FORD 500 / AISIN AF40-6
PRELIMINARY INFORMATION

The AF40-6 is a front wheel drive 6 speed electronically controlled transmission (Figure 1) which is being utilized in a large variety of car manufacturers such as General Motors, Ford 500 and Volkswagen to name a few. It seems that Aisin AW LTD Co. said, you build the car and we will design the architecture of the transmission to accommodate the engine and body style just like the JF506-E. As a result, there are various versions of this transmission.

One variation you will encounter besides case designs is the amount of pressure taps available for diagnosing. Another would be the selector lever where some models offer the Tip-Up and Tip-Down Tiptronic feature utilizing 4 quadrants P, R, N, D and a Tiptronic position. Without the Tiptronic feature, 5 quadrants are used, P, R, N, D and L. When L is selected, it will shift from 1st through 4th with extended shift scheduling and increased engine breaking. The Transmission Control Module (TCM) utilizes shift adapt strategies that provide for smooth garage shift engagements and controlled gear changes relative to torque input. A torque converter clutch apply is available as early as second gear for improved fuel economy but the computer strategically slip controls the apply making the apply as seamless as possible for driver pleas ability.

AW40-6 Gear Ratios

1st gear - 4.148
2nd gear - 2.370
3rd gear - 1.556
4th gear - 1.155
5th gear - 0.859
6th gear - 0.686
Reverse - 3.394

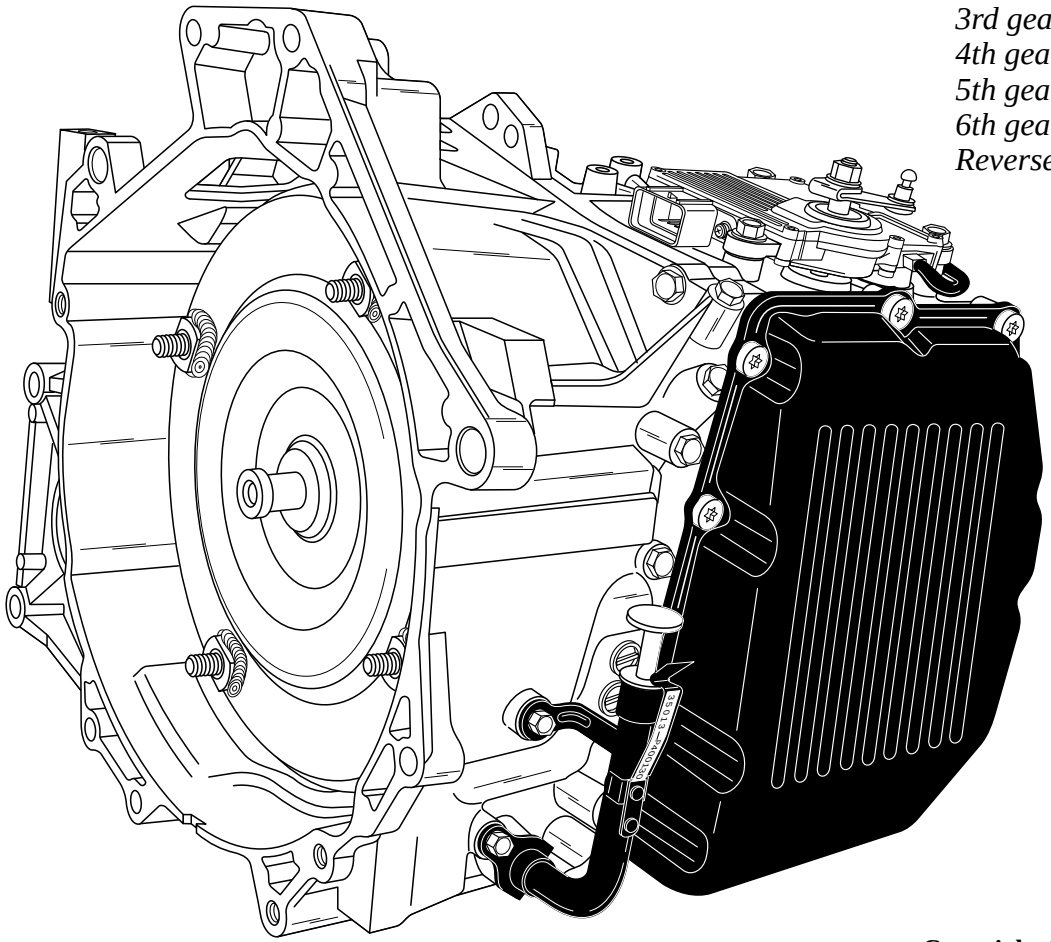


Figure 1

Alternative shift strategy in most vehicle applications does not provide a driving mode select switch that allows the driver to select a mode themselves. However, when specific driving conditions are met, the TCM selects a shifting pattern appropriate to driving conditions from all available shift modes and can switch modes automatically on the fly. The different driving modes available for the TCM to select from are as follows:

Adaptive - Used during normal driving conditions the TCM (as previously described) performs garage shift learning and shift control learning so as to provide smooth clutch engagements with gear selection as well as smooth shifting while driving. Economy mode is used during normal driving conditions.

High Temp - When ATF temperature becomes too high, this mode activates lock-up at an earlier timing to stop the temperature rise and lower the temperature.

Warm-Up Shift Pattern - This mode warms up the engine (and catalytic converter when equipped) by providing slightly higher shift and lock-up points.

Up-Slope - The TCM detects up-slope by comparing engine load to vehicle speed and brake command. When an up hill climb is detected, kick down shifts are desensitized to prevent over revving of the engine.

Down-Slope - The TCM detects down-slope by comparing engine load to vehicle speed and brake command. When a downhill run is detected, transmission engine breaking is utilized alleviating the load on the vehicle's brakes.

TCC Slip Control

Converter clutch slip control is another aspect of the TCM's strategy with which to provide optimum driver comfort and fuel economy during any and all driving modes (Figure 2). Based on input and output rpm signals as well as engine load data from the ECM (TPS, Engine RPM's), the TCM can time control converter clutch slip to complete engagement. The length of time from a gradual slip to complete engagement is varied based on driving conditions. Since the strategy of the TCM is to gradually slip the clutch on to a full engagement at varying lengths of time, Ford recommends 6-Speed Motorcraft Premium Automatic Transmission Fluid Part Number XT-8-QAW. The approximate capacity of the transmission is 7 quarts. Refer to Figure 15 Fluid Fill and dipstick locations.

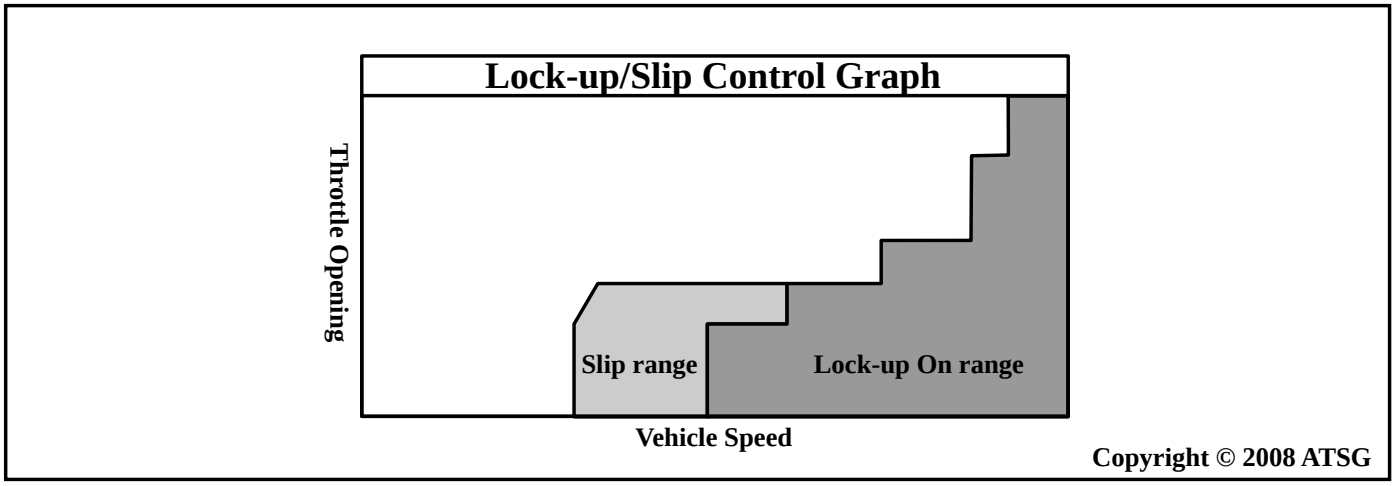


Figure 2

RELEARN PROCEDURES

After replacing or rebuilding the transmission, replacing the TCM, or after re-flashing a TCM, be sure to initialize the following learned values:

Neutral Position Learning - Verify that the N position mark on the TCM is positioned correctly with the manual arm shaft and adjust as necessary (Figure 3). With the ignition ON and engine OFF, release the shift lock and place the shift lever into the Neutral position. Verify with a scanner that Neutral has been selected. Factory scan tools can input a Neutral signal to the TCM to inform the TCM that the Neutral position is selected. Turn the ignition off after releasing the shift lock and place the shift lever into Park. Turn the ignition on for 5 seconds and then shift into the Drive range and check that the indicator light displays the correct position. Once completed, perform the following Initial Learning.

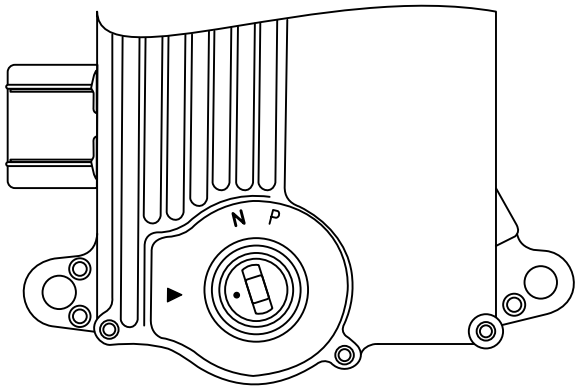


Figure 3

Initial Garage Shift and Gear Shift Learning - Warm up the vehicle by idle or city driving until the transmission fluid temperature has reached between 66° to 110° C (150° - 230° F). During this time, note the degree of shock during garage shifts and gear shifts and compare after the following relearn procedures.

Garage Shift Learning: Place the selector lever into Neutral and hold the brake for 3 seconds. Then place the selector lever into Drive and maintain this position for 3 seconds. Repeat this procedure 5 times. Then repeat this same procedure with reverse.

Gear Shift Learning: From a stand still, take off in the Drive position with the throttle opened between 25% to 35% until sixth gear and 80km/h (50 mph) or higher has been reached. Then release the accelerator pedal and coast down to a stop in 60 seconds minimum. Repeat this procedure 10 times.

Once completed, verify that the degree of shock during garage shifts into gear and shift changes have decreased as compared to conditions before learning.

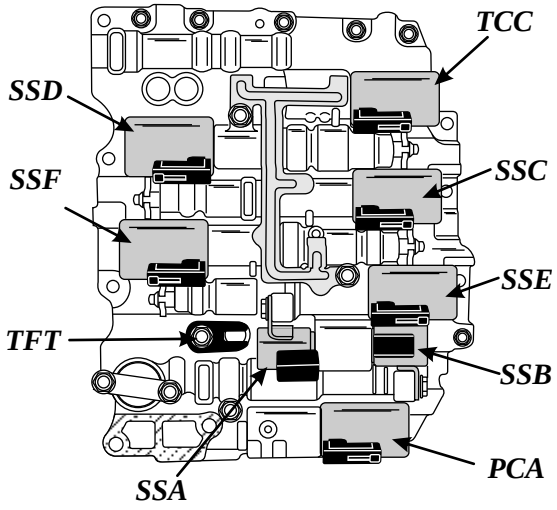
Inside the transmission there are 8 solenoids , two speed sensors and a fluid temperature sensor (Figure 4).Refer to figures 11 and 12 for solenoid locations on the valve body, and Figure 13 for solenoid functions. The Transmission Range Sensor (Neutral Safety Switch/Gear Select Switch) is integrated with the TCM making one unit that can be located on the transmission above the side pan mounted to the gear select shaft. The underside of the TCM also plugs into an internal wiring harness 22 pin case connector along side the gear select shaft. This TCM has an additional 16 pin side connector which a vehicle harness plugs into connecting the TCM to keep alive power and ground, ignition power, the CAN Bus system, and a start lock signal (Figure 6).

The transmission contains 3 driving elements (C1, C2 and C3), 2 brake elements (B1 and B2) and 1 one-way holding device that are used to provide 6 forward speeds and reverse through a Ravigneaux-type planetary gear set. See Figure 5 for a cross-sectional view of the transmission and an application chart. See Figure 10 for correct freewheel operation. Refer to Figure 14 for case passage identification for air checking, and Figure 15 for pressure port locations as well as specifications. Should a malfunction occur causing the TCM to failsafe, the TCM will inhibit certain driving features or cause high pressure. A hard fault code may cause 3rd or 5th gear starts.

Electrical Diagnosis

A list of Diagnostic Trouble Codes, their meaning and the action taken are provided in Figures 16-20. For simple electrical diagnosis, refer to a typical wiring diagram of the electrical system in Figure 7. Use Figure 8 for checking the transmission's internal electrical system through the external case connector with the TCM removed.

The input speed sensor is called the TSS sensor reading the C2 Clutch drum which is driven by the converter via a turbine shaft that is hard splined to C2 Clutch shaft through the Ravigneaux gear set . The output speed sensor is called the OSS sensor and it reads the Counter Driven Gear. Both of these sensors are Hall Affect Sensors which provide a 5 volt square wave signal to the TCM. Since this signal is sent directly into the TCM it is not possible to view this signal using a scope which is why bench testing these sensors is highly recommended. This method of testing these sensors is provided in Figure 9.

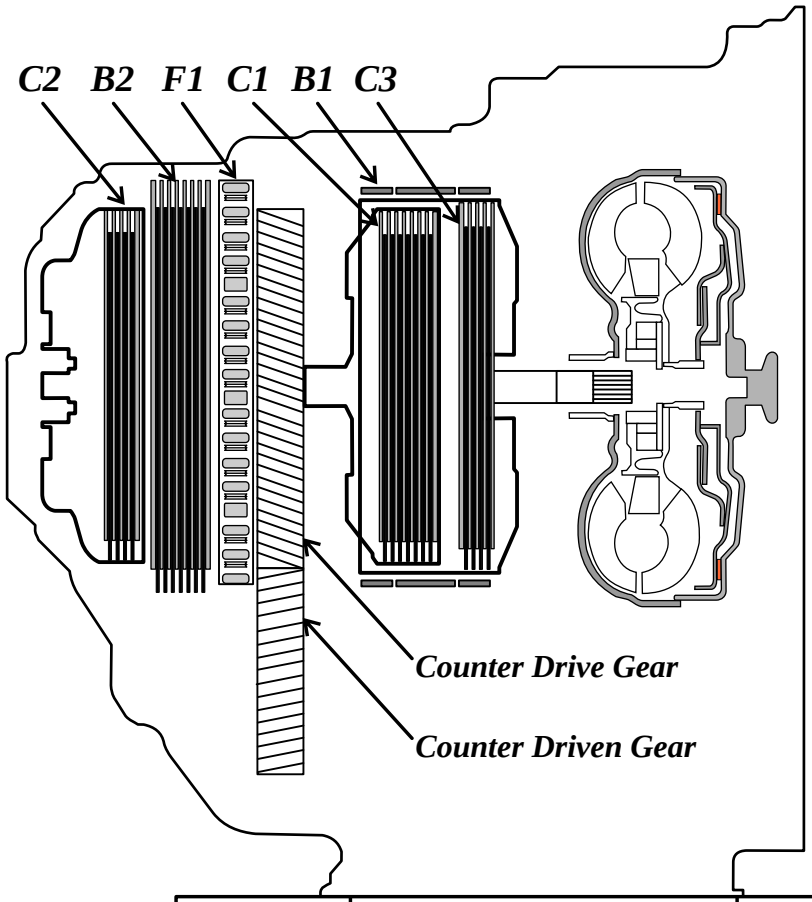


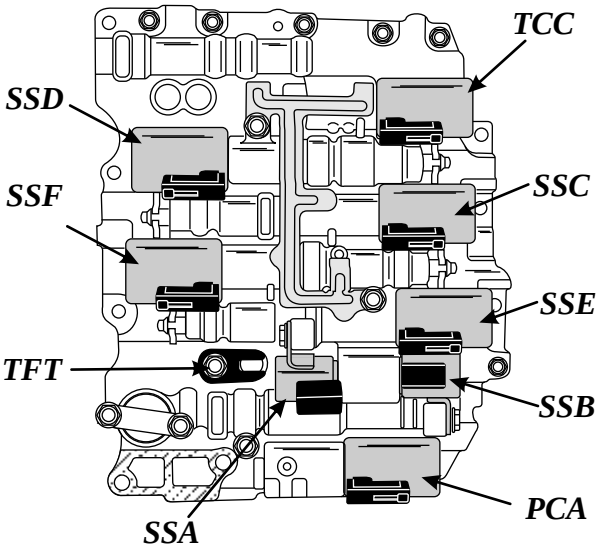
OSS Reads Counter Drive Gear

TSS Reads C2 Clutch Drum

Both sensors are under the valve body installed into the case

Figure 4





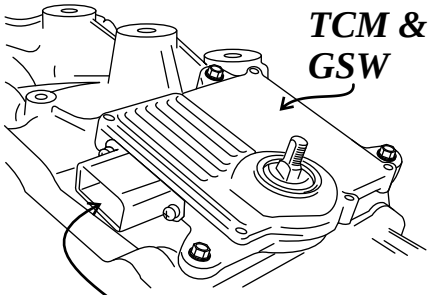
OSS
Reads Counter Drive Gear

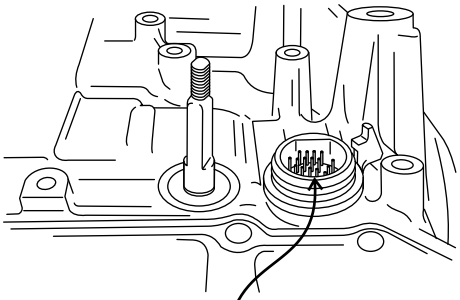
TSS
Reads C2 Clutch Drum

Both sensors are under the valve body installed into the case

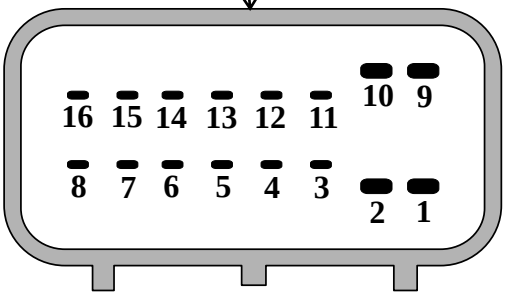
Shift Position		Shift Solenoids						Clutches			Brakes		One-way Clutch
		SSC	SSD	SSE	SSF	SSA	SSB	C1	C2	C3	B1	B2	F1
Park		●	●	●	●								
Rev.	Below 7	●	●		●					●		●	
Rev. Inhibit	Above 7	●	●	●	●							●	
Neutral		●	●	●	●								
Drive	1st		●	●	●			●					●
	Engine Braking		●	●	●	●	●	●				●	●
	2nd		●	●				●			●		
	3rd		●		●			●		●			
	4th			●	●			●	●				
	5th	●			●				●	●			
	6th	●		●					●		●		

Figure 5

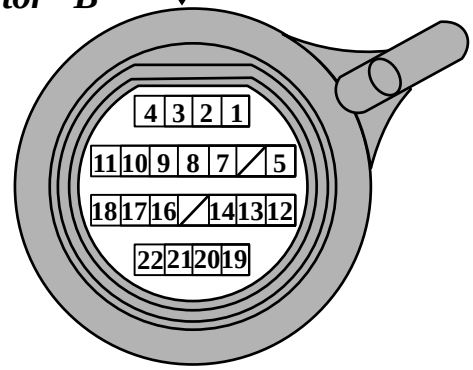




Connector "A"



Connector "B"



1. Battery +	9. Ground
2.	10.
3.	11. Ignition +
4.	12.
5. STLK	13.
6. CAN -	14. CAN +
7.	15.
8.	16.

Typical terminal functions - these will vary depending upon vehicle model

1. PCA -	12. TSS Signal
2. SSB	13. TSS -
3. PCA +	14. SSE +
4. TCC -	15.
5. SSA	16. SSF -
6.	17. SSD +
7. TFT -	18. SSD -
8. TFT +	19. OSS Signal
9. TCC +	20. OSS-
10. SSC -	21. SSF +
11. SSC +	22. SSF -

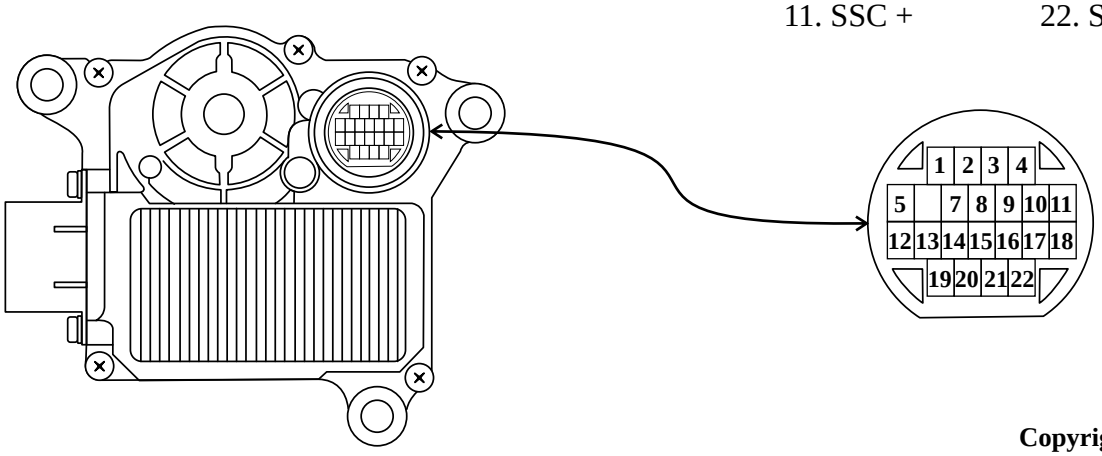


Figure 6

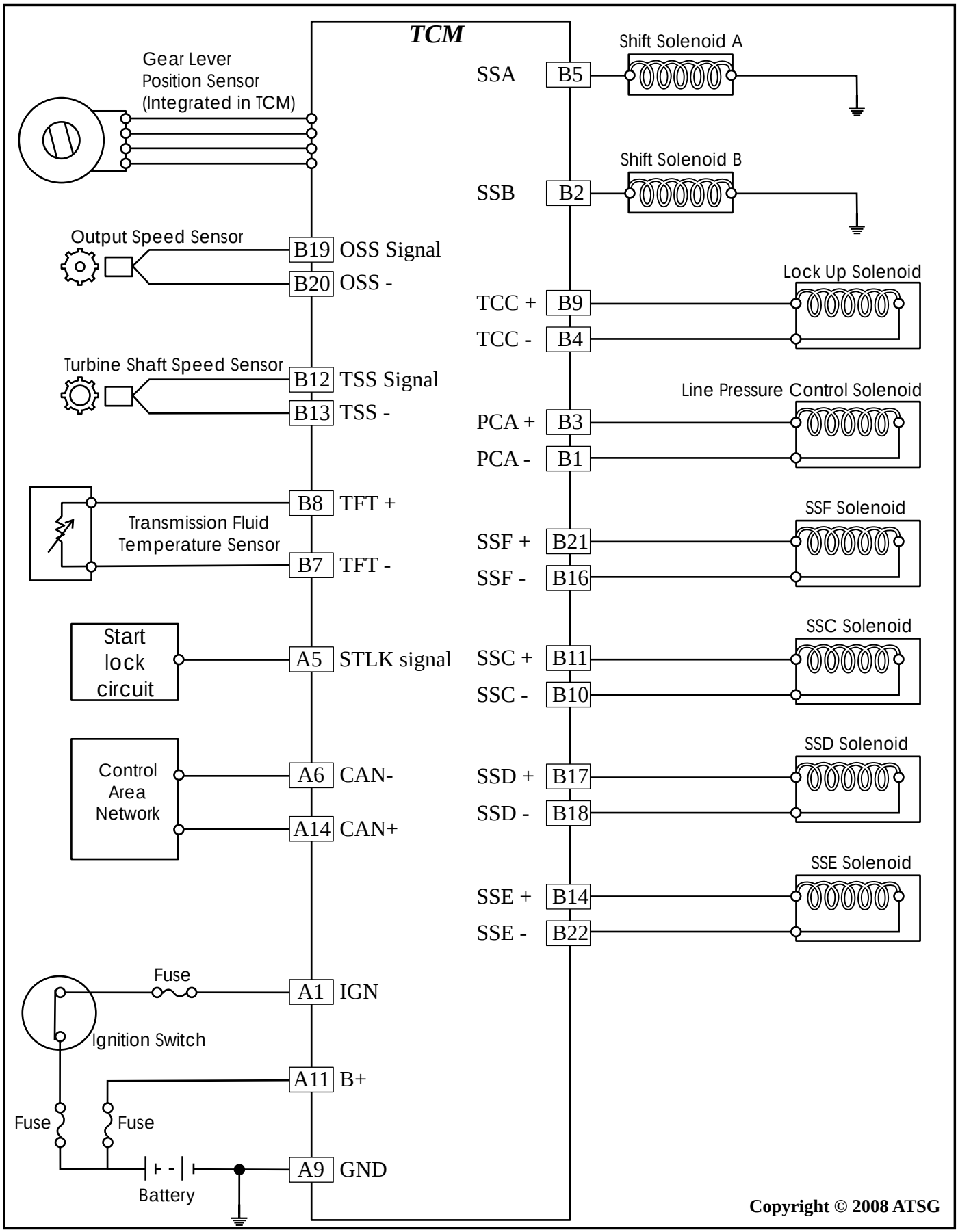

TCM
Gear Lever Position Sensor (Integrated in TCM)
Output Speed Sensor
B19 OSS Signal
B20 OSS -
Turbine Shaft Speed Sensor
B12 TSS Signal
B13 TSS -
B8 TFT +
Transmission Fluid Temperature Sensor
B7 TFT -
Start lock circuit
A5 STLK signal
Control Area Network
A6 CAN-
A14 CAN+
Fuse
A1 IGN
Ignition Switch
A11 B+
Fuse
Fuse
A9 GND
Battery
SSA B5
Shift Solenoid A
SSB B2
Shift Solenoid B
TCC + B9
TCC - B4
Lock Up Solenoid
PCA + B3
PCA - B1
Line Pressure Control Solenoid
SSF + B21
SSF - B16
SSF Solenoid
SSC + B11
SSC - B10
SSC Solenoid
SSD + B17
SSD - B18
SSD Solenoid
SSE + B14
SSE - B22
SSE Solenoid
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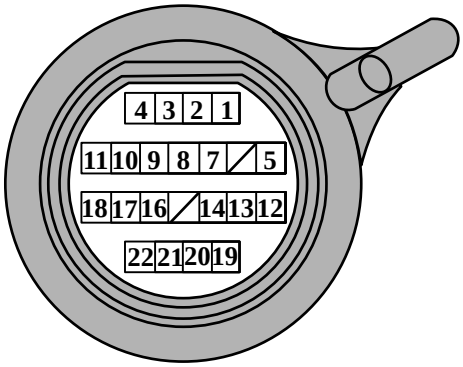
Figure 7

Connector "B"

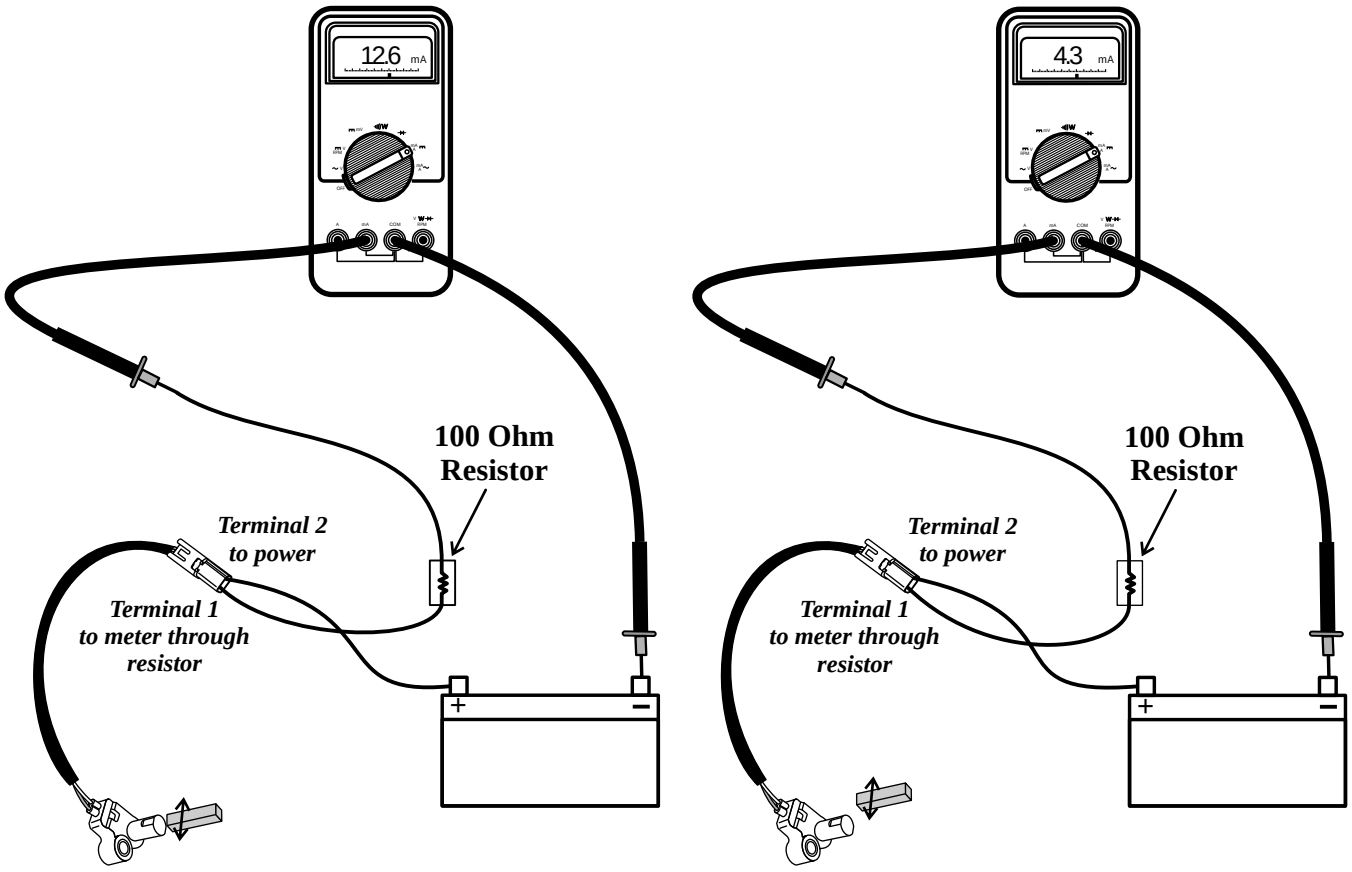


Resistance Check Chart			
Component Name	**Terminals**		**Resistance Value**
	Pos.	**Neg.**	
SSA Solenoid	**5**	**Case Gnd.**	**11.0 - 15.0 Ohms**
SSB Solenoid	**2**	**Case Gnd.**	**11.0 - 15.0 Ohms**
TCC Solenoid	**9**	**4**	**5.0 - 5.6 Ohms**
PCA Solenoid	**3**	**1**	**5.0 - 5.6 Ohms**
SSF Solenoid	**21**	**16**	**5.0 - 5.6 Ohms**
SSC Solenoid	**11**	**10**	**5.0 - 5.6 Ohms**
SSD Solenoid	**17**	**18**	**5.0 - 5.6 Ohms**
SSE Solenoid	**14**	**22**	**5.0 - 5.6 Ohms**
OSS Speed Sensor*	**19**	**20**	**1.0 - 10.0 M Ohms**
TSS Speed Sensor*	**12**	**13**	**1.0 - 10.0 M Ohms**
TFT Sensor	**8**	**7**	**10 °C - 5..62-7.31 K Ohms** **25 °C - 3.5 K Ohms** **110 °C - 0.22-.027 K Ohms**

* Both the OSS and TSS speed sensors are two wire Hall Effect Sensors so they are not checked in the normal fashion as an AC voltage generator. For bench testing see Figure 9

Figure 8

Bench Testing the Input and Output Hall Effect Sensors

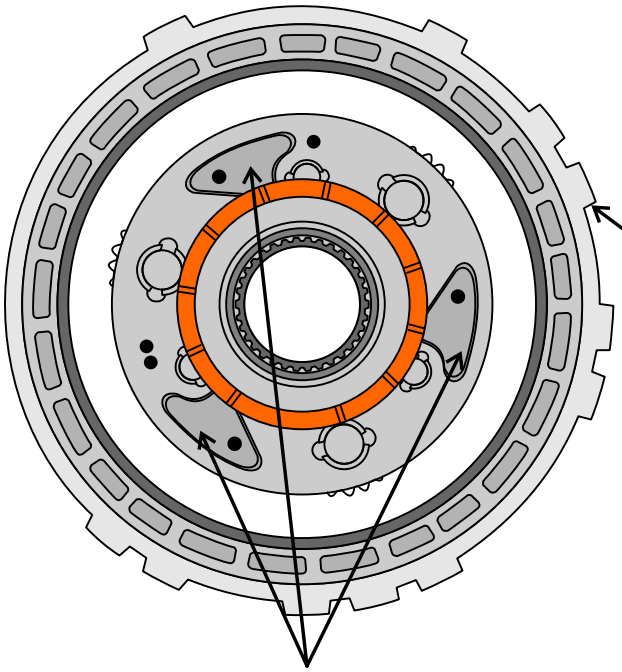


Set meter up to read milli-amps and acquire a 100 ohm resistor and a magnet. Using a 12 volt battery, run voltage directly into the speed sensor on terminal 2 being careful to not damage the connector or terminal end. Place the 100 ohm resistor onto terminal 1 in the sensor connector in series with the positive meter lead located in the mA jack. Place the negative meter lead to the ground post of the battery.

Slowly sweep the magnet pass the tip of the speed sensor. When the magnet is directly in front of the tip of the sensor, approximately 3 mA should be observed. When the magnet has cleared the tip of the sensor, approximately 11 mA should be observed.

Figure 9

F1 Low One-Way Clutch

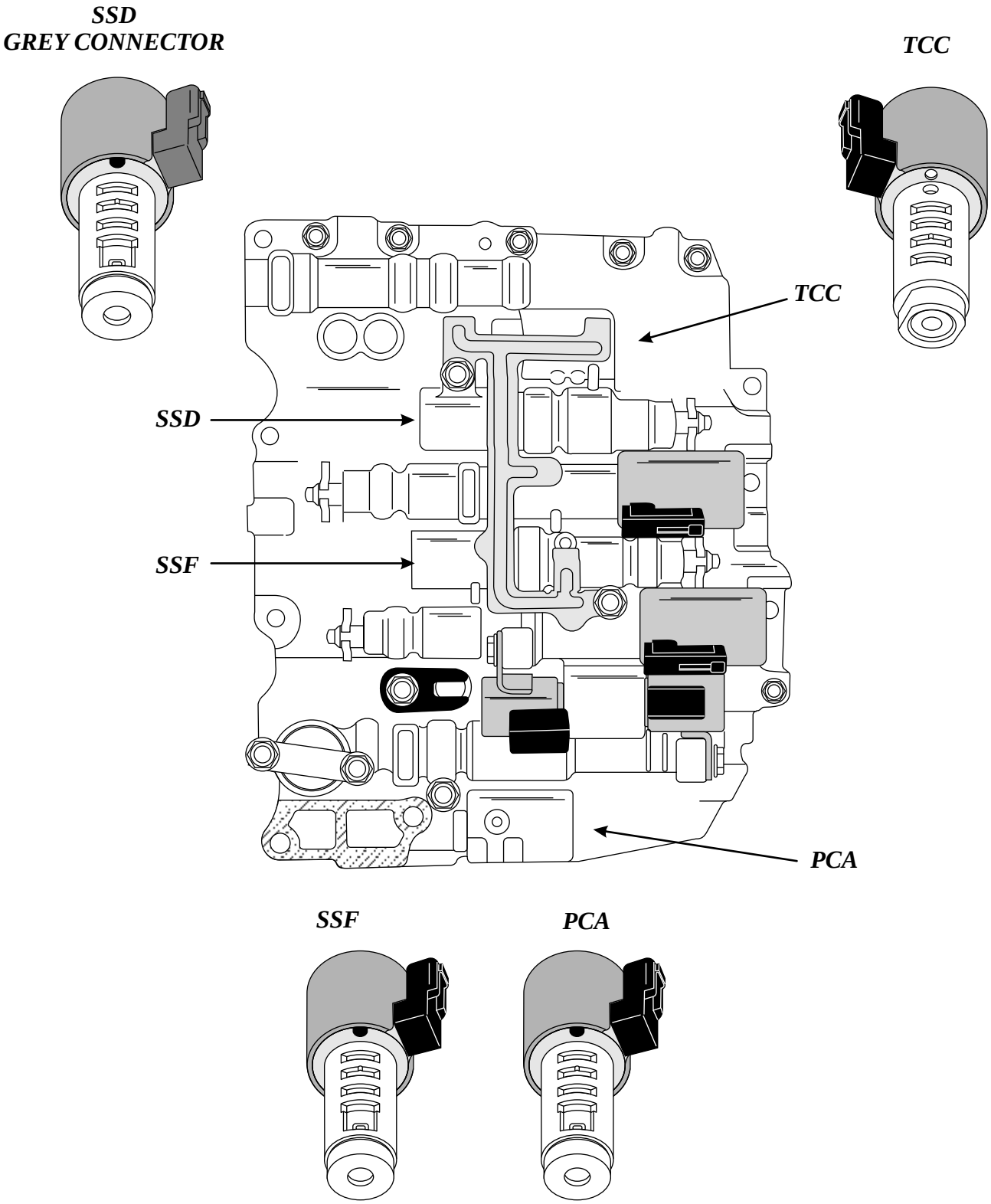


Outer race held stationary by case

Inner race should rotate in a clockwise direction (The front planetary is integral to the sprag's inner race. Using the carrier's pockets as shown, the inner race rotation can be easily checked by hand)

Figure 10

SOLENOID LOCATIONS



Note: Make sure to verify that the solenoids are in the right locations by the positioning of the connectors and the ports. The Solenoids are retained into the Valve Body by roll pins, If a Solenoid is put into the wrong location the feed ports may be blocked, making it inoperable.

Figure 11

SOLENOID LOCATIONS

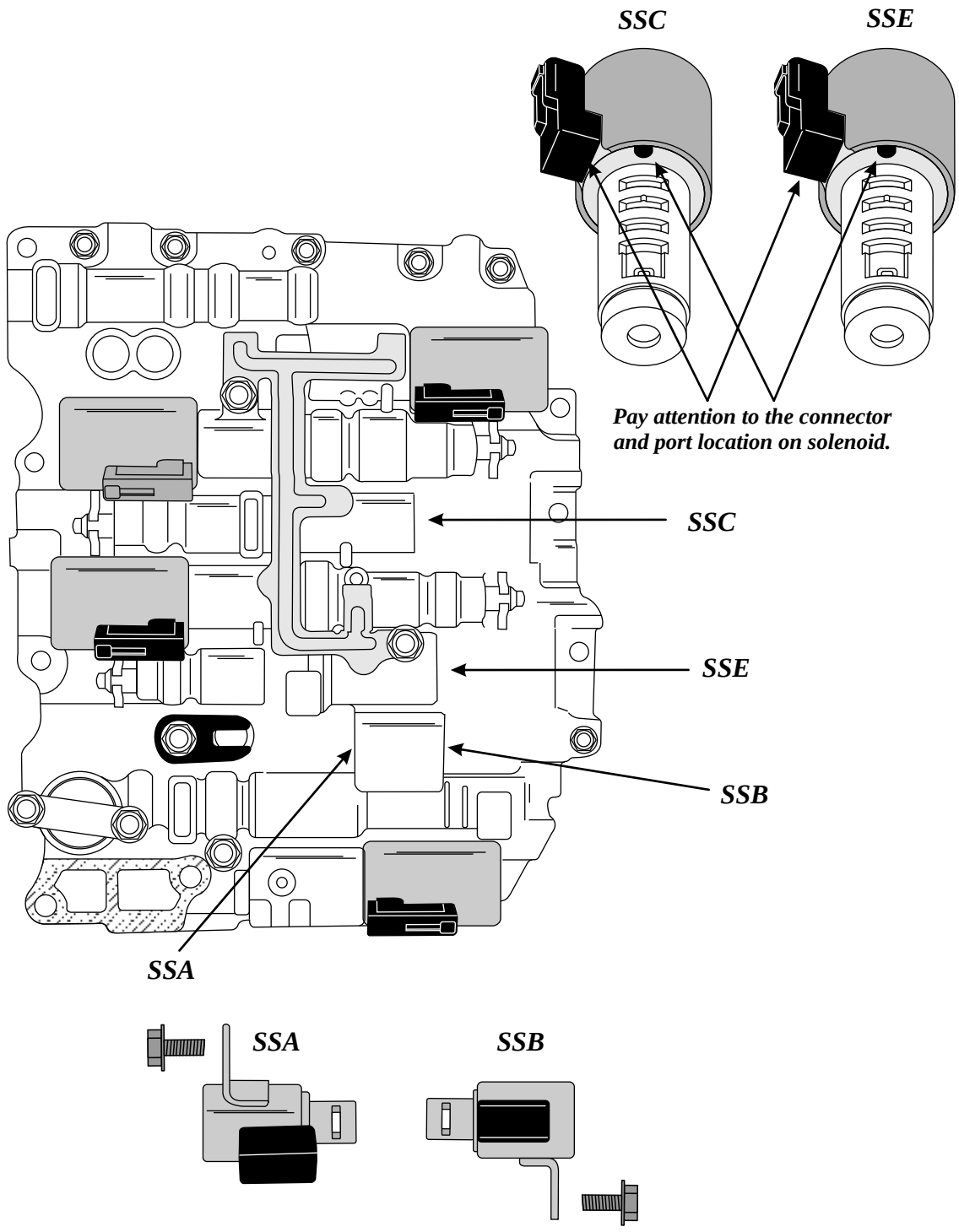


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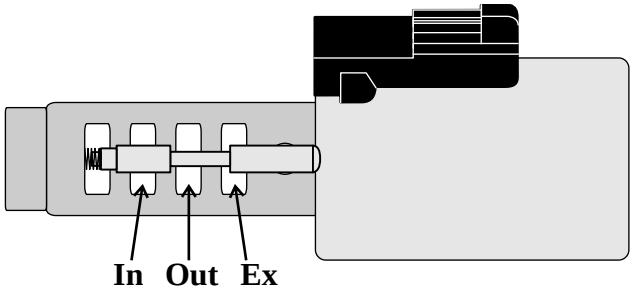
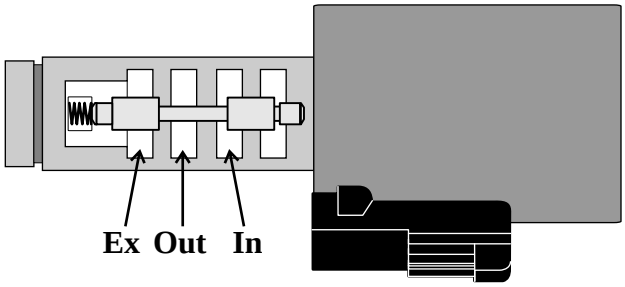
Figure 12

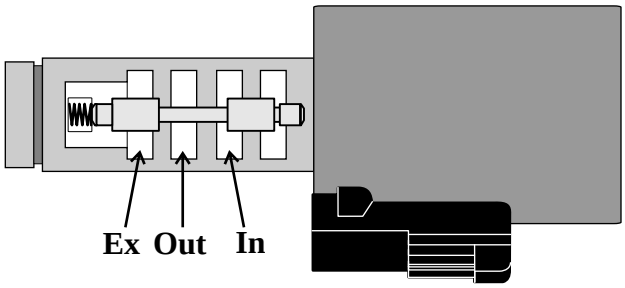
SOLENOID OPERATION



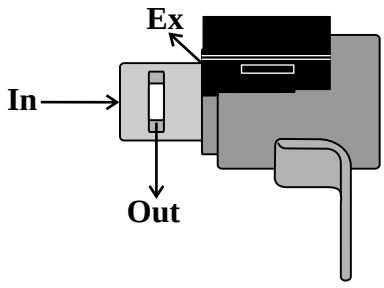
The Lock-up Control Solenoid (TCC) is a Normally Vented Solenoid where without electricity the inlet port is blocked and the outlet port is open to exhaust.



The Line Pressure Control Solenoid (PCA) is a Normally Applied Solenoid where without electricity the exhaust port is blocked and the inlet port is open to the outlet port.



All Shift Control Solenoids (SSD, SSF, SSC,SSE) are Normally Applied Solenoids where without electricity the exhaust port is blocked and the inlet port is open to the outlet port.



SSA and SSB Solenoids are Normally Vented Solenoids where without electricity the inlet port is blocked and the outlet port is open to exhaust.

Figure 13

CASE PASSAGE IDENTIFICATION

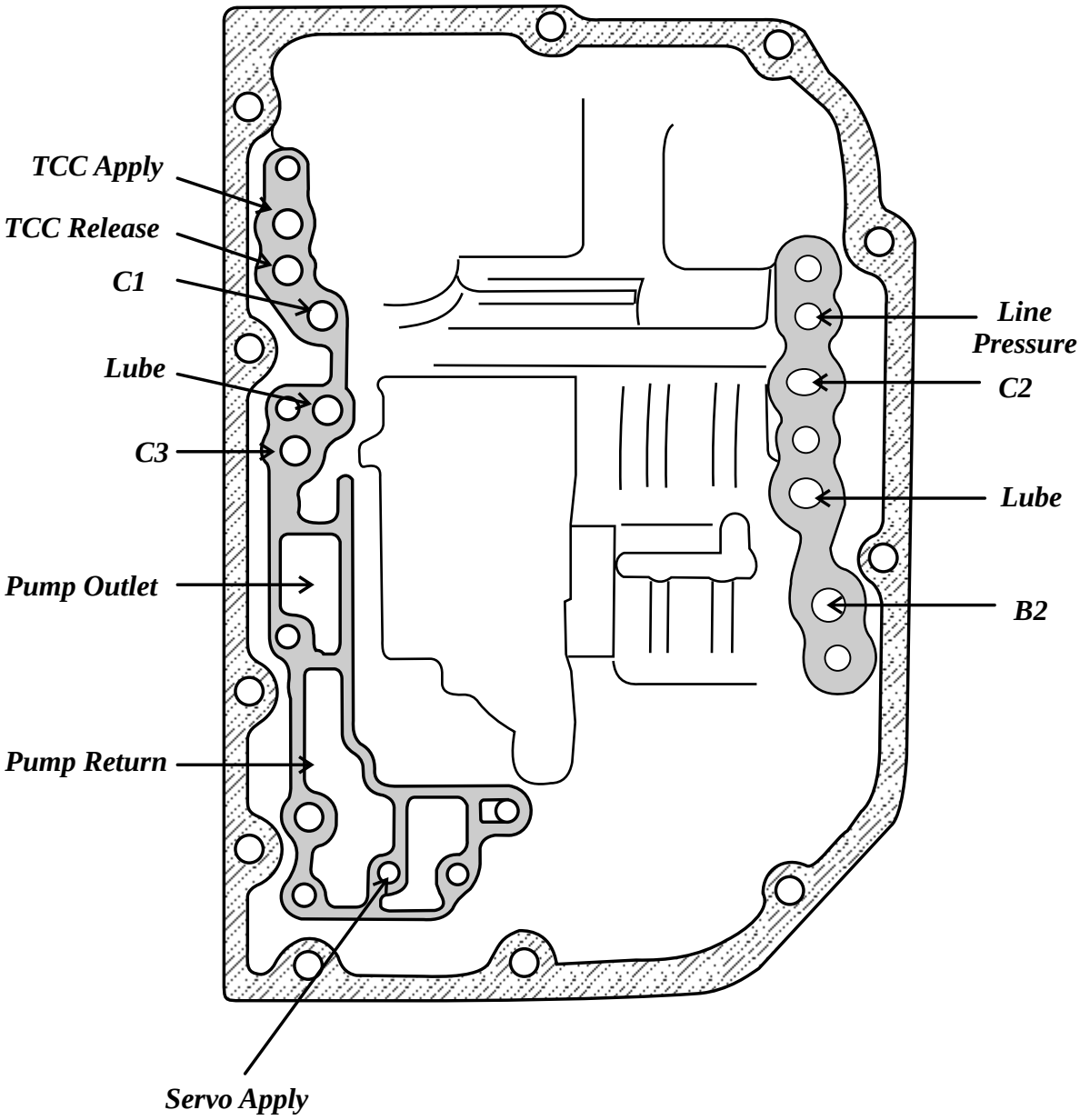
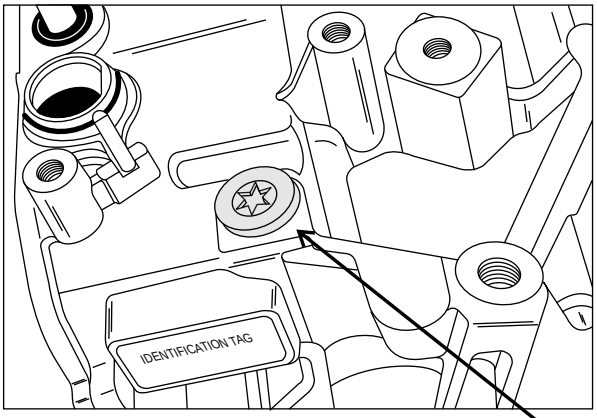
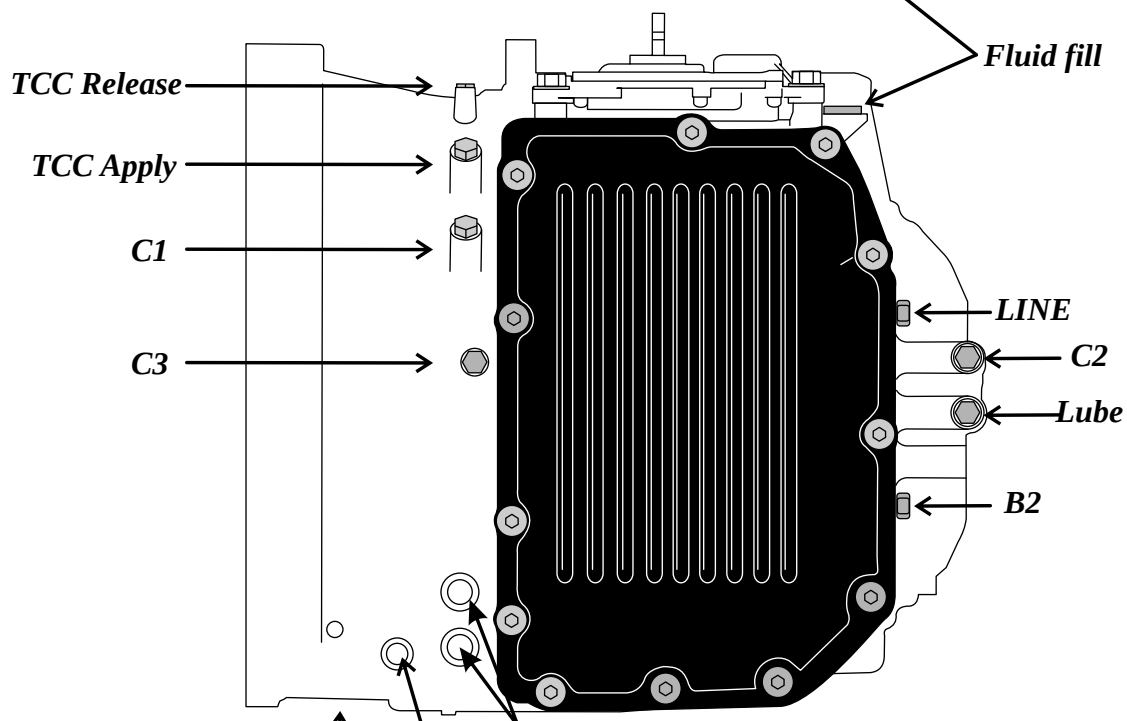
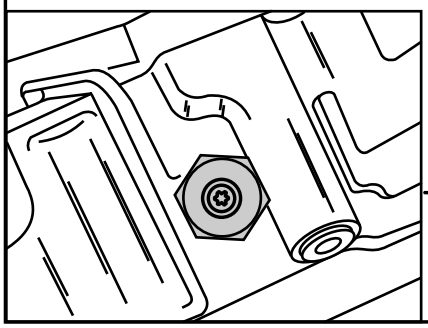


Figure 14

Pressure Taps and Fluid Fill Locations







Line Pressure Specs
Drive - 54-60psi. at Idle 195psi. at Stall
Reverse - 84-97psi. at Idle 271-303psi. at Stall

Check and Drain plug located at the bottom of the front case half

Figure 15

DIAGNOSTIC TROUBLE CODE LIST

P0562 - ***System voltage low***
No self learning control
No adaptive shift control

P0563 - ***System voltage high***
No self learning control
No adaptive shift control

P0601 - ***PCM Read Only Memory Failure***
No Engagements
No self learning Control
No adaptive Control

P0603 - ***PCM Keep Alive Memory***
No self learning Control
No adaptive Control

P0604 - ***PCM Random Access Memory***
No self learning Control
No adaptive Control

P0706 - ***Transmission Range Sensor or Performance***
D-3rd gear
No self learning Control
No adaptive Control

P0707 - ***Transmission Range Sensor circuit Low Input***
D-3rd gear
No self learning Control
No adaptive Control

P0708 - ***Transmission Range Sensor circuit High Input***
D-3rd gear
No self learning Control
No adaptive Control

P0711 - ***Transmission Fluid Temp sensor indicates 176° at all times***
No self learning control
No TCC

P0712 - ***Transmission Fluid Temp sensor circuit exceeds scale 329° indicated***
No self learning control
No TCC

P0713 - ***Transmission Fluid Temp sensor circuit exceeds scale -45° indicated***
No self learning control

P0716 - ***Turbine Shaft Speed Sensor Loss or Noise***
No self learning control
No adaptive shift control
No TCC

P0717 - ***Turbine Shaft Speed Sensor No Signal***
No self learning control
No adaptive shift control
No TCC

P0721 - ***Output Speed Sensor Loss or Noise***
No self learning control
No adaptive shift control

P0722 - ***Output Speed Sensor No Signal***
No self learning control
No adaptive shift control

P0729 - ***Gear Ratio (6th)***
No 6th gear
No TCC
No self learning control
No adaptive shift control

P0730 - ***Gear Ratio Error***
No self learning control

P0731 - ***Gear Ratio Error (1st)***
No 1st gear
No TCC
No self learning control
No adaptive shift control

P0732 - ***Gear Ratio Error (2nd)***
No 2nd gear
No TCC
No self learning control
No adaptive shift control

P0733 - ***Gear Ratio Error (3rd)***
No 3rd gear
No TCC
No self learning control
No adaptive shift control

P0734 - ***Gear Ratio Error (4th)***
No 4th gear
No TCC
No self learning control
No adaptive shift control

Figure 16

DIAGNOSTIC TROUBLE CODE LIST

P0735 - ***Gear Ratio Error (5th)***
No 5th gear
No TCC
No self learning control
No adaptive shift control

P0736 - ***Gear Ratio Error (Reverse)***
No Reverse
No self learning control

P0780 - ***Solenoid or Valve mechanical fault***
Increased rpm during shifts
Slipping or erratic shifting

P0817 - ***Starter circuit error***
No self learning control
No adaptive control
No TCC

P0961 - ***PCA circuit or solenoid failure***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

P0962 - ***PCA Solenoid signal short or open***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

P0963 - ***PCA circuit short to power***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

P0973 - ***SSA solenoid or short to ground***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

P0974 - ***SSA solenoid or short to power or open***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

P0976 - ***SSB solenoid or short to ground***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

P0977 - ***SSB solenoid or short to power or open***
Failsafe 3rd or 5th gear only
No Adaptive control
No Self learning control

Figure 17

DIAGNOSTIC TROUBLE CODE LIST

P0978 - ***SSC circuit or solenoid failure***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0979 - ***SSC Signal circuit short or open***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0980- ***SSC Signal circuit short to power***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0981 - ***SSD circuit or solenoid failure***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0982 - ***SSD Signal circuit short or open***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0983- ***SSD Signal circuit short to power***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0984 - ***SSE circuit or solenoid failure***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0985 - ***SSE Signal circuit short or open***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0986- ***SSE Signal circuit short to power***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0997 - ***SSF circuit or solenoid failure***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P0998 - ***SSF Signal circuit short or open***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

Figure 18

DIAGNOSTIC TROUBLE CODE LIST

P0999 - ***SSF Signal circuit short to power***
Failsafe 3rd or 5th gear only
No self learning control
No adaptive shift control

P1573 - ***APP sensor input error***
No self learning control
No adaptive shift control

P1657 - ***TCM communication link error (CAN)***
No self learning control
No adaptive shift control
Limited Fuel and spark

P1700 - ***TCM detected neutral in the D position***
No self learning control
No adaptive shift control

P1701 - ***TCM detected neutral in the R position***
No self learning control
No adaptive shift control

P1919 - ***ECT Sensor signal error***
No TCC

P1920 - ***Engine Rpm sensor signal error***
No self learning control
No adaptive shift control
Limited Fuel and spark

P2544 - ***Torque management request input signal A***
Failsafe, increased pressures
May also have ECT or MAF codes stored

P2757 - ***TCC Solenoid circuit stuck ON***
No TCC
No self learning control
No adaptive shift control

P2758 - ***TCC Solenoid circuit stuck OFF***
No TCC
No self learning control
No adaptive shift control

P2762 - ***TCC Solenoid circuit electrical during driving***
No TCC
No self learning control
No adaptive shift control

P2763 - ***TCC Solenoid circuit short to Power***
No TCC
No self learning control
No adaptive shift control

Figure 19

DIAGNOSTIC TROUBLE CODE LIST

P2764 - ***TCC Solenoid circuit grounded or open***
No TCC
No self learning control
No adaptive shift control

U0073 / U100 - ***TCM CAN communication error detected by PCM***
No self learning control
No adaptive shift control

U0121 - ***PCM/TCM link fault with ABS***
No self learning control
No adaptive shift control

U0401 - ***Invalid data received from PCM (Engine Performance)***
Failsafe, increased pressures
May also have ECT or MAF codes stored

U415 - ***Wheel speed sensor fault thru CAN via ABS***
No self learning control
No adaptive shift control

Figure 20