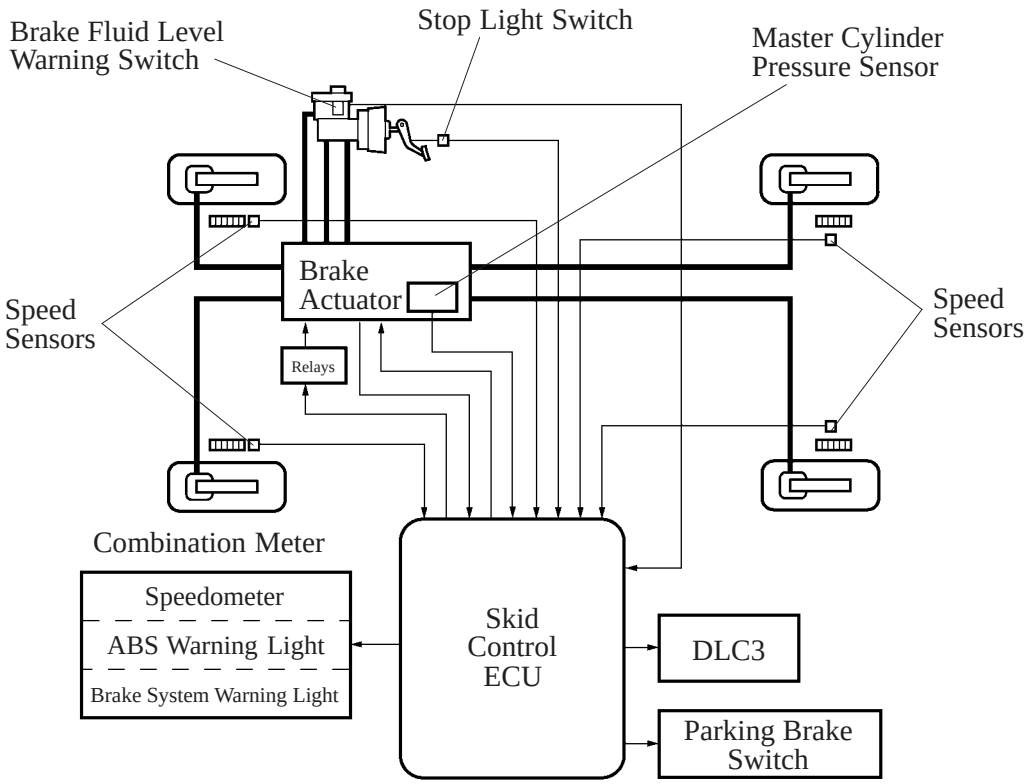
■ ABS with EBD & BRAKE ASSIST SYSTEM

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.
- 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.

2. System Diagram



209CH04

3. Outline of EBD Control

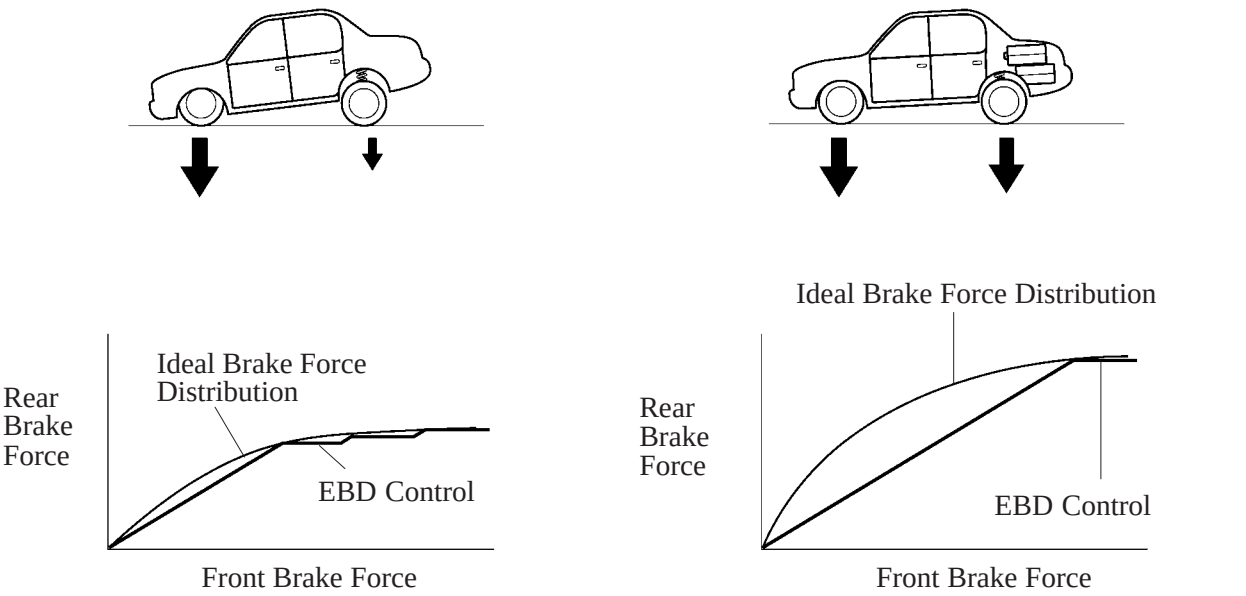
General

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.

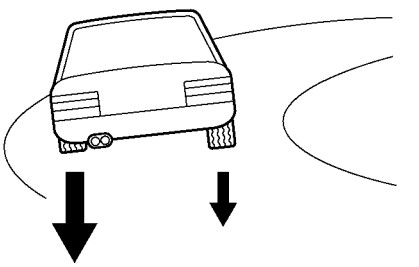
▶ EBD Control Concept ◀



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.



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4. 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 increse 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 —

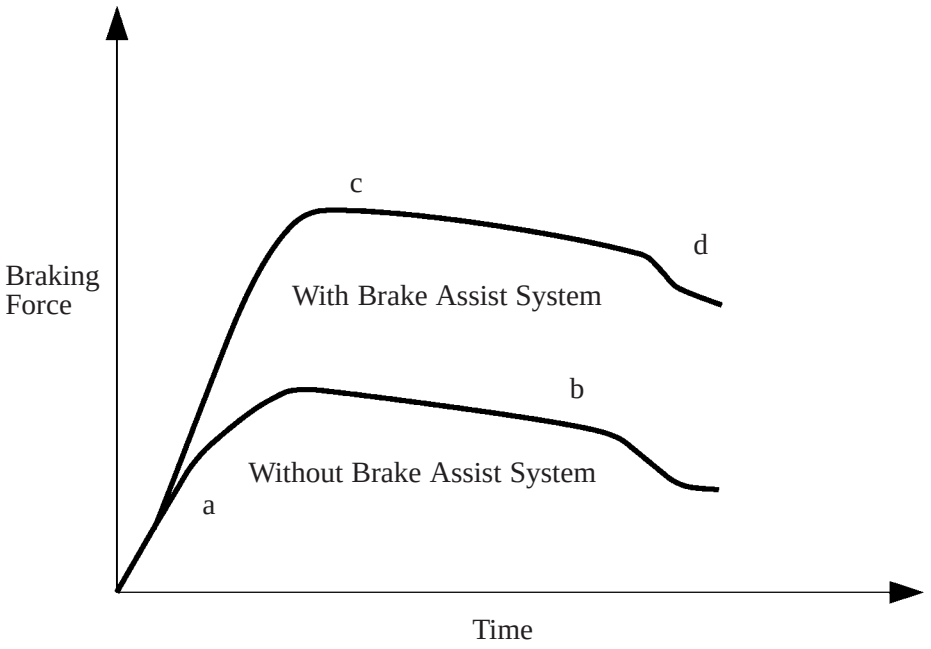
Effectiveness of the Brake Assist Operation:

a. 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.

b. The pedal effort of this type of driver might weaken as time passes, causing a reduction in the braking force.

c. 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.

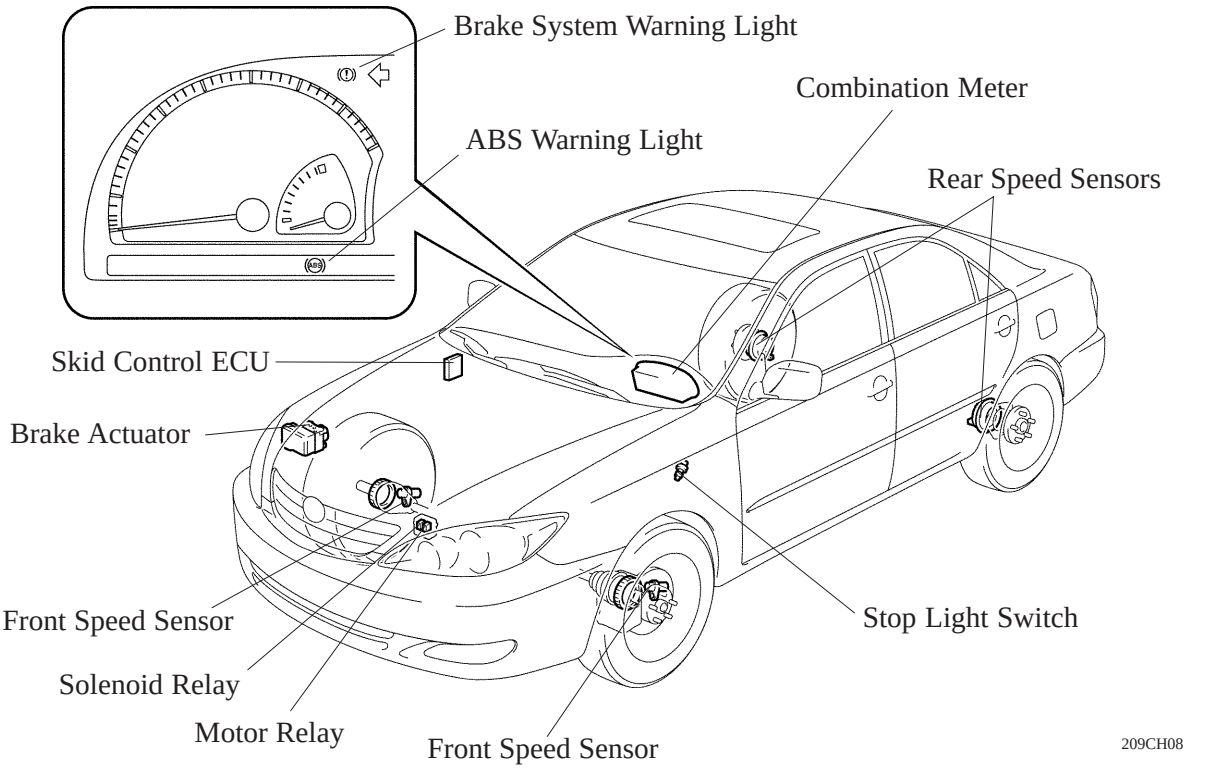
d. After the Brake Assist operation, if the driver intentionally releases the brake pedal, the assist operation reduces the amount of Brake Assist in order to reduce the feeling of uneasiness.



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.

5. Layout of Component



6. Function of Component

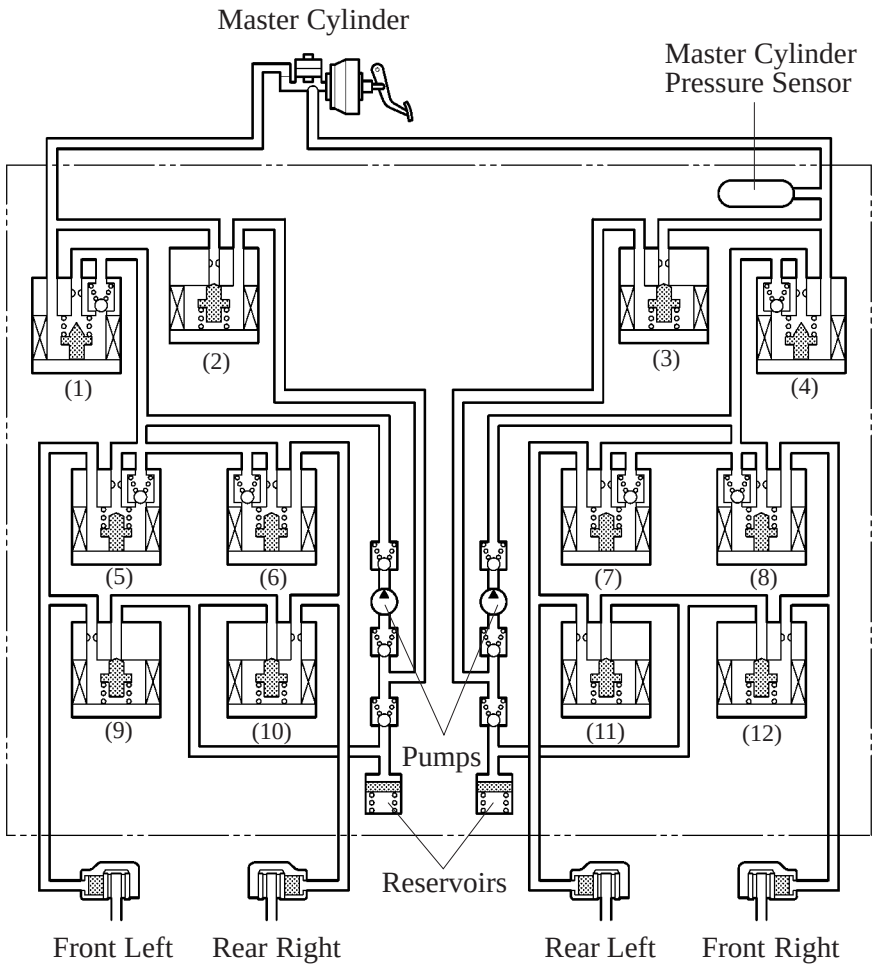
Component		Function
Combination Meter	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the ABS or Brake Assist system.
	Brake System Warning Light	Lights up together with the ABS warning light to alert the driver when the skid control ECU detects the 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		Charges the fluid path based on the signals from the skid control ECU during the operation of the ABS with EBD & Brake Assist 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.
Motor Relay		Supply power to the pump motor in the brake actuator.
Solenoid Relay		Supply power to the solenoid valves in the brake actuator.

7. Brake Actuator

Construction

The brake actuator consists of 12 two-position solenoid valves, 1 motor, 2 pumps, and 2 reservoirs and master cylinder pressure sensor.
The 12 two-position solenoid valves consists of 2 master cylinder cut solenoid valves [(1), (4)], 2 suction solenoid valves [(2), (3)], 4 pressure holding valves [(5), (6), (7), (8)], and 4 pressure reduction valves.

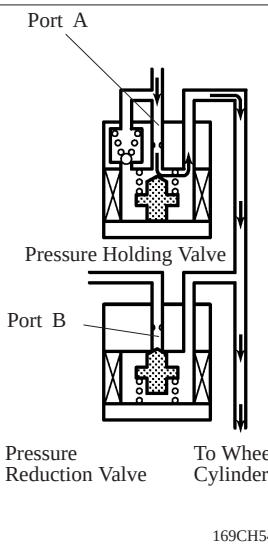
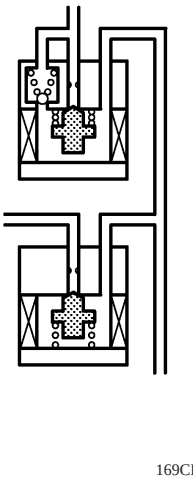
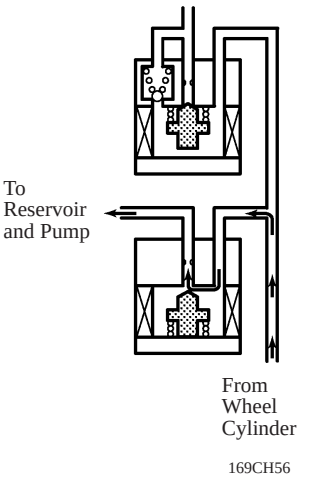
▶ Hydraulic Circuit ◀



209CH06

ABS with EBD Operation

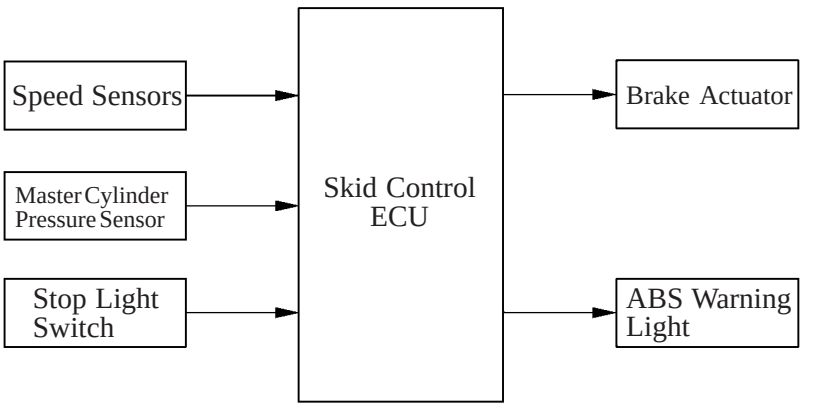
Based on the signals received from the 4 wheel speed sensors, the skid control ECU calculates each wheel speed and deceleration, and checks wheel slipping condition. And according to the slipping condition, the ECU controls the pressure holing valve and pressure reduction valve in order to adjust the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

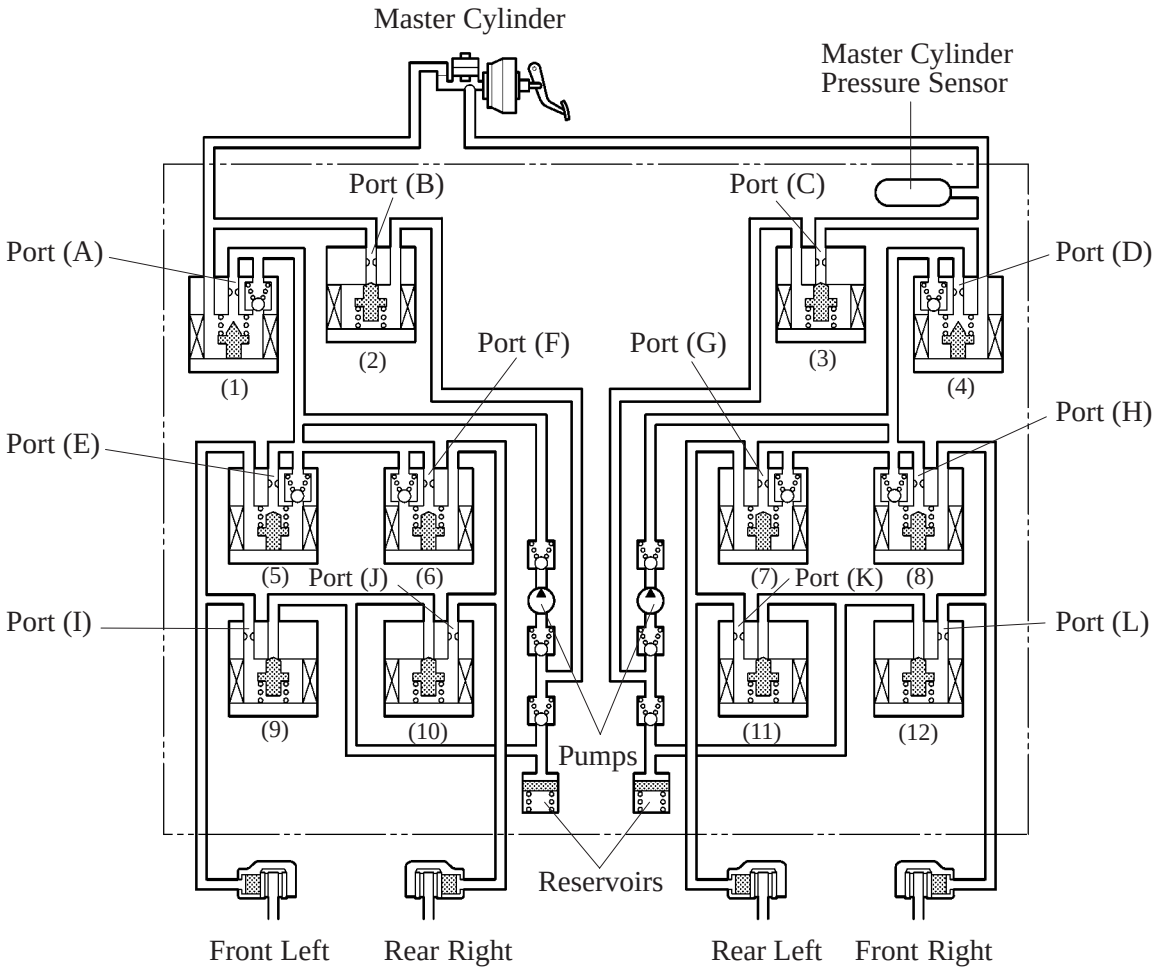
Not Activated	Normal Braking	—	—
Activated	Increase Mode	Holding Mode	Reduction Mode
Hydraulic Circuit			
Pressure Holding Valve (Port A)	OFF (Open)	ON (Close)	ON (Close)
Pressure Reduction Valve (Port B)	OFF (Close)	OFF (Close)	ON (Open)
Wheel Cylinder Pressure	Increase	Hold	Reduction

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 ◀





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

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

8. 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 and Brake Assist 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	Brake Assist	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 Ts and CG terminals of DLC3 and observing the blinking of the ABS warning light or by connecting a hand-held tester.
- The check connector has been discontinued.
- The DTCs listed below have been added to the ABS of the previous model.

DTC No.	Detection Item	DTC No.	Detection Item
C1225/25	Open or short circuit to brake actuator solenoid circuit (SMC1 or SMC2 circuit)	C1238/38	Foreign matter is attached on the tip of the right rear sensor
C1226/26	Open or short circuit to brake actuator solenoid circuit (SRM1 or SRM2 circuit)	C1239/39	Foreign matter is attached on the tip of the left rear sensor
C1235/35	Foreign matter is attached on the tip of the right front sensor	C1246/46	Malfunction in master cylinder pressure sensor
C1236/36	Foreign matter is attached on the tip of the left front 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 Camry Chassis & Body Repair Manual (Pub. No. RM915E).

Fail-Safe

- In the event of a malfunction in the ABS and/or Brake Assist, the skid control ECU prohibits the ABS control and Brake Assist.
- In the event of a malfunction in 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 control and Brake Assist.