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Flow Control: How Solenoid Design Influences Clutch Circuits

Sonnax

Flow control to clutches is as important as the pressure that applies these clutches. It is the routing of this fluid, under pressure, through the various valves, solenoids and passages, which allows proper shifting in an automatic transmission. Without the proper fluid flow, adequate pressure cannot be obtained or maintained, and clutches will not apply correctly, resulting in a host of shift concerns, burnt clutches and potential DTCs. While the variety of these valves, solenoids and circuits which get the flow from the pump to the clutches are numerous, there are some basic functional similarities which can help when trying to diagnose hydraulic-related shift concerns and clutch failures.

Linear Solenoids

Linear solenoids are solenoids that use electrical energy to move an enclosed valve a certain distance linearly. The movement of this valve opens and closes the various hydraulic circuits of the solenoid. Some transmissions which use linear solenoids to help control flow to the clutches are the 09G and U660E (**Figure 1**). However, the methods in which these linear solenoids are used are different for each transmission.

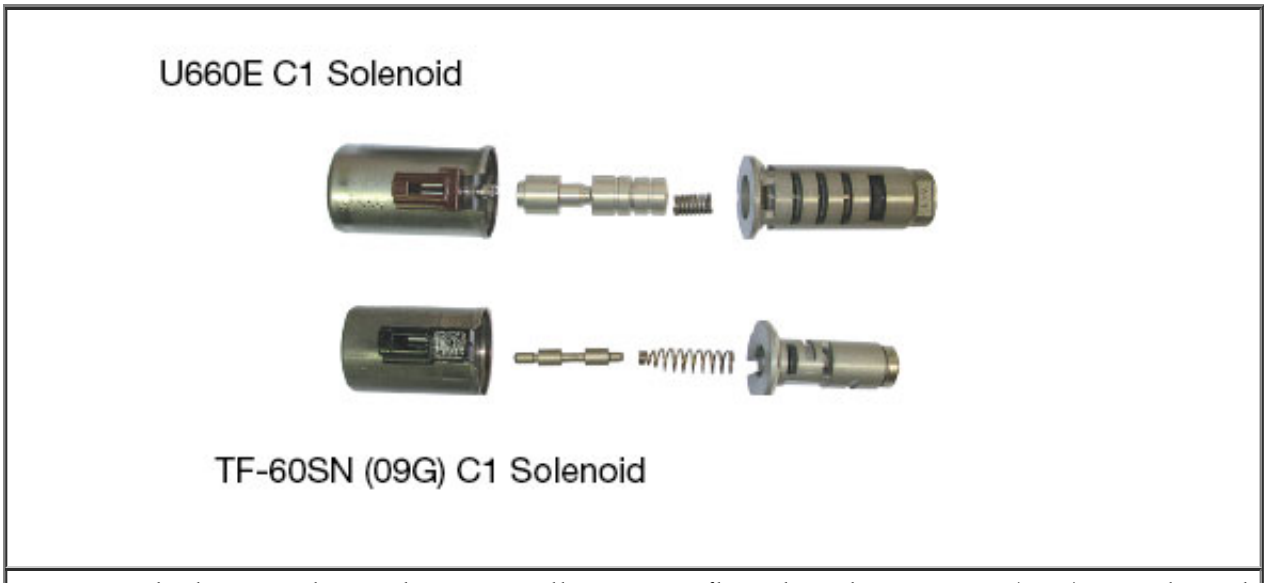

Figure 1- The larger valve in the U660E allows more flow than the TF-60SN (09G) C1 Solenoid.

The 09G (and 09D, TF-80, TF-81) utilizes a separate linear solenoid for each clutch (K1, K2, K3 and B1). The solenoid modulator fluid is routed through the solenoid to create a low flow signal pressure, which is then routed to individual clutch control valves for each clutch. (The exception

here is the B2 clutch, which is fed line pressure directly off the manual valve when Reverse is selected.) This modulated signal pressure adjusts the position of the clutch control valve to help control the clutch apply rate (**Figure 2**).

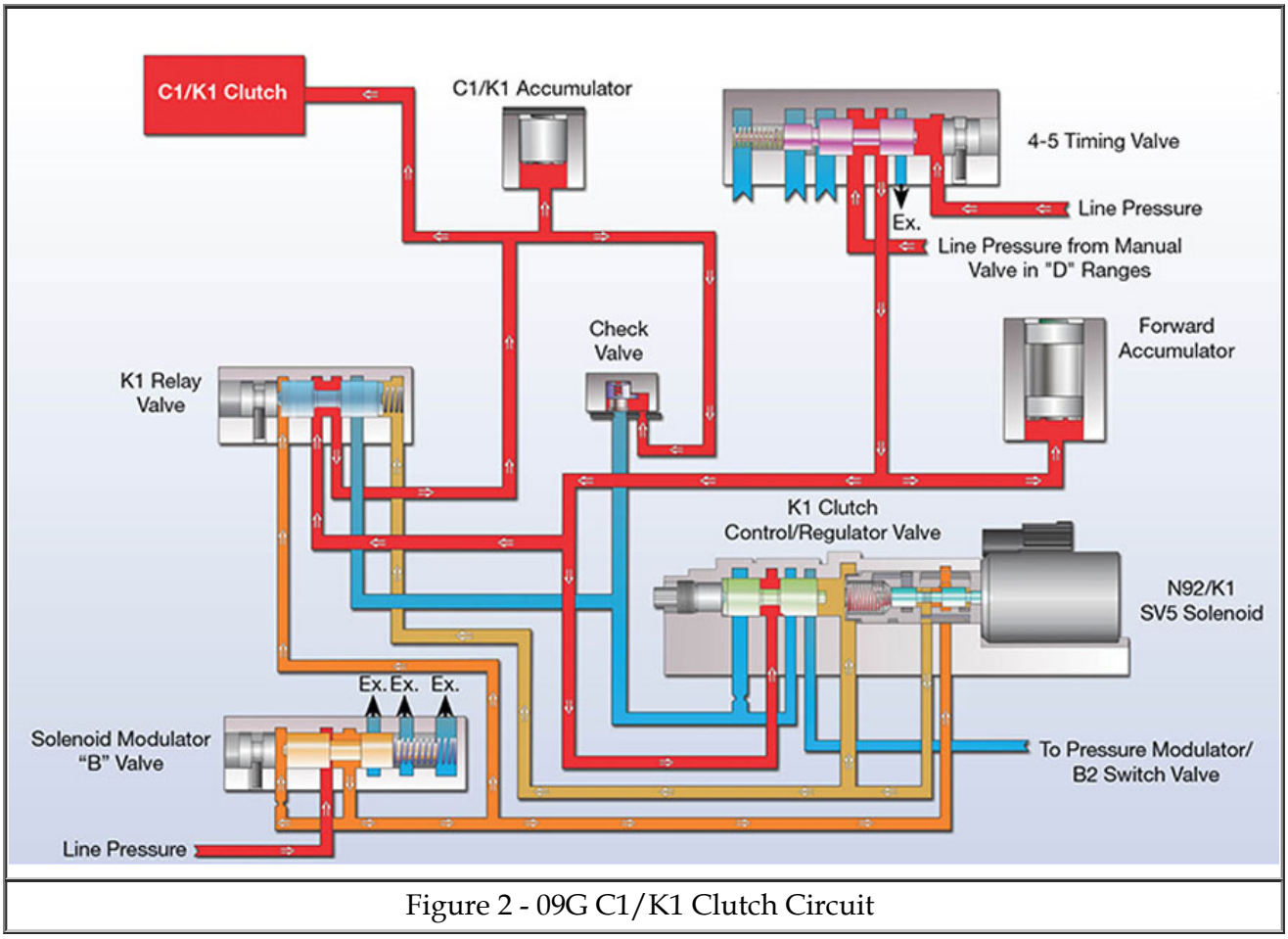

Figure 2 - 09G C1/K1 Clutch Circuit

Clutch apply pressure is routed through a variety of relay, switch and timing valves. With this type of arrangement, wear at the solenoid modulator valves reduces solenoid feed, and wear within the linear solenoids results in loss of signal pressure. Because the clutch control valves are continuously moving and adjusting pressure in response to the solenoid, they have been known to wear the casting bores. Wear in any of these areas results in fluid pressure loss, which causes shift concerns and clutch failure. The bushings within these solenoids also have been known to stick at elevated temperature, resulting in very rough solenoid valve movement that causes DTCs, shift concerns and burnt clutches.

The U660E also uses a linear solenoid for each clutch (C1, C2, B1, and B3), again with the exception of the B2 which is applied by line pressure from the manual valve in Reverse. However, these are high flow solenoids which direct line pressure through the enclosed control valve to directly apply the clutches (**Figure 3**). By having the TCM control these solenoids directly, adjusting the duty cycle to modulate the valve and apply pressure, a much less complex series of valves are needed than in the 09G style. Because these larger valves within the solenoids are continuously moving,

wear at the solenoid snout inside diameter can occur. This results in loss of clutch apply fluid, which can cause shift concerns and clutch failure. The few clutch control or apply valves which route this clutch apply fluid are stroked by orificed line pressure, solenoid modulator pressure or SLT pressure. So a worn solenoid modulator valve, primary pressure regulator or secondary pressure regulator valve can create numerous issues.

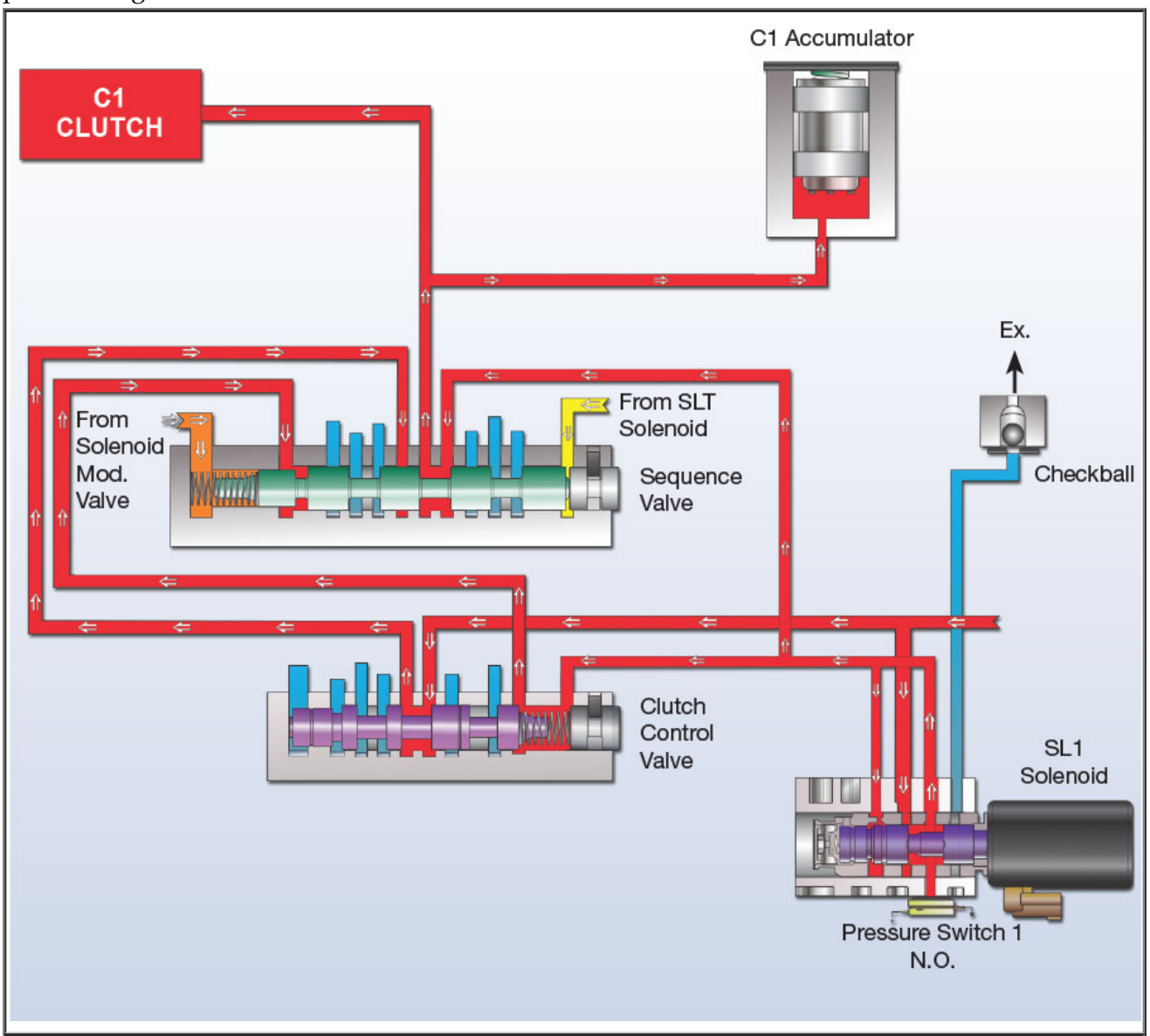

Figure 3 - U660E C1 Clutch Circuit

EDS/PWM Solenoids

These solenoids are pulse-width modulated via the duty cycle commanded by the TCM. When actuated, they typically unseat a ball that allows modulated low flow to be directed to the appropriate clutch regulator valve (**Figure 4**). The clutch regulator valves then direct line pressure through the appropriate circuits to apply the clutches. Some modern transmissions with these types of solenoids and circuits are the ZF6HP19/21/26/28/32/34, 6T40/70, and 6F35/50 (**Figure**

5). Failure of these solenoids is not uncommon, often from debris-related issues. Cleaning of the screens and internals can help. Because these solenoids output variable pressure, the valves that they actuate are in continuous movement. So wear at the clutch regulator valves and clutch boost or latch valves is common, and results in the associated clutch burning and/or clutch-related shift concerns. Solenoid feed pressure from the solenoid modulator or actuator feed limit valve is also critical for proper shifts and clutch operation, so that bore should be checked for wear.

Figure 4 - Exploded view of 6T40 solenoid.

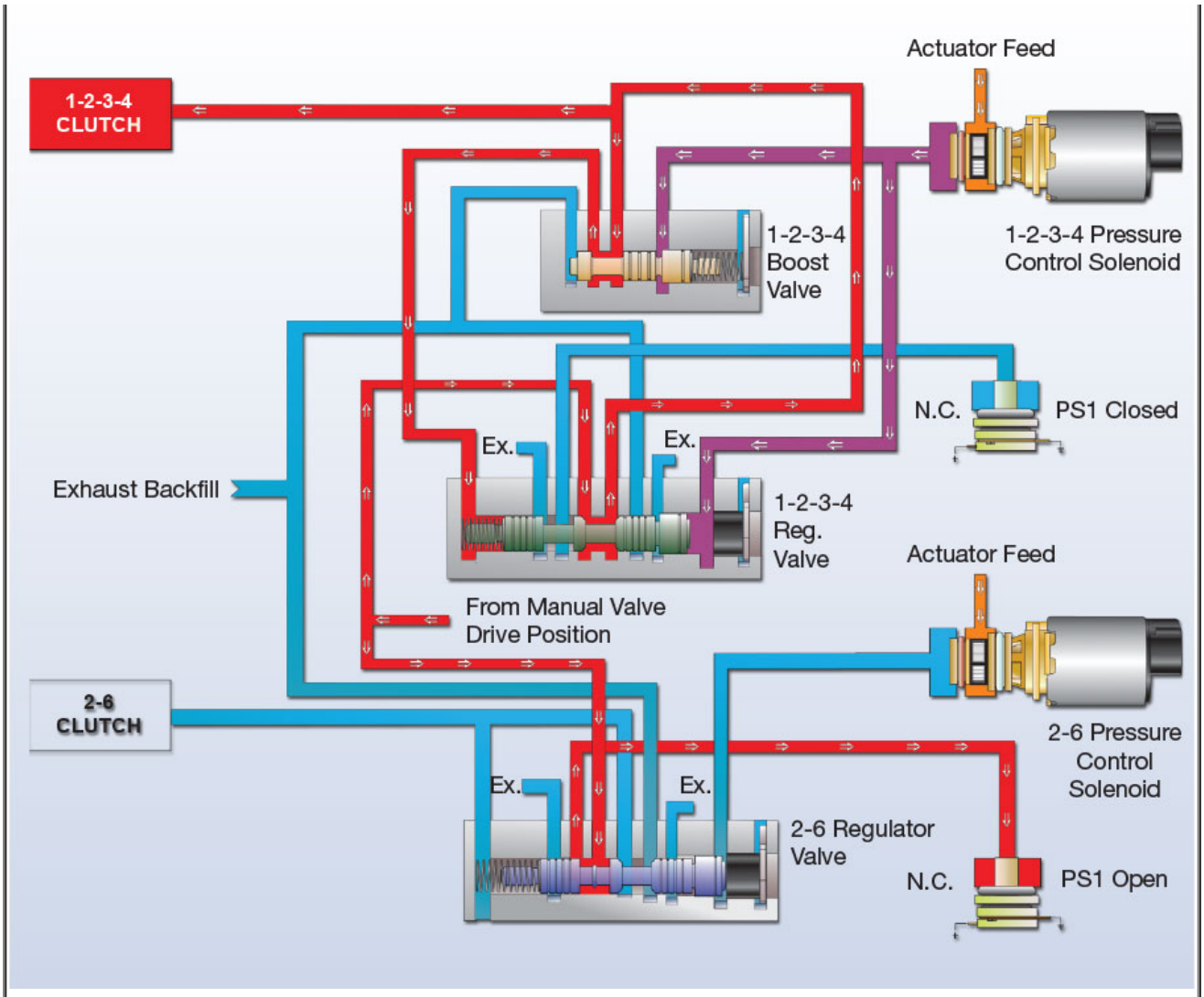

Figure 5 - 6T40 (Gen. 1), 1-2-3-4 (Forward) Clutch Circuit

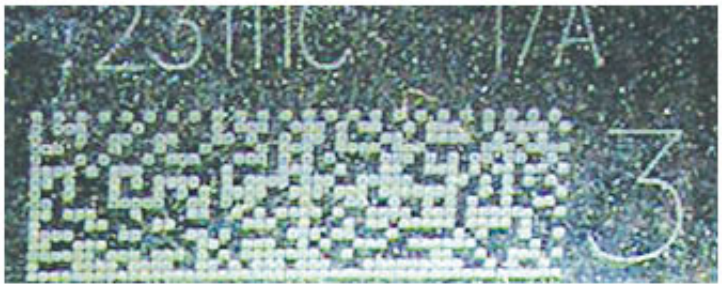

Figure 6 - Number Etched on the solenoid can.

A new development with these types of EDS/PWM solenoids is that some are "banded" or flow

controlled, meaning that they have various ranges that offer different flow rates. For example, on the 6R140, there is a number between 2 and 5 etched into the solenoid can (**Figure 6**). This indicates that the solenoids provide incrementally different amounts of flow rates. The graph in **Figure 7** shows a typical EDS/PWM solenoid from the ZF6HP26 (red), compared to the banded (flow controlled) solenoids in the 6R80. So as these solenoids fill the port cavity at the apply end of the clutch regulator and clutch latch valves, the timing for that fill is apparently being monitored by the TCM. The OEM recommendation is that if replacing a flow controlled solenoid, a solenoid of the same band number be substituted. Whether the computer is capable of adapting to a differently rated solenoid is at this point still questionable in the aftermarket. For this reason, caution should be used before altering separator plate orifices to compensate for wear. Any orifice changes might have a significant enough change on the flow rate that either the solenoid or computer cannot adjust. These solenoids, the clutch regulator and clutch latch or boost valves that they are applying, and the solenoid feed pressure regulator valve would all be subject to the same failure and wear concerns as previously noted for the non-flow controlled circuit.

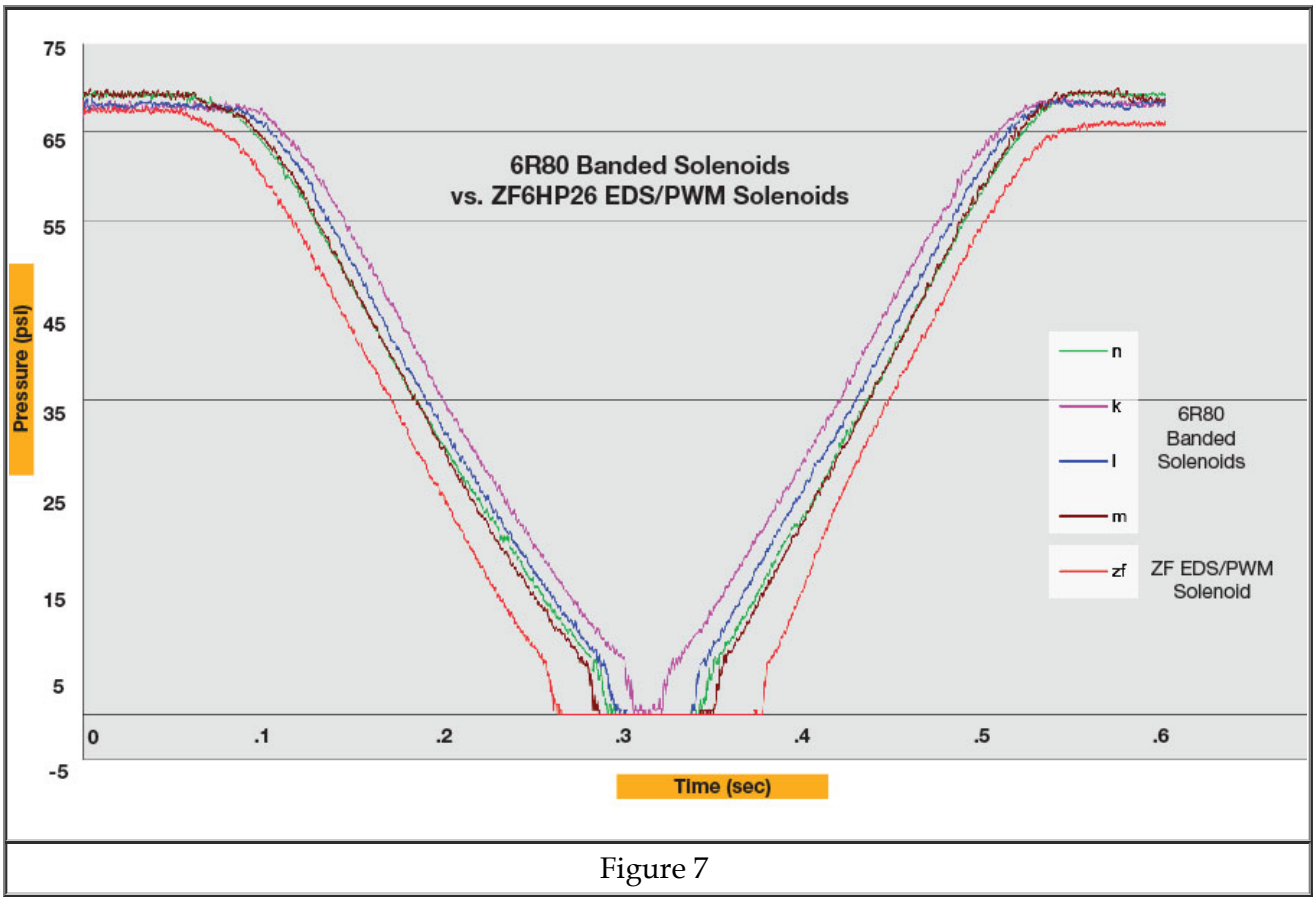

Figure 7

Knowing how the particular transmission you are working on controls flow to the clutches can aid you in deciding which valves and solenoids to look at for any shift or clutch concerns. It should also be considered when determining how to address wear or failure at the various components within the circuits. Much of this information can be found by looking at the oil circuits, and back-tracking the clutch apply circuit to the valves and solenoids controlling the apply.

Related Unit(s)

- U660E
- 09D
- ZF6HP19
- ZF6HP21

See All

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