ASE 2 - Transmissions

Module 6
Automatic Transmission Electronic Controls
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# Module 6 - Automatic Transmission Electronic Controls

## Objectives

- Course Focus
- Transmission Inputs
- Transmission Outputs
- Transmission Electrical Diagnosis
- Code types for automatic transmissions
- Tech 2
- J-39200 Fluke DVOM
- J-44152 Transmission Test Harness
- J-35616-B Terminal Test Kit
- Hydramatic Standardization
- Troubleshooting Tips
This workbook is designed to help you to gain a working knowledge of the operation, diagnosis and repair of Electronically Controlled Automatic Transmissions used in General Motor's cars and light trucks. Toward that purpose, we will be assigning you a number of different exercises that will test your ability to diagnose these vehicles.

**CAUTION!**

Extreme care must be exercised when working on or around automatic transmissions! Hot components such as exhaust pipes and catalytic converters must be avoided or serious injury could result!

**Objectives**

- Understanding the operation of transmission electronic controls.
- Diagnosis of transmission controls with a DVOM and a Tech 2 scan tool.
- Repair procedures for electrical and electronic transmission concerns.
Course Focus
The course will focus on Hydramatic 4L60-E and 4L65-E transmissions and 4T65-E transaxles. Many of the diagnostic procedures will be similar for other current Hydramatic transmissions and transaxles.

Transmission Controls:
All General Motors current production transmissions and transaxles are controlled by the PCM, or power train control module or, by a TCM or transmission control module.

Types of Transmission Controls:
Shift pattern, or when a transmission makes upshifts and downshifts, and...Shift quality, or how soft or harsh a transmission shift feels to the customer.

How the PCM controls the transmission:
PCM's command the shifts based on data received from sensors called "Inputs". The PCM will then use that data to calculate when to shift the transmission and also how to make the shift "feel" i.e. soft or harsh. The PCM will also control the shifts using critical controls called "Outputs".
Transmission Inputs

- Speed sensors
- Pressure switch assembly (PSA)
- Transmission fluid temperature sensor
- Neutral safety back up switch (NSBU)
- Throttle Position Sensor or TPS
- Mass Air Flow Sensor or MAF
- Manifold Absolute pressure or MAP
- Coolant Temperature Sensor or CTS
- Brake switch input

These sensors all play a part in telling how and when the transmission should be shifted, or the torque converter clutch applied, by the PCM.
**Input operation: Speed Sensors**

Speed sensors send an A/C signal to the PCM that varies with transmission input speed and vehicle speed. The 4L60-E does not use an input speed sensor, they use the engine RPM signal from the ignition system. The PCM uses speed sensor signals to control transmission upshifts and downshifts.

![Figure 6-3](image)

**Figure 6-3**

![Figure 6-4](image)

**Figure 6-4**
**Input operation: Pressure Switch Assembly**

The pressure switch assembly (PSA) monitors the position of the transmission's manual valve. The PCM uses PSA data to control shifts based on the driver's inputs to the shift lever control manual valve.

**Figure 6-5**
Input operation: Transmission Fluid Temperature Sensor (TFT)

The PCM uses the Transmission Fluid Temperature (TFT) sensor to help control shifting and Torque Converter Clutch (TCC) apply. Cold temperature may inhibit some upshifts or TCC apply. Hot temperatures may cause early TCC apply and earlier than normal shifting.

**Figure 2-6**
Input operation: Neutral Safety Back Up Switch (NSBU)
The Neutral Safety Back Up switch can give input on all or some of the following:
- Park or Neutral selection for starting
- Driver commanded gear range
- Back up lamp control

![Figure 6-7](image)

Input operation: Throttle Position Sensor (TPS)
The Throttle Position Sensor (TPS) sends a signal to the PCM detailing what is happening with the throttle. The TPS can show if the customer is accelerating, holding steady throttle or decelerating, along with the rate of acceleration or deceleration. This information is critical to help the PCM select the proper gear for smooth operation.

![Figure 6-8](image)
Input operation: Mass Air Flow Sensor (MAF)
The Mass Air Flow sensor signal is used by the PCM to determine the load that is being placed on the engine. The engine load data is used by the PCM to control shift timing and shift feel.

![Figure 6-9](image1)

Input operation: Manifold Absolute Pressure Sensor (MAP)
The Manifold Absolute Pressure (MAP) sensor signal is used much the same way as the MAF sensor signal, the MAP sensor signal tells the PCM an indication of engine load. The PCM uses the MAP sensor data to control shift timing and shift feel.

![Figure 6-10](image2)
Input operation: Coolant Temperature Sensor (CTS)
The Coolant Temperature Sensor (CTS) signal is used by the PCM to modify shift and Torque Converter Clutch control. The CTS signal is also used by the PCM to help verify that the Transmission Fluid Temperature signal reading is accurate.

![Figure 6-11](image)

Input operation: Brake Switch Input
The Brake Switch Input is used by the PCM to control the release of the Torque Converter Clutch (TCC) when the brakes are applied. This feature allows for a smooth deceleration when coming to a stop.

Input operation summary
Inputs supply information that the PCM uses to control transmission operation. Many transmission concerns may be caused by failed input sensors or failed sensor circuits. The thorough understanding of PCM inputs is critical to correct transmission diagnosis.
Transmission Outputs

- 1-2 shift solenoid
- 2-3 shift solenoid
- TCC/PWM solenoid
- Pressure Control Solenoid (PCS)
- 3-2 downshift solenoid
- TCC apply solenoid

Output operation: Shift Solenoids

The PCM grounds and un-grounds shift solenoids to control shift valve position in the transmissions’ valve body. Shift valve position determines which gear range the transmission will operate in. When the PCM grounds a shift solenoid, the solenoid closes a hydraulic exhaust path. The hydraulic pressure then forces the shift valve to the up shift position. By using two shift solenoids, we can provide 4 forward gear ranges.
Output operation: Shift solenoid control
All 60 & 65 series transmissions (4L60-E, 4L65-E, 4T60-E and 4T65-E) share the same solenoid operation. They used a 1-2 and a 2-3 shift solenoid, each with two positions, giving us four gear ranges. The PCM uses shift solenoids to control "shift pattern" or when the transmission shifts.

Output operation: Shift solenoid status
1-2 shift solenoid on, 2-3 shift solenoid on = 1st gear
1-2 shift solenoid off, 2-3 shift solenoid on = 2nd gear
1-2 shift solenoid off, 2-3 shift solenoid off = 3rd gear
1-2 shift solenoid on, 2-3 shift solenoid off = 4th gear
### Output operation: Gear ranges

1st gear: 1-2 on, 2-3 on
2nd gear: 1-2 off, 2-3 on
3rd gear: 1-2 off, 2-3 off
4th gear: 1-2 on, 2-3 off

<table>
<thead>
<tr>
<th>GEAR RANGE</th>
<th>1-2, 3-4 SS VALVE</th>
<th>2-3 SS VALVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park/Reverse/Neutral</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>First</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Second</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Third</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Fourth</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

*Figure 6-14*
**Output operation: Torque Converter Clutch Pulse Width Modulated Solenoid (TCC/PWM)**

The PCM uses the TCC/PWM solenoid to control when the torque converter clutch applies and how soft or harsh the TCC apply feels to the customer. The TCC/PWM also controls the release feel of the torque converter clutch.

![Diagram of TCC apply solenoid](image)

**Figure 6-15**

**Output operation: TCC apply solenoid**

Some older model Hydramatic transmissions and transaxles used only a TCC apply solenoid. These older transmissions and transaxles may have used an accumulator to "cushion" the TCC apply feel. Some models of the 4L60-E transmissions have used both a TCC apply solenoid and a TCC/PWM solenoid to control torque converter clutch operation. The PCM provides the TCC apply solenoid with a ground to complete the control circuit. When the TCC solenoid is energized, the hydraulic vent is closed and hydraulic pressure moves the converter clutch valve, applying the TCC.
Output operation: Pressure Control Solenoid (PCS)

The pressure control solenoid (PCS) is used by the PCM to control what is known as "line pressure" inside of the transmission. The PCM controls the PCS based on data received from the various transmission inputs. The PCM controls the amount of amperage to the PCS. The range of that amperage is .1 amps to 1.1 amps. The higher the amperage, the lower the line pressure. Conversely, the lower the amperage supplied to the PCS, the higher the line pressure. The PCM controls line pressure with the PCS based on inputs such as engine load, TPS reading, MAF or MAP sensor, engine speed or VSS signal and RPM signal. The PCM is also able to compare desired shift times to actual shift times and adjust the PCS current accordingly. The PCM can maintain shift quality over the life of the vehicle by adjusting PCS amperage to control shift times at "new" vehicle levels. If the PCS control signal is lost, the line pressure goes to maximum to prevent internal transmission damage.

![Pressure Control Solenoid (PCS)](image)
Transmission Electrical Diagnosis

Electrical problems in automatic transmissions can store a DTC or Diagnostic Trouble Code. Electrical problems in transmissions can cause inappropriate operation and customer concerns.

Code types for automatic transmissions

Circuit Codes

Circuit codes set when the solenoid circuit or sensor circuit is electrically open or shorted. The PCM detects the electrical fault and stores the proper diagnostic trouble code (DTC).

Performance Codes

Performance codes are set when the PCM commands an action and that action does not occur, i.e. no 2-3 up shift. The PCM has already verified the integrity of the electrical circuit and has found no electrical fault that would cause the problem. Performance codes are usually an indication of a mechanical or hydraulic problem.

Diagnostic Tools

Use of these tools will make electronic transmission diagnosis very straight-forward.
Figure 6-18
J-39200 Fluke DVOM

Figure 6-19
J-44152 Transmission Test Harness

Figure 6-20
J-35616-B Terminal Test Kit

Figure 6-21
Hydramatic Standardization

All Hydramatics share a common wiring design. This allows for ease of diagnosis. Pin "A" is the control circuit for the 1-2 shift solenoid. Pin "B" is the control circuit for the 2-3 shift solenoid. Pins "C&D" are used to supply current to the Pressure Control Solenoid (PCS). Pin "E" is the 12 volt supply to all of the transmission solenoids. Pin "L&M" are the transmission fluid temperature sensor wires (TFT). NOTICE! Make sure that you recognize which end of the harness you are working with! Mixing up of the transmission connector pin-out with the harness pin-out will result in misdiagnosis!

Troubleshooting Tips

Most circuit codes are limited to the two wires and the solenoid, don’t over complicate the diagnosis! Use the functions of the TECH 2 to the fullest, especially for controlling things like commanded gear and actual gear. If multiple codes are stored, look for common causes such as poor grounds or power supply problems. Don’t rule out that a concern with a circuit could be in the internal transmission electrical harness. Many intermittent electrical problems can be caused by chaffing of the transmission external wiring harness.