AUTO TRANS DIAGNOSIS - AW-40

1994 Volvo 960

AUTOMATIC TRANSMISSIONS
Volvo AW-40 Series Testing & Diagnosis

APPLICATION & LABOR TIMES

APPLICATION & LABOR TIMES

Vehicle Application	Labor Times (1) R & I	(2) Overhaul	Series
960	4.3	10.3	AW-40

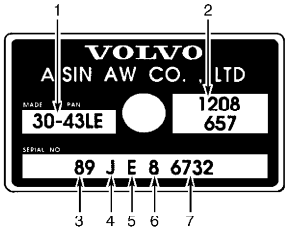
(1) - Removal and installation of transmission from vehicle chassis.
(2) - Bench overhaul time for transmission. DOES NOT include removal and installation.

CAUTION: Vehicle is equipped with a Supplemental Restraint System (SAS). When servicing vehicle, use care to avoid accidental air bag deployment. SRS-related components are located in steering column, center console, instrument panel and lower panel on instrument panel. DO NOT use electrical test equipment on these circuits. If may be necessary to deactivate SRS before servicing components. See AIR BAG SERVICING article in APPLICATIONS & IDENTIFICATION section. Refer to the following:

* 1992 models, see: AIR BAG RESTRAINT SYSTEM
* 1993 models, see: AIR BAG RESTRAINT SYSTEM
* 1994 models, see: AIR BAG RESTRAINT SYSTEM

IDENTIFICATION

Transmission can be identified by identification plate attached at right rear of transmission case. Identification plate contains transmission model, year of manufacture and transmission part number. See Fig. 1. Transmission model number may be AW30-40LE or AW30-43LE.



1. Transmission Model
2. Transmission Part Number
3. Year Of Manufacture
4. Month Of Manufacture (June)
5. Designates 30-43LE
6. Manufactured For Volvo
7. Manufacturing Number Starting With 0001 Each Month

95H21144

Fig. 1: Locating Transmission Identification Plate Information
Courtesy of Volvo Cars of North America.

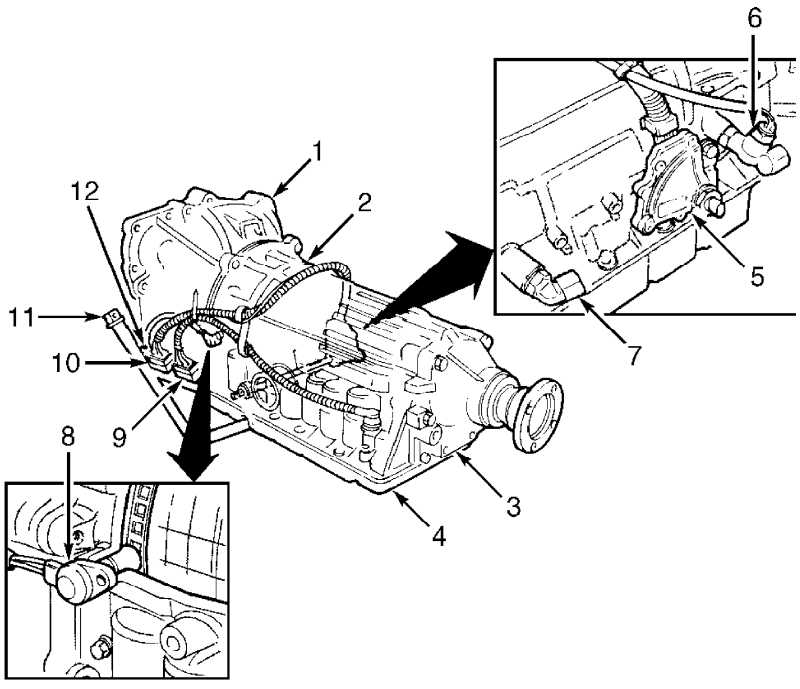
DESCRIPTION

Transmission is a 4-speed overdrive electronically controlled automatic transmission. Transmission consists of lock-up torque converter, oil pump, 3 planetary gear sets, clutch and brake units, accumulator pistons, valve body and 4 electronic valve body solenoids.

Valve body with solenoids and Transmission Control Module (TCM) are used for controlling transmission operation. Solenoids are controlled by TCM.

TCM receives input signals from various components to determine transmission shift points and torque converter lock-up. Components consist of mode selector switch, throttle position sensor, transmission speed (RPM) sensor, gear position sensor, transmission oil temperature sensor, brake switch and kickdown switch. See Fig. 2.

Transmission is equipped with a mode selector switch. Switch is used for normal, high performance and winter driving conditions. Transmission is also equipped with a shift lock and key interlock system. Shift lock system prevents shift lever from being moved from Park position unless brake pedal is applied. In case of malfunction, shift lever can be released by depressing shift lock override button, located near shift lever. Key interlock system prevents ignition switch from being moved from ACC to LOCK position unless shift lever is in Park position.



1. Torque Converter Housing
2. Transmission Housing
3. Extension Housing
4. Transmission Oil Pan
5. Gear Position Sensor
6. Oil Temperature Sensor
7. Oil Cooler Inlet
8. Transmission Speed (RPM) Sensor
9. Solenoid Assembly Connector
10. Gear Position Sensor Connector
11. Dipstick Tube
12. Oil & Speed Sensor Connector

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Fig. 2: Locating Transmission Components
Courtesy of Volvo Cars of North America.

OPERATION

BRAKE SWITCH

Brake switch is an input device mounted above the brake pedal. When brake pedal is applied, brake switch delivers an input signal to the TCM. TCM uses input signal to control No. 3 solenoid for torque converter lock-up.

GEAR POSITION SENSOR

NOTE: Gear position sensor may also be referred to as neutral safety switch.

Gear position sensor is an input device mounted on the transmission manual valve shaft. Sensor delivers an input signal to TCM, indicating transmission manual valve gear position.

KEY INTERLOCK SYSTEM

With ignition key in ignition switch, place shift lever into "P" position. Ensure ignition key can be installed and removed from ignition switch with ease. If key is difficult to remove, key interlock cable is too short. Adjust cable as necessary. Move shift lever to position other than Park. Ignition key should not be removable from ignition switch. If key can be removed, cable is too long. Adjust cable as necessary.

KICKDOWN SWITCH

Kickdown switch, located at firewall on accelerator cable, sends input signal to TCM when accelerator pedal is fully depressed. TCM uses input signal for controlling transmission downshifting and torque converter lock-up.

MODE SELECTOR SWITCH

Mode selector switch, located to left of shift lever, has 3 different modes which effect transmission shift points. Input signal from mode selector switch is sent to TCM. TCM uses input signal for controlling transmission shifting and torque converter lock-up.

"E" (Economy) mode, is for normal driving and provides early upshifts combined with lock-up as often as possible for top 3 gears. Transmission line pressure is modulated to provide smooth gear engagement.

In "S" (Sport) mode, transmission shift points are designed to provide the highest possible performance. Under normal acceleration, transmission shifts occur the same as in economy mode. During increased acceleration, TCM selects shift and lock-up points for best possible performance.

"W" (Winter) mode prevents wheel spin on slippery surfaces. Transmission starts out in high gear. When "W" mode is selected, warning light on dash is illuminated. This mode may also be used when driver wants to control gear selection.

OIL TEMPERATURE SENSOR

Oil temperature sensor, located on right side of transmission, forward of gear position sensor, measures transmission fluid temperature and delivers an input signal to TCM. TCM uses input signal for controlling transmission shifting and torque converter lock-up.

SHIFT LOCK OVERRIDE FUNCTION

Move shift lever to "P" position and turn ignition key to (I) or (II) position. Press override button. Shift lever should move from "P" position. Return shift lever to "P" position and remove ignition key. Press override button. Shift lever should not move from "P" position. Override function should operate only when ignition key is in (I) or (II) position.

TRANSMISSION CONTROL MODULE (TCM)

TCM is located under instrument panel, to right of steering column. See Fig. 3. TCM determines shift points and torque converter lock-up timing based on input signals received from various components. Components consist of mode selector switch, throttle position sensor, transmission speed (RPM) sensor, gear position sensor, transmission oil temperature sensor, brake switch and kickdown switch.

TCM contains a self-diagnostic system which stores a Diagnostic Trouble Code (DTC). If a transmission problem exists, DTC(s) can be retrieved to determine transmission problem area.

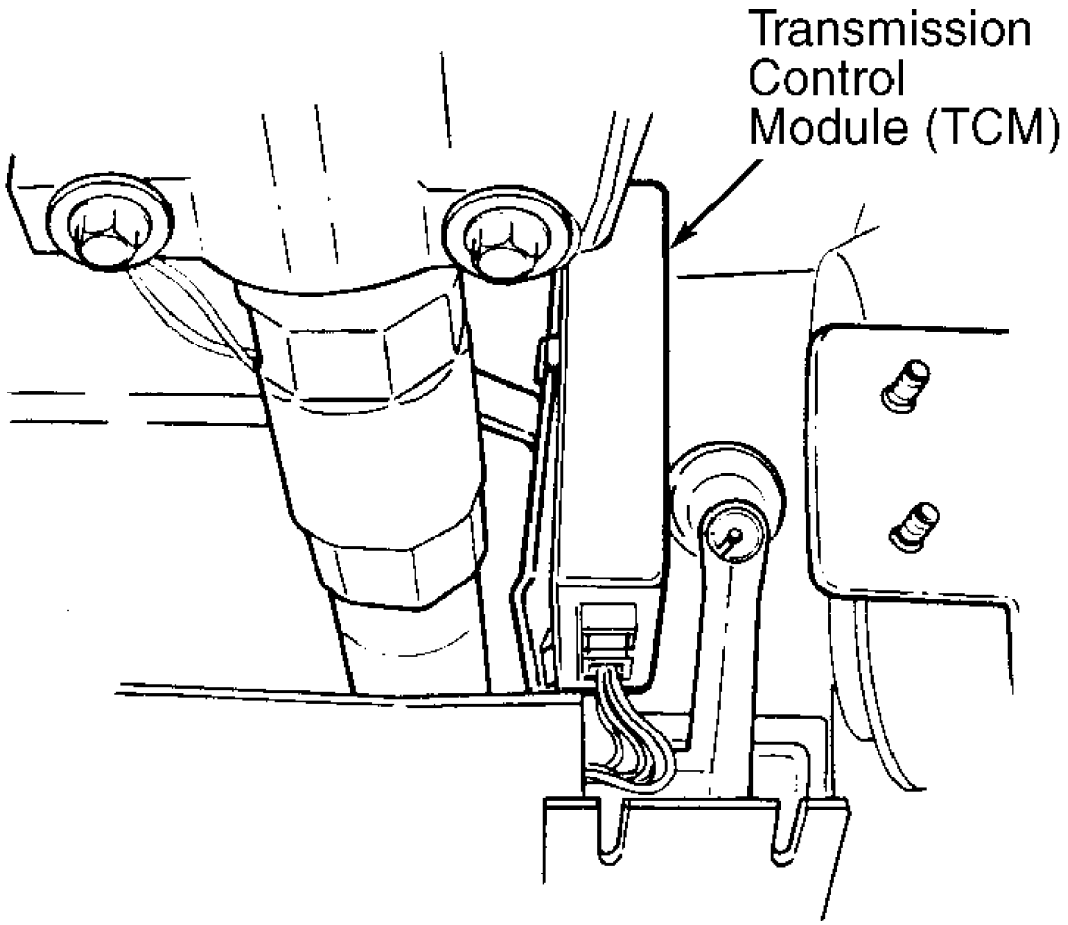

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Fig. 3: Locating Transmission Control Module (TCM)
Courtesy of Volvo Cars of North America.

TRANSMISSION SPEED (RPM) SENSOR

Electromagnetic RPM sensor, mounted in transmission housing, is activated by a toothed impulse wheel. Sensor is an input device which delivers an RPM signal to the TCM. By comparing transmission RPM and vehicle speed, TCM calculates torque converter slippage.

THROTTLE POSITION (TP) SENSOR

Throttle position sensor, mounted on throttle body, determines throttle position and delivers an input signal to TCM. TCM uses input signal for controlling transmission upshifts and torque converter lock-up.

VALVE BODY SOLENOIDS

Valve body solenoids, mounted on the valve body, are output devices controlled by signals received from the TCM. The No. 1 and No. 2 solenoids are used to control transmission shifting. No. 3 solenoid is used to control torque converter lock-up. No. 4 solenoid is used to control transmission line pressure. For valve body solenoid usage, see VALVE BODY SOLENOID APPLICATION table.

VALVE BODY SOLENOID APPLICATION (1)

Shift Lever Position	No. 1 Solenoid	No. 2 Solenoid
"D" (Drive)		
1st	ON	OFF
2nd	ON	ON
3rd	OFF	ON
4th	OFF	OFF
"3"		
1st	ON	OFF
2nd	ON	ON
3rd	OFF	ON
"L"		
1st	ON	OFF
2nd	ON	ON
"R" (Reverse)	ON	OFF
"N" Or "P"	ON	OFF

(1) - Valve body contains 4 solenoids. No. 1 and No. 2 solenoids are used to control transmission shifts. No. 3 solenoid is used to control torque converter lock-up. No. 4 solenoid is used to control line pressure.

LUBRICATION & ADJUSTMENTS

See the TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANS SERVICING section.

TROUBLE SHOOTING

Preliminary Checks
Ensure fluid level is correct. Inspect throttle cable,

kickdown cable and gear position sensor. Check idle speed RPM and adjust as necessary.

NOTE: Manufacturer recommends transmission assembly replacement only. Manufacturer does not provide mechanical trouble shooting or overhaul information.

TESTING

ROAD TEST

"D" & "3" Position

1) Engine and transmission must be at normal operating temperature. Shift transmission into "D" position. Set mode selector switch to "E" position. Test drive vehicle and ensure all upshifts and downshifts occur at specified speeds. See SHIFT SPEED SPECIFICATIONS table.

2) Ensure lock-up occurs at appropriate speeds. See LOCK-UP SPEED SPECIFICATIONS table. Lightly depress accelerator. If excessive increase in engine RPM exists, lock-up did not occur.

NOTE: Lock-up in 2nd gear occurs when transmission oil temperature exceeds 257°F (125°C) on AW30-40 transmission or 239°F (115°C) on AW30-43 transmission. Lock-up in 3rd gear occurs when transmission oil temperature exceeds 140°F (60°C). Lock-up in 4th gear occurs when transmission oil temperature exceeds 86°F (30°C).

"L" Position

While driving vehicle in "L" position, check for failure to upshift to 2nd gear. Check engine braking effect when accelerator pedal is released.

"R" Position

Shift vehicle into "R" position. Accelerate vehicle and check for transmission slippage.

"P" Position

Stop vehicle on incline of 5 degrees or steeper. Shift vehicle into "P" position and release parking brake. Ensure parking pawl prevents vehicle from moving.

TIME LAG TEST

1) Engine and transmission must be at normal operating temperature. Start engine and ensure idle RPM is within specification with A/C off. Apply service and parking brakes. Using stop watch, measure time until engagement shock is felt when shift lever is shifted from "N" to "D" position.

2) Allow one minute intervals between tests. Perform time measurement several times and calculate average time. Time should be less than .7 seconds. Repeat test procedure to test time lag when shift lever is shifted from "N" to "R" position. Time lag should be less than 1.2 seconds. If test time is not as described, check transmission line pressure. See HYDRAULIC PRESSURE TEST.

SHIFT SPEED SPECIFICATIONS (1)

Application	MPH
AW30-40	
Economy Mode	
1st-2nd	25
2nd-3rd	50

3rd-4th	87
4th-3rd	59
3rd-2nd	37
2nd-1st	16
Sport Mode	
1st-2nd	36
2nd-3rd	76
3rd-4th	127
4th-3rd	112
3rd-2nd	50
2nd-1st	23
AW30-43	
Economy Mode	
1st-2nd	22
2nd-3rd	50
3rd-4th	92
4th-3rd	53
3rd-2nd	31
2nd-1st	12
Sport Mode	
1st-2nd	32
2nd-3rd	69
3rd-4th	108
4th-3rd	53
3rd-2nd	58
2nd-1st	19

(1) - With shift lever in "D" position and throttle valve open 60 percent.

LOCK-UP SPEED SPECIFICATIONS (1) (2)

Application	MPH
AW30-40	
Economy Mode	
Lock-Up ON	
2nd Gear	25
3rd Gear	65
4th Gear	90
Lock-Up OFF	
2nd Gear	19
3rd Gear	59
4th Gear	82
Sport Mode	
Lock-Up ON	
2nd Gear	50
3rd Gear	76
4th Gear	127
Lock-Up OFF	
2nd Gear	40
3rd Gear	71
4th Gear	122
AW30-43	
Economy Mode	
Lock-Up ON	
2nd Gear	29
3rd Gear	50
4th Gear	92
Lock-Up OFF	
2nd Gear	19
3rd Gear	59

4th Gear	71
Sport Mode	
Lock-Up ON	
2nd Gear	43
3rd Gear	79
4th Gear	108
Lock-Up OFF	
2nd Gear	37
3rd Gear	68
4th Gear	100

(1) - With shift lever in "D" position and throttle valve open 60 percent.
(2) - Lock-up in 2nd gear occurs when transmission oil temperature exceeds 257°F (125°C) on AW30-40 transmission or 239°F (115°C) on AW30-43 transmission. Lock-up in 3rd gear occurs when transmission oil temperature exceeds 140°F (60°C). Lock-up in 4th gear occurs when transmission oil temperature exceeds 86°F (30°C).

STALL SPEED TEST

1) Operate engine and transmission at normal operating temperature. Connect tachometer to vehicle and ensure it is visible to driver. Apply parking brake and block all 4 wheels.

CAUTION: DO NOT maintain stall speed RPM for more than 5 seconds. Transmission damage may occur.

2) Ensure A/C is off. Start engine, apply brakes and place transmission in "D" position. Depress accelerator to full throttle and note maximum RPM obtained. Repeat test in "R" position. For stall speed specifications, see STALL SPEED SPECIFICATIONS table.

STALL SPEED SPECIFICATIONS

Transmission	RPM
AW30-40	2700
AW30-43	2100

3) If stall speed RPM recorded is lower or higher then specified, check fluid color and odor. If fluid color and odor is normal, replace torque converter. If fluid is discolored or has a burnt smell, manufacturer recommends replacing transmission as an assembly.

NOTE: If stall speed RPM is greater than 600 RPM lower than specification and poor acceleration exists, torque converter may be faulty.

HYDRAULIC PRESSURE TEST

1) Ensure transmission is at normal operating temperature. Connect pressure gauge to line pressure test port. See Fig. 4.
2) Connect tachometer to vehicle and ensure it is visible to driver. Block drive wheels and fully apply parking brake. Start engine and let idle.
3) Apply service brake and shift transmission into "D" position. Check line pressure at idle and record pressure reading. Accelerate engine to stall speed and record line pressure reading.

4) Repeat test procedure in "R" position. If line pressures are not as specified, check throttle cable adjustment. Adjust throttle cable as necessary, and repeat test procedure and record pressure readings. Compare all readings to specification. See LINE PRESSURE SPECIFICATIONS table.

LINE PRESSURE SPECIFICATIONS

Engine Speed	"D" Position psi (kg/cm²)	"R" Position psi (kg/cm²)
Idle Speed	59-65 (4.1-4.6)	88-98 (6.2-6.9)
Stall Speed	180-194 (12.6-13.6)	209-252 (14.7-17.7)

5) If line pressures are not as specified, internal components in transmission may be malfunctioning. Check self-diagnostic system for trouble codes. See SELF-DIAGNOSTIC SYSTEM. If no trouble codes are found, manufacturer recommends replacing transmission as an assembly.

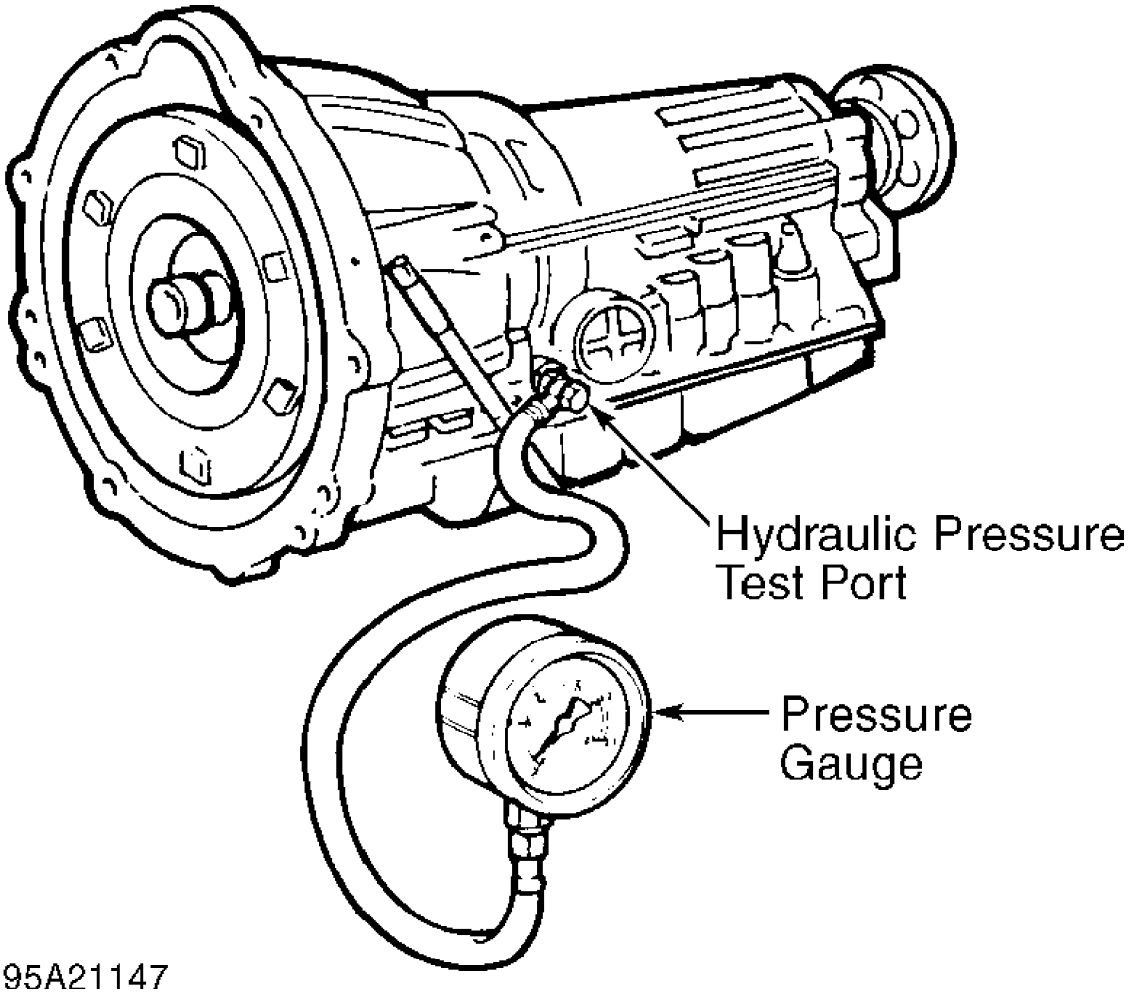

Fig. 4: Locating Line Pressure Test Port
Courtesy of Volvo Cars of North America.

ON-VEHICLE SERVICE

EXTENSION HOUSING SEAL

Removal & Installation

1) Raise and support vehicle. Mark drive shaft location at transmission flange for reassembly reference. Remove 4 nuts securing drive shaft to flange. Secure drive shaft aside. Free staked area of flange nut. Secure flange to prevent rotation. Remove flange nut and flange. Using appropriate puller, remove extension housing seal.

2) To install, reverse removal procedure. Lubricate seal lip prior to installation. Install NEW "O" ring on flange. Install NEW flange nut. Apply Loctite to flange nut threads prior to installation. Tighten flange nut to 91 ft. lbs. (123 N.m) and stake to secure. Install drive shaft. Tighten nuts to 37 ft. lbs. (50 N.m).

THROTTLE & KICKDOWN CABLES

Information is not available from manufacturer.

REMOVAL & INSTALLATION

TRANSMISSION

For transmission removal and installation procedure, see the TRANSMISSION REMOVAL & INSTALLATION - A/T article in the AUTOMATIC TRANS SERVICING section.

ACCUMULATOR PISTONS & SPRINGS

Removal & Installation

1) Remove control valve assembly. See CONTROL VALVE ASSEMBLY. Remove retainers securing accumulator pistons and springs. Apply compressed air to transmission case oil ports to remove accumulator pistons and springs from transmission case. Note direction and location of springs and pistons for reassembly reference.

2) Measure accumulator piston spring free length and outside diameter. Replace springs if not within specification. Refer to the ACCUMULATOR SPRING SPECIFICATIONS table.

3) To install, reverse removal procedure. Replace accumulator piston seal rings prior to installation. Lubricate seal rings with ATF. Ensure components are installed in correct direction and location.

ACCUMULATOR SPRING SPECIFICATIONS

Piston Spring (Color)	Free Length In. (mm)	Diameter In. (mm)
2nd Brake (Blue)	2.78 (70.6)	.78 (19.8)
Direct Clutch		
Inner (Pink)	1.66 (42.2)	.58 (14.7)
Outer (Blue)	2.70 (68.6)	.80 (20.3)
OD Brake (Green)	2.40 (61.0)	.62 (15.7)
OD Clutch		
Inner (Yellow)	1.81 (46.0)	.55 (14.0)
Outer (Orange)	2.91 (73.9)	.81 (20.5)

CONTROL VALVE ASSEMBLY

CAUTION: Accumulator pistons, springs and non-return valve are

secured in transmission case by control valve assembly. Components may fall from case when control valve assembly is removed. Secure components in case using retainers prior to removing control valve assembly.

Removal

1) Raise and support vehicle. Remove transmission drain plug and drain fluid. Remove wiring harness from clips on oil pan. Remove oil pan bolts and remove oil pan. Remove 3 oil strainer bolts and oil strainer. Remove 2 bolts securing solenoid wire harness. Disconnect 4 valve body solenoid wire connectors, noting wire color and locations.

2) Loosen 18 control valve assembly bolts. Lower control valve assembly slightly. Secure accumulator pistons, springs and non-return valve in transmission case using retainers. Remove control valve assembly bolts, noting length and location of bolts for installation reference. Remove control valve assembly.

Installation

To install, reverse removal procedure. Ensure accumulator pistons, springs and non-return valve are installed in correct locations. Ensure control valve assembly bolts are installed in correct locations. Tighten oil strainer bolts and control valve assembly bolts to 89 INCH lbs. (10 N.m). Install .12" (3 mm) thick bead of sealing compound on oil pan and install pan. Tighten oil pan bolts to 62 INCH lbs. (7 N.m). Tighten drain plug to 15 ft. lbs. (21 N.m).

GEAR POSITION SENSOR

NOTE: Gear position sensor may also be referred to as neutral safety switch.

Removal & Installation

1) Disconnect negative battery cable. Ensure transmission is in "N" position and parking brake is applied. Raise and support vehicle. Remove exhaust pipe and heat shield. Remove shift rod arm from manual shaft on left side of transmission. Disconnect 8-pin gear position sensor connector. Remove cooler inlet tube from transmission.

2) Note position of gear position sensor prior to removal. Remove nut with locking washer and rubber washer. Remove gear position sensor bolt and sensor. To install, reverse removal procedure. Tighten sensor bolt to 62 INCH lbs. (7 N.m). Tighten shift rod arm nut to 13 ft. lbs. (18 N.m). Ensure sensor is installed in correct position.

TRANSMISSION OVERHAUL

NOTE: Manufacturer does not provide transmission overhaul information or specifications. If internal malfunction occurs to transmission, manufacturer recommends replacing transmission as an assembly.

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.

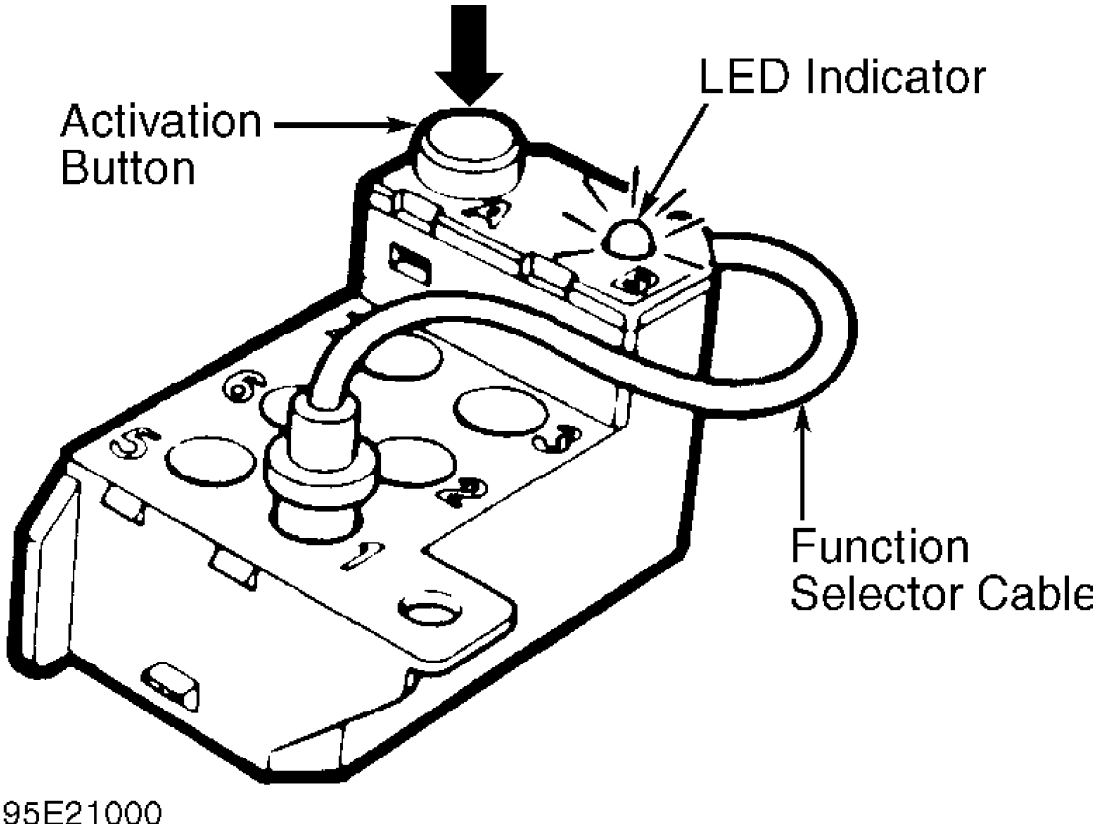

Fig. 5: Identifying Diagnostic Unit Components
Courtesy of Volvo Cars of North America.

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.

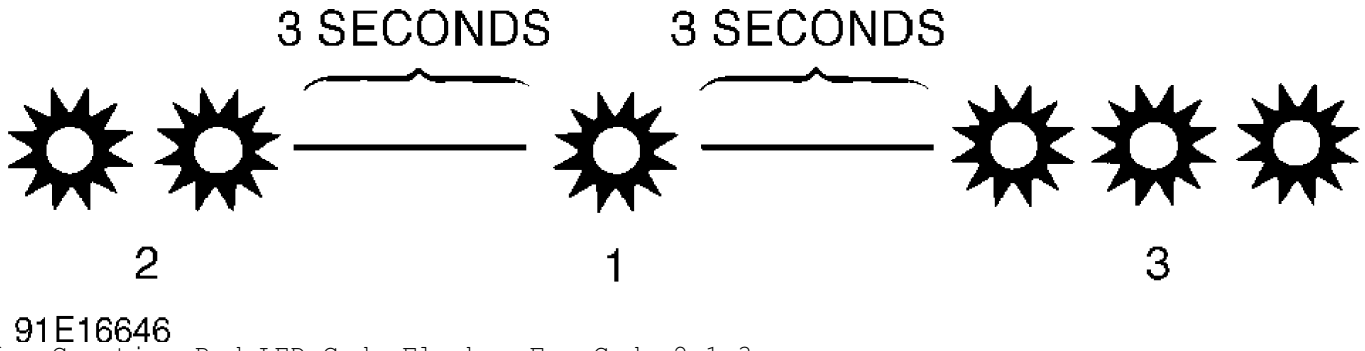

Fig. 6: Counting Red LED Code Flashes For Code 2-1-3
Courtesy of Volvo Cars of North America.

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 terminalNo. 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.

MEASURING UNIT

Connecting Measuring Unit (9813190) & Adapter (9813194)

1) Measuring unit is used to measure system voltage while engine is running. Measuring unit also is used to check individual circuit resistance without influence from other systems.

2) Disconnect negative battery cable. Locate TCM under instrument panel, to right of steering column. See Fig. 3. Remove TCM connectors. Press adapter into TCM connector base. Press TCM connectors into adapter. Connect measuring unit to adapter connector. See Fig. 7.

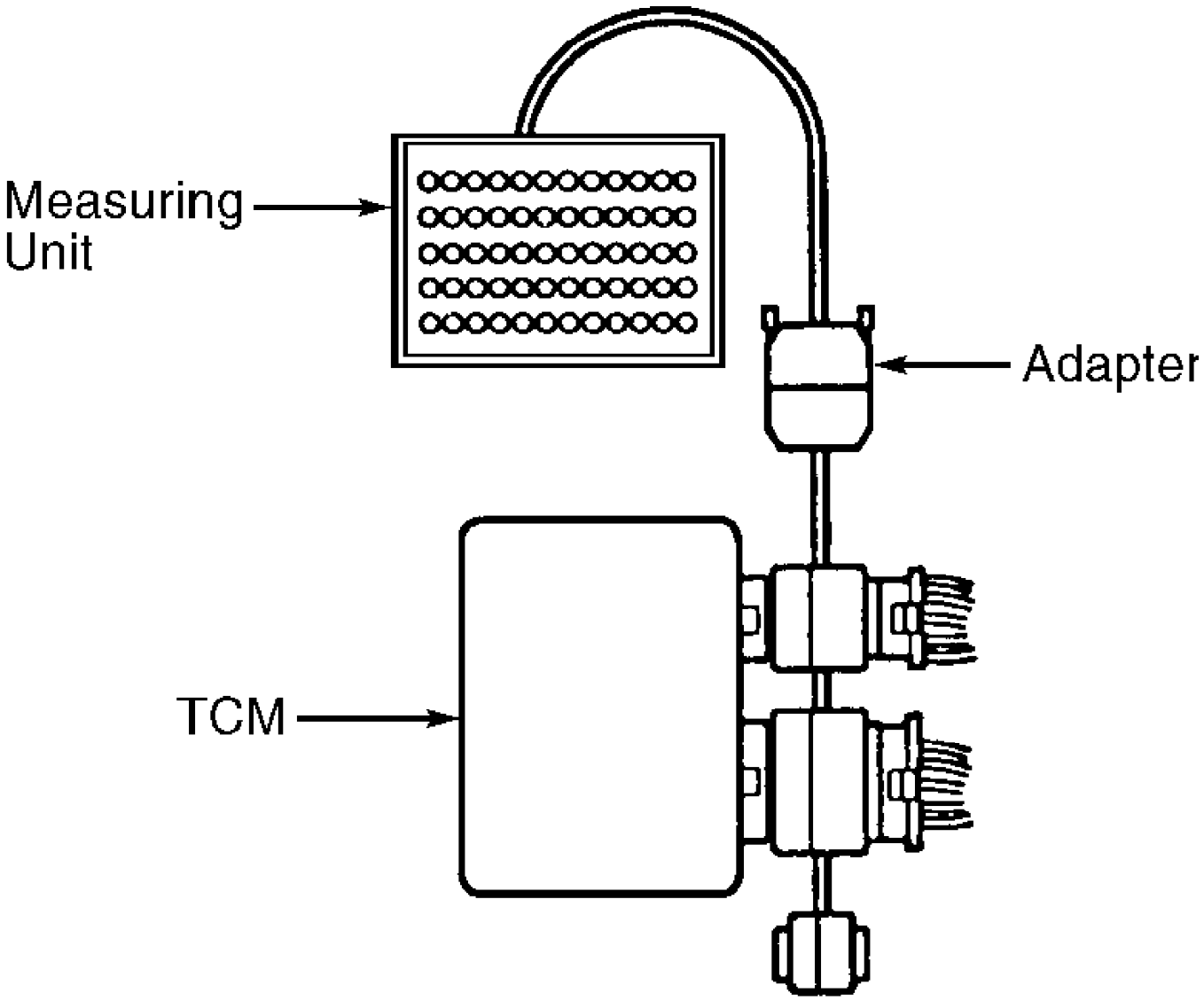

Fig. 7: Installing Measuring Unit & Adapter
Courtesy of Volvo Cars of North America.

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.

Volvo Self-Diagnostic System

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.

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 DTC's, ignition must be switched off BEFORE engine is started.

Test Mode No. 1 (Displaying Codes)

1) To display DTC's, 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 DTC's have been displayed and first DTC has been repeated at least once. To clear DTC's, 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 1-1-1, 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	2-4-2
"P" To "R"	Reverse	1-4-4
"R" To "N"	Neutral	2-4-1
"N" To "D"	Drive	2-1-4
"D" To "3"	3rd Gear	2-2-4
"3" To "L"	Low Gear	2-3-4
Any Position	(2) Position Sensor	2-4-3
Mode Selector Switch		
"E"	Ecomomy Mode	2-4-4
"S"	Sport Mode	3-1-4
"W"	Winter Mode	3-2-4
Brake Pedal Depressed	Brake Switch	3-3-4
Acc. Pedal At WOT	Kickdown Switch	3-4-1

(1) - If response code is displayed, component and circuit tested are okay.
(2) - If response code 2-4-3 is present, gear position sensor is faulty.

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	3-4-2
No. 2 Shift Solenoid	3-4-3
Lock-Up Solenoid	3-4-4
Line Pressure Solenoid	4-1-1
Warning Indicator Light	4-1-2
Drive Compensation (1)	4-1-4
Torque Limiting TC2 (1)	4-2-2
Torque Limiting TC1 (1)	4-2-3
Basic Code Transmission Rate	3-1-1
2 Times Basic Code Transmission Rate	3-1-2
10 Times Basic Code Transmission Rate	3-1-3

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

TROUBLE CODE DEFINITION

DIAGNOSTIC TROUBLE CODE DEFINITION

DTC	Warning Light On (1)	Fault/Repair
1-1-1	No	No Faults Recorded
1-1-2	Yes	Short To Voltage In No. 1 Shift Solenoid Circuit
1-1-3	Yes	TCM Fault
1-1-4	No	Mode Selector Switch Circuit Malfunction
1-2-1	Yes	Short To Ground In No. 1 Shift Solenoid Circuit
1-2-2	Yes	Open In No. 1 Shift Solenoid Circuit
1-2-3	Yes	Short To Voltage In Line Pressure Solenoid Circuit
1-2-4	No	Short To Ground In Mode Selector Switch Circuit
1-3-1	Yes	Open Or Short To Ground In Line Pressure Solenoid Circuit
1-3-2	Yes	TCM Fault
1-3-4	No	Incorrect Load Signal
1-4-1	No	Short Circuit In Oil Temperature Sensor Circuit
1-4-2	No	Open In Oil Temperature Sensor Circuit
1-4-3	No	Short To Ground In Kickdown Switch Circuit
2-1-1	Yes	TCM Fault

2-1-2	.....	Yes	..... Short To Voltage In No. 2 Shift Solenoid Circuit
2-1-3	.....	Yes	..... Throttle Position Sensor Signal Too High
2-2-1	.....	Yes	..... Short To Ground In No. 2 Shift Solenoid Circuit
2-2-2	.....	Yes	..... Open In No. 2 Shift Solenoid Circuit
2-2-3	.....	Yes	..... Throttle Position Sensor Signal Too Low
2-3-1	.....	Yes	..... Erratic Throttle Position Sensor Signal
2-3-2	.....	Yes	..... Speedometer Signal Missing
2-3-3	.....	Yes	..... Speedometer Signal Incorrect
2-3-5	.....	(2) Yes	..... High Oil Temperature
2-4-5	.....	Yes	..... Open Or Short In Torque Limiting Circuit
3-1-1	.....	Yes	..... Transmission RPM Signal Missing
3-1-2	.....	Yes	... Transmission RPM Signal Incorrect
3-1-3	.....	Yes	..... Gear Position Sensor Signal Incorrect
3-2-2 (3)	.....	Yes	.... Gear Ratio Information Incorrect
3-2-3 (3)	.....	Yes	..... Lock-Up Slips Or Is Not Engaged
3-3-1	.....	No	..... Short To Voltage In Lock-Up Solenoid Circuit
3-3-2	.....	No	..... Open In Lock-Up Solenoid Circuit
3-3-3	.....	No	..... Short To Ground In Lock-Up Solenoid Circuit

(1) - 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.
(2) - Only for as long at oil temperature remains high.
(3) - If DTC is present, mechanical malfunction has occurred. Manufacturer recommends replacing transmission assembly.

CIRCUIT & COMPONENT TESTING

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 1-2-4 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 measuring unit to TCM. See Fig. 7. Using a DVOM, measure resistance between measuring unit terminals No. 6 and 7. If resistance is as specified in 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 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 °F (°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.

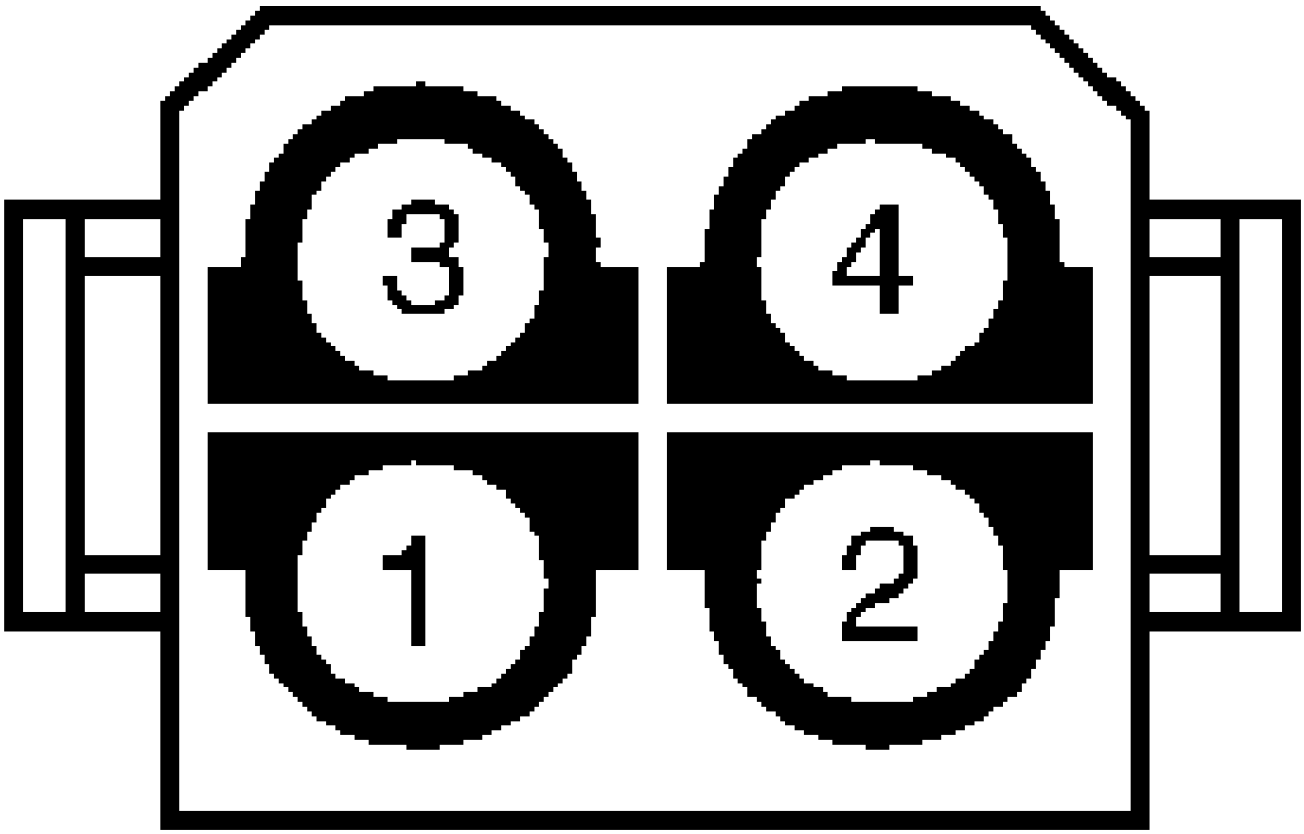

Fig. 8: Identifying Oil & Transmission Speed (RPM) Sensor Connector Terminals
Courtesy of Volvo Cars of North America.

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, see 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, see SENSOR-TO-TCM CONNECTOR TERMINAL IDENTIFICATION table.

SENSOR-TO-TCM CONNECTOR TERMINAL IDENTIFICATION

Gear Position Sensor Terminal No. (1) (2)	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.

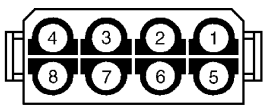

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Fig. 9: Identifying Gear Position Sensor Connector Terminals
Courtesy of Volvo Cars of North America.

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.

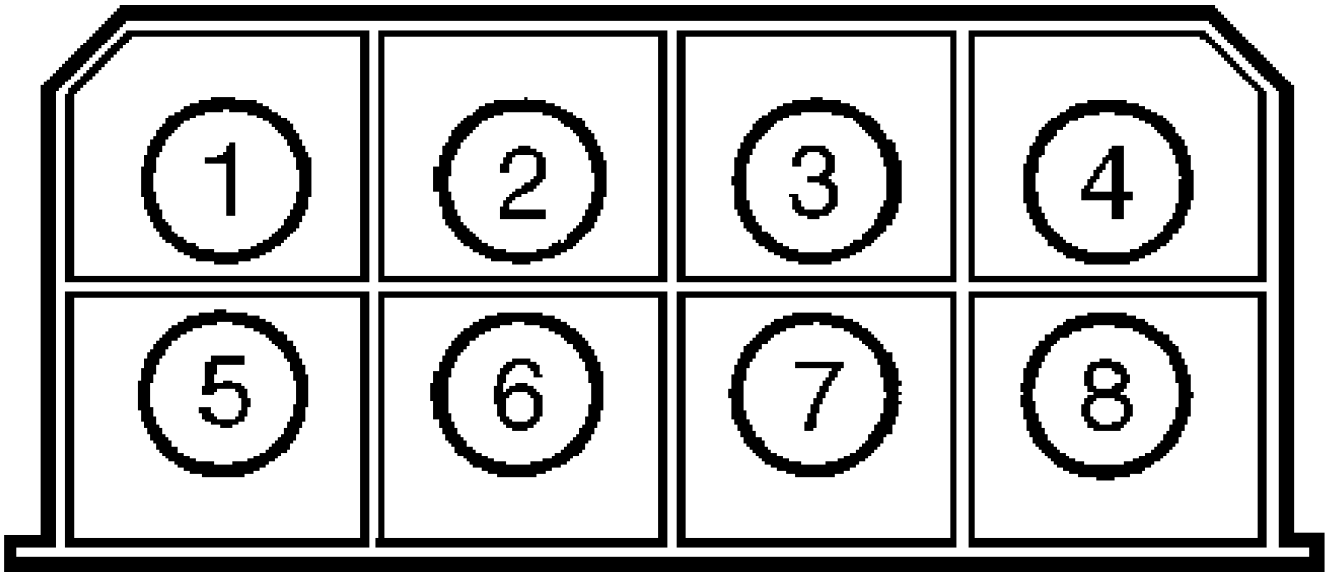

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Fig. 10: Identifying Solenoid Connector Terminals
Courtesy of Volvo Cars of North America.

TCM WIRING CIRCUITS

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 TCM CONNECTOR TERMINAL IDENTIFICATION table.

TCM CONNECTOR TERMINAL IDENTIFICATION

Terminal No. (1) (2)	Component

Connector "A"

3	Line Pressure Solenoid
4	Line Pressure Solenoid Ground
6	Oil Temperature Sensor
7	Oil Temperature Sensor Ground
8	No. 1 Shift Solenoid
9	No. 2 Shift Solenoid
11	Power Ground
12	Signal Ground
14	Battery Voltage Via Ignition Switch
16	Speed Sensor
17	Speed Sensor Ground
19	Gear Position Sensor
20	Gear Position Sensor
21	Gear Position Sensor
22	Gear Position Sensor
25	Kickdown Switch
26	Lock-Up Solenoid
30	Battery Power

Connector "B"

1	Throttle Valve
2	Warning Indicator Light
4	Diagnostic Output
5	TCM Response Signal
6	Torque Limiting TC2
7	Torque Limiting TC1
8	Speedometer
9	Mode Selector Switch
10	Brake Lights
11	Mode Selector Switch
15	Gear Position Sensor
16	Engine Load

(1) - For terminal locations, See Fig. 11.
(2) - Terminals not listed are blank.

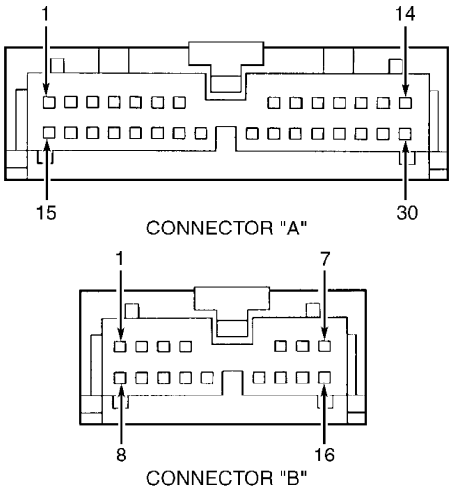

Fig. 11: Identifying TCM Connector Terminals
Courtesy of Volvo Cars of North America.

WIRING DIAGRAM

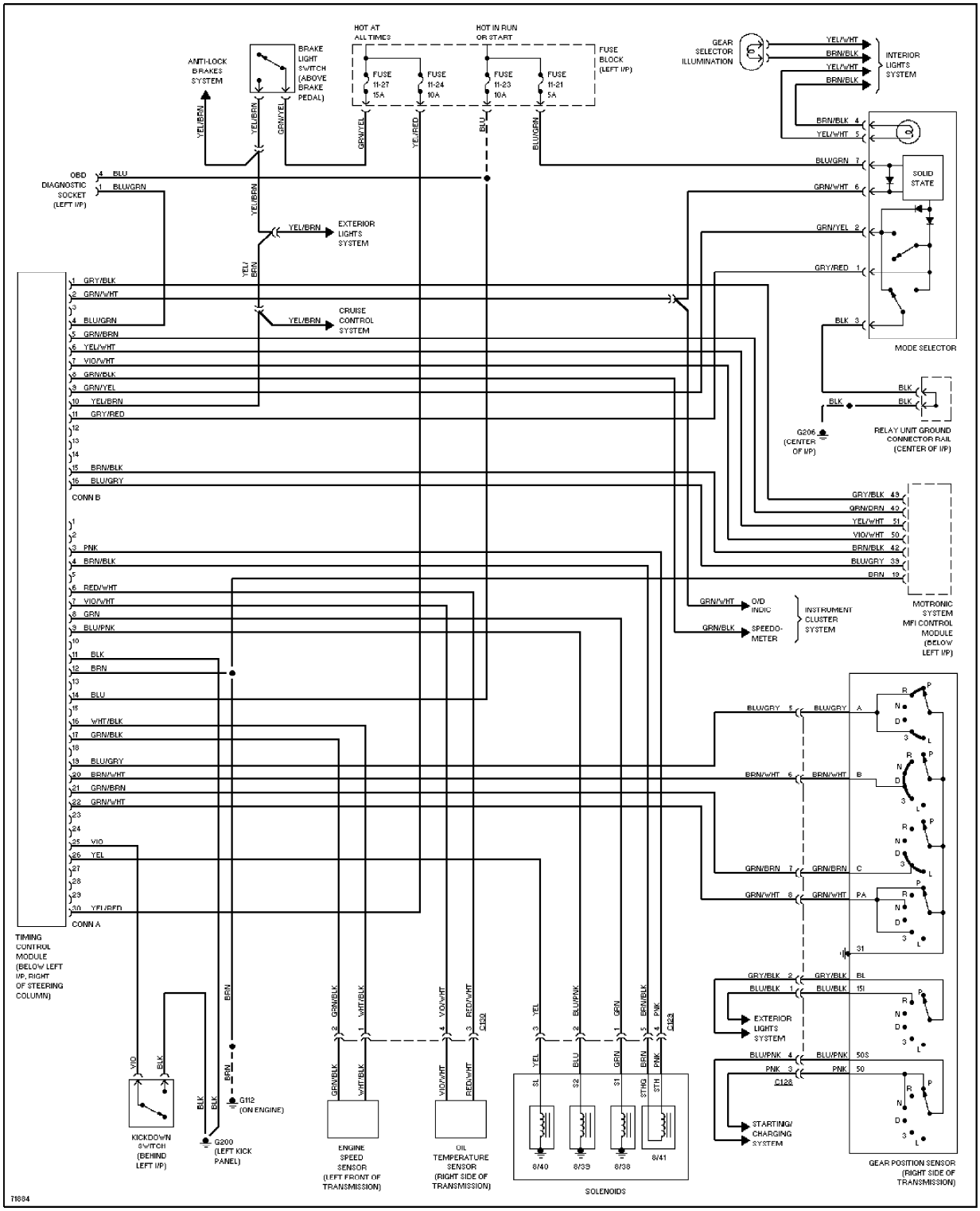

Fig. 12: Transmission Wiring Diagram (AW-40 Series)