Electronic Shift Control

Automatic Transmission

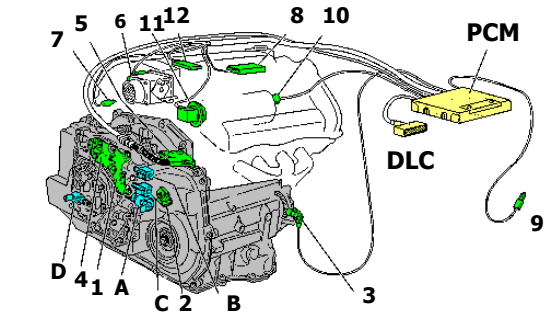
Electronic Controlled Transmissions

Modern transmissions are hydraulically operated with electronic controls. These controls provide:

- A better correlation between the engine and transmission
- Improved shift timing control
- Improved shift quality control
- Ability to provide driver-selected economy or performance operation
- Improved ability to determine proper transmission operation

Control System

An electronic control system has three major portions:
1. The inputs provide needed information.
2. The controller processes information and activates the outputs.
3. The outputs do the work.



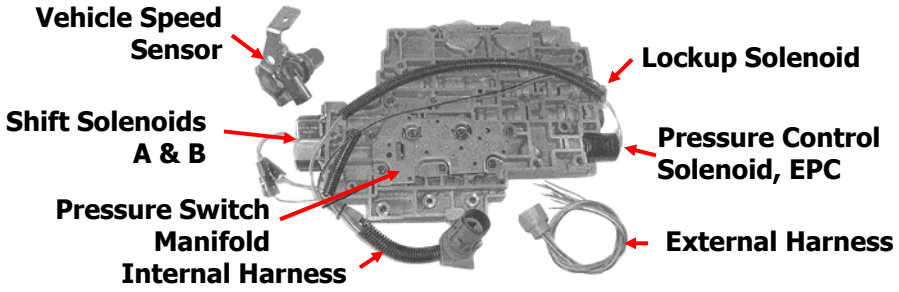
Sensors: 1-5 Trans. 6-12 Eng.

Electronic Controllers PCM & DLC

Transaxle Mounted Solenoids: A-D, MIL: 9

INPUTS **OUTPUTS**

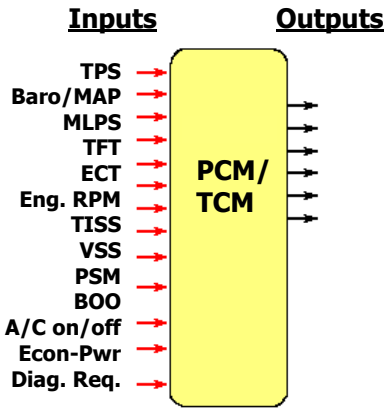
Electronic Valve Body



The internal harness transfers signals between the valve body and the controller. The section of the external harness is a repair part for the connector. The vehicle speed sensor is mounted outside of the transmission

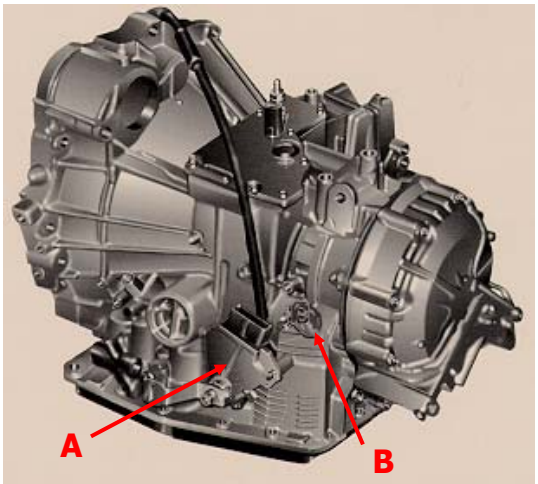
Inputs

Inputs are electrical signals that provide information to the powertrain control module (PCM) or transmission control module (TCM). Inputs are transmission, engine, and vehicle sensors or switches.



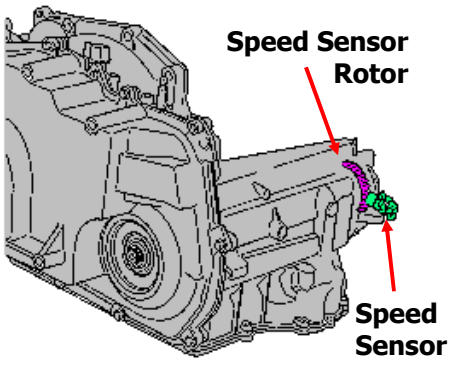
Transmission Mounted Inputs

Some inputs/sensors like the manual lever position sensor (MLPS) (A) and output speed sensor (B) are mounted on the outside of the transmission. Others sensors are mounted internally.



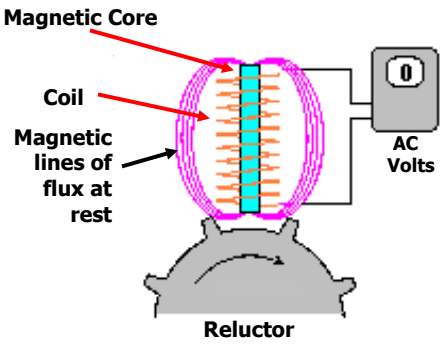
VSS

The vehicle speed sensor (VSS) provides a transmission output shaft speed signal. The VSS signal performs the same job as a governor in a hydraulic-controlled transmission. The VSS signal is also used for the vehicle's speedometer and other speed-related functions.



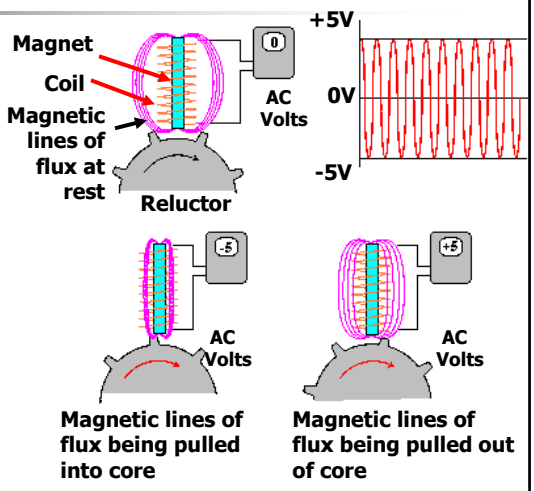
VSS Operation

Most VSS are a coil of wire around a magnetic core. The VSS is mounted close to a reluctor that has gear-like teeth. When the reluctor rotates, the teeth pull the magnetic lines of force over the coils of wire in the sensor.



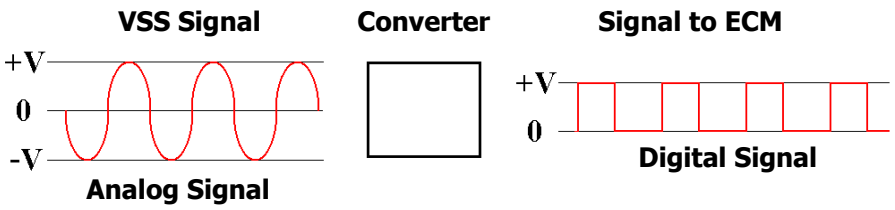
VSS Operation

The reluctor rotation generates an AC voltage with a frequency relative to reluctor speed (Top Right). Note that current direction changes with the tooth moving toward or away from the sensor core.



Animation: VSS Operation

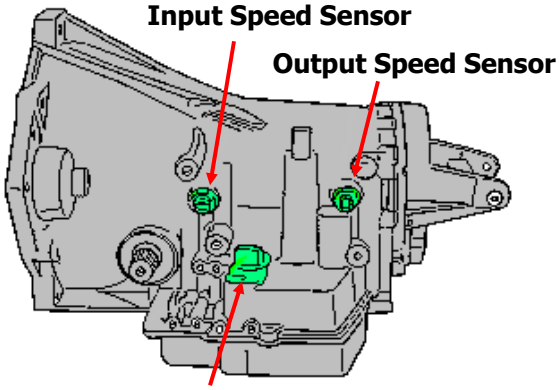
Analog to Digital



An analog signal, like that from the previous VSS, has a variable voltage. A digital signal is a series of on-off electrical pulses. Some ECMs require a converter to change analog signals into digital signals.

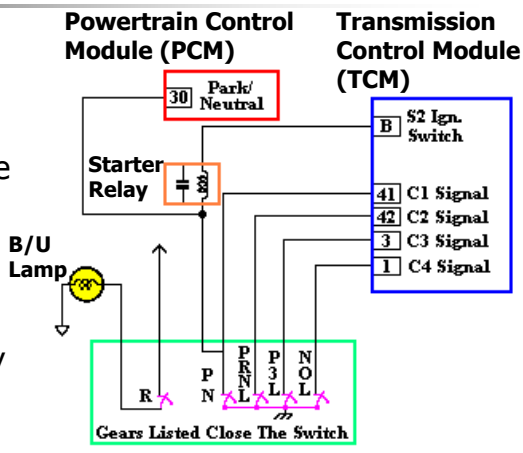
MLPS

Manual lever position switch (MLPS) is mounted onto the manual shift linkage entering the transmission. Shift linkage movement operates the MLPS. Note that this transaxle has two speed sensors.



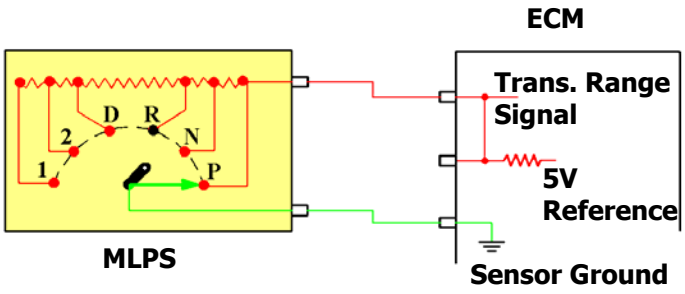
MLPS Operation

This MLPS is a group of four switches. Moving the shift lever will open or close the switch contacts, and the signal transfers that information to the TCM. Note that the MLPS also works with the starter relay and the backup lamp.



Animation: MLPS

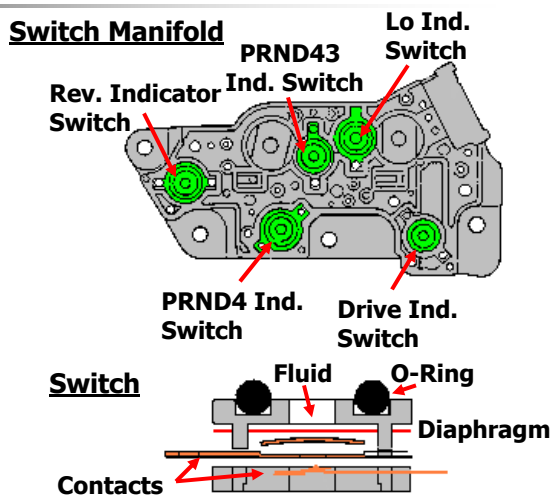
MLPS Wire Connections



Some MLPS use a separate wire for each gear range (previous slide). Others use a pair of wires with a block of resistors. The ECM monitors the return voltage to determine the gear range.

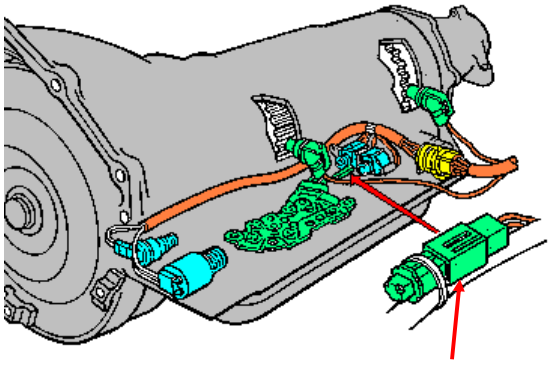
Pressure Switch

This transmission uses five pressure switches mounted on a special manifold. Each switch has a set of contacts that are closed when fluid pressure acting on a diaphragm pushes them together.



TFT Sensor

Transmission fluid temperature (TFT) sensors are placed into the ATF. It is a thermister; a variable resistor with a negative temperature coefficient. The resistance decreases as the fluid temperature increases.

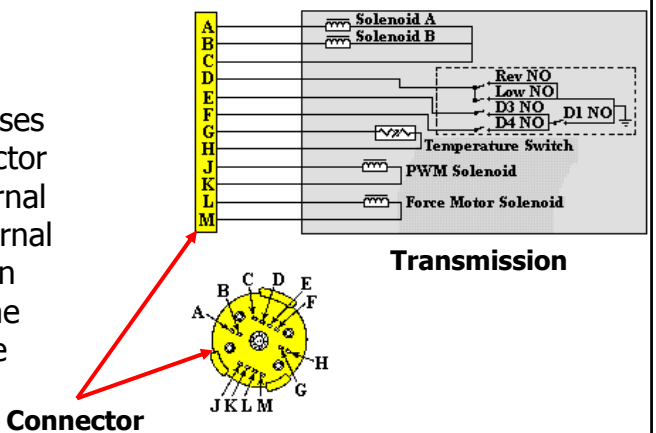


Transmission Fluid Temperature (TFT) Sensor

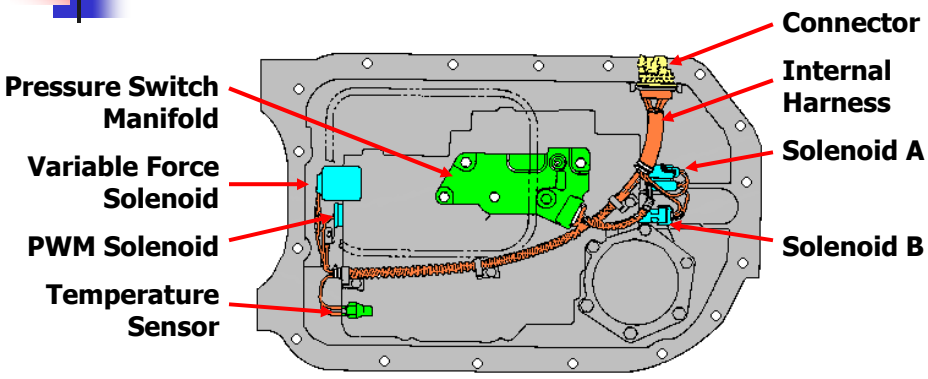
Animation: Transmission Temperature Sensor

Internal Harness

This transmission uses a twelve pin connector to connect the internal harness to the external electrical harness on the vehicle. Note the identification on the connector pins.



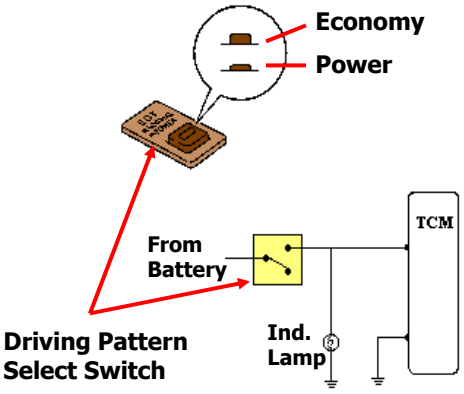
Harness Connector



The internal harness contains the wires to connect the sensors and solenoids to the connector at the side of the transmission.

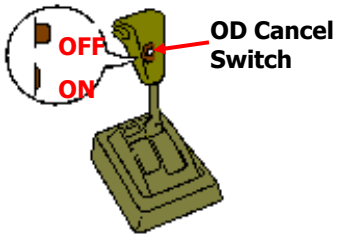
Driving Pattern Select Switch

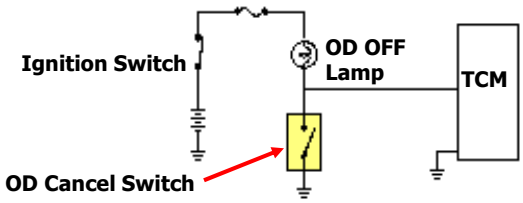
This switch is also called the Power-Economy switch. It allows the driver to select one of two or more driving modes. The power mode will have higher shift points and torque converter clutch (TCC) lockup.



OD Cancel Switch

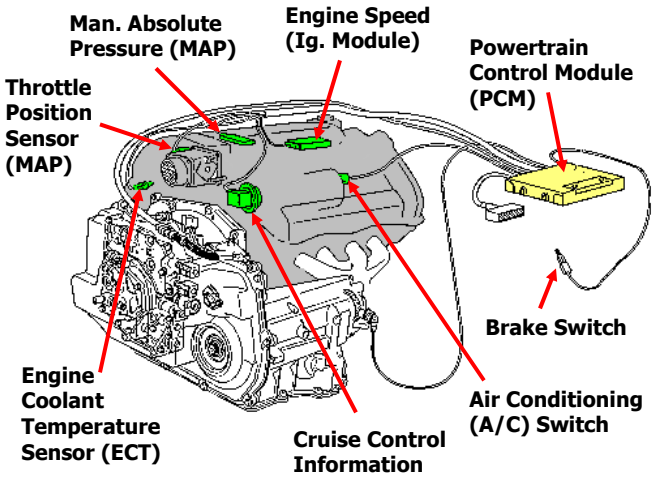
This switch cancels overdrive (OD) range and limits transmission operation to 1-2 and 2-3 operation only.





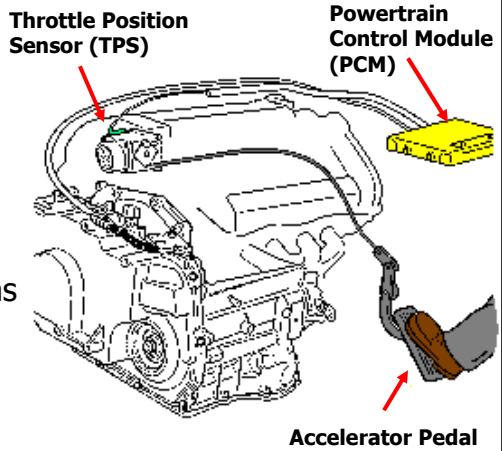
Engine Mounted Inputs

These engine and body mounted sensors are used for both engine and transmission control. They have a definite affect on transmission operation.



TPS

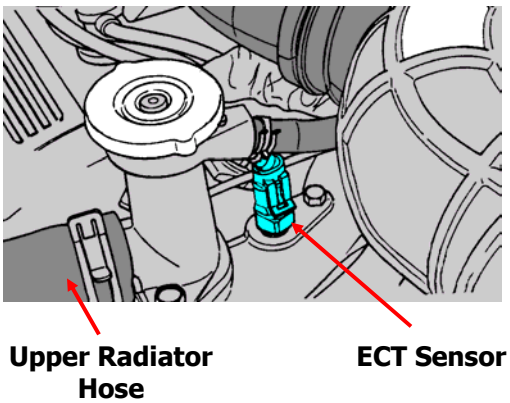
The throttle position sensor (TPS) is a major engine control sensor. It is mounted at the fuel injector or carburetor. The TPS signal to the transmission controller performs the same function as the throttle valve on a hydraulic-controlled transmission.



Animation: Throttle Position Sensor

ECT Sensor

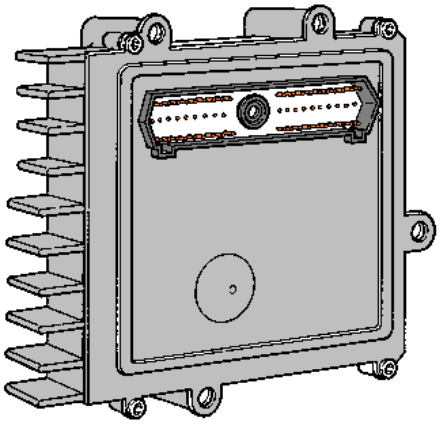
The engine coolant temperature, ECT, sensor lets the ECM know if the engine coolant is too cold, at operating temperature, or approaching an overheat condition.



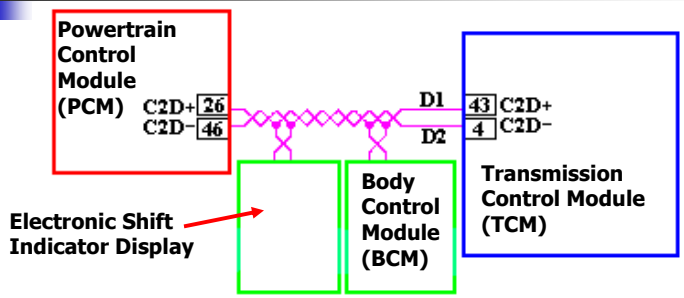
Animation: ECT Sensor

Controllers

This transmission control module (TCM) has a multi-pin connector for the wiring harness. The TCM notes changes in engine and transmission operation and produces the proper output signal so the transmission can adapt to those changes.



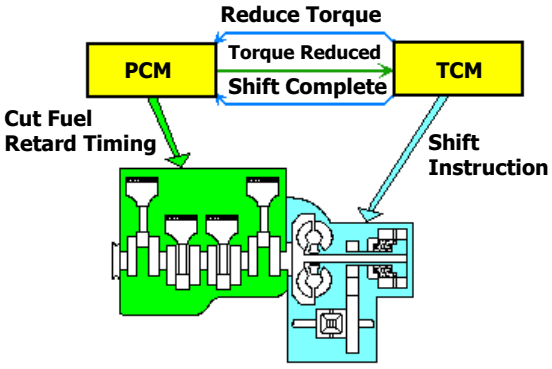
Bus Communication



The control modules can share input and output information through a Bus/Multiplex Link. Two wires, normally twisted, connect two or more control modules. This feature greatly reduces the amount of wires in a vehicle.

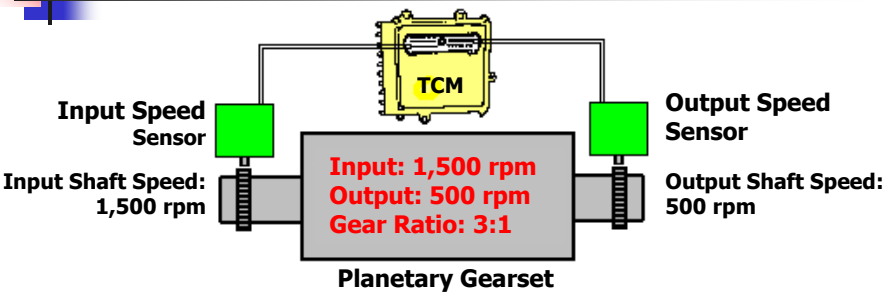
Engine Transmission Coordination

When this transmission is ready for an upshift, the transmission controller (TCM) signals the engine controller (PCM) to reduce torque/ power. Normal engine operation resumes after the shift.



This feature increases transmission life because of the reduced torque loads during upshifts.

Shift Quality



The TCM compares the speed of the two speed sensors. It can calculate the gear ratio and the time it took for the transmission to complete the ratio change. From this, the TCM can determine if the shift took the proper amount of time.

Shift Quality

If the shift took too much time, the TCM can increase fluid pressures for future shifts. The TCM can reduce pressure if the shift was too fast and harsh. It can also determine if the transmission is slipping internally, and in this case, it will turn on the MIL, Malfunction Indicator Light.

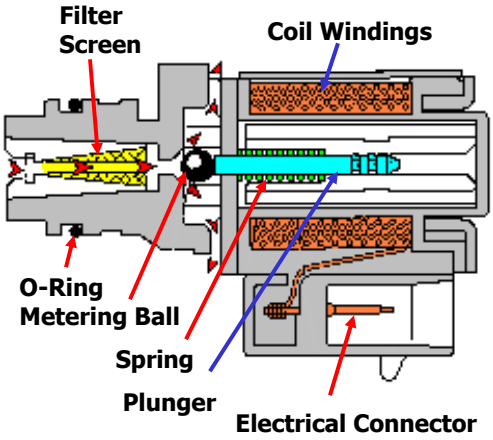
Outputs

Transmission outputs include:

- Shift solenoids
- Pressure control solenoids
- Torque converter clutch solenoids
- Shift indicator lights
- Malfunction indicator lamps (MIL)

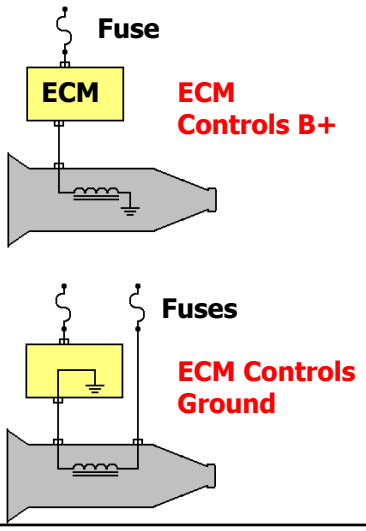
Shift Solenoids

A solenoid has a coil of wires that becomes a magnet when current flows through the windings. When magnetized, the plunger will move to the right and allow the metering ball to move off its seat. This will allow fluid to flow through the filter screen and out the exhaust.



Animation: Shift Solenoid

Solenoid B+ & Ground

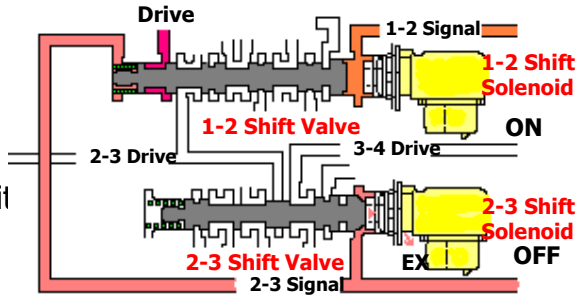


A one-wire solenoid is connected directly to ground by its mount and switched to B+ by the ECM to turn it on.

Most two-wire solenoids are connected to B+ through a fuse and the ECM controls the ground to turn it off or on.

Shift Solenoid Operation

These shift solenoids control the pressure at one end of a shift valve. The upper solenoid (normally open) is on so it is blocking fluid flow, and the pressure is keeping the shift valve to the left.

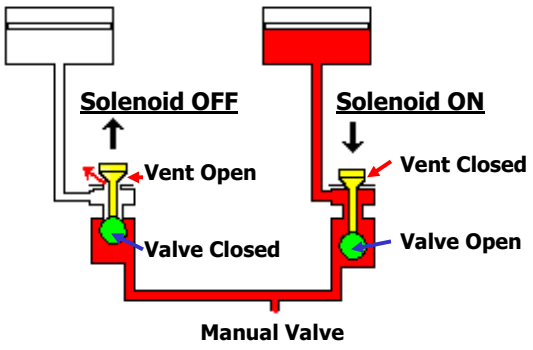


The lower solenoid is off so fluid pressure escapes to the exhaust. The spring (at the left end) has moved the valve to the right.

Animation: Shift Solenoid Operation

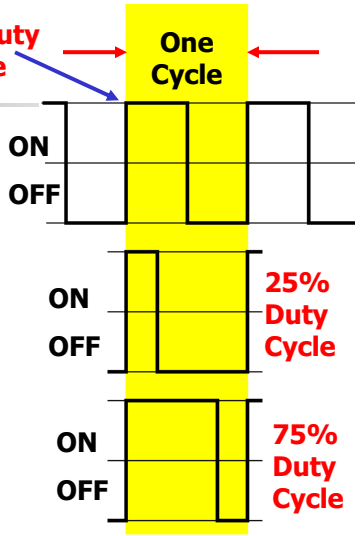
Direct Solenoid Operation

In this transmission, the solenoid stems (yellow) act on the check ball/ valve. The taper on the stems opens or closes a vent. When the solenoid is off, the stem is upward, opening the vent and closing the valve.



Animation: Shift Solenoid Operation 2

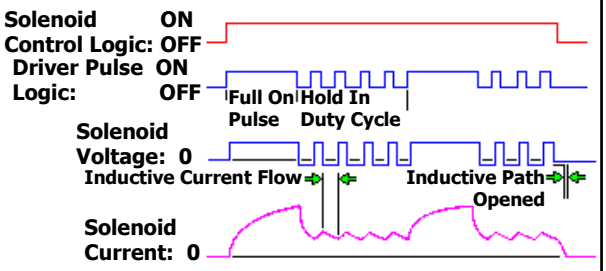
Duty Cycle



Duty Cycle tells us how much of the time the solenoid is turned on. Fluid pressure control solenoids are either cycled or partially applied to produce a specific pressure.

Many shift solenoids are either on or off. Some shift solenoids are cycled to vary the apply rate (fluid pressure increase).

PWM Solenoids

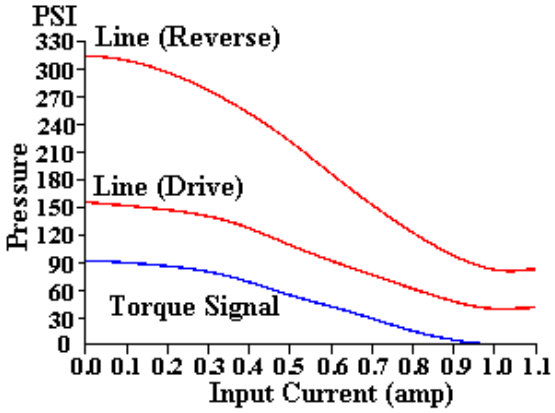


Pulse width modulation (PWM) turns the solenoid on and off at a specific pulse width or rate (Duty Cycle). Some PWM solenoids are cycled at 3 Hz (3,000 times per second).

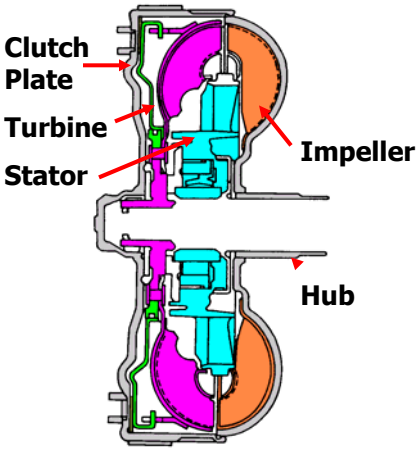
Animation: PWM Solenoid

Fluid Pressure Control

Increasing the current flow to this pressure control solenoid/force motor will reduce line pressure. No current flow produces the highest pressure for the firmest or strongest shifts.



TCC Apply

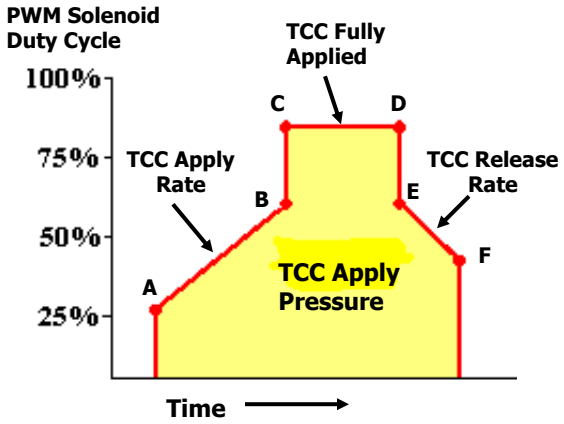


Modern torque converter clutches, TCC, apply the clutch to reduce slippage, reduce emissions, and improve fuel mileage. TCC application is commonly controlled using a solenoid.

Animation: TCC Operation

TCC Control

This solenoid is cycled at a 25 to 50% duty cycle during torque converter clutch (TCC) apply. This produces a much smoother TCC apply and release.



MIL

On this vehicle, the OD cancel lamp (OD OFF) also serves as the malfunction indicator lamp (MIL). A transmission problem is indicated if this light is flashing.