■BRAKE CONTROL SYSTEM (ABS with EBD, BRAKE ASSIST, TRC and VSC)

1. General

- The brake control system (ABS with EBD, Brake Assist, TRC and VSC) of new Kluger has a following function:

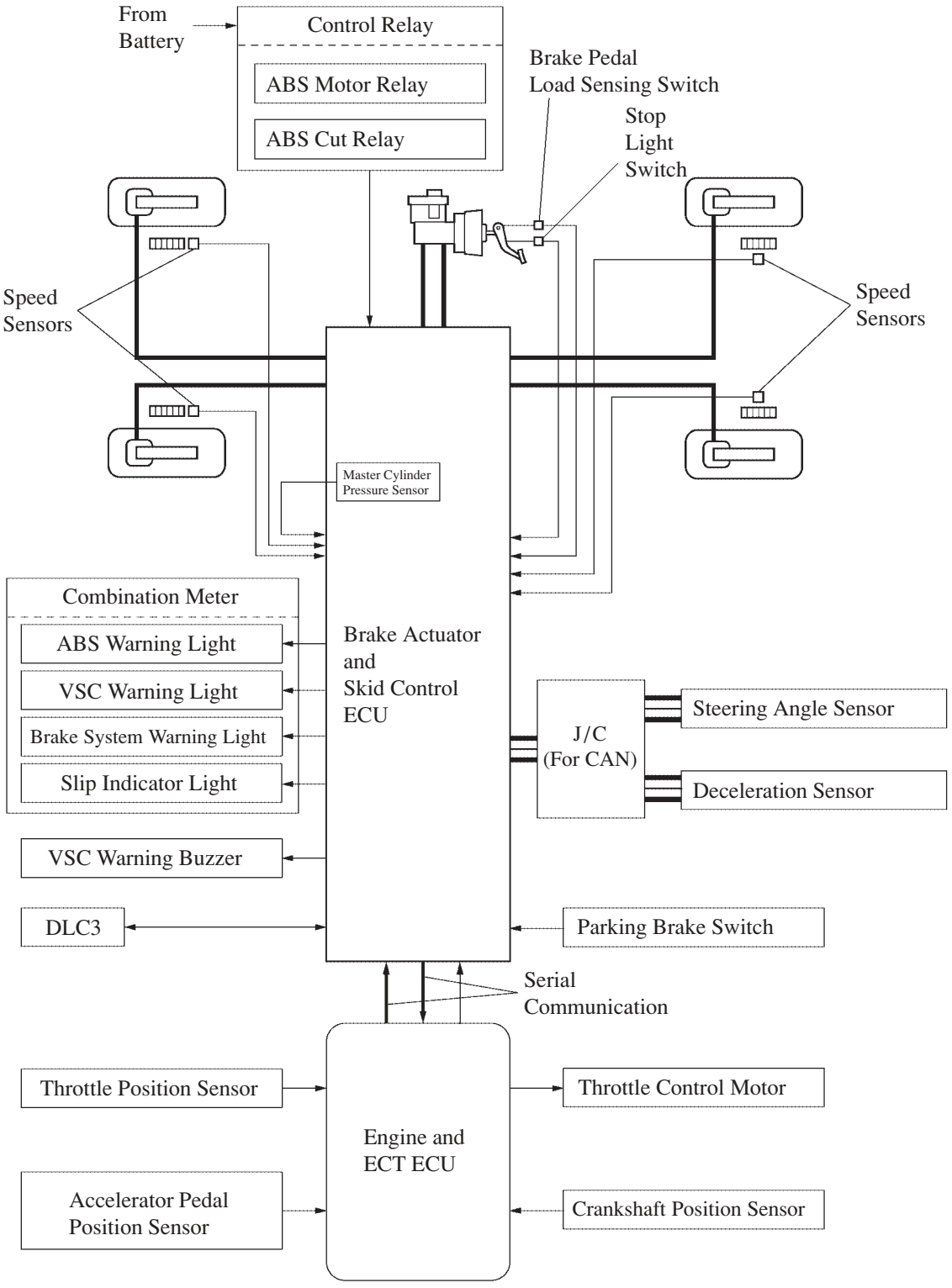
Function	Outline
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.
EBD (Electronic Brake force Distribution)	The EBD control utilizes ABS, realizing the proper brake force distribution between front and 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 Brake Assist has three functions: ● To increase the braking force if the brake pedal operation is not sufficient when urgent braking is needed. ● To increase the braking force if stronger brake force is required. ● To increase the braking force if the brake booster is in failure.
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.

- This model uses the CAN (Controller Area Network) communication system for communication between the skid control ECU, steering angle sensor and yaw rate sensor.

Service Tip

When brake control system (ABS with EBD) is activated, the brake pedal could shudder, which is a normal occurrence of the system in operation and should not be considered a malfunction.

▶ System Diagram ◀



: CAN (Controller Area Network)

D012CH28

2. Outline of EBD Control

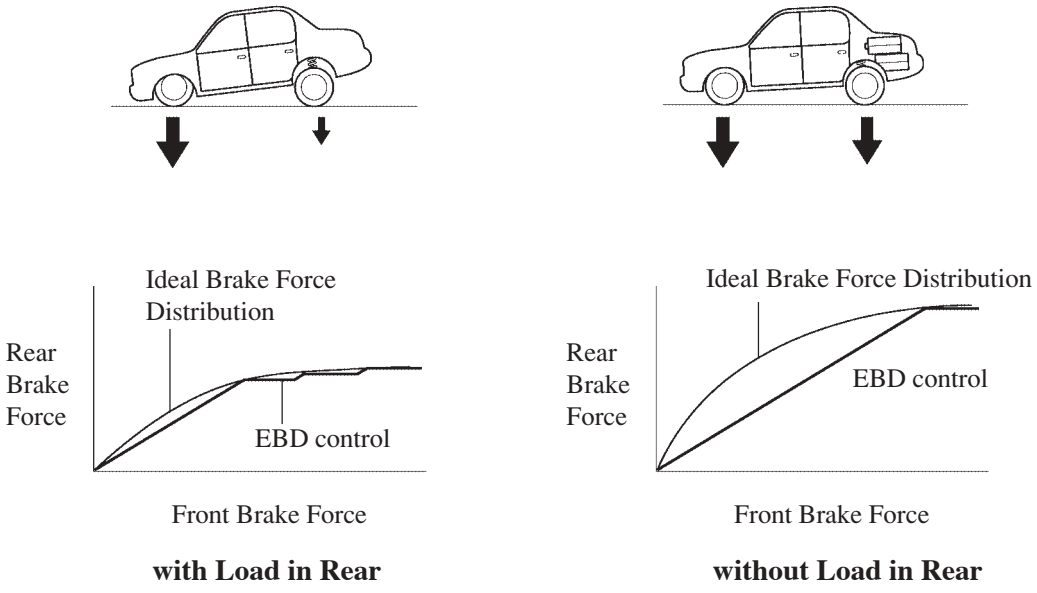
General

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 Wheels Brake Force Distribution

If the brakes are applied while the vehicle is moving straight forward, the transfer of the road 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.
For example, the amount of the brake force that is applied to the rear wheels during braking varies whether or not 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 the brake force to the rear is optimally controlled in order to effectively utilize the braking force of the rear wheels under these conditions.

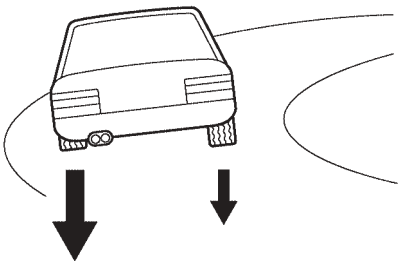
▶ EBD Control Concept ◀



182CH56

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

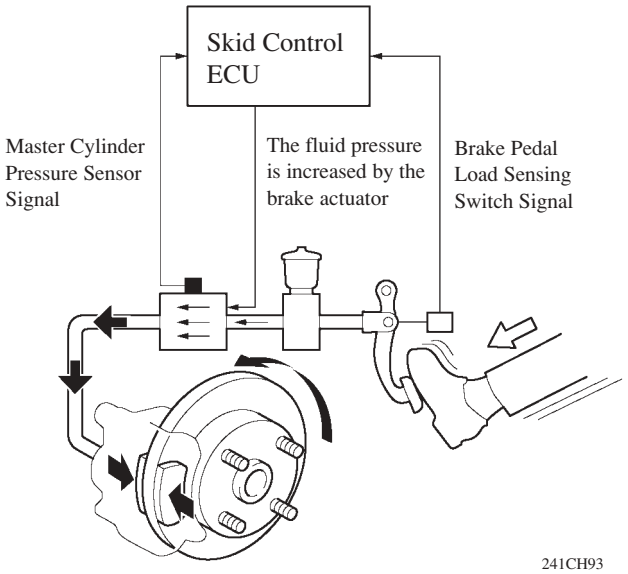
When the brakes are applied while the vehicle is cornering, the load that applied to the inner wheel decreases to the outer wheel increases.
The skid control ECU determines this condition by way of the signals from the speed sensor, and the brake actuator regulates the brake force in order to optimally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



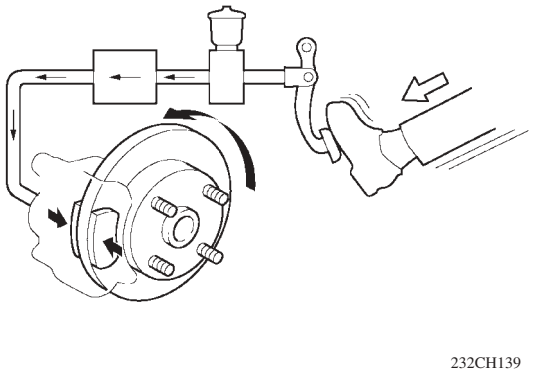
181CH56

3. Outline of Brake Assist System

- The Brake Assist System interprets a quick push of the brake pedal as emergency braking and supplements the braking 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 on the brake pedal. 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 emergency braking, the system activates the brake actuator to increase the brake fluid pressure.
  The Brake Assist System in combination with ABS helps ensure the vehicle's brake performance.
  A key feature of Brake Assist system is that the timing and the degree of braking assistance are designed to ensure that the driver does not discern anything unusual about the braking operation. When the driver intentionally eases up on the brake pedal, the system reduces the amount of assistance it provides.
- For example, in case that the vehicle is fully loaded, stronger brake force may be required even if the brakes are not applied quickly. Then, the brake assist system also operates to increase brake force.
- If the brake booster should fail, the skid control ECU detects the failure of the brake booster based on the signals from the brake pedal load sensing switch and the master cylinder pressure sensor and actuates the brake actuator to increase the brake fluid pressure to meet the requirements for braking.



with Brake Assist System



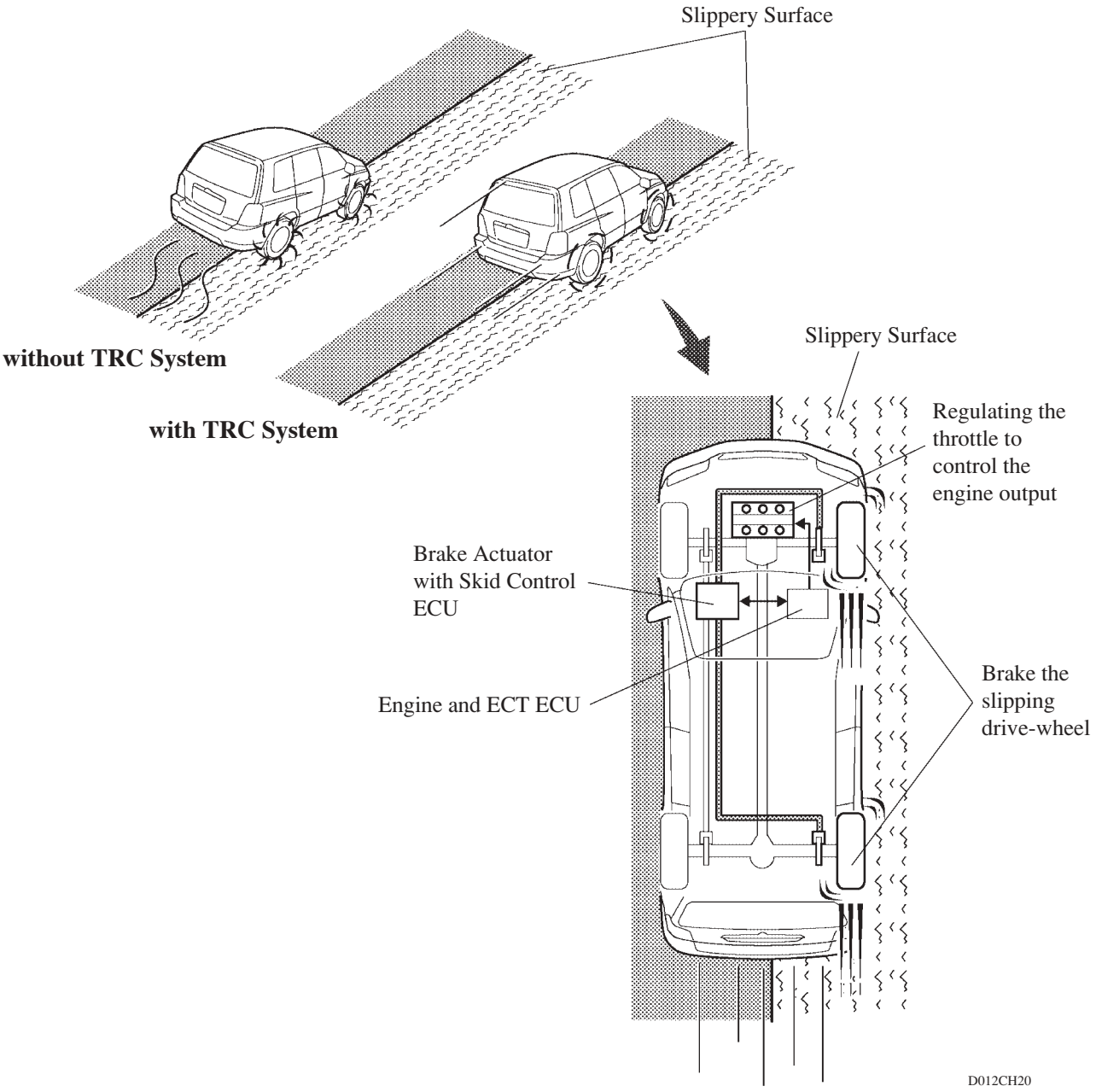
without Brake Assist System

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

4. Outline of TRC System

- If the driver presses the accelerator pedal aggressively when starting off or accelerating on a slippery surface, the drive wheel 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 system 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 system 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 smoothly.
  However, when the vehicle is equipped with the TRC system, the skid control ECU instantly determines the state of the vehicle and operates the brake actuator in order to apply the brake of the slipping drive wheel. Furthermore, the engine and ECT ECU receives the signals from the skid control ECU and regulates the throttle in order to control the engine output. Thus, the system can help maintain a stable driving force.

▶ Driving condition on road with different surface friction characteristics ◀

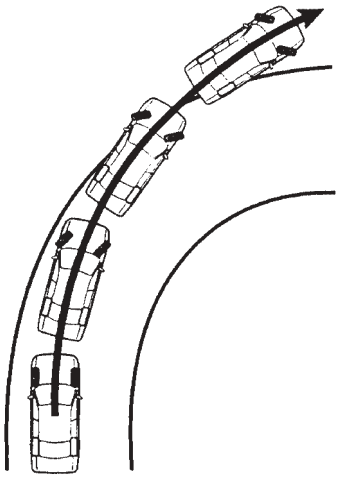


5. Outline of VSC System

General

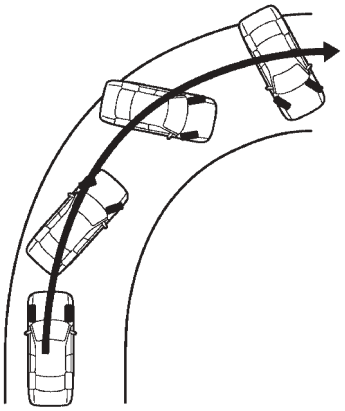
The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit.
The VSC system is designed to help control the vehicle behavior by controlling the engine output and the brakes at each wheel when the vehicle is under one of the conditions indicated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



151CH17

Front Wheel Skid Tendency



189CH100

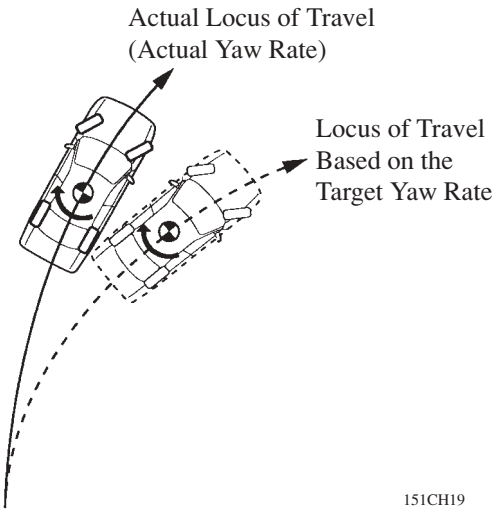
Rear Wheel Skid Tendency

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 Front Wheel Skid

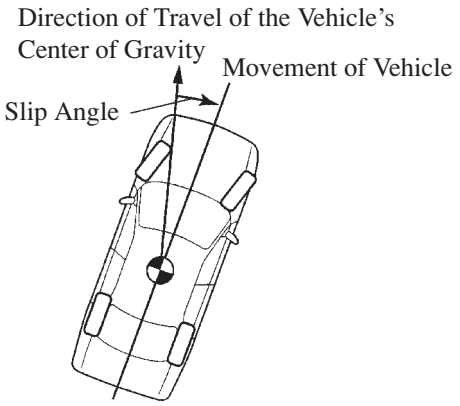
Whether or not the vehicle is in the state of front wheel skid is determined by the difference between the target yaw rate and the vehicle's actual yaw rate.
When the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) 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.



151CH19

2) Determining Rear Wheel Skid

Whether or not the vehicle is in the state of 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

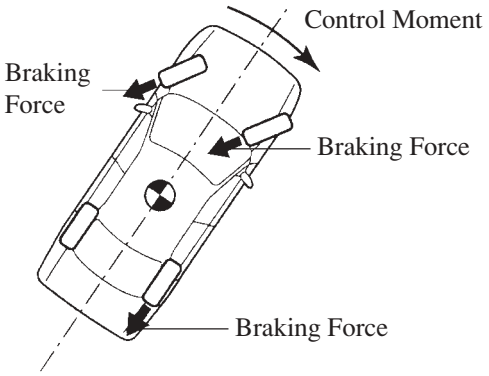
Method for VSC Operation

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 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.

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1) Dampening a Strong Front Wheel Skid

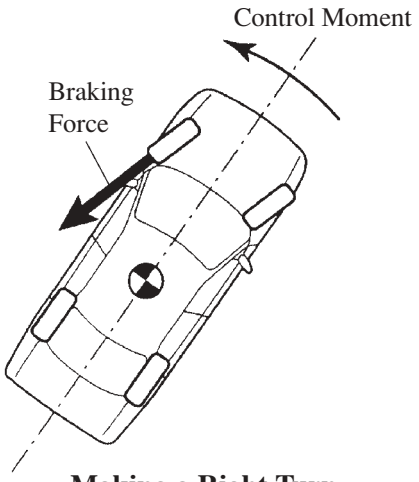
When the skid control ECU determines that there is a large front wheel skid tendency, it counteracts in accordance with the extent of that tendency. The skid control ECU controls the engine power output and applies the brakes of the front wheels and rear wheel of the inner circle of the turn in order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



Making a Right Turn 161ES30

2) Dampening a Strong Rear Wheel Skid

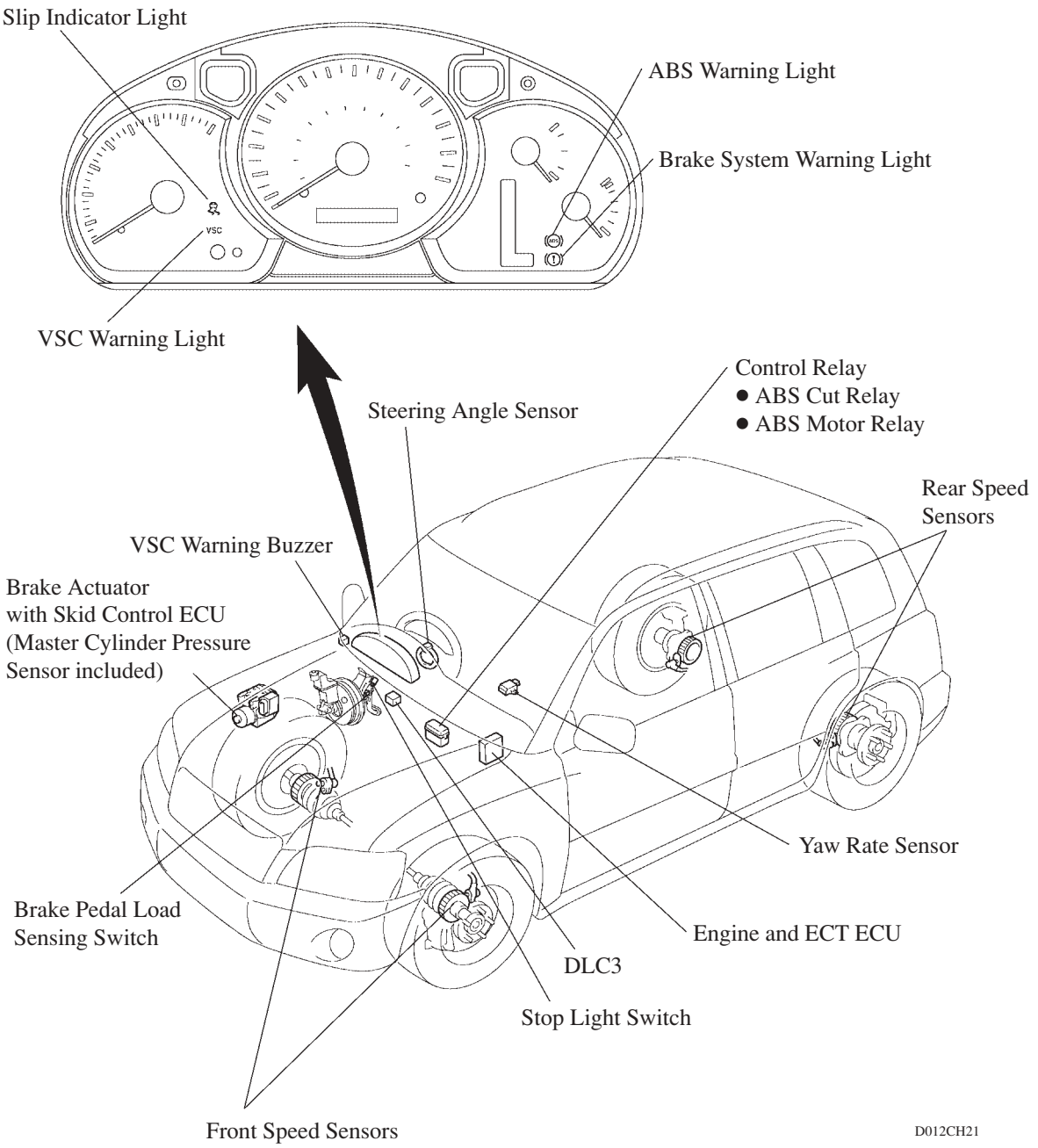
When the skid control ECU determines that there is a large rear wheel skid tendency, it counteracts in accordance with the extent of that tendency. It applies the brakes of the front wheel of the outer circle of the turn, and generates an outward moment of inertia in the vehicle, in order to help restrain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



204CH15

Making a Right Turn

6. Layout of Main Components



7. Function of Main Components

Components		Function
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 wheel cylinders.
	Skid Control ECU	Judges the vehicle driving condition based on signals from each sensor, and sends brake control signals to the brake actuator.
	Master Cylinder Pressure Sensor	Assembled in the brake actuator and detects the master cylinder pressure.
Combination Meter	Brake System Warning Light	● Lights up to alert the driver when a malfunction occurs in the brake system. ● Lights up to alert the driver when the skid control ECU detects a malfunction in the EBD control. (In this case, ABS warning light is also on.) ● Light up to inform the driver when the parking brake pedal depressed. ● Light up to alert the driver when the brake fluid level decreased.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS, EBD, and Brake Assist system.
	VSC Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the TRC and VSC.
	Slip Indicator Light	Blinks to inform the driver when the TRC and VSC is operated.
Speed Sensor (FL, FR, RL, RR)		Detects the wheel speed of each wheels.
Steering Angle Sensor		Detects the steering direction and angle of the steering wheel.
Yaw Rate Sensor		Detects the vehicle's yaw rate.
Control Relay	ABS Cut Relay	Cut off power to the pump motor in the brake actuator.
	ABS Motor Relay	Supply power to the pump motor in the brake actuator.
Stop Light Switch		Detects the brake pedal depressing signal.
VSC Warning Buzzer		This buzzer sounds intermittently to inform the driver that the VSC is actives.
Engine and ECT ECU		Controls the throttle valve opening angle based on the signals receives from the skid control ECU, in order to control the engine output. Also, sends the throttle valve opening angle signal, accelerator pedal position signal, and engine speed signal to the skid control ECU.
Brake Pedal Load Sensing Switch		● This switch turns ON when a pedal pressure of 59N (6 kgf) or more is applied, in order to detect the pressure on the brake pedal. ● Detects the brake booster failure.
Throttle Position Sensor		Detects the opening of the throttle valve and inputs it into the Engine and ECT ECU.
Accelerator Pedal Position Sensor		Detects the depressing of the accelerator pedal and inputs it into the Engine and ECT ECU.
Crankshaft Position Sensor		Detects the engine speed, and sends it via the Engine and ECT ECU to the skid control ECU.
Throttle Control Motor		Controls the opening of the throttle valve in accordance with the signals received from the Engine and ECT ECU.

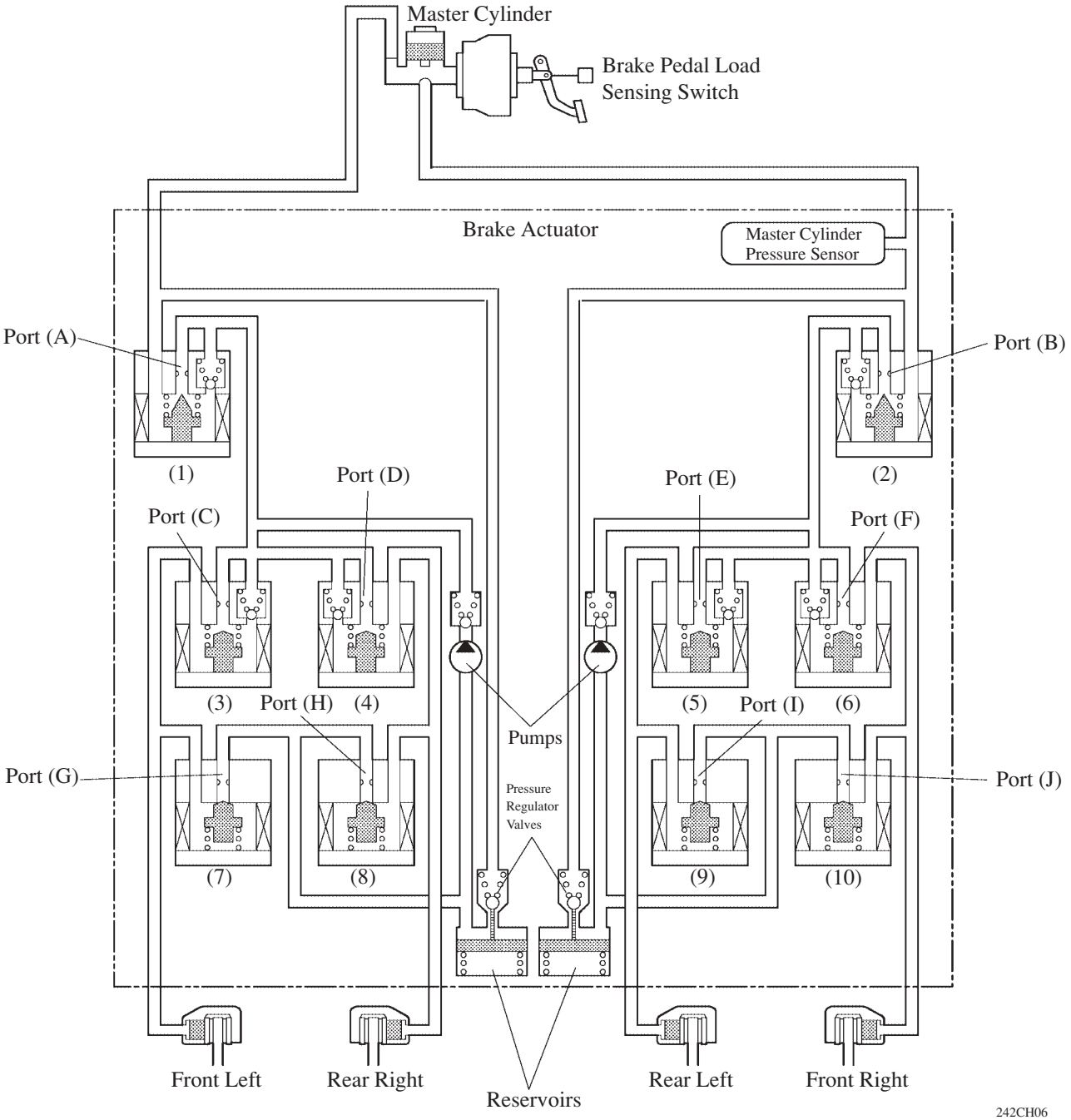
8. Construction and Operation of Main Components

Brake Actuator

1) General

- A brake actuator with an integrated skid control ECU has been adopted.
- The brake actuator consists of 10 two-position solenoid valves, 1 pump motor, 2 trochoid gear type pump, 2 reservoirs, and master cylinder pressure sensor.
  The 10 two-position solenoid valves consists of the following:
  – 2 master cylinder cut solenoid valves (linear type) [(1), (2)]
  – 4 pressure holding solenoid valves [(3), (4), (5), (6)]
  – 4 pressure reduction solenoid valves [(7), (8), (9), (10)]

▶ Hydraulic Circuit ◀

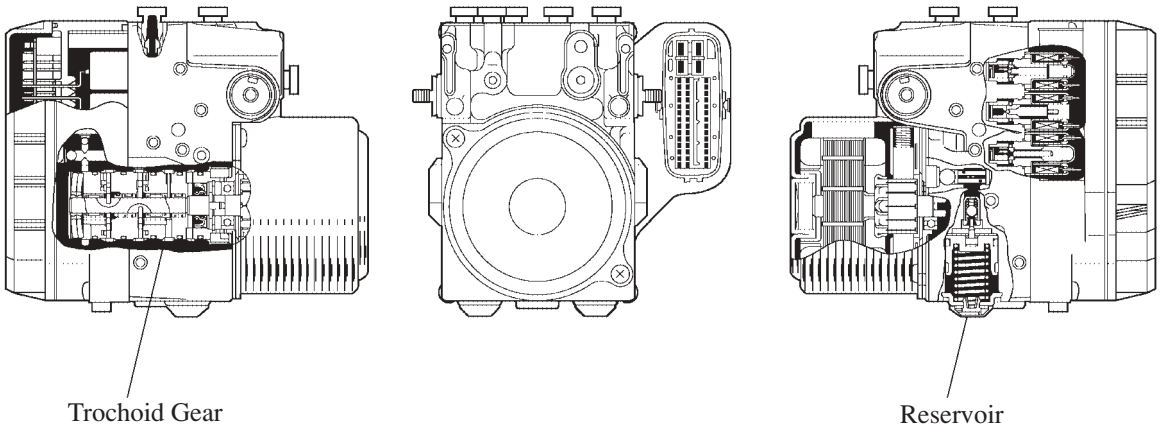


▶ Function of Main Components ◀

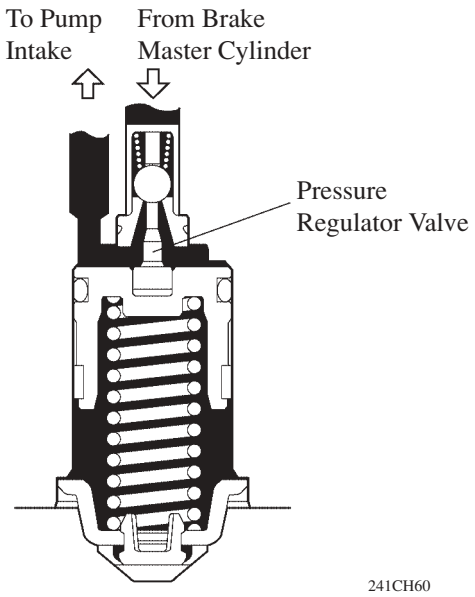
Component		Function
(1), (2)	Master Cylinder Cut Solenoid Valve (Linear Type)	To effect the respective brake controls of the Brake Assist, TRC, and VSC system, a combination of the ON/OFF conditions of the master cylinder cut solenoid valve is used to appropriately vary the fluid pressure.
(3), (4), (5), (6)	Pressure Holding Valve	Each wheel cylinder contains a pressure holding solenoid valve and a pressure reduction solenoid valve. A combination of the ON/OFF conditions of the respective valves is used in order to change the increase mode, holding mode, or the reduction mode during the operation of the ABS, TRC, and VSC system.
(7), (8), (9), (10)	Pressure Reduction Valve	
Master Cylinder Pressure Sensor		The master cylinder pressure sensor converts the brake fluid pressure that the master cylinder applies to the brake actuator into an electrical signal and sends it to the skid control ECU. The skid control ECU can thus monitor the brake fluid pressure that is applied to the brake actuator in accordance with this signal.
Reservoir		While effecting the reduction mode during the operation of the ABS, TRC, and VSC system, the reservoir stores the brake fluid that has returned from the wheel cylinders. It also functions as an accumulator.
Pump		Pumps the brake fluid that is stored in the reservoir and returns it to the master cylinder. While effecting the increase mode during the operating of the Brake Assist, TRC, and VSC system, the pump operates in order to apply brake fluid pressure to the wheel cylinders.
Pressure Regulator Valve		Regulates the pressure of the fluid supplied to the pump, and closes the pressure passage between the master cylinder and the pump when the brake pedal is depressed.

2) Pump and Reservoir

- The trochoid gear type pump has been newly adopted, to reduce operating noise.



- The pressure regulator valve has been adopted in the reservoir for the purpose of regulating the pressure of the fluid to be supplied to the pump and to close the passage between the pump and the master cylinder during braking.



Reservoir Cross Section

ABS with EBD Operation

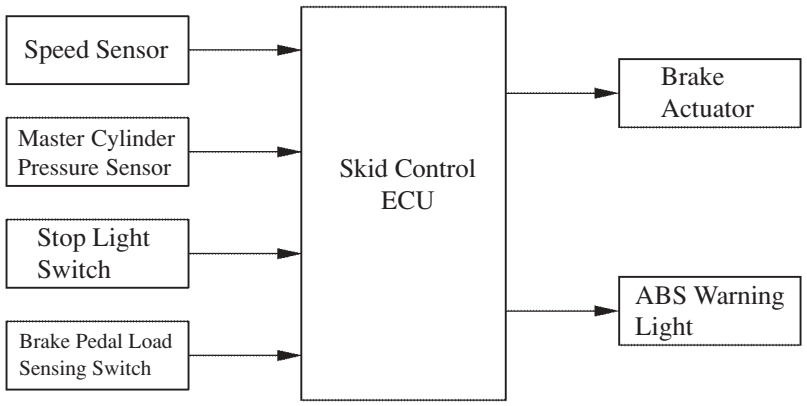
The ABS with EBD operation is the same as the ABS with EBD operation of Brake Control System (ABS with EBD and Brake Assist). See page CH-60.

Brake Assist Operation

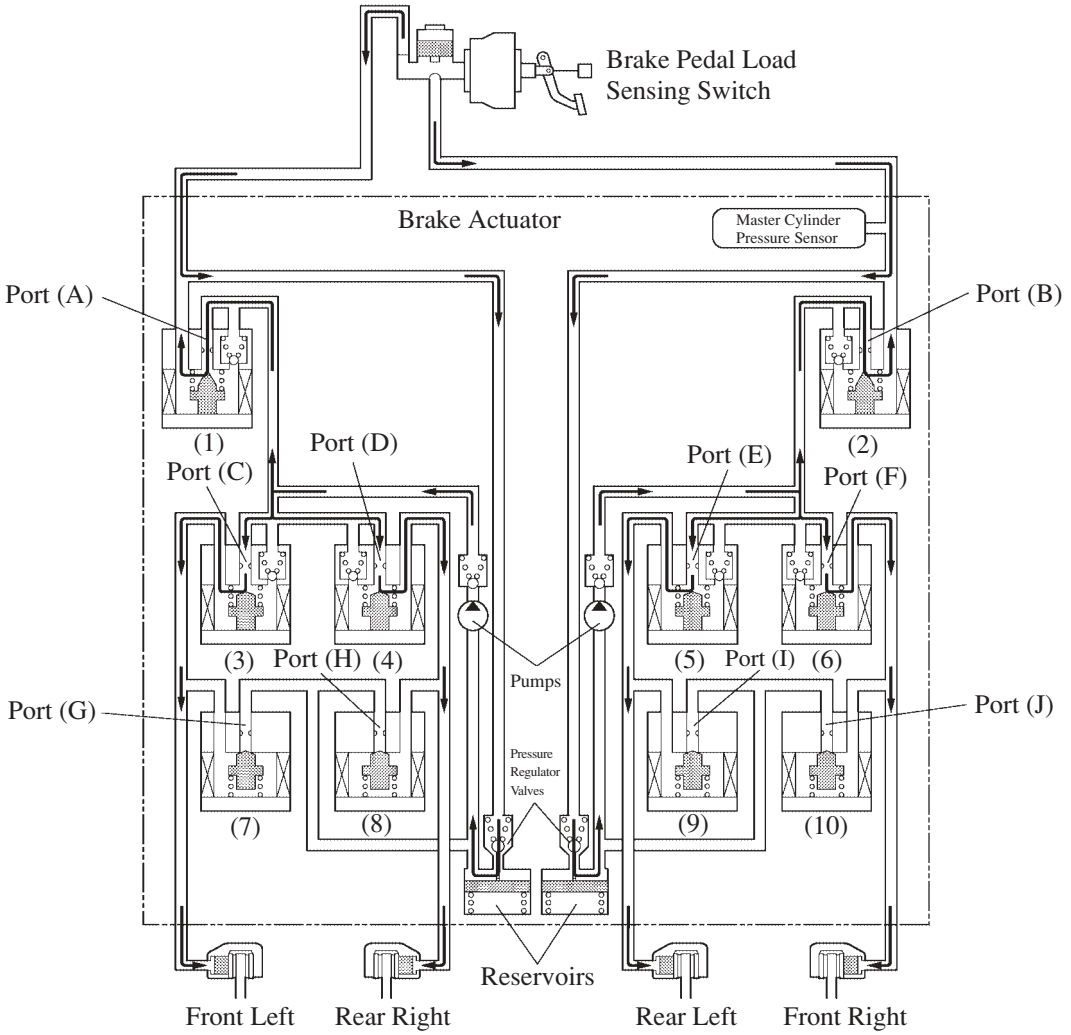
In the event of emergency braking, the skid control ECU detects the driver's intention based on the speed of the pressure increase in the master cylinder determined by the pressure sensor signal. If the ECU judges the need for the additional brake assist, the fluid pressure is generated by the pump in the actuator and directed to the wheel cylinder to apply a greater fluid pressure than the master cylinder.Also in the following cases, the skid control ECU provides brake assist.

- In the event of a brake booster failure, the skid control ECU detects the failure based on the data from the brake load sensing switch and master cylinder pressure sensor.
- In the event the vehicle is fully loaded, the skid control ECU detects the condition using the master cylinder pressure sensor and vehicle speed signal.

▶ System Diagram ◀



242CH14



242CH07

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)	OFF (Open)
	Port: (C), (D), (E), (F)		
(7), (8), (9), (10)	Pressure Reduction Solenoid Valve	OFF (Close)	OFF (Close)
	Port: (G), (H), (I), (J)		

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

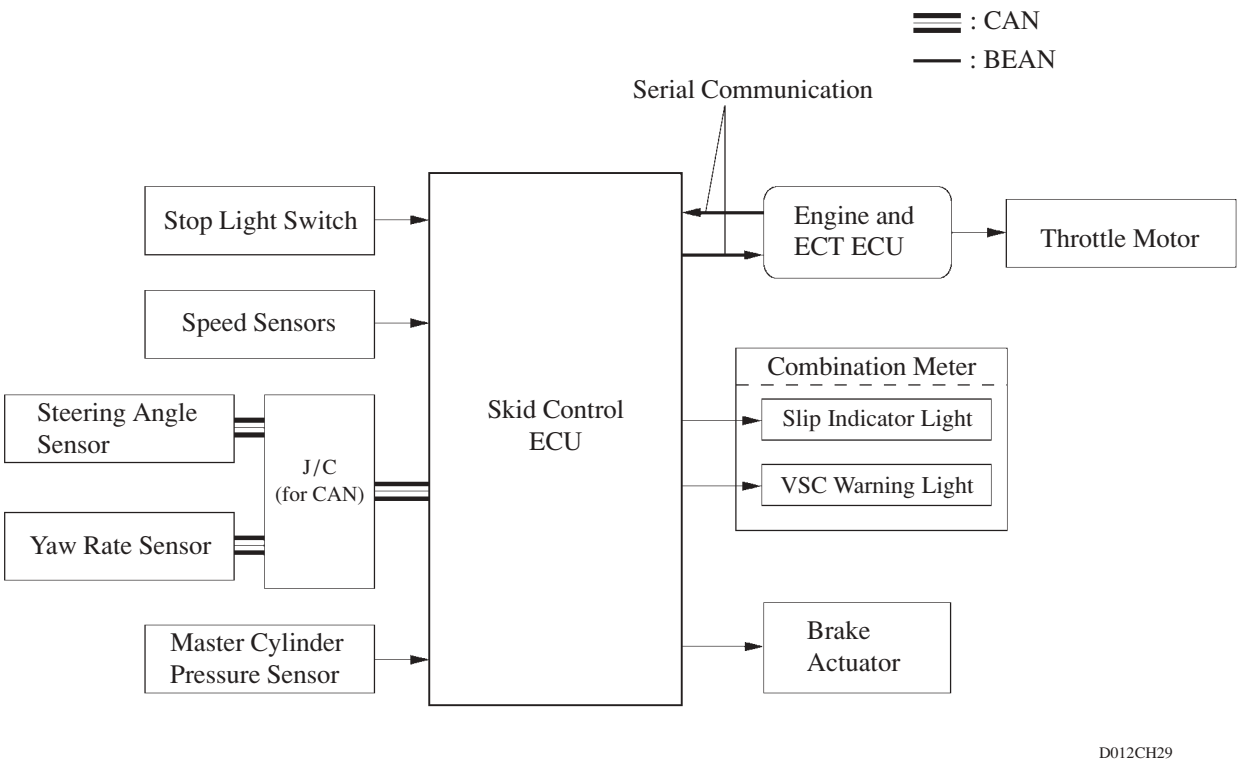
TRC Operation

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.

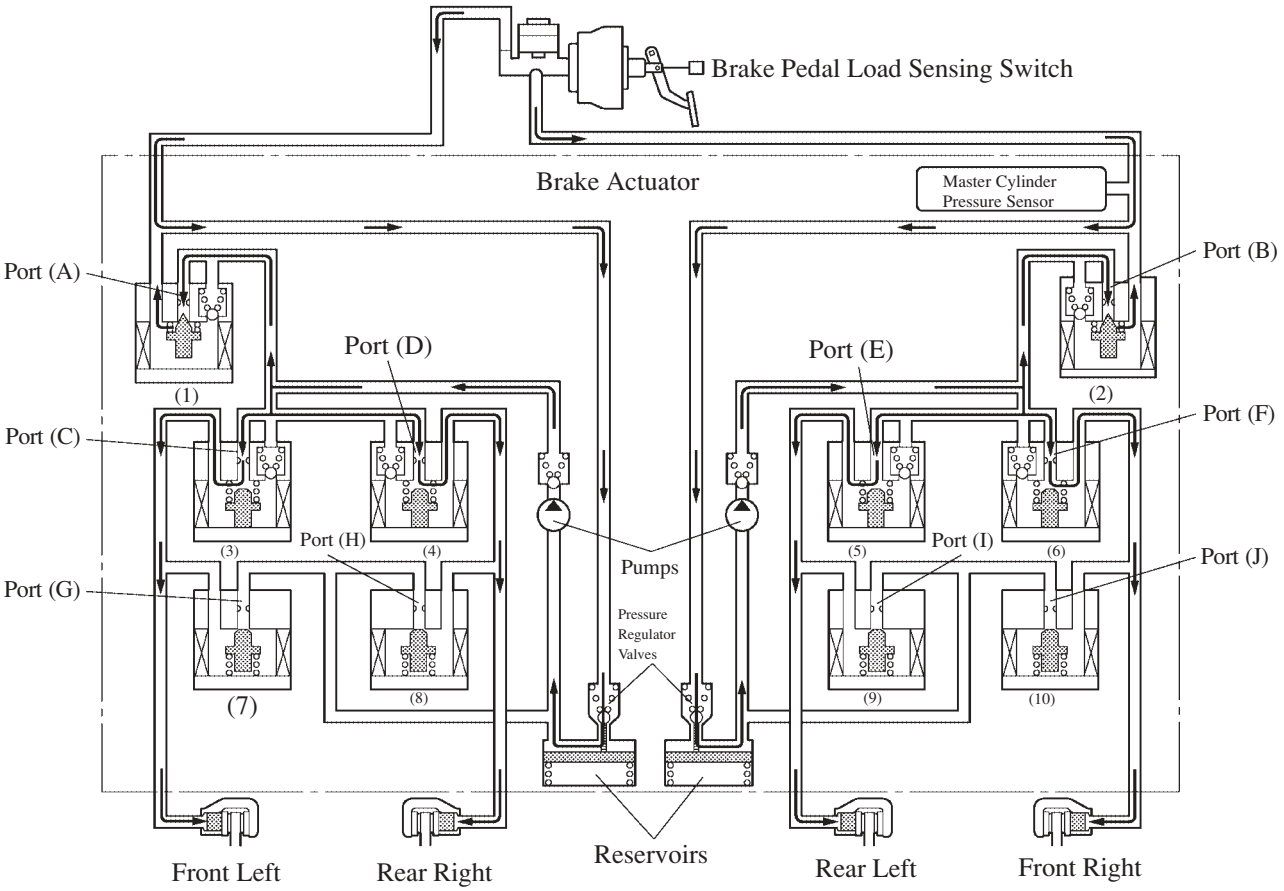
The diagram below shows the hydraulic circuit in the pressure increase mode when the TRC system is activated.

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 ◀



CH



Increase Mode

D012CH37

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

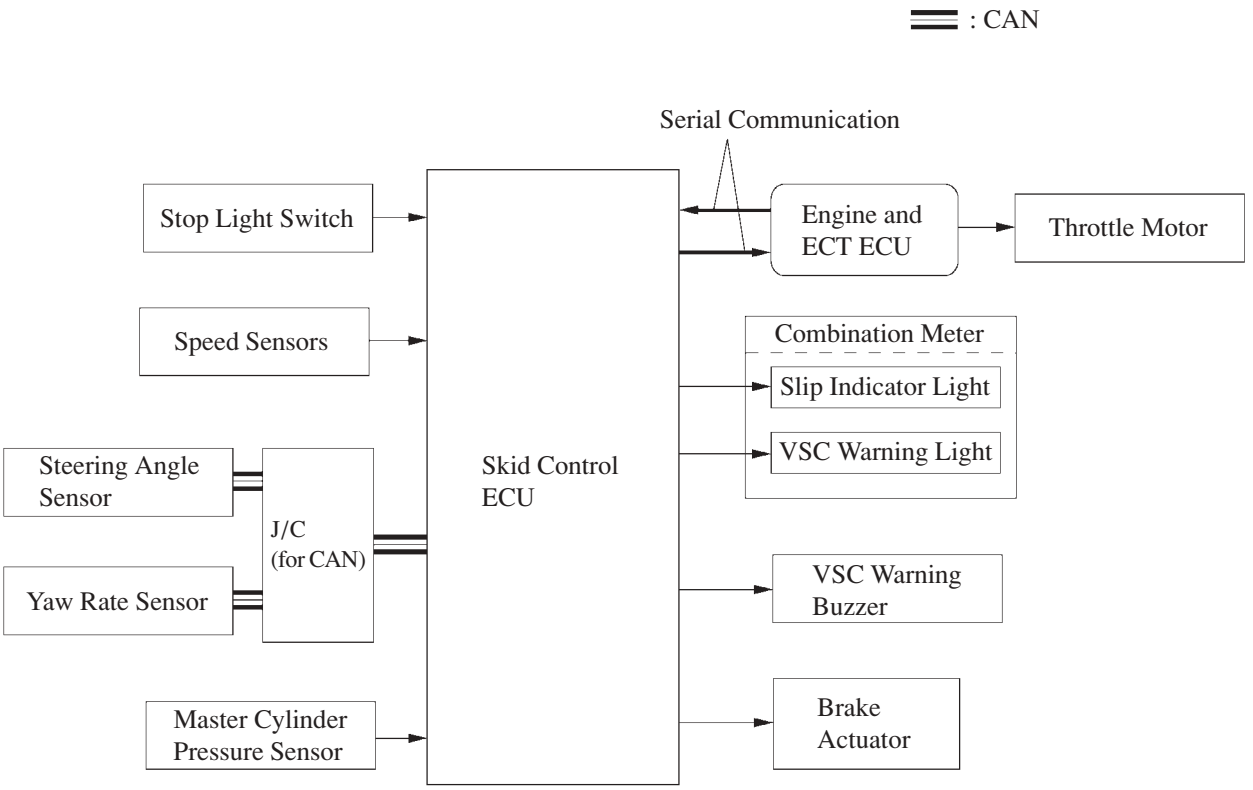
*: The solenoid valve controls the hydraulic pressure between “open” through “close ”according to the operating condition by adjusting continually.

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 to front wheel skid or rear wheel skid is controlled.

▶ System Diagram ◀



D012CH31

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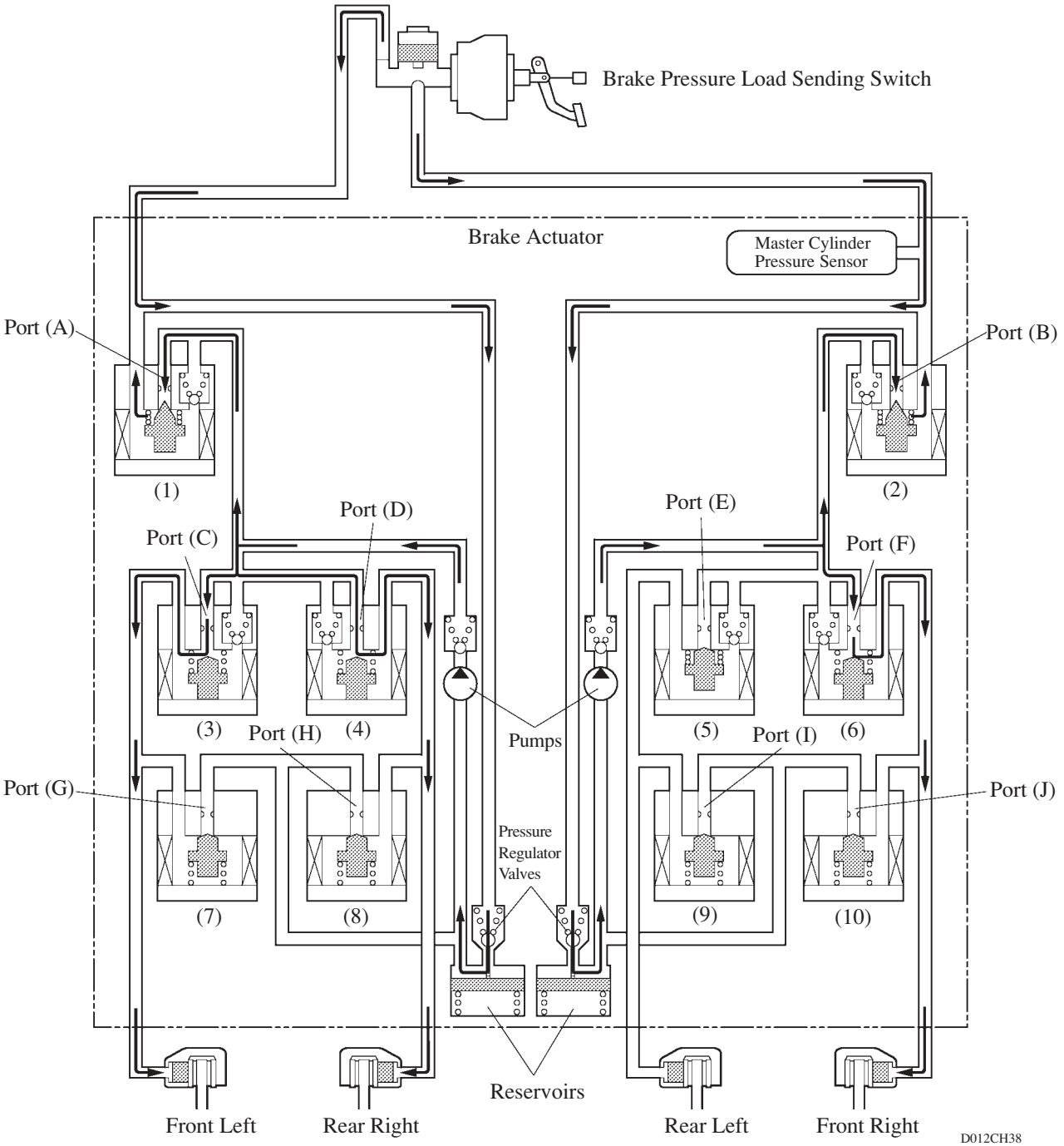
2) Front Wheel Skid Control (Turn to the Right)

In the front wheel skid control, the brakes of the front wheels and the rear wheel of the inner circle 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 front wheel skid condition while the vehicle makes a right turn.

The pressure holding solenoid valve and the pressure reduction solenoid valve are turned ON/OFF according to the ABS operation pattern.



Increase Mode

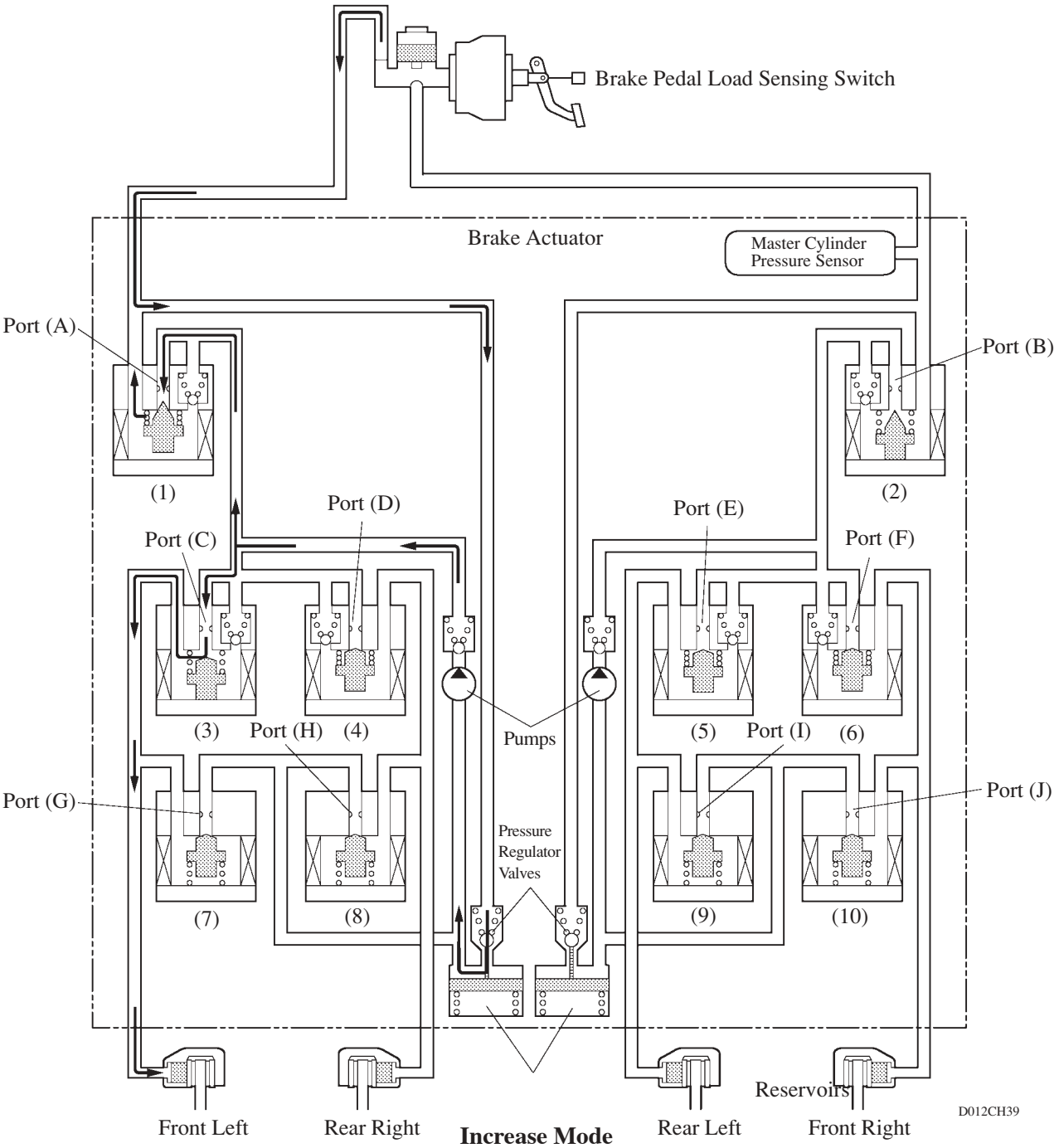
Item			VSC not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve Port: (A), (B)		OFF (Open)	ON*	ON*	ON*
Front Brake	(3)	Pressure Holding Solenoid Valve Port: (C)	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
	(6)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

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

3) Rear Wheel Skid Control (Turn to the Right)

In rear wheel skid control, the brake of the front wheel of the outer circle of the turn is applied. As an example, the diagram below shows the hydraulic circuit in the pressure increase mode, as it controls the rear wheel skid condition while the vehicle make a right turn.

As in front wheel skid control the pressure holding solenoid valve and the pressure reduction solenoid valve are turned ON/OFF according to the ABS operating pattern.



Increase Mode

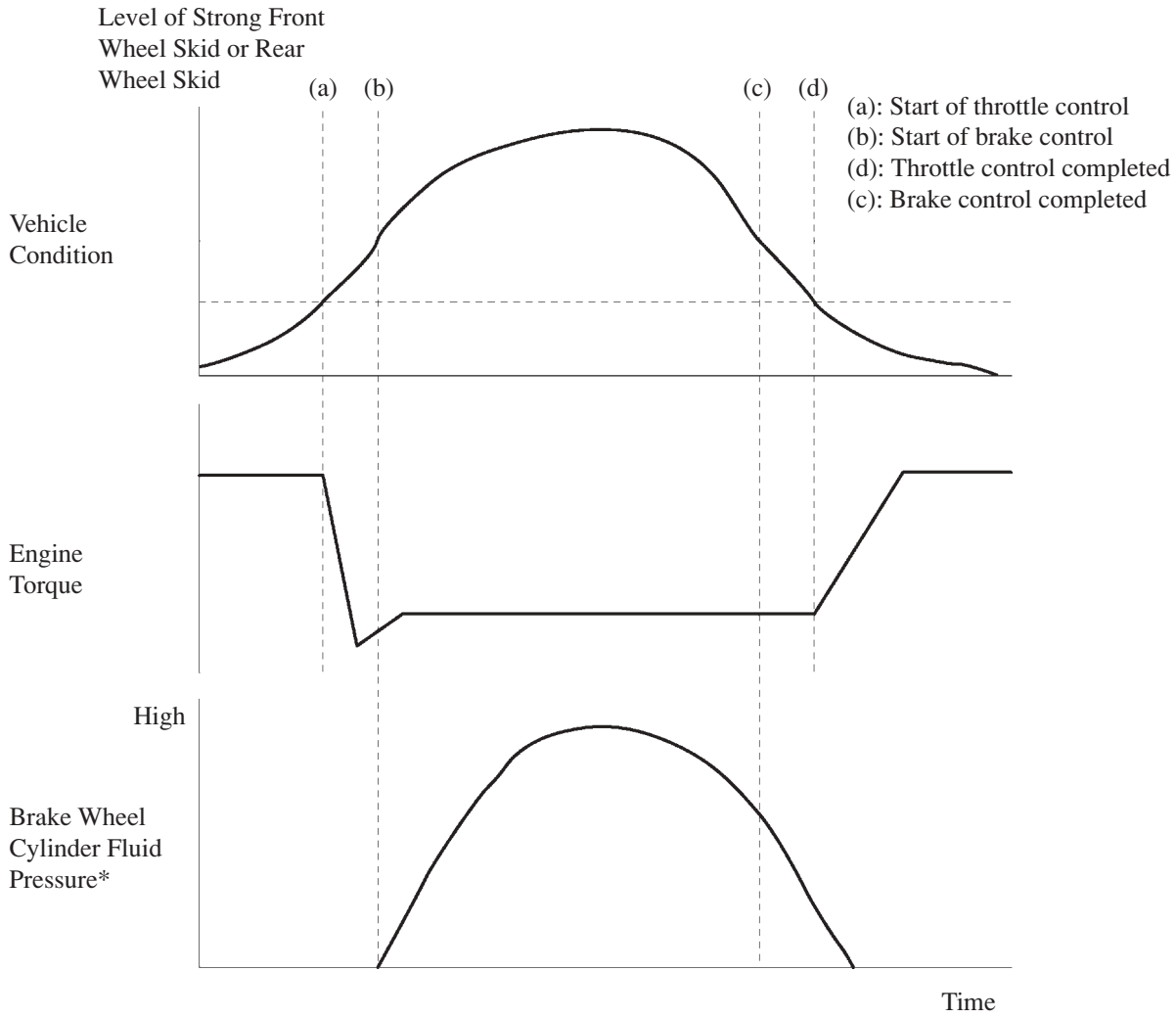
Item			VSC not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
(1)	Master Cylinder Cut Solenoid Valve Port: (A)		OFF (Open)	ON*	ON*	ON*
(2)	Master Cylinder Cut Solenoid Valve Port: (B)		OFF (Open)	OFF (Open)	OFF (Open)	OFF (Open)
Front Brake	(3)	Pressure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

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

9. Skid Control ECU

VSC

Based on the 4 different sensor signals received from the speed sensors, yaw rate sensor and steering angle sensor, the skid control ECU calculates the vehicle condition.
If a strong front wheel skid or rear wheel skid tendency is created during an emergency avoidance maneuver or cornering, and the skid control ECU determines that the amount of vehicle condition exceeds a prescribed value, it controls the engine torque through throttle and the brake fluid pressure according to the amount of needed to control the vehicle.



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

Initial Check

Each time the ignition switch is turned ON, and the vehicle reaches approximately speed of 6 km/h (4 mph) or more, the skid control ECU performs the initial check.
The functions of each solenoid valve and pump motor in the brake actuator are checked in order.

Self-Diagnosis

- If the skid control ECU detects a malfunction in the ABS with EBD, Brake Assist, TRC, and VSC systems, the ABS, brake system and VSC warning lights that corresponds to the function in which the malfunction has been detected lights up, as indicated in the table below, to alert the driver of the malfunction.

○: Light ON —: Light OFF

Item	ABS	EBD	Brake Assist	TRC	VSC
ABS Warning Light	○	○	○	—	—
Brake System Warning Light	—	○	—	—	—
VSC Warning Light	—	—	—	○	○
Slip Indicator Light	—	—	—	—	—

- At the same time, the DTC (Diagnostic Trouble Code) are stored in memory. The DTC can be read by connecting the SST (09843-18040) between the Tc and CG terminals DLC3, and observing the blinking of the ABS and VSC warning light (2-digit code), or by connecting a hand-held tester (5-digit code).
- 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 a hand-held tester. This check function performs yaw rate sensor zero point calibration, yaw rate sensor check, master cylinder pressure sensor check, and speed sensor check.
- If the skid control ECU detects a malfunction during a sensor check, it stores the DTC in its memory. This DTC can be read during a sensor signal check operation by connecting the Tc and CG terminals of the DLC3 and observing the blinking of the ABS warning light and the VSC warning light, or on a hand-held tester.
- If the CAN has communication error at ECU or sensors, multiple DTCs (Diagnostic Trouble Codes) are output simultaneously to indicate the malfunction location.

For details on the DTC that are stored in skid control ECU memory and the DTC that are output through the sensor check function, see the Kluger Repair Manual (Pub. No. DR1087E).

▶ DTC Chart (Blinking ABS Warning Light) ◀

DTC No.		Detection Item	DTC No.		Detection Item
2-digit	5-digit		2-digit	5-digit	
11	C0278	Open circuit in ABS SOL relay circuit	38	C1238	Foreign matter in attached on the tip of the right rear sensor
12	C0279	Short circuit in ABS SOL relay circuit	39	C1239	Foreign matter in attached on the tip of the left rear sensor
13	C0273	Open circuit in ABS MTR relay circuit	41	C1241	Low battery positive voltage
14	C0274	Short circuit in ABS MTR relay circuit	43	C1243	Malfunction in deceleration sensor (constant output)
21	C0226	Open or short circuit in brake actuator solenoid circuit (SFR circuit)	44	C1244	Malfunction in deceleration sensor
22	C0236	Open or short circuit in brake actuator solenoid circuit (SFL circuit)	45	C1245	Malfunction in deceleration sensor
23	C0246	Open or short circuit in brake actuator solenoid circuit (SRR circuit)	46	C1246	Malfunction in master cylinder pressure sensor
24	C0256	Open or short circuit in brake actuator solenoid circuit (SRL circuit)	49	C1249	Open circuit in stop light switch circuit
25	C1225	Open or short circuit of brake actuator solenoid circuit (SM circuit)	51	C1251	● ABS pump motor is locked ● Open circuit in pump motor circuit
31	C0200	Right front wheel speed sensor signal malfunction	67	C1267	Malfunction in brake pedal load sensing switch
32	C0205	Left front wheel speed sensor signal malfunction	91	C1361	Short circuit in ABS motor fail safe relay circuit
33	C0210	Right rear wheel speed sensor signal malfunction	94	U0121	Malfunction in CAN communication
34	C0215	Left rear wheel speed sensor signal malfunction	95	U0124	Malfunction in CAN communication with deceleration sensor
35	C1235	Foreign matter in attached on the tip of the right front sensor	97	C1381	Malfunction in power supply voltage yaw rate sensor
36	C1236	Foreign matter in attached on the tip of the left front sensor	Always ON		● Malfunction in skid control ECU ● Open circuit in ABS warning light circuit

▶ DTC Chart of Sensor Check (Blinking ABS Warning Light) ◀

DTC No.		Detection Item	DTC No.		Detection Item
2-digit	5-digit		2-digit	5-digit	
71	C1271	Low output voltage of right front speed sensor	76	C1276	Abnormal change in output voltage of left front speed sensor
72	C1272	Low output voltage of left front speed sensor	77	C1277	Abnormal change in output voltage of right rear speed sensor
73	C1273	Low output voltage of right rear speed sensor	78	C1278	Abnormal change in output voltage of left rear speed sensor
74	C1274	Low output voltage of left rear speed sensor	81	C1281	Master cylinder pressure sensor output signal is faulty
75	C1275	Abnormal change in output voltage of right front speed sensor			

▶ DTC Chart (Blinking VSC Warning Light) ◀

DTC No.		Detection Item	DTC No.		Detection Item
2-digit	5-digit		2-digit	5-digit	
31	C1231	Malfunction in steering angle sensor	44	C1224	Open or short circuit in NEO signal circuit
32	C1232	Malfunction in deceleration sensor	51	C1201	Malfunction in engine and ECT ECU
34	C1234	Malfunction in yaw rate sensor	53	C1203	Malfunction in engine and ECT ECU communication circuit
36	C1210	Zero point calibration of yaw rate sensor undone	62	U0123	Malfunction in CAN communication with yaw rate sensor
39	C1336	Zero point calibration of deceleration sensor undone	63	U0126	Malfunction in CAN communication with steering angle sensor
43	C1223	Malfunction in ABS control system	Always ON		● Malfunction in skid control ECU ● Open circuit in VSC warning indicator circuit

▶ DTC Chart of Sensor Check (Blinking VSC Warning Light) ◀

DTC No.		Detection Item
2-digit	5-digit	
71	C0371	Yaw rate sensor output signal is faulty

Fail-Safe

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