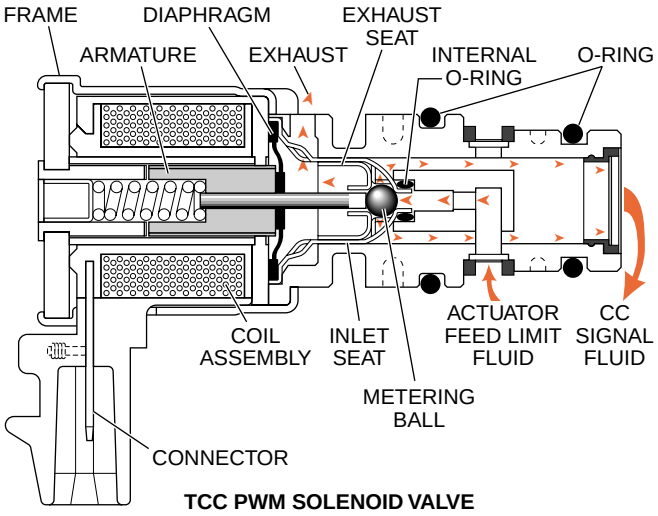
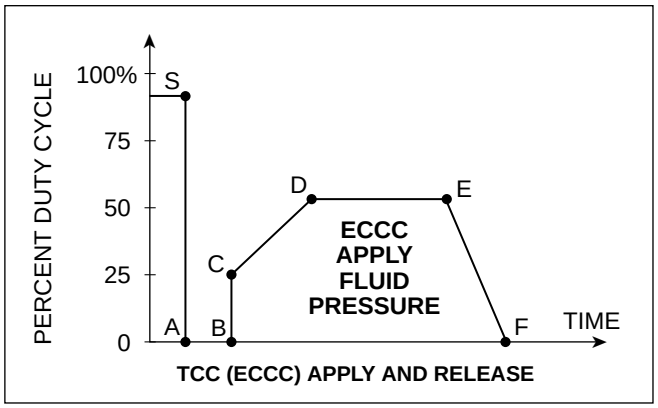


TCC PWM SOLENOID VALVE



TCC (ECCC) APPLY AND RELEASE

When the PCM detects a continuous open, short to ground or short to power in the TCC PWM solenoid valve circuit, then DTC P1860 sets and the PCM will command the following default actions:

- The PCM illuminates the malfunction indicator lamp (MIL)
- The PCM inhibits TCC engagement
- The PCM inhibits 4th gear if the transmission is in hot mode
- The PCM freezes shift adapts from being updated
- The PCM stores Freeze Frame and Failure records
- The PCM stores DTC P1860 in PCM history

Torque Converter Clutch Pulse Width Modulated (TCC PWM) Solenoid Valve

The TCC PWM solenoid valve is a normally closed, pulse width modulated (PWM) solenoid used to control the apply and release of the converter clutch. The PCM operates the solenoid with a negative duty cycle at a fixed frequency of 32 Hz to control the rate of TCC apply/release. The solenoid's ability to "ramp" the TCC apply and release pressures results in a smoother TCC operation.

TCC PWM Solenoid Valve Operation

The TCC PWM solenoid valve is one electronic control component of the TCC apply and release system. The other electronic component is the TCC solenoid valve, which enables TCC ON and OFF. The other components are all hydraulic control or regulating valves. The illustration below shows all the valves and the TCC PWM solenoid valve that make up the TCC control system. (For more information on system operation see pages 62 and 63 in the Powerflow section.)

In first gear, at approximately 13 km/h (8 mph), the PCM operates the TCC PWM solenoid valve at approximately 90 percent duty cycle (point S on the graph at left). This duty cycle is maintained until a TCC apply is commanded. When vehicle operating conditions are appropriate to apply the TCC, the PCM immediately decreases the duty cycle to 0 percent, then increases it to approximately 25% (see point C on graph). The PCM then ramps the duty cycle up to approximately 50% to achieve regulated apply pressure in vehicles equipped with the Electronically Controlled Clutch Capacity. With the ECCC system, the pressure plate does not fully lock to the torque converter, instead a consistent slip of 20 to 40 RPM is regulated. The rate at which the PCM increases the duty cycle controls the TCC apply. Similarly, the PCM also ramps down the TCC solenoid duty cycle to control TCC release. Under some high torque or high vehicle speeds, the converter clutch is fully locked.

There are some operating conditions that prevent or enable TCC apply under various conditions (refer to the Automatic Transmission Fluid Temperature sensor description). Also, if the PCM receives a high voltage signal from the brake switch, signalling that the brake pedal is depressed, the PCM immediately releases the TCC.

Note: Duty cycles given are for example only. Actual duty cycles will vary depending on vehicle application and vehicle operating conditions.

TCC PWM solenoid valve resistance should measure between 10.0 and 11.5 ohms when measured at 20°C (68°F). The resistance should measure between 15.0 and 17 ohms at 150°C (302°F).

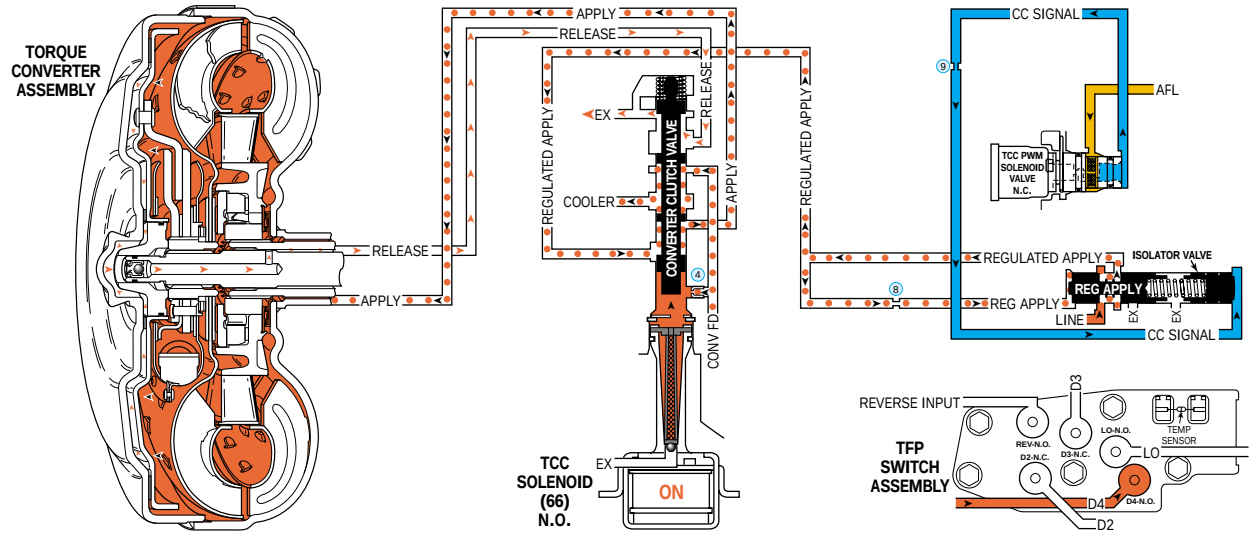


Figure 41

OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch Applied)

1-2 SHIFT SOLENOID VALVE	2-3 SHIFT SOLENOID VALVE	2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO-ROLLER CLUTCH	LO/REV CLUTCH
ON	OFF	APPLIED			APPLIED		APPLIED		

Overdrive Range – Fourth Gear is used to maximize engine efficiency and fuel economy under most normal driving conditions. In order to shift the transmission into Fourth gear, the PCM receives input signals from the vehicle speed sensor, the TP sensor and other vehicle sensors to determine the precise moment to energize or "turn ON" the 1-2 shift solenoid (SS) valve. The 1-2 SS valve is ON when the PCM provides a path to ground for that electrical circuit. This prevents 1-2 signal fluid from exhausting at the 1-2 SS valve, thereby increasing 1-2 signal fluid pressure.

1 2-4 BAND APPLIED

1a 1-2 Shift Solenoid (SS) Valve:
The 1-2 SS valve is energized (ON) blocking 1-2 signal fluid from exhausting through the solenoid. This creates pressure in the 1-2 signal fluid circuit.

1b 3-4 Shift Valve:
1-2 signal fluid pressure moves the valve into the upshifted position routing 3-4 signal fluid into the 4th signal fluid circuit.

1c 3-4 Relay Valve and 4-3 Sequence Valve:
4th signal fluid pressure moves both valves into the upshifted position causing the following changes.

- Orificed (#7) 2nd fluid is routed through the 3-4 relay valve and into the servo feed fluid circuit.
- Servo feed fluid is routed through the 4-3 sequence valve and into the 4th fluid circuit.
- 3-4 accumulator fluid routed from the 2-3 shuttle valve is blocked by both valves.

1d 2nd & 4th Servo:
4th fluid pressure is routed through the center of the servo apply pin and acts on the apply side of the 4th apply piston. This action moves the apply pin and applies the 2-4 band in order to obtain fourth gear.

2 3-4 SHIFT ACCUMULATION

2a 3-4 Accumulator Assembly:
3-4 accumulator fluid pressure moves the 3-4 accumulator piston absorbing some of the initial increase of 4th clutch apply fluid pressure in order to cushion the 2-4 band apply.

2b Accumulator Valve:
Accumulator fluid forced from the 3-4 accumulator is orificed to the end of the accumulator valve. This regulates the exhaust of excess accumulator fluid pressure through the middle of the valve.

3 TORQUE CONVERTER CLUTCH APPLIED

3a TCC Solenoid Valve:
When operating conditions are appropriate, the PCM energizes the normally open TCC solenoid valve. This closes the solenoid, blocks converter feed fluid from exhausting, and creates enough pressure in the converter feed fluid circuit at the TCC solenoid valve to shift the converter clutch valve.

3b Converter Clutch Apply Valve:
The converter clutch valve is shifted into the apply position allowing release fluid to exhaust from the torque converter clutch and regulated apply fluid to enter the apply fluid circuit at the same time. This provides for smooth engagement of the TCC.

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OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch Applied)

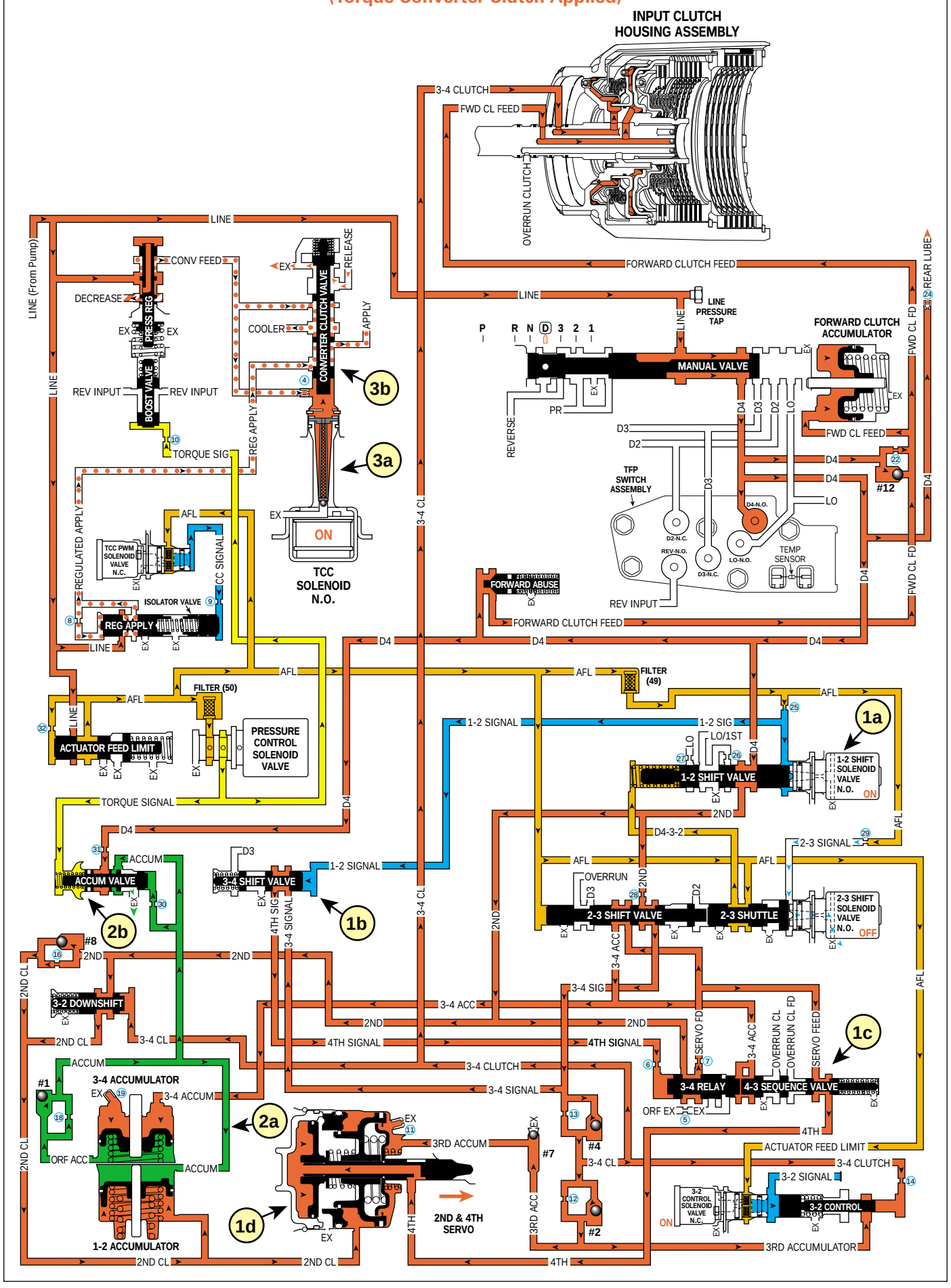
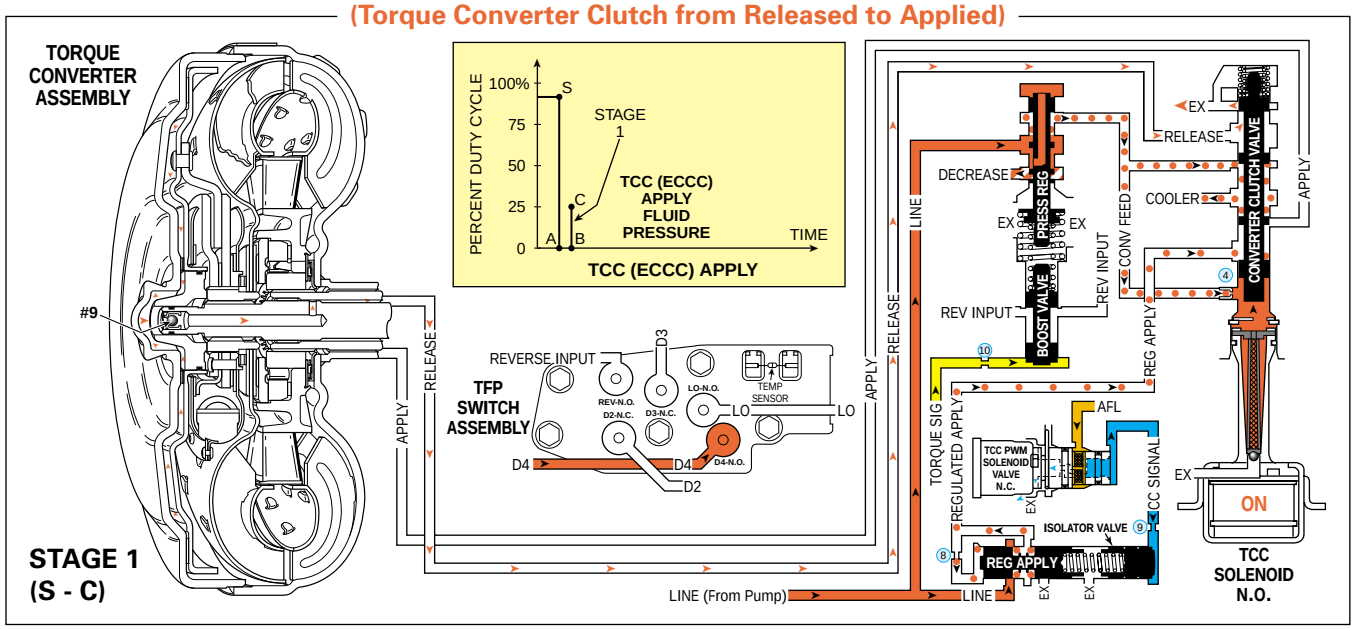
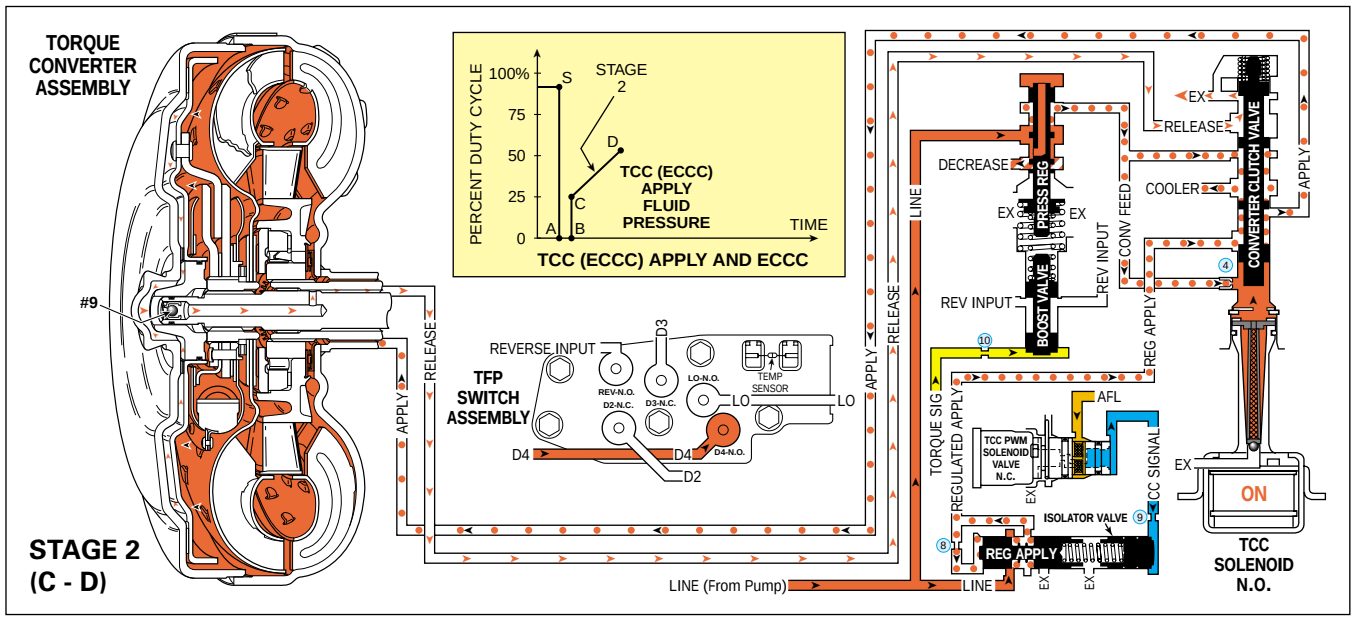


Figure 58

OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch from Released to Applied)





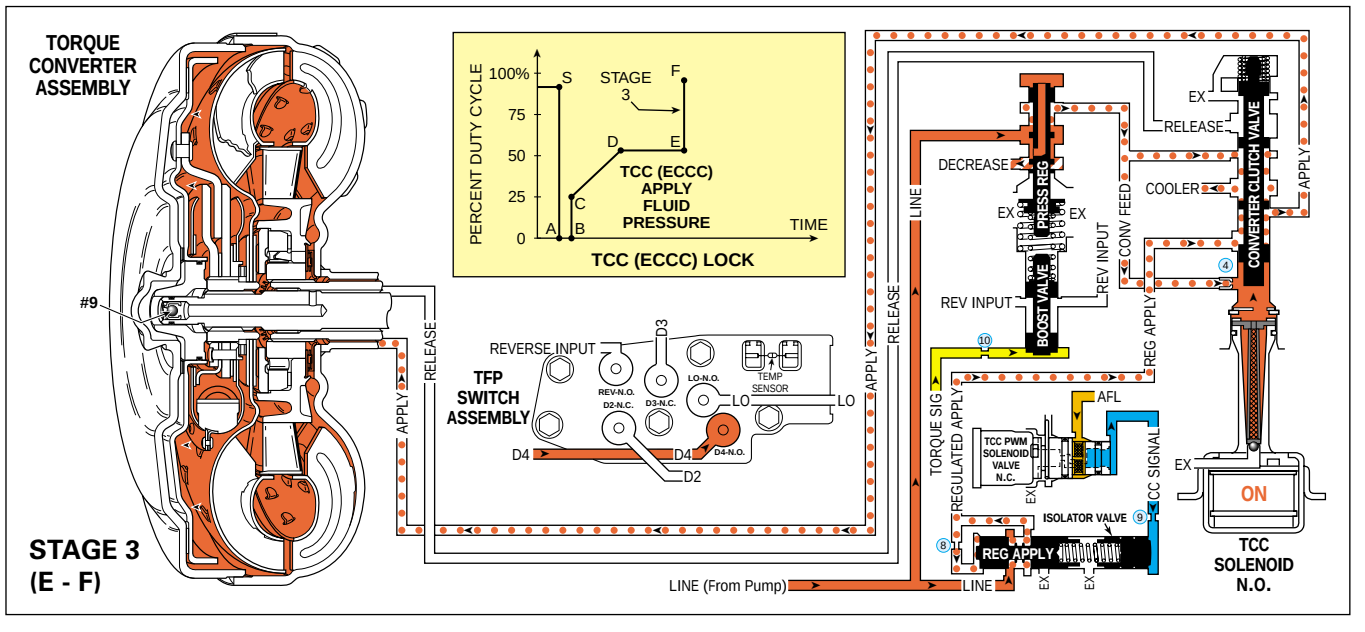


Figure 59

OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch from Released to Applied)

When the powertrain control module (PCM) determines that the engine and transmission are operating properly to engage the torque converter clutch (TCC), the PCM energizes the TCC solenoid valve and regulates the duty cycle of the TCC PWM solenoid valve. The following events occur in order to apply the torque converter clutch:

OFF **At this time the Torque Converter Clutch is considered to be disengaged (OFF), TCC solenoid valve OFF, TCC PWM solenoid valve parked at 90% duty cycle.**

PCM decision to apply TCC (see pages 39 and 43, in the Electrical Components section, for more information).

Stage 1 The PCM immediately decreases the TCC PWM solenoid valve duty cycle to 0% (from point **S** to point **A)** then pulses the TCC PWM solenoid valve to approximately 25% duty cycle from point **B** to point **C**. Actuator feed limit fluid at the TCC PWM solenoid is “pulsed” into the CC signal fluid circuit. The CC signal fluid pressure at point **C** regulates a line pressure branch which creates regulated apply fluid. The PCM also energizes the TCC solenoid valve, blocking converter feed fluid from exhausting through the solenoid and causing pressure to build up and shift the converter clutch valve to the apply position. With the converter clutch valve in the apply position, Release fluid can exhaust through the valve. This stage is designed to move the converter clutch valve from the released to the applied position; there is not enough pressure to apply the TCC.

Stage 2 The TCC PWM solenoid valve duty cycle is ramped up from point **C** to point **D** to approximately 50%. Regulated apply fluid pressure is now strong enough to cause the converter apply to occur. Line pressure from the pump enters the regulated apply circuit at the regulated apply valve. Regulated apply fluid is routed to the converter clutch valve into the apply fluid circuit. The pressure value in the regulated apply circuit should now be high enough to fully apply the TCC pressure plate. Slip speed should be at the correct value (near “0”).

In vehicles equipped with the Electronically Controlled Clutch Capacity (ECCC) system, the pressure plate does not fully lock to the torque converter cover. It is instead precisely controlled to maintain a small amount of slippage between the engine and the turbine, reducing driveline torsional disturbances.

Stage 3 If it is determined by the PCM that it is desirable to fully lock the TCC, regulated apply fluid pressure is increased. This is caused by the TCC PWM solenoid valve duty cycle being increased from point **E** to point **F,** to approximately 98%. This extra pressure ensures that the apply force on the TCC pressure plate is not at the slip threshold, but a little above it. TCC plate material is therefore protected from excessive heat.

Note: The TCC PWM solenoid valve operates independently from the TCC solenoid valve. The TCC solenoid valve only controls when the TCC is applied. The TCC PWM solenoid valve only controls how the TCC is applied.

Note: Under normal operating conditions the torque converter clutch is in the released position during first, second and third gears. However, when the transmission fluid temperatures exceed approximately 121°C (250°F), the PCM will apply the torque converter clutch in second and third gears to help reduce fluid temperatures.

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OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch from Applied to Released)

When the TCC pressure plate is applied, it is held against the torque converter cover. Since it is splined to the converter turbine hub, it provides a mechanical coupling (direct drive) of the engine to the transmission gear sets. This mechanical coupling eliminates the small amount of slippage that occurs in the fluid coupling of a torque converter, resulting in a more efficient transfer of engine torque through the transmission and to the drive wheels.

ON **At this time the Torque Converter Clutch is considered to be engaged (ON).**

PCM decision to release TCC (see pages 39 and 43, in the Electrical Components section, for more information).

Stage 4 During this stage, the apply fluid pressure from the regulated apply valve is decreased by the TCC PWM solenoid valve duty cycle dropping from point **G** to point **H**, to approximately 50%. Reduced CC signal fluid pressure from the TCC PWM solenoid valve allows orificed regulated apply fluid to move the regulated apply valve, decreasing the flow of line fluid feeding the regulated apply circuit. This reduces the apply force on the TCC pressure plate to the slip threshold. This gets the TCC pressure plate ready for a smooth release.

Stage 5 The TCC PWM solenoid valve duty cycle is ramped down to 0% from point **H** to point **I** through this stage. This action allows the regulated apply pressure to start at the slip threshold, and decrease to near "0" pressure over a very short time to point **I**. The regulated apply pressure value from the TCC regulator apply valve at this duty cycle (point **I**) should fully release the TCC pressure plate. Slip speed should be at the maximum value. The PCM also de-energizes the TCC solenoid allowing converter clutch valve spring force to shift the converter clutch valve to the released position. Release fluid is now directed back to the torque converter.

Stage 6 The PCM pulses the TCC PWM solenoid valve to a value of "90". This stage is designed to prepare the TCC apply and release system for another apply of the TCC.

OFF **At this time the Torque Converter Clutch is considered to be disengaged (OFF).**

(Some PCM calibrations may allow stages 4 - 6 to happen very rapidly in almost a straight line down from point **G** to point **K**.)

The PCM monitors for high TCC slip for most models. Excessive slip is recognized by Diagnostic Trouble Code (DTC) P1870. The transmission must be in hot mode or experiencing a wide open throttle maneuver in order for the TCC to be commanded on in second and third gear.

If the PCM detects a continuous open, short to ground, or short to power in the TCC solenoid valve circuit, then DTC P0740 will set and the PCM will illuminate the malfunction indicator lamp (MIL), inhibit TCC operation, inhibit 4th gear and freeze shift adapts. The DTC P0740 will then be stored in PCM history.

If the PCM detects low TCC slip when the TCC is commanded OFF, then DTC P0742 will set and the PCM will illuminate the malfunction indicator lamp (MIL), increase line pressure and freeze shift adapts. The DTC P0742 will then be stored in PCM history.

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OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch from Applied to Released)

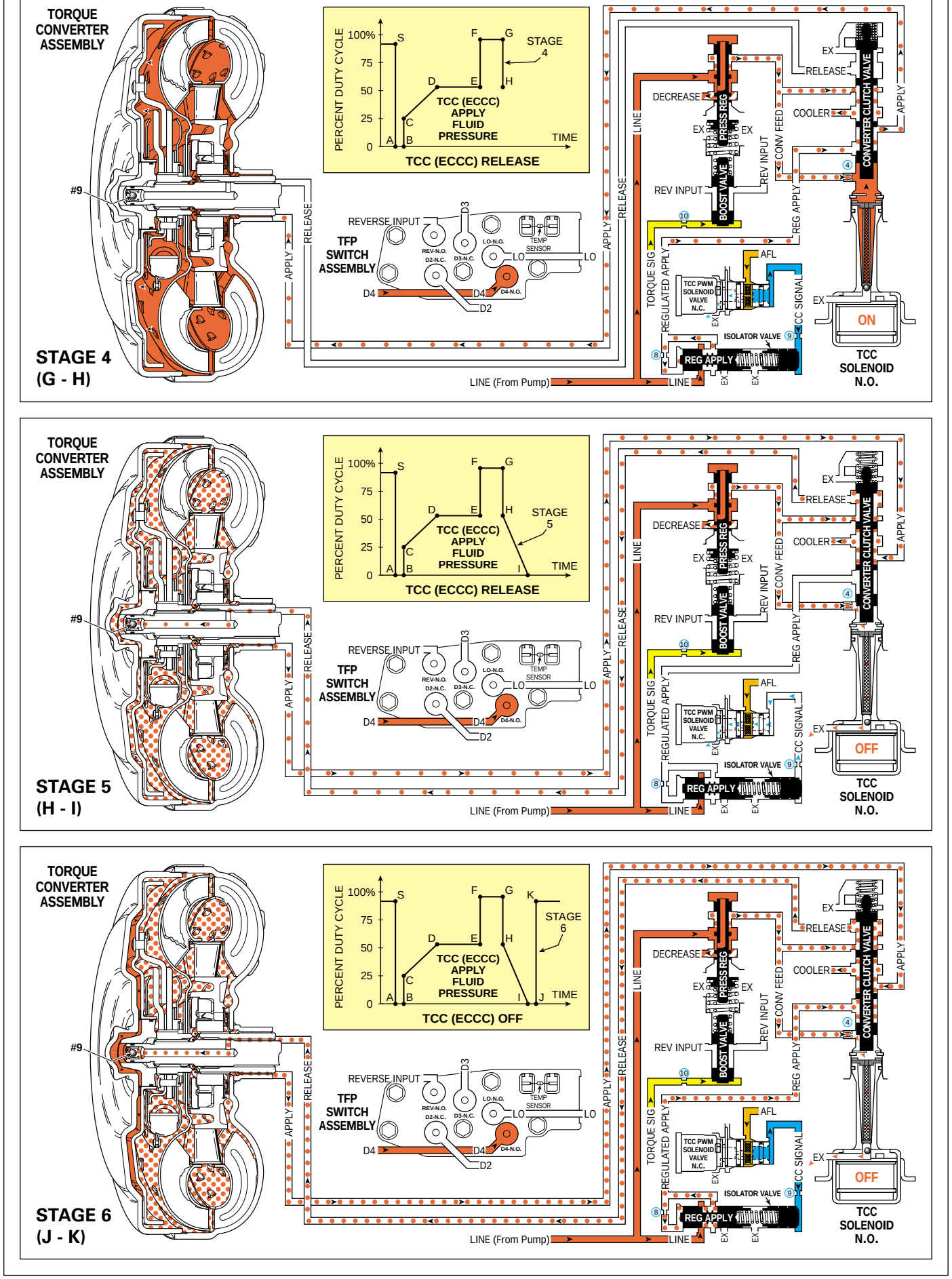

Figure 60