■BRAKE CONTROL SYSTEM (ABS with EBD, Brake Assist)

1. General

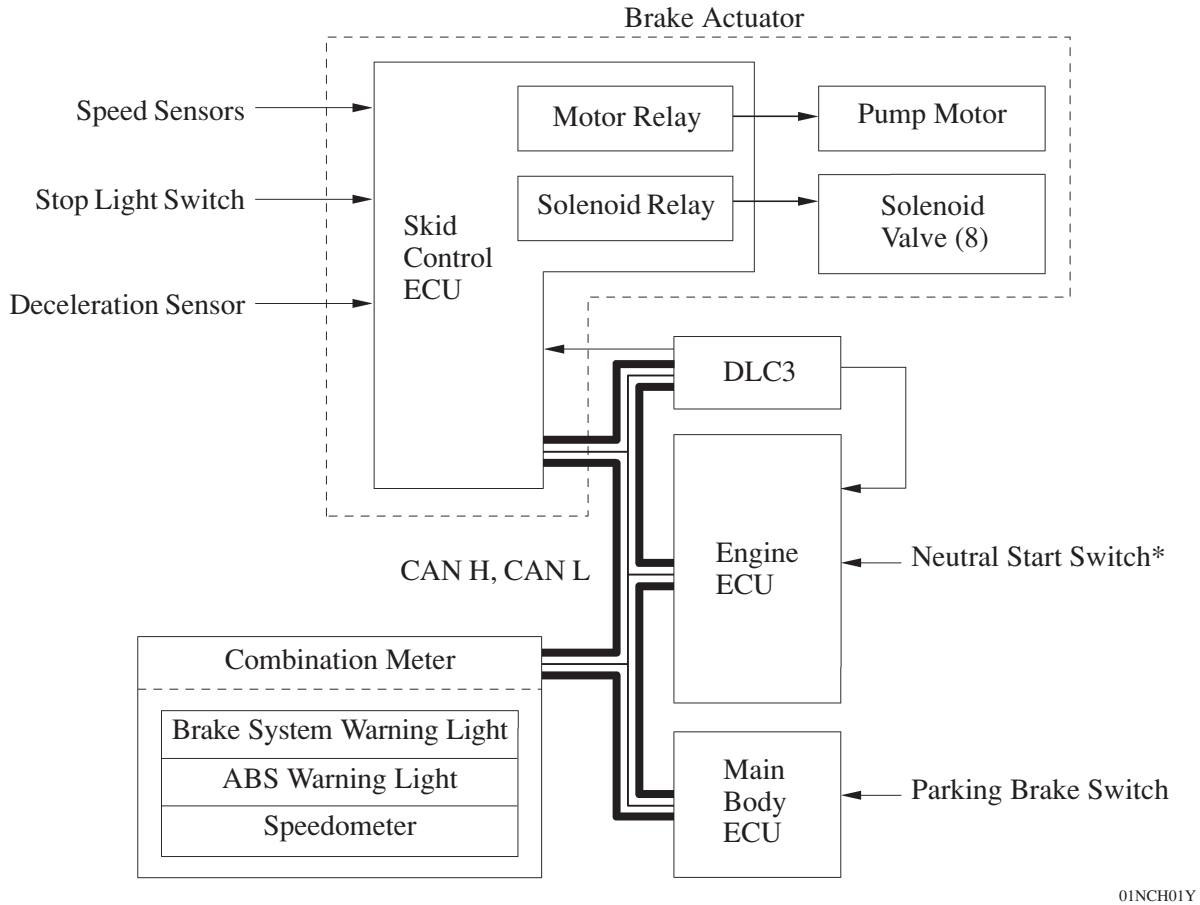
The brake control system (ABS with EBD) of the new models has the following functions:

Function	Outline
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brake is applied firmly or applied on a slippery surface.
EBD (Electronic Brake force Distribution)	The EBD control utilizes the ABS, realizing the proper brake force distribution between the front and rear wheels in accordance with the driving conditions. In addition, during cornering braking, it also controls the brake forces of the right and left wheels, helping to maintain the vehicle behavior.
Brake Assist (Mechanical Type)	The primary purpose of the Brake Assist function is to provide an auxiliary brake force to assist the driver who cannot generate a large brake force during emergency braking, thus helping draw the vehicle's brake performance.

Service Tip

When brake control system (except Brake Assist) is activated, the brake pedal could shudder, which is a normal occurrence of the system in operation and should not be considered as a malfunction.

▶ System Diagram ◀



*: Only for A/T Models

2. Outline of EBD Function

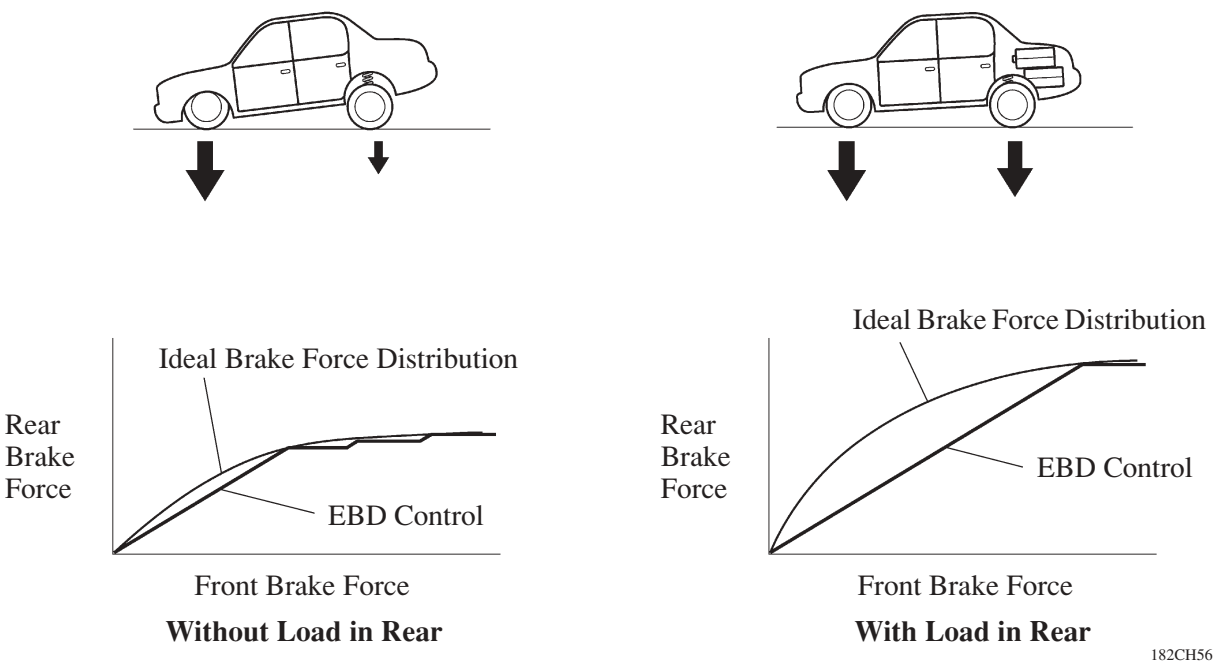
General

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 controls the brake 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 load reduces the weight that is applied to the rear wheels. The skid control ECU determines this condition by way of the signals from the deceleration 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 depending on whether the vehicle is carrying load or not. 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 wheels is optimally controlled in order to effectively utilize the brake force of the rear wheels under these conditions.

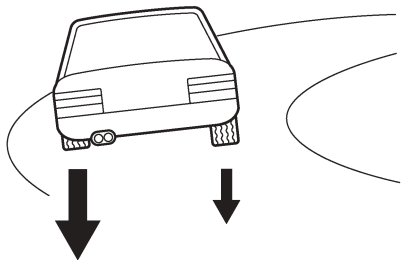
▶ EBD Control Concept ◀



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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 is applied to the inner wheel decreases as the load 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.

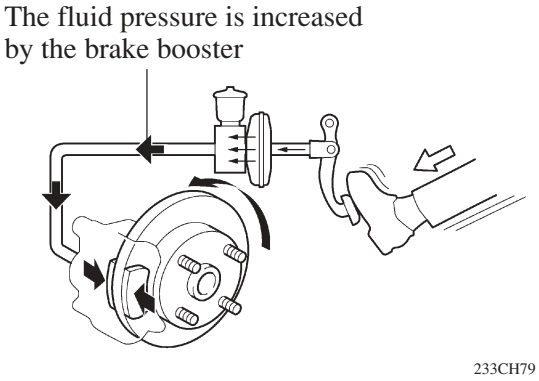


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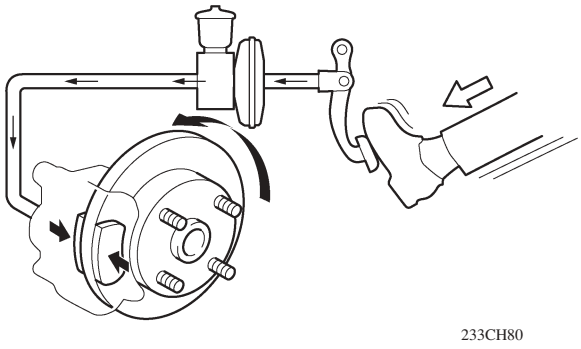
3. Outline of Brake Assist Function (Mechanical Type)

- The Brake Assist function in combination with the ABS helps ensure the vehicle's brake performance.
- The Brake Assist function interprets a quick push of the brake pedal as emergency braking and supplements the brake force applied if the driver has not depressed hard enough the brake pedal. In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure on the brake pedal.
- A key feature of Brake Assist function is that the timing and the degree of braking assistance are designed to help 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 function 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-85.

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

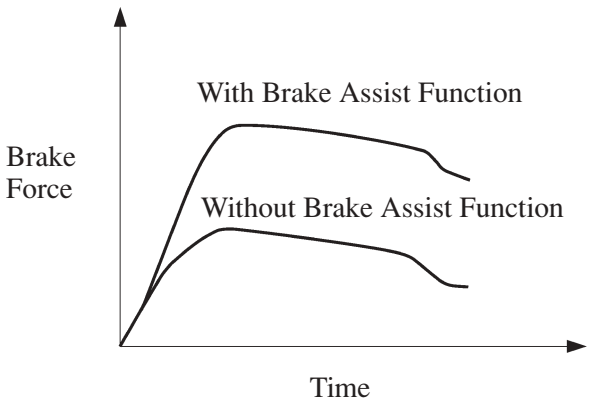


With Brake Assist Function

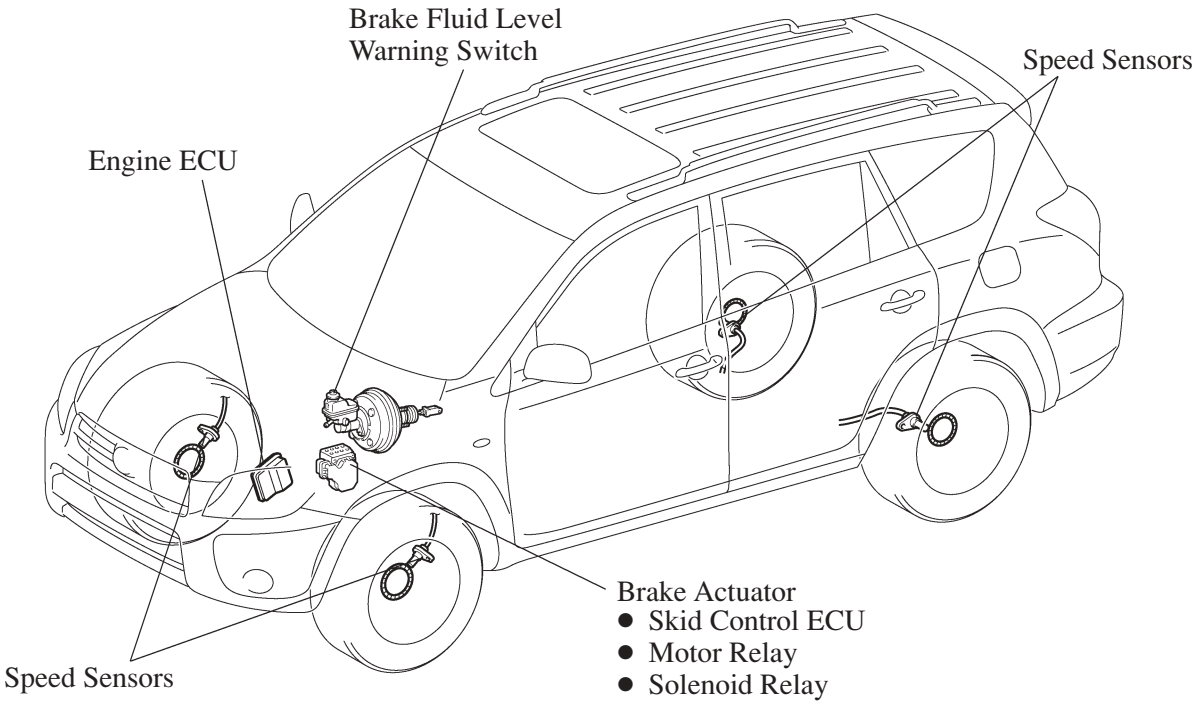


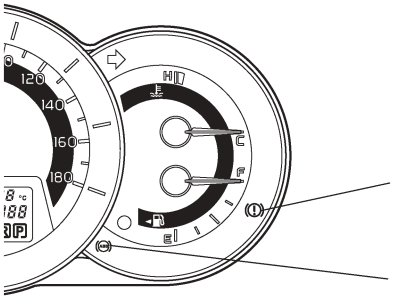
Without Brake Assist Function*

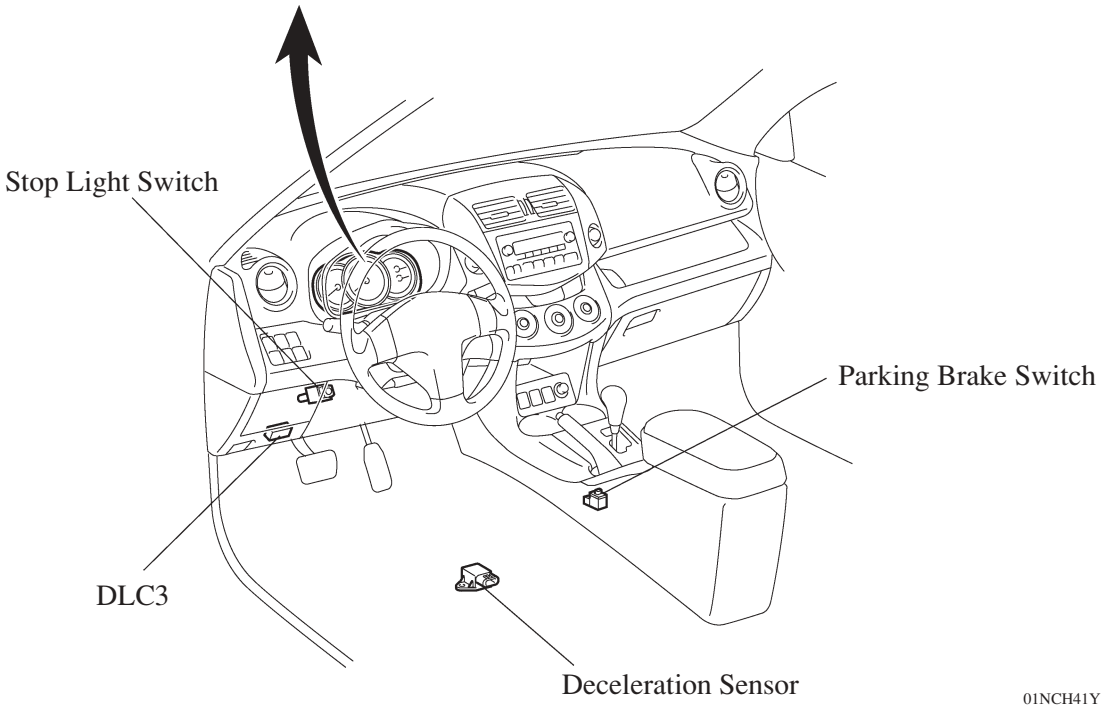
*: The basic performance of the brake is the same as that of the models with the Brake Assist function



4. Layout of Main Components







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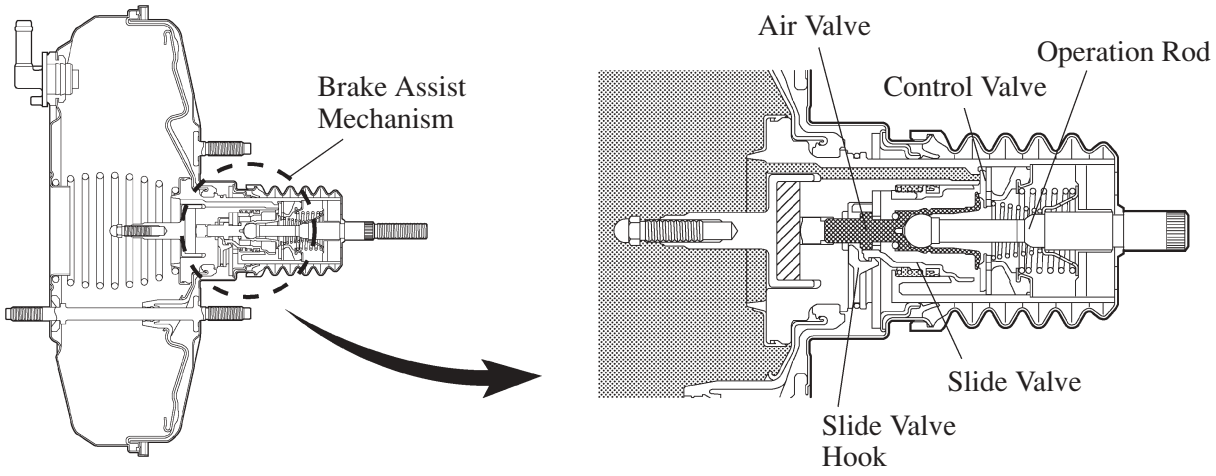
5. Function of Main Components

Component		Function
Combination Meter	Brake System Warning Light	● Lights up together with ABS warning light to alert the driver when the skid control ECU detects the malfunction in the ABS, EBD or skid control ECU. ● Lights up to inform the driver when the parking brake lever is pulled up. ● Lights up to alert the driver when the brake fluid level is low.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS.
Speed Sensor (4)		Detects the wheel speed of each of 4 wheels.
Deceleration Sensor		Detects the longitudinal acceleration and deceleration.
Parking Brake Switch		Detects when the parking brake lever is pulled up.
Stop light Switch		Detects the brake pedal depressing signal.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Brake Booster		● Increases the brake pedal effort. ● Operates the brake assist mechanism to mechanically activate the brake assist function.
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, 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.
	Motor Relay	Supplies or cuts off power to the motor in the brake actuator.
	Solenoid Relay	Supplies or cuts off power to the solenoid valves in the brake actuator.
Engine ECU		Sends the signals from the neutral start switch etc., to the skid control ECU.

6. Brake Booster (with Brake Assist Mechanism)

General

This brake booster consists of the conventional type brake booster to which a brake assist mechanism 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.

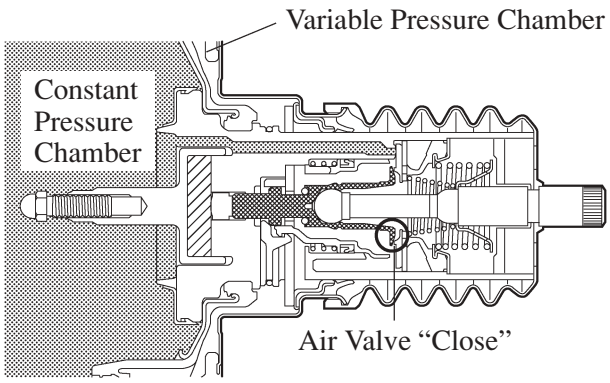


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Operation

1) No Braking Condition

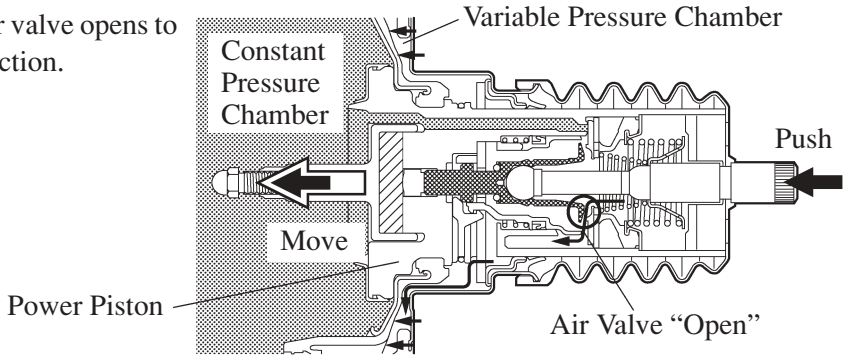
The air valve closes, and the pressure is the same in the variable pressure chamber and the constant pressure chamber.



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

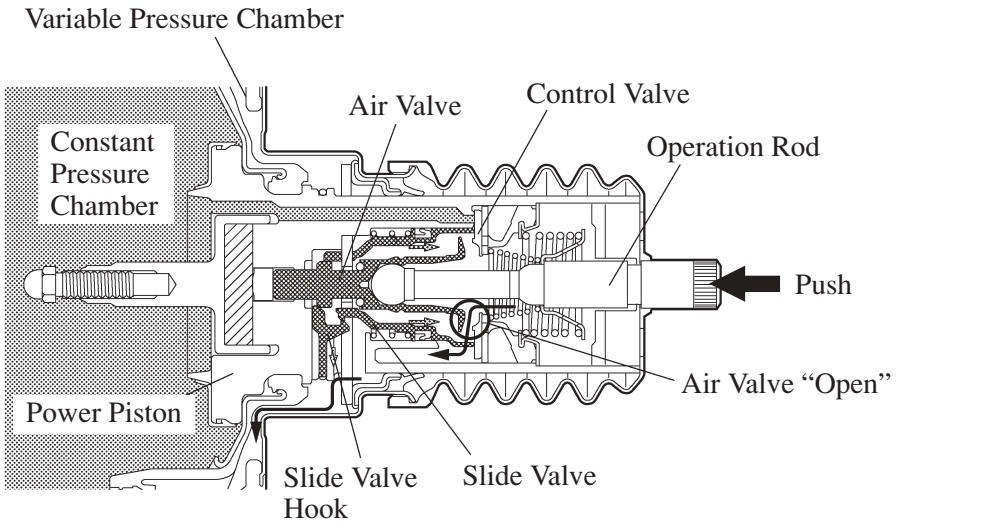
During normal braking, the air valve opens to activate the brake booster function.



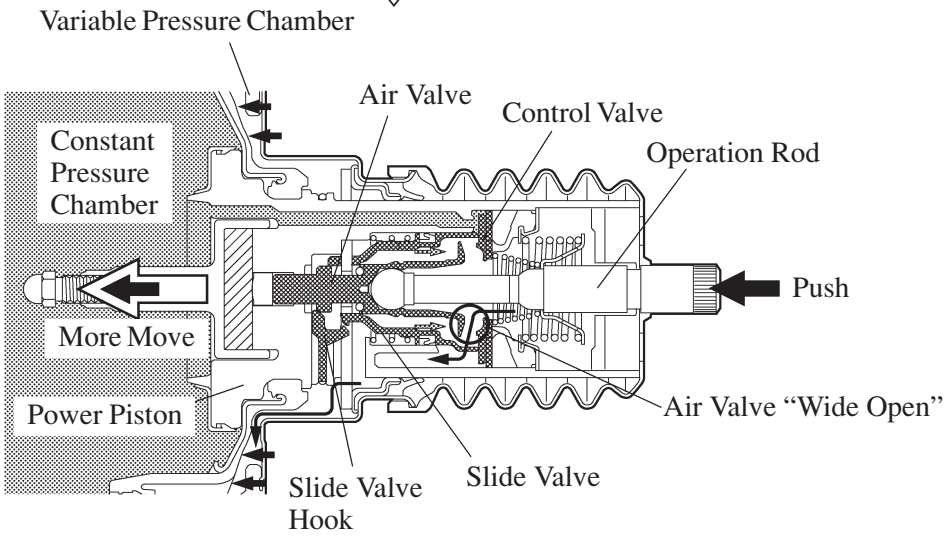
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3) Brake Assist Condition
(Operation Rod Speed > Power Piston Speed)

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, and the slide valve pushes the control valve to open the air valve wider than in the normal brake condition. Thus, the air volume that is introduced increases. This results in a brake assist force to powerfully push the power piston.



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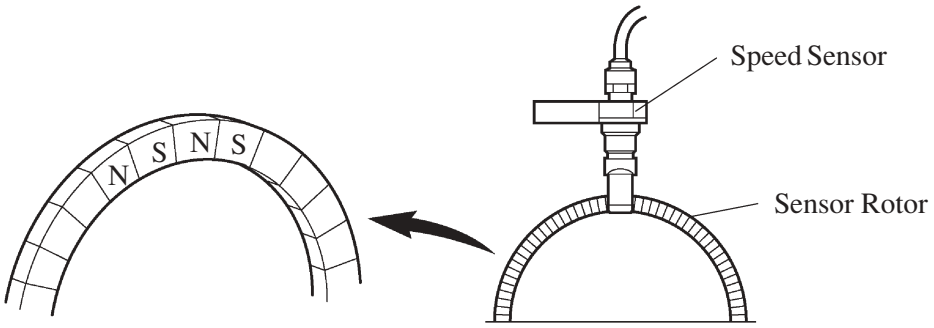


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7. Speed Sensor

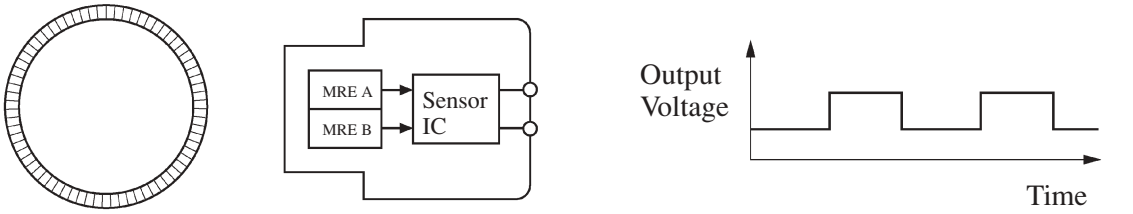
General

- An active type speed sensor is used. This sensor contains a sensor IC, which consists of two MREs (Magnetic Resistance Elements).
- The sensor rotor, which consists of N and S poles that are arranged in a circle, is integrated with the hub bearing inner race.



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▶ **Active Type Speed Sensor** ◀



Sensor Rotor (Hub Bearing Inner Race)

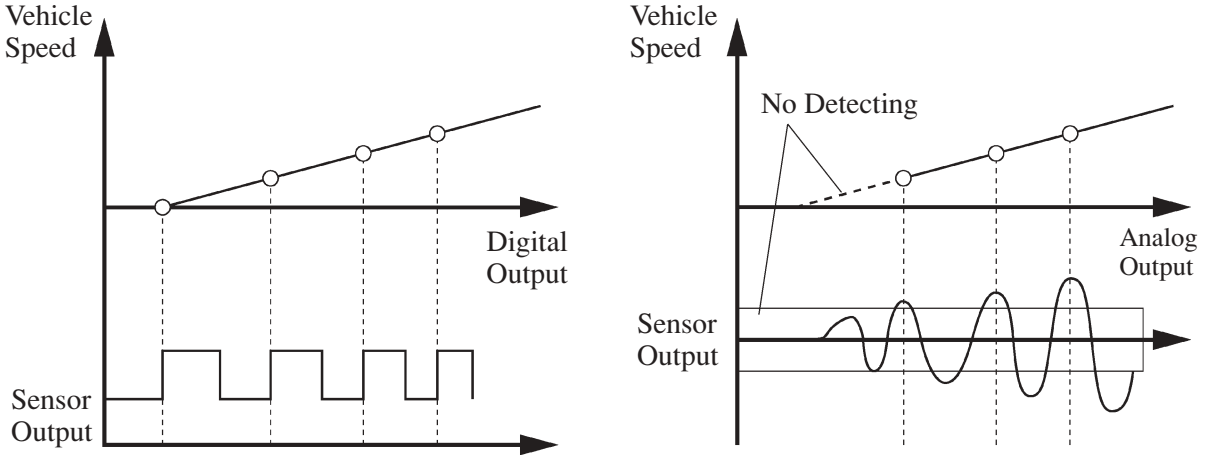
Forward and Backward

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Operation

- Along with the rotational movement of the magnetic rotor, the N and S poles of the magnetic rotor pass alternately near the sensing portion of the speed sensor. This speed sensor outputs magnetic flux as a current value. The skid control ECU detects the changes in the output current to determine the wheel speed.
- Unlike the passive type speed sensors used on conventional models that output analog pulses, the active type speed sensor outputs digital pulses. Therefore, it can start detecting vehicle speeds at approximately 0 km/h.

▶ **Comparison between Active Type and Passive Type Output Waveform Image** ◀



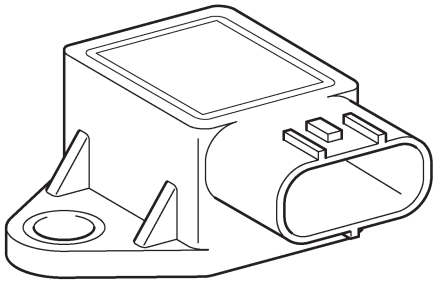
Active Type

Passive Type

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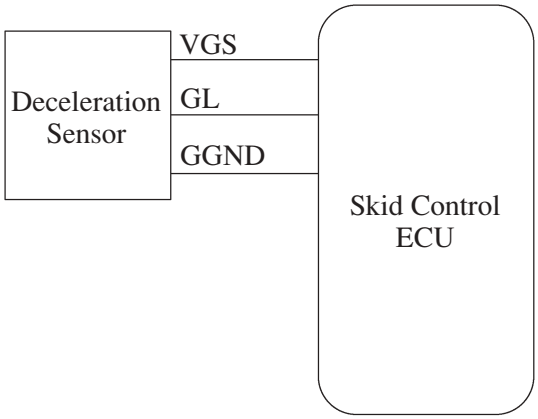
8. Deceleration Sensor

A deceleration sensor has been provided under the driver seat. This sensor detects the longitudinal acceleration and deceleration of the vehicle and transmits it to the skid control ECU.



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Deceleration Sensor

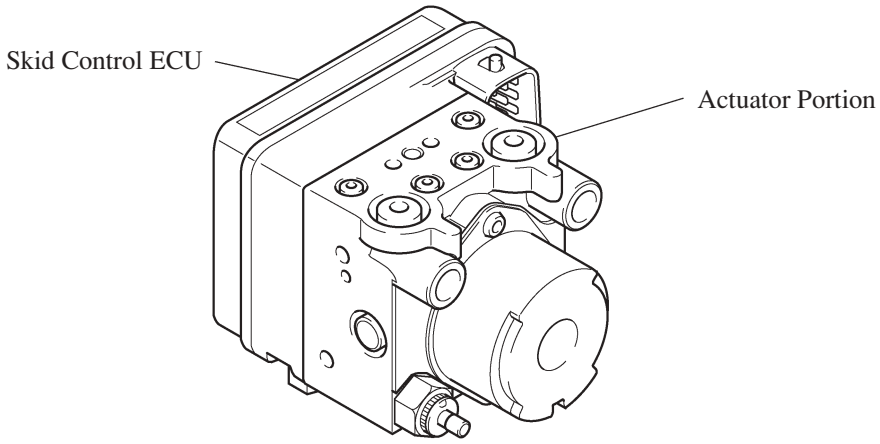


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9. Brake Actuator

General

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

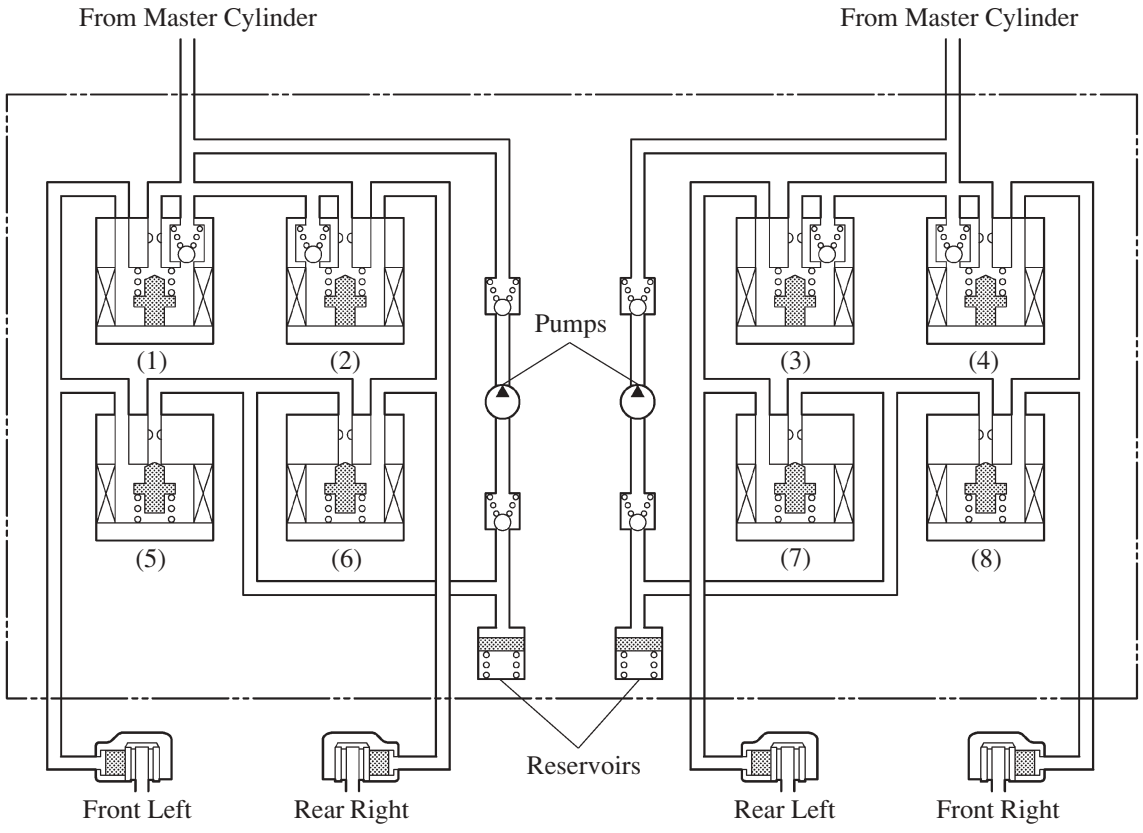


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Actuator Portion

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

▶ Hydraulic Circuit ◀

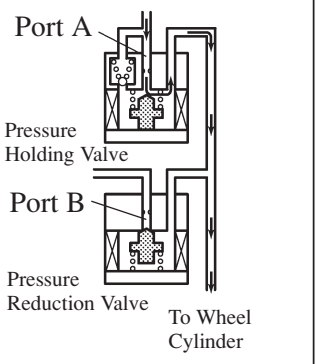
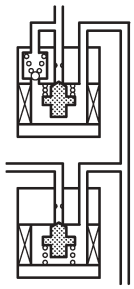
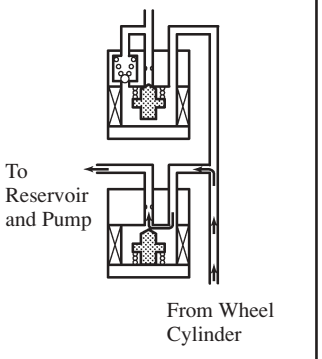


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10. System Operation

ABS with EBD Operation

Based on the signals received from the 4 speed sensors, the skid control ECU calculates each wheel speed and deceleration, and checks wheel slipping conditions. 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	Reduce

Initial Check

After the ignition switch is turned ON*1 or the engine switch is selected in the IG-ON mode*2, 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.

*1: Models without Smart Entry & Start System
*2: Models with Smart Entry & Start System

Self-diagnosis

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

For details of the DTCs that are stored in skid control ECU memory and the DTCs that are output through the sensor signal check (test mode) functions, see the RAV4 Repair Manual (Pub. No. RM01N0E).

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 the EBD control, the brake system is operated as long as possible even if the ABS control is prohibited. If the EBD control becomes impossible, the brake system warning light illuminates to inform the driver of that. In this case, the brake system is operated in the same condition as the brake system without the ABS with EBD.