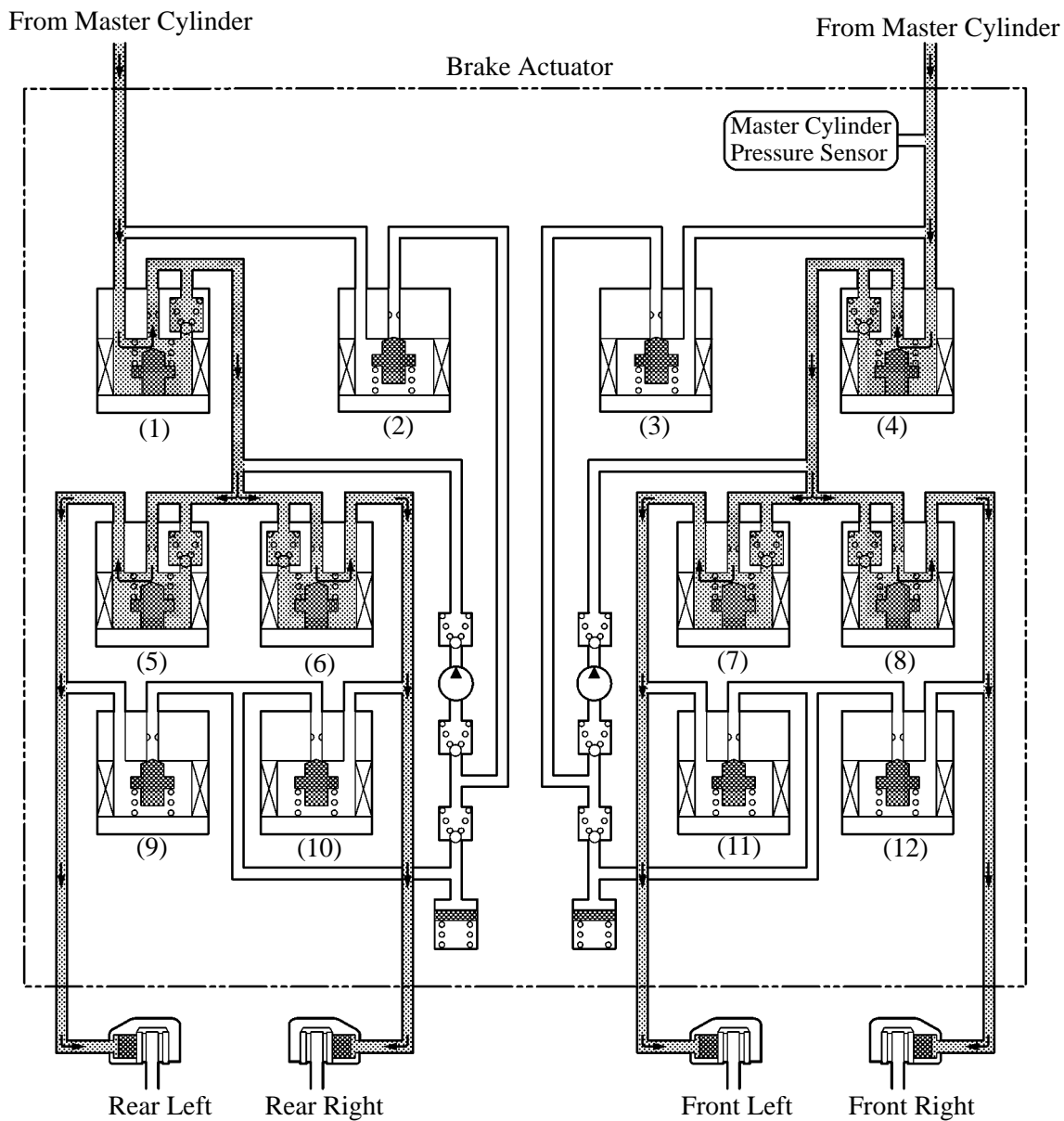


## 12. System Operation

### Normal Braking

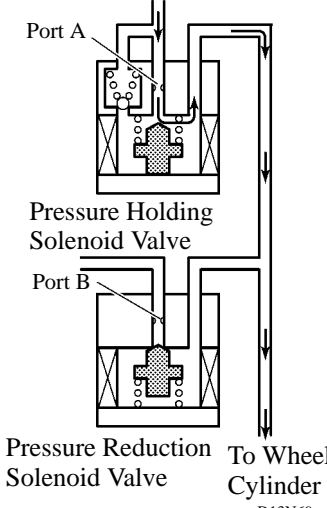
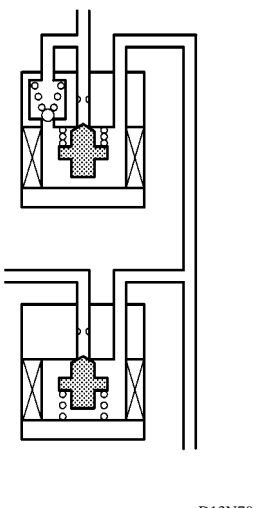
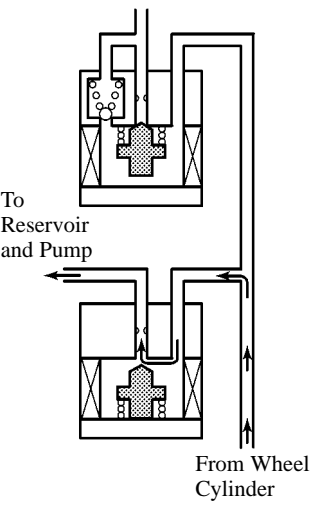
During normal braking, all solenoid valves are turned OFF.



08LCH169I

## ABS and EBD Operation

Based on the signals received from the four wheel speed sensors and yaw rate & deceleration sensor, the skid control ECU calculates the wheel rotation speed and deceleration for each wheel, in order to check for a wheel slippage condition. According to the slippage condition, the skid control ECU controls the pressure holding solenoid valves and pressure reduction solenoid valves in order to adjust the fluid pressure of the brakes for each of the wheels in the following three modes: pressure reduction, pressure holding, and pressure increase modes.

Not Activated	Normal Braking	—	—
Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Hydraulic Circuit	 <p>Port A</p> <p>Pressure Holding Solenoid Valve</p> <p>Port B</p> <p>Pressure Reduction Solenoid Valve</p> <p>To Wheel Cylinder</p> <p>D13N69</p>	 <p>D13N70</p>	 <p>To Reservoir and Pump</p> <p>From Wheel Cylinder</p> <p>D13N71</p>
Pressure Holding Solenoid Valve (Port A)	OFF/Open	ON/Close	ON/Close
Pressure Reduction Solenoid Valve (Port B)	OFF/Close	OFF/Close	ON/Open
Pressure	Increase	Hold	Reduce

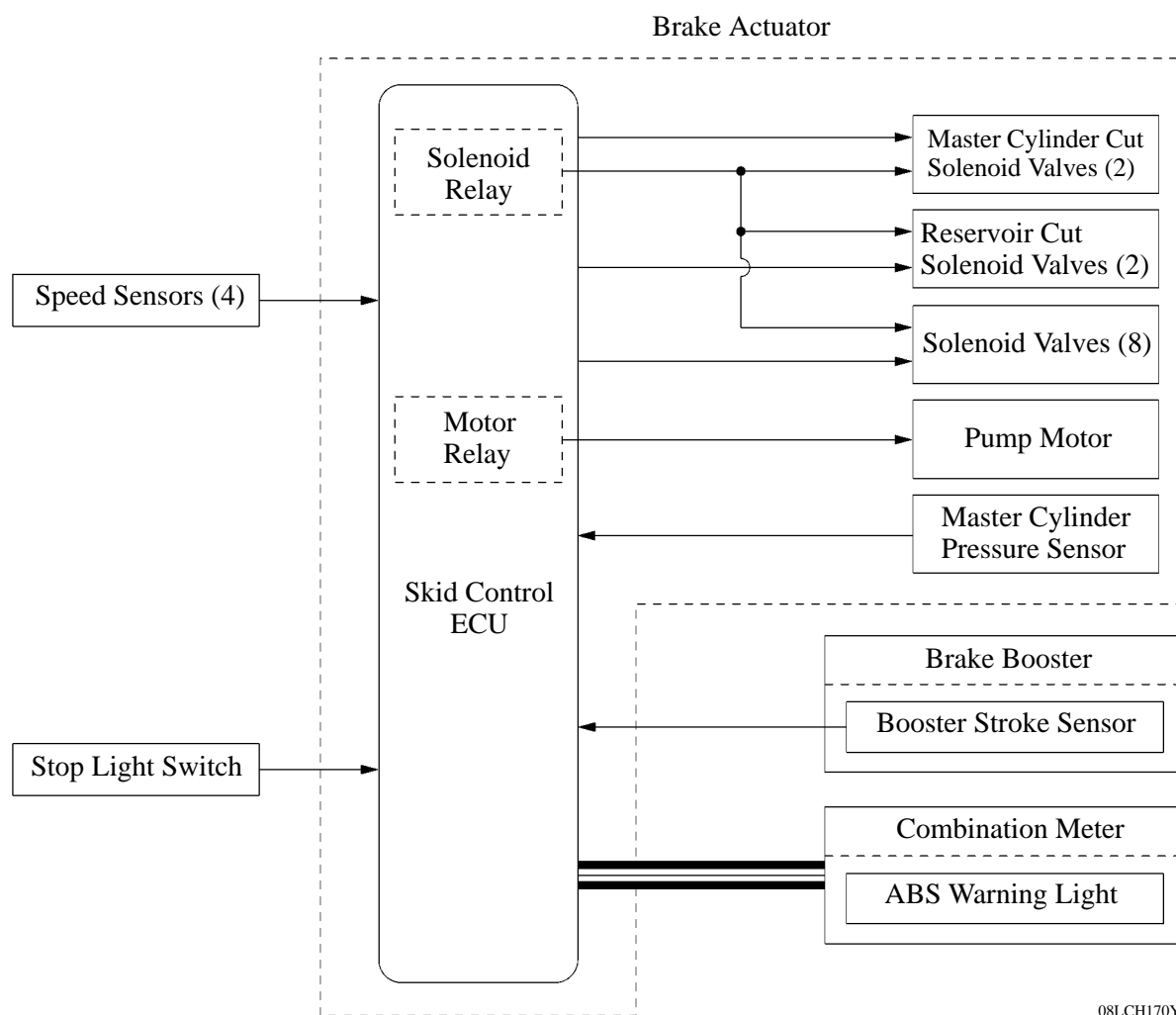
## Brake Assist Operation

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 master cylinder pressure sensor signals. If the skid control ECU judges the need for additional brake assist, pressure is generated by the pump in the brake actuator and directed to the brakes to apply a greater fluid pressure than the master cylinder. Also, in the following case, the skid control ECU provides brake assist.

- In the event of a brake booster failure, the skid control ECU judges the failure using the booster stroke sensor in the brake booster and master cylinder pressure sensor signals.

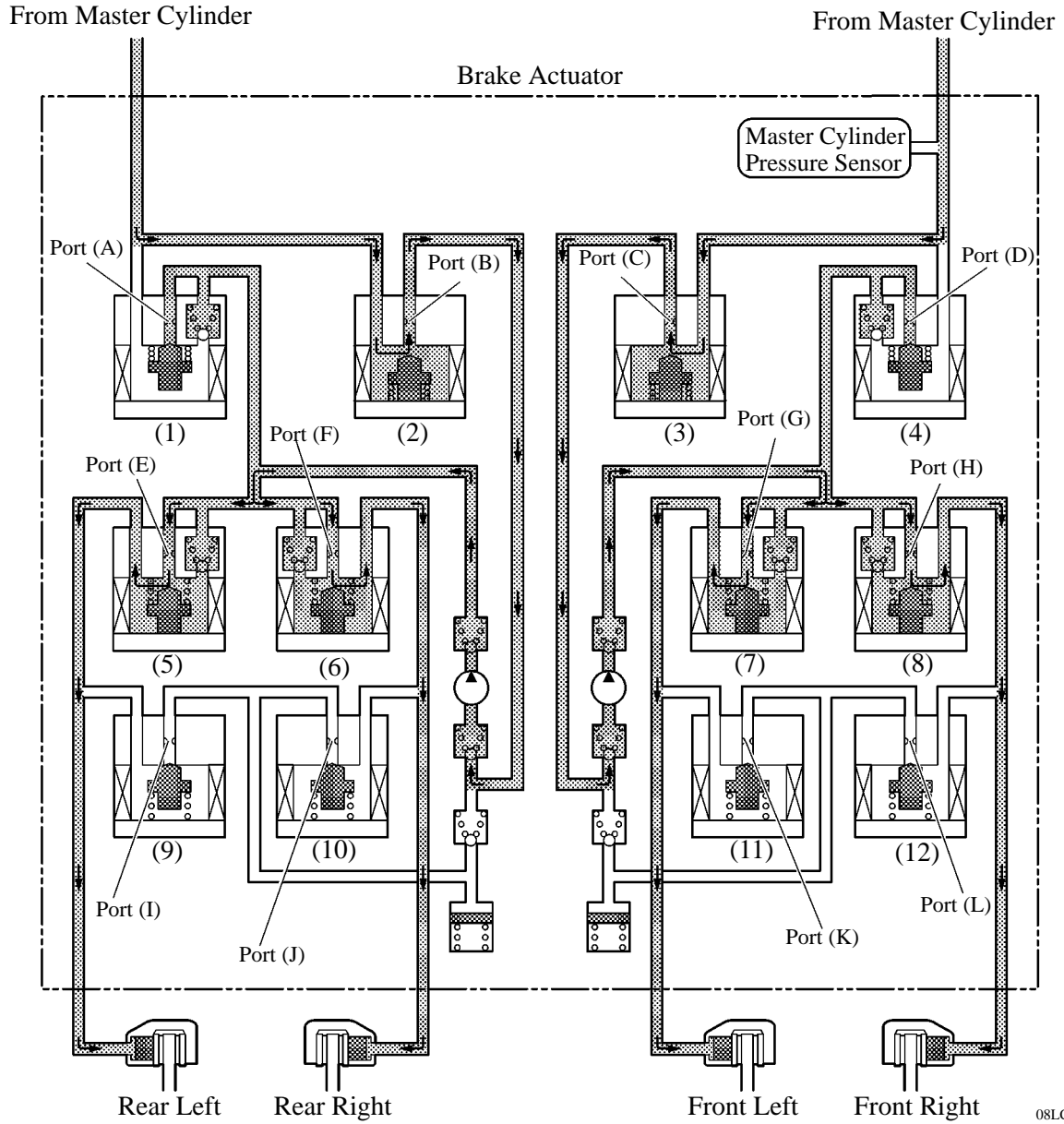
When the brake assist is activated, each solenoid valve operates as shown in the table on the next page.

### ► System Diagram ◀



08LCH170Y

## ► Brake Assist Operation ◀



08LCH171Y

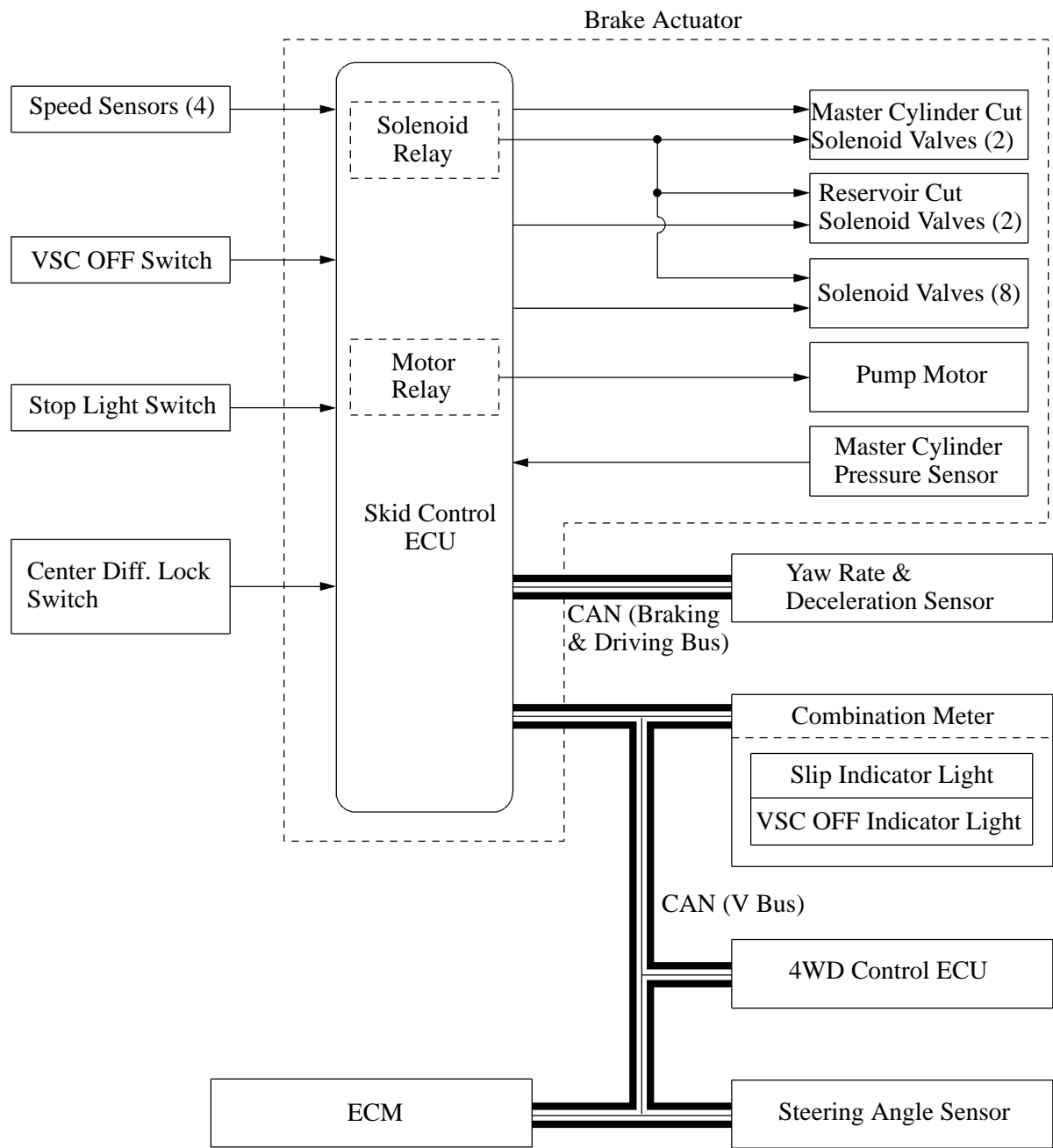
Item			Brake Assist Not Activated	Brake Assist Activated
Pump			OFF	ON
Master Cylinder Cut Solenoid Valve	(1)	Port (A)	OFF/Open	ON/Close
	(4)	Port (D)		
Reservoir Cut Solenoid Valve	(2)	Port (B)	OFF/Close	ON/Open
	(3)	Port (C)		
Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	←
	(6)	Port (F)		
	(7)	Port (G)		
	(8)	Port (H)		
Pressure Reduction Solenoid Valve	(9)	Port (I)	OFF/Close	←
	(10)	Port (J)		
	(11)	Port (K)		
	(12)	Port (L)		

TRAC Operation

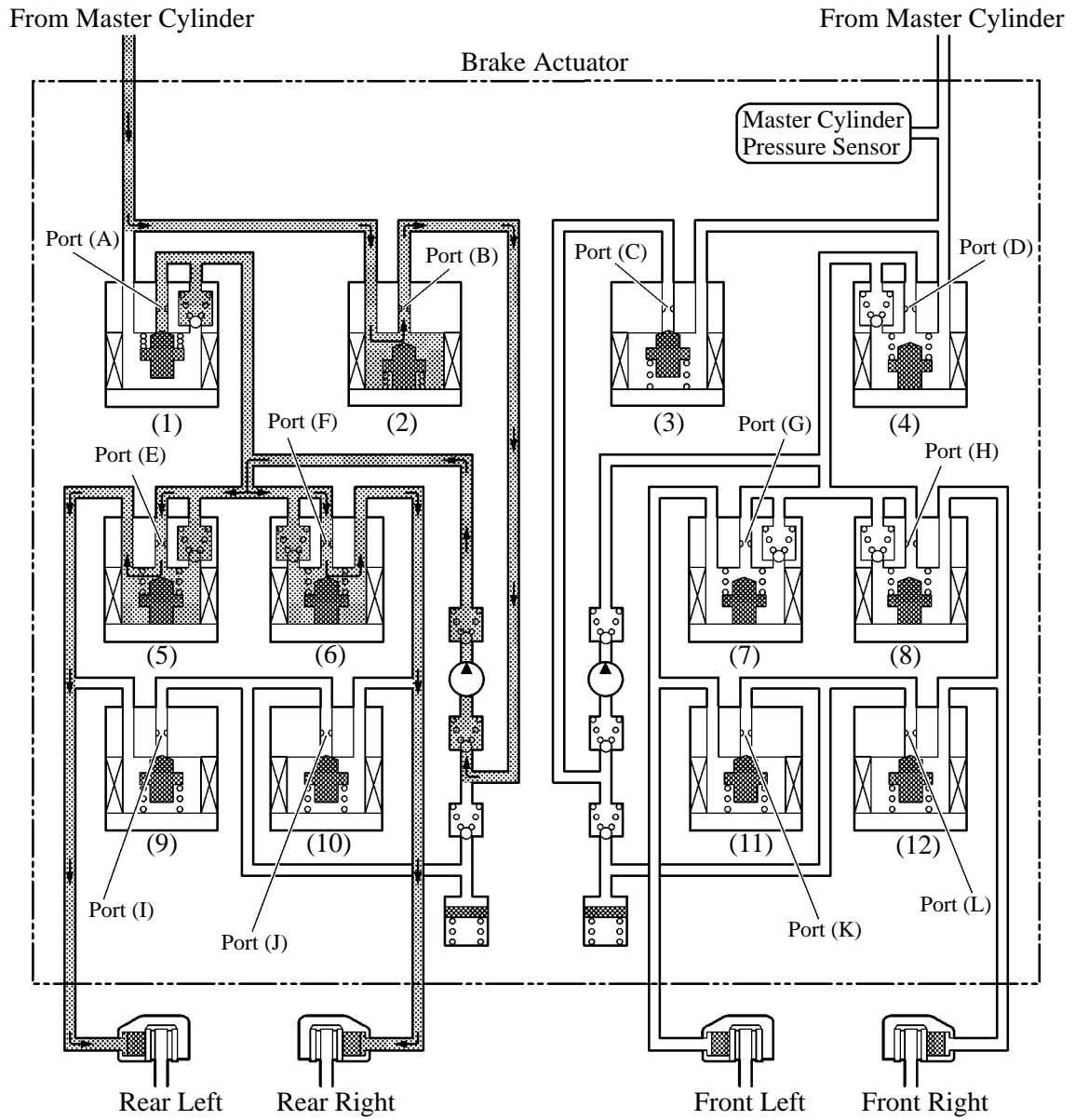
The fluid pressure generated by the pump is regulated by the master cylinder cut solenoid valve to the required pressure. Thus, the wheel cylinders of the drive wheels are controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes to control the slippage of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

The diagram on the next page shows the hydraulic circuit in the pressure increase mode when the TRAC is activated. The pressure holding solenoid valve and the pressure reduction solenoid valve are turned ON/OFF according to the ABS and EBD operation pattern described on page CH-185. When the TRAC is activated, each solenoid valve operates as shown in the table on page CH-190.

► System Diagram ◀



## ► TRAC Operation ◀



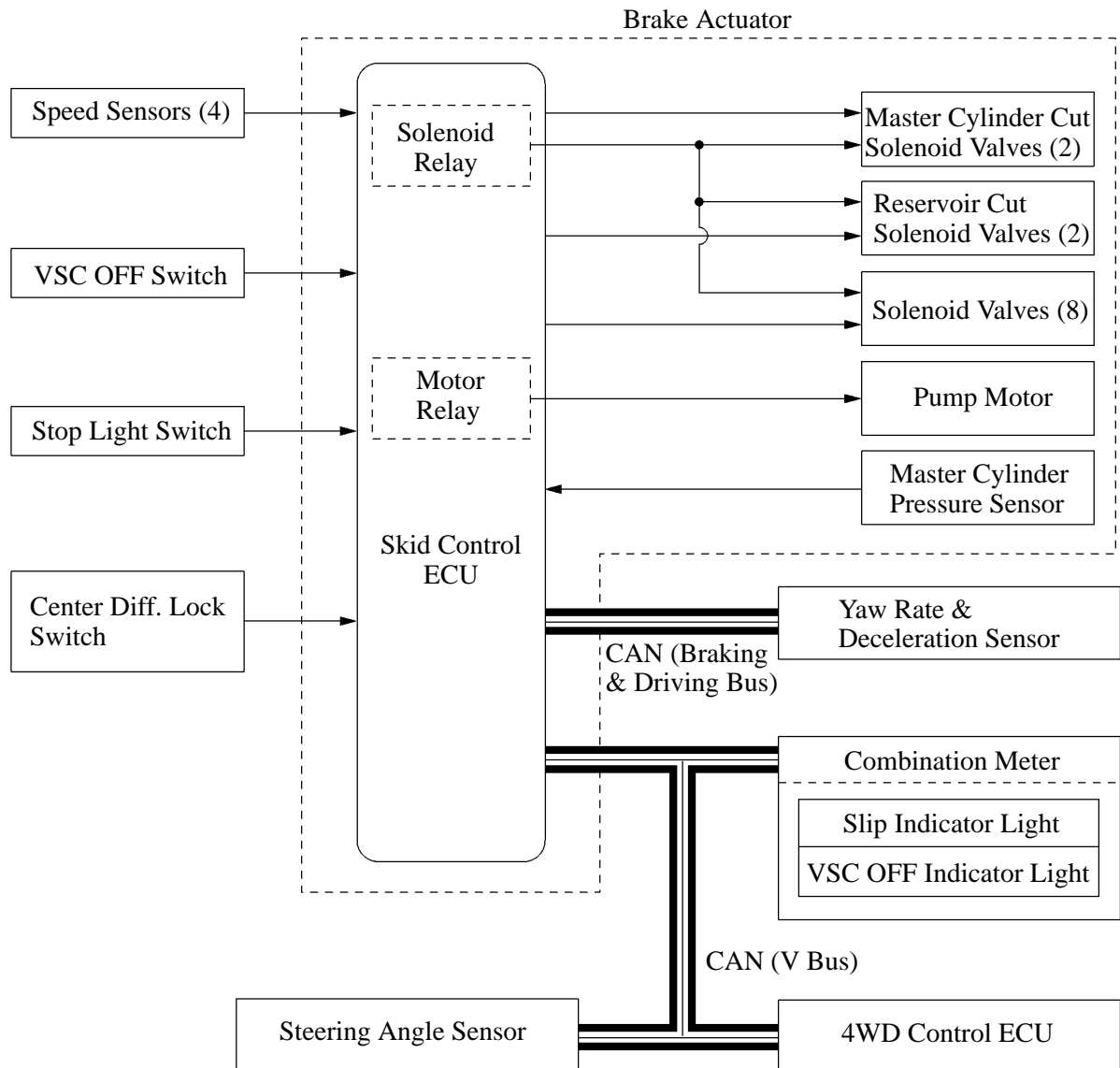
08LCH173I

Item				TRAC Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve		(1)	Port (A)	OFF/Open	ON/Close	←	OFF/Open
		(4)	Port (D)	OFF/Open	←	←	←
Reservoir Cut Solenoid Valve		(2)	Port (B)	OFF/Close	ON/Open	←	OFF/Close
		(3)	Port (C)	OFF/Close	←	←	←
Front Brake	Pressure Holding Solenoid Valve	(7)	Port (G)	OFF/Open	OFF/Open	←	←
		(8)	Port (H)				
	Pressure Reduction Solenoid Valve	(11)	Port (K)	OFF/Close	←	←	←
		(12)	Port (L)				
	Wheel Cylinder Pressure	Right		—	—	—	—
		Left					
Rear Brake	Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	←	ON/Close	OFF/Open
		(6)	Port (F)				
	Pressure Reduction Solenoid Valve	(9)	Port (I)	OFF/Close	←	←	←
		(10)	Port (J)				
	Wheel Cylinder Pressure	Right		—	Increase	Hold	Reduce
		Left					

## A-TRAC Operation

- Based on the vehicle speed that has been calculated from each speed sensor and the signals of the yaw rate & deceleration sensor, the skid control ECU computes the target control speed. The skid control ECU compares the target control speed and the speeds of the wheels to determine whether or not slippage exists. Upon detecting slippage, the skid control ECU controls the solenoid valves of the brake actuator to control the brake fluid pressure that is applied to the slipping wheel. When the wheel speed becomes lower than the target control speed, the skid control ECU stops increasing the brake fluid pressure.

### ► System Diagram ◀





- The target control speed and the brake control are as shown in the table below.

Road Condition	Transfer Range	Control		Outline
Ordinary	H4	Target Control Speed	Vehicle Speed + Slip Rate (H4 range set value)	Control designed to ensure the ease of driving on low-friction roads, dirt roads, and general roads.
		Brake Control	Gradual Fluid Pressure Control	
Rocky or Rough Road	L4	Target Control Speed	Vehicle Speed + Slip Rate (L4 range set value)	Control designed for rugged off-road driving conditions.
		Brake Control	Sudden Fluid Pressure Control	

#### NOTICE

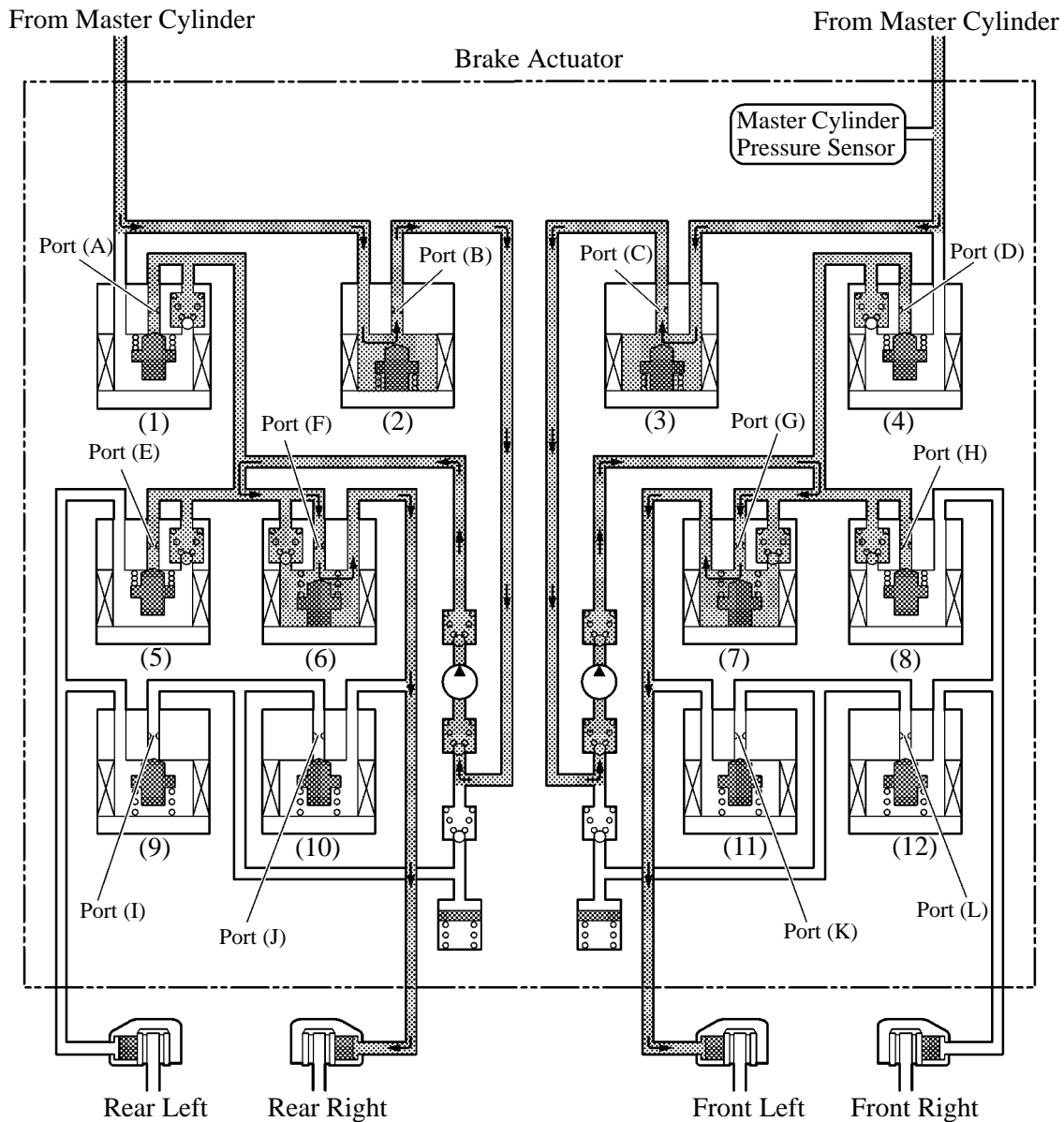
##### Precaution on A-TRAC Operation

When the A-TRAC is operating continuously while the vehicle is being driven on a slippery surface, the temperature of the brake pads increases. After a set length of time elapses, the skid control ECU alerts the driver of this condition by causing the VSC warning buzzer to sound, and the slip indicator warning light to illuminate. Also, the A-TRAC operation is temporarily interrupted to protect the pads.

When the temperature of the pads decreases, the slip indicator light turns OFF, and the A-TRAC is automatically restored to an operating state.

- The diagram on this page shows the hydraulic circuit in the pressure increase mode when the A-TRAC is activated. When the A-TRAC is activated, each solenoid valve operates as shown in the table on the next page.

► **A-TRAC Operation (When wheelspin of the front left wheel and rear right wheel occurs)** ◀



08LCH1751

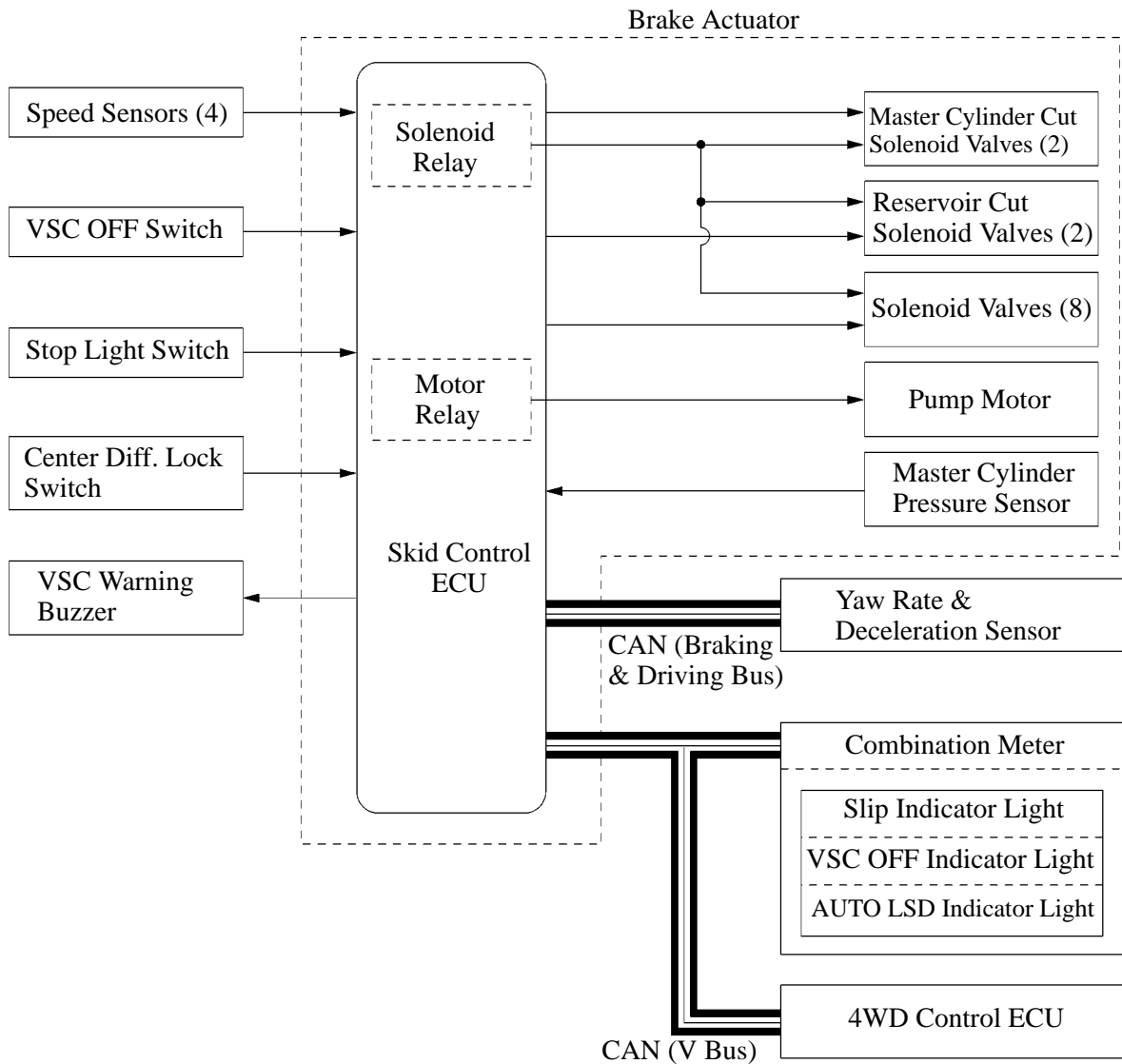
Item				A-TRAC Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve		(1)	Port (A)	OFF/Open	ON/Close	←	OFF/Open
		(4)	Port (D)				
Reservoir Cut Solenoid Valve		(2)	Port (B)	OFF/Close	ON/Open	OFF/Close	←
		(3)	Port (C)				
Front Brake	Pressure Holding Solenoid Valve	(7)	Port (G)	OFF/Open	←	←	←
		(8)	Port (H)	OFF/Open	ON/Close	←	←
	Pressure Reduction Solenoid Valve	(11)	Port (K)	OFF/Close	←	←	←
		(12)	Port (L)	OFF/Close	←	←	←
	Wheel Cylinder Pressure	Right		—	—	—	—
		Left		—	Increase	Hold	Reduce
Rear Brake	Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	ON/Close	←	←
		(6)	Port (F)	OFF/Open	←	←	←
	Pressure Reduction Solenoid Valve	(9)	Port (I)	OFF/Close	←	←	←
		(10)	Port (J)	OFF/Close	←	←	←
	Wheel Cylinder Pressure	Right		—	Increase	Hold	Reduce
		Left		—	—	—	—

## Auto LSD Operation

### 1) General

- The Auto LSD is a function that has effects similar to a mechanical type LSD (Limited Slip Differential). The Auto LSD employs the TRAC to control brake hydraulic pressure. The skid control ECU detects slippage that occurs as a result of a rotational speed difference between the wheel with grip and the wheel without grip. Via the TRAC, the Auto LSD detects the wheel slip that occurs (the wheel that is rotating faster), based on the rotational difference of the right and left drive wheels, and creates the Auto LSD effect.
- The diagram on page CH-197 shows the hydraulic circuit in the pressure increase mode when the Auto LSD is activated. When the Auto LSD is activated, each solenoid valve operates as shown in the table on page CH-198.

### ► System Diagram ◀



## 2) Auto LSD Operation Condition

The following conditions must be met to enable operation of Auto LSD. The AUTO LSD indicator light turns ON when the operation is enabled.

Operating Condition	Content
2WD mode is selected	The Auto LSD is operational only in the 2WD mode.
TRAC OFF mode or Auto LSD mode is selected	By operating the VSC OFF switch, the vehicle is in the TRAC OFF mode or Auto LSD mode.
Accelerator Pedal is ON	The Auto LSD does not operate when the brake pedal is being operated. This ensures that the Auto LSD does not interfere with the driver's attempt to reduce vehicle speed.
Vehicle speed is less than 50 km/h (31 mph)	The vehicle is driving at less than 50 km/h (31 mph).

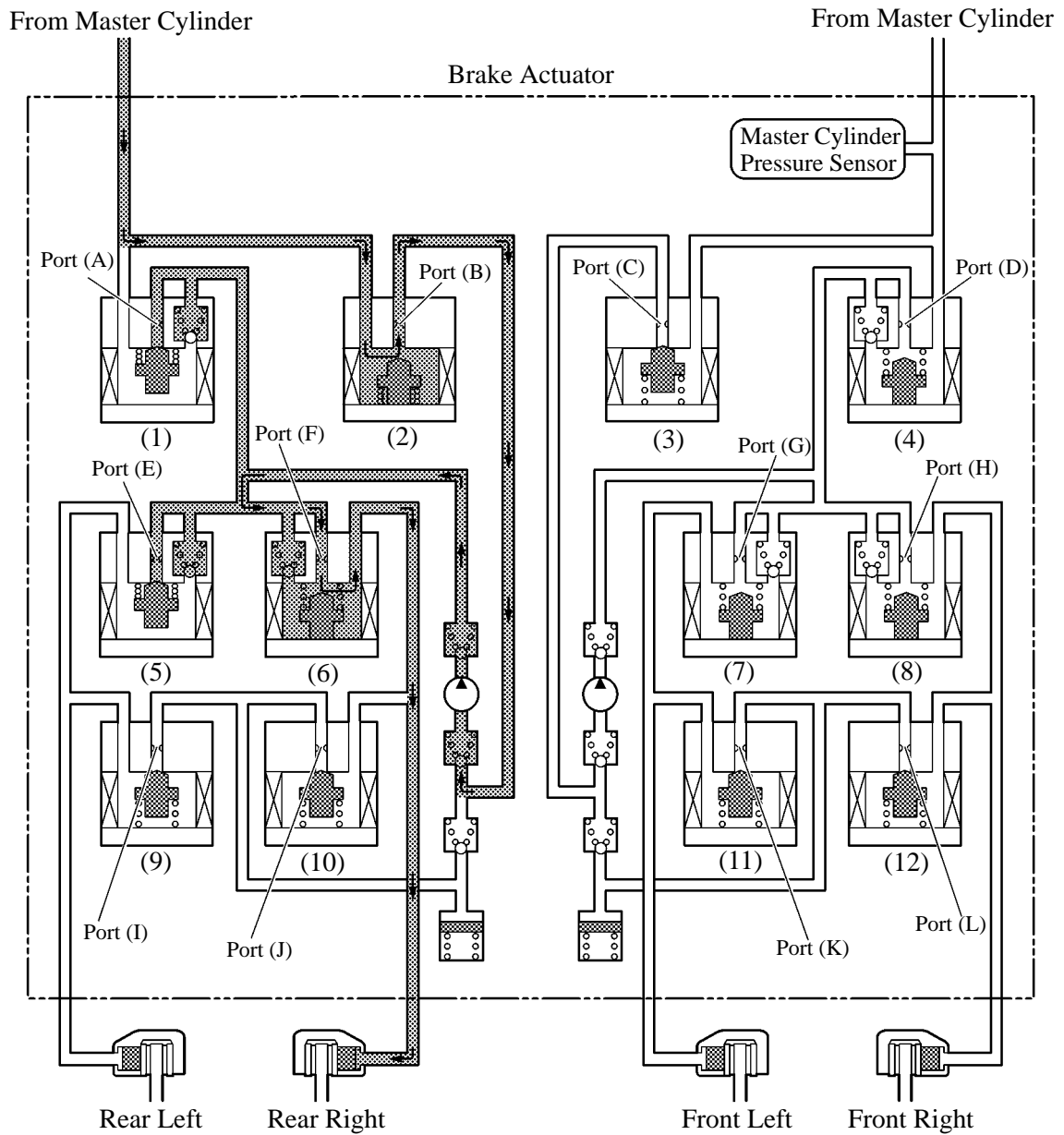
### NOTICE

#### Precaution on Auto LSD Operation

- Operate the Auto LSD control only when the wheels are susceptible to spinning, such as when driving on a grooved, slippery, or rough surface.
- Make sure the vehicle is stopped before turning ON the Auto LSD.
- To prevent instability, do not continue driving the vehicle with the Auto LSD turned ON.
- The slip indicator light will blink when the Auto LSD is operating.
- If the brake control of the Auto LSD is operated continuously, the temperature of the brake pads will rise. The skid control ECU, which monitors\* the temperature of the brake pads, alerts the driver by sounding the VSC warning buzzer if the brake pads becomes overheated. In this case, the Auto LSD will temporarily stop operating in order to protect the system.
- The Auto LSD applies the brakes to the drive wheel with the higher speed and controls the extent of the brake application in order to achieve the function of an LSD. However, it might not be able to achieve this function on a steep incline or on an extremely slippery surface, such as a frozen or snowy surface.

\*: The skid control ECU calculates the temperature of the brake pads based on its operating time.

► Auto LSD Operation (When wheelspin of the rear right wheel occurs) ◀



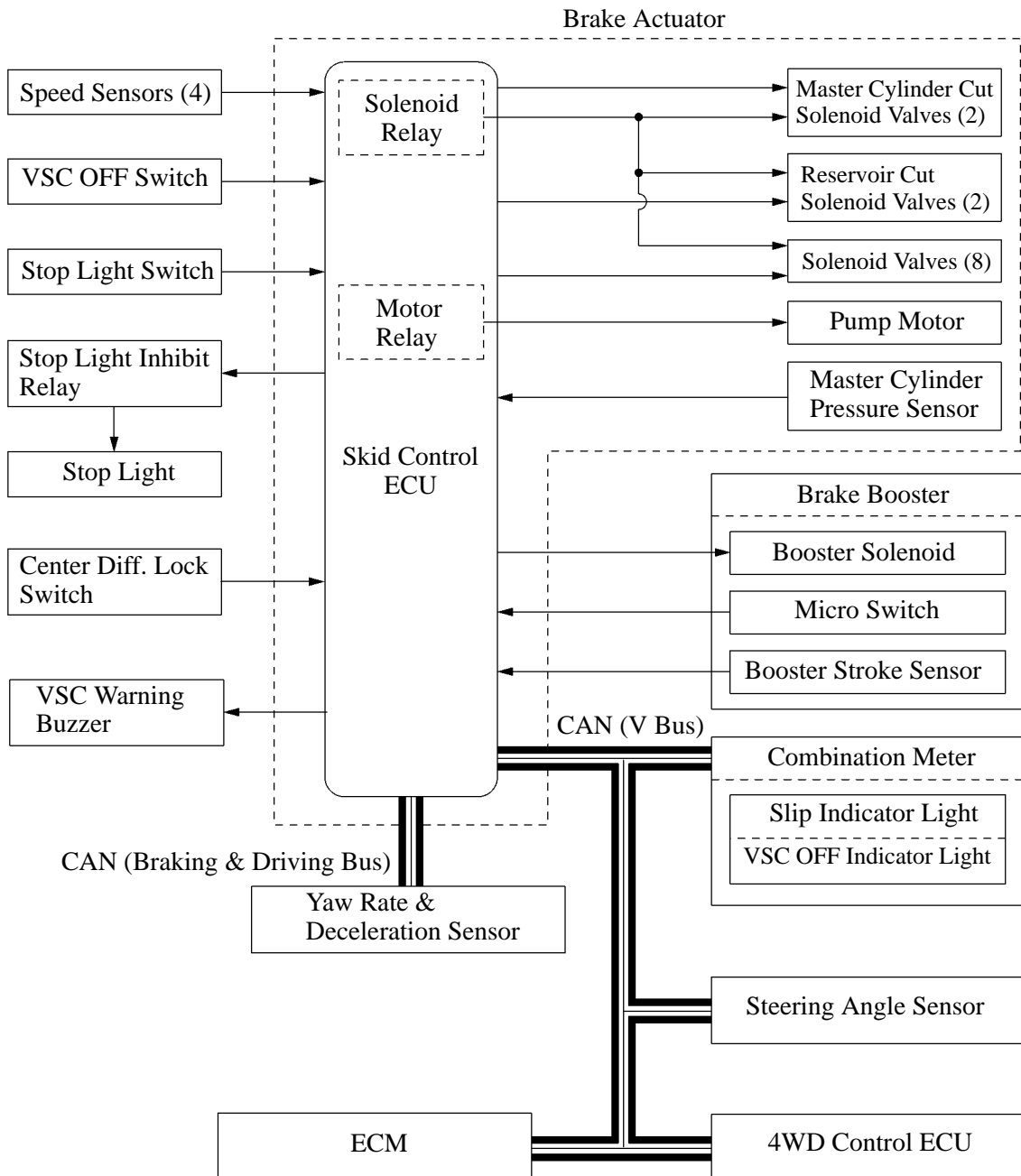
Item				Auto LSD Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve	(1)	Port (A)		OFF/Open	ON/Close	←	OFF/Open
	(4)	Port (D)		OFF/Open	←	←	←
Reservoir Cut Solenoid Valve	(2)	Port (B)		OFF/Close	ON/Open	OFF/Close	←
	(3)	Port (C)		OFF/Close	←	←	←
Front Brake	Pressure Holding Solenoid Valve	(7)	Port (G)	OFF/Open	←	←	←
		(8)	Port (H)				
	Pressure Reduction Solenoid Valve	(11)	Port (K)	OFF/Close	←	←	←
		(12)	Port (L)				
	Wheel Cylinder Pressure	Right		—	—	—	—
		Left		—	—	—	—
Rear Brake	Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	ON/Close	←	←
		(6)	Port (F)	OFF/Open	←	←	←
	Pressure Reduction Solenoid Valve	(9)	Port (I)	OFF/Close	←	←	←
		(10)	Port (J)	OFF/Close	←	←	←
	Wheel Cylinder Pressure	Right		—	Increase	Hold	Reduce
		Left		—	—	—	—

## VSC Operation

### 1) General

- Based on the information provided by various sensors, switches, and the ECM, the skid control ECU determines the vehicle's yaw moment. Then, the skid control ECU controls the fluid pressure that is generated by the pump & pump motor and applies it by way of the solenoid valves to the brake wheel cylinder of each wheel in the following three modes: pressure reduction, pressure hold, and pressure increase modes. As a result, the tendency of the vehicle to experience a front wheel skid or rear wheel skid is restrained.
- At this time, the skid control ECU outputs a VSC operation signal to the ECM and the combination meter and causes the VSC warning buzzer to sound. Upon receiving this signal, the ECM controls the throttle to regulate the engine output. The slip indicator light will blink in the combination meter.

### ► System Diagram ◀



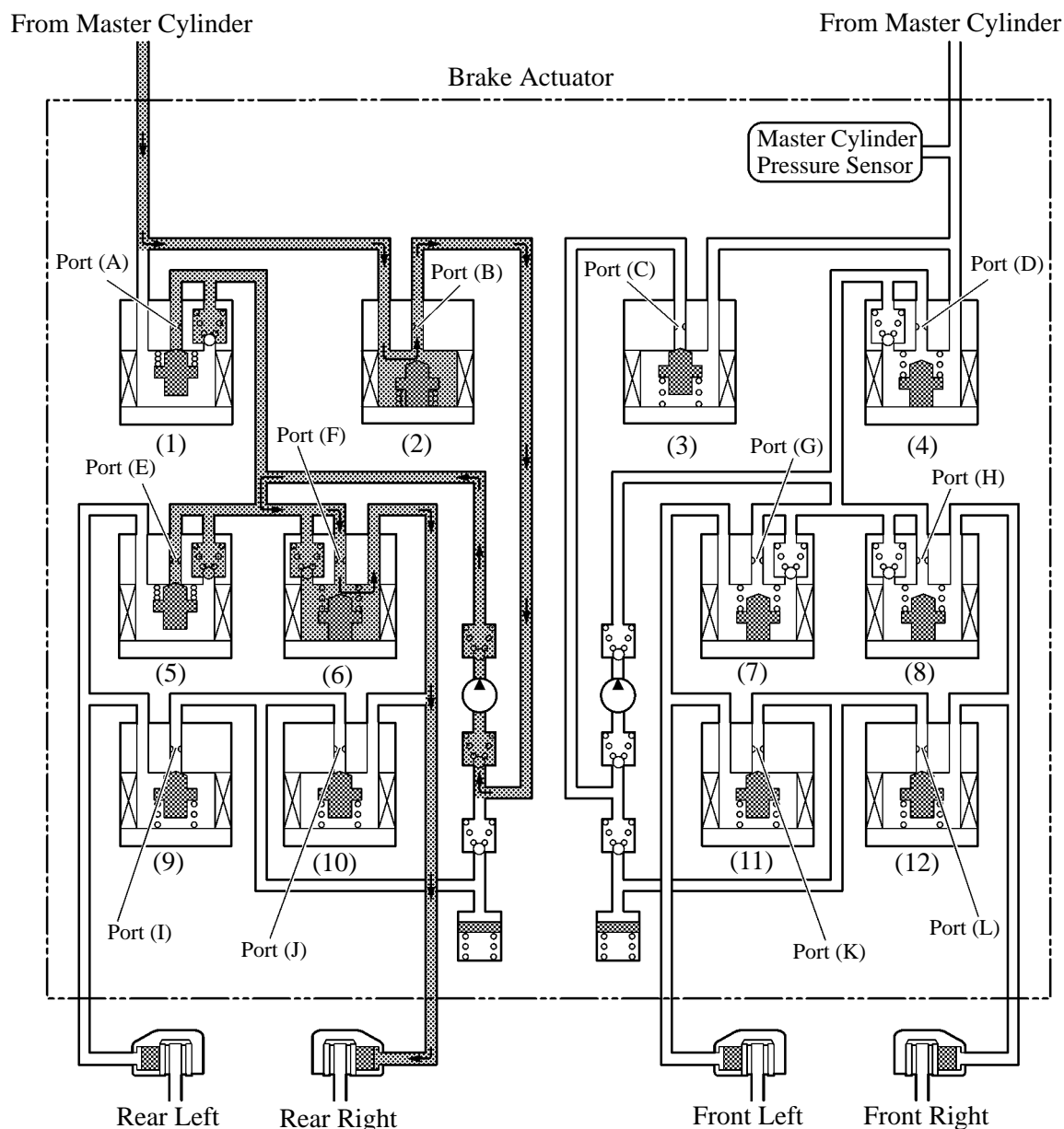


## 2) Front Wheel Skid Restraining (Turning to the Right)

In front wheel skid restraining control, the brakes of the rear wheel of the inner side of the turn is 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.
- In other operating modes, the pressure holding valves and the pressure reduction valves are turned ON/OFF according to a pattern that suits the ABS and EBD operation.
- When the VSC is activated, each solenoid valve operates as shown in the table on the next page.

### ► VSC Operation (Front Wheel Skid Restraining) ◀



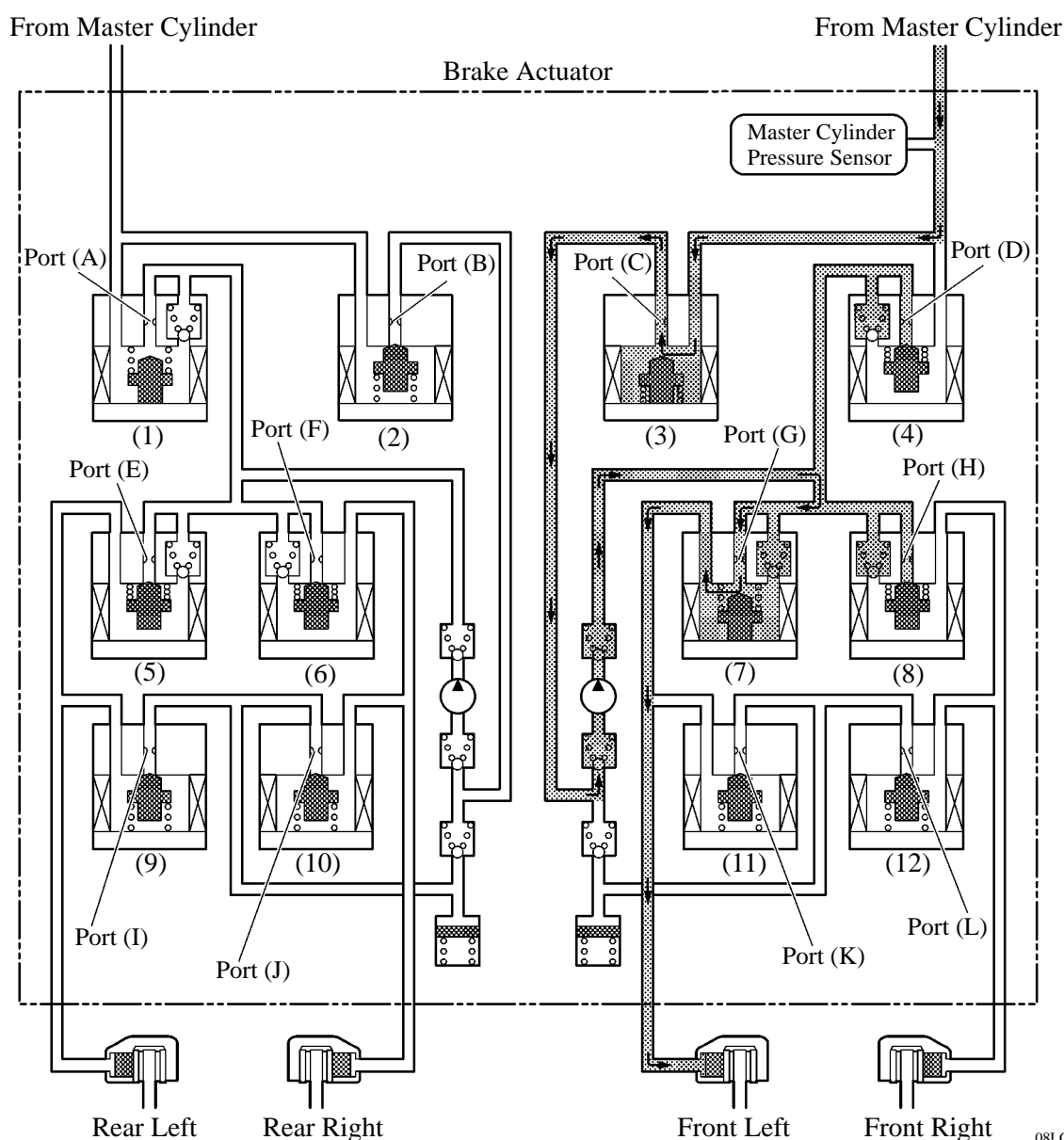
Item				VSC Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve	(1)	Port (A)		OFF/Open	ON/Close	←	OFF/Open
	(4)	Port (D)		OFF/Open	←	←	←
Reservoir Cut Solenoid Valve	(2)	Port (B)		OFF/Close	ON/Open	OFF/Close	←
	(3)	Port (C)		OFF/Close	←	←	←
Front Brake	Pressure Holding Solenoid Valve	(7)	Port (G)	OFF/Open	←	←	←
		(8)	Port (H)				
	Pressure Reduction Solenoid Valve	(11)	Port (K)	OFF/Close	←	←	←
		(12)	Port (L)				
	Wheel Cylinder Pressure	Right		—	—	—	—
		Left		—	—	—	—
Rear Brake	Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	ON/Close	←	←
		(6)	Port (F)	OFF/Open	←	←	←
	Pressure Reduction Solenoid Valve	(9)	Port (I)	OFF/Close	←	←	←
		(10)	Port (J)	OFF/Close	←	←	←
	Wheel Cylinder Pressure	Right		—	Increase	Hold	Reduce
		Left		—	—	—	—

### 3) Rear Wheel Skid Restraining (Turning to the Right)

In rear wheel skid restraining control, the brake of the front wheel of the outer side of the turn is 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 rear wheel skid condition while the vehicle makes a right turn.
- In other operating modes, the pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS and EBD operation pattern.
- When the VSC is activated, each solenoid valve operates as shown in the table on the next page.

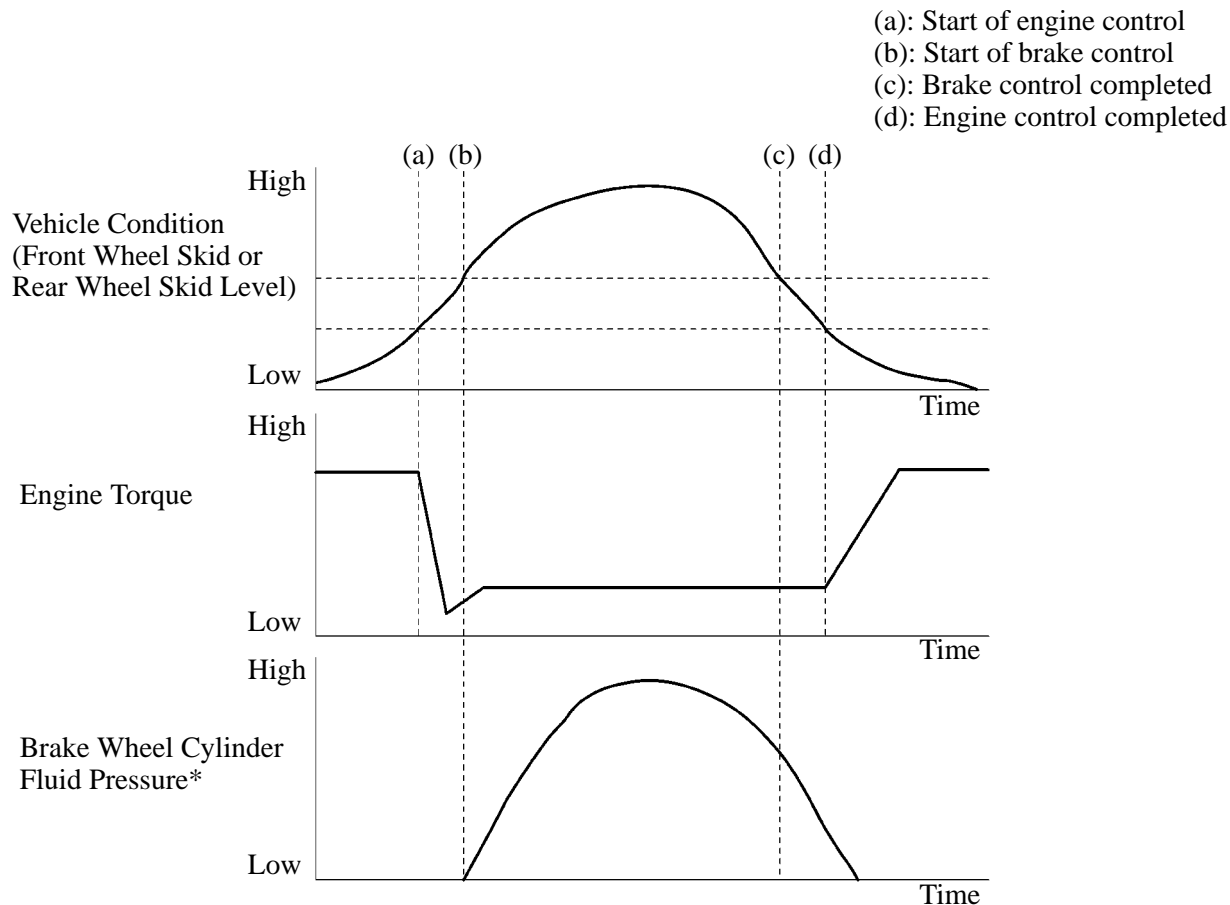
#### ► VSC Operation (Rear Wheel Skid Restraining) ◀



Item				VSC Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve	(1)	Port (A)		OFF/Open	←	←	←
	(4)	Port (D)		OFF/Open	ON/Close	←	OFF/Open
Reservoir Cut Solenoid Valve	(2)	Port (B)		OFF/Close	←	←	←
	(3)	Port (C)		OFF/Close	ON/Open	←	OFF/Close
Front Brake	Pressure Holding Solenoid Valve	(7)	Port (G)	OFF/Open	←	ON/Close	OFF/Open
		(8)	Port (H)	OFF/Open	ON/Close	←	←
	Pressure Reduction Solenoid Valve	(11)	Port (K)	OFF/Close	←	←	←
		(12)	Port (L)	OFF/Close	←	←	←
	Wheel Cylinder Pressure	Right		—	—	—	—
		Left		—	Increase	Hold	Reduce
Rear Brake	Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	ON/Close	←	←
		(6)	Port (F)				
	Pressure Reduction Solenoid Valve	(9)	Port (I)	OFF/Close	←	←	←
		(10)	Port (J)				
	Wheel Cylinder Pressure	Right		—	—	—	—
		Left		—	—	—	—

### 13. Engine Output Control

During the VSC and TRAC operation, the skid control ECU outputs an engine output control request signal to the ECM. Upon receiving this signal, the ECM effects throttle control to regulate the engine output.



151CH31

\*: The wheel cylinder that activates varies depending on the condition of the vehicle.

### 14. Initial Check

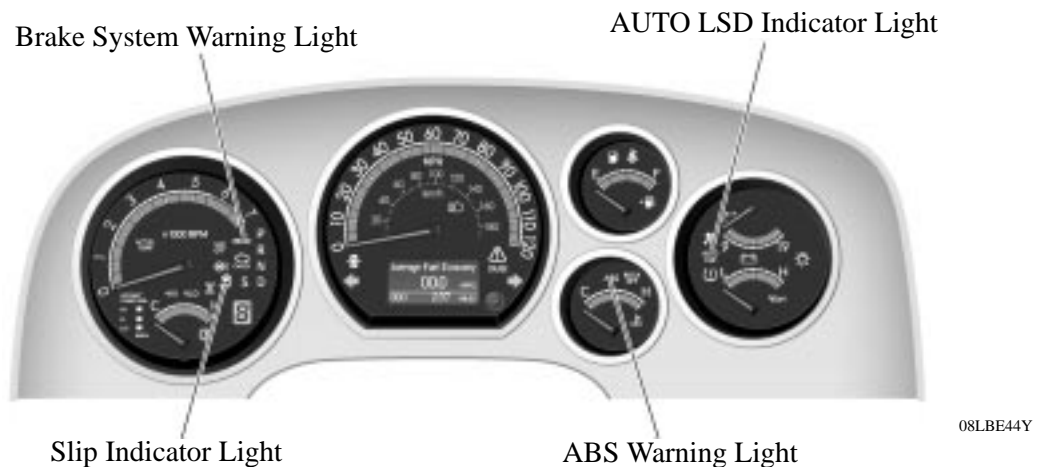
Each time the ignition switch is turned ON, and the vehicle reaches approximately speed of 23 km/h (14.3 mph) or more, the skid control ECU performs an initial check.

The functions of each solenoid valve and pump motor in the brake actuator are checked in sequence.

## 15. Diagnosis

- If the skid control ECU detects a malfunction in the brake control system (ABS, EBD, brake assist, TRAC, A-TRAC, Auto LSD, or VSC), the warning lights or indicator lights illuminate to alert the driver of the malfunction. At the same time, the skid control ECU stores the DTC (Diagnostic Trouble Code) in memory. This DTC can be read by the following two methods.
  - The 5-digit DTC can be read by connecting a Techstream to the DLC3.
  - The 2-digit DTC can be read from the number of the blinking of the ABS warning light by connecting the SST (09843-18040) to the TC and CG terminals of the DLC3.
- This system has a sensor signal check (test mode) function. This function is activated by connecting a Techstream or by connecting the SST (09843-18040) to the TS and CG terminals of the DLC3. If the skid control ECU detects a malfunction during a sensor signal check (test mode), it stores the DTC in its memory.

For details on the DTC that are stored in skid control ECU memory and the DTC that are output through the sensor signal check function, see the 2008 Sequoia Repair Manual (Pub. No. RM08L0U).



## 16. Fail-safe

- In the event of a malfunction in the ABS and/or brake assist, the skid control ECU prohibits ABS, brake assist, TRAC, A-TRAC, Auto LSD, and VSC operation.
- In the event of a malfunction in the EBD control, the skid control ECU prohibits EBD operation. In this case, normal (non electronically assisted) braking performance will be available. Functions of the brake control system (ABS, EBD, brake assist, TRAC, A-TRAC, Auto LSD, and VSC) will not be available.
- In the event of a malfunction in the TRAC, A-TRAC, Auto LSD, and/or VSC, the skid control ECU prohibits TRAC, A-TRAC, Auto LSD, and VSC operations.
- If a communication malfunction occurs between the skid control ECU and the steering angle sensor or the yaw rate & deceleration sensor, the skid control ECU stops TRAC, A-TRAC, Auto LSD, and VSC operation.
- When the ECM detects a DTC in the engine control system, it will disable the TRAC, A-TRAC, Auto LSD, and VSC operations.