■ELECTRONIC CONTROL SYSTEM

1. General

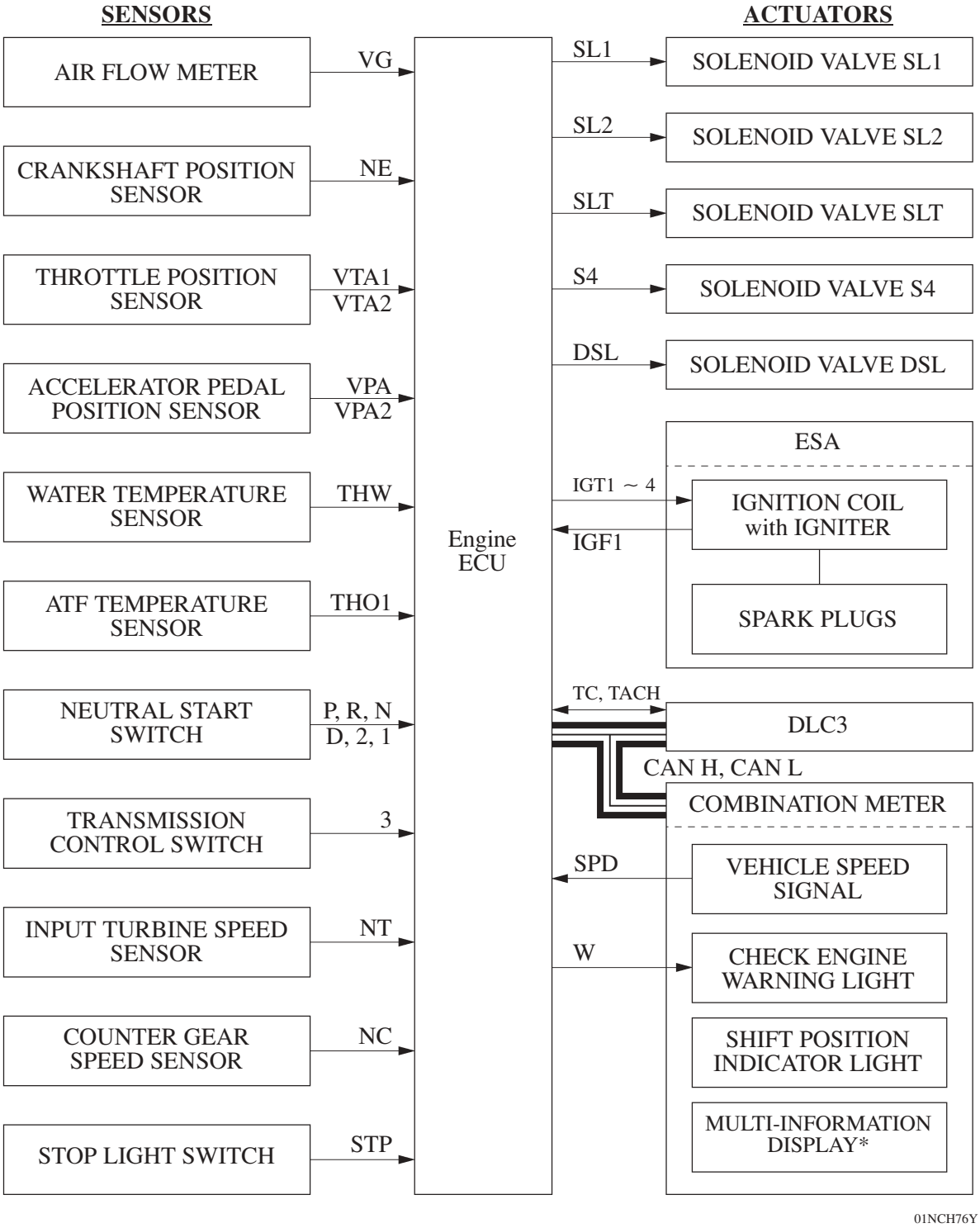
The electronic control system of the U140F and U241E automatic transaxles consists of the controls listed below.

System	Function
Clutch Pressure Control (See page CH-34)	● Controls the pressure that is applied directly to B_1 brake and C_2 clutch by actuating the shift solenoid valves (SL1, SL2) in accordance with engine ECU signals. ● The solenoid valve SLT minutely controls the clutch pressure in accordance with the engine output and driving conditions.
Line Pressure Optimal Control (See page CH-35)	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.
High Response Shift Control (See page CH-35)	The shift time lag has been reduced to half by the centrifugal fluid pressure canceling mechanism and clutch pressure optimal control.
Engine Torque Control	Retards the engine ignition timing temporarily to improve shift feeling during up or down shifting.
Shift Control in Uphill/Downhill Traveling*1 (See page CH-36)	Controls to restrict the 4th upshift or to provide appropriate engine braking by using the engine ECU to determine whether the vehicle is traveling on uphill or downhill.
Shift Timing Control	The engine ECU sends current to the solenoid valve SL1 and/or SL2 based on the signals from each sensor and shifts the gear.
Lock-up Timing Control	The engine ECU sends current to the solenoid valve DSL based on signals from each sensor and engages or disengages the lock-up clutch.
Flex Lock-up Clutch Control*2 (See page CH-37)	Controls the solenoid valve 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 ensure fuel economy.
“N” to “D” Squat Control	When the shift lever is shifted from the “N” to “D” position, the gear is temporarily shifted to the 2nd and then to the 1st to reduce vehicle squat.
Diagnosis (See page CH-38)	When the engine ECU detects a malfunction, the engine ECU makes a diagnosis and memorizes the failed section.
Fail-safe (See page CH-38)	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.

*1: Except Europe Models
*2: Only for Europe Models

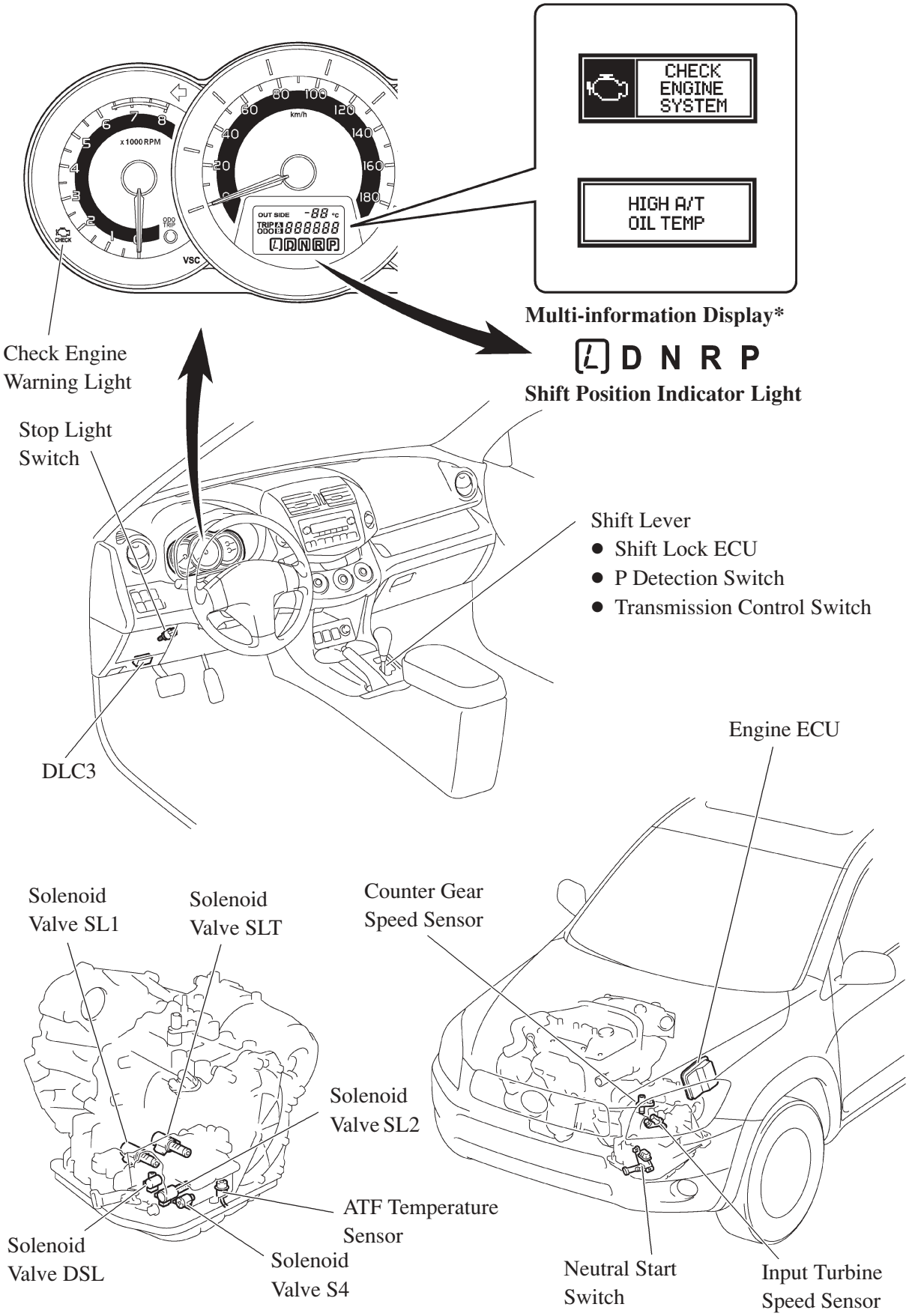
2. Construction

The configuration of the electronic control system in the U140F and U241E automatic transaxles is as shown in the following chart.



*: Only for Europe Models

3. Layout of Main Components



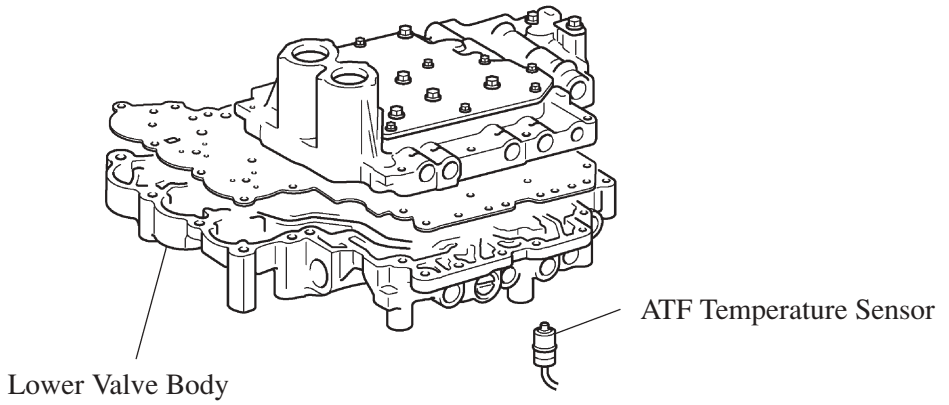
*: Only for Europe Models

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4. Construction and Operation of Main Components

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.

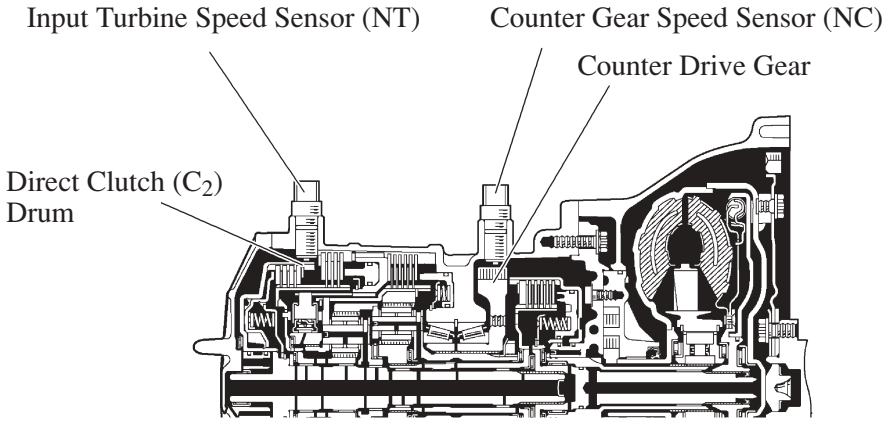


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Input Turbine Speed Sensor and Counter Gear Speed Sensor

The U140F and U241E automatic transaxles use 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.

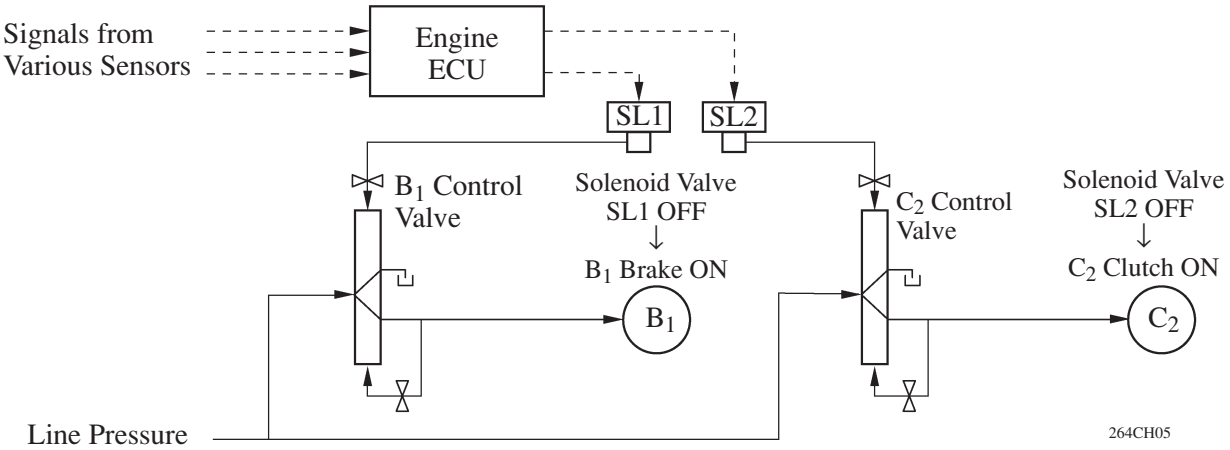


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5. Clutch Pressure Control

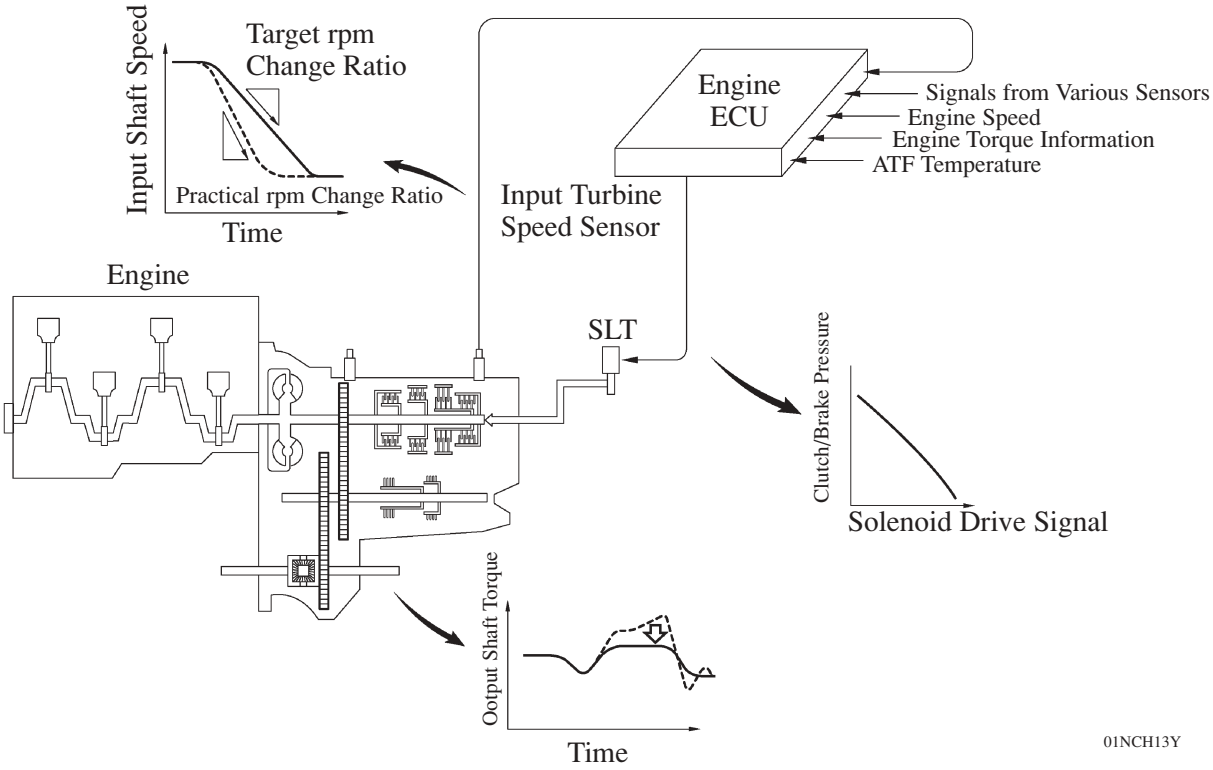
Clutch to Clutch Pressure Control

A clutch to clutch pressure control has been used for shifting from the 1st to 2nd gear, and from the 2nd to 3rd gear. Solenoid valves SL1 and SL2 are actuated in accordance with the signals from the engine ECU, and this output pressure is guided directly to the control valves B_1 and C_2 in order to regulate the line pressure that acts on the B_1 brake and C_2 clutch.
As a result, high response and excellent shift characteristics have been achieved.



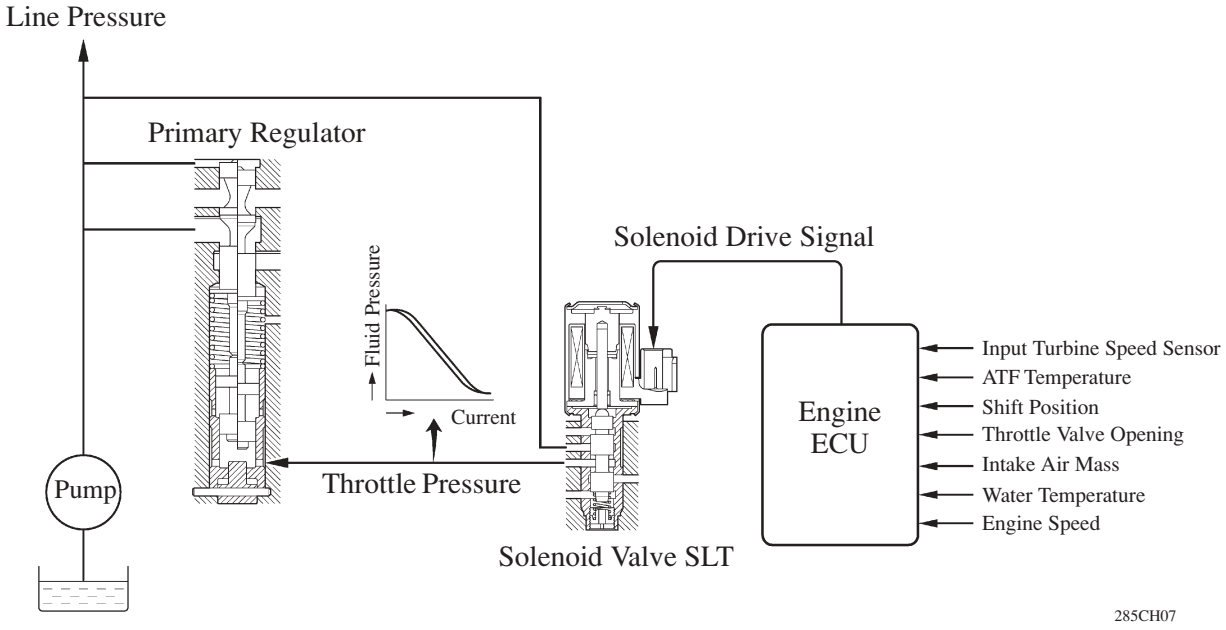
Clutch Pressure Optimal Control

The solenoid valve SLT is used for optimal control of clutch pressure. The engine ECU monitors the signals from various sensors such as the input turbine speed sensor, allowing solenoid valve SLT to minutely control the clutch pressure in accordance with engine output and driving conditions.
As a result, smooth shift characteristics have been realized.



6. 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.



7. High Response Shift Control

Due to the use of the previously mentioned centrifugal fluid pressure canceling mechanism and the clutch pressure optimal control, not only smooth shifting has been achieved, but the shift time lag has been halved to realize excellent response.

8. Shift Control in Uphill/Downhill Traveling

General

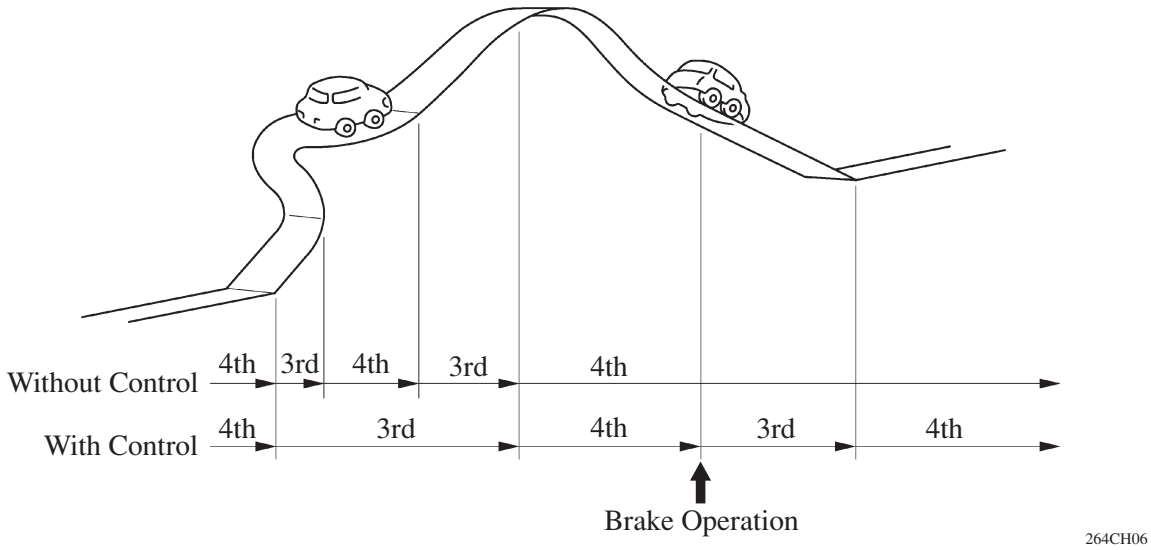
This control helps minimize the gear shifting when the driver operates the accelerator pedal while driving on a winding uphill or downhill road in order to ensure a smooth drive.

Shift Control in Uphill Traveling

When the engine ECU detects uphill travel, it prohibits upshifting to the 4th after downshifting to the 3rd.

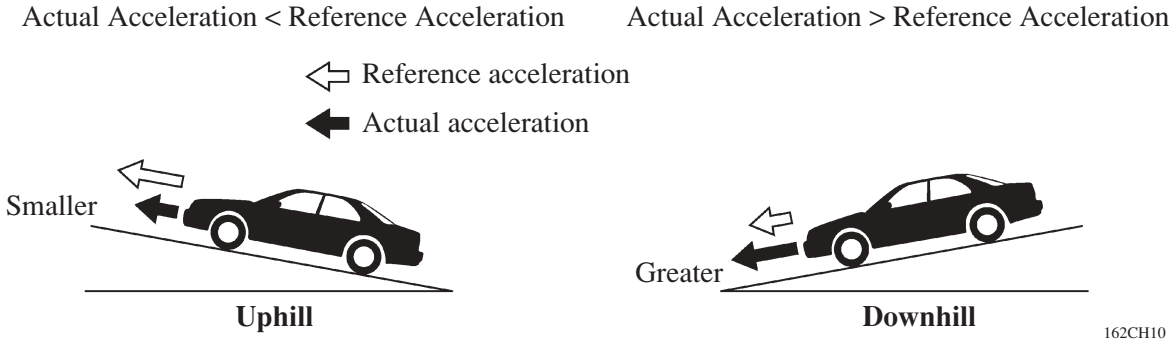
Shift Control in Downhill Traveling

If a signal indicating that the driver has operated the brake pedal is input while the engine ECU detects downhill travel, it downshifts from the 4th to 3rd.



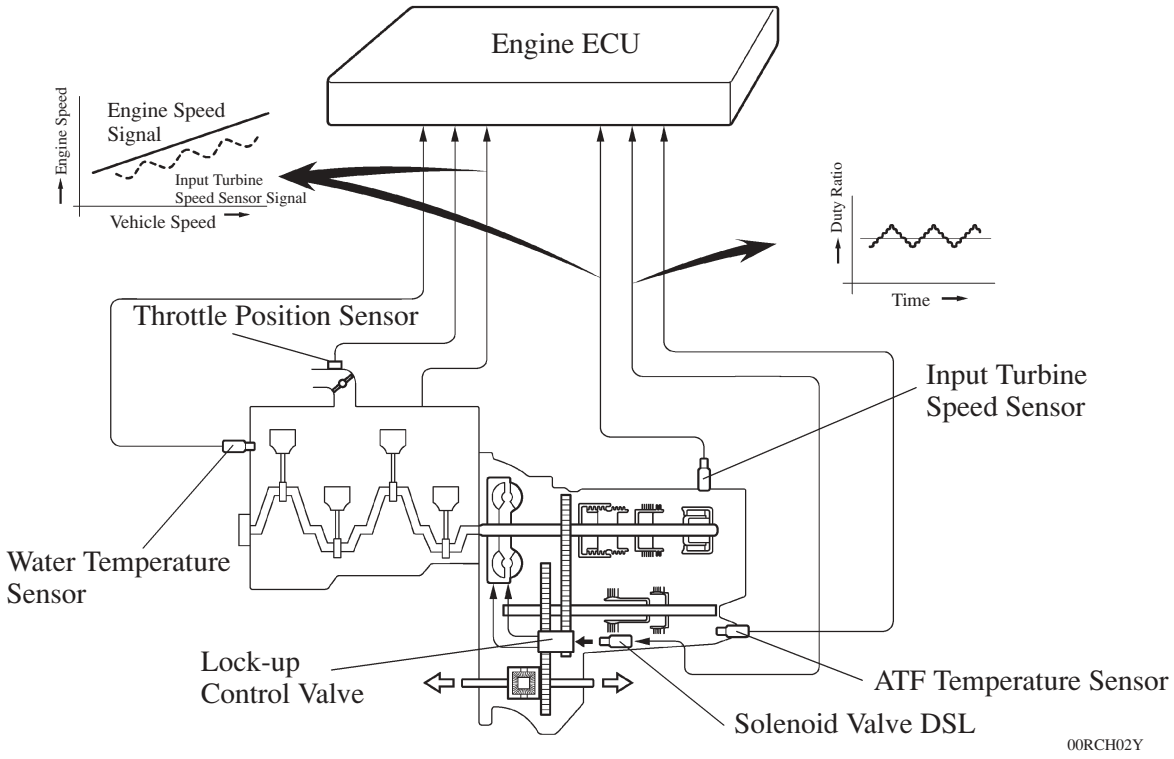
Uphill/Downhill Judgment

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.

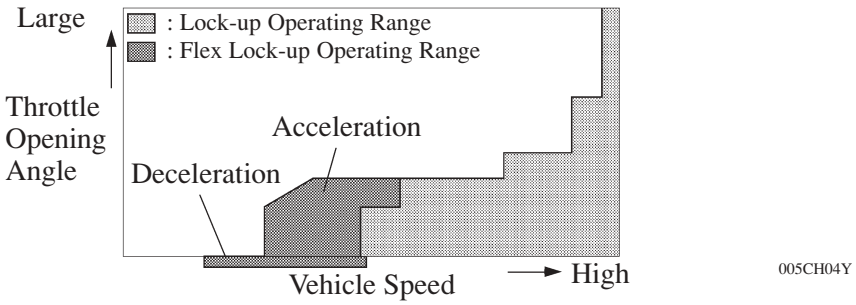


9. Flex Lock-up Clutch Control

In addition to the conventional lock-up timing control, flex lock-up clutch control is used.
This flex lock-up clutch control regulates the solenoid valve DSL as an intermediate mode between the ON/OFF operation of the lock-up clutch.
The flex lock-up clutch control operates in the 3rd and 4th gears in the D range during acceleration, and in the 3rd and 4th gears in the D range, and in the 3rd gear in the 3 range during deceleration.



▶ Flex Lock-up Operating Range ◀



▶ Flex Lock-up Operation Gear in D and 3 Range ◀

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

10. 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 (Pub. No. RM01N0E).

11. Fail-safe

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

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 a ATF temperature sensor malfunction, the 4th upshift is prohibited.
Counter Gear Speed Sensor	During a counter gear speed sensor malfunction, the 4th upshift is prohibited.
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.
Solenoid Valves SL1, SL2, and S4	The current to the failed solenoid valve is cut off and control is effected by operating the other solenoid valves with normal operation. Shift control is effected as described in the table below, depending on the failed solenoid.

▶ When all solenoid valves are normal ◀

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

▶ When solenoid valve SL1 is abnormal ◀

Traveling in 1st or 2nd			Gear
Solenoid Valve			
SL1	SL2	S4	
x*	ON	OFF	2nd
x*	ON	OFF	2nd
x*	OFF→ON	OFF→ON	3rd
x*	OFF→ON	ON	3rd

Traveling 3rd or 4th			Gear
Solenoid Valve			
SL1	SL2	S4	
x	ON→OFF	OFF	3rd
x	ON→OFF	OFF	3rd
x	OFF	OFF	3rd
x	OFF	ON	4th

*: The 2nd brake (B1) is constantly operating.

▶ When solenoid valve SL2 is abnormal ◀

Solenoid Valve			Gear
SL1	SL2	S4	
ON→OFF	x	OFF	3rd
OFF	x	OFF	3rd
OFF	x	OFF	3rd
OFF	x	ON	4th

▶ When solenoid valve S4 is abnormal ◀

Solenoid Valve			Gear
SL1	SL2	S4	
ON	ON	x	1st
OFF	ON	x	2nd
OFF	OFF	x	3rd
OFF	OFF	x	3rd

▶ When solenoid valves SL1 and SL2 are abnormal ◀

Solenoid Valve			Gear
SL1	SL2	S4	
x	x	OFF	3rd
x	x	OFF	3rd
x	x	OFF	3rd
x	x	ON	4th

▶ When solenoid valves SL1 and S4 are abnormal ◀

Traveling in 1st or 2nd			Gear
Solenoid Valve			
SL1	SL2	S4	
x	ON	x	2nd
x	ON	x	2nd
x	OFF→ON	x	2nd
x	OFF→ON	x	2nd

Traveling in 3rd or 4th			Gear
Solenoid Valve			
SL1	SL2	S4	
x	ON→OFF	x	3rd
x	ON→OFF	x	3rd
x	OFF	x	3rd
x	OFF	x	3rd

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▶ When solenoid valves SL2 and S4 are abnormal ◀

Solenoid Valve			Gear
SL1	SL2	S4	
ON→OFF	x	x	3rd
OFF	x	x	3rd
OFF	x	x	3rd
OFF	x	x	3rd

▶ When solenoid valves SL1, SL2 and S4 are abnormal ◀

Solenoid Valve			Gear
SL1	SL2	S4	
x	x	x	3rd
x	x	x	3rd
x	x	x	3rd
x	x	x	3rd