In the operating room, doctors are faced with precise test procedures that are not only challenging but need to be done correctly to prevent damage. If done incorrectly, these procedures not only waste time, but can also be costly in unnecessary parts replacement or circuit damage.

So far, here is what we have covered in this series:

- Part 1 – We went over the importance of power and grounds, and how to check them properly (January/February 2002).
- Part 2 – Testing temperature sensors and throttle position sensors; starting tests at the sensor and confirming them at the computer (March 2002).
- Part 3 – We looked at park/neutral switches and accelerator switches. Along with the park/neutral switches we led into range selectors which are a very important input not only for line rise in electronic controlled transmissions but how they tie into what range the driver has selected (October 2002).
- Part 4 – We looked at speed sensing devices and pressure switches. We covered all the...
similarities in all the speed sensors. How to check them and pressure switch’s and their uses. Leaving with an understanding that when you see the name “switch” it is exactly what the name implies. A switch of power, on-off like a light switch (January-February 2003).

In this issue of Doctor, Doctor we are going to see how all these different inputs to the controller tie in to basically control only two things in the transmission: Electrically controlled shifting solenoids and pressure control (modulating) solenoids (when applicable). Unfortunately because of space, in this issue we will only discuss shifting solenoids and in Part 6 we will talk about pressure controlling solenoids and how the computer controls them. Terms commonly used for these shifting solenoids are:

- Shift solenoids 1-2-3 or A, B and C
- Lock-up Solenoid
- 3-4 Solenoid
- 3-2 downshift Solenoid
- Kick Down Solenoid

**Shift Solenoids**

Basically the shift solenoid has taken the place of the governor pressure that was used in earlier units to manipulate the shift. You will find as we explore these shifting solenoids that the myth of complexity really is in fact an area of simplicity. When the solenoid is energized it will either redirect line oil in a circuit or exhaust oil causing a shift valve to stroke (making a shift). If a failure were to occur that the computer picked up, it can shut the solenoids off. This is called **failsafe mode**. When this happens (depending on the manufacture of that particular transmission), it will have 2nd, 3rd, or 4th gear in the “D” drive range and may offer lower gears when manually shifted. Some manufactures such as Ford, supply a failsafe chart that shows shift patterns that are common when one solenoid fails. These charts will show the failed “ON” or failed “OFF” modes (figure 1). Charts such as the one illustrated can make solenoid diagnoses much more understandable. If a chart was unavailable, you can make your own chart!

This is what makes our job as surgeons fun! Simply look at an oil flow chart and find which valves are controlled by which solenoid to determine which component will be effected if that valve does not move. If it is a lock-up solenoid or 3-4 Solenoid such as the ones used on the Chrysler 42 – 46 series transmissions, failures will give you a shift concern that pertains to that particular solenoid. For Example; If the lock-up solenoid fails “ON” it will lock-up on top of second gear. This happens because second gear oil feeds the solenoid circuit. If it fails “OFF”, there will be no lock-up. If the 3-4 solenoid fails it will make a 1-2-4 shift if failed “ON” since third gear oil feeds the solenoid. It will not get 4th gear at all if failed “OFF” (figure 2). In many ways this means, technology has made things a little easier for us the surgeons to diagnose solenoid failures. In diagnosing shift solenoids, make sure you have a chart that shows you the shift sequences (when they are energized or de-energized). These books are available at the ATRA Book Store. These will also show you the failsafe mode for each transmission as well as show you how to energize the shift solenoids.
Electrical Testing in the Operating Room; Part 5

Figure 7

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and make the transmission shift apart from the computer controls. Understanding failsafe modes sometimes can help when diagnosing a no movement forward or reverse on an AX4N (front wheel drive Ford) transmission. Understanding what the clutch and band applications are (in this case you would have a forward clutch used for both applications Figure 3) by unplugging the transmission it will cause the failsafe gear to be used. In this transmission failsafe will be second gear. The forward clutch is not even being used to drive the gear train since the second clutch becomes your driving clutch (Figure 4). If it now moves forward in second gear you know that there is a problem with the forward clutch (see, simple diagnoses)! Simply unplugging the transmission and knowing what will happen, will save you time, and time is money. If the transmission is in good health (no broken parts), unplugging it will always offer a forward and reverse application. What you are checking is, if an electrical
failure were to happen, or if an input to the controller were incorrect the computer can take away a forward or reverse engagement (model specific).

For instance, after a rebuild you have no reverse but forward is ok. Unplug the transmission and see if it now has both ranges. If so, an input to the controller may have caused a solenoid to energize that will prohibit reverse such as on KM units. By design, the transmissions will always offer **Forward** and **Reverse** (so long as there are no broken parts) with no power to the solenoids, so it does make it easier for diagnosing certain problems such as a no reverse after repair etc etc.

On-Off solenoids will always have a higher resistance (ohms) than modulated solenoids. This is for circuit protection. Things to remember about shift solenoids; They can have one wire or two wires depending on the system so always refer to an accurate wire chart to determine what you’re working on (figure 5). The single wire solenoids will use the housing of the solenoid for a ground and the computer will send power to the solenoid causing it to energize (figure 6). This makes the ground wire for the battery very important (Actually this is always important!). **Note:** Always start with power and ground tests for any shift concern. The two wire solenoids generally will have a consistent power supply (12 Volts), and the controller will supply the...
ground causing the solenoid to be energized (figure 7), or it can have consistent ground and the controller will supply the power (figure 8). You will hear or read terms such as N/O (normally open) or N/C (normally closed) when referring to shift solenoids. This is the state of the solenoid when it is not energized. A Normally closed solenoid is blocking the flow of oil and a normally open solenoid allows the oil to flow through the solenoid (figure 9). Some solenoids will exhaust the oil back into the sump (oil pan) allowing a valve spring to move the shift valve. Others will just switch the oil into a connecting oil galley to control the shift valve movement. If the solenoid is an exhausting solenoid, the flow of oil exhausting is going to be orificed at the solenoid so it will not take away from the oil feeding the circuit. In either situation, the solenoids are used to move shift valves (figure 10a, 10b). When diagnosing a Shift Solenoid failure, keep in mind always that a stuck shift valve can cause you to believe a solenoid is bad. This means; do not just assume that changing the solenoid will fix the problem (this can waste time and money). Make sure those valves are free floating in their valve bores and always take time to remove them from the valve bodies when servicing for these shift concerns. Inputs that the controller uses for these different shift commands (timing and strategy) are pretty much all of the ones we have covered. Keep things simple; remember any input to the controller that is out of range or has failed, you will have shift timing issues such as:

- No shift
- Uninitiated shifts
- Wrong gear starts
- Missing gears

Summing this all up lets see what we have learned:

- Power and Ground circuits are very important with these systems and must be checked first.
- Shift Solenoids have taken the place of the mechanical governors

(Continued on page 67)
used in earlier design transmissions.
• The timing and quality of the shifts are influenced by drivers demand (how hard they are pushing the accelerator pedal)
• The Computer is watching many sensors to determine what engine load is (TPS, MAP, BARO or MAF)
• Speed sensors are monitored by the controller for all driving conditions (VSS, TSS, RPM, OSS, ITS, or OTS)
• Temperatures of both the transmission and engine are watched (CTS, and TTS)

See how simple this is! All these inputs basically control two things on the transmission:
• Solenoid manipulation (on-off)
• Pressure rise (next issue of GEARS Part 6)

In the next issue of Doctor, Doctor we will cover the Modulating Pressure Control Solenoids seeing just how simple they can be to diagnose for line pressure rise issues as well as governor pressures problems in some models. Until next time, keep those transmissions in good shifting health

The Doctor