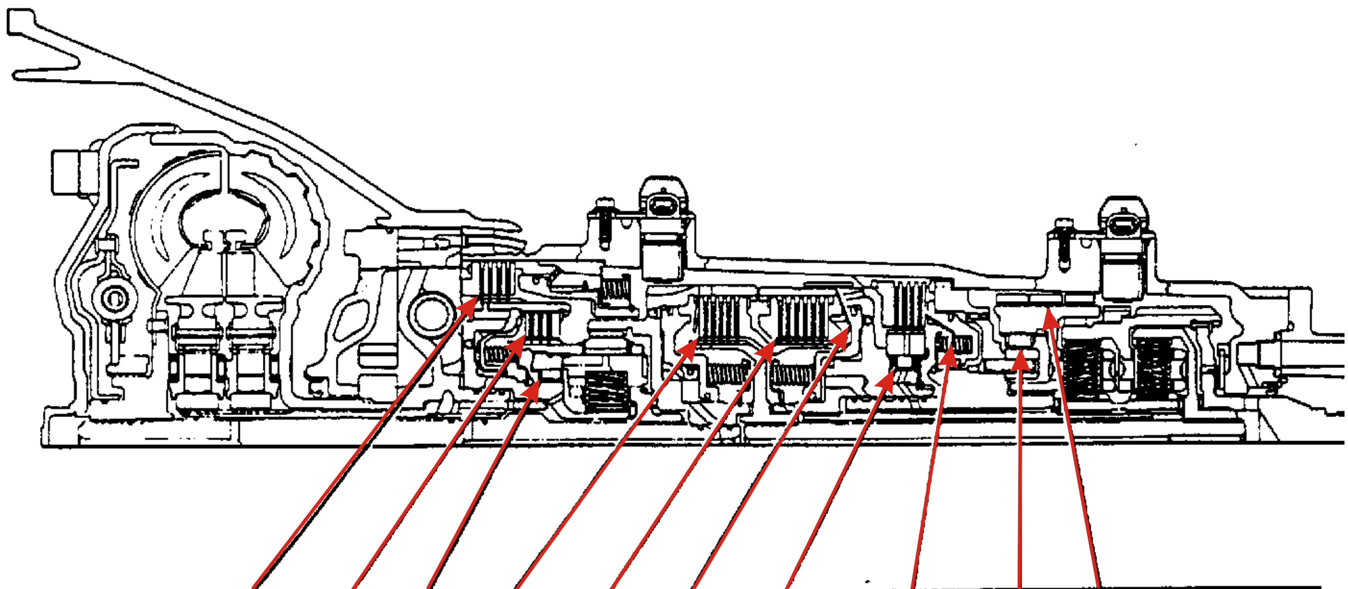
THM 4L80-E

PRELIMINARY INFORMATION

HYDRA-MATIC 4L80-E GEAR RATIOS

FIRST	2.48	FOURTH	.75
SECOND	1.48	REVERSE	2.08
THIRD	1.00		



RANGE	GEAR	FOURTH CLUTCH	OVERRUN CLUTCH	OVERDRIVE ROLLER CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	FRONT BAND	INTERMEDIATE SPRAG CLUTCH	INTERMEDIATE CLUTCH	LO ROLLER CLUTCH	REAR BAND	SOLENOID A	SOLENOID B
P-N											APPLIED	ON	OFF
D4	1st			HOLDING	APPLIED			*		HOLDING		ON	OFF
	2nd			HOLDING	APPLIED			HOLDING	APPLIED			OFF	OFF
	3rd			HOLDING	APPLIED	APPLIED			APPLIED			OFF	ON
	4th	APPLIED			APPLIED	APPLIED			APPLIED			ON	ON
D3	1st		APPLIED	HOLDING	APPLIED			*		HOLDING		@ ON	@OFF
	2nd		APPLIED	HOLDING	APPLIED			HOLDING	APPLIED			@OFF	@OFF
	3rd		APPLIED	HOLDING	APPLIED	APPLIED			APPLIED			@OFF	@ ON
D2	1st		APPLIED	HOLDING	APPLIED			*		HOLDING		@ ON	@OFF
	2nd		APPLIED	HOLDING	APPLIED		APPLIED	HOLDING	APPLIED			@OFF	@OFF
D1	1st		APPLIED	HOLDING	APPLIED			*		HOLDING	APPLIED	@ ON	@OFF
	2nd		APPLIED	HOLDING	APPLIED		APPLIED	HOLDING	APPLIED			@OFF	@OFF
R	REVERSE			HOLDING		APPLIED				*	APPLIED	ON	OFF

*HOLDING BUT NOT EFFECTIVE

ON = SOLENOID ENERGIZED

OFF = SOLENOID DE-ENERGIZED

@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED AND THROTTLE POSITION. IT DOES NOT DEPEND UPON THE SELECTED GEAR.

Figure 1

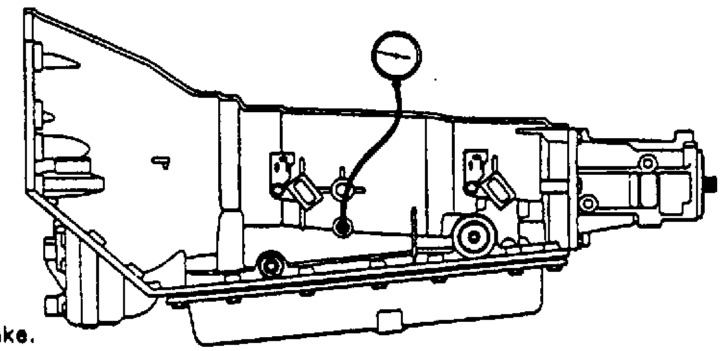
1991 HYDRA-MATIC 4L80-E LINE PRESSURE CHECK PROCEDURE

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:

Gear Range	Line Pressure Range
Drive, Park or Neutral	35 - 171 PSI
Reverse	67 - 324 PSI

Before performing a line pressure check, verify that the force motor is receiving the correct electrical signal from the vehicle computer:

1. Install a scan tool.
2. Start the engine and set parking brake.
3. Check for a stored force motor malfunction code, and other malfunction 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 "override force motor" test on the TECH 1 scan tool.
8. Increase FORCE MOTOR CURRENT 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.

   Line pressure will pulse either high or low every ten seconds to keep the force motor plunger free. This is normal and will not harm the transmission.

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

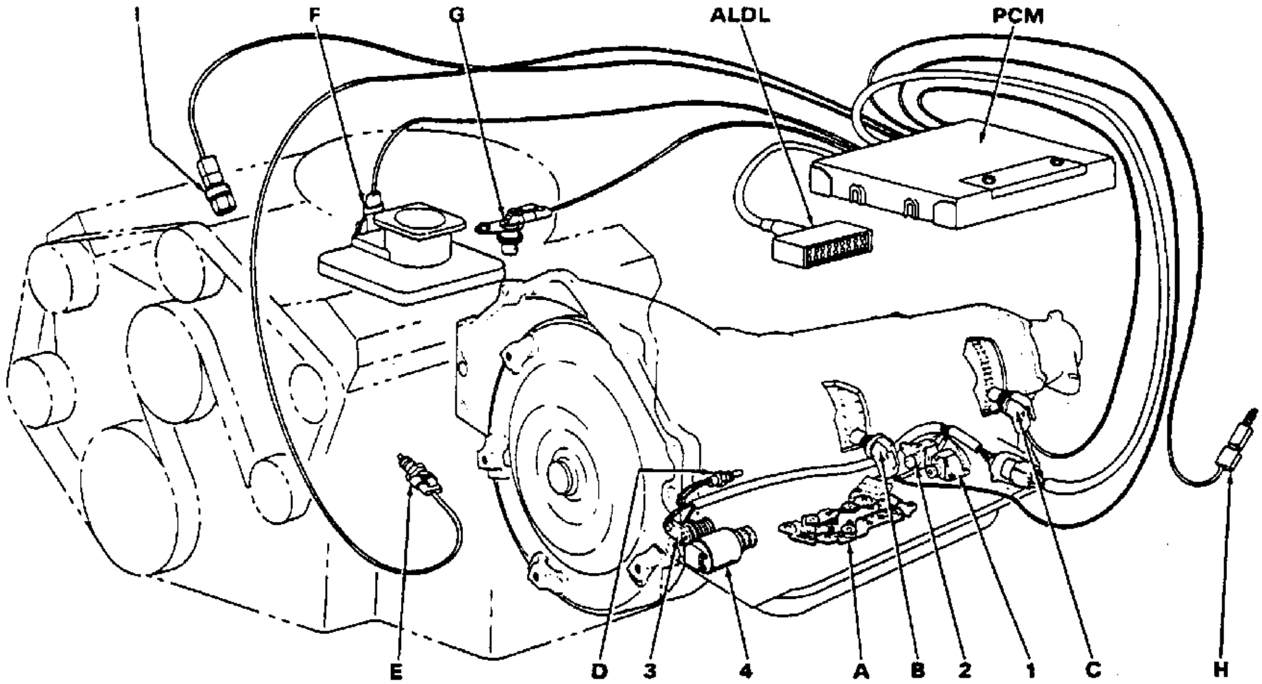
CAUTION Brakes must be applied at all times to prevent unexpected vehicle motion.

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 force motor in Park and Neutral with the vehicle stopped at idle. This protects the clutches from extremely high or low pressures in Drive or Reverse ranges.

Force Motor Current (Amp)	Line Pressure (PSI)
0.02	157 - 177
0.10	151 - 176
0.20	140 - 172
0.30	137 - 162
0.40	121 - 147
0.50	102 - 131
0.60	88 - 113
0.70	63 - 93
0.80	43 - 73
0.90	37 - 61
0.98	35 - 56

Figure 1



INPUTS **OUTPUTS**

INFORMATION SENSORS

A. PRESSURE SWITCH MANIFOLD (PSM)
B. TRANSMISSION INPUT SPEED SENSOR (TISS)
C. TRANSMISSION OUTPUT SPEED SENSOR (TOSS)
D. TRANSMISSION FLUID
E. ENGINE COOLANT TEMPERATURE SENSOR (CTS)
F. THROTTLE POSITION SENSOR (TPS)
G. ENGINE SPEED SENSOR
H. BRAKE SWITCH
I. A/C REQUEST SWITCH

ELECTRONIC CONTROLLERS

- POWERTRAIN CONTROL MODULE (PCM) OR TRANSMISSION CONTROL MODULE (TCM) (SEE NOTE BELOW)
- ASSEMBLY LINE DIAGNOSTIC LINK (ALDL)

ELECTRONICALLY CONTROLLED TRANSMISSION COMPONENTS

1. SHIFT SOLENOID "A"
2. SHIFT SOLENOID "B"
3. PULSE WIDTH MODULATED TCC SOLENOID (PWM)
4. VARIABLE FORCE MOTOR

The HYDRA-MATIC 4L80-E transmission incorporates electronic controls that utilize the Powertrain Control Module (PCM) [see Note below] to control shift points (through shift solenoids), torque converter clutch (TCC) apply and release (through the Pulse Width Modulated solenoid - PWM) and line pressure (through the variable force motor). Electrical signals from various sensors provide information to the PCM about vehicle speed, throttle position, engine coolant temperature, transmission fluid temperature, gear range selector position, engine speed, converter turbine speed, engine load and braking. The PCM uses this information to determine the precise moment to upshift or downshift, apply or release the TCC and what fluid pressure is needed to apply the clutches or bands. This type of control provides consistent and precise shift points and shift quality based on the operating conditions of the vehicle.

If for any reason the entire electronic control system of the transmission becomes disabled, both of the shift solenoids will be de-energized (turned OFF). This "failsafe mode" operating state of the solenoids forces the transmission to operate in Second gear regardless of other vehicle operating conditions when the gear selector is in a forward drive range. Also, in "failsafe mode" the force motor is turned off which increases line pressure to a maximum and the PWM solenoid cannot apply the TCC. This allows the vehicle to be operated safely, despite the disabled electronic controls, until the condition can be corrected.

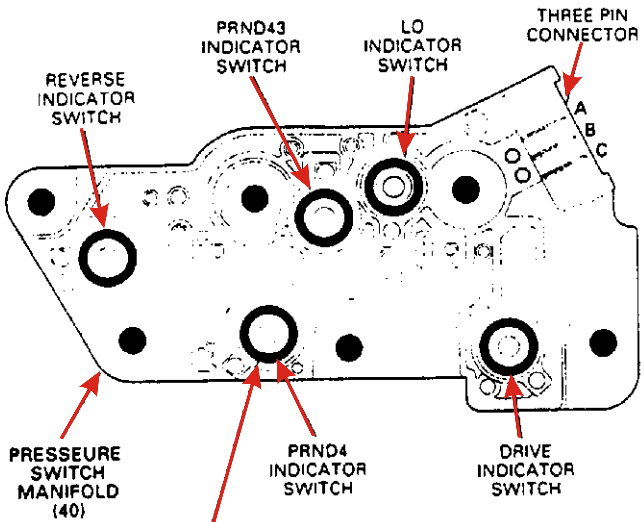
Another feature of the HYDRA-MATIC 4L80-E is the hydraulic override of the electronic control system in Manual Third and Manual Second. In the Manual gear ranges, the PCM controls the shift solenoids in the same manner as in Overdrive Range. However, when Manual Third is selected, the hydraulic system prevents the transmission from shifting into Fourth gear regardless of the solenoid states and vehicle operating conditions. Similarly, in Manual Second the hydraulic system prevents the transmission from shifting into either Third or Fourth gear regardless of solenoid states. However, in Manual First the gear selection is completely electronic for safety and durability reasons. This means the PCM must electronically command the solenoids to be in a First gear state for the transmission to downshift into First gear when Manual First is selected.

Note: Some models utilize a Transmission Control Module (TCM) instead of a PCM. The TCM functions similar to the PCM but does incorporate some different controls. However, throughout this publication only the PCM is referenced for simplicity. Refer to the appropriate General Motors Service Manual for a description of TCM controls.

Figure 1

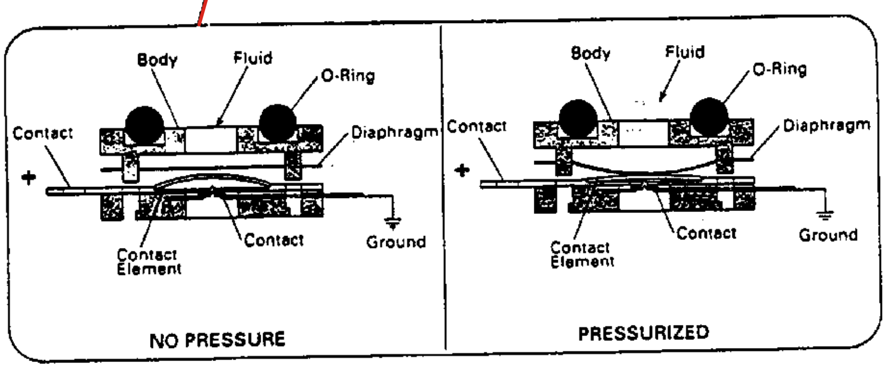
Pressure Switch Manifold (40):

The Pressure Switch Manifold (PSM) is a multiple switch assembly made up of five normally open (N.O.) pressure switches. Various fluid pressures are fed from the manual valve to the switches (see hydraulic circuit below) depending on gear selector and manual valve positioning. These fluid pressures determine the digital logic at the electrical pins (A, B and C) in the PSM three pin connector. This logic is used by the PCM to determine what gear range (PRN Ⓓ D21) the transmission is operating in. The electrical schematic and chart below show the circuitry and logic used at the PSM and electrical connector to signal the Powertrain Control Module (PCM) which range the gear selector lever is in.



Fluid Pressure Switch:

The pressure switches in the PSM are normally open (contacts not touching) when no fluid pressure is present, thereby stopping electrical current at the switch. When fluid pressure is routed to the switch, it moves the diaphragm and upper contact such that the contact element touches both the positive (+) contact and the ground (⏚) contact. This creates a closed circuit and allows current to flow from the positive contact and through the switch. Depending on the circuit, the closed switch may provide a ground path from one of the three electrical pins.

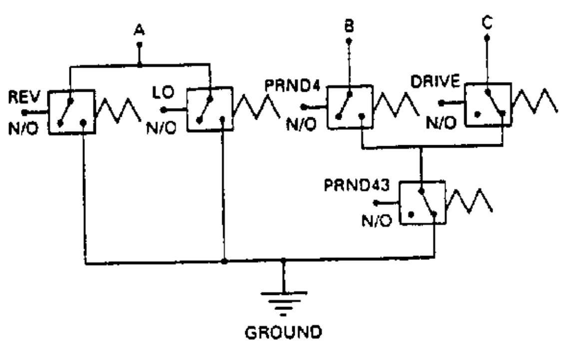


For example, the hydraulic and electrical schematics below are shown in the Manual Third position. The Drive and PRND43 switches are pressurized in Manual Third, thereby closing these switches and allowing current to flow from Pin C to ground. This changes the digital logic at Pin C to a "0" and, with digital logic at Pin A and Pin B being "1", signals the PCM that the transmission is in Manual Third gear range. For Pin A to connect to ground, either the Reverse or Lo pressure switches must be energized. For Pin B to connect to ground, the PRND4 pressure switch must be pressurized in addition to the PRND43 switch.

Range Indicator	Fluids: Rev	Lo	PRND4	PRND43	Drive	Circuit: A	B	C
Park			X	X		1	0	1
Reverse	X		X	X		0	0	1
Neutral			X	X		1	0	1
Ⓓ			X	X	X	1	0	0
D				X	X	1	1	0
2					X	1	1	1
1		X			X	0	1	1

☒ - Pressurized

0 - Grounded: 0V LOW
1 - Open: 12V HIGH



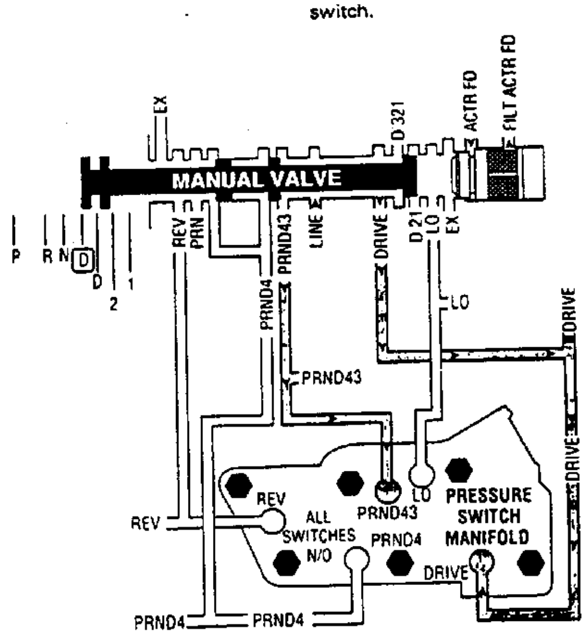
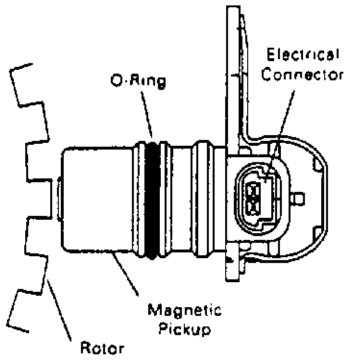


Figure 1

TRANSMISSION SPEED SENSORS



SPEED SENSOR

Transmission Output Speed Sensor (TOSS) (22):
The output speed sensor is a variable reluctance magnetic pickup located in the rear of the transmission case. This sensor is mounted in the case opposite the output speed sensor ring (660) that is pressed onto the output carrier assembly (661). It consists of a permanent magnet surrounded by a coil of wire. As the output carrier and speed sensor ring rotate, an alternating current (AC) is induced in the coil from the "teeth" on the sensor ring passing by the magnetic pickup. Therefore, whenever the vehicle is moving, the output speed sensor produces an AC voltage signal proportional to vehicle speed. This signal is sent to either the DRAC (Digital Ratio Adapter Controller) or the PCM depending on model application. Refer to the appropriate General Motors Service Manual for specific application.

At the DRAC or PCM, the AC signal is electronically conditioned to a 5 volt square wave form (see Figure A). The square wave form can then be interpreted as transmission output speed by the PCM through the frequency of square waves in a given time frame. The square waves can be thought of as the speed sensor ring teeth. Therefore, the more teeth (or waves) that pass by the magnetic pickup in a given time frame, the faster the vehicle is moving. The square wave form is compared to a fixed clock signal internally within the PCM to determine transmission output speed.

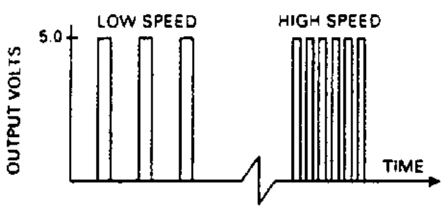
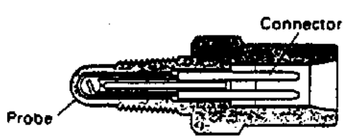


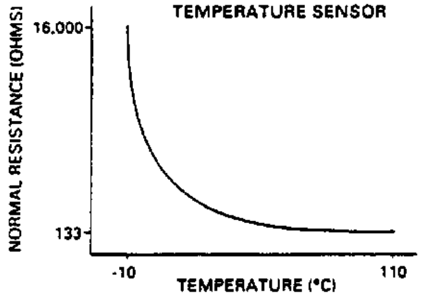
FIGURE A: CONDITIONED SIGNAL

Transmission Input Speed Sensor (TISS) (22):
The input speed sensor operates identical to the output speed sensor except it uses the machined teeth on the forward clutch housing (602) as the rotor. Remember that the forward clutch housing is driven at converter turbine speed (except in fourth gear when it is driven in an overdrive mode with respect to the converter turbine). The input speed sensor square wave form is also compared to a fixed clock signal internally within the PCM to determine actual converter turbine speed. The PCM uses transmission input and output speeds to help determine line pressure, transmission shift patterns and TCC apply pressure and timing. This speed sensor information is also used to calculate turbine speed, gear ratios, and TCC slippage for diagnostic purposes.



TEMPERATURE SENSOR

Temperature Sensor (332):
The temperature sensor is a negative temperature coefficient thermistor (temperature sensitive resistor) that is located on the control valve assembly (44). The internal electrical resistance of the sensor varies according to the operating temperature of the transmission fluid (see chart). The lower the temperature, the higher the resistance. The PCM interprets this resistance as another input to help control the torque converter clutch operation through the Pulse Width Modulated Solenoid (PWM) and line pressure through the variable force motor.



The PCM inhibits TCC operation until transmission fluid temperatures reach approximately 20°C (68°F). If transmission fluid temperatures become excessively high (above approximately 122°C, 250°F), the PCM will apply the TCC whenever the transmission is in Second, Third or Fourth gears. Applying the TCC serves to reduce transmission fluid temperatures created by the fluid coupling in the torque converter with the TCC released. If fluid temperatures increase even further (above approximately 150°C, 300°F), the PCM will not allow the TCC to apply in any gear range. This prevents the excessive fluid temperatures from damaging the converter clutch. Above approximately 154°C (310°F), the PCM will set a transmission fluid temperature code. This causes the PCM to use a fixed value of 130°C (266°F) as the transmission fluid temperature input signal. At a value of 130°C, the TCC will apply in Second, Third and Fourth gears.

Components External to Transmission

Throttle Position Sensor (TPS): The PCM monitors the variable voltage signal from this sensor to calculate throttle position (angle). These input signals are then used by the PCM, in addition to other vehicle and transmission sensor inputs, to determine the appropriate shift pattern and TCC apply and release for the transmission. In general, with greater throttle angle, upshift speeds and line pressure both increase. Also, the PCM releases the torque converter clutch at minimum throttle positions and during heavy acceleration.

Coolant Temperature Sensor (CTS): The PCM monitors the variable resistance signal from this sensor to determine engine coolant temperature. When the engine is cold, resistance is high, and when the engine is hot, resistance through the sensor is low. The PCM uses this information to prevent the TCC from applying when engine temperature is below approximately 54°C (130°F).

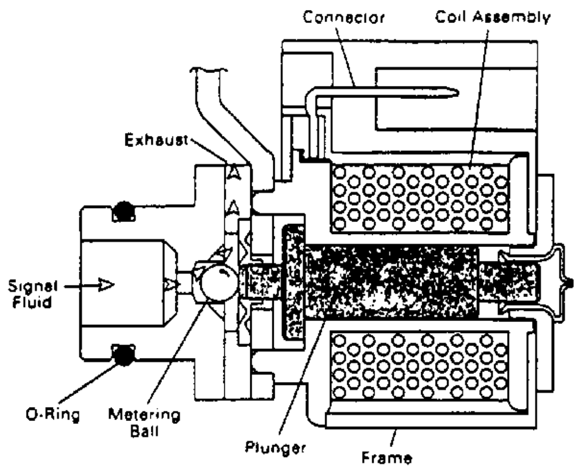
Engine Speed Sensor: Monitored by the PCM through the ignition module, this sensor is used to help determine shift patterns and TCC apply and release.

Brake Switch: This switch causes the PCM to command TCC release. When the brake pedal is depressed, the PCM opens the path to ground for the TCC electrical circuit which releases the converter clutch.

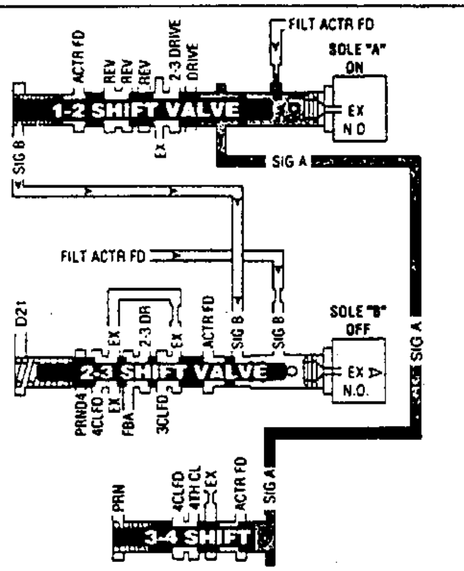
A/C Request: When the A/C pressure cycling switch closes, the PCM is signaled that the air conditioning compressor is ON. This signal is used by the PCM to adjust transmission line pressure as well as shift timing for the added engine load provided by the compressor.

Assembly Line Diagnostic Link (ALDL): This is a multi-terminal connector wired to the PCM that is located under the vehicle dashboard. The ALDL can be used to diagnose conditions in the vehicles electrical system, PCM or TCM, and various transmission components. Refer to the appropriate General Motors Service Manual for specific electrical diagnosis information.

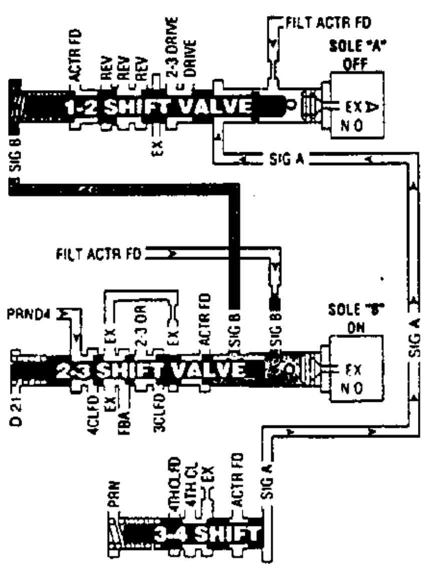
Figure 1



SHIFT SOLENOID (OFF)



EXAMPLE A: PARK/REVERSE/NEUTRAL/& FIRST GEAR



EXAMPLE B: THIRD GEAR

SHIFT SOLENOIDS

The HYDRA-MATIC 4L80-E uses two electronic shift solenoids ("A" and "B") to control upshifts and downshifts in all forward gear ranges. These shift solenoids work together in a combination of ON and OFF sequences to control the various shift valves. The PCM uses numerous inputs (as shown in Figure 34) to determine which solenoid state combination the transmission should be in. The following table shows the solenoid state combination required for each gear range:

GEAR RANGE	SOLENOID "A"	SOLENOID "B"
Park, Reverse, Neutral	ON	OFF
First	ON	OFF
Second	OFF	OFF
Third	OFF	ON
Fourth	ON	ON

The shift solenoids are de-energized (turned OFF) when the PCM opens the path to ground for the solenoid's electrical circuit. With the solenoid OFF, signal fluid pressure moves the checkball and plunger away from the checkball's seat. This allows signal fluid to flow past the checkball and exhaust out of the solenoid as shown in the drawing. When the PCM provides a path to ground for the electrical circuit to energize (turn ON) the solenoid, current flows through the coil assembly in the solenoid and creates a magnetic field. The magnetic field moves the plunger to the left (with respect to the drawing) and seats the checkball, thereby blocking the exhaust passage and causing signal fluid pressure to increase.

Solenoid "A" (313):
Filtered actuator feed fluid feeds the signal "A" fluid circuit at the 1-2 shift valve (314). When solenoid "A" is de-energized (OFF), signal "A" fluid exhausts through the solenoid, thereby creating low pressure in the signal "A" circuit (Example B). Even with the solenoid de-energized, fluid remains in the signal "A" fluid circuit but at low pressure because filtered actuator feed fluid continues to feed the circuit. Low pressure is shown by light blue fluid color while high signal "A" fluid pressure is shown as dark blue fluid color.

When solenoid "A" is energized (ON), signal "A" fluid is blocked from exhausting through the solenoid, thereby creating high signal "A" fluid pressure (Example A). High signal "A" fluid pressure acts on the 1-2 shift valve to keep it in the downshifted position (against spring force and actuator feed fluid pressure) when signal "B" fluid pressure is low. High signal "A" fluid pressure also acts on the 3-4 shift valve (308) to keep it in the upshifted position (against spring force and actuator feed fluid pressure) in the absence of PRN fluid pressure.

Solenoid "B" (311):
Solenoid "B" functions similar to solenoid "A" in that the PCM controls the path to ground for the electrical circuit to turn the solenoid ON or OFF. Filtered actuator feed fluid feeds the signal "B" fluid circuit at the 2-3 shift valve (312). When solenoid "B" is de-energized (OFF), signal "B" fluid exhausts through the solenoid, thereby creating low pressure in the signal "B" circuit (Example A). Similar to the signal "A" circuit, fluid remains in the signal "B" circuit with solenoid "B" de-energized (OFF), only at a low pressure due to the exhaust through the solenoid. Low pressure is shown by light blue fluid color while high signal "B" fluid pressure is shown as dark blue fluid color.

When solenoid "B" is energized (ON), signal "B" fluid is blocked from exhausting through the solenoid, thereby creating high signal "B" fluid pressure (Example B). High signal "B" fluid pressure acts on the 2-3 shift valve to move it into the upshifted position (against spring force and actuator feed fluid pressure). However, in Manual Second and Manual First gear ranges, D21 fluid pressure keeps the 2-3 shift valve in the downshifted position regardless of solenoid "B" state. High signal "B" fluid pressure also assists spring force and actuator feed fluid pressure at the 1-2 shift valve to keep the valve in the upshifted position wher signal "A" fluid pressure is either high or low.

Figure 1

PULSE WIDTH MODULATED (PWM) SOLENOID (323)

The PWM solenoid is used to control torque converter clutch (TCC) apply and release. This is accomplished by the Powertrain Control Module (PCM) varying the solenoid's duty cycle (percent time energized) according to various PCM input signals. Under normal operating conditions, the PCM does not energize (turn ON) the solenoid to apply the converter clutch until the transmission is in Fourth gear. However, if transmission fluid temperatures exceed approximately 122°C (250°F) the PCM will also command TCC apply in Second and Third gears (see Temperature Sensor explanation).

The PWM solenoid operates on a negative duty cycle. This means that the ground (negative or low) side of the solenoid circuit is controlled by the PCM. Therefore, the PWM solenoid is constantly fed approximately 12 volts to the high (positive) side and the PCM controls the length of time the path to ground for the electrical circuit is closed (duty cycle). When the PCM closes the solenoid ground circuit, current flows through the PWM solenoid and the ground circuit, or negative side, is at a low voltage state (0 volts and solenoid energized).

Figure A shows an example of the PWM solenoid operating with an 80% negative duty cycle at the constant operating frequency of 32 Hz (cycles per second). The frequency means that the solenoid is pulsed (energized) with current from the PCM 32 times per second. The 80% negative duty cycle means that during each cycle the solenoid is energized (ON), and 0 volts is measured on the low (negative) side of the circuit, 80% of the time (see inset in Figure A).

When the TCC is released, the electrical path to ground is always open and the negative duty cycle is 0%. Therefore, no current flows through the coil and the PWM solenoid is always OFF (as shown in the drawing). With the solenoid OFF, spring force moves the plunger to keep the checkball seated against the filtered 2-3 drive fluid circuit. This opens the TCC signal fluid circuit to exhaust through the solenoid and blocks filtered 2-3 drive fluid from entering the TCC signal circuit. With no TCC signal fluid pressure, the converter clutch remains in the release position.

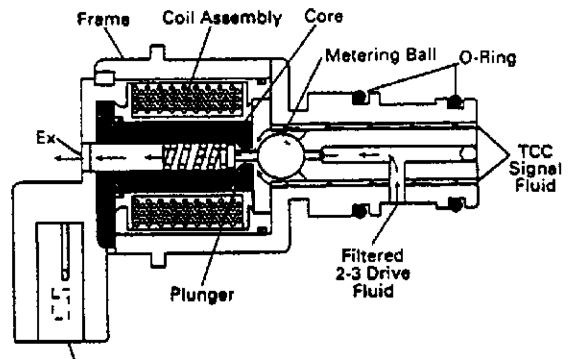
When the PCM signals TCC apply, the PWM solenoid operates with a negative duty cycle range from 0% to over 90% and at the operating frequency of 32 Hz. The PCM sends current through the solenoid coil according to the duty cycle which creates a magnetic field that magnetizes the solenoid core. The magnetized core attracts the checkball to seat against spring force. This blocks the exhaust for TCC signal fluid and allows filtered 2-3 drive fluid to feed the TCC signal circuit. A higher percent duty cycle keeps the checkball seated more often, thereby creating higher TCC signal fluid pressure.

TCC signal fluid pressure acts on the TCC regulator valve to regulate line pressure into the regulated apply fluid circuit. TCC signal fluid pressure also shifts the converter clutch shift valve into the apply position. Regulated apply fluid pressure is then directed through the converter clutch shift valve and to the converter to apply the torque converter clutch. Therefore, the rate at which the converter clutch applies depends on TCC signal fluid pressure as controlled by the duty cycle of the PWM solenoid. Refer to Torque Converter Clutch Release and Apply on pages 58A and 58B for a complete description of converter clutch hydraulic control.

To apply the converter clutch, the PCM immediately increases the duty cycle to approximately 30% (see point A on Figure B). This allows TCC signal fluid pressure to move the converter clutch shift valve into the apply position and direct regulated apply fluid to the torque converter. The PCM then increases (ramps) the duty cycle to approximately 60% where regulated apply fluid pressure applies the converter clutch (point B). The rate at which the duty cycle increases controls TCC apply rate and TCC apply feel as determined by vehicle application and operating conditions. Once the TCC applies, the duty cycle immediately increases to approximately 80% to achieve full apply pressure in the regulated apply fluid circuit (point C). Note that the duty cycle and TCC apply pressure continually vary depending on vehicle operating conditions.

When operating conditions are appropriate to release the TCC, the PCM decreases the duty cycle immediately from approximately 80% (point D) to approximately 60% (point E) where the TCC begins to release. The PCM then decreases the duty cycle to a calibrated value (point F) where the solenoid is completely de-energized (0% duty cycle, point G). The rate at which the duty cycle decreases controls TCC release rate and release feel. However, if the PCM receives an input from the brake switch that the brake pedal is depressed, the duty cycle immediately reduces to 0% for a quick release of the converter clutch.

Note: The duty cycle percentages in Figure B are only approximate values and vary depending on vehicle application and vehicle operating conditions. Also, some models do not use the duty cycle to control TCC release and simply de-energize the PWM solenoid to release the converter clutch. When de-energized, the duty cycle immediately reduces to 0%, allowing TCC signal fluid and regulated apply fluid to exhaust and the TCC to release.



PWM SOLENOID (OFF)

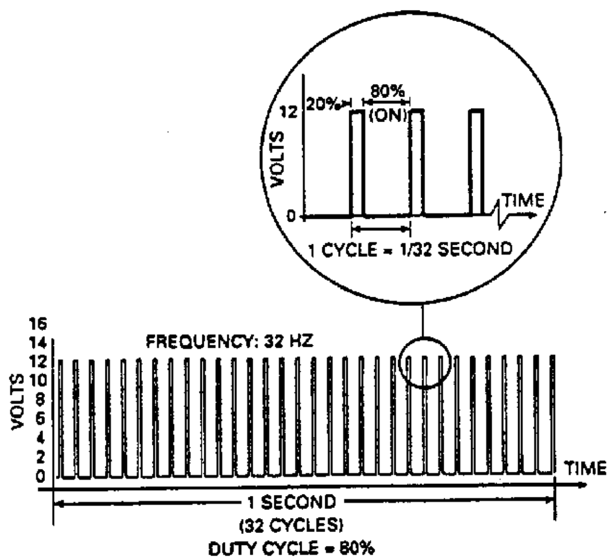


FIGURE A: PWM SOLENOID NEGATIVE DUTY CYCLE

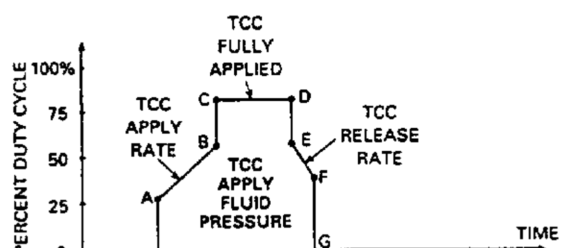


Figure 1

FORCE MOTOR (320)

The variable force motor is a precision electronic pressure regulator controlled by the PCM. The force motor operates at 292.5 Hz (cycles per second) and regulates filtered actuator feed fluid pressure into the torque signal fluid circuit. The PCM controls the pressure that torque signal fluid is regulated at by varying the current flow to the force motor coil. The amount of current flow is controlled by the duty cycle of the force motor. Similiar to the PWM solenoid, the duty cycle represents the percent time that current flow energizes the coil. The high frequency of the force motor acts to smooth the pulses created by the duty cycle energizing and de-energizing the force motor.

The PCM operates the force motor on a positive duty cycle. This means that the high (positive) side of the force motor electrical circuit at the PCM controls the force motor operation. Therefore, the PCM always provides a ground path for the circuit and continually monitors and adjusts current flow to the force motor depending on vehicle and transmission operating conditions. The PCM controls current flow by varying the force motor duty cycle. A positive duty cycle is measured as approximately 12 volts on the high (positive) side of the force motor when the force motor is energized (ON). Figure A shows an example of a 60% positive force motor duty cycle.

The duty cycle and amount of current flow to the force motor are mainly affected by throttle position. Both current flow and duty cycle are inversely proportional to throttle angle; as throttle angle increases, the duty cycle is decreased by the PCM which decreases current flow.

Current flow to the force motor coil creates a magnetic field that attracts the armature, thereby moving the plunger to the right (with respect to the drawing) against spring force. Note that the force motor is assembled with some transmission fluid inside. This fluid assists the damper spring in cushioning the armature movement.

At minimum throttle (idle), the current flow approaches 1.1 amps (always energized - ON). This keeps the armature forced against the plunger and compressing the spring. Therefore, torque signal fluid pressure acting on the end of the force motor valve moves the valve towards the armature and blocks the filtered actuator feed fluid circuit. The torque signal fluid circuit is then open to an exhaust port and torque signal fluid pressure a minimum.

At maximum throttle, the current flow approaches 0.0 amps (always de-energized or OFF as shown in the drawing). Therefore, the magnetic field is a minimum and spring force holds the plunger, armature and valve to the left (with respect to the drawing) against torque signal fluid pressure acting on the end of the valve. This closes the exhaust port and opens the torque signal circuit to filtered actuator feed fluid, creating maximum torque signal fluid pressure.

Under normal operating conditions between maximum and minimum throttle positions, the PCM varies the duty cycle which varies current flow to the force motor between approximately 0.0 and 1.1 amps to control torque signal fluid pressure. This allows the valve to regulate between opening and closing the exhaust port to regulate torque signal fluid pressure. Torque signal fluid pressure then controls line pressure at the pressure regulator valve accordingly (see chart). If the electrical system becomes disabled for any reason, current flow will be become 0.0 amps and the force motor will regulate maximum torque signal fluid pressure. This creates maximum line pressure to prevent any apply components from slipping until the condition can be corrected.

Torque signal fluid pressure also acts on the accumulator valve to increase accumulator pressure, and apply rate of the clutches and bands, as throttle angle increases. Remember that with greater accumulator fluid pressure there is less cushion for clutch apply fluid. The PCM also boosts torque signal fluid pressure, and line pressure, in the Manual gear ranges through the force motor depending on vehicle operating conditions.

Approximately every 10 seconds the PCM pulses the force motor to either maximum (100% duty cycle) or minimum current flow (0% duty cycle) depending on the force motor operating conditions. These pulses function to prevent possible contamination from sticking the force motor valve or plunger in any given position. To prevent these pulses from causing major line pressure fluctuations, torque signal fluid pressure acts on the torque signal compensator valve (409) in the accumulator housing. The torque signal compensator spring (410) absorbs these pulses to stabilize torque signal fluid pressure. However, if the transmission is upshifting or downshifting the PCM will not pulse the force motor.

The 4L80-E PCM/TCM programming also allows for adjustments in line pressure based on the changing characteristics of the transmission components. This process is referred to as Adaptive Learning and is used to assure consistent shift patterns and to increase transmission durability. As transmission apply components wear and shift overlap time (time required to apply a clutch or band) increases, the PCM/TCM adjusts line pressure to maintain the originally calibrated shift timing. This is done by changing torque signal fluid pressure through force motor control. Adaptive learning is accomplished in the 4L80-E by monitoring the inputs and calculations from the various PCM/TCM inputs.

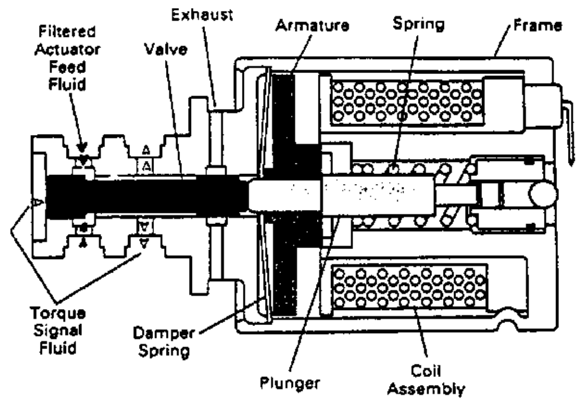


FIGURE A: FORCE MOTOR (OFF)

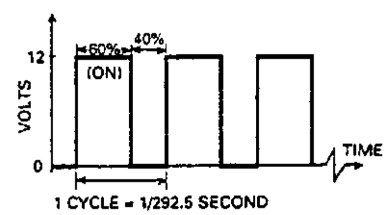


FIGURE B: FORCE MOTOR POSITIVE DUTY CYCLE

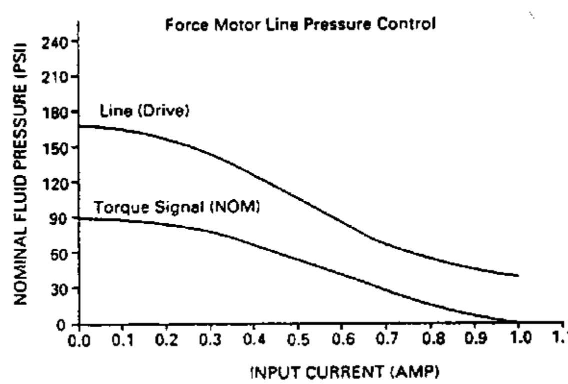
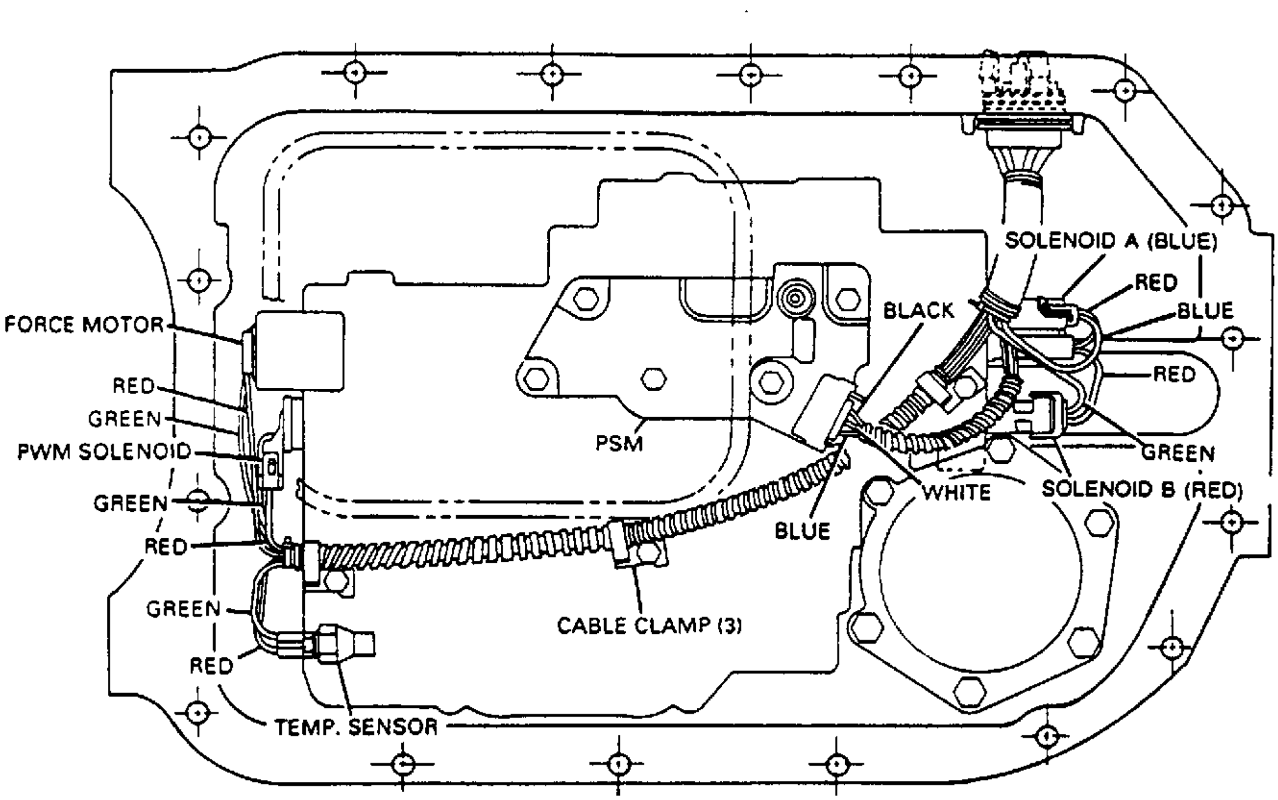
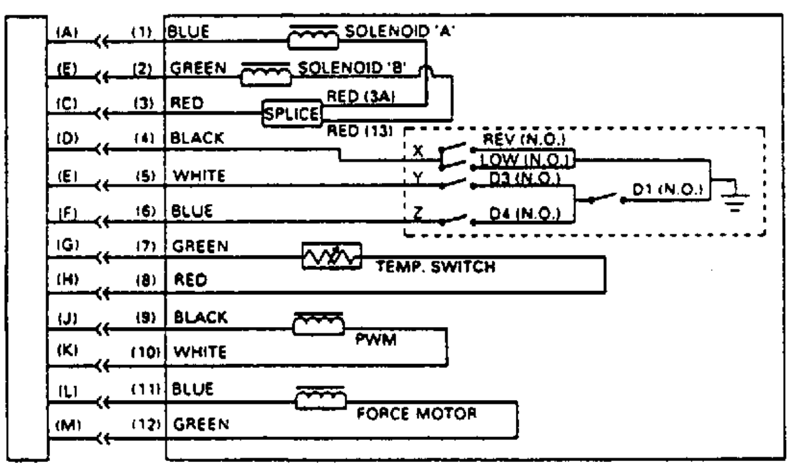


Figure 1





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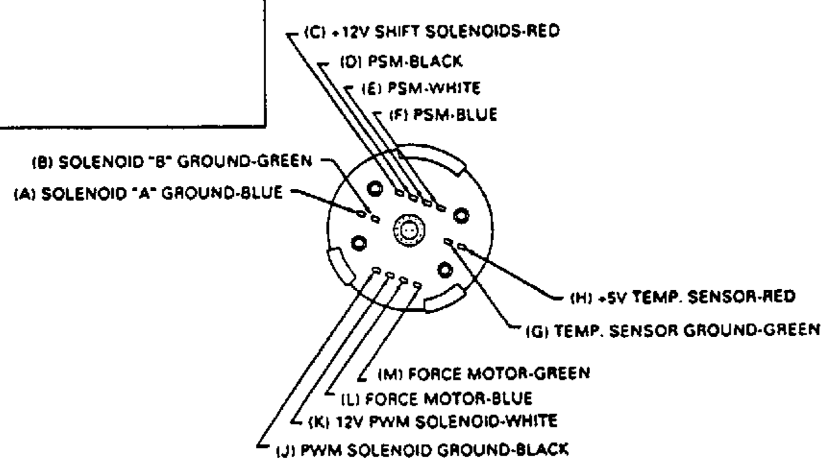

Figure 1

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). — Line pressure (high or low). — Engine (rough).
Engine Speed Sensor	— TCC apply (at wrong time, or no apply).
Input Speed Sensor	— TCC apply (no apply).
Output Speed Sensor	— Shift pattern (erratic). — TCC apply (at wrong time).
Force Motor	— Line pressure (high or low). — Shift quality (harsh or soft).
TCC Solenoid (PWM)	— TCC apply (timing, harsh or soft).
Pressure Switch Manifold	— TCC apply (won't apply). — Fourth gear (no fourth gear). — Shift quality (harsh). — Line pressure (high).
Transmission Temperature Sensor	— TCC control (on or off).
Engine Temperature Sensor	— TCC control (no apply).
Shift Solenoids	— Gear application (wrong gear, only two gears, no shift).

Figure 1

1991 HYDRA-MATIC 4L80-E MALFUNCTION CODE ACTIONS

Some malfunction codes have "actions" associated with them. This means if a particular code is set, the PCM commands the transmission to behave in a certain way. This protects the transmission components from damage, and allows the transmission to function until it can be serviced.

MALFUNCTION CODES	ACTION
24 – Output Speed 53 – System Voltage High 75 – System Voltage Low 81 – QDM And Solenoid B	STUCK IN SECOND GEAR
21 – TPS High 22 – TPS Low 28 – Pressure Switch Manifold 68 – Overdrive Ratio 75 – System Voltage Low	NO FOURTH GEAR
21 – TPS High 22 – TPS Low 28 – Pressure Switch Manifold 53 – System Voltage High 68 – Overdrive Ratio 75 – System Voltage Low 81 – QDM And Solenoid B	NO TCC
28 – Pressure Switch Manifold 68 – Overdrive Ratio	PSM DEFAULTS TO READ D4
21 – TPS High 22 – TPS Low 24 – Output Speed 28 – Pressure Switch Manifold 53 – System Voltage High 68 – Overdrive Ratio 73 – Force Motor Current 75 – System Voltage Low 81 – QDM And Solenoid B 85 – Undefined Ratio	LINE PRESSURE DEFAULTS TO PRESET VALUES (Preset values vary with calibration and gear selector position. This action may be described as harsh or erratic shift quality.)

Figure 1

CODE IDENTIFICATION AND DEFAULT ACTION		
CODE AND CIRCUIT	**PROBABLE CAUSE**	**DEFAULT ACTION**
14 Engine Temperature High	Signal voltage has been above 130°C (270°F) for 1 second.	• TCC apply cold. • Loss of driveability.
15 Engine Temperature Low	Signal voltage has been less than -33°C (-27°F) for 1 second.	• TCC apply cold. • Loss of driveability.
21 Throttle Position High	Code 21 will set if signal voltage has been above 4.9 volts for 1 second.	• Set line pressure to maximum. • Fixed shift points. • Inhibit 4th gear. • Inhibit TCC operation.
22 Throttle Position Low	Code 22 will set if TPS signal voltage is below .06 volt for more than 1 second.	• Set pressure to maximum. • Fixed shift points. • Inhibit 4th gear. • Inhibit TCC operation.
24 Output Speed Low	With input speed at least 3000 rpm, output speed must read less than 200 rpm.	• Set pressure to maximum. • Allow 4–3, 3–2, and 1–2 shifts, then maintain 2nd gear. • Calculate output speed from input speed.
28 Pressure Switch Manifold	PCM/TCM must see one of two "illegal" combinations from the pressure switch manifold.	• Assume D Drive 4 is selected. • Inhibit 4th gear operation. • Inhibit TCC operation.
39 TCC Stuck "OFF"	Code 39 sets if the TCC slip is greater than 65 rpm for 2 seconds.	• Inhibit 4th gear. • Inhibit TCC operation.
53 System Voltage High	Code 53 will set if system voltage is above 19.5 volts for 2 seconds.	• Maximum line pressure. • 2nd gear only. • Inhibit TCC operation.
58 Transmission Temperature High	Transmission temperature must be above 154°C (304°F) for 1 second.	• TCC in 2nd, 3rd, 4th gears. • Maximum line pressure.
59 Transmission Temperature Low	Transmission Temperature must be below -48°C (-54°F) for 1 second.	• TCC in 2nd, 3rd and 4th gears. • Maximum line pressure.

Figure 1

CODE IDENTIFICATION AND DEFAULT ACTION		
CODE AND CIRCUIT	**PROBABLE CAUSE**	**DEFAULT ACTION**
68 Over Drive Ratio	Code 68 will set if the engine speed is 200 rpm higher than input speed for 2 seconds must be in 4th gear TCC engaged.	• Set Pressure to maximum.
73 Force Motor Current	Code 73 sets when actual force motor current is more than 1.6 amps lower than command current.	• Maximum line pressure.
75 System Voltage Low	Code 75 will set when system voltage falls below 8.6 volts.	• Turn force motor "OFF." • Allow 4–3, 3–2, and 1–2 shifts, then maintain 2nd gear. • Inhibit TCC and 4th gear.
81 Quad Driver and Shift Solenoid "B" Fault	Code 81 will set if the PCM/TCM detects an inappropriate voltage on the shift solenoid "B" circuit.	• Shift to 2nd gear. • Inhibit TCC operation.
82 Quad Driver and Shift Solenoid "A" Fault	Code 82 will set if the PCM/TCM detects an inappropriate voltage on the shift solenoid "A" circuit.	• 2nd and 3rd gears only or 1st and 4th gears only.
83 Quad Driver and TCC Fault	Code 83 will set if an inappropriate voltage is detected on the TCC circuit.	• Inhibit 4th gear. • Inhibit TCC operation.
85 Undefined Ratio	Code 85 will set if the PCM/TCM's calculations indicate an unexpected gear ratio does not include over drive.	• Set pressure to maximum.
86 Shift Solenoid "B" Stuck "ON"	Code 86 will set if the PCM/TCM has commanded 1st or 2nd gear but a ratio calculation indicates 3rd gear.	• Set pressure to maximum.
87 Shift Solenoid "B" Stuck "OFF"	Code 87 will set if the PCM/TCM commands 3rd or 4th gear but a ratio calculation indicates 2nd gear.	• Set pressure to maximum.

Figure 1

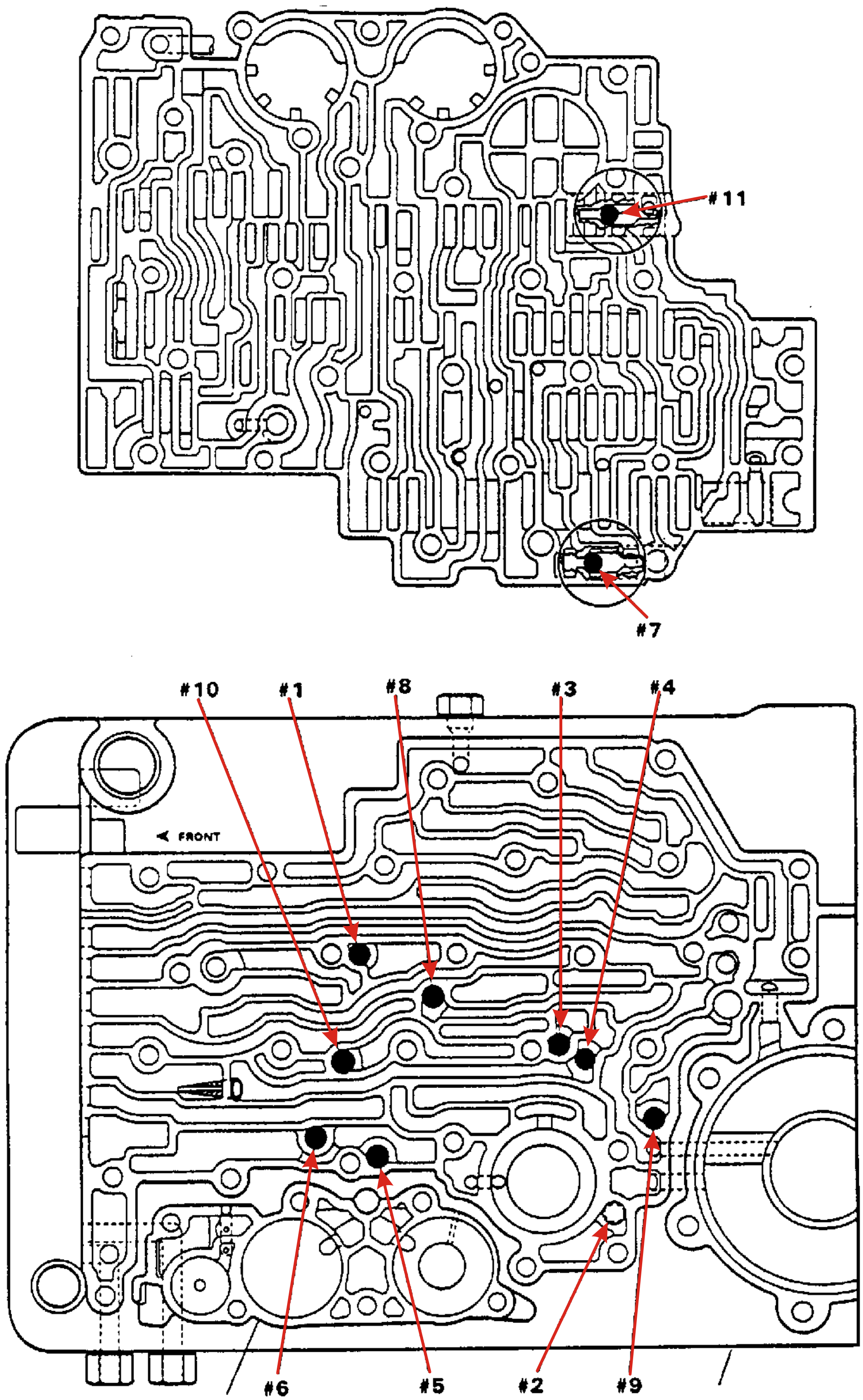

Figure 1

CHECKBALL FUNCTION AND LOCATION

NUMBER 1 OVERRUN CLUTCH
Located in the transmission case, it seats to force D321 fluid through an orifice and into the overrun clutch fluid circuit. This helps control the apply rate of the overrun clutch. When the overrun clutch releases, exhausting fluid unseats, and flows past, the #l checkball and into the D321 circuit. This allows for a faster exhaust of overrun clutch fluid, and a quicker release of the overrun clutch.

NUMBER 2 2ND ACCUMULATOR
(Used Only On Some Models) Located in the transmission case, it seats to force accumulator fluid through an orifice before entering the 2nd accumulator circuit and filling the 2nd accumulator. This helps control the rate at which 2nd clutch fluid exhausts from the rear servo and the release rate of the intermediate clutch.

NUMBER 3 FRONT BAND APPLY
Located in the transmission case, it seats to force front band apply oil through an orifice to help control the apply rate of the front band. When the band releases, exhausting fluid unseats, and flows past, the #3 checkball. This allows for faster exhaust of fluid and a quick release of the front band.

NUMBER 4 2ND CLUTCH
Located in the transmission case, it seats to force 2-3 drive oil through an orifice and into the 2nd clutch feed circuit. This helps control the apply rate of the intermediate clutch. When the intermediate clutch releases, exhausting 2nd clutch fluid unseats, and flows past, the #4 checkball and into the 2-3 drive circuit. This allows for a faster exhaust of 2nd clutch oil and a quick release of the intermediate clutch.

NUMBER 5 3RD ACCUMULATOR
Located in the transmission case, it seats to force accumulator oil through an orifice before entering the 3rd accumulator circuit and filling the 3rd accumulator. This helps control the rate at which 3rd clutch fluid exhausts from the 3rd accumulator and the release rate of the direct clutch.

NUMBER 6 4TH ACCUMULATOR
Located in the transmission case, it seats to force accumulator fluid through an orifice before entering the 4th accumulator circuit and filling the 4th accumulator. This helps control the rate at which 4th clutch oil exhausts from the 4th accumulator and the release rate of the 4th clutch.

NUMBER 7 LO/REVERSE
(Located Inside the Valve Body) Located "Inside" the valve body, it allows either Lo fluid (In Manual 1st) or reverse fluid (In Reverse) to enter the rear band apply circuit while blocking the other fluid circuit.

NUMBER 8 3RD CLUTCH
Located in the transmission case, it seats to force 3rd clutch feed oil through an orifice and into the 3rd clutch circuit. This helps control the apply rate of the direct clutch in 3rd gear. When the direct clutch releases, exhausting 3rd clutch oil unseats, and flows past, the #8 checkball and into the 3rd clutch feed circuit. This allows for a faster exhaust of 3rd clutch oil and a quick release of the direct clutch. Continued on next page.

Figure 1

NUMBER9 REVERSE
Located in the transmission case, it seats to force reverse oil through an orifice to help control the apply rate of the direct clutch in reverse. When the direct clutch releases, exhausting reverse oil unseats, and flows past, the #9 checkball. This allows for a faster exhaust of reverse oil and a quick release of the direct clutch.

NUMBER 10 4TH CLUTCH
Located in the transmission case, it seats to force 4th clutch oil through an orifice to help control the apply rate-of the 4th clutch. When the 4th 'clutch releases, exhausting 4th clutch oil unseats, and flows past, the #10 checkball. This allows for a faster exhaust of 4th clutch oil and a quick release of the 4th clutch

NUMBER 11 3RD CLUTCH/REVFRSE
(Located Inside the Valve Body)
Located "Inside" the valve body, it allows either 3rd clutch oil (In 3rd Gear) or reverse oil (In Reverse) to enter the 3rd/reverse circuit while blocking the other 'circuit.

Figure 1