

## ■ BRAKE CONTROL SYSTEM (ABS with EBD and BRAKE ASSIST)

### 1. General

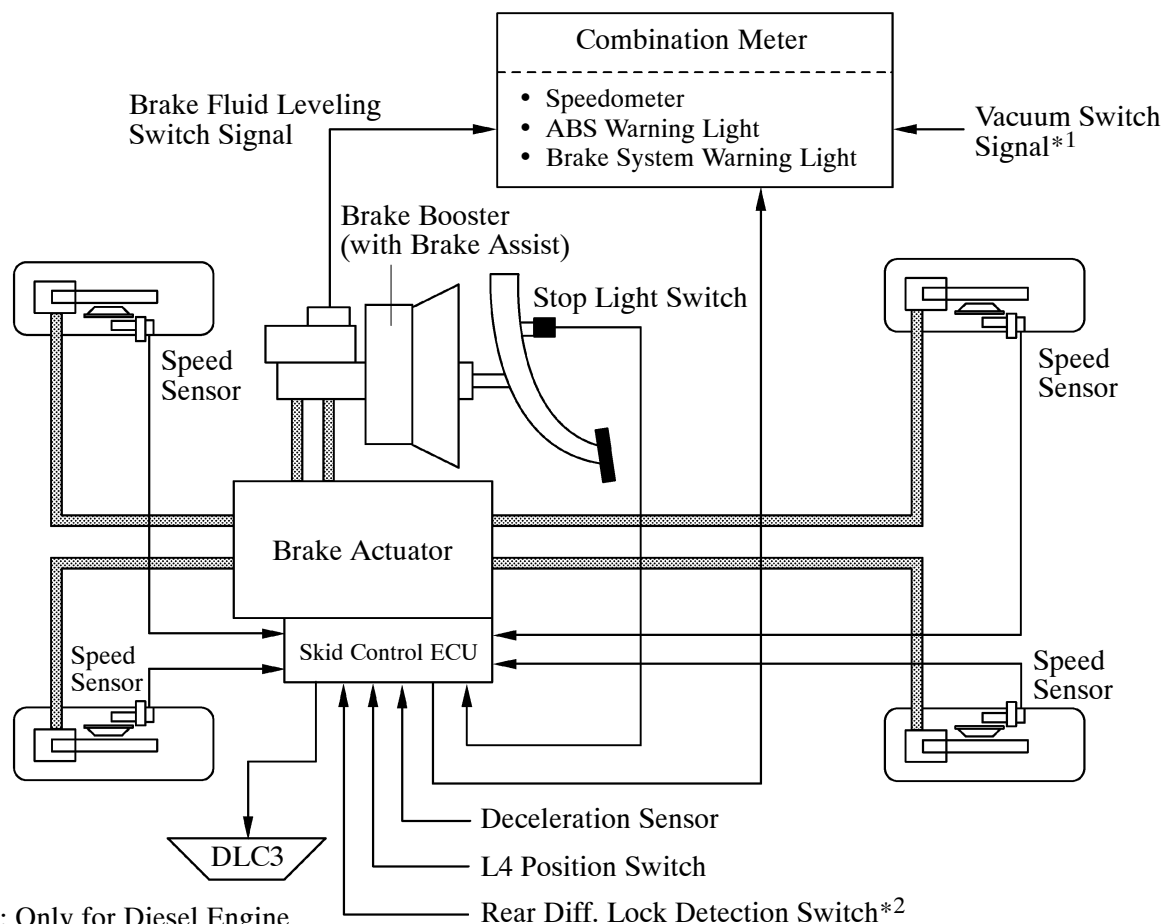
The brake control system (ABS with EBD and Brake Assist) of new Land Cruiser/ Land Cruiser Prado has a following function:

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 system 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 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.

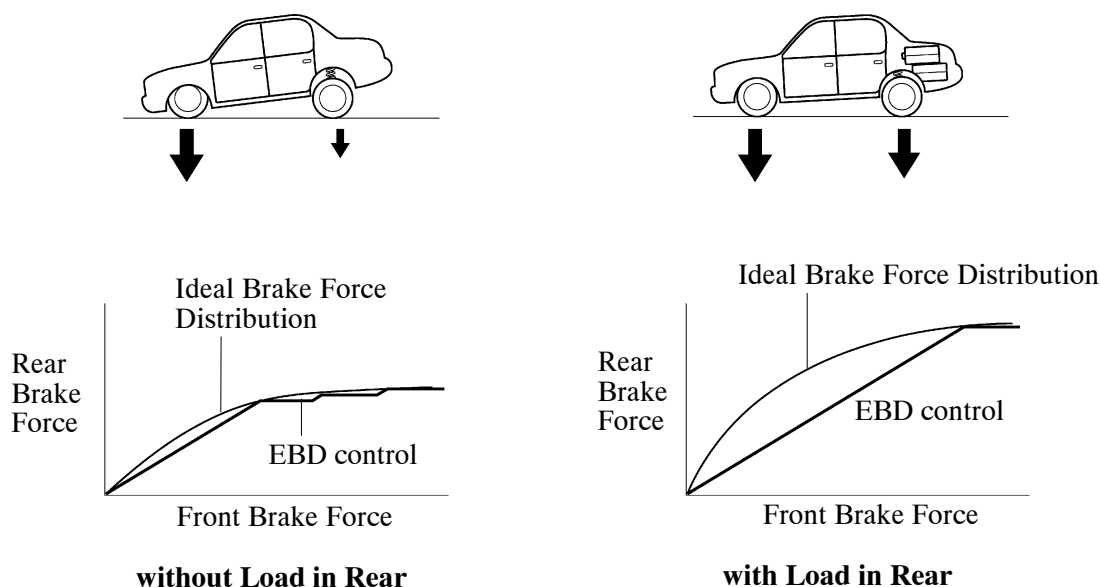
### Front/ Rear Wheels Brake Force Distribution

If the brakes are applied while the vehicle is moving straight forward, the transfer of the 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 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 ◀

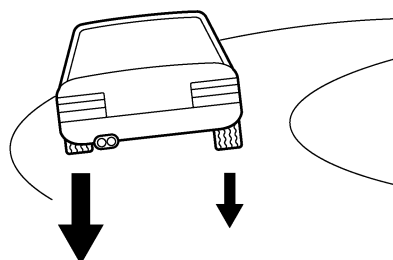


182CH56

### 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.



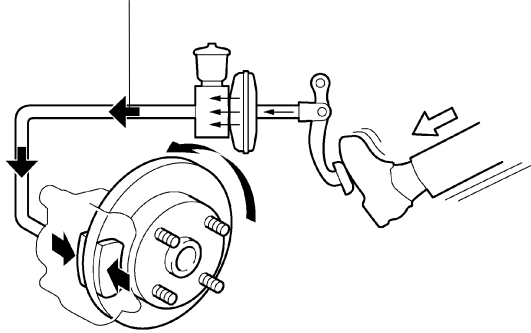
181CH56

### 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 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-103.

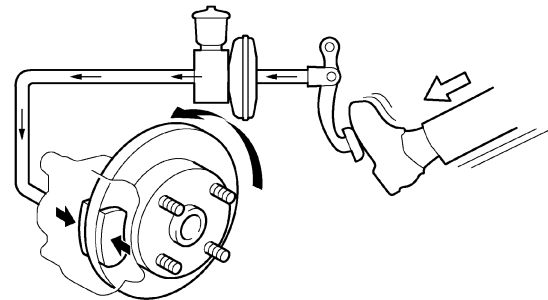
► In case that the driver's depressing force is small when applying emergency braking ◀

The fluid pressure is increased by the brake booster



with Brake Assist

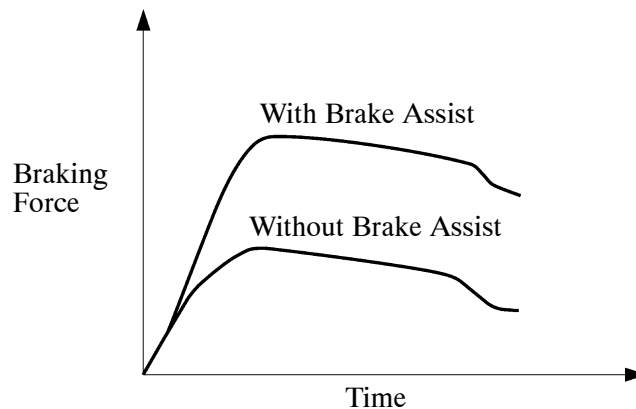
233CH79



without Brake Assist\*

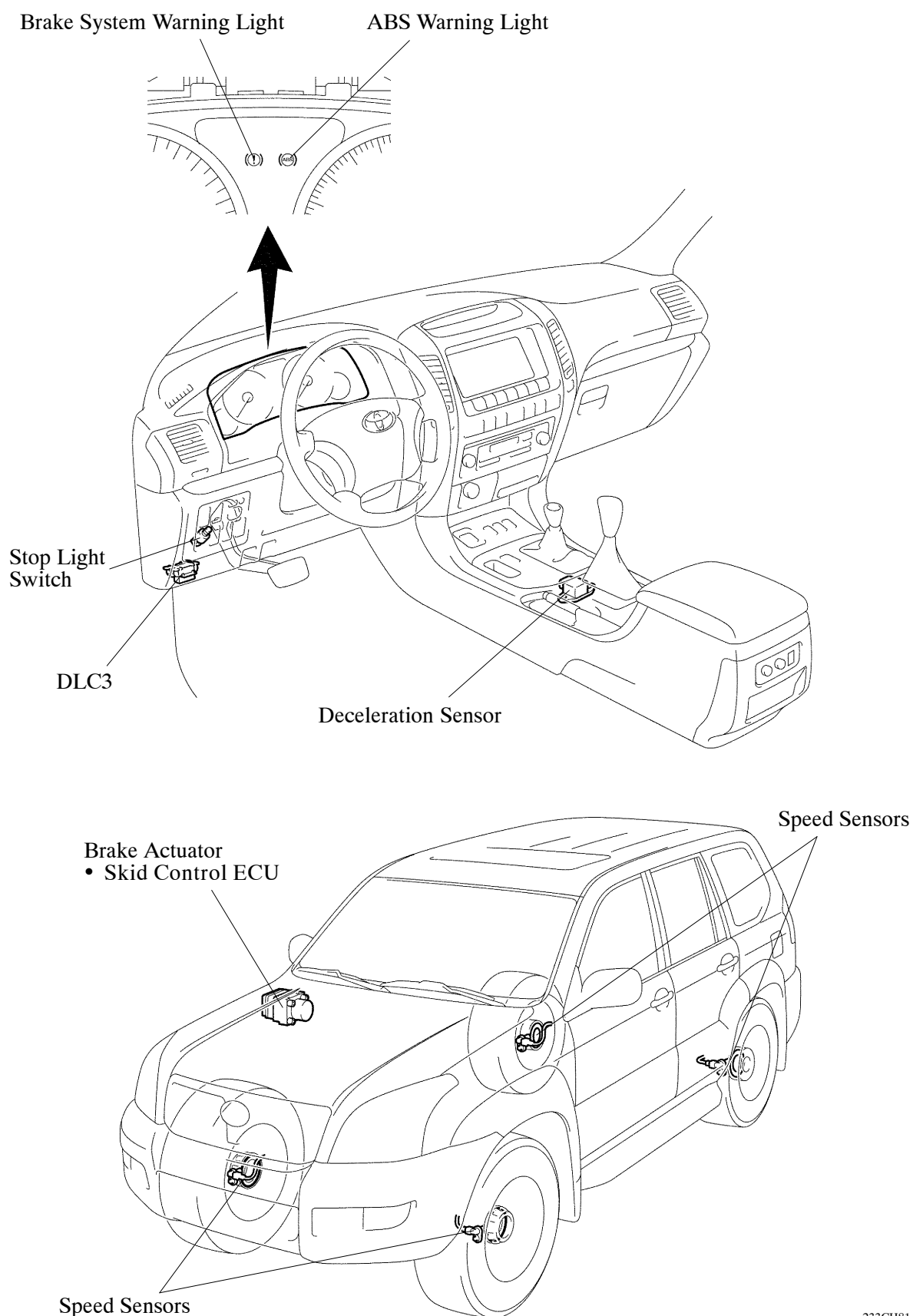
233CH80

\*: The basic performance of the brake is the same as of the model with the brake assist.



170CH18

#### 4. Layout of Main Component



## 5. Function of Main Component

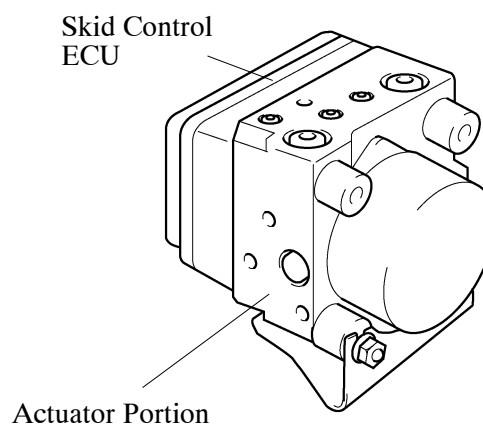
Components		Function
Combination Meter	Brake System Warning Light	<ul style="list-style-type: none"> <li>Lights up to alert the driver when a malfunction occurs in the EBD or skid control ECU.</li> <li>Blinks to alert the driver that the vacuum pressure of the brake booster has decreased. (only for Diesel Engine/ 5L, 1KZ, or 1KD)</li> </ul>
	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.
Stop Light Switch		Detects the brake pedal depressing signals.
Speed Sensor (4)		Detects the wheel speed of each of 4 wheels.
Vacuum Switch*		Detects the vacuum pressure of the brake booster.
Deceleration Sensor		Detects the vehicle's acceleration in the forward, rearward and lateral.
Brake Booster (with Brake Assist Mechanism)		<ul style="list-style-type: none"> <li>Increases the brake pedal effort.</li> <li>Operates the brake assist mechanism to mechanically activate the brake assist function.</li> </ul>
Brake Actuator	Actuator Portion	Charges 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.

\*: Only for Diesel Engine

## 6. Brake Actuator

### General

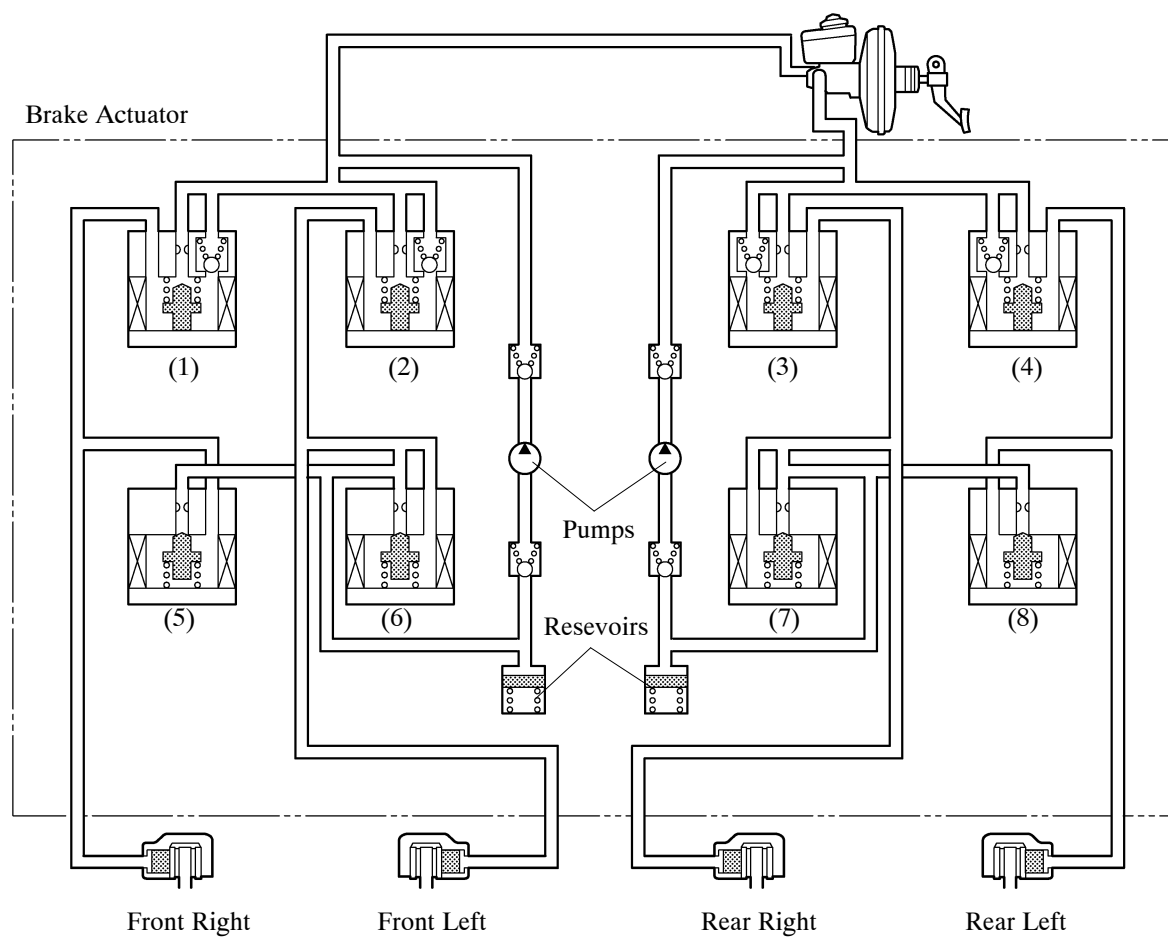
The brake actuator consists of actuator portion and skid control ECU.



## Actuator Portion

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

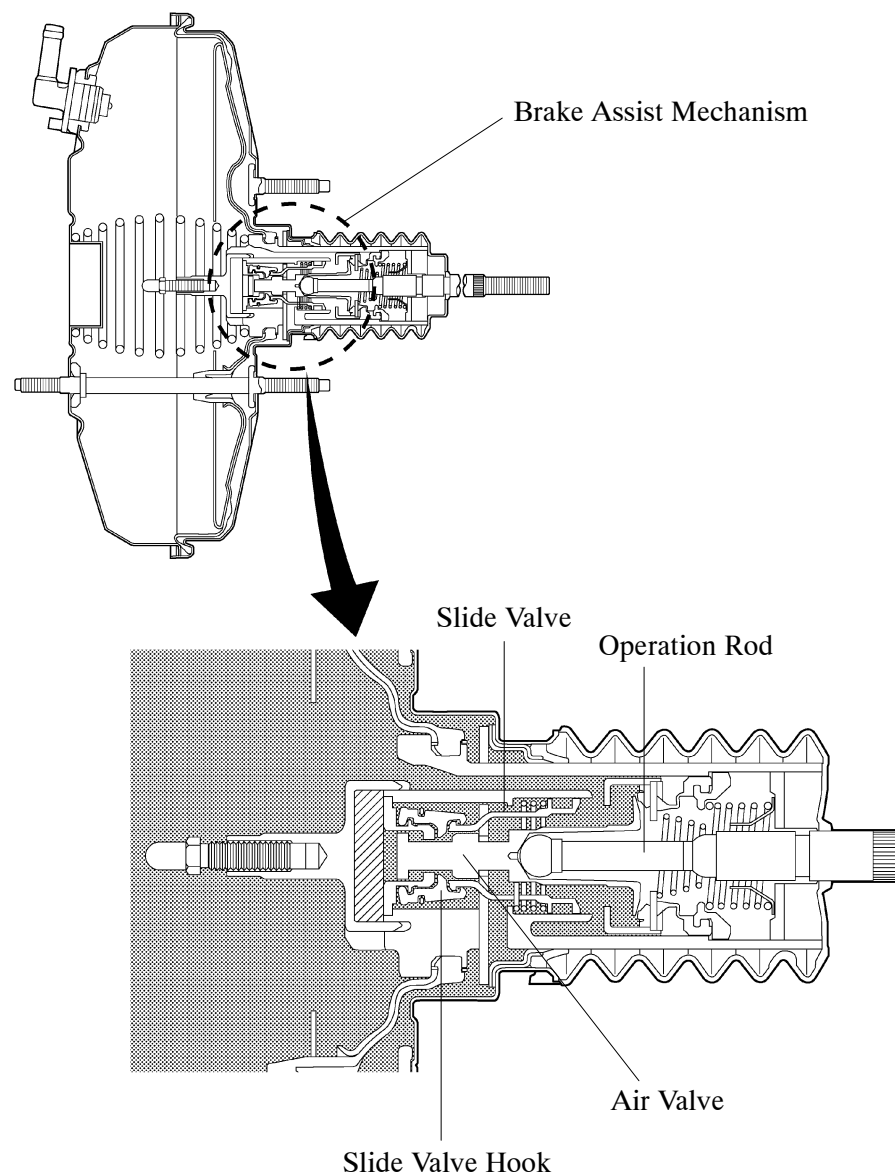
### ► Hydraulic Circuit ◀



## 7. Brake Booster (with Brake Assist Mechanism)

### General

This brake booster consists of 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 in the conventional type. The major difference in construction between this booster from the conventional type is the addition of the slide valve and the slide valve hook in the air valve.

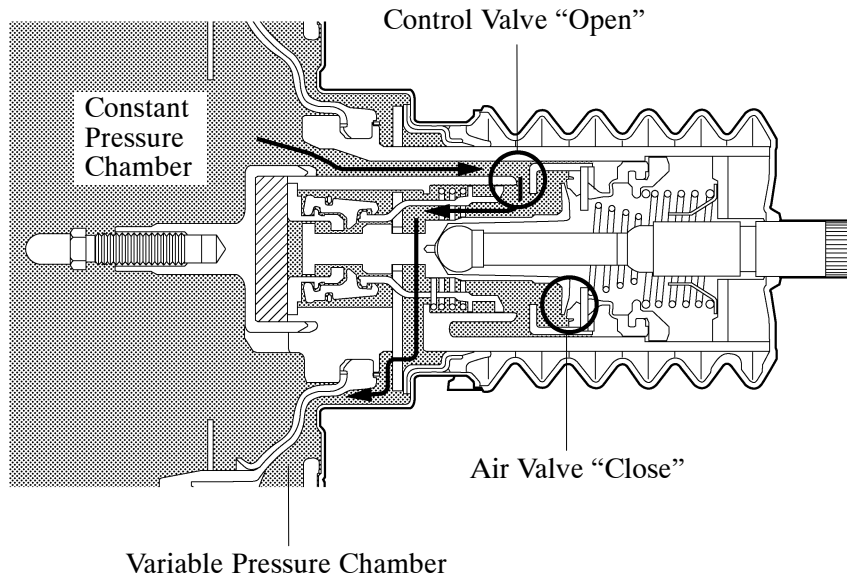


CH

## Operation

### 1) No Braking Condition

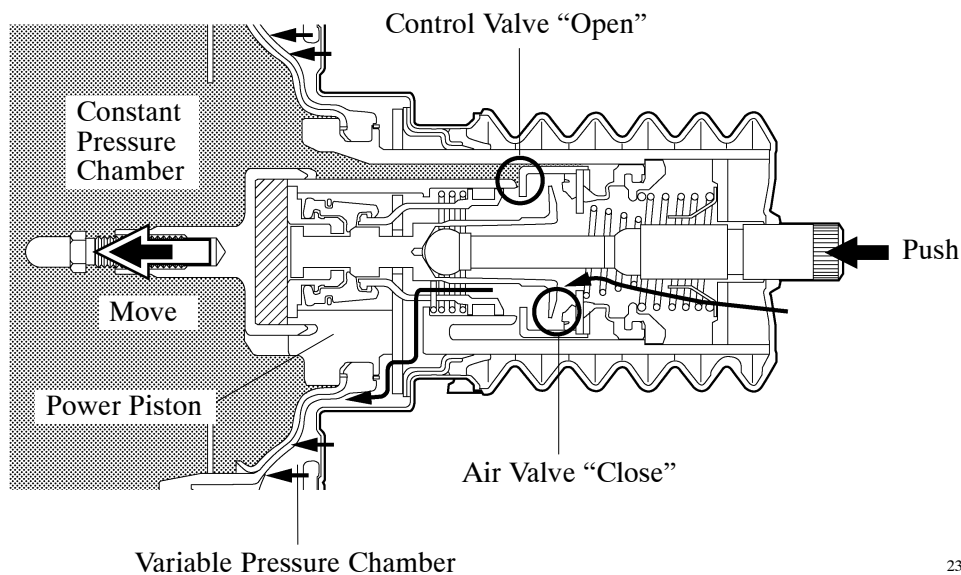
The air valve closes, the control valve opens, and the pressure is the same in the variable pressure chamber and the constant pressure chamber.



233CH85

### 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.

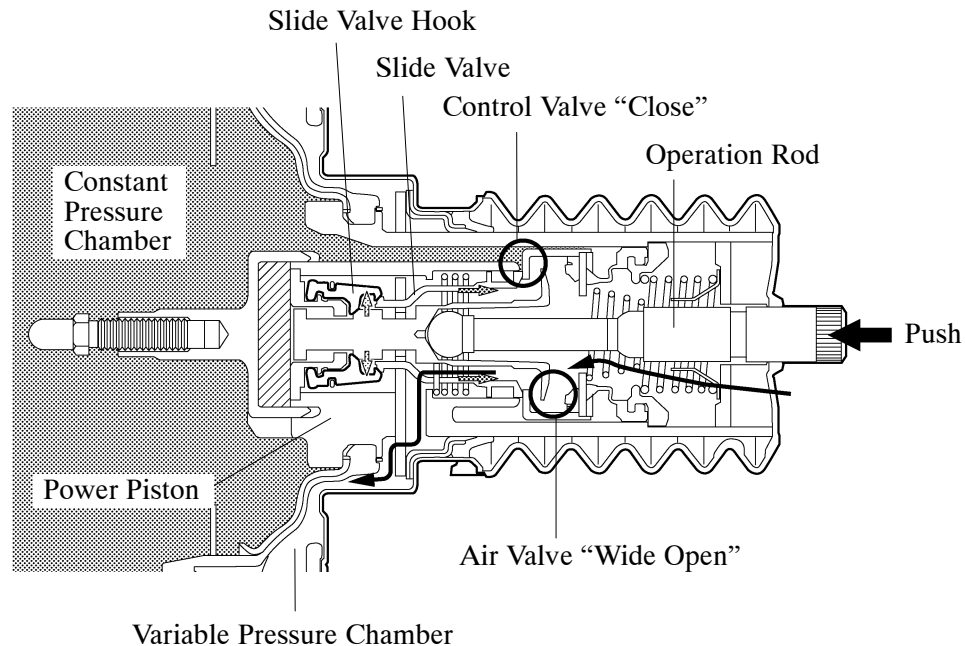


233CH86

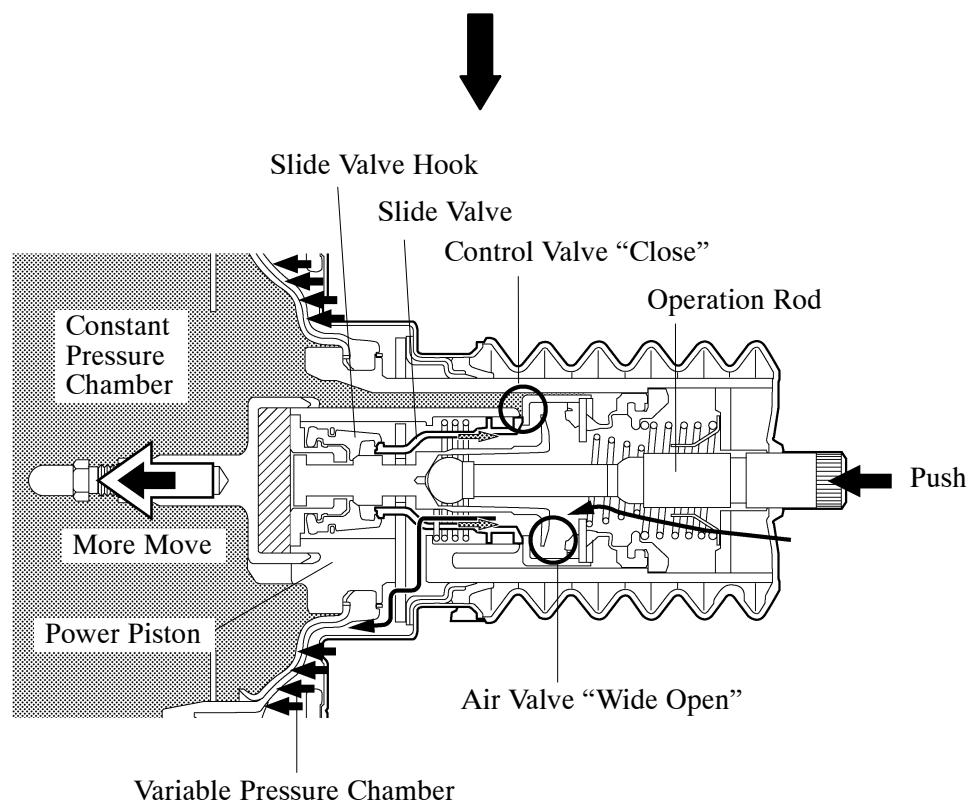


### 3) Brake Assist Condition (Operation Rod Speed > Power Piston Speed)

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 increases the volume of air that is introduced. This results in a brake assist force to powerfully push the power piston.



233CH87



233CH88

# 8. System Operation

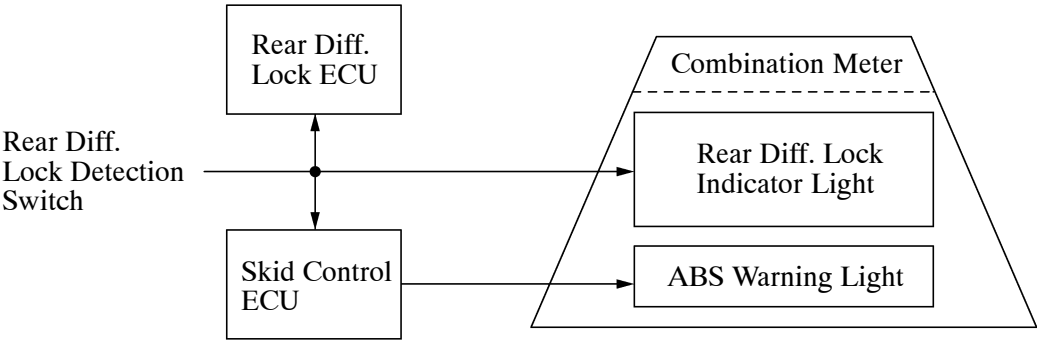
## ABS with EBD Operation

Based on the signals received from the 4 wheel speed sensors and yaw rate & deceleration sensor, 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, pressure increase modes.

Not Activated	Normal Braking	—	—
Activated	Increase Mode	Holding Mode	Reduction Mode
Hydraulic Circuit	<p>Port A</p> <p>Pressure Holding Valve</p> <p>Port B</p> <p>Pressure Reduction Valve</p> <p>To Wheel Cylinder</p> <p>169CH54</p>	<p>169CH55</p>	<p>To Reservoir and Pump</p> <p>From Wheel Cylinder</p> <p>169CH56</p>
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

## ABS with EBD Operation Prohibit Control (with Rear Diff. Lock)

When the rear differential is locked, ABS with EBD is prohibited. At this time, the ABS warning light turns ON.



233CH89

## 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 function of each solenoid valve and pump motor in the brake actuator are check 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 (Diagnostic 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 blinks of the ABS warning light, or by connecting a hand-held tester.
- This system has a sensor signal check (test mode) function. This function is activated by connecting the SST (09843-18040) the between Ts and CG terminals of the DLC3 or by connecting a hand-held tester.
- If the skid control ECU detects a malfunction during a sensor check, it stores the DTCs in its memory. These DTCs can be read during a sensor check operation by connecting the Tc and CG terminals of the DLC3 and observing the blinking of the ABS warning light or on a hand-held tester.

For details, on 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 Land Cruiser/ Land Cruiser Prado Repair Manual (Pub. No. RM990E).

## ► DTC Chart (blinking ABS warning light) ◀

DTC No.		Detection Item	DTC No.		Detection Item
2-digit	5-digit		2-digit	5-digit	
11	C0278	Open circuit in ABS solenoid relay circuit	36	C1236	Foreign matter is attached on the tip of the left front sensor
12	C0279	Short circuit in ABS solenoid relay circuit	37	C1337	Some tire's different size is from the other tire's
13	C0273	Open circuit in ABS motor relay circuit	38	C1238	Foreign matter is attached on the tip of the right rear sensor
14	C0274	Short circuit in ABS motor relay circuit	39	C1239	Foreign matter is attached on the tip of the left rear sensor
21	C0226	Open or short circuit in 2-position solenoid circuit for right front wheel	41	C1241	Power source voltage down
22	C0236	Open or short circuit in 2-position solenoid circuit for left front wheel	43	C1243	Malfunction in deceleration sensor (constant output)
23	C0246	Open or short circuit in 2-position solenoid circuit for right rear wheel	44	C1244	Open or short circuit in deceleration sensor circuit
24	C0256	Open or short circuit in 2-position solenoid circuit for left rear wheel	45	C1245	Malfunction in deceleration sensor
31	C0200	Right front wheel speed sensor signal malfunction	48	C1248	Open circuit in rear diff. lock
32	C0205	Left front wheel speed sensor signal malfunction	49	C1249	Open circuit in stop light switch circuit
33	C0210	Right rear wheel speed sensor signal malfunction	51	C1251	Pump motor is locked
34	C0215	Left rear wheel speed sensor signal malfunction	96	C1306	Malfunction in speed sensor power supply
35	C1235	Foreign matter is attached on the tip of the right front sensor	—	—	—

## ► DTC Chart of sensor signal check (blinking ABS warning light) ◀

DTC No.		Detection Item	DTC No.		Detection Item
2-digit	5-digit		2-digit	5-digit	
71	C1271	Low output voltage of right front speed sensor	77	C1277	Abnormal change in output voltage of right rear speed sensor
72	C1272	Low output voltage of left front speed sensor	78	C1278	Abnormal change in output voltage of left rear speed sensor
73	C1273	Low output voltage of right rear speed sensor	79	C1279	Deceleration sensor is faulty
74	C1274	Low output voltage of left rear speed sensor	82	C1282	Transfer indicator (center diff. lock) switch malfunction
75	C1275	Abnormal change in output voltage of right front speed sensor	83	C1283	Transfer L4 position switch malfunction
76	C1276	Abnormal change in output voltage of left front speed sensor	—	—	—

**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, 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.