

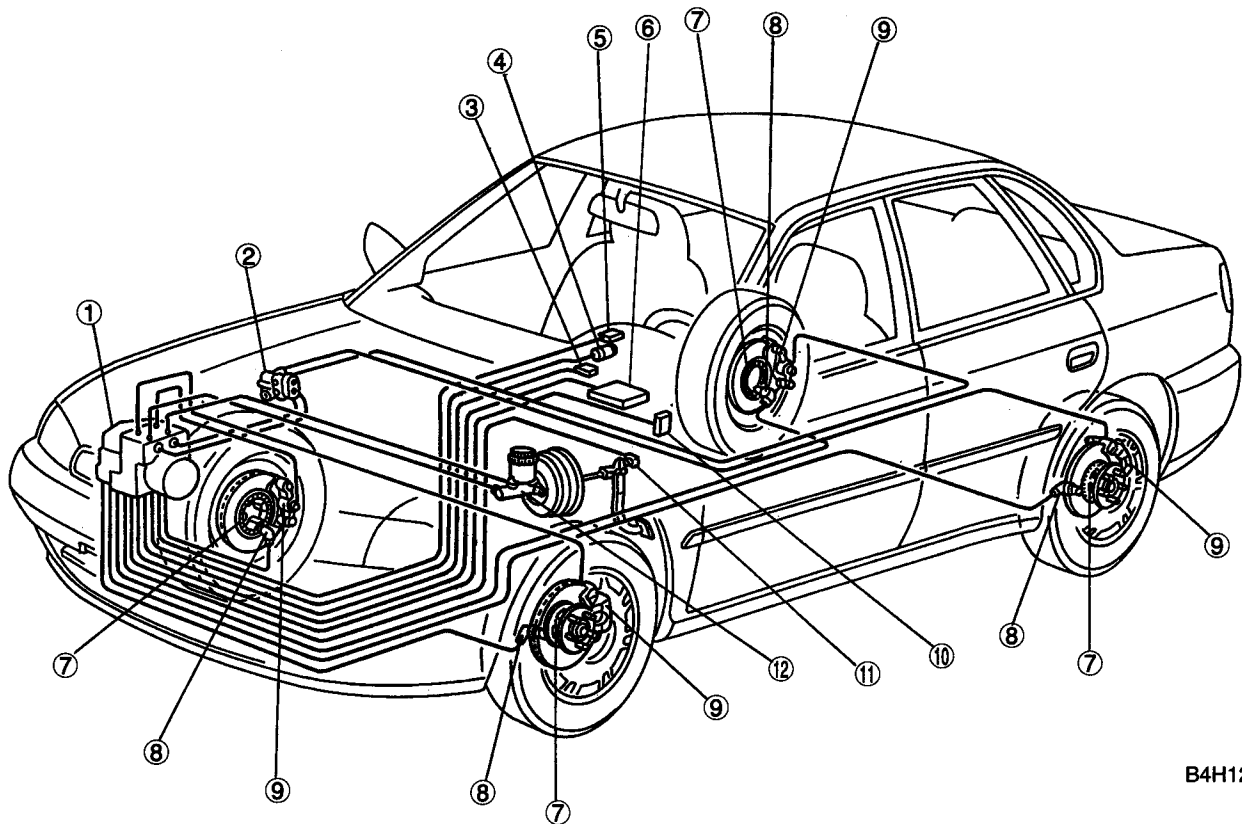
13. Anti-lock Brake System (ABS) [5.3i Type]

1. FEATURE

- This ABS 5.3i type incorporates the hydraulic control unit, ABS control module, valve relay and motor relay in one unit for better productivity and lightweight.
- The ABS (Anti-lock brake system) electrically controls brake fluid pressure to prevent wheel "lock" during braking on slippery road surfaces, thereby improving directional/steering stability as well as shortening the braking distance.
- If the ABS becomes inoperative, the fail-safe system activates to ensure it acts as a conventional brake system. The warning light also comes on to indicate that the ABS is malfunctioning.
- The front-and-rear wheels utilize a 4-sensor, 4-channel control design: the front wheels have an independent control design*¹ and the rear wheels have a select low control design*².

*1: A system which independently controls fluid pressure to left and right front wheels.

*2: A system which provides the same fluid pressure control for the two rear wheels if either wheel starts to "lock."

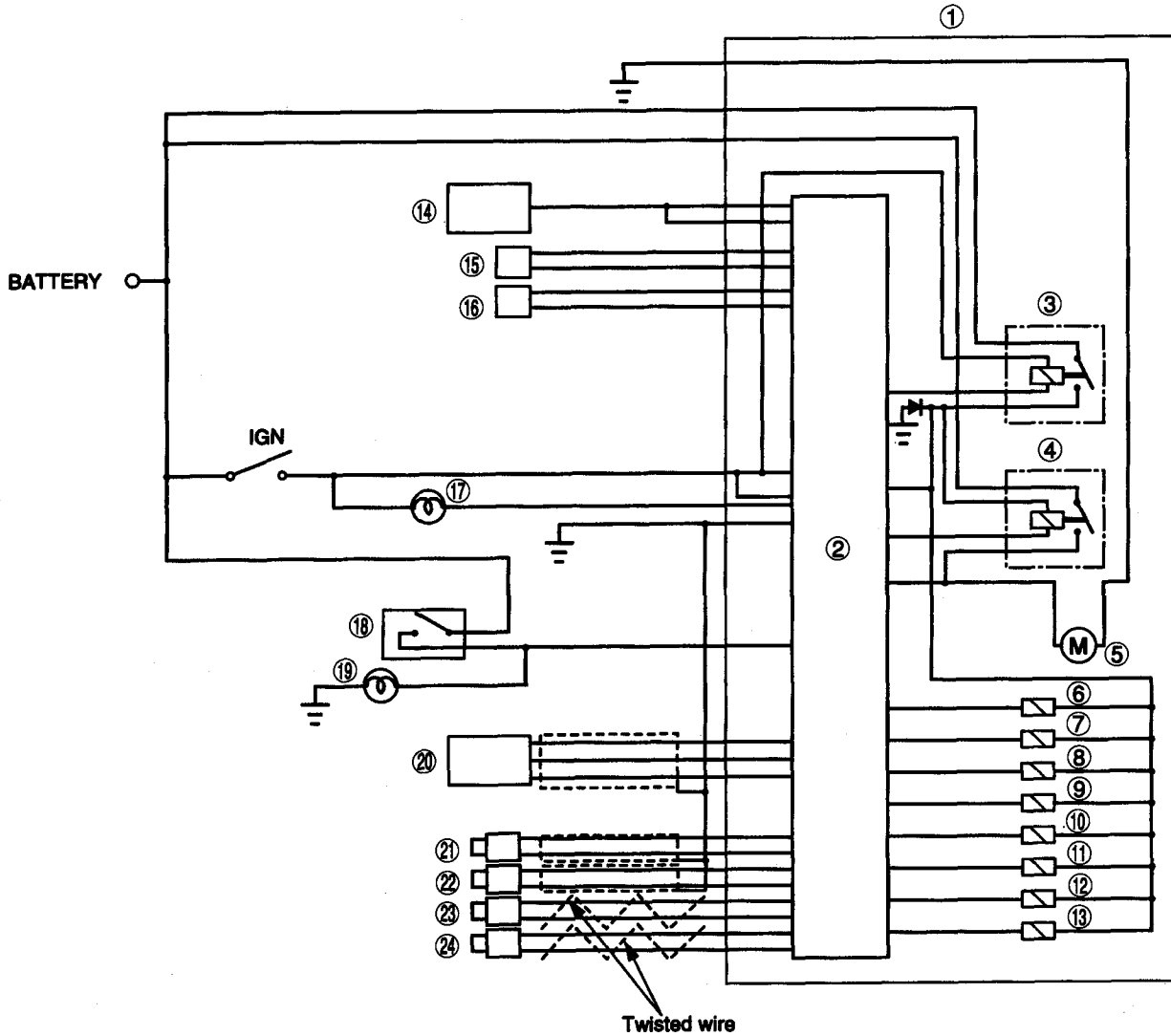


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| ① ABS control module and hydraulic control unit (ABSCM&H/U) | ⑤ Data link connector (for SUBARU select monitor) | ⑧ ABS sensor |
| ② Proportioning valve | ⑥ Transmission control module (only AT vehicle) | ⑨ Wheel cylinder |
| ③ Diagnosis connector | ⑦ Tone wheel | ⑩ G sensor (only AWD vehicle) |
| ④ ABS warning light | | ⑪ Brake switch |
| | | ⑫ Master cylinder |

2. FUNCTIONS OF SENSORS AND ACTUATORS

Name		Function
ABS control module and hydraulic control unit (ABSCM&H/U)	ABSCM-section	<ul style="list-style-type: none"> ● Calculates and determine the conditions of the wheels and body from the wheel speeds and makes a proper decision suitable for the current situation to control the hydraulic unit. ● In the ABS operation mode, the module outputs a cooperative control signal to the AT control module. (AT vehicles only) ● Whenever the ignition switch is placed at ON, the module makes a self diagnosis. When anything wrong is detected, the module cuts off the system. ● Communicates with the Subaru select monitor.
	H/U-section	<p>In the ABS operation mode, the H/U changes fluid passages to control the fluid pressure of the wheel cylinders in response to an instruction from the ABSCM.</p> <p>The H/U also constitutes the brake fluid passage from the master cylinder to the wheel cylinders together with pipings.</p>
	Valve relay-section	Serves as a power switch for the solenoid valve and motor relay coil in response to an instruction from the ABSCM.
	Motor relay-section	Serves as a power switch for the pump motor in response to an instruction from the ABSCM.
Wheel speed sensor (ABS sensor)		Detects the wheel speed in terms of a change in the magnetic flux density passing through the sensor, converts it into an electrical signal, and outputs the electrical signal to the ABSCM.
Tone wheel		Gives a change in the magnetic flux density by the teeth around the tone wheel to let the ABS sensor generate an electrical signal.
G sensor (AWD vehicle only)		Detects a change in G in the longitudinal direction of the vehicle and outputs it to the ABSCM in terms of a change in voltage.
Stop light switch		Transmits the information on whether the brake pedal is depressed or not to the ABSCM for use as a condition in determining ABS operation.
ABS warning light		Alerts the driver to an ABS fault. When the diagnosis connector and diagnosis terminal are connected, the light flashes to indicate a trouble codes in response to an instruction from the ABSCM.
AT control module (TCM) (AT vehicles only)		Provides shift controls (fixing the speed at 3rd or changing front and rear wheel transmission characteristics on 4WD vehicle) in response to an instruction from the ABSCM.



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| ① ABS control module and hydraulic control unit | ⑨ Front right outlet solenoid valve | ⑰ ABS warning light |
| ② ABS control module section | ⑩ Rear left inlet solenoid valve | ⑱ Stop light switch |
| ③ Valve relay | ⑪ Rear left outlet solenoid valve | ⑲ Stop light |
| ④ Motor relay | ⑫ Rear right inlet solenoid valve | ⑳ G sensor (only AWD model) |
| ⑤ Motor | ⑬ Rear right outlet solenoid valve | ㉑ Front left ABS sensor |
| ⑥ Front left inlet solenoid valve | ⑭ Transmission control module (only AT module) | ㉒ Front right ABS sensor |
| ⑦ Front left outlet solenoid valve | ⑮ Diagnosis connector | ㉓ Rear left ABS sensor |
| ⑧ Front right inlet solenoid valve | ⑯ Data link connector | ㉔ Rear right ABS sensor |

3. THEORY OF ABS CONTROL

Refer to 4-4 [M8-3].★1

4. ABS SENSOR

Refer to 4-4 [M8-4].★1

5. ABS CONTROL MODULE AND HYDRAULIC CONTROL UNIT (ABSCM&H/U)

● ABS CONTROL MODULE SECTION (ABSCM)

The ABSCM is a digital control type electronic control module accommodating two microcontrol modules (MCMs); master and slave. Both MCMs process the same program and monitor the respective outputs, and when a mismatch occurs, cut off the system to activate the fail-safe function.

A maximum of 3 trouble codes are stored in the EEPROM and if 3 or more areas fail, then only the 3 most recent failures are stored. The trouble codes remain stored until they are erased.

This ABSCM induces a sequence control pattern and facilitates the checking of the hydraulic unit.

● ABS control

Based on the four wheel speed signals, the ABSCM calculates a simulated body speed or body deceleration rate, while referencing the G sensor output as an auxiliary means, and compares them with the wheel speeds and wheel deceleration rates. If it determines that the wheels are about to lock, it controls the solenoid valve or motor pump of the H/U to adjust the brake fluid pressures that act on the wheel cylinders, thereby preventing the wheels from locking.

The ABSCM controls the right and left front wheel fluid pressures independently and controls the rear wheel fluid pressures on the basis of the wheel which is more likely to lock (Select-low control).

● Select monitor associated functions

The Subaru select monitor may be used to perform the following operations.

- ① To read out analog data
- ② To read out ON/OFF data
- ③ To read out or erase trouble code
- ④ To read out status information in the event of trouble (Freeze frame data)
- ⑤ To initiate ABS sequence control pattern

● Indication functions

The ABS warning light can be made to indicate the following three states.

- ① ABS trouble
- ② Flashes to indicate trouble codes in diagnosis mode.
- ③ Valve ON/OFF when sequence control pattern is in effect

● HYDRAULIC CONTROL UNIT SECTION (H/U)

The H/U is a fluid pressure controller comprising a motor, solenoid valve, housing, relay, etc. It constitutes two diagonally independent brake fluid circuits for a cross piping vehicle.

- The pump motor rotates an eccentric cam to let the plunger pump generate a hydraulic pressure.
- The housing accommodates the pump motor, solenoid valve, reservoir, etc., and also constitutes a brake fluid passage.
- The plunger pump is a hydraulic pump which drains off the brake fluid which, when the pressure is reduced, is discharged to the reservoir, and sends it toward the master cylinder.
- The solenoid valve is a 2-position type solenoid valve which switches the brake fluid passages between the wheel and master cylinder and reservoir sides in response to an instruction from the ABSCM.

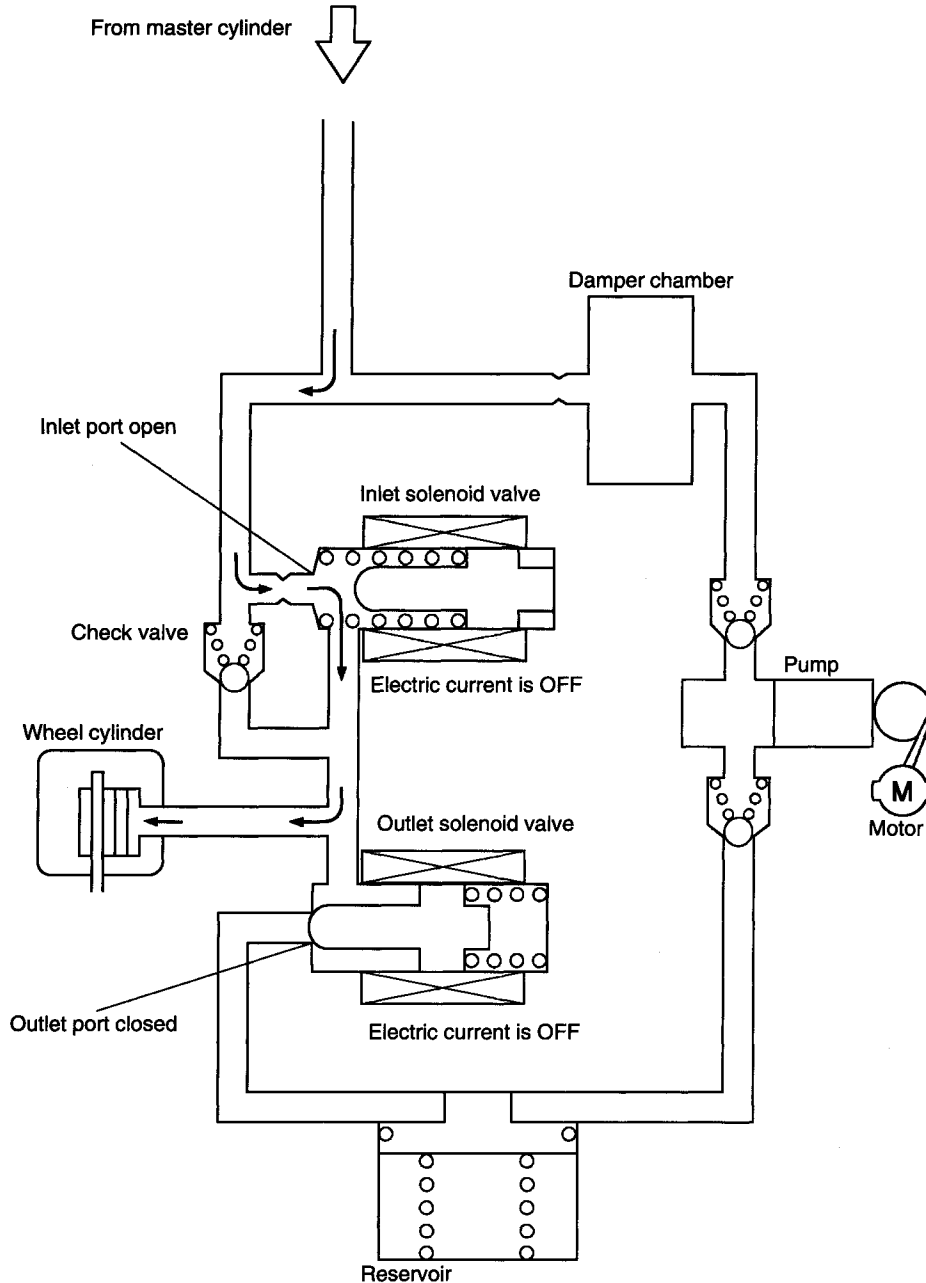
For each wheel cylinder, a pair of normally-closed and -opened solenoid valves are provided.

- The inlet solenoid valve is duty-controlled to reduce brake fluid pulsation for lower ABS operation noise.
- The reservoir is a fluid chamber which temporarily stores the brake fluid to be discharged from the wheel cylinder when the pressure is reduced.
- The damper chamber suppresses the pulsation of the brake fluid which, when the pressure is reduced, is discharged from the plunger pump, thereby minimizing the kickbacks to the brake pedal.
- The valve relay controls the solenoid valve and motor relay energizing power supply in response to an instruction from the ABSCM. In normal (IG ON) condition, the relay is actuated to supply power to the solenoid valve and motor relay. When an error occurs in the system, the valve relay is forced to OFF to keep the fluid pressure circuit in the normal mode (normal brake mode) and also constitute the ABS warning light operating circuit.
- The motor relay supplies power to the pump motor to operate the plunger pump in response to an instruction from the ABSCM in the ABS control mode.

The H/U has four operating modes; normal mode (control OFF: normal brake mode), "increase", "hold" and "decrease" modes (control ON in all the three modes).

1) During normal braking (Explained with one wheel's control as an example)

Since no current is supplied to the inlet and outlet solenoid valves, no solenoid valve attracting force is generated. So the valves remain stationary. Accordingly, the inlet port of the inlet solenoid valve is in an opened state, whereas the outlet port of the outlet solenoid valve is in a closed state. So the fluid pressure of the master cylinder is transmitted to the wheel cylinder to produce a brake force in the wheel cylinder.

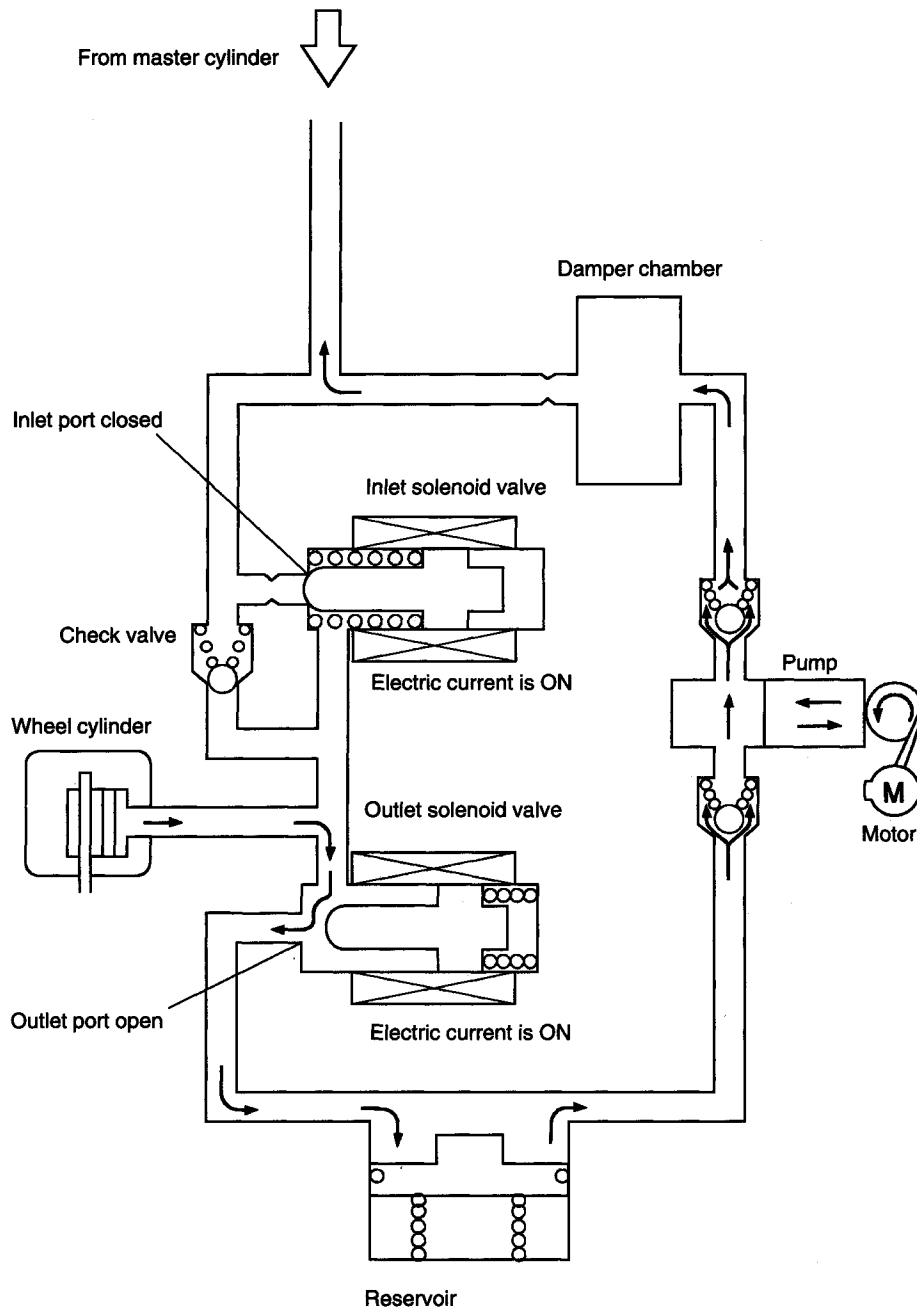


2) Pressure “decrease” action with ABS in operation (Explained with one wheel’s control as an example)

Current is supplied to the inlet and outlet solenoid valves, and the generated solenoid valve attracting forces close the inlet port and open the outlet port.

Accordingly, the wheel cylinder is isolated from the master cylinder and becomes clear to the reservoir, allowing the brake fluid to flow to the reservoir. So the fluid pressure of the wheel cylinder is decreased.

The brake fluid collected in the reservoir is fed to the master cylinder by the pump.

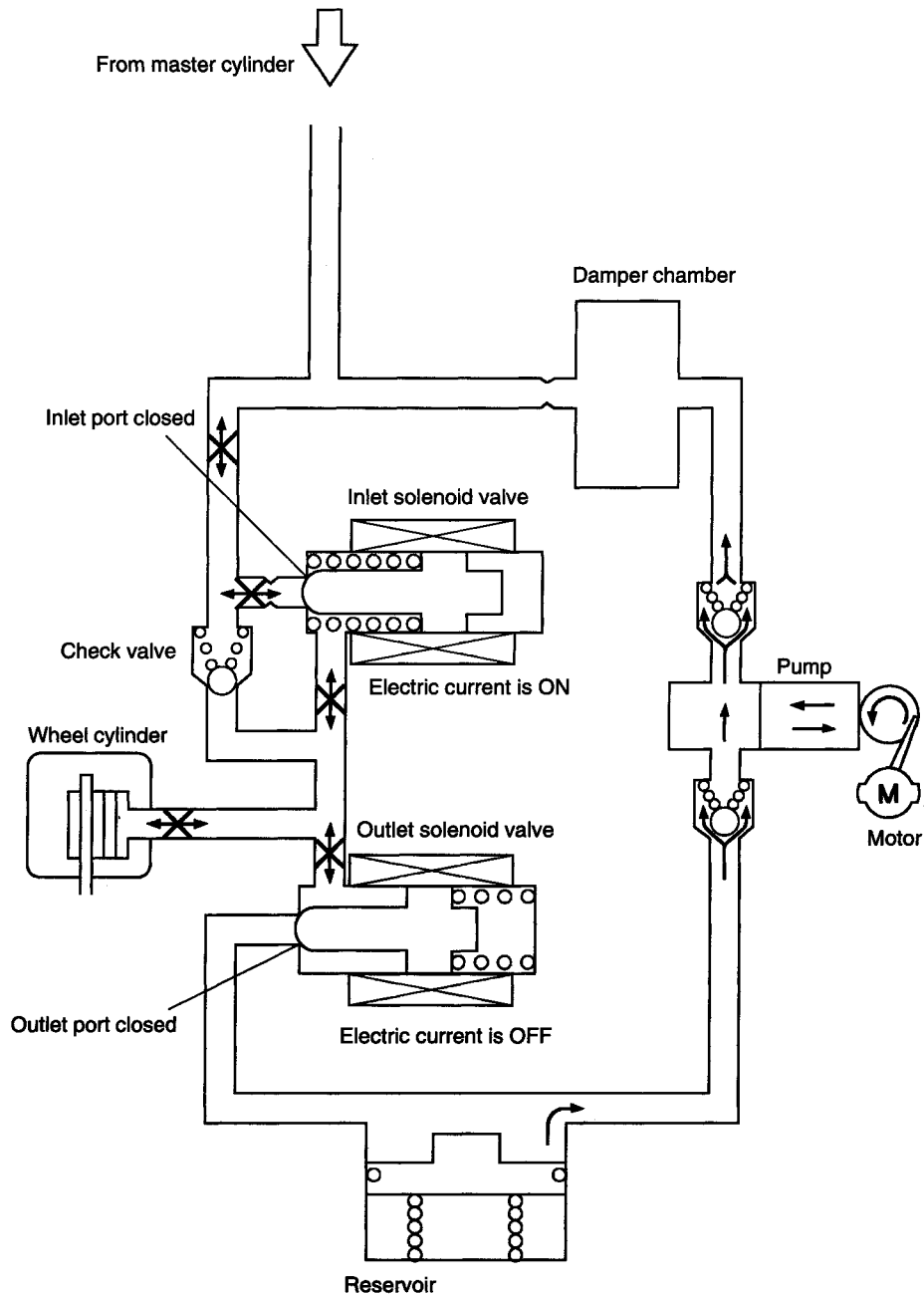


3) Pressure “hold” action with ABS in operation (Explained with one wheel’s control as an example)

Current is supplied to the inlet solenoid valve, and the generated solenoid valve attracting force closes the inlet port.

Since no current is supplied to the outlet solenoid valve, the output port remains in a closed state. As a result, the wheel cylinder, master cylinder and reservoir are blocked, and the fluid pressure of the wheel cylinder is maintained constant.

During ABS operation, the pump motor continues to operate.

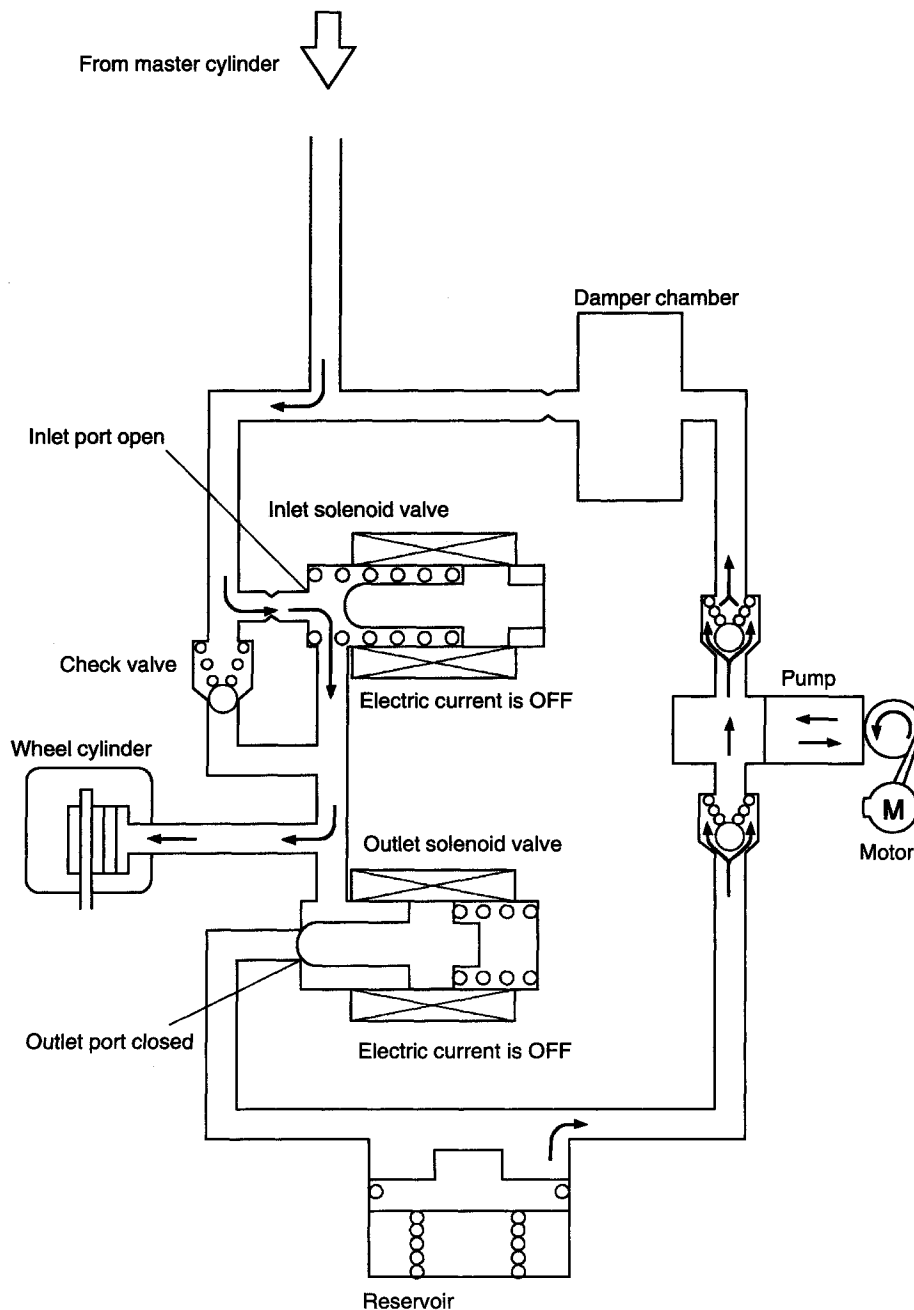


4) Pressure “increase” action with ABS in operation (Explained with one wheel’s control as an example)

Since no current is supplied to the inlet and outlet solenoid valves, no solenoid valve attracting force is generated. So the valves remain stationary.

Accordingly, the inlet port of the inlet solenoid valve is in an opened state, whereas the outlet port of the outlet solenoid valve is in a closed state. So the fluid pressure of the master cylinder is transmitted to the wheel cylinder to increase the brake force in the wheel cylinder.

During ABS operation, the pump motor continues to operate.



6. ABS CONTROL CYCLE CURVES

Refer to 4-4 [M8-6].★1

7. ABS WARNING LIGHT

Refer to 4-4 [M8-7].★1

8. G SENSOR

Refer to 4-4 [M12-8].★5