In the operating room, transmission surgeons are often faced with split-second decisions regarding repairs. These decisions are based on situations we experience day in and day out. Here’s one of those scenarios: The Check Engine light is on. Out comes the scan tool, and lo and behold, code 0740 is stored in memory — No RPM Drop Registered When Lockup Is Commanded On.

Lockup Torque Converters — AUGH! To some, when they hear those words or see that code, it means run! yet to others, it means let’s start our diagnosis here. In this issue of Doctor, Doctor, we’ll look at the let’s-start-here genetic strains of lockup problems that seem to plague RE units. In this issue we’ll examine the electronics. In the next issue we’ll continue by looking at hydraulic and mechanical systems.

**Electrical**

We’ll start with the brain of the system; the control module: What influences cause the control module to supply power and ground to the rest of the body (the car’s other modules, sensors, actuators, etc.)? We could go all the way back to Chrysler’s first lockup torque converter system, but that would be a little too far back, as they were hydraulically actuated. Electrically, we’re going to use a rear wheel drive hydraulic governor (RH unit) system and examine the rear wheel drive electronic governor (RE unit) to understand the evolution of lockup problems on these overdrive transmissions. As you begin to understand these systems, the “let’s start here” attitude becomes easier and easier to accept.

There are many different systems that come into play to lock the transmission to engine rotation. What these inputs do is inform the brain (control module):

- I am not stopping…
- I am warm enough…
- I don’t plan on passing anyone, and…
- I am okay at this speed.

The control module (brain), understanding from these inputs that the vehicle is ready for lockup, commands a ground to energize the lockup solenoid. This action (solenoid commanded on) allows oil that was exhausting at the solenoid to shift the TCC and SWITCH valves, which redirect oil that was holding the converter clutch off to be exhausted at the switch valve and — BAM! — the transmission locks to engine rotation.

Let’s look at the inputs involved with this process:

**Brake Switch**

The brake switch is an on-off switch. This input tells the control module whether the driver is slowing down using the brakes. With the brake applied, the control module releases the converter clutch. When the control module sees that the driver’s foot is off the brake pedal, it knows it’s okay to apply or reapply the torque converter clutch.

Worn bushings on the brake pedal or an improperly adjusted switch can cause an intermittent in-and-out of lockup as the vehicle is driven at highway speeds.
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Throttle Position Sensor

Throttle position input is a load signal based on the position of the driver’s foot on the throttle. To command lockup, the control module is looking for a throttle angle less than 70%. When this angle is greater than 70%, the module can interpret this as a demand for a detent downshift.

Throttle angle is more sensitive in diesel applications, since they don’t use the same voltage scale as a gas engine. Gas engines have about a 3 1/2 volt sweep from minimum to maximum angles; a diesel will have around a 2 1/2 volt sweep.

Underhood electrical interferences (EMI) can mix up this signal and cause the lockup system to do strange things, such as shifting in and out of lockup (control module removes the ground signal). This is a big problem area with 1998 and 1999 diesel trucks, which use an Accelerator Pedal Position Sensor (APPS) to control a drive-by-wire system. Drive by wire is a system that controls throttle operation without a cable or linkage. These diesels have a stand-alone engine module (ECM) that mirrors the APPS signal and sends it to the Powertrain Module (PCM) as TPS voltage. If the ECM sends erratic signals to the PCM, it can cause the converter clutch to apply and release erratically (PCM supplies and releases the ground signal to the torque converter clutch solenoid). This will create a very noticeable surge.

Temperature Sensor

There are two temperature sensors monitored for transmission control (3-4 shift timing and lockup) in late model units. Early systems only used the engine coolant temperature sensor; later systems use the coolant sensor and the transmission temperature sensor to control lockup.

The coolant temperature sensor allows the module to wait until the engine is warm enough before it engages the converter clutch. This sensor is also used to inhibit the 3-4 shift until the engine warms up. When coolant temperature is above 90º F, the module allows the 3-4 shift and lockup. If the engine runs hot — over 260º F — the module disables 4th gear and main-
tains lockup in 3rd gear until the engine temperature drops below 230º F, then it re-enables 4th gear.

The transmission fluid temperature sensor operates on the same voltage scale as the coolant temperature sensor, and monitors ATF temperature with the same strategy. Both these inputs are critical for 4th gear and lockup commands. The module supplies about 5 volts to the sensors, which ground the signal through a thermistor. As the sensor warms up, the resistance lowers, lowering the voltage in the signal wire from the control module. Generally speaking, the system expects this voltage to be between 1.8 and 3.3 volts.

**Vehicle Speed Sensor**

Vehicle speed inputs let the control module know whether the vehicle is moving fast enough to allow lockup. The module needs to know that the brakes aren’t applied, temperatures aren’t too cold or hot, throttle angle isn’t too aggressive, and vehicle speed is fast enough for lockup… and then it happens — BAM! — the transmission locks to engine rotation.

To measure vehicle speed, the module monitors a voltage signal that pulses between 0 and 5 volts, 8000 times per mile (Ouch! Do the math at 60 miles an hour!) Early systems — pre-1998 — the vehicle speed sensor was located in the transfer case in 4x4 vehicles. On 2-wheel drive systems it was driven by a gear on the output shaft, and was located in the tail housing.

Around 1998, the vehicle speed sensor was eliminated from both of these locations and replaced with a signal from and the Rear Antilock Brake (RAB) system. Wow! A new dilemma: ABS problems can also cause no lock-up! This is why you need to understand the players when diagnosing these
Chrysler Lockup, Part 1

**Figure 4**

The **Engine Coolant Temperature Sensor** is a negative temperature coefficient (NTC) thermistor type sensor (resistance varies inversely with temperature). This means at cold temperatures its resistance is high so the voltage signal will be high. As coolant temperature increases, resistance decreases and the voltage will be low. This allows the sensor to provide an analog voltage signal (0 to 5-volt) to the PCM.

**Figure 5**

The **Vehicle Speed Sensor** is a hall-effect type sensor used to detect the vehicle speed. The PCM calculates the vehicle speed based on the VSS signal. The PCM supplies 5 volts to power up the sensor. Sensor ground is supplied by the PCM. The PCM also supplies a 5-volt pull-up voltage to the sensor. The VSS signal is created when the sensor alternates the 5-volt pull-up from high to low.

**O2 Sensor**

The O₂ sensor, although not a direct input for controlling converter clutch operation, can cause the PCM to command lockup to shift in and out. Many of these sensors share a common PCM ground and will affect the control module’s ability to maintain lockup. Monitor the O₂ signal to the PCM using a scan tool. If you don’t see a change in sensor voltage, suspect that the oxygen sensor may be causing lockup problems.

On OBD-II vehicles, you may be able to switch the suspect sensor with one from behind the catalytic converter and see if the lockup problem goes away. If the wire to the sensor is damaged, replace the sensor.

**Grounds**

Grounds are the number one cause of electrical system problems. Many sensors share a sensor ground in the control module. There should be no (0) voltage in the ground circuit. Loose or damaged redundant grounds — the ones screwed into fenderwells, radiator supports, and firewalls — can cause all kinds of different shift and drivability problems. Make sure not only the battery terminals are clean and tight, but also these redundant grounds are clean and secure.

Commonly overlooked are the ones that you can’t readily see. One such place is under the battery box, close to the radiator support. Make sure to locate all the grounds, and clean and secure them for a positive connection.

**Charging System**

Charging system failures can cause lockup problems such as shifting in and out of lockup during normal highway driving. If there is a weak cell in the battery or bad connections, the charging system may try to compensate by drawing amperage into the system to try and excite the weak cell. When this happens you get a condition similar to the one we discussed earlier as EMI. This means voltage is flying all around under the hood; where these stray voltages land is always a guessing game.

If you think your problem may be caused by a charging system failure, unplug the alternator and road test the vehicle. If the problem goes away, you know the failure is caused by the charging system. Make sure that the battery and charging system check out okay when doing any type of electrical diagnosis; very important!

You can see there are many conditions that can cause lockup electrical problems. Engine running conditions, wires, sensors, modules, batteries... and this is just a start. In the next issue of *Doctor, Doctor* we’ll continue by examining the hydraulic controls and mechanical failures that can cause lockup problems. Until next time, keep those transmissions in good shifting health.

The Doctor
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