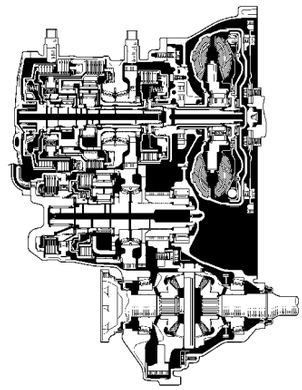
U140E AND U241E AUTOMATIC TRANSAXLE

■DESCRIPTION

- The ’02 Camry line-up uses the following types of automatic transaxles:
  2AZ-FE × U241E
  1MZ-FE × U140E
- These automatic transaxles are compact and high-capacity 4-speed Super ECT (Electronically Controlled Transaxle).
- The basic construction and operation of these automatic transaxles are the same.
  However, the gear ratio, disc, and spring number have been changed to accommodate the characteristic of the engine.



U140E

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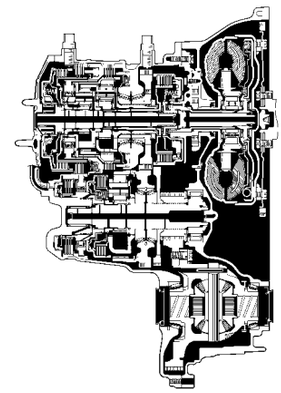


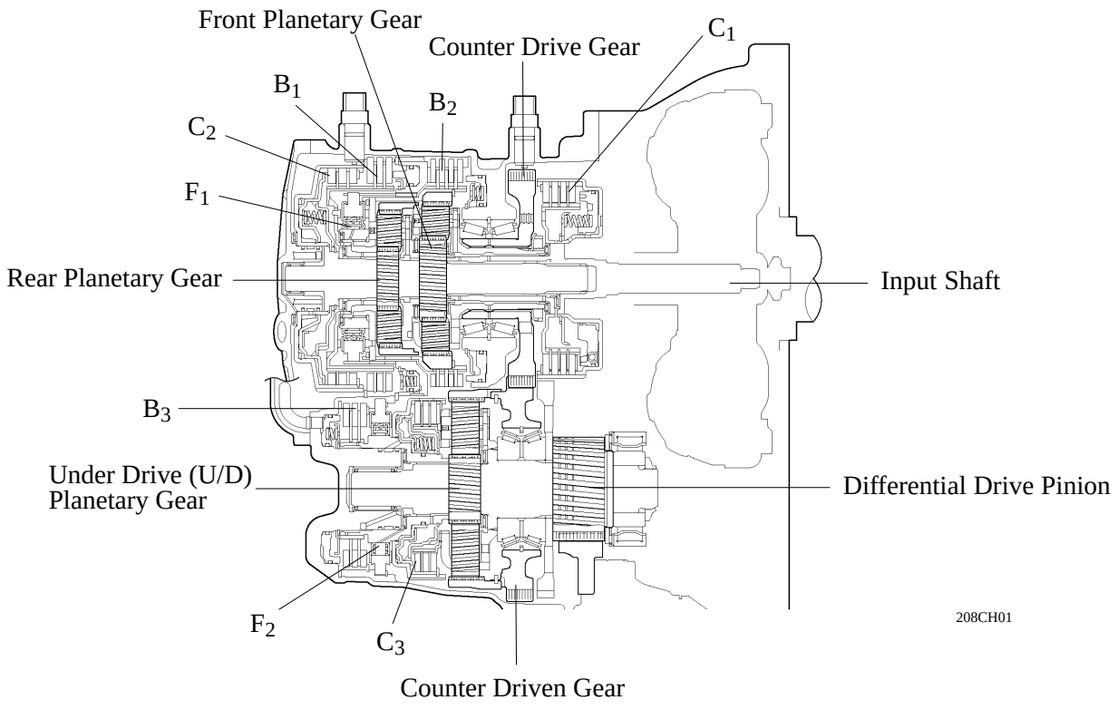
U241E

181CH09

▶ Specification ◀

Model		’02 Camry		’01 Camry	
Transaxle Type		U140E	U241E	A140E	A541E
Engine Type		1MZ-FE	2AZ-FE	5S-FE	1MZ-FE
Gear Ratio	1st	3.938*1	3.943*1	2.810	←
	2nd	2.194*1	2.197*1	1.549	←
	3rd	1.411*1	1.413*1	1.000	←
	4th	1.019*1	1.020*1	0.706	0.735
	Reverse	3.141*1	3.145*1	2.296	←
Counter Gear Ratio		1.019	1.020	0.945	←
Differential Gear Ratio		2.814	2.740	3.944	3.933
Fluid Capacity Liters (US qts, Imp. qts)		8.6 (9.1, 7.7)*2	←	5.6 (5.9, 4.9)*3 1.6 (1.7, 1.4)*4	6.8 (7.2, 5.9)*3 0.9 (0.9, 0.8)*4
Fluid Type		ATF Type T-IV	←	ATF D-II or DEXRON®III (DEXRON®II)	←
Dry Weight kg (lb)		91 (200.6)	82 (180.8)	73 (160.9)	83.3 (183.6)

*1: Counter Gear Ratio Included
*2: Differential Included
*3: Only for Transmission
*4: Only for Differential



▶ Specification ◀

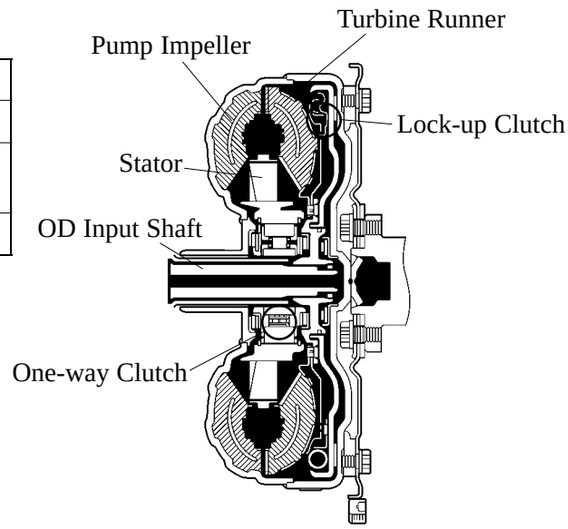
Transaxle Type			U140E	U241E
C_1	Forward Clutch	The No. of Discs	6	5
C_2	Direct Clutch		4	3
C_3	U/D Direct Clutch		4	3
B_1	2nd Brake		4	3
B_2	1st & Reverse Brake		7	5
B_3	U/D Brake		4	3
F_1	No. 1 One-Way Clutch	The No. of Sprags	28	←
F_2	U/D One-Way Clutch		24	15
Front Planetary Gear		The No. of Sun Gear Teeth	43	←
		The No. of Pinion Gear Teeth	17	←
		The No. of Ring Gear Teeth	77	←
Rear Planetary Gear		The No. of Sun Gear Teeth	31	←
		The No. of Pinion Gear Teeth	19	←
		The No. of Ring Gear Teeth	69	←
U/D Planetary Gear		The No. of Sun Gear Teeth	35	32
		The No. of Pinion Gear Teeth	28	26
		The No. of Ring Gear Teeth	91	83
Counter Gear		The No. of Drive Gear Teeth	52	50
		The No. of Driven Gear Teeth	53	51

■TORQUE CONVERTER

- These torque converters have optimally designed fluid passages and impeller configuration resulting in substantially enhanced transmission efficiency to ensure better starting, acceleration and fuel economy.
- Furthermore, a hydraulically operated lock-up mechanism which cuts power transmission losses due to slippage at medium and high speeds is used.
- The basic construction and operation are the same as for the A541E for the previous models.

▶ Specification ◀

Engine Type	1MZ-FE	2AZ-FE
Transaxle Type	U140E	U241E
Torque Converter Type	3-Element, 1-Step, 2-Phase (with Lock-up Mechanism)	
Stall Torque Ratio	1.8	2.0



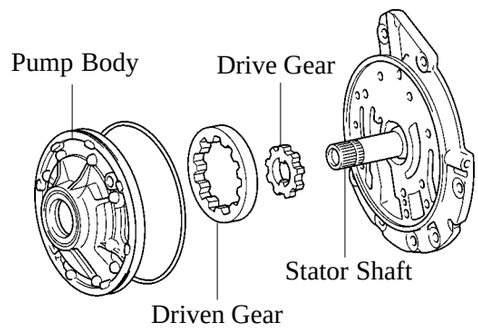
208CH02

■OIL PUMP

The oil pump is combined with torque converter, lubricates the planetary gear units and supplies operating pressure to the hydraulic control.

▶ Specification ◀

Gear	Gear Teeth
Drive Gear	9
Driven Gear	10

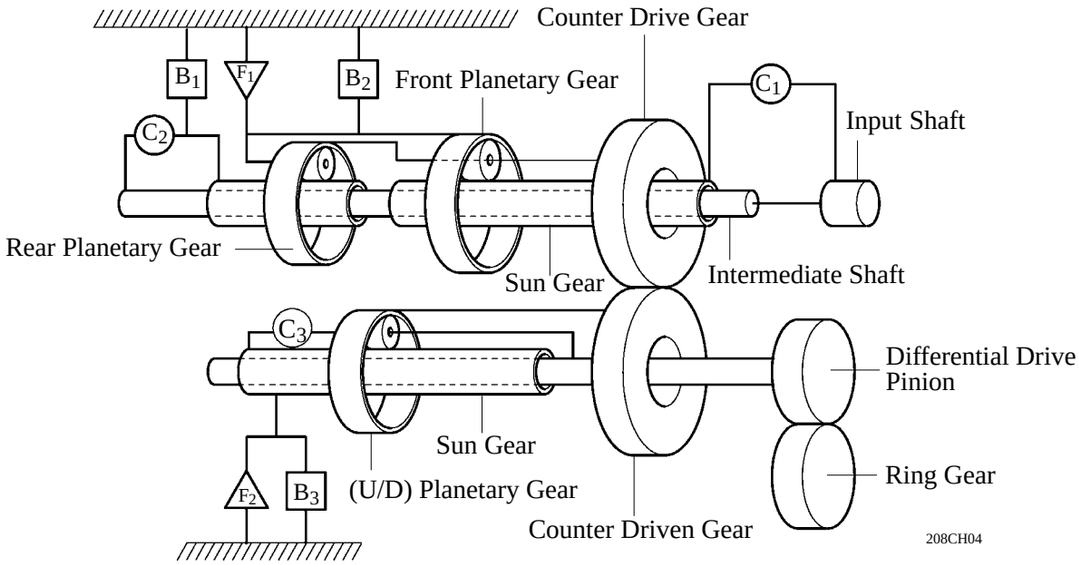


208CH03

■PLANETARY GEAR UNIT

1. Construction

- The counter drive and driven gears are placed in front of the front planetary gear and the under drive (U/D) planetary gear unit is placed above the counter shaft. Furthermore, the force transmission method has been changed by eliminating the brake and the one-way clutch. As a result, a torque capacity that accommodates the high output engine has been attained, while realizing a compact gear unit.
- A centrifugal fluid pressure canceling mechanism has been adopted in the C_2 and C_3 clutches that are applied when shifting from 2nd to 3rd and from 3rd to 4th.



2. Function of Component

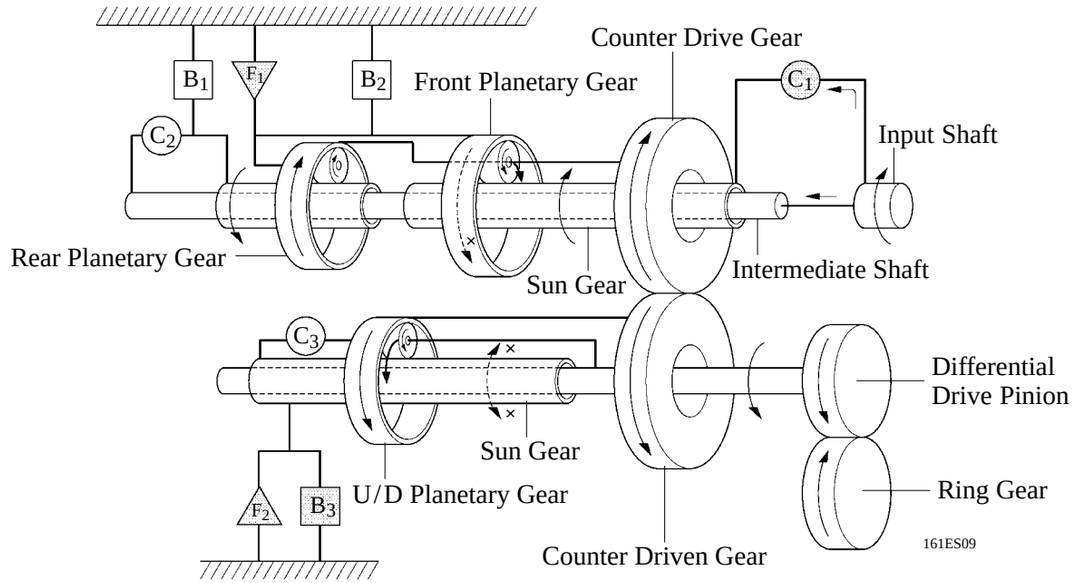
Component		Function
C_1	Forward Clutch	Connects input shaft and front planetary sun gear.
C_2	Direct Clutch	Connects input shaft and rear planetary sun gear.
C_3	U/D Direct Brake	Connects U/D sun gear and U/D planetary carrier.
B_1	2nd Brake	Prevents rear planetary carrier from turning either clockwise or counterclockwise.
B_2	1st & Reverse Brake	Prevents rear planetary carrier and front planetary ring gear from turning either clockwise or counterclockwise.
B_3	U/D Brake	Prevents U/D sun gear from turning either clockwise or counterclockwise.
F_1	No. 1 One-Way Clutch	Prevents rear planetary carrier from turning counterclockwise.
F_2	U/D One-Way Clutch	Prevents U/D planetary sun gear from turning clockwise.
Planetary Gears		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 input and output speed.

3. Motive Power Transaxle

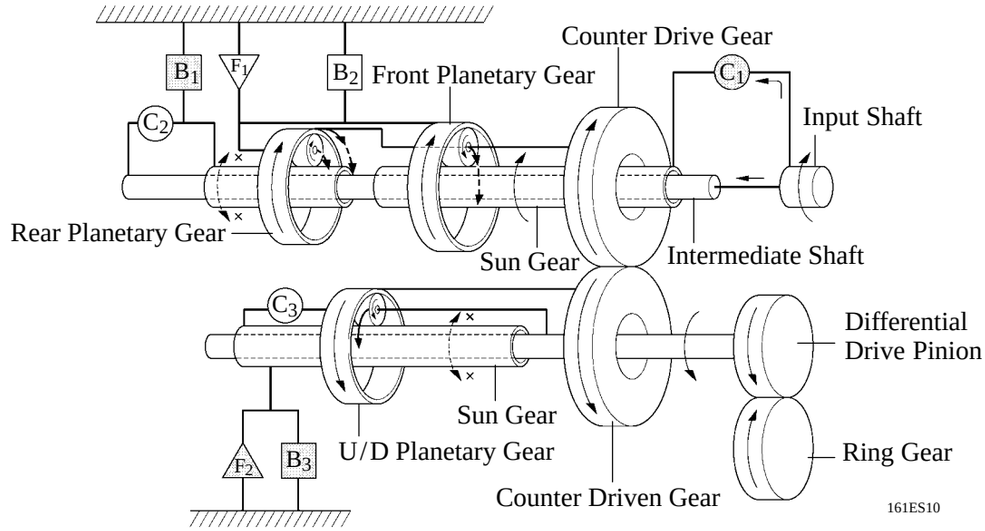
Shift Lever Position	Gear	Solenoid Valve				C_1	C_2	C_3	B_1	B_2	B_3	F_1	F_2
		SL1	SL2	S4	DSL								
P	Park	ON	ON	OFF	OFF						○		
R	Reverse	ON	OFF	OFF	OFF		○			○	○		
N	Neutral	ON	ON	OFF	OFF						○		
D	1st	ON	ON	OFF	OFF	○					○	○	○
	2nd	OFF	ON	OFF	OFF	○			○		○		○
	3rd	OFF	OFF	OFF	OFF/ON*	○	○				○		○
	4th	OFF	OFF	ON	OFF/ON*	○	○	○					
2	1st	ON	ON	OFF	OFF	○					○	○	○
	2nd	OFF	ON	OFF	OFF	○			○		○		○
L	1st	ON	ON	OFF	ON	○				○	○	○	○

*: Lock-up ON

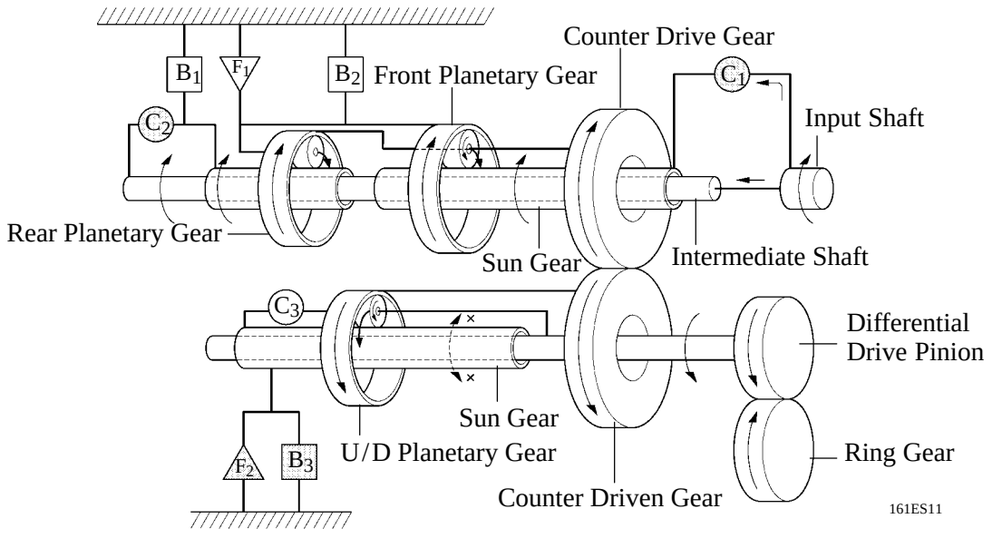
1st Gear (D or 2 Position)



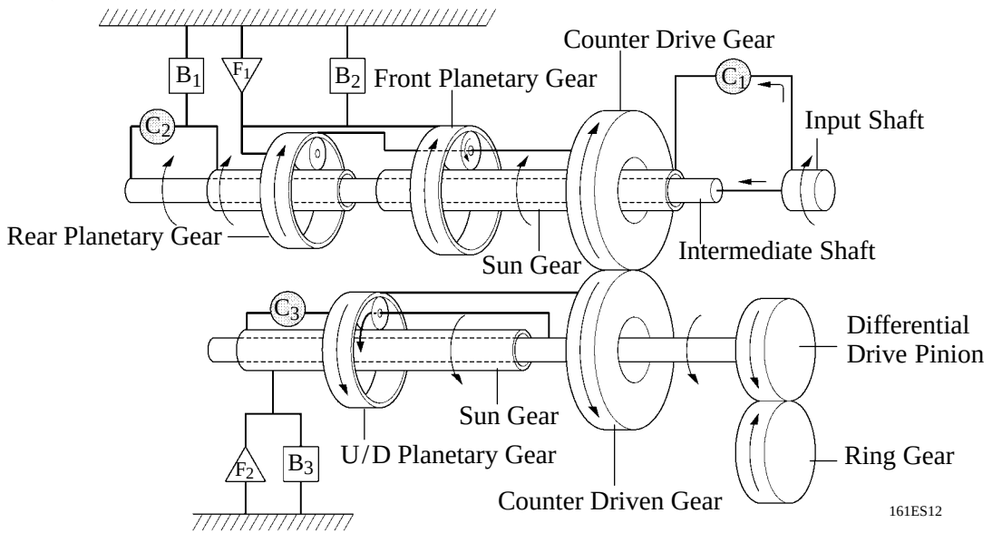
2nd Gear (D or 2 Position)



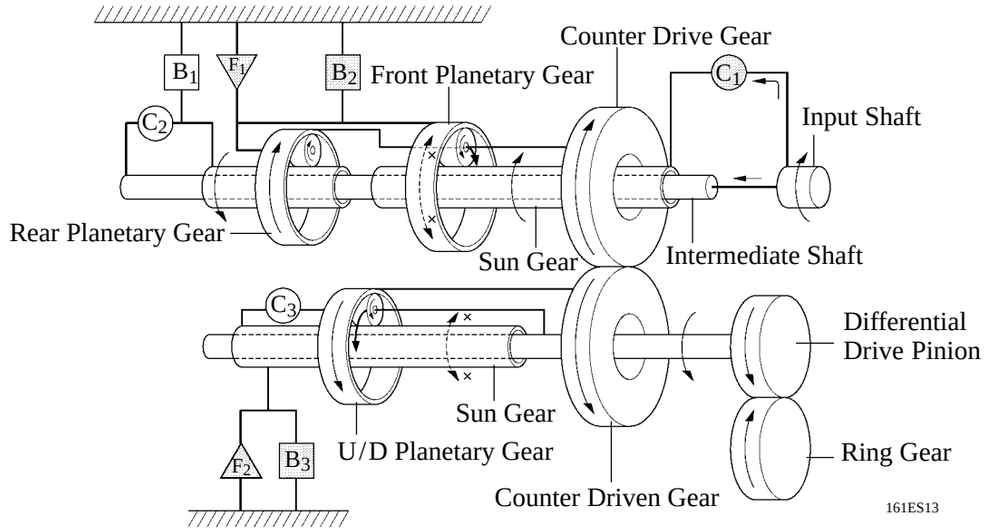
3rd Gear (D Position)



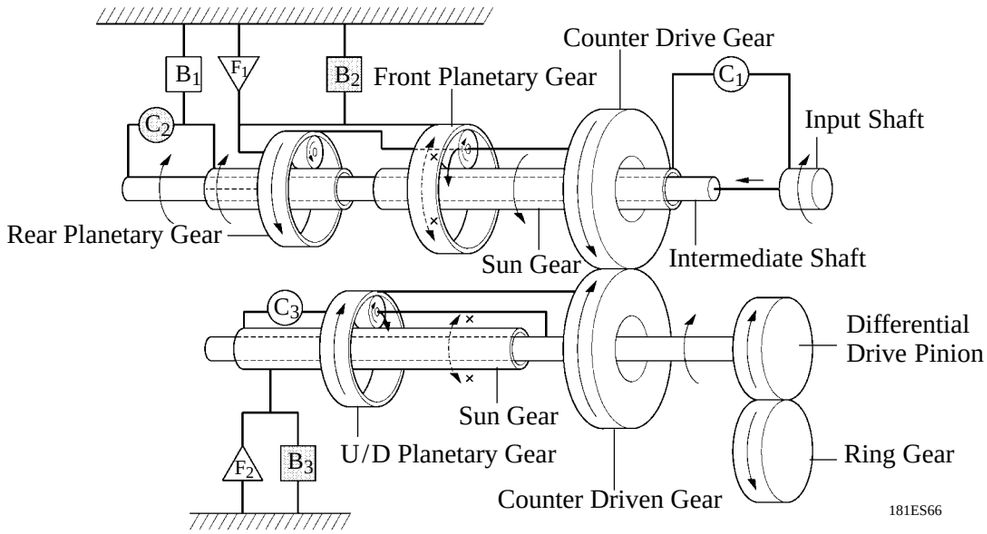
4th Gear (D Position)



1st Gear (L Position)



Reverse Gear (R Position)

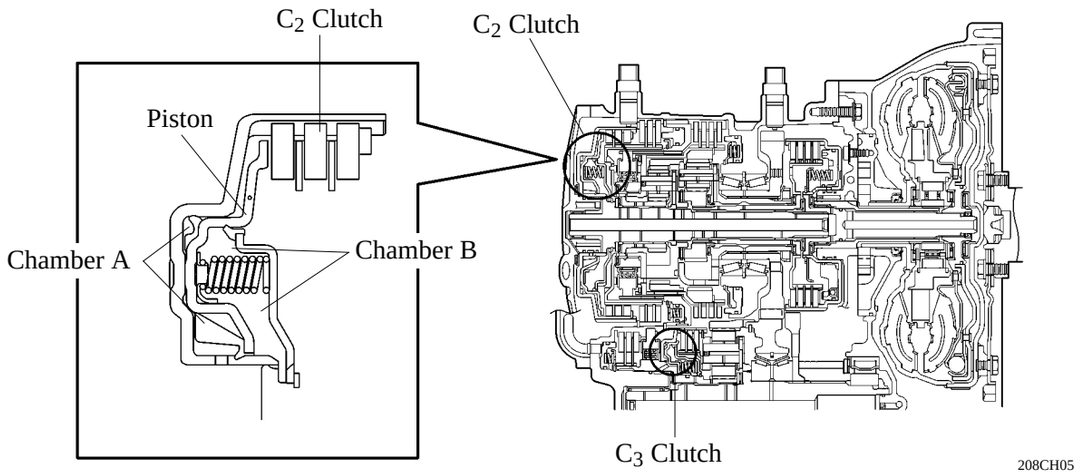


4. Centrifugal Fluid Pressure Canceling Mechanism

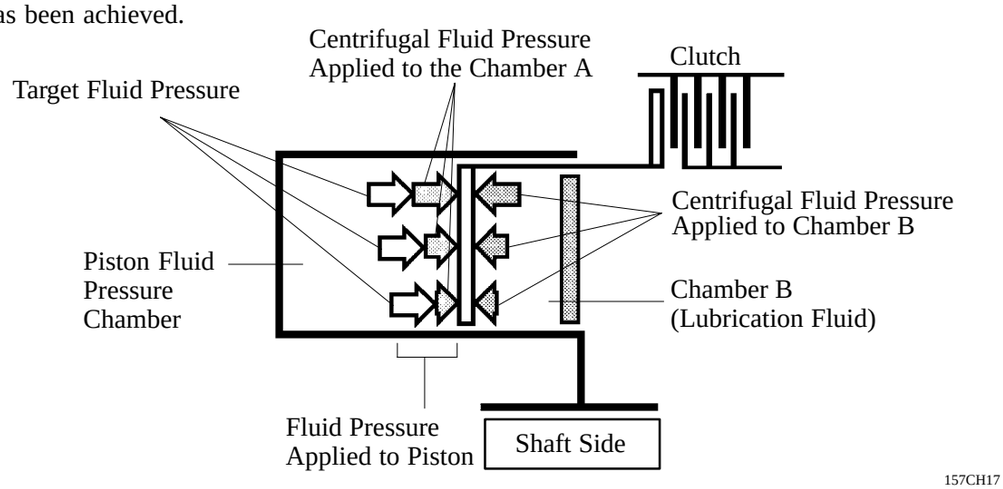
There are two reasons for improving the conventional clutch mechanism:

- To prevent the generation of pressure by the centrifugal force that applied to the fluid in piston fluid pressure chamber (hereafter referred to as “chamber A”) when the clutch is released, a check ball is provided to discharge the fluid. Therefore, before the clutch can be subsequently applied, it took time for the fluid to fill the chamber A.
- During shifting, in addition to the original clutch pressure that is controlled by the valve body, the pressure that acts on the fluid in the chamber A also exerts influence, which is dependent upon revolution fluctuations.

To address these two needs for improvement, a canceling fluid pressure chamber (hereafter referred to as “chamber B”) has been provided opposite chamber A.



By utilizing the lubrication fluid such as that of the shaft, the same amount of centrifugal force is applied, thus canceling the centrifugal force that is applied to the piston itself. Accordingly, it is not necessary to discharge the fluid through the use of a check ball, and a highly responsive and smooth shifting characteristic has been achieved.

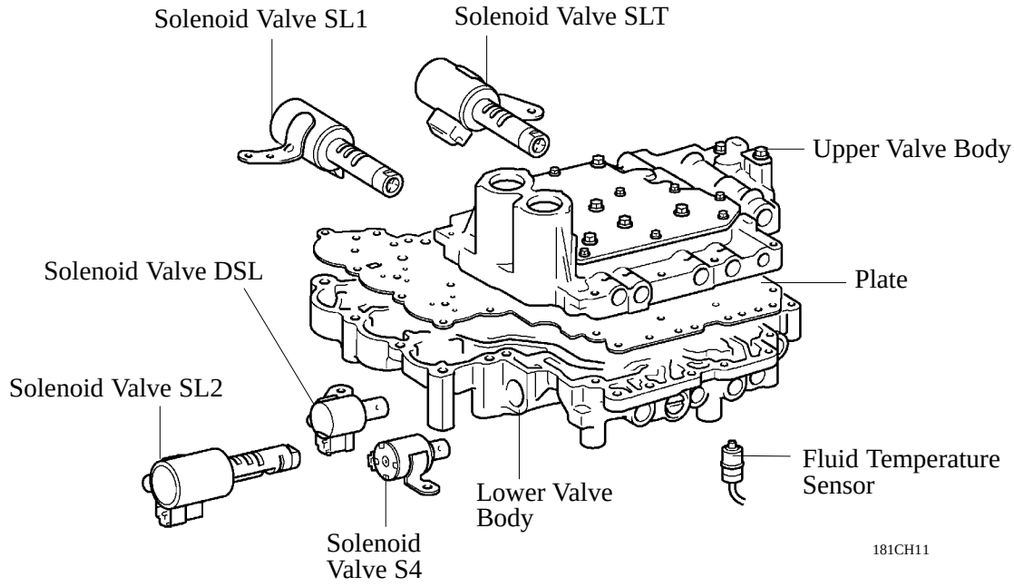


Fluid pressure applied to piston	-	Centrifugal fluid pressure applied to chamber B	=	Target fluid pressure (original clutch pressure)

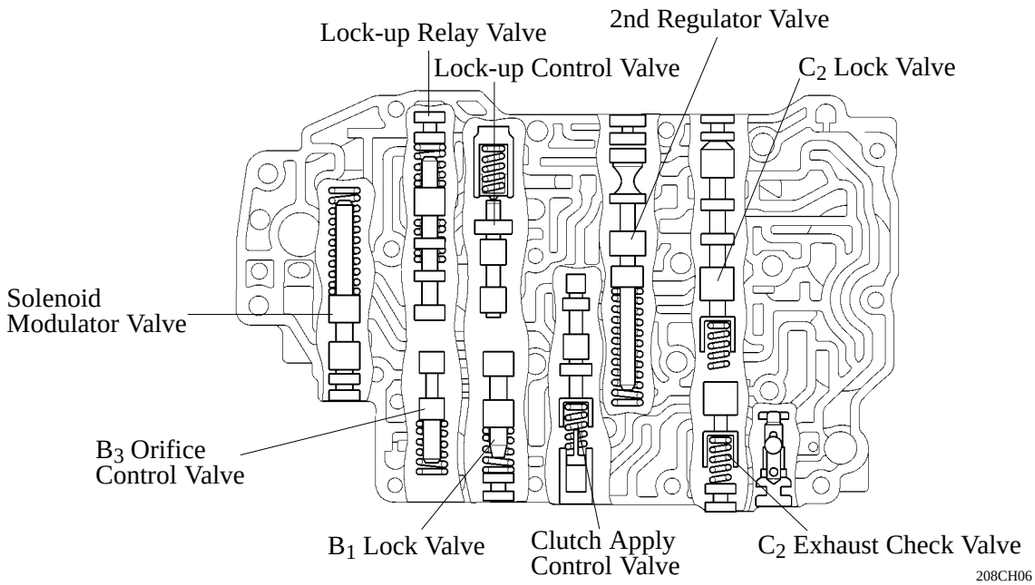
■VALVE BODY UNIT

1. General

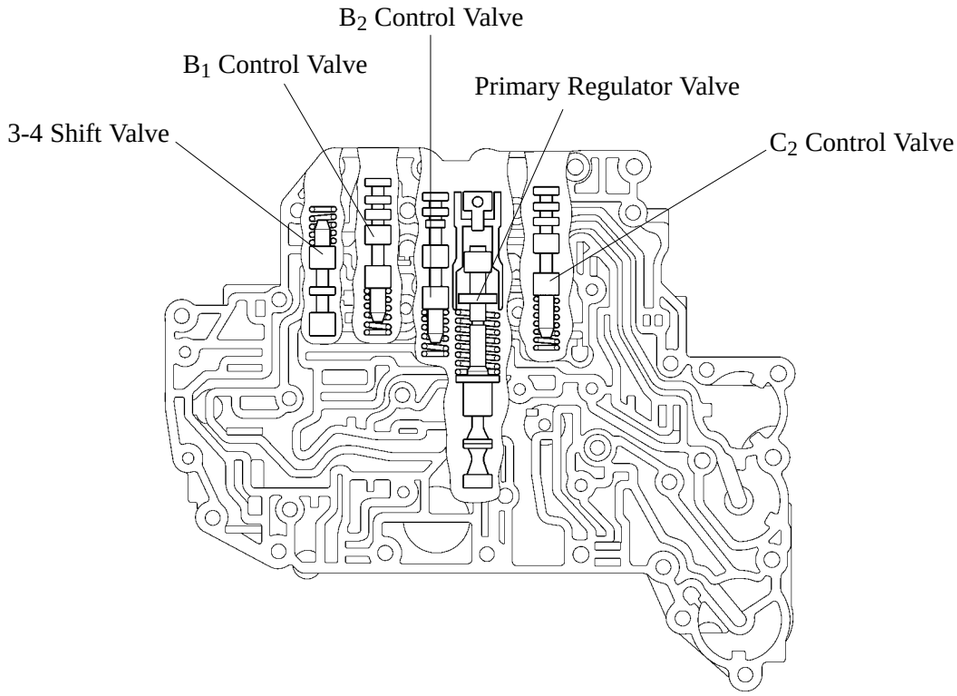
The valve body consists of the upper and lower valve bodies and 5 solenoid valves.
Apply orifice control, which controls the flow volume to the B_3 brake, has been adopted in this unit.



▶ Upper Valve Body ◀



▶ Lower Valve Body ◀



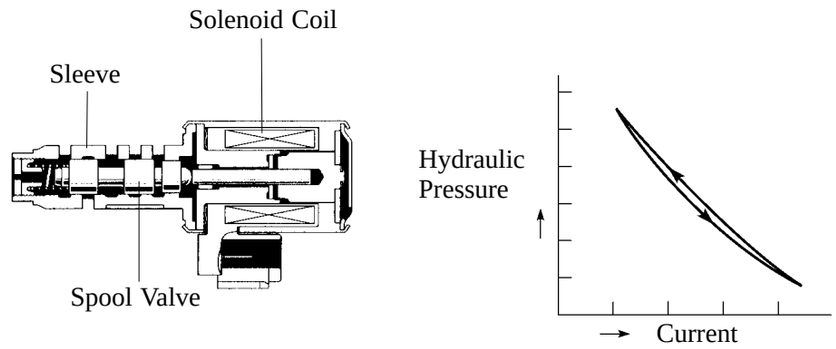
208CH07

2. Solenoid Valve

Solenoid Valves SL1, SL2, and SLT

1) General

In order to provided a hydraulic pressure that is proportion to current that flows to the solenoid coil, the solenoid valve SL1, SL2, and SLT linearly controls the line pressure and clutch and brake engagement pressure based on the signals it receives from the ECM.
The solenoid valves SL1, SL2, and SLT have the same basic structure.



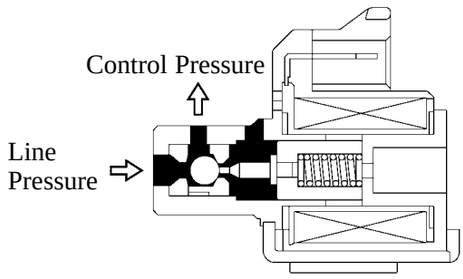
2) Function of Solenoid Valve SL1, SL2, and SLT

Solenoid Valve	Action	Function
SL1	For clutch and brake engagement pressure control	• B_1 brake pressure control • Lock-up clutch pressure control
SL2		C_2 clutch pressure control
SLT	For line pressure control	• Line pressure control • Secondary pressure control

Solenoid Valves S4 and DSL

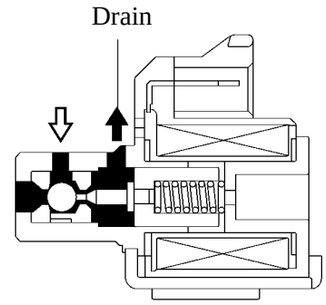
1) General

The solenoid valves S4 and DSL use a three-way solenoid valve.



Solenoid Valve ON

161ES65

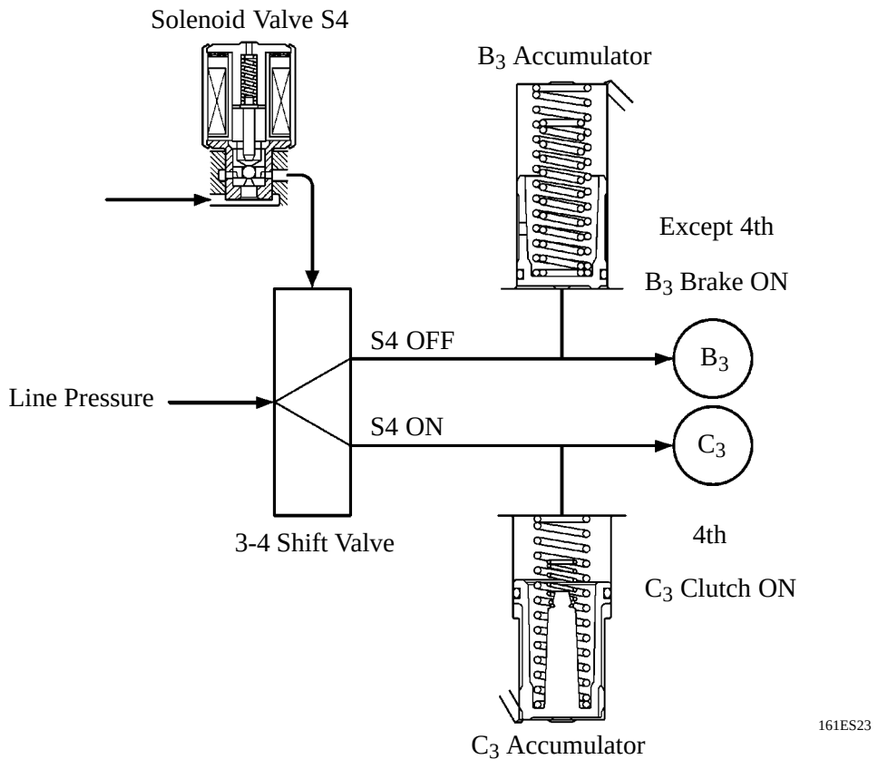


Solenoid Valve OFF

181CH12

2) Function of Solenoid Valve S4

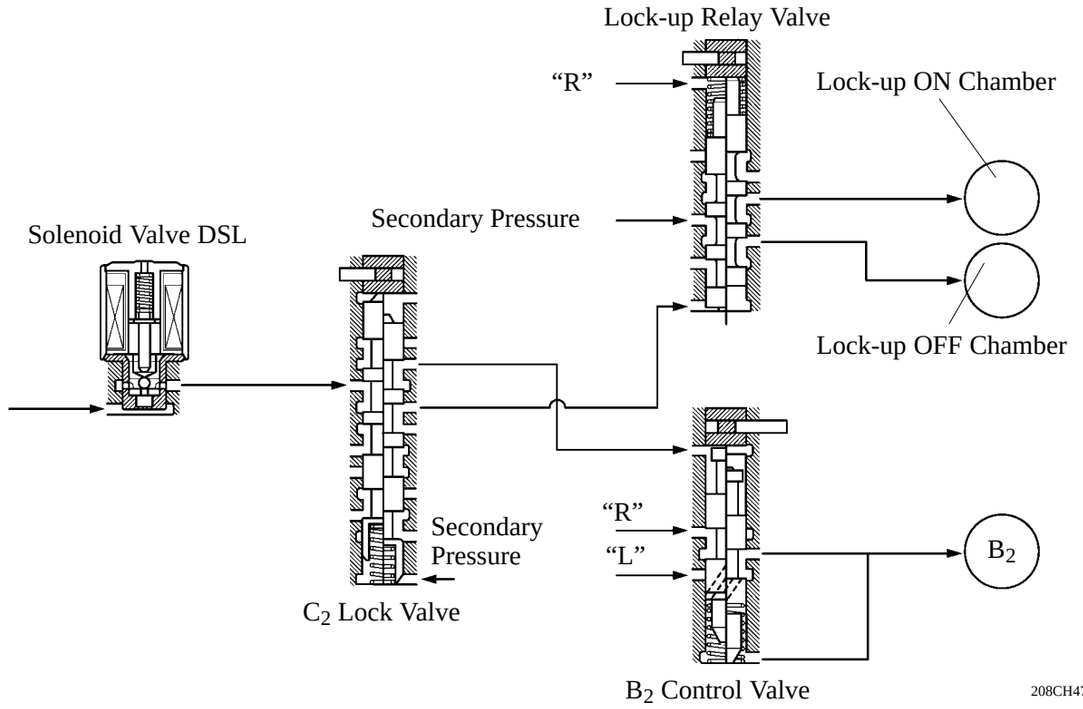
The solenoid valves S4 when set to ON controls the 3-4 shift valve to establish the 4th by changing over the fluid pressure applied to B_3 brake and C_3 clutch.



161ES23

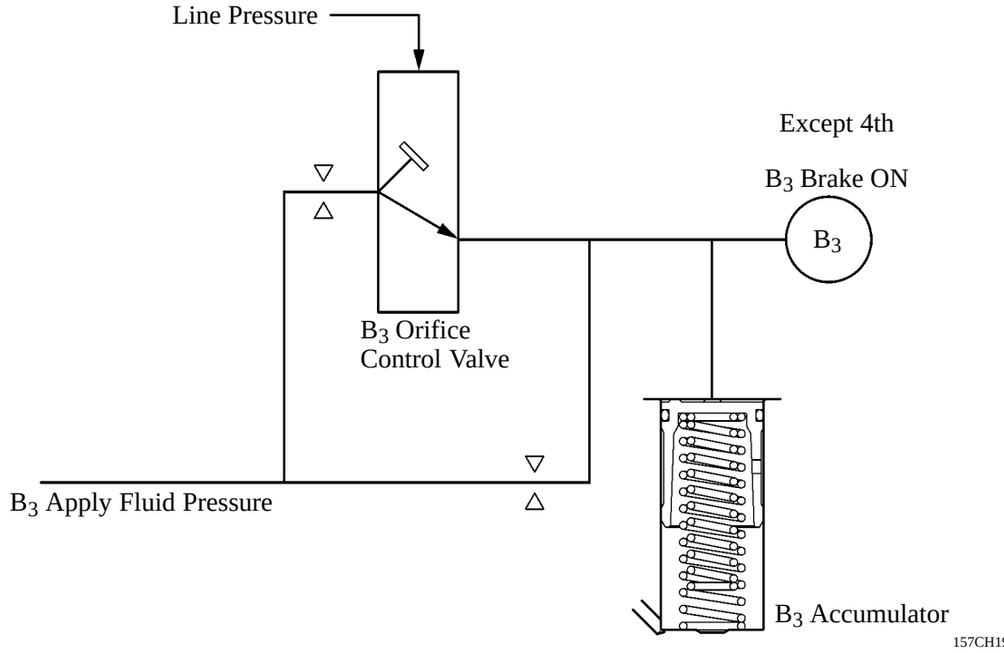
3) Function of Solenoid Valve DSL

The solenoid valve DSL controls the B_2 control valve via the C_2 lock valve when the transaxle is shifted in the R or L position.
During lock-up, the lock-up relay valve is controlled via the C_2 lock valve.



3. Apply Orifice Control

This control is effected by the B_3 orifice control valve. The B_3 orifice control valve has been provided for the B_3 brake, which is applied when shifting from 4th to 3rd. The B_3 orifice control valve is controlled by the amount of the line pressure in accordance with shifting conditions, and the flow volume of the fluid that is supplied to the B_3 brake is controlled by varying the size of the control valve's apply orifice.



■ELECTRONIC CONTROL SYSTEM

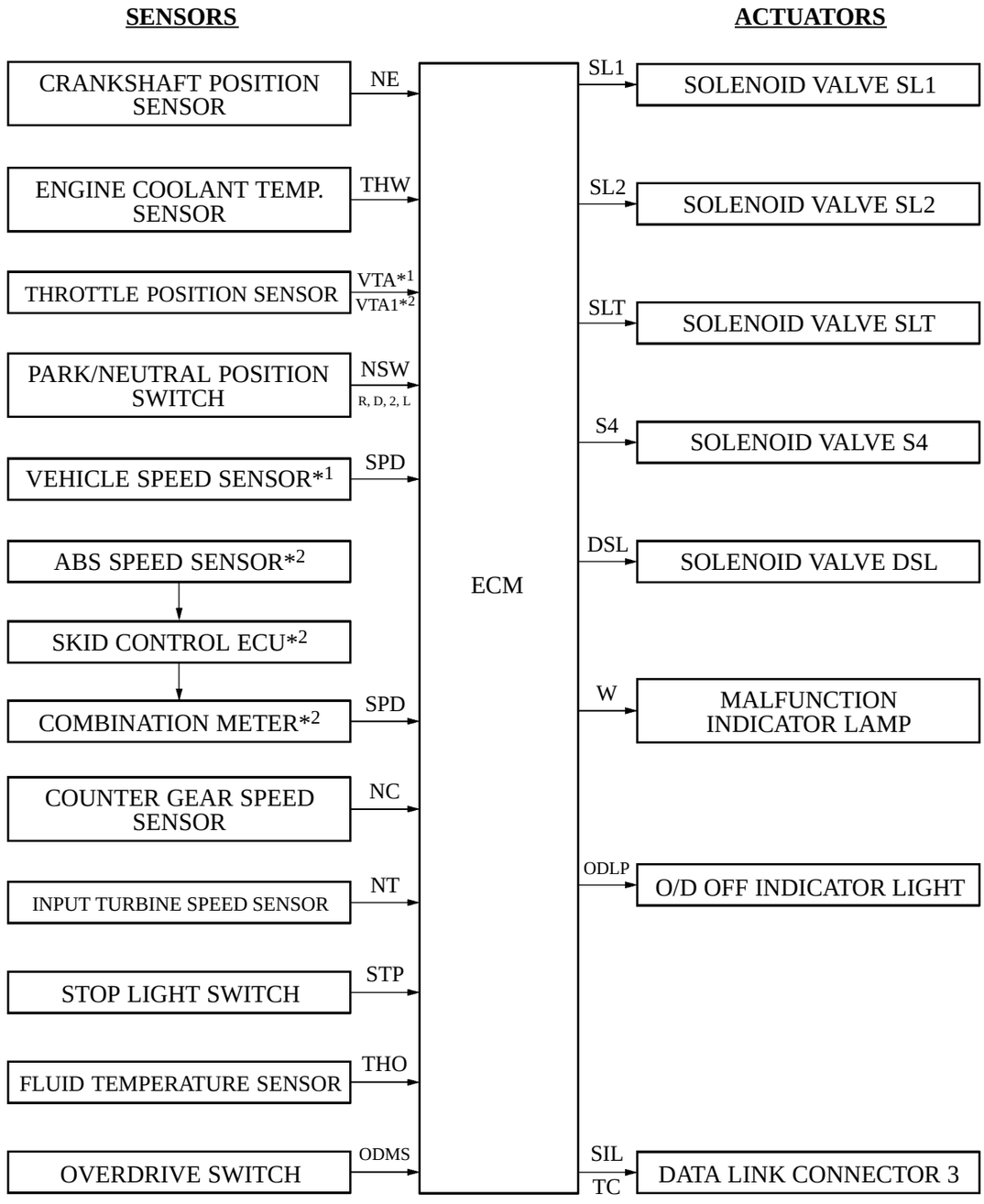
1. General

The electronic control system of the U140E and U241E automatic transaxles consists of the control listed below.

System	Function	U140E, U241E	A541E
Clutch Pressure Control	• Controls the pressure that is applied directly to B_1 brake and C_2 clutch by actuating the shift solenoid valve (SL1, SL2) in accordance with ECM signals. • The solenoid valves SL1 and SL2 minutely controls the clutch pressure in accordance with the engine output and driving conditions.	○	—
Line Pressure Optimal Control	Actuates the 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 Control in Uphill/Downhill Traveling	Controls to restrict the 4th upshift or to provide appropriate engine braking by using the ECM to determine whether the vehicle is traveling uphill or downhill.	○	—
Shift Timing Control	The ECM sends current to the solenoid valve SL1 and/or SL2 based on signals from each sensor and shifts the gear.	○	○
Lock-up Timing Control	The ECM sends current to the shift solenoid valve (DSL) based on signals from each sensor and engages or disengages the lock-up clutch.	○	○
Accumulator Back Pressure Control	The ECM sends signals to solenoid valve SLN when gear shift occurs to temporarily lower the accumulator back pressure so that the gear shift is completed smoothly.	—	○
“N” to “D” Squat Control	When the shift lever is shifted from “N” to “D” position, the gear is temporarily shifted to 2nd or O/D and then to 1st to reduce vehicle squat.	—	○
	When the shift lever is shifted from “N” to “D” position, the gear is temporarily shifted to 3rd and then to 1st to reduce vehicle squat.	○	—
Diagnosis	When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section.	○	○
	To increase the speed for processing the signals, the 32-bit CPU of the ECM has been adopted.	○	—
Fail-safe	Even if a malfunction is detected in the sensors or solenoids, the ECM effects fail-safe control to prevent the vehicle’s drivability from being affected significantly.	○	○

2. Construction

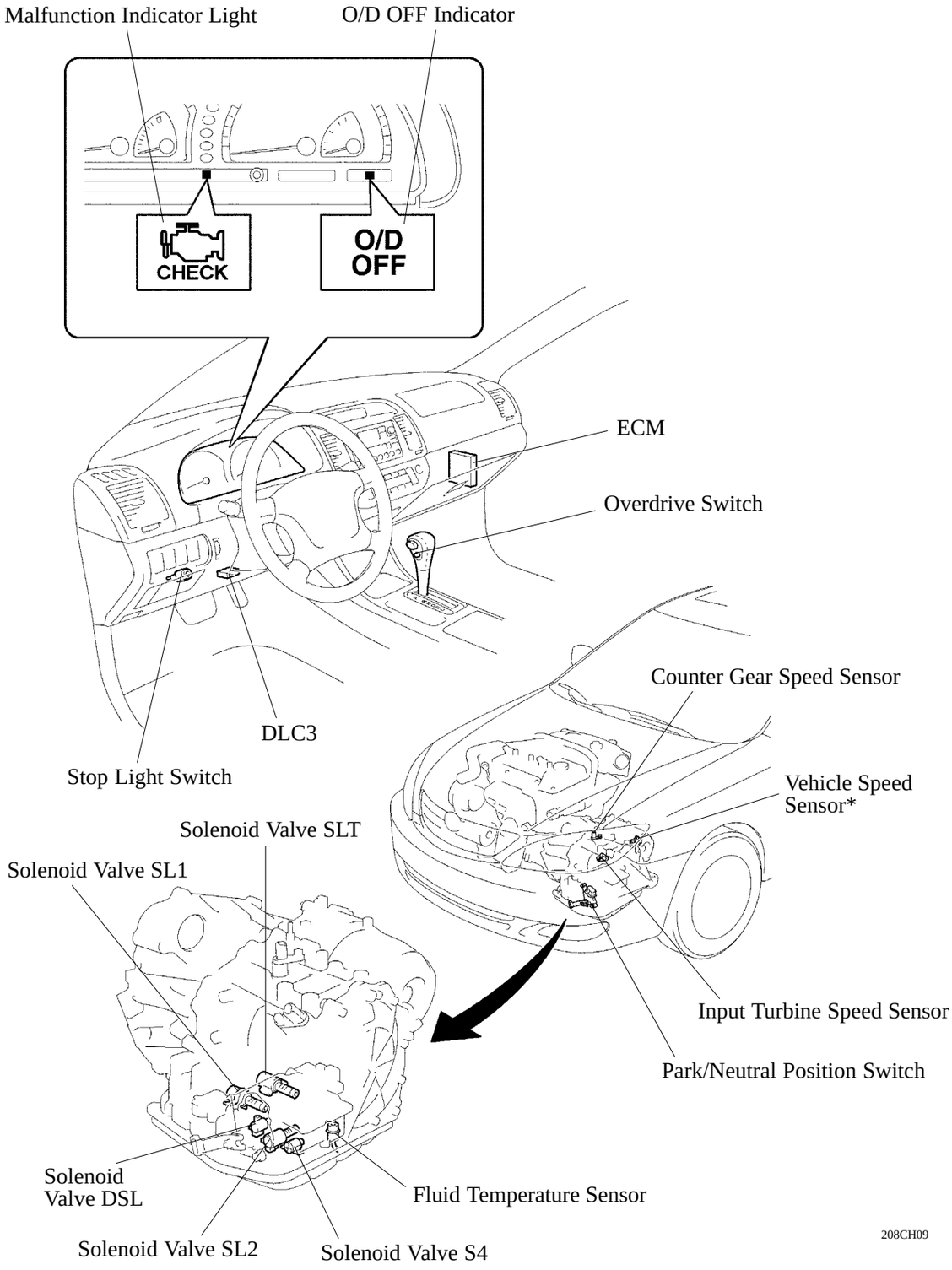
The configuration of the electronic control system in the U140E and U241E automatic transaxles are as shown in the following chart.



*1: 2AZ-FE Engine Model
*2: 1MZ-FE Engine Model

208CH08

3. Layout of Components

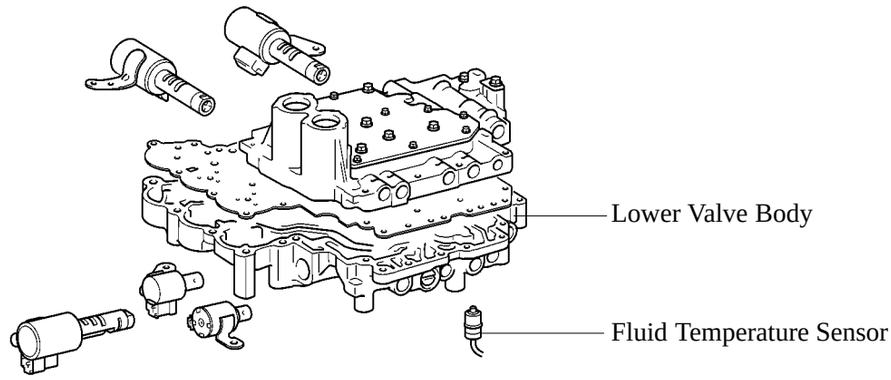


*: 2AZ-FE Engine Model

4. Construction and Operation of Main Component

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.

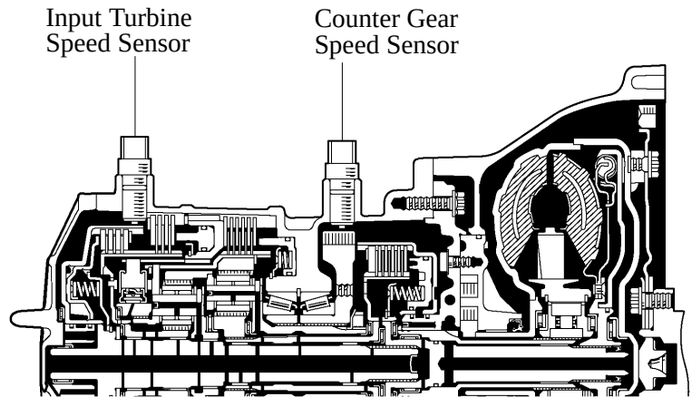


181CH11

Speed Sensors

The U140E and U241E automatic transaxles have adopted an input turbine speed sensor (for the NT signal) and a counter gear speed sensor (for the NC 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 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.

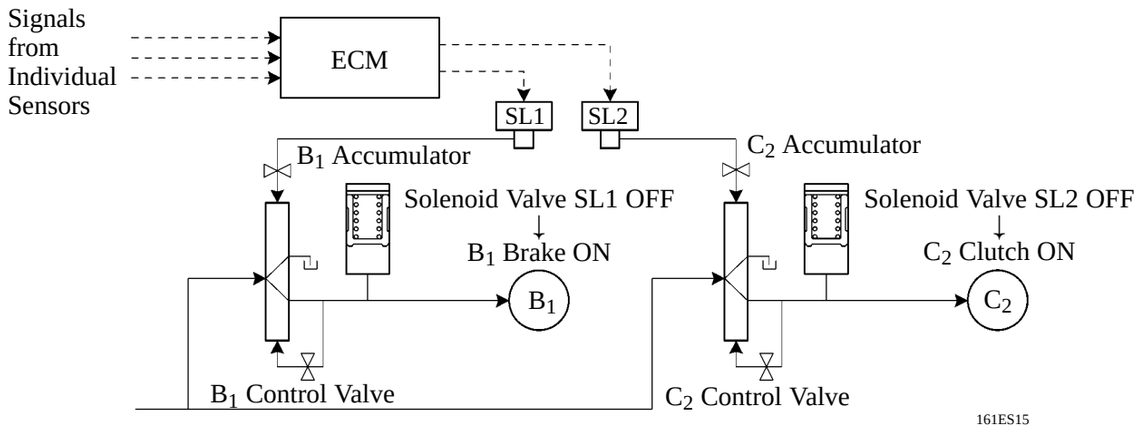


181CH14

5. Clutch Pressure Control

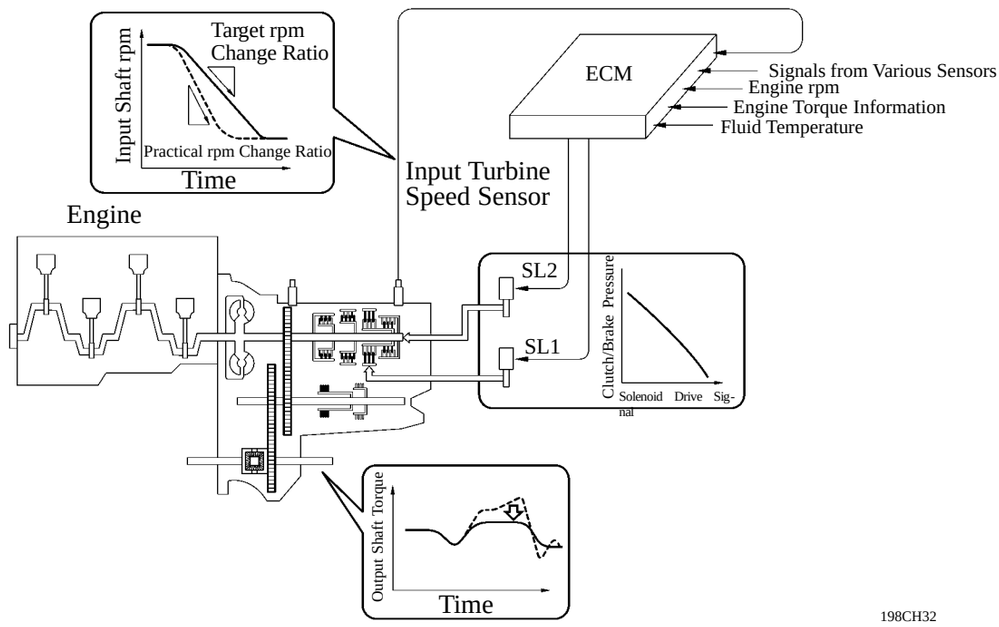
Clutch to Clutch Pressure Control

This control has been adopted for shifting from the 1st to 2nd gear, and from the 2nd to 3rd gear.
Actuates solenoid valves SL1 and SL2 in accordance with the signals from the ECM, and guides this output pressure directly to the control valves B_1 and C_2 in order to regulate the line pressure that acts on the B_1 brake and C_2 clutch.
As a result, compact B_1 and C_2 accumulators without a back pressure chamber have been realized.



Clutch Pressure Optimal Control

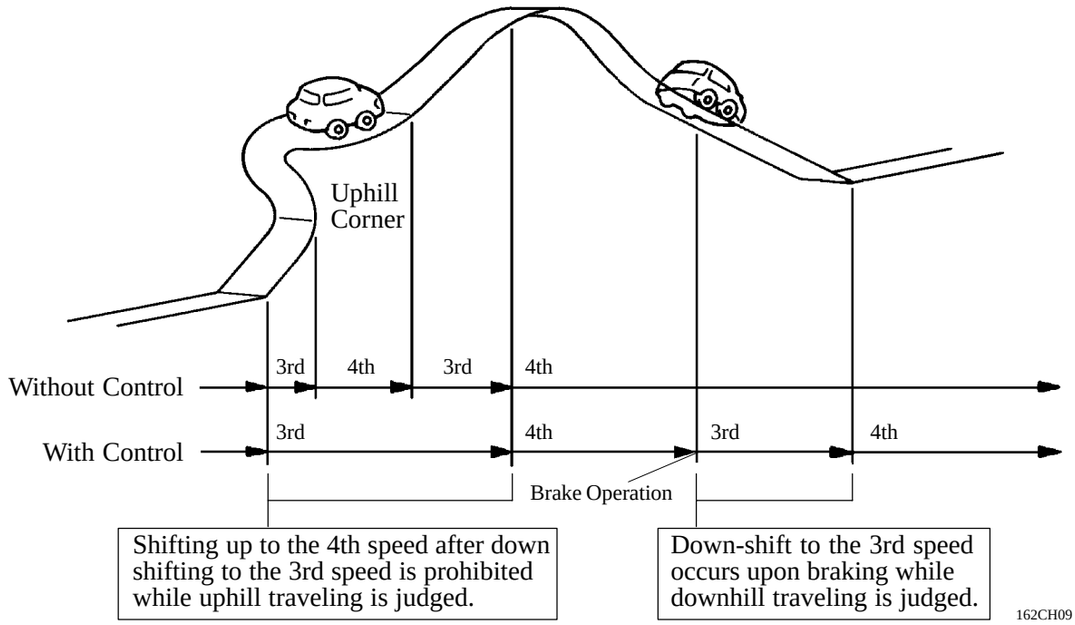
The ECM monitors the signals from various types of sensor such as the input turbine speed sensor, allowing shift solenoid valves SL1 and SL2 to minutely control the clutch pressure in accordance with engine output and driving conditions.
As a result, smooth shift characteristics have been realized.



6. Shifting Control in Uphill/Downhill Traveling

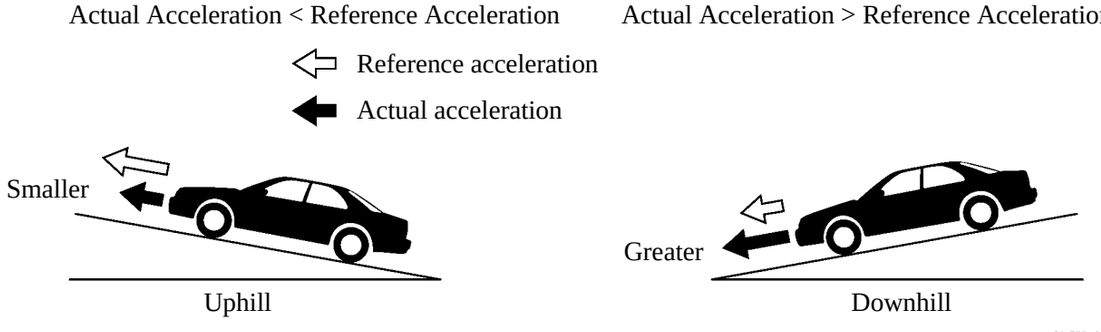
General

With shifting control in uphill/downhill traveling, the ECM calculates the throttle opening angle and the acceleration rate to determine whether the vehicle is in the uphill or downhill state. While driving uphill on a winding road with ups and downs, the 4th upshift is restricted to ensure a smooth drive. Also, if a brake application is detected while the ECM judges a downhill travel in 4th, the transmission automatically downshifts to 3rd in order to provide an appropriate engine brake.
In addition, while the ECM judges a downhill travel, it restricts the travel in 3rd without keeping the brake application.



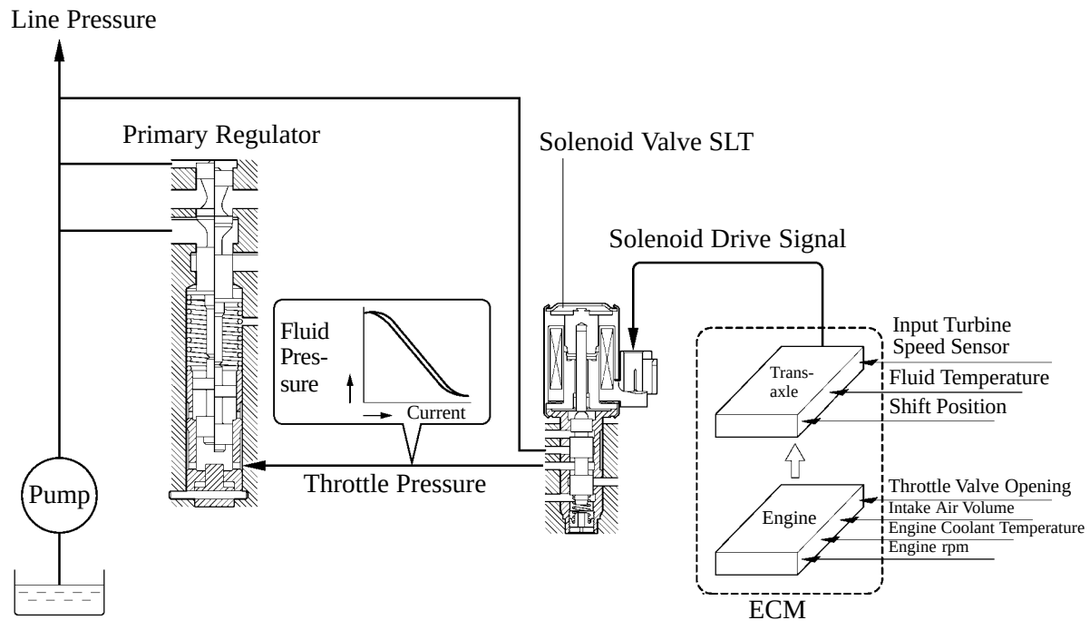
Uphill/Downhill Judgment

The actual acceleration calculated from the speed sensor signal is compared with the reference acceleration stored in the ECM to judge uphill or downhill traveling.
The ECM judges an uphill travel if the actual acceleration is smaller than the reference acceleration, and restricts the 3rd to 4th upshift after a 4th to 3rd downshift has occurred. Also, the ECM judges a downhill travel if the actual acceleration is greater than the reference acceleration, and restricts the 4th upshift while traveling in 3rd. If a brake application is detected while traveling in 4th, it downshifts to 3rd.



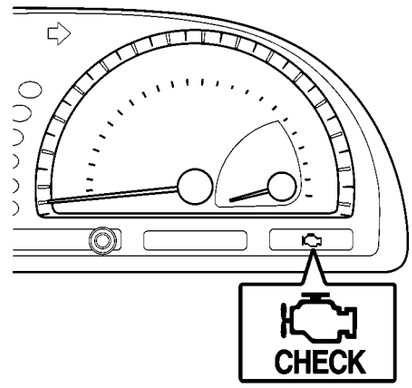
7. Line Pressure Optimal Control

Through the use of the solenoid valve SLT, the line pressure is optimally controlled in accordance with the engine toque information, as well as with the internal operating conditions of the toque 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.



8. Diagnosis

- When the ECM detected a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL (Malfunction Indicator Lamp) in the combination meter illuminates or blinks toinform 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.



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— Changes (from A541E) —

The DTCs (Diagnosis Trouble Codes) listed below have been added or discontinued.

DTC No.		Detection Item
Added DTC	P0710	Transmission Fluid Temp. Sensor Malfunction (Fluid Temp. Sensor)
	P0711	Transmission Fluid Temp. Sensor Range/Performance Problem (Fluid Temp. Sensor)
	P0765	Shift Solenoid D Malfunction (Solenoid Valve S4)
	P0768	Shift Solenoid D Electrical Malfunction (Solenoid Valve S4)
	P1725	NT Revolution Sensor Circuit Malfunction (Input Turbine Speed Sensor)
	P1730	NC Revolution Sensor Circuit Malfunction (Counter Gear Speed Sensor)
	P1760	Linear Solenoid for Line Pressure Control Circuit Malfunction (Solenoid Valve SLT)
Discontinued DTC	P1705	NC2 Revolution Sensor Circuit Malfunction (Direct Clutch Speed Sensor)
	P1765	Linear Solenoid for Accumulator Pressure Control Circuit Malfunction (Solenoid Valve SLN)

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.

9. Fail Safe

General

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

When all solenoids are normal				When shift solenoid SL1 is abnormal								When SL2 is abnormal			
				Traveling 3rd or 4th				Traveling 1st or 2nd							
Solenoid			Gear	Solenoid			Gear	Solenoid			Gear	Solenoid			Gear
SL1	SL2	S4		SL1	SL2	S4		SL1	SL2	S4		SL1	SL2	S4	
ON	ON	OFF	1st	×	ON ↓ OFF	OFF	3rd	×*	ON	OFF	2nd	ON ↓ OFF	×	OFF	3rd
OFF	ON	OFF	2nd	×	ON ↓ OFF	OFF	3rd	×*	ON	OFF	2nd	OFF	×	OFF	3rd
OFF	OFF	OFF	3rd	×	OFF	OFF	3rd	×*	OFF ↓ ON	OFF ↓ ON	3rd	OFF	×	OFF ↓ ON	3rd
OFF	OFF	ON	4th	×	OFF	ON	4th	×*	OFF ↓ ON	ON	3rd	OFF	×	ON	4th

*: B_1 is constantly operating.

When S4 is abnormal				When SL1 and SL2 are abnormal				When SL1 and S4 are abnormal							
								Traveling 3rd or 4th				Traveling 1st or 2nd			
Solenoid			Gear	Solenoid			Gear	Solenoid			Gear	Solenoid			Gear
SL1	SL2	S4		SL1	SL2	S4		SL1	SL2	S4		SL1	SL2	S4	
ON	ON	×	1st	×	×	OFF	3rd	×	ON ↓ OFF	×	3rd	×	ON	×	2nd
OFF	ON	×	2nd	×	×	OFF	3rd	×	ON ↓ OFF	×	3rd	×	ON	×	2nd
OFF	OFF	×	3rd	×	×	OFF	3rd	×	OFF ↓ ON	×	3rd	×	OFF ↓ ON	×	2nd
OFF	OFF	×	4th	×	×	ON	4th	×	OFF ↓ ON	×	3rd	×	OFF ↓ ON	×	2nd

(Continued)

When SL2 and S4 are abnormal				When SL1, SL2 and S4 are abnormal			
Solenoid			Gear	Solenoid			Gear
SL1	SL2	S4		SL1	SL2	S4	
ON ↓ OFF	×	×	3rd	×	×	×	3rd
OFF	×	×	3rd	×	×	×	3rd
OFF	×	×	3rd	×	×	×	3rd
OFF	×	×	3rd	×	×	×	3rd

■SHIFT CONTROL MECHANISM

1. General

- As in the past, the shift control mechanism of the ’02 Camry consists of a straight shift lever that uses a shift control cable.
- The O/D (overdrive) switch has been adopted on the momentary type.
- A shift lock system consists of the key interlock device and shift lock mechanism, has been adopted.

2. Overdrive Switch

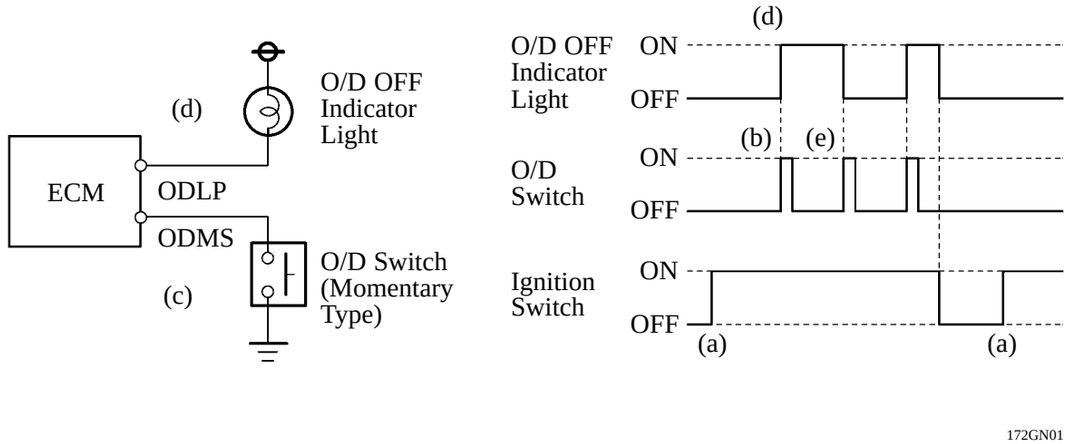
a) Turn the ignition switch from OFF to ON turns the overdrive ON.

b) Pressing the O/D switch close (turn ON) the contact points, and releasing the switch opens (turn OFF) the contact points.

c) Accordingly, pressing the switch cause the signal to be input into the ECM.

d) The ECM turns OFF the overdrive (O/D OFF indicator light turn ON).

e) Pressing the O/D switch again turns the overdrive back ON (O/D OFF indicator light turns OFF).



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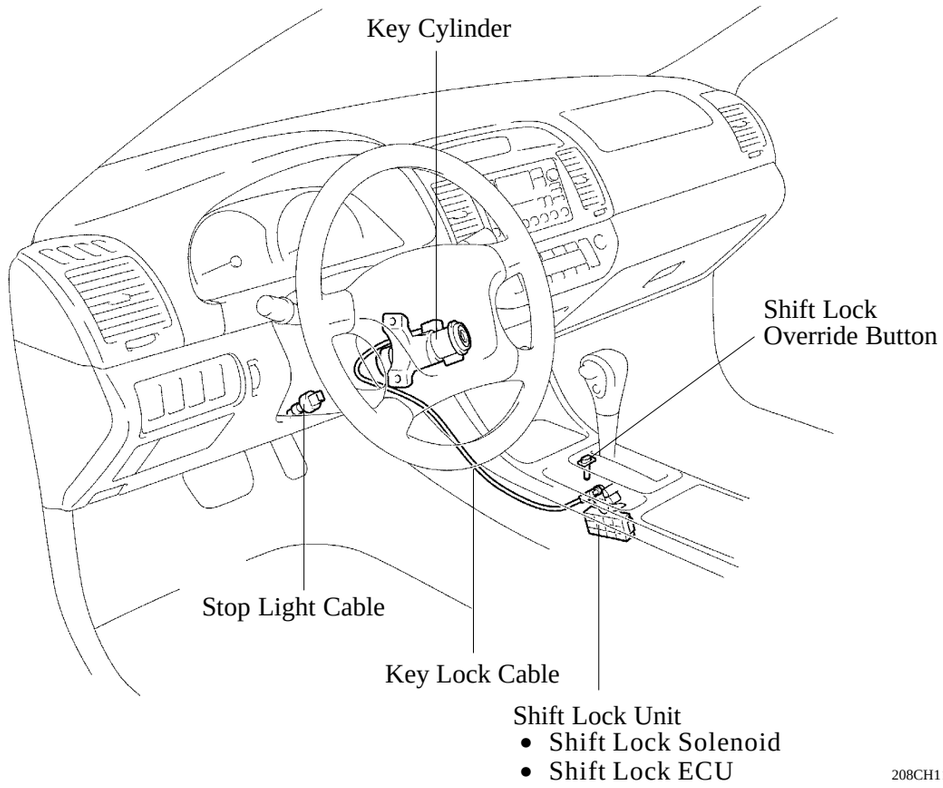
3. Shift Lock System

General

- A shift lock system consists of the key interlock device and shift lock mechanism, that prevents the unintended operation of the shift lever has been provided.
- A mechanical key interlock device that uses the key lock cable has been adopted.
- An electrical shift lock mechanism, in which a shift lock solenoid and a shift lock ECU are integrated, has been adopted.

Layout of Component



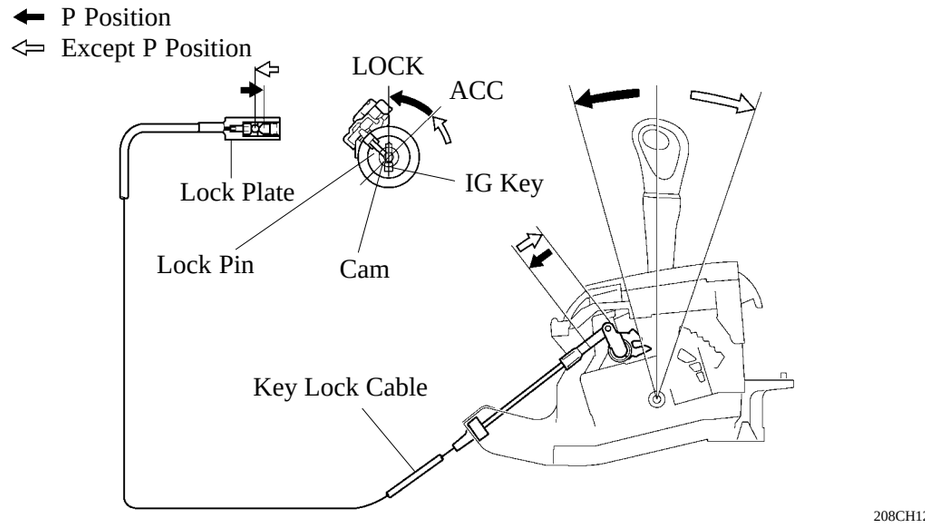
Key Interlock Device

1) General

- This device will not allow the ignition key to be turned to the LOCK position or to pull out the ignition key unless the shift lever is moved to the P position.
- This device, in which the shift lever and the key cylinder are connected via the key lock cable, mechanically limits the movement of the ignition key through the movement of the shift lever.

2) Construction and Operation

- The key cylinder contains a cam and a lock pin that move in unison with the ignition key. In addition, a key lock cable and a lock plate are placed above the lock pin.
- When the driver moves the shift lever, the lock plate slides to restrict the movement of the lock pin, which in turn, restricts the movement of the ignition key.



Shift Lock Mechanism

- The shift lock mechanism prevents the shift lever from being shifted out of the ”P” position to any other position unless the ignition switch is turned ON and the brake pedal is pressed.
- A shift lock override button, which manually overrides the shift lock mechanism, is provided.

▶ System Diagram ◀