■ELECTRONIC CONTROL SYSTEM

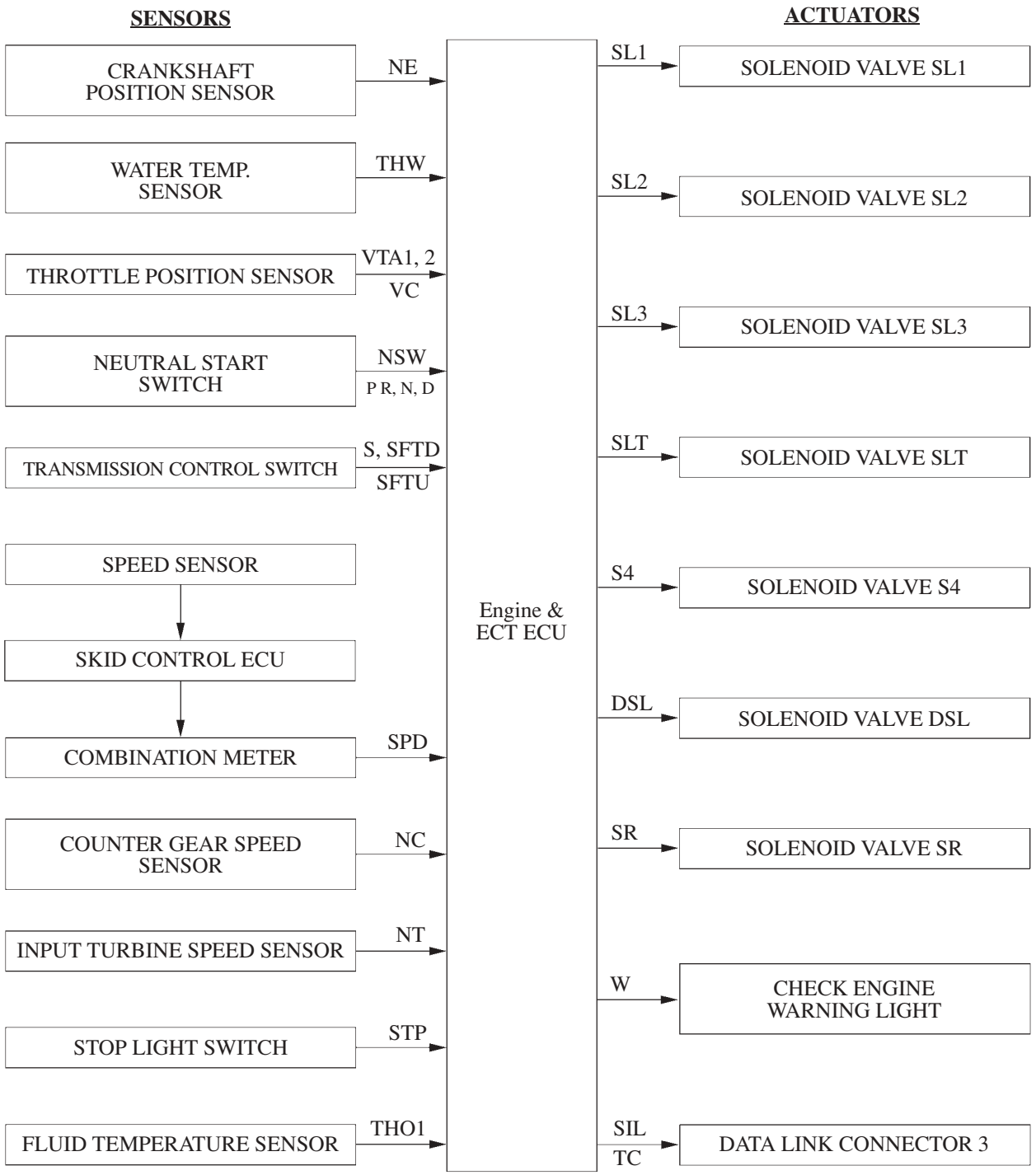
1. General

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

System	Function
Clutch Pressure Control (See page CH-23)	● 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 & ECT ECU signals. ● 3 solenoid valves (SL1, SL2 and SL3) minutely controls the clutch pressure in accordance with the engine output and driving conditions.
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 CH-24)	Controls to restrict the 4th or 5th upshift or to provide appropriate engine braking by the engine & ECT ECU to determine whether the vehicle is traveling uphill or downhill.
Line Pressure Optimal Control (See page CH-25)	Actuates the solenoid valve SLT to control the line pressure in accordance with information from the engine & ECT ECU and the operating conditions of the transaxle.
Shift Timing Control	The engine & ECT ECU sends current to 3 solenoid valves (SL1, SL2 and SL3) based on signals from each sensor and shifts the gear.
Flex Lock-up Clutch Control (See page CH-26)	Controls the solenoid valve SL2 and DSL, provides an intermediate mode between the ON/OFF operation of the lock-up clutch, and increase the operating range of the lock-up clutch to improve fuel economy. However, this control operates only during deceleration.
Lock-up Timing Control	The engine & ECT ECU sends current to the solenoid valve 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 2nd or 3rd and then to 1st to reduce vehicle squat.
Diagnosis (See page CH-27)	When the engine & ECT ECU detects a malfunction, the engine & ECT ECU makes a diagnosis and memorizes the failed section.
Fail-safe (See page CH-28)	Even if a malfunction is detected in the sensors or solenoids, the engine & ECT ECU effects fail-safe control to prevent the vehicle’s drivability from being affected significantly.

2. Construction

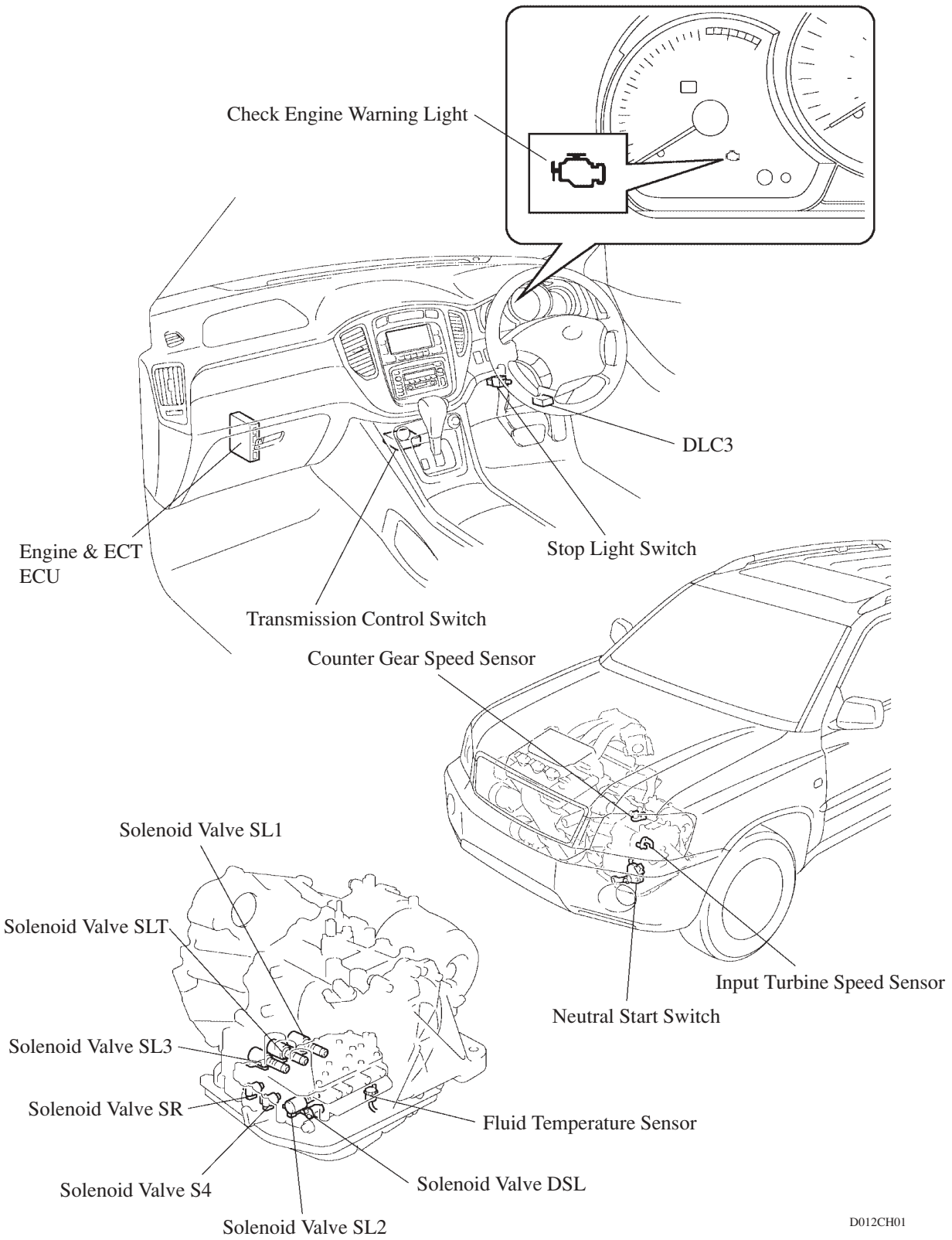
The configuration of the electronic control system in the U151F automatic transaxle is as shown in the following chart.



242CH01

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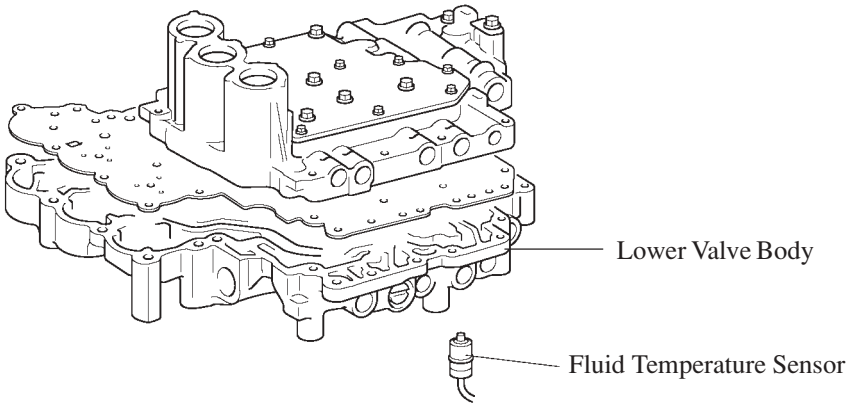
3. Layout of Main Components



4. Construction and Operation of Main Components

Fluid Temperature Sensor

A fluid temperature sensor is installed in the valve body for direct detection of the fluid temperature. Fluid temperature sensor is used for revision of clutches and brakes pressure to keep smooth shift quality every time.

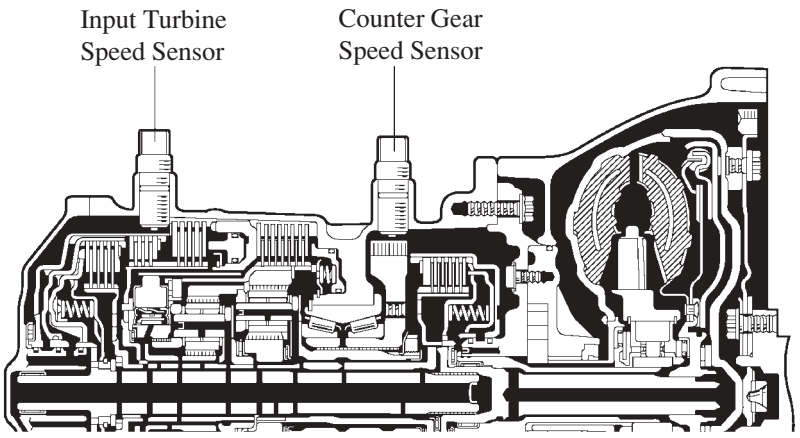


241CH87

Speed Sensors

The U151F automatic transaxle has adopted an input turbine speed sensor (for the NT signal) and a counter gear speed sensor (for the NC signal). Thus, the engine & ECT 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.

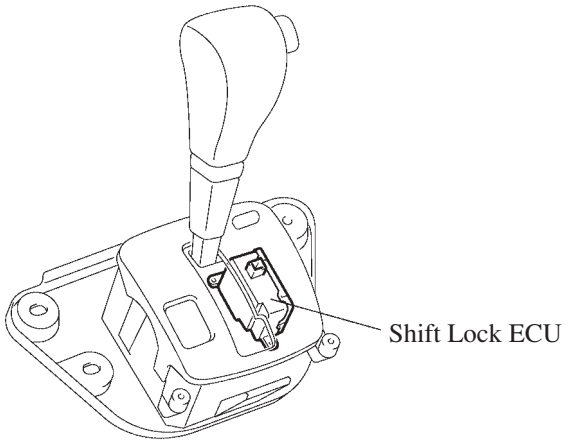


211CH16

Shift Lock ECU

The shift lock ECU is installed inside shift lever assembly to detect the shift lever position and to inform engine & ECT ECU the shift position indicator light in the combination meter.

- The shift lock mechanism prevents the shift lever from being shifted to a position other than the P position, unless the ignition switch is ON and the brake pedal is pressed. It prevents the vehicle from starting off suddenly against the wish of the driver.



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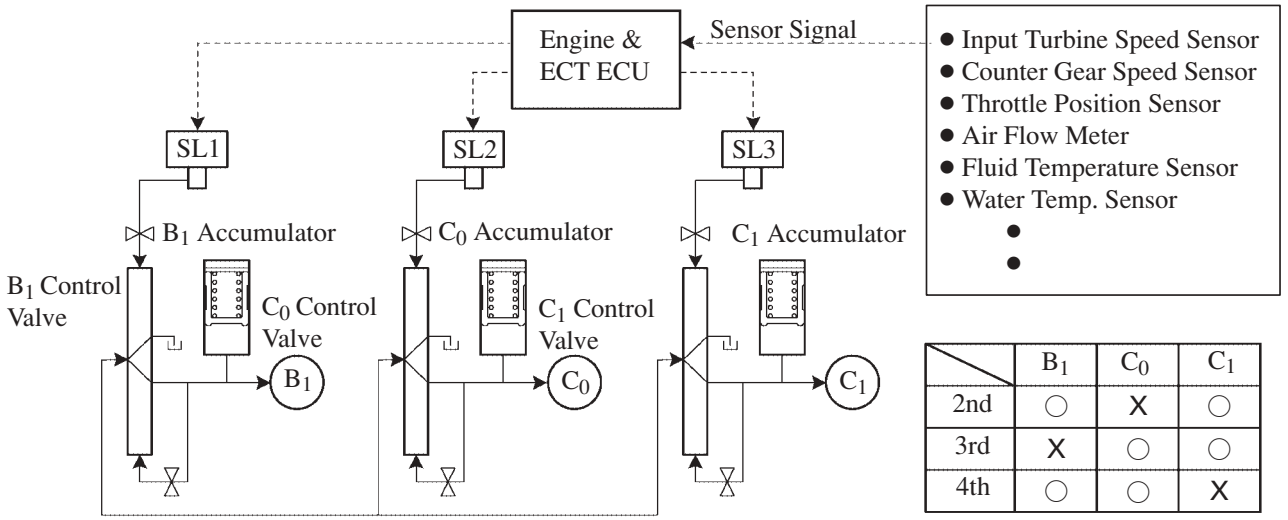
5. Clutch Pressure Control

Clutch to Clutch Pressure Control

This control has been adopted for shifting from the 1st to 2nd gear, from the 2nd to 3rd gear, and from the 3rd to 4th gear.

Actuates solenoid valves SL1, SL2 and SL3 in accordance with the signals from the engine & ECT ECU, and guides this output pressure 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, C_0 and C_1 clutches.

As a result, compact B_1, C_0, and C_1 accumulators without a back pressure chamber have been realized.



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

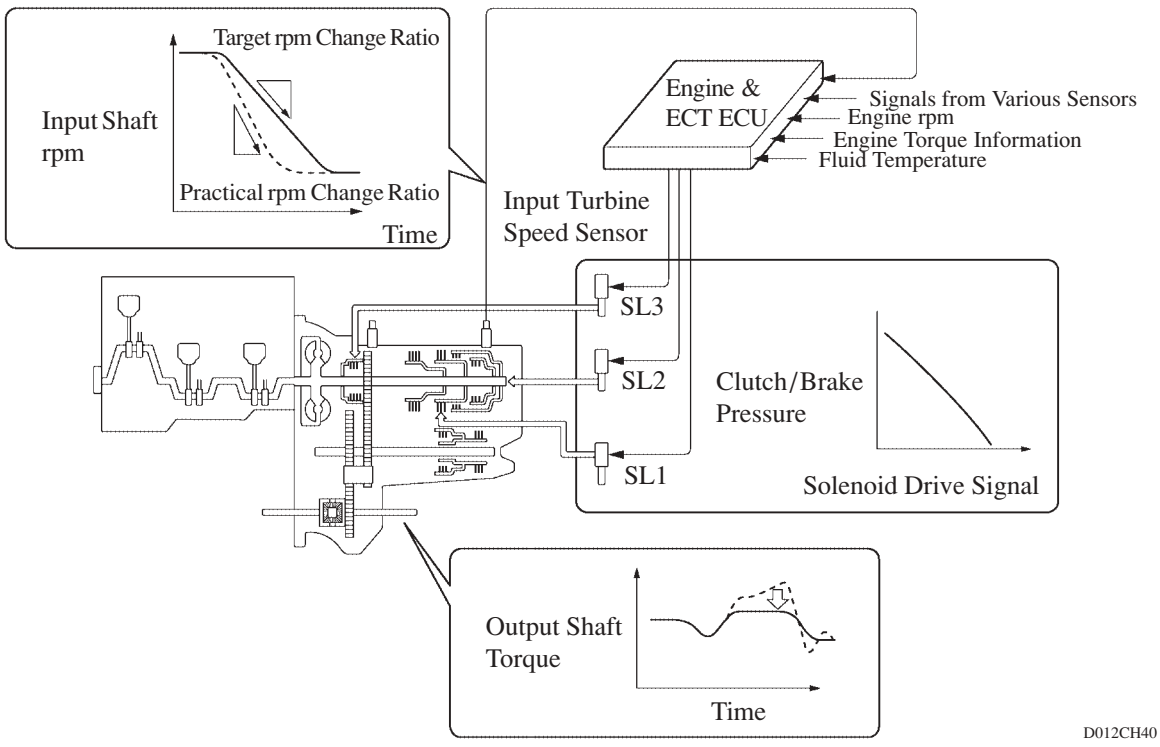
○: ON X: OFF

211CH15

Clutch Pressure Optimal Control

The engine & ECT ECU monitors the signals from various types of sensor 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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6. Shifting Control in Uphill / Downhill Traveling

General

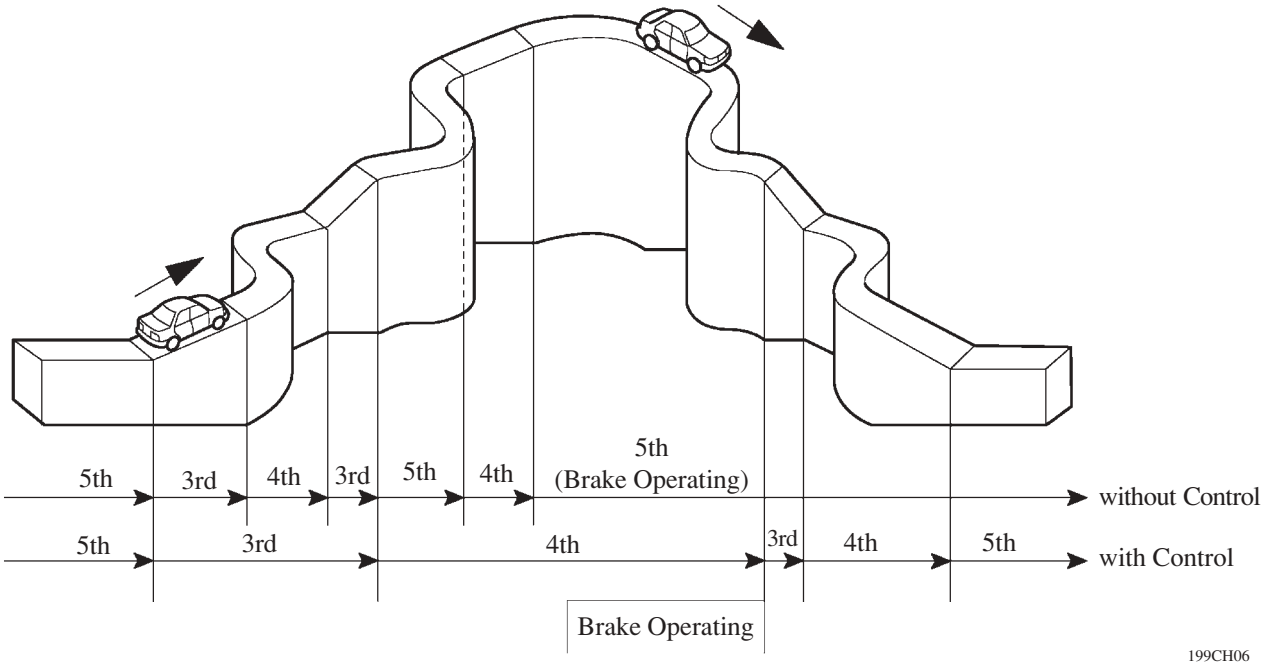
This control minimizes the shifting of gears when the driver operates the accelerator pedal while driving on a winding road with ups and downs, in order to ensure a smooth drive.

Shift control in uphill traveling

When the engine & ECT ECU determines uphill traveling and before the transaxle attempts to shift up or after it finishes to shift down according to the control of shift timing, the engine & ECT ECU prohibits the shift-up until it determines the uphill travel is over.

Shift control in downhill traveling

When the engine & ECT 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 & ECT ECU determines downhill travel with a steeper grade, and a brake operation signal is input again, the engine & ECT ECU shifts the transaxle down from 4th to 3rd.



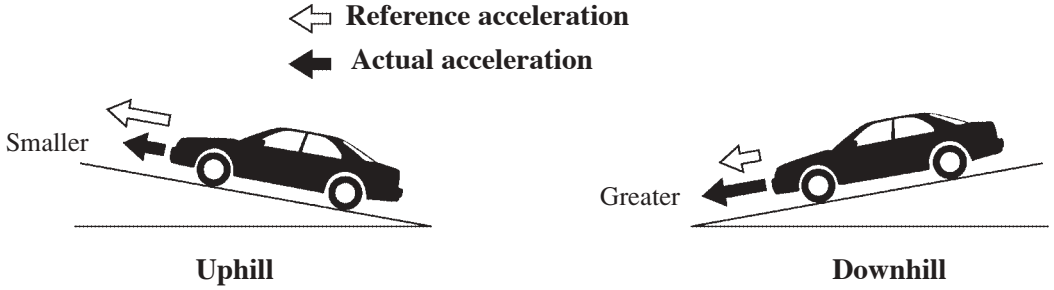
199CH06

Uphill / Downhill Judgment

The actual acceleration calculated from the speed sensor signal is compared with the reference acceleration stored in the engine & ECT ECU to judge uphill or downhill traveling.

Actual Acceleration < Reference Acceleration

Actual Acceleration > Reference Acceleration

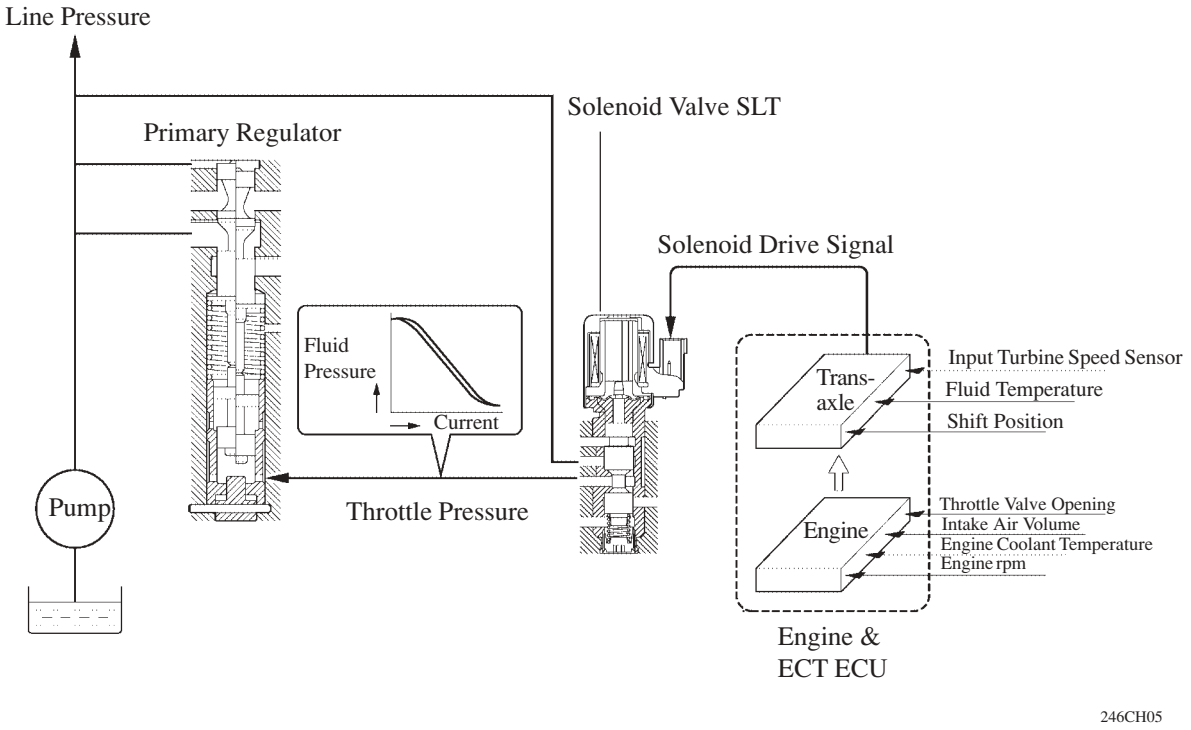


162CH10

7. 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.

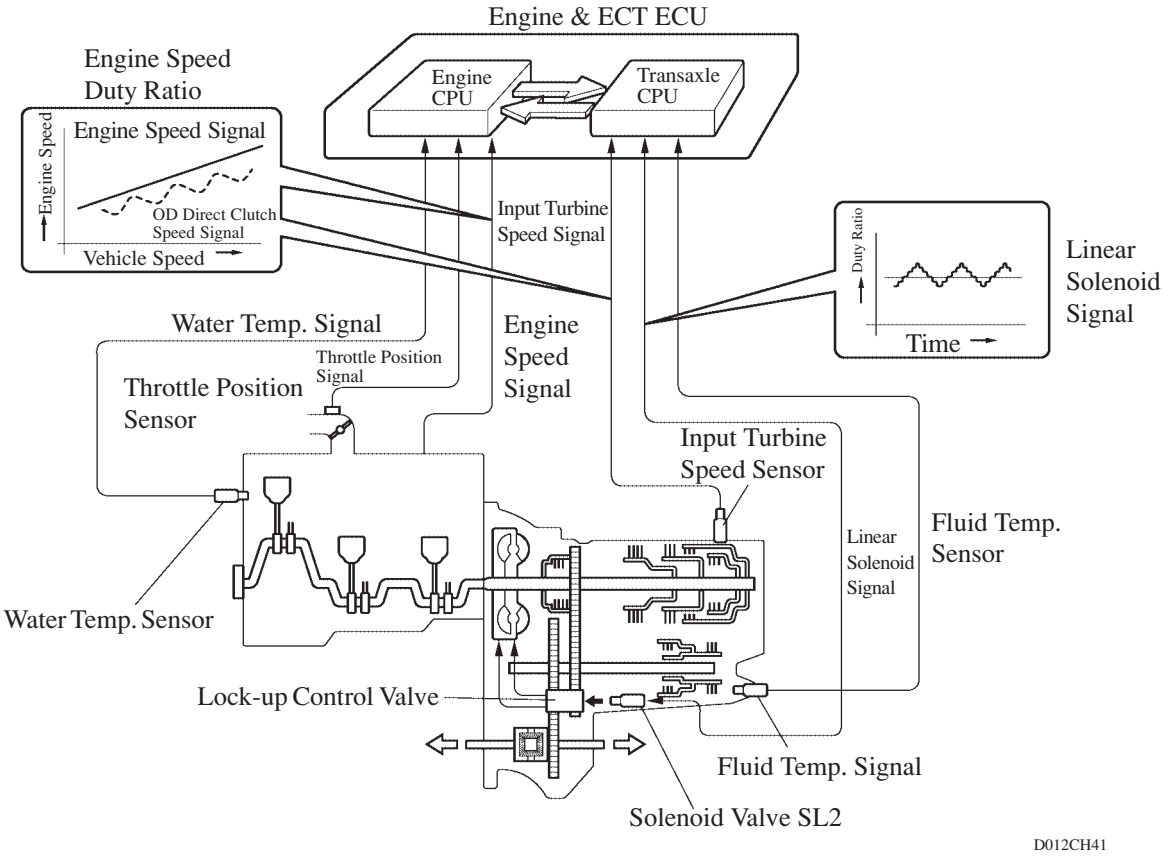
Accordingly, the line pressure can be controlled minutely in accordance with the engine output, traveling condition, and the ATF temperature, thus realizing smooth shift characteristics and optimizing the workload in the oil pump.



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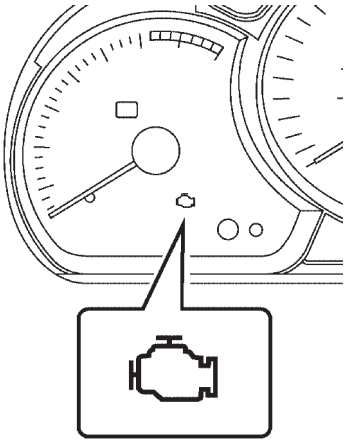
8. Flex Lock-up Clutch Control

In addition to the conventional lock-up timing control, flex lock-up clutch control is used.
During deceleration, 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, in order that lock-up clutch is made to operate in low speed.
Therefore fuel-economy has been improved. The flex lock-up clutch control operates during deceleration, in the 4th and 5th gears in the D range, and in the 4th gear in the 4 range.



9. Diagnosis

- When the engine & ECT ECU detected a malfunction, the engine & ECT 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 a hand-held tester. For details, refer to the Kluger Repair Manual (Pub. No. RM1087E)



D012CH03

Service Tip

The length of time to clear the DTC by the battery terminal disconnection has been changed from the previous 10 seconds to 1 minute.

10. Fail-Safe

This function minimizes the loss of operability 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.
Fluid Temp. Sensor	During a fluid temp. sensor malfunction, 5th upshift is prohibited.
Counter Gear Speed Sensor	During a counter gear speed sensor malfunction, 5th 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 the other solenoid valves with normal operation. Shift control is effected as described in the table below, depending on the failed solenoid. Even if starting the engine under this condition, the gear position remains where it was before.

○: ON Δ: According to Flex Lock-up X: OFF

Normal	Solenoid Valve	SL1	○	X	○	X	X
		SL2	○	○	X	Δ	Δ
		SL3	X	X	X	○	○
		S4	X	X	X	X	○
	Gear Position		1st	2nd	3rd	4th	5th
SL1 Malfunction (During driving at 1st or 2nd)	Solenoid Valve	SL1	X				
		SL2	○	○	○	○	○
		SL3	X	X	X	○ → X	○ → X
		S4	X	X	X	X	○ → X
	Gear Position		1st → 2nd	2nd	3rd → 2nd	4th → 2nd	5th → 2nd
SL1 Malfunction (During driving at 3rd)	Solenoid Valve	SL1	X				
		SL2	○ → Δ	○ → Δ	Δ	Δ	Δ
		SL3	X	X	X	○ → X	○ → X
		S4	X → ○	X → ○	X → ○	X → ○	○
	Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th
SL1 Malfunction (During driving at 4th or 5th)	Solenoid Valve	SL1	X				
		SL2	○ → Δ	○ → Δ	Δ	Δ	Δ
		SL3	X → ○	X → ○	X → ○	○	○
		S4	X	X	X	X	○
	Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th

(Continued)

SL2 Malfunction	Solenoid Valve	SL1	○	X → ○	○	X → ○	X → ○
		SL2	X				
		SL3	X	X	X	○ → X	○ → X
		S4	X → ○	X → ○	X → ○	X → ○	○
	Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th
SL3 Malfunction	Solenoid Valve	SL1	○	X	○	X → ○	X → ○
		SL2	○	○	X	Δ	Δ
		SL3	X				
		S4	X	X	X	X → ○	○
	Gear Position		1st	2nd	3rd	4th	5th → 4th
S4 Malfunction	Solenoid Valve	SL1	○	X	○	X	X
		SL2	○	○	X	Δ	Δ
		SL3	X	X	X	○	○
		S4	X				
	Gear Position		1st	2nd	3rd	4th	5th → 4th
SL1, SL2, SL3, and S4 Malfunction	Solenoid Valve	SL1	X				
		SL2	X				
		SL3	X				
		S4	X				
	Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th

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