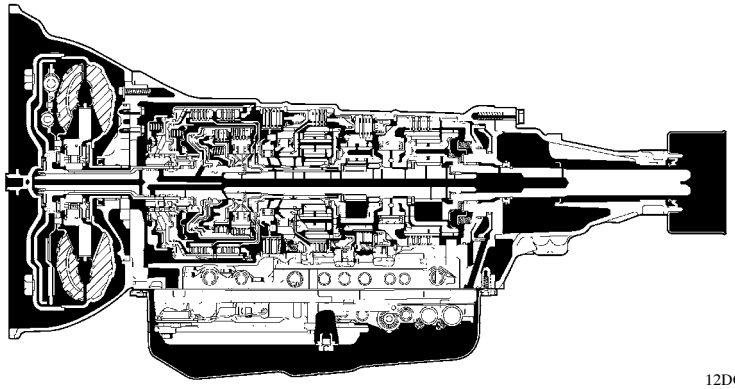
■A760E AND A760F AUTOMATIC TRANSMISSIONS

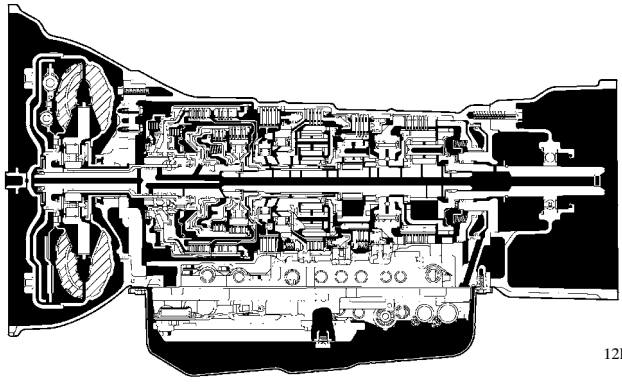
1. Description

- An A760E 6-speed Super Electronic Controlled Transmission (Super ECT) is used on the 2WD models with 1UR-FE engine.
- An A760F 6-speed Super Electronic Controlled Transmission (Super ECT) is used on the 4WD models with 1UR-FE engine.
- A tow/haul control is used on the models with towing package. This controls the engine throttle, transmission shift schedule and shift timing to ensure driveability when a trailer is being towed.



12DCH001Y

A760E Automatic Transmission



12DCH002Y

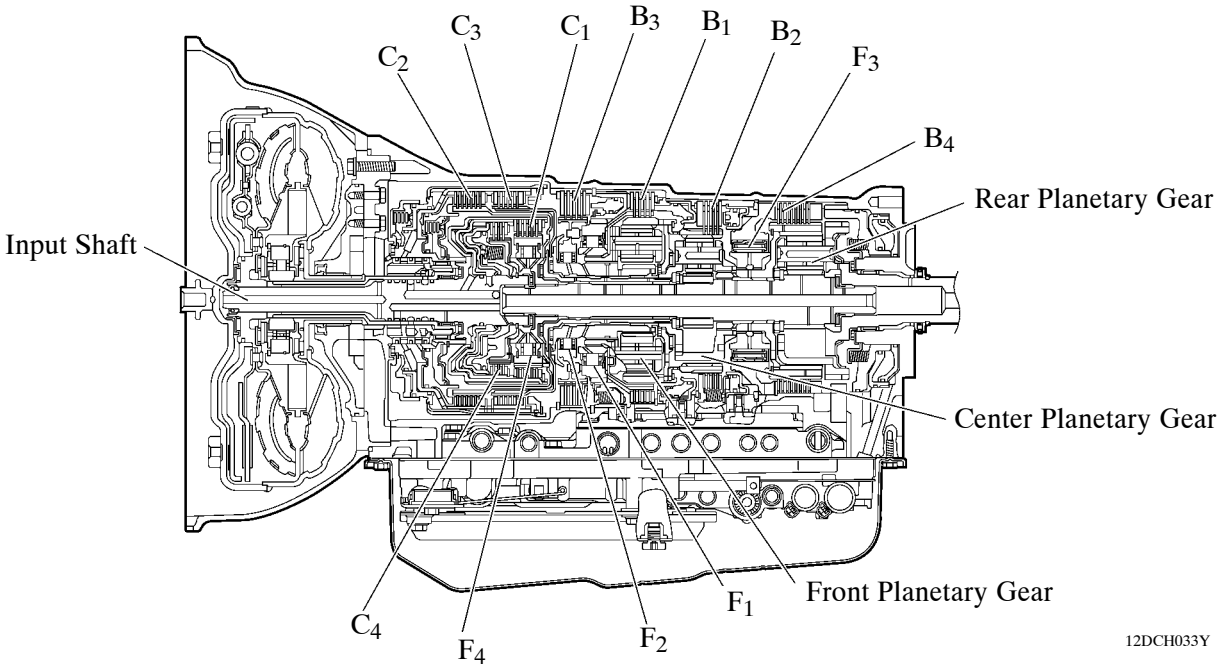
A760F Automatic Transmission

▶ Specifications ◀

Transmission Type		A760E
Engine Type		1UR-FE
Gear Ratio	1st	3.520
	2nd	2.042
	3rd	1.400
	4th	1.000
	5th	0.716
	6th	0.586
	Reverse	3.224
Fluid Type		Toyota Genuine ATF WS
Fluid Capacity	Models without Towing Package	11.1 Liters (11.6 US qts, 9.7 Imp. qts)
	Models with Towing Package	11.6 Liters (12.3 US qts, 10.2 Imp. qts)
Weight (Reference)*	Models without Towing Package	88.7 kg (195.1 lb)
	Models with Towing Package	89.2 kg (196.2 lb)

Transmission Type		A760F
Engine Type		1UR-FE
Gear Ratio	1st	3.520
	2nd	2.042
	3rd	1.400
	4th	1.000
	5th	0.716
	6th	0.586
	Reverse	3.224
Fluid Type		Toyota Genuine ATF WS
Fluid Capacity	Models without Towing Package	10.8 Liters (11.4 US qts, 9.5 Imp. qts)
	Models with Towing Package	11.3 Liters (11.9 US qts, 9.9 Imp. qts)
Weight (Reference)*	Models without Towing Package	90.5 kg (199.1 lb)
	Models with Towing Package	90.9 kg (200.0 lb)

*: Weight shows the figure with the fluid fully filled.

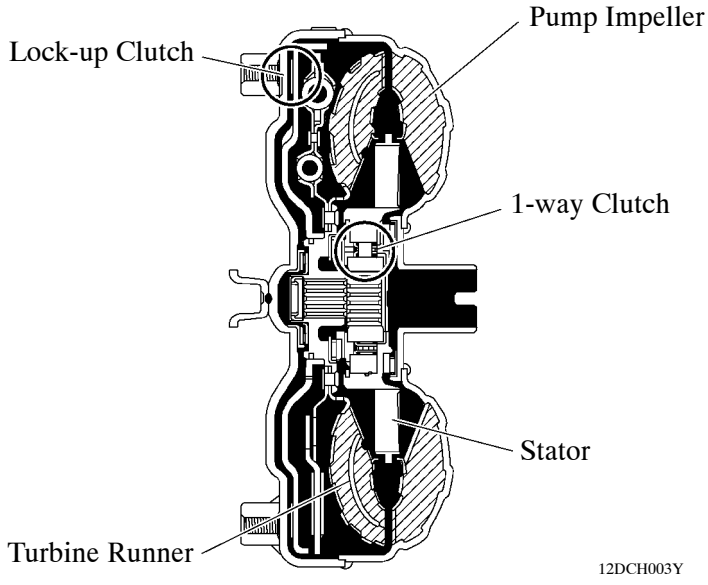


▶ Specifications ◀

Item				A760E	A760F
C_1	No. 1 Clutch	No. of Discs		5	←
C_2	No. 2 Clutch			6	←
C_3	No. 3 Clutch			5	←
C_4	No. 4 Clutch			3	←
B_1	No. 1 Brake			4	←
B_2	No. 2 Brake			4	←
B_3	No. 3 Brake			4	←
B_4	No. 4 Brake			8	←
F_1	No. 1 1-way Clutch	No. of Sprags		18	←
F_2	No. 2 1-way Clutch			25	←
F_3	No. 3 1-way Clutch			26	←
F_4	No. 4 1-way Clutch			27	←
Front Planetary Gear		No. of Sun Gear Teeth		40	←
		No. of Pinion Gear Teeth	Inner	22	←
			Outer	21	←
		No. of Ring Gear Teeth		91	←
Center Planetary Gear		No. of Sun Gear Teeth		31	←
		No. of Pinion Gear Teeth		23	←
		No. of Ring Gear Teeth		77	←
Rear Planetary Gear		No. of Sun Gear Teeth		25	←
		No. of Pinion Gear Teeth		19	←
		No. of Ring Gear Teeth		63	←

2. Torque Converter

A compact, lightweight and high-capacity torque converter is used. The torque converter supports flex lock-up clutch control, thus allowing for improved fuel economy.

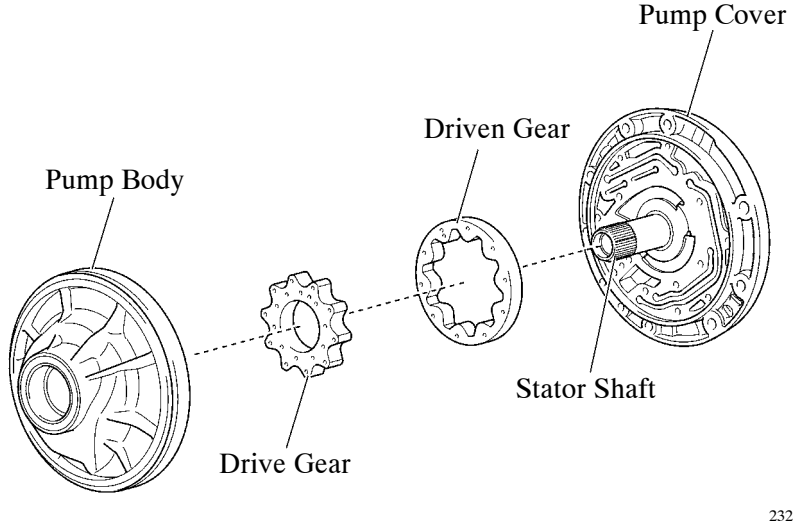


▶ Specifications ◀

Transmission Type	A760E	A760F
Torque Converter Type	3-element, 1-step, 2-phase (with Lock-up Mechanism)	←
Stall Torque Ratio	1.80	←

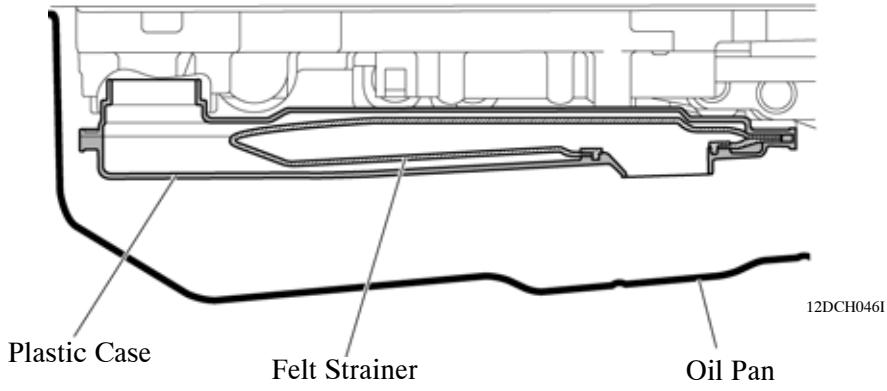
3. Oil Pump

- The oil pump is driven by the torque converter. It lubricates the planetary gear units and supplies operating fluid pressure for hydraulic control.
- The pump cover is made of aluminum to reduce weight.



4. Oil Strainer

A felt type oil strainer (in a plastic case) is used because it weighs less, offers excellent debris capturing ability, and is more reliable. This oil strainer is maintenance-free.

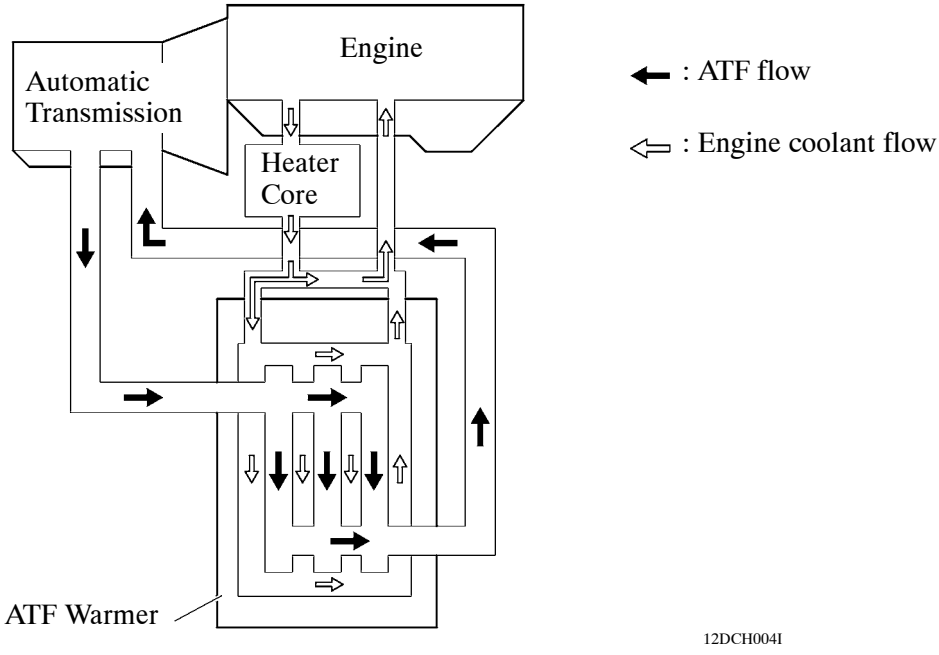


5. ATF Cooling System

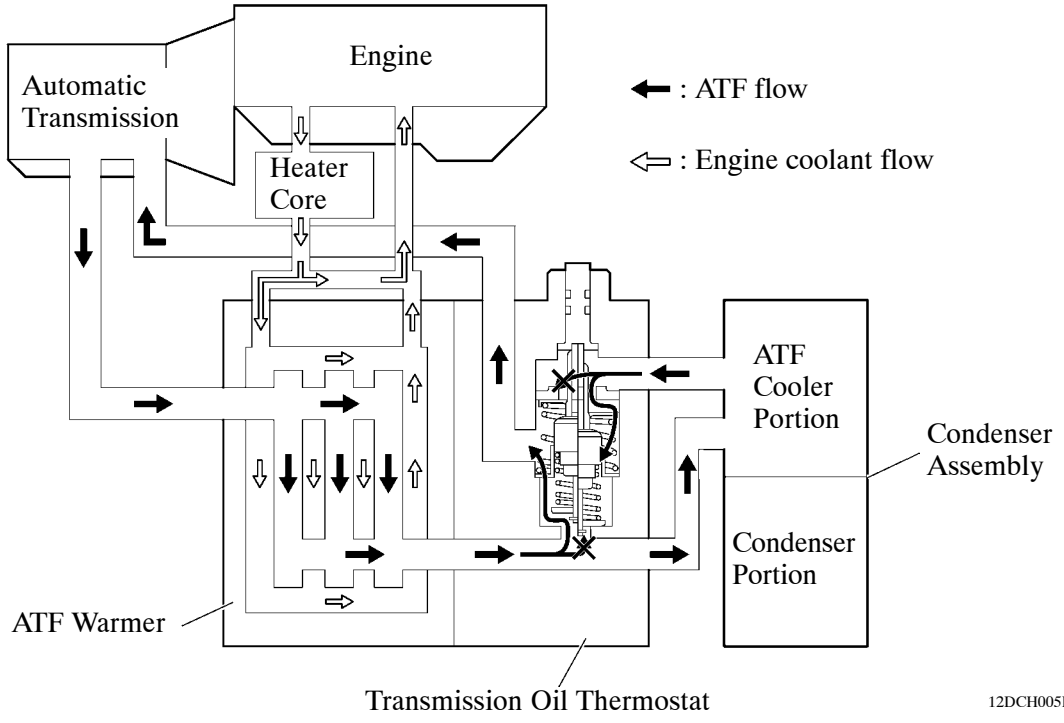
General

- These automatic transmissions use an ATF warmer that increases the rate at which the ATF warms up, and an ATF cooler that cools down the ATF.
- The ATF warmer is provided as standard.
- An air-cooled type ATF cooler integrated with the condenser is provided on the models with towing package.

▶ Models without ATF Cooler ◀

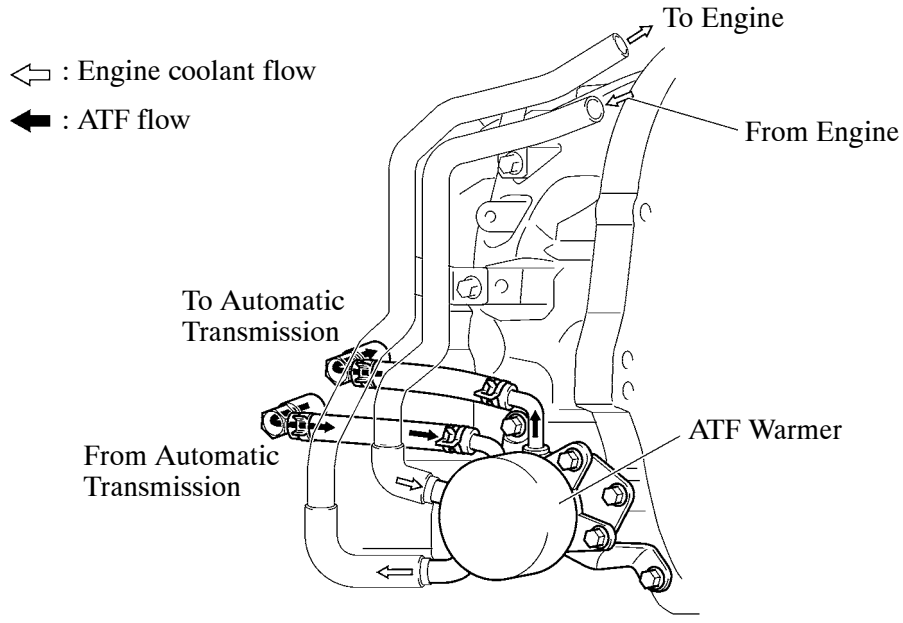


▶ Models with ATF Cooler ◀

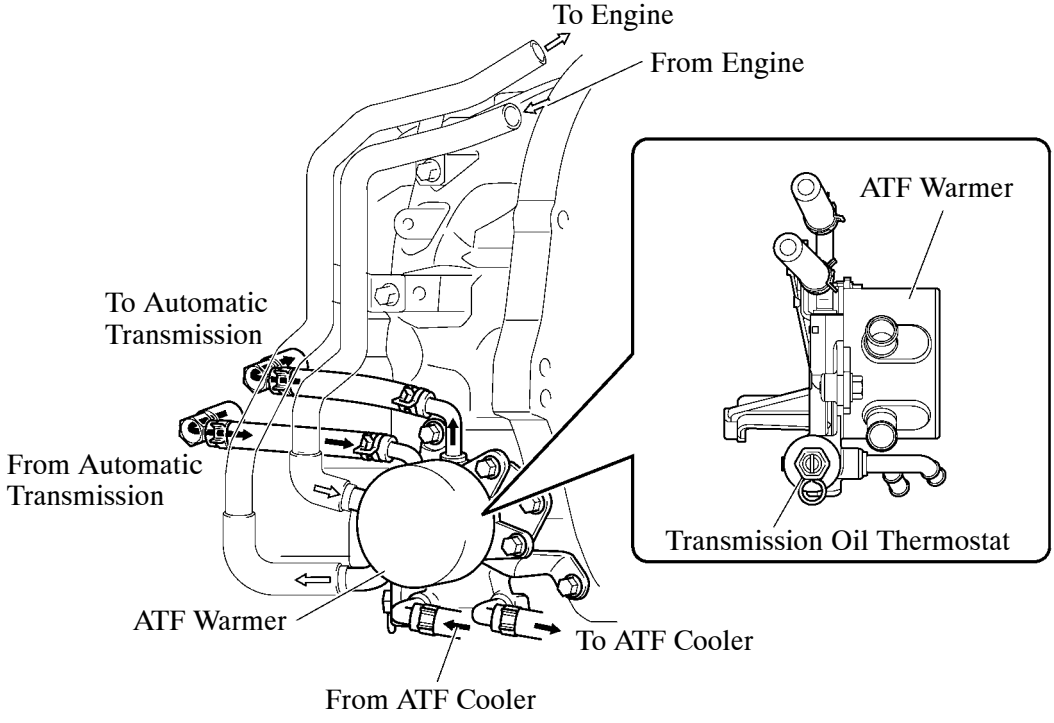


ATF Warmer

- The ATF warmer uses engine coolant to warm up the ATF quickly and keep the ATF temperature higher (within limits). Consequently, the friction losses of the automatic transmission are quickly reduced, thus improving fuel economy.
- Models with an ATF cooler have a transmission oil thermostat to switch the ATF passages.



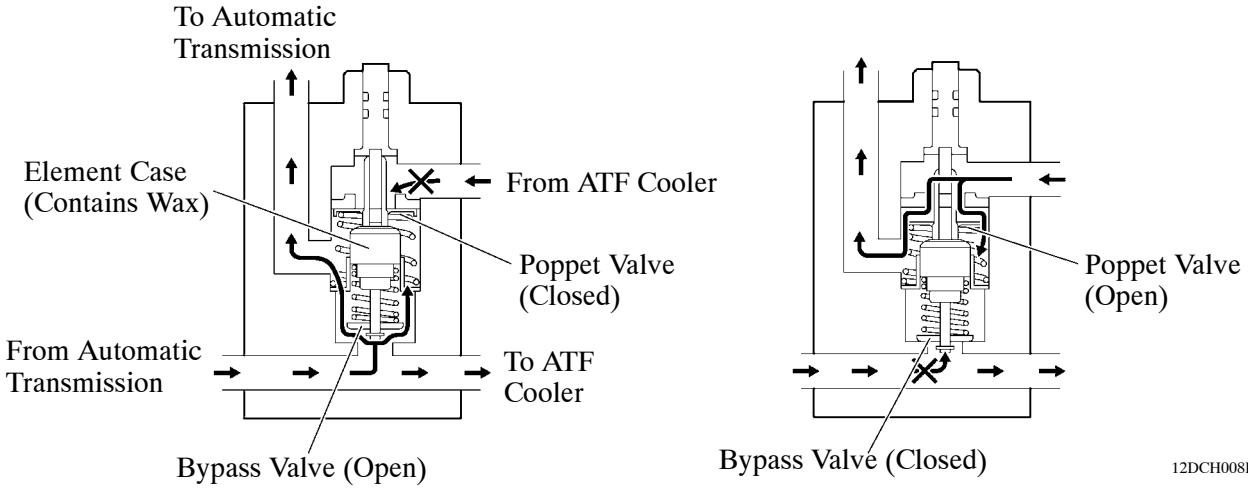
Models without ATF Cooler 12DCH006Y



Models with ATF Cooler 12DCH007Y

Transmission Oil Thermostat (Models with Towing Package)

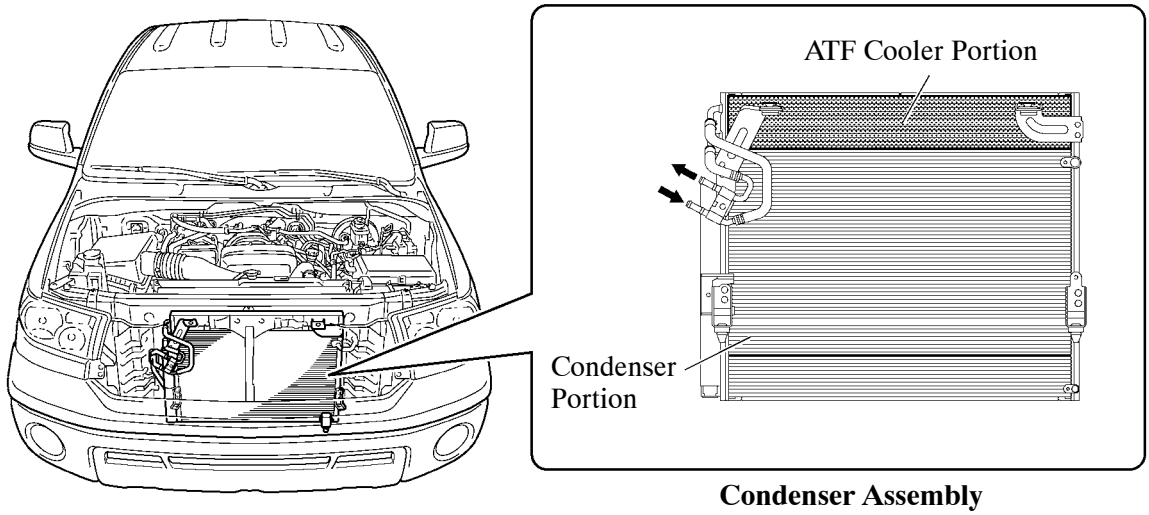
The transmission oil thermostat consists of the poppet valve, bypass valve and element case (contains wax). When the ATF temperature changes from low to high, the wax will expand to start to open the poppet valve and close the bypass valve, thus switching the ATF passages.



ATF Temperature Low Condition **ATF Temperature High Condition**

ATF Cooler (Models with Towing Package)

The air-cooled type ATF cooler integrated with the condenser is used to maintain ATF cooling performance under high loads.

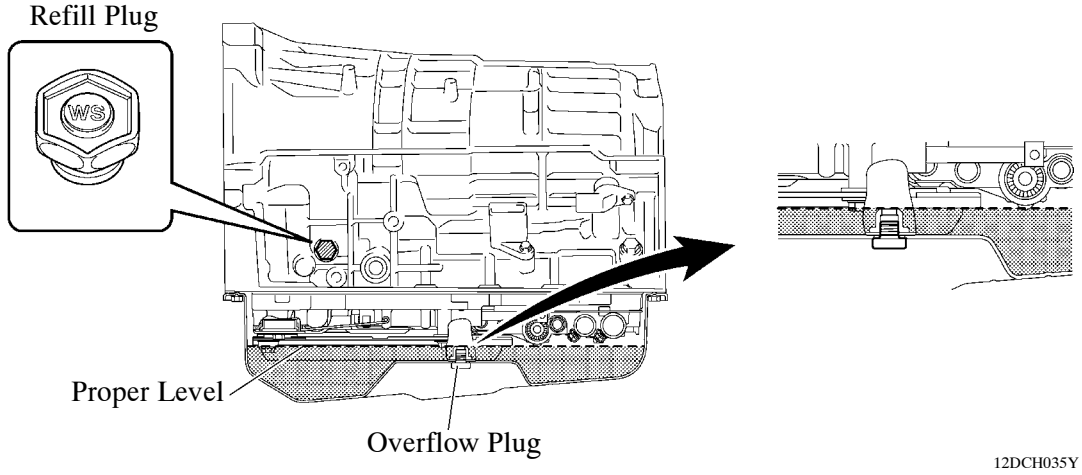


Condenser Assembly

6. ATF Filling Procedure

An ATF filling procedure is used in order to improve the accuracy of the ATF level when the transmission is being repaired or replaced. As a result, the oil filler tube and the oil level gauge used in the conventional automatic transmission have been discontinued, eliminating the need to inspect the fluid level as a part of routine maintenance.

- This filling procedure uses a refill plug, an overflow plug, an ATF temperature sensor No. 2, and a D indicator.



Service Tip

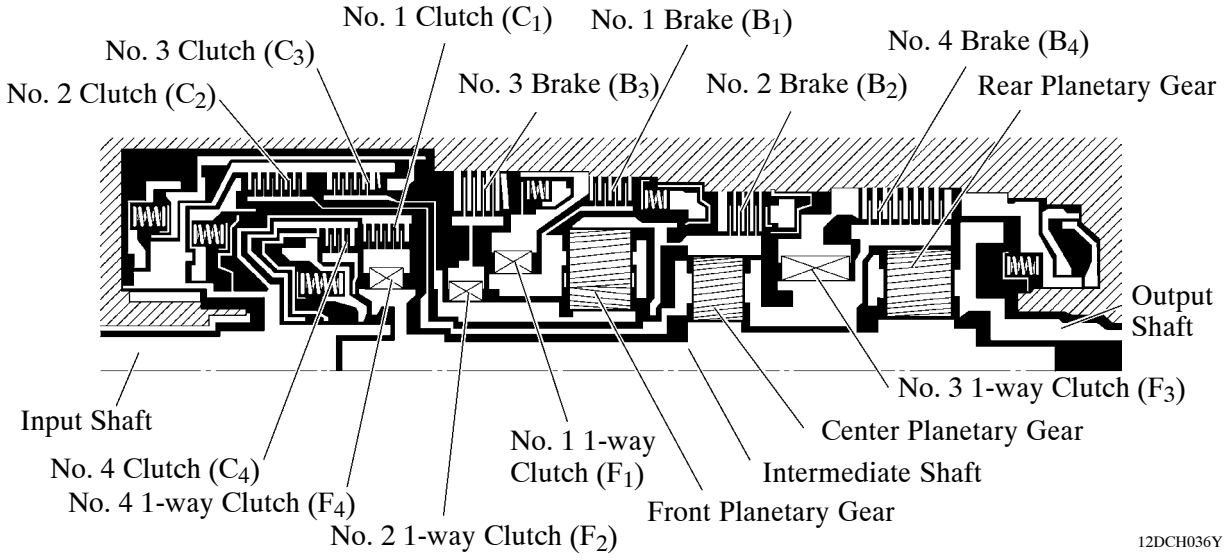
For details about the ATF filling procedures, refer to the 2010 TOYOTA TUNDRA Repair Manual.

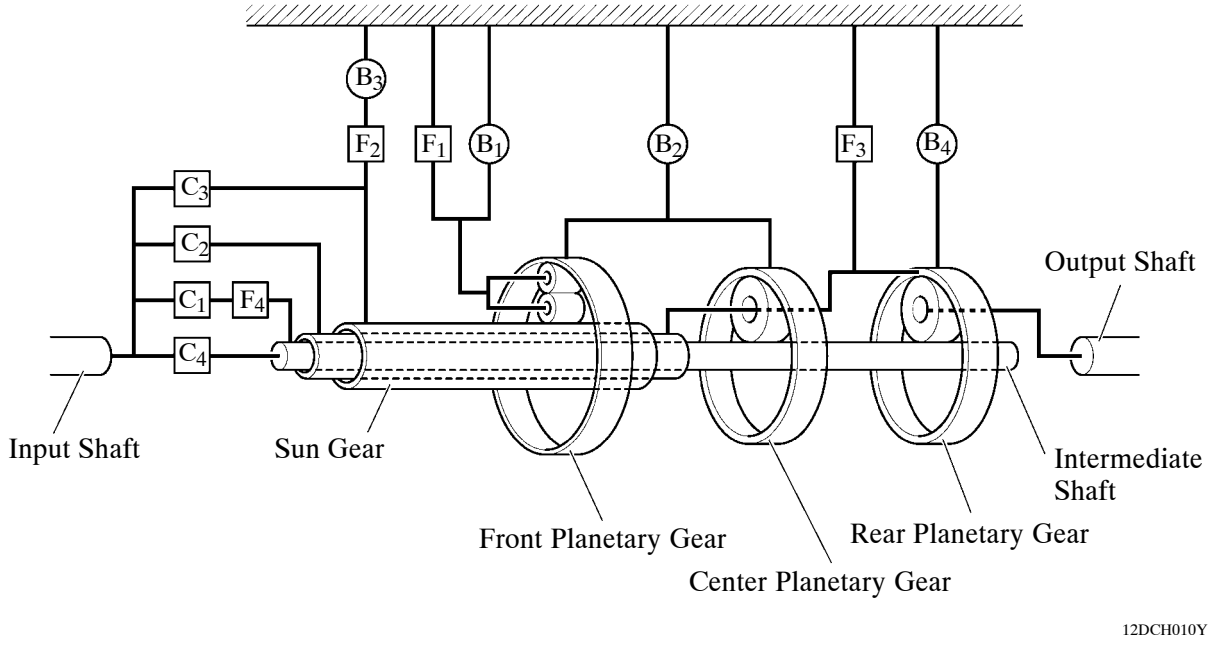
7. Planetary Gear Unit

Construction

The planetary gear unit consists of 3 planetary gear units, 4 clutches, 4 brakes, and 4 1-way clutches.

- A centrifugal fluid pressure canceling mechanism is used in the C_1, C_2, C_3, and C_4 clutches applied when shifting 2nd → 3rd, 3rd → 4th, 4th → 5th, and 5th → 6th. For details, see page 124.





Function of Components

Component		Function
C_1	No. 1 Clutch	Connects the input shaft, F_4 and intermediate shaft.
C_2	No. 2 Clutch	Connects the input shaft and center planetary carrier.
C_3	No. 3 Clutch	Connects the input shaft and sun gear.
C_4	No. 4 Clutch	Connects the input shaft and intermediate shaft.
B_1	No. 1 Brake	Prevents the front planetary carrier from turning either clockwise or counterclockwise.
B_2	No. 2 Brake	Prevents the front and the center ring gears from turning either clockwise or counterclockwise.
B_3	No. 3 Brake	Prevents the outer race of F_2 from turning either clockwise or counterclockwise.
B_4	No. 4 Brake	Prevents the center planetary carrier and rear ring gear from turning either clockwise or counterclockwise.
F_1	No. 1 1-way Clutch	Prevents the front planetary carrier from turning counterclockwise.
F_2	No. 2 1-way Clutch	When B_3 is operating, the 1-way clutch prevents the front sun gear from turning counterclockwise.
F_3	No. 3 1-way Clutch	Prevents the center planetary carrier and rear ring gear from turning counterclockwise.
F_4	No. 4 1-way Clutch	Prevents the intermediate shaft from turning counterclockwise.
Planetary Gear		These gears change the route through which driving force is transmitted, in accordance with the operation of each clutch and brake, in order to increase or reduce the output shaft speed.

Transmission Power Flow

Shift Position or Shift Range		Shift Solenoid Valve								Clutch				Brake				1-way Clutch			
		S1	S2	S3	S4	SR	SL1	SL2	SLU	C_1	C_2	C_3	C_4	B_1	B_2	B_3	B_4	F_1	F_2	F_3	F_4
P			On	On		On		On													
R*			On	On		On		On				○		Δ			○	○			
N			On	On		On		On													
D, S6	1st		On	On		On		On		○										○	○
	2nd	On	On	On		On		On	On	○						○		○	○		○
	3rd	On		On		On		On	On	○		○				●		○			○
	4th*	On				On		On	On	○	○	●	Δ			●					○
	5th*	On			On		On		On	●	○	○		○		●					
	6th*	On	On		On		On		On	●	○			●	○	●					
S5	1st		On	On		On		On		○										○	○
	2nd	On	On	On		On		On	On	○						○		○	○		○
	3rd	On		On		On		On	On	○		○				●		○			○
	4th*	On				On		On	On	○	○	●	Δ			●					○
	5th*	On			On		On		On	●	○	○		○		●					
S4	1st		On	On		On		On		○										○	○
	2nd	On	On	On		On		On	On	○						○		○	○		○
	3rd	On		On		On		On	On	○		○				●		○			○
	4th*	On				On		On	On	○	○	●	Δ			●					○
S3	1st		On	On		On		On		○										○	○
	2nd	On	On	On		On		On	On	○						○		○	○		○
	3rd*	On		On		On			On	○		○	Δ	Δ		●		○			○
S2	1st		On	On		On		On		○										○	○
	2nd*	On	On	On	On	On			On	○			Δ		Δ	○		○	○		○
S1	1st*		On	On		On				○			Δ				Δ			○	○

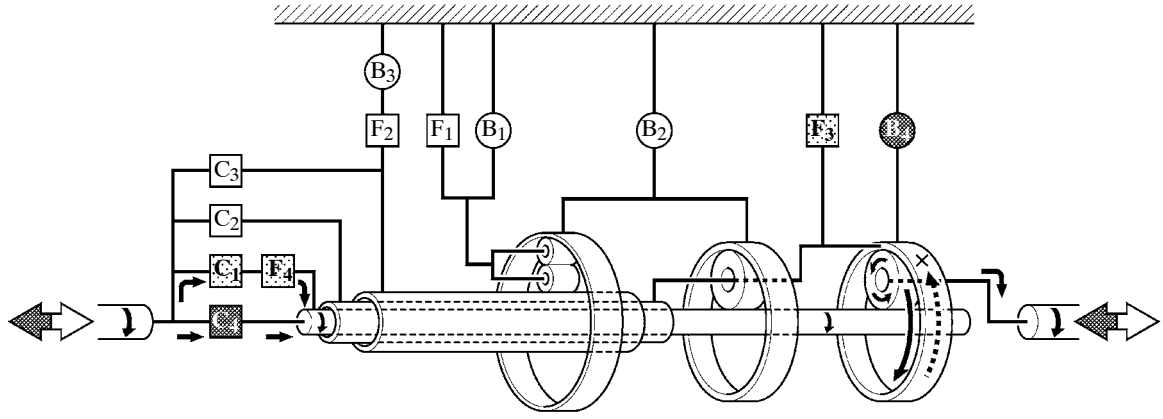
○: Operates

●: Operates but is not related to power transmission

Δ: Operates during engine braking

*: Engine braking occurs

1) 1st Gear (Shift Lever is in D or S)



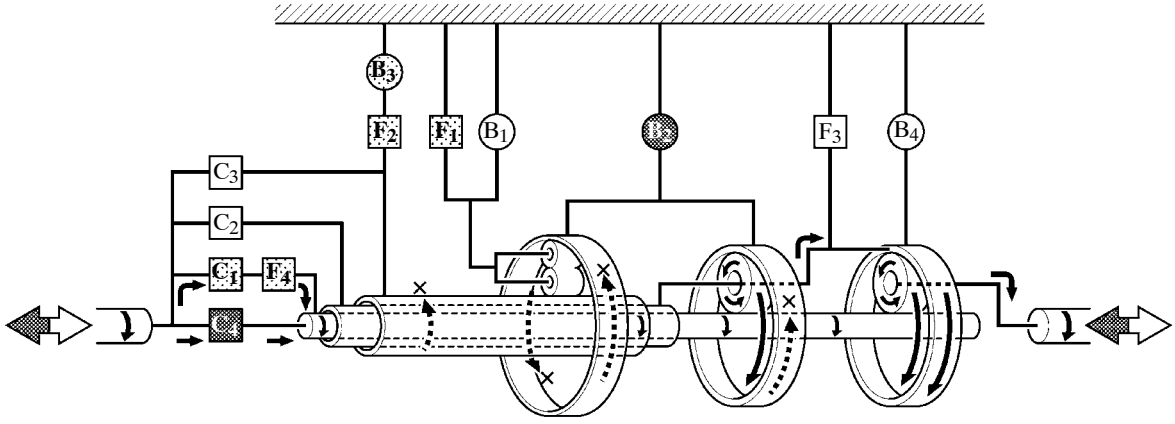
: Operates
: Operates during engine braking

12DCH011Y

C_1	C_2	C_3	C_4	B_1	B_2	B_3	B_4	F_1	F_2	F_3	F_4
○			Δ				Δ			○	○

○: Operates Δ: Operates during engine braking (S1 range)

2) 2nd Gear (Shift Lever is in D or S)



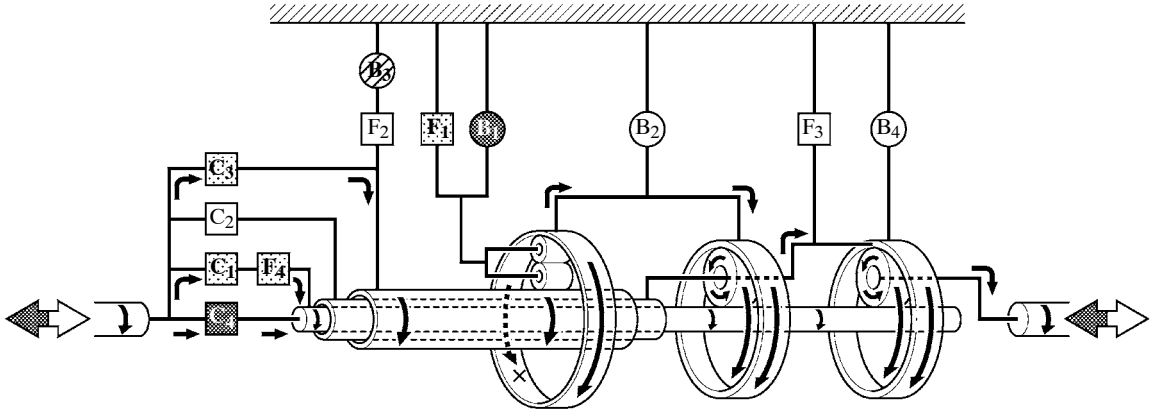
: Operates
: Operates during engine braking

12DCH012Y

C_1	C_2	C_3	C_4	B_1	B_2	B_3	B_4	F_1	F_2	F_3	F_4
○			Δ		Δ	○		○	○		○

○: Operates Δ: Operates during engine braking (S2 range)

3) 3rd Gear (Shift Lever is in D or S)



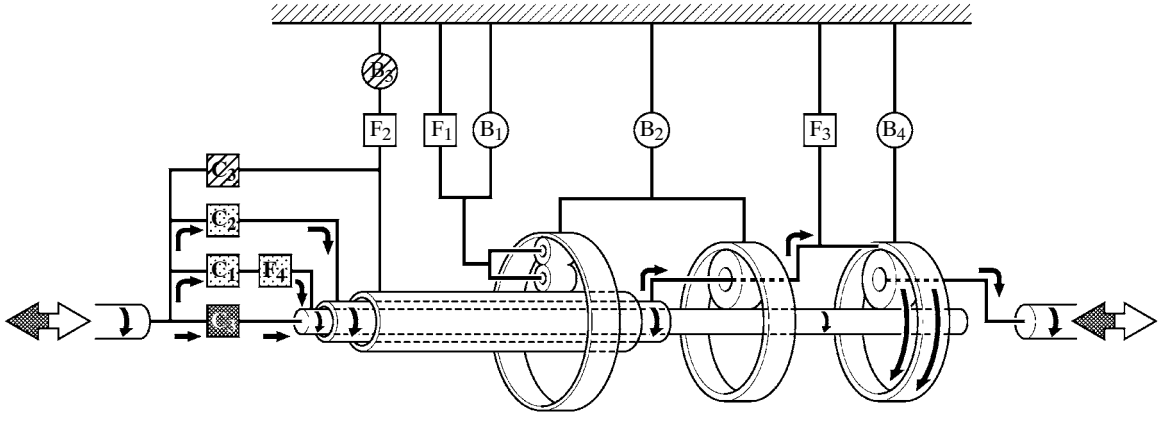
: Operates
: Operates during engine braking
: Operates but is not related to power transmission

12DCH013Y

C_1	C_2	C_3	C_4	B_1	B_2	B_3	B_4	F_1	F_2	F_3	F_4
○		○	△	△		●		○			○

○: Operates △: Operates during engine braking (S3 range)
●: Operates but is not related to power transmission

4) 4th Gear (Shift Lever is in D or S)



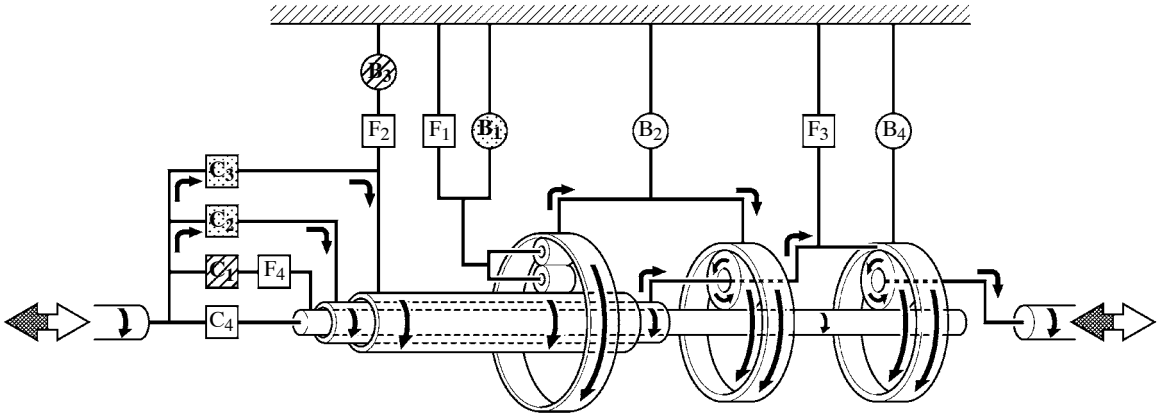
: Operates
: Operates during engine braking
: Operates but is not related to power transmission

12DCH014Y

C_1	C_2	C_3	C_4	B_1	B_2	B_3	B_4	F_1	F_2	F_3	F_4
○	○	●	△			●					○

○: Operates △: Operates during engine braking
●: Operates but is not related to power transmission

5) 5th Gear (Shift Lever is in D or S)



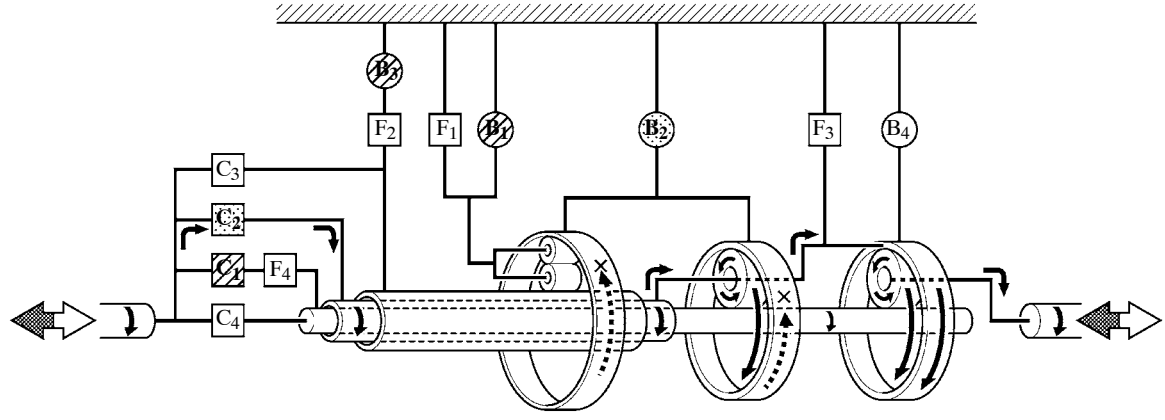
: Operates
: Operates but is not related to power transmission

12DCH015Y

C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4
●	○	○		○		●					

○: Operates ●: Operates but is not related to power transmission

6) 6th Gear (Shift Lever is in D or S)



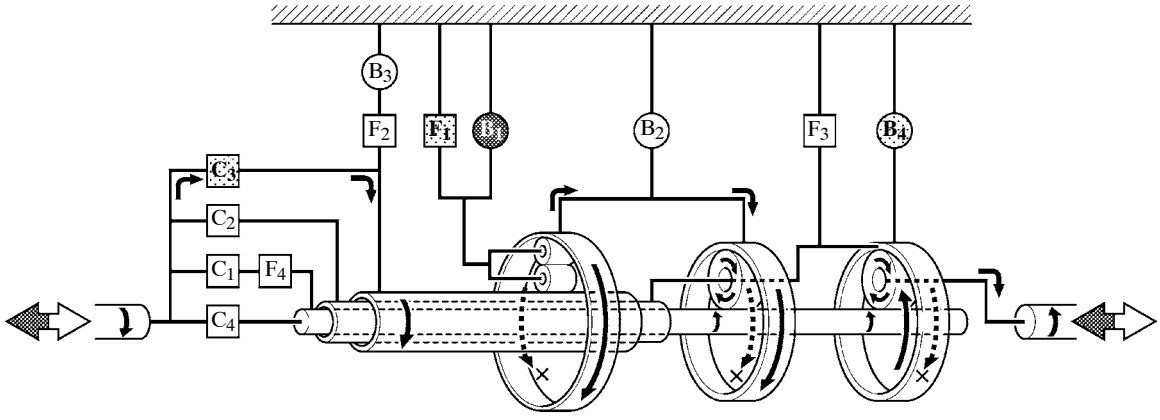
: Operates
: Operates but is not related to power transmission

12DCH016Y

C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4
●	○			●	○	●					

○: Operates ●: Operates but is not related to power transmission

7) Reverse Gear (Shift Lever is in R)



: Operates
: Operates during engine braking

12DCH017Y

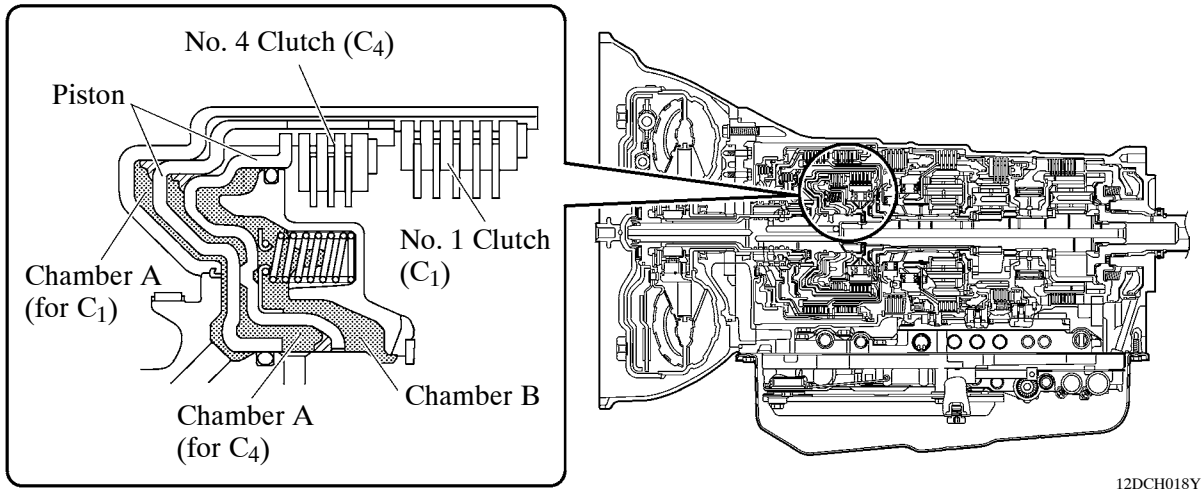
C_1	C_2	C_3	C_4	B_1	B_2	B_3	B_4	F_1	F_2	F_3	F_4
		○		△			○	○			

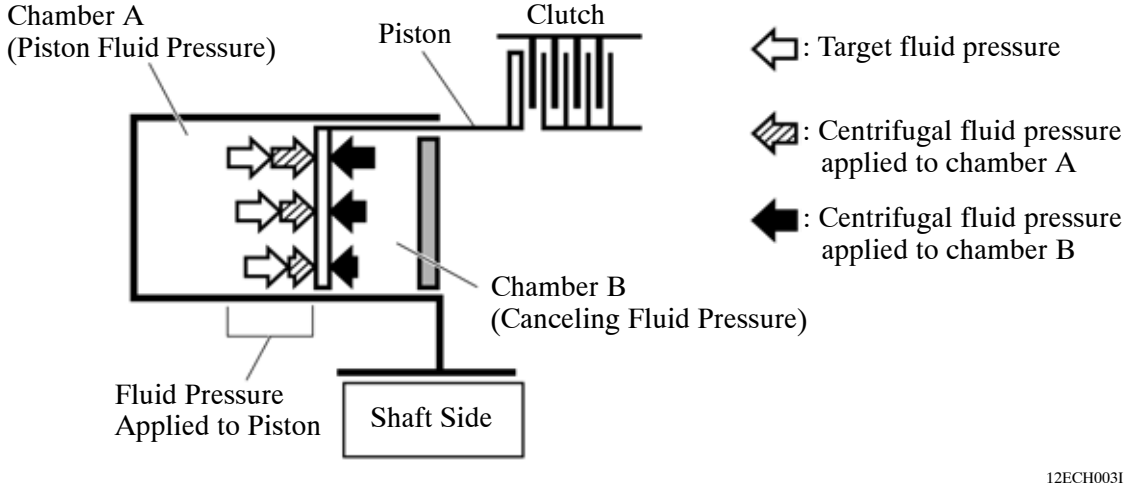
○: Operates △: Operates during engine braking

Centrifugal Fluid Pressure Canceling Mechanism

For the following reason, the centrifugal fluid pressure canceling mechanism is used on the C_1, C_2, C_3, and C_4 clutches.

- Clutch shifting operation is affected not only by the valve body controlling fluid pressure but also by centrifugal fluid pressure that is present due to fluid in the clutch piston oil pressure chamber. The centrifugal fluid pressure canceling mechanism has chamber B to reduce the effect applied to the chamber A. As a result, smooth shifting with excellent response has been achieved.



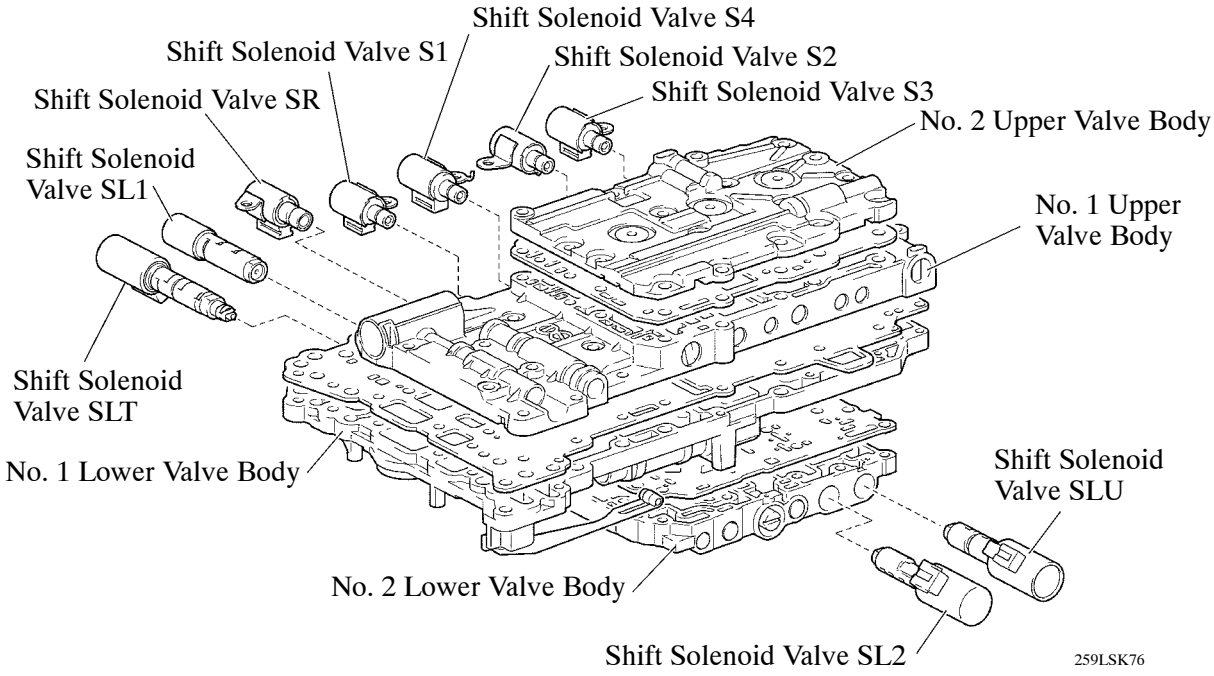


Fluid pressure applied to piston	–	Centrifugal fluid pressure applied to chamber B	=	Target fluid pressure (original clutch pressure)

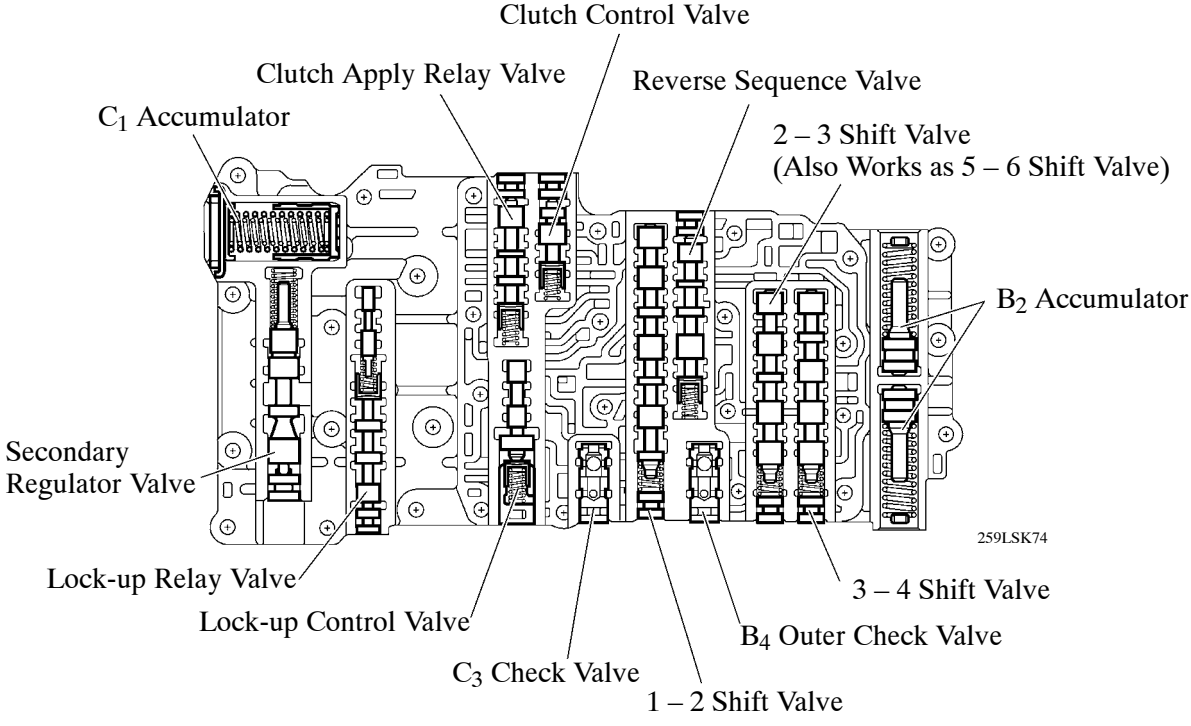
8. Valve Body Unit

General

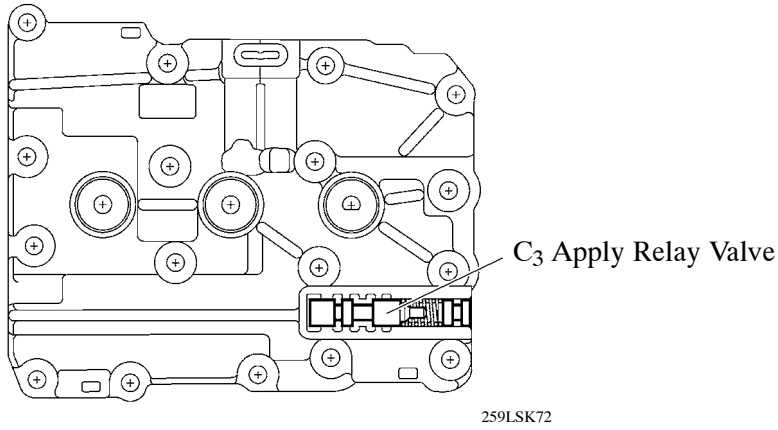
The valve body consists of the upper (No. 1 and No. 2) and lower (No. 1 and No. 2) valve bodies and 9 shift solenoid valves.



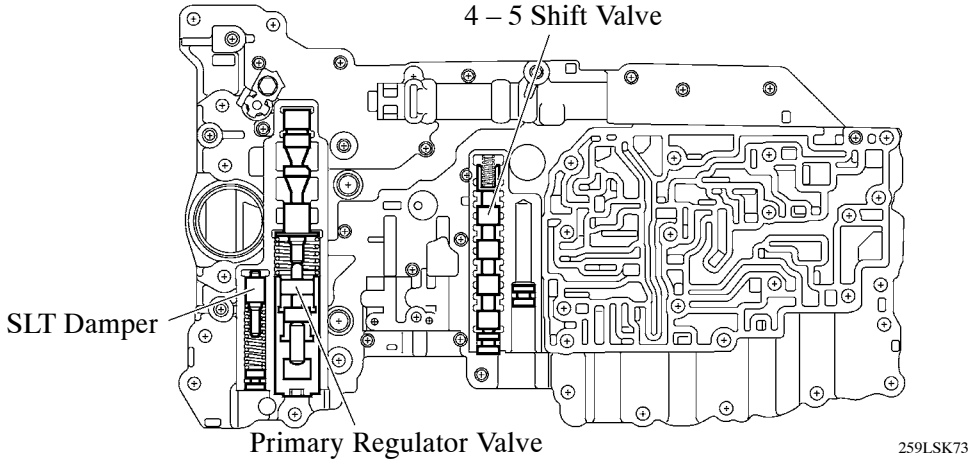
▶ No. 1 Upper Valve Body ◀



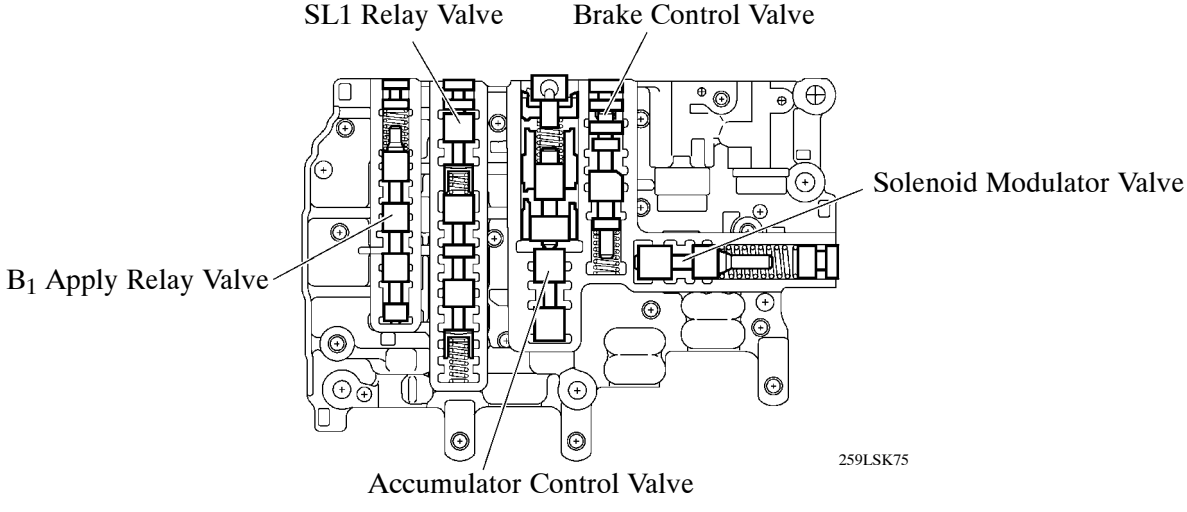
▶ No. 2 Upper Valve Body ◀



▶ No. 1 Lower Valve Body ◀



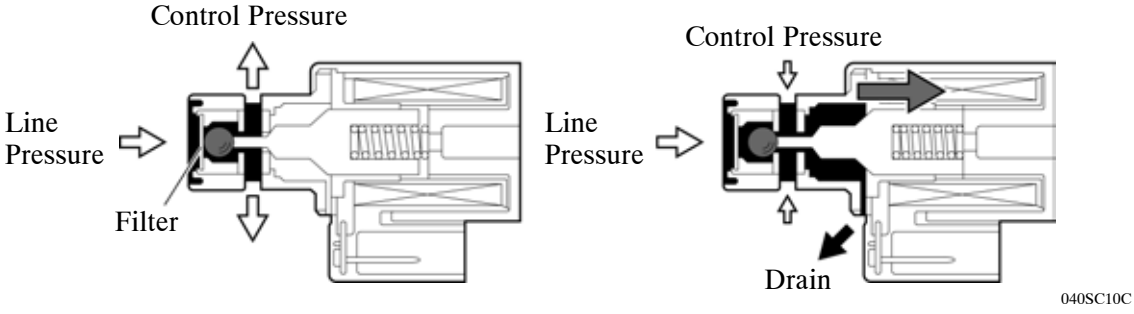
▶ No. 2 Lower Valve Body ◀



Shift Solenoid Valve

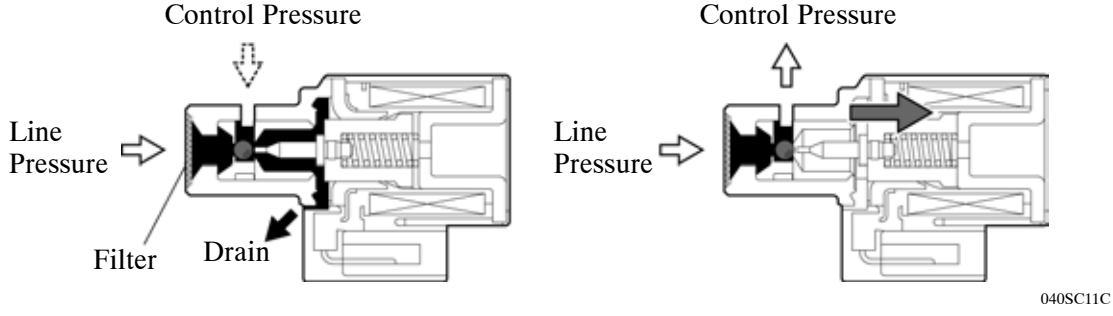
1) Shift Solenoid Valves S1, S2, S3, S4 and SR

- These shift solenoid valves are 3-way solenoid valves.
- A filter is provided at the tip of the shift solenoid valve to further improve operational reliability.



Shift Solenoid Valve Off (S1, S2, S3 and SR)

Shift Solenoid Valve On (S1, S2, S3 and SR)



Shift Solenoid Valve Off (S4)

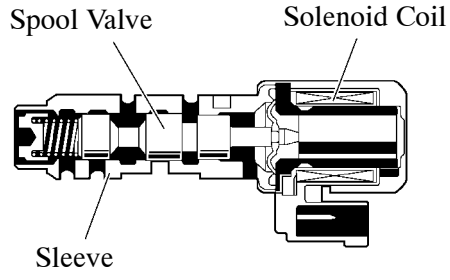
Shift Solenoid Valve On (S4)

▶ Function of Shift Solenoid Valves S1, S2, S3, S4 and SR ◀

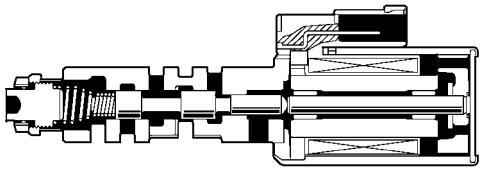
Shift Solenoid Valve	Type	Function
S1	3-way	● Switches the 1 – 2 shift valve. ● Switches the SL1 relay valve.
S2	3-way	● Switches the 2 – 3 shift valve. ● Switches the 5 – 6 shift valve.
S3	3-way	Switches the 3 – 4 shift valve.
S4	3-way	● Switches the 4 – 5 shift valve. ● Switches the SL1 relay valve. ● Switches the reverse sequence valve.
SR	3-way	● Switches the clutch apply relay valve. ● Switches the B_1 apply relay valve.

2) Shift Solenoid Valves SL1, SL2, SLT and SLU

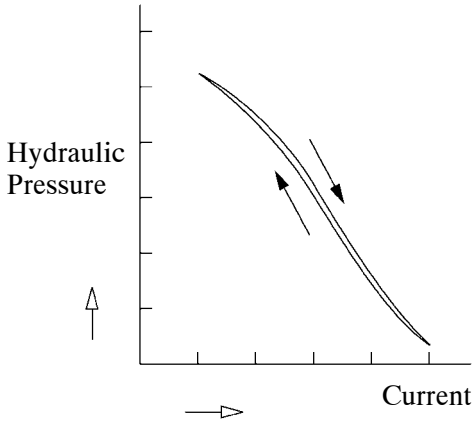
These shift solenoid valves are used by the ECM to control hydraulic pressures in a linear fashion based on the current that the ECM causes to flow through their solenoid coils. They control line, clutch, and brake engagement pressure based on the signals received from the ECM.



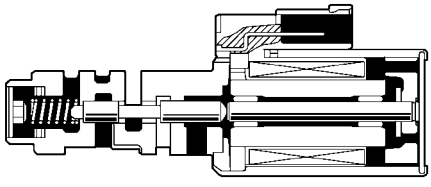
Shift Solenoid Valves SL1 and SL2



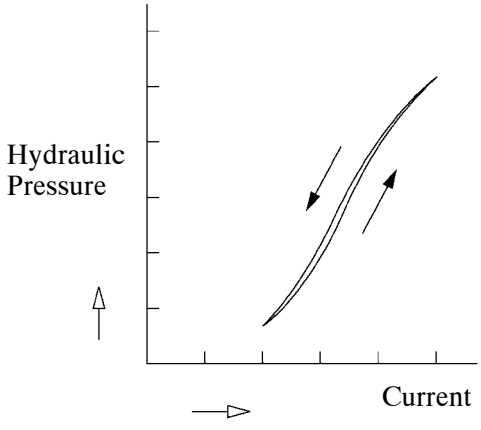
Shift Solenoid Valve SLT



Output Characteristics of SL1, SL2 and SLT



Shift Solenoid Valve SLU



Output Characteristics of SLU

259LSK16

▶ Function of Shift Solenoid Valves SL1, SL2, SLT and SLU ◀

Shift Solenoid Valve	Function
SL1	● Clutch pressure control ● Accumulator back pressure control
SL2	Brake pressure control
SLT	● Line pressure control ● Accumulator back pressure control
SLU	Lock-up clutch pressure control

9. Electronic Control System

General

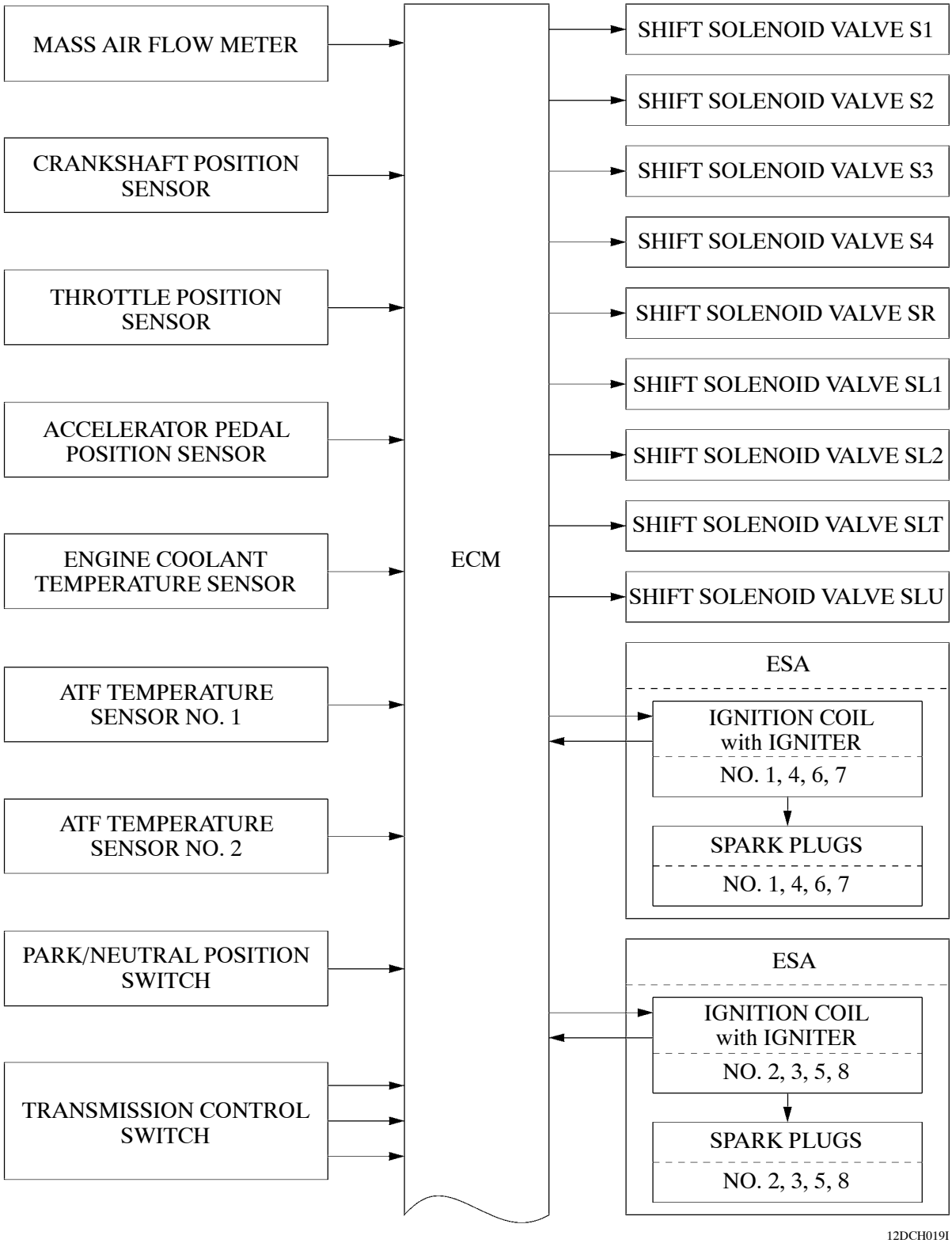
The electronic control system of the A760E and A760F automatic transmissions consists of the control functions listed below:

Control	Function
Shift Timing Control	The ECM sends current to shift solenoid valves S1, S2, S3, S4 and/or SR based on signals from various sensors, in order to shift the gears.
Clutch Pressure Control (See page 37)	• Controls the pressure applied directly to B_2 brake and C_3 clutch by actuating the shift solenoid valves SL1 and SL2 in accordance with the ECM signals. • The shift solenoid valves SLT and SL1 minutely control the clutch pressure in accordance with the engine output and driving conditions.
Line Pressure Optimal Control (See page 38)	Actuates the shift solenoid valve SLT to control the line pressure in accordance with information from the ECM and the operating conditions of the transmission.
Engine Torque Control	Retards the engine ignition timing temporarily to improve shift feeling while upshifting or downshifting occurs.
Lock-up Timing Control (See page 39)	The ECM sends current to the shift solenoid valve SLU based on signals from various sensors and engages or disengages the lock-up clutch.
Flex Lock-up Clutch Control (See page 40)	Controls the shift solenoid valve SLU, provides an intermediate mode for when the lock-up clutch is between on and off, and increases the operating range of the lock-up clutch to improve fuel economy.
Powertrain Cooperative Control (See page 42)	Controls both the shift control and engine output control in an integrated way, achieving excellent shift characteristics and driveability.
Coast Downshift Control (See page 43)	To prevent engine speed from decreasing and thus maintain the fuel cut, the ECM performs downshifting before the fuel cut ends.
Tow/Haul Control* (See page 44)	To ensure driveability when a trailer is towed, the ECM controls the engine output, transmission shift schedule and shift timing.
Artificial Intelligence-shift (AI-shift) Control (See page 47)	Based on the signals from various sensors, the ECM determines the road conditions and the intention of the driver. Thus, an appropriate shift pattern is automatically determined, thus improving driveability.
Multi-mode Automatic Transmission (See page 50)	The ECM appropriately controls the automatic transmission in accordance with the range position selected while the shift lever is in S.
Diagnosis (See page 53)	When the ECM detects a malfunction, the ECM records the malfunction and memorizes the information that relates to the fault.
Fail-safe (See page 53)	If a malfunction is detected in the sensors or solenoids, the ECM effects fail-safe control to prevent the vehicle's driveability from being affected significantly.

*: Models with towing package

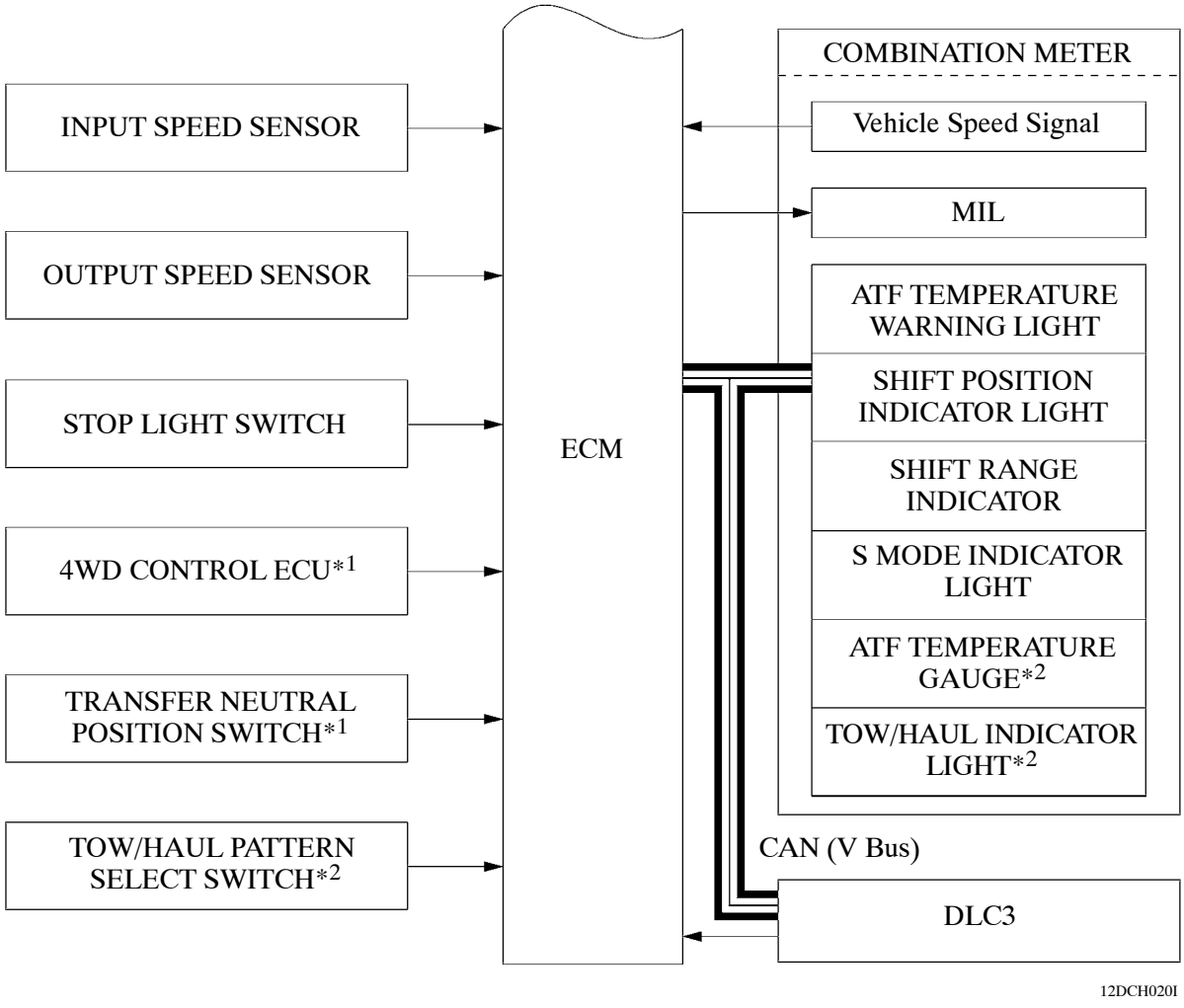
Construction

The configurations of the electronic control system for the A760E and A760F automatic transmissions are as shown in the following chart:



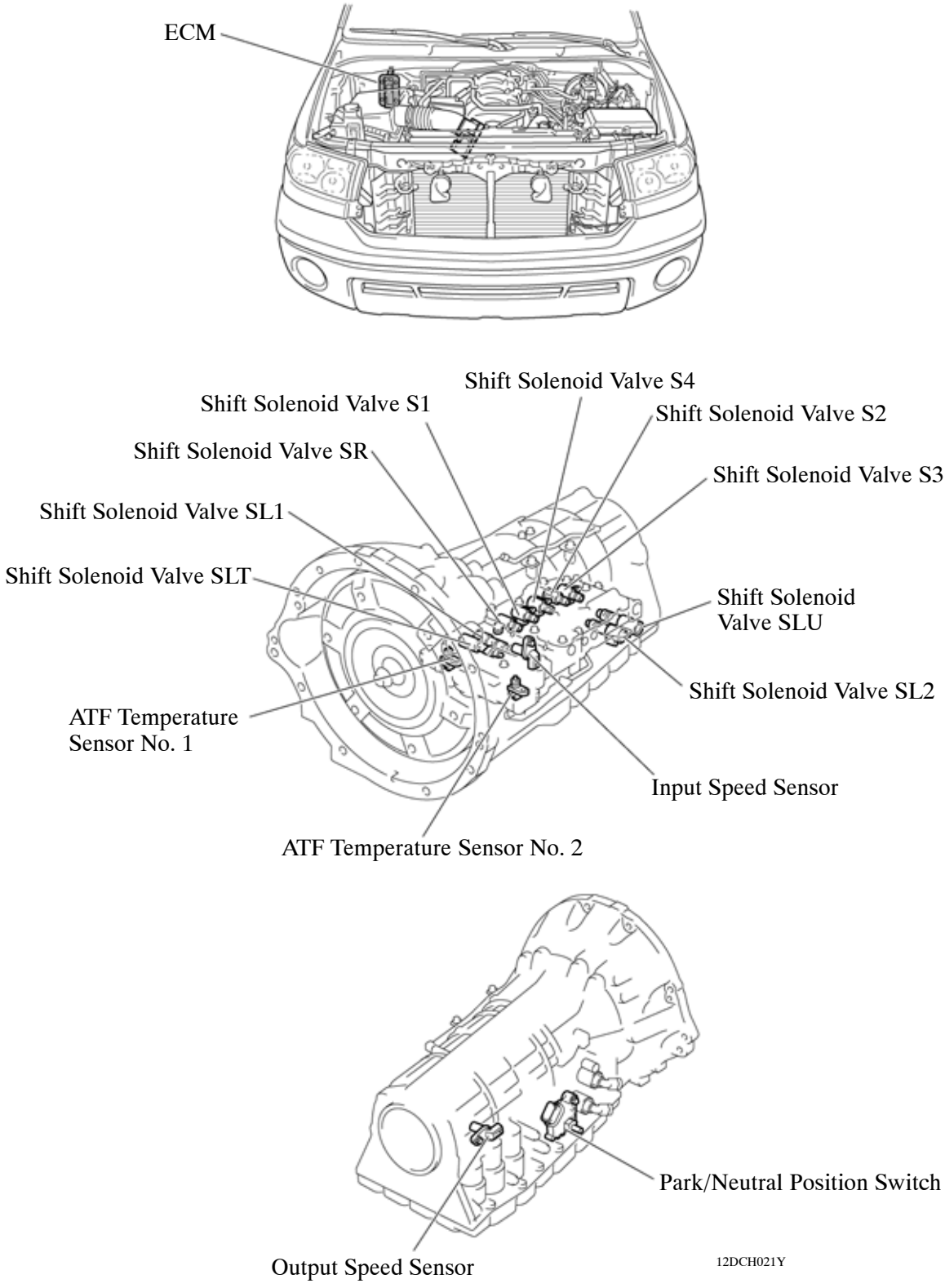
12DCH019I

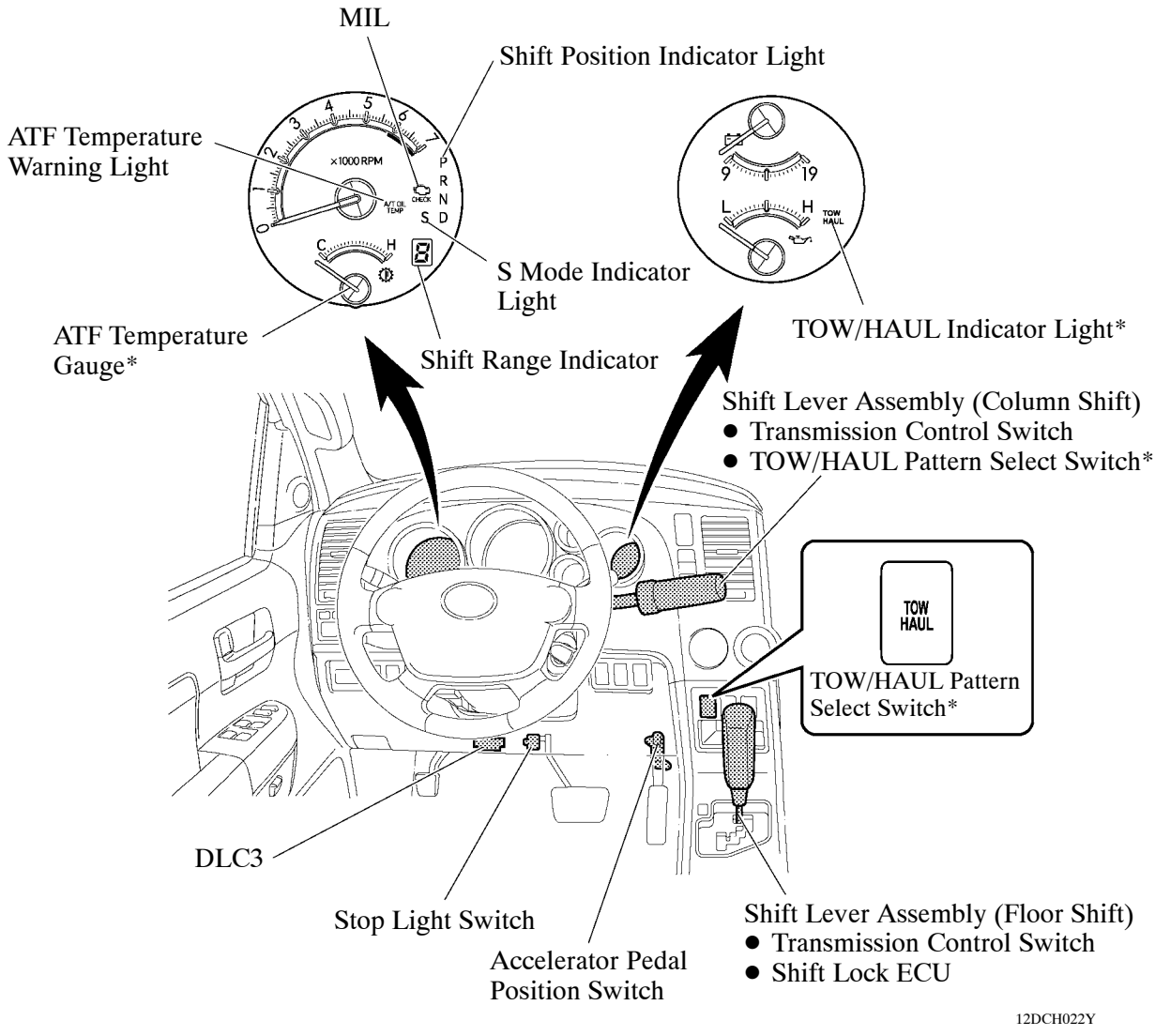
(Continued)



*1: 4WD models
*2: Models with towing package

Layout of Main Components



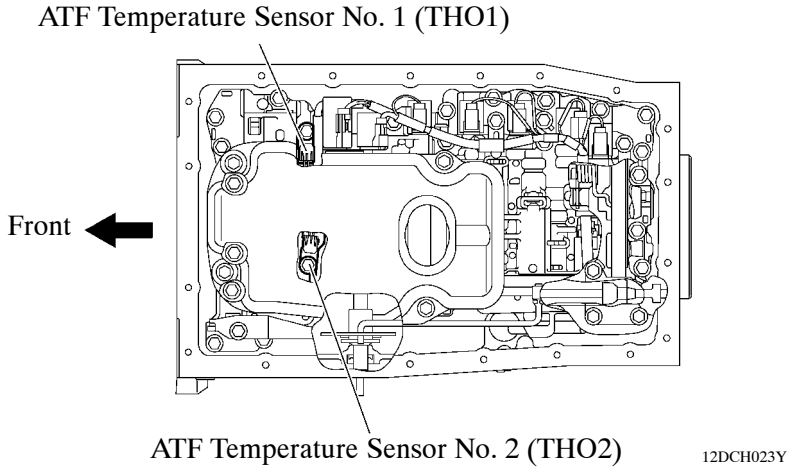


*: Models with towing package

Construction and Operation of Main Components

1) ATF Temperature Sensors No. 1 and No. 2

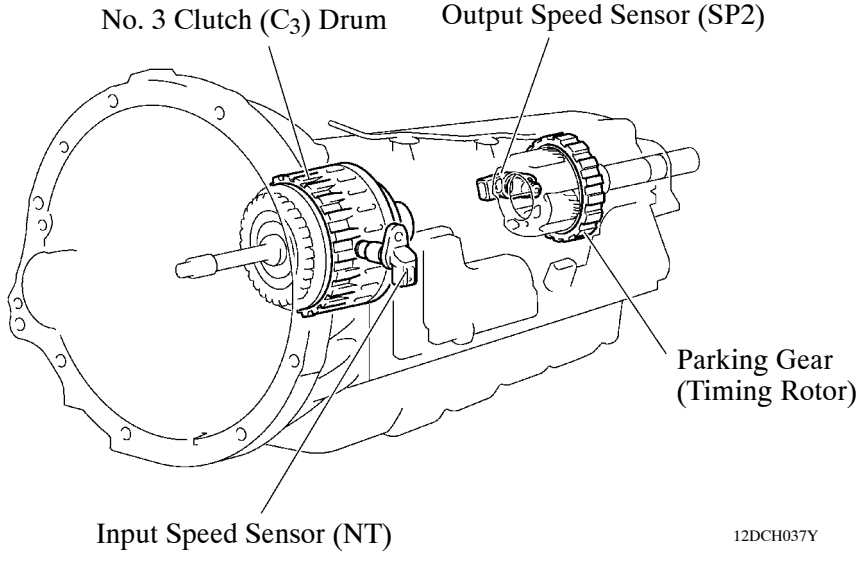
- The ATF temperature sensor No. 1 (THO1) is used for hydraulic pressure control. This sensor is used for revision of the pressure that is used to apply clutches and brakes in the transmission. This helps to ensure smooth shift quality.
- The ATF temperature sensor No. 2 (THO2) is used as a basis for modifying the ECT shift timing control when the ATF temperature is high. It is also used for the ATF temperature warning light.



2) Input Speed Sensor and Output Speed Sensor

The A760E and A760F automatic transmissions use an input speed sensor (for NT signal) and an output speed sensor (for SP2 signal). 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 various conditions. These speed sensors are the pick-up coil type.

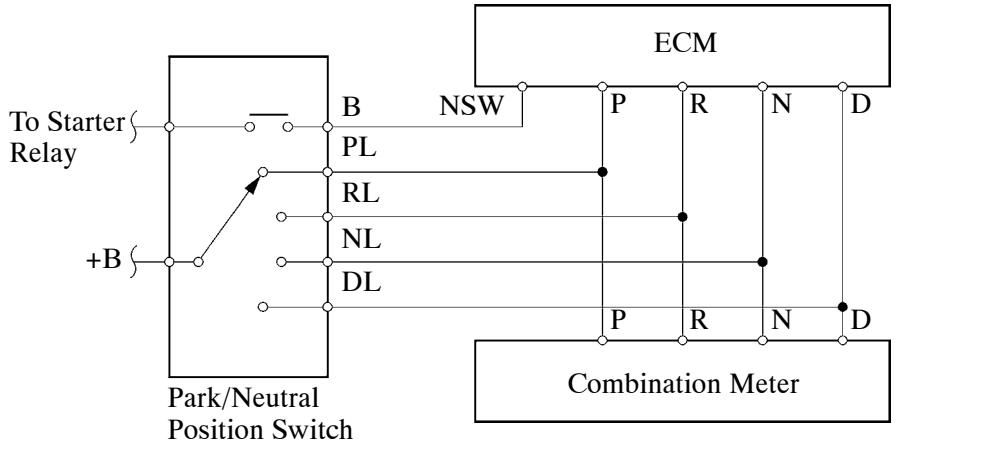
- The input speed sensor detects the input speed of the transmission. The No. 3 clutch (C_3) drum is used as the timing rotor for this sensor.
- The output speed sensor detects the speed of the output shaft. The parking gear on the rear planetary gear is used as the timing rotor for this sensor.



3) Park/Neutral Position Switch

The park/neutral position switch sends the P, R, N, D and NSW position signals to the ECM. It also sends signals for the shift position indicator light (P, R, N, and D).

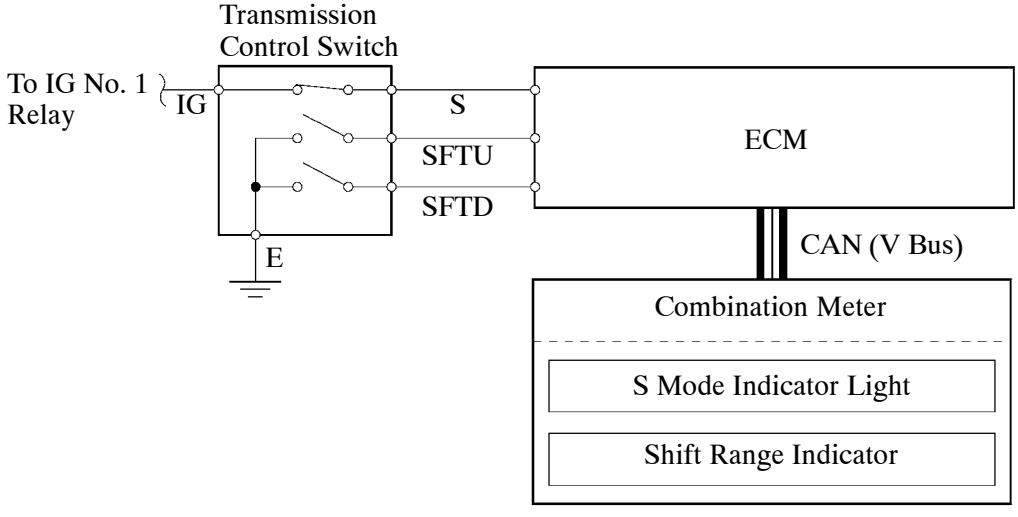
▶ Wiring Diagram ◀



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4) Transmission Control Switch

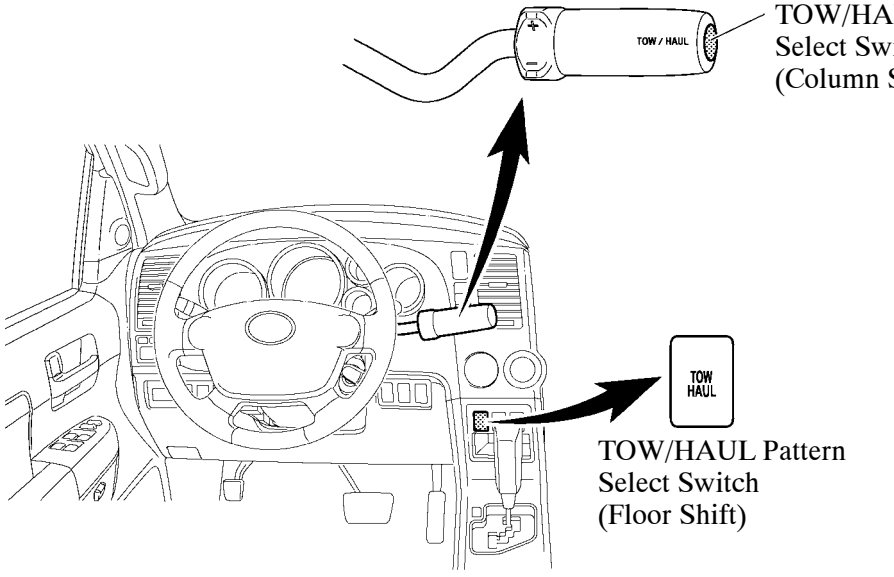
- The transmission control switch is installed inside the shift lever assembly to detect the shift lever position and to inform the ECM. The ECM turns on the shift position indicator light and S mode indicator light.
- The transmission control switch detects whether the shift lever is in D or S, detects the operating conditions of the shift lever ("+" or "–") if S mode is selected, and sends signals to the ECM. At this time, the ECM turns on the shift range indicator for the selected range.



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5) TOW/HAUL Pattern Select Switch (Models with Towing Package)

- If the shift lever is in D when the switch is pushed once, the tow/haul control will be performed. At this time, the TOW/HAUL indicator light illuminates to inform the driver of the tow/haul control mode.
- If the TOW/HAUL pattern select switch is operated again, or the ignition switch is turned off, the tow/haul control will be canceled.

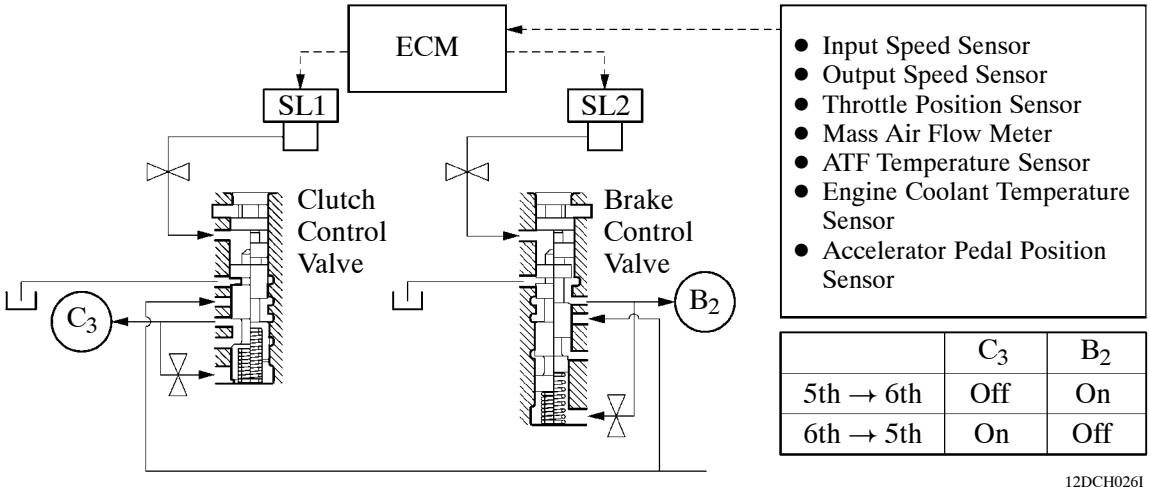


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Clutch Pressure Control

1) Clutch to Clutch Pressure Control

This control is used for shifting from 5th to 6th gear and from 6th to 5th gear.
The ECM actuates shift solenoid valves SL1 and SL2 in accordance with various signals. The output from these shift solenoid valves acts directly on control valves B_2 and C_3 in order to regulate the line pressure that acts on the No. 2 brake (B_2) and No. 3 clutch (C_3). As a result, high response and excellent shift characteristics have been achieved.

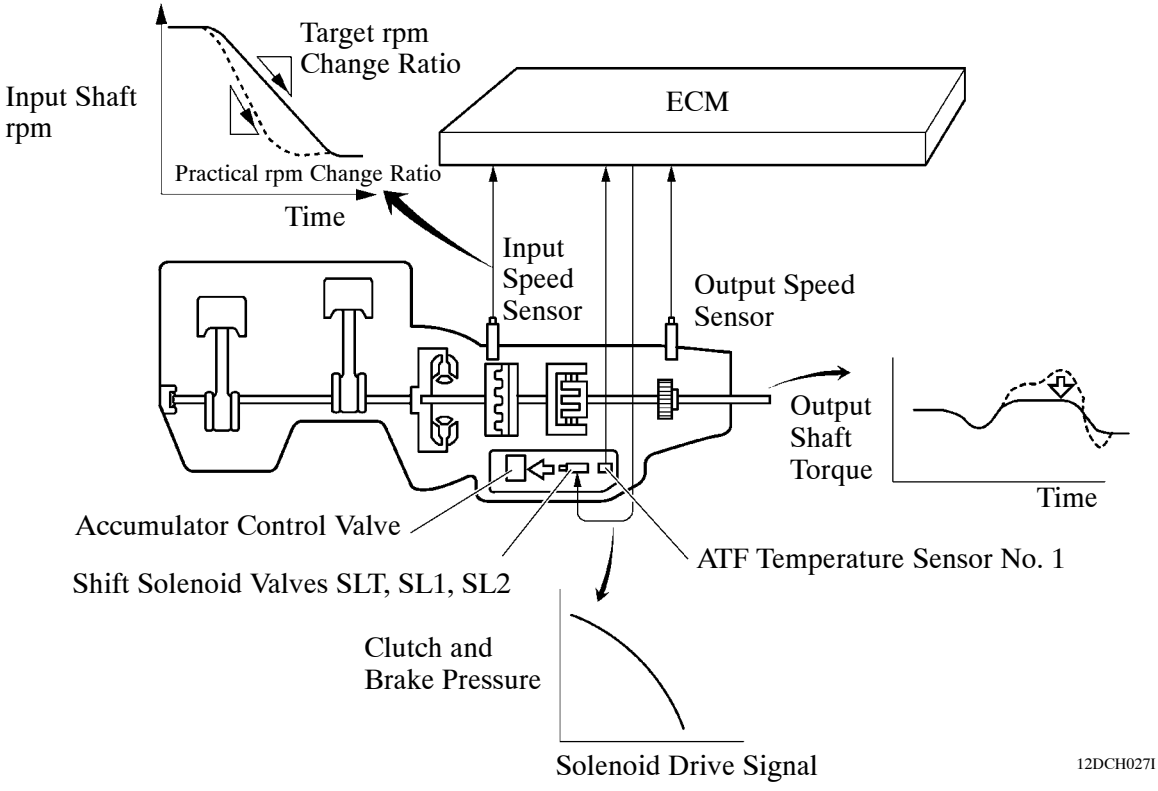


	C_3	B_2
5th → 6th	Off	On
6th → 5th	On	Off

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2) Clutch Pressure Optimal Control

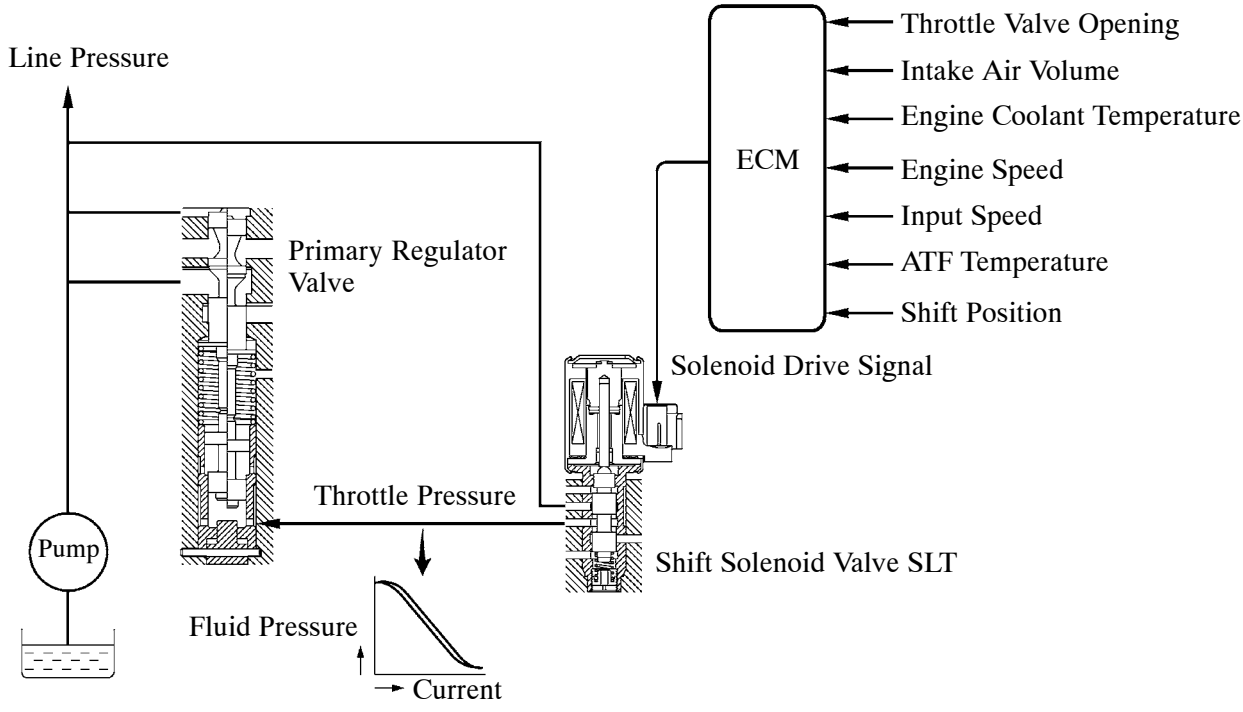
The ECM monitors the signals from various types of sensors, such as the input speed sensor, allowing shift solenoid valves SLT, SL1 and SL2 to minutely control the clutch pressure in accordance with engine output and driving conditions. As a result, smooth shift characteristics are achieved.



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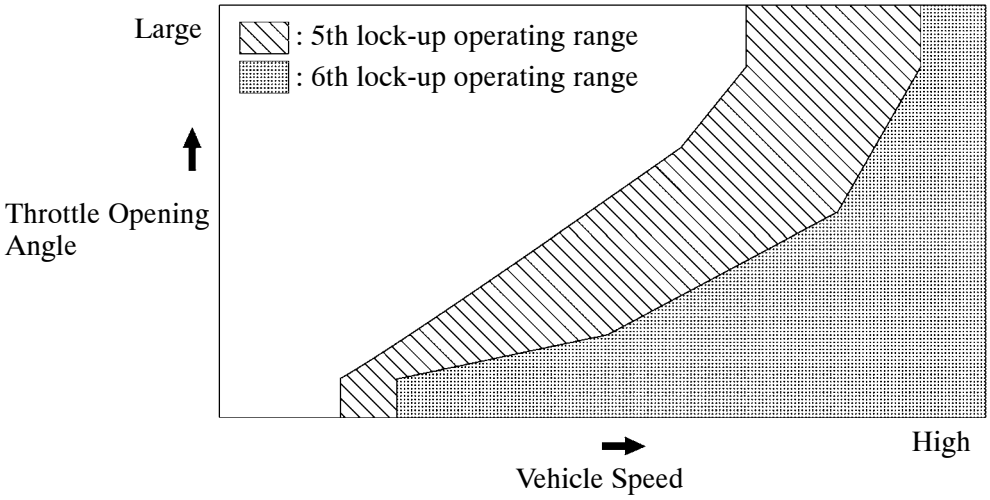
Line Pressure Optimal Control

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 and the transmission.
Accordingly, the line pressure can be controlled minutely in accordance with the engine output, traveling condition, and ATF temperature, thus achieving smooth shift characteristics and optimizing the workload of the oil pump (reducing unnecessary parasitic losses).



Lock-up Timing Control

The ECM operates the lock-up timing control in order to improve the fuel consumption performance while in top gear with the shift lever in the S4 or S5 range, and in 5th or 6th gear with the shift lever in the S6 range or D.



Lock-up Timing in S6 Range or D

12DCH027I

▶ Lock-up Operation Gears in Each Range ◀

○: Available ×: Not available —: Not applicable

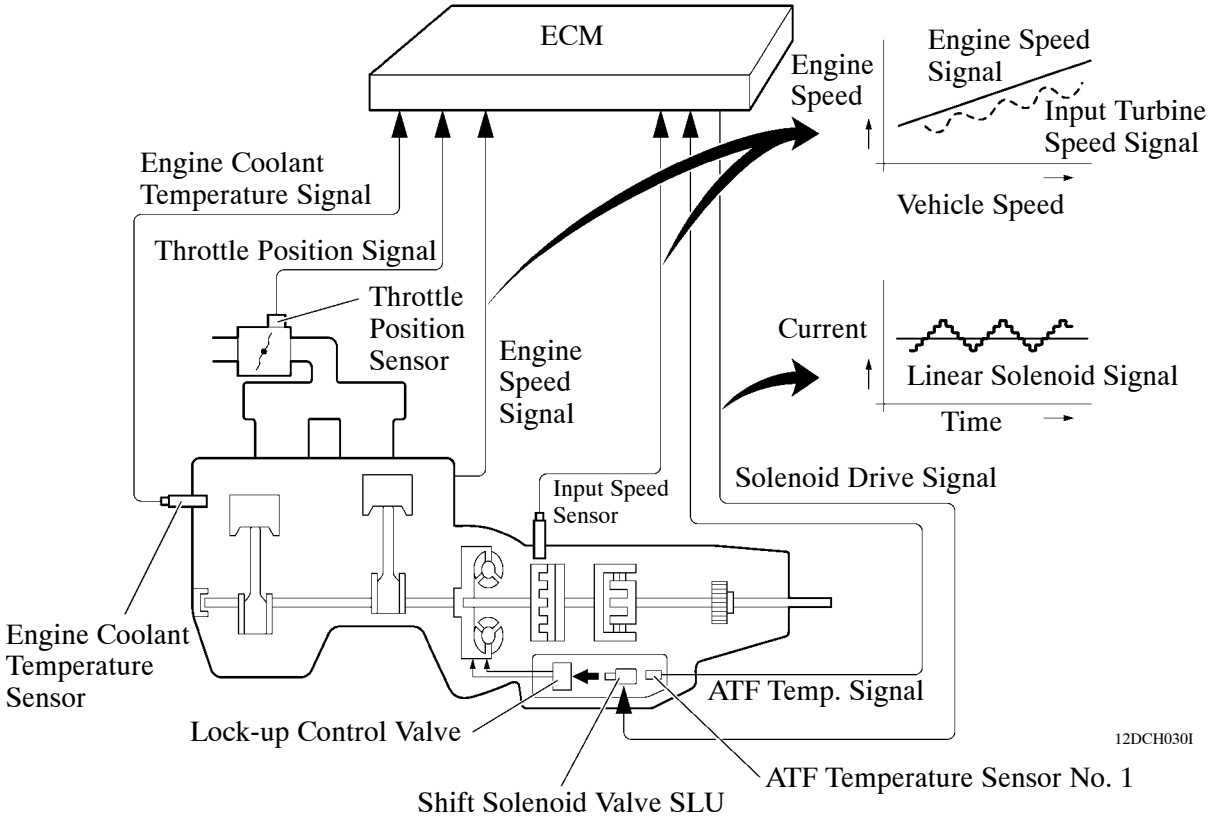
Shift Position or Shift Range		D, S6	S5	S4
Gear	1st	×	×	×
	2nd	×	×	×
	3rd	×	×	×
	4th	×*	×*	○
	5th	○	○	—
	6th	○	—	—

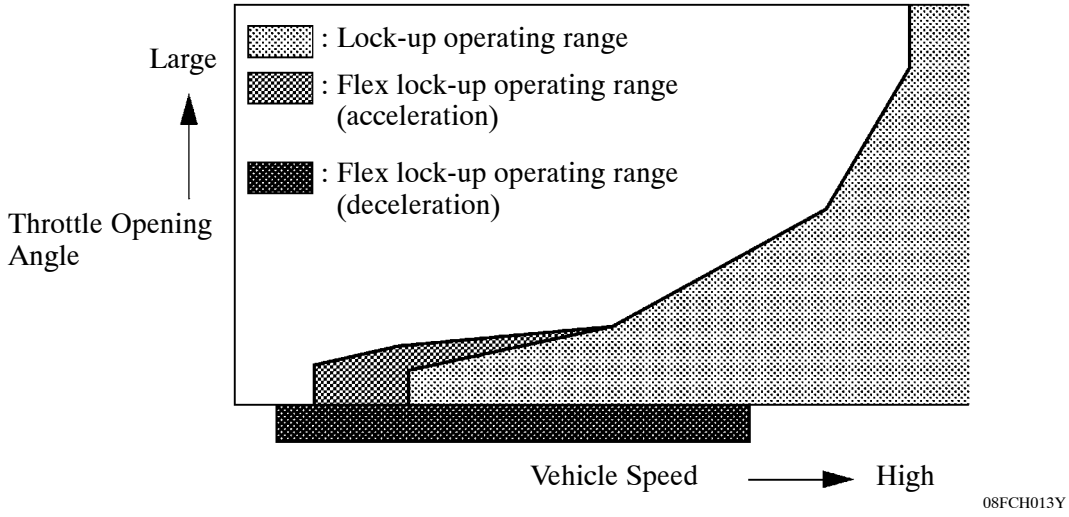
*: Lock-up operation is performed when the 4th gear is held during the AI-shift control or the cruise control.

Flex Lock-up Clutch Control

In the low-to-mid-speed range, the flex lock-up clutch control regulates the shift solenoid valve SLU to provide an intermediate mode between the on and off operation of the lock-up clutch in order to improve energy transmitting efficiency.
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, 5th and 6th gears in D and S6 range, in the 3rd, 4th and 5th gears in the S5 range, and in the 3rd and 4th gears in the S4 range.

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





Flex Lock-up Timing in 6th Gear

▶ Flex Lock-up Operation Gears in Each Range ◀

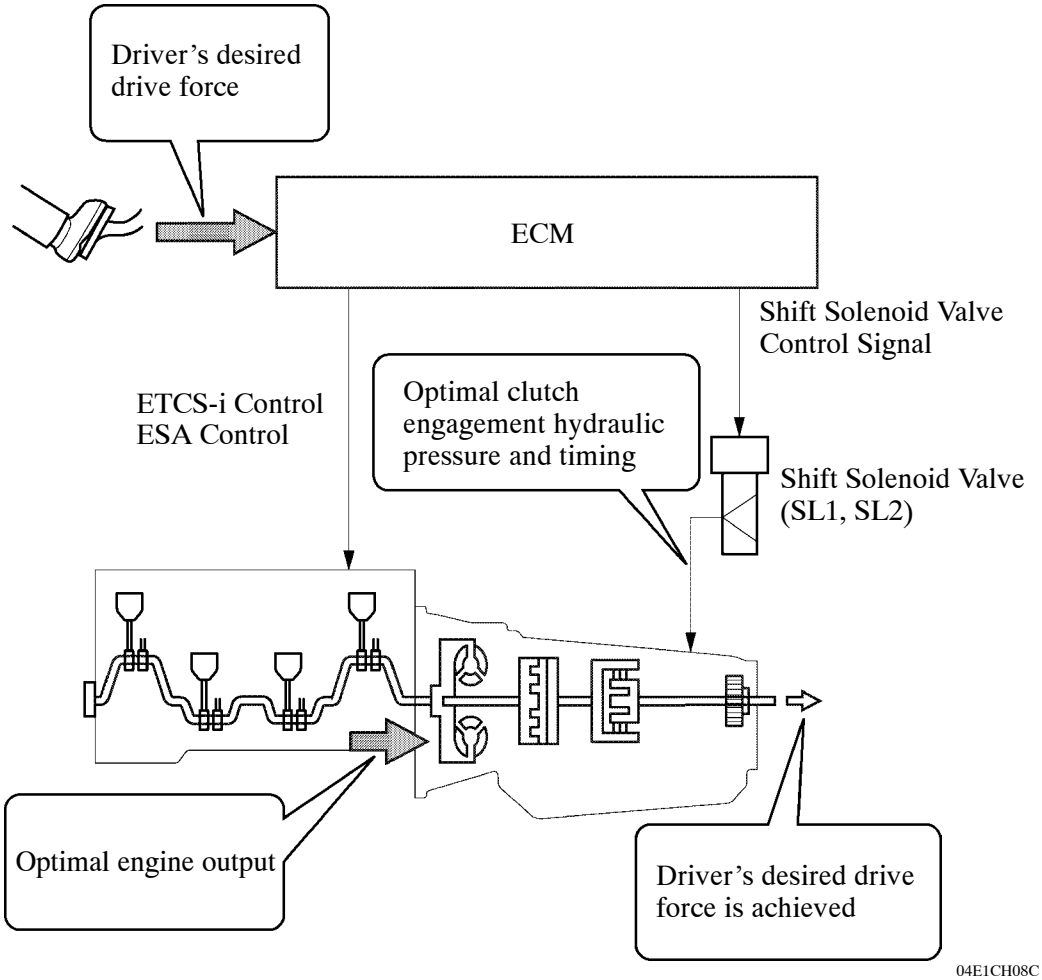
○: Available ×: Not available —: Not applicable

Shift Position or Shift Range		D, S6	S5	S4
Gear	1st	×	×	×
	2nd	×	×	×
	3rd	○*1	○*1	○*1
	4th	○	○	○
	5th	○	○	—
	6th	○*2	—	—

*1: Only flex lock-up operates when the vehicle is accelerating
*2: Only flex lock-up operates when the vehicle is decelerating

Powertrain Cooperative Control

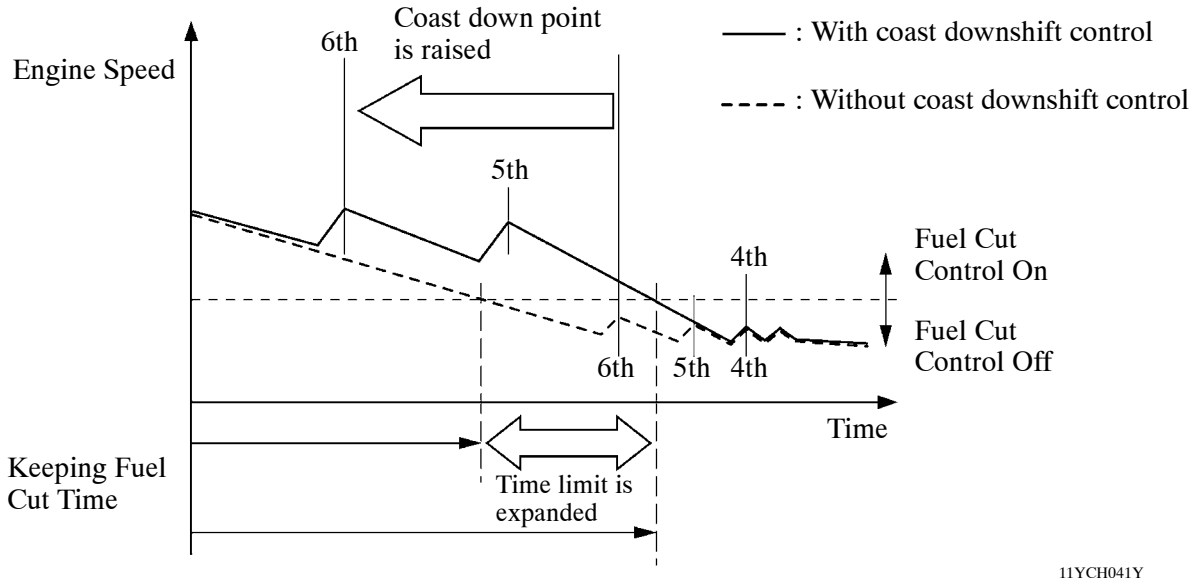
Through cooperative control with Electronic Throttle Control System-intelligent (ETCS-i) and Electronic Spark Advance (ESA), and electronic control of the engagement and release speed of the clutch and brake hydraulic pressures, excellent response and shift shock reduction have been achieved.



Coast Downshift Control

As a result of coast downshift control, downshifting is performed to maintain sufficient engine speed to avoid ending fuel cut control. Thus, fuel cut time is extended and fuel economy is achieved.

- In this control, the transmission downshifts from 6th to 5th and then 5th to 4th before fuel cut control ends when the vehicle is decelerated in the 6th gear, so that fuel cut control can continue to operate.

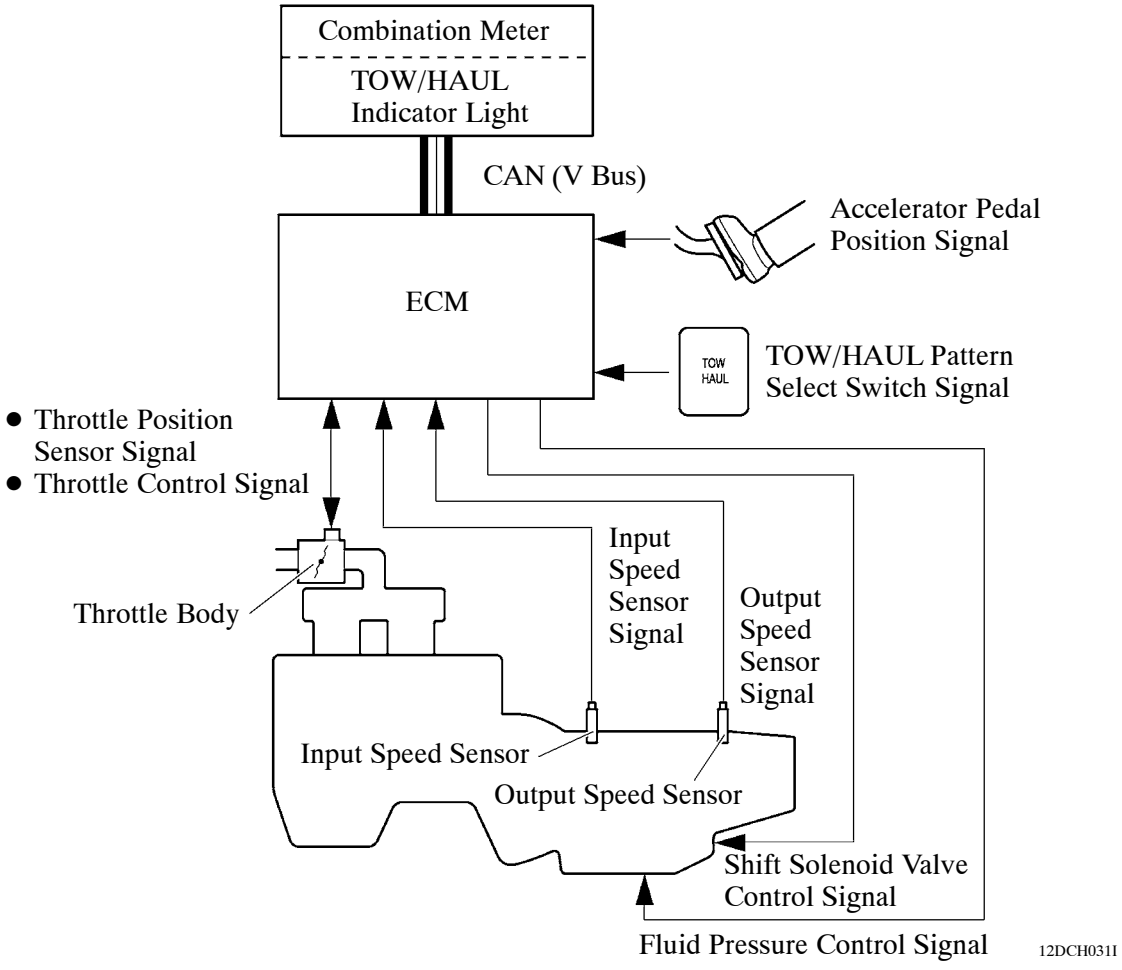


Tow/Haul Control (Models with Towing Package)

1) General

During tow/haul control, the ECM controls the engine output, transmission shift schedule and shift timing to ensure driveability when a trailer is towed. The tow/haul control includes a throttle control, a shift schedule control, a wide open throttle shift timing control and an AI-shift control.

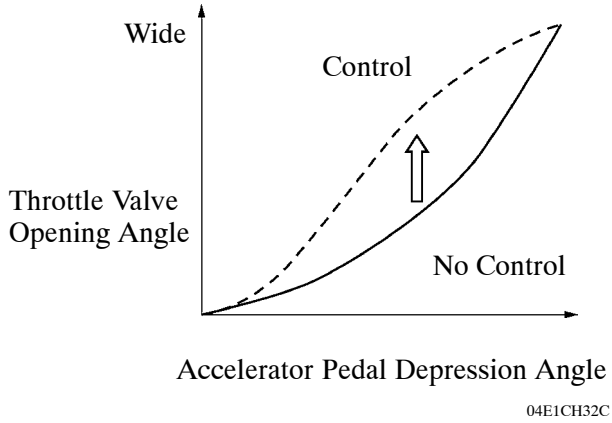
- The tow/haul control operates when the TOW/HAUL pattern select switch is turned on.
- The TOW/HAUL indicator light is used to inform the driver that tow/haul control is operating.



2) Throttle Control

Throttle control changes the relationship between the accelerator pedal depression angle and the throttle valve opening angle.

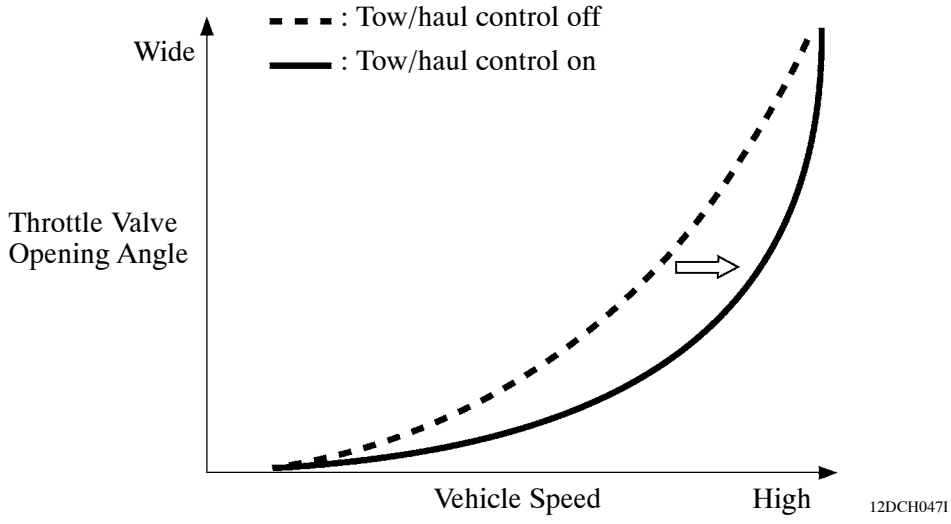
- During tow/haul control, the throttle valve opening is increased by throttle control. As a result, acceleration performance is ensured.



3) Shift Schedule Control

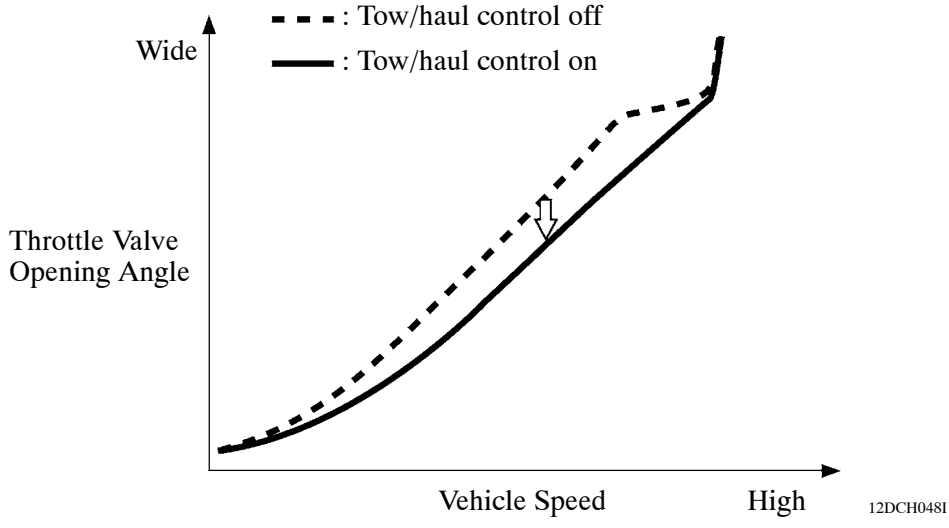
The shift schedule control changes the upshift and downshift schedules during tow/haul control.

- Compared to normal mode, in the upshift schedule of tow/haul control, the shift pattern is moved toward higher vehicle speeds and the low gear usage area is enlarged, thus ensuring driveability.



Upshift Schedule

- Compared to normal mode, in the downshift schedule of tow/haul control, the shift pattern is moved toward narrower throttle valve opening angles and the low gear usage area is enlarged, thus ensuring towing force.

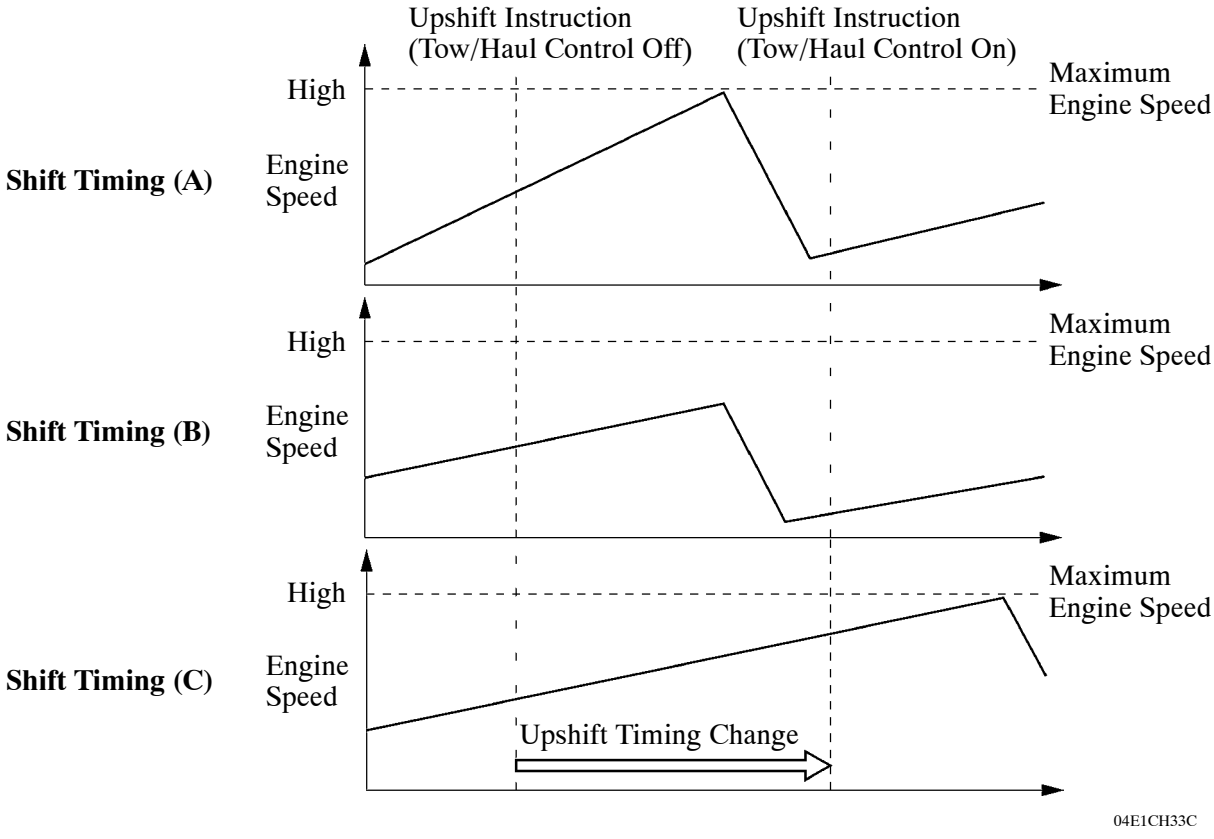


Downshift Schedule

4) Wide Open Throttle Shift Timing Control

Due to wide open throttle shift timing control, upshift timing is delayed to make use of high engine power when the accelerator pedal is fully open.

- Wide open throttle shift timing control operates in the 1st, 2nd and 3rd gears during tow/haul control.

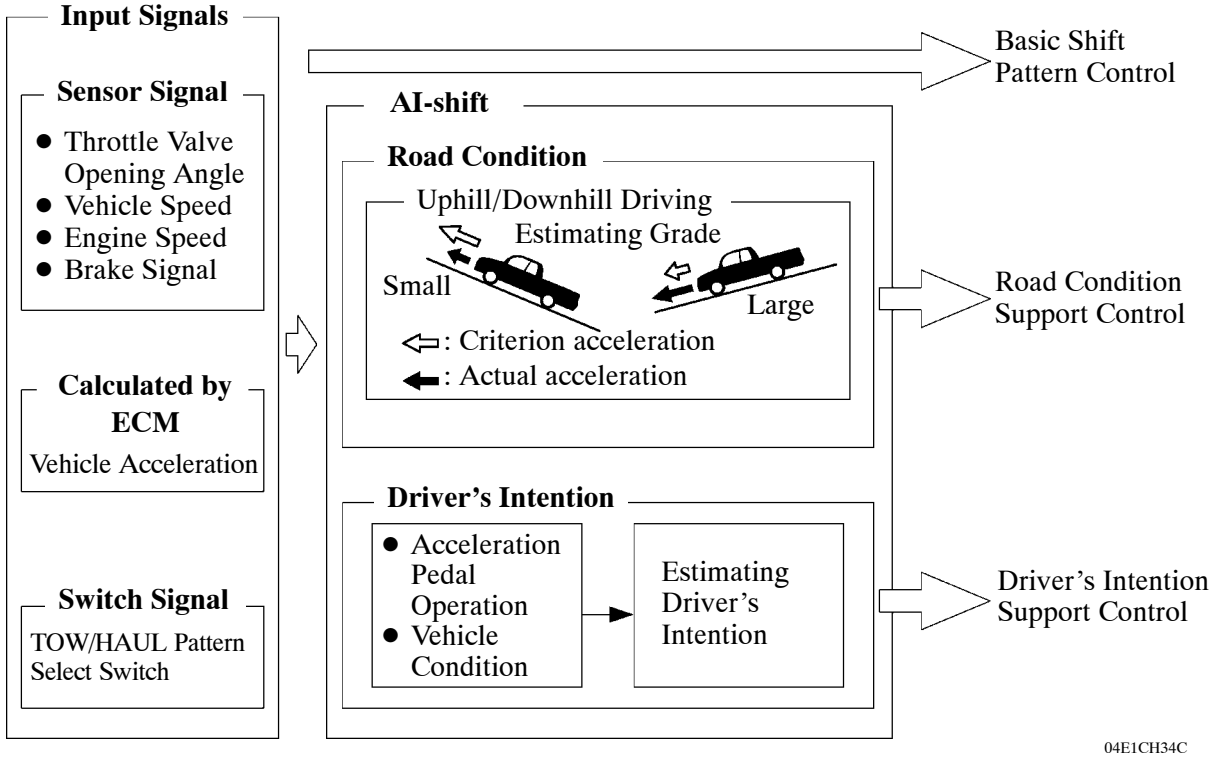


Shift Timing	Towing	Tow/Haul Control
(A)	Without	Off
(B)	With	Off
(C)	With	On

Artificial Intelligence-shift (AI-shift) Control

1) General

- The AI-shift control determines optimal transmission control based on input signals and automatically changes the shift pattern. As a result, a high caliber of transmission operation is achieved.
- The AI-shift control includes a road condition support control and a driver's intention support control.
- The AI-shift control is effected only with the shift lever in D, based on the accelerator pedal and brake operation data. The AI-shift control will be canceled when the driver selects the S mode.

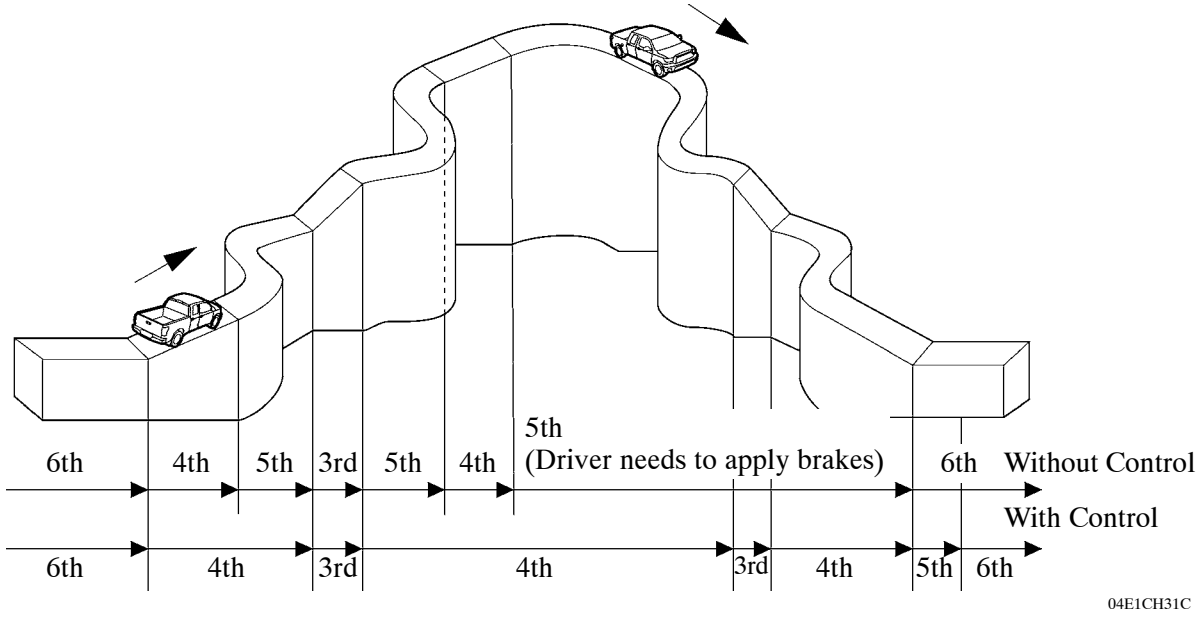


2) Road Condition Support Control

Under road condition support control, the ECM identifies the throttle valve opening angle and the vehicle speed to determine whether the vehicle is being driven uphill or downhill.

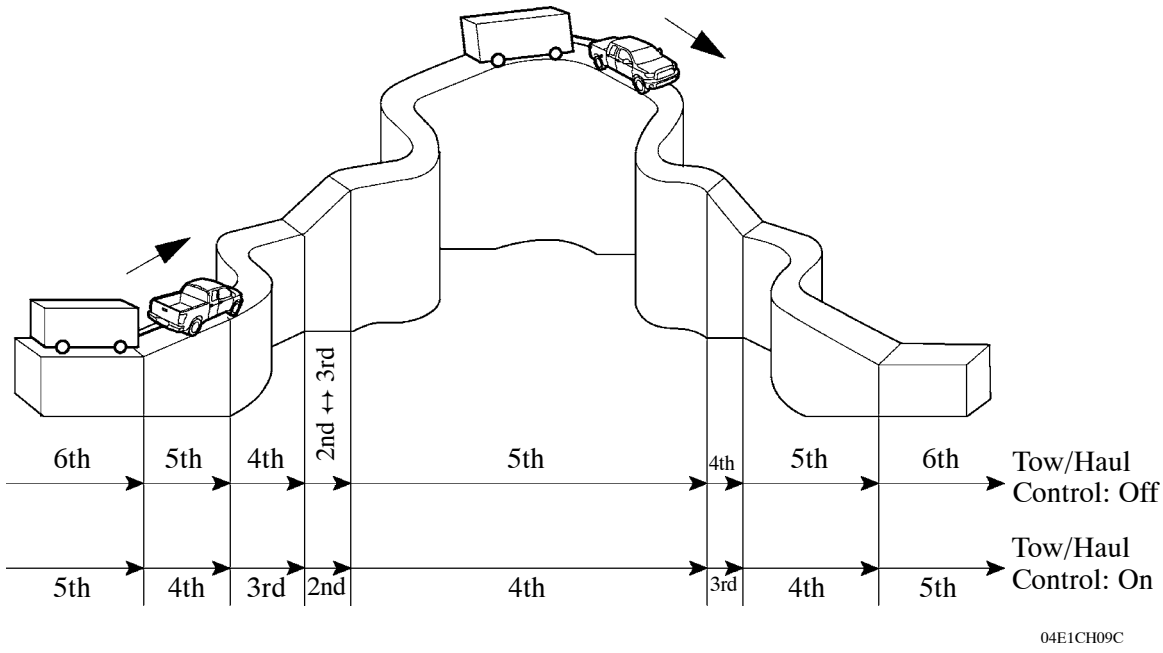
a. When a trailer is not being towed

- To achieve an optimal drive force while driving uphill, this control prevents the transmission from upshifting to 4th, 5th or 6th gear.
- To achieve an optimal engine braking effect while driving downhill, this control automatically downshifts the transmission to 5th, 4th or 3rd gear.



b. When a trailer is being towed

- To achieve an optimal drive force while driving uphill, this control prevents the transmission from upshifting.
- To achieve an optimal engine braking effect while driving downhill, this control automatically downshifts the transmission.
- In addition to the shift pattern changes caused by the road condition support control, the shift pattern is further changed when the tow/haul control is turned on.



3) Driver's Intention Support Control

a. When a trailer is not being towed

The driver's intention support control estimates the driver's intention based on the accelerator pedal operation and vehicle condition, and selects a shift pattern that is well-suited to the driver.

b. When a trailer is being towed

While the vehicle is being driven with the shift lever in D, the driver's intention support control ensures driveability while towing a trailer by determining the driver's intention based on the accelerator pedal operation and vehicle condition, and performs the controls shown in the table below:

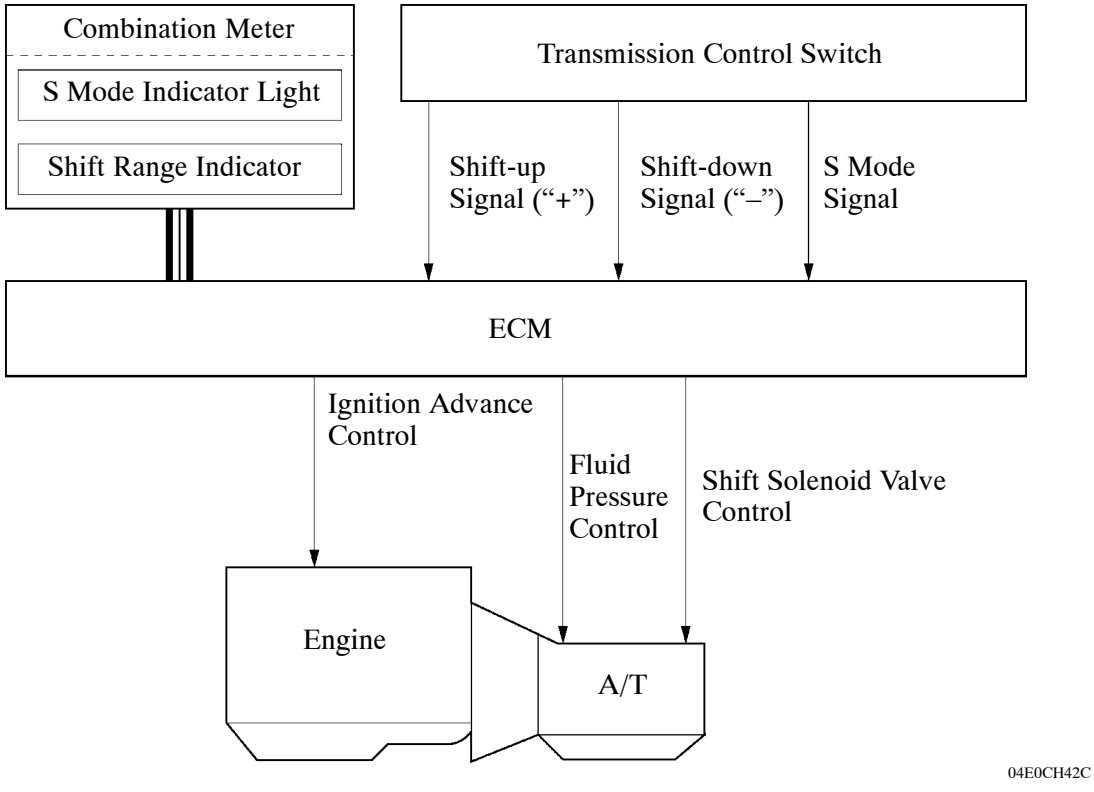
Control	Operation	Available for
Sudden Accelerator Pedal Depress Control	When the driver operates (presses) the accelerator pedal quickly, this control causes the transmission to downshift rapidly to improve acceleration response.	5th to 6th
Sudden Accelerator Pedal Release Control	When the driver releases the accelerator pedal quickly, this control makes it easy for the transmission to hold the gear, which improves engine braking force and re-acceleration response.	3rd to 5th
Sudden Deceleration Downshift Control	When the driver decelerates the vehicle suddenly, this control downshifts rapidly, which improves engine braking force and re-acceleration response.	4th to 6th

Multi-mode Automatic Transmission

1) General

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

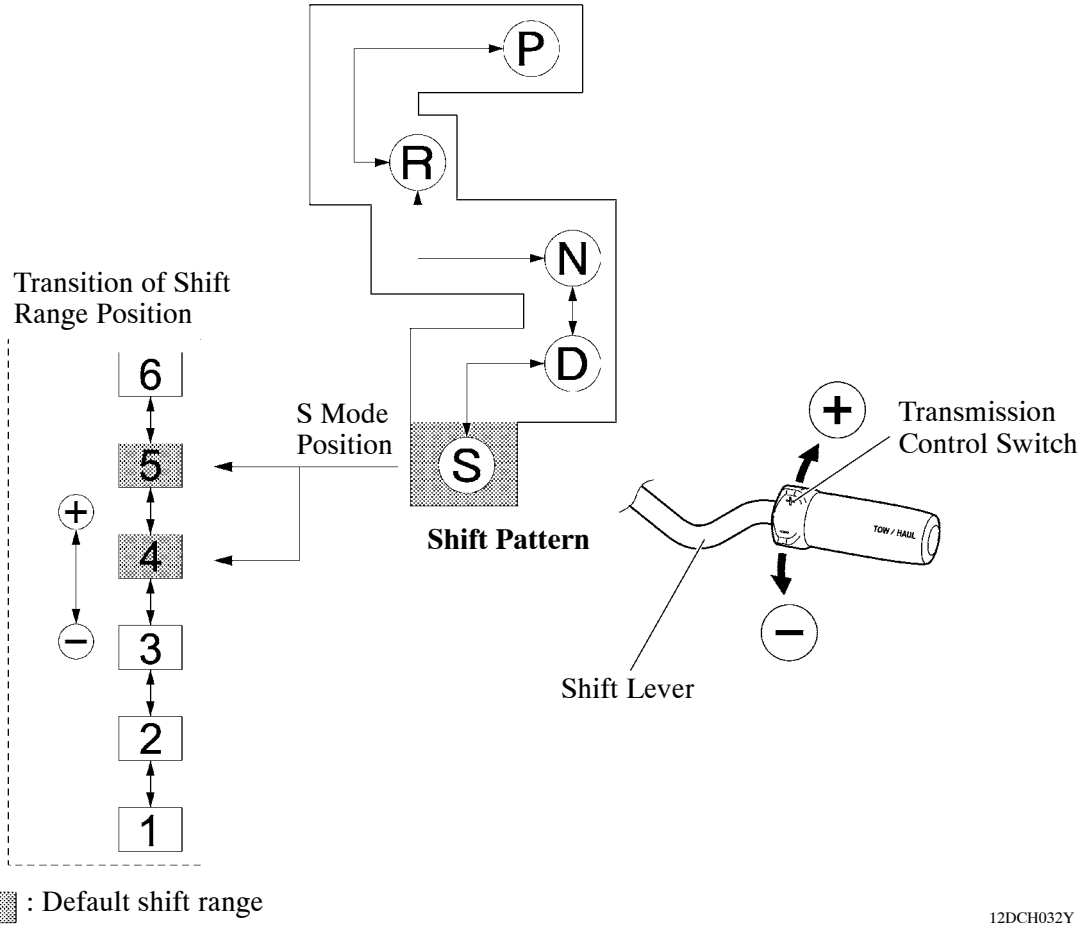
▶ System Diagram ◀



2) Operation

a. Column Shift

- The driver selects the S mode by engaging the shift lever. At this time, the S4 or S5 range is selected in accordance with the vehicle speed. (When the driver selects the S mode during AI-shift control, the current gear will be selected as the shift range.) Then, the shift range changes one at a time, as the driver moves the transmission control switch forward ("+") or backward ("–").
- Under the multi-mode automatic transmission control, the ECM effects optimal shift control within the usable gear range that the driver has selected. The 1st gear is shifted to when the vehicle is stopped.
- Holding the transmission control switch in "+" with the shift lever in S will change the shift range to the S6 range regardless of range (S1 to S5).
- When the shift lever is in S, the S mode indicator light in the combination meter illuminates. The shift range indicator indicates the shift range position that the driver has selected.

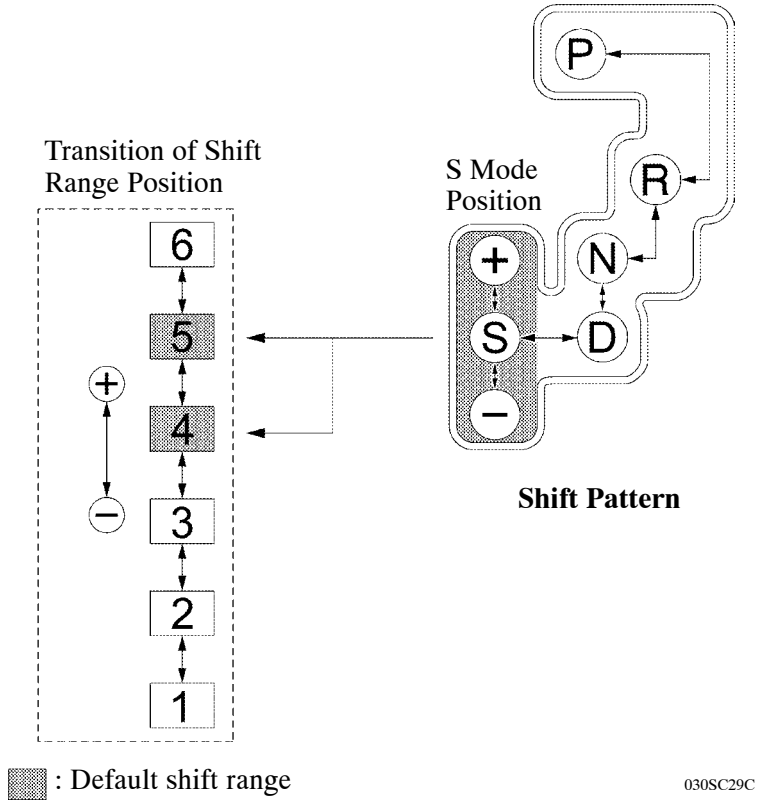


▶ Usable Gear Chart ◀

Shift Range	Shift Range Indicator Display	Usable Gears
S6	6	6th ↔ 5th ↔ 4th ↔ 3rd ↔ 2nd ↔ 1st
S5	5	5th ↔ 4th ↔ 3rd ↔ 2nd ↔ 1st
S4	4	4th ↔ 3rd ↔ 2nd ↔ 1st
S3	3	3rd ↔ 2nd ↔ 1st
S2	2	2nd ↔ 1st
S1	1	1st

b. Floor Shift

- The driver selects the S mode by engaging the shift lever. At this time, the S4 or S5 range is selected in accordance with the vehicle speed. (When the driver selects the S mode during AI-shift control, the current gear will be selected as the shift range.) Then, the shift range changes one at a time, as the driver moves the shift lever forward (“+”) or backward (“–”).
- Under this control, the ECM effects optimal shift control within the usable gear range that the driver has selected. The 1st gear is shifted to when the vehicle is stopped.
- Holding the shift lever forward (“+”) will change the shift range to the S6 range regardless of range (S1 to S5).
- When the shift lever is in S, the S mode indicator light in the combination meter illuminates. The shift range indicator indicates the shift range position that the driver has selected.



Shift Pattern

▶ Usable Gear Chart ◀

Shift Range	Shift Range Indicator Display	Usable Gears
S6	6	6th ↔ 5th ↔ 4th ↔ 3rd ↔ 2nd ↔ 1st
S5	5	5th ↔ 4th ↔ 3rd ↔ 2nd ↔ 1st
S4	4	4th ↔ 3rd ↔ 2nd ↔ 1st
S3	3	3rd ↔ 2nd ↔ 1st
S2	2	2nd ↔ 1st
S1	1	1st

Diagnosis

- When the ECM detects a malfunction, the ECM records the malfunction and memorizes the information related to the fault. Furthermore, the Malfunction Indicator Lamp (MIL) in the combination meter illuminates or blinks to inform the driver.
- The ECM will also store the Diagnostic Trouble Codes (DTCs) of the malfunctions. The DTCs can be accessed using the Techstream.

For details, see the 2010 TOYOTA TUNDRA Repair Manual.

Fail-safe

The fail-safe function minimizes the loss of operability when an abnormality occurs in a sensor or a shift solenoid valve.

▶ Fail-safe Control List ◀

Malfunction Part	Function
Input Speed Sensor (NT)	When the input speed sensor malfunctions, shift control is effected using the information from the output speed sensor signal (SP2). During an input speed sensor malfunction, upshifting to the 5th and 6th, AI-shift and flex lock-up clutch control are prohibited.
Output Speed Sensor (SP2)	When the output speed sensor malfunctions, shift control is effected using the information from the input speed sensor signal (NT). When the output speed sensor malfunctions, upshifting to the 5th and 6th, AI-shift and flex lock-up clutch control are prohibited.
ATF Temperature Sensor No. 1 (THO1)	When the ATF temperature sensor No. 1 malfunctions, upshifting to the 5th and 6th and flex lock-up clutch control are prohibited.
Shift Solenoid Valves S1, S2, S3, S4 and SR	When a shift solenoid valve listed at left fails, the current to the failed shift solenoid valve is cut off. Shift control is changed to a fail-safe mode to shift gears using the normal shift solenoid valves to allow for continued driving. Refer to the table on the next page for an operation example.
Shift Solenoid Valves SL1 and SL2	During a shift solenoid valve SL1 or SL2 malfunction, upshifting to the 5th and 6th and flex lock-up clutch control are prohibited.
Shift Solenoid Valve SLU	During a shift solenoid valve SLU malfunction, the current to the shift solenoid valve is stopped. Because this stops the lock-up control and flex lock-up control, fuel economy decreases.
Shift Solenoid Valve SLT	During a shift solenoid valve SLT malfunction, the current to the shift solenoid valve is stopped. Because this stops the line pressure optimal control, the shift shock increases. However, shifting is effected through normal clutch pressure control.

▶ Normal Condition ◀

Shift Position or Range	Shift Solenoid Valve							Gear
	S1	S2	S3	S4	SR	SL1	SL2	
D, S6	Off	On	On	Off	On	Off	On	1st
	On	On	On	Off	On	Off	On	2nd
	On	Off	On	Off	On	Off	On	3rd
	On	Off	Off	Off	On	Off	On	4th
	On	Off	Off	On	Off	On	Off	5th
	On	On	Off	On	Off	On	Off	6th
S5	Off	On	On	Off	On	Off	On	1st
	On	On	On	Off	On	Off	On	2nd
	On	Off	On	Off	On	Off	On	3rd
	On	Off	Off	Off	On	Off	On	4th
	On	Off	Off	On	Off	On	Off	5th
S4	Off	On	On	Off	On	Off	On	1st
	On	On	On	Off	On	Off	On	2nd
	On	Off	On	Off	On	Off	On	3rd
	On	Off	Off	Off	On	Off	On	4th
S3	Off	On	On	Off	On	Off	On	1st
	On	On	On	Off	On	Off	On	2nd
	On	Off	On	Off	On	Off	Off	3rd
S2	Off	On	On	Off	On	Off	On	1st
	On	On	On	On	On	Off	Off	2nd
S1	Off	On	On	Off	On	Off	Off	1st

▶ Example (Shift Solenoid Valve S1 Malfunction) ◀

Shift Position or Range	Shift Solenoid Valve							Gear
	S1	S2	S3	S4	SR	SL1	SL2	
D, S6	×	On	On	Off	On	Off	On	1st
	×	On → Off	On → Off	Off	On	Off	On	1st → 4th
	×	Off	On → Off	Off	On	Off	On	3rd → 4th
	×	Off	Off	Off	On	Off	On	4th
	×	Off	Off	On	Off	On	Off	5th
	×	On → Off	Off	On	Off	On	Off	N → 5th
S5	×	On	On	Off	On	Off	On	1st
	×	On → Off	On → Off	Off	On	Off	On	1st → 4th
	×	Off	On → Off	Off	On	Off	On	3rd → 4th
	×	Off	Off	Off	On	Off	On	4th
	×	Off	Off	On	Off	On	Off	5th
S4	×	On	On	Off	On	Off	On	1st
	×	On → Off	On → Off	Off	On	Off	On	1st → 4th
	×	Off	On → Off	Off	On	Off	On	3rd → 4th
	×	Off	Off	Off	On	Off	On	4th
S3	×	On	On	Off	On	Off	On	1st
	×	On → Off	On → Off	Off	On	Off	On	1st → 4th
	×	Off	On → Off	Off	On	Off	Off → On	3rd (E/B) → 4th
S2	×	On	On	Off	On	Off	On	1st
	×	On → Off	On → Off	On → Off	On	Off	Off → On	3rd (E/B) → 4th
S1	×	On	On	Off	On	Off	Off	1st (E/B)

E/B: Engine Braking