

■ BRAKE CONTROL SYSTEM

(ABS with EBD, BRAKE ASSIST, A-TRC, VSC, DAC, AND HAC)

1. General

The brake control system (ABS with EBD, Brake Assist, A-TRC, VSC, DAC, and HAC) of new Land Cruiser/ Land Cruiser Prado has the following functions:

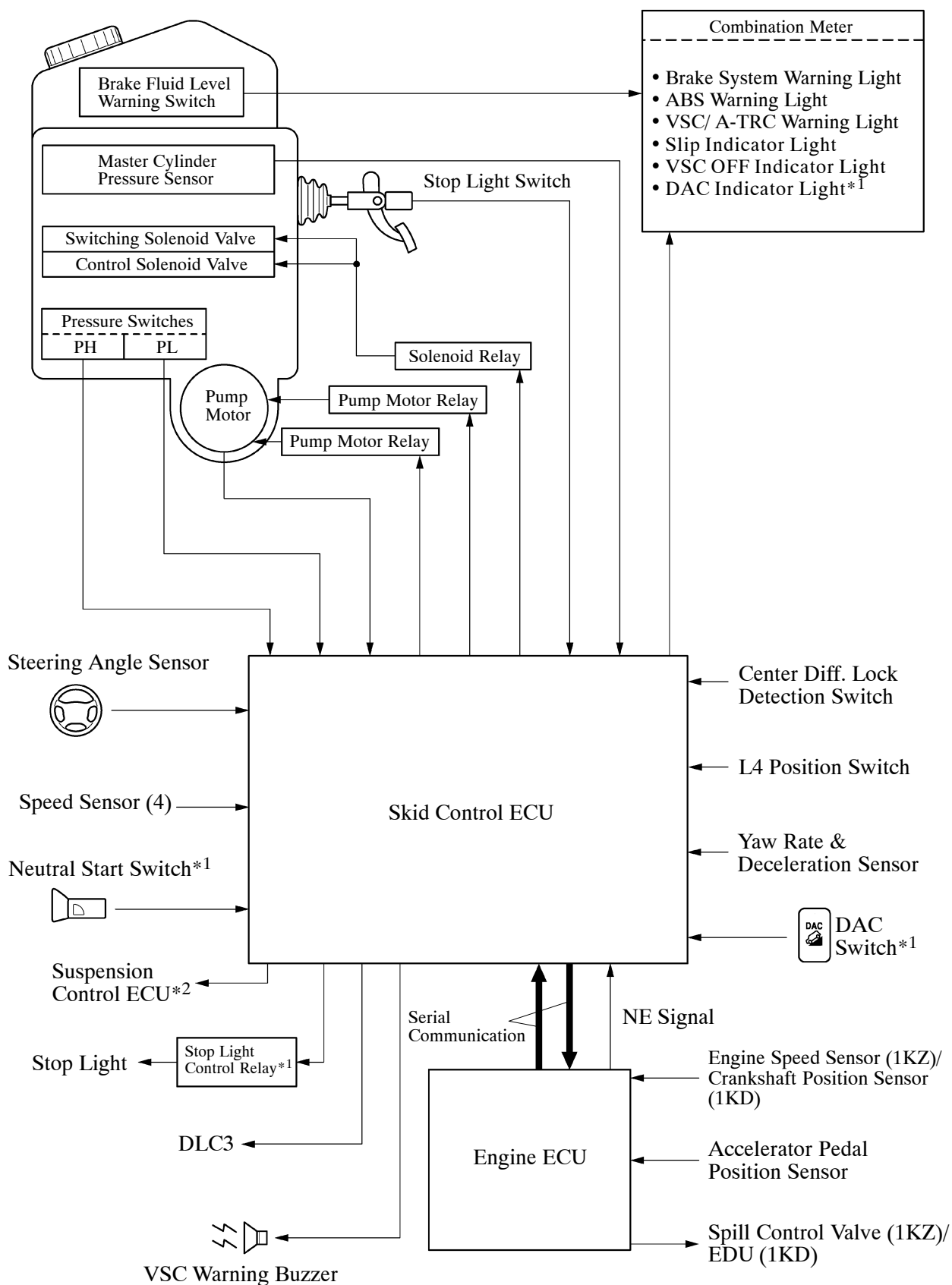
☐: New

Function	Outline	Model	
		MT	AT
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.	○	○
EBD (Electronic Brake force Distribution)	The EBD control utilizes ABS, realizing the proper brake force distribution between front and rear wheels in accordance with the driving conditions. In addition, during cornering braking, it also controls the brake forces of right and left wheels, helping to maintain the vehicle behavior.	○	○
Brake Assist	The primary purpose of the Brake Assist system 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.	○	○
A-TRC (Active Traction Control)	During rugged offroad driving, this function controls the engine output and the brake fluid pressure that is applied to the slipping wheel, and distributes the drive force that would have been lost through the slippage to the remaining wheels in order to achieve a LSD (Limited Slip Differential) effect. As a result, the vehicle's offroad drivability and ability to free itself from the mogul have been increased.	○	○
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.	○	○
DAC (Downhill Assist Control)	When the DAC switch is pressed with transfer in low range and without accelerator and brake pedals operation, DAC activates to effect 4-wheel hydraulic pressure control, in order to maintain a constant low vehicle speed without causing the wheels to become locked. Thus, the vehicle can descend a steep hill in a stable manner.	—	○
HAC (Hill-start Assist Control)	When the vehicle starts off on a steep or a slippery hill, HAC detects the backward movement of the vehicle and effects 4-wheel hydraulic pressure control to reduce the backward speed of the vehicle.	—	○

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.

► System Diagram ◀



*1: Only for Automatic Transaxle

*2: with TEMS Models

2. Outline of EBD Control

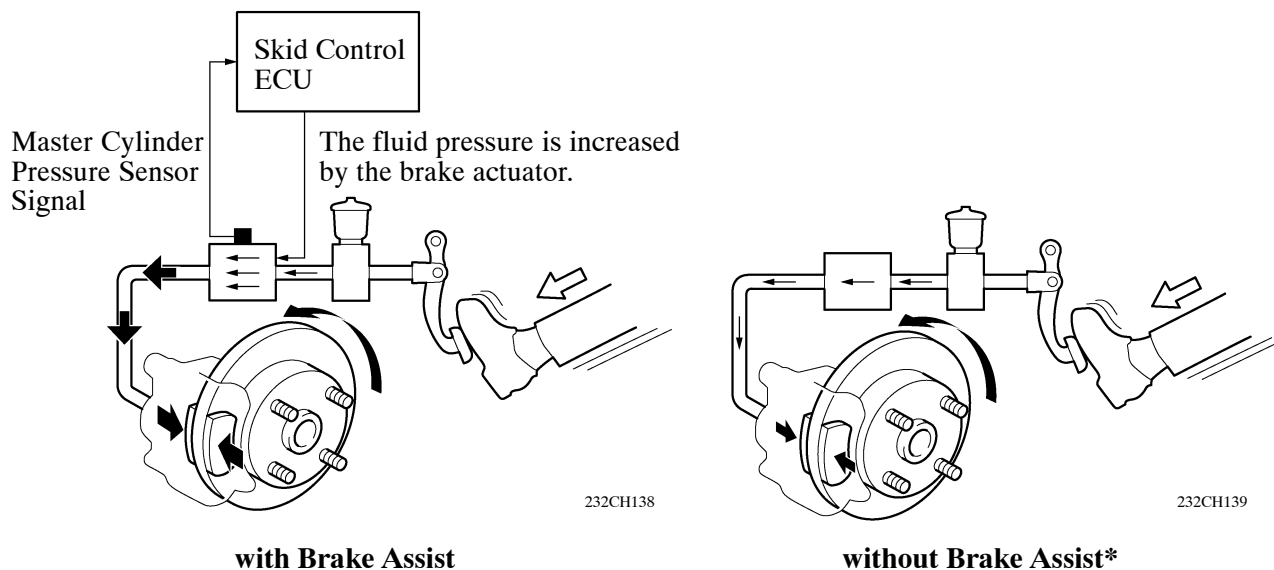
The detailed outline is the same as that of the brake control system (ABS with EBD and Brake Assist). See page CH-98.

3. Outline of Brake Assist

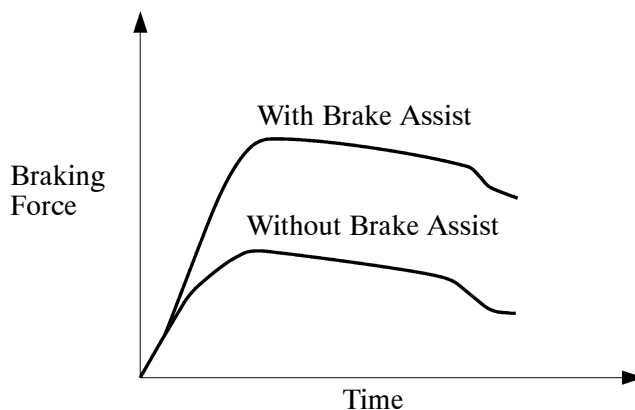
The detailed outline is the same as that of the brake control system (ABS with EBD and Brake Assist). See page CH-99. However, this is not a mechanical type.

- 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 ◀



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

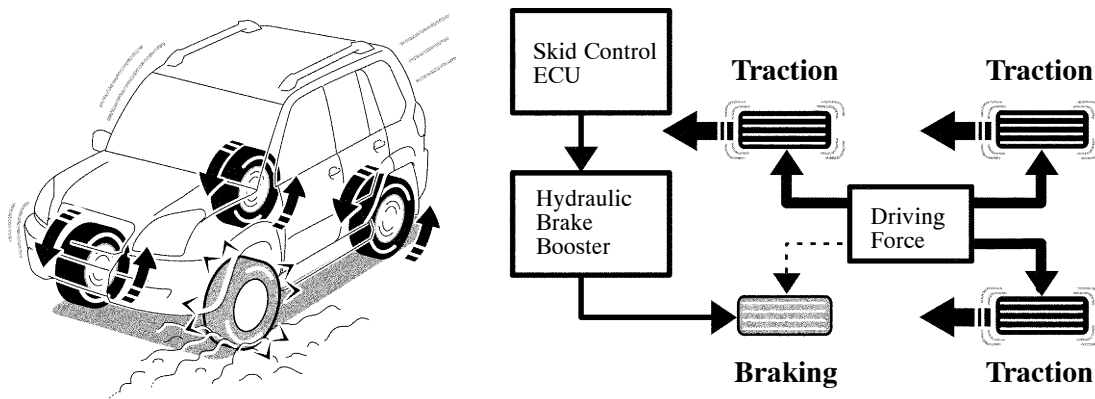


4. Outline of A-TRC System

General

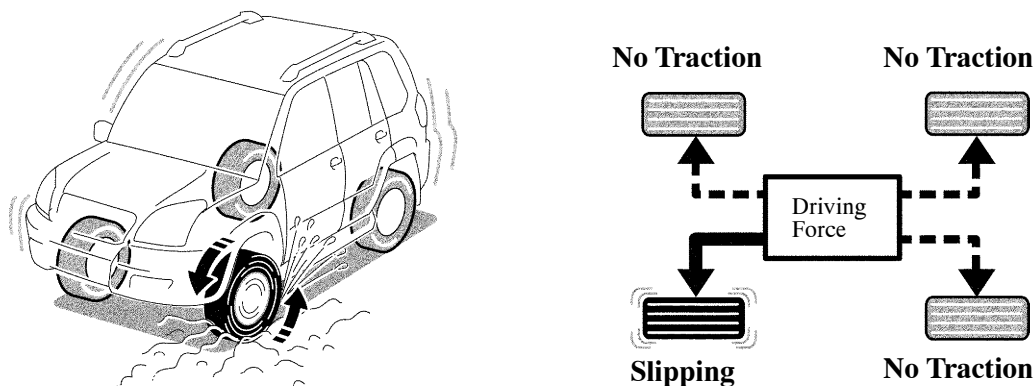
- If a tire slips while the vehicle is being driven on a low friction surface, such as a snow-covered road or off-road, the function of the differential gear causes a large amount of drive force to be applied to the tire that is slipping.
- The A-TRC function helps restrain the slippage by controlling the engine output and brake fluid pressure that is applied to the slipping wheel, and distributes the drive force that would have been lost through the slippage to the remaining wheels in order to achieve an effect that is similar to an LSD (Limited Slip Differential).
- It independently controls the brake hydraulic pressure to the four wheels in accordance with the extent of the slippage at the wheels, as detected by the skid control ECU.

► with A-TRC ◀



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► without A-TRC ◀



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Effectiveness of A-TRC

The effectiveness of the A-TRC is as follows:

- Off-road drivability that is equivalent to having the center differential locked and limited slip differential on both front and rear differentials has been realized.
- This function makes the operation of the differential lock switch basically unnecessary to ensure the ease of driving.
- While realizing the off-road drivability that is equivalent to having the center and rear differentials locked, as compared to the differential gear in the locked state, the essential function of the differential gear itself ensures the ease of nimble steerability.

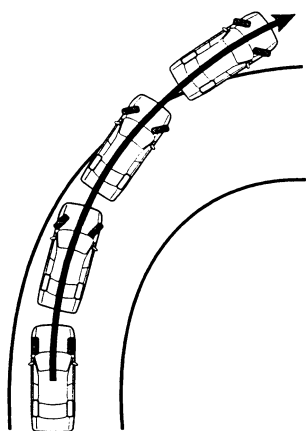
5. Outline of VSC System

General

The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit.

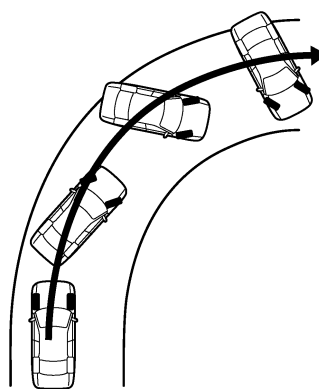
The VSC system is designed to help control the vehicle behavior by controlling the engine output and the brakes at each wheel when the vehicle is under one of the conditions indicated below.

- 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).



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Front Wheel Skid Tendency



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Rear Wheel Skid Tendency

Method for Determining the Vehicle Condition

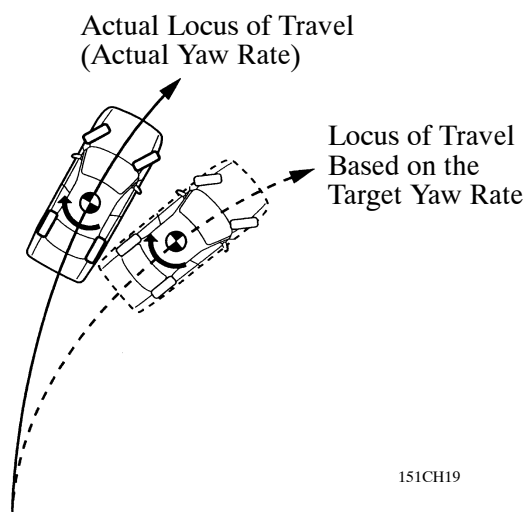
To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and the vehicle's lateral acceleration, which are then calculated by the skid control ECU.

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.

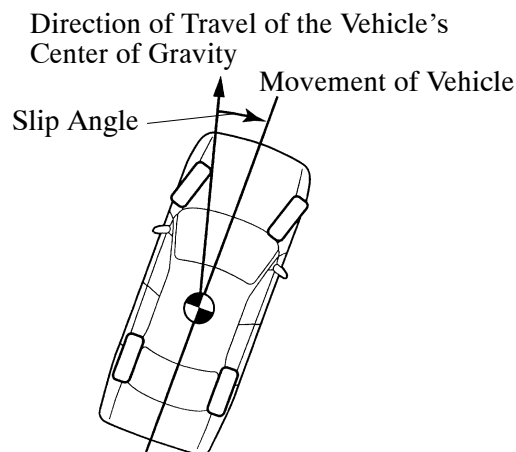
Thus, the skid control ECU determines that there is a large tendency to front wheel skid.



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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.



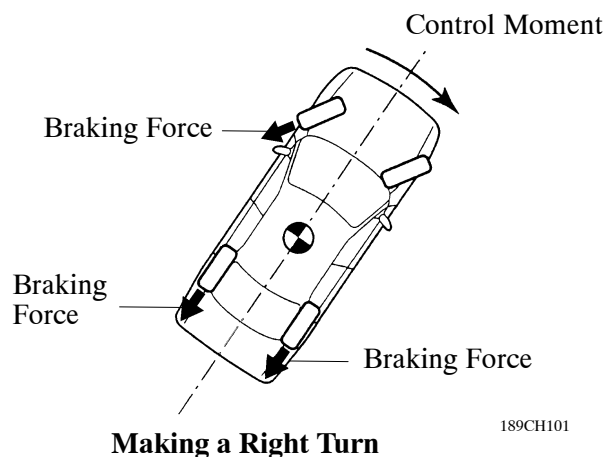
Method for VSC Operation

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.

1) Dampening a Front Wheel Skid

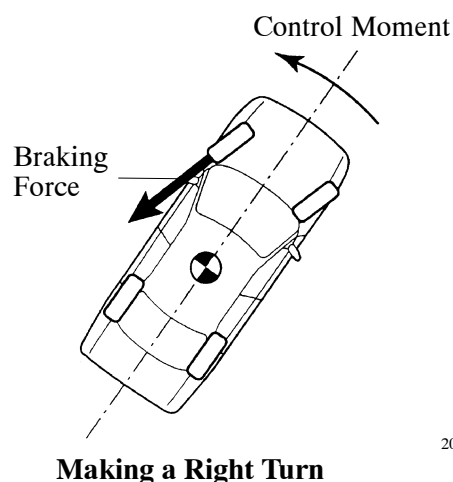
When the skid control ECU determines that there is a large front wheel skid tendency, it counteracts in accordance with the extent of that tendency. The skid control ECU controls the engine power output and applies the brakes of the front wheel of the outer circle in the turns and rear wheels in order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



2) Dampening a 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 vehicle's stability is further improved.

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



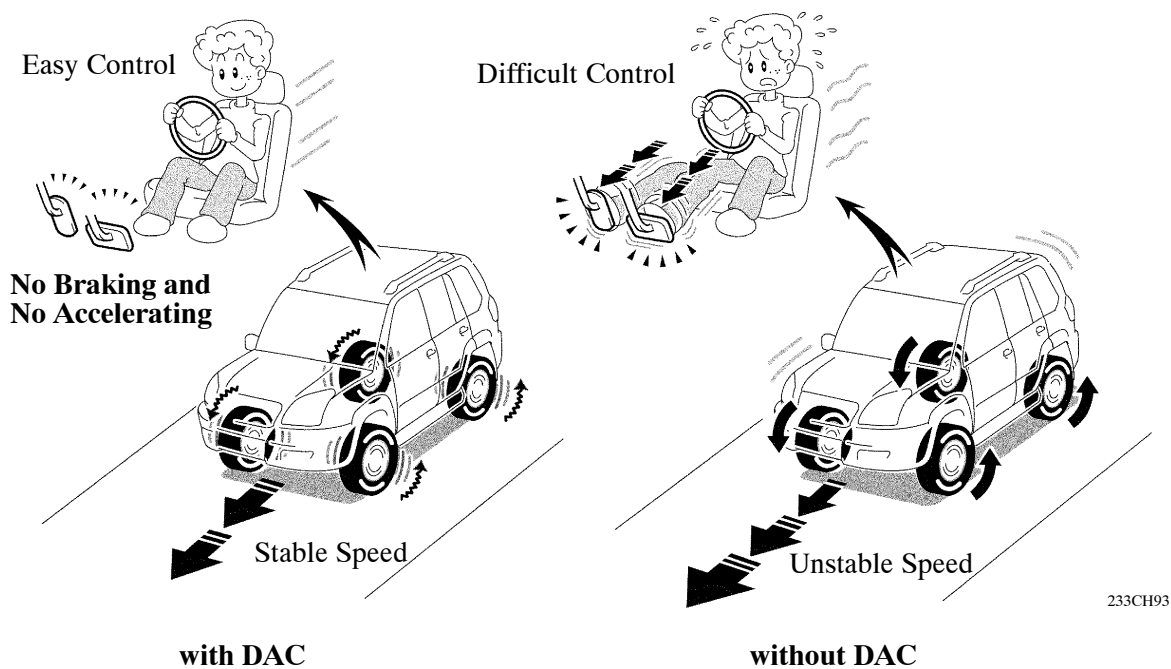
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6. Outline of DAC System (only for Automatic Transmission Models)

- When the vehicle is descending a steep hill and the engine brake alone cannot provide a sufficient deceleration force while the transfer is in the L4 range, DAC effects 4-wheel brake control to maintain a constant, low vehicle speed. Thus, the vehicle is able to descend in a stable manner without causing the wheels to become locked.
- When the vehicle descends a steep hill without DAC, the driver must pay close attention to the brake and accelerator pedal maneuvers. However, with DAC, the driver can concentrate on the steering operation, without accelerator and brake pedals operation.
- DAC enables the vehicle to realize a high level of stability because it can descend a slippery hill at low speeds without causing the wheels to become locked.

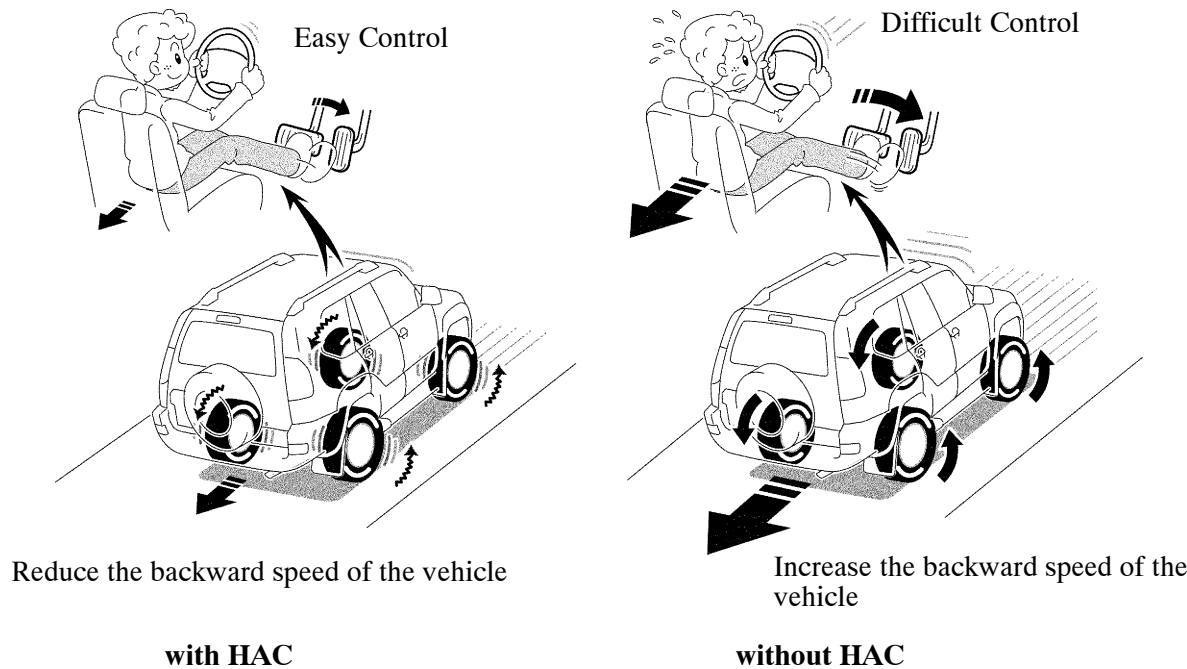


- DAC operates when all of the following conditions have been met:

DAC Operate Condition	<ul style="list-style-type: none">• DAC switch ON• Transfer is L range.• Accelerator pedal and brake pedal are not pressed.• Descending a hill at a vehicle speed of 25 km/h (16 mph) or less.
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7. Outline of HAC System (only for Automatic Transmission Models)

- When the vehicle starts off on a steep or slippery hill, the vehicle could descend backward while the driver switches from the pedal brake to the accelerator pedal, thus making it difficult for the vehicle to start off. To prevent this from occurring, HAC temporarily (approximately 5 seconds at the maximum) applies the brakes to the 4 wheels in order to reduce the backward speed of the vehicle.
- Without HAC, the driver must quickly and precisely switch from the brake pedal to the accelerator pedal. With HAC however, the driver can start off easily and operate the pedal in a relaxed manner because HAC reduces the backward speed of the vehicle.

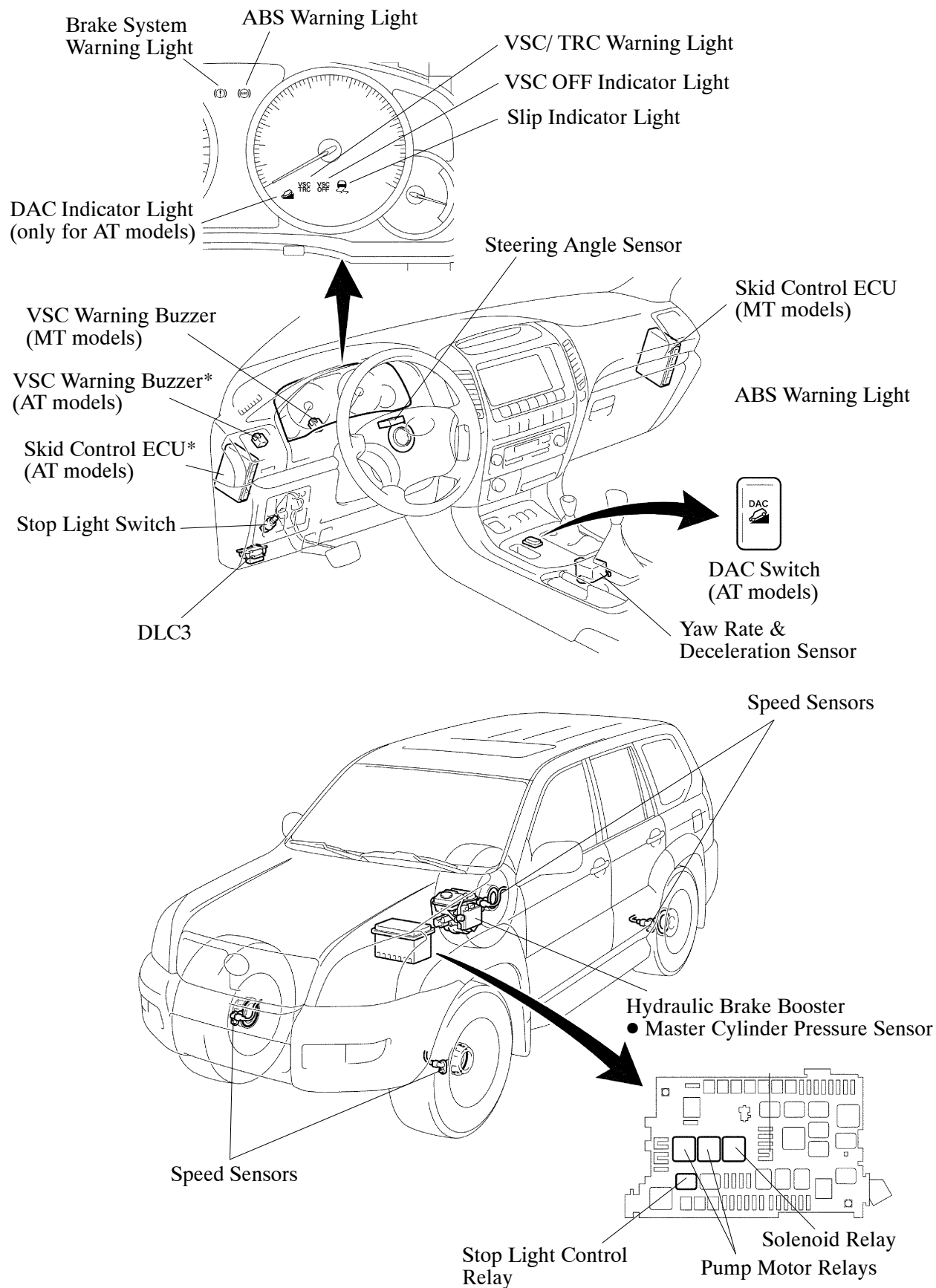


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- HAC operates when all of the following conditions have been met:

HAC Operate Condition	<ul style="list-style-type: none">• Shift lever position is D, 3, 2, or L positions.• The brake pedal is not pressed.• The skid control ECU has detected the backward movement of the vehicle when the driver is starting off on a hill.
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8. Layout of Main Component



*: On the RHD model, these parts are installed in this position of the driver side regardless of whether it has a MT or AT.

9. Function of Main Component

Components		Function
Hydraulic Brake Booster (Including Brake Actuator)		<ul style="list-style-type: none"> Assists with the brake pedal effort applied to the brake pedal. Changes the brake fluid path based on the signals from the skid control ECU during the operations of the ABS with EBD, Brake Assist, A-TRC, VSC, DAC (for AT models), and HAC (for AT models), in order to control the fluid pressure that is applied to the wheel cylinders.
	Brake Fluid Level Warning Switch	Detects the brake fluid level.
	Master Cylinder Pressure Sensor	Detects the master cylinder pressure.
	Pressure Switches	Monitors the hydraulic pressure of the accumulator and outputs control signals for the pump motor. There are two types: the pressure switch PH for controlling the pump, the pressure switch PL for giving a warning when the pressure is low.
Combination Meter	Brake System Warning Light	<ul style="list-style-type: none"> Lights up to alert the driver when a malfunction occurs in the EBD or skid control ECU. Lights up to alert the driver that the hydraulic pressure of the accumulator in the hydraulic brake booster has decreased.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS, EBD, or Brake Assist system.
	VSC/TRC Warning Light	<ul style="list-style-type: none"> Lights up to alert the driver when the skid control ECU detects a malfunction in the A-TRC or VSC, DAC (for AT models), and HAC (for AT models). Lights up to alert the driver when the operation of the A-TRC, DAC (for AT models), and HAC (for AT models) are momentarily interrupted in order to protect the brake actuator.
	VSC OFF Indicator Light	<ul style="list-style-type: none"> Lights up to inform the driver when the center differential has been locked, and the operation of the VSC have been prohibited. Lights up to inform the driver when the skid control ECU detects a malfunction in the ABS with EBD, Brake Assist, A-TRC, VSC, DAC (for AT models), or HAC (for AT models).
	Slip Indicator Light	Blinks to inform the driver when the A-TRC, VSC, DAC (for AT models), or HAC (for AT models) is operated.
	DAC Indicator Light* ¹	<ul style="list-style-type: none"> Lights up to inform the driver when the DAC switch turned ON. Blinks to alert the driver when the skid control ECU detects that the current condition is not under a DAC operation condition, the operation of the DAC is momentarily interrupted in order to protect the brake actuator, or the transfer shift lever is shifted to H4 range.

(Continued)

Skid Control ECU	<ul style="list-style-type: none"> • Judges the vehicle driving condition based on signals from each sensor, and sends brake control signals to the brake actuator. • Sends the VSC operate signals to the engine ECU and suspension control ECU.
Speed Sensor (4)	Detects the wheel speed and rotating direction of each of four wheels.
Steering Angle Sensor	Detects the steering direction and angle of the steering wheel.
Yaw Rate & Deceleration Sensor	<ul style="list-style-type: none"> • Detects the vehicle's yaw rate. • Detects the vehicle's acceleration in the forward, rearward, and lateral.
Pump Motor Relays	Control the pump motor operation in the hydraulic brake booster.
Solenoid Relay	Supply or cut off power to solenoid valves in the brake actuator.
Stop Light Control Relay* ¹	Turn on the stop light during DAC or HAC operation.
Stop Light Switch	Detects the brake pedal depressing signal.
Neutral Start Switch* ¹	Detects the shift position.
VSC Warning Buzzer	<p>This buzzer has 3 types of sounds.</p> <ul style="list-style-type: none"> • This buzzer sounds intermittently to inform the driver that the VSC and HAC are actives. • This buzzer sounds intermittently to inform the driver if the temperature of the brake actuator has increased excessively due to the continuous operation of the A-TRC, DAC (for AT models), and HAC (for AT models). • This buzzer sounds continuously to alert the driver that the hydraulic pressure of the accumulator in the hydraulic brake booster has decreased, and that the power supply system is malfunctioning.
Engine ECU	Cutoff the fuel injection based on the signals receives from the skid control ECU, in order to control the engine output. Also, sends the accelerator pedal position signal, and engine speed signal to the skid control ECU.
Accelerator Pedal Position Sensor	Detects the depressing of the accelerator pedal and inputs it into the engine ECU.
Engine Speed Sensor (1KZ)/ Crankshaft Position Sensor (1KD)	Detects the engine speed, and sends it via the engine ECU to the skid control ECU.
Spill Control Valve (1KZ)/ EDU (1KD)	Controls the fuel injection in accordance with the signals received from the engine ECU.
Center Diff. Lock Detection Switch	Detects the condition of the center differential lock.
L4 Position Switch	Detect the transfer condition shifted in the L4.
Suspension Control ECU* ²	Control the TEMS based on the VSC operation signals (front or rear skid) from the skid control ECU, in order to control constantly vehicle posture.

*¹: Only for Automatic Transmission Models

*²: with TEMS models

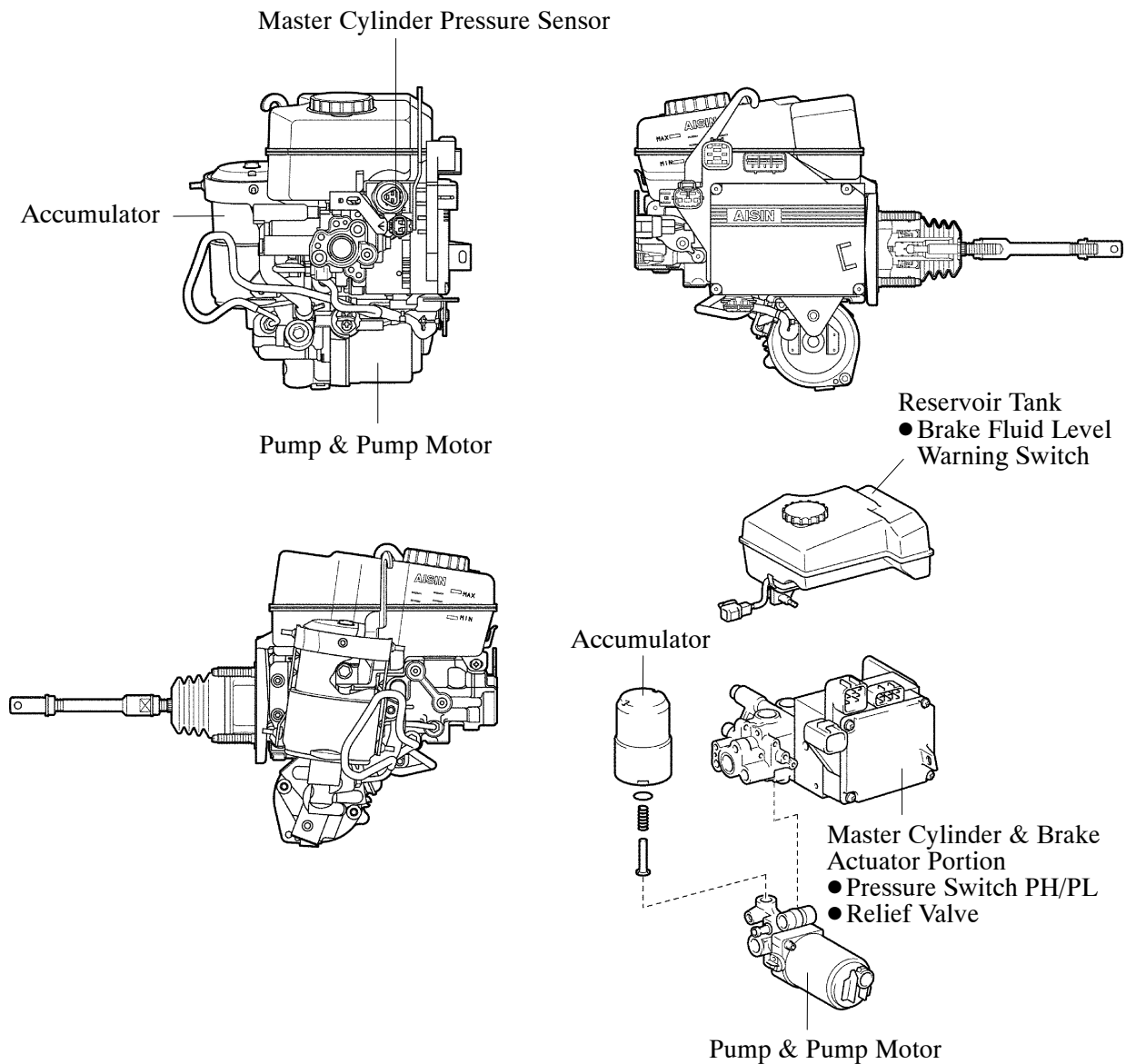
10. Construction and Operation of Main Component

Hydraulic Brake Booster

1) General

The hydraulic brake booster consists of the master cylinder & brake actuator portion, reservoir tank, pump & pump motor, and accumulator.

- The master cylinder & brake actuator portion contains a master cylinder & brake booster, 12 solenoid valves, relief valve, and 2 pressure switches (PH, PL).
- The reservoir tank contains a brake fluid level warning switch.

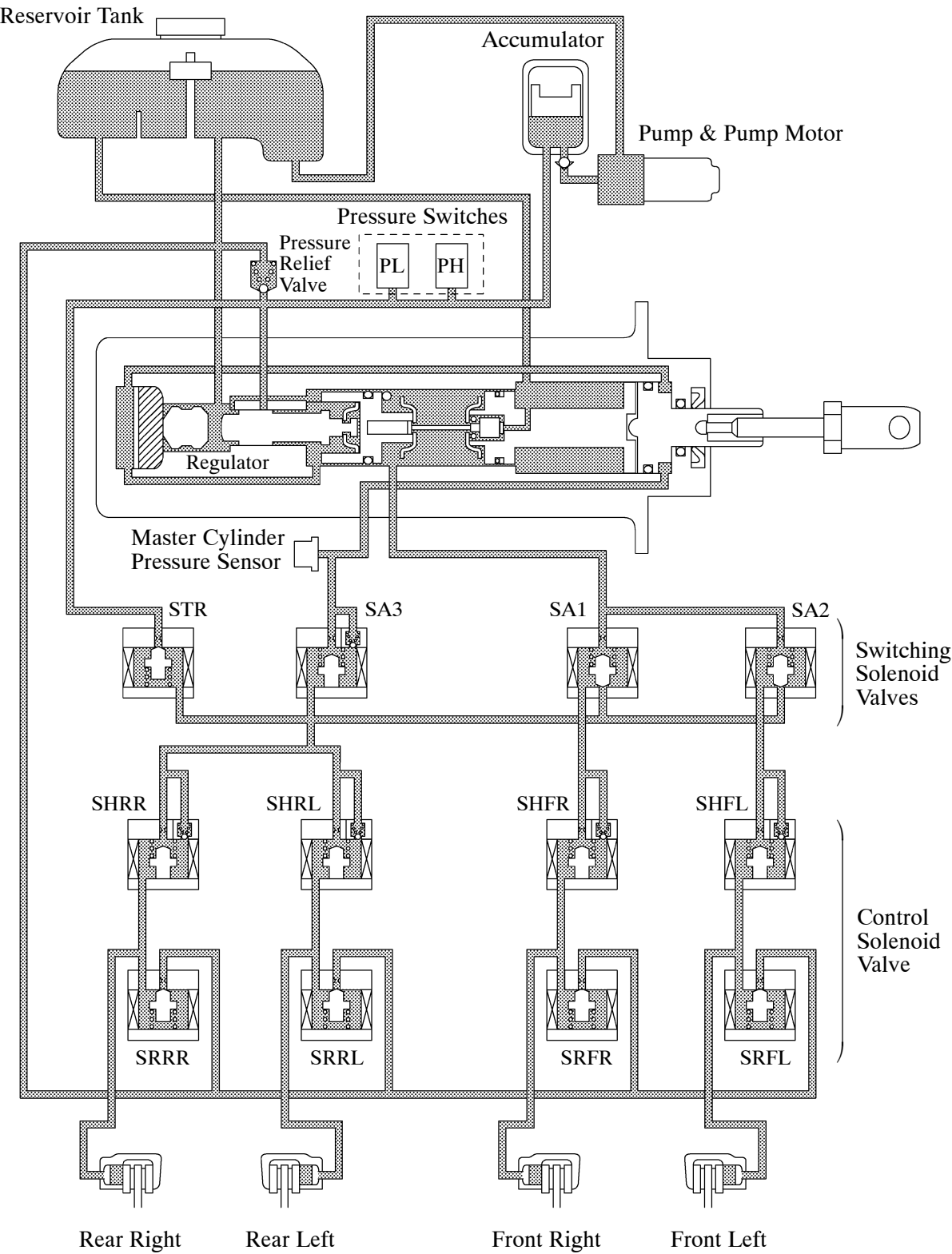


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The hydraulic brake booster consists of the following components:

Components		Function
Master Cylinder & Brake Actuator	Master Cylinder & Brake Booster	<ul style="list-style-type: none"> Generates the hydraulic pressure that is provided to the wheel cylinders during normal brake. Regulates the accumulator pressure in accordance with the pedal effort that is applied to the brake pedal and introduce this pressure to the booster chamber in order to provide a power assist to the brakes.
	Switching Solenoid Valves (SA1, SA2, SA3, STR)	Switches the brake hydraulic path when the brake control system is activated, or normal braking is applied.
	Control Solenoid Valves	Controls the hydraulic pressure that is applied to the wheel cylinders during brake control.
	Relief Valve	Returns the brake fluid to the reservoir tank to prevent excessive pressure if the pump operates continuously due to a malfunction of the pressure switch.
	Pressure Switch PH/ PL	Monitors the hydraulic pressure of the accumulator and outputs control signals for the pump motor. <ul style="list-style-type: none"> Pressure switch PH (for controlling the pump) Pressure switch PL (for giving a warning when the pressure is low)
Reservoir Tank		Stores the brake fluid.
	Brake Fluid Level Warning Switch	Detects the low brake fluid level.
Pump and Pump Motor		Draws up the brake fluid from the reservoir tank and provides high hydraulic pressure to the accumulator.
Accumulator		Stores the hydraulic pressure that was generated by the pump. The accumulator is filled with high-pressure nitrogen gas.

► Hydraulic Circuit ◀



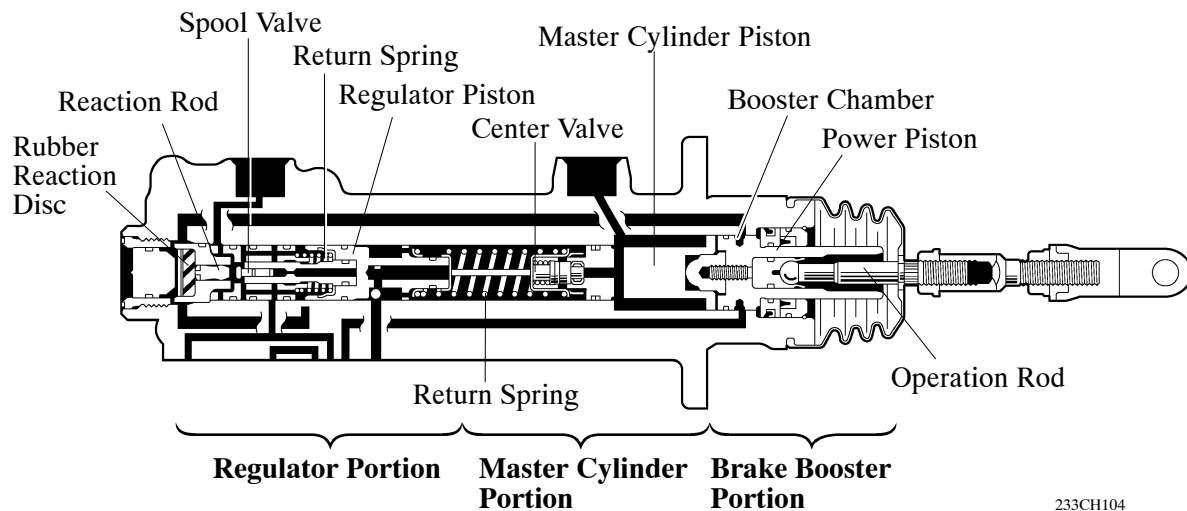
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2) Master Cylinder & Brake Booster

a. Construction

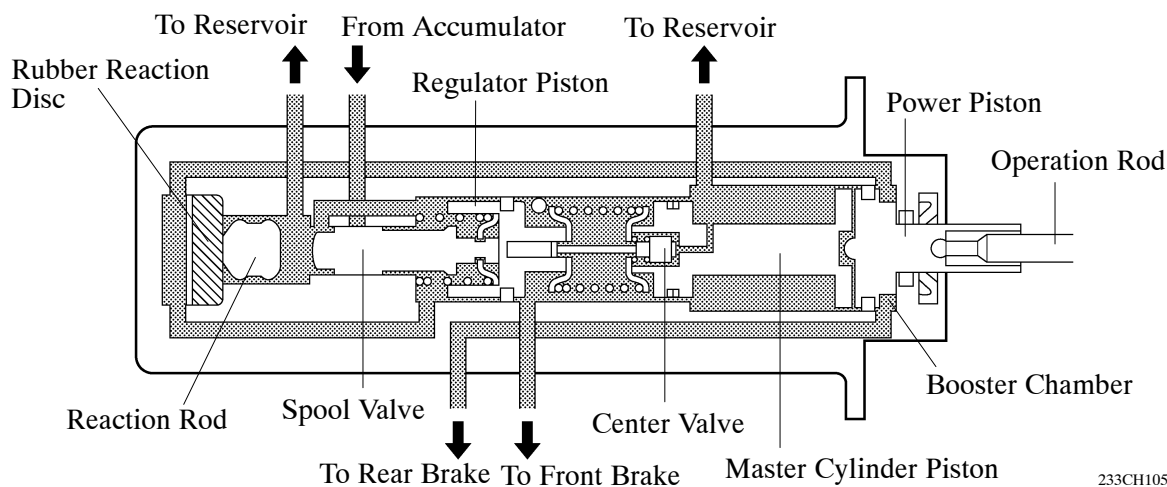
The master cylinder & brake booster consists of a brake booster portion, master cylinder portion, and regulator portion. These are positioned coaxially to achieve a simple and compact construction.

- The brake booster portion consists of an operation rod, power piston and booster chamber.
- The master cylinder portion consists of a master cylinder piston, return spring and center valve.
- The regulator portion consists of a regulator piston, return spring, spool valve, reaction rod, and rubber reaction disc.



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► Simplified Diagram ◀



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Service Tip

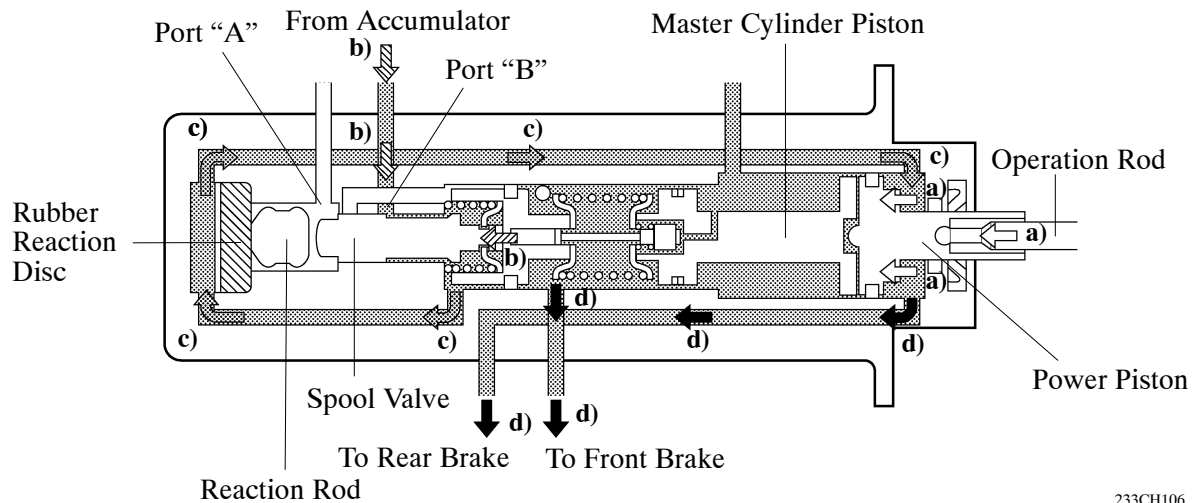
The supply parts for the master cylinder & brake booster portion are provided as follows:

- The operation rod and the power piston, which are integrated, are supplied as the No. 1 piston.
- The master cylinder piston is supplied as the No. 2 piston.
- Other parts are not available as supply parts, so do not remove them.

For detailed removal procedure, see the Land Cruiser/ Land Cruiser Prado Repair Manual (Pub. No. RM990E).

b. Operation**i) Pressure Increase (Low Pressure)**

- a) The pedal operation force transmits as follows: Operation Rod → Power Piston → Master Cylinder Piston
- b) The load setting of the master cylinder's return spring is higher than that of the regulator piston's return spring, the regulator piston gets pushed before the volume in the master cylinder becomes compressed.
- c) The spool valve closes the port "A" (between the reservoir tank and booster chamber) and opens the port "B" (between the reservoir tank and accumulator). Then, the pressurized brake fluid is introduced into the booster chamber to provide a power assist to the pedal effort.
- d) This time, the power assist overcomes the force of the master cylinder's return spring. This causes the volume in the master cylinder to become compressed and increased the pressure that is applied to the front brakes. At the same time, the pressure in the booster chamber increases the pressure that is applied to the rear brakes.



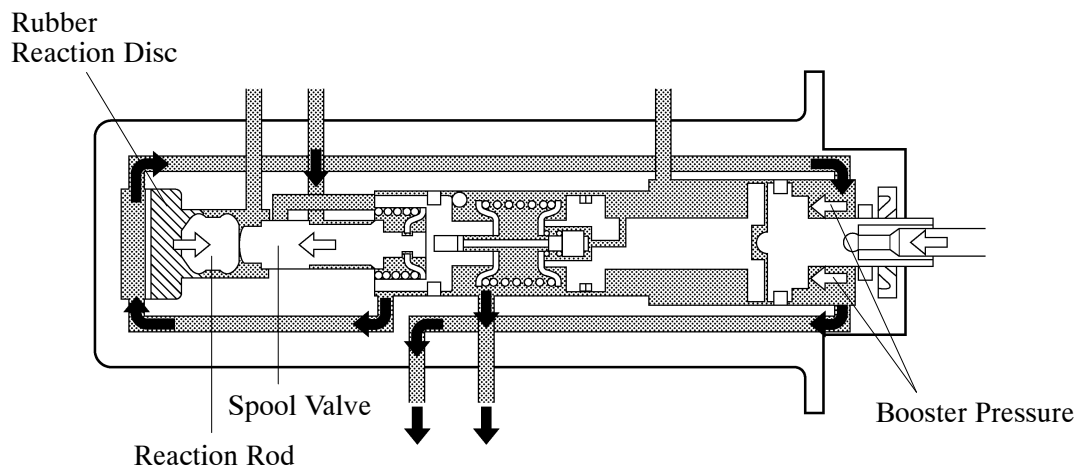
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During the initial stage of the brake operation, the booster pressure that is applied to the rubber reaction disc is small. Therefore, a return force in the rightward direction does not apply to the spool valve via the reaction rod.

ii) Pressure Increase (High Pressure)

In contrast to the time when the pressure is low, when the pressure is high, the booster pressure that is applied to the rubber reaction disc increases. Accordingly, the rubber reaction disc deforms and causes a return force in the rightward direction to be applied to the spool valve via the reaction rod. Therefore, in contrast to the time when the pressure is low, a greater reaction force is transmitted to the brake pedal.

As a result, a variable servo mechanism is realized, in which the servo ratio is lower during high pressure than during low pressure.

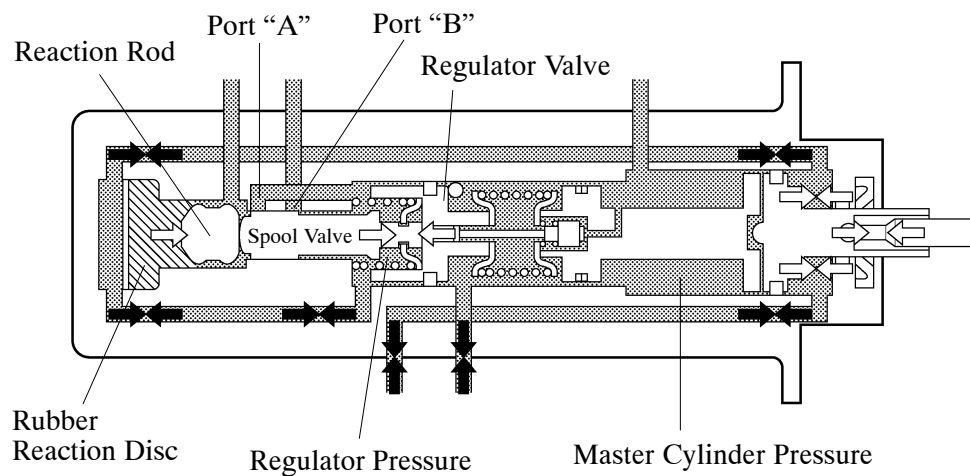


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iii) Holding

This is a state in which the force that is applied via the brake pedal and the master cylinder pressure are in balance.

The forces that are applied to the front and the rear of the regulator piston, in other words, forces that are generated by the master cylinder pressure and the regulator pressure become balanced. This causes the spool valve to close both port "B" from the booster chamber to the accumulator and port "A" to the reservoir. As a result, the brake is in the holding state.

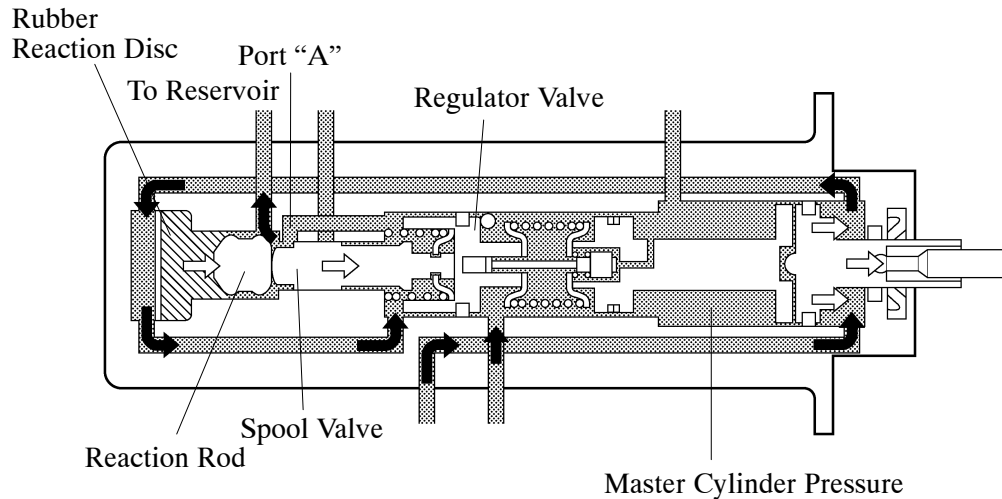


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iv) Pressure Reduce

When the pressure that is applied to the brake pedal is relaxed, the master cylinder pressure decreases. Then, the regulator piston's return (rightward) force becomes relatively greater, causing the regulator piston to retract and the spool valve to also retract. As a result, the port "A" between the reservoir tank and the booster chamber opens.

The booster pressure becomes reduced in this state, creating a balance that corresponds to the force that is newly applied via the brake pedal. This process is performed repetitively to reduce the booster pressure and the master cylinder pressure in accordance with the force that is applied via the brake pedal.



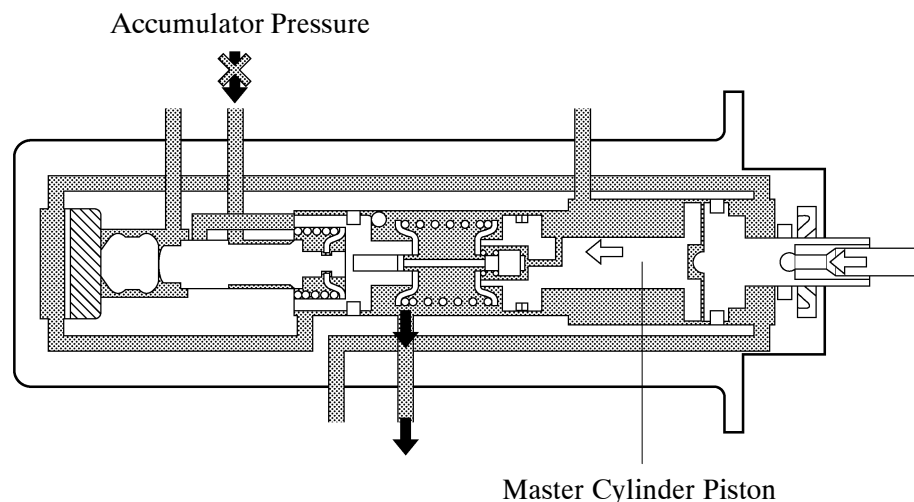
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v) During Power Supply Malfunction

If the accumulator pressure is affected by any malfunction, no hydraulic pressure will be supplied to the booster chamber. For this reason, a power assist cannot be provided to the force that is applied via the brake pedal and the pressure to the rear brakes cannot be increased.

However, the pressure to the front brakes will be increased at the master cylinder piston in accordance with the pedal effort applied to the brake pedal.



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3) Solenoid Valve

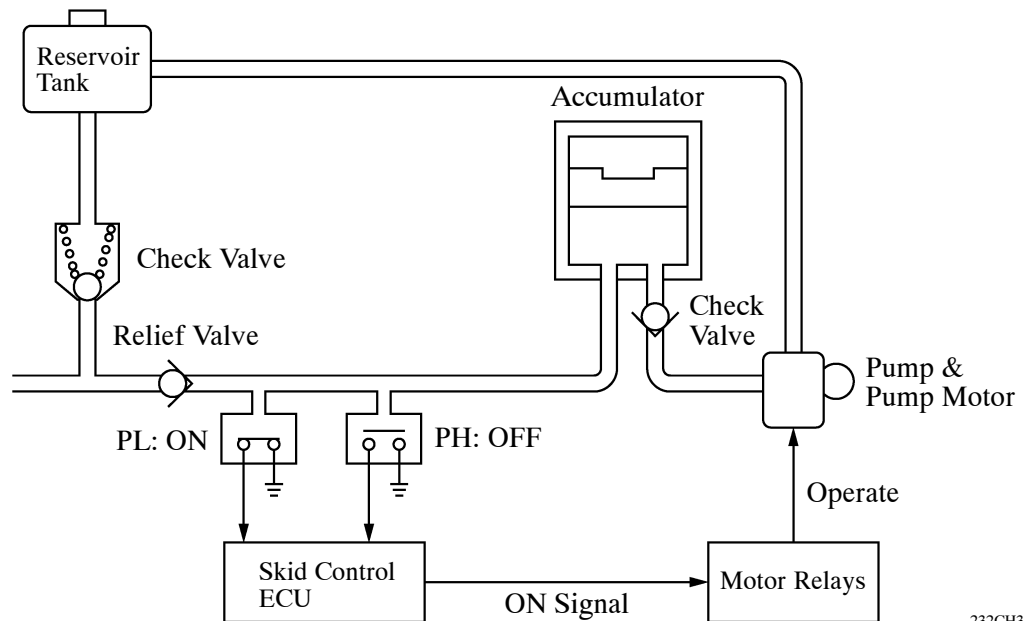
There are two types of solenoid valves: the switching solenoid valve and the control solenoid valve.

- A total of 4 switching solenoid valves are used: 2 (SA1, SA2) in the front brake fluid path, 1 (SA3) in the rear brake fluid path, and 1 (STR) in the accumulator fluid path. The switching valves open and close in accordance with the control signals from the skid control ECU in order to switch the respective brake fluid paths.
- A total of 8 control solenoid valves are used for the 4 wheels (2 types per wheel: pressure holding solenoid and pressure reduction solenoid).
The pressure increase mode, the pressure holding mode, and the pressure reduction mode are effected based on the combination of these valves that are turned ON and OFF, in order to control the hydraulic pressure that is applied to each of the wheel cylinders.
- On the new Land Cruiser/ Land Cruiser Prado, the resistance of the solenoid coil of 8 solenoid valves (4 switching solenoid valves: SA1, SA2, SA3, and STR: 4 pressure holding valves: SFRH, SFLH, SRRH, and SRLH) has been changed from the previous Land Cruiser/ Land Cruiser Prado as indicated below, in order to improve their heat resistance. As a result, the continuous operation time of the solenoid valves has been increased.

Model		New	Previous
Switching Solenoid Valve	SA1, SA2, STR	Approx. 4.3 Ω	Approx. 3.7 Ω
	SA3	Approx. 7.2 Ω	Approx. 5.0 Ω
Control Solenoid Valve	Pressure Holding Valve SFRH, SFLH, SRRH, SRLH	Approx. 7.2 Ω	Approx. 5.0 Ω
	Pressure Reduction Valve SFRR, SFLR, SRRR, SRLR	Approx. 5.0 Ω	←

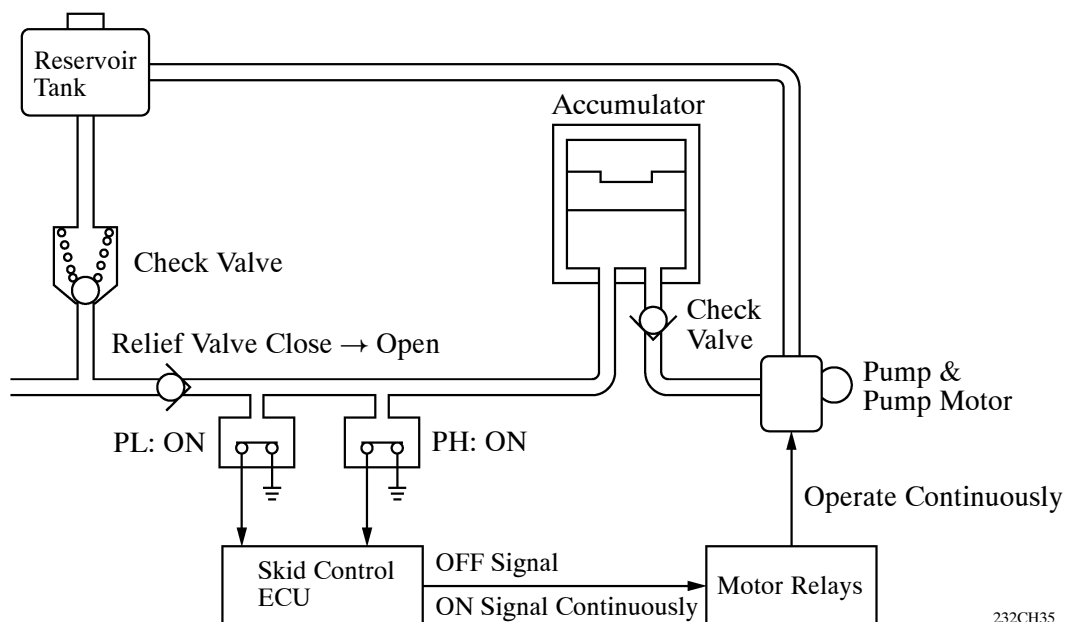
4) Pump & Pump Motor, Accumulator, Pressure Switches PH/ PL and Relief Valve

- If the accumulator pressure becomes lower than the pressure that is specified in the pressure switch PH, which is used for detecting high pressure, the pressure switch PH turns OFF. Then, the skid control ECU turns ON the pump motor relays to operate the pump & pump motor. The brake fluid that is discharged by the pump passes through the check valve and is stored in the accumulator. The hydraulic pressure that is stored in the accumulator is used for providing the hydraulic pressure that is needed for normal braking and for operating the brake control.



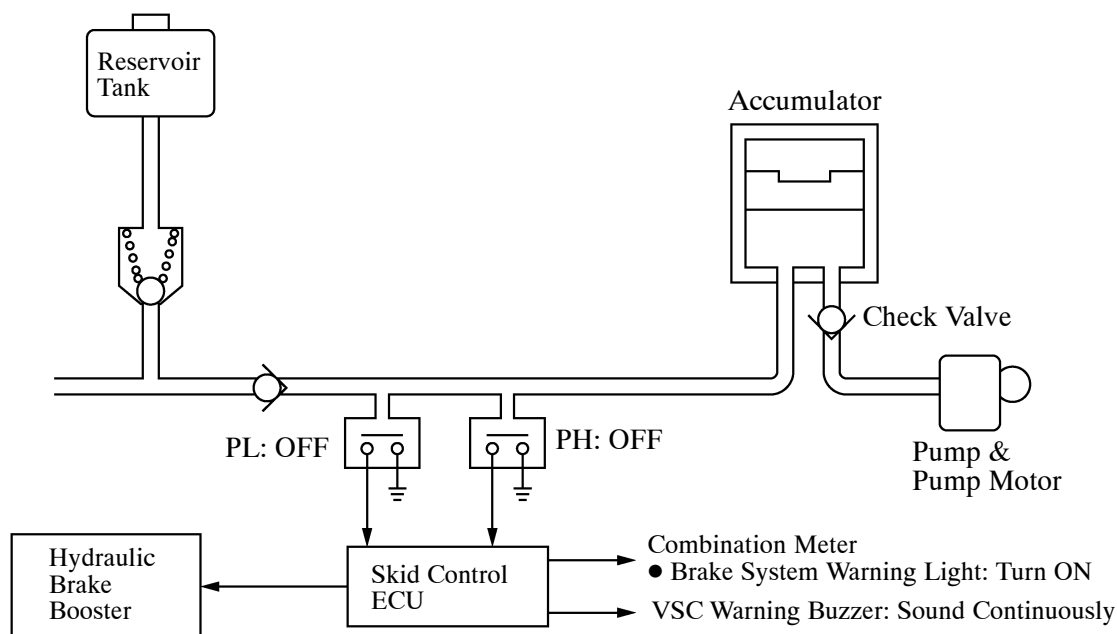
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- If the accumulator pressure becomes higher than the pressure that is specified in the pressure switch PH, the pressure switch PH turns ON. Then after several seconds, the skid control ECU turns OFF the pump & pump motor. At this time, if the pressure switch malfunctions and causes the pump & pump motor to operate continuously, the relief valve opens to prevent excessive pressure from being generated.



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- If the accumulator pressure becomes lower than the pressure that is specified in the pressure switch PL, which is used for detecting low pressure, the pressure switch PL turns OFF. As a result, the brake warning light turns ON and the VSC warning buzzer activates. At this time, the brake control (ABS with EBD, Brake Assist, A-TRC, VSC, DAC, and HAC) is prohibited from operating.

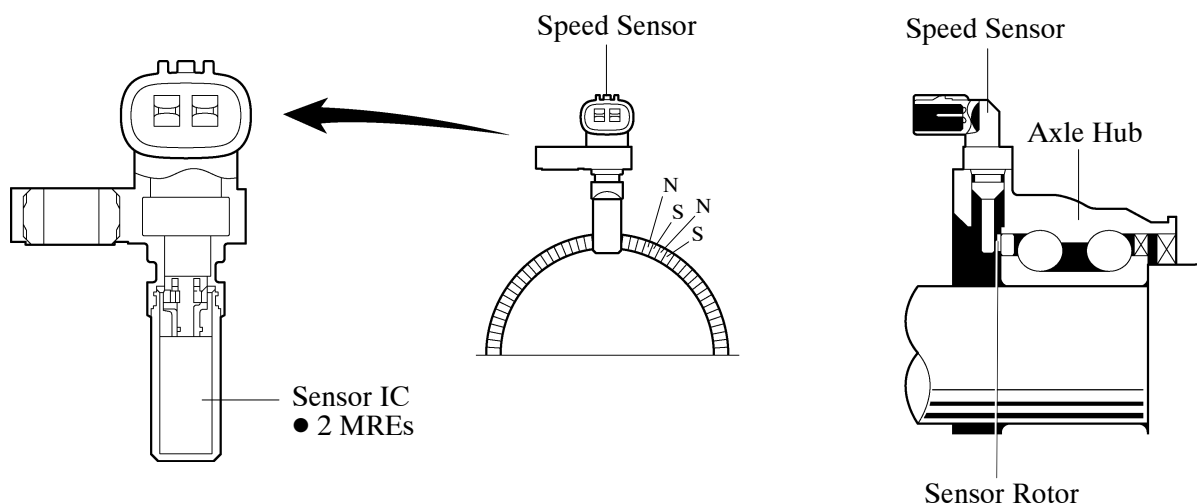


232CH36

Speed Sensor

1) General

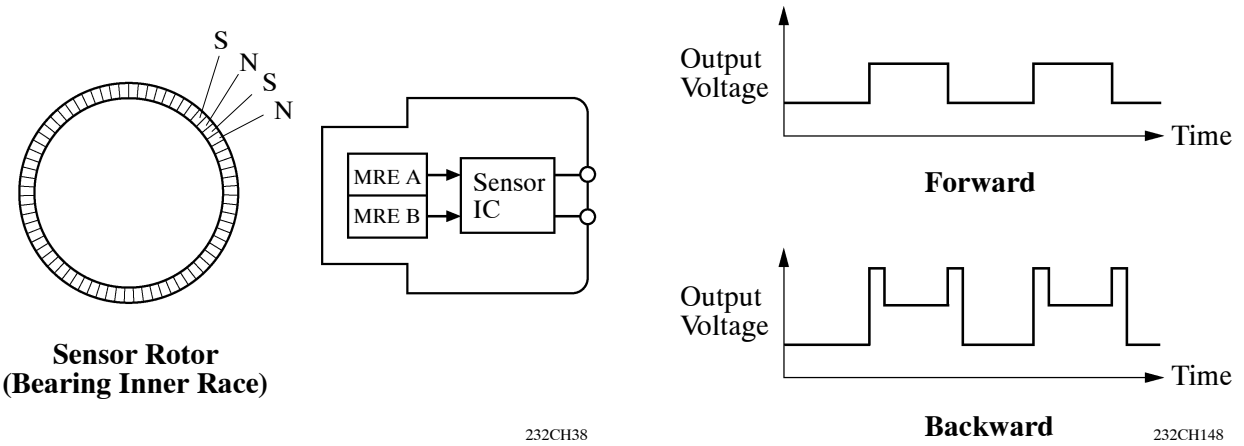
- Active type speed sensors that can detect the tire rotational direction forward and backward movement of the wheel have been adopted on the new Land Cruiser/ Land Cruiser Prado. This sensor contains a sensor IC, which consists of two MREs (Magnetic Resistance Elements).
- The sensor rotor, which consists of N and S poles that are arranged in a circle, is integrated with the inner race of the hub bearing.



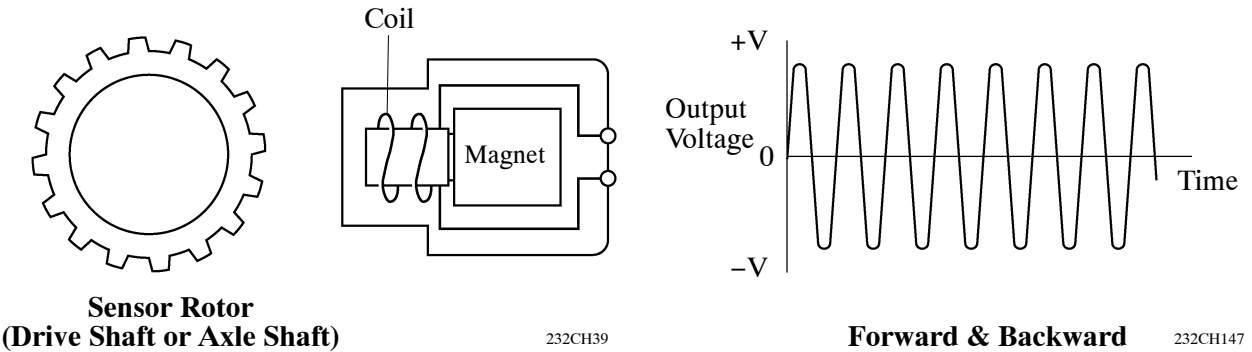
232CH37

- The following differences exist between the passive type speed sensor (containing a pick-up coil to detect speeds) that is used on the previous Land Cruiser/ Land Cruiser Prado and the active type that is used on the new Land Cruiser/ Land Cruiser Prado:

► Active Type Speed Sensor ◀



► Passive Type Speed Sensor ◀

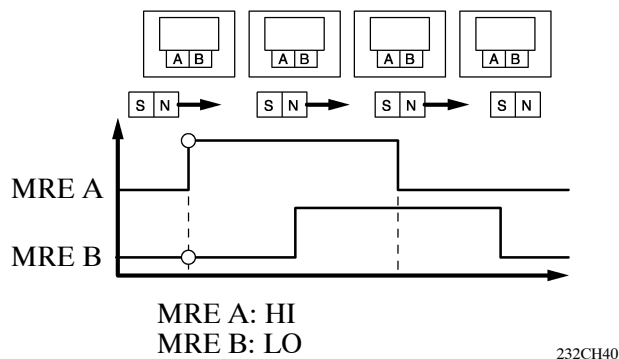


Model	New	Previous
Type	Active	Passive
Direction Detection	Possible to judge both forward and backward	Impossible to judge the wheel rotation direction
Detection Speed	Approx. 0 km/h (0 mph)	3 km/h (5 mph) or more
Weight	Approx. 1/3 of passive type	—

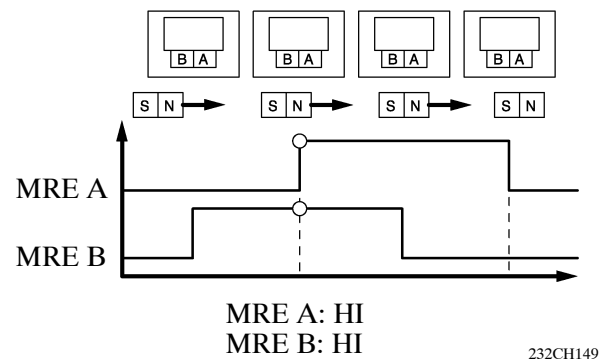
2) Detection Method

- To detect the rotation direction, the output waves are used to determine the relationship of the pulses that are generated by the 2 MREs.
- Upon receiving this signal, the sensor IC outputs a forward or backward wave.

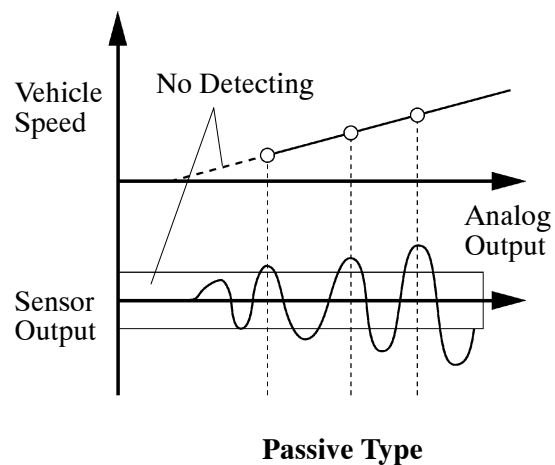
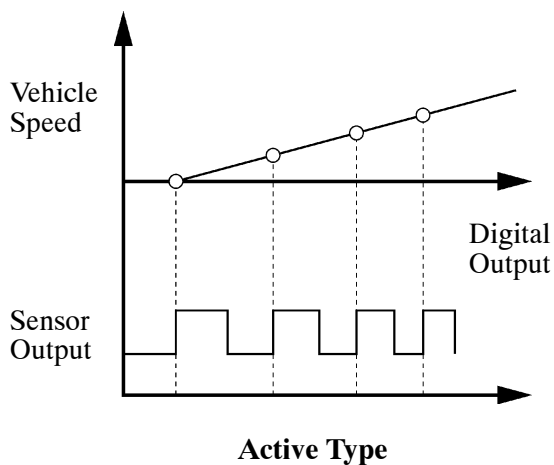
► Forward ◀



► Backward ◀



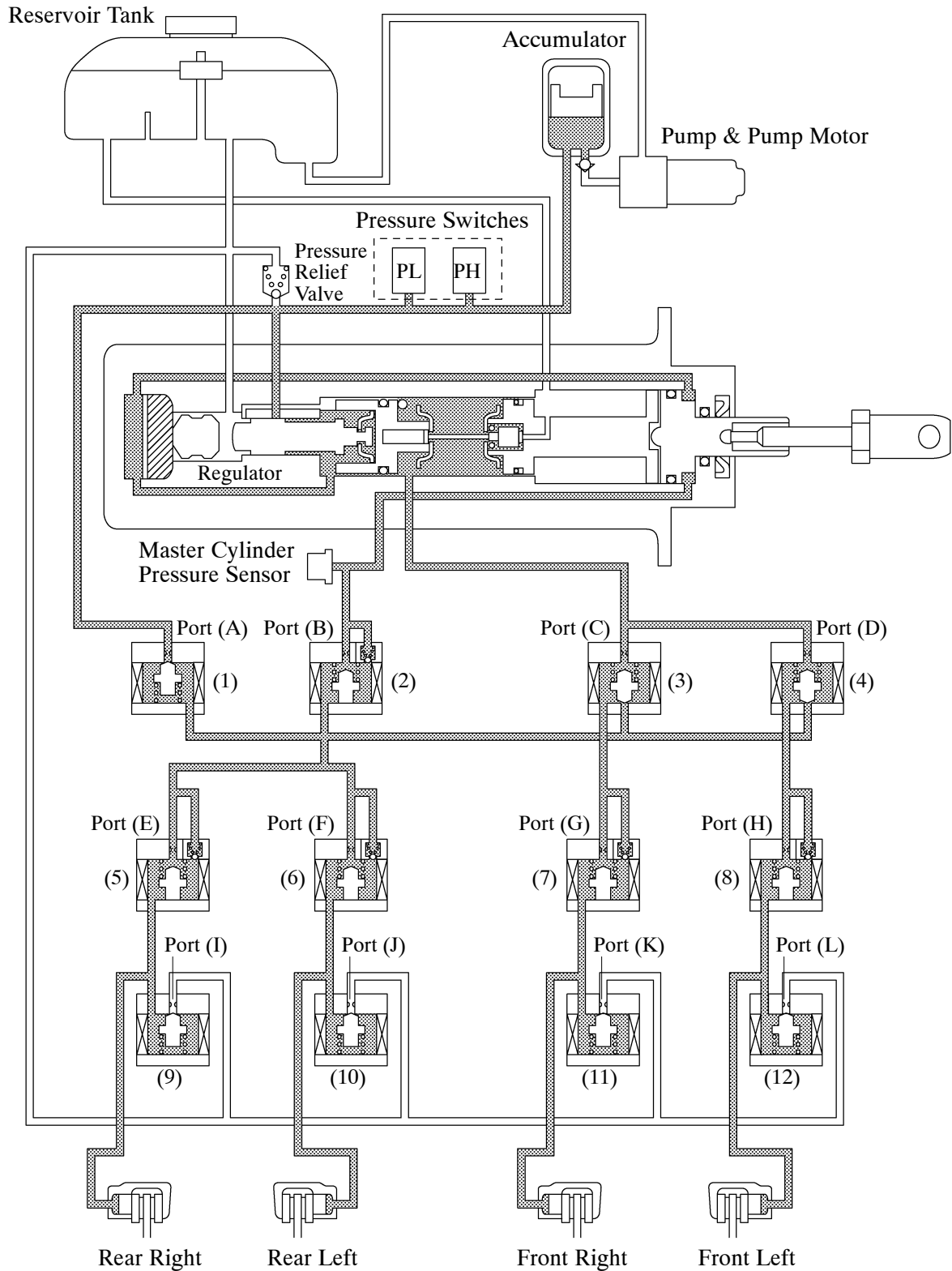
- To detect the vehicle speed, the duration of the output pulses is used. Because the active type sensor outputs digital pulses, it can detect vehicle speeds even at approximately 0 km/h (0 mph).
- This function enables the HAC of the brake control.



11. System Operation

Normal Braking

During normal braking, all solenoid valves are turned OFF.



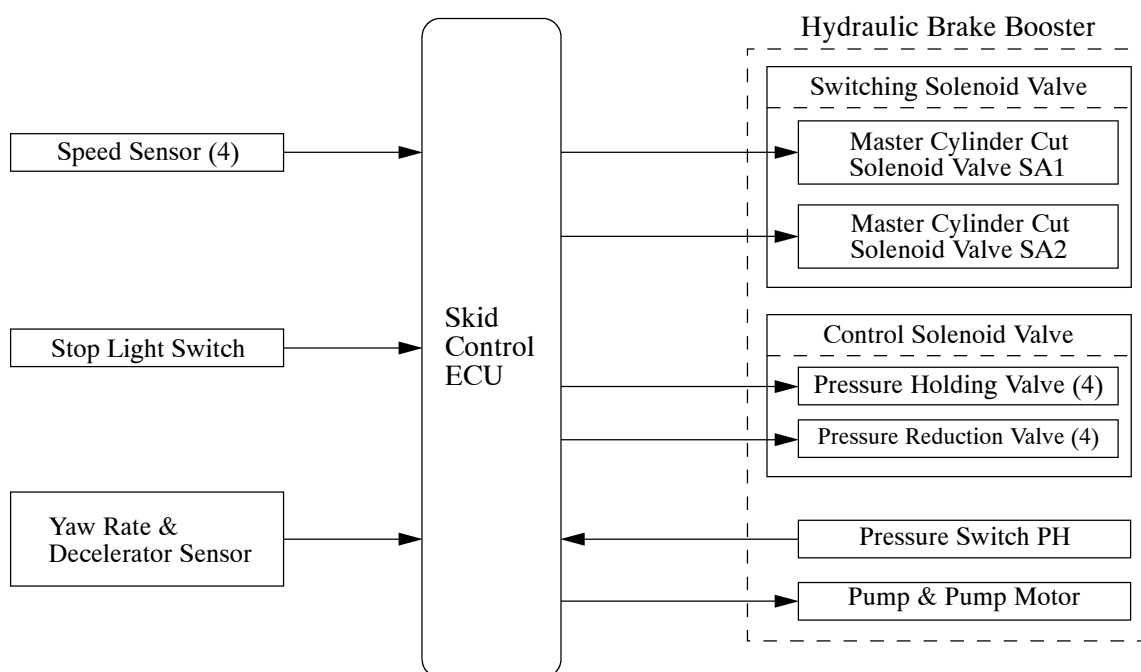
CH

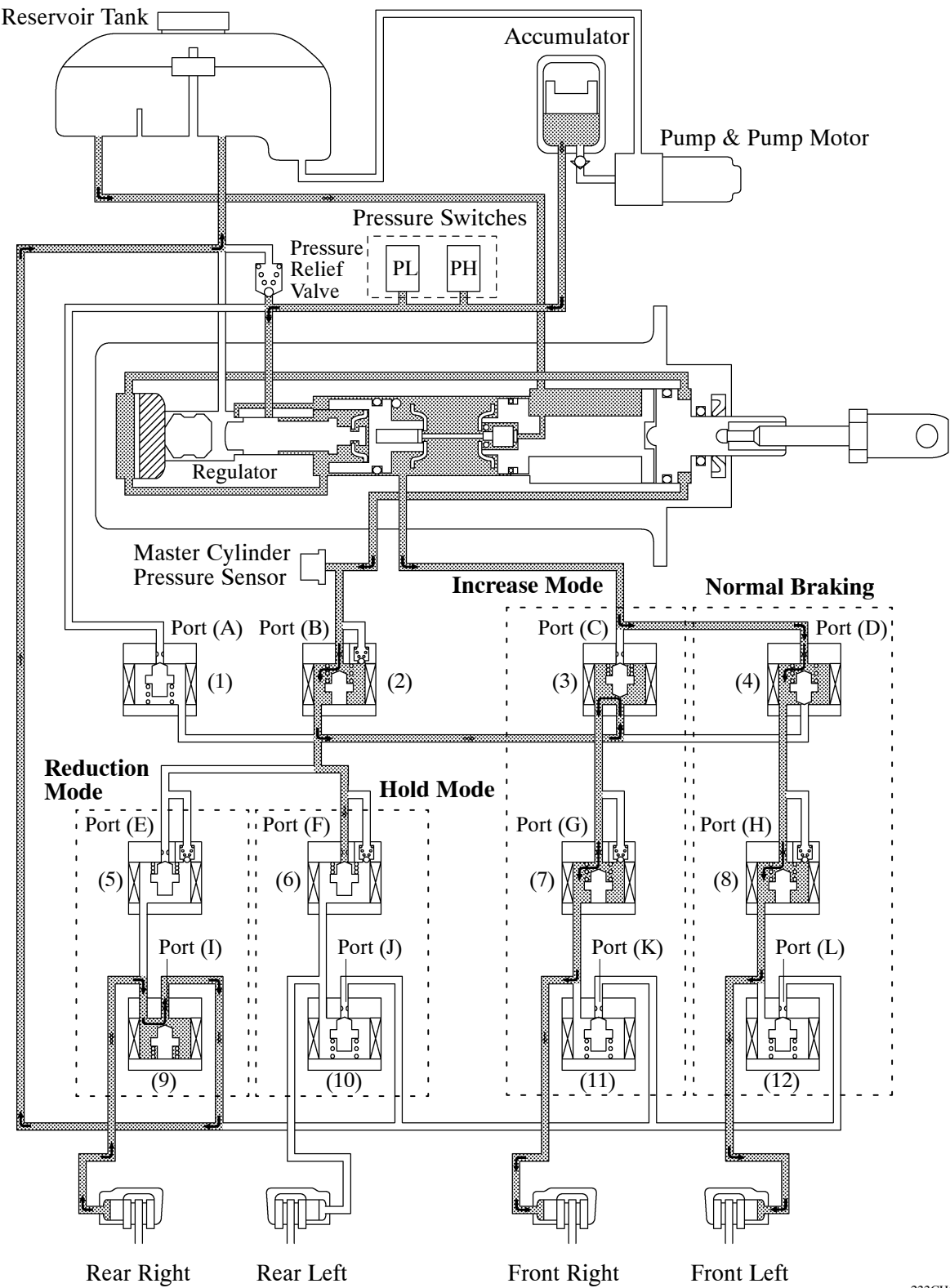
ABS with EBD Operation

Based on the signals received from the 4 wheel speed sensors and yaw rate & decelerator sensor, the skid control ECU calculates speed and deceleration of each wheel, and checks wheel slipping condition. And according to the slipping condition, the skid control ECU controls the pressure holding valve and pressure reduction valve in order to adjust the fluid pressure of each wheel cylinder in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes.

If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure switch PH and actuates the pump & pump motor to ensure the proper accumulator pressure.

► System Diagram ◀





CH

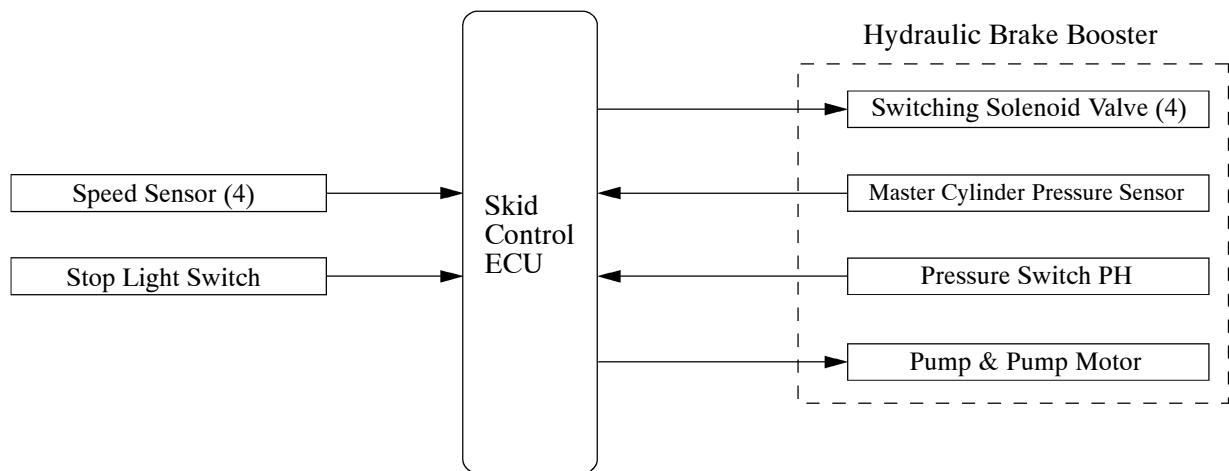
Item			ABS with EBD not Activated	ABS with EBD Activated			
				Increase Mode	Hold Mode	Reduction Mode	
Switching Solenoid Valve	(1)	Accumulator Cut Solenoid Valve STR	OFF (Close)	←	←	←	
		Port (A)					
	(2)	Regulator Cut Solenoid Valve SA3	OFF (Open)	←	←	←	
		Port (B)					
	(3)	Master Cylinder Cut Solenoid Valve SA1	OFF (Open)	ON (Close)	←	←	
		Port (C)					
	(4)	Master Cylinder Cut Solenoid Valve SA2	OFF (Open)	ON (Close)	←	←	
		Port (D)					
Control Solenoid Valve	Front Brake	(7), (8)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
		(11), (12)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction
	Rear Brake	(5), (6)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
		(9), (10)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction

Brake Assist Operation

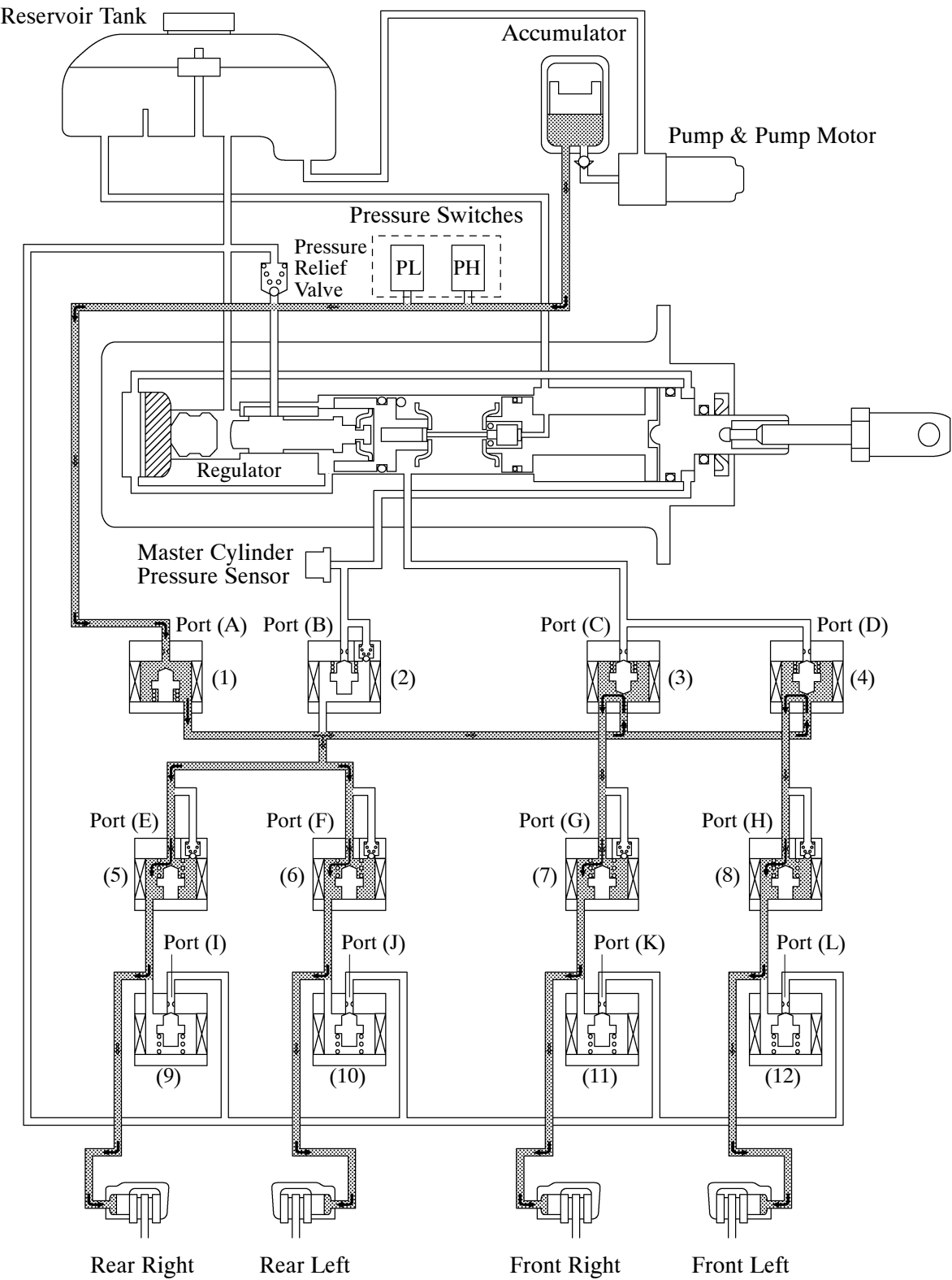
If an emergency braking situation has occurred, it is detected by the skid control ECU based on the vehicle speed signal from the speed sensor, the brake pedal application speed from the master cylinder pressure sensor, and the signal representing the amount of pedal effort. Then, the skid control ECU actuates the switching solenoid valves. As a result, the fluid pressure from the accumulator is applied to the wheel cylinders. The accumulator fluid pressure that is applied to the wheel cylinders generates a higher fluid pressure than the master cylinder.

If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure switch PH and actuates the pump & pump motor to ensure the proper accumulator pressure.

► System Diagram ◀



232CH43

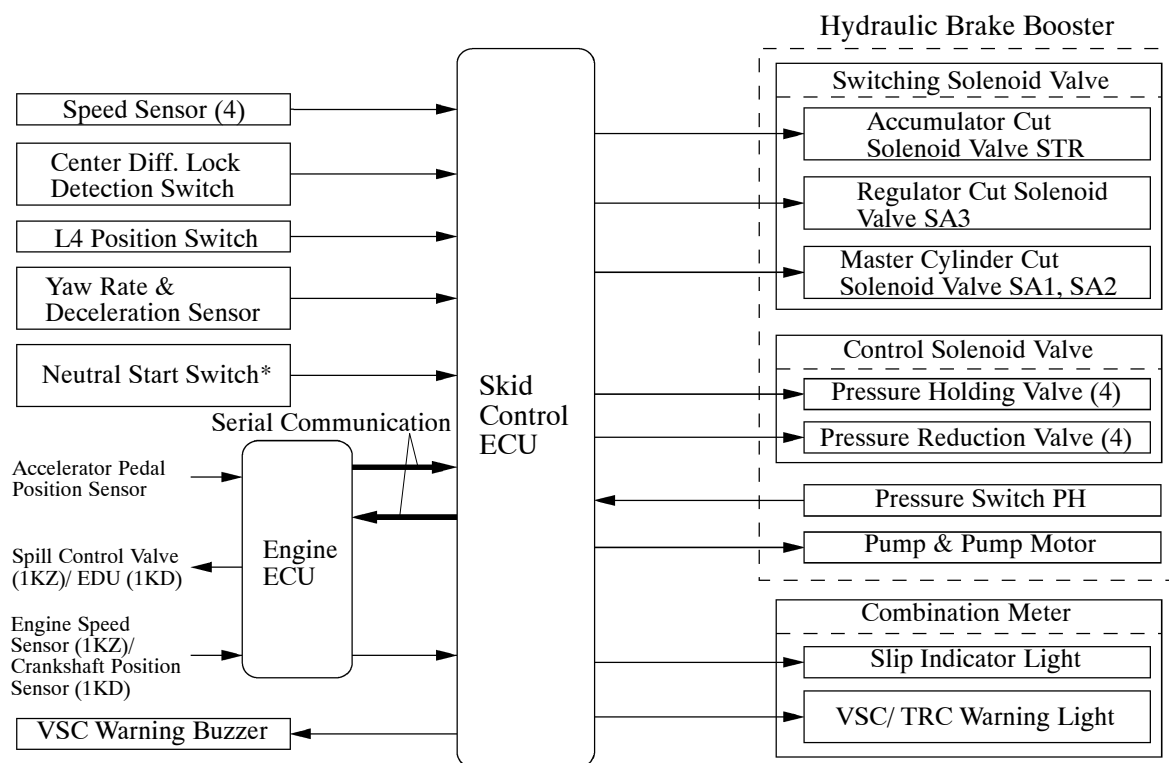


Item			Brake Assist not Activated	Brake Assist Activated	
Switching Solenoid Valve		(1)	Accumulator Cut Solenoid Valve STR	OFF (Close)	ON (Open)
			Port (A)		
		(2)	Regulator Cut Solenoid Valve SA3	OFF (Open)	ON (Close)
			Port (B)		
		(3)	Master Cylinder Cut Solenoid Valve SA1	OFF (Open)	ON (Close)
			Port (C)		
		(4)	Master Cylinder Cut Solenoid Valve SA2	OFF (Open)	ON (Close)
			Port (D)		
Control Solenoid Valve	Front Brake	(7), (8)	Pressure Holding Valve	OFF (Open)	←
			Port: (G), (H)		
		(11), (12)	Pressure Reduction Valve	OFF (Close)	←
			Port: (K), (L)		
		Wheel Cylinder Pressure		—	Increase
	Rear Brake	(5), (6)	Pressure Holding Valve	OFF (Open)	←
			Port: (E), (F)		
		(9), (10)	Pressure Reduction Valve	OFF (Close)	←
			Port: (I), (J)		
		Wheel Cylinder Pressure		—	Increase

A-TRC Operation

- Based on the vehicle speed that has been calculated from each speed sensor and deceleration signal of the yaw rate & deceleration sensor, the skid control ECU computes the target control speed in accordance with the transfer range.
- The skid control ECU outputs an A-TRC operate signal to the engine ECU and the combination meter. Upon receiving this signal, the engine ECU effects fuel injection to regulate the engine output. The slip indicator light in combination meter begins to blink.
- If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure switch PH and actuates the pump & pump motor to ensure the proper accumulator pressure.
- Furthermore, when the A-TRC is operating continuously while the vehicle is being driven on a slippery surface, the temperature of the brake actuator in the hydraulic brake booster increases. After a prescribed length of time elapses, the skid control ECU alerts the driver of this condition by causing the VSC warning buzzer to sound intermittently for approximately 3 seconds, and the VSC/TRC warning light to illuminate. Also, the A-TRC operation is momentarily interrupted to protect the brake actuator. When the temperature of the brake actuator decreases, the VSC/TRC warning light turns OFF, and the A-TRC is automatically restored to an operating state.

► System Diagram ◀



233CH96

*: Only for Automatic Transmission Models

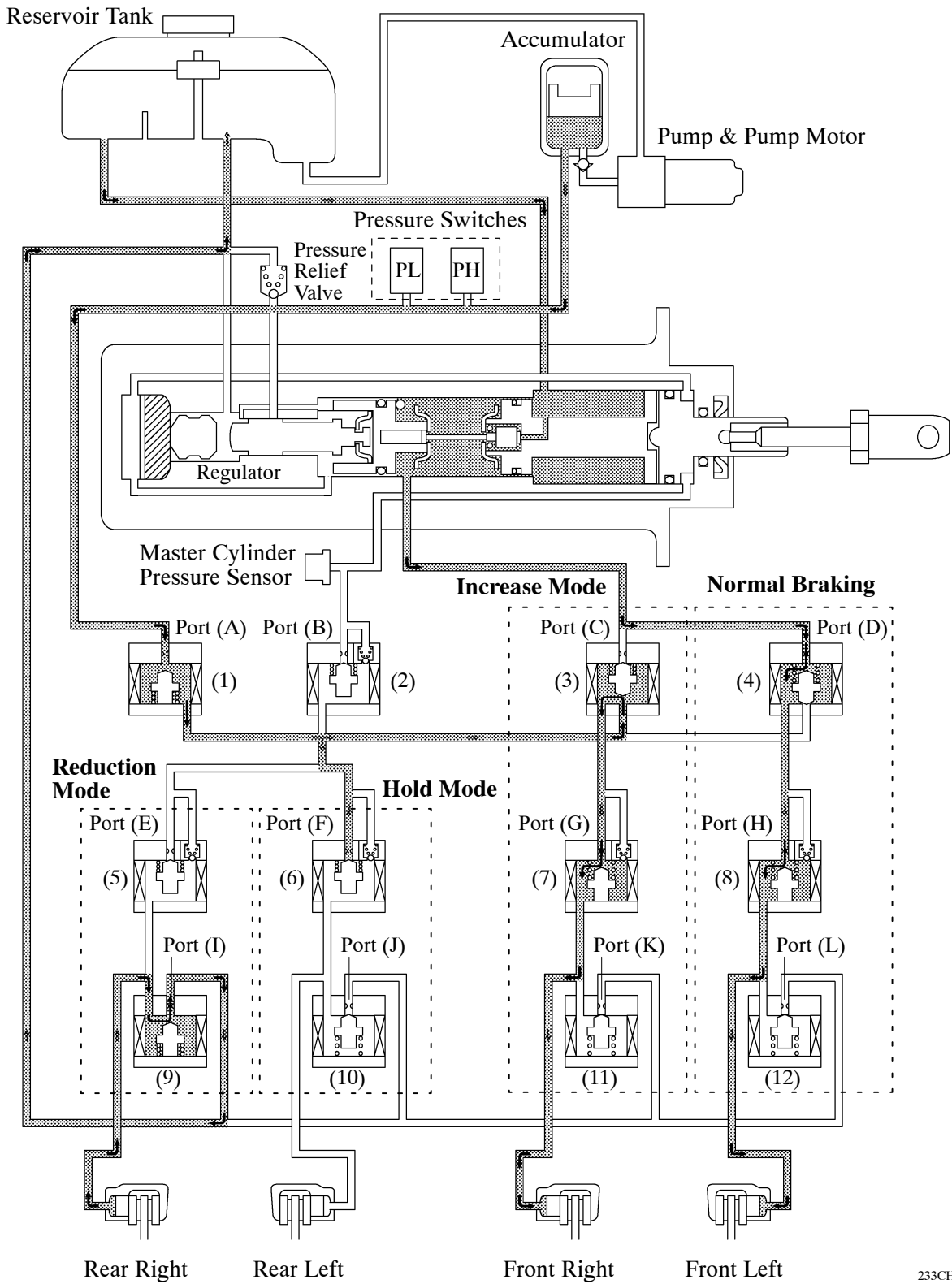
- The engine output control of the A-TRC function varies in accordance with the range in which the transfer is engaged. When the transfer is engaged in the H range, this function effects engine output control that varies between stability-priority and drivability-priority in accordance with the amount of pedal effort applied to the accelerator pedal. When the transfer is engaged in the L range, it effects engine output control on a drivability-priority basis.

- The skid control ECU compares the target control speed and the speeds of the wheels to determine whether or not a slippage exists. Upon detecting a slippage, the skid control ECU controls the solenoid valve of the hydraulic brake booster to control the brake fluid pressure that is applied to the slipping wheel. When the wheel speed becomes lower than the target control speed, the skid control ECU stops controlling the brake fluid pressure.
- As shown in the table below, the target control speed and the brake fluid pressure control vary in accordance with the transfer range.

Road Condition	Transfer Range	Control	Contents	Outline
Ordinary Road	H	Target Control Speed	Vehicle Speed + Slip Rate (H range set value)	Control designed to ensure the ease of driving on low-friction roads, dirt roads, and general roads.
		Brake Control	Gradual Fluid Pressure Control	
Rocky or Offroad	L	Target Control Speed	Vehicle Speed + Slip Rate (L range set value)	Control designed for rugged offroad driving.
		Brake Control	Sudden fluid Pressure Control	
Downhill	L + 1st gear	Target Control Speed	Vehicle speed when deceleration slippage has been determined during downhill driving.	Designed for rugged, offroad downhill driving with the engine brake applied. It prevents the acceleration of the vehicle that could be caused by the release of the engine brake.
		Brake Control	Fluid pressure control to the front wheels	

- The fluid pressure control of the A-TRC independently controls the brake of each wheel by operating the individual solenoid valves in accordance with the signals received from the skid control ECU. The brake of each wheel is controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes.

NOTE: The “L” range shift position is used when a maximum amount of drive force or engine brake is required, such as to free the vehicle that is stuck or to drive down a steep hill.



Item			A-TRC not Activated	A-TRC Activated			
				Increase Mode	Hold Mode	Reduction Mode	
Switching Solenoid Valve	(1)	Accumulator Cut Solenoid Valve STR	OFF (Close)	ON* ¹ (Open)	←	←	
		Port (A)					
	(2)	Regulator Cut Solenoid Valve SA3	OFF (Open)	ON* ¹ (Close)	←	←	
		Port (B)					
	(3)	Master Cylinder Cut Solenoid Valve SA1	OFF (Open)	ON* ² (Close)	←	←	
		Port (C)					
	(4)	Master Cylinder Cut Solenoid Valve SA2	OFF (Open)	ON* ³ (Close)	←	←	
		Port (D)					
Control Solenoid Valve	Front Brake	(7), (8)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (G), (H)				
		(11), (12)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (K), (L)				
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction
	Rear Brake	(5), (6)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (E), (F)				
		(9), (10)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (I), (J)				
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction

*1: When either wheel is under brake control (A-TRC), STR and SA3 are ON.

*2: When the front right wheel is under brake control (A-TRC), SA1 is ON.

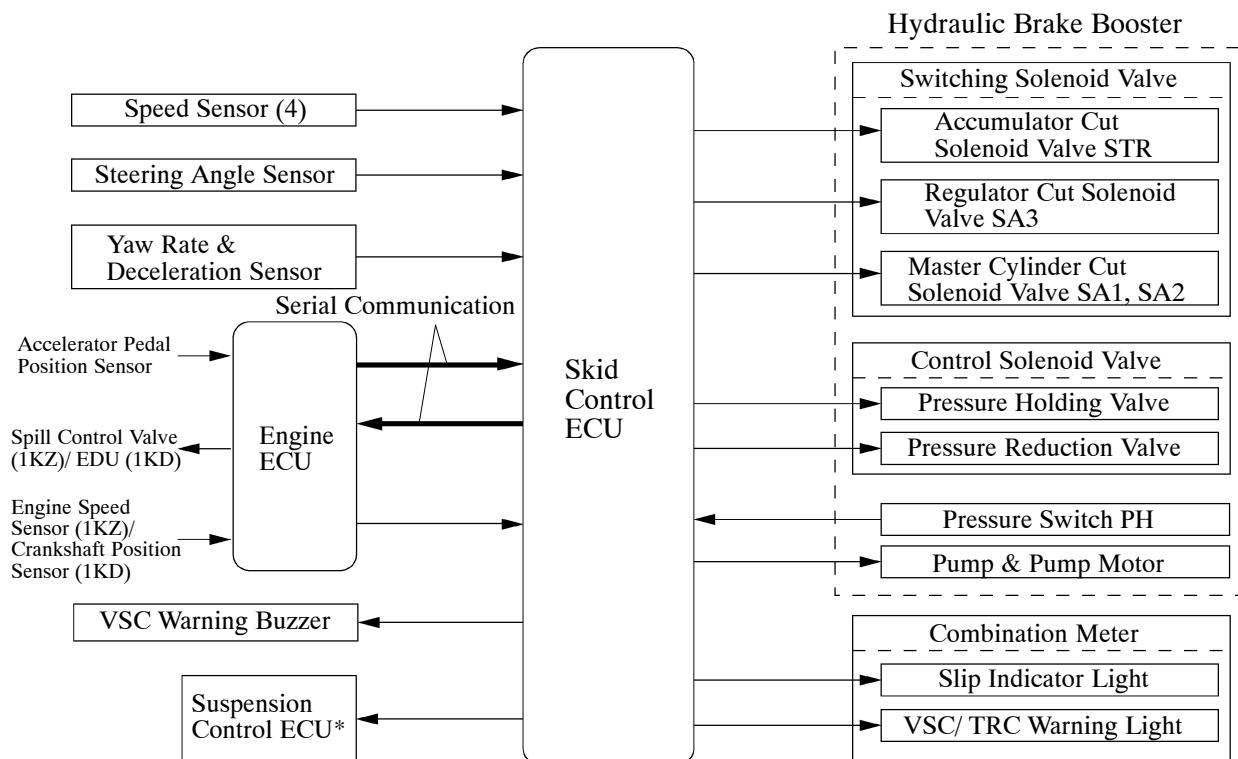
*3: When the front left wheel is under brake control (A-TRC), SA2 is ON.

VSC Operation

1) General

- Based on the information provided by various sensors, switches, and the engine ECU, the skid control ECU determines the vehicle's yaw moment. Then, the skid control ECU controls the fluid pressure that is generated by the pump & pump motor and applies it by way of the solenoid valves to the brake wheel cylinder of each wheel in the following 3 modes: pressure reduction, pressure hold, and pressure increase modes. As a result, the tendency of the front wheels or the rear wheels to skid is restrained.
- At this time, the skid control ECU outputs a VSC operate signal to the engine ECU, the suspension control ECU and the combination meter and causes the VSC warning buzzer to sound intermittently. Upon receiving this signal, the engine ECU effects fuel injection to regulate the engine output. The suspension control ECU controls TEMS. The combination meter causes the slip indicator light to blink.
- If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure switch PH and actuates the pump & pump motor to ensure the proper accumulator pressure.

► System Diagram ◀

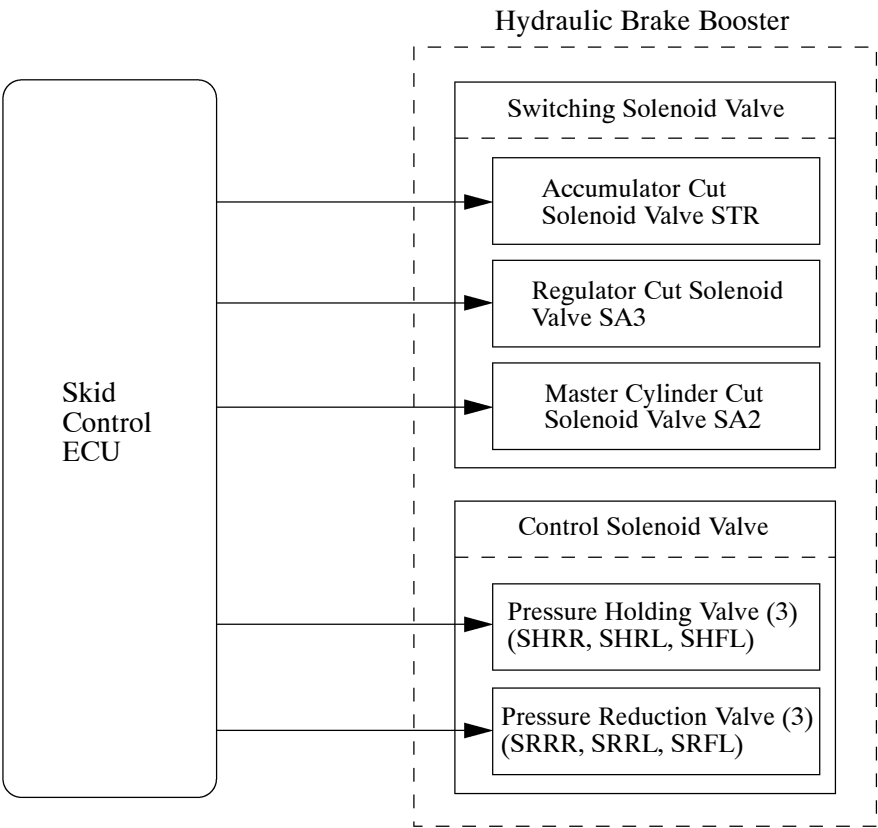


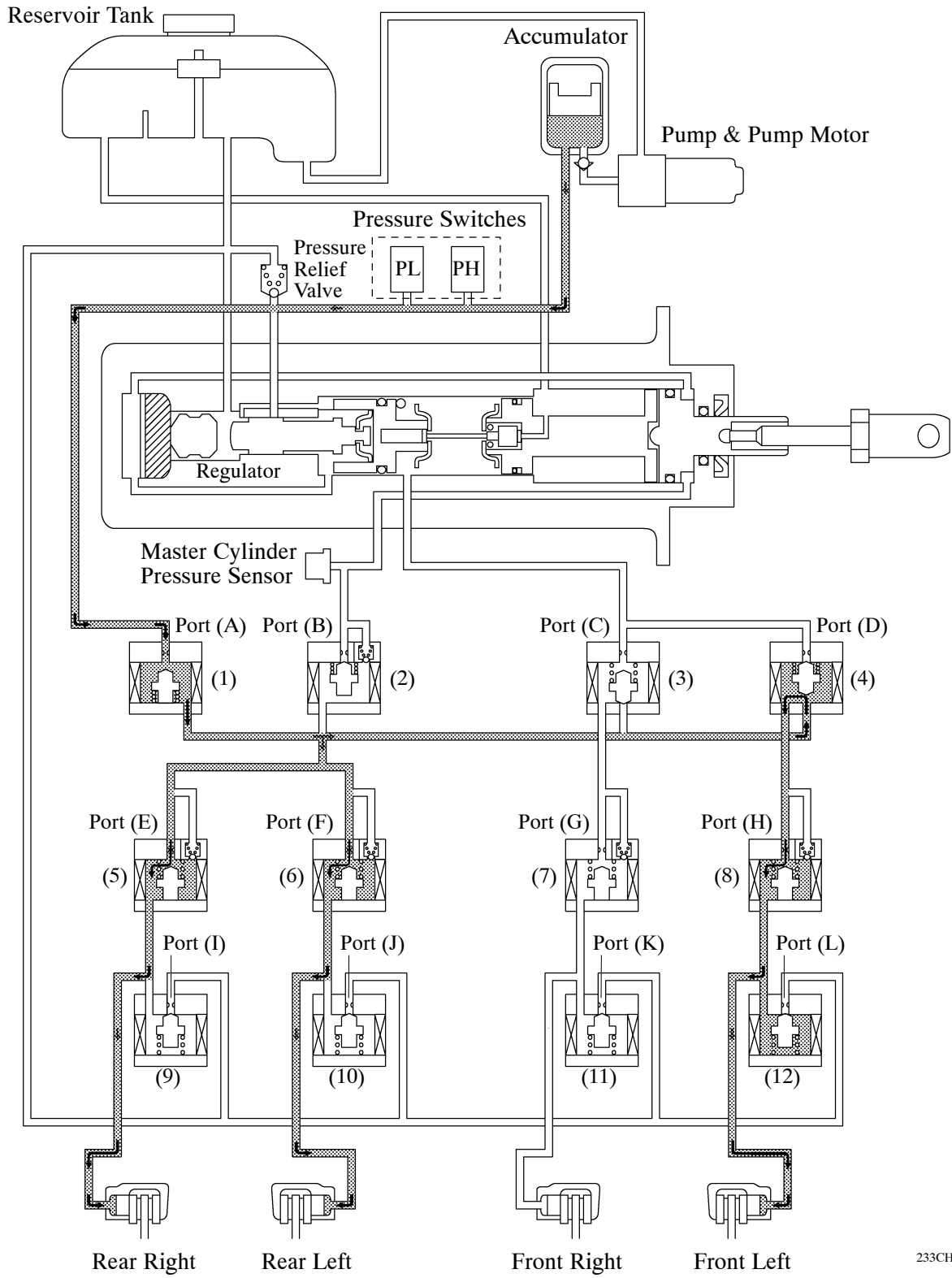
*: with TEMS Models

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

In front wheel skid restraining control, the brakes of the rear wheels and front wheel of the outer side 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 restrains a 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.

► System Diagram ◀





233CH115

Increase Mode

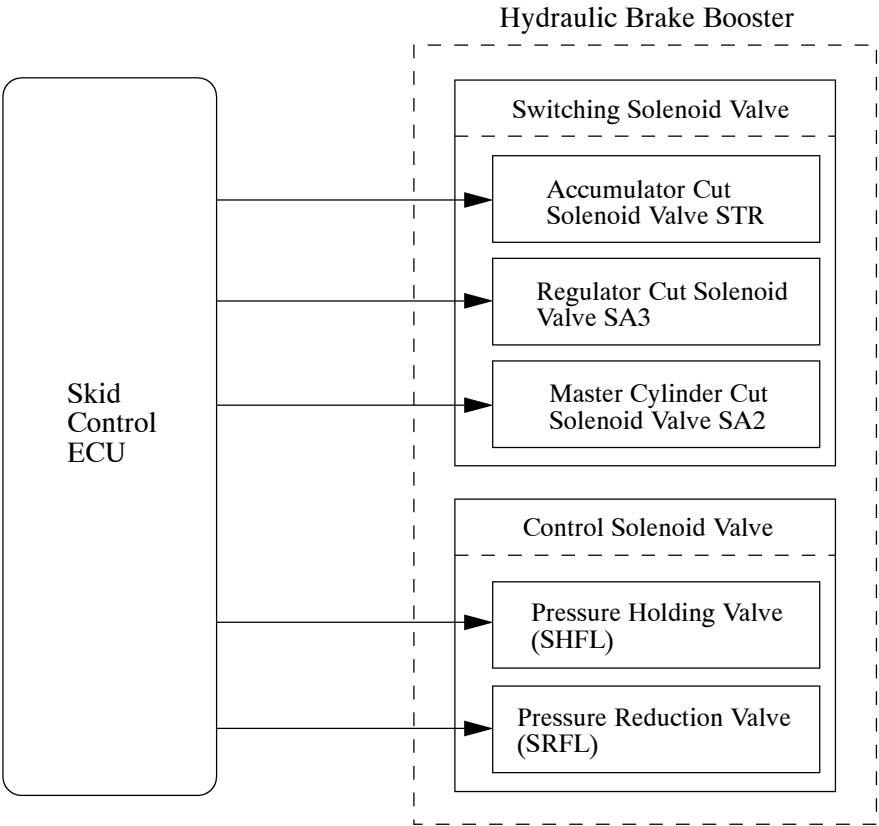
Item				VSC not Activated	VSC Activated			
					Increase Mode	Hold Mode	Reduction Mode	
Switching Solenoid Valve	(1)	Accumulator Cut Solenoid Valve STR		OFF (Close)	ON (Open)	←	←	
		Port (A)						
	(2)	Regulator Cut Solenoid Valve SA3		OFF (Open)	ON (Close)	←	←	
		Port (B)						
	(3)	Master Cylinder Cut Solenoid Valve SA1		OFF (Open)	←	←	←	
		Port (C)						
	(4)	Master Cylinder Cut Solenoid Valve SA2		OFF (Open)	ON (Close)	←	←	
		Port (D)						
Control Solenoid Valve	Front Brake	(7)	Pressure Holding Valve		OFF (Open)	OFF (Open)	←	←
			Port: (G)					
		(8)	Pressure Holding Valve		OFF (Open)	←	ON (Close)	←
			Port: (H)					
		(11)	Pressure Reduction Valve		OFF (Close)	←	←	←
			Port: (K)					
		(12)	Pressure Reduction Valve		OFF (Close)	←	←	ON (Open)
			Port: (L)					
		Wheel Cylinder Pressure		Right	—	—	—	—
				Left	—	Increase	Hold	Reduction
	Rear Brake	(5), (6)	Pressure Holding Valve		OFF (Open)	←	ON (Close)	←
			Port: (E), (F)					
		(9), (10)	Pressure Reduction Valve		OFF (Close)	←	←	ON (Open)
			Port: (I), (J)					
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction	

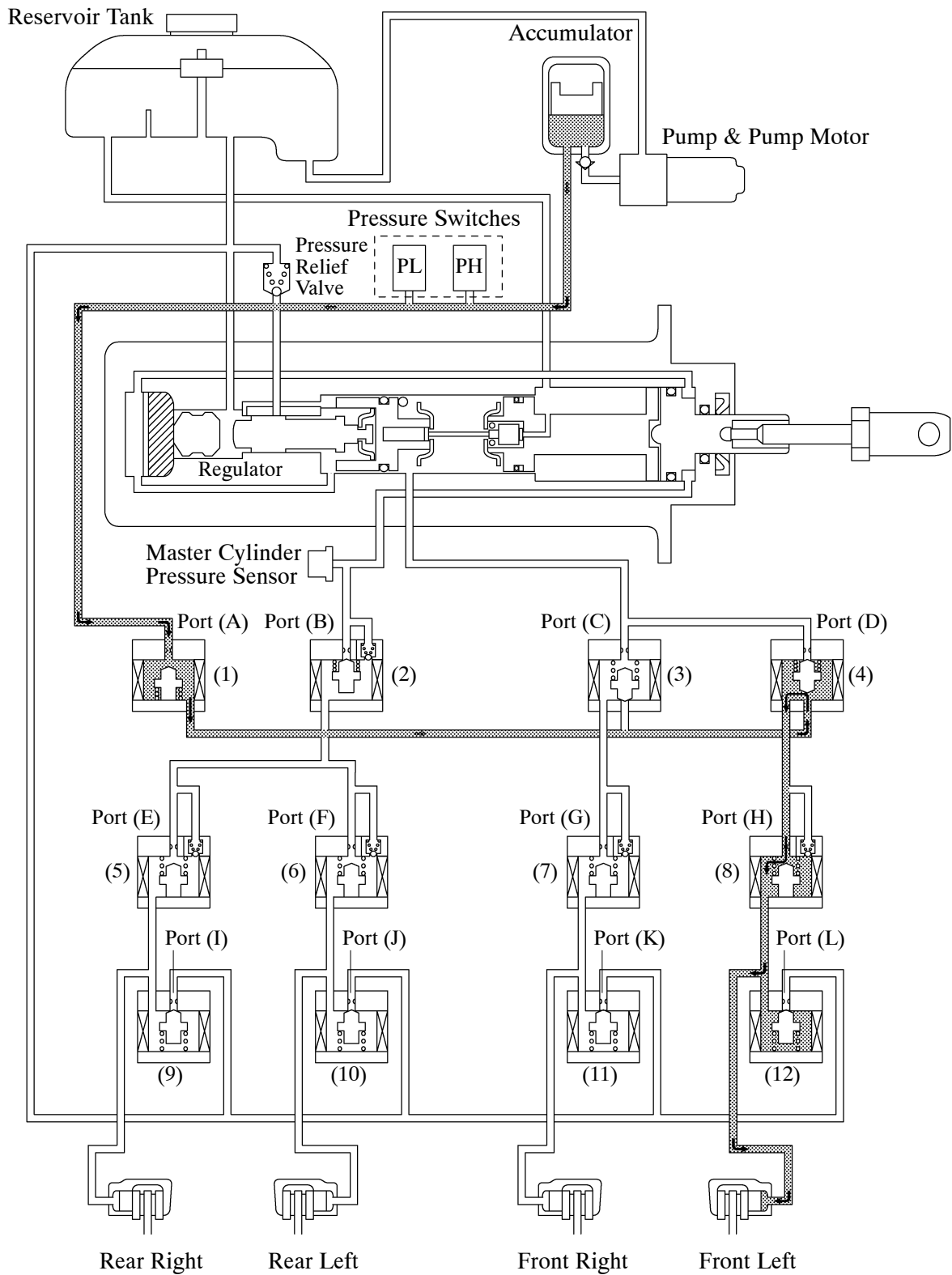
3) Rear Wheel Skid Restraining Control (Turning to the Right)

In rear wheel skid restraining control, the front wheel brake of the outer side 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 restrains a 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.

► System Diagram ◀





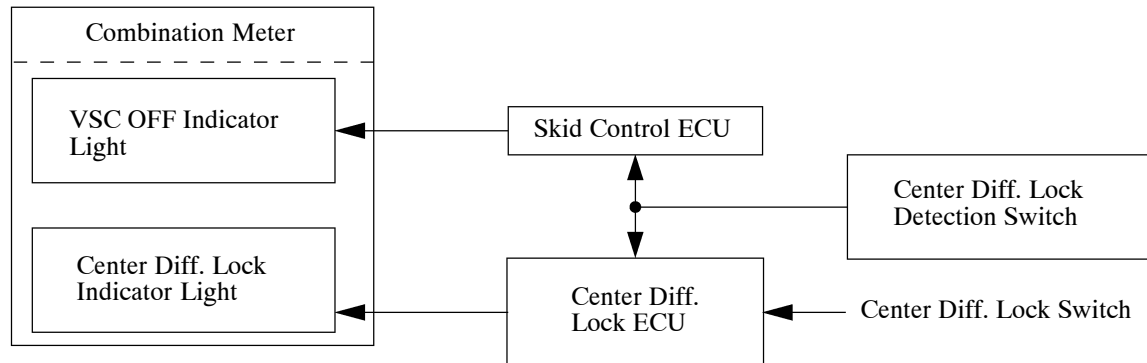
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Item				VSC not Activated	VSC Activated		
					Increase Mode	Hold Mode	Reduction Mode
Switching Solenoid Valve	(1)	Accumulator Cut Solenoid Valve STR		OFF (Close)	ON (Open)	←	←
		Port (A)					
	(2)	Regulator Cut Solenoid Valve SA3		OFF (Open)	ON (Close)	←	←
		Port (B)					
	(3)	Master Cylinder Cut Solenoid Valve SA1		OFF (Open)	ON (Close)	←	←
		Port (C)					
	(4)	Master Cylinder Cut Solenoid Valve SA2		OFF (Open)	←	←	←
		Port (D)					
Control Solenoid Valve	Front Brake	(7)	Pressure Holding Valve	OFF (Open)	←	←	←
			Port: (G)				
		(8)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (H)				
		(11)	Pressure Reduction Valve	OFF (Close)	←	←	←
			Port: (K)				
		(12)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (L)				
		Wheel Cylinder Pressure		Right	—	—	—
				Left	—	Increase	Hold
	Rear Brake	(5), (6)	Pressure Holding Valve	OFF (Open)	←	←	←
			Port: (E), (F)				
		(9), (10)	Pressure Reduction Valve	OFF (Close)	←	←	←
			Port: (I), (J)				
		Wheel Cylinder Pressure		—	—	—	—

4) VSC Prohibit Control

When the center differential is locked, VSC is prohibited. At this time, the center differential indicator light and the VSC OFF indicator light turn ON. After the center differential is unlocked, the 2 indicator lights will turn OFF, and the VSC operation will turn ON.

► System Diagram ◀



233CH98

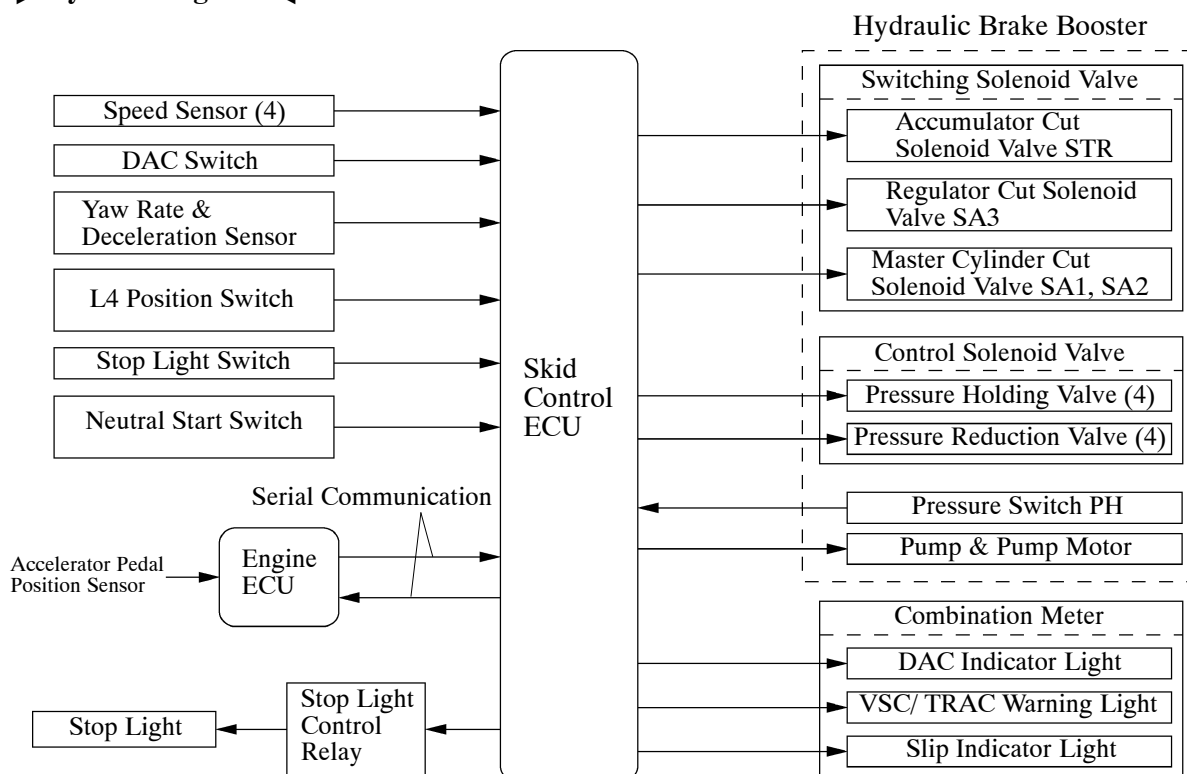
DAC Operation (only for Automatic Transmission Models)

- Based on the information provided by various sensors, switches, and the engine ECU, the skid control ECU determines the conditions that enable DAC operation. Then, the skid control ECU controls the fluid pressure that is generated by the pump & pump motor and applies it by way of the solenoid valves to the brake wheel cylinder of each wheel in the following 3 modes: pressure reduction, pressure hold, and pressure increase modes.
- The skid control ECU computes the vehicle speed, travel direction, and the gradient of the hill in accordance with the signals that are input by the speed sensor and the yaw rate & deceleration sensor, and effects 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 – 7 km/h (3 – 4 mph)
Backward	3 – 5 km/h (2 – 3 mph)

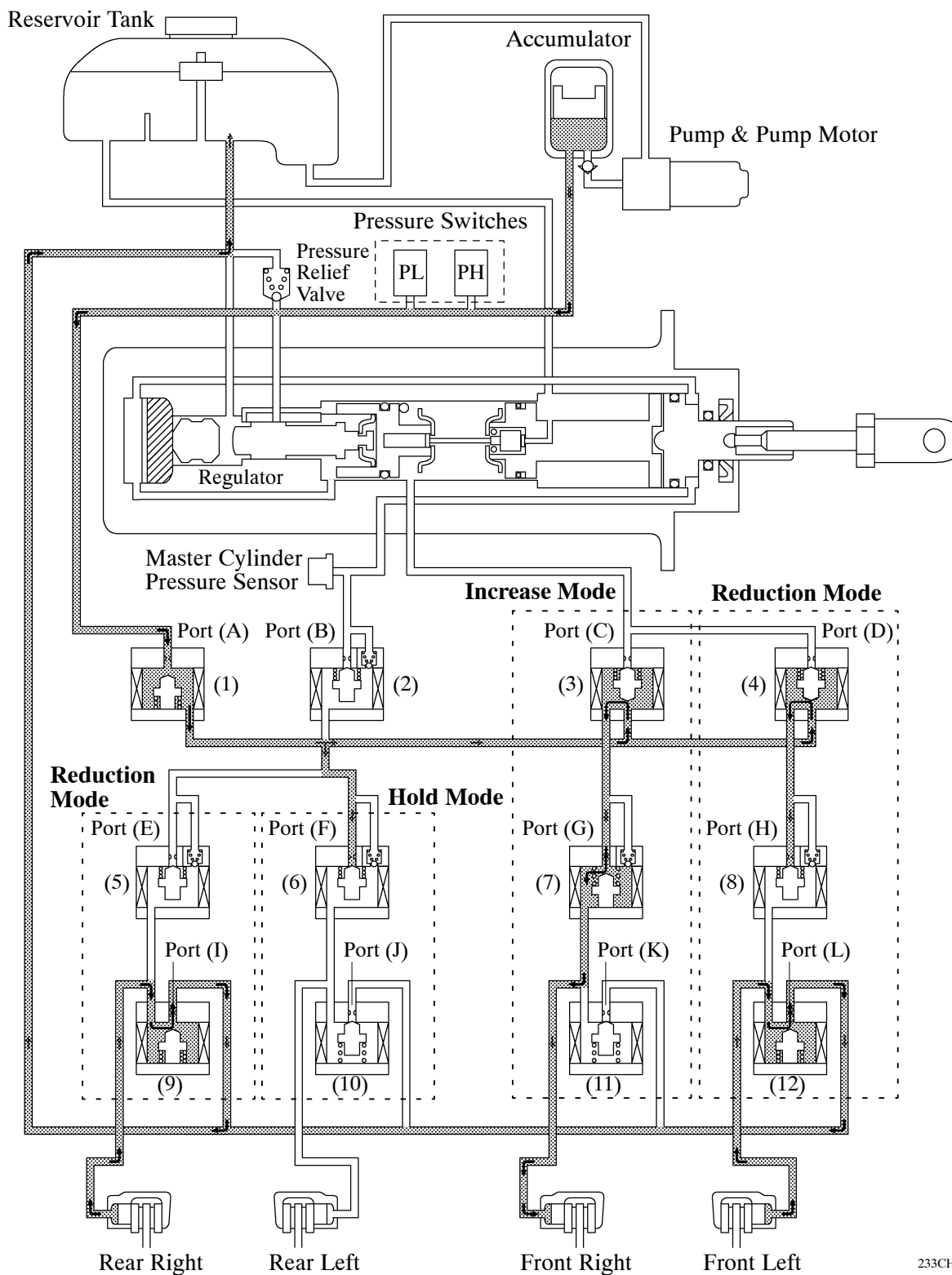
- During DAC operation, the skid control ECU outputs signals to the stop light control relay to cause the stop light to turn ON and combination meter causing the slip indicator light to blink.
- If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure switch PH and actuates the pump & pump motor to ensure the proper accumulator pressure.
- Furthermore, when the DAC is operating continuously, the temperature of the brake actuator in the hydraulic brake booster increases. After a prescribed length of time elapses, the skid control ECU alerts the driver of this condition by causing the VSC/TRC warning light to illuminate and the DAC indicator light to blink. Also, the DAC operation is momentarily interrupted to protect the brake actuator. When the temperature of the brake actuator decreases, the VSC/TRC warning light turns OFF, and the DAC is automatically restored to an operating state.

► System Diagram ◀



The DAC does not operate in the condition described below even if the DAC switch is turned ON; In this case, the DAC indicator light blinks to alert the driver.

- When shift lever is N position.
- If the DAC switch is turned OFF during a DAC operation, the hydraulic pressure decreases gradually to end the DAC operation.
- Transfer is H4 range.
- Driving at a vehicle speed of 25 km/h (16 mph) or higher.



Item			DAC not Activated	DAC Activated			
				Increase Mode	Hold Mode	Reduction Mode	
Switching Solenoid Valve	(1)	Accumulator Cut Solenoid Valve STR	OFF (Close)	ON* ¹ (Open)	←	←	
		Port (A)					
	(2)	Regulator Cut Solenoid Valve SA3	OFF (Open)	ON* ¹ (Close)	←	←	
		Port (B)					
	(3)	Master Cylinder Cut Solenoid Valve SA1	OFF (Open)	ON* ² (Close)	←	←	
		Port (C)					
	(4)	Master Cylinder Cut Solenoid Valve SA2	OFF (Open)	ON* ³ (Close)	←	←	
		Port (D)					
Control Solenoid Valve	Front Brake	(7), (8)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (G), (H)				
		(11), (12)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (K), (L)				
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction
	Rear Brake	(5), (6)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (E), (F)				
		(9), (10)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (I), (J)				
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction

*1: When either wheel is under brake control (DAC), STR and SA3 are ON.

*2: When the front right wheel is under brake control (DAC), SA1 is ON.

*3: When the front left wheel is under brake control (DAC), SA2 is ON.

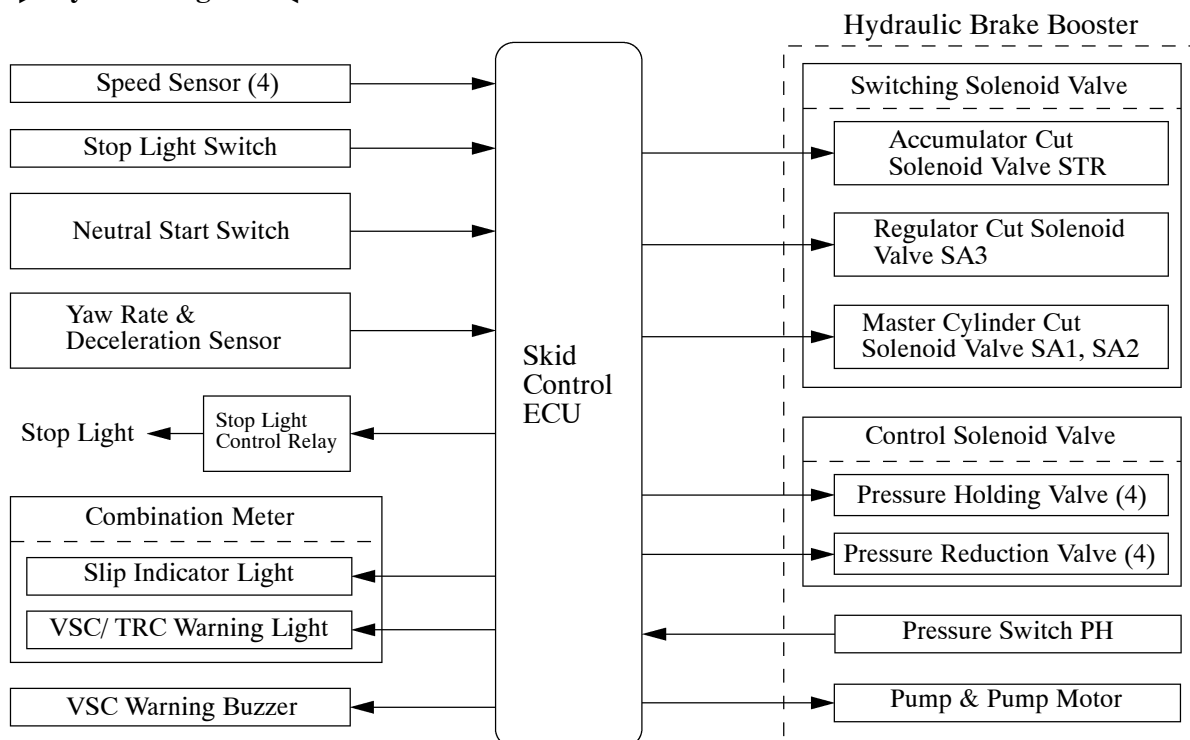
HAC Operation (only for Automatic Transmission Models)

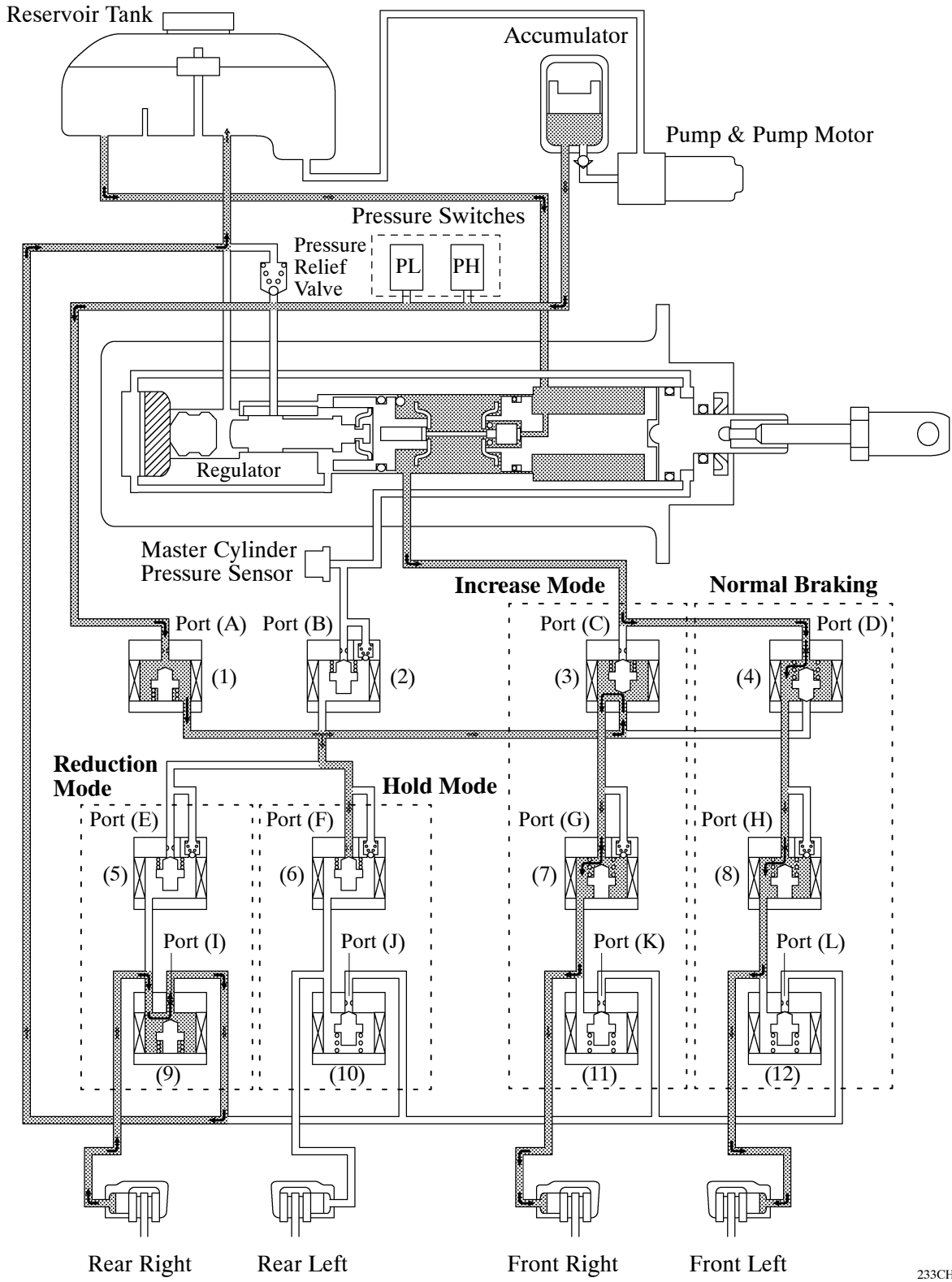
Based on the information provided by various sensors, switches, and the engine ECU, the skid control ECU computes the backward movement of the vehicle that occurs when the vehicle starts off on a hill. Then, the skid control ECU controls the fluid pressure that is generated by the pump & pump motor and applies it by way of the solenoid valves to the brake wheel cylinder of each wheel in the following 3 modes: pressure reduction, pressure hold, and pressure increase modes.

- The skid control ECU determines the state of the backward movement of the vehicle while the driver is attempting to drive uphill, based on the speed sensors and the neutral start switch.
- This ECU determines the gradient of the hill, the acceleration state of the vehicle, the locked state and the direction of rotation of each wheel through the speed sensors, and the yaw rate & deceleration sensor. Then, this ECU computes the amount of brake control that prevents the wheels from locking.
- During this operation, the skid control ECU outputs an HAC operation signal to the combination meter. This causes the slip indicator light to blink, outputs signals to the stop light control relay which turns ON the stop light.
- If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure switch PH and actuates the pump & pump motor to ensure the proper accumulator pressure.
- The HAC operates for approximately 5 seconds. At this time, skid control ECU informs the driver by the slow and intermittent sound of the VSC warning buzzer. After that, this ECU alerts the driver by using the quick and intermittent sound of the VSC warning buzzer, and gradually releases the brake hydraulic pressure in order to end the HAC operation.
- When the HAC is operating continuously while the vehicle is being driven on a slippery surface, the temperature of the brake actuator in the hydraulic brake booster increases. After a prescribed length of time elapses, the skid control ECU alerts the driver of this condition by causing the VSC/TRC warning light to illuminate. Also, the HAC operation is momentarily interrupted to protect the brake actuator. When the temperature of the brake actuator decreases, the VSC/TRC warning light turns OFF, and the HAC is automatically restored to an operating state.

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► System Diagram ◀





Item			HAC not Activated	HAC Activated			
				Increase Mode	Hold Mode	Reduction Mode	
Switching Solenoid Valve	(1)	Accumulator Cut Solenoid Valve STR	OFF (Close)	ON* ¹ (Open)	←	←	
		Port (A)					
	(2)	Regulator Cut Solenoid Valve SA3	OFF (Open)	ON* ¹ (Close)	←	←	
		Port (B)					
	(3)	Master Cylinder Cut Solenoid Valve SA1	OFF (Open)	ON* ² (Close)	←	←	
		Port (C)					
	(4)	Master Cylinder Cut Solenoid Valve SA2	OFF (Open)	ON* ³ (Close)	←	←	
		Port (D)					
Control Solenoid Valve	Front Brake	(7), (8)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (G), (H)				
		(11), (12)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (K), (L)				
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction
	Rear Brake	(5), (6)	Pressure Holding Valve	OFF (Open)	←	ON (Close)	←
			Port: (E), (F)				
		(9), (10)	Pressure Reduction Valve	OFF (Close)	←	←	ON (Open)
			Port: (I), (J)				
		Wheel Cylinder Pressure		—	Increase	Hold	Reduction

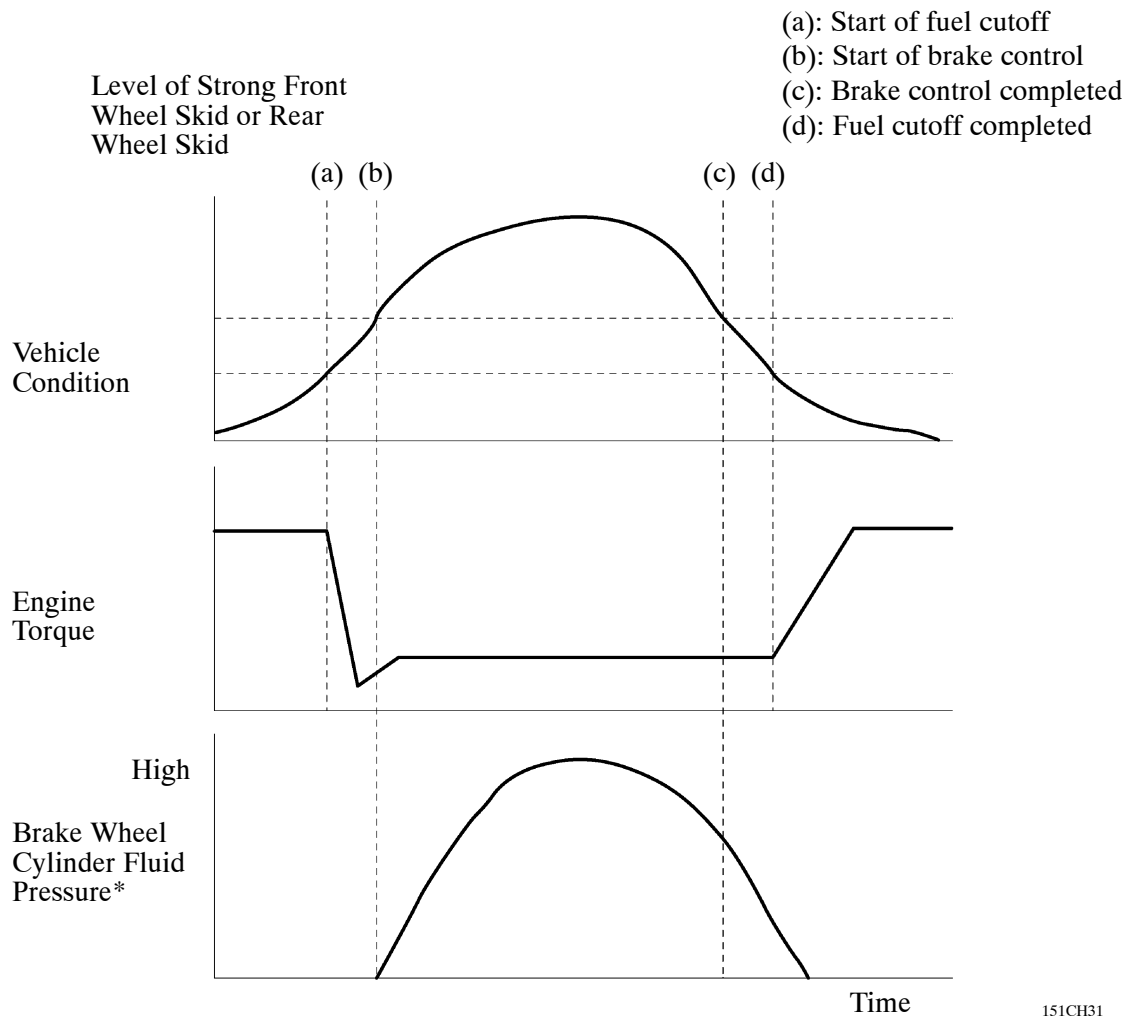
*1: When either wheel is under brake control (HAC), STR and SA3 are ON.

*2: When the front right wheel is under brake control (HAC), SA1 is ON.

*3: When the front left wheel is under brake control (HAC), SA2 is ON.

Engine Output Control

During an A-TRC, or VSC operation, the skid control ECU outputs a brake control operation signal to the engine ECU. Upon receiving this signal, the engine ECU effects fuel injection to regulate the engine output.



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*: 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 & pump motor in the hydraulic brake booster are checked in order.

Self-Diagnosis

- If the skid control ECU detects a malfunction in the brake control system (ABS with EBD, Brake Assist, A-TRC, VSC, DAC, and HAC), the ABS, brake system, and VSC/TRC warning lights, and VSC OFF indicator 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	A-TRC	VSC	DAC*	HAC*	Skid Control ECU
ABS Warning Light	○	○	○	—	—	—	—	○
Brake System Warning Light	—	○	—	—	—	—	—	○
VSC/TRC Warning Light	○	○	○	○	○	○	○	○
VSC OFF Indicator Light	○	○	○	○	○	○	○	○

*: Only for Automatic Transmission Models

- 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 ABC warning light and VSC warning light 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 terminals of the DLC3 or by connecting a hand-held tester. This check function performs yaw rate sensor zero point calibration, deceleration 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.

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 Land Cruiser/ Land Cruiser Prado Repair Manual (Pub. No. RM990E).

► 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 solenoid relay circuit	38	C1238	Foreign matters attached on the tip of the right rear sensor
12	C0279	B+ short circuit in ABS solenoid relay circuit	39	C1239	Foreign matters attached on the tip of the left rear sensor
21	C0226	Open or short circuit in brake master cylinder solenoid circuit (SFR circuit)	41	C1241	Low battery positive voltage or abnormally high battery positive voltage
22	C0239	Open or short circuit in brake master cylinder solenoid circuit (SFL circuit)	42	C1242	Open circuit in IG2 circuit
23	C0246	Open or short circuit in brake master cylinder solenoid circuit (SRR circuit)	43	C1243	Malfunction in deceleration sensor (constant output)
24	C0256	Open or short circuit in brake master cylinder solenoid circuit (SRL circuit)	44	C1244	Open or short circuit in deceleration sensor circuit
25	C1225	Open or short circuit in brake master cylinder solenoid circuit (SMC (SA1) circuit)	45	C1245	Malfunction in deceleration sensor
26	C1226	Open or short circuit in brake master cylinder solenoid circuit (SPC (SA2) circuit)	46	C1246	Malfunction in master cylinder pressure sensor
27	C1227	Open or short circuit in brake master cylinder solenoid circuit (SRC (SA3) circuit)	49	C1249	Open circuit in stop light switch circuit
28	C1228	Open or short circuit in brake master cylinder solenoid circuit (STR circuit)	51	C1251	Pump motor is locked
31	C0200	Right front wheel speed sensor signals malfunction	52	C1252	Brake booster pump motor malfunction
32	C0205	Left front wheel speed sensor signals malfunction	53	C1253	Brake booster pump motor relay malfunction
33	C0210	Right rear wheel speed sensor signals malfunction	54	C1254	Pressure switch malfunction
34	C0215	Left rear wheel speed sensor signals malfunction	56	C1256	Accumulator low pressure malfunction
35	C1235	Foreign matters attached on the tip of the right front speed sensor	57	C1257	Power supply drive circuit malfunction
36	C1236	Foreign matters attached on the tip of the left front speed sensor	68	C1268	Transfer L4 position switch signal transmission failure
37	C1337	Some tire's different size is from the other tire's	96	C1306	Malfunction in speed sensor power supply

► DTC Chart of sensor signal 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	77	C1277	Abnormal change in output voltage of right rear speed sensor
72	C1272	Low output voltage of left front speed sensor	78	C1278	Abnormal change in output voltage of left rear speed sensor
73	C1273	Low output voltage of right rear speed sensor	79	C1279	Deceleration sensor is faulty
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	82	C1282	Transfer indicator (center diff. lock) switch malfunction
76	C1276	Abnormal change in output voltage of left front speed sensor	83	C1283	Transfer L4 position switch malfunction

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► 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	43	C1223	Malfunction in ABS control system
32	C1232	Malfunction in deceleration sensor	44	C1224	Open or short circuit in NE signal circuit
33	C1233	Open or short circuit in yaw rate sensor circuit	47	C1340	Open circuit in center differential lock signal
34	C1234	Malfunction in yaw rate sensor	51	C1201	ECM system malfunction
35	C1335	Open circuit in steering angle sensor	53	C1203	ECM communication circuit malfunction
36	C1210	Zero point calibration of yaw rate sensor undone	64	C1380	Malfunction in stop light operation relay
39	C1336	Zero point calibration of deceleration sensor undone	—	—	—

► DTC Chart of sensor signal check (blinking VSC warning light) ◀

DTC No.		Detection Item
2-digit	5-digit	
71	C0371	Malfunction in zero point voltage of yaw rate sensor
74	C1379	DAC operating switch malfunction

Fail-Safe

- In the event of a malfunction in the A-TRC and/or VSC, the skid control ECU prohibits the brake control (A-TRC and VSC) operation.
- In the event of a malfunction in the ABS and/or Brake Assist, the skid control ECU prohibits the brake control (ABS with EBD, Brake Assist, A-TRC, VSC, DAC, and HAC) operation.
- In the event of the malfunction in the EBD control, skid control ECU prohibits the EBD control. Thus, the brake and throttle control will be operated in the same condition as in condition without the brake control system (ABS with EBD, Brake Assist, A-TRC, VSC, DAC, and HAC).