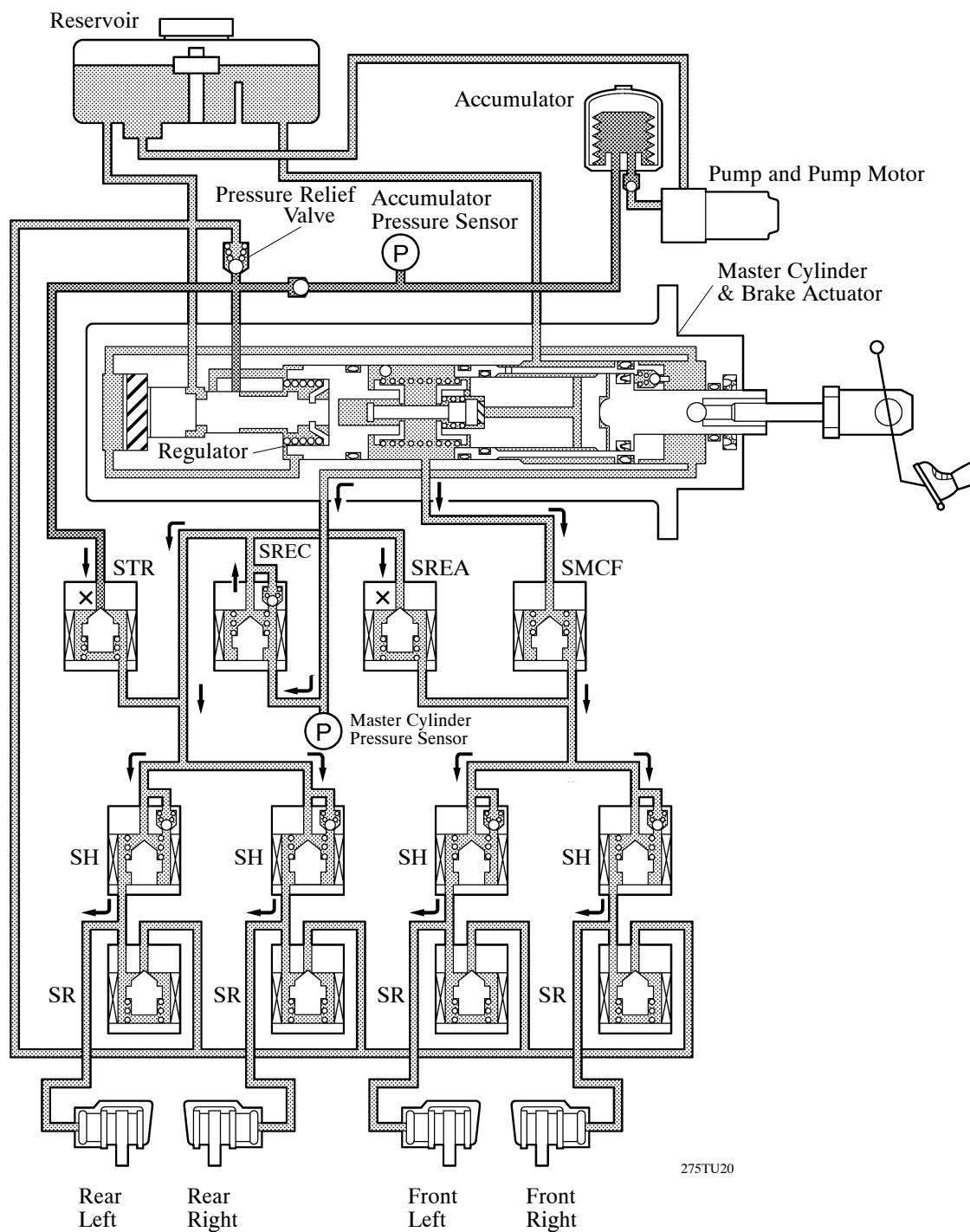


## 6. System Operation

### Normal Braking

During normal braking, all solenoid valves are turns OFF.



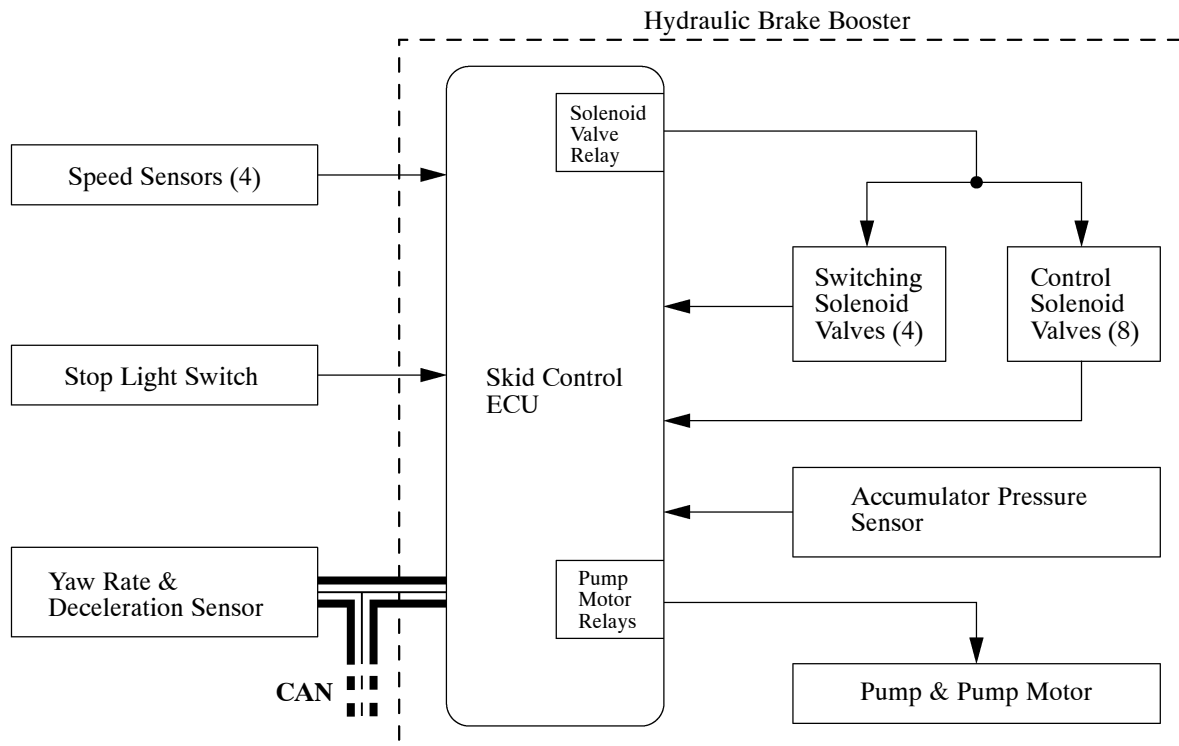
SMCF: Master Cut for Front Solenoid Valve  
 SREA: Regulator Apply for Front Solenoid Valve  
 SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve  
 (Accumulator Cut Solenoid Valve)  
 SH: Pressure Holding Solenoid Valve  
 SR: Pressure Reduction Solenoid Valve

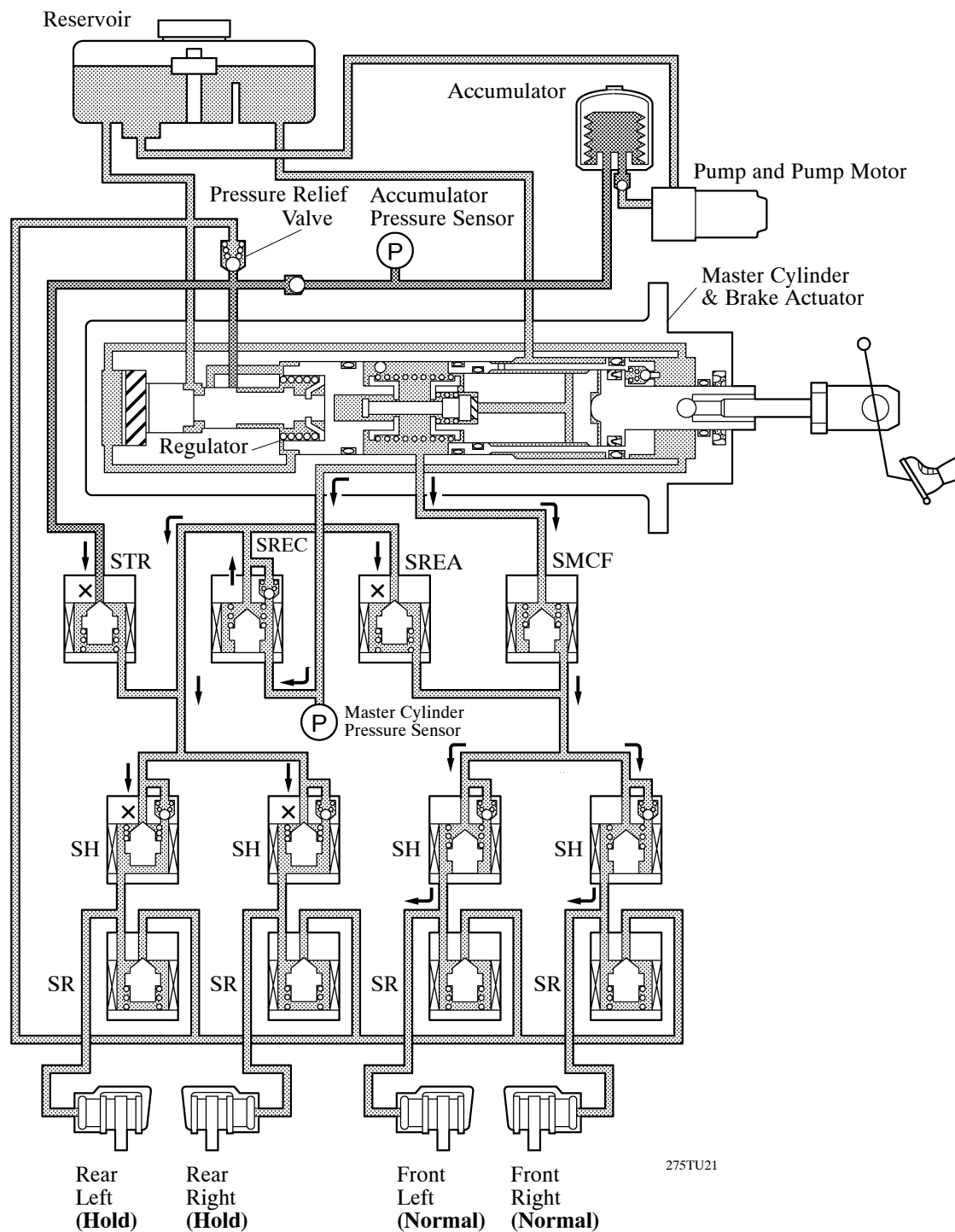
## ABS with EBD Operation

- Based on the signals received from the 4 wheel speed sensors, the skid control ECU calculates the speed and deceleration of each wheel, and checks wheel slipping condition.
- The skid control ECU compares the speeds of the front and rear wheels, and when it detects that the rear wheels have started to slip, it starts the operation of the EBD.
- When a wheel is about to lock, the ABS operation starts in order to regulate the hydraulic pressure at the wheel cylinders while switching between the three modes: pressure increase, pressure holding, and pressure reduction.

### ► System Diagram ◀



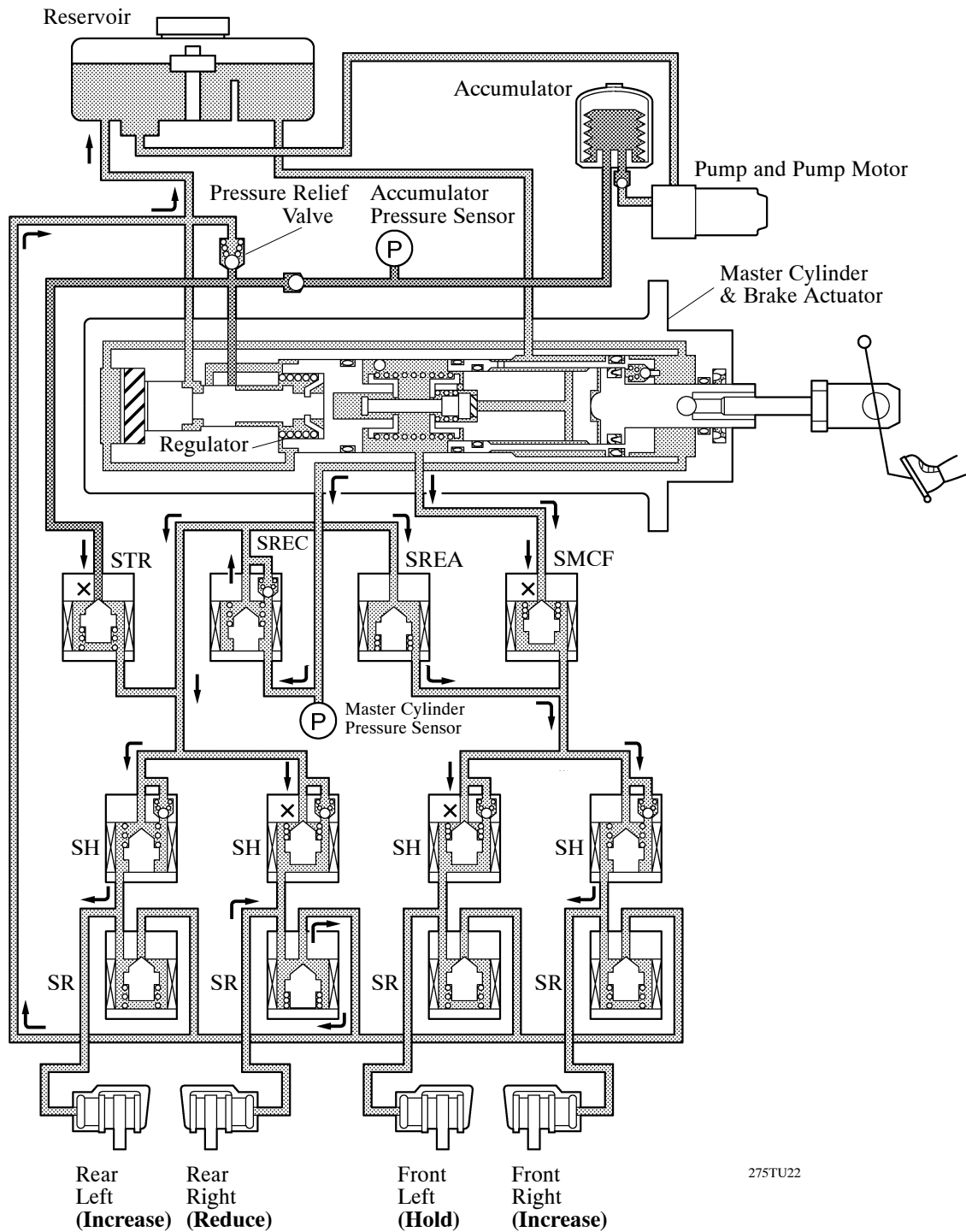
## ► EBD Operation ◀



SMCF: Master Cut for Front Solenoid Valve  
 SREA: Regulator Apply for Front Solenoid Valve  
 SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve  
 (Accumulator Cut Solenoid Valve)  
 SH: Pressure Holding Solenoid Valve  
 SR: Pressure Reduction Solenoid Valve

► ABS Operation ◀



SMCF: Master Cut for Front Solenoid Valve  
SREA: Regulator Apply for Front Solenoid Valve  
SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve  
(Accumulator Cut Solenoid Valve)  
SH: Pressure Holding Solenoid Valve  
SR: Pressure Reduction Solenoid Valve

275TU22

► States of the solenoid valves during ABS and EBD control ◀

Item			ABS Not Activated	ABS Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Signals (Open/Close)		SREC	OFF (Open)	←	←	←
		STR	OFF (Close)	←	←	←
Front Brake	Signals	SMCF*1	OFF (Open)	ON (Close)	←	←
		SREA*1	OFF (Close)	ON (Open)	←	←
		SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce
Rear Brake	Signals	SH*2	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce

\*1: When the front brakes are under the ABS control, the SMCF and SREA are ON.

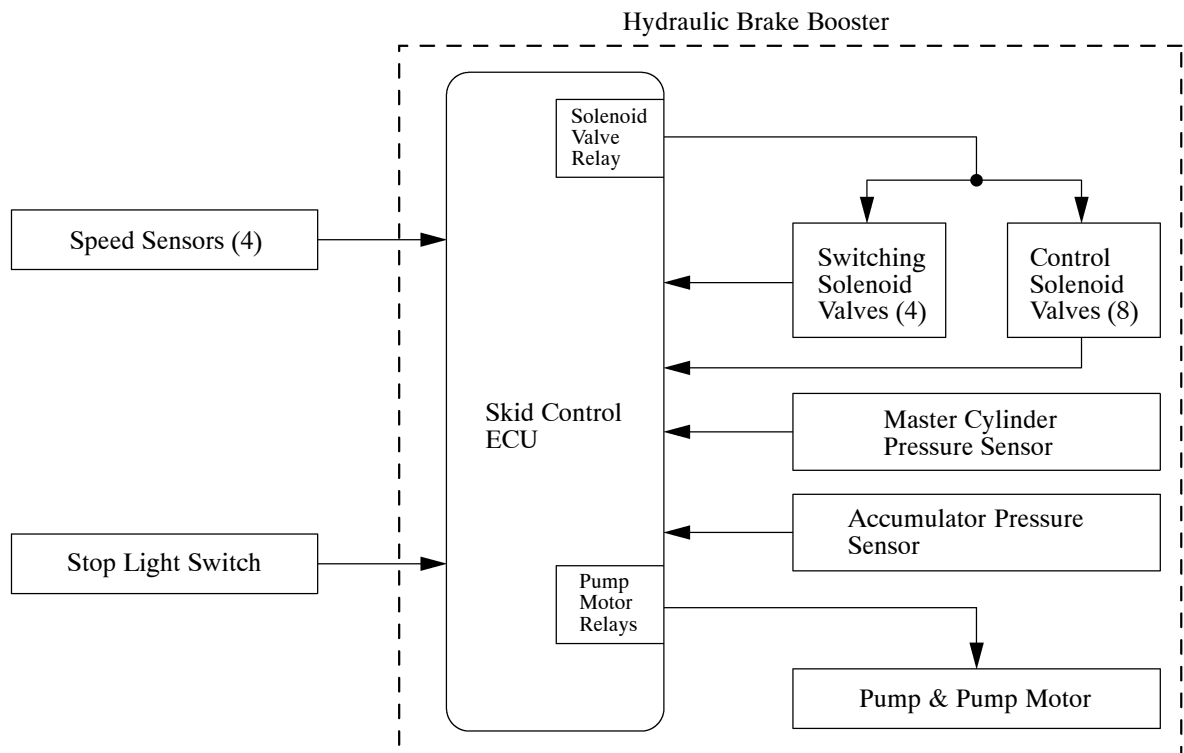
When only the rear brakes are under the ABS control, the SMCF and SREA are OFF.

\*2: Under the EBD control, only the SHs of both rear wheels are ON.

## Brake Assist Operation

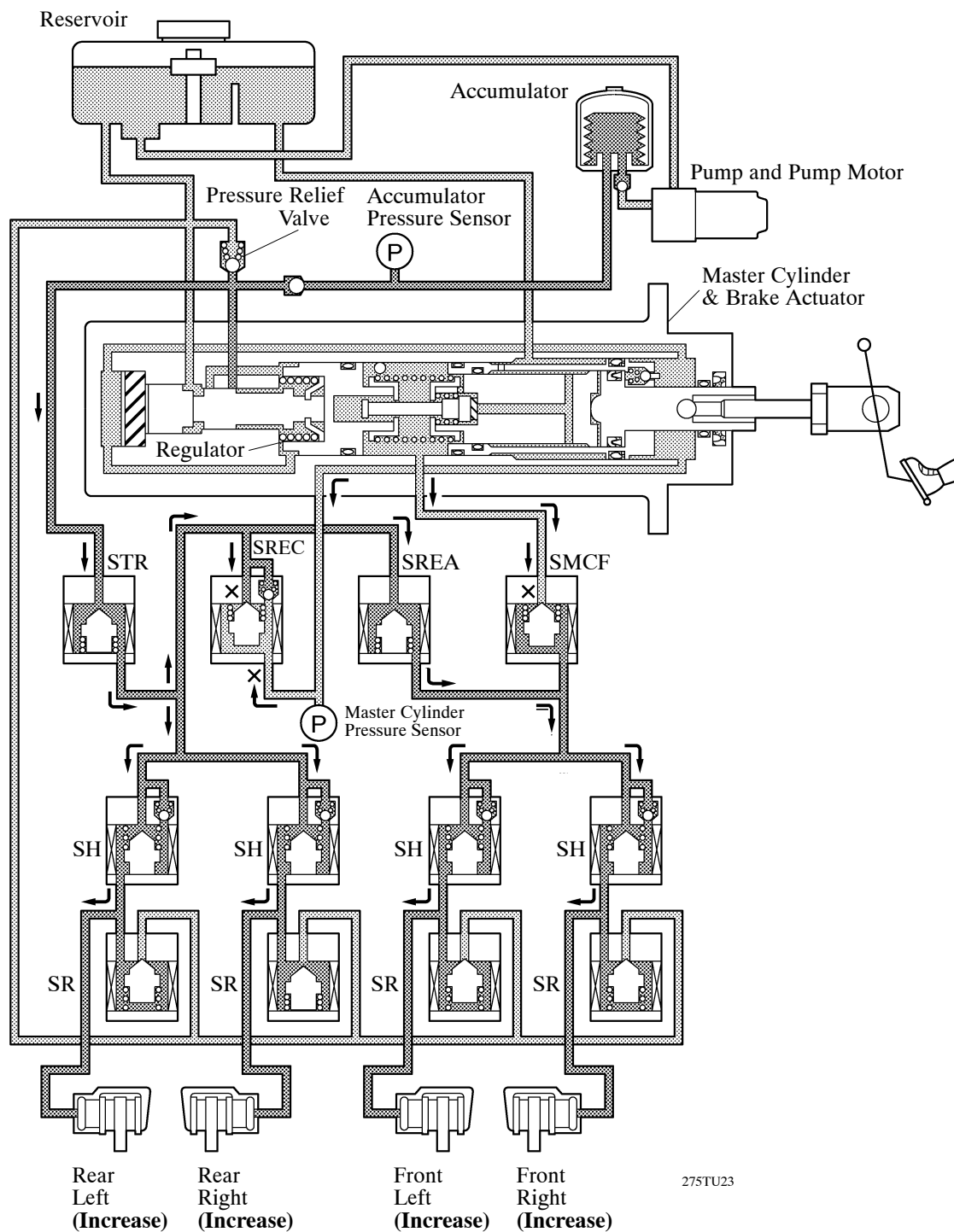
If an emergency braking situation has occurred, it is detected by the skid control ECU based on the vehicle speed signal from the speed sensor, the brake pedal application speed from the master cylinder pressure sensor, and the signal representing the amount of pedal effort. Then, the skid control ECU 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.

### ► System Diagram ◀



275RN30

# ► Brake Assist Operation ◀



SMCF: Master Cut for Front Solenoid Valve  
 SREA: Regulator Apply for Front Solenoid Valve  
 SREC: Regulator Cut Solenoid Valve

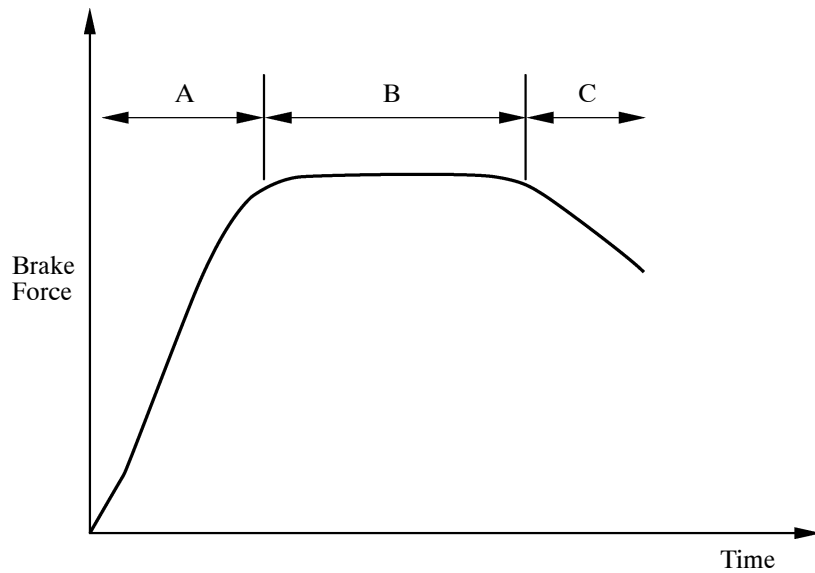
STR: Traction Solenoid Valve  
 (Accumulator Cut Solenoid Valve)  
 SH: Pressure Holding Solenoid Valve  
 SR: Pressure Reduction Solenoid Valve

► States of the solenoid valves during brake assist control ◀

Item		Brake Assist Not Activated	Brake Assist Activated			
			A	B	C	
Signals (Open/Close)		SREC	OFF (Open)	ON (Close)	←	OFF (Open)
		STR	OFF (Close)	ON (Open)	←	OFF (Close)
Front Brake	Signals	SMCF	OFF (Open)	ON (Close)	←	←
		SREA	OFF (Close)	ON (Open)	←	←
		SH	OFF (Open)	←	ON (Close)	OFF (Open)
		SR	OFF (Close)	←	←	←
Rear Brake	Signals	SH	OFF (Open)	←	ON (Close)	OFF (Open)
		SR	OFF (Close)	←	←	←
Wheel Cylinder Pressure		Depending on driver's operation	Increase	Hold	Reduce	

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A, B, and C in the table above correspond to A, B, and C in the diagram below.



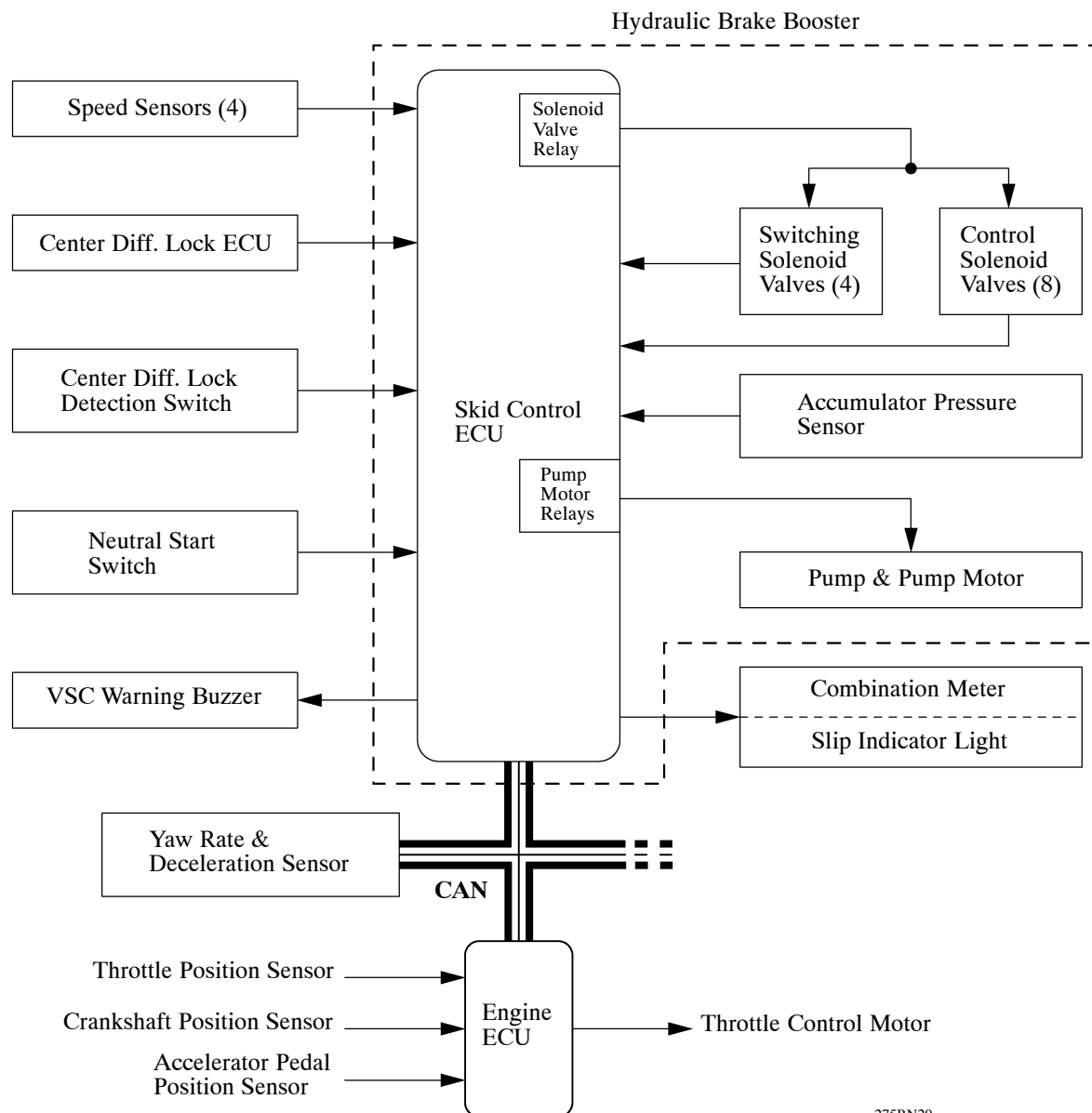
273GX54



## A-TRC Operation

- Based on the vehicle speed that has been calculated from each speed sensor and signals 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 throttle control to regulate the engine output. 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 sensor 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, and the slip indicator 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 slip indicator light turns OFF, and the A-TRC is automatically restored to an operating state.

### ► System Diagram ◀



- 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, the function effects engine output control on a drivability-priority basis.
- The skid control ECU compares the target control speed to the speeds of the wheels in order 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.

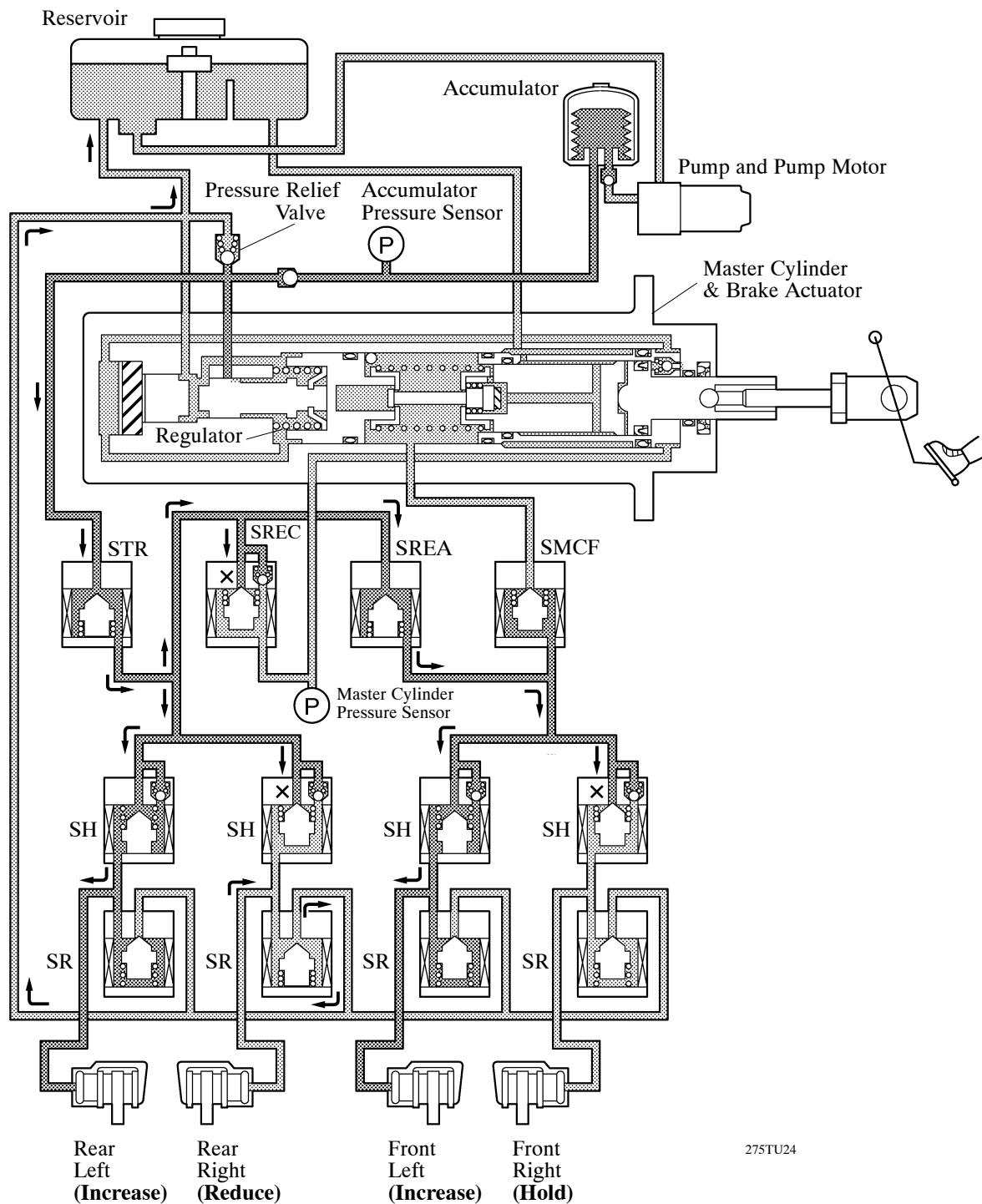
Road Condition	Transfer Range	Control	Contents	Outline
Ordinary Road	H	Target Control Speed	Vehicle Speed + Slip Rate (H range set value)	Control designed to ensure the ease of driving on low-friction roads, dirt roads, and general roads
		Brake Control	Gradual Fluid Pressure Control	
Rocky or Offroad	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.

# ► A-TRC Operation ◀



275TU24

SMCF: Master Cut for Front Solenoid Valve  
 SREA: Regulator Apply for Front Solenoid Valve  
 SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve  
 (Accumulator Cut Solenoid Valve)  
 SH: Pressure Holding Solenoid Valve  
 SR: Pressure Reduction Solenoid Valve

## ► States of the solenoid valves during A-TRC control ◀

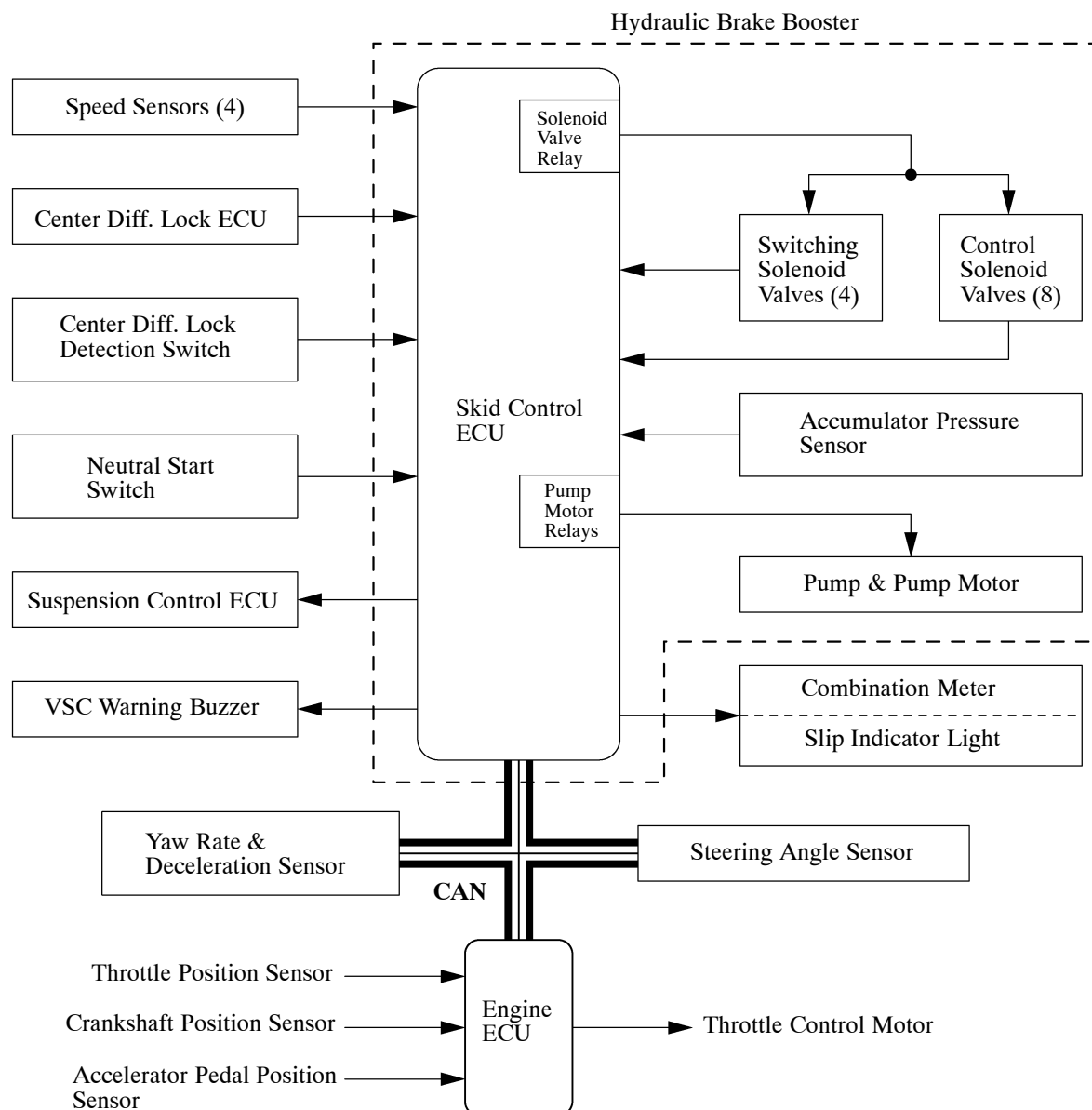
Item			A-TRC Not Activated	A-TRC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Signals (Open/Close)	SREC		OFF (Open)	ON (Close)	←	←
	STR		OFF (Close)	ON (Open)	←	←
Front Brake	Signals	SMCF	OFF (Open)	ON (Close)	←	←
		SREA	OFF (Close)	ON (Open)	←	←
		SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce
Rear Brake	Signals	SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce

## 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 holding, and pressure increase modes. As a result, the tendency of the vehicle to skid is reduced.
- At this time, the skid control ECU outputs a VSC operate signal to the engine ECU and the combination meter and causes the VSC warning buzzer to sound intermittently. Upon receiving this signal, the engine ECU effects throttle control to regulate the engine output. 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 sensor and actuates the pump & pump motor to ensure the proper accumulator pressure.

### ► System Diagram ◀

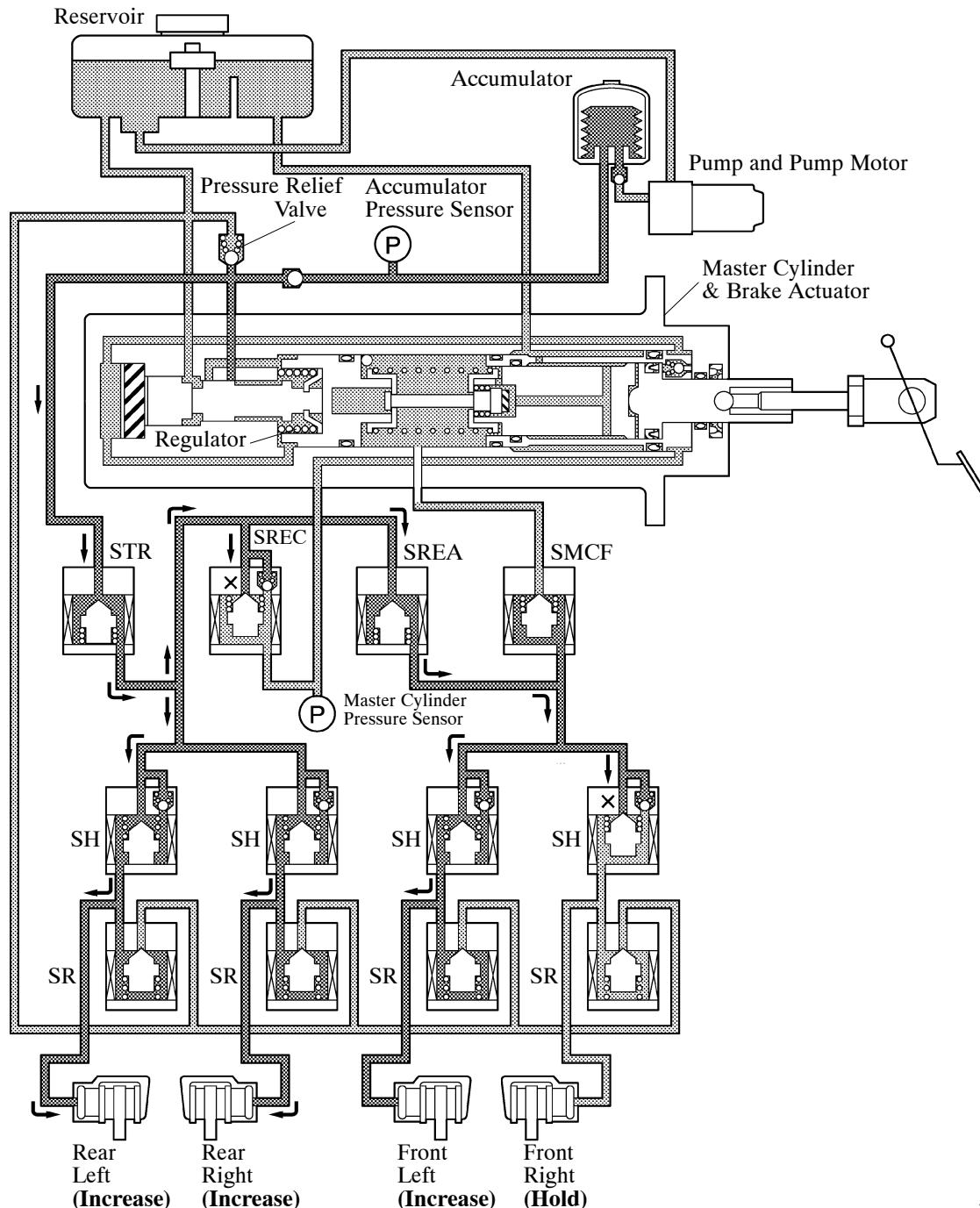


## 2) Front Wheel Skid Restraining (Turning to Right)

In the front wheel skid restraining control, the brakes of the rear wheels and front wheel of the outer side of the turn are applied. Also, depending on whether the brake is ON or OFF and the condition of the vehicle, there are circumstances in which the brake might not be applied to the wheels even if those wheels are targeted for braking. The diagram below shows the hydraulic circuit in the pressure increase mode, as it helps restrain 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.

### ► VSC Operation (Front Wheel Skid Restraining) ◀



SMCF: Master Cut for Front Solenoid Valve  
SREA: Regulator Apply for Front Solenoid Valve  
SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve (Accumulator Cut Solenoid Valve)  
SH: Pressure Holding Solenoid Valve  
SR: Pressure Reduction Solenoid Valve

► States of the solenoid valves during VSC operation (front wheel skid restraining) ◀

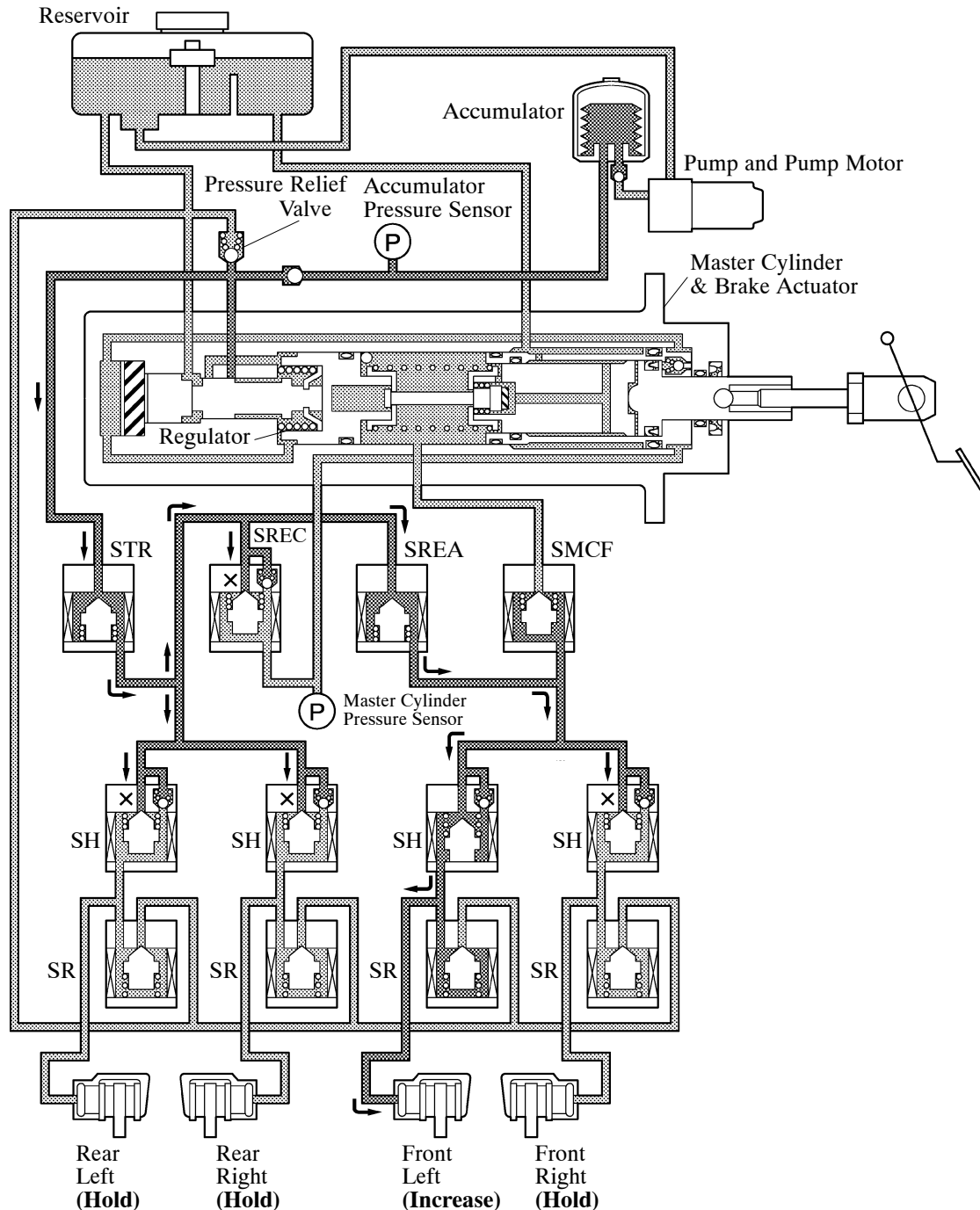
Item			VSC Not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Signals (Open/Close)	SREC		OFF (Open)	ON (Close)	←	←
	STR		OFF (Close)	ON (Open)	←	←
Front Brake	Signals	SMCF	OFF (Open)	ON (Close)	←	←
		SREA	OFF (Close)	ON (Open)	←	←
		SH	RH	OFF (Open)	ON (Close)	←
			LH	OFF (Open)	←	ON (Close)
		SR	RH	OFF (Close)	←	←
			LH	OFF (Close)	←	ON (Open)
		Wheel Cylinder Pressure	RH	—	—	—
			LH	—	Increase	Hold
Rear Brake	Signals	SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce

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

In the 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 be applied to the rear brake of the outer side of the turn. The diagram below shows the hydraulic circuit in the pressure increase mode, as it helps restrain 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.

#### ► VSC Operation (Rear Wheel Skid Restraining) ◀



SMCF: Master Cut for Front Solenoid Valve  
 SREA: Regulator Apply for Front Solenoid Valve  
 SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve (Accumulator Cut Solenoid Valve)  
 SH: Pressure Holding Solenoid Valve  
 SR: Pressure Reduction Solenoid Valve



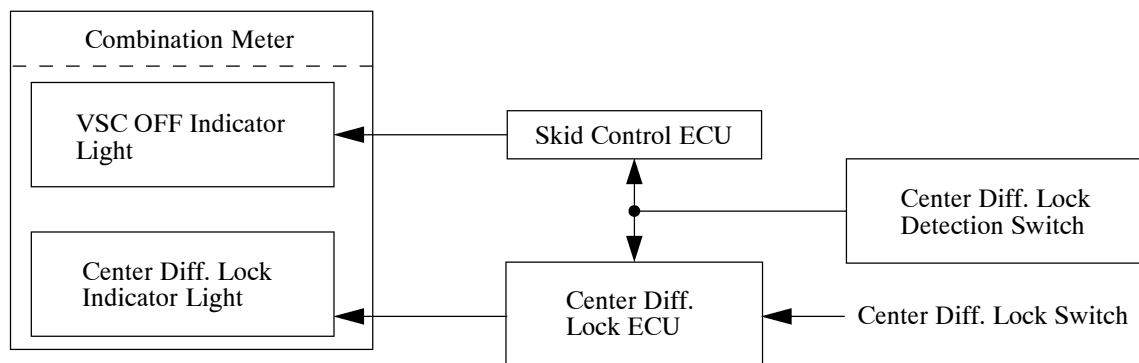
► States of the solenoid valves during VSC operation (rear wheel skid restraining) ◀

Item			VSC Not Activated	VSC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Signals (Open/Close)	SREC		OFF (Open)	ON (Close)	←	←
	STR		OFF (Close)	ON (Open)	←	←
Front Brake	SMCF		OFF (Open)	ON (Close)	←	←
	SREA		OFF (Close)	ON (Open)	←	←
	SH	RH	OFF (Open)	ON (Close)	←	←
		LH	OFF (Open)	←	ON (Close)	←
	SR	RH	OFF (Close)	←	←	←
		LH	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure	RH	—	—	—	—
		LH	—	Increase	Hold	Reduce
Rear Brake	Signals	SH	OFF (Open)	←	←	←
		SR	OFF (Close)	←	←	←
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce

#### 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. If the vehicle is stuck in mud, it might become difficult for the vehicle to free itself from the mud if VSC effects both the brake control and the engine output control. In this case, the center differential is locked to turn the VSC operation OFF. After the center differential is freed, the 2 indicator lights will turn OFF, and the VSC operation will turn ON.

► System Diagram ◀

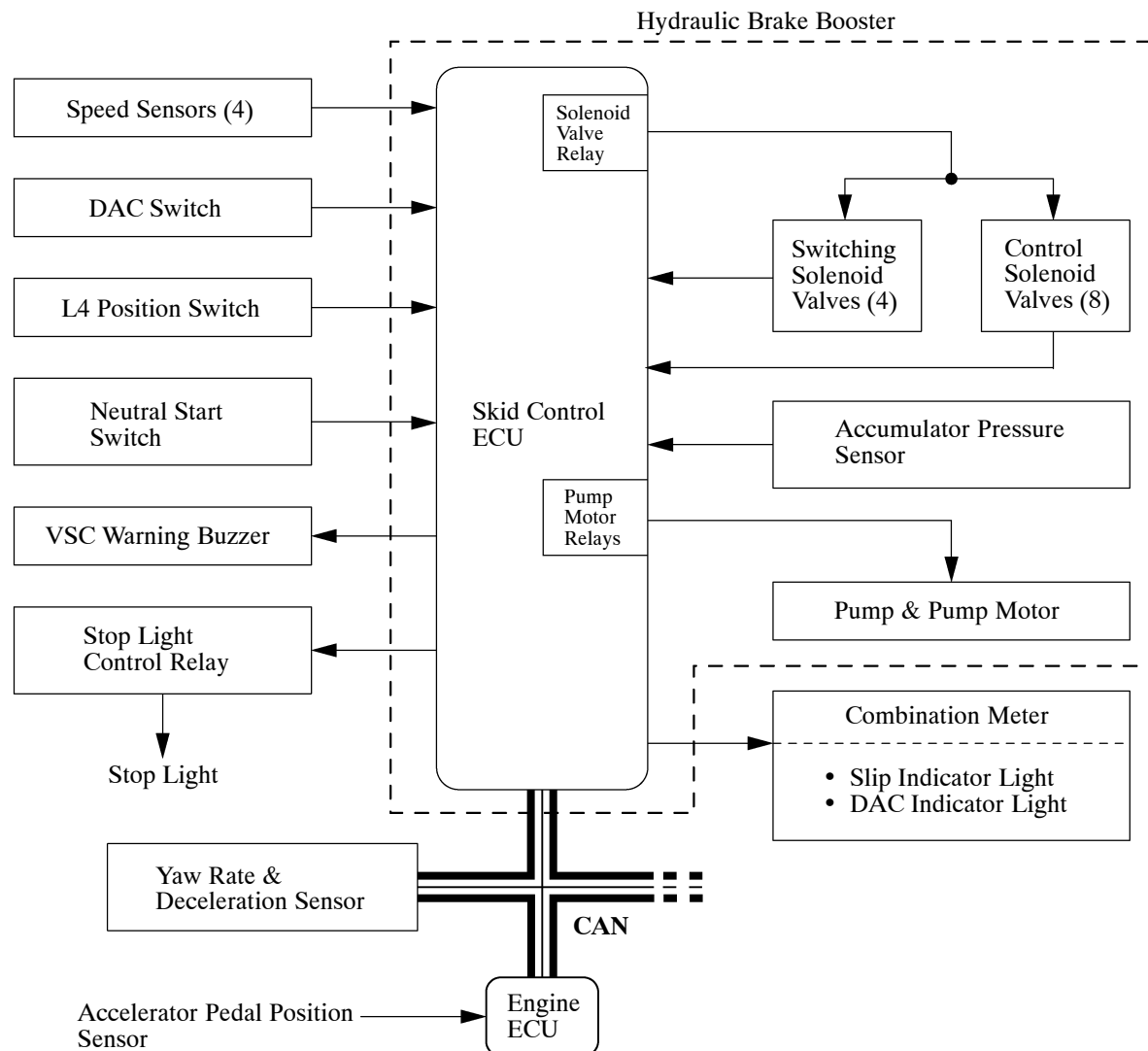


**DAC Operation (Automatic Transmission Model Only)**

- Based on the information provided by various sensors, switches, and the engine ECU, the skid control ECU determines the conditions that enable a 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 holding, 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 the brake control to attain the target vehicle speed. The target vehicle speed is determined in accordance with the travel direction.

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

- During a DAC operation, the skid control ECU outputs signals to the stop light control relay and the combination meter to cause the stop light to turn ON and the slip indicator light to blink.
- If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure sensor and actuates the pump & pump motor to ensure the proper accumulator pressure.

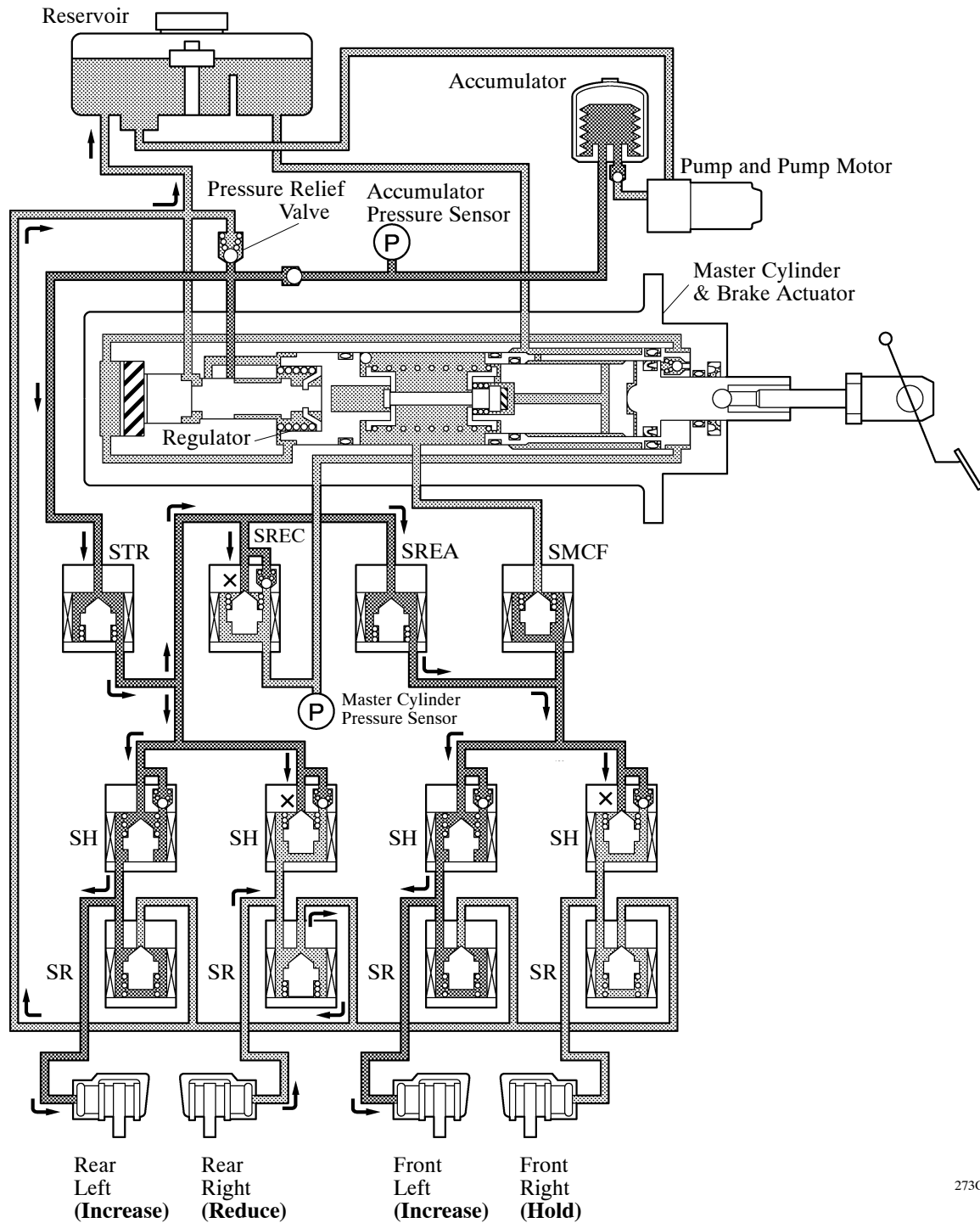
**► System Diagram ◀**

- Furthermore, when the DAC is operating continuously while the vehicle is being driven on a steep descent, 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 slip indicator 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 slip indicator light turns OFF, and the DAC is automatically restored to an operating state.

- The DAC operates in the conditions described below; however, the DAC indicator light blinks to alert the driver.
  - If the DAC switch is turned OFF during a DAC operation, the hydraulic pressure decreases gradually to end the DAC operation.
  - Transfer is in the H4 range.
  - Driving at a vehicle speed of 25 km/h (16 mph) or higher.

► DAC Operation ◀



5

SMCF: Master Cut for Front Solenoid Valve  
SREA: Regulator Apply for Front Solenoid Valve  
SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve  
(Accumulator Cut Solenoid Valve)  
SH: Pressure Holding Solenoid Valve  
SR: Pressure Reduction Solenoid Valve

273GX49

► States of the solenoid valves under DAC control ◀

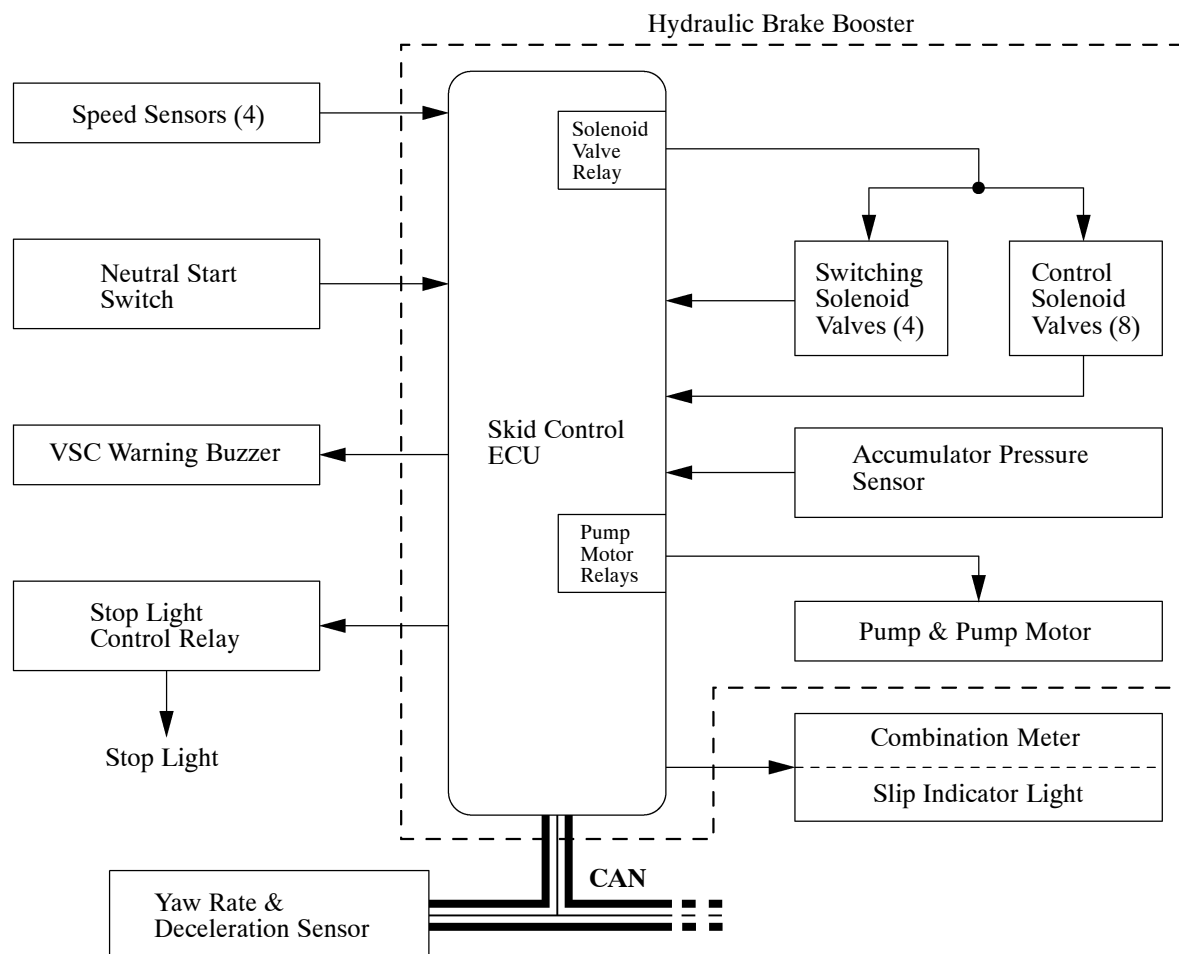
Item			DAC Not Activated	DAC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Signals (Open/Close)		SREC	OFF (Open)	ON (Close)	←	←
		STR	OFF (Close)	ON (Open)	←	←
Front Brake	Signals	SMCF	OFF (Open)	ON (Close)	←	←
		SREA	OFF (Close)	ON (Open)	←	←
		SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce
Rear Brake	Signals	SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce

## HAC Operation (Automatic Transmission Model Only)

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 is started 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 holding, and pressure increase modes.

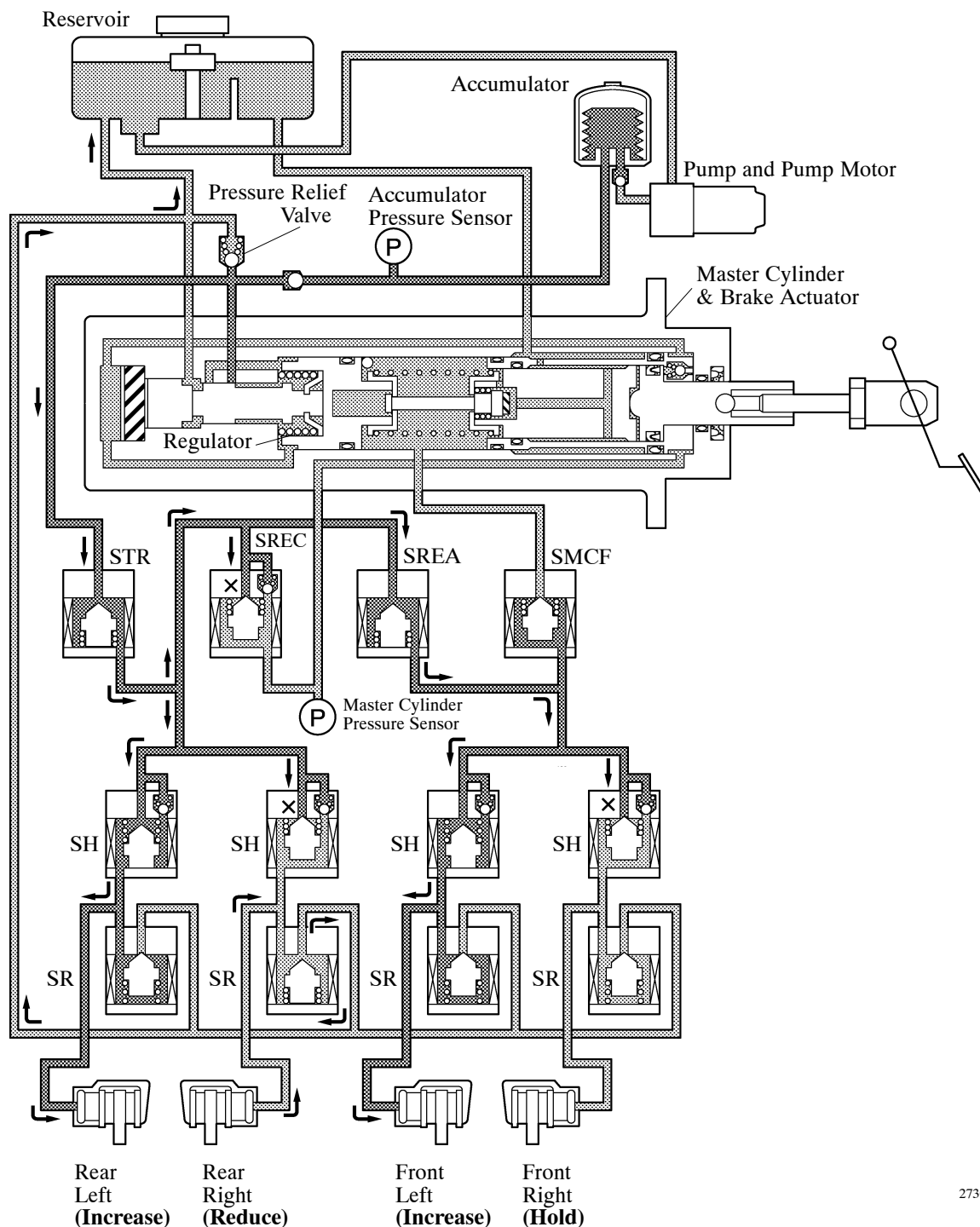
- The skid control ECU determines the state of the backward movement of the vehicle while the driver is attempting to drive uphill based on the speed sensors and the park/neutral position switch.
- This ECU determines the gradient of the hill, the acceleration state of the vehicle, the locked state and 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, causes the slip indicator light to blink, outputs signals to the stop light control relay, and turns ON the stop light.
- If the accumulator pressure drops during this operation, the skid control ECU receives the signals from the pressure sensor and actuates the pump & pump motor to ensure the proper accumulator pressure.
- The HAC operates for approximately 5 seconds at the maximum. At this time, the 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.

### ► System Diagram ◀



- 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 slip indicator light to illuminate. Also, the HAC operation is momentarily interrupted to protect the brake actuator. When the temperature of the brake actuator decreases, the slip indicator light turns OFF, and the HAC is automatically restored to an operating state.

### ► HAC Operation ◀



273GX49

SMCF: Master Cut for Front Solenoid Valve  
 SREA: Regulator Apply for Front Solenoid Valve  
 SREC: Regulator Cut Solenoid Valve

STR: Traction Solenoid Valve (Accumulator Cut Solenoid Valve)  
 SH: Pressure Holding Solenoid Valve  
 SR: Pressure Reduction Solenoid Valve

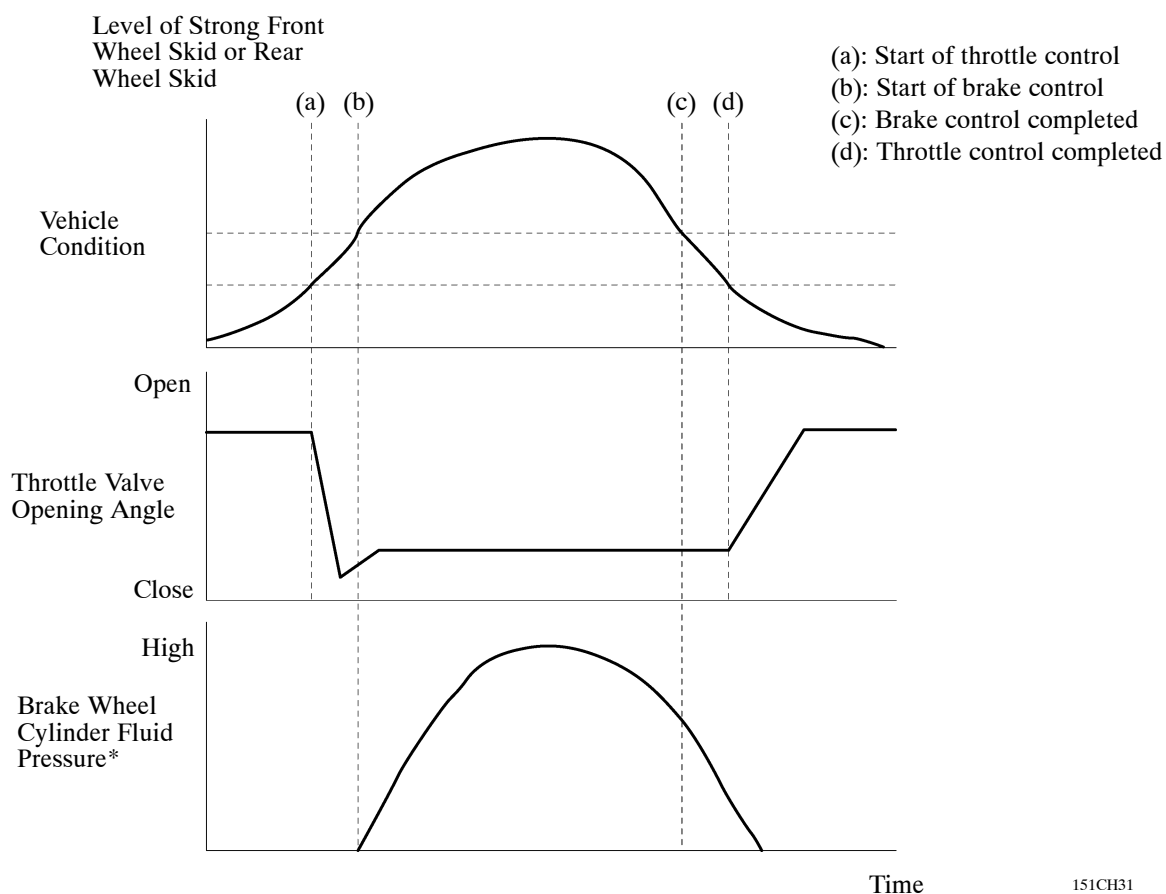
## ► States of the solenoid valves under HAC control ◀

Item			HAC Not Activated	HAC Activated		
				Pressure Increase Mode	Pressure Holding Mode	Pressure Reduction Mode
Signals (Open/Close)	SREC		OFF (Open)	ON (Close)	←	←
	STR		OFF (Close)	ON (Open)	←	←
Front Brake	Signals	SMCF	OFF (Open)	ON (Close)	←	←
		SREA	OFF (Close)	ON (Open)	←	←
		SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce
Rear Brake	Signals	SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
	Wheel Cylinder Pressure		—	Increase	Hold	Reduce



## Engine Output Control

During an A-TRC and a VSC operations, the skid control ECU outputs an engine control operation signal to the engine ECU. Upon receiving this signal, the engine ECU effects throttle control to regulate the engine output.



151CH31

\*: 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 a speed of 6 km/h (4 mph) or more, the skid control ECU performs the initial check.

The functions of each solenoid valve and the pump & pump motor in the hydraulic brake booster are checked in order.

**Self-Diagnosis**

The following DTCs (Diagnostic Trouble Codes) are added or discontinued.

**► DTC Chart (Blinking ABS Warning Light) ◀**

	DTC No.		Detection Item
	2-digit	5-digit	
Added DTC	58	C1202	Brake fluid level low/open circuit in brake fluid level warning switch circuit
	94	U0073	Control module communication bus Off
	95	U0124	Lost communication with lateral acceleration sensor module
	97	C1381	Malfunction in power supply voltage of yaw/deceleration sensor
Discontinued DTC	49	C1249	Open circuit in stop light switch circuit
	96	C1306	Sensor power supply abnormality

**► DTC Chart (Blinking VSC Warning Light) ◀**

	DTC No.		Detection Item
	2-digit	5-digit	
Added DTC	52	C1202	Brake fluid level low/open circuit in brake fluid level warning switch circuit
	62	U0123	Lost communication with yaw rate sensor module
	63	U0126	Lost communication with steering angle sensor module
	65	C1203	Engine control system communication circuit malfunction
	66	C1290	Malfunction in zero point of steering sensor
	72	C1208	Steering position sensor output signal malfunction
Discontinued DTC	33	C1233	Open or short circuit in yaw rate sensor circuit
	35	C1335	Communication malfunction of steering sensor
	44	C1224	Open or short circuit in NE signal circuit