■BRAKE CONTROL SYSTEM (ABS with EBD, Brake Assist, TRC, VSC and HAC)

1. General

The brake control system (ABS with EBD, Brake Assist, TRC, VSC and HAC) the following functions:

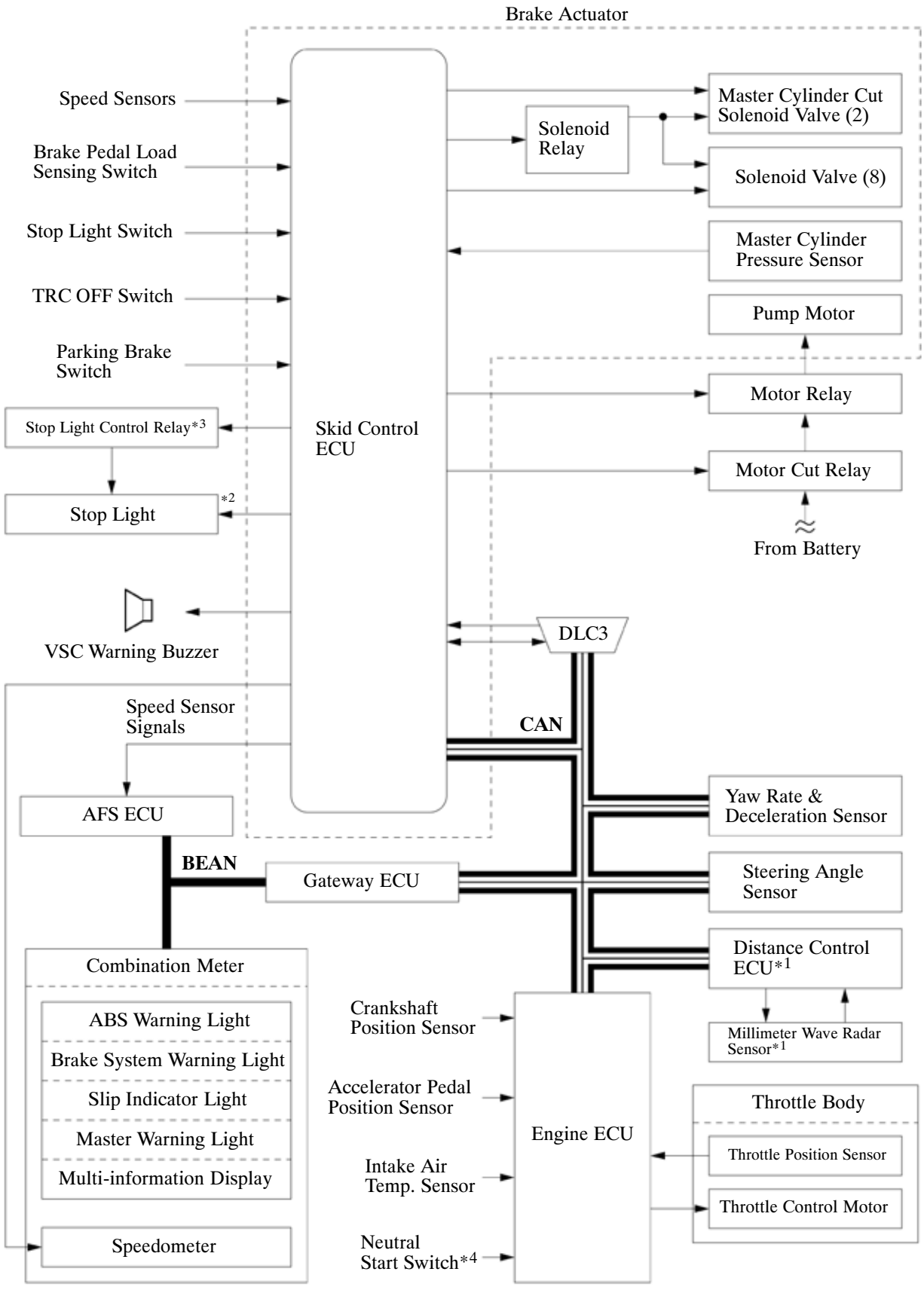
Function	Outline
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.
EBD (Electronic Brake force Distribution)	The EBD control utilizes ABS, realizing the proper brake force distribution between front and 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 to maintain the vehicle behavior.
Brake Assist	The primary purpose of the Brake Assist is to provide an auxiliary brake force to assist a driver who cannot generate a large brake force during emergency braking, thus helping improve the vehicle's brake performance.
TRC (Traction Control)	The TRC system helps prevent the drive wheels from slipping if the driver presses the accelerator pedal excessively when starting off or accelerating on a slippery surface.
VSC (Vehicle Stability Control)	The VSC system helps prevent the vehicle from slipping sideways as a result of strong front wheel skid or strong rear wheel skid during cornering.
HAC* (Hill-start Assist Control)	When the vehicle starts off on a steep or a slippery hill, HAC detects the backward movement of the vehicle and effects 4-wheel hydraulic pressure control to reduce the backward speed of the vehicle.

*: Only for A/T Model

Service Tip

When brake control system is activated, the brake pedal may shudder, this is a normal occurrence of system operation and should not be considered a malfunction.

2. System Diagram



0150CH02Z

*1: With Dynamic Radar Cruise Control System *2: Only for M/T Model
*3: A/T Model and With Dynamic Radar Cruise Control System *4: Only for A/T Model

3. Outline of EBD Control

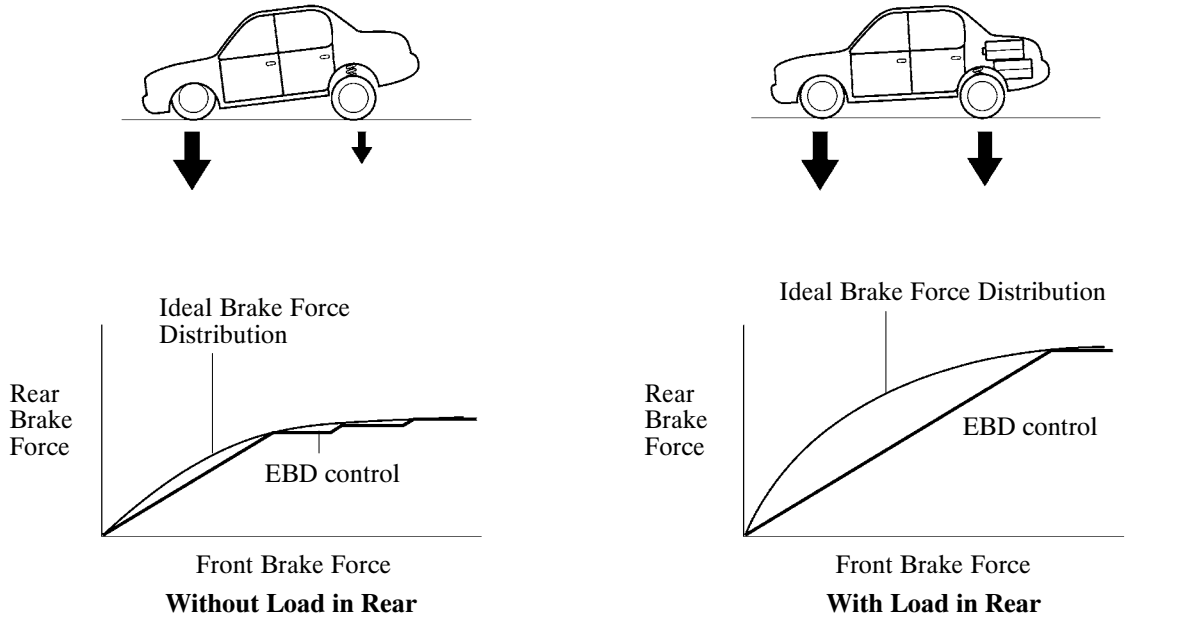
General

The distribution of the brake force, which was performed mechanically in the past, is now performed under electrical control of the Skid Control ECU, which precisely controls the braking force in accordance with the vehicle's driving conditions.

Front/Rear Wheel Brake Force Distribution

If the brakes are applied while the vehicle is moving straight forward, the transfer of load due to braking reduces the load that is applied to the rear wheels. The skid control ECU determines this condition by way of the signals from the speed sensor, and the brake actuator regulates the distribution of the brake force of the rear wheels to optimally control brake balance.
For example, the amount of the brake force that can be applied to the rear wheels during braking varies depending on whether the vehicle is carrying a load. The amount of the brake force that is applied to the rear wheels also varies in accordance with the extent of the deceleration.
Thus, the distribution of brake force to the rear is optimally controlled in order to effectively utilize the braking force of the rear wheels under these conditions.

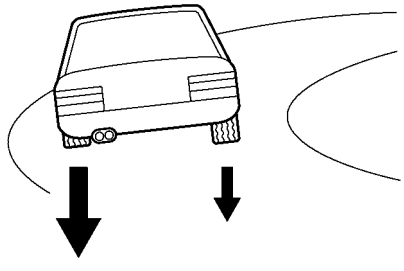
▶ EBD Control Concept ◀



182CH56

Right/Left Wheel Brake Force Distribution (During Cornering Braking)

When the brakes are applied while the vehicle is cornering, the load that is applied to the inner wheel decreases as the load applied to the outer wheel increases.
The Skid Control ECU determines this condition by way of the signals from the speed sensors, and the brake actuator regulates the brake force in order to optimally control the distribution of the brake force to the inner and outer wheels.

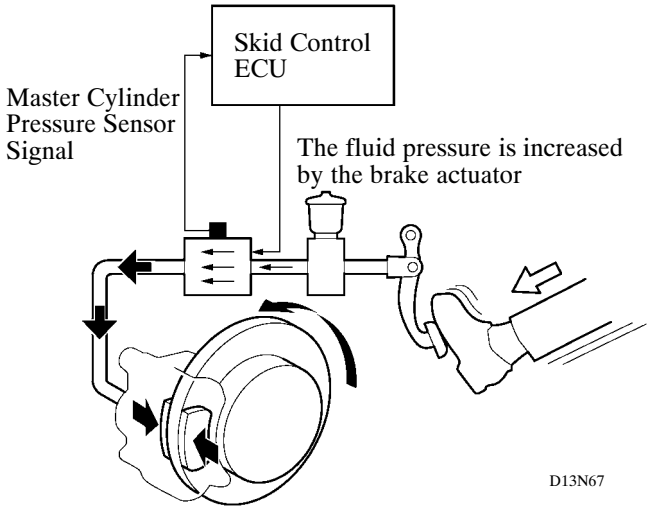


181CH56

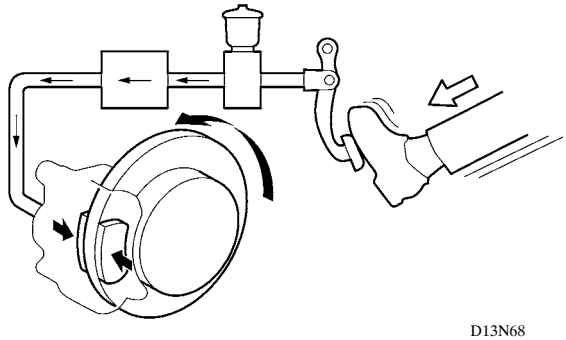
4. Outline of Brake Assist

- The Brake Assist in combination with ABS helping improves the vehicle's brake performance.
- The Brake Assist interprets a quick push of the brake pedal as emergency braking and supplements the brake power applied if the driver has not stepped hard enough on the brake pedal. In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure to the brake pedal.
- A key feature of Brake Assist is that the timing and the degree of braking assistance are designed to help ensure that the driver does not discern anything unusual about the braking operation. When the driver intentionally eases up on the brake pedal, the Brake Assist reduces the amount of assistance it provides.
- 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 perform emergency braking. If the Skid Control ECU determines that the driver intends emergency braking, the system activates the brake actuator to increase the brake fluid pressure, which increases the braking force.
- When the vehicle is fully loaded, stronger brake force may be required, even if the brakes are not applied quickly. In such a case where stronger brake force is required, the Brake Assist also increases brake force.

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

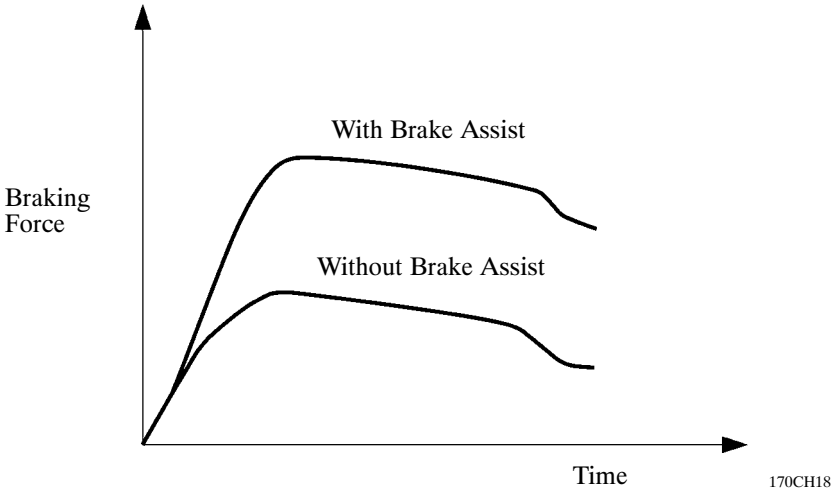


With Brake Assist



Without Brake Assist*

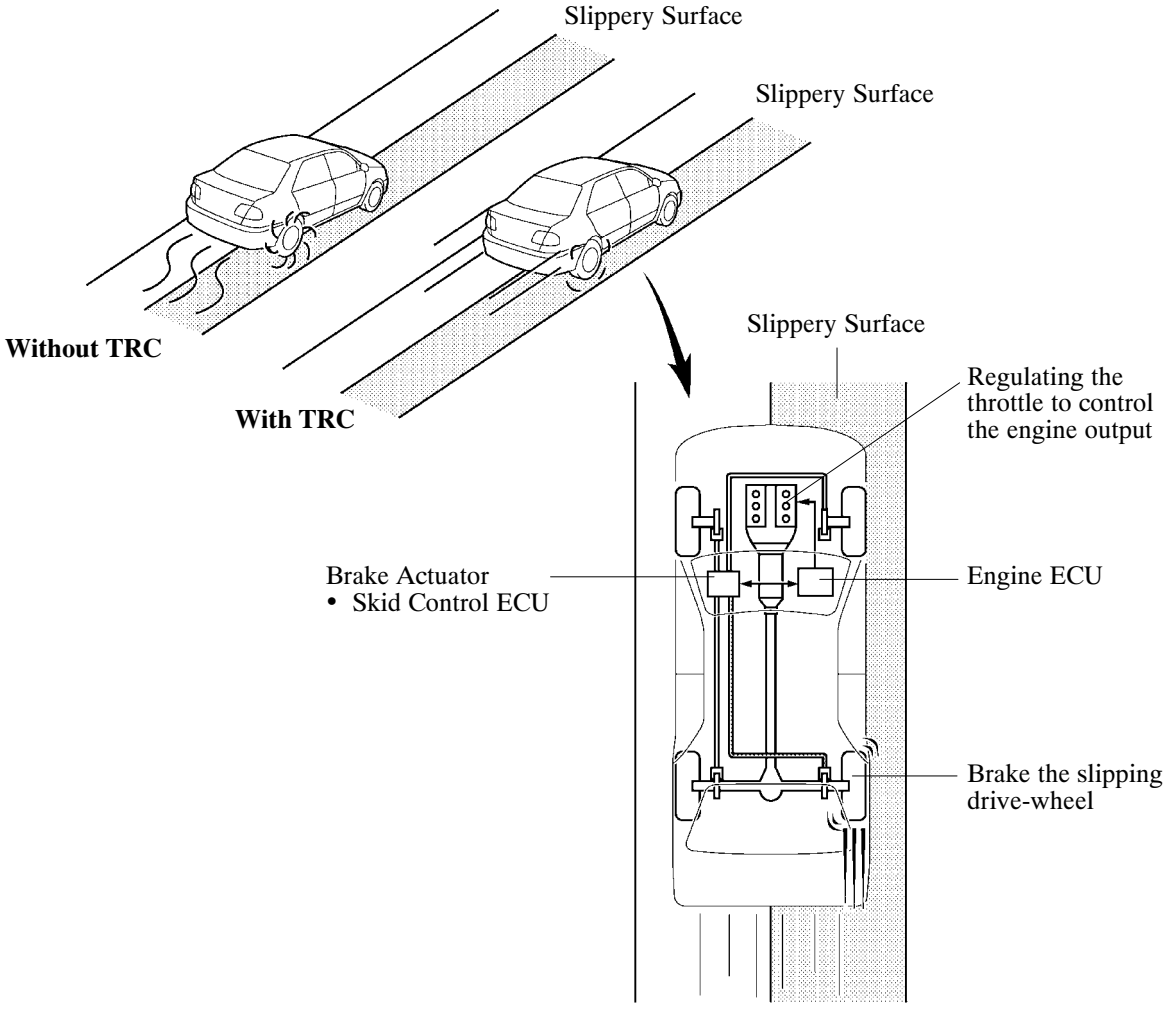
*: The basic performance of the brakes is the same as the model with the Brake Assist.



5. Outline of TRC

- If the driver presses the accelerator pedal aggressively when initially acceleration 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, the TRC helps minimize the slippage of the drive wheels, thus generating the drive force that is appropriate for the road surface conditions.
- For example, a comparison may be made between two vehicles, one with the TRC 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 the TRC, 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 Engine ECU receives the signals from the Skid Control ECU and regulates the throttle in order to control the engine output. Thus, the TRC can constantly help the driver to maintain stability while accelerating.

▶ Driving condition on road with different surface friction characteristics ◀



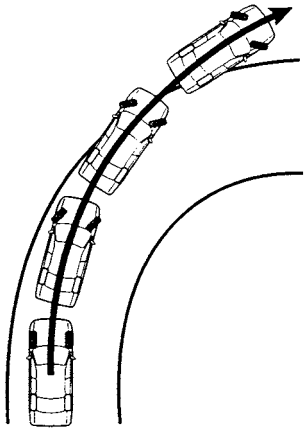
0140CH98Y

6. Outline of VSC

General

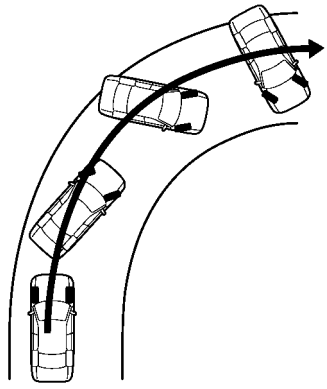
The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit.
The VSC is designed to help control the vehicle behavior by controlling the engine output and the brakes at each wheel when the vehicle experiences one of the conditions indicated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

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



151CH17

Front Wheel Skid Tendency



189CH100

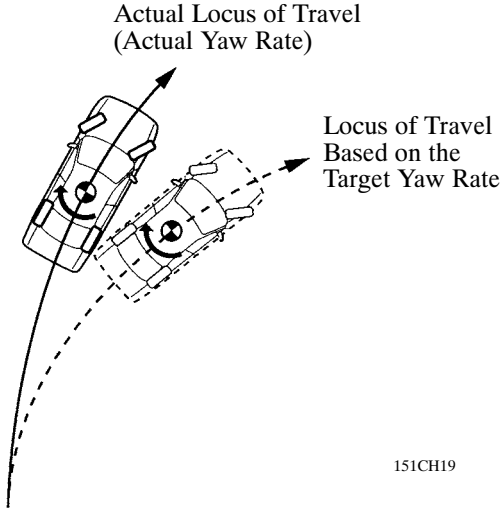
Rear Wheel Skid Tendency

Method for Determining the Vehicle Condition

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

1) Determining a Front Wheel Skid

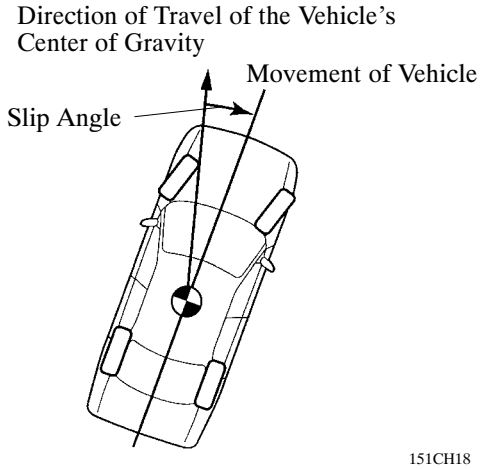
Whether or not the vehicle is experiencing a front wheel skid is determined by the difference between the target yaw rate and the vehicle's actual yaw rate.
When the vehicle's actual yaw rate is smaller than the target yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) 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 target locus of travel.
Thus, the Skid Control ECU determines that there is a large front wheel skid tendency.



151CH19

2) Determining a Rear Wheel Skid

Whether or not the vehicle is experiencing a rear wheel skid 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 is large, and the slip angular velocity is also large, the Skid Control ECU determines that the vehicle has a large rear wheel skid tendency.



151CH18

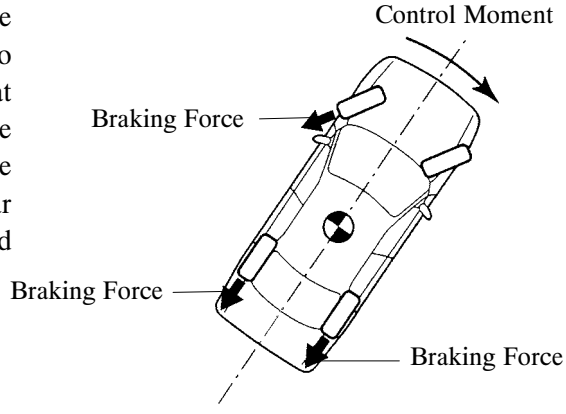
Method for VSC Operation

When the Skid Control ECU determines that the vehicle exhibits a tendency to front wheel skid or rear wheel skid, it decreases the engine output and applies the brake to 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 may differ depending on the vehicle's characteristics and driving conditions.

CH

1) Dampening a Strong Front Wheel Skid

When the Skid Control ECU determines that there is a large front wheel skid tendency, it attempts to counteract the tendency based on the extent of that tendency. The Skid Control ECU controls the engine power output and applies the brakes of the front wheel of the outer circle in the turn and rear wheels in order to restrain the front wheel skid tendency.

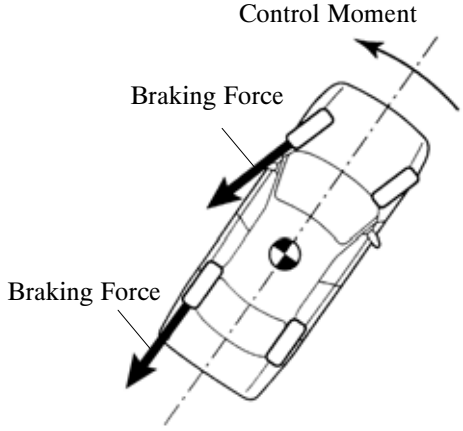


Making a Right Turn

189CH101

2) Dampening a Strong Rear Wheel Skid

When the Skid Control ECU determines that there is a large rear wheel skid tendency, it attempts to counteract the tendency based on the extent of that tendency. It applies the brakes of the front and rear wheels of the outer circle of the turn, and generates an outward moment of inertia in the vehicle, in order to restrain the rear wheel skid tendency. Along with the reduction in the vehicle speed caused by the braking force, excellent vehicle stability is ensured.
In some cases, the Skid Control ECU applies the brakes to the rear wheels, as necessary.



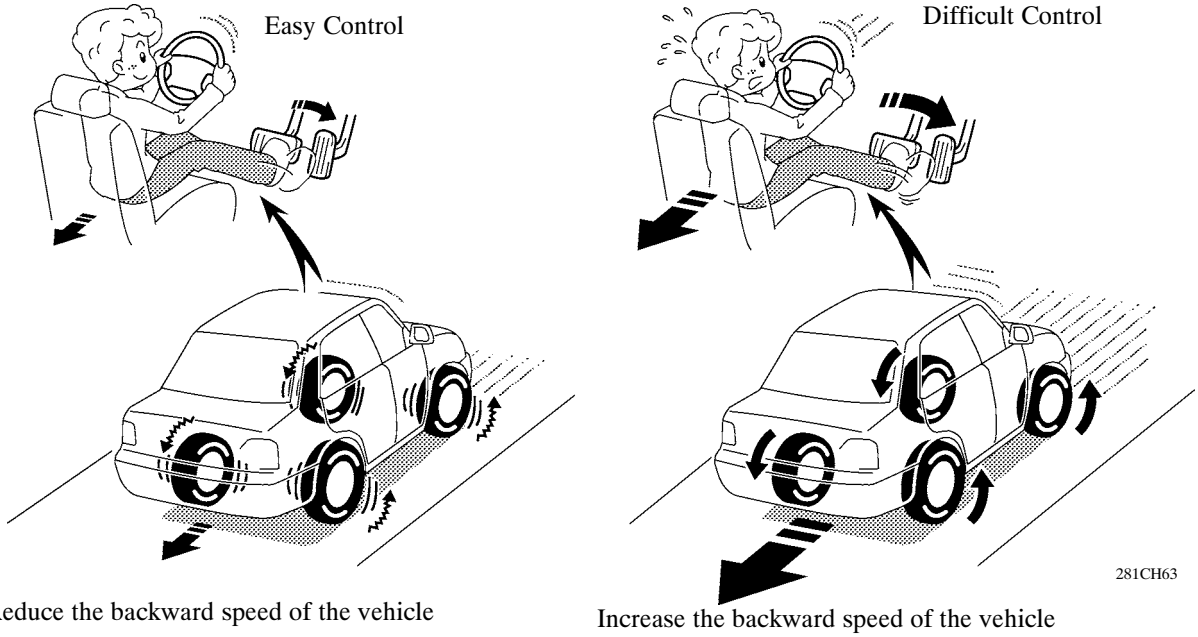
204CH15

Making a Right Turn

7. Outline of HAC* System

- When the vehicle starts off on a steep or slippery hill, the vehicle could descend backward while the driver switches from the brake pedal to the accelerator pedal, thus making it difficult for the vehicle to start off. To prevent this from occurring, HAC temporarily (approximately 5 seconds at the maximum) applies the brakes to all the wheels in order to reduce the backward speed of the vehicle.
- Without HAC, the driver must quickly and precisely switch from the brake pedal to the accelerator pedal. With HAC however, the driver can start off easily and operate the pedal in a relaxed manner because HAC reduces the backward speed of the vehicle.

*: Only for A/T Model



Reduce the backward speed of the vehicle
With HAC

Increase the backward speed of the vehicle
Without HAC

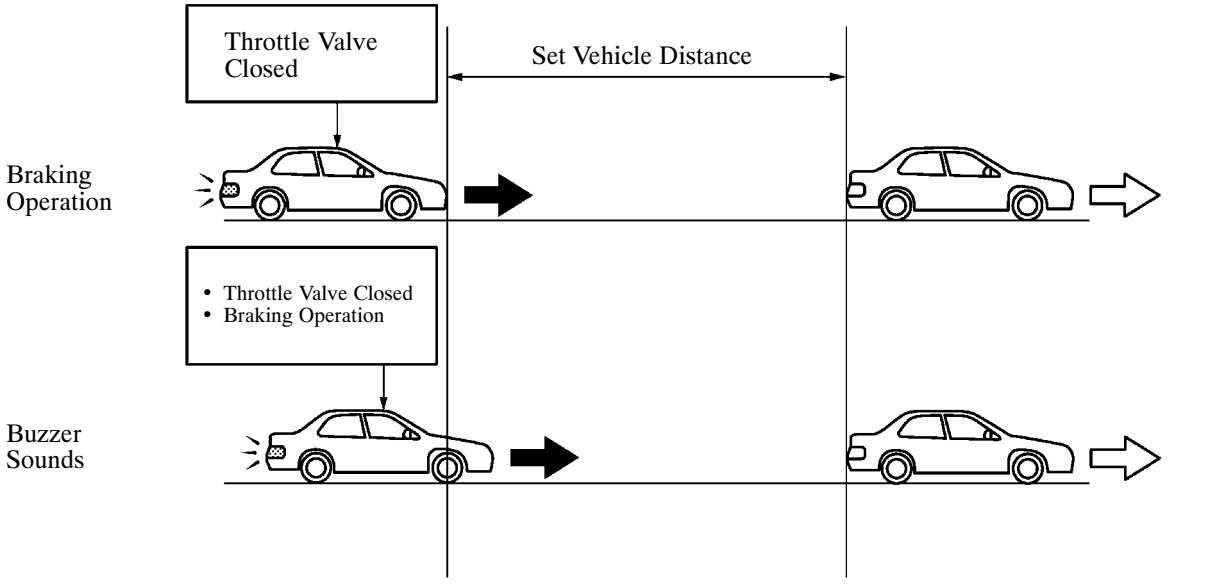
- HAC operates when all of the following conditions have been met:

HAC Operate Condition	• Shift lever position is D or S position. • The brake pedal is not pressed. • The Skid Control ECU has detected the backward movement of the vehicle when the driver is starting off on a hill.

8. Outline of Brake Control (During Operation of Dynamic Radar Cruise Control System)*

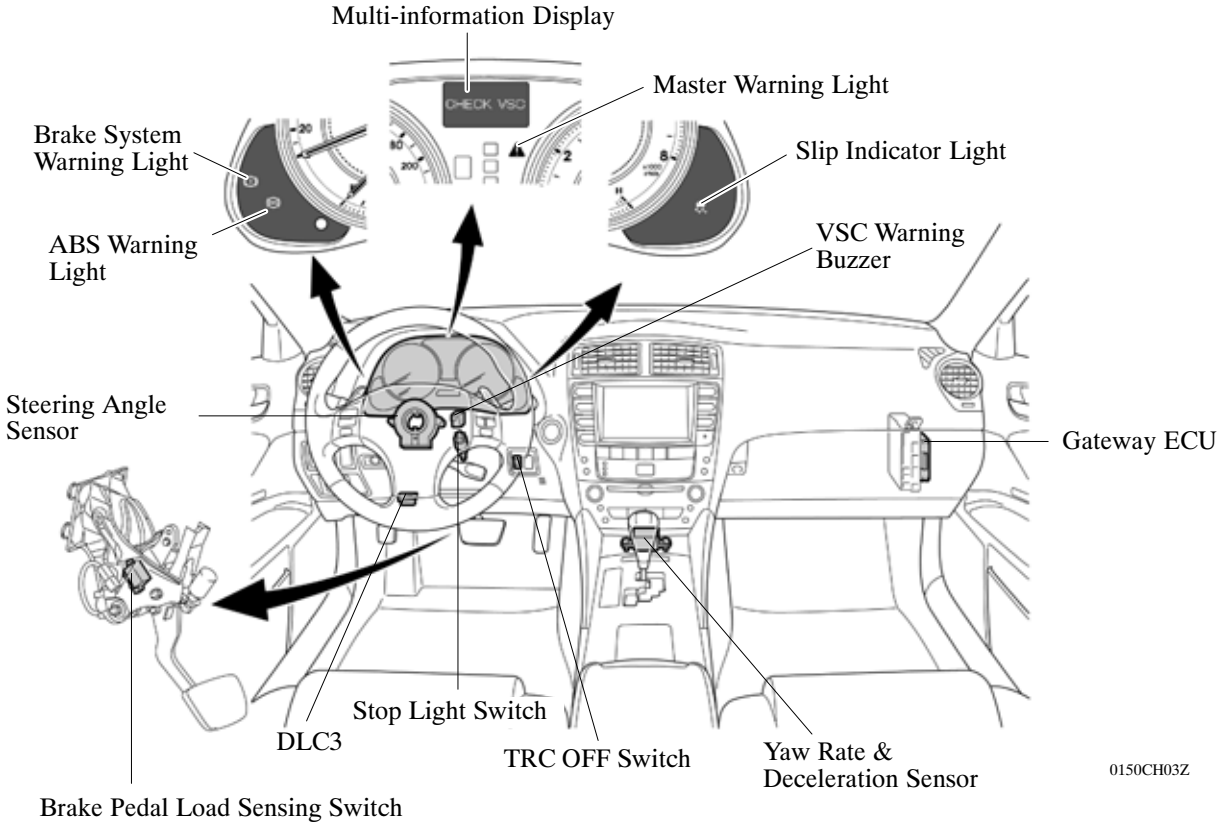
During dynamic radar cruise control system operation, if the distance to the vehicle being driven ahead is reduced, and if a sufficient deceleration cannot be attained by fully closing the throttle valve, the Skid Control ECU activates the brake actuator to apply the brakes according to the Distance Control ECU's request. As a result, the stoplights illuminate.
If further deceleration is required, the system sounds a VSC warning buzzer to alert the driver to apply the brakes. This warning buzzer is the same buzzer that the VSC system uses.

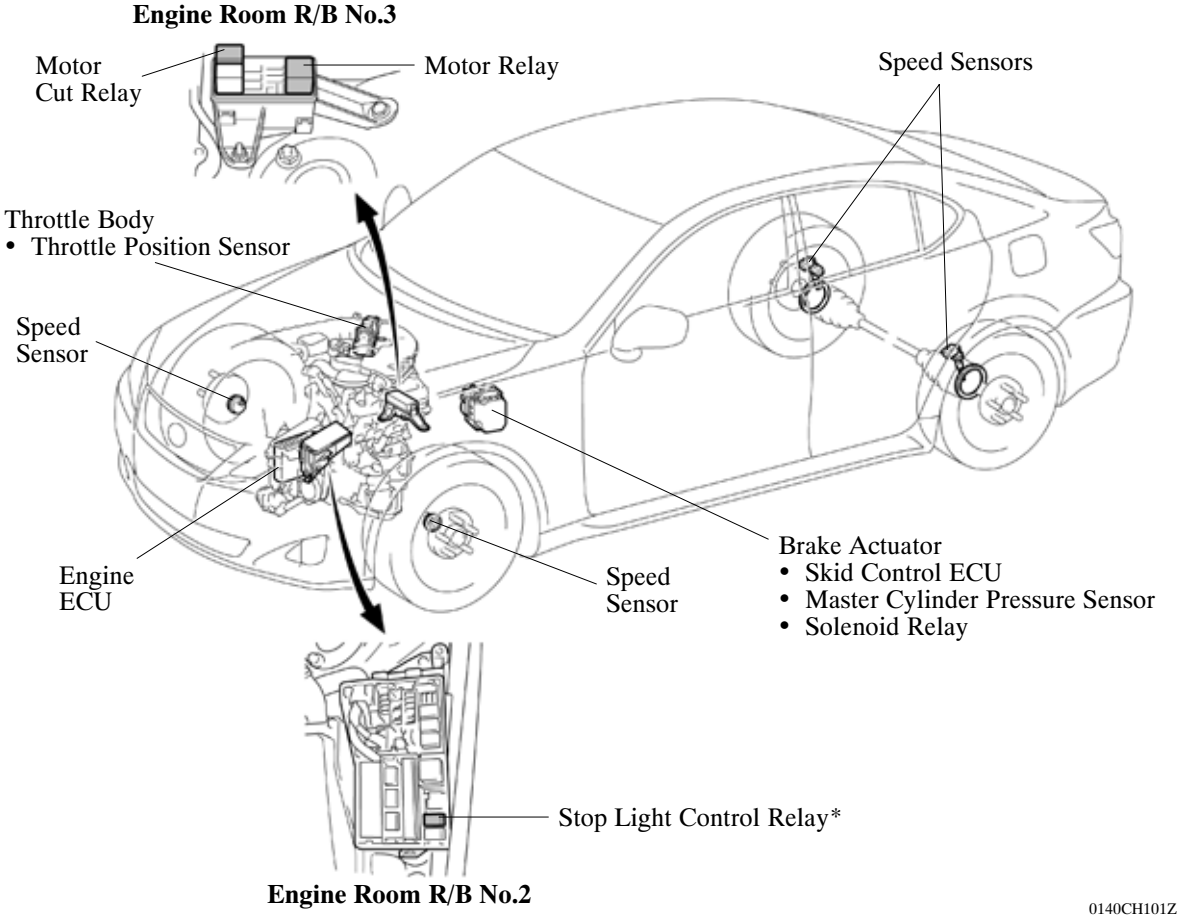
*: With Dynamic Radar Cruise Control System



189CH71

9. Layout of Main Component





*: A/T Model and With Dynamic Radar Cruise Control System

10. Function of Main Component

Component		Function
Combination Meter	ABS Warning Light	Lights up to alert the driver when the Skid Control ECU detects the malfunction in the ABS, EBD or Brake Assist system.
	Slip Indicator Light	• Blinks to inform the driver when the TRC system, VSC system or the HAC system is operated. • Light up to inform the driver when the TRC system is turned off using the TRC OFF switch.
	Brake System Warning Light	• Lights up together with the ABS warning light to alert the driver when the Skid Control ECU detects a malfunction in the EBD control or when a malfunction occurs in the brake booster. • Lights up to alert the driver when the brake fluid level is low. • Lights up to alert the driver when the parking brake pedal is depressed.
	Master Warning Light	Illuminates to alert the driver when the Skid Control ECU detects the malfunction in the TRC or VSC system.
	Multi-information Display	Displays a warning message "CHECK VSC" to alert the driver when the Skid Control ECU detects a malfunction in the TRC or VSC system.
Engine ECU		• Sends the throttle valve angle signal, accelerator pedal position signal, engine speed signal, and intake air temp. signal to the Skid Control ECU. • Receives an engine output adjustment command signal from the skid control ECU. Based on this signal, the Engine ECU operates the throttle valve to control engine output.
Brake Pedal Load Sensing Switch		Detects the brake pedal depressing force.
TRC OFF Switch		Cancels the TRC operation only: it does not apply to other systems.
Speed Sensors		Detects the wheel speed of all 4 wheels.
Parking Brake Switch		Detects parking brake pedal application.
Stop Light Switch		Detects brake pedal application.
Neutral Start Switch		Detects the "D" position.
Stop Light Control Relay*1		Turn on the stop light during HAC or dynamic radar cruise control system operation.
VSC Warning Buzzer		Emits an intermittent sound to inform the driver that the Skid Control ECU detects a strong front skid tendency or a strong rear skid tendency.
Brake Actuator		Changes the fluid path based on the signals from the Skid Control ECU during the operation of the ABS with EBD, Brake Assist, TRAC, VSC & HAC system, in order to control the fluid pressure that is applied to the brakes for the different wheels.
	Master Cylinder Pressure Sensor	Located in the brake actuator, it detects the master cylinder pressure.
	Skid Control ECU	• Judges the vehicle operating conditions based on signals from different sensors, and sends brake control signals to the brake actuator. • Judges the vehicle operating conditions based on signals from different sensors, and calculates the amount of engine output adjustment required. The Skid Control ECU transmits command signals to the Engine ECU.
	Solenoid Relay	Supply power to the solenoid valves.
AFS ECU		Receives front speed sensor signals that are output from the Skid Control ECU.

*1: A/T Model and With Dynamic Radar Cruise Control System

(Continued)

Component	Function
Distance Control ECU*2	Transmits a signal to the Skid Control ECU via the Engine ECU, in order to activate brake control when the Distance Control ECU has determined that the distance to the vehicle being driven ahead has been shortened based on the signals from the millimeter wave radar sensor.
Millimeter Wave Radar Sensor*2	Emits millimeter waves forward, and uses the reflected millimeter waves to measure the distance and the direction of the object in front, as well as to calculate the relative speed.
Yaw Rate & Deceleration Sensor	• Detects the vehicle's yaw rate. • Detects the vehicle's longitudinal and lateral acceleration.
Steering Angle Sensor	Detects the steering direction and angle of the steering wheel.
Motor Relay	Supplies power to the pump motor in the brake actuator.
Motor Cut Relay	Cuts the power to the pump motor in the brake actuator.

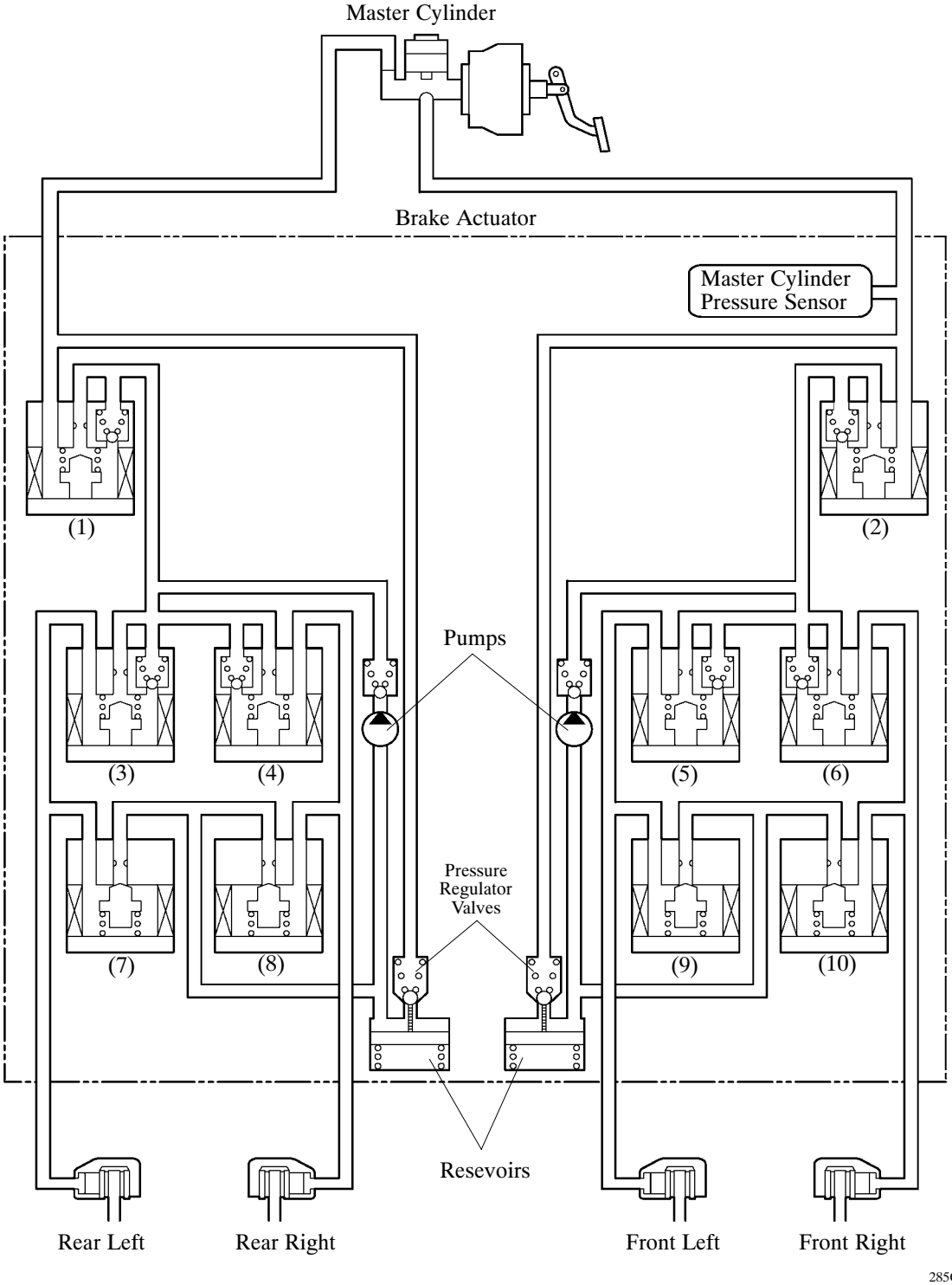
*2: With Dynamic Radar Cruise Control System

11. Brake Actuator

The brake actuator consists of the actuator, Skid Control ECU, solenoid relay, pump motor, and master cylinder pressure sensor.

- The actuator portion consists of ten solenoid valves, two pressure regulator valves, two pump, two reservoirs, and master cylinder pressure sensor.
- The ten solenoid valves consist of two master cylinder cut solenoid valves [(1), (2)], four pressure holding solenoid valves [(3), (4), (5), (6)], and four pressure reduction solenoid valves [(7), (8), (9), (10)].

▶ Hydraulic Circuit ◀

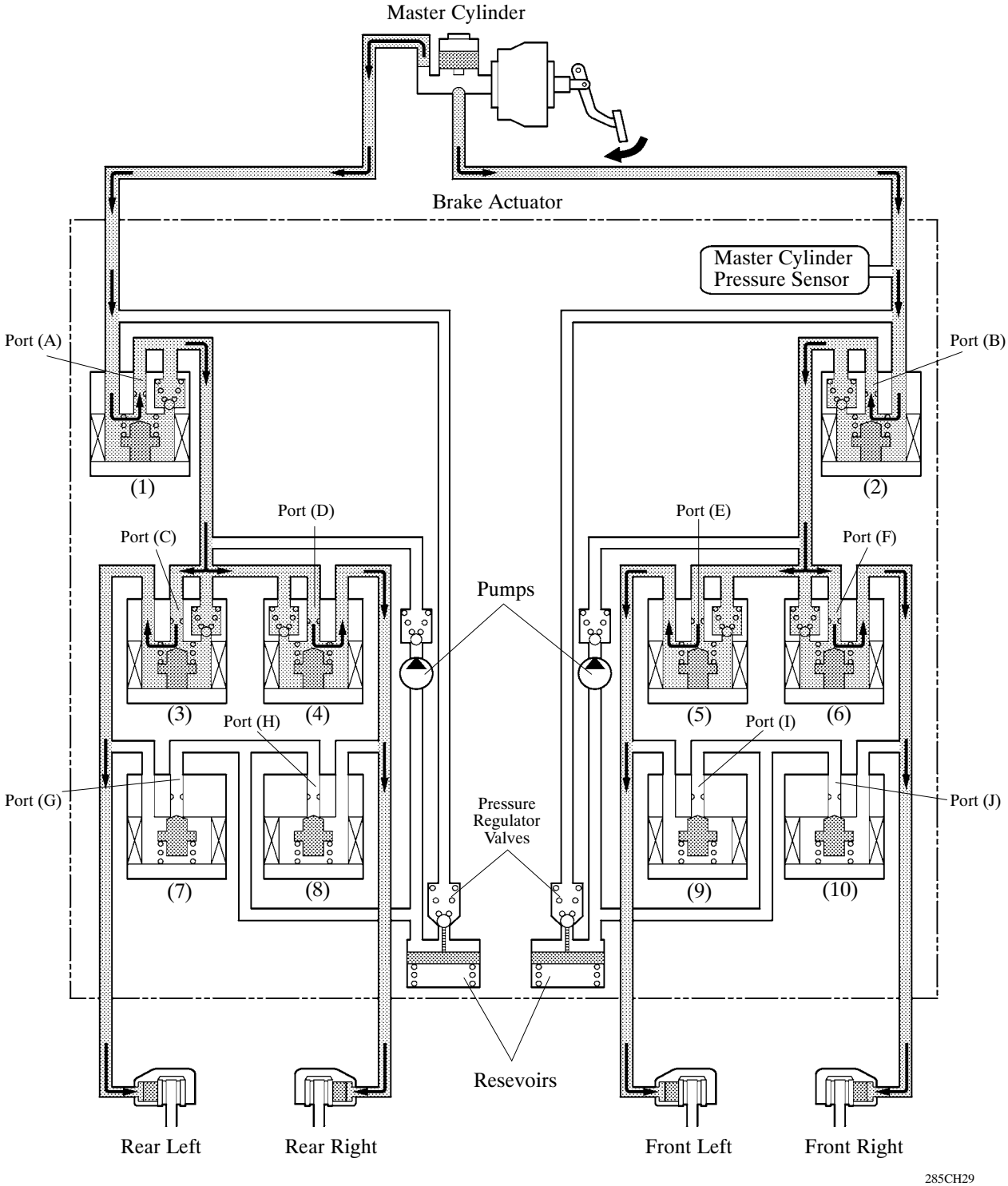


285CH28

12. System Operation

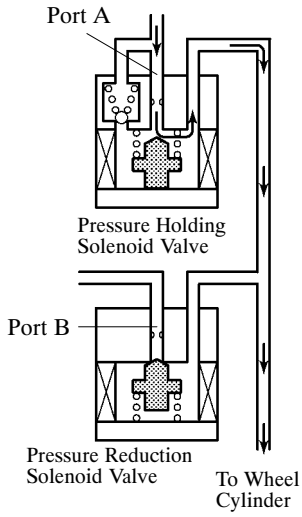
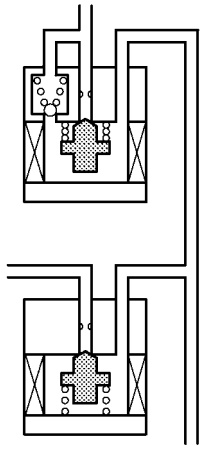
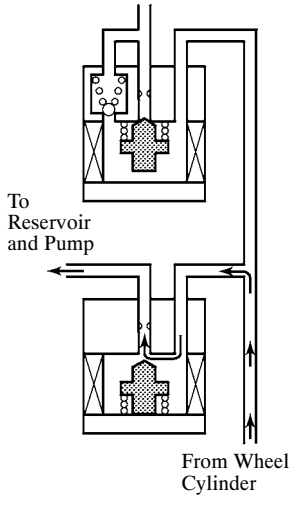
Normal Braking Operation

During normal braking, all solenoid valves remain OFF.



ABS with 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 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.

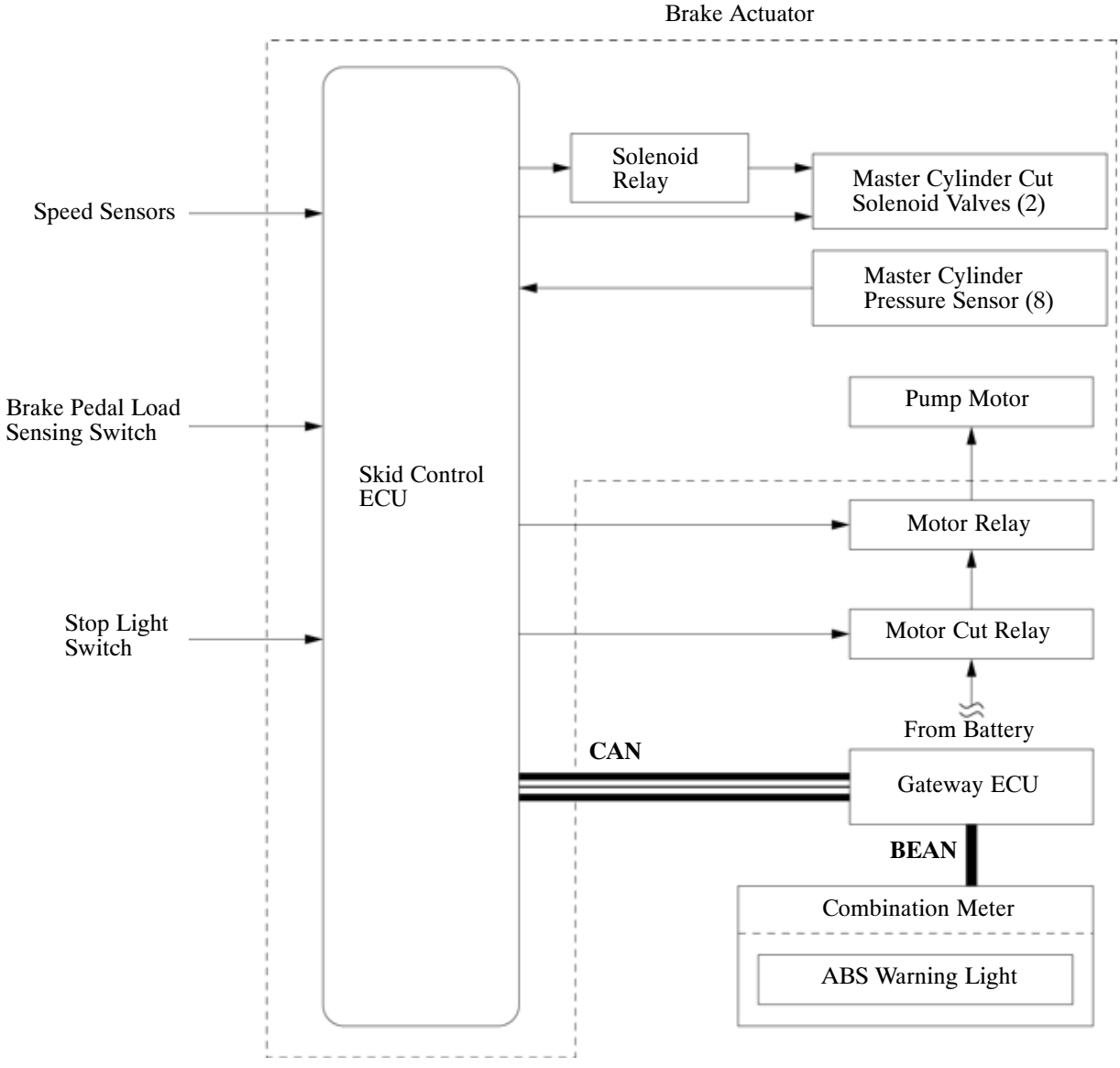
Not Activated	Normal Braking	—	—
Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Hydraulic Circuit			
Pressure Holding Valve (Port A)	OFF/Open	ON/Closed	ON/Closed
Pressure Reduction Valve (Port B)	OFF/Closed	OFF/Closed	ON/Open
Pressure	Increase	Hold	Reduce

Brake Assist Operation

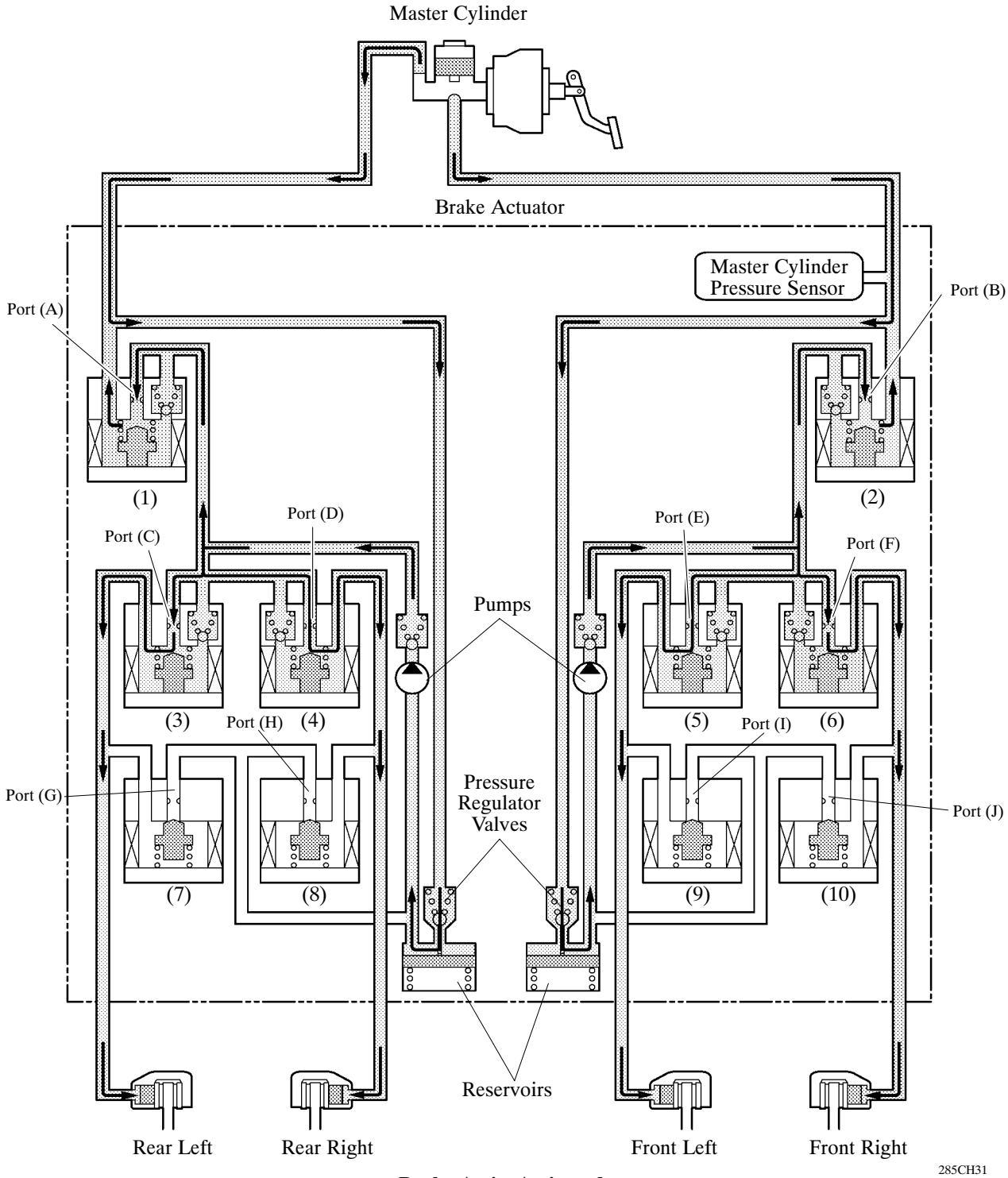
In the event of emergency braking, the Skid Control ECU detects the driver's intention based on the speed of the pressure increase in the master cylinder which is based on the master cylinder pressure sensor signals. If the ECU judges the need for additional Brake Assist, pressure is generated by the pump in the brake actuator and directed to the brakes to apply a greater fluid pressure than is present in the master cylinder. Also, in the following cases, the system provides Brake Assist.

- When greater braking force is needed than normal, such as when the vehicle is fully loaded or driving downhill, etc., the Skid Control ECU judges the need for Brake Assist using the master cylinder pressure sensor.
- In the event of a brake booster failure, the skid control ECU judges the failure using the brake load sensing switch and master cylinder pressure sensor signals.

▶ System Diagram ◀



0140CH104C



Brake Assist Activated

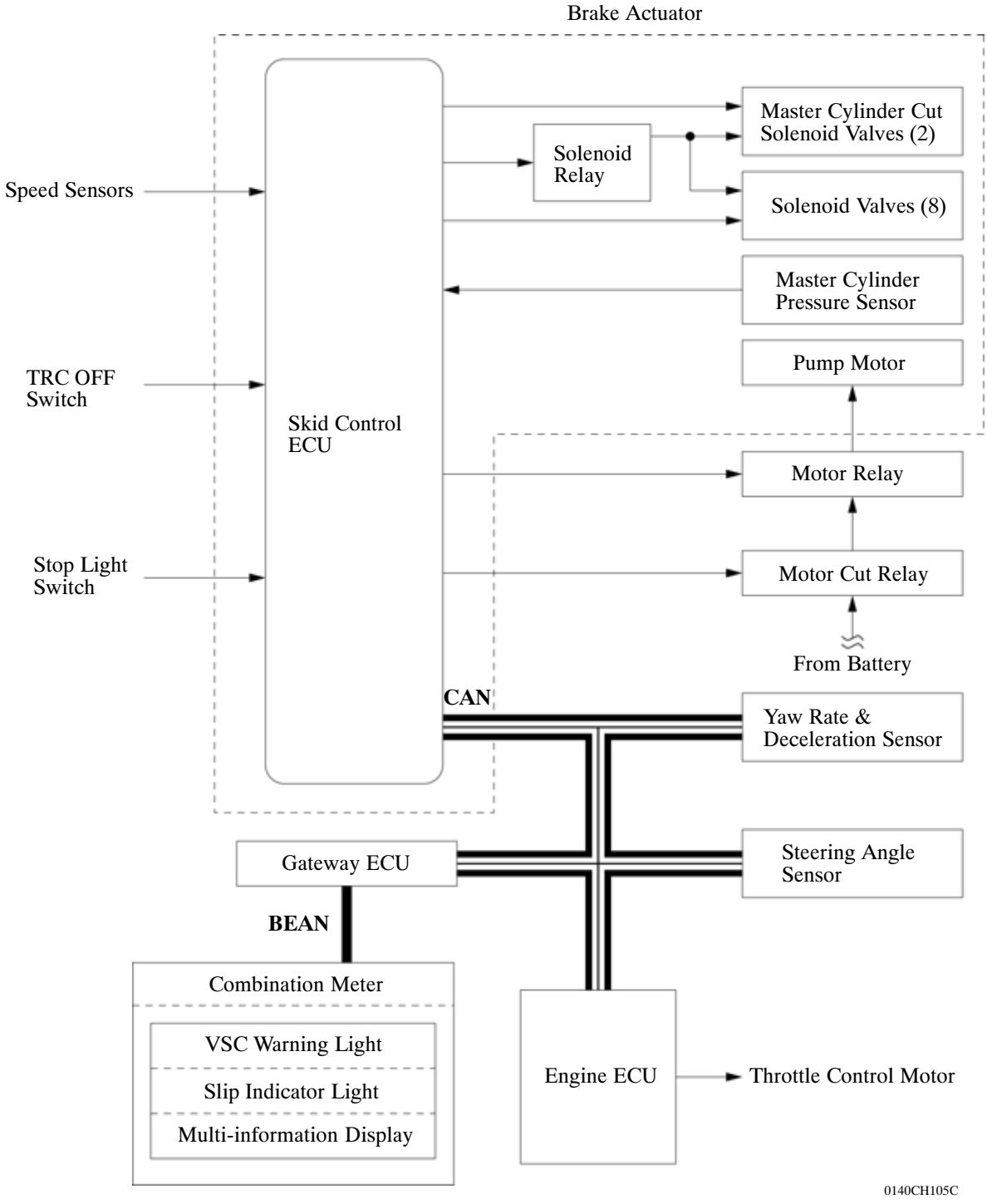
Item		Brake Assist Not Activated	Brake Assist Activated
(1), (2)	Master Cylinder Cut Solenoid Valve	OFF/Open	ON*
	Port: (A), (B)		
(3), (4), (5), (6)	Pressure Holding Solenoid Valve	OFF/Open	←
	Port: (C), (D), (E), (F)		
(7), (8), (9), (10)	Pressure Reduction Solenoid Valve	OFF/Closed	←
	Port: (G), (H),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

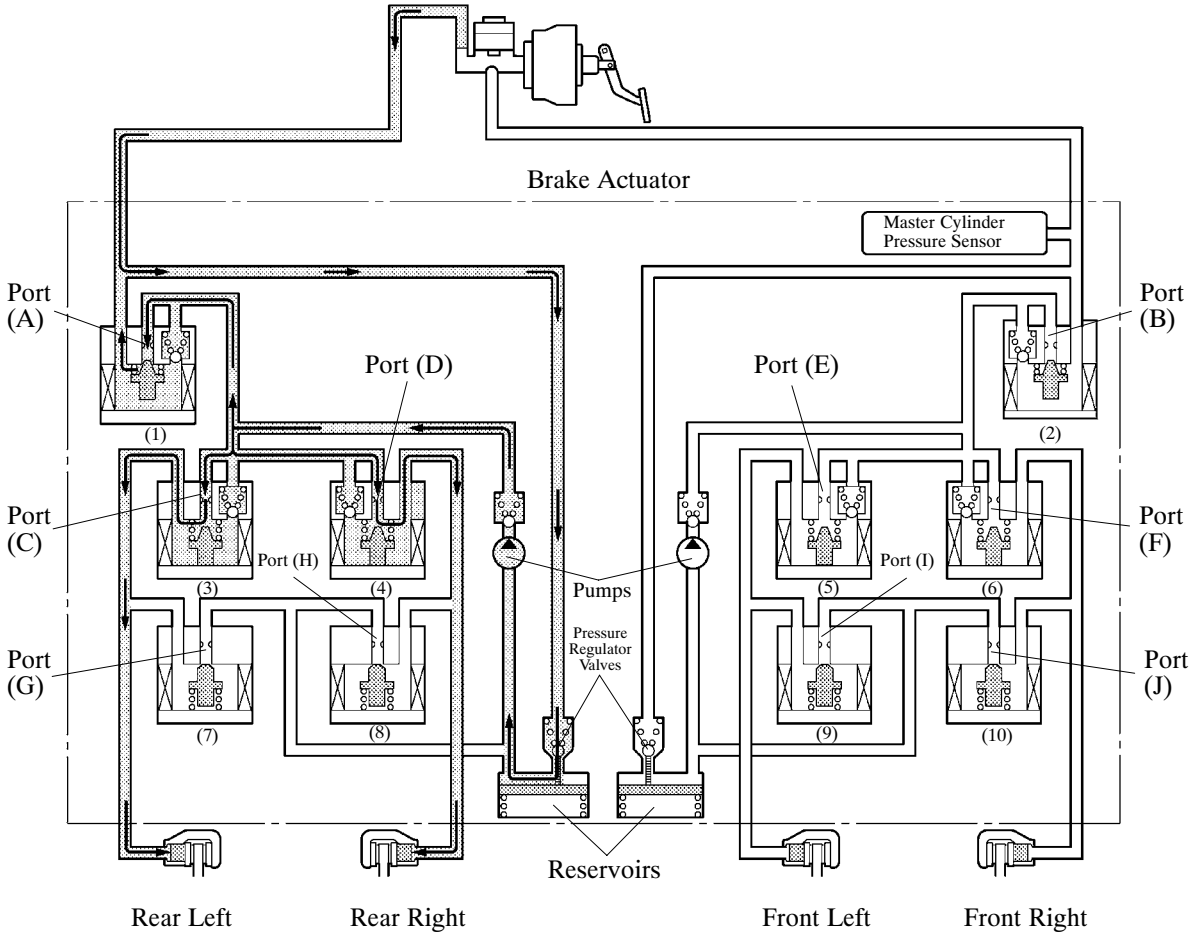
*: The solenoid valves control the hydraulic pressure by cycling continually between "open" and "closed" according to the operating conditions.

TRC Operation

The fluid pressure generated by the pump is regulated by the master cylinder cut solenoid valve to achieve the required pressure. Thus, the brakes for the drive wheels are controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes, to control 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 solenoid valve and the pressure reduction solenoid valve are turned ON/OFF according to the ABS operation pattern described on the previous page.

▶ System Diagram ◀





Pressure Increase Mode

0140CH106Y

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

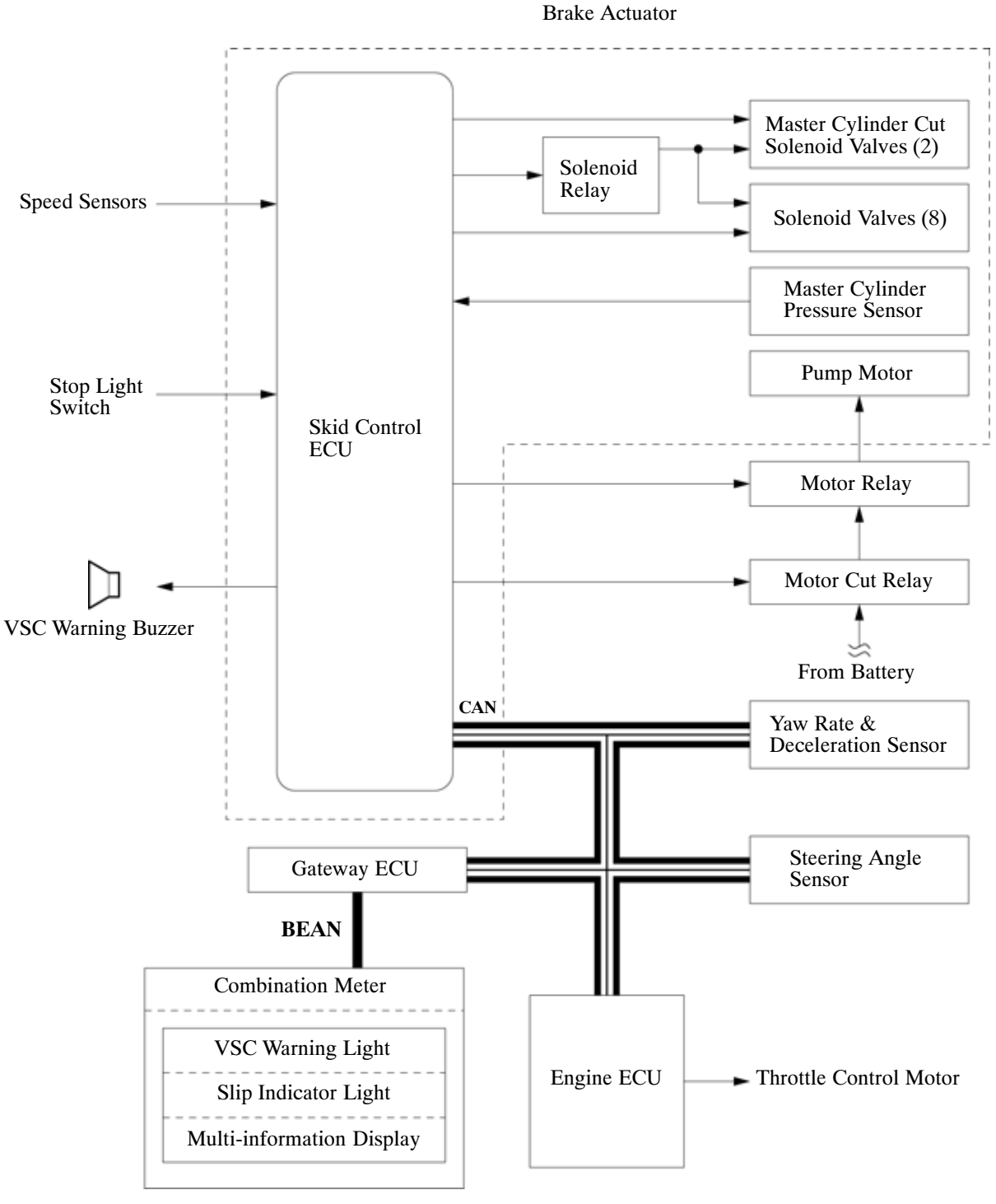
*: The solenoid valves control the hydraulic pressure by cycling continually between “open” and “closed” according to the operating conditions.

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 of the vehicle to experience a front wheel skid or rear wheel skid is controlled.

▶ System Diagram ◀

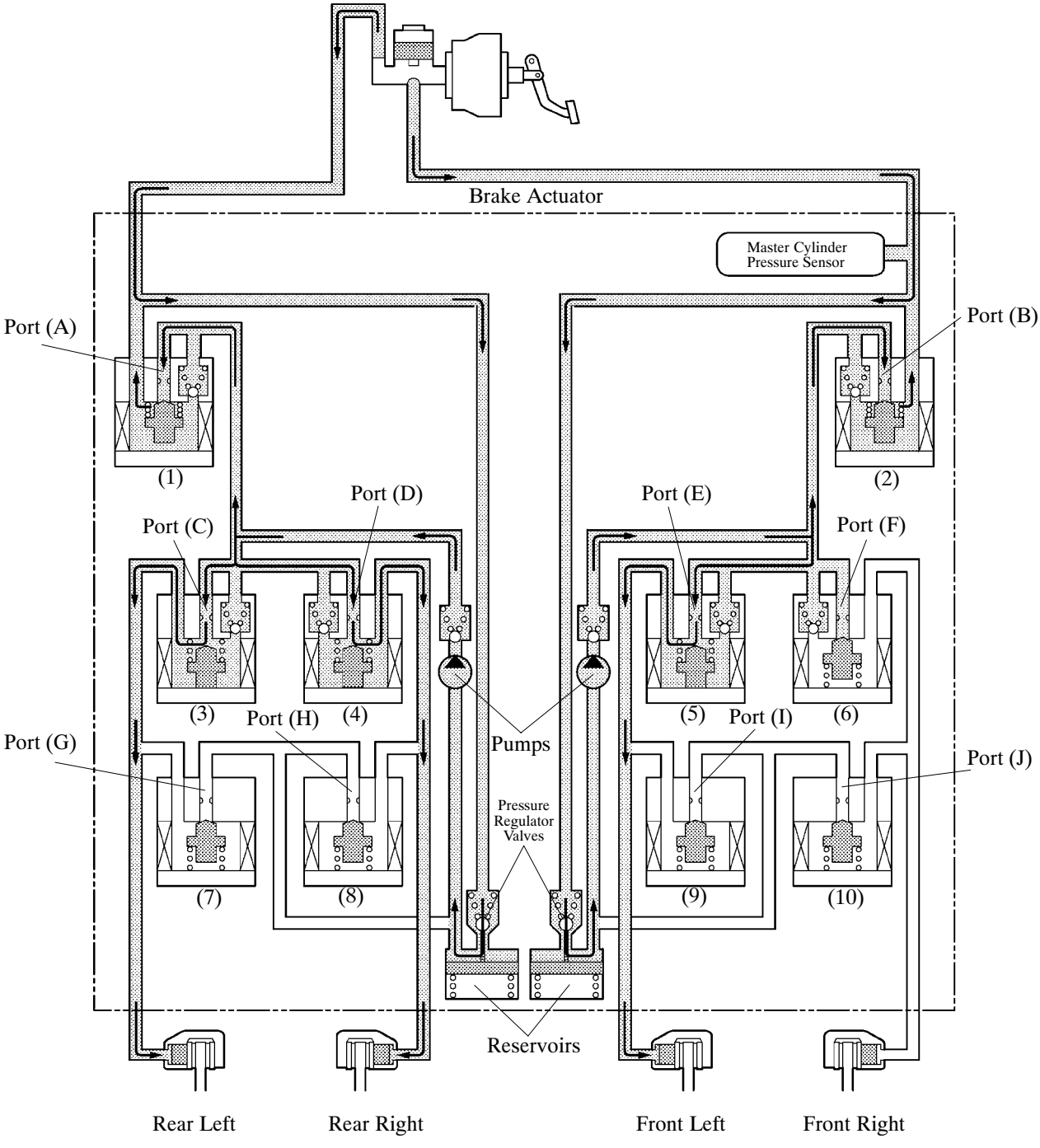


0140CH108C

2) Front Wheel Skid Restraining Control (Right Turn)

For the front wheel skid restraining control, the brakes of the front wheel of the outer side of the turn and the rear wheels 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.
- In other operating modes, the pressure holding valve and the pressure reduction valve are turned ON/OFF according to the ABS with EBD operation pattern.



Pressure Increase Mode

0140CH109Y

CH

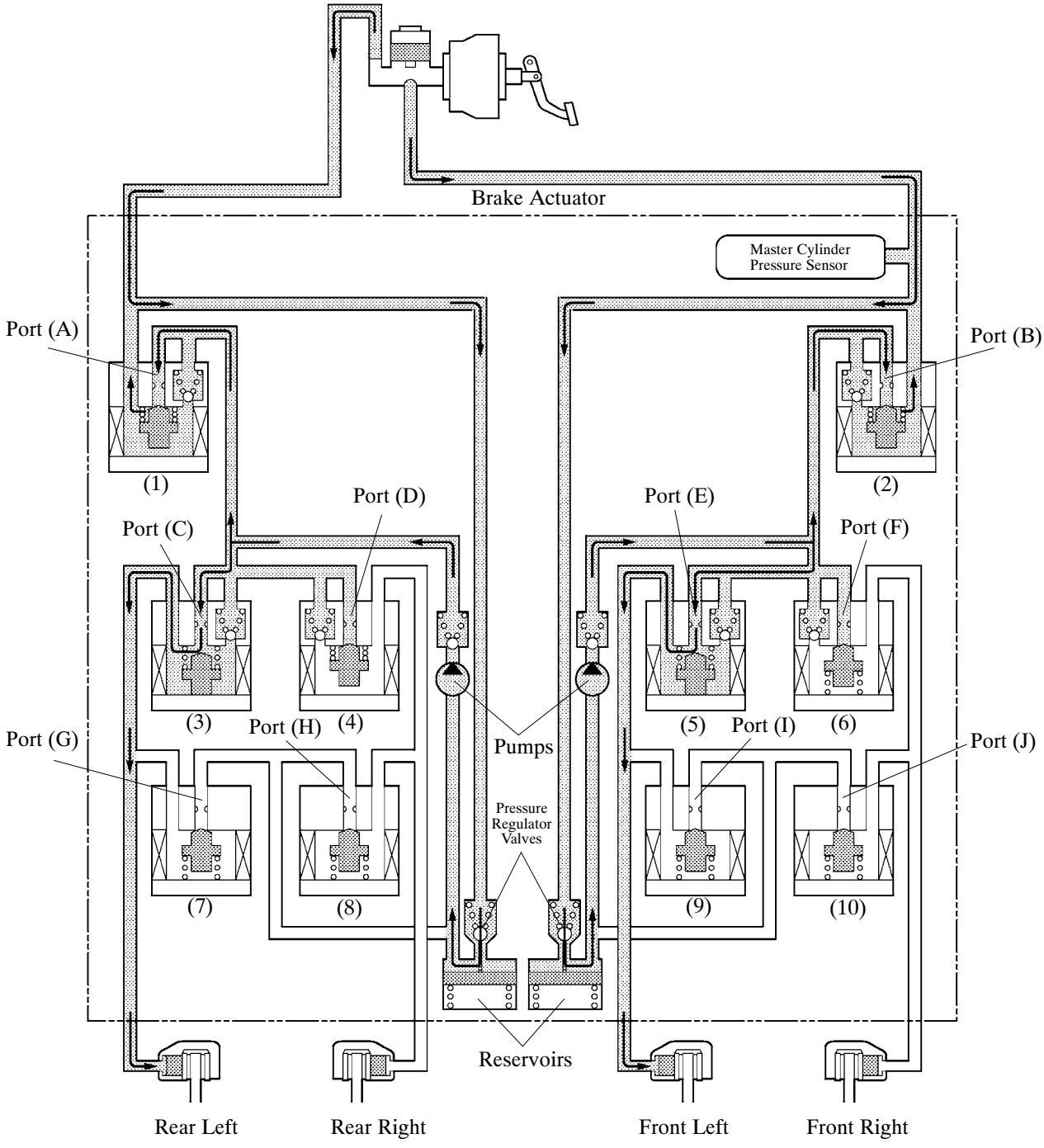
Item			VSC Not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF/Open	ON*	←	←
	Port: (A), (B)					
Front Brake	(5)	Pressure Holding Valve	OFF/Open	←	ON/Closed	←
		Port: (E)				
	(6)	Pressure Holding Valve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

*: The solenoid valves control the hydraulic pressure by cycling continually between "open" and "closed" according to the operating conditions.

3) Rear Wheel Skid Restraining Control (Right Turn)

For the rear wheel skid restraining control, the brake of the front and rear wheels of the outer side 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 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 with EBD operation pattern.



Pressure Increase Mode

0140CH110Y

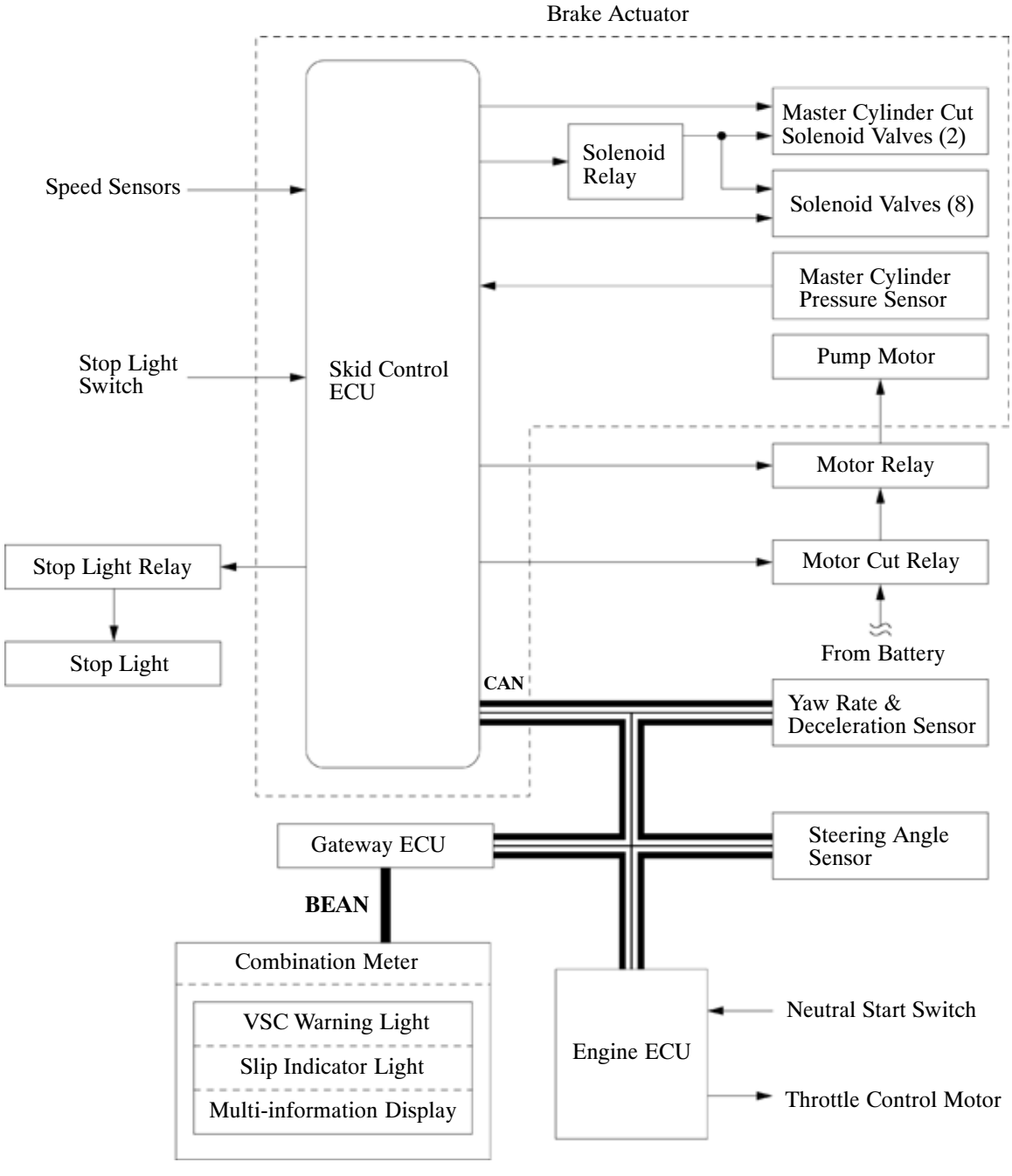
Item			VSC Not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF/Open	ON*	←	←
	Port: (A), (B)					
Front Brake	(5)	Pressure Holding Valve	OFF/Open	←	ON/Closed	←
		Port: (E)				
	(6)	Pressure Holding Valve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

*: The solenoid valves control the hydraulic pressure by cycling continually between "open" and "closed" according to the operating conditions.

HAC Operation

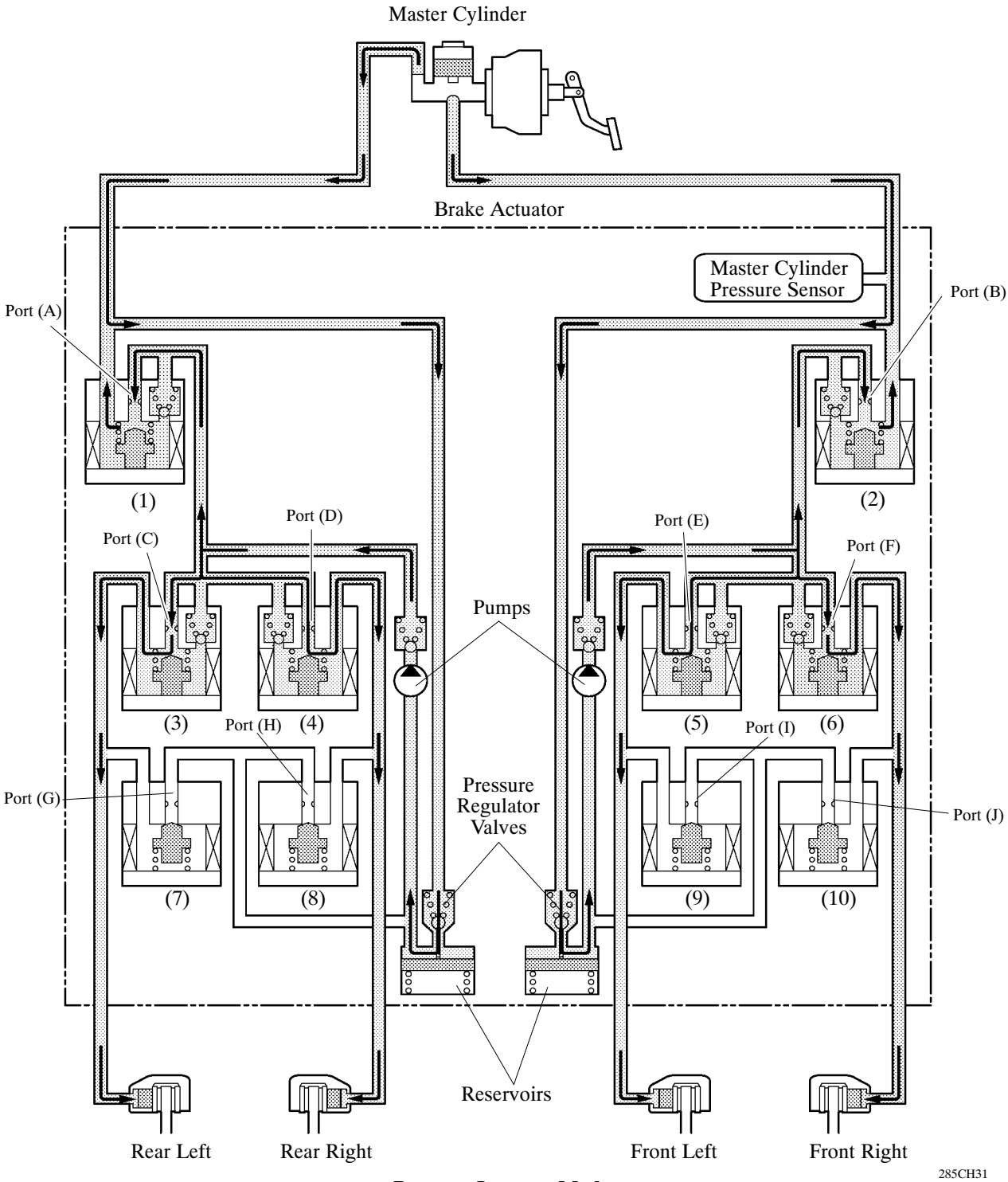
- For HAC operation, the hydraulic pressure generated by the pump is distributed to the wheel cylinders in order to apply the brakes. Thus, this operation reduces the ability of the vehicle to roll backward while HAC operation is being performed.
- The system controls the hydraulic pressure to the brakes by changing the hydraulic paths to the brakes at each wheel in the following modes: pressure reduction, pressure holding, and pressure increase modes.
- The operating conditions of the valves and the flow of the brake fluid during the pressure increase mode of the HAC operation are described on the next page.
- The pressure holding valves and the pressure reduction valves are turned ON/OFF according to the ABS with EBD operation pattern described on the previous page.

▶ System Diagram ◀



0140CH111C

CH



Pressure Increase Mode

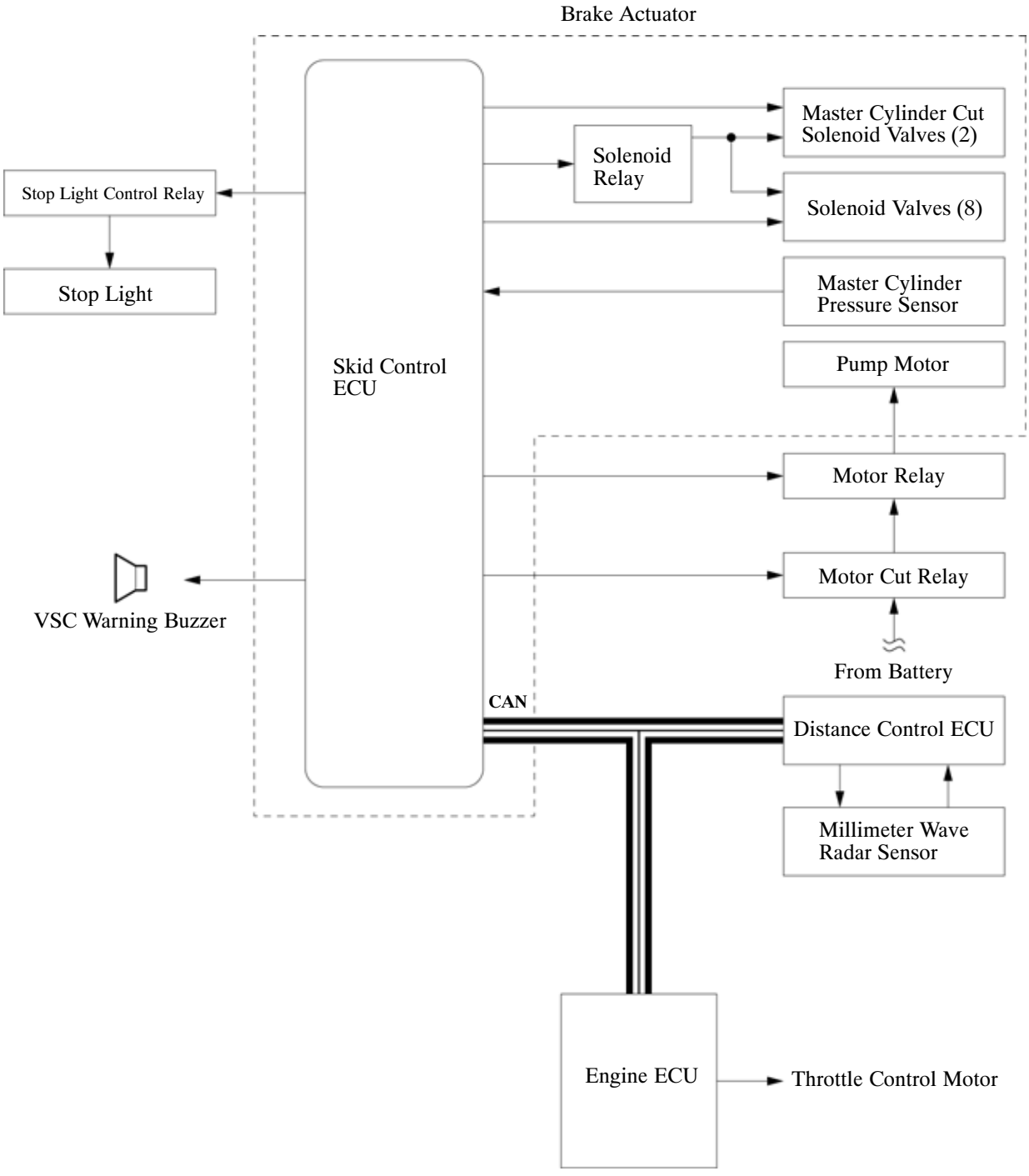
Item			HAC Not Activated	HAC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF/Open	ON*	←	←
	Port: (A), (B)					
Front Brake	(5), (6)	Pressure Holding Valve	OFF/Open	←	ON/Closed	←
		Port: (E), (F)				
	(9), (10)	Pressure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

*: The solenoid valves control the hydraulic pressure by cycling continually between “open” and “closed” according to the operating conditions.

Brake Control Operation (During Operation of Dynamic Radar Cruise Control System)*

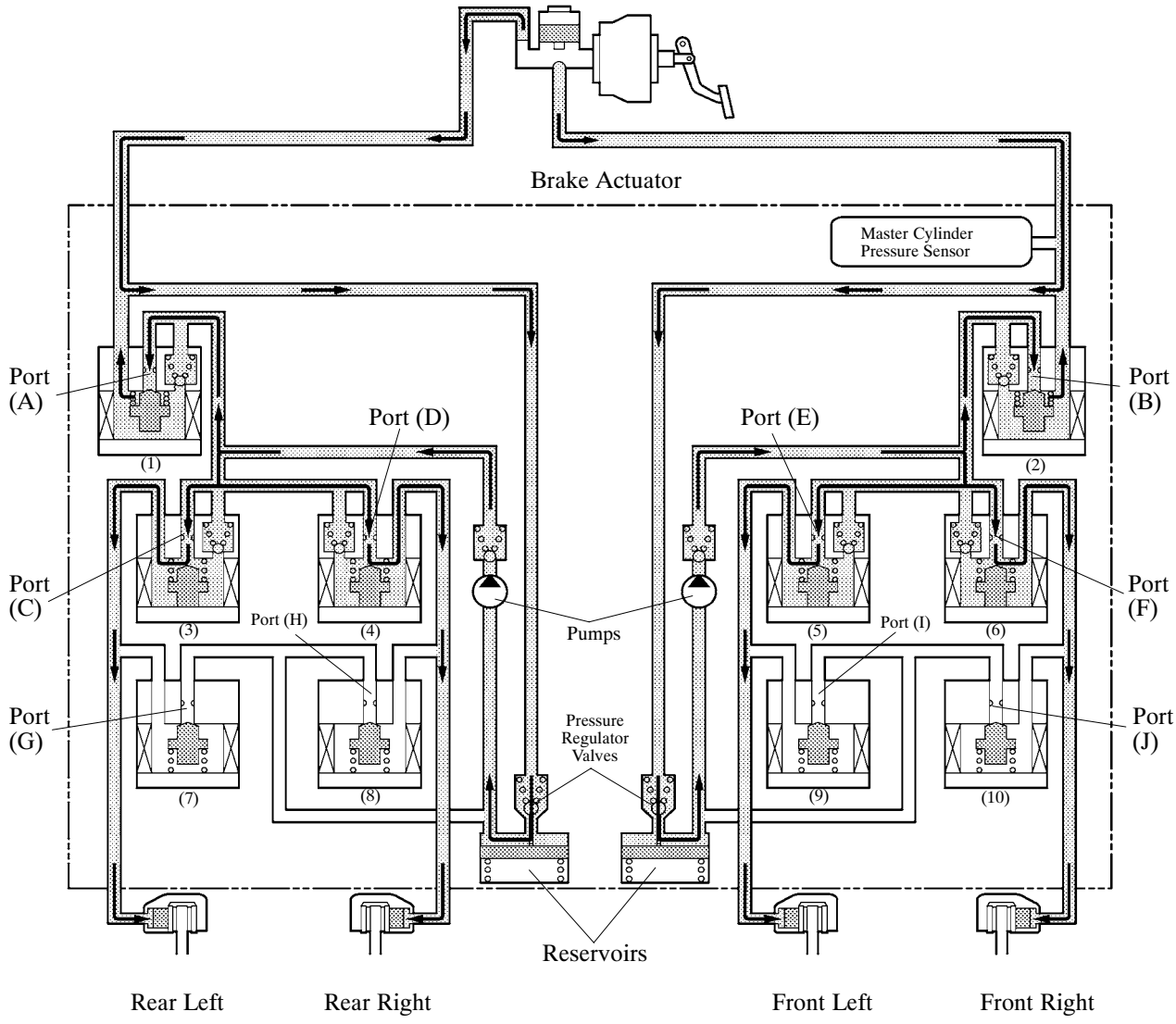
The fluid pressure that is generated by the pump in the brake actuator is directed to the brakes.

▶ System Diagram ◀



*: With Dynamic Radar Cruise Control System

0140CH112C



Brake Control Actuated

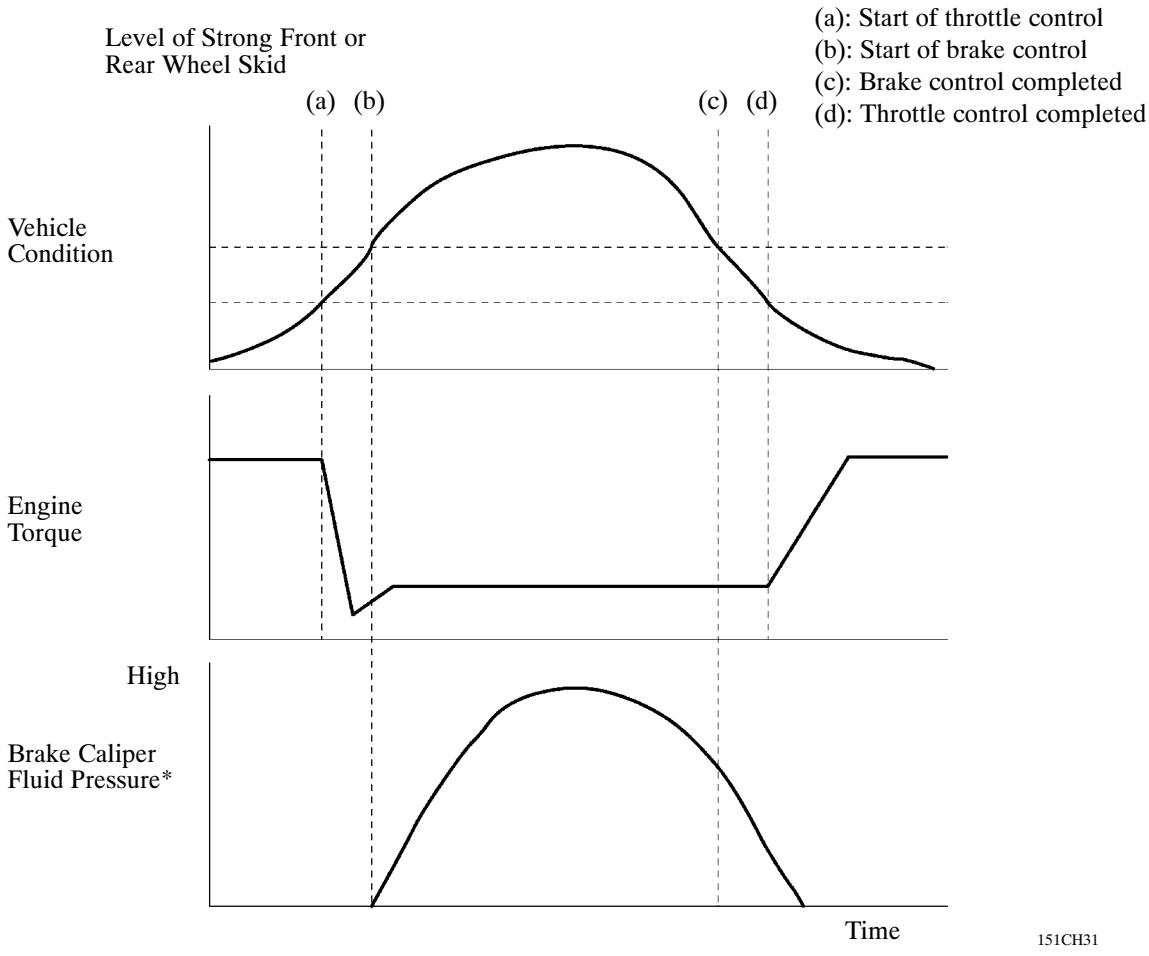
285CH38

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

*: The solenoid valves control the hydraulic pressure by cycling continually between "open" and "closed" according to the operating conditions.

Engine Output Control

During a TRC, VSC or Brake Control operation, the Skid Control ECU outputs a engine output control request signal to the Engine ECU. Upon receiving this signal, the Engine ECU effects throttle control to regulate the engine output.



*: The caliper that activates varies depending on the driving conditions experienced by the vehicle.

Initial Check

Each time the power source is IG ON, and the vehicle reaches a speed of approximately 6 km/h (4 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.

13. CAN (Controller Area Network)

CAN communication is used between the Skid Control ECU, steering angle sensor, yaw rate & deceleration sensor, Engine ECU, Gateway ECU, Distance Control ECU and DLC3. For details on CAN communication, refer to page BE-7.

14. Diagnosis

General

If the Skid Control ECU detects a malfunction in the brake control system (ABS with EBD, Brake Assist, TRC, VSC and HAC), the ABS, brake system, master warning lights, slip indicator light and multi-information display that corresponds to the function for which the malfunction has been detected illuminates or indicates, as indicated in the table below, to alert the driver of the malfunction.

○: Illuminate △: Indicate

Item	ABS	EBD	Brake Assist	TRC	VSC	HAC
ABS Warning Light	○	○	○	—	—	—
Brake System Warning Light	—	○	—	—	—	—
Slip Indicator Light	—*	—*	—*	○	○	○
Master Warning Light	—*	—*	—*	○	○	○
Multi-information Display (Warning Massage “CHECK VSC”)  0140CH113C	—*	—*	—*	△	△	△

*: Failure in the ABS, EBD, and Brake Assist systems prohibits operation of the TRC, VSC, and HAC systems. Accordingly, the master warning lights and slip indicator light will be illuminated and the “CHECK VSC” message will appear on the multi-information display.

- At the same time, the DTCs (Diagnostic Trouble Codes) are stored in the memory. The DTCs can be read by connecting SST (09843-18040) between the Tc and CG terminals of the DLC3, and observing the blinking of the ABS warning light or observing the diagnostic code indicated on the multi-information display, or by connecting an intelligent tester II.
- This system has a sensor signal check (test mode) function. This function is activated by connecting the SST (09843-18040) between the Ts and CG terminals of the DLC3 or by connecting an intelligent tester II. The ABS warning light blinks at a 0.13-second intervals and “VSC TEST MODE” will appear on the multi-information display. This check function performs deceleration sensor check, yaw rate sensor check, master cylinder pressure sensor check, and speed sensor check.

Display example of the multi-information display

Normal system code is displayed

0140CH114C

DTC is displayed

0140CH115C

Test mode is activated

0140CH116C

- If the Skid Control ECU detects a malfunction during a sensor signal check (test mode), it stores the DTC in its memory. These DTCs can be read during a sensor check operation by connecting the SST (09843-18040) to the Tc and CG terminals of the DLC3 and observing the blinking of the ABS warning light or observing the diagnostic code indicated on the multi-information display, or connecting an intelligent tester II.

For details of the DTCs that are stored in Skid Control ECU memory and the DTCs that are output through the sensor signal check (test mode) functions, see the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

Service Tip

The Skid Control uses the CAN protocol for diagnostic communication. Therefore, an intelligent tester II is required for accessing diagnostic data. For details, see the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

Diagnosis of CAN

If a malfunction occurs on a CAN communication line, the Skid Control ECU is connected to CAN communication lines and it will store the DTCs (Diagnostic Trouble Codes) in its memory.

- There are 2-digit DTCs and 5-digit DTCs for CAN communication related to the brake control system (ABS with EBD, Brake Assist, TRC, VSC and HAC).
  - 2-digit DTCs can be read by connecting the SST (09843-18040) to Tc and CG terminals of the DLC3, and observing the diagnostic code indicated on the multi-information display in the combination meter.
  - 5-digit DTCs can be read by connecting an intelligent tester II to the DLC3.

Service Tip

The Skid Control ECU uses the CAN protocol for diagnostic communication. Therefore, an intelligent tester II is required for accessing diagnostic data. For details, see the LEXUS IS250 Repair Manual (Pub. No. RM0150E).

Fail-Safe

- In the event of a malfunction in the ABS and/or Brake Assist controls, the Skid Control ECU prohibits the ABS, Brake Assist, TRC, VSC and HAC operations.
- In the event of a malfunction in the EBD control, the Skid Control ECU prohibits the EBD operation. Even in this case, usual braking performance excluding the brake control system (ABS with EBD, Brake Assist, TRC, VSC and HAC) is secured.
- In the event of a malfunction in the TRC and/or VSC, the Skid Control ECU prohibits TRC and VSC operations.
- If a communication malfunction occurs between the Skid Control ECU, the steering angle sensor, the yaw rate & deceleration sensor or Engine ECU, the Skid Control ECU stops the TRC, VSC and HAC.
- When the Engine ECU detects an engine control the DTC, it will disable the TRC, VSC and HAC operations.