## ■ELECTRONIC CONTROL SYSTEM

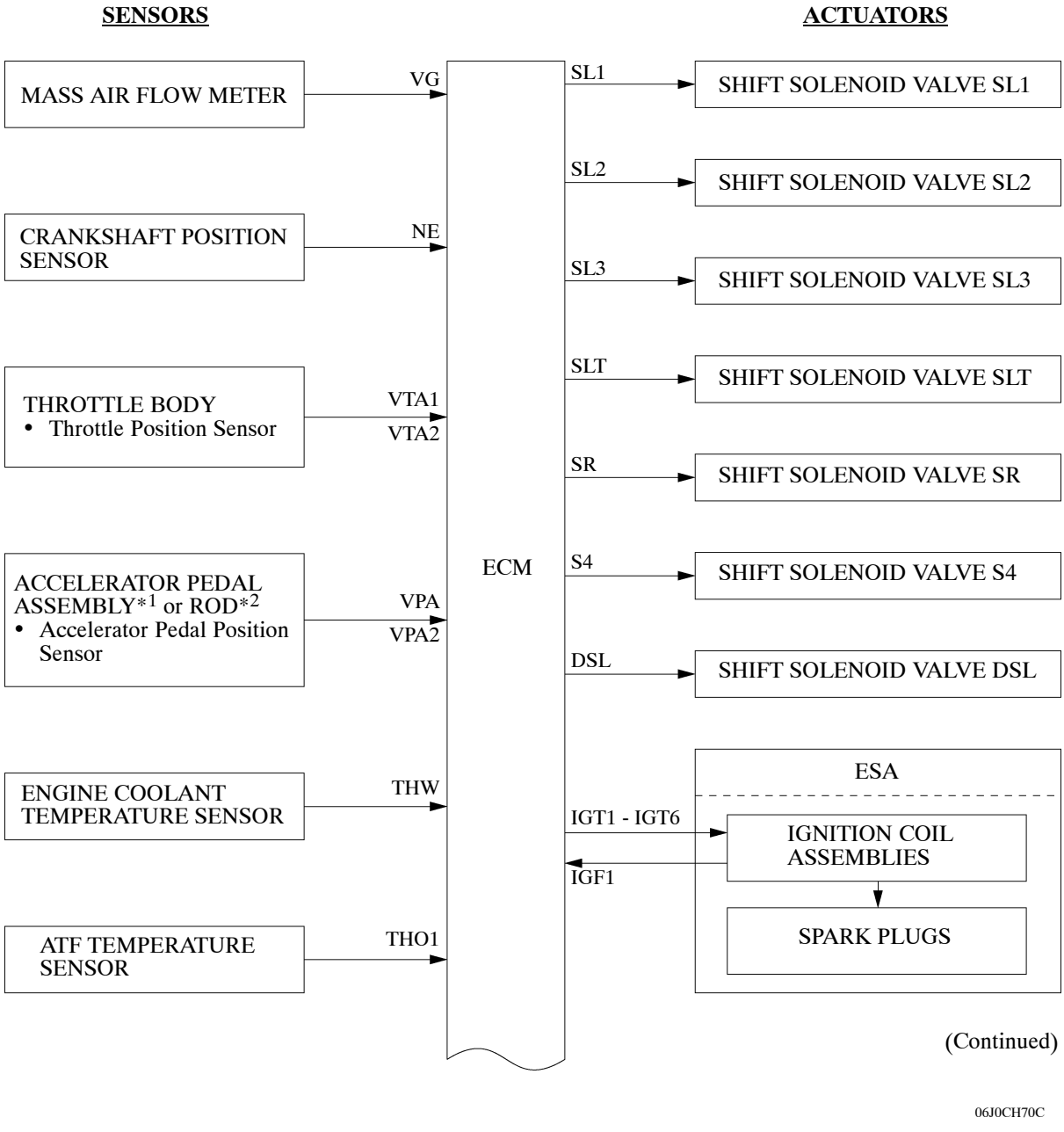
### 1. General

The electronic control system of the U151E and U151F automatic transaxles consists of the controls listed below.

| System | Function |
|---|---|
| Clutch Pressure Control (See page CH-28) | Controls the pressure that is applied directly to $B_1$ brake, $C_0$ and $C_1$ clutches by actuating 3 shift solenoid valves (SL1, SL2 and SL3) in accordance with ECM signals. The 3 shift solenoid valves (SL1, SL2 and SL3) minutely control the clutch pressure in accordance with the engine output and driving conditions. |
| Line Pressure Optimal Control (See page CH-29) | Actuates the shift solenoid valve SLT to control the line pressure in accordance with information from the ECM 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 Timing Control | The ECM sends current to shift solenoid valves (SL1, SL2 and/or SL3) to select gears, based on the signals from various sensors. |
| “N” to “D” Squat Control | When the shift lever is shifted from “N” to “D” position, 3rd gear is temporarily selected before 1st to reduce vehicle squat. |
| Lock-up Timing Control | The ECM sends current to the shift solenoid valves DSL and SL2 to engage or disengage the lock-up clutch, based on signals from various sensors. |
| Flex Lock-up Clutch Control (See page CH-30) | The shift solenoid valves SL2 and DSL are used to provide 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. Shift solenoid valve SL2 is used for the gradual engagement of flex lock-up. |
| Shifting Control in Uphill/Downhill Traveling (See page CH-31) | Restricts 4th or 5th gear upshift or to provide appropriate engine braking by the ECM to determine whether the vehicle is traveling uphill or downhill. |
| Multi-mode Automatic Transmission (See page CH-32) | The ECM appropriately controls the automatic transmission in accordance with the range position selected while the shift lever is in the S mode position. |
| Diagnosis (See page CH-36) | When the ECM detects a malfunction, the ECM records it and information related to the fault. |
| Fail-safe (See page CH-36) | Even if a malfunction is detected in the sensors or solenoids, the ECM performs fail-safe control to help allow the vehicle to continue to be driven. |

## 2. Construction

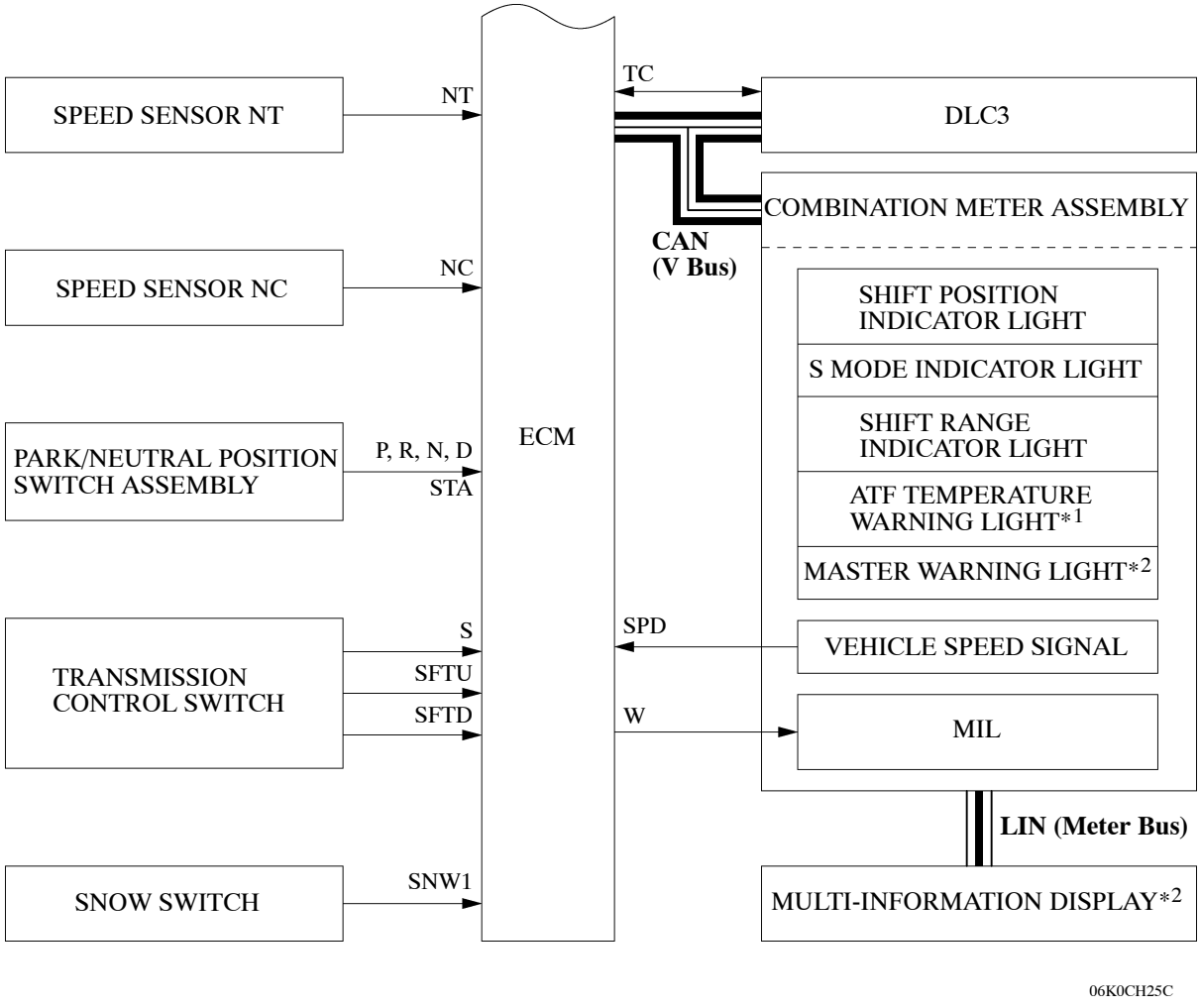
The configuration of the electronic control system in the U151E and U151F automatic transaxles is as shown in the following chart.




(Continued)

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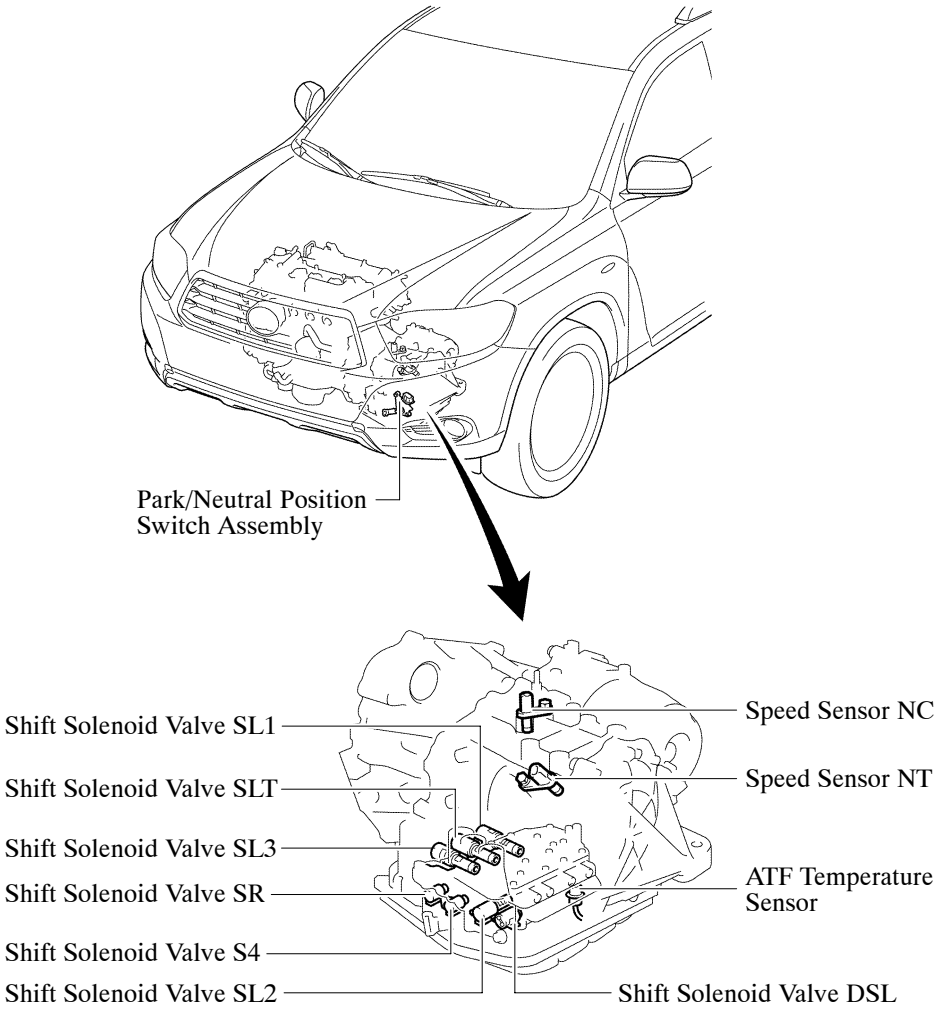
*1: Models for Australia
*2: Models for China




*1: Models without Multi-information Display for China
*2: Models with Multi-information Display

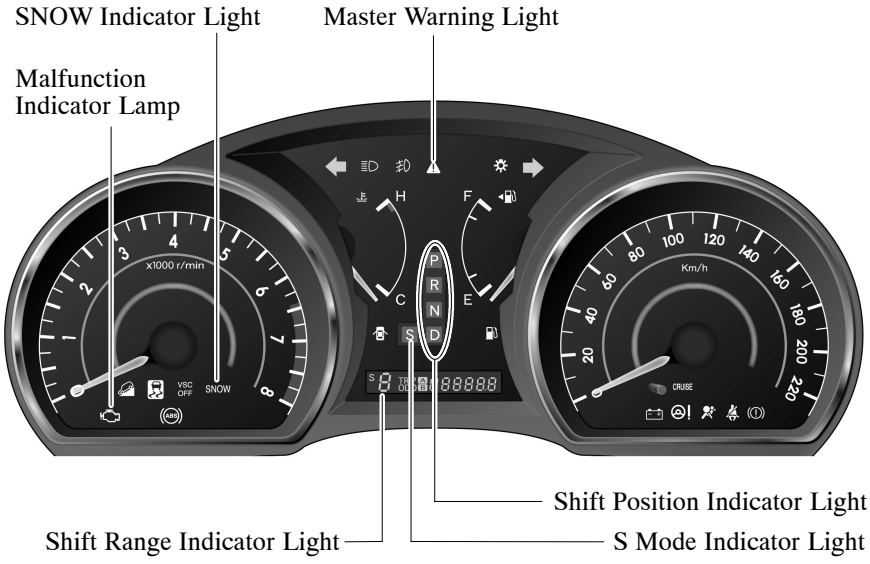
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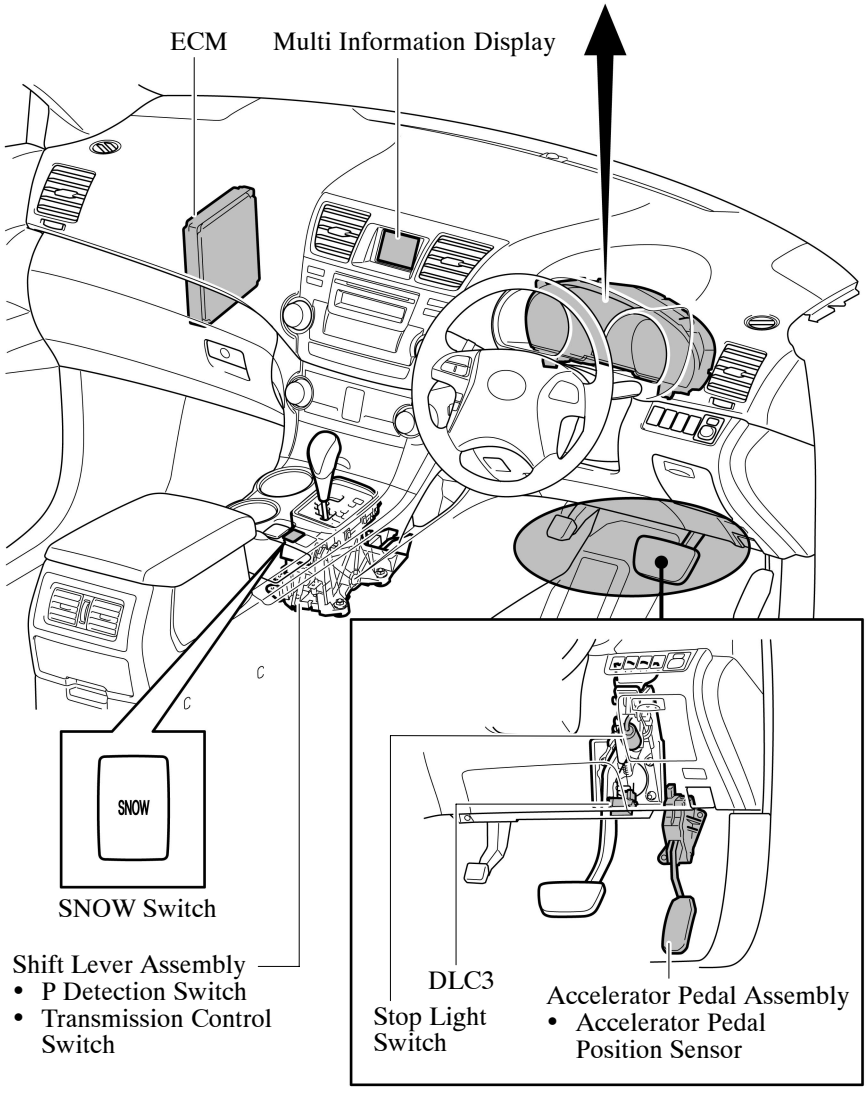
## 3. Layout of Main Components




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**▶ Models for Australia ◀**

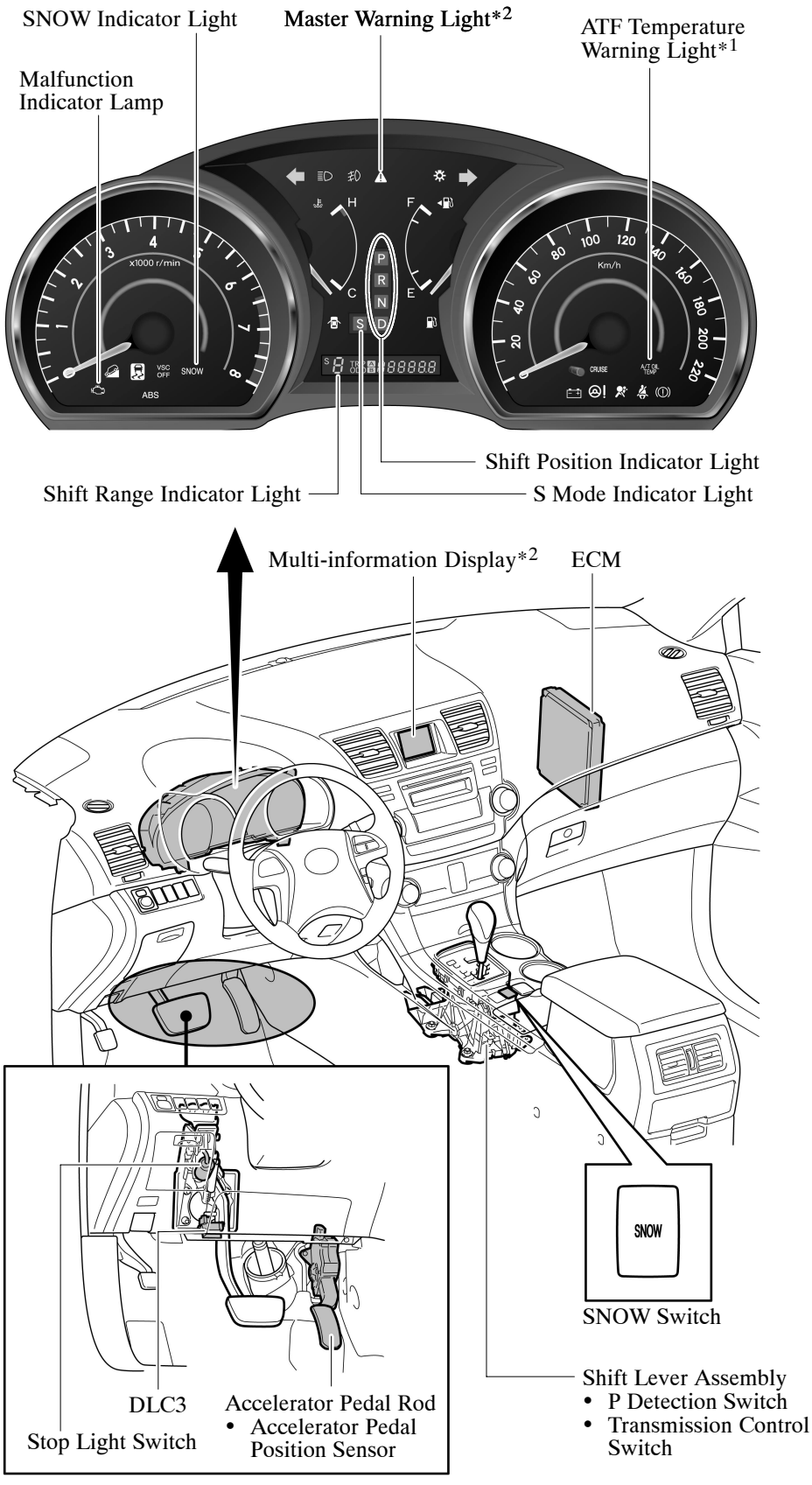



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**▶ Models for China ◀**



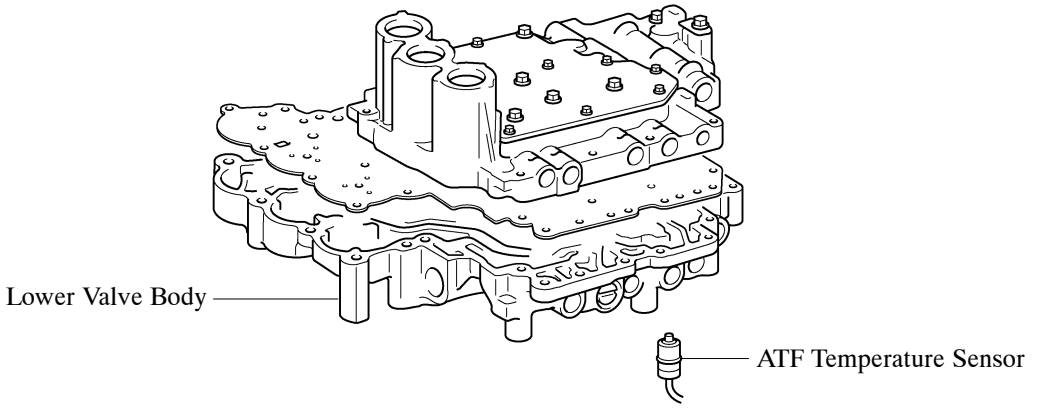

06K0CH01Z

*1: Models without Multi-information Display
*2: Models with Multi-information Display

## 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. This sensor is used for correction of clutch and brake pressure to keep smooth shift quality every time.



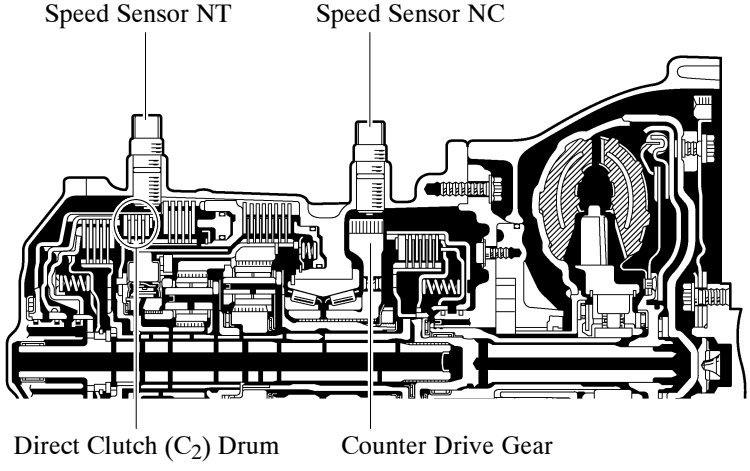

241CH87



### Speed Sensor NT and Speed Sensor NC

The U151E and U151F automatic transaxles use a speed sensor NT and a speed sensor NC. Thus, the ECM 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.

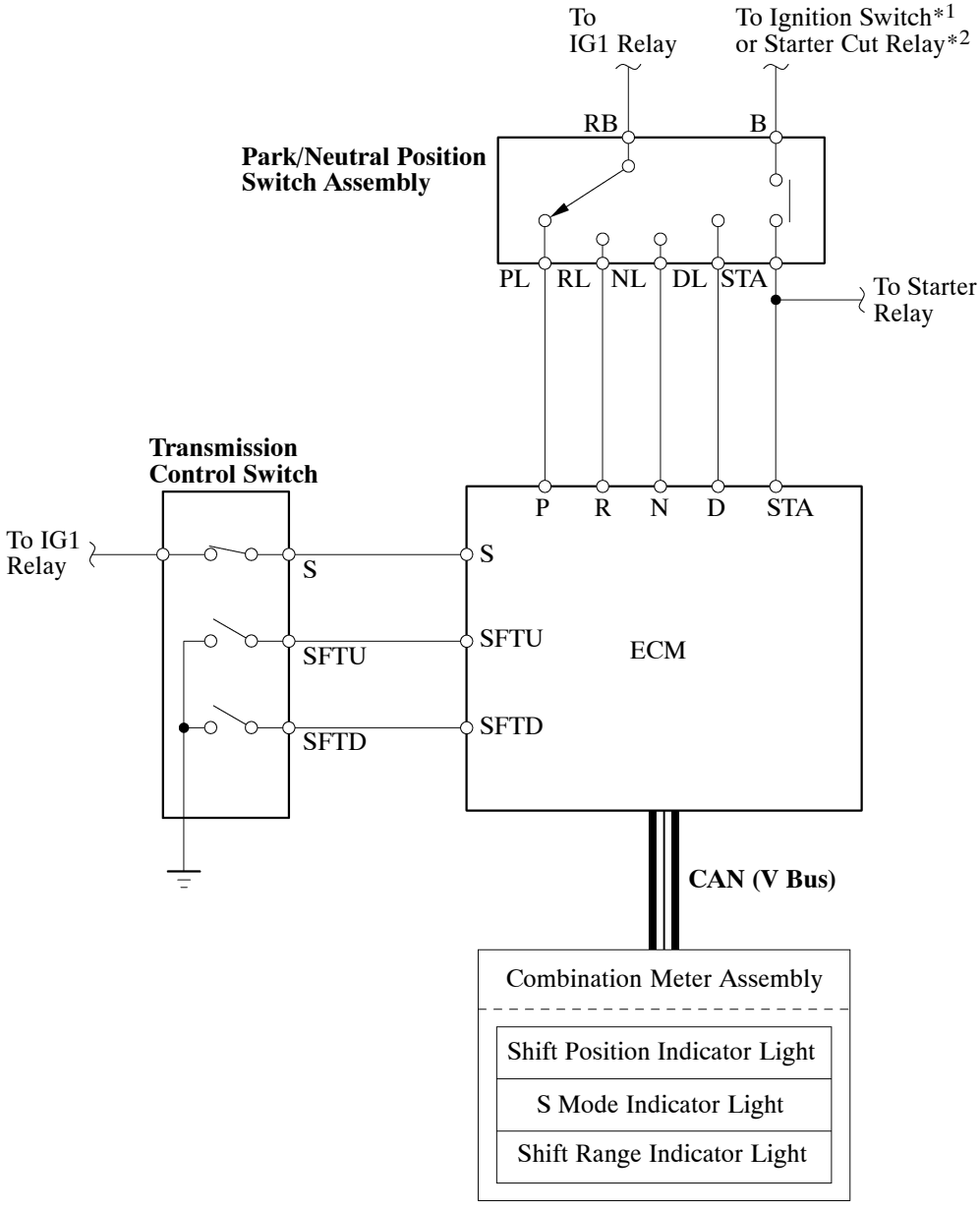
- The speed sensor NT detects the input speed (input turbine speed signal) of the transaxle. The direct clutch ($C_2$) drum is used as the timing rotor for this sensor.
- The speed sensor NC detects the speed of the counter drive gear. The counter drive gear is used as the timing rotor for this sensor.




211CH16

### Park/Neutral Position Switch Assembly and Transmission Control Switch

- The park/neutral position switch assembly sends the P, R, N, and D position, and STA signals to the ECM.
- The transmission control switch detects whether the shift lever is in the D position or in the S mode position.
- When the shift lever is in the S mode position and the shift lever is moved to "+" or "-", the transmission control switch sends signals to the ECM.




06J0CH71C

*1: Models without Smart Entry and Start System
*2: Models with Smart Entry and Start System

### SNOW Switch

The SNOW switch is a momentary-type switch.

- If the shift lever is in the D position when the switch is pushed once, SNOW mode will be selected. If the SNOW switch is operated again, or the power source is changed to IG OFF*, SNOW mode will be cancelled.

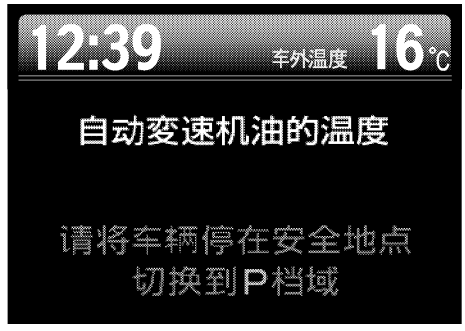
*: The power source condition can be changed by operating the engine switch on models with the smart entry and start system, and the ignition switch on models without the smart entry and start system.

### Multi-information Display

The multi-information display will show a warning message if the ATF temperature exceeds 140°C (284°F).




**Models for Australia**



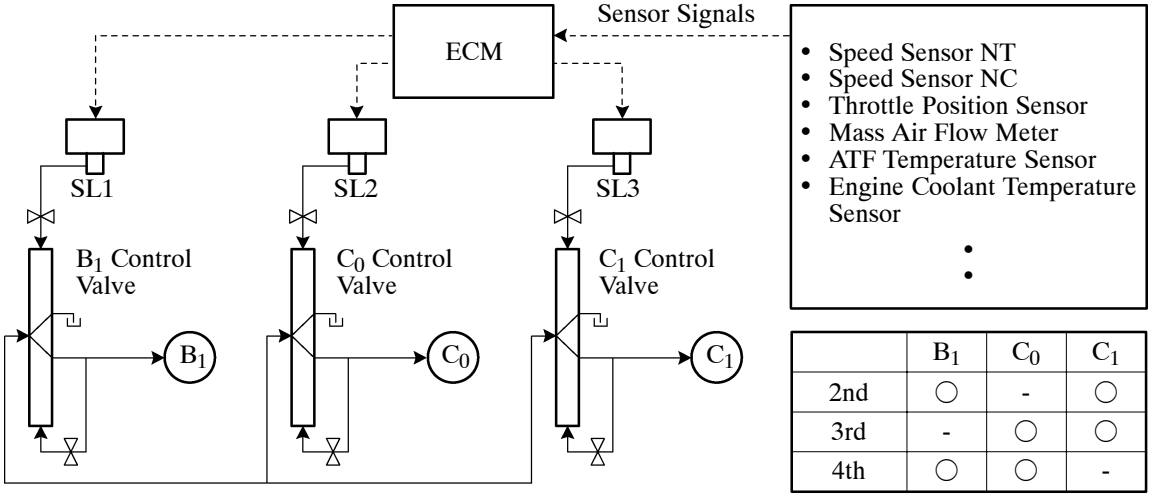

**Models for China**

06K0CH20C

## 5. Clutch Pressure Control

### Clutch to Clutch Pressure Control

This control is used for shifting from 2nd to 3rd gear, and from 3rd to 4th gear.
Shift solenoid valves SL1, SL2, and SL3 are actuated in accordance with the signals from the ECM, 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 are realized.



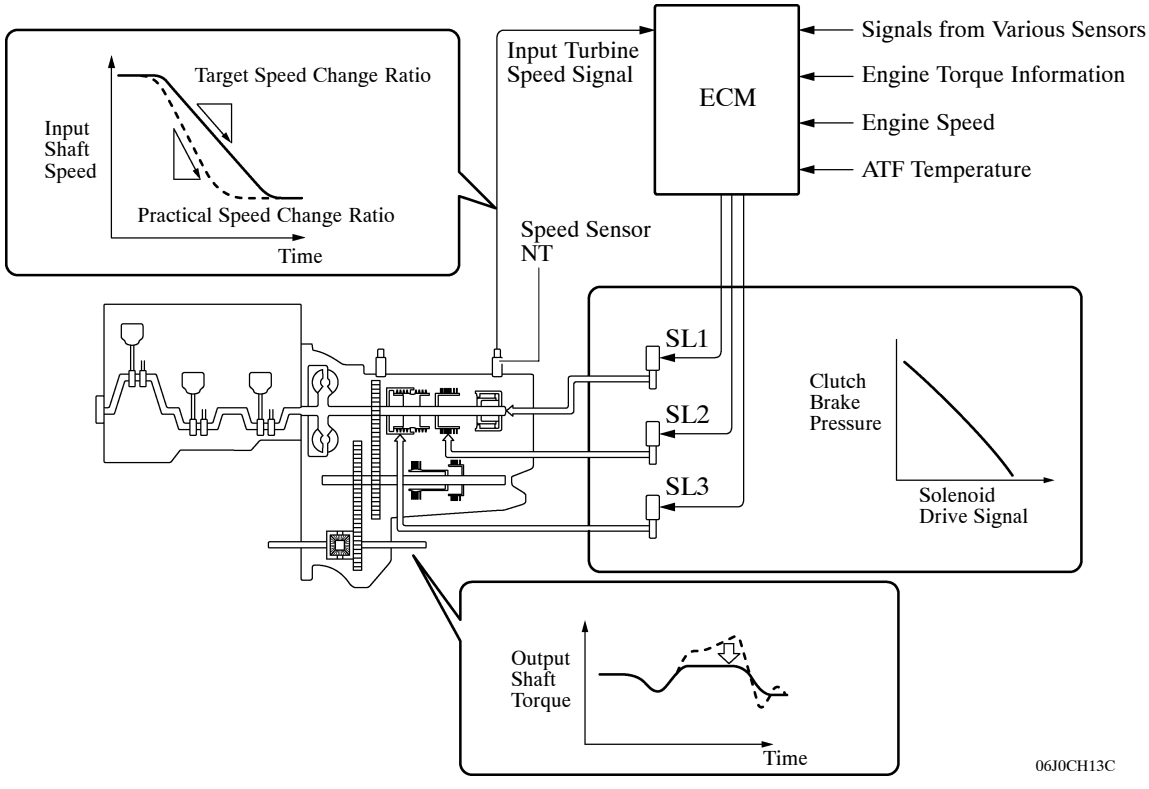

| | $B_1$ | $C_0$ | $C_1$ |
|---|---|---|---|
| 2nd | ○ | - | ○ |
| 3rd | - | ○ | ○ |
| 4th | ○ | ○ | - |

○: ON -: OFF

06J0CH12C

### Clutch Pressure Optimal Control

The ECM monitors the signals from various sensors such as the speed sensor NT lowing shift solenoid valves SL1, SL2, and SL3 to precisely control the clutch pressure in accordance with engine output and driving conditions. As a result, smooth shift characteristics are realized.

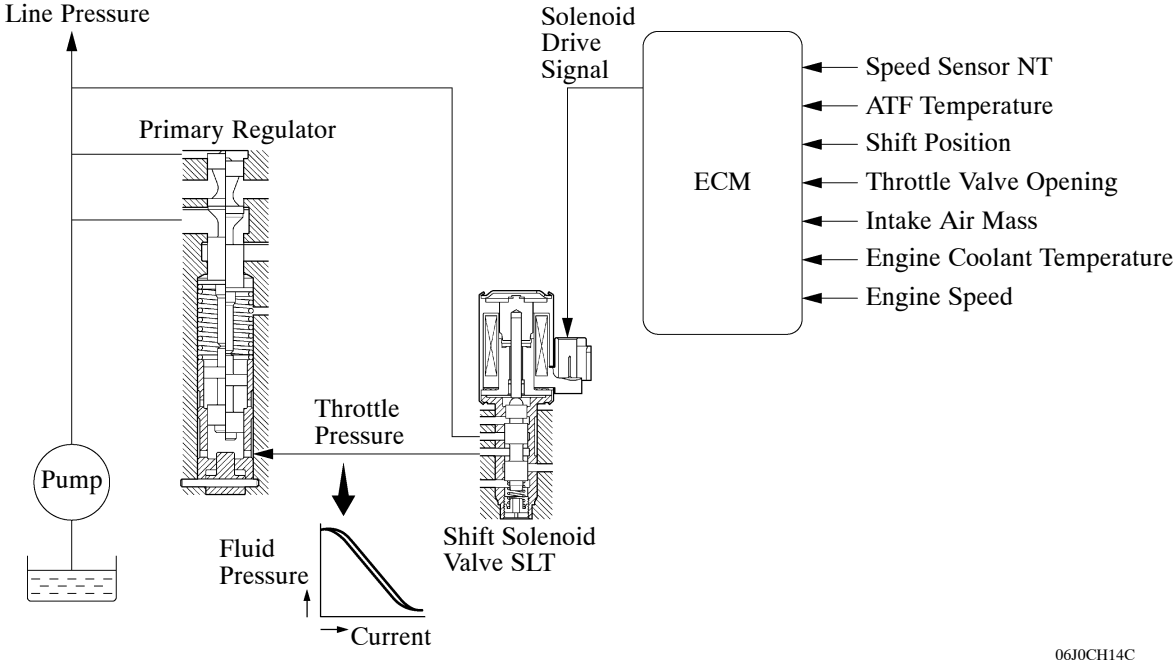



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## 6. Line Pressure Optimal Control

Through the use of the shift 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 clutch assembly and the transaxle.

Accordingly, the line pressure can be controlled precisely in accordance with engine output, driving conditions, and ATF temperature, thus realizing smooth shift characteristics and reducing the energy consumption of the oil pump assembly.

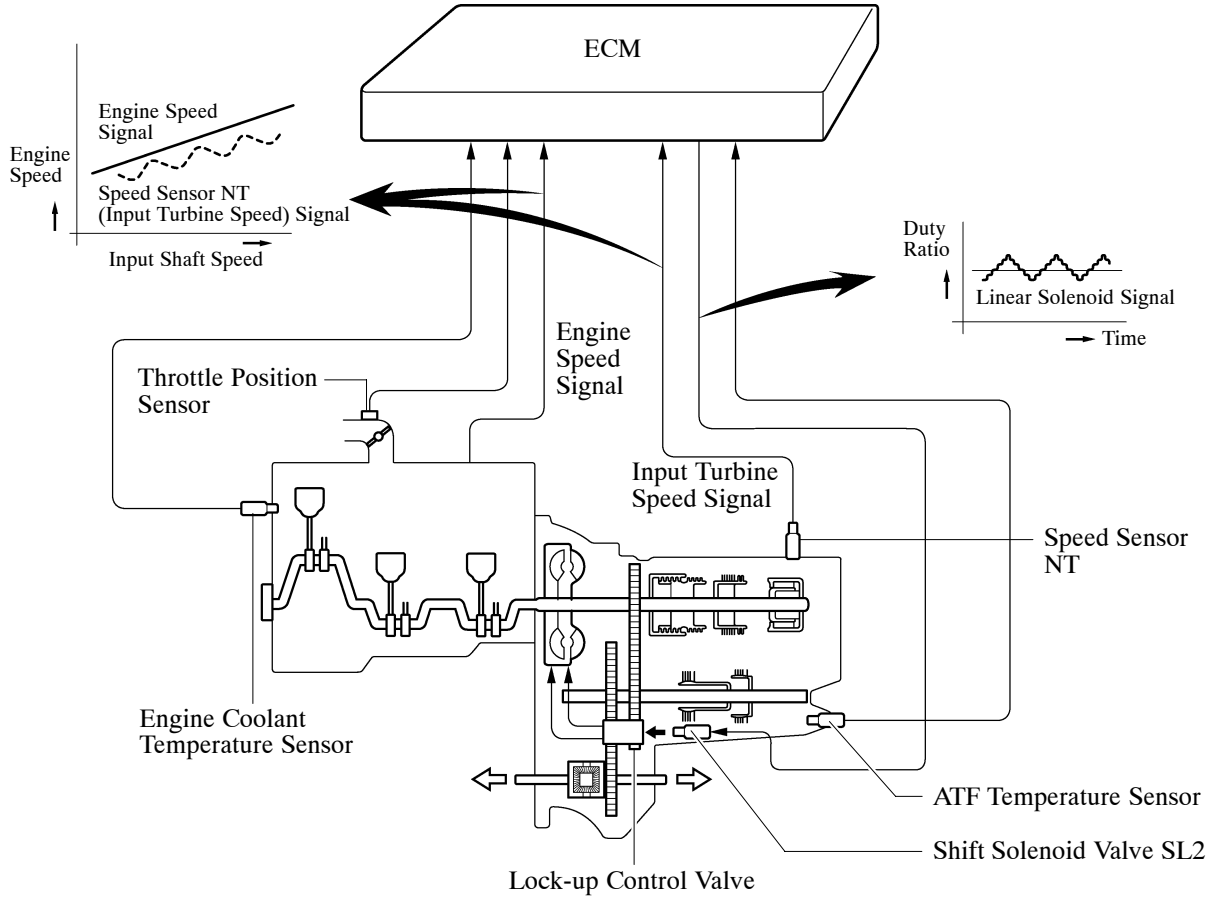


## 7. Flex Lock-up Clutch Control

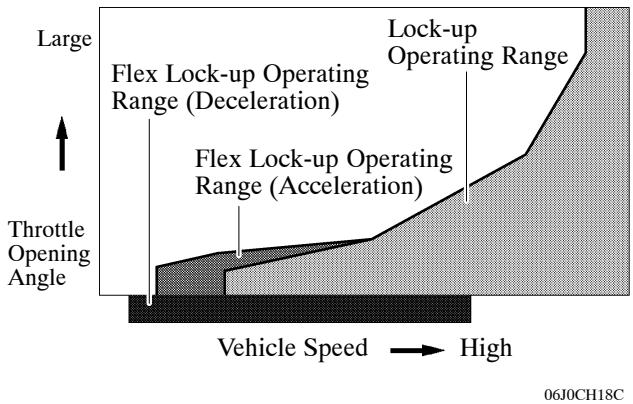
In the low-to-mid-speed range, this flex lock-up clutch control regulates the solenoid valve SL2 to provide an intermediate mode between the ON and OFF states of the lock-up clutch in order to improve the energy transmitting efficiency in this range.

As a result, the operating range of the lock-up clutch is increased and fuel economy is improved. The flex lock-up clutch control operates in 4th and 5th gears in the D position and S5 range, 4th gear in the S4 range.

- Even when the vehicle is decelerating (the accelerator pedal is released), the flex lock-up clutch control operates. Therefore, fuel-cut area of the engine is expanded and fuel-economy is improved.




06J0CH17C




06J0CH18C

**▶ Flex Lock-up Operation Gear in Each Range ◀**

| Position | Gear | Acceleration Flex Lock-up | Deceleration Flex Lock-up |
|---|---|---|---|
| D, S5 | 1st | × | × |
| | 2nd | × | × |
| | 3rd | × | × |
| | 4th | ○ | ○ |
| | 5th | ○ | ○ |
| S4 | 1st | × | × |
| | 2nd | × | × |
| | 3rd | × | × |
| | 4th | × | ○ |

× = Off ○ = Operates

## 8. Shifting Control in Uphill/Downhill Traveling

### 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.

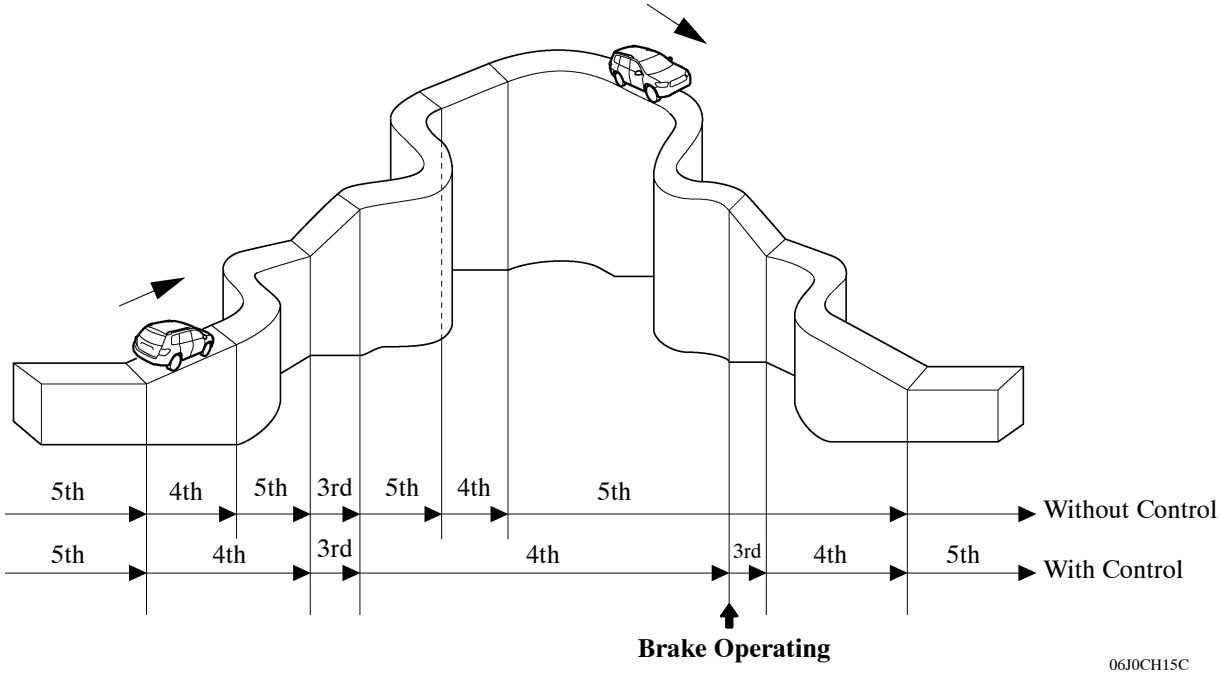
### Shift Control in Uphill Traveling

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

### Shift Control in Downhill Traveling

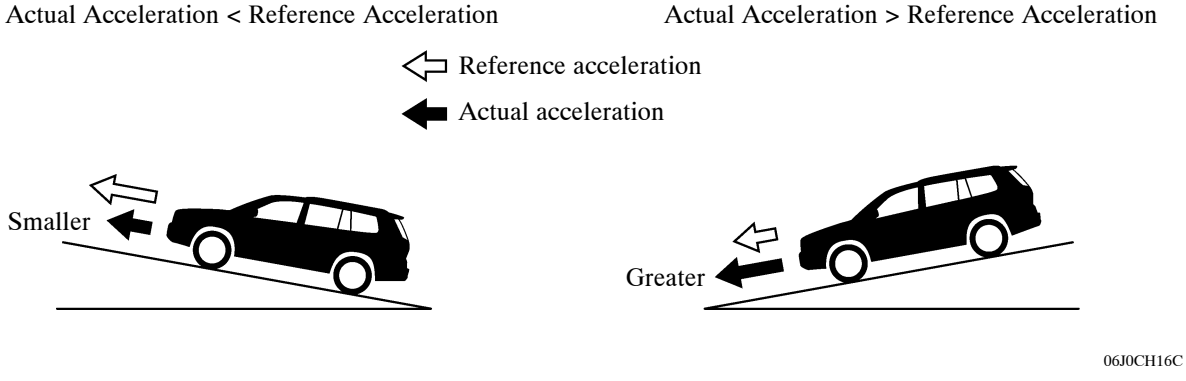
When the ECM determines downhill travel, it shifts down the transaxle from 5th to 4th in accordance with the brake operation signal that is input when the driver operates the brake pedal.
When the ECM determines downhill travel with a steeper grade, and a brake operation signal is input again, the ECM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



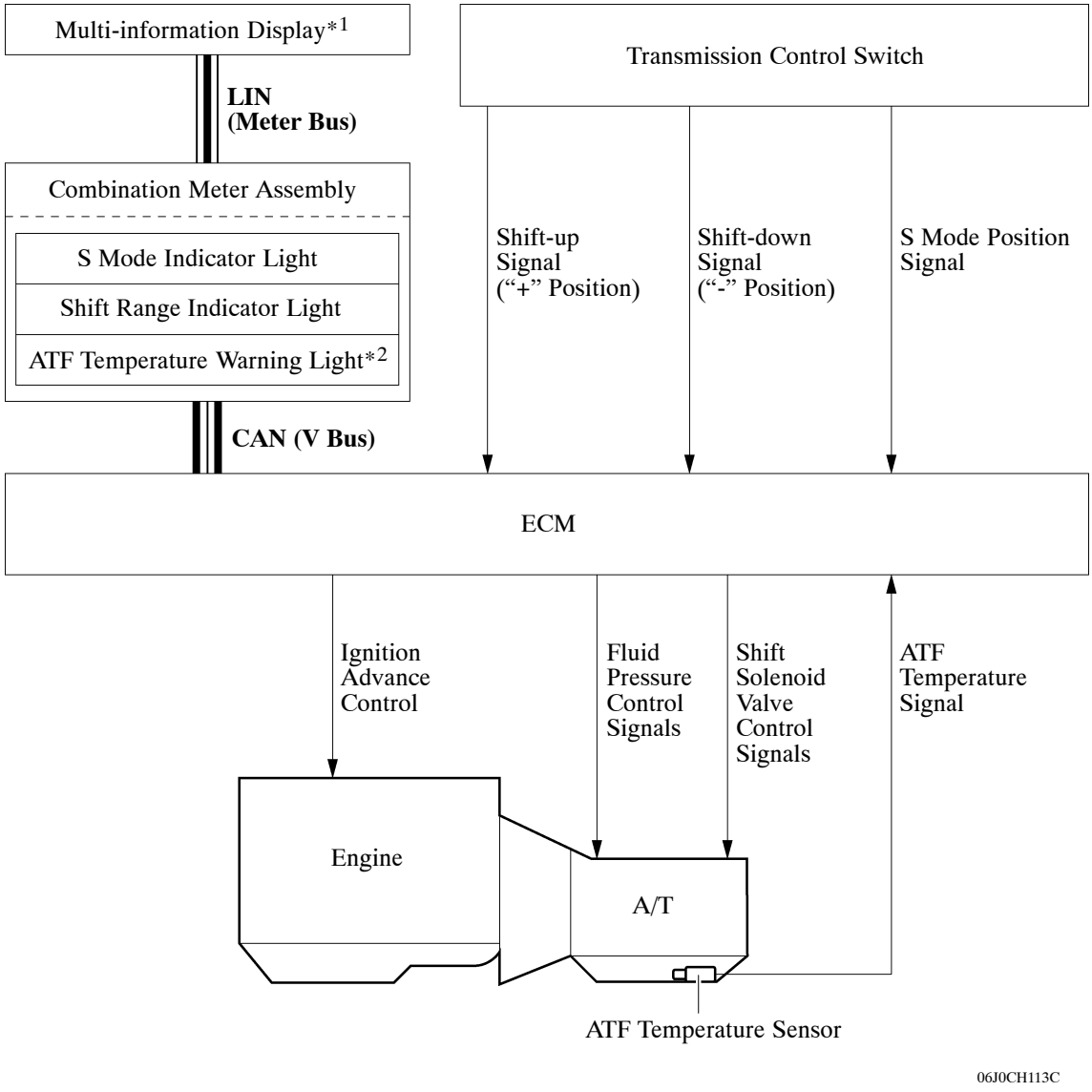
## 9. Multi-mode Automatic Transmission

### General

A multi-mode automatic transmission is designed to allow the driver to switch the gear ranges (a multi-mode transmission is not for manually selecting single gears). After shifting the shift lever to the S mode position and moving the shift lever to the "+" position or to the "-" position, the driver can select the desired shift range. Thus, the driver is able to shift gears with a manual-like feel.

- An automatic up-shift function is provided to protect the transmission.

**▶ System Diagram ◀**



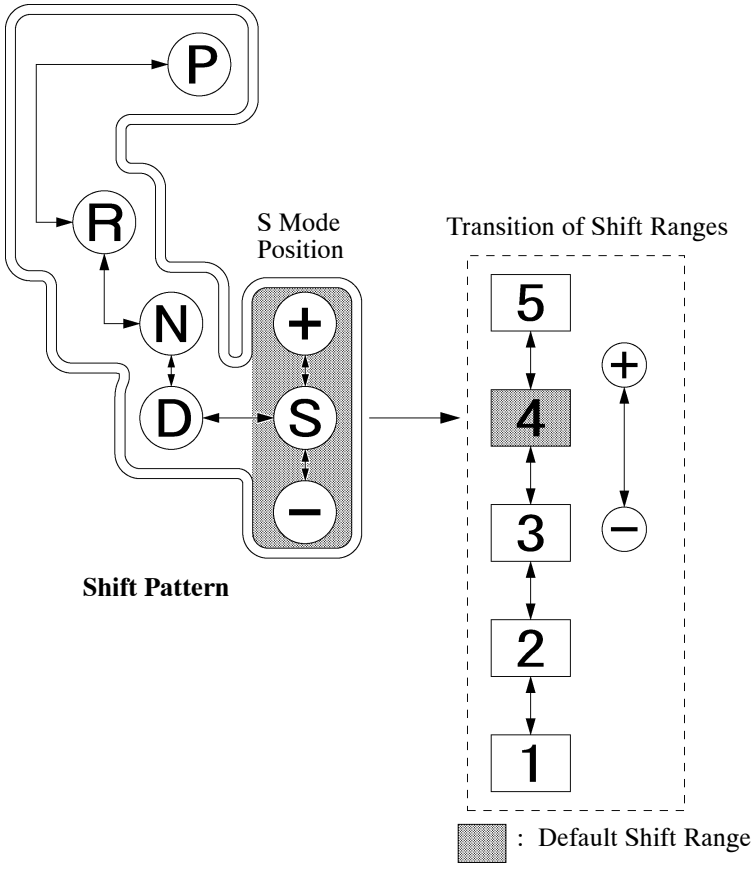

*1: Models with Multi-information Display
*2: Models without Multi-information Display

### Operation

- The driver selects S mode by placing the shift lever in S position. At this time, the S4 shift range is selected. Then, the shift ranges change one at a time, as the driver moves the shift lever to the front ("+" position) or to the rear ("-" position).
- Under this control, the ECM effects optimal shift control within the usable gear range that the driver selects. As with an ordinary automatic transmission, it shifts to the 1st gear when the vehicle is stopped.
- Holding the shift lever toward the "+" position with the shift lever in S position will change the shift range to the S5 range regardless of current range (S1 to S4).
- When the shift lever is in the S position, the S mode indicator light in the combination meter illuminates. The shift range indicator light indicates the shift range that the driver has selected.

**▶ Models for Australia ◀**

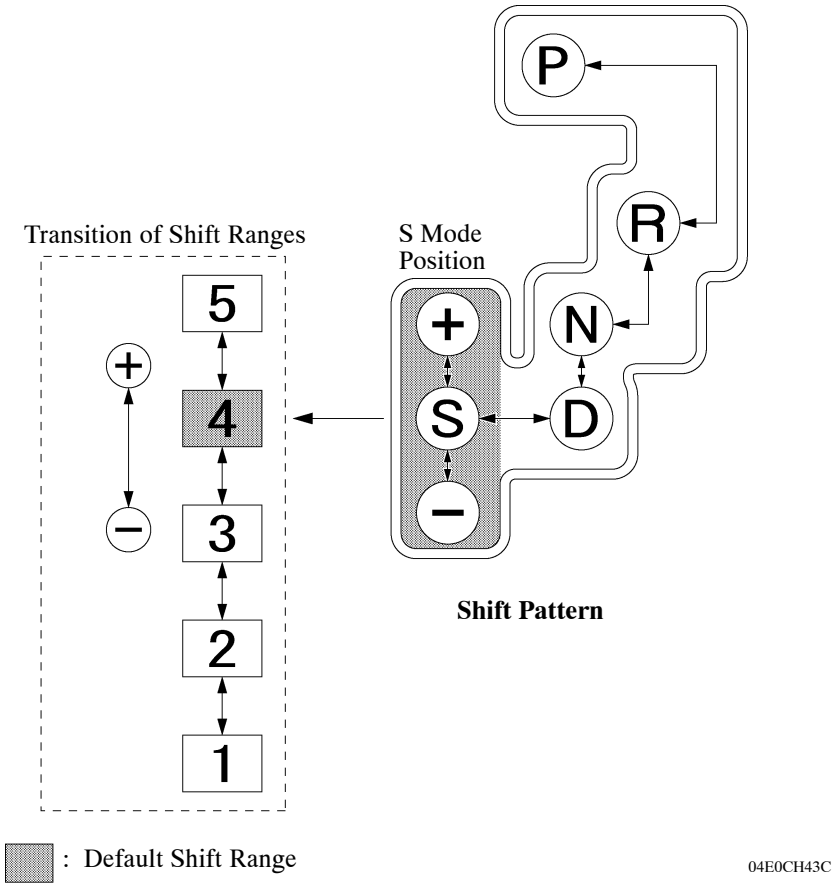





**Shift Pattern**

06K0CH26C

**▶ Models for China ◀**




**▶ Usable Gear Chart ◀**

| Shift Range | Shift Range Indicator Light Display | Usable Gear Range |
|---|---|---|
| S5 |  06J0CH104C | 5th ↔ 4th ↔ 3rd ↔ 2nd ↔ 1st |
| S4 |  06J0CH105C | 4th ↔ 3rd ↔ 2nd ↔ 1st |
| S3 |  06J0CH106C | 3rd ↔ 2nd ↔ 1st |
| S2 |  06J0CH107C | 2nd ↔ 1st |
| S1 |  06J0CH108C | 1st |

### Automatic Up-shift Function

If ATF temperature reaches 140°C (284°F) when driving in 3rd gear (S3 range) or in 4th gear (S4 range), this function will automatically up-shift to 5th gear (S5 range) in order to protect the transmission.

- At the same time, the ATF temperature warning light will turn on or the multi-information display will show a warning massage.

## 10. Diagnosis

- When the ECM detects a malfunction, the ECM records the malfunction and memorizes the information related to the fault. Furthermore, the MIL (Malfunction Indicator Lamp) in the combination meter assembly illuminates or blinks to inform the driver.
- The ECM will also store the DTCs (Diagnostic Trouble Codes) of the malfunctions. The DTCs can be accessed using the intelligent tester.
- For details, see the HIGHLANDER Repair Manual (Pub. No. RM06K0E).

**Service Tip**

- The ECM uses the CAN protocol for diagnostic communication. Therefore, an intelligent tester and the CAN VIM (Vehicle Interface Module) are required for accessing diagnostic data.
- To clear DTCs that are stored in the ECM, use an intelligent tester, disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

For details, see the HIGHLANDER Repair Manual (Pub. No. RM06K0E).

## 11. Fail-safe

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

**▶ Fail-safe Control List ◀**

| Malfunctioning Part | Function |
|---|---|
| Speed Sensor Signal | During a speed sensor signal malfunction, the vehicle speed is detected through the signals from the speed sensor NC to allow normal control to be performed. |
| ATF Temperature Sensor | During an ATF temperature sensor malfunction, 5th gear upshift is prohibited. |
| Speed Sensor NC | During a speed sensor NC malfunction, 5th gear upshift is prohibited. |
| Shift Solenoid Valves SL1, SL2, SL3, and S4 | When a shift solenoid valve listed at left malfunctions, current to the failed shift solenoid valve is cut off.<br>Shift control is changed to a fail-safe mode to shift gears using the normal shift solenoid valves to allow continued driving. Refer to the table on the next page for operation examples. |
| Shift Solenoid Valve DSL | When the shift solenoid valve DSL malfunctions, the current to the solenoid valve is stopped. This stops lock-up control, as a result, fuel economy decreases. |

| **Normal** | | | | | **Shift Solenoid Valve SL1 Malfunction** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shift Solenoid Valve | | | | Gear | Driving in 1st or 2nd gear | | | | |
| | | | | | Shift Solenoid Valve | | | | Gear |
| SL1 | SL2 | SL3 | S4 | | SL1 | SL2 | SL3 | S4 | |
| ON | ON | OFF | OFF | 1st | × | ON | OFF | OFF | 1st → 2nd |
| OFF | ON | OFF | OFF | 2nd | × | ON | OFF | OFF | 2nd |
| ON | OFF | OFF | OFF | 3rd | × | ON | OFF | OFF | 3rd → 2nd |
| OFF | Δ | ON | OFF | 4th | × | ON | ON → OFF | OFF | 4th → 2nd |
| OFF | Δ | ON | ON | 5th | × | ON | ON → OFF | ON → OFF | 5th → 2nd |

Δ: According to flex lock-up clutch control.

| **Shift Solenoid Valve SL1 Malfunction** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Driving in 3rd gear | | | | | Driving in 4th or 5th gear | | | | |
| Shift Solenoid Valve | | | | Gear | Shift Solenoid Valve | | | | Gear |
| SL1 | SL2 | SL3 | S4 | | SL1 | SL2 | SL3 | S4 | |
| × | ON → Δ | OFF | OFF → ON | 1st → 4th | × | ON → Δ | OFF → ON | OFF | 1st → 4th |
| × | ON → Δ | OFF | OFF → ON | 2nd → 4th | × | ON → Δ | OFF → ON | OFF | 2nd → 4th |
| × | Δ | OFF | OFF → ON | 3rd → 4th | × | Δ | OFF → ON | OFF | 3rd → 4th |
| × | Δ | ON → OFF | OFF → ON | 4th | × | Δ | ON | OFF | 4th |
| × | Δ | ON → OFF | ON | 5th → 4th | × | Δ | ON | ON | 5th |

Δ: According to flex lock-up clutch control.

CH