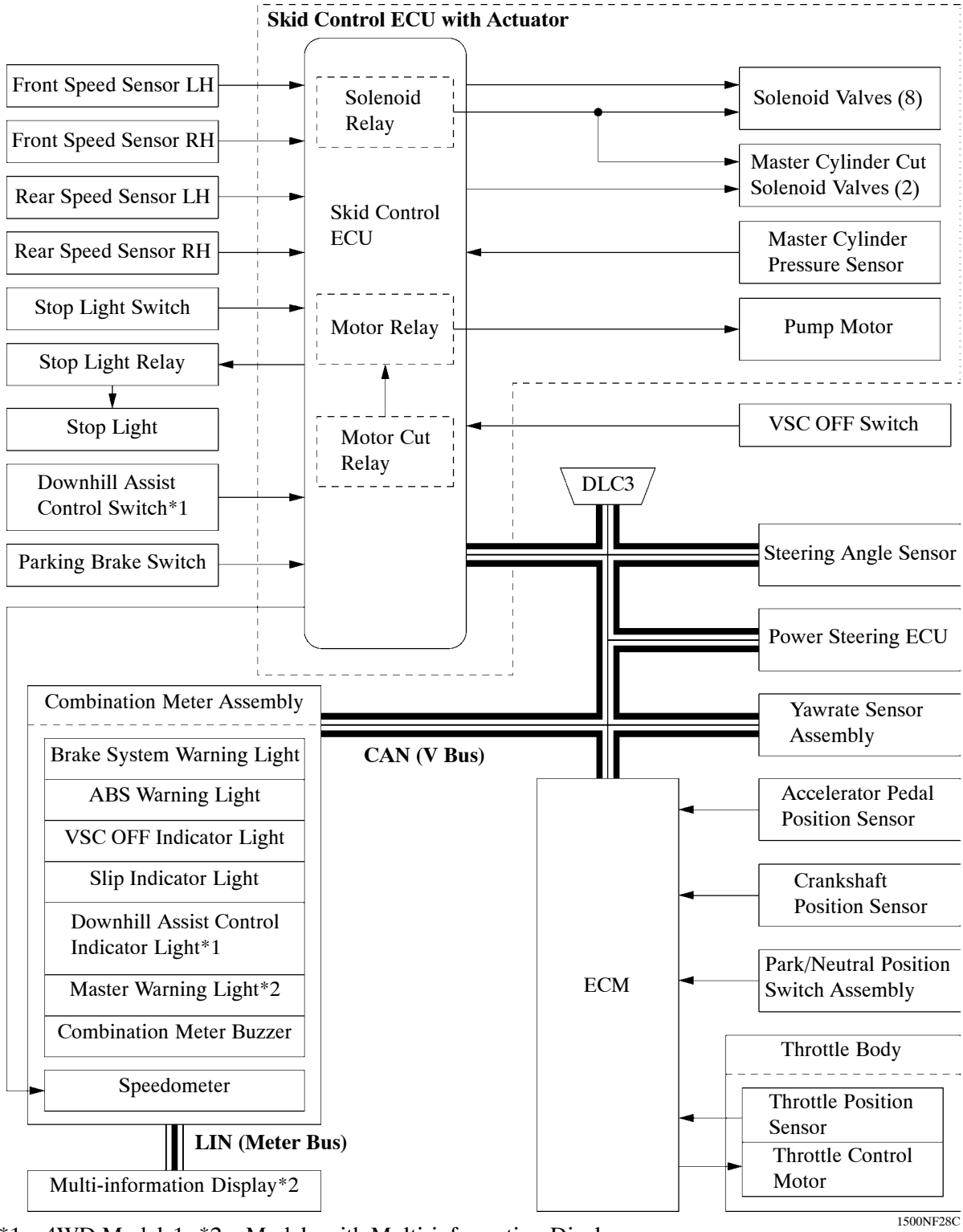
■ BRAKE CONTROL SYSTEM

1. Major Difference

Both the warning buzzer used to inform the driver when VSC control is operating and the skid control buzzer have been discontinued. The buzzer in the combination meter assembly sounds in place of the skid control buzzer to inform the driver when Hill-start Assist control or Downhill Assist Control operates.

2. System Diagram



*1: 4WD Models1 *2: Models with Multi-information Display

3. Function of Main Components

Component		Function
Combination Meter Assembly	Brake System Warning Light	● Lights up together with the ABS warning light to alert the driver when the skid control ECU detects an EBD control malfunction. ● Lights up to inform the driver when the parking brake is ON.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in ABS or Brake Assist.
	Slip Indicator Light	● Blinks to inform the driver when TRC, VSC, Hill-start Assist Control or Downhill Assist Control operates. ● Lights up together with the VSC OFF indicator light to alert the driver when the skid control ECU detects a malfunction in TRC, VSC, Hill-start Assist Control or Downhill Assist Control.
	VSC OFF Indicator Light	● Lights up to inform the driver when VSC OFF mode is entered using the VSC OFF switch. ● Blinks to alert the driver when the skid control ECU detects a malfunction in TRC, VSC, Hill-start Assist Control or Downhill Assist Control.
	Downhill Assist Control Indicator Light*1	● Light up to inform the driver when Downhill Assist Control operates. ● When the Downhill Assist Control switch is on but not all operating conditions are met, the Downhill Assist Control indicator light blinks to inform the driver.
	Master Warning Light*2	Lights up to alert the driver when the skid control ECU detects a malfunction in the brake control system.
	Buzzer	The buzzer will sound to inform the driver of the following conditions: ● Hill-start Assist Control starts operating or stops operating. ● Downhill Assist Control is temporarily cancelled due to overheating of the brake actuator while Downhill Assist Control is operating.
Front and Rear Speed Sensors (4)		Detect the wheel speed of each of the four wheels.
Stop Light Switch		Detects the brake pedal depression signal.
Parking Brake Switch		Detects parking brake application.
Accelerator Pedal Position Sensor		Detects the accelerator pedal depression angle.
VSC OFF Switch		● Cancels the TRC or VSC. ● Selects any of the three modes (Normal mode, TRC-OFF mode, VSC-OFF mode).
Downhill Assist Control Switch*2		Allows the driver to turn Downhill Assist Control ON or OFF.

*1: 4WD Models *2: Models with Multi-information Display

Component			Function
Skid Control ECU with Actuator			Changes the internal fluid paths based on signals from the skid control ECU during the operation of the ABS with EBD, Brake Assist, TRC, VSC, Hill-start Assist Control and Downhill Assist Control in order to control the fluid pressure that is applied to the brake wheel cylinders.
	Master Cylinder Pressure Sensor		Located in the brake actuator to detect the master cylinder pressure.
	Skid Control ECU		Judges the vehicle driving condition based on signals from each sensor, and sends a brake control signal to the brake actuator.
		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.
Yawrate Sensor Assembly			● Detects the vehicle's yaw rate. ● Detects the vehicle's longitudinal and lateral acceleration and deceleration.
Steering Angle Sensor			Detects the steering direction and angle of the steering wheel.
ECM			● Sends the throttle valve angle signal, accelerator pedal position signal, engine speed signal, and shift lever position signal to the skid control ECU. ● Receives throttle control close request signals from the skid control ECU.
Multi-information Display			● Shows a warning message to alert the driver when the Skid Control ECU detects a malfunction in the brake control system. ● Shows the Downhill Assist Control operating conditions when the Downhill Assist Control switch is on but not all operating conditions are met.

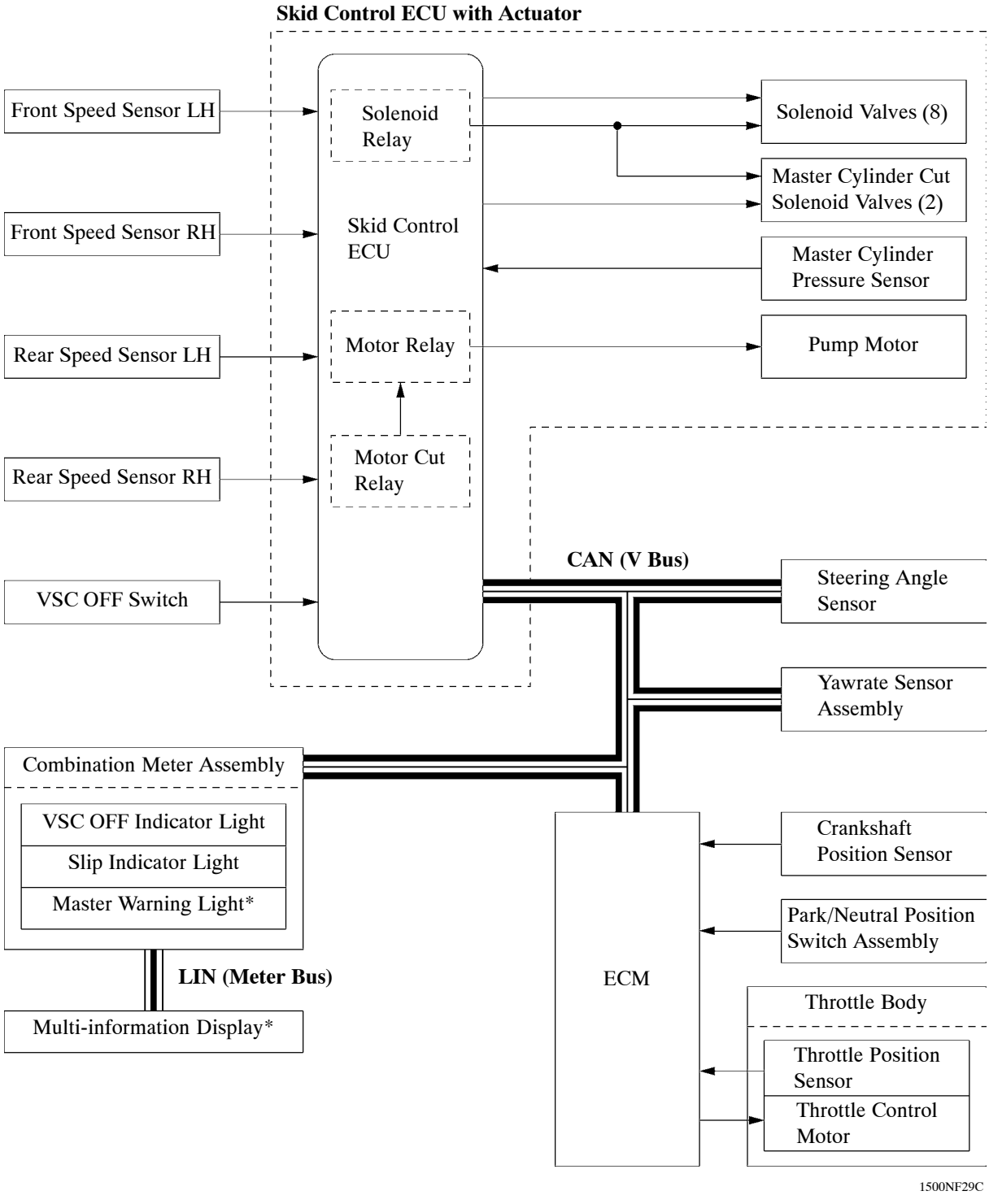
4. System Operation

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 the wheels in the following three 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.

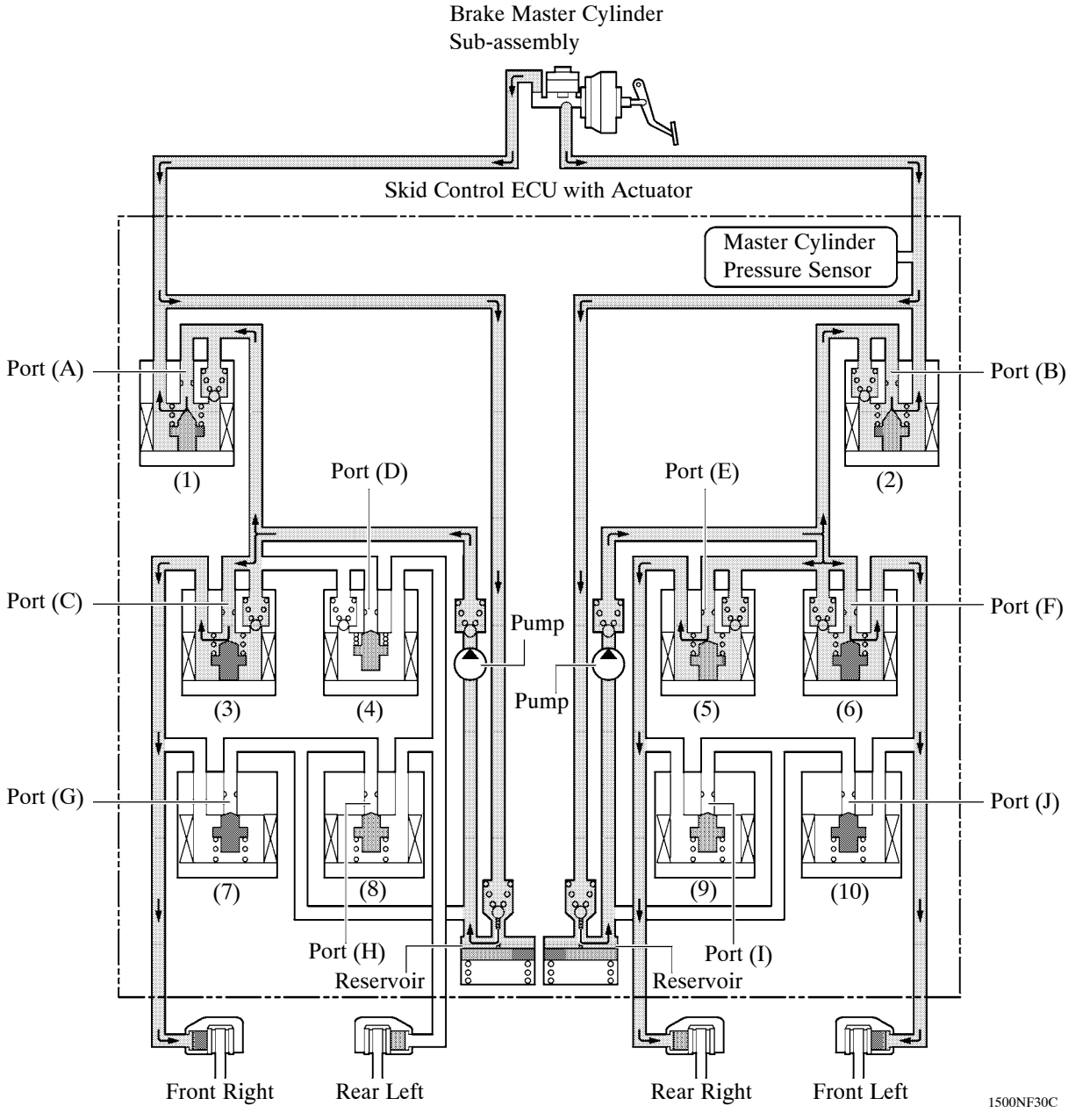
▶ System Diagram ◀



*: Models with Multi-information Display

2) Front Wheel Skid Restraining Control (Making a Right Turn)

During front wheel skid restraining control, the brakes of the wheels on the inside of the turn are applied. Also, depending on whether the brakes are on or off and the operating conditions of the vehicle, there are circumstances in which the brakes might not be applied to a wheel even if the wheel is 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 mode, the pressure holding valve and the pressure reduction valve are turned on/off according to the ABS and EBD operation pattern. When the front wheel skid restraining control is activated, the solenoid valves operate as shown in the table.

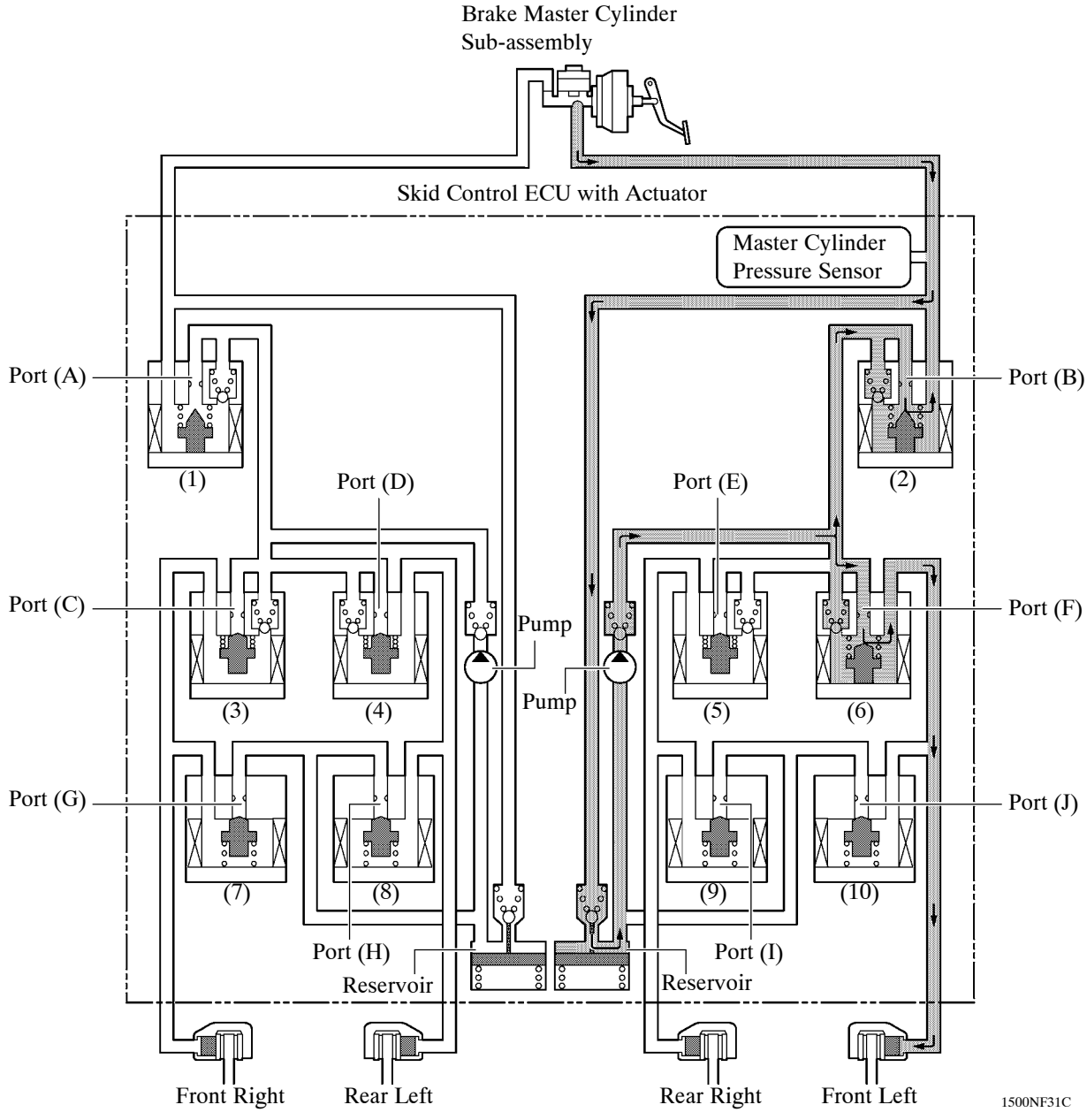


Item				Port	VSC Not Activated	VSC Activated		
						Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1) (2)	(A) (B)	Off (Open)	On*	On*	On*
Front Brakes	Pressure Holding Solenoid Valves		(3)	(C)	Off (Open)	Off (Open)	On (Closed)	On (Closed)
			(6)	(F)	Off (Open)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves		(7)	(G)	Off (Closed)	Off (Closed)	Off (Closed)	On (Open)
			(10)	(J)	Off (Closed)	Off (Closed)	Off (Closed)	On (Open)
	Brake Wheel Cylinder Pressure	Right	—	—	—	Increased	Held	Reduced
		Left	—	—	—	Increased	Held	Reduced
Rear Brakes	Pressure Holding Solenoid Valves		(4)	(D)	Off (Open)	On (Closed)	On (Closed)	On (Closed)
			(5)	(E)	Off (Open)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves		(8)	(H)	Off (Closed)	Off (Closed)	Off (Closed)	Off (Closed)
			(9)	(I)	Off (Closed)	Off (Closed)	Off (Closed)	On (Open)
	Brake Wheel Cylinder Pressure	Right	—	—	—	Increased	Held	Reduced
		Left	—	—	—	—	—	—
Pump					Off	On	On	On

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

3) Rear Wheel Skid Restraining Control (Making a Right Turn)

During rear wheel skid restraining control, the brakes of the wheels on the outside of the turn are applied. Also, depending on whether the brakes are on or off and the operating conditions of the vehicle, there are circumstances in which the brakes might not be applied to a wheel even if the wheel is 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 patterns. When the rear wheel skid restraining control is activated, the solenoid valves operate as shown in the table.



Item				Port	VSC Not Activated	VSC Activated		
						Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1)	(A)	Off (Open)	Off (Open)	Off (Open)	Off (Open)
			(2)	(B)	Off (Open)	On*	On*	On*
Front Brakes	Pressure Holding Solenoid Valves		(3)	(C)	Off (Open)	On (Closed)	On (Closed)	On (Closed)
			(6)	(F)	Off (Open)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves		(7)	(G)	Off (Closed)	Off (Closed)	Off (Closed)	Off (Closed)
			(10)	(J)	Off (Closed)	Off (Closed)	Off (Closed)	On (Open)
	Brake Wheel Cylinder Pressure	Right	—	—	—	—	—	—
		Left	—	—	—	Increased	Held	Reduced
Rear Brakes	Pressure Holding Solenoid Valves		(4)	(D)	Off (Open)	On (Closed)	On (Closed)	On (Closed)
			(5)	(E)	Off (Open)	On (Closed)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves		(8)	(H)	Off (Closed)	Off (Closed)	Off (Closed)	Off (Closed)
			(9)	(I)	Off (Closed)	Off (Closed)	Off (Closed)	Off (Closed)
	Brake Wheel Cylinder Pressure	Right	—	—	—	—	—	—
		Left	—	—	—	—	—	—
Pump					Off	On	On	On

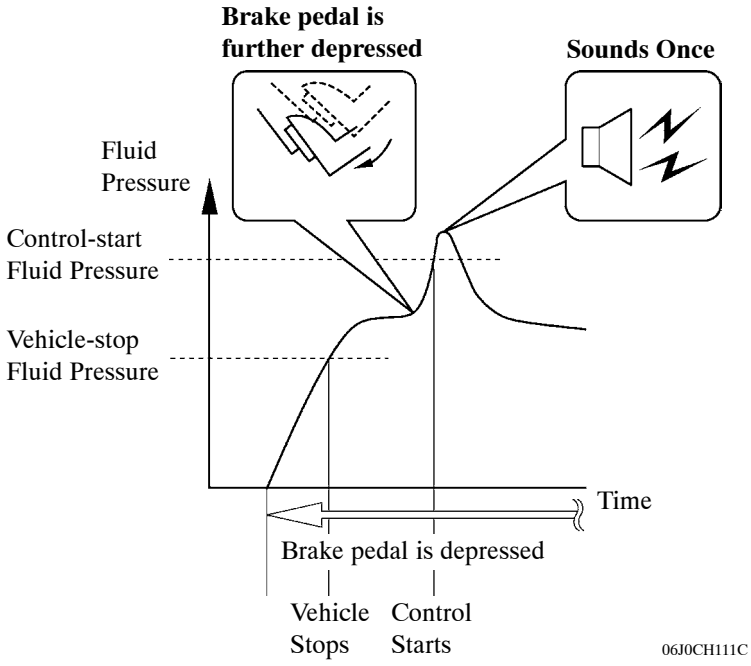
*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

Hill-start Assist Control Operation

When Hill-start Assist Control is operating, the skid control ECU controls the brake fluid pressure generated by the pump and applies it using solenoid valves to the wheel cylinders using pressure holding and pressure reduction modes.

- Based on the information provided by various sensors, switches, and the ECM, the skid control ECU detects if Hill-start Assist Control can operate.
- The skid control ECU starts Hill-start Assist Control operation when the operating conditions below are met and the driver further depresses the brake pedal, causing the fluid pressure to exceed the control-start fluid pressure.
- When Hill-start Assist Control operation starts, the buzzer in the combination meter assembly will sound once.

Hill-start Assist Control Operating Conditions	● Shift lever is in a position other than P. ● The accelerator pedal is not depressed. ● The vehicle is at a standstill. ● The parking brake is not applied.



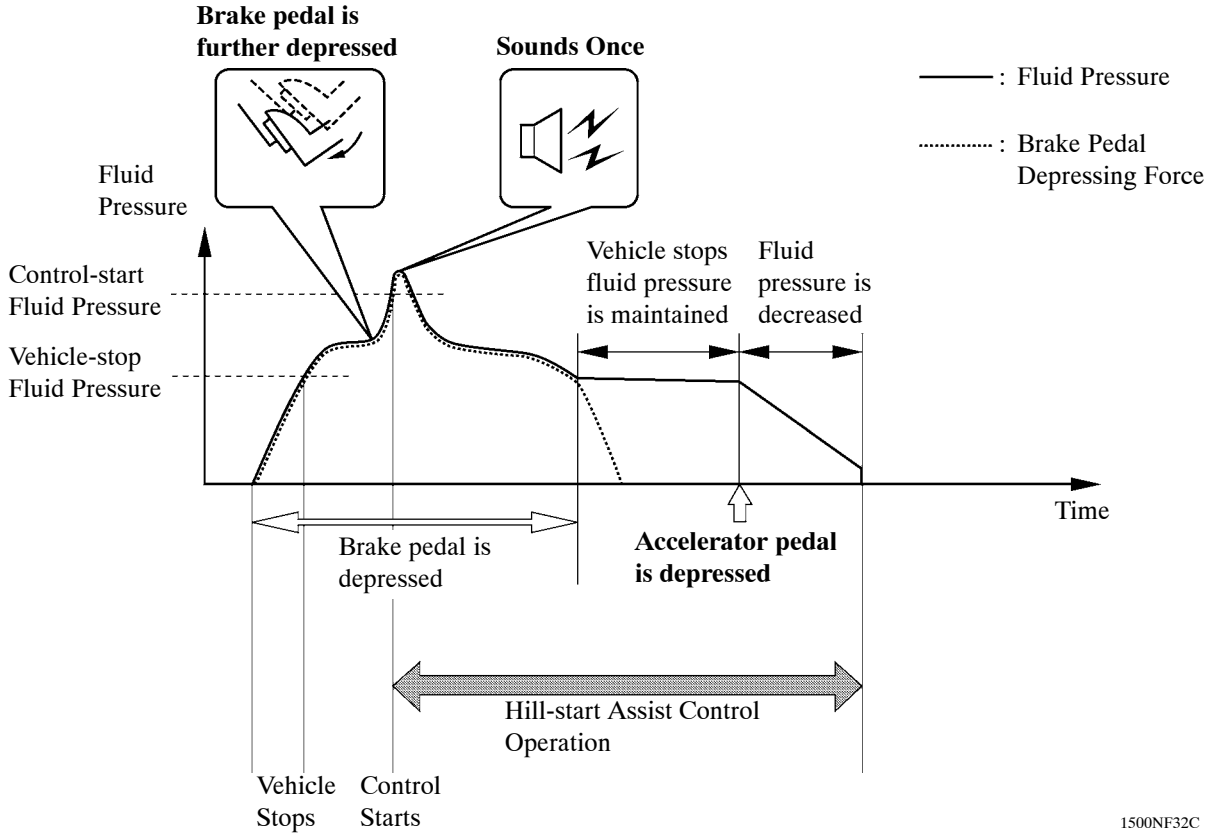
- During Hill-start Assist Control, the slip indicator light blinks and the stop lights are illuminated.
- If any one of the conditions below is met during Hill-start Assist Control operation, Hill-start Assist Control will be cancelled causing the slip indicator light to turn off.
- The buzzer in the combination meter assembly will operate as indicated below when Hill-start Assist Control is cancelled.

Conditions which cause Hill-start Assist Control operation to be canceled	● The driver depresses the accelerator pedal.	a) Buzzer does not sound
	● The driver moves the shift lever to P. ● The driver depresses the parking brake pedal. ● The driver depresses the brake pedal. ● The driver releases the brake pedal for several seconds. ● The driver keeps the brake pedal depressed continually for 3 minutes.	b) Buzzer sounds twice

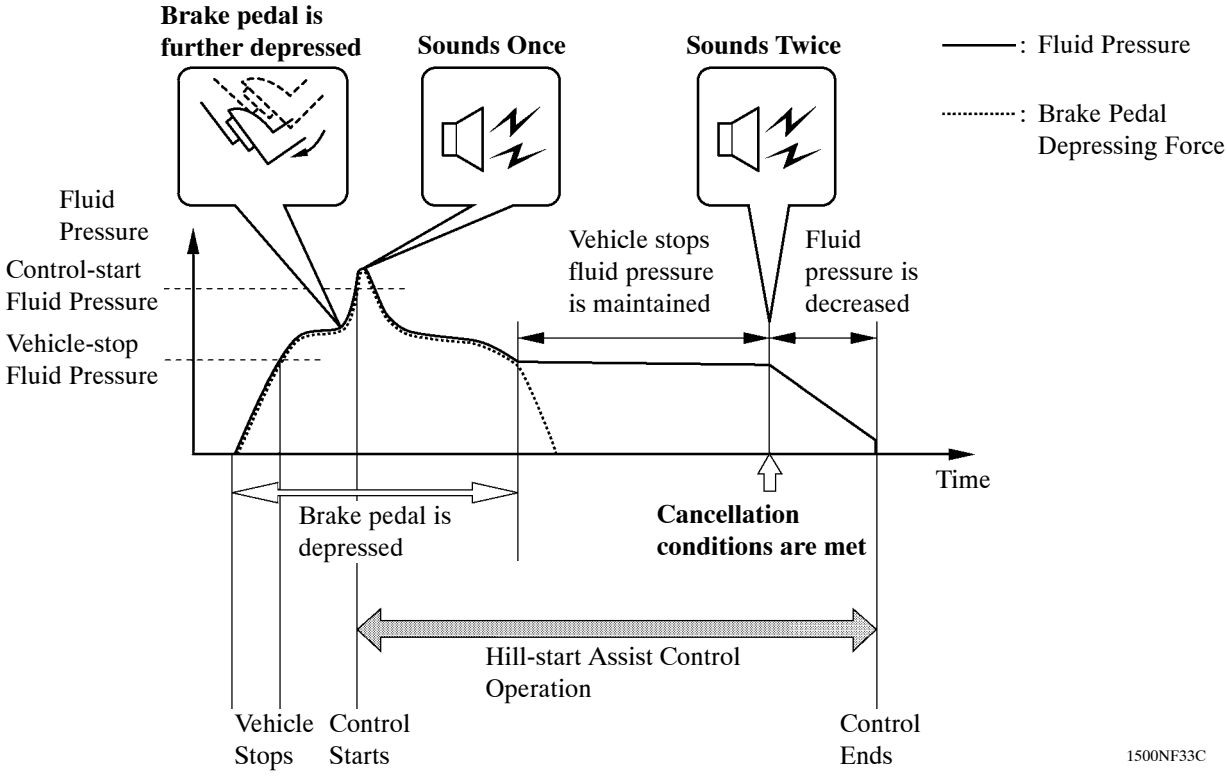
CAUTION

- The buzzer that indicates the start of Hill-start Assist Control may not sound if the buzzer of the combination meter assembly is already sounding due to other buzzer operation conditions. Even if the buzzer does not sound, the slip indicator light will still start flashing and Hill-start Assist Control will start operating.
- The buzzer that indicates the cancellation of Hill-start Assist Control may not sound if the buzzer of the combination meter assembly is already sounding due to other buzzer operation conditions. Even if the buzzer does not sound, the slip indicator light will stop flashing and Hill-start Assist Control will stop operating.

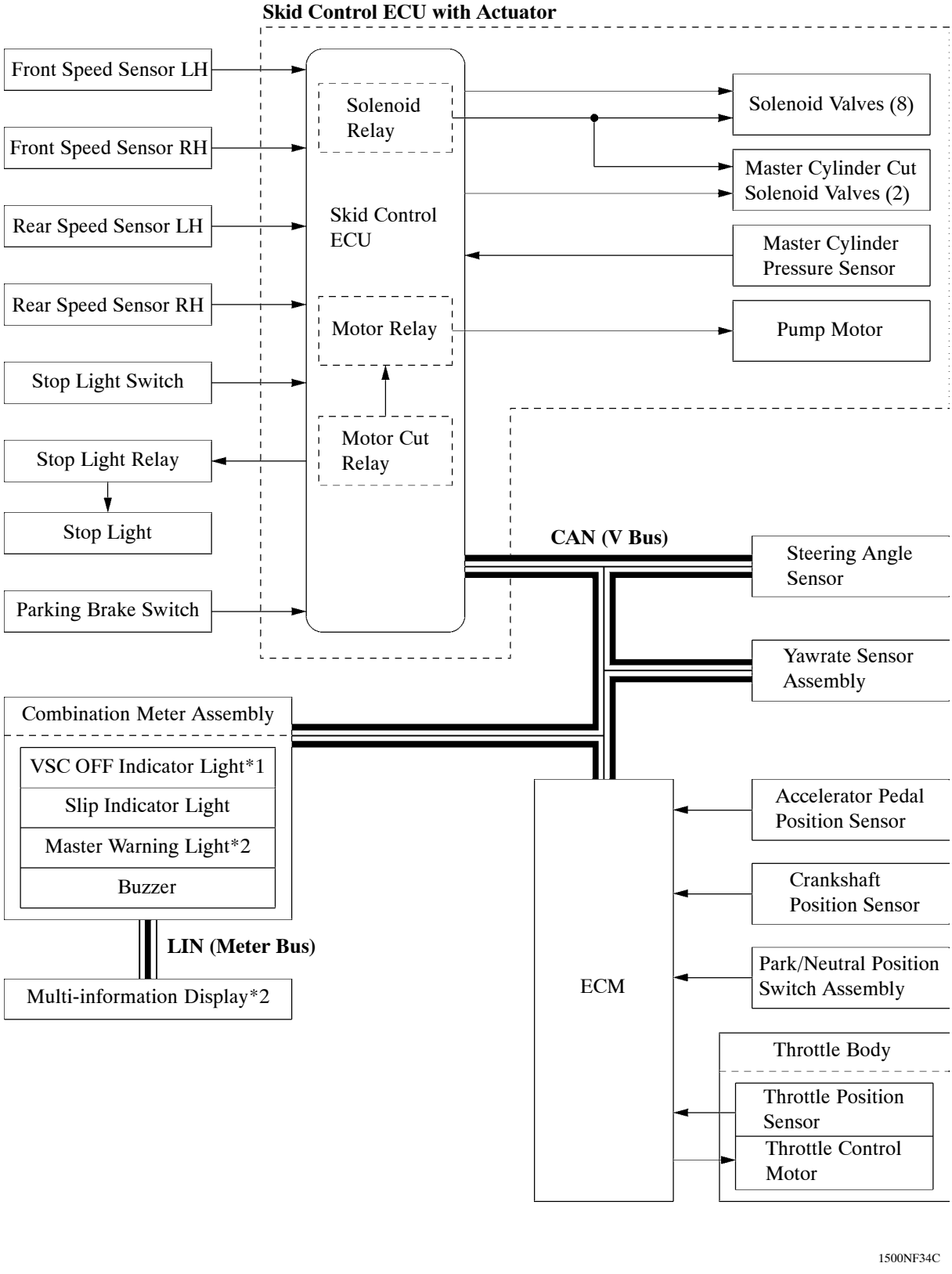
1) Buzzer in the combination meter assembly does not sound when Hill-start Assist Control ends normally:



2) Buzzer in the combination meter assembly sounds twice when Hill-start Assist Control is cancelled:

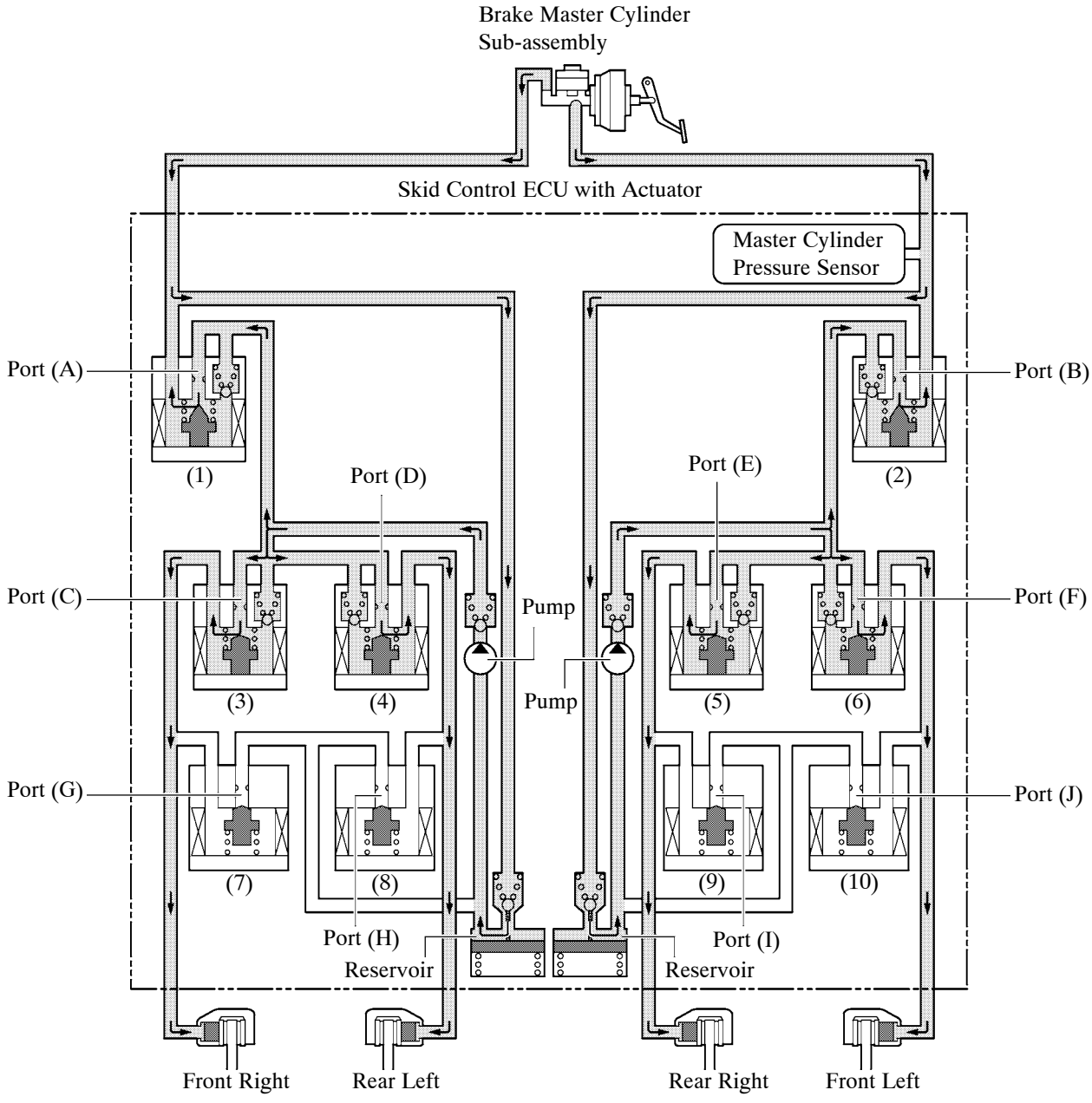


▶ System Diagram ◀



*1: Models without Multi-information Display
*2: Models with Multi-information Display

▶ Hill-start Assist Control Operation ◀



1500NF35C

Item				Port	Hill-start Assist Control Not Activated	Hill-start Assist Control Activated	
						Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1) (2)	(A) (B)	Off (Open)	On*	On*
Front Brake	Pressure Holding Solenoid Valves		(5) (6)	(E) (F)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves		(9) (10)	(I) (J)	Off (Closed)	Off (Closed)	On (Open)
	Brake Wheel Cylinder Pressure	Right	—	—	—	Held	Reduced
		Left	—	—	—	Held	Reduced
Rear Brake	Pressure Holding Solenoid Valves		(3) (4)	(C) (D)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves		(7) (8)	(G) (H)	Off (Closed)	Off (Closed)	On (Open)
	Brake Wheel Cylinder Pressure	Right	—	—	—	Held	Reduced
		Left	—	—	—	Held	Reduced
Pump					Off	On	On

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

Downhill Assist Control Operation

When Downhill Assist Control is operating, the skid control ECU controls the brake fluid pressure generated by the pump and applies it using solenoid valves to the wheel cylinders using pressure holding, pressure reduction, and pressure increase modes.

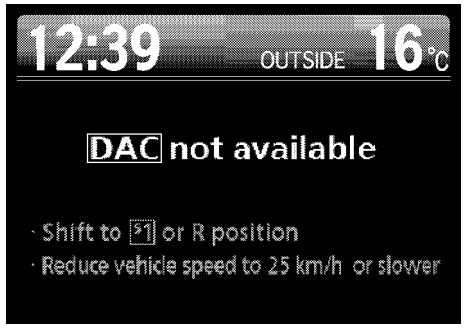
- During Downhill Assist Control, the slip indicator light blinks, the Downhill Assist Control indicator light illuminates and the stop lights illuminate.
- The skid control ECU determines the vehicle speed, travel direction, and the gradient of the hill in accordance with the signals from the speed sensor and the yawrate sensor assembly, and operates brake control to attain the target vehicle speed. The target vehicle speed is determined by the direction of the vehicle.

Travel Direction	Target Vehicle Speed
Forward	5 to 9 km/h (3 to 6 mph)
Backward	3 to 7 km/h (2 to 4 mph)

- If the temperature of the brake actuator reaches a specified level during Downhill Assist Control operation, Downhill Assist Control will be suspended temporarily in order to protect the system. In this event, the buzzer in the combination meter assembly will sound continuously to inform the driver.

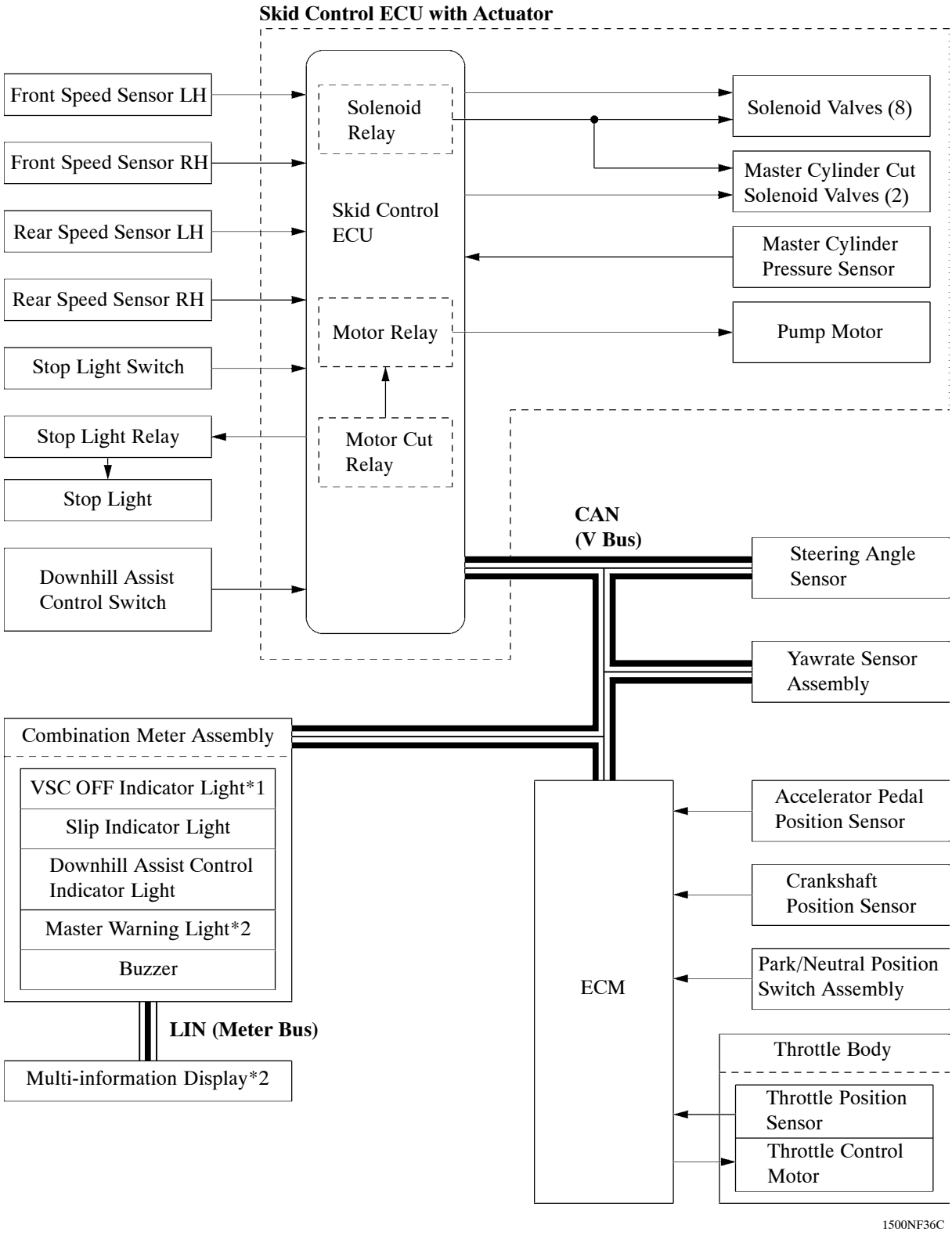
Service Tip

When the Downhill Assist Control switch is on but not all operating conditions are met, Downhill Assist Control will not operate. In this case, the Downhill Assist Control indicator light will blink to inform the driver. In addition, for models with multi-information display, the required Downhill Assist Control operation conditions will be shown.



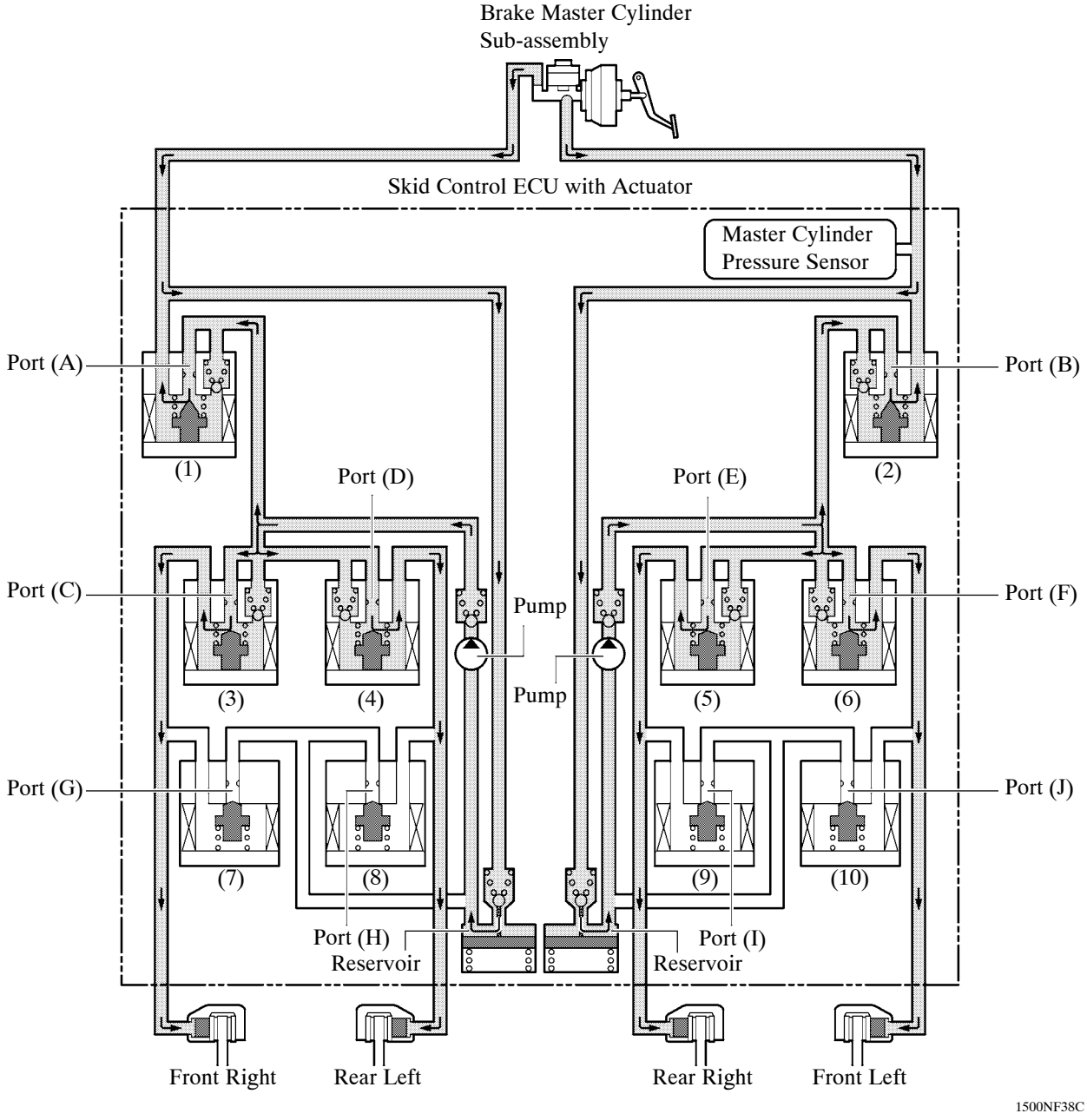
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▶ System Diagram ◀



*1: Models without Multi-information Display
*2: Models with Multi-information Display

▶ Downhill Assist Control Operation ◀



Item			Port	Downhill Assist Control Not Activated	Downhill Assist Control Activated		
					Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves		(1) (2)	(A) (B)	Off (Open)	On*	On*	On*
Front Brake	Pressure Holding Solenoid Valves	(3) (6)	(C) (F)	Off (Open)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves	(7) (10)	(G) (J)	Off (Closed)	Off (Closed)	Off (Closed)	On (Open)
	Wheel Cylinder Pressure Right	—	—	—	Increased	Held	Reduced
	Wheel Cylinder Pressure Left	—	—	—	Increased	Held	Reduced
Rear Brake	Pressure Holding Solenoid Valves	(4) (5)	(D) (E)	Off (Open)	Off (Open)	On (Closed)	On (Closed)
	Pressure Reduction Solenoid Valves	(8) (9)	(H) (I)	Off (Closed)	Off (Closed)	Off (Closed)	On (Open)
	Wheel Cylinder Pressure Right	—	—	—	Increased	Held	Reduced
	Wheel Cylinder Pressure Left	—	—	—	Increased	Held	Reduced
Pump				Off	On	On	On

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.