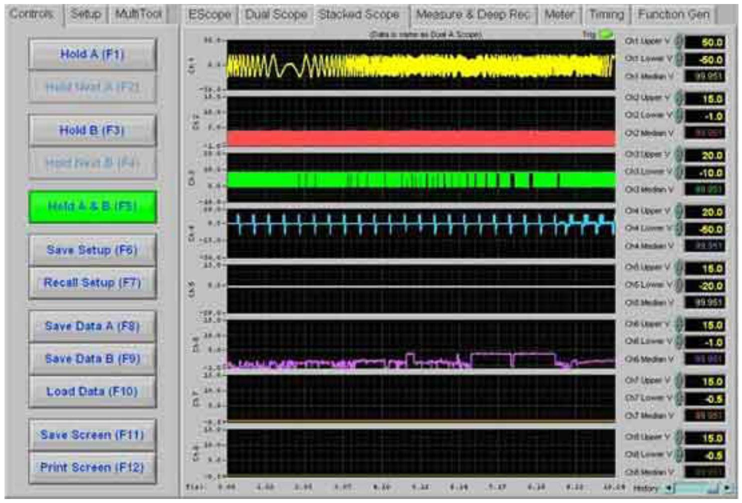
eSCOPE Article - Making the Shift

by Bernie Thompson

What a wondrous world we live in. Imagine the world through the eyes of the octopus. What a marvelous creature having eight arms each doing individual tasks all at the same time. Now imagine you are like the octopus and you have eight arms and hands all being used at the same time for different operations. One arm could be disconnecting the drive line while another is removing the starter and yet another could be removing the torque converter shield and bolts. This would be a valuable example of multitasking. The sheer amount of work you could do would be many times that of only having two arms and two hands. In the same way eight arms would speed up the work one could do, having eight channels on an oscilloscope would speed up the diagnostic work that you can do. Eight individual channels each providing you with real time information is an efficient way of repairing vehicles quickly and accurately. Diagnostic procedures for modern transmissions are some of the most difficult because there are three distinct systems with which to deal--the mechanical, hydraulic and electrical. Any of these can cause problems; however, the electrical system adds a new dimension to what is already a tough diagnosis. To properly diagnose an electronically controlled transmission, the first step would be to use a scan tool to acquire a large amount of data very quickly and easily. With these data the technician can choose a diagnostic direction. It is important to understand that the scanner is only displaying what the power train control module believes to be true. An example of this would be the input and output speed sensors. If one of these sensors were failing and the electrical signal was breaking down causing pulses to be added or to be missing the PCM would send incorrect electrical information to the scanner. The scanner would then display the incorrect RPM for the sensor. The sensor, having the incorrect number of pulses, may cause the PCM to default or have a harsh gear engagement due to its program counting input pulses against output pulses. The PCM judgment is then made that the transmission has a gear ratio error or is slipping and the MIL would be illuminated although there are no problems with the hydraulic or mechanical functions of the transmission. The PCM's interpretation of the incorrect data is the problem. If the technician failed to check the input and output speed sensors with an oscilloscope the transmission problem would be misdiagnosed. Another example would be if the PCM commanded a shift solenoid to close but it failed to do so. Since the command had been given, the scan tool would show the solenoid as closed. This may not be the case for if the driver in the PCM fails or if there is excessive resistance in the solenoid circuit, or the solenoid is faulty, the shift solenoid in fact may not have closed at all. This would cause the transmission to not shift properly. If the only information the technician had was from the scan tool, the transmission would be misdiagnosed. Once the scan tool data has been analyzed and the technician has a diagnostic direction the next step would be to confirm the problem. The oscilloscope is the best tool for this operation. Since there are many circuits, both input and output, a multi-trace scope is needed. The eSCOPE by ATS is an 8 trace, dual-time, base scope that is perfect for diagnosing electrically controlled transmissions.

With 8 channels on 2 time bases, you can check fast signals like input and output speed sensors and slow signals like solenoid operations on the same screen. This format synchronizes all signals and this is a great advantage when diagnosing modern transmissions because you can be sure the speed sensors are working correctly and the commands to the solenoids occur at the right time and in the right sequence. The transmission's internal pressure can be monitored as well with electrical pressure transducers. If the transmission has multiple pressure taps you can correlate the solenoid's operation with the pressure buildup in the hydraulic circuit. The oscilloscope makes it easy for the technician to verify what is going on with the transmission. The electrical pressure control and mechanical conditions can be verified easily. The EScope has a special feature that allows the technician to verify the mechanical condition of the transmission. This is accomplished by taking the input speed frequency from the sensor and subtracting it from the output speed frequency. A window on the eSCOPE displays this number and when the transmission shifts into a gear, the number in the window should remain steady. Any change in this number is an indication that the transmission is slipping. This feature can also be used with the engine RPM and the input speed sensor to verify torque converter lockup. If the transmission does not make the correct gear selection and the commands and electrical circuits are working correctly, then the problem is inside the transmission. On the other hand, if the commands are not given correctly, then the transmission control unit needs to be analyzed. eSCOPE connections will need to be made to inputs, outputs, powers and grounds. When viewing the signals on one screen, it is very easy to determine the signal that is causing the transmission's failure. If the solenoid is pulled to ground (closed), when it should not be in this state, the transmission will default. Just watch what has occurred right before the shift problem happened. This information is stored into the eSCOPE's memory so you can go back and review the details of the failure before, during and after the problem has occurred. Unlike the scanner, these data indicate what is really occurring within the electrical and hydraulic circuits. The eSCOPE with its 8 channels and dual-time base will make quick work of automatic transmission diagnostics.

Below are examples of problems. It is important to understand that these screen shots capture just a moment in time. If you were driving your car down the road and took a picture of a building it would be hard to understand just how you got there. But, if you were driving your car and took a movie of your journey it would be much easier to understand how you got there. This is similar to using a scope, if you are watching the data as the event is happening it is much easier to understand how you got to these screen shots.



1995 Nissan

This 1995 Nissan solenoid driver Ch6 (purple) is failing. This signal should be pulled to ground and should stay there. This transmission was rebuilt by another shop and the problem was not fixed.

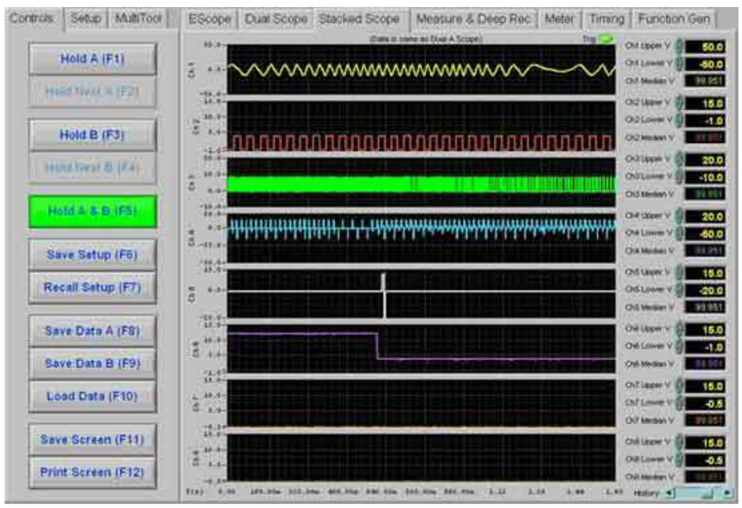
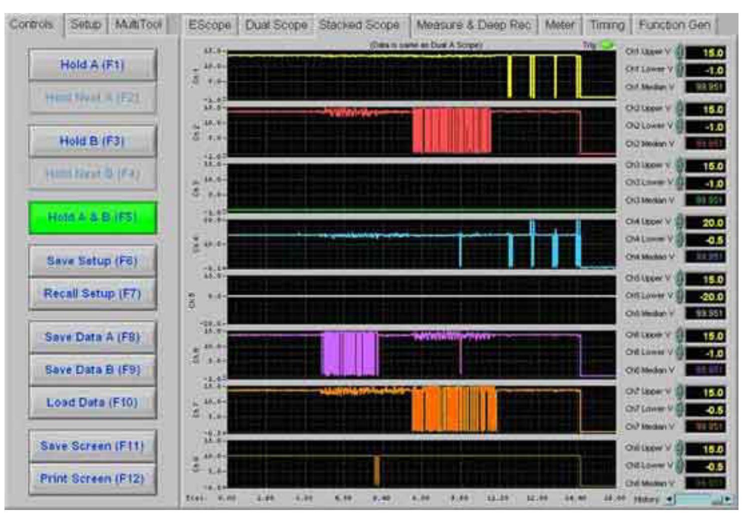


Figure 2 – 1995 Nissan

After checking the powers and grounds the PCM was replaced. This is a screen shot of the driver Ch6 (purple) with the new PCM.



1999 Grand Cherokee

This 1999 Grand Cherokee had an intermittent problem with the transmission defaulting. The 45RFE uses this L-R solenoid to apply first gear. After first gear the SSV valve is shifted allowing the L-R solenoid to apply the torque converter clutch. The SSV valve has three valves within the assembly. In third gear the pressure to shuttle the SSV comes from the OD clutch being applied. In forth gear the pressure to shuttle the SSV valve comes from the 4c clutch being applied. If the small valve sticks in the bore the SSV valve will not shuttle in third but will shuttle in forth. The program does not apply the TCC clutch in third in normal driving so the problem becomes intermittent. When the vehicle is driven aggressively the TCC will apply in third gear. If the SSV does not shuttle, the pressure will then be routed to the L-R clutch in third gear. The L-R pressure switch will be activated and the PCM will default. The Ch1 (yellow) trace is the L-R pressure switch. The Ch4 (blue) trace is the L-R solenoid. The key to understanding what happened in the control circuit is to watch how quickly the pressure switch is activated. Look at Fig. 2 and Figure 3. If the valve body would have been bleeding across, the time lag between the solenoid being applied and the pressure switch changing would be much longer. To change this quickly the L-R solenoid is in direct control of the pressure switch. The only way this can happen is if the SSV valve is stuck in the bore.

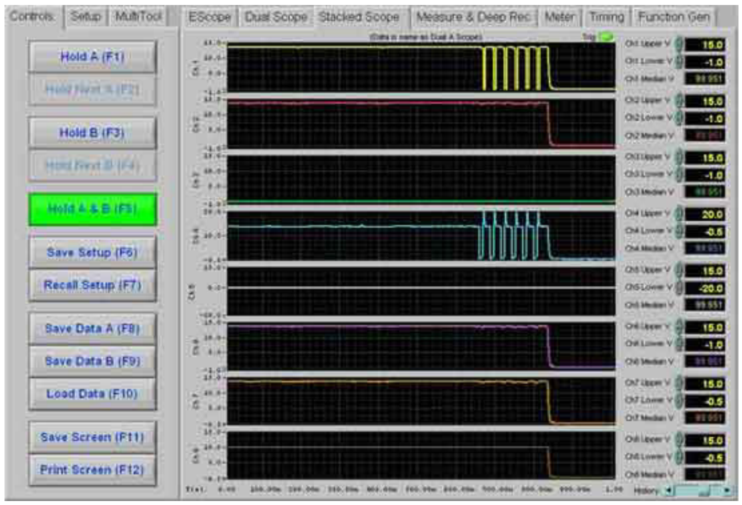


Figure 2 – 1999 Grand Cherokee

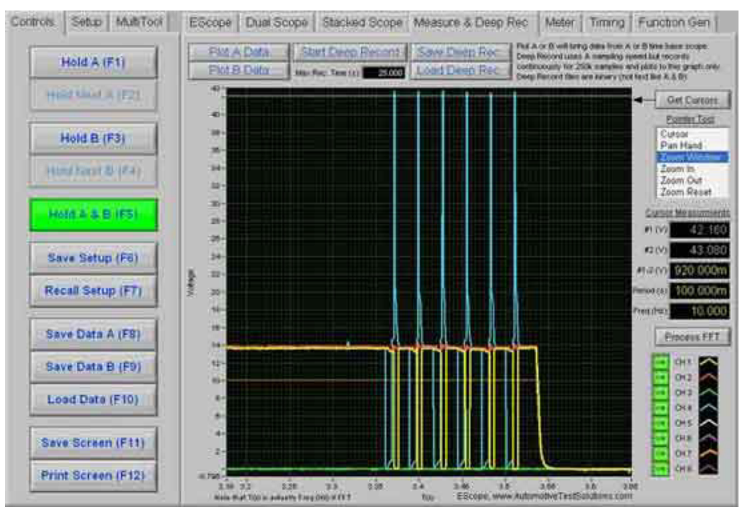
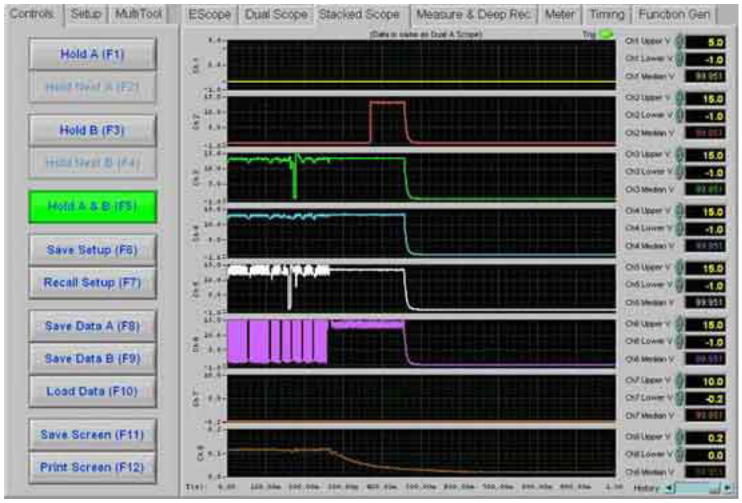
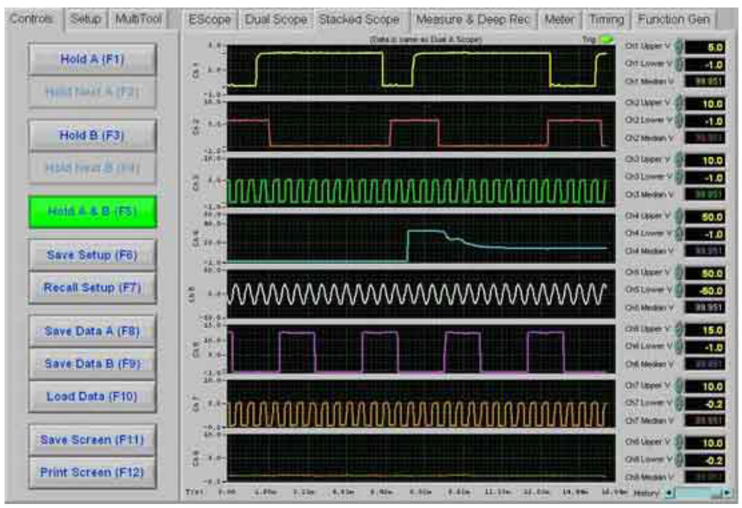


Figure 3 – 1999 Grand Cherokee



1993 Voyager

This 1993 Voyager had a code for L-R pressure switch. The program determines this by noting which pressure switches are high and which are low. However, this information is wrong. If you went to the L-R pressure port and tested the hydraulic pressure and watched the electrical circuit for the problem you would not see any problem at all. The real cause of the transmission default is the 2-4 pressure switch failing. The Ch2 (red) trace is the 2-4 pressure switch changing states from low to high. The Ch8 (brown) trace is the pressure in the hydraulic passage. The 2-4 pressure switch went high at about 50psi. The pressure in the passage is great enough to keep the switch in the low state. This default is caused by a defective 2-4 pressure switch.



1992 Suburban

This 1992 Suburban had a problem with the torque converter locking and unlocking. Several parts had been replaced by another repair facility including the PCM. It is very important to analyze the waveforms to determine where the problem is. Let us check the waveforms Ch1 (yellow) electronic spark timing and Ch2 (red) revolutions per minute. When comparing the signals you need to look at the rising edge of the RPM (red) compared to the falling edge of the EST (yellow). Now look at the falling edge of the RPM (red) and the rising edge of the EST (yellow). If these signals have large movements from each other in a small time span this would be an indication that the distributor is worn out. The PCM's program watches the time from the RPM signal edge to edge. When this movement becomes great enough the PCM's judgment will unlock the TCC until the signal returns to normal, at which time it will relock the TCC. In Figure 2-1992 Suburban the worn out distributor has been replace with a new unit. This is what the signals should look like.

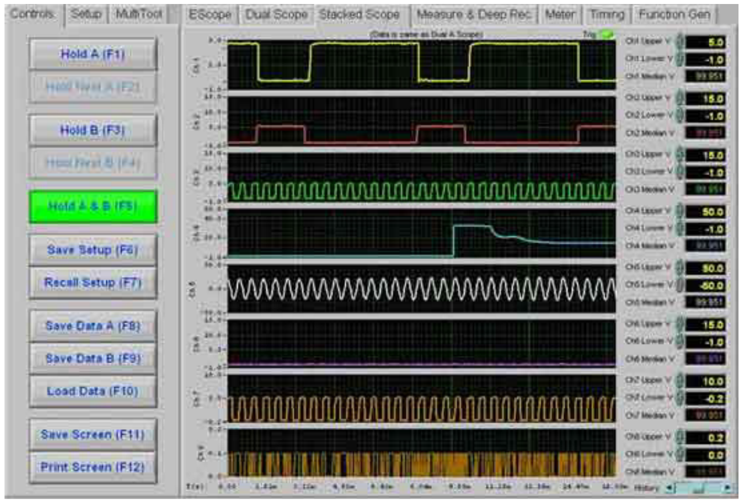
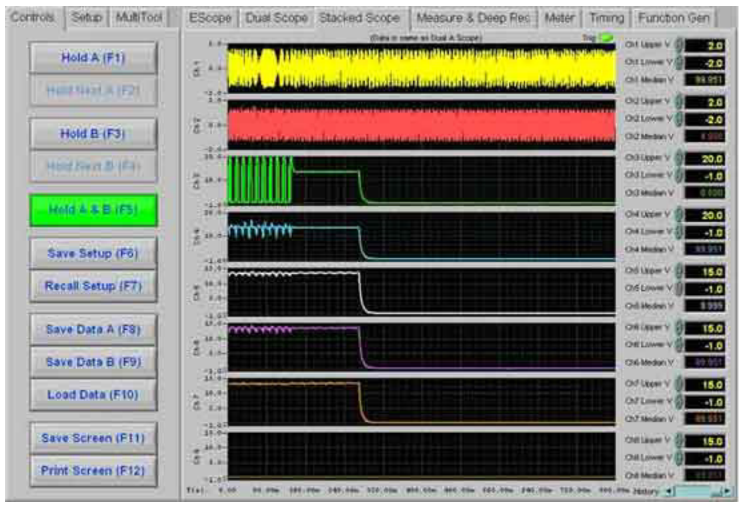


Figure 2-1992 Suburban



1999 Voyager

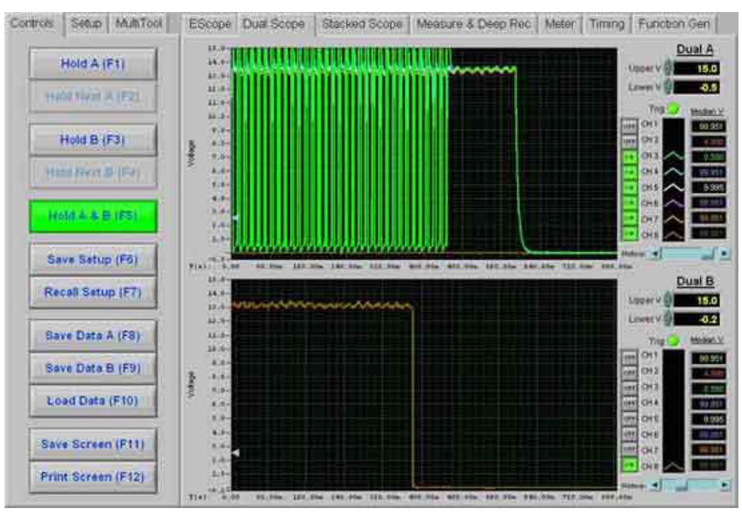


Figure 2-1999 Voyager

This 1999 Plymouth Voyager had a problem with the transmission intermittently defaulting. The computer and valve assembly had been replaced by another repair facility. Checking the electronic controls the pressure switch was found to be going low with no solenoid being applied. The problem was that the wiring harness had become chaffed and the pressure switch wire was intermittently shorting to ground.