

# Anti-lock Brake System (ABS)

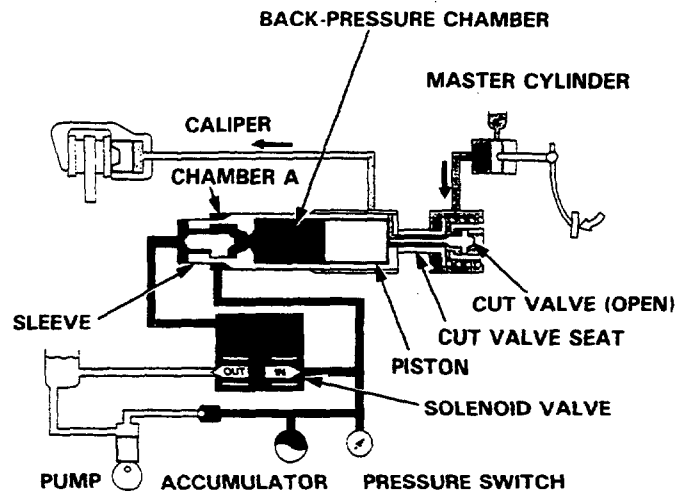
## Operation

The following description of ABS operation is for one of the front wheels. The ABS operation for the remaining wheels is the same.

### Ordinary braking function:

In ordinary brake operations when the ABS is not functioning, the solenoid outlet valve is closed and the inlet valve is open, the brake fluid pressure is transmitted to the back-pressure chamber between the sleeve and piston, and the cut valve is pushed by the piston. As the high-pressure is also transmitted to chamber A between the sleeve and cylinder, the sleeve pushes the cut valve seat toward the cut valve, too.

Under these conditions, the cut valve is kept open, and the hydraulic pressure from the master cylinder is transmitted to the caliper just like an ordinary brake system.

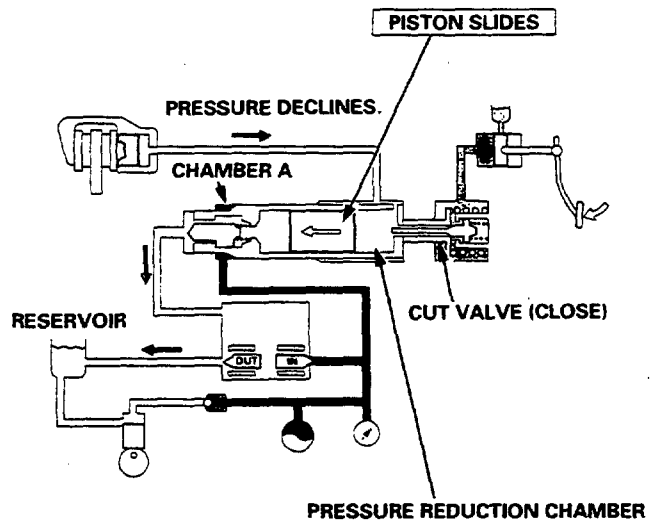


### When ABS is functioning:

- Control by reducing caliper fluid pressure:

When brake inputs (force exerted on brake pedal) are excessively large, and a possibility of wheel locking occurs, the control unit operates the solenoid valve, closing the inlet valve and opening the outlet valve.

As a result, high pressure in the back-pressure chamber is released to the reservoir, and the piston is pushed by the caliper fluid pressure toward the back-pressure chamber. However, the cut valve seat is kept in the pushed position because high pressure is transmitted to chamber A. As the piston moves, the cut valve moves and shuts the flow from the master cylinder to the caliper, the volume of the pressure reduction chamber connected to the caliper increases, and the fluid pressure in the caliper declines, relieving the braking force. The wheel speed is therefore restored, preventing the wheel from locking.

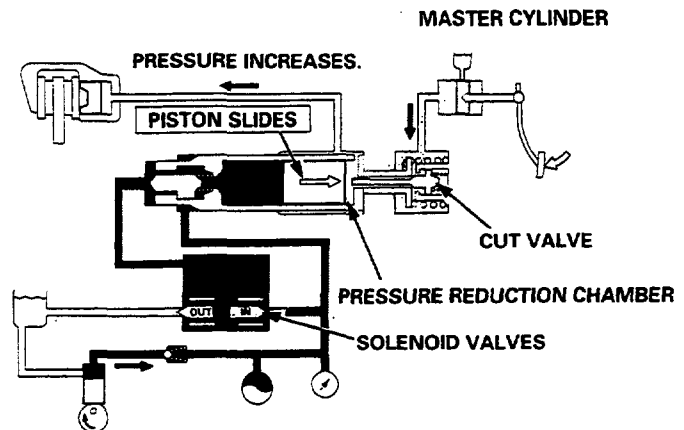


- **Control by increasing caliper fluid pressure:**

When the ABS control unit senses that the caliper fluid pressure declined, and the wheel speed is restored, it signals the solenoid inlet valve to open and the solenoid outlet valve to close.

As a result, the high pressure brake fluid is transmitted to the back-pressure chamber, and the piston is pushed toward the pressure reduction chamber, increasing the caliper fluid pressure, and thereby the braking force again.

When the master cylinder side's fluid pressure is low, the cut valve is slightly opened as the piston moves, and the caliper fluid pressure is transmitted to the master cylinder. The kickback is felt on the brake pedal this time. When the force depressing the brake pedal is relieved while the ABS is functioning, the cut valve is opened and the pressure in the pressure reduction chamber is returned to the master cylinder side. As a result, the caliper fluid pressure is relieved.

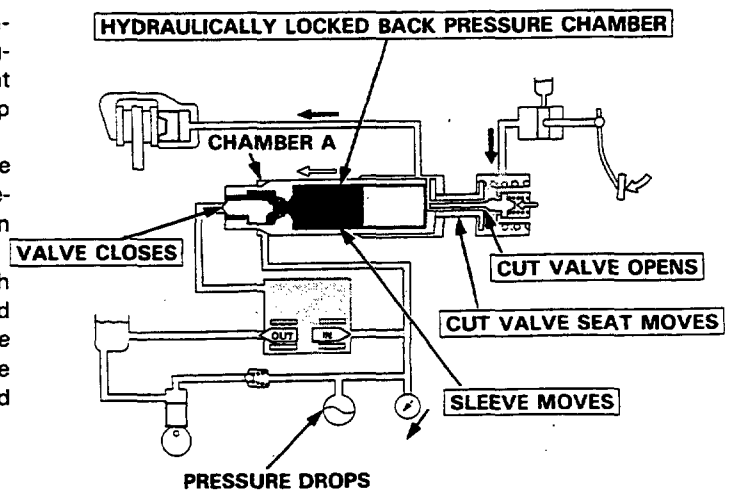


**When high-pressure declines:**

The ABS control unit monitors the pressure in the high-pressure passage by means of the pressure switch signals. The ABS control unit turns the ABS indicator light on, and stops the ABS when it detects an excessive drop in pressure in the high-pressure passage.

When the pressure declined due to leakage from the passage, for example, the pressure in chamber A declines, too, and the cut valve seat and sleeve return toward chamber A.

As a result, the valve at the sleeve end closes, which hydraulically locks the back-pressure chamber and blocks the piston movement. Because the cut valve opens as the cut valve seat moves, this connects the brake fluid passage between the master cylinder and caliper for ordinary brake operation.



(cont'd)

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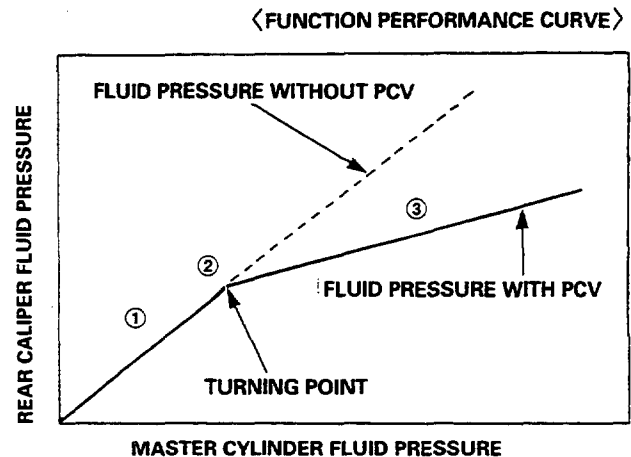
## Operation (cont'd)

### Proportioning Control Valve Function:

The modulators for the rear brakes serve as proportioning control valves to prevent the rear wheels from locking if the ABS malfunctions or when the ABS is not activated. When this function is not provided, the hydraulic pressure from the master cylinder and the hydraulic pressure to the rear brake system are equal.

If the fluid pressure is transmitted to the rear brakes at the same rate as the front brakes, the rear wheels will lock first because the rear axle load becomes lighter when the brakes are applied.

To prevent the rear wheels from locking, the proportioning control valve function changes the distribution rate of the fluid pressure to the rear wheels when the pressure in the rear brake system exceeds the given value of the fluid pressure from the master cylinder. The fluid pressure point where the distribution rate changes is called the turning point.



The cut valve seat in the rear brake system has a shoulder between sections A and B. Section A, where pressure from the master cylinder is applied, has a smaller diameter than section B, where pressure from the rear brake caliper is applied. This design provides the proportioning control valve function as follows.

1. When the fluid pressure from the master cylinder is below the turning point, the cut valve seat is pushed by the spring force and the cut valve is open. Therefore, the fluid pressure from the master cylinder is transmitted to the rear brake caliper side. Under these conditions, fluid pressure from the master cylinder is equal to the pressure to the rear brake caliper, but because of the diameter difference between sections A and B, the force on the cut valve overcomes the spring force, moving the cut valve seat toward the cut valve slowly.
2. When the fluid pressure to the rear brake caliper reaches the turning point, the cut valve is closed by the cut valve seat, blocking the fluid passage between the master cylinder side and rear wheel cylinder side.
3. When the fluid from the master cylinder exceeds the turning point, the fluid pressure from the master cylinder rises, while the pressure to the rear brake caliper remains at the turning point value. As a result, the cut valve seat moves away from the cut valve and the cut valve opens. The passage between the master cylinder and caliper opens momentarily, but it is blocked again because the fluid pressure to the brake caliper rises, and the cut valve seat moves to close the cut valve. As described above, when the pressure in the master cylinder is above the turning point, the cut valve seat reduces the pressure in the rear brake caliper to the prescribed amount by repeating this process.

