■BRAKE CONTROL SYSTEM (ABS with EBD)

1. General

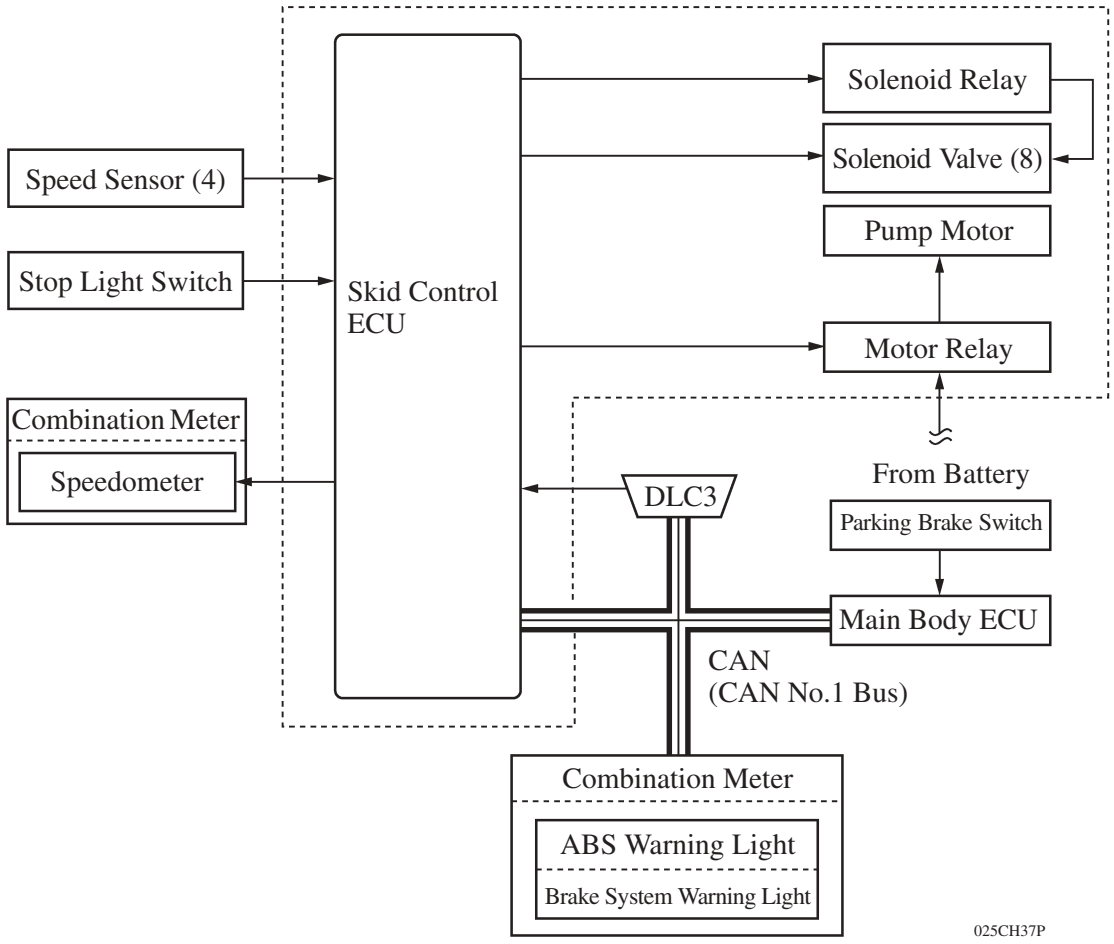
The brake control system (ABS with EBD) of new Camry has the following functions:

Function	Outline
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.
EBD (Electronic Brake force Distribution)	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.
Brake Assist (Mechanical Type)	The primary purpose of the Brake Assist is to provide an auxiliary brake force to assist the driver who cannot generate a large brake force during emergency braking, thus helping to realize the vehicle's brake performance.

Service Tip

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

▶ System Diagram ◀



2. Outline of EBD Control

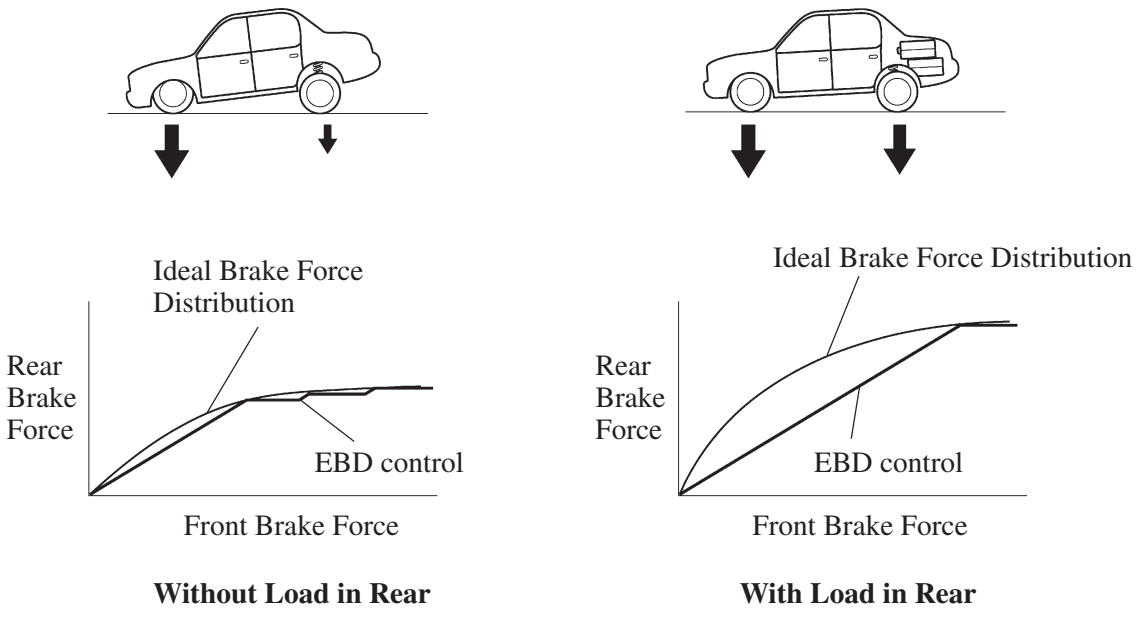
General

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 wheel speed sensors, 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.

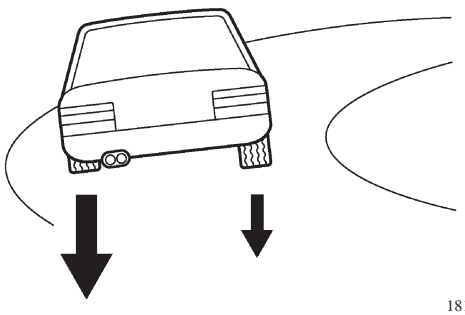
▶ EBD Control Concept ◀



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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 and the outer wheel increases.
The skid control ECU determines this condition by way of the signals from the wheel speed sensors, 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.

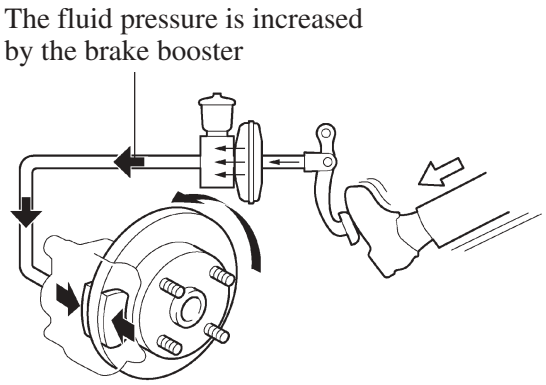


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3. Outline of Brake Assist (Mechanical Type)

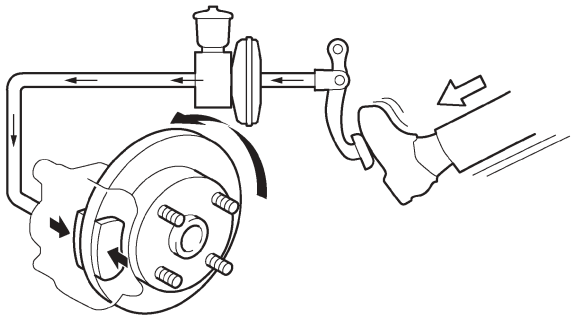
- The brake assist in combination with ABS helps improve the vehicle's brake performance.
- The brake assist interprets a quick push of the brake pedal as emergency braking and supplements the brake power applied if the driver has not stepped hard enough on the brake pedal. In emergencies, the driver, especially inexperienced ones, often panic and do not apply sufficient pressure on the brake pedal.
- 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 reduces the amount of assistance it provides.
- The mechanical type brake assist uses the brake assist mechanism in the brake booster to mechanically activate the brake booster function in order to increase the brake force. For details, see page CH-126.

▶ In case that the driver's depressing force is small when applying emergency braking ◀



With Brake Assist

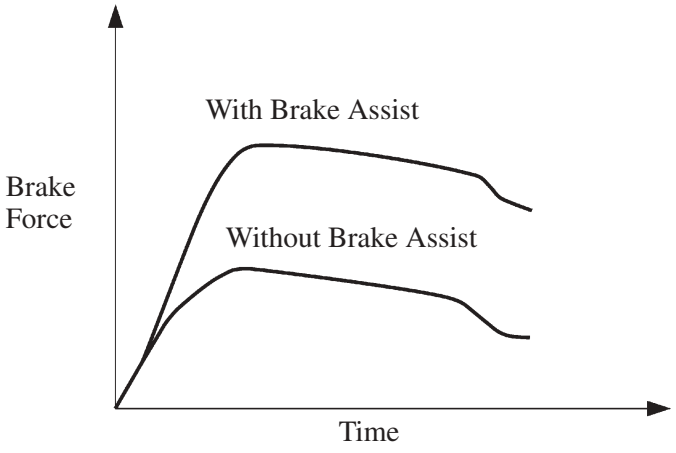
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Without Brake Assist*

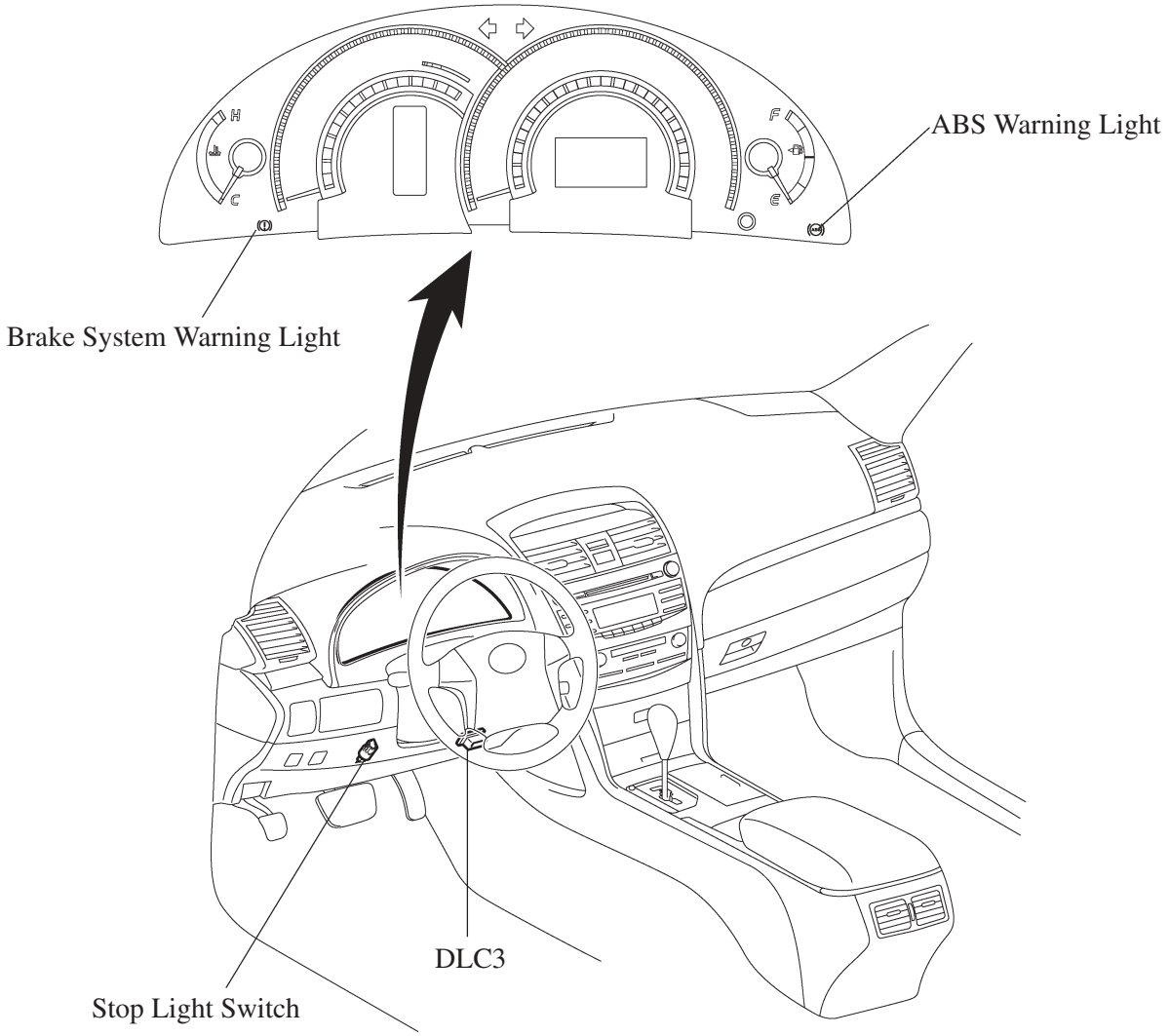
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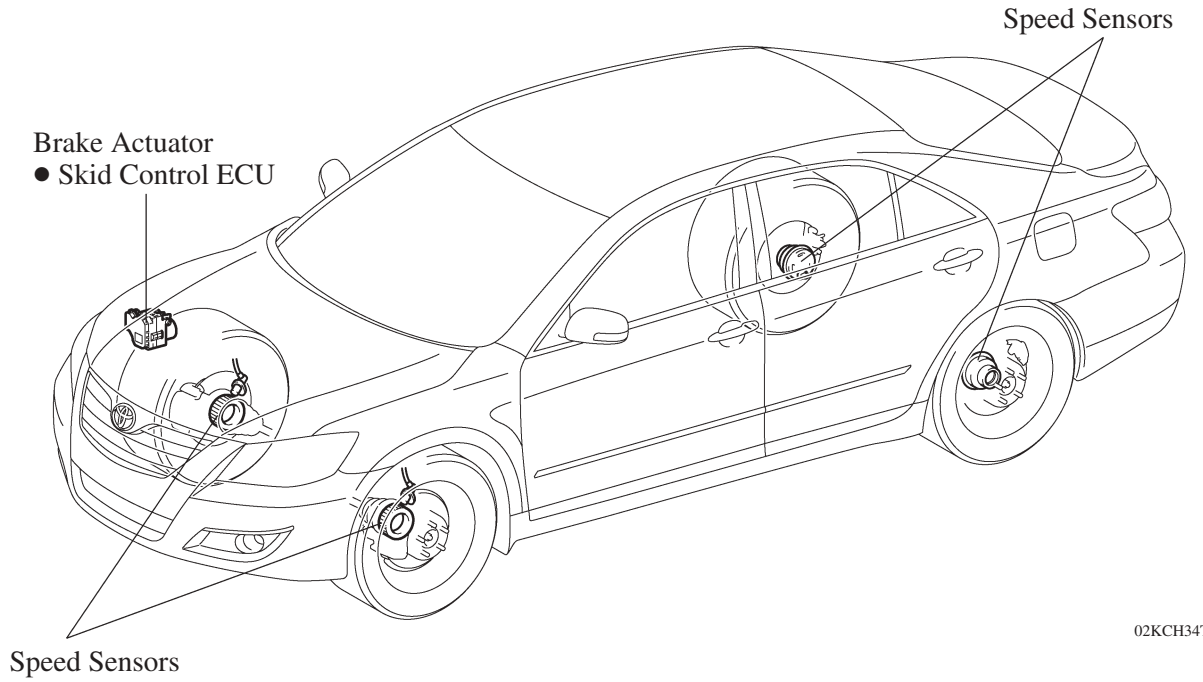
*: The basic performance of the brake is the same as of the models with the brake assist system



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4. Layout of Main Components





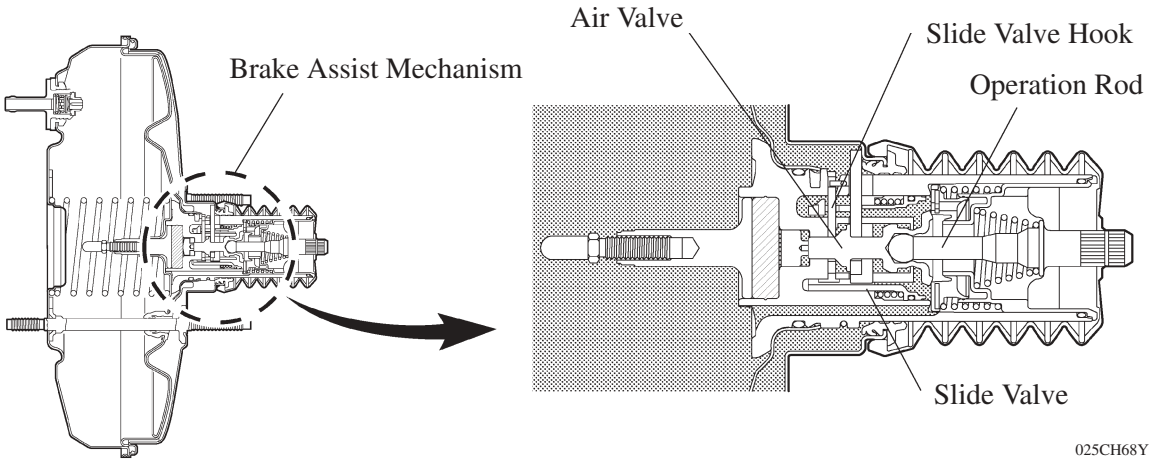
5. Function of Main Components

Component		Function
Combination Meter	Brake System Warning Light	● Lights up to alert the driver when a malfunction occurs in the EBD or skid control ECU. ● Lights up to alert the driver when the brake fluid level is low. ● Lights up to alert the driver when the parking brake pedal is depressed.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS or EBD.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Speed Sensors		Detects the wheel speed of each of 4 wheels.
Stop Light Switch		Detects the brake pedal depressing signals.
Parking Brake Switch		Detects the parking brake pedal depressing signals.
Brake Actuator	Actuator Portion	In charge of fluid path based on the signals from the skid control ECU during the operation of the ABS with EBD, in order to control the fluid pressure that is applied to the wheel cylinders.
	Skid Control ECU	Judges the vehicle driving condition based on the signals from each sensor, and sends brake control signals to the brake actuator.
	ABS solenoid relay	Supplies or cuts off power to solenoid valves in the brake actuator.
	ABS motor relay	Supplies or cuts off power to motor in the brake actuator.

6. Brake Booster (with Brake Assist Mechanism)

General

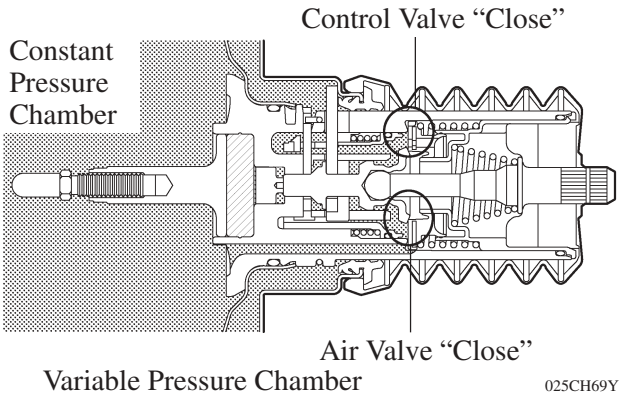
This brake booster consists of the conventional type brake booster to which a brake assist has been added. During a normal brake operation, the function of the brake booster is the same as that of the conventional type. The major difference in construction between this booster and the conventional type one is that the slide valve and the slide valve hook are added in the air valve in this booster.



Operation

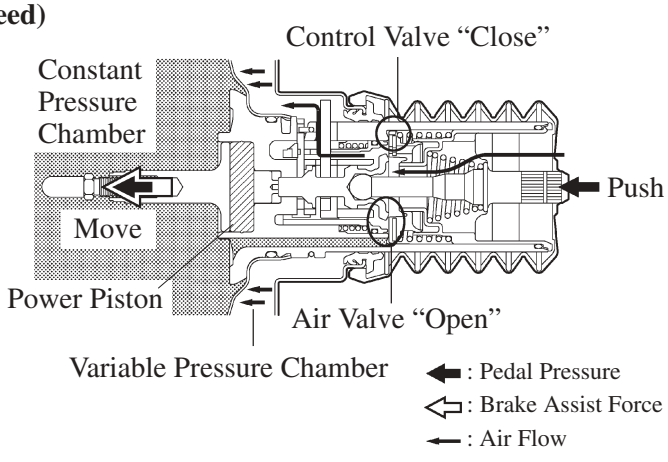
1) No Braking Condition

When the air valve closes, the pressure in the constant pressure chamber and that in the variable pressure chamber become the same, and the control valve closes.



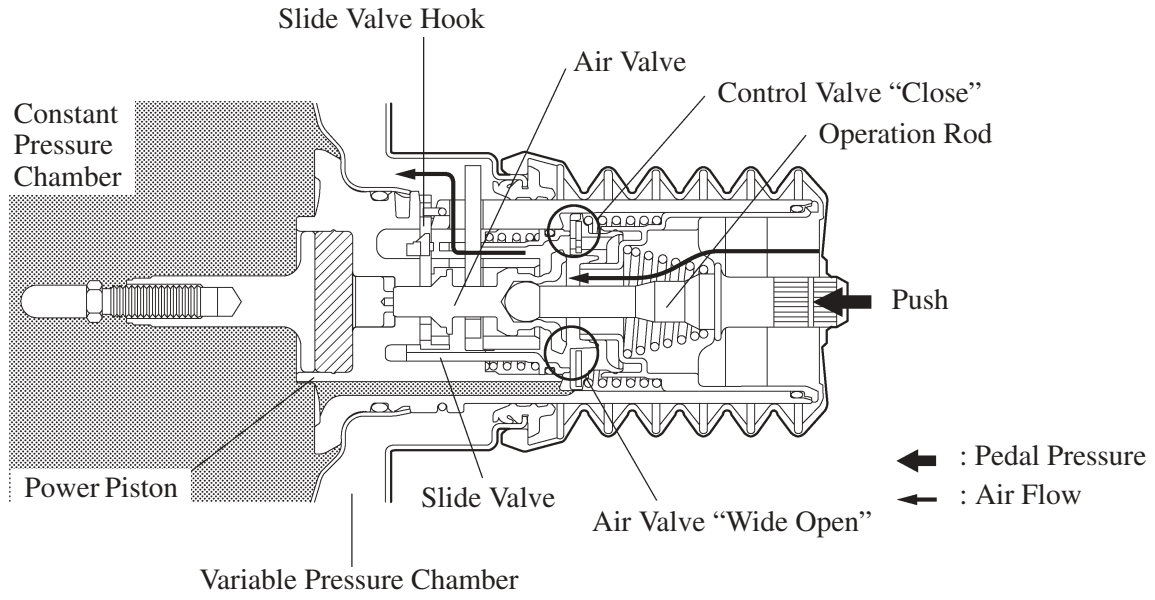
2) Normal Braking Condition (Operation Rod Speed = Power Piston Speed)

During normal braking, the air valve opens and the control valve closes to activate the brake booster function.

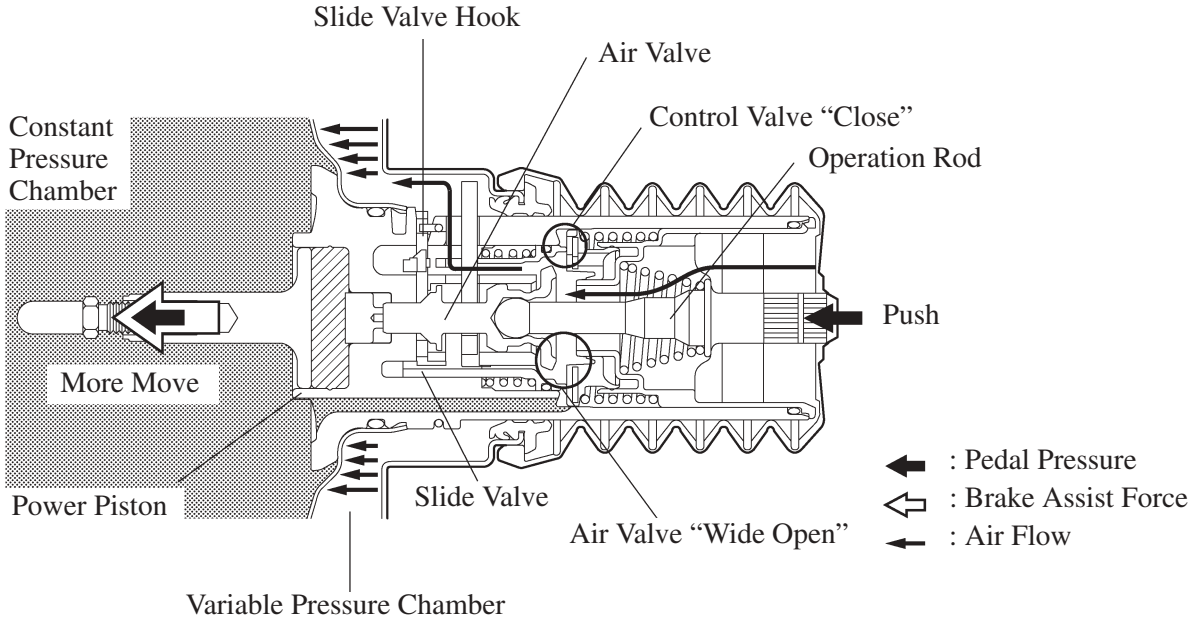


3) Brake Assist Condition (Operation Rod Speed > Power Piston Speed)

When the operation rod speed is faster than the power piston speed, the air valve pushes the slide valve hook. Consequently, the slide valve separates from the slide valve hook, the spring pushes the control valve, and the control valve closes. Thus, the opening of the air valve becomes enlarged and the air volume that is introduced increases. This results in a brake assist force to powerfully push the power piston.



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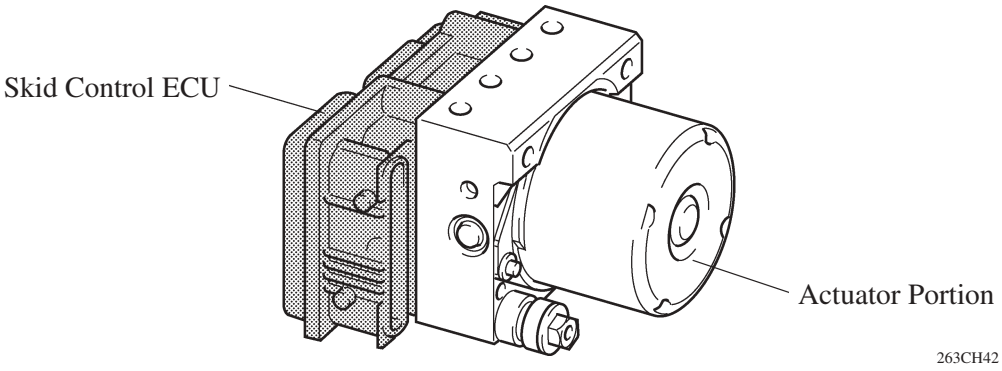


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7. Brake Actuator

General

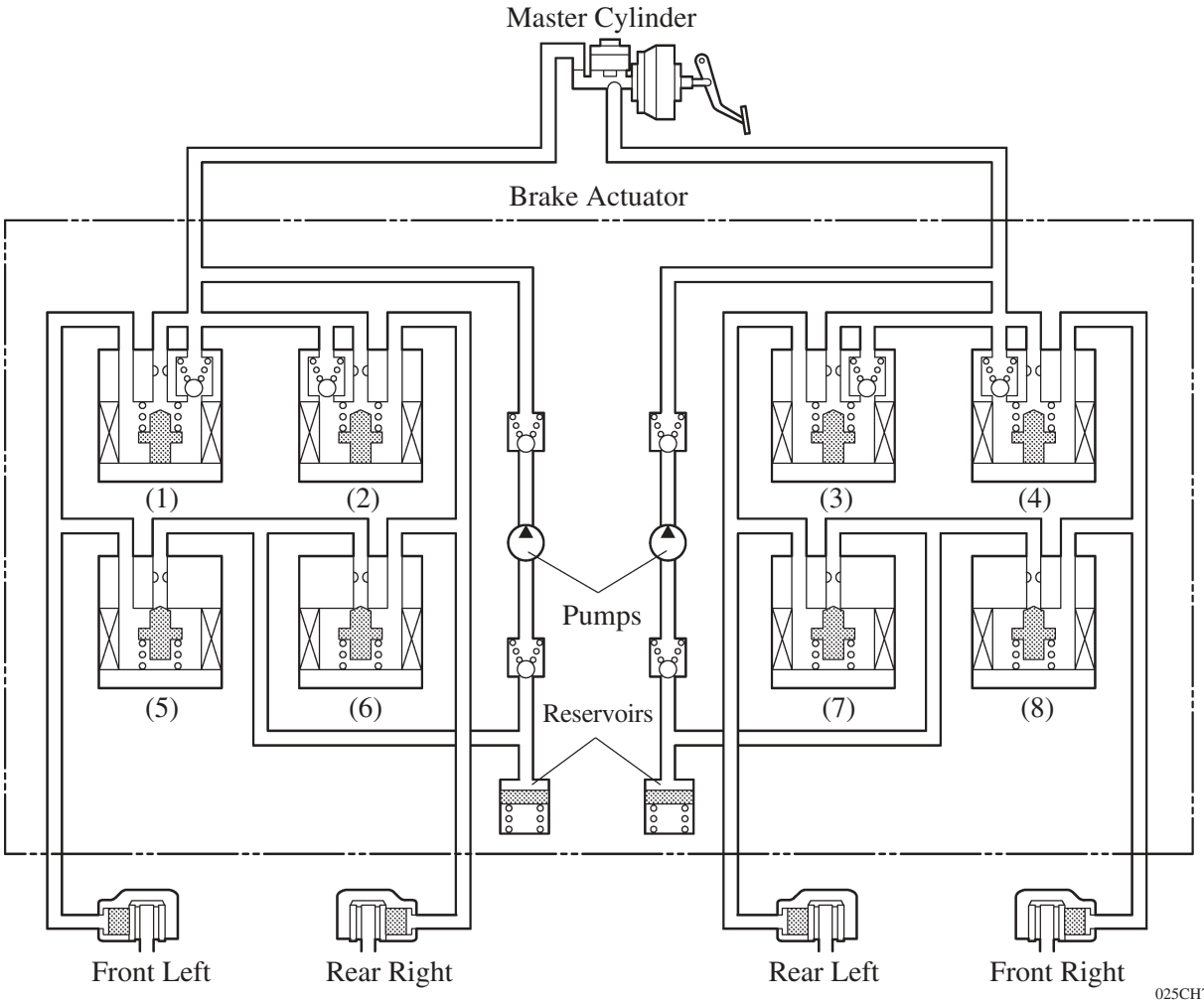
- The brake actuator consists of actuator portion, skid control ECU, ABS solenoid relay, and ABS motor relay.
- The 2 relays are built in the brake actuator.



Actuator Portion

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

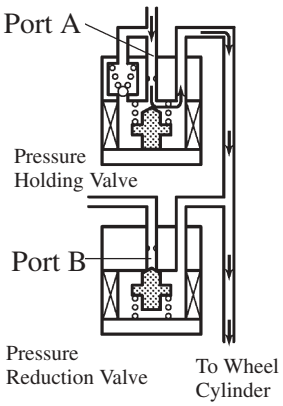
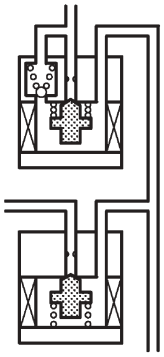
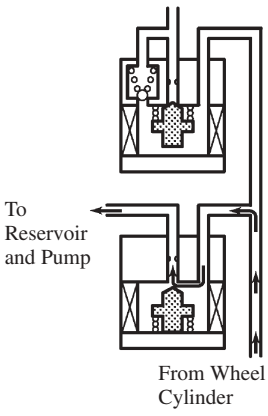
▶ Hydraulic Circuit ◀



8. System Operation

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 conditions. And according to the slipping condition, the skid control ECU controls the pressure holding valve and pressure reduction valve in order to adjust the fluid pressure of the 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)	←
Pressure Reduction Valve (Port B)	OFF (Close)	←	ON (Open)
Wheel Cylinder Pressure	Increase	Hold	Reduction

Initial Check

After the ignition is turned ON, and the vehicle attains an approximate speed of 15 km/h (9 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.

9. Diagnosis

General

If the skid control ECU detects a malfunction in the brake control system (ABS with EBD), the ABS and brake system warning lights that correspond to the function in which the malfunction have been detected indicate or light up to alert the driver of the malfunction as indicated in the table below.

○: Light ON —: Light OFF

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

- At the same time, the DTC (Diagnostic Trouble Code) are stored in the memory. The DTC can be read by connecting the SST (09843-18040) between the Tc and CG terminals of DLC3 and observing the blinks of the ABS warning light, or by connecting an intelligent tester II.
- This system has a sensor signal check (test mode) function. This function is activated by connecting the SST (09843-18040) between the Ts and CG terminal of the DLC3 or by connecting an intelligent tester II.
- If the skid control ECU detects a malfunction during a sensor signal check (test mode), it stores the DTC in its memory. These DTC can be read during a sensor check operation by connecting the SST (09843-18040) to the Tc and CG terminals of the DLC3 and observing the blinking of the ABS warning light or a connecting an intelligent tester II.

Diagnosis of CAN

- If a malfunction occurs on a CAN communication line, the skid control ECU is connected to the CAN communication lines and it will store the DTC (Diagnostic Trouble Code) in its memory.
- There are 2-digit DTC and 5-digit DTC for CAN communications related to the brake control system (ABS with EBD and brake assist).
  - 2-digit DTC can be read by connecting the SST (09843-18040) to Tc and CG terminals of the DLC3, and observing the diagnostic code indicated on the multi-information display in the combination meter.
  - 5-digit DTC can be read by connecting an intelligent tester II to the DLC3.

Fail-Safe

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