMSHA	FW	DLSH (330)	
TMSHS	FW	LREB (739)	
TMSKS	FW	BBBO (853)	
TMSLOF	FW	BBKHZ (890)	
TMSNOGA	FW	BBTEGA (750)	
TMSTMAD	FW	KOS (896)	
TMSUKTD	FW	DKAT (361)	
TMSUS	FW	SU (617)	
TMSUSV	FW	SU (617)	
TMSUTMUMA	FW	BGDVE (934)	
TMSV	FW	DLSV (301)	
TMSVA	FW	DLSV (301)	
TMTE	FW	TEBEB (762)	
TMUKAK	FW	ESUKA (711)	
TMUKAU	FW	ESUKA (711)	
TMUKAW	FW	ESUKA (711)	
TMVER	FW		MDKOG (516)
TMWAFMN	FW	WANWKW (125)	
TMWALA	FW	ATWAL (297)	
TMWALE	FW	ATWAL (297)	
TMWUC	FW	DMDMIL (216), DWUC (1147)	
TMWUCST	FW	DWUC (1147)	
TMZUB2MX	FW	AZUE (904)	
TN2FGRGA	KL	FGRREGL (1174)	
TNALU	FW	DMDLU (193)	
TNLATM	FW	ATM (20)	
TNLATMTM	FW	ATM (20)	
TNLATMTU	FW	ATM (20)	
TNLEKPVL	FW	AEKP (970)	
TNLPHWAIT	FW	NLDG (157)	
TNLSGM	KL	BGTABST (1030)	
TNLSGMN	FW	MOTAUS (1028)	
TNLSGMX	FW	MOTAUS (1028)	
TNLSYN	FW	NLDG (157)	
TNMAXP	FW	NMAXMD (584)	
TNMXH	FW	NMAXMD (584)	
TNMXPR	FW		NMAXMD (584)
TNOME	FW	SREAKT (963)	
TNSC	FW	MDZUL (523)	
TNSLFA	FW	LLRNFA (564)	
TNSOF	FW	MDZUL (523)	
TNSRT	FW	GGTFM (289)	
TNSTDN	FW	DLSV (301)	
TNSTDNH	FW	DLSH (330)	
TNSTFON	FW	DMDFON (161)	
TNSTKO	FW	KOS (896)	
TNSURLP	FW	BGRLP (266)	
TNSUUK	FW	ESUK (699)	
TNSUUKA	FW	ESUKA (711)	

Symbol	Type	Created within	Used within
TOCKUP	FW	CAN (1124)	
TPERDTE	FW	DTEV (856)	
TPHERKMN	FW	NLPH (150)	
TPHSABSP	FW	NLPH (150)	
TPHSSP	FW	NLPH (150)	
TPNSE	FW	DDVE (950)	
TPNSE1	FW	GGPED (454)	
TPREL	FW	GGDPG (74)	
TPSVKMN	FW	DLSSA (350)	
TPSVKMX	FW	DLSSA (350)	
TPVL	FW	AEKP (970)	
TPWRSV	FW	ADVE (918)	
TQTEAB	FW	TEB (826)	
TQTEDAB	FW	TEB (826)	
TRAU	FW	LREB (739)	
TRD	FW	ALE (136)	
TREHS	FW	HLS (392)	
TRIAKTH	FW	GGLSH (318)	
TRIAKTV	FW	GGLSV (382)	
TRIIMPH	FW	GGLSH (318)	
TRIIMPV	FW	GGLSV (382)	
TRIPFASH	FW	DLSAHK (339)	
TRKA	FW	DKVS (811)	
TRKATZ	FW	DKVS (811)	
TRKAZZ	FW	DKVS (811)	
TRSA	FW	DLSV (301)	
TRSAFA	FW	DLSH (330)	
TRSAH	FW	DLSH (330)	
TRSE	FW	DLSH (330)	DLSV (301)
TSAKAMN	FW	LRKA (795)	
TSALASH	FW	DLSAHK (339)	
TSBBVTMS	KL	LREB (739)	
TSFBREMS	FW	GGEGAS (474)	
TSFEV1	FW	DEVE (1017)	
TSFEV2	FW	DEVE (1017)	
TSFEV3	FW	DEVE (1017)	
TSFEV4	FW	DEVE (1017)	
TSFEV5	FW	DEVE (1017)	
TSFEV6	FW	DEVE (1017)	
TSFEV7	FW	DEVE (1017)	
TSFEV8	FW	DEVE (1017)	
TSFHSH	FW	DHLSHK (1154)	
TSFHSH2	FW	DHLSHK (1154)	
TSFHSV	FW	DHLSVK (29)	
TSFHSV2	FW	DHLSVK (29)	
TSFHSVE	FW	DHLSVKE (902)	
TSFHSVE2	FW	DHLSVKE (902)	
TSFKAT	FW	DKAT (361)	
TSFKAT2	FW	DKAT (361)	
TSFKPE	FW	DEKPE (1020)	
TSFKRNT	FW	DKRNT (445)	
TSFKROF	FW	DKRNT (445)	
TSFKRTP	FW	DKRTP (451)	
TSFKS1	FW	DKRS (437)	
TSFKS2	FW	DKRS (437)	
TSFKS3	FW	DKRS (437)	
TSFKS4	FW	DKRS (437)	
TSFLASH	FW	DLSAHK (339)	
TSFLASH2	FW	DLSAHK (339)	
TSFLATP	FW	DLSA (398)	
TSFLATP2	FW	DLSA (398)	
TSFLATV	FW	DLSA (398)	
TSFLATV2	FW	DLSA (398)	
TSFLSH	FW	DLSH (330)	
TSFLSH2	FW	DLSH (330)	
TSFLSV2	FW	DLSV (301)	
TSFLUEA	FW	DMLSE (34)	
TSFLUEB	FW	DMLSE (34)	
TSFMDB	FW	MDKOG (516)	
TSFMILE	FW	DMILE (36)	
TSFNWKW	FW	DNWKW (134)	
TSFNWKW2	FW	DNWKW (134)	
TSFNWS	FW	DNWS (622)	
TSFNWS2	FW	DNWS (622)	
TSFPH	FW	DPH (144)	
TSFPH2	FW	DPH (144)	
TSFTA	FW	GGTFA (298)	
TSFTES	FW	DTEV (856)	
TSFTEVE	FW	DTEVE (1022)	
TSFTM	FW	GGTFM (289)	
TSFUB	FW	GGUB (487)	
TSFUF2SG	FW	DUF (1089)	

Symbol	Type	Created within	Used within
TSFUFMV	FW	DUF (1089)	
TSFUFSKA	FW	DUF (1089)	
TSFURRAM	FW	DUR (1052)	
TSFURROM	FW	DUR (1052)	
TSFURRST	FW	DUR (1052)	
TSFVKUP	FW	DVKUP (1027)	
TSGSCNU_UM	FW	UFSGSC (1070)	
TSLUES2	FW	LFS (69)	
TSPERN	KL	LR (768)	
TSPERN2	KL	LR (768)	
TSTEAA	FW	DLSA (398)	
TSVKKO	FW	DLSA (398)	
TSVKKTO	FW	DLSA (398)	
TSVKKTU	FW	DLSA (398)	
TSVKKU	FW	DLSA (398)	
TSVKO	FW	DLSA (398)	
TSVKU	FW	DLSA (398)	
TSWKNBGA	KL	FGRFULO (1160)	
TSWKNVGA	KL	FGRFULO (1160)	
TTBMH	FW	DLSH (330), DLSV (301)	
TTDSST	FW	DDST (851)	
TTDSTP	FW	DDST (851)	
TTE	FW	BBTEGA (750)	
TTEAE	FW	BBTEGA (750)	
TTEAUS	FW	TEBEB (762)	
TTEBSTP	FW	BBTEGA (750)	
TTEGA	FW	BBTEGA (750)	
TTEGAI	FW	BBTEGA (750)	
TTEGAZO	FW	BBTEGA (750)	
TTEGAZU	FW	BBTEGA (750)	
TTEINI	FW	BBTEGA (750)	
TTEMN	FW	BBTEGA (750)	
TTEPRIO	FW	BBTEGA (750)	
TTEVAZ	FW	DTEV (856)	
TTEVUB	KL	ATEV (969)	
TTEZAO	FW	BBTEGA (750)	
TTEZAU	FW	BBTEGA (750)	
TTIPINEN	FW	ZWMIN (669)	
TTIPINON	FW	ZWMIN (669)	
TTLASH	FW	DLSAHK (339)	
TTMUMASTA	FW	BGDVE (934)	
TUMDETM	FW	GGTFM (289)	
TUMTAI	FW	BGTABST (1030)	
TUMTAIT	FW	ATM (20)	
TUPWBWV	FW	GGPED (454)	
TUPWG12	FW	GGPED (454)	
TUPWG1O	FW	GGPED (454)	
TUPWG1U	FW	GGPED (454)	
TUPWG2O	FW	GGPED (454)	
TUPWG2U	FW	GGPED (454)	
TUSBELH	FW	GGLSH (318)	
TUSBELV	FW	GGLSV (382)	
TUSCHUB	FW	DLSAHK (339)	
TUSDU	FW	DLSV (301)	
TUSDUC	FW	DLSV (301)	
TUSDUFA	FW	DLSH (330)	
TUSDUH	FW	DLSH (330)	
TUSDYN	FW	DLSAHK (339)	
TUSEINH	FW	DLSH (330)	
TUSEINV	FW	DLSV (301)	
TUSENLASH	FW	DLSAHK (339)	
TUSFETT	FW	DLSV (301)	
TUSHSMIN	FW	DLSAHK (339)	
TUSKS	FW	DLSH (330)	DLSV (301)
TUSLASH	FW	DLSAHK (339)	
TUSMAX	FW	DLSH (330)	DLSV (301)
TUSPNMN	FW	DLSSA (350)	
TUSPNMX	FW	DLSSA (350)	
TUSSA	FW	DLSAHK (339)	
TUSTAL	FW	DLSH (330)	
TVARS	FW	ARMD (531)	
TVDK	FW	LLRBB (575)	
TVDNWS	FW	DNWS (622)	
TVDRREC	FW	DMS (37)	
TVDTEABG	FW	DTEV (856)	
TVDTEB	FW	DTEV (856)	
TVDTEE	FW	DTEV (856)	
TVDTELLA	FW	DTEV (856)	
TVDTEVP	FW	DTEV (856)	
TVDTEVPM	FW	DTEV (856)	
TVDTEVZ	FW	DTEV (856)	
TVERBR	FW	GGEGAS (474)	

Symbol	Type	Created within	Used within
TVFHS	FW	DHLSHK (1154)	
TVFRG	FW	FUEREG (595)	
TVFSAM	KL	MDWAN (554)	
TVFSAWE	FW	MDFAW (508)	
TVFSEM	KL	MDWAN (554)	
TVFSTA	FW	GGFST (502)	
TVFUE	FW	MDWAN (554)	
TVFZNW	FW	ACIFI (1013)	
TVHSH	FW	HLS (392)	
TVHSV	FW	HLS (392)	
TVHSVMX	FW	HLS (392)	
TVKOE1	FW	KOS (896)	
TVKOEV	FW	KOS (896)	
TVKOSSIM	FW	KOS (896)	
TVKTDTK	KL	DKAT (361)	
TVKUP	FW	GGEGAS (474)	
TVKUPHS	KL	ARMD (531)	
TVKUPPL	FW	LLRBB (575)	
TVKUPRS	KL	ARMD (531)	
TVKUPV	FW	GGEGAS (474)	
TVLADV	KL	FGRREGL (1174)	
TVLISTU	FW	LLRRM (566)	
TVLLR	FW	LLRBB (575)	
TVLLRI	KL	LLRBB (575)	
TVLLRPD	KL	LLRBB (575)	
TVLLRPST	FW	LLRRM (566)	
TVLLRSTE	FW	LLRBB (575)	
TVLRA	FW	LRAEB (759)	
TVLRHDK	FW	LRHK (781)	
TVLRHMN	FW	DLSA (398)	
TVLRHMN2	FW	DLSA (398)	
TVLRHMX	FW	DLSA (398)	
TVLRHMX2	FW	DLSA (398)	
TVMIBEG	FW	MDKOG (516)	
TVMXPR	FW	VMAXMD (588)	
TVNWF	FW	NWS (618)	
TVNWGE	FW	NWS (618)	
TVNWNST	FW	NWS (618)	
TVNWS	FW	NWS (618)	
TVNWSTTM	KL	NWS (618)	
TVNW_S	FW	NWS (618)	
TVPDKP1	FW	GGDVE (477)	
TVPDKP2	FW	GGDVE (477)	
TVPKH	FW	LLRRM (566)	
TVPWDK12	FW	GGDVE (477)	
TVPWDK13	FW	GGDVE (477)	
TVPWDK23	FW	GGDVE (477)	
TVRESLL	FW	LLRMR (572)	
TVRESTM	FW	LLRMR (572)	
TVRIF	FW	DHLSHK (1154), DHLSVK (29)	
TVSAG0	FW	BBSAWE (557)	
TVSATEM	KL	TEB (826)	
TVSATM	KL	BBSAWE (557)	
TVSLR	KL	LREB (739)	
TVSU	FW	SU (617)	
TVSU2	FW	SU (617)	
TVSUM	KL	SU (617)	
TVSUST	FW	SU (617)	
TVTMWAL	FW	ATWAL (297)	
TVTUMTA	FW	BGTABST (1030)	
TVUB	KL	AES (973)	
TVWDKS	FW	FUEDKSA (610)	
TVZWMSA	FW	ZWMIN (669)	
TVZWMSE	FW	ZWMIN (669)	
TWBDCY	FW	DDCY (1146)	
TWDDTV	FW	DLSA (398)	
TWDKATST	FW	DKAT (361)	
TWDKRED	FW	WDKSOM (614)	
TWDKSNST	KL	WDKSOM (614)	
TWDKSV	KL	FUEDK (597)	
TWDLSSA	FW	DLSSA (350)	
TWDMAD	FW	MDVERAD (549)	
TWKTDLP	FW	DKAT (361)	
TWLRTMS	KL	GGTFM (289)	
TWNSTA	FW	GGFST (502)	
TWNTAL	FW	GGFST (502)	
TWPLK	FW	GGPED (454)	
TWPMBBR	FW	GGPED (454)	
TWSTT	KL	ESSTT (679)	
TWTMNHST	FW	GGTFM (289)	
TZ2FGRGA	KL	FGRREGL (1174)	
TZMIN	FW	AEKP (970)	

Symbol	Type	Created within	Used within
TZSPINI	FW	ARMD (531)	
TZTOL_UM	FW	UFNC (1063)	
T_LAMPE	FW	ATWAL (297)	
UADHFMMN	FW	DHFM (233)	
UADHFMMX	FW	DHFM (233)	
UANAUFRP	FW	BGDVE (934)	
UANNMAX	FW	BGDVE (934)	
UANPEDMAX	FW	BGDVE (934)	
UANPIDMIN	FW	BGDVE (934)	
UANPIDMINA	FW	BGDVE (934)	
UANUATS	FW	BGDVE (934)	
UANVFZG	FW	BGDVE (934)	
UANZURP	FW	BGDVE (934)	
UAN_O_MT	FW	BGDVE (934)	
UAN_STORE	FW	BGDVE (934)	
UAN_U_MT	FW	BGDVE (934)	
UBDCAN	FW	CAN (1124), DCKUP (1128), DCINS (1126), DCAS (1128)	
UBDE	FW	GGUB (487)	
UBDLS	FW	DHLSHK (1154), DHLSVK (29), DLSH (330) DLSV (301)	
UBDLSMX	FW	DHLSHK (1154), DHLSVK (29)	
UBDMN1	FW	GGUB (487)	
UBDMN2	FW	GGUB (487)	
UBDMN3	FW	GGUB (487)	
UBDMX	FW	GGUB (487)	
UBDTRDE	FW	RDE (112)	
UBHFM	FW	DHFM (233)	
UBHS	FW	HLS (392)	
UBKST	FW	STADAP (684)	
UBKSTMX	FW	STADAP (684)	
UBLF	FW	LFS (69)	
UBNACHL	FW	GGUB (487)	
UBNLMN	FW	MOTAUS (1028)	
UBSOLMN	FW	BGLBZ (489)	
UBSOLMX	FW	BGLBZ (489)	
UBSTS	FW	AEKP (970)	
UBVDKPO	FW	GGDVE (477)	
UBVDKPU	FW	GGDVE (477)	
UB_UANL	FW	BGDVE (934)	
UDKNLP1N	FW	BGDVE (934)	
UDKNLP2N	FW	BGDVE (934)	
UDKNLPTOL	FW	ADVE (918)	
UDKP1AMAX	FW	BGDVE (934)	
UDKP1AMIN	FW	BGDVE (934)	
UDKP1AURI	FW	BGDVE (934)	
UDKP1DUS	FW	BGDVE (934)	
UDKP1NHUB	FW	BGDVE (934)	
UDKP1O	FW	GGDVE (477)	
UDKP1U	FW	GGDVE (477)	
UDKP1VID	FW	BGDVE (934)	
UDKP1VOMA	FW	BGDVE (934)	
UDKP1VOMI	FW	BGDVE (934)	
UDKP1VOSC	FW	BGDVE (934)	
UDKP1VUSC	FW	BGDVE (934)	
UDKP1VVMA	FW	BGDVE (934)	
UDKP1VVMI	FW	BGDVE (934)	
UDKP2AMAX	FW	BGDVE (934)	
UDKP2AMIN	FW	BGDVE (934)	
UDKP2AURI	FW	BGDVE (934)	
UDKP2O	FW	GGDVE (477)	
UDKP2U	FW	GGDVE (477)	
UDKPALOS	FW	BGDVE (934)	
UDKPAOFF	FW	BGDVE (934)	
UDKPATMX	FW	BGDVE (934)	
UDKRGOFS	FW	DKRNT (445)	
UDKRTP	FW	DKRTP (451)	
UDKSNO	KL	DKRS (437)	
UDKSNU	KL	DKRS (437)	
UEVERG	KL	MDWAN (554)	
UHDMN	FW	DHLSHK (1154)	
UHDMX	FW	DHLSHK (1154)	
UHSN	FW	HLS (392)	
UNWDHFM	FW	DHFM (233)	
UNWDNWS	FW	DNWS (622)	
UPVGNENN	FW	BGDVE (934)	
UPW1BE	FW	GGPED (454)	
UPW1LLMX	FW	GGPED (454)	
UPWG12U	FW	GGPED (454)	
UPWG1O	FW	GGPED (454)	
UPWG1U	FW	GGPED (454)	
UPWG2O	FW	GGPED (454)	
UPWG2U	FW	GGPED (454)	

Symbol	Type	Created within	Used within
UPWGO	FW	GGPED (454)	
UPWGTG	FW	GGPED (454)	
UPWGTL	FW	GGPED (454)	
UPWGU	FW	GGPED (454)	
UPWGUBF	FW	GGPED (454)	
UPWGUR	FW	GGPED (454)	
UPWGVG	FW	GGPED (454)	
URL2SUNM	KL	BGSRM (245)	
URL3SUNM	KL	BGSRM (245)	
URLNM	KL	BGSRM (245)	
URLSUNM	KL	BGSRM (245)	
USDBO	FW	DLSV (301)	
USDBU	FW	DLSV (301)	
USFHK	FW	DLSV (301)	
USHKAMN	FW	LRKA (795)	
USHKAMX	FW	LRKA (795)	
USHLEAN	FW	DLSAHK (339)	
USHOV	FW	HLS (392)	
USHRICH	FW	DLSAHK (339)	
USHSTGMX	FW	DLSAHK (339)	
USHSTSOLL	FW	DLSAHK (339)	
USHUV	FW	HLS (392)	
USIVMAXH	FW	DLSSA (350)	
USIVMAXV	FW	DLSSA (350)	
USIVMINH	FW	DLSSA (350)	
USIVMINV	FW	DLSSA (350)	
USMASO	FW	DLSV (301)	
USMAX	FW	DLSH (330)	DLSV (301)
USMHK	FW	DLSV (301)	
USMIN	FW	DLSH (330)	DLSV (301)
USMNSAMN	FW	DLSSA (350)	
USMNSAMX	FW	DLSSA (350)	
USMNSHMN	FW	DLSSA (350)	
USMNSHMX	FW	DLSSA (350)	
USMXSAMN	FW	DLSSA (350)	
USMXSAMX	FW	DLSSA (350)	
USMXSHMN	FW	DLSSA (350)	
USMXSHMX	FW	DLSSA (350)	
USPVR	FW	DLSV (301)	
USR	FW	DLSSA (350), LR (768), LREB (739)	
USREF	FW	DLSV (301)	
USREFH	FW	DLSH (330)	
USREM	FW	DLSV (301)	
USREMH	FW	DLSH (330)	
USRHKSH	FW	DLSSA (350)	
USRHKSHJ	FW	DLSSA (350)	
USRIMINH	FW	GGLSH (318)	
USRIMINV	FW	GGLSV (382)	
USRIOH	FW	GGLSH (318)	
USRIOV	FW	GGLSV (382)	
USRIUH	FW	GGLSH (318)	
USRIUV	FW	GGLSV (382)	
USSCHUB	FW	DLSAHK (339)	
USVKAMX	FW	LRKA (795)	
VABSCH	FW	VMAXMD (588)	
VANF	FW	LLRMR (572)	
VARAU	FW	ARMD (531)	
VDASH	FW	MDFAW (508)	
VDKUP	FW	DVKUP (1027)	
VDMN	FW	DVFZ (500)	
VDMX	FW	DVFZ (500)	
VFGREMAX	FW	FGRABED (491)	
VFGREMIN	FW	FGRABED (491)	
VFGRMAX	FW	FGRABED (491)	FGRFULO (1160)
VFGRMIN	FW	FGRABED (491)	FGRFULO (1160)
VFZGADMD	FW	DMDSTP (205)	
VFZMN	FW	GGVFZG (497)	
VFZR1O	FW	GGVFZG (497)	
VFZR1U	FW	GGVFZG (497)	
VFZR2O	FW	GGVFZG (497)	
VFZR2U	FW	GGVFZG (497)	
VHA	FW	BGPU (276)	
VHYST	FW	VMAXMD (588)	
VKO	FW	KOS (896)	
VKOAO	FW	KOS (896)	
VKOB	FW	KOS (896)	
VLLR	FW	LLRBB (575)	
VLMXVZ	KL	FGRREGL (1174)	
VLSD	FW	MDFAW (508)	
VMAXO	FW	VMAXMD (588)	
VMAXP	FW	VMAXMD (588)	
VMDUB	FW	GGUB (487)	

Symbol	Type	Created within	Used within
VMIBGR	FW	MDBGRG (530)	
VMIN_UM	FW	UFFGRC (1078)	
VNMX	FW	NMAXMD (584)	
VNVKO	FW	KOS (896)	
VNVKOB	FW	KOS (896)	
VREGLMAX	FW	FGRFULO (1160)	
VREGLMIN	FW	FGRFULO (1160)	
VRFGRMN	FW	GGVFZG (497)	
VSAA	FW	BBSAWE (557)	
VSL	FW	LLRNS (562)	
VTUMTA	FW	BGTABST (1030)	
VTUMTAT	FW	ATM (20)	
VVORH	FW	VMAXMD (588)	
VWPMBBR	FW	GGPED (454)	
WAD0T1	FW	STADAP (684)	
WAD0T2	FW	STADAP (684)	
WAD1T0	FW	STADAP (684)	
WAD1T2	FW	STADAP (684)	
WAD2T0	FW	STADAP (684)	
WAD2T1	FW	STADAP (684)	
WAIT_T_UM	FW	UFREAC (1088), URMEM (1044)	
WDKARN	KL	LRAEB (759)	
WDKBEWS	FW	ADVE (918)	
WDKETE	FW	ADVE (918)	
WDKFPRO1	FW	BGDVE (934)	
WDKFPRO2	FW	BGDVE (934)	
WDKFPRZ1	FW	BGDVE (934)	
WDKFPRZ2	FW	BGDVE (934)	
WDKHKDN	KL	BGPU (276)	
WDKHKN	KL	BGPU (276)	
WDKNLPMA	FW	BGDVE (934)	
WDKNLPMI	FW	BGDVE (934)	
WDKNLPTOL	FW	ADVE (918)	
WDKNSTORE	FW	BGDVE (934)	
WDKPMXN	KL	GGDVE (477)	
WDKREIB	FW	ADVE (918)	
WDKSAPNOL	FW	ADVE (918)	
WDKSAPP	FW	FUEDK (597)	
WDKSFPR	FW	BGDVE (934)	
WDKSFPRO	FW	BGDVE (934)	
WDKSNLN	KL	WDKSOM (614)	
WDKSOFS	FW	FUEDK (597)	
WDKSTFEIN	FW	ADVE (918)	
WDKSTGROB	FW	ADVE (918)	
WDKSTMUMA	FW	BGDVE (934)	
WDKUGDN	KL	BGMSZS (239)	
WEAN	KL	ESVW (1009)	
WEEM	KL	ESVW (1009)	
WEEMRFAN	KL	ESVW (1009)	
WEESTATI	KL	ESVW (1009)	
WEESTM	KL	ESVW (1009)	
WEESTN	KL	ESVW (1009)	
WEESTS	FW	ACIFI (1013)	
WEVS	FW	ESVW (1009)	
WFRL	KL	ESUK (699)	
WKRLZOF	KL	KRRA (639)	
WKRLZOFEKS	FW	KRRA (639)	
WMABGKH	FW	ATM (20)	
WMABGKH2	FW	ATM (20)	
WMKATKH	FW	ATM (20)	
WMKATKH2	FW	ATM (20)	
WMNDOPZ	FW	ZUE (627)	
WNWA	FW	DNWS (622)	
WNWAFMX	FW	WANWKW (125)	
WNWASA	FW	NWS (618)	
WNWASMX	FW	WANWKW (125)	
WNWEOA	FW	NWS (618)	
WNWIMXT	FW	NWS (618)	
WNWP	FW	DNWS (622)	
WNWSPMN	FW	DNWKW (134)	
WNWSPMX	FW	DNWKW (134)	
WNWSPS2_0	FW	DNWKW (134), WANWKW (125)	
WNWSPS2_1	FW	WANWKW (125)	
WNWSPS2_2	FW	WANWKW (125)	
WNWSPS2_3	FW	WANWKW (125)	
WNWSPS_0	FW	DNWKW (134), WANWKW (125)	
WNWSPS_1	FW	WANWKW (125)	
WNWSPS_2	FW	WANWKW (125)	
WNWSPS_3	FW	WANWKW (125)	
WNWUEMNT	FW	NWS (618)	
WNWUEMXT	FW	NWS (618)	
WPEDKO	KL	KOS (896)	

Symbol	**Type**	**Created within**	**Used within**
WPFGRBMR	KL	BGWPFGR (548)	
WPHN	KL	ZUE (627)	
WPMXBR	FW	GGPED (454)	
WPMXNOT	FW	GGPED (454)	
WPRMBVH	FW	GGPED (454)	
WPRMX	FW	BGRLP (266)	
WPUAVLN	KL	BGPU (276)	
WPUAVLSN	KL	BGPU (276)	
ZATMAML	KL	ATM (20)	
ZATMAML2	KL	ATM (20)	
ZATMIKML	KL	ATM (20)	
ZATMIKML2	KL	ATM (20)	
ZATMKML	KL	ATM (20)	
ZATMKML2	KL	ATM (20)	
ZATMRML	KL	ATM (20)	
ZATMRML2	KL	ATM (20)	
ZBALM	KL	ESUK (699)	
ZBFIL	FW	VMAXMD (588)	
ZBRT	FW	BGTEMPK (252)	
ZBTEML	KL	TEB (826)	
ZBURNABR	FW	STADAP (684)	
ZBURNDEC	FW	STADAP (684)	
ZBURNLIM	FW	ESSTT (679)	
ZBURNSOL	FW	STADAP (684)	
ZBWF	FW	GGPED (454)	
ZDBTMN	KL	BGTEMPK (252)	
ZDBTMP	KL	BGTEMPK (252)	
ZDELBMSRCH	FW	GGDPG (74)	
ZDFFDTE	FW	DTEV (856)	
ZDFR	FW	LR (768)	
ZDGZA1	FW	ESNSWL (691)	
ZDGZA2	FW	ESNSWL (691)	
ZDGZA3	FW	ESNSWL (691)	
ZDKATAD	FW	DKAT (361)	
ZDKATAF	FW	DKAT (361)	
ZDKATSH	FW	DKAT (361)	
ZDKTBD	FW	DKAT (361)	
ZDKTBF	FW	DKAT (361)	
ZDLBTS	FW	LAMBTS (732)	
ZERBR	FW	GGEGAS (474)	
ZETATE	FW	TEB (826)	
ZFBFZGL	FW	GGVFZG (497)	
ZFCNT1	FW	GGVFZG (497)	
ZFCNT2	FW	GGVFZG (497)	
ZFMDVERL	FW	MDVER (546)	
ZFRIH	FW	GGLSH (318)	
ZFRIV	FW	GGLSV (382)	
ZFRMFIL	FW	DTEV (856)	
ZFRMST	FW	DKVS (811)	
ZFRMXAF	FW	DTEV (856)	
ZFTSVK	FW	DLSA (398)	
ZFUKA	FW	ESUKA (711)	
ZFV	FW	GGVFZG (497)	
ZHLLA	FW	LLRNS (562)	
ZHLLE	FW	LLRNS (562)	
ZIDFBM	FW	DDG (141)	
ZIDNOBM	FW	DDG (141)	
ZIVMAX	FW	VMAXMD (588)	
ZKARIH	FW	DHLSHK (1154)	
ZKARIV	FW	DHLSVK (29)	
ZKDMADFK	FW	MDVERAD (549)	
ZKDMADFS	FW	MDVERAD (549)	
ZKDMADKO	FW	MDVERAD (549)	
ZKDMADLL	FW	MDVERAD (549)	
ZKDRLSOL	FW	MDFUE (594)	
ZKFRAOA	KL	LRA (797)	
ZKFRAUA	KL	LRA (797)	
ZKFTEAD	FW	TEB (826)	
ZKFUB	FW	BGLBZ (489)	
ZKHABB	FW	BBKHZ (890)	
ZKLAMKH	FW	BBKHZ (890)	
ZKLBZ	FW	BGLBZ (489)	
ZKLLRD	FW	LLRRM (566)	
ZKMDKO	FW	MDVERB (540)	
ZKMDSLP	FW	MDVERB (540)	
ZKMDWA	FW	MDWAN (554)	
ZKMSDKT	KL	BGMSZS (239)	
ZKNS	FW	LLRNS (562)	
ZKNWS	FW	NWS (618)	
ZKPRIH	FW	DHLSHK (1154)	
ZKPRIV	FW	DHLSVK (29)	
ZKPVDKT	KL	BGMSZS (239)	

Symbol	Type	Created within	Used within
ZKRKATA	KL	LRA (797)	
ZKRKAZA	KL	LRA (797)	
ZKRMSTEV	FW	DTEV (856)	
ZKTABTU	KL	BGTABST (1030)	
ZKTDRL	FW	DKAT (361)	
ZKTDTKM	FW	DKAT (361)	
ZKUBDLR	FW	ADVE (918)	
ZKWDKSPT1	FW	ADVE (918)	
ZKWNWI	FW	NWS (618)	
ZLASHKAB	FW	LRHK (781)	
ZLASOHML	KL	LRHK (781)	
ZLASOHML2	KL	LRHK (781)	
ZLIBG	FW	LLRRM (566)	
ZLRFRI	FW	LR (768)	
ZLRHML	KL	LRHK (781)	
ZLRHML2	KL	LRHK (781)	
ZMDNSM	KL	MDVER (546)	
ZMLETAN	FW	DTEV (856)	
ZMLRO	FW	DHFM (233)	
ZMLTE	FW	TEB (826)	
ZMSSGIN	FW	TEB (826)	
ZMSTEDTE	FW	DTEV (856)	
ZNFNGLL	FW	LLRRM (566)	
ZNGFIL	FW	BGNG (121)	
ZNOSTMX	FW	AEKP (970)	
ZNSUB	FW	LLRNS (562)	
ZNWSP	FW	WANWKW (125)	
ZPDDST	FW	DDST (851)	
ZPUN	FW	BGPU (276)	
ZPUSA	FW	BGPU (276)	
ZPVDKR	KL	FUEDK (597)	
ZRLTEDTE	FW	DTEV (856)	
ZSYNABR	FW	STADAP (684)	
ZSYNAUSW	FW	STADAP (684)	
ZSYNC_I_UM	FW	UFNC (1063)	
ZTAGR	FW	BGAGR (263)	
ZTAGRV	FW	BGAGR (263)	
ZTDAGR	FW	BGTEMPK (252)	
ZTMMBR	FW	BGTEMPK (252)	
ZTPREL	FW	GGDPG (74)	
ZUKE	FW	ESUK (699)	
ZUKK	FW	ESUK (699)	
ZUKNST	FW	ESUK (699)	
ZVALM	KL	ESUK (699)	
ZVTPRGSU	FW	BGSRM (245)	
ZWAPPL	FW	ZUE (627)	
ZWC_T_UM	FW	UFZWC (1075)	
ZWDKM1	FW	BGWDKM (273)	
ZWDKM2	FW	BGWDKM (273)	
ZWFUBAMN	FW	AZUE (904)	
ZWSPTIP	FW	ZWMIN (669)	
ZYLANZ_UM	FW	UFZWC (1075)	
ZYLEAUS	FW	NLPH (150)	
ZYLZA	FW	DEVE (1017)	
ZYRKR	FW	KRKE (427)	
ZZWEETM	KL	ESVW (1009)	
A	LOK	DHLSVK (29)	
ABAK	LOK	ESUK (699)	
ABAOV	LOK	ESUKA (711)	
ABAOV2	LOK	ESUKA (711)	
ABMF	AUS	AEVAB (980)	BGEVAB (1005)
ABMFOLD	LOK	BGEVAB (1005)	
ABO	AUS	BBBO (853)	LRA (797), TEB (826)
ABR1_COUNT	LOK	ESNSWL (691)	
ADASTEP	LOK	STADAP (684)	
ADCC_C_UM	LOK	URADCC (1049)	
AFNMN	LOK	DMDMIL (216)	
AFNMX	LOK	DMDMIL (216)	
AFRLMN	LOK	DMDMIL (216)	
AFRLMX	LOK	DMDMIL (216)	
AFTNMN	LOK	DMDMIL (216)	
AFTNMX	LOK	DMDMIL (216)	
AFTRLMN	LOK	DMDMIL (216)	
AFTRLMX	LOK	DMDMIL (216)	
AGRR	AUS	BGSRM (245)	SWADAP (47), MDBAS (529)
AGRR_W	AUS	BGSRM (245)	EGFE (228), BGTEMPK (252)
AGRVP_W	AUS	EGAG (486)	
AHEARV_W	LOK	DMDMIL (216)	
AHKAT	LOK	DKAT (361)	
AHKAT2	LOK	DKAT (361)	
AHKATI	LOK	DKAT (361)	
AHKATI2	LOK	DKAT (361)	

Symbol	Type	Created within	Used within
AHKATN	LOK	DKAT (361)	
AHKATN2	LOK	DKAT (361)	
AHKTKI2_W	LOK	DKAT (361)	
AHKTKI_W	LOK	DKAT (361)	
AHKTNK	LOK	DKAT (361)	
AHKTNK2	LOK	DKAT (361)	
AINKBA	LOK	ESUKA (711)	
AINKVA	LOK	ESUKA (711)	
AINTKAMIN	LOK	DMDMIL (216)	
AINT_0	LOK	DMDMIL (216)	
AINT_1	LOK	DMDMIL (216)	
AINT_10	LOK	DMDMIL (216)	
AINT_11	LOK	DMDMIL (216)	
AINT_2	LOK	DMDMIL (216)	
AINT_3	LOK	DMDMIL (216)	
AINT_4	LOK	DMDMIL (216)	
AINT_5	LOK	DMDMIL (216)	
AINT_6	LOK	DMDMIL (216)	
AINT_7	LOK	DMDMIL (216)	
AINT_8	LOK	DMDMIL (216)	
AINT_9	LOK	DMDMIL (216)	
AKATBN	LOK	DKAT (361)	
AKATBN2	LOK	DKAT (361)	
AKATBNK	LOK	DKAT (361)	
AKATBNK2	LOK	DKAT (361)	
AKRLZ	LOK	KRRA (639)	
ANWFOH	LOK	DMDFON (161)	
ANWFOS	LOK	DMDFON (161)	
ANZAINTEN	LOK	DMDMIL (216)	
ANZEAB	LOK	AEVAB (980)	
ANZEAUSB	AUS	NLPH (150)	AEVAB (980)
ANZHFMA_W	LOK	GGHFM (230)	
ANZNMAX	AUS	BGBSZ (73)	
ANZTI	AUS	ACIFI (1013)	BGKV (71), ESWE (698), ESUK (699)
ANZTIB	AUS	ACIFI (1013)	ESSTT (679), ESVW (1009)
ANZTIB_W	AUS	ACIFI (1013)	
ANZTID	LOK	BGKV (71)	
ANZTIP	LOK	FGRFULO (1160)	
ANZTI_W	AUS	ACIFI (1013)	
ANZWEFIM	LOK	ESWE (698)	
APDTEV	AUS	DTEV (856)	
APEDKT	LOK	DKAT (361)	
APEDKT2	LOK	DKAT (361)	
ASPUKA	LOK	ESUKA (711)	
ASPUKA2	LOK	ESUKA (711)	
ATV	AUS	LRHK (781)	DLSA (398), DLSSA (350)
ATV2	AUS	LRHK (781)	DLSA (398), DLSSA (350)
ATVFETT	AUS	DLSSA (350)	
ATVFETT2	AUS	DLSSA (350)	
ATVINII	LOK	LRHK (781)	
ATVINII2	LOK	LRHK (781)	
ATVMAGER	AUS	DLSSA (350)	
ATVMAGER2	AUS	DLSSA (350)	
AUSGH_C_UM	LOK	URMEM (1044)	
AUSG_C_UM	LOK	URMEM (1044)	
AUSZH_C_UM	LOK	URMEM (1044)	
AUSZ_C_UM	LOK	URMEM (1044)	
AVAK	LOK	ESUK (699)	
AVAOV	LOK	ESUKA (711)	
AVAOV2	LOK	ESUKA (711)	
AVDTEV	AUS	DTEV (856)	
AVKATF	AUS	DKAT (361)	LRHK (781), LRKA (795)
AVKATF2	AUS	DKAT (361)	LRHK (781)
AZKELDY	LOK	KRDY (659)	
AZKRLDY	LOK	KRDY (659)	
AZKRNDY	LOK	KRDY (659)	
AZPDTEFRE	AUS	DTEV (856)	
AZYCNT	LOK	DMDMIL (216)	
AZYLWE	LOK	ESWE (698)	
BBDCY	AUS	DDCY (1146)	
BBWUC	AUS	DWUC (1147)	
BBZWZYL	EIN		ZUE (627), ZUESZ (632)
BFGRS_W	AUS	FGRFULO (1160)	
BFNMN	LOK	DMDMIL (216)	
BFNMX	LOK	DMDMIL (216)	
BFRLMN	LOK	DMDMIL (216)	
BFRLMX	LOK	DMDMIL (216)	
BFZGLF	LOK	VMAXMD (588)	
BFZGL_B	AUS	GGVFZG (497)	VMAXMD (588)
BFZGL_W	AUS	GGVFZG (497)	FGRABED (491), FGRUE (490)

Symbol	**Type**	**Created within**	**Used within**
BLOKNR	EIN		DDVE (950), DHFM (233), DHLSHK (1154), GGUB (487), GGTFM (289), GGTFA (298), GGPED (454), GGEGAS (474), DTEV (856), DNWS (622), DLSV (301), MDKOG (516), DKAT (361), DHLSVK (29)
BMFZ_W	LOK	DDG (141)	
BMLOSCTR_W	AUS	GGDPG (74)	DDG (141)
BMZZYL	LOK	GGDPG (74)	
BRAFGR_W	LOK	FGRFULO (1160)	
BSC	EIN		DSWEC (32)
BSSP	LOK	DSWEC (32)	
BZMSR_A_UM	LOK	UFMSRC (1080)	
BZ_M	DOK	UFMSRC (1080)	
BZ_MSR	EIN		UFMSRC (1080)
BZ_SGSA_UM	LOK	UFSGSC (1070)	
BZ_SGSA_UR	LOK	UFSGSC (1070)	
BZ_SGS_UM	LOK	UFSGSC (1070)	
BZ_V	DOK	UFMSRC (1080)	
B_2PH	LOK	NLDG (157)	
B_2WART	LOK	BGDVE (934)	
B_3PH	LOK	NLDG (157)	
B_4WD	AUS	PROKON (53)	
B_ABGLE	AUS	BGDVE (934)	DDVE (950)
B_ABGSTG	LOK	DLSAHK (339)	
B_ABGSTG2	LOK	DLSAHK (339)	
B_ABOR	AUS	BBBO (853)	LRA (797), TEB (826)
B_ABSFGR	EIN		FGRABED (491)
B_ABSTNL	AUS	PROKON (53)	BGTABST (1030)
B_ABSTNLG	EIN		GGTFM (289), BGTABST (1030)
B_ABSTNLGP	AUS	BGTABST (1030)	
B_ABW	LOK	RDE (112)	
B_AC	AUS	SWADAP (47)	
B_ACC	EIN		FGRABED (491), FGRFULO (1160), FGRREGL (1174)
B_ACRES	AUS	KOS (896)	SWADAP (47), MDVERB (540)
B_ACSDH	LOK	DLSH (330)	
B_ACSDH2	LOK	DLSH (330)	
B_AD	LOK	STADAP (684)	
B_ADB0	LOK	STADAP (684)	
B_ADB1	LOK	STADAP (684)	
B_ADB2	LOK	STADAP (684)	
B_ADCSD	LOK	DLSV (301)	
B_ADCSD2	LOK	DLSV (301)	
B_ADDE	LOK	DLSV (301)	
B_ADDE2	LOK	DLSV (301)	
B_ADLCK	LOK	STADAP (684)	
B_ADSH	LOK	DLSH (330)	
B_ADSH2	LOK	DLSH (330)	
B_ADSHS	LOK	DLSH (330)	
B_ADSHS2	LOK	DLSH (330)	
B_ADSVB	LOK	DLSV (301)	
B_ADSVB2	LOK	DLSV (301)	
B_ADWFK	LOK	MDVERAD (549)	
B_ADWFS	LOK	MDVERAD (549)	
B_ADWKO	LOK	MDVERAD (549)	
B_AFKLT	LOK	DMDMIL (216)	
B_AFTKLT	LOK	DMDMIL (216)	
B_AFTWRM	LOK	DMDMIL (216)	
B_AFWE	LOK	ESWE (698)	
B_AFWRM	LOK	DMDMIL (216)	
B_AGR	EIN		BGPU (276), EGAG (486), BGTEMPK (252)
B_AGRRDY	AUS	DIMC (1148)	
B_AIRBAG	EIN		AEKP (970), DECJ (1013)
B_ALE	AUS	ALE (136)	GGDPG (74)
B_AMNUKA	LOK	ESUKA (711)	
B_AMNUKA2	LOK	ESUKA (711)	
B_ANALU	AUS	DMDLU (193)	DMDDLU (199)
B_ANALU_M	LOK	DMDDLU (199)	DMDLU (193)
B_ANALU_M2	LOK	DMDDLU (199)	DMDLU (193)
B_ANFW	LOK	GGTFM (289)	
B_ANF_KUP	EIN		CAN (1124), DVKUP (1027)
B_ANLAUS	LOK	RDE (112)	
B_APNOLUV	LOK	ADVE (918)	
B_APPNOLU	AUS	ADVE (918)	SREAKT (963)
B_AR	AUS	ARMD (531)	
B_ASC1NEW	EIN		CAN (1124), DCAS (1128)
B_ASC2NEW	EIN		DCAS (1128)
B_ASC_REG	EIN		DMDSTP (205)
B_ASGAB	AUS	DVKUP (1027)	KOEVAB (124)
B_ASR	AUS	MDKOG (516)	MDFAW (508), MDRED (976)
B_ASREXT	LOK	UFMSRC (1080)	
B_ASRFZ	AUS	PROKON (53)	CAN (1124)
B_ASR_C	EIN		CAN (1124)
B_ATEV	AUS	DTEVE (1022)	
B_ATMST	LOK	ATM (20)	

Symbol	Type	Created within	Used within
B_ATMST2	LOK	ATM (20)	
B_ATMTPA	AUS	ATM (20)	DHLSVK (29), DLSV (301), LR (768), TEBEB (762), HLS (392)
B_ATMTPA2	AUS	ATM (20)	DHLSVK (29), DLSV (301), HLS (392), LR (768)
B_ATMTPF	AUS	ATM (20)	
B_ATMTPF2	AUS	ATM (20)	
B_ATMTPK	AUS	ATM (20)	DHLSHK (1154), DLSH (330), HLS (392)
B_ATMTPK2	AUS	ATM (20)	DHLSHK (1154), HLS (392), DLSH (330)
B_ATMTPL	AUS	ATM (20)	
B_ATMTPL2	AUS	ATM (20)	
B_ATVINI	LOK	LRHK (781)	
B_ATVINI2	LOK	LRHK (781)	
B_AUAKT	EIN		GGTFM (289), LRAEB (759)
B_AUSW	LOK	STADAP (684)	
B_AUTGET	AUS	PROKON (53)	ARMD (531), NMAXMD (584), LLRNFA (564), KOS (896), GGEGAS (474), DMDSTP (205), DMDFON (161), CAN (1124), BBGANG (501)
B_AWUEAB	EIN		KOEVAB (124)
B_BA	AUS	ESUK (699)	
B_BAG	AUS	ESUK (699)	LREB (739)
B_BBDECJ	AUS	DECJ (1013)	
B_BBUBR	AUS	DECJ (1013)	
B_BEBWF	AUS	GGPED (454)	
B_BEFP1P	AUS	GGPED (454)	
B_BEFP2P	AUS	GGPED (454)	
B_BEFPP	AUS	GGPED (454)	
B_BEKAT	AUS	DKAT (361)	
B_BEKAT2	AUS	DKAT (361)	
B_BELM	AUS	DHFM (233)	
B_BELSV	AUS	DLSV (301)	
B_BELSV2	AUS	DLSV (301)	
B_BEMDB	AUS	MDKOG (516)	
B_BETES	AUS	DTEV (856)	
B_BEVAB	AUS	AES (973)	BGEVAB (1005), LAMKO (729), LRKA (795)
B_BEVAB2	AUS	AES (973)	BGEVAB (1005), LAMKO (729), LRKA (795)
B_BFKLT	LOK	DMDMIL (216)	
B_BFWRM	LOK	DMDMIL (216)	
B_BKBREMS	LOK	GGEGAS (474)	
B_BKBWF	AUS	GGPED (454)	
B_BKDVEN	LOK	DDVE (950)	
B_BKDVEU	LOK	DDVE (950)	
B_BKDVEUW	AUS	DDVE (950)	
B_BKDVEV	AUS	DDVE (950)	
B_BKFP1P	AUS	GGPED (454)	
B_BKFP2P	AUS	GGPED (454)	
B_BKFPP	AUS	GGPED (454)	
B_BKKAT	AUS	DKAT (361)	
B_BKKAT2	AUS	DKAT (361)	
B_BKKS1	AUS	DKRS (437)	
B_BKKS2	AUS	DKRS (437)	
B_BKKS3	AUS	DKRS (437)	
B_BKKS4	AUS	DKRS (437)	
B_BKLM	AUS	DHFM (233)	
B_BKLSV	AUS	DLSV (301)	
B_BKLSV2	AUS	DLSV (301)	
B_BKMDB	AUS	MDKOG (516)	
B_BKTA	AUS	GGTFA (298)	
B_BKTES	AUS	DTEV (856)	
B_BKTM	AUS	GGTFM (289)	
B_BKUB	AUS	GGUB (487)	
B_BKVA	EIN		GGPED (454)
B_BKVLEER	EIN		AK (855), LLRMR (572)
B_BKVV	EIN		GGPED (454)
B_BL	LOK	GGEGAS (474)	
B_BLKEB	LOK	DMIL (1150)	
B_BLKFB	EIN		DMIL (1150)
B_BLKMD	AUS	DMDMIL (216)	DMIL (1150)
B_BLRKA	LOK	LRKA (795)	
B_BLRKA2	LOK	LRKA (795)	
B_BM	AUS	GGDPG (74)	BGNMOT (111), WANWKW (125), NLPH (150)
B_BR	LOK	GGEGAS (474)	
B_BR2K	AUS	GGEGAS (474)	DMDSTP (205), GGPED (454)
B_BREMS	AUS	EGEG (453)	GGEGAS (474), ARMD (531), FGRABED (491), FGRUE (490), LRAEB (759), LLRNFA (564), GGPED (454)
B_BREMSE	AUS	SWADAP (47)	
B_BREMS_UM	AUS	UFFGRE (1096)	UFFGRC (1078), UFSPSC (1060)
B_BRFGR_UM	AUS	UFFGRE (1096)	
B_BUSOFF	EIN		CAN (1124)
B_BVDEL	LOK	LREB (739)	
B_BWF	LOK	GGPED (454)	
B_BWUNPL	LOK	GGPED (454)	
B_C95BF0	LOK	GGKS (412)	
B_C95BF1	LOK	GGKS (412)	
B_C95BF2	LOK	GGKS (412)	

Symbol	Type	Created within	Used within
B_C95BF3	LOK	GGKS (412)	
B_C95DIFF	LOK	GGKS (412)	
B_C95KS1	LOK	GGKS (412)	
B_C95KS2	LOK	GGKS (412)	
B_C95KS3	LOK	GGKS (412)	
B_C95KTI	LOK	GGKS (412)	
B_C95T0	LOK	GGKS (412)	
B_C95T1	LOK	GGKS (412)	
B_C95T2	LOK	GGKS (412)	
B_C95TP0	LOK	GGKS (412)	
B_C95TP1	LOK	GGKS (412)	
B_C95TP2	LOK	GGKS (412)	
B_C95_G0	LOK	GGKS (412)	
B_C95_G1	LOK	GGKS (412)	
B_C95_G2	LOK	GGKS (412)	
B_CANKBI	EIN		GGVFZG (497)
B_CASRLVAL	EIN		CAN (1124)
B_CASRSVAL	EIN		CAN (1124)
B_CDAGR	AUS	PROKON (53)	DIMC (1148), TC6MOD (1112)
B_CDAGRL	AUS	PROKON (53)	
B_CDATR	AUS	PROKON (53)	
B_CDATS	AUS	PROKON (53)	
B_CDDST	AUS	PROKON (53)	DDST (851)
B_CDHSH	AUS	PROKON (53)	DHLSHK (1154)
B_CDHSHE	AUS	PROKON (53)	
B_CDHSV	AUS	PROKON (53)	DHLSVK (29), DIMC (1148)
B_CDHSVE	AUS	PROKON (53)	DHLSVKE (902)
B_CDKAT	AUS	PROKON (53)	DKAT (361), TC6MOD (1112)
B_CDKATNO	EIN		TC6MOD (1112)
B_CDKVS	AUS	PROKON (53)	DKVS (811)
B_CDLASH	AUS	PROKON (53)	DLSAHK (339), TC6MOD (1112)
B_CDLATP	AUS	PROKON (53)	DLSA (398), TC6MOD (1112)
B_CDLATV	AUS	PROKON (53)	DLSA (398), TC6MOD (1112)
B_CDLDP	AUS	PROKON (53)	DIMC (1148), TC6MOD (1112)
B_CDLLR	AUS	PROKON (53)	DLLR (578)
B_CDLSA	AUS	PROKON (53)	
B_CDLSH	AUS	PROKON (53)	DLSH (330), DLSV (301)
B_CDLSV	AUS	PROKON (53)	DIMC (1148), DLSV (301)
B_CDMD	AUS	PROKON (53)	DMDDLU (199), DMDLU (193), DMDMIL (216), DMDLUA (202), DMDUE (158), DMDSTP (205), DMDLAD (215), DMDFON (161)
B_CDNWS	AUS	PROKON (53)	DNWS (622)
B_CDSLS	AUS	PROKON (53)	DIMC (1148), TC6MOD (1112)
B_CDSLSE	AUS	PROKON (53)	
B_CDSWE	AUS	PROKON (53)	DSWEC (32)
B_CDTANKL	AUS	PROKON (53)	
B_CDTES	AUS	PROKON (53)	DIMC (1148), TC6MOD (1112), DTEV (856)
B_CDVKT	EIN		TC6MOD (1112)
B_CFUKABA	LOK	ESUKA (711)	
B_CFUKAVA	LOK	ESUKA (711)	
B_CIDIS	LOK	BGDVE (934)	
B_CKIEN	EIN		GGTFM (289)
B_CLBM	EIN		DDG (141), GGDPG (74)
B_CLBREMS	EIN		GGEGAS (474)
B_CLBWF	EIN		GGPED (454)
B_CLCAS	EIN		DCAS (1128)
B_CLCINS	EIN		DCINS (1126)
B_CLCKUP	EIN		DCKUP (1128)
B_CLDK	EIN		GGDVE (477)
B_CLDK1P	EIN		GGDVE (477)
B_CLDK2P	EIN		GGDVE (477)
B_CLDVEE	EIN		ADVE (918)
B_CLDVEF	EIN		BGDVE (934), DDVE (950)
B_CLDVEFO	EIN		BGDVE (934), DDVE (950)
B_CLDVEL	EIN		ADVE (918)
B_CLDVEN	EIN		BGDVE (934), DDVE (950)
B_CLDVER	EIN		ADVE (918)
B_CLDVEU	EIN		BGDVE (934), DDVE (950)
B_CLDVEUW	EIN		BGDVE (934), DDVE (950)
B_CLDVEV	EIN		BGDVE (934), DDVE (950)
B_CLEGFE	EIN		BGMSZS (239), DEGFE (592)
B_CLEV	EIN		DEVE (1017)
B_CLFP1P	EIN		GGPED (454)
B_CLFP2P	EIN		GGPED (454)
B_CLFPP	EIN		GGPED (454)
B_CLFRAO	EIN		DKVS (811), LRA (797)
B_CLFRAO2	EIN		DKVS (811), LRA (797)
B_CLFRAU	EIN		DKVS (811), LRA (797)
B_CLFRAU2	EIN		DKVS (811), LRA (797)
B_CLFRST	EIN		DKVS (811)
B_CLFRST2	EIN		DKVS (811)
B_CLHSH	EIN		DHLSHK (1154)
B_CLHSH2	EIN		DHLSHK (1154)

Symbol	Type	Created within	Used within
B_CLHSV	EIN		DHLSVK (29)
B_CLHSV2	EIN		DHLSVK (29)
B_CLHSVE	EIN		DHLSVKE (902)
B_CLHSVE2	EIN		DHLSVKE (902)
B_CLKAT	EIN		DKAT (361)
B_CLKAT2	EIN		DKAT (361)
B_CLKOSE	EIN		DKOSE (901)
B_CLKPE	EIN		DEKPE (1020)
B_CLKRNT	EIN		DKRNT (445)
B_CLKROF	EIN		DKRNT (445)
B_CLKRTP	EIN		DKRTP (451)
B_CLKS1	EIN		DKRS (437)
B_CLKS2	EIN		DKRS (437)
B_CLKS3	EIN		DKRS (437)
B_CLKS4	EIN		DKRS (437)
B_CLLASH	EIN		DLSAHK (339)
B_CLLASH2	EIN		DLSAHK (339)
B_CLLATP	EIN		DLSA (398)
B_CLLATP2	EIN		DLSA (398)
B_CLLATV	EIN		DLSA (398), LRHK (781)
B_CLLATV2	EIN		DLSA (398), LRHK (781)
B_CLLLR	EIN		DLLR (578)
B_CLLM	EIN		DHFM (233), EGFE (228)
B_CLLSH	EIN		DLSH (330)
B_CLLSH2	EIN		DLSH (330)
B_CLLSV	EIN		DLSV (301)
B_CLLSV2	EIN		DLSV (301)
B_CLMDB	EIN		MDKOG (516)
B_CLMILE	LOK	DMILE (36)	
B_CLMLE	EIN		DMLSE (34)
B_CLN	EIN		DDG (141)
B_CLNWKW	EIN		DNWKW (134)
B_CLNWKW2	EIN		DNWKW (134)
B_CLNWS	EIN		DNWS (622)
B_CLNWS2	EIN		DNWS (622)
B_CLNWSE	EIN		DNWSE (1025)
B_CLPH	EIN		DPH (144), NLPH (150)
B_CLPH2	EIN		DPH (144)
B_CLRKAT	EIN		DKVS (811), LRA (797)
B_CLRKAT2	EIN		DKVS (811), LRA (797)
B_CLRKAZ	EIN		DKVS (811), LRA (797)
B_CLRKAZ2	EIN		DKVS (811), LRA (797)
B_CLTA	EIN		GGTFA (298)
B_CLTES	EIN		DTEV (856)
B_CLTEVE	EIN		DTEVE (1022)
B_CLTM	EIN		GGTFM (289)
B_CLUB	EIN		GGUB (487)
B_CLUF2SG	EIN		DUF (1089)
B_CLUFMV	EIN		DUF (1089)
B_CLUFSKA	EIN		DUF (1089)
B_CLURRAM	EIN		DUR (1052)
B_CLURROM	EIN		DUR (1052)
B_CLURRST	EIN		DUR (1052)
B_CLVFZ	EIN		DVFZ (500)
B_CLVKUP	LOK	DVKUP (1027)	
B_CMSRVAL	EIN		CAN (1124)
B_CMUTE	AUS	CAN (1124)	DCAS (1128), DCKUP (1128), DCINS (1126)
B_CRAUS	EIN		LREB (739)
B_CSCATT	AUS	PROKON (53)	
B_CVT	AUS	PROKON (53)	BBGANG (501), BBSAWE (557), CAN (1124)
B_CWDK	EIN		FUEDK (597)
B_CWDSLT	EIN		TC6MOD (1112)
B_CWESAKT	AUS	ACIFI (1013)	
B_CWLSHDYN	EIN		DLSAHK (339), TC6MOD (1112)
B_CWLSHSCH	EIN		DLSAHK (339), TC6MOD (1112)
B_DAGR	EIN		FUEREG (595)
B_DASH	AUS	MDFAW (508)	BBSAWE (557), LLRBB (575), MDKOG (516), MDAUTG (515)
B_DASHV	EIN		ARMD (531), MDKOL (526), MDFAW (508)
B_DCDISCAN	AUS	SREAKT (963)	ADVE (918)
B_DCDISFR	AUS	ADVE (918)	BGDVE (934)
B_DCDISR	AUS	BGDVE (934)	ADVE (918)
B_DCDIS_C	AUS	UFMER (1060)	
B_DCDIS_UM	AUS	UFMVER (1087)	UFNC (1063), UFSPSC (1060), UFZWC (1075), URADCC (1049), UFRLC (1066), UFREAC (1088), UFMET (1060), UFUE (1056)
B_DCY	AUS	DDCY (1146)	DFPM (1132), DMDMIL (216), DTRIG (1139)
B_DDYLASH	LOK	DLSAHK (339)	
B_DDYLASH2	LOK	DLSAHK (339)	
B_DECR	LOK	STADAP (684)	
B_DELAYSYN	LOK	NLPH (150)	
B_DESEE	AUS	DECJ (1013)	DKOSE (901), DEKPE (1020), DHLSVKE (902), DEVE (1017), DMILE (36), DTEVE (1022), DMLSE (34)
B_DFRF	AUS	LR (768)	

Symbol	Type	Created within	Used within
B_DFRF2	AUS	LR (768)	
B_DFRM	AUS	LR (768)	
B_DFRM2	AUS	LR (768)	
B_DFUKABA	LOK	ESUKA (711)	
B_DFUKAVA	LOK	ESUKA (711)	
B_DIDYSCH	LOK	DLSAHK (339)	
B_DIDYSCH2	LOK	DLSAHK (339)	
B_DISCH	LOK	DLSAHK (339)	
B_DISCH2	LOK	DLSAHK (339)	
B_DISTP	AUS	DLSA (398)	
B_DISTP2	AUS	DLSA (398)	
B_DISTV	LOK	DLSA (398)	
B_DISTV2	LOK	DLSA (398)	
B_DKADEN	AUS	BGDVE (934)	ADVE (918), DDVE (950)
B_DKBEW	LOK	ADVE (918)	
B_DKINI	LOK	DKAT (361)	
B_DKINI2	LOK	DKAT (361)	
B_DKLPI	LOK	DKAT (361)	
B_DKLPI2	LOK	DKAT (361)	
B_DKNACH	LOK	BGDVE (934)	
B_DKNOLU	AUS	SREAKT (963)	SWADAP (47), ADVE (918), FGRABED (491), FUEDKSA (610), DLLR (578), NWS (618), NMAXMD (584), MDRED (976), LLRNS (562), KOS (896), AEVABU (1002), CAN (1124), BGRLP (266), BGDVE (934)
B_DKNOLU_C	EIN		FGRABED (491)
B_DKNOT	AUS	SREAKT (963)	BGDVE (934)
B_DKP1E	AUS	GGDVE (477)	ADVE (918), SREAKT (963), DDVE (950), BGDVE (934)
B_DKP1EV	LOK	GGDVE (477)	
B_DKP1MN	AUS	GGDVE (477)	DDVE (950)
B_DKP1MX	AUS	GGDVE (477)	DDVE (950)
B_DKP1NP	AUS	GGDVE (477)	DDVE (950)
B_DKP2E	AUS	GGDVE (477)	ADVE (918), DDVE (950), BGDVE (934), SREAKT (963)
B_DKP2EV	LOK	GGDVE (477)	
B_DKP2MN	AUS	GGDVE (477)	DDVE (950)
B_DKP2MX	AUS	GGDVE (477)	DDVE (950)
B_DKP2NP	AUS	GGDVE (477)	DDVE (950)
B_DKPAW	EIN		SREAKT (963), GGDVE (477)
B_DKPIU	AUS	SREAKT (963)	ADVE (918), BGDVE (934), FUEDKSA (610)
B_DKPRU	AUS	SREAKT (963)	
B_DKPU	AUS	SREAKT (963)	SWADAP (47), AEVABU (1002), NWS (618), NMAXMD (584), MDRED (976), LLRNS (562), KOS (896), GGDVE (477), DLLR (578), DMDSTP (205), FGRABED (491), CAN (1124)
B_DKPU_C	EIN		FGRABED (491)
B_DKSBEG	AUS	GGDVE (477)	FGRABED (491), FUEDKSA (610), GGPED (454)
B_DKSBEGT	AUS	GGDVE (477)	
B_DKSBEG_C	EIN		GGDVE (477)
B_DKTAKT	LOK	DKAT (361)	
B_DKTAKT2	LOK	DKAT (361)	
B_DKTEN	LOK	DKAT (361)	
B_DKTEN2	LOK	DKAT (361)	
B_DKTLP	AUS	DKAT (361)	ESUKA (711), LR (768)
B_DKTNR	LOK	DKAT (361)	
B_DKTNR2	LOK	DKAT (361)	
B_DKTPB2	LOK	DKAT (361)	
B_DKTSB	LOK	DKAT (361)	
B_DKTSB2	LOK	DKAT (361)	
B_DKTSP	LOK	DKAT (361)	
B_DKTSP2	LOK	DKAT (361)	
B_DKTST	LOK	DKAT (361)	
B_DKTST2	LOK	DKAT (361)	
B_DKTT	LOK	DKAT (361)	
B_DKTT2	LOK	DKAT (361)	
B_DKTTK	LOK	DKAT (361)	
B_DKTTK2	LOK	DKAT (361)	
B_DKUEVAB	AUS	AEVABU (1002)	AEVAB (980)
B_DKUNB	LOK	SREAKT (963)	
B_DKVSF	AUS	DKVS (811)	
B_DKVSFM	LOK	DKVS (811)	
B_DKVSTR	AUS	DKVS (811)	
B_DLAFF	LOK	DLSA (398)	
B_DLAFF2	LOK	DLSA (398)	
B_DLASH	LOK	DLSAHK (339)	
B_DLASH2	LOK	DLSAHK (339)	
B_DLATP	AUS	DLSA (398)	DLSSA (350)
B_DLATP2	AUS	DLSA (398)	DLSSA (350)
B_DLATV	AUS	DLSA (398)	
B_DLATV2	AUS	DLSA (398)	
B_DLDPTE	AUS	GKRA (766)	BBTEGA (750), TEBEB (762), DTEV (856)
B_DLLR	AUS	DLLR (578)	SWADAP (47), LLRRM (566)
B_DLLRA	AUS	DLLR (578)	DTEV (856), TEBEB (762)
B_DLRBE	AUS	ADVE (918)	DDVE (950), SREAKT (963)
B_DLRIEN	AUS	BGDVE (934)	
B_DLRIKLA	LOK	ADVE (918)	

Symbol	Type	Created within	Used within
B_DLRIKLST	LOK	ADVE (918)	
B_DLRPARC	LOK	ADVE (918)	
B_DLRPIDE	AUS	ADVE (918)	DDVE (950), SREAKT (963)
B_DLRSPID	AUS	ADVE (918)	BGDVE (934)
B_DLRUMZU	LOK	ADVE (918)	
B_DLUERK	AUS	DMDDLU (199)	DMDLAD (215)
B_DLUERK_M	EIN		NLPH (150), DMDDLU (199)
B_DLUER_M2	LOK	DMDDLU (199)	
B_DMASO	LOK	DLSV (301)	
B_DMASO2	LOK	DLSV (301)	
B_DMBV	EIN		DMDSTP (205)
B_DMTLTZ	EIN		BBTEGA (750), DTEV (856)
B_DMVERLIN	LOK	MDVER (546)	
B_DNSLL	LOK	BBSAWE (557)	
B_DNT	LOK	GGKS (412)	
B_DNTB	LOK	GGKS (412)	
B_DNWS	AUS	DNWS (622)	
B_DOPZUE	AUS	NLPH (150)	DMDLU (193), ZUE (627), RDE (112), NMAXMD (584), KRRA (639)
B_DP	LOK	MDFAW (508)	
B_DRLKRDY	LOK	KRDY (659)	
B_DS	LOK	DKRS (437)	
B_DSHEN	LOK	DLSH (330)	
B_DSHEN2	LOK	DLSH (330)	
B_DSHK	LOK	DLSAHK (339)	
B_DSHK2	LOK	DLSAHK (339)	
B_DSI	LOK	DKRS (437)	
B_DSL1	EIN		LR (768)
B_DSL4	EIN		LR (768)
B_DSLA	EIN		BBKHZ (890), LAKH (735), LAMKO (729)
B_DSLME	EIN		LR (768)
B_DSLS	EIN		BBSAWE (557), TEBEB (762), LRHK (781), LREB (739), LRAEB (759), DLSA (398), DLSV (301), DTEV (856), DLSH (330), DLSAHK (339), DLLR (578), DKAT (361)
B_DSLSK	EIN		LREB (739)
B_DSLSP4	LOK	AK (855)	
B_DSLVH	EIN		BGMSZS (239)
B_DSSV	EIN		BGMSZS (239)
B_DSUV	EIN		BGMSZS (239)
B_DSVEN	AUS	DLSV (301)	
B_DSVEN2	AUS	DLSV (301)	
B_DTEAA	AUS	DTEV (856)	BGTEV (257), TEBEB (762), LRAEB (759)
B_DTEAAB	LOK	DTEV (856)	
B_DTEAAM	AUS	DTEV (856)	LLRRM (566)
B_DTEAAV	AUS	GKRA (766)	
B_DTEABU	LOK	DTEV (856)	
B_DTEANFL	LOK	DTEV (856)	
B_DTEEND	LOK	DTEV (856)	
B_DTEENDL	LOK	DTEV (856)	
B_DTEENF	LOK	DTEV (856)	
B_DTEFRE	LOK	DTEV (856)	
B_DTEFRR	AUS	DTEV (856)	GKRA (766), LR (768), LRINI (749)
B_DTELAB	LOK	DTEV (856)	
B_DTELBM	LOK	DTEV (856)	
B_DTELBR	LOK	DTEV (856)	
B_DTELNM	LOK	DTEV (856)	
B_DTELNMB	LOK	DTEV (856)	
B_DTELNMV	LOK	DTEV (856)	
B_DTENAM	LOK	DTEV (856)	
B_DTEPHM	LOK	DTEV (856)	
B_DTEPM	LOK	DTEV (856)	
B_DTERAB	LOK	DTEV (856)	
B_DTERAP	LOK	DTEV (856)	
B_DTERES	LOK	DTEV (856)	
B_DTERNM	LOK	DTEV (856)	
B_DTES	AUS	DTEV (856)	GKRA (766), ATEV (969), BBTEGA (750), DKAT (361), MDVERAD (549), DLSV (301), DLSH (330), DLLR (578)
B_DTEST	AUS	DTEV (856)	DLSA (398), LRAEB (759), LR (768), DMDSTP (205), GKEB (737), LLRRM (566), DLSAHK (339)
B_DTEZAM	LOK	DTEV (856)	
B_DTP	LOK	GGKS (412)	
B_DTPB	LOK	GGKS (412)	
B_DUPW	LOK	GGPED (454)	
B_DUPW12	LOK	GGPED (454)	
B_DUSHSCH	LOK	DLSAHK (339)	
B_DUSHSCH2	LOK	DLSAHK (339)	
B_DVEADA	AUS	BGDVE (934)	AEVABZK (1003)
B_DVEADAMC	EIN		BGDVE (934)
B_DVEADASC	EIN		BGDVE (934)
B_DVEADAT	AUS	BGDVE (934)	
B_DVEESE	EIN		DDVE (950), ADVE (918)
B_DVEESH	LOK	ADVE (918)	
B_DVEESON	EIN		ADVE (918)

Symbol	Type	Created within	Used within
B_DVETE	AUS	ADVE (918)	BGDVE (934)
B_DVETV	LOK	BGDVE (934)	
B_DWDKSUS	LOK	FUEDK (597)	
B_DWDKSUT	LOK	FUEDK (597)	
B_DYLASH	LOK	DLSAHK (339)	
B_DYLASH2	LOK	DLSAHK (339)	
B_EAGRNWS	EIN		FUEDK (597)
B_ECULOCK	EIN		AEVABZK (1003)
B_EDKS	AUS	GGDVE (477)	DHFM (233)
B_EDKVS	AUS	DKVS (811)	BBTEGA (750), LRHK (781), LRA (797), DTEV (856), DMDSTP (205), DKAT (361), DLSAHK (339), DLSA (398)
B_EDKVS2	AUS	DKVS (811)	BBTEGA (750), DKAT (361), DTEV (856), LRHK (781), LRA (797), DLSAHK (339), DLSA (398)
B_EDP	LOK	MDFAW (508)	
B_EEV	AUS	DEVE (1017)	DMDSTP (205), LREB (739)
B_EFRAO	LOK	DKVS (811)	
B_EFRAO2	LOK	DKVS (811)	
B_EFRAU	LOK	DKVS (811)	
B_EFRAU2	LOK	DKVS (811)	
B_EHFM	AUS	DHFM (233)	EGFE (228)
B_EHFM1	LOK	DHFM (233)	
B_EHFS	AUS	DHFM (233)	DUF (1089), GGDVE (477), UFRLC (1066)
B_EHSV	LOK	DHLSVK (29)	
B_EHSV2	LOK	DHLSVK (29)	
B_EKATS	LOK	DKAT (361)	
B_EKATS2	LOK	DKAT (361)	
B_EKP	AUS	AEKP (970)	
B_EKPD	LOK	AEKP (970)	
B_EKPN	LOK	AEKP (970)	
B_EKPUBN	LOK	AEKP (970)	
B_EKPVL	LOK	AEKP (970)	
B_EKS	LOK	KRRA (639)	
B_ELLS	EIN		BBSAWE (557), BGPU (276), DLLR (578), LREB (739), DTEV (856), BGMSZS (239)
B_ELMI	AUS	DHFM (233)	BGPU (276)
B_ELSD	LOK	MDFAW (508)	
B_ELZMN	LOK	KRRA (639)	
B_ENABALE	LOK	ALE (136)	
B_ENABDDG	LOK	DDG (141)	
B_ENABRDE	LOK	RDE (112)	
B_ENFMST	LOK	DLSAHK (339)	
B_ENLASH	LOK	DLSAHK (339)	
B_ENLASH2	LOK	DLSAHK (339)	
B_ENLLRI	AUS	LLRBB (575)	WDKSOM (614)
B_ENQSYN	LOK	GGDPG (74)	
B_ENRINH	LOK	GGLSH (318)	
B_ENRINH2	LOK	GGLSH (318)	
B_ENRINV	LOK	GGLSV (382)	
B_ENRINV2	LOK	GGLSV (382)	
B_ENWS	AUS	DNWS (622)	DLSA (398), DMDSTP (205), DTEV (856), LRAEB (759), ESUKA (711)
B_EOBDLR	AUS	LREB (739)	TEBEB (762)
B_EOBDLR2	AUS	LREB (739)	
B_EPCL	AUS	DEPCL (1151)	
B_ERBR	LOK	GGEGAS (474)	
B_ERDKT	LOK	DKAT (361)	
B_ERDKT2	LOK	DKAT (361)	
B_ERINOFH	LOK	GGLSH (318)	
B_ERINOFH2	LOK	GGLSH (318)	
B_ERINOFV	LOK	GGLSV (382)	
B_ERINOFV2	LOK	GGLSV (382)	
B_ERKAT	LOK	DKVS (811)	
B_ERKAT2	LOK	DKVS (811)	
B_ERKAZ	LOK	DKVS (811)	
B_ERKAZ2	LOK	DKVS (811)	
B_ERRKUP	AUS	DVKUP (1027)	SREAKT (963)
B_ESDIA	AUS	DECJ (1013)	
B_ESGCAN	EIN		AEVABZK (1003), DUF (1089), DMDSTP (205), BBTEGA (750), SREAKT (963)
B_ESLS	EIN		DLSH (330), DLSV (301), LREB (739)
B_EVABU	AUS	AEVABU (1002)	AEVABZK (1003)
B_EVABZ	AUS	AEVAB (980)	
B_EVABZI	LOK	AEVAB (980)	
B_EVASEL	AUS	AES (973)	AEVAB (980), DMDSTP (205)
B_EVASGA	EIN		AEVABZK (1003)
B_EVLOC	AUS	AES (973)	BGEVAB (1005), ATEV (969), DMDSTP (205), DLSAHK (339), TEB (826), LREB (739)
B_F1GETR	AUS	PROKON (53)	
B_FA	EIN		BBKHZ (890), DKAT (361), DLSH (330), DNWS (622), LRA (797), NWS (618), LRAEB (759), DTEV (856), DLSA (398), DKVS (811)
B_FAAN	EIN		DMDSTP (205)
B_FAATM	EIN		ATM (20)
B_FABR	EIN		GGPED (454)

Symbol	Type	Created within	Used within
B_FAEVZ	EIN		AES (973), AEVAB (980)
B_FAKAT	EIN		DKAT (361), LLRNFA (564)
B_FAKAT2	EIN		DKAT (361)
B_FAKVS	EIN		DKVS (811), LLRNFA (564), LRA (797)
B_FALRA	EIN		LRAEB (759)
B_FALSH	EIN		DLSH (330), LLRNFA (564), LAMKO (729), LRHK (781)
B_FALSH2	EIN		DLSH (330), LAMKO (729), LRHK (781)
B_FALSV	EIN		LLRNFA (564)
B_FAN	EIN		DMDSTP (205)
B_FANWS	EIN		DNWS (622), NWS (618)
B_FASH	EIN		DLSAHK (339), LLRNFA (564)
B_FASH2	EIN		DLSAHK (339)
B_FASLA	EIN		BBKHZ (890), KHMD (894), LAMKO (729), LAKH (735)
B_FATES	EIN		DTEV (856), LRAEB (759)
B_FATP	EIN		DLSA (398)
B_FATP2	EIN		DLSA (398)
B_FATV	EIN		DLSA (398)
B_FATV2	EIN		DLSA (398)
B_FBM	AUS	GGDPG (74)	DDG (141), RDE (112), DMDSTP (205)
B_FDYFGR	EIN		FGRABED (491), FGRUE (490)
B_FF	AUS	ZUESZ (632)	
B_FGR	AUS	MDFAW (508)	ARMD (531), UFUE (1056), UFFGRC (1078), MDZUL (523), FGRREGL (1174), FGRFULO (1160), FGRABED (491), DUF (1089)
B_FGRAB	AUS	FGRREGL (1174)	FGRUE (490), UFFGRE (1096)
B_FGRAT	AUS	GGFGRH (473)	FGRABED (491), FGRUE (490)
B_FGRDVI	LOK	FGRREGL (1174)	
B_FGREN	AUS	FGRREGL (1174)	FGRUE (490), FGRABED (491)
B_FGREN_UM	AUS	UFFGRE (1096)	UFFGRC (1078)
B_FGRHE	AUS	GGFGRH (473)	FGRABED (491), FGRUE (490)
B_FGRHEV	LOK	GGFGRH (473)	
B_FGRHSA	AUS	GGFGRH (473)	FGRABED (491), FGRUE (490)
B_FGRTBE	LOK	FGRUE (490)	
B_FGRTBH	AUS	GGFGRH (473)	FGRBESI (1158), FGRUE (490)
B_FGRTSB	AUS	GGFGRH (473)	FGRBESI (1158)
B_FGRTSE	LOK	FGRUE (490)	
B_FGRTSV	AUS	GGFGRH (473)	FGRBESI (1158)
B_FGRTVE	LOK	FGRUE (490)	
B_FGRTVH	AUS	GGFGRH (473)	FGRBESI (1158), FGRUE (490)
B_FGRTWA	AUS	GGFGRH (473)	FGRBESI (1158), FGRUE (490)
B_FGR_UM	AUS	UFFGRC (1078)	UFUE (1056), DUF (1089), FGRABED (491)
B_FHZ	EIN		LLRNS (562)
B_FIL	AUS	MDFAW (508)	LLRBB (575), MDKOG (516), MDAUTG (515)
B_FKMSDKS	AUS	FUEDK (597)	BGMSZS (239), FUEREG (595)
B_FKMSMN	AUS	BGMSZS (239)	DEGFE (592)
B_FKMSMX	AUS	BGMSZS (239)	DEGFE (592)
B_FKPVDK	AUS	BGMSZS (239)	
B_FKPVMN	AUS	BGMSZS (239)	DEGFE (592)
B_FKPVMX	AUS	BGMSZS (239)	DEGFE (592)
B_FLBC	EIN		DCINS (1126), GGPOEL (296)
B_FMFKRC	AUS	GGKS (412)	KRKE (427)
B_FNSOFF	LOK	ESNSWL (691)	
B_FODO	LOK	DMDFON (161)	
B_FODON	LOK	DMDFON (161)	
B_FOF	DOK	DMDFON (161)	
B_FOFSTP	AUS	DMDSTP (205)	DMDFON (161)
B_FOFSTPC	EIN		DMDSTP (205)
B_FOFSTPT	AUS	DMDSTP (205)	
B_FOF_M	LOK	DMDFON (161)	
B_FOHE	LOK	DMDFON (161)	
B_FOHOLD	LOK	DMDFON (161)	
B_FOLUNW	LOK	DMDFON (161)	
B_FON	DOK	DMDFON (161)	
B_FONSTP	AUS	DMDSTP (205)	DMDFON (161)
B_FONSTPC	EIN		DMDSTP (205)
B_FONSTPT	AUS	DMDSTP (205)	
B_FONTM	LOK	DMDFON (161)	DMDSTP (205)
B_FON_M	LOK	DMDFON (161)	
B_FOPHSNL	LOK	AEVAB (980)	
B_FOR	DOK	DMDFON (161)	
B_FOR11	LOK	DMDFON (161)	
B_FOR12	LOK	DMDFON (161)	
B_FOR13	LOK	DMDFON (161)	
B_FOR21	LOK	DMDFON (161)	
B_FOR22	LOK	DMDFON (161)	
B_FOR23	LOK	DMDFON (161)	
B_FOR31	LOK	DMDFON (161)	
B_FOR32	LOK	DMDFON (161)	
B_FOR33	LOK	DMDFON (161)	
B_FOR41	LOK	DMDFON (161)	
B_FOR42	LOK	DMDFON (161)	
B_FOR43	LOK	DMDFON (161)	
B_FOR51	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
B_FOR52	LOK	DMDFON (161)	
B_FOR53	LOK	DMDFON (161)	
B_FOR61	LOK	DMDFON (161)	
B_FOR62	LOK	DMDFON (161)	
B_FOR63	LOK	DMDFON (161)	
B_FOR71	LOK	DMDFON (161)	
B_FOR72	LOK	DMDFON (161)	
B_FOR73	LOK	DMDFON (161)	
B_FOR81	LOK	DMDFON (161)	
B_FOR82	LOK	DMDFON (161)	
B_FOR83	LOK	DMDFON (161)	
B_FORDO	DOK	DMDFON (161)	
B_FORDO_M	LOK	DMDFON (161)	
B_FORN	DOK	DMDFON (161)	
B_FORN01	LOK	DMDFON (161)	
B_FORN02	LOK	DMDFON (161)	
B_FORN03	LOK	DMDFON (161)	
B_FORN04	LOK	DMDFON (161)	
B_FORN05	LOK	DMDFON (161)	
B_FORN06	LOK	DMDFON (161)	
B_FORN07	LOK	DMDFON (161)	
B_FORN08	LOK	DMDFON (161)	
B_FORN_M	LOK	DMDFON (161)	
B_FORSET	LOK	DMDFON (161)	
B_FORUN	LOK	DMDFON (161)	
B_FOR_M	LOK	DMDFON (161)	
B_FOS	LOK	DMDFON (161)	
B_FOXFG	LOK	DMDFON (161)	
B_FPRAKT	LOK	BGDVE (934)	
B_FPROAB	AUS	BGDVE (934)	DDVE (950), SREAKT (963)
B_FPROE	AUS	BGDVE (934)	DDVE (950)
B_FPROOK	AUS	BGDVE (934)	DDVE (950)
B_FPRORDY	AUS	BGDVE (934)	DDVE (950)
B_FPROVB	LOK	BGDVE (934)	
B_FPRRDY	AUS	BGDVE (934)	DDVE (950)
B_FPRZAB	AUS	BGDVE (934)	DDVE (950), SREAKT (963)
B_FPRZE	AUS	BGDVE (934)	DDVE (950)
B_FPRZOK	LOK	BGDVE (934)	
B_FPRZVB	LOK	BGDVE (934)	
B_FPWDKAP	AUS	PROKON (53)	FUEDK (597)
B_FRAB	AUS	LR (768)	
B_FRAB2	AUS	LR (768)	
B_FRAO	AUS	LRA (797)	BBTEGA (750), DKVS (811)
B_FRAOAN	AUS	BBTEGA (750)	TEBEB (762)
B_FRAOANC	EIN		BBTEGA (750)
B_FRAOR	AUS	LRA (797)	
B_FRAOR2	AUS	LRA (797)	
B_FRAT	LOK	LRA (797)	
B_FRAU	AUS	LRA (797)	DKVS (811)
B_FRAUR	AUS	LRA (797)	DKVS (811)
B_FRAUR2	AUS	LRA (797)	DKVS (811)
B_FRGBS	LOK	FGRBESI (1158)	
B_FRINI	AUS	LRINI (749)	LR (768), GKRA (766)
B_FRINI2	AUS	LRINI (749)	LR (768)
B_FRMAX	AUS	LR (768)	DKAT (361), ESUKA (711), DLSH (330), TEB (826)
B_FRMAX2	AUS	LR (768)	DKAT (361), TEB (826), ESUKA (711), DLSH (330)
B_FRMIN	AUS	LR (768)	DKAT (361), ESUKA (711), TEB (826)
B_FRMIN2	AUS	LR (768)	DKAT (361), ESUKA (711), TEB (826)
B_FRMINI	LOK	LR (768)	
B_FRMINI2	LOK	LR (768)	
B_FRMLASH	LOK	DLSAHK (339)	
B_FRMLASH2	LOK	DLSAHK (339)	
B_FRSP	LOK	LR (768)	
B_FRSP2	LOK	LR (768)	
B_FRSTE	LOK	DKVS (811)	
B_FRSTE2	LOK	DKVS (811)	
B_FS	AUS	BBGANG (501)	BBKHZ (890), BBSAWE (557), MDWAN (554), MDVERAD (549), LLRNS (562), LLRNFA (564), LLRBB (575), DTEV (856)
B_FSLR	LOK	LREB (739)	
B_FSLR2	LOK	LREB (739)	
B_FSU	DOK	MDWAN (554)	
B_FTBWF	AUS	GGPED (454)	
B_FTEDAB	AUS	DTEV (856)	TEBEB (762)
B_FTFP1P	AUS	GGPED (454)	
B_FTFP2P	AUS	GGPED (454)	
B_FTFPP	AUS	GGPED (454)	
B_FTKAT	AUS	DKAT (361)	
B_FTKAT2	AUS	DKAT (361)	
B_FTLM	AUS	DHFM (233)	
B_FTLSV	AUS	DLSV (301)	
B_FTLSV2	AUS	DLSV (301)	
B_FTMDB	AUS	MDKOG (516)	

Symbol	Type	Created within	Used within
B_FTTES	AUS	DTEV (856)	
B_FURENA	LOK	FUEREG (595)	
B_FURPEN	LOK	FUEREG (595)	
B_FWE	LOK	ESWE (698)	
B_GAE	AUS	DKVS (811)	BBTEGA (750), DTEV (856), GKEB (737)
B_GAE2	EIN		GKEB (737)
B_GAEFRA	AUS	DKVS (811)	BBTEGA (750)
B_GAEFRA2	AUS	DKVS (811)	BBTEGA (750)
B_GAEING	EIN		DLSAHK (339), DKVS (811)
B_GAEING2	EIN		DLSAHK (339), DKVS (811)
B_GAP	AUS	BBTEGA (750)	GKEB (737), DTEV (856), LRAEB (759)
B_GAPNLDG	LOK	NLDG (157)	
B_GASP	AUS	LRAEB (759)	BBTEGA (750), DLSA (398), GKEB (737)
B_GASP2	EIN		DLSA (398)
B_GEKOA	EIN		KOS (896)
B_GLF	LOK	GGPED (454)	
B_GRDST	EIN		BBTEGA (750), DTEV (856), KOS (896)
B_GSCH	EIN		KOS (896), NWS (618)
B_GWHS	AUS	BBGANG (501)	ARMD (531), MDFAW (508), KOS (896), FGRUE (490), FGRABED (491)
B_GWRTE	LOK	TEB (826)	
B_HAG	AUS	BGPU (276)	BBKHZ (890), DTEV (856)
B_HFM	AUS	DHFM (233)	BGMSZS (239), BGSRM (245), UFRLC (1066), EGFE (228)
B_HLL	LOK	LLRNS (562)	
B_HOLP1	LOK	GGPED (454)	
B_HOLP1A	LOK	GGPED (454)	
B_HOLP1L	LOK	GGPED (454)	
B_HOLP2	LOK	GGPED (454)	
B_HOLP2A	LOK	GGPED (454)	
B_HOLP2L	LOK	GGPED (454)	
B_HOP1MN	LOK	GGPED (454)	
B_HOP2MN	LOK	GGPED (454)	
B_HOPAKT	LOK	GGPED (454)	
B_HPNMOT	AUS	ARMD (531)	
B_HREVAB	EIN		KOEVAB (124)
B_HSHE	AUS	HLS (392)	DHLSHK (1154), DLSH (330)
B_HSHE2	AUS	HLS (392)	DHLSHK (1154), DLSH (330)
B_HSHMX	LOK	HLS (392)	
B_HSHMX2	LOK	HLS (392)	
B_HSOKV	LOK	DHLSVK (29)	
B_HSOKV2	LOK	DHLSVK (29)	
B_HSRDY	AUS	DIMC (1148)	
B_HST	AUS	ESSTT (679)	ESNSWL (691), GGTFM (289), ESVST (677)
B_HSVE	AUS	HLS (392)	DHLSVKE (902), DLSV (301)
B_HSVE2	AUS	HLS (392)	DHLSVKE (902), DLSV (301)
B_HSVMX	LOK	HLS (392)	
B_HSVMX2	LOK	HLS (392)	
B_IFLSD	LOK	MDFAW (508)	
B_IFUKABA	LOK	ESUKA (711)	
B_IFUKAVA	LOK	ESUKA (711)	
B_IIPUMS	LOK	BGPU (276)	
B_IKLREST	LOK	ADVE (918)	
B_IKLSTAR	LOK	ADVE (918)	
B_ILMLKAT	AUS	LRKA (795)	
B_ILMLKAT2	AUS	LRKA (795)	
B_IMLKVSE	LOK	DKVS (811)	
B_INCR	LOK	STADAP (684)	
B_INI	EIN		ATWAL (297), GGPOEL (296), MDWAN (554)
B_INIAR	AUS	ARMD (531)	
B_INIARV	AUS	ARMD (531)	
B_INIFRM	LOK	LR (768)	
B_INIFRM2	LOK	LR (768)	
B_INS1NEW	EIN		DCINS (1126)
B_INT	LOK	LR (768)	
B_INT2	LOK	LR (768)	
B_ISOPROT	EIN		SCATT (1097), TC9MOD (1121), TC1MOD (1100), TC5MOD (1110), TC6MOD (1112), TC8MOD (1120), TC2MOD (1107)
B_I_SKA	AUS	UFEING (1058)	UFMVER (1087), UFRLC (1066), UFREAC (1088), UFUE (1056)
B_I_SKA_FR	AUS	SREAKT (963)	UFEING (1058), UFUE (1056)
B_I_SKA_UM	AUS	UFMVER (1087)	URADCC (1049), UFZWC (1075), UFSPSC (1060), UFNC (1063), UFUE (1056), UFRLC (1066), UFREAC (1088), ADVE (918), SREAKT (963), FUEDKSA (610), DUF (1089), BGDVE (934), AEVABU (1002)
B_KATFZ	AUS	PROKON (53)	BBKHZ (890), DIMC (1148)
B_KATH	AUS	PROKON (53)	DIMC (1148)
B_KATHRDY	AUS	DIMC (1148)	
B_KATRDY	AUS	DIMC (1148)	
B_KAWE	LOK	LRKA (795)	
B_KAWE2	LOK	LRKA (795)	
B_KFVSWK	LOK	FGRFULO (1160)	
B_KFWEE	LOK	ESVW (1009)	
B_KH	AUS	AK (855)	BBKHZ (890), ATM (20), BBSAWE (557), DMDLU (193), LAKH (735), LLRMR (572), MDAUTG (515), NWS (618), MDKOG (516), ZWMIN (669), LAMKO (729), KHMD (894), DMDFON (161)

Symbol	Type	Created within	Used within
B_KHA	AUS	BBKHZ (890)	LLRRM (566), AK (855)
B_KHAB	AUS	BBKHZ (890)	AK (855)
B_KHLL	LOK	BBKHZ (890)	
B_KHLLE	LOK	BBKHZ (890)	
B_KHLLMX	LOK	BBKHZ (890)	
B_KHN	EIN		LLRNS (562), BBKHZ (890)
B_KL	AUS	EGKE (409)	KRKE (427), KRDY (659), KRRA (639)
B_KL15	EIN		ADVE (918), DCKUP (1128), DCINS (1126), RDE (112), MOTAUS (1028), LFS (69), GGDPG (74), DMIL (1150), ALE (136), CAN (1124), DCAS (1128)
B_KL50	EIN		RDE (112)
B_KLAFBG	LOK	FUEDK (597)	
B_KLDF	LOK	LLRNS (562)	
B_KLDYNRM	LOK	KRDY (659)	
B_KLDYSTK	LOK	KRDY (659)	
B_KLIMA	AUS	PROKON (53)	
B_KLLKNL	DOK	NLDG (157)	
B_KMMIL	AUS	DMIL (1150)	BGKMST (1008)
B_KMMILSCT	EIN		TC1MOD (1100)
B_KO	EIN		KOS (896), LLRNS (562), MDFAW (508)
B_KOA	LOK	KOS (896)	
B_KOBAUS	LOK	KOS (896)	
B_KOBMNON	LOK	KOS (896)	
B_KOBPED	LOK	KOS (896)	
B_KOBPEDT	LOK	KOS (896)	
B_KOBWPEDT	LOK	KOS (896)	
B_KOE	AUS	KOS (896)	BBSAWE (557), DMDSTP (205), DTEV (856), DKOSE (901), MDVERAD (549), MDVERB (540), LRA (797)
B_KOENA	LOK	KOS (896)	
B_KOENAT	LOK	KOS (896)	
B_KOEVAB	AUS	KOEVAB (124)	AEVABZK (1003)
B_KOINT	LOK	KOS (896)	
B_KOMNOFF	LOK	KOS (896)	
B_KOMNON	LOK	KOS (896)	
B_KOMXOFF	LOK	KOS (896)	
B_KOOFF	LOK	KOS (896)	
B_KOOFFT	LOK	KOS (896)	
B_KOTMSK	LOK	KOS (896)	
B_KOTMSKO	LOK	KOS (896)	
B_KOV	AUS	KOS (896)	
B_KOVDOWN	LOK	KOS (896)	
B_KOWPED	LOK	KOS (896)	
B_KR	AUS	KRDY (659)	KRRA (639), DKRS (437), KRKE (427), GGKS (412), EGKE (409)
B_KRA	LOK	KRRA (639)	
B_KRDWS	AUS	EGKE (409)	KRRA (639), KRDY (659)
B_KRFDKS	AUS	KRRA (639)	DKRS (437)
B_KRGZ	LOK	KRRA (639)	
B_KRKEZ	AUS	KRRA (639)	
B_KRLDY	AUS	KRDY (659)	DKRS (437), EGKE (409), GGKS (412), KRRA (639), KRKE (427)
B_KRLDYA	AUS	KRDY (659)	KRRA (639), EGKE (409)
B_KRLDYF	LOK	KRDY (659)	
B_KRLDYV	LOK	KRDY (659)	
B_KRLZ	AUS	KRRA (639)	
B_KRLZN	LOK	KRRA (639)	
B_KRNDY	AUS	KRDY (659)	DKRS (437), KRRA (639), EGKE (409), KRKE (427), GGKS (412)
B_KRNL	AUS	KRRA (639)	KRKE (427)
B_KRSYNE	LOK	KRRA (639)	
B_KRVF	LOK	KRRA (639)	
B_KSTAI	LOK	STADAP (684)	
B_KSTAUE	LOK	STADAP (684)	
B_KSTEBF	EIN		AEKP (970)
B_KS_MIN_I	LOK	DKRS (437)	
B_KUP1NEW	EIN		CAN (1124), DCKUP (1128), DVKUP (1027)
B_KUPGW	AUS	ARMD (531)	
B_KUPPL	AUS	EGEG (453)	GGEGAS (474), SWADAP (47), ARMD (531), FGRUE (490), KRDY (659), LLRMR (572), LLRBB (575), ZWMIN (669), MDFAW (508), KOS (896), FGRABED (491), BBSAWE (557), DMDSTP (205)
B_KUPPLV	AUS	GGEGAS (474)	MDFAW (508), MDKOG (516)
B_KVSFFL	LOK	DKVS (811)	
B_KVTA	AUS	BGKV (71)	
B_KW	AUS	BBKHZ (890)	ATM (20), MDKOG (516), ZWMIN (669), MDAUTG (515), KHMD (894), AK (855)
B_LALGF	AUS	LAMKO (729)	LAMSOLL (726)
B_LALGF2	AUS	LAMKO (729)	LAMSOLL (726)
B_LAMBTS	LOK	LAMKO (729)	
B_LAMBTS2	LOK	LAMKO (729)	
B_LAMEND	LOK	DLSAHK (339)	
B_LAMEND2	LOK	DLSAHK (339)	
B_LAMKA	EIN		TEBEB (762), LAMKO (729)
B_LAMKA2	EIN		TEBEB (762), LAMKO (729)
B_LAMLASH	EIN		LAMKO (729), DLSAHK (339)
B_LAMLASH2	EIN		LAMKO (729), DLSAHK (339)

Symbol	Type	Created within	Used within
B_LAMNSE	EIN		LAMKO (729)
B_LAMNSWL	LOK	LAMKO (729)	
B_LAMPE	AUS	ATWAL (297)	
B_LAMSDEF	AUS	LAMKO (729)	TEBEB (762)
B_LAMVERG	LOK	DLSAHK (339)	
B_LAMVERG2	LOK	DLSAHK (339)	
B_LCLMOD5	LOK	DLSSA (350)	
B_LCLMOD52	LOK	DLSSA (350)	
B_LDEF	LOK	LAMKO (729)	
B_LDEF2	LOK	LAMKO (729)	
B_LDOB	EIN		LAMFAW (728)
B_LDPI	EIN		DTEV (856), TEBEB (762)
B_LDRUGD	EIN		DHFM (233), FUEDK (597)
B_LDSAFW	AUS	PROKON (53)	
B_LDSAPP	AUS	PROKON (53)	
B_LF1NBRES	AUS	LFS (69)	MDVERB (540)
B_LF1S	AUS	LFS (69)	DMLSE (34), MDVERB (540)
B_LF2NBRES	AUS	LFS (69)	MDVERB (540)
B_LF2S	AUS	LFS (69)	DMLSE (34), MDVERB (540)
B_LFB1	LOK	LFS (69)	
B_LFB2	LOK	LFS (69)	
B_LKKLNL	DOK	NLDG (157)	
B_LL	AUS	MDFAW (508)	MSF (506), ARMD (531), BBKHZ (890), BBSAWE (557), BGRLP (266), ESWE (698), ESUK (699), DTEV (856), DMDSTP (205), DMDLU (193), DLLR (578), DDST (851), BGPU (276), LREB (739), LR (768), LLRNS (562), LLRNFA (564), LLRMR (572), LLRBB (575), KRDY (659), KOS (896), GKRA (766), GGTFA (298), WANWKW (125), NWS (618), NLPH (150), MDKOG (516), MDAUTG (515), GGHFM (230), FUEDKSA (610), BBTEGA (750), EGFE (228)
B_LLDIA	LOK	DLLR (578)	
B_LLR	AUS	LLRBB (575)	DLLR (578), DTEV (856), MDVERAD (549), LLRRM (566), LLRMD (561)
B_LLREIN	AUS	LLRBB (575)	LLRMD (561), FUEDK (597), MDKOG (516), MDVERAD (549), MDVER (546), ZWSTT (637), ZWMIN (669), ZUE (627), WDKSOM (614), MDVERB (540), MDKOL (526), LLRNS (562), LLRRM (566)
B_LLRI	AUS	LLRBB (575)	LLRRM (566), LLRMD (561)
B_LLRPD	AUS	LLRBB (575)	FUEREG (595), LLRRM (566), LLRMD (561)
B_LLRPKH	LOK	LLRRM (566)	
B_LLRPST	LOK	LLRRM (566)	
B_LLRST	AUS	LLRRM (566)	LLRNS (562)
B_LLVFGR	AUS	FGRREGL (1174)	FGRUE (490), MDFAW (508)
B_LLVFGRC	EIN		FGRREGL (1174)
B_LMSSLOF	EIN		BBKHZ (890)
B_LR	AUS	GKEB (737)	LREB (739), BBTEGA (750), TEBEB (762), TEB (826), LRHK (781), LRAEB (759), LRA (797), ESUKA (711), DTEV (856), DLSV (301), DLSA (398), DKVS (811), DKAT (361), GKRA (766)
B_LR2	AUS	GKEB (737)	LREB (739), BBTEGA (750), TEBEB (762), TEB (826), LRHK (781), LRAEB (759), LRA (797), DKVS (811), DLSA (398), DTEV (856), ESUKA (711), DLSV (301), DKAT (361), GKRA (766)
B_LR2S	LOK	LREB (739)	
B_LR2S2	LOK	LREB (739)	
B_LR2V	LOK	LRHK (781)	
B_LRA	AUS	GKEB (737)	LRAEB (759), DKVS (811), LRA (797), GKRA (766)
B_LRA2	AUS	GKEB (737)	LRAEB (759), DKVS (811), LRA (797), GKRA (766)
B_LRACT	AUS	LREB (739)	
B_LRACT2	AUS	LREB (739)	
B_LRAEN	LOK	LRAEB (759)	
B_LRAR	AUS	TEB (826)	DLLR (578), LRA (797)
B_LRARE	AUS	LRA (797)	DKVS (811)
B_LRARE2	AUS	LRA (797)	DKVS (811)
B_LRAREB	AUS	LRA (797)	
B_LRAT	AUS	LRAEB (759)	LRA (797)
B_LREB100	LOK	LREB (739)	
B_LREBLE	LOK	LREB (739)	
B_LREBLE2	LOK	LREB (739)	
B_LREBPR	LOK	LREB (739)	
B_LREBPR2	LOK	LREB (739)	
B_LREBRI	LOK	LREB (739)	
B_LREBRI2	LOK	LREB (739)	
B_LRHK	AUS	LRHK (781)	DLSA (398), DLSH (330), DLSSA (350), DLSAHK (339)
B_LRHK2	AUS	LRHK (781)	DLSA (398), DLSAHK (339), DLSH (330), DLSSA (350)
B_LRHKB	LOK	LRHK (781)	
B_LRHKB2	LOK	LRHK (781)	
B_LRHKBV2	LOK	LRHK (781)	
B_LRHKG	LOK	LRHK (781)	
B_LRHKGI	LOK	LRHK (781)	
B_LRHKP	LOK	LRHK (781)	
B_LRHKP2	LOK	LRHK (781)	
B_LRKA	AUS	LRKA (795)	DKAT (361), LRHK (781), GKRA (766)
B_LRKA2	AUS	LRKA (795)	DKAT (361), LRHK (781), GKRA (766)
B_LRKAA	LOK	LRKA (795)	
B_LRKAA2	LOK	LRKA (795)	
B_LRKAE	LOK	LRKA (795)	

Symbol	**Type**	**Created within**	**Used within**
B_LRKAE2	LOK	LRKA (795)	
B_LRKAEI	LOK	LRKA (795)	
B_LRKAEI2	LOK	LRKA (795)	
B_LRKAON	LOK	LRKA (795)	
B_LRKARG	LOK	LRKA (795)	
B_LRKARG2	LOK	LRKA (795)	
B_LRKAST	LOK	LRKA (795)	
B_LRKAST2	LOK	LRKA (795)	
B_LRNAKT	AUS	BGDVE (934)	DDVE (950)
B_LRND	AUS	GKEB (737)	LREB (739), AK (855), LRINI (749), LR (768), GKRA (766)
B_LRND2	AUS	GKEB (737)	LREB (739), LR (768), LRINI (749), GKRA (766)
B_LRNDA	AUS	LREB (739)	
B_LRNDA2	AUS	LREB (739)	
B_LRNDIA	EIN		BGDVE (934)
B_LRNERF	AUS	BGDVE (934)	DDVE (950)
B_LRNFG	LOK	BGDVE (934)	
B_LRNRDY	AUS	BGDVE (934)	ADVE (918), DDVE (950)
B_LRNTESA	LOK	BGDVE (934)	
B_LRNVB	AUS	BGDVE (934)	DDVE (950)
B_LRNWS	AUS	BGDVE (934)	DDVE (950)
B_LRNWT	EIN		ADVE (918), BGDVE (934)
B_LRPERF	LOK	LR (768)	
B_LRPERM	LOK	LR (768)	
B_LRPSPA	DOK	LREB (739)	
B_LRRL	LOK	LREB (739)	
B_LRSP	AUS	LR (768)	ESUKA (711), LRHK (781)
B_LRSP2	AUS	LR (768)	ESUKA (711), LRHK (781)
B_LRSSA	EIN		TEBEB (762)
B_LRSSA2	EIN		TEBEB (762)
B_LRSTAT	AUS	LR (768)	
B_LRSTAT2	AUS	LR (768)	
B_LRSTTA	AUS	LR (768)	
B_LRSTTA2	AUS	LR (768)	
B_LRSTTAMA	LOK	LR (768)	
B_LRSYINH	AUS	LR (768)	DKAT (361)
B_LRSYNB1	EIN		LRHK (781), LR (768)
B_LRSYNC	AUS	DKAT (361)	LR (768), LRHK (781)
B_LRSYNI	EIN		LRHK (781), LR (768)
B_LRTPP	AUS	LR (768)	DLSA (398), DLSSA (350)
B_LRTPP2	AUS	LR (768)	DLSA (398), DLSSA (350)
B_LRVK	AUS	LREB (739)	
B_LRVK2	AUS	LREB (739)	
B_LRWLA	DOK	LREB (739)	
B_LS	LOK	MDFAW (508)	
B_LS3	AUS	PROKON (53)	
B_LS32	AUS	PROKON (53)	
B_LS4	AUS	PROKON (53)	
B_LS42	AUS	PROKON (53)	
B_LSADS	LOK	DLSV (301)	
B_LSADS2	LOK	DLSV (301)	
B_LSAHKSP	LOK	DLSAHK (339)	
B_LSAHKSP2	LOK	DLSAHK (339)	
B_LSASTP	LOK	DLSA (398)	
B_LSASTP2	LOK	DLSA (398)	
B_LSD	AUS	MDFAW (508)	ARMD (531), FUEDK (597), MDKOG (516), MDKOL (526), MDAUTG (515)
B_LSFET	LOK	DLSV (301)	
B_LSFET2	LOK	DLSV (301)	
B_LSH	AUS	PROKON (53)	GGLSH (318)
B_LSH2	AUS	PROKON (53)	GGLSH (318)
B_LSHKLT	LOK	DLSH (330)	
B_LSHUB	LOK	DLSV (301)	
B_LSHUB2	LOK	DLSV (301)	
B_LSRDY	AUS	DIMC (1148)	
B_LSV	AUS	PROKON (53)	GGLSV (382)
B_LSV2	AUS	PROKON (53)	GGLSV (382)
B_LSVKLT	LOK	DLSV (301)	
B_LSVKLT2	LOK	DLSV (301)	
B_LSVN	LOK	DLSV (301)	
B_LSVN2	LOK	DLSV (301)	
B_LSVVSP	EIN		LRA (797)
B_LUAERK	AUS	DMDLUA (202)	DMDLAD (215)
B_LUAERK_M	EIN		NLPH (150), DMDLUA (202)
B_LUAER_M2	LOK	DMDLUA (202)	
B_LUECKE	AUS	GGDPG (74)	AZUE (904), WANWKW (125)
B_LUECKE2	EIN		AZUE (904)
B_LUENA	LOK	DMDSTP (205)	
B_LUERK	AUS	DMDLU (193)	DMDLAD (215)
B_LUERK_M	EIN		NLPH (150), DMDLU (193)
B_LUERK_M2	LOK	DMDLU (193)	
B_LUSTOP	AUS	DMDSTP (205)	DMDDLU (199), DMDLUA (202), DMDLU (193)
B_LUSTOPC	EIN		DMDSTP (205)
B_LUSTOPT	AUS	DMDSTP (205)	

Symbol	Type	Created within	Used within
B_LUSTOPU	LOK	DMDSTP (205)	
B_LUSTOP_M	EIN		NLPH (150)
B_LWSER	EIN		MDVERB (540)
B_LZUP	LOK	KRRA (639)	
B_M6ATV	LOK	DLSA (398)	
B_M6ATV2	LOK	DLSA (398)	
B_M8TE	AUS	TC8MOD (1120)	DTEV (856), TEBEB (762), SCATT (1097)
B_MADFK	EIN		KOS (896), MDVERAD (549)
B_MADFS	EIN		KOS (896), MDVERAD (549)
B_MADKO	EIN		KOS (896), MDVERAD (549)
B_MADLL	EIN		KOS (896), MDVERAD (549)
B_MASO	LOK	DLSV (301)	
B_MASO2	LOK	DLSV (301)	
B_MASTER	EIN		BBTEGA (750), MDVERB (540), DMDUE (158), DMDTSB (159), DMDLUA (202), DMDLU (193), DMDLAD (215), DMDFON (161), DLLR (578), DMDDLU (199)
B_MASTERHW	EIN		AEVAB (980), BGDVE (934), DDST (851), AEVABZK (1003), TEBEB (762), SREAKT (963), GGPED (454), FGRREGL (1174), FGRFULO (1160), DNWSE (1025), DMDSTP (205)
B_MAXFLSH	LOK	DLSH (330)	
B_MAXFLSH2	LOK	DLSH (330)	
B_MAXFLSV	LOK	DLSV (301)	
B_MAXFLSV2	LOK	DLSV (301)	
B_MAXLASH	LOK	DLSAHK (339)	
B_MAXLASH2	LOK	DLSAHK (339)	
B_MAXLATV	LOK	DLSA (398)	
B_MAXLATV2	LOK	DLSA (398)	
B_MBVH	LOK	GGPED (454)	
B_MCACTI	LOK	VS_VERST (67)	
B_MDARV	AUS	DMDMIL (216)	DKAT (361), DLSA (398), DTEV (856), DLSAHK (339), DMDSTP (205), ESUKA (711), LRHK (781), LRAEB (759)
B_MDDRLA	LOK	DMDSTP (205)	
B_MDE8E	EIN		SCATT (1097)
B_MDE9E	EIN		SCATT (1097)
B_MDEE	LOK	MDRED (976)	
B_MDEIN	AUS	MDKOG (516)	DMDSTP (205), LLRBB (575)
B_MDERK	AUS	DMDLAD (215)	DMDFON (161), DMDSTP (205)
B_MDKAT	AUS	DMDMIL (216)	DKAT (361), LREB (739)
B_MDMAX	AUS	SWADAP (47)	
B_MDMIN	AUS	MDFUE (594)	SWADAP (47), LLRRM (566), MDKOG (516)
B_MDMXZU	LOK	MDZUL (523)	
B_MDNG	LOK	DMDSTP (205)	
B_MDNMOT	LOK	DMDSTP (205)	
B_MDRL	LOK	DMDSTP (205)	
B_MDSTIM_M	EIN		NLPH (150), DMDUE (158)
B_MDSTOP	AUS	DMDSTP (205)	DMDDLU (199), DMDLU (193), DMDFON (161), DMDLUA (202)
B_MDSTOPC	EIN		DMDSTP (205)
B_MDSTOPT	AUS	DMDSTP (205)	
B_MDSTOP_M	EIN		DMDFON (161), NLPH (150)
B_MDTNST	LOK	DMDSTP (205)	
B_MDZYL1	DOK	DMDFON (161)	DMDLUA (202)
B_MDZYL1_M	EIN		DMDFON (161), DMDUE (158)
B_MFACT	LOK	FUEDK (597)	
B_MGBGAKT	LOK	MDFAW (508)	
B_MGBGET	EIN		FUEDK (597), MDFAW (508)
B_MIBEG	AUS	MDKOG (516)	DUF (1089), MDAUTG (515), MDKOL (526)
B_MIBEGL	AUS	MDKOL (526)	MDKOG (516)
B_MIFABG	EIN		MDKOL (526), MDFAW (508)
B_MIL	EIN		DMILE (36)
B_MILBLK	LOK	DMIL (1150)	
B_MILEB	LOK	DMIL (1150)	
B_MILFB	EIN		DMIL (1150)
B_MILMD	AUS	DMDMIL (216)	
B_MILST	LOK	DMIL (1150)	
B_MILSTAT	AUS	DMIL (1150)	TC1MOD (1100)
B_MILSTP	AUS	DMDSTP (205)	DMDMIL (216)
B_MINLASH	LOK	DLSAHK (339)	
B_MINLASH2	LOK	DLSAHK (339)	
B_MINLATV	LOK	DLSA (398)	
B_MINLATV2	LOK	DLSA (398)	
B_MLDYN	LOK	DLSAHK (339)	
B_MLRSA	AUS	GKEB (737)	LREB (739), TEBEB (762)
B_MLUECKE	AUS	GGDPG (74)	
B_MLUSTEST	LOK	DLSAHK (339)	
B_MNBREMS	LOK	GGEGAS (474)	
B_MNBWF	AUS	GGPED (454)	
B_MNDK	LOK	DDVE (950)	
B_MNDK1P	LOK	DDVE (950)	
B_MNDK2P	LOK	DDVE (950)	
B_MNDSS	LOK	EGFE (228)	
B_MNDST	AUS	DDST (851)	
B_MNDVEE	LOK	DDVE (950)	

Symbol	Type	Created within	Used within
B_MNDVEF	AUS	DDVE (950)	
B_MNDVEFO	AUS	DDVE (950)	
B_MNDVEL	LOK	DDVE (950)	
B_MNDVEN	LOK	DDVE (950)	
B_MNDVER	LOK	DDVE (950)	
B_MNDVEU	LOK	DDVE (950)	
B_MNDVEUB	LOK	DDVE (950)	
B_MNDVEV	LOK	DDVE (950)	
B_MNEGFE	AUS	DEGFE (592)	
B_MNEV1	EIN		DEVE (1017)
B_MNEV1C	EIN		DMDMIL (216)
B_MNEV2	EIN		DEVE (1017)
B_MNEV2C	EIN		DMDMIL (216)
B_MNEV3	EIN		DEVE (1017)
B_MNEV3C	EIN		DMDMIL (216)
B_MNEV4	EIN		DEVE (1017)
B_MNEV4C	EIN		DMDMIL (216)
B_MNEV5	EIN		DEVE (1017)
B_MNEV5C	EIN		DMDMIL (216)
B_MNEV6	EIN		DEVE (1017)
B_MNEV6C	EIN		DMDMIL (216)
B_MNEV7	EIN		DEVE (1017)
B_MNEV8	EIN		DEVE (1017)
B_MNFHSH	LOK	DHLSHK (1154)	
B_MNFHSH2	LOK	DHLSHK (1154)	
B_MNFP1P	AUS	GGPED (454)	
B_MNFP2P	AUS	GGPED (454)	
B_MNFPP	AUS	GGPED (454)	
B_MNFRAO	LOK	DKVS (811)	
B_MNFRAO2	LOK	DKVS (811)	
B_MNFRAU	LOK	DKVS (811)	
B_MNFRAU2	LOK	DKVS (811)	
B_MNFRST	LOK	DKVS (811)	
B_MNFRST2	LOK	DKVS (811)	
B_MNHFM	LOK	DHFM (233)	
B_MNHSH	AUS	DHLSHK (1154)	
B_MNHSH2	AUS	DHLSHK (1154)	
B_MNHSVE	AUS	DHLSVKE (902)	
B_MNHSVE2	AUS	DHLSVKE (902)	
B_MNKAT	AUS	DKAT (361)	
B_MNKAT2	AUS	DKAT (361)	
B_MNKOSE	AUS	DKOSE (901)	
B_MNKPE	EIN		DEKPE (1020)
B_MNKS1	AUS	DKRS (437)	
B_MNKS2	AUS	DKRS (437)	
B_MNKS3	AUS	DKRS (437)	
B_MNKS4	AUS	DKRS (437)	
B_MNLASH	AUS	DLSAHK (339)	
B_MNLASH2	AUS	DLSAHK (339)	
B_MNLATP	AUS	DLSA (398)	
B_MNLATP2	AUS	DLSA (398)	
B_MNLATV	AUS	DLSA (398)	
B_MNLATV2	AUS	DLSA (398)	
B_MNLLR	AUS	DLLR (578)	
B_MNLM	AUS	DHFM (233)	EGFE (228)
B_MNLSV	AUS	DLSV (301)	
B_MNLSV2	AUS	DLSV (301)	
B_MNMD	LOK	DMDMIL (216)	
B_MNMDB	AUS	MDKOG (516)	
B_MNMILE	AUS	DMILE (36)	
B_MNNWKW	AUS	DNWKW (134)	
B_MNNWKW2	AUS	DNWKW (134)	
B_MNNWS	AUS	DNWS (622)	
B_MNNWS2	AUS	DNWS (622)	
B_MNPH	AUS	DPH (144)	
B_MNPH2	AUS	DPH (144)	
B_MNPUA	AUS	BGPU (276)	
B_MNRKAT	LOK	DKVS (811)	
B_MNRKAT2	LOK	DKVS (811)	
B_MNRKAZ	LOK	DKVS (811)	
B_MNRKAZ2	LOK	DKVS (811)	
B_MNTA	AUS	GGTFA (298)	
B_MNTES	AUS	DTEV (856)	
B_MNTEVE	AUS	DTEVE (1022)	
B_MNTM	AUS	GGTFM (289)	
B_MNUB	AUS	GGUB (487)	
B_MOTAUS	EIN		DVKUP (1027)
B_MOTSTOP	AUS	RDE (112)	KOEVAB (124)
B_MRAKT	AUS	MDKOL (526)	MDZUL (523)
B_MRFAMX	LOK	ESVW (1009)	
B_MSFSLR	LOK	LREB (739)	
B_MSFSLR2	LOK	LREB (739)	

Symbol	Type	Created within	Used within
B_MSLOFF	EIN		BBKHZ (890), AK (855)
B_MSLR	LOK	LREB (739)	
B_MSLR2	LOK	LREB (739)	
B_MSR	AUS	MDKOG (516)	BBSAWE (557), MDZUL (523), DUF (1089), MDRED (976)
B_MSREXT	LOK	UFMSRC (1080)	
B_MSR_C	EIN		CAN (1124)
B_MSTHW_UM	EIN		UFMER (1060), UFMET (1060)
B_MT	AUS	PROKON (53)	
B_MUNST	AUS	WDKSOM (614)	ZWMIN (669)
B_MXBREMS	LOK	GGEGAS (474)	
B_MXBWF	AUS	GGPED (454)	
B_MXDK	LOK	DDVE (950)	
B_MXDK1P	LOK	DDVE (950)	
B_MXDK2P	LOK	DDVE (950)	
B_MXDSS	LOK	EGFE (228)	
B_MXDST	AUS	DDST (851)	
B_MXDVEE	LOK	DDVE (950)	
B_MXDVEF	AUS	DDVE (950)	
B_MXDVEFO	AUS	DDVE (950)	
B_MXDVEL	LOK	DDVE (950)	
B_MXDVEN	LOK	DDVE (950)	
B_MXDVER	LOK	DDVE (950)	
B_MXDVEU	LOK	DDVE (950)	
B_MXDVEUB	LOK	DDVE (950)	
B_MXDVEV	LOK	DDVE (950)	
B_MXEGFE	AUS	DEGFE (592)	
B_MXEV1	EIN		DEVE (1017)
B_MXEV2	EIN		DEVE (1017)
B_MXEV3	EIN		DEVE (1017)
B_MXEV4	EIN		DEVE (1017)
B_MXEV5	EIN		DEVE (1017)
B_MXEV6	EIN		DEVE (1017)
B_MXEV7	EIN		DEVE (1017)
B_MXEV8	EIN		DEVE (1017)
B_MXFHSH	LOK	DHLSHK (1154)	
B_MXFHSH2	LOK	DHLSHK (1154)	
B_MXFP1P	AUS	GGPED (454)	
B_MXFP2P	AUS	GGPED (454)	
B_MXFPP	AUS	GGPED (454)	
B_MXFRAO	LOK	DKVS (811)	
B_MXFRAO2	LOK	DKVS (811)	
B_MXFRAU	LOK	DKVS (811)	
B_MXFRAU2	LOK	DKVS (811)	
B_MXFRST	LOK	DKVS (811)	
B_MXFRST2	LOK	DKVS (811)	
B_MXHFM	LOK	DHFM (233)	
B_MXHSH	AUS	DHLSHK (1154)	
B_MXHSH2	AUS	DHLSHK (1154)	
B_MXHSVE	AUS	DHLSVKE (902)	
B_MXHSVE2	AUS	DHLSVKE (902)	
B_MXKAT	AUS	DKAT (361)	
B_MXKAT2	AUS	DKAT (361)	
B_MXKOSE	AUS	DKOSE (901)	
B_MXKPE	EIN		DEKPE (1020)
B_MXKS1	AUS	DKRS (437)	
B_MXKS2	AUS	DKRS (437)	
B_MXKS3	AUS	DKRS (437)	
B_MXKS4	AUS	DKRS (437)	
B_MXLASH	AUS	DLSAHK (339)	
B_MXLASH2	AUS	DLSAHK (339)	
B_MXLATP	AUS	DLSA (398)	
B_MXLATP2	AUS	DLSA (398)	
B_MXLATV	AUS	DLSA (398)	
B_MXLATV2	AUS	DLSA (398)	
B_MXLLR	AUS	DLLR (578)	
B_MXLM	AUS	DHFM (233)	EGFE (228)
B_MXLSH	AUS	DLSH (330)	
B_MXLSH2	AUS	DLSH (330)	
B_MXLSV	AUS	DLSV (301)	
B_MXLSV2	AUS	DLSV (301)	
B_MXMD	LOK	DMDMIL (216)	
B_MXMDB	AUS	MDKOG (516)	
B_MXMILE	AUS	DMILE (36)	
B_MXNWKW	AUS	DNWKW (134)	
B_MXNWKW2	AUS	DNWKW (134)	
B_MXNWS	AUS	DNWS (622)	
B_MXNWS2	AUS	DNWS (622)	
B_MXPH	AUS	DPH (144)	
B_MXPH2	AUS	DPH (144)	
B_MXPUA	AUS	BGPU (276)	
B_MXRKAT	LOK	DKVS (811)	
B_MXRKAT2	LOK	DKVS (811)	

Symbol	Type	Created within	Used within
B_MXRKAZ	LOK	DKVS (811)	
B_MXRKAZ2	LOK	DKVS (811)	
B_MXRLROH	EIN		BGSRM (245)
B_MXTA	AUS	GGTFA (298)	
B_MXTES	AUS	DTEV (856)	
B_MXTEVE	AUS	DTEVE (1022)	
B_MXTM	AUS	GGTFM (289)	
B_MXUB	AUS	GGUB (487)	
B_MZNS	LOK	MDZUL (523)	
B_MZNS_C	AUS	UFMER (1060)	
B_MZNS_UM	AUS	UFNSC (1077)	MDZUL (523), UFMET (1060), UFMZUL (1084), UFUE (1056)
B_NAC	AUS	KOS (896)	LLRNS (562)
B_NACHL	AUS	MOTAUS (1028)	HLS (392)
B_NACHLEND	AUS	MOTAUS (1028)	AEKP (970), BGPU (276), ATM (20)
B_NACHLRAM	AUS	MOTAUS (1028)	
B_NACHLSTP	AUS	MOTAUS (1028)	BGTABST (1030)
B_NDYLASH	LOK	DLSAHK (339)	
B_NDYLASH2	LOK	DLSAHK (339)	
B_NESCH	LOK	DLSAHK (339)	
B_NESCH2	LOK	DLSAHK (339)	
B_NGASOK	AUS	BGNG (121)	BGRLG (274)
B_NKONS_UM	AUS	UFMSRC (1080)	
B_NLACLS	EIN		MOTAUS (1028)
B_NLALE	AUS	ALE (136)	MOTAUS (1028)
B_NLATM	AUS	ATM (20)	MOTAUS (1028)
B_NLCAN	EIN		MOTAUS (1028)
B_NLDG	EIN		ALE (136), DPH (144), DLLR (578), DMDSTP (205), DTEV (856), GGDPG (74), ESUKA (711), WANWKW (125), NMAXMD (584), NLPH (150), NLDG (157), LLRNS (562), KRRA (639)
B_NLDGC	EIN		GGDPG (74)
B_NLDTE	EIN		MOTAUS (1028)
B_NLEEPR	EIN		MOTAUS (1028)
B_NLMLS	AUS	LFS (69)	MOTAUS (1028)
B_NLOBD	EIN		MOTAUS (1028)
B_NLPE	AUS	BGDVE (934)	DDVE (950)
B_NLPERF	AUS	BGDVE (934)	DDVE (950)
B_NLPH	AUS	NLPH (150)	GGDPG (74)
B_NLPHEA	AUS	AEVAB (980)	NLPH (150)
B_NLPHEAI	LOK	AEVAB (980)	
B_NLPNE	AUS	ADVE (918)	SREAKT (963)
B_NLPNEW	AUS	BGDVE (934)	DDVE (950)
B_NLPREQ	AUS	BGDVE (934)	
B_NLSGLS	EIN		MOTAUS (1028)
B_NLSIKO	EIN		MOTAUS (1028)
B_NLWFS	EIN		MOTAUS (1028)
B_NLWST	AUS	BGTABST (1030)	MOTAUS (1028)
B_NMAX	AUS	NMAXMD (584)	BGBSZ (73), GGPED (454), MDRED (976)
B_NMAXD	EIN		AEVABU (1002), NMAXMD (584)
B_NMIN	AUS	GGDPG (74)	AEKP (970), WDKSOM (614), RDE (112), GGTFM (289), BGNMOT (111), BGTABST (1030), DECJ (1013), ESSTT (679), DDG (141), AZUE (904)
B_NMOT	AUS	GGDPG (74)	ADVE (918), TEB (826), MDFAW (508), DMIL (1150), DLLR (578), DHLSVK (29), DHLSHK (1154), DEPCL (1151), ALE (136), BBSTT (148), BBKHZ (890), BGKMST (1008), LLRBB (575), GGTFM (289), GGTFA (298), DLSV (301), DLSH (330), BBTEGA (750)
B_NO	LOK	DTRIG (1139)	
B_NOADSH	LOK	DLSH (330)	
B_NOADSH2	LOK	DLSH (330)	
B_NOBM	AUS	GGDPG (74)	
B_NOBM1	AUS	GGDPG (74)	
B_NODEC	LOK	STADAP (684)	
B_NOFLR	AUS	DDST (851)	
B_NOFRA	AUS	LRA (797)	DKVS (811)
B_NOFRAT	LOK	LRA (797)	
B_NOINC	LOK	STADAP (684)	
B_NOKATFZ	EIN		GGTFM (289)
B_NOLASH	LOK	DLSAHK (339)	
B_NOLASH2	LOK	DLSAHK (339)	
B_NOLATP	LOK	DLSA (398)	
B_NOLATP2	LOK	DLSA (398)	
B_NOLATV	LOK	DLSA (398)	
B_NOLATV2	LOK	DLSA (398)	
B_NOLRB	AUS	LREB (739)	
B_NOLRB2	AUS	LREB (739)	
B_NOLRE	AUS	LREB (739)	
B_NOLRE2	AUS	LREB (739)	
B_NOLRW	AUS	LREB (739)	
B_NOLRW2	AUS	LREB (739)	
B_NOLSH	AUS	DLSH (330)	
B_NOLSH2	AUS	DLSH (330)	
B_NOLSV	LOK	DLSV (301)	
B_NOLSV2	LOK	DLSV (301)	
B_NOME_C	AUS	UFMER (1060)	

Symbol	Type	Created within	Used within
B_NOME_UM	AUS	UFMER (1060)	DUF (1089), SREAKT (963), UFMET (1060)
B_NOMIL	LOK	DMIL (1150)	
B_NOMSR_FR	AUS	CAN (1124)	UFMSRC (1080)
B_NOMSR_UM	AUS	UFMSRC (1080)	UFUE (1056), CAN (1124), DUF (1089)
B_NOPH	AUS	GGDPG (74)	
B_NOPH2	AUS	GGDPG (74)	
B_NOPHNLDG	AUS	DPH (144)	
B_NORKAM	LOK	DKVS (811)	
B_NORKAT	AUS	LRA (797)	DKVS (811)
B_NORKAZ	AUS	LRA (797)	DKVS (811)
B_NOSGS_FR	EIN		UFSGSC (1070), CAN (1124)
B_NOSGS_UM	AUS	UFSGSC (1070)	CAN (1124), DUF (1089)
B_NOSYNPH	AUS	NLPH (150)	GGDPG (74)
B_NOTLU	AUS	UFEING (1058)	UFMVER (1087), UFREAC (1088), UFRLC (1066), UFUE (1056)
B_NOTLU_FR	AUS	SREAKT (963)	DUF (1089), UFUE (1056), UFEING (1058)
B_NOWUC	AUS	DWUC (1147)	
B_NOZWE	AUS	MDZW (636)	ZUE (627)
B_NPBM	AUS	DDG (141)	
B_NPBREMS	LOK	GGEGAS (474)	
B_NPBUOF	AUS	CAN (1124)	
B_NPBWF	AUS	GGPED (454)	
B_NPDK	LOK	DDVE (950)	
B_NPDK1P	LOK	DDVE (950)	
B_NPDK2P	LOK	DDVE (950)	
B_NPDST	AUS	DDST (851)	
B_NPDVEE	LOK	DDVE (950)	
B_NPDVEF	LOK	DDVE (950)	
B_NPDVEL	LOK	DDVE (950)	
B_NPDVEN	AUS	DDVE (950)	
B_NPDVER	LOK	DDVE (950)	
B_NPDVET	LOK	DDVE (950)	
B_NPDVEU	AUS	DDVE (950)	
B_NPDVEUW	AUS	DDVE (950)	
B_NPDVEV	AUS	DDVE (950)	
B_NPFHSH	LOK	DHLSHK (1154)	
B_NPFHSH2	LOK	DHLSHK (1154)	
B_NPFP1P	AUS	GGPED (454)	
B_NPFP2P	AUS	GGPED (454)	
B_NPFPP	AUS	GGPED (454)	
B_NPFRST	LOK	DKVS (811)	
B_NPFRST2	LOK	DKVS (811)	
B_NPHSH	AUS	DHLSHK (1154)	
B_NPHSH2	AUS	DHLSHK (1154)	
B_NPHSV	AUS	DHLSVK (29)	
B_NPHSV2	AUS	DHLSVK (29)	
B_NPKAT	AUS	DKAT (361)	
B_NPKAT2	AUS	DKAT (361)	
B_NPKRNT	AUS	DKRNT (445)	
B_NPKROF	AUS	DKRNT (445)	
B_NPKRTP	AUS	DKRTP (451)	
B_NPKS1	AUS	DKRS (437)	
B_NPKS2	AUS	DKRS (437)	
B_NPKS3	AUS	DKRS (437)	
B_NPKS4	AUS	DKRS (437)	
B_NPLASH	AUS	DLSAHK (339)	
B_NPLASH2	AUS	DLSAHK (339)	
B_NPLFLSH	LOK	DLSH (330)	
B_NPLFLSH2	AUS	DLSH (330)	
B_NPLFLSV	LOK	DLSV (301)	
B_NPLFLSV2	LOK	DLSV (301)	
B_NPLM	AUS	DHFM (233)	
B_NPLSV	AUS	DLSV (301)	
B_NPLSV2	AUS	DLSV (301)	
B_NPMD	LOK	DMDMIL (216)	
B_NPMDB	AUS	MDKOG (516)	
B_NPNWS	AUS	DNWS (622)	
B_NPNWS2	AUS	DNWS (622)	
B_NPPH	AUS	DPH (144)	
B_NPPH2	AUS	DPH (144)	
B_NPPOEL	AUS	GGPOEL (296)	
B_NPTES	AUS	DTEV (856)	
B_NPTM	AUS	GGTFM (289)	
B_NPUB	AUS	GGUB (487)	
B_NPUF2SG	AUS	DUF (1089)	
B_NPUFMV	AUS	DUF (1089)	
B_NPUFSKA	AUS	DUF (1089)	
B_NPURRAM	AUS	DUR (1052)	
B_NPURROM	AUS	DUR (1052)	
B_NPURRST	AUS	DUR (1052)	
B_NS2	LOK	LLRNS (562)	
B_NS2A	LOK	LLRNS (562)	
B_NSAKT	LOK	MDZUL (523)	

Symbol	Type	Created within	Used within
B_NSAKT_UM	LOK	UFNSC (1077)	
B_NSEND	LOK	MDZUL (523)	
B_NSEND_UM	LOK	UFNSC (1077)	
B_NSKS	LOK	LLRNS (562)	
B_NSP	AUS	BGRLP (266)	
B_NSSL	LOK	LLRNS (562)	
B_NSTU	AUS	LLRBB (575)	
B_NSWO1	AUS	PROKON (53)	BGAGR (263), FUEREG (595), FUEDK (597), TEB (826), MDVERAD (549), LLRRM (566), LLRNS (562), LLRMR (572), DTEV (856), DLLR (578), ESUKA (711)
B_NSWO2	AUS	PROKON (53)	BGRLP (266), ESUK (699)
B_NTINI	LOK	GGKS (412)	
B_NUSGS_UM	AUS	UFSGSC (1070)	
B_NWS	AUS	FE (591)	MSF (506), NWS (618), ACIFI (1013), GGHFM (230), DNWSE (1025), DNWS (622), DMDSTP (205), BGPU (276)
B_NWS2	EIN		DMDSTP (205)
B_NWSB	LOK	NWS (618)	
B_NWSFA	AUS	DNWS (622)	
B_NWSFA2	AUS	DNWS (622)	
B_NWSFP	AUS	DNWS (622)	
B_NWSFP2	AUS	DNWS (622)	
B_NWSVF	AUS	DNWS (622)	WANWKW (125)
B_NWSVF2	AUS	DNWS (622)	WANWKW (125)
B_NWSVS	AUS	DNWS (622)	
B_NWSVS2	AUS	DNWS (622)	
B_NWVS	AUS	BGSRM (245)	
B_NW_S	AUS	NWS (618)	WANWKW (125)
B_OPTPHERK	EIN		DMDLU (193), NLPH (150)
B_PAGR	AUS	BGAGR (263)	EGFE (228)
B_PGXQSYN	LOK	GGDPG (74)	
B_PHA2ACT	AUS	GGDPG (74)	NLPH (150)
B_PHAACT	AUS	GGDPG (74)	NLPH (150)
B_PHAD	AUS	WANWKW (125)	DNWKW (134), GGDPG (74), DPH (144), DNWS (622)
B_PHAD2	AUS	WANWKW (125)	DNWKW (134), GGDPG (74), DNWS (622), DPH (144)
B_PHAS2	AUS	GGDPG (74)	DPH (144)
B_PHASE	AUS	GGDPG (74)	DPH (144)
B_PHEXOR	LOK	DPH (144)	
B_PHEXOR2	LOK	DPH (144)	
B_PHFALSE	LOK	NLDG (157)	
B_PHNEGTIV	LOK	NLDG (157)	
B_PHNLDG	AUS	NLDG (157)	GGDPG (74)
B_PHREGOK	LOK	DPH (144)	
B_PHREGOK2	LOK	DPH (144)	
B_PHSNL	AUS	NLPH (150)	AEVAB (980), DMDSTP (205), DMDUE (158)
B_PHSNLAB	AUS	NLPH (150)	
B_PHSNLINV	AUS	NLPH (150)	ALE (136)
B_PHSNLOK	AUS	NLPH (150)	
B_PHSOK	AUS	DPH (144)	GGDPG (74), NLPH (150)
B_PHSOK2	AUS	DPH (144)	GGDPG (74), NLPH (150)
B_PHW	LOK	GGDPG (74)	
B_PHW2	LOK	GGDPG (74)	
B_PHWNEG	LOK	GGDPG (74)	
B_PHWOK	LOK	GGDPG (74)	
B_PHWOK2	LOK	GGDPG (74)	
B_PHWPOS	LOK	GGDPG (74)	
B_PLOK	LOK	DMDFON (161)	
B_PLOK01	LOK	DMDFON (161)	
B_PLOK02	LOK	DMDFON (161)	
B_PLOK03	LOK	DMDFON (161)	
B_PLOK04	LOK	DMDFON (161)	
B_PLOK05	LOK	DMDFON (161)	
B_PLOK06	LOK	DMDFON (161)	
B_PLOK07	LOK	DMDFON (161)	
B_PLOK08	LOK	DMDFON (161)	
B_PLOKN	DOK	DMDFON (161)	
B_PLOKN_M	LOK	DMDFON (161)	
B_PLRA	LOK	DKVS (811)	
B_PLSOLAP	EIN		FUEDK (597)
B_PLTAB	LOK	BGTABST (1030)	
B_PN	AUS	SWADAP (47)	
B_POEL	AUS	GGPOEL (296)	
B_PRESYNC	EIN		GGDPG (74)
B_PRIPH	AUS	GGLSH (318)	
B_PRIPH2	AUS	GGLSH (318)	
B_PRIPV	AUS	GGLSV (382)	
B_PRIPV2	AUS	GGLSV (382)	
B_PSPAUS	LOK	LREB (739)	
B_PSPWL	LOK	LREB (739)	
B_PUA	LOK	BGPU (276)	
B_PUAMS	AUS	BGPU (276)	EGFE (228)
B_PUAVL	LOK	BGPU (276)	
B_PUAVLE	LOK	BGPU (276)	

Symbol	Type	Created within	Used within
B_PUAVLEI	LOK	BGPU (276)	
B_PVL1	LOK	AEKP (970)	
B_PVL2	LOK	AEKP (970)	
B_PVLNL	LOK	AEKP (970)	
B_PWF	EIN		ADVE (918), BGPU (276), DDVE (950), DIMC (1148), DKRS (437), DLSV (301), DLLR (578), GGPED (454), GGFST (502), GGEGAS (474), ESSTT (679), DTEV (856), DKAT (361), DEGFE (592), BGTABST (1030), NLPH (150), LRA (797), LR (768), LLRNS (562), KRRA (639), KRDY (659), BGKMST (1008), BGMSZS (239), BGDVE (934)
B_PWGBWF	LOK	GGPED (454)	
B_PWGLK	LOK	GGPED (454)	
B_PWGNOTFR	AUS	GGPED (454)	DUF (1089), UFSPSC (1060), FGRABED (491)
B_PWGNOTUM	AUS	UFSPSC (1060)	URADCC (1049), GGPED (454)
B_PWGNOT_C	EIN		GGPED (454)
B_PWRSV	LOK	ADVE (918)	
B_QSYN	AUS	GGDPG (74)	
B_QTEDAB	AUS	TEBEB (762)	TEB (826)
B_RALECTR	LOK	ALE (136)	
B_RALEOK	LOK	ALE (136)	
B_RDEPLAUS	AUS	RDE (112)	
B_RDEUNDEF	AUS	RDE (112)	
B_REDKL	LOK	ESUK (699)	
B_REFMAX	LOK	DLSV (301)	
B_REFMAX2	LOK	DLSV (301)	
B_REHS	LOK	HLS (392)	
B_RESETSYN	LOK	NLDG (157)	
B_RIAKV	LOK	GGLSV (382)	
B_RIAKV2	LOK	GGLSV (382)	
B_RIBEH	LOK	GGLSH (318)	
B_RIBEH2	LOK	GGLSH (318)	
B_RIBEV	LOK	GGLSV (382)	
B_RIBEV2	LOK	GGLSV (382)	
B_RIIBV	LOK	GGLSV (382)	
B_RIIBV2	LOK	GGLSV (382)	
B_RIIMPH	LOK	GGLSH (318)	
B_RIIMPV	LOK	GGLSV (382)	
B_RIMH	LOK	GGLSH (318)	
B_RIMH2	LOK	GGLSH (318)	
B_RIMV	LOK	GGLSV (382)	
B_RIMV2	LOK	GGLSV (382)	
B_RINH	AUS	GGLSH (318)	DHLSHK (1154)
B_RINH2	AUS	GGLSH (318)	DHLSHK (1154)
B_RINV	AUS	GGLSV (382)	DHLSVK (29)
B_RINV2	AUS	GGLSV (382)	DHLSVK (29)
B_RIPUH	LOK	GGLSH (318)	
B_RIPUH2	LOK	GGLSH (318)	
B_RIPUV	LOK	GGLSV (382)	
B_RIPUV2	LOK	GGLSV (382)	
B_RIREH	LOK	GGLSH (318)	
B_RIREH2	LOK	GGLSH (318)	
B_RIREV	LOK	GGLSV (382)	
B_RIREV2	LOK	GGLSV (382)	
B_RISIGH	LOK	DLSH (330)	
B_RISIGH2	LOK	DLSH (330)	
B_RISIGV	LOK	DLSV (301)	
B_RISIGV2	LOK	DLSV (301)	
B_RKAM	LOK	DKVS (811)	
B_RKAMR	LOK	DKVS (811)	
B_RKAMR2	LOK	DKVS (811)	
B_RKAT	AUS	LRA (797)	DKVS (811)
B_RKATR	AUS	LRA (797)	DKVS (811)
B_RKATR2	AUS	LRA (797)	DKVS (811)
B_RKAZ	AUS	LRA (797)	DKVS (811)
B_RKAZR	AUS	LRA (797)	DKVS (811)
B_RKAZR2	AUS	LRA (797)	DKVS (811)
B_RLP	LOK	BGRLP (266)	
B_RLPNS	LOK	BGRLP (266)	
B_RLRAB	AUS	GKEB (737)	
B_RMSVAL	AUS	DTEV (856)	
B_RPHSP	LOK	NLDG (157)	
B_SA	AUS	AES (973)	MDRED (976), ACIFI (1013), BGPU (276), ARMD (531), DLLR (578), DVFZ (500), ESUK (699), EGAG (486), ZWMIN (669), ZUE (627), MDVER (546), LREB (739), LLRBB (575), KOS (896), GGTFM (289), GGTFA (298), GGLSV (382), GGLSH (318), ESWE (698), MDKOG (516), MDFUE (594), MDFAW (508), LRKA (795), DMDSTP (205), DLSV (301), DKVS (811), DEVE (1017), ATM (20)
B_SAB	AUS	BBSAWE (557)	MSF (506), LLRBB (575), TEB (826), MDRED (976), MDMIN (538), MDAUTG (515), MDFAW (508)
B_SABFG	AUS	BBSAWE (557)	MDFAW (508)
B_SABGT	LOK	BBSAWE (557)	
B_SABT	LOK	BBSAWE (557)	
B_SACVT	EIN		BBSAWE (557)

Symbol	Type	Created within	Used within
B_SAVACC	EIN		FGRREGL (1174)
B_SAVFGR	AUS	FGRREGL (1174)	FGRUE (490), BBSAWE (557)
B_SAVFGRC	EIN		FGRREGL (1174)
B_SAVMD	AUS	MDKOG (516)	
B_SAVMSR	EIN		BBSAWE (557)
B_SBBHK	AUS	DLSH (330)	DKAT (361), DLSAHK (339), LRKA (795), LRHK (781), HLS (392), DLSV (301)
B_SBBHK2	AUS	DLSH (330)	DKAT (361), DLSAHK (339), HLS (392), LRKA (795), LRHK (781), DLSV (301)
B_SBBVK	AUS	DLSV (301)	HLS (392), LR (768), TEBEB (762), LREB (739)
B_SBBVK2	AUS	DLSV (301)	DKAT (361), HLS (392), LR (768), TEBEB (762), LREB (739)
B_SBBVKSL	LOK	LR (768)	
B_SELESPED	EIN		BBGANG (501), SREAKT (963), NMAXMD (584), CAN (1124), DVKUP (1027)
B_SELESPEE	EIN		DCKUP (1128)
B_SGNALT	LOK	LR (768)	
B_SGNALT2	LOK	LR (768)	
B_SGNDFET	LOK	LR (768)	
B_SGNDFET2	LOK	LR (768)	
B_SGNDMAG	LOK	LR (768)	
B_SGNDMAG2	LOK	LR (768)	
B_SGNLR	AUS	LR (768)	
B_SGNLR2	AUS	LR (768)	
B_SGNRA	LOK	LR (768)	
B_SGNRA2	LOK	LR (768)	
B_SGS	AUS	MDKOG (516)	DUF (1089), MDZUL (523), MDRED (976)
B_SGSAC_UM	LOK	UFSGSC (1070)	
B_SGSERH_C	EIN		CAN (1124)
B_SGSKON_C	EIN		CAN (1124)
B_SGSNL	EIN		NMAXMD (584)
B_SGSRED	AUS	CAN (1124)	DVKUP (1027), MDRED (976)
B_SGSRED_C	EIN		CAN (1124)
B_SHUERF	EIN		GGLSV (382), GGLSH (318)
B_SHUERF2	EIN		GGLSV (382), GGLSH (318)
B_SIBREMS	LOK	GGEGAS (474)	
B_SIBWF	AUS	GGPED (454)	
B_SICAS	AUS	DCAS (1128)	
B_SICINS	AUS	DCINS (1126)	
B_SICKUP	LOK	DCKUP (1128)	
B_SIDK1P	LOK	DDVE (950)	
B_SIDVEE	LOK	DDVE (950)	
B_SIDVEF	LOK	DDVE (950)	
B_SIDVEL	LOK	DDVE (950)	
B_SIDVEN	LOK	DDVE (950)	
B_SIDVER	LOK	DDVE (950)	
B_SIDVEU	LOK	DDVE (950)	
B_SIDVEV	LOK	DDVE (950)	
B_SIEV1	EIN		DEVE (1017)
B_SIEV2	EIN		DEVE (1017)
B_SIEV3	EIN		DEVE (1017)
B_SIEV4	EIN		DEVE (1017)
B_SIEV5	EIN		DEVE (1017)
B_SIEV6	EIN		DEVE (1017)
B_SIEV7	EIN		DEVE (1017)
B_SIEV8	EIN		DEVE (1017)
B_SIFHSH	LOK	DHLSHK (1154)	
B_SIFHSH2	LOK	DHLSHK (1154)	
B_SIFP1P	AUS	GGPED (454)	
B_SIFP2P	AUS	GGPED (454)	
B_SIFPP	AUS	GGPED (454)	
B_SIGFLSH	LOK	DLSH (330)	
B_SIGFLSH2	LOK	DLSH (330)	
B_SIGFLSV	LOK	DLSV (301)	
B_SIGFLSV2	LOK	DLSV (301)	
B_SIHSH	AUS	DHLSHK (1154)	
B_SIHSH2	AUS	DHLSHK (1154)	
B_SIHSVE	AUS	DHLSVKE (902)	
B_SIHSVE2	AUS	DHLSVKE (902)	
B_SIKAT	AUS	DKAT (361)	
B_SIKAT2	AUS	DKAT (361)	
B_SIKOSE	AUS	DKOSE (901)	
B_SIKPE	EIN		DEKPE (1020)
B_SIKS1	AUS	DKRS (437)	
B_SIKS2	AUS	DKRS (437)	
B_SIKS3	AUS	DKRS (437)	
B_SIKS4	AUS	DKRS (437)	
B_SILM	AUS	DHFM (233)	
B_SILSH	AUS	DLSH (330)	
B_SILSH2	AUS	DLSH (330)	
B_SILSV	AUS	DLSV (301)	
B_SILSV2	AUS	DLSV (301)	
B_SIMDB	AUS	MDKOG (516)	

Symbol	Type	Created within	Used within
B_SIMILE	AUS	DMILE (36)	
B_SIMUTE	AUS	CAN (1124)	
B_SIN	AUS	DDG (141)	
B_SIPH	AUS	DPH (144)	
B_SIPH2	AUS	DPH (144)	
B_SITES	AUS	DTEV (856)	
B_SITEVE	AUS	DTEVE (1022)	
B_SITM	AUS	GGTFM (289)	
B_SIVFZ	AUS	DVFZ (500)	
B_SIVKUP	LOK	DVKUP (1027)	
B_SKAEVAB	LOK	AEVABU (1002)	
B_SL	EIN		LLRMR (572), MDVERB (540), LLRNS (562)
B_SLKHOF	LOK	AK (855)	
B_SLP	AUS	AK (855)	MDVERB (540)
B_SLPC	EIN		MDVERB (540)
B_SLPOFF	EIN		BBKHZ (890)
B_SLS	AUS	AK (855)	DKAT (361), DTEV (856), LRAEB (759), TEBEB (762), TC1MOD (1100), LRKA (795), LREB (739), DLSH (330), DLSV (301)
B_SLSFZ	AUS	PROKON (53)	BBKHZ (890), LAMKO (729), TC1MOD (1100), LAKH (735)
B_SLSN2	AUS	AZUE (904)	
B_SLSOFF	AUS	AK (855)	LREB (739)
B_SLSRDY	AUS	DIMC (1148)	
B_SLV	AUS	AK (855)	
B_SP1	AUS	DMDMIL (216)	DTRIG (1139)
B_SP1S	AUS	GGPED (454)	DUF (1089), UFSPSC (1060)
B_SP2	AUS	DMDMIL (216)	DTRIG (1139)
B_SP2S	AUS	GGPED (454)	DUF (1089), UFSPSC (1060)
B_SP3	EIN		DTRIG (1139)
B_SPSA	AUS	WANWKW (125)	DNWKW (134)
B_SPSA2	AUS	WANWKW (125)	DNWKW (134)
B_SPSMIN	AUS	GGPED (454)	DUF (1089), LLRNS (562), UFSPSC (1060)
B_SRSTZ_UM	LOK	URMEM (1044)	
B_SRST_UM	LOK	URMEM (1044)	
B_ST	AUS	BBSTT (148)	SWADAP (47), ADVE (918), AEKP (970), ATM (20), BGRLP (266), DLLR (578), DDST (851), DLSV (301), DPH (144), DMDSTP (205), ZWMIN (669), WANWKW (125), LFS (69), KOS (896), GGTFM (289), GGDVE (477), GGDPG (74), ESUK (699), DLSH (330), BGLBZ (489), NLDG (157), LRHK (781), LREB (739), LLRRM (566), LLRNS (562), LLRMR (572)
B_STAA	AUS	STADAP (684)	ESNSWL (691), ESVST (677)
B_STARTINI	AUS	GGDPG (74)	ALE (136)
B_STDPERR	LOK	STADAP (684)	
B_STEIGM	LOK	DLSAHK (339)	
B_STEIGM2	LOK	DLSAHK (339)	
B_STEND	AUS	BBSTT (148)	AEKP (970), RKTI (979), MOTAUS (1028), MDKOG (516), MDFAW (508), LREB (739), LRA (797), LLRRM (566), LLRNS (562), LLRMR (572), LLRBB (575), LFS (69), KRRA (639), KRKE (427), KOS (896), HLS (392), GGUB (487), GGTFM (289), GGKS (412), GGFST (502), FUEREG (595), ESVW (1009), BGTABST (1030), BGRLP (266), BBSAWE (557), BBKHZ (890), BBBO (853), AZUE (904), ATWAL (297), ATM (20), ARMD (531), ALE (136), SU (617), GGTFA (298), GGPED (454), ESUK (699), ESSTT (679), DWUC (1147), DHLSVK (29), DHFM (233), DEVE (1017), DEGFE (592), DDVE (950), DDCY (1146), BGDVE (934), EGFE (228)
B_STENDES	AUS	ESSTT (679)	ESNSWL (691), GK (675)
B_STERHK	EIN		DLSH (330)
B_STERVK	EIN		LRINI (749)
B_STIMNLPH	AUS	NLPH (150)	
B_STNDFR	LOK	FUEREG (595)	
B_STNDNL	LOK	ATM (20)	
B_SU	AUS	FE (591)	MSF (506), SU (617), BGPU (276), DMDSTP (205), GGHFM (230), MDMAX (514)
B_SU2	AUS	FE (591)	SU (617), DMDSTP (205)
B_SUKP	LOK	SU (617)	
B_SUKP2	LOK	SU (617)	
B_SUMOD1	LOK	BGSRM (245)	
B_SUMOD2	LOK	BGSRM (245)	
B_SUMOD3	LOK	BGSRM (245)	
B_SVUERF	EIN		GGLSH (318), GGLSV (382)
B_SVUERF2	EIN		GGLSH (318), GGLSV (382)
B_SW0	AUS	AZUE (904)	
B_SW1	AUS	AZUE (904)	
B_SWEV	LOK	DSWEC (32)	
B_SWE_B	EIN		DMDSTP (205)
B_SWE_C	AUS	DSWEC (32)	DMDSTP (205)
B_SWE_P	EIN		DMDSTP (205)
B_SWE_S	EIN		DMDSTP (205)
B_SWITCHPG	AUS	DPH (144)	NLDG (157)
B_SYN	AUS	GGDPG (74)	
B_SYNBMALE	LOK	GGDPG (74)	
B_SYNCM	AUS	LR (768)	LREB (739)
B_SYNCM2	AUS	LR (768)	LREB (739)

Symbol	Type	Created within	Used within
B_SYNNLDG	AUS	NLDG (157)	GGDPG (74), WANWKW (125)
B_SYNNOT	EIN		KOEVAB (124)
B_SYNOKNL	LOK	NLDG (157)	
B_SYNPH	AUS	GGDPG (74)	DMDMIL (216), EGKE (409), NLPH (150), DMDSTP (205), KRRA (639)
B_SYSERR	AUS	D2CTR (496)	
B_SZ	LOK	BGPU (276)	
B_SZKAT	LOK	DKAT (361)	
B_SZKAT2	LOK	DKAT (361)	
B_TABUNPL	LOK	BGTABST (1030)	
B_TAL	AUS	GGFST (502)	DKVS (811), DLSH (330)
B_TALVAL	AUS	GGFST (502)	DKVS (811), DLSH (330)
B_TARAU	LOK	LREB (739)	
B_TATMSA	LOK	BBSAWE (557)	
B_TDCAN	AUS	CAN (1124)	DCAS (1128), DCINS (1126)
B_TE	AUS	GKEB (737)	TEBEB (762), BBTEGA (750), LRAEB (759), TEB (826), LR (768), DKVS (811), ESUKA (711), DLSA (398), GKRA (766)
B_TEABB	AUS	TEB (826)	BBTEGA (750), GKEB (737)
B_TEAKT	LOK	TEB (826)	
B_TEBTES	LOK	LR (768)	
B_TEF	AUS	GKEB (737)	TEBEB (762), TEB (826)
B_TEHB	AUS	TEB (826)	DKAT (361), DLSA (398), DLSAHK (339), LRHK (781), ESUKA (711), DMDSTP (205), DLLR (578)
B_TEHBX	AUS	TEB (826)	BBTEGA (750), LR (768)
B_TEHBXF	LOK	BBTEGA (750)	
B_TEI	AUS	GKEB (737)	TEBEB (762), TEB (826)
B_TEIC	EIN		TEBEB (762)
B_TEMIN	AUS	RKTI (979)	LREB (739)
B_TEMIN2	AUS	RKTI (979)	LREB (739)
B_TEN	AUS	TEBEB (762)	BBTEGA (750), TEB (826)
B_TENC	EIN		BBTEGA (750), TEBEB (762)
B_TEP	AUS	BBTEGA (750)	GKEB (737), TEB (826), TEBEB (762)
B_TEPC	EIN		BBTEGA (750)
B_TEPI	LOK	BBTEGA (750)	
B_TEPZUS	LOK	BBTEGA (750)	
B_TESLASH	LOK	DLSAHK (339)	
B_TESLASH2	LOK	DLSAHK (339)	
B_TESRDY	AUS	DIMC (1148)	
B_TESSTP	LOK	BBTEGA (750)	
B_TEVIOI	EIN		DTEV (856)
B_TEVIOL	LOK	DTEV (856)	
B_TEVIOLM	LOK	DTEV (856)	
B_TEVIOP	LOK	DTEV (856)	
B_TEVIOR	LOK	DTEV (856)	
B_TEVIOT	EIN		DTEV (856)
B_TEVNIO	LOK	DTEV (856)	
B_TEVNIOM	LOK	DTEV (856)	
B_TEZA	EIN		BBTEGA (750)
B_TEZSTP	LOK	BBTEGA (750)	
B_TFU	AUS	PROKON (53)	ATM (20), BGTABST (1030)
B_TFWDKSOM	AUS	WDKSOM (614)	FUEDK (597)
B_TIAB0	AUS	DMDMIL (216)	
B_TIAB1	AUS	DMDMIL (216)	
B_TIAB10	AUS	DMDMIL (216)	
B_TIAB11	AUS	DMDMIL (216)	
B_TIAB2	AUS	DMDMIL (216)	
B_TIAB3	AUS	DMDMIL (216)	
B_TIAB4	AUS	DMDMIL (216)	
B_TIAB5	AUS	DMDMIL (216)	
B_TIAB6	AUS	DMDMIL (216)	
B_TIAB7	AUS	DMDMIL (216)	
B_TIAB8	AUS	DMDMIL (216)	
B_TIAB9	AUS	DMDMIL (216)	
B_TIM	LOK	DTRIG (1139)	
B_TIPIN	LOK	KRDY (659)	
B_TIPPG	EIN		BBGANG (501), BBSAWE (557)
B_TIRED	AUS	BGRLP (266)	
B_TLFSARMX	LOK	LFS (69)	
B_TLFSART	LOK	LFS (69)	
B_TMKICB	EIN		GGTFM (289)
B_TMKR	AUS	KRRA (639)	EGKE (409), KRDY (659), GGKS (412)
B_TMLR	AUS	LREB (739)	
B_TMMN	LOK	GGTFM (289)	
B_TMSRT	AUS	GGTFM (289)	
B_TNALU	AUS	DMDLU (193)	
B_TNALU_M	LOK	DMDLU (193)	
B_TNALU_M2	LOK	DMDLU (193)	
B_TNMAX	LOK	NMAXMD (584)	
B_TOCASR1	LOK	CAN (1124)	
B_TOCKUP	LOK	CAN (1124)	
B_TPNMOT	AUS	ARMD (531)	
B_TPNT_AW	LOK	GGKS (412)	
B_TPNT_E	LOK	GGKS (412)	

Symbol	Type	Created within	Used within
B_TPVL	LOK	AEKP (970)	
B_TRFASH	LOK	DLSAHK (339)	
B_TRFASH2	LOK	DLSAHK (339)	
B_TRIP	AUS	D2CTR (496)	
B_TRKH	AUS	AK (855)	BBKHZ (890), ATM (20), LLRRM (566)
B_TRSA	LOK	DLSV (301)	
B_TRSA2	LOK	DLSV (301)	
B_TRSAH	LOK	DLSH (330)	
B_TRSAH2	LOK	DLSH (330)	
B_TSPER	LOK	LR (768)	
B_TSPER2	LOK	LR (768)	
B_TSPON	LOK	LR (768)	
B_TSPON2	LOK	LR (768)	
B_TSROOV	AUS	DMDTSB (159)	DMDFON (161), DMDSTP (205)
B_TSROOV_M	LOK	DMDFON (161)	
B_TTBMH	EIN		GGLSV (382), DLSV (301)
B_TTBMH2	EIN		GGLSV (382), DLSV (301)
B_TTBMHH	AUS	DLSH (330)	GGLSH (318)
B_TTBMHH2	AUS	DLSH (330)	GGLSH (318)
B_TTEAE	LOK	BBTEGA (750)	
B_TUMCB	EIN		MDVERB (540)
B_TUSPN	LOK	DLSSA (350)	
B_TUSPN2	LOK	DLSSA (350)	
B_TUSRE	LOK	DLSSA (350)	
B_TUSRE2	LOK	DLSSA (350)	
B_TVARS	LOK	ARMD (531)	
B_UBDVE	AUS	ADVE (918)	BGDVE (934), SREAKT (963)
B_UBDVEC	EIN		ADVE (918)
B_UBDVET	AUS	ADVE (918)	
B_UBPVG	AUS	ADVE (918)	GGDVE (477), GGPED (454)
B_UBRK	EIN		DECJ (1013), GGUB (487)
B_UBRMAX	EIN		DECJ (1013)
B_UBVDKP	LOK	GGDVE (477)	
B_UB_OK	AUS	ADVE (918)	DUF (1089), SREAKT (963), UFEING (1058), UFUE (1056)
B_UB_SKA	AUS	UFEING (1058)	UFMET (1060), UFSPSC (1060), UFRLC (1066), UFMVER (1087), UFREAC (1088), UFUE (1056)
B_UB_SKA_C	AUS	UFMER (1060)	
B_UDK1NV	LOK	GGDVE (477)	
B_UEINH	LOK	DLSH (330)	
B_UEINH2	LOK	DLSH (330)	
B_UEINV	LOK	DLSV (301)	
B_UEINV2	LOK	DLSV (301)	
B_UFGRHE	AUS	UFFGRE (1096)	
B_UFGRHS	AUS	UFFGRE (1096)	GGFGRH (473)
B_UFGRSB	AUS	UFFGRE (1096)	GGFGRH (473)
B_UFGRSV	AUS	UFFGRE (1096)	GGFGRH (473)
B_UFGRWA	AUS	UFFGRE (1096)	GGFGRH (473)
B_UGD	AUS	BGMSZS (239)	BGPU (276)
B_UGDS	LOK	FUEDK (597)	
B_UGDSP	LOK	BGRLP (266)	
B_UHRRMIN	AUS	PROKON (53)	ATM (20), BGTABST (1030)
B_UHRRSEC	AUS	PROKON (53)	AEKP (970), ATM (20), BGTABST (1030)
B_UHSIG	LOK	DLSH (330)	
B_UHSIG2	LOK	DLSH (330)	
B_UK1	LOK	ESUK (699)	
B_UKA	LOK	ESUKA (711)	
B_UKA2	LOK	ESUKA (711)	
B_UKAB	LOK	ESUKA (711)	
B_UKABA	LOK	ESUKA (711)	
B_UKABA2	LOK	ESUKA (711)	
B_UKABAF	LOK	ESUKA (711)	
B_UKABAF2	LOK	ESUKA (711)	
B_UKABAH	LOK	ESUKA (711)	
B_UKABAL	LOK	ESUKA (711)	
B_UKABAM	LOK	ESUKA (711)	
B_UKABAM2	LOK	ESUKA (711)	
B_UKADBA	LOK	ESUKA (711)	
B_UKADBA2	LOK	ESUKA (711)	
B_UKADVA	LOK	ESUKA (711)	
B_UKADVA2	LOK	ESUKA (711)	
B_UKAIBA	LOK	ESUKA (711)	
B_UKAIBA2	LOK	ESUKA (711)	
B_UKAIVA	LOK	ESUKA (711)	
B_UKAIVA2	LOK	ESUKA (711)	
B_UKAT	LOK	ESUKA (711)	
B_UKAVA	LOK	ESUKA (711)	
B_UKAVA2	LOK	ESUKA (711)	
B_UKAVAF	LOK	ESUKA (711)	
B_UKAVAF2	LOK	ESUKA (711)	
B_UKAVAH	LOK	ESUKA (711)	
B_UKAVAL	LOK	ESUKA (711)	
B_UKAVAM	LOK	ESUKA (711)	

Symbol	Type	Created within	Used within
B_UKAVAM2	LOK	ESUKA (711)	
B_UKE	LOK	ESUK (699)	
B_UKG	AUS	ESUK (699)	DKAT (361), LRAEB (759), ESVST (677)
B_UKNS	LOK	ESUK (699)	
B_UMAE	AUS	BGDVE (934)	DDVE (950)
B_UMAUAB	AUS	BGDVE (934)	DDVE (950), SREAKT (963)
B_UPW12E	LOK	GGPED (454)	
B_UPW1MN	LOK	GGPED (454)	
B_UPW1MX	LOK	GGPED (454)	
B_UPW2MN	LOK	GGPED (454)	
B_UPW2MX	LOK	GGPED (454)	
B_UPWG1O	LOK	GGPED (454)	
B_UPWG1U	LOK	GGPED (454)	
B_UPWG2O	LOK	GGPED (454)	
B_UPWG2U	LOK	GGPED (454)	
B_USBEV	LOK	GGLSV (382)	
B_USBEV2	LOK	GGLSV (382)	
B_USHKF	LOK	DLSAHK (339)	
B_USHKF2	LOK	DLSAHK (339)	
B_USHKM	LOK	DLSAHK (339)	
B_USHKM2	LOK	DLSAHK (339)	
B_USHSCH	LOK	DLSAHK (339)	
B_USHSCH2	LOK	DLSAHK (339)	
B_UVSIG	LOK	DLSV (301)	
B_UVSIG2	LOK	DLSV (301)	
B_VA	AUS	ESUK (699)	
B_VAAU	LOK	ESUK (699)	
B_VADGE	LOK	DLSV (301)	
B_VADGE2	LOK	DLSV (301)	
B_VAG	AUS	ESUK (699)	LREB (739)
B_VAKL	LOK	ESUK (699)	
B_VBEMG	AUS	ESSTT (679)	BGTABST (1030), STADAP (684)
B_VBMG	LOK	ESSTT (679)	
B_VEKAT	AUS	DKAT (361)	
B_VEKAT2	AUS	DKAT (361)	
B_VERRUECK	LOK	RDE (112)	
B_VGEFLR	LOK	DLSV (301)	
B_VGEFLR2	LOK	DLSV (301)	
B_VIRT_TR	EIN		AZUE (904)
B_VL	AUS	MDFAW (508)	MSF (506), LRAEB (759), NWS (618)
B_VLLR	AUS	LLRBB (575)	BBSAWE (557), LLRRM (566), MDVERAD (549), LLRMD (561)
B_VMAX	AUS	VMAXMD (588)	
B_VNULL	AUS	GGVFZG (497)	BBGANG (501), MDFAW (508), KRDY (659)
B_VPWGERR	LOK	GGPED (454)	
B_VS	EIN		ESVW (1009), LREB (739)
B_VZIELS	EIN		FGRFULO (1160)
B_WAITGAP	LOK	RDE (112)	
B_WAL	AUS	ATWAL (297)	
B_WALALT	LOK	ATWAL (297)	
B_WDK12EV	LOK	GGDVE (477)	
B_WDK13EV	LOK	GGDVE (477)	
B_WDK1V	EIN		ADVE (918), FUEDKSA (610), GGDVE (477)
B_WDK23EV	LOK	GGDVE (477)	
B_WDK2SEL	AUS	GGDVE (477)	ADVE (918), UFRLC (1066), BGDVE (934), DUF (1089)
B_WDK2ST	LOK	GGDVE (477)	
B_WDKAP	LOK	FUEDK (597)	
B_WDKSAP	AUS	PROKON (53)	FUEDK (597)
B_WDKSIVE	AUS	ADVE (918)	DDVE (950), SREAKT (963)
B_WDKSOM	AUS	WDKSOM (614)	FUEDK (597)
B_WF	LOK	ESUK (699)	
B_WK	EIN		ARMD (531), DMDLU (193), DMDLUA (202), DMDSTP (205), DSWEC (32), DMDDLU (199)
B_WKAUF	EIN		LLRNS (562)
B_WKR	EIN		DMDDLU (199), DMDLU (193), DMDSTP (205), DMDLUA (202)
B_WKRAL	LOK	KRRA (639)	
B_WKS	AUS	ESSTT (679)	ESNSWL (691), STADAP (684), ESVST (677)
B_WNWI2OUT	AUS	WANWKW (125)	NLDG (157)
B_WNWIOUT	AUS	WANWKW (125)	NLDG (157)
B_WNWIOUTX	LOK	NLDG (157)	
B_WPABNB	LOK	GGPED (454)	
B_WPMBBR	LOK	GGPED (454)	
B_WST	AUS	ESSTT (679)	AK (855), BBKHZ (890)
B_WST0	LOK	ESSTT (679)	
B_WST1	LOK	ESSTT (679)	
B_WST2	LOK	ESSTT (679)	
B_WUC	AUS	DWUC (1147)	DFPM (1132), DTRIG (1139), DMDMIL (216)
B_YDKT	LOK	DKAT (361)	
B_Z1	AUS	AZUE (904)	
B_ZAS	EIN		AEVAB (980)
B_ZASA	EIN		DMDDLU (199), DMDLU (193), DMDLUA (202)
B_ZASAKT	EIN		MDVER (546)
B_ZASA_M	LOK	DMDUE (158)	

Symbol	Type	Created within	Used within
B_ZESYNC	AUS	AZUE (904)	ESSTT (679)
B_ZKATB	LOK	DKAT (361)	
B_ZKATB2	LOK	DKAT (361)	
B_ZKATS	LOK	DKAT (361)	
B_ZKATS2	LOK	DKAT (361)	
B_ZKATZ	LOK	DKAT (361)	
B_ZKATZ2	LOK	DKAT (361)	
B_ZPREL	AUS	GGDPG (74)	ALE (136)
B_ZTEV	AUS	DTEVE (1022)	
B_ZWAFH	AUS	LLRMR (572)	
B_ZWAPPL	AUS	PROKON (53)	ZUE (627)
B_ZWGET	LOK	MDKOG (516)	
B_ZWKRA	LOK	ZUE (627)	
B_ZWKRAA	AUS	KRRA (639)	KRDY (659), EGKE (409)
B_ZWKRUM	LOK	KRRA (639)	
B_ZWMNPST	LOK	ZWMIN (669)	
B_ZWNGET	LOK	MDKOG (516)	
B_ZWS0	AUS	AZUE (904)	
B_ZWVS	AUS	MDKOG (516)	MDZW (636)
B_ZWVZ	AUS	MDKOG (516)	MDAUTG (515), MDZW (636)
B_ZWVZVB	LOK	MDKOG (516)	
B_ZZTAB	AUS	GGDPG (74)	DPH (144), WANWKW (125)
CFOXX	LOK	DMDFON (161)	
CIDISTIM	LOK	BGDVE (934)	
CPAW1	LOK	GGDVE (477)	
CPAW2	LOK	GGDVE (477)	
CRYAGR	EIN		DIMC (1148)
CRYHS	EIN		DIMC (1148)
CRYKAT	EIN		DIMC (1148)
CRYLS	EIN		DIMC (1148)
CRYSLS	EIN		DIMC (1148)
CRYTES	EIN		DIMC (1148)
CTBETIP	LOK	GGFGRH (473)	
CTDVIVZ_W	LOK	FGRABED (491)	
CTDVZVI_W	LOK	FGRABED (491)	
CTFGRAB	LOK	FGRREGL (1174)	
CTFGRFDY	LOK	FGRABED (491)	
CTFGRHE	LOK	GGFGRH (473)	
CTFGRUEOB	LOK	FGRABED (491)	
CTFGRUM	LOK	FGRABED (491)	
CTFGRUNUB	LOK	FGRABED (491)	
CTRBWF	LOK	GGPED (454)	
CTRERBR	LOK	GGEGAS (474)	
CTRERF1	AUS	D2CTR (496)	
CTRRDY1	AUS	D2CTR (496)	
CTRSFP	AUS	D2CTR (496)	
CTRZYF0	AUS	D2CTR (496)	
CTRZYF1	AUS	D2CTR (496)	
CTSWK	LOK	FGRFULO (1160)	
CTVETIP	LOK	GGFGRH (473)	
CVFUBAANZ	EIN		ZUESZ (632)
CVOFFZ_W	EIN		ZUESZ (632)
CVSZFUBA_W	EIN		ZUESZ (632)
CVWDK	EIN		FUEDK (597)
CVZWZYL	EIN		ZUE (627)
CWDKNOLU	EIN		ADVE (918)
CWDLRIKL	EIN		ADVE (918)
CW_ERFIL	AUS	PROKON (53)	TCSORT (1122)
CW_OBD	AUS	PROKON (53)	
CW_TABST	EIN		GGTFM (289)
C_BMSUCH	EIN		BGNMOT (111), GGDPG (74)
C_FCMCLR	EIN		BGDVE (934), DCAS (1128), CAN (1124), DCINS (1126), DDCY (1146), DEKPE (1020), DHLSHK (1154), DEVE (1017), DLSAHK (339), DLSA (398), DKVS (811), DKRTP (451), DKRNT (445), DKOSE (901), DIMC (1148), DHLSVKE (902), GGDPG (74), DWUC (1147), DVFZ (500), DTEVE (1022), DPH (144), DNWSE (1025), DNWS (622), DNWKW (134), DMILE (36), DMIL (1150), DLSH (330), WANWKW (125), LRHK (781), GGUB (487), GGTFM (289), GGTFA (298), DHLSVK (29), DDG (141), BGKMST (1008), DCKUP (1128), EGFE (228), DVKUP (1027)

Symbol	Type	Created within	Used within
C_INI	AUS	SWADAP (47)	AEKP (970), BBBO (853), BGDVE (934), BBKHZ (890), GGLSV (382), GGLSH (318), GGDPG (74), FUEREG (595), ESUKA (711), DWUC (1147), DVFZ (500), DTEVE (1022), MOTAUS (1028), MDZUL (523), MDWAN (554), MDVERAD (549), MDNSTAB (556), MDFUE (594), LRKA (795), LRHK (781), UFUE (1056), UFRLC (1066), UFREAC (1088), UFNSC (1077), UFMSRC (1080), STADAP (684), RKTI (979), LREB (739), LR (768), LAMKO (729), LAMBTS (732), HLS (392), GGUB (487), GGTFM (289), GGTFA (298), DMLSE (34), DLSH (330), DLSAHK (339), DLSA (398), DKVS (811), DKRTP (451), DKRNT (445), DKOSE (901), DPH (144), DNWSE (1025), DNWS (622), DNWKW (134), BGTEV (257), BGNMOT (111), BGLBZ (489), BGKMST (1008), BGAGR (263), ALE (136), ATM (20), AES (973), DMILE (36), DIMC (1148), DHLSVKE (902), DHLSVK (29), DHLSHK (1154), DEVE (1017), DEKPE (1020), DDST (851), DDG (141), DDCY (1146), DCKUP (1128), DCINS (1126), DCAS (1128), CAN (1124), BGWDKM (273), DVKUP (1027)
C_INI2	EIN		BGTABST (1030)
C_INISYN	EIN		ALE (136), BGNMOT (111), BGRLG (274), DDG (141), DMIL (1150), DPH (144), NLDG (157), WANWKW (125), GGDPG (74), DNWS (622), DEPCL (1151), BGTABST (1030), BGNG (121), BBSTT (148)
C_NACHL	EIN		AEKP (970), GGUB (487), GGTFM (289), GGTFA (298), DMIL (1150), BGTABST (1030), BGDVE (934), BBKHZ (890), ATM (20), WANWKW (125), MOTAUS (1028), ALE (136)
C_NMAX	AUS	BGBSZ (73)	
C_NORM	EIN		MOTAUS (1028), WANWKW (125)
C_NOSERE	EIN		CAN (1124)
C_NSUCH	EIN		GGDPG (74)
C_PWF	AUS	SWADAP (47)	ALE (136), ATM (20), BGDVE (934), BBBO (853), DWUC (1147), DVFZ (500), DTOP (1145), DTEVE (1022), DPH (144), DNWSE (1025), DNWKW (134), DMILE (36), DKOSE (901), DHLSVKE (902), DHLSVK (29), DHLSHK (1154), DEVE (1017), DEKPE (1020), DDG (141), DDCY (1146), GGUB (487), ESUKA (711), DLSSA (350), DLSAHK (339), DKVS (811), DKRTP (451), DKRNT (445), DCKUP (1128), DCINS (1126), WANWKW (125), STADAP (684), MOTAUS (1028), MDVERAD (549), LRHK (781), GGTFM (289), GGTFA (298), GGDPG (74), DCAS (1128), CAN (1124), BGTABST (1030), DVKUP (1027)
C_SYN	EIN		BGNG (121), WANWKW (125), DNWS (622), GGDPG (74)
DCYCNT	AUS	DDCY (1146)	
DEKPUB	LOK	AEKP (970)	
DETAZWBS	LOK	LAMBTS (732)	
DETAZWTE	LOK	DTEV (856)	
DEVOFF	EIN		AES (973), AEVAB (980)
DFP_AAVE	DOK	DTEV (856)	TEBEB (762)
DFP_AGRE	DOK	DKAT (361)	DTEV (856), LRAEB (759), DMDSTP (205)
DFP_AGRF	DOK	DKAT (361)	DTEV (856), LRAEB (759), DMDSTP (205)
DFP_BM	DOK	LRAEB (759)	RDE (112), DMDSTP (205)
DFP_BREMS	DOK	GGEGAS (474)	
DFP_BWF	DOK	GGPED (454)	
DFP_DK	DOK	BGMSZS (239)	DTEV (856), DKAT (361), GGDVE (477), TEBEB (762), LRAEB (759)
DFP_DK1P	DOK	GGDVE (477)	
DFP_DK2P	DOK	GGDVE (477)	
DFP_DPL	DOK	LRA (797)	
DFP_DVEE	DOK	DDVE (950)	
DFP_DVEF	DOK	DDVE (950)	
DFP_DVEFO	DOK	DDVE (950)	
DFP_DVEL	DOK	DDVE (950)	
DFP_DVEN	DOK	DDVE (950)	
DFP_DVER	DOK	DDVE (950)	
DFP_DVET	DOK	DDVE (950)	
DFP_DVEU	DOK	DDVE (950)	LRAEB (759), DTEV (856)
DFP_DVEUB	DOK	DDVE (950)	
DFP_DVEUW	DOK	DDVE (950)	
DFP_DVEV	DOK	DDVE (950)	GGDVE (477)
DFP_EV1	DOK	AEVAB (980)	
DFP_EV2	DOK	AEVAB (980)	
DFP_EV3	DOK	AEVAB (980)	
DFP_EV4	DOK	AEVAB (980)	
DFP_EV5	DOK	AEVAB (980)	
DFP_EV6	DOK	AEVAB (980)	
DFP_EV7	DOK	AEVAB (980)	
DFP_EV8	DOK	AEVAB (980)	
DFP_FP1P	DOK	GGPED (454)	
DFP_FP2P	DOK	GGPED (454)	
DFP_FPP	DOK	GGPED (454)	
DFP_FRAO	DOK	LRA (797)	
DFP_FRAO2	DOK	LRA (797)	
DFP_FRAU	DOK	LRA (797)	
DFP_FRAU2	DOK	LRA (797)	
DFP_HSH	DOK	DKAT (361)	
DFP_HSH2	DOK	DKAT (361)	
DFP_HSV	DOK	DKAT (361)	
DFP_HSV2	DOK	DKAT (361)	
DFP_KAT	DOK	DKAT (361)	

Symbol	Type	Created within	Used within
DFP_KAT2	DOK	DKAT (361)	
DFP_KRNT	DOK	KRRA (639)	
DFP_KROF	DOK	KRRA (639)	
DFP_KRTP	DOK	KRRA (639)	
DFP_KS1	DOK	KRRA (639)	
DFP_KS2	DOK	KRRA (639)	
DFP_KS3	DOK	KRRA (639)	
DFP_KS4	DOK	KRRA (639)	
DFP_LASH	DOK	DKAT (361)	
DFP_LASH2	DOK	DKAT (361)	
DFP_LATP	DOK	DKAT (361)	
DFP_LATP2	DOK	DKAT (361)	
DFP_LATV	DOK	DKAT (361)	
DFP_LATV2	DOK	DKAT (361)	
DFP_LDE	EIN		DMDSTP (205)
DFP_LDPE	DOK	DTEV (856)	TEBEB (762)
DFP_LLR	DOK	DTEV (856)	
DFP_LM	DOK	BGMSZS (239)	DTEV (856), DLLR (578), DKAT (361), DHFM (233)
DFP_LSH	DOK	DKAT (361)	
DFP_LSH2	DOK	DKAT (361)	
DFP_LSHV	DOK	DKAT (361)	
DFP_LSV	DOK	DKAT (361)	DLSV (301), TEB (826)
DFP_LSV2	DOK	DKAT (361)	DLSV (301), TEB (826)
DFP_MD	DOK	DKAT (361)	DMDSTP (205)
DFP_MDB	DOK	MDKOG (516)	
DFP_N	DOK	RDE (112)	DMDSTP (205)
DFP_NWKW	EIN		DMDSTP (205)
DFP_NWKW2	EIN		DMDSTP (205)
DFP_NWS	EIN		DMDSTP (205)
DFP_NWS2	EIN		DMDSTP (205)
DFP_NWSE	EIN		DMDSTP (205)
DFP_PH	DOK	NLPH (150)	
DFP_RKAT	DOK	LRA (797)	
DFP_RKAT2	DOK	LRA (797)	
DFP_RKAZ	DOK	LRA (797)	
DFP_RKAZ2	DOK	LRA (797)	
DFP_SLPE	DOK	DKAT (361)	
DFP_SLS	DOK	DTEV (856)	
DFP_SLVE	DOK	DKAT (361)	
DFP_SUE	EIN		DMDSTP (205)
DFP_SUE2	EIN		DMDSTP (205)
DFP_TA	DOK	DLLR (578)	LRAEB (759)
DFP_TES	DOK	DKAT (361)	LRAEB (759), DTEV (856), DLSV (301), DLLR (578), DMDSTP (205)
DFP_TEVE	DOK	DKAT (361)	DLLR (578), DTEV (856), TEBEB (762), LRAEB (759), DLSV (301), DMDSTP (205)
DFP_TM	DOK	DLLR (578)	LRAEB (759), DTEV (856), DLSV (301)
DFP_UB	DOK	DTEV (856)	LRAEB (759)
DFP_UVSE	EIN		DMDSTP (205)
DFP_VFZ	DOK	BBGANG (501)	RDE (112), GGVFZG (497), GGPED (454), DTEV (856), DLLR (578), DMDSTP (205)
DFRKA2_W	LOK	GKRA (766)	
DFRKA_W	LOK	GKRA (766)	
DFRM2_W	LOK	LRA (797)	
DFRMT2_W	LOK	LRA (797)	
DFRMT_W	LOK	LRA (797)	
DFRM_W	LOK	LRA (797)	
DFRSP2_W	AUS	LR (768)	ESUKA (711)
DFRSP_W	AUS	LR (768)	ESUKA (711)
DFRST2_W	AUS	LR (768)	ESUKA (711)
DFRSTGA2_W	DOK	LR (768)	
DFRSTGA_W	DOK	LR (768)	
DFRSTTE2_W	DOK	LR (768)	
DFRSTTE_W	DOK	LR (768)	
DFRST_W	AUS	LR (768)	ESUKA (711)
DFSE01	LOK	DMDFON (161)	
DFSE02	LOK	DMDFON (161)	
DFSE03	LOK	DMDFON (161)	
DFSE04	LOK	DMDFON (161)	
DFSE05	LOK	DMDFON (161)	
DFSE06	LOK	DMDFON (161)	
DFSE07	LOK	DMDFON (161)	
DFSE08	LOK	DMDFON (161)	
DFSEN	LOK	DMDFON (161)	
DFSERESZ	LOK	DMDFON (161)	
DFTEF_W	LOK	TEB (826)	
DFUELSAN_W	AUS	BGMSZS (239)	DTEV (856)
DKATAKT2_W	LOK	DKAT (361)	
DKATAKT_W	LOK	DKAT (361)	
DKATEFRG	LOK	TEB (826)	
DKHC_W	LOK	TEB (826)	
DKLAGERC	LOK	ADVE (918)	
DKLDFPWM_W	LOK	DTEV (856)	

Symbol	Type	Created within	Used within
DKPSTG_W	AUS	BGDVE (934)	GGDVE (477)
DLAHI2_W	EIN		DLSSA (350)
DLAHISA	AUS	DLSSA (350)	
DLAHISA2	AUS	DLSSA (350)	
DLAHI_W	EIN		DLSSA (350)
DLAHKAB2_W	LOK	LRHK (781)	
DLAHKAB_W	LOK	LRHK (781)	
DLAMATR2_W	EIN		LAMKO (729), LAMSOLL (726)
DLAMATR_W	EIN		LAMKO (729), LAMSOLL (726)
DLAMBTS_W	AUS	LAMBTS (732)	LAMKO (729), LAMSOLL (726)
DLASHKI2_W	LOK	LRHK (781)	
DLASHKI_W	LOK	LRHK (781)	
DLASHKM2_W	LOK	LRHK (781)	
DLASHKM_W	LOK	LRHK (781)	
DLASHKP2_W	LOK	LRHK (781)	
DLASHKP_W	LOK	LRHK (781)	
DLRBATKP_W	LOK	ADVE (918)	
DLRD	LOK	ADVE (918)	
DLRDANT_W	LOK	ADVE (918)	
DLRDSV_W	LOK	ADVE (918)	
DLRDSW_W	LOK	ADVE (918)	
DLRI	LOK	ADVE (918)	
DLRIAMAX	LOK	ADVE (918)	
DLRIANTMAN	LOK	ADVE (918)	
DLRIANT_L	LOK	ADVE (918)	
DLRIANT_W	LOK	ADVE (918)	
DLRIKLMAN	LOK	ADVE (918)	
DLRIKLST_W	LOK	ADVE (918)	
DLRIKL_W	LOK	ADVE (918)	
DLRKOMP	LOK	ADVE (918)	
DLRMXT	LOK	BGDVE (934)	
DLRP	LOK	ADVE (918)	
DLRPANT_L	LOK	ADVE (918)	
DLRPERI_W	LOK	LR (768)	
DLRPERP_W	LOK	LR (768)	
DLRPER_W	LOK	LR (768)	
DLRPIDC	LOK	ADVE (918)	
DLRRAST	LOK	ADVE (918)	
DLRSPID_W	AUS	ADVE (918)	BGDVE (934)
DLSD_W	LOK	MDFAW (508)	
DLURS	LOK	DMDDLU (199)	
DLURS_M	LOK	DMDDLU (199)	
DLURS_M2	LOK	DMDDLU (199)	
DLUTS	LOK	DMDDLU (199)	
DLUTS1	AUS	DMDDLU (199)	
DLUTS10	AUS	DMDDLU (199)	
DLUTS11	AUS	DMDDLU (199)	
DLUTS12	AUS	DMDDLU (199)	
DLUTS2	AUS	DMDDLU (199)	
DLUTS3	AUS	DMDDLU (199)	
DLUTS4	AUS	DMDDLU (199)	
DLUTS5	AUS	DMDDLU (199)	
DLUTS6	AUS	DMDDLU (199)	
DLUTS7	AUS	DMDDLU (199)	
DLUTS8	AUS	DMDDLU (199)	
DLUTS9	AUS	DMDDLU (199)	
DLUTS_M	LOK	DMDDLU (199)	
DLUTS_M2	LOK	DMDDLU (199)	
DLWSL_W	LOK	MDVERB (540)	
DLWS_W	EIN		MDVERB (540)
DMAR_W	AUS	ARMD (531)	MSF (506), MDKOG (516)
DMAUFR_W	EIN		MDAUTG (515), MDZW (636)
DMBEBL_W	LOK	MDFAW (508)	
DMDEVAB	LOK	AEVAB (980)	
DMDPO_W	LOK	MDFAW (508)	
DMDPU_W	LOK	MDFAW (508)	
DMGBEG_W	LOK	MDFAW (508)	
DMLETANF_W	LOK	DTEV (856)	
DMLETANU	LOK	DTEV (856)	
DMLETAN_W	LOK	DTEV (856)	
DMLFTEF	LOK	TEB (826)	
DMLLRD_W	AUS	LLRRM (566)	
DMLLRI_W	AUS	LLRMD (561)	LLRRM (566), DLLR (578), MDVERAD (549), MDFAW (508), KHMD (894)
DMLLRL_W	AUS	LLRRM (566)	MDKOL (526)
DMLLRP_W	AUS	LLRRM (566)	
DMLLR_W	AUS	LLRMD (561)	LLRRM (566), MDAUTG (515), MSF (506), MDKOG (516)
DMLMS_W	LOK	MDKOL (526)	
DMLSDO_W	LOK	MDFAW (508)	
DMLSDU_W	LOK	MDFAW (508)	
DMNMXP_W	LOK	NMAXMD (584)	
DMRAC	AUS	MDVERB (540)	LLRMR (572)
DMRAR_W	LOK	FGRREGL (1174)	

Symbol	Type	Created within	Used within
DMRDAGR_W	EIN		MDTRIP (538)
DMRDKT_W	AUS	DKAT (361)	MDTRIP (538)
DMRDSLS_W	AUS	KHMD (894)	MDTRIP (538)
DMRESLL_W	LOK	LLRMR (572)	
DMRKH	AUS	AK (855)	MSF (506), KHMD (894), DMDLU (193), MDKOL (526), MDKOG (516)
DMRKHZ_W	LOK	KHMD (894)	
DMRKH_W	AUS	KHMD (894)	
DMRKT_W	AUS	MDTRIP (538)	MDKOG (516), MDKOL (526)
DMRLASH_W	AUS	DLSAHK (339)	MDTRIP (538)
DMRLF	AUS	MDVERB (540)	LLRMR (572)
DMRLF1	LOK	MDVERB (540)	
DMRLF2	LOK	MDVERB (540)	
DMRLLR_W	AUS	LLRMD (561)	LLRMR (572), MDKOG (516), MSF (506), MDKOL (526)
DMRLSH_W	AUS	DLSH (330)	MDTRIP (538)
DMRLSV_W	EIN		MDTRIP (538)
DMRMX_W	AUS	MDKOL (526)	MDZUL (523)
DMRWAN	EIN		LLRMR (572)
DMSNTE_W	AUS	DTEV (856)	
DMSSGINR	LOK	TEB (826)	
DMVADFK_W	LOK	MDVERAD (549)	
DMVADFS_W	LOK	MDVERAD (549)	
DMVADKO_W	LOK	MDVERAD (549)	
DMVADLL_W	LOK	MDVERAD (549)	
DMVAD_W	AUS	MDVERAD (549)	DTEV (856), MDMIN (538), MDVER (546)
DMVAMNFK_W	DOK	MDVERAD (549)	
DMVAMNFS_W	DOK	MDVERAD (549)	
DMVAMNKO_W	DOK	MDVERAD (549)	
DMVAMNLL_W	DOK	MDVERAD (549)	
DMVAMXFK_W	DOK	MDVERAD (549)	
DMVAMXFS_W	DOK	MDVERAD (549)	
DMVAMXKO_W	DOK	MDVERAD (549)	
DMVAMXLL_W	DOK	MDVERAD (549)	
DMVERL_W	AUS	MDVER (546)	MDFAW (508)
DMVLLRSU_W	LOK	LLRMR (572)	
DMVMXI_W	LOK	VMAXMD (588)	
DMVMXP_W	LOK	VMAXMD (588)	
DMZMS_W	AUS	MDKOG (516)	
DN	AUS	LLRRM (566)	LLRBB (575), LLRMR (572), LLRMD (561)
DNIKORR_W	LOK	LLRRM (566)	
DNMOTAS_W	AUS	BGNG (121)	
DNMOT_W	AUS	BGNG (121)	ESSTT (679), STADAP (684), RDE (112)
DNS	AUS	LLRNS (562)	DLLR (578), LLRRM (566), LLRMR (572), LLRMD (561)
DNSA	LOK	BBSAWE (557)	
DNSI_W	LOK	NMAXMD (584)	
DNTURB	LOK	MDWAN (554)	
DN_W	AUS	LLRRM (566)	LLRMD (561)
DPDK_W	LOK	FUEDK (597)	
DPERMF_W	LOK	LR (768)	
DPSDVS_W	LOK	BGRLP (266)	
DPSFG_W	AUS	BGSRM (245)	BGRLP (266), EGFE (228)
DPSMP_W	LOK	BGRLP (266)	
DPUS_W	AUS	AES (973)	
DPWRSVC	LOK	ADVE (918)	
DRKUKE_L	LOK	ESUK (699)	
DRKUKE_W	LOK	ESUK (699)	
DRKWTMP_W	LOK	KHMD (894)	
DRLAS_W	AUS	BGRLG (274)	
DRLFUE_W	AUS	FUEREG (595)	FUEDK (597), FE (591)
DRLKRDY	LOK	KRDY (659)	
DRLLAD_W	LOK	BGMSZS (239)	
DRLM_W	LOK	FUEREG (595)	
DRLP	AUS	BGRLP (266)	
DRLP_W	AUS	BGRLP (266)	ESUK (699), KRDY (659)
DRLSOLF_W	AUS	MDFUE (594)	
DRLSOLMF_W	LOK	FUEDK (597)	
DRLSOL_W	AUS	MDFUE (594)	
DRLSP	LOK	ESUKA (711)	
DRLSP2	LOK	ESUKA (711)	
DRL_W	AUS	BGSRM (245)	SWADAP (47), BGRLP (266), KRDY (659), EGFE (228)
DRUCK	LOK	EGAG (486)	
DSTERT20_W	LOK	TEB (826)	
DTBRT_W	LOK	BGTEMPK (252)	
DTSEGPH_W	LOK	NLDG (157)	
DTVKA	AUS	LRKA (795)	LR (768), GKRA (766)
DTVKA2	AUS	LRKA (795)	LR (768), GKRA (766)
DTVKAI	LOK	LRKA (795)	
DTVKAI2	LOK	LRKA (795)	
DUB	LOK	BGLBZ (489)	
DUF_C	AUS	DUF (1089)	
DUMMY	LOK	AEVAB (980)	
DVEADCHST	AUS	BGDVE (934)	DDVE (950)
DVFGR_W	LOK	FGRREGL (1174)	

Symbol	Type	Created within	Used within
DVIVR_W	LOK	FGRREGL (1174)	
DVPRAE_W	LOK	VMAXMD (588)	
DVSI_W	LOK	VMAXMD (588)	
DVZI_W	LOK	FGRFULO (1160)	
DVZVI_W	LOK	FGRREGL (1174)	
DWDKBA_W	AUS	GGDVE (477)	
DWDKDLR_W	LOK	ADVE (918)	
DWDKSUMX_W	LOK	FUEDK (597)	
DWDKSUS_W	LOK	FUEDK (597)	
DWDKSUT_W	LOK	FUEDK (597)	
DWDKS_KGE	LOK	ADVE (918)	
DWDKS_W	AUS	FE (591)	FUEDKSA (610), ADVE (918)
DWFK_W	LOK	ESUK (699)	
DWFL_W	LOK	ESUK (699)	
DWF_W	AUS	ESUK (699)	
DWKR	AUS	EGKE (409)	KRRA (639)
DWKRMSW	LOK	KRRA (639)	
DWKRZ	AUS	KRRA (639)	ZUE (627)
DWNWSP2_W	AUS	DNWKW (134)	
DWNWSP_W	AUS	DNWKW (134)	
DWPED	AUS	GGPED (454)	KOS (896)
DWPED_W	AUS	EGEG (453)	GGPED (454)
DYESOFV	LOK	KRDY (659)	
DYESV	LOK	KRDY (659)	
DYNLSU2_W	EIN		DLSSA (350)
DYNLSUSA	AUS	DLSSA (350)	
DYNLSUSA2	AUS	DLSSA (350)	
DYNLSU_W	EIN		DLSSA (350)
DZWDYNTP	LOK	ZWMIN (669)	
DZWG	LOK	LAMBTS (732)	
DZWI	LOK	MDIST (528)	
DZWKG	LOK	ZWGRU (634)	
DZWMNA	LOK	ZWMIN (669)	
DZWOAG	AUS	MDBAS (529)	ZWGRU (634), ZWMIN (669)
DZWOL	AUS	MDBAS (529)	ZWGRU (634)
DZWOTM	LOK	MDBAS (529)	
DZWS	LOK	MDZW (636)	
DZWSPAE	LOK	ZWMIN (669)	
DZWWL	AUS	ZWWL (638)	ZUE (627)
DZW_UM	LOK	UFMIST (1086)	
EDGE_CTR	LOK	GGDPG (74)	
EEVMNC	EIN		DMDMIL (216)
EEVX	AUS	AEVAB (980)	
EGASPFAD	AUS	DUF (1089)	DFFT (1140)
EI_ADCC_UM	AUS	URADCC (1049)	DUF (1089)
EI_IPA_UM	AUS	UFRLC (1066)	DUF (1089)
EI_MSRC_UM	AUS	UFMSRC (1080)	
EI_MVER_UM	AUS	UFMVER (1087)	DUF (1089)
EI_NC_UM	AUS	UFNC (1063)	DUF (1089)
EI_REAC_UM	AUS	UFREAC (1088)	DUF (1089)
EI_RLC_UM	AUS	UFRLC (1066)	DUF (1089)
EI_RLIP_UM	AUS	UFRLC (1066)	DUF (1089)
EI_SGSC_UM	AUS	UFSGSC (1070)	
EI_SPSC_UM	AUS	UFSPSC (1060)	DUF (1089)
EI_UBR_UM	EIN		DUF (1089)
EI_ZWC_UM	AUS	UFZWC (1075)	DUF (1089)
EKPFZ	LOK	DEKPE (1020)	
EKPPZ	LOK	DEKPE (1020)	
ETALAB	AUS	MDBAS (529)	FE (591), MDFUE (594)
ETATE	AUS	TEB (826)	
ETATEINT	LOK	TEB (826)	
ETATESOL	LOK	TEB (826)	
ETATRMN	AUS	MDBAS (529)	
ETAZAIST	AUS	MDIST (528)	MSF (506), MDZW (636)
ETAZWB	AUS	MDBAS (529)	MDKOG (516)
ETAZWBM	AUS	MDBAS (529)	FE (591), MDFUE (594), MDKOL (526), MSF (506), MDZUL (523)
ETAZWG	LOK	LAMBTS (732)	
ETAZWIF	LOK	DTEV (856)	
ETAZWIM	LOK	LAMBTS (732)	
ETAZWIMT	LOK	ATM (20)	
ETAZWIST	AUS	MDIST (528)	ATM (20), DTEV (856), LAMBTS (732)
ETAZWKTE	LOK	DTEV (856)	
ETAZWMN	AUS	ZWMIN (669)	AES (973), MDKOL (526), MDZUL (523), MDRED (976)
ETAZWMN_W	LOK	AES (973)	
ETAZWS	LOK	MDZW (636)	
ETAZW_UM	LOK	UFMIST (1086)	
EVRBGN_ONE	LOK	AEVAB (980)	
EVSUP1	AUS	DIMC (1148)	
EVTMOD	AUS	BGTEMPK (252)	FUEDK (597), EGFE (228)
EVZ_AGS	LOK	AES (973)	
EVZ_AUS	AUS	AEVAB (980)	AEVABZK (1003), KRRA (639), UFUE (1056), AES (973)
EVZ_AUSOLD	LOK	BGEVAB (1005)	

Symbol	Type	Created within	Used within
EVZ_AUSTOT	AUS	AEVABZK (1003)	ACIFI (1013), UFEING (1058), DEVE (1017), BGEVAB (1005), AES (973)
EVZ_AUS_UM	AUS	UFEING (1058)	UFREAC (1088), UFUE (1056)
E_AAVE	EIN		DTEV (856), TEBEB (762)
E_AGRE	EIN		DKAT (361), LRAEB (759), DLSA (398), DMDSTP (205), DTEV (856), DLSAHK (339)
E_AGRF	EIN		DIMC (1148), LRAEB (759), DTEV (856), DMDSTP (205), DLSAHK (339), DLSA (398), DKAT (361)
E_BM	AUS	DDG (141)	DMDSTP (205), WANWKW (125), RDE (112), LRAEB (759), DNWS (622), GGDPG (74)
E_BREMS	AUS	EGEG (453)	GGEGAS (474)
E_BUOF	AUS	CAN (1124)	NMAXMD (584)
E_BUSOFF	AUS	CAN (1124)	DCAS (1128), DCKUP (1128), DCINS (1126)
E_BWF	AUS	GGPED (454)	
E_CAS	AUS	DCAS (1128)	CAN (1124), DVFZ (500)
E_CINS	AUS	DCINS (1126)	
E_CKUP	EIN		CAN (1124), DCKUP (1128), NMAXMD (584)
E_DK	AUS	DDVE (950)	BGMSZS (239), TEBEB (762), SU (617), LRAEB (759), EGFE (228), DTEV (856), DKAT (361), BGPU (276), BGRLP (266)
E_DK1P	AUS	DDVE (950)	
E_DK2P	AUS	DDVE (950)	
E_DPL	EIN		LRA (797)
E_DSL	EIN		BGMSZS (239)
E_DSLI	LOK	BGMSZS (239)	
E_DSS	EIN		BGPU (276), EGFE (228)
E_DST	AUS	EGAG (486)	
E_DVEE	AUS	DDVE (950)	
E_DVEF	AUS	DDVE (950)	BGDVE (934)
E_DVEFO	AUS	DDVE (950)	BGDVE (934)
E_DVEL	AUS	DDVE (950)	
E_DVEN	AUS	DDVE (950)	BGDVE (934)
E_DVER	AUS	DDVE (950)	
E_DVET	AUS	DDVE (950)	ADVE (918)
E_DVEU	AUS	DDVE (950)	DTEV (856), LRAEB (759)
E_DVEUB	AUS	DDVE (950)	
E_DVEUW	AUS	DDVE (950)	
E_DVEV	AUS	DDVE (950)	BGDVE (934), GGDVE (477)
E_EGFE	AUS	DEGFE (592)	BGPU (276)
E_EV	EIN		DMDMIL (216)
E_EV1	AUS	DEVE (1017)	AEVAB (980), DMDMIL (216), STADAP (684)
E_EV2	AUS	DEVE (1017)	AEVAB (980), STADAP (684), DMDMIL (216)
E_EV3	AUS	DEVE (1017)	AEVAB (980), DMDMIL (216), STADAP (684)
E_EV4	AUS	DEVE (1017)	AEVAB (980), DMDMIL (216), STADAP (684)
E_EV5	AUS	DEVE (1017)	AEVAB (980), DMDMIL (216), STADAP (684)
E_EV6	AUS	DEVE (1017)	AEVAB (980), STADAP (684), DMDMIL (216)
E_EV7	AUS	DEVE (1017)	AEVAB (980), STADAP (684), DMDMIL (216)
E_EV8	AUS	DEVE (1017)	AEVAB (980), STADAP (684), DMDMIL (216)
E_FP1P	AUS	GGPED (454)	
E_FP2P	AUS	GGPED (454)	
E_FPP	AUS	EGEG (453)	GGPED (454)
E_FRA	AUS	GKRA (766)	
E_FRA2	AUS	GKRA (766)	
E_FRAO	AUS	DKVS (811)	STADAP (684)
E_FRAO2	AUS	DKVS (811)	STADAP (684)
E_FRAU	AUS	DKVS (811)	STADAP (684)
E_FRAU2	AUS	DKVS (811)	STADAP (684)
E_FRST	AUS	DKVS (811)	
E_FRST2	AUS	DKVS (811)	
E_HKS_I	LOK	DKRS (437)	
E_HLPKS_I	LOK	DKRS (437)	
E_HSH	AUS	DHLSHK (1154)	DIMC (1148), DKAT (361), DLSA (398), LRHK (781), DLSAHK (339)
E_HSH2	AUS	DHLSHK (1154)	DIMC (1148), LRHK (781), DLSAHK (339), DLSA (398), DKAT (361)
E_HSV	AUS	DHLSVK (29)	DIMC (1148), LRHK (781), DLSA (398), DKAT (361)
E_HSV2	AUS	DHLSVK (29)	DIMC (1148), LRHK (781), DLSA (398), DKAT (361)
E_HSVE	AUS	DHLSVKE (902)	DHLSVK (29)
E_HSVE2	AUS	DHLSVKE (902)	DHLSVK (29)
E_KAT	AUS	DKAT (361)	DIMC (1148), LRHK (781), DLSA (398)
E_KAT2	AUS	DKAT (361)	DIMC (1148), LRHK (781), DLSA (398)
E_KOSE	AUS	DKOSE (901)	
E_KPE	AUS	DEKPE (1020)	
E_KRNT	AUS	DKRNT (445)	KRRA (639), EGKE (409)
E_KROF	AUS	DKRNT (445)	KRRA (639), EGKE (409)
E_KRTP	AUS	DKRTP (451)	KRRA (639), EGKE (409)
E_KS1	AUS	DKRS (437)	KRRA (639), EGKE (409)
E_KS1H	LOK	KRRA (639)	
E_KS2	AUS	DKRS (437)	KRRA (639), EGKE (409)
E_KS2H	LOK	KRRA (639)	
E_KS3	AUS	DKRS (437)	KRRA (639), EGKE (409)
E_KS3H	LOK	KRRA (639)	
E_KS4	AUS	DKRS (437)	KRRA (639), EGKE (409)
E_KS4H	LOK	KRRA (639)	
E_LASH	AUS	DLSAHK (339)	DKAT (361), LRHK (781)
E_LASH2	AUS	DLSAHK (339)	DKAT (361), LRHK (781)

Symbol	Type	Created within	Used within
E_LATP	AUS	DLSA (398)	DIMC (1148), DKAT (361)
E_LATP2	AUS	DLSA (398)	DIMC (1148), DKAT (361)
E_LATV	AUS	DLSA (398)	DKAT (361)
E_LATV2	AUS	DLSA (398)	DKAT (361)
E_LDE	EIN		DMDSTP (205)
E_LDPE	EIN		DTEV (856), TEBEB (762)
E_LLR	AUS	DLLR (578)	DTEV (856)
E_LM	AUS	DHFM (233)	SWADAP (47), EGFE (228), BBKHZ (890), BGTEV (257), BGMSZS (239), LRHK (781), FUEREG (595), DTEV (856), DLSA (398), DLLR (578), DKAT (361), BGPU (276)
E_LSH	AUS	DLSH (330)	DIMC (1148), DKAT (361), DLSAHK (339)
E_LSH2	AUS	DLSH (330)	DIMC (1148), DLSAHK (339), DKAT (361)
E_LSHV	EIN		DKAT (361)
E_LSV	AUS	DLSV (301)	DIMC (1148), LREB (739), TEB (826), DKAT (361)
E_LSV2	AUS	DLSV (301)	DIMC (1148), DKAT (361), TEB (826), LREB (739)
E_LUEA	AUS	DMLSE (34)	
E_LUEB	AUS	DMLSE (34)	
E_MD	AUS	DMDMIL (216)	DKAT (361), DMDSTP (205)
E_MD00	AUS	DMDMIL (216)	
E_MD01	AUS	DMDMIL (216)	
E_MD02	AUS	DMDMIL (216)	
E_MD03	AUS	DMDMIL (216)	
E_MD04	AUS	DMDMIL (216)	
E_MD05	AUS	DMDMIL (216)	
E_MD06	AUS	DMDMIL (216)	
E_MD07	AUS	DMDMIL (216)	
E_MD08	AUS	DMDMIL (216)	
E_MD09	AUS	DMDMIL (216)	
E_MD10	AUS	DMDMIL (216)	
E_MD11	AUS	DMDMIL (216)	
E_MDB	AUS	MDKOG (516)	
E_MILE	AUS	DMILE (36)	
E_MUTE	AUS	CAN (1124)	NMAXMD (584)
E_N	AUS	DDG (141)	DMDSTP (205), RDE (112), STADAP (684), GGDPG (74)
E_NWKW	AUS	DNWKW (134)	DMDSTP (205)
E_NWKW2	AUS	DNWKW (134)	DMDSTP (205)
E_NWS	AUS	DNWS (622)	DMDSTP (205)
E_NWS2	AUS	DNWS (622)	DMDSTP (205)
E_NWSE	AUS	DNWSE (1025)	DMDSTP (205), WANWKW (125), DNWS (622)
E_NWSE2	EIN		DMDSTP (205)
E_NWSE_C	EIN		DNWSE (1025)
E_PH	AUS	DPH (144)	DLSA (398), NWS (618), WANWKW (125), STADAP (684), DLSAHK (339), NLPH (150)
E_PH2	AUS	DPH (144)	NWS (618), WANWKW (125)
E_POEL	AUS	GGPOEL (296)	
E_PUA	AUS	BGPU (276)	
E_RKAT	AUS	DKVS (811)	STADAP (684)
E_RKAT2	AUS	DKVS (811)	STADAP (684)
E_RKAZ	AUS	DKVS (811)	
E_RKAZ2	AUS	DKVS (811)	
E_SGCAN	EIN		GGDPG (74)
E_SLPE	EIN		DKAT (361)
E_SLS	EIN		DIMC (1148), LRHK (781), DTEV (856)
E_SLS2	EIN		LRHK (781)
E_SLVE	EIN		DKAT (361)
E_SUE	EIN		DMDSTP (205)
E_SUE2	EIN		DMDSTP (205)
E_SWE	EIN		DSWEC (32)
E_TA	AUS	GGTFA (298)	ATM (20), BBKHZ (890), SU (617), NWS (618), LRAEB (759), LLRNS (562), GGTFM (289), DLSA (398), DLLR (578), BGTABST (1030)
E_TANKL	EIN		STADAP (684)
E_TES	AUS	DTEV (856)	DIMC (1148), DLSH (330), DMDSTP (205), LRHK (781), LRAEB (759), LR (768), ESUKA (711), DLSV (301), DLSAHK (339), DKAT (361), DLLR (578), DLSA (398)
E_TEVE	AUS	DTEVE (1022)	DKAT (361), TEBEB (762), LRHK (781), LRAEB (759), ESUKA (711), DTEV (856), DMDSTP (205), DLSV (301), DLSH (330), DLSAHK (339), DLLR (578), DLSA (398)
E_TEVE2	EIN		LRHK (781)
E_TM	AUS	GGTFM (289)	ATWAL (297), WANWKW (125), SU (617), STADAP (684), LRAEB (759), LLRNS (562), LFS (69), DTEV (856), DNWS (622), DLSV (301), DLSH (330), DLSA (398), DLLR (578), BBKHZ (890), BGTABST (1030)
E_TOL	EIN		GGTFM (289)
E_TUM	EIN		ATM (20), BGTABST (1030)
E_UB	AUS	EGAG (486)	GGUB (487), DLSA (398), STADAP (684), LRAEB (759), DLSAHK (339), DTEV (856)
E_UF2SG	AUS	DUF (1089)	
E_UFMV	AUS	DUF (1089)	
E_UFSKA	AUS	DUF (1089)	
E_URRAM	AUS	DUR (1052)	
E_URROM	AUS	DUR (1052)	
E_URRST	AUS	DUR (1052)	
E_UVSE	EIN		DMDSTP (205)

Symbol	Type	Created within	Used within
E_VFZ	AUS	DVFZ (500)	EGAG (486), BBGANG (501), RDE (112), NMAXMD (584), GGVFZG (497), GGUB (487), GGPED (454), DVKUP (1027), DTEV (856), DMDSTP (205), DMDLU (193), DDG (141), DLLR (578), BGPU (276)
E_VKUP	LOK	DVKUP (1027)	
FAFTEKF	LOK	BGTEV (257)	
FAFTE_W	LOK	BGTEV (257)	
FALRDKT	AUS	DKAT (361)	LR (768)
FAMAL	LOK	DMDLU (193)	
FAVKATMX	LOK	LRKA (795)	
FAWIFGR	EIN		FGRFULO (1160), FGRREGL (1174)
FAWIFGR_W	LOK	FGRREGL (1174)	
FBAKL_W	AUS	ESUK (699)	
FBANS	LOK	ESUK (699)	
FBANS_W	LOK	ESUK (699)	
FBAVST_W	LOK	ESUK (699)	
FBETATE	LOK	TEB (826)	
FBKATE	LOK	TEB (826)	
FDAR	AUS	ARMD (531)	
FDMD_M	LOK	DMDFON (161)	DMDUE (158)
FFLUTN	LOK	DMDLUA (202)	
FFONN1	LOK	DMDFON (161)	
FFONN2	LOK	DMDFON (161)	
FFONN3	LOK	DMDFON (161)	
FFORN1	LOK	DMDFON (161)	
FFPL1	LOK	DMDFON (161)	
FFRI	LOK	LR (768)	
FFRI2	LOK	LR (768)	
FFRIP_W	LOK	LR (768)	
FFZDFP	EIN		TC2MOD (1107)
FGRU	AUS	ESGRU (678)	ESVST (677), GK (675)
FGWRTE	LOK	TEB (826)	
FHO	AUS	BGPU (276)	DLLR (578), WDKSOM (614), STADAP (684), MDVER (546), MDFUE (594), KOS (896), ESUK (699), ESSTT (679), ESNSWL (691)
FHODSS_W	LOK	BGPU (276)	
FHOMS_W	LOK	BGPU (276)	
FHO_W	AUS	BGPU (276)	BBKHZ (890), MDMAX (514), KHMD (894), FUEDK (597), FE (591), DTEV (856), DHFM (233), BGTEV (257), BGSRM (245), EGFE (228)
FIVZABG	LOK	DMDMIL (216)	
FKATEAPP	LOK	TEB (826)	
FKATEFRG	LOK	TEB (826)	
FKATEI	AUS	TEB (826)	DTEV (856), LR (768)
FKATES	AUS	TEB (826)	
FKHAB	AUS	BBKHZ (890)	
FKHFM	LOK	GGHFM (230)	
FKLAFS_W	LOK	FUEDK (597)	
FKLAF_W	AUS	BGMSZS (239)	DTEV (856)
FKMSDKK_W	LOK	BGPU (276)	
FKMSDKS_W	AUS	BGMSZS (239)	
FKMSDK_W	AUS	BGMSZS (239)	BGPU (276), FUEDK (597)
FKPVDK_W	AUS	BGMSZS (239)	
FKTNS_W	LOK	ESNSWL (691)	
FLAKH	AUS	BBKHZ (890)	LAKH (735), AK (855)
FLAMKH	AUS	BBKHZ (890)	LAMKO (729), AK (855), LAMSOLL (726)
FLAMSL	LOK	AK (855)	
FLAMSL2_W	EIN		LAKH (735), LAMKO (729)
FLAMSL_W	EIN		LAKH (735), LAMKO (729)
FLGKAT_W	LOK	DMDMIL (216)	
FLGLRS	AUS	LREB (739)	DFFT (1140), TC1MOD (1100)
FLGLRS2	AUS	LREB (739)	DFFT (1140), TC1MOD (1100)
FLGTIAB	AUS	DMDMIL (216)	AES (973), AEVAB (980)
FLGTIABC	EIN		AEVAB (980)
FLGTIABT	AUS	DMDMIL (216)	
FLG_M	LOK	DMDFON (161)	DMDUE (158)
FLMSSL	EIN		LAKH (735), AK (855)
FLMX	LOK	DMDFON (161)	
FLMXRESZ	LOK	DMDFON (161)	
FLN11_02	LOK	DMDFON (161)	
FLN11_03	LOK	DMDFON (161)	
FLN11_04	LOK	DMDFON (161)	
FLN11_05	LOK	DMDFON (161)	
FLN11_06	LOK	DMDFON (161)	
FLN11_07	LOK	DMDFON (161)	
FLN11_08	LOK	DMDFON (161)	
FLN11_09	LOK	DMDFON (161)	
FLN11_10	LOK	DMDFON (161)	
FLN11_11	LOK	DMDFON (161)	
FLN11_12	LOK	DMDFON (161)	
FLN12_02	LOK	DMDFON (161)	
FLN12_03	LOK	DMDFON (161)	
FLN12_04	LOK	DMDFON (161)	
FLN12_05	LOK	DMDFON (161)	
FLN12_06	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FLN12_07	LOK	DMDFON (161)	
FLN12_08	LOK	DMDFON (161)	
FLN12_09	LOK	DMDFON (161)	
FLN12_10	LOK	DMDFON (161)	
FLN12_11	LOK	DMDFON (161)	
FLN12_12	LOK	DMDFON (161)	
FLN13_02	LOK	DMDFON (161)	
FLN13_03	LOK	DMDFON (161)	
FLN13_04	LOK	DMDFON (161)	
FLN13_05	LOK	DMDFON (161)	
FLN13_06	LOK	DMDFON (161)	
FLN13_07	LOK	DMDFON (161)	
FLN13_08	LOK	DMDFON (161)	
FLN13_09	LOK	DMDFON (161)	
FLN13_10	LOK	DMDFON (161)	
FLN13_11	LOK	DMDFON (161)	
FLN13_12	LOK	DMDFON (161)	
FLN21_02	LOK	DMDFON (161)	
FLN21_03	LOK	DMDFON (161)	
FLN21_04	LOK	DMDFON (161)	
FLN21_05	LOK	DMDFON (161)	
FLN21_06	LOK	DMDFON (161)	
FLN21_07	LOK	DMDFON (161)	
FLN21_08	LOK	DMDFON (161)	
FLN21_09	LOK	DMDFON (161)	
FLN21_10	LOK	DMDFON (161)	
FLN21_11	LOK	DMDFON (161)	
FLN21_12	LOK	DMDFON (161)	
FLN22_02	LOK	DMDFON (161)	
FLN22_03	LOK	DMDFON (161)	
FLN22_04	LOK	DMDFON (161)	
FLN22_05	LOK	DMDFON (161)	
FLN22_06	LOK	DMDFON (161)	
FLN22_07	LOK	DMDFON (161)	
FLN22_08	LOK	DMDFON (161)	
FLN22_09	LOK	DMDFON (161)	
FLN22_10	LOK	DMDFON (161)	
FLN22_11	LOK	DMDFON (161)	
FLN22_12	LOK	DMDFON (161)	
FLN23_02	LOK	DMDFON (161)	
FLN23_03	LOK	DMDFON (161)	
FLN23_04	LOK	DMDFON (161)	
FLN23_05	LOK	DMDFON (161)	
FLN23_06	LOK	DMDFON (161)	
FLN23_07	LOK	DMDFON (161)	
FLN23_08	LOK	DMDFON (161)	
FLN23_09	LOK	DMDFON (161)	
FLN23_10	LOK	DMDFON (161)	
FLN23_11	LOK	DMDFON (161)	
FLN23_12	LOK	DMDFON (161)	
FLN31_02	LOK	DMDFON (161)	
FLN31_03	LOK	DMDFON (161)	
FLN31_04	LOK	DMDFON (161)	
FLN31_05	LOK	DMDFON (161)	
FLN31_06	LOK	DMDFON (161)	
FLN31_07	LOK	DMDFON (161)	
FLN31_08	LOK	DMDFON (161)	
FLN31_09	LOK	DMDFON (161)	
FLN31_10	LOK	DMDFON (161)	
FLN31_11	LOK	DMDFON (161)	
FLN31_12	LOK	DMDFON (161)	
FLN32_02	LOK	DMDFON (161)	
FLN32_03	LOK	DMDFON (161)	
FLN32_04	LOK	DMDFON (161)	
FLN32_05	LOK	DMDFON (161)	
FLN32_06	LOK	DMDFON (161)	
FLN32_07	LOK	DMDFON (161)	
FLN32_08	LOK	DMDFON (161)	
FLN32_09	LOK	DMDFON (161)	
FLN32_10	LOK	DMDFON (161)	
FLN32_11	LOK	DMDFON (161)	
FLN32_12	LOK	DMDFON (161)	
FLN33_02	LOK	DMDFON (161)	
FLN33_03	LOK	DMDFON (161)	
FLN33_04	LOK	DMDFON (161)	
FLN33_05	LOK	DMDFON (161)	
FLN33_06	LOK	DMDFON (161)	
FLN33_07	LOK	DMDFON (161)	
FLN33_08	LOK	DMDFON (161)	
FLN33_09	LOK	DMDFON (161)	
FLN33_10	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FLN33_11	LOK	DMDFON (161)	
FLN33_12	LOK	DMDFON (161)	
FLN41_02	LOK	DMDFON (161)	
FLN41_03	LOK	DMDFON (161)	
FLN41_04	LOK	DMDFON (161)	
FLN41_05	LOK	DMDFON (161)	
FLN41_06	LOK	DMDFON (161)	
FLN41_07	LOK	DMDFON (161)	
FLN41_08	LOK	DMDFON (161)	
FLN41_09	LOK	DMDFON (161)	
FLN41_10	LOK	DMDFON (161)	
FLN41_11	LOK	DMDFON (161)	
FLN41_12	LOK	DMDFON (161)	
FLN42_02	LOK	DMDFON (161)	
FLN42_03	LOK	DMDFON (161)	
FLN42_04	LOK	DMDFON (161)	
FLN42_05	LOK	DMDFON (161)	
FLN42_06	LOK	DMDFON (161)	
FLN42_07	LOK	DMDFON (161)	
FLN42_08	LOK	DMDFON (161)	
FLN42_09	LOK	DMDFON (161)	
FLN42_10	LOK	DMDFON (161)	
FLN42_11	LOK	DMDFON (161)	
FLN42_12	LOK	DMDFON (161)	
FLN43_02	LOK	DMDFON (161)	
FLN43_03	LOK	DMDFON (161)	
FLN43_04	LOK	DMDFON (161)	
FLN43_05	LOK	DMDFON (161)	
FLN43_06	LOK	DMDFON (161)	
FLN43_07	LOK	DMDFON (161)	
FLN43_08	LOK	DMDFON (161)	
FLN43_09	LOK	DMDFON (161)	
FLN43_10	LOK	DMDFON (161)	
FLN43_11	LOK	DMDFON (161)	
FLN43_12	LOK	DMDFON (161)	
FLN51_02	LOK	DMDFON (161)	
FLN51_03	LOK	DMDFON (161)	
FLN51_04	LOK	DMDFON (161)	
FLN51_05	LOK	DMDFON (161)	
FLN51_06	LOK	DMDFON (161)	
FLN51_07	LOK	DMDFON (161)	
FLN51_08	LOK	DMDFON (161)	
FLN51_09	LOK	DMDFON (161)	
FLN51_10	LOK	DMDFON (161)	
FLN51_11	LOK	DMDFON (161)	
FLN51_12	LOK	DMDFON (161)	
FLN52_02	LOK	DMDFON (161)	
FLN52_03	LOK	DMDFON (161)	
FLN52_04	LOK	DMDFON (161)	
FLN52_05	LOK	DMDFON (161)	
FLN52_06	LOK	DMDFON (161)	
FLN52_07	LOK	DMDFON (161)	
FLN52_08	LOK	DMDFON (161)	
FLN52_09	LOK	DMDFON (161)	
FLN52_10	LOK	DMDFON (161)	
FLN52_11	LOK	DMDFON (161)	
FLN52_12	LOK	DMDFON (161)	
FLN53_02	LOK	DMDFON (161)	
FLN53_03	LOK	DMDFON (161)	
FLN53_04	LOK	DMDFON (161)	
FLN53_05	LOK	DMDFON (161)	
FLN53_06	LOK	DMDFON (161)	
FLN53_07	LOK	DMDFON (161)	
FLN53_08	LOK	DMDFON (161)	
FLN53_09	LOK	DMDFON (161)	
FLN53_10	LOK	DMDFON (161)	
FLN53_11	LOK	DMDFON (161)	
FLN53_12	LOK	DMDFON (161)	
FLN61_02	LOK	DMDFON (161)	
FLN61_03	LOK	DMDFON (161)	
FLN61_04	LOK	DMDFON (161)	
FLN61_05	LOK	DMDFON (161)	
FLN61_06	LOK	DMDFON (161)	
FLN61_07	LOK	DMDFON (161)	
FLN61_08	LOK	DMDFON (161)	
FLN61_09	LOK	DMDFON (161)	
FLN61_10	LOK	DMDFON (161)	
FLN61_11	LOK	DMDFON (161)	
FLN61_12	LOK	DMDFON (161)	
FLN62_02	LOK	DMDFON (161)	
FLN62_03	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FLN62_04	LOK	DMDFON (161)	
FLN62_05	LOK	DMDFON (161)	
FLN62_06	LOK	DMDFON (161)	
FLN62_07	LOK	DMDFON (161)	
FLN62_08	LOK	DMDFON (161)	
FLN62_09	LOK	DMDFON (161)	
FLN62_10	LOK	DMDFON (161)	
FLN62_11	LOK	DMDFON (161)	
FLN62_12	LOK	DMDFON (161)	
FLN63_02	LOK	DMDFON (161)	
FLN63_03	LOK	DMDFON (161)	
FLN63_04	LOK	DMDFON (161)	
FLN63_05	LOK	DMDFON (161)	
FLN63_06	LOK	DMDFON (161)	
FLN63_07	LOK	DMDFON (161)	
FLN63_08	LOK	DMDFON (161)	
FLN63_09	LOK	DMDFON (161)	
FLN63_10	LOK	DMDFON (161)	
FLN63_11	LOK	DMDFON (161)	
FLN63_12	LOK	DMDFON (161)	
FLN71_02	LOK	DMDFON (161)	
FLN71_03	LOK	DMDFON (161)	
FLN71_04	LOK	DMDFON (161)	
FLN71_05	LOK	DMDFON (161)	
FLN71_06	LOK	DMDFON (161)	
FLN71_07	LOK	DMDFON (161)	
FLN71_08	LOK	DMDFON (161)	
FLN71_09	LOK	DMDFON (161)	
FLN71_10	LOK	DMDFON (161)	
FLN71_11	LOK	DMDFON (161)	
FLN71_12	LOK	DMDFON (161)	
FLN72_02	LOK	DMDFON (161)	
FLN72_03	LOK	DMDFON (161)	
FLN72_04	LOK	DMDFON (161)	
FLN72_05	LOK	DMDFON (161)	
FLN72_06	LOK	DMDFON (161)	
FLN72_07	LOK	DMDFON (161)	
FLN72_08	LOK	DMDFON (161)	
FLN72_09	LOK	DMDFON (161)	
FLN72_10	LOK	DMDFON (161)	
FLN72_11	LOK	DMDFON (161)	
FLN72_12	LOK	DMDFON (161)	
FLN73_02	LOK	DMDFON (161)	
FLN73_03	LOK	DMDFON (161)	
FLN73_04	LOK	DMDFON (161)	
FLN73_05	LOK	DMDFON (161)	
FLN73_06	LOK	DMDFON (161)	
FLN73_07	LOK	DMDFON (161)	
FLN73_08	LOK	DMDFON (161)	
FLN73_09	LOK	DMDFON (161)	
FLN73_10	LOK	DMDFON (161)	
FLN73_11	LOK	DMDFON (161)	
FLN73_12	LOK	DMDFON (161)	
FLN81_02	LOK	DMDFON (161)	
FLN81_03	LOK	DMDFON (161)	
FLN81_04	LOK	DMDFON (161)	
FLN81_05	LOK	DMDFON (161)	
FLN81_06	LOK	DMDFON (161)	
FLN81_07	LOK	DMDFON (161)	
FLN81_08	LOK	DMDFON (161)	
FLN81_09	LOK	DMDFON (161)	
FLN81_10	LOK	DMDFON (161)	
FLN81_11	LOK	DMDFON (161)	
FLN81_12	LOK	DMDFON (161)	
FLN82_02	LOK	DMDFON (161)	
FLN82_03	LOK	DMDFON (161)	
FLN82_04	LOK	DMDFON (161)	
FLN82_05	LOK	DMDFON (161)	
FLN82_06	LOK	DMDFON (161)	
FLN82_07	LOK	DMDFON (161)	
FLN82_08	LOK	DMDFON (161)	
FLN82_09	LOK	DMDFON (161)	
FLN82_10	LOK	DMDFON (161)	
FLN82_11	LOK	DMDFON (161)	
FLN82_12	LOK	DMDFON (161)	
FLN83_02	LOK	DMDFON (161)	
FLN83_03	LOK	DMDFON (161)	
FLN83_04	LOK	DMDFON (161)	
FLN83_05	LOK	DMDFON (161)	
FLN83_06	LOK	DMDFON (161)	
FLN83_07	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FLN83_08	LOK	DMDFON (161)	
FLN83_09	LOK	DMDFON (161)	
FLN83_10	LOK	DMDFON (161)	
FLN83_11	LOK	DMDFON (161)	
FLN83_12	LOK	DMDFON (161)	
FLP11_02	LOK	DMDFON (161)	
FLP11_03	LOK	DMDFON (161)	
FLP11_04	LOK	DMDFON (161)	
FLP11_05	LOK	DMDFON (161)	
FLP11_06	LOK	DMDFON (161)	
FLP11_07	LOK	DMDFON (161)	
FLP11_08	LOK	DMDFON (161)	
FLP11_09	LOK	DMDFON (161)	
FLP11_10	LOK	DMDFON (161)	
FLP11_11	LOK	DMDFON (161)	
FLP11_12	LOK	DMDFON (161)	
FLP12_02	LOK	DMDFON (161)	
FLP12_03	LOK	DMDFON (161)	
FLP12_04	LOK	DMDFON (161)	
FLP12_05	LOK	DMDFON (161)	
FLP12_06	LOK	DMDFON (161)	
FLP12_07	LOK	DMDFON (161)	
FLP12_08	LOK	DMDFON (161)	
FLP12_09	LOK	DMDFON (161)	
FLP12_10	LOK	DMDFON (161)	
FLP12_11	LOK	DMDFON (161)	
FLP12_12	LOK	DMDFON (161)	
FLP13_02	LOK	DMDFON (161)	
FLP13_03	LOK	DMDFON (161)	
FLP13_04	LOK	DMDFON (161)	
FLP13_05	LOK	DMDFON (161)	
FLP13_06	LOK	DMDFON (161)	
FLP13_07	LOK	DMDFON (161)	
FLP13_08	LOK	DMDFON (161)	
FLP13_09	LOK	DMDFON (161)	
FLP13_10	LOK	DMDFON (161)	
FLP13_11	LOK	DMDFON (161)	
FLP13_12	LOK	DMDFON (161)	
FLP21_02	LOK	DMDFON (161)	
FLP21_03	LOK	DMDFON (161)	
FLP21_04	LOK	DMDFON (161)	
FLP21_05	LOK	DMDFON (161)	
FLP21_06	LOK	DMDFON (161)	
FLP21_07	LOK	DMDFON (161)	
FLP21_08	LOK	DMDFON (161)	
FLP21_09	LOK	DMDFON (161)	
FLP21_10	LOK	DMDFON (161)	
FLP21_11	LOK	DMDFON (161)	
FLP21_12	LOK	DMDFON (161)	
FLP22_02	LOK	DMDFON (161)	
FLP22_03	LOK	DMDFON (161)	
FLP22_04	LOK	DMDFON (161)	
FLP22_05	LOK	DMDFON (161)	
FLP22_06	LOK	DMDFON (161)	
FLP22_07	LOK	DMDFON (161)	
FLP22_08	LOK	DMDFON (161)	
FLP22_09	LOK	DMDFON (161)	
FLP22_10	LOK	DMDFON (161)	
FLP22_11	LOK	DMDFON (161)	
FLP22_12	LOK	DMDFON (161)	
FLP23_02	LOK	DMDFON (161)	
FLP23_03	LOK	DMDFON (161)	
FLP23_04	LOK	DMDFON (161)	
FLP23_05	LOK	DMDFON (161)	
FLP23_06	LOK	DMDFON (161)	
FLP23_07	LOK	DMDFON (161)	
FLP23_08	LOK	DMDFON (161)	
FLP23_09	LOK	DMDFON (161)	
FLP23_10	LOK	DMDFON (161)	
FLP23_11	LOK	DMDFON (161)	
FLP23_12	LOK	DMDFON (161)	
FLP31_02	LOK	DMDFON (161)	
FLP31_03	LOK	DMDFON (161)	
FLP31_04	LOK	DMDFON (161)	
FLP31_05	LOK	DMDFON (161)	
FLP31_06	LOK	DMDFON (161)	
FLP31_07	LOK	DMDFON (161)	
FLP31_08	LOK	DMDFON (161)	
FLP31_09	LOK	DMDFON (161)	
FLP31_10	LOK	DMDFON (161)	
FLP31_11	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FLP31_12	LOK	DMDFON (161)	
FLP32_02	LOK	DMDFON (161)	
FLP32_03	LOK	DMDFON (161)	
FLP32_04	LOK	DMDFON (161)	
FLP32_05	LOK	DMDFON (161)	
FLP32_06	LOK	DMDFON (161)	
FLP32_07	LOK	DMDFON (161)	
FLP32_08	LOK	DMDFON (161)	
FLP32_09	LOK	DMDFON (161)	
FLP32_10	LOK	DMDFON (161)	
FLP32_11	LOK	DMDFON (161)	
FLP32_12	LOK	DMDFON (161)	
FLP33_02	LOK	DMDFON (161)	
FLP33_03	LOK	DMDFON (161)	
FLP33_04	LOK	DMDFON (161)	
FLP33_05	LOK	DMDFON (161)	
FLP33_06	LOK	DMDFON (161)	
FLP33_07	LOK	DMDFON (161)	
FLP33_08	LOK	DMDFON (161)	
FLP33_09	LOK	DMDFON (161)	
FLP33_10	LOK	DMDFON (161)	
FLP33_11	LOK	DMDFON (161)	
FLP33_12	LOK	DMDFON (161)	
FLP41_02	LOK	DMDFON (161)	
FLP41_03	LOK	DMDFON (161)	
FLP41_04	LOK	DMDFON (161)	
FLP41_05	LOK	DMDFON (161)	
FLP41_06	LOK	DMDFON (161)	
FLP41_07	LOK	DMDFON (161)	
FLP41_08	LOK	DMDFON (161)	
FLP41_09	LOK	DMDFON (161)	
FLP41_10	LOK	DMDFON (161)	
FLP41_11	LOK	DMDFON (161)	
FLP41_12	LOK	DMDFON (161)	
FLP42_02	LOK	DMDFON (161)	
FLP42_03	LOK	DMDFON (161)	
FLP42_04	LOK	DMDFON (161)	
FLP42_05	LOK	DMDFON (161)	
FLP42_06	LOK	DMDFON (161)	
FLP42_07	LOK	DMDFON (161)	
FLP42_08	LOK	DMDFON (161)	
FLP42_09	LOK	DMDFON (161)	
FLP42_10	LOK	DMDFON (161)	
FLP42_11	LOK	DMDFON (161)	
FLP42_12	LOK	DMDFON (161)	
FLP43_02	LOK	DMDFON (161)	
FLP43_03	LOK	DMDFON (161)	
FLP43_04	LOK	DMDFON (161)	
FLP43_05	LOK	DMDFON (161)	
FLP43_06	LOK	DMDFON (161)	
FLP43_07	LOK	DMDFON (161)	
FLP43_08	LOK	DMDFON (161)	
FLP43_09	LOK	DMDFON (161)	
FLP43_10	LOK	DMDFON (161)	
FLP43_11	LOK	DMDFON (161)	
FLP43_12	LOK	DMDFON (161)	
FLP51_02	LOK	DMDFON (161)	
FLP51_03	LOK	DMDFON (161)	
FLP51_04	LOK	DMDFON (161)	
FLP51_05	LOK	DMDFON (161)	
FLP51_06	LOK	DMDFON (161)	
FLP51_07	LOK	DMDFON (161)	
FLP51_08	LOK	DMDFON (161)	
FLP51_09	LOK	DMDFON (161)	
FLP51_10	LOK	DMDFON (161)	
FLP51_11	LOK	DMDFON (161)	
FLP51_12	LOK	DMDFON (161)	
FLP52_02	LOK	DMDFON (161)	
FLP52_03	LOK	DMDFON (161)	
FLP52_04	LOK	DMDFON (161)	
FLP52_05	LOK	DMDFON (161)	
FLP52_06	LOK	DMDFON (161)	
FLP52_07	LOK	DMDFON (161)	
FLP52_08	LOK	DMDFON (161)	
FLP52_09	LOK	DMDFON (161)	
FLP52_10	LOK	DMDFON (161)	
FLP52_11	LOK	DMDFON (161)	
FLP52_12	LOK	DMDFON (161)	
FLP53_02	LOK	DMDFON (161)	
FLP53_03	LOK	DMDFON (161)	
FLP53_04	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FLP53_05	LOK	DMDFON (161)	
FLP53_06	LOK	DMDFON (161)	
FLP53_07	LOK	DMDFON (161)	
FLP53_08	LOK	DMDFON (161)	
FLP53_09	LOK	DMDFON (161)	
FLP53_10	LOK	DMDFON (161)	
FLP53_11	LOK	DMDFON (161)	
FLP53_12	LOK	DMDFON (161)	
FLP61_02	LOK	DMDFON (161)	
FLP61_03	LOK	DMDFON (161)	
FLP61_04	LOK	DMDFON (161)	
FLP61_05	LOK	DMDFON (161)	
FLP61_06	LOK	DMDFON (161)	
FLP61_07	LOK	DMDFON (161)	
FLP61_08	LOK	DMDFON (161)	
FLP61_09	LOK	DMDFON (161)	
FLP61_10	LOK	DMDFON (161)	
FLP61_11	LOK	DMDFON (161)	
FLP61_12	LOK	DMDFON (161)	
FLP62_02	LOK	DMDFON (161)	
FLP62_03	LOK	DMDFON (161)	
FLP62_04	LOK	DMDFON (161)	
FLP62_05	LOK	DMDFON (161)	
FLP62_06	LOK	DMDFON (161)	
FLP62_07	LOK	DMDFON (161)	
FLP62_08	LOK	DMDFON (161)	
FLP62_09	LOK	DMDFON (161)	
FLP62_10	LOK	DMDFON (161)	
FLP62_11	LOK	DMDFON (161)	
FLP62_12	LOK	DMDFON (161)	
FLP63_02	LOK	DMDFON (161)	
FLP63_03	LOK	DMDFON (161)	
FLP63_04	LOK	DMDFON (161)	
FLP63_05	LOK	DMDFON (161)	
FLP63_06	LOK	DMDFON (161)	
FLP63_07	LOK	DMDFON (161)	
FLP63_08	LOK	DMDFON (161)	
FLP63_09	LOK	DMDFON (161)	
FLP63_10	LOK	DMDFON (161)	
FLP63_11	LOK	DMDFON (161)	
FLP63_12	LOK	DMDFON (161)	
FLP71_02	LOK	DMDFON (161)	
FLP71_03	LOK	DMDFON (161)	
FLP71_04	LOK	DMDFON (161)	
FLP71_05	LOK	DMDFON (161)	
FLP71_06	LOK	DMDFON (161)	
FLP71_07	LOK	DMDFON (161)	
FLP71_08	LOK	DMDFON (161)	
FLP71_09	LOK	DMDFON (161)	
FLP71_10	LOK	DMDFON (161)	
FLP71_11	LOK	DMDFON (161)	
FLP71_12	LOK	DMDFON (161)	
FLP72_02	LOK	DMDFON (161)	
FLP72_03	LOK	DMDFON (161)	
FLP72_04	LOK	DMDFON (161)	
FLP72_05	LOK	DMDFON (161)	
FLP72_06	LOK	DMDFON (161)	
FLP72_07	LOK	DMDFON (161)	
FLP72_08	LOK	DMDFON (161)	
FLP72_09	LOK	DMDFON (161)	
FLP72_10	LOK	DMDFON (161)	
FLP72_11	LOK	DMDFON (161)	
FLP72_12	LOK	DMDFON (161)	
FLP73_02	LOK	DMDFON (161)	
FLP73_03	LOK	DMDFON (161)	
FLP73_04	LOK	DMDFON (161)	
FLP73_05	LOK	DMDFON (161)	
FLP73_06	LOK	DMDFON (161)	
FLP73_07	LOK	DMDFON (161)	
FLP73_08	LOK	DMDFON (161)	
FLP73_09	LOK	DMDFON (161)	
FLP73_10	LOK	DMDFON (161)	
FLP73_11	LOK	DMDFON (161)	
FLP73_12	LOK	DMDFON (161)	
FLP81_02	LOK	DMDFON (161)	
FLP81_03	LOK	DMDFON (161)	
FLP81_04	LOK	DMDFON (161)	
FLP81_05	LOK	DMDFON (161)	
FLP81_06	LOK	DMDFON (161)	
FLP81_07	LOK	DMDFON (161)	
FLP81_08	LOK	DMDFON (161)	

Symbol	**Type**	**Created within**	**Used within**
FLP81_09	LOK	DMDFON (161)	
FLP81_10	LOK	DMDFON (161)	
FLP81_11	LOK	DMDFON (161)	
FLP81_12	LOK	DMDFON (161)	
FLP82_02	LOK	DMDFON (161)	
FLP82_03	LOK	DMDFON (161)	
FLP82_04	LOK	DMDFON (161)	
FLP82_05	LOK	DMDFON (161)	
FLP82_06	LOK	DMDFON (161)	
FLP82_07	LOK	DMDFON (161)	
FLP82_08	LOK	DMDFON (161)	
FLP82_09	LOK	DMDFON (161)	
FLP82_10	LOK	DMDFON (161)	
FLP82_11	LOK	DMDFON (161)	
FLP82_12	LOK	DMDFON (161)	
FLP83_02	LOK	DMDFON (161)	
FLP83_03	LOK	DMDFON (161)	
FLP83_04	LOK	DMDFON (161)	
FLP83_05	LOK	DMDFON (161)	
FLP83_06	LOK	DMDFON (161)	
FLP83_07	LOK	DMDFON (161)	
FLP83_08	LOK	DMDFON (161)	
FLP83_09	LOK	DMDFON (161)	
FLP83_10	LOK	DMDFON (161)	
FLP83_11	LOK	DMDFON (161)	
FLP83_12	LOK	DMDFON (161)	
FLRAR	AUS	ARMD (531)	
FLURKH	LOK	DMDLU (193)	
FLUTS1	LOK	DMDLUA (202)	
FLUTS10	LOK	DMDLUA (202)	
FLUTS11	LOK	DMDLUA (202)	
FLUTS12	LOK	DMDLUA (202)	
FLUTS2	LOK	DMDLUA (202)	
FLUTS3	LOK	DMDLUA (202)	
FLUTS4	LOK	DMDLUA (202)	
FLUTS5	LOK	DMDLUA (202)	
FLUTS6	LOK	DMDLUA (202)	
FLUTS7	LOK	DMDLUA (202)	
FLUTS8	LOK	DMDLUA (202)	
FLUTS9	LOK	DMDLUA (202)	
FLUTS_M	LOK	DMDLUA (202)	
FLUTS_M2	LOK	DMDLUA (202)	
FMDKH	AUS	BBKHZ (890)	KHMD (894), ZWMIN (669), AK (855)
FMFKRAKT	LOK	GGKS (412)	
FMFKRAKTOL	LOK	GGKS (412)	
FMFW	LOK	GGKS (412)	
FMKHFHO_W	LOK	KHMD (894)	
FMKHTM	LOK	KHMD (894)	
FNGWRTE	LOK	TEB (826)	
FNS	AUS	ESVST (677)	
FNSTAB_W	AUS	MDNSTAB (556)	MDMIN (538)
FNSWLST_W	AUS	ESNSWL (691)	
FNSWL_W	AUS	ESNSWL (691)	GK (675)
FNS_W	AUS	ESNSWL (691)	
FNWUE	AUS	NWS (618)	BGSRM (245), ZWGRU (634), MDBAS (529)
FOSTAT	AUS	DMDFON (161)	DMDDLU (199), DMDLU (193)
FPAG	DOK	BGAGR (263)	
FPBRKDS_W	AUS	BGSRM (245)	BGRLP (266), FUEDK (597)
FPRSTEP_C	AUS	BGDVE (934)	DDVE (950)
FPRTIM_C	LOK	BGDVE (934)	
FPUK	LOK	GGHFM (230)	
FPVDK	AUS	BGMSZS (239)	SWADAP (47), EGFE (228)
FPVDKDS	AUS	BGPU (276)	GGDVE (477)
FPVDKDSS_W	LOK	BGPU (276)	
FPVDKDS_W	AUS	BGPU (276)	BGMSZS (239), EGFE (228)
FPVDKMS_W	LOK	BGPU (276)	
FPVDK_W	AUS	BGMSZS (239)	EGFE (228), BGRML (287)
FR	LOK	GKRA (766)	
FR2_U	AUS	DFFTCNV (1143)	DFFT (1140)
FR2_W	AUS	GKRA (766)	LR (768), DFFTCNV (1143), TC1MOD (1100), TC2MOD (1107), LREB (739), GK (675), DKAT (361)
FRA	LOK	GKRA (766)	
FRA2_U	AUS	DFFTCNV (1143)	DFFT (1140)
FRA2_W	AUS	GKRA (766)	LRA (797), DFFTCNV (1143), GK (675), TC2MOD (1107), TC1MOD (1100)
FRAO2_W	AUS	LRA (797)	DKVS (811), GKRA (766)
FRAO_W	AUS	LRA (797)	DKVS (811), GKRA (766)
FRAT2_W	LOK	LRA (797)	
FRATI2_W	LOK	LRA (797)	
FRATI_W	LOK	LRA (797)	
FRAT_W	LOK	LRA (797)	
FRAU2_W	AUS	LRA (797)	DKVS (811), GKRA (766)
FRAUZS2_W	LOK	DKVS (811)	

Symbol	Type	Created within	Used within
FRAUZS_W	LOK	DKVS (811)	
FRAU_W	AUS	LRA (797)	DKVS (811), GKRA (766)
FRA_U	AUS	DFFTCNV (1143)	DFFT (1140)
FRA_W	AUS	GKRA (766)	LRA (797), DFFTCNV (1143), GK (675), TC1MOD (1100), TC2MOD (1107)
FRBAND2_W	LOK	LR (768)	
FRBAND_W	LOK	LR (768)	
FRDTER_W	AUS	DTEV (856)	LRINI (749), GKRA (766)
FREGFTE	LOK	TEB (826)	
FRHODKR_W	LOK	FUEDK (597)	
FRHODK_W	AUS	BGMSZS (239)	EGFE (228), BGRLP (266), FUEDK (597)
FRHOL_W	AUS	BGPU (276)	EGFE (228)
FRI	LOK	LR (768)	
FRI2	LOK	LR (768)	
FRIBAND2_W	LOK	LR (768)	
FRIBAND_W	LOK	LR (768)	
FRIINT	LOK	LR (768)	
FRIINT2	LOK	LR (768)	
FRINI2_W	AUS	LRINI (749)	LR (768)
FRINI_W	AUS	LRINI (749)	LR (768), GKRA (766)
FRINT2_W	LOK	LR (768)	
FRINT_W	LOK	LR (768)	
FRKTE	EIN		RKTI (979), AES (973)
FRM	EIN		AK (855)
FRM2_W	AUS	LR (768)	DKVS (811), DLSAHK (339), TEB (826), LRA (797), GKRA (766)
FRMA_W	LOK	LR (768)	
FRMFDIF_W	LOK	DTEV (856)	
FRMFREF_W	LOK	DTEV (856)	
FRMI2_W	LOK	LR (768)	
FRMIT	AUS	TEB (826)	
FRMITF_W	LOK	DTEV (856)	
FRMIT_W	AUS	TEB (826)	DTEV (856)
FRMI_W	LOK	LR (768)	
FRMMA_W	LOK	LR (768)	
FRMN2_W	AUS	LR (768)	
FRMN_W	AUS	LR (768)	DTEV (856)
FRMSL_W	LOK	LR (768)	
FRMTRIP2_W	LOK	DLSAHK (339)	
FRMTRIP_W	LOK	DLSAHK (339)	
FRMX2_W	AUS	LR (768)	
FRMXA	LOK	TEB (826)	
FRMXAF_W	LOK	DTEV (856)	
FRMXA_W	AUS	TEB (826)	DTEV (856)
FRMX_W	AUS	LR (768)	DTEV (856)
FRM_W	AUS	LR (768)	DKVS (811), TEB (826), LRA (797), DLSAHK (339), GKRA (766)
FRP	LOK	LR (768)	
FRP2	LOK	LR (768)	
FRPINT	LOK	LR (768)	
FRPINT2	LOK	LR (768)	
FRSL_W	LOK	LR (768)	
FRSP2_W	LOK	LR (768)	
FRSP_W	LOK	LR (768)	
FRTV	LOK	LR (768)	
FRTV2	LOK	LR (768)	
FR_U	AUS	DFFTCNV (1143)	DFFT (1140)
FR_W	AUS	GKRA (766)	LR (768), DFFTCNV (1143), GK (675), LREB (739), TC2MOD (1107), TC1MOD (1100), DKAT (361)
FS11_02	LOK	DMDFON (161)	
FS11_03	LOK	DMDFON (161)	
FS11_04	LOK	DMDFON (161)	
FS11_05	LOK	DMDFON (161)	
FS11_06	LOK	DMDFON (161)	
FS11_07	LOK	DMDFON (161)	
FS11_08	LOK	DMDFON (161)	
FS11_09	LOK	DMDFON (161)	
FS11_10	LOK	DMDFON (161)	
FS11_11	LOK	DMDFON (161)	
FS11_12	LOK	DMDFON (161)	
FS12_02	LOK	DMDFON (161)	
FS12_03	LOK	DMDFON (161)	
FS12_04	LOK	DMDFON (161)	
FS12_05	LOK	DMDFON (161)	
FS12_06	LOK	DMDFON (161)	
FS12_07	LOK	DMDFON (161)	
FS12_08	LOK	DMDFON (161)	
FS12_09	LOK	DMDFON (161)	
FS12_10	LOK	DMDFON (161)	
FS12_11	LOK	DMDFON (161)	
FS12_12	LOK	DMDFON (161)	
FS13_02	LOK	DMDFON (161)	
FS13_03	LOK	DMDFON (161)	
FS13_04	LOK	DMDFON (161)	
FS13_05	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FS13_06	LOK	DMDFON (161)	
FS13_07	LOK	DMDFON (161)	
FS13_08	LOK	DMDFON (161)	
FS13_09	LOK	DMDFON (161)	
FS13_10	LOK	DMDFON (161)	
FS13_11	LOK	DMDFON (161)	
FS13_12	LOK	DMDFON (161)	
FS21_02	LOK	DMDFON (161)	
FS21_03	LOK	DMDFON (161)	
FS21_04	LOK	DMDFON (161)	
FS21_05	LOK	DMDFON (161)	
FS21_06	LOK	DMDFON (161)	
FS21_07	LOK	DMDFON (161)	
FS21_08	LOK	DMDFON (161)	
FS21_09	LOK	DMDFON (161)	
FS21_10	LOK	DMDFON (161)	
FS21_11	LOK	DMDFON (161)	
FS21_12	LOK	DMDFON (161)	
FS22_02	LOK	DMDFON (161)	
FS22_03	LOK	DMDFON (161)	
FS22_04	LOK	DMDFON (161)	
FS22_05	LOK	DMDFON (161)	
FS22_06	LOK	DMDFON (161)	
FS22_07	LOK	DMDFON (161)	
FS22_08	LOK	DMDFON (161)	
FS22_09	LOK	DMDFON (161)	
FS22_10	LOK	DMDFON (161)	
FS22_11	LOK	DMDFON (161)	
FS22_12	LOK	DMDFON (161)	
FS23_02	LOK	DMDFON (161)	
FS23_03	LOK	DMDFON (161)	
FS23_04	LOK	DMDFON (161)	
FS23_05	LOK	DMDFON (161)	
FS23_06	LOK	DMDFON (161)	
FS23_07	LOK	DMDFON (161)	
FS23_08	LOK	DMDFON (161)	
FS23_09	LOK	DMDFON (161)	
FS23_10	LOK	DMDFON (161)	
FS23_11	LOK	DMDFON (161)	
FS23_12	LOK	DMDFON (161)	
FS31_02	LOK	DMDFON (161)	
FS31_03	LOK	DMDFON (161)	
FS31_04	LOK	DMDFON (161)	
FS31_05	LOK	DMDFON (161)	
FS31_06	LOK	DMDFON (161)	
FS31_07	LOK	DMDFON (161)	
FS31_08	LOK	DMDFON (161)	
FS31_09	LOK	DMDFON (161)	
FS31_10	LOK	DMDFON (161)	
FS31_11	LOK	DMDFON (161)	
FS31_12	LOK	DMDFON (161)	
FS32_02	LOK	DMDFON (161)	
FS32_03	LOK	DMDFON (161)	
FS32_04	LOK	DMDFON (161)	
FS32_05	LOK	DMDFON (161)	
FS32_06	LOK	DMDFON (161)	
FS32_07	LOK	DMDFON (161)	
FS32_08	LOK	DMDFON (161)	
FS32_09	LOK	DMDFON (161)	
FS32_10	LOK	DMDFON (161)	
FS32_11	LOK	DMDFON (161)	
FS32_12	LOK	DMDFON (161)	
FS33_02	LOK	DMDFON (161)	
FS33_03	LOK	DMDFON (161)	
FS33_04	LOK	DMDFON (161)	
FS33_05	LOK	DMDFON (161)	
FS33_06	LOK	DMDFON (161)	
FS33_07	LOK	DMDFON (161)	
FS33_08	LOK	DMDFON (161)	
FS33_09	LOK	DMDFON (161)	
FS33_10	LOK	DMDFON (161)	
FS33_11	LOK	DMDFON (161)	
FS33_12	LOK	DMDFON (161)	
FS41_02	LOK	DMDFON (161)	
FS41_03	LOK	DMDFON (161)	
FS41_04	LOK	DMDFON (161)	
FS41_05	LOK	DMDFON (161)	
FS41_06	LOK	DMDFON (161)	
FS41_07	LOK	DMDFON (161)	
FS41_08	LOK	DMDFON (161)	
FS41_09	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FS41_10	LOK	DMDFON (161)	
FS41_11	LOK	DMDFON (161)	
FS41_12	LOK	DMDFON (161)	
FS42_02	LOK	DMDFON (161)	
FS42_03	LOK	DMDFON (161)	
FS42_04	LOK	DMDFON (161)	
FS42_05	LOK	DMDFON (161)	
FS42_06	LOK	DMDFON (161)	
FS42_07	LOK	DMDFON (161)	
FS42_08	LOK	DMDFON (161)	
FS42_09	LOK	DMDFON (161)	
FS42_10	LOK	DMDFON (161)	
FS42_11	LOK	DMDFON (161)	
FS42_12	LOK	DMDFON (161)	
FS43_02	LOK	DMDFON (161)	
FS43_03	LOK	DMDFON (161)	
FS43_04	LOK	DMDFON (161)	
FS43_05	LOK	DMDFON (161)	
FS43_06	LOK	DMDFON (161)	
FS43_07	LOK	DMDFON (161)	
FS43_08	LOK	DMDFON (161)	
FS43_09	LOK	DMDFON (161)	
FS43_10	LOK	DMDFON (161)	
FS43_11	LOK	DMDFON (161)	
FS43_12	LOK	DMDFON (161)	
FS51_02	LOK	DMDFON (161)	
FS51_03	LOK	DMDFON (161)	
FS51_04	LOK	DMDFON (161)	
FS51_05	LOK	DMDFON (161)	
FS51_06	LOK	DMDFON (161)	
FS51_07	LOK	DMDFON (161)	
FS51_08	LOK	DMDFON (161)	
FS51_09	LOK	DMDFON (161)	
FS51_10	LOK	DMDFON (161)	
FS51_11	LOK	DMDFON (161)	
FS51_12	LOK	DMDFON (161)	
FS52_02	LOK	DMDFON (161)	
FS52_03	LOK	DMDFON (161)	
FS52_04	LOK	DMDFON (161)	
FS52_05	LOK	DMDFON (161)	
FS52_06	LOK	DMDFON (161)	
FS52_07	LOK	DMDFON (161)	
FS52_08	LOK	DMDFON (161)	
FS52_09	LOK	DMDFON (161)	
FS52_10	LOK	DMDFON (161)	
FS52_11	LOK	DMDFON (161)	
FS52_12	LOK	DMDFON (161)	
FS53_02	LOK	DMDFON (161)	
FS53_03	LOK	DMDFON (161)	
FS53_04	LOK	DMDFON (161)	
FS53_05	LOK	DMDFON (161)	
FS53_06	LOK	DMDFON (161)	
FS53_07	LOK	DMDFON (161)	
FS53_08	LOK	DMDFON (161)	
FS53_09	LOK	DMDFON (161)	
FS53_10	LOK	DMDFON (161)	
FS53_11	LOK	DMDFON (161)	
FS53_12	LOK	DMDFON (161)	
FS61_02	LOK	DMDFON (161)	
FS61_03	LOK	DMDFON (161)	
FS61_04	LOK	DMDFON (161)	
FS61_05	LOK	DMDFON (161)	
FS61_06	LOK	DMDFON (161)	
FS61_07	LOK	DMDFON (161)	
FS61_08	LOK	DMDFON (161)	
FS61_09	LOK	DMDFON (161)	
FS61_10	LOK	DMDFON (161)	
FS61_11	LOK	DMDFON (161)	
FS61_12	LOK	DMDFON (161)	
FS62_02	LOK	DMDFON (161)	
FS62_03	LOK	DMDFON (161)	
FS62_04	LOK	DMDFON (161)	
FS62_05	LOK	DMDFON (161)	
FS62_06	LOK	DMDFON (161)	
FS62_07	LOK	DMDFON (161)	
FS62_08	LOK	DMDFON (161)	
FS62_09	LOK	DMDFON (161)	
FS62_10	LOK	DMDFON (161)	
FS62_11	LOK	DMDFON (161)	
FS62_12	LOK	DMDFON (161)	
FS63_02	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FS63_03	LOK	DMDFON (161)	
FS63_04	LOK	DMDFON (161)	
FS63_05	LOK	DMDFON (161)	
FS63_06	LOK	DMDFON (161)	
FS63_07	LOK	DMDFON (161)	
FS63_08	LOK	DMDFON (161)	
FS63_09	LOK	DMDFON (161)	
FS63_10	LOK	DMDFON (161)	
FS63_11	LOK	DMDFON (161)	
FS63_12	LOK	DMDFON (161)	
FS71_02	LOK	DMDFON (161)	
FS71_03	LOK	DMDFON (161)	
FS71_04	LOK	DMDFON (161)	
FS71_05	LOK	DMDFON (161)	
FS71_06	LOK	DMDFON (161)	
FS71_07	LOK	DMDFON (161)	
FS71_08	LOK	DMDFON (161)	
FS71_09	LOK	DMDFON (161)	
FS71_10	LOK	DMDFON (161)	
FS71_11	LOK	DMDFON (161)	
FS71_12	LOK	DMDFON (161)	
FS72_02	LOK	DMDFON (161)	
FS72_03	LOK	DMDFON (161)	
FS72_04	LOK	DMDFON (161)	
FS72_05	LOK	DMDFON (161)	
FS72_06	LOK	DMDFON (161)	
FS72_07	LOK	DMDFON (161)	
FS72_08	LOK	DMDFON (161)	
FS72_09	LOK	DMDFON (161)	
FS72_10	LOK	DMDFON (161)	
FS72_11	LOK	DMDFON (161)	
FS72_12	LOK	DMDFON (161)	
FS73_02	LOK	DMDFON (161)	
FS73_03	LOK	DMDFON (161)	
FS73_04	LOK	DMDFON (161)	
FS73_05	LOK	DMDFON (161)	
FS73_06	LOK	DMDFON (161)	
FS73_07	LOK	DMDFON (161)	
FS73_08	LOK	DMDFON (161)	
FS73_09	LOK	DMDFON (161)	
FS73_10	LOK	DMDFON (161)	
FS73_11	LOK	DMDFON (161)	
FS73_12	LOK	DMDFON (161)	
FS81_02	LOK	DMDFON (161)	
FS81_03	LOK	DMDFON (161)	
FS81_04	LOK	DMDFON (161)	
FS81_05	LOK	DMDFON (161)	
FS81_06	LOK	DMDFON (161)	
FS81_07	LOK	DMDFON (161)	
FS81_08	LOK	DMDFON (161)	
FS81_09	LOK	DMDFON (161)	
FS81_10	LOK	DMDFON (161)	
FS81_11	LOK	DMDFON (161)	
FS81_12	LOK	DMDFON (161)	
FS82_02	LOK	DMDFON (161)	
FS82_03	LOK	DMDFON (161)	
FS82_04	LOK	DMDFON (161)	
FS82_05	LOK	DMDFON (161)	
FS82_06	LOK	DMDFON (161)	
FS82_07	LOK	DMDFON (161)	
FS82_08	LOK	DMDFON (161)	
FS82_09	LOK	DMDFON (161)	
FS82_10	LOK	DMDFON (161)	
FS82_11	LOK	DMDFON (161)	
FS82_12	LOK	DMDFON (161)	
FS83_02	LOK	DMDFON (161)	
FS83_03	LOK	DMDFON (161)	
FS83_04	LOK	DMDFON (161)	
FS83_05	LOK	DMDFON (161)	
FS83_06	LOK	DMDFON (161)	
FS83_07	LOK	DMDFON (161)	
FS83_08	LOK	DMDFON (161)	
FS83_09	LOK	DMDFON (161)	
FS83_10	LOK	DMDFON (161)	
FS83_11	LOK	DMDFON (161)	
FS83_12	LOK	DMDFON (161)	
FSE	LOK	DMDFON (161)	
FSE11_02	LOK	DMDFON (161)	
FSE11_03	LOK	DMDFON (161)	
FSE11_04	LOK	DMDFON (161)	
FSE11_05	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FSE11_06	LOK	DMDFON (161)	
FSE11_07	LOK	DMDFON (161)	
FSE11_08	LOK	DMDFON (161)	
FSE11_09	LOK	DMDFON (161)	
FSE11_10	LOK	DMDFON (161)	
FSE11_11	LOK	DMDFON (161)	
FSE11_12	LOK	DMDFON (161)	
FSE12_02	LOK	DMDFON (161)	
FSE12_03	LOK	DMDFON (161)	
FSE12_04	LOK	DMDFON (161)	
FSE12_05	LOK	DMDFON (161)	
FSE12_06	LOK	DMDFON (161)	
FSE12_07	LOK	DMDFON (161)	
FSE12_08	LOK	DMDFON (161)	
FSE12_09	LOK	DMDFON (161)	
FSE12_10	LOK	DMDFON (161)	
FSE12_11	LOK	DMDFON (161)	
FSE12_12	LOK	DMDFON (161)	
FSE13_02	LOK	DMDFON (161)	
FSE13_03	LOK	DMDFON (161)	
FSE13_04	LOK	DMDFON (161)	
FSE13_05	LOK	DMDFON (161)	
FSE13_06	LOK	DMDFON (161)	
FSE13_07	LOK	DMDFON (161)	
FSE13_08	LOK	DMDFON (161)	
FSE13_09	LOK	DMDFON (161)	
FSE13_10	LOK	DMDFON (161)	
FSE13_11	LOK	DMDFON (161)	
FSE13_12	LOK	DMDFON (161)	
FSE21_02	LOK	DMDFON (161)	
FSE21_03	LOK	DMDFON (161)	
FSE21_04	LOK	DMDFON (161)	
FSE21_05	LOK	DMDFON (161)	
FSE21_06	LOK	DMDFON (161)	
FSE21_07	LOK	DMDFON (161)	
FSE21_08	LOK	DMDFON (161)	
FSE21_09	LOK	DMDFON (161)	
FSE21_10	LOK	DMDFON (161)	
FSE21_11	LOK	DMDFON (161)	
FSE21_12	LOK	DMDFON (161)	
FSE22_02	LOK	DMDFON (161)	
FSE22_03	LOK	DMDFON (161)	
FSE22_04	LOK	DMDFON (161)	
FSE22_05	LOK	DMDFON (161)	
FSE22_06	LOK	DMDFON (161)	
FSE22_07	LOK	DMDFON (161)	
FSE22_08	LOK	DMDFON (161)	
FSE22_09	LOK	DMDFON (161)	
FSE22_10	LOK	DMDFON (161)	
FSE22_11	LOK	DMDFON (161)	
FSE22_12	LOK	DMDFON (161)	
FSE23_02	LOK	DMDFON (161)	
FSE23_03	LOK	DMDFON (161)	
FSE23_04	LOK	DMDFON (161)	
FSE23_05	LOK	DMDFON (161)	
FSE23_06	LOK	DMDFON (161)	
FSE23_07	LOK	DMDFON (161)	
FSE23_08	LOK	DMDFON (161)	
FSE23_09	LOK	DMDFON (161)	
FSE23_10	LOK	DMDFON (161)	
FSE23_11	LOK	DMDFON (161)	
FSE23_12	LOK	DMDFON (161)	
FSE31_02	LOK	DMDFON (161)	
FSE31_03	LOK	DMDFON (161)	
FSE31_04	LOK	DMDFON (161)	
FSE31_05	LOK	DMDFON (161)	
FSE31_06	LOK	DMDFON (161)	
FSE31_07	LOK	DMDFON (161)	
FSE31_08	LOK	DMDFON (161)	
FSE31_09	LOK	DMDFON (161)	
FSE31_10	LOK	DMDFON (161)	
FSE31_11	LOK	DMDFON (161)	
FSE31_12	LOK	DMDFON (161)	
FSE32_02	LOK	DMDFON (161)	
FSE32_03	LOK	DMDFON (161)	
FSE32_04	LOK	DMDFON (161)	
FSE32_05	LOK	DMDFON (161)	
FSE32_06	LOK	DMDFON (161)	
FSE32_07	LOK	DMDFON (161)	
FSE32_08	LOK	DMDFON (161)	
FSE32_09	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FSE32_10	LOK	DMDFON (161)	
FSE32_11	LOK	DMDFON (161)	
FSE32_12	LOK	DMDFON (161)	
FSE33_02	LOK	DMDFON (161)	
FSE33_03	LOK	DMDFON (161)	
FSE33_04	LOK	DMDFON (161)	
FSE33_05	LOK	DMDFON (161)	
FSE33_06	LOK	DMDFON (161)	
FSE33_07	LOK	DMDFON (161)	
FSE33_08	LOK	DMDFON (161)	
FSE33_09	LOK	DMDFON (161)	
FSE33_10	LOK	DMDFON (161)	
FSE33_11	LOK	DMDFON (161)	
FSE33_12	LOK	DMDFON (161)	
FSE41_02	LOK	DMDFON (161)	
FSE41_03	LOK	DMDFON (161)	
FSE41_04	LOK	DMDFON (161)	
FSE41_05	LOK	DMDFON (161)	
FSE41_06	LOK	DMDFON (161)	
FSE41_07	LOK	DMDFON (161)	
FSE41_08	LOK	DMDFON (161)	
FSE41_09	LOK	DMDFON (161)	
FSE41_10	LOK	DMDFON (161)	
FSE41_11	LOK	DMDFON (161)	
FSE41_12	LOK	DMDFON (161)	
FSE42_02	LOK	DMDFON (161)	
FSE42_03	LOK	DMDFON (161)	
FSE42_04	LOK	DMDFON (161)	
FSE42_05	LOK	DMDFON (161)	
FSE42_06	LOK	DMDFON (161)	
FSE42_07	LOK	DMDFON (161)	
FSE42_08	LOK	DMDFON (161)	
FSE42_09	LOK	DMDFON (161)	
FSE42_10	LOK	DMDFON (161)	
FSE42_11	LOK	DMDFON (161)	
FSE42_12	LOK	DMDFON (161)	
FSE43_02	LOK	DMDFON (161)	
FSE43_03	LOK	DMDFON (161)	
FSE43_04	LOK	DMDFON (161)	
FSE43_05	LOK	DMDFON (161)	
FSE43_06	LOK	DMDFON (161)	
FSE43_07	LOK	DMDFON (161)	
FSE43_08	LOK	DMDFON (161)	
FSE43_09	LOK	DMDFON (161)	
FSE43_10	LOK	DMDFON (161)	
FSE43_11	LOK	DMDFON (161)	
FSE43_12	LOK	DMDFON (161)	
FSE51_02	LOK	DMDFON (161)	
FSE51_03	LOK	DMDFON (161)	
FSE51_04	LOK	DMDFON (161)	
FSE51_05	LOK	DMDFON (161)	
FSE51_06	LOK	DMDFON (161)	
FSE51_07	LOK	DMDFON (161)	
FSE51_08	LOK	DMDFON (161)	
FSE51_09	LOK	DMDFON (161)	
FSE51_10	LOK	DMDFON (161)	
FSE51_11	LOK	DMDFON (161)	
FSE51_12	LOK	DMDFON (161)	
FSE52_02	LOK	DMDFON (161)	
FSE52_03	LOK	DMDFON (161)	
FSE52_04	LOK	DMDFON (161)	
FSE52_05	LOK	DMDFON (161)	
FSE52_06	LOK	DMDFON (161)	
FSE52_07	LOK	DMDFON (161)	
FSE52_08	LOK	DMDFON (161)	
FSE52_09	LOK	DMDFON (161)	
FSE52_10	LOK	DMDFON (161)	
FSE52_11	LOK	DMDFON (161)	
FSE52_12	LOK	DMDFON (161)	
FSE53_02	LOK	DMDFON (161)	
FSE53_03	LOK	DMDFON (161)	
FSE53_04	LOK	DMDFON (161)	
FSE53_05	LOK	DMDFON (161)	
FSE53_06	LOK	DMDFON (161)	
FSE53_07	LOK	DMDFON (161)	
FSE53_08	LOK	DMDFON (161)	
FSE53_09	LOK	DMDFON (161)	
FSE53_10	LOK	DMDFON (161)	
FSE53_11	LOK	DMDFON (161)	
FSE53_12	LOK	DMDFON (161)	
FSE61_02	LOK	DMDFON (161)	

Symbol	**Type**	**Created within**	**Used within**
FSE61_03	LOK	DMDFON (161)	
FSE61_04	LOK	DMDFON (161)	
FSE61_05	LOK	DMDFON (161)	
FSE61_06	LOK	DMDFON (161)	
FSE61_07	LOK	DMDFON (161)	
FSE61_08	LOK	DMDFON (161)	
FSE61_09	LOK	DMDFON (161)	
FSE61_10	LOK	DMDFON (161)	
FSE61_11	LOK	DMDFON (161)	
FSE61_12	LOK	DMDFON (161)	
FSE62_02	LOK	DMDFON (161)	
FSE62_03	LOK	DMDFON (161)	
FSE62_04	LOK	DMDFON (161)	
FSE62_05	LOK	DMDFON (161)	
FSE62_06	LOK	DMDFON (161)	
FSE62_07	LOK	DMDFON (161)	
FSE62_08	LOK	DMDFON (161)	
FSE62_09	LOK	DMDFON (161)	
FSE62_10	LOK	DMDFON (161)	
FSE62_11	LOK	DMDFON (161)	
FSE62_12	LOK	DMDFON (161)	
FSE63_02	LOK	DMDFON (161)	
FSE63_03	LOK	DMDFON (161)	
FSE63_04	LOK	DMDFON (161)	
FSE63_05	LOK	DMDFON (161)	
FSE63_06	LOK	DMDFON (161)	
FSE63_07	LOK	DMDFON (161)	
FSE63_08	LOK	DMDFON (161)	
FSE63_09	LOK	DMDFON (161)	
FSE63_10	LOK	DMDFON (161)	
FSE63_11	LOK	DMDFON (161)	
FSE63_12	LOK	DMDFON (161)	
FSE71_02	LOK	DMDFON (161)	
FSE71_03	LOK	DMDFON (161)	
FSE71_04	LOK	DMDFON (161)	
FSE71_05	LOK	DMDFON (161)	
FSE71_06	LOK	DMDFON (161)	
FSE71_07	LOK	DMDFON (161)	
FSE71_08	LOK	DMDFON (161)	
FSE71_09	LOK	DMDFON (161)	
FSE71_10	LOK	DMDFON (161)	
FSE71_11	LOK	DMDFON (161)	
FSE71_12	LOK	DMDFON (161)	
FSE72_02	LOK	DMDFON (161)	
FSE72_03	LOK	DMDFON (161)	
FSE72_04	LOK	DMDFON (161)	
FSE72_05	LOK	DMDFON (161)	
FSE72_06	LOK	DMDFON (161)	
FSE72_07	LOK	DMDFON (161)	
FSE72_08	LOK	DMDFON (161)	
FSE72_09	LOK	DMDFON (161)	
FSE72_10	LOK	DMDFON (161)	
FSE72_11	LOK	DMDFON (161)	
FSE72_12	LOK	DMDFON (161)	
FSE73_02	LOK	DMDFON (161)	
FSE73_03	LOK	DMDFON (161)	
FSE73_04	LOK	DMDFON (161)	
FSE73_05	LOK	DMDFON (161)	
FSE73_06	LOK	DMDFON (161)	
FSE73_07	LOK	DMDFON (161)	
FSE73_08	LOK	DMDFON (161)	
FSE73_09	LOK	DMDFON (161)	
FSE73_10	LOK	DMDFON (161)	
FSE73_11	LOK	DMDFON (161)	
FSE73_12	LOK	DMDFON (161)	
FSE81_02	LOK	DMDFON (161)	
FSE81_03	LOK	DMDFON (161)	
FSE81_04	LOK	DMDFON (161)	
FSE81_05	LOK	DMDFON (161)	
FSE81_06	LOK	DMDFON (161)	
FSE81_07	LOK	DMDFON (161)	
FSE81_08	LOK	DMDFON (161)	
FSE81_09	LOK	DMDFON (161)	
FSE81_10	LOK	DMDFON (161)	
FSE81_11	LOK	DMDFON (161)	
FSE81_12	LOK	DMDFON (161)	
FSE82_02	LOK	DMDFON (161)	
FSE82_03	LOK	DMDFON (161)	
FSE82_04	LOK	DMDFON (161)	
FSE82_05	LOK	DMDFON (161)	
FSE82_06	LOK	DMDFON (161)	

Symbol	Type	Created within	Used within
FSE82_07	LOK	DMDFON (161)	
FSE82_08	LOK	DMDFON (161)	
FSE82_09	LOK	DMDFON (161)	
FSE82_10	LOK	DMDFON (161)	
FSE82_11	LOK	DMDFON (161)	
FSE82_12	LOK	DMDFON (161)	
FSE83_02	LOK	DMDFON (161)	
FSE83_03	LOK	DMDFON (161)	
FSE83_04	LOK	DMDFON (161)	
FSE83_05	LOK	DMDFON (161)	
FSE83_06	LOK	DMDFON (161)	
FSE83_07	LOK	DMDFON (161)	
FSE83_08	LOK	DMDFON (161)	
FSE83_09	LOK	DMDFON (161)	
FSE83_10	LOK	DMDFON (161)	
FSE83_11	LOK	DMDFON (161)	
FSE83_12	LOK	DMDFON (161)	
FSLPDYN	EIN		LAKH (735)
FSP_CL	EIN		DCINS (1126)
FST0_W	LOK	ESSTT (679)	
FST_W	AUS	ESSTT (679)	ESVST (677), GK (675)
FSWARES	LOK	DSWEC (32)	
FTADMSTE	LOK	TEB (826)	
FTBR	AUS	BGTEMPK (252)	EGFE (228)
FTBR_W	AUS	BGTEMPK (252)	BGSRM (245), EGFE (228)
FTEADF	AUS	TEB (826)	
FTEADF_W	LOK	TEB (826)	
FTEAD_W	AUS	TEB (826)	BBTEGA (750), DTEV (856)
FTEFSOLD_W	LOK	TEB (826)	
FTEFSOLL_W	EIN		DTEV (856), TEB (826)
FTEFVA	LOK	TEB (826)	
FTEFVAB	LOK	TEB (826)	
FTEFVAMX_W	LOK	TEB (826)	
FTEFVA_W	AUS	TEB (826)	
FTEML	AUS	TEB (826)	
FTHOZS_W	LOK	DTEV (856)	
FTHO_W	LOK	BGTEV (257)	
FTKLRA_W	LOK	LRA (797)	
FTSR	AUS	BGTEMPK (252)	BGSRM (245), EGFE (228)
FTU	AUS	BGTEMPK (252)	BGPU (276), EGFE (228)
FTV	LOK	LRHK (781)	
FTV2	LOK	LRHK (781)	
FTVDK	AUS	BGTEMPK (252)	SWADAP (47), BGMSZS (239), BGTEV (257), BGPU (276), MDMAX (514), GGDVE (477), FUEDK (597), DTEV (856), EGFE (228)
FTW	LOK	BGTEMPK (252)	
FUBAANZ	AUS	ZUESZ (632)	
FUEPMLD_W	LOK	FUEDK (597)	
FUKABAK_W	LOK	ESUKA (711)	
FUKABAW_W	LOK	ESUKA (711)	
FUKABA_W	AUS	ESUKA (711)	ESUK (699)
FUKAVA	EIN		ESUK (699)
FUKAVAK_W	LOK	ESUKA (711)	
FUKAVAW_W	LOK	ESUKA (711)	
FUKAVA_W	AUS	ESUKA (711)	
FUPSRL_W	AUS	BGSRM (245)	EGFE (228), BGRLP (266), FUEDK (597)
FVAKL_W	AUS	ESUK (699)	
FVANS	LOK	ESUK (699)	
FVAVST_W	LOK	ESUK (699)	
FVERMTE_W	LOK	TEB (826)	
FVISRM_W	AUS	BGSRM (245)	BGAGR (263), BGRLP (266), EGFE (228)
FVST_W	LOK	GK (675)	
FWE	AUS	ESVST (677)	ESWE (698), GK (675), LRKA (795)
FWEG	AUS	ACIFI (1013)	
FWEZ0	AUS	ACIFI (1013)	
FWL	AUS	ESNSWL (691)	ESVST (677)
FWLRL	LOK	ESNSWL (691)	
FWMLHFM	AUS	DHFM (233)	
FWPRS_W	LOK	BGRLP (266)	
FZABGS	EIN		DMDFON (161)
FZABGS_W	LOK	DMDMIL (216)	
FZABG_W_0	LOK	DMDMIL (216)	
FZABG_W_1	LOK	DMDMIL (216)	
FZABG_W_10	LOK	DMDMIL (216)	
FZABG_W_11	LOK	DMDMIL (216)	
FZABG_W_2	LOK	DMDMIL (216)	
FZABG_W_3	LOK	DMDMIL (216)	
FZABG_W_4	LOK	DMDMIL (216)	
FZABG_W_5	LOK	DMDMIL (216)	
FZABG_W_6	LOK	DMDMIL (216)	
FZABG_W_7	LOK	DMDMIL (216)	
FZABG_W_8	LOK	DMDMIL (216)	
FZABG_W_9	LOK	DMDMIL (216)	

Symbol	Type	Created within	Used within
FZANS1	LOK	ESNSWL (691)	
FZARV_W	LOK	DMDMIL (216)	
FZDASH	LOK	MDFAW (508)	
FZKATS1_W	LOK	DMDMIL (216)	
FZKATS2_W	LOK	DMDMIL (216)	
FZKATS_W	LOK	DMDMIL (216)	
FZKAT_W_0	LOK	DMDMIL (216)	
FZKAT_W_1	LOK	DMDMIL (216)	
FZKAT_W_10	LOK	DMDMIL (216)	
FZKAT_W_11	LOK	DMDMIL (216)	
FZKAT_W_2	LOK	DMDMIL (216)	
FZKAT_W_3	LOK	DMDMIL (216)	
FZKAT_W_4	LOK	DMDMIL (216)	
FZKAT_W_5	LOK	DMDMIL (216)	
FZKAT_W_6	LOK	DMDMIL (216)	
FZKAT_W_7	LOK	DMDMIL (216)	
FZKAT_W_8	LOK	DMDMIL (216)	
FZKAT_W_9	LOK	DMDMIL (216)	
FZWMN_W	LOK	ZWMIN (669)	
GANGAUTI	EIN		BBGANG (501)
GANGI	AUS	BBGANG (501)	SWADAP (47), ARMD (531), BBSAWE (557), FGRUE (490), KOS (896), LLRBB (575), KRDY (659), ZWMIN (669), MDWAN (554), MDMIN (538), MDFAW (508), MDBGRG (530), FGRABED (491), EGAG (486)
GANG_I	AUS	EGAG (486)	
GANG_KUP	AUS	CAN (1124)	BBGANG (501)
GAPTOOTH	AUS	GGDPG (74)	ALE (136), WANWKW (125), RDE (112)
GKLFNSSM	LOK	ESNSWL (691)	
GRUNDWERT	EIN		BGRLP (266), GGKS (412)
HAGR	AUS	EGAG (486)	BGAGR (263), EGFE (228)
I	LOK	KRDY (659)	
IASP1PLAUS	EIN		URADCC (1049)
IAVKATF	DOK	LRHK (781)	
IDLASHKM_W	DOK	LRHK (781)	
IDXFOB	LOK	DMDFON (161)	
IDXFON	LOK	DMDFON (161)	
IDXFORL	LOK	DMDFON (161)	
IGOD_W	AUS	GGKS (412)	DKRNT (445)
IGOKR_W	AUS	GGKS (412)	EGKE (409)
IKR	AUS	GGKS (412)	KRKE (427), EGKE (409)
IKRMA	EIN		DKRNT (445), DKRTP (451), KRKE (427), EGKE (409), GGKS (412)
IKRME	EIN		KRKE (427), EGKE (409), GGKS (412)
IKRMEN	AUS	GGKS (412)	
IKRMET	EIN		DKRTP (451), EGKE (409), GGKS (412)
IKR_TST	LOK	GGKS (412)	
ILMLKA2_W	LOK	LRKA (795)	
ILMLKAH2_W	LOK	LRKA (795)	
ILMLKAH_W	LOK	LRKA (795)	
ILMLKAM_W	LOK	LRKA (795)	
ILMLKAT2_W	AUS	LRKA (795)	
ILMLKAT_W	AUS	LRKA (795)	
ILMLKAV2_W	LOK	LRKA (795)	
ILMLKAV_W	LOK	LRKA (795)	
ILMLKAX2_W	LOK	LRKA (795)	
ILMLKAX_W	LOK	LRKA (795)	
ILMLKA_W	LOK	LRKA (795)	
IMLATM	AUS	ATM (20)	AK (855), ESSTT (679), BGTABST (1030)
IMLATM_W	AUS	ATM (20)	BBKHZ (890)
IMLBBO	AUS	BBBO (853)	
IMLKA2_W	LOK	LRKA (795)	
IMLKAV2_W	LOK	LRKA (795)	
IMLKAV_W	LOK	LRKA (795)	
IMLKAX2_W	LOK	LRKA (795)	
IMLKAX_W	LOK	LRKA (795)	
IMLKA_W	LOK	LRKA (795)	
IMLKVSZS_W	LOK	DKVS (811)	
IMLKVS_W	LOK	DKVS (811)	
IMLPR	AUS	BBKHZ (890)	AK (855)
IMLPR_W	AUS	BBKHZ (890)	
IMLRSA_W	LOK	LREB (739)	
IMSTEINI	EIN		DTEV (856), TEB (826)
INGAS	LOK	BGNG (121)	
IOKKR	AUS	GGKS (412)	
IPA_C_UM	LOK	UFRLC (1066)	
IPLSUVJ2_W	EIN		TC1MOD (1100)
IPLSUVJ_W	EIN		TC1MOD (1100)
IPSN_UM	LOK	UFRLC (1066)	
IRSPSYN	AUS	BGNG (121)	BGRLG (274)
IUIPOTI1	EIN		UFRLC (1066), UFUE (1056)
IUIPOTI2	EIN		UFRLC (1066), UFUE (1056)
IUSPOTI1	EIN		UFSPSC (1060), UFUE (1056), URADCC (1049)
IUSPOTI2	EIN		UFSPSC (1060), UFUE (1056)
IVER	LOK	LLRRM (566)	

Symbol	Type	Created within	Used within
IVMAX	LOK	VMAXMD (588)	
IVZABG_W	LOK	DMDMIL (216)	
IVZAINT_W	LOK	DMDMIL (216)	
IVZARV_W	LOK	DMDMIL (216)	
IVZKAT_W	LOK	DMDMIL (216)	
IWFLSD_W	LOK	MDFAW (508)	
IWMATM2_W	AUS	ATM (20)	
IWMATM_W	AUS	ATM (20)	
KAKBMT	LOK	DKAT (361)	
KAKBMT2	LOK	DKAT (361)	
KATBF	LOK	DKAT (361)	
KATBF2	LOK	DKAT (361)	
KATBFI2_W	LOK	DKAT (361)	
KATBFI_W	LOK	DKAT (361)	
KATBFS	LOK	DKAT (361)	
KATBFS2	LOK	DKAT (361)	
KATBFTP	LOK	DKAT (361)	
KATBFTP2	LOK	DKAT (361)	
KATBSHD2_W	LOK	DKAT (361)	
KATBSHD_W	LOK	DKAT (361)	
KBDKT2_W	LOK	DKAT (361)	
KBDKT_W	LOK	DKAT (361)	
KE0W	LOK	KRKE (427)	
KE1W	LOK	KRKE (427)	
KE2W	LOK	KRKE (427)	
KE3W	LOK	KRKE (427)	
KE4W	LOK	KRKE (427)	
KE5W	LOK	KRKE (427)	
KE6W	LOK	KRKE (427)	
KE7W	LOK	KRKE (427)	
KEK	AUS	EGKE (409)	KRKE (427), KRDY (659)
KEK_TST	AUS	KRKE (427)	
KFBS2_W	LOK	GK (675)	
KFBS_W	LOK	GK (675)	
KFGR_W	LOK	FGRREGL (1174)	
KFKFWWNS	LOK	ESNSWL (691)	
KFMDSZAS_W	LOK	MDVER (546)	
KFMDS_W	LOK	MDVER (546)	
KHC_W	LOK	TEB (826)	
KIFZ_W	AUS	ARMD (531)	
KINMX	LOK	NMAXMD (584)	
KLDFPWM	EIN		DTEV (856), LLRNS (562), MDVERB (540)
KL_TWSTT_W	LOK	ESSTT (679)	
KMST100M_W	AUS	BGBSZ (73)	
KMST6553_W	AUS	BGBSZ (73)	
KMSTMIL_W	AUS	BGKMST (1008)	TC1MOD (1100)
KMST_L	AUS	BGBSZ (73)	
KMST_W	AUS	BGKMST (1008)	
KRAL1W	LOK	KRRA (639)	
KRAL2W	LOK	KRRA (639)	
KRAL3W	LOK	KRRA (639)	
KRDWSW	LOK	KRRA (639)	
KRFKW	LOK	KRRA (639)	
KRFTPAKT	AUS	KRKE (427)	GGKS (412)
KRLZN	LOK	KRRA (639)	
KRMXW	LOK	KRRA (639)	
KRVFSW	LOK	KRRA (639)	
KRVFW	LOK	KRRA (639)	
KSTA0	LOK	STADAP (684)	
KSTA0W	LOK	STADAP (684)	
KSTA1	LOK	STADAP (684)	
KSTA1W	LOK	STADAP (684)	
KSTA2	LOK	STADAP (684)	
KSTA2W	LOK	STADAP (684)	
KSTAA	AUS	STADAP (684)	ESSTT (679), ESVST (677)
KSWF	LOK	DMDMIL (216)	
KS_SYM	AUS	GGKS (412)	
KTEEV_W	LOK	TEB (826)	
KTETEVVZ_W	LOK	TEB (826)	
KTETEV_W	LOK	TEB (826)	
KVB_W	AUS	BGKV (71)	
LAHKMZ	LOK	LRHK (781)	
LAHKMZ2	LOK	LRHK (781)	
LALSUVJ2_W	EIN		TC1MOD (1100)
LALSUVJ_W	EIN		TC1MOD (1100)
LAMBAS	AUS	LAMKO (729)	MSF (506), SWADAP (47), MDBAS (529), ZWGRU (634)
LAMBAS_W	AUS	SWADAP (47)	
LAMBTS_W	AUS	LAMBTS (732)	LAMKO (729), LAMSOLL (726)
LAMELSH2_W	AUS	DLSH (330)	LAMKO (729), LAMSOLL (726)
LAMELSH_W	AUS	DLSH (330)	LAMKO (729), LAMSOLL (726)
LAMFA_W	AUS	LAMFAW (728)	LAMKO (729), LAMSOLL (726)
LAMFRM2_W	LOK	DLSAHK (339)	

Symbol	Type	Created within	Used within
LAMFRM_W	LOK	DLSAHK (339)	
LAMHF2_W	LOK	LRHK (781)	
LAMHF_W	LOK	LRHK (781)	
LAMHM2_W	LOK	LRHK (781)	
LAMHM_W	LOK	LRHK (781)	
LAMKA2_W	AUS	LRKA (795)	LAMKO (729), LAMSOLL (726)
LAMKAI2_W	LOK	LRKA (795)	
LAMKAII2_W	LOK	LRKA (795)	
LAMKAII_W	LOK	LRKA (795)	
LAMKAI_W	LOK	LRKA (795)	
LAMKA_W	AUS	LRKA (795)	LAMKO (729), LAMSOLL (726)
LAMKH	LOK	AK (855)	
LAMKH2_W	AUS	LAKH (735)	LAMKO (729), LAMSOLL (726)
LAMKHE2_W	LOK	LAMKO (729)	
LAMKHE_W	LOK	LAMKO (729)	
LAMKHR2_W	LOK	LAKH (735)	
LAMKHR_W	LOK	LAKH (735)	
LAMKH_W	AUS	LAKH (735)	MSF (506), LAMKO (729), LAMSOLL (726)
LAMLASH2_W	AUS	DLSAHK (339)	LAMKO (729), LAMSOLL (726)
LAMLASH_W	AUS	DLSAHK (339)	LAMKO (729), LAMSOLL (726)
LAMLGM	LOK	LAMKO (729)	
LAMNSWL_W	AUS	ESVST (677)	LAMKO (729), LAMSOLL (726)
LAMNS_W	AUS	ESVST (677)	GK (675)
LAMS2_W	LOK	LAMKO (729)	
LAMSBG	AUS	AK (855)	
LAMSBG2_W	AUS	LAMKO (729)	LAMSOLL (726), ATM (20), GK (675)
LAMSBG_W	AUS	LAMKO (729)	LAMSOLL (726), ATM (20), GK (675)
LAMSISA	AUS	DLSSA (350)	
LAMSISA2	AUS	DLSSA (350)	
LAMSNKA2_W	LOK	LRKA (795)	
LAMSNKA_W	LOK	LRKA (795)	
LAMSOLH2_W	AUS	LRHK (781)	
LAMSOLH_W	AUS	LRHK (781)	
LAMSONH2_W	AUS	LRHK (781)	
LAMSONH_W	AUS	LRHK (781)	
LAMSONI2_W	EIN		DLSSA (350)
LAMSONI_W	EIN		DLSSA (350)
LAMSONS	AUS	AK (855)	
LAMSONS2_W	AUS	LAMKO (729)	LAMSOLL (726), DLSH (330), LRKA (795), LREB (739), GKRA (766), GKEB (737), DLSV (301), DLSSA (350)
LAMSONS_W	AUS	LAMKO (729)	LAMSOLL (726), DLSH (330), GKRA (766), GKEB (737), TEBEB (762), LRKA (795), LREB (739), LRAEB (759), DLSV (301), DLSSA (350)
LAMSOS2_W	LOK	LAMKO (729)	
LAMSOSA	AUS	DLSSA (350)	
LAMSOSA2	AUS	DLSSA (350)	
LAMSOS_W	LOK	LAMKO (729)	
LAMSUBG2_W	LOK	LAMKO (729)	
LAMSUBG_W	LOK	LAMKO (729)	
LAMS_W	LOK	LAMKO (729)	
LAMVOA2_W	AUS	LAMKO (729)	LAMSOLL (726)
LAMVOA_W	AUS	LAMKO (729)	LAMSOLL (726)
LASDSL_W	LOK	LAKH (735)	
LASKH_W	LOK	LAKH (735)	
LBZ	AUS	BGLBZ (489)	SWADAP (47), EGAG (486), LLRNS (562)
LDITV_W	EIN		FUEDK (597)
LDTVM	AUS	FE (591)	
LEN_HISEG	LOK	GGDPG (74)	
LEN_LOSEG	LOK	GGDPG (74)	
LIMAX_W	EIN		DLLR (578), LLRRM (566)
LIMIN_W	EIN		DLLR (578), LLRRM (566)
LIMNST	LOK	LLRRM (566)	
LKRNEW	LOK	KRDY (659)	
LKROLD	LOK	KRDY (659)	
LKRW	LOK	KRRA (639)	
LMSKH_W	LOK	LAKH (735)	
LMSSL2_W	LOK	LAKH (735)	
LMSSL_W	LOK	LAKH (735)	
LRFRMZ	LOK	LR (768)	
LRFRMZ2	LOK	LR (768)	
LRFRZ	LOK	LR (768)	
LRFRZ2	LOK	LR (768)	
LRKAZ	LOK	LRKA (795)	
LRKAZ2	LOK	LRKA (795)	
LRNSTAT	AUS	BGDVE (934)	
LRNSTEP_C	AUS	BGDVE (934)	DDVE (950)
LRNTIM_C	LOK	BGDVE (934)	
LRNVB_C	LOK	BGDVE (934)	
LSADKT	LOK	DKAT (361)	
LUAR	DOK	DMDLUA (202)	
LUARMN	LOK	DMDLUA (202)	
LUAROFF	LOK	DMDLUA (202)	
LUAR_M	LOK	DMDLUA (202)	

Symbol	Type	Created within	Used within
LUAR_M2	LOK	DMDLUA (202)	
LUMS	DOK	DMDLU (193)	
LUMS_M	LOK	DMDLU (193)	
LUMS_M2	LOK	DMDLU (193)	
LUNW	LOK	DMDFON (161)	
LURMS	DOK	DMDLU (193)	
LURMS_M	LOK	DMDLU (193)	
LURMS_M2	LOK	DMDLU (193)	
LURS	DOK	DMDLU (193)	
LURSKTM	AUS	DMDLU (193)	DMDDLU (199)
LURS_M	LOK	DMDLU (193)	
LURS_M2	LOK	DMDLU (193)	
LURS_MIN	AUS	DMDLU (193)	DMDLUA (202)
LUTS	AUS	DMDLU (193)	DMDDLU (199)
LUTS1	AUS	DMDLU (193)	DMDLUA (202)
LUTS10	AUS	DMDLU (193)	DMDLUA (202)
LUTS11	AUS	DMDLU (193)	DMDLUA (202)
LUTS12	AUS	DMDLU (193)	DMDLUA (202)
LUTS2	AUS	DMDLU (193)	DMDLUA (202)
LUTS3	AUS	DMDLU (193)	DMDLUA (202)
LUTS4	AUS	DMDLU (193)	DMDLUA (202)
LUTS5	AUS	DMDLU (193)	DMDLUA (202)
LUTS6	AUS	DMDLU (193)	DMDLUA (202)
LUTS7	AUS	DMDLU (193)	DMDLUA (202)
LUTS8	AUS	DMDLU (193)	DMDLUA (202)
LUTS9	AUS	DMDLU (193)	DMDLUA (202)
LUTS_M	LOK	DMDLU (193)	
LUTS_M2	LOK	DMDLU (193)	
LWS_W	EIN		MDVERB (540)
LZIST	LOK	KRRA (639)	
M6CATV	AUS	DLSA (398)	TC6MOD (1112)
M6CATV2	AUS	DLSA (398)	TC6MOD (1112)
M6CKTH	EIN		TC6MOD (1112)
M6CKTH2	EIN		TC6MOD (1112)
M6CLSCH	AUS	DLSAHK (339)	TC6MOD (1112)
M6CLSCH2	AUS	DLSAHK (339)	TC6MOD (1112)
M6CLSDY	AUS	DLSAHK (339)	TC6MOD (1112)
M6CLSDY2	AUS	DLSAHK (339)	TC6MOD (1112)
M6CMSL	EIN		TC6MOD (1112)
M6CMSL2	EIN		TC6MOD (1112)
M6CMSLV	EIN		TC6MOD (1112)
M6CMSLV2	EIN		TC6MOD (1112)
M6CSHKF	AUS	DLSAHK (339)	TC6MOD (1112)
M6CSHKF2	AUS	DLSAHK (339)	TC6MOD (1112)
M6CSHKM	AUS	DLSAHK (339)	TC6MOD (1112)
M6CSHKM2	AUS	DLSAHK (339)	TC6MOD (1112)
M6CTP	AUS	DLSA (398)	TC6MOD (1112)
M6CTP2	AUS	DLSA (398)	TC6MOD (1112)
M6KATNC	EIN		TC6MOD (1112)
M6KATNS_W	EIN		TC6MOD (1112)
M6SATV	AUS	DLSA (398)	TC6MOD (1112)
M6SATV2	AUS	DLSA (398)	TC6MOD (1112)
M6SKTH2_W	EIN		TC6MOD (1112)
M6SKTH_W	EIN		TC6MOD (1112)
M6SLSCH	AUS	DLSAHK (339)	TC6MOD (1112)
M6SLSCH2	AUS	DLSAHK (339)	TC6MOD (1112)
M6SLSDY	AUS	DLSAHK (339)	TC6MOD (1112)
M6SLSDY2	AUS	DLSAHK (339)	TC6MOD (1112)
M6SMSL2_W	EIN		TC6MOD (1112)
M6SMSLV2_W	EIN		TC6MOD (1112)
M6SMSLV_W	EIN		TC6MOD (1112)
M6SMSL_W	EIN		TC6MOD (1112)
M6SSHKF	AUS	DLSAHK (339)	TC6MOD (1112)
M6SSHKF2	AUS	DLSAHK (339)	TC6MOD (1112)
M6SSHKM	AUS	DLSAHK (339)	TC6MOD (1112)
M6SSHKM2	AUS	DLSAHK (339)	TC6MOD (1112)
M6STP2_W	AUS	DLSA (398)	TC6MOD (1112)
M6STP_W	AUS	DLSA (398)	TC6MOD (1112)
M6VKANW_W	EIN		TC6MOD (1112)
M6WATV	AUS	DLSA (398)	TC6MOD (1112)
M6WATV2	AUS	DLSA (398)	TC6MOD (1112)
M6WKTH2_W	EIN		TC6MOD (1112)
M6WKTH_W	EIN		TC6MOD (1112)
M6WLSCH	AUS	DLSAHK (339)	TC6MOD (1112)
M6WLSCH2	AUS	DLSAHK (339)	TC6MOD (1112)
M6WLSDY	AUS	DLSAHK (339)	TC6MOD (1112)
M6WLSDY2	AUS	DLSAHK (339)	TC6MOD (1112)
M6WMSL2_W	EIN		TC6MOD (1112)
M6WMSLV2_W	EIN		TC6MOD (1112)
M6WMSLV_W	EIN		TC6MOD (1112)
M6WMSL_W	EIN		TC6MOD (1112)
M6WSHKF	AUS	DLSAHK (339)	TC6MOD (1112)

Symbol	Type	Created within	Used within
M6WSHKF2	AUS	DLSAHK (339)	TC6MOD (1112)
M6WSHKM	AUS	DLSAHK (339)	TC6MOD (1112)
M6WSHKM2	AUS	DLSAHK (339)	TC6MOD (1112)
M6WTP2_W	AUS	DLSA (398)	TC6MOD (1112)
M6WTP_W	AUS	DLSA (398)	TC6MOD (1112)
MBEG_C	AUS	UFSGSC (1070)	
MDBES_W	AUS	ARMD (531)	
MDDLWS_W	LOK	MDVERB (540)	
MDGEN	AUS	MDVERB (540)	
MDGRAD_W	EIN		MDFAW (508)
MDIF_W_UM	AUS	UFMVER (1087)	
MDINDG_W	LOK	MDIST (528)	
MDIND_ASRL	LOK	UFMSRC (1080)	
MDIND_ASRS	LOK	UFMSRC (1080)	
MDIND_MSR	LOK	UFMSRC (1080)	
MDKO	AUS	MDVERB (540)	KOS (896)
MDKOINI	LOK	MDVERB (540)	
MDLFS	AUS	MDVERB (540)	
MDLWS_W	LOK	MDVERB (540)	
MDNS_W	AUS	MDVER (546)	
MDSLPF	AUS	MDVERB (540)	
MDSMZAS_W	LOK	MDVER (546)	
MDSM_W	LOK	MDVER (546)	
MDSWL	AUS	MDVERB (540)	
MDS_W	LOK	MDVER (546)	
MDVERB	AUS	MDVERB (540)	MDVER (546)
MDVERBC	EIN		MDVERB (540)
MDVERF_W	AUS	MDVER (546)	MDMIN (538)
MDVERL_W	AUS	MDVER (546)	ARMD (531), CAN (1124), MDFAW (508)
MDVERVF_W	LOK	MDVER (546)	
MDWAN_W	AUS	MDWAN (554)	MDVER (546)
MEBZA_UM_C	LOK	UFMER (1060)	
MEBZ_UM	AUS	UFMET (1060)	
MEBZ_UM_C	LOK	UFMER (1060)	
MECS_UM	AUS	UFMET (1060)	
MECS_UM_C	LOK	UFMER (1060)	
MEND_C	AUS	UFSGSC (1070)	
MER_C1_UM	EIN		DUF (1089)
MER_C2_UM	EIN		DUF (1089)
MEST_UM	AUS	UFMET (1060)	
MEST_UM_C	LOK	UFMER (1060)	
MFGR_UM	AUS	UFFGRC (1078)	UFMET (1060), UFMZUL (1084), UFUE (1056)
MFGR_UM_C	AUS	UFMER (1060)	
MIASRL_C	EIN		CAN (1124)
MIASRL_W	AUS	CAN (1124)	SWADAP (47), MDKOG (516), MSF (506), MDKOL (526)
MIASRS_C	EIN		CAN (1124)
MIASRS_W	AUS	CAN (1124)	SWADAP (47), MDAUTG (515), MDKOG (516), MSF (506)
MIAUTGET_W	AUS	MDAUTG (515)	
MIAUTGS_W	AUS	MDAUTG (515)	
MIBAS_W	AUS	MDBAS (529)	AES (973), MDAUTG (515), MDRED (976), MSF (506), MDZW (636), MDKOG (516)
MIBDP_W	LOK	MDFAW (508)	
MIBEG_W	LOK	MDKOG (516)	
MIBGR_W	AUS	MDBGRG (530)	MDAUTG (515), MDKOG (516), MDKOL (526)
MIBLSD_W	LOK	MDFAW (508)	
MIFA	AUS	MDFAW (508)	AK (855)
MIFABG_W	LOK	MDFAW (508)	
MIFABH_W	LOK	NMAXMD (584)	
MIFAB_W	AUS	MDKOG (516)	NMAXMD (584), VMAXMD (588)
MIFAFU_W	AUS	MDKOL (526)	FUEDK (597)
MIFAKH_W	LOK	KHMD (894)	
MIFAL_W	AUS	MDFAW (508)	MSF (506), KOS (896), MDKOL (526)
MIFAMX_W	AUS	GGPED (454)	
MIFA_UM	EIN		UFFGRC (1078), UFUE (1056)
MIFA_W	AUS	MDFAW (508)	MSF (506), ARMD (531), MDKOL (526), TEB (826), MDKOG (516), MDAUTG (515), GKRA (766), LLRMR (572), KHMD (894)
MIGEF_W	LOK	MDFAW (508)	
MIGES_W	AUS	SWADAP (47)	MDKOL (526), MSF (506)
MIGSL_W	AUS	CAN (1124)	MDKOL (526)
MIGS_W	AUS	CAN (1124)	SWADAP (47), MDKOG (516), MSF (506), ZWMIN (669)
MIISTOAR_W	AUS	MDAUTG (515)	MDFAW (508)
MIIST_W	AUS	MDIST (528)	MSF (506), VMAXMD (588), WDKSOM (614)
MILL_W	AUS	MDMIN (538)	LLRMD (561)
MILRES_W	AUS	MDKOL (526)	MDKOG (516)
MILSOL_UM	AUS	UFEING (1058)	UFUE (1056)
MILSOL_W	AUS	MDKOL (526)	FE (591), FUEDK (597), UFUE (1056), UFEING (1058), MSF (506), MDFUE (594)
MIMAX_W	AUS	MDMAX (514)	MDFAW (508), MSF (506), MDKOG (516)
MIMINDS_W	AUS	MDMIN (538)	
MIMINI_W	AUS	MDMIN (538)	
MIMINS_W	LOK	MDMIN (538)	
MIMIN_W	AUS	MDMIN (538)	MDFAW (508), MSF (506)

Symbol	Type	Created within	Used within
MIMSR_C	EIN		CAN (1124)
MIMSR_W	AUS	CAN (1124)	SWADAP (47), MDAUTG (515), MDKOL (526), MSF (506), MDKOG (516)
MIMXL1_W	LOK	MDMAX (514)	
MINBEG_W	LOK	MDFAW (508)	
MINMX_W	AUS	NMAXMD (584)	MDAUTG (515), MDKOG (516), MSF (506), MDKOL (526)
MINZAHN	AUS	AZUE (904)	
MIOPTL1_W	LOK	MDBAS (529)	
MIOPT_UM	LOK	UFMIST (1086)	
MIOPT_W	AUS	MDBAS (529)	AES (973), MSF (506), MDZW (636), MDRED (976), MDKOG (516), MDIST (528)
MIRED	LOK	VMAXMD (588)	
MIRRORCSP	LOK	RSTMON (1152)	
MIRRORIP	LOK	RSTMON (1152)	
MIRRORTFR	LOK	RSTMON (1152)	
MISGSL_W	AUS	CAN (1124)	MDKOL (526)
MISGS_C	EIN		CAN (1124), DVKUP (1027)
MISGS_UM	LOK	UFSGSC (1070)	
MISGS_W	AUS	CAN (1124)	MDKOG (516)
MISOLP_W	LOK	MDKOG (516)	
MISOLV_W	AUS	MDKOG (516)	ARMD (531), ZWMIN (669)
MISOL_W	AUS	MDKOG (516)	MSF (506), AES (973), MDRED (976), ZWMIN (669), MDZW (636)
MISOPL1_W	LOK	MDFUE (594)	
MISTT	EIN		LLRMD (561)
MISZULLB_W	DOK	MDZUL (523)	
MISZULL_W	AUS	MDZUL (523)	MDKOL (526)
MISZUL_W	AUS	MDZUL (523)	MDAUTG (515), WDKSOM (614), MSF (506), MDKOG (516)
MITEBG_W	AUS	GKRA (766)	TEB (826), MDKOG (516), MDKOL (526)
MIVBEB_W	EIN		MDAUTG (515), MDFAW (508)
MIVBEG_W	LOK	MDFAW (508)	
MIVMXS	LOK	VMAXMD (588)	
MIVMX_W	AUS	VMAXMD (588)	MDAUTG (515), MSF (506), MDKOG (516), MDKOL (526)
MIZSOLV_W	AUS	MDKOG (516)	
MIZSOL_W	AUS	MDKOG (516)	MSF (506), MDZW (636)
MIZUFIL_W	LOK	MDZUL (523)	
MIZUOFIL	LOK	MDZUL (523)	
MIZUVFIL	LOK	MDZUL (523)	
MIZWMN_W	AUS	MDRED (976)	MDAUTG (515), MDZW (636), MDFAW (508)
MI_DUF	AUS	DUF (1089)	DFFT (1140)
MI_UM	AUS	UFMIST (1086)	DUF (1089), UFMVER (1087), UFUE (1056)
MKAR_W	AUS	ARMD (531)	
MKFANB_W	AUS	MDFAW (508)	
MKFA_W	LOK	MDFAW (508)	
MKLLSC	EIN		MDVERB (540)
MKOLSC	EIN		MDVERB (540)
ML	AUS	BGSRM (245)	SWADAP (47), AK (855), BBKHZ (890), DFFT (1140), DKVS (811), GGTFM (289), LRHK (781), ZWMIN (669), TEB (826), LRKA (795), LAKH (735), DTEV (856), DKAT (361), BGMSABG (328), BGAGR (263)
MLAST_W	AUS	ARMD (531)	
MLBB	AUS	BGMSABG (328)	
MLBB2	AUS	BGMSABG (328)	
MLBB2_W	AUS	BGMSABG (328)	
MLBB_W	AUS	BGMSABG (328)	
MLDMN_W	AUS	DHFM (233)	
MLDMX_W	AUS	DHFM (233)	GGHFM (230)
MLDYN_W	LOK	DLSAHK (339)	
MLETANZS_W	LOK	DTEV (856)	
MLETAN_W	LOK	DTEV (856)	
MLHFMAS_W	LOK	GGHFM (230)	
MLHFMA_W	LOK	GGHFM (230)	
MLHFMF_W	LOK	DHFM (233)	
MLHFMM_W	AUS	GGHFM (230)	DHFM (233)
MLKGE_W	LOK	FUEDK (597)	
MLNKA2_W	LOK	LRHK (781)	
MLNKA_W	LOK	LRHK (781)	
MLSOL_W	AUS	FUEDK (597)	TEB (826)
MLSU	LOK	BBKHZ (890)	
MLWDKNF_W	LOK	FUEDK (597)	
ML_W	AUS	BGSRM (245)	SWADAP (47), EGFE (228), ATM (20), BGMSABG (328), BBBO (853), TEB (826), LRKA (795), LRHK (781), LREB (739), LRA (797), FUEDK (597), DTEV (856), DLSAHK (339), BGRML (287), BGPU (276), BGMSZS (239), BGAGR (263), AK (855)
MMSR_UM	AUS	UFMSRC (1080)	UFMZUL (1084), UFUE (1056)
MPED_UM	LOK	UFMZUL (1084)	
MPFAD	AUS	DUF (1089)	DFFT (1140)
MRACC_W	EIN		FGRREGL (1174)
MRFABUGD_W	LOK	FUEDK (597)	
MRFAMX_W	AUS	MDFAW (508)	FUEDK (597)
MRFAUGD_W	LOK	FUEDK (597)	
MRFA_W	AUS	MDFAW (508)	ESVW (1009), FUEDK (597), LAMFAW (728)
MRFGRC_W	EIN		FGRREGL (1174)
MRFGRI_W	LOK	FGRREGL (1174)	

Symbol	Type	Created within	Used within
MRFGR_W	AUS	FGRREGL (1174)	SWADAP (47), FGRUE (490), MSF (506), BGWPFGR (548), FGRFULO (1160), MDFAW (508)
MRPED_W	EIN		FGRREGL (1174), MDFAW (508)
MSABG	AUS	BGMSABG (328)	
MSABG2	AUS	BGMSABG (328)	
MSABG2_W	AUS	BGMSABG (328)	DKAT (361)
MSABG_W	AUS	BGMSABG (328)	DKAT (361)
MSAGR	AUS	BGAGR (263)	EGFE (228)
MSDIF_W	AUS	EGFE (228)	
MSDKALM_W	AUS	BGMSZS (239)	TEB (826), EGFE (228)
MSDKOO_W	LOK	DTEV (856)	
MSDKS_W	LOK	FUEDK (597)	
MSDKUE_W	AUS	BGMSZS (239)	
MSDK_W	AUS	BGMSZS (239)	EGFE (228)
MSGSCPL_UM	LOK	UFSGSC (1070)	
MSGS_UM	AUS	UFSGSC (1070)	
MSGS_UR	AUS	UFSGSC (1070)	
MSG_DATA_R	EIN		UFSGSC (1070)
MSHFMS_W	AUS	GGHFM (230)	
MSHFM_W	AUS	GGHFM (230)	BGMSZS (239), TC1MOD (1100), EGFE (228)
MSL	EIN		BGMSABG (328), AK (855)
MSL2	EIN		BGMSABG (328)
MSLSTAT	LOK	AK (855)	
MSNDKOOS_W	LOK	FUEDK (597)	
MSNDKOO_W	AUS	BGMSZS (239)	DTEV (856)
MSNDKO_W	AUS	BGMSZS (239)	EGFE (228), BGRLP (266), FUEDK (597)
MSNDKPK_W	LOK	BGRLP (266)	
MSNDKS_W	LOK	FUEDK (597)	
MSNDK_W	AUS	BGMSZS (239)	EGFE (228)
MSNLLS_W	EIN		BGMSZS (239), BGRLP (266)
MSNSAUG_W	AUS	BGMSZS (239)	
MSNTAGR	DOK	BGAGR (263)	
MSNTETEV_W	LOK	BGTEV (257)	
MSNTEVO_W	AUS	BGTEV (257)	ATEV (969)
MSRC_C_UM	LOK	UFMSRC (1080)	
MSSAUG_W	AUS	BGMSZS (239)	
MSSGINMN_W	LOK	TEB (826)	
MSSGIN_W	LOK	TEB (826)	
MSTE	AUS	BGTEV (257)	BGMSZS (239), BGRLP (266), TEB (826), EGFE (228), BGPU (276)
MSTEDTE	AUS	BGTEV (257)	DTEV (856)
MSTEDTEF_W	LOK	DTEV (856)	
MSTEDTE_W	AUS	BGTEV (257)	TEB (826)
MSTEEV_W	LOK	TEB (826)	
MSTEO_W	AUS	BGTEV (257)	ATEV (969), TEB (826)
MSTESMX_W	LOK	TEB (826)	
MSTESOLL_W	AUS	MSF (506)	TEB (826), ATEV (969)
MSTETEV_W	LOK	BGTEV (257)	
MSTE_W	AUS	BGTEV (257)	FUEDK (597), TEB (826), GKRA (766)
MTSEGPH_W	LOK	NLDG (157)	
MVER_C_UM	LOK	UFMVER (1087)	
MZFO_UM	LOK	UFMVER (1087)	
MZF_LOW_UM	LOK	UFMZF (1083)	
MZF_UM	AUS	UFMZF (1083)	UFMVER (1087), UFUE (1056)
MZMAX_UM	LOK	UFMZUL (1084)	
MZO_UM	AUS	UFMZUL (1084)	UFMVER (1087), UFUE (1056)
MZ_UM	AUS	UFMZUL (1084)	UFMZF (1083), UFUE (1056)
NASNOTTM	AUS	MDKOG (516)	MDKOL (526)
NBM	EIN		GGDPG (74)
NC_C_UM	LOK	UFNC (1063)	
NDAR_W	AUS	ARMD (531)	
NDFIL_W	AUS	ARMD (531)	
NDIFFOG_W	AUS	ARMD (531)	
NDIFF_W	AUS	ARMD (531)	
NFSKH	AUS	BBKHZ (890)	SWADAP (47), LLRNS (562)
NGASF_W	LOK	LLRRM (566)	
NGAS_W	AUS	BGNG (121)	KRDY (659), LLRRM (566)
NGFIL	AUS	BGNG (121)	SWADAP (47), BBSAWE (557), LLRRM (566), ZWMIN (669), LLRNS (562)
NGFIL_W	AUS	BGNG (121)	SWADAP (47), DMDSTP (205), NMAXMD (584), MDFAW (508)
NGKRV_W	LOK	KRDY (659)	
NLLCVT1	EIN		LLRNS (562)
NLLCVT2	LOK	LLRNS (562)	
NLLDAGKT	EIN		LLRNFA (564)
NLLKH	AUS	AK (855)	SWADAP (47), BBKHZ (890), LLRNS (562), NWS (618)
NLP1TIM	LOK	BGDVE (934)	
NMAXDVG_W	LOK	NMAXMD (584)	
NMOD_W	AUS	ARMD (531)	

Symbol	Type	Created within	Used within
NMOT	AUS	BGNMOT (111)	SWADAP (47), ACIFI (1013), ZWWL (638), ZWSTT (637), ZWMIN (669), ZWGRU (634), ZUESZ (632), ZUE (627), WDKSOM (614), WANWKW (125), VMAXMD (588), UFUE (1056), UFNC (1063), TEB (826), SU (617), STADAP (684), RKTI (979), PROKON (53), NWS (618), NLPH (150), NLDG (157), MSF (506), MDZUL (523), MDVERB (540), MDMIN (538), MDMAX (514), MDKOL (526), MDKOG (516), MDFUE (594), MDBGRG (530), LRKA (795), LRHK (781), LREB (739), LRAEB (759), LRA (797), LR (768), LLRNS (562), LLRBB (575), LAMFAW (728), LAMBTS (732), LAKH (735), KRRA (639), KRKE (427), KRDY (659), KOS (896), GK (675), GGPED (454), GGKS (412), GGHFM (230), GGDVE (477), GGDPG (74), FUEREG (595), FUEDKSA (610), FUEDK (597), FGRREGL (1174), ESVW (1009), ESUKA (711), ESUK (699), ESSTT (679), ESGRU (678), DVFZ (500), DNWS (622), DMDSTP (205), DMDMIL (216), DMDLUA (202), DMDLU (193), DMDFON (161), DMDDLU (199), DLSA (398), DKRS (437), DKRNT (445), DKAT (361), DFFTK (1142), DFFT (1140), DECJ (1013), BGMSZS (239), BGBSZ (73), BGAGR (263), BBSTT (148), BBSAWE (557), AZUE (904), ATM (20), ATEV (969), BGTEV (257), BGTEMPK (252), BGTABST (1030), BGPU (276), AK (855), AEVABU (1002), ADVE (918), EGAG (486), EGFE (228)
NMOTKOR	LOK	GGHFM (230)	
NMOTLL	AUS	BGNMOT (111)	BGDVE (934), DTEV (856), LLRBB (575), FUEREG (595), BGLBZ (489), LLRMD (561), MDVER (546), RDE (112), LLRNS (562)
NMOTLLFIL	AUS	BGNMOT (111)	DDG (141)
NMOTPR_W	LOK	NMAXMD (584)	
NMOTRSP_W	AUS	BGNG (121)	
NMOT_UM	AUS	UFNC (1063)	DUF (1089), UFRLC (1066), UFMIST (1086), UFNSC (1077), UFREAC (1088), UFUE (1056)
NMOT_W	AUS	BGNMOT (111)	SWADAP (47), ARMD (531), ZWMIN (669), ZUESZ (632), TEB (826), TC1MOD (1100), NMAXMD (584), MDZW (636), MDVER (546), MDNSTAB (556), MDMIN (538), MDMAX (514), MDFUE (594), MDFAW (508), MDBAS (529), LLRRM (566), LLRMR (572), LLRMD (561), KHMD (894), GGPOEL (296), GGDPG (74), FUEDK (597), FGRUE (490), FGRABED (491), ESUK (699), EGFE (228), EGAG (486), CAN (1124), BGWPFGR (548), BGSRM (245), BGRLP (266), BGPU (276), BGNG (121), BGMSZS (239), BBGANG (501), DHFM (233)
NMXPR	LOK	NMAXMD (584)	
NOME_C	AUS	DUF (1089)	
NSA	LOK	BBSAWE (557)	
NSACTR	LOK	ESNSWL (691)	ESVST (677)
NSACTR_W	LOK	ESVST (677)	
NSBER_W	EIN		FGRABED (491), NMAXMD (584)
NSFSMN	LOK	LLRNS (562)	
NSKA_UM	LOK	UFREAC (1088)	
NSLBZ	LOK	LLRNS (562)	
NSLFA	AUS	LLRNFA (564)	LLRNS (562)
NSLLMN	LOK	LLRNS (562)	
NSNF	LOK	LLRNS (562)	
NSOL	AUS	LLRMD (561)	LLRNS (562), DTEV (856), MDWAN (554), MDVER (546), LLRBB (575)
NSOL_W	EIN		LLRRM (566)
NSST	AUS	LLRNS (562)	
NSTAT	AUS	LLRMD (561)	LLRNS (562), DDG (141), MDNSTAB (556), LLRBB (575), LLRRM (566)
NSTAT2	AUS	LLRNS (562)	
NSTAT3	LOK	LLRNS (562)	
NSTATFIL	AUS	LLRNS (562)	
NSWRL	LOK	ESNSWL (691)	
NSYNNLPH	LOK	NLPH (150)	
NTURB	LOK	MDWAN (554)	
NTURBV	LOK	MDWAN (554)	
NVER_W	EIN		MDMIN (538)
NVQUOT_W	AUS	BBGANG (501)	
NWE	LOK	BBSAWE (557)	
NWECVT	LOK	BBSAWE (557)	
NWEMA	LOK	BBSAWE (557)	
NWENGA	LOK	BBSAWE (557)	
NZ_UM	LOK	UFNC (1063)	
OFFZ_W	AUS	ZUESZ (632)	
OFPBRINT_W	EIN		FUEDK (597)
OVLCTR	AUS	AZUE (904)	
PA_W	LOK	BGAGR (263)	
PBRINT_W	EIN		BGTEMPK (252)
PBRMP_W	LOK	BGRLP (266)	
PBRP_W	LOK	BGRLP (266)	
PBR_W	AUS	BGSRM (245)	
PDPLD	EIN		FUEDK (597)
PERCNT2_W	LOK	LRHK (781)	
PERCNT_W	LOK	LRHK (781)	
PERMFMA_W	LOK	LR (768)	
PERMFSL_W	LOK	LR (768)	
PH	EIN		GGDPG (74), WANWKW (125), NLDG (157)
PH2	EIN		GGDPG (74), NLDG (157), WANWKW (125)
PHLOSCTR_W	AUS	NLPH (150)	

Symbol	Type	Created within	Used within
PHLSNH	AUS	HLS (392)	DHLSHK (1154)
PHLSNH2	AUS	HLS (392)	DHLSHK (1154)
PHLSNHF	DOK	DHLSVK (29)	DHLSHK (1154)
PHLSNHF2	LOK	DHLSHK (1154)	
PHLSNV	AUS	HLS (392)	DHLSVK (29), DLSV (301)
PHLSNV2	AUS	HLS (392)	DHLSVK (29), DLSV (301)
PHLSNVF2	DOK	DHLSVK (29)	
PHPW	LOK	DPH (144)	
PHPW2	LOK	DPH (144)	
PIRGFUE_W	EIN		FUEDK (597)
PIRGRO_W	LOK	BGSRM (245)	
PIRG_W	AUS	BGSRM (245)	EGFE (228), BGRLP (266), FUEDK (597), BGTEMPK (252)
PLSOL	AUS	FUEDK (597)	
PLSOL_W	AUS	FUEDK (597)	
PRG2SU_W	AUS	BGSRM (245)	
PRG3SU_W	AUS	BGSRM (245)	
PRGSU_W	AUS	BGSRM (245)	
PRG_W	AUS	BGSRM (245)	
PS	EIN		BGTEMPK (252)
PSAGR_W	AUS	BGAGR (263)	BGSRM (245), EGFE (228)
PSDSS_U	AUS	DFFTCNV (1143)	TC1MOD (1100)
PSDSS_W	EIN		BGPU (276), DFFTCNV (1143), EGFE (228)
PSES_W	LOK	AES (973)	
PSFG_W	AUS	BGSRM (245)	EGFE (228)
PSL	EIN		LLRNS (562)
PSMPPVDK_W	LOK	BGRLP (266)	
PSMP_W	LOK	BGRLP (266)	
PSMX_W	AUS	BGSRM (245)	EGFE (228)
PSPMX_W	LOK	BGRLP (266)	
PSPU	LOK	TEB (826)	
PSPVDB_W	AUS	BGMSZS (239)	EGFE (228)
PSPVDK_W	AUS	BGMSZS (239)	EGFE (228), BGPU (276), FUEDK (597), BGTEV (257)
PSPVDS_W	AUS	BGMSZS (239)	BGRLP (266)
PSPVMIN_W	LOK	FUEDK (597)	
PSP_W	LOK	BGRLP (266)	
PSRLFUE_W	EIN		FUEDK (597)
PSRLRO_W	LOK	BGSRM (245)	
PSSOL_W	AUS	FUEDK (597)	FE (591)
PSSPVDKB_W	LOK	FUEDK (597)	
PSSPVDK_W	LOK	FUEDK (597)	
PS_W	AUS	BGSRM (245)	EGFE (228), AES (973), BGAGR (263), TEB (826), BGTEMPK (252), BGRLP (266), BGMSZS (239)
PTE	AUS	EGAG (486)	GGDST (504), GKRA (766), TEB (826)
PTERW	AUS	GGDST (504)	DDST (851)
PTERW_W	AUS	EGAG (486)	GGDST (504)
PTE_W	AUS	GGDST (504)	
PTV	LOK	LRHK (781)	
PTV2	LOK	LRHK (781)	
PU	AUS	BGPU (276)	AES (973), DFFT (1140), TEB (826)
PUANS	LOK	GGHFM (230)	
PU_W	AUS	BGPU (276)	BGAGR (263), FUEDK (597), BGSRM (245), EGFE (228)
PVDK	AUS	BGMSZS (239)	EGFE (228)
PVDKDS	AUS	BGPU (276)	
PVDKDS_W	AUS	BGPU (276)	BGMSZS (239), BGSRM (245), EGFE (228)
PVDKR_W	LOK	FUEDK (597)	
PVDK_W	AUS	BGMSZS (239)	EGFE (228), BGRLP (266), FUEDK (597)
QMSDYN	LOK	TEB (826)	
QNTNS	LOK	MDWAN (554)	
QTETEMIN	LOK	TEB (826)	
QZZYL	LOK	GGDPG (74)	
R	DOK	GGDPG (74)	
R10MSCTR	EIN		UFSGSC (1070)
RAM_C_UM	LOK	URMEM (1044)	
REAC_C1_UM	LOK	UFREAC (1088)	
REAC_C2_UM	LOK	UFREAC (1088)	
REAC_C_UM	LOK	UFREAC (1088)	
READY	AUS	DIMC (1148)	
REDBAS	AUS	AES (973)	SWADAP (47), BGEVAB (1005)
REDHYST	LOK	MDRED (976)	
REDIST	AUS	AES (973)	SWADAP (47), BGEVAB (1005), MDIST (528), MDRED (976), MSF (506), ZUE (627), MDZW (636)
REDNEU	LOK	MDRED (976)	
REDSOL	AUS	MDRED (976)	SWADAP (47), AEVAB (980), AES (973)
REDSOLR	AUS	AEVAB (980)	
REDSOL_ONE	LOK	AEVAB (980)	
REDZE	LOK	MDRED (976)	
REDZST_W	LOK	MDRED (976)	
RFAGRROH_W	DOK	BGAGR (263)	
RFAGR_W	AUS	BGSRM (245)	BGAGR (263), FUEDK (597), BGRLP (266), BGPU (276), EGFE (228)
RFGES_W	LOK	BGSRM (245)	
RFRS_W	EIN		FUEDK (597)
RFR_W	EIN		FUEDK (597)

Symbol	Type	Created within	Used within
RINH2_U	AUS	DFFTCNV (1143)	DFFT (1140)
RINH2_W	AUS	GGLSH (318)	DFFTCNV (1143), DHLSHK (1154), DLSH (330)
RINH_U	AUS	DFFTCNV (1143)	DFFT (1140)
RINH_W	AUS	GGLSH (318)	DFFTCNV (1143), DHLSHK (1154), DLSH (330)
RINKFH	LOK	DHLSHK (1154)	
RINKFH2	LOK	DHLSHK (1154)	
RINKFV	DOK	DHLSVK (29)	
RINKFV2	DOK	DHLSVK (29)	
RINOFH2_W	LOK	GGLSH (318)	
RINOFH_W	LOK	GGLSH (318)	
RINOFV2_W	AUS	GGLSV (382)	
RINOFVA2_W	LOK	GGLSV (382)	
RINOFVA_W	LOK	GGLSV (382)	
RINOFV_W	AUS	GGLSV (382)	
RINSH2_W	LOK	DHLSHK (1154)	
RINSH_W	LOK	DHLSHK (1154)	
RINSV2_W	DOK	DHLSVK (29)	
RINSV_W	DOK	DHLSVK (29)	
RINV2_U	AUS	DFFTCNV (1143)	DFFT (1140)
RINV2_W	AUS	GGLSV (382)	DFFTCNV (1143), DLSV (301), DHLSVK (29)
RINV_U	AUS	DFFTCNV (1143)	DFFT (1140)
RINV_W	AUS	GGLSV (382)	DFFTCNV (1143), DHLSVK (29), DLSV (301)
RK2_W	AUS	GK (675)	MSF (506), AES (973), RKTI (979), BGKV (71)
RKA2_W	AUS	GKRA (766)	LRA (797), GK (675)
RKACO_W	EIN		GK (675)
RKAM2_W	LOK	DKVS (811)	
RKAMZS2_W	LOK	DKVS (811)	
RKAMZS_W	LOK	DKVS (811)	
RKAM_W	LOK	DKVS (811)	
RKAT2_W	AUS	LRA (797)	DKVS (811), GKRA (766)
RKAT_W	AUS	LRA (797)	DKVS (811), DTEV (856), GKRA (766)
RKAZ2_W	AUS	LRA (797)	DKVS (811), GKRA (766)
RKAZ_W	AUS	LRA (797)	DKVS (811), DTEV (856), GKRA (766)
RKA_W	AUS	GKRA (766)	LRA (797), GK (675)
RKR	AUS	KRKE (427)	DKRS (437), EGKE (409)
RKRMX	LOK	KRKE (427)	
RKRMX1W	LOK	KRKE (427)	
RKRMX2W	LOK	KRKE (427)	
RKRN_W	LOK	DKRS (437)	
RKRTP	LOK	KRKE (427)	
RKR_TST	AUS	KRKE (427)	
RKTE_W	AUS	GKRA (766)	TEB (826), BGKV (71), GK (675)
RKUKE_W	LOK	ESUK (699)	
RKUKG_W	AUS	ESUK (699)	ESVST (677), GK (675)
RKUKKL_W	LOK	ESUK (699)	
RKUKK_W	AUS	ESUK (699)	
RKUKL_W	LOK	ESUK (699)	
RKUK_W	LOK	ESUK (699)	
RK_W	AUS	GK (675)	MSF (506), AES (973), RKTI (979), BGKV (71)
RL	AUS	BGSRM (245)	SWADAP (47), AK (855), DFFT (1140), DKAT (361), GGKS (412), GGHFM (230), GGDVE (477), ESUKA (711), ESGRU (678), DMDMIL (216), DMDLUA (202), DMDLU (193), DMDFON (161), DMDDLU (199), DLSA (398), DLLR (578), BGTEMPK (252), LRA (797), LR (768), LLRNS (562), LAMBTS (732), LAKH (735), KRRA (639), KRDY (659), GK (675), UFRLC (1066), TEB (826), NWS (618), NLPH (150), MSF (506), MDVERB (540), LRHK (781), LREB (739), ZWMIN (669), ZWGRU (634), UFUE (1056), ESVW (1009), DMDSTP (205), ATM (20), EGFE (228)
RLC_C_UM	LOK	UFRLC (1066)	
RLDKTHP	LOK	DKAT (361)	
RLDKTHP2	LOK	DKAT (361)	
RLDVS_W	AUS	BGMSZS (239)	EGFE (228), BGRLP (266)
RLFGKS_W	LOK	FUEDK (597)	
RLFGS_W	LOK	FUEDK (597)	
RLGAS_W	AUS	BGRLG (274)	DMDSTP (205)
RLIPF_UM	LOK	UFRLC (1066)	
RLIP_UM	LOK	UFRLC (1066)	
RLMAX_W	EIN		MDFUE (594), MDMAX (514), FE (591)
RLMINDP_W	LOK	MDFAW (508)	
RLMIN_W	AUS	MDFUE (594)	MDFAW (508), MDKOG (516)
RLMP_W	LOK	BGRLP (266)	
RLNOTN	LOK	BGMSZS (239)	
RLP	AUS	BGRLP (266)	ESUK (699)
RLP_W	AUS	BGRLP (266)	GK (675), KRDY (659), ESUK (699), ESVST (677)
RLQK_W	LOK	BGPU (276)	
RLQ_W	LOK	BGPU (276)	
RLROHMP_W	LOK	BGRLP (266)	
RLROH_W	AUS	BGMSZS (239)	BGSRM (245), EGFE (228)
RLRSP_W	LOK	BGRLG (274)	
RLRS_W	EIN		FUEDK (597)
RLR_W	EIN		BGPU (276), FUEDK (597)
RLSHK	EIN		NWS (618), SU (617), FE (591)

Symbol	Type	Created within	Used within
RLSNW	LOK	NWS (618)	
RLSNWTM	LOK	NWS (618)	
RLSOL_W	AUS	MDFUE (594)	FUEDK (597), MDKOG (516), NWS (618), FUEREG (595), FE (591)
RLSP	LOK	ESUKA (711)	
RLSP2	LOK	ESUKA (711)	
RLTEDTE_W	AUS	DTEV (856)	MDFUE (594)
RLTEEV_W	LOK	TEB (826)	
RLUGD_W	LOK	MDMAX (514)	
RLVPPL	LOK	GGDVE (477)	
RLVUGD	LOK	MDMAX (514)	
RLWKS_W	AUS	BGPU (276)	
RLWK_W	LOK	BGPU (276)	
RLW_W	LOK	BGPU (276)	
RLZO_UM	LOK	UFRLC (1066)	
RL_U	AUS	DFFTCNV (1143)	
RL_UM	EIN		UFMIST (1086), UFRLC (1066), UFUE (1056)
RL_W	AUS	BGSRM (245)	SWADAP (47), EGFE (228), BGPU (276), DFFTCNV (1143), VMAXMD (588), UFUE (1056), UFRLC (1066), MSF (506), MDVER (546), MDFAW (508), MDBAS (529), KRDY (659), ZWMIN (669), FUEREG (595), FE (591), BGRLG (274), BGRLP (266)
RL_W_UM	LOK	UFRLC (1066)	
RML	AUS	BGRML (287)	DFFT (1140)
RMSTEVF_W	LOK	DTEV (856)	
RMSTEVUF_W	LOK	DTEV (856)	
RMSTEV_W	AUS	DTEV (856)	
ROMRSTC_UM	LOK	URROM (1041)	
ROMZ_C_UM	LOK	URMEM (1044)	
RREXT_W	EIN		BGTEMPK (252)
RSTMON_0	LOK	RSTMON (1152)	
RSTMON_1	LOK	RSTMON (1152)	
RSTMON_10	LOK	RSTMON (1152)	
RSTMON_11	LOK	RSTMON (1152)	
RSTMON_2	LOK	RSTMON (1152)	
RSTMON_3	LOK	RSTMON (1152)	
RSTMON_4	LOK	RSTMON (1152)	
RSTMON_5	LOK	RSTMON (1152)	
RSTMON_6	LOK	RSTMON (1152)	
RSTMON_7	LOK	RSTMON (1152)	
RSTMON_8	LOK	RSTMON (1152)	
RSTMON_9	LOK	RSTMON (1152)	
RSTPFAD	AUS	DUR (1052)	DFFT (1140)
RST_TV	AUS	UFREAC (1088)	URMEM (1044), URRAM (1043)
R_BM	DOK	GGDPG (74)	
R_BURN	DOK	STADAP (684)	
R_FLAGS_UM	AUS	UFSGSC (1070)	
R_NBM	AUS	GGDPG (74)	AEKP (970), BGNMOT (111)
R_NBMNLDG	AUS	NLDG (157)	GGDPG (74)
R_NNLDG	LOK	NLDG (157)	
R_PH	LOK	WANWKW (125)	
R_PH2	LOK	WANWKW (125)	
R_PHNLDG	LOK	NLDG (157)	
R_SYN	AUS	GGDPG (74)	BGAGR (263), BGRLG (274), WANWKW (125), STADAP (684), RKTI (979), MDBAS (529), MDZW (636), DMDFON (161), BGNMOT (111), BGNG (121), DMDTSB (159)
R_SYNPH	AUS	GGDPG (74)	DDG (141), DPH (144)
R_SYNPH2	AUS	GGDPG (74)	DPH (144)
R_T1	EIN		ALE (136), GGLSH (318), GGLSV (382)
R_T10	EIN		AEKP (970), AEVABU (1002), ALE (136), BBKHZ (890), BBSTT (148), HLS (392), GGUB (487), GGLSV (382), GGLSH (318), GGDST (504), GGDPG (74), ESUKA (711), DECJ (1013), MOTAUS (1028), MDFUE (594), LRHK (781), LREB (739), LAMKO (729), LAMBTS (732), BGWDKM (273), BGRLG (274), BGNMOT (111), BGNG (121), ATM (20)
R_T100	EIN		BBKHZ (890), BBSTT (148), BGAGR (263), LAMBTS (732), HLS (392), GGUB (487), GGTFM (289), GGTFA (298), GGLSV (382), GGLSH (318), ESUKA (711), RKTI (979), MOTAUS (1028), LRHK (781), LAMKO (729), DPH (144), DHLSVK (29), DHLSHK (1154), DECJ (1013), DDG (141)
R_T1000	EIN		BGKMST (1008)
R_T1S	EIN		AEKP (970), BGTABST (1030), MOTAUS (1028), GGTFM (289)
R_T20	EIN		BGTEV (257), STADAP (684)
R_T200	EIN		ATM (20), DNWKW (134), DNWS (622), WANWKW (125)
R_T50	EIN		BGTABST (1030), DHLSHK (1154)
SDWFK_W	LOK	ESUK (699)	
SDWFL_W	LOK	ESUK (699)	
SEN_C95	AUS	GGKS (412)	
SFPBREMS	AUS	GGEGAS (474)	
SFPBWF	AUS	GGPED (454)	
SFPCAS	AUS	DCAS (1128)	
SFPCINS	AUS	DCINS (1126)	
SFPCKUP	LOK	DCKUP (1128)	
SFPDK	EIN		DDVE (950)
SFPDK1P	EIN		DDVE (950)
SFPDK2P	EIN		DDVE (950)

Symbol	Type	Created within	Used within
SFPDVEE	EIN		DDVE (950)
SFPDVEF	EIN		DDVE (950)
SFPDVEFO	EIN		DDVE (950)
SFPDVEL	EIN		DDVE (950)
SFPDVEN	EIN		DDVE (950)
SFPDVER	EIN		DDVE (950)
SFPDVET	EIN		DDVE (950)
SFPDVEU	EIN		DDVE (950)
SFPDVEUB	EIN		DDVE (950)
SFPDVEUW	EIN		DDVE (950)
SFPDVEV	EIN		DDVE (950)
SFPFP1P	AUS	GGPED (454)	
SFPFP2P	AUS	GGPED (454)	
SFPFPP	AUS	GGPED (454)	
SFPHSH	AUS	DHLSHK (1154)	
SFPHSH2	AUS	DHLSHK (1154)	
SFPHSV	AUS	DHLSVK (29)	
SFPHSV2	AUS	DHLSVK (29)	
SFPKAT	AUS	DKAT (361)	
SFPKAT2	AUS	DKAT (361)	
SFPKRNT	AUS	DKRNT (445)	
SFPKROF	AUS	DKRNT (445)	
SFPKRTP	AUS	DKRTP (451)	
SFPKS1	AUS	DKRS (437)	
SFPKS2	AUS	DKRS (437)	
SFPKS3	AUS	DKRS (437)	
SFPKS4	AUS	DKRS (437)	
SFPLASH	AUS	DLSAHK (339)	
SFPLASH2	AUS	DLSAHK (339)	
SFPLATP	AUS	DLSA (398)	
SFPLATP2	AUS	DLSA (398)	
SFPLATV	AUS	DLSA (398)	
SFPLATV2	AUS	DLSA (398)	
SFPLM	AUS	DHFM (233)	
SFPLSH	AUS	DLSH (330)	
SFPLSH2	AUS	DLSH (330)	
SFPLSV	AUS	DLSV (301)	
SFPLSV2	AUS	DLSV (301)	
SFPMDB	AUS	MDKOG (516)	
SFPMILE	AUS	DMILE (36)	
SFPNWKW	AUS	DNWKW (134)	
SFPNWKW2	AUS	DNWKW (134)	
SFPNWS	AUS	DNWS (622)	
SFPNWS2	AUS	DNWS (622)	
SFPPH	AUS	DPH (144)	
SFPPH2	AUS	DPH (144)	
SFPTA	AUS	GGTFA (298)	
SFPTES	AUS	DTEV (856)	
SFPTM	AUS	GGTFM (289)	
SFPUB	AUS	GGUB (487)	
SFPUFMV	AUS	DUF (1089)	
SFPUFSKA	AUS	DUF (1089)	
SFPURRAM	AUS	DUR (1052)	
SFPURROM	AUS	DUR (1052)	
SFPURRST	AUS	DUR (1052)	
SFPVKUP	LOK	DVKUP (1027)	
SGID	EIN		AEVAB (980), BGEVAB (1005)
SGSC_C_UM	LOK	UFSGSC (1070)	
SGSC_C_UR	LOK	UFSGSC (1070)	
SGSNU_C_UM	LOK	UFSGSC (1070)	
SGSNU_C_UR	LOK	UFSGSC (1070)	
SKAPFAD	AUS	DUF (1089)	DFFT (1140)
SLSNINKR	AUS	AZUE (904)	
SLSNINKR2	AUS	AZUE (904)	
SLSNZAHN	AUS	AZUE (904)	
SLSNZAHN2	AUS	AZUE (904)	
SN2ZKVEK	AUS	AZUE (904)	
SNZKVEK	AUS	AZUE (904)	
SP1P_A_UM	LOK	URADCC (1049)	
SP1P_ST_UM	LOK	URADCC (1049)	
SP1SN_UM	LOK	UFSPSC (1060)	
SP1S_A_UM	LOK	URADCC (1049)	
SP1S_ST_UM	LOK	URADCC (1049)	
SP1S_UM	LOK	UFSPSC (1060)	
SP2SN_UM	LOK	UFSPSC (1060)	
SP2S_UM	LOK	UFSPSC (1060)	
SPSC_C_UM	LOK	UFSPSC (1060)	
SPSN_UM	AUS	UFSPSC (1060)	UFMET (1060), UFREAC (1088), UFUE (1056)
SPSN_UM_C	AUS	UFMER (1060)	
SRST_C_UM	LOK	URMEM (1044)	
SRST_UR	AUS	UFSGSC (1070)	
STACTR	LOK	STADAP (684)	

Symbol	Type	Created within	Used within
STATEAEVAB	AUS	AEVAB (980)	BGEVAB (1005)
STATEQSYN	LOK	GGDPG (74)	
STAT_MD_E	AUS	CAN (1124)	
STFGRAB_W	AUS	FGRABED (491)	FGRFULO (1160), FGRREGL (1174), FGRUE (490)
STFGRBS_W	AUS	FGRBESI (1158)	FGRFULO (1160), FGRUE (490)
STFGRFL	AUS	FGRFULO (1160)	FGRREGL (1174), FGRUE (490)
STKRAX	LOK	KRRA (639)	
STKRLX	LOK	KRRA (639)	
STKRNX	AUS	KRRA (639)	KRDY (659), EGKE (409)
SUMODE	AUS	SU (617)	BGSRM (245), EGFE (228)
SWOUT	AUS	AZUE (904)	
SYNSTATE	EIN		GGDPG (74), NLPH (150), RDE (112)
SY_2SG	AUS	PROKON (53)	ADVE (918), SREAKT (963), DMDUE (158), DMDTSB (159), DMDLUA (202), DMDLU (193), DMDLAD (215), DMDDLU (199), BGDVE (934)
SY_2SLS	EIN		LRHK (781)
SY_2TEV	EIN		LRHK (781)
SY_AAU	AUS	PROKON (53)	
SY_AAV	AUS	PROKON (53)	DTEV (856), TEBEB (762)
SY_AGR	AUS	PROKON (53)	
SY_AIRBAG	AUS	PROKON (53)	AEKP (970)
SY_ATR	AUS	PROKON (53)	LAMKO (729)
SY_BLOOP	EIN		BGDVE (934)
SY_CAN	AUS	PROKON (53)	
SY_CDCSIZE	AUS	PROKON (53)	
SY_CDKSIZE	AUS	PROKON (53)	
SY_CDTSIZE	AUS	PROKON (53)	
SY_CLASIZE	AUS	PROKON (53)	
SY_CONFSL	AUS	PROKON (53)	
SY_DELFCMS	AUS	PROKON (53)	SCATT (1097)
SY_DFPMENV	EIN		DFPM (1132)
SY_DFPMTIM	AUS	PROKON (53)	DFPM (1132)
SY_DFPMVAR	AUS	PROKON (53)	DFPM (1132)
SY_DGANZ	AUS	PROKON (53)	
SY_DLS	AUS	PROKON (53)	
SY_DOPZW	AUS	PROKON (53)	
SY_DTANKL	AUS	PROKON (53)	
SY_DVEADA	AUS	PROKON (53)	
SY_EGAS	AUS	PROKON (53)	LREB (739)
SY_EGFE	AUS	PROKON (53)	
SY_ENVBLOK	EIN		DFPM (1132)
SY_FCMSIZE	AUS	PROKON (53)	DFPM (1132)
SY_FFCSIZE	AUS	PROKON (53)	
SY_FFESIZE	AUS	PROKON (53)	DFPM (1132)
SY_FFTSIZE	AUS	PROKON (53)	
SY_FLUQ	AUS	PROKON (53)	
SY_FREQCPU	AUS	PROKON (53)	DMDTSB (159)
SY_GAP	AUS	PROKON (53)	ALE (136), GGDPG (74), WANWKW (125), NLDG (157)
SY_GDWRT	EIN		ALE (136)
SY_GGGTS	AUS	PROKON (53)	
SY_GRDWRT	AUS	PROKON (53)	DMDTSB (159)
SY_HYBRID	AUS	PROKON (53)	
SY_INGASOS	LOK	BGNG (121)	
SY_ISOPROT	AUS	PROKON (53)	
SY_KMTR	AUS	PROKON (53)	
SY_KOAC	EIN		KOS (896)
SY_KS1	AUS	PROKON (53)	
SY_KS2	AUS	PROKON (53)	
SY_KS3	AUS	PROKON (53)	
SY_KS4	AUS	PROKON (53)	
SY_KWP71	AUS	PROKON (53)	
SY_LAMBTS	AUS	PROKON (53)	LAMBTS (732)
SY_LLR	AUS	PROKON (53)	
SY_M1I00A	AUS	PROKON (53)	TC1MOD (1100)
SY_M1I00B	AUS	PROKON (53)	TC1MOD (1100)
SY_M1I00C	AUS	PROKON (53)	TC1MOD (1100)
SY_M1I00D	AUS	PROKON (53)	TC1MOD (1100)
SY_M1I20A	EIN		TC1MOD (1100)
SY_M1I20B	EIN		TC1MOD (1100)
SY_M1I20C	EIN		TC1MOD (1100)
SY_M1I20D	EIN		TC1MOD (1100)
SY_M2I00A	AUS	PROKON (53)	TC2MOD (1107)
SY_M2I00B	AUS	PROKON (53)	TC2MOD (1107)
SY_M2I00C	AUS	PROKON (53)	TC2MOD (1107)
SY_M2I00D	AUS	PROKON (53)	TC2MOD (1107)
SY_M5IH00A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH00B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH00C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH00D	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH20A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH20B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH20C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IH20D	AUS	PROKON (53)	TC5MOD (1110)

Symbol	Type	Created within	Used within
SY_M5IH40A	AUS	PROKON (53)	
SY_M5IH40B	AUS	PROKON (53)	
SY_M5IH40C	AUS	PROKON (53)	
SY_M5IH40D	AUS	PROKON (53)	
SY_M5IH60A	AUS	PROKON (53)	
SY_M5IH60B	AUS	PROKON (53)	
SY_M5IH60C	AUS	PROKON (53)	
SY_M5IH60D	AUS	PROKON (53)	
SY_M5IH80A	AUS	PROKON (53)	
SY_M5IH80B	AUS	PROKON (53)	
SY_M5IH80C	AUS	PROKON (53)	
SY_M5IH80D	AUS	PROKON (53)	
SY_M5IV00A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV00B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV00C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV00D	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV20A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV20B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV20C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV20D	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV40A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV40B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV40C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV40D	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV60A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV60B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV60C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV60D	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV80A	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV80B	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV80C	AUS	PROKON (53)	TC5MOD (1110)
SY_M5IV80D	AUS	PROKON (53)	TC5MOD (1110)
SY_M6I00A	AUS	PROKON (53)	TC6MOD (1112)
SY_M6I00B	AUS	PROKON (53)	TC6MOD (1112)
SY_M6I00C	AUS	PROKON (53)	TC6MOD (1112)
SY_M6I00D	AUS	PROKON (53)	TC6MOD (1112)
SY_M7VAR	EIN		SCATT (1097)
SY_M8I00A	AUS	PROKON (53)	
SY_M8I00B	AUS	PROKON (53)	SCATT (1097), TC8MOD (1120)
SY_M8I00C	AUS	PROKON (53)	SCATT (1097), TC8MOD (1120)
SY_M8I00D	AUS	PROKON (53)	SCATT (1097), TC8MOD (1120)
SY_M8I00E	AUS	PROKON (53)	SCATT (1097), TC8MOD (1120)
SY_M9I00A	EIN		SCATT (1097), TC9MOD (1121)
SY_M9I00B	EIN		SCATT (1097), TC9MOD (1121)
SY_M9I00C	EIN		SCATT (1097), TC9MOD (1121)
SY_M9I00D	EIN		SCATT (1097), TC9MOD (1121)
SY_MAX_EV	AUS	PROKON (53)	
SY_NLDG	AUS	PROKON (53)	GGDPG (74)
SY_NWS	AUS	PROKON (53)	DNWS (622), MDBAS (529), ZWGRU (634), WANWKW (125), VS_VERST (67)
SY_NZUEB	AUS	PROKON (53)	
SY_PBRPW	AUS	PROKON (53)	
SY_PGRAD	AUS	PROKON (53)	DPH (144), GGDPG (74), WANWKW (125)
SY_PGRAD2	AUS	PROKON (53)	DDG (141), DPH (144), GGDPG (74), WANWKW (125), DNWKW (134)
SY_PGTPO	EIN		GGDPG (74)
SY_PH2OFST	AUS	PROKON (53)	DPH (144), GGDPG (74)
SY_PHTWIN	AUS	PROKON (53)	DNWS (622)
SY_REDMX	AUS	PROKON (53)	
SY_SGANZ	AUS	PROKON (53)	GGDPG (74)
SY_STEREO	AUS	PROKON (53)	
SY_STERHK	AUS	PROKON (53)	DHLSHK (1154), DLSA (398), HLS (392), LR (768), LRHK (781), LREB (739), TC6MOD (1112), TC1MOD (1100), LRKA (795), GGLSH (318), DLSAHK (339)
SY_STERSY	AUS	PROKON (53)	DLSA (398), LRKA (795), LRHK (781), LR (768)
SY_STERVK	AUS	PROKON (53)	DHLSVK (29), DHLSVKE (902), DKVS (811), TC6MOD (1112), TC2MOD (1107), TC1MOD (1100), RKTI (979), LRKA (795), LRHK (781), LREB (739), LR (768), LAMKO (729), LAKH (735), HLS (392), GGLSV (382), ESUKA (711), DLSA (398)
SY_STETLR	AUS	PROKON (53)	DLSSA (350), TC6MOD (1112), GGLSV (382), LAKH (735)
SY_SU	AUS	PROKON (53)	
SY_SWE_S	AUS	PROKON (53)	
SY_TAGR	AUS	PROKON (53)	
SY_TCNS	AUS	PROKON (53)	
SY_TDZW	AUS	PROKON (53)	
SY_TEBF	AUS	PROKON (53)	AEKP (970)
SY_TEETH	AUS	PROKON (53)	ALE (136), GGDPG (74), NLDG (157), BGNMOT (111)
SY_TFA	AUS	PROKON (53)	
SY_TFBA	AUS	PROKON (53)	
SY_TFMA	AUS	PROKON (53)	GGTFM (289)
SY_TFMAP	AUS	PROKON (53)	GGTFA (298)
SY_TFMHST	EIN		GGTFM (289)
SY_TFMO	AUS	PROKON (53)	GGTFM (289)

Symbol	**Type**	**Created within**	**Used within**
SY_TFNS	AUS	PROKON (53)	
SY_TFRK	AUS	PROKON (53)	ESGRU (678)
SY_TFST	AUS	PROKON (53)	
SY_TFUMG	AUS	PROKON (53)	GGTFM (289)
SY_TFVA	AUS	PROKON (53)	
SY_TFWL	AUS	PROKON (53)	
SY_TLR	AUS	PROKON (53)	LR (768)
SY_TMDR	AUS	PROKON (53)	
SY_TN	AUS	PROKON (53)	
SY_TNLS	AUS	PROKON (53)	
SY_TRLX	AUS	PROKON (53)	
SY_TSFSIZE	AUS	PROKON (53)	
SY_TURBO	AUS	PROKON (53)	LAMFAW (728), VS_VERST (67), MDMAX (514), MDFUE (594)
SY_TVVR	AUS	PROKON (53)	VMAXMD (588)
SY_TWDKS	EIN		ADVE (918), BGDVE (934)
SY_UB13V	AUS	PROKON (53)	
SY_UBDEDIS	AUS	PROKON (53)	ADVE (918)
SY_UBDEEN	AUS	PROKON (53)	ADVE (918)
SY_UBKL15	EIN		GGUB (487)
SY_UBOKDIS	AUS	PROKON (53)	
SY_UBOKEN	AUS	PROKON (53)	
SY_UBR	AUS	PROKON (53)	BGDVE (934), GGUB (487), SREAKT (963)
SY_UBSQ_W	EIN		BGDVE (934), GGUB (487)
SY_UMALS	AUS	PROKON (53)	
SY_USOFF	AUS	PROKON (53)	
SY_VS	EIN		LREB (739)
SY_WMAX	AUS	PROKON (53)	
SY_WMIN	AUS	PROKON (53)	
SY_WNBM	AUS	PROKON (53)	ALE (136), NLDG (157), WANWKW (125)
SY_ZAS	AUS	PROKON (53)	
SY_ZNDAUS	AUS	PROKON (53)	KRRA (639)
SY_ZSGMT	EIN		WANWKW (125)
SY_ZYLZA	AUS	PROKON (53)	ALE (136), GGDPG (74), BGNMOT (111), BGRLG (274), BGNG (121)
SY_ZZBANK	AUS	PROKON (53)	
SZFUBA_W	AUS	ZUESZ (632)	
SZOUT_W	AUS	MSF (506)	ZUESZ (632), AZUE (904)
SZTCALC_W	AUS	ZUESZ (632)	
S_AC	EIN		KOS (896), LLRNS (562)
S_ASR	AUS	CAN (1124)	
S_BLS	EIN		EGEG (453), GGEGAS (474), UFFGRE (1096)
S_BRS	EIN		EGEG (453), UFFGRE (1096), GGEGAS (474)
S_FGRHS	EIN		UFFGRE (1096)
S_FGRSB	EIN		UFFGRE (1096)
S_FGRSV	EIN		UFFGRE (1096)
S_FGRWA	EIN		UFFGRE (1096)
S_FS	AUS	SWADAP (47)	BBGANG (501), MDWAN (554)
S_KO	AUS	SWADAP (47)	LLRNS (562)
S_KUPP	EIN		EGEG (453), GGEGAS (474)
S_ML1	EIN		LFS (69)
S_ML2	EIN		LFS (69)
S_MSR	AUS	CAN (1124)	
S_POEL	EIN		GGPOEL (296)
T	EIN		BGNMOT (111), NLDG (157), WANWKW (125), GGDPG (74)
TABGM	AUS	ATM (20)	DFFT (1140), DHLSVK (29), DLSA (398), DLSV (301), HLS (392), DLSAHK (339)
TABGM2	AUS	ATM (20)	DFFT (1140), DLSV (301), DLSAHK (339), HLS (392), DLSA (398), DHLSVK (29)
TABGM2_W	AUS	ATM (20)	
TABGMAB	LOK	ATM (20)	
TABGMAB2	LOK	ATM (20)	
TABGMF	DOK	DHLSVK (29)	
TABGMST	LOK	ATM (20)	
TABGMST2	LOK	ATM (20)	
TABGM_W	AUS	ATM (20)	BGTEMPK (252), LAMBTS (732)
TABGSANT_W	LOK	BGTEMPK (252)	
TABSMN_W	LOK	BGTABST (1030)	
TABSNL_W	LOK	BGTABST (1030)	
TABSSC_W	LOK	BGTABST (1030)	
TABST	EIN		AK (855)
TABSTATM	LOK	ATM (20)	
TABSTMX_W	LOK	ATM (20)	
TABSTM_W	LOK	BGTABST (1030)	
TABST_W	AUS	BGTABST (1030)	AEKP (970), ATM (20), ESSTT (679), GGTFM (289), WDKSOM (614), ESNSWL (691)
TADTEA	AUS	DTEV (856)	ATEV (969), GKRA (766)
TADTEAZS	LOK	DTEV (856)	
TAGAV	DOK	BGAGR (263)	
TAGRV	LOK	BGAGR (263)	
TAGRV_W	DOK	BGAGR (263)	
TAGS_W	AUS	BGAGR (263)	EGFE (228), BGTEMPK (252)
TAKOLS	EIN		MDVERB (540)
TALT_UM	LOK	UFNC (1063)	

Symbol	Type	Created within	Used within
TANKFST	EIN		GGFST (502)
TANS	AUS	GGTFA (298)	SWADAP (47), AK (855), BBKHZ (890), BGAGR (263), BGDVE (934), BGTEMPK (252), DLLR (578), DFFT (1140), ZWWL (638), ZWSTT (637), WDKSOM (614), UFUE (1056), UFEING (1058), TEB (826), SU (617), NWS (618), MDZUL (523), MDVERB (540), LREB (739), LRAEB (759), LLRNS (562), LLRMR (572), KOS (896), GGTFM (289), GGHFM (230), ESSTT (679), ESNSWL (691), EGFE (228), DMDSTP (205), BGTABST (1030), BBSTT (148), BBTEGA (750), ATM (20)
TANSAB	AUS	GGTFA (298)	ESSTT (679), GGTFM (289)
TANSABK_W	AUS	GGTFA (298)	
TANSK_W	AUS	GGTFA (298)	
TANSLIN	AUS	GGTFA (298)	TC1MOD (1100)
TANSST	LOK	LREB (739)	
TANS_UM	AUS	UFEING (1058)	UFNSC (1077), UFUE (1056)
TAS_W	LOK	BGRLG (274)	
TATEIST	LOK	BGTEV (257)	
TATEOUT	AUS	ATEV (969)	DTEV (856), DTEVE (1022)
TATESLO1	LOK	BGTEV (257)	
TATESLO2	LOK	BGTEV (257)	
TATESLO3	LOK	BGTEV (257)	
TATESOLL	AUS	ATEV (969)	GKRA (766), BGTEV (257), GKEB (737), TEBEB (762)
TATMKF	LOK	ATM (20)	
TATMKF2	LOK	ATM (20)	
TATMSTA	LOK	ATM (20)	
TATMSTA2	LOK	ATM (20)	
TATU	LOK	ATM (20)	
TAVHKM_W	EIN		BBSAWE (557)
TAVVKM_W	EIN		BBSAWE (557)
TBRRAUM_W	LOK	BGTEMPK (252)	
TC6KATA	AUS	DKAT (361)	
TC6KATC	AUS	DKAT (361)	TC6MOD (1112)
TC6KATC2	AUS	DKAT (361)	TC6MOD (1112)
TC6KATS	AUS	DKAT (361)	TC6MOD (1112)
TC6KATS2	AUS	DKAT (361)	TC6MOD (1112)
TC6KATW	AUS	DKAT (361)	TC6MOD (1112)
TC6KATW2	AUS	DKAT (361)	TC6MOD (1112)
TC6LDPC	EIN		TC6MOD (1112)
TC6LDPS	EIN		TC6MOD (1112)
TC6LDPW	EIN		TC6MOD (1112)
TC6TESC	AUS	DTEV (856)	TC6MOD (1112)
TC6TESS	AUS	DTEV (856)	TC6MOD (1112)
TC6TESW	AUS	DTEV (856)	TC6MOD (1112)
TCAP_UM	LOK	UFNC (1063)	
TDDSTST	DOK	DDST (851)	
TDIF_UM	LOK	UFNC (1063)	
TDKNACH_W	LOK	BGDVE (934)	
TDLRTM	AUS	GGTFM (289)	
TDTESTA	LOK	DTEV (856)	
TDTETEVO	LOK	DTEV (856)	
TE2_W	EIN		TEB (826)
TEMPIN	LOK	BGTEMPK (252)	
TEPHC	LOK	BBTEGA (750)	
TEVPER	AUS	ATEV (969)	BGTEV (257)
TEVPERO1	LOK	BGTEV (257)	
TEVPERO2	LOK	BGTEV (257)	
TEVPERO3	LOK	BGTEV (257)	
TEVPERVZ	LOK	BGTEV (257)	
TEXOIKM2_W	LOK	ATM (20)	
TEXOIKM_W	LOK	ATM (20)	
TEXOM2_W	LOK	ATM (20)	
TEXOM_W	LOK	ATM (20)	
TE_W	EIN		BGRLP (266), TEB (826)
TFETTIF_W	LOK	LR (768)	
TFETTIMA_W	LOK	LR (768)	
TFETTIM_W	LOK	LR (768)	
TFETTMA_W	LOK	LR (768)	
TFETTSL_W	LOK	LR (768)	
TFRGSANT_W	LOK	BGTEMPK (252)	
TFRN2_W	AUS	LR (768)	DLSA (398), DLSSA (350)
TFRNINT2_W	LOK	LR (768)	
TFRNINT_W	LOK	LR (768)	
TFRN_W	AUS	LR (768)	DLSA (398), DLSSA (350)
TFRP2_W	EIN		DLSA (398), LR (768)
TFRPINT2_W	LOK	LR (768)	
TFRPINT_W	LOK	LR (768)	
TFRP_W	EIN		DLSA (398), LR (768)
TFST	AUS	GGFST (502)	DFFT (1140), DMDMIL (216)
TFWDKSOM_W	AUS	WDKSOM (614)	FUEDK (597)
TFWDKS_W	LOK	FUEDK (597)	
THHAIST	LOK	HLS (392)	
THHAIST2	LOK	HLS (392)	
THHAT	LOK	HLS (392)	

Symbol	Type	Created within	Used within
THHAT2	LOK	HLS (392)	
THVAIST	LOK	HLS (392)	
THVAIST2	LOK	HLS (392)	
THVAT	LOK	HLS (392)	
THVAT2	LOK	HLS (392)	
TI2_W	AUS	RKTI (979)	
TIKATM	AUS	ATM (20)	DKAT (361), LRHK (781)
TIKATM2	AUS	ATM (20)	DKAT (361), LRHK (781)
TIKATM2_W	AUS	ATM (20)	
TIKATM_W	AUS	ATM (20)	
TIMMOT	EIN		DCKUP (1128)
TIMMOT_W	EIN		DCAS (1128), DCINS (1126), DVKUP (1027)
TINKR	AUS	AZUE (904)	
TISPLDPX_W	EIN		DTEV (856)
TISPLDP_W	EIN		DTEV (856)
TI_B1	AUS	RKTI (979)	ACIFI (1013), AES (973)
TI_B2	AUS	RKTI (979)	ACIFI (1013), AES (973)
TI_EV0	AUS	ACIFI (1013)	AES (973)
TI_EV1	LOK	AES (973)	
TI_EV7	AUS	AES (973)	
TI_EV8	LOK	AES (973)	
TI_TVU_W	AUS	RKTI (979)	ACIFI (1013), AES (973)
TI_W	AUS	RKTI (979)	
TKATM	AUS	ATM (20)	AK (855), DFFT (1140), DHLSHK (1154), DKAT (361), DLSH (330), HLS (392), BBSAWE (557), LRHK (781), BBKHZ (890)
TKATM2	AUS	ATM (20)	DFFT (1140), LRHK (781), HLS (392), DLSH (330), DHLSHK (1154), DKAT (361)
TKATM2_W	AUS	ATM (20)	LRKA (795)
TKATMAB	LOK	ATM (20)	
TKATMAB2	LOK	ATM (20)	
TKATMF	LOK	DHLSHK (1154)	
TKATMF2	LOK	DHLSHK (1154)	
TKATMST	LOK	ATM (20)	
TKATMST2	LOK	ATM (20)	
TKATM_W	AUS	ATM (20)	LRKA (795)
TKDKTE	LOK	DKAT (361)	
TKDKTE2	LOK	DKAT (361)	
TKDKTH	LOK	DKAT (361)	
TKDKTH2	LOK	DKAT (361)	
TKDKTHP	LOK	DKAT (361)	
TKDKTHP2	LOK	DKAT (361)	
TLFSAR_W	LOK	LFS (69)	
TLOK	LOK	MDVERB (540)	
TLOOP	LOK	BGDVE (934)	
TMADB	LOK	STADAP (684)	
TMAGERMA_W	LOK	LR (768)	
TMAGERSL_W	LOK	LR (768)	
TMAGRIF_W	LOK	LR (768)	
TMAGRIMA_W	LOK	LR (768)	
TMAGRIM_W	LOK	LR (768)	
TMCORCTR_W	AUS	GGDPG (74)	
TMEW	AUS	GGTFM (289)	DFFT (1140)
TMEWAB	AUS	GGTFM (289)	
TMFA_W	AUS	GGKS (412)	
TMFLN_W	EIN		DKRNT (445), GGKS (412)
TMFL_W	AUS	GGKS (412)	
TMISCHBR_W	LOK	BGTEMPK (252)	
TMKI	EIN		KOS (896)
TMKIC	EIN		GGTFM (289)
TMOT	AUS	GGTFM (289)	SWADAP (47), ACIFI (1013), GGKS (412), GGDPG (74), FUEREG (595), ESVW (1009), EGFE (228), DWUC (1147), DVFZ (500), DTEV (856), DNWS (622), DLSH (330), DLLR (578), DFFTK (1142), DFFT (1140), BGTEMPK (252), BGDVE (934), BBSTT (148), BBKHZ (890), ATWAL (297), ATM (20), ARMD (531), KRDY (659), KOS (896), KHMD (894), HLS (392), ESUKA (711), ESUK (699), ESNSWL (691), DMDSTP (205), ZWWL (638), ZWMIN (669), ZUESZ (632), WANWKW (125), UFUE (1056), UFEING (1058), TEBEB (762), TEB (826), SU (617), RDE (112), NWS (618), NMAXMD (584), NLPH (150), NLDG (157), MDZUL (523), MDVERAD (549), MDVER (546), MDRED (976), MDKOG (516), MDFUE (594), MDFAW (508), MDBGRG (530), MDBAS (529), LREB (739), LRAEB (759), LRA (797), LR (768), LLRRM (566), LLRNS (562), LLRMR (572), LLRBB (575), LFS (69), LAMKO (729), LAKH (735), KRRA (639), DMDMIL (216), DMDLU (193), DLSV (301), AK (855)
TMOTAB	AUS	GGTFM (289)	AEKP (970), DLSV (301), DLSH (330), ESSTT (679), BGTABST (1030)
TMOTDIF	LOK	BGTEMPK (252)	
TMOTFIL	LOK	BGTEMPK (252)	
TMOTLIN	AUS	GGTFM (289)	DFFTCNV (1143), TC1MOD (1100), LREB (739)
TMOTLIN_W	AUS	GGTFM (289)	
TMOTST	AUS	SWADAP (47)	
TMOTVT	LOK	GGTFM (289)	
TMOT_U	AUS	DFFTCNV (1143)	DFFT (1140)
TMOT_UM	AUS	UFEING (1058)	UFNSC (1077), UFUE (1056)

Symbol	Type	Created within	Used within
TMPUMAST	LOK	BGDVE (934)	
TMRW	AUS	GGTFM (289)	LREB (739)
TMRWEND	LOK	GGTFM (289)	
TMST	AUS	GGTFM (289)	AK (855), ZWWL (638), ZWSTT (637), WDKSOM (614), STADAP (684), LLRNS (562), KOS (896), DKAT (361), DDST (851), BGTABST (1030), ATM (20), BBKHZ (890), BBSAWE (557), BBTEGA (750), BBBO (853), LREB (739), LR (768), ESVW (1009), ESUK (699), ESSTT (679), ES-NSWL (691), EGAG (486)
TMSTEM	LOK	DWUC (1147)	
TN2	EIN		GGKS (412)
TN2FGR_W	LOK	FGRREGL (1174)	
TNACHL_W	AUS	MOTAUS (1028)	AEKP (970), BGDVE (934)
TNBM1_W	AUS	GGDPG (74)	BGNMOT (111)
TNBM2_W	AUS	GGDPG (74)	
TNBMPHS0_W	LOK	NLDG (157)	
TNBMRDE	LOK	RDE (112)	
TNBMRDE1	LOK	RDE (112)	
TNBMRDE2	LOK	RDE (112)	
TNBM_W	AUS	GGDPG (74)	WANWKW (125), BGNMOT (111)
TNSE_W	AUS	BBSTT (148)	BBTEGA (750), DTEV (856), DLLR (578)
TNST	EIN		AK (855), LR (768), LLRNS (562)
TNST_W	AUS	BBSTT (148)	BBKHZ (890), DMDSTP (205), ZWMIN (669), NWS (618), ESUKA (711), DMDFON (161), DNWS (622)
TNTEVZU	LOK	DTEV (856)	
TNTIMER	EIN		BGPU (276)
TOEL	EIN		GGTFM (289)
TOOTH_RALE	LOK	ALE (136)	
TOP_W	AUS	DTOP (1145)	
TPCORCTR_W	AUS	GGDPG (74)	
TPH1_W	DOK	NLDG (157)	
TPLDPTCX_W	EIN		DTEV (856)
TPLDPTC_W	EIN		DTEV (856)
TPLRVK2_W	AUS	LR (768)	DLSA (398)
TPLRVK_W	AUS	LR (768)	DLSA (398)
TPNT_AKTIV	AUS	EGKE (409)	DKRNT (445), KRRA (639), KRKE (427), DKRTP (451), GGKS (412)
TPOTV2_W	LOK	DLSA (398)	
TPOTV_W	LOK	DLSA (398)	
TPSVKMF2_U	AUS	DFFTCNV (1143)	DFFT (1140)
TPSVKMF2_W	AUS	DLSA (398)	DFFTCNV (1143), DKAT (361), DLSSA (350)
TPSVKMF_U	AUS	DFFTCNV (1143)	DFFT (1140)
TPSVKMF_W	AUS	DLSA (398)	DFFTCNV (1143), DKAT (361), DLSSA (350)
TPSVKOF2_W	LOK	DLSA (398)	
TPSVKOF_W	LOK	DLSA (398)	
TPSVLSA2	AUS	DLSSA (350)	
TPSVLSSA	AUS	DLSSA (350)	
TPSVLSSA2	AUS	DLSSA (350)	
TR_ZAHN	EIN		AZUE (904)
TR_ZEIT	EIN		AZUE (904)
TS01	LOK	DMDFON (161)	
TS02	LOK	DMDFON (161)	
TS03	LOK	DMDFON (161)	
TS04	LOK	DMDFON (161)	
TS05	LOK	DMDFON (161)	
TS06	LOK	DMDFON (161)	
TS07	LOK	DMDFON (161)	
TS08	LOK	DMDFON (161)	
TSAKA	LOK	LRKA (795)	
TSAKA2	LOK	LRKA (795)	
TSAS_W	LOK	BGNG (121)	
TSEGHI	AUS	BGNMOT (111)	
TSEGPH_W	LOK	NLDG (157)	
TSEGRSP_W	AUS	BGNG (121)	BGRLG (274)
TSEG_W	AUS	BGNMOT (111)	AZUE (904), BGNG (121)
TSGES_W	LOK	BGTEMPK (252)	
TSK	AUS	DMDFON (161)	DMDLU (193)
TSK01	LOK	DMDFON (161)	
TSK02	LOK	DMDFON (161)	
TSK03	LOK	DMDFON (161)	
TSK04	LOK	DMDFON (161)	
TSK05	LOK	DMDFON (161)	
TSK06	LOK	DMDFON (161)	
TSK07	LOK	DMDFON (161)	
TSK08	LOK	DMDFON (161)	
TSK_M	LOK	DMDFON (161)	
TSPERR	LOK	LR (768)	
TSPERR2	LOK	LR (768)	
TSROH2_W	AUS	DMDTSB (159)	DMDFON (161)
TSROH_W	AUS	DMDTSB (159)	DMDFON (161)
TSWK	LOK	FGRFULO (1160)	
TS_M	LOK	DMDFON (161)	
TTMUMAD	LOK	BGDVE (934)	
TTOOTH10MS	AUS	GGDPG (74)	ALE (136)

Symbol	Type	Created within	Used within
TUM	LOK	GGTFM (289)	
TUMC	EIN		MDVERB (540)
TUMG	EIN		ATM (20), DFFT (1140), BGTABST (1030)
TUMTA	LOK	BGTABST (1030)	
TUM_EIN	EIN		MDVERB (540), BGTABST (1030)
TUSPNF	AUS	DLSSA (350)	
TUSPNF2	AUS	DLSSA (350)	
TV	LOK	LR (768)	
TV2	LOK	LR (768)	
TVDKTTK	LOK	DKAT (361)	
TVDKTTK2	LOK	DKAT (361)	
TVFRRDTE	LOK	DTEV (856)	
TVLR	LOK	LR (768)	
TVLR2	LOK	LR (768)	
TVLRH	AUS	LRHK (781)	LR (768), GKRA (766)
TVLRH2	AUS	LRHK (781)	LR (768), GKRA (766)
TVLRHI	AUS	LRHK (781)	LR (768)
TVLRHI2	AUS	LRHK (781)	LR (768)
TVLRHP	LOK	LRHK (781)	
TVLRHP2	LOK	LRHK (781)	
TVRNR	LOK	AEVAB (980)	
TVSAA	LOK	BBSAWE (557)	
TVSANS	LOK	BBSAWE (557)	
TVU	EIN		BGRLP (266)
TVU_W	EIN		RKTI (979), AES (973)
TWAN	AUS	SWADAP (47)	MDWAN (554)
TWDLSSA2_W	LOK	DLSSA (350)	
TWDLSSA_W	LOK	DLSSA (350)	
TWDLSSH2_W	LOK	DLSSA (350)	
TWDLSSH_W	LOK	DLSSA (350)	
TYP_LASH	AUS	DLSAHK (339)	
TYP_LASH2	AUS	DLSAHK (339)	
TYP_LATP	LOK	DLSA (398)	
TYP_LATP2	LOK	DLSA (398)	
TYP_LATV	LOK	DLSA (398)	
TYP_LATV2	LOK	DLSA (398)	
TYP_LSH	AUS	DLSH (330)	
TYP_LSH2	AUS	DLSH (330)	
TZ2FGR_W	LOK	FGRREGL (1174)	
TZLSATV	LOK	DLSA (398)	
TZLSATV2	LOK	DLSA (398)	
TZND	AUS	AZUE (904)	
TZWMNNST_W	LOK	ZWMIN (669)	
UADKI	EIN		EGKE (409), GGKS (412)
UADMFA	LOK	GGKS (412)	
UB	AUS	GGUB (487)	SWADAP (47), ADVE (918), AEKP (970), AES (973), ZUESZ (632), STADAP (684), RDE (112), MOTAUS (1028), HLS (392), GGDVE (477), EGFE (228), DLSV (301), DLSH (330), DHLSVK (29), DHLSHK (1154), DHFM (233), DFFT (1140), DECJ (1013), DCKUP (1128), DCINS (1126), DCAS (1128), CAN (1124), BGLBZ (489), BGDVE (934), ATEV (969), EGAG (486)
UBF	LOK	BGLBZ (489)	
UBRDE	LOK	RDE (112)	
UBRSQ	EIN		BGDVE (934)
UBRSQ_W	EIN		GGUB (487)
UBSOL	LOK	BGLBZ (489)	
UBSQ	AUS	GGUB (487)	LFS (69)
UBSQF	AUS	GGUB (487)	
UBSQF_W	AUS	GGUB (487)	
UBSQ_W	AUS	GGUB (487)	
UBUANLR	LOK	BGDVE (934)	
UDKNLP1	EIN		ADVE (918), BGDVE (934)
UDKNLP1R	LOK	BGDVE (934)	
UDKNLP2	EIN		ADVE (918), BGDVE (934)
UDKNLP2R	LOK	BGDVE (934)	
UDKP1A	AUS	BGDVE (934)	UFRLC (1066), UFUE (1056)
UDKP1AALT	LOK	BGDVE (934)	
UDKP1ASR_W	LOK	BGDVE (934)	
UDKP1AS_W	AUS	BGDVE (934)	
UDKP1A_W	AUS	BGDVE (934)	GGDVE (477)
UDKP1ROB	LOK	BGDVE (934)	
UDKP1RUN	LOK	BGDVE (934)	
UDKP1SV	AUS	BGDVE (934)	GGDVE (477)
UDKP1VOR	LOK	BGDVE (934)	
UDKP1VOU	AUS	BGDVE (934)	
UDKP1VO_W	AUS	BGDVE (934)	GGDVE (477)
UDKP1VROB	LOK	BGDVE (934)	
UDKP1VRUN	LOK	BGDVE (934)	
UDKP1VV	AUS	BGDVE (934)	
UDKP1VVR	LOK	BGDVE (934)	
UDKP1VV_W	AUS	BGDVE (934)	GGDVE (477)
UDKP1V_W	EIN		BGDVE (934), GGDVE (477)

Symbol	Type	Created within	Used within
UDKP1_U	AUS	DFFTCNV (1143)	DFFT (1140)
UDKP1_W	EIN		ADVE (918), BGDVE (934), DFFTCNV (1143), GGDVE (477)
UDKP2A	AUS	BGDVE (934)	UFRLC (1066), UFUE (1056)
UDKP2AALT	LOK	BGDVE (934)	
UDKP2ASR_W	LOK	BGDVE (934)	
UDKP2AS_W	AUS	BGDVE (934)	
UDKP2A_W	AUS	BGDVE (934)	GGDVE (477)
UDKP2_U	AUS	DFFTCNV (1143)	DFFT (1140)
UDKP2_W	EIN		ADVE (918), DFFTCNV (1143), BGDVE (934), GGDVE (477)
UDKPATR_W	LOK	BGDVE (934)	
UDKPAT_W	LOK	BGDVE (934)	
UDKSNOA_W	LOK	DKRS (437)	
UDKSNUA_W	LOK	DKRS (437)	
UDSM_W	LOK	EGFE (228)	
UDSS_W	EIN		EGFE (228)
UEFKTGET	EIN		BBGANG (501)
UEVGES	AUS	BBGANG (501)	FGRFULO (1160), FGRREGL (1174)
UEVGES_W	LOK	FGRREGL (1174)	
UFST_W	EIN		GGFST (502)
UHAGR	LOK	EGAG (486)	
UHFM_W	EIN		DHFM (233), EGFE (228), GGHFM (230)
UHSH	EIN		DFFT (1140), DHLSHK (1154)
UHSH2	EIN		DFFT (1140), DHLSHK (1154)
UHSV	EIN		DFFT (1140)
UHSV2	EIN		DFFT (1140)
UMSRLN_W	AUS	BGMSZS (239)	BGAGR (263), BGSRM (245), BGPU (276), FUEDK (597), DTEV (856), BGRLP (266), EGFE (228)
UPW2LL_W	LOK	GGPED (454)	
UPWG1_U	AUS	DFFTCNV (1143)	DFFT (1140)
UPWG1_W	EIN		DFFTCNV (1143), GGPED (454), EGEG (453)
UPWG2D_U	AUS	DFFTCNV (1143)	DFFT (1140)
UPWG2D_W	EIN		DFFTCNV (1143), GGPED (454)
UPWG2FIL_W	LOK	GGPED (454)	
UPWG2_U	AUS	DFFTCNV (1143)	DFFT (1140)
UPWG2_W	EIN		DFFTCNV (1143), EGEG (453), GGPED (454)
UPWGEJ_W	LOK	GGPED (454)	
UPWG_W	LOK	GGPED (454)	
URDDKTP	LOK	DKAT (361)	
URDDKTP2	LOK	DKAT (361)	
URL2SU_W	AUS	BGSRM (245)	
URL3SU_W	AUS	BGSRM (245)	
URLSU_W	AUS	BGSRM (245)	
URL_W	AUS	BGSRM (245)	
URMCKSCO	LOK	URMEM (1044)	
URMCKSDA	LOK	URMEM (1044)	
URMPATCO	LOK	URMEM (1044)	
USBEH2_W	LOK	GGLSH (318)	
USBEH_W	LOK	GGLSH (318)	
USBEV2_W	LOK	GGLSV (382)	
USBEV_W	LOK	GGLSV (382)	
USHDKTP	LOK	DKAT (361)	
USHDKTP2	LOK	DKAT (361)	
USHFMXSTG	LOK	DLSAHK (339)	
USHFMXSTG2	LOK	DLSAHK (339)	
USHK	AUS	GGLSH (318)	DFFT (1140), DLSA (398), DKAT (361), TC1MOD (1100), LRKA (795), GKRA (766), DLSSA (350), DLSH (330), DLSAHK (339)
USHK2	AUS	GGLSH (318)	DFFT (1140), DLSAHK (339), DLSSA (350), DLSH (330), DLSA (398), TC1MOD (1100), LRKA (795), GKRA (766), DKAT (361)
USHK2_W	AUS	GGLSH (318)	SWADAP (47), DLSV (301), LRHK (781)
USHKJ	LOK	DLSSA (350)	
USHKJ2	LOK	DLSSA (350)	
USHKJF2_W	LOK	DLSSA (350)	
USHKJF_W	LOK	DLSSA (350)	
USHKMXSTG	LOK	DLSAHK (339)	
USHKMXSTG2	LOK	DLSAHK (339)	
USHKR2_W	LOK	GGLSH (318)	
USHKR_W	LOK	GGLSH (318)	
USHKSTEIG	LOK	DLSAHK (339)	
USHKSTEIG2	LOK	DLSAHK (339)	
USHK_W	AUS	GGLSH (318)	SWADAP (47), DLSV (301), LRHK (781)
USMNSAA	LOK	DLSSA (350)	
USMNSAA2	LOK	DLSSA (350)	
USMNSAN	AUS	DLSSA (350)	
USMNSAN2	AUS	DLSSA (350)	
USMNSHA	LOK	DLSSA (350)	
USMNSHA2	LOK	DLSSA (350)	
USMNSHN	AUS	DLSSA (350)	
USMNSHN2	AUS	DLSSA (350)	
USMXSAA	LOK	DLSSA (350)	
USMXSAA2	LOK	DLSSA (350)	
USMXSAN	AUS	DLSSA (350)	
USMXSAN2	AUS	DLSSA (350)	

Symbol	Type	Created within	Used within
USMXSHA	LOK	DLSSA (350)	
USMXSHA2	LOK	DLSSA (350)	
USMXSHN	AUS	DLSSA (350)	
USMXSHN2	AUS	DLSSA (350)	
USOBH2_W	LOK	GGLSH (318)	
USOBH_W	LOK	GGLSH (318)	
USOBV2_W	LOK	GGLSV (382)	
USOBV_W	LOK	GGLSV (382)	
USRHK	AUS	LRHK (781)	DLSA (398), DLSAHK (339)
USRHK2	AUS	LRHK (781)	DLSA (398), DLSAHK (339)
USRJ	AUS	DLSSA (350)	
USVK	AUS	GGLSV (382)	DFFT (1140), TC1MOD (1100), DLSSA (350), LR (768), LREB (739), LRKA (795)
USVK2	AUS	GGLSV (382)	DFFT (1140), DLSSA (350), TC1MOD (1100), LRKA (795), LREB (739), LR (768)
USVK2_W	AUS	GGLSV (382)	SWADAP (47), DLSV (301), LR (768), HLS (392), GKRA (766)
USVKJ	AUS	DLSSA (350)	
USVKJ2	AUS	DLSSA (350)	
USVKJF2_W	LOK	DLSSA (350)	
USVKJF_W	LOK	DLSSA (350)	
USVKMA_W	LOK	LR (768)	
USVKR2_W	LOK	GGLSV (382)	
USVKR_W	LOK	GGLSV (382)	
USVKSL_W	LOK	LR (768)	
USVK_W	AUS	GGLSV (382)	SWADAP (47), DLSV (301), LR (768), HLS (392), GKRA (766)
USVMB2_W	LOK	GGLSV (382)	
USVMB_W	LOK	GGLSV (382)	
USVOB2_W	LOK	GGLSV (382)	
USVOB_W	LOK	GGLSV (382)	
UUSHK2_W	LOK	GGLSH (318)	
UUSHK_W	LOK	GGLSH (318)	
UUSHMB2_W	LOK	GGLSH (318)	
UUSHMB_W	LOK	GGLSH (318)	
UUSHOB2_W	LOK	GGLSH (318)	
UUSHOB_W	LOK	GGLSH (318)	
UUSVK2_W	LOK	GGLSV (382)	
UUSVK_W	LOK	GGLSV (382)	
UUSVMB2_W	LOK	GGLSV (382)	
UUSVMB_W	LOK	GGLSV (382)	
UUSVOB2_W	LOK	GGLSV (382)	
UUSVOB_W	LOK	GGLSV (382)	
UZKW_W	AUS	GGDPG (74)	DHFM (233), ESVW (1009), DNWS (622)
VAMSR_W	EIN		GGVFZG (497)
VFGRO_W	LOK	FGRREGL (1174)	
VFGR_W	AUS	GGVFZG (497)	FGRABED (491), FGRUE (490), FGRFULO (1160), FGRREGL (1174)
VFIL_W	LOK	GGVFZG (497)	
VFZG	AUS	GGVFZG (497)	SWADAP (47), ARMD (531), TC1MOD (1100), NMAXMD (584), MDWAN (554), MDFAW (508), MDBGRG (530), LLRNS (562), LLRNFA (564), LLRMR (572), LLRBB (575), KOS (896), GGUB (487), GGPED (454), FUEDK (597), DTEV (856), DSWEC (32), DMDSTP (205), DMDLU (193), DLLR (578), DFFTCNV (1143), BGTABST (1030), BGPU (276), BGDVE (934), ATM (20), BBSAWE (557)
VFZGKB_W	EIN		GGVFZG (497)
VFZGPR_W	LOK	VMAXMD (588)	
VFZG_U	AUS	DFFTCNV (1143)	BGBSZ (73), BGKMST (1008), DFFT (1140)
VFZG_UM	EIN		UFFGRC (1078), UFUE (1056)
VFZG_W	AUS	EGAG (486)	GGVFZG (497), BBGANG (501), DVKUP (1027), DDG (141), RDE (112), VMAXMD (588), UFUE (1056), MSF (506)
VFZROH_W	AUS	GGVFZG (497)	DVFZ (500), EGAG (486)
VIRKR	AUS	EGKE (409)	KRKE (427), KRDY (659)
VKR	AUS	KRKE (427)	DKRS (437), EGKE (409)
VKR_C95	AUS	KRKE (427)	GGKS (412), EGKE (409)
VKR_TST	AUS	KRKE (427)	
VLAST_W	LOK	FGRREGL (1174)	
VOFFS_W	LOK	FGRREGL (1174)	
VPSSPLS_W	EIN		FUEDK (597)
VPSSPU_W	EIN		FUEDK (597)
VREGDIA_W	AUS	BGTEV (257)	
VREGL_W	AUS	FGRFULO (1160)	FGRREGL (1174), FGRUE (490)
VROH_W	LOK	GGVFZG (497)	
VSDMR	AUS	VS_VERST (67)	MDKOL (526)
VSFPSES	AUS	VS_VERST (67)	AES (973)
VSFRK	AUS	VS_VERST (67)	ESGRU (678)
VSKE	AUS	VS_VERST (67)	KRKE (427)
VSKSML_W	AUS	BGKV (71)	
VSKS_W	AUS	BGKV (71)	
VSLDTV	AUS	VS_VERST (67)	
VSNS	AUS	VS_VERST (67)	LLRNS (562)
VSRLMX	AUS	VS_VERST (67)	
VSTCNS	EIN		LLRNS (562)
VSTFBA	EIN		ESUK (699)
VSTFNS	EIN		ESNSWL (691)

Symbol	Type	Created within	Used within
VSTFRK	EIN		ESGRU (678)
VSTFST	EIN		ESSTT (679)
VSTFVA	EIN		ESUK (699)
VSTFWL	EIN		ESNSWL (691)
VSTLR	EIN		LR (768)
VSTMDR	EIN		LLRMR (572)
VSTNLS	EIN		LLRNS (562)
VSTVVR	EIN		VMAXMD (588)
VSVW	AUS	VS_VERST (67)	ESVW (1009)
VSWNWS	AUS	VS_VERST (67)	
VSZW	AUS	VS_VERST (67)	ZUE (627)
VSZWKR	AUS	VS_VERST (67)	KRRA (639)
VSZWM	AUS	KRRA (639)	
VWKW	LOK	BGRLP (266)	
VZIELS_W	EIN		FGRFULO (1160)
VZIEL_W	AUS	FGRFULO (1160)	FGRABED (491), FGRREGL (1174), FGRUE (490)
WDK1	LOK	GGDVE (477)	
WDK1G	LOK	GGDVE (477)	
WDK2	LOK	GGDVE (477)	
WDK2G	LOK	GGDVE (477)	
WDK3	LOK	GGDVE (477)	
WDKADA_W	AUS	BGDVE (934)	ADVE (918)
WDKBA	AUS	GGDVE (477)	BGPU (276), BGTEV (257), DFFT (1140), TC1MOD (1100), LRAEB (759), GGHFM (230), EGFE (228)
WDKBAALT_W	LOK	ADVE (918)	
WDKBAB_W	LOK	BGMSZS (239)	
WDKBADMN_W	LOK	DHFM (233)	
WDKBADMX_W	LOK	DHFM (233)	
WDKBAPB_W	LOK	BGRLP (266)	
WDKBAP_L	LOK	BGWDKM (273)	
WDKBAP_W	AUS	BGWDKM (273)	BGRLP (266)
WDKBAS_W	LOK	ADVE (918)	
WDKBA_W	AUS	GGDVE (477)	ADVE (918), BGDVE (934), DHFM (233), BGPU (276), BGMSZS (239), EGFE (228)
WDKDLR_W	LOK	ADVE (918)	
WDKINK_W	LOK	FUEDKSA (610)	
WDKNLP	AUS	BGDVE (934)	
WDKNLPR	AUS	BGDVE (934)	
WDKNLPR_W	AUS	BGDVE (934)	
WDKNLP_W	AUS	BGDVE (934)	ADVE (918), FUEDKSA (610)
WDKPMX	LOK	GGDVE (477)	
WDKS	AUS	FUEDKSA (610)	DFFT (1140)
WDKSAP_W	AUS	FUEDK (597)	FUEDKSA (610)
WDKSBA2_W	LOK	FUEDKSA (610)	
WDKSBA_W	LOK	FUEDKSA (610)	
WDKSB_W	LOK	FUEDKSA (610)	
WDKSFI_W	LOK	ADVE (918)	
WDKSFL	LOK	FUEDKSA (610)	
WDKSGV_W	LOK	FUEDK (597)	
WDKSMX_W	LOK	FUEDK (597)	
WDKSOM_W	AUS	WDKSOM (614)	FUEDK (597)
WDKSPA_W	LOK	FUEDKSA (610)	
WDKSP_W	AUS	FUEDKSA (610)	BGWDKM (273)
WDKSSTSW_W	LOK	ADVE (918)	
WDKSVFL	LOK	FUEDKSA (610)	
WDKSV_W	LOK	FUEDK (597)	
WDKSWE_W	LOK	FUEDKSA (610)	
WDKS_W	AUS	FE (591)	FUEDKSA (610), MSF (506), ADVE (918), BGDVE (934)
WDKUGD_W	AUS	BGMSZS (239)	BGRLP (266), EGFE (228), FUEDK (597)
WDKVABOB	LOK	BGDVE (934)	
WDKVABUB	LOK	BGDVE (934)	
WDMDKOE	LOK	MDVERB (540)	
WEA	AUS	AES (973)	ESVW (1009), BGRLP (266)
WEE	AUS	AES (973)	ESVW (1009), BGRLP (266)
WEEMRFA	LOK	ESVW (1009)	
WEENST	LOK	ESVW (1009)	
WEER	AUS	ESVW (1009)	AES (973)
WEEST	LOK	ESVW (1009)	
WEESTZ	LOK	AES (973)	
WESSBM	EIN		BGRLP (266)
WF_W	LOK	ESUK (699)	
WKFMDKO	LOK	MDVERB (540)	
WKR	LOK	KRRA (639)	
WKRA	LOK	KRRA (639)	
WKRATST	AUS	KRRA (639)	
WKRDY	AUS	KRDY (659)	ZUE (627), EGKE (409)
WKRDYA	LOK	KRDY (659)	
WKRDYAA	LOK	KRDY (659)	
WKRDYTI	LOK	KRDY (659)	
WKRM	LOK	KRRA (639)	
WKRMA	AUS	EGKE (409)	KRRA (639)
WKR_TST	AUS	KRRA (639)	

Symbol	Type	Created within	Used within
WKWAS	LOK	ALE (136)	
WKWAS_KOR	LOK	ALE (136)	
WKWAS_RDE	LOK	RDE (112)	
WKWBZM0_W	AUS	GGDPG (74)	ALE (136), RDE (112)
WKWNEG_W	LOK	GGDPG (74)	
WKWPOS_W	LOK	GGDPG (74)	
WKWSTART_W	LOK	GGDPG (74)	
WKWSTOP	AUS	ALE (136)	GGDPG (74)
WKWSYN_W	AUS	GGDPG (74)	WANWKW (125)
WKW_W	AUS	GGDPG (74)	ALE (136), RDE (112), WANWKW (125)
WMFA	LOK	GGKS (412)	
WMFL	LOK	GGKS (412)	
WNWEM	EIN		ESVW (1009)
WNWI2_AD_W	AUS	WANWKW (125)	NLDG (157), NWS (618)
WNWIAW2_W	AUS	NWS (618)	DNWS (622)
WNWIAW_W	AUS	NWS (618)	DNWS (622)
WNWIA_W	AUS	NWS (618)	
WNWIM2_W	LOK	WANWKW (125)	
WNWIM_W	LOK	WANWKW (125)	
WNWISA_W	EIN		BGSRM (245)
WNWIX_W	LOK	NLDG (157)	
WNWI_AD_W	AUS	WANWKW (125)	NLDG (157), NWS (618)
WNWI_W	EIN		ESVW (1009)
WNWKWAS2_W	AUS	WANWKW (125)	NLDG (157)
WNWKWASX_W	LOK	NLDG (157)	
WNWKWAS_W	AUS	WANWKW (125)	NLDG (157)
WNWSE	AUS	NWS (618)	
WNWSP2_W	AUS	WANWKW (125)	DNWKW (134), GGDPG (74)
WNWSPAS2_W	AUS	WANWKW (125)	NLDG (157)
WNWSPASX_W	LOK	NLDG (157)	
WNWSPAS_W	AUS	WANWKW (125)	NLDG (157)
WNWSP_W	AUS	WANWKW (125)	DNWKW (134), GGDPG (74)
WNWSRM_W	AUS	BGSRM (245)	
WNWUE	AUS	NWS (618)	MDBAS (529), ZWGRU (634)
WNWUE_W	AUS	NWS (618)	BGSRM (245)
WOUTA0	AUS	AZUE (904)	
WOUTA1	AUS	AZUE (904)	
WOUTA2	AUS	AZUE (904)	
WOUTA3	AUS	AZUE (904)	
WOUTST0	AUS	AZUE (904)	
WOUTST1	AUS	AZUE (904)	
WOUTST2	AUS	AZUE (904)	
WOUTST3	AUS	AZUE (904)	
WPED	AUS	GGPED (454)	ADVE (918), WDKSOM (614), NMAXMD (584), MDZUL (523), MDMIN (538), KOS (896), DFFT (1140), BGDVE (934)
WPEDC_W	EIN		GGPED (454)
WPEDT_W	LOK	GGPED (454)	
WPEDV_W	LOK	GGPED (454)	
WPED_W	AUS	EGEG (453)	GGPED (454), SWADAP (47), FUEDK (597), MSF (506), MDFUE (594), MDFAW (508)
WPFGR_W	AUS	BGWPFGR (548)	
WPHG	LOK	ZUE (627)	
WPR	LOK	BGRLP (266)	
WPRNSP	LOK	BGRLP (266)	
WRI_C_UM	LOK	URMEM (1044)	
WTANS	EIN		GGTFA (298)
WTMOT_W	EIN		GGTFM (289)
WUB	EIN		RDE (112), EGAG (486), GGUB (487)
WUB_W	EIN		GGUB (487)
WUCCNT	AUS	DWUC (1147)	
XQTM_W	LOK	BGTABST (1030)	
XS02	LOK	DMDFON (161)	
XS03	LOK	DMDFON (161)	
XS04	LOK	DMDFON (161)	
XS05	LOK	DMDFON (161)	
XS06	LOK	DMDFON (161)	
XS07	LOK	DMDFON (161)	
XS08	LOK	DMDFON (161)	
XZKRZNT	LOK	DKRNT (445)	
XZKRZOF	LOK	DKRNT (445)	
XZKRZS(I)	LOK	DKRS (437)	
XZKRZTP	LOK	DKRTP (451)	
XZSEN(I)	LOK	DKRS (437)	
XZSKRNT	AUS	DKRNT (445)	GGKS (412), EGKE (409)
XZSKROF	AUS	DKRNT (445)	GGKS (412), EGKE (409)
XZSKRTP	AUS	DKRTP (451)	GGKS (412), EGKE (409)
ZALDY	LOK	KRDY (659)	
ZALT_UM	LOK	UFNC (1063)	
ZATV	LOK	LRHK (781)	
ZATV2	LOK	LRHK (781)	
ZBALE	LOK	ESUK (699)	
ZBURN	LOK	STADAP (684)	

Symbol	Type	Created within	Used within
ZBURNSU	LOK	STADAP (684)	
ZBURNSUM	LOK	ESSTT (679)	
ZCAP_UM	LOK	UFNC (1063)	
ZDASH_W	LOK	MDFAW (508)	
ZDELAY	LOK	GGDPG (74)	
ZDIF_UM	LOK	UFNC (1063)	
ZERDYSH	LOK	DLSAHK (339)	
ZERDYSH2	LOK	DLSAHK (339)	
ZERLATV	LOK	DLSA (398)	
ZERLATV2	LOK	DLSA (398)	
ZERSCH	LOK	DLSAHK (339)	
ZERSCH2	LOK	DLSAHK (339)	
ZFCNT	LOK	GGVFZG (497)	
ZHLL	LOK	LLRNS (562)	
ZKRFMU	LOK	GGKS (412)	
ZKRVF	LOK	KRRA (639)	
ZKVEK	AUS	AZUE (904)	
ZLASH2_W	LOK	DLSAHK (339)	
ZLASH_W	LOK	DLSAHK (339)	
ZLDY	LOK	KRDY (659)	
ZLDYKE	LOK	KRDY (659)	
ZLSATP	LOK	DLSA (398)	
ZLSATP2	LOK	DLSA (398)	
ZLSD_W	LOK	MDFAW (508)	
ZNACHANZ	AUS	ZUE (627)	
ZNBM_W	AUS	GGDPG (74)	
ZNDY	LOK	KRDY (659)	
ZNLPHAUSF	LOK	NLPH (150)	
ZNLPHAUSR	LOK	NLPH (150)	
ZNLPHSTIM	LOK	NLPH (150)	
ZNOSTEND	LOK	AEKP (970)	
ZNZKVEK	AUS	AZUE (904)	
ZOUTTMX	AUS	AZUE (904)	
ZPHFL	AUS	WANWKW (125)	NLDG (157)
ZPHFL2	AUS	WANWKW (125)	NLDG (157)
ZPHFLSYN	AUS	NLDG (157)	WANWKW (125)
ZPHFLX	LOK	NLDG (157)	
ZPHNOK	LOK	DPH (144)	
ZPHNOK2	LOK	DPH (144)	
ZRIBERV	LOK	GGLSV (382)	
ZRIBERV2	LOK	GGLSV (382)	
ZRINV2_W	LOK	GGLSV (382)	
ZRINV_W	LOK	GGLSV (382)	
ZRPH	AUS	GGDPG (74)	DDG (141), DPH (144)
ZRPH2	AUS	GGDPG (74)	DDG (141), DPH (144)
ZSTFGR	AUS	FGRFULO (1160)	BGWPFGR (548), FGRREGL (1174), FGRBESI (1158), FGRABED (491), FGRUE (490)
ZSYNCHRO	LOK	STADAP (684)	
ZSYNC_UM	LOK	UFNC (1063)	
ZSYNC_UR	LOK	UFNC (1063)	
ZSYNSU	LOK	STADAP (684)	
ZTPNT_A	LOK	GGKS (412)	
ZUBKST	LOK	STADAP (684)	
ZUENBEG	EIN		AZUE (904)
ZUENINKR	AUS	AZUE (904)	
ZUENTMX	AUS	AZUE (904)	
ZUENZAHN	AUS	AZUE (904)	
ZVALE	LOK	ESUK (699)	
ZWBAS	AUS	ZUE (627)	MDBAS (529), MSF (506)
ZWBASAR	AUS	ZUE (627)	
ZWC_C_UM	LOK	UFZWC (1075)	
ZWDYNSH	LOK	DLSAHK (339)	
ZWDYNSH2	LOK	DLSAHK (339)	
ZWGEFLR	AUS	DLSV (301)	
ZWGEFLR2	AUS	DLSV (301)	
ZWGRU	AUS	ZWGRU (634)	LAMBTS (732), ZUE (627)
ZWIST	AUS	ZUE (627)	MDIST (528), MSF (506), ZWMIN (669)
ZWKRAFLD	AUS	ZUE (627)	KRRA (639)
ZWLATE	LOK	ZWMIN (669)	
ZWMATM	AUS	ATM (20)	
ZWMATM2	AUS	ATM (20)	
ZWMATMF	AUS	ATM (20)	
ZWMATMF2	AUS	ATM (20)	
ZWMN	LOK	ZWMIN (669)	
ZWMND	LOK	ZWMIN (669)	
ZWMNMS	LOK	ZWMIN (669)	
ZWMNT	LOK	ZWMIN (669)	
ZWNWS	LOK	ZWGRU (634)	
ZWOPT	AUS	MDBAS (529)	MSF (506), LAMBTS (732), MDIST (528), MDZW (636), ZWMIN (669)
ZWOPTL1	LOK	MDBAS (529)	
ZWOPT_UM	LOK	UFMIST (1086)	
ZWOUT	AUS	MSF (506)	ZUE (627), AZUE (904), UFZWC (1075), UFUE (1056), CAN (1124)

Symbol	Type	Created within	Used within
ZWOUTAR	AUS	ZUE (627)	
ZWOUTAR0	EIN		AZUE (904)
ZWOUTAR1	EIN		AZUE (904)
ZWOUTAR2	EIN		AZUE (904)
ZWOUTAR3	EIN		AZUE (904)
ZWOUTCPL	AUS	ZUE (627)	UFUE (1056), UFZWC (1075)
ZWOUT_UM	AUS	UFZWC (1075)	UFMIST (1086), UFUE (1056)
ZWPVK	LOK	DLSA (398)	
ZWSOL	AUS	MDZW (636)	ZUE (627)
ZWSPAE	AUS	ZWMIN (669)	CAN (1124), ZUE (627)
ZWSTNM	LOK	ZWSTT (637)	
ZWSTT	AUS	ZWSTT (637)	ZUE (627), ZWMIN (669)
ZWSTTA	LOK	ZWSTT (637)	
ZWSTTM	LOK	ZWSTT (637)	
ZWZYL1	AUS	ZUE (627)	TC1MOD (1100)
ZYLEAUSB	AUS	NLPH (150)	AEVAB (980)
ZYLINDEX	LOK	GGKS (412)	
ZYLVEK	EIN		AZUE (904)
ZYLVIRT	AUS	GGDPG (74)	
ZZALE_INI	LOK	GGDPG (74)	
ZZBANK	EIN		ACIFI (1013)
ZZPRZ	LOK	KRDY (659)	
ZZSEG	AUS	GGDPG (74)	ALE (136), RDE (112), WANWKW (125)
ZZTAB	AUS	GGDPG (74)	WANWKW (125)
ZZVIRT	AUS	GGDPG (74)	
ZZWDYKR	LOK	KRDY (659)	
ZZWDYMD	LOK	KRDY (659)	
ZZYL	AUS	GGDPG (74)	AEVAB (980), WANWKW (125), NLPH (150), GGKS (412), EGKE (409), DMDLU (193), DMDFON (161)
ZZYLKR	AUS	EGKE (409)	GGKS (412), KRDY (659), KRKE (427), KRRA (639)
ZZYLZUE	EIN		ZUE (627)
ZZYL_VIRT	LOK	GGDPG (74)	
Z_AGRF	EIN		DIMC (1148)
Z_BM	AUS	DDG (141)	
Z_BREMS	AUS	EGEG (453)	GGEGAS (474)
Z_BUOF	AUS	CAN (1124)	
Z_BWF	AUS	GGPED (454)	
Z_CAS	AUS	DCAS (1128)	
Z_CINS	AUS	DCINS (1126)	
Z_CKUP	EIN		DCKUP (1128)
Z_DK	AUS	DDVE (950)	
Z_DK1P	AUS	DDVE (950)	
Z_DK2P	AUS	DDVE (950)	
Z_DSS	LOK	EGFE (228)	
Z_DST	AUS	EGAG (486)	
Z_DVEE	AUS	DDVE (950)	
Z_DVEF	AUS	DDVE (950)	
Z_DVEFO	AUS	DDVE (950)	
Z_DVEL	AUS	DDVE (950)	
Z_DVEN	AUS	DDVE (950)	
Z_DVER	AUS	DDVE (950)	
Z_DVET	AUS	DDVE (950)	
Z_DVEU	AUS	DDVE (950)	
Z_DVEUB	AUS	DDVE (950)	
Z_DVEUW	AUS	DDVE (950)	
Z_DVEV	AUS	DDVE (950)	
Z_EGFE	AUS	DEGFE (592)	
Z_EV1	AUS	DEVE (1017)	
Z_EV2	AUS	DEVE (1017)	
Z_EV3	AUS	DEVE (1017)	
Z_EV4	AUS	DEVE (1017)	
Z_EV5	AUS	DEVE (1017)	
Z_EV6	AUS	DEVE (1017)	
Z_EV7	AUS	DEVE (1017)	
Z_EV8	AUS	DEVE (1017)	
Z_FP1P	AUS	GGPED (454)	
Z_FP2P	AUS	GGPED (454)	
Z_FPP	AUS	EGEG (453)	GGPED (454)
Z_FRA	AUS	GKRA (766)	
Z_FRA2	AUS	GKRA (766)	
Z_FRAO	AUS	DKVS (811)	BBTEGA (750)
Z_FRAO2	AUS	DKVS (811)	BBTEGA (750)
Z_FRAU	AUS	DKVS (811)	
Z_FRAU2	AUS	DKVS (811)	
Z_FRST	AUS	DKVS (811)	
Z_FRST2	AUS	DKVS (811)	
Z_HLPKS_I	LOK	DKRS (437)	
Z_HSH	AUS	DHLSHK (1154)	DIMC (1148), DLSAHK (339), DLSA (398)
Z_HSH2	AUS	DHLSHK (1154)	DIMC (1148), DLSA (398), DLSAHK (339)
Z_HSV	AUS	DHLSVK (29)	DIMC (1148), DLSA (398)
Z_HSV2	AUS	DHLSVK (29)	DIMC (1148), DLSA (398)
Z_HSVE	AUS	DHLSVKE (902)	DHLSVK (29)

Symbol	Type	Created within	Used within
Z_HSVE2	AUS	DHLSVKE (902)	DHLSVK (29)
Z_KAT	AUS	DKAT (361)	DIMC (1148)
Z_KAT2	AUS	DKAT (361)	DIMC (1148)
Z_KOSE	AUS	DKOSE (901)	
Z_KPE	AUS	DEKPE (1020)	
Z_KRNT	AUS	DKRNT (445)	EGKE (409)
Z_KROF	AUS	DKRNT (445)	EGKE (409)
Z_KRTP	AUS	DKRTP (451)	EGKE (409)
Z_KS1	AUS	DKRS (437)	EGKE (409)
Z_KS2	AUS	DKRS (437)	EGKE (409)
Z_KS3	AUS	DKRS (437)	EGKE (409)
Z_KS4	AUS	DKRS (437)	EGKE (409)
Z_LASH	AUS	DLSAHK (339)	LRHK (781)
Z_LASH2	AUS	DLSAHK (339)	LRHK (781)
Z_LATP	AUS	DLSA (398)	DIMC (1148), DKAT (361)
Z_LATP2	AUS	DLSA (398)	DIMC (1148), DKAT (361)
Z_LATV	AUS	DLSA (398)	
Z_LATV2	AUS	DLSA (398)	
Z_LLR	AUS	DLLR (578)	
Z_LM	AUS	DHFM (233)	EGFE (228)
Z_LSH	AUS	DLSH (330)	DIMC (1148), DLSAHK (339)
Z_LSH2	AUS	DLSH (330)	DIMC (1148), DLSAHK (339)
Z_LSHV	EIN		DKAT (361)
Z_LSV	AUS	DLSV (301)	DIMC (1148)
Z_LSV2	AUS	DLSV (301)	DIMC (1148)
Z_LUEA	AUS	DMLSE (34)	
Z_LUEB	AUS	DMLSE (34)	
Z_MD	AUS	DMDMIL (216)	
Z_MD00	AUS	DMDMIL (216)	
Z_MD01	AUS	DMDMIL (216)	
Z_MD02	AUS	DMDMIL (216)	
Z_MD03	AUS	DMDMIL (216)	
Z_MD04	AUS	DMDMIL (216)	
Z_MD05	AUS	DMDMIL (216)	
Z_MD06	AUS	DMDMIL (216)	
Z_MD07	AUS	DMDMIL (216)	
Z_MD08	AUS	DMDMIL (216)	
Z_MD09	AUS	DMDMIL (216)	
Z_MD10	AUS	DMDMIL (216)	
Z_MD11	AUS	DMDMIL (216)	
Z_MDB	AUS	MDKOG (516)	
Z_MILE	AUS	DMILE (36)	
Z_MUTE	AUS	CAN (1124)	
Z_N	AUS	DDG (141)	
Z_NWKW	AUS	DNWKW (134)	
Z_NWKW2	AUS	DNWKW (134)	
Z_NWS	AUS	DNWS (622)	
Z_NWS2	AUS	DNWS (622)	
Z_NWSE	AUS	DNWSE (1025)	
Z_PH	AUS	DPH (144)	
Z_PH2	AUS	DPH (144)	
Z_POEL	AUS	GGPOEL (296)	
Z_PUA	AUS	BGPU (276)	
Z_RKAT	AUS	DKVS (811)	
Z_RKAT2	AUS	DKVS (811)	
Z_RKAZ	AUS	DKVS (811)	
Z_RKAZ2	AUS	DKVS (811)	
Z_SLS	EIN		DIMC (1148)
Z_TA	AUS	GGTFA (298)	
Z_TES	AUS	DTEV (856)	DIMC (1148), DLLR (578)
Z_TEVE	AUS	DTEVE (1022)	
Z_TM	AUS	GGTFM (289)	
Z_UB	AUS	EGAG (486)	GGUB (487)
Z_UF2SG	AUS	DUF (1089)	
Z_UFMV	AUS	DUF (1089)	
Z_UFSKA	AUS	DUF (1089)	
Z_URRAM	AUS	DUR (1052)	
Z_URROM	AUS	DUR (1052)	
Z_URRST	AUS	DUR (1052)	
Z_VFZ	AUS	DVFZ (500)	EGAG (486), DLLR (578)
Z_VKUP	LOK	DVKUP (1027)	

Production Note

This document is concatenated from different SGML fragments. The SGML tree transformations needed have been done by the tool MetaMorphosis from Ovidius. The typesetting has been done by the typesetting system TeX using the macro package MMTeX.

Chosen (resp. default) options

Option	**Value**
`colophon`	`yes`
`damosfile`	`i:\programme\mm3\..\mmapps\fdr3\lib\damos_dummy.sgm`
`efatable`	`yes`
`efatree`	`no`
`graphicborder`	`no`
`graphicinfo`	`no`
`inputfile`	`FRE07E0.SGM`
`lineart`	`fast`
`minlines`	`2`
`newpage`	`owners`
`pavastfile`	`i:\programme\mm3\..\mmapps\fdr3\lib\pavast_dummy.sgm`
`pavastnew`	`yes`
`pavastorig`	`retain`