7. Electronic Control System

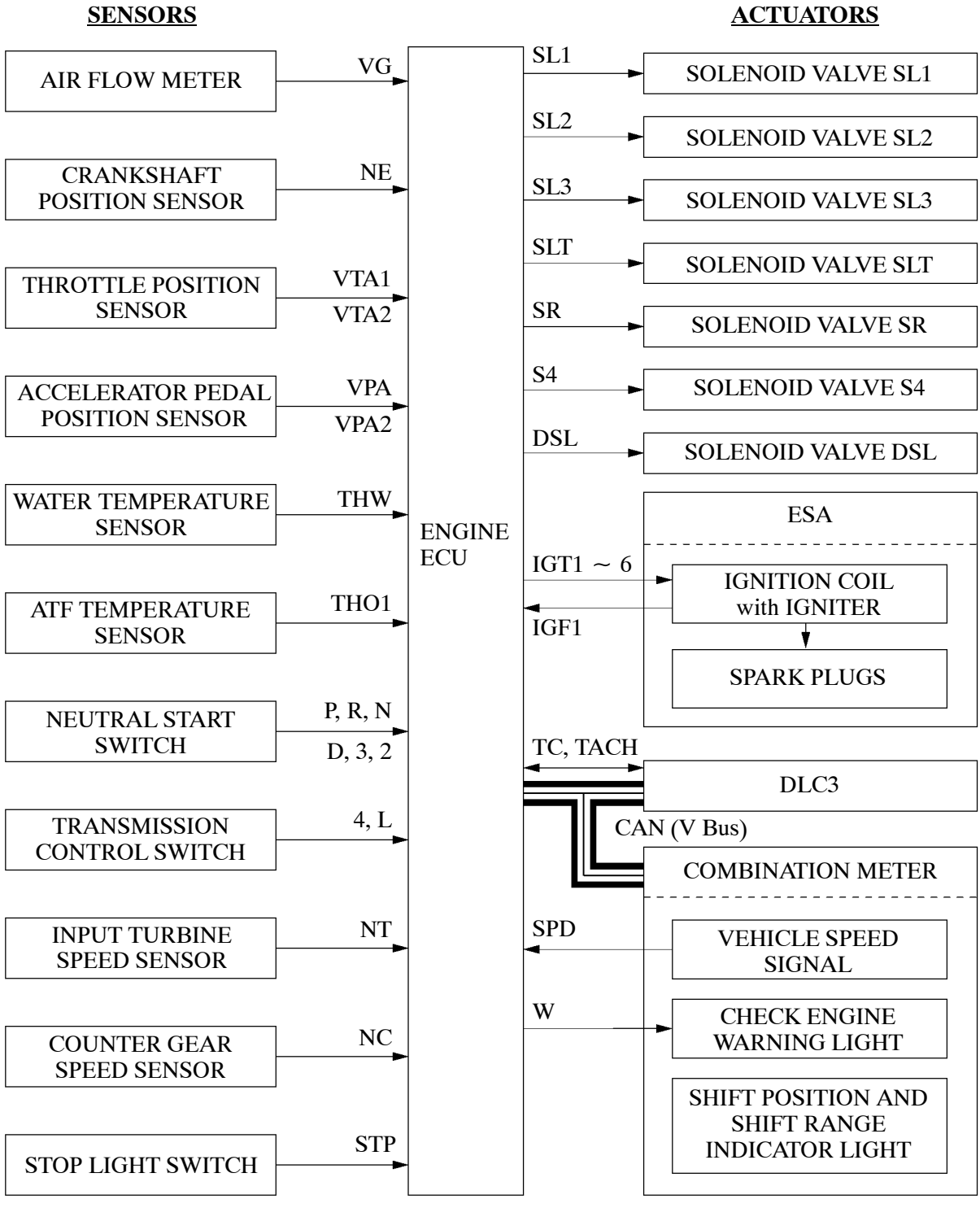
General

The electronic control system of the U151F automatic transaxle consists of the controls listed below.

System	Function
Clutch Pressure Control (See page 125)	● Controls the pressure that is applied directly to B_1 brake, C_0 and C_1 clutches by actuating 3 solenoid valves (SL1, SL2 and SL3) in accordance with engine ECU signals. ● 3 solenoid valves (SL1, SL2 and SL3) minutely controls the clutch pressure in accordance with the engine output and driving conditions.
Line Pressure Optimal Control (See page 126)	Actuates the solenoid valve SLT to control the line pressure in accordance with information from the engine ECU and the operating conditions of the transaxle.
Engine Torque Control	Retards the engine ignition timing temporarily to improve shift feeling during up or down shifting.
Shift Control in Uphill/Downhill Traveling (See page 127)	Controls to restrict the 4th or 5th gear upshift or to provide appropriate engine braking by the engine ECU to determine whether the vehicle is traveling uphill or downhill.
Shift Timing Control	The engine ECU sends current to solenoid valves (SL1, SL2 and/or SL3) based on signals from each sensor and shifts the gear.
Flex Lock-up Clutch Control (See page 128)	Controls the solenoid valves SL2 and DSL, provides an intermediate mode between the ON/OFF operation of the lock-up clutch, and increases the operating range of the lock-up clutch to improve fuel economy.
Lock-up Timing Control	The engine ECU sends current to the solenoid valves DSL and SL2 based on signals from each sensor and engages or disengages the lock-up clutch.
“N” to “D” Squat Control	When the shift lever is shifted from “N” to “D” position, the gear is temporarily shifted to 3rd and then to 1st to reduce vehicle squat.
Diagnosis (See page 130)	When the engine ECU detects a malfunction, the engine ECU makes a diagnosis and memorizes the failed section.
Fail-safe (See page 130)	Even if a malfunction is detected in the sensors or solenoids, the engine ECU effects fail-safe control to prevent the vehicle’s drivability from being affected significantly.

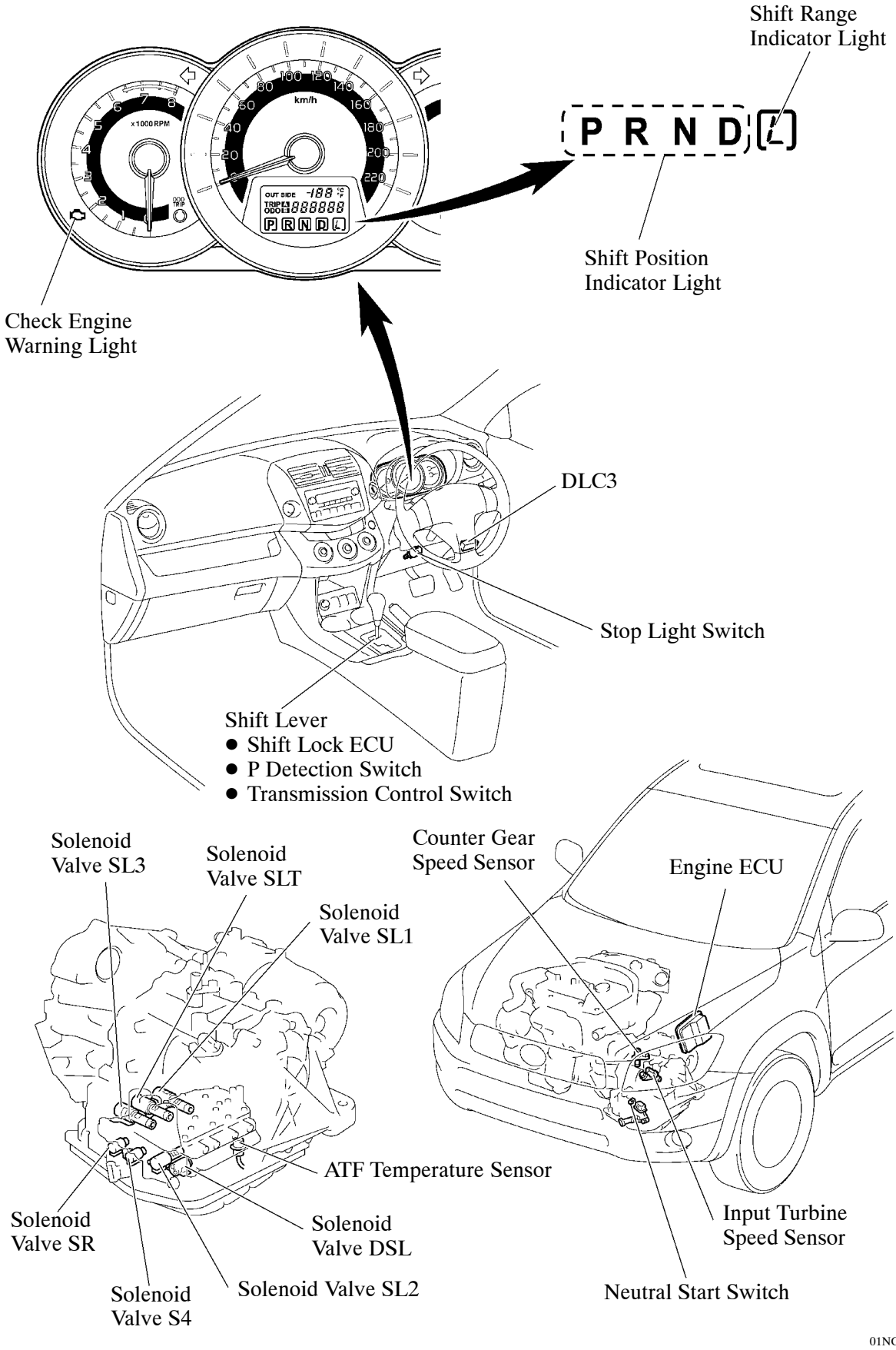
Construction

The configuration of the electronic control system in the U151F automatic transaxle is as shown in the following chart.



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Layout of Main Components

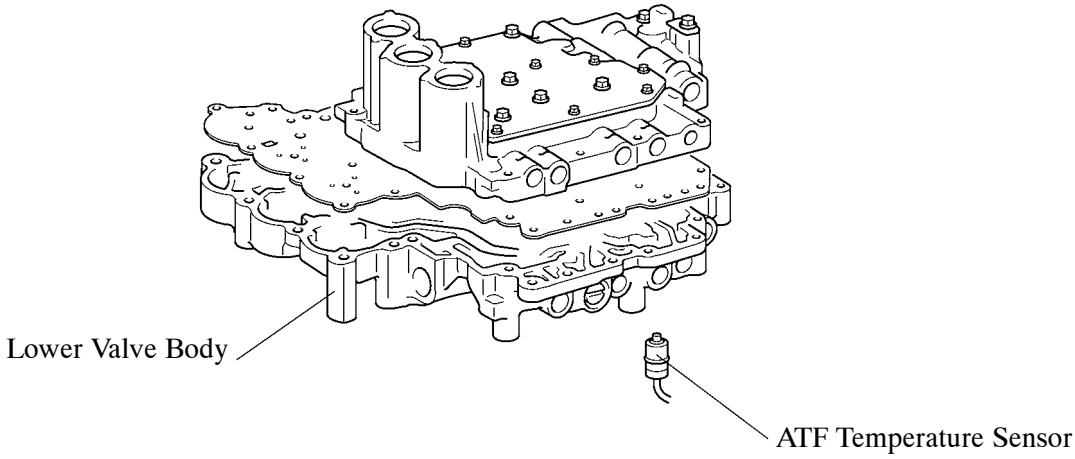


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Construction and Operation of Main Components

1) ATF Temperature Sensor

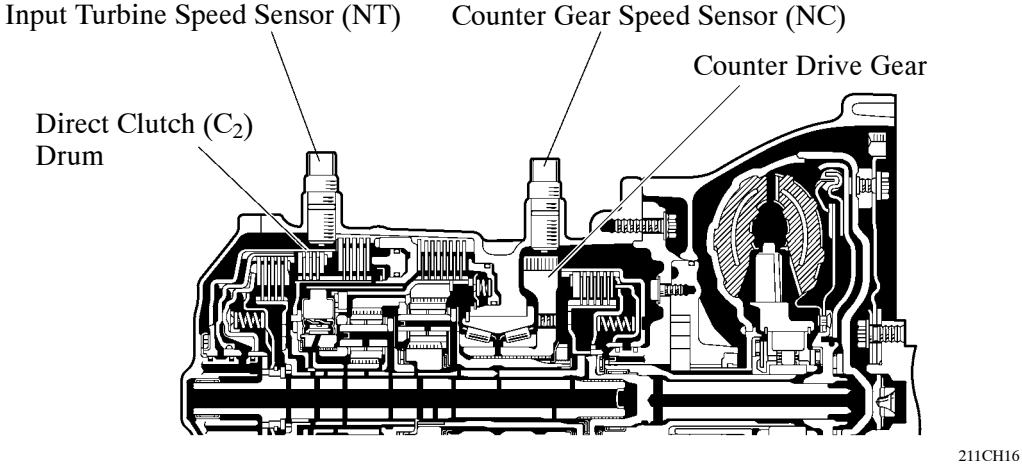
- The ATF temperature sensor is installed in the lower valve body for direct detection of the fluid temperature.
- The ATF temperature sensor is used for correction of clutch and brake pressure to keep smooth shift quality every time.



2) Input Turbine Speed Sensor and Counter Gear Speed Sensor

The U151F automatic transaxle uses an input turbine speed sensor (for the NT signal) and a counter gear speed sensor (for the NC signal). Thus, the engine ECU can detect the timing of the shifting of the gears and appropriately control the engine torque and hydraulic pressure in response to the various conditions.

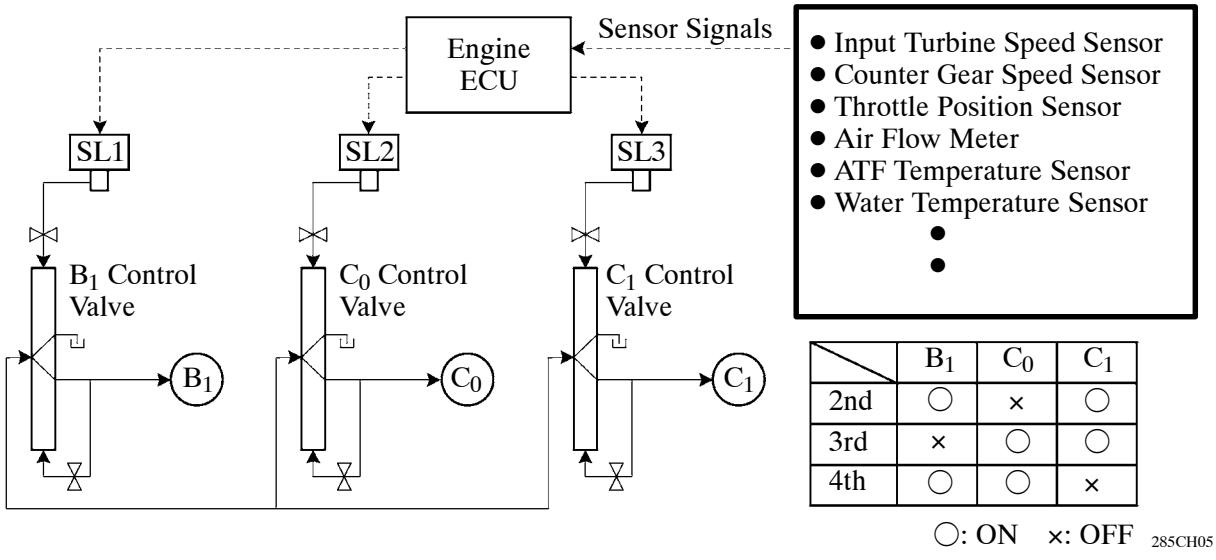
- The input turbine speed sensor detects the input speed of the transaxle. The direct clutch (C_2) drum is used as the timing rotor for this sensor.
- The counter gear speed sensor detects the speed of the counter gear. The counter drive gear is used as the timing rotor for this sensor.



Clutch Pressure Control

1) Clutch to Clutch Pressure Control

This control is used for shifting from the 2nd to 3rd gear, and from the 3rd to 4th gear.
Solenoid valves SL1, SL2, and SL3 are actuated in accordance with the signals from the engine ECU, and this output pressure is guided directly to the control valves B_1, C_0, and C_1 in order to regulate the line pressure that acts on the B_1 brake, and C_0 and C_1 clutches.
As a result, high response and excellent shift characteristics have been realized.

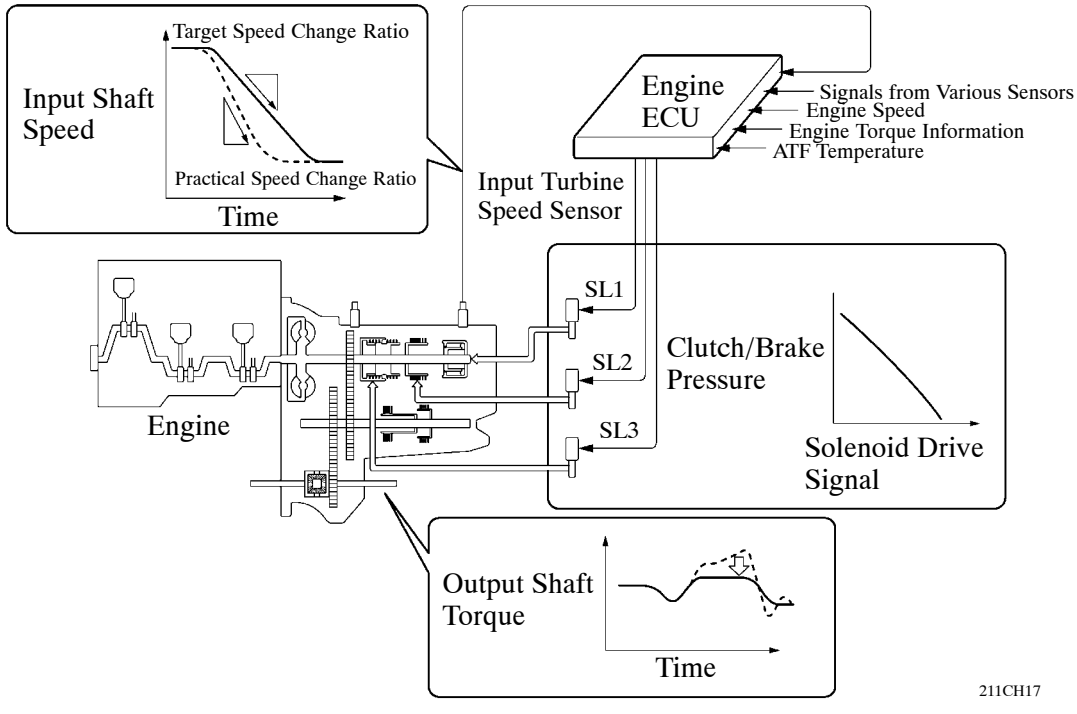


	B_1	C_0	C_1
2nd	○	×	○
3rd	×	○	○
4th	○	○	×

○: ON ×: OFF 285CH05

2) Clutch Pressure Optimal Control

The engine ECU monitors the signals from various sensors such as the input turbine speed sensor, allowing shift solenoid valves SL1, SL2, and SL3 to minutely control the clutch pressure in accordance with engine output and driving conditions.
As a result, smooth shift characteristics have been realized.

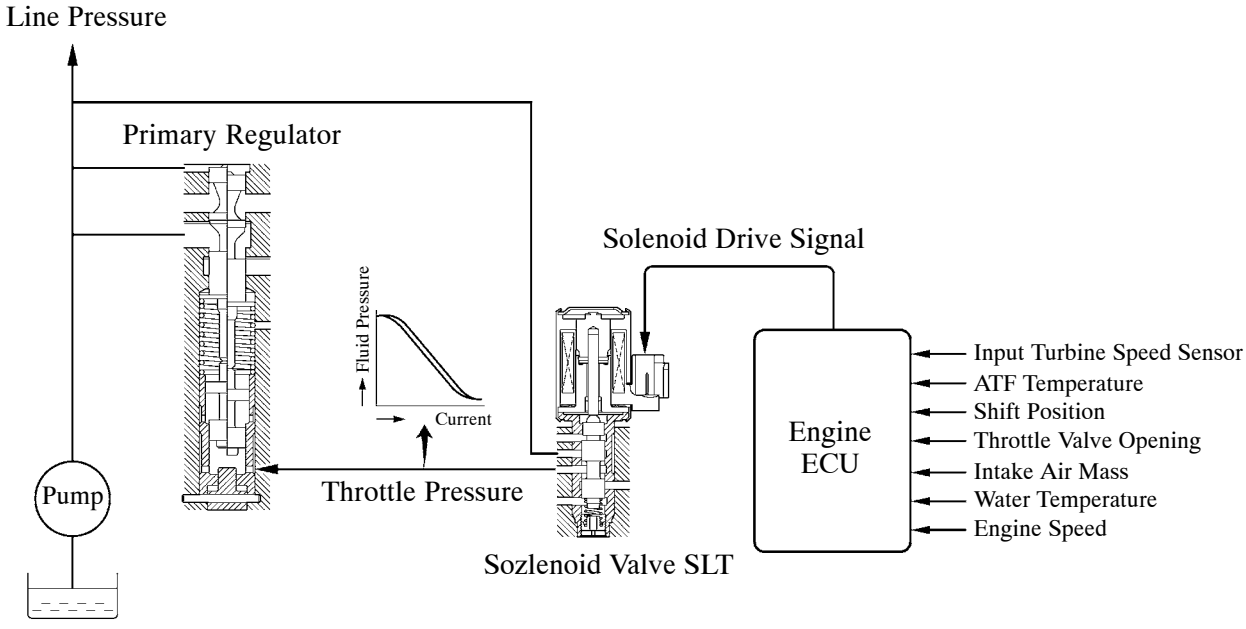


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Line Pressure Optimal Control

Through the use of the solenoid valve SLT, the line pressure is optimally controlled in accordance with the engine torque information, as well as with the internal operating conditions of the torque converter and the transaxle.

Accordingly, the line pressure can be controlled minutely in accordance with the engine output, traveling condition, and the ATF temperature, thus realizing smooth shift characteristics and optimizing the workload in the oil pump.



Shift Control in Uphill/Downhill Traveling

1) General

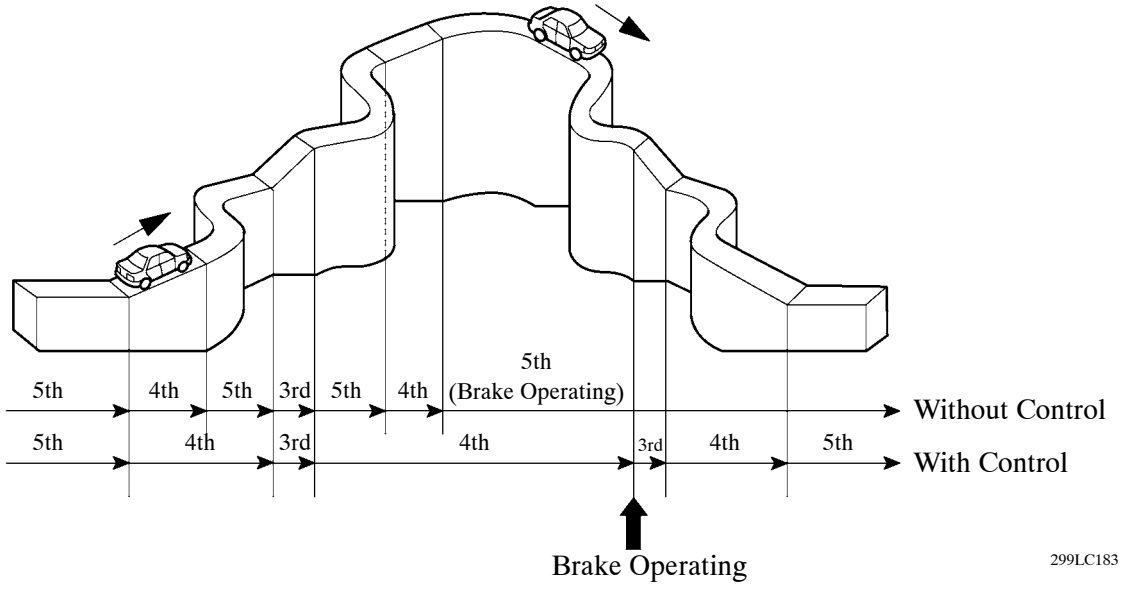
This control help minimize the gear shifting when the driver operates the accelerator pedal while driving on a winding road with ups and downs, in order to ensure a smooth drive.

2) Shift Control in Uphill Traveling

When the engine ECU determines uphill travel, it prohibits the transaxle from shifting up into 5th after the transaxle has shifted down below 4th.
When the engine ECU determines uphill travel with a steeper grade, it prohibits the transaxle from shifting up into 4th after the transaxle has shifted down below 3rd.

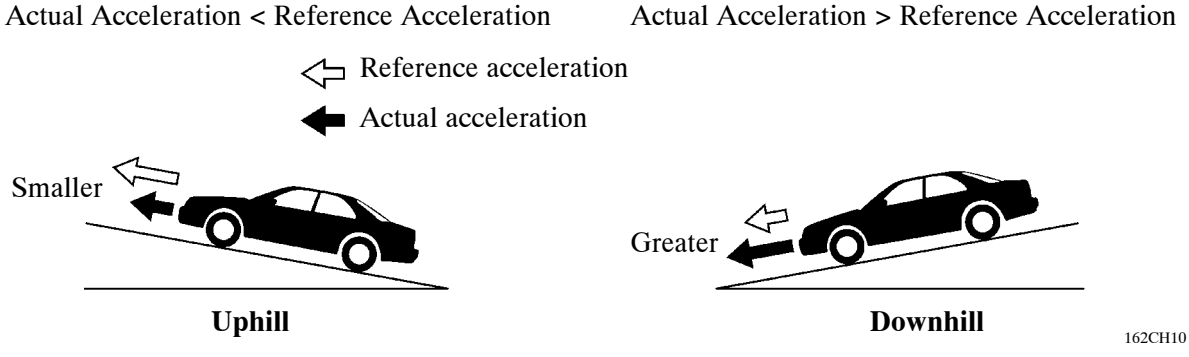
3) Shift Control in Downhill Traveling

When the engine ECU determines downhill travel, it shifts down the transaxle from 5th to 4th in accordance with the brake operation signal that is input when the driver operates the brake pedal.
When the engine ECU determines downhill travel with a steeper grade, and a brake operation signal is input again, the engine ECU shifts the transaxle down from 4th to 3rd.



4) Uphill/Downhill Judgment

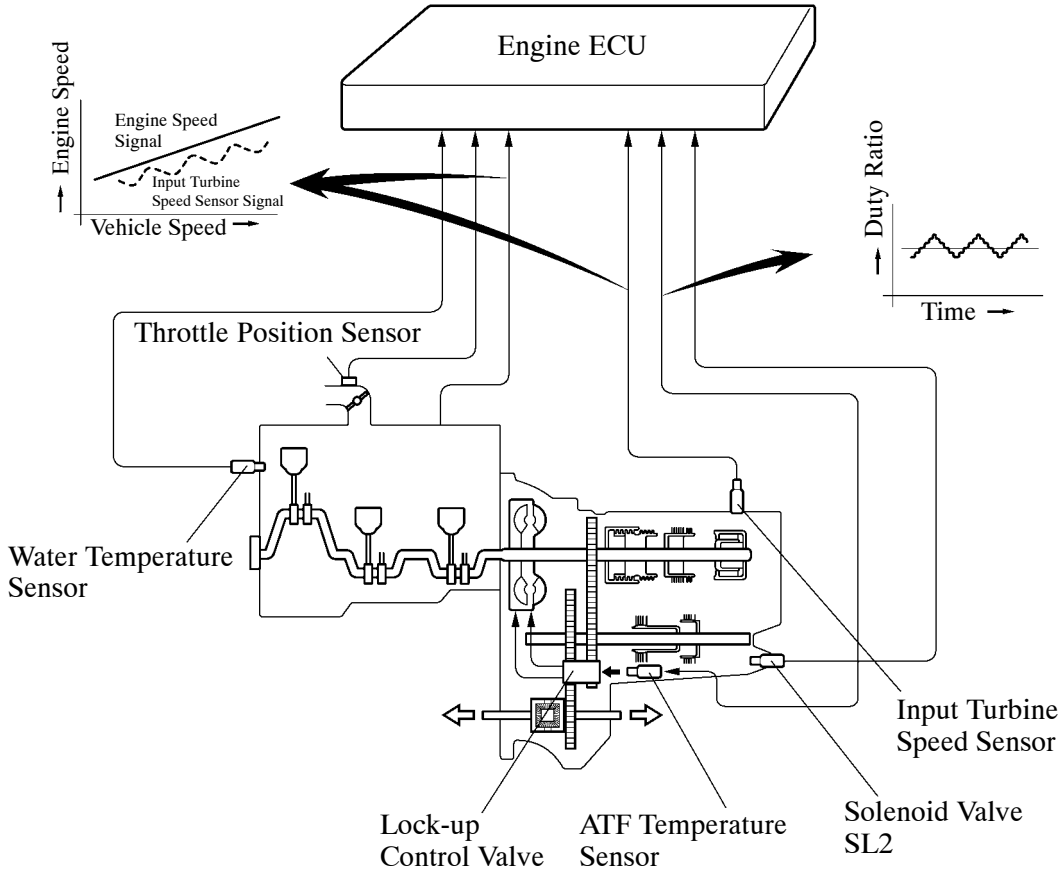
The actual acceleration calculated from the speed sensor signal is compared with the reference acceleration (based on level road travel) stored in the engine ECU to determine uphill or downhill travel.



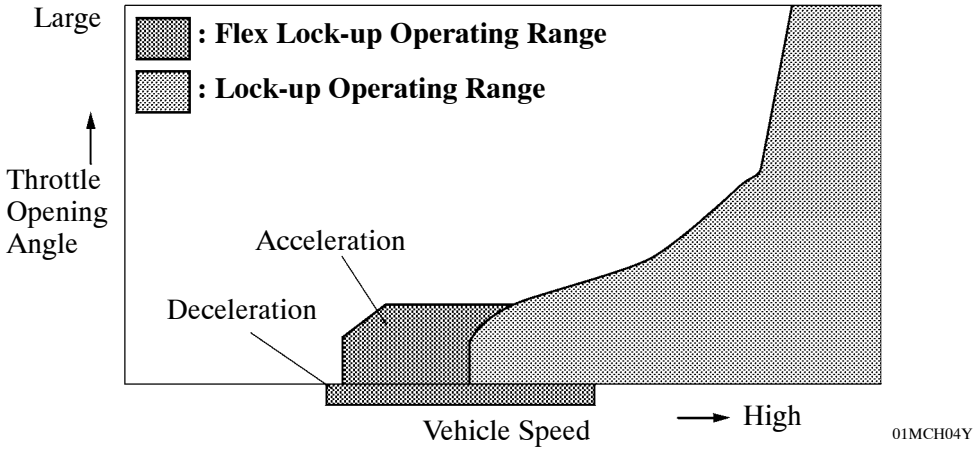
Flex Lock-up Clutch Control

The flex lock-up clutch control is used.
This flex lock-up clutch control regulates the solenoid valve SL2 as an intermediate mode between the ON/OFF operation of the lock-up clutch.
The flex lock-up clutch control operates in the 4th and 5th gears in the D range during acceleration, and in the 4th and 5th gears in the D range, and in the 4th gear in the 4 range during deceleration.

- During the acceleration, the partition control of the power transmission between the lock-up clutch and torque converter according to the driving conditions greatly boosts transmission efficiency, and fuel-economy has been improved.
- During the deceleration, lock-up clutch is made to operate. Therefore fuel-cut area has been expanded and fuel-economy has been improved.



▶ Flex Lock-up Operating Range ◀



▶ Flex Lock-up Operation Gears in D, 5 and 4 Range ◀

Range	Gear	Acceleration Flex Lock-up	Deceleration Flex Lock-up
D, 5	1st	×	×
	2nd	×	×
	3rd	×	×
	4th	○	○
	5th	○	○
4	1st	×	×
	2nd	×	×
	3rd	×	×
	4th	×	○

Diagnosis

- When the engine ECU detects a malfunction, the engine ECU makes a diagnosis and memorizes the failed section. Furthermore, the check engine warning light in the combination meter illuminates or blinks to inform the driver.
- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be read by connecting an intelligent tester II. For details, see the RAV4 Repair Manual Supplement (Pub. No. RM01N2E).

Fail-safe

This function minimizes the loss of drivability when any abnormality occurs in each sensor or solenoid.

1) Fail-safe Control List

Malfunction Part	Function
Speed Sensor	During a speed sensor malfunction, the vehicle speed is detected through the signals from the counter gear speed sensor to effect normal control.
ATF Temperature Sensor	During an ATF temperature sensor malfunction, 5th gear upshift is prohibited.
Counter Gear Speed Sensor	During a counter gear speed sensor malfunction, 5th gear upshift is prohibited.
Solenoid Valves SL1, SL2, SL3, and S4	The current to the failed solenoid valve is cut off and control is effected by operating other solenoid valves with normal operation. Shift control is effected as described in the table below, depending on the failed solenoid. Even if the engine starts under this condition, the gear position remains where it was before.
Solenoid Valve DSL	When the solenoid valve DSL has a malfunction, the current to the solenoid valve is stopped. This stops lock-up control, then fuel economy decreases.

▶ Normal ◀

Δ: According to Flex Lock-up

Solenoid Valve	SL1	ON	OFF	ON	OFF	OFF
	SL2	ON	ON	OFF	Δ	Δ
	SL3	OFF	OFF	OFF	ON	ON
	S4	OFF	OFF	OFF	OFF	ON
Gear Position		1st	2nd	3rd	4th	5th

▶ Solenoid Valve SL1 Malfunction (During driving at 1st or 2nd) ◀

Solenoid Valve	SL1	×				
	SL2	ON	ON	OFF → ON	Δ → ON	Δ → ON
	SL3	OFF	OFF	OFF	ON → OFF	ON → OFF
	S4	OFF	OFF	OFF	OFF	ON → OFF
Gear Position		1st → 2nd	2nd	3rd → 2nd	4th → 2nd	5th → 2nd

▶ Solenoid Valve SL1 Malfunction (During driving at 3rd) ◀ Δ: According to Flex Lock-up

Solenoid Valve	SL1	×				
	SL2	ON → Δ	ON → Δ	OFF → Δ	Δ	Δ
	SL3	OFF	OFF	OFF	ON → OFF	ON → OFF
	S4	OFF → ON	OFF → ON	OFF → ON	OFF → ON	ON
Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th

▶ Solenoid Valve SL1 Malfunction (During driving at 4th or 5th) ◀ Δ: According to Flex Lock-up

Solenoid Valve	SL1	×				
	SL2	ON → Δ	ON → Δ	OFF → Δ	Δ	Δ
	SL3	OFF → ON	OFF → ON	OFF → ON	ON	ON
	S4	OFF	OFF	OFF	OFF	ON
Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th

▶ Solenoid Valve SL2 Malfunction ◀

Solenoid Valve	SL1	ON	OFF → ON	ON	OFF → ON	OFF → ON
	SL2	×				
	SL3	OFF	OFF	OFF	ON → OFF	ON → OFF
	S4	OFF → ON	OFF → ON	OFF → ON	OFF → ON	ON
Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th

▶ Solenoid Valve SL3 Malfunction ◀ Δ: According to Flex Lock-up

Solenoid Valve	SL1	ON	OFF	ON	OFF → ON	OFF → ON
	SL2	ON	ON	OFF	Δ	Δ
	SL3	×				
	S4	OFF	OFF	OFF	OFF → ON	ON
Gear Position		1st	2nd	3rd	4th	5th → 4th

▶ Solenoid Valve S4 Malfunction ◀ Δ: According to Flex Lock-up

Solenoid Valve	SL1	ON	OFF	ON	OFF	OFF
	SL2	ON	ON	OFF	Δ	Δ
	SL3	OFF	OFF	OFF	ON	ON
	S4	×				
Gear Position		1st	2nd	3rd	4th	5th → 4th

▶ Solenoid Valves SL1, SL2, SL3 and S4 Malfunction ◀

Solenoid Valve	SL1	×				
	SL2					
	SL3					
	S4					
Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th