BRAKE

■BRAKE CONTROL SYSTEM (ABS with EBD, Brake Assist, TRAC, A-TRAC, AUTO LSD and VSC)

1. General

A CRAWL function has been provided as an option for the brake control system (ABS with EBD, brake assist, TRAC, A-TRAC, AUTO LSD and VSC) of ’13 FJ Cruiser.

○: Operate —: Not Operating

Function	Outline	Model		
		2WD	4WD	
			MT	AT
CRAWL	When the vehicle runs on extremely bumpy rough ground or a slippery road, by activating the CRAWL, the engine output and the hydraulic pressure of the 4-wheel are regulated by the CRAWL, allowing the driver to drive the vehicle at the desired speed and keep that speed with virtually no accelerator or brake pedal operation. This allows the driver to concentrate on steering and maintains vehicle stability.	—	—	○

2. Drive Modes

Drive Modes and Each Function

The functions of the various drive modes are shown in the following table:

▶ Part-time 4WD Models (AT) ◀

○: Operate —: Not Operating

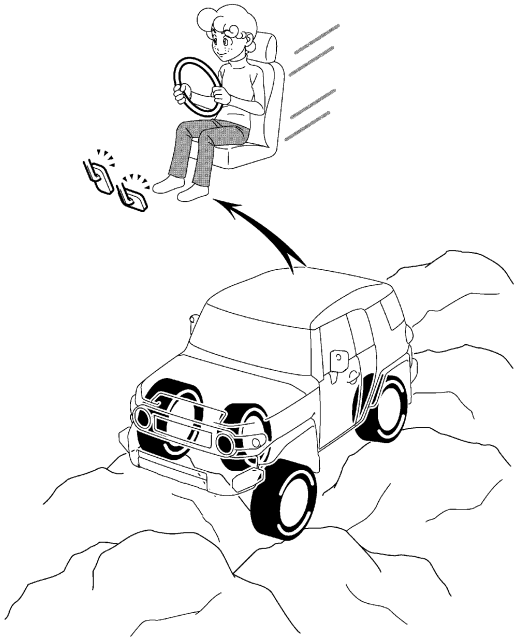
Drive Mode			Brake Control						
			ABS	EBD	Brake Assist	TRAC	A-TRAC	VSC	CRAWL*3
2WD	H2		○	○	○	○	—	○	—
4WD	H4		○	○	○	○*2	—	○	—
	L4	Rear Diff. Free	○	○	○	—	○*5	—	○*4
		Rear Diff. Lock*1	—	○	—	—	○*5	—	○*4

*1: Models with Rear Diff. Lock
*2: Engine output is not regulated.
*3: Models with CRAWL
*4: When the CRAWL control switch assembly is turned.
*5: When the A-TRAC switch assembly is turned.

3. Outline of CRAWL

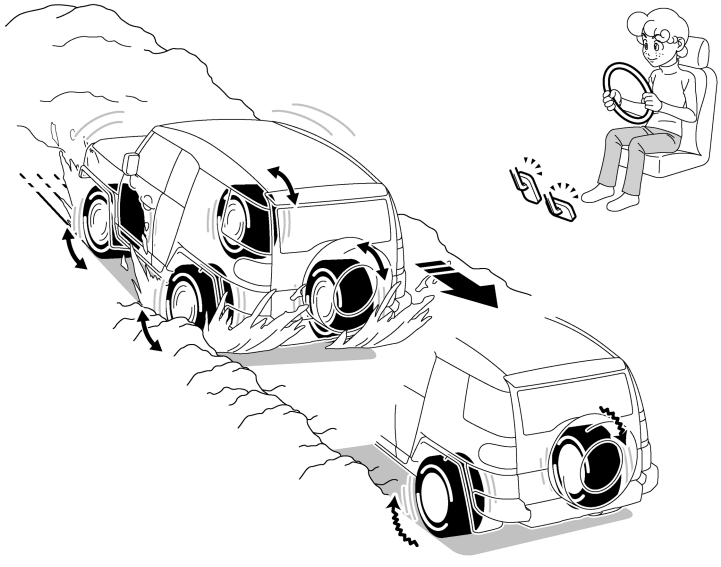
The CRAWL is a driving support system that regulates the engine output and the brake force, enabling the vehicle to be driven at a constant speed on rough ground or slippery roads.

- When the vehicle drives across rough grounds such as extremely bumpy rough roads, the driver needs to pay attention to the steering, braking and acceleration operations. However, with the CRAWL, the driver can concentrate on steering, without worrying about the accelerator or brake pedals.



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- The CRAWL ensures good vehicle stability in situations such as when the vehicle is running on a slippery or steep road because the chances of the wheels spinning or locking is minimized by regulating the engine output and the brake force.



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4. CRAWL Indicator Lights and Buzzer

The warning and indicator lights and buzzer that are associated with the CRAWL function operate as follows.

○: Illuminates △: Blinks —: Not Operating

Condition		Indicator Light			Buzzer
		 10FCH15TE	 03NCH009Y	 2300CH03	
Initial Check		○	○	○	—
During Operation	CRAWL	○	△	○	—
During Hydraulic Brake Booster Protection		○	○*1	△*2	Intermittent Sound*1
Cannot operate due to a malfunction	CRAWL	○	○	△*3	Intermittent Sound*3

*1: An extreme rise in the temperature of the hydraulic brake booster causes the buzzer to sound. Further rise in the temperature causes the buzzer to sound (continuously for 3 seconds) and the slip indicator light to come on.

*2: If CRAWL is continuously used for a long duration, the brake actuator inside the hydraulic brake booster might overheat. If that happens, a buzzer will intermittently sound, the CRAWL indicator will blink and then turn off, and CRAWL will temporarily stop functioning.

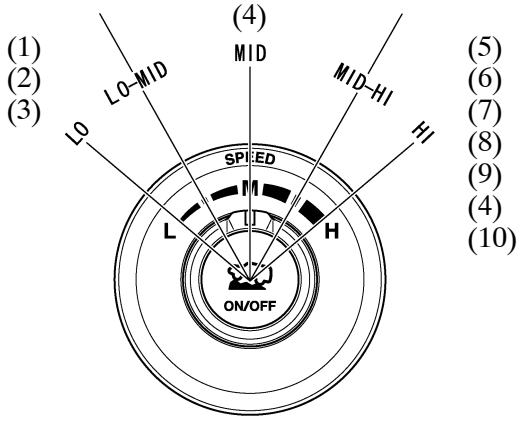
*3: If CRAWL control turns off for any reason other than operation of the on/off switch, the CRAWL indicator will start to blink instead of being illuminated, and a buzzer will intermittently sound.

5. System Operation

CRAWL Operation

- Based on the information provided by various sensors, switches, and the ECM, the skid control ECU determines the conditions that enable the CRAWL to operate. The skid control ECU computes the target vehicle speed (approximately 1 to 6 km/h, 1 to 3.7 mph) to control the vehicle speed, and the target wheel speeds to control the wheel slipping. The target vehicle speed can be changed using the speed selector switch.
- When the vehicle speed exceeds the target speed, the engine output is reduced. When the wheel speeds exceed the target speeds, the hydraulic brake pressure on the wheels is increased.
- When the vehicle speed falls below the target speed, the engine output is increased. When the wheel speeds fall below the target speeds, the hydraulic brake pressure on the wheels is reduced.
- There are five stages for CRAWL vehicle target speeds, and the recommended speeds are set as shown below.

  (1) Rocks and stones
  (2) Mogul (downhill)
  (3) Rubble (downhill)
  (4) Mogul (uphill)
  (5) Snow
  (6) Mud
  (7) Rubble (uphill)
  (8) Sand
  (9) Gravel
  (10) Grass



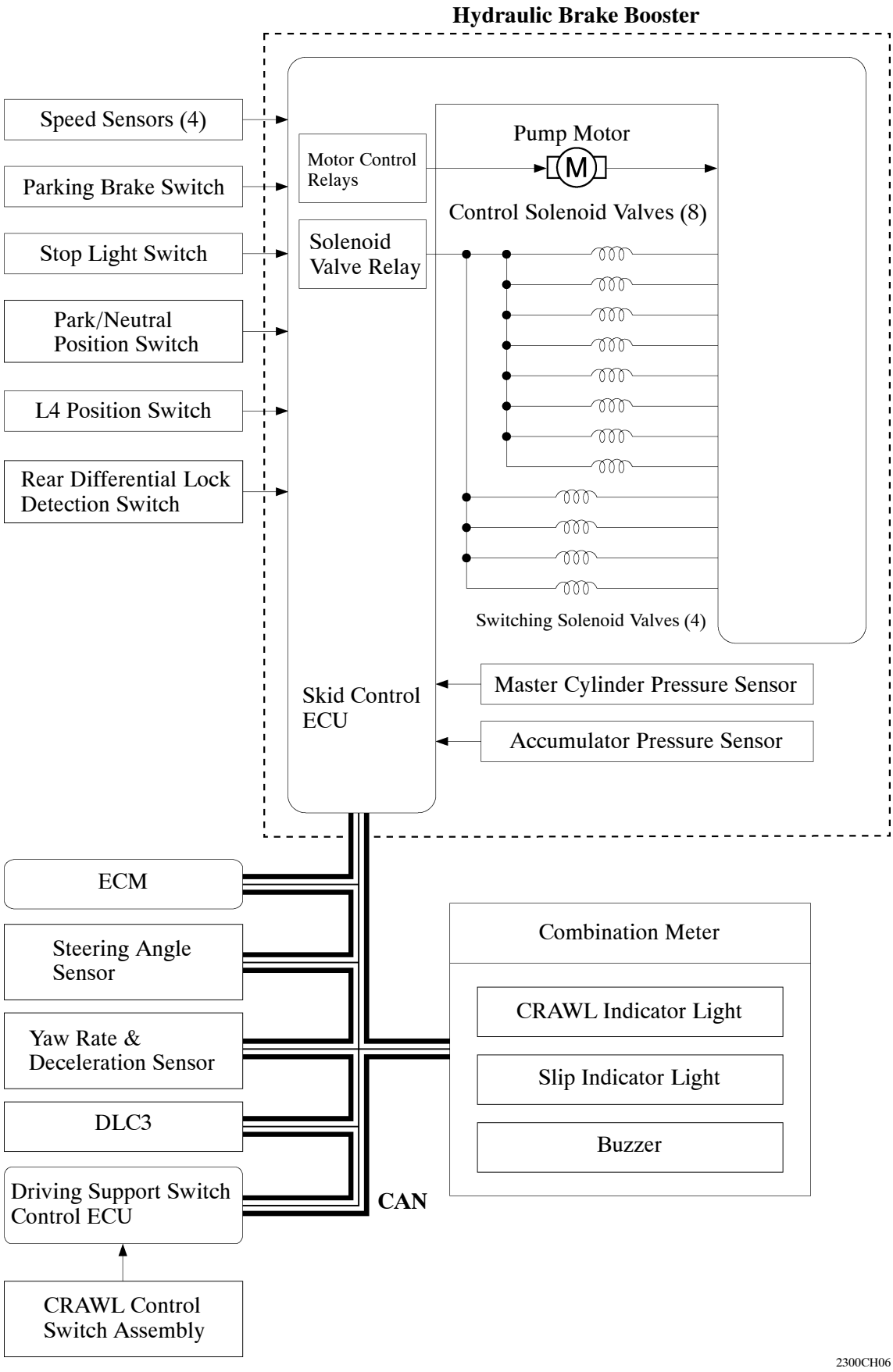
CRAWL Control Switch Assembly

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NOTICE

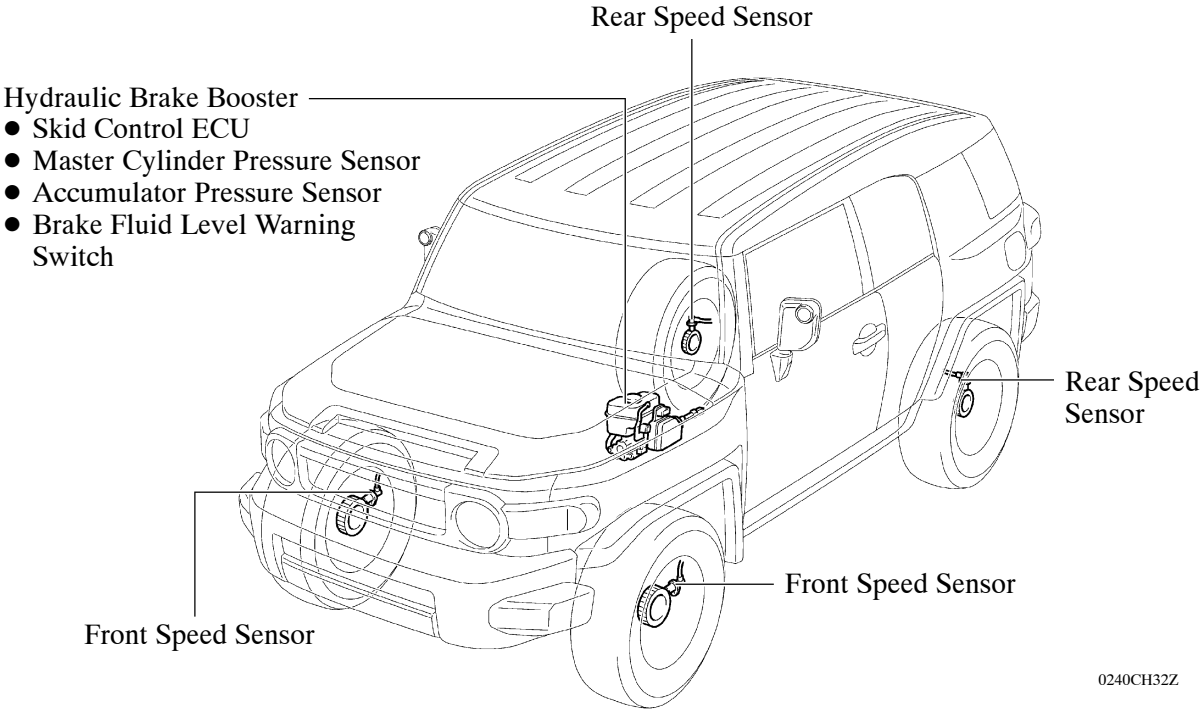
Recommended speeds are provided for reference. They might not be optimal in some cases, depending on road surface conditions (grades, road surface, undulation). Carefully check the road surface when driving.

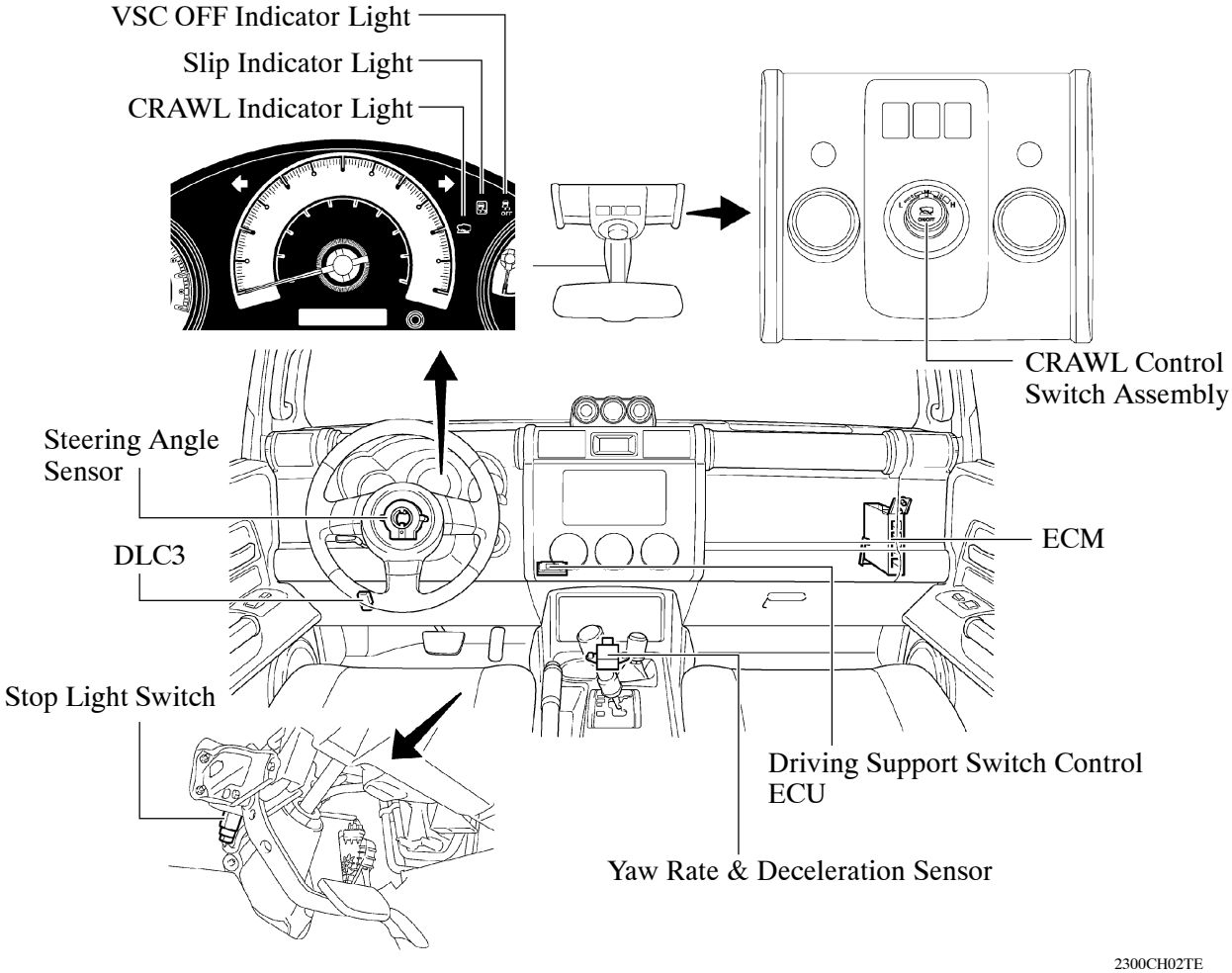
▶ System Diagram ◀



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6. Layout of Main Components





7. Function of Main Components

Component		Function
Hydraulic Brake Booster	Skid Control ECU	Judges the vehicle driving condition based on signals from each sensor, and sends brake control signals to the control solenoid valves and switching solenoid valves.
	Brake Actuator Portion ● Control Solenoid Valves (8) ● Switching Solenoid Valves (4) ● Pump Motor	● 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, TRAC, AUTO LSD, A-TRAC, VSC and CRAWL, in order to control the fluid pressure that is applied to the wheel cylinders.
	Solenoid Valve Relay	Supplies or cuts off power to control solenoid valves and switching solenoid valves.
	Motor Control Relays (3)	Supplies or cuts off power to pump motor.
	Master Cylinder Pressure Sensor	Detects the master cylinder pressure.
	Accumulator Pressure Sensor	Detects the accumulator pressure.
	Brake Fluid Level Warning Switch	Detects the brake fluid level.
Combination Meter	VSC OFF Indicator Light	● When the rear differential is locked, the VSC OFF indicator light lights up to alert the driver. (Models with Rear Diff. Lock) ● When the center differential is locked, the VSC OFF indicator light lights up to alert the driver. (4WD Models with MT) ● When the transfer shift lever is L4 position, the VSC OFF indicator light lights up to alert the driver. (4WD Models with AT) ● When the VSC OFF switch is depressed for 3 seconds, the VSC OFF indicator light light up to inform driver the VSC is not activate.
	Slip Indicator Light	● When the skid control ECU detects a malfunction and determines that the VSC is not available, slip indicator lights come on to alert the driver. ● When the TRAC, AUTO LSD, A-TRAC, or CRAWL is operated, slip indicator light blinks to inform the driver.
	CRAWL Indicator Light	Lights up to inform the driver when the CRAWL control switch assembly turned ON.
	Buzzer	The buzzer has two types of sounds. ● The buzzer sounds intermittently to inform the driver if the temperature of the hydraulic brake booster has increased excessively due to the continuous operation of the AUTO LSD, CRAWL, TRAC or A-TRAC. ● The buzzer sounds continuously to alert the driver that the hydraulic pressure of the accumulator in the hydraulic brake booster has decreased, and that the brake pressure supply system in malfunctioning.

(Continued)

Component	Function
Speed Sensors (4)	Detects the wheel speed and rotating direction of each of four wheels.
Steering Angle Sensor	Detects the steering direction and steering angle of the steering wheel.
Yaw Rate & Deceleration Sensor	● Detects the vehicle's yaw rate. ● Detects the vehicle's acceleration in the forward, rearward, and lateral.
Stop Light Switch	Detects the brake pedal depressing signal.
Parking Brake Switch	Detects the parking brake signal.
L4 Position Switch	Detects the L4 condition of the transfer.
CRAWL Control Switch Assembly	● Turns the CRAWL ON and OFF. ● Used to select the target vehicle speed when the CRAWL is active.
Stop Light Control Relay	Turn on the stop light during CRAWL operation.
Driving Support Switch Control ECU	Sends signals from the CRAWL control switch assembly to the skid control ECU.
ECM	● Sends the throttle valve angle signal, accelerator pedal position signal, engine speed signal, and intake air temperature signal to the skid control ECU. ● Receives an engine output adjustment command signal from the skid control ECU. Based on this signal, the ECM operates the throttle valve to control engine output.

CRAWL Operation Condition

When the CRAWL control switch assembly is pressed with all of the following conditions met, the CRAWL control starts operating. The activation of the control causes the CRAWL indicator light to illuminate and the slip indicator light to blink.

- Transfer is L4.
- Shift position is in any position other than P or N.
- Parking brake is not applied.
- Driver's door is closed.
- The hydraulic brake booster is not overheat.
- ATF is not overheat.
- VSC system is operating normally.

CRAWL Operation Ending Condition

If any of the following conditions are met, the CRAWL control stops operating. When CRAWL stops, a buzzer continuously sounds and the CRAWL indicator light starts to blink instead of being illuminated.

- CRAWL control switch assembly is turned OFF.*1
- Transfer is changed to H4.
- Shift position is shifted into P or N.
- Driver's door is opened.
- VSC malfunctions. (If this happens, take appropriate actions such as stopping the vehicle.)
- The hydraulic brake booster is overheat.
- ATF is overheat.
- Vehicle speed is above 25 km/h (16 mph).*2
- Vehicle speed is 10 km/h (6 mph) or faster. (When the rear differential is locked.)*3

*1: If CRAWL is turned off using the CRAWL on/off switch assembly, no buzzer will sound and the indicator light will not blink.

*2: Control will temporarily stop at speeds of 25 km/h (16 mph) or faster, and the CRAWL indicator light will blink.

*3: When the rear differential is locked, control will temporarily stop at speeds of 10 km/h (6 mph) or faster, and the CRAWL indicator light will blink.

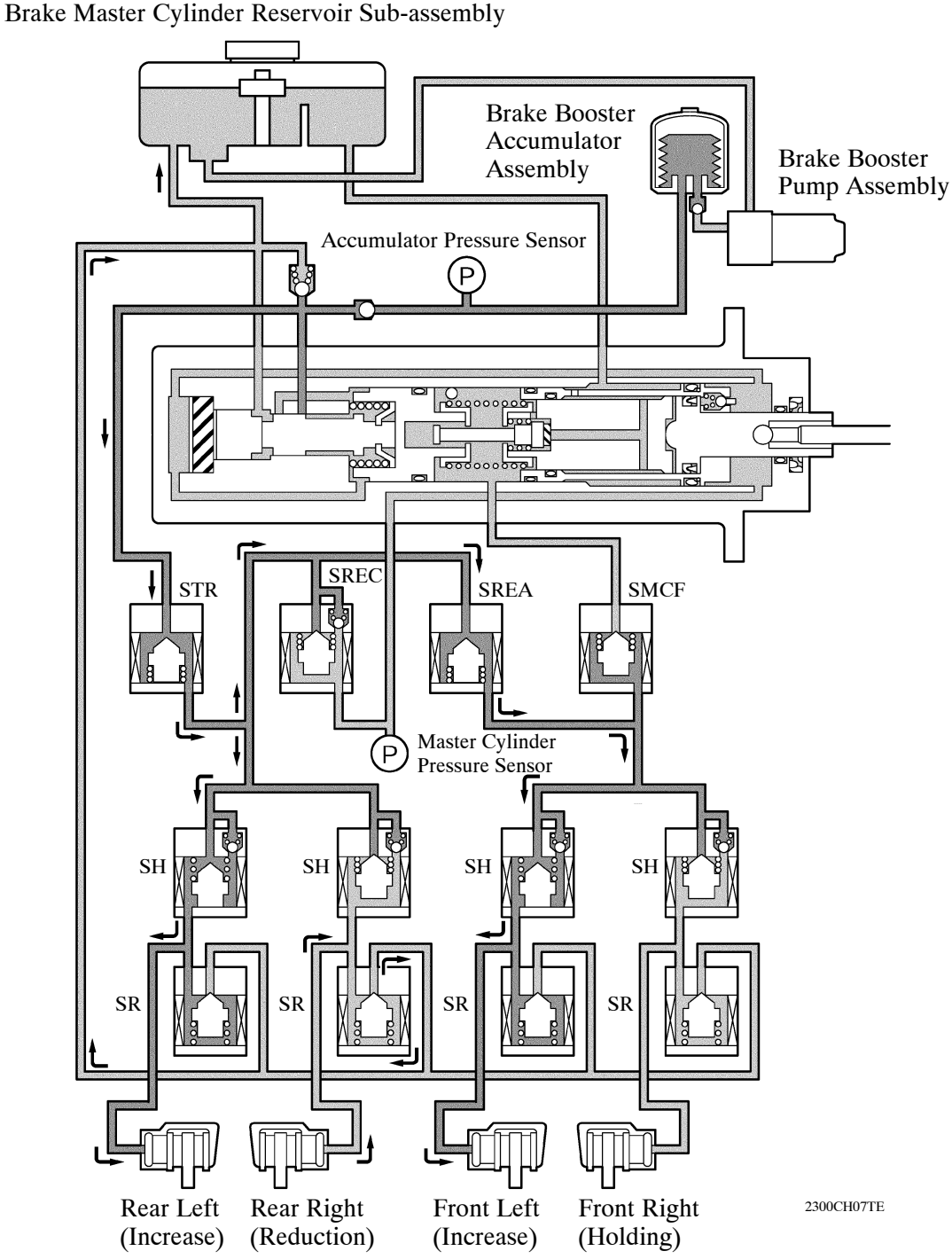
NOTICE

Precaution on CRAWL Operation

- Check the CRAWL indicator status before driving.
- If CRAWL control turns off for any reason other than operation of the on/off switch, the CRAWL indicator will start to blink instead of being illuminated, and a buzzer will intermittently sound. If this happens, take appropriate measures, such as stopping the vehicle.
- If CRAWL is continuously used for a long duration, the brake actuator inside the hydraulic brake booster might overheat. If that happens, a buzzer will intermittently sound, the CRAWL indicator will blink and then turn off, and CRAWL will temporarily stop functioning. In such instances, promptly stop the vehicle in a safe location and allow it to cool off sufficiently. After a while, the temperature of the actuator will fall, and CRAWL will return to a functional state. Normal driving is possible in the meantime.
- If CRAWL is continuously used for a long duration, the ATF might overheat. If driving continues in such a state, ATF leaks or damage may result, so promptly stop the vehicle in a safe location and allow it to cool off sufficiently.
- It might not be possible to maintain a constant vehicle speed on the diagonal surface of extremely steep grades, on pebble-like road surfaces with large bumps, and road surfaces with a low μ value like snow-covered surfaces.
- CRAWL is not a device for improving a vehicle's marginal performance. Carefully check the state of the road surface and take caution to drive safely.

▶ CRAWL Operation ◀

The skid control ECU controls the fluid pressure that is generated by the pump and pump motor and applies it by way of the solenoid valves to the brake wheel cylinder of each wheel in the following three modes: pressure reduction, pressure hold, and pressure increase modes.



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

Item			CRAWL not Activated	CRAWL Activated		
				Mode		
				Increase	Holding	Reduction
Switching Solenoid Valve		SREC	OFF (Open)	ON (Close)	←	←
		STR	OFF (Close)	ON (Open)	←	←
	Front Brake	SMCF	OFF (Open)	ON (Close)	←	←
		SREA	OFF (Close)	ON (Open)	←	←
Control Switching Valve		SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
		Wheel Cylinder Pressure	—	Increase	Hold	Reduce
	Rear Brake	SH	OFF (Open)	←	ON (Close)	←
		SR	OFF (Close)	←	←	ON (Open)
		Wheel Cylinder Pressure	—	Increase	Hold	Reduce