Signal Name	Transmitter	Notes
Fuel Level Percent	Powertrain	Required
Fuel Level Percent Validity	Powertrain	Required
Fuel Level Tank 2 Percent	Powertrain	Required for CNG/LPG vehicles
Fuel Level Tank 2 Percent Validity	Powertrain	Required for CNG/LPG vehicles
Fuel Mode Status	Powertrain	Required for CNG/LPG vehicles
Fuel Mode Switch Active	Powertrain	Required for CNG/LPG vehicles
Fuel Mode Switch Active Validity	Powertrain	Required for CNG/LPG vehicles
Fuel Pump Enabled Discrete Output Commanded Status	Powertrain	Required
Fuel System Emissions Related DTC	Platform	Required
Fuel System Emissions Related Malfunction Active	Platform	Required
Fuel System Estimated Pressure Delivered	Platform	Required
Fuel System Estimated Pressure Delivered Validity	Platform	Required
Fuel Total Capacity	Powertrain	Required
Fuel Total Capacity Tank 2	Powertrain	Required for CNG/LPG vehicles
Instantaneous Fuel Flow Estimate	Powertrain	Required
Legislated Diagnostics Standard Conditions Fault Present	Powertrain	Required
Legislated Diagnostics Standard Conditions Met	Powertrain	Required
Outside Air Temperature Powertrain Estimated	Powertrain	Required
Outside Air Temperature Powertrain Estimated Mask	Powertrain	Required
Outside Air Temperature Powertrain Estimated Validity	Powertrain	Required

3.3.2 Calibrations. The following table (Table 2) contains calibrations that cross the Platform – Powertrain Electrical Interface (i.e., calibrations are located in devices on one side of the interface but controlled by the other side of the interface or driven by variation in the other side of the interface). Refer to 4.1 Fuel Volume Determination Algorithm and Table 3: Fuel Tank Vapor Pressure Sensor Calibration Description for details.

Table 2: Enhanced Evaporative and Fuel System Calibrations

Calibration Name	Location	Owner
K_Consumption_Reentry	Powertrain	Platform
K_Exit_Consumption_ModeTime	Powertrain	Platform
K_Exit_Hill_Mode	Powertrain	Platform
K_FastFillEngRun	Powertrain	Platform
K_FastFiltGearTime	Powertrain	Platform
K_FastFiltVehSpeedTime	Powertrain	Platform
K_Fuel_Consumption_Hysteresis	Powertrain	Platform
K_Fuel_Consumption_Threshold	Powertrain	Platform
K_Fuel_Monitor_Time	Powertrain	Platform
K_FuelLvlFastFiltHysPair	Powertrain	Platform
K_FuelLvlFastFiltHysPairTime	Powertrain	Platform
K_FuelLvlInFiltDsplyPri	Powertrain	Platform
K_FuelLvlInFiltDsplySec	Powertrain	Platform
K_FuelLvlIntgrTmDsply	Powertrain	Platform
K_FuelLvlVehSpeedDsply	Powertrain	Platform
K_FuelPlatFastFilt	Powertrain	Platform
K_FuelPlatNormalFilt	Powertrain	Platform
K_FuelSenderUnitType	Powertrain	Platform
K_FuelSystemRatedCapDsply	Powertrain	Platform
K_FuelTankSt1_ChgDsply	Powertrain	Platform
K_FuelTankSt2_ChgDsply	Powertrain	Platform
K_FuelTankSt3_ChgDsply	Powertrain	Platform
K_FuelTankSt4_ChgDsply	Powertrain	Platform
K_FuelTankSt5_ChgDsply	Powertrain	Platform
K_MaxFuelVolDlvdInState2_Dsply	Powertrain	Platform
K_PriFuelTankXferOff	Powertrain	Platform
K_PriFuelTankXferOn	Powertrain	Platform
K_PrimaryFuelTankDsply	Powertrain	Platform
K_PriTankFullDsply	Powertrain	Platform
K_PriTankRatedCapDsply	Powertrain	Platform
K_Refuel_Delta_Threshold	Powertrain	Platform

Calibration Name	Location	Owner
K_SecFuelTankXferOff	Powertrain	Platform
K_SecFuelTankXferOn	Powertrain	Platform
K_SecondaryFuelTankDsply	Powertrain	Platform
K_SecTankEmptyDsply	Powertrain	Platform
K_SecTankEstimateDsply	Powertrain	Platform
K_Sensor_Intercept_Fuel_Tank_Vapor_Pres	Powertrain	Platform
K_Sensor_Offset	Powertrain	Platform
K_Sensor_Pres_Fuel_Tank_Vapor Pres	Powertrain	Platform
K_Sensor_Pressure_Max	Powertrain	Platform
K_Sensor_Slope	Powertrain	Platform
K_Sensor_Slope_Fuel_Tank_Vapor_Pres	Powertrain	Platform
K_XferPumpMaxOnTime	Powertrain	Platform
K_XferPumpMinOffTime	Powertrain	Platform

3.3.3 Primary Fuel Pump Control. This output shall be a high side driver. This driver shall be directly powered from the Run/Crank input to the Powertrain electronics.

This interface may be emissions-related. Refer to GMW8762 Section 1.4 PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.3.1 Constant Speed Fuel Pump. In constant speed application this output shall be used as a discrete high side driver, which is used to activate a relay controlling a constant speed fuel pump.

3.3.3.2 Fuel Line Pressure Control. In Fuel Line Pressure Control applications this output shall be used as a discrete high side driver, which is used to enable the operation of a FSCM (Fuel System Control Module).

3.3.4 Secondary Fuel Pump Control. This output shall be a discrete high side driver used to activate a relay controlling a constant speed fuel pump. This driver shall be directly powered from the Run/Crank input to the Powertrain electronics. This driver is required only on vehicles that utilize secondary fuel pumps.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.5 Fuel Tank Vapor Pressure. Platform shall provide a Fuel Tank Vapor Pressure Sensor that produces an analog signal that is a linear function of the fuel tank vacuum/pressure. The Powertrain electronics shall provide an analog input that reads the Fuel Tank Vapor Pressure Sensor.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.6 Fuel Tank Vapor Pressure Supply. The Powertrain electronics shall provide a regulated +5 V supply to the Fuel Tank Vapor Pressure Sensor.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.7 +5 V Return. The Powertrain electronics shall provide a common signal ground return to the Fuel Tank Vapor Pressure Sensor, Primary Fuel Level Sensor, and Fuel Temperature Sensor and shall act as an electrostatic drain for the Modular Reservoir Assembly plastic case. This ground shall not be shared with high current actuator returns.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.7.1 Fuel Tank Vapor Pressure Return. The Fuel Tank Vapor Pressure Return is a common signal shared with the Primary Fuel Level Sensor and the Fuel Temperature Sensor. Refer to 3.5.10.

The Powertrain electronics shall provide the algorithm diagnostic to detect an “open” connection of the Fuel Vapor Pressure Sensor Return hardwire signal. The sensor interface shall indicate a sensor voltage out of normal operating range when this condition exists.

3.3.8 Primary Fuel Level. Platform shall provide a Primary Fuel Level Sensor that produces an analog signal that tracks the level of fuel in the fuel tank. The Powertrain electronics shall provide an analog input that reads the Fuel Level Sensor. Refer to 4.1 Fuel Volume Determination Algorithm for specific filtering requirements.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.9 Secondary Fuel Level. On dual and saddle fuel tank systems, Platform shall provide a Secondary Fuel Level Sensor that produces an analog signal that tracks the level of fuel in the secondary fuel tank. The Powertrain electronics shall provide an analog input that reads the Secondary Fuel Level Sensor. Refer to 4.1 Fuel Volume Determination Algorithm for specific filtering requirements.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.10 Secondary Fuel Level +5 V Return. The Secondary Fuel Level +5 V Return is a dedicated signal ground for Secondary Fuel Level Sensor and shall act as an electrostatic drain for the Modular Reservoir Assembly plastic case. This ground shall not be shared with high current actuator returns.

3.3.11 Canister Vent. Platform shall provide a Canister Vent Solenoid to control the vent to the fuel vapor canister. The vent is normally open when the solenoid is not energized. The Powertrain electronics shall close the vent by energizing the Canister Vent Solenoid with a low-side drive output. The control of this vent allows the purge system to produce the required vacuum within the evaporative system in order for the Powertrain electronics to perform the leak detection algorithm.

Applications utilizing Engine Off Natural Vacuum (EONV) evaporative diagnostics shall power the canister vent solenoid from a battery feed. Powertrain Electronics may remain energized in the OFF power mode to perform EONV diagnostics.

Applications not utilizing EONV shall power the solenoid from a Run/Crank power feed.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.12 Fuel Temperature. Platform shall provide a Fuel Temperature Sensor that produces an analog signal that tracks the temperature of fuel in the fuel tank. The Powertrain electronics shall provide an analog input that reads the Fuel Temperature Sensor. This sensor is Powertrain optional when Powertrain implements the Engine Off Natural Vacuum (EONV) diagnostic.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.4 Failure Modes and Diagnostics. In OBD applications, Powertrain shall turn on the Service Engine Soon (MIL) telltale and set the appropriate diagnostic trouble codes if faults are detected with any of the OBD relevant components.

Refer to GMW8772, PPEI Serial Data Architecture Requirements for serial data failure modes and diagnostic information.

3.5 Electrical Characteristics.

3.5.1 Primary Fuel Pump Control. This output shall be a discrete high side driver. This driver must meet the characteristics of a high side driver, as described in GMW8762, PPEI Electrical Requirements. This driver shall be directly powered from the Run/Crank input to the Powertrain electronics.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.5.1.1 Constant Speed Fuel Pump. In constant speed application this output shall be used as a discrete high side driver have the characteristics of a high side driver, as described in GMW8762, PPEI Electrical Requirements.

3.5.1.2 Fuel Line Pressure Control. In Fuel Line Pressure Control applications this output shall be used as a discrete high side driver have the characteristics of a high side driver, as described in GMW8762, PPEI Electrical Requirements.

3.5.2 Secondary Fuel Pump Control. This output of the Powertrain electronics shall be powered by Run/Crank voltage and have the characteristics of a high side driver, as described in GMW8762, PPEI Electrical Requirements.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.5.3 Fuel Tank Vapor Pressure. Refer to GMW8762, for electrical characteristics.

See Table 3: Fuel Tank Vapor Pressure Sensor Calibration description for details.

3.5.4 Fuel Tank Vapor Pressure Supply. This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

Refer to GMW8762, for electrical characteristics.

3.5.5 +5 V Return. This is a dedicated ground return line provided at the ECM specifically restricted to sensor returns and Modular Reservoir Assembly plastic case electrostatic drain.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements.

3.5.5.1 Fuel Tank Vapor Pressure Return. Platform shall provide a common point ground internal to the Fuel Tank Assembly with the Primary Fuel Level Return and Fuel Temperature Return signals.

Powertrain shall provide one dedicated signal pin to the ECM for this function.

Refer to GMW8762, for electrical characteristics.

3.5.6 Primary Fuel Level.

3.5.6.1 Primary Fuel Level Sensor Output. The sensor output is a variable resistance with a minimum impedance of 40 Ω and a maximum impedance of 250 Ω.

The sensor transfer function is a calibration owned by Platform, and is described in 4.1.

3.5.6.2 Primary Fuel Level Sensor Input. Refer to Table 4.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.5.7 Secondary Fuel Level. The electrical interface is identical to the interface for the primary fuel level sensor. Refer to 3.5.6. The secondary fuel level sensor may have a distinct transfer function, which is a calibration owned by Platform and is described in 4.1.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.5.8 Secondary Fuel Level +5 V Return. This is a dedicated ground return line provided at the ECM specifically restricted to sensor returns and Modular Reservoir Assembly plastic case electrostatic drain.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements.

3.5.9 Canister Vent. The output of the Powertrain electronics shall have the characteristics of a low-side driver, LSD1, as described in GMW8762, PPEI Electrical Requirements.

For EONV applications, Powertrain Electronics may remain energized in the OFF power mode for a maximum of 40 minutes and shall not exceed a steady state current of 2.5 A.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.5.10 Fuel Temperature. The Powertrain electronics shall provide an analog input interface to a Fuel Temperature sensor.

3.5.10.1 Fuel Temperature Sensor Output. The sensor output is a variable resistance with a minimum impedance of 44.3 Ω (at 150°C) and a maximum impedance of 152.1 kΩ (at -40°C).

3.5.10.2 Fuel Temperature Sensor Input. Refer to Table 5.

This interface may be emissions-related. Refer to GMW8762, PPEI On-Board Diagnostics Requirements for platform design guidelines.

Table 3: Fuel Tank Vapor Pressure Sensor Calibration Description

Fuel Tank Vapor Pressure Sensor Calibration	Description
K_Sensor_Slope_Fuel_Tank_Vapor_Pres	Typically = 0.04 to 0.16
K_Sensor_Intercept_Fuel_Tank_Vapor_Pres	Typically = 0.3 to 0.5
K_Sensor_Fuel_Tank_Vapor_Pres	Pd (Differential Pressure) = P (Fuel Tank) - P (Atmosphere), where the range typically is -3.75 to 1.50 kPa

Table 4: Fuel Level Analog Input Characteristics

Parameter	Value
Pull Up Resistance to regulated + 5 V	243 Ω ± 2.5%
Input Voltage Range (minimum)	0.00 to 2.54 V
Accuracy	± 78 mV of the actual input
Electrical Time Constant	1.0 ms (typical)

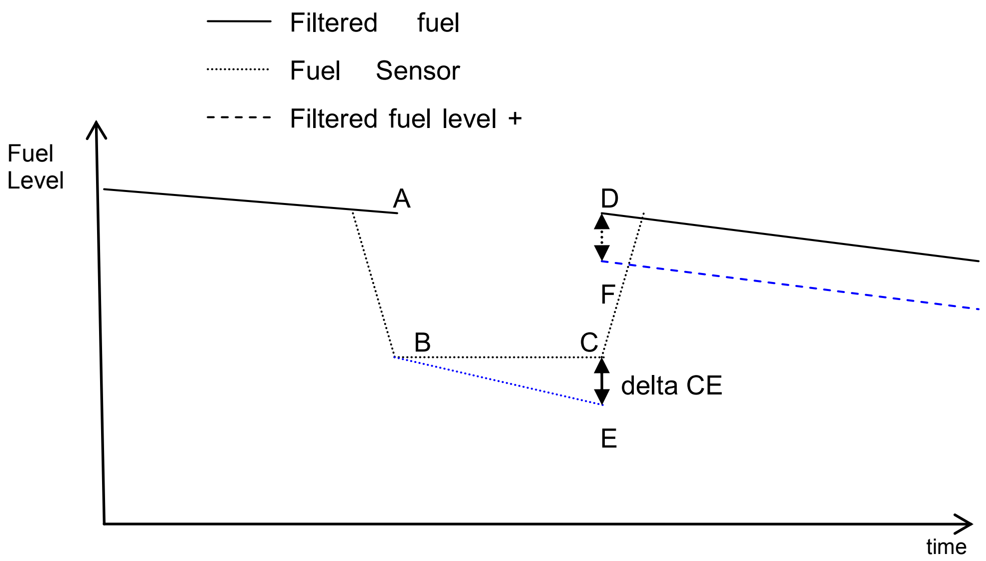
Table 5: Fuel Temperature Analog Input Characteristics

Parameter	Value
Pull Up Resistance to regulated +5 V	Value within the range of: 1800 to 4200 Ω
Accuracy	± 78 mV of the actual input
Electrical Time Constant	1.0 ms (typical)

4 Algorithm

4.1 Fuel Volume Determination. Refer to Section 3 for the hardware interface and serial data signal summary.

This specification is intended to document the algorithm used for determining the amount of fuel remaining in the fuel tanks of a dual fuel tank system as well as a single fuel tank system. It is also intended to describe the logic behind hill mode strategy and fuel consumption strategy. Hill mode strategy is a way to improve fuel gauge performance when parked on an incline (refer to Figure 2), and is done by monitoring the fuel level for a certain time after the vehicle has been turned OFF to determine the fuel monitored value. When the vehicle is turned ON again, a check is made between the fuel monitored value and the new fuel sender value to determine a delta. If the delta is close to zero, the fuel level filter is started with the previous key off value (NV_Fuel_Stored_Value), and normal filtering of fuel level is required. If the delta is larger than a threshold, the value NV_Fuel_Stored_Value is adjusted with this delta to get an accurate fuel level value. This is done to ensure the correct behavior when the vehicle is parked on a hill. Fuel consumption strategy takes into consideration the accumulated fuel consumption from injectors and auxiliary heaters when the vehicle is running low on fuel. This is more accurate than using the fuel sender value at low fuel levels because of the sender dead band.



Note: The filtered fuel level will still be affected by hill slopes when the vehicle is parked a hill and the engine is still running. Heavy filtering minimizes the effect of this.

Parking the vehicle on a slope causes the sensor fuel reading to drop (A to B).

A similar case exists when a slope causes the sensor reading to rise.

A: This is the filtered value used for displaying when the vehicle parks on a hill.

B: The sensor value goes down because of the hill slope.

B to C: The vehicle is parked and turned off. Sensor value is stable.

B to E: The vehicle is parked and turned off. Sensor value indicates a delta (because of fuel drain).

D: If the delta is close to zero, the fuel level will be started with the stored value of A.

F: If there is a delta, the fuel level will be started with (A - delta CE).

Figure 2: Fuel Volume Determination Hill Mode Strategy

For single fuel tank applications, the secondary fuel tank parameters must be calibrated to 0, and the Primary Tank Full Threshold calibration parameter must be greater than or equal to the Primary Tank Rated Capacity calibration parameter. For dual fuel tank applications, it is assumed that the transfer of fuel between tanks is controlled by a powertrain module due to the different strategies being implemented. The algorithm comprehends the following known implementation strategies for dual fuel tanks:

a. Fuel is consumed from the primary tank while a transfer pump continuously transfers fuel from the secondary tank to the primary tank. Therefore, it appears that fuel is consumed from the secondary tank before the primary tank. Refer to Figure 3.

b. Fuel is consumed from the primary tank, however, some fuel volume from the secondary tank is initially gravity fed to the primary tank making it appear as if the fuel is being consumed from the secondary tank. When the fuel is no longer being gravity fed to the primary tank, the fuel level decreases in the primary tank until the primary tank is empty enough at which time a transfer pump transfers all the remaining fuel from the secondary tank to the primary tank. Refer to Figure 4.

c. Fuel is consumed from the primary tank until the primary tank is empty enough at which time a transfer pump transfers all the fuel from the secondary tank to the primary tank.

d. Fuel is consumed from the primary tank while a transfer pump is transferring fuel from the secondary tank to the primary tank to keep the levels within the tanks equalized. Refer to Figure 5.

e. In general, the total fuel volume can be determined by adding the amount of fuel in the two tanks together. The total fuel volume can be accurately determined when the fuel is measurable in each of the tanks. Unfortunately, there are certain cases where one or both tanks have un-measurable fuel in the tanks. These cases are accounted for in the algorithm and can be visualized by viewing Figure 6.

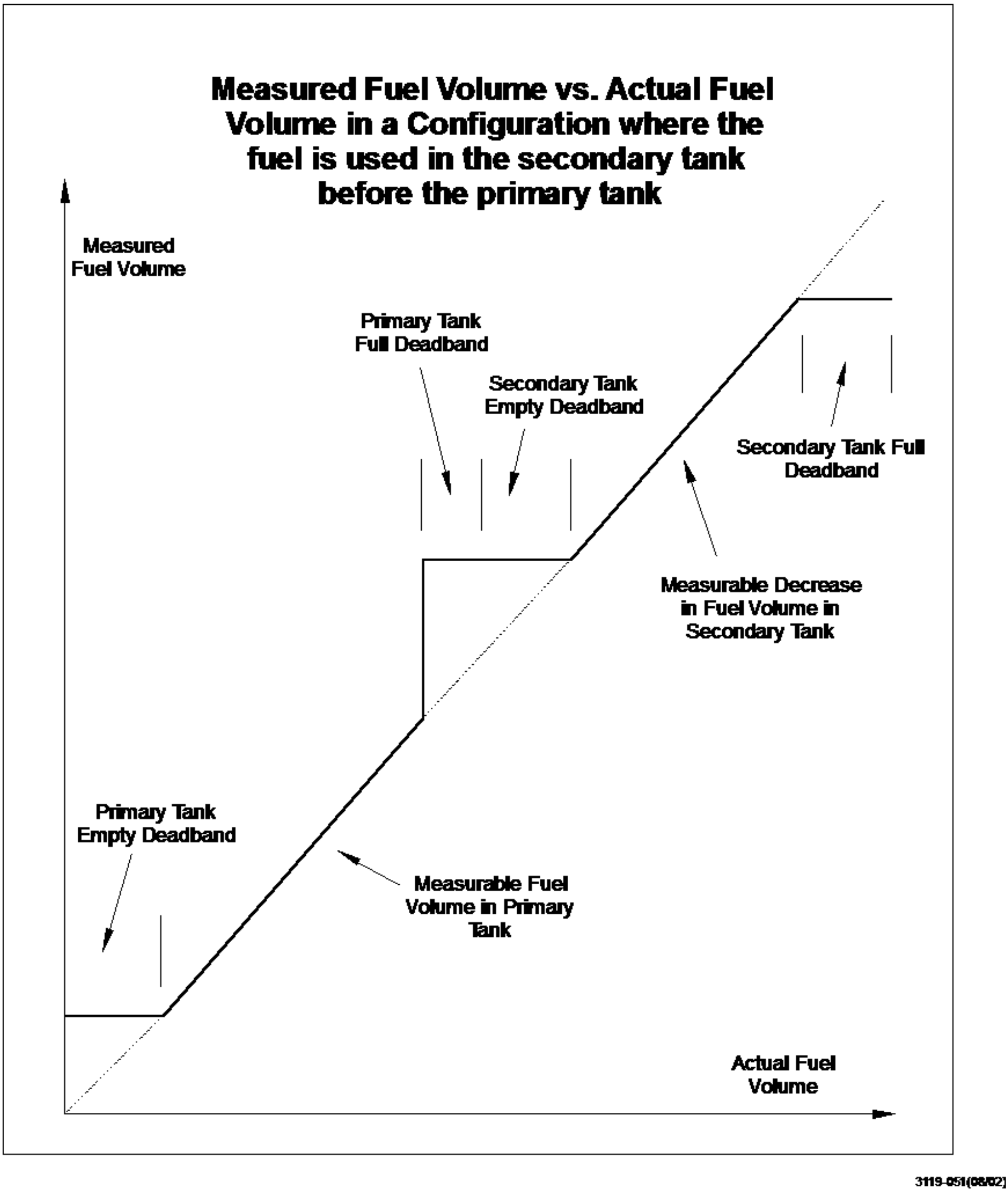


Figure 3: Measured Fuel Volume versus Actual Fuel Volume (Strategy 1)

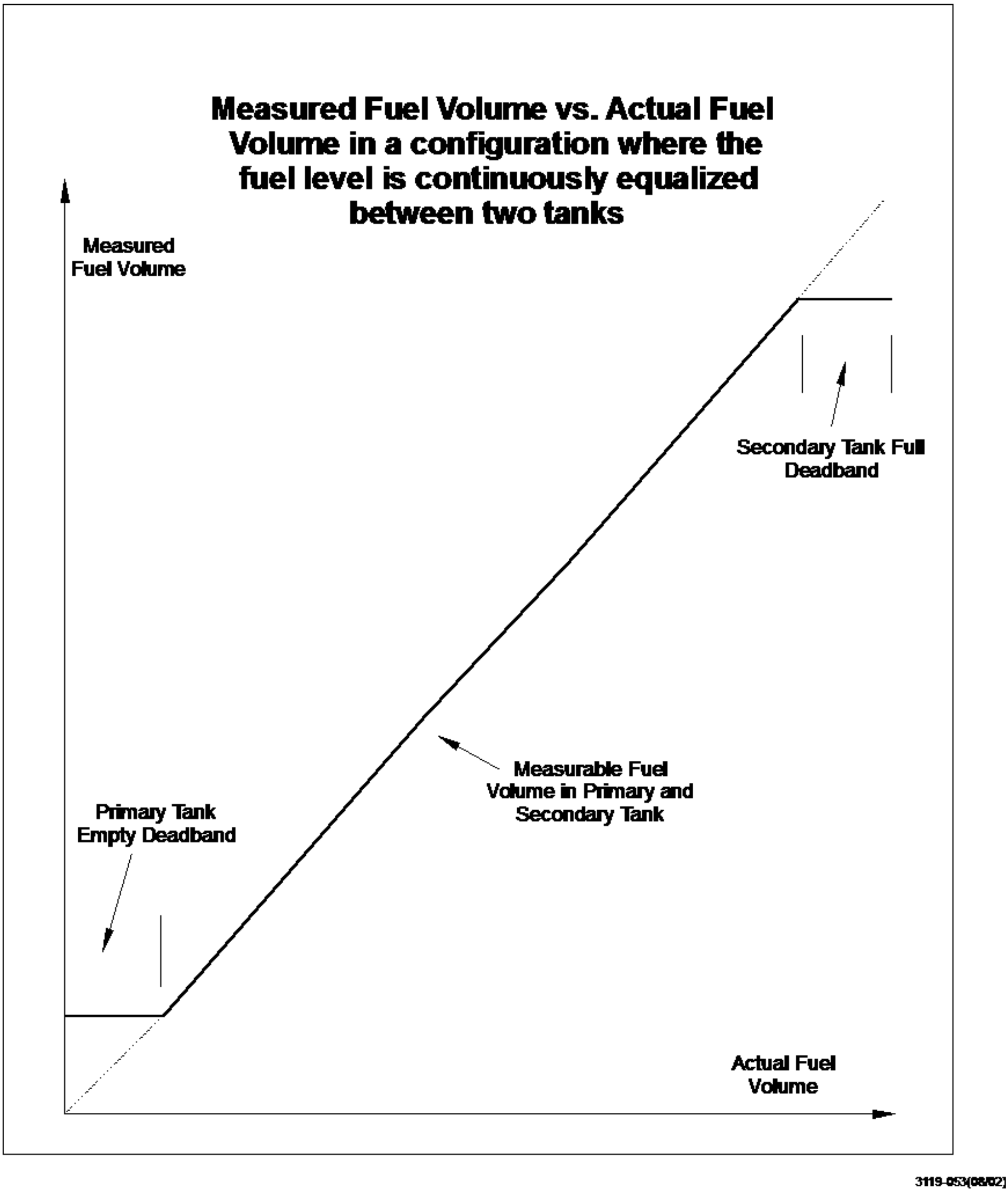


Figure 4: Measured Fuel Volume versus Actual Fuel Volume (Strategy 2)

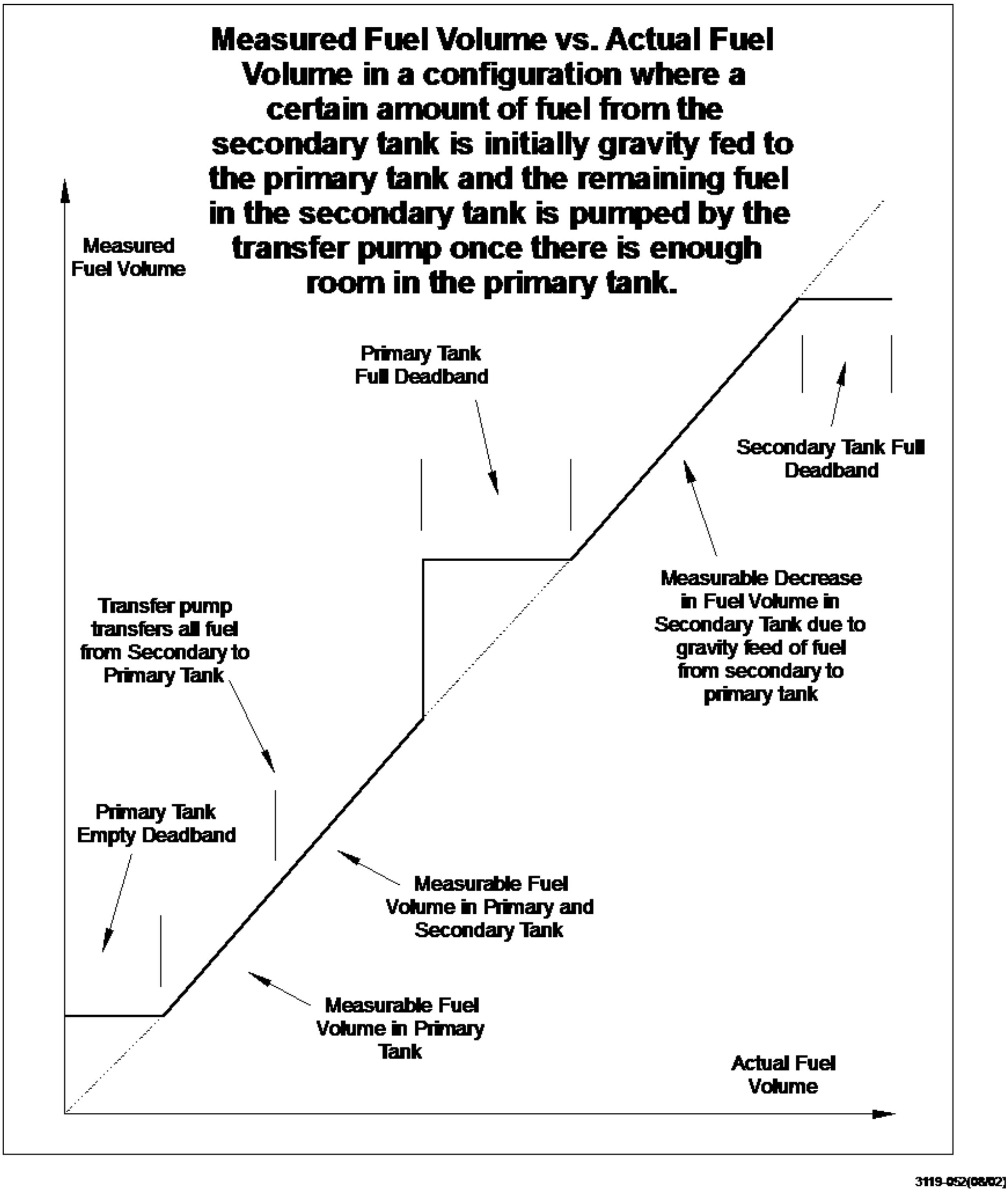
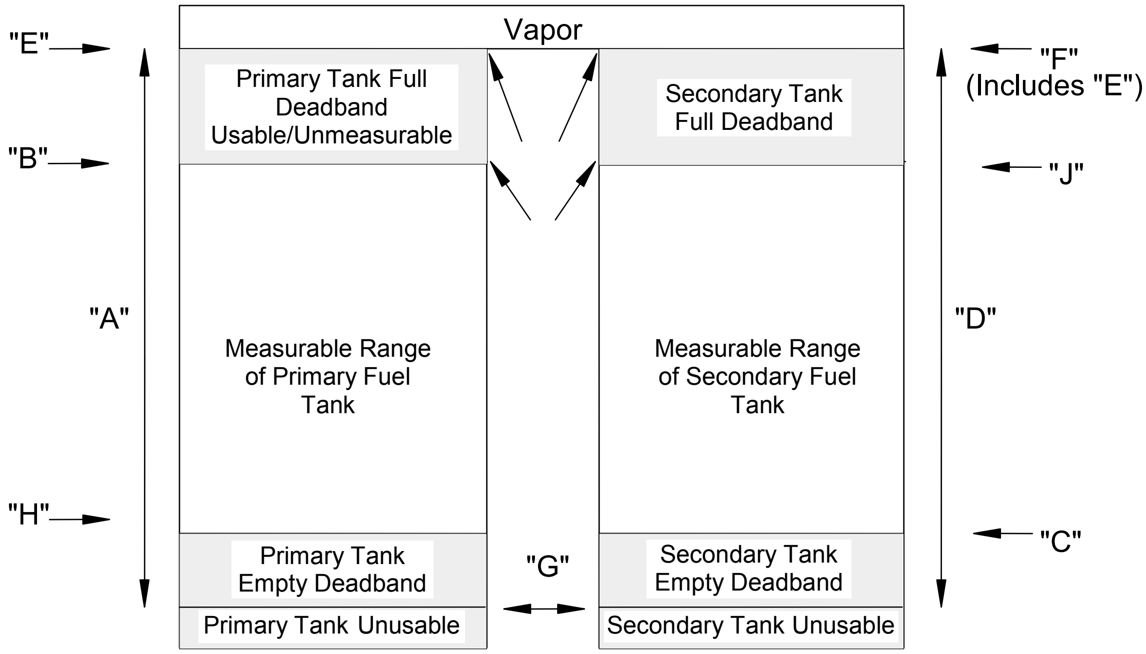


Figure 5: Measured Fuel Volume versus Actual Fuel Volume (Strategy 4)



A = Primary Tank Fuel Volume (Voltage vs. Fuel Volume calibration table)

B = Primary Tank Full Threshold (Fuel Volume calibration parameter)

C = Secondary Tank Empty Threshold (Fuel Volume calibration parameter)

D = Secondary Tank Fuel Volume (Voltage vs. Fuel Volume calibration table)

E = Primary Tank Rated Capacity (Fuel Volume calibration parameter)

F = Primary Tank Rated Capacity + Secondary Tank Rated Capacity (Fuel Volume calibration parameter)

G = Primary Tank Unusable + Secondary Tank Unusable (for EVAP calc Fuel Volume calibration parameter)

H = Primary Tank Failsoft Threshold (Fuel Volume calibration parameter)

J = Secondary Tank Estimate Threshold (Fuel Volume calibration parameter) (same as C on most applications)

Diagnostics: If A < H AND D > J (Primary Tank Almost Empty AND Secondary Tank Above Estimate Threshold indicates a potential diagnostic failure with the secondary mechanical transfer jet pump for saddle fuel tanks. Please refer to the GMPT Fuel Level Diagnostics for detectable failure modes with the fuel level system.)

Fuel Volume = 0 (failsoft the fuel level to the display because the transfer pump failed)

Zone 1: A ≥ B AND D ≥ J (Primary Tank Full AND Secondary Tank Above Estimate Threshold)

Fuel Volume = E + D

Zone 2: A ≥ B AND D < J (Primary Tank Full AND Secondary Tank Below Estimate Threshold)

Fuel Volume = E + J - Fuel Used while in the state (Case)

Zone 3: A < B AND D > J (Primary Tank Not Full AND Secondary Tank Above Estimate Threshold for the secondary mechanical transfer jet pump)

Fuel Volume = A + D

Zone 4: A < B AND D ≤ C (Primary Tank Not Full AND Secondary Tank Below Empty Threshold)

Fuel Volume = A

Zone 5: A < B AND D > C (Primary Tank Not Full AND Secondary Tank Above Empty Threshold for the secondary electrical transfer pump)

Fuel Volume = A + D

Figure 6: Dual Fuel Tank – Fuel Volume Determination

4.1.2 Context Diagram (Figure 7).

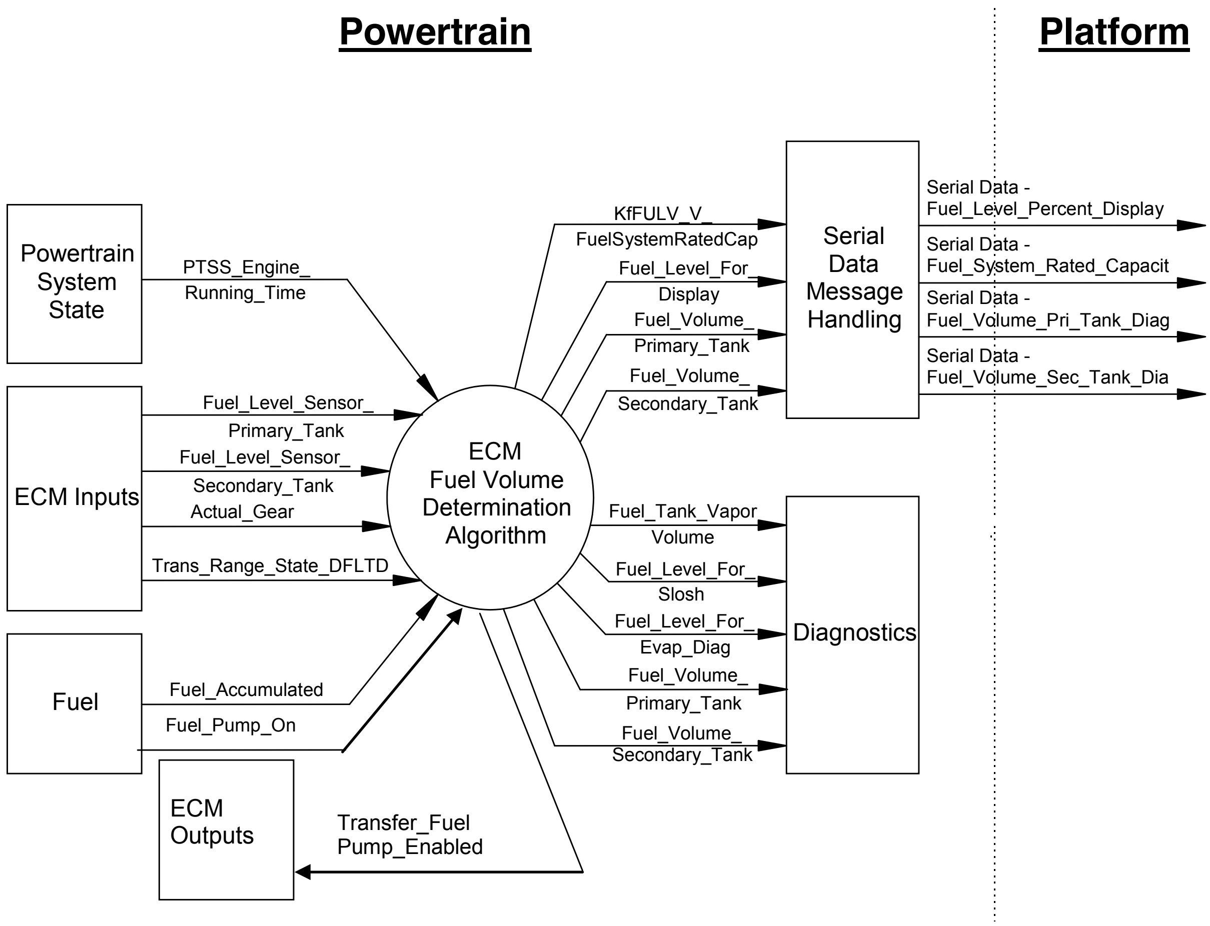


Figure 7: Fuel Volume Determination Block Diagram

4.1.3 Fuel Volume Determination Algorithm. Fuel volume determination depends on which one of the following states currently represents the fuel tank levels measured in the tanks:

a. (Primary Tank Full) AND (Secondary Tank Above Estimate Threshold).
b. (Primary Tank Full) AND (Secondary Tank Below Estimate Threshold).
c. (Primary Tank Not Full) AND (Secondary Tank Above Estimate Threshold).
d. (Primary Tank Not Full) AND (Secondary Tank Below Empty Threshold).
e. (Primary Tank Not Full) AND (Secondary Tank Above Empty Threshold).

A transition from one state to another state is filtered such that the conditions for entering the new state must be satisfied for a calibrated amount of continuous time before changing to the new state.

4.1.3.1 Fuel Volume Calculation for Platform Displays. Fuel Volume is the usable amount of fuel remaining in the fuel tank(s). Fuel Volume is needed for the calculation of other fuel level parameters for platform use.

4.1.3.1.1 Convert Fuel Tank Level Raw to Fuel Tank Volume for Display. The following logic is used to convert raw fuel level into fuel volume for display purposes:

SELECT FIRST

WHEN **(K_FuelSenderUnitType** = “NoSender”)

Fuel_Level_Sender_Pri_Tank_Display ← 0.0

Fuel_Level_Sender_Sec_Tank_Display ← 0.0

Fuel_Volume_Pri_Tank_Display ← 0.0

Fuel_Volume_Sec_Tank_Display ← 0.0

WHEN (**K_FuelSenderUnitType** = “DualSenderMechPump”)

OR

(**K_FuelSenderUnitType** = “DualSenderElectPump”)

Note: Filter fuel sender input for display using a first order lag filter.

Fuel_Level_Sensor_Pri_Tank_Display ← filtered Fuel_Level_Sensor_Pri_Tank, using **K_FuelLvlInFiltDsplyPri** as a first order lag filter coefficient

Fuel_Level_Sensor_Sec_Tank_Display ← filtered Fuel_Level_Sensor_Sec_Tank, using **K_FuelLvlInFiltDsplySec** as a first order lag filter coefficient

Note: Convert filtered fuel sender input into fuel volume.

Fuel_Volume_Pri_Tank_Display ← **K_PrimaryFuelTankDsply**[Fuel_Level_Sensor_Pri_Tank_Display]

Fuel_Volume_Sec_Tank_Display ← **K_SecondaryFuelTankDsply**[Fuel_Level_Sensor_Sec_Tank_Display]

WHEN **(K_FuelSenderUnitType** = “SingleSender”)

Note: Filter fuel sender input for display using a first order lag filter.

Fuel_Level_Sensor_Pri_Tank_Display ← filtered Fuel_Level_Sensor_Pri_Tank, using **K_FuelLvlInFiltDsplyPri** as a first order lag filter coefficient

Fuel_Level_Sensor_Sec_Tank_Display ← 0.0

Note: Convert filtered fuel sender input into fuel volume.

Fuel_Volume_Pri_Tank_Display ← **K_PrimaryFuelTankDsply**[Fuel_Level_Sensor_Pri_Tank_Display]

Fuel_Volume_Sec_Tank_Display ← 0.0

OTHERWISE

NO ACTION

ENDSELECT

4.1.3.1.2 Determine the Fuel Tank System Zone for Display. The following logic is used to determine what fuel tank system zone the vehicle is in for display purposes:

Note: Determine method for fuel volume calculation.

SELECT FIRST

WHEN (Fuel_Volume_Pri_Tank_Display ≥ **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display ≥ **K_SecTankEstimateDsply**)
continuously for **K_FuelTankSt1_ChgDsply**
Fuel_Level_State_Display ← "Zone_1"

WHEN (Fuel_Volume_Pri_Tank_Display ≥ **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display < **K_SecTankEstimateDsply**)
continuously for **K_FuelTankSt2_ChgDsply**
Fuel_Level_State_Display ← "Zone_2"

WHEN (Fuel_Volume_Pri_Tank_Display < **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display > **K_SecTankEstimateDsply**
AND
K_FuelSenderUnitType ≠ "DualSenderElectPump")
continuously for **K_FuelTankSt3_ChgDsply**
Fuel_Level_State_Display ← "Zone_3"

WHEN (Fuel_Volume_Pri_Tank_Display < **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display > **K_SecTankEmptyDsply**)
continuously for **K_FuelTankSt5_ChgDsply**
Fuel_Level_State_Display ← "Zone_5"

WHEN (Fuel_Volume_Pri_Tank_Display < **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display ≤ **K_SecTankEmptyDsply**)
continuously for **K_FuelTankSt4_ChgDsply**
Fuel_Level_State_Display ← "Zone_4"

ENDSELECT

4.1.3.1.3 Calculate Fuel Volume based on the Fuel Tank System Zone for Display. The following logic is used to calculate fuel volume based on the fuel tank system for display purposes:

Note: Calculate fuel volume.

SELECT FIRST

WHEN (Fuel_Level_State_Display = “Zone_1”)
Fuel_Volume_Display ← (**K_PriTankRatedCapDsply** + Fuel_Volume_Sec_Tank_Display)

WHEN (Fuel_Level_State_Display = “Zone_2”)
Fuel_Volume_Display ← (**K_PriTankRatedCapDsply** + **K_SecTankEstimateDsply** – Fuel_Delivered_In_State_2_Display)

WHEN (Fuel_Level_State_Display = “Zone_3”)
OR
(Fuel_Level_State_Display = “Zone_5”)
Fuel_Volume_Display ← (Fuel_Volume_Pri_Tank_Display + Fuel_Volume_Sec_Tank_Display)

WHEN (Fuel_Level_State_Display = “Zone_4”)
Fuel_Volume_Display ← Fuel_Volume_Pri_Tank_Display

ENDSELECT

IF ((Filt_Fuel_Volume_Display > **(K_PriTankRatedCapDsply + K_SecTankEstimateDsply)**
OR
(Filt_Fuel_Volume_Display < **K_PriTankFullDsply**))
AND
(Vehicle_Speed ≥ **K_FuelLvlVehSpeedDsply)**

THEN
DECREMENT Fuel_Level_Integration_Timer_Display

ELSE
Fuel_Level_Integration_Timer_Display ← **K_FuelLvlIntgrTmDsply**

END

IF (Fuel_Level_Integration_Timer_Display = 0.0)

THEN
Fuel_Delivered_In_State_2_Display ← 0.0

ELSE

IF (Fuel_Level_State_Display = “Zone_2”

THEN
ACCUMULATE Fuel_Delivered_In_State_2_Display
(LIMIT Fuel_Delivered_In State_2_Display to the maximum calibration value of **K_MaxFuelVolDlvdInState2_Dsply**)

ELSE
NO ACTION

END
END

Note: Fuel_Level_Intergration_Timer_Display was introduced for re-fueling recognition with ignition on/engine running, and to preserve Fuel_Delivered_In_State_2_Display for a time when Zone 2 is left (when the reason for leaving was driving maneuvers, road grades or bad road surfaces) so that upon re-entry (when maneuver finished, road level, road smooth) the algorithm remembers how much fuel has been consumed in Zone 2. It starts to run when Zone 2 is left. A suitable calibration value is determined through evaluation how long driving maneuvers, road grades or bad road surfaces can force exiting of Zone 2, although the fuel content within the tanks is unchanged. If Fuel_Level_Intergration_Timer_Display has expired, Fuel_Delivered_In_State_2_Display is reset. This leads to indication of a higher fuel amount (Fuel_Delivered_In_State_2_Display = 0) when Zone 2 is entered for the next time. Fuel_Level_Intergration_Timer_Display might be calibrated to zero in markets, where re-fueling with ignition on/engine running is quite unusual or with small "hidden" fuel amounts in Zone 2.

4.1.3.1.4 Fuel Level Parameters for Platform Displays. The determination of the fuel level parameters needed by Platform for display purposes is represented by the following pseudo code:

Fuel_System_Rated_Capacity ← **K_FuelSystemRatedCapDsply**

Fuel_Level_Display ← (Fuel_Volume_Display/**K_FuelSystemRatedCapDsply)** × 100

Filt_Fuel_Volume_Display ← filter Fuel_Volume_Display using a first order lag filter with the filter coefficient chosen per the criteria below:

Use **K_FuelPlatFastFilt** as the filter coefficient if any of the following conditions are satisfied, otherwise, use **K_FuelPlatNormalFilt** as the filter coefficient:

a. The engine has been running for a period of time less than **K_FastFillEngRun**.

b. The Actual_Gear is equal to “TransGrPark” or “TransGrNeutral” for **K_FastFiltGearTime** seconds.

   Note: This condition must be bypassed during a PRNDL failure. This will be accomplished if Trans_Range_State_DFLTD is set equal to “True”. Also, this condition must be bypassed if the vehicle has a manual transmission, i.e., Transmission_Type = “Manual”.

c. The Vehicle_Speed is equal to 0.0 kph for **K_FastFiltVehSpeedTime** seconds.

   Note: This condition must be bypassed during a Vehicle Speed failure.

d. Filt_Fuel_Volume_Display is less than the hysteresis pair, (**K_FuelLvlFastFiltHysPair.fHigh** and **K_FuelLvlFastFiltHysPair.fLow)** for a continuous amount of time, **K_FuelLvlFastFiltHysPairTime**.

Filt_Fuel_Level_Display ← (Filt_Fuel_Volume_Display/**K_FuelSystemRatedCapDsply**) ×100

4.1.3.1.5 Hill Mode Strategy. The following logic is required to be executed for the hill mode strategy.

```
IF      (Power mode Transitions to OFF)
THEN
        Monitor_Timeout ← Current_Time + K_Fuel_Monitor_Time
        NV_Fuel_Stored_Value ← Filt_Fuel_Volume_Display
END
IF      (Power mode is OFF AND Monitor_Timeout > Current_Time)
        NV_Fuel_Stable_Value ← Fuel_Sensor_Value
END
IF      (Power mode Transitions to RUN)
THEN
        Delta ← (NV_Fuel_Stable_Value – Fuel_Sensor_Value)
IF      |Delta| ≤ K_Refuel_Delta_Threshold
THEN
        Filt_Fuel_Volume_Display ← NV_Fuel_Stored_Value
        Force normal filtering until vehicle speed ≥ K_Exit_Hill_Mode
ELSE
```

Filt_Fuel_Volume_Display ← Fuel_Sensor_Value

END

END

4.1.3.1.6 Calculate Fuel Volume for Display based on Fuel Injected. The following logic is required to be executed for the Fuel Consumption Strategy:

IF (Fuel_Consumption_Mode = “False”)
THEN

IF (Filt_Fuel_Volume_Display < **K_Fuel_Consumption_Threshold**)

THEN

Fuel_Consumption_Mode ← True

Fuel_Consumption_Start_Point ← Fuel_Injected_This_Ign_Cycle

Fuel_Consumption_Carryover ← NV_Fuel_Accumulated_Used

ELSE

NV_Fuel_Accumulated_Used ← 0

Fuel_Consumption_Carryover ← 0

END

END

IF (Fuel_Consumption_Mode = “True”)

THEN

IF (Fuel_Volume_Display ≥ (**K_Fuel_Consumption_Threshold** + **K_Fuel_Consumption_Hysteresis**)) for ≥ **K_Exit_Consumption_ModeTime**

THEN

Fuel_Consumption_Mode ← False

NV_Fuel_Accumulated_Used ← 0

Exit_Consumption_Mode_Flag ← True

Fuel_Consumption_Reentry_Point ← Filt_Fuel_Volume_Display_Prev

Filt_Fuel_Volume_Display ← **K_Fuel_Consumption_Threshold**

ELSE IF

(Fuel_Volume_Display ≥ (**K_Fuel_Consumption_Threshold** + **K_Fuel_Consumption_Hysteresis**)) for < **K_Exit_Consumption_ModeTime**

THEN

NV_Fuel_Accumulated_Used ← (Fuel_Consumption_Carryover + Fuel_Injected_This_Ign_Cycle) - Fuel_Consumption_Start_Point

IF Exit_Consumption_Mode_Flag = “True”

THEN

Filt_Fuel_Volume_Display ← Fuel_Consumption_Reentry_Point – NV_Fuel_Accumulated_Used

ELSE

Filt_Fuel_Volume_Display ← **K_Consumption_Threshold** – NV_Fuel_Accumulated_Used

END

ELSE IF

(Fuel_Volume_Display < (**K_Fuel_Consumption_Threshold** + **K_Fuel_Consumption_Hysteresis**))

THEN

NV_Fuel_Accumulated_Used ← (Fuel_Consumption_Carryover + Fuel_Injected_This_Ign_Cycle) – Fuel_Consumption_Start_Point

IF Exit_Consumption_Mode_Flag = "True"

THEN

Filt_Fuel_Volume_Display ← Fuel_Consumption_Reentry_Point – NV_Fuel_Accumulated_Used filtered using first-order lag filter coefficient **K_Consumption_Reentry**

Filt_Fuel_Volume_Display ← **K_Fuel_Consumption_Threshold** – NV_Fuel_Accumulated_Used

END

Filt_Fuel_Volume_Display_Prev ← Filt_Fuel_Volume_Display

END

4.1.3.2 Fuel Volume Calculation for Diagnostics. Fuel Volume is the usable amount of fuel remaining in the fuel tank(s). Fuel_Volume is needed for the calculation of other fuel level parameters for diagnostics use.

4.1.3.2.1 Convert Fuel Tank Level Raw to Fuel Tank Volume for Diagnostic. The following logic is used to convert raw fuel level into fuel volume for diagnostic purposes:

SELECT FIRST

WHEN (**K_FuelSenderUnitType** = "NoSender"

Fuel_Level_Sender_Pri_Tank_Diag ← 0.0

Fuel_Level_Sender_Sec_Tank_Diag ← 0.0

Fuel_Volume_Pri_Tank_Diag ← 0.0

Fuel_Volume_Sec_Tank_Diag ← 0.0

WHEN (**K_FuelSenderUnitType** = "DualSenderMechPump")

OR

(**K_FuelSenderUnitType** = "DualSenderElectPump")

Note: Filter fuel sender input for diagnostic using a first order lag filter.

Fuel_Level_Sensor_Pri_Tank_Diag ← filtered Fuel_Level_Sensor_Pri_Tank, using **K_FuelLvlInFiltDiagPri** as a first order lag filter coefficient.

Fuel_Level_Sensor_Sec_Tank_Diag ←filtered Fuel_Level_Sensor_Sec_Tank, using **K_FuelLvlInFiltDiagSec** as a first order lag filter coefficient.

Note: Convert filtered fuel sender input into fuel volume

Fuel_Volume_Pri_Tank_Diag ← **K_PrimaryFuelTankDiag**[Fuel_Level_Sensor_Pri_Tank_Diag]

Fuel_Volume_Sec_Tank_Diag ← **K_SecondaryFuelTankDiag**[Fuel_Level_Sensor_Sec_Tank_Diag]

WHEN (**K_FuelSenderUnitType** = "SingleSender")

Note: Filter fuel sender input for display using a first order lag filter**.**

Fuel_Level_Sensor_Pri_Tank_Diag ← filtered Fuel_Level_Sensor_Pri_Tank, using **K_FuelLvlInFiltDiagPri** as a first order lag filter coefficient

Fuel_Level_Sensor_Sec_Tank_Diag ← 0.0

Note: Convert filtered fuel sender input into fuel volume.

Fuel_Volume_Pri_Tank_Diag ← **K_PrimaryFuelTankDiag**[Fuel_Level_Sensor_Pri_Tank_Display]

Fuel_Volume_Sec_Tank_Diag ← 0.0

OTHERWISE

NO ACTION

ENDSELECT

4.1.3.2.2 Determine the Fuel Tank System Zone for Diagnostic. The following logic is used to determine what fuel tank system zone the vehicle is in for diagnostic purposes:

Note: Determine method for fuel volume calculation.

SELECT FIRST

WHEN (Fuel_Volume_Pri_Tank_Diag ≥ **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag ≥ **K_SecTankEstimateDiag**)
continuously for **K_FuelTankSt1_ChgDiag**

Fuel_Level_State_Diag ← “Zone_1”

WHEN (Fuel_Volume_Pri_Tank_Diag ≥ **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag < **K_SecTankEstimateDiag**)
continuously for **K_FuelTankSt2_ChgDiag**

Fuel_Level_State_Diag ← “Zone_2”

WHEN (Fuel_Volume_Pri_Tank_Diag < **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag > **K_SecTankEstimateDiag**
AND
K_FuelSenderUnitType ≠ “DualSenderElectPump”) continuously for **K_FuelTankSt3_ChgDiag**

Fuel_Level_State_Diag ← “Zone_3”

WHEN (Fuel_Volume_Pri_Tank_Diag < **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag > **K_SecTankEmptyDiag**) continuously for **K_FuelTankSt5_ChgDiag**

Fuel_Level_State_Diag ← “Zone_5”

WHEN (Fuel_Volume_Pri_Tank_Diag < **K_PriTankFullDiag**
AND

Fuel_Volume_Sec_Tank_Diag ≤ **K_SecTankEmptyDiag**) continuously for **K_FuelTankSt4_ChgDiag**

Fuel_Level_State_Diag ← “Zone_4”

ENDSELECT

4.1.3.2.3 Calculate Fuel Volume Based on the Fuel Tank System Zone for Diagnostic. The following logic is used to calculate fuel volume based on the fuel tank system for diagnostic purposes:

Note: Calculate fuel volume.

SELECT FIRST

WHEN (Fuel_Level_State_Diag = “Zone_1”)

Fuel_Volume_Diag ← (**K_PriTankRatedCapDiag** + Fuel_Volume_Sec_Tank_Diag)

WHEN (Fuel_Level_State_Diag = “Zone_2”)

Fuel_Volume_Diag ← (**K_PriTankRatedCapDiag** + **K_SecTankEstimateDiag** - Fuel_Delivered_In_State_2_Diag)

WHEN (Fuel_Level_State_Diag = “Zone_3”)

OR

(Fuel_Level_State_Diag = “Zone_5”)

Fuel_Volume_Diag ← (Fuel_Volume_Pri_Tank_Diag + Fuel_Volume_Sec_Tank_Diag)

WHEN (Fuel_Level_State_Diag = “Zone_4”)

Fuel_Volume_Diag ← Fuel_Volume_Pri_Tank_Diag

ENDSELECT

IF ((Filt_Fuel_Volume_Diag > (**K_PriTankRatedCapDiag** + **K_SecTankEstimatedDiag**)

OR

(Filt_Fuel_Volume_Diag < **K_PriTankFullDiag**))

AND

(Vehicle_Speed ≥ **K_FuelLvlVehSpeedDiag**)

THEN

DECREMENT Fuel_Level_Integration_Timer_Diag

ELSE

Fuel_Level_Integration_Timer_Diag ← **K_FuelLvlIntgrTmDiag**

END

IF (Fuel_Level_Integration_Timer_Diag = 0.0)

THEN

Fuel_Delivered_In_State_2_Diag ← 0.0

ELSE

IF (Fuel_Level_State_Diag = “Zone_2”

THEN

ACCUMULATE Fuel_Delivered_In_State_2_Diag

(LIMIT Fuel_Delivered_In State_2_Diag to the maximum calibration value of **K_MaxFuelVolDlvdInState2_Diag**)

ELSE

NO ACTION

END

END

4.1.3.2.4 Fuel Level Parameters for Powertrain Diagnostics. The determination of the fuel level parameters used for Powertrain diagnostics is represented by the following logic:

Fuel_Level_Diag ← (Fuel_Volume_Diag ÷ **K_FuelSystemRatedCapDiag**) × 100

Filt_Fuel_Volume_Diag ← filter Fuel_Volume_Diag, using **K_FuelLvlDiagFilt** as a first-order lag filter coefficient

Filt_Fuel_Level_Diag ← (Filt_Fuel_Volume_Diag ÷ **K_FuelSystemRatedCapDiag**) × 100

4.1.4 Calculate Fuel Volume for Single Tank. The Fuel Volume Determination Algorithm is designed to calculate fuel volume for a single fuel tank application as well as a dual fuel tank application. If this algorithm is being used for a single fuel tank application, the following calibrations should be set equal to 0.

K_FuelLvlInFiltDiagSec

K_FuelLvlInFiltDsplySec

K_SecondaryFuelTankDsply

K_SecondaryFuelTankDiag

K_SecTankEmptyDsply

K_SecTankEmptyDiag

K_SecTankEstimateDsply

K_SecTankEstimateDiag

4.1.5 Use of First Order Lag Filters. The following equation shows the use of a first order lag filter:

[New_Filtered_Value] =

[Old_Filtered_Value] + ([New_Unfiltered_Value] - [Old_Filtered_Value]) × [Filter_Coefficient])

Where:

Filter_Coefficient Range: 0 < [Filter_Coefficient] ≤ 1

[Filter_Coefficient] ≅ 0; means heavy filtering

[Filter_Coefficient] ≅ 1; means no or light filtering

4.1.6 Execution / Activation Requirements. Refer to Table 6.

Table 6: Fuel Level Execution/Activation Requirements

Algorithm Section	Nominal Execution Interval
Fuel Volume Calculation for Platform Displays	500 ms
Fuel Volume Calculation for Diagnostics	100 ms

4.1.7 Enable/Initialization Strategy.

4.1.7.1 Enable Strategy. The following Fuel Volume algorithm sections must be enabled during the ACCESSORY and RUN Power Modes:

Fuel Volume Calculation for Platform Displays

Fuel Volume Calculation for Diagnostics

Hill Mode Strategy

Fuel Consumption Strategy

4.1.7.2 Initialization Strategy. The following logic is required to be executed at the Init_Controller system state transition to guarantee that all fuel level data is correctly initialized for diagnostic and platform display purposes:

IF (Memory_Nonvolatile_Reset = “True”)
THEN
Fuel_Delivered_In_State_2_Display ← 0
Fuel_Delivered_In_State_2_Diag ← 0
ELSE
do nothing
ENDIF

SELECT FIRST
WHEN (**K_FuelSenderUnitType** = “NoSender”)

Fuel_Level_Sensor_Pri_Tank_Display ← 0.0
Fuel_Level_Sensor_Sec_Tank_Display ← 0.0
Fuel_Level_Sensor_Pri_Tank_Diag ← 0.0
Fuel_Level_Sensor_Sec_Tank_Diag ← 0.0
Fuel_Volume_Pri_Tank_Display ← 0.0
Fuel_Volume_Sec_Tank_Display ← 0.0
Fuel_Volume_Pri_Tank_Diag ← 0.0
Fuel_Volume_Sec_Tank_Diag ← 0.0

WHEN (**K_FuelSenderUnitType** = “DualSenderMechPump”)
OR
(**K_FuelSenderUnitType** = “DualSenderElectPump”)

Fuel_Level_Sensor_Pri_Tank_Display ← Fuel_Level_Sensor_Pri_Tank
Fuel_Level_Sensor_Sec_Tank_Display ← Fuel_Level_Sensor_Sec_Tank
Fuel_Level_Sensor_Pri_Tank_Diag ← Fuel_Level_Sensor_Pri_Tank
Fuel_Level_Sensor_Sec_Tank_Diag ← Fuel_Level_Sensor_Sec_Tank
Fuel_Volume_Pri_Tank_Display ← **K_PrimaryFuelTankDsply**[Fuel_Level_Sensor_Pri_Tank_Display]
Fuel_Volume_Sec_Tank_Display ← **K_SecondaryFuelTankDsply**[Fuel_Level_Sensor_Sec_Tank_Display]
Fuel_Volume_Pri_Tank_Diag ← **K_PrimaryFuelTankDiag**[Fuel_Level_Sensor_Pri_Tank_Diag]
Fuel_Volume_Sec_Tank_Diag ← **K_SecondaryFuelTankDiag**[Fuel_Level_Sensor_Sec_Tank_Diag]

WHEN **(K_FuelSenderUnitType** = “SingleSender”)

Fuel_Level_Sensor_Pri_Tank_Display ← Fuel_Level_Sensor_Pri_Tank
Fuel_Level_Sensor_Sec_Tank_Display ← 0.0
Fuel_Level_Sensor_Pri_Tank_Diag ← Fuel_Level_Sensor_Pri_Tank
Fuel_Level_Sensor_Sec_Tank_Diag ← 0.0
Fuel_Volume_Pri_Tank_Display ←
K_PrimaryFuelTankDsply[Fuel_Level_Sensor_Pri_Tank_Display]
Fuel_Volume_Sec_Tank_Display ← 0.0
Fuel_Volume_Pri_Tank_Diag ←

K_PrimaryFuelTankDiag[Fuel_Level_Sensor_Pri_Tank_Diag]
Fuel_Volume_Sec_Tank_Diag ← 0.0

OTHERWISE
NO ACTION
ENDSELECT

SELECT FIRST

WHEN (Fuel_Volume_Pri_Tank_Display ≥ **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display ≥ **K_SecTankEstimateDsply**)

Fuel_Level_State_Display ← "Zone_1"
Fuel_Volume_Display ← (**K_PriTankRatedCapDsply** +Fuel_Volume_Sec_Tank_Display)
Fuel_Delivered_In_State_2_Display ← 0

WHEN (Fuel_Volume_Pri_Tank_Display ≥ **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display < **K_SecTankEstimateDsply**)

Fuel_Level_State_Display ← "Zone_2"
Fuel_Volume_Display ← (**K_PriTankRatedCapDsply** + **K_SecTankEstimateDsply** - Fuel_Delivered_In_State_2_Display)
Fuel_Delivered_In_State_2_Display ← no change
Note: No need to accumulate fuel delivered in state 2 because the engine should not be running during initialization.

WHEN (Fuel_Volume_Pri_Tank_Display < **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display > **K_SecTankEstimateDsply**
AND
K_FuelSenderUnitType ≠ "DualSenderElectPump")
Fuel_Level_State_Display ← "Zone_3"
Fuel_Volume_Display ← (Fuel_Volume_Pri_Tank_Display + Fuel_Volume_Sec_Tank_Display)
Fuel_Delivered_In_State_2_Display ← no change

WHEN (Fuel_Volume_Pri_Tank_Display < **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display > **K_SecTankEmptyDsply**)

Fuel_Level_State_Display ← "Zone_5"
Fuel_Volume_Display ← (Fuel_Volume_Pri_Tank_Display + Fuel_Volume_Sec_Tank_Display)
Fuel_Delivered_In_State_2_Display ← no change

WHEN (Fuel_Volume_Pri_Tank_Display < **K_PriTankFullDsply**
AND
Fuel_Volume_Sec_Tank_Display ≤ **K_SecTankEmptyDsply**)

Fuel_Level_State_Display ← "Zone_4"
Fuel_Volume_Display ← Fuel_Volume_Pri_Tank_Display
Fuel_Delivered_In_State_2_Display ← 0

ENDSELECT

SELECT FIRST

WHEN (Fuel_Volume_Pri_Tank_Diag ≥ **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag ≥ **K_SecTankEstimateDiag**)

Fuel_Level_State_Diag ← "Zone_1"
Fuel_Volume_Diag ← (**K_PriTankRatedCapDiag** + Fuel_Volume_Sec_Tank_Diag)
Fuel_Delivered_In_State_2_Diag ← 0

WHEN (Fuel_Volume_Pri_Tank_Diag ≥ **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag < **K_SecTankEstimateDiag**)

Fuel_Level_State_Diag ← "Zone_2"
Fuel_Volume_Diag ← (**K_PriTankRatedCapDiag** + **K_SecTankEstimateDiag** - Fuel_Delivered_In_State_2_Diag)
Fuel_Delivered_In_State_2_Diag ← no change
Note: No need to accumulate fuel delivered in state 2 because the engine should not be running during initialization.

WHEN (Fuel_Volume_Pri_Tank_Diag < **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag > **K_SecTankEstimateDiag**
AND
K_FuelSenderUnitType ≠ "DualSenderElectPump")
Fuel_Level_State_Diag ← "Zone_3"
Fuel_Volume_Diag ← (Fuel_Volume_Pri_Tank_Diag + Fuel_Volume_Sec_Tank_Diag)
Fuel_Delivered_In_State_2_Diag ← no change

WHEN (Fuel_Volume_Pri_Tank_Diag < **K_PriTankFullDiag** AND
Fuel_Volume_Sec_Tank_Diag > **K_SecTankEmptyDiag**)

Fuel_Level_State_Diag ← "Zone_5"
Fuel_Volume_Diag ← (Fuel_Volume_Pri_Tank_Diag + Fuel_Volume_Sec_Tank_Diag)

Fuel_Delivered_In_State_2_Diag ← no change

WHEN (Fuel_Volume_Pri_Tank_Diag < **K_PriTankFullDiag**
AND
Fuel_Volume_Sec_Tank_Diag ≤ **K_SecTankEmptyDiag**)

Fuel_Level_State_Diag ← "Zone_4"
Fuel_Volume_Diag ← Fuel_Volume_Pri_Tank_Diag
Fuel_Delivered_In_State_2_Diag ← 0

ENDSELECT

Filt_Fuel_Volume_Display ← Fuel_Volume_Display
Filt_Fuel_Volume_Diag ← Fuel_Volume_Diag
Fuel_System_Rated_Capacity ← **K_FuelSystemRatedCapDsply**
Fuel_Level_Display ← (Fuel_Volume_Display / **K_FuelSystemRatedCapDsply**) × 100
Filt_Fuel_Level_Display ← Fuel_Level_Display
Fuel_Level_Diag ← (Fuel_Volume_Diag / **K_FuelSystemRatedCapDiag**) × 100
Filt_Fuel_Level_Diag ← Fuel_Level_Diag

4.1.7.3 Transfer Fuel Pump Control. This process describes transfer fuel pump control on vehicles equipped with dual fuel tanks and electric secondary transfer fuel pumps. Dual Fuel tank applications with mechanical transfer pumps are not required to implement this logic.

The transfer pump is turned on when all the following conditions are present:

- The primary tank fuel level is below a calibration and the secondary tank fuel level is above a calibration (not empty plus some hysteresis):
- Fuel_Volume_Pri_Tank_Diag < **K_PriFuelTankXferOn**
  AND
  Fuel_Volume_Sec_Tank_Diag > **K_SecFuelTankXferOn**
- No fuel level sensing faults are present
- The enhanced evaporative diagnostic is not in a phase where transfer pump activity will interfere with the diagnostic
- The fuel level system is in Zone_5
  Fuel_Level_State_Diag is equal to "Zone_5"
- Transfer pump has not exceeded maximum on time for that ignition cycle:
  Transfer_Pump_On_Time < **K_XferPumpMaxOnTime**
- Transfer pump has been off for a minimum off time (used to prevent cycling of the transfer pump):
  Transfer_Pump_Off_Time > **K_XferPumpMinOffTime**
- The primary fuel pump is commanded On
  Fuel_Pump_On is equal "True"
- The engine is running.

When the transfer fuel pump is commanded on Transfer_Pump_On_Time keeps track of the cumulative time that the pump is on for the ignition cycle.

The transfer pump is turned off when any one of the following conditions are present:

- The primary fuel tank becomes stuffed (overfilled):
  Fuel_Volume_Pri_Tank_Diag > **K_PriFuelTankXferOff**

- The enhanced evaporative diagnostic is in a phase where transfer pump activity will interfere with the diagnostic
- The secondary fuel tank becomes empty:
  Fuel_Volume_Sec_Tank_Diag < **K_SecFuelTankXferOff**
- Transfer pump has exceeded maximum on time for that ignition cycle:
  Transfer_Pump_On_Time > **K_XferPumpMaxOnTime**
- The primary fuel pump is commanded off:
  Fuel_Pump_On is equal “False”.
- The engine is not running.
- The fuel level sensing faults are present.

When the transfer fuel pump is commanded off, Transfer_Pump_Off_Time keeps track of the time that the pump off and is reset to 0 the next time the pump is commanded on.

Note: When the secondary fuel level becomes empty, the pump shall remain on for a calibration time. If the secondary fuel level never gets to empty, the timer will time out and cause the pump to be turned off. Under this condition, the pump can no longer be triggered for the remainder of the ignition cycle.

Note: At startup, all conditions are reset, and the algorithm is not limited by any means. The fuel level zone must be at Zone_5; otherwise the pump control will not be allowed to be enabled.

Note: Once the pump is enabled, the pump should continue until it times out by some means. The transfer pump must remain off for a calibrated period after it has been shut off. This assists in limiting the amount of on/off cycling the pump experiences and prolongs the life of the pump.

Note: The Evap_State enumerated value contains information about where the Evaporative diagnostic is with respect to the test. If the test is about to run or the test is finished then the electric secondary transfer pump can be allowed to run. If the test is running, the electric secondary transfer pump should not be allowed to run. The pump is turned off if it is currently on, and/or is not allowed on if it is currently off.

4.1.9 Diagnostic Action Requirements. Other than the consumers of the data needing an indication that there is a failure with a fuel level sensor, there are no diagnostic actions taken specifically by this algorithm.

4.1.10 On-Vehicle Communications / Serial Data Interaction Requirements.

4.1.10.1 GMLAN Serial Data. (Table 7)

Table 7: Fuel Level Serial Data Signals

GMLAN Signal Name	Variable Name
Fuel Total Capacity	Fuel_System_Rated_Capacity
Fuel Level Percent	Filt_Fuel_Level_Display
Fuel Level Percent Validity	Fuel_Level_Data_Failed

4.1.10.2 Device Control. None.

4.1.11 Data Dictionary.

4.1.11.1 Calibrations. All calibrations are Platform owned unless otherwise specified.

4.1.11.1.1 K_Consumption_Reentry. First order lag filter coefficient used to filter the displayed fuel level when consumption mode has been entered for a second time in a key cycle. (Platform Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.1500

4.1.11.1.2 K_Exit_Consumption_ModeTime. Time that the unfiltered fuel level for displays is high enough to cause consumption mode to be exited. (Platform Owned Calibration.)

Minimum Range: 0 to 120 s

Minimum Resolution: 1 s

Typical Value: 45 s

4.1.11.1.3 K_Exit_Hill_Mode. Value of vehicle speed that terminates hill mode functionality on new key cycle.

Minimum Range: 0 to 255 km/h

Minimum Resolution: 1 km/h

Typical Value: 3 km/h

4.1.11.1.4 K_FastFillEngRun. Engine run time below which the fast filter is used to filter fuel level for displays. (Platform Owned Calibration.)

Minimum Range: 0 to 120 s

Minimum Resolution: 1 s

Typical Value: 60 s

4.1.11.1.5 K_FastFiltGearTime. The amount of time that must expire while the transmission is in either Park or Neutral gear state before the fast filter is used to filter fuel level for displays. (Platform Owned Calibration.)

Minimum Range: 0 to 120 s

Minimum Resolution: 1 s

Typical Value: 30 s

4.1.11.1.6 K_FastFiltVehSpeedTime. The amount of time that must expire while the vehicle speed is equal to zero before the fast filter is used to filter fuel level for displays. (Platform Owned Calibration.)

Minimum Range: 0 to 120 s

Minimum Resolution: 1 s

Typical Value: 50 s

4.1.11.1.7 K_Fuel_Consumption_Hysteresis. A delta value used to check when to switch off Fuel Consumption mode.

Minimum Range: 0 to 50 L

Minimum Resolution: 1 L

Typical Value: 3 L

4.1.11.1.8 K_Fuel_Consumption_Threshold. A value in liters used for detecting low fuel.

Minimum Range: 0 to 50 L

Minimum Resolution: 1 L

Typical Value: 8 L

4.1.11.1.9 K_Fuel_Monitor_Time. Value in seconds used for monitoring the fuel after transition to power OFF.

Minimum Range: 0 to 120 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.10 K_FuelLvlDiagFilt. First order lag filter coefficient used to filter fuel level information for diagnostic uses. (Powertrain Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.2500

4.1.11.1.11 K_FuelLvlFastFiltHysPair = fLow and fHigh. Hysteresis pair or calibrations, which define the fuel volume below which the fast filter is used for filtering fuel level for displays. (Platform Owned Calibration.)

Minimum Range: 0.0 to 512.0 L

Minimum Resolution: 0.5 L

Typical Value: fLow = 12.0 L
fHigh = 13.0 L

4.1.11.1.12 K_FuelLvlFastFiltHysPairTime. The continuous time period before transitioning to the fast filter during which the fuel level must be less than the hysteresis pair. (Platform Owned Calibration.)

Minimum Range: 0 to 120 s

Minimum Resolution: 1 s

Typical Value: 60 s

4.1.11.1.13 K_FuelLvlInFiltDiagPri. First order lag filter coefficient used to filter the fuel level sensor input to the primary fuel tank for diagnostic use. (Powertrain Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.1500

4.1.11.1.14 K_FuelLvlInFiltDiagSec. First order lag filter coefficient used to filter the fuel level sensor input to the secondary fuel tank for diagnostic use. (Powertrain Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.1500

4.1.11.1.15 K_FuelLvlInFiltDsplyPri. First order lag filter coefficient used to filter the fuel level sensor input to the primary fuel tank for display use.

Note: A filter coefficient value of approximately 1 is essentially no filtering at all. The smaller the value of the filter coefficient, the heavier the filtering is. (Platform Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.1500

4.1.11.1.16 K_FuelLvlInFiltDsplySec. First order lag filter coefficient used to filter the fuel level sensor input to the secondary fuel tank for display use. (Platform Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.1500

4.1.11.1.17 K_FuelLvlIntgrTmDiag. The fuel level integration timer will be reset to this calibration, when either the vehicle speed less than **K_FuelLvlVehSpeedDiag** or the fuel level state is equal to “Zone_2”. (Powertrain Owned Calibration.)

Minimum Range: 0 to 600 s

Minimum Resolution: 1 s

Typical Value: 0 s

4.1.11.1.18 K_FuelLvlIntgrTmDsply. The fuel level integration timer will be reset to this calibration, when either the vehicle speed less than **K_FuelLvlVehSpeedDsply** or the fuel level state is equal to “Zone_2”. (Platform Owned Calibration.)

Minimum Range: 0 to 600 s

Minimum Resolution: 1

Typical Value: 0

4.1.11.1.19 K_FuelLvlVehSpeedDiag. Vehicle speed must be equal to or greater than this calibration to allow the fuel level integration timer to expire when the fuel level state is not in “Zone_2”. If the fuel level integration timer expires, the value for fuel delivered in “Zone_2” will be reset to zero. (Powertrain Owned Calibration.)

Minimum Range: 0 to 200 km/h

Minimum Resolution: 1 km/h

Typical Value: 0 km/h

4.1.11.1.20 K_FuelLvlVehSpeedDsply. Vehicle speed must be equal to or greater than this calibration to allow the fuel level integration timer to expire when the fuel level state is not in “Zone_2”. If the fuel level integration timer expires, the value for fuel delivered in “Zone_2” will be reset to zero. (Platform Owned Calibration.)

Minimum Range: 0 to 100 km/h

Minimum Resolution: 1 km/h

Typical Value: 0 km/h

4.1.11.1.21 K_FuelPlatFastFilt. First order lag filter coefficient used to filter fuel level information for displays during conditions which require a faster than normal filter. (Platform Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.2000

4.1.11.1.22 K_FuelPlatNormalFilt. First order lag filter coefficient used to filter fuel level information for displays during conditions which require a normal filter. (Platform Owned Calibration.)

Minimum Range: 0.0000 to 1.0000

Minimum Resolution: 0.0005

Typical Value: 0.0050

4.1.11.1.23 K_FuelSenderUnitType. Identifies the type of fuel sender for the fuel tank system. (Platform Owned Calibration.)

Minimum Range: “NoSender”, “DualSenderMechPump”, “DualSenderElectPump”, “SingleSender”

Minimum Resolution: (Not applicable)

Typical Value: “SingleSender”

4.1.11.1.24 K_FuelSystemRatedCapDiag. Rated (advertised) capacity of the fuel tank(s). (Powertrain Owned Calibration.)

Minimum Range: 0.0 to 512.0 L

Minimum Resolution: 0.5 L

Typical Value: 80.0 L

4.1.11.1.25 K_FuelSystemRatedCapDsply. Rated (advertised) capacity of the fuel tank(s). (Platform Owned Calibration.)

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Typical Value: 80.0 L

4.1.11.1.26 K_FuelTankSt1_ChgDiag. A continuous period of time spent in fuel state Zone_1 which must be met before transitioning to the state for fuel volume calculation for diagnostics. (Powertrain Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.27 K_FuelTankSt1_ChgDsply. A continuous period of time spent in fuel state Zone_1 which must be met before transitioning to the state for fuel volume calculation for display. (Platform Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.28 K_FuelTankSt2_ChgDiag. A continuous period of time spent in fuel state Zone_2 which must be met before transitioning to the state for fuel volume calculation for diagnostics. (Powertrain Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.29 K_FuelTankSt2_ChgDsply. A continuous period of time spent in fuel state Zone_2 which must be met before transitioning to the state for fuel volume calculation for display. (Platform Owned Calibration.)

Minimum Range: 0 to 240 se

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.30 K_FuelTankSt3_ChgDiag. A continuous period of time spent in fuel state Zone_3 which must be met before transitioning to the state for fuel volume calculation for diagnostics. (Powertrain Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.31 K_FuelTankSt3_ChgDsply. A continuous period of time spent in fuel state Zone_3 which must be met before transitioning to the state for fuel volume calculation for display. (Platform Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.32 K_FuelTankSt4_ChgDiag. A continuous period of time spent in fuel state Zone_4 which must be met before transitioning to the state for fuel volume calculation for diagnostics. (Powertrain Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.33 K_FuelTankSt4_ChgDsply. A continuous period of time spent in fuel state Zone_4 which must be met before transitioning to the state for fuel volume calculation for display. (Platform Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.34 K_FuelTankSt5_ChgDiag. A continuous period of time spent in fuel state Zone_5 which must be met before transitioning to the state for fuel volume calculation for diagnostics. (Powertrain Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.35 K_FuelTankSt5_ChgDsply. A continuous period of time spent in fuel state Zone_5 which must be met before transitioning to the state for fuel volume calculation for display. (Platform Owned Calibration.)

Minimum Range: 0 to 240 s

Minimum Resolution: 1 s

Typical Value: 20 s

4.1.11.1.36 K_MaxFuelVolDlvdInState2_Diag. The maximum allowable fuel that can be delivered (consumed by the engine) in the fuel level state 2 for diagnostic use. (Powertrain Owned Calibration.)

Minimum Range: 0.00 to 10.00 L

Minimum Resolution: 0.05 L

Typical Value: 2.00 L

4.1.11.1.37 K_MaxFuelVolDlvdInState2_Dsply. The maximum allowable fuel that can be delivered (consumed by the engine) in the fuel level state 2 for display use. (Platform Owned Calibration.)

Minimum Range: 0.00 to 10.00 L

Minimum Resolution: 0.05 L

Typical Value: 2.00 L

4.1.11.1.38 K_PrimaryFuelTankDiag. Calibration table used to determine the fuel volume read by the primary fuel tank level sensor input. (Powertrain Owned Calibration.)

Minimum Range: 0.0 to 512.0 L

Minimum Resolution: 0.5 L

Table Description: 33-place interpolated table (recommend using calibratable breakpoints) which ranges from 0 to 100 percent of analog to digital (A/D) reference voltage (5.0 V, under normal voltage conditions.)

Typical Values:	0.000%	2.0 L
	3.125%	3.0 L
	(etc.)	
	96.875%	36.0 L
	100.000%	37.0 L

4.1.11.1.39 K_PriFuelTankXferOff. Primary fuel tank level above which the transfer pump is not allowed to be commanded on.

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Typical Value: Platform Dependent

4.1.11.1.40 K_PriFuelTankXferOn. Primary fuel tank level below which the transfer pump is allowed to be commanded on.

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Typical Value: Platform Dependent

4.1.11.1.41 K_PrimaryFuelTankDsply. Calibration table used to determine the fuel volume read by the primary fuel tank level sensor input. (Platform Owned Calibration.)

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Table Description: 33-place interpolated table (recommend using calibratable breakpoints) which ranges from 0 to 100 percent of A/D reference voltage (5.0 V, under normal voltage conditions).

Typical Values:	0.000%	2.0 L
	3.125%	3.0 L
	(etc.)	
	96.875%	36.0 L
	100.000%	37.0 L

4.1.11.1.42 K_PriTankFullDiag. Threshold above which the primary tank is assumed to be full. (Powertrain Owned Calibration.)

Minimum Range: 0.0 to 512.0 L

Minimum Resolution: 0.5 L

Typical Value: 38.0 L

4.1.11.1.43 K_PriTankFullDsply. Threshold above which the primary tank is assumed to be full. (Platform Owned Calibration.)

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Typical Value: 38.0 L

4.1.11.1.44 K_PriTankRatedCapDiag. Rated capacity of the primary tank. Value used in the fuel volume calculation when the volume is greater than the primary tank full threshold calibration. (Powertrain Owned Calibration.)

Minimum Range:	0.0 to 200.0 L
Minimum Resolution:	0.5 L
Typical Value:	40.0 L

4.1.11.1.45 K_PriTankRatedCapDsply. Rated capacity of the primary tank. Value used in the fuel volume calculation when the volume is greater than the primary tank full threshold calibration. (Platform Owned Calibration.)

Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L
Typical Value:	40.0 L

4.1.11.1.46 K_Refuel_Delta_Threshold. A value in liters used for detecting if the vehicle has been refueled.

Minimum Range:	0 to 50 L
Minimum Resolution:	1 L
Typical Value:	3 L

4.1.11.1.47 K_SecFuelTankXferOff. Secondary fuel tank level below which the transfer pump is not allowed to be commanded on.

Minimum Range:	0.0 to 200.0 L
Minimum Resolution:	0.5 L
Typical Value:	Platform Dependent

4.1.11.1.48 K_SecFuelTankXferOn. Secondary fuel tank level above which the transfer pump is allowed to be commanded on.

Minimum Range:	0.0 to 200.0 L
Minimum Resolution:	0.5 L
Typical Value:	Platform Dependent

4.1.11.1.49 K_SecondaryFuelTankDiag. Calibration table used to determine the fuel volume read by the secondary fuel tank level sensor input. (Powertrain Owned Calibration.)

Minimum Range:	0.0 to 512.0 L	
Minimum Resolution:	0.5 L	
Table Description:	33-place interpolated table (recommend using calibratable breakpoints) which ranges from 0 to 100 percent of A/D reference voltage (5.0 V, under normal voltage conditions).	
Typical Values:	0.000%	2.0 L
	3.125%	3.0 L
	(etc.)	
	96.875%	36.0 L
	100.000%	37.0 L

4.1.11.1.50 K_SecondaryFuelTankDsply. Calibration table used to determine the fuel volume read by the secondary fuel tank level sensor input. (Platform Owned Calibration.)

Minimum Range:	0.0 to 200.0 L	
Minimum Resolution:	0.5 L	
Table Description:	33-place interpolated table (recommend using calibratable breakpoints) which ranges from 0 to 100 percent of A/D reference voltage (5.0 V, under normal voltage conditions).	
Typical Values:	0.000%	2.0 L
	3.125%	3.0 L
	(etc.)	

96.875%	36.0 L
100.000%	37.0 L

4.1.11.1.51 K_SecTankEmptyDiag. Threshold below which the secondary tank is assumed to be empty. (Powertrain Owned Calibration.)

Minimum Range: 0.0 to 512.0 L

Minimum Resolution: 0.5 L

Typical Value: 2.0 L

4.1.11.1.52 K_SecTankEmptyDsply. Threshold below which the secondary tank is assumed to be empty. (Platform Owned Calibration.)

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Typical Value: 2.0 L

4.1.11.1.53 K_SecTankEstimateDiag. When the primary tank is full and the secondary tank volume is below this threshold, fuel usage is not measureable in this region and must be estimated based on fuel delivery to the engine. (Powertrain Owned Calibration.)

Minimum Range: 0.0 to 512.0 L

Minimum Resolution: 0.5 L

Typical Value: 2.0 L

4.1.11.1.54 K_SecTankEstimateDsply. When the primary tank is full and the secondary tank volume is below this threshold, fuel usage is not measureable in this region and must be estimated based on fuel delivery to the engine. (Platform Owned Calibration.)

Minimum Range: 0.0 to 200.0 L

Minimum Resolution: 0.5 L

Typical Value: 2.0 L

4.1.11.1.55 K_XferPumpMinOffTime. A minimum period of time that the pump must remain off before the next time it is enabled.

Minimum Range: 0 to 1800 s

Minimum Resolution: 1 s

Typical Value: 300 s

4.1.11.1.56 K_XferPumpMaxOnTime. A maximum period of time that the pump can be enabled in an ignition cycle.

Minimum Range: 0 to 300 minutes

Minimum Resolution: 1 minute

Typical Value: 30 minutes

4.1.11.2 Variables.

4.1.11.2.1 Actual_Gear. Keeps track of the actual gear state for automatic and manual transmissions. For manual transmissions, the Actual Gear state will indicate “TransGrNeut”, if the clutch is engaged or the shifter is not engaged to any gear.

Type: Random Access Memory (RAM)

Range: “TransGr1”, “TransGr2”, “TransGr3”, “TransGr4”, “TransGr5”, “TransGr6”, “TransGrNeut”, “TransGrRvrs”, “TransGrPark”, “TransGrSize”, or “TransGrIllegal”

4.1.11.2.2 Current_Time. The current system time.

Type: RAM

Minimum Resolution: seconds

4.1.11.2.3 Engine_Running_Time. Period of time that the engine has been running.

Type:	RAM
Minimum Range:	0 to 120 s
Minimum Resolution:	1 s

4.1.11.2.4 Filt_Fuel_Level_Diag. Filtered fuel level scaled in percent of advertised capacity filtered for diagnostic uses.

Type:	RAM
Minimum Range:	0 to < 100%
Minimum Resolution:	100/256%

4.1.11.2.5 Filt_Fuel_Level_Display. Total filtered fuel level scaled in percent of advertised capacity filtered for the display.

Type:	RAM
Minimum Range:	0 to <100%
Minimum Resolution:	100/256%

4.1.11.2.6 Filt_Fuel_Volume_Diag. Filtered version of the fuel volume needed for diagnostic uses.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.7 Filt_Fuel_Volume_Display. Total fuel volume filtered for the display.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.8 Filt_Fuel_Volume_Display_Prev. Total fuel volume filtered for the display as determined from the previous execution loop.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.9 Fuel_Consumption_Carryover. Total fuel volume consumed (below the entry threshold) in consumption mode on the previous ignition cycle.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.10 Fuel_Consumption_Mode. A calculated variable (True/False) used to keep track if we are in Fuel Consumption mode or not.

Type:	RAM
Minimum Range:	“True” or “False”

4.1.11.2.11 Fuel_Consumption_Reentry_Point. The last reading of the filtered fuel level before consumption mode is exited – saved in order to begin consumption mode over (upon reentry due to vehicle orientation) from the proper level.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.12 Fuel_Consumption_Start_Point. Value of fuel consumed this ignition cycle at the time consumption mode is entered.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.13 Fuel_Delivered_In_State_2_Diag. Amount of fuel which has been delivered while Fuel_Level_State was equal to 2 for diagnostics.

Type:	Non-Volatile Memory (NVM)
Minimum Range:	0 to 20 L
Minimum Resolution:	Defined by fuel economy algorithm

4.1.11.2.14 Fuel_Delivered_In_State_2_Display. Amount of fuel which has been delivered while Fuel_Level_State was equal to 2 for displays.

Type:	Non-Volatile Memory
Minimum Range:	0 to 20 L
Minimum Resolution:	Defined by fuel economy algorithm

4.1.11.2.15 Fuel_Injected. Fuel injected from injectors.

Type:	RAM
Minimum Range:	0.00 to 50.00 L
Minimum Resolution:	0.01 L

4.1.11.2.16 Fuel_Level_Data_Failed. Indication that there is a problem with the fuel level sensor input(s) as determined by the Fuel Level Sensor Diagnostics. Used to set the Validity bits (GMLAN).

Type:	RAM
Minimum Range:	“True” or “False”

4.1.11.2.17 Fuel_Level_Diag. Unfiltered fuel level scaled in percent of advertised capacity filtered for diagnostic uses.

Type:	RAM
Minimum Range:	0 to < 100%
Minimum Resolution:	100/256%

4.1.11.2.18 Fuel_Level_Integration_Timer_Diag. Keeps track of the fuel level integration time before the fuel accumulated in “Zone_2” can be cleared when the fuel level state is no longer equal to “Zone_2”.

Type:	RAM
Minimum Range:	0 to 600 s
Minimum Resolution:	1 s

4.1.11.2.19 Fuel_Level_Integration_Timer_Display. Keeps track of the fuel level integration time before the fuel accumulated in “Zone_2” can be cleared when the fuel level state is no longer equal to “Zone_2”.

Type:	RAM
Minimum Range:	0 to 600 s
Minimum Resolution:	1 s

4.1.11.2.20 Fuel_Level_Display. Total unfiltered fuel level scaled in percent of advertised capacity filtered for the display.

Type:	RAM
Minimum Range:	0 to < 100%
Minimum Resolution:	100/256%

4.1.11.2.21 Fuel_Level_Sensor_Pri_Tank. Fuel level sensor input reading of the primary tank.

Type:	RAM
Minimum Range:	0 to 100% of A/D reference voltage (5.0 V)
Minimum Resolution:	100/256%

4.1.11.2.22 Fuel_Level_Sensor_Pri_Tank_Diag. Filtered fuel level sensor reading of the primary tank for diagnostic use.

Type:	RAM
Minimum Range:	0 to 100% of A/D reference voltage (5.0 V)
Minimum Resolution:	100/256%

4.1.11.2.23 Fuel_Level_Sensor_Pri_Tank_Display. Filtered fuel level sensor reading of the primary tank for display use.

Type:	RAM
Minimum Range:	0 to 100% of A/D reference voltage (5.0 V)
Minimum Resolution:	100/256%

4.1.11.2.24 Fuel_Level_Sensor_Sec_Tank. Fuel level sensor input reading of the secondary tank.

Type:	RAM
Minimum Range:	0 to 100% of A/D reference voltage (5.0 V)
Minimum Resolution:	100/256%

4.1.11.2.25 Fuel_Level_Sensor_Sec_Tank_Diag. Filtered fuel level sensor reading of the secondary tank for diagnostic use.

Type:	RAM
Minimum Range:	0 to 100% of A/D reference voltage (5.0 V)
Minimum Resolution:	100/256%

4.1.11.2.26 Fuel_Level_Sensor_Sec_Tank_Display. Filtered fuel level sensor reading of the secondary tank for display use.

Type:	RAM
Minimum Range:	0 to 100% of A/D reference voltage (5.0 V)
Minimum Resolution:	100/256%

4.1.11.2.27 Fuel_Level_State_Diag. State which represents the fuel level region used for the calculation of fuel volume for diagnostic use.

Type:	RAM
Minimum Range:	“Zone_1”, “Zone_2”, “Zone_3”, “Zone_4”, “Zone_5”
Minimum Resolution:	Not applicable

4.1.11.2.28 Fuel_Level_State_Display. State which represents the fuel level region used for the calculation of fuel volume for display use.

Type:	RAM
Minimum Range:	“Zone_1”, “Zone_2”, “Zone_3”, “Zone_4”, “Zone_5”
Minimum Resolution:	Not applicable

4.1.11.2.29 Fuel_Sensor_Value. The fuel level as read from the Fuel Sender without filtering.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.30 Fuel_System_Rated_Capacity. Rated (advertised) capacity of the fuel tank(s) that is stored to this variable for use with serial data. This variable represents the data value transmitted in the GMLAN signal “Fuel Total Capacity”.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.31 Fuel_Volume_Diag. Total unfiltered amount of fuel remaining in the fuel tank(s) for diagnostic use.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.32 Fuel_Volume_Display. Total unfiltered amount of fuel remaining in the fuel tank(s) for display use.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.33 Fuel_Volume_Pri_Tank_Diag. Amount of fuel remaining in the primary fuel tank for diagnostic use. Does not include any unusable amount of fuel in the primary fuel tank.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.34 Fuel_Volume_Pri_Tank_Display. Amount of fuel remaining in the primary fuel tank for display use. Does not include any unusable amount of fuel in the primary fuel tank.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.35 Fuel_Volume_Sec_Tank_Diag. Amount of fuel remaining in the secondary fuel tank for diagnostic use. Does not include any unusable amount of fuel in the secondary fuel tank.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.36 Fuel_Volume_Sec_Tank_Display. Amount of fuel remaining in the secondary fuel tank for display use. Does not include any unusable amount of fuel in the secondary fuel tank.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.37 Monitor_Timeout. Timeout time when monitoring fuel.

Type:	RAM
Minimum Range:	0 to 60 s
Minimum Resolution:	1 s

4.1.11.2.38 NV_Fuel_Accumulated_Used. The accumulated fuel consumption based on injectors as auxiliary heaters.

Type:	Non-Volatile Random Access Memory (NVRAM)
Minimum Range:	0.00 to 50.00 L
Minimum Resolution:	0.01 L

4.1.11.2.39 NV_Fuel_Stable_Value. The Fuel_Sensor_Value that is read after monitoring the fuel for some time when the vehicle is turned off.

Type:	RAM
Minimum Range:	0.0 to 512.0 L
Minimum Resolution:	0.5 L

4.1.11.2.40 NV_Fuel_Stored_Value. The Filt_Fuel_Volume_Display Stored in Memory When the Vehicle is Turned OFF.

Type:	KAM
Minimum Range:	0 to 512 L
Minimum Resolution:	0.5 L

4.1.11.2.41 Trans_Range_State_DFLTD. When “True”, indicates a PRNDL failure.

Type:	RAM
Minimum Range:	“True” or “False”

4.1.11.2.42 Transfer_Pump_Off_Time. Keeps track of the time between activations of the transfer fuel pump.

Type:	RAM
Minimum Range:	0 to 1800 s
Minimum Resolution:	1 s

4.1.11.2.43 Transfer_Pump_On_Time. Keeps track of the cumulative time the transfer fuel pump is on in an ignition cycle.

Type: RAM

Minimum Range: 0 to 300 minutes

Minimum Resolution: 1 minute

4.1.11.2.44 Transmission_Type. Variable indicating the transmission type on the vehicle.

Type: RAM

Minimum Range: “Manual” or “Automatic”

4.1.11.2.45 Vehicle_Speed. Velocity of the vehicle**.**

Type: RAM

Minimum Range: 0 to 200 km/h

Minimum Resolution: 1 km/h

5 Provisions for Shipping

Not applicable.

6 Notes

6.1 Glossary. Not applicable.

6.2 Acronyms, Abbreviations, and Symbols.

Refer to GMW8762, Appendix A.3

7 Additional Paragraphs

7.1 All materials supplied to this specification must comply with the requirements of GMW3001, **Rules and Regulations for Materials Specifications.**

7.2 All parts or systems supplied to this standard must comply with the requirements of GMW3059, **Restricted and Reportable Substances for Parts.**

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

GMW8774

9 Release and Revisions

This standard was originated in June 2003. It was first approved by The Global PPEI Core Team in December 2003. It was first published in February 2004.

Issue	Publication Date	Description (Organization)
1	FEB 2004	Initial publication.
2	AUG 2004	Global PPEI Version 3.5 Release.
3	JUL 2005	Global PPEI Version 3.6 Release.
4	MAR 2006	Global PPEI Version 3.7 Release.
5	AUG 2010	Global PPEI Version 3.8 Release. (Global PPEI Core Team)

Appendix A

The following are approved Change Requests (CRs) for the Global PPEI Version 3.8 Release that impacted the GMW8774 Enhanced Evaporative Emissions and Fuel Subsystem.

Sections Changed	Description Of Changes	Rationale/Authorization
3.3.1	Add serial data signals for CNG/LPG	CR1759
3.3.2 4.1 4.1.3.1.5 4.1.7.1 4.1.10.1 4.1.10.2	Added calibrations to Table 2: **K_Fuel_Hill_Delta_Threshold** **K_Fuel_Monitor_Time** Added overview description of hill mode Added the hill mode algorithm Added ´Hill Mode Strategy´ Added calibration definitions: **K_Fuel_Hill_Delta_Threshold** **K_Fuel_Monitor_Time** Added variable definitions: Current_Time Fuel_Monitoring Fuel_Sensor_Value Fuel_Stable_Value Fuel_Stored_Value Monitor_Timeout	CR586 CR592
3.3.2 4.1.2 4.1.8 4.1.10.1 4.1.10.2	Added 6 calibrations to Table 2 Updated Context Diagram to include a new PCM output and then added another output from Fuel Added algorithm for Transfer Fuel Pump Enabled Added 6 calibrations Added 2 variables	CR 3230
4.1.3 4.1.3.2.3	Changed logic/wording in bullets 4 and 5 Changed to a less than sign in the algorithm	CR 3779
4.1 4.1.3.1.2 4.1.3.1.3	Instead of Fuel Sensor made it Fuel Sender. Added clarification to hill mode. Crossed out the word Pending, this should not be used. Added Note at the end of this section for clarification	CR 5022

Sections Changed	Description Of Changes	Rationale/Authorization
4.1.3.1.5	on the use of “integration timer” Added clarification to hill mode algorithm	
3.3.1	Add serial data signals for CNG/LPG	CR5900
3.3.2 4.1.3.5.6 4.1.11	Added Calibration to Table 2 Added further detail to algorithm under Calculate Fuel Volume for Display based on Fuel Injected Added Calibration: **K_Exit_Consumption_ModeTime**	CR 6473
Block Diagram 3.3.7 3.5.5 3.3.10 3.5.8	Revise diagram to show Modular Reservoir Assembly components tied to +5 V Return and Secondary Fuel Level +5 V Return. Revise +5 V Return description to include Modular Reservoir Assembly components. Revise Secondary Fuel Level +5 V Return description to include Modular Reservoir Assembly components.	CR7238
3.3.1	Add signal Fuel Level Emissions Related Status to Table 1.	CR10156
Table 2 Table 2, 4.1.3.1.5 4.1.3.5.6 4.1.11.1 4.1.11.2	Add the following Calibrations: **K_Consumption_Reentry** **K_Exit_Consumption_ModeTime** Revise **K_Fuel_Hill_Delta_Threshold to: K_Refuel_Delta_Threshold** Add IF (Fuel_Consumption_Mode = “False”) to algorithm. Revise algorithm. **K_Consumption_Reentry** **K_Exit_Consumption_ModeTime** Revise **K_Fuel_Hill_Delta_Threshold to K_Refuel_Delta_Threshold** Fuel_Consumption_Carryover Fuel_Consumption_Reentry_Point Fuel_Consumption_Start_Point Filt_Fuel_Volume_Display_Prev	CR8014

Deviations

Not applicable.