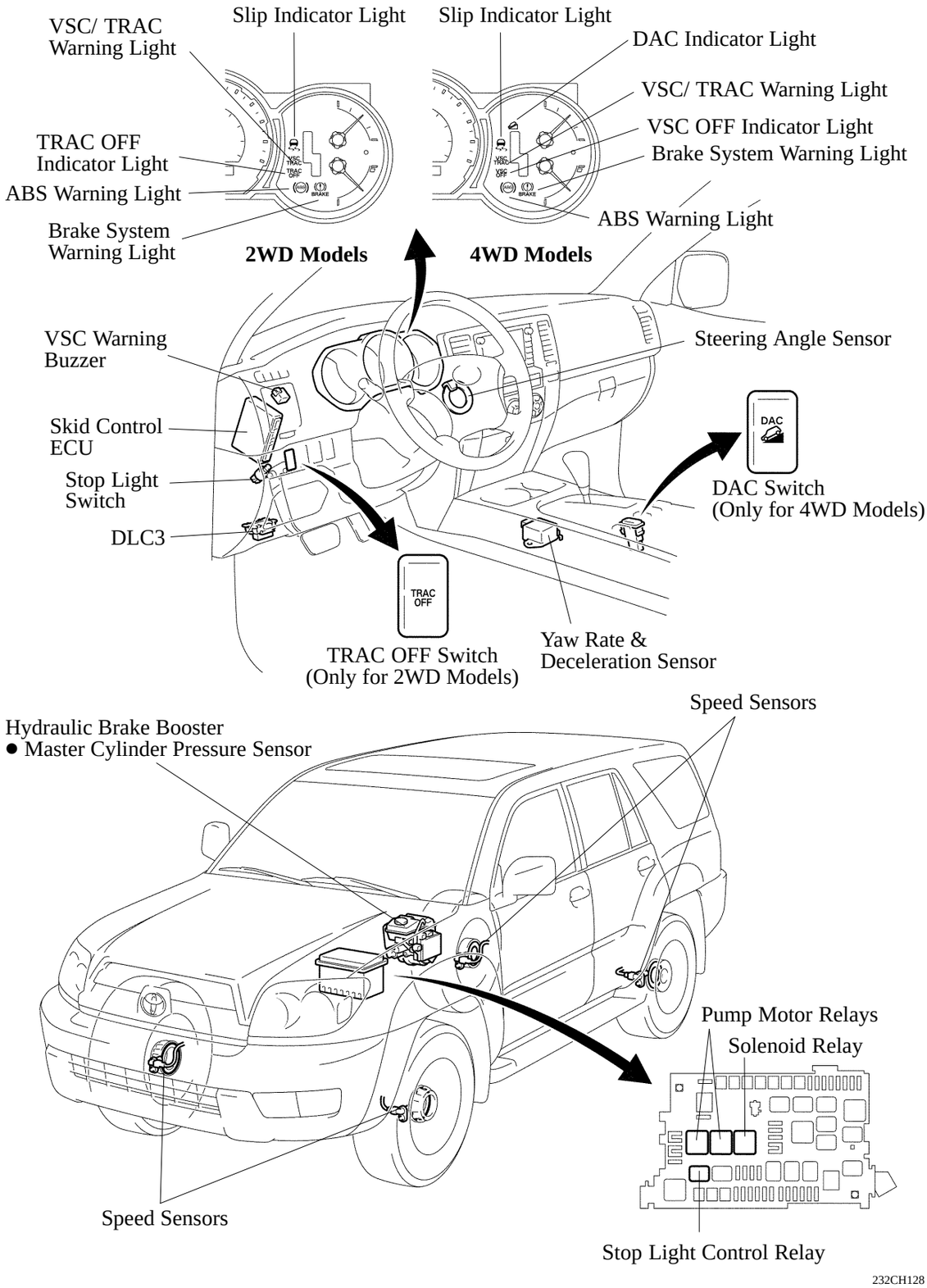
10. Layout of Main Component



11. Function of Main Component

Components		Function
Hydraulic Brake Booster (Including Brake Actuator)		• Assists with the brake pedal effort applied to the brake pedal. • Changes the brake fluid path based on the signals from the skid control ECU during the operations of the ABS with EBD, Brake Assist, TRAC (for 2WD)/A-TRAC (for 4WD), VSC, DAC (for 4WD), and HAC, in order to control the fluid pressure that is applied to the wheel cylinders.
	Brake Fluid Level Warning Switch	Detects the brake fluid level.
	Master Cylinder Pressure Sensor	Detects the master cylinder pressure.
	Pressure Switches	Monitors the hydraulic pressure of the accumulator and outputs control signals for the pump motor. There are two types: the pressure switch PH for controlling the pump, the pressure switch PL for giving a warning when the pressure is low.
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 that the hydraulic pressure of the accumulator in the hydraulic brake booster has decreased.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS, EBD, or Brake Assist system.
	VSC/TRAC Warning Light	• Lights up to alert the driver when the skid control ECU detects a malfunction in the TRAC (for 2WD)/A-TRAC (for 4WD) or VSC, DAC (for 4WD), and HAC. • Lights up to alert the driver when the operation of the TRAC (for 2WD), A-TRAC (for 4WD), DAC (for 4WD), and HAC are momentarily interrupted in order to protect the brake actuator.
	TRAC OFF Indicator Light*1	• Lights up to inform the driver when the TRAC system is turned OFF by the TRAC OFF switch. • Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS, EBD, Brake Assist, TRAC, VSC or HAC.
	VSC OFF Indicator Light*2	• Lights up to inform the driver when the center differential has been locked, and the operation of the VSC have been prohibited. • Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS, EBD, Brake Assist, A-TRAC, VSC, DAC or HAC.
	Slip Indicator Light	Blinks to inform the driver when the TRAC (for 2WD)/ A-TRAC (for 4WD), VSC, DAC (for 4WD), or HAC is operated.
	DAC Indicator Light*2	• Lights up to inform the driver when the DAC switch turned ON. • Blinks to alert the driver when the skid control ECU detects that the current condition is not under a DAC operation condition, the operation of the DAC is momentarily interrupted in order to protect the brake actuator, or the transfer shift lever is shifted to H4 range.
	Center Diff. Lock Indicator Light*2	Lights up to inform the driver when the center differential condition is locked.
Skid Control ECU		Judges the vehicle driving condition based on signals from each sensor, and sends brake control signals to the brake actuator.

(Continued)

Speed Sensor (4)		Detects the wheel speed and rotating direction of each of four wheels.
Steering Angle Sensor		Detects the steering direction and angle of the steering wheel.
Yaw Rate & Deceleration Sensor		• Detects the vehicle's yaw rate. • Detects the vehicle's acceleration in the forward, rearward, and lateral.
Pump Motor Relays		Control the pump motor operation in the hydraulic brake booster.
Solenoid Relay		Supply or cut off power to solenoid valves in the brake actuator.
Stop Light Control Relay		Turn on the stop light during DAC or HAC operation.
Stop Light Switch		Detects the brake pedal depressing signal.
TRAC OFF Switch*1		Cancels the TRAC operation only: it does not apply to other systems.
Park/Neutral Position Switch		Detects the shift position.
VSC Warning Buzzer		This buzzer has 3 types of sounds. • This buzzer sounds intermittently to inform the driver that the VSC and HAC are actives. • This buzzer sounds intermittently to inform the driver if the temperature of the brake actuator has increased excessively due to the continuous operation of the TRAC (for 2WD), A-TRAC (for 4WD), DAC (for 4WD), and HAC. • This buzzer sounds continuously to alert the driver that the hydraulic pressure of the accumulator in the hydraulic brake booster has decreased, and that the power supply system in malfunctioning.
ECM		Controls the throttle valve opening angle based on the signals receives from the skid control ECU, in order to control the engine output. Also, sends the throttle valve opening angle signal, accelerator pedal position signal, and engine speed signal to the skid control ECU.
Throttle Position Sensor		Detects the opening of the throttle valve and inputs it into the ECM.
Accelerator Pedal Position Sensor		Detects the depressing of the accelerator pedal and inputs it into the ECM.
Crankshaft Position Sensor		Detects the engine speed, and sends it via the ECM to the skid control ECU.
Throttle Control Motor		Controls the opening of the throttle valve in accordance with the signals received from the ECM.
Transfer Shift Actuator*2	Center Diff. Lock Detection Switch	Detects the condition of the center differential lock.
4WD Control ECU*2		Detect the transfer condition shifted in the L4 and sends the L4 signal to the skid control ECU.

*1: Only for 2WD Models
*2: Only for 4WD Models

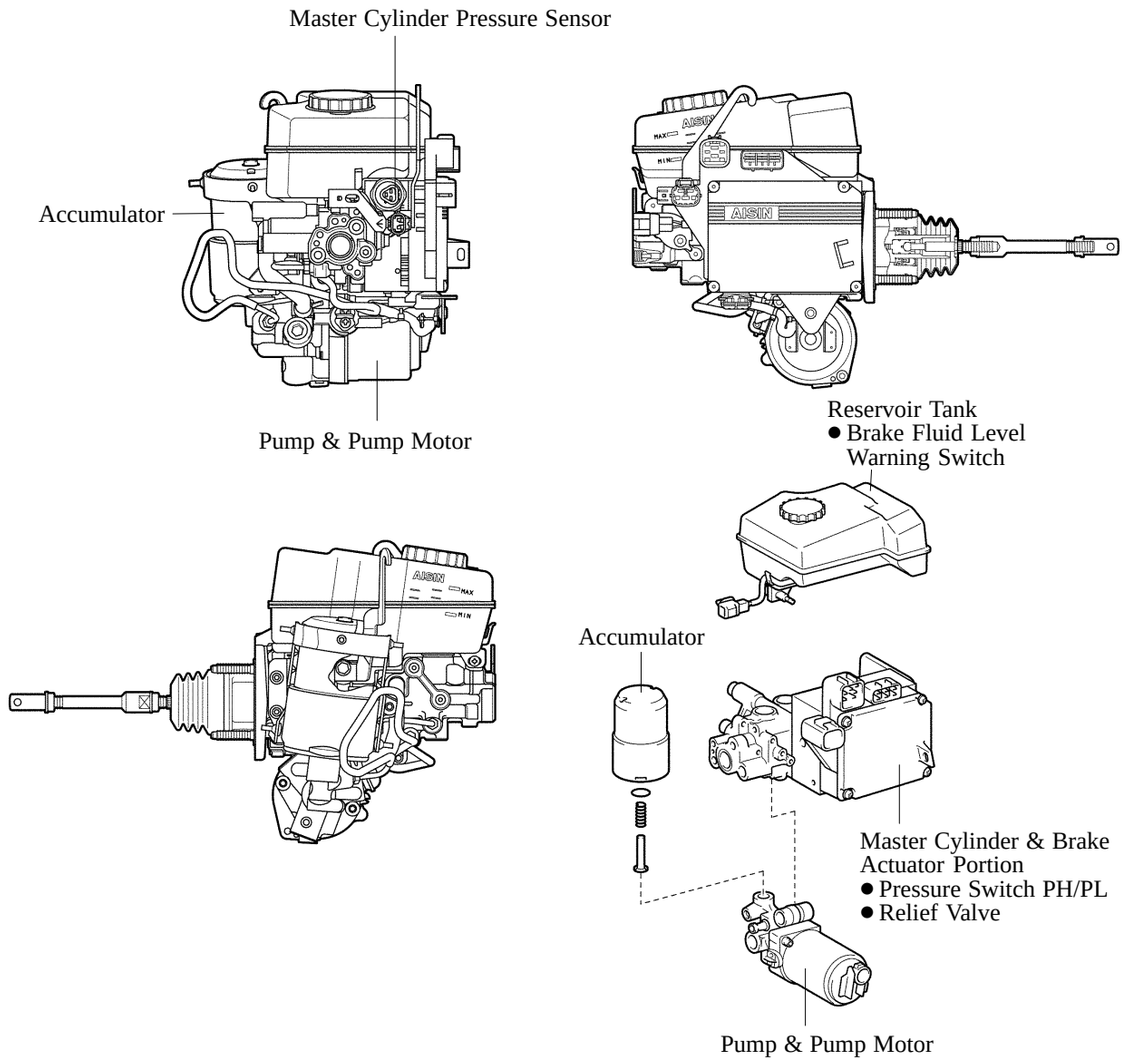
12. Construction of Main Components

Hydraulic Brake Booster

1) General

The hydraulic brake booster consists of the master cylinder & brake actuator portion, reserve tank, pump & pump motor, and accumulator.

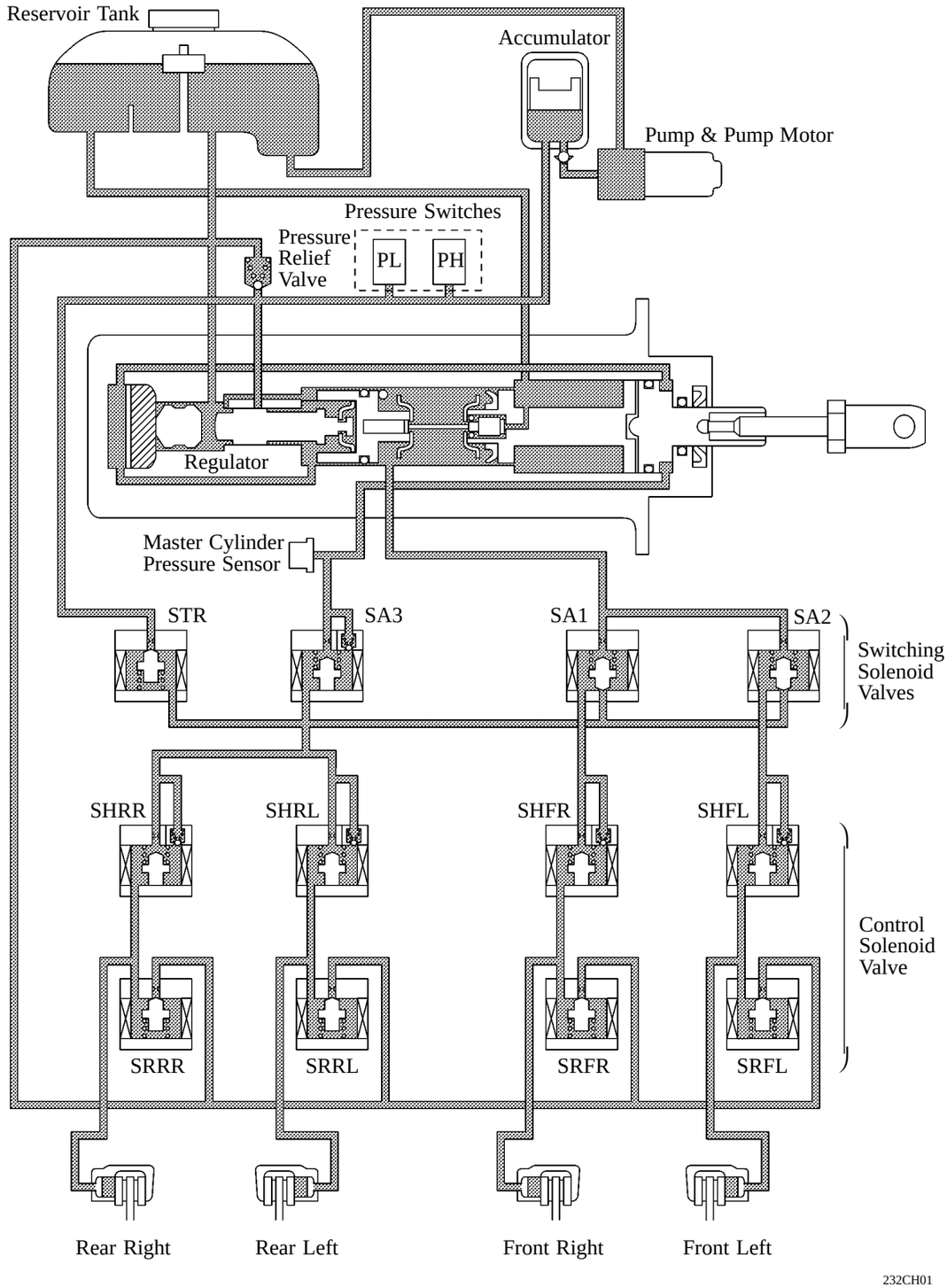
- The master cylinder & brake actuator portion contains a master cylinder & brake booster, 12 solenoid valves, relief valve, and 2 pressure switches (PH, PL).
- The reserve tank contains a brake fluid level warning switch.



The hydraulic brake booster consists of the following components:

Components		Function
Master Cylinder & Brake Actuator	Master Cylinder & Brake Booster	• Generates the hydraulic pressure that is provided to the wheel cylinders during normal brake. • Regulates the accumulator pressure in accordance with the pedal effort that is applied to the brake pedal and introduce this pressure to the booster chamber in order to provide a power assist to the brakes.
	Switching Solenoid Valves (SA1, SA2, SA3, STR)	Switches the brake hydraulic path when the brake control system is activated, or normal braking is applied.
	Control Solenoid Valves	Controls the hydraulic pressure that is applied to the wheel cylinders during brake control.
	Relief Valve	Returns the brake fluid to the reservoir tank to prevent excessive pressure if the pump operates continuously due to a malfunction of the pressure switch.
	Pressure Switch PH/ PL	Monitors the hydraulic pressure of the accumulator and outputs control signals for the pump motor. • Pressure switch PH (for controlling the pump) • Pressure switch PL (for giving a warning when the pressure is low)
Reservoir Tank		Stores the brake fluid.
	Brake Fluid Level Warning Switch	Detects the low brake fluid level.
Pump and Pump Motor		Draws up the brake fluid from the reservoir tank and provides high hydraulic pressure to the accumulator.
Accumulator		Stores the hydraulic pressure that was generated by the pump. The accumulator is filled with high-pressure nitrogen gas.

▶ Hydraulic Circuit ◀

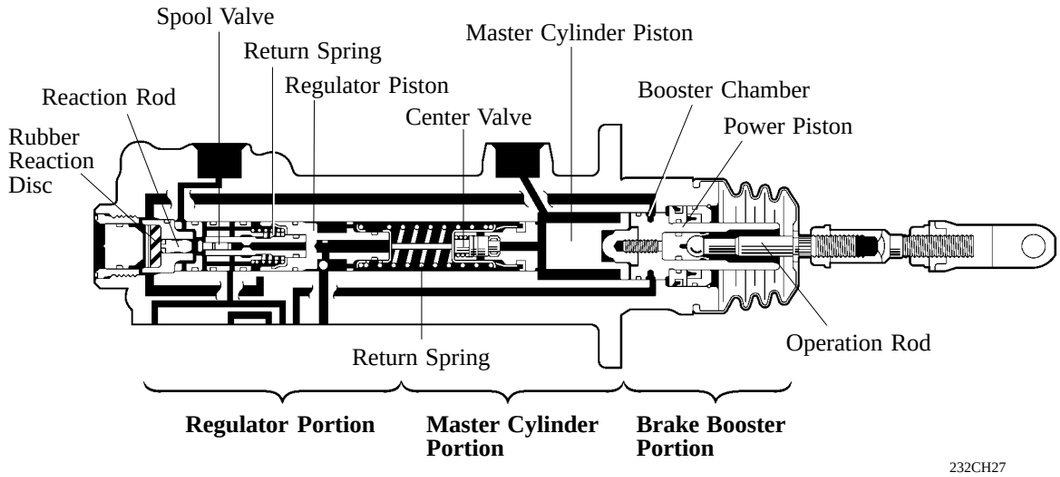


2) Master Cylinder & Brake Booster

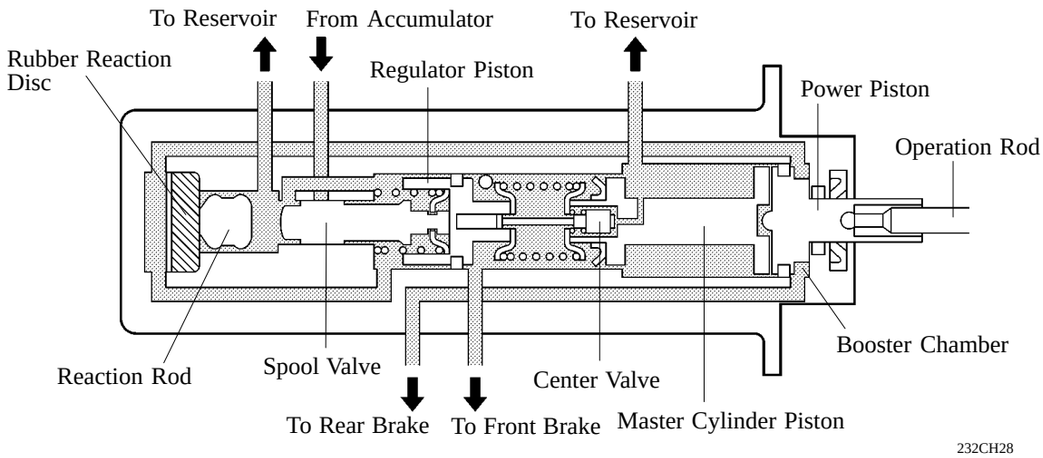
a. Construction

The master cylinder & brake booster consists of a brake booster portion, master cylinder portion, and regulator portion. These are positioned coaxially to achieve a simple and compact construction.

- The brake booster portion consists of an operation rod, power piston and booster chamber.
- The master cylinder portion consists of a master cylinder piston, return spring and center valve.
- The regulator portion consists of a regulator piston, return spring, spool valve, reaction rod, and rubber reaction disc.



▶ Simplified Diagram ◀



Service Tip

The supply parts for the master cylinder & brake booster portion are provided as follows:

- The operation rod and the power piston, which are integrated, are supplied as the No. 1 piston.
- The master cylinder piston is supplied as the No. 2 piston.
- Other parts are not available as supply parts, so do not remove them.

For detailed removal procedure, see the 2003 4Runner Repair Manual (Pub. No. RM1001U).

b. Operation

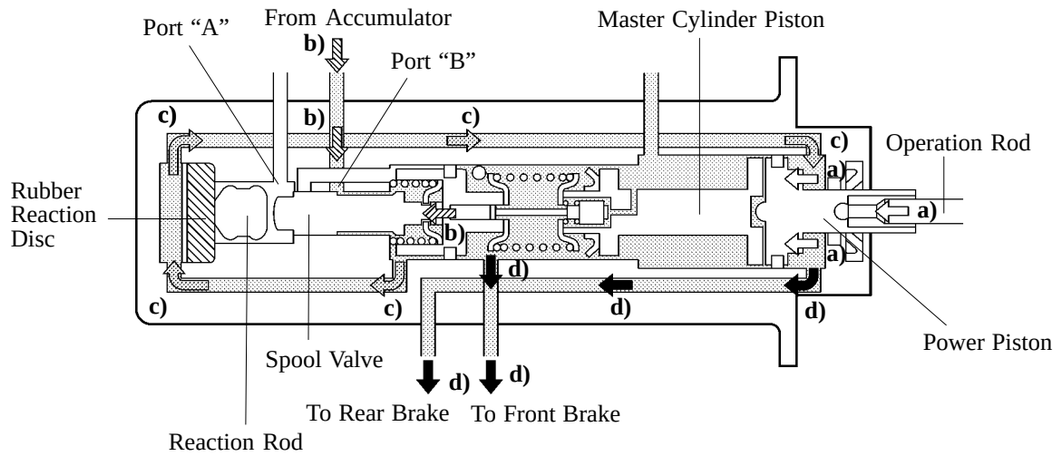
i) Pressure Increase (Low Pressure)

a) The pedal operation force transmits as follows: Operation Rod → Power Piston → Master Cylinder Piston

b) The load setting of the master cylinder's return spring is higher than that of the regulator piston's return spring, the regulator piston gets pushed before the volume in the master cylinder becomes compressed.

c) The spool valve closes the port "A" (between the reservoir tank and booster chamber) and opens the port "B" (between the reservoir tank and accumulator). Then, the pressurized brake fluid is introduced into the booster chamber to provide a power assist to the pedal effort.

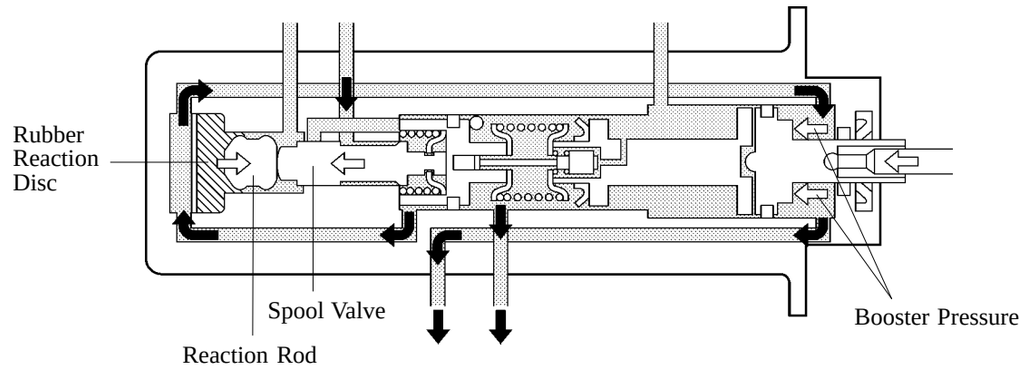
d) This time, the power assist overcomes the force of the master cylinder's return spring. This causes the volume in the master cylinder to become compressed and increased the pressure that is applied to the front brakes. At the same, the pressure in the booster chamber increases the pressure that is applied to the rear brakes.



During the initial stage of the brake operation, the booster pressure that is applied to the rubber reaction disc is small. Therefore, a return force in the rightward direction does not apply to the spool valve via the reaction rod.

ii) Pressure Increase (High Pressure)

In contrast to the time when the pressure is low, when the pressure is high, the booster pressure that is applied to the rubber reaction disc increases. Accordingly, the rubber reaction disc deforms and causes a return force in the rightward direction to be applied to the spool valve via the reaction rod. Therefore, in contrast to the time when the pressure is low, a greater reaction force is transmitted to the brake pedal.
As a result, a variable servo mechanism is realized, in which the servo ratio is lower during high pressure than during low pressure.



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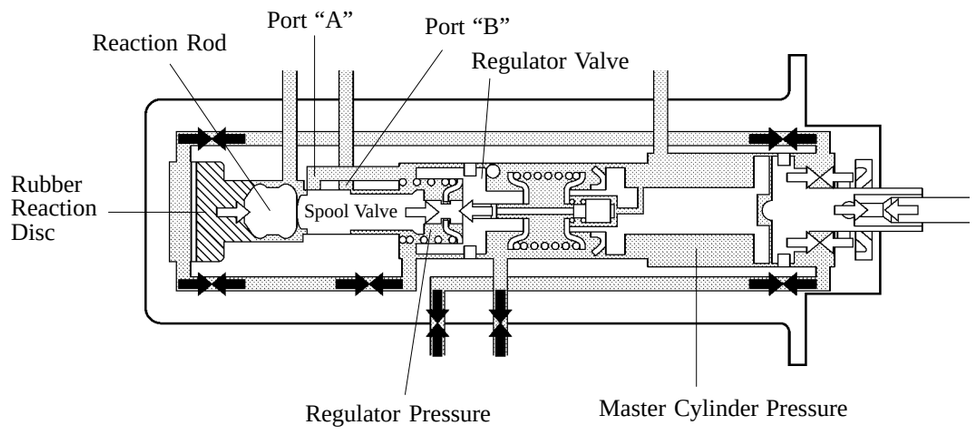
iii) Holding

This is a state in which the force that is applied via the brake pedal and the master cylinder pressure are in balance.
The forces that are applied to the front and the rear of the regulator piston, in other words, forces that are generated by the master cylinder pressure and the regulator pressure become balanced. This causes the spool valve to close both port “B” from the booster chamber to the accumulator and port “A” to the reservoir. As a result, the brake is in the holding state.



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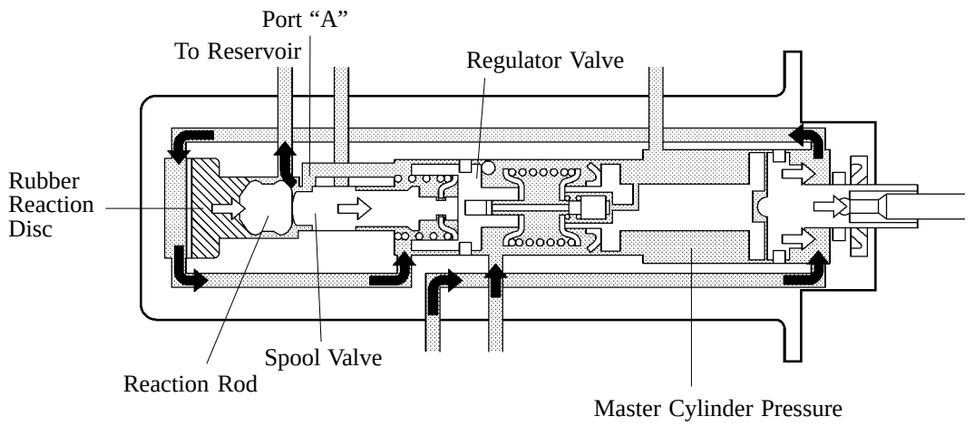
iv) Pressure Reduce

When the pressure that is applied to the brake pedal is relaxed, the master cylinder pressure decreases. Then, the regulator piston's return (rightward) force becomes relatively greater, causing the regulator piston to retract and the spool valve to also retract. As a result, the port "A" between the reservoir tank and the booster chamber opens.
The booster pressure becomes reduced in this state, creating a balance that corresponds to the force that is newly applied via the brake pedal. This process is performed repetitively to reduce the booster pressure and the master cylinder pressure in accordance with the force that is applied via the brake pedal.



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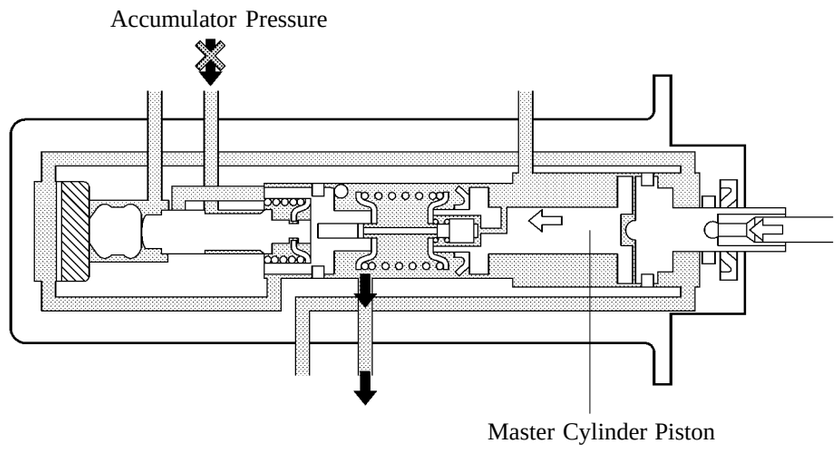
v) During Power Supply Malfunction

If the accumulator pressure is affected by any malfunction, no hydraulic pressure will be supplied to the booster chamber. For this reason, a power assist cannot be provided to the force that is applied via the brake pedal and the pressure to the rear brakes cannot be increased.
However, the pressure to the front brakes will be increased at the master cylinder piston in accordance with the pedal effort applied to the brake pedal.



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3) Solenoid Valve

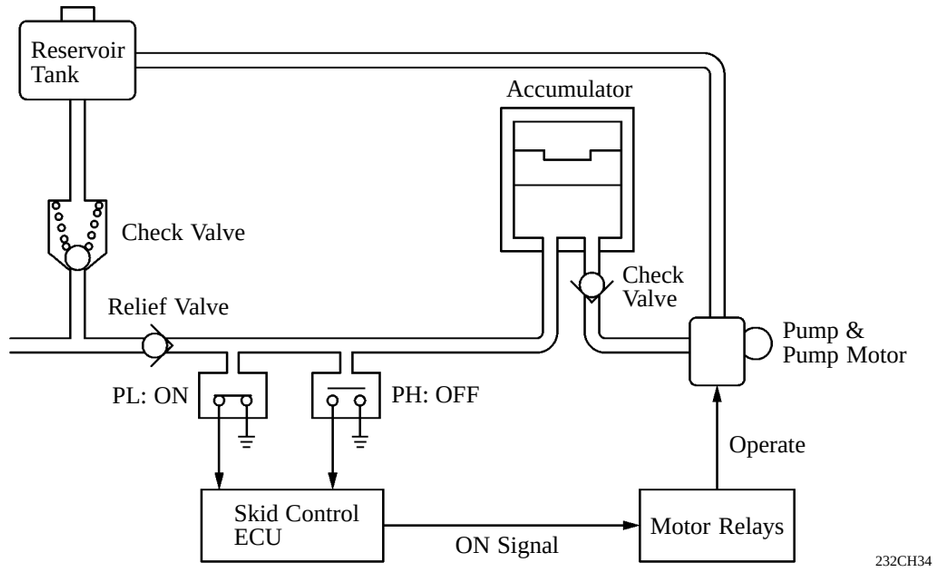
There are two types of solenoid valves: the switching solenoid valve and the control solenoid valve.

- A total of 4 switching solenoid valves are used: 2 (SA1, SA2) in the front brake fluid path, 1 (SA3) in the rear brake fluid path, and 1 (STR) in the accumulator fluid path. The switching valves open and close in accordance with the control signals from the skid control ECU in order to switch the respective brake fluid paths.
- A total of 8 control solenoid valves are used for the 4 wheels (2 types per wheel: pressure holding solenoid and pressure reduction solenoid).
  The pressure increase mode, the pressure holding mode, and the pressure reduction mode are effected based on the combination of these valves that are turned ON and OFF, in order to control the hydraulic pressure that is applied to each of the wheel cylinders.
- On the ’03 4Runner, the resistance of the solenoid coil of the 8 solenoid valves (4 switching solenoid valves: SA1, SA2, SA3, and STR: 4 pressure holding valves: SFRH, SFLH, SRRH, and SRLH) has been changed from the ’02 4Runner as indicated below, in order to improve their heat resistance. As a result, the continuous operation of the solenoid valves has been increased of the ’02 4Runner.

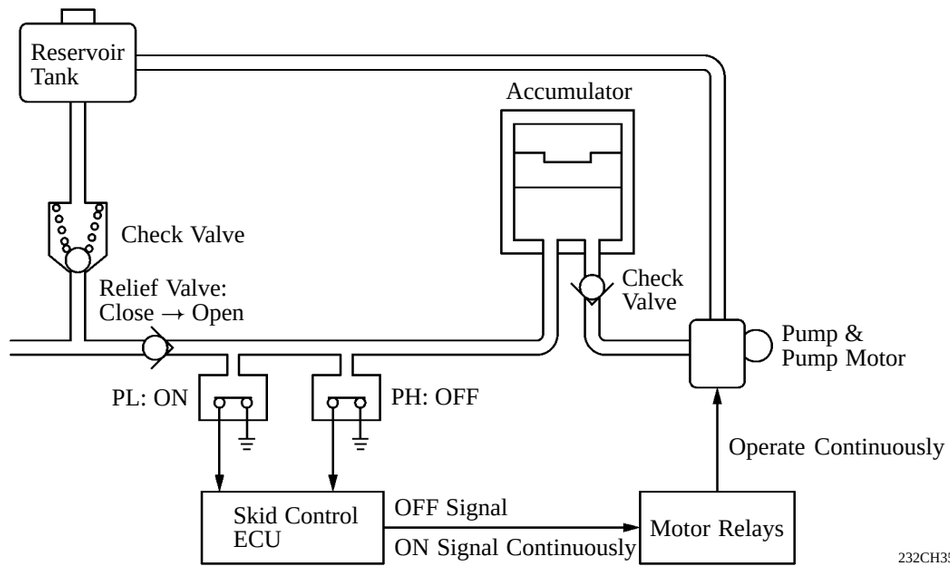
Model		’03 4Runner	’02 4Runner
Switching Solenoid Valve	SA1, SA2, STR	Approx. 4.3 Ω	Approx. 3.7 Ω
	SA3	Approx. 7.2 Ω	Approx. 5.0 Ω
Control Solenoid Valve	Pressure Holding Valve SFRH, SFLH, SRRH, SRLH	Approx. 7.2 Ω	Approx. 5.0 Ω
	Pressure Reduction Valve SFRR, SFLR, SRRR, SRLR	Approx. 5.0 Ω	←

4) Pump & Pump Motor, Accumulator, Pressure Switches PH/ PL and Relief Valve

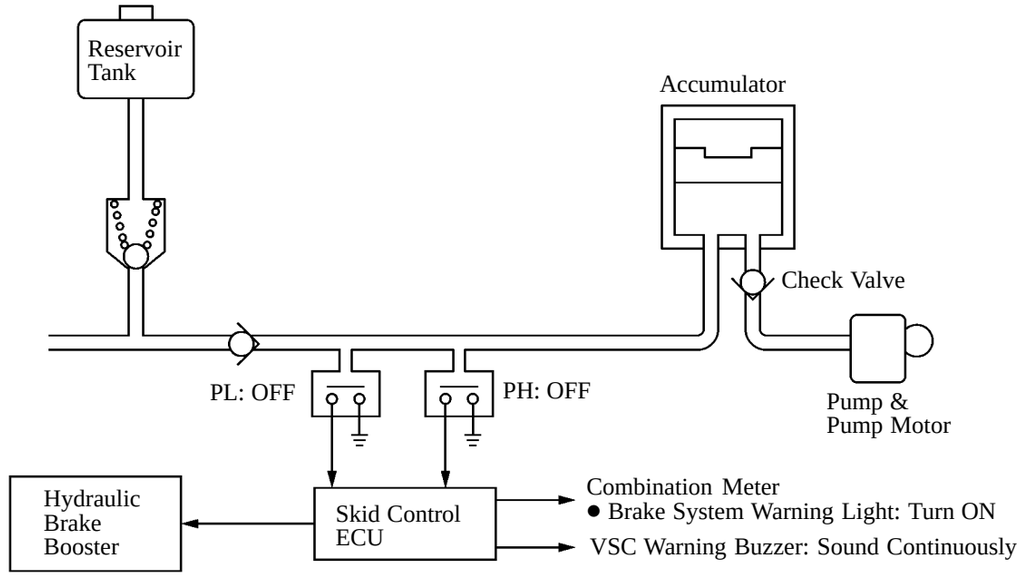
- If the accumulator pressure becomes lower than the pressure that is specified in the pressure switch PH, which is used for detecting high pressure, the pressure switch PH turns OFF. Then, the skid control ECU turns ON the pump motor relays to operates the pump & pump motor.
  The brake fluid that is discharged by the pump passes through the check valve and is stored in the accumulator. The hydraulic pressure that is stored in the accumulator is used for providing the hydraulic pressure that is needed for normal braking and for operating the brake control.



- If the accumulator pressure becomes higher than the pressure that is specified in the pressure switch PH, the pressure switch PH turns ON. Then after several seconds, the skid control ECU turns OFF the pump & pump motor. At this time, if the pressure switch malfunctions and causes the pump & pump motor to operate continuously, the relief valve opens the prevent excessive pressure from being generated.



- If the accumulator pressure becomes lower than the pressure that is specified in the pressure switch PL, which is used fore detecting low pressure, the pressure switch PL turns OFF. As a result, the brake warning light turns ON and the VSC warning buzzer activates. At this time, the brake control (ABS with EBD, Brake Assist, TRAC/A-TRAC, VSC, DAC, and HAC) prohibited from operating.



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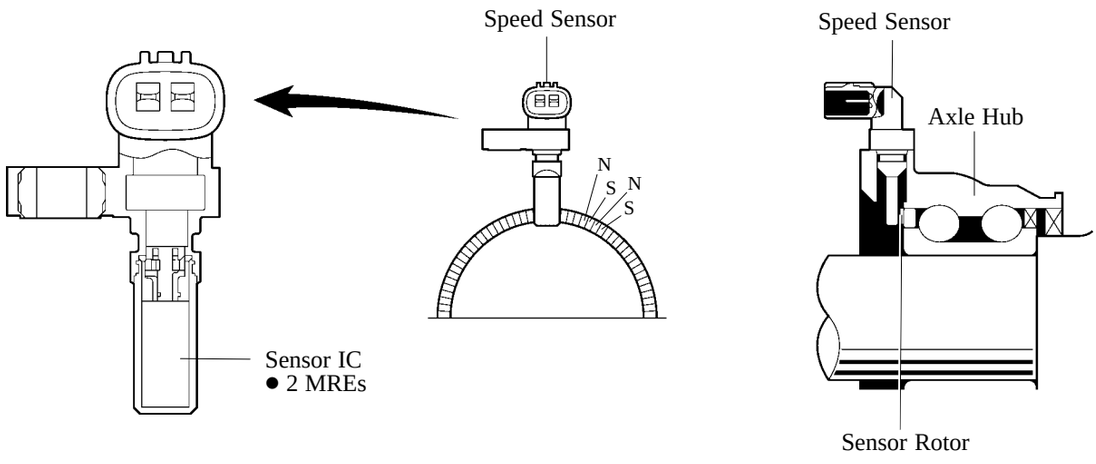
Speed Sensor

1) General

- Active type speed sensors that can detect the tire rotational direction forward and backward movement of the wheel have been adopted on the ’03 4Runner.
  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 inner race of the hub bearing.



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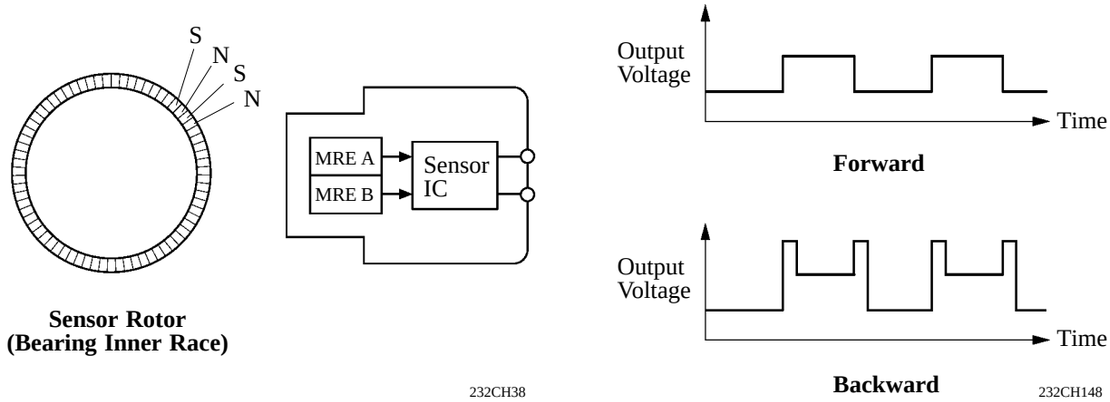
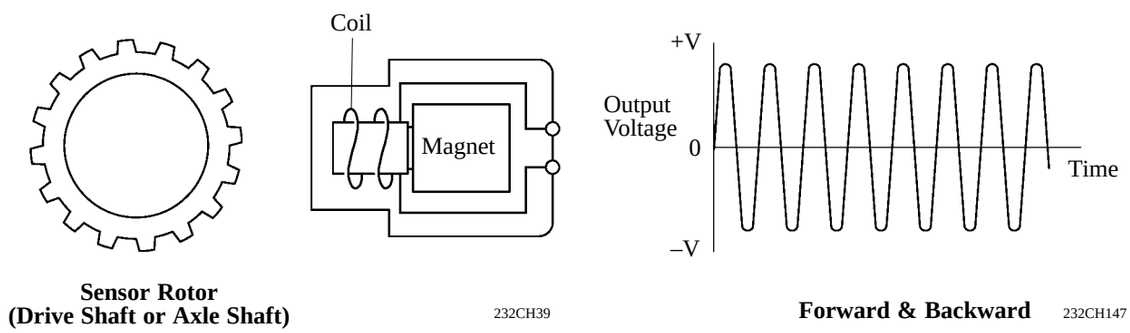
- The following differences exist between the passive type speed sensor (containing a pick-up coil to detect speeds) that is used on the ’02 4Runner and the active type that is used on the ’03 4Runner:

▶ Active Type Speed Sensor ◀



▶ Passive Type Speed Sensor ◀



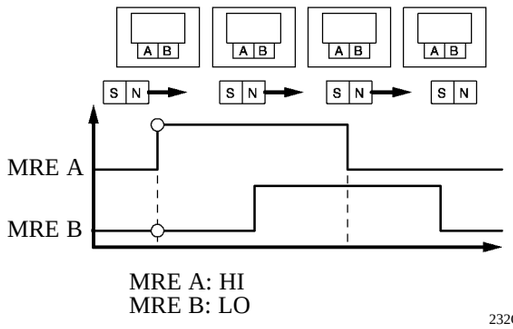
Time

Model	’03 4Runner	’02 4Runner
Type	Active	Passive
Direction Detection	Possible to judge both forward and backward	Impossible to judge the wheel rotation direction
Detection Speed	Approx. 0 km/h (0 mph)	3 km/h (5 mph) more than
Weight	Approx. 1/3 of passive type	—

2) Detection Method

- To detect the rotation direction, the output waves are used to determine the relationship of the pulses that are generated by the 2 MREs.
- Upon receiving this signal, the sensor IC outputs a forward or backward wave.

▶ Forward ◀



MRE A: HI
MRE B: LO

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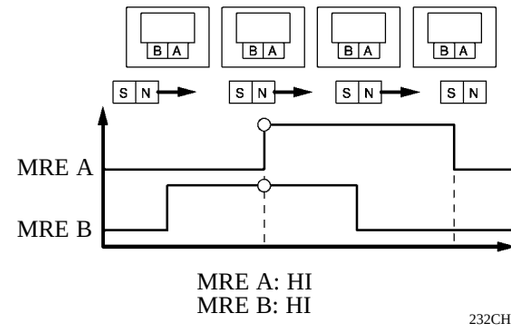
▶ Backward ◀



MRE A: HI
MRE B: HI

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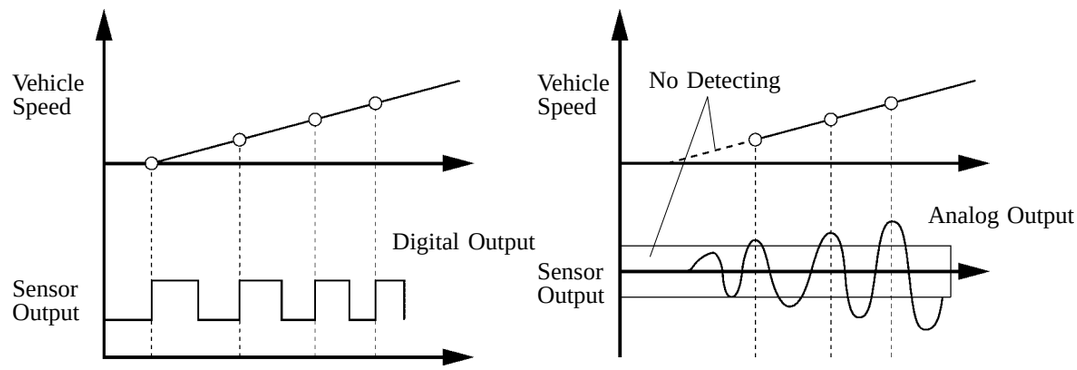
- To detect the vehicle speed, the duration of the output pulses is used. Because the active type sensor outputs digital pulses, it can detect vehicle speeds even at approximately 0 km/h (0 mph).
- This function enables the HAC of the brake control.



Active Type **Passive Type**

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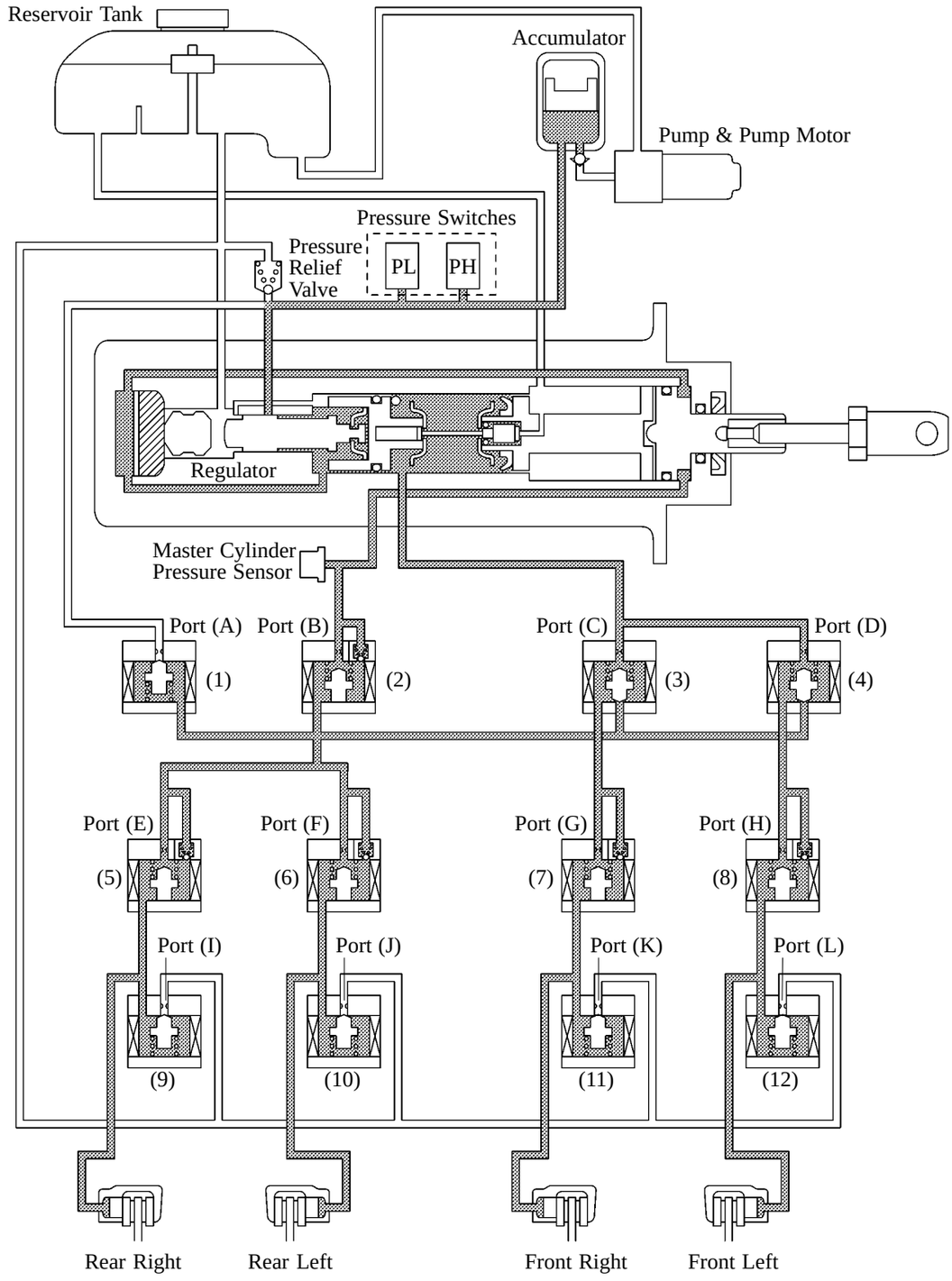
13. System Operation

Normal Braking

During normal braking, all solenoid valves are turned OFF.



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