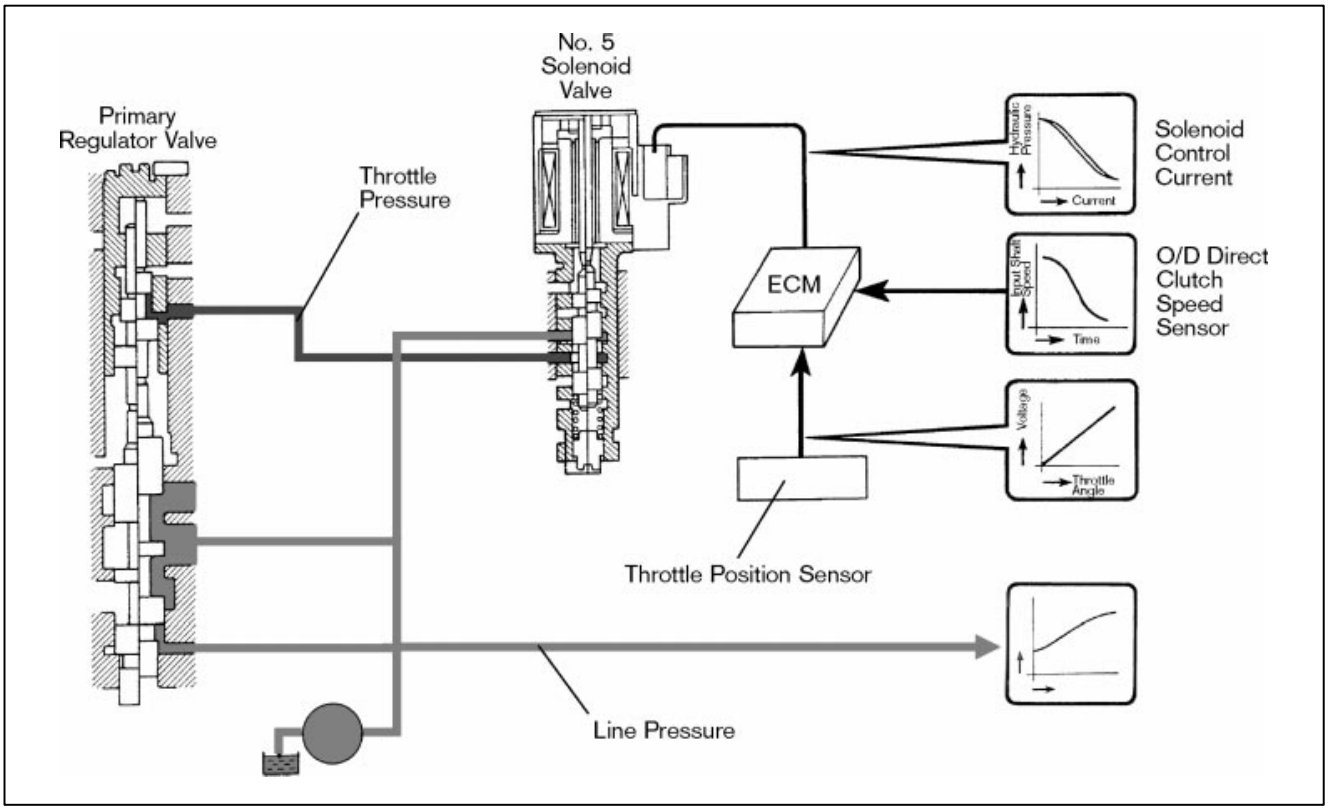
Section 4

Electronic Control System



Lesson Objectives

1. Describe the operation of the O/D Main Switch and its control of fourth gear.
2. Describe the effect of the O/D solenoid on the torque converter lock-up control of non-ECT transmissions.
3. Explain the effect of the neutral start switch in maintaining manual select positions in ECT transmissions.
4. Given the solenoid back-up function chart, describe the ECU control of the remaining solenoid to allow the vehicle to operate.
5. Describe the coolant temperature sensor's affect on transmission operation.
6. Describe the affect to the throttle position sensor and speed sensor on the transmission ability to upshift.
7. Describe the A-series ECT transmission shift control operation.
8. Differentiate the operation of the linear and ON/OFF solenoids.
9. Describe how the three/four shift in a U-341 transaxle is accomplished with the ST solenoid.

Notes

Non-ECT Transmission

The Non-ECT transmission operates on a balance of hydraulic pressure based on vehicle speed and throttle opening. Overdrive and torque converter lock-up operation are the only functions controlled electronically.

Overdrive Control System

Overdrive enables the output rpm of the transmission to be greater than the input rpm, so the vehicle can maintain road speed with lower engine rpm. The control system manages line pressure at the top of the 3-4 shift valve to hold it in the third gear position or allow a shift to O/D.

The hydraulic circuit is controlled by the No. 3 solenoid, also referred to as the O/D solenoid. The solenoid controls the drain on the hydraulic circuit at the top of the 3-4 shift valve which will counteract governor pressure at the valve base when the solenoid drain is closed.

O/D Solenoid Valve

The O/D solenoid valve below is a normally closed solenoid; that is, the valve is spring loaded in the closed position. This solenoid is controlled by a normally closed relay. When the solenoid is energized, the valve opens a drain in the hydraulic circuit to the top of the 3-4 shift valve. This allows governor pressure to overcome spring tension and throttle pressure to allow an upshift to overdrive.

Overdrive Solenoid Operation

O/D solenoid is a normally closed solenoid.

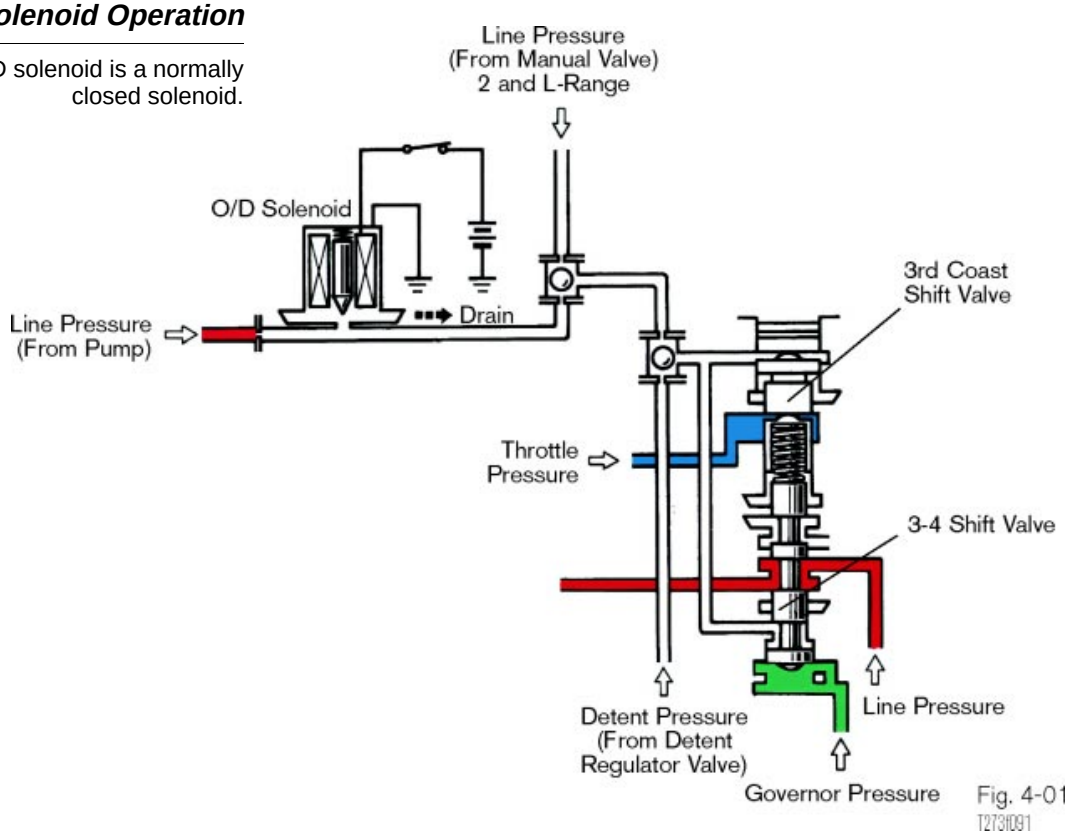


Fig. 4-01

The components which make up this system include:

- O/D main switch
- O/D off indicator light
- Water temperature sensor
- O/D solenoid valve

O/D Wiring Diagram

O/D solenoid can be grounded by:
- Cruise Control ECM
- Water Temperature Sensor
- O/D Main Switch

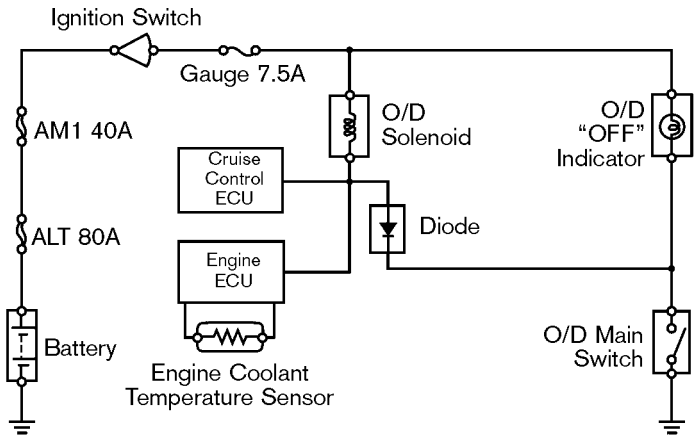


Fig. 4-02
T273f092

O/D Main Switch

The O/D main switch is located on the gear selector. Generally we think of a switch as closed when it is on and open when it is off. However, the O/D main switch is just the opposite. When the O/D switch is in the ON position, the switch contacts are open and the overdrive system is working. When the O/D switch is in the OFF position, the switch contacts are closed and the overdrive system is not working and the top gear is third gear.

O/D Off Indicator Light

This indicator light remains on as long as the overdrive main switch is off (O/D switch contact closed). It is located in the combination meter.

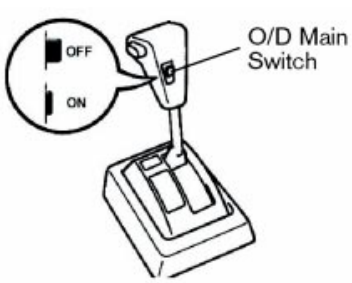
Water Temperature Sensor

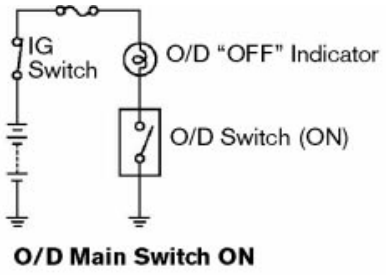
The water temperature sensor monitors the temperature of the engine coolant and is connected to the engine ECM. The engine ECM grounds the circuit through the ECT terminal. It prevents the transmission from shifting into overdrive until the engine coolant is greater than 122°F. This threshold temperature may vary depending on the vehicle model.

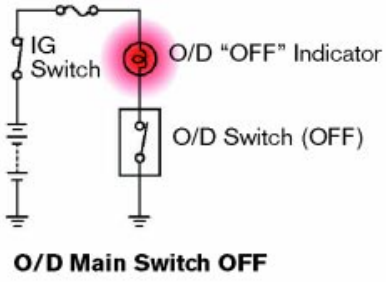
While the engine temperature is below the threshold temperature, the lock-up solenoid circuit will be open, preventing movement of the 3-4 shift valve. On some earlier models, this sensor function was accomplished by a water thermo switch. The outcome is the same; however, the thermo switch controls the circuit without the engine ECM.

O/D Main Switch

The operation of the switch is the opposite of its description.







	O/D Switch	
	ON	OFF
CONTACTS OF O/D SWITCH	Open	Closed
UPSHIFTING	Enabled	Disabled
O/D "OFF" INDICATOR	Off	On

Fig. 4-03
T2731093

Cruise Control

The cruise control ECU sends a signal to the ECM to cancel the overdrive when vehicle speed drops 2.5 mph below the set speed. Cruise control will resume when vehicle speed is within 1.2 mph of set speed.

Converter Lock-Up

Lock-up in a non-ECT transmission is controlled hydraulically by governor pressure and line pressure. Lock-up occurs only in the top gear position. For example: in an A-130L series transmission, lock-up occurs only in third gear; in an A-140L or A-240L series transmission, lock-up occurs only in fourth gear.

Lock-Up Clutch - Disengaged

When overdrive is disabled through solenoid No. 3, the lock-up clutch is also disabled.

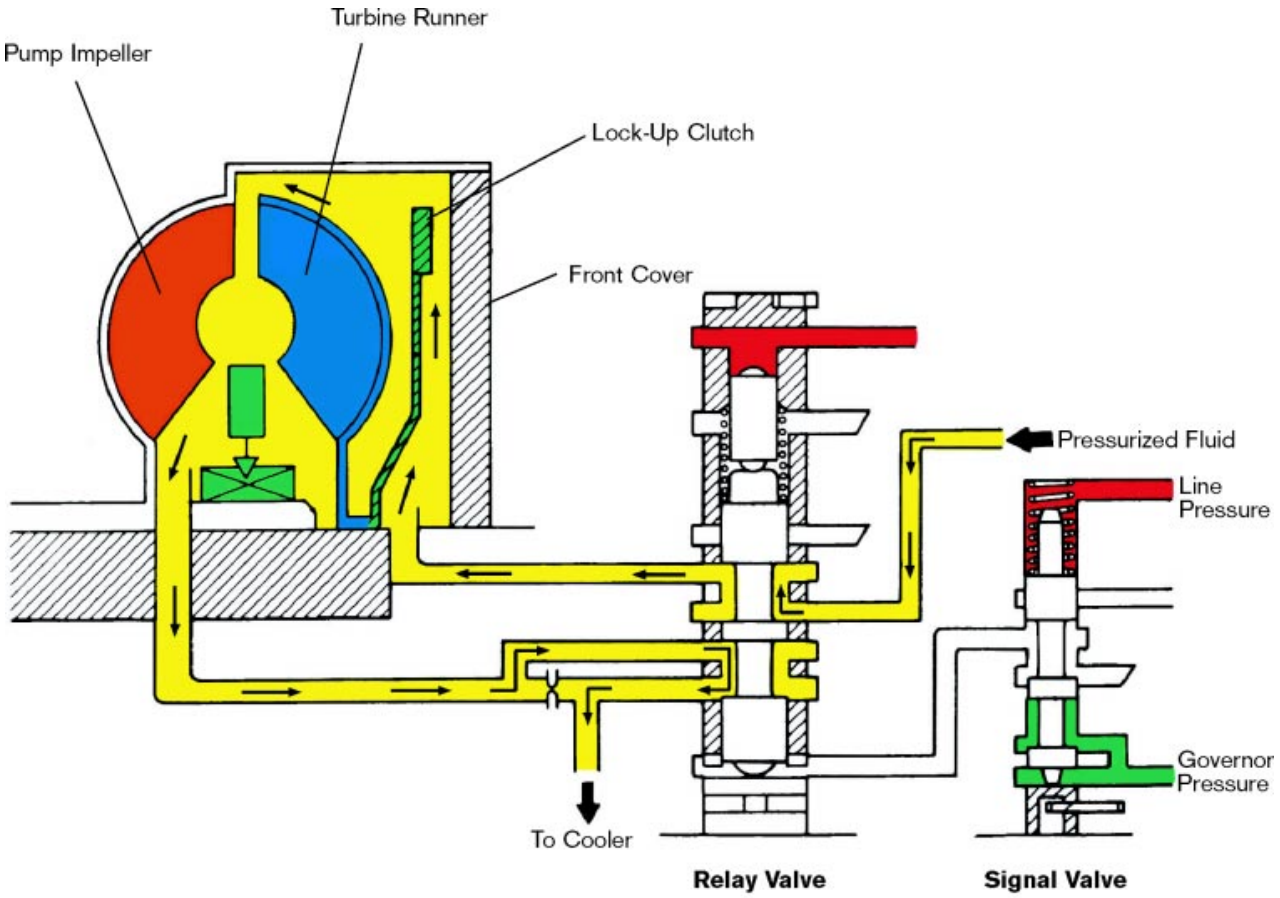


Fig. 4-04
T2731094

Two valves control the operation of the lock-up converter. The lock-up relay valve controls the distribution of converter/lubrication pressure to the torque converter. Line pressure and spring tension hold the relay valve in its normal down position. In fourth gear, governor pressure increases with vehicle speed to overcome spring tension at the top of the signal valve. When the signal valve moves up, line pressure flows through the valve to the base of the relay valve. The relay valve has a larger surface area at the base than at the top and it moves upward, changing the flow of converter pressure to the converter and opening a drain to the front of the lock-up clutch, engaging the clutch with the converter housing.

Lock-Up Clutch - Engaged

The relay valve changes the flow of converter pressure to the converter and opens a drain to the front of the lock-up clutch, engaging the clutch with the converter housing.

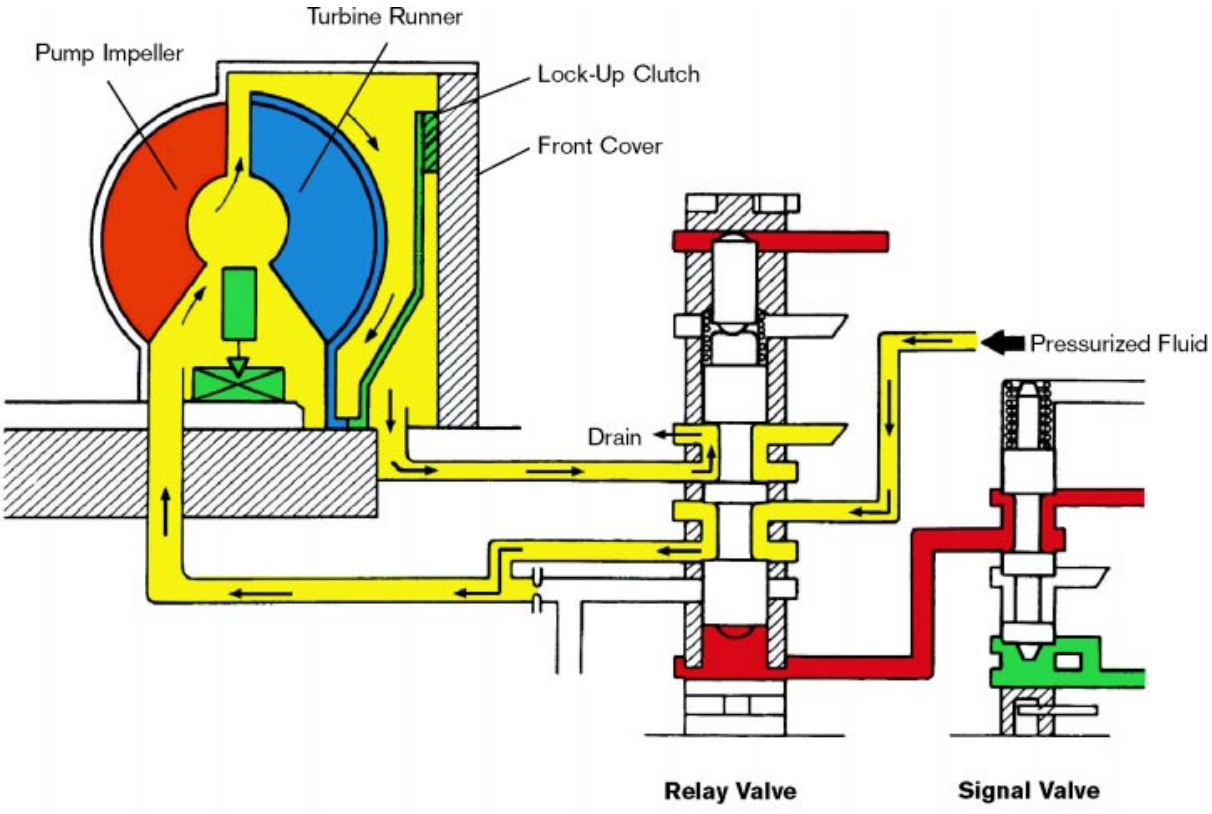


Fig. 4-05
T2731095

Electronic Control Transmission (ECT)

The Electronic Control Transmission is an automatic transmission which uses electronic technology to control transmission operation. The transmission, except for the valve body and speed sensor, is virtually the same as a fully hydraulic controlled transmission. It includes electronic solenoids, sensors, and an electronic control unit.

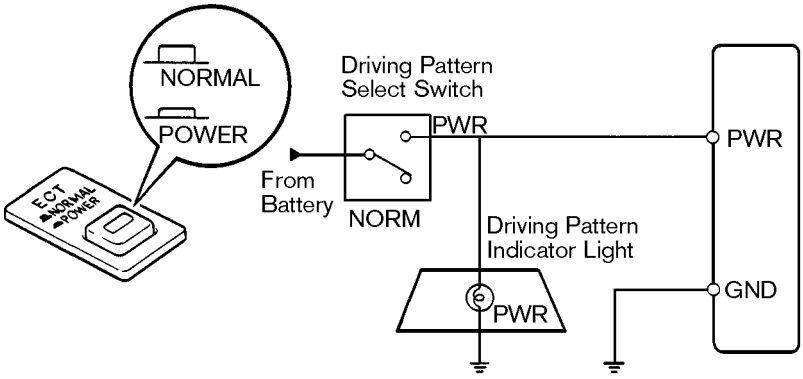
The electronic sensors monitor the speed of the vehicle, speed of the input shaft, gear position selection and throttle opening, providing this information to the ECM. The ECM then controls the operation of the clutches and brakes based on this data and controls the timing of shift points and torque converter lock-up and maintains on-board diagnosis.

Drive Pattern Select Switch

The pattern select switch is controlled by the driver to select the desired driving mode, either “Normal” or “Power.” Based on the position of the switch, the ECM selects the shift pattern and lock-up accordingly. The upshift in the power mode will occur later at a higher speed depending on the throttle opening. For example, an upshift to third gear at 50% throttle will occur at about 37 mph in normal mode and about 47 mph in power mode.

Drive Pattern Select Switch

When the ECM does not receive 12 volts at the PWR terminal, it determines that normal has been selected.



Driving Pattern	“PWR” Terminal Voltage
Normal	0V
Power	12V

Fig. 4-06
T2731D96

The ECM has a “PWR” terminal but does not have a “Normal” terminal. When “Power” is selected, 12 volts are applied to the “PWR” terminal of the ECM and the power light illuminates. When “Normal” is selected, the voltage at “PWR” is 0 volts. When the ECM senses 0 volts at the terminal, it recognizes that “Normal” has been selected.

Beginning with the 1990 MR2 and Celica and 1991 Previa, pattern select switches were discontinued as models went through major body style changes. In the Celica and Previa systems, several shift patterns are stored in the ECM memory. Utilizing sensory inputs, the ECM selects the appropriate shift pattern and operates the shift solenoids accordingly. The MR2 and 1993 Corolla have only one shift pattern stored in the ECM memory. As of the 1999 model year, RAV4, Tacoma, Land Cruiser and 4Runner all have a pattern select switch.

Neutral Start Switch

The ECM receives information on the selected gear range from the shift position sensor, located in the neutral start switch, and determines the appropriate shift pattern. The neutral start switch is actuated by the manual valve shaft in response to gear selector movement.

Neutral Start Switch

ECM monitors gear position through the neutral start switch.

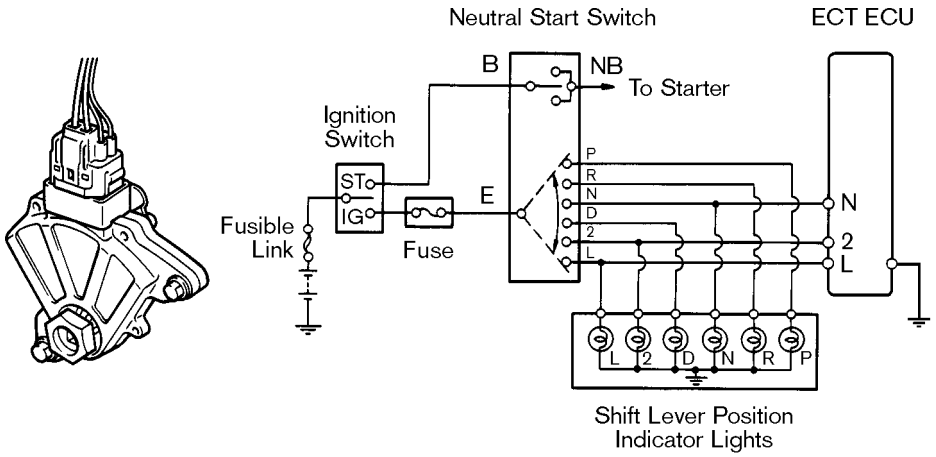


Fig. 4-07
T2731097

Some ECMs monitor positions “2” and “L”. If either of these terminals provides a 12-volt signal to the ECM, it determines that the transmission is in neutral, second gear or first gear. If the ECM does not receive a 12-volt signal at terminals “2” or “L,” the ECM determines that the transmission is in the D-range. Yet, others monitor all gear ranges. Each contact is attached to the gear position indicator lights in the combination meter.

In addition to sensing gear positions, the neutral switch prevents the starter from cranking the engine unless it is in the park or neutral position. In the park and neutral position, continuity is established between terminals “B” and “NB” of the neutral start switch illustrated below.

Starter Control

In Park and Neutral positions, continuity exists between terminals “B” and “NB.”

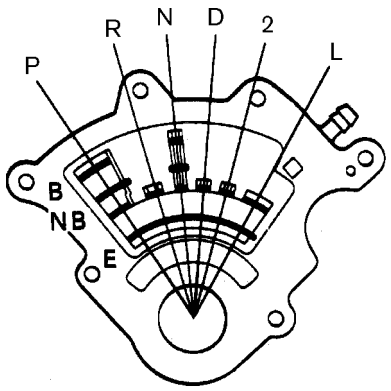


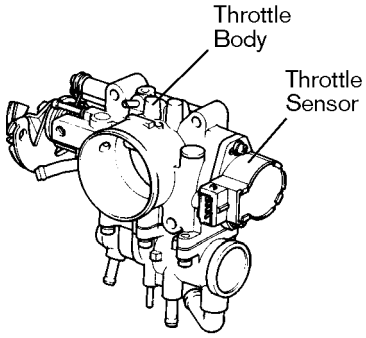
Fig. 4-08
T273f098

Throttle Position Sensor (TPS)

This sensor is mounted on the throttle body and electronically senses how far the throttle is open and then sends this data to the ECM. The throttle position sensor takes the place of throttle pressure for shifting purposes. By relaying the throttle position, it gives the ECM an indication of engine load to control the shifting and lock-up timing of the transmission. A throttle cable controls line pressure based on throttle opening. In models where the throttle cable is eliminated, the TPS’s input to the ECM controls shift timing and line pressure.

Throttle Position Sensor (TPS)

The throttle position sensor converts the throttle valve opening angle into voltage signals.



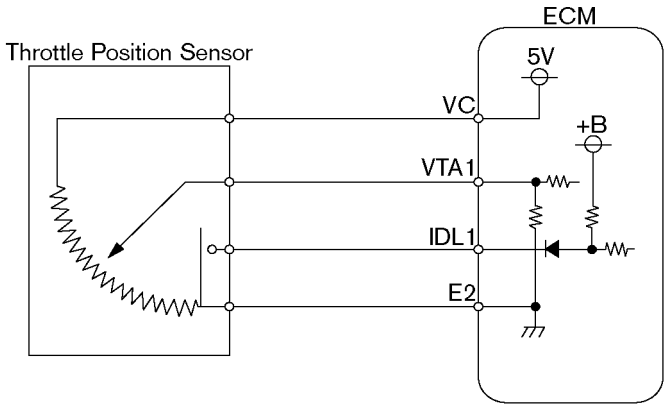


Fig. 4-09
T273f099/T273f409

Five volts are supplied from the VC terminal of the engine ECM. As the contact point slides along the resistor with throttle opening, voltage is applied to the VTA terminal. This voltage increases linearly from 0.6 - 0.9 volts at closed throttle to 3.5 - 4.7 volts at wide-open throttle. When the throttle valve is completely closed, the contact points for the IDL signal connect the IDL and E terminals, sending an IDL signal to the ECM to inform it that the throttle is fully closed.

Throttle Position Terminals

A linear voltage signal indicates throttle opening position and idle contacts indicate when the throttle is closed.

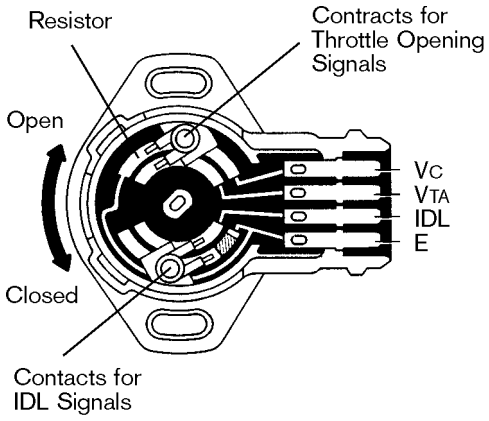


Fig. 4-10
T273f101

Throttle Position Sensor without Idle Control

Throttle sensor printed circuit board and contact points provide the ECM with the same signal pattern for throttle opening as the indirect type throttle sensor.

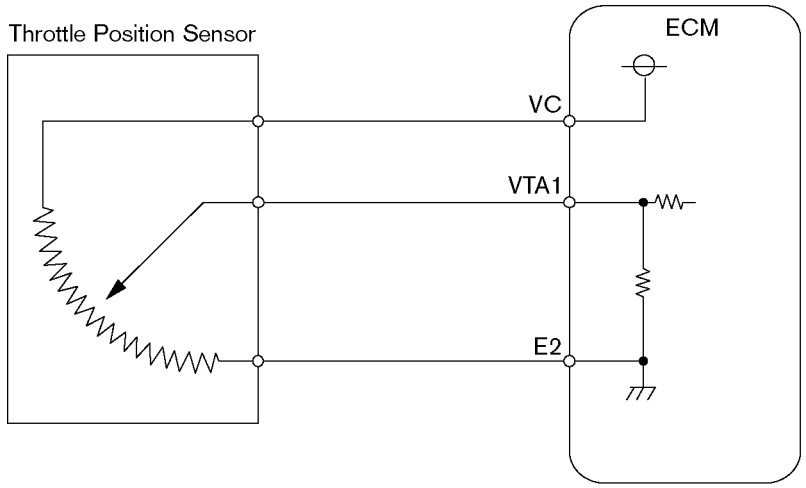


Fig. 4-11

T273f112

Later models no longer use the idle contact. The closed throttle position is a learned position determined by the VTA voltage signal to the ECM.

Engine Coolant Temperature Sensor

The engine coolant temperature sensor monitors engine coolant temperature and is typically located near the cylinder head water outlet. A thermistor is mounted within the temperature sensor, and its resistance value decreases as the temperature increases. Therefore, when the engine temperature is low, resistance will be high.

When the engine coolant is below a predetermined temperature, the engine performance and the vehicle's driveability would suffer if the transmission were shifted into overdrive or the converter clutch were locked-up. The engine ECM monitors coolant temperature and prevents the transmission from upshifting into overdrive and lock-up until the coolant has reached a predetermined temperature. This temperature will vary from 122°F to 162°F depending on the transmission and vehicle model.

Some models cancel upshifts to third gear at lower temperatures. This information is found in the appendix, ECT Diagnostic Information chart, under the column heading “O/D Cancel Temp”. The temperature in parenthesis is the temperature to which third gear is restricted.

Engine Coolant Temperature Sensor

Coolant temperature is monitored by the engine ECM which controls the signal to O/D1 of the ECM to cancel overdrive.

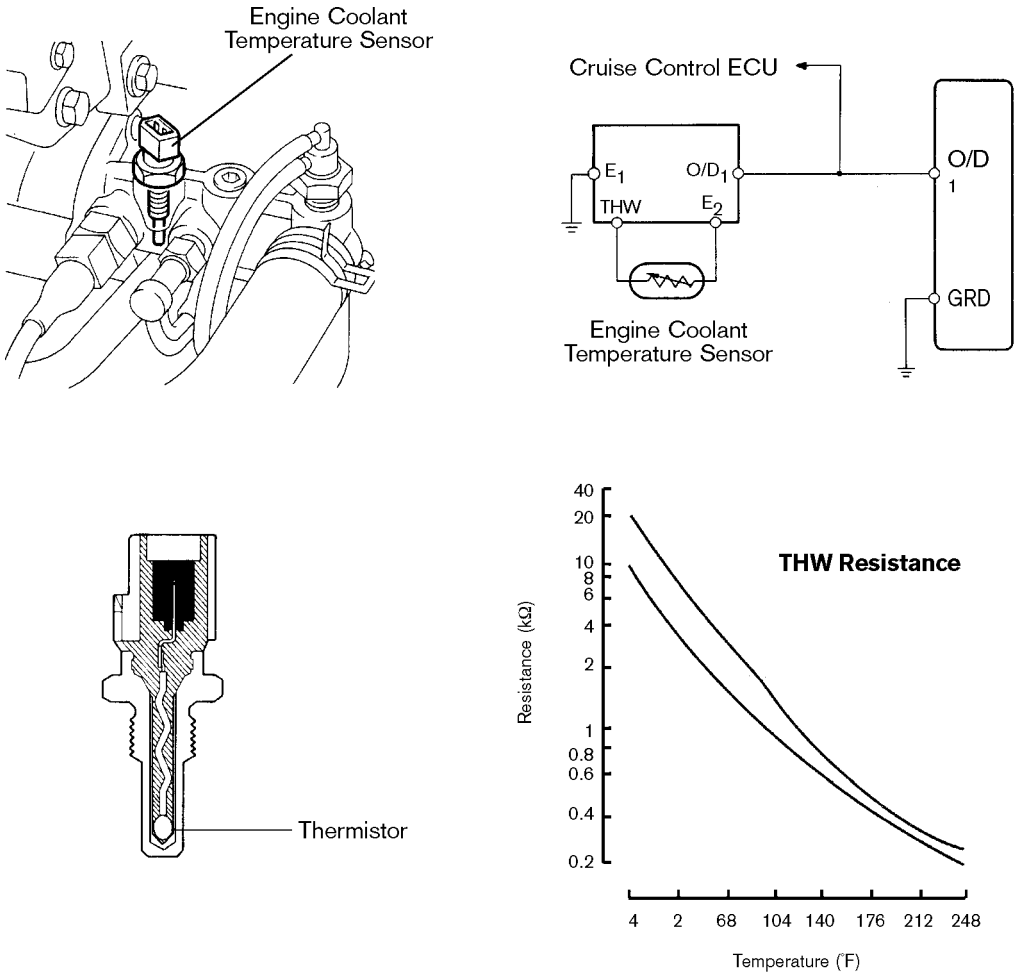


Fig. 4-12
T273f107/T273f108
T273f109/T273f110

Speed Sensors

The speed sensor in an ECT transmission is used in place of governor pressure in the conventional hydraulically controlled transmission. Lock up converter operation and transmission shifting are based on vehicle speed and throttle position.

The speed sensor signal originates from a sensor measuring transmission/transaxle output speed or wheel speed. Different types of sensors have been used depending on models and applications. On some vehicles, the vehicle speed sensor signal is processed in the combination meter and then sent to the ECM.

Pickup Coil (Variable Reluctance) Type

This speed sensor consists of a permanent magnet, yoke and coil. The sensor is mounted close to a toothed gear. As each tooth moves by the sensor, an AC voltage pulse is induced in the coil. Each tooth produces a pulse. As the gear rotates faster more pulses are produced. The ECM determines the speed the component is revolving based on the number of pulses.

Speed Sensors

In ECT transmissions, speed sensors are used in place of the governor valve.

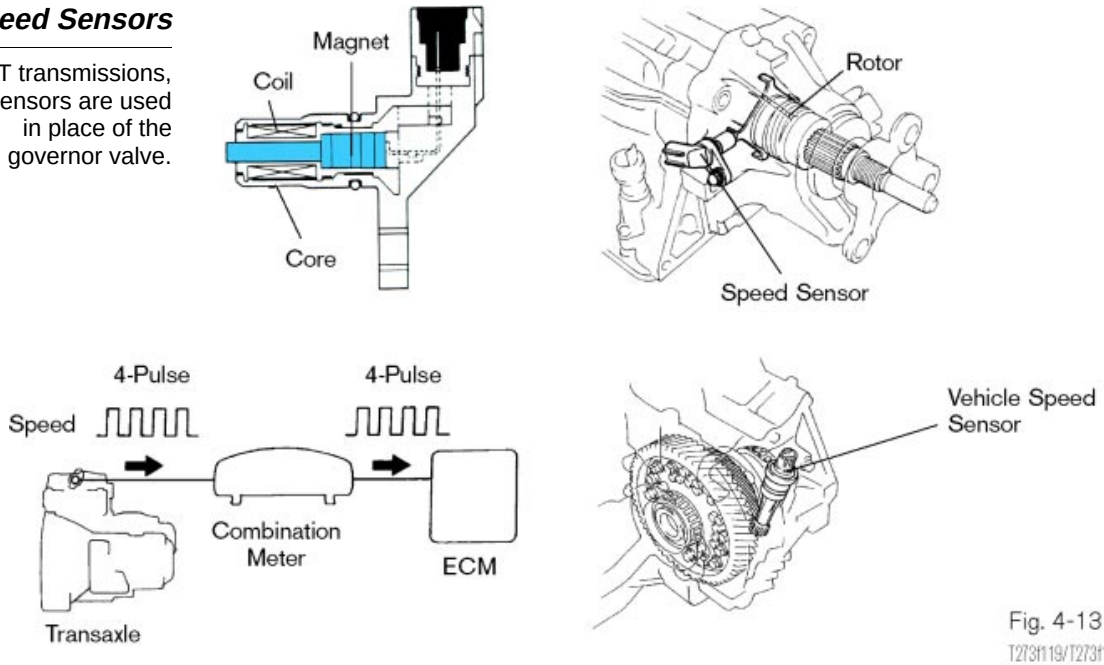


Fig. 4-13
T273I119/T273I113
T273I114/T273I115

The distance between the rotor pickup coil is critical. The further apart they are, the weaker the signal.

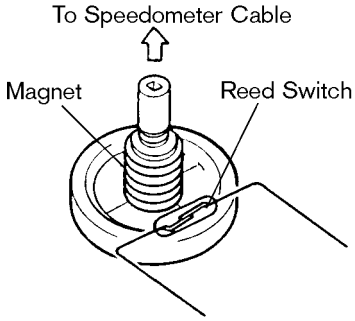
Reed Switch Type

The reed switch type is driven by the speedometer cable. The main components are a magnet, reed switch, and the speedometer cable. As the magnet revolves the reed switch contacts open and close four times per revolution. The action produces 4 pulses per revolution. From the

number of pulses put out by the speed sensor, the combination meter/ECM is able to determine vehicle speed.

Reed Switch Type Speed Sensor

As the magnet revolves the reed switch contacts open and close four times per revolution.



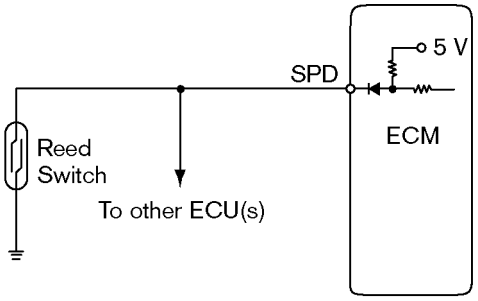


Fig. 4-14
T273f241/T273f267

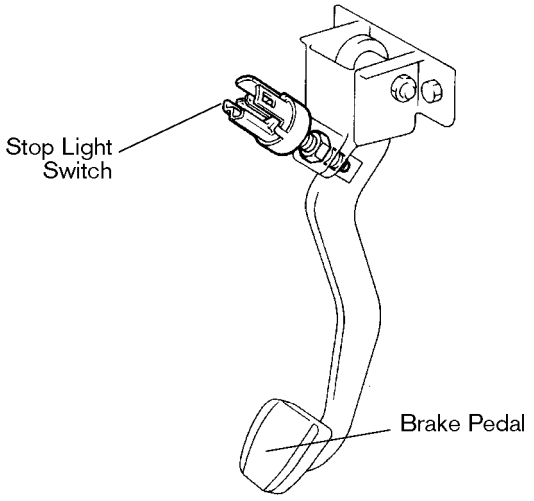
Stop Light Switch

The stop light switch is mounted on the brake pedal bracket. When the brake pedal is depressed, it sends a signal to the STP terminal of the ECM informing it that the brakes have been applied.

Stop Light Switch

The ECM Cancels torque converter lock-up and neutral-to-drive squat control based on stop light switch.

Brake Pedal	STP Terminal Voltage
Depressed	12V
Released	0V



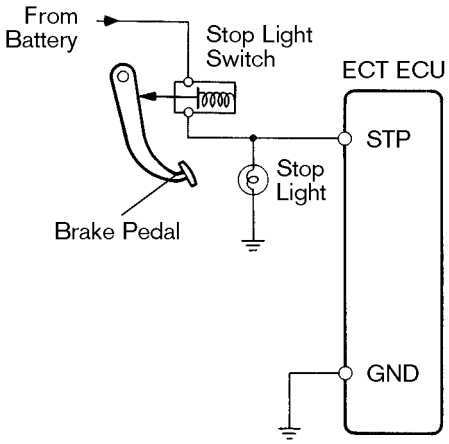


Fig. 4-15
T273f116/T273f117

The ECM cancels torque converter lock-up when the brake pedal is depressed. It also cancels "N" to "D" squat control when the brake pedal is not depressed and the gear selector is shifted from neutral to drive.

Overdrive Main Switch

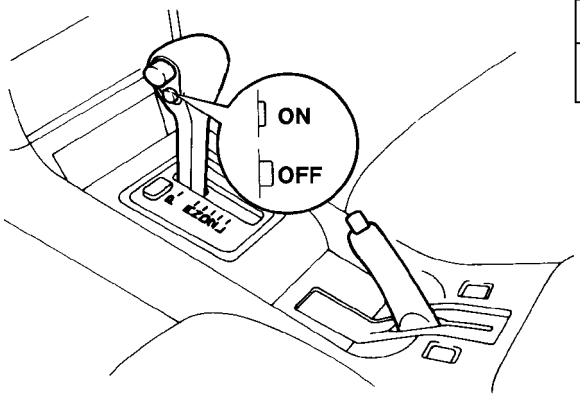
The overdrive main switch is located on the gear selector. It allows the driver to manually control overdrive. When it is turned on, the transmission can shift into overdrive. When it is turned off, the transmission is prevented from shifting into overdrive.

Locking Type O/D Main Switch

The locking type O/D main switch maintains its set position when selected. When the switch is in the off position, overdrive will be locked out until the switch is placed in the ON position. When the O/D switch is in the ON position, the electrical contacts are actually open and current from the battery voltage is available at the O/D2 terminal of the ECM as shown below.

Overdrive Main Switch

Allows driver to manually control overdrive.



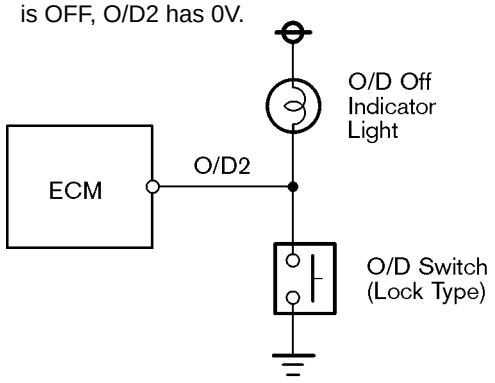
	O/D Main Switch	
	ON	OFF
Contacts of O/D Main Switch	Open	Closed
O/D Gear	Enabled	Disabled
O/D OFF Indicator Light	OFF	ON

Fig. 4-16
T273f118

When the O/D switch is in the OFF position, the electrical contacts are actually closed and current from the battery flows to ground and 0 volts are present at the O/D2 terminal and the O/D OFF indicator is illuminated.

Locking Type O/D Main Switch Circuit

When the O/D main switch is ON, O/D2 terminal has 12V. When O/D main switch is OFF, O/D2 has 0V.



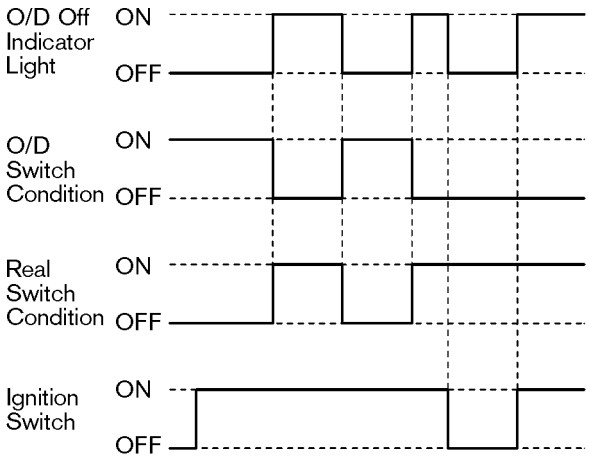


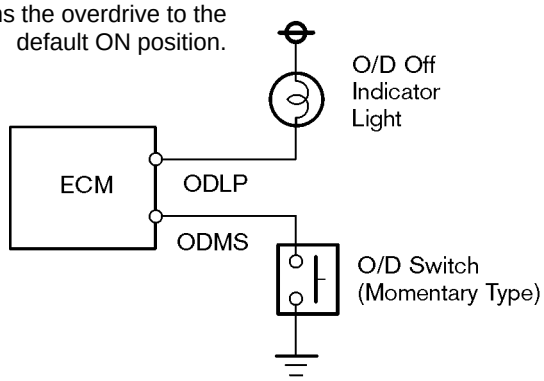
Fig. 4-17
T273f121/T273f122

Momentary Type O/D Main Switch

A new type O/D switch has been implemented as new models are introduced beginning with the 2000 model year. The switch is input directly to the ECM and the O/D solenoid is controlled by the ECM. Pressing the switch once turns the O/D OFF while pressing the switch a second time turns it ON. When the O/D is OFF, cycling the ignition switch from OFF to ON turns the overdrive to the default ON position.

Momentary O/D Switch

When the O/D is OFF, cycling the ignition switch from OFF to ON turns the overdrive to the default ON position.



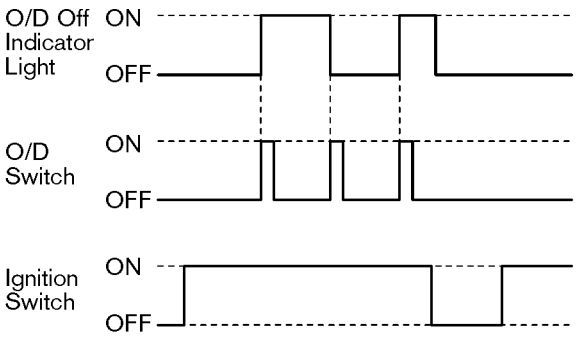


Fig. 4-18
T273f120

Transmission Sport Shift System

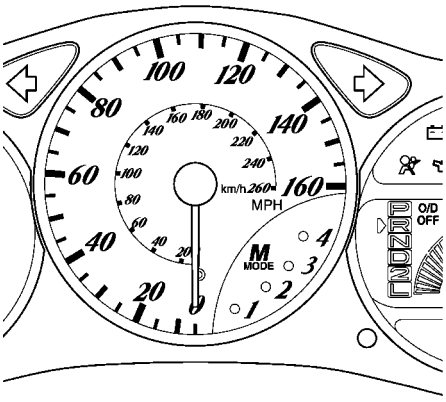
The sport shift feature, starting with the 2000 Celica, allows the driver to manually upshift and downshift by operating the shift switches located on the steering wheel. There are two pairs of switches located on either side of the steering wheel. The two DOWN switches are located on the front of the wheel, and the two UP switches are located on the back side of the wheel.

To enable the use of the shift switches, the gear selector must be placed in the “M” position. A gear position indicator located on the combination meter illuminates the gear position. The only automatic function while in the “M” position will be to downshift to first gear when the vehicle comes to a stop.

The “M” indicator light flashes if the transmission fluid is too hot or too cold when the gear selector is moved to the “M” position. If it continues to flash after the fluid has normalized, check for DTC PO710, which is the ATF Temperature Sensor or it’s circuit.

Sport Shift System

The Sport switch must be closed before the engine ECM permits the shift switch to control shifting.



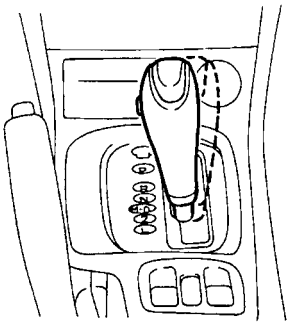


Fig. 4-19
T273f123/T273f135
T273f136

Solenoid Valves

Solenoid valves are electro-mechanical devices which control hydraulic circuits by opening a drain for pressurized hydraulic fluid. Solenoid valves control gear shift timing, torque converter lock-up control, throttle pressure control, and accumulator back pressure control.

Shift Solenoid Valves (No. 1 and No. 2)

These solenoid valves are mounted on the valve body and are turned on and off by electrical signals from the ECM, causing various hydraulic circuits to be switched as necessary. By controlling the two solenoids' on and off sequences, we are able to control four forward gear ranges.

Solenoid Valves

Solenoids provide electrical control over shifting, torque converter lock-up, and pressure control.

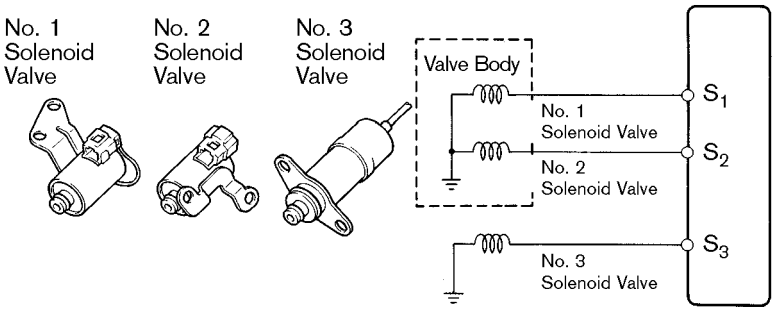


Fig. 4-20
T273f1124

The No. 1 and No. 2 solenoids are normally closed. The plunger is spring-loaded to the closed position, and when energized the plunger is pulled up, allowing line pressure fluid to drain. The operation of these solenoids by the ECM is described on pages 4-20 to 4-23 of this book.

Lock-Up Control Solenoid Valve (No. 3 or SL)

The Lock-up Control Solenoid Valve is mounted on the transmission exterior or valve body. It controls line pressure which affects the operation of the torque converter lock-up system. This solenoid is either a normally open or normally closed solenoid. The A-340E, A-340H, A-540E and A-540H transmissions use the normally open solenoid.

Accumulator Back Pressure Control Solenoid Valve (SLN)

The accumulator back pressure control solenoid (SLN) is controlled by the ECM to temporarily lower the accumulator back pressure to ensure a smooth shift. The ECM controls the duty cycle based on shift select mode (normal or power), throttle valve opening, direct clutch drum speed and vehicle speed. For example, if vehicle speed is low and throttle opening is large, accumulator back pressure should be higher to prevent slippage. Additionally, if the speed difference between the direct clutch drum and the vehicle was higher than the parameters of the ECU, accumulator back pressure should increase to reduce slippage.

Line Pressure Control Solenoid Valve

The line pressure control solenoid valve (SLT) is found on '93.5 and later Supras and '98 and later Land Cruisers. Beginning in the 2000 model year, Echo, Celica, and Tundra also include the SLT solenoid. The solenoid receives a duty cycle signal from the ECM based on throttle position sensor input and O/D direct clutch speed. It provides throttle pressure to the primary regulator valve to precisely control line pressure to ensure smooth shift characteristics.

Line Pressure Control Solenoid

The solenoid provides throttle pressure to the primary regulator valve to precisely control line pressure to ensure smooth shift characteristics.

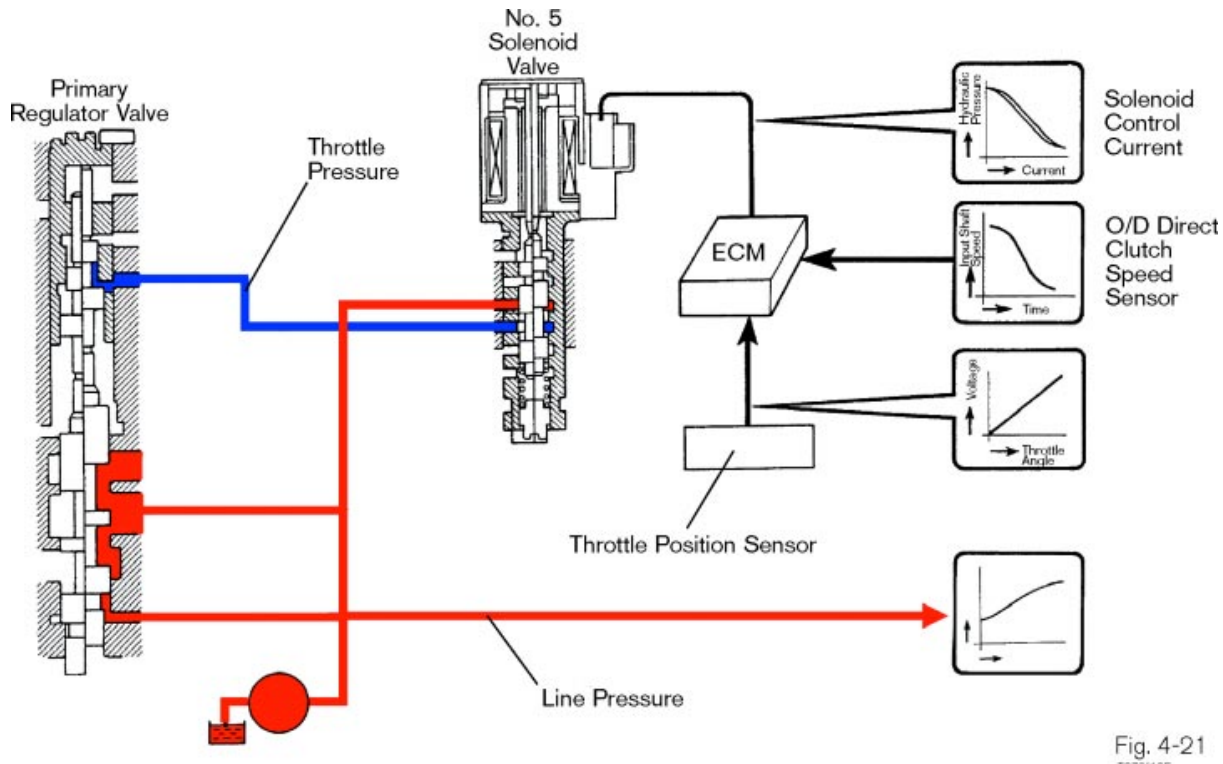


Fig. 4-21
T273I125

Shift Timing Control

The components which make up this system include:

- O/D Main switch
- O/D Off indicator light
- ECM
- Water temperature sensor
- Cruise control ECM
- No. 1 and No. 2 solenoid valves (shift solenoids)

Overdrive Control System - ECT

When O/D main switch is on,
O/D2 terminal has 12V.

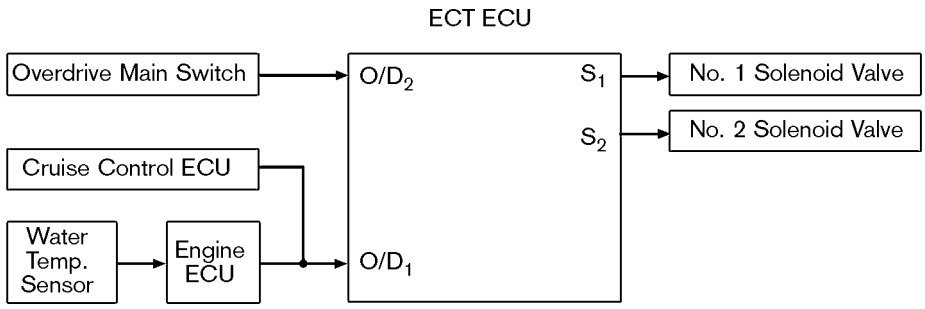


Fig. 4-22
T273f126

The ECM controls No. 1 and No. 2 solenoid valves based on vehicle speed, throttle opening angle and mode select switch position.

The ECM prevents an upshift to overdrive under the following conditions:

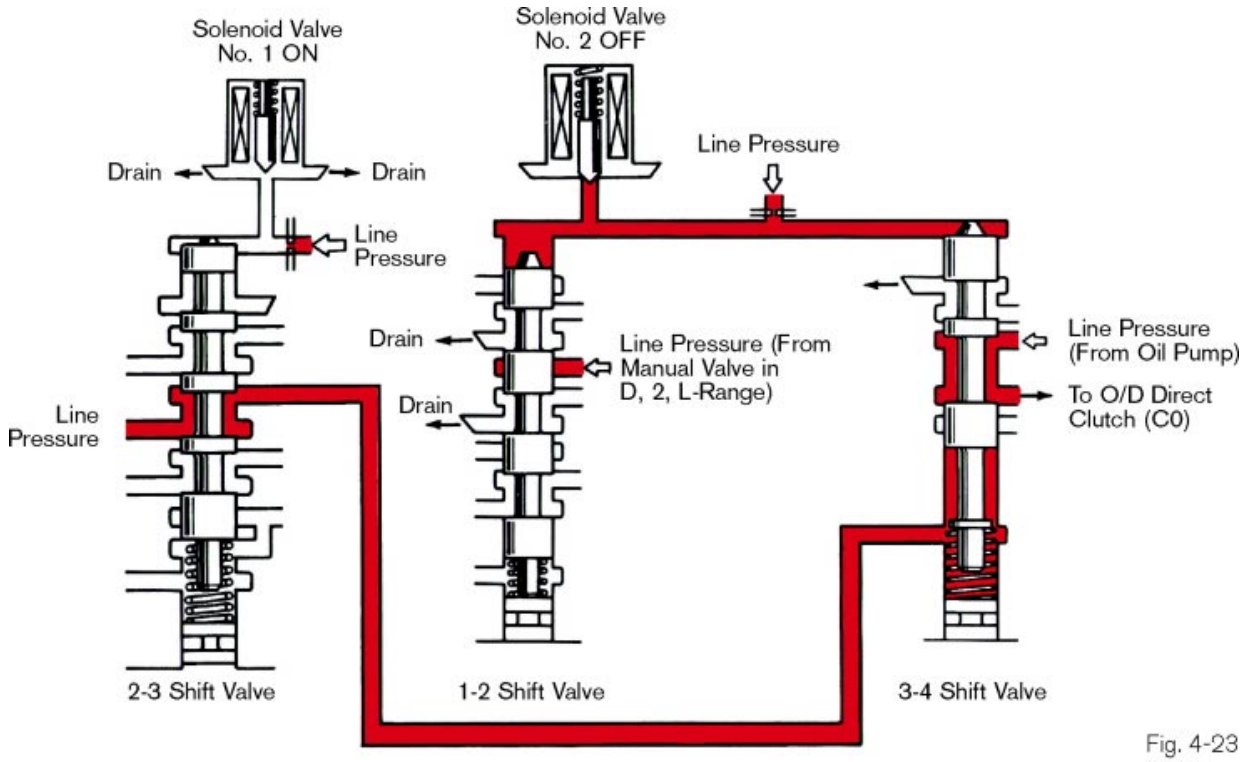
- Water temperature is below 122°F to 146°F.*
- Cruise control speed is 6 mph below set speed.
- O/D main switch is off (contacts closed).

* Consult the specific repair manual or the ECT Diagnostic Information Technician Reference Card for the specific temperature at which overdrive is enabled.

A-Series ECT Shift Valve Operation

Two electrically operated solenoids control the shifting of all forward gears in the Toyota electronic control four speed automatic transmission. These solenoids are controlled by an ECM which uses throttle position and speed sensor input to determine when the solenoids are turned on. The solenoids normal position is closed, but when it is turned on it opens to drain fluid from the hydraulic circuit. Solenoid No. 1 controls the 2-3 shift valve. It is located between the manual valve and the top of the 2-3 shift valve. Solenoid No. 2 controls the 1-2 shift valve and the 3-4 shift valve.

Shift Solenoid Operation ECT - First Gear



First Gear

During first gear operation, solenoid No. 1 is ON and solenoid No. 2 is OFF. With line pressure drained from the top of the 2-3 shift valve by solenoid No. 1, spring tension at the base of the valve pushes it upward. With the shift valve up, line pressure flows from the manual valve through the 2-3 shift valve and on to the base of the 3-4 shift valve.

With solenoid No. 2 OFF, line pressure pushes the 1-2 shift valve down. In this position, the 1-2 shift valve blocks line pressure from the manual valve. Line pressure and spring tension at the base of the 3-4 shift valve push it upward.

Second Gear During second gear operation, solenoid No. 1 and No. 2 are ON. Solenoid No. 1 has the same effect that it had in first gear with the 2-3 shift valve being held up by the spring at its base. Pressure from the manual valve flows through the 2-3 shift valve and holds the 3-4 shift valve up.

With solenoid No. 2 ON, line pressure from the top of the 1-2 shift valve bleeds through the solenoid. Spring tension at the base of the 1-2 shift valve pushes it upward. Line pressure which was blocked, now is directed to the *second brake* (B2), causing second gear. The 3-4 shift valve maintains its position with line pressure from the 2-3 shift valve holding it up.

Shift Solenoid Operation ECT - Second Gear

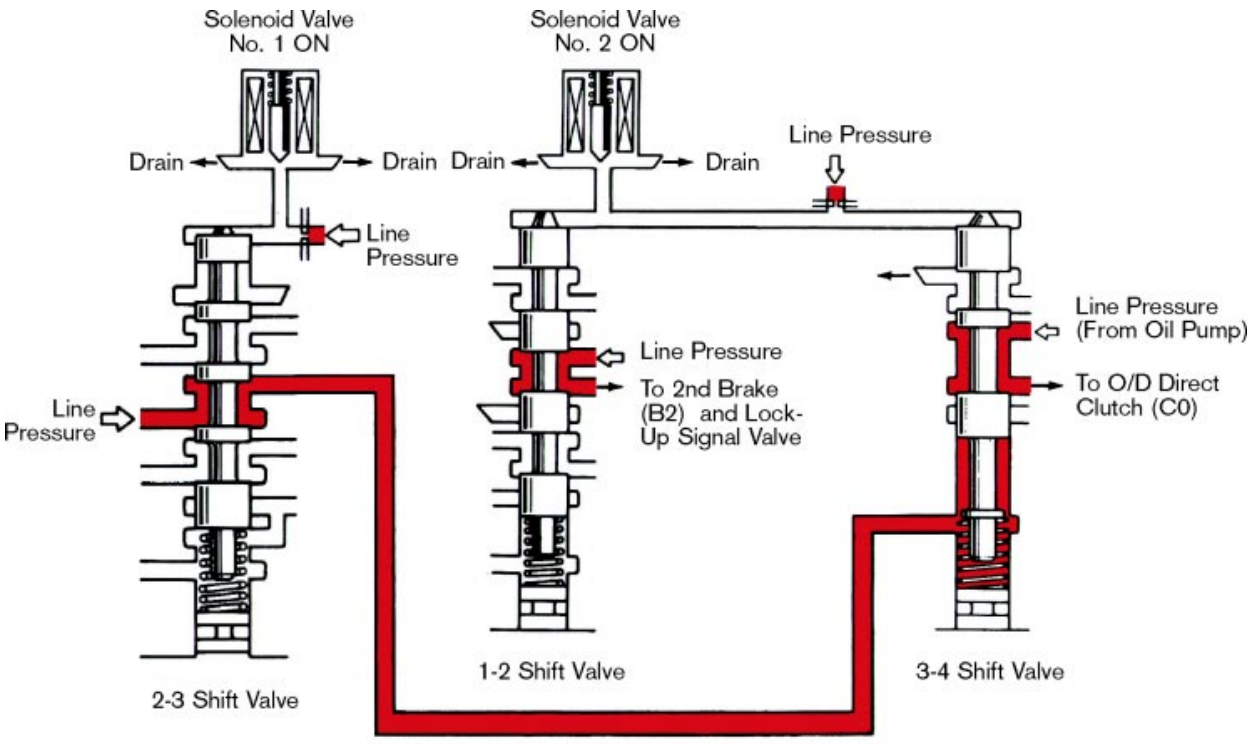


Fig. 4-24
T2731201

Third Gear During third gear operation, solenoid No. 1 is OFF and Solenoid No. 2 is ON. When solenoid No. 1 is OFF, it closes its drain and line pressure from the manual valve pushes the 2-3 shift valve down. Line pressure from the manual valve is directed to the *direct clutch* (C2) and to the base of the 1-2 shift valve.

With solenoid No. 2 ON, it has the same effect that it had in second gear; pressure is bled at the top of the 1-2 shift valve and spring tension pushes it up. Line pressure is directed to the second brake (B2). However in third gear, the *second brake* (B2) has no effect since it holds the *No. 1 one-way clutch* (F1) and freewheels in the clockwise direction. The *2nd coast brake* (B1) is ready in the event of a downshift when the overdrive *direct clutch* (C2) is released.

Shift Solenoid Operation ECT - Third Gear

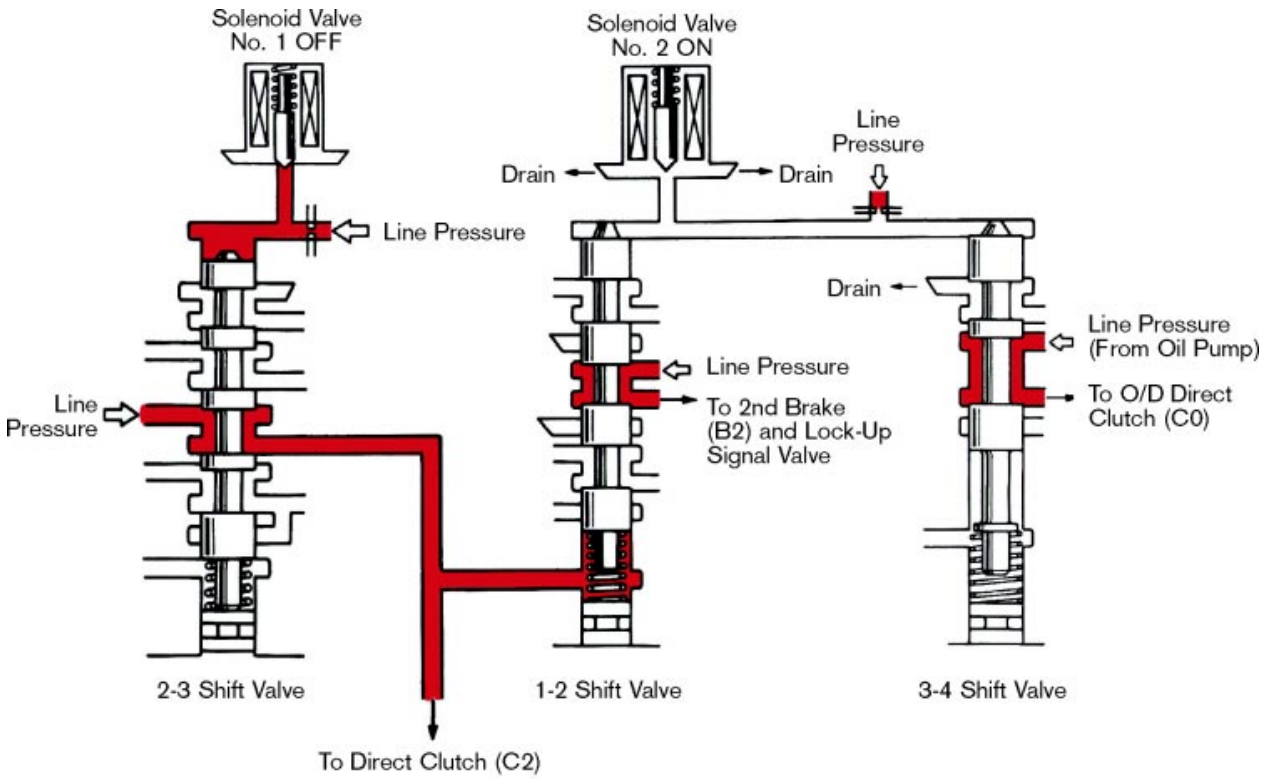


Fig. 4-25
T273f202

Fourth Gear

During fourth gear operation, both solenoids are OFF. When solenoid No. 1 is OFF, its operation is the same as in second and third gears. Line pressure holds the 2-3 shift valve down. Line pressure is maintained to the *direct clutch* (C2) and to the base of the 1-2 shift valve. Spring tension and line pressure at the base of the 1-2 shift valve holds the valve in the 2nd gear position.

When solenoid No. 2 is OFF, line pressure builds in the circuit, pushing the 3-4 shift valve down. Line pressure is directed to the *O/D Brake* (B0) and exposing the *O/D Direct Clutch* (C0) circuit to a drain.

Shift Solenoid Operation ECT - Fourth Gear

When solenoid No. 2 is OFF, line pressure builds in the circuit, pushing the 3-4 shift valve down. Line pressure is directed to the O/D Brake (B0) and exposing the O/D Direct Clutch (C0) circuit to a drain.

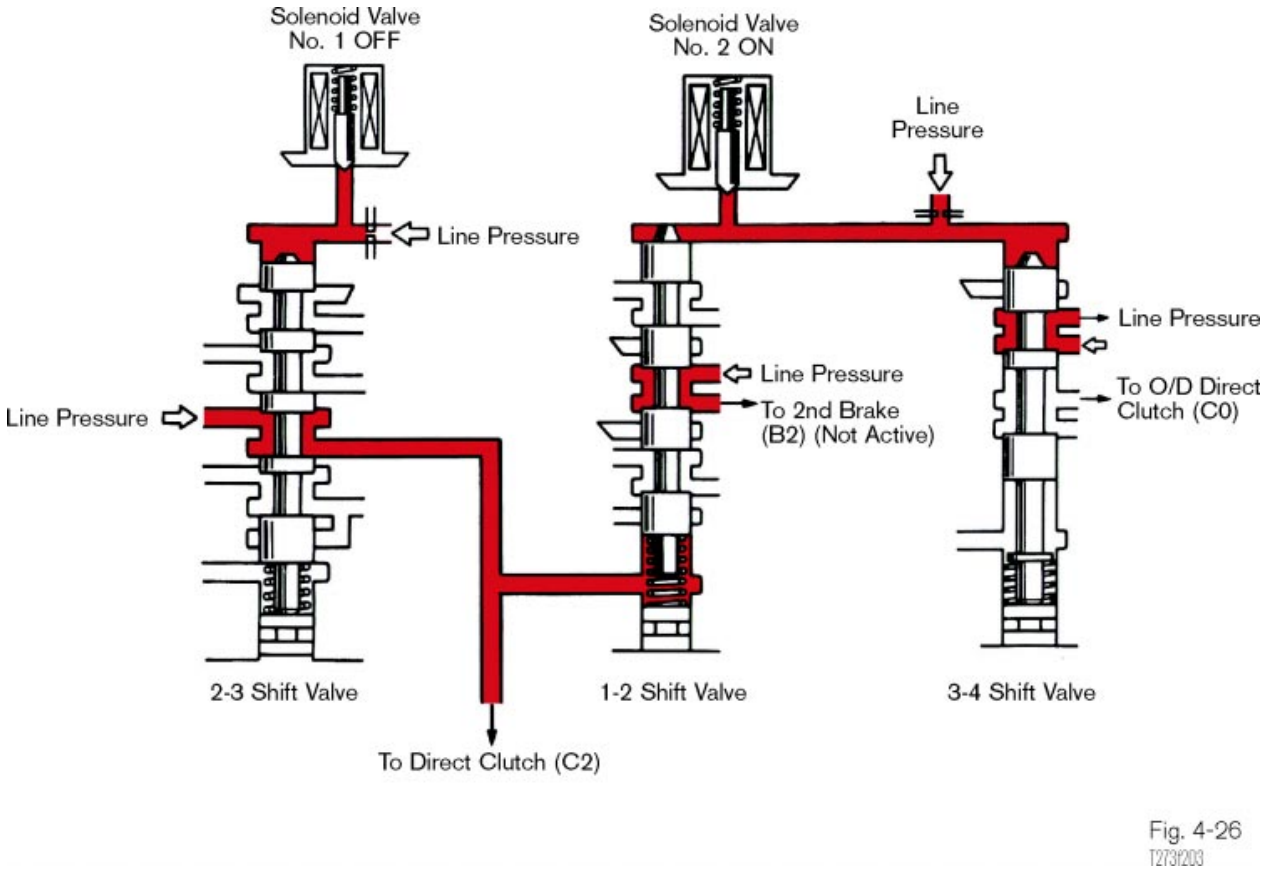


Fig. 4-26
T273f203

U-Series Solenoids

The U-series transmissions have multiple solenoids that control:

- shifting.
- clutch application pressure.
- system line pressure.
- converter lock-up.
- clutch to clutch control.

Solenoids are controlled by the ECM based on:

- engine RPM.
- engine load.
- throttle position.
- ATF temperature.
- input turbine speed sensor.

Linear solenoids regulate hydraulic pressure based on current flow. Current flow is duty cycle controlled from the ECM. The longer the ON cycle, the higher the current flow and the lower the hydraulic pressure.

ON/OFF solenoids control hydraulic circuits by opening or closing the circuit. They do not vary the pressure like the linear solenoids. They are spring loaded in the closed position, exposing a drain to the controlled circuit and when energized will open the controlled circuit to line pressure.

U-Series Solenoid Operation

The Linear solenoids regulate hydraulic pressure based on current flow. ON/OFF solenoids control hydraulic circuits by opening or closing the circuit.

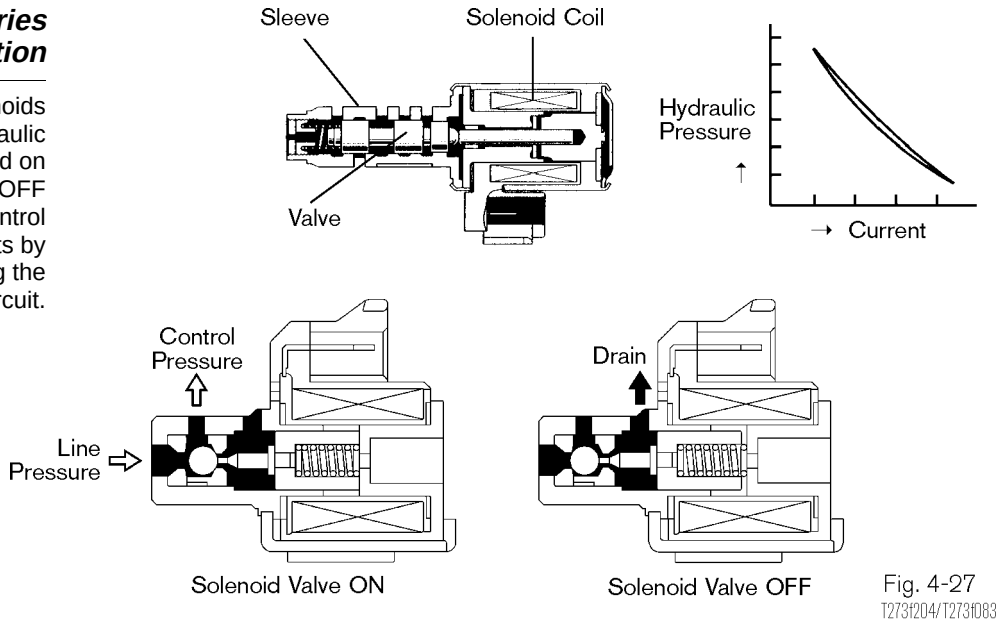


Fig. 4-27
T2731204/T2731083
T2731081/T2731085

U-240E Solenoid Operation

The U-240E transaxle uses five solenoids to control line pressure, converter lock-up and transmission shifting. Three solenoids are linear controlled to regulate pressure and two are ON/OFF solenoids which apply or release line pressure. Linear valves regulate hydraulic pressure based on current flow. Current flow is duty cycle controlled from the ECM. The longer the ON cycle, the higher the current flow and the lower the hydraulic pressure. The ECU monitors the input turbine speed and the counter gear speed to detect the timing of the shift as well as any slipping that might occur.

U-240E Solenoids

The U-240 series transaxle uses five solenoids to control line pressure, converter lockup and transmission shifting.

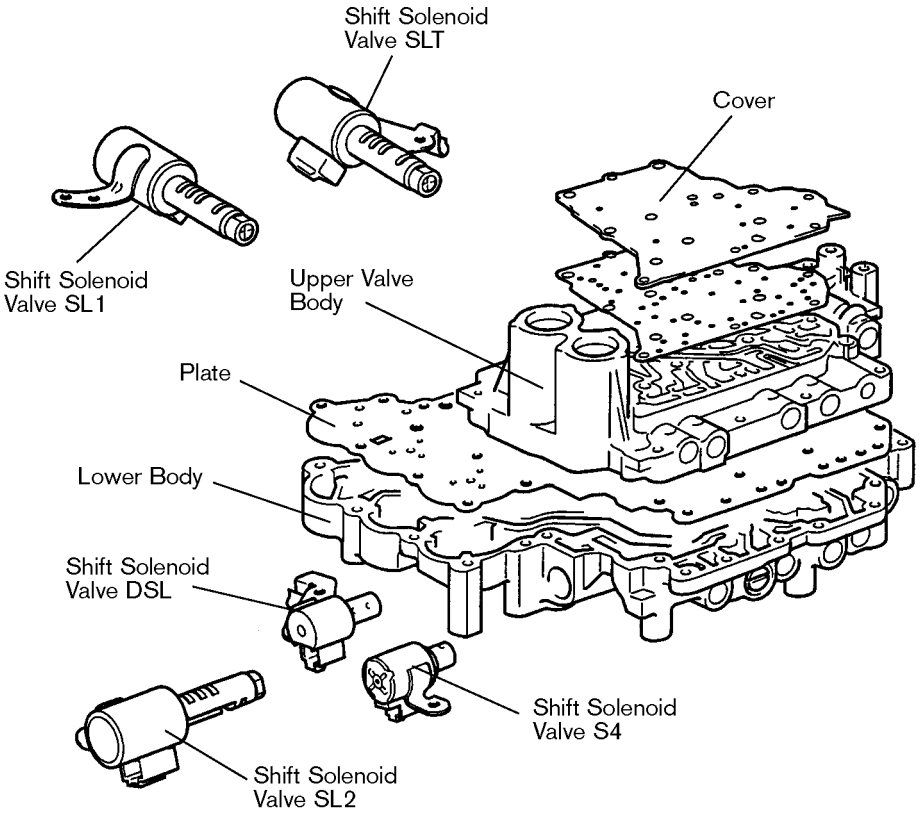


Fig. 4-28
T273f205

SL1 & SL2 - Shift Timing

Solenoids SL1 & SL2 are linear solenoids which control shifting of the transmission. The linear design also provides a means of controlling pressure to more closely tailor clutch application. Because the applied pressure is directly regulated by the solenoid, there is no need to provide back pressure to the B1 and C2 accumulators.

The B1 Control Valve is located between SL1 and the *second brake* (B1). SL1 controls the B1 Control Valve which meters line pressure to B1. When the solenoid is ON, as in first gear, the B1 Control Valve opens a drain for the *second brake* (B1). When the solenoid is OFF, line pressure is metered to B1 through the B1 Control Valve.

SL1 and SL2 Operation

Solenoid SL1 controls the B1 Control Valve which controls line pressure to the second brake (B1).

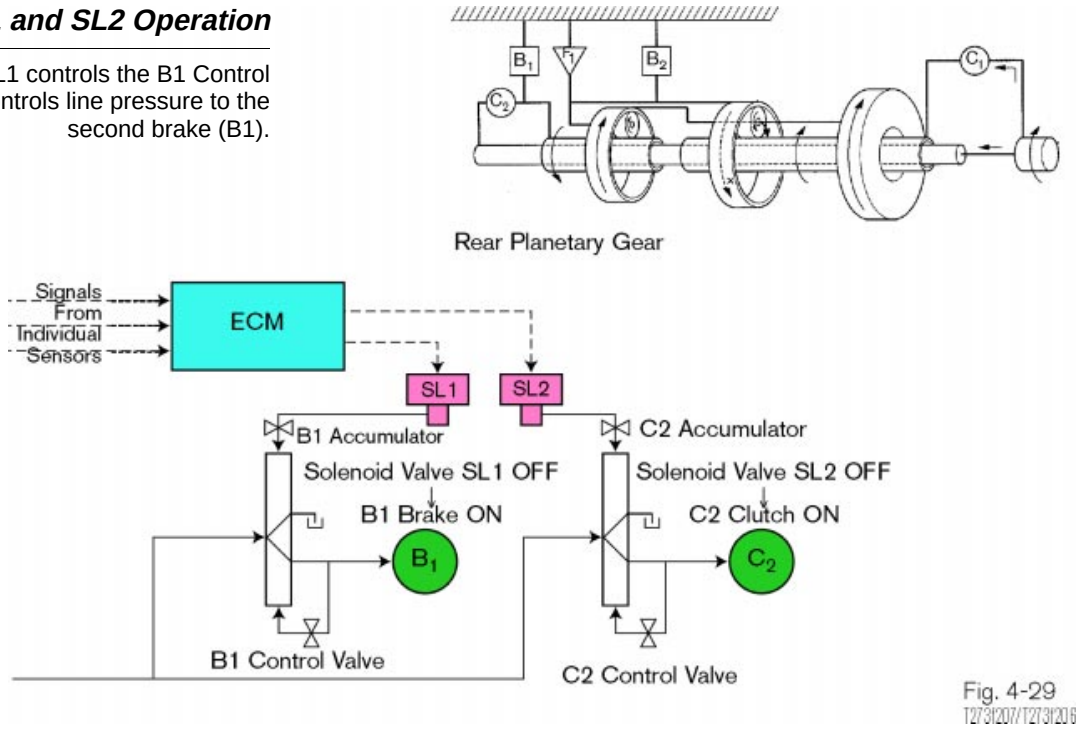


Fig. 4-29
T2731207/T2731206

The *second brake* (B1) and the *direct clutch* (C2) both control the rear planetary sun gear. The shift from second gear to third requires the application of one holding device while the other is released. In an upshift to third gear, C2 connects the intermediate shaft to the sun gear while B1 releases the sun gear from the transmission case.

The C2 Control Valve is located between SL2 and the *direct clutch* (C2). Solenoid SL2 controls the C2 Control Valve which regulates line pressure to C2. When SL2 is ON, as in second gear, the C2 Control Valve opens a drain for C2. When the solenoid is OFF, the control valve moves up and line pressure is metered to C2 and it is engaged for third gear. Because B1 and C2 are attached to the same planetary component, it makes this shift critical as B1 must be released as C2 is applied for the upshift to third gear, or the transmission will slip and engine speed will flare.

The ECM monitors the shift via inputs from engine rpm and vehicle speed. It is capable of tailoring SL1 and SL2 to control the transition from 2nd to 3rd gears.

S4 Solenoid

Solenoid S4 is an ON/OFF solenoid that controls the 3-4 upshift. The *underdrive direct clutch* (C3) and *underdrive brake* (B3) both control the underdrive sun gear. B3 connects the sun gear to the case so there is a gear reduction through the underdrive unit in all gears except fourth gear. C3 connects the sun gear to the planetary carrier to provide direct drive through the underdrive unit in fourth gear. When the upshift to fourth gear occurs, C3 is applied while B3 is released through the action of the 3-4 shift valve.

The 3-4 shift valve is spring loaded to allow B3 to be applied and C3 to be released. When the S4 solenoid is turned ON, line pressure forces the 3-4 shift valve to compress the spring applying C3 and releasing B3.

S4 Operation

When the S4 solenoid is turned ON, line pressure forces the 3-4 shift valve to compress the spring applying C3 and releasing B3.

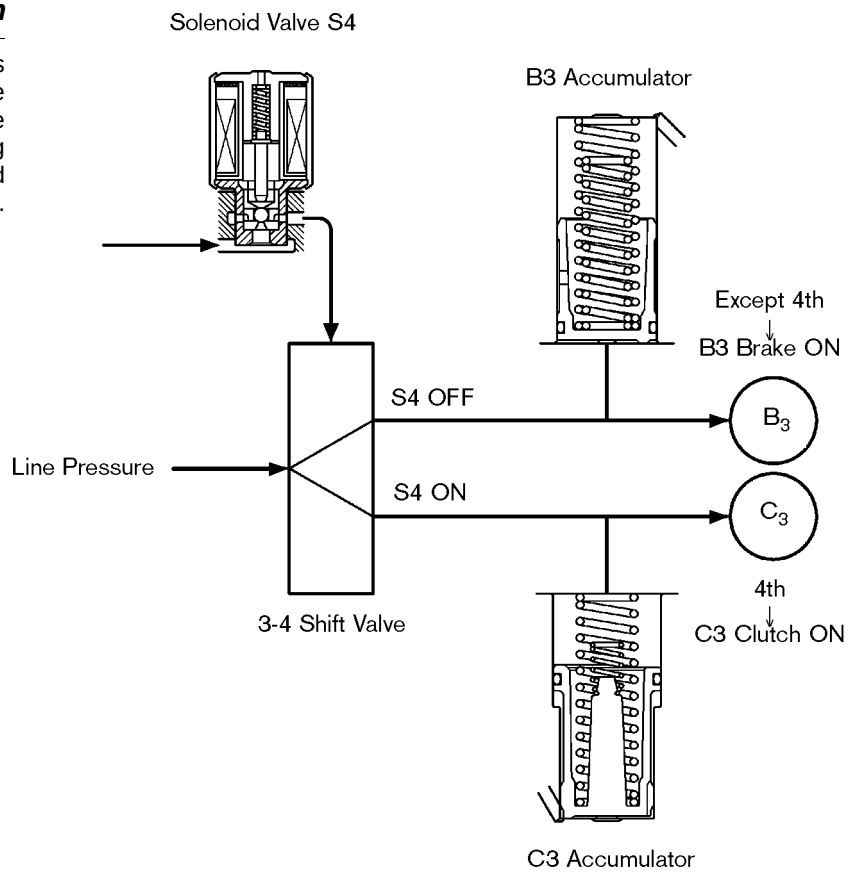


Fig. 4-30
T273f208

DSL Solenoid

The DSL solenoid is an ON/OFF solenoid used to control the *first and reverse brake* (B2) which is applied in reverse and low gear only. The C2 lock valve and B2 control valve are located between the DSL solenoid and B2. Line pressure from the manual valve in low and reverse is controlled by the B2 control valve.

Reverse In reverse gear, C2 and B2 are applied. The B2 control valve is spring loaded pushing the valve upward exposing pressure from the manual valve to apply B2.

Low In low gear, B2 is applied in parallel with F1 to provide engine braking. The C2 lock valve controls the application of B2 when low is selected. The lock valve is pushed down allowing DSL controlled pressure to push the B2 control valve down. In this position, pressure from the manual valve applies B2 for low gear.

Lock-Up The lock-up relay valve is spring loaded in the lock-up off position where secondary pressure is directed to the lock-up off chamber in front of the torque converter lock-up clutch. Line pressure holds the C2 lock valve down until C2 is applied in third and fourth gear. When the C2 lock valve moves up, it opens the passage from the DSL solenoid to the base of the lock-up relay valve. At the appropriate speed the ECM turns the DSL solenoid on to push up on the lock up relay valve. Secondary pressure is directed to the lock-up on chamber applying the lock-up clutch.

B2 and Lock-Up Control

The DSL solenoid is an ON/OFF solenoid used to control the first and reverse brake (B2) and lock-up clutch operation.

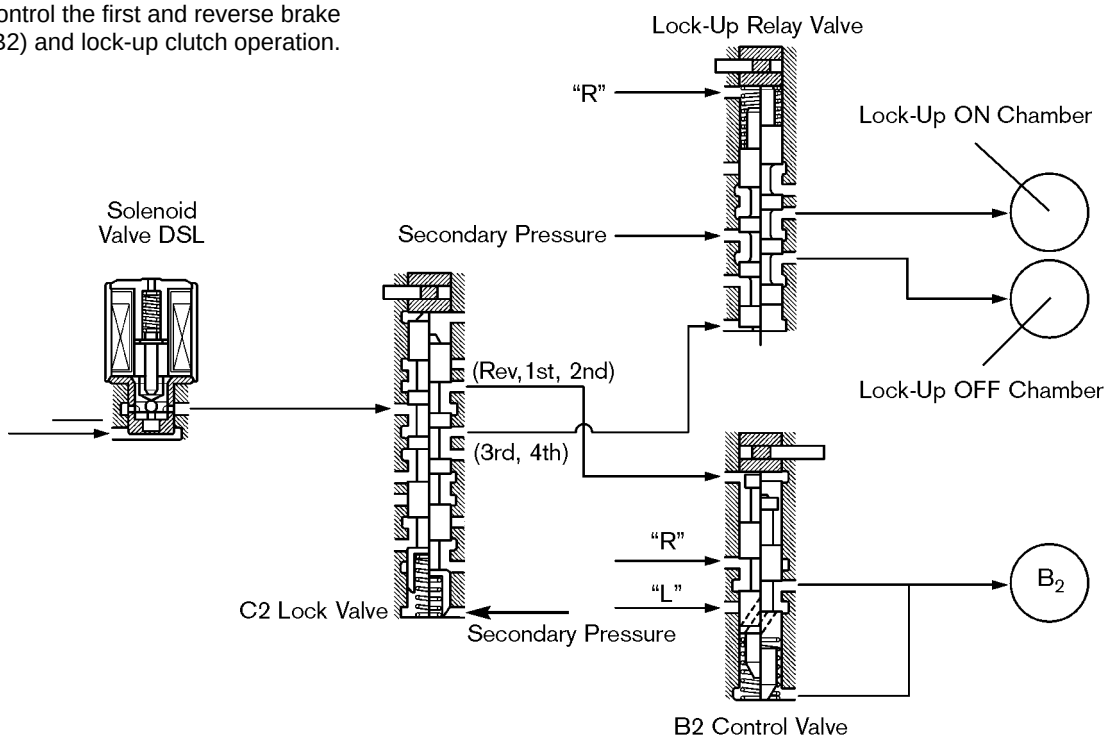


Fig. 4-31
T273f209

U-341E Solenoid Operation

The U-341E transaxle uses five solenoids to control line pressure, converter lock-up and transmission shifting. Two solenoids are linear controlled to regulate pressure and three are ON/OFF solenoids which control line pressure. The ECU monitors the input turbine speed and vehicle speed to detect the timing of the shift as well as any slipping that might occur.

U-341E Solenoids

The U-341E transaxle uses five solenoids to control line pressure, converter lockup and transmission shifting.

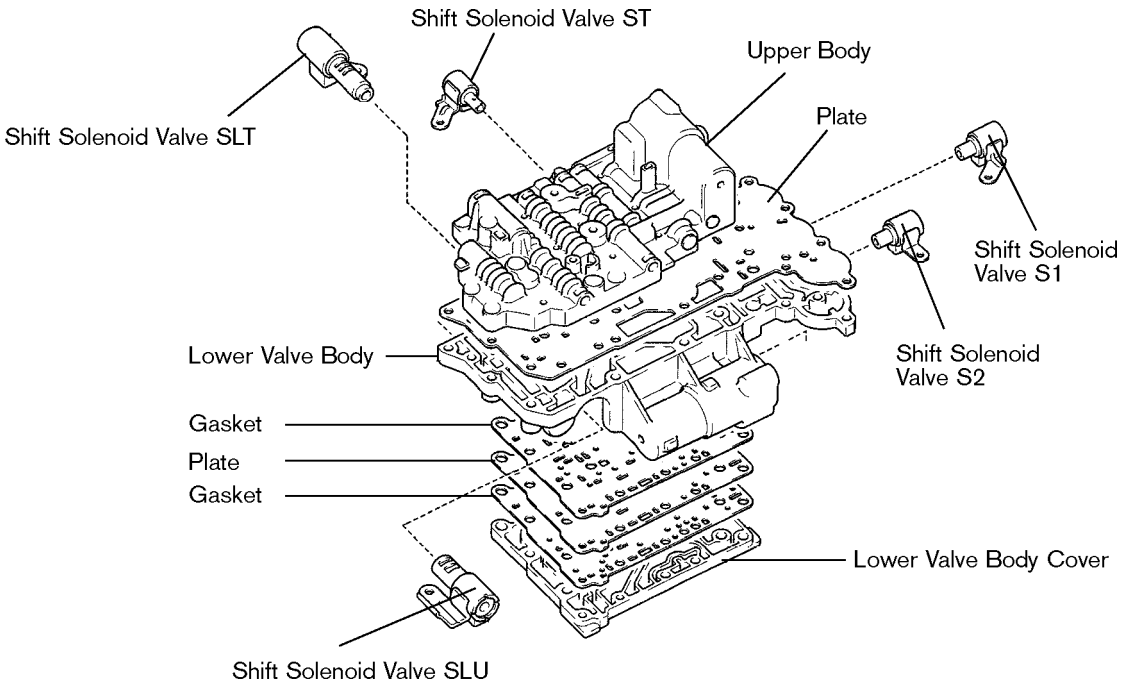


Fig. 4-32
T273f210

Solenoids S1 & S2 are ON/OFF solenoids which control shifting of the transmission. When the gear selector is placed in drive, both solenoids are turned ON. The *forward clutch* (C1) is applied by the manual valve. When solenoid S2 is turned off, the *2nd brake* (B2) is applied for second gear. When S1 is also turned off, the *direct clutch* (C2) is applied locking the planetary gear sets together for direct drive. S2 is turned on for fourth gear, causing the 3-4 shift valve to open a drain for the *forward clutch* (C1) and allow line pressure to apply *overdrive and 2nd brake* (B1).

ST Solenoid

The ST solenoid regulates the shift quality between third and fourth gears. It is an ON/OFF solenoid which controls the release of one clutch and the application of a second clutch.

ST controls shift timing by regulating pressure control through the 3-4 and 4-3 timing valves. Passages to C1 and B1 have an orifice restriction which delays clutch engagement. The timing valve controlled by ST provides a parallel circuit to C1 and B1 which bypass the orifice, providing metered application or release of C1 & B1.

SLT Solenoid

The SLT solenoid is a linear solenoid which regulates the accumulator backpressure for each accumulator to improve shift quality.

ST Solenoid Operation

The O/D & 2nd brake (B1) is applied as the forward clutch (C1) is released.

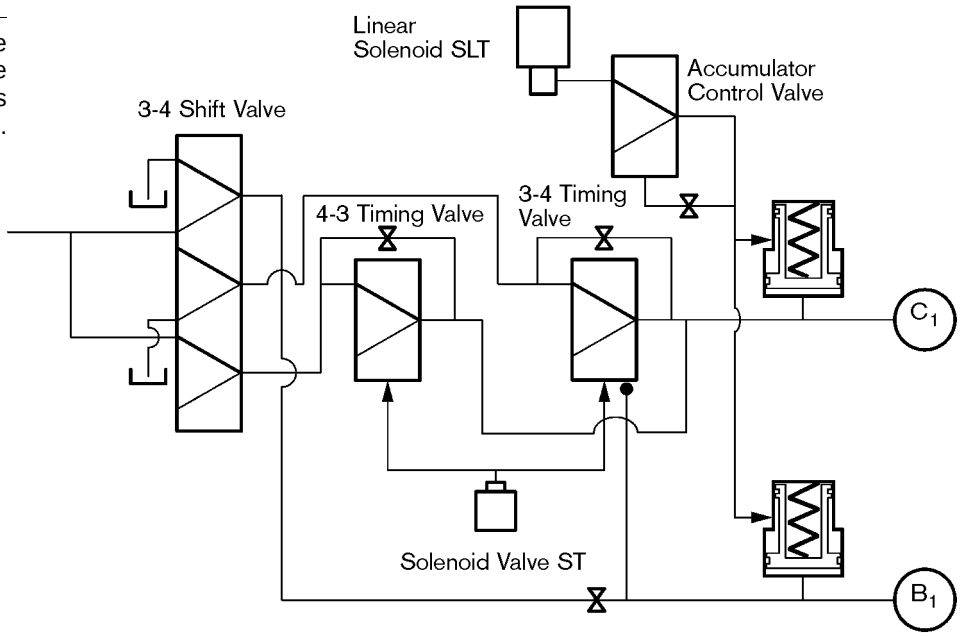


Fig. 4-33
T27312I1

Lock-Up Control

The ECM has lock-up clutch operation pattern for each driving mode (Normal and Power) programmed in its memory. The ECM turns the No. 3 solenoid valve on or off according to vehicle speed and throttle opening signals. The lock-up control valve changes the fluid passages for the converter pressure acting on the torque converter piston to engage or disengage the lock-up clutch.

In order to turn on solenoid valve No. 3 to operate the lock-up system, the following three conditions must exist simultaneously:

- The vehicle is traveling in overdrive.
- Vehicle speed is at or above the specified speed and the throttle opening is at or above the specified value.
- The ECM has received no mandatory lock-up system cancellation signal.

The ECM controls lock-up timing in order to reduce shift shock. If the transmission down-shifts while the lock-up is in operation, the ECM deactivates the lock-up clutch.

Lock-Up Control System - ECT

The EMC monitors multiple sensors to determine torque converter operations.

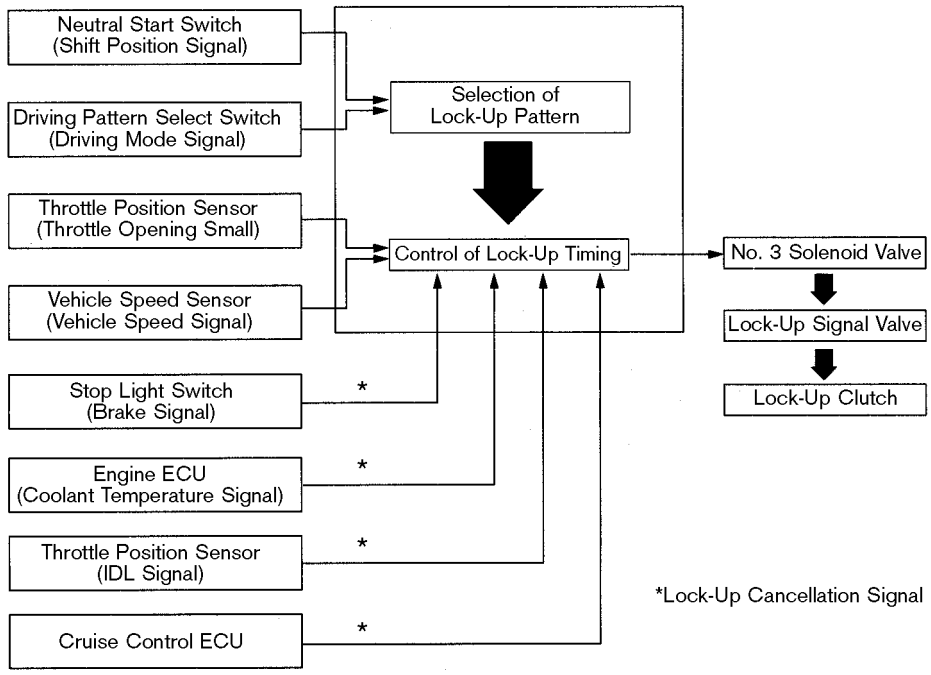


Fig. 4-34
T273f212

The ECM will cancel lock-up if any of the following condition occur:

- The stop light switch comes on.
- The coolant temperature is below 122°F to 145°F depending on the model. (Consult the vehicle repair manual or the ECT Diagnostic Information Technician Reference Card.)
- The IDL contact points of the throttle position sensor close.
- The vehicle speed drops about 6 mph or more below the set speed while the cruise control system is operating.

The stop light switch and IDL contacts are monitored in order to prevent the engine from stalling in the event that the drive wheels lock up during braking. Coolant temperature is monitored to enhance driveability and transmission warm-up. The cruise control monitoring allows the engine to run at higher rpm and gain torque multiplication through the torque converter.

Neutral-to-Drive Squat Control

When the transmission is shifted from the neutral to the drive range, the ECM prevents it from shifting directly into first gear by causing it to shift into second or third gear before it shifts to first gear. It does this in order to reduce shift shock and squatting of the vehicle.

Engine Torque Control

To prevent shifting shock on some models, the ignition timing is retarded temporarily during gear shifting in order to reduce the engine's torque. The TCCS and ECM monitors engine speed signals (NE) and transmission output shaft speed (No. 2 speed sensor) then determines how much to retard the ignition timing based on shift pattern selection and throttle opening angle.