Transmission electronic controls outline

Inputs-processing-outputs

Inputs provide the system the environmental conditions that are needed to operate or check the operation of the transmission. Inputs can be directly wired to the module, wired to another module and broadcast over network, or a signal created by another module that is sent over network.

Processing contained in the TCM/PCM and is the calculations required for operation of the transmission. Preprogrammed strategies are used to basically operate, learn fine-tuning, and for diagnostic operations.

Outputs consist of Solenoids, signals, and lamps. Which are directly controlled by the TCM/PCM to operate the transmission. Circuits are monitored for correct operation by the module.

Inputs:
May be Primary or Secondary.
May be directly wired to module, wired to another module, or signal over network.

Signals:

Engine torque estimate is a signal from the engine control module that tells the transmission the approximate torque output of the engine. This information will be used by the TCM/PCM to adjust for engagement feel, shift feel/timing, and torque converter engagement/feel.

Primary:

Inputs are required to operate the transmission at a basic level of quality. These inputs include: TSS/ISS/OSS/TFT/TR/TCS Pressure sensors.

Secondary:

Inputs are required for extended operation of self-diagnosis or Failure Mode Effects Management (FMEM). These inputs include: IAT/CHT/ECT/MAF/CKP/WSS

Primary

<u>TFT Sensor:</u>

The TFT is a thermistor that is usually a NTC type. As its temperature increases its resistance decreases. When cold TFT_V will usually be a high voltage around 3.0-4.5 volts depending on outside temperature and at operating temperature it will usually be around .5-1.5v. Can be tested by using a DVOM on Ohm or Volt scale. Best to back probe with circuit left intact while watching voltage

on signal circuit and signal return. Signal circuit should match data-stream while signal return should be near zero volts.

TR sensor:

Used by TCM/PCM to determine actual transmission shifter position. The manual hydraulic valve does not tell TCM/PCM its position and some transmission manual valves have only three positions for operation (park,reverse,drive). Since the Drive position may include OD, D, 3, 2, and 1 the TCM/TCM must know what schedules and what gears to provide.

Types:

Digital TR utilizes at a series of input circuits that will be grounded to signal return in TCM/PCM. (usually 4 circuits with 1 signal return) as the circuits are grounded they create a logic or combination that TCM/PCM can use to determine the shifter position. Can be diagnosed with Data-stream by monitoring each circuit form the DTR for activity and with DVOM for component diagnosis.

Stepped resistor is similar in operation to an AC blower motor. Each shifter position has its own resistance. Can be diagnosed with a DVOM to check for correct resistance in each gear position.

Switched TR uses individual circuits for each gear shifter position. As shifter is moved through its range each circuit is shorted to signal return indicating the position. Can be diagnosed using a DVOM to check for circuit continuity for each position.

PWM uses internal circuitry to indicate each gear position. Each shifter position is indicated by a differing duty cycle. (example park=12% Drive = 60%) diagnosis can be done with a DVOM capable of reading duty cycle. No internal resistance readings are possible due to circuitry involved.

TSS/ISS/OSS Sensors:

TSS = Turbine Shaft Speed sensor
ISS = Input Shaft Speed sensor
OSS = Output Shaft Speed sensor
May be a VRS or Hall effect type of sensor.

VRS sensors use a 2 wire circuit that the sensor transmits its AC voltage. The voltage is generated by exciting the magnetic field of the sensor which induces voltage into the windings of the sensor. The AC voltage Frequency is monitored by the TCM/PCM the actual Volts of the signal is not monitored. As shaft speed increases the frequency of the signal increases as well. A DVOM on OHMS or Volts AC can be used to test a sensor. Specific resistance is measureable across the sensor terminals and if excited an AC voltage will be created.

Hall Effect sensors use at minimum 3 wires for operation. These sensors will indicate shaft sped via a square wave type of DC signal. The voltage does not vary based on speed, but the frequency will increase as shaft speed increases. A DVOM on volts is used for diagnosis, with circuit intact measure voltage on the signal wire and

monitor for high and low voltage while slowly turning the excitor. Internal resistance readings are not possible due to internal circuitry.

TCS/BPP:

BPP is used to control the operation of the torque converter clutch.

TCS is used to modify the operation of the transmission schedules, feel and torque converter clutch.

While not technically a sensor the TCS (transmission control switch) or BPP (brake pedal position) are monitored switch inputs. It is a momentary contact that the TCM/PCM uses to create a "Latch" type of operation. Operates with a signal circuit and signal return circuit that when the button is depressed the signal circuit goes low. A DVOM can be used to measure resistance of the switch.

Engine Torque Estimate:

ETM is a calculated value based on engine load, rpm, and ignition timing. This is not a sensor, but a signal from the engine control module. Diagnosis of the ETM is not directly done but is done through the diagnosis of the engine performance.

Secondary Inputs

ECT/CHT/IAT

All thermistors that are NTC types that will be used for diagnosis of the TFT during a comprehensive component monitor. When the key is first turned to ON the TCM and PCM will compare the temperature readings of the different sensors, if the vehicle has been OFF for a long enough time the temperatures should all be within a specified amount. Diagnosis can be done with a DVOM using either OHMS or Volts. If using a scan tool be sure to monitor both the Temp voltage and Degree reading due to FMEM affecting the Temp reading.

CKP/WSS

VRS or Hall Effect sensors may be used and will be used to calculate Engine Torque Estimate for CKP and vehicle speed for WSS. If there is a loss of OSS in the transmission system it is feasible for the WSS to replace that value in the TCM/PCM for transmission operation. Diagnosis of the VRS can be done with DVOM on OHMS or Volts AC, but a hall effect will require DVOM only on Volts DC.

4WD

May be a NC or NO type of switch that indicates the activation of 4wd operation. This activation may change the shift and torque converter engagement schedules and possibly the line pressure applied.

MAF

Used by engine control module to calculate engine torque estimate. Hot wire sensor diagnosed with the use of a scan tool and Data-stream.

ACCS: (Air Conditioning Control Signal)
May be used to augment the shift schedule or torque converter operation.

Transmission Control Outputs

MIL
Malfunction indicator lamp. Used by the TCM/PCM to indicate a failure of the transmission or engine control systems.

TCIL
Transmission control indicator lamp. Used by the TCM/PCM to indicate either a failure or a change in the operating strategy. If the transmission indicator is flashing then codes may be present. It may be controlled via direct module control or via network communication to the instrument panel.

Data Link Connector
Diagnostic information is accessed via the DLC along with the possible update of the transmission control strategy through a calibration update.

Solenoids:
Used to control clutch/band elements, torque converter clutch, and line pressure. May be directly or inversely proportional in operation and may be NO (normally open) or NC (normally closed). May be a VFS (variable force solenoid) or a on/off type.
If a transmission uses an on/off group of solenoids they are Shift Solenoids that control shift timing and to control shift feel and engagement an EPC (pwm or vfs) solenoid is used.
If a transmission uses only VFS to control clutch/band elements shift timing and feel are controlled with both the element solenoid and the EPC solenoid.

Shift solenoids normally have B+ supplied through a common circuit and each solenoid is then module controlled through a dedicated ground control circuit. Diagnosis can be done with a dvom measuring the resistance of the solenoid circuits and resistance to its ground. Shift solenoids may also be a Normally open or a normally closed type of circuit.

VFS solenoids normally have B+ supplied through a common circuit and each solenoid is then module controlled through a dedicated variable amperage circuit. The module is able to control the position of the solenoid armature with fine detail. In these cases the solenoid often controls a clutch or band element directly in addition to being used for TCC or EPC operation. Diagnosis can be done with a DVOM measuring the resistance of the solenoid circuits and its ground. Functional testing (click test) is not always effective due to the small amount of armature travel in the solenoid.

PWM solenoids normally have a common B+ circuit and use a dedicated module control circuit to a varying Duty cycle type of signal. Normally used for TCC or EPC operation. Diagnosis can be done with a DVOM measuring the resistance of the solenoid circuits and their resistance to ground.

Engine Torque Modulation

The TCM has the ability to send a signal to the Engine control module to reduce power during an up-shift to prevent slippage and reduce harshness. In the event of a failure the ETM signal can also command overall reduced output to prevent transmission damage.

Module strategy

Programmed strategy

Commonly referred to as Calibration and is the basic operating commands for transmission operation. It is the portion of processing that the module uses to operate, diagnose, and "learn" the transmission and torque converter. It is not erased by removing battery power and is semi-permanent in memory. Calibration can only be changed by a module reprogramming or through a module replacement.

Adaptive strategy

As the transmission is operated by the Calibration it is always trying to meet preprogrammed parameters (shift times, torque converter application time, etc…) the adaptive strategy is the learned information about the specifics of a transmission to meet those parameters. (EPC pressures per shift, TCC engagement percentages, EPC pressures during engagement, and others) Adaptive strategy is located in a volatile memory location and can be lost by Erasing KAM, replacing the module, calibration update, and disconnecting battery. Adaptive strategy quickly learned through a Transmission Drive Cycle type of test drive.

Failure Mode Effects Management

FMEM is a set of rules that in the event of a failure the TCM/PCM can still operate the transmission in a useable state. Example: Loss of the TFT sensor will effect the torque converter clutch operation and shift scheduling. FMEM may replace that TFT value with an inferred value from another input such as CHT or ECT. FMEM also has the ability to adapt shift scheduling to avoid further damage to a transmission due to a failure. Example: in the event of a shift solenoid failure the TCM may skip gears that involve that solenoid.

Just remember. WWMD

What Would Macyver Do? And, watch out for Daleks.