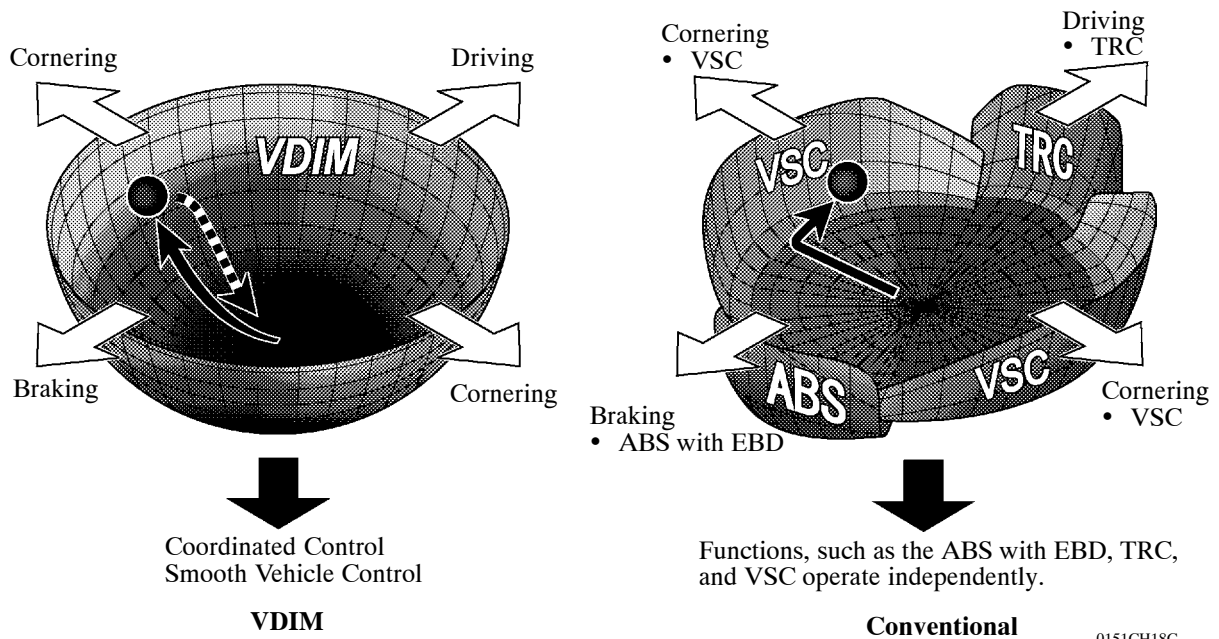


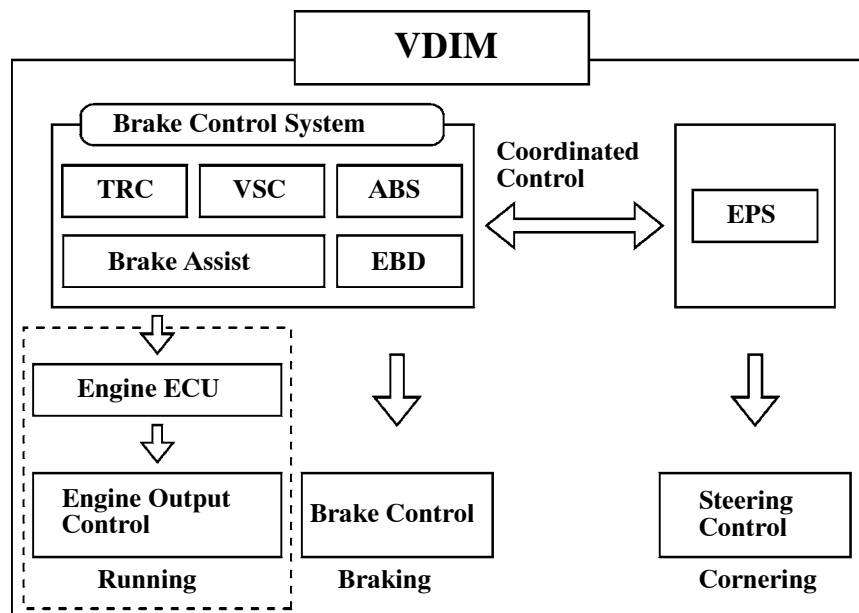
■ VDIM (VEHICLE DYNAMICS INTEGRATED MANAGEMENT)

1. General

- A new concept of vehicle motion control called VDIM (Vehicle Dynamics Integrated Management) is used, which integrates brake control, drive force control, and steering control.
- Conventional vehicles use a combination of independent functions such as the ABS, EBD, Brake Assist, TRC, VSC and EPS. In contrast, the VDIM integrates the operations of these systems to enhance the dynamic performance of the vehicle to “run, turn, and stop”.
- In the past, ABS, EBD, Brake Assist, TRC and VSC acted independently, control starts at the limit of vehicle running, cornering and stopping performance. VDIM, however, begins to control earlier in order to ensure that the vehicle does not exceed its behavioral limits.



- The VDIM system manages all functions, such as the ABS with EBD, Brake Assist, TRC and VSC. The Skid Control ECU coordinates all of these functions. In addition, steering coordination control and LSD functions are also available, thus this allowing the VDIM to perform comprehensive vehicle dynamics management.



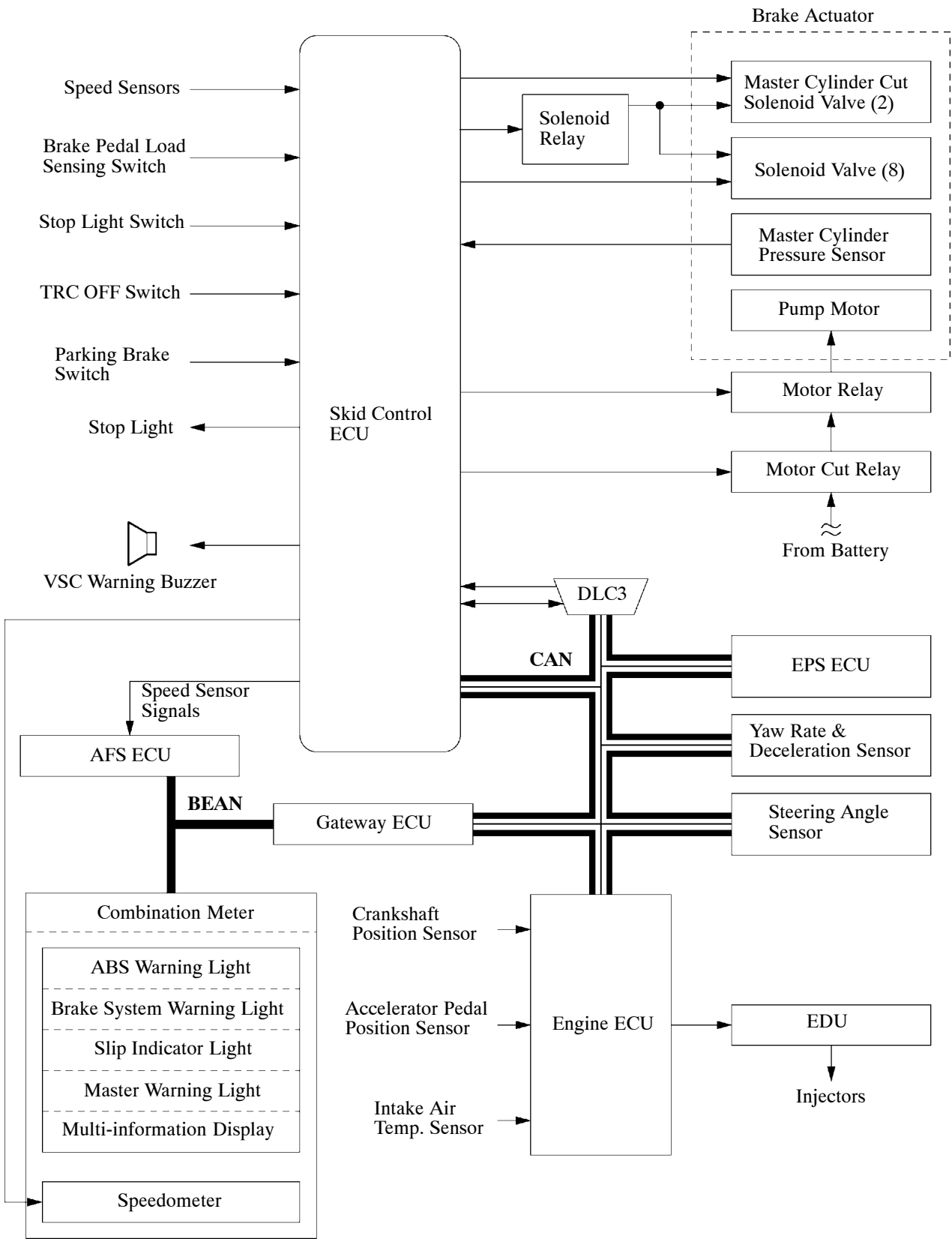
- The VDIM (Vehicle Dynamics Integrated Management) has the following functions:

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) [See page CH-80]	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 the right and left wheels, helping to maintain the vehicle behavior.
Brake Assist [See page CH-81]	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 enhance the vehicle's braking performance.
TRC (Traction Control)	The TRC system helps prevent the drive wheels from slipping if the driver presses the accelerator pedal excessively when initially accelerating, or accelerating on a slippery surface.
VSC (Vehicle Stability Control) [See page CH-83]	The VSC system helps prevent the vehicle from slipping sideways as a result of strong front or rear wheel skidding during cornering.
Steering Coordination Control	Controls of the VSC and EPS are coordinated to ensure drivability while driving the vehicle.
LSD (Limited Slip Differential) Function	The LSD function of the VDIM detects vehicle turning condition and wheel slippage. Then, brake force is applied to the inner wheel to limit slippage and to transmit power to the outer wheels, ensuring acceleration performance during a vehicle turn.

Service Tip

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

2. System Diagram

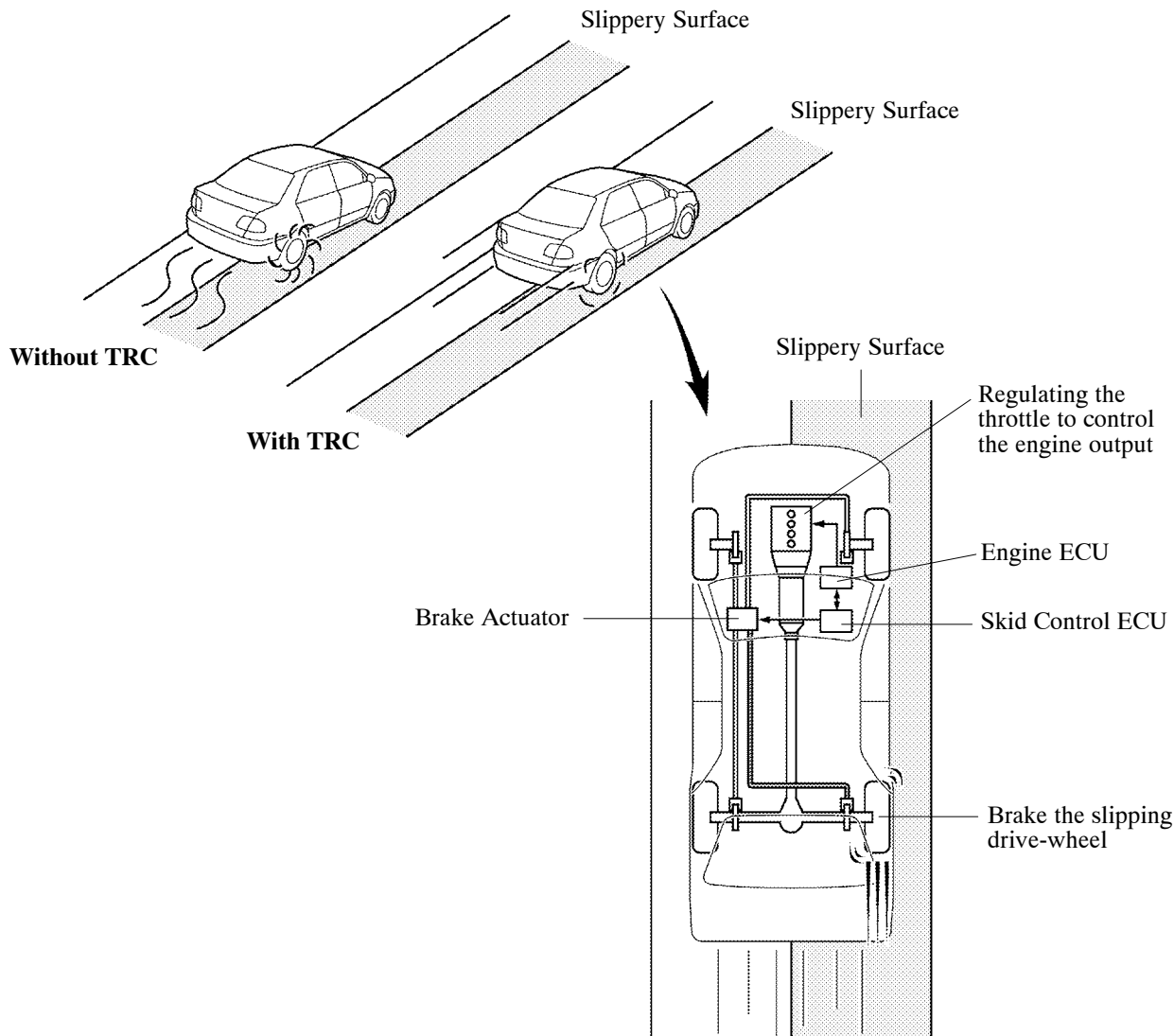


CH

3. Outline of TRC

- If the driver presses the accelerator pedal aggressively when initially accelerating or 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 to control the engine output. Thus, the TRC can constantly help the driver to maintain stability while accelerating.

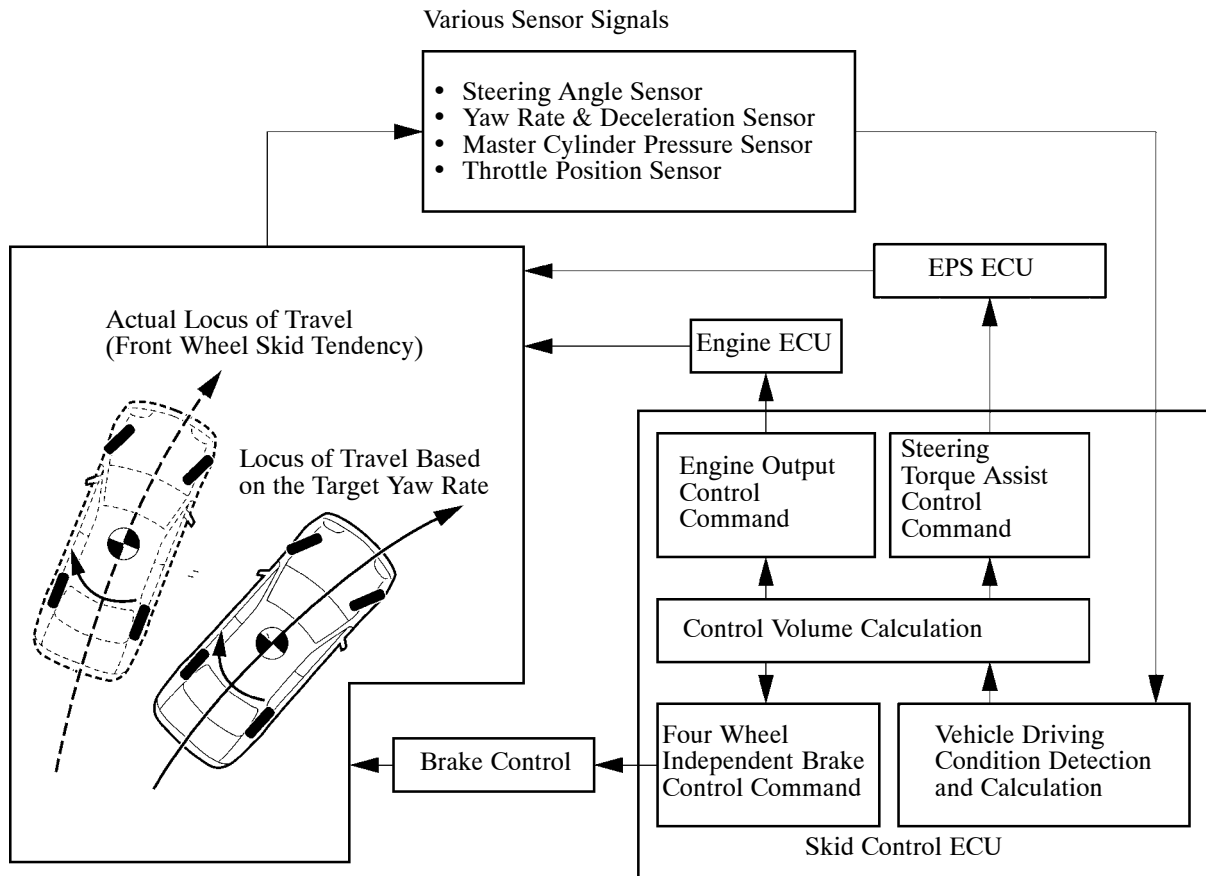
► Driving condition on road with different surface friction characteristics ◀



4. Outline of Steering Coordination Control

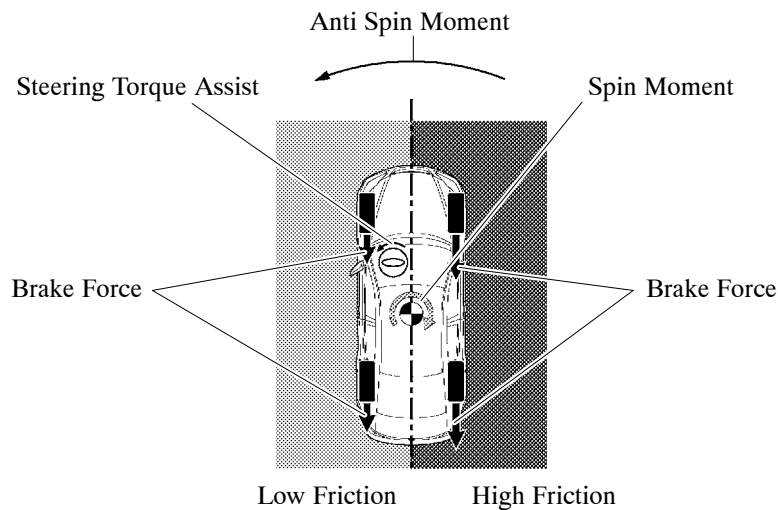
General

- The VDIM effects coordinated control consisting of VSC (Vehicle Stability Control) and EPS (Electric Power Steering). By integrating these preventive safety functions, the VDIM ensures excellent driving stability and maneuverability of the vehicle.
- The VDIM coordinates EPS and the brake control systems to perform braking control on split friction roads, rear wheel skid control and front wheel skid control.
- If the vehicle loses stability due to wheel slippage, this function effects brake control by applying brake pressure to the wheels. At the same time, the EPS provides steering torque assist control to facilitate the driver's steering maneuver.



Braking Control on Split Friction Roads

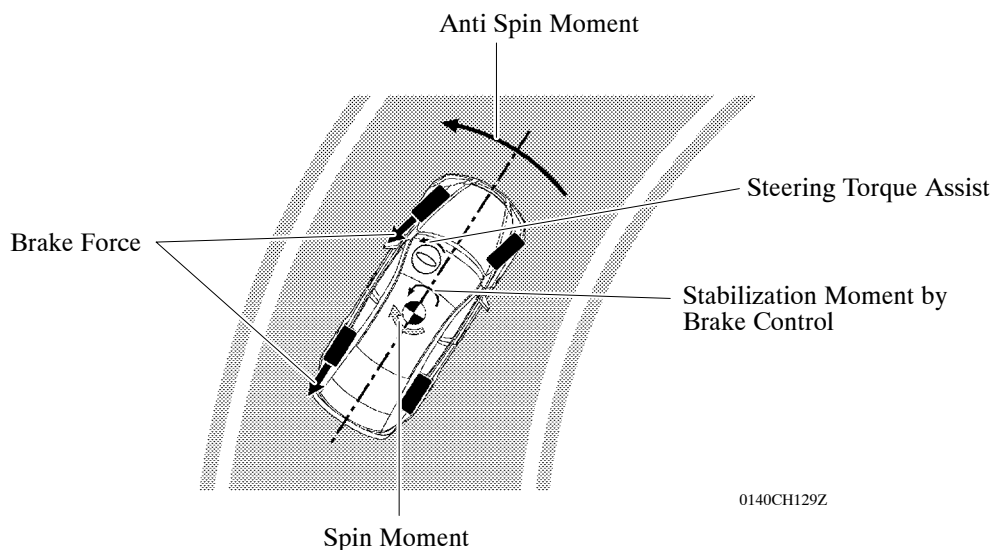
When braking on a split friction road, the vehicle tends to deflect toward the higher friction side due to the difference between the braking forces on the left and right sides. In the VDIM, the EPS ECU receives command signals from the Skid Control ECU. Based on these signals, the EPS ECU operates the motor for the electric power steering to reduce the effect of the difference between the braking forces on the left and right sides, assisting steering operation. This enables the driver to operate the steering wheel to make steering corrections easily.



0140CH128Z

Rear Wheel Skid Control

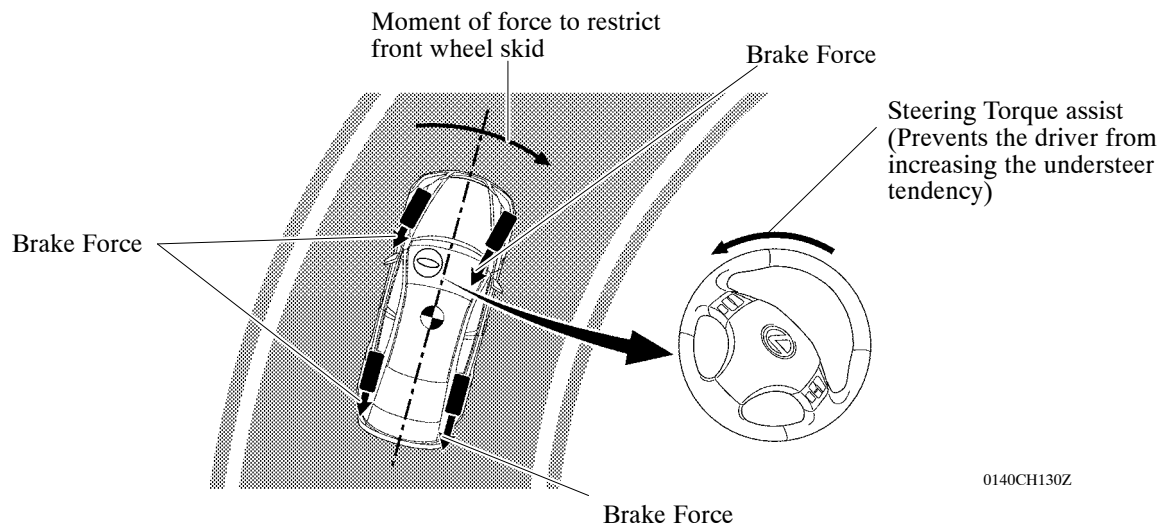
- When rear wheel skidding is detected, brake force is applied to mainly the outer wheels according to the amount of oversteer tendency. Accordingly, an anti-spin moment is generated to limit the rear wheel skid tendency.
- With the VDIM, the EPS ECU receives command signals from the Skid Control ECU. Based on these signals, the EPS ECU operates the motor for the electric power steering to provide steering assist to help the driver compensate for the rear wheel skid tendency. This enables the driver to operate the steering wheel easily.



0140CH129Z

Front Wheel Skid Control

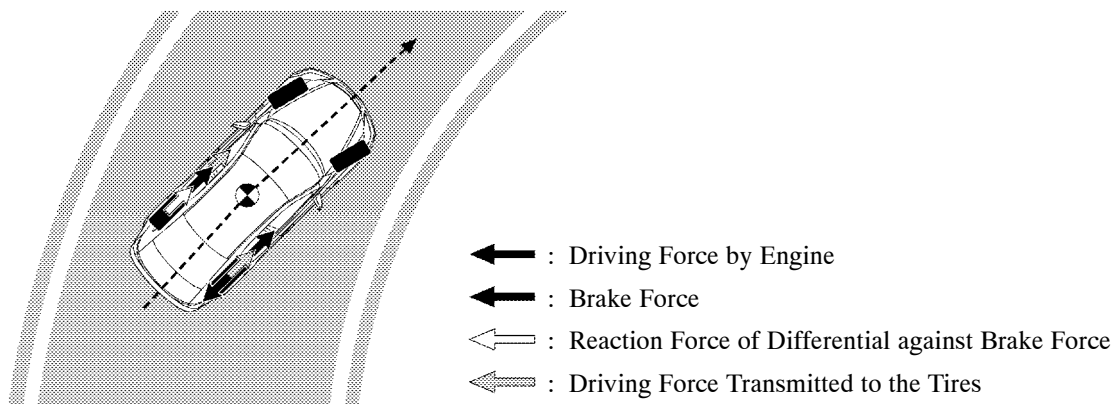
- When front wheel skidding is detected, engine output is limited and braking control is performed based on the amount of understeer tendency. Accordingly, a moment of force is generated in the vehicle turning direction to limit front wheel skid tendency.
- In the case of a front wheel skid tendency, the steering torque will be light as a signal to the driver.
- With the VDIM system, if the driver turns the steering wheel excessively, the EPS ECU will receive command signals from the Skid Control ECU. Based on these signals, the EPS ECU will operate to reduce the steering assist. This prevents the driver from increasing the understeer tendency.



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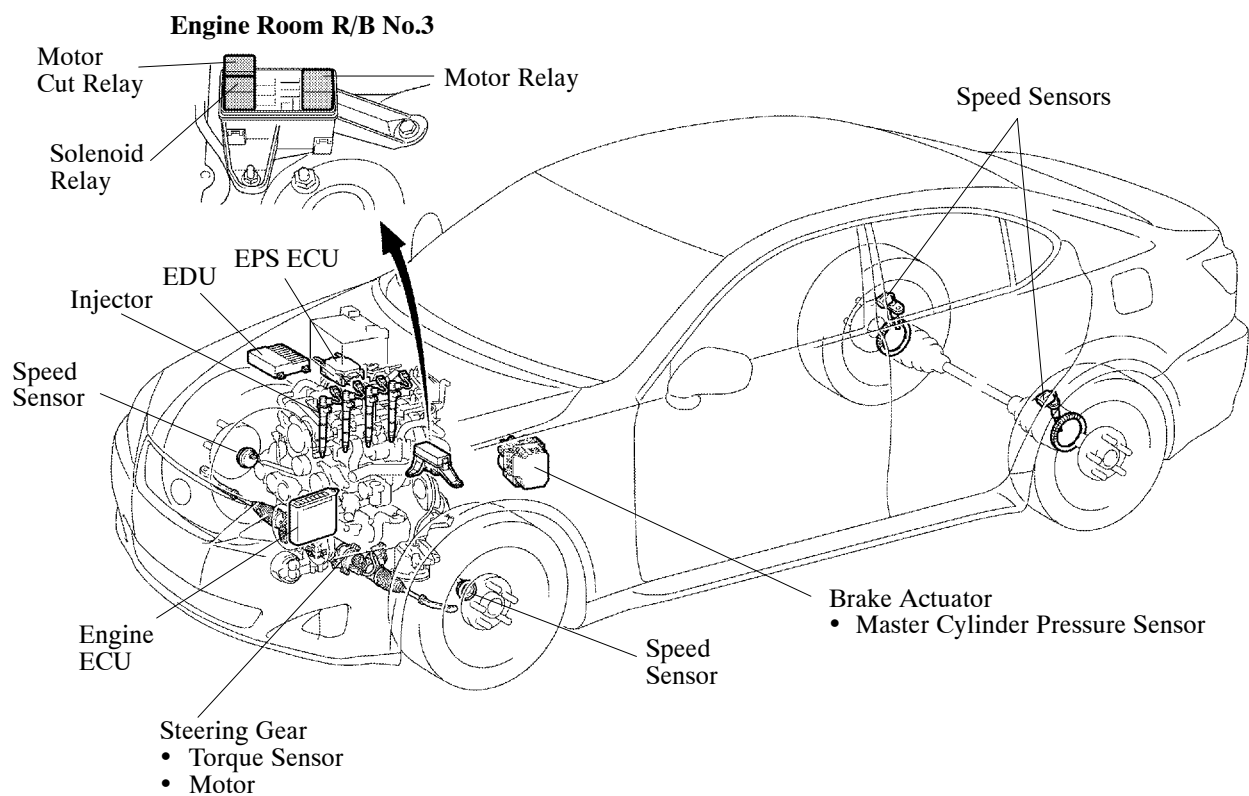
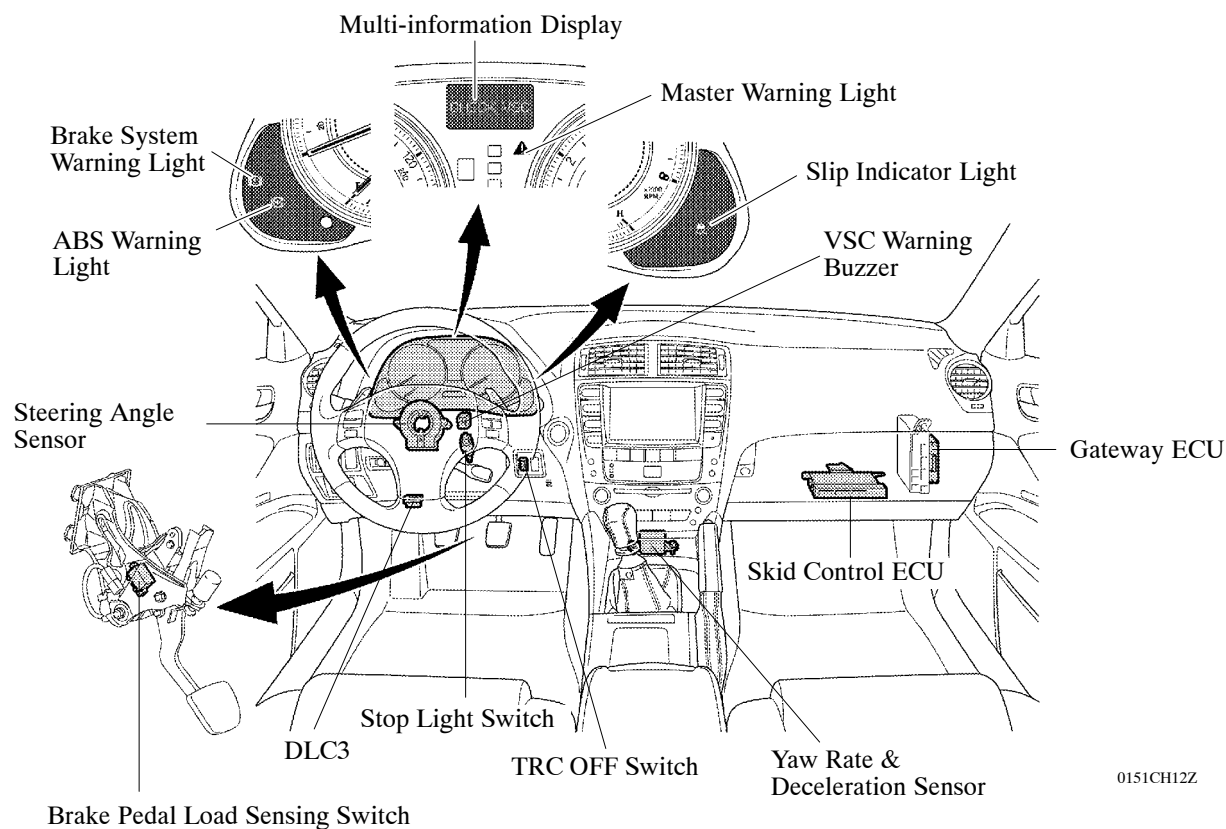
5. LSD Function

- When the vehicle accelerates around a turn, the load shifts to the outside of the turn. This hinders the transfer of the drive force from the inner wheels to the road surface, causing those wheels to spin.
- Upon detecting a turning condition and wheelspin, the VDIM applies the brake to the inner drive wheel. This suppresses the spinning, transfers drive force to the outer wheel, and thus realizes the intended acceleration of the driver.



0140CH131Z

6. Layout of Main Component



7. 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 or the VSC 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 lever is pulled up.
	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 when the parking brake lever is pulled up.
Stop Light Switch		Detects brake pedal application.
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, TRC & VSC system, in order to control the fluid pressure that is applied to the brakes for the different wheels.
	Master Cylinder Pressure Sensor	Assembled in the brake actuator and 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 steering torque assist required. The Skid Control ECU transmits command signals to the EPS ECU. - 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.
AFS ECU		Receives front speed sensor signals that are output from the Skid Control ECU.

(Continued)

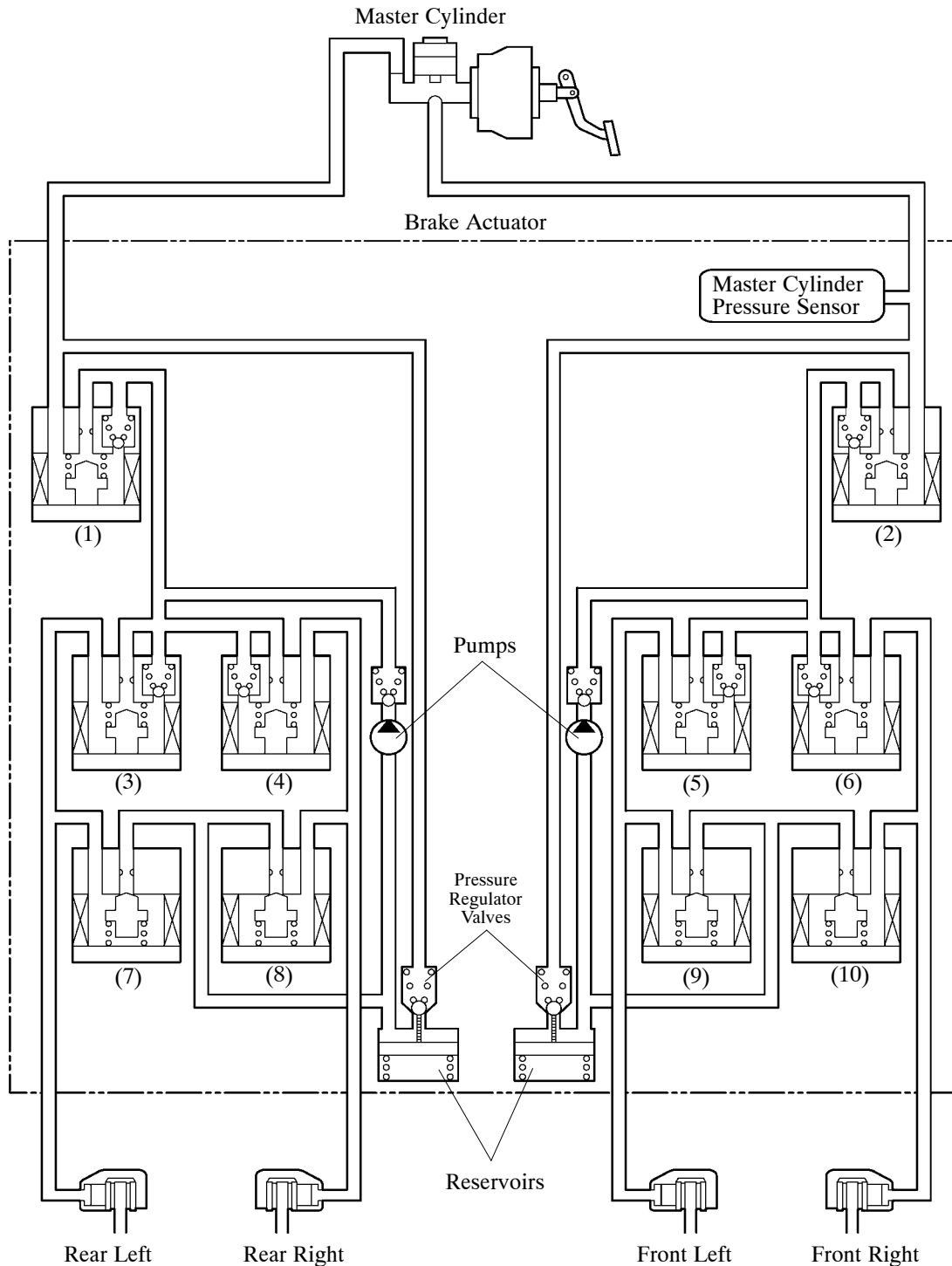
Component	Function
EPS ECU	Receives a steering torque assist command signal from the Skid Control ECU during steering coordination control. Based on this signal, the EPS ECU operates the motor for electric power steering to provide a level of steering assist that will allow the driver to operate the steering so as to stabilize the vehicle.
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.
Solenoid Relay	Supplies power to the solenoid valves.
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.

8. Brake Actuator

The brake actuator consists of the actuator, pump motor, and master cylinder pressure sensor.

- The actuator portion consists of two master cylinder cut solenoid valves, eight solenoid valves, two pressure regulator valves, two pumps, 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)].

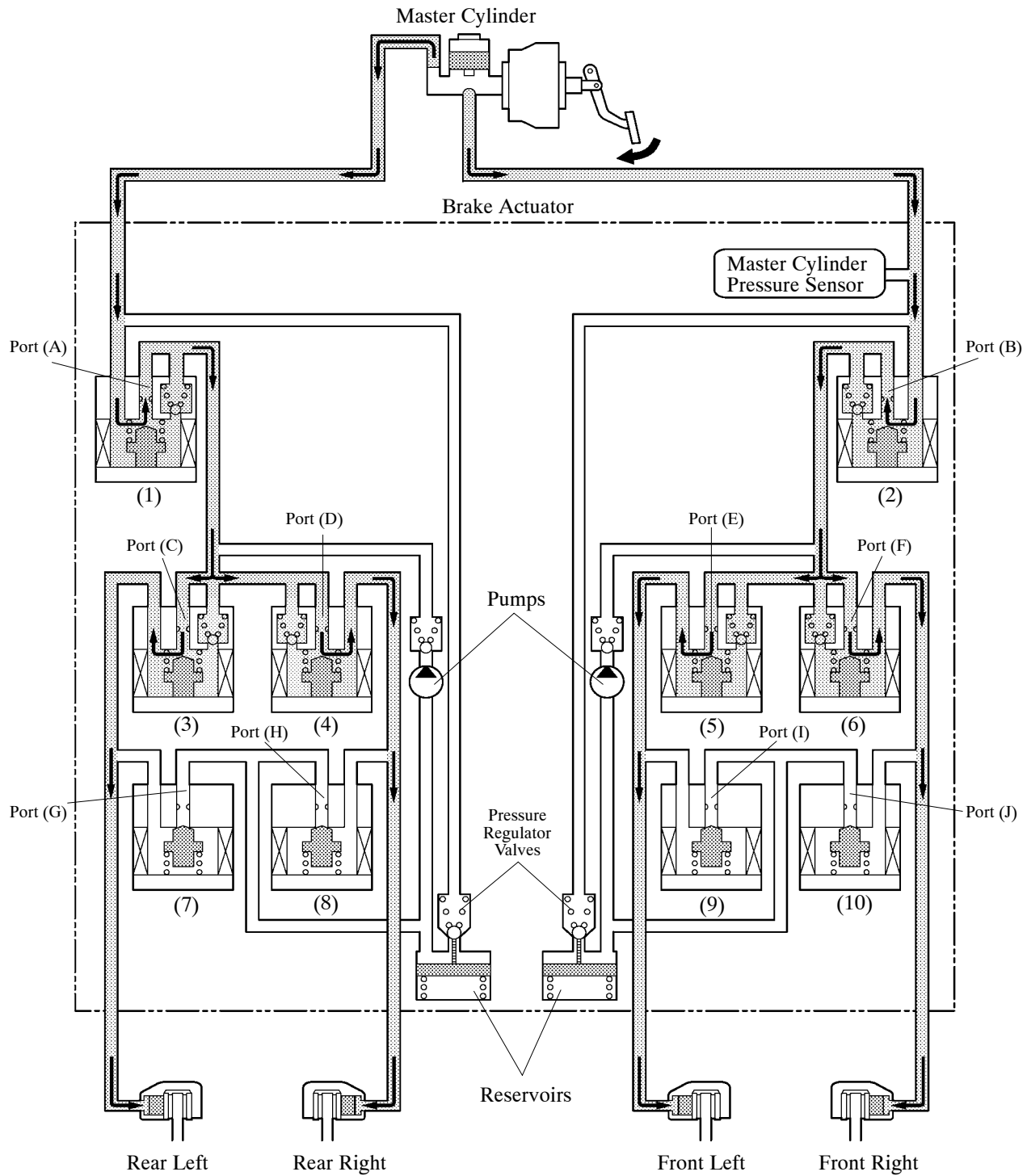
► Hydraulic Circuit ◀



9. System Operation

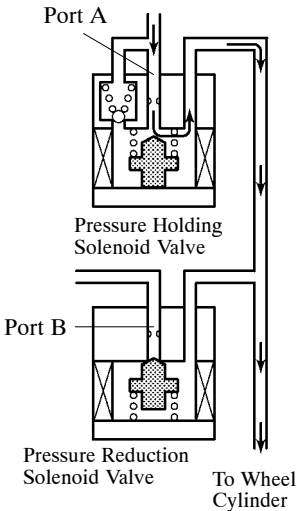
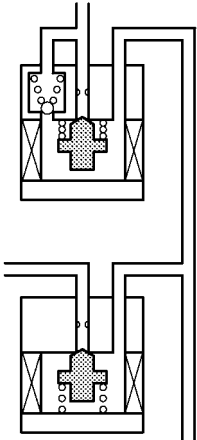
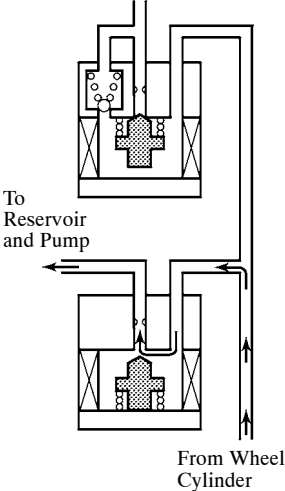
Normal Braking Operation

During normal braking, all solenoid valves are remained 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.

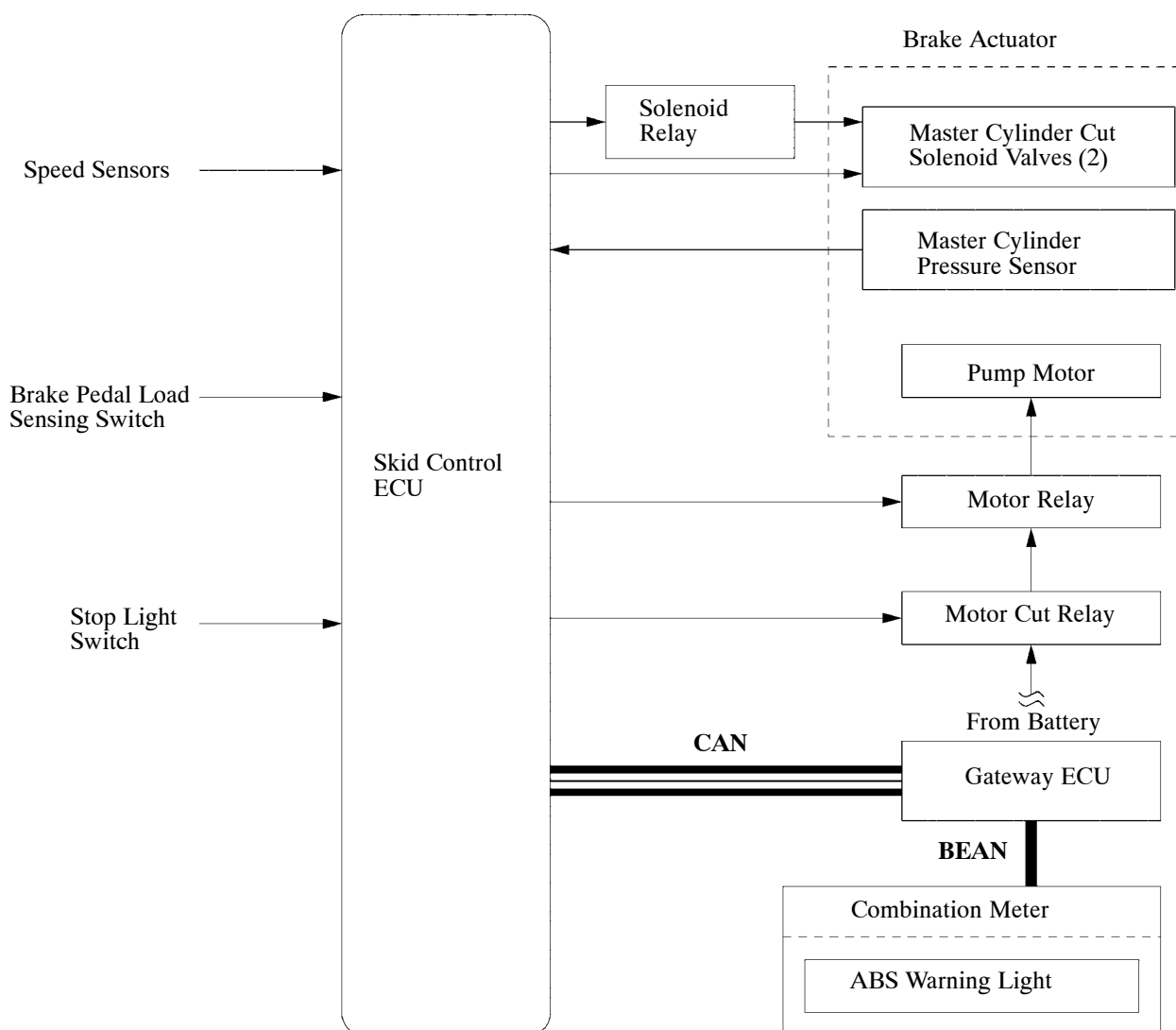
Not Activated	Normal Braking	—	—
Activated	Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Hydraulic Circuit	 D13N69	 D13N70	 D13N71
	Pressure Holding Valve (Port A)	OFF/Open	ON/Closed
	Pressure Reduction Valve (Port B)	OFF/Closed	ON/Open
	Pressure	Increase	Hold

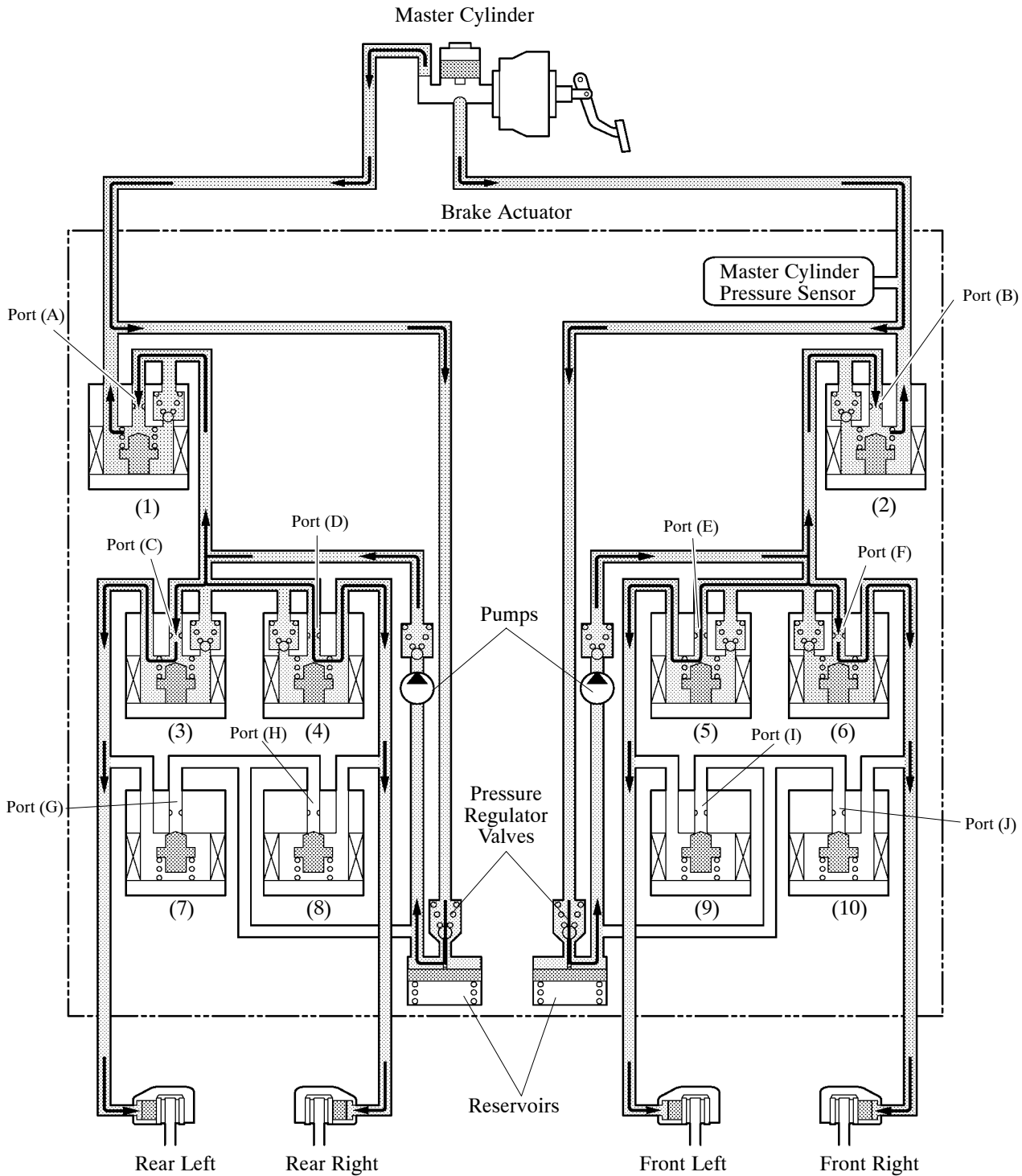
Brake Assist Operation

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 ◀





Brake Assist Activated

285CH31

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)		

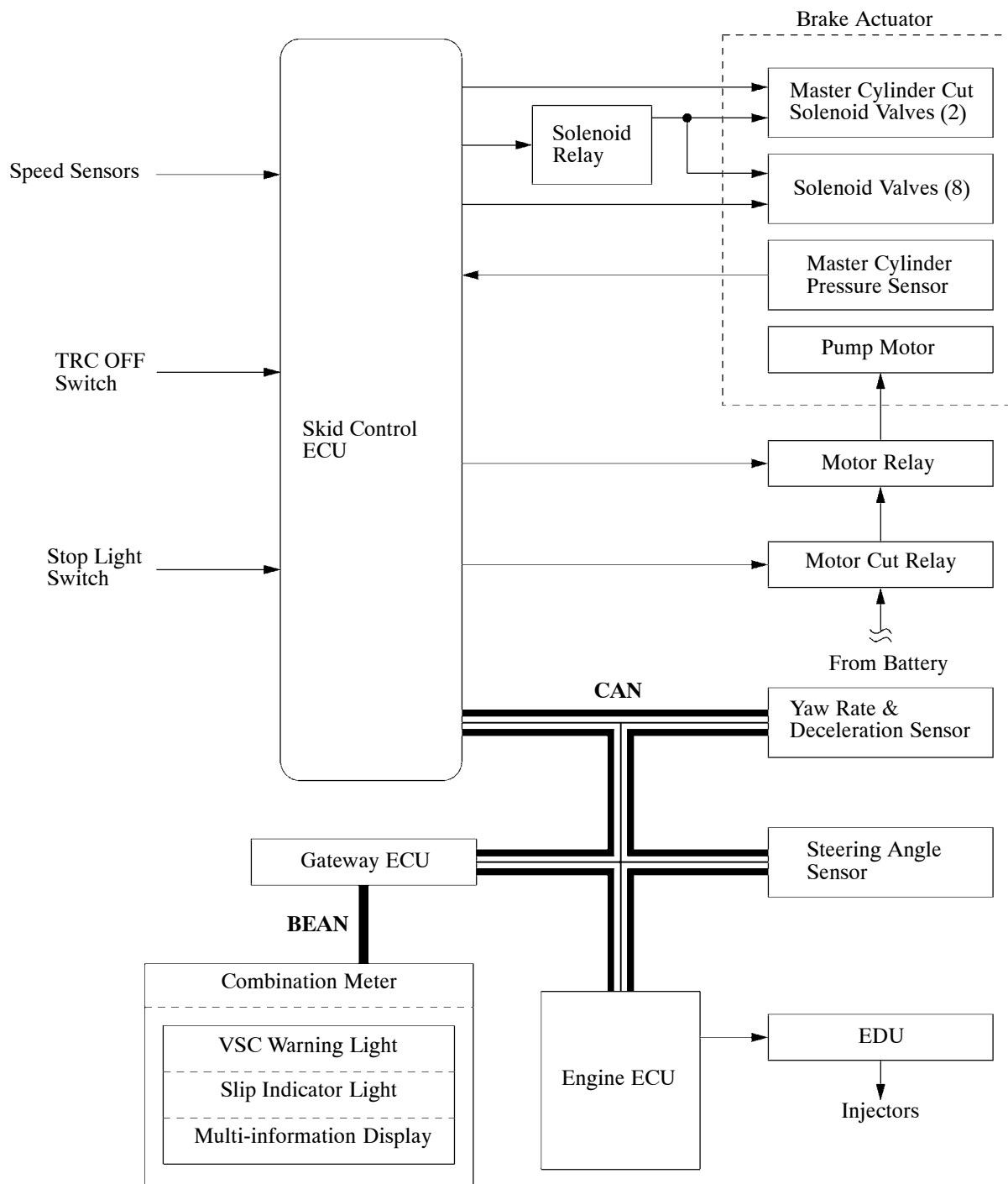
*: The solenoid valve controls the hydraulic pressure by cycling continually between “open” and “closed” according to the operating conditions.

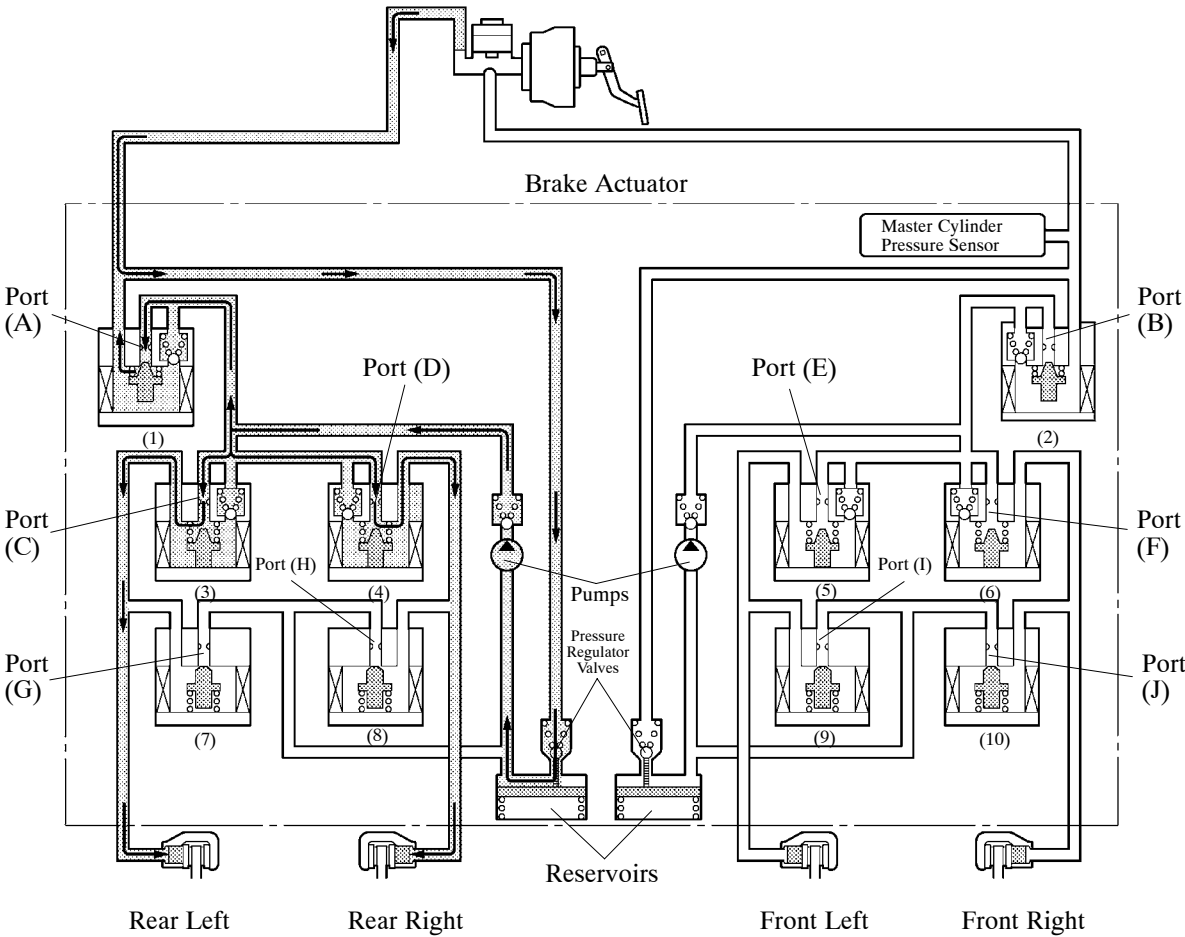
TRC Operation

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 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

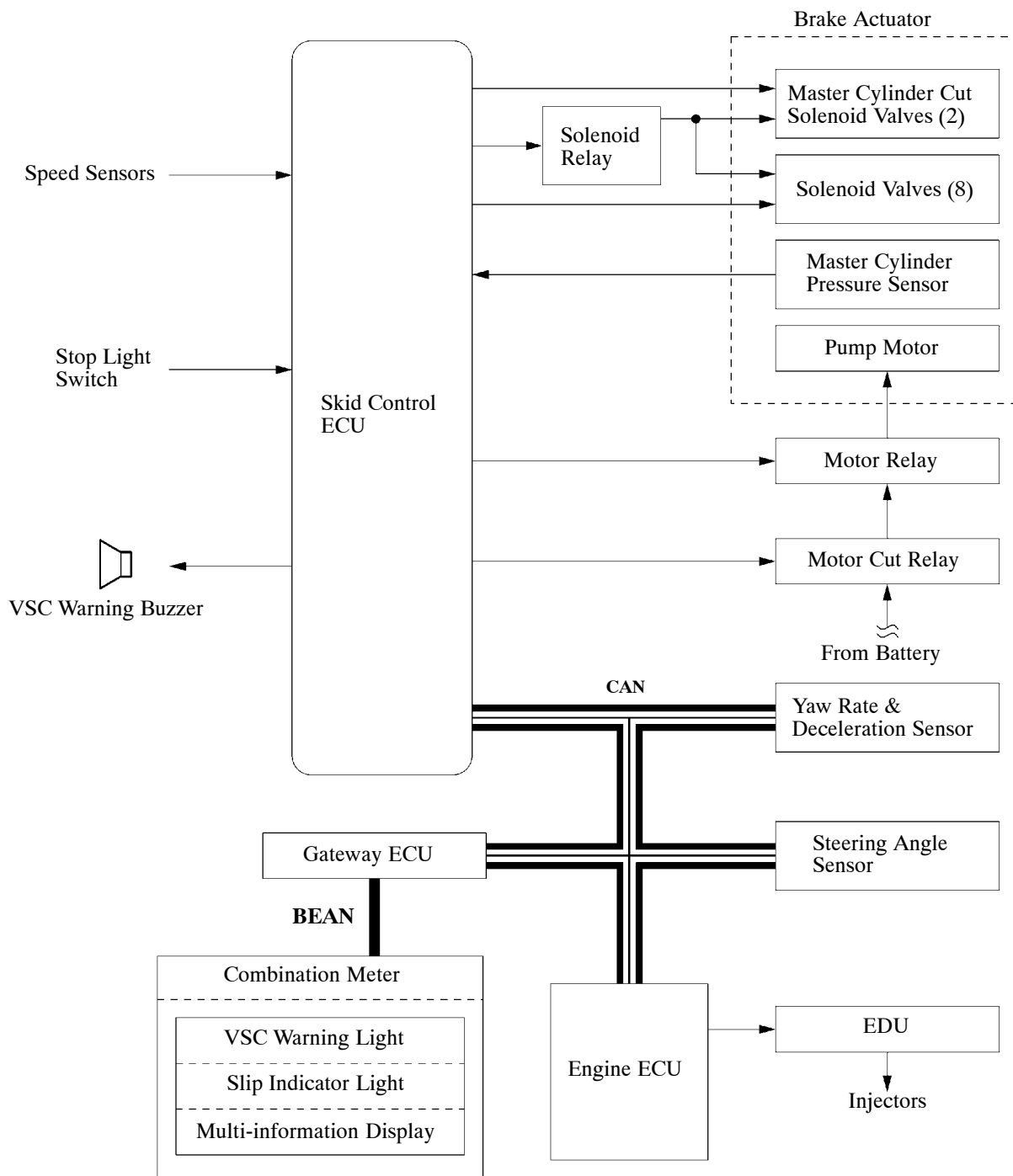
*: The solenoid valve controls the hydraulic pressure between “open” and “closed” according to the operating condition by adjusting continually .

VSC Operation

1) General

The VSC, 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.

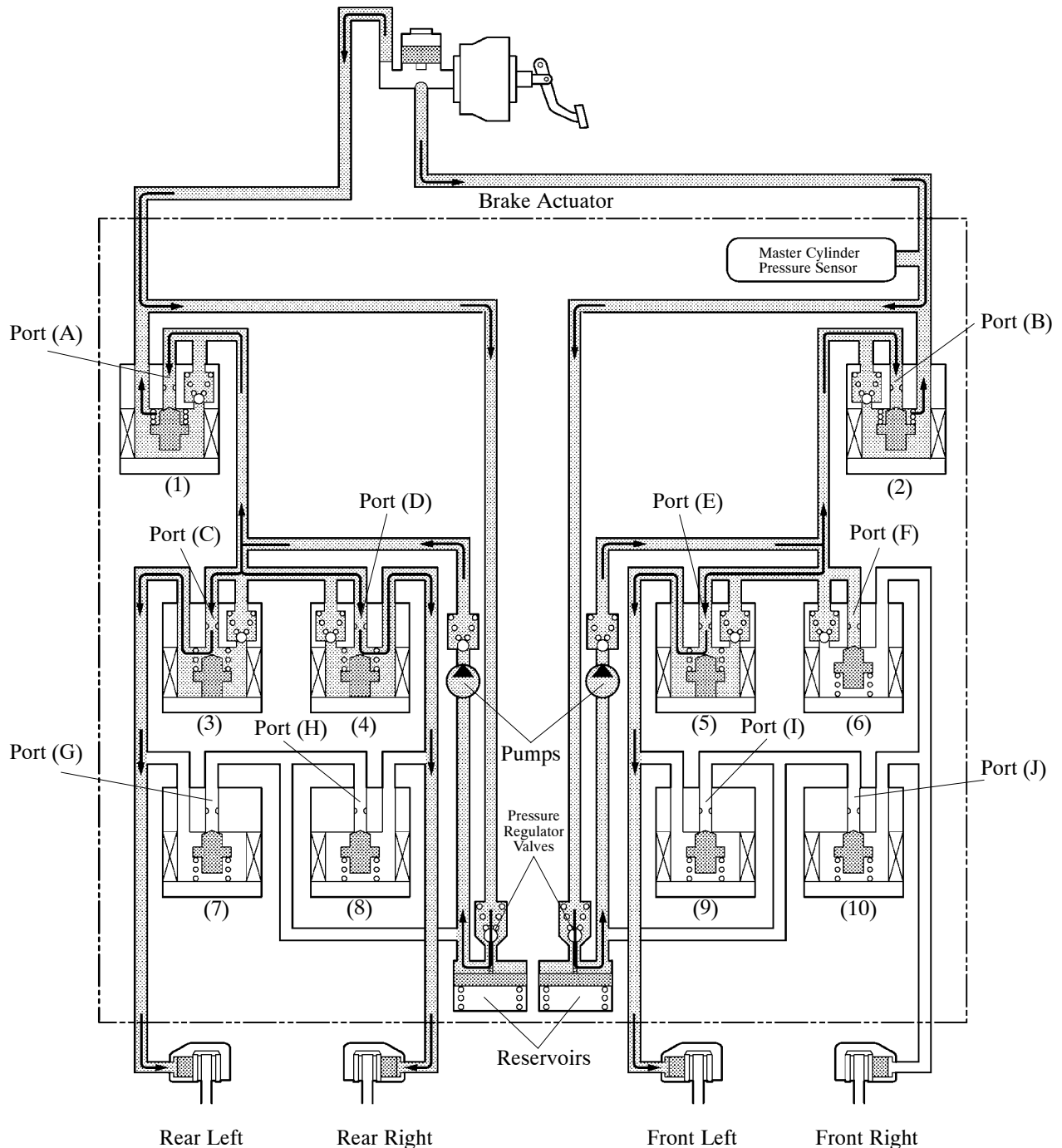
► System Diagram ◀



2) Front Wheel Skid Restraining Control (Right Turn)

For 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

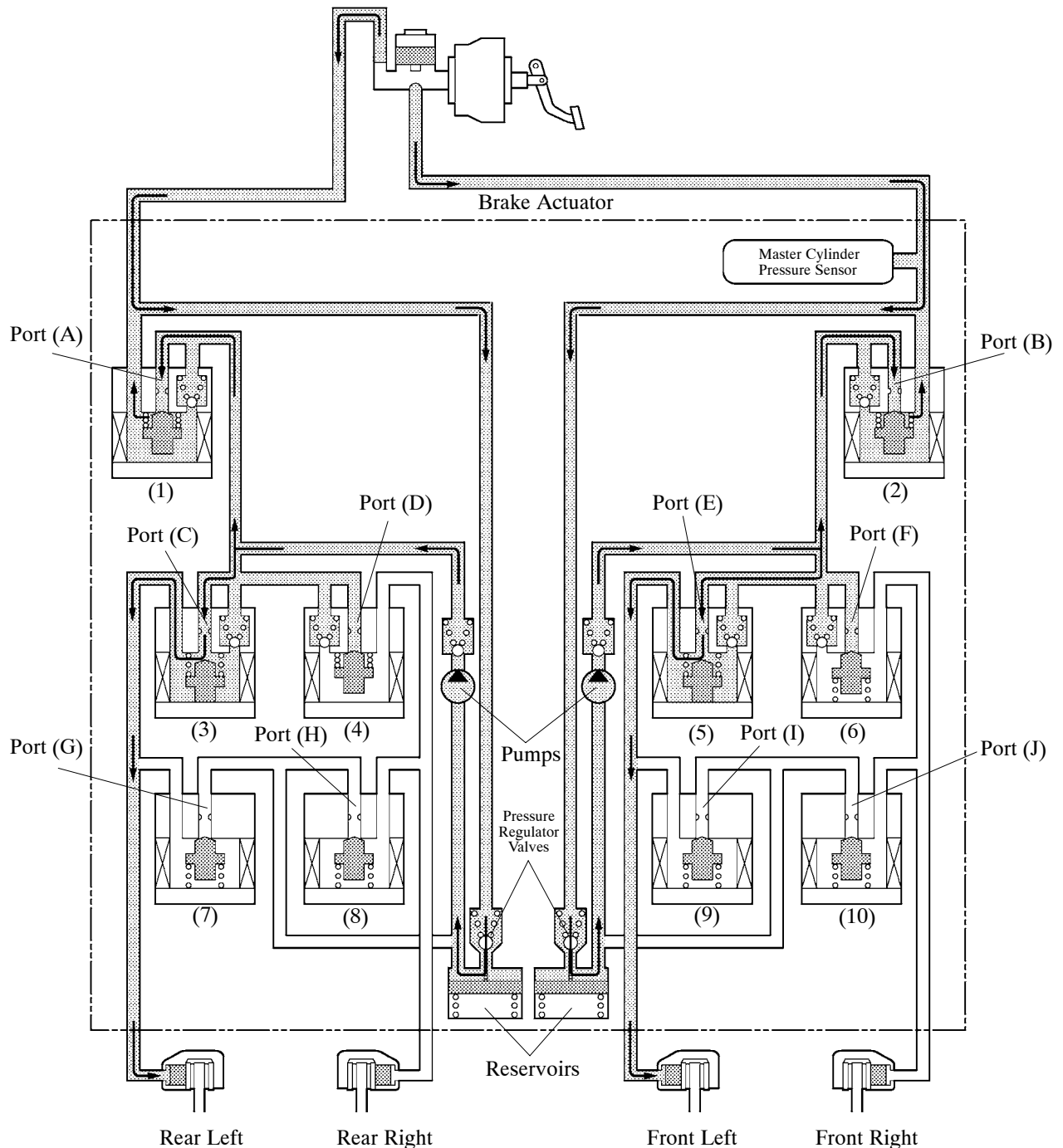
Item			VSC Not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		OFF/Open	ON*	←	←
	Port: (A), (B)					
Front Brake	(5)	Pressure Holding Valve	OFF/Open	←	ON/Closed	←
		Port: (E)				
	(6)	Pressure Holding Valve	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 valve controls the hydraulic pressure between “open” and “closed” according to the operating condition by adjusting continually .

3) Rear Wheel Skid Restraining Control (Right Turn)

For 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.



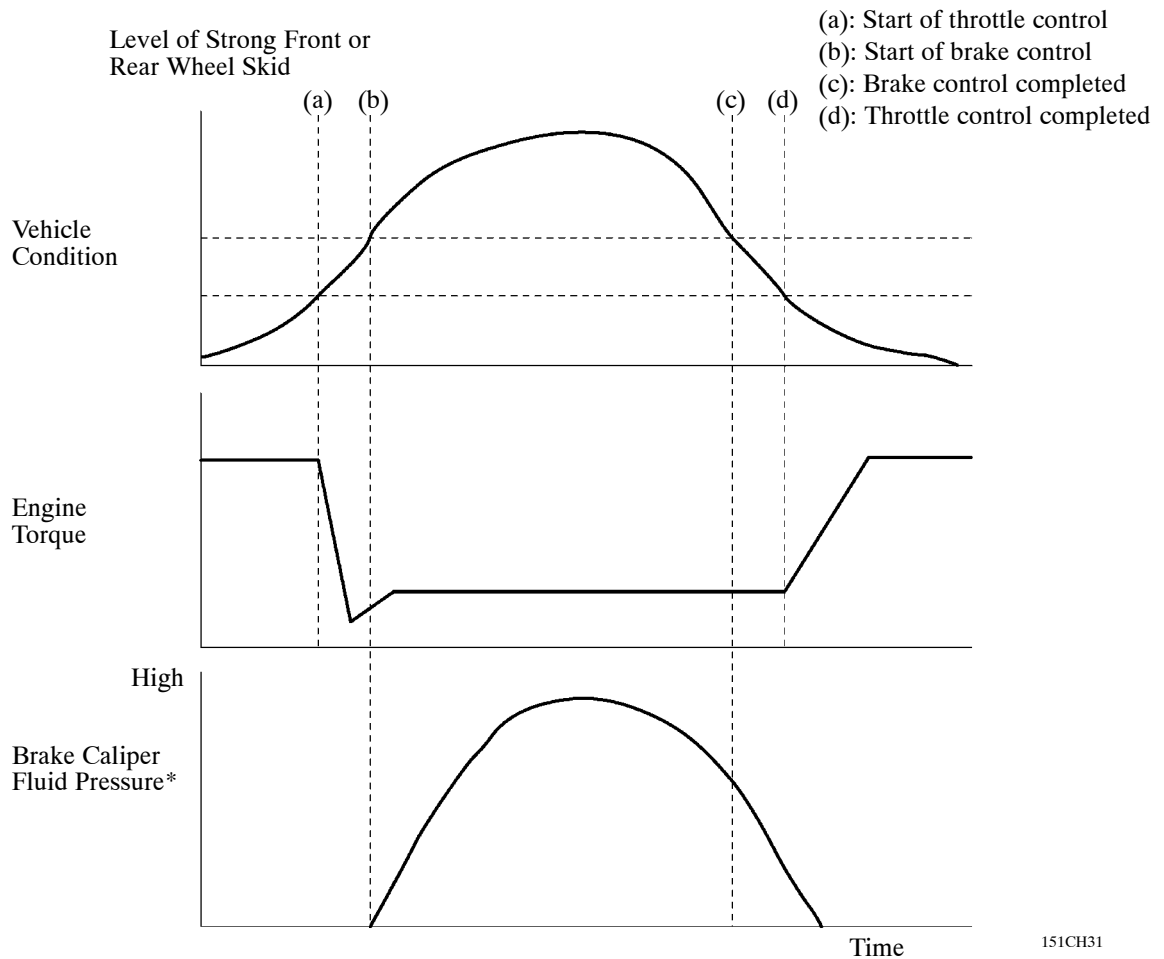
Pressure Increase Mode

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 valve controls the hydraulic pressure between “open” and “closed” according to the operating condition by adjusting continually .

Engine Output Control

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



151CH31

*: 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.

10. 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, EPS ECU and DLC3. For details on CAN communication, refer to page BE-7.

11. Diagnosis

General

If the Skid Control ECU detects a malfunction in the brake control system (ABS with EBD, Brake Assist, TRC and VSC), 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 Δ: Indicate

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

*: Failure in the ABS, EBD, and Brake Assist systems prohibits operation of the TRC and VSC 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 the observing the diagnostic code indicated on the multi-information display, or by connecting a hand-held tester.
- 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 terminal of the DLC3 or by connecting a hand-held tester. The ABS warning light blinks at a 0.13-second interval 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 DTCs 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 a hand-held tester.

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 IS250/220d Repair Manual (Pub. No. RM0151E).

Service Tip

The Skid Control ECU uses the CAN protocol for diagnostic communication. Therefore, a hand-held tester and a dedicated adapter [CAN VIM (Vehicle Interface Module)] are required for accessing diagnostic data. For details, see the LEXUS IS250/220d Repair Manual (Pub. No. RM0151E).

Diagnosis of CAN

If a malfunction occurs on a CAN communication line, the Skid Control ECU is connected to the 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 communications related to the brake control system (ABS with EBD, Brake Assist, TRC and VSC).
 - 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 a hand-held tester to the DLC3.

Service Tip

The Skid Control ECU uses the CAN protocol for diagnostic communication. Therefore, a hand-held tester and a dedicated adapter [CAN VIM (Vehicle Interface Module)] are required for accessing diagnostic data. For details, see the LEXUS IS250/220d Repair Manual (Pub. No. RM0151E).

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 and VSC 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 and VSC) 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 and VSC.
- When the Engine ECU detects an engine control DTC, it will disable the TRC and VSC operations.