

AUTO TRANS DIAGNOSIS - AW-40

Volvo 960

SELF-DIAGNOSTIC SYSTEM

DIAGNOSTIC PROCEDURE

When performing vehicle diagnosis;

- * Ensure transmission fluid level is correct and fluid is neither contaminated nor aerated.
- * Ensure battery is fully charged.
- * Perform visual inspection, ensuring all electrical connections at transmission, TCM, throttle position sensor, gear position sensor, speed sensor and brake switch are clean and properly installed.
- * Repair diagnostic trouble codes in order displayed.

NOTE: Volvo scan tool and Volvo diagnostic unit can be used in 6 different system test functions using manufacturer's instructions to activate system components and perform several tests on transmission. See SYSTEM TEST FUNCTIONS.

SELF-DIAGNOSTICS

Signals from various sensors are monitored continuously by TCM. If certain signals are lost or become faulty, TCM will cut off electrical signal to transmission components to protect transmission. TCM adopts fixed substitute values (limp-home mode) to enable vehicle to be driven when certain failures occur. Warning indicator light will illuminate. Transmission will not shift gears due to lack of electrical signal. Transmission will operate in 4th gear in "D", and in 3rd gear in "L" position. Manual shifting is possible into all other shift lever positions. When starting off in limp-home mode, shift lever should be in "L" position to minimize transmission wear.

Faults are recorded in TCM memory in the form of Diagnostic Trouble Codes (DTC's). Codes can be displayed using LED on Volvo diagnostic unit or by using Volvo Diagnostic Key Scan Tool. Diagnostic unit is located in engine compartment at left strut tower. Diagnostic unit is equipped with an LED indicator, activation button and function select cable. See Fig. 5.

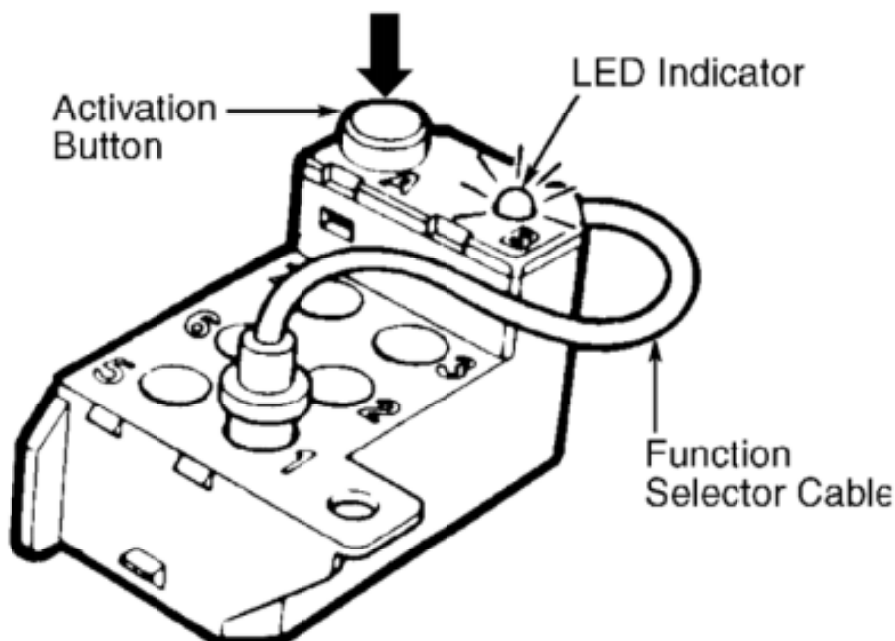


Fig.5

Diagnostic unit output socket No. 1 is used to retrieve TCM diagnostic codes. Once function selector cable has been inserted in correct socket, depressing button 1-6 times selects from 1 to 6 control (system test) functions. Depress button and keep depressed for more than one second (but not more than 3 seconds). DTC's stored in memory are read by observing diagnostic unit LED flashes. Observe LED and count number of flashes to determine DTC. If LED does not flash, see DIAGNOSTIC UNIT LED DOES NOT FLASH.

All codes contain 3 digits (example: 2-1-3). Since all codes have 3 digits, each code requires 3 series of flashes. A 3-second interval separates each series of flashes. See Fig. 6. For DTC definition, see DIAGNOSTIC TROUBLE CODE DEFINITION table under TROUBLE CODE DEFINITION.

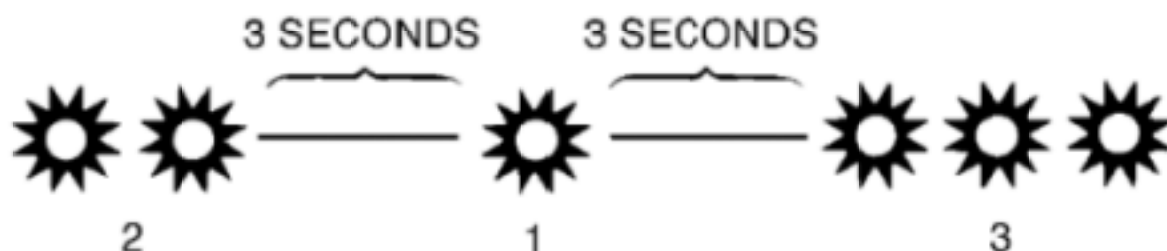


Fig. 6: Counting Red LED Code Flashes For Code 2-1-3
Courtesy of Volvo Cars of North America.

DIAGNOSTIC SYSTEM FAULTS

Diagnostic Unit LED Does Not Flash

1) Disconnect diagnostic unit. Turn ignition on. Check for voltage at diagnostic connector terminal No. 4. If voltage is not present, check fuse and wiring. If voltage is present, turn ignition off.

2) Connect an ohmmeter between diagnostic connector terminal No. 8 and ground. Ohmmeter should indicate approximately zero ohms. If reading is not approximately zero ohms, check wiring. If wiring is okay, replace diagnostic unit.

CLEARING CODES

1) Codes can be cleared only after all DTC's have been displayed and first DTC has been repeated at least once. To clear DTC, turn ignition on. Press test button on diagnostic unit and hold for more than 5 seconds. Wait for LED response.

2) Press button again and hold for more than 5 seconds. LED should go out when button is released. Ensure codes have been cleared by pressing button once. If LED displays code 1-1-1, codes have been cleared.

TCM LOCATION

TCM is located under instrument panel, to right of steering column. See Fig. 3.

SYSTEM TEST FUNCTIONS

CAUTION: Never disconnect or connect TCM connector with ignition switch in ON position.

NOTE: Follow tool manufacturer's instructions if retrieving codes with Volvo Diagnostic Key Scan Tool.

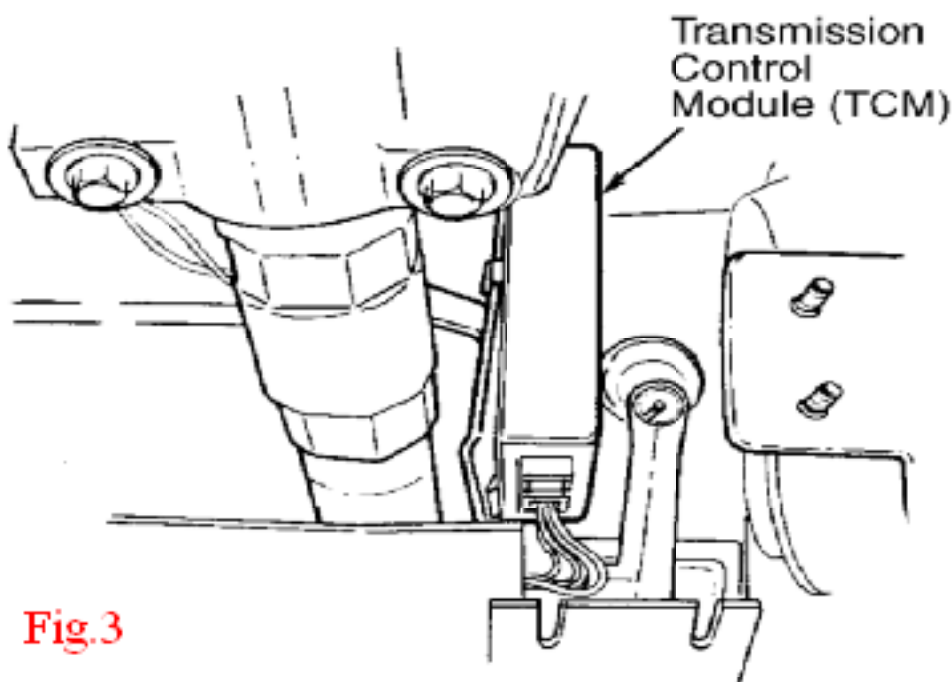


Fig.3

SYSTEM TEST FUNCTIONS

CAUTION: Never disconnect or connect TCM connector with ignition on.

NOTE: Follow tool manufacturer's instructions if retrieving codes with Volvo Diagnostic Key Scan Tool or generic scan tool.

Volvo Self-Diagnostic System

1) System is capable of self-diagnostic functions through the use of diagnostic unit in engine compartment, or manufacturer's scan tool. Access to diagnostic system is provided by socket No. 1 on diagnostic unit with ignition on. See Fig. 5 System has 6 test modes. Test mode No. 1 is used to display and clear codes. Test mode No. 2 is used to verify operation of system components. Test mode No. 3 operates components in a certain order.

2) Test mode No. 4 activates individual components to verify component operation when a specific code is input into diagnostic unit. Test mode No. 5 reads data values of various sensors. Values are for vehicle speed, throttle position, engine RPM and transmission oil temperature. Test mode No. 6 is used to enter data to reset adaptive values for throttle signal and shift speed adjustment function. Shift speed must be reset when transmission has been replaced.

NOTE: Manufacturer recommends use of scan tool when test modes No. 5 and 6 are performed. Follow manufacturer's instructions when performing these modes.

CAUTION: After displaying DTCs, ignition must be switched off BEFORE engine is started.

Test Mode No. 1 (Displaying Codes)

1) To display DTCs, open diagnostic unit cover (located in engine compartment at left strut tower) and connect test lead to socket No. 1. Turn ignition on. Enter test mode No. 1 by pressing test button once for 1-3 seconds.

2) Observe LED, and count number of flashes in 3 digit series comprising a DTC. Because series are displayed at 3-second intervals, codes can be easily distinguished.

3) If a DTC is displayed, refer to DIAGNOSTIC TROUBLE CODES DEFINITION table under TROUBLE CODE DEFINITION. Depress button again, and check for additional codes. Depress button a third time if necessary. If first code repeats, no other codes are present.

Test Mode No. 1 (Clearing Codes)

1) Codes can be cleared only after all DTCs have been displayed and first DTC has been repeated at least once. To clear DTCs, turn ignition on. Press button on diagnostic unit and hold for more than 5 seconds. Wait for LED response.

2) Press button again and hold for more than 5 seconds. LED should go out when button is released. Ensure codes have been cleared by pressing button once. If LED flashes code 111, codes have been cleared.

Test Mode No. 2 (Verifying Operation Of System Components)

1) Sensors and switches are activated by diagnostic unit. When TCM receives a signal, a response code is displayed for each input signal. This function checks component operation, wiring and connections in each circuit. If response code is displayed, component and circuit are okay. If response code is not displayed, TCM has not received a signal. Check appropriate component or circuit and repair as necessary.

2) This test mode is activated by briefly pressing test button on diagnostic unit 2 times, causing LED to rapidly flash. TCM will flash a code indicating receipt of a signal from components.

3) Activate sensors or switches by operating appropriate component as described in RESPONSE CODE IDENTIFICATION table. Diagnostic unit LED should display appropriate response code.

NOTE: For optimum results, components should be activated in order given in RESPONSE CODE IDENTIFICATION table. Components may be tested individually if necessary.

RESPONSE CODE IDENTIFICATION

.....		
Component & Position	Circuit Tested	Response (1) Code
Gear Position Sensor		
"R" To "P"	Park	242
"P" To "R"	Reverse	144
"R" To "N"	Neutral	241
"N" To "D"	Drive	214
"D" To "3"	3rd Gear	224
"3" To "L"	Low Gear	234
Any Position	(2) Position Sensor	243
Mode Selector Switch		
"E"	Economy Mode	244
"S"	Sport Mode	314
"W"	Winter Mode	324
Brake Pedal Depressed	Brake Switch	334
Acc. Pedal At WOT	Kickdown Switch	341

(1) - If response code is displayed, component and circuit tested are okay.

(2) - If response code 243 is present, gear position sensor is faulty.

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Test Mode No. 3 (Operating Components In Specified Order)

1) Output signals are checked at actuators to monitor component operation. Testing is performed in a cycle in which each component is activated 6 times with a short delay between each test. A longer delay occurs before next component is tested. The entire cycle is repeated 3 times, then test is exited automatically.

2) Test must be performed with shift lever in "P" or "N" position, and vehicle must be stopped. Test cannot be performed while driving vehicle. Output signals can be monitored by watching or listening to appropriate component to be activated.

3) Engine RPM will increase and decrease during tests. If any signal fails to activate a component, check electrical circuit and repair as necessary.

4) Test mode No. 3 is activated by briefly pressing test button on diagnostic unit 3 times. LED will flash each time component is activated. Components will be activated in the following order:

- * No. 1 Shift Solenoid.
- * No. 2 Shift Solenoid.
- * Torque Converter Lock-Up Solenoid.
- * Line Pressure Solenoid.
- * Warning Indicator Light In Instrument Panel Flashes.
- * Pause While Spare Output Terminal Is Tested.
- * Drive Compensation For Idling.
- * Torque Limiting Signal TC2 When Engine Idling.
- * Torque Limiting Signal TC1 When Engine Idling.

NOTE: Engine idle speed will change during drive compensation, TC1 and TC2 activation.

Test Mode No. 4 (Activating Individual Components)

1) Test mode No. 4 activates individual components to verify operation when a specific code is input into diagnostic unit. Components are activated 6 times in sequence. Shift lever must be in "P" or "N" position and vehicle must be stopped.

2) Rate of code transmission between TCM and diagnostic unit can be changed to 2 or 10 times the basic rate. Doubled rate can be used for reading codes from diagnostic unit LED. Highest rate is selected automatically when Volvo scan tool is used.

3) To activate test mode No. 4, push diagnostic unit button 4 times. Enter code for chosen component. See COMPONENT ACTIVATION CODES table. One digit is entered each time diagnostic unit LED is lit. Diagnostic unit LED flashes when chosen component is activated. After testing components, system automatically exits test mode No. 4.

COMPONENT ACTIVATION CODES

.....	
Component	Code
No. 1 Shift Solenoid	342
No. 2 Shift Solenoid	343
Lock-Up Solenoid	344
Line Pressure Solenoid	411
Warning Indicator Light	412
Drive Compensation (1)	414
Torque Limiting TC2 (1)	422
Torque Limiting TC1 (1)	423
Basic Code Transmission Rate	311
2 Times Basic Code Transmission Rate	312
10 Times Basic Code Transmission Rate	313

(1) - Engine idle speed will change during activation.

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TROUBLE CODE DEFINITION

DIAGNOSTIC TROUBLE CODE DEFINITION

DTC (1)	Warning Light On (2)	Fault/Repair
111	No	No Faults Recorded
112	Yes	Short To Voltage In No. 1 Shift Solenoid Ckt
113	Yes	TCM Fault
114	No	Mode Selector Switch Ckt Malfunction
121/P0750	Yes	Short To Ground In No. 1 Shift Solenoid Ckt
122/P0750	Yes	Open In No. 1 Shift Solenoid Ckt
123/P0745	Yes	Short To Voltage In Line
*****	***	Pressure Solenoid Ckt
124	No	Short To Ground In Mode Selector Switch Ckt
131	Yes	Open Or Short To Ground In
***	***	Line Pressure Solenoid (STH) Ckt
132/P0745	Yes	TCM Fault
134	No	Incorrect Load Signal
141	No	Short Ckt In Oil Temperature Sensor Ckt
142	No	Open In Oil Temperature Sensor Ckt
143	No	Short To Ground In Kickdown Switch Ckt
211	Yes	TCM Fault
212	Yes	Short To Voltage In No. 2 Shift Solenoid Ckt
213/P0120	Yes	Throttle Position Sensor Signal Too High
221/P0755	Yes	Short To Ground In No. 2 Shift Solenoid Ckt
222/P0755	Yes	Open In No. 2 Shift Solenoid Ckt
223/P0120	Yes	Throttle Position Sensor Signal Too Low
231	Yes	Erratic Throttle Position Sensor Signal
232/P0500	Yes	Speedometer Signal Missing
233	Yes	Speedometer Signal Incorrect
235	(3) Yes	High Oil Temperature
245	Yes	Open Or Short In Torque Limiting Ckt
311	Yes	Transmission RPM/Speed Sensor Signal Missing
312	Yes	Transmission RPM Signal Incorrect
313/P0705	Yes	Gear Position Sensor Signal Incorrect
321/P0731	Yes	Incorrect Gear Ratio
322/P0732	Yes	Incorrect Gear Ratio
323/P0733	Yes	Incorrect Gear Ratio
331	No	Short To Voltage In Lock-Up Solenoid Ckt
332	No	Open In Lock-Up Solenoid Ckt
333	No	Short To Ground In Lock-Up Solenoid Ckt
341	No	Lock-Up Function Slips Or Disengages
411	No	Control Module EEPROM Memory Fault
421	No	Battery Voltage Too Low

(1) - OBD II DTCs are emission-related codes.

(2) - Warning light is located in instrument panel. When a fault occurs, DTC is recorded and warning light comes on. If fault is intermittent, warning light will go out, but DTC will remain.

(3) - Only for as long as oil temperature remains high.

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CIRCUIT & COMPONENT TESTING (1995)

BRAKE SWITCH

1) Ensure ignition is off. Remove sound insulator to gain access to brake switch, located at top of brake lever. Connect a voltmeter between brake switch terminal No. 1 (Green/Yellow wire) and a good known ground. Battery voltage should be present. If battery voltage is not present, check for open circuit between terminal No. 1 and brake switch fuse.

2) Disconnect brake switch connector. Connect an ohmmeter between brake switch terminals No. 1 (Green/Yellow wire) and 2 (Yellow/Brown wire). With brake pedal released, resistance should be infinite. With brake pedal depressed, resistance should be zero ohms. If resistance is not as specified, replace brake switch.

KICKDOWN SWITCH

Ensure ignition switch is off. Disconnect kickdown switch connector, located left of brake booster assembly. Using a DVOM, measure resistance between switch terminals when accelerator pedal is in WOT position. Resistance should be zero ohms. While slowly releasing accelerator pedal continue to measure resistance. Resistance should be infinite in all other pedal positions. If kickdown switch does not test as described, replace switch.

MODE SELECTOR SWITCH

1) Perform test mode No. 2. See SYSTEM TEST FUNCTIONS. If response codes are correct, intermittent condition exists in wiring circuit. Visually inspect wiring. Ensure connectors fit tightly and are not corroded. If wiring is okay, go to next step.

2) Ensure ignition switch is off. Connect measuring unit to TCM. See Fig. 7 Turn ignition switch on. Using a DVOM, measure voltage between measuring unit terminals No. 12 and 39. With mode selector switch in "E" position, battery voltage should exist. With switch in any other position, voltage should exist.

3) Measure voltage between measuring unit terminals No. 12 and 41. With mode selector switch in "E" or "S" position, battery voltage should exist. With switch in any other position, voltage should not exist. If voltage is as specified, and each mode selector switch light illuminates in each position, wiring and switch are okay. If voltage is as specified, but vehicle does not function in all modes, replace TCM.

4) If voltage is not as specified, check appropriate circuit and repair as necessary. If mode selector switch lights illuminate but fault remains, check for open circuit and repair as necessary. If only one switch light illuminates, replace switch.

NOTE: DTC 124 will set if "W" button on mode selector switch is applied for more than 30 seconds.

OIL TEMPERATURE SENSOR

1) Ensure ignition switch is off. Connect the measuring unit to the TCM. See Fig. 7 Using a DVOM, measure resistance between measuring unit terminals No. 6 and 7. If resistance is as specified in the OIL TEMPERATURE SENSOR RESISTANCE table, sensor and wiring are okay. If resistance is not as specified, go to next step.

2) Disconnect transmission 4-pin connector. See Fig. 2 Connect the DVOM leads to 4-pin connector terminals No. 3 and 4. See Fig. 8 Measure resistance between connector terminals (oil temperature sensor terminals) as transmission fluid temperature gradually increases. See OIL TEMPERATURE SENSOR RESISTANCE table. If resistance is not as specified, replace oil temperature sensor.

OIL TEMPERATURE SENSOR RESISTANCE

Temperature $^{\circ}$ F ($^{\circ}$ C)		Resistance (Ohms)
32 (0)	.....	2000
68 (20)	.....	900
104 (40)	.....	400
176 (80)	.....	125
212 (100)	.....	75
302 (150)	.....	27

TRANSMISSION SPEED (RPM) SENSOR

1) Ensure ignition switch is off. Connect measuring unit to TCM. See Fig. 7 Using a DVOM, measure resistance between measuring unit terminals No. 16 and 17. Resistance should be 400-800 ohms. If resistance is as specified, sensor and wiring are okay. If resistance is not as specified, go to next step.

2) Measure resistance between transmission 4-pin connector terminals No. 1 and 2. See Fig. 8 Resistance should be 400-800 ohms. If resistance is as specified, sensor is okay. If resistance is not as specified, replace sensor.

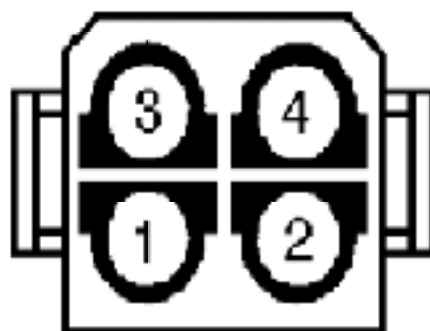


Fig. 8

THROTTLE POSITION SENSOR (TPS)

1) Ensure ignition switch is off. Connect measuring unit to TCM. See Fig. 7 Turn ignition switch on. Using a DVOM, measure voltage between measuring unit terminals No. 12 and 31. Voltage should be .2 volt with throttle closed and up to 4.8 volts with Wide Open Throttle (WOT). If voltage is as specified, sensor is okay. If voltage is not as specified, replace sensor.

2) Using a DVOM, measure voltage between measuring unit terminal No. 12 and a good known ground. Voltage should be less than .7 volt. If voltage is as specified, TCM is properly grounded. If voltage is not as specified, check for poor ground connection.

TORQUE LIMITING SIGNAL VOLTAGE

1) Ensure ignition is off. Connect measuring unit to TCM. See Fig. 7 Turn ignition on. Check torque limiting signals using test mode No. 4. Using a DVOM, measure voltage at measuring unit terminals No. 12 and 35. Voltage should vary between zero and 5 volts.

2) If voltage is not as specified, fault is in wiring to TCM or TCM. Check appropriate circuits and repair as necessary. If voltage is correct, but fault is still present, replace TCM.

VALVE BODY SOLENOIDS

1) Remove transmission oil pan. Disconnect solenoid wire connector(s). For solenoid wire color identification, refer to the SOLENOID WIRE COLOR IDENTIFICATION table. Using a DVOM, measure resistance between appropriate solenoid terminal and ground. Resistance should be 10-15 ohms for No. 1, No. 2 and torque converter lock-up solenoids. If resistance is not as specified, replace solenoid.

2) Using DVOM, measure resistance between line pressure solenoid terminals. Resistance should be 2-6 ohms. If resistance is not as specified, replace solenoid.

SOLENOID WIRE COLOR IDENTIFICATION

.....	
Solenoid	Wire Color
No. 1	Green
No. 2	Blue
Line Pressure	Pink & Brown
Torque Converter Lock-Up	Yellow
.....	

GEAR POSITION SENSOR CIRCUITS

Using a DVOM, check continuity between appropriate gear position sensor 8-pin connector terminal and TCM 30-pin connector terminal. See Figs. 9 and 11. Continuity should exist for each circuit. If continuity does not exist, repair circuit(s) as necessary. For gear position sensor connector terminal locations, See Fig. 9 For gear position sensor connector terminal identification, refer to the SENSOR-TO-TCM CONNECTOR TERMINAL IDENTIFICATION table.

SENSOR-TO-TCM CONNECTOR TERMINAL IDENTIFICATION (1) (2)		
.....		
Gear Position Sensor Terminal No.		TCM Terminal No.
5	.....	19
6	.....	20
7	.....	21
8	.....	22
(1) - For terminal locations, See Figs. 9 and 11.		
(2) - Terminals No. 1-4 do not send signal to TCM.		
.....		

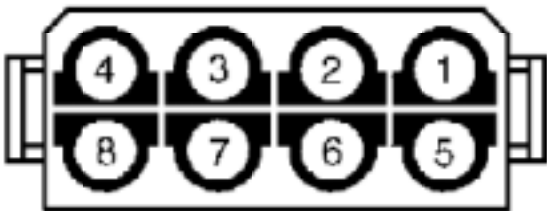


Fig. 9

VALVE BODY SOLENOID CIRCUITS

Using a DVOM, measure resistance between appropriate solenoid wire connector and appropriate terminal at transmission 8-pin connector. See Fig. 2 Resistance should be zero ohms for each solenoid wire. For transmission connector terminal locations, See Fig. 10 For transmission connector terminal identification, see TRANSMISSION CONNECTOR TERMINAL IDENTIFICATION table. If resistance is not as specified, repair appropriate circuit as necessary.

TRANSMISSION CONNECTOR TERMINAL IDENTIFICATION		
.....		
Terminal No.	(1) (2)	Component
1		No. 1 Shift Solenoid
2		No. 2 Shift Solenoid
3		Lock-Up Solenoid
4 & 5		Line Pressure Solenoid
(1) - For terminal locations, See Fig. 10		
(2) - Terminals No. 6-8 are blank.		
.....		

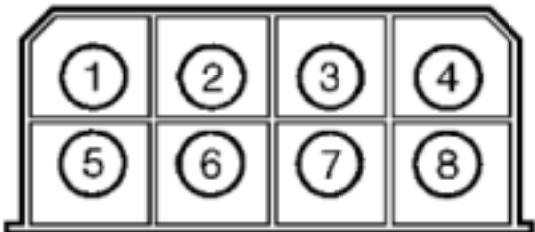


Fig. 10

CONNECTOR IDENTIFICATION

If component and/or circuit fault is diagnosed, check appropriate circuit between component and TCM connector terminal(s) and repair as necessary. If component and circuits are okay, replace TCM. For TCM connector terminal locations, See Fig. 11 For TCM connector terminal identification, see WIRING DIAGRAMS.

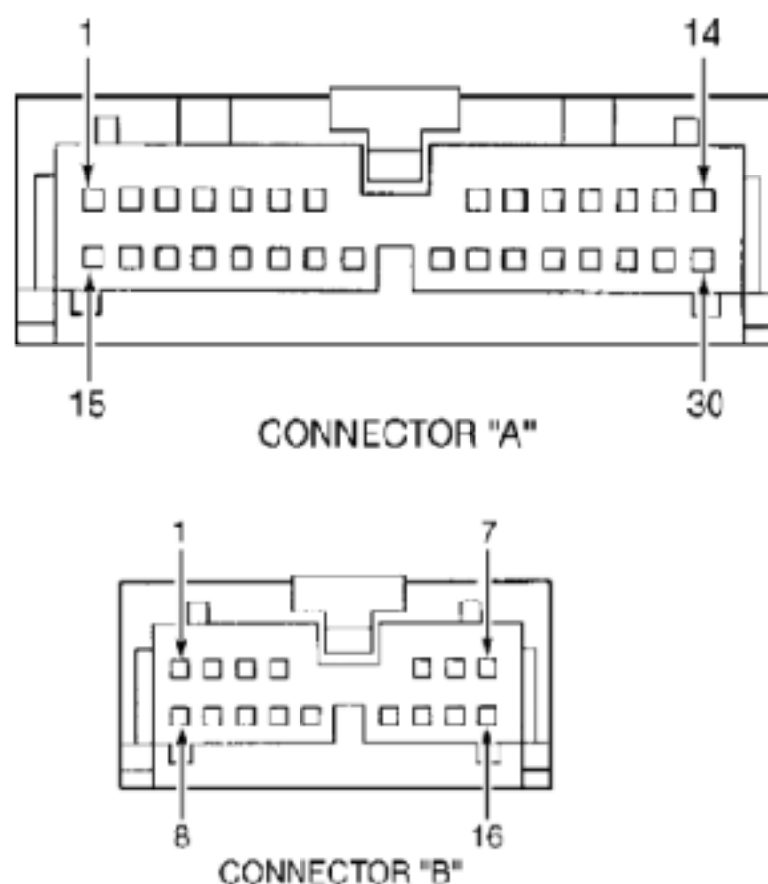


Fig. 11

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Drive Shaft-To-Transmission Bolt	37 (50)
Flexplate-To-Torque Converter Bolt	22 (30)
Transmission-To-Engine Bolt	
Starter Bolts	30 (40)
Remaining Bolts	35 (48)

- (1) - Tighten an additional 120 degrees.
- (2) - Tighten an additional 60 degrees.
- (3) - Tighten an additional 90 degrees.