

## 7. Construction and Operation of Main Components

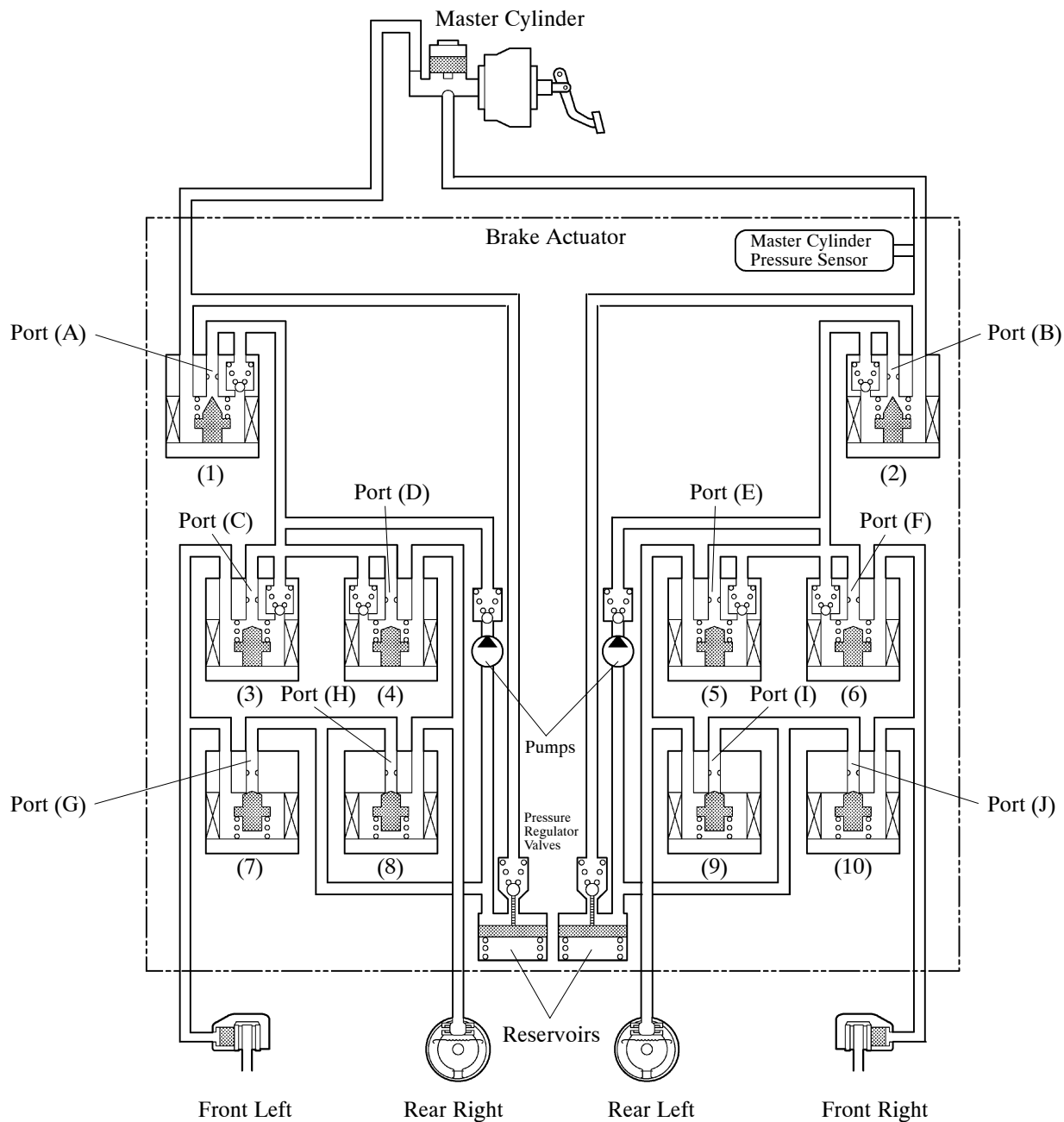
### Brake Actuator

#### 1) General

- A brake actuator with an integrated skid control ECU has been adopted.
- The brake actuator consists of 10 two-position valves, 1 pump motor, 2 pump gears, 1 master cylinder pressure sensor, and 2 reservoirs.

The 10 two-position solenoid valves consist of the following:

- 2 master cylinder cut solenoid valves (linear type) [(1), (2)]
- 4 pressure holding valves [(3), (4), (5), (6)]
- 4 pressure reduction valves [(7), (8), (9), (10)]

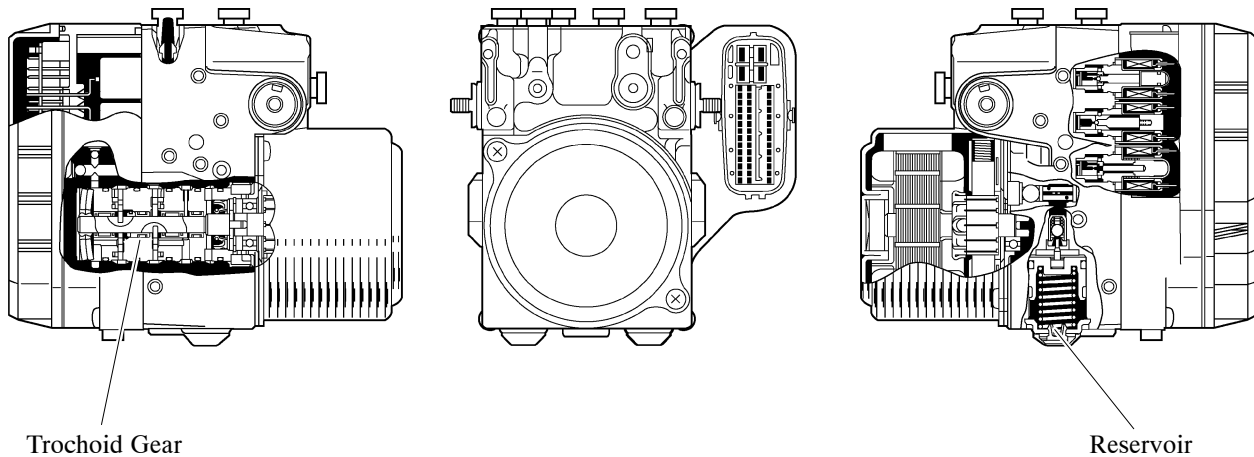


### ► Function of Main Components ◀

Components		Function
(1), (2)	Master Cylinder Cut Solenoid Valve (Linear Type)	To effect the respective brake controls of the Brake Assist, TRC, and VSC system, a combination of the ON/OFF conditions of the master cylinder cut solenoid valve is used to appropriately vary the fluid pressure.
(3), (4), (5), (6)	Pressure Holding Valve	Each wheel cylinder contains a pressure holding valve and a pressure reduction valve. A combination of the ON/OFF conditions of the respective valves is used in order to switch between the increase mode, holding mode, and the reduction mode during the operation of the ABS, Brake Assist, TRC, and VSC system.
(7), (8), (9), (10)	Pressure Reduction Valve	
Master Cylinder Pressure Sensor		The master cylinder pressure sensor converts the brake fluid pressure that the master cylinder applies to the brake actuator into an electrical signal and sends it to the skid control ECU. The skid control ECU can thus monitor the brake fluid pressure that is applied to the brake actuator in accordance with this signal.
Reservoir		While effecting the reduction mode during the operation of the ABS, Brake Assist, TRC, and VSC system, the reservoir stores the brake fluid that has returned from the wheel cylinders. It also functions as an accumulator.
Pump		Pumps the brake fluid that is stored in the reservoir and returns it to the master cylinder. While effecting the increase mode during the operation of the Brake Assist, TRC, and VSC system, the pump operates in order to apply brake fluid pressure to the wheel cylinders.
Pressure Regulator Valve		Pressure regulator valves open only in one direction to prevent the brake fluid from flowing backwards.

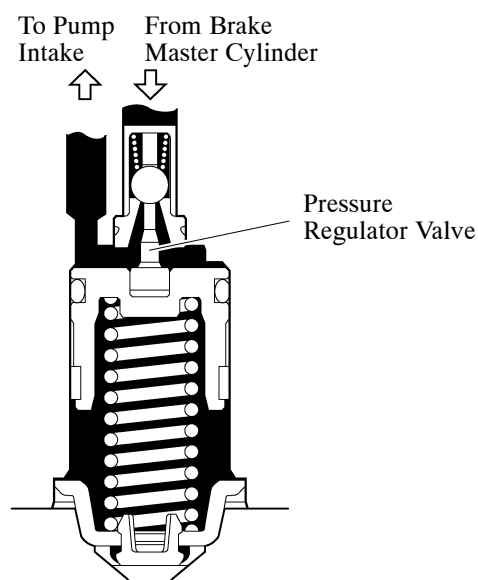
## 2) Pump and Reservoir

- The trochoid gear type pump has been newly adopted to reduce operating noise.



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- A pressure regulator valve has been adopted in the reservoir for the purpose of regulating the pressure of the fluid to be supplied to the pump and to close the passage between the pump and the master cylinder during braking.



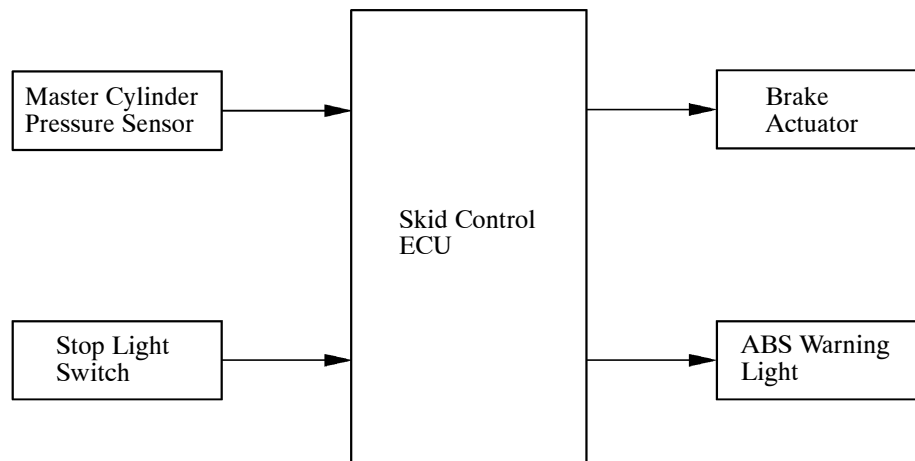
**Reservoir Cross Section**

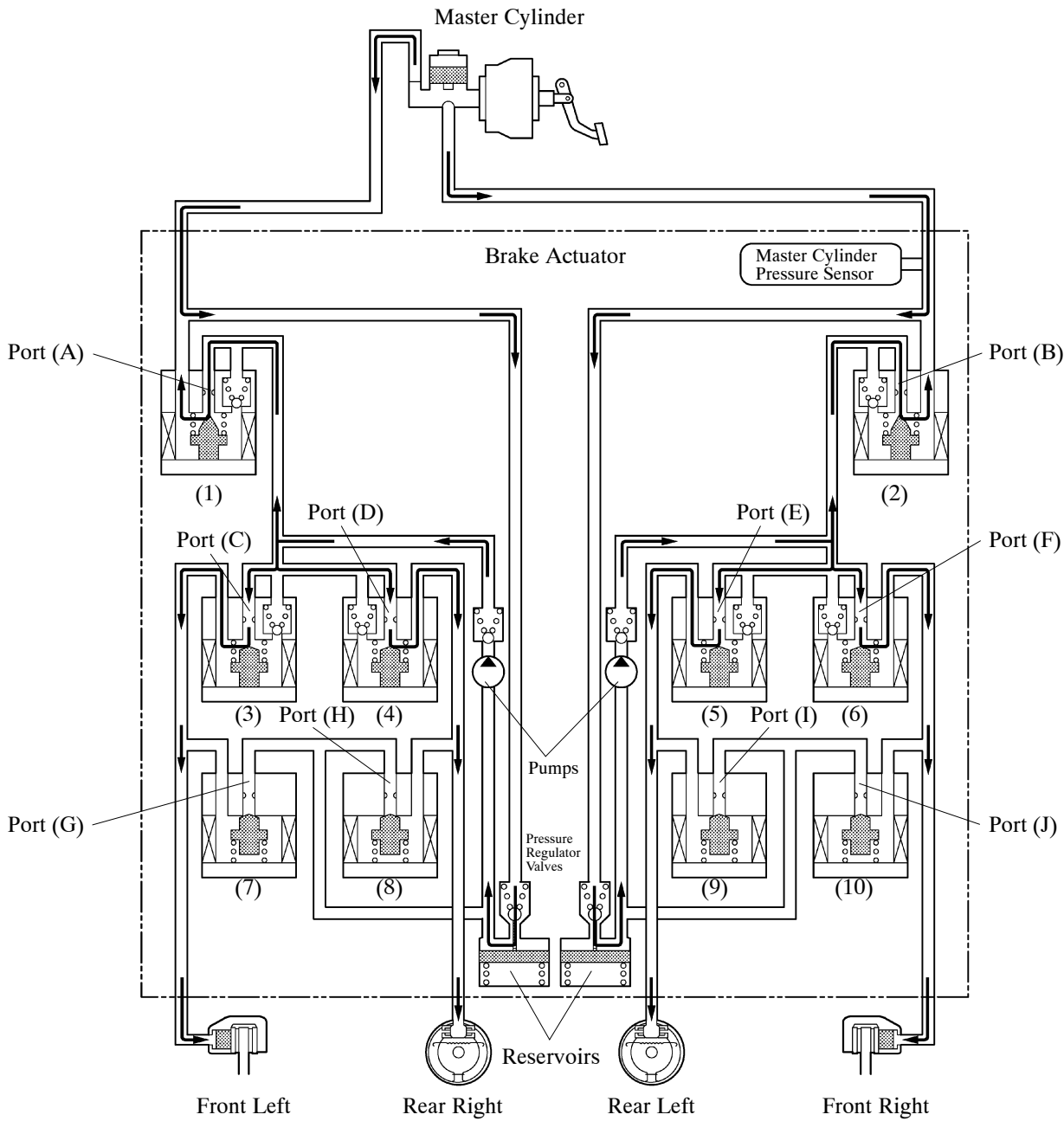
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## Brake Assist Operation

In the event of emergency braking, the skid control ECU detects the driver's intention based on the speed of the pressure increase in the master cylinder determined by the pressure sensor signal. If the ECU judges the need for the additional brake assist, the fluid pressure is generated by the pump in the actuator and directed to the wheel cylinder to apply a greater fluid pressure than the master cylinder.

### ► System Diagram ◀





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Item		Brake Assist Not Activated	Brake Assist Activated
(1), (2)	Master Cylinder Cut Solenoid Valve	OFF (Open)	ON*
	Port: (A), (B)		
(3), (4), (5), (6)	Pressure Holding Valve	OFF (Open)	OFF (Open)
	Port: (C), (D), (E), (F)		
(7), (8), (9), (10)	Pressure Reduction Valve	OFF (Close)	OFF (Close)
	Port: (G), (H), (I), (J)		

\*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

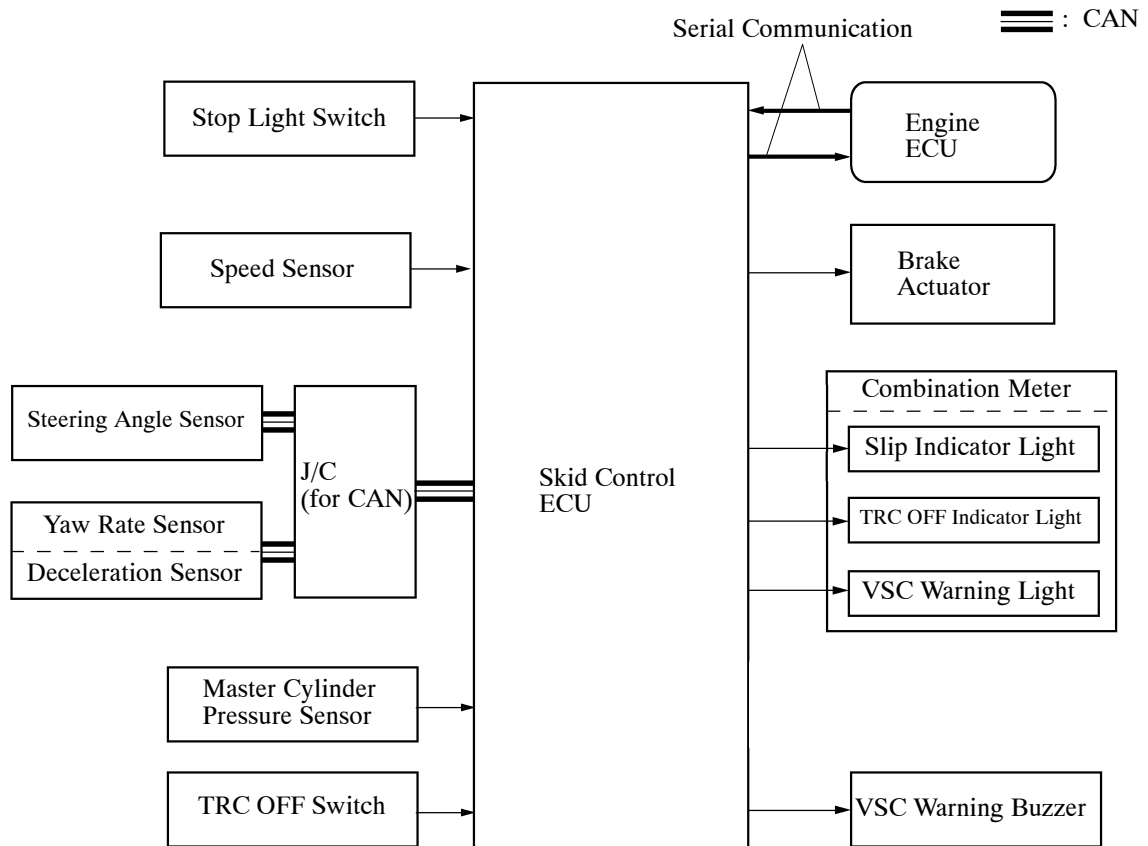
## TRC Operation

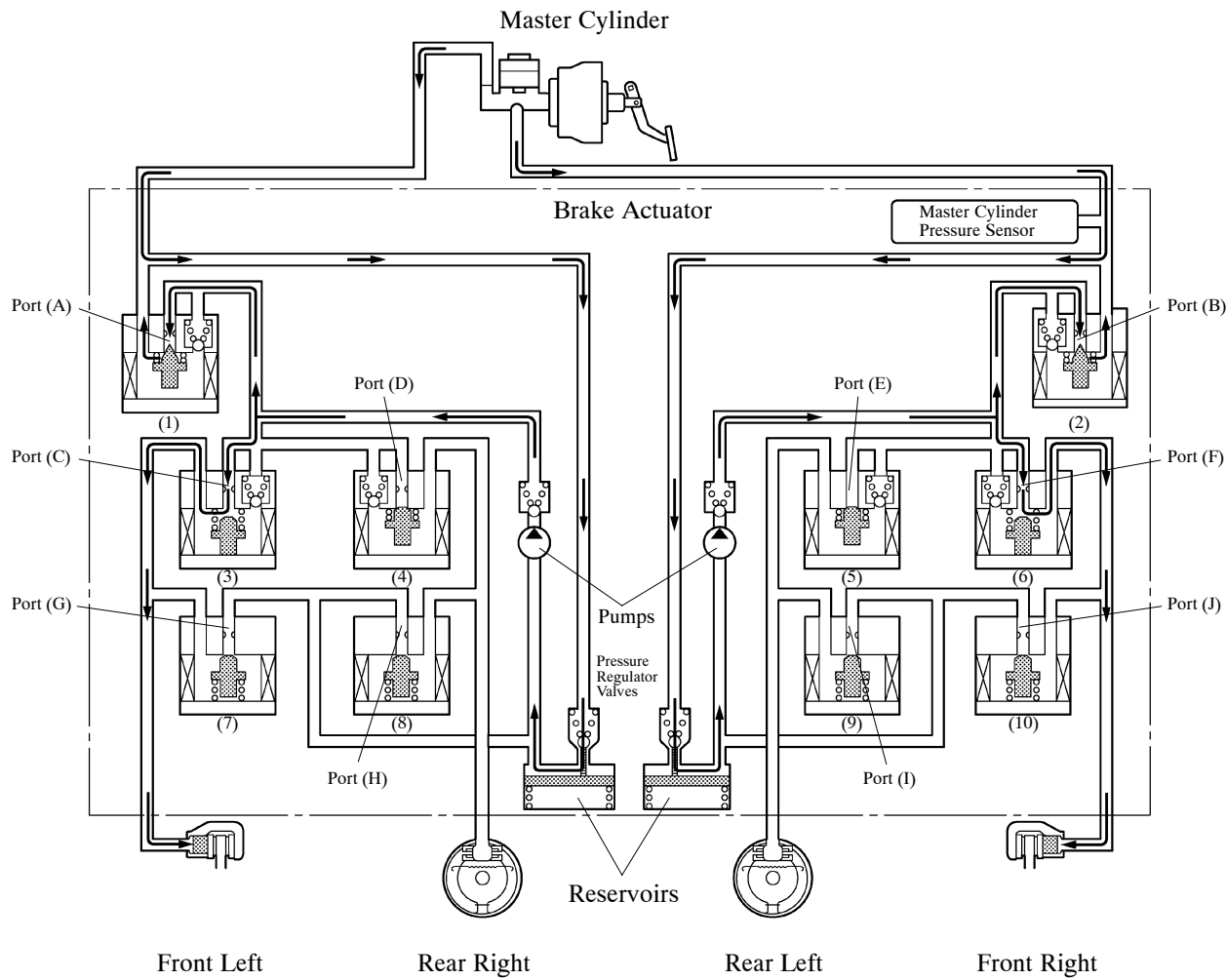
The fluid pressure generated by the pump is regulated by the master cylinder cut solenoid valve to the required pressure. Thus, the wheel cylinders of the drive wheels are controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes, to control the slippage of the drive wheels.

The diagram below shows the hydraulic circuit in the pressure increase mode when the TRC system is activated.

The pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS operation pattern described on the previous page.

### ► System Diagram ◀





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Item			TRC not Activated	TRC Activated		
				Increase Mode	Holding Mode	Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF (Open)	ON*	ON*	ON*
	Port: (A), (B)					
Front Brake	(3), (6)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
		Port: (C), (F)				
	(7), (10)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)
		Port: (G), (J)				
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce
Rear Brake	(4), (5)	Pressure Holding Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Close)
		Port: (D), (E)				
	(8), (9)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (H), (I)				
	Wheel Cylinder Pressure		—	—	—	—

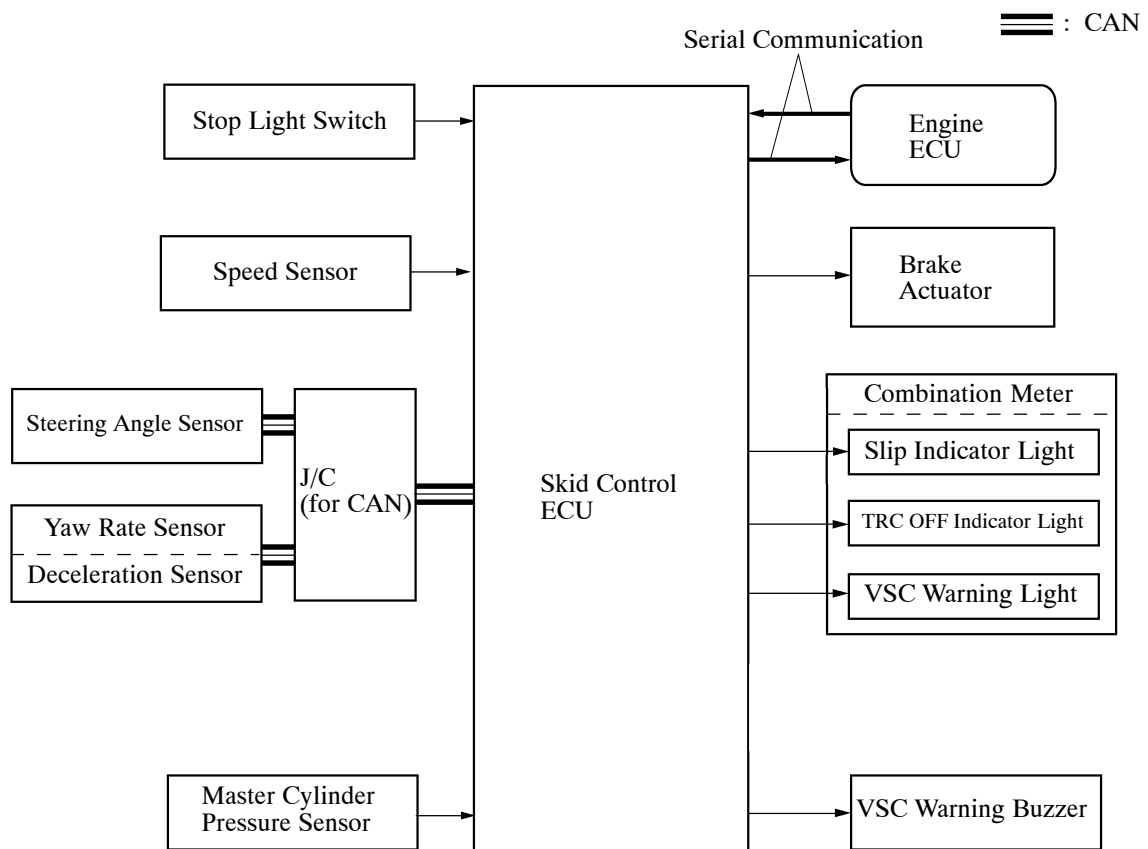
\*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

## VSC Operation

### 1) General

The VSC system, by way of solenoid valves, controls the fluid pressure that is generated by the pump and applies it to the brake wheel cylinder of each wheel in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes. As a result, the tendency to front wheel skid or rear wheel skid is controlled.

#### ► System Diagram ◀

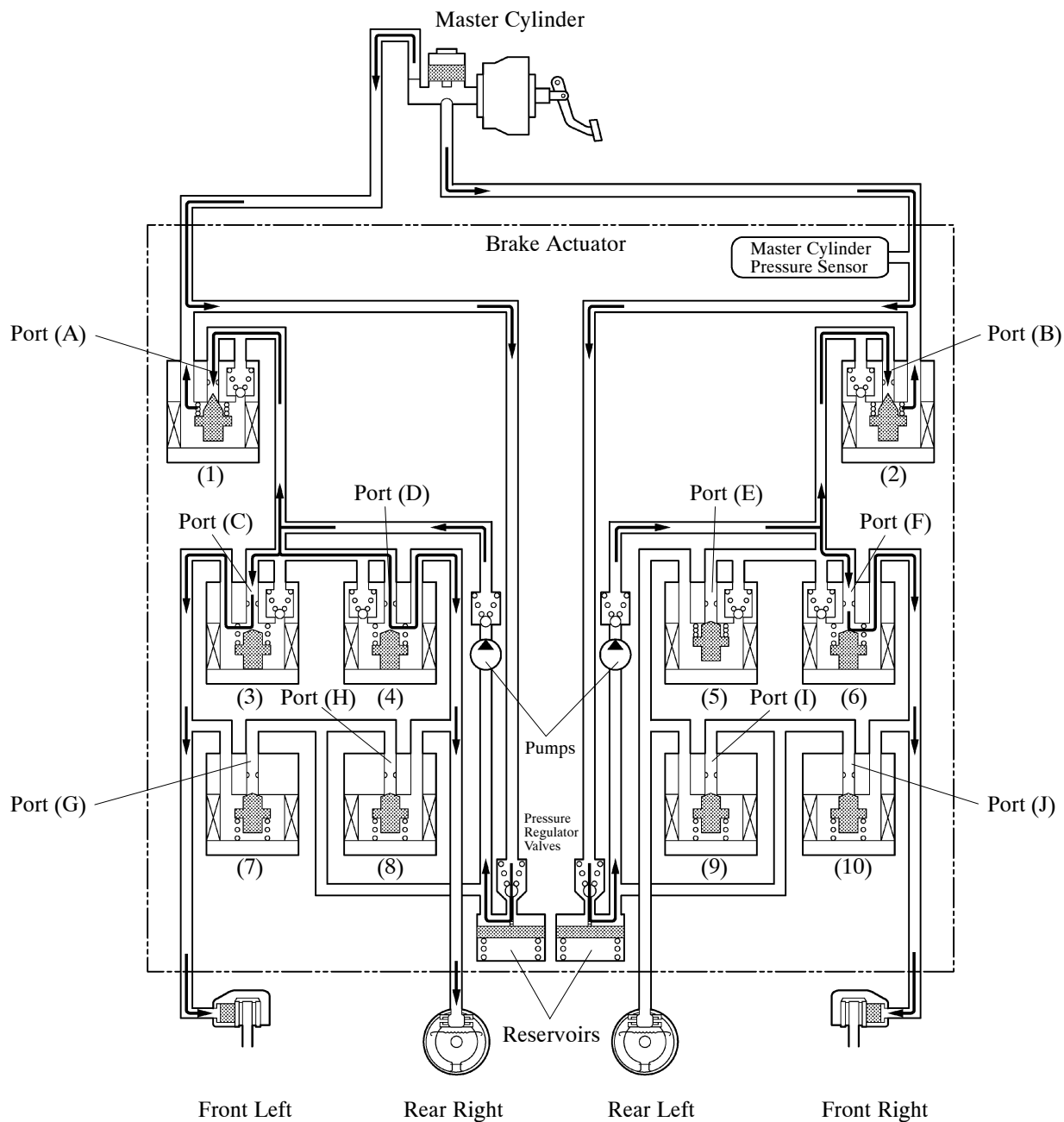




## 2) Front Wheel Skid Control (Turn to the Right)

- In the front wheel skid control, the brakes of the front wheels and the rear wheel of the inner circle of the turn are applied.
- Also, depending on whether the brake is ON or OFF and the condition of the vehicle, there are circumstances in which the brake might not be applied to the wheels even if those wheels are targeted for braking.
- The diagram below shows the hydraulic circuit in the pressure increase mode, as it controls the front wheel skid condition while the vehicle makes a right turn.

The pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS operation pattern.



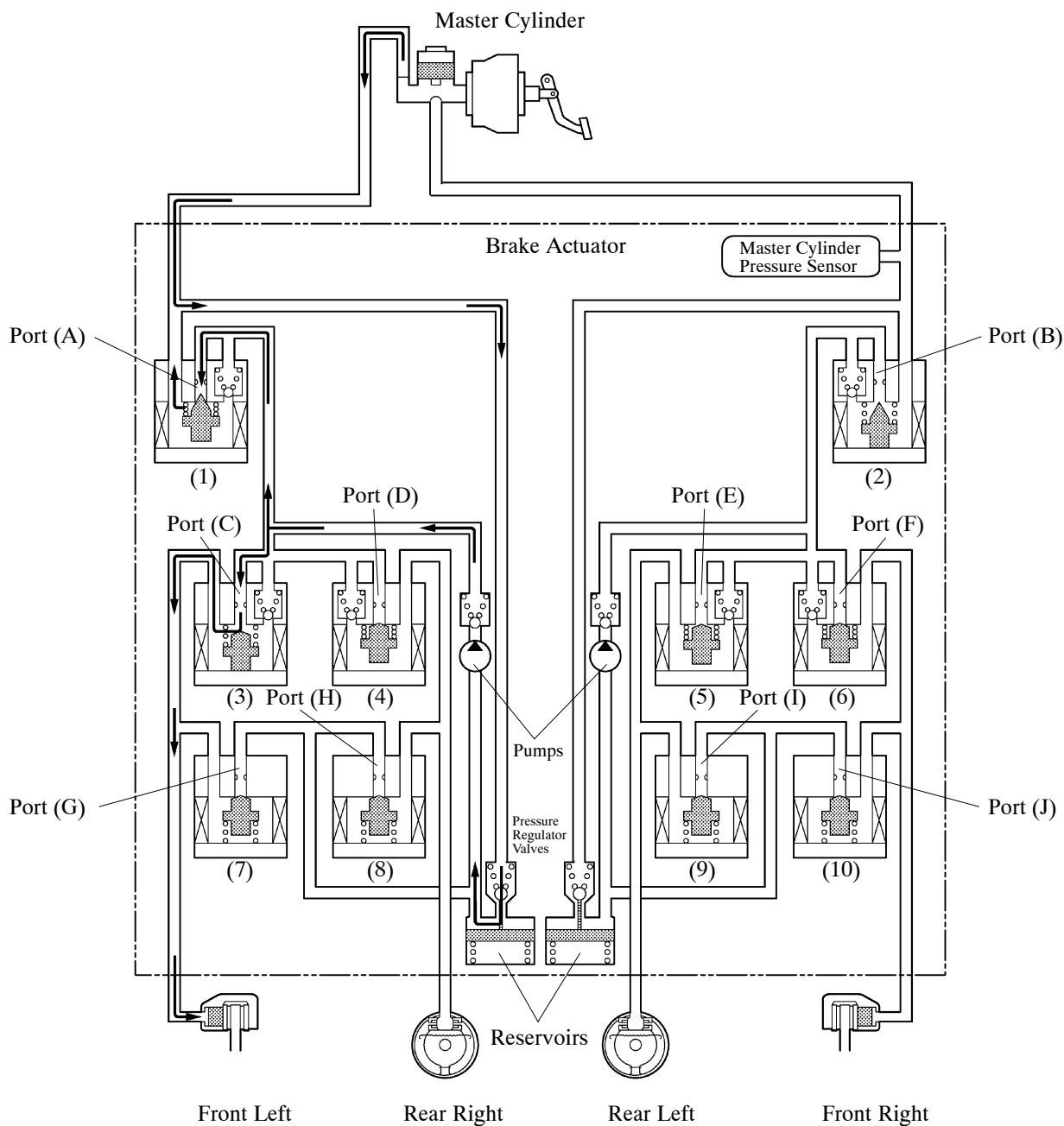
Item			VSC not Activated	VSC Activated		
				Increase Mode	Holding Mode	Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF (Open)	ON*	ON*	ON*
	Port: (A), (B)					
Front Brake	FL (3)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
		Port: (C)				
	FR (6)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
		Port: (F)				
	FL (7)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)
		Port: (G)				
	FR (10)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)
		Port: (J)				
Wheel Cylinder Pressure	Right	—	Increase	Hold	Reduce	
	Left	—	Increase	Hold	Reduce	
Rear Brake	RR (4)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
		Port: (D)				
	RL (5)	Pressure Holding Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Close)
		Port: (E)				
	RR (8)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)
		Port: (H)				
	RL (9)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (I)				
Wheel Cylinder Pressure	Right	—	Increase	Hold	Reduce	
	Left	—	—	—	—	

\*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.

### 3) Rear Wheel Skid Control (Turn to the Right)

In the rear wheel skid control, the brake of the front wheel of the outer circle of the turn is applied. As an example, the diagram below shows the hydraulic circuit in the pressure increase mode, as it controls the rear wheel skid condition while the vehicle makes a right turn.

As in the front wheel skid control the pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS operating pattern.



Item			VSC not Activated	VSC Activated		
				Increase Mode	Holding Mode	Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF (Open)	ON*	ON*	ON*
	Port: (A), (B)					
Front Brake	FL (3)	Pressure Holding Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
		Port: (C)				
	FR (6)	Pressure Holding Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Close)
		Port: (F)				
	FL (7)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Open)
		Port: (G)				
	FR (10)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (J)				
	Wheel Cylinder Pressure	Right	—	—	—	—
		Left	—	Increase	Hold	Reduce
Rear Brake	RR (4)	Pressure Holding Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Close)
		Port: (D)				
	RL (5)	Pressure Holding Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Close)
		Port: (E)				
	RR (8)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (H)				
	RL (9)	Pressure Reduction Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (I)				
	Wheel Cylinder Pressure	Right	—	—	—	—
Left		—	—	—	—	

\*: The solenoid valve controls the hydraulic pressure between “open” through “close” according to the operating condition by adjusting continually.