

SECTION 7A-14A HYDRA-MATIC 4L60-E AUTOMATIC TRANSMISSION DIAGNOSIS

RPO M30

CONTENTS

General Information	7A-14A- 1	Transmission Fluid Checking	
How to Use This Section	7A-14A- 1	Procedure	7A-14A-16
Transmission Definitions and		Line Pressure Check Procedure	7A-14A-17
Abbreviations	7A-14A- 1	Electrical/Garage Shift Test	7A-14A-18
Throttle Positions	7A-14A- 1	Road Test Procedure	7A-14A-20
Shift Conditions	7A-14A- 1	Torque Converter Clutch (TCC) Diagnosis ..	7A-14A-20
Noise Conditions	7A-14A- 2	Torque Converter Evaluation	7A-14A-20
Abbreviations	7A-14A- 2	TCC Shudder	7A-14A-21
Transmission General Description	7A-14A- 2	Flexplate/Torque Converter Vibration	
Transmission Component and System		Test Procedure	7A-14A-22
Descriptions	7A-14A- 3	Shift Speed Chart	7A-14A-33
Transmission Adapt Function	7A-14A- 3	Internal Wiring Harness Check	7A-14A-34
Electronic Component Location		Component Resistance Chart	7A-14A-36
Views	7A-14A- 5	Pressure Switch Assembly	
Transmission Electrical Connector	7A-14A- 9	Resistance Check	7A-14A-37
Range Reference Chart	7A-14A-10	Diagnosis Charts	7A-14A-40
Diagnosis	7A-14A-11	Fluid Leak Diagnosis	7A-14A-50
Basic Knowledge Required	7A-14A-11	Leak Inspection Points	7A-14A-51
Special Tools	7A-14A-11 & 85	Fluid Flow and Circuit Descriptions	7A-14A-52
Functional Test Procedure	7A-14A-12	Fluid Passage Identification	7A-14A-76
Trouble Code Actions	7A-14A-14		

GENERAL INFORMATION

HOW TO USE THIS SECTION

This section provides general information on transmissions, a detailed description of the operation of the HYDRA-MATIC 4L60-E and procedures for diagnosing the HYDRA-MATIC 4L60-E. When diagnosing any condition on the HYDRA-MATIC 4L60-E, begin with the "HYDRA-MATIC 4L60-E Functional Test Procedure" in this section. After the cause of a condition is determined, refer to SECTION 7A-14B, "ON-VEHICLE SERVICE" for repair procedures.

TRANSMISSION DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations are provided to establish a common language for describing transmission related conditions. These terms are used in SECTION 7A-14B.

Throttle Positions

- Minimum Throttle – the least amount of throttle opening required for an upshift.

- Light Throttle – approximately 1/4 of accelerator pedal travel. (25% Throttle Position)
- Medium Throttle – approximately 1/2 of accelerator pedal travel. (50% Throttle Position)
- Heavy Throttle – approximately 3/4 of accelerator pedal travel. (75% Throttle Position)
- Wide Open Throttle (WOT) – full travel of the accelerator pedal. (100% Throttle Position)
- Full Throttle Detent Downshift – a quick apply of the accelerator pedal to its full travel, forcing a downshift.
- Zero Throttle Coastdown – a full release of the accelerator pedal while the car is in motion and in drive range.
- Engine Braking – a condition where the engine is used to slow the car by manually downshifting during a zero throttle coastdown.

Shift Conditions

- Bump – a sudden and forceful apply of a clutch or band.
- Chuggle – a bucking or jerking may be most noticeable when the converter clutch is engaged; similar to the feel of towing a trailer.

- Delayed – a condition where a shift is expected but does not occur for a period of time. Samples of this could be described as clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator or, when manually downshifting to a lower range. Also defined as “LATE” or “EXTENDED”.
- Double Bump (Double Feel) – two sudden and forceful applies of a clutch or band.
- Early – a condition where the shift occurs before the car has reached proper speed. Tends to labor the engine after the upshift.
- End Bump – a firmer feel at the end of a shift as compared to the feel at the start of the shift. Also defined as “END FEEL” or “SLIP BUMP”.
- Firm – a noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. Should not be confused with “HARSH” or “ROUGH”.
- Flare – a quick increase in engine rpm along with a momentary loss of torque. This most generally occurs during a shift. Also defined as “SLIPPING”.
- Harsh (Rough) – a more noticeable apply of a clutch or band as compared with “FIRM”. This condition is considered undesirable at any throttle position.
- Hunting – a repeating quick series of upshifts and downshifts that causes a noticeable change in engine rpm. An example could be described as a 4-3-4 shift pattern. Also defined as “BUSYNESS”.
- Initial Feel – a distinct firmer feel at the start of a shift as compared to the finish of the shift.
- Late – a shift that occurs when the engine is at a higher than normal rpm for a given amount of throttle.
- Shudder – a repeating jerking condition similar to “CHUGGLE” but more severe and rapid. This condition may be most noticeable during certain ranges of car speed.
- Slipping – a noticeable increase in engine rpm without a car speed increase. A slip usually occurs during or after initial clutch or band apply.
- Soft – a slow, almost unnoticeable clutch or band apply with very little shift feel.
- Surge – a repeating engine related condition of acceleration and deceleration that is less intense than “CHUGGLE”.
- Tie-Up – a condition where two opposing clutches and/or bands are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine rpm.

Noise Conditions

- Planetary Gear Noise – a whine related to car speed most noticeable in first gear or reverse. Becomes less noticeable after an upshift.
- Pump Noise – a high pitch whine that increases with engine rpm.

Abbreviations

- PCM – Powertrain Control Module.
- TCC – Torque Converter Clutch.
- TP Sensor – Throttle Position Sensor.
- ECT Sensor – Engine Coolant Temperature Sensor.
- VS Sensor – Vehicle Speed Sensor.
- RWD – Rear Wheel Drive.
- 2WD – 2 Wheel Drive.
- 4WD – 4 Wheel Drive.
- PSA – Transmission Fluid Pressure Switch Assembly.
- TTS – Transmission Temperature Sensor

TRANSMISSION GENERAL DESCRIPTION

The HYDRA-MATIC 4L60-E is a fully automatic rear wheel drive electronically controlled transmission. It provides four forward ranges including overdrive, and reverse. Shift points are controlled by the PCM via two shift solenoids. Oil pressure is supplied by a vane type oil pump, and regulated by the PCM with a transmission pressure control solenoid (force motor). Shift schedules and TCC apply rates are also controlled by the PCM and are influenced by transmission temperature.

The transmission can be operated in any one of the following seven modes:

P – Park position prevents the vehicle from rolling either forward or backward. (For safety reasons the parking brake should be used in addition to the park position.)

R – Reverse allows the vehicle to be operated in a rearward direction.

N – Neutral allows the engine to be started and operated while driving the vehicle. If necessary this position may be selected if the engine must be restarted with the vehicle moving.

D – Overdrive is used for all normal driving conditions. It provides four gear ratios plus converter clutch operation. Downshifts are available for safe passing by depressing the accelerator.

D – Drive position is used for city traffic and hilly terrain. It provides three gear ranges. Again, downshifts are available by depressing the accelerator.

2 – Manual second is used to provide acceleration, engine braking, or greater traction from a stop. When manual second is chosen, the vehicle will start out and remain in second gear. This range may be selected at any vehicle speed.

1 – Manual Lo is used to provide maximum engine braking. This range may also be selected at any vehicle speed.

TRANSMISSION COMPONENT AND SYSTEM DESCRIPTIONS

The mechanical components of this unit are:

- Torque converter with converter clutch (TCC)
- Vane type oil pump
- Five multiple disc clutches
- 2-4 band assembly
- Two planetary gear sets
- One sprag clutch
- One roller clutch
- Control valve assembly

The electrical components of this unit are:

- Two shift solenoids
- 3-2 downshift solenoid
- Transmission pressure control solenoid (force motor)
- Torque converter clutch solenoid and wiring harness assembly
- Transmission fluid temperature sensor
- Fluid pressure switch assembly
- Vehicle speed sensor (2WD only)

Refer to Figure 1 for component locations. Refer to Range Reference Chart Figure 7 for component operation in all seven modes of transmission operation. Refer to Figures 2-6 for detailed descriptions of electrical components.

Transmission Adapt Function

The HYDRA-MATIC 4L60-E uses a line pressure control system which has the ability to adapt the system's line pressure to compensate for normal wear of clutch fiber plates, seals, springs, etc. This "learning" feature is similar to what is used for fuel control (integrator/block learn).

The HYDRA-MATIC 4L60-E transmission only uses the adapt function for the 1-2 upshift. The PCM monitors engine speed to determine if the shift is occurring too fast (harsh) or too slow (soft) and adjusts the pressure control solenoid to maintain the correct shift feel. The line pressure can adapt to values ranging from 5 psi below, to 10 psi above normal line pressure.

HYDRA-MATIC 4L60-E

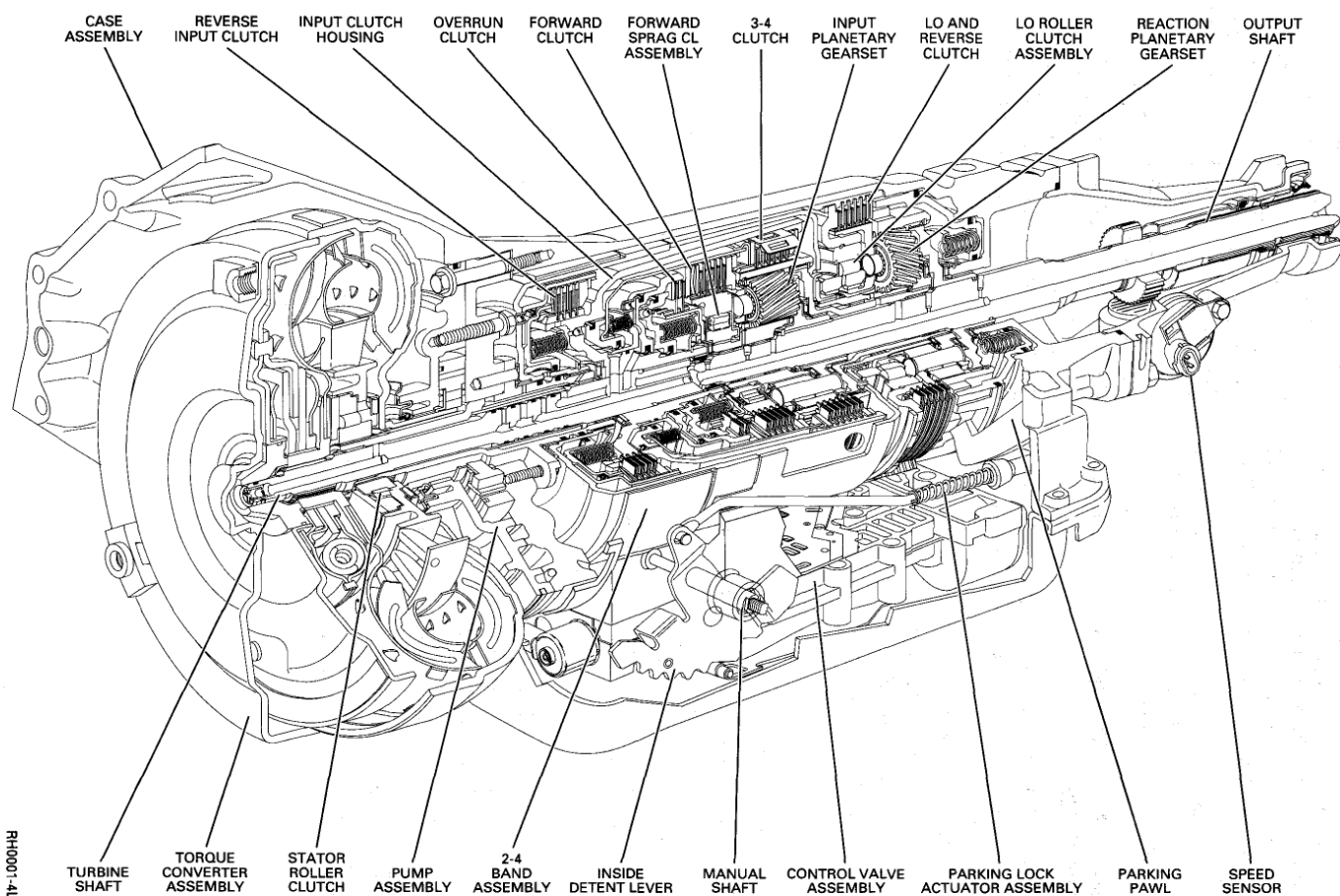


Figure 1 HYDRA-MATIC 4L60-E Transmission

RH0001-4L60-E

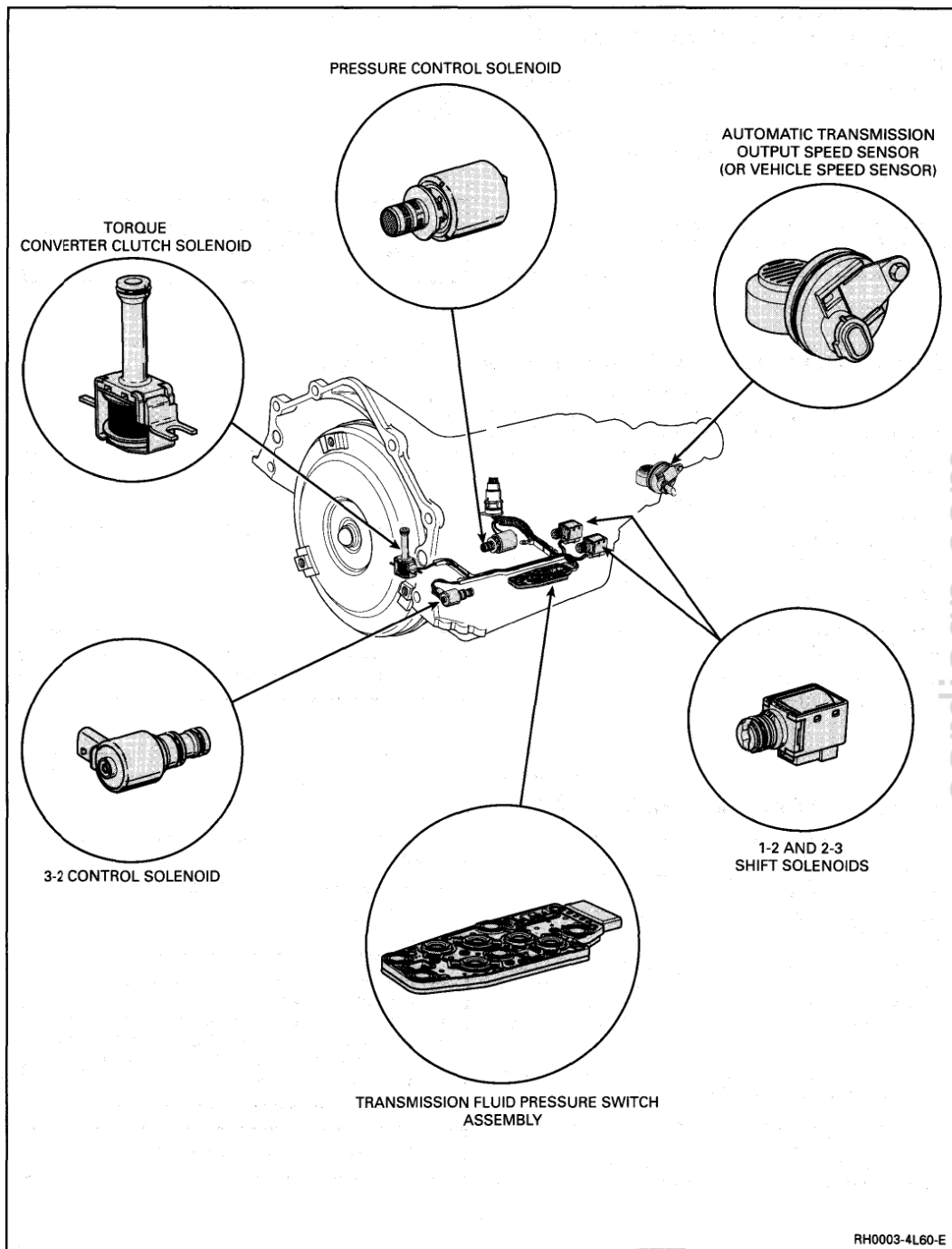


Figure 2 Electronic Component Location Views

Torque Converter Clutch Solenoid

The torque converter clutch solenoid is a normally open exhaust valve that is used to control torque converter clutch apply and release.



When grounded (energized) by the PCM, the TCC solenoid stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and shift the TCC valve to shift into the apply position

The brake switch is an input to the PCM, and the PCM directly controls TCC apply based on the brake switch status.

If a fault is detected in the TCC circuit, code 067 or 069 will set.

TCC solenoid resistance should be 20-40 ohms minimum when measured at 20°C (68°F).

Transmission Pressure Control Solenoid



The transmission pressure control solenoid (or force motor) is an electronic pressure regulator that controls pressure based on current flow through its coil winding. The magnetic field produced by the coil moves the solenoid's internal valve which varies pressure to the pressure regulator valve.

The PCM controls the pressure control solenoid by commanding current between 0 and 1.1 amps. This changes the duty cycle of the solenoid, which can range between 0 % and 60 %. 1.1 amps corresponds to minimum line pressure, and 0 amps is maximum line pressure (if solenoid loses power, transmission will still have maximum line pressure).

Line pressure values are calculated by the PCM using inputs such as the throttle position sensor.

The pressure control solenoid takes the place of the throttle valve that was used on past model transmissions.

If there is a difference between the amperage commanded by the PCM and the actual amperage, diagnostic trouble code 073 will set.

Unlike the pressure control solenoid on the HYDRA-MATIC 4L80-E, the 4L60-E pressure control solenoid does not pulse every 10 seconds for a cleaning cycle.

Force High	Force Low	Line Pressure
+ 0% Duty Cycle	0 Amps	Maximum
+ 60% Duty Cycle	1.1 Amps @ 4-5 V	Minimum

Transmission Pressure Control Solenoid resistance should measure 3.5 - 8 ohm when measured at 20°C (68°F).

1-2 and 2-3 Shift Solenoids



The 1-2 and 2-3 shift solenoids (also called A and B solenoids) are identical solenoid devices that control the movement of the 1-2 and 2-3 shift valves (the 3-4 shift valve is not directly controlled by a shift solenoid). The solenoids are normally open exhaust valves that work in four combinations to shift the transmission into different gears (see chart).

The PCM energizes each solenoid by grounding it through an internal quad driver. This sends current through the coil winding in the solenoid and moves the internal plunger out of the exhaust position. When 'ON', the solenoid redirects fluid to move a shift valve.

PCM controlled shift solenoids eliminate the need for TV and governor pressures to control shift valve operation.

Note: The manual valve can hydraulically override the shift solenoids. Only in D4 are the shift solenoid states totally determining what gear the transmission is in. In the other manual valve positions, the transmission shifts hydraulically and the shift

solenoid states 'catch up' when throttle position and vehicle speed fall into the correct ranges.

Diagnostic trouble codes 081 and 082 indicate shift solenoid circuit voltage faults.

Shift solenoid resistance should measure 20-40 ohms minimum when measured at 20°C (68°F). Shift solenoid current flow should not exceed 0.75 amps. The shift solenoid should energize at a voltage of 7.5 volts or more (measured across the terminals). The shift solenoid should de-energize when voltage is one volt or less.

If both solenoids lose power, third gear only will result.

RH0004-4L60-E

Figure 3 Electronic Component Descriptions

Transmission Fluid Pressure Switch Assembly



The transmission fluid pressure switch assembly (PSA) is a set of five pressure switches on the valve body that sense whether fluid pressure is present in five different valve body passages. The combination of which switches are open and closed is used by the PCM to determine actual manual valve position. The PSA assembly however cannot distinguish between Park and Neutral because the monitored valve body pressures are identical in both cases.

The switches are wired to provide three signal lines that are monitored by the PCM. These inputs are used to help control line pressure, torque converter clutch apply and shift solenoid operation. Voltage at each of the signal lines will be either zero or twelve volts.

To monitor PSA assembly operation, the PCM compares the actual voltage combination of the switches to a PSA combination chart stored in its memory. If the PCM sees one of two 'illegal' voltage combinations (see chart) a code 028 will result.

PSA assembly signal voltage can be measured from each pin to ground, and compared to the combination chart. On the transmission wiring harness, pin N is 'range signal A', pin R is 'range signal B', and pin P is 'range signal C'. With the wiring harness connected and engine running, a voltage measurement of these three lines will indicate a 'high' reading (near 12 volts) when a circuit is open, and a low (zero volts) when the circuit is switched to ground.

The transmission temperature sensor is part of the transmission fluid pressure switch assembly.

Seven valid combination and two invalid combinations are available from the TPS: Valid combinations for Circuits A, B and C are shown below. Invalid combinations are A=0V, B=0V AND C=0V; OR A=0V, B=12V AND C=0V.

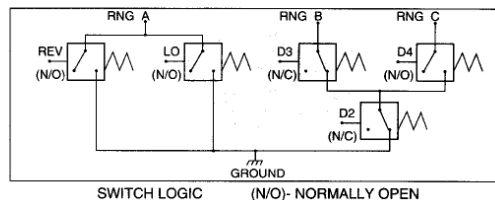
RANGE INDICATOR	OIL PRESSURE				
	REV	D4	D3	D2	LO
PARK					
REVERSE					
NEUTRAL					
D4					
D3					
D2					
D1					

OIL PRESSURE PRESENT

VALID TPS COMBINATION CHART

	"A"	"B"	"C"
PARK	12	0	12
REVERSE	0	0	12
NEUTRAL	12	0	12
D4	12	0	0
D3	12	12	0
D2	12	12	12
D1	0	12	12
ILLEGAL	0	12	0
ILLEGAL	0	0	0

EXPECTED VOLTAGE READINGS



Vehicle Speed Sensor



The vehicle speed sensor (or transmission output speed sensor) is used to control shift points and calculate TCC slip.

The speed sensor contains a coil that gives off a continuous magnetic field. A rotor rotates past the sensor, and the rotor teeth break the magnetic field. Each break in the field sends a pulse to the VSSB (Vehicle Speed Sensor Buffer). The VSSB sends two signals to the PCM, the first is a 2002 pulse per mile (PPM) signal used by the engine. The second is the transmission/transfer case 40 pulse per revolution (PPR) signal used to control the transmission.

In two wheel drive (2WD) applications, the vehicle speed sensor is located on the transmission extension housing.

Sensor resistance should be 1260-1540 ohms when measured at 20°C (68°F). Output voltage will vary with speed from a minimum of 0.5 Volts AC at 100 RPM, to more than 100 Volts AC at 8000 RPM.

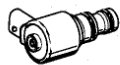
Four wheel drive (4WD) applications use a vehicle speed sensor located on the transfer case.

In 2WD or 4WD Hi, trans output speed = transfer case speed

In 4WD Lo, trans output speed = transfer case speed x constant

Codes 024 or 072 will set if a fault exists in the vehicle speed sensor circuit 40 PPR line.

3-2 Control Solenoid



The 3-2 control solenoid is a pulse width modulated solenoid used to improve the 3-2 downshift. The solenoid regulates the release of the 3-4 clutch and 2-4 band apply.

The solenoid uses duty cycle to regulate pressures that smoothly release the clutch and apply the band. Duty cycle is normally about 0% in first gear, 90% in all other drive gears and drops during the 3-2 downshift. Throttle position, vehicle speed and the commanded gear are used to determine duty cycle.

3-2 Control solenoid resistance should be a minimum of 9-14 ohms at 20°C (68°F). It is operated using pulse width modulation at a frequency of 50 Hz.

If a voltage fault is detected in the 3-2 control solenoid circuit, diagnostic trouble code 066 will set.

PH0005-4L60-E-R1

Figure 4 Electronic Component Descriptions

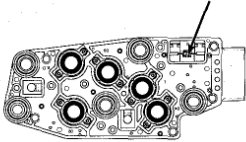
Transmission Fluid Temperature Sensor

The transmission fluid temperature sensor is part of the transmission fluid pressure switch assembly and is used to help control torque converter clutch apply and shift quality.

The temperature sensor is a resistor (thermister) which changes value based on temperature. At low temperatures the resistance is high, and at high temperatures the resistance is low.

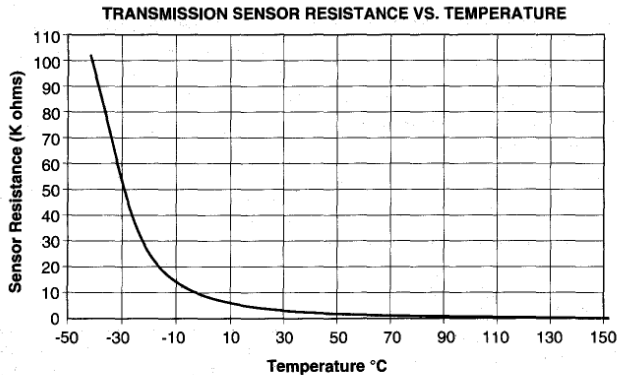
The PCM sends a 5 volt signal to the temperature sensor and measures the voltage drop in the circuit. This means you will measure a high voltage when the transmission is cold, and a low voltage when the transmission is hot.

If the temperature sensor circuit has a fault, code 058 or 059 will set. Code 079 will set if the transmission is operating at a high temperature for a period of time.



TRANSMISSION SENSOR – TEMPERATURE TO RESISTANCE TO VOLTAGE (approximate)

°C	°F	RESISTANCE	VOLTS
-40	-40	100544	5
-28	-21	52426	4.78
-16	10	18580	4.18
-4	23	12300	3.84
0	32	9379	3.45
7	40	7270	3.20
19	68	3520	2.56
31	86	2232	1.80
43	110	1200	1.10
55	131	858	3.25
67	145	675	2.88
79	176	333	2.24
91	194	241	1.70
103	213	154	1.28
115	239	115	.96
127	260	79	.64
139	284	60	.32
151	302	47	.00



RH0006-4L60-E

Figure 5 Electronic Component Descriptions

cardiagn.com

TRANSMISSION ELECTRICAL CONNECTOR

The transmission electrical connector is a very important part of the HYDRA-MATIC 4L60-E operating system. Anything that interferes with the electrical connection can cause the transmission to set Diagnostic Trouble Codes and/or operate incorrectly.

The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped (in either the transmission or vehicle wiring harness)
- Dirt contamination entering the connector when it is unconnected
- Pins in the connector backing out of the connector or pushed out during connection
- Excessive transmission fluid leaking into the connector, wicking up into the vehicle wiring harness and degrading the wire insulation *
- Water/moisture intrusion in the connector
- Low pin retention from excessive connection and disconnection of the wiring harness
- Pin corrosion from contamination

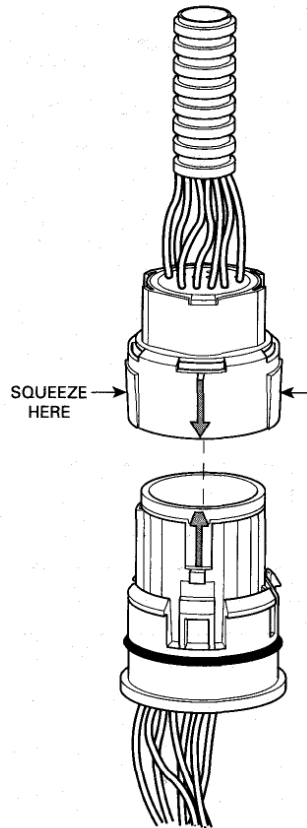
* The presence of transmission fluid in the transmission connector is not harmful in itself. The fluid only affects the vehicle harness wiring insulation if the fluid wicks up that far.

Points to remember when working with the transmission electrical connector:

- To remove the connector, squeeze the two tabs towards each other and pull straight up (See illustration).
- Carefully limit twisting or wiggling the connector during removal. This can bend pins.
- DO NOT pry the connector off with a screwdriver or other tool.
- To install the connector, first orient the pins by lining up the arrows on each half of the connector. Push the connector straight down into the transmission without twisting or angling the mating parts.
- The connector should click into place with a positive feel and/or noise.
- Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple Diagnostic Trouble Codes will set. Be sure to clear these codes after re-connecting the pass-thru connector.

DTC's 59, 67 and 82 will set with key on, engine off.

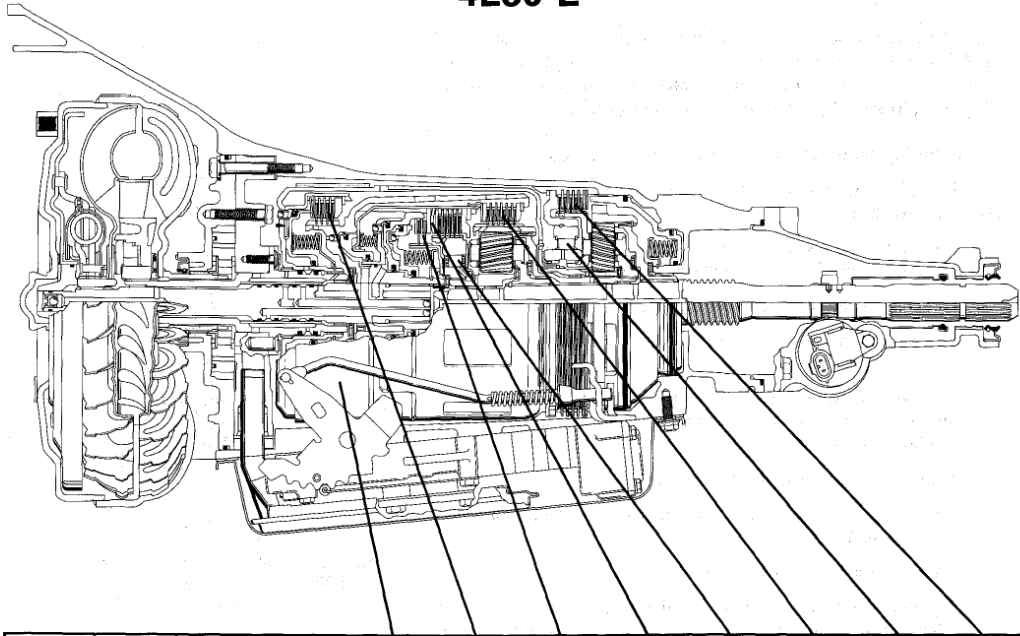
DTC's 59, 66, 67, 73 and 82 will set with key on, engine on.



PH0220-4L60-E

Figure 6 Transmission Electrical Connector

4L60-E



RANGE	GEAR	SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
		1-2	2-3								
PARK		ON*	ON*								APPLIED
REVERSE		ON*	ON*		APPLIED						APPLIED
NEUTRAL		ON*	ON*								
D	1st	ON	ON				APPLIED	HOLDING		HOLDING	
	2nd	OFF	ON	APPLIED			APPLIED	HOLDING			
	3rd	OFF	OFF				APPLIED	HOLDING	APPLIED		
	4th	ON	OFF	APPLIED			APPLIED		APPLIED		
D	1st	ON	ON				APPLIED	HOLDING		HOLDING	
	2nd	OFF	ON	APPLIED			APPLIED	HOLDING			
	3rd	OFF	OFF			APPLIED	APPLIED	HOLDING	APPLIED		
2	1st**	ON	ON			APPLIED	APPLIED	HOLDING		HOLDING	
	2nd	OFF	ON	APPLIED		APPLIED	APPLIED	HOLDING			
1	1st	ON	ON			APPLIED	APPLIED	HOLDING		HOLDING	APPLIED
	2nd***	OFF	ON	APPLIED		APPLIED	APPLIED	HOLDING			

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

** MANUAL SECOND – FIRST GEAR IS ELECTRONICALLY PREVENTED UNDER NORMAL OPERATING CONDITIONS.

*** MANUAL FIRST – SECOND GEAR IS ONLY AVAILABLE ABOVE APPROXIMATELY 48 TO 56 KM/H (30 TO 35 MPH).

Figure 7 Range Reference Chart

DIAGNOSIS

NOTICE: If a wire is probed with a sharp instrument and not properly sealed afterward, the wire will corrode and an open circuit will result.

Diagnostic test probes are now available that allow you to probe individual wires without leaving the wire open to the environment. These probe devices are inexpensive and easy to install, and they permanently seal the wire from corrosion.

BASIC KNOWLEDGE REQUIRED (Refer to 6E)

You must be familiar with some basic electronics to use this section of the Service Manual. They will help you to follow diagnostic procedures.

NOTICE: Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in incorrect diagnostic performance or damage to powertrain components. Do not, under any circumstances, attempt to diagnose a powertrain problem without this basic knowledge.

Special Tools

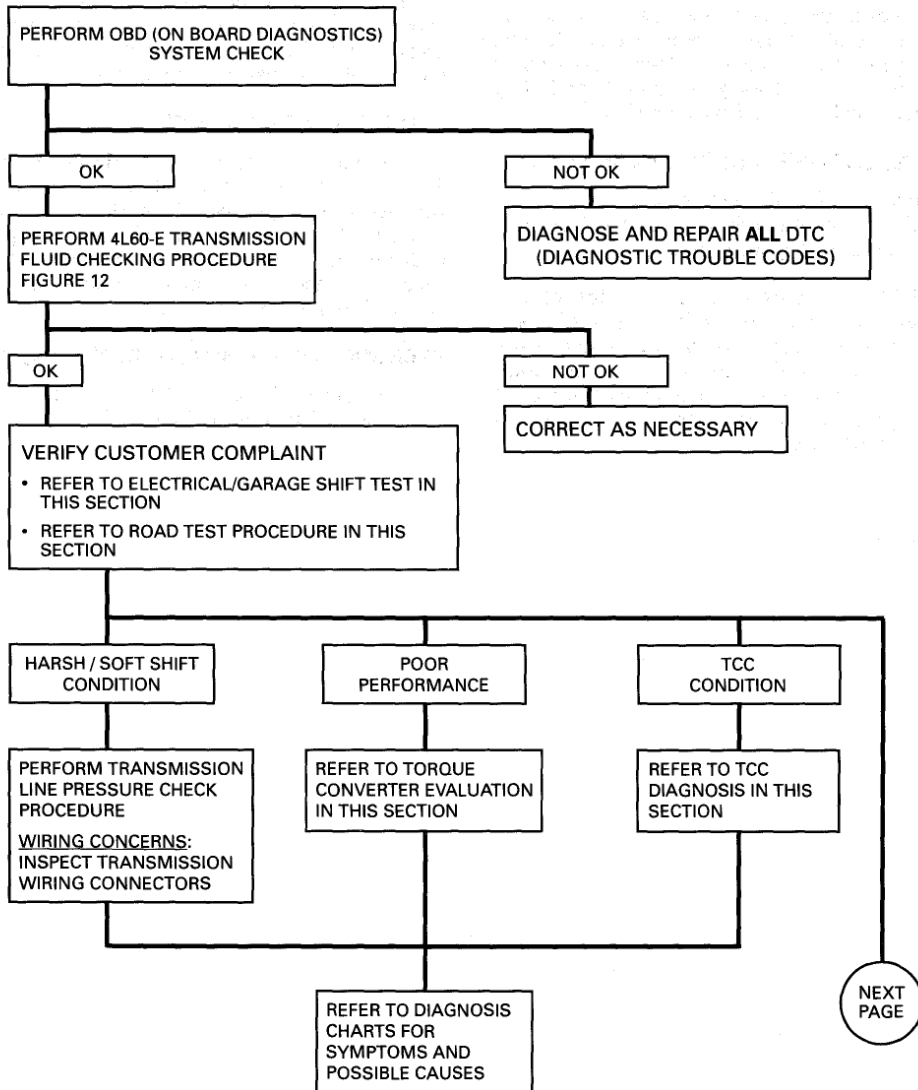
You should be able to use a Digital Volt Meter (DVM), a circuit tester, jumper wires or leads and a line pressure gage set. The functional test procedures given in Figures 8 and 9 are designed to verify the correct operation of electronic components in the transmission. This will eliminate the unnecessary removal of transmission components.

QUICK CHECK PROCEDURE

When diagnosing any HYDRA-MATIC 4L60-E related condition, always begin with the functional test procedure in this section. The functional test procedure will indicate the proper path of diagnosing the transmission by describing the basic checks and then referencing the locations of specific checks. Refer to Figures 8 and 9.

TRANSMISSION FLUID CHECKING PROCEDURE

Whenever checking HYDRA-MATIC 4L60-E transmission fluid refer to Figure 12.

**4L60-E TRANSMISSION
FUNCTIONAL TEST (1 of 2)**

RH0011-4L60-E

Figure 8 Transmission Functional Test (1 of 2)

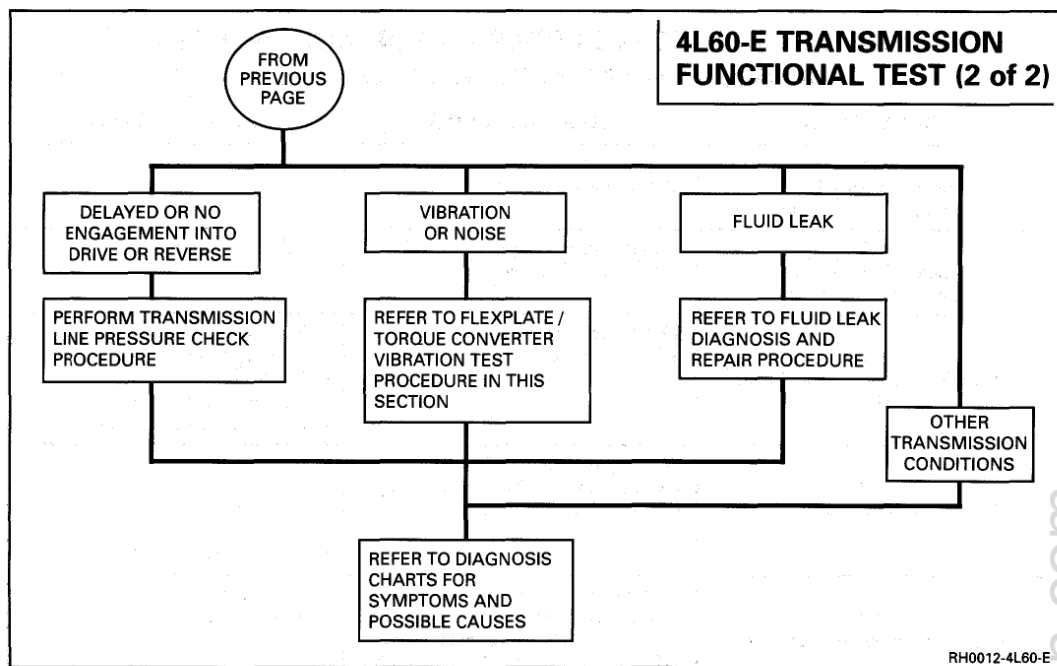


Figure 9 Transmission Functional Test (2 of 2)

DIAGNOSTIC TROUBLE CODES AND DEFAULT ACTIONS

Refer to Section 6E3 to Diagnose Trouble Codes.

TROUBLE CODE	CODE PARAMETERS	DEFAULT ACTION
14 Engine Coolant Temp Sensor Circuit (High)	Engine coolant temp over 151°C (306°F) for 1/2 second.	• TCC apply cold.
15 Engine Coolant Temp Sensor Circuit (Low)	Engine coolant temp less than -40°C (-40°F) for 1/2 second.	• TCC apply cold.
21 Throttle Position Sensor Circuit (High)	TP voltage greater than 4.88 volts for four seconds.	• No TCC. • Fixed shift points. • Harsh shifts. • Maximum line pressure. • No fourth gear in hot mode.
22 Throttle Position Sensor Circuit (Low)	With engine running, TP voltage less than .06 volts for four seconds. (Diesel is less than .16 volts.)	• No TCC. • Fixed shift points. • Harsh shifts. • Maximum line pressure. • No fourth gear in hot mode.
24 Vehicle Speed Sensor Signal Low	In Drive or Reverse with engine speed greater than 3000 rpm, output speed is less than 250 rpm for three seconds. (MAP is 100-255 kPa, TP is 10-100%)	• Maximum line pressure. • Second gear only.
28 Fluid Pressure Switch Assembly Fault	PCM detects one of two "invalid" combinations of PSM signals for five seconds.	• No TCC. • Harsh shifts. • No fourth gear in hot mode. • No 2nd gear in D2.
37 Brake Switch Stuck "ON"	With brake on, vehicle speed is 5-20 mph for six seconds, then vehicle speed is >20 mph for six seconds. After vehicle speed is < 5 mph. This must happen seven times.	• No TCC. • No fourth gear in hot mode.
38 ⁽¹⁾ Brake Switch Stuck "OFF"	With brake off, vehicle speed is >20 mph for six seconds, then vehicle speed is 5-20 mph for six seconds. After vehicle speed is < 5 mph. This must happen seven times.	• No TCC. • No fourth gear in hot mode.
53 System Voltage High	Generator voltage is greater than 19.5 volts for two seconds.	• No TCC. • Maximum line pressure. • Third gear only.
58 Transmission Fluid Temp Sensor Circuit (High)	Transmission fluid temperature is greater than 151°C (306°F) for one second.	• No default action.
59 Transmission Fluid Temp Sensor Circuit (Low)	Transmission fluid temperature is below -40°C (-40°F) for one second.	• No default action.

⁽¹⁾ Not used on 3.4L F-Cars.

RH0026-4L60-E-C

Figure 10 Trouble Chart Diagnosis Chart A

DIAGNOSTIC TROUBLE CODES AND DEFAULT ACTIONS

Refer to Section 6E3 to Diagnose Trouble Codes.

TROUBLE CODE	CODE PARAMETERS	DEFAULT ACTION
72 Vehicle Speed Sensor Loss	Two successive speed readings have a difference of more than 1000 RPM. (Difference must be more than 1500 RPM in P and N.)	- Maximum line pressure. - Soft landing second gear only. - No TCC.
73 ⁽¹⁾ Pressure Control Solenoid Current 93 ⁽²⁾	Pressure control solenoid return amperage varies more than .16 amp from commanded amperage for one second.	- Harsh shifts. - Maximum line pressure.
74 ⁽¹⁾ TCS/ASR Circuit Low	ASR active for five seconds.	- Inhibit TCC operation. - Inhibit 4th gear, if not in Hot mode.
75 ⁽¹⁾ System Voltage Low 96 ⁽²⁾	System voltage is less than 7.3 V at low temps and less than 11.7 V at high temps for four seconds.	- No TCC. - Maximum line pressure. - Third gear only.
79 Transmission Fluid Overtemp	Transmission temp is higher than 146°C (302°F) for 30 minutes.	
80 Trans Component Slipping	Slip > 100 RPM, TCC Mode = Locked, Gear = 2, 3, or 4, Gear selector in D3 or D4, No code 28; 0 < TPS < 3.5% Transmission temp is between 60-100°C. This must happen for at least 10 seconds.	- Inhibit TCC Operation. - Maximum line pressure. - Inhibit 4th gear if not in Hot mode.
81 ⁽¹⁾ 2-3 Shift Solenoid Circuit Fault	2-3 Shift Solenoid is commanded "ON" by PCM but circuit voltage is high for two seconds OR 2-3 Shift Solenoid is commanded "OFF" by PCM but circuit voltage is low for two seconds.	- No TCC. - Maximum line pressure. - Second or third gear only.
82 ⁽¹⁾ 1-2 Shift Solenoid Circuit Fault	1-2 Shift Solenoid is commanded "ON" by PCM but circuit voltage is high for two seconds OR 1-2 Shift Solenoid is commanded "OFF" by PCM but circuit voltage is low for two seconds.	- Maximum line pressure. - Second or third gear only - OR - First and fourth gears only.
84 3-2 Control Solenoid Circuit Fault ⁽¹⁾	At high duty cycle, the circuit voltage high -OR- at low duty cycle the circuit voltage is low for four seconds.	- Third gear only. - Soft landing to 3rd gear.
85 ⁽¹⁾ TCC Stuck "ON" 90 ⁽²⁾	With gear selector in a drive range, transmission in 2nd, 3rd or 4th, TP Sensor greater than 25% and TCC unlocked - slip is between -20 and 20 RPM.	- TCC "ON" in all gears. - Early shifts.
90 TCC Solenoid Circuit Fault ⁽¹⁾	TCC is commanded on, but circuit is high -OR- TCC is commanded off but circuit voltage is low for two seconds.	- No TCC. - No fourth gear in hot mode.

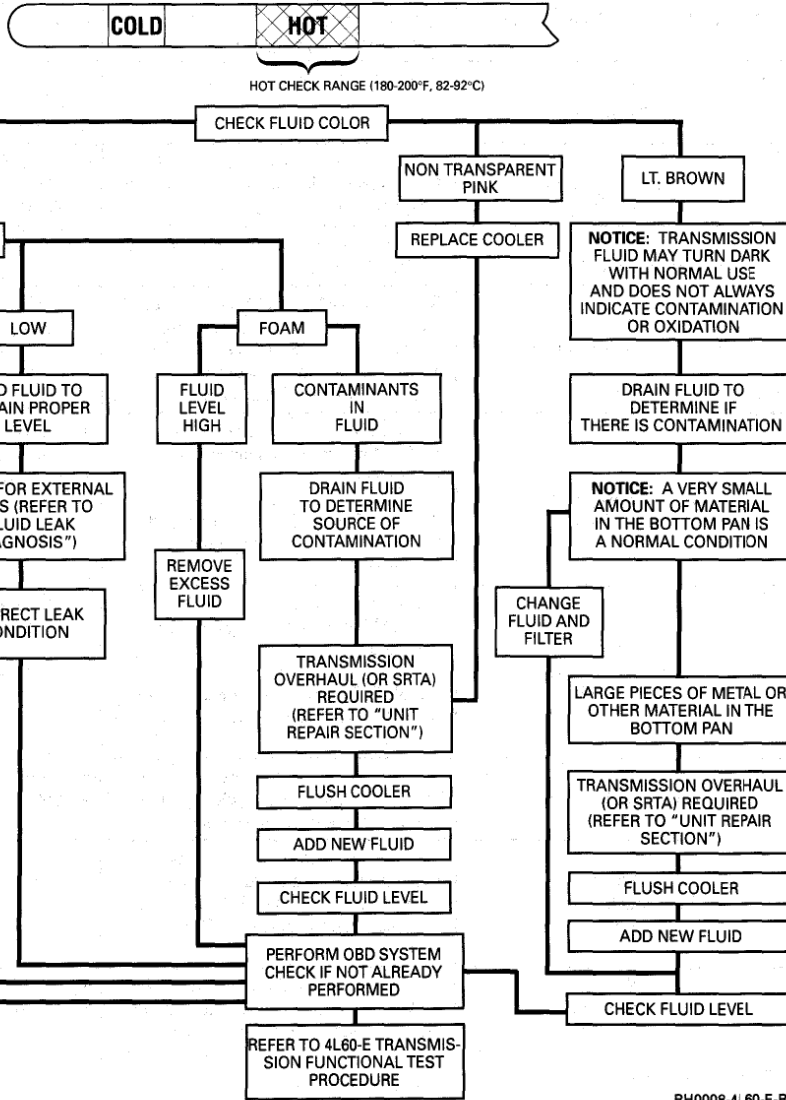
⁽¹⁾ Not used on 3.4L F-Cars.⁽²⁾ Used on 3.4L F-Cars only.

RH0027-4L60-E-C

Figure 11 Trouble Code Diagnosis Chart B

4L60-E TRANSMISSION FLUID CHECKING PROCEDURE

1. Warm the transmission to operating temperature by driving the vehicle about 15 miles (24 km). Operating temperature is 180-200°F (82-94°C).
 2. Park vehicle on a level surface, place shift lever in "P" park and apply the parking brake.
 3. Check fluid level on the dipstick (read the lower level).
 4. If fluid level is low, DEXRON®-III Automatic Transmissions Fluid is preferred, if unavailable DEXRON®-III-E is acceptable, add only enough to bring the fluid level into the hot area.
- * It is important to check fluid level when the transmission has reached operating temperature. The hot range is calibrated to correspond to the correct fluid level range for fluid between 180 and 200°F (82-94°C).



RH0008-4L60-E-R1

Figure 12 Fluid Checking Procedure

HYDRA-MATIC 4L60-E LINE PRESSURE CHECK PROCEDURE

Line pressures are calibrated for two sets of gear ranges – Drive-Park-Neutral and Reverse. This allows the transmission line pressure to be appropriate for different pressure needs in different gear ranges:

<u>Gear Range</u>	<u>Line Pressure Range</u>
Drive, Park or Neutral	55 - 189 PSI
Reverse	64 - 324 PSI

Before performing a line pressure check, verify that the pressure control solenoid is receiving the correct electrical signal from the PCM:

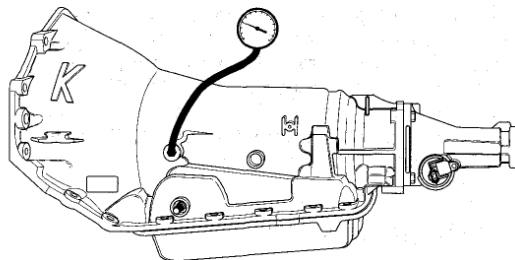
1. Install a scan tool.
2. Start the engine and set parking brake.
3. Check for a stored pressure control solenoid diagnostic trouble code, and other diagnostic trouble codes.
4. Repair vehicle if necessary.

Inspect

- Fluid level (see Section 7A)
- Manual linkage

Install or Connect

- TECH 1 Scan tool
- Oil pressure gage at line pressure tap



5. Put gear selector in Park and set the parking brake.
6. Start engine and allow it to warm up at idle.
7. Access the "PCS Control" test on the TECH 1 scan tool.
8. Increase DESIRED PCS in 0.1 Amp increments and read the corresponding line pressure on the pressure gage. (Allow pressure to stabilize for 5 seconds after each current change.)
9. Compare data to the Drive-Park-Neutral line pressure chart below.

*NOTICE

Total test running time should not exceed 2 minutes, or transmission damage could occur.

CAUTION

Brakes must be applied at all times to prevent unexpected vehicle motion.

If pressure readings differ greatly from the line pressure chart, refer to the Diagnosis Charts contained in this section.

The TECH 1 scan tool is only able to control the pressure control solenoid in Park and Neutral with the vehicle stopped. This protects the clutches from extremely high or low pressures in Drive or Reverse ranges.

<u>Pressure Control Solenoid Current (Amp)</u>	<u>Line Pressure (PSI)</u>
0.02	170 - 190
0.10	165 - 185
0.20	160 - 180
0.30	155 - 175
0.40	148 - 168
0.50	140 - 160
0.60	130 - 145
0.70	110 - 130
0.80	90 - 115
0.90	65 - 90
0.98	55 - 65

Pressures at 1500 RPM and 66°C (150°F). Line pressure drops as temperature increases.

PH0010-4L60-E-R1

Figure 13 Line Pressure Check Procedure

LINE PRESSURE CHECK PROCEDURE

This test can be performed during the hoist or road test. It is easier to check pressures during the hoist test because the tubing and pressure gage can remain outside of the vehicle, and won't be damaged by road conditions or debris. The technician can diagnose more quickly on the hoist since the driver doesn't have to watch the road.

The HYDRA-MATIC 4L60-E uses a vane type oil pump to produce hydraulic pressure, and a transmission pressure control solenoid (force motor) to control that pressure at the pressure regulator valve, after it leaves the pump. The transmission pressure control solenoid is controlled by an electrical signal that ranges from 0 to 1 amp. One amp corresponds to minimum line pressure (approx. 50 to 55 PSI not 0 PSI) and 0 amps corresponds to a maximum line pressure (approx. 265 to 290 PSI) in D. Refer to Figure 13 to perform line pressure test.

ELECTRICAL/GARAGE SHIFT TEST

This preliminary test should be performed before a hoist or road test to make sure electronic control inputs are connected and operating. If the inputs are not checked before operating the transmission, a simple electrical condition could be misdiagnosed as a major transmission condition.

A scan tool provides valuable information and must be used on the HYDRA-MATIC 4L60-E transmission for accurate diagnosis. Refer to Figure 15 for an example of Tech 1 information.

1. Move gear selector to "Park" (P) and set the parking brake.
2. Connect scan tool to DLC terminal.
3. Start engine.
4. Connect power to scan tool.
5. Verify that the following signals are present:
 - ENGINE SPEED
 - TRANS OUTPUT SPEED
 - VEHICLE SPEED
 - A/B/C RNG
 - PRNDL SELECT
 - DESIRED PCS
 - ACTUAL PCS
 - PCS DUTY CYCLE
 - BRAKE SWITCH
 - 4 WD LOW SWITCH (4WD Only)
 - ENG COOLANT TEMP
 - TRANS FLUID TEMP
 - THROTTLE ANGLE
 - SYSTEM VOLTS

6. Monitor the BRAKE SWITCH signal while tapping the brake pedal with your foot.
 - The BRAKE SWITCH should be on when the pedal is depressed, and come off when the brake pedal is released.
7. Monitor the PRNDL SELECT signal and move the gear selector through all the ranges.
 - Verify that the PRNDL SELECT value matches the gear range indicated on the instrument panel or console.
 - Gear selections should be immediate and not harsh.
8. Move gear selector to neutral and monitor the THROTTLE ANGLE signal while increasing and decreasing engine RPM with the accelerator pedal.
 - THROTTLE ANGLE should increase with engine RPM.

Upshift Control and Torque Converter Clutch (TCC) Apply

The PCM calculates upshift points based primarily on two inputs: THROTTLE ANGLE and VEHICLE SPEED. When the PCM says a shift should occur, an electrical signal is sent to the shift solenoids which in turn moves the valves to perform the upshift.

The shift speed charts reference THROTTLE ANGLE instead of "min throttle" or "wot" to make shift speed measurement more uniform and accurate. A scan tool should be used to monitor THROTTLE ANGLE. Some scan tools have been programmed to record shift point information. Check the instruction manual to see if this test is available. Refer to Figures 16, 17 and 18 for examples of Tech 1 information.

With gear selector in D4:

1. Look at the shift speed chart contained in this section and choose a percent throttle angle of 15 or 20. (Figure 24.)
2. Set up the scan tool to monitor THROTTLE ANGLE and VEHICLE SPEED.
3. Accelerate to the chosen throttle angle and hold the throttle steady.
4. As the transmission upshifts, note the shift speed and commanded gear changes for:
 - 2nd gear.
 - 3rd gear.
 - 4th gear.

**Important**

- Shift speeds may vary due to slight hydraulic delays responding to electronic controls. A change from the original equipment tire size also affects shift speeds.

Note when TCC applies. This should occur in third or fourth gear. If the apply is not noticed by an RPM drop, refer to the "Preliminary Torque Converter Clutch Diagnosis" information contained in this section.

The TCC should not apply unless the **transmission** has reached a minimum operating temperature of 18°C TRAN TEMP and engine coolant temp of 60°C.

- Repeat steps 1-4 using several different throttle angles.

Part Throttle Detent Downshift

At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, quickly increase throttle angle.

Verify that:

- TCC releases.
- Transmission downshifts to 3rd gear immediately.
- 1-2 Shift Solenoid turns off.

Full Throttle Detent Downshift

At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, quickly increase throttle angle to its maximum position. Refer to Figures 20, 21 and 22 for examples of Tech 1 information.

Verify that:

- TCC releases.
- Transmission downshifts to 2nd gear immediately.
- 1-2 Shift Solenoid is off, 2-3 Shift Solenoid is on.

Manual Downshifts

The shift solenoids do not control the initial downshift during 4-3 and 3-2 manual downshifts. All manual downshifts are hydraulic except the 2-1. The solenoid states will change during, or shortly after a manual downshift is selected. Refer to Figure 23 for an example of Tech 1 information.

- At vehicle speeds of 64 to 88 km/h (40 to 55 mph) in fourth gear, release the accelerator pedal while moving the gear selector to D3. Observe that:

- TCC releases.
- Transmission downshifts to 3rd gear immediately.
- Engine slows vehicle down.

- Move gear selector back to D4 and accelerate to 64 to 72 km/h (40 to 45 mph). Release the accelerator while moving the gear selector to D2 and observe that:

- TCC releases.
- Transmission downshifts to 2nd gear immediately.
- Engine slows vehicle down.

- Move gear selector back to D4 and accelerate to 48 km/h (30 mph). Release the accelerator pedal while moving the gear selector to D1 and observe that:

- TCC releases.
- Transmission downshifts to 1st gear immediately.
- Engine slows vehicle down.

Coasting Downshifts

- With the gear selector in D4, accelerate to 4th gear with TCC applied.
- Release the accelerator pedal and lightly apply the brakes, and observe that:
 - TCC releases.
 - Downshifts occur at speeds shown on the shift speed chart.

Manual Gear Range Selection

Upshifts in the manual gear ranges are controlled by the shift solenoids.

Perform the following tests by accelerating at 10-15 degrees TP Sensor.

Manual Third (D3)

- With vehicle stopped, move the gear selector to D3 and accelerate to observe:
 - 1-2 shift.
 - 2-3 shift.

Manual Second (D2)

- With vehicle stopped, move gear selector to D2 and accelerate to observe:
 - Transmission starts and remains in second gear.
- Accelerate to 40 km/h (35 mph) and observe:
 - 2-3 shift does not occur.
 - TCC does not apply.

Manual First (D1)

- With vehicle stopped, move gear selector to D1. Accelerate to 32 km/h (20 mph) and observe:
 - No upshifts occur.
 - TCC does not apply.
 - Can upshift out of first at fuel cut-off.

Reverse (R)

- With vehicle stopped, move gear selector to R and slowly accelerate to observe:
 - 1-2 and 2-3 Shift Solenoids are on.

Use a scan tool to see if any transmission trouble codes have been set. Refer to "Trouble Code Diagnosis" in this section and repair the vehicle as directed. After repairing the vehicle, perform the hoist test and verify that the code has not set again.

If the transmission is not performing well and no trouble codes have been set, there may be an intermittent condition. Check all electrical connections for damage or a loose fit. Some scan tools have a snapshot test which can help catch an intermittent condition that doesn't occur long enough to set a code.

You may want to read "Electronic Component Diagnosis" in this section to become familiar with transmission conditions caused by transmission electrical malfunctions.

If no trouble codes have been set and the condition is suspected to be hydraulic, take the vehicle on a road test.

ROAD TEST PROCEDURE

- Perform the road test using a scan tool.
 - This test should be performed when traffic and road conditions permit.
 - Observe all traffic safety regulations.
1. Start engine.
 2. Depress brake pedal.
 3. Move gear selector from:
 - Park to Reverse.
 - Reverse to Neutral.
 - Neutral to D4.
- ?** **Important**
- Gear selections should be immediate and not harsh.
4. Perform the same test procedure as instructed previously in the road test:
 - Upshifts and TCC apply.
 - Part Throttle Detent Downshift.

- Full Throttle Detent Downshift.
- Manual Downshifts.
- Coasting Downshifts.
- Manual Gear Range Selection.

Use a scan tool to see if any transmission malfunction codes have been set. If so, perform transmission functional test. (Figure 8.) After repairing the vehicle, perform the road test and verify that no codes have been set again.

If no codes have been set and the condition remains, refer to the "Diagnosis Charts" contained in this section. If the condition is suspected to originate in the torque converter, refer to "Torque Converter Clutch (TCC) Diagnosis" later in this section.

TORQUE CONVERTER CLUTCH (TCC) DIAGNOSIS

To properly diagnose the Torque Converter Clutch (TCC) system, perform all electrical testing first and then the hydraulic testing.

The TCC is applied by fluid pressure which is controlled by a solenoid located inside the Automatic Transmission assembly. The solenoid is energized by completing an electrical circuit through a combination of switches and sensors. Refer to Figure 19 for an example of Tech 1 information.

Functional Check Procedure** Inspect**

1. Install a tachometer or scan tool.
2. Operate the vehicle until proper operating temperature is reached.
3. Drive vehicle at 80 to 88 km/h (50 to 55 mph) with light throttle (road load).
4. Maintaining throttle, lightly touch the brake pedal and check for release of the TCC and a slight increase in engine speed (RPM).
5. Release the brake, slowly accelerate and check for a re-apply of the converter clutch and a slight decrease in engine speed (RPM).

TORQUE CONVERTER EVALUATION**Torque Converter Stator**

The torque converter stator roller clutch can have one of two different type **malfunctions**:

- A. Stator assembly freewheels in both directions.
- B. Stator assembly remains locked up at all times.

Condition A-Poor Acceleration Low Speed

The car tends to have poor acceleration from a standstill. At speeds above 50 to 55 km/h (30 to 35 mph), the car may act normal. If poor acceleration is noted, it should first be determined that the exhaust system is not blocked, and the transmission is in first (1st) gear when starting out.

If the engine freely accelerates to high RPM in "NEUTRAL" (N), it can be assumed that the engine and exhaust system are normal. Checking for poor performance in "Drive" and "Reverse" will help determine if the stator is freewheeling at all times.

Condition B-Poor Acceleration High Speed

Engine RPM and car speed limited or restricted at high speeds. Performance when accelerating from a standstill is normal. Engine may over-heat. Visual examination of the converter may reveal a blue color from over-heating.

If the converter has been removed, the stator roller clutch can be checked by inserting two fingers into the splined inner race of the roller clutch and trying to turn the race in both directions. The inner race should turn freely clockwise, but not turn or be very difficult to turn counterclockwise.

Noise

Torque converter whine is usually noticed when the vehicle is stopped and the transmission is in "Drive" or "Reverse". The noise will increase when engine RPM is increased. The noise will stop when the vehicle is moving or when the torque converter clutch is applied because both halves of the converter are turning at the same speed.

Perform a stall test to make sure the noise is actually coming from the converter:

1. Place foot on brake.
2. Put gear selector in "Drive".
3. Depress accelerator to approximately 1200 RPM for no more than six seconds.

NOTICE: If the accelerator is depressed for more than six seconds, damage to the transmission may occur.

A torque converter noise will increase under this load.



Important

- This noise should not be confused with pump whine noise which is usually noticeable in "Park", "Neutral" and all other gear ranges. Pump whine will vary with pressure ranges.

The torque converter should be replaced under any of the following conditions:

- External leaks in the hub weld area.
- Converter hub is scored or damaged.
- Converter pilot is broken, damaged or fits poorly into crankshaft.
- Steel particles are found after flushing the cooler and cooler lines.
- Pump is damaged or steel particles are found in the converter.
- Vehicle has TCC shudder and/or no TCC apply. Replace only after all hydraulic and electrical diagnoses have been made. (Converter clutch material may be glazed.)
- Converter has an imbalance which cannot be corrected. (Refer to Converter Vibration Test Procedure.)
- Converter is contaminated with engine coolant containing antifreeze.
- Internal failure of stator roller clutch.
- Excess end play.
- Heavy clutch debris due to overheating (blue converter).
- Steel particles or clutch lining material found in fluid filter or on magnet when no internal parts in unit are worn or damaged – indicates that lining material came from converter.

The Torque Converter Should Not Be Replaced If:

- The oil has an odor, is discolored, and there is no evidence of metal or clutch facing particles.
- The threads in one or more of the converter bolt holes are damaged.
 - Correct with thread insert. (Refer to SECTION 6A.)
- Transmission failure did not display evidence of damage or worn internal parts, steel particles or clutch plate lining material in unit and inside the fluid filter.
- Vehicle has been exposed to high mileage (only). The exception may be where the torque converter clutch damper plate lining has seen excess wear by vehicles operated in heavy and/or constant traffic, such as taxi, delivery or police use.

TCC SHUDDER

The key to diagnosing Torque Converter Clutch (TCC) shudder is to note when it happens and under what conditions.

TCC Shudder should only occur during the APPLY and/or RELEASE of the converter clutch; SELDOM after the TCC plate is fully applied.

While TCC Is Applying Or Releasing:

If the shudder occurs while TCC is applying, the problem can be within the transmission or torque converter. Something is not allowing the clutch to become fully engaged, not allowing clutch to release, or is trying to release and apply the clutch at the same time. This could be caused by leaking turbine shaft seals, a restricted release orifice, a distorted clutch or housing surface due to long converter bolts, or defective friction material on the TCC plate.

Shudder Occurs After TCC Has Applied:

In this case, most of the time there is nothing wrong with the transmission! As mentioned above, once the TCC has been applied, it is very unlikely that it will slip. Engine problems may go unnoticed under light throttle and load, but become noticeable after TCC apply when going up a hill or accelerating, due to the mechanical coupling between engine and transmission.

REMEMBER: Once TCC is applied there is no torque converter (fluid coupling) assistance. Engine or driveline vibrations could be unnoticeable before TCC engagement.

Inspect the following components to avoid misdiagnosis of TCC Shudder and possibly disassembling a transmission and/or replacing a torque converter unnecessarily:

- Spark plugs – Inspect for cracks, high resistance or broken insulator.
- Plug wires – Look in each end. If there is red dust (ozone) or black substance (carbon) present, then the wires are bad. Also look for a white discoloration of the wire indicating arcing during hard acceleration.
- Distributor cap and rotor – Look for broken or uncrimped parts.
- Coil – Look for black on bottom indication arcing while engine is misfiring.
- Fuel injector – Filter may be plugged.
- Vacuum leak – Engine won't get correct amount of fuel. May run rich or lean depending on where the leak is.
- EGR valve – Valve may let in too much unburnable exhaust gas and cause engine to run lean.
- MAP/MAF sensor – Like vacuum leak, engine won't get correct amount of fuel for proper engine operation.
- Carbon on intake valves – Restricts proper flow or air/fuel mixture into cylinders.
- Flat cam – Valves don't open enough to let proper fuel/air mixture into cylinders.
- Oxygen sensor – May command engine too rich or too lean for too long.
- Fuel pressure – May be too low.
- Engine mounts – Vibration of mounts can be multiplied by TCC engagement.
- Axle joints – Check for vibration.
- TPS – TCC apply and release depends on TPS in many engines. If TPS is out of specification, TCC may remain applied during initial engine crowd.
- Cylinder balance – Bad piston rings or poorly sealing valves can cause low power in a cylinder.
- Fuel contamination – Causes poor engine performance.

FLEXPLATE/TORQUE CONVERTER VIBRATION TEST PROCEDURE

- Start engine.
- With engine at idle speed and transmission in "Park" (P) or "Neutral" (N), observe vibration.
- Key off.

**Remove or Disconnect**

1. Flexplate shield attaching bolts.
2. Flexplate to torque converter attaching bolts.
3. Rotate torque converter 120 degrees (1/3 turn).

**Install or Connect**

1. Flexplate to torque converter attaching bolts.

**Tighten**

- Bolts to 62 N•m (46 lb. ft.)
2. Flexplate shield attaching bolts.
- Start engine and check for vibration. Repeat procedure until best possible balance is obtained.

TECH 1 PARAMETER	IN PARK AT IDLE
ENGINE SPEED	550-750 RPM
TRANS OUTPUT SPD	0 RPM (1)
ENG COOL TEMP	85°C - 105°C (5)
TRANS FLUID TEMP	30°C - 130°C (5)
THROT POSITION	.4 - .6 V
THROTTLE ANGLE	0%
A/B/C RNG	OFF ON OFF
TRANS RANGE SW.	Park/Neutral
COMMANDED GEAR	1
ADAPTABLE SHIFT	NO (3)
1-2 SOL / 2-3 SOL	ON ON
CTR FDBK 1/2 2/3	ON ON (4)
3-2 CONTROL SOL	0%
3-2 CONTROL FDBK	OFF
HOT MODE	NO
TCC SLIP RPM	600-750
TCC SOLENOID	OFF
CTR FDBK TCC	OFF (4)
DESIRED PCS	1.01
ACTUAL PCS	1.01
PCS DUTY CYCLE	40 - 60%
VEHICLE SPEED	0
4WD LOW SWITCH	OFF
CRUISE ENGAGED	OFF
TCC BRAKE SWITCH	Released
KICKDOWN ENABLED	NO
1-2 SHIFT TIME	.3 - 1.35 Sec. (2)(3)
1-2 SHIFT ERROR	0 - 6.25 Sec. (2)(3)
2-3 SHIFT TIME	.3 - 1.35 Sec. (2)(3)
CURR. ADAPT CELL	N/A < 25% TP
TRANS CALIB ID	Internal ID Only
SYSTEM VOLTS	13.6
PRESS ADAPT 25% TP	-5 - 10
PRESS ADPT 40% TP	-5 - 10
PRESS ADPT 70% TP	-5 - 10
CURR. ADAPT PSI	-5 - 10

1. There may be a small speed reading due to vehicle vibration.
2. Zero until a shift occurs.
3. 'Yes' means the shift time is an accurate and valid number. (If shift was adaptable.)
If shift was adaptable, 'No' indicates the shift time is not accurate for one or more of the following reasons:
 - Transmission is in D2 or D1
 - There is a long shift delay
 - There is a long shift time
 - There has been a significant throttle angle change
 - Transmission is in hot mode
 - A shift starts too soon after the solenoids change states
 - Diagnostic codes are set (21, 22, 24, 28, 53, 58, 59, 72, 73, 75, 79, 81 or 82)
 - There has been a significant vehicle speed change
 - 4WD lo switch is on
4. Should match commanded solenoid state.
5. Normal operating temperature.

RH0065-4L60-E

Figure 14 Typical TECH 1 Data Values

GARAGE SHIFTS
 EXAMPLE ONLY

TECH 1 INFORMATION

	PARK	DRIVE 4	REVERSE
ENGINE SPEED	639 RPM	538 RPM	524 RPM
TRANS FLUID TEMP	81°C	81°C	81°C
A / B / C RNG	OFF ON OFF	OFF ON ON	ON ON OFF
TRANS RANGE SW	P - N	DRIVE 4	REV
DESIRED PCS	1.07 AMPS	1.07 AMPS	.96 AMPS
ACTUAL PCS	1.11 AMPS	1.07 AMPS	.98 AMPS

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

- ENGINE SPEED should drop approximately 50 RPM.
 - This verifies that the transmission has engaged.
- When DESIRED PCS = 1.07 AMPS, the transmission is commanded to minimum line pressure.
- ACTUAL PCS AMPS should always be within .16 AMPS of DESIRED PCS.
- PRNDL SWITCH should match the selected gear range.
 - IF not, the Transmission Pressure Switch Assembly should be checked.
 - A / B / C RNG should be used to identify the failed circuit.

RH0222-4L60-E-C

Figure 15 Example of TECH 1 Information (Garage Shifts)

cardiagn.com

1-2 UPSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application.)**TECH 1 INFORMATION**

	1ST GEAR	2ND GEAR
ENGINE SPEED	2476 RPM	2146 RPM
TRANS OUTPUT SPD	767 RPM	1086 RPM
TRANS FLUID TEMP	83°C	83°C
THROTTLE POSITION	2.16 VOLTS	2.12 VOLTS
THROTTLE ANGLE	41 %	38 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	1	2
ADAPTABLE SHIFT	NO	YES
1-2 SOL 2-3 SOL	ON ON	OFF ON
3-2 CONTROL SOL	0 %	90 %
TCC SLIP SPEED	+257	+408
1-2 SHIFT TIME	1.30 SEC	0.83 SEC
1-2 SHIFT ERROR	5.95 SEC	0.03 SEC
CURR ADAPT CELL		
CURR ADAPT PSI		
2BD GEAR START	NO	NO
PRESS ADPT 25%TP	-1	-1
PRESS ADPT 31%TP	-1	-1
PRESS ADPT 38%TP	-1	-1
PRESS ADPT 44%TP	-1	-1
PRESS ADPT 50%TP	-1	-1
PRESS ADPT 56%TP	-1	-1
PRESS ADPT 63%TP	-1	-1
PRESS ADPT 69%TP	-1	-1
PRESS ADPT 75%TP	-1	-1
PRESS ADPT 81%TP	-1	-1
PRESS ADPT 88%TP	-1	-1
PRESS ADPT 94%TP	-1	-1
PRESS ADPT 100%TP	-1	-1
3-2 CONTROL SOL	0 %	90 %

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 1-2 UPSHIFT

- TRANS OUTPUT SPD must be greater than 300 RPM to upshift
 - Refer to 1993 HYDRA-MATIC 4L60-E SHIFT SPEED CHART
- ENGINE SPEED will drop approximately 250 RPM during a shift
- TRANS RANGE SW should match the selected gear range
- THROTTLE ANGLE should equal 0% at idle and 100% at wide-open-throttle

- If COMMANDED GEAR changes from 1 to 2 and the vehicle does not shift (ENGINE SPEED should drop approximately 250 RPM)

- Refer to Diagnosis Charts (6E3)

- 2ND GEAR START must display NO to start in first gear

HARSH 1-2 UPSHIFT

- 1-2 SHIFT TIME and 1-2 SHIFT ERROR are not accurate unless ADAPTABLE SHIFT is YES
- 1-2 SHIFT TIME is normally between 0.3 SEC and 1.35 SEC (This value is not accurate unless ADAPTABLE SHIFT is YES).
 - If not, refer to Diagnosis Charts (6E3)
- 1-2 SHIFT ERROR should be below 1.0 SEC (This value is not accurate unless ADAPTABLE SHIFT is YES).
- If any PRESS ADPT XX%TP cell is - 5 (lowering line pressure to adapt for harsh shifts) and if 1-2 SHIFT TIME is below 0.3 SEC, then an internal transmission problem is indicated. Refer to Diagnosis Charts (6E3)

SOFT 1-2 UPSHIFT

- 1-2 SHIFT TIME and 1-2 SHIFT ERROR are not accurate unless ADAPTABLE SHIFT is YES
- 1-2 SHIFT TIME is normally between 0.3 SEC and 1.35 SEC (This value is not accurate unless ADAPTABLE SHIFT is YES).
 - If not, refer to Diagnosis Charts (6E3)
- 1-2 SHIFT ERROR should be below 1.0 SEC (This value is not accurate unless ADAPTABLE SHIFT is YES).
- If any PRESS ADPT XX%TP cell is + 10 (increasing line pressure to adapt for soft shifts) and if 1-2 SHIFT TIME is above 1.35 SEC, then an internal transmission problem is indicated. Refer to Diagnosis Charts (6E3).

RH0223-4L60-E-C

Figure 16 Example of TECH 1 Information (1-2 Upshifts)

2-3 UPSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application.)**TECH 1 INFORMATION**

	2ND GEAR	3RD GEAR
ENGINE SPEED	3039 RPM	2770 RPM
TRANS OUTPUT SPD	1760 RPM	1970 RPM
TRANS FLUID TEMP	86°C	86°C
THROTTLE POSITION	2.82 VOLTS	2.84 VOLTS
THROTTLE ANGLE	61 %	61 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	2	3
1-2 SOL 2-3 SOL	OFF ON	OFF OFF
3-2 CONTROL SOL	90 %	90 %
2-3 SHIFT TIME	1.60 SEC	0.85 SEC
2ND GEAR START	NO	NO

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 2-3 UPSHIFT

- TRANS OUTPUT SPD must be greater than 750 RPM to upshift
 - Refer to 1993 HYDRA-MATIC 4L60-E SHIFT SPEED CHART
- ENGINE SPEED will drop approximately 250 RPM during a shift
- PRNDL SWITCH should match the selected gear range
- THROTTLE ANGLE should equal 0% at idle and 100% at wide-open-throttle
- If COMMANDED GEAR changes from 2 to 3 and the vehicle does not shift (ENGINE SPEED should drop approximately 250 RPM)
 - Refer to Diagnosis Charts (6E3)

HARSH OR SOFT 2-3 UPSHIFT

- 2-3 SHIFT TIME is normally between 0.3 SEC and 1.35 SEC however the Tech 1 will display the last shift time. If the conditions of the last shift are unknown (lift foot upshift, manual upshift), it is recommended to repeat the upshift in the following manner.
 - To achieve an accurate shift time
 - Accelerate the vehicle from rest holding the throttle steady.
 - If not, refer to Diagnosis Charts (6E3)

RH0225-4L60-E-C

Figure 17 Example of TECH 1 Information (2-3 Upshifts)

3-4 UPSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application.)**TECH 1 INFORMATION**

	3RD GEAR	4TH GEAR
ENGINE SPEED	1757 RPM	1617 RPM
TRANS OUTPUT SPD	1456 RPM	1534 RPM
TRANS FLUID TEMP	42°C	42°C
THROTTLE ANGLE	20 %	21 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	3	4
1-2 SOL 2-3 SOL	OFF OFF	ON OFF

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 3-4 UPSHIFT

- TRANS OUTPUT SPD must be greater than 1250 RPM to upshift
 - Refer to 1993 HYDRA-MATIC 4L60-E SHIFT SPEED CHART
- ENGINE SPEED will drop approximately 100 RPM during a shift
- PRNDL SWITCH should match the selected gear range
 - In Drive 2 the transmission will not upshift to 3rd or 4th gears
 - In Drive 3 the transmission will not upshift to 4th gear but TCC will normally apply
- THROTTLE ANGLE should equal 0% at idle and 100% at wide-open-throttle
- If COMMANDED GEAR changes from 3 to 4 and the vehicle does not shift (ENGINE SPEED should drop approximately 100 RPM)
 - Refer to Diagnosis Charts (6E3).

RH0226-4L60-E-C

Figure 18 Example of TECH 1 Information (3-4 Upshifts)

TCC SYSTEM EXAMPLE ONLY

TECH 1 INFORMATION

	RELEASED	APPLIED	RELEASED
ENGINE SPEED	1867 RPM	1353 RPM	1769
TRANS OUTPUT SPD	1909 RPM	1950 RPM	1883
TRANS FLUID TEMP	64°C	64°C	64°C
THROTTLE ANGLE	27 %	27 %	38 %
TRANS RANGE SW	DRIVE 4	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	4	4
1-2 SOL 2-3 SOL	ON OFF	ON OFF	ON OFF
HOT MODE	NO	NO	NO
COMMANDED TCC	OFF	ON	OFF
TCC SLIP SPD	+531 RPM	-1 RPM	+447 RPM
TCC BRAKE SWITCH	RELEASED	RELEASED	RELEASED

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

TCC DOES NOT APPLY

- COMMANDED TCC will display ON only if
 - PRNDL SWITCH displays DRIVE 4 or DRIVE 3
 - TRANS OUTPUT SPD must be greater than approximately 1800 RPM
 - TCC BRAKE SWITCH displays APPLIED
 - THROTTLE ANGLE must be at least approximately 2%
 - THROTTLE ANGLE must remain steady
 - TRANS FLUID TEMP must be above
 - ENG COOL TEMP must be above
 - TCC SLIP SPD is less than -60 RPM
 - If the cruise control is on, then TCC uses a shift pattern that requires a higher vehicle speed.
- TCC SLIP SPD should be +/-30 RPM if TCC is applied

TCC DOES NOT RELEASE

- The Torque Converter Clutch is fed by 2nd gear fluid.
 - The earliest TCC can apply is 2nd gear
- If HOT MODE displays YES, the TCC is engaged in 4th gear or Drive 3, 3rd gear, except for the following conditions:
 - TCC BRAKE SWITCH displays APPLIED
 - THROTTLE ANGLE must be at least approximately 2%
 - A DTC is current

RH0228-4L60-E-C

Figure 19 Example of TECH 1 Information (TCC System)

3-2 DETENT DOWNSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application.)**TECH 1 INFORMATION**

	3RD GEAR	2ND GEAR
ENGINE SPEED	1414 RPM	2430 RPM
TRANS OUTPUT SPD	1059 RPM	1315 RPM
TRANS FLUID TEMP	75°C	75°C
THROTTLE ANGLE	10 %	100 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	3	2
1-2 SOL 2-3 SOL	OFF OFF	OFF ON
3-2 CONTROL SOL	90 %	47 %

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 3-2 DOWNSHIFT

- If COMMANDED GEAR changes from 3 to 2 and the vehicle does not shift (ENGINE SPEED should dramatically increase)

HARSH OR SOFT 3-2 DOWNSHIFTS

- If 3-2 CONTROL SOL drops from 90% to a lower value during the shift, and the shift is harsh or soft

RH0229-4L60-E-C

Figure 20 Example of TECH 1 Information (3-2 Detent Downshifts)

4-2 DETENT DOWNSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application.)**TECH 1 INFORMATION**

	4TH GEAR	2ND GEAR
ENGINE SPEED	919 RPM	2788 RPM
TRANS OUTPUT SPD	1390 RPM	1555 RPM
TRANS FLUID TEMP	79°C	79°C
THROTTLE ANGLE	0 %	100 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	2
1-2 SOL 2-3 SOL	ON OFF	OFF ON
3-2 CONTROL SOL	90 %	59 %

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 4-2 DOWNSHIFT

- If COMMANDED GEAR changes from 3 to 2 and the vehicle does not shift (ENGINE SPEED should dramatically increase)

HARSH OR SOFT 4-2 DOWNSHIFTS

- If 3-2 CONTROL SOL drops from 90% to a lower value during the shift, and the shift is harsh or soft

RH0230-4L60-E-C

Figure 21 Example of TECH 1 Information (4-2 Detent Downshifts)

4-3 DETENT DOWNSHIFTS**EXAMPLE ONLY** (Refer to 1994 Hydra-matic 4L60-E Shift Speed Chart for Vehicle Application.)**TECH 1 INFORMATION**

	4TH GEAR	3RD GEAR
ENGINE SPEED	1434 RPM	2240 RPM
TRANS OUTPUT SPD	1434 RPM	1688 RPM
TRANS FLUID TEMP	80°C	80°C
THROTTLE ANGLE	19 %	54 %
TRANS RANGE SW	DRIVE 4	DRIVE 4
COMMANDED GEAR	4	3
1-2 SOL 2-3 SOL	ON OFF	OFF OFF
3-2 CONTROL SOL	90 %	90 %

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

NO 4-3 DOWNSHIFT

- If COMMANDED GEAR changes from 3 to 2 and the vehicle does not shift (ENGINE SPEED should dramatically increase)

RH0231-4L60-E-C

Figure 22 Example of TECH 1 Information (4-3 Downshifts)

MANUAL DOWNSHIFTS
EXAMPLE ONLY
TECH 1 INFORMATION

	DRIVE 4	DRIVE 3	DRIVE 2	DRIVE 1
ENGINE SPEED	1205 RPM	1543 RPM	2172 RPM	2087 RPM
TRANS OUTPUT SPD	1714 RPM	1638 RPM	1412 RPM	899 RPM
THROTTLE ANGLE	0 %	0 %	0 %	0 %
TRANS RANGE SW	DRIVE 4	DRIVE 3	DRIVE 2	DRIVE 1
COMMANDED GEAR	4	3	2	1

* THERE IS APPROXIMATELY 2 SECONDS OF DATA MISSING BETWEEN EACH COLUMN

- ENGINE SPEED should increase as lower gears are selected
- PRNDL SWITCH should match the selected gear range
 - In Drive 2 the transmission starts in 2nd gear

cardiagn.com

Figure 23 Example of TECH 1 Information (Manual Downshifts)

1994 HYDRA-MATIC 4L60-E SHIFT SPEED CHART

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS					
			10	25	50	10	25	50	10	25	50			
3.4L (L32)	F	3.23	472	837	1072	815	1523	1994	1373	2016	N/A	1286	1501	2874
4.3L (L99)	B	2.93	376	581	924	650	992	1642	992	1300	N/A	1027	1505	2395
4.3L (L99)	B	2.73	376	615	1026	650	1026	1711	958	1403	N/A	1027	1711	2395

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM			2-3 SHIFT +/- 200 RPM			3-4 SHIFT +/- 150 RPM			2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			TPS			TPS			TPS					
			10	25	50	10	25	50	10	25	50			
5.7L (LT1)	B	3.08	457	724	1182	724	1220	2212	1106	1716	N/A	1258	1716	3051
5.7L (LT1)	B/D	2.93	317	570	951	570	951	1680	887	1268	N/A	982	1331	2250
5.7L (LT1)	B/D	2.56	348	602	1046	602	1077	1902	919	1458	N/A	951	1648	2536
5.7L (LT1)	F Normal Mode	2.73	434	543	1375	760	1303	2570	977	1448	N/A	1339	1737	3366
	F Performance Mode (Pontiac Only)	2.73	434	651	1194	760	1267	2280	977	1737	N/A	1339	1520	3004
5.7L (LT1)	F Normal Mode	3.23	481	788	1182	832	1576	2190	1401	1883	N/A	1620	1664	3197
	F Performance Mode (Pontiac Only)	3.23	481	788	1357	876	1357	2934	1401	1883	N/A	1620	1576	3197
5.7L (LT1)	Y	2.59	386	737	1193	751	1333	2211	1053	1860	N/A	1404	1755	3439
5.7L (LT1)	Y	3.07	456	830	1286	871	1618	2407	1203	2241	N/A	1618	1743	3237

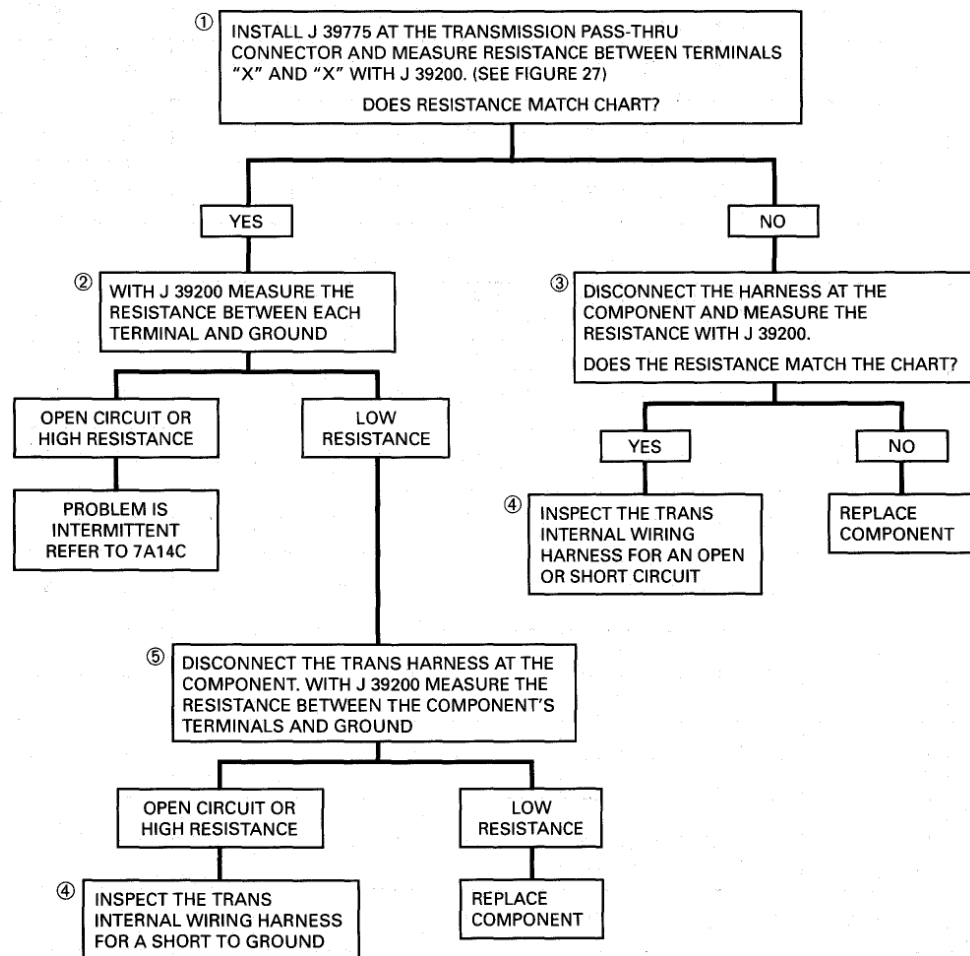
1. ALL SPEEDS ARE GIVEN IN TRANSMISSION OUTPUT SHAFT RPM
2. SPEEDS ARE BASED ON PERCENT THROTTLE POSITION SENSOR (TPS) DATA
3. USE A TECH 1 OR OTHER SCAN TOOL TO MONITOR THIS DATA
4. ALL SHIFT SPEEDS ARE APPROXIMATE

RH0009-4L60-E-C

Figure 24 1994 4L60-E Shift Speed Chart

NOTE: This procedure cannot be used on the pressure switch assembly. See figure 28.

4L60-E TRANSMISSION INTERNAL WIRING HARNESS CHECK



① This test measures the resistance of the component at the transmission pass-thru connector.

② This test checks for a short to ground in the internal wiring harness or component.

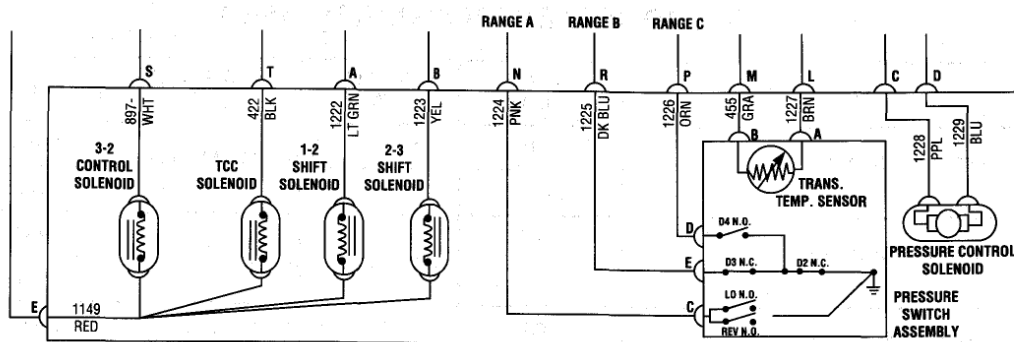
③ This test measures the resistance of the component.

④ Check the internal wiring harness for continuity, pinched wires and corrosion.

⑤ This test checks for a short to ground in the component (cannot be used on TCC solenoid).

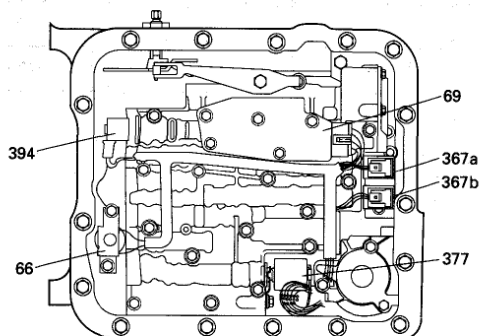
PH0217-4L60-E-C

Figure 25 Internal Wiring Harness Check

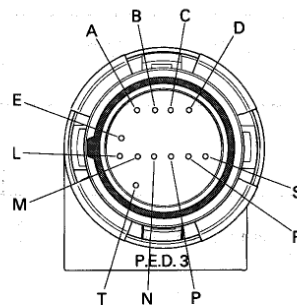


INTERNAL TRANSMISSION WIRING HARNESS

N.C. = NORMALLY CLOSED SWITCH
N.O. = NORMALLY OPEN SWITCH



- 66 SOLENOID ASSEMBLY, WIRING HARNESS AND
- 69 SWITCH ASSEMBLY, TRANSMISSION PRESSURE
- 367a 1-2 SHIFT SOLENOID
- 367b 2-3 SHIFT SOLENOID
- 377 PRESSURE CONTROL SOLENOID
- 394 3-2 CONTROL SOLENOID



CAVITY	FUNCTION
A	1-2 SHIFT SOLENOID (LOW)
B	2-3 SHIFT SOLENOID (LOW)
C	PRESSURE CONTROL SOLENOID (HIGH)
D	PRESSURE CONTROL SOLENOID (LOW)
E	BOTH SHIFT SOLENOIDS, TCC SOLENOID, AND 3-2 CONTROL SOLENOID (HIGH)
L	TRANSMISSION FLUID TEMPERATURE (HIGH)
M	TRANSMISSION FLUID TEMPERATURE (LOW)
N	RANGE SIGNAL "A"
P	RANGE SIGNAL "C"
R	RANGE SIGNAL "B"
S	3-2 CONTROL SOLENOID (LOW)
T	TCC SOLENOID (LOW)

RH0028-4L60-E

Figure 26 Wiring Diagram

4L60-E COMPONENT RESISTANCE CHART

COMPONENT	WIRE COLOR	PASS-THRU PIN	RESISTANCE @ 20°C	CKT #
1-2 SHIFT SOLENOID	RED	E *	20 - 40 Ohms	1149B
	GRN LT	A		1222
2-3 SHIFT SOLENOID	RED	E *	20 - 40 Ohms	1149A
	YEL	B		1223
3-2 CONTROL SOLENOID	RED	E *	9 - 14 Ohms	1149C
	WHT	S		897
PRESSURE CONTROL SOLENOID	PPL	C	3.5 - 8 Ohms	1228
	BLU LT	D		1229
TCC SOLENOID	RED	E *	20 - 40 Ohms	1149E
	BLACK	T		422A

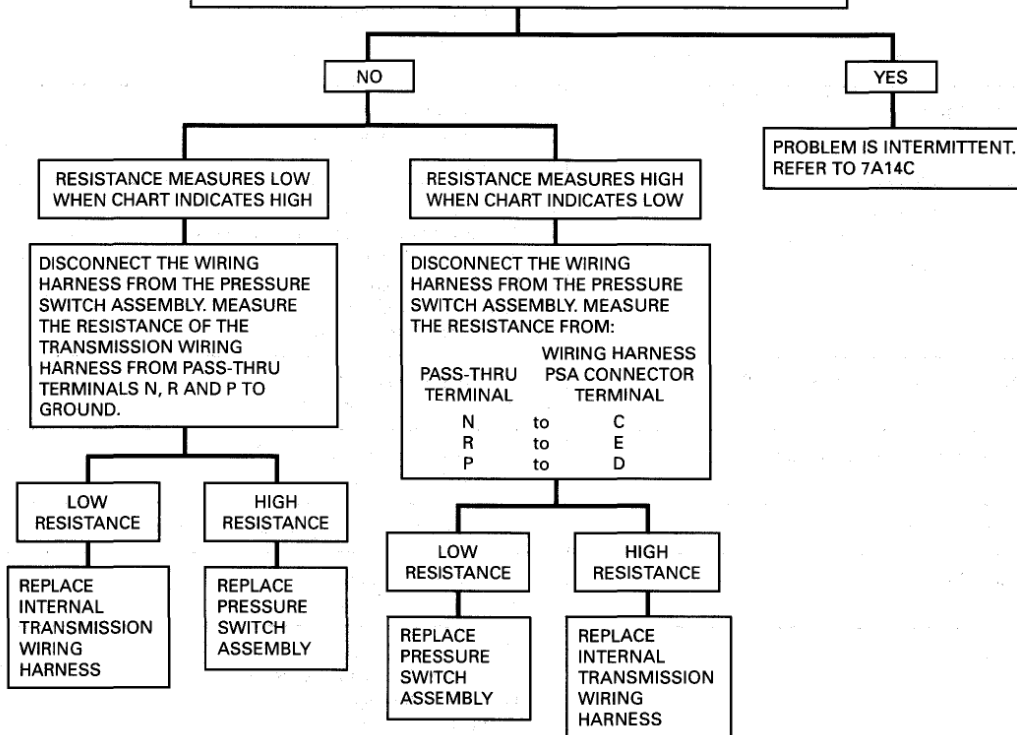
* Spliced internally to Pin E.

PH0218-4L60-E

Figure 27 Component Resistance Chart

4L60-E TRANSMISSION PRESSURE SWITCH ASSEMBLY RESISTANCE CHECK

INSTALL J 39775 AT THE TRANSMISSION PASS-THRU CONNECTOR. WITH ENGINE RUNNING, MEASURE RESISTANCE BETWEEN EACH TERMINAL (N, R AND P) AND GROUND WITH J 39200. (SEE CHART BELOW). MOVE THE GEAR SELECTOR THROUGH THE DIFFERENT GEAR RANGES.



Pressure Switch Assembly (PSA) Resistance Chart

Gear Selector Position	Range		
	A	B	C
PARK	H	L	H
REVERSE	L	L	H
NEUTRAL	H	L	H
D4	H	L	L
D3	H	H	L
D2	H	H	H
D1	L	H	H

When range "X" is measured for resistance to ground,
 H = High resistance (over 100 Ohms) - open circuit
 L = Low resistance (under 200 Ohms) - grounded circuit

IMPORTANT:

Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple transmission Diagnostic Trouble Codes will set. Be sure to clear these codes when finished with this procedure.

RH0219-4L60-E

Figure 28 Pressure Switch Assembly Resistance Check

HYDRA-MATIC 4L60-E ELECTRONIC COMPONENT MALFUNCTIONS

This chart gives some general information about electronic component malfunctions. Use this information to become familiar with possible conditions caused by transmission/vehicle electrical components. Refer to the diagnosis charts for more specific information.

COMPONENT/SYSTEM	CAN EFFECT
Throttle Position Sensor	– Shift pattern (erratic). – Shift quality (firm or soft). – Engine (rough).
Output Speed Sensor	– Shift pattern (erratic). – TCC apply (at wrong time). – Shift quality (harsh or soft).
Pressure Switch Assembly	– TCC apply (no apply). – Shift pattern (no fourth gear in hot mode). – Shift quality (harsh). – Line pressure (high). – Manual downshift (erratic). – No 4th gear if in hot mode.
Transmission Fluid Temperature Sensor	– TCC control (on or off). – Shift quality (harsh or soft).
Engine Coolant Temperature Sensor	– TCC control (no apply). – Shift quality (harsh).
Shift Solenoids	– Gear application (wrong gear, only two gears, no shift).
Brake Switch	– TCC apply (no apply). – No 4th gear if in hot mode.
System Voltage	– Line pressure (high). – Gear application (third gear only). – TCC control (no apply). – No 4th gear if in hot mode.
3-2 Control Solenoid	– Gear application (third gear only). – 3-2 downshifts (flare or tie-up).
Pressure Control Solenoid	– Line pressure (high or low). – Shift quality (harsh or soft).
TCC Solenoid	– TCC apply (no apply). – No 4th gear if in hot mode.
4WD Low Switch	– Incorrect shift pattern.

RH0007-4L60-E

Figure 29 Component Malfunctions

HYDRA-MATIC 4L60-E ELECTRONIC COMPONENT MALFUNCTIONS (continued)

COMPONENT/SYSTEM	CAN EFFECT
Cruise Control	- Delays 3-4 upshift and TCC apply during heavy throttle
Acceleration Slip Regulation (ASR) (Y-car only)	- Downshift
2nd Gear Start Switch (Second) (V6 Pontiac F-car only)	- 2nd Gear starts
Manual Switch (V8 Pontiac F-car only)	- Shift pattern
Performance Switch (V8 Pontiac F-car only)	- Shift quality - Shift pattern

RH0221-4L60

Figure 30 Component Malfunctions

CONDITION	INSPECT COMPONENT	FOR CAUSE
OIL PRESSURE HIGH OR LOW (Verify With Gage – Refer To Line Pressure Check Procedure)	- Oil Pump Assembly (4) - Oil Filter (72) - Valve Body (60) - Pressure Control Solenoid (377) - System Voltage - Pressure Switch Assembly (69) - Case (8) - Possible Codes: - 24 Vehicle Speed Sensor Signal Low - 52 Long System Voltage High - 53 System Voltage High - 72 Vehicle Speed Sensor Loss - 73 Pressure Control Solenoid Current - 75 System Voltage Low - 81 2-3 Shift Solenoid Circuit Fault - 82 1-2 Shift Solenoid Circuit Fault	- Pressure regulator valve (216) stuck. - Pressure regulator valve spring (217). - Rotor guide (211) omitted or misassembled. - Rotor (212) cracked or broken. - Reverse boost valve (219) or sleeve (220) stuck, damaged or incorrectly assembled. - Orifice hole in pressure regulator valve (217) plugged. - Sticking slide (203) or excessive rotor clearance. - Pressure relief ball (228) not seated or damaged. - Porosity in pump cover or body. - Wrong pump cover. - Pump faces not flat. - Excessive rotor clearance. - Intake pipe restricted by casting flash. - Cracks in filter body or intake pipe. - O-ring seal (71) missing, cut or damaged. - Wrong grease used on rebuild. - Manual valve (340) scored or damaged. - Spacer plate (48) or gaskets (47 and 52) incorrect, misassembled or damaged. - Face not flat. - 2-3 Shift valve (369) stuck. - Checkballs omitted or misassembled. - Damage to pins or seal. - Contamination. - Damaged seals. - Case to valve body face not flat.
HARSH SHIFTS	- Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low) - 28 Fluid Pressure Switch Assembly Fault - 73 Pressure Control Solenoid Current	

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0013-4L60-E

Figure 31 Diagnosis Chart A

CONDITION	INSPECT COMPONENT	FOR CAUSE
HARSH SHIFTS (Continued)	• Throttle Position Sensor • Vehicle Speed Sensor (36) • Pressure Switch Assembly (69) • Trans Fluid Temperature Sensor (69) • Engine Coolant Temperature Sensor • Pressure Control Solenoid (377)	– Open or shorted circuit. – Open or shorted circuit. – Contamination. – Damaged seals. – Open or shorted circuit. – Open or shorted circuit. – Damage to pins or seal. – Contamination.
INACCURATE SHIFT POINTS	• Oil Pump Assembly (4) • Valve Body Assembly (60) • Case (8) • Throttle Position Sensor • Vehicle Speed Sensor (36) • 4WD Low Switch	– Stuck pressure regulator valve (216). – Sticking pump slide (203). – Spacer plate (48) or gaskets (47 and 52) misassembled, damaged or incorrect. – Porous or damaged valve body pad. – 2-4 Servo Assembly (12-29) a. 2-4 accumulator porosity. b. Damaged servo piston seals. c. Apply pin damaged or improper length. – 2-4 Band Assembly (602). a. Burned. b. Anchor pin not engaged. – Disconnected. – Damage. – Disconnected. – Damaged. – Bolt not tightened. – Disconnected. – Damaged.
1ST GEAR STARTS WHILE IN SECOND GEAR START MODE (PONTIAC F-CAR ONLY)	• Second Gear Start Switch	– Open or shorted circuit. (Refer to Second Gear Start Switch Circuit check. Section 6E3-C8.)
EARLY SHIFTS	• Possible Codes: - 69 TCC Stuck "ON"	
FIXED SHIFT POINTS	• Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low)	
1ST GEAR RANGE ONLY – NO UPSHIFT	• Valve Body (60) • Case (8) • Shift Solenoids (379)	– 1-2 Shift valve (366) sticking. – Spacer plate (48) or gaskets (47 and 52) mispositioned or damaged. – Case to valve body face not flat or damaged. – Stuck or damaged. – Electrical connection.
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION		

RH0014-4L60-E-C

Figure 32 Diagnosis Chart B

CONDITION	INSPECT COMPONENT	FOR CAUSE
1ST GEAR RANGE ONLY – NO UPSHIFTS (Continued)	• 2-4 Servo Assembly (12-29) • 2-4 Band Assembly (602)	– Restricted or blocked apply passages case. – Nicks or burrs on servo pin (13) or pin bore in case – 4th Servo piston (25) in backwards. – 2-4 Band (602) worn or damaged. – Band anchor pin not engaged.
SLIPS IN 1ST GEAR	• Forward Clutch Assembly • Forward Clutch Accumulator • Input Housing and Shaft Assembly (621) • Valve Body (60) • Low Roller Clutch (678) • Torque Converter (1) • 1-2 Accumulator Assembly (54-59) • Line Pressure • 2-4 Servo Assembly (12-29)	– Clutch plates (649) worn. – Porosity or damage in forward clutch piston (630). – Forward clutch piston inner and outer seals (629) missing, cut or damaged. – Input housing to forward clutch housing O-ring seal (622) missing, cut or damaged. – Damaged forward clutch housing (628). – Forward clutch housing retainer and ball assembly (627) not sealing or damaged. – Piston seal (353) missing, cut or damaged. – Piston (354) out of its bore. – Porosity in the piston or valve body (350). – Stuck abuse valve (357). – Turbine shaft seals (619) missing, cut or damaged. – 1-2 Accumulator valve (371) stuck. – Face not flat, damaged lands or interconnected passages. – Spacer plate (48) or gaskets (47 and 52) incorrect, mispositioned or damaged. – Damage to lugs or inner ramps. – Rollers not free moving. – Inadequate spring tension. – Damage to inner splines. – Lube passage plugged. – Stator roller clutch not holding. – Porosity in piston (56) or 1-2 Accumulator cover and pin assembly (57). – Damaged ring grooves on piston. – Piston seal (55) missing, cut or damaged. – Valve body to spacer plate gasket (52) at 1-2 Accumulator cover, missing or damaged. – Leak between piston and pin. – Broken 1-2 Accumulator spring (54). – (See Causes of High or Low Oil Pressure.) – 4th Servo piston (25) in backwards.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

RH0015-4L60-E-C

Figure 33 Diagnosis Chart C

CONDITION	INSPECT COMPONENT	FOR CAUSE
SLIPPING OR ROUGH 1-2 SHIFT	- Valve Body Assembly (60) 2-4 Servo Assembly (12-29) 2nd Accumulator (54-59) 2-4 Band (602) - Oil Pump Assembly (4) or Case (8)	1-2 Shift valve train (365-366) stuck. - Gaskets (47 and 52) or spacer plate (48) incorrect, mispositioned or damaged. 1-2 Accumulator valve (371) stuck. - Face not flat. - Apply pin (13) too long or too short. 2nd servo apply piston seal missing, cut or damaged. - Restricted or missing oil passages. - Servo bore in case damaged. - Porosity in 1-2 accumulator housing (57) or piston (56). - Piston seal or groove damaged. - Nicks or burrs in 1-2 accumulator housing. - Missing or restricted oil passage. - Worn or mispositioned. - Faces not flat.
NO 2-3 SHIFT OR 2-3 SHIFT SLIPPING, ROUGH OR HUNTING	- Converter (1) - Oil Pump (4) - Valve Body (60) - Input Housing Assembly (621) - Case (8) 2-4 Servo Assembly (12-29) - Possible Codes: 24 Vehicle Speed Sensor Signal Low 72 Vehicle Speed Sensor Loss	- Internal damage. - Stator shaft (214) sleeve scored or off location. 2-3 Valve train (268-269) stuck. - Accumulator valve (371) stuck. - Spacer plate (48) or gaskets (47 and 52) incorrect, mispositioned or damaged. - Clutch plates worn [3-4 (654) or forward (649)]. - Excessive clutch plate travel. - Cut or damaged piston seals [3-4 (624) or forward (629)]. - Porosity in input clutch housing (621) or piston (623). 3-4 Piston checkball (620) stuck, damaged or not sealing. - Restricted apply passages. - Forward clutch piston retainer and ball assembly (627) not seating. - Sealing balls loose or missing. 3rd Accumulator retainer and ball assembly not seating. 2nd Apply piston seals (18 and 19) missing, cut or damaged.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0016-4L60-E

Figure 34 Diagnosis Chart D

CONDITION	INSPECT COMPONENT	FOR CAUSE
2ND AND 3RD GEARS ONLY OR 1ST AND 4TH GEARS ONLY	• Possible Codes: - 82 1-2 Shift Solenoid Circuit Fault • Shift Solenoids (379)	- Sediment. - Electrical Connection. - Damaged seal.
THIRD GEAR ONLY	• Possible Codes: - 53 System Voltage High - 75 System Voltage Low - 81 2-3 Shift Solenoid Circuit Fault - 84 3-2 Control Solenoid Circuit Fault • System Voltage • 3-2 Control Solenoid (394)	
3-2 FLARE OR TIE-UP	• 3-2 Control Solenoid (394)	- Shorted or damaged. - Contamination. - Damaged seal.
NO 3-4 SHIFT/SLIPPING OR ROUGH 3-4 SHIFT	• Oil Pump Assembly (4) • Valve Body Assembly (60) • 2-4 Servo Assembly (12-29) • Case (8) • Input Housing Assembly (621) • 2-4 Band Assembly (602)	- Faces not flat. - Pump cover retainer and ball assembly omitted or damaged. - Valves stuck. • 2-3 Shift valve (368-369) train. • Accumulator valve (371). • 1-2 Shift valve train (365-366). • 3-2 Control valve (391). - Spacer plate (48) or gaskets (47 and 52) incorrect, mispositioned or damaged. - Incorrect band apply pin (13). - Missing or damaged servo seals (26 and 27). - Porosity in pistons, cover or case. - Damaged piston seal grooves. - Plugged or missing orifice cup plug (11). - 3rd Accumulator retainer and ball assembly leaking. - Porosity in 3-4 accumulator piston (44) or bore. - 3-4 Accumulator piston seal (45) or seal grooves damaged. - Plugged or missing orifice cup plug. - Restricted oil passage. - Refer to Slipping 2-3 Shift. - Worn or misassembled.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

RH0017-4L60-E-C

Figure 35 Diagnosis Chart E

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO 3-4 SHIFT/SLIPPING OR ROUGH 3-4 SHIFT (Continued)	• Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low) - 28 Fluid Pressure Switch Assembly Fault - 37 Brake Switch Stuck "ON" - 38 Brake Switch Stuck "OFF" - 90 TCC Solenoid Circuit Fault	
R NO REVERSE OR SLIPS IN REVERSE	• Input Housing Assembly (621) • Manual Valve Link (705) • Oil Pump Assembly (4) • Valve Body Assembly (60) • Reverse Input Clutch Assembly (605) • Lo And Reverse Clutch	- 3-4 Apply ring (625) stuck in applied position. - Forward clutch not releasing. - Turbine shaft seals (619) missing, cut or damaged. - Disconnected. - Retainer and ball assembly missing or damaged. - Stator shaft seal rings (230) or ring grooves damaged. - Stator shaft sleeve scored or damaged. - Reverse boost valve (219) stuck, damaged or misassembled. - Cup plug missing. - Restricted oil passage. - Faces not flat. - Converter clutch valve (224) stuck. - 2-3 Shift valve (369) stuck. - Manual linkage (705) not adjusted. - Spacer plate (48) and gaskets (47 and 52) incorrect, mispositioned or damaged. - Lo overrun valve (361) stuck. - Orificed cup plug restricted, missing or damaged. - Clutch plate (612) worn. - Reverse input housing and drum assembly (605) cracked at weld. - Clutch plate retaining ring out of groove. - Return spring assembly retaining ring (610) out of groove. - Seals (608) cut or damaged. - Restricted apply passage. - Porosity in piston (607). - Belleville plate (611) installed incorrectly. - Excessive clutch plate travel. - Oversized housing. - Clutch plates (682) worn. - Porosity in piston (695). - Seals (696) damaged. - Return spring assembly retaining ring (693) mispositioned. - Restricted apply passage.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

RH0018-4L60-E-C

Figure 36 Diagnosis Chart F

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO PART THROTTLE OR DELAYED DOWNSHIFTS	• 2-4 Servo Assembly (12-29) • Valve Body Assembly (60)	- Servo cover retaining ring (29) omitted or misassembled. - 4th Apply piston (25) damaged or misassembled. - Servo inner housing (20) damaged or misassembled. - 3-2 Downshift valve (389) stuck. - 4-3 Sequence valve body channel blocked.
HARSH GARAGE SHIFT	• Valve Body Assembly (60)	- Orifice cup plug missing. - Checkball missing.
NO OVERRUN BRAKING - MANUAL 3-2-1	• External Linkage • Valve Body Assembly (60) • Input Clutch Assembly (621)	- Not adjusted properly. - 4-3 Sequence valve (382) stuck. - Checkball mispositioned. - Spacer plate (48) and gaskets (47 and 52) incorrect, damaged or mispositioned. - Turbine shaft oil passages plugged or not drilled. - Turbine shaft seal rings (619) damaged. - Turbine shaft sealing balls loose or missing. - Porosity in forward (630) or overrun clutch piston (632). - Overrun piston seals (631) cut or damaged. - Overrun piston checkball (633) not sealing.
NO TORQUE CONVERTER CLUTCH APPLY	• Electrical • TCC Solenoid • Engine Speed Sensor • Converter (1) • Engine Coolant Temperature Sensor • Oil Pump Assembly (4)	- 12 Volts not supplied to transmission. - Outside electrical connector damaged. - Inside electrical connector, wiring harness or solenoid damaged. - Electrical short (pinched solenoid wire). - Solenoid not grounded. - Internal damage. - Converter clutch valve (224) stuck or assembled backwards. - Converter clutch valve retaining ring (222) mispositioned. - Pump to case gasket (6) mispositioned. - Orifice cup plug restricted or damaged. - Solenoid O-ring seal (67) cut or damaged. - High or uneven bolt torque (pump body to cover).
ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION		

PH0019-4L60-E

Figure 37 Diagnosis Chart G

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO TORQUE CONVERTER CLUTCH APPLY (Continued)	• Trans Fluid Temperature Sensor (69) • Input Housing and Shaft (621) • Brake Switch • Pressure Switch Assembly (69) • Valve Body Assembly (60) • Solenoid Screen • Possible Codes: - 21 Throttle Position Sensor Circuit (High) - 22 Throttle Position Sensor Circuit (Low) - 28 Fluid Pressure Switch Assembly Fault - 37 Brake Switch Stuck "ON" - 38 Brake Switch Stuck "OFF" - 52 Long System Voltage High - 53 System Voltage High - 67 TCC Solenoid Circuit Fault - 75 System Voltage Low - 81 2-3 Shift Solenoid Circuit Fault	- Turbine shaft O-ring seal (618) cut or damaged. - Turbine shaft retainer and ball assembly (617) restricted or damaged. - Contamination. - Damaged seals. - TCC signal valve (380) stuck. - Solenoid O-ring leaking. - Blocked.
TORQUE CONVERTER CLUTCH SHUDDER	• Torque Converter Assembly (1) • Oil Pump Assembly (4) • Oil Filter (72) • Miscellaneous • Input Housing and Shaft Assembly (621)	- Internal damage. - Converter clutch valve (224) stuck. - Restricted oil passage. - Crack in filter body. - Flash restricting filter neck. - O-ring seal (71) cut or damaged. - Low oil pressure. - Engine not tuned properly. - Turbine shaft O-ring (618) cut or damaged. - Turbine shaft retainer and ball assembly (617) restricted or damaged.
TCC APPLY WITH A COLD ENGINE	• Possible Codes: - 14 Engine Coolant Temp Sensor Circuit (High) - 15 Engine Coolant Temp Sensor Circuit (Low)	

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0020-4L60-E

Figure 38 Diagnosis Chart H

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO TORQUE CONVERTER CLUTCH RELEASE	• TCC Solenoid • Converter (1) • Valve Body Assembly (60) • Oil Pump Assembly (4) • PCM	- External ground. - Clogged exhaust orifice. - Internal damage. - Converter clutch apply valve stuck in apply position. - Converter clutch valve (224) stuck. - External ground.
TCC ON IN ALL GEARS	• Possible Codes: - 85 TCC Stuck "On"	
DRIVES IN NEUTRAL	• Forward Clutch • Manual Valve Link (705) • Case (8)	- Not releasing. - Disconnected. - Face not flat. - Internal leakage.
2ND GEAR START (DRIVE RANGE)	• Forward Clutch Sprag Assembly (642)	- Sprag assembly installed backwards.
NO PARK	• Parking Linkage (63, 79-90)	- Actuator rod assembly (85) bent or damaged. - Actuator rod spring binding or improperly crimped. - Actuator rod not attached to inside detent lever (788). - Parking lock bracket (86) damaged or not torqued properly. - Inside detent lever (88) not torqued properly. - Detent roller and spring assembly (63) mispositioned or not torqued properly. - Parking pawl (81) binding or damaged.
RATCHETING NOISE	• Parking Pawl (81)	- Parking pawl return spring (80) weak, damaged or misassembled.
OIL OUT THE VENT	• Oil Pump (4) • Miscellaneous	- Chamfer in pump body rotor pocket too large. - Fluid level - overfilled.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

RH0021-4L60-E-C

Figure 39 Diagnosis Chart I

CONDITION	INSPECT COMPONENT	FOR CAUSE
VIBRATION IN REVERSE AND WHINING NOISE IN PARK	• Oil Pump (4)	– Broken vane rings (210).
NO DRIVE IN ALL RANGES	• Torque Converter (1)	– Converter to flex plate bolts missing.
NO DRIVE IN DRIVE RANGE	• Torque Converter (1)	– Stator roller clutch not holding. – Converter not bolted to flex plate.
FRONT OIL LEAK	• Torque Converter (1) • Torque Converter Seal (243)	– Welded seam leaking. – Damaged converter hub. – Damaged seal assembly. – Missing garter spring.
DELAY IN DRIVE AND REVERSE	• Torque Converter (1)	– Converter drainback.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60-E UNIT REPAIR SECTION

PH0022-4L60-E

Figure 40 Diagnosis Chart J

FLUID LEAK DIAGNOSIS AND REPAIR

The cause of most external leaks can generally be located and repaired with the transmission in the vehicle.

METHODS FOR LOCATING LEAKS

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut the engine off and look for fluid spots on the paper.
6. Make necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder (foot powder) to the suspected leak area.
3. Operate the vehicle for about 15 miles or until normal operating temperatures are reached.
4. Shut the engine off.
5. Inspect the suspected leak area and trace the leak path through the powder to find the source.
6. Make necessary repairs.

Dye and Black Light Method

1. Follow the manufacturer's recommendation for the amount of dye to be used.
2. Find the leak with a black light.
3. Make necessary repairs.

REPAIRING THE LEAK

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check to be sure that the following conditions are correct as they may cause a leak.

Gaskets

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.
- Improperly torqued fasteners or dirty/ damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs, or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant used (where applicable).
- Porosity.

Seals

- Fluid level or pressure is too high.
- Plugged vent or drain-back holes.

- Damaged seal bore (scratched, burred or nicked).
- Damaged or worn seal.
- Improper installation.
- Cracks in component.
- Manual or output shaft surface scratched, nicked, or missing.
- Loose or worn bearing causing excess seal wear.

POSSIBLE POINTS OF OIL LEAKS

1. Transmission and transmission oil pan:
 - Attaching bolts not torqued correctly.
 - Improperly installed or damaged gasket.
 - Oil pan or mounting face not flat.
2. Case Leak:
 - Filler tube multi-lip seal damaged or missing.
 - Filler tube bracket misaligned.
 - Speed sensor seal damaged.
 - Manual shaft seal damaged.
 - Oil cooler connector fittings loose or damaged.
 - Propeller shaft oil seal worn or damaged.
 - Line pressure pipe plug loose.
 - Porous casting.
3. Leak at converter end:
 - Converter seal damaged.
 - Seal lip cut (check converter hub for damage).
 - Bushing moved forward and damaged.
 - Garter spring missing from seal.
 - Converter leak in weld area.
 - Porous casting (case or pump).
4. Fluid comes out vent pipe or fill tube:
 - Overfilled.
 - Water or coolant in fluid (fluid will appear milky).
 - Case porous.
 - Incorrect fluid level indicator.
 - Plugged vent.
 - Drain back holes plugged.
 - The alignment of the oil pump to case gasket (if equipped).

CASE POROSITY REPAIR

1. Clean the leak area with solvent and air dry.

CAUTION: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Mix a sufficient amount of epoxy adhesive (GM P/N 1052533 or equivalent) following the manufacturer's recommendations.
3. While the transmission case is hot, apply epoxy adhesive with a clean, dry soldering acid brush.
4. Allow the epoxy adhesive to cure for three hours before starting the engine.
5. Repeat fluid leak diagnosis procedures.

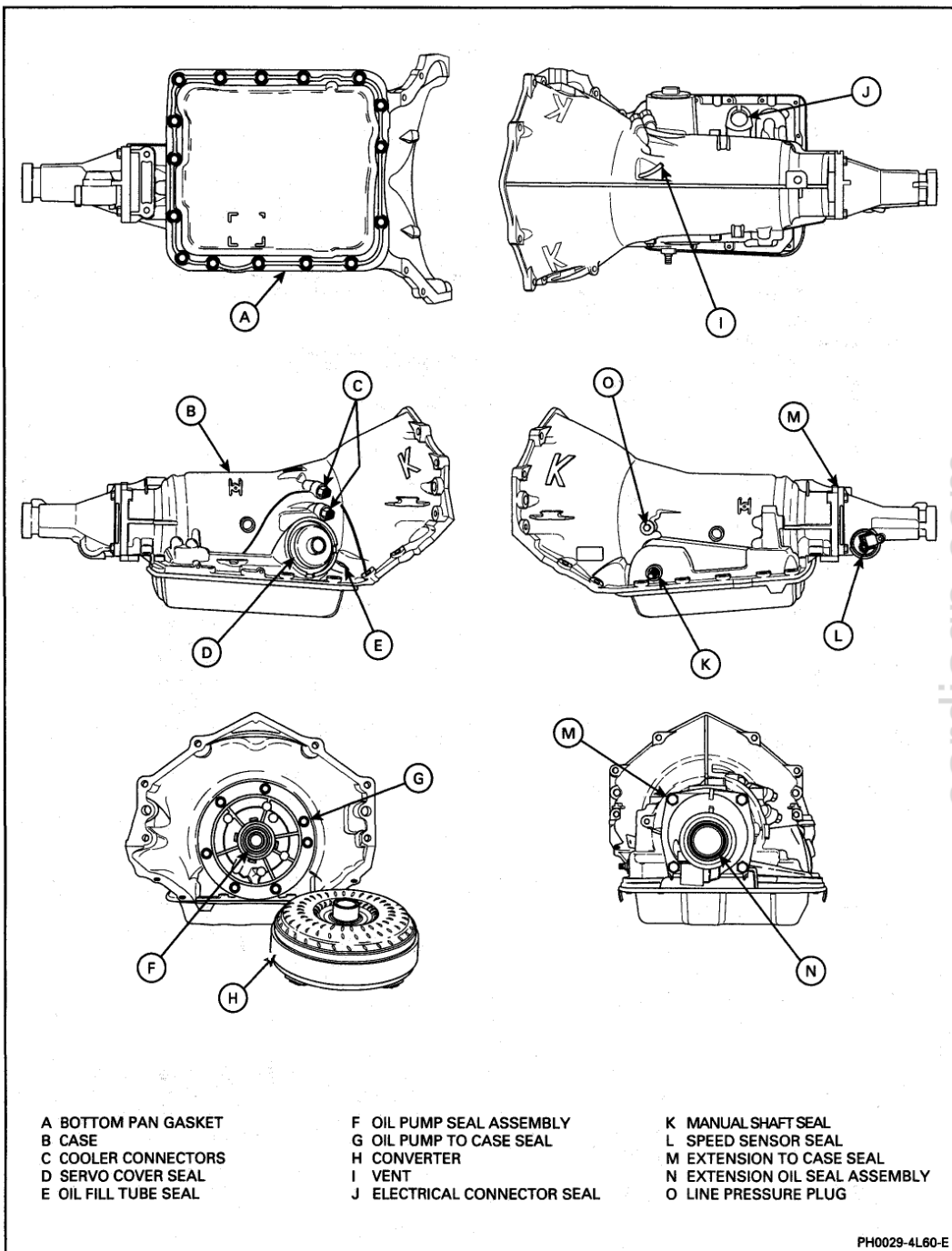
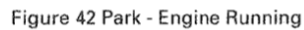


Figure 41 Leak Inspection Points



PARK - (Engine Running)

With the gear selector lever in the Park (P) position and the engine running, line pressure from the oil pump assembly is directed to various components in the valve body and oil pump.

PRESSURE REGULATION

Pressure Regulator Valve: Regulates oil pump output (line pressure) in response to torque signal fluid pressure, spring force and line pressure acting on the end of the valve. Line pressure is routed through the valve and into both the converter feed and decrease fluid circuits. Regulated line pressure is also directed to the manual valve, converter clutch signal valve and actuator feed limit valve.

Pressure Relief Valve: Controlled by spring force, this checkball limits the maximum value of line pressure. When line pressure reaches this limiting value, fluid is exhausted past the ball and returns to the sump.

Line Pressure Tap: Provides a location to measure line pressure with a fluid pressure gage.

Actuator Feed Limit (AFL) Valve: Biased by spring force and orificed AFL fluid, it limits the maximum value of line pressure entering the AFL fluid circuit. Below this limiting value, AFL fluid pressure equals line pressure. AFL fluid is routed to the pressure control solenoid, 3-2 control solenoid, 1-2 and 2-3 shift solenoids, and the 2-3 shift valve train.

Pressure Control Solenoid: Controlled by the Powertrain Control Module (PCM), it regulates filtered AFL fluid into torque signal fluid pressure. This regulation is controlled by varying the current value to the solenoid in relation to throttle position and other vehicle operating conditions.

TORQUE CONVERTER CLUTCH (TCC)

Torque Converter Clutch Signal Valve: The valve may be in a position to allow line pressure to enter the converter clutch (CC) signal fluid circuit. If this occurs with the 2nd clutch fluid circuit empty, CC signal fluid pressure orificed to the end of the CC signal valve will close the valve and block line pressure. Any fluid in the CC signal fluid circuit will exhaust through the normally open and closed TCC solenoid.

Converter Clutch Apply Valve: Held in the release position by spring force, it directs converter feed fluid into the release fluid circuit. Also, fluid returning from the converter in the apply fluid circuit is routed through the valve and into the cooler fluid circuit.

Torque Converter: Release fluid pressure unseats the TCC apply checkball (#9), keeps the pressure plate released from the converter cover and fills the converter with fluid. Fluid exits the converter between the converter hub and stator shaft in the apply fluid circuit.

Cooler and Lubrication System: Cooler fluid from the converter clutch apply valve is routed through the transmission fluid cooler and into the lubrication fluid circuits.

Manual Valve: Controlled by the selector lever and manual shaft, the manual valve is in the Park (P) position and directs line pressure into the PR (Park/Reverse) fluid circuit. Line pressure is blocked from entering any other fluid circuit at the manual valve.

LO AND REVERSE CLUTCH APPLIES

Lo and Reverse Clutch Piston: PR fluid seats the lo/reverse clutch checkball (#10) and is orificed to the outer area of the piston. Orificing PR fluid around the #10 checkball helps control the lo and reverse clutch apply. Also, lo/reverse fluid pressure from the lo overrun valve acts on the inner area of the lo and reverse clutch piston to increase the clutch holding capacity.

Lo Overrun Valve: PR fluid pressure moves the valve against spring force and fills the lo/reverse fluid circuit. Lo/reverse fluid is orificed (#23) back to the lo/overrun valve to assist PR fluid in moving the valve against spring force. Spring force provides a time delay for PR fluid filling the lo/reverse fluid circuit. Lo/reverse fluid is routed to the inner area of the lo and reverse clutch piston to increase the holding capacity of the clutch.

Pressure Switch Assembly (PSA): The PSA consists of five fluid pressure switches: D2 and D3 are normally closed and D4, Lo and Rev are normally open. All fluid circuits routed to the assembly are empty and the PSA signals the PCM that the transmission is in either Park or Neutral.

Shift Solenoids (1-2 and 2-3): Both shift solenoids, which are normally open, are energized by the PCM and block fluid from exhausting. This maintains AFL fluid pressure at solenoid "B" and signal "A" fluid pressure at the 1-2 solenoid.

Shift Valves (1-2, 2-3 and 3-4): Signal "A" fluid pressure holds the 1-2 shift valve in the downshifted position and the 3-4 shift valve in the upshifted (First and Fourth gear) position. AFL fluid pressure from 2-3 shift solenoid holds the 2-3 shift valve train in the downshifted position.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON*	ON*								APPLIED

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

RH0031-4L60-E

Figure 43 Park - Engine Running (Legend)



Figure 44 Reverse

REVERSE

When the gear selector lever is moved to the Reverse (R) position (from the Park position), the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve: The manual valve moves to the Reverse position and line pressure enters the reverse fluid circuit. As in Park, line pressure also fills the PR (Park/Reverse) fluid circuit. All other fluid circuits are blocked by the manual valve.

Lo and Reverse Clutch: As in Park, PR fluid pressure acts on the outer area of the lo and reverse clutch piston to apply the lo and reverse clutch. Also, lo/reverse fluid from the lo overrun valve acts on the inner area of the piston to increase the holding capacity of the clutch (see Note Below).

REVERSE INPUT CLUTCH APPLIES

Reverse Input Checkball (#3): Reverse fluid pressure seats the #3 checkball, flows through orifice #17 and fills the reverse input fluid circuit. This orifice helps control the reverse input clutch apply rate when engine speed is at idle.

Reverse Abuse Valve: Reverse fluid pressure acts on the end of the valve opposite of spring force. At engine speeds above idle, reverse fluid pressure, which is fed by line pressure, increases and moves the valve against spring force (as shown). Reverse fluid can then fill the reverse input fluid circuit through the reverse abuse valve. This bypasses the control of orifice #17 and provides a faster clutch apply.

Boost Valve: Reverse input fluid pressure moves the boost valve against the pressure regulator valve spring. The spring acts on the pressure regulator valve to increase the operating range of line pressure in Reverse. Reverse input fluid also flows through the valve and to the reverse input clutch piston. Remember that torque signal fluid pressure continually acts on the boost valve to control line pressure in response to vehicle operating conditions.

Reverse Input Clutch Piston: Reverse input fluid pressure moves the piston to apply the reverse input clutch plates and obtain Reverse.

Reverse Input Air Bleed Checkball: This ball and capsule is located in the reverse input fluid circuit in the oil pump to provide an air escape when the fluid pressure increases. It also allows air into the circuit to displace the fluid when the clutch releases.

Pressure Switch Assembly (PSA): Reverse input fluid pressure closes the normally open reverse switch in the PSA. This signals the PCM that the manual valve is in the Reverse (R) position.

Shift Solenoids (1-2 and 2-3): Both solenoids are energized as in Park range. Signal "A" and actuator feed limit (AFL) fluids are blocked from exhausting through the shift solenoids to maintain fluid pressure in these circuits at the end of the shift valves.

Shift Valves (1-2, 2-3 and 3-4): Signal "A" fluid pressure holds the 1-2 shift valve in the downshifted position and the 3-4 shift valve in the upshifted (First and Fourth gear) position. AFL fluid pressure from shift the 2-3 solenoid holds the 2-3 shift valve train in the downshifted position.

Pressure Control Solenoid: It continues to regulate AFL fluid into torque signal fluid pressure. The PCM varies the current at the solenoid to regulate torque signal fluid pressure in response to throttle position and other PCM input signals. Torque signal fluid pressure is used to control line pressure at the boost and pressure regulator valves.

Note: The explanation in each gear range is, for the most part, limited to what changes from the range on the previous page. However, some component descriptions are repeated for clarity and continuity. Also, refer to the appropriate General Motors Service Manual for specific fluid pressure information.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON*	ON*		APPLIED						APPLIED

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

RH0033-4L60-E

Figure 45 Reverse (Legend)

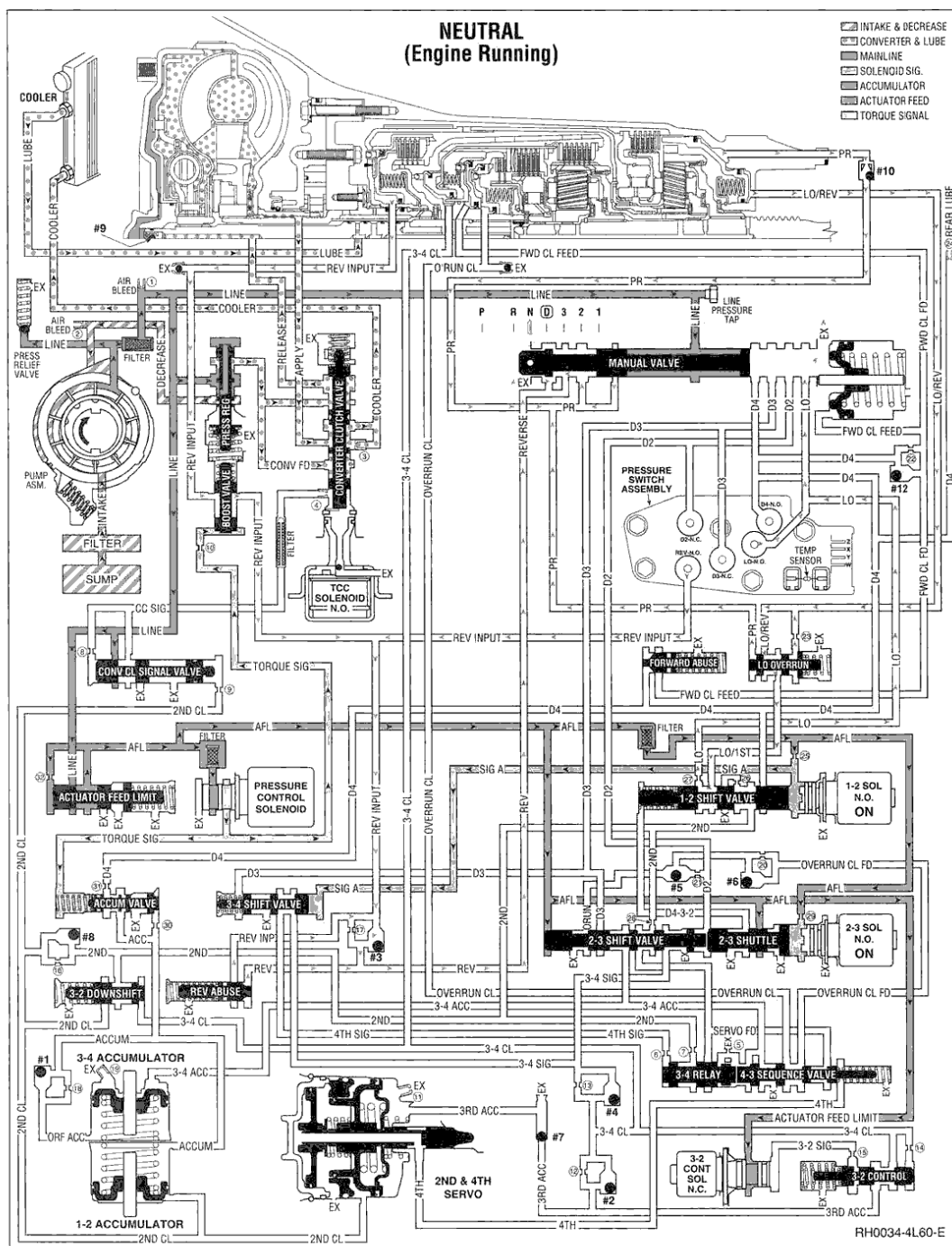


Figure 46 Neutral - Engine Running

NEUTRAL - (Engine Running)

When the gear selector lever is moved to the Neutral position (N), from the Reverse position, the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve: In the Neutral position, the manual valve blocks line pressure from entering any other fluid circuits. Reverse and PR fluids exhaust past the manual valve.

LO and REVERSE CLUTCH RELEASES

Lo and Reverse Clutch Piston: PR and lo/reverse fluids exhaust from the piston, thereby releasing the lo and reverse clutch plates. Exhausting PR fluid unseats the lo/reverse checkball (#10) for a quick exhaust.

Lo Overrun Valve: Spring force closes the valve when PR fluid pressure exhausts. Lo/reverse fluid exhausts through the valve, into the lo/1st fluid circuit, past the 1-2 shift valve, into the lo fluid circuit and through an exhaust port at the manual valve.

REVERSE INPUT CLUTCH RELEASES

Reverse Input Clutch Piston: Reverse input fluid pressure exhausts from the piston, through the boost valve, past the #3 checkball and to the manual valve. With reverse input fluid exhausted, the reverse input clutch plates are released and the transmission is in Neutral.

Reverse Abuse Valve: Reverse fluid pressure exhausts and spring force closes the valve.

Boost Valve: Reverse input fluid pressure exhausts and line pressure returns to the normal operating range as in the Park and Overdrive positions.

Reverse Input Checkball (#3): Exhausting reverse input fluid unseats the ball for a quick exhaust through the reverse fluid circuit and past the manual valve.

Pressure Switch Assembly (PSA): Reverse input fluid exhausts from the PSA. With no other fluid routed to it, the PSA signals the PCM that the transmission is operating in either Park or Neutral.

Note: In Park, Reverse, and Neutral the shift solenoids are shown energized. This is the normal operating state when the vehicle is stationary or at low vehicle speeds. However, the PCM will change the shift solenoid states depending on vehicle speed. For example, if Neutral is selected when the transmission is operating in Second Gear, the shift solenoids will remain in a Second Gear state. However, with the manual valve blocking line pressure, the shift solenoid states do not affect transmission operation in Park, Reverse and Neutral.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON*	ON*								

* SHIFT SOLENOID STATE IS A FUNCTION OF VEHICLE SPEED AND MAY CHANGE IF VEHICLE SPEED INCREASES SUFFICIENTLY IN PARK, REVERSE OR NEUTRAL. HOWEVER, THIS DOES NOT AFFECT TRANSMISSION OPERATION.

RH0035-4L60-E

Figure 47 Neutral - Engine Running (Legend)

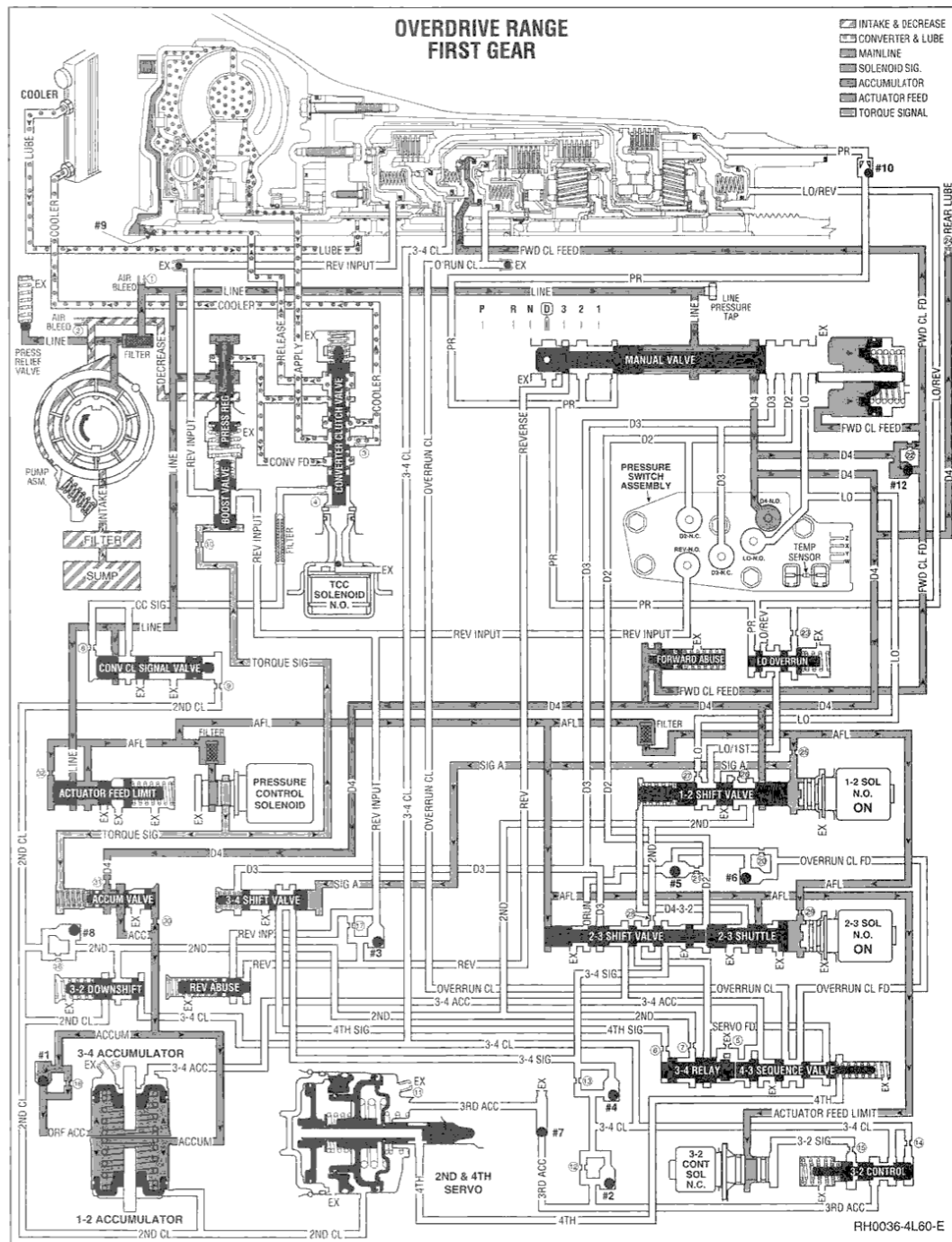


Figure 48 Overdrive Range - First Gear

OVERDRIVE RANGE - FIRST GEAR

When the gear selector lever is moved to the Overdrive (D) position, from the Neutral position, the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve: Line pressure flows through the manual valve and fills the D4 fluid circuit. All other fluid circuits remain empty with the manual valve in the Overdrive position.

FORWARD CLUTCH APPLIES

Forward Clutch Accumulator Checkball (#12): D4 fluid pressure seats the ball and is orificed (#22) into the forward clutch feed fluid circuit. This orifice helps control the forward clutch apply rate.

Forward Clutch Piston: Forward clutch feed fluid pressure moves the piston to apply the forward clutch plates and obtain First gear.

Forward Clutch Accumulator Piston: Forward clutch feed fluid pressure moves the piston against spring force. This action absorbs some of the initial increase of forward clutch feed fluid pressure to cushion the forward clutch apply.

Forward Clutch Abuse Valve: D4 fluid pressure acts on the valve opposite of spring force. At engine speeds greater than idle, D4 fluid pressure increases and moves the valve against spring force (as shown). D4 fluid can then quickly fill the forward clutch feed fluid circuit, thereby bypassing the control of orifice #22 and providing a faster apply of the forward clutch. Otherwise, with increased throttle opening and engine torque, the clutch may slip during apply.

Pressure Switch Assembly (PSA): D4 fluid pressure is routed to the PSA and closes the normally open D4 fluid pressure switch. This signals the PCM that the transmission is operating in Overdrive range.

1-2 Shift Solenoid: Energized (ON) as in Neutral, the normally open solenoid is closed and blocks signal "A" fluid from exhausting through the solenoid. This maintains pressure in the signal "A" fluid circuit.

2-3 Shift Solenoid: Energized (ON) as in Neutral, the normally open solenoid is closed and blocks actuator feed limit (AFL) fluid from exhausting through the solenoid. This maintains AFL fluid pressure at the solenoid end of the 2-3 shift valve.

2-3 Shift Valve Train: AFL fluid pressure at the solenoid end of the 2-3 shift valve holds the valve train in the downshifted position against AFL fluid pressure acting on the 2-3 shuttle valve. In this position, the 2-3 shift valve blocks AFL fluid from entering the D432 fluid circuit. The D432 fluid circuit is open to an exhaust port past the valve.

1-2 Shift Valve: Signal "A" fluid pressure holds the valve in the downshifted position against spring force. In the First gear position the valve blocks D4 fluid from entering the 2nd fluid circuit.

Accumulator Valve: Biased by torque signal fluid pressure, spring force and orificed accumulator fluid pressure at the end of the valve, the accumulator valve regulates D4 fluid into accumulator fluid pressure. Accumulator fluid is routed to both the 1-2 and 3-4 accumulator assemblies in preparation for the 1-2 and 3-4 upshifts respectively.

Rear Lube: D4 fluid is routed through an orifice cup plug (#24) in the rear of the transmission case to feed the rear lube fluid circuit.

Pressure Control Solenoid: Remember that the pressure control solenoid continually varies torque signal fluid pressure in relation to throttle position and vehicle operating conditions. This provides a precise control of line pressure.

3-2 Control Solenoid: The PCM keeps the solenoid OFF in First gear and the normally closed solenoid blocks AFL fluid from entering the 3-2 signal fluid circuit.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON	ON				APPLIED	HOLDING		HOLDING	

RH0037-4L60-E

Figure 49 Overdrive Range - First Gear (Legend)



Figure 50 Overdrive Range - Second Gear

OVERDRIVE RANGE - SECOND GEAR

As vehicle speed increases, and other operating conditions are appropriate, the PCM de-energizes the 1-2 shift solenoid to shift the transmission into Second gear.

1-2 Shift Solenoid: De-energized (turned OFF) by the PCM, the normally open solenoid opens and signal "A" fluid exhausts through the solenoid.

Note: Actuator feed limit (AFL) fluid continues to feed the signal "A" fluid circuit through orifice #25. However, the exhaust port through the solenoid is larger than orifice #25 to prevent a pressure buildup in the signal "A" fluid circuit. Exhausting signal "A" fluid is represented by the blue arrows.

2-3 Shift Solenoid: Energized (ON) as in First gear, it blocks AFL fluid from exhausting through the solenoid. This maintains AFL fluid pressure at the solenoid end of the 2-3 shift valve.

2-4 BAND APPLIES

1-2 Shift Valve: Without signal "A" fluid pressure, spring force moves the valve into the upshifted position. D4 fluid is routed through the valve and fills the 2nd fluid circuit.

1-2 Shift Checkball (#8): 2nd fluid pressure seats the #8 checkball, flows through orifice #16 and fills the 2nd clutch fluid circuit. This orifice helps control the 2-4 band apply rate.

2-4 Servo Assembly: 2nd clutch fluid pressure moves the 2nd apply piston against servo cushion and servo return spring forces. The apply piston moves the band apply pin to apply the 2-4 band. These spring forces help control the 2-4 band apply rate.

1-2 Accumulator: 2nd clutch fluid pressure also moves the 1-2 accumulator piston against spring force and accumulator fluid pressure. This action absorbs initial 2nd clutch fluid pressure to cushion the 2-4 band apply rate. Also, the movement of the 1-2 accumulator piston forces some accumulator fluid out of the accumulator assembly. This accumulator fluid is routed back to the accumulator valve.

Accumulator Valve: Accumulator fluid forced out of the 1-2 accumulator is orificed (#30) to the end of the accumulator valve. This pressure moves the valve against spring force and torque signal fluid pressure to regulate the exhaust of excess accumulator fluid. This regulation provides additional control for the 2-4 band apply rate. The oil circuit shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.

2-3 Shift Valve Train: AFL fluid pressure from the 2-3 shift solenoid holds the valve train in the downshifted position. 2nd fluid is routed through the 2-3 shuttle valve and fills the servo feed fluid circuit.

3-4 Relay Valve and 4-3 Sequence Valve: Spring force holds these valves in the downshifted position (First, Second and Third gear position). 2nd fluid is blocked by the 3-4 relay valve and servo feed fluid is blocked by both valves in preparation for a 3-4 upshift.

3-2 Downshift Valve: Spring force holds the valve closed, blocking 2nd fluid and 2nd clutch fluid. This valve is used to help control the 3-2 downshift.

3-2 Control Solenoid: In Second gear, the PCM operates the normally closed solenoid at approximately a 90% duty cycle. This opens the AFL fluid circuit to fill the 3-2 signal fluid circuit (at 100% duty cycle the AFL fluid circuit is completely open).

3-2 Control Valve: 3-2 signal fluid pressure moves the valve against spring force. This action does not affect the transmission operation in Second gear.

3-4 Shift Valve: Signal "A" fluid pressure exhausts and spring force moves the valve into the downshift position (Second and Third gear position).

TORQUE CONVERTER CLUTCH

Converter Clutch Signal Valve: 2nd clutch fluid pressure opens the valve and line pressure feeds the converter clutch (CC) signal fluid circuit. CC signal fluid is orificed (#8) to the end of the CC signal valve and opposes 2nd clutch fluid pressure. CC signal fluid is routed through a filter and orificed (#4) to the TCC solenoid.

TCC Solenoid: Under normal operating conditions in Second gear the PCM keeps the normally open TCC solenoid de-energized (OFF). CC signal fluid exhausts through the open solenoid and spring force keeps the converter clutch apply valve in the release position.

Note: The orifice cup plug (#4) in the CC signal fluid circuit is smaller than the exhaust through the TCC solenoid. Therefore, fluid pressure does not build up at the end of the converter clutch apply valve.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRING CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	ON	APPLIED			APPLIED	HOLDING			

RH0039-4L60-E

Figure 51 Overdrive Range - Second Gear (Legend)



Figure 52 Overdrive Range - Third Gear

OVERDRIVE RANGE - THIRD GEAR

As vehicle speed increases further, and other vehicle operating conditions are appropriate, the PCM de-energizes the normally open the 2-3 shift solenoid to shift the transmission into Third gear.

2-3 Shift Solenoid: De-energized (turned OFF) by the PCM, the solenoid opens and actuator feed limit (AFL) fluid exhausts through the solenoid.

Note: AFL fluid continues to feed the solenoid through orifice #29. However, the exhaust port through the solenoid is larger than orifice #29 to prevent a buildup of pressure in the AFL fluid circuit at the solenoid end of the 2-3 shift valve. Exhausting AFL fluid is represented by the arrows through the solenoid.

3-4 CLUTCH APPLIES

2-3 Shift Valve Train: AFL fluid pressure at the 2-3 shuttle valve moves the valve train toward the solenoid. In the upshifted position the following changes occur:

- AFL fluid is routed through the 2-3 shift valve and fills the D432 fluid circuit.
- 2nd fluid is blocked from entering the servo feed fluid circuit and is orificed (#28) into the 3-4 signal fluid circuit. This orifice helps control the 3-4 clutch apply rate.
- Servo feed fluid exhausts past the valve, into the 3-4 accumulator fluid circuit and through an exhaust port at the 3-4 relay valve.

3-4 Clutch Exhaust Checkball (#4): 3-4 signal fluid unseats the ball and enters the 3-4 clutch fluid circuit.

3-4 Clutch Piston: 3-4 clutch fluid pressure moves the piston to apply the 3-4 clutch plates and obtain 3rd gear. However, the 2-4 band must release as the 3-4 clutch applies.

2-4 BAND RELEASES and

3-4 CLUTCH ACCUMULATION

3rd Accumulator Checkball (#2): 3-4 clutch fluid pressure unseats the ball and fills the 3rd accumulator fluid circuit.

3rd Accumulator Exhaust Checkball (#7): 3rd accumulator fluid seats the ball against the orificed exhaust and is routed to the release side of the 2nd apply piston. Before the #7 checkball seats, air in the 3rd accumulator fluid circuit is exhausted through the orifice.

2-4 Servo Assembly: 3rd accumulator fluid pressure acts on the release side of the 2nd apply piston and assists servo return spring force. The surface area on the release side of the piston is greater than the surface area on the apply side. Therefore, 3rd accumulator fluid pressure and servo return

spring force move the 2nd apply piston against 2nd clutch fluid pressure. This action serves two functions:

1. Move the apply pin to release the 2-4 band.
2. Act as an accumulator by absorbing initial 3-4 clutch fluid to cushion the 3-4 clutch apply rate. Remember that the 3rd accumulator fluid circuit is fed by 3-4 clutch fluid.

3-2 Downshift Valve: 3-4 clutch fluid pressure moves the valve against spring force. This opens the valve and allows 2nd fluid to feed the 2nd clutch fluid circuit through the valve.

3-2 Control Solenoid and 3-2 Control Valve: The solenoid remains at approximately 90% duty cycle and routes AFL fluid into the 3-2 signal fluid circuit. 3-2 signal fluid pressure holds the 3-2 control valve against spring force, thereby blocking the 3rd accumulator and 3-4 clutch fluid circuits.

1-2 Shift Solenoid and 1-2 Shift Valve: The 1-2 shift solenoid remains de-energized and signal "A" fluid is exhausted through the solenoid. Also, D432 fluid pressure from the 2-3 shift valve assists spring force to hold the 1-2 shift valve in the upshifted position.

3-4 Shift Valve: Spring force holds the valve in the downshifted position, blocking 3-4 clutch fluid in preparation for a 3-4 upshift.

TORQUE CONVERTER CLUTCH

TCC Solenoid: Under normal operating conditions in Overdrive Range - Third Gear the PCM keeps the normally open TCC solenoid de-energized. CC signal fluid exhausts through the open solenoid and spring force keeps the converter clutch apply valve in the release position. However, at speeds above approximately 121 km/h (75 mph) the PCM will command TCC apply in Third gear.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRING CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	OFF				APPLIED	HOLDING	APPLIED		

RH0041-4L60-E

Figure 53 Overdrive Range - Third Gear (Legend)



Figure 54 Overdrive Range - Fourth Gear – Converter Clutch Applied

OVERDRIVE RANGE - FOURTH GEAR

Converter Clutch Applied

At higher vehicle speeds, the Hydra-matic 4L60-E transmission uses an Overdrive gear ratio (Fourth gear) to increase fuel economy and maximize engine performance. When vehicle operating conditions are appropriate, the PCM energizes the 1-2 shift solenoid to shift the transmission into Fourth gear.

1-2 Shift Solenoid: Energized (turned ON) by the PCM, the normally open solenoid closes and blocks signal "A" fluid from exhausting through the solenoid. This creates pressure in the signal "A" fluid circuit.

2-3 Shift Solenoid: De-energized (OFF) as in Third gear, it exhausts actuator feed limit (AFL) fluid through the solenoid.

1-2 Shift Valve: D432 fluid pressure from the 2-3 shift valve and spring force hold the valve in the upshifted position against signal "A" fluid pressure.

2-4 BAND APPLIES

3-4 Shift Valve: Signal "A" fluid pressure moves the valve into the upshifted position against spring force. In this position, the valve routes 3-4 signal fluid into the 4th signal fluid circuit.

3-4 Relay Valve and 4-3 Sequence Valve: 4th signal fluid pressure moves both valves into the upshifted (Fourth gear) position against spring force acting on the 4-3 sequence valve. This causes the following changes:

- Orificed (#7) 2nd fluid is routed through the 3-4 relay valve and into the servo feed fluid circuit.
- Servo feed fluid is routed through the 4-3 sequence valve and into the 4th fluid circuit.
- 3-4 accumulator fluid routed from the 2-3 shuttle valve is blocked by both valves.

2-4 Servo Assembly: 4th fluid is routed through the center of the servo pin and acts on the apply side of the 4th apply piston. 4th fluid pressure moves the 4th apply piston against the apply pin spring force acting on the release side of the 4th apply piston. This action moves the apply pin and applies the 2-4 band to obtain Fourth gear.

2-4 BAND APPLY ACCUMULATION

2-3 Shift Valve Train: The valve train remains in the upshifted position with AFL fluid pressure acting on the 2-3 shuttle valve. In addition to its operation in Third gear, the 2-3 shift valve directs servo feed fluid into the 3-4 accumulator fluid circuit.

3-4 Accumulator Assembly: 3-4 accumulator fluid pressure moves the 3-4 accumulator piston against spring force and orificed accumulator fluid pressure. This action absorbs initial 4th clutch apply fluid pressure to cushion the 2-4 band apply. Remember that both the 3-4 accumulator and 4th fluid circuits are fed by servo feed fluid. As 3-4 accumulator fluid fills the accumulator, any air in the system will exhaust through orifice #19. The piston movement forces some orificed accumulator fluid out of the 3-4 accumulator assembly.

3-4 Accumulator Checkball (#1): The accumulator fluid forced from the accumulator unseats the #1 checkball and enters the accumulator fluid circuit. This fluid is routed to the accumulator valve. This is shown by the arrow directions in the oil circuit.

Accumulator Valve: Accumulator fluid forced from the 3-4 accumulator is orificed to the end of the accumulator valve. This fluid pressure, in addition to spring force and torque signal fluid pressure, regulates the exhaust of excess accumulator fluid pressure through the middle of the valve. This regulation helps control the 2-4 band apply feel.

3-2 Control Solenoid and 3-2 Control Valve: Similar to Third gear, the PCM operates the solenoid at approximately a 90% duty cycle, AFL fluid fills the 3-2 signal fluid circuit and 3-2 signal fluid pressure holds the 3-2 control valve against spring force.

TORQUE CONVERTER CLUTCH APPLIES

TCC Solenoid: When operating conditions are appropriate, the PCM energizes the normally open TCC solenoid. This closes the solenoid, blocks converter clutch signal fluid from exhausting and creates pressure in the converter clutch signal fluid circuit.

Converter Clutch Apply Valve: Converter clutch signal fluid pressure moves the valve against spring force and into the apply position. In this position, release fluid is open to an exhaust port and converter feed fluid fills the apply fluid circuit. Converter feed fluid also feeds the cooler fluid circuit through orifice #3.

Torque Converter: Release fluid from behind the pressure plate exhausts through the end of the turbine shaft. Apply fluid pressure is routed between the converter hub and stator shaft where it enters the torque converter. This fluid applies the converter clutch against the converter cover and keeps the converter filled with fluid.

TCC Apply Checkball (#9): Release fluid exhausting from the converter seats the #9 checkball, located in the end of the turbine shaft, and is orificed around the ball. Orificing the exhausting release fluid controls the converter clutch apply rate.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
ON	OFF	APPLIED			APPLIED		APPLIED		

RH0043-4L60-E

Figure 55 Overdrive Range - Fourth Gear - Converter Clutch Applied (Legend)



Figure 56 Overdrive Range – 4-3 Downshift

OVERDRIVE RANGE: 4-3 DOWNSHIFT

When the transmission is operating in Fourth gear, a forced 4-3 downshift will occur if there is a significant increase in throttle position. At minimum throttle, vehicle speed will decrease gradually (coastdown) and the PCM will command a 4-3 downshift. The PCM will also initiate a forced 4-3 downshift when throttle position remains constant but engine load is increased, such as driving up a steep incline. To achieve a 4-3 downshift, the PCM de-energizes the 1-2 shift solenoid and the following changes occur to the transmissions electrical and hydraulic systems:

1-2 Shift Solenoid: De-energized by PCM, the normally open solenoid opens and signal "A" fluid exhausts through the solenoid.

1-2 Shift Valve: As in Fourth gear, D432 fluid pressure and spring force hold the valve in the upshifted position.

2-4 BAND RELEASES

3-4 Shift Valve: With signal "A" fluid pressure exhausted, spring force moves the valve into the downshifted position. In this position, the valve blocks 3-4 signal fluid and 4th signal fluid exhausts past the valve.

3-4 Relay Valve and 4-3 Sequence Valve: These valves control the timing of the 2-4 band release. With 4th signal fluid pressure exhausted, 3-4 accumulator fluid pressure moves the 3-4 relay valve into the Third gear position. This opens 3-4 accumulator fluid to an orificed exhaust (#5) past the 3-4 relay valve (shown by red arrows). Because the exhaust is orificed, 3-4 accumulator fluid pressure momentarily holds the 4-3 sequence valve against spring force before completely exhausting.

When exhausting 3-4 accumulator fluid pressure decreases sufficiently, spring force will move the 4-3 sequence valve into the Third gear position as shown. This opens both the 3-4 accumulator and 4th fluid circuits to a quick exhaust past the 4-3 sequence valve. In this position the valve blocks 2nd fluid from entering the servo feed fluid circuit.

2-4 Servo Assembly: 4th fluid exhausts from the 4th apply piston in the servo assembly. The apply pin spring moves the 4th apply piston and apply pin to release the band from the reverse input drum and shift the transmission into Third gear.

3-4 Accumulator Assembly: 3-4 accumulator fluid exhausts from the 3-4 accumulator piston. Orificed accumulator fluid pressure and spring force move the piston to a Third gear position.

3-4 Accumulator Checkball (#1): As accumulator fluid fills the 3-4 accumulator it seats the #1 checkball and is forced through orifice #18. This orifice controls the rate at which accumulator fluid pressure fills the 3-4 accumulator and 3-4 accumulator fluid exhausts from the accumulator assembly.

Accumulator Valve: Biased by torque signal fluid pressure and spring force, the accumulator valve regulates drive fluid into the accumulator fluid circuit.

2-3 Shift Solenoid: This solenoid remains de-energized as in Fourth gear and AFL fluid exhausts through the solenoid.

2-3 Shift Valve Train: AFL fluid pressure at the 2-3 shuttle valve holds the valves in the upshifted position. This allows servo feed fluid to exhaust through the valve, into the 3-4 accumulator fluid circuit and past the 4-3 sequence valve.

Torque Converter Clutch: The PCM releases the converter clutch prior to initiating the 4-3 downshift. However, if vehicle speed is above approximately 121 km/h (75 mph), the PCM will command TCC apply in Third gear.

Pressure Control Solenoid: Remember that the force motor continually adjusts torque signal fluid pressure in relation to the various PCM input signals (mainly throttle position).

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	OFF				APPLIED	HOLDING	APPLIED		

RH0045-4L60-E

Figure 57 Overdrive Range - 4-3 Downshift (Legend)



Figure 58 Overdrive Range – 3-2 Downshift

OVERDRIVE RANGE: 3-2 DOWNSHIFT

Similar to a forced 4-3 downshift, a forced 3-2 downshift can occur due to minimum throttle (coastdown conditions), heavy throttle or increased engine load. To achieve a forced 3-2 downshift, the PCM energizes the 2-3 shift solenoid and the following changes occur:

2-3 Shift Solenoid: Energized by the PCM, the normally open solenoid closes and blocks actuator feed limit (AFL) fluid from exhausting through the solenoid. This creates pressure in the AFL fluid circuit at the solenoid end of the 2-3 shift valve.

2-3 Shift Valve Train: AFL fluid pressure from the shift solenoid moves both valves to the downshifted position against AFL fluid pressure acting on the 2-3 shuttle valve. This causes the following changes:

- AFL fluid is blocked from the D432 fluid circuit and D432 fluid exhausts past the 2-3 shift valve.
- 2nd fluid is blocked from feeding the 3-4 signal fluid circuit and 2nd fluid is routed into the servo feed fluid circuit.
- 3-4 signal fluid is exhausted past the valve. 3-4 clutch fluid and 3rd accumulator fluid, which were fed by 3-4 signal fluid, also exhaust.

3-4 CLUTCH RELEASES and 2-4 BAND APPLIES

3-4 Clutch Piston: 3-4 clutch fluid exhausts from the piston and the 3-4 clutch plates are released.

3-4 Clutch Exhaust Checkball (#4): Exhausting 3-4 clutch fluid seats the #4 checkball and is forced through orifice #13. This orifice controls 3-4 clutch fluid exhaust and the 3-4 clutch release rate.

2-4 Servo Assembly: 3rd accumulator fluid exhausts from the servo assembly. 2nd clutch fluid pressure moves the 2nd apply piston against servo return spring force to move the apply pin and apply the 2-4 band.

3-2 Downshift Valve and 1-2 Upshift Checkball (#8): 3-4 clutch fluid exhausts from the valve and spring force moves the valve into the Second gear position. However, before spring force overcomes exhausting 3-4 clutch fluid pressure, 2nd fluid feeds the 2nd clutch fluid circuit through the valve. This bypasses the control of orifice #16 at the #8 checkball and provides a faster 2-4 band apply. Remember that the #8 checkball and orifice #16 are used to help control the 2-4 band apply during a 1-2 upshift.

DOWNSHIFT TIMING and CONTROL

At higher vehicle speeds the 2-4 band apply must be delayed to allow engine speed RPM to increase sufficiently for a smooth transfer of engine load to the 2-4 band. Therefore, exhaust of 3rd accumulator fluid must be delayed. However, at lower speeds the band must be applied quickly. To provide for the varying requirements for the 2-4 band apply rate,

exhausting 3rd accumulator fluid is routed to both the 3rd accumulator checkball (#2) and the 3-2 control valve.

3rd Accumulator Checkball (#2): Exhausting 3rd accumulator fluid seats the #2 ball and is forced through orifice #12. This fluid exhausts through the 3-4 clutch and 3-4 signal fluid circuits and past the 2-3 shuttle valve. Orifice #12 slows the exhaust of 3rd accumulator fluid and delays the 2-4 band apply rate.

Note: The #12 orifice is not used on some models. For these models, all of the exhausting 3rd accumulator fluid is routed to the 3-2 control valve when the #2 checkball seats.

3-2 Control Solenoid and 3-2 Control Valve: These components are used to increase the exhaust rate of 3rd accumulator fluid; as needed depending on vehicle speed. The normally closed 3-2 control solenoid is Pulse Width Modulated (PWM) and controlled by the PCM through a duty cycle operation. The PCM decreases the solenoid's duty cycle during a 3-2 downshift from approximately 90% to as low as 10%. Once the shift is complete the solenoid returns to a 90% duty cycle. The duty cycle value during the shift controls the 2-4 band apply rate.

- At lower vehicle speed the PCM operates the 3-2 control solenoid at a lower duty cycle during the shift.
- At a lower duty cycle the solenoid regulates 3-2 signal fluid to a lower pressure.
- With lower 3-2 signal fluid pressure, 3-2 control valve spring force opens the valve farther to regulate a faster exhaust of 3rd accumulator fluid into the 3-4 clutch fluid circuit (as shown).
- A faster exhaust of 3rd accumulator exhaust provides a faster apply of the 2-4 band, as needed at lower speeds.

3rd Accumulator Exhaust Checkball (#7): After the downshift is completed, the #7 checkball unseats and allows residual fluid in the 3rd accumulator fluid circuit to exhaust.

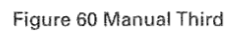
Pressure Control Solenoid: Remember that the pressure control solenoid continually adjusts torque signal fluid in relation to the various PCM input signals (mainly throttle position).

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERDRIVE CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	ON	APPLIED			APPLIED	HOLDING			

RH0047-4L60-E

Figure 59 Overdrive Range – 3-2 Downshift (Legend)



DRIVE RANGE - MANUAL THIRD (from Overdrive Range - Fourth Gear)

A manual 4-3 downshift is available to increase vehicle performance when the use of only three gear ratios is desired. Manual Third gear range also provides engine braking in Third gear when the throttle is released. A manual 4-3 downshift is accomplished by moving the selector lever into the Manual Third (D) position. This moves the manual valve and immediately downshifts the transmission into Third gear. Refer to *Overdrive Range: 4-3 Downshift* for a complete description of a 4-3 downshift. In Manual Third, the transmission is prevented, both hydraulically and electronically, from shifting into Fourth gear. The following information explains the additional changes during a manual 4-3 downshift as compared to a forced 4-3 downshift.

Manual Valve: The selector lever moves the manual shaft and manual valve into the Manual Third position (D). This allows line pressure to enter the D3 fluid circuit.

Pressure Switch Assembly (PSA): D3 fluid is routed to the PSA and opens the normally closed D3 fluid pressure switch. The combination of the opened D3 switch and the closed D4 switch signals the PCM that the transmission is operating in Manual Third.

FOURTH GEAR PREVENTED

1-2 Shift Solenoid: When Manual Third is selected, the PCM de-energizes the 1-2 shift solenoid to immediately downshift the transmission into Third gear. This electronically prevents Fourth gear.

3-4 Shift Valve: D3 fluid pressure assists spring force to keep the valve in the downshifted position against the signal "A" fluid circuit. In this position the valve blocks 3-4 signal fluid and the 4th signal fluid circuit is open to an exhaust port past the valve. Therefore, with D3 fluid pressure assisting spring force, Fourth gear is hydraulically prevented.

OVERRUN CLUTCH APPLIED

2-3 Shift Valve Train: With the 2-3 shift solenoid de-energized and open, actuator feed limit (AFL) fluid acting on the 2-3 shuttle valve holds both valves in the upshifted position. This allows D3 fluid to feed the overrun fluid circuit through the 2-3 shuttle valve.

Overrun Clutch Feed Checkball (#5): Overrun fluid pressure seats the ball against the empty D2 fluid circuit.

Overrun Clutch Control Checkball (#6): Overrun fluid pressure seats the #6 checkball and is orificed (#20) to fill the overrun clutch feed fluid circuit. This orifice controls the overrun clutch apply rate.

3-4 Relay Valve and 4-3 Sequence Valve: 4th signal fluid pressure is exhausted from the end of the 3-4 relay valve. Overrun clutch feed fluid pressure assists spring force and closes both valves. This allows overrun clutch feed fluid to flow through the 4-3 sequence valve and fill the overrun clutch fluid circuit.

Overrun Clutch Piston: Overrun clutch fluid pressure moves the piston to apply the overrun clutch plates. The overrun

clutch plates provide engine compression braking in Manual Third - Third Gear.

Overrun Clutch Air Bleed Checkball: This ball and cap-sule is located in the overrun clutch fluid circuit in the oil pump. It allows air to exhaust from the circuit as fluid pressure increases and also allows air into the circuit to displace the fluid when the clutch releases.

Torque Converter Clutch: The PCM de-energizes the TCC solenoid to release the converter clutch prior to downshifting (assuming the converter clutch is applied in Overdrive Range - Fourth Gear when Manual Third is selected). The PCM will re-apply the converter clutch in Manual Third - Third Gear only when vehicle speed is above approximately 121 km/h (75 mph).

Pressure Control Solenoid: The pressure control solenoid operates in the same manner as Overdrive Range, regulating in response to throttle position and other vehicle operating conditions.

MANUAL THIRD - FIRST and SECOND GEARS: OVERRUN CLUTCH RELEASED

In Manual Third the transmission upshifts and downshifts normally between First, Second and Third gears. However, in First and Second gears, the 2-3 shift solenoid is energized and the 2-3 shift valve train is in the downshifted position. The 2-3 shuttle valve blocks D3 fluid from entering the overrun fluid circuit and opens the overrun fluid circuit to an exhaust port at the valve. This prevents overrun clutch apply and engine compression braking in Manual Third - First and Second Gears.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	OFF			APPLIED	APPLIED	HOLDING	APPLIED		

RH0049-4L60-E

Figure 61 Manual Third (Legend)

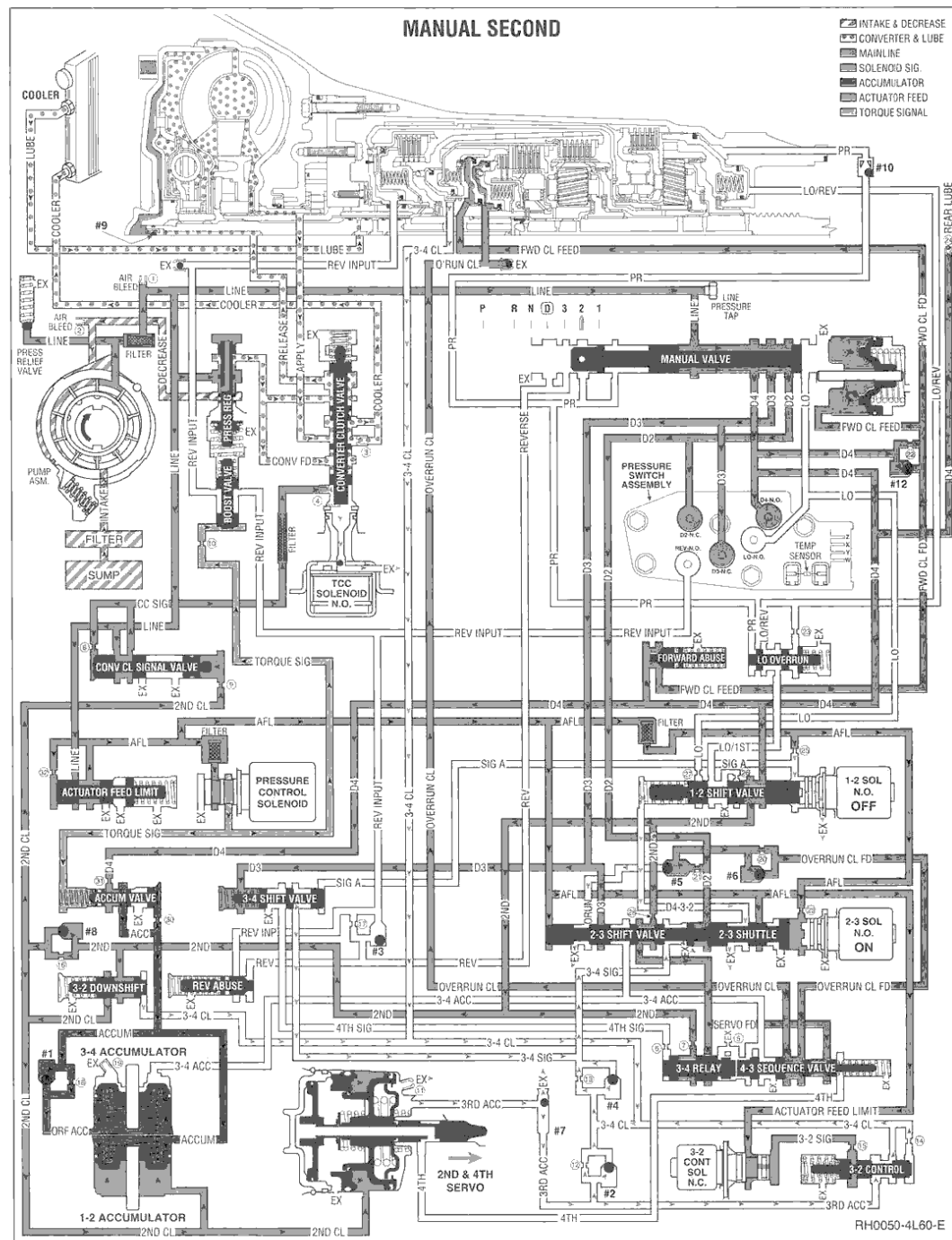


Figure 62 Manual Second

MANUAL SECOND - SECOND GEAR (from Manual Third - Third Gear)

A manual 3-2 downshift can be accomplished by moving the gear selector lever into the Manual Second (2) position when the transmission is operating in Third gear. This causes the transmission to shift immediately into Second gear regardless of vehicle operating conditions. Refer to *Overdrive Range: 3-2 Downshift* for a complete description of a 3-2 downshift. Also, the transmission is prevented from operating in any other gear, First, Third or Fourth. The following information explains the additional changes during a manual 3-2 downshift as compared to a forced 3-2 downshift.

Manual Valve: The selector lever moves the manual shaft and manual valve into the Manual Second (2) position. This allows line pressure to enter the D2 fluid circuit.

Pressure Switch Assembly (PSA): D2 fluid is routed to the PSA where it opens the normally closed D2 fluid pressure switch. With the D2, and D3 pressure switches closed and the D4 pressure switch open, the PSA signals the PCM that the transmission is operating in Manual Second.

THIRD and FOURTH GEARS PREVENTED

2-3 Shift Solenoid: The PCM energizes the 2-3 shift solenoid and AFL fluid pressure holds the 2-3 shift valve in the downshifted position. This electronically prevents Third and Fourth gears.

2-3 Shift Valve Train: D2 fluid is routed between the 2-3 shuttle and 2-3 shift valves and causes the following:

- Regardless of operating conditions, D2 fluid pressure holds the 2-3 shuttle valve in the downshifted position against AFL fluid pressure.
- 2nd fluid is blocked from entering the 3-4 signal fluid circuit and the 3-4 signal fluid circuit is open to an exhaust port at the valve.
- The 3-4 clutch cannot apply with 3-4 signal fluid exhausted. Therefore, Third and Fourth gears are hydraulically prevented.
- 2nd fluid feeds the servo feed fluid circuit but has no function in Manual Second.
- AFL fluid is blocked by the 2-3 shift valve and the D432 fluid circuit is exhausted through the valve.
- Overrun fluid is exhausted through the 2-3 shuttle valve.

1-2 Shift Valve: The 1-2 solenoid is OFF, signal "A" fluid exhausts through the solenoid and spring force holds the valve in the upshifted position.

FIRST GEAR PREVENTED

The prevention of First gear is controlled electronically by the PCM through the 1-2 shift solenoid. The PCM keeps the 1-2 shift solenoid de-energized regardless of vehicle operating conditions when the PSA signals Manual Second gear range. This keeps signal "A" fluid exhausted and spring force holds the 1-2 shift valve in the upshifted position.

OVERRUN CLUTCH REMAINS APPLIED

Overrun Clutch Feed Checkball (#5): Orificed D2 fluid pressure seats the #5 checkball against the empty overrun clutch fluid circuit. This is done simultaneously with overrun clutch fluid exhausting such that there is a continuous fluid supply to the overrun clutch feed fluid circuit.

Overrun Clutch Piston: A continuous supply of fluid pressure is routed to the piston to keep the overrun clutch plates applied.

Torque Converter Clutch: The converter clutch is released prior to downshifting into Manual Second - Second Gear. Under normal operating conditions the TCC will not apply in Second gear.

Pressure Control Solenoid: The PCM output signal to the force motor increases the operating range of torque signal fluid pressure in Manual Second. This provides increased line pressure for the additional torque requirements during engine compression braking and increased engine loads.

SUMMARY

SHIFT SOLENOID		2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
1-2	2-3								
OFF	ON	APPLIED		APPLIED	APPLIED	HOLDING			

RH0051-4L60-E

Figure 63 Manual Second (Legend)

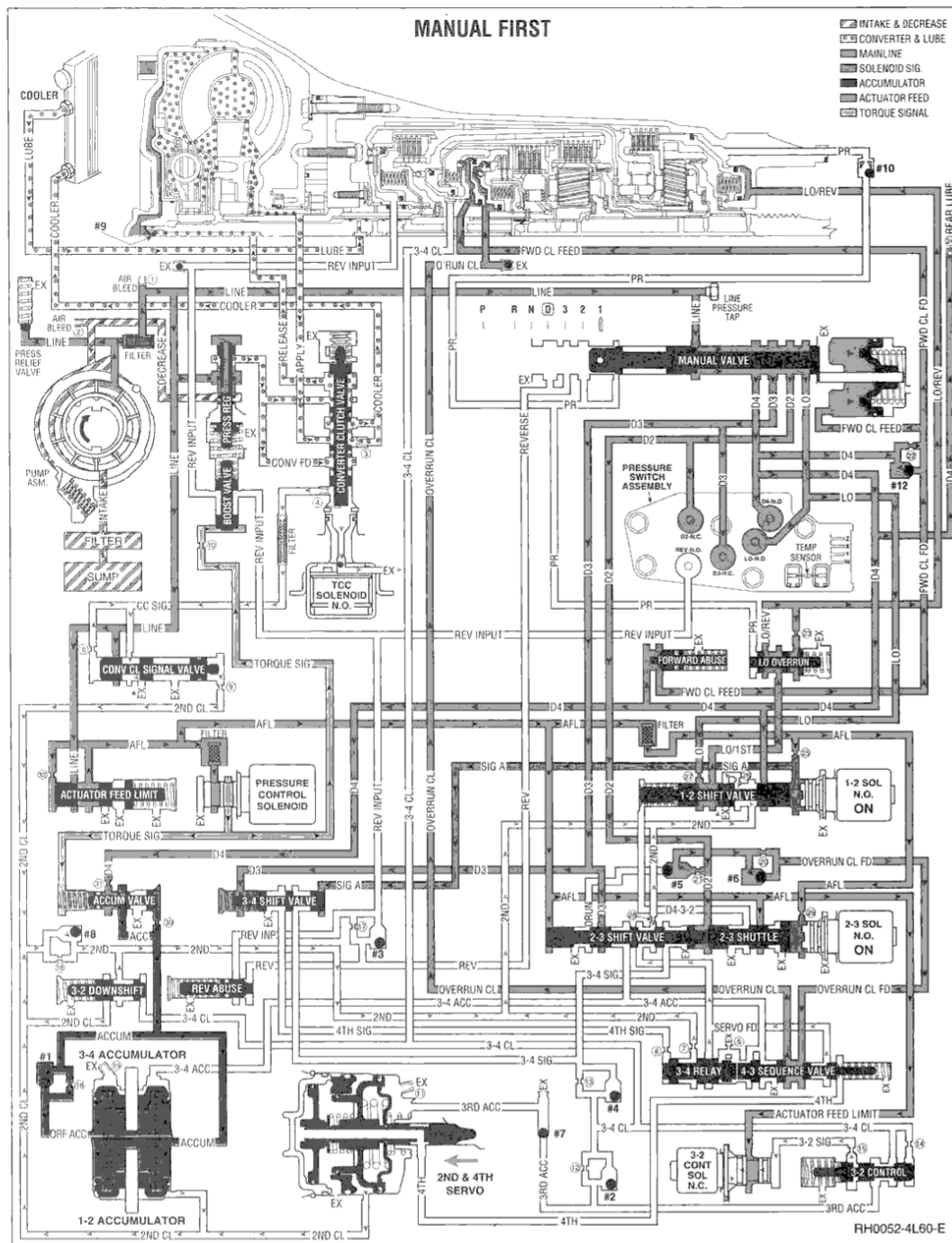


Figure 64 Manual First

MANUAL FIRST - FIRST GEAR (from Manual Second - Second Gear)

A manual 2-1 downshift can be accomplished by moving the gear selector lever into the Manual First (1) position when the transmission is operating in Second gear. The downshift to First gear is controlled electronically by the PCM. The PCM will not energize the 1-2 shift solenoid to initiate the downshift until vehicle speed is below approximately 48 to 56 km/h (30 to 35 mph). Above this speed, the transmission will operate in a Manual First - Second Gear state. The following text explains the manual 2-1 downshift.

Manual Valve: The selector lever moves the manual shaft and manual valve into the Manual First (1) position. This allows line pressure to enter the lo fluid circuit.

Pressure Switch Assembly (PSA): Lo fluid is routed to the PSA where it closes the normally open lo pressure switch. The addition of the lo pressure switch being closed signals the PCM that Manual First is selected.

2-3 Shift Solenoid: In both First and Second gears this solenoid is energized and maintaining actuator feed limit (AFL) fluid pressure at the solenoid end of the 2-3 shift valve train.

2-3 Shift Valve Train: Held in the downshifted position by AFL fluid pressure from the solenoid, the valve train blocks AFL fluid from entering the D432 fluid circuit. The D432 fluid circuit is open to an exhaust past the valve.

1-2 Shift Solenoid: Below approximately 48 to 56 km/h (30 to 35 mph) the PCM energizes the normally open solenoid. This blocks signal "A" fluid pressure from exhausting through the solenoid and creates pressure in the signal "A" fluid circuit. Above this speed, the PCM keeps the solenoid de-energized and the transmission operates in Manual First - Second Gear.

1-2 Shift Valve: Signal "A" fluid pressure moves the valve against spring force and into the downshifted position. In this position, lo fluid from the manual valve is routed into the lo-1st fluid circuit and D4 fluid is blocked from entering the 2nd fluid circuit. 2nd fluid exhausts through an orifice and an annulus exhaust port past the valve. This orifice (#26) helps control the 2-4 band release during a 2-1 downshift.

2-4 BAND RELEASES

2-4 Servo Assembly: 2nd clutch fluid, which was fed by 2nd fluid, exhausts from the servo. This allows spring force from the servo cushion and servo return springs to move the 2nd apply piston and apply pin to release the 2-4 band. These spring forces help control the 2-4 band release.

1-2 Accumulator Assembly: 2nd clutch fluid also exhausts from the 1-2 accumulator assembly. Spring force and accumulator fluid pressure move the accumulator piston to assist 2nd clutch fluid exhaust.

Accumulator Valve: As accumulator fluid is filling the 1-2 accumulator assembly, the accumulator valve regulates D4 fluid into the accumulator fluid circuit. This regulation, biased by torque signal fluid pressure and spring force, helps

control the movement of the 1-2 accumulator piston, 2nd clutch fluid exhaust and the 2-4 band release.

1-2 Upshift Checkball (#8): Exhausting 2nd clutch fluid pressure unseats the ball and is routed through the 2nd fluid circuit.

Converter Clutch Signal Valve: 2nd fluid exhausts from the converter clutch signal valve. Refer to Park range on for a description of the TCC signal valve operation in First gear.

LO AND REVERSE CLUTCH APPLIES

Lo Overrun Valve: Lo 1st fluid is regulated through the lo overrun valve and into the lo/reverse fluid circuit to control the lo/reverse clutch apply.

Lo/Reverse Piston: Lo/reverse fluid pressure acts on the inner area of the piston to move the piston and apply the lo/reverse clutch plates.

OVERRUN CLUTCH APPLIED

The overrun clutch remains applied in Manual First to provide engine compression braking.

Pressure Control Solenoid: Similar to Manual Second, the PCM output signal to the force motor increases the operating range of torque signal fluid pressure. This provides increased line pressure for the additional torque requirements during engine compression braking and increased engine loads.

3-2 Downshift Control Solenoid and 3-2 Control Valve: In First gear the solenoid is OFF, AFL fluid is blocked by the solenoid, 3-2 signal fluid exhausts through the solenoid and spring force opens the 3-2 control valve.

SUMMARY

SHIFT SOLENOID	2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO/ROLLER CLUTCH	LO/REV. CLUTCH
12	23							
ON	ON		APPLIED	APPLIED	HOLDING		HOLDING	APPLIED

RH0053-4L60-E

Figure 65 Manual First (Legend)

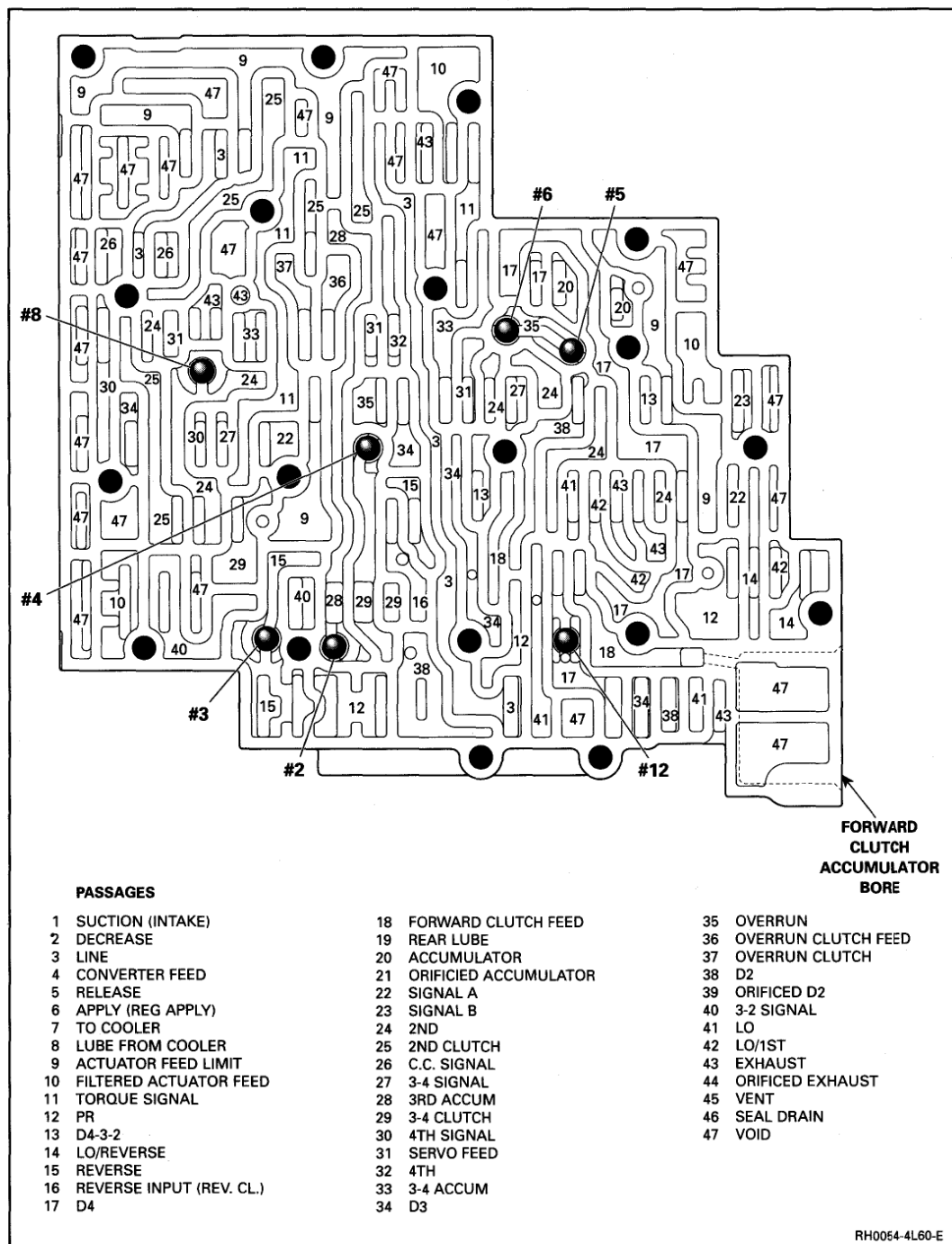


Figure 66 Valve Body Passages and Checkball Locations

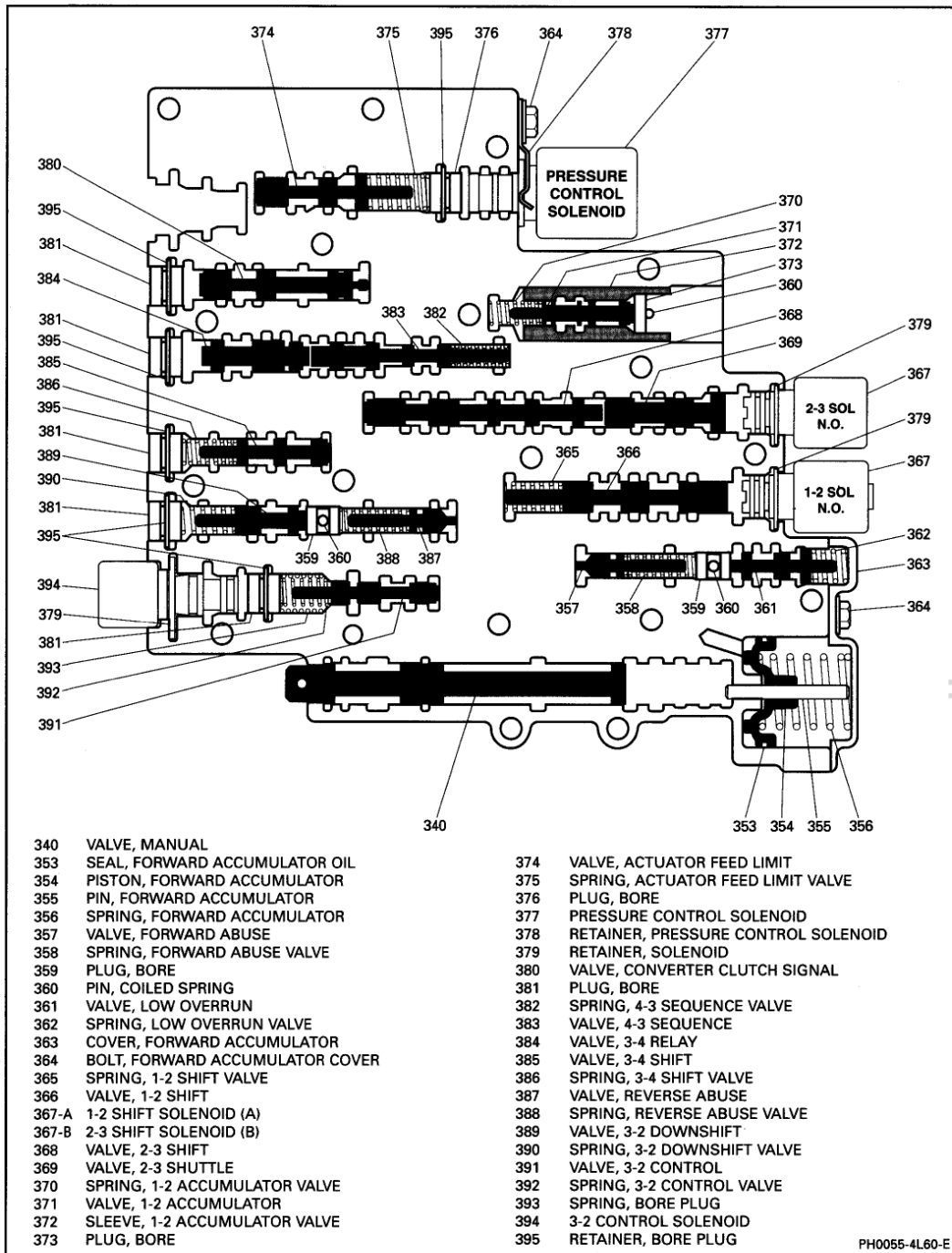
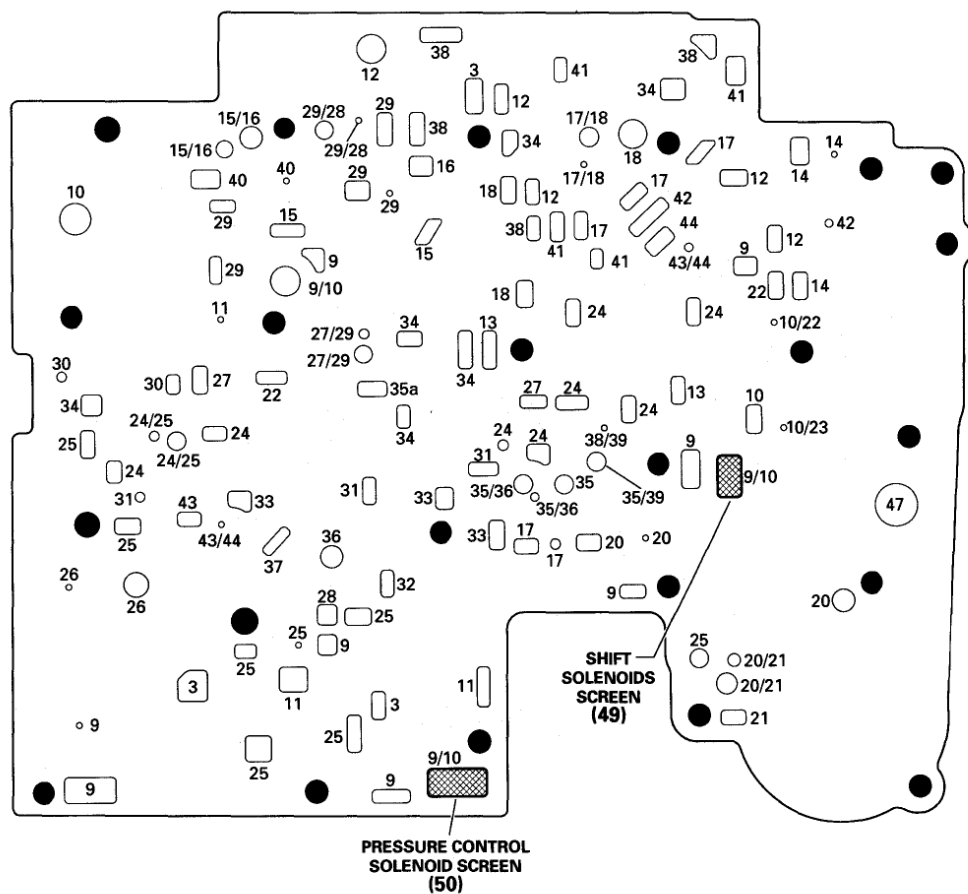


Figure 67 Valve Trains

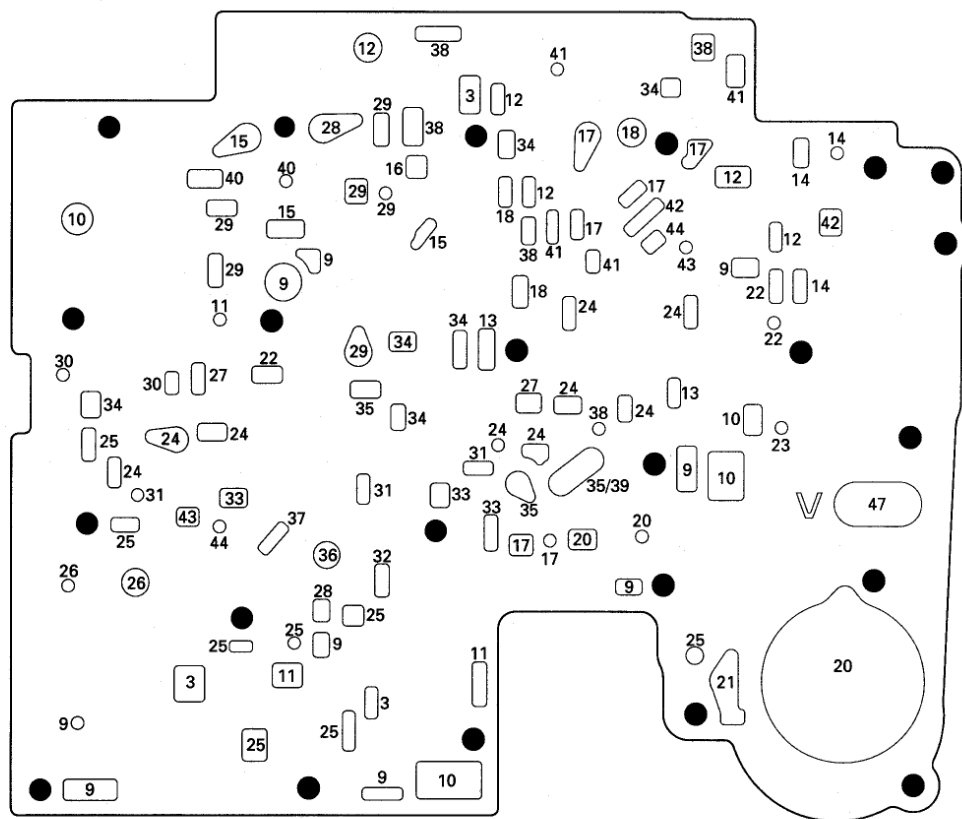


PASSES

- | | | |
|-----------------------------|-------------------------|------------------------|
| 1 SUCTION (INTAKE) | 18 FORWARD CLUTCH FEED | 35 OVERRUN |
| 2 DECREASE | 19 REAR LUBE | 36 OVERRUN CLUTCH FEED |
| 3 LINE | 20 ACCUMULATOR | 37 OVERRUN CLUTCH |
| 4 CONVERTER FEED | 21 ORIFICED ACCUMULATOR | 38 D2 |
| 5 RELEASE | 22 SIGNAL A | 39 ORIFICED D2 |
| 6 APPLY (REG APPLY) | 23 SIGNAL B | 40 3-2 SIGNAL |
| 7 TO COOLER | 24 2ND | 41 LO |
| 8 LUBE FROM COOLER | 25 2ND CLUTCH | 42 LO/1ST |
| 9 ACTUATOR FEED LIMIT | 26 C.C. SIGNAL | 43 EXHAUST |
| 10 FILTERED ACTUATOR FEED | 27 3-4 SIGNAL | 44 ORIFICED EXHAUST |
| 11 TORQUE SIGNAL | 28 3RD ACCUM | 45 VENT |
| 12 PR | 29 3-4 CLUTCH | 46 SEAL DRAIN |
| 13 D4-3-2 | 30 4TH SIGNAL | 47 VOID |
| 14 LO/REVERSE | 31 SERVO FEED | |
| 15 REVERSE | 32 4TH | |
| 16 REVERSE INPUT (REV. CL.) | 33 3-4 ACCUM | |
| 17 D4 | 34 D3 | |

RH0058-4L60-E

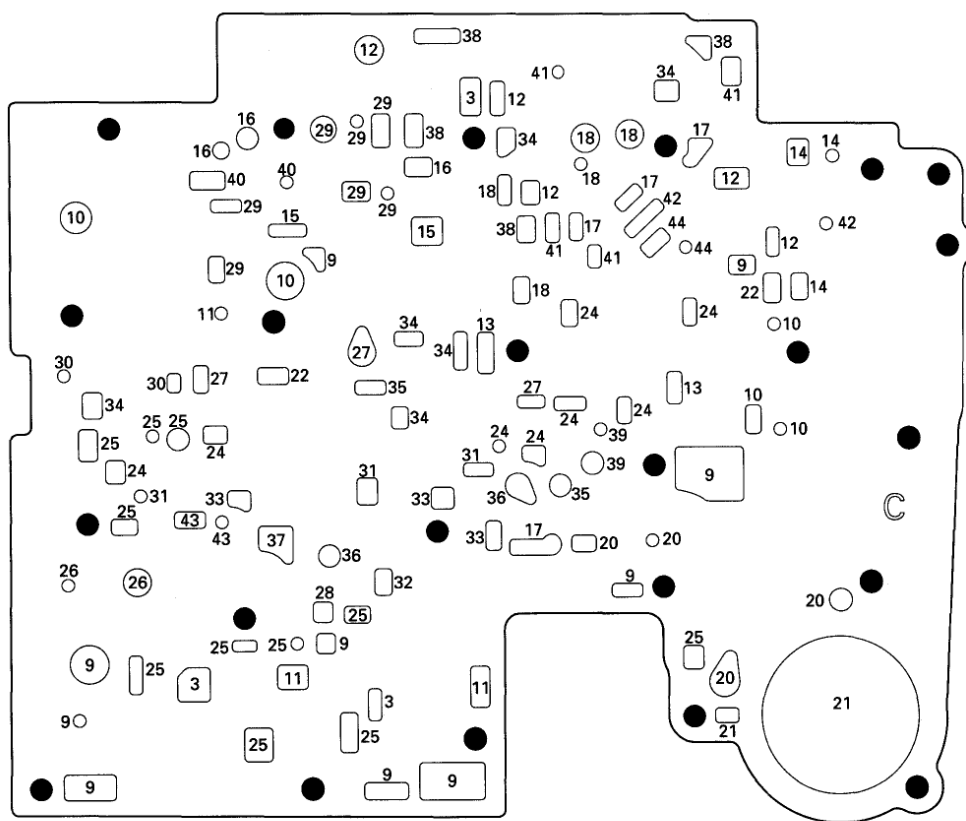
Figure 68 Spacer Plate Passages

**PASSAGES**

- | | | |
|-----------------------------|-------------------------|------------------------|
| 1 SUCTION (INTAKE) | 18 FORWARD CLUTCH FEED | 35 OVERRUN |
| 2 DECREASE | 19 REAR LUBE | 36 OVERRUN CLUTCH FEED |
| 3 LINE | 20 ACCUMULATOR | 37 OVERRUN CLUTCH |
| 4 CONVERTER FEED | 21 ORIFICED ACCUMULATOR | 38 D2 |
| 5 RELEASE | 22 SIGNAL A | 39 ORIFICED D2 |
| 6 APPLY (REG APPLY) | 23 SIGNAL B | 40 3-2 SIGNAL |
| 7 TO COOLER | 24 2ND | 41 LO |
| 8 LUBE FROM COOLER | 25 2ND CLUTCH | 42 LO/1ST |
| 9 ACTUATOR FEED LIMIT | 26 C.C. SIGNAL | 43 EXHAUST |
| 10 FILTERED ACTUATOR FEED | 27 3-4 SIGNAL | 44 ORIFICED EXHAUST |
| 11 TORQUE SIGNAL | 28 3RD ACCUM | 45 VENT |
| 12 PR | 29 3-4 CLUTCH | 46 SEAL DRAIN |
| 13 D4-3-2 | 30 4TH SIGNAL | 47 VOID |
| 14 LO/REVERSE | 31 SERVO FEED | |
| 15 REVERSE | 32 4TH | |
| 16 REVERSE INPUT (REV. CL.) | 33 3-4 ACCUM | |
| 17 D4 | 34 D3 | |

RH0057-4L60-E

Figure 69 Spacer Plate to Valve Body Gasket



PASSAGES

- | | | |
|-----------------------------|--------------------------|------------------------|
| 1 SUCTION (INTAKE) | 18 FORWARD CLUTCH FEED | 35 OVERRUN |
| 2 DECREASE | 19 REAR LUBE | 36 OVERRUN CLUTCH FEED |
| 3 LINE | 20 ACCUMULATOR | 37 OVERRUN CLUTCH |
| 4 CONVERTER FEED | 21 ORIFICIED ACCUMULATOR | 38 D2 |
| 5 RELEASE | 22 SIGNAL A | 39 ORIFICIED D2 |
| 6 APPLY (REG APPLY) | 23 SIGNAL B | 40 3-2 SIGNAL |
| 7 TO COOLER | 24 2ND | 41 LO |
| 8 LUBE FROM COOLER | 25 2ND CLUTCH | 42 LO/1ST |
| 9 ACTUATOR FEED LIMIT | 26 C.C. SIGNAL | 43 EXHAUST |
| 10 FILTERED ACTUATOR FEED | 27 3-4 SIGNAL | 44 ORIFICIED EXHAUST |
| 11 TORQUE SIGNAL | 28 3RD ACCUM | 45 VENT |
| 12 PR | 29 3-4 CLUTCH | 46 SEAL DRAIN |
| 13 D4-3-2 | 30 4TH SIGNAL | 47 VOID |
| 14 LO/REVERSE | 31 SERVO FEED | |
| 15 REVERSE | 32 4TH | |
| 16 REVERSE INPUT (REV. CL.) | 33 3-4 ACCUM | |
| 17 D4 | 34 D3 | |

RH0058-4L60-E

Figure 70 Spacer Plate to Case Gasket

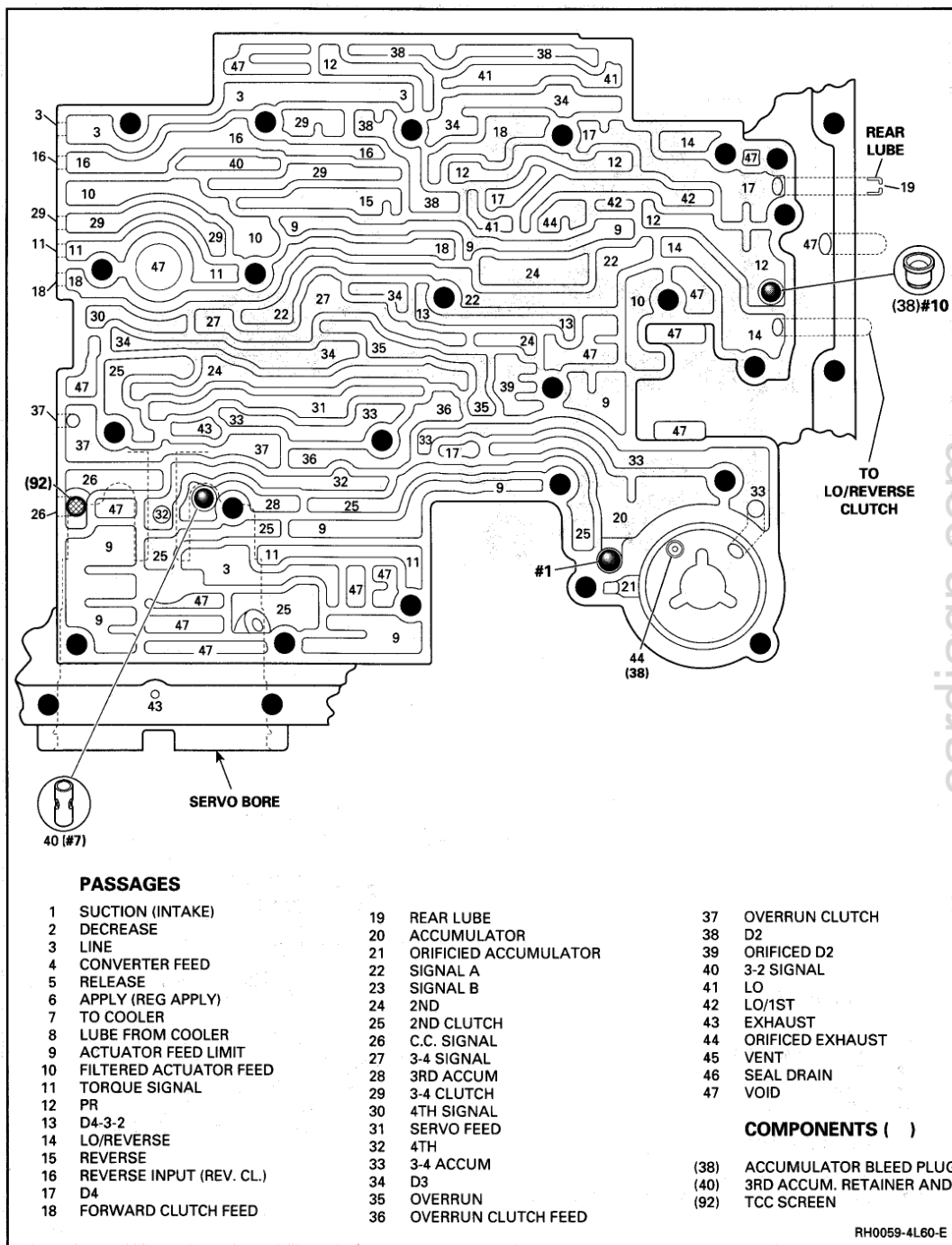
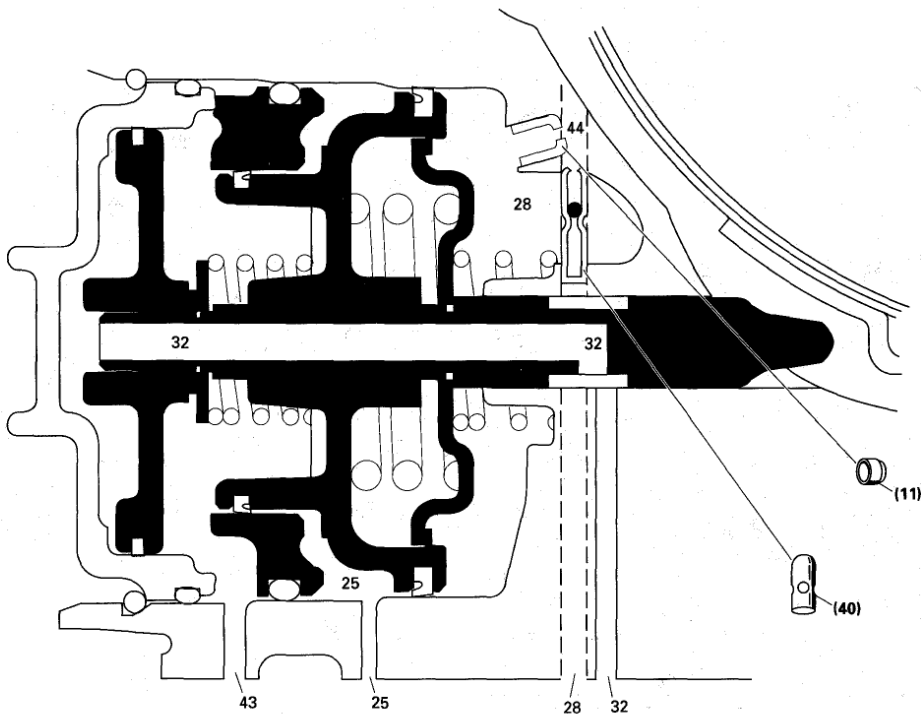


Figure 71 Case Passages and Checkball Locations

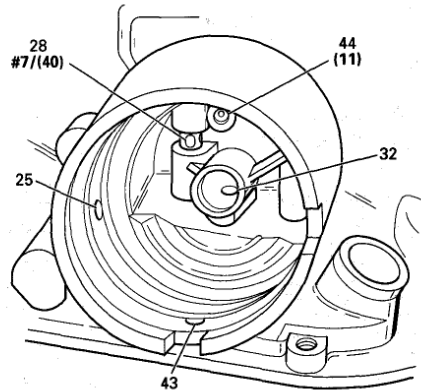


PASSAGES

- 25 2ND CLUTCH
- 28 3RD ACCUMULATOR
- 32 4TH
- 43 EXHAUST
- 44 ORIFICED EXHAUST

COMPONENTS ()

- (11) CASE SERVO ORIFICED PLUG
- (40) 3RD ACCUM. RETAINER AND BALL ASSEMBLY (#7)



RH0062-4L60-E

Figure 72 2-4 Servo Passages

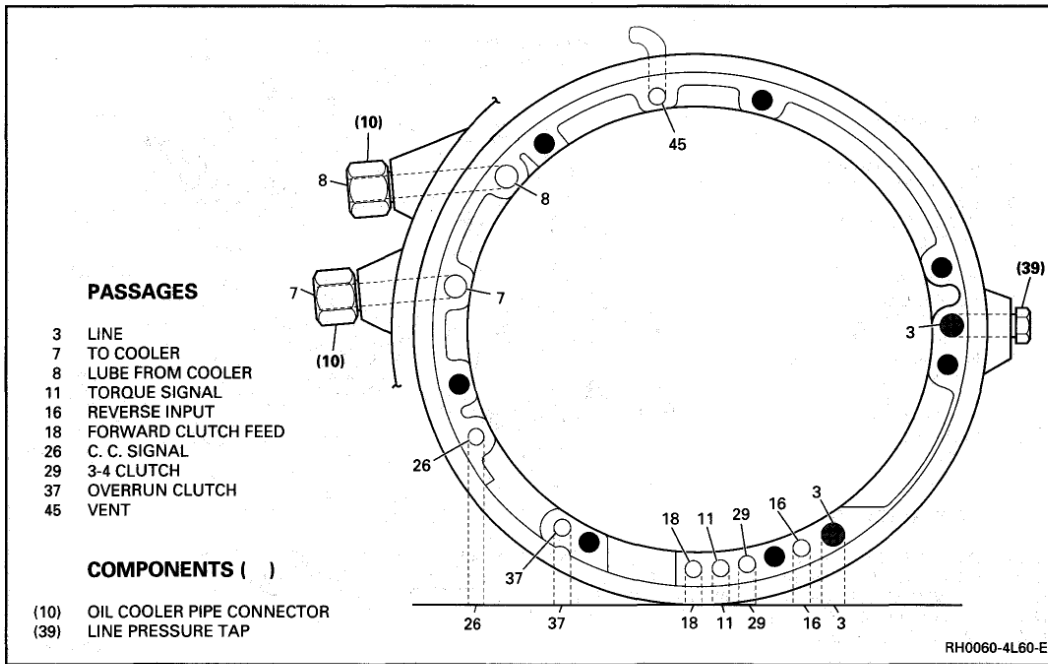


Figure 73 Pump to Case Passages

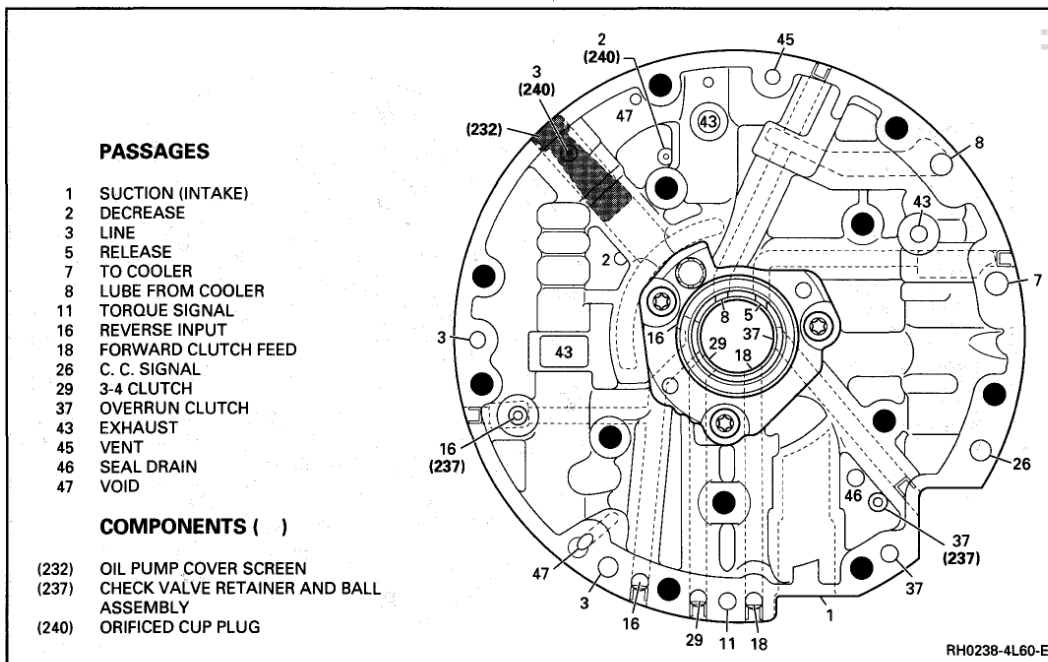


Figure 74 Pump Cover Passages (Case Side)

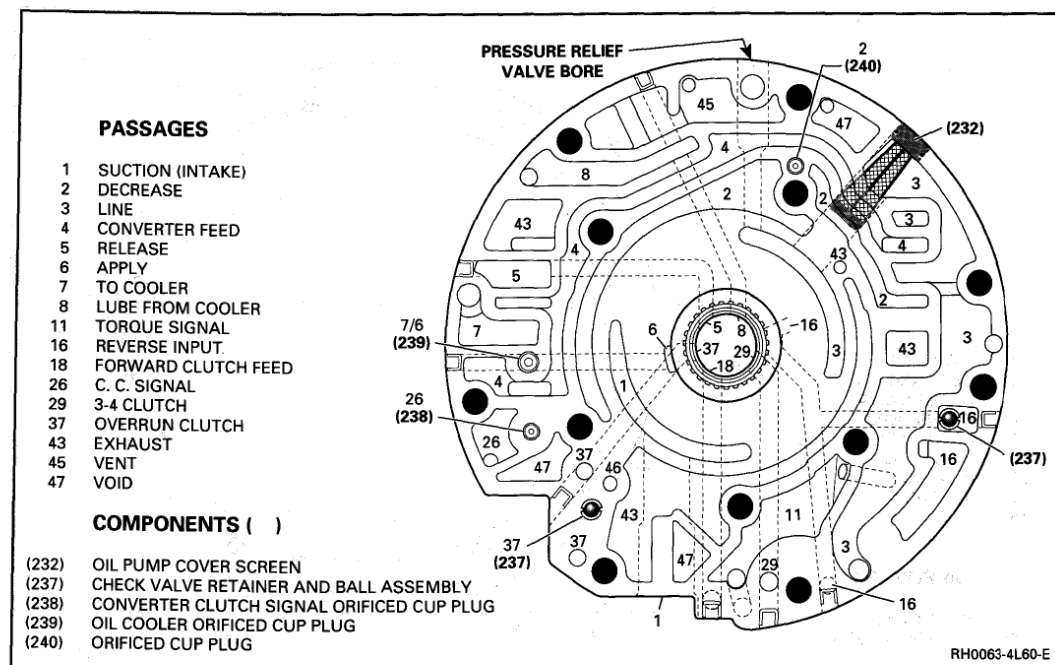


Figure 75 Pump Cover Passages

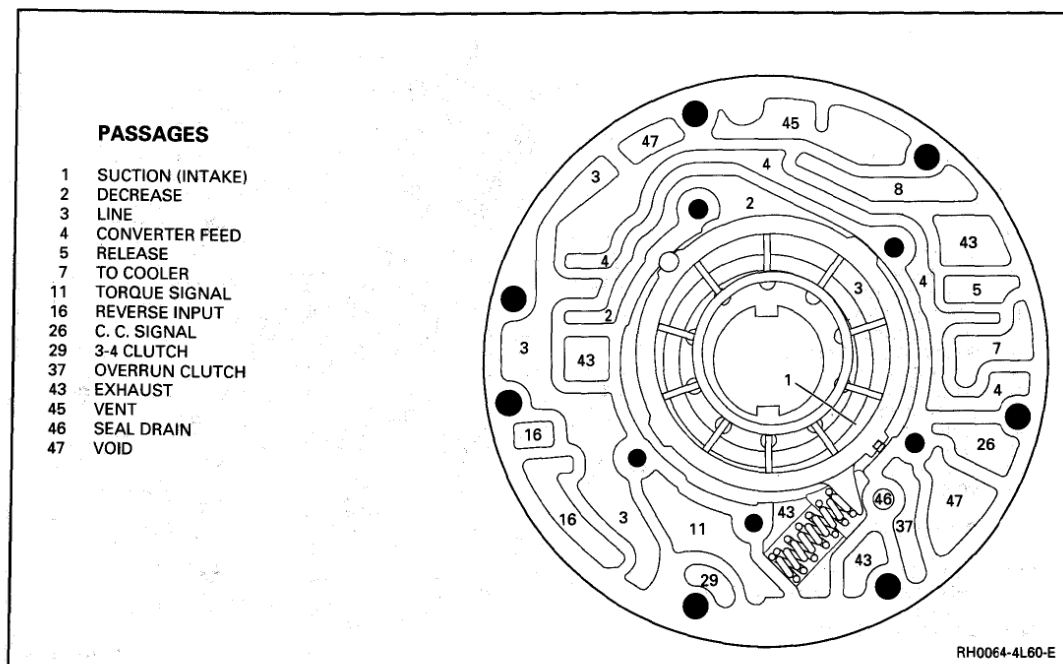
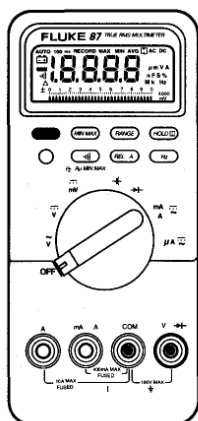


Figure 76 Pump Body Passages



FLUKE 87 TRUE RMS
MULTIMETER
J 39200

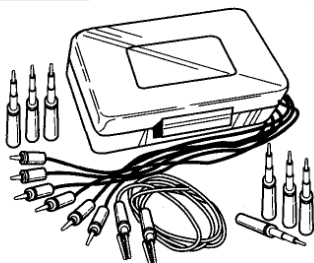
VOLTMETER – Voltage position measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 meg ohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings because they have a very high resistance.

AMMETER – When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information.

- Selector must be set properly for both function and range. DC is used for most automotive measurements.

OHMMETER – Measures resistance of circuit directly in ohms. Refer to meter instructions for more information.

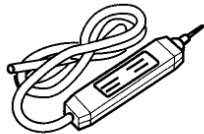
- OL display in all ranges indicates open circuit.
- Zero display in all ranges indicates a short circuit.
- An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit.
- Autoranges to the 400 Ω , 4 k Ω , 40 k Ω , 400 k Ω , 4 M Ω , or 40 M Ω resistance range.



J 35616-A

CONNECTOR TEST ADAPTER KIT

Assortment of flexible connectors to adapt a multimeter or jumper cords to connectors.



J 34636

CIRCUIT TESTER

Used for checking all relays and solenoids before connecting them to a new ECM. Measures the circuit resistance and indicates pass or fail via green or red LED. Amber LED indicates current polarity. Can also be used as a non-powered continuity checker.



J 34142-A

UNPOWERED TEST LIGHT

Used for checking wiring for complete circuit, short to ground, or voltage.



TECH 1 TESTER

Used to check solenoids and other electronic components. Can record vehicle data during dynamic testing, and turn some electronic components on and off.



J 21867

UNIVERSAL PRESSURE GAUGE SET

(9 Ft. Hose; 0-300 PSI)

Used for checking line pressure, pump output (min., max.) in all gear ranges.

RH0239-4L60-E

Figure 77 Electrical Diagnosis Tools

