■ELECTRONIC CONTROL SYSTEM

1. General

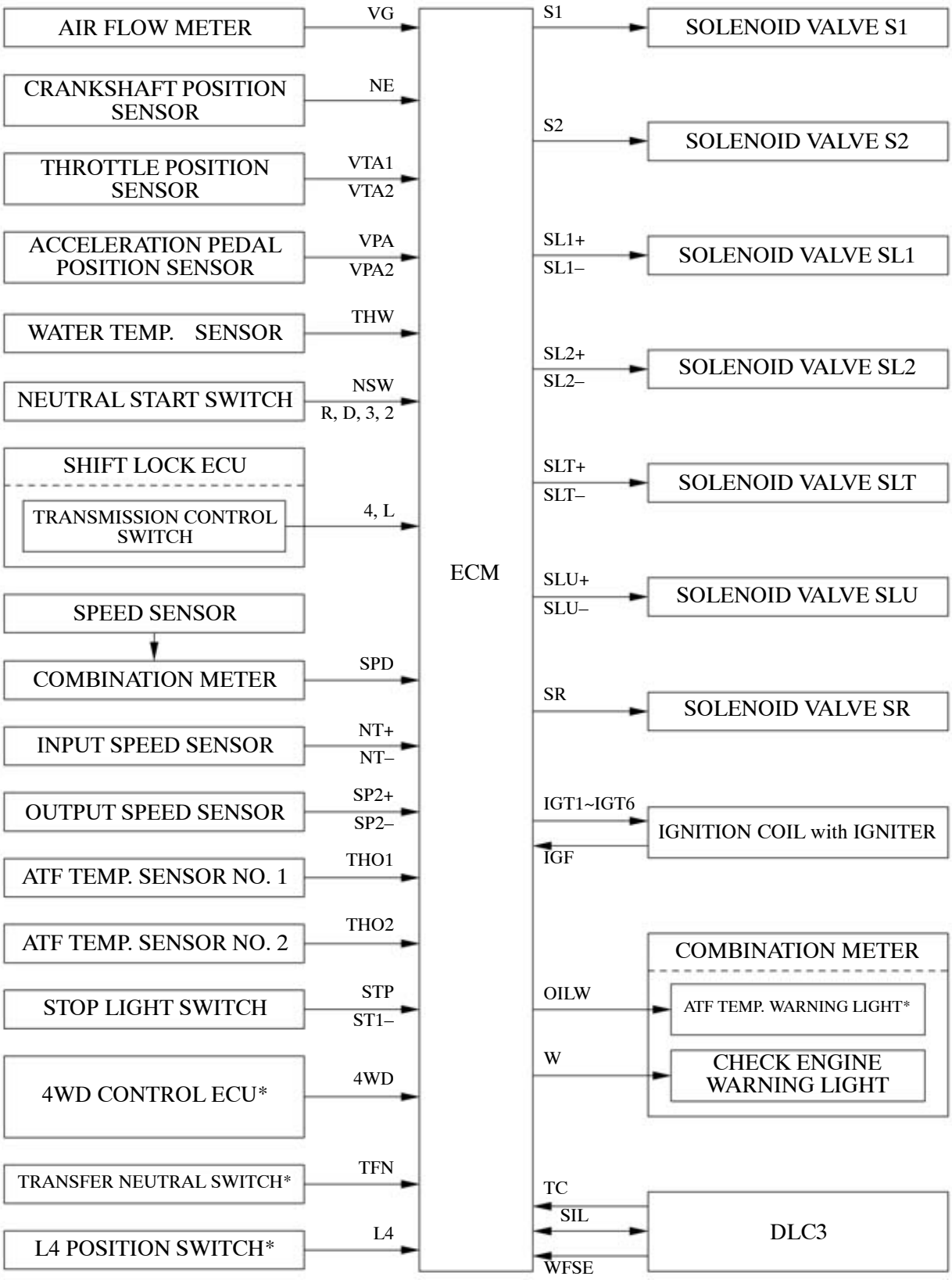
The electronic control system of the A750E and A750F automatic transmissions consists of the controls listed below.

System	Function	Engine Type	
		1GR-FE	1KD-FTV
Clutch Pressure Control	● Controls the pressure that is applied directly to B_1 brake and C_1 clutch by actuating the linear solenoid valves SL1 and SL2 in accordance with the ECM or ECT ECU signals. ● The solenoid valves SLT and SL1 minutely control the clutch pressure in accordance with the engine output and driving conditions.	○	○
Line Pressure Control	Actuates the solenoid valve SLT to control the line pressure in accordance with information from the ECM or ECT ECU and the operating conditions of the transmission.	○	○
Engine Torque Control	Retards the ignition timing temporarily to improve shift feeling during up or down shifting.	○	—
	Retards the fuel injection volume temporarily to improve shift feeling during up or down shifting.	—	○
Shift Timing Control	The ECM or ECT ECU sends current to the solenoid valves S1, S2 and/or SR based on signals from each sensor and shifts the gear.	○	○
Lock-up Timing Control	The ECM or ECT ECU sends current to the shift solenoid valve SLU based on signals from each sensor and engages or disengages the lock-up clutch.	○	○
Flex Lock-up Clutch Control	Controls the solenoid valve SLU, 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.	—	○
“N” to “D” Squat Control	When the shift lever is shifted from “N” to “D” position, the gear is temporarily shifted to 2nd and then to 1st to reduce vehicle squat.	○	○
AI (Artificial Intelligence) -SHIFT Control	Based on the signals from various sensors, the ECM or ECT ECU determines the road conditions and the intention of the driver. Thus, the shift pattern is automatically regulated to an optimal level, thus improving drivability.	○	○
Diagnosis	When the ECM or ECT ECU detects a malfunction, it makes a diagnosis and memorizes the failed section.	○	○
Fail-safe	If a malfunction is detected in the sensors or solenoids, the ECM or 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 new Hilux A750E and A750F is as shown in the following charts.

▶ Models with 1GR-FE Engine ◀

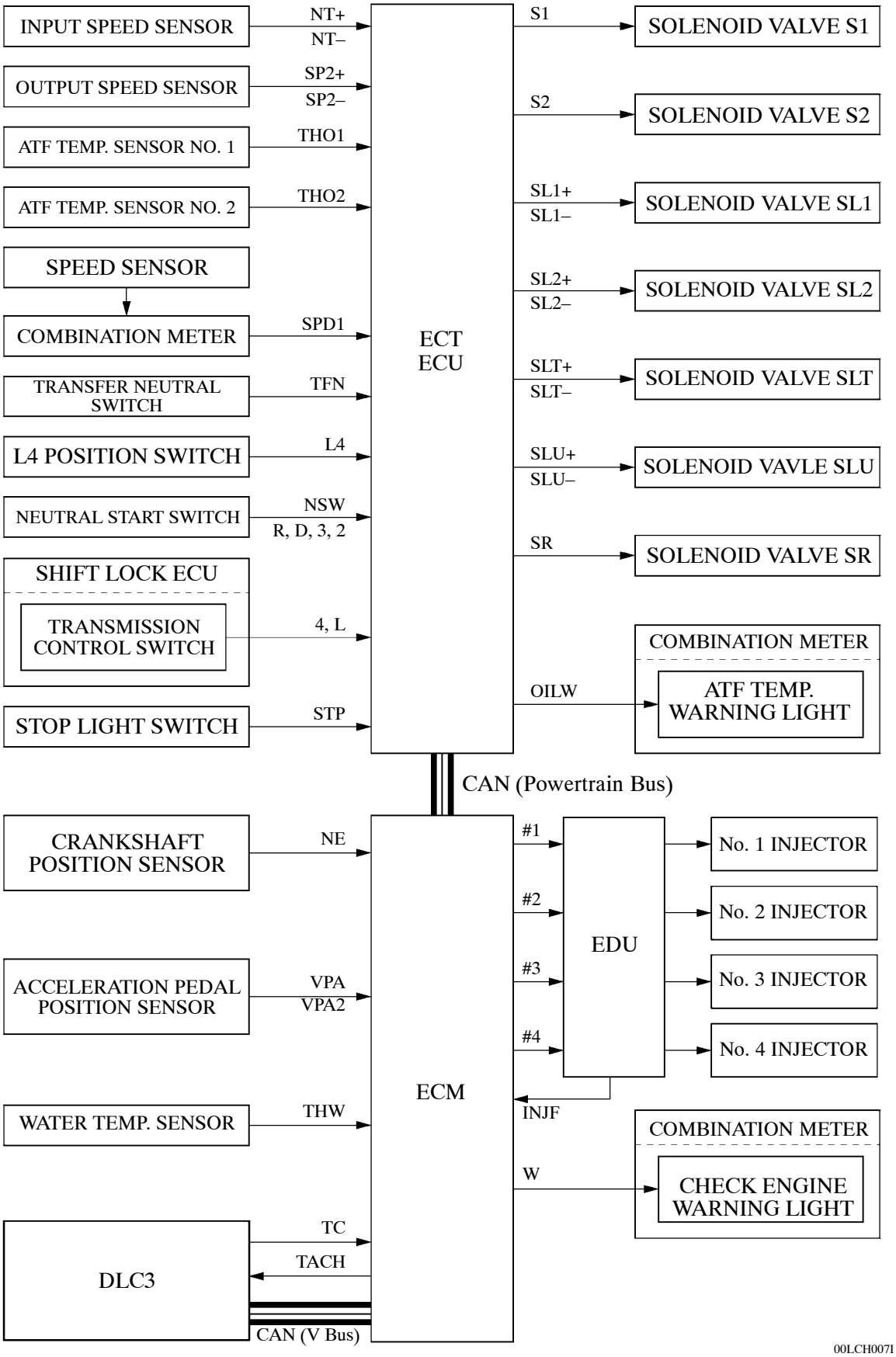


*: Models with A750F automatic transmission

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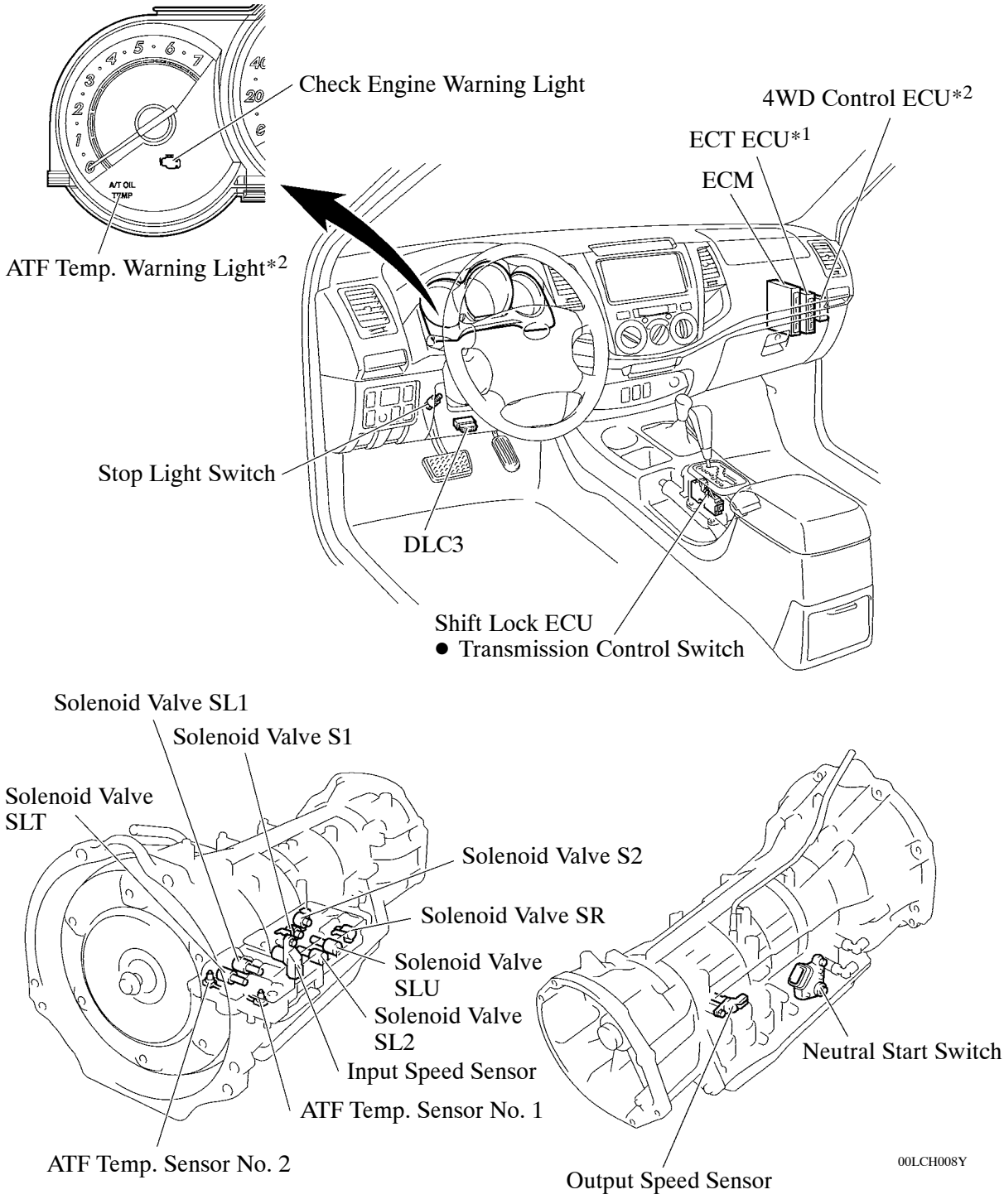
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▶ Models with 1KD-FTV Engine ◀



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3. Layout of Main Components



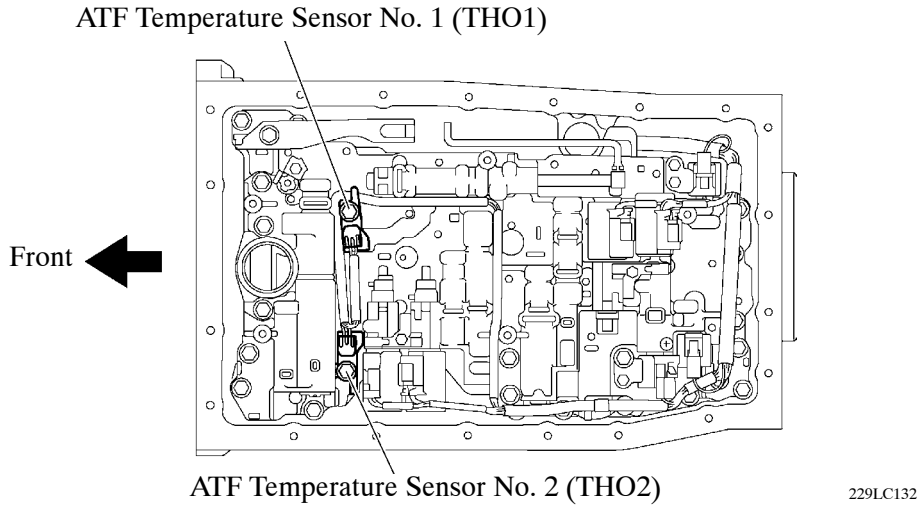
*1: Models with 1KD-FTV engine
*2: Models with A750F automatic transmission

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4. Construction and Operation of Main Components

ATF Temperature Sensors No. 1 and No. 2

- ATF temperature sensor No. 1 (THO1) is used for hydraulic pressure control. This sensor is used for revision of clutches and brakes pressure to ensure smooth shift quality every time.
- ATF temperature sensor No. 2 (THO2) is used for shifting of the shift timing control of ECT when the ATF temperature is high. However, on the 4WD model, it is also used for the ATF temperature warning light.

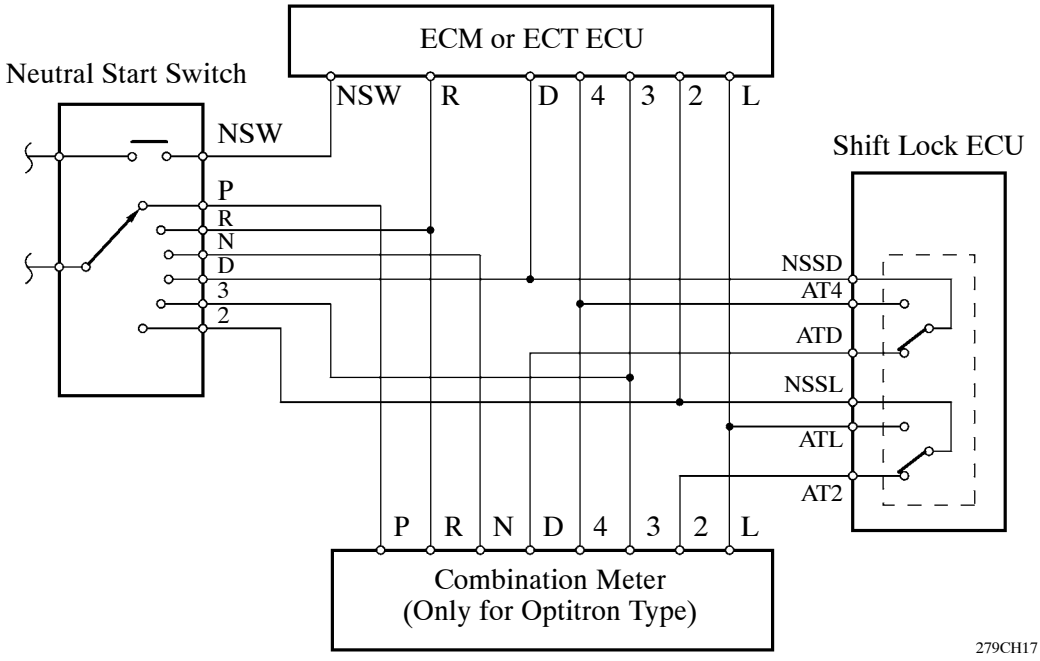


Transmission Control Switch and Neutral Start Switch

The ECM or ECT ECU uses these switches to detect the shift position.

- The neutral start switch sends the R, D, 3, 2, and NSW position signals to the ECM or ECT ECU. It also sends signals for the shift position indicator light (P, R, N, and 3) in the combination meter (only for Optitron type).
- The transmission control switch is located in the shift lock ECU. This switch sends the 4th and L signals to the ECM or ECT ECU. It also sends signals for the shift position indicator light (D, 4, 2 and L) in the combination meter (only for Optitron type).

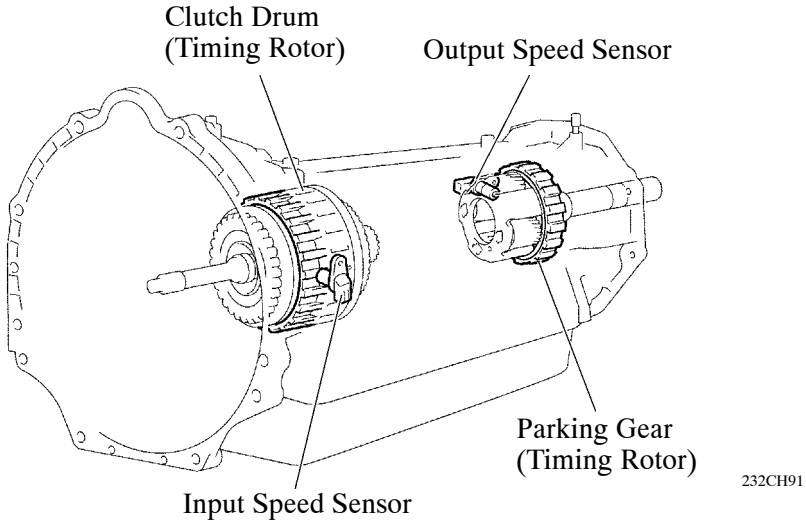
▶ Wiring Diagram ◀



Input Speed Sensor and Output Speed Sensor

The A750E and A750F automatic transmissions use an input speed sensor (for the NT signal) and output speed sensor (for the SP2 signal). Thus, the ECM or 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.

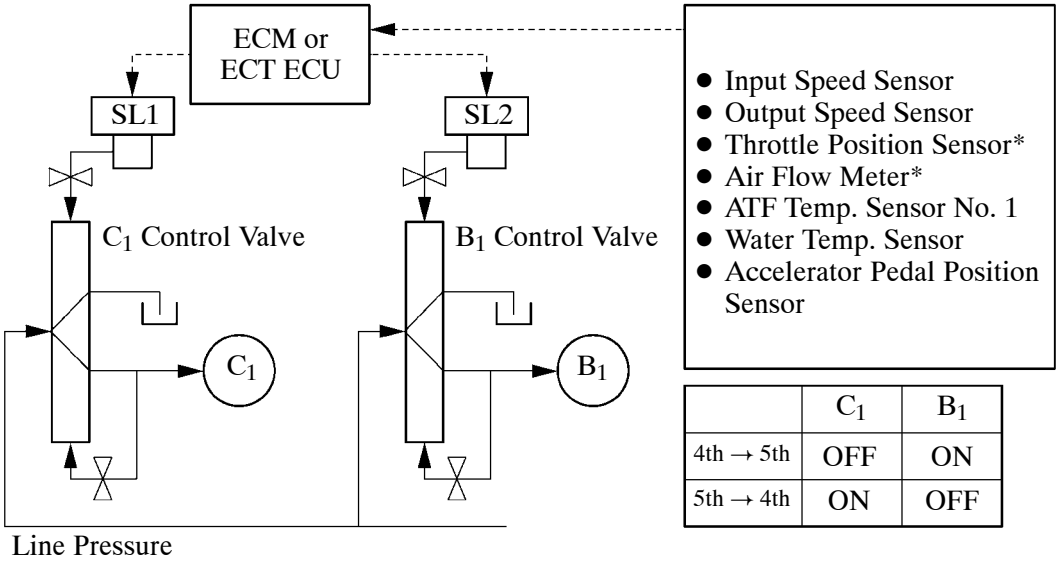
- These speed sensors are the pick-up coil type.
- The input speed sensor detects the input speed of the transmission. The clutch drum is used as the timing rotor for this sensor.
- The output speed sensor detects the speed of the output shaft. The parking gear on the rear planetary gear is used as the timing rotor for this sensor.



5. Clutch Pressure Control

Clutch to Clutch Pressure Control

This control is used for shifting from the 4th to 5th gear and from the 5th to 4th gear.
It actuates solenoid valves SL1 and SL2 in accordance with the signals from the ECM or ECT ECU, and guides this output pressure directly to the control valves B_1 and C_1 in order to regulate the line pressure that acts on the B_1 brake and C_1 clutch.
As a result, high response and excellent shift characteristics have been achieved.



	C_1	B_1
4th → 5th	OFF	ON
5th → 4th	ON	OFF

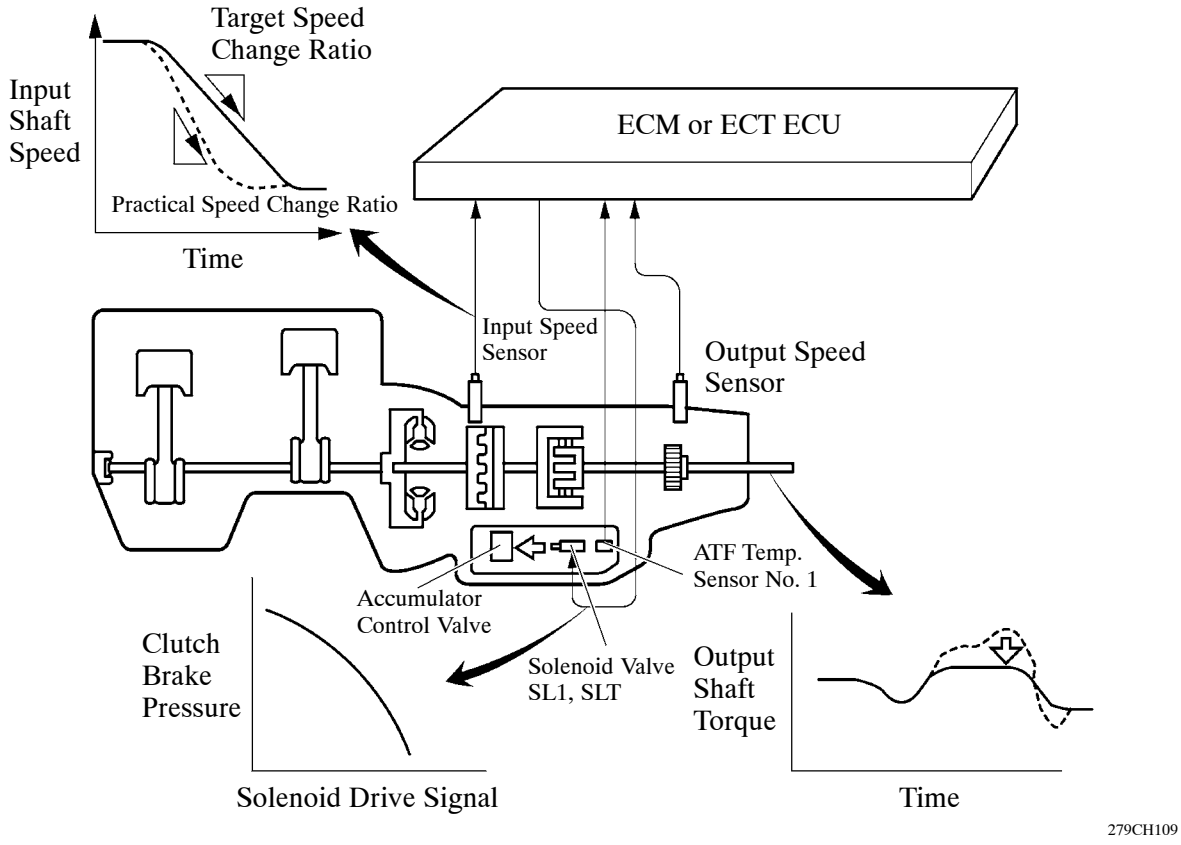
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*: Models with 1GR-FE engine

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Clutch Pressure Optimal Control

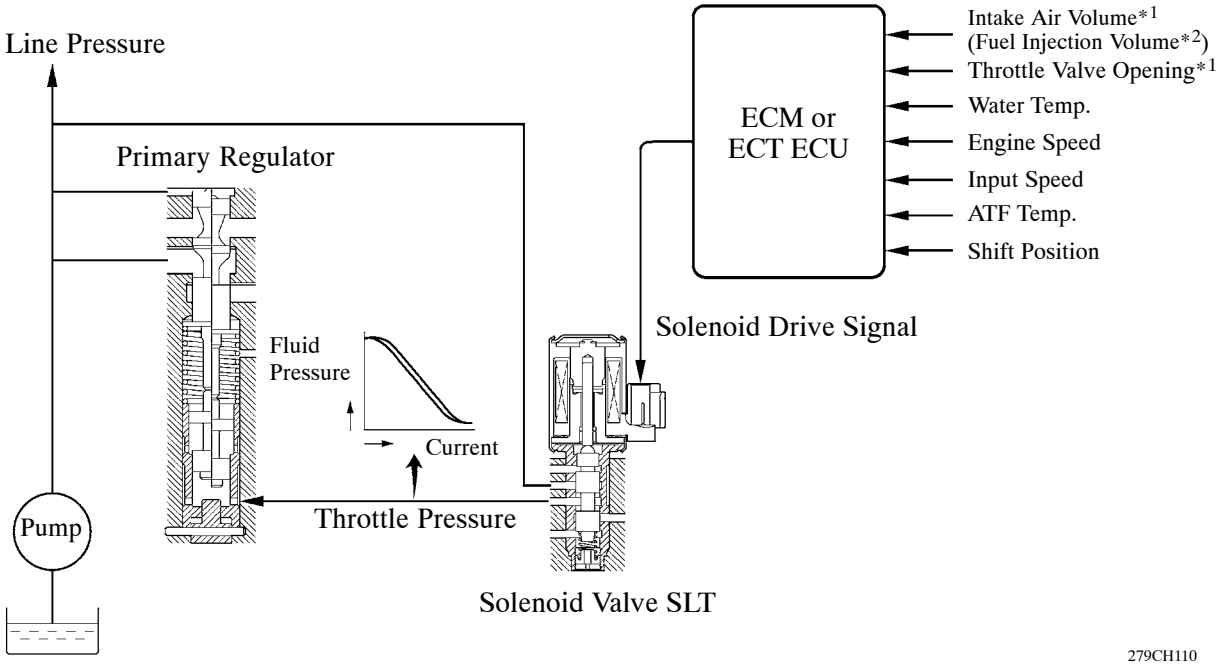
The ECM or ECT ECU monitors the signals from various types of sensor such as the input speed sensor, allowing solenoid valves SLT and SL1 to minutely control the clutch pressure in accordance with engine output and driving conditions. As a result, smooth shift characteristics have been achieved.



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 transmission.

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



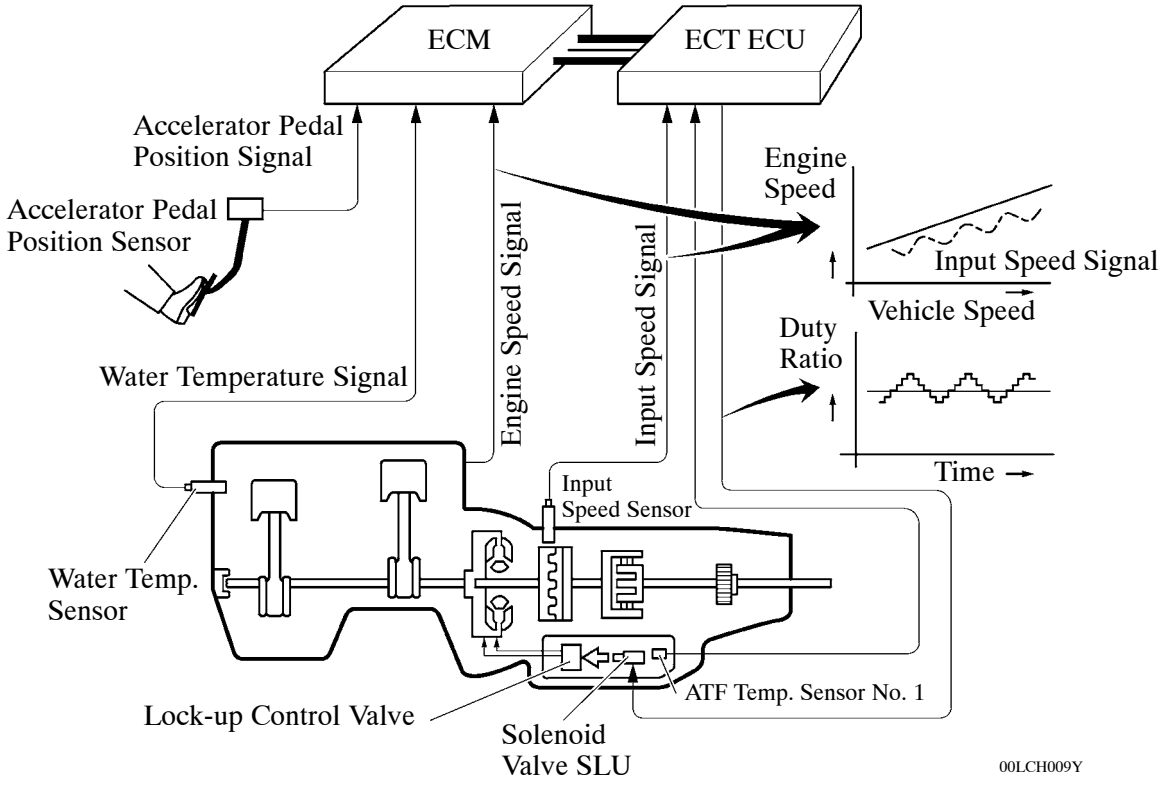
*1: Models with 1GR-FE engine

*2: Models with 1KD-FTV engine

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7. Flex Lock-up Clutch Control (Models with 1KD-FTV Engine)

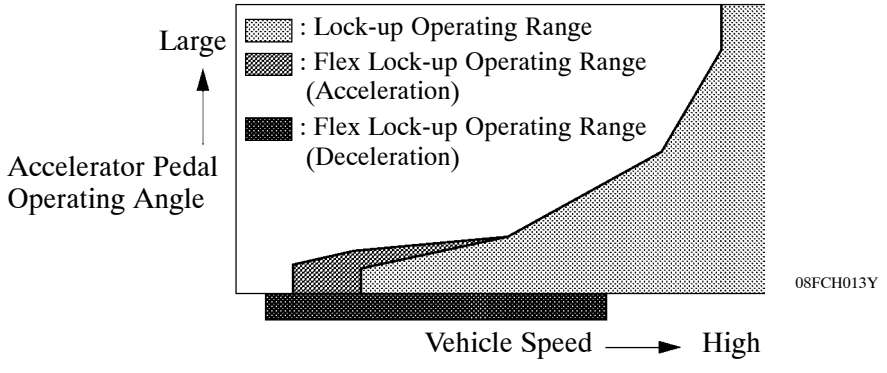
In the low-to-mid-speed range, this flex lock-up clutch control regulates the solenoid valve SLU to provide an intermediate mode between the ON and OFF operations of the lock-up clutch in order to improve the energy transmitting efficiency in this range.
As a result, the operating range of the lock-up clutch has been increased and fuel economy has been improved. The flex lock-up clutch control operates in the 3rd, 4th and 5th gears in the D position, and 4th gear in the 4 position.



▶ Flex Lock-up Operation Gear ◀

Shift Lever Position		D	4
Gear	1st	×	×
	2nd	×	×
	3rd	△	×
	4th	○	□
	5th	○	–

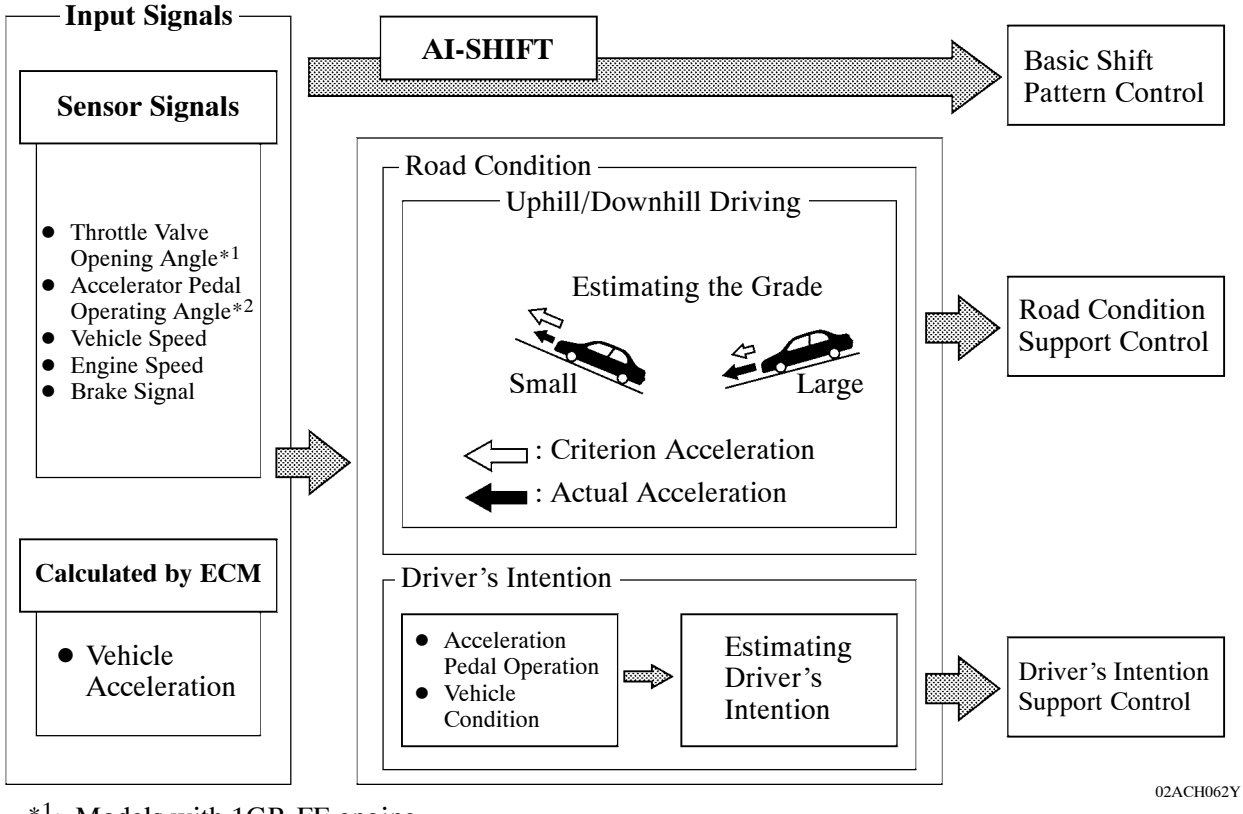
○: Flex Lock-up operates when the vehicle is accelerating and decelerating
△: Flex Lock-up operates when the vehicle is accelerating
□: Flex Lock-up operates when the vehicle is decelerating
×: Not operating



8. AI (Artificial Intelligence)-SHIFT Control

General

In addition to the switching of the shift pattern through the pattern select switch, the AI-SHIFT control enables the ECM or ECT ECU to estimate the road conditions and the driver's intention in order to automatically switch to the optimal shift pattern. As a result, a comfortable ride has been achieved.



*1: Models with 1GR-FE engine

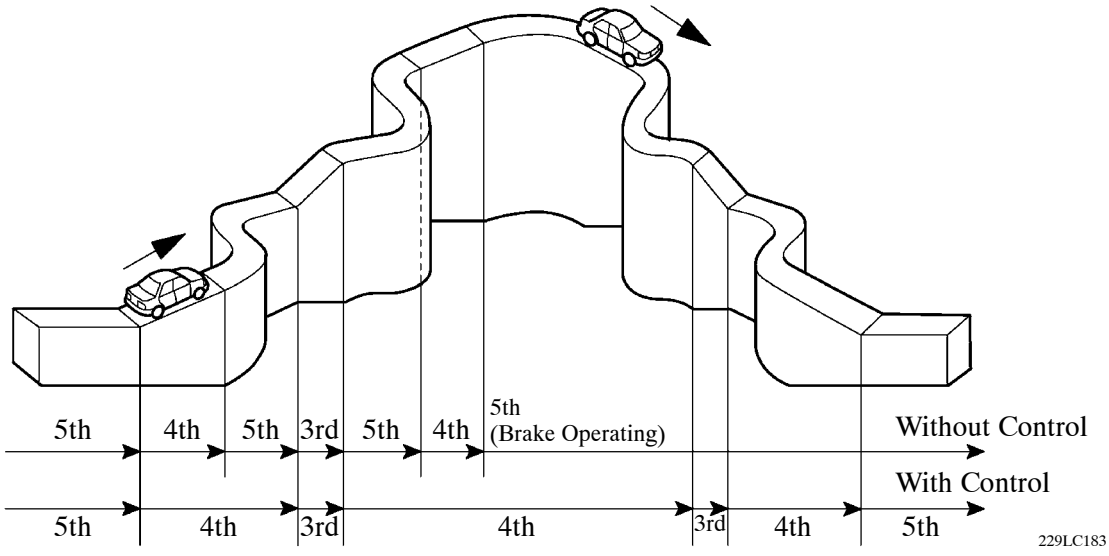
*2: Models with 1KD-FTV engine

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Road Condition Support Control

Under road condition support control, the ECM or ECT ECU identifies throttle valve opening angle, accelerator pedal operating angle and the vehicle speed whether the vehicle is being driven uphill or downhill.

To achieve an optimal drive force while driving uphill, this control prevents the transmission from upshifting to the 4th or 5th gear. To achieve an optimal engine brake effect while driving downhill, this control automatically downshifts the transmission to the 4th or 3rd gear.



Driver's Intention Support Control

Under driver's intention support control, the driver's intention is estimated based on the accelerator operation and vehicle condition to switch to a shift pattern that is well-suited to each driver.

9. Diagnosis

- When the ECM or ECT ECU detects a malfunction, it 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 to DLC3.

For details, refer to the Hilux Repair Manual.

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
Input Speed Sensor (NT)	During an input speed sensor malfunction, shift control is effected through the output speed sensor signal (SP2). During an input speed sensor malfunction, shift control is effected through the input speed sensor signal (SPD).
Output Speed Sensor (SP2)	During an output speed sensor malfunction, shift control is effected through the input speed sensor signal (NT). During an output speed sensor malfunction, shift control is effected through the input speed sensor signal (SPD).
ATF Temp. Sensor No. 1	During an ATF temperature sensor No. 1 malfunction, up-shifts to 5th and flex lock-up clutch control are prohibited. During an ATF temperature sensor No. 1 malfunction, the system effects control by fixing the ATF temperature at 80°C (176°F).
Solenoid Valves S1, S2 and SR	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 depending on the failed solenoid as described in the table on the next page.
Solenoid Valves SL1 and SL2	During a solenoid valve SL1 or SL2 malfunction, up-shifts to 5th and flex lock-up clutch control are prohibited.
Solenoid Valve SLU	During a solenoid valve SLU malfunction, the current to the solenoid valve is stopped. Because this stops lock-up control and flex lock-up clutch control, and fuel economy decreases.
Solenoid Valve SLT	During a solenoid valve SLT malfunction, the current to the solenoid valve is stopped. Because this stops line pressure optimal control, the shift shock increases. However, shifting is effected through normal clutch pressure control.

Position	Normal						Solenoid Valve S1 Malfunction					
	Solenoid Valve					Gear	Solenoid Valve					Gear
	S1	S2	SR	SL1	SL2		S1	S2	SR	SL1	SL2	
D	ON	OFF	OFF	OFF	ON	1st	×	OFF → ON	OFF	OFF	ON	4th → 3rd
	ON	ON	OFF	OFF	ON	2nd	×	ON	OFF	OFF	ON	3rd
	OFF	ON	OFF	OFF	ON	3rd	×	ON	OFF	OFF	ON	3rd
	OFF	OFF	OFF	OFF	ON	4th	×	OFF	OFF	OFF	ON	4th
	OFF	OFF	ON	ON	OFF	5th	×	OFF	ON	ON	OFF	5th
4	ON	OFF	OFF	OFF	ON	1st	×	OFF → ON	OFF	OFF	ON	4th → 3rd
	ON	ON	OFF	OFF	ON	2nd	×	ON	OFF	OFF	ON	3rd
	OFF	ON	OFF	OFF	ON	3rd	×	ON	OFF	OFF	ON	3rd
	OFF	OFF	OFF	OFF	ON	4th	×	OFF	OFF	OFF	ON	4th
3	ON	OFF	OFF	OFF	ON	1st	×	OFF → ON	OFF	OFF	ON → OFF	3rd → 3rd (E/B)
	ON	ON	OFF	OFF	ON	2nd	×	ON	OFF	OFF	ON → OFF	3rd → 3rd (E/B)
	OFF	ON	OFF	OFF	OFF	3rd (E/B)	×	ON	OFF	OFF	OFF	3rd (E/B)
2	ON	OFF	OFF	OFF	ON	1st	×	OFF	OFF	OFF	ON	1st
	ON	ON	ON	OFF	OFF	2nd (E/B)	×	ON	ON	OFF	OFF	3rd (E/B)
L	ON	OFF	OFF	OFF	OFF	1st (E/B)	×	OFF	OFF	OFF	OFF	1st (E/B)

Position	Solenoid Valve S2 Malfunction						Solenoid Valve SR Malfunction					
	Solenoid Valve					Gear	Solenoid Valve					Gear
	S1	S2	SR	SL1	SL2		S1	S2	SR	SL1	SL2	
D	ON	×	OFF	OFF	ON	1st	ON	OFF	×	OFF	ON	1st
	ON → OFF	×	OFF	OFF	ON	1st → 4th	ON	ON	×	OFF	ON	2nd
	OFF	×	OFF	OFF	ON	4th	OFF	ON	×	OFF	ON	3rd
	OFF	×	OFF	OFF	ON	4th	OFF	OFF	×	OFF	ON	4th
	OFF	×	ON	ON	OFF	5th	OFF	OFF	×	ON	OFF	4th
4	ON	×	OFF	OFF	ON	1st	ON	OFF	×	OFF	ON	1st
	ON → OFF	×	OFF	OFF	ON	1st → 4th	ON	ON	×	OFF	ON	2nd
	OFF	×	OFF	OFF	ON	4th	OFF	ON	×	OFF	ON	3rd
	OFF	×	OFF	OFF	ON	4th	OFF	OFF	×	OFF	ON	4th
3	ON	×	OFF	OFF	ON	1st	ON	OFF	×	OFF	ON	1st
	ON → OFF	×	OFF	OFF	ON → OFF	1st → 3rd (E/B)	ON	ON	×	OFF	ON	2nd
	OFF	×	OFF	OFF	OFF	3rd (E/B)	OFF	ON	×	OFF	OFF → ON	3rd (E/B) → 3rd
2	ON	×	OFF	OFF	ON	1st	ON	OFF	×	OFF	ON	1st
	ON → OFF	×	ON	OFF	OFF → ON	2nd (E/B) → 4th	ON	ON	×	OFF	OFF	2nd
L	ON	×	OFF	OFF	OFF	1st (E/B)	ON	OFF	×	OFF	OFF	1st (E/B)

Position	Solenoid Valves S1 and S2 Malfunction						Solenoid Valves S1 and SR Malfunction					
	Solenoid Valve					Gear	Solenoid Valve					Gear
	S1	S2	SR	SL1	SL2		S1	S2	SR	SL1	SL2	
D	×	×	OFF	OFF	ON	4th	×	OFF → ON	×	OFF	ON	4th → 3rd
	×	×	OFF	OFF	ON	4th	×	ON	×	OFF	ON	3rd
	×	×	OFF	OFF	ON	4th	×	ON	×	OFF	ON	3rd
	×	×	OFF	OFF	ON	4th	×	OFF	×	OFF	ON	4th
	×	×	ON	ON	OFF	5th	×	OFF	×	ON → OFF	OFF → ON	4th
4	×	×	OFF	OFF	ON	4th	×	OFF → ON	×	OFF	ON	4th → 3rd
	×	×	OFF	OFF	ON	4th	×	ON	×	OFF	ON	3rd
	×	×	OFF	OFF	ON	4th	×	ON	×	OFF	ON	3rd
	×	×	OFF	OFF	ON	4th	×	OFF	×	OFF	ON	4th
3	×	×	OFF	OFF	ON → OFF	3rd → 3rd (E/B)	×	OFF → ON	×	OFF	ON	3rd
	×	×	OFF	OFF	ON → OFF	3rd → 3rd (E/B)	×	ON	×	OFF	ON	3rd
	×	×	OFF	OFF	OFF	3rd (E/B)	×	ON	×	OFF	OFF → ON	3rd (E/B) → 3rd
2	×	×	OFF	OFF	ON	1st	×	OFF	×	OFF	ON	1st
	×	×	ON	OFF	OFF → ON	4th	×	ON	×	OFF	OFF	2nd
L	×	×	OFF	OFF	OFF	1st (E/B)	×	OFF	×	OFF	OFF	1st (E/B)

Position	Solenoid Valves S2 and SR Malfunction						Solenoid Valves S1, S2 and SR Malfunction					
	Solenoid Valve					Gear	Solenoid Valve					Gear
	S1	S2	SR	SL1	SL2		S1	S2	SR	SL1	SL2	
D	ON	×	×	OFF	ON	1st	×	×	×	OFF	ON	4th
	ON → OFF	×	×	OFF	ON	1st → 4th	×	×	×	OFF	ON	4th
	OFF	×	×	OFF	ON	4th	×	×	×	OFF	ON	4th
	OFF	×	×	OFF	ON	4th	×	×	×	OFF	ON	4th
	OFF	×	×	ON → OFF	OFF → ON	4th	×	×	×	ON → OFF	OFF → ON	4th
4	ON	×	×	OFF	ON	1st	×	×	×	OFF	ON	4th
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	OFF	×	×	OFF	ON	4th	×	×	×	OFF	ON	4th
	OFF	×	×	OFF	ON	4th	×	×	×	OFF	ON	4th
3	ON	×	×	OFF	ON	1st	×	×	×	OFF	ON	3rd
	ON → OFF	×	×	OFF	ON	1st → 3rd	×	×	×	OFF	ON	3rd
	OFF	×	×	OFF	OFF → ON	3rd (E/B) → 3rd	×	×	×	OFF	OFF → ON	3rd (E/B) → 3rd
2	ON	×	×	OFF	ON	1st	×	×	×	OFF	ON	1st
	ON	×	×	OFF	OFF → ON	1st (E/B) → 1st	×	×	×	OFF	OFF → ON	1st (E/B) → 1st
L	ON	×	×	OFF	OFF	1st (E/B)	×	×	×	OFF	OFF	1st (E/B)

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