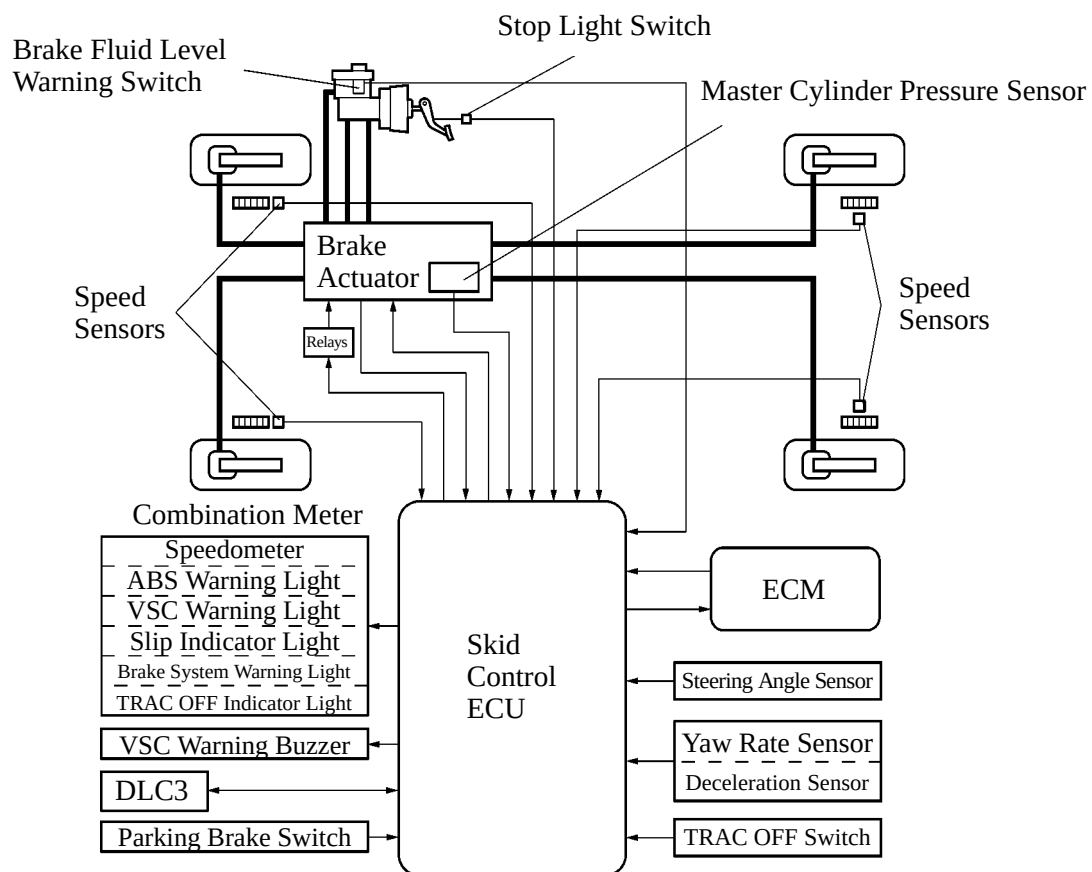


■ ABS with EBD & BRAKE ASSIST & TRAC & VSC SYSTEM

1. General

- The primary purpose of the ABS and TRAC system has been to help the vehicle's behavior during braking and acceleration.
In contrast, the purpose of the VSC system is to help maintain the vehicle's behavior during cornering.
- The TRAC system controls driving wheels, therefore, it controls the front wheels.
However, depending on the unexpected situations or external elements such as the ground surface conditions, vehicle speed, and emergency avoidance maneuvers, the vehicle may exhibit strong understeer or oversteer tendencies. In such situations, the VSC system dampens the strong understeer or oversteer to help maintain vehicle behavior.
- The primary purpose of the Brake Assist system is to provide an auxiliary brake force assist to the driver who cannot generate a large brake force during emergency braking.
- The EBD control utilizes ABS, realizing the proper brake force distribution between front and rear wheels in accordance with the driving conditions.
In addition, during cornering braking, it also controls the brake forces of right and left wheels, helping to maintain the vehicle behavior.

2. System Diagram



3. Outline of Brake Assist System

Brake Assist system interprets a quick push of the brake pedal as emergency braking and supplements the braking power applied if the driver has not stepped hard enough on the brake pedal.

In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure on the brake pedal.

Brake Assist system measures the speed and force with which the brake pedal is pushed to determine whether the driver is attempting to brake rapidly, and applies additional pressure to increase braking performance.

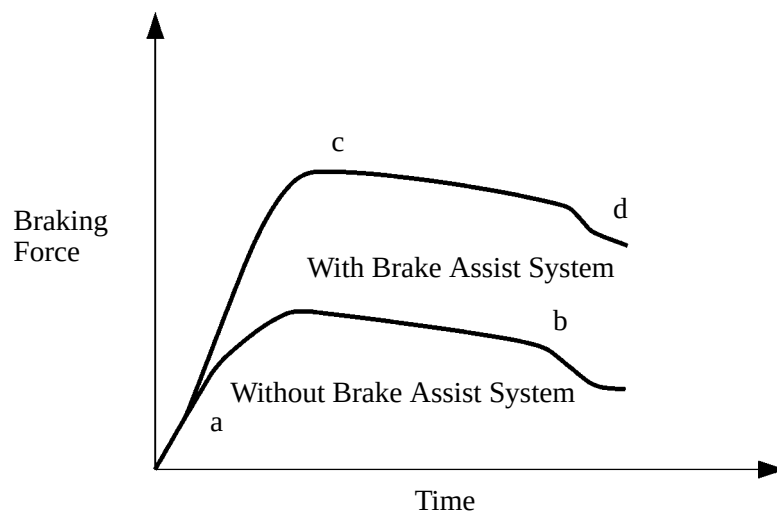
A key feature of Brake Assist system is that the timing and the degree of braking assistance are designed to ensure that the driver does not discern anything unusual about the braking operation.

When the driver intentionally eases up on the brake pedal, the system reduce the amount of assistance it provides.

– REFERENCE –

Effectiveness of the Brake Assist Operation:

- During emergency braking, an inexperienced driver, or a driver in a state of panic might not be able to firmly depress the brake pedal, although driver can depress it quickly. As a result, only a small amount of brake force is generated.
- The pedal effort of this type of driver might weaken as time passes, causing a reduction in the braking force.
- Based on how quickly the brake pedal is depressed, the Brake Assist operation assesses the intention of the driver to apply emergency braking and increases the brake force.
- After the Brake Assist operation, if the driver intentionally releases the brake pedal, the assist operation reduces the amount of Brake Assist in order to reduce the feeling of uneasiness.



170CH18

Service Tip

When this system is activated, the brake pedal could shudder, which is a normal occurrence of the system in operation and should not be considered a malfunction.

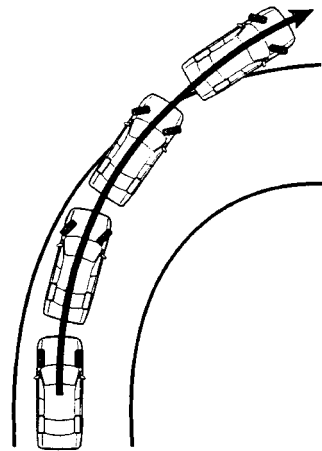
4. Outline of VSC System

General

The followings are two examples that can be considered as circumstances in which the tires over their lateral grip limit.

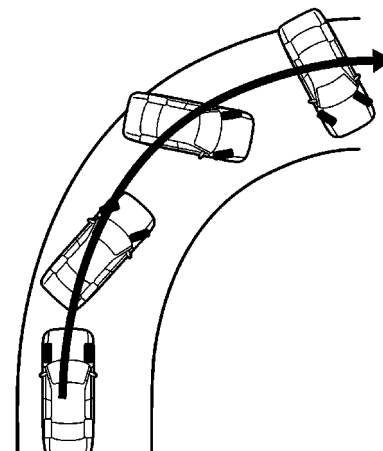
VSC system is to help control the vehicle behavior by applying the engine output control and each wheels brake control when the vehicle is under the condition indicated below.

- When the front wheels lose grip in relation to the rear wheels (strong understeer tendency).
- When the rear wheels lose grip in relation to the front wheels (strong oversteer tendency).



Strong Understeer Tendency

151CH17



Strong Oversteer Tendency

189CH100

Method for Determining the Vehicle Condition

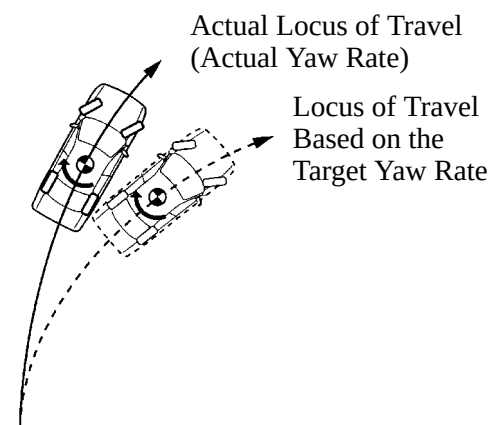
To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and the vehicle's lateral acceleration, which are then calculated by the skid control ECU.

1) Determining UnderSteer

Whether or not the vehicle is in the state of understeer is determined by the difference between the target yaw rate and the vehicle's actual yaw rate.

When the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) that should be rightfully generated when the driver operates the steering wheel, it means the vehicle is making a turn at a greater angle than the loss of travel.

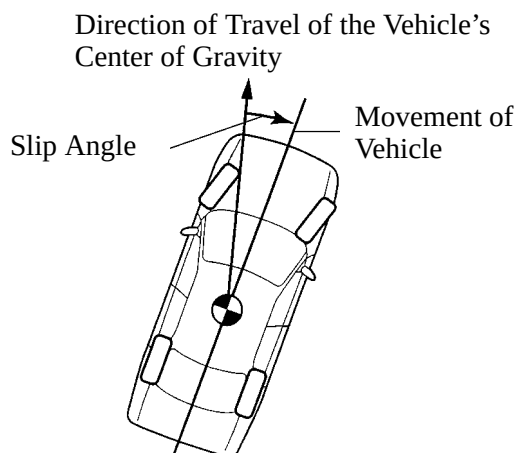
Thus, the ECU determines that there is a large tendency to understeer.



151CH19

2) Determining Oversteer

Whether or not the vehicle is in the state of oversteer is determined by the values of the vehicle's slip angle and the vehicle's slip angular velocity (time-dependent changes in the vehicle's slip angle). When the vehicle's slip angle is large, and the slip angular velocity is also large, the ECU determines that the vehicle has a large oversteer tendency.



151CH18

Method of VSC Operation

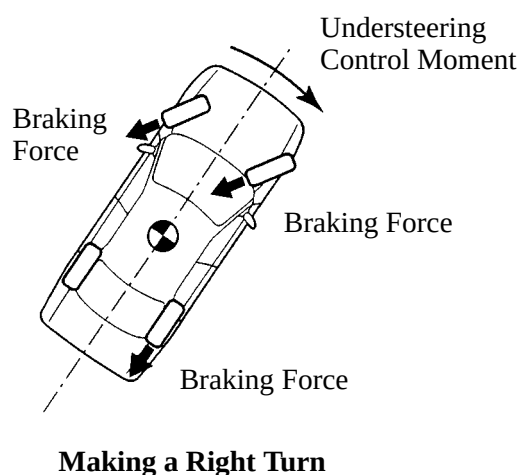
When the skid control ECU determines that the vehicle exhibits a tendency to understeer or oversteer, it decreases the engine output and applies the brake of a front or rear wheel to control the vehicle's yaw moment.

The basic operation of the VSC is described below. However, the control method differs depending on the vehicle's characteristics and driving conditions.

1) Dampening a Strong Understeer

When the skid control ECU determines that the vehicle exhibits a strong tendency to understeer, depending on the extent of that tendency, it decreases the engine output and applies the brakes of the front wheels and inside rear wheel, thus providing the vehicle with an understeer control moment, which helps dampen its tendency to understeer.

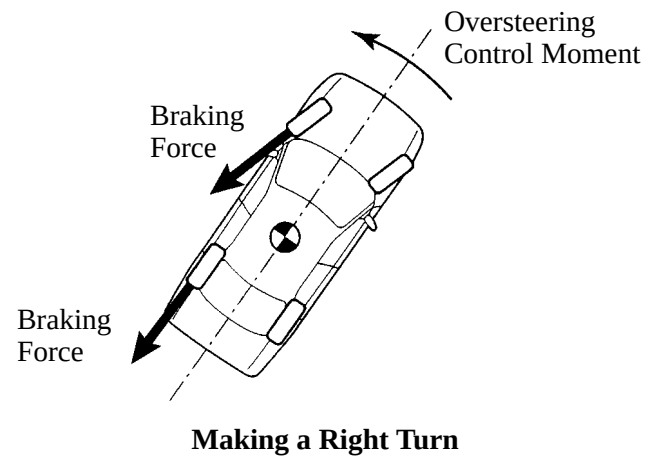
Also, depending on whether the brakes are ON or OFF and the condition of the vehicle, there are circumstances in which the brakes might not be applied to the wheels even if those wheels are targeted for braking.



161ES30

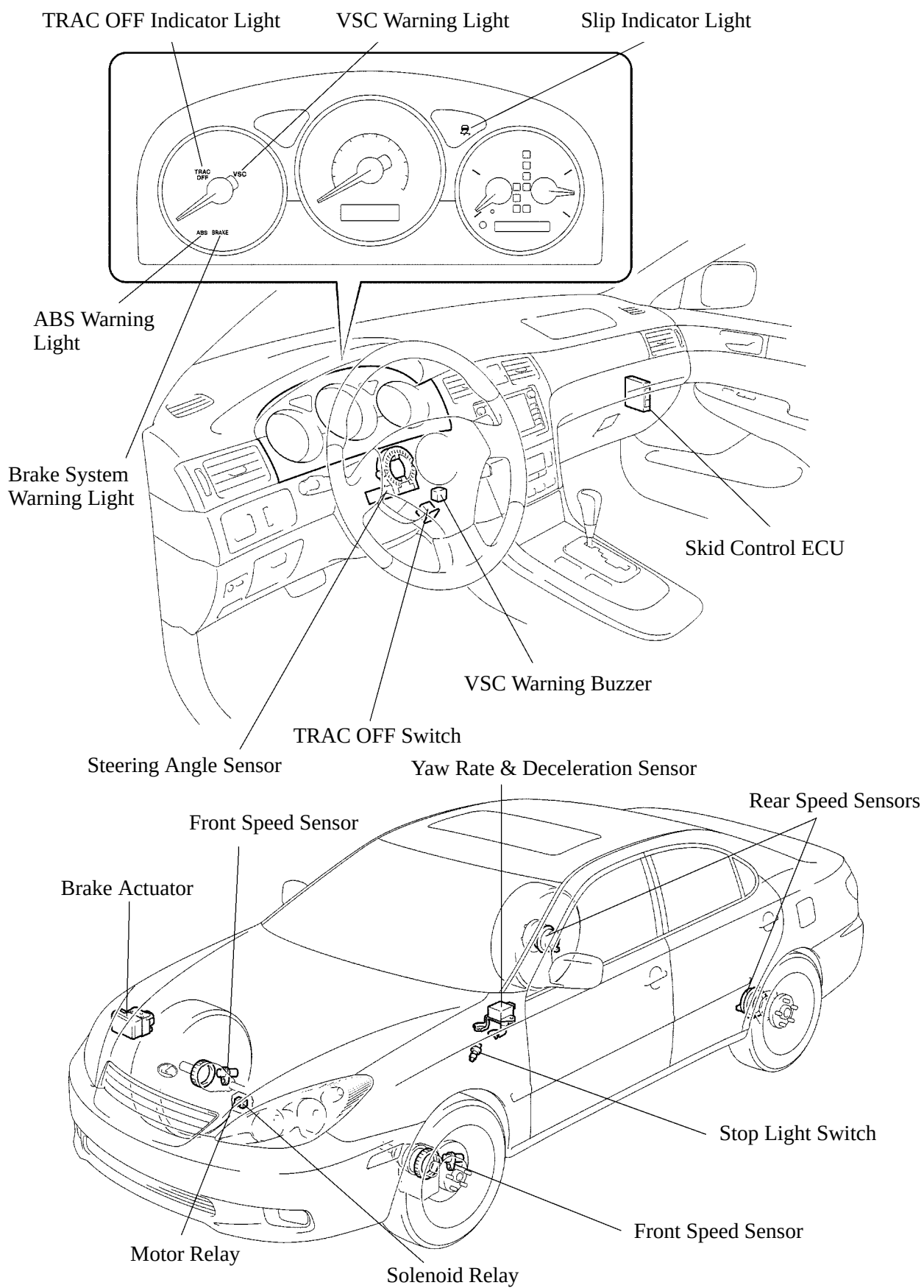
2) Dampening a Strong Oversteer

When the skid control ECU determines that the vehicle exhibits a strong tendency to oversteer, depending on the extent of that tendency, it controls the engine output and applies the brakes of the front and rear wheels of the outside of the turn, thus generating an inertial moment in the vehicle's outward direction, which helps dampen its tendency to oversteer.



170CH07

6. Layout of Component



7. Function of Component

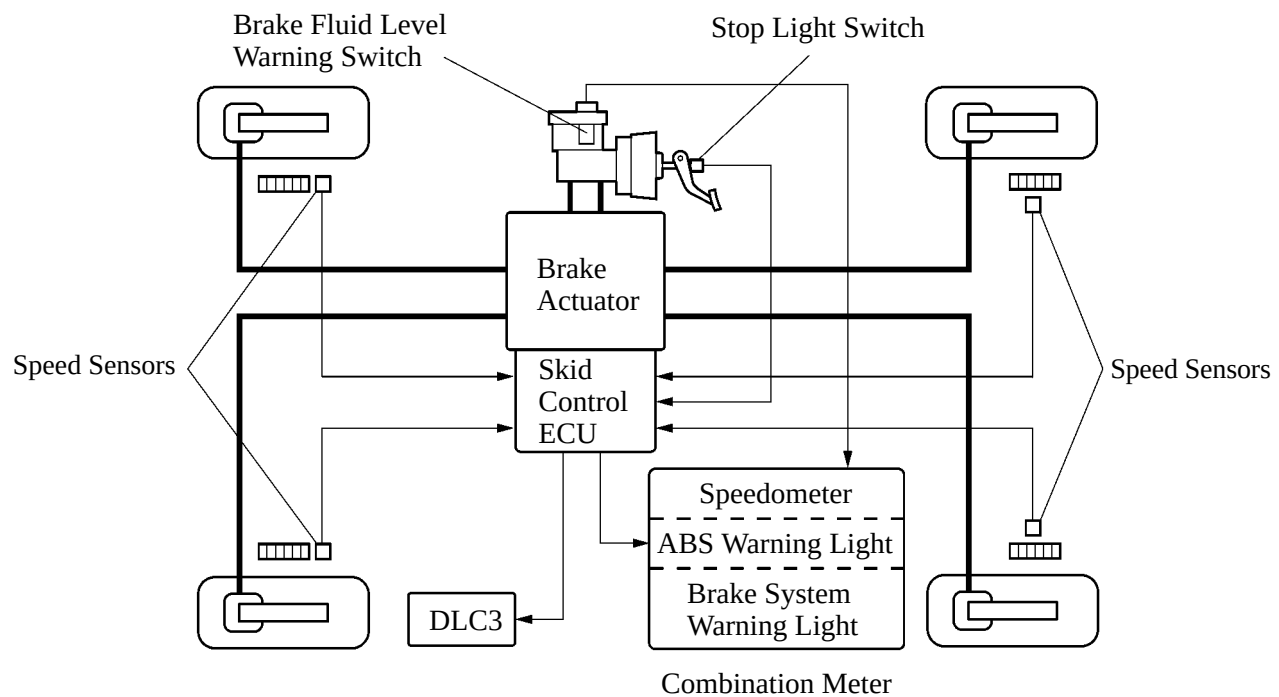
Component		Function
Combination Meter	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the ABS or Brake Assist system.
	VSC Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the VSC system.
	Slip Indicator Light	Blinks to inform the driver when the TRAC system or the VSC system is operated.
	TRAC OFF Indicator Light	• Lights up to inform the driver when the TRAC system is turned OFF by the TRAC OFF switch. • Lights up to inform the driver when the skid control ECU detects the malfunction in the TRAC or VSC system.
	Brake System Warning Light	Lights up together with the ABS warning light to alert the driver when the skid control ECU detects the malfunction in the EBD control.
ECM		• Sends the throttle valve opening angle signal, crankshaft position sensor, intake air temp. sensor, etc., to the skid control ECU. • Receive the signal of throttle valve opening request from the skid control ECU.
Speed Sensors		Detects the wheel speed of each four wheels.
Brake Actuator		Charges the fluid path based on the signals from the skid control ECU during the operation of the ABS with EBD & Brake Assist & TRAC & VSC system, in order to control the fluid pressure that is applied to the wheel cylinders.
	Master Cylinder Pressure Sensor	Assembled in the brake actuator and detects the master cylinder pressure.
Skid Control ECU		Judges the vehicle driving condition based on signals from each sensor, and sends brake control signal to the brake actuator.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Stop Light Switch		Detects the brake pedal depressing signal.
TRAC OFF Switch		Turns the TRAC system inoperative.
VSC Warning Buzzer		Emits an intermittent sound to inform the driver that the skid control ECU detects the strong understeer tendency or strong oversteer tendency.
Yaw Rate & Deceleration Sensor		• Detects the vehicle's yaw rate. • Detects the vehicle's acceleration in the forward, rearward, lateral.
Steering Angle Sensor		Detects the steering direction and angle of the steering wheel.
Motor Relay		Supply power to the pump motor in the brake actuator.
Solenoid Relay		Supply power to the solenoid valves in the brake actuator.

■ ABS with EBD System

1. General

- The primary purpose of the ABS has been to help the vehicle's behavior during braking.
- The EBD control utilizes ABS, realizing the proper brake force distribution between front and rear wheels in accordance with the driving conditions.
In addition, during cornering braking, it also controls the brake forces of right and left wheels, helping to maintain the vehicle behavior.

2. System Diagram



208CH22

3. Outline of EBD Control

General

The distribution of the brake force, which was performed mechanically in the past, is now performed under electrical control of the skid control ECU, which precisely controls the braking force in accordance with the vehicle's driving conditions.

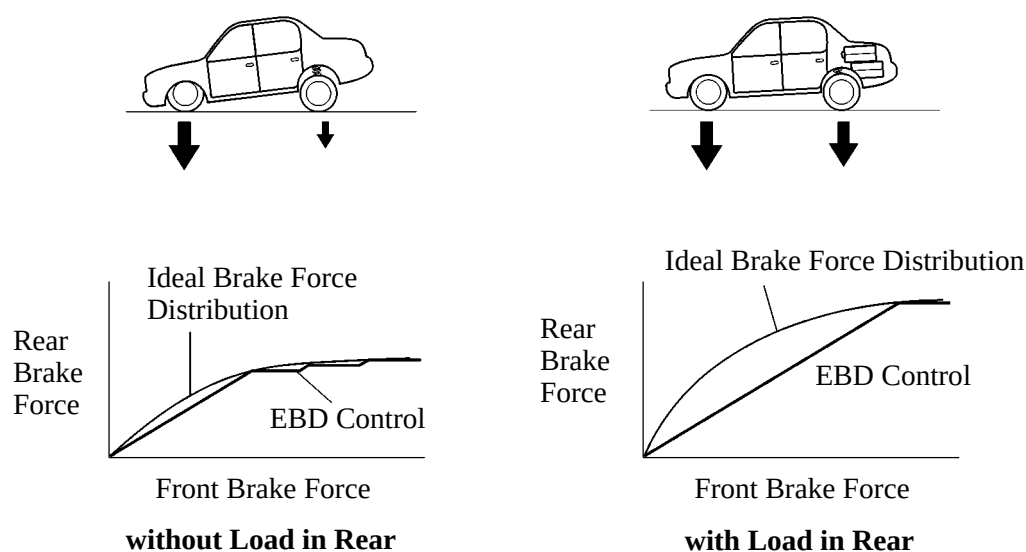
Front/Rear Wheels Brake Force Distribution

If the brakes are applied while the vehicle is moving straight forward, the transfer of the road reduces the load that is applied to the rear wheels. The skid control ECU determines this condition by way of the signals from the speed sensor, and the brake actuator regulates the distribution of the brake force of the rear wheels to optimally control.

For example, the amount of the brake force that is applied to the rear wheels during braking varies whether or not the vehicle is carrying a load. The amount of the brake force that is applied to the rear wheels also varies in accordance with the extent of the deceleration.

Thus, the distribution of the brake force to the rear is optimally controlled in order to effectively utilize the braking force of the rear wheels under these conditions.

► EBD Control Concept ◀

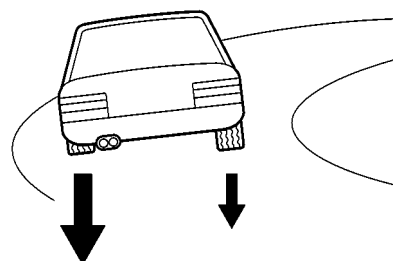


182CH56

Right/Left Wheels Brake Force Distribution (During Cornering Braking)

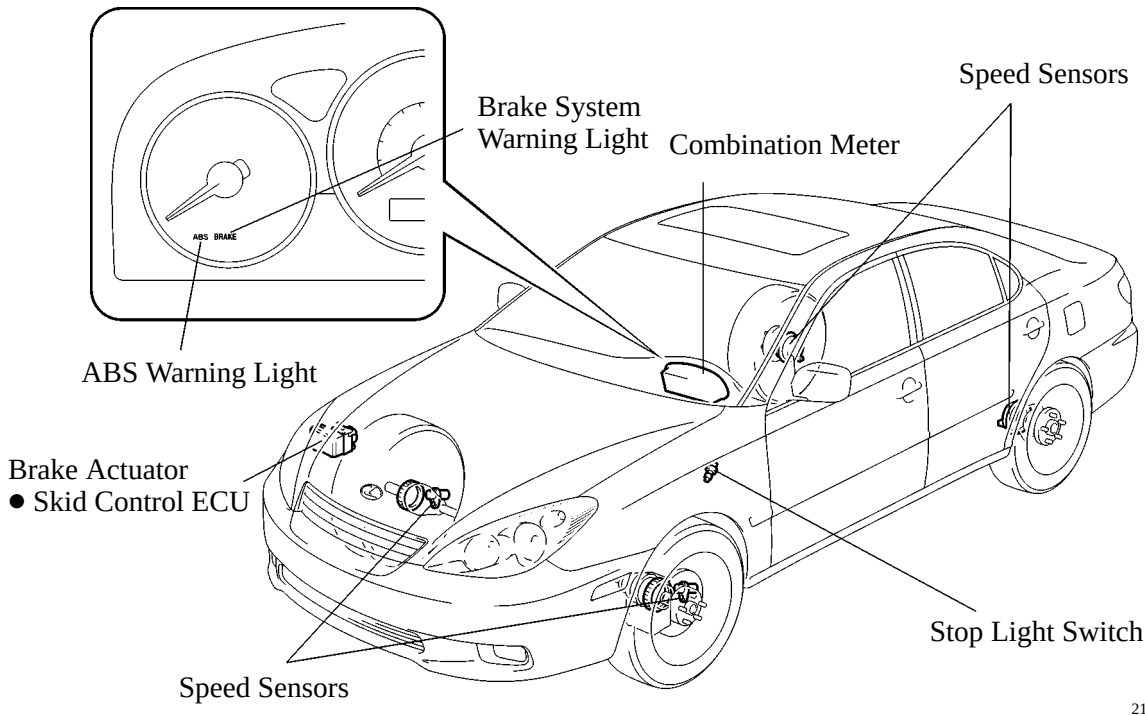
When the brakes are applied while the vehicle is cornering, the load that applied to the inner wheel decreases to the outer wheel increases.

The skid control ECU determines this condition by way of the signals from the speed sensor, and the brake actuator regulates the brake force in order to optimally control the distribution of the brake force to the inner wheel and outer wheel.



181CH56

4. Layout of Component



211CH29

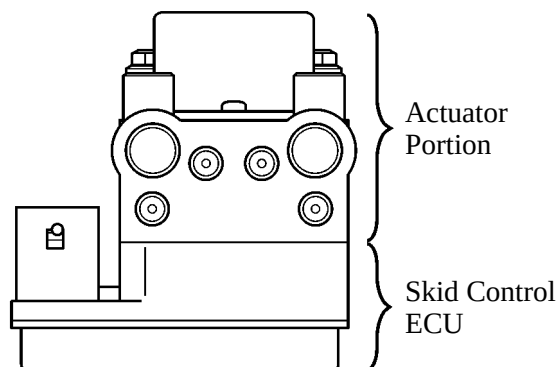
5. Function of Component

Component		Function
Combination Meter	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the ABS.
	Brake System Warning Light	Lights up together with the ABS warning light to alert the driver when the skid control ECU detects the malfunction in the EBD control.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Stop Light Switch		Detect the brake pedal depressing signal.
Speed Sensors		Detect the wheel speed of each four wheels.
Brake Actuator	Actuator Portion	Charges the fluid path based on the signals from the skid control ECU during the operation of the ABS with EBD system, in order to control the fluid pressure that is applied to the wheel cylinders.
	Skid Control ECU	Judges the vehicle driving condition based on signals from each sensor, and sends brake control signal to the brake actuator.

6. Brake Actuator

General

The brake actuator consists of actuator portion and skid control ECU.



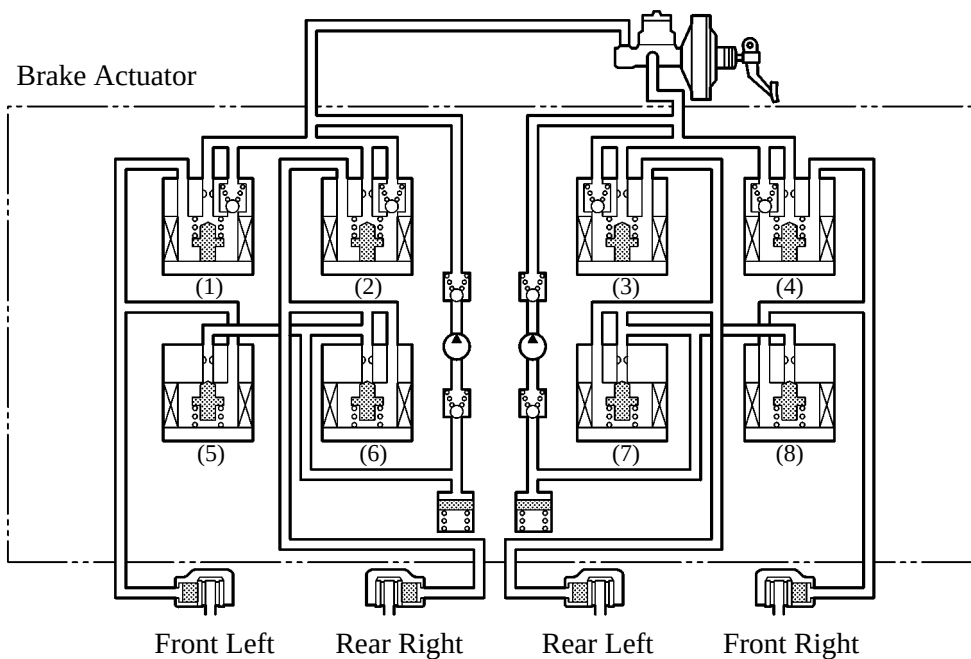
211CH30

Actuator Portion

1) Construction

The brake actuator consists of 8 two-position solenoid valves, 1 motor, 2 pumps and 2 reservoirs. The 8 two-position solenoid valves consists of 4 pressure holding valves [(1), (2), (3), (4)], and 4 pressure reduction valves [(5), (6), (7), (8)].

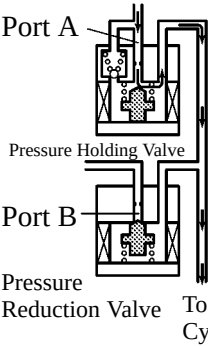
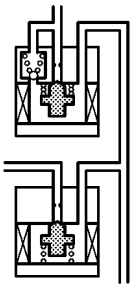
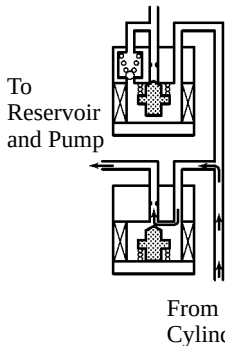
► Hydraulic Circuit ◀



208CH25

2) ABS with EBD Operation

Based on the signals received from the 4 wheel speed sensors, the skid control ECU calculates each wheel speed and deceleration, and checks wheel slipping condition. And according to the slipping condition, the ECU controls the pressure holding valve and pressure reduction valve in order to adjust the fluid pressure of each wheel cylinder in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes.

Not Activated	Normal Braking	—	—
Activated	Increase Mode	Holding Mode	Reduction Mode
Hydraulic Circuit	 169CH54	 169CH55	 169CH56
	Pressure Holding Valve (Port A)	OFF (Open)	ON (Close)
	Pressure Reduction Valve (Port B)	OFF (Close)	ON (Open)
	Wheel Cylinder Pressure	Increase	Hold

3) Skid Control ECU

Initial Check

After the ignition is turned ON, and the vehicle attains an approximate speed of 6 km/h (4 mph) or more only at first time, the skid control ECU performs the initial check.

The functions of each solenoid valve and pump motor in the brake actuator are checked in order.

Self-Diagnosis

- If the skid control ECU detects a malfunction in the ABS with EBD system, the ABS and brake system warning lights that corresponds to the function in which the malfunction has been detected indicates or lights up, indicated in the table below, to alert the driver of the malfunction.

○: Light ON –: Light OFF

Item	ABS	EBD	Skid Control ECU
ABS Warning Light	○	○	○
Brake System Warning Light	—	○	○

- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be read by connecting the SST (09843-18040) between the Tc and CG terminals of DLC3 and observing the blinking of the ABS warning light, or by connecting a hand-held tester.
- This system has a sensor signal check function. The DTCs can be read by connecting the SST (09843-18040) between the Tc and CG terminals of DLC3 and observing the blinking of the ABS warning light after check the function or by connecting a hand-held tester.
- The DLC1 has been discontinued.
- The DTCs listed below have been added.

DTC No.	Detection Item
C1235/35	Foreign matter is attached on the tip of the right front sensor
C1236/36	Foreign matter is attached on the tip of the left front sensor
C1238/38	Foreign matter is attached on the tip of the right rear sensor
C1239/39	Foreign matter is attached on the tip of the left rear sensor

For details on the DTCs that are stored in skid control ECU memory and the DTCs that are output through the sensor check function, see the 2002 LEXUS ES300 Repair Manual (Pub. No. RM911U).

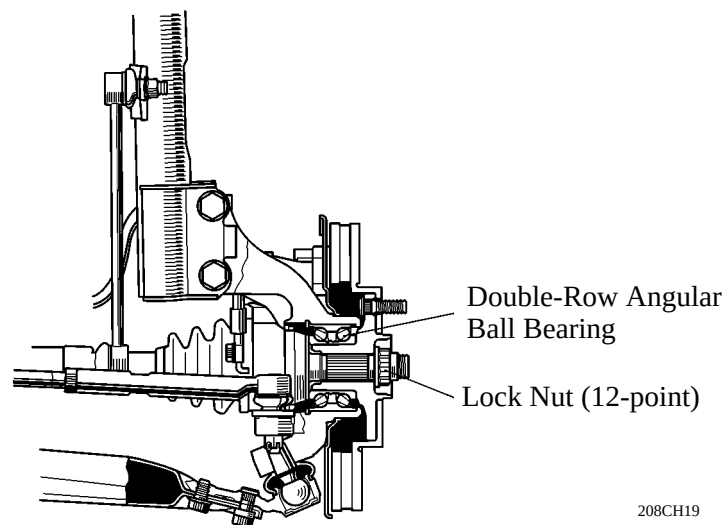
4) Fail-Safe

- In the event of a malfunction in the ABS, the skid control ECU prohibits the ABS operation.
- In the event of the malfunction in the EBD control, skid control ECU prohibits the EBD control. Thus, the brake will be operated in the same condition as in the condition without the ABS with EBD.

■ AXLE

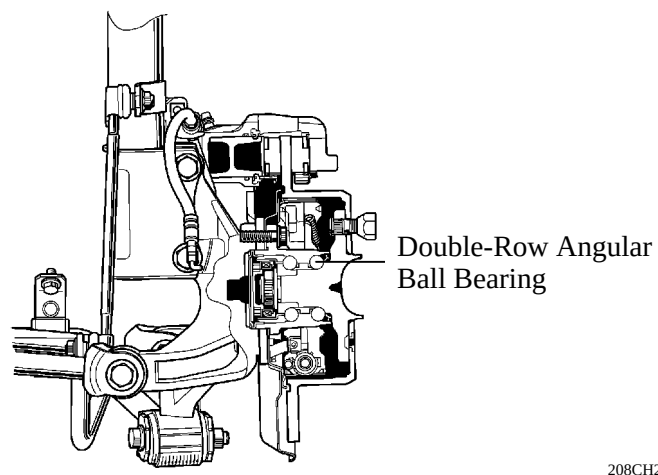
1. Front Axle

- The front axle use a double-row angular ball bearing which offers low rolling resistance.
- A lock nut (12-point) has been adopted and staked for tightening the axle hub in order to ensure the tightening performance.
This nut cannot reused.
- A lead-free material is used in the front axle hub to address environmental concerns.



2. Rear Axle

- The rear axle use a double-row angular ball bearing which offers low rolling resistance.
- Part of the inner race is integrated with the shaft, thus optimizes the high rigidity.



BRAKE**DESCRIPTION**

The '02 ES300 has a brake system with the following specifications:

Model		'02 ES300	'01 ES300
Front Brake	Type	Ventilated Disc	←
	Rotor Size	for 16 in. wheel	for 15 in. wheel
Rear Brake	Type	Solid Disc	←
	Rotor Size	for 14 in. wheel	←
ABS with EBD		STD	—
ABS & TRAC		—	STD
ABS & Brake Assist & TRAC & VSC		—	OPT
ABS with EBD & Brake Assist & TRAC & VSC		OPT	—
Brake Control Valve		EBD	Dual P valve
Parking Brake Lever Type		Pedal	←

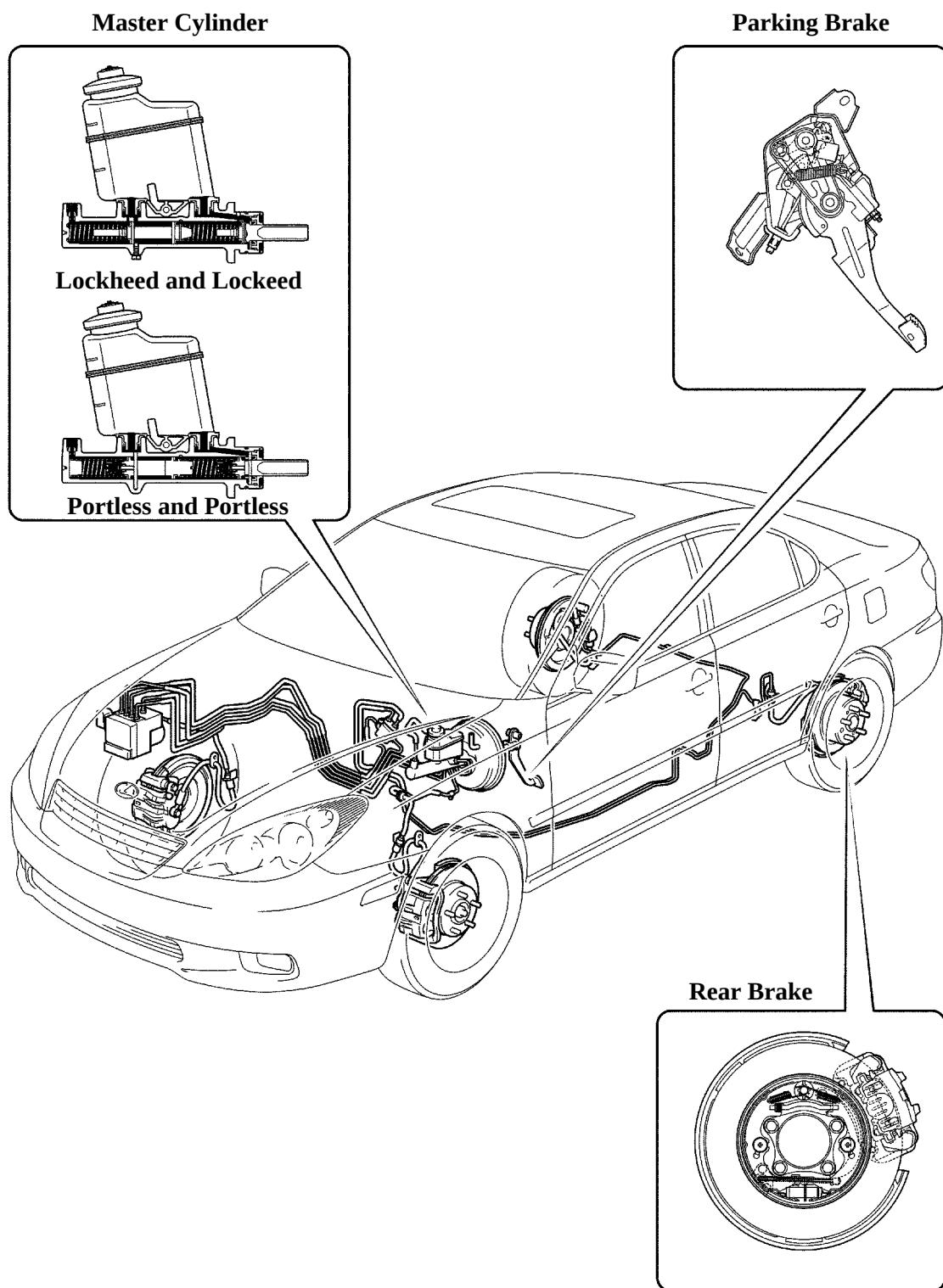
► Specification ◀

Model		'02 ES300	'01 ES300
Master Cylinder	Type	Tandem (Lockheed and Lockheed)* ¹ (Portless and Portless)* ²	Tandem (Portless and Lockheed)
	Diameter mm (in.)	22.22 (0.87)	23.8 (0.93)
Brake Booster	Type	Single	Tandem
	Size in.	10.5	8.5 + 8.5
Front Disc Brake	Pad Area cm ² (in. ²)	52.9 (8.20)	44 (6.89)
	Wheel Cylinder Dia. mm (in.)	44.45 (1.75) x 2	60.3 (2.38)
	Rotor Size (D x T)* ³ mm (in.)	296 x 28 (11.65 x 1.10)	275 x 28 (10.83 x 1.10)
	Pad Material	PA556H	←
Rear Disc Brake	Pad Area cm ² (in. ²)	21.5 (3.33)	34 (5.27)
	Wheel Cylinder Dia. mm (in.)	38.1 (1.50)	34.9 (1.38)
	Rotor Size (D x T)* ³ mm (in.)	269 x 12 (10.6 x 0.47)	269 x 10 (10.6 x 0.39)
	Pad Material	PA544	←
P Valve	Type	—	Dual
Parking Brake	Type	Duo Servo	←
	Drum Inner Dia. mm (in.)	170.0 (6.69)	←

*¹: with ABS with EBD

*²: with ABS with EBD & Brake Assist & TRAC & VSC

*³: D: Outer Diameter, T: Thickness



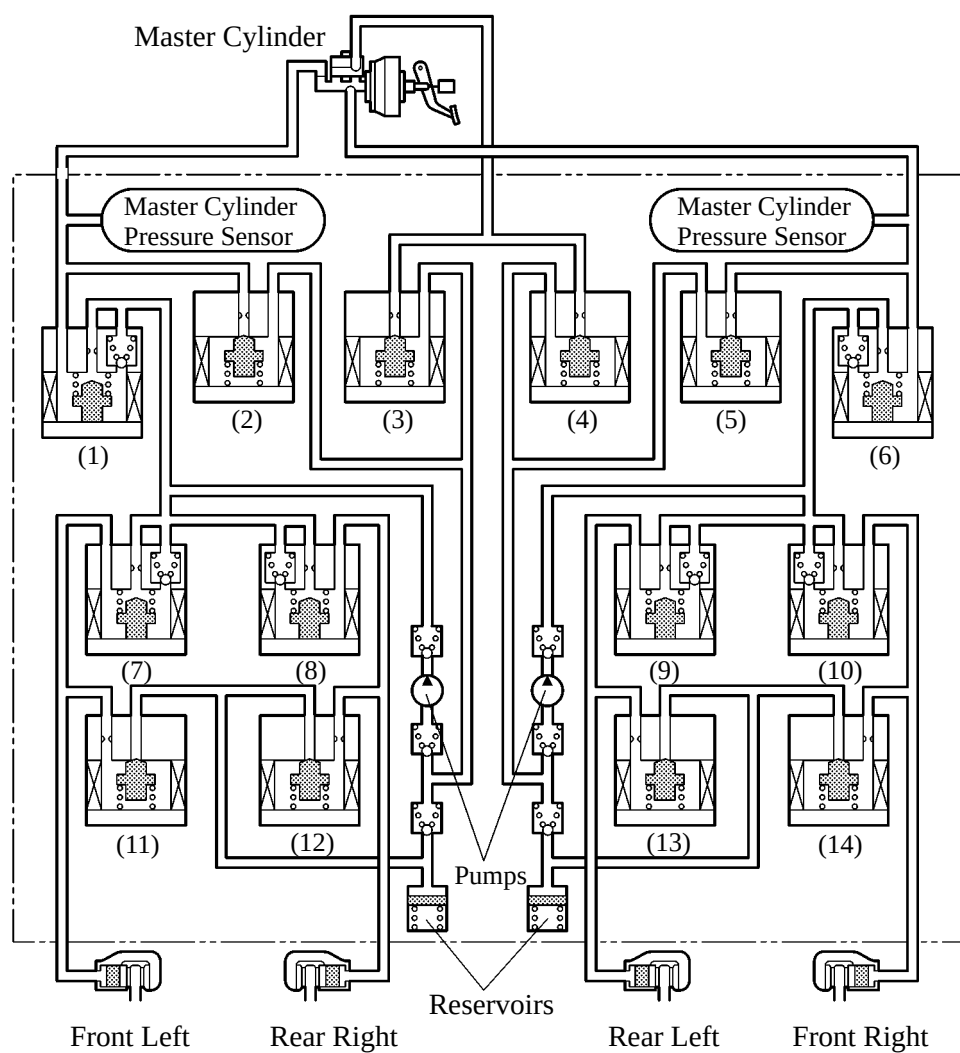
8. Brake Actuator

Construction

The brake actuator consists of 14 two-position valves, 1 motor, 2 pumps, and 2 reservoirs, and 2 master cylinder pressure sensor.

The 14 two-position solenoid valves consists of 2 master cylinder cut solenoid valve [(1), (6)], 2 suction solenoid valves [(2), (5)], 2 reservoir cut solenoid valves [(3), (4)], 4 pressure holding valves [(7), (8), (9), (10)], and 4 pressure reduction valves [(11), (12), (13), (14)].

► Hydraulic Circuit ◀

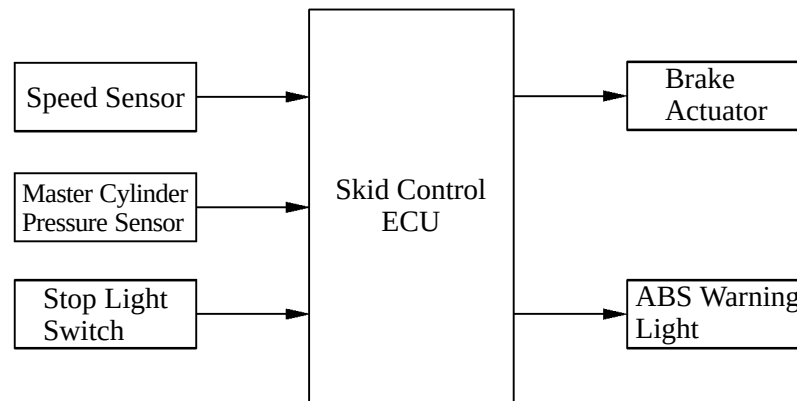


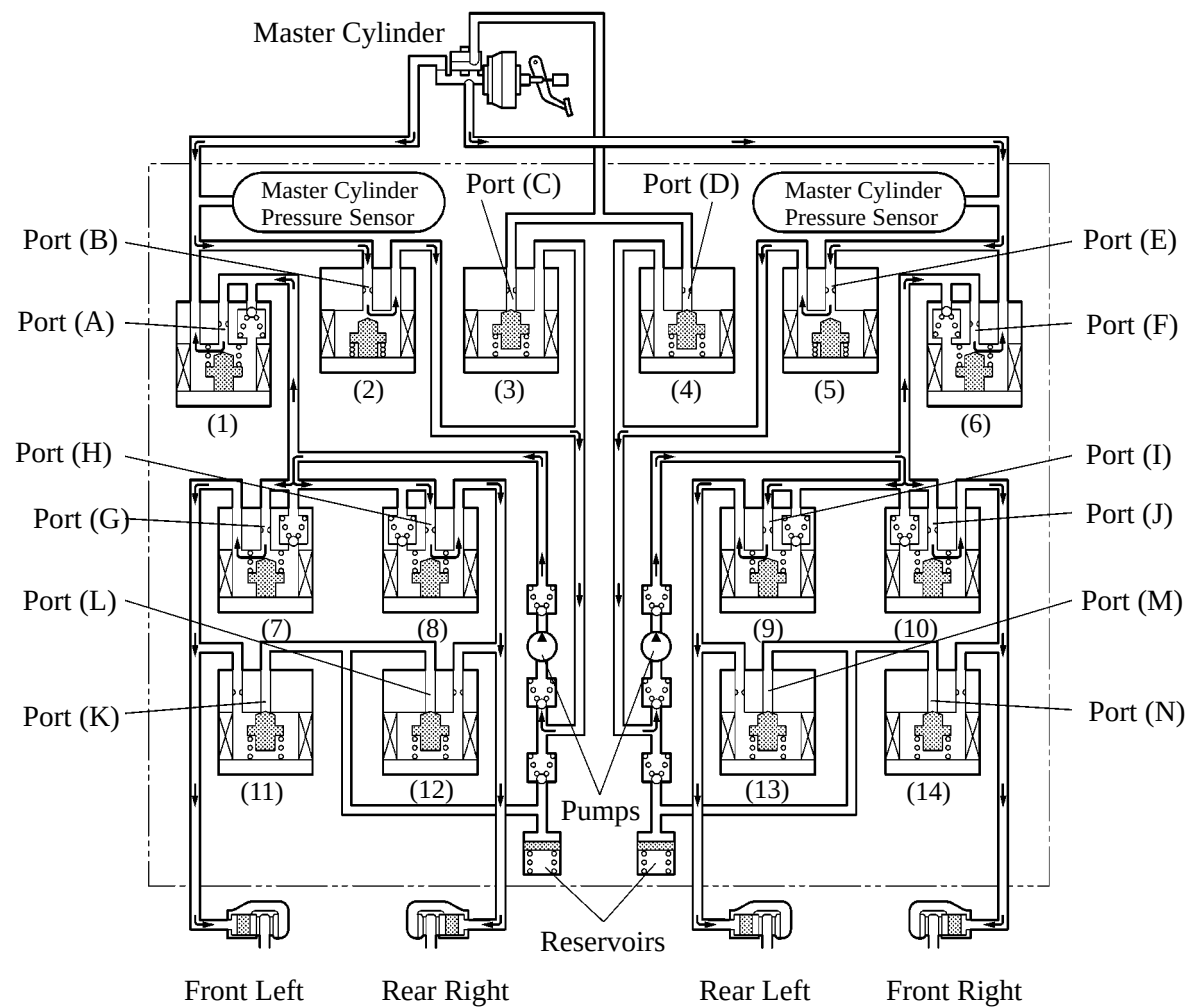
ABS with EBD Operation

The ABS with EBD operation is the same as the operation of the ABS with EBD system. Refer to that system for details.

Brake Assist Operation

The fluid pressure that has been generated by the pump in the brake actuator is directed to the wheel cylinders. By applying a greater fluid pressure than the master cylinder, a greater braking force is achieved.

► System Diagram ◀



208CH29

Item		Brake Assist Not Activated	Brake Assist Activated
(1), (6)	Master Cylinder Cut Solenoid Valve	OFF (Open)	ON*
	Port: (A), (F)		
(3), (4)	Reservoir Cut Solenoid Valve	OFF (Close)	OFF (Close)
	Port: (C), (D)		
(2), (5)	Suction Solenoid Valve	OFF (Close)	ON (Open)
	Port: (B), (E)		
(7), (8), (9), (10)	Pressure Holding Valve	OFF (Open)	OFF (Open)
	Port: (G), (H), (I), (J)		
(11), (12), (13), (14)	Pressure Reduction Valve	OFF (Close)	OFF (Close)
	Port: (K), (L), (M), (N)		

*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

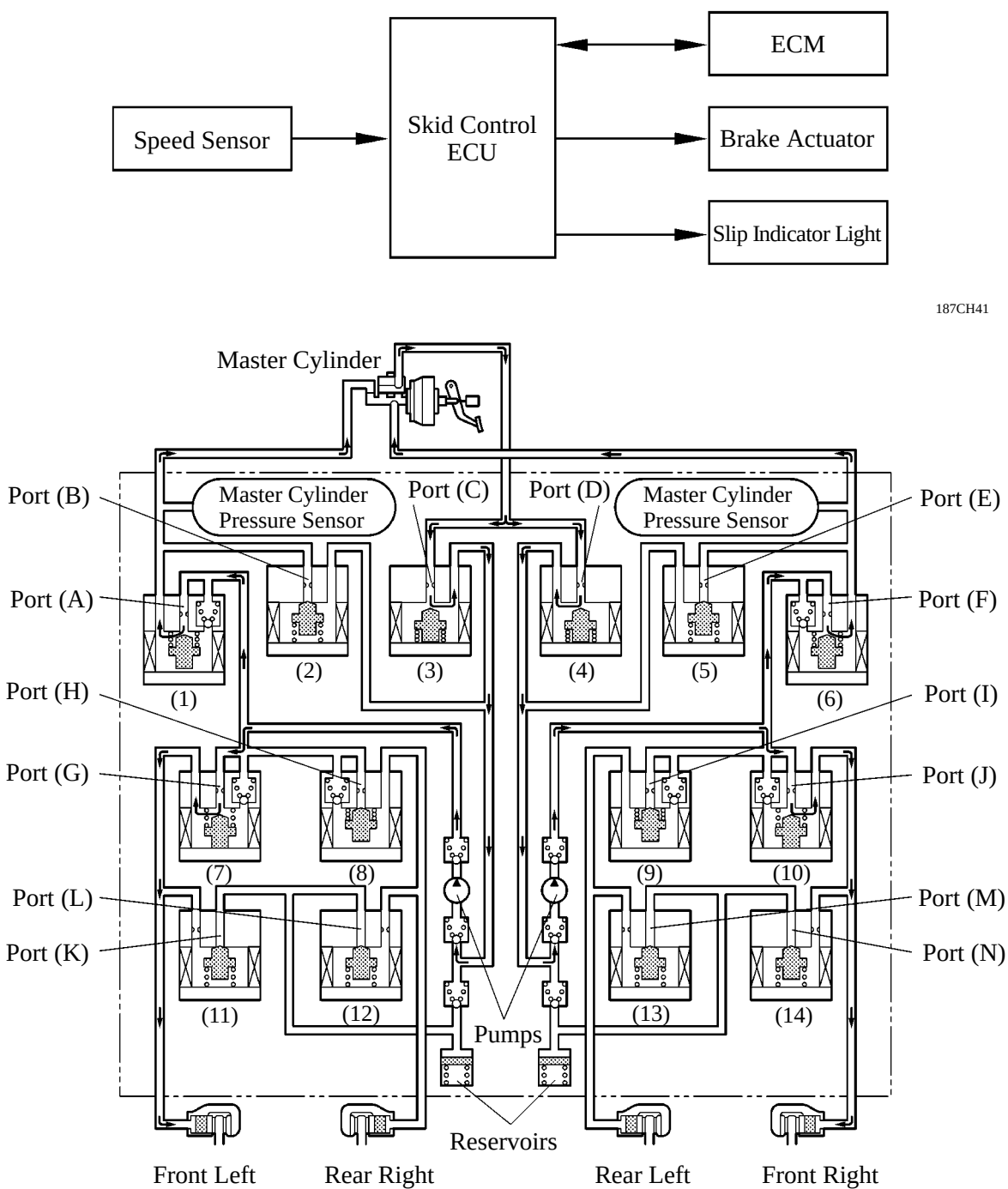
TRAC Operation

The fluid pressure that is generated by the pump is regulated by the master cylinder cut solenoid valve to the required pressure. Thus, the wheel cylinder of the drive wheels are controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes, to restrain the slippage of the drive wheels.

The diagram below shows the hydraulic circuit in the pressure increase mode when the TRAC system is activated.

In other, the pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS operation pattern described on the previous page.

► System Diagram ◀



187CH41

208CH31

Item		TRAC not Activated	TRAC Activated			
			Increase Mode	Holding Mode	Reduction Mode	
(1), (6)	Master Cylinder Cut Solenoid Valve	OFF (Open)	ON*	ON*	ON*	
	Port: (A), (F)					
(3), (4)	Reservoir Cut Solenoid Valve	OFF (Close)	ON (Open)	ON (Open)	ON (Open)	
	Port: (C), (D)					
(2), (5)	Suction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)	
	Port: (B), (E)					
Front Brake	(7), (10)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
		Port: (G), (J)				
	(11), (14)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)
		Port: (K), (N)				
	Wheel Cylinder Pressure		—	Increase	Hold	Reduction
Rear Brake	(8), (9)	Pressure Holding Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Close)
		Port: (H), (J)				
	(12), (13)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (L), (M)				
	Wheel Cylinder Pressure		—	—	—	—

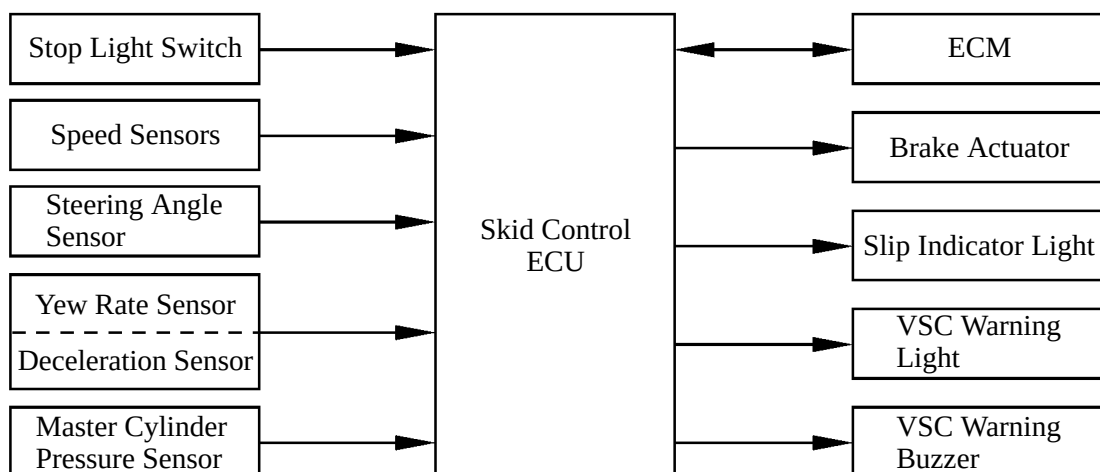
*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

VSC Operation

1) General

The VSC system, by way of solenoid valves, controls the fluid pressure that is generated by the pump and applies it to the brake wheel cylinder of each wheel in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes. As a result, the tendency to understeer or oversteer is restrained.

► System Diagram ◀



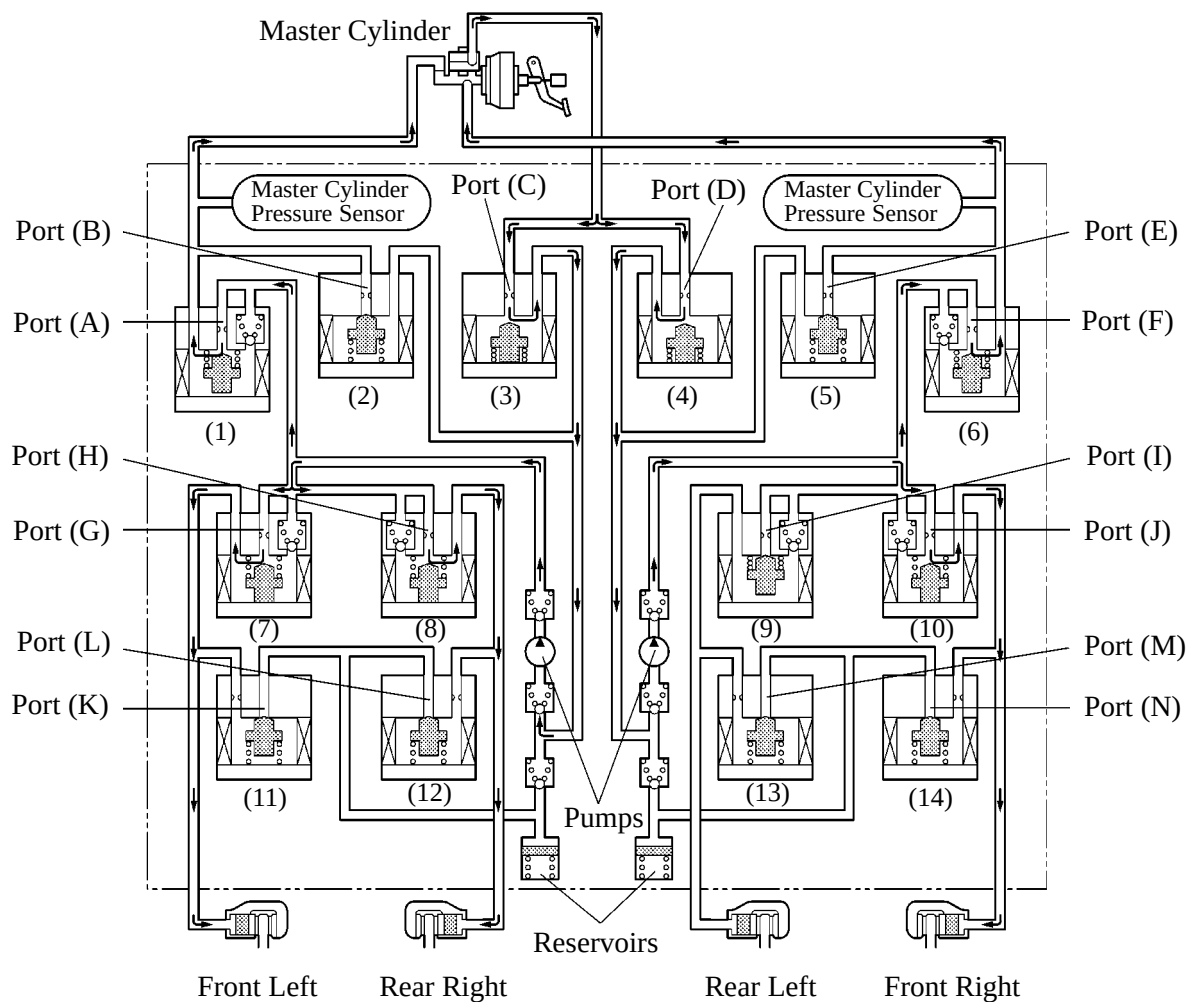
2) Understeer Restraining Control (Turning to the Right)

In understeer restraining control, the brake of the front wheels and rear wheel of the inner side of the turn is applied.

Also, depending on whether the brake is ON or OFF and the condition of the vehicle, there are circumstances in which the brake might not be applied to the wheels even if those wheels are targeted for braking.

The diagram below shows the hydraulic circuit in the pressure increase mode, as it restrains an understeer condition while the vehicle makes a right turn.

In other, the pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS operation pattern.



Increase Mode

208CH33

Item			VSC not Activated	VSC Activated			
				Increase Mode	Holding Mode	Reduction Mode	
(1), (6)	Master Cylinder Cut Solenoid Valve		OFF (Open)	ON*	ON*	ON*	
	Port: (A), (F)						
(3), (4)	Reservoir Cut Solenoid Valve		OFF (Close)	ON (Open)	ON (Open)	ON (Open)	
	Port: (C), (D)						
(2), (5)	Suction Solenoid Valve		OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)	
	Port: (B), (E)						
Front Brake	(7), (10)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)	
		Port: (G), (J)					
	(11), (14)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)	
		Port: (K), (N)					
	Wheel Cylinder Pressure		—	Increase	Hold	Reduction	
Rear Brake	(8)	Pressure Holding Valve (Rear Right)	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)	
		Port: (H)					
	(9)	Pressure Holding Valve (Rear Left)	OFF (Open)	ON (Close)	ON (Close)	ON (Close)	
		Port: (I)					
	(12)	Pressure Reduction Valve (Rear Right)	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)	
		Port: (L)					
	(13)	Pressure Reduction Valve (Rear Left)	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)	
		Port: (M)					
	Wheel Cylinder Pressure		Right	—	Increase	Hold	Reduction
			Left	—	—	—	—

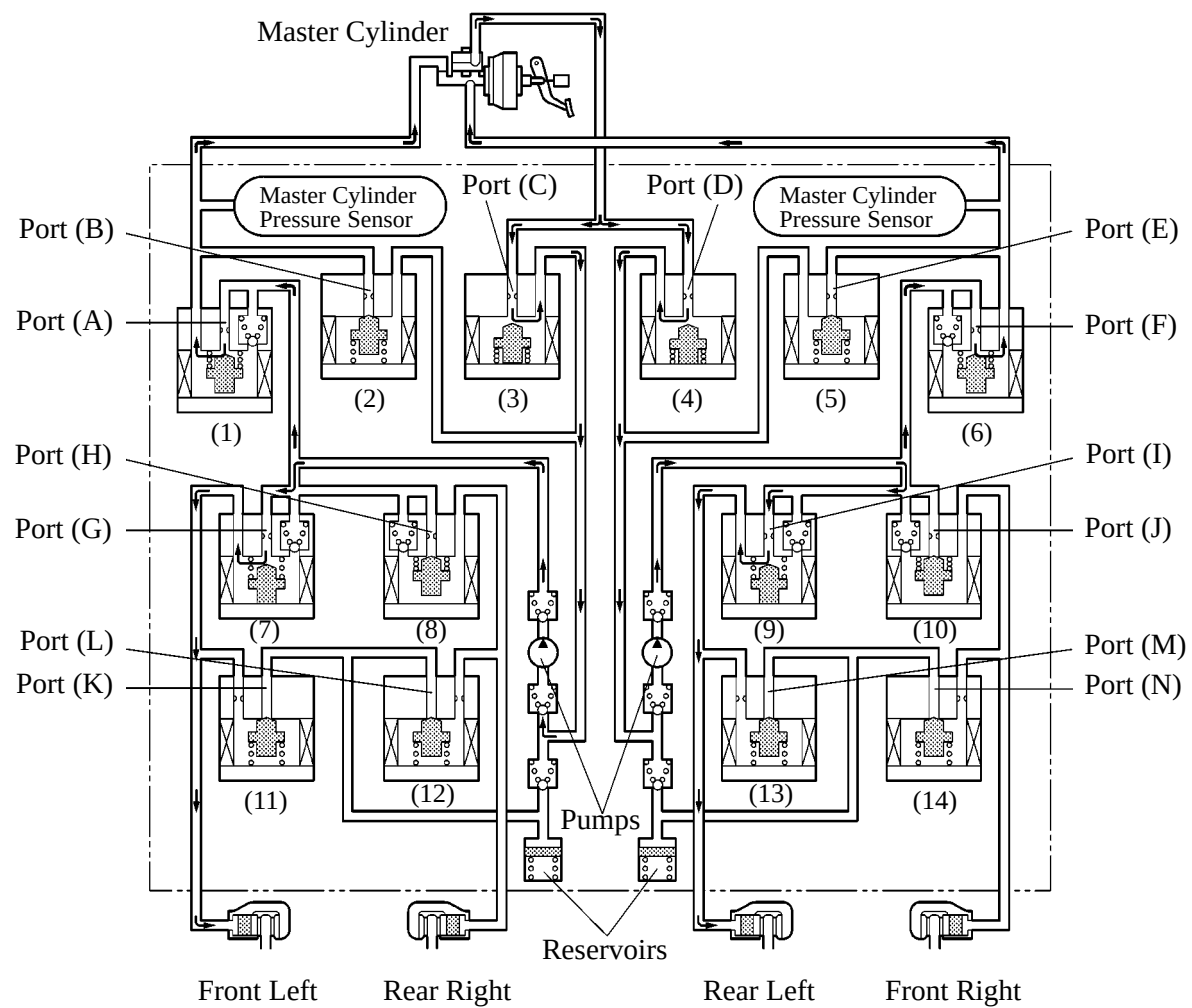
*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

3) Oversteer Restraining Control (Turning to the Right)

In oversteer restraining control, the brake of the front and rear wheels of the outer side of the turn is applied. As an example, the diagram below shows the hydraulic circuit in the pressure increase mode, as it restrains an oversteer condition while the vehicle make a right turn.

As in understeer restraining control, in other, the pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS operating pattern.

However, in oversteer control, the pressure holding valve is turned ON and blocks the hydraulic passage to the front inner wheel in order to prevent applying the brake to the front inner wheel.



Increase Mode

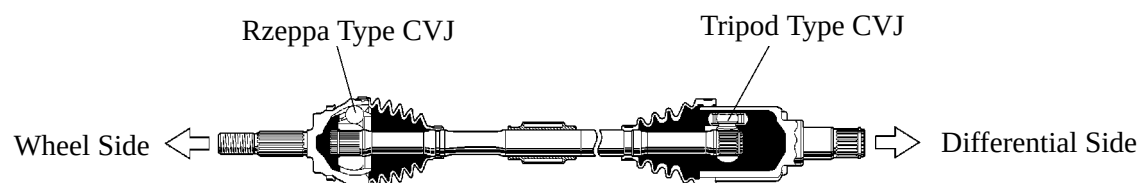
Item			VSC not Activated	VSC Activated			
				Increase Mode	Holding Mode	Reduction Mode	
(1), (6)		Master Cylinder Cut Solenoid Valve	OFF (Open)	ON*	ON*	ON*	
		Port: (A), (F)					
(3), (4)		Reservoir Cut Solenoid Valve	OFF (Close)	ON (Open)	ON (Open)	ON (Open)	
		Port: (C), (D)					
(2), (5)		Suction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)	
		Port: (B), (E)					
Front Brake	(10)	Pressure Holding Valve (Front Right)	OFF (Open)	ON (Close)	ON (Close)	ON (Close)	
		Port: (J)					
	(7)	Pressure Holding Valve (Front Left)	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)	
		Port: (G)					
	(14)	Pressure Reduction Valve (Front Right)	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)	
		Port: (N)					
	(11)	Pressure Reduction Valve (Front Left)	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)	
		Port: (K)					
	Wheel Cylinder Pressure		Right	—	—	—	—
			Left	—	Increase	Hold	Reduction
Rear Brake	(8)	Pressure Holding Valve (Rear Right)	OFF (Open)	ON (Close)	ON (Close)	ON (Close)	
		Port: (H)					
	(9)	Pressure Holding Valve (Rear Left)	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)	
		Port: (I)					
	(12)	Pressure Reduction Valve (Rear Right)	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)	
		Port: (L)					
	(13)	Pressure Reduction Valve (Rear Left)	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)	
		Port: (M)					
	Wheel Cylinder Pressure		Right	—	—	—	—
			Left	—	Increase	Hold	Reduction

*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

DRIVE SHAFT

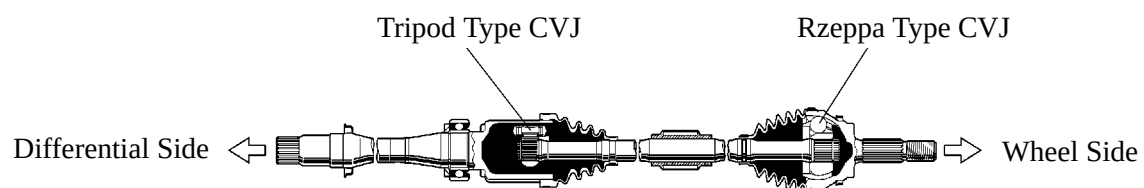
■ DESCRIPTION

The drive shaft use the low-vibration tripod type CVJ (Constant-Velocity Joint) on the differential side, and Rzeppa type CVJ on the wheel side.



Front Left-Hand

211CH50



Front Right-Hand

211CH51

■ ELECTRIC MODULATED SUSPENSION

1. General

Through electronic control, this system automatically controls the damping force of the shock absorbers, thus realizes excellent riding comfort and controllability.

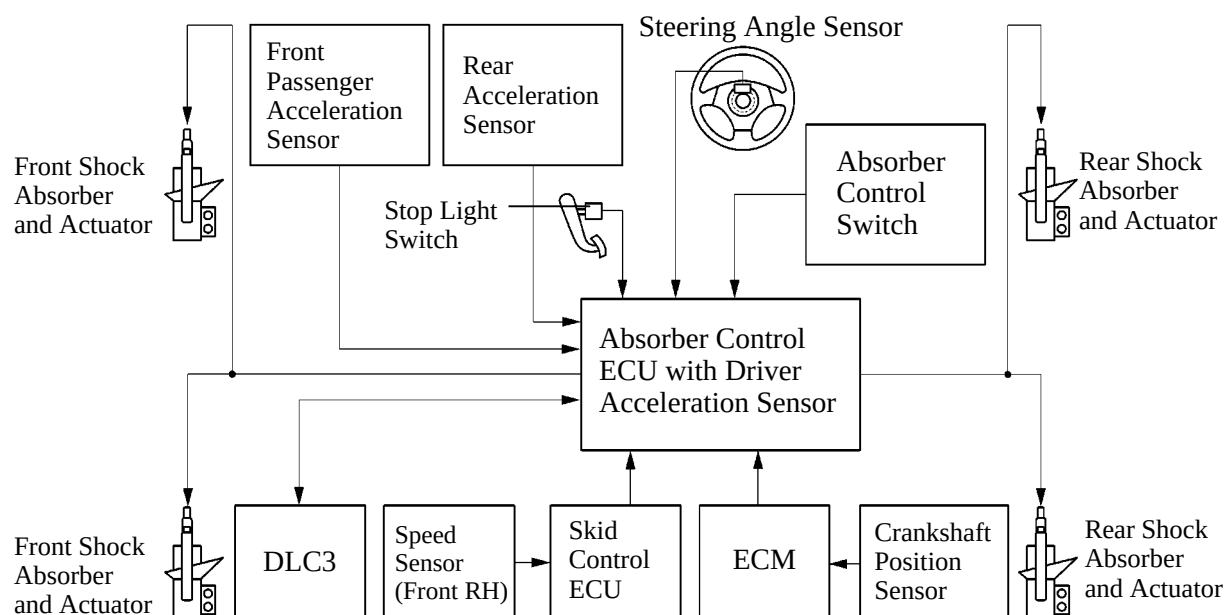
– Main Changes –

Construction and Operation of Component	• 2 acceleration sensors (front passenger and rear) have been provided. • The construction of the steering angle sensor has been changed. • The damping force of the shock absorbers has been changed.
System Control	• The semi-active control of the damping force has been changed from sky-hook control to non-linear H^∞ control in order to effect 4-wheel independent control that constantly achieves an optimal damping force in relation to the bumpiness of the road surface. As a result, excellent ride comfort has been realized. • Imaginary roll damper control has been adopted for damping force control to optimize the vehicle roll attitude during cornering. As a result, excellent cornering stability and controllability have been realized.
Diagnosis	• Outputs a 5-digit DTC (Diagnosis Trouble Code) and a 2-digit DTC to support the M-OBD (Multiplex On-Board Diagnosis) system. • The DLC1 has been discontinued. • The method for erasing the DTCs has been changed.

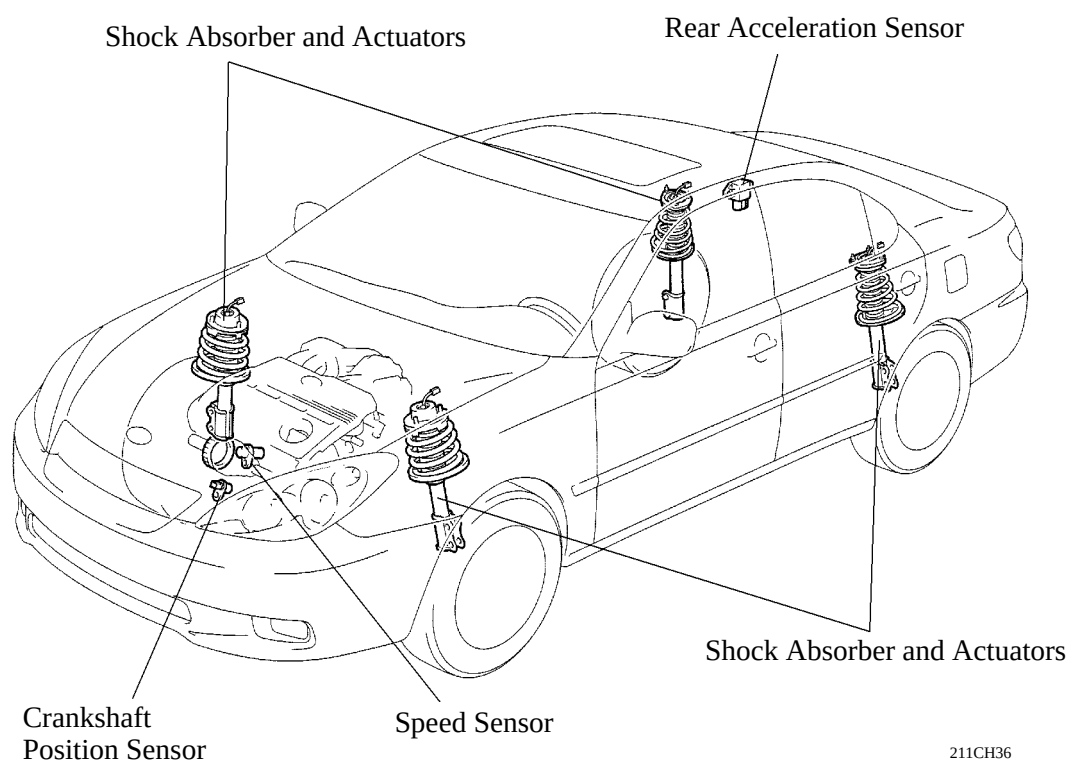
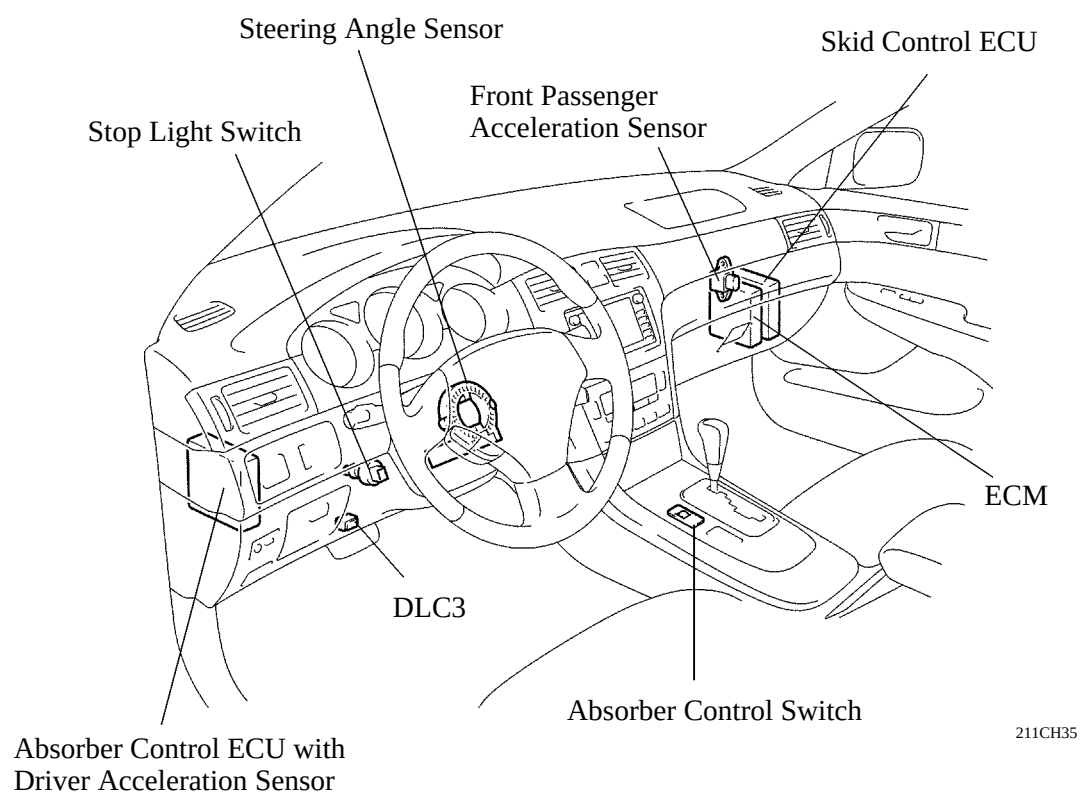
–Reference–

- To summarize, H^∞ control is a theory for designing a controller that meets the control specifications that are represented by the H^∞ norm (a unit of measurement of the transfer function of the system). When this is expanded into a non-linear system, it is called “non-linear H^∞ control”.
- The “H” is the initial letter of the mathematician named Hardy (who studied the stability of control systems) who advocated the mathematical space that is handled by this control theory. The “ ∞ ” represents the “ ∞ norm”, which is one of the mathematical units used for measuring the size of the signals.

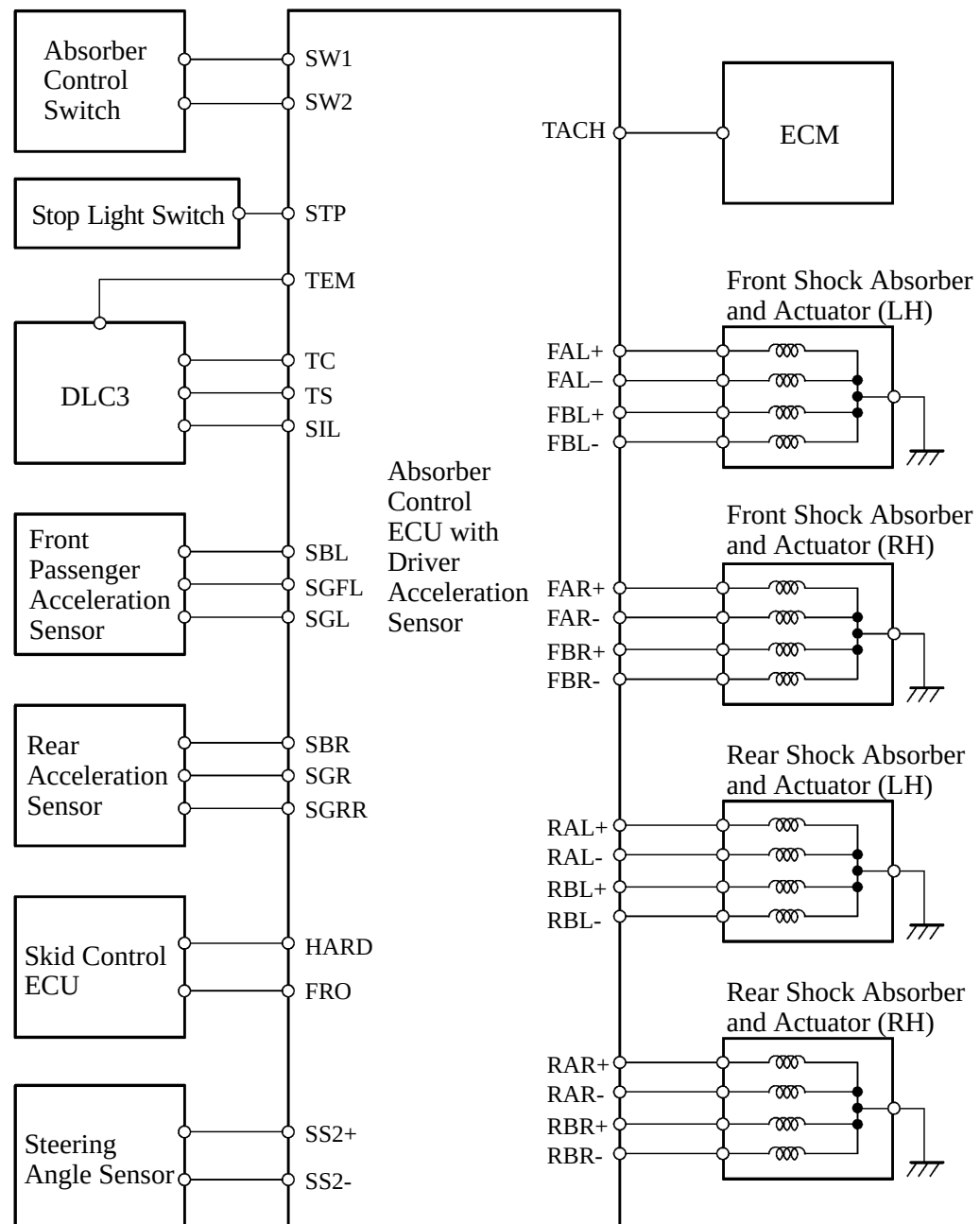
2. System Diagram



3. Layout of Component



4. Wiring Diagram



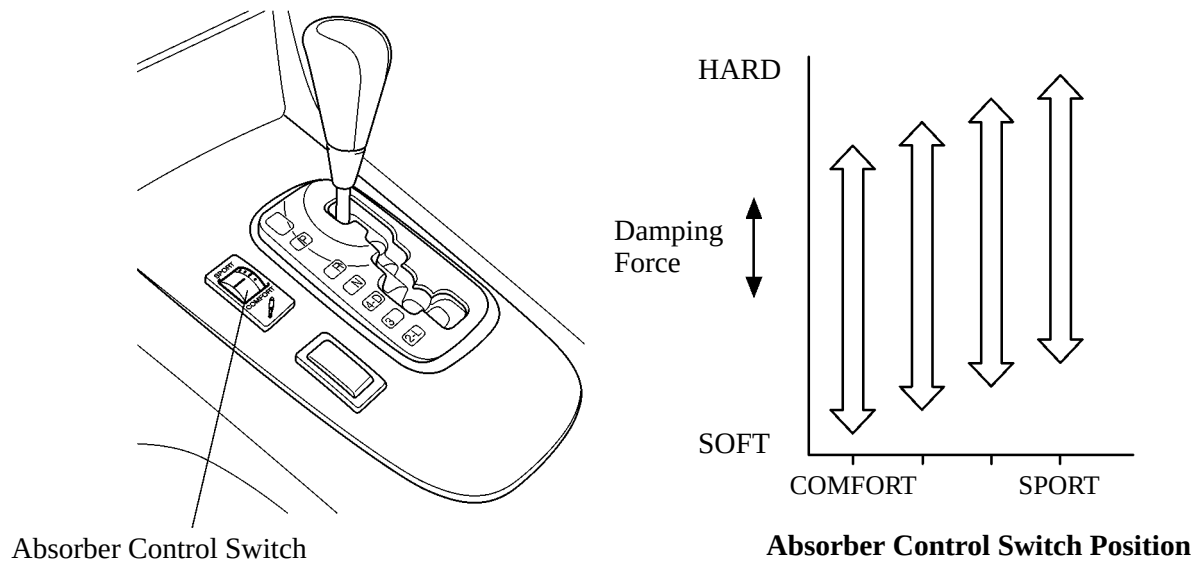
5. Function of Component

Component	Function
Steering Angle Sensor	Detects the steering direction and angle of the steering wheel.
Front Passenger Acceleration Sensor	Detects the vehicle's vertical (front passenger side) acceleration rate.
Rear Acceleration Sensor	Detects the vehicle's vertical acceleration rate.
Speed Sensor (Front Right)	Detects the wheel speed of front right wheel.
Shock Absorber and Actuator	Changes the damping force by the absorber control ECU signal.
Skid Control ECU	Converts the wheel speed signal from the speed sensors and sends it to the absorber control ECU.
Crankshaft Position Sensor	Detects the engine speed.
ECM	Sends the engine speed signal from the crankshaft position sensor to the absorber control ECU.
Absorber Control ECU with Driver Acceleration Sensor	● Determines the condition of the vehicle based on the signals received from the sensors and switches and sends a control signal to the actuator located in the shock absorber. ● Uses an internal acceleration sensor to detect the vehicle's vertical (driver side) acceleration rate.
Stop Light Switch	Detects the brake condition.
Absorber Control Switch	Selects the damping force of the shock absorber.

6. Construction and Operation of Component

Absorber Control Switch

As in the '01 ES300, the absorber control switch uses a rotary type switch. By operating this switch, the driver can select 4 types of damping forces of the shock absorbers.

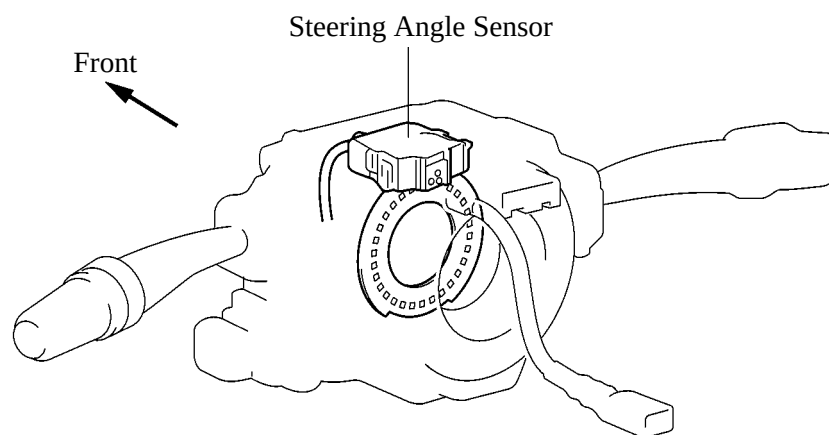


211CH38

Steering Angle Sensor

This sensor contains 3 photo interrupters with phases, and a slotted disc interrupts the light to turn the photo transistor ON and OFF to detect the steering direction and angle.

This steering angle sensor is the same steering angle sensor as used for ABS with EBD & Brake Assist & TRAC & VSC system.



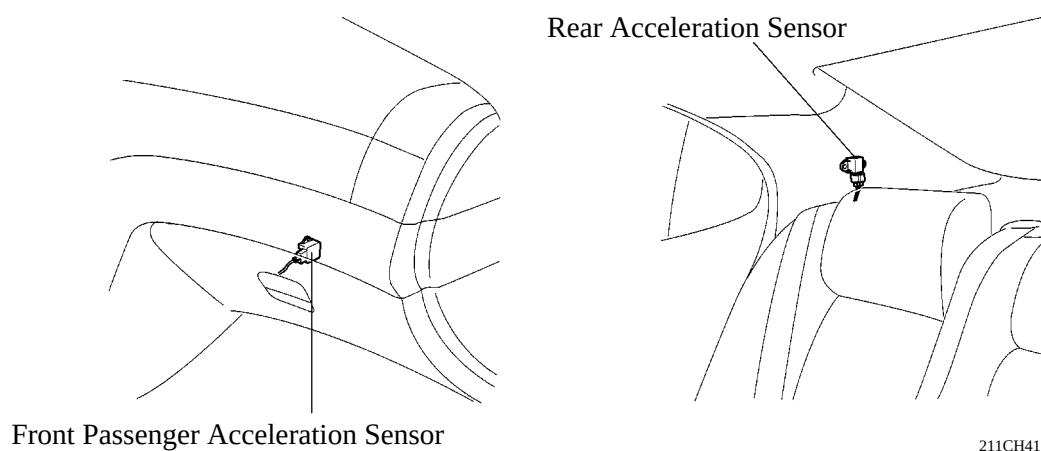
211CH39

Acceleration Sensor

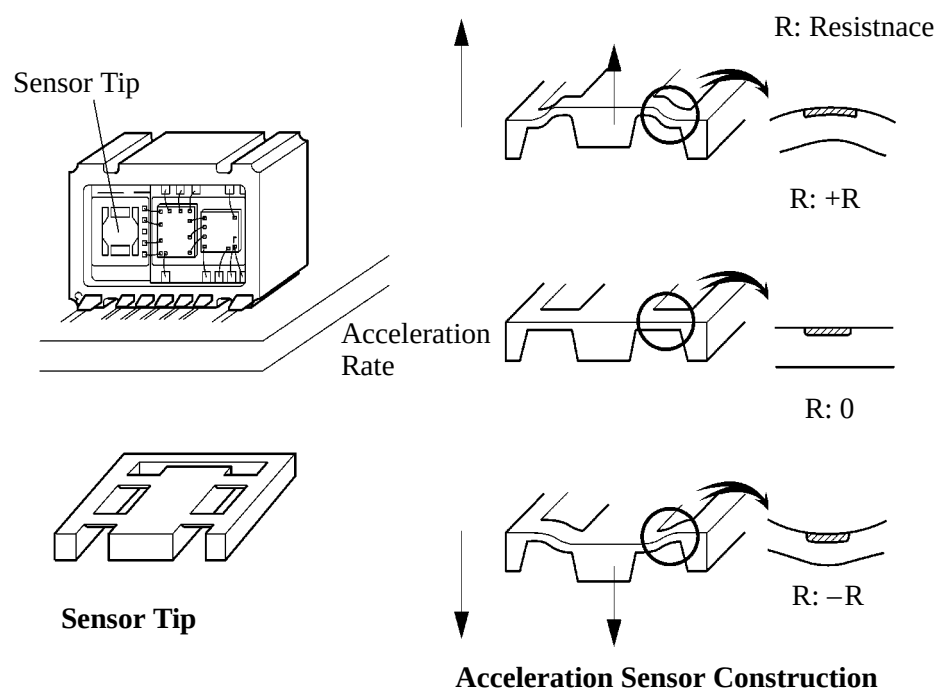
The driver acceleration sensor is built into the absorber control ECU.

The front passenger acceleration sensor is fitted to the instrument panel reinforcement.

The rear acceleration sensor is fitted to the right roof side inner.

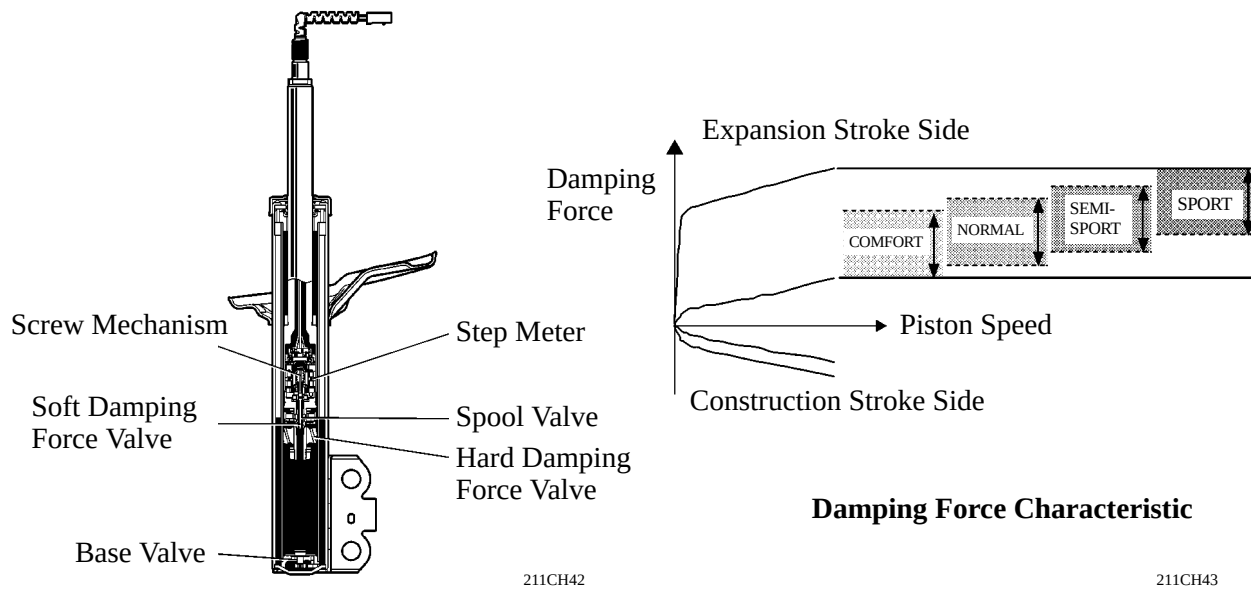


These sensors are the piezoresistive type. When the vehicle accelerates, a piezoresistive sensor deflects, thus changing its resistance. The resistance is then converted into an electrical signal in order to output a voltage that is proportionate to the acceleration rate.

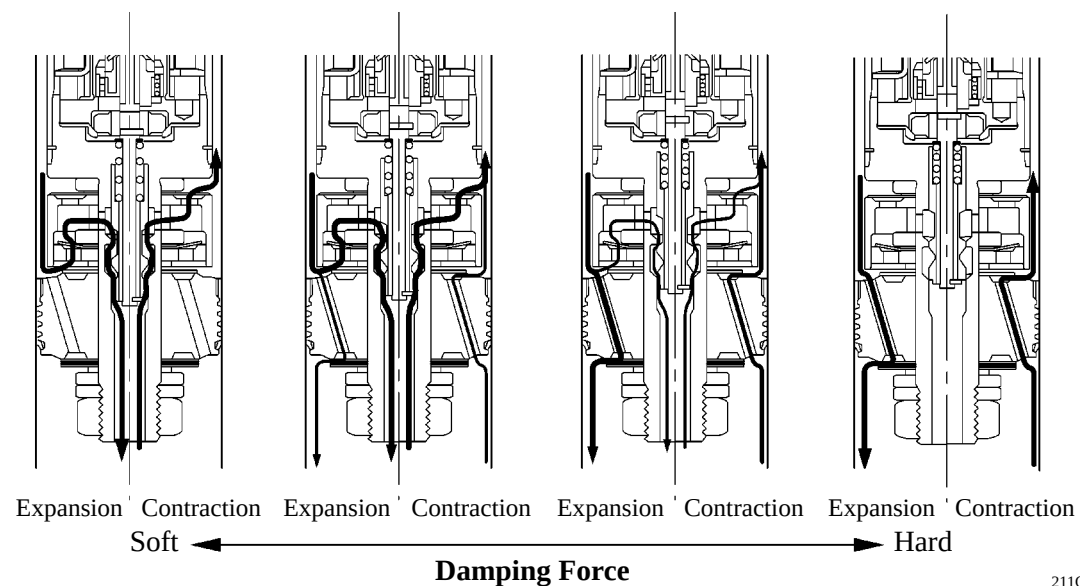


Front and Rear Shock Absorber

- The basic construction and operation of the shock absorbers on the '02 ES300 are the same as those of the '01 ES300. However, the damping force of the shock absorbers has been changed for the '02 ES300.
- The piston rod of the shock absorber is equipped with an internal actuator. The actuator consists of a step motor, a screw mechanism (which converts the rotational movement to a linear movement) and a spool valve. Also, the piston rod is equipped with a soft damping force valve and a hard damping force valve.
- Signals from the absorber control ECU activate the actuator causing the spool valve to switch the oil passage. Thus, the volume of oil that passes through each valve is varied in order to control the damping force in 16 steps.



► Flow of Oil ◀

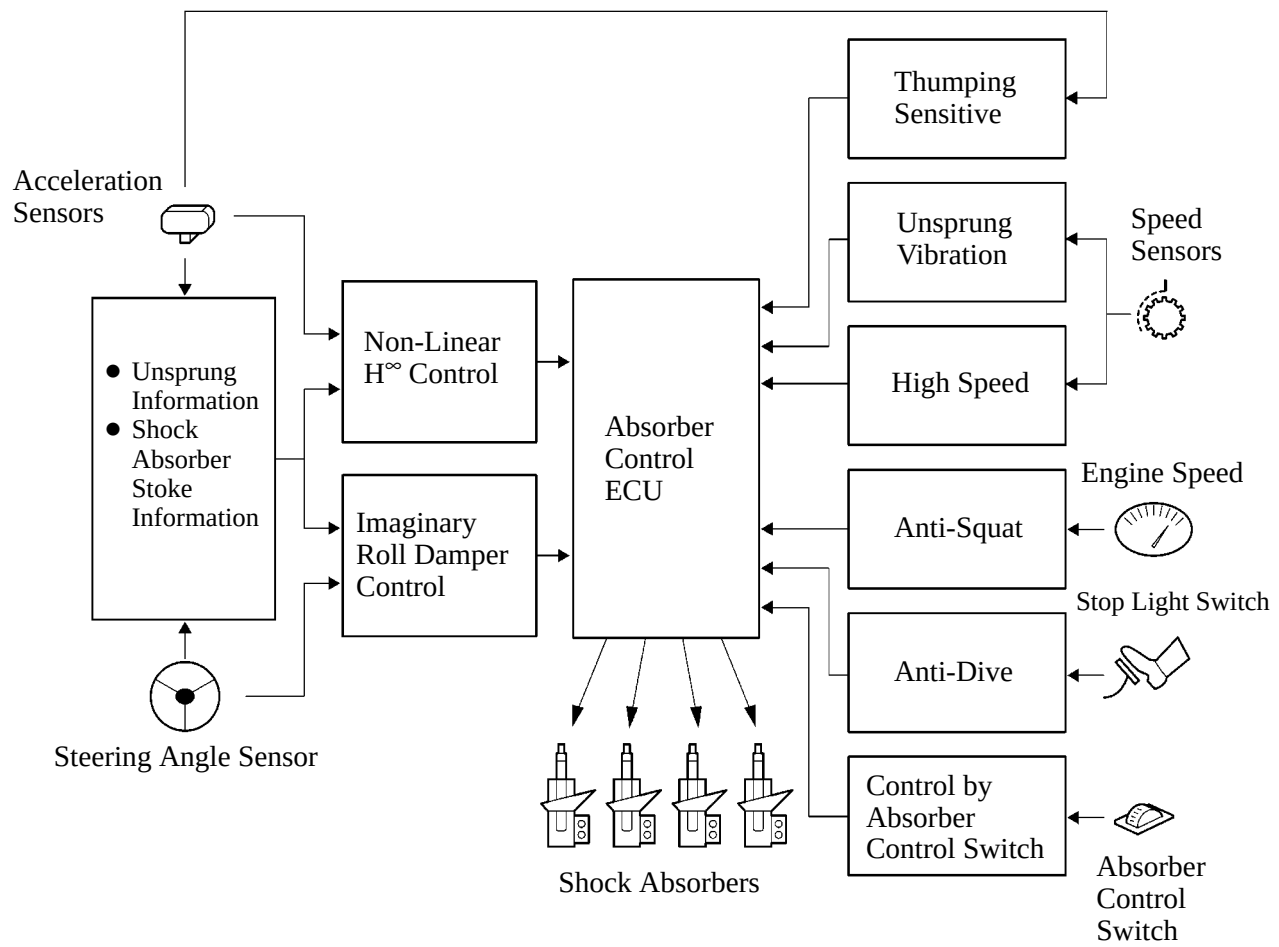


7. Electronic Modulated Suspension System Control

General

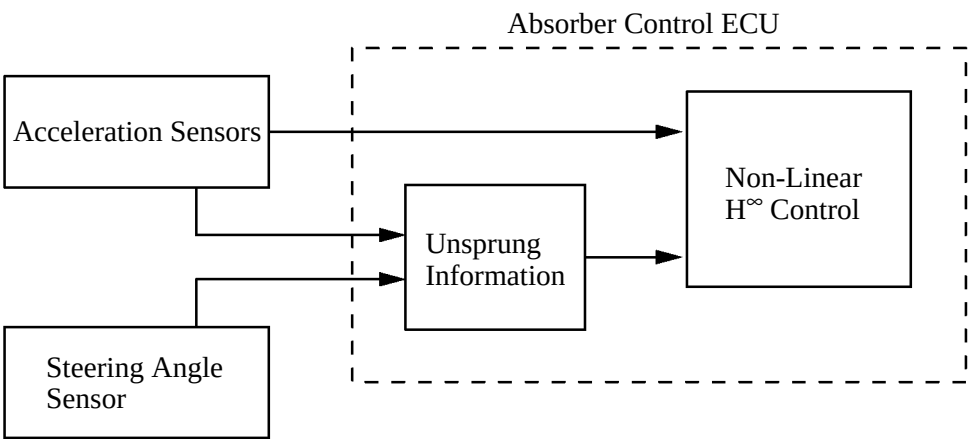
The electronic modulated suspension system of '02 ES300 and '01 ES300 are compared below.

Control		Function	'02 ES300	'01 ES300
Semi-Active Control	Non-Linear H^∞ Control	Smoothly changes the damping force to a target value in accordance with the changes in the road surface or driving conditions. Thus, excellent ride comfort has been realized while ensuring a level of vibration damping performance that is higher than the sky-hook control of the '01 ES300.	○	—
	Sky-Hook Control	Changes the damping force to a target value in accordance with the changes in the road surface or driving conditions. Thus, excellent ride comfort has been realized while ensuring a high level of vibration damping performance.	—	○
Thumping Sensitive Control		When the road surface condition does not require a damping force, this function controls the shock absorbers so that their damping force will not increase.	○	○
Unsprung Vibration Control		If unsprung resonance is detected, this function controls so that the damping force will not decrease below a certain level, in order to reduce the unsprung resonance.	○	○
Imaginary Roll Damper Control		Changes the damping force to control the vehicle posture during cornering. As a result, excellent stability and controllability have been realized during cornering.	○	—
Anti-Roll Control		During cornering, this function makes the damping force firmer, thus restraining the body roll speed in order to realize excellent stability and controllability.	—	○
Anti-Dive Control		During braking, this function makes the damping force firmer to restrain the body dive, thus ensuring excellent stability and controllability.	○	○
Anti-Squat Control		During acceleration, this function makes the damping force firmer to minimize the changes in the vehicle body posture.	○	○
High Speed Control		This function varies the variable range of the damping force according to vehicle speed in order to realize a soft and comfortable ride and a stable driving condition. The damping force is controlled at a softer variable range at low speeds, and at a firmer variable range at high speeds.	○	○
Control by Absorber Control Switch		The absorber control switch enables the driver to select a desired damping force from the 4 modes.	○	○
Fail-Safe		When the absorber control ECU detected a malfunction, the control of the damping force will be limited.	○	○
Diagnosis		When the absorber control ECU detects a malfunction, the absorber control ECU makes a diagnosis and memorizes the failed section.	○	○

Control Diagram

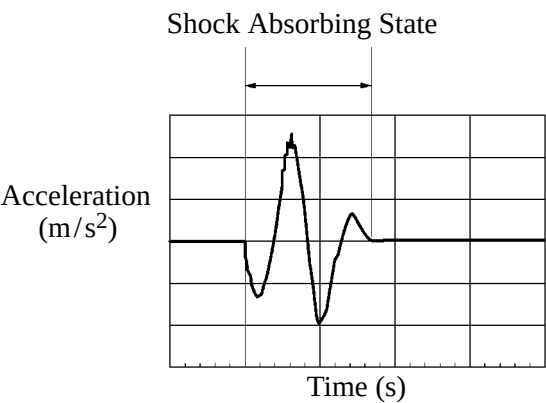
Semi-Active Control (Non-Linear H^∞ Control)

- To effect this control, the unsprung information is calculated based on the sprung acceleration rate from the 3 acceleration sensors and the information from the steering angle sensor. Thus, the driving conditions of the vehicle are detected.



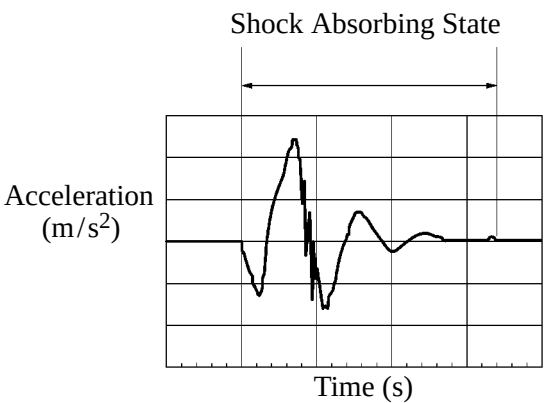
211CH46

- This control smoothly changes the damping force to a target value in accordance with the changes in the road surface or driving conditions. Thus, excellent ride comfort has been realized while ensuring a high level of vibration damping performance.



'02 ES300
(Non-Linear H^∞ Control)

189CH51

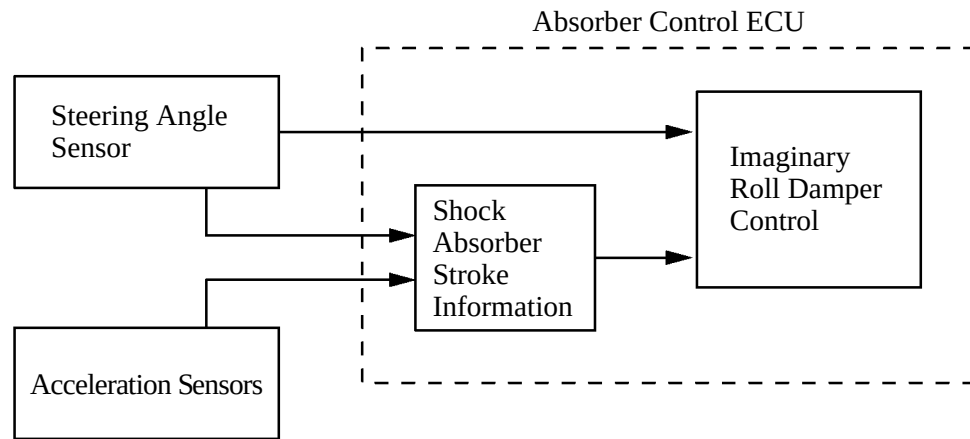


'01 ES300
(Sky-Hook Control)

189CH52

Imaginary Roll Damper Control

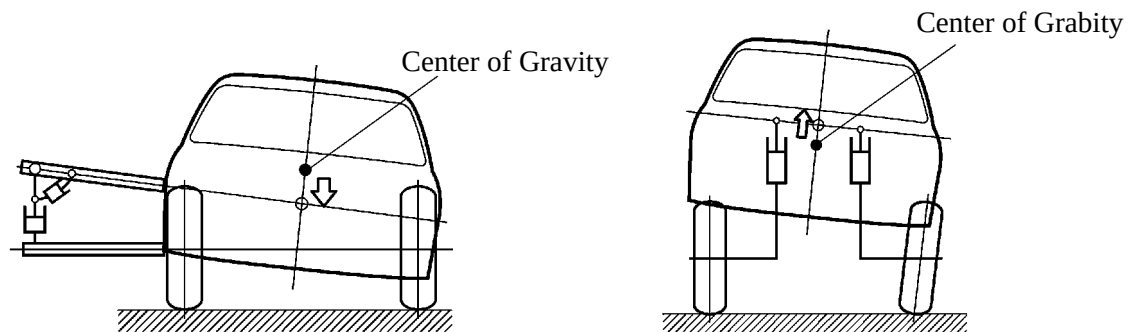
- To effect this control, the stroke information of the shock absorbers is calculated based on the information from the 3 acceleration sensors and a steering angle sensor. Thus, the driving conditions of the vehicle are detected.



211CH46

- Changes the damping force to control the vehicle posture during cornering. As a result, excellent stability and controllability have been realized during cornering. This control assumes that two types of shock absorbers, (one for restraining roll and the other for restraining lift) are provided at an imaginary point on the inside of the turn of the vehicle. The function of these shock absorbers is to prevent the center of gravity of the vehicle from rising.

The damping force of the front and rear shock absorbers is controlled in order to control the vehicle's posture as in this imaginary condition.



'02 ES300

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'01 ES300

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Diagnosis

When the absorber control ECU detected a malfunction, the absorber control ECU makes a DTC (Diagnosis Trouble Code) of that malfunction is stored in memory.

– Changes –

- The method for erasing the DTCs has been changed as follows (the DTCs on the '01 ES300 were erased by turning the ignition switch OFF):
Using the SST (09843-18040), short terminals Tc and CG of DLC3. Turn the ignition switch ON, and press the brake pedal 8 or more times within approximately 5 seconds.
- The DTCs can also be erased through the use of a hand-held tester.
- The DLC1 has been discontinued.
- M-OBD (Multiplex On-Board Diagnosis) system has been adopted. This system can output 5-digit DTC to the hand-held tester, which are more detailed than the previous 2-digit DTC.

► DTC Chart ◀

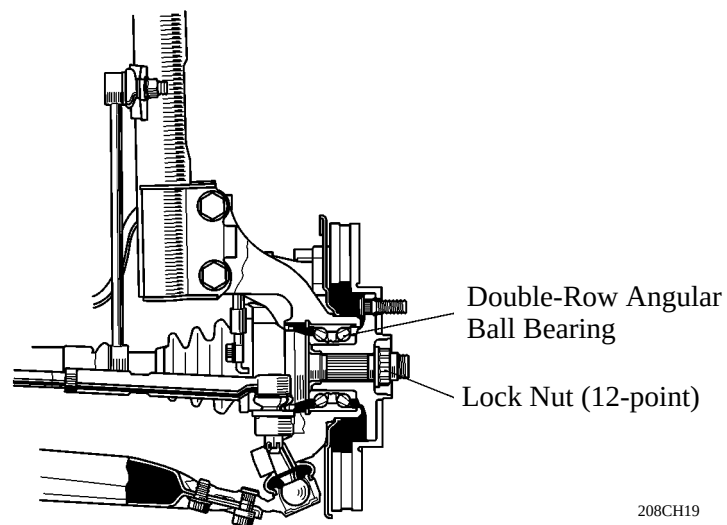
DTC No.	Detection Item	DTC No.	Detection Item
C1715/15	Front driver acceleration sensor malfunction	C1777/77	Steering angle sensor signal malfunction
C1716/16	Front passenger acceleration sensor malfunction	C1779/79	Engine speed signal malfunction
C1717/17	Rear acceleration sensor malfunction	C1782/82	Stop light switch signal does not input
C1725/21	Short/open circuit in front right absorber control actuator circuit	C1787/87	Absorber control switch signal malfunction
C1726/22	Short/open circuit in front left absorber control actuator circuit	C1791/91	Front driver acceleration sensor malfunction
C1727/23	Short/open circuit in rear right absorber control actuator circuit	C1792/92	Front passenger acceleration sensor malfunction
C1728/24	Short/open circuit in rear left absorber control actuator circuit	C1793/93	Rear acceleration sensor malfunction
C1774/74	Low battery positive voltage or abnormally high positive voltage	C1794/94	Front right speed sensor malfunction
C1776/76	Vehicle speed sensor signal malfunction	C1797/97	Engine speed signal malfunction

Refer to the 2002 LEXUS ES300 Repair Manual (Pub. No. RM 911U).

■ AXLE

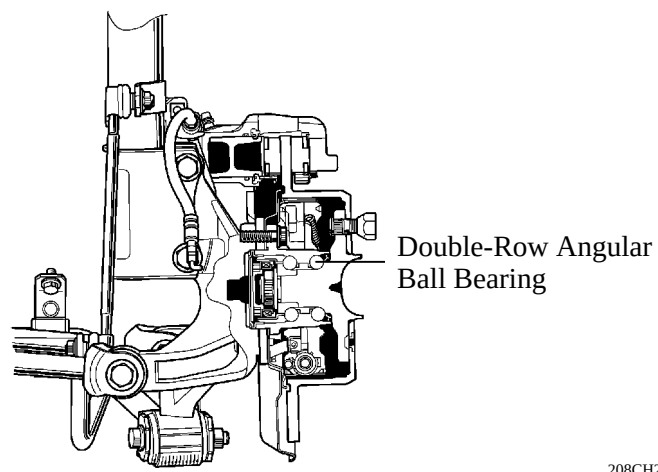
1. Front Axle

- The front axle use a double-row angular ball bearing which offers low rolling resistance.
- A lock nut (12-point) has been adopted and staked for tightening the axle hub in order to ensure the tightening performance.
This nut cannot reused.
- A lead-free material is used in the front axle hub to address environmental concerns.



2. Rear Axle

- The rear axle use a double-row angular ball bearing which offers low rolling resistance.
- Part of the inner race is integrated with the shaft, thus optimizes the high rigidity.

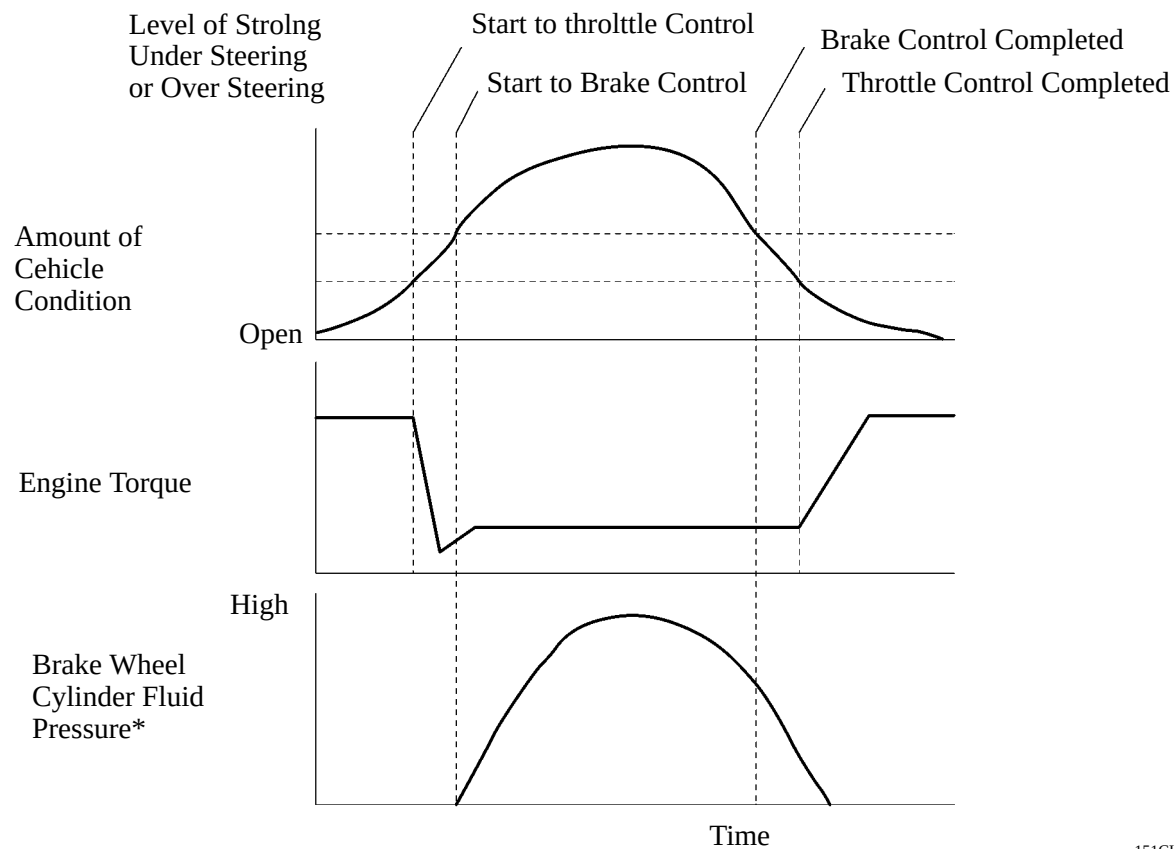


9. Skid Control ECU

VSC

Based on the 4 type of sensor signals received from the speed sensors, yaw rate sensor, deceleration sensor and steering sensor, the skid control ECU calculates the amount of vehicle condition.

If a strong understeer or oversteer tendency is created during an emergency avoidance maneuver or cornering, and the skid control ECU determines that the amount of vehicle condition exceeds a prescribed value, it controls the engine torque through throttle and the brake fluid pressure according to the amount of the vehicle condition.



151CH31

*: The wheel cylinder that activates varies depending on the condition of the vehicle.

Initial Check

After the ignition is turned ON, and the vehicle attains an approximate speed of 6 km/h (4 mph) or more only at first time, the skid control ECU performs the initial check.

The functions of each solenoid valve and pump motor in the brake actuator are checked in order.

Self-Diagnosis

- If the skid control ECU detects a malfunction in the ABS with EBD, Brake Assist, TRAC, and VSC systems, the ABS, brake system, VSC warning lights and TRAC OFF indicator light that corresponds to the function in which the malfunction has been detected indicates or lights up, as indicated in the table below, to alert the driver of the malfunction.

○: Light ON —: Light OFF

Item	ABS	EBD	Brake Assist	TRAC	VSC	Skid Control ECU
ABS Warning Light	○	○	○	—	—	○
Brake System Warning Light	—	○	—	—	—	○
TRAC OFF Indicator Light	○	○	○	○	○	○
VSC Warning Light	○	○	○	○	○	○

- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be read by connecting the SST (09843-18040) between the Tc and CG terminals DLC3 and observing the blinking of the ABS warning light and VSC warning light, or by connecting a hand-held tester.
- This system has a sensor signal check function. The DTCs can be read by connecting the SST (09843-18040) between the Tc and CG terminals of DLC3 and observing the blinking of the ABS warning light and VSC warning light after check function, or by connecting a hand-held tester.
- The DLC1 has been discontinued.
- The following DTCs have been added to the ABS & Brake Assist & VSC system of the '01 ES300 model:

► Output by blinking ABS warning light ◀

DTC No.	Detection Item
C1235/35	Foreign matter is attached on the tip of the right front sensor
C1236/36	Foreign matter is attached on the tip of the left front sensor
C1238/38	Foreign matter is attached on the tip of the right rear sensor
C1239/39	Foreign matter is attached on the tip of the left rear sensor

► Output by blinking VSC warning light ◀

DTC No.	Detection Item
C1335/35	Malfunction in steering angle sensor input circuit
C1336/39	Zero point calibration of deceleration sensor undone
C1261/61	Malfunction in master cylinder pressure sensor

- The C1207/37, C1208/72, and C1228/28 DTCs have been discontinued to the TRAC system of the previous model.

For details on the DTCs that are stored in skid control ECU memory and the DTCs that are output through the sensor check function, see the 2002 LEXUS ES300 Repair Manual (Pub. No. RM911U).

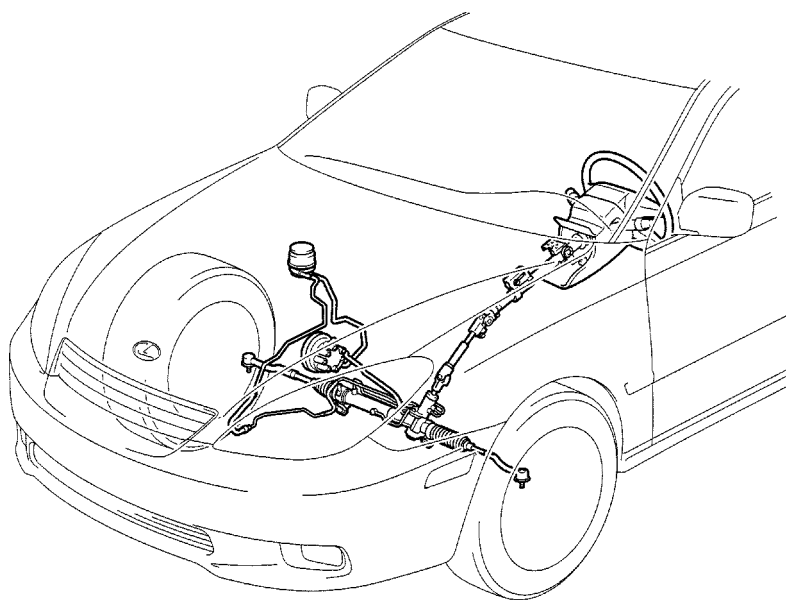
Fail-Safe

- In the event of a malfunction in the TRAC and/or VSC, the skid control ECU prohibits the TRAC and VSC operations.
- In the event of a malfunction in the ABS and/or Brake Assist, the skid control ECU prohibits the ABS with EBD, Brake Assist, TRAC, and VSC operations.
- In the event of the malfunction in the EBD control, skid control ECU prohibits the EBD control. Thus, the brake and throttle valve opening angle control will be opened in the same condition as in the condition without the ABS with EBD, Brake Assist, TRAC, VSC.

STEERING

■ DESCRIPTION

- As in the previous models, a rack and pinion type steering gear and an engine revolution sensing type power steering are used on all model.
- The power steering vane pump on '02 ES300 has newly adopted a pressure return type vane pump which makes the discharge pressure flow volume return at middle and high speed, thus secured the fine steering feeling.
- The stepless tilt steering is used on all models.
- The steering column has adopted an energy absorbing mechanism that uses energy absorbing plate.



211CH32

► Specification ◀

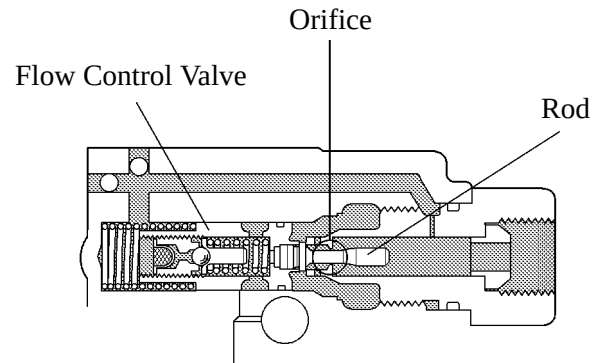
Gear Ratio (Overall)		16.0
No. to Turns Lock to Lock		3.06
Rack Stroke	mm (in.)	149.0 (5.87)
Fluid Type		ATF Type DEXRON® II or III

■ POWER STEERING VANE PUMP

1. Construction

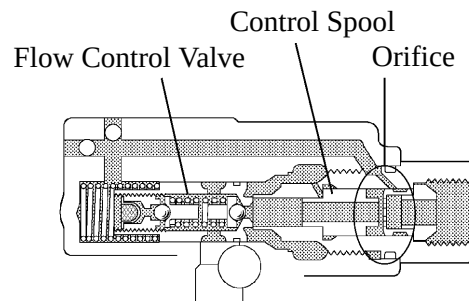
In this pump, the control spool to control the pump flow volume in the middle and high range of the pump speed has been discontinued and a rod for the flow control valve which decides the flow volume opening area has been established instead.

Other basic structure and operation are the same as '01 ES300.



208CH39

'02 ES300

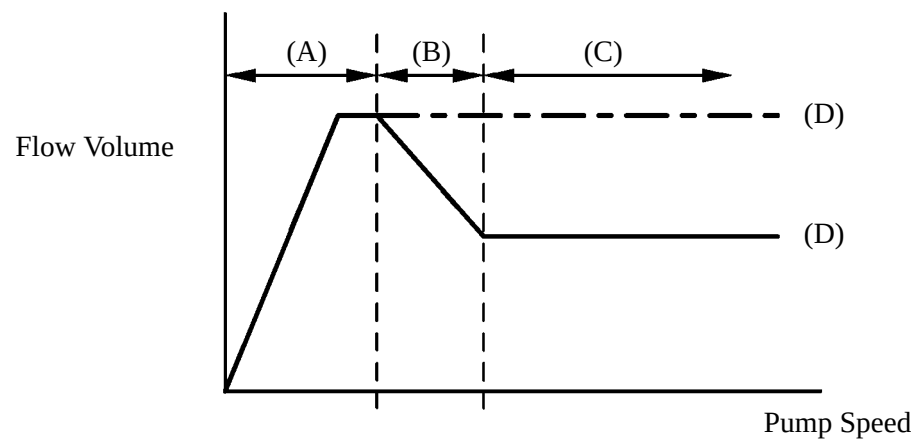


208CH38

'01 ES300

2. Operation

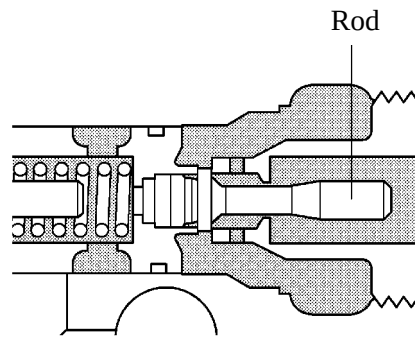
► Flow Volume Characteristics ◀



208CH45

Low Speed Range (A)

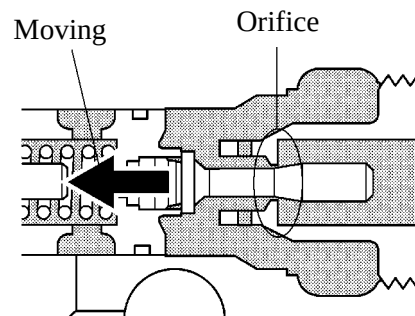
Flow volume increases in accordance with the increase of pump speed.



208CH41

Middle Speed Range without Steering (B)

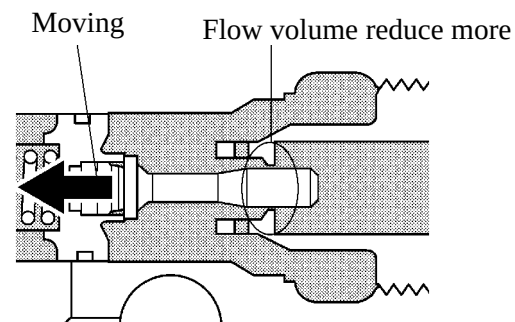
The flow control valve moves to the left and reduces the flow volume by drawing the orifice according to the change of the shaft diameter of the rod.



208CH42

High Speed Range without Steering (C)

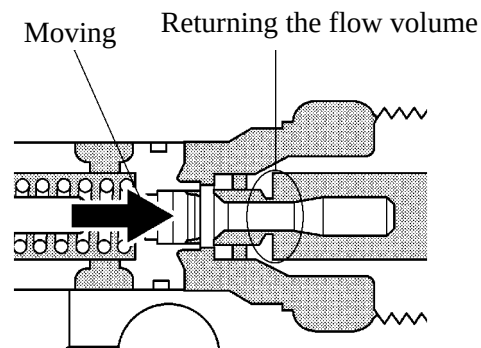
The flow control valves moves further left and with the maximum shaft diameter of the rod, the flow volume reduces more.



208CH43

During Pressure Loading (D → D')

If operating the steering in the middle and high speed range, the flow control valve moves to the right according to the pressure increase of the vane pump resulting in opening the orifice and returning the flow volume.



208CH44

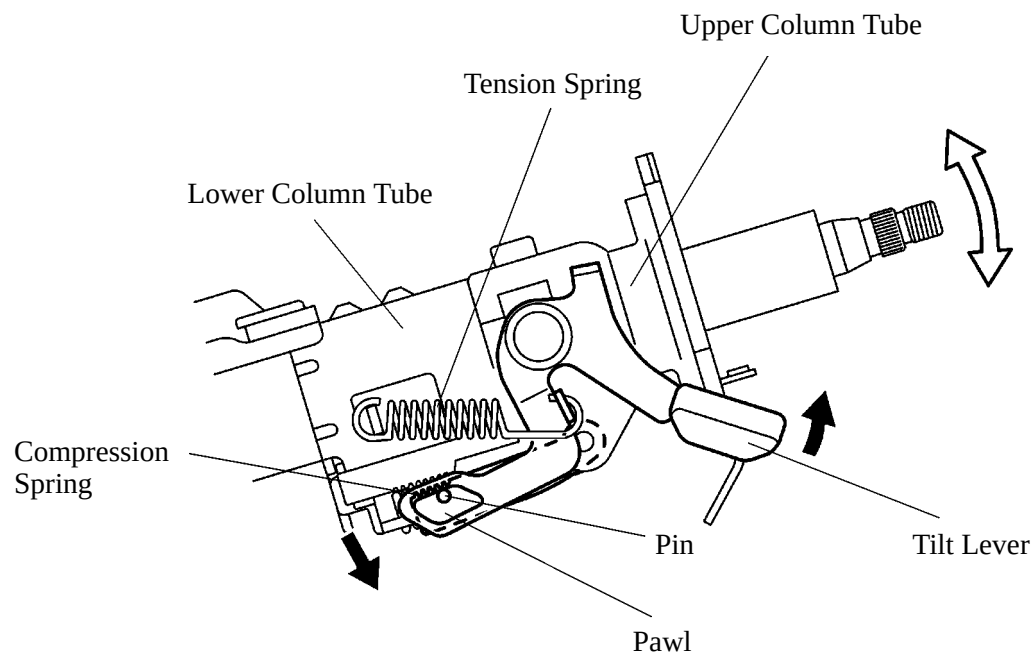
■ TILT STEERING

The tilt mechanism consists of a tilt lever, pawl, upper column tube, lower column tube, tension spring and compression spring.

A hole is provided at the tip of the tilt lever, into which the pawl pin is inserted.

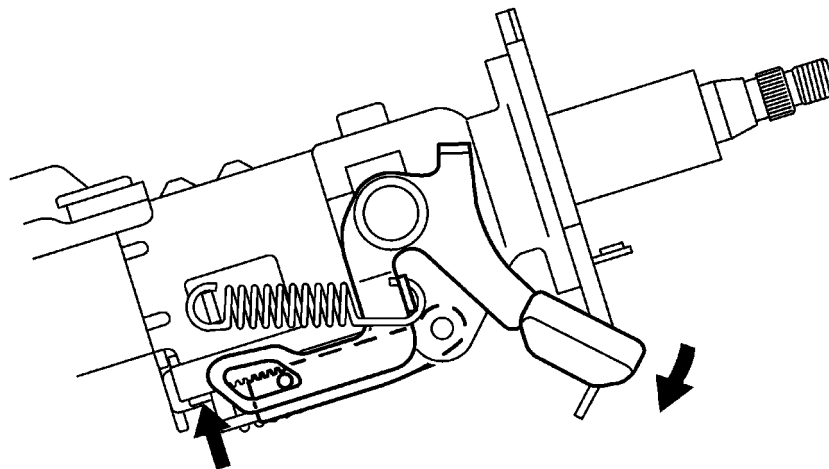
Because the pawl pin is inserted into the hole at the tip the lever, moving the tilt lever causes the pawl to move downward. As a result, the ratchet of the lower column tube and the ratchet of the pawl disengage from each other to release the tilt lock.

Releasing the tilt lever causes the lever (which is under spring tension) to return. Accordingly, the pawl is pushed upward, causing the ratchet of the column tube and the ratchet of the pawl to engage with each other, thus locking the tilt lock.



Free

211CH52



Lock

211CH53

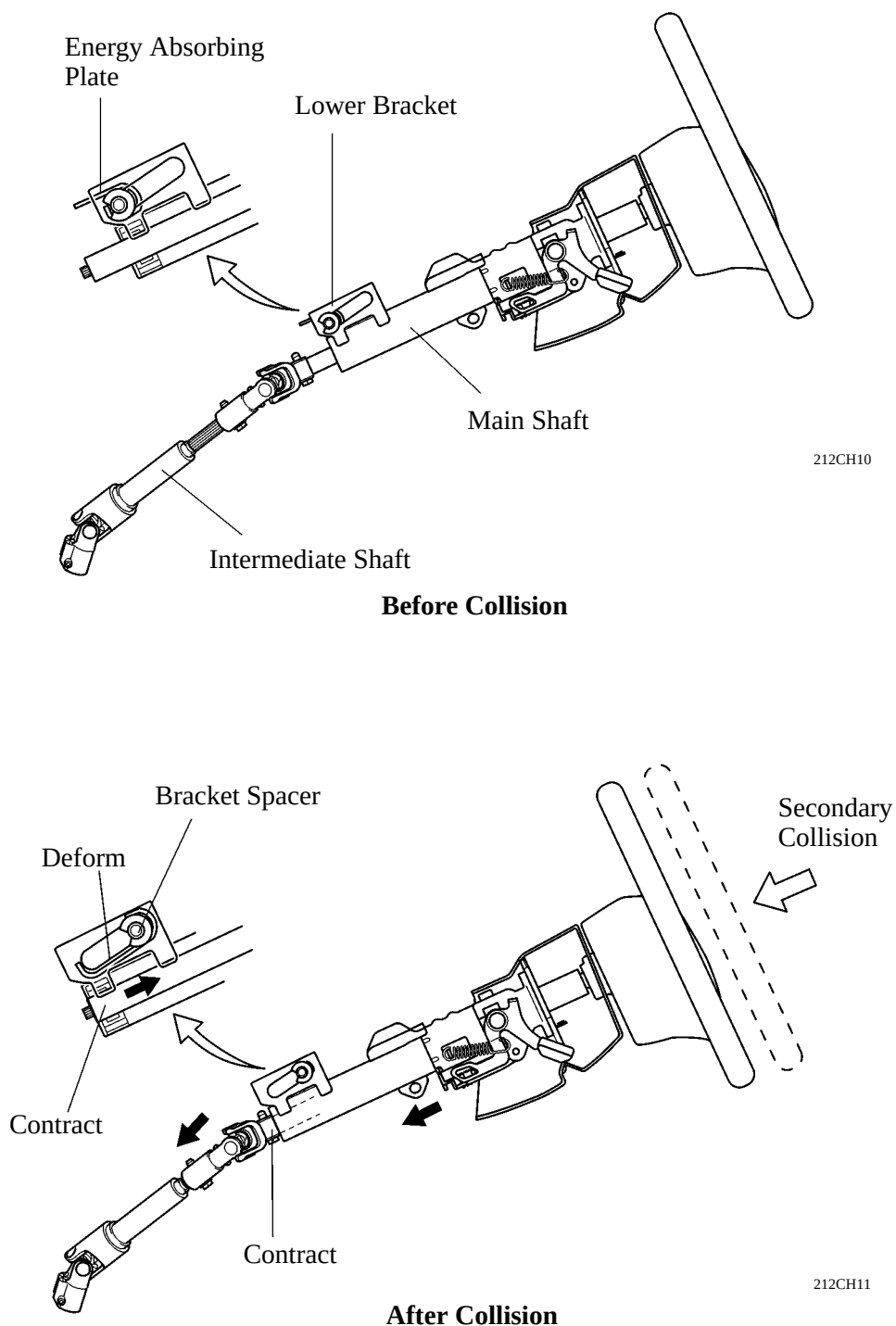
■ ENERGY ABSORBING MECHANISM

The energy absorbing mechanism mainly consists of a lower bracket, energy absorbing plate, contractile main shaft and contractile intermediate shaft.

When an impact is transmitted to the steering wheel in a frontal collision (secondary collision), the lower bracket and the bracket spacer, causing the entire steering column to move forward.

At the same time, the energy absorbing plate in the lower bracket is deformed by the bracket spacer to and helps absorb the impact of the secondary collision.

Furthermore, the amount of forward movement of the entire steering column is absorbed by the contraction of the main shaft and the intermediate shaft.

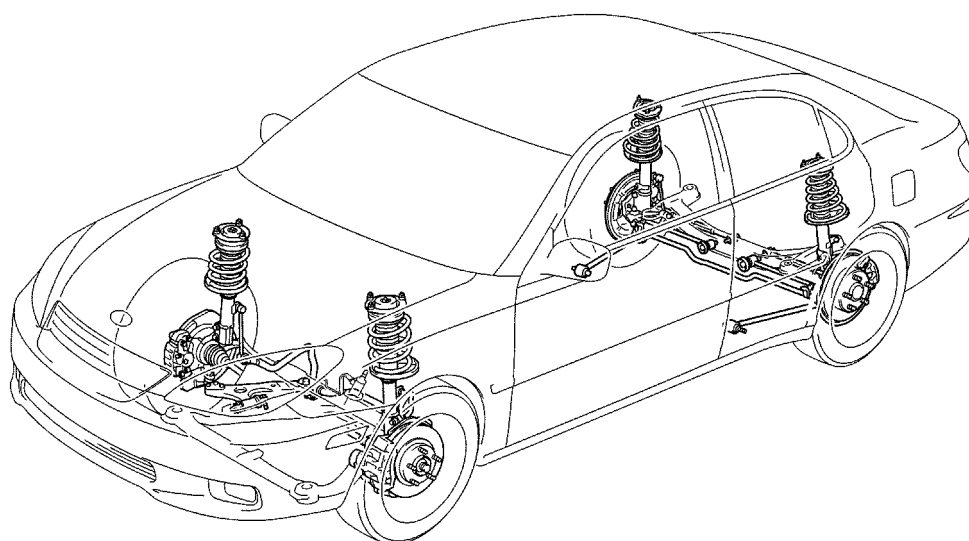


SUSPENSION AND AXLE

■ SUSPENSION

1. General

- A MacPherson strut type independent suspension has been adopted for the front.
- A dual link MacPherson strut type independent suspension has been adopted for the rear.
- An electric modulated suspension is optional equipment.



211CH18

► Specification ◀

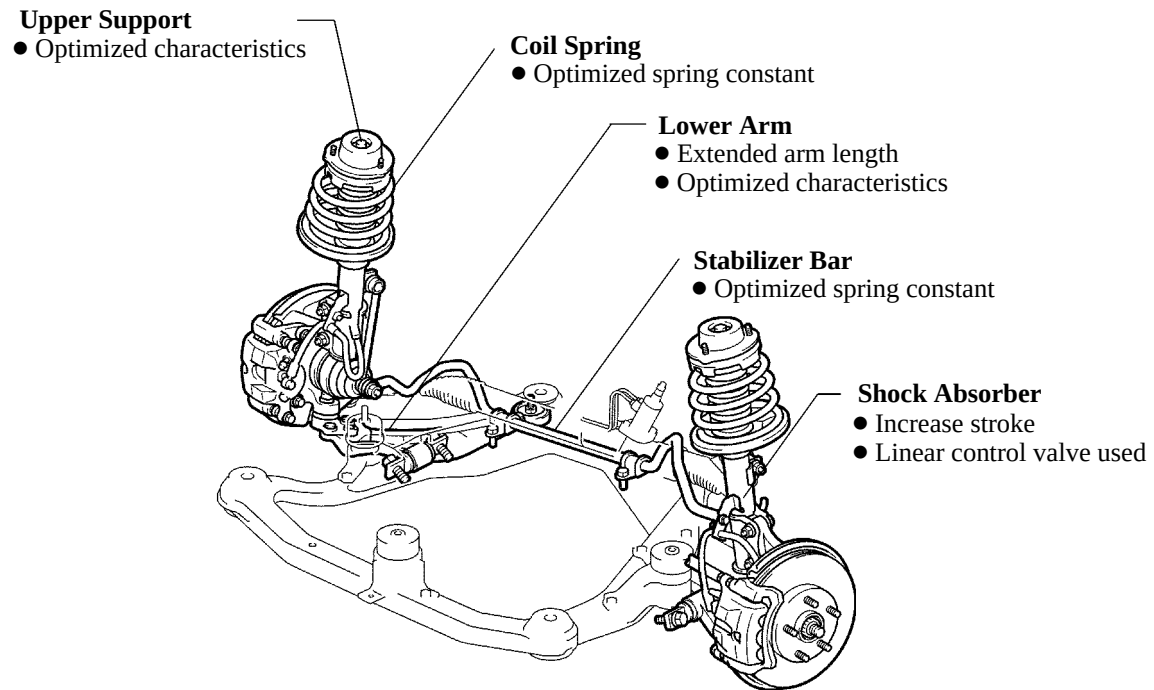
Front Suspension*	Tread	mm (in.)	1549 (70.0)
	Caster	degrees	2° 46'
	Camber	degrees	-0° 43'
	Toe-in	mm (in.)	0
	King Pin Inclination	degrees	11° 27'
Rear Suspension*	Tread	mm (in.)	1535 (60.4)
	Camber	degrees	-1° 23'
	Toe-in	mm (in.)	4 (0.16)

*: Unload Vehicle Condition

2. Front Suspension

General

Through the optimal allocation of components, and the adoption of the nachlauf geometry, the front suspension realizes excellent riding comfort and controllability.



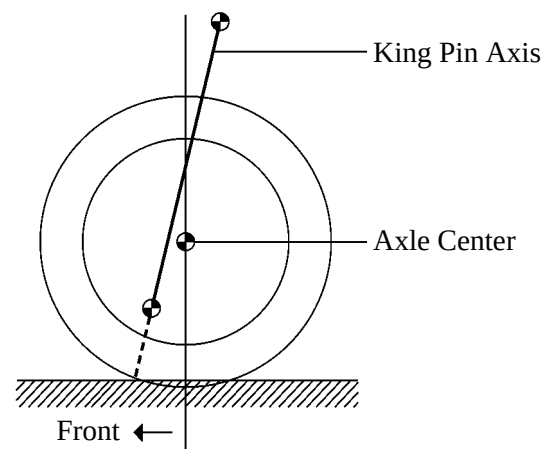
211CH56

Service Tip

To prevent hazardous conditions, make sure to empty the gas from the shock absorber before discarding a low-pressure (N₂) gas sealed shock absorber. For details, refer to the 2002 LEXUS ES300 Repair Manual (Pub. No. RM911U).

Nachlauf Geometry

The front suspension adopts the nachlauf geometry in which the king pin axis is located ahead of the axle carrier. As a result, excellent straightline stability has been realized and the steering feeling has been improved.

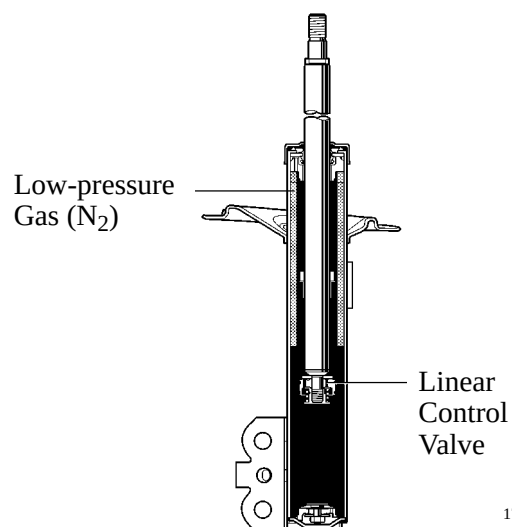


181CH22

Shock Absorber

1) General

Low-pressure (N_2) gas sealed front shock absorbers with a linear control valve have been adopted to realize both driving stability and riding comfort.

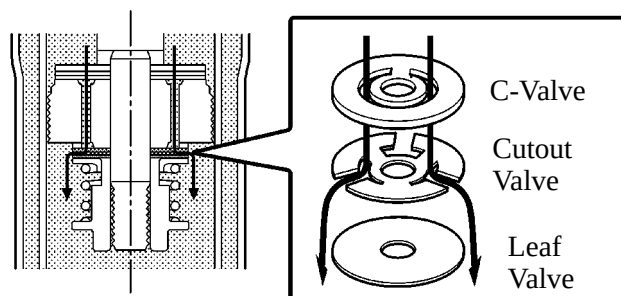


174CH03

2) Construction of Linear Control Valve

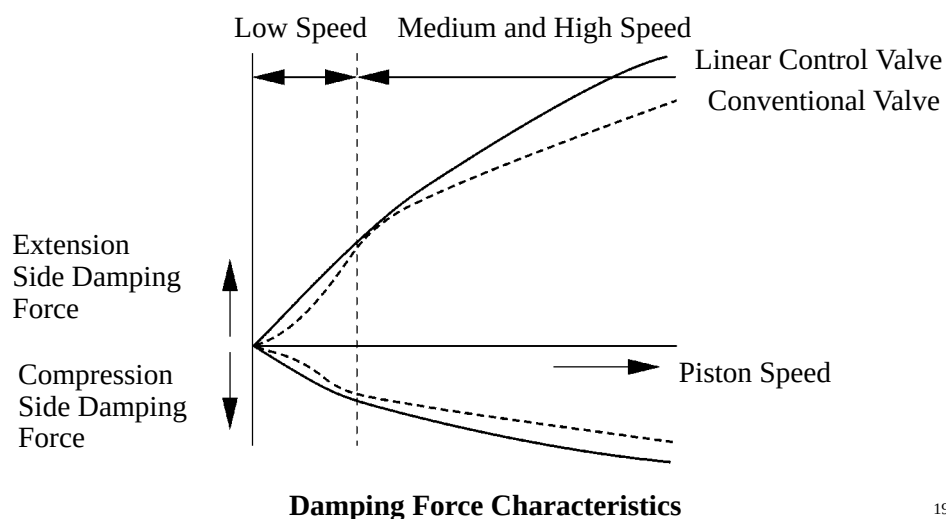
The linear control valve consists of a C-valve, a cutout valve and a leaf valve. These valves adopt a laminate construction and form orifices. At low piston speeds, the oil flows through the cutouts of the valves to achieve a linear damping force.

Through the adoption of the linear control valve, the changes in the damping force are made constant at low piston speeds, thus making the vehicle behave more smoothly in relation to the steering operation.



206CH29

Low Speeds



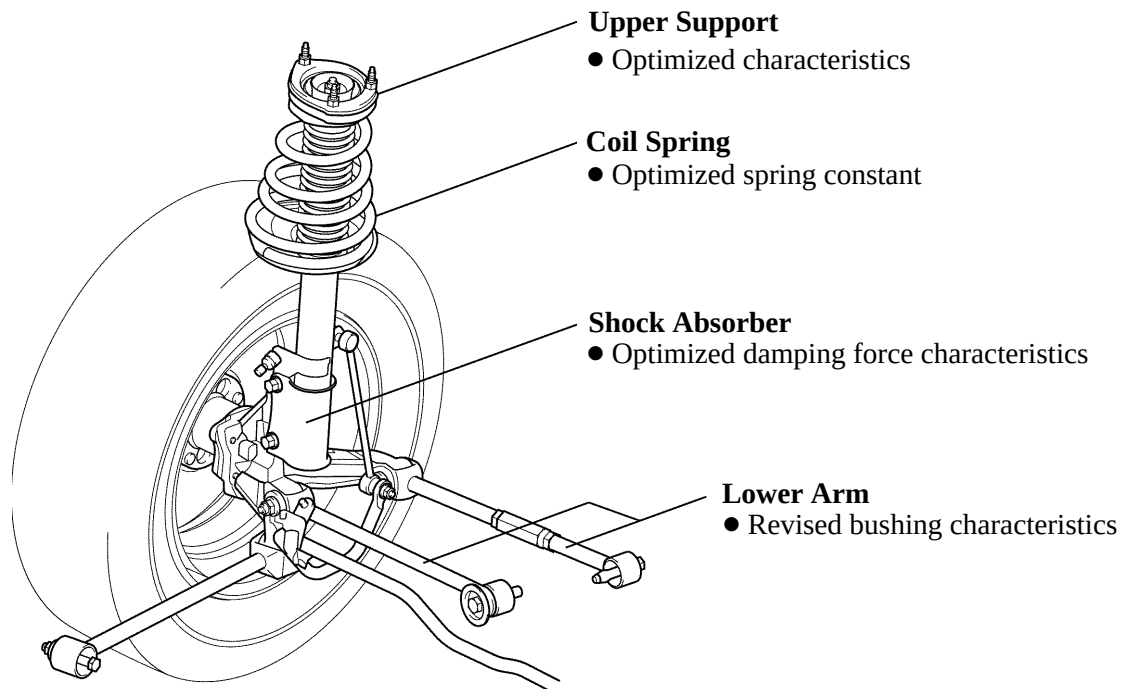
199CH110

3. Rear Suspension

General

Rear suspension realizes excellent stability and controllability by optimizing the suspension geometry and the allocation of components.

The wheel stroke has been increased to ensure stability and ride comfort on rough roads.



208CH16

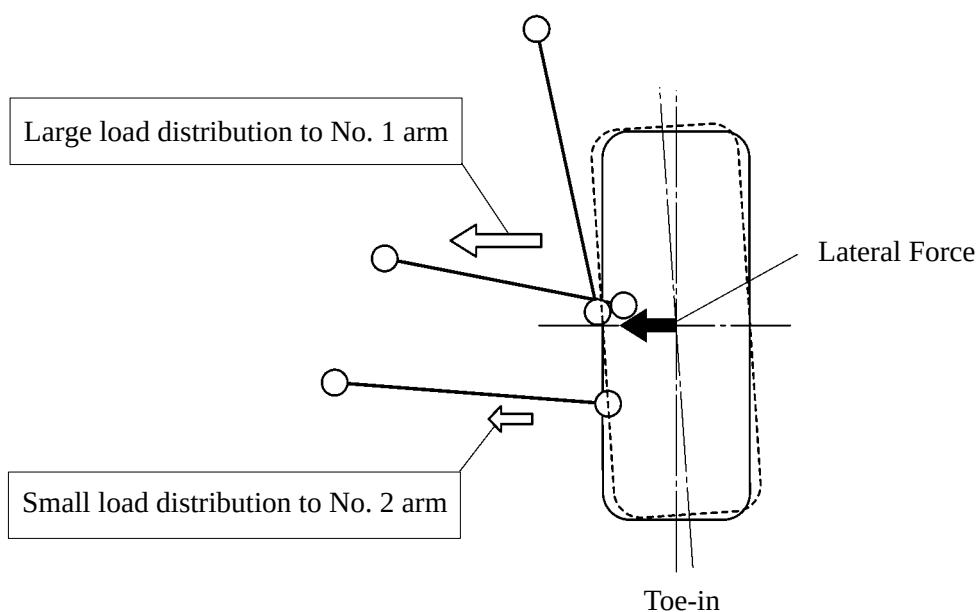
Service Tip

- To prevent hazardous conditions, make sure to empty the gas from the shock absorber before discarding a low-pressure (N₂) gas sealed shock absorber.
- Removal/installation of the height control sensor or replacement of the rear suspension will cause the height control sensor output to change on models equipped with the automatic headlight beam level control system. If any such work is done, perform initialization in order to store the value of the height control sensor output in the memory of the headlight beam level control ECU and adjust the aim of the headlight beam.

For details, refer to the 2002 LEXUS ES300 Repair Manual (Pub. No. RM911U).

Cornering Geometry

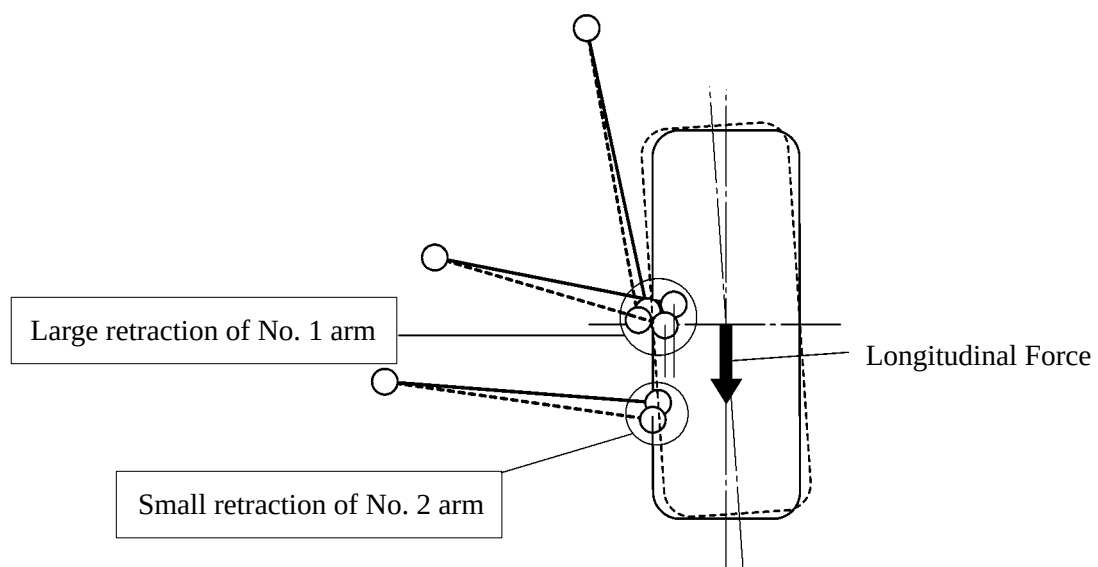
When a lateral force is generated, the load becomes distributed to the No. 1 and No. 2 suspension arms as shown below. This causes the wheels to toe-in, in order to ensure the proper stability of the rear suspension.



208CH18

Braking Geometry

When the longitudinal force is generated, the displacement locus of the No. 1 and No. 2 suspension arms will toe-in as shown below, in order to ensure the stability of the vehicle.



208CH17

PLANETARY GEAR UNIT

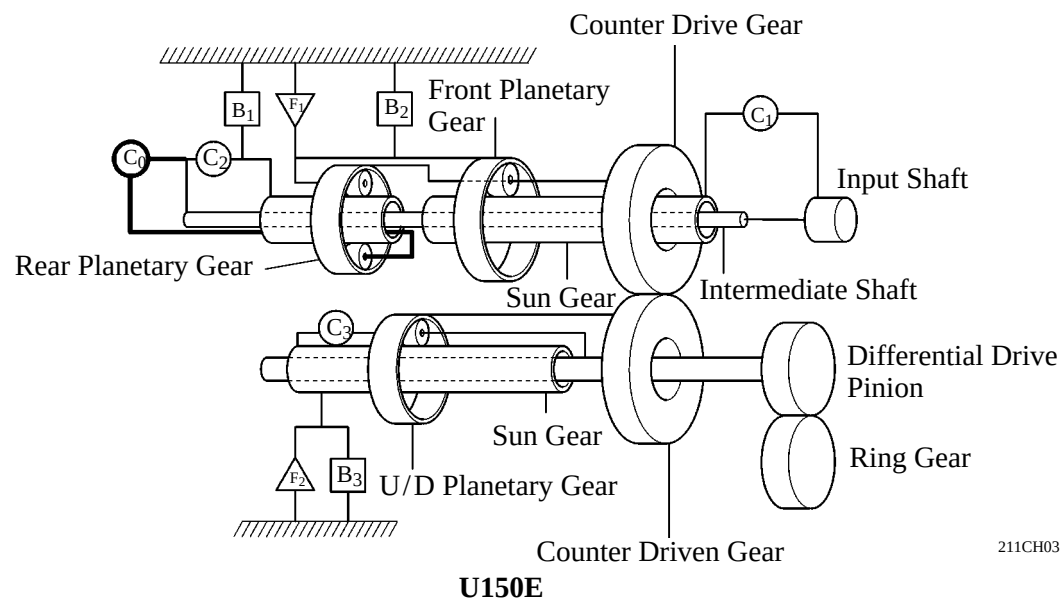
1. Construction

- The gear layout of the U150E A/T is the same as that of the U140E A/T.
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.

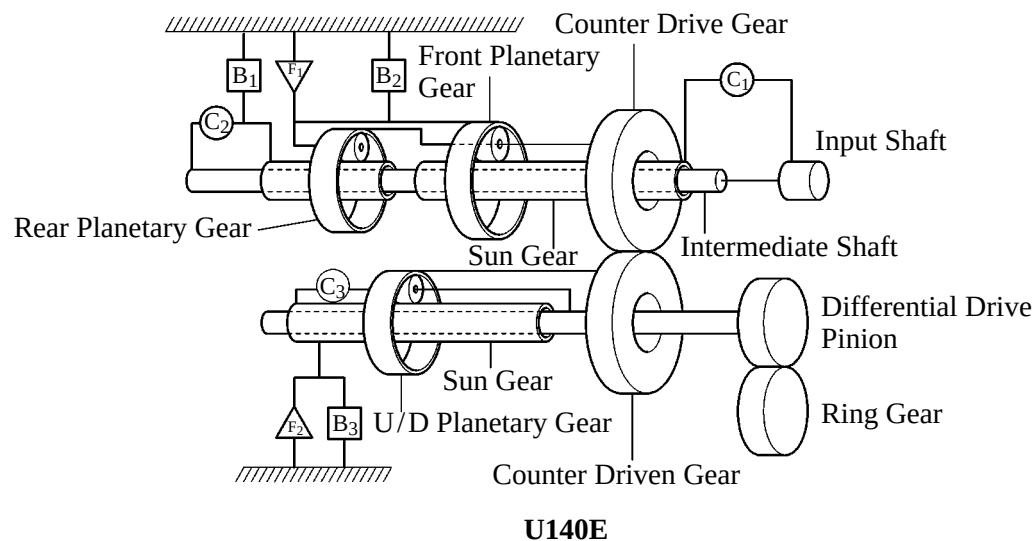
- A centrifugal fluid pressure canceling mechanism has been adopted in the C_0 , C_2 , C_3 , and C_1 clutches that are applied when shifting from 2nd to 3rd and from 3rd to 4th. For detail, refer to CH-12.

– Changes (from U140E) –

- Direct & O/D clutch (C_0) has been adopted.
- A centrifugal fluid pressure canceling mechanism has been adopted in the C_0 clutch that is applied when shifting from 4th to 5th.
- The operating gears for the C_2 clutch and the B_1 brake have been changed, and their names have been changed to the “reverse clutch” and “2nd & O/D brake”, respectively.



211CH03



208CH04

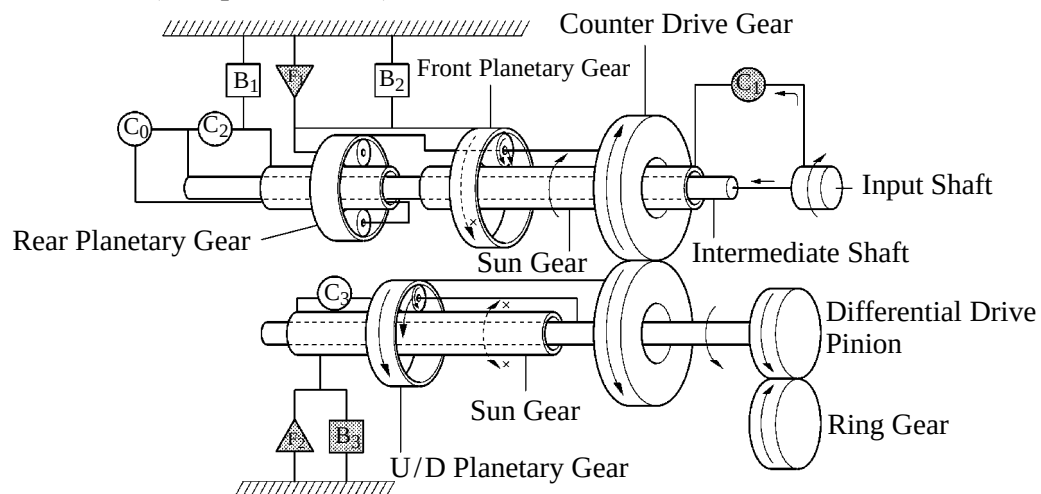
2. Function of Component

Component		Function	U150E	U140E
C ₁	Forward Clutch	Connects input shaft and front planetary sun gear.	○	○
C ₂	Direct Clutch	Connects input shaft and rear planetary sun gear.	—	○
	Reverse Clutch		○	—
C ₃	U/D Direct Brake	Connects U/D sun gear and U/D planetary carrier.	○	○
C ₀	Direct & O/D Clutch	Connects input shaft and rear planetary carrier.	○	—
B ₁	2nd Brake	Prevents rear planetary sun gear from turning either clockwise or counterclockwise.	—	○
	2nd & O/D Brake		○	—
B ₂	1st & Reverse Brake	Prevents rear planetary carrier from turning counterclockwise.	○	○
B ₃	U/D Brake	Prevents U/D planetary sun gear from turning clockwise.	○	○
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.	○	○

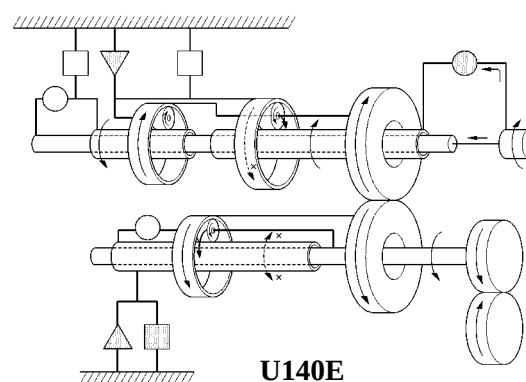
3. Motive Power Transaxle

Shift Lever Position	Gear	Solenoid Valve						Clutch				Brake			One-way Clutch	
		S4	SR	DSL	SL1	SL2	SL3	C ₀	C ₁	C ₂	C ₃	B ₁	B ₂	B ₃	F ₁	F ₂
P	Park				○	○								○		
R	Reverse				○	○				○			○	○		
N	Neutral				○	○								○		
D	1st				○	○			○					○	○	○
	2nd					○			○			○		○		○
	3rd		○	△	○	△		○	○					○		○
	4th		○	△		△	○	○				○		○		○
	5th	○	○	△		△	○	○			○	○				
4	1st				○	○			○					○	○	○
	2nd					○			○			○		○		○
	3rd		○	△	○	△		○	○					○		○
	4th		○	△		△	○	○				○		○		○
3	1st				○	○			○					○	○	○
	2nd					○			○			○		○		○
	3rd		○	△	○	△		○	○					○		○
2	1st				○	○			○					○	○	○
	2nd					○			○			○		○		○
L	1st			○	○	○			○				○	○	○	○

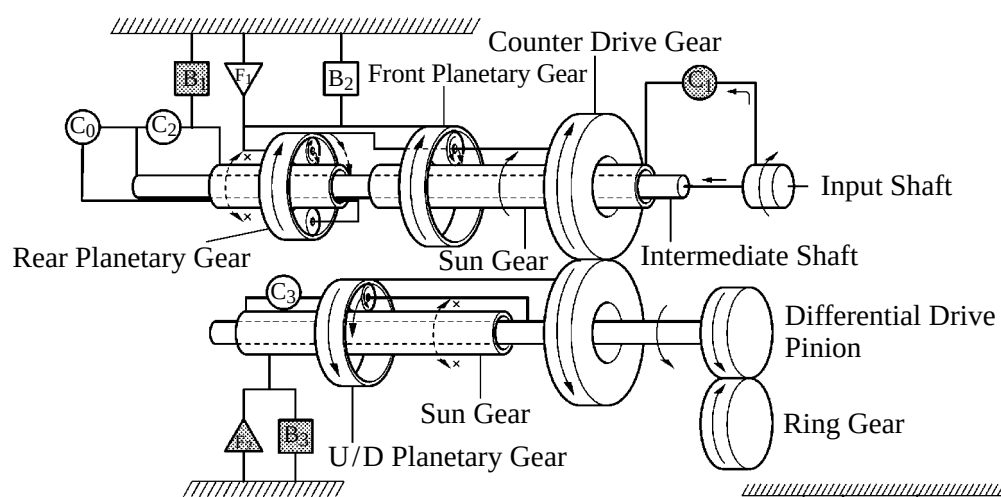
○: ON △: Lock-up ON

1st Gear (Except L Position)**U150E**

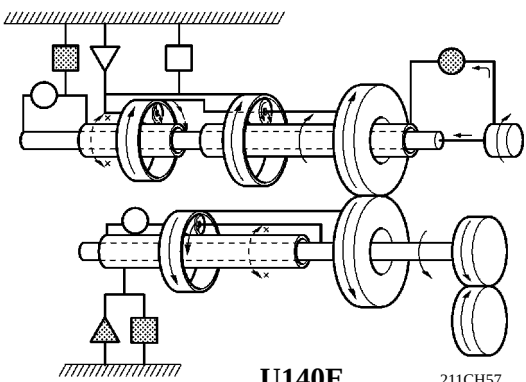
211CH04



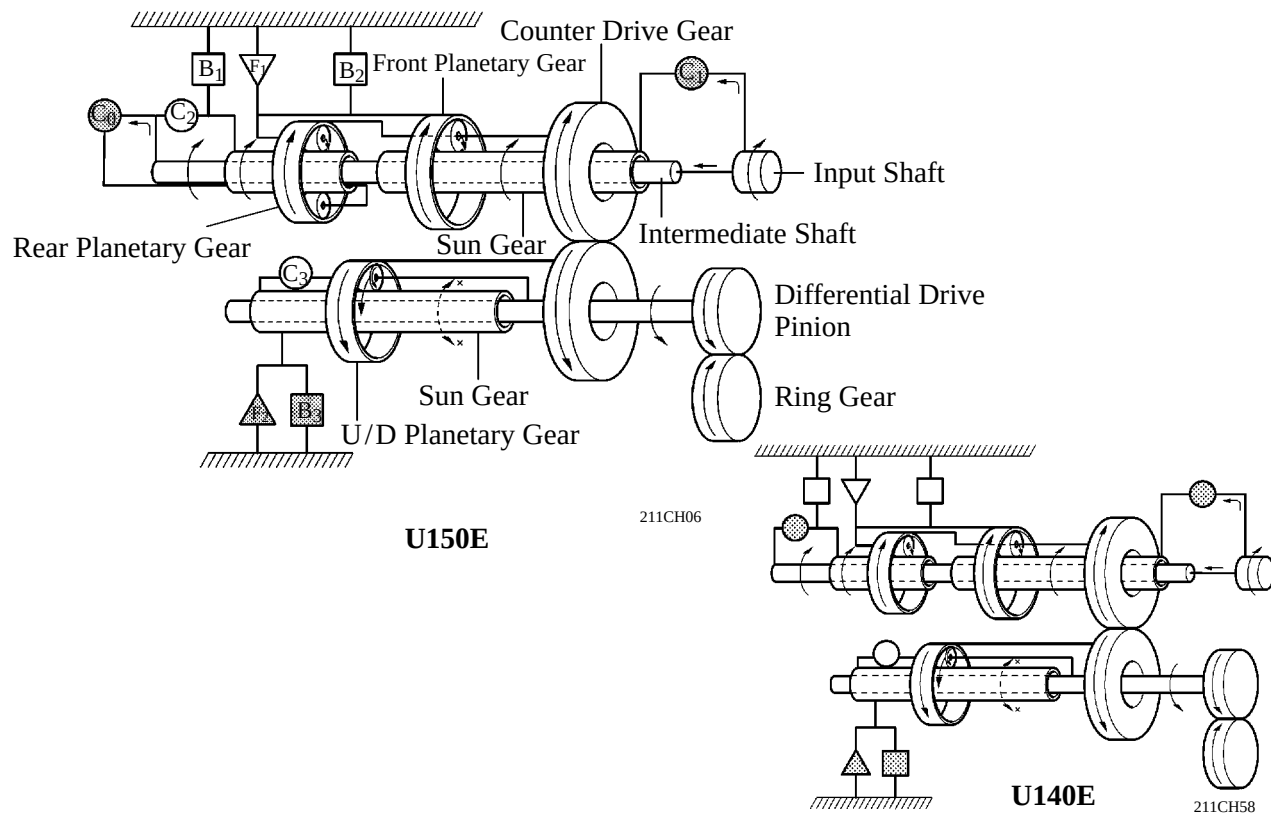
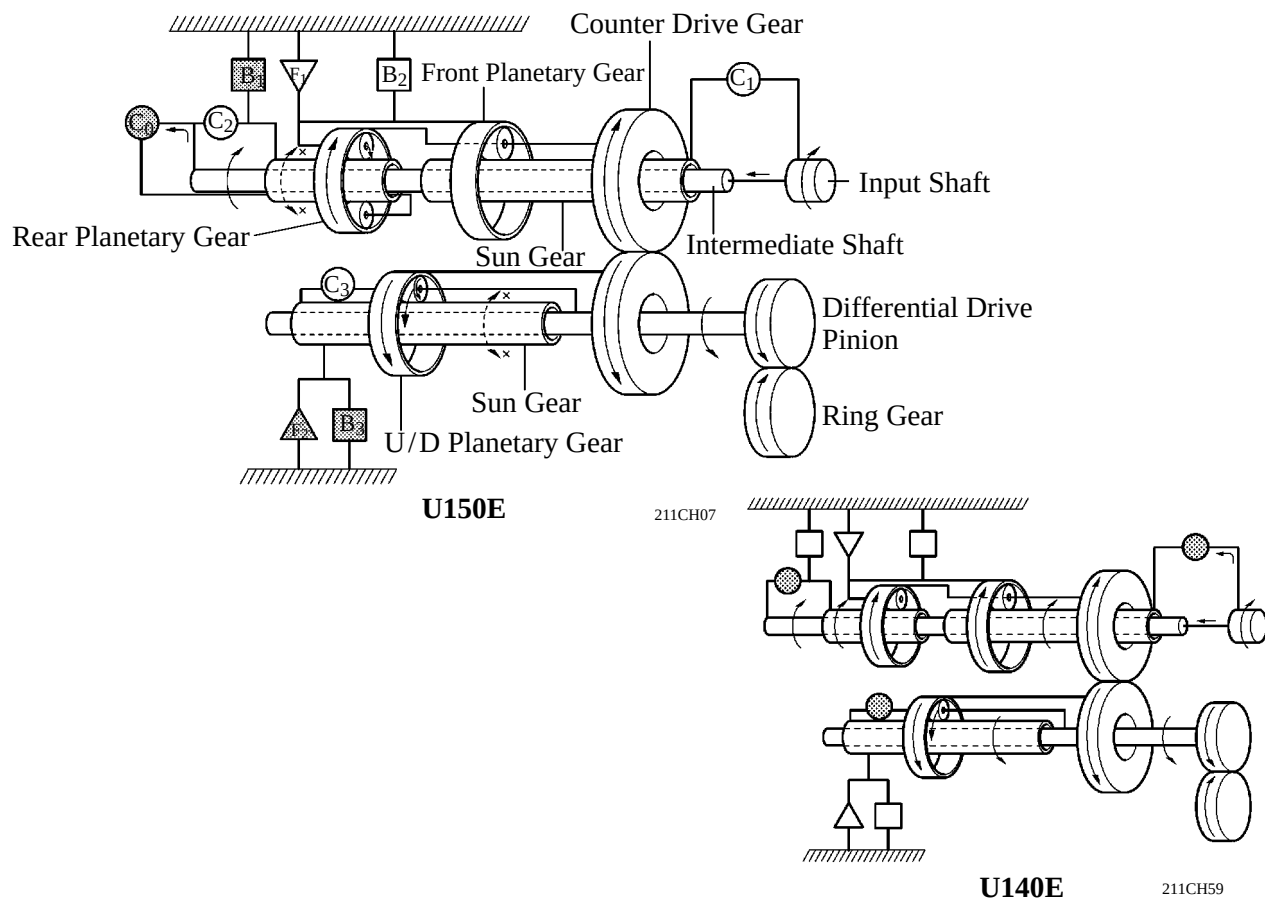
161ES09

2nd Gear**U150E**

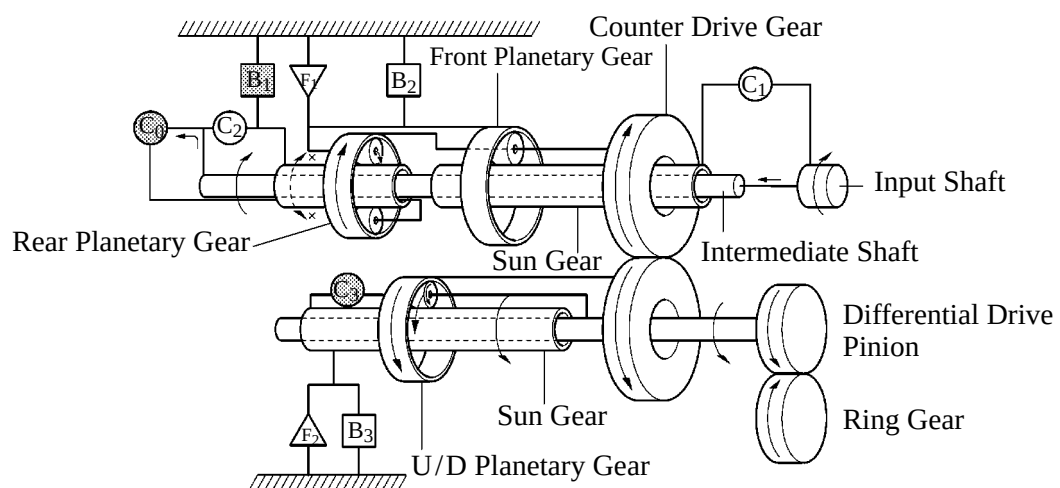
211CH05



211CH57

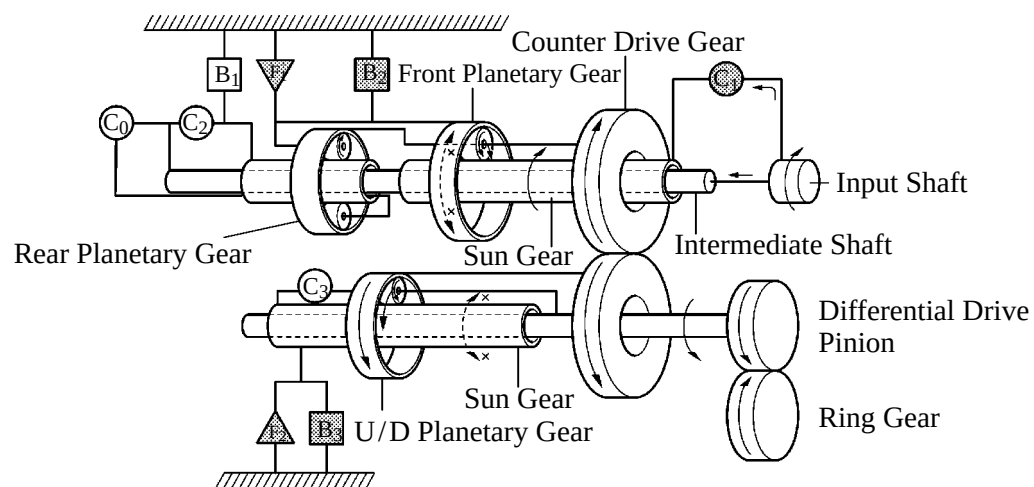
3rd Gear**4th Gear**

5th Gear



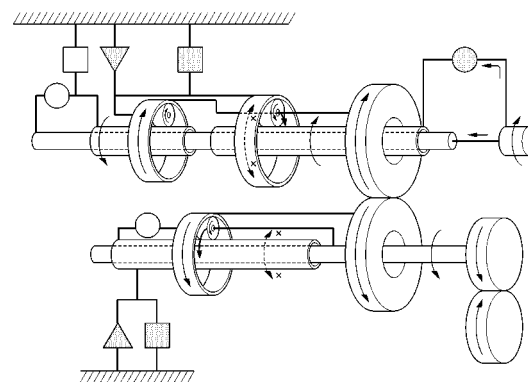
211CH08

1st Gear (L Position)



211CH09

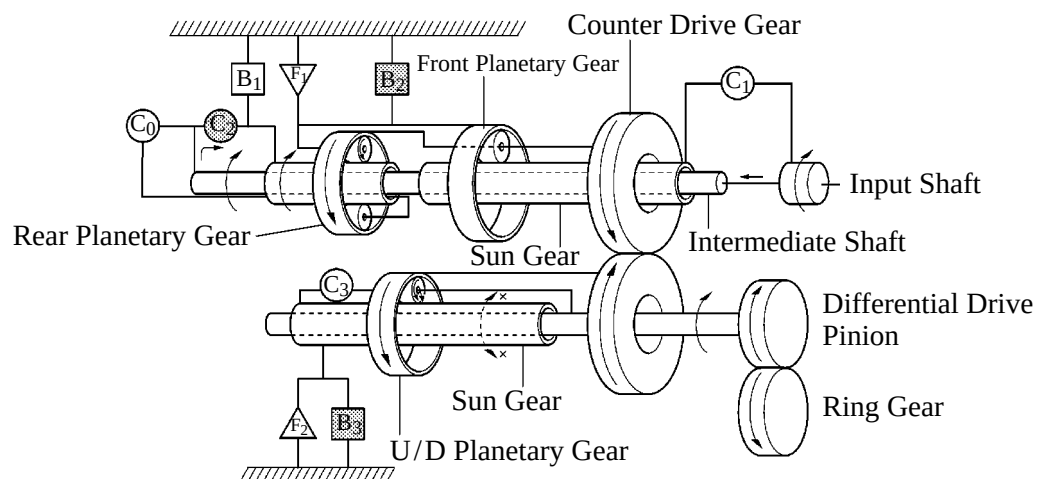
U150E



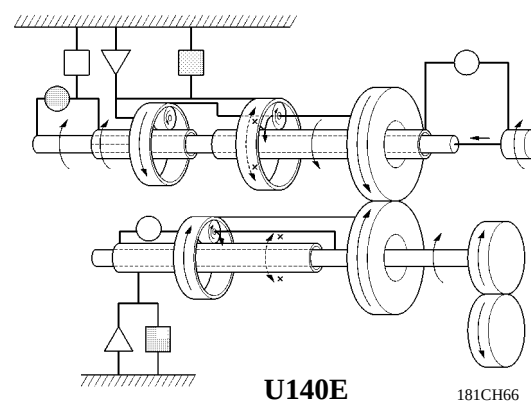
U140E

161ES13

Reverse Gear (R Position)



U150E



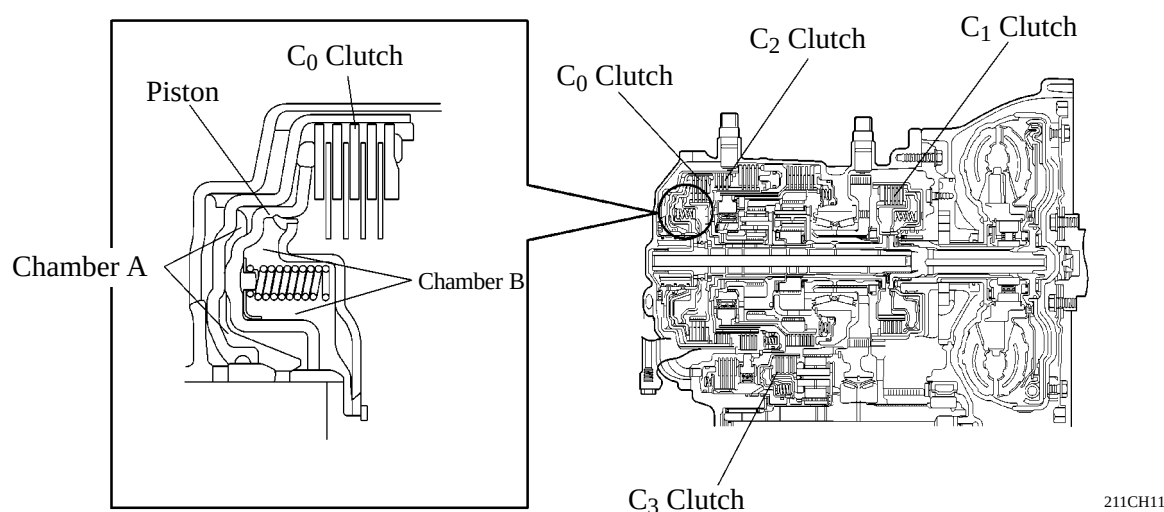
U140E

4. Centrifugal Fluid Pressure Canceling Mechanism

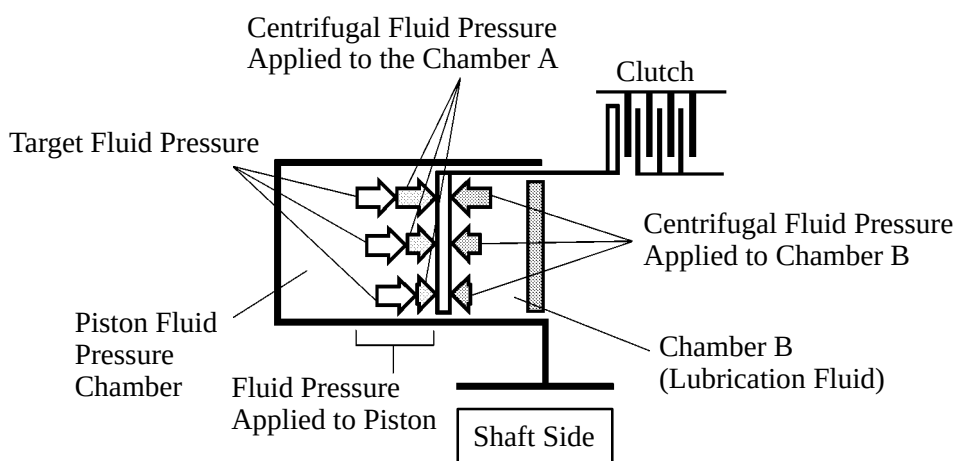
There are two reasons for improving the conventional clutch mechanism:

- 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.



157CH17

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

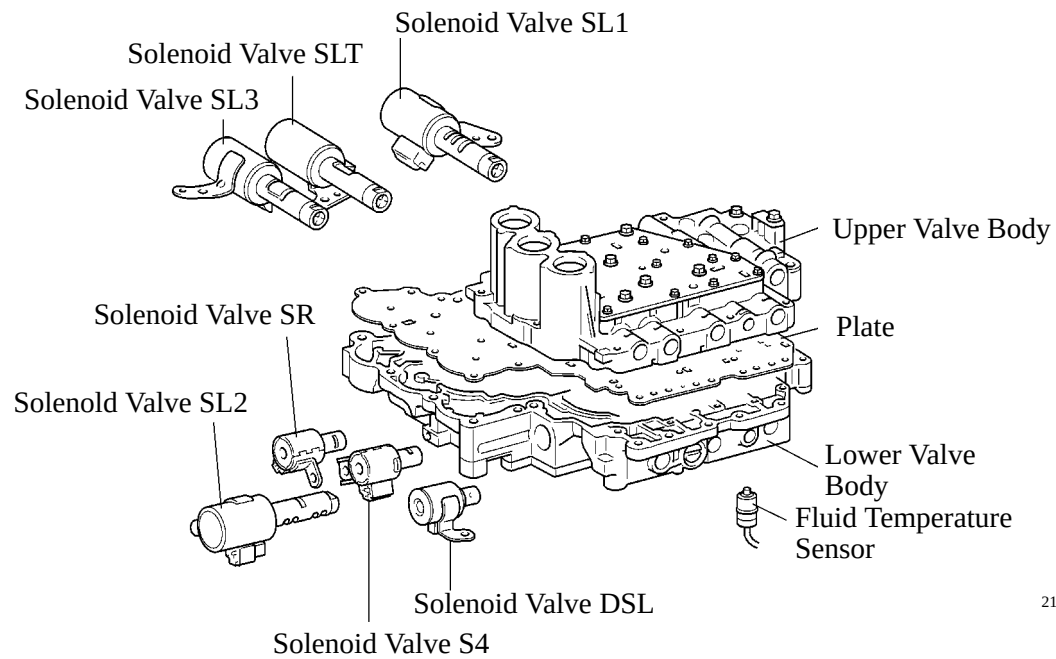
■ VALVE BODY UNIT

1. General

This valve body unit has been developed for the U150E A/T application.

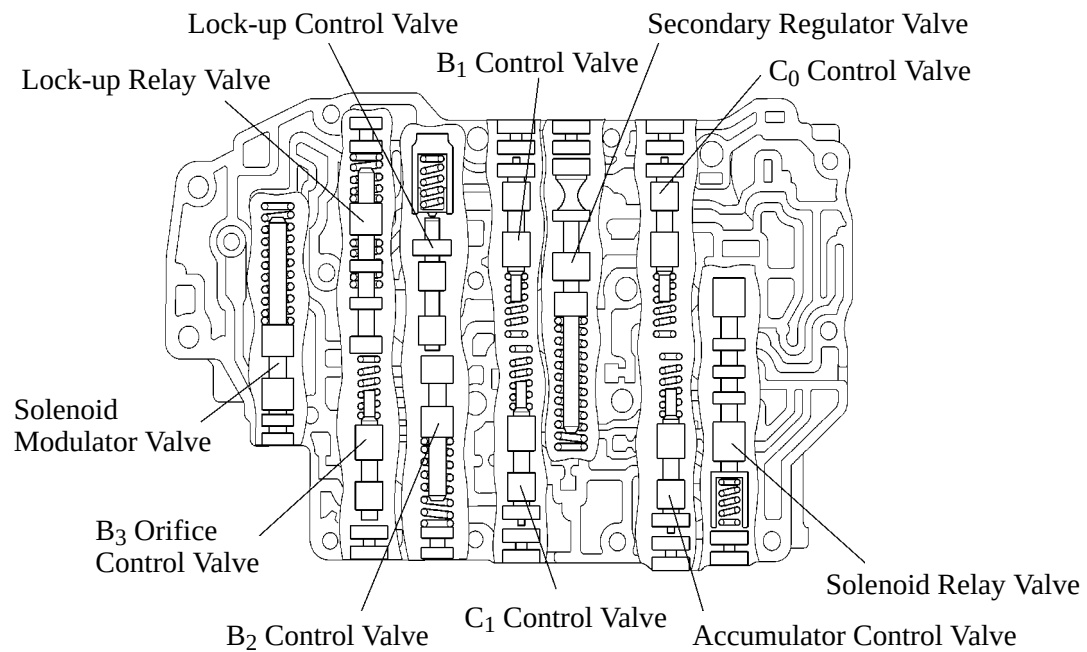
The valve body consists of the upper and lower valve bodies and 7 solenoid valves.

Apply orifice control, which controls the flow volume to the B₃ brake, has been adopted in this unit.



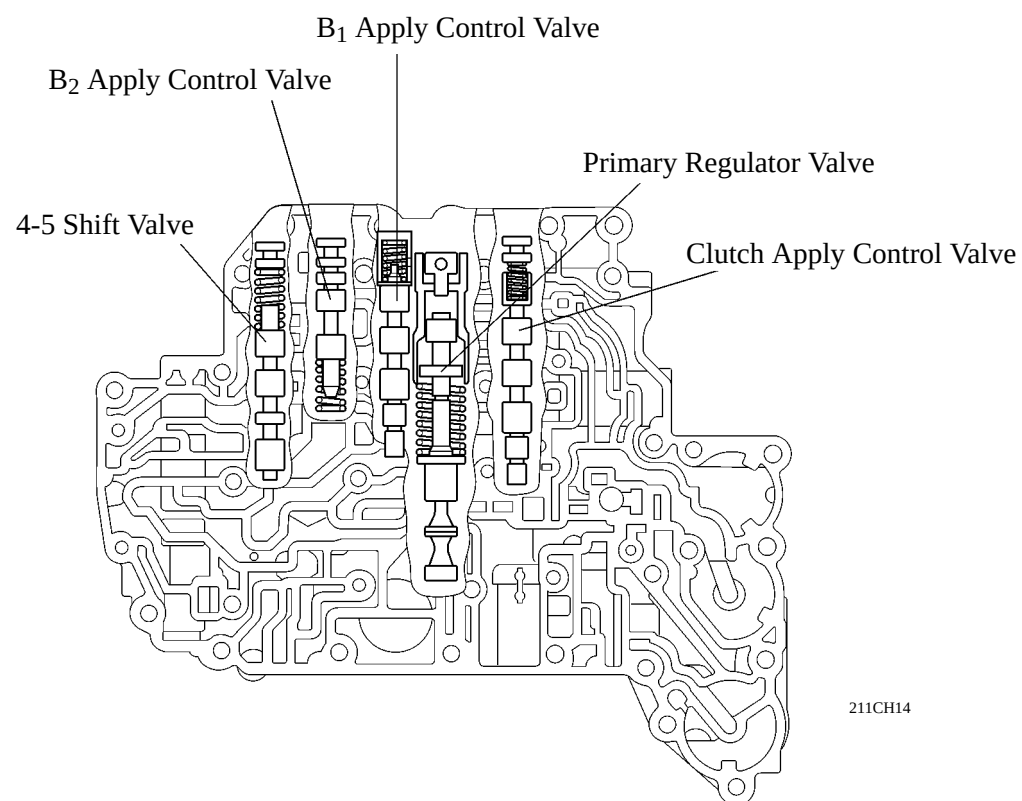
211CH12

► Upper Valve Body ◀



211CH13

► Lower Valve Body ◀



211CH14

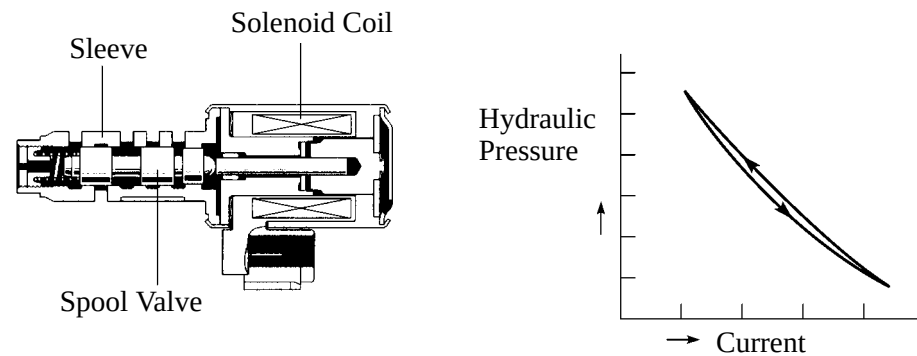
2. Solenoid Valve

Solenoid Valves SL1, SL2, SL3 and SLT

1) General

In order to provide a hydraulic pressure that is proportion to current that flows to the solenoid coil, the solenoid valve SL1, SL2, SL3, 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, SL3, and SLT have the same basic structure.



198CH31

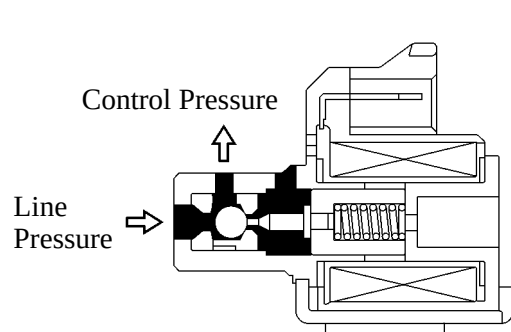
2) Function of Solenoid Valve SL1, SL2, and SLT

Solenoid Valve	Action	Function
SL1	For clutch and brake engagement pressure control	B ₁ brake pressure control
SL2		• C₀ clutch pressure control • Lock-up clutch pressure control
SL3		C ₁ clutch pressure control
SLT	For line pressure control	• Line pressure control • Secondary pressure control

Solenoid Valves SR, S4, and DSL

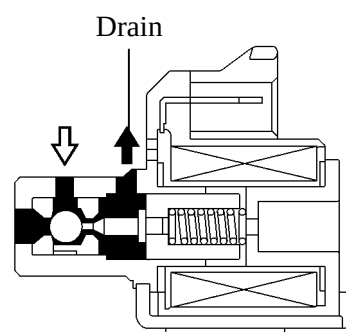
1) General

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



Solenoid Valve ON

161ES65

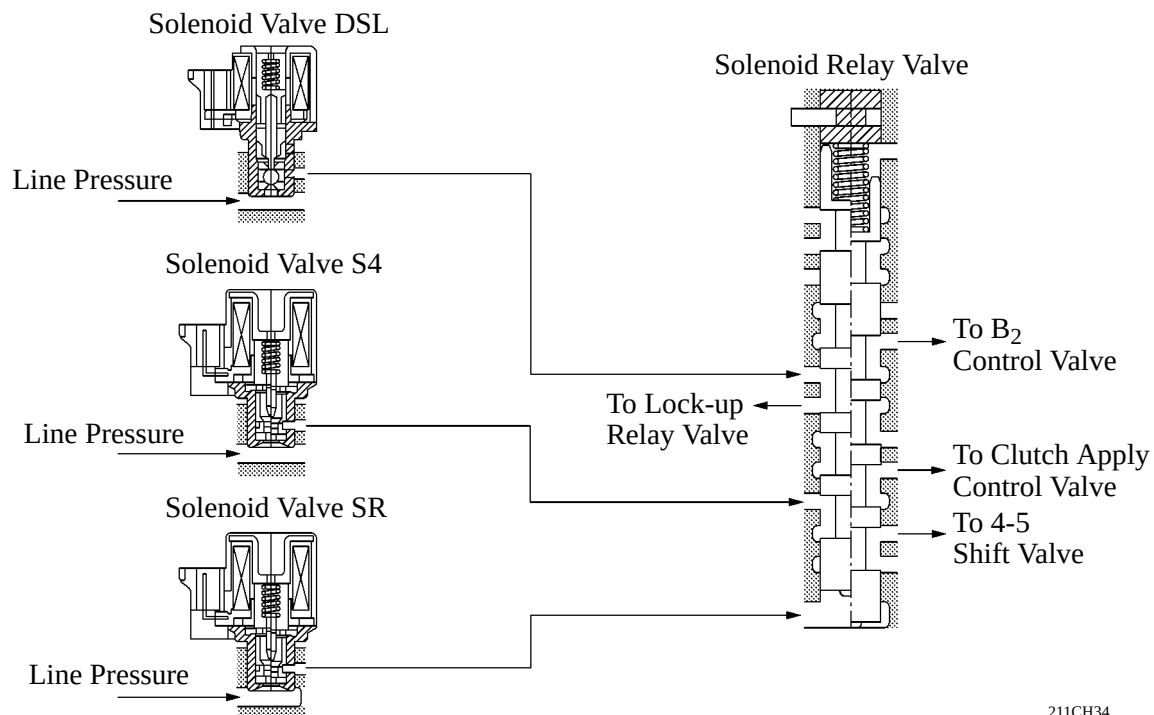


Solenoid Valve OFF

181CH12

2) Function of Solenoid Valve SR

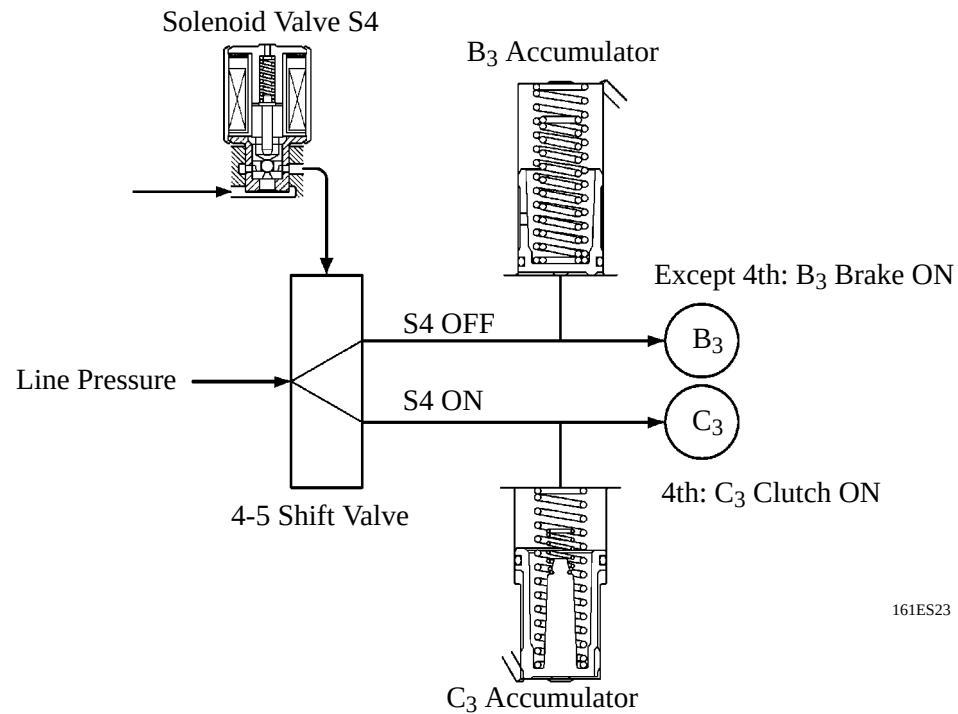
The solenoid valve SR controls the solenoid relay valve. Accordingly, the fluid passages from the solenoid valve DSL and S4 have been changed.



211CH34

3) Function of Solenoid Valve S4

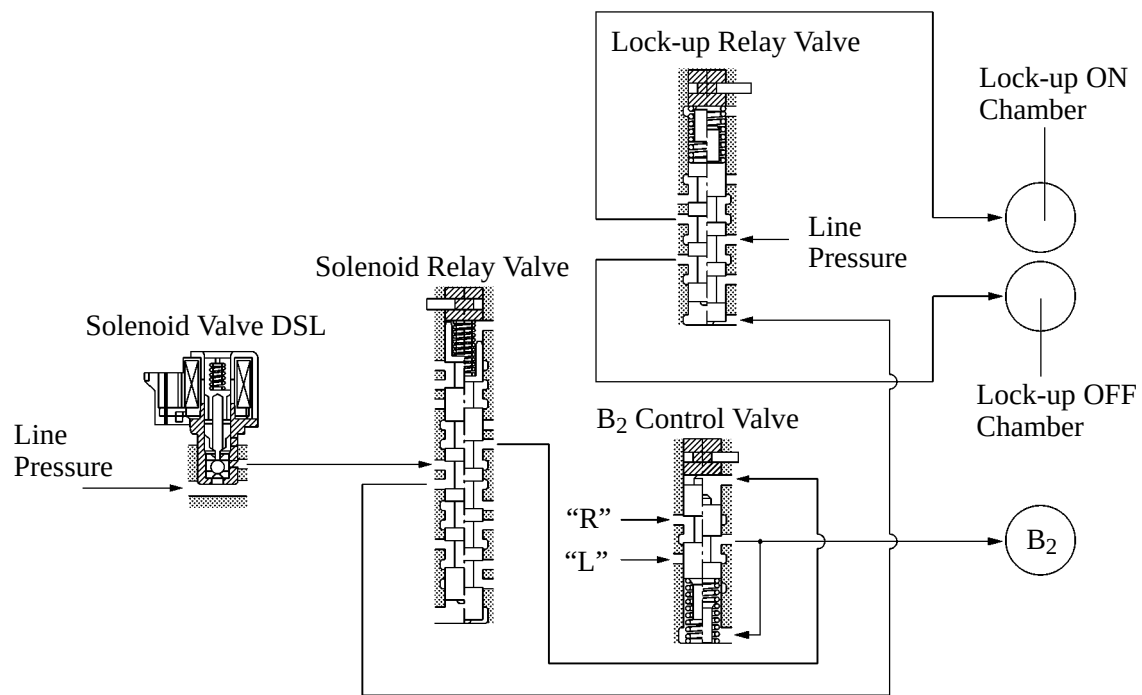
The solenoid valves S4 when set to ON controls the 4-5 shift valve to establish the 5th by changing over the fluid pressure applied to B₃ brake and C₃ clutch.



4) Function of Solenoid Valve DSL

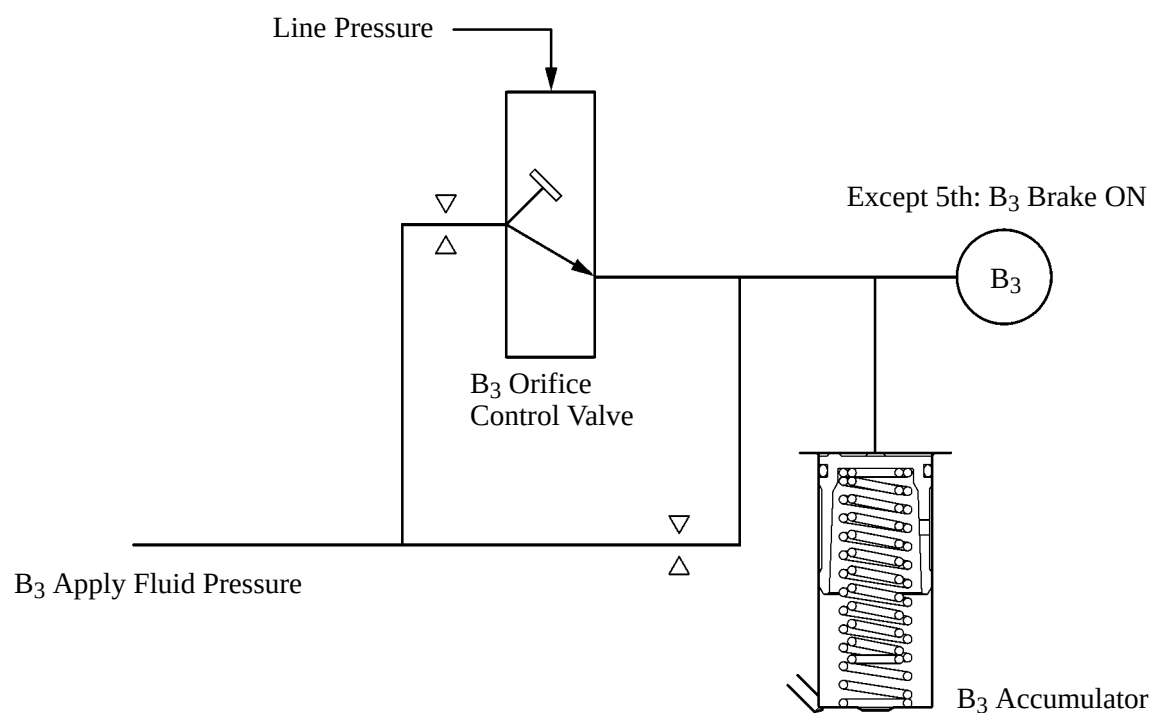
The solenoid valve DSL controls the B₂ control valve via the solenoid relay valve when the transaxle is shifted in the R or L position.

During lock-up, the lock-up relay valve is controlled via the solenoid relay valve.



3. Apply Orifice Control

This control is effected by the B₃ orifice control valve. The B₃ orifice control valve has been provided for the B₃ brake, which is applied when shifting from 5th to 4th. The B₃ 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 B₃ brake is controlled by varying the size of the orifice in the control valve.



■ ELECTRONIC CONTROL SYSTEM

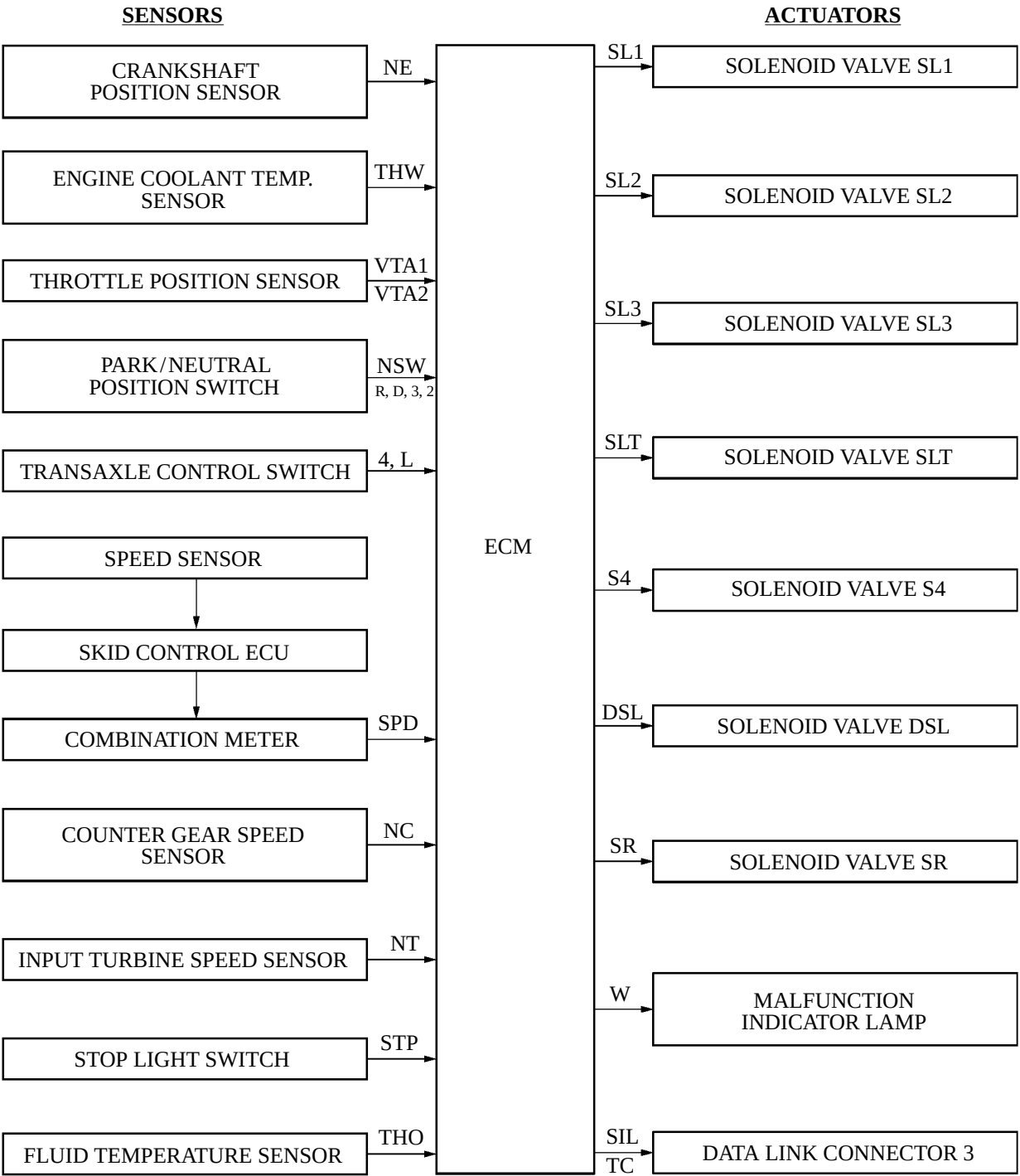
1. General

The electronic control system of the U150E automatic transaxle consists of the control listed below.

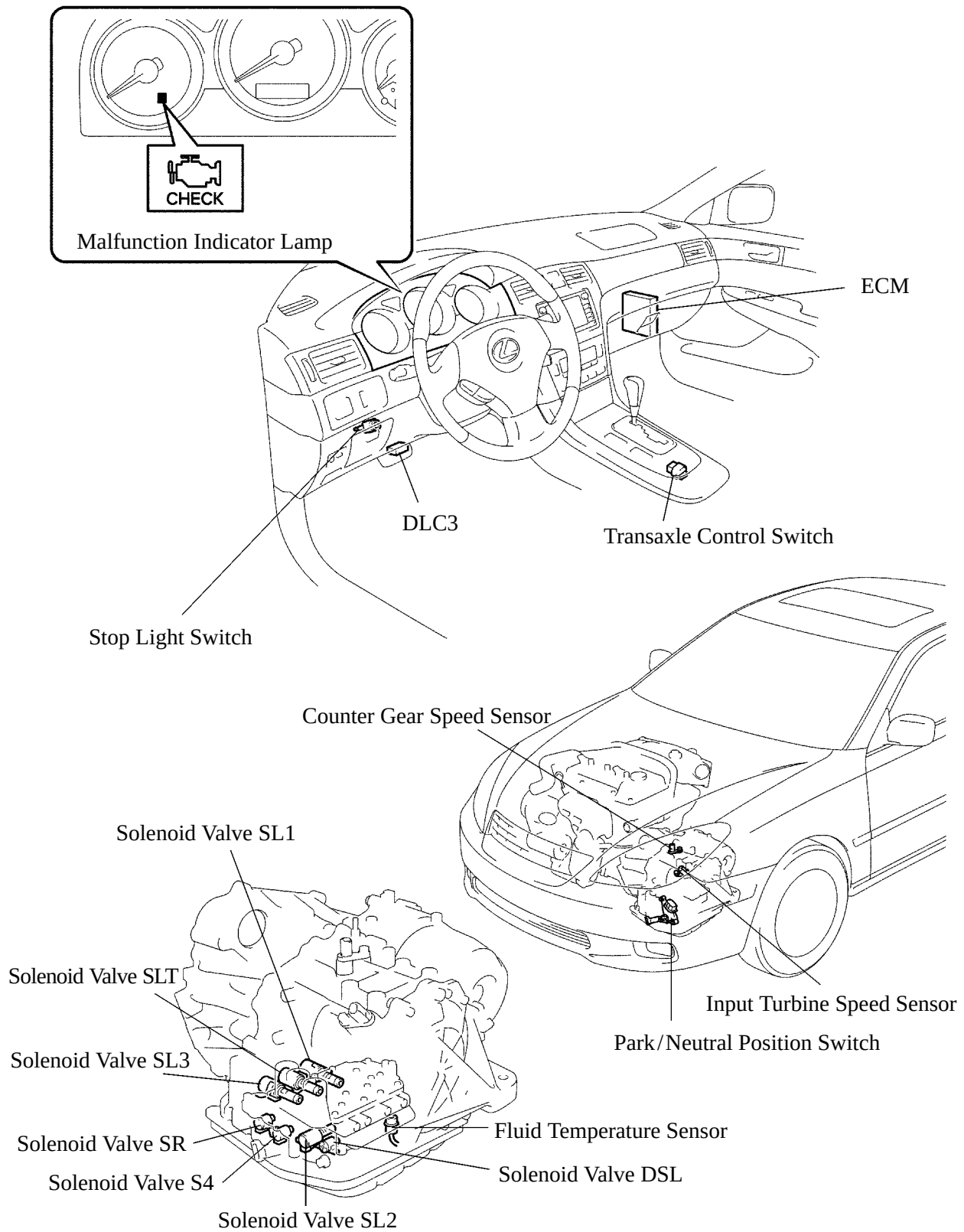
System	Function	U150E	U140E
Clutch Pressure Control (Refer to CH-24)	- Controls the pressure that is applied directly to B₁ brake and C₂ clutch by actuating 2 solenoid valves (SL1, SL2) in accordance with ECM signals. 2 solenoid valves (SL1 and SL2) minutely controls the clutch pressure in accordance with the engine output and driving conditions.	—	○
	- Controls the pressure that is applied directly to B₁ brake, C₀ and C₁ clutches by actuating 3 solenoid valves (SL1, SL2, and SL3) in accordance with ECM signals. 3 solenoid valves (SL1, SL2, and SL3) minutely controls the clutch pressure in accordance with the engine output and driving conditions.	○	—
Line Pressure Optimal Control (Refer to CH-26)	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 (Refer to CH-25)	Controls to restrict the 4th upshift or to provide appropriate engine braking by the ECM to determine whether the vehicle is traveling uphill or downhill.	—	○
	Controls to restrict the 4th or 5th upshift or to provide appropriate engine braking by 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.	—	○
	The ECM sends current to 3 solenoid valves (SL1, SL2, and SL3) based on signals from each sensor and shifts the gear.	○	—
Lock-up Timing Control	The ECM sends current to the solenoid valve DSL based on signals from each sensor and engages or disengages the lock-up clutch.	○	○
“N” to “D” Squat Control	When the shift lever is shifted from “N” to “D” position, the gear is temporarily shifted to 3rd and then to 1st to reduce vehicle squat.	○	○
Diagnosis (Refer to CH-27)	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 (Refer to CH-28)	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 U150E automatic transaxle is as shown in the following chart.



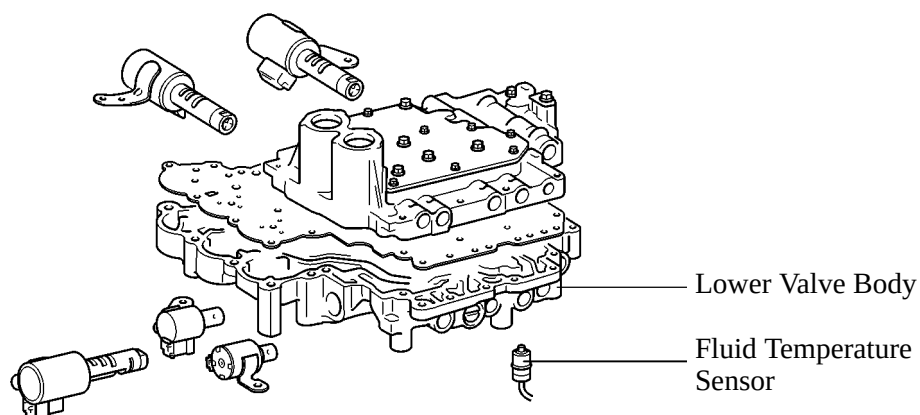
3. Layout of Component



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.

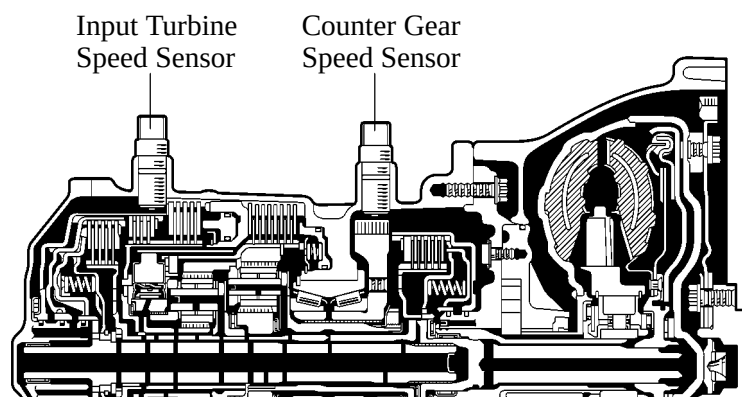


181CH11

Speed Sensors

The U150E automatic transaxle has adopted an input turbine speed sensor (for the NT signal) and a counter gear speed sensor (for the NC signal). Thus, the 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.

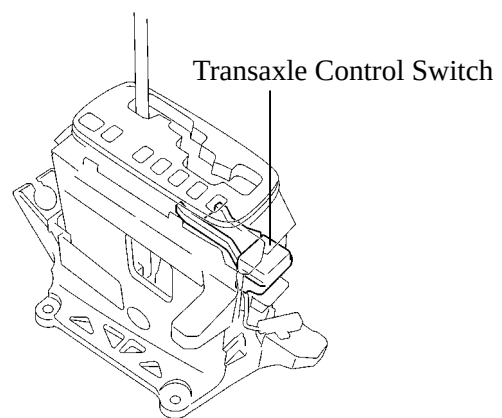
- The input turbine speed sensor detects the input speed of the transaxle. The direct clutch (C₂) drum is used as the timing rotor for this sensor.
- The counter gear speed sensor detects the speed of the counter gear. The counter drive gear is used as the timing rotor for this sensor.



211CH16

Transaxle Control Switch

The transaxle control switch is installed inside shift lever assembly to detect the shift lever position (“4th” or “D” and “2nd” or “L”) and to inform ECM the shift position indicator light in the combination meter.



211CH47

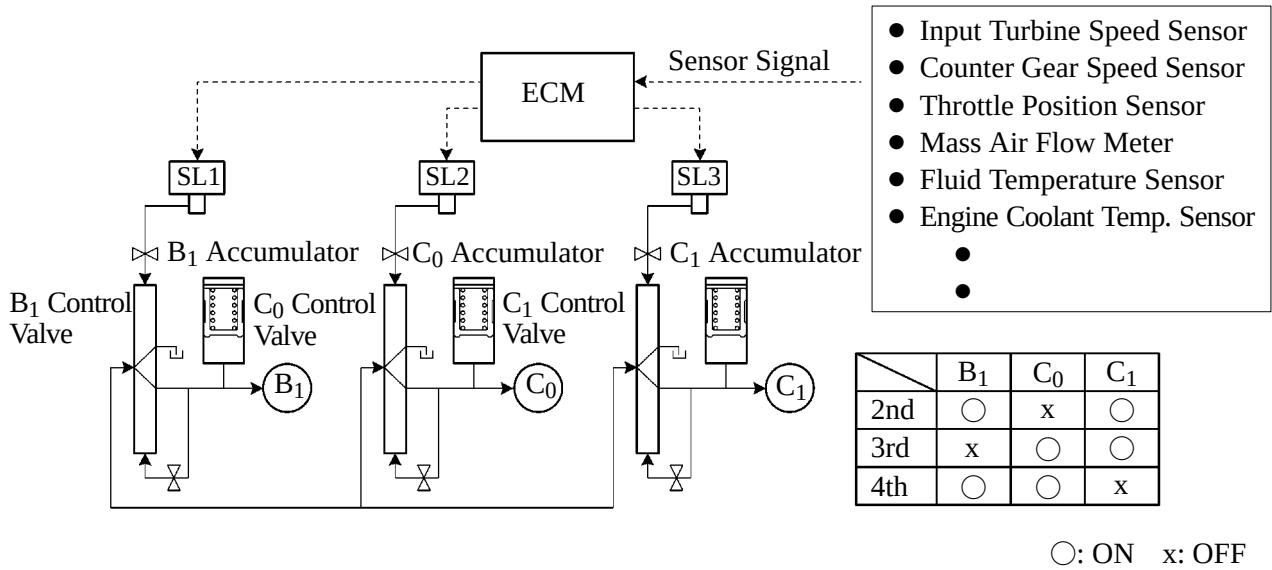
5. Clutch Pressure Control

Clutch to Clutch Pressure Control

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

Actuates solenoid valves SL1, SL2, and SL3 in accordance with the signals from the ECM, and guides this output pressure directly to the control valves B₁, C₀, and C₁ in order to regulate the line pressure that acts on the B₁ brake, C₀, and C₁ clutches.

As a result, compact B₁, C₀, and C₁ accumulators without a back pressure chamber have been realized.

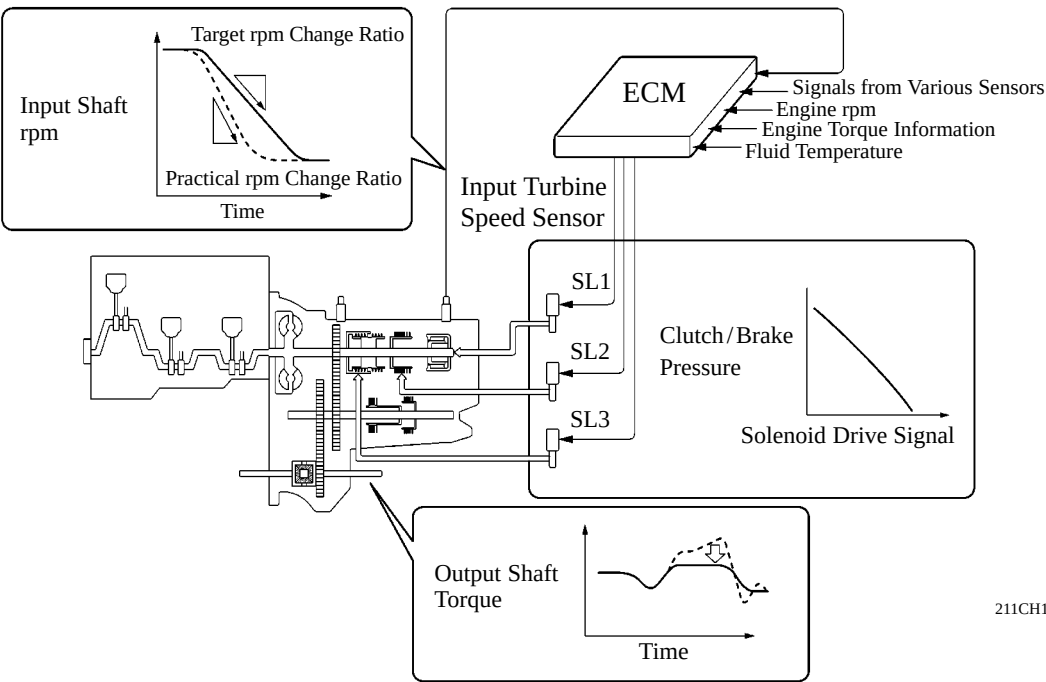


211CH15

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, SL2, and SL3 to minutely control the clutch pressure in accordance with engine output and driving conditions.

As a result, smooth shift characteristics have been realized.



211CH17

6. Shifting Control in Uphill/Downhill Traveling

General

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

Shift control in uphill traveling

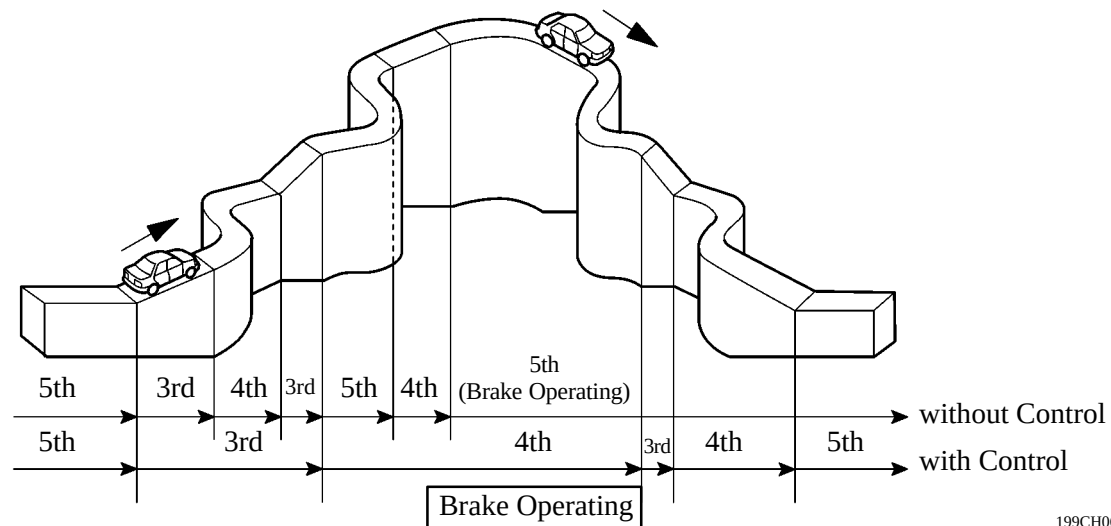
When the ECM determines uphill travel before the transaxle attempts to shift up into 5th or after it has shifted down into 4th, it prohibits the transaxle from shifting up into 5th.

When the ECM determines uphill travel with a steeper grade, it automatically shifts down into 3rd and thus prevents the transaxle from shifting up into 4th.

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.



199CH06

Uphill/Downhill Judgment

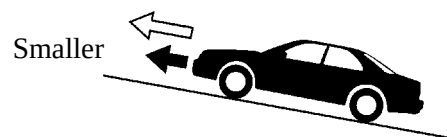
The actual acceleration calculated from the speed sensor signal is compared with the reference acceleration stored in the ECM to judge uphill or downhill traveling.

Actual Acceleration < Reference Acceleration

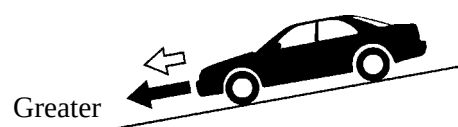
Actual Acceleration > Reference Acceleration

⇐ Reference acceleration

⇐ Actual acceleration



Uphill



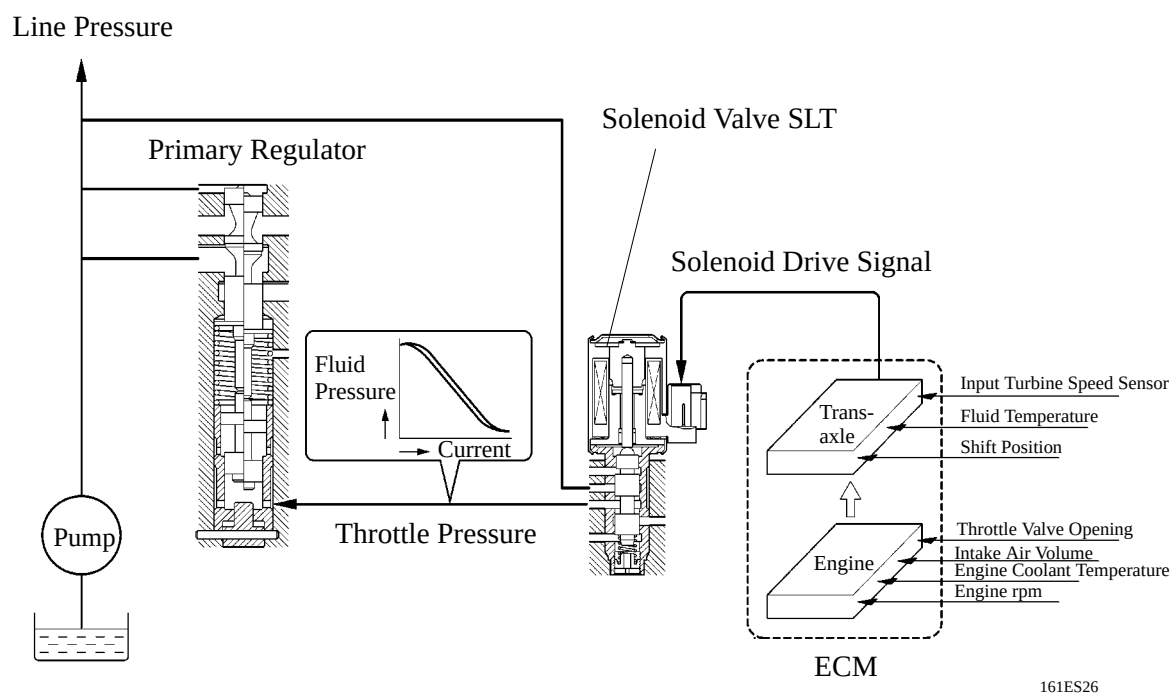
Downhill

162CH10

7. Line Pressure Optimal Control

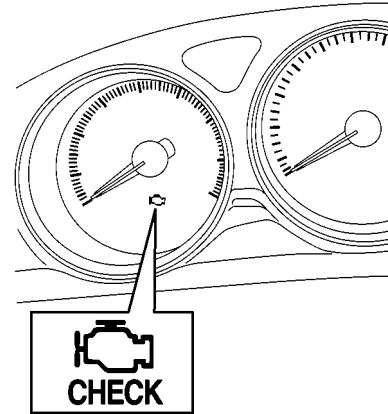
Through the use of the solenoid valve SLT, the line pressure is optimally controlled in accordance with the engine torque information, as well as with the internal operating conditions of the torque converter and the transaxle.

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



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 to inform the driver.
- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be read by connecting a hand-held tester.



211CH21

–Changes (from U140E)–

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

DTC No.	Detection Item
P0711	Transmission Fluid Temp. Sensor Malfunction (Fluid Temp. Sensor)
P0760	Shift Solenoid C Malfunction (Solenoid Valve SL3)
P0763	Shift Solenoid C Electrical Malfunction (Solenoid Valve SL3)
P1815	Solenoid Valve SR Malfunction
P1818	Solenoid Valve SR Electrical Malfunction

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

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

► Fail-Safe Control List ◀

Malfunction Part	Function
Speed Sensor	During a speed sensor malfunction, the vehicle speed is detected through the signals from the counter gear speed sensor to effect normal control.
Fluid Temp. Sensor	During a fluid temp. sensor malfunction, 5th upshift is prohibited.
Counter Gear Speed Sensor	During a counter gear speed sensor malfunction, 5th upshift is prohibited.
Solenoid Valve SL1, SL2, SL3, and S4	The current to the failed solenoid valve is cut off and control is effected by operating the other solenoid valves with normal operation. Shift control is effected as described in the table below, depending on the failed solenoid. Even if starting the engine under this condition, the gear position remains where it was before.

○: ON Δ: Lock-up ON x: OFF

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

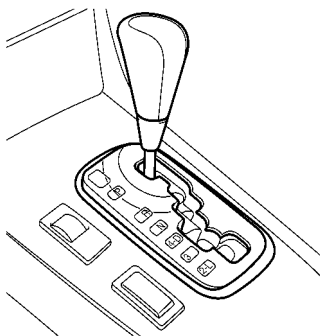
(Continued)

SL2 Malfunction	Solenoid Valve	SL1	○	x → ○	○	x → ○	x → ○
		SL2	x				
		SL3	x	x	x	○ → x	○ → x
		S4	x → ○	x → ○	x → ○	x → ○	○
	Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th
SL3 Malfunction	Solenoid Valve	SL1	○	x	○	x → ○	x → ○
		SL2	○	○	△	△	△
		SL3	x				
		SL4	x	x	x	x → ○	○
	Gear Position		1st	2nd	3rd	4th	5th → 4th
S4 Malfunction	Solenoid Valve	SL1	○	x	○	x	x
		SL2	○	○	△	△	△
		SL3	x	x	x	○	○
		S4	x				
	Gear Position		1st	2nd	3rd	4th	5th → 4th
SL1, SL2, SL3, and S4 Malfunction	Solenoid Valve	SL1	x				
		SL2	x				
		SL3	x				
		S4	x				
	Gear Position		1st → 4th	2nd → 4th	3rd → 4th	4th	5th → 4th

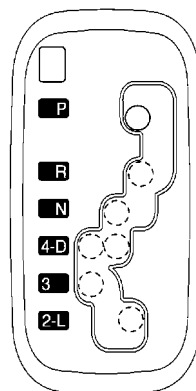
■ SHIFT CONTROL MECHANISM

1. General

- A gate type shift lever that uses a shift control cable has been newly adopted in conjunction with the installation of the 5-speed automatic transaxle.
With the gate type, the shift lever button and the overdrive switch of the straight type shift lever have been discontinued. Similar functions are achieved through a single-shift operation (fore-aft and side-to-side).
- A shift lock system consists of the key interlock device and shift lock mechanism, has been adopted.



211CH24



Shift Pattern

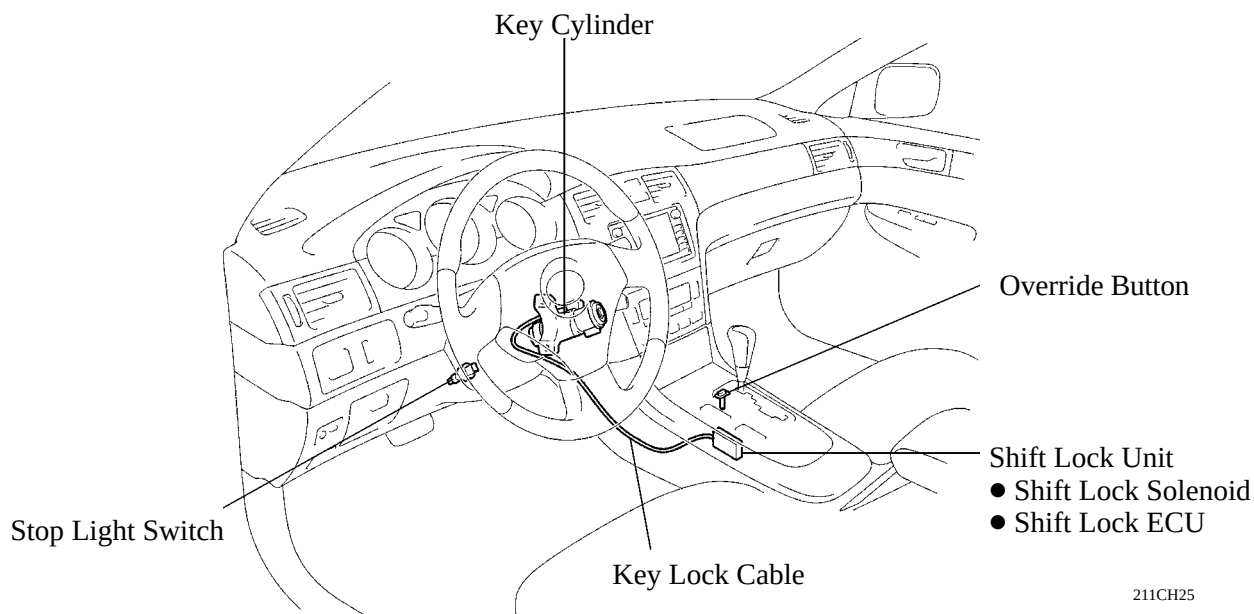
211CH23

2. Shift Lock System

General

- A shift lock system 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



211CH25

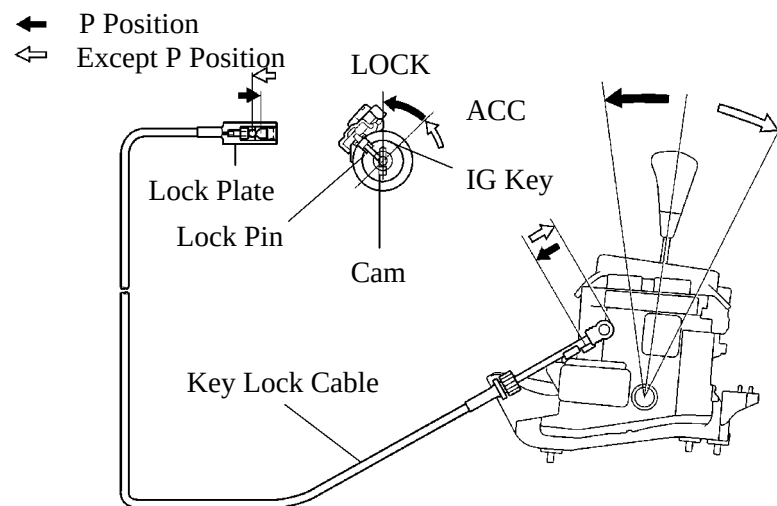
Key Interlock Device

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.

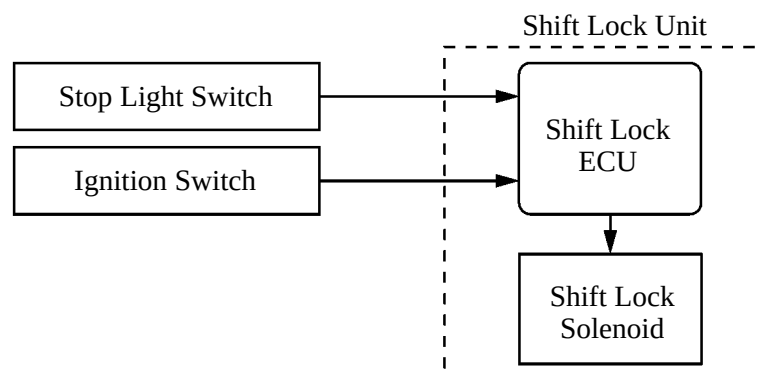


211CH26

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 ◀



208CH13

CHASSIS

U150E AUTOMATIC TRANSAXLE

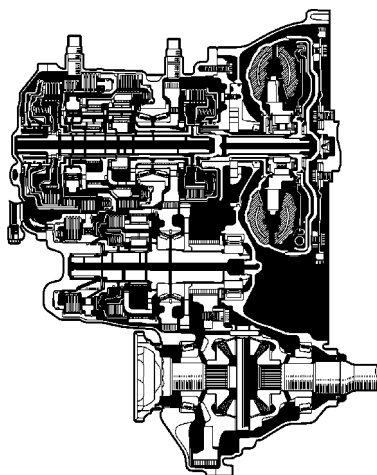
DESCRIPTION

The U150E automatic transaxle (hereafter referred to as “A/T”) is a newly developed, compact and high-capacity 5-speed Super ECT (Electronically Controlled Transaxle).

Based on the U140E A/T of the '01 ES300, this U150E A/T has been changed into a 5-speed to improve fuel economy and dynamic performance.

– Main Changes (from U140E A/T) –

- Direct & O/D (C₀) clutch and 2 solenoid valves (SL3, SR) have been adopted.
- Fluid passages have been changed for the 5-speed application.

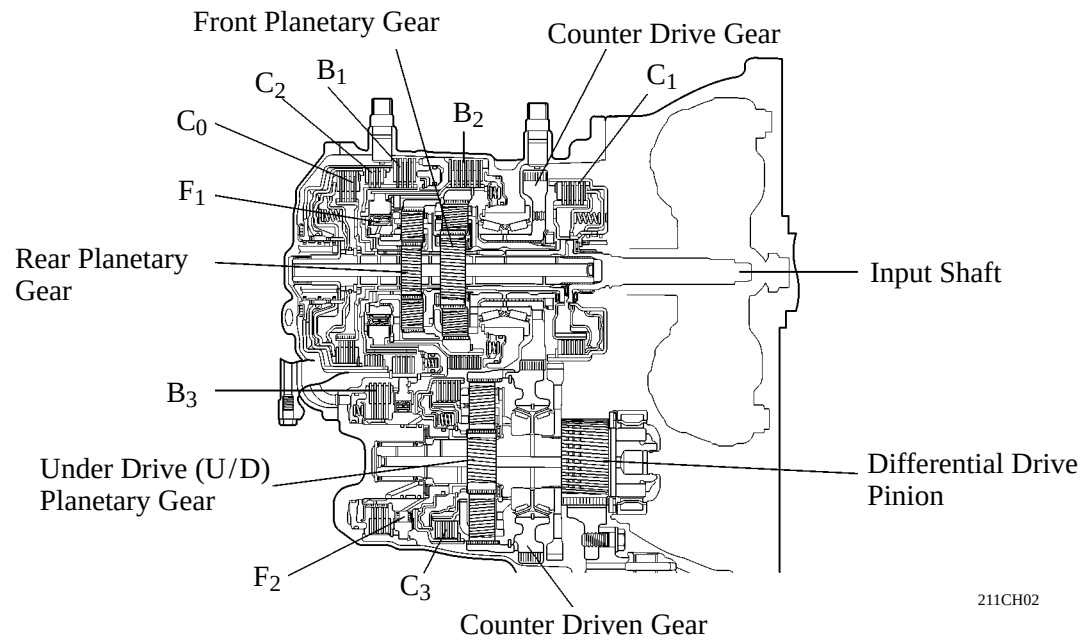


211CH01

► Specification ◀

Model		'02 ES300	'01 ES300
Transaxle Type		U150E	U140E
Engine Type		1MZ-FE	←
Gear Ratio*1	1st	3.938	←
	2nd	2.194	←
	3rd	1.411	←
	4th	0.973	1.019
	5th	0.703	–
	Reverse	3.141	←
Counter Gear Ratio		1.019	←
Differential Gear Ratio		3.478	2.642
Fluid Capacity Liters (US qts, Imp. qts)		9.1 (9.5, 7.9)*2	8.4 (8.9, 7.4)*2
Fluid Type		ATF Type T-IV	←
Dry Weight kg (lb)		94.1 (207.5)	91 (200.6)

*1: Counter Gear Ratio Included *2: Differential Included



► Specification ◀

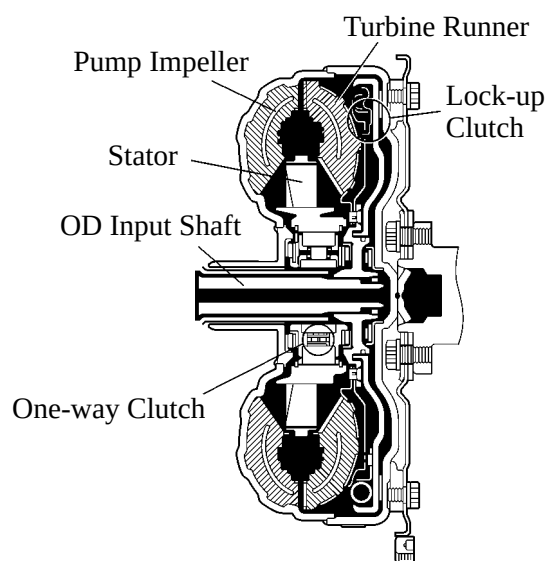
Transaxle Type			U150E	U140E
C ₁	Forward Clutch	The No. of Discs	5	6
C ₂	Direct Clutch		—	4
	Reverse Clutch		3	—
C ₃	U/D Direct Clutch		4	←
C ₀	Direct & O/D Clutch		4	—
B ₁	2nd & O/D Brake		4	—
	2nd Brake		—	4
B ₂	1st & Reverse Brake		6	7
B ₃	U/D Brake		4	←
F ₁	No.1 One-Way Clutch	The No. of Sprags	28	←
F ₂	U/D One-Way Clutch		24	←
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	←
	The No. of Pinion Gear Teeth		28	←
	The No. of Ring Gear Teeth		91	←
Counter Gear	The No. of Drive Gear Teeth		52	←
	The No. of Driven Gear Teeth		53	←

■ TORQUE CONVERTER

- This torque converter has 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 U140E for the '01 ES300 models. However, the stall torque ratio has been changed.

► Specification ◀

Model	'02 ES300	'01 ES300
Transaxle Type	U150E	U140E
Type	3-Element, 1-Step, 2-Phase (with Lock-up Mechanism)	
Stall Torque Ratio	1.75	1.8



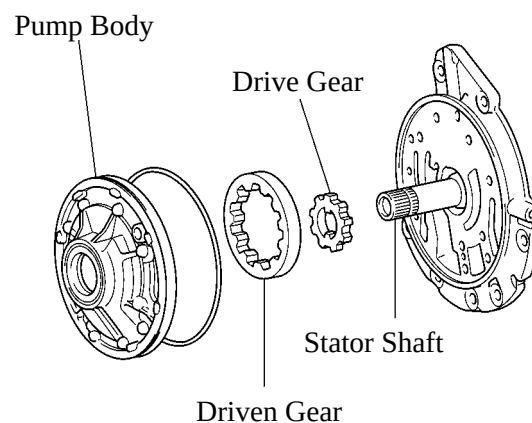
208CH02

■ 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