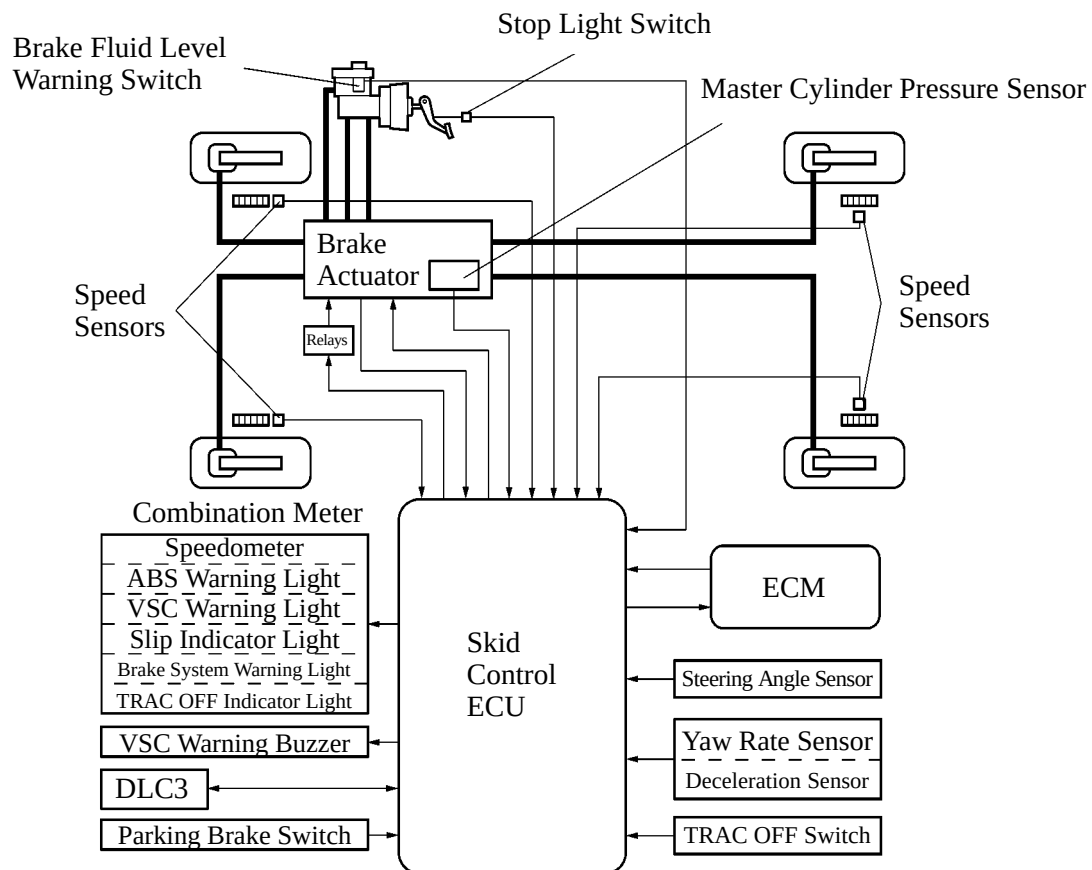


■ ABS with EBD & BRAKE ASSIST & TRAC & VSC SYSTEM

1. General

- The primary purpose of the ABS and TRAC system has been to help the vehicle's behavior during braking and acceleration.
In contrast, the purpose of the VSC system is to help maintain the vehicle's behavior during cornering.
- The TRAC system controls driving wheels, therefore, it controls the front wheels.
However, depending on the unexpected situations or external elements such as the ground surface conditions, vehicle speed, and emergency avoidance maneuvers, the vehicle may exhibit strong understeer or oversteer tendencies. In such situations, the VSC system dampens the strong understeer or oversteer to help maintain vehicle behavior.
- The primary purpose of the Brake Assist system is to provide an auxiliary brake force assist to the driver who cannot generate a large brake force during emergency braking.
- 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.

2. System Diagram



3. Outline of Brake Assist System

Brake Assist system interprets a quick push of the brake pedal as emergency braking and supplements the braking power applied if the driver has not stepped hard enough on the brake pedal.

In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure on the brake pedal.

Brake Assist system measures the speed and force with which the brake pedal is pushed to determine whether the driver is attempting to brake rapidly, and applies additional pressure to increase braking performance.

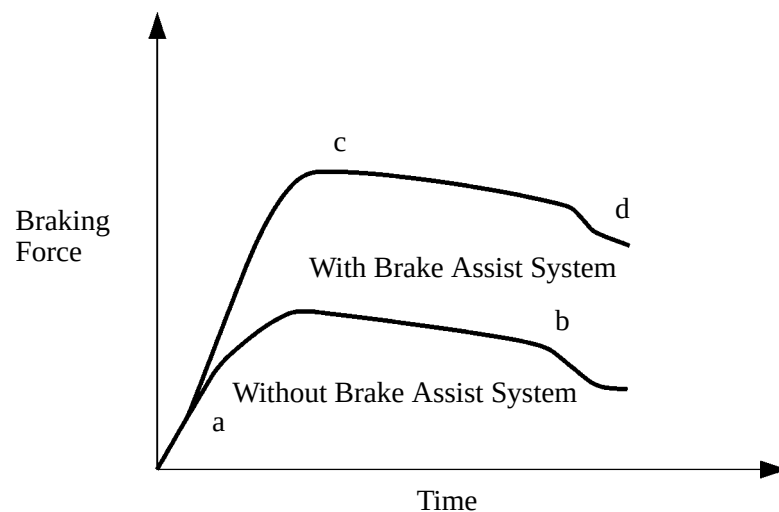
A key feature of Brake Assist system is that the timing and the degree of braking assistance are designed to ensure that the driver does not discern anything unusual about the braking operation.

When the driver intentionally eases up on the brake pedal, the system reduce the amount of assistance it provides.

– REFERENCE –

Effectiveness of the Brake Assist Operation:

- During emergency braking, an inexperienced driver, or a driver in a state of panic might not be able to firmly depress the brake pedal, although driver can depress it quickly. As a result, only a small amount of brake force is generated.
- The pedal effort of this type of driver might weaken as time passes, causing a reduction in the braking force.
- Based on how quickly the brake pedal is depressed, the Brake Assist operation assesses the intention of the driver to apply emergency braking and increases the brake force.
- After the Brake Assist operation, if the driver intentionally releases the brake pedal, the assist operation reduces the amount of Brake Assist in order to reduce the feeling of uneasiness.



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Service Tip

When this 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.

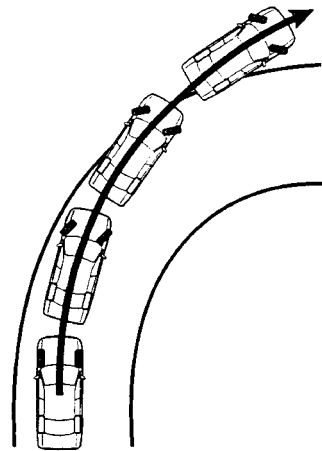
4. Outline of VSC System

General

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

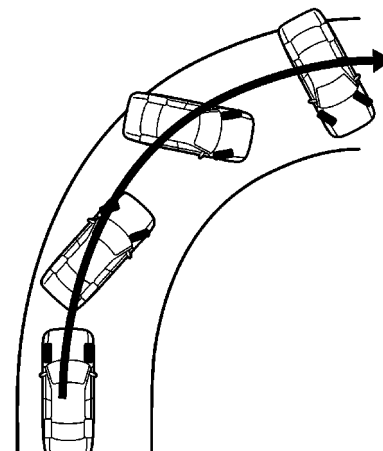
VSC system is to help control the vehicle behavior by applying the engine output control and each wheels brake control when the vehicle is under the condition indicated below.

- When the front wheels lose grip in relation to the rear wheels (strong understeer tendency).
- When the rear wheels lose grip in relation to the front wheels (strong oversteer tendency).



Strong Understeer Tendency

151CH17



Strong Oversteer Tendency

189CH100

Method for Determining the Vehicle Condition

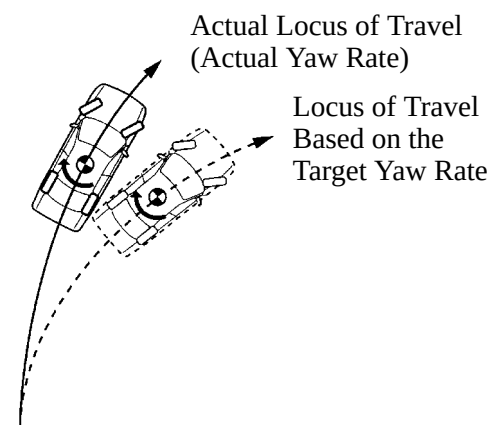
To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and the vehicle's lateral acceleration, which are then calculated by the skid control ECU.

1) Determining UnderSteer

Whether or not the vehicle is in the state of understeer 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 loss of travel.

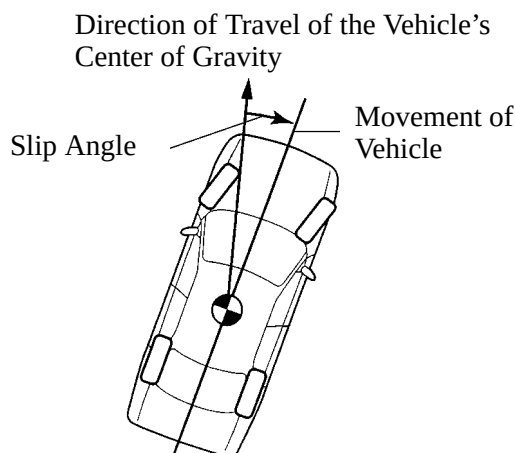
Thus, the ECU determines that there is a large tendency to understeer.



151CH19

2) Determining Oversteer

Whether or not the vehicle is in the state of oversteer 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 ECU determines that the vehicle has a large oversteer tendency.



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Method of VSC Operation

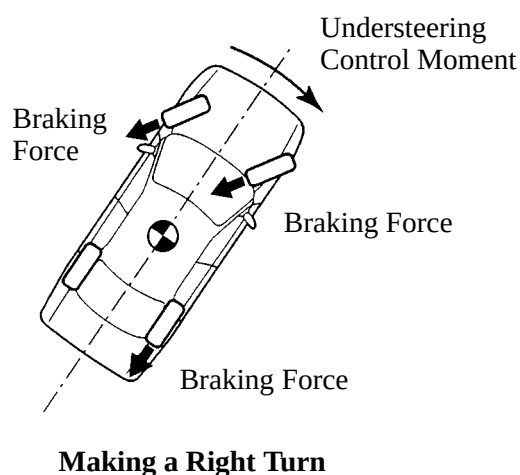
When the skid control ECU determines that the vehicle exhibits a tendency to understeer or oversteer, it decreases the engine output and applies the brake of a front or rear wheel to control the vehicle's yaw moment.

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 Strong Understeer

When the skid control ECU determines that the vehicle exhibits a strong tendency to understeer, depending on the extent of that tendency, it decreases the engine output and applies the brakes of the front wheels and inside rear wheel, thus providing the vehicle with an understeer control moment, which helps dampen its tendency to understeer.

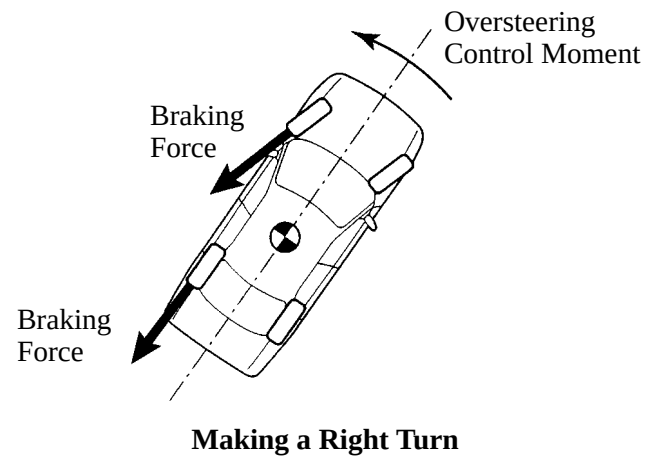
Also, depending on whether the brakes are ON or OFF and the condition of the vehicle, there are circumstances in which the brakes might not be applied to the wheels even if those wheels are targeted for braking.



161ES30

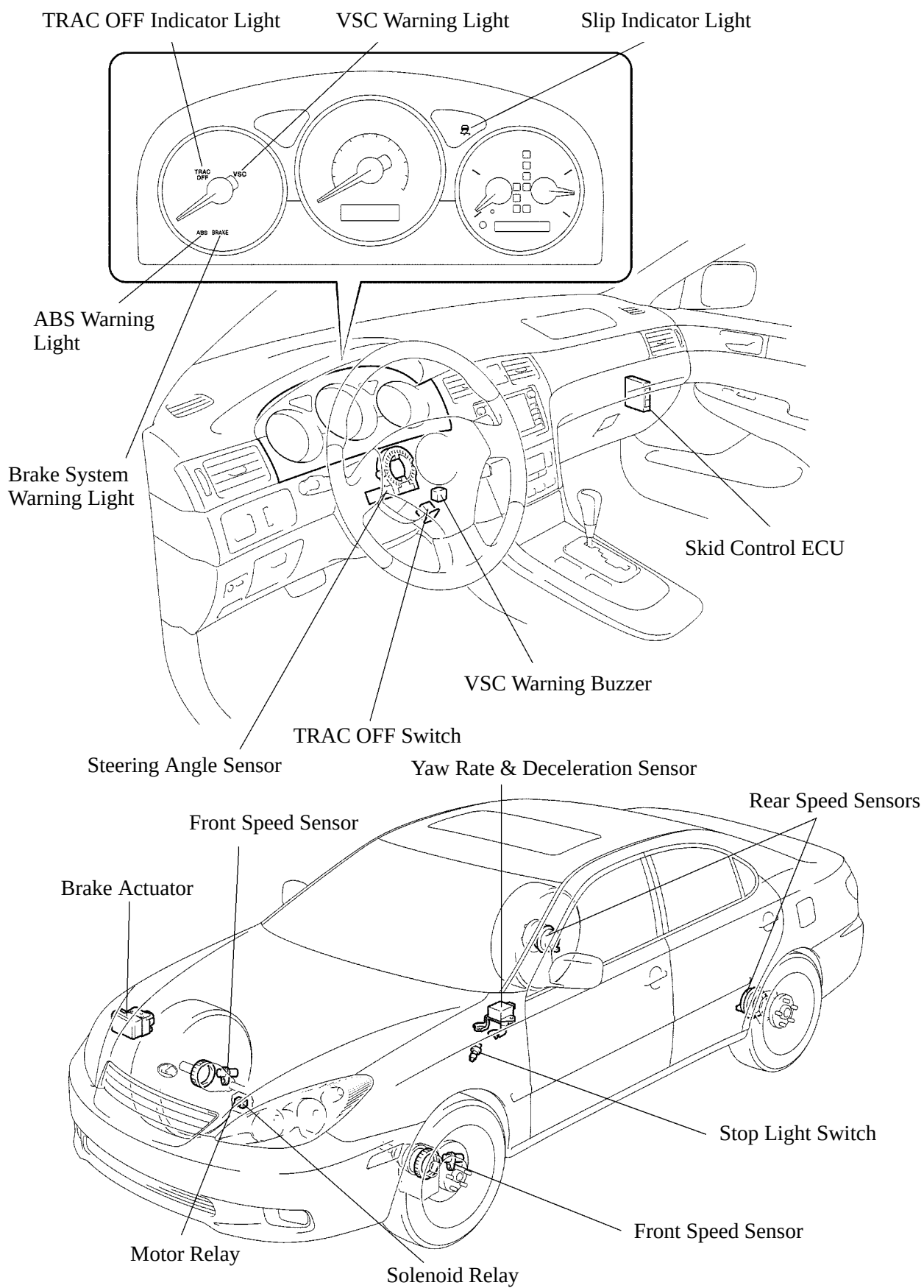
2) Dampening a Strong Oversteer

When the skid control ECU determines that the vehicle exhibits a strong tendency to oversteer, depending on the extent of that tendency, it controls the engine output and applies the brakes of the front and rear wheels of the outside of the turn, thus generating an inertial moment in the vehicle's outward direction, which helps dampen its tendency to oversteer.



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6. Layout of Component



7. Function of Component

Component		Function
Combination Meter	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the ABS or Brake Assist system.
	VSC Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the VSC system.
	Slip Indicator Light	Blinks to inform the driver when the TRAC system or the VSC system is operated.
	TRAC OFF Indicator Light	● Lights up to inform the driver when the TRAC system is turned OFF by the TRAC OFF switch. ● Lights up to inform the driver when the skid control ECU detects the malfunction in the TRAC or VSC system.
	Brake System Warning Light	Lights up together with the ABS warning light to alert the driver when the skid control ECU detects the malfunction in the EBD control.
ECM		● Sends the throttle valve opening angle signal, crankshaft position sensor, intake air temp. sensor, etc., to the skid control ECU. ● Receive the signal of throttle valve opening request from the skid control ECU.
Speed Sensors		Detects the wheel speed of each four wheels.
Brake Actuator		Charges the fluid path based on the signals from the skid control ECU during the operation of the ABS with EBD & Brake Assist & TRAC & VSC system, in order to control the fluid pressure that is applied to the wheel cylinders.
	Master Cylinder Pressure Sensor	Assembled in the brake actuator and detects the master cylinder pressure.
Skid Control ECU		Judges the vehicle driving condition based on signals from each sensor, and sends brake control signal to the brake actuator.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Stop Light Switch		Detects the brake pedal depressing signal.
TRAC OFF Switch		Turns the TRAC system inoperative.
VSC Warning Buzzer		Emits an intermittent sound to inform the driver that the skid control ECU detects the strong understeer tendency or strong oversteer tendency.
Yaw Rate & Deceleration Sensor		● Detects the vehicle's yaw rate. ● Detects the vehicle's acceleration in the forward, rearward, lateral.
Steering Angle Sensor		Detects the steering direction and angle of the steering wheel.
Motor Relay		Supply power to the pump motor in the brake actuator.
Solenoid Relay		Supply power to the solenoid valves in the brake actuator.