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

1. General

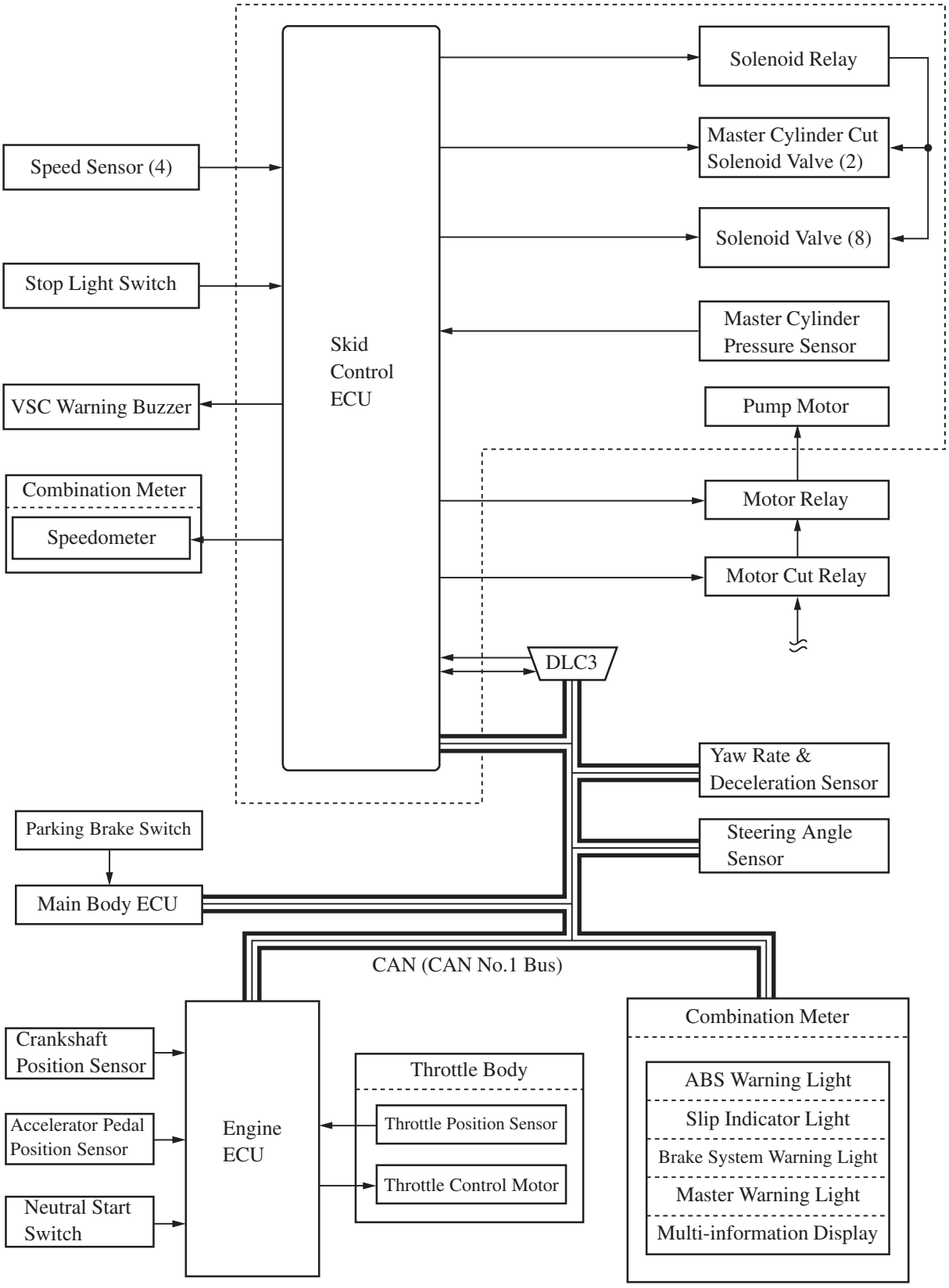
The brake control system (ABS with EBD, brake assist, TRC and VSC) of new Camry has the following functions:

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)	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 (Electrical Type)	The primary purpose of the brake assist is to provide an auxiliary brake force to assist the driver who cannot generate a large brake force during emergency braking, thus helping draw the vehicle's brake performance.
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.

Service Tip

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

2. System Diagram



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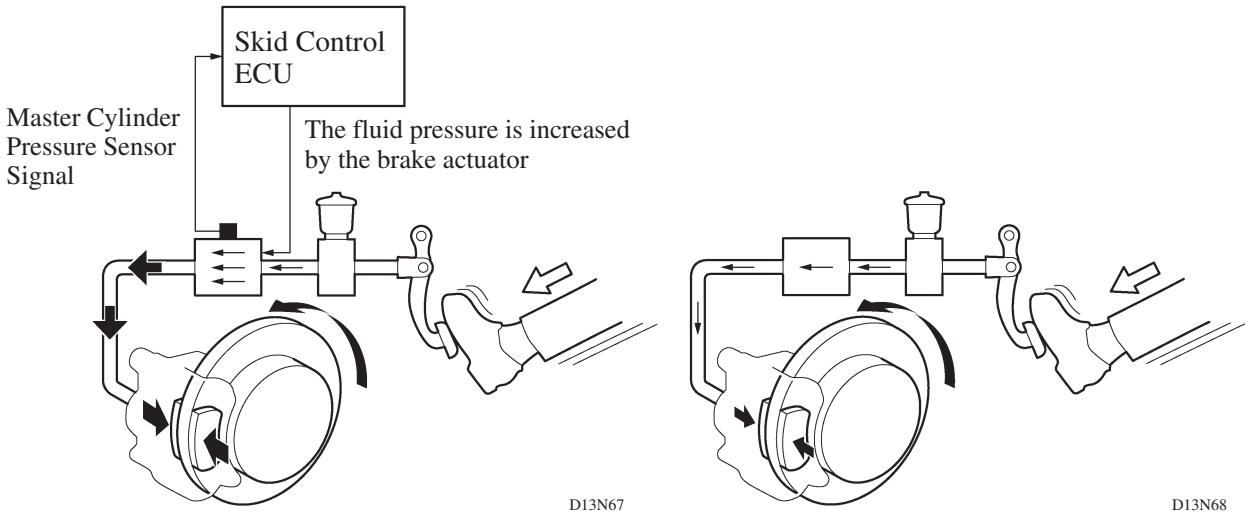
3. Outline of EBD Control Function

The detailed outline is the same as that of brake control system (ABS with EBD). For details, see page CH-89.

4. Outline of Brake Assist System

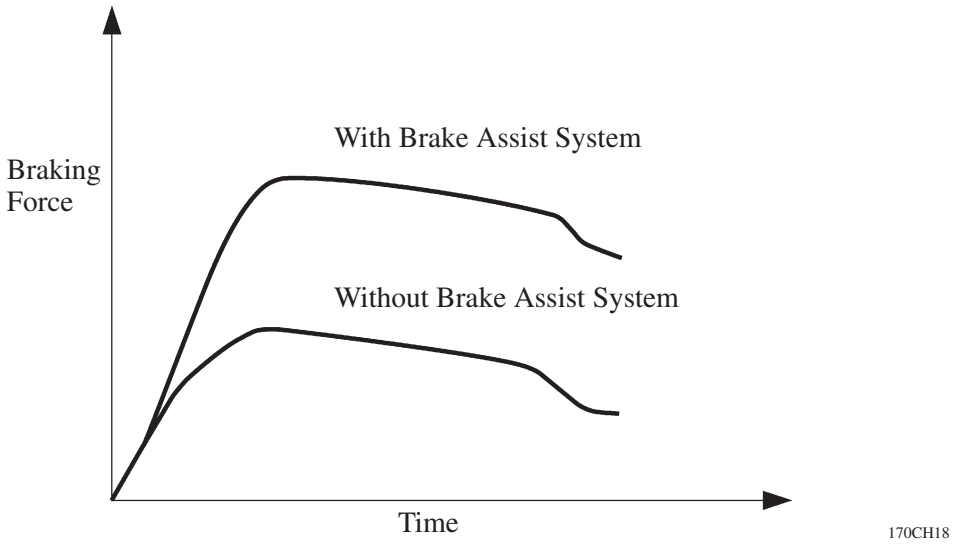
- The brake assist system in combination with ABS helping improves the vehicle's brake performance.
- The brake assist system interprets a quick push of the brake pedal as emergency braking and supplements the brake power applied if the driver has not stepped hard enough on the brake pedal. In emergencies, driver, especially inexperienced ones, often panic and do not apply sufficient pressure on the brake pedal.
- A key feature of brake assist system 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 system 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 make an emergency braking. If the skid control ECU determines that the driver intends the emergency braking, the system activates the brake actuator to increase the brake fluid pressure, which increases the braking force.

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



With Brake Assist System **Without Brake Assist System***

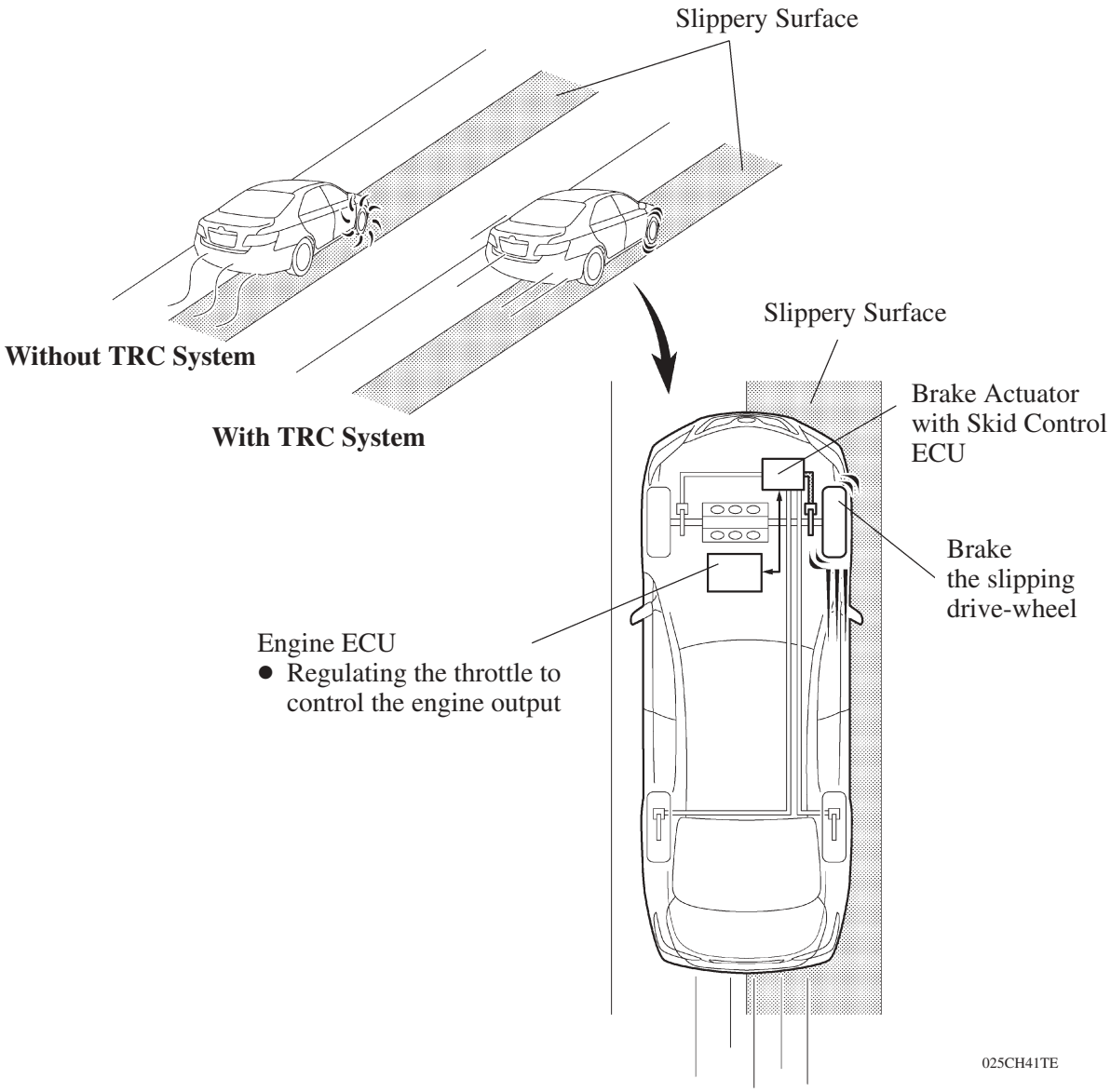
*: The basic performance of the brake is the same as of the model with the brake assist



5. Outline of TRC Function

- 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 function 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 could become unstable.
  However, when the vehicle is equipped with the TRC function, 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 ECU receives the signals from the skid control ECU and regulates the throttle in order to control the engine output. Thus, this function can constantly maintain a stable vehicle posture.

▶ Driving condition on road with different surface friction characteristics ◀

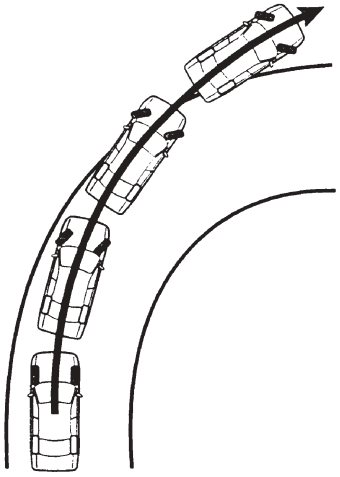


6. Outline of VSC Function

General

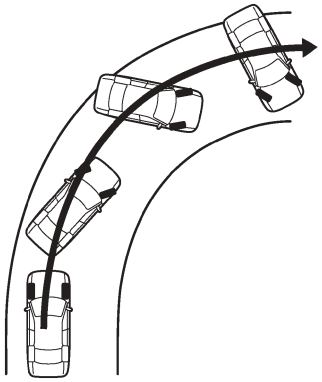
The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit.
The VSC function is designed to help control the vehicle behavior by controlling the motive force and the brakes at each wheel when the vehicle is under one of the conditions indicated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

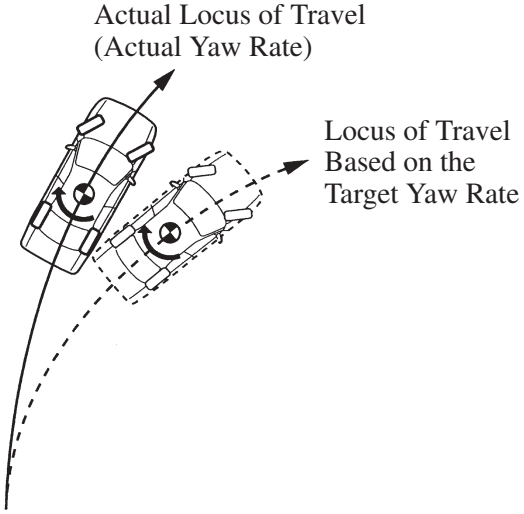
Rear Wheel Skid Tendency

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

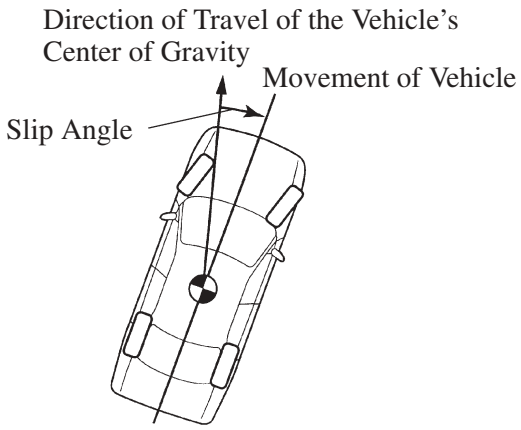
Whether or not the vehicle is in the state of front wheel skid is determined by the difference between the target yaw rate and the vehicle's actual yaw rate.
When the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle)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

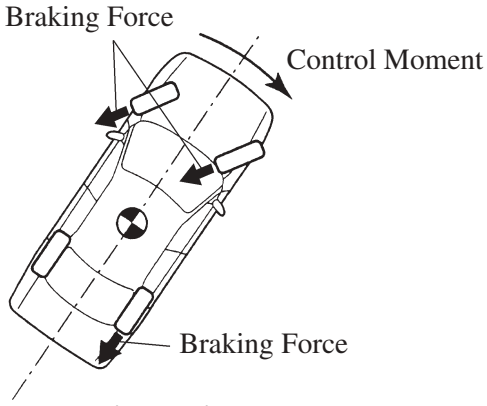
When the Skid Control ECU determines that the vehicle exhibits a tendency to front wheel skid or rear wheel skid, it decreases the engine output and applies the brake of a front or rear wheel to control the vehicle's yaw moment.

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 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.



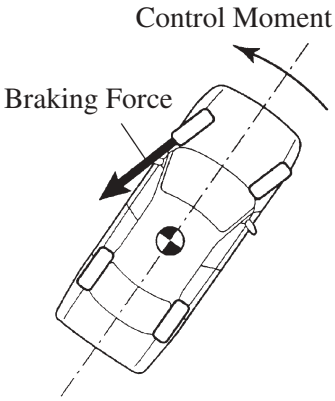
Making a Right Turn

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 restrain the rear wheel skid tendency. Along with the reduction in the vehicle speed caused by the braking force, the excellent vehicle's stability is ensured.

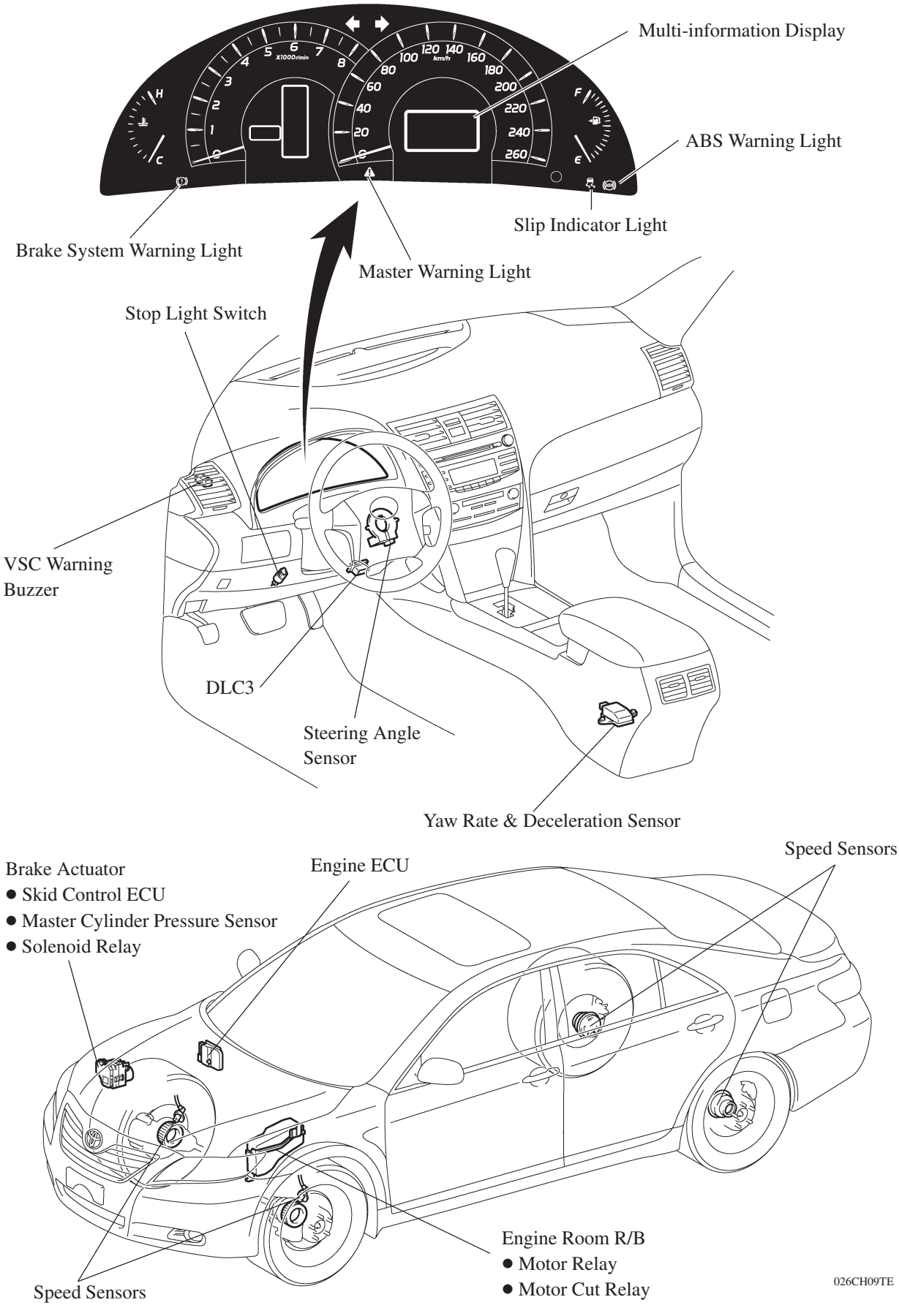
In some cases, the skid control ECU applies the brake of the rear wheels, as necessary.



Making a Right Turn

204CH15

7. Layout of Main Components



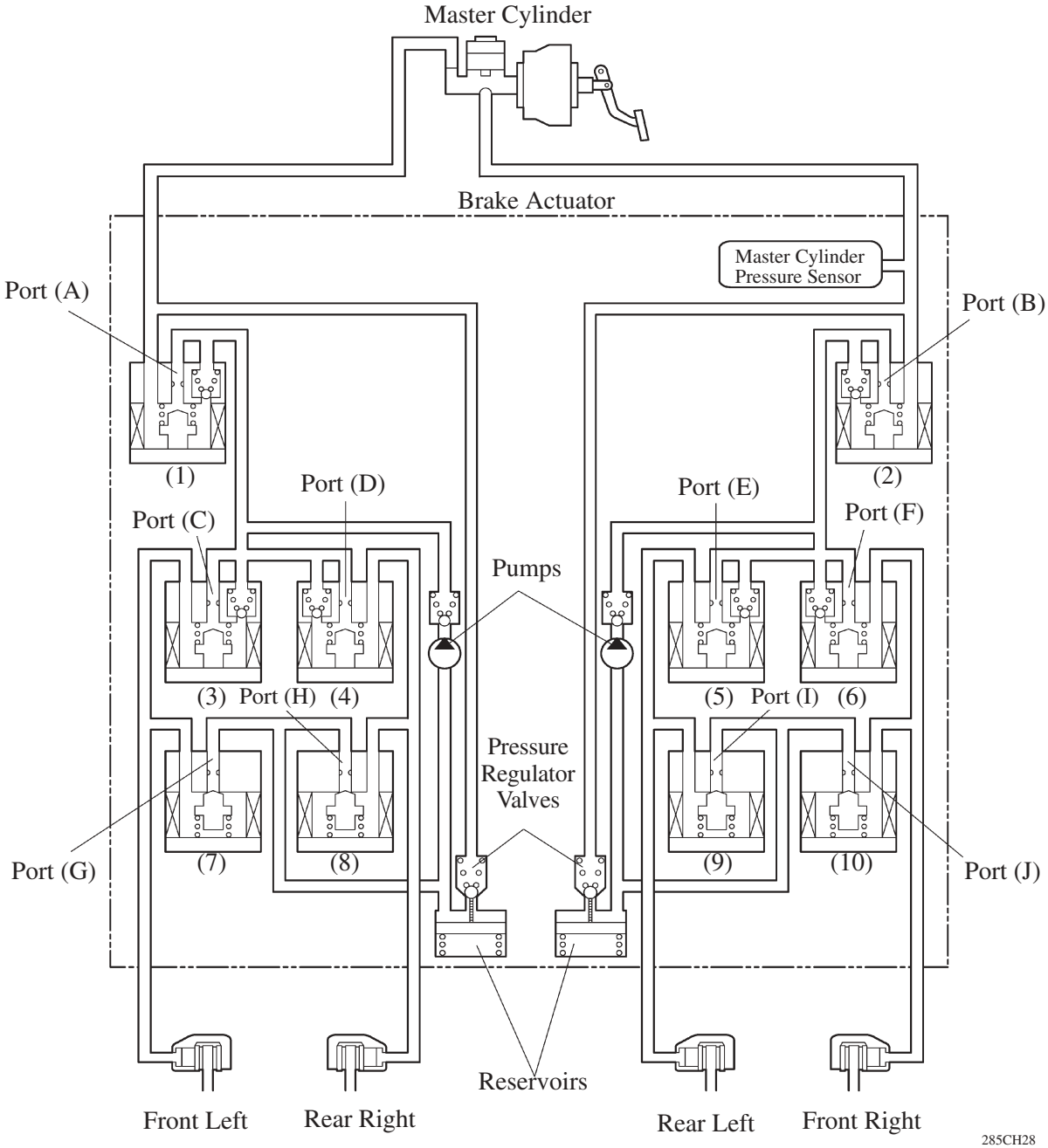
8. Function of Main Components

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 alert the driver when the skid control ECU detects the malfunction in the TRC or VSC system.
	Brake System Warning Light	● Lights up together with ABS warning light to alert the driver when the skid control ECU detects the malfunction in the EBD control. ● Lights up to inform the driver when the parking brake is ON or the brake fluid level is low.
	Master Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the TRC or VSC system.
	Multi-information Display	Displays a warning massage “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 shift lever position signal to the skid control ECU. ● Receives the signal of throttle control request from the skid control ECU.
Parking Brake Switch		Detects when the parking brake lever is pulled up.
Speed Sensors		Detects the wheel speed of each 4 wheels.
Stop Light Switch		Detects the brake pedal depressing signal.
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.
	Master Cylinder Pressure Sensor	Assembled in the brake actuator and detects the master cylinder pressure.
	Skid Control ECU	Judges the vehicle driving condition based on signals from each sensor, and sends brake control signal to the brake actuator.
	Solenoid Relay	Supply power to the solenoid valves.
VSC Warning Buzzer		Emits an intermittent sound to inform the driver that the skid control ECU detects the strong front skid tendency or strong rear skid tendency.
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		Supply power to the pump motor in the brake actuator.
Motor Cut Relay		Cut the power to the pump motor in the brake actuator.

9. Brake Actuator

The brake actuator consists of the actuator portion, skid control ECU, solenoid relay, pump motor, and master cylinder pressure sensor.

▶ Hydraulic Circuit ◀



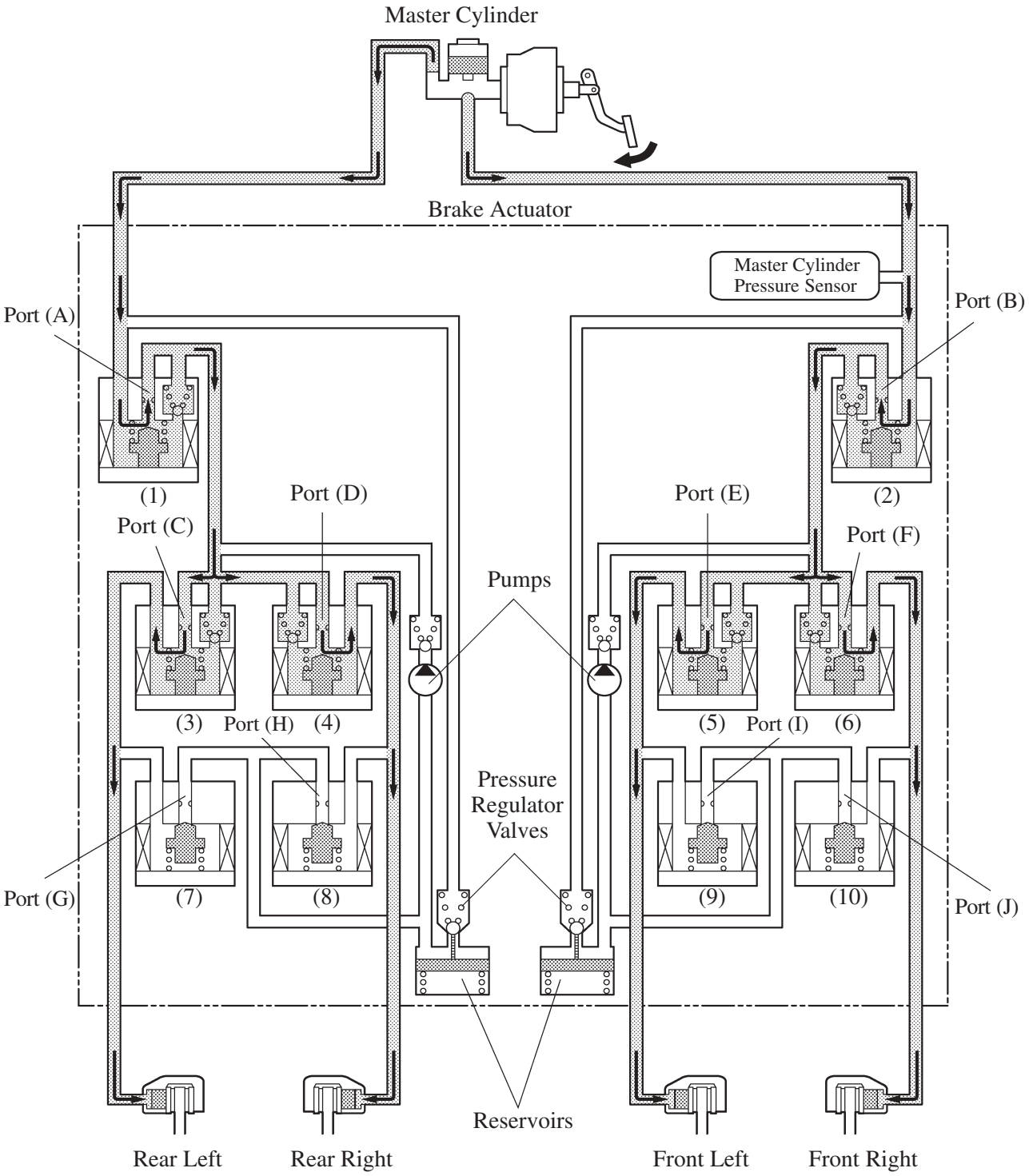
Component	
(1), (2)	Master Cylinder Cut Solenoid Valve
(3), (4), (5), (6)	Pressure Holding Valve
(7), (8), (9), (10)	Pressure Reduction Valve

10. System Operation

Normal Braking Operation

During normal braking, all solenoid valves are remained OFF.

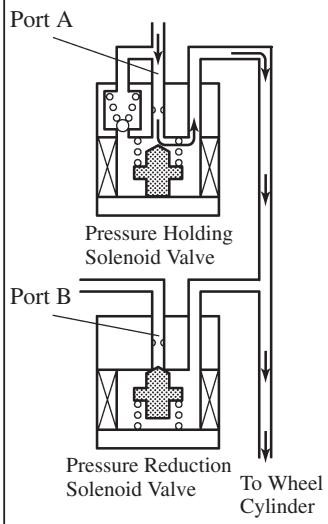
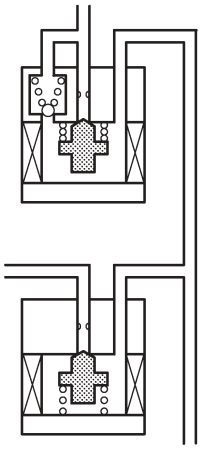
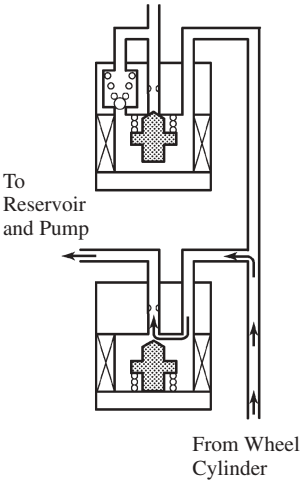
▶ Hydraulic Circuit ◀



285CH29

ABS with EBD Operation

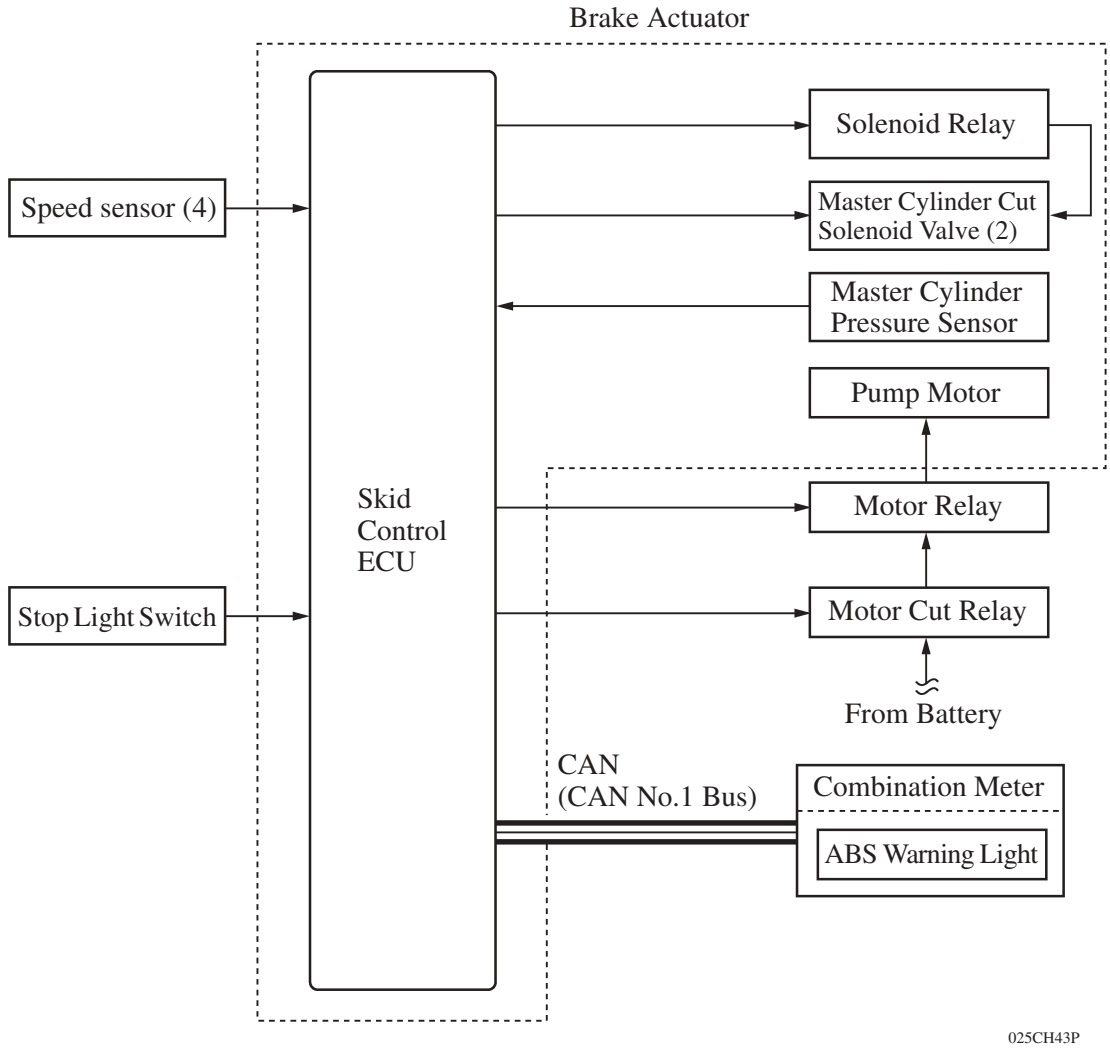
Based on the signals received from the 4 wheel speed sensors and yaw rate & deceleration sensor, the skid control ECU calculates each wheel speed and deceleration, and checks wheel slipping condition. According to the slipping condition, the ECU controls the pressure holding solenoid valve and pressure reduction solenoid valve in order to adjust the fluid pressure of each wheel cylinder 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/Close	ON/Close
Pressure Reduction Valve (Port B)	OFF/Close	OFF/Close	ON/Open
Pressure	Increase	Hold	Reduce

Brake Assist Operation

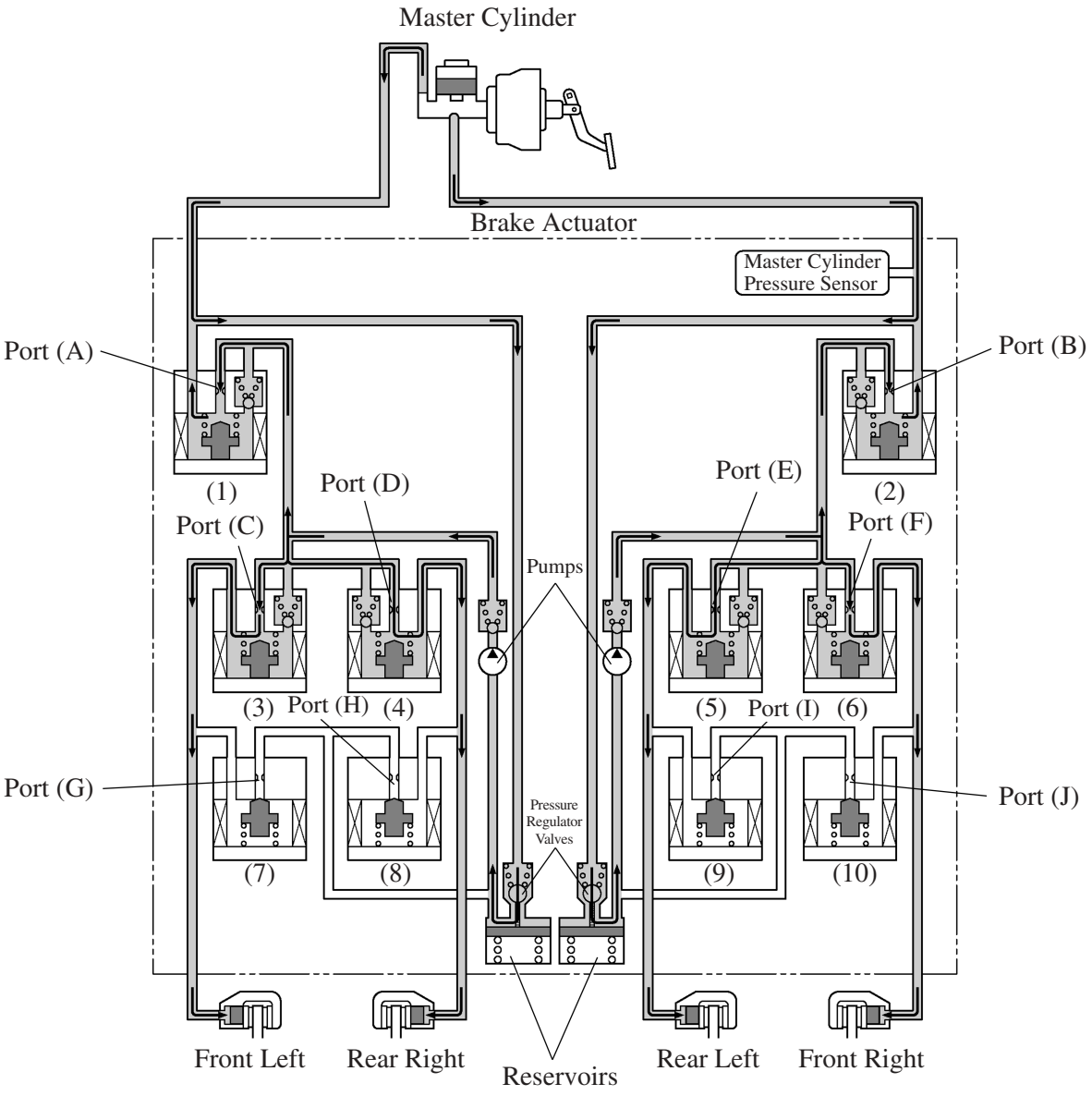
- In the event of emergency braking, the skid control ECU detects the driver's intention based on the speed of the pressure increase in the master cylinder determined by the pressure sensor signal. If the ECU judges the need for the additional brake assist, the fluid pressure is generated by the pump 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.
- The brake assist system is activated, each solenoid operates as shown in the table on the next page.

▶ System Diagram ◀



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▶ Pressure Increase Mode ◀



Brake Assist Activated

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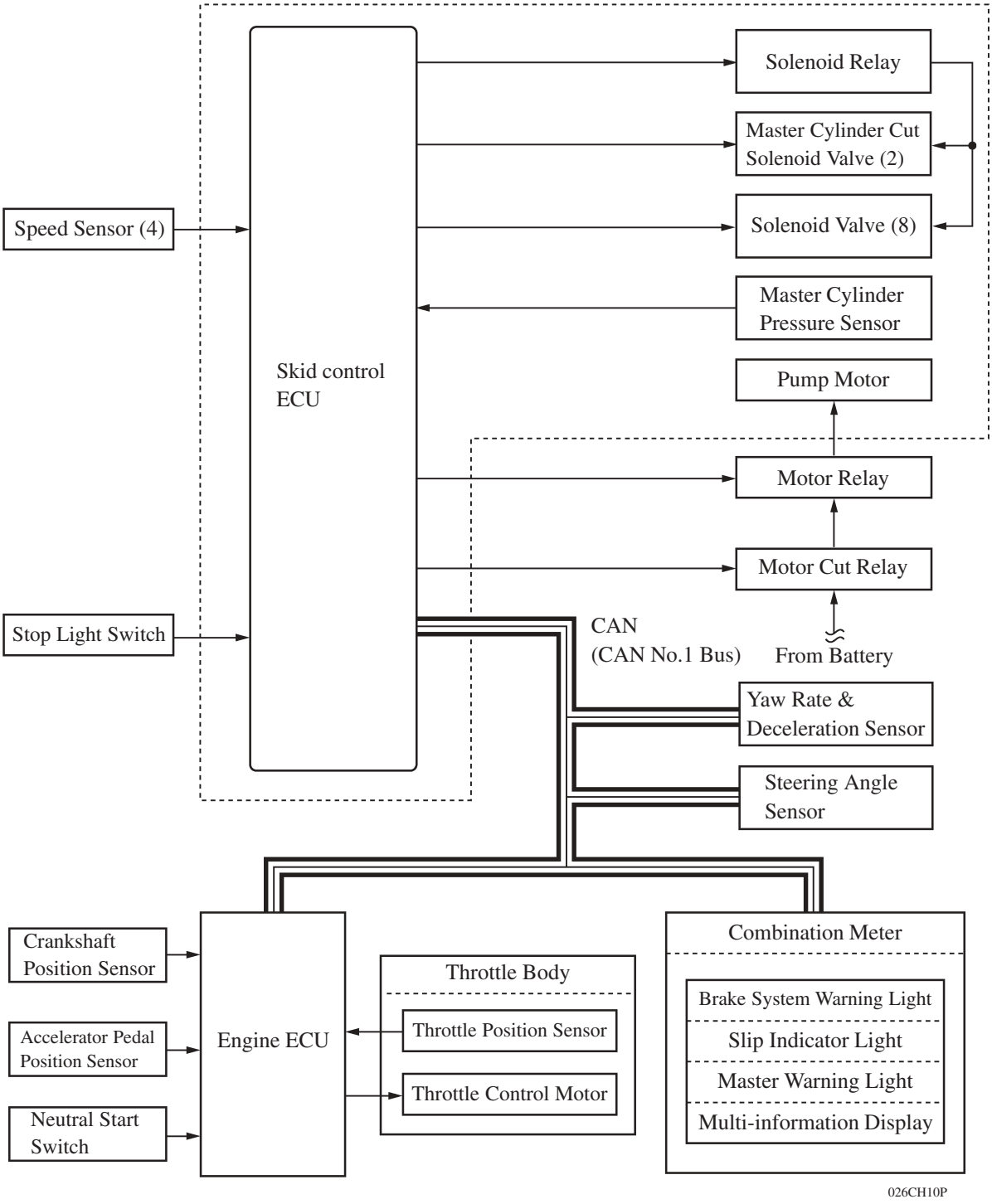
Item		Brake Assist Not Activated	Brake Assist Activated
(1), (2)	Master Cylinder Cut Solenoid Valve	OFF/Open	ON*
	Port: (A), (B)		
(3), (4), (5), (6)	Pressure Holding Solenoid Valve	OFF/Open	←
	Port: (C), (D), (E), (F)		
(7), (8), (9), (10)	Pressure Reduction Solenoid Valve	OFF/Close	←
	Port: (G), (H),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

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

TRC Operation

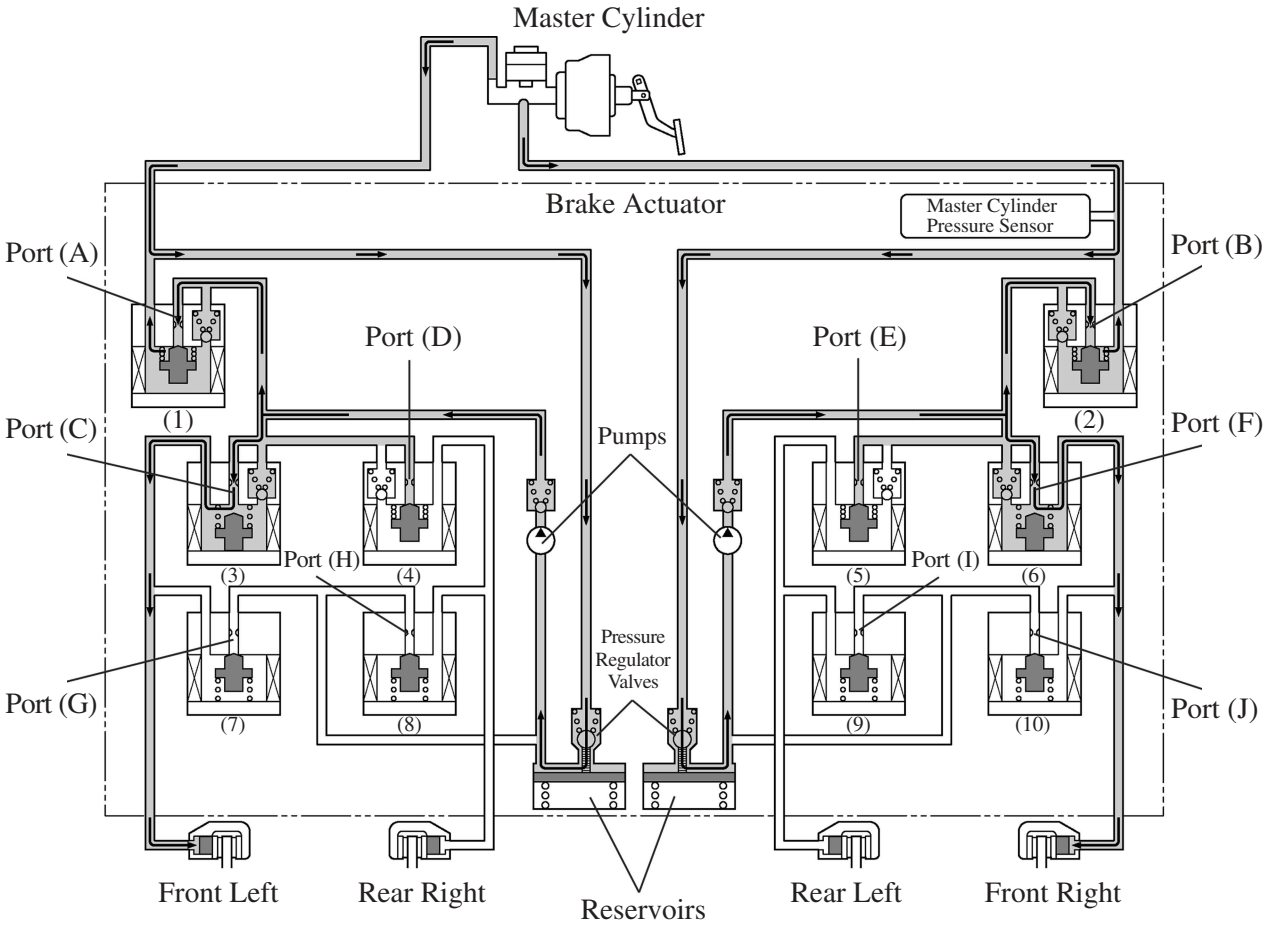
- The fluid pressure generated by the pump is regulated by the master cylinder cut solenoid valve to the required pressure. Thus, the wheel cylinders of the drive wheels are controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes, to control the slippage of the drive wheels.
- The diagram below shows the hydraulic circuit in the pressure increase mode when the TRC 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.
- The TRC is activated, each solenoid operates as shown in the table on the next page.

▶ System Diagram ◀



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▶ Pressure Increase Mode ◀



Pressure Increase Mode

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

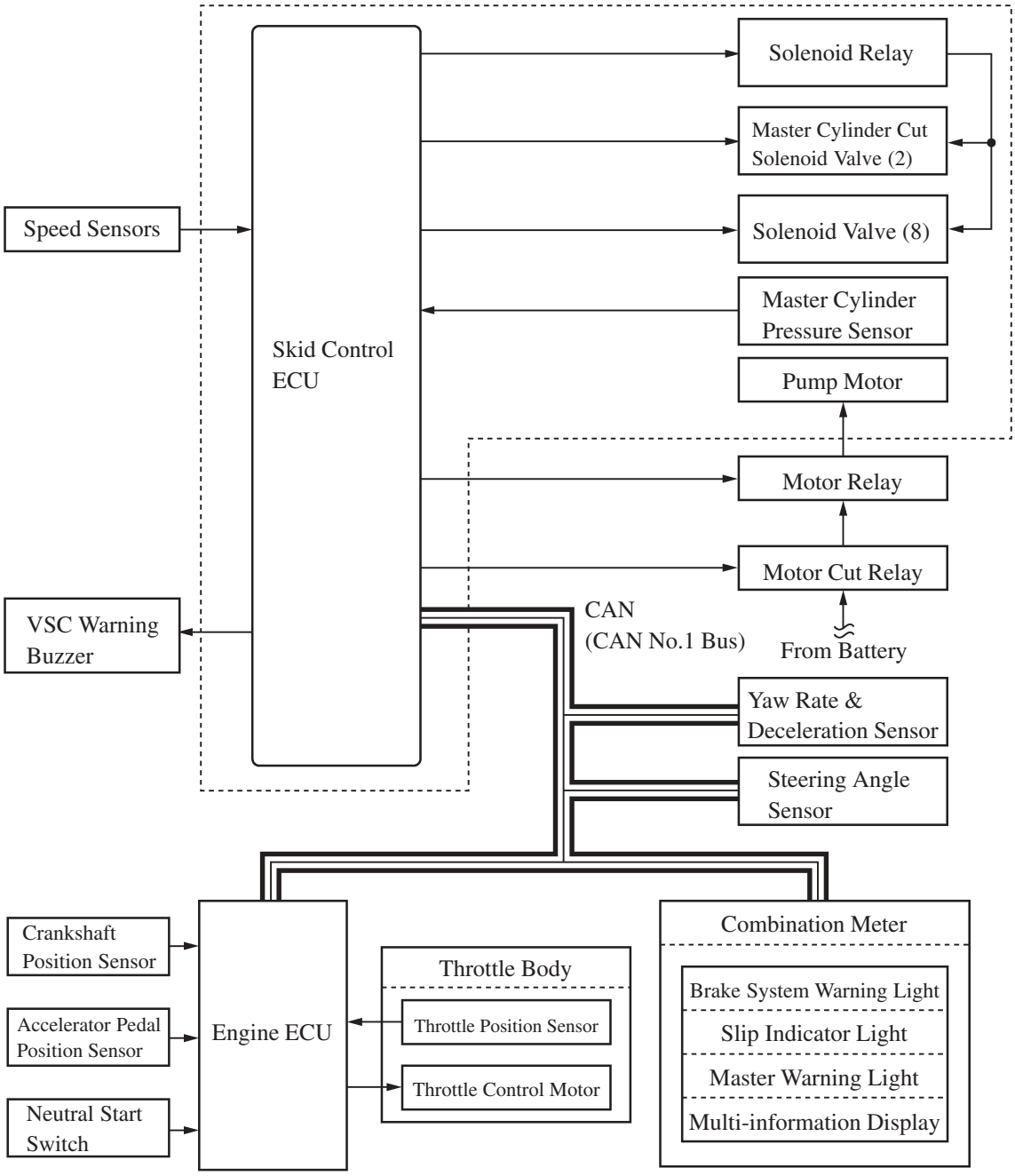
*: The solenoid valve controls the hydraulic pressure between “open” and “close” according to the operating condition by adjusting continually.

VSC Operation

1) General

The VSC operation, 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 ◀



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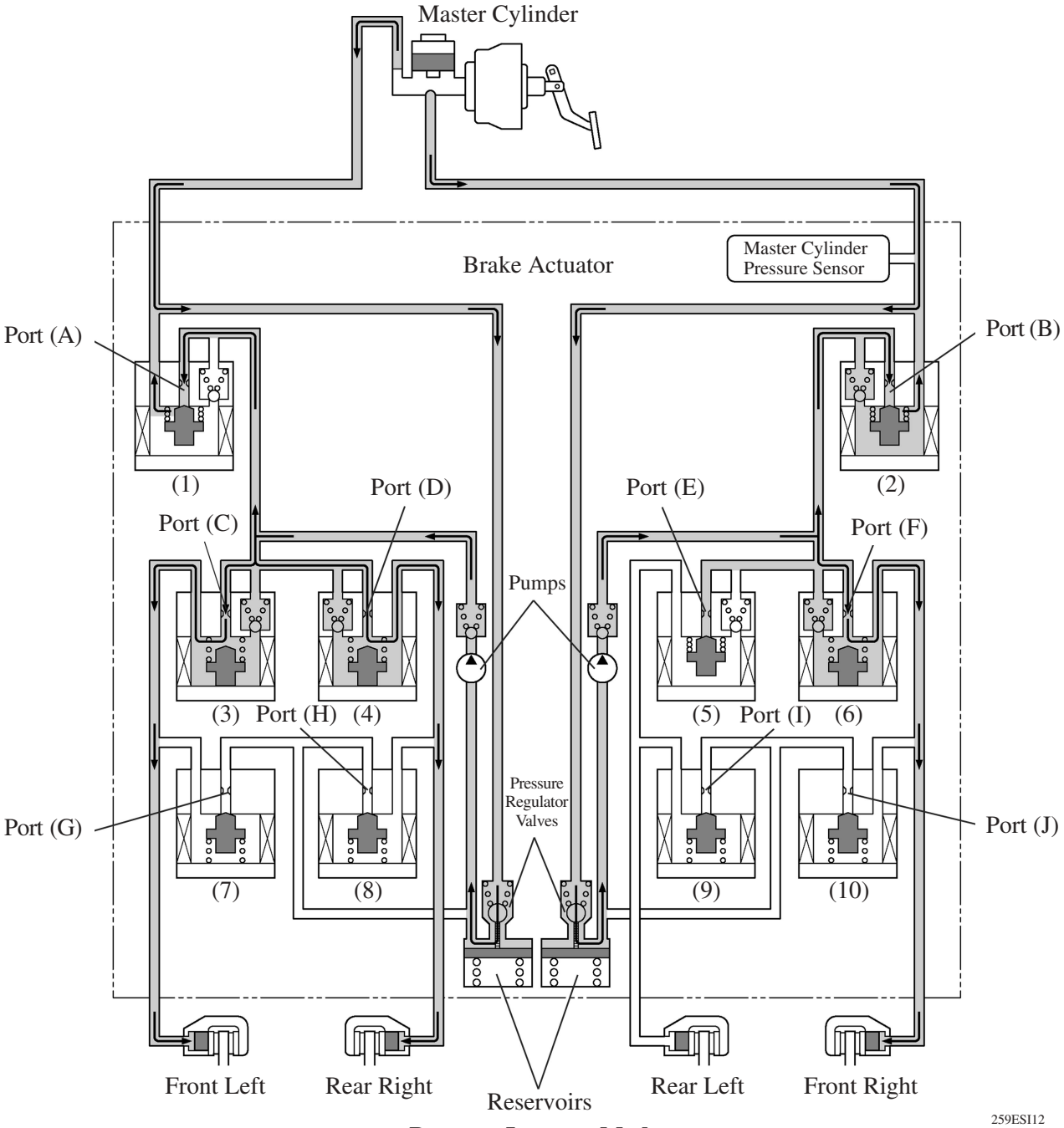
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2) Front Wheel Skid Restraining Control (Turn to the Right)

In the front wheel skid restraining 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.
- 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.
- The front wheel skid restraining control is activated, each solenoid operates as shown in the table on the next page.

▶ Pressure Increase Mode ◀



Pressure Increase Mode

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

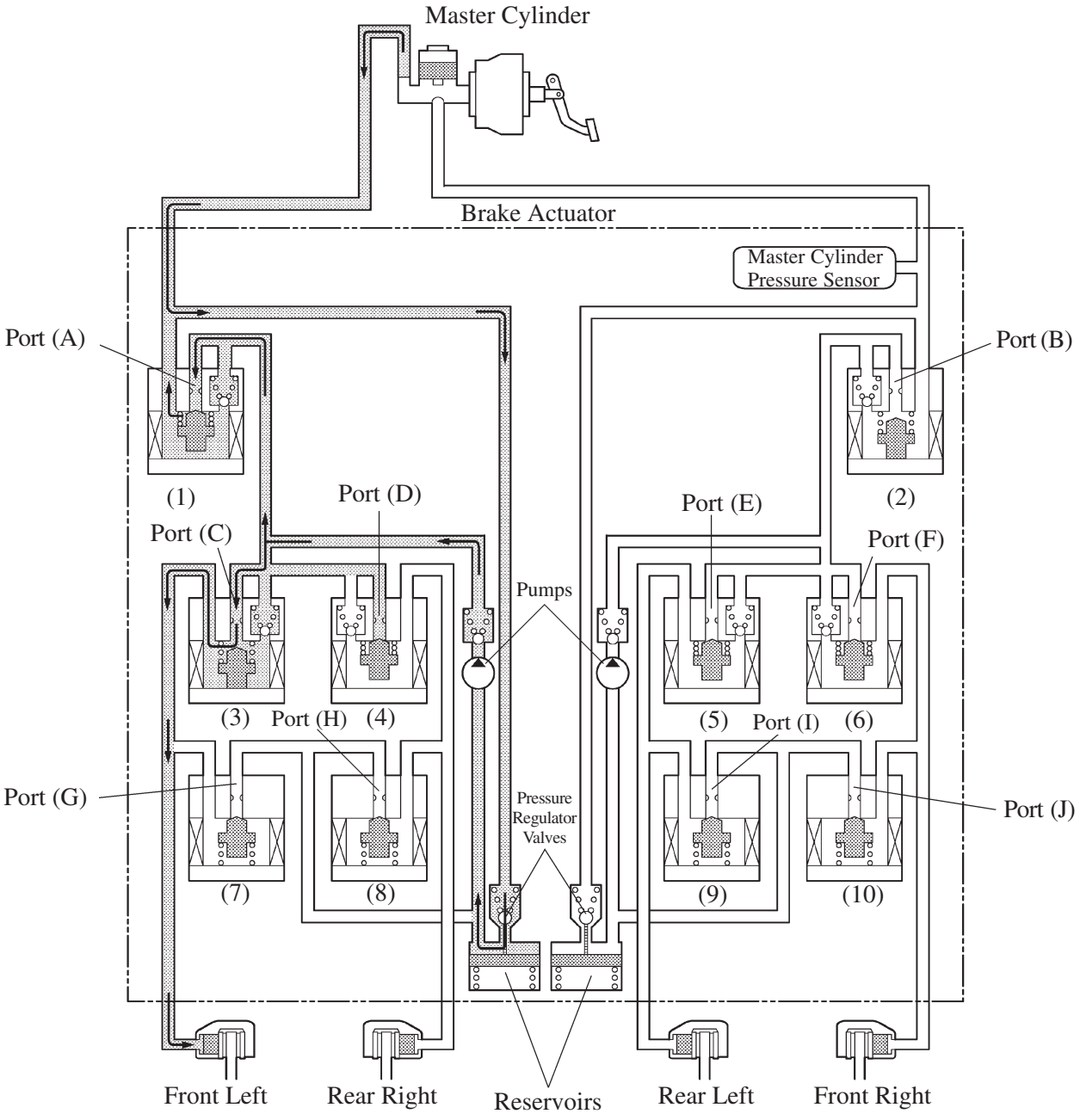
*: The solenoid valve controls the hydraulic pressure between “open” and “close” according to the operating condition by adjusting continually.

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

In rear wheel skid restraining control, the brake of the front wheel of the outer circle of the turn is applied. Also, depending on whether the brake is ON or OFF and the condition of the vehicle, there are circumstances in which the brake might not be applied to the wheels even if those wheels are targeted for braking.

- The diagram below shows the hydraulic circuit in the pressure increase mode, as it controls the rear wheel skid condition while the vehicle make 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 operating pattern.
- The rear wheel skid restraining control system is activated, each solenoid operates as shown in the table on the next page.

▶ Pressure Increase Mode ◀



Pressure Increase Mode

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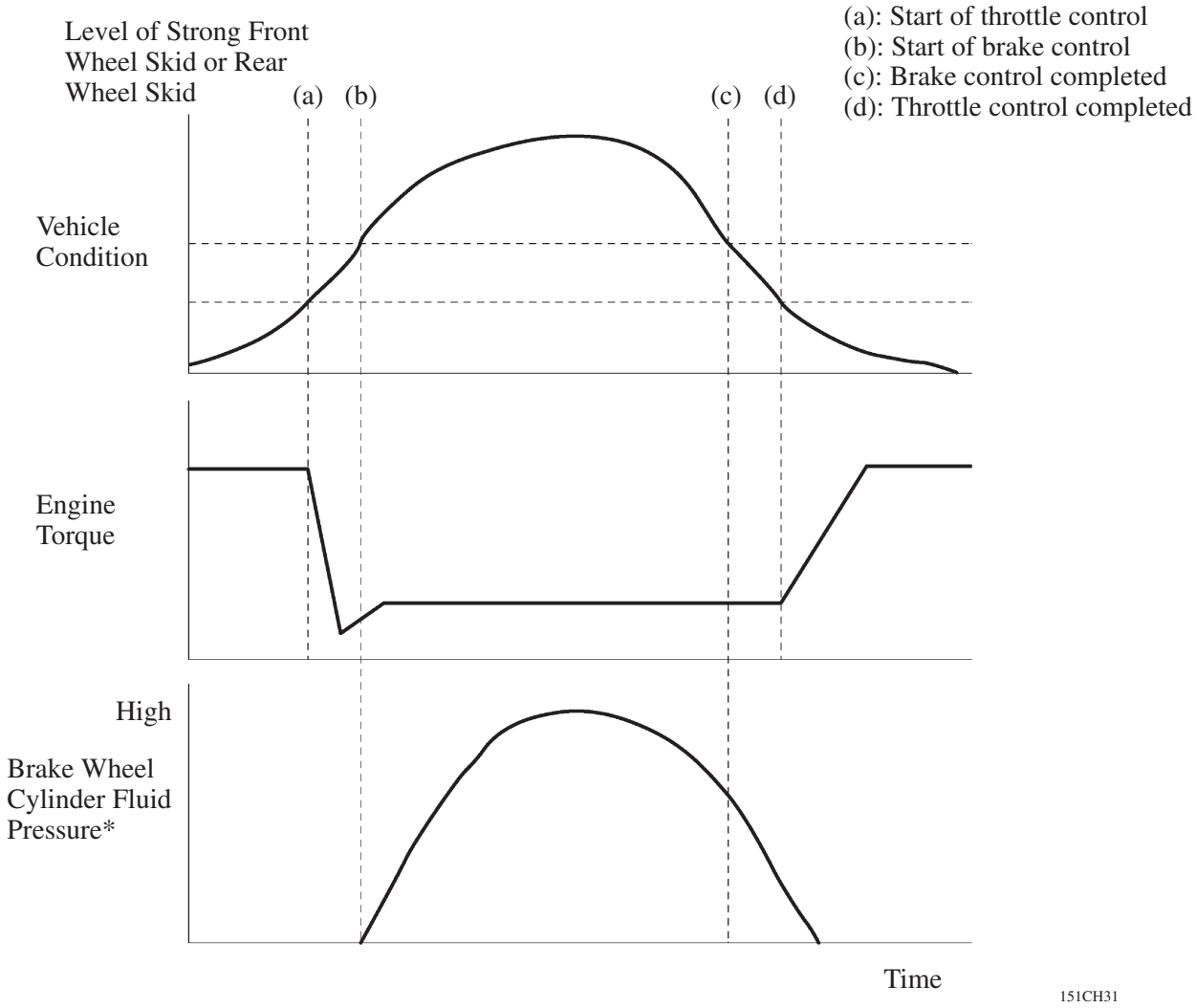
Item			VSC not Activated	VSC Activated		
				Mode		
				Increase Mode	Holding Mode	Reduction Mode
(1)	Master Cylinder Cut Solenoid Valve Port: (A)		OFF/Open	ON*	←	←
(2)	Master Cylinder Cut Solenoid Valve Port: (B)		OFF/Open	←	←	←
Front Brake	(3)	Pressure Holding Solenoid Valve Port: (C)	OFF/Open	←	ON/Close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

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

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Engine Output Control

During a VSC operation, the skid control ECU outputs a VSC operation signal to the Engine ECU. Upon receiving this signal, the Engine ECU effects throttle control to regulate the engine output.



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

Initial Check

Each time the ignition switch is 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.

12. CAN (Controller Area Network)

CAN communication is used between the skid control ECU, steering angle sensor, yaw rate & deceleration sensor, Engine ECU, main body ECU and DLC3. For details of CAN communication, see page BE-6.

13. Service Mode

The TRC OFF switch designed for previous Camry is not used on new Camry.
A new service mode has been created for new Camry. In this mode, TRC and VSC functions can be forcibly turned OFF, either through the operation of an intelligent tester II or by operating the parking brake and the brake pedal together.
Please refer to the following service tip for information regarding changing the service mode.

Service Tip

Transition to the service mode (TRC and VSC OFF mode).
The TRC and VSC systems can be turned off by following the procedures below:

- When using the parking brake and brake pedal:
  1) Check that the power source is OFF and the shift lever is in position P.
  2) Start the engine after turning the power source ON.
  3) Operate the following steps 4 to 8 within 30 seconds of starting the engine.
  4) Turn the parking brake switch on.
  5) Depress and release the brake pedal twice.
  6) Turn the parking brake switch on and off twice while depressing the brake pedal.
  7) Depress and release the brake pedal twice while the parking brake switch is on.
     Notice: Steps 6 and 7 should each be performed within 15 seconds.
  8) Check that the slip indicator light and “CHECK VSC SYSTEM” message will appear on the multi-information display. If not, repeat the procedure from the step 1.
  9) The brake control system can be returned to the normal mode by turning the power source ON position from OFF.
- When using the intelligent tester II:
  1) Check that the power source is OFF and the shift lever is in position P.
  2) Start the engine after turning the power source ON.
  3) Connect the intelligent tester II to the DLC3, and operate it to send signals of memory change function.
  4) The brake control system can be returned to the normal mode by turning the power source ON from OFF.

For details of the transition to service mode, see the Camry Repair Manual (Pub. No. RM0260E).

14. 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 the corresponds to the function for which the malfunction has been detected illuminates or indicates, as indicated in the table below, to alert the drive of the malfunction.

○: Illuminate △: Indicate

Item	ABS	EBD	Brake Assist	TRC	VSC
ABS Warning Light	○	○	○	—	—
Brake System Warning Light	—	○	—	—	—
Master Warning Light	—*	—*	—*	○	○
Multi-information Display (Warning Message "CHECK VSC")  025CH49P	—*	—*	—*	△	△

*: Failure in the ABS, EBD, and brake assist systems prohibits operation of the TRC, 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 DTC (Diagnostic Trouble Code) are stored in the memory. The DTC 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, 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 terminal of the DLC3 or by connecting an intelligent tester II. The ABS warning light and VSC warning light blinks at a 0.25-second interval. 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

025CH50P



DTC is displayed

025CH56P

- If the skid control ECU detects a malfunction during a sensor signal check (test mode), it stores the DTC in its memory. These DTC 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 DTC that are stored in skid control ECU memory and the DTC that are output through the sensor signal check (test mode) functions, see the Camry Repair Manual (Pub. No. RM0260E).

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 DTC (Diagnostic Trouble Code) in its memory.

- There are 2-digit DTC and 5-digit DTC for CAN communications related to the brake control system (ABS with EBD, brake assist, TRC and VSC).
  - 2-digit DTC 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 DTC can be read by connecting an intelligent tester II to the DLC3.

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 the DTC, it will disable the TRC and VSC.