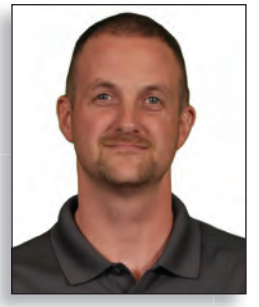
UNDER CONTROL: Subaru Lineartronic CVT



by Jarad Warren
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In earlier articles we covered a number of issues with the Subaru Lineartronic CVT. We examined how it operates, checked the fluid levels, identified its components, tested sensors and pressures, disassembled it, and more. By now we have this unit pretty much under control.

In this article, we'll identify the transmission solenoids, cover their operation, and learn how to test them. We'll take a close look at the valve body, including identifying all the small parts, spring sizes, and valves. And we'll examine how the system controls the pulleys to change the transmission drive ratio.

Subaru has done a good job of controlling this transmission for economy and sporty feel. There are many sensors used for the all-wheel drive and transmission control, including the transmission speed sensor, wheel speed sensors, and engine load sensors.

We'll start by focusing on the transmission solenoids and their controls.

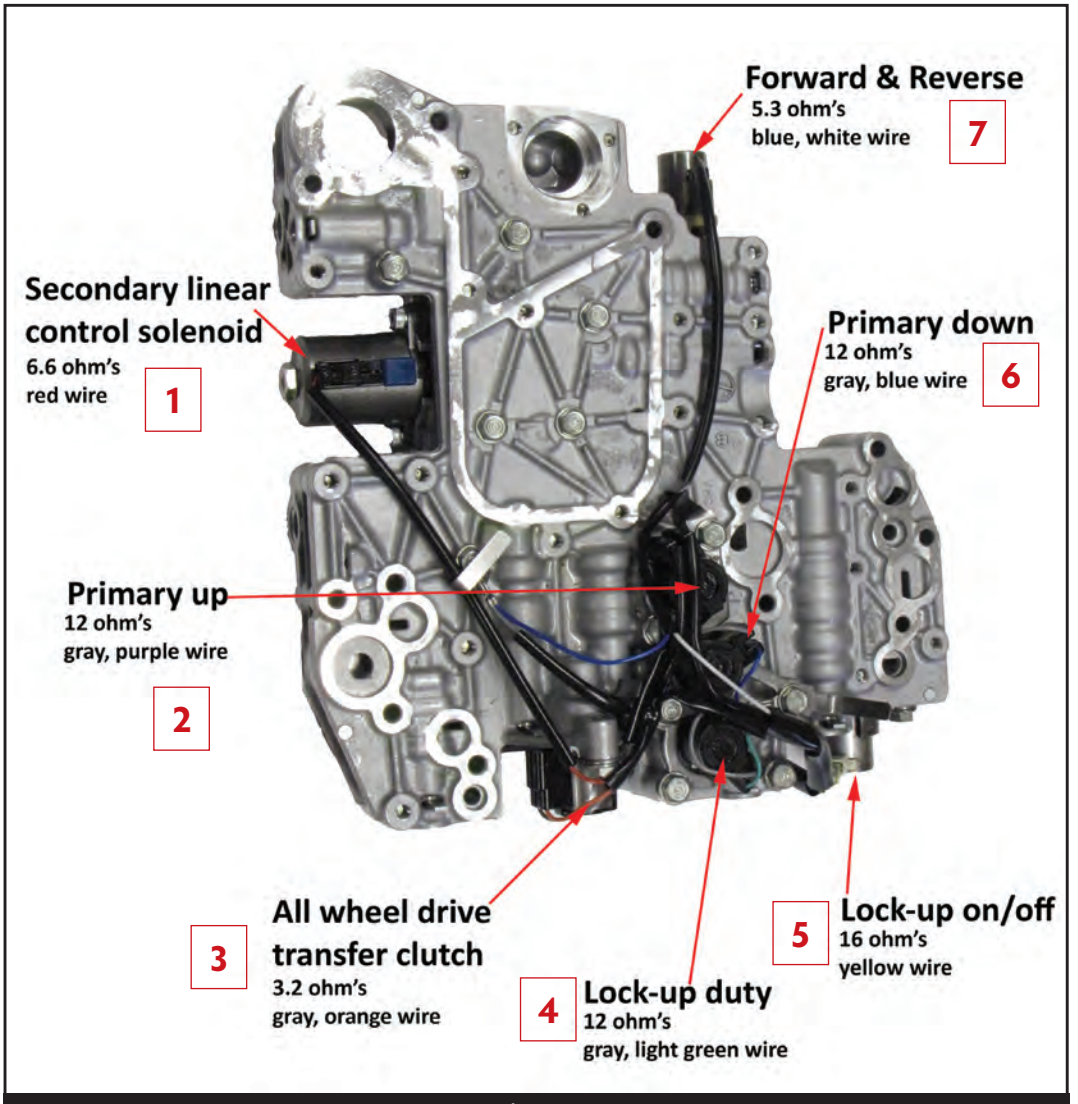

Figure 1

Solenoid Identification

The Subaru Lineartronic uses seven solenoids to control its operation (figure 1):

1. Secondary Linear Control
2. Primary-Up
3. AWD Transfer Case Clutch
4. Lockup Duty
5. Lockup On/Off
6. Primary-Down
7. Forward/Reverse Linear

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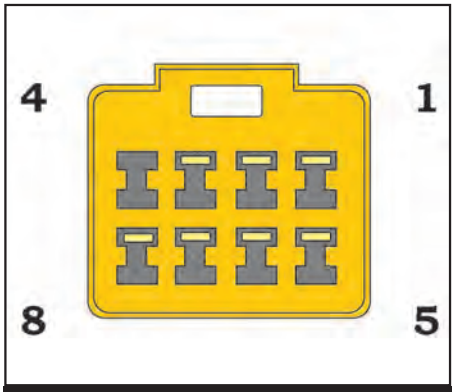

Figure 2

Solenoid Resistance Chart			
Solenoids	**Valve Body Connecter**		**Resistance**
Secondary	1	GND	5-7 ohms
Forward & Reverse	3	GND	4-6 ohms
Lock-up on/off	5	GND	15-17 ohms
Primary Down	6	GND	10-13.5 ohms
Primary Up	7	GND	10-13.5 ohms
Lock-up Duty	2	GND	10-13.5 ohms
AWD	8	GND	2-4.5 ohms

Figure 3: Solenoid Resistance

All of the solenoids are feed-controlled by the TCM and grounded at the valve body. The secondary linear control solenoid and forward/reverse solenoid are linear-style solenoids.

The lockup duty, primary-up, primary-down, and all wheel drive transfer clutch solenoids are PWM-controlled solenoids. These solenoids are normally closed and are fully interchangeable.

The lockup on/off solenoid is the only on/off style solenoid in the unit; it's normally closed.

An easy place to check the resistance of the solenoids is at the valve body solenoid connecter (figure 2). Connect one meter lead to the valve body and test the corresponding pins for each solenoid (figure 3).

About the Solenoids

Secondary Linear Control — This is an interesting solenoid; it controls pressure to the pulleys to keep the chain tight enough that it doesn't slip. Secondary pressure can be as high as 900 PSI.

The main regulator for this transmission is built into the snout of this solenoid (figure 4).

Pump pressure enters the end port of the solenoid snout. We've removed the valve from the snout to show orifices A and B. Orifice B is behind the screen on the valve. The pressure regulation spring controls base line pressure.

There are two balance orifices built into the valve. Orifice A is the balance orifice for main regulation, and keeps the valve balanced, like most normal pressure regulator valves.

Orifice B is a little unusual; it's

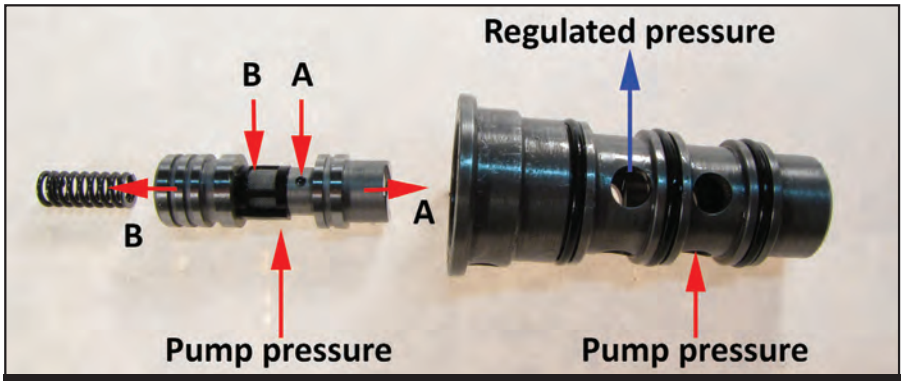

Figure 4

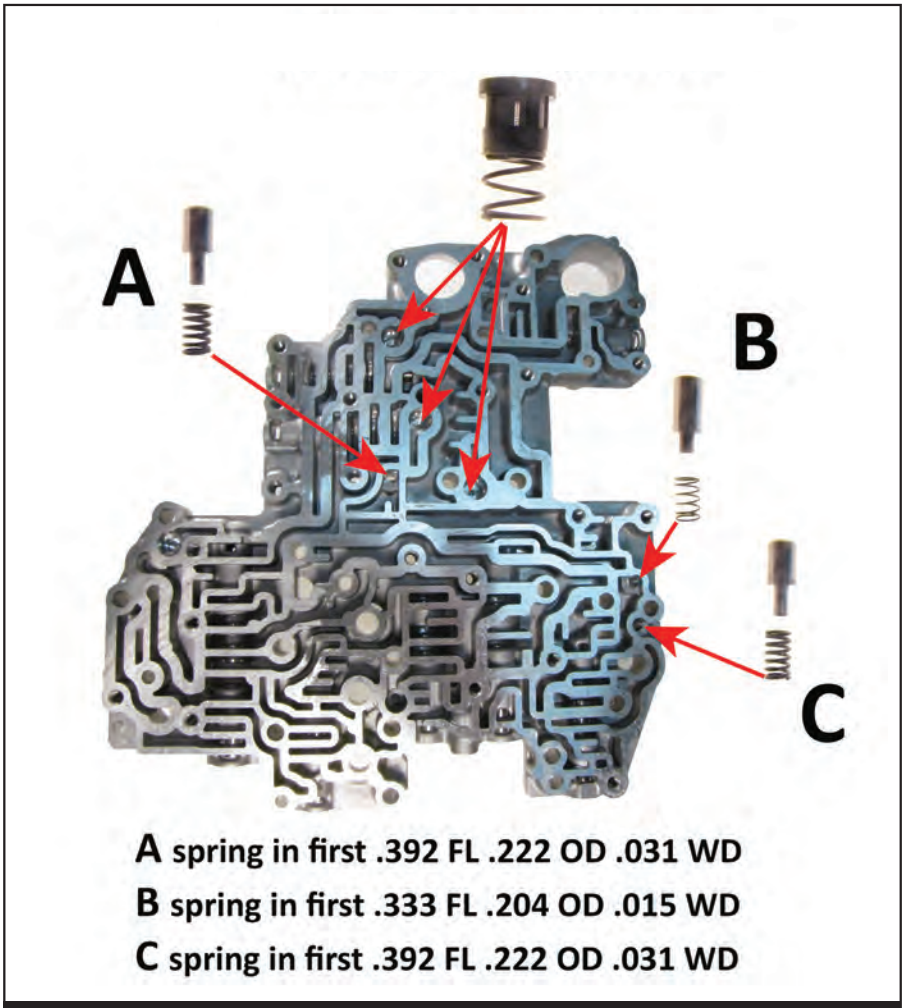

Figure 5

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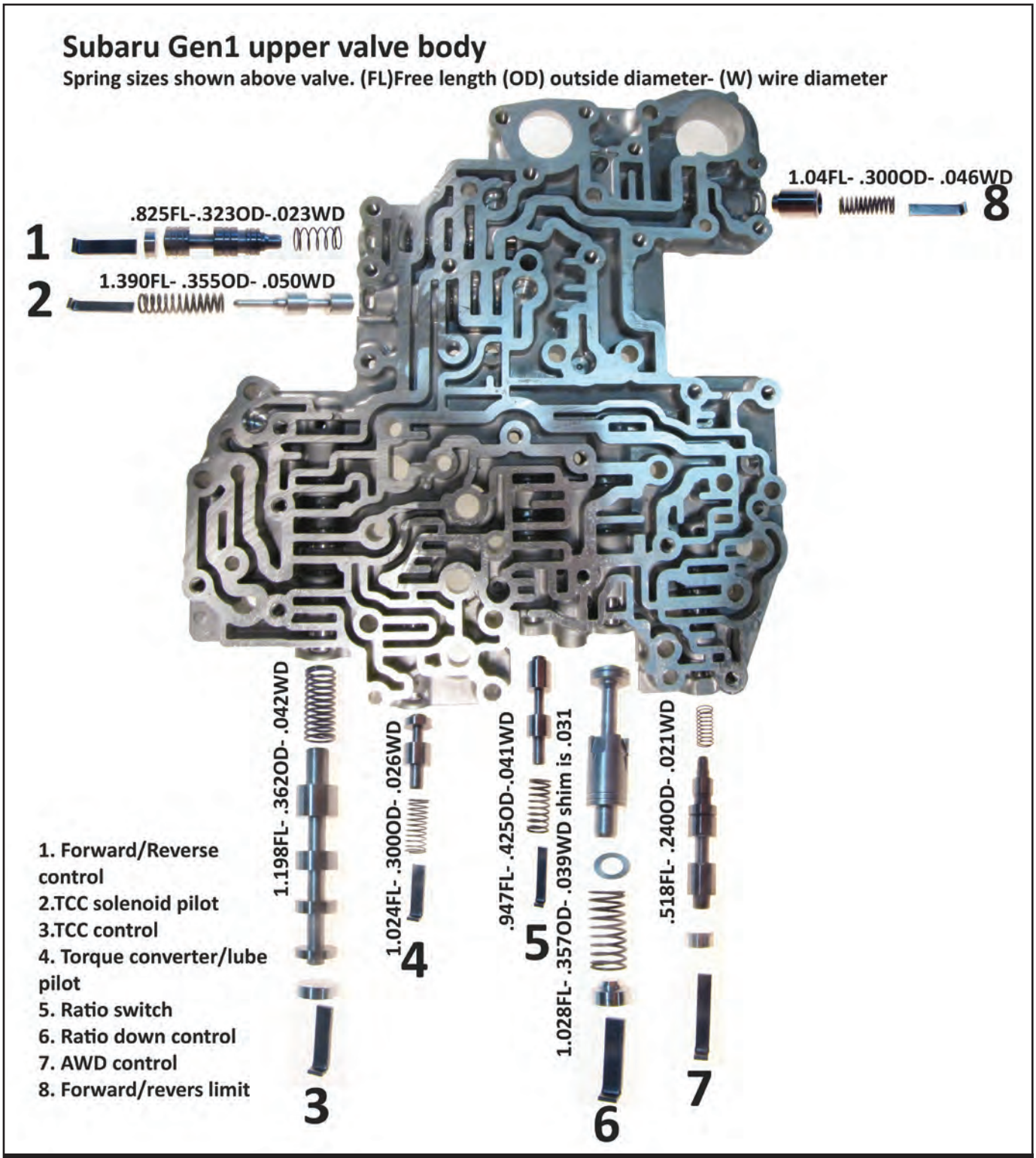


Figure 6

controlled by the solenoid. The solenoid acts on a needle and seat that opens or seals this orifice to control the position of the pressure regulator valve.

The secondary linear control solenoid operates at 2000 Hz. This is very fast, which keeps the control pressure smooth.

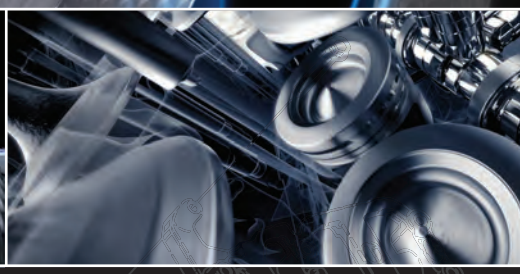
If a problem occurs with the secondary linear solenoid, the TCM will shut the signal off and the transmission line pressure will rise to maximum. This will cause harsh forward and reverse engagements and no lockup. The transmission will continue to adjust gear ratios normally.

Lockup On/Off — This solenoid controls the TCC control valve and the direction of oil through the torque converter.

A problem with this solenoid or its control signal will inhibit lockup. The transmission will continue to adjust gear ratios normally.

Lockup Duty — This solenoid controls the lockup boost valve and regulator valve as it controls the pressure in the torque converter clutch circuit. The lockup on/off solenoid has to be commanded on before this solenoid

A higher level.



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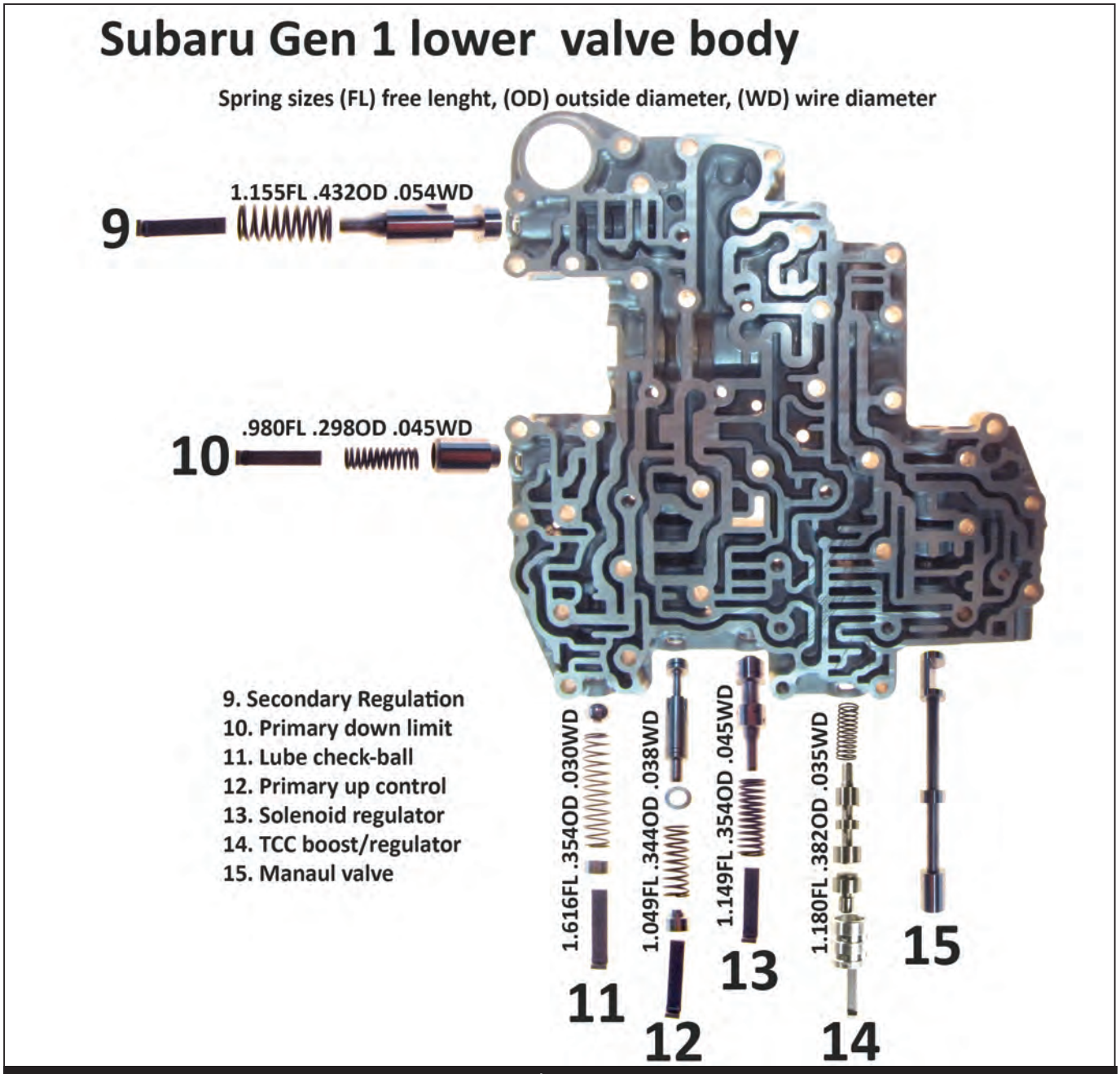

Figure 7

will operate.

A fault with this solenoid or its control signal will inhibit lockup. The transmission will continue to adjust gear ratios normally.

Primary-Up — This solenoid controls the primary-up control valve, which increases primary pressure in the ratio chamber of the primary pulley. The increased pressure in ratio chamber squeezes the pulley together and forces the chain to ride higher in the pulley. That increases the ratio (toward overdrive) of the transmission.

A fault in this solenoid or circuit will prevent the transmission from changing ratios.

Primary-Down — This solenoid controls the primary-down control valve, which releases primary pressure in the ratio chamber of the primary pulley. This opens the primary pulley, which allows the chain to ride deeper in the pulley. This lowers the transmission ratio.

A fault in this solenoid or circuit will keep transmission ratio high.

Forward/Reverse Linear — This solenoid controls the forward/reverse control valves and engagement feel.

If this solenoid or circuit fails, pressure will rise to maximum levels, which will cause harsh engagements. The transmission will continue to adjust gear ratios normally.

All Wheel Drive Transfer Case Clutch — This is a linear solenoid that controls the AWD control valve, which operates the transfer case clutch. This clutch powers the rear differential when the TCM identifies wheel slip in the front wheels. The TCM identifies wheel slip by monitoring wheel speed and transmission output speed.

If this solenoid or circuit fails, all torque to drive the vehicle will come from the front wheels; the rear differential won't operate. The transmission will continue to adjust gear ratios normally.

If any solenoid or solenoid circuit

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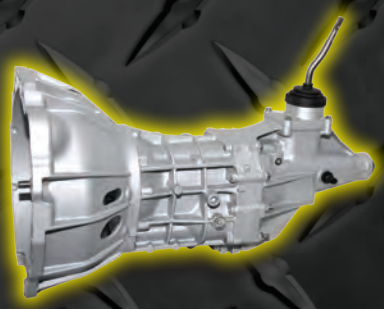

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fails, the AT Temp light will flash and store a code in the system. The system will reset and test the system again on next key cycle.

If the system cuts power to the transmission, it'll take off in a higher gear. It'll feel like the transmission is slipping and there'll be no power on takeoff.

The Valve Body

When disassembling the valve body, pay close attention to the solenoid wires, including the solenoid grounds attached to the valve body bolts. If these wires are loose or have bad connections, the TCM will set solenoid codes.

Remove the solenoids and separate the valve body. Try to keep the separator plate against the upper valve body, because all of the small parts are in the upper half. There are no checkballs in this valve body.

In the upper half of the valve body you'll see three check valves, each with its own spring. There are also three filters with springs (figure 5).

One of the springs is different from the others, so pay attention to which spring went where. The springs go into the valve body first, then the check valve.

For now, Subaru doesn't provide valve body information on valve names or the layout (figures 6 and 7). The valve body is sold as one piece with solenoids. The valves are identified by what they control or their function.

The Pulley Operation

The Subaru Lineartronic CVT uses an electronically controlled, hydraulically operated pair of adjustable pulleys and a link chain that runs between them.

The pulleys are V-shaped: As the pulleys open, the chain rides down toward the small part of the pulley. When the pulley closes or squeezes together, it forces the chain outward so it rides on the larger part of the pulley (figure 8).

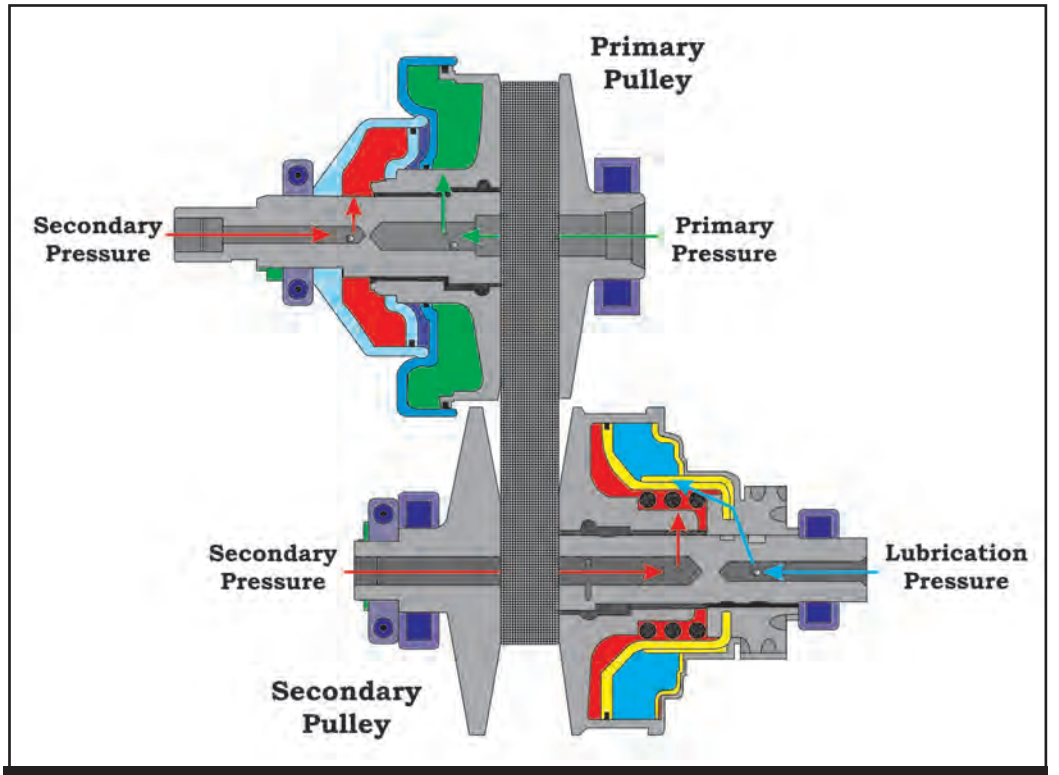


Figure 8

Secondary pressure is line pressure and is the same in both pulleys at all times. The purpose of secondary pressure is to squeeze the pulley together to clamp the pulley against the chain and keep it from slipping.

The primary pulley receives engine power from the input clutch. When the primary pulley is small and the secondary pulley big, it's easy to accelerate and take off from a stop. This is first or low gear ratio. At this point the primary pressure is low to the ratio chamber.

As vehicle speed increases, the transmission needs to change ratio to allow the vehicle to drive faster and keep the engine from over-revving.

To change the ratio of the transmission, the TCM adjusts the signal to the primary-up solenoid. This alters the position of the primary-up control valve, which increases primary pressure in the ratio chamber.

The added pressure in the ratio chamber squeezes the primary pulley together, making the chain ride up in the pulley, increasing the effective pulley diameter. At the same time, it forces the secondary pulley apart, reducing the effective diameter of the driven pulley. This raises the effective gear ratio toward an overdrive range.

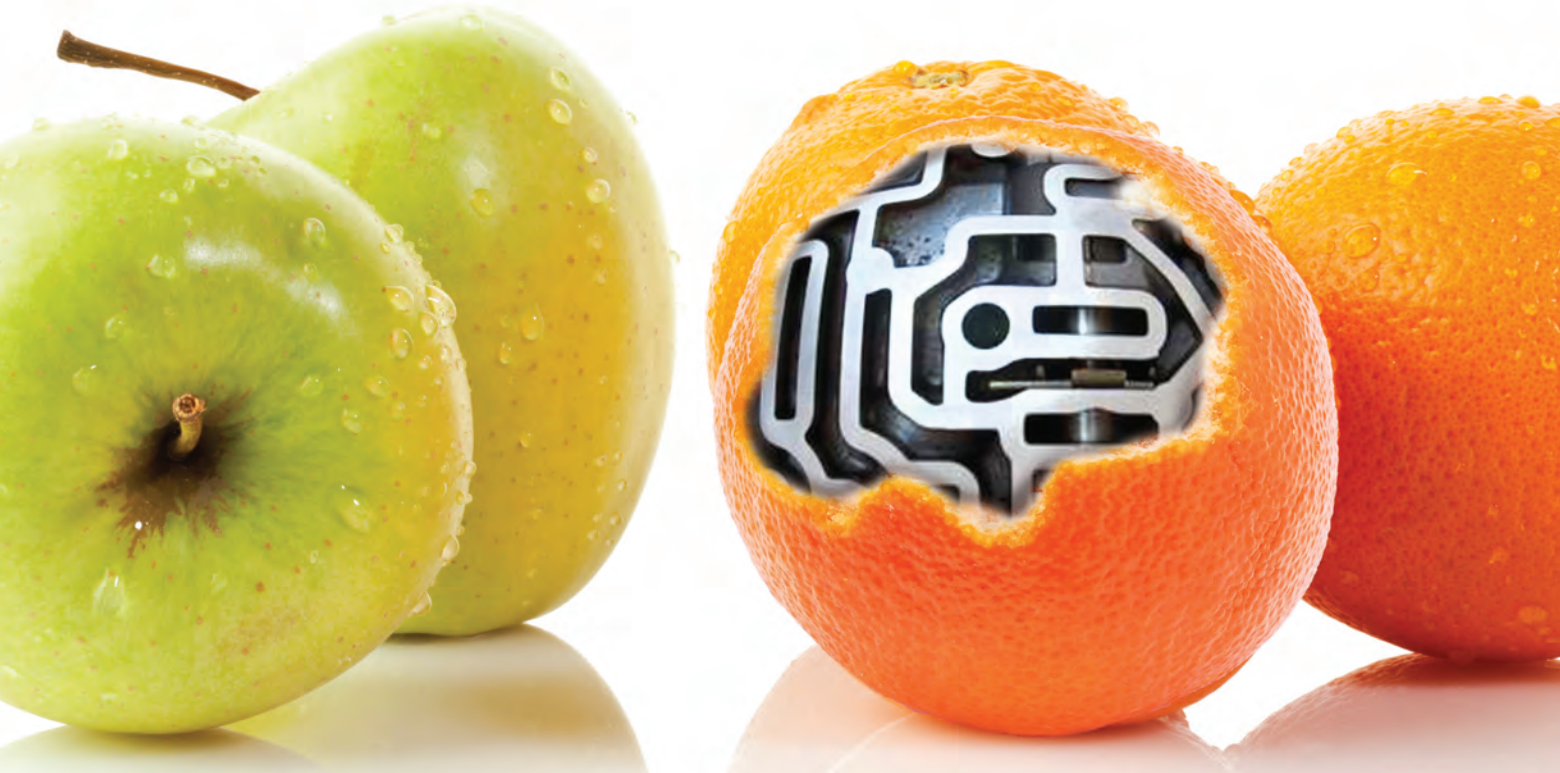
As the vehicle slows, the transmission needs to go back to low gear position. The TCM sends a signal to the primary-down solenoid. The oil from the solenoid controls the primary-down valve, which dumps pressure through the ratio switch valve.

As pressure drains from the ratio chamber in the primary pulley, spring force takes over in the secondary pulley. The spring squeezes the secondary pulley closed, effectively increasing its diameter. At the same time, it forces the primary pulley open, effectively reducing the front pulley's diameter. This puts the transmission back into low gear range.

The ratio changes up and down are smooth. This helps keep the engine RPM at the prime speed for power and fuel efficiency.

This puts the Subaru Lineartronic CVT transmission under control, and it provides you with the information you'll need to work on this transmission. So when one of these units makes its way into your shop, you, too, will be in control.

Special thanks to Perfection Plus Transmission Parts in Portland, Oregon for the use of the core to help make this article possible.



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