■ BRAKE CONTROL SYSTEM

1. General

The brake control system has the following functions:

Function	Outline	Model	
		2WD	4WD
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brakes are applied firmly or on a slippery surface.	○	○
EBD (Electronic Brake force Distribution)	The EBD utilizes the ABS, realizing the proper brake force distribution between front and rear wheels in accordance with the driving conditions. In addition, during cornering braking, it also controls the brake forces of right and left wheels, helping maintain the vehicle behavior.	○	○
Brake Assist	● The primary purpose of brake assist is to provide a supplemental braking force to assist a driver who cannot generate a large brake force during emergency braking, thus helping improve the vehicle's braking performance. ● If the brake booster malfunctions and the skid control ECU judges that the brake pedal force applied by the driver is not sufficient to ensure adequate braking force, brake assist is used to enhance the braking force.	○	○
TRAC (Traction Control)	TRAC helps prevent the drive wheels from slipping if the driver presses the accelerator pedal excessively when starting off or accelerating on a slippery surface.	○	○*
A-TRAC (Active Traction Control)	When the vehicle drive mode is H4 or L4, the A-TRAC operates. A-TRAC controls the brake hydraulic pressure that is applied to the slipping wheel, and distributes the drive force that would have been lost through the slippage to the remaining wheels in order to achieve an LSD effect.	—	○
Auto LSD (Limited Slip Differential)	Briefly pressing the VSC OFF switch in normal mode enters TRAC OFF mode, allowing the Auto LSD to operate. The Auto LSD achieves a function equivalent to that of an LSD system through the use of the TRAC. The Auto LSD applies brake hydraulic pressure to a slipping wheel to reduce the difference in rotation speed between the left and right drive wheels. This causes driving torque to be transmitted to the wheel opposite the slipping wheel.	○	○*
VSC (Vehicle Stability Control)	VSC helps prevent the vehicle from slipping sideways as a result of strong front wheel skid or strong rear wheel skid during unstable situation [VSC operates when the vehicle speed is 15 km/h (9.3 mph) or more].	○	○

*: For 4WD models, these functions operate while in 2WD mode.

2. Drive Modes

The brake control functions vary by the drive mode as shown in the following table:

▶ 2WD Models ◀

○: Operates

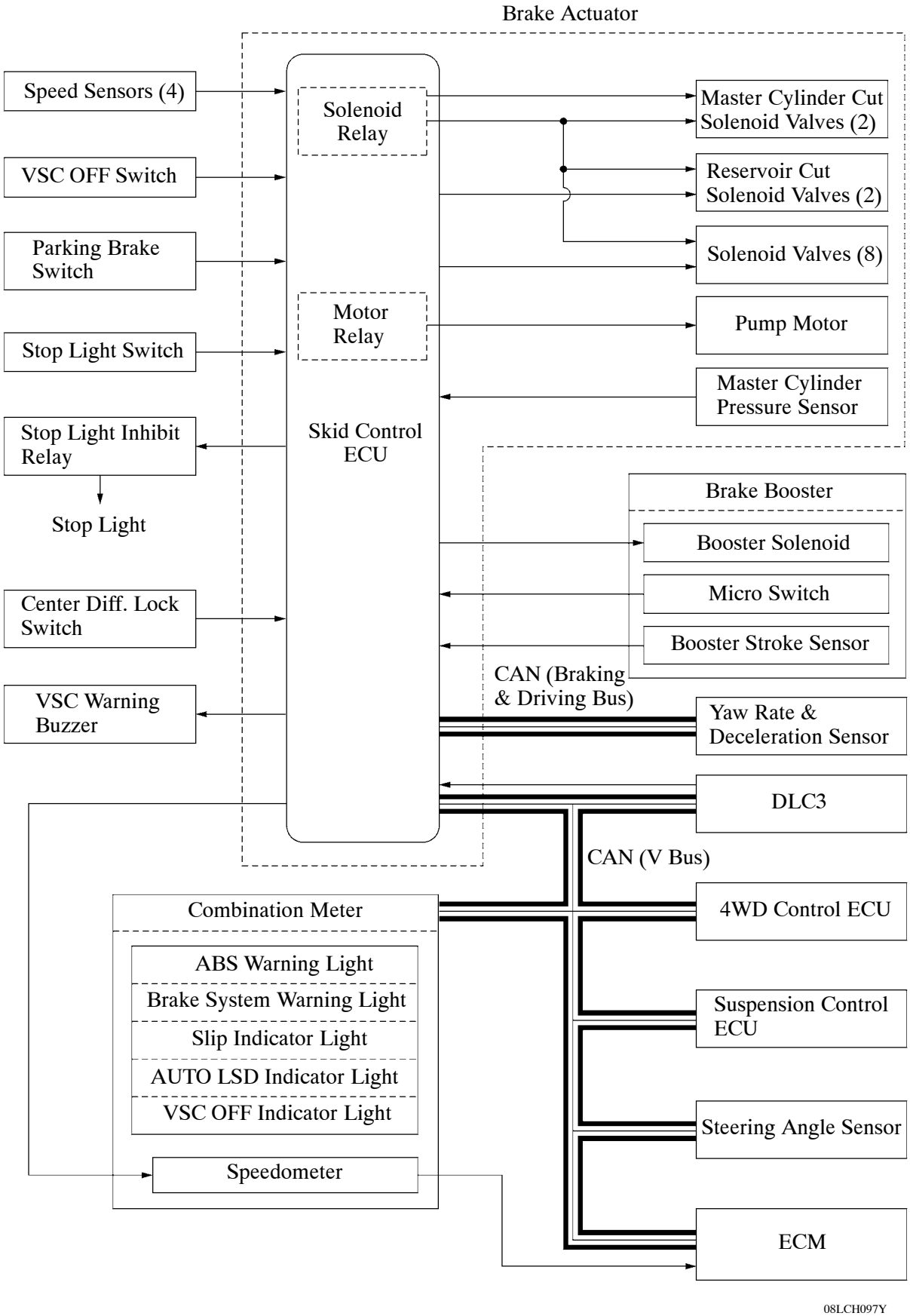
Drive Mode	VSC OFF Switch	Brake Control Function					
		ABS	EBD	Brake Assist	TRAC	Auto LSD	VSC
2WD	Normal Mode	○	○	○	○	—	○
	TRAC OFF Mode	○	○	○	—	○	○
	Auto LSD Mode	○	○	○	—	○	—
	VSC OFF Mode	○	○	○	—	—	—

▶ 4WD Models ◀

○: Operates

Drive Mode		VSC OFF Switch	Brake Control Function						
			ABS	EBD	Brake Assist	TRAC	A-TAC	Auto LSD	VSC
2WD		Normal Mode	○	○	○	○	—	—	○
		TRAC OFF Mode	○	○	○	—	—	○	○
		Auto LSD Mode	○	○	○	—	—	○	—
		VSC OFF Mode	○	○	○	—	—	—	—
4WD	H4F	Normal Mode	○	○	○	—	○	—	○
		TRAC OFF Mode	○	○	○	—	○	—	○
		VSC OFF Mode	○	○	○	—	—	—	—
	L4F	Normal Mode	○	○	○	—	○	—	○
		VSC OFF Mode	○	○	○	—	—	—	—
	H4L L4L	Normal Mode	○	○	○	—	○	—	—
		VSC OFF Mode	○	○	○	—	—	—	—

3. System Diagram



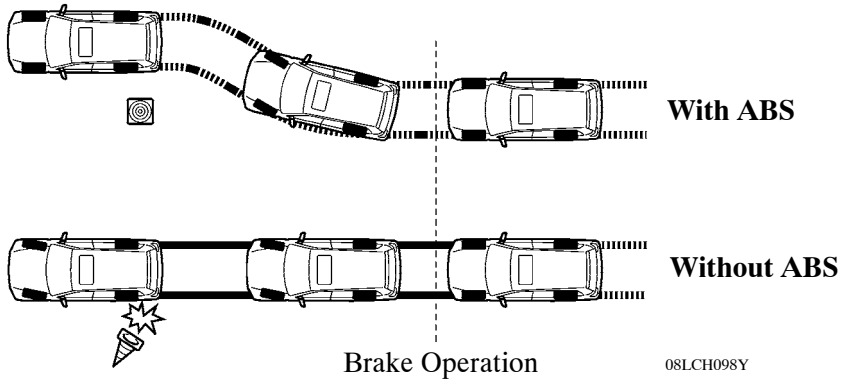
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4. Outline of Brake Control Function

ABS (Anti-lock Brake System)

The ABS prevents the wheels from locking during sudden braking or braking on a slippery surface. This provides the proper braking force when the vehicle slips, thus ensuring vehicle stability and excellent braking performance.



◆: The illustration provides a conceptual image.

EBD (Electronic Brake force Distribution)

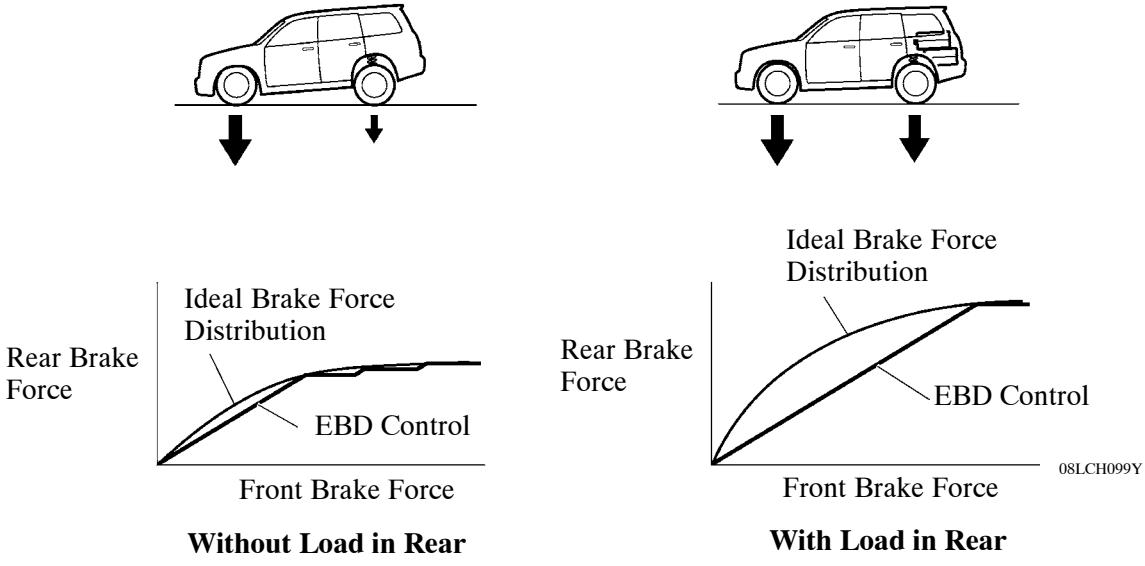
1) General

The EBD control utilizes the ABS, realizing the proper brake force distribution between the front and rear wheels in accordance with the driving conditions. In addition, during cornering braking, it also controls the brake forces of the right and left wheels, helping to maintain the vehicle behavior.

2) Front/Rear Wheels Brake Force Distribution

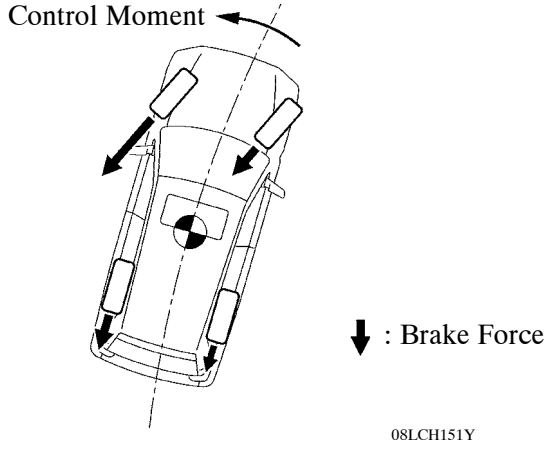
This function controls the brake force that acts on the rear wheels in accordance with the changes in the vehicle conditions such as load factors or deceleration, in order to ensure excellent braking performance.

▶ EBD Control Concept ◀



3) Right/Left Wheels Brake Force Distribution (During Cornering Braking)

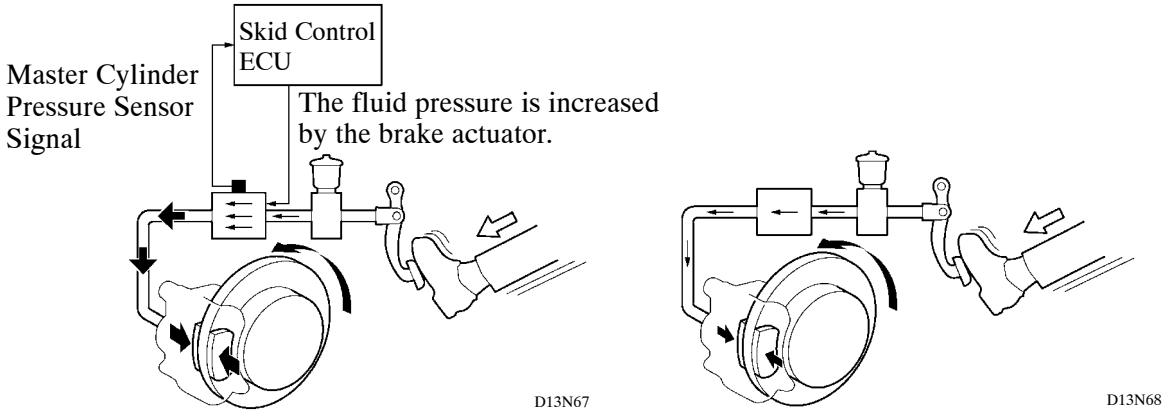
During cornering braking, this function controls the brake force that acts on the left and right wheels in accordance with the vehicle conditions at that time. This ensures vehicle stability and excellent braking performance.



Brake Assist

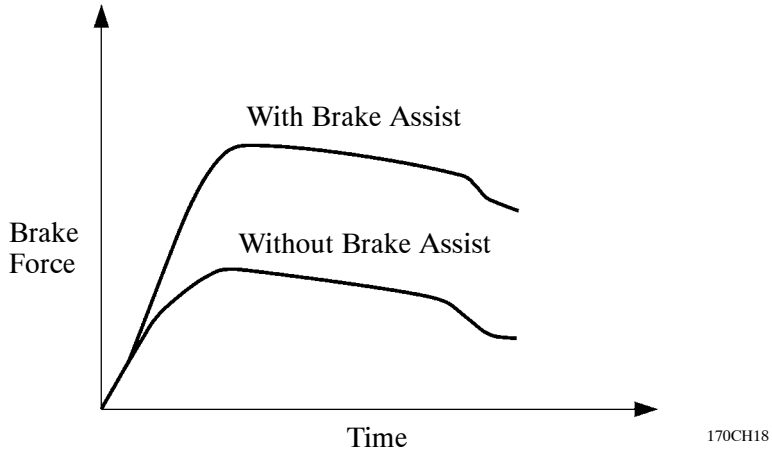
- The primary purpose of the brake assist is to provide an auxiliary brake force to assist the driver who cannot generate a large brake force during emergency braking, thus helping draw the vehicle's brake performance.
- Based on the signals from the master cylinder pressure sensor, the skid control ECU calculates the speed and the amount of the brake pedal application and then determines the intention of the driver to make an emergency braking. If the skid control ECU determines that the driver intends the emergency braking, this function activates the brake actuator to increase the brake fluid pressure, which increases the brake force.

▶ In case that the driver's depressing force is small when applying emergency braking ◀



With Brake Assist **Without Brake Assist**

◆: There is no difference of the maximum brake performance between the vehicles with and without brake assist.

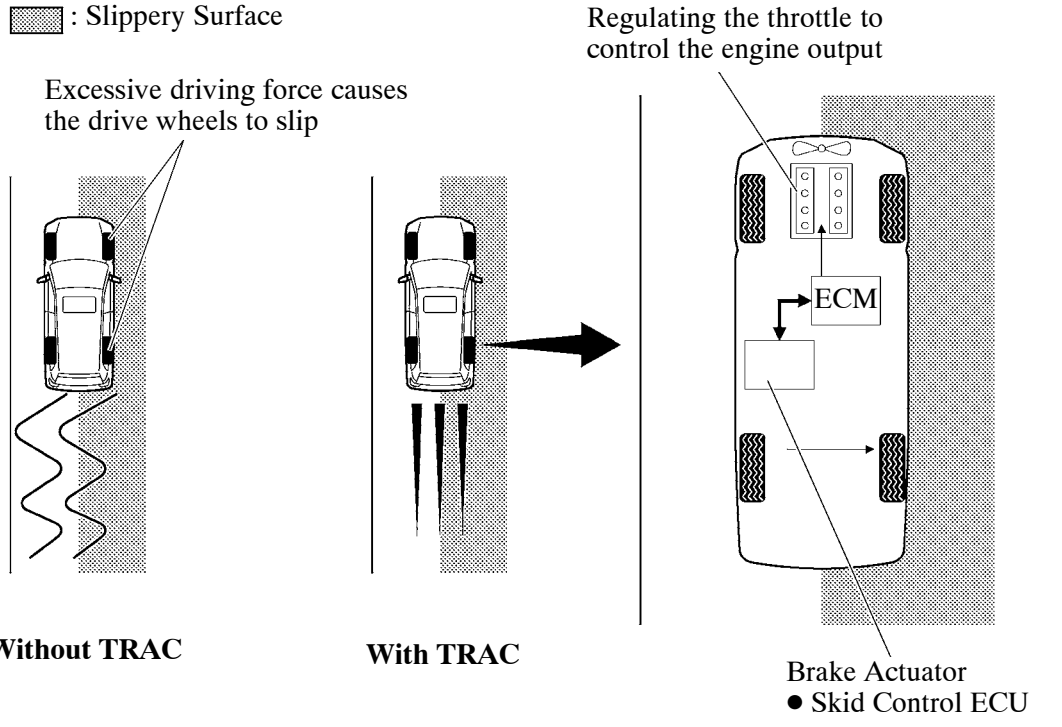


TRAC (Traction Control)

- If the driver presses the accelerator pedal aggressively when initially accelerating or when accelerating on a slippery surface, the drive wheels could slip due to the excessive amount of torque that is generated. By applying hydraulic brake control to the drive wheels and regulating the throttle to control the engine output, TRAC helps minimize the slippage of the drive wheels, thus helping to apply the drive force that is appropriate for the road surface conditions.
- For example, a comparison may be made between two vehicles, one with TRAC and the other without. If the driver of each vehicle operates the accelerator pedal in a rough manner while driving over a surface with different surface friction characteristics, the drive wheel on the slippery surface could slip as illustrated. As a result, the vehicle can not start accelerating smoothly.
  However, when the vehicle is equipped with TRAC, the skid control ECU instantly determines the state of the vehicle and operates the brake actuator in order to apply the brakes to the slipping drive wheel. Furthermore, the ECM receives the signals from the skid control ECU and regulates the throttle in order to control the engine output. Thus, TRAC can constantly help the driver to maintain stability while accelerating.

◆: On the 4WD models, this function operates only when the vehicle is driving in 2WD mode.

▶ Driving condition on road with different surface friction characteristics ◀



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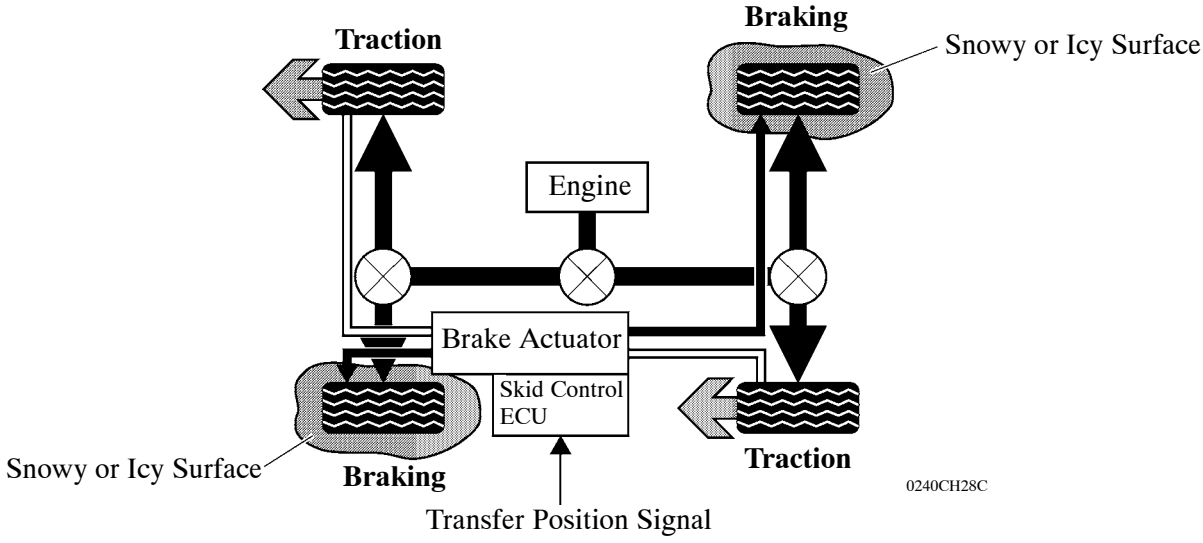
A-TRAC (Active Traction Control)

1) General

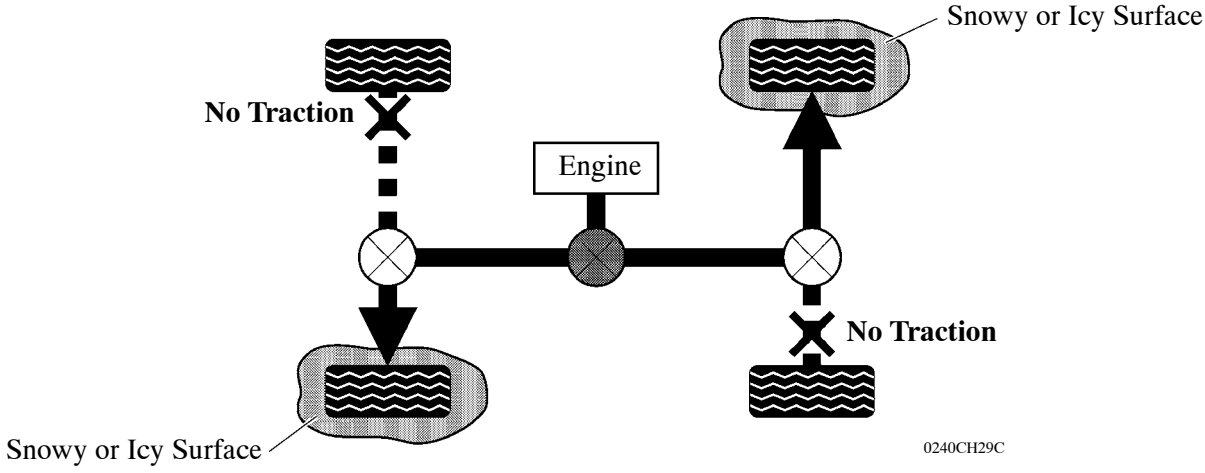
When the vehicle drive mode is H4 or L4, the A-TRAC helps restrain wheelspin by controlling the brake fluid pressure that is applied to the spinning wheels, and distributes the drive force that would have been lost through the slippage to the remaining wheels in order to achieve an effect that is similar to LSD.

- It independently controls the brake fluid pressure to the four wheels in accordance with the extent of the slippage at the wheels, as detected by the skid control ECU.

▶ With A-TRAC ◀



▶ Without A-TRAC ◀



2) Effectiveness of A-TRAC

The effectiveness of A-TRAC is as follows:

- Off-road drivability that is equivalent to having the center differential locked and limited slip differentials on both front and rear has been realized.
- This function makes the operation of the differential lock switches basically unnecessary to ensure the ease of driving.
- While realizing the off-road drivability that is equivalent to having the center and rear differentials locked, as compared to the differential gear in the locked state, the prevention of tight corner braking phenomenon ensures the ease of nimble steerability.

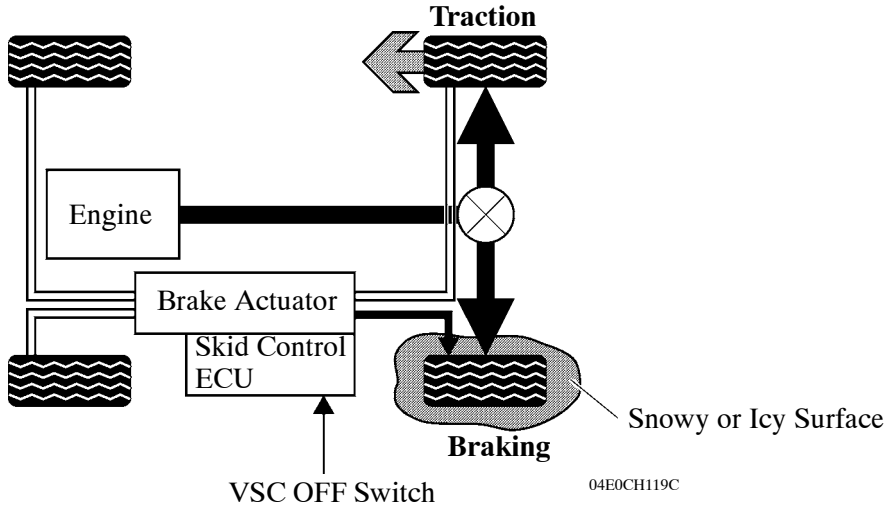
Auto LSD

Briefly pressing the VSC OFF switch in normal mode allows the Auto LSD to operate (TRAC OFF mode is selected). The Auto LSD achieves the LSD effect by regulating the hydraulic pressure that acts on the drive wheels.

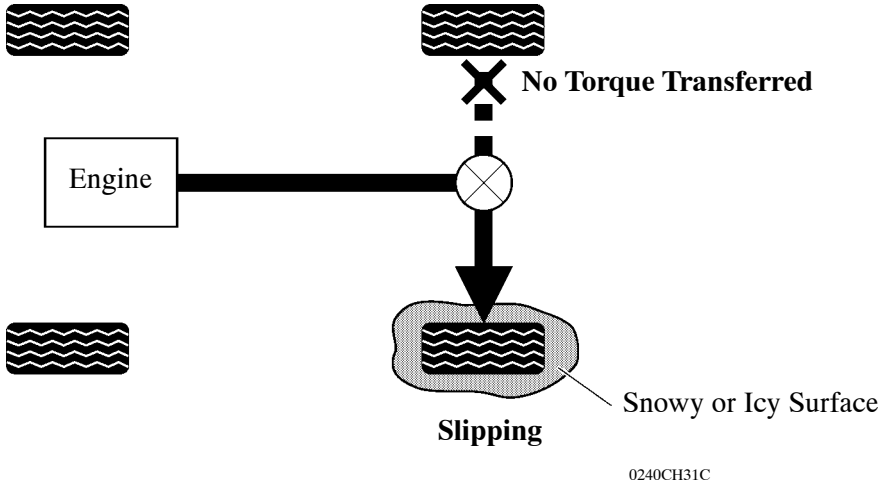
- TRAC enhances the start-off performance of the vehicle during low-grip surface conditions, such as snow or mud, by restricting the acceleration effort during a start-off, in order to help prevent the wheels from spinning.
- The Auto LSD enhances the acceleration effort, in order to apply greater drive torque to the wheel that has grip. Thus, this function enables the vehicle to get unstuck if a wheel loses its grip, and enhances the vehicle's start-off performance when high-resistance surface conditions exist, such as loose gravel or sand.

◆: On the 4WD models, this function operates only when the vehicle is driving in 2WD mode.

▶ With Auto LSD ◀



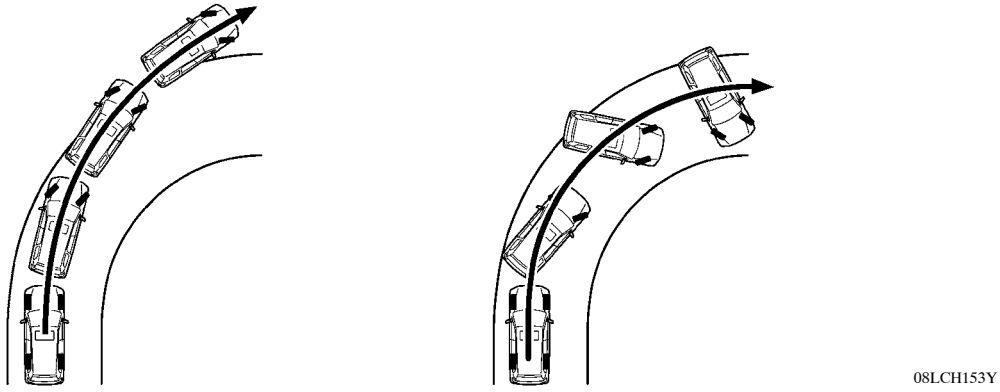
▶ Without Auto LSD ◀



VSC (Vehicle Stability Control)

The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit. The VSC is designed to help control the vehicle behavior by controlling the engine output and the brakes at each wheel when the vehicle is under one of the conditions indicated below.

- When the front wheels lose grip in relation to the rear wheels (front wheel skid tendency).
- When the rear wheels lose grip in relation to the front wheels (rear wheel skid tendency).



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Front Wheel Skid Tendency **Rear Wheel Skid Tendency**

1) Method for Determining Vehicle Condition

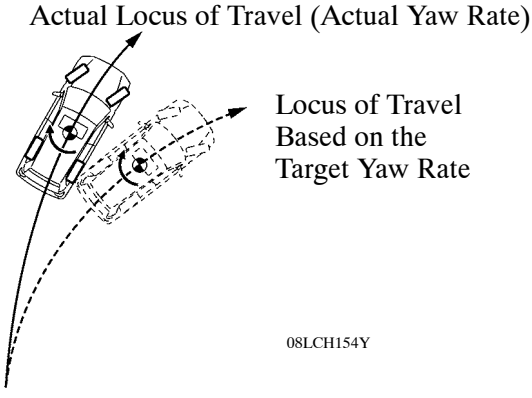
To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and vehicle's lateral acceleration, which are then calculated by the skid control ECU.

a. Determining Front Wheel Skid

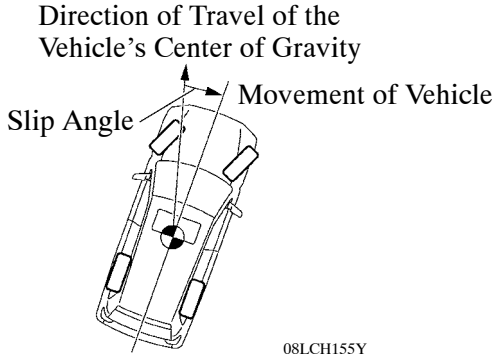
Whether the vehicle is in the state of the front wheel skid or not is determined by the difference between the target yaw rate and the vehicle's actual yaw rate. When the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) that should be rightfully generated when the driver operates the steering wheel, it means the vehicle is making a turn at a greater angle than the locus of travel. Thus, the skid control ECU determines that there is a large tendency to front wheel skid.

b. Determining Rear Wheel Skid

Whether the vehicle is in the state of the rear wheel skid or not is determined by the values of the vehicle's slip angle and the vehicle's slip angular velocity (time-dependent changes in the vehicle's slip angle). When the vehicle's slip angle and the slip angular velocity are large, the skid control ECU determines that the vehicle has a large rear wheel skid tendency.



Determining Front Wheel Skid



Determining Rear Wheel Skid

2) Method for VSC Operation

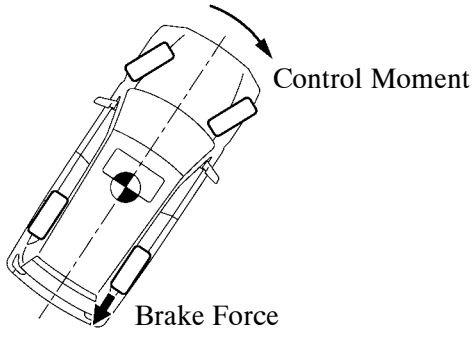
When the skid control ECU determines that the vehicle has a tendency to front wheel skid or rear wheel skid, it decreases the engine output and applies the brake of a front or rear wheel to control the vehicle's yaw moment.
The basic operation of the VSC is described below. However, the control method differs depending on the vehicle's characteristics and driving conditions.

a. Dampening Front Wheel Skid

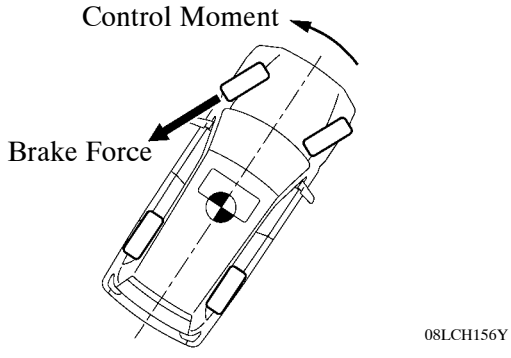
When the skid control ECU determines that there is a large front wheel skid tendency, it counteracts in accordance with the extent of that tendency. The skid control ECU controls the engine output and applies the brake to the rear wheel of the inner circle of the turn in order to help restrain the front wheel skid tendency.

b. Dampening Rear Wheel Skid

When the skid control ECU determines that there is a large rear wheel skid tendency, it counteracts in accordance with the extent of that tendency. It applies the brakes of the front wheel of the outer circle of the turn, and generates an outward moment of inertia in the vehicle, in order to help restrain the rear wheel skid tendency. Along with the reduction in the vehicle speed caused by the brake force, the excellent vehicle's stability is ensured.
In some cases, the skid control ECU applies the brake of the rear wheels as necessary.

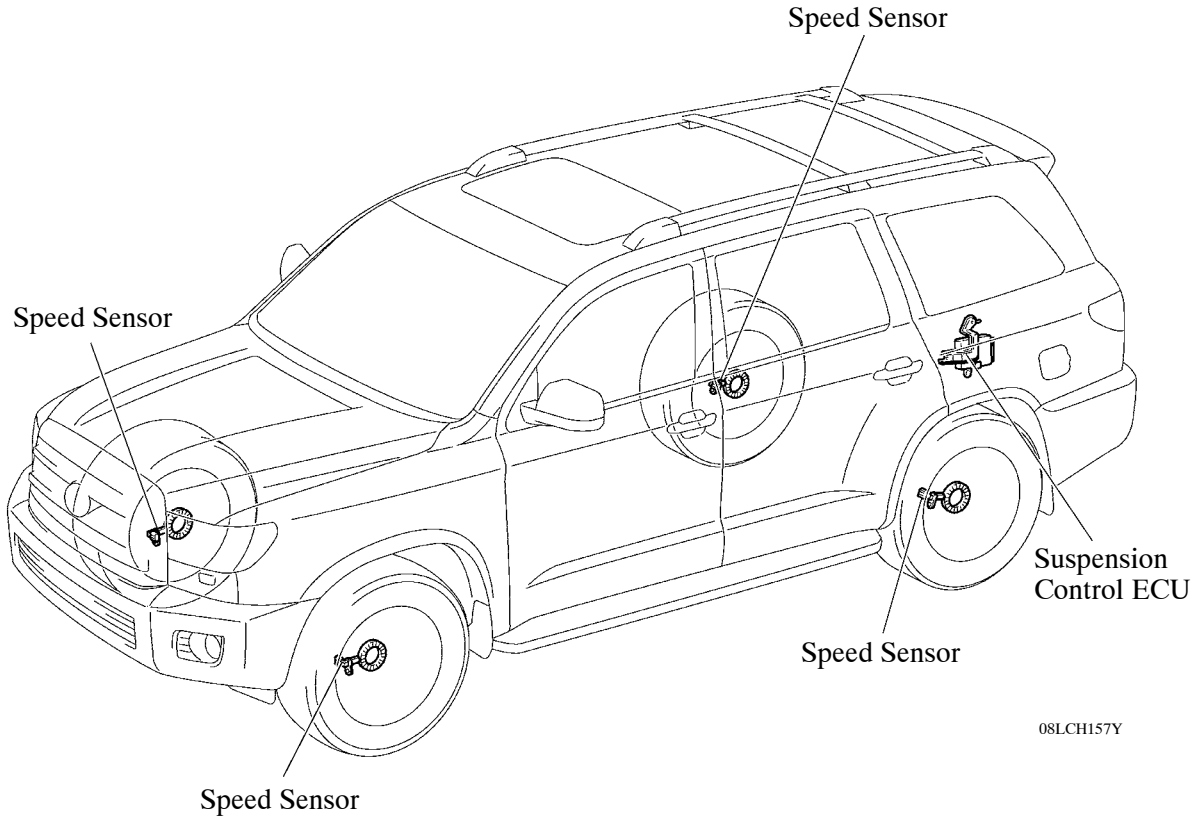


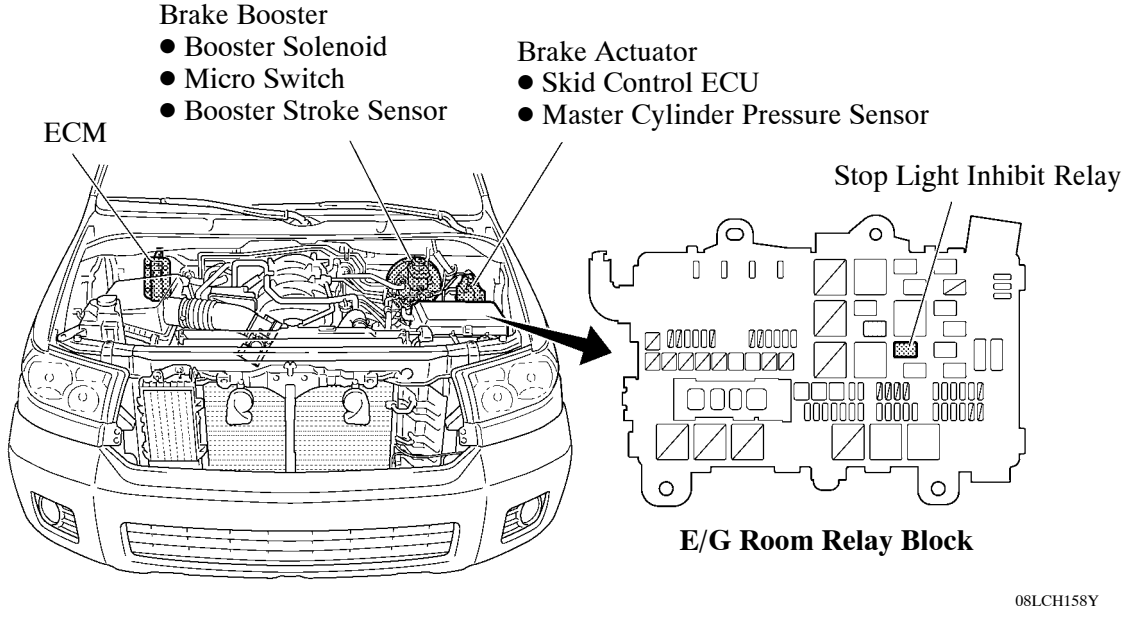
Dampening a Front Wheel Skid (Marking a Right Turn)

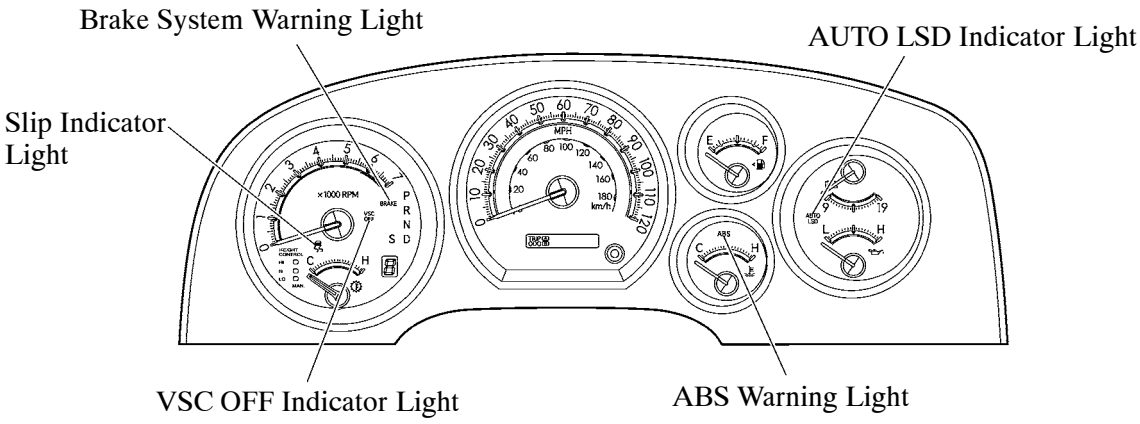


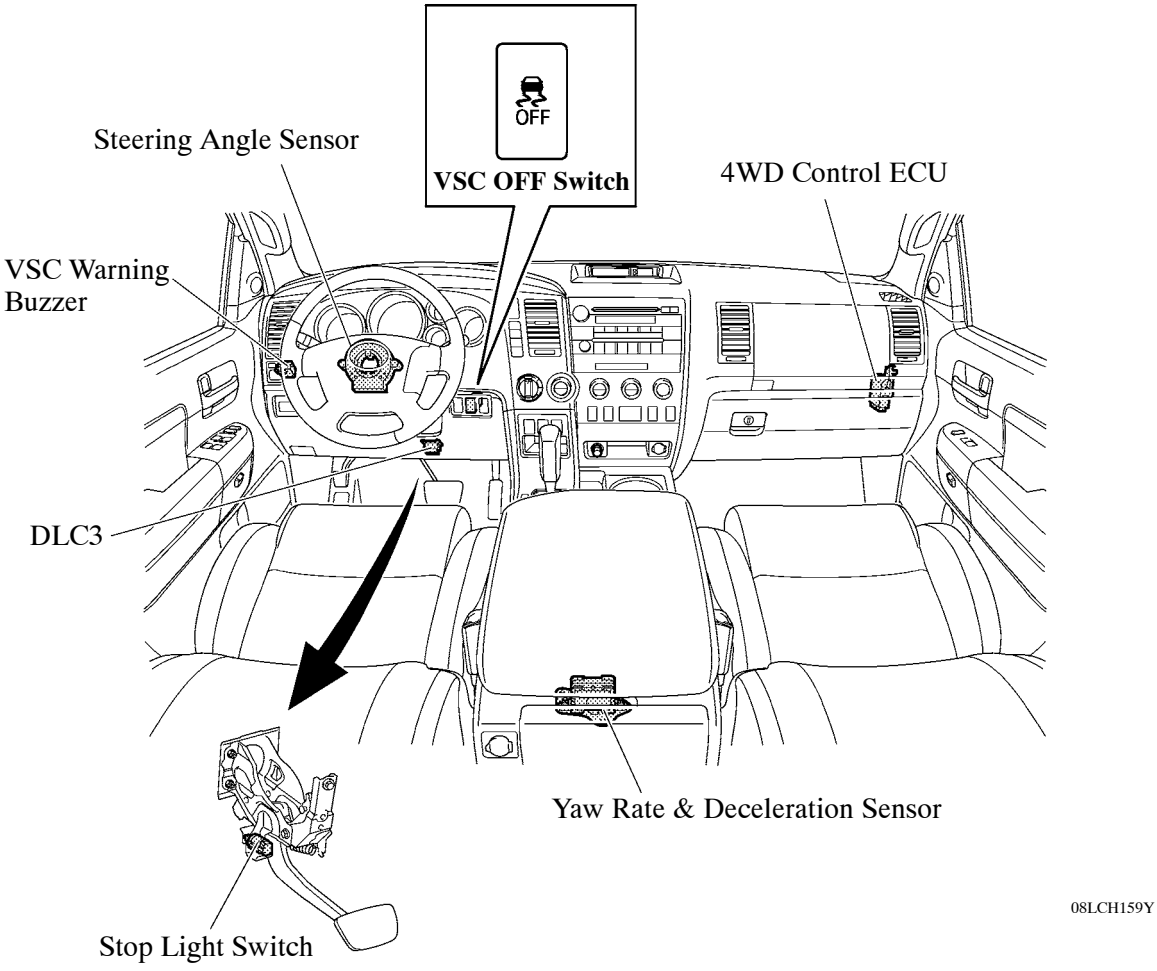
Dampening a Rear Wheel Skid (Marking a Right Turn)

5. Layout of Main Components






Brake System Warning Light
AUTO LSD Indicator Light
Slip Indicator Light
VSC OFF Indicator Light
ABS Warning Light


OFF
VSC OFF Switch
Steering Angle Sensor
4WD Control ECU
VSC Warning Buzzer
DLC3
Yaw Rate & Deceleration Sensor
Stop Light Switch
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6. Function of Main Components

Component			Function
Combination Meter	ABS Warning Light		Lights up to alert the driver that the skid control ECU detects a malfunction in the ABS, EBD or brake assist system.
	Brake System Warning Light		● Lights up together with the ABS warning light to alert the driver that the skid control ECU detects a malfunction in the EBD or when a malfunction occurs in the brake booster. ● Lights up to alert the driver that the brake fluid level is low. ● Lights up to alert the driver that the parking brake is applied.
	Slip Indicator Light		● Blinks to inform the driver that the TRAC, A-TRAC, Auto LSD or VSC is operated. ● Lights up to alert the driver that the skid control ECU detects a malfunction in the TRAC, A-TRAC, Auto LSD or VSC. ● Lights up to inform the driver that the TRAC OFF mode or VSC OFF mode is entered using the VSC OFF switch.
	VSC OFF Indicator Light		● Lights up to inform the driver that the VSC OFF mode is selected using the VSC OFF switch. ● When the skid control ECU detects a malfunction and determines that the TRAC, A-TRAC, Auto LSD, or VSC is not available, the VSC OFF indicator light blinks to alert the driver.
	AUTO LSD Indicator Light		● Lights up to inform the driver that the TRAC OFF mode (Auto LSD ON) is selected using the VSC OFF switch.
VSC Warning Buzzer			The VSC warning buzzer has two types of sounds. ● The buzzer sounds intermittently to inform the driver that the VSC is active. ● The buzzer sounds intermittently to inform the driver if the temperature of the brake pads has increased excessively due to the continuous operation of the TRAC, A-TRAC or Auto LSD.
Brake Actuator			Changes the fluid path based on the signals from the skid control ECU during the operation of the ABS, EBD, brake assist, TRAC, A-TRAC, Auto LSD and VSC, in order to control the fluid pressure that is applied to the brakes for the different wheels.
	Master Cylinder Pressure Sensor		Detects the master cylinder pressure.
	Skid Control ECU		● Judges the vehicle driving conditions based on signals from each sensor, and sends brake control signals to the brake actuator. ● Judges the vehicle driving conditions based on signals from each sensor, and calculates the amount of engine output adjustment required. The skid control ECU transmits command signals to the ECM.
		Solenoid Relay	Controls power supplied to the solenoid valves.
		Motor Relay	Supplies power to the pump motor in the brake actuator.

(Continued)

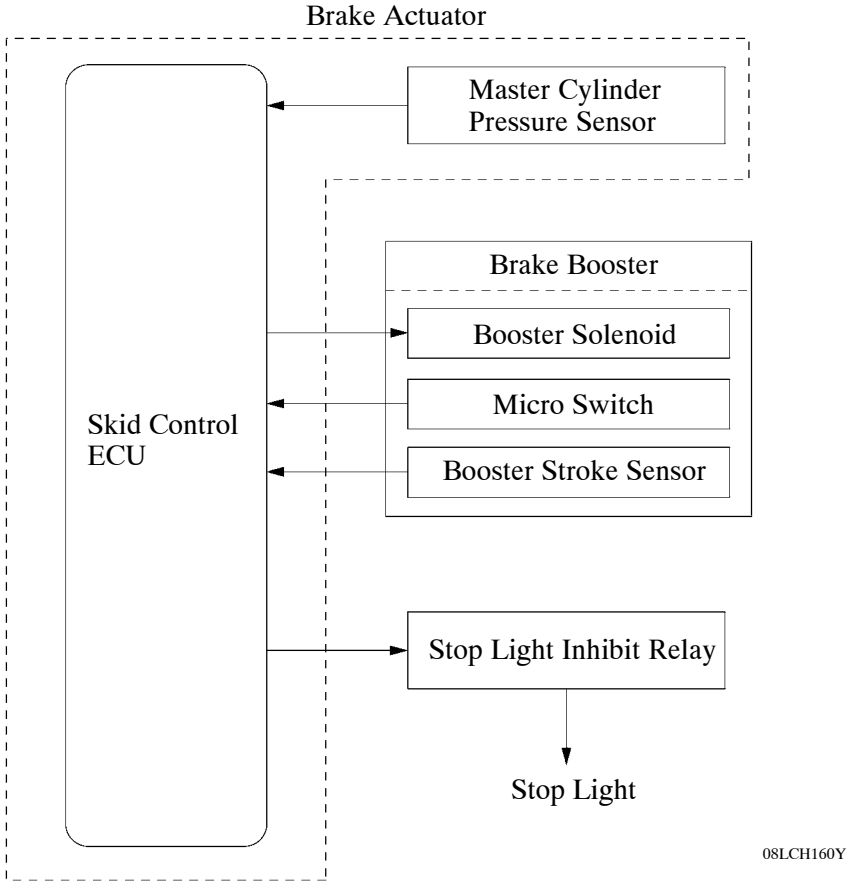
Component		Function
Brake Booster	Booster Solenoid	When the VSC is activated, this solenoid operates in accordance with the signals from the skid control ECU to boost the hydraulic pressure to the wheel cylinders.
	Micro Switch	Detects that the brake pedal is depressed.
	Booster Stroke Sensor	Detects the brake pedal stroke distance.
Speed Sensor		Detects the wheel speed of each of the four wheels.
Yaw Rate & Deceleration Sensor		● Detects the vehicle's yaw rate. ● Detects the vehicle's lateral acceleration (2WD models). ● Detects the vehicle's longitudinal and lateral acceleration (4WD models).
Steering Angle Sensor		Detects the steering direction and angle of the steering wheel.
VSC OFF Switch		● Cancels the TRAC or VSC. ● Selects the 4 modes (Normal mode, TRAC-OFF mode, Auto LSD mode, VSC-OFF mode).
Parking Brake Switch		Detects parking brake application.
Stop Light Switch		Detects brake pedal application.
Stop Light Inhibit Relay		Because the brake pedal could move down when the VSC is activated (booster solenoid is turned ON) even thought the driver is not depressing the brake pedal, this relay prevents the stop light from turning ON.
4WD Control ECU (Only for 4WD models)		Detects the transfer shift position (H4 or L4) and sends the information to the skid control ECU.
ECM		● Sends the throttle valve angle signal, accelerator pedal position signal, engine speed signal, and intake air temperature signal to the skid control ECU. ● Receives an engine output adjustment command signals from the skid control ECU. Based on these signals, the ECM operates the throttle valve to control engine output.

7. Brake Booster

General

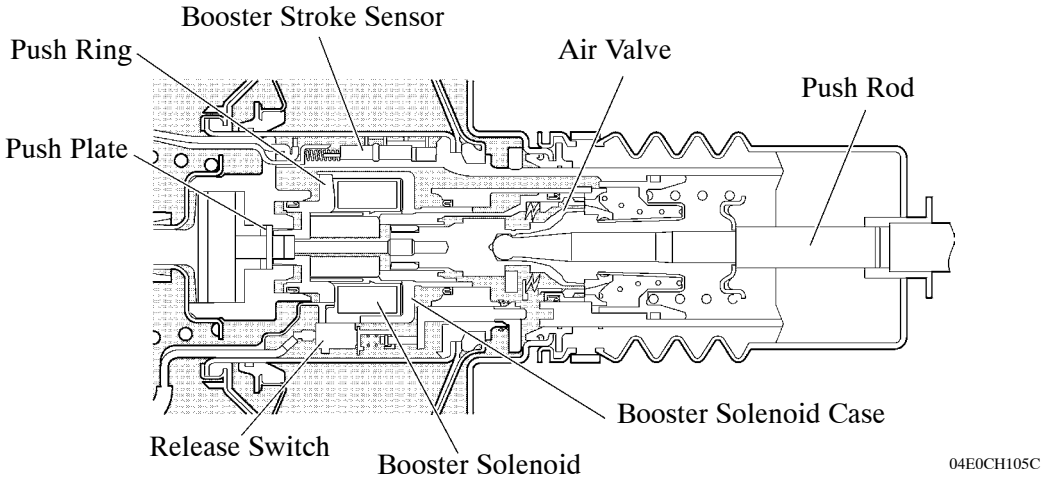
- When the VSC is activated, the booster solenoid that is enclosed in the brake booster moves the air valve to regulate the amount of pressure applied by the master cylinder.
  At this time, the skid control ECU controls the solenoid in accordance with the signals from the master cylinder pressure sensor. Thus, the brake fluid pressure is supplemented when the VSC is activated, resulting in excellent brake control.
- Because the brake pedal could move down with the activation of the VSC, the fact that the driver is depressing the brake pedal is determined by the release switch that is enclosed in the brake booster.
- The booster stroke sensor is used to detect a malfunction of the active brake booster. If the booster malfunctions, the brake assist system will be activated to assist the braking force.

▶ System Diagram ◀



Construction

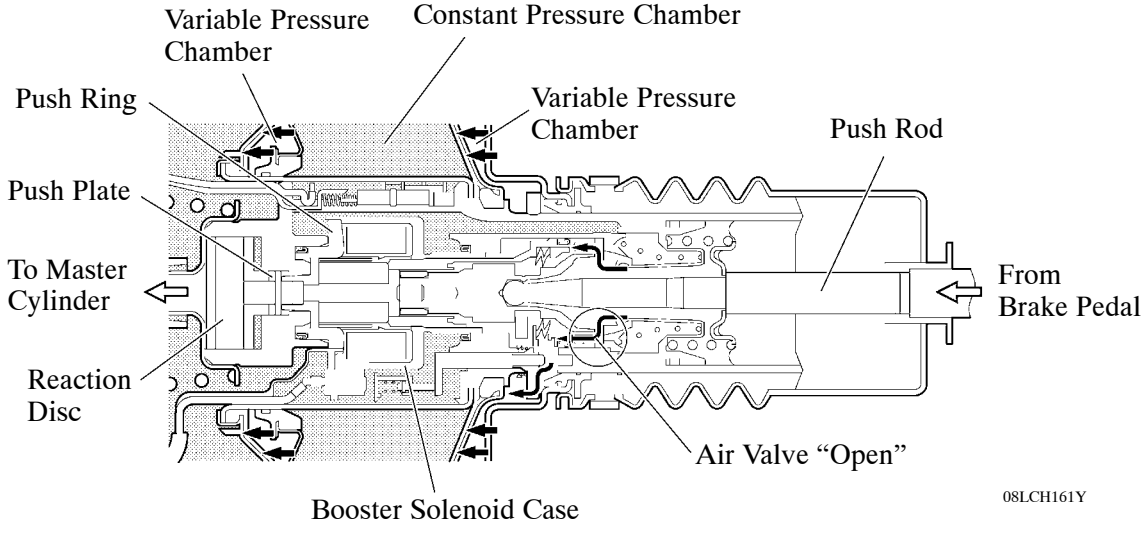
The brake booster mainly consists of the push rod, air valve, booster solenoid, booster solenoid case, release switch, push ring, push plate and booster stroke sensor.



Operation

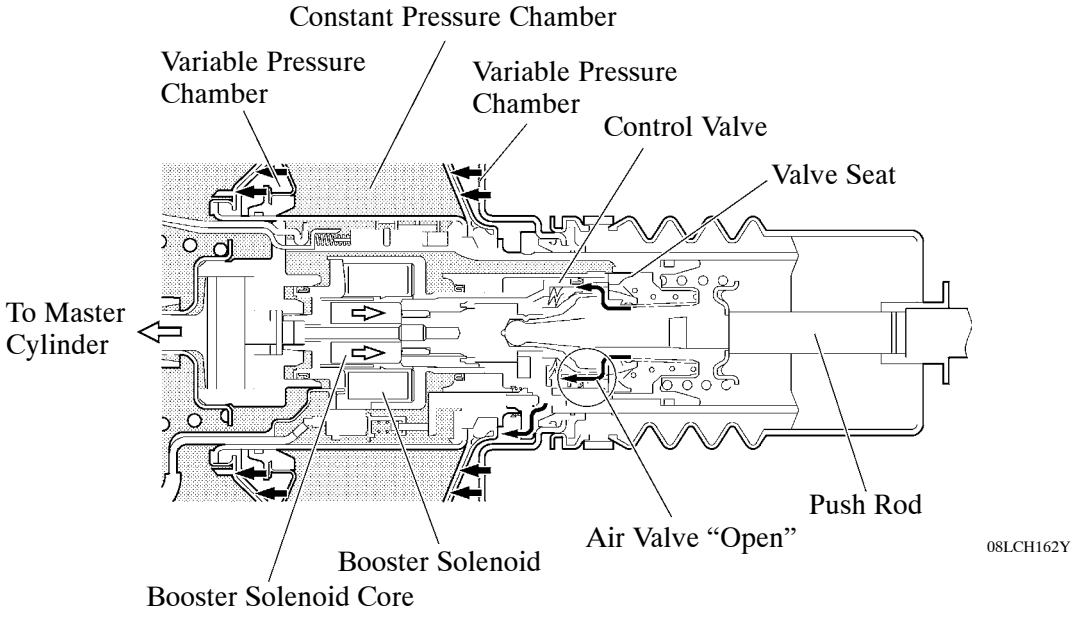
1) Normal Braking

During normal braking, the input load from the brake pedal is transmitted to the push rod, air valve, booster solenoid case, push ring, push plate, and reaction disc, and then output to the master cylinder. At this time, the air valve moves, and air flows into the variable pressure chamber. This creates a pressure difference between the constant pressure chamber and the variable pressure chamber, and the input load from the brake pedal is amplified and output to the master cylinder.



2) VSC Operation

When the VSC is activated, current flows to the booster solenoid in accordance with the signals from the skid control ECU. The booster solenoid core and the control valve then move toward the brake pedal, thus moving the valve seat toward the brake pedal.
As a result, the air valve opens and air flows into the variable pressure chamber. This creates a pressure difference between the constant pressure chamber and the variable pressure chamber. The pressure difference causes the brake booster to activate and output to the master cylinder.
VSC operation may cause the brake pedal to move downward. A stop light inhibit relay is provided to prevent undesired operation of the stop lights due to operation of VSC.

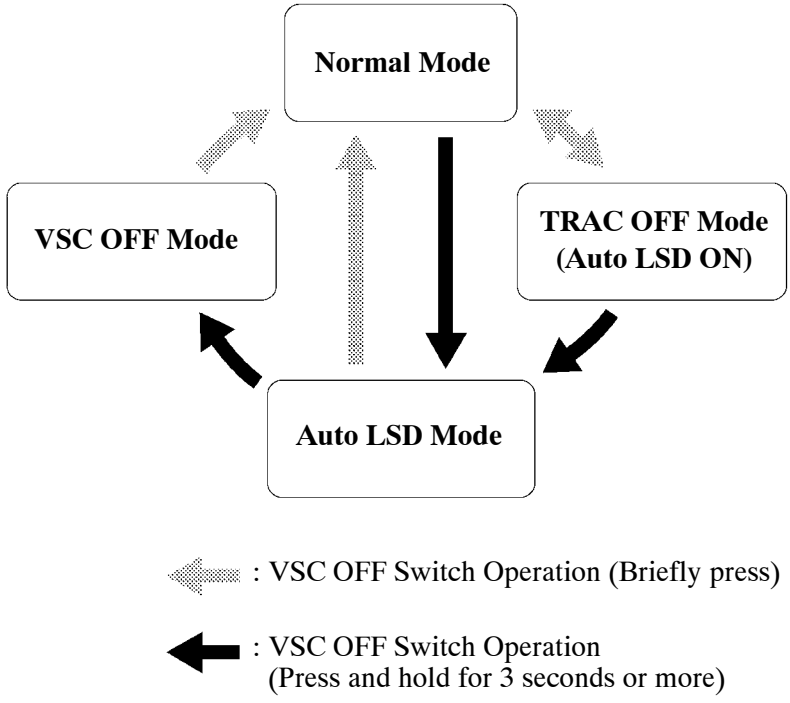


8. VSC OFF Switch

4WD Models (in 2WD Mode) and 2WD Models

The VSC OFF switch can select the 4 modes (Normal mode, TRAC OFF mode, Auto LSD mode, VSC OFF mode).

- Briefly pressing the VSC OFF switch in Normal mode selects the TRAC OFF mode, turning the Auto LSD ON (standby).
- Pressing and holding the VSC OFF switch for 3 seconds or more with the vehicle stopped selects the Auto LSD mode, disabling the TRAC and VSC functions.
- In the Auto LSD mode, pressing and holding the VSC OFF switch for 3 seconds or more with the vehicle stopped selects the VSC OFF mode, disabling all functions.
- After the ignition switch is turned OFF in the TRAC OFF mode, Auto LSD mode or VSC OFF mode, turning the ignition switch ON again selects the Normal mode.



- The operation of the brake control functions and the illumination state of the respective indicator lights in each mode are as follows:

○: Controlled —: Not Controlled

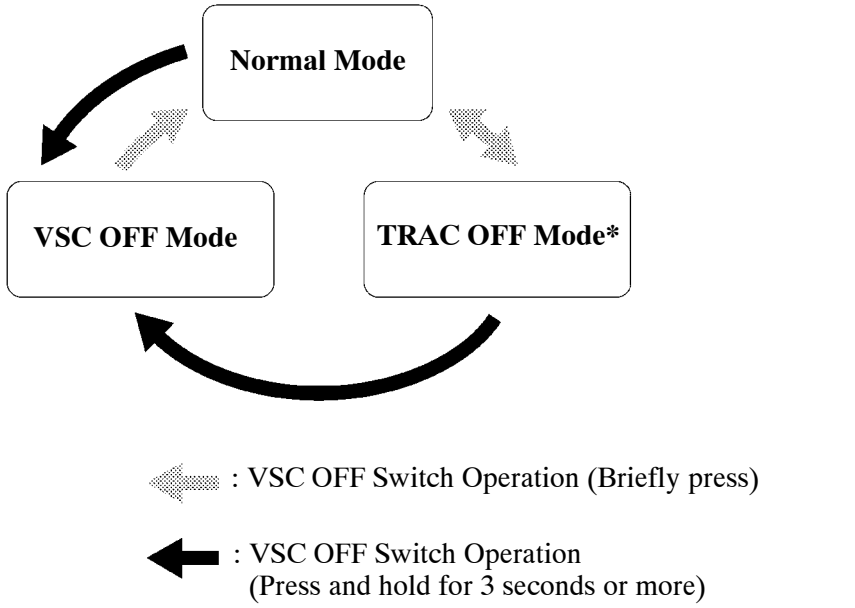
Item	Brake Control Function			AUTO LSD Indicator Light	Slip Indicator Light	VSC OFF Indicator Light
	TRAC	VSC	Auto LSD	AUTO LSD 03NCH004Y	03NCH005Y	VSC OFF 03NCH006Y
Normal Mode	○	○	—	—	—	—
TRAC OFF Mode	—	○	○	Light ON	Light ON	—
Auto LSD Mode	—	—	○	Light ON	Light ON	Light ON
VSC OFF Mode	—	—*	—	—	Light ON	Light ON

*: When the vehicle is braking or the yaw rate is large, the VSC will operate even in the VSC OFF mode.

4WD Models (in 4WD Mode)

The VSC OFF switch can select the 3 modes (Normal mode, TRAC OFF mode*, VSC OFF mode).

- Briefly pressing the VSC OFF switch in Normal mode selects the TRAC OFF mode*.
- Pressing and holding the VSC OFF switch for 3 seconds or more with the vehicle stopped selects the VSC OFF mode, disabling the TRAC and VSC functions.
- Briefly pressing the VSC OFF switch in the TRAC OFF mode* or VSC OFF mode or turning the ignition switch OFF returns to the Normal mode.



*: The driver can't choose the TRAC OFF mode when the transfer is in the H4L, L4F and L4L mode.

- The operation of the brake control functions and the illumination state of the respective indicator lights in each mode are as follows:

○: Controlled —: Not Controlled

Item		Brake Control Function		Slip Indicator Light	VSC OFF Indicator Light
		A-TRAC	VSC	03NCH005Y	VSC OFF 03NCH006Y
H4F	Normal Mode	○	○	—	—
	TRAC OFF Mode*1	○	○	Light ON	—
	VSC OFF Mode	—	—*2	Light ON	Light ON
L4F	Normal Mode	○	○	—	—
	VSC OFF Mode	—	—	Light ON	Light ON
H4L L4L	Normal Mode	○	—	—	Light ON
	VSC OFF Mode	—	—	Light ON	Light ON

*1: The driver can't choose the TRAC OFF mode when the transfer is in the H4L, L4F and L4L mode.
*2: When the vehicle is braking or the yaw rate is large, the VSC will operate even in the VSC OFF mode.

9. Warning Light, Indicator Light and VSC Warning Buzzer

The warning and indicator lights and VSC warning buzzer operate as follows:

○: Illuminates △: Blinks

Condition			Warning Light		Indicator Light			VSC Warning Buzzer
			BRAKE 08LCH165I	ABS 03NCH008Y	VSC OFF 03NCH006Y	 03NCH005Y	AUTO LSD 03NCH004Y	
Initial Check			○	○	○	○	○	
During Operation	TRAC/A-TRAC*1					△		
	Auto LSD	TRAC OFF Mode				△	○	
		Auto LSD Mode			○	△	○	
	VSC					△		Intermittent Sound
Drive Mode*1	H4L, L4L				○			
Brake Actuator Protection						○*2		Intermittent Sound*2
Cannot operate due to a malfunction	ABS, Brake Assist			○	△	○*3		
	EBD		○	○	△	○*3		
	TRAC/A-TRAC*1				△	○		
	Auto LSD				△	○		
	VSC				△	○		
Other	Low Brake Fluid Level		○					
	Zero point calibration of yaw rate and deceleration sensor not done			○	△	○		

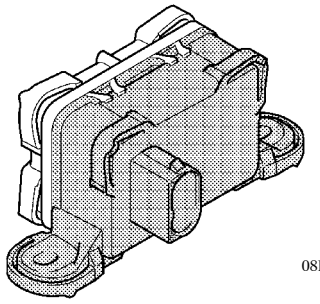
*1: Only for 4WD Models

*2: An extreme rise in the temperature of the brake pads causes the VSC warning buzzer to sound. Further rise in the temperature causes the VSC warning buzzer to sound (continuously for 3 seconds) and the slip indicator light to come ON.

*3: Failure in the ABS, EBD and brake assist prohibits operation of the TRAC, A-TRAC, Auto LSD and VSC. Accordingly, the VSC OFF indicator light will be blinked and slip indicator light will be illuminated.

10. Yaw Rate & Deceleration Sensor

- A deceleration sensor is built into the yaw rate sensor.
- This sensor detects the yaw rate and lateral and longitudinal* acceleration and deceleration.



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*: Only for 4WD Models

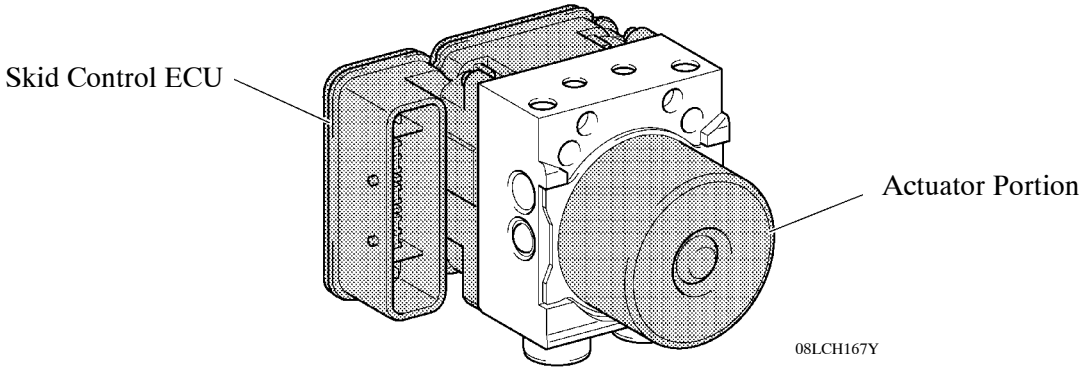
Service Tip

After replacing the yaw rate and deceleration sensor or the skid control ECU, initialization of the yaw rate and deceleration sensor is required.
For details, refer to the 2008 Sequoia Repair Manual (Pub. No. RM08L0U).

11. Brake Actuator

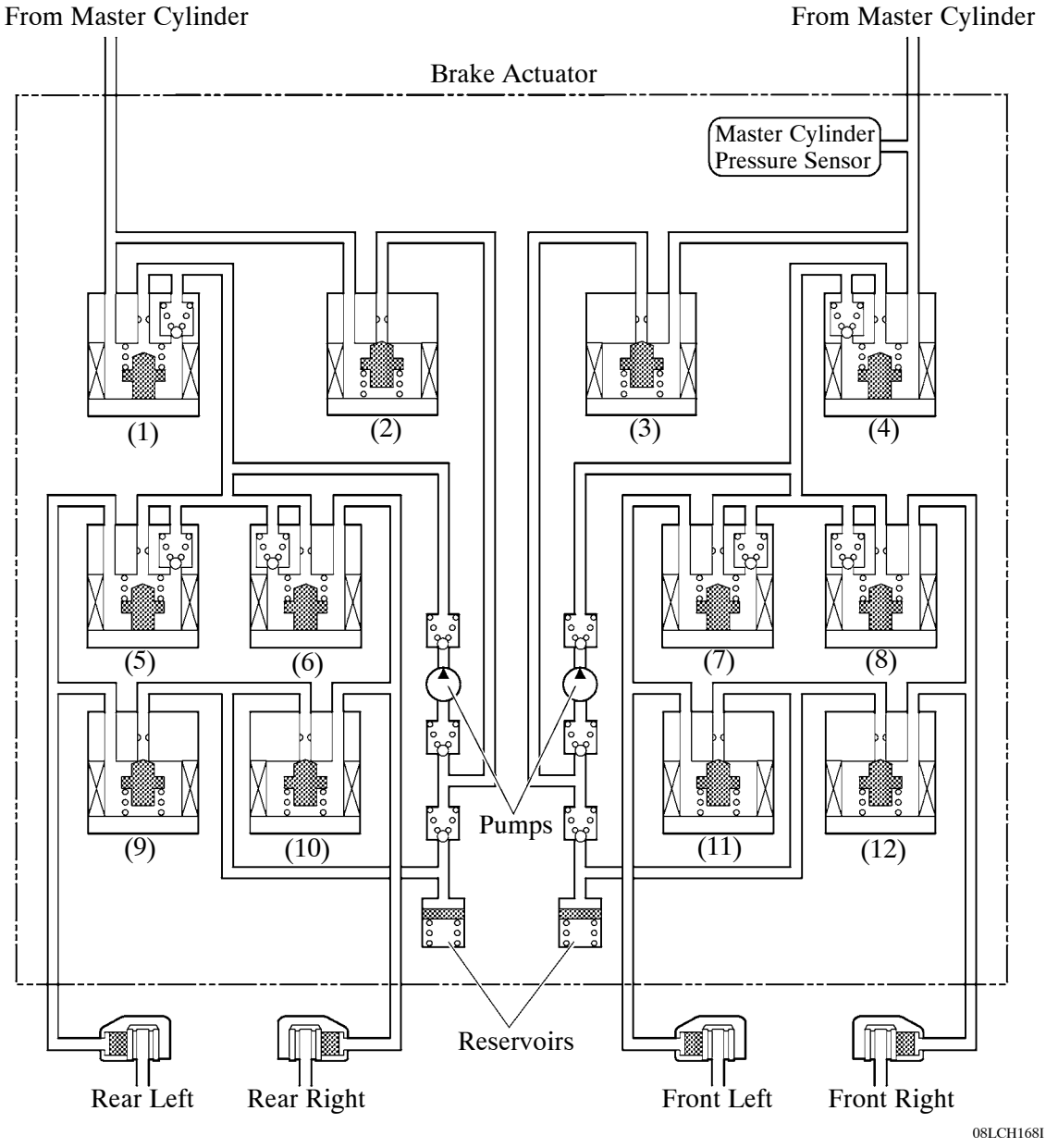
The brake actuator consists of the actuator portion and skid control ECU.

- The actuator portion consists of 12 solenoid valves, pump motor, 2 pumps, 2 reservoirs, and master cylinder pressure sensor.
- The 12 solenoid valves consists of 2 master cylinder cut solenoid valves [(1), (4)], 2 reservoir cut solenoid valves [(2), (3)], 4 pressure holding solenoid valves [(5), (6), (7), (8)], and 4 pressure reduction solenoid valves [(9), (10), (11), (12)].



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▶ Hydraulic Circuit ◀



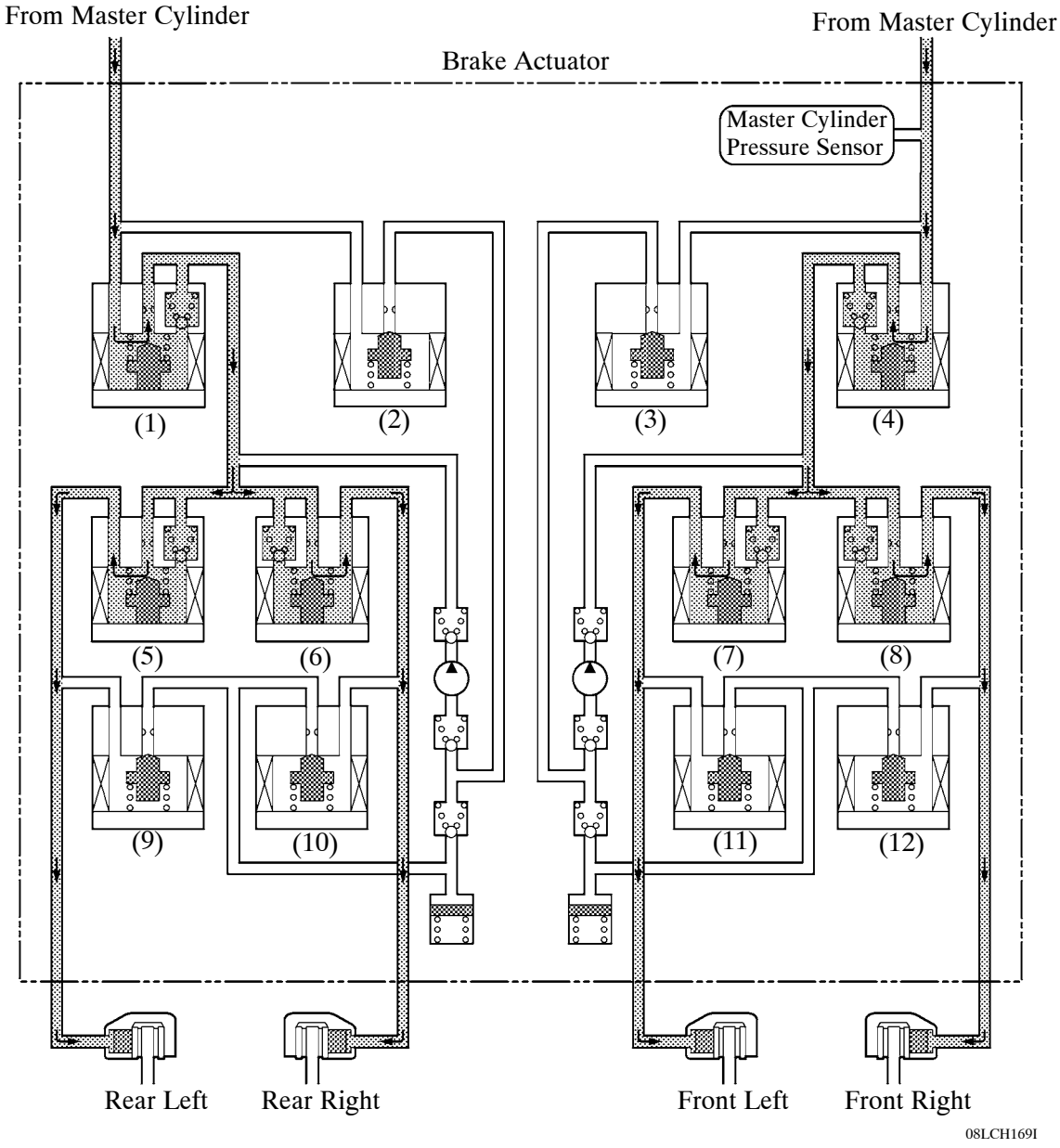
Item	
(1), (4)	Master Cylinder Cut Solenoid Valve
(2), (3)	Reservoir Cut Solenoid Valve
(5), (6), (7), (8)	Pressure Holding Solenoid Valve
(9), (10), (11), (12)	Pressure Reduction Solenoid Valve

CH

12. System Operation

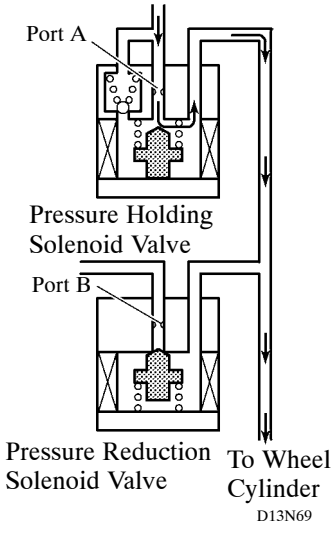
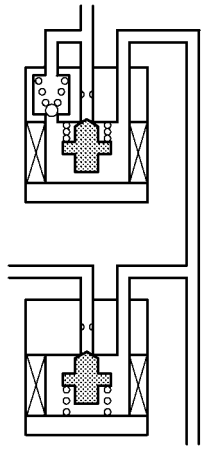
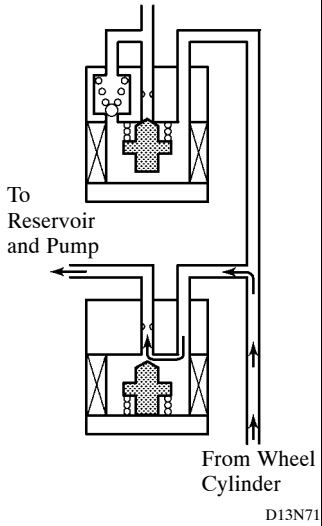
Normal Braking

During normal braking, all solenoid valves are turned OFF.



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			
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

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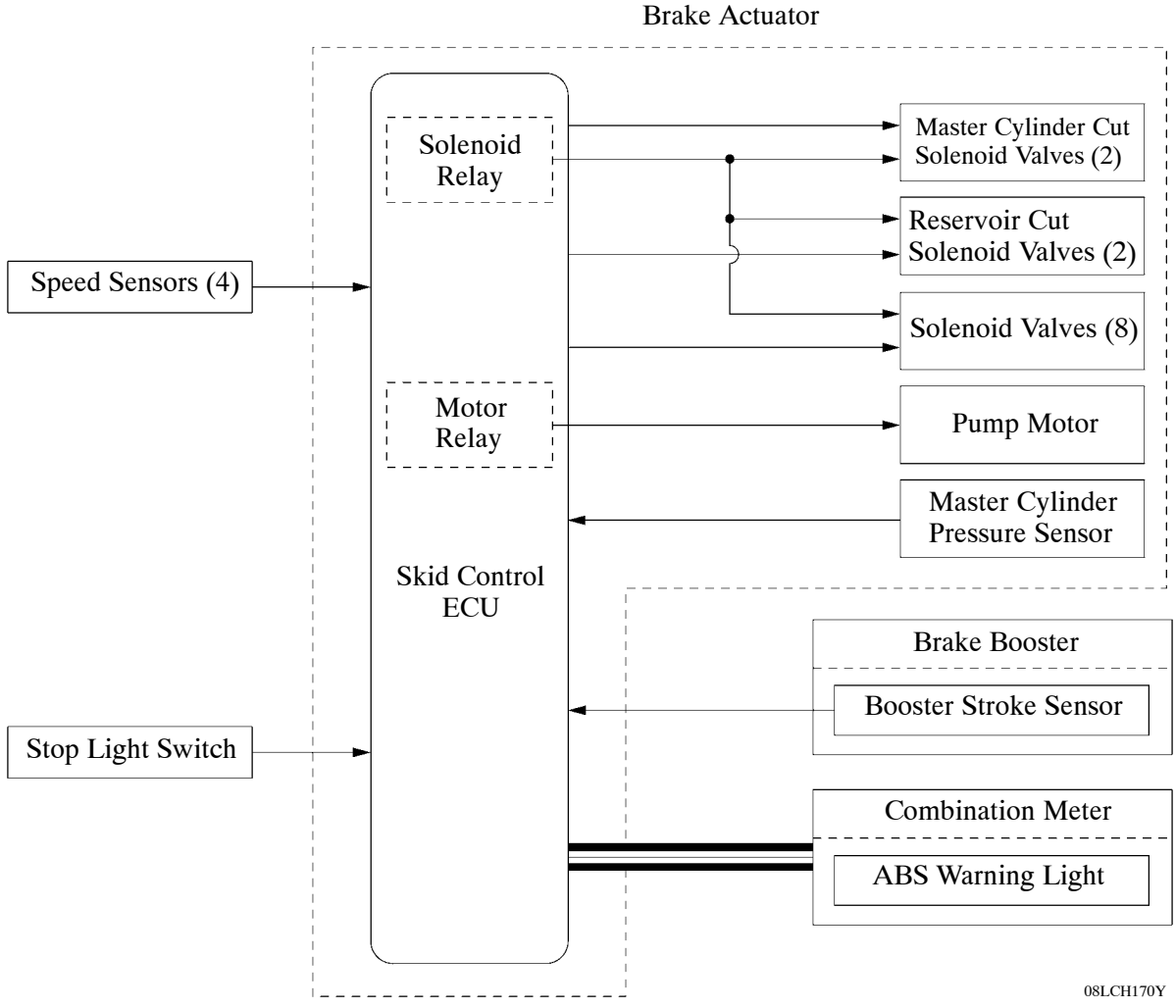
Brake Assist Operation

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 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.

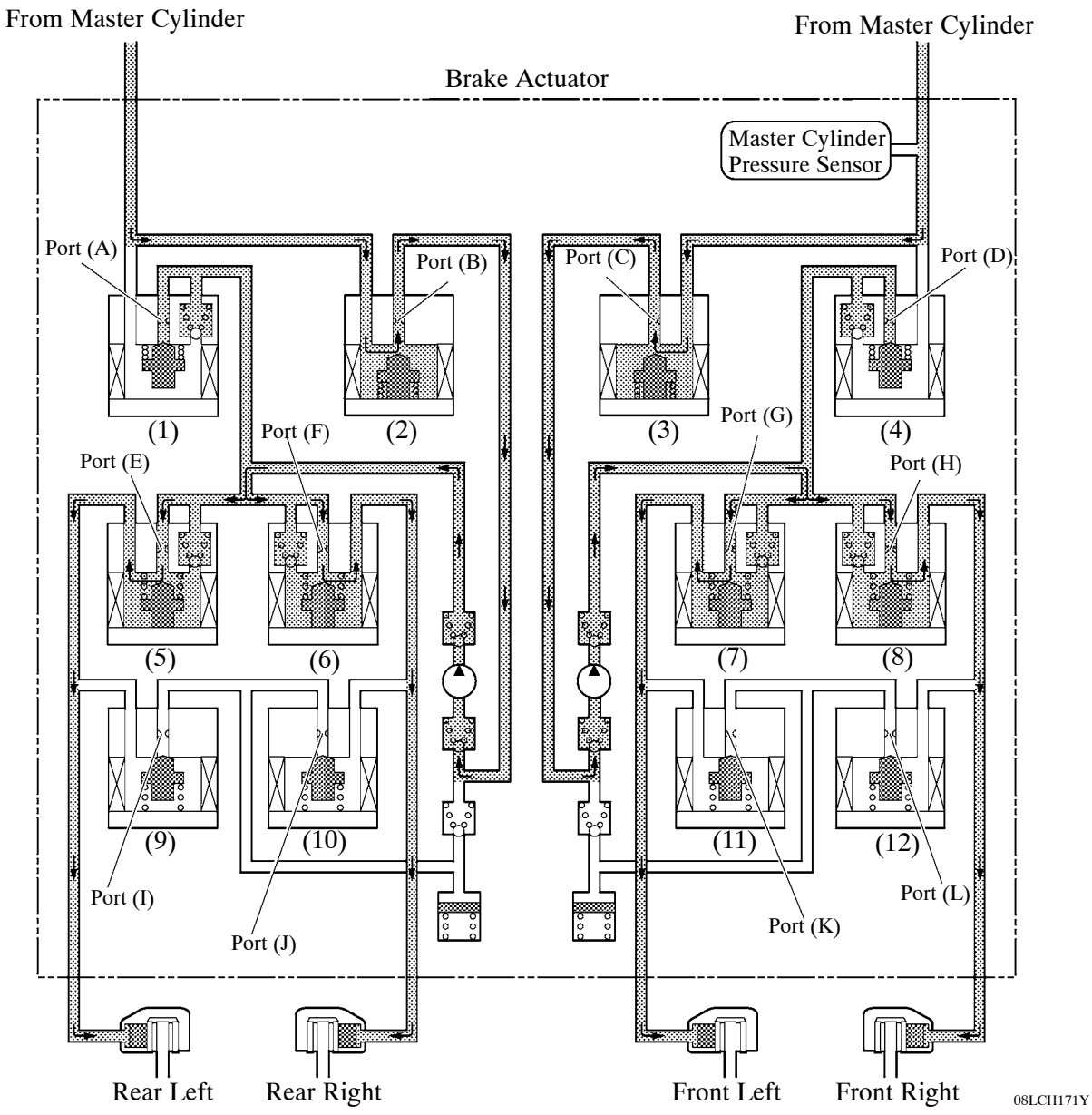
- In the event of a brake booster failure, the skid control ECU judges the failure using the booster stroke sensor in the brake booster and master cylinder pressure sensor signals.

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

▶ System Diagram ◀



▶ Brake Assist Operation ◀



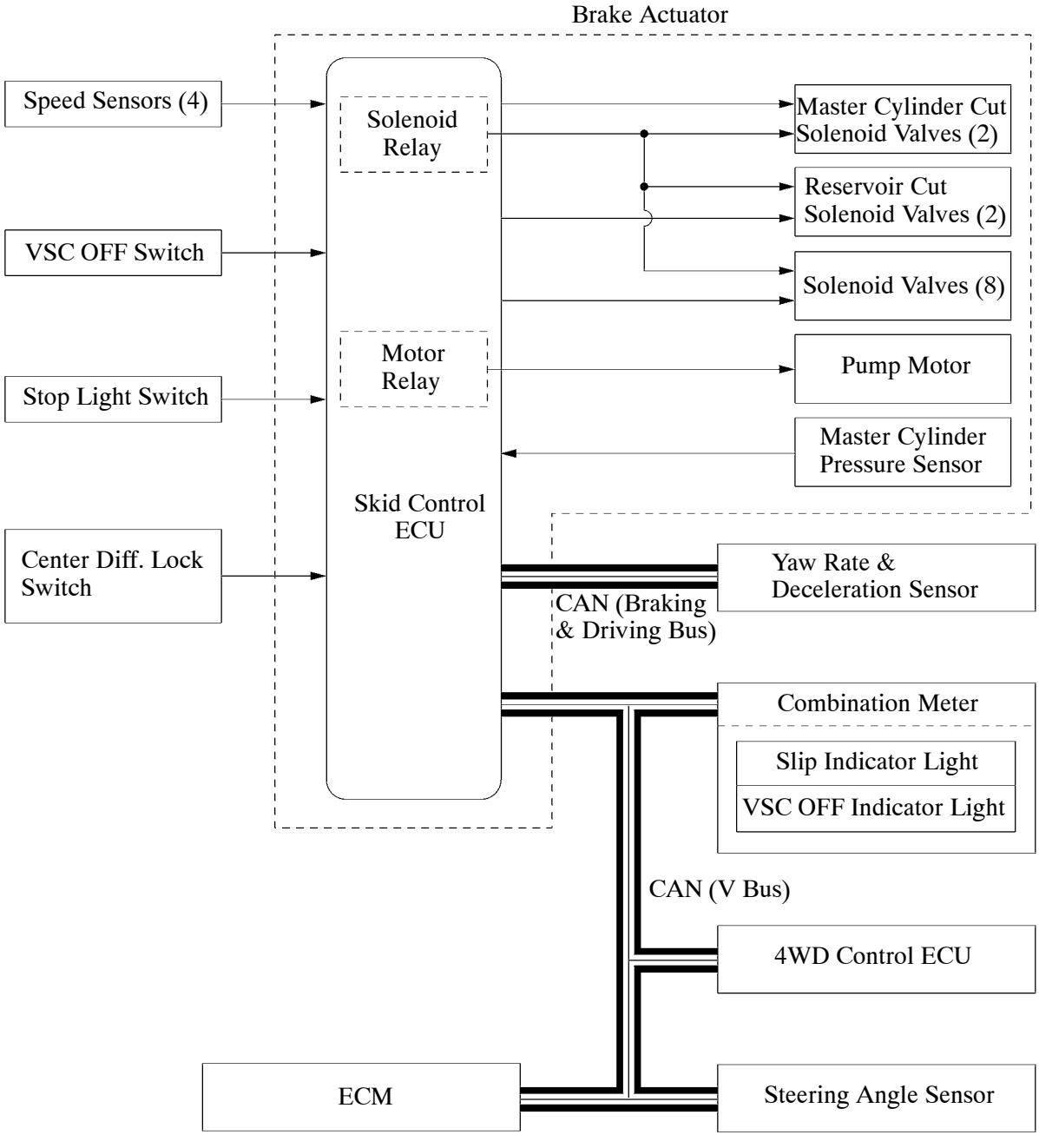
Item			Brake Assist Not Activated	Brake Assist Activated
Pump			OFF	ON
Master Cylinder Cut Solenoid Valve	(1)	Port (A)	OFF/Open	ON/Close
	(4)	Port (D)		
Reservoir Cut Solenoid Valve	(2)	Port (B)	OFF/Close	ON/Open
	(3)	Port (C)		
Pressure Holding Solenoid Valve	(5)	Port (E)	OFF/Open	←
	(6)	Port (F)		
	(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.

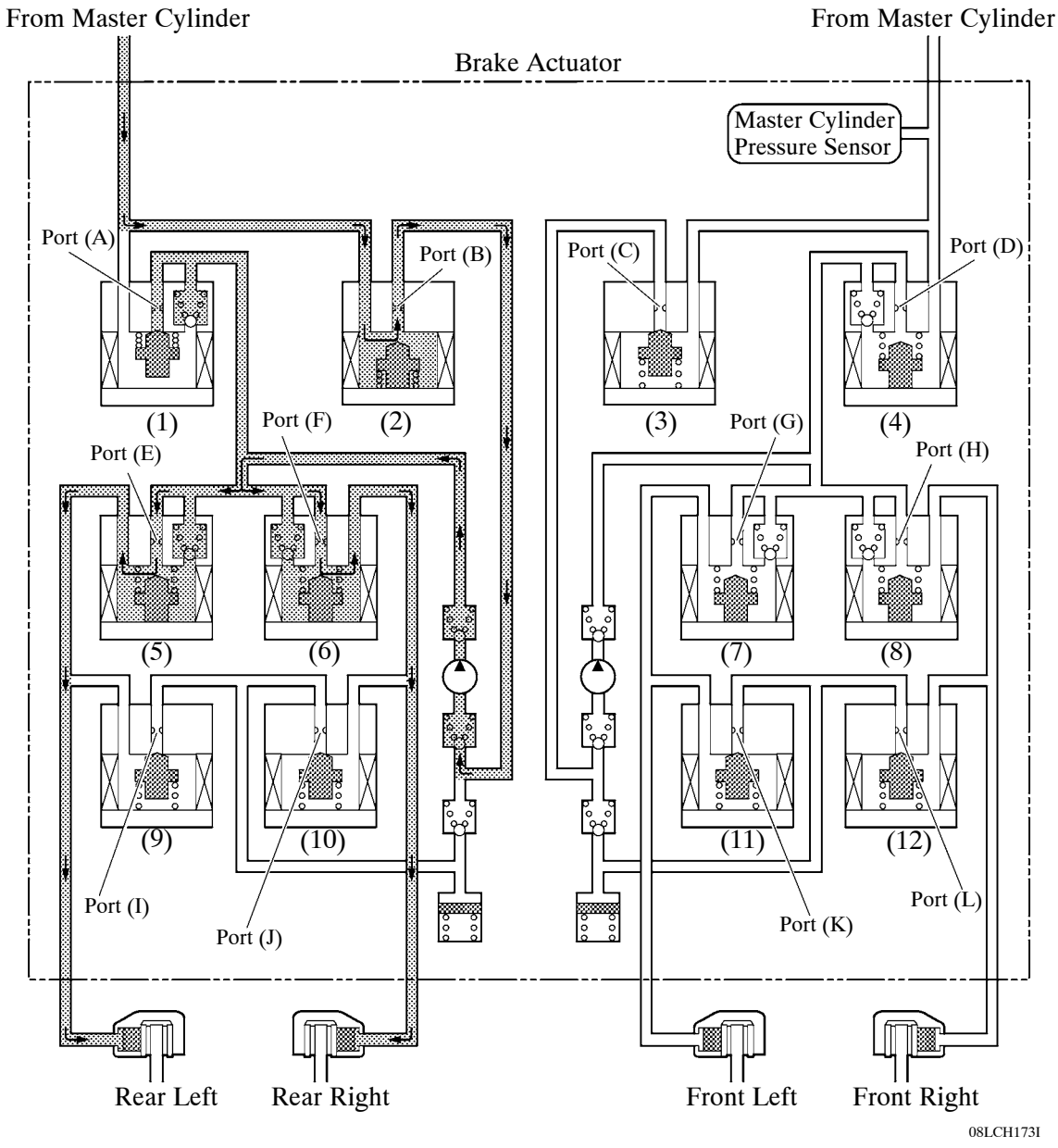
The diagram on the next page shows the hydraulic circuit in the pressure increase mode when the TRAC is activated. The pressure holding solenoid valve and the pressure reduction solenoid valve are turned ON/OFF according to the ABS and EBD operation pattern described on page CH-185. When the TRAC is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

▶ System Diagram ◀



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▶ TRAC Operation ◀



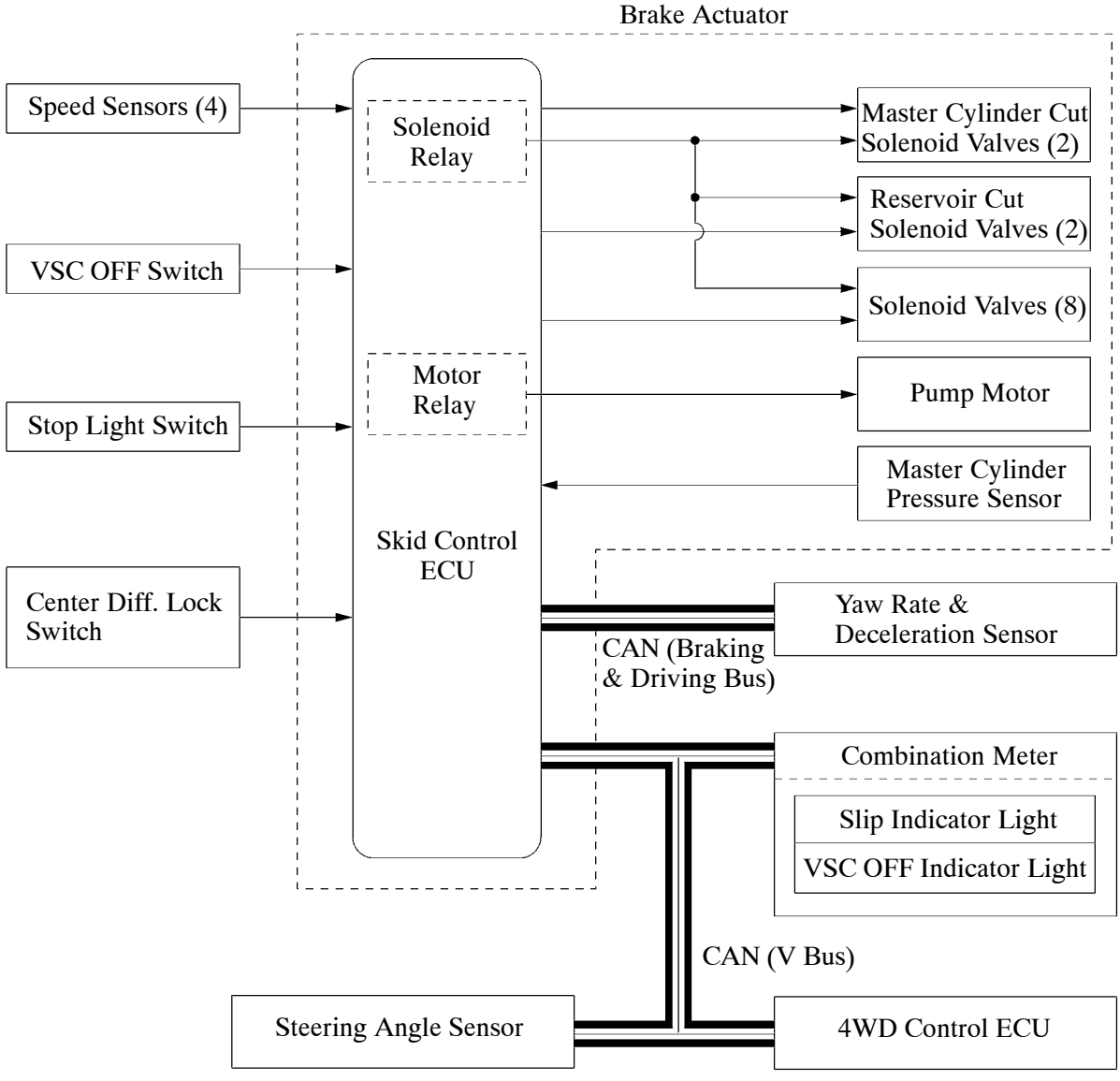
CH

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 ◀



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- 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	

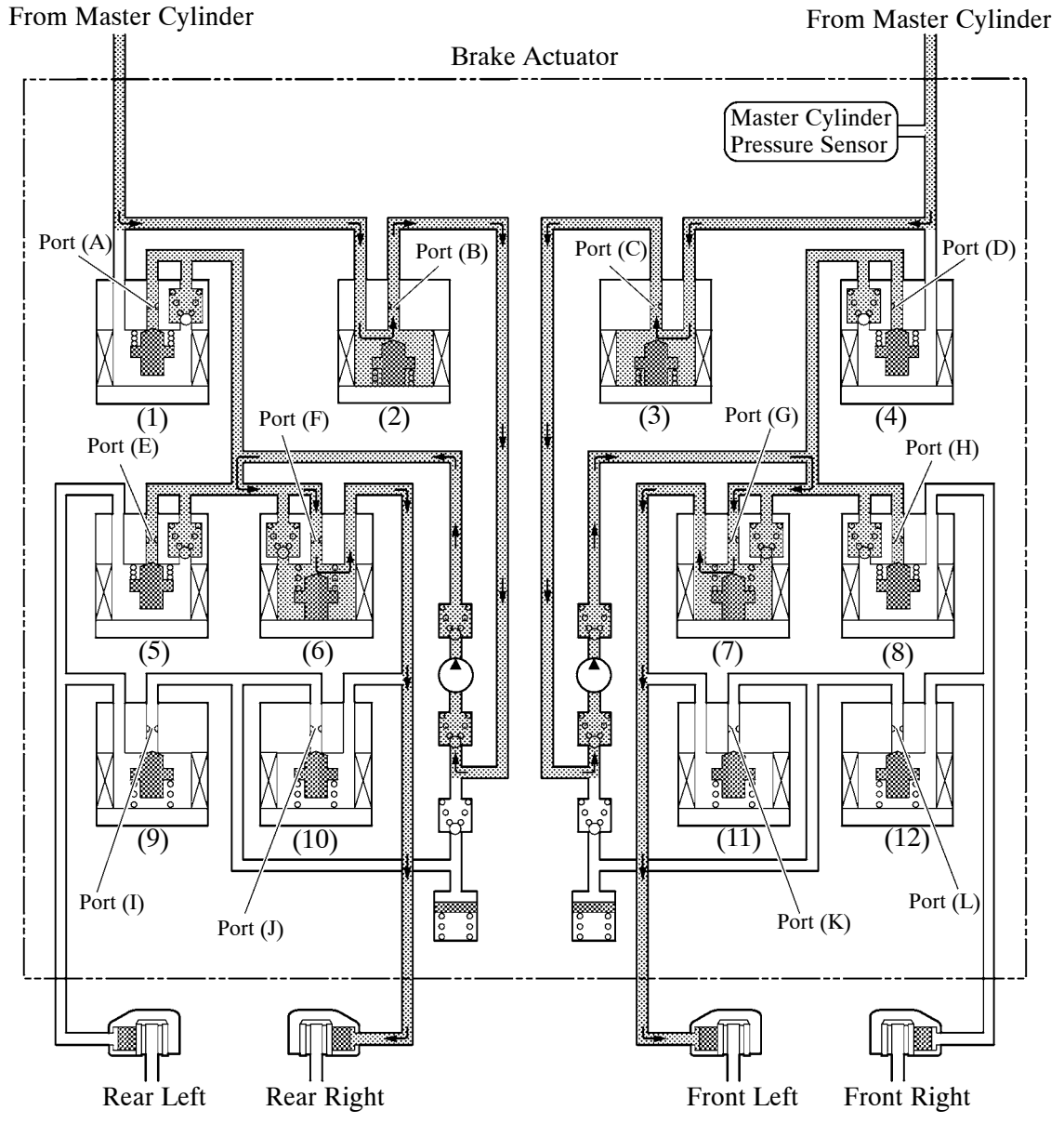
NOTICE

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) ◀



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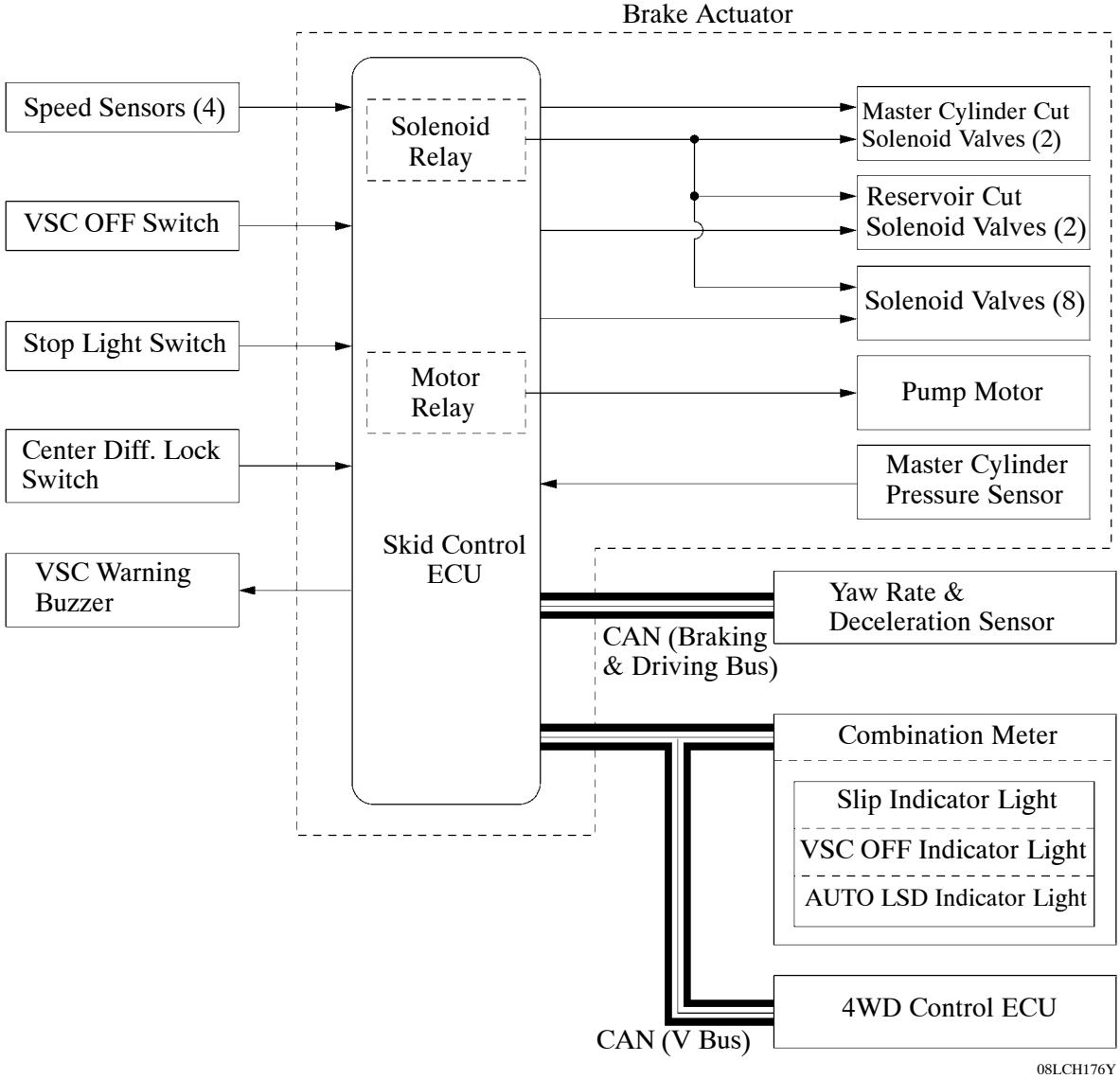
Item				A-TRAC Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve		(1)	Port (A)	OFF/Open	ON/Close	←	OFF/Open
		(4)	Port (D)				
Reservoir Cut Solenoid Valve		(2)	Port (B)	OFF/Close	ON/Open	OFF/Close	←
		(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 ◀



CH

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).

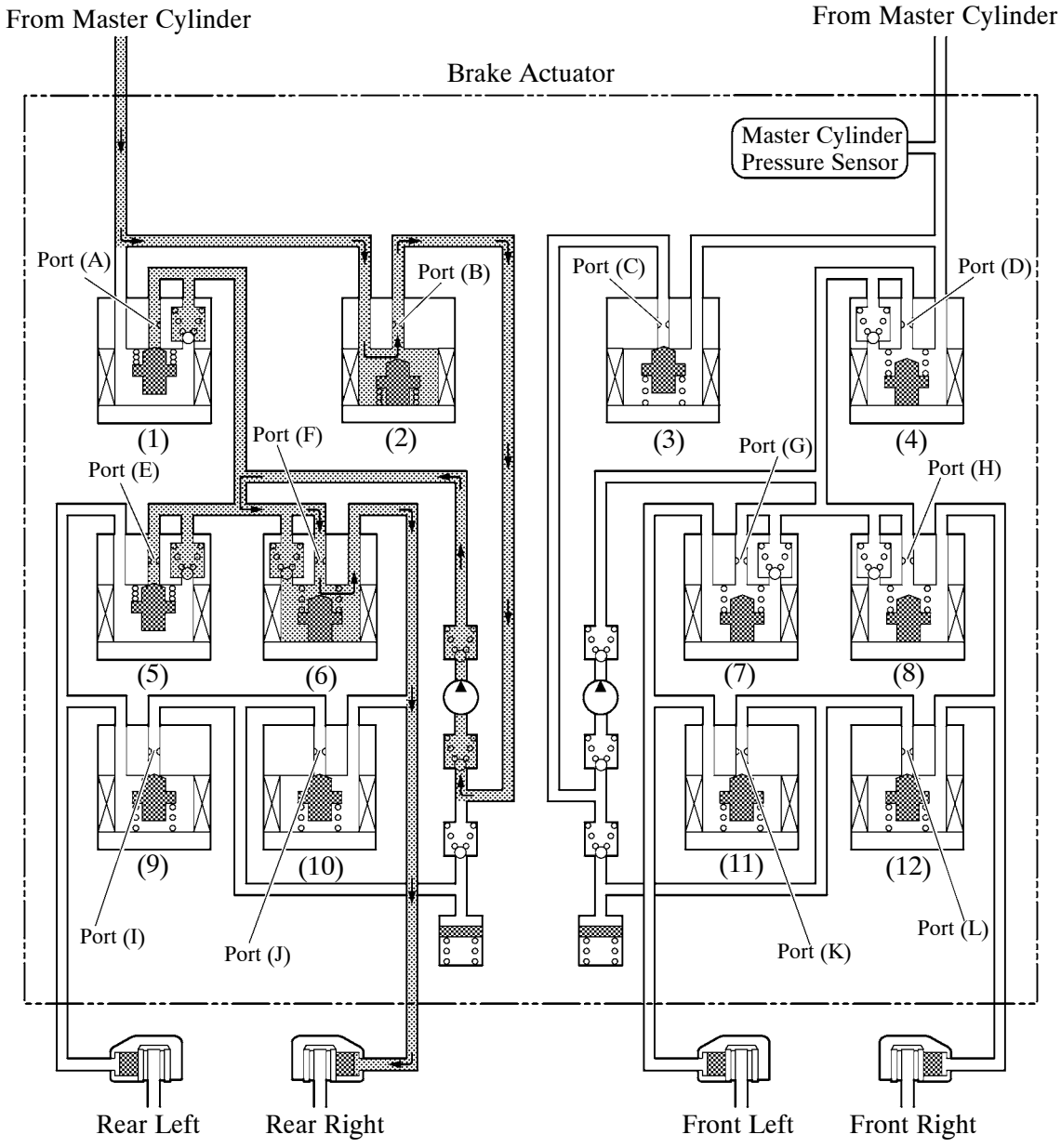
NOTICE

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) ◀



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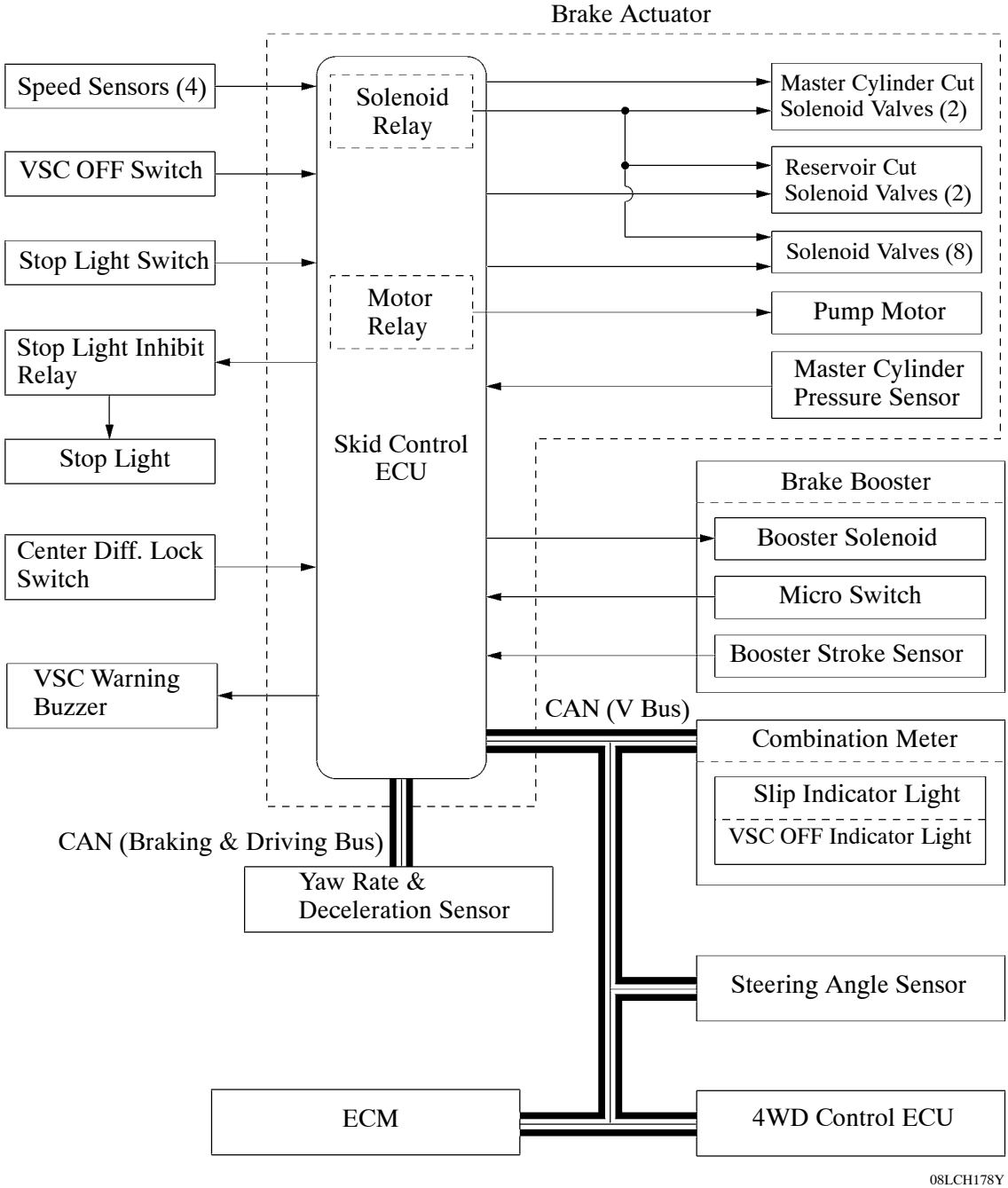
Item				Auto LSD Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve		(1)	Port (A)	OFF/Open	ON/Close	←	OFF/Open
		(4)	Port (D)	OFF/Open	←	←	←
Reservoir Cut Solenoid Valve		(2)	Port (B)	OFF/Close	ON/Open	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 ◀



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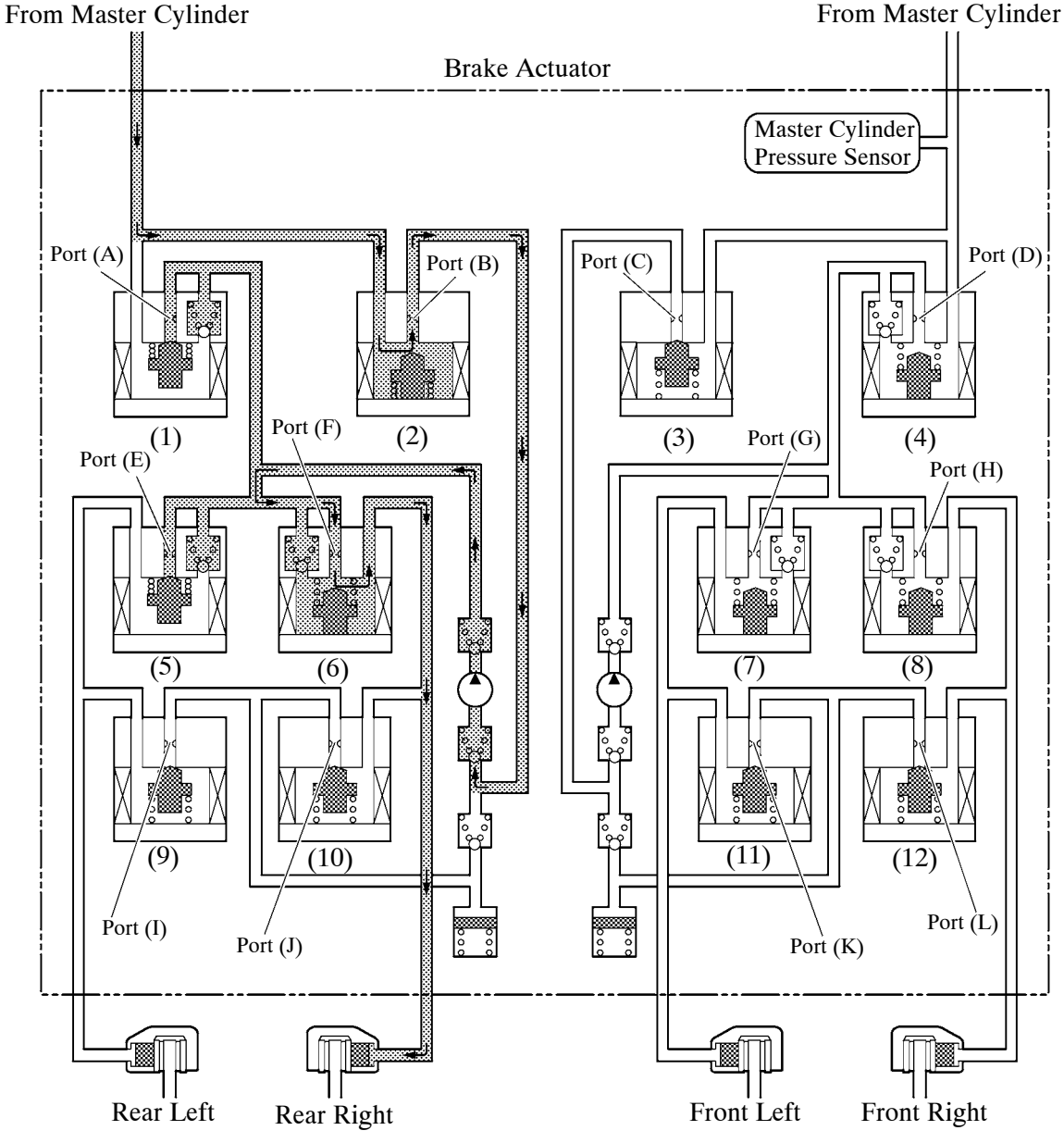
CH

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) ◀



08LCH177I

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		—	—	—	—

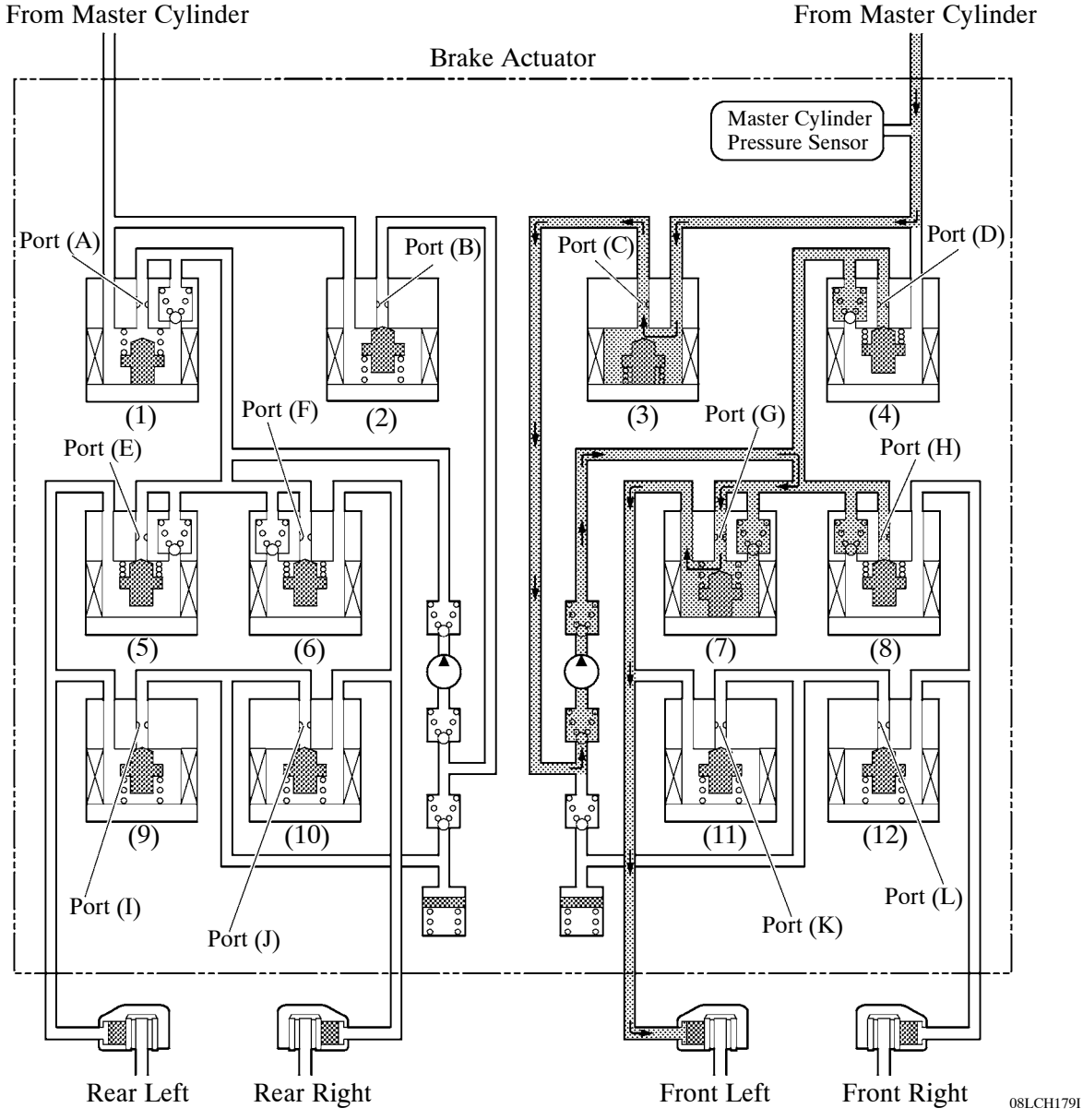
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3) Rear Wheel Skid Restraining (Turning to the Right)

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) ◀

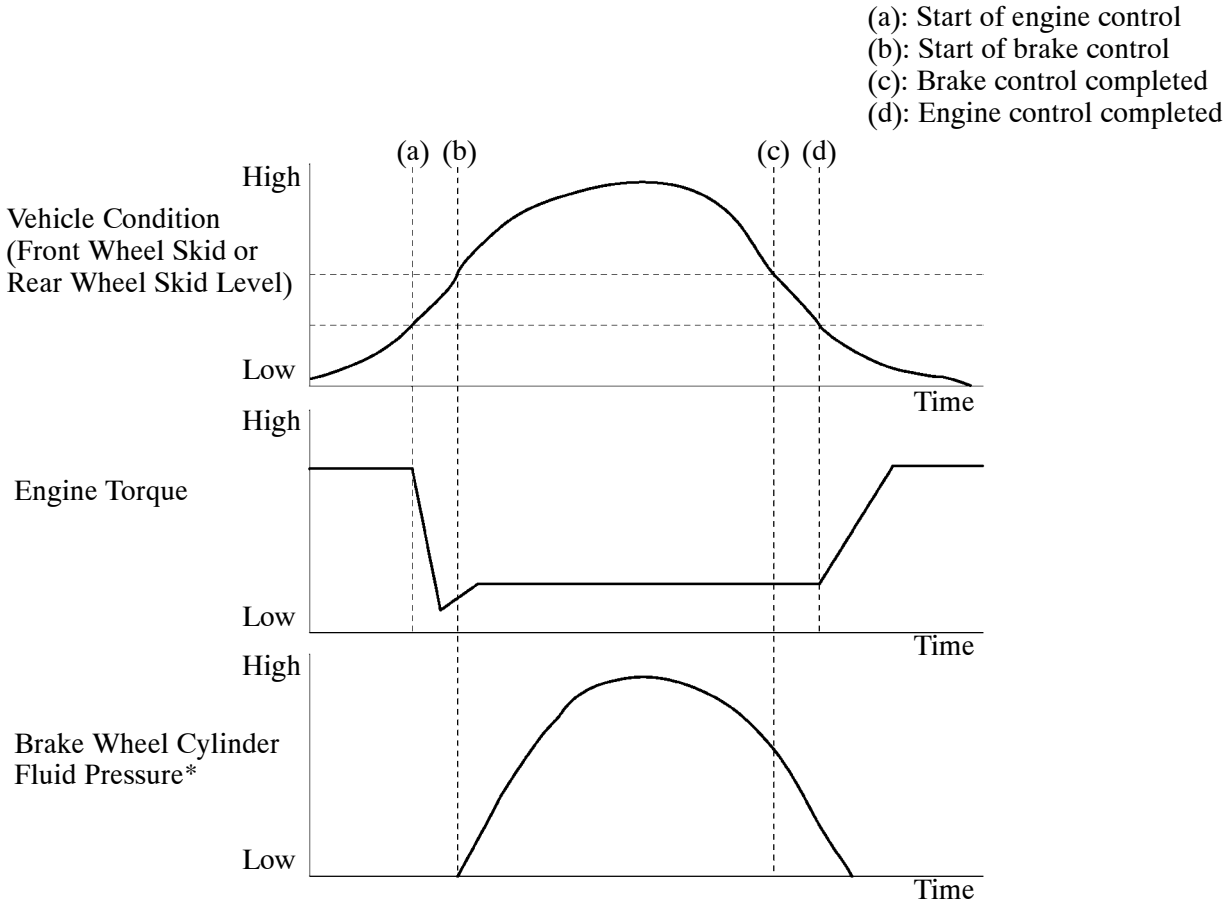


Item				VSC Operation			
				Not Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Pump				OFF	ON	←	←
Master Cylinder Cut Solenoid Valve		(1)	Port (A)	OFF/Open	←	←	←
		(4)	Port (D)	OFF/Open	ON/Close	←	OFF/Open
Reservoir Cut Solenoid Valve		(2)	Port (B)	OFF/Close	←	←	←
		(3)	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		—	—	—	—

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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.



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

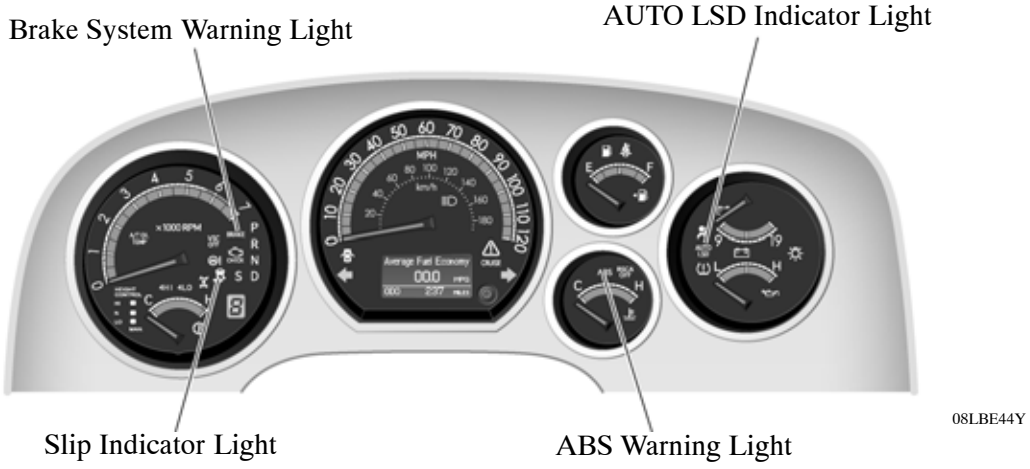
14. Initial Check

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.