AUTOMATIC TRANSMISSION

Solenoid Control in the TF60-SN (09G/09K/09M)

Starting with a few four-speed automatic transmissions, increasing with the five-speeds and more so with units having six or more speeds, it is interesting to see the use of counterbalance pistons in clutch drums that drive the planetary system. Since drive-style clutches are rotational, there is a tendency for centrifugal force to creep the clutch on when it is not in use, which could cause premature damage to the frictions.

By **Wayne Colonna**
on November 1, 2008

Technically Speaking

- **Subject**: Use of counterbalance pistons in clutch drums
- **Units**: TF60-SN (09G/09K/09M)
- **Vehicle Applications**: Audi, BMW, Volkswagen
- **Essential Reading**: Rebuilder, Diagnostician
- **Author**: Wayne Colonna, ATSG, Transmission Digest Technical Editor

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Starting with a few four-speed automatic transmissions, increasing with the five-speeds and more so with units having six or more speeds, it is interesting to see the use of counterbalance pistons in clutch drums that drive the planetary system. Since drive-style clutches are rotational, there is a tendency for centrifugal force to creep the clutch on when it is not in use, which could cause premature damage to the frictions.

As a preventive measure, there is a balance area in each of these clutch packs in front of the piston. A slight amount of fluid pressure is supplied to this area to balance centrifugal head oil behind the apply piston, neutralizing its effect. In ZF 6HP26-style transmissions this feature is referred to as “dynamic pressure balance.” GM’s 6L80 operates in a similar manner, and the circuit used to provide fluid into these balance pistons is called the compensator feed fluid.

This feature of the clutch assembly is really a by-product or an additional benefit to what is really the main reason for the strategy. And that is that it gives the computer greater control over the engagement and disengagement of the clutch pack through the solenoids, which ultimately improves gear-shift comfort.

The six-speed TF60-SN (**Figure 1**) used in BMW, Audi and Volkswagen vehicles makes full use of this strategy. Interestingly enough, lube pressure is used as a feed into the counterbalance-piston area.

control the shift timing as well as clutch-pressure control and shift overlaps.

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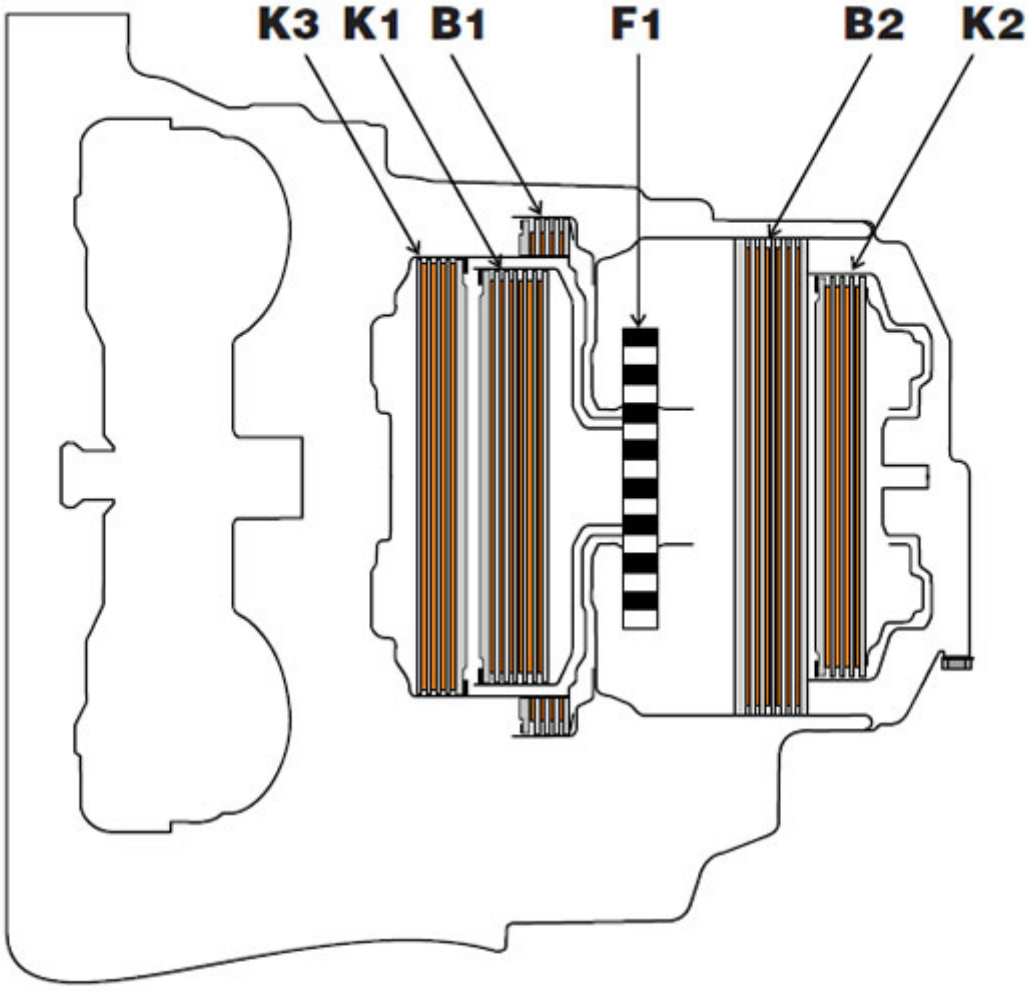

Clutch-Application Chart						
Gear	Component					
	K1	K2	K3	B1	B2	F1
1st	X				X*	X
2nd	X			X		
3rd	X		X			
4th	X	X				
5th		X	X			
6th		X		X		
Rev			X		X	

* The B2 clutch is applied in Tiptronic mode 1st gear only for engine braking.

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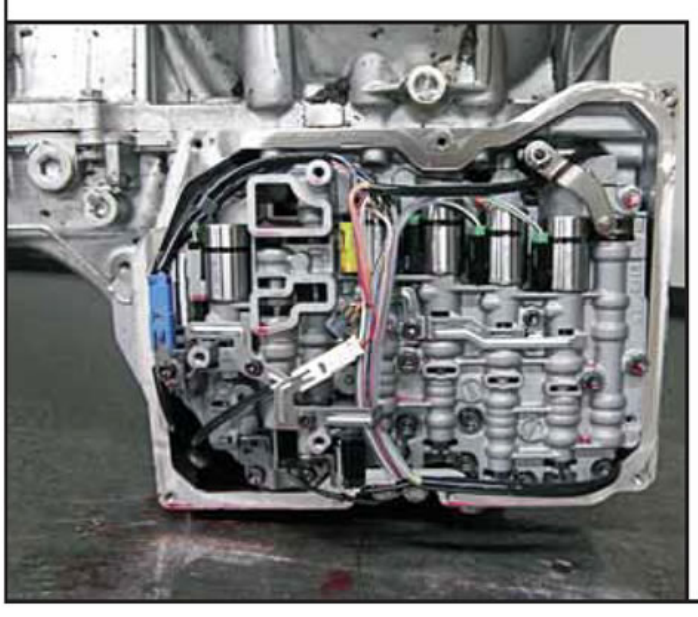
Solenoid Identification



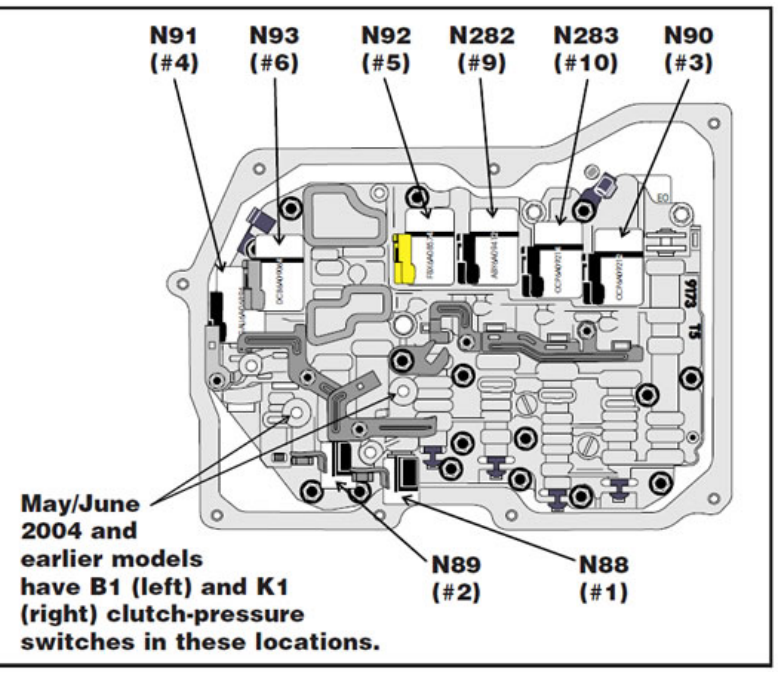


Figure 4 provides an overview of the solenoid shift strategy as it compares with the clutch application.

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Gear Shift Position	Solenoid Shift Sequence: On/Off Solenoids		Solenoid Shift Sequence: Pressure-Control Solenoids						Clutch Application Chart: Clutch and Freewheel Components					
	N89 SV-2	N88 SV-1	N92 SV-5	N282 SV-9	N90 SV-3	N283 SV-10	N93 SV-6	N91 SV-4	K1	K2	K3	B1	B2	F1
Park			Off	Off	On	On	PWM							
Neutral			On	On	On	On	PWM							
Reverse			On	On	Off	On	PWM				On		On	
1st Gear	T	T	Off	On	On	On	PWM		On					On
2nd Gear			Off	On	On	Off	PWM	PWM	On			On		
3rd Gear	T/To	To	Off	On	Off	On	PWM	PWM	On		On			
4th Gear	T/To	To	Off	Off	On	On	PWM	PWM	On	On				
5th Gear	T/To	To	On	Off	Off	On	PWM	PWM		On	On			
6th Gear	On	To	On	Off	On	Off	PWM	PWM		On		On		

N90 controls the K3-clutch apply
N91 controls converter-clutch apply
N92 controls the K1-clutch apply
N93 controls main line pressure
N282 controls the K2-clutch apply
N283 controls the B1-clutch apply

N88 and N89 are alternately toggled on and off to control the fourth through sixth shifts.

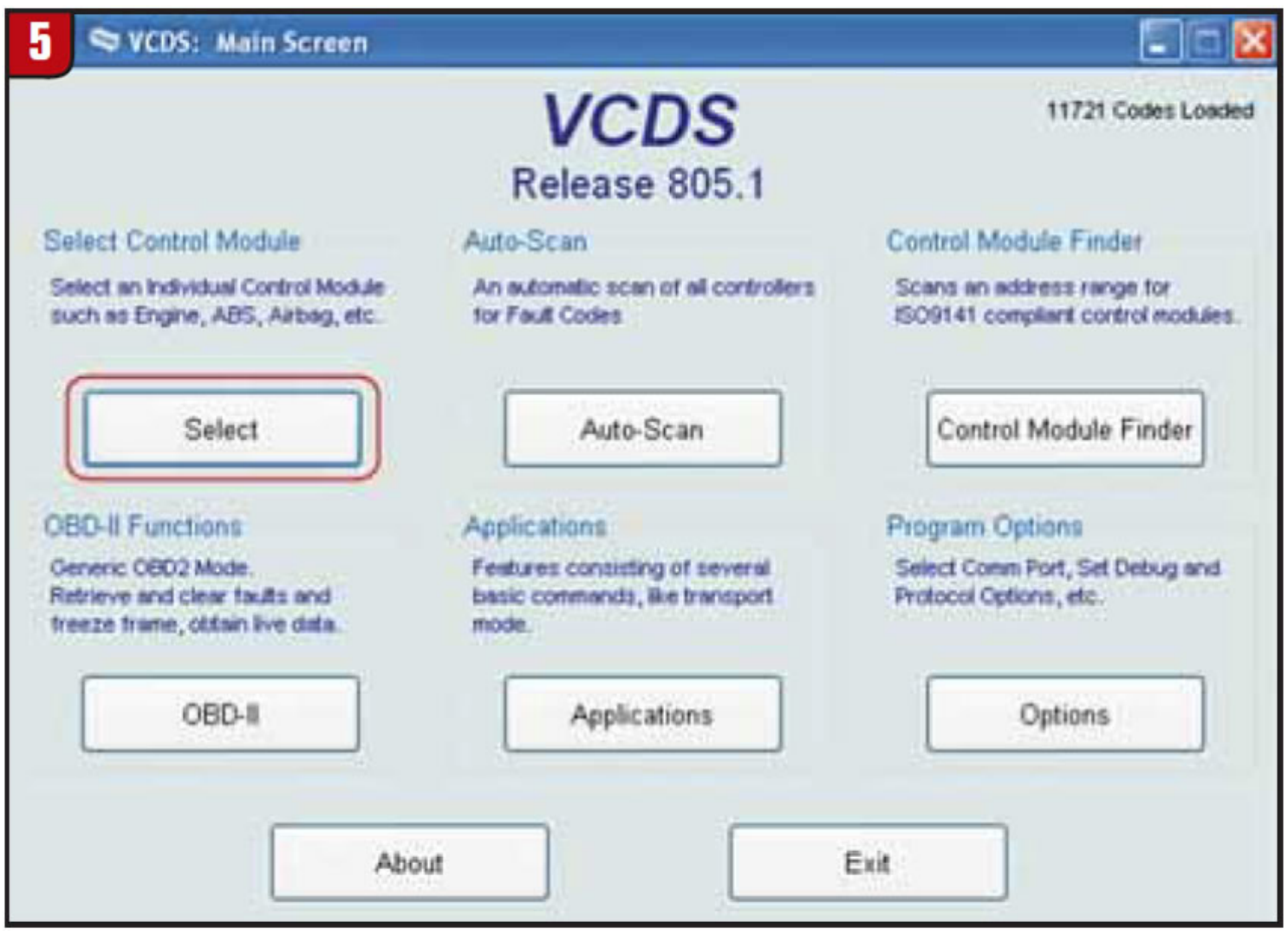
N88 and N89 also control B2-clutch apply in Tiptronic first gear for engine braking.

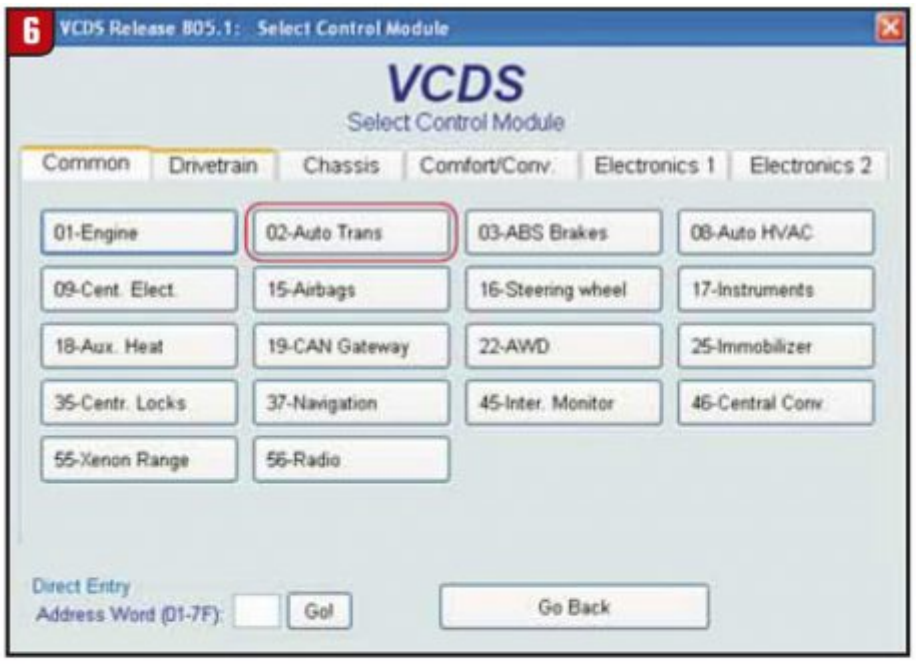
T = On in Tiptronic mode
To = Solenoid is toggled On to Off

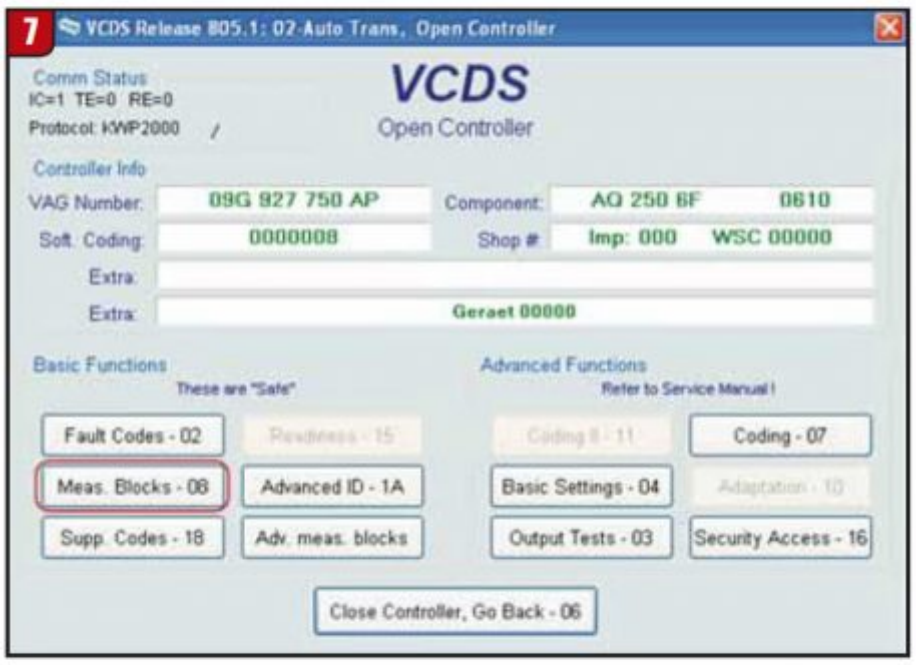
With the exception of the N91 converter-clutch-apply solenoid, all the other remaining pressure-control solenoids (N90, N92, N93, N282, N283) supply full pressure when they are in the off state. When they are pulsed fully on, they block pressure from entering their respective circuits. The N88 and N89 solenoids are typical on/off solenoids; however, during certain shifts the computer toggles them rapidly for a short time.

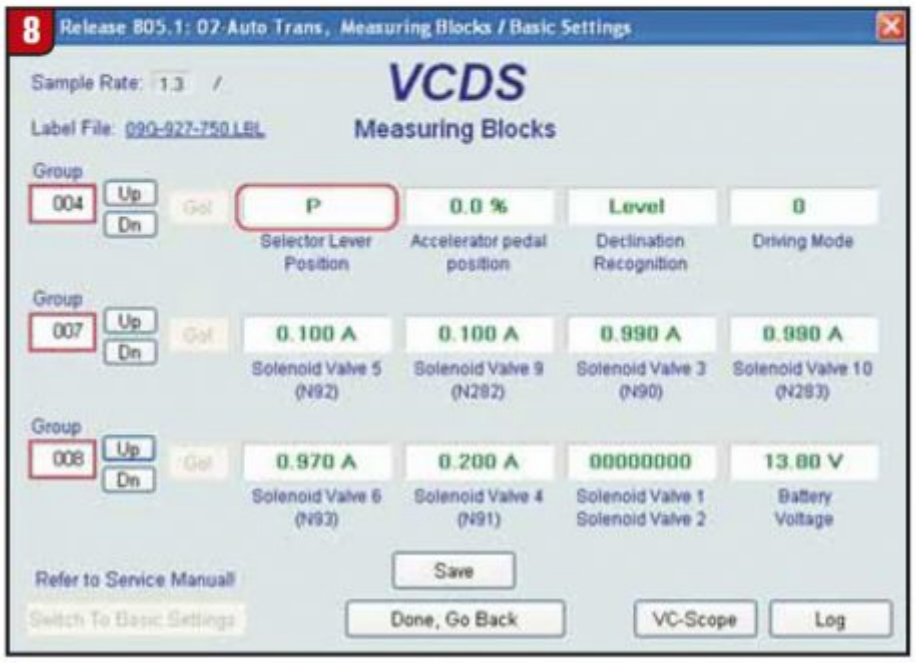
The use of these solenoids in conjunction with balance pistons provides greatly controlled shift feel. When these balance pistons lose pressure, harsh shifts are usually result, since the balance control of the piston is lost. And this is the type of drivability complaints we will become more familiar with as these types of transmissions begin to visit the shops for repair.

To take a closer look at the computer strategy of these solenoids we hooked up a laptop-based program called the VAG-COM from Ross-Tech, of Lansdale, Pa. When it was up and running (**Figure 5**), we selected the control-module mode. The next screen (**figure 6**) allowed us to select the TCM. Once we were in (**Figure 7**), we selected measuring blocks. The measuring blocks allow you to observe data stream of various inputs and outputs and to have the ability to record (log) data while driving.









When we entered the measuring-block area (**Figure 8**), you will see that measuring-block group 004 provides some data related to gearshift position and TPS percentage while groups 007 and 008 present all the pressure-control solenoids in amps. The N88 and N89 are shown only as off by a 0 number and on with a 1 number. When you're looking at the amperage of the pressure-control solenoids, 0.100 amp indicates that the solenoid is off, applying pressure to its respective circuit. When you see 1.000/0.990 amp, it indicates that the solenoid is turned on, blocking pressure from its respective circuit.

In **Figure 8** we can see that we are in Park and that both the N88 and N89 solenoids are off. N92 and N282 are off while N93 and N283 are on. N93 is the pressure-control solenoid, so when that solenoid is on, line pressure is down. N91, the PWM TCC-control solenoid, is off so converter-clutch apply is off. **Figure 9** shows the transition from the Park position into Drive. Only clutch pressure control solenoid N92 is off, applying the K1 clutch for a first

9

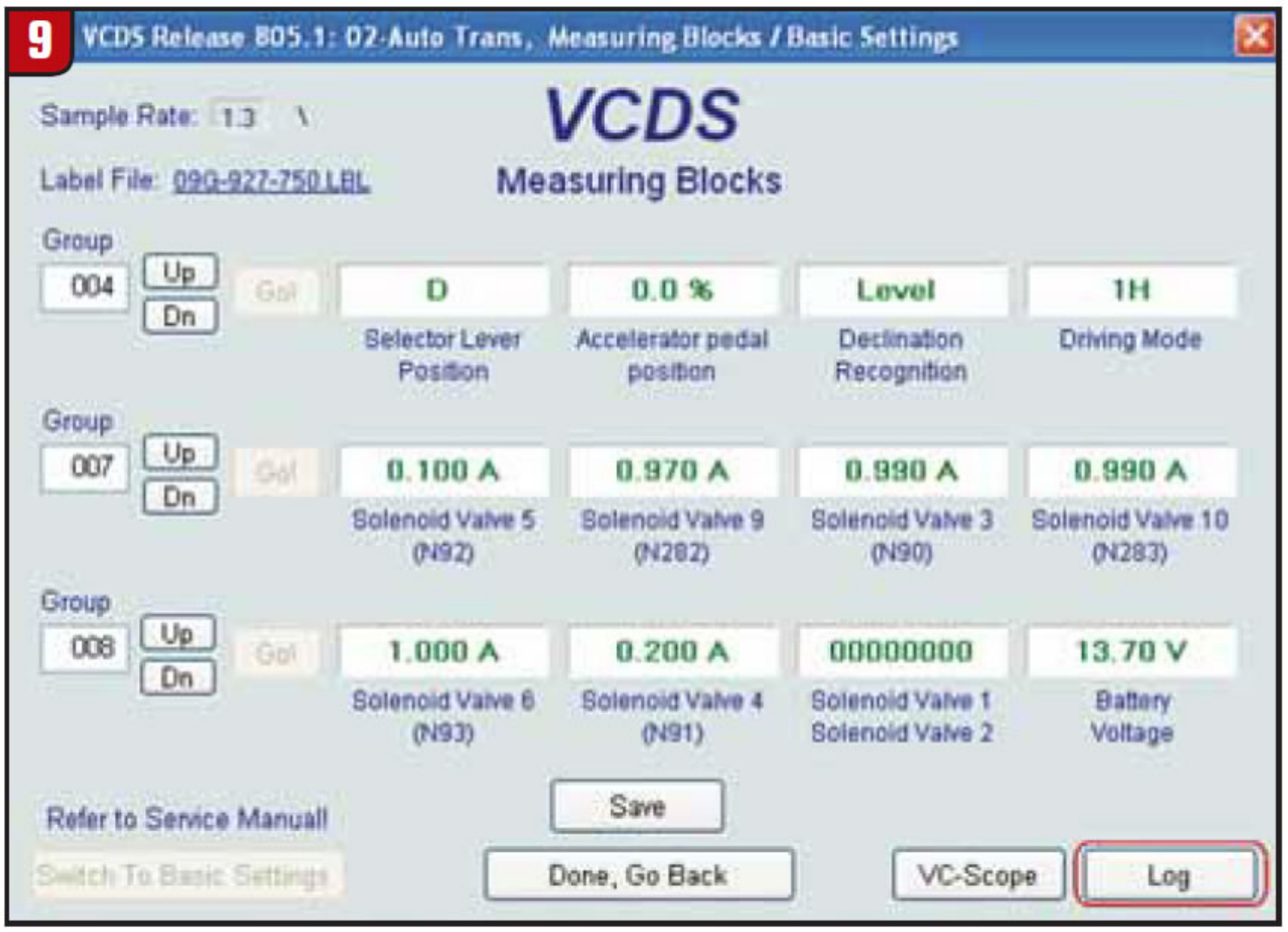


Figure 10 is a solenoid amp chart showing what the VAG-COM revealed throughout all the ranges. When you see the letter H next to the gear it means the converter clutch is off. When you see the letter M it means the converter clutch is applied. Be sure to read the notes provided for **Figure 10**.

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Solenoid Amperage Chart

Solenoid	Range				Gear					
	Park	Reverse	Neutral	Drive 1H	Manual 1H	2H	3H 3M	4H 4M	5H 5M	6H 6M
SV5-N92 (K1)	0.100	0.980	0.980	0.100	0.100	0.100	0.100	0.100	0.980	0.980
SV9-N282 (K2)	0.100	0.980	0.980	0.980	0.980	0.980	0.980	0.100	0.100	0.100
SV3-N90 (K3)	0.980	0.100	0.980	0.980	0.980	0.980	0.100	0.980	0.100	0.980
SV10-N283 (B1)	0.980	0.980	0.980	0.980	0.980	0.100	0.980	0.980	0.980	0.100
SV6-N93 (LP)	0.980	0.980	0.980	0.980	0.740	0.860	0.980	0.980	0.740	0.740
SV4-N91 (TC-PWM)	0.200	0.200	0.200	0.200	0.200	0.200	0.200 0.990	0.200 0.990	0.200 0.990	0.200 0.990
SV2-N89	0	0	0	0	1	0	3H=0 3M=1	4H=0 4M=1	5H=0 5M=1	6H=0 6M=1
SV1-N88	0	0	0	0	1	0	0*-1	0*-1	0*-1	0*-1

Description of terms:

100A = very-low-amperage solenoid off
0.980A = very-high-amperage solenoid on

SV1 & 2 – N88 & 89
0 = off
1= on
0*-1= off or on during shift transitions

3H = 3rd gear TCC off
3M = 3rd gear TCC on (This applies to gears 3-6)

1. Solenoid valves 3, 5, 9 and 10 are normally applied; when these solenoids are off, the components they are in charge of are applied. They are energized (turned on) to turn off the components they are in charge of. These solenoids are also modulated to control both apply and release rates. Consult the clutch-application chart in Figure 4 and compare the amperage to clutch/brake application.

Example:
Solenoid valve 10 (N283) is pulsed off during the 1H-2H transition, and the amperage will drop from 0.980 in 1H to 0.690 to 0.300 to 0.100 when the shift is finally completed into 2H to control the apply rate and shift feel of the B1 brake.

2. Solenoid valve 6 (N93) is modulated on the basis of engine load. Low line pressure will indicate amperages of 1.0 to 0.980. Amperage will drop to increase line pressure.

3. Solenoid valve 4 (N91) is modulated to control torque-converter apply rate but is dependent on solenoid valve 2 (N89) to apply the TCC. There will be situations where during manual shifts in Tiptronic mode, SV4 (N91) amperage will indicate 0.500 to 0.700 and the TCC will be off as solenoid valve 2 (N89) is 0, which indicates off.

11	Group A: 004	Group B: 007					Group C: 008					
	Driving Mode	TIME	SV 5 (N92)	SV 9 (N282)	SV 3 (N90)	SV 10 (N283)	TIME	SV 6 (N93)	SV 4 (N91)	SV 1 SV 2		
1H	1H	0.53	0.1	0.98	0.99	0.99	0.01	0.74	0.2	11	N88-on	N89-on
driving	1H	1.33	0.1	0.98	0.99	0.99	0.79	0.74	0.2	11		
driving	1H	2.11	0.1	0.97	0.99	0.99	1.58	0.74	0.2	11		
driving	1H	29.98	0.1	0.97	0.99	0.99	29.45	0.74	0.2	11		
1H	1H	30.78	0.1	0.97	0.99	0.99	30.24	0.74	0.2	11		
transition	1H	31.56	0.1	0.97	0.99	0.69	31.04	0.75	0.2	0	N88-off	N89-off
transition	1H	32.36	0.1	0.98	0.99	0.3	31.83	0.65	0.2	0		
2H	2H	33.14	0.1	0.97	0.99	0.1	32.62	0.8	0.2	0		
driving	2H	36.29	0.1	0.97	0.99	0.1	35.76	0.86	0.2	0		
driving	2H	37.09	0.1	0.97	0.99	0.1	36.55	0.86	0.2	0		
driving	2H	37.88	0.1	0.97	0.99	0.1	37.36	0.86	0.2	0		
driving	2H	38.66	0.1	0.97	0.99	0.1	38.14	0.86	0.2	0		
2H	2H	39.46	0.1	0.97	0.99	0.1	38.92	0.85	0.2	0		
transition	2H	40.25	0.1	0.98	0.69	0.69	39.72	0.85	0.19	0		
transition	2H	41.06	0.1	0.97	0.55	0.99	40.52	0.8	0.46	0		
3H	3H	41.84	0.1	0.97	0.1	0.99	41.31	0.83	0.51	0		
3M	3M	42.64	0.1	0.97	0.1	0.99	42.1	0.82	0.98	10	N89-on-tc	
driving	3M	43.42	0.1	0.98	0.1	0.99	42.89	0.82	1	10	N88-off	
driving	3M	44.23	0.1	0.98	0.1	0.99	43.69	0.81	1	10		
driving	3M	48.21	0.1	0.98	0.1	0.99	47.69	0.8	0.99	10		
3M	3M	49	0.1	0.72	0.72	0.99	48.46	0.8	1	10		
transition	3M	49.79	0.1	0.56	0.99	0.99	49.26	0.65	0.33	1	N88-on	N89-off
4M	4M	50.58	0.1	0.1	0.99	0.99	50.06	0.79	0.48	0	N88-off	
driving	4M	51.36	0.1	0.1	0.99	0.99	50.84	0.85	0.52	0		
driving	4M	52.14	0.1	0.1	0.99	0.99	51.61	0.78	1	10	N89-on-tc	
4M	4M	52.93	0.1	0.1	0.99	0.99	52.4	0.78	0.99	10	N88-off	
transition	4M	60.07	0.65	0.1	0.67	0.99	59.54	0.81	0.99	10		
transition	4M	60.88	0.97	0.1	0.67	0.99	60.33	0.56	0.45	1	N88-on	N89-off
5M	5M	61.68	0.97	0.1	0.1	0.98	61.15	0.6	0.49	0	N88-off	
	5M	62.48	0.97	0.1	0.1	0.99	61.95	0.67	1	10	N89-on-tc	
driving	5M	63.26	0.97	0.1	0.1	0.99	62.74	0.68	0.99	10	N88-off	
5M	5M	67.98	0.97	0.1	0.1	0.99	67.46	0.73	0.99	10		
transition	5M	68.78	0.98	0.09	0.34	0.99	68.25	0.74	0.99	10		
transition	5M	69.58	0.97	0.1	0.99	0.72	69.04	0.81	0.2	1	N88-on	N89-off
transition	5M	70.38	0.98	0.1	0.99	0.1	69.85	0.81	0.2	1	N88-on	N89-off
6M	6M	71.17	0.97	0.1	0.99	0.1	70.65	0.92	0.51	0	N88-off	N89-off
driving	6M	71.97	0.97	0.1	0.99	0.1	71.43	0.94	0.54	0		
driving	6M	72.77	0.98	0.1	0.99	0.1	72.22	0.94	0.58	0		
driving	6M	73.58	0.97	0.1	0.99	0.1	73.04	0.94	0.61	0		
driving	6M	74.37	0.98	0.1	0.99	0.1	73.85	0.94	0.65	0		
driving	6M	75.17	0.97	0.1	0.99	0.1	74.63	0.9	0.67	0		
driving	6M	75.97	0.98	0.1	0.99	0.1	75.44	0.86	0.69	0		
driving	6M	76.78	0.97	0.1	0.99	0.1	76.24	0.86	0.72	0		
driving	6M	77.59	0.98	0.1	0.99	0.1	77.05	0.84	0.74	0		
driving	6M	78.37	0.98	0.1	0.99	0.1	77.84	0.73	1	10	N89-on-tc	

When it all makes sense to you, **Figure 11** is a recording showing all the activity of each of the solenoids as we shift in Tiptronic mode from first all the way to sixth gear, including the converter clutch being applied and released. The highlighted areas provided in the movie point out solenoid shift transitions as the transmission is shifting through each of the gears. Compare this with the "time" column so you can see how quickly the computer can control these solenoids. Considering this along with the drive-clutch drums being equipped with balance pistons, the clutch apply and release can respond more rapidly to these commands than they could without them.

Technically Speaking

In this article: clutch drums, counterbalance pistons, Technically Speaking, TF60-SN

AUTOMATIC TRANSMISSION: Fast and Simple

AUTOMATIC TRANSMISSION: Hydraulics Fundamentals: Manual Valves

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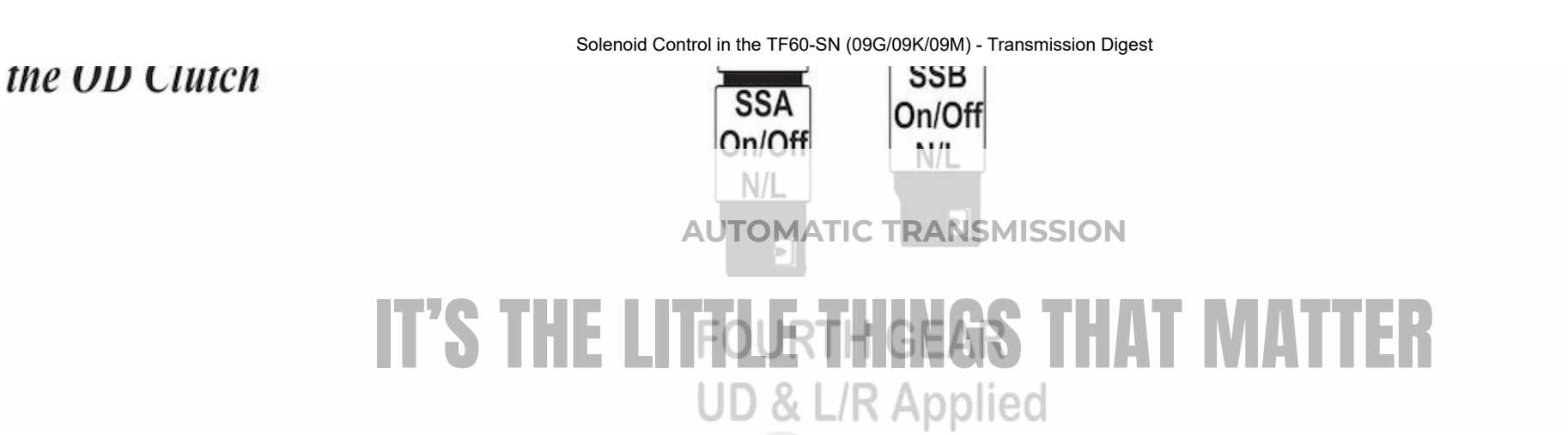
AUTOMATIC TRANSMISSION: Tasc Force Tips: Ford E4OD, 4R100

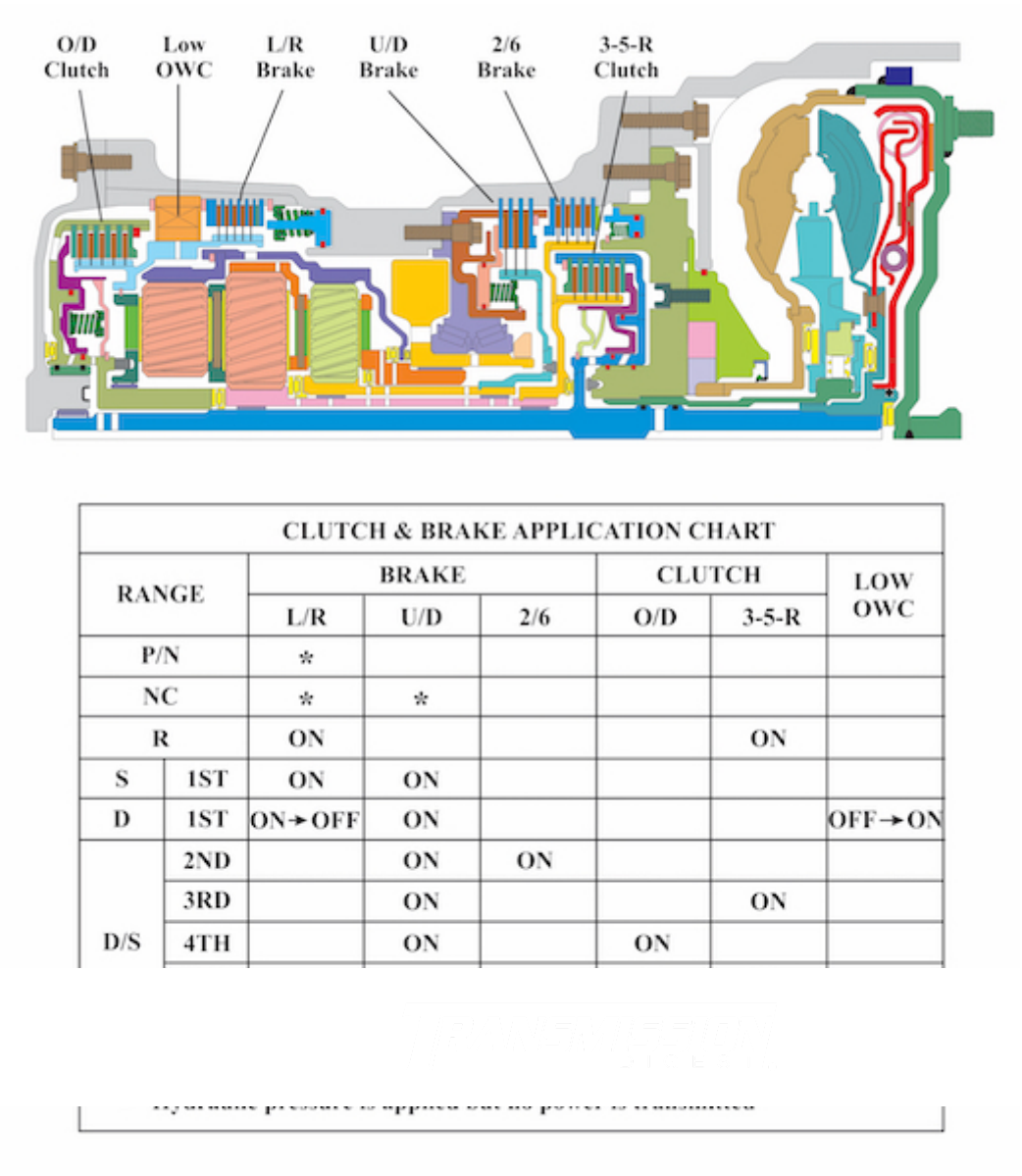
AUTOMATIC TRANSMISSION: An Inexpensive Fix for the 4R70W

Solenoid A backed out allowing the L/R Brake to come on rather than



By **Wayne Colonna**
on October 5, 2020

Whenever a transmission fails to work correctly after a rebuild, a small error like cross-connecting speed sensors can cause a major headache. It does not take much to correct this error if you know it occurred, but when you do not, a small error turns into a giant monster. Without a doubt, when it comes to many things in life, little things can matter.



CLUTCH & BRAKE APPLICATION CHART							
RANGE		BRAKE			CLUTCH		LOW OWC
		L/R	U/D	2/6	O/D	3-5-R	
P/N		*					
NC		*	*				
R		ON				ON	
S	1ST	ON	ON				
D	1ST	ON→OFF	ON				OFF→ON
D/S	2ND		ON	ON			
	3RD		ON			ON	
	4TH		ON		ON		

Figure 1

A little thing that “could” have caused a bit of a headache for Darrell at ACE Transmission occurred with a 2011 Kia Forte using the A6MF1 transmission. On the initial test drive the technician that test drove the vehicle experienced what felt like a bind up on the 3-4 shift. It literally near put him through the windshield. When the transmission was disassembled, only the L/R clutch was found to be damaged. The question is, why? Looking at the clutch application chart in **figure 1**, how could the L/R clutches come on in fourth? Something very odd hydraulically would have to cause it. If the L/R clutches were stuck on, a bind-up would have occurred on the 1-2 upshift.

Figure 2

When the valve body was being disassembled, they discovered that one of the tabs on the solenoid retainer bracket had broken off (**figure 2**). When the bracket was put up against the solenoids, the tab that had broken was between to two black solenoids as seen in **figure 3**. An ATSG A6MF1 Tech Guide was used to identify these two solenoids. They are On/Off Shift Solenoid A and B (**figure 4**).

Figure 3

This manual has complete hydraulics which help determine exactly what had occurred confirming that replacing the bracket would resolve the problem.

Figure 4

Figure 5 is a partial hydraulic showing the OD-L/R Switch Valve. Shift Solenoid A strokes this valve to allow the OD Variable Force Solenoid to supply pressure to the L/R clutch for first gear. In second and third gear Shift Solenoid A in not on the and OD-L/R switch valve closes by spring tension. The OD VLP solenoid does not supply pressure to this switch valve as seen in **figure 6**. When it's time to shift into fourth, SSA remains off while the OD VLP supplies pressure to the Switch Valve which passes through the valve and on to apply the OD clutch (**figure 7**).

Figure 5

With the tab being broken on the retainer bracket, SSA had popped out if its position. Regulated solenoid feed pressure was routed directly into the circuit that strokes the OD-L/R Switch Valve. This didn't have any negative effect for Reverse and First gear as the L/R brake is applied in P, R and D first gear.

Figure 6

The valve being fully stroked in second and third had no effect as the OD VLP isn't supplying pressure to the switch valve. But, keeping this valve stroked when a shift into fourth takes place, this causes the L/R brake to apply rather than the OD clutch (**figure 8**). This means a shift into first gear takes place at a high speed making it feel like a bind up as you kiss the windshield.

Figure 7

The L/R clutches being applied at this speed will certainly cause them to get a little heated, wouldn’t you say? All due to a small tab. Without a doubt, in this case, it’s the little things that matter!

Figure 8

In this article: A6MF1, Kia, Shift Pointers, Solenoid Switch Valve

AUTOMATIC TRANSMISSION: It’s the Little Things That Matter

TRANSMISSION TECH/TALK: GM 4L70-E ISS DTC P0716 or P0717

VIDEO: Video: Ford DPS6 TCM

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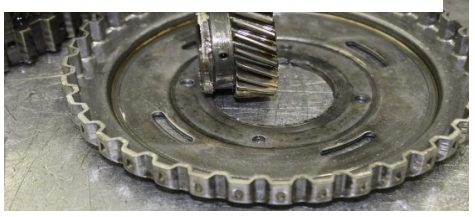
AUTOMATIC TRANSMISSION

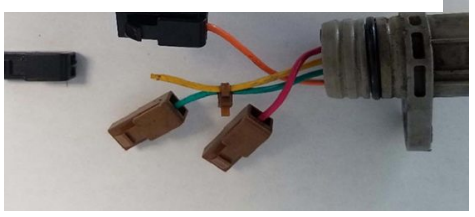


[The Problematic CVT 7]

AUTOMATIC TRANSMISSION

[Slamming reverse in MAXA]

AUTOMATIC TRANSMISSION



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AUTOMATIC TRANSMISSIO

[Tech Tip: GM 6L80, 6L90 Low Pressure Repair]

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