

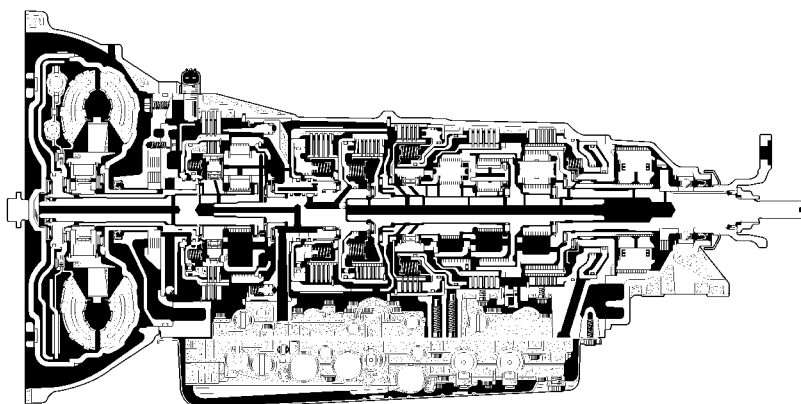
## CHASSIS

### A650E AUTOMATIC TRANSMISSION

#### ■ DESCRIPTION

The A650E is a newly adopted 5-speed automatic transmission [Super ECT (Electronically Controlled Transmission)]. The basic construction and operation are the same as those of the LS400's A650E. For details, see the LS400 New Car Features Supplement (Pub. No. NCF144E). The A650E automatic transmission differs from the A343E automatic transmission of the previous model in the following areas:

- 4 planetary gear units are adopted.
- The throttle valve and throttle cable have been discontinued, and the line pressure is controlled by a linear solenoid valve.
- The flex lock-up clutch control is adopted.
- High response shift control is adopted.
- AI (Artificial Intelligence) - SHIFT control is adopted.
- A newly developed ATF type T-IV, which offers superior friction characteristics, has been adopted.
- The gate type shift lever is used.



## ► Specifications ◀

| Model                                       |         | New                            | Previous                       | LS400                          |
|---------------------------------------------|---------|--------------------------------|--------------------------------|--------------------------------|
| Transmission Type                           |         |                                |                                |                                |
| Item                                        |         | A650E                          | A343E                          | A650E                          |
| Gear Ratio                                  | 1st     | 3.357                          | 2.804                          | 3.357                          |
|                                             | 2nd     | 2.180                          | 1.531                          | 2.180                          |
|                                             | 3rd     | 1.424                          | 1.000                          | 1.424                          |
|                                             | 4th     | 1.000                          | 0.753                          | 1.000                          |
|                                             | 5th     | 0.753                          | —                              | 0.753                          |
|                                             | Reverse | 3.431                          | 2.393                          | 3.431                          |
| Fluid Capacity<br>Liters (US qts, Imp. qts) |         | 7.45 (7.9, 6.6)                | 7.9 (8.4, 7.0)                 | 8.5 (9.0, 7.5)                 |
| Fluid Type                                  |         | ATF Type T-IV or<br>Equivalent | ATF Type T-II or<br>Equivalent | ATF Type T-IV or<br>Equivalent |

## ■ TORQUE CONVERTER

The torque converter supports flex lock-up clutch control, thus improving the fuel economy.

## ■ PLANETARY GEAR UNIT

### 1. General

A new gear train construction, which uses 4 sets of planetary gear units, has been adopted.

Also, the 5-speed configuration has been achieved without increasing the number of one-way clutches, thus creating a 5-speed automatic transmission with practically the same size as the previous 4-speed automatic transmission.

For the purpose of improving dynamic performance and fuel economy, the gear ratio from the 1st to the 5th gear has been changed from a wide to a close gear ratio.

The 1st gear ratio has been increased to improve the acceleration performance during the startoff and in the low-to medium-speed range.

Also, the close gear ratio made shifting smoother to realize a smooth ride.

## ► Specifications ◀

| Model                                       |         | New                            | Previous                       | LS400                          |
|---------------------------------------------|---------|--------------------------------|--------------------------------|--------------------------------|
| Transmission Type                           |         |                                |                                |                                |
| Item                                        |         | A650E                          | A343E                          | A650E                          |
| Gear Ratio                                  | 1st     | 3.357                          | 2.804                          | 3.357                          |
|                                             | 2nd     | 2.180                          | 1.531                          | 2.180                          |
|                                             | 3rd     | 1.424                          | 1.000                          | 1.424                          |
|                                             | 4th     | 1.000                          | 0.753                          | 1.000                          |
|                                             | 5th     | 0.753                          | —                              | 0.753                          |
|                                             | Reverse | 3.431                          | 2.393                          | 3.431                          |
| Fluid Capacity<br>Liters (US qts, Imp. qts) |         | 7.45 (7.9, 6.6)                | 7.9 (8.4, 7.0)                 | 8.5 (9.0, 7.5)                 |
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Also, the close gear ratio made shifting smoother to realize a smooth ride.

► Specifications ◀

| Model                 |                                     |                              | New       | Previous | LS400 |
|-----------------------|-------------------------------------|------------------------------|-----------|----------|-------|
| Transmission Type     |                                     |                              | A650E     | A343E    | A650E |
| Item                  |                                     |                              |           |          |       |
| C <sub>0</sub>        | OD Direct Clutch                    | The No. of Discs             | 2         | ←        | ←     |
| C <sub>1</sub>        | Forward Clutch                      |                              | 5         | 5        | 6     |
| C <sub>2</sub>        | Direct Clutch                       |                              | 4         | 3        | 5     |
| B <sub>0</sub>        | OD Brake                            |                              | 3         | ←        | 4     |
| B <sub>1</sub>        | 3rd Coast Brake<br>2nd Coast Brake* | Band Width      mm (in.)     | 40 (1.57) | ←        | ←     |
| B <sub>2</sub>        | 3rd Brake<br>2nd Brake*             | The No. of Discs             | 4         | 5        | ←     |
| B <sub>3</sub>        | 2nd Brake<br>1st & Reverse Brake*   |                              | 5         | 6        | 5     |
| B <sub>4</sub>        | 1st & Reverse Brake                 |                              | 5         | —        | 6     |
| F <sub>0</sub>        | OD One-Way Clutch                   | The No. of Sprags            | 20        | 24       | ←     |
| F <sub>1</sub>        | No. 1 One-Way Clutch                |                              | 16        | 18       | 20    |
| F <sub>2</sub>        | No. 2 One-Way Clutch                |                              | 24        | 28       | 24    |
| OD Planetary Gear     |                                     | The No. of Sun Gear Teeth    | 31        | ←        | ←     |
|                       |                                     | The No. of Pinion Gear Teeth | 32        | ←        | ←     |
|                       |                                     | The No. of Ring Gear Teeth   | 95        | ←        | ←     |
| Front Planetary Gear  |                                     | The No. of Sun Gear Teeth    | 41        | 42       | 41    |
|                       |                                     | The No. of Pinion Gear Teeth | 16        | 19       | 16    |
|                       |                                     | The No. of Ring Gear Teeth   | 73        | 79       | 73    |
| Center Planetary Gear |                                     | The No. of Sun Gear Teeth    | 31        | —        | 31    |
|                       |                                     | The No. of Pinion Gear Teeth | 21        | —        | 21    |
|                       |                                     | The No. of Ring Gear Teeth   | 73        | —        | 73    |
| Rear Planetary Gear   |                                     | The No. of Sun Gear Teeth    | 28        | 33       | 28    |
|                       |                                     | The No. of Pinion Gear Teeth | 19        | 23       | 19    |
|                       |                                     | The No. of Ring Gear Teeth   | 66        | 79       | 66    |

\*: A343E Automatic Transmission

## ■ ELECTRONIC CONTROL SYSTEM

### 1. General

A new electronic control has been adopted to improve the acceleration feeling, shift feeling, drivability, and fuel economy.

The electronic control system of the new model's A650E, previous model's A343E and LS400's A650E automatic transmissions are compared below.

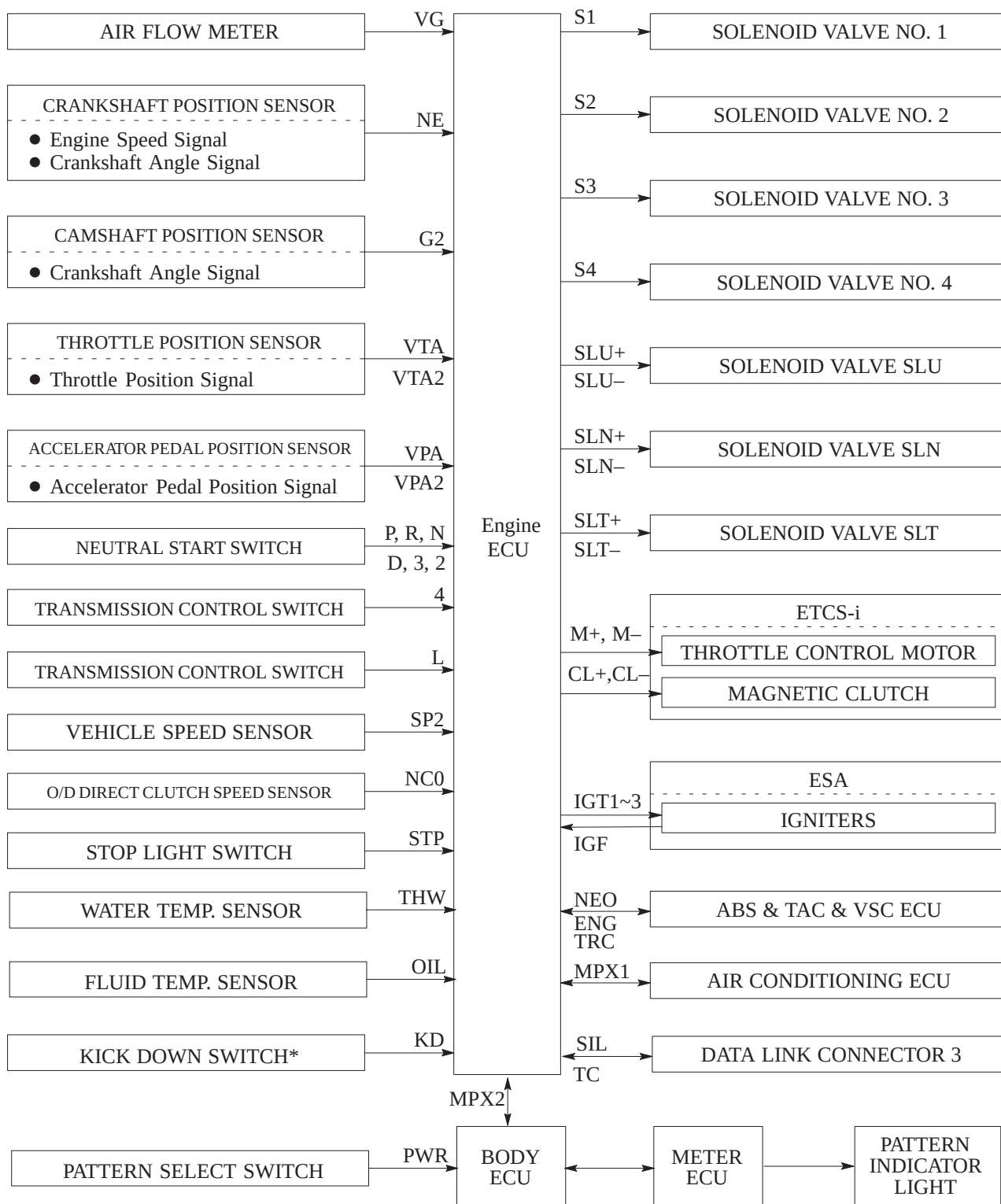
| System                               | Function                                                                                                                                                                                                                                               | New   | Previous | LS400 |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|-------|
|                                      |                                                                                                                                                                                                                                                        | A650E | A343E    | A650E |
| Shift Timing Control                 | The optimum shift pattern is selected from 2 shift patterns in the engine ECU by the pattern select switch. The engine ECU sends current to the No. 1, No. 2 and/or No. 3* solenoid valves based on signals from each sensor and shifts the gear.      | ○     | ○        | ○     |
| Lock-Up Timing Control               | The optimum lock-up pattern is selected from 2 lock-up patterns in the engine ECU by the pattern select switch. The engine ECU sends current to the solenoid valve SLU based on signals from each sensor and engages or disengages the lock-up clutch. | ○     | ○        | ○     |
| Flex Lock-Up Clutch Control          | Controls the solenoid valve SLU, provides an intermediate mode between the ON/OFF operation of the lock-up clutch, and increases the operating range of the lock-up clutch to improve fuel economy.                                                    | ○     | —        | ○     |
| Line Pressure Optimal Control        | Based on the throttle opening angle and various signals, the engine ECU sends a signal to solenoid valve SLT to generate line pressure according to the engine output and to effect a smooth gear shift change.                                        | ○     | —        | ○     |
| Clutch Pressure Control              | To achieve smooth shifting, the solenoid valve SLN controls the accumulator back pressure in order to finely regulate the hydraulic pressure that is applied to the clutch.                                                                            | ○     | ○        | ○     |
|                                      | Uses the solenoid valve SLU to directly control the hydraulic pressure that is applied to the clutch.                                                                                                                                                  | ○     | —        | ○     |
| Engine Torque Control                | Retards the engine ignition timing temporarily to improve shift feeling during up or down shifting.                                                                                                                                                    | ○     | ○        | ○     |
| High Response Shift Control          | Through the cooperative control with the ETCS-i (Electronic Throttle Control System-intelligent), and the electronic control of supply and discharge speed of the clutch and brake hydraulic pressure, excellent response has been realized.           | ○     | —        | ○     |
| AI (Artificial Intelligence) - SHIFT | Based on the signals from various sensors, the engine ECU determines the road conditions and the intention of the driver. Thus, the shift pattern is automatically regulated to an optimal level, thus improving drivability.                          | ○     | —        | ○     |

\*: Only for the A650E automatic transmission

(Continued)

| System         | Function                                                                                                                                                                                                                                                                                                                                    | New   | Previous | LS400 |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|-------|
|                |                                                                                                                                                                                                                                                                                                                                             | A650E | A343E    | A650E |
| Self-Diagnosis | Causes the O/D OFF indicator light to turn on to inform the driver if the electrical circuit malfunction.                                                                                                                                                                                                                                   | —     | ○        | —     |
|                | <ul style="list-style-type: none"> <li>● Causes the pattern indicator light to turn on to inform the driver if the electrical circuit malfunction.</li> <li>● The diagnostic code can be checked by the pattern indicator light and the hand-held tester.</li> <li>● The hand-held tester can be used to perform an active test.</li> </ul> | ○     | —        | ○     |
| Fail-Safe      | Controls other normally operating components, permitting continued driving if malfunctions occur in the electrical circuit.                                                                                                                                                                                                                 | ○     | ○        | ○     |

## 2. Block Diagram

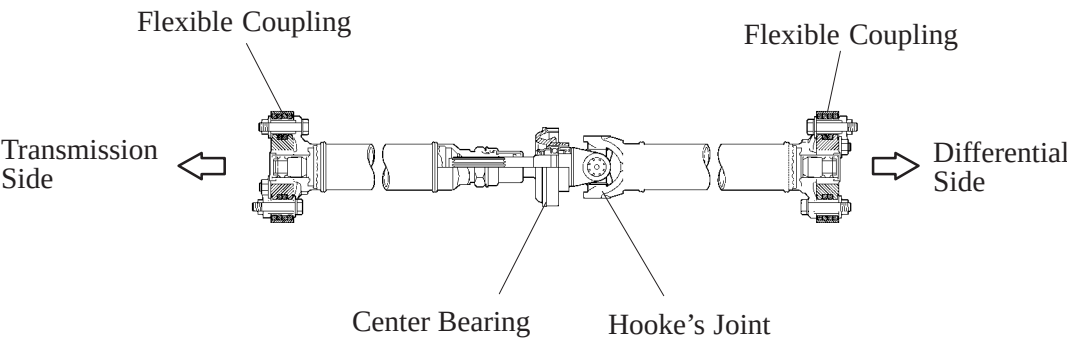


\*: Models for Europe

PROPELLER SHAFT

DESCRIPTION

A 3-joint type propeller shaft is used as in the previous model.

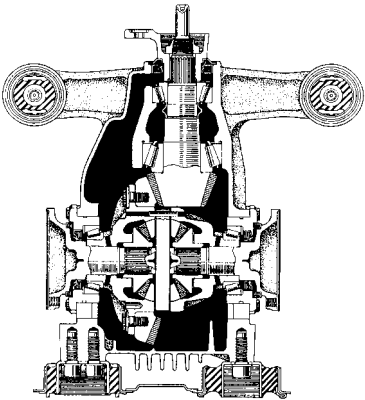


152CH05

DIFFERENTIAL

DESCRIPTION

The differential with an 8-inch ring gear continues to be used. However, the differential gear ratio has been changed.



152CH06

Specifications

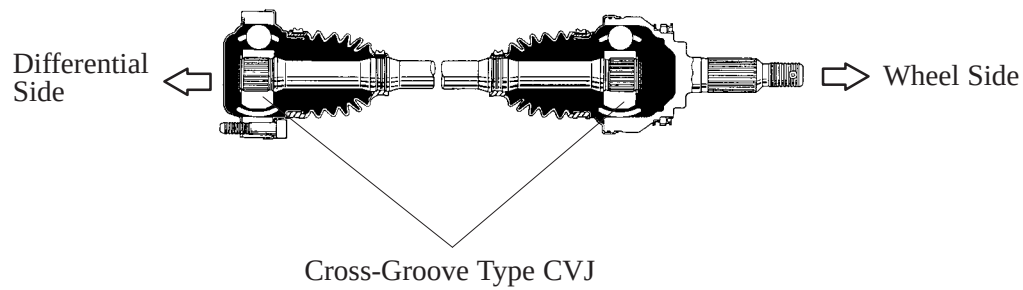
| Model                      |                           | New                                                           |           | Previous                   |
|----------------------------|---------------------------|---------------------------------------------------------------|-----------|----------------------------|
| Destination                |                           | Europe<br>G.C.C. Countries                                    | Australia | Europe<br>G.C.C. Countries |
| Item                       |                           |                                                               |           |                            |
| Differential Gear Ratio    |                           | 3.615                                                         | 3.916     | 4.083                      |
| Drive Pinion               | No. of Teeth              | 13                                                            | 12        | ←                          |
| Ring Gear                  | Size mm (in.)             | 200 (8)                                                       | ←         | ←                          |
|                            | No. of Teeth              | 47                                                            | ←         | 49                         |
| No. of Differential Pinion |                           | 2                                                             | ←         | ←                          |
| Oil Capacity               | Liters (US qts, Imp. qts) | 1.35<br>(1.42, 1.19)                                          | ←         | ←                          |
| Oil Viscosity              |                           | SAE80* <sup>1</sup> ,<br>SAE80W or<br>SAE80W-90* <sup>2</sup> | ←         | ←                          |
| Oil Grade                  |                           | API GL-5                                                      | ←         | ←                          |

\*1: Above -18°C (0°F)  
\*2: Below -18°C (0°F)

## DRIVE SHAFT

### ■ DESCRIPTION

The cross-groove type CVJ (Constant-Velocity Joint) is used both the wheel and differential side as in the previous model.



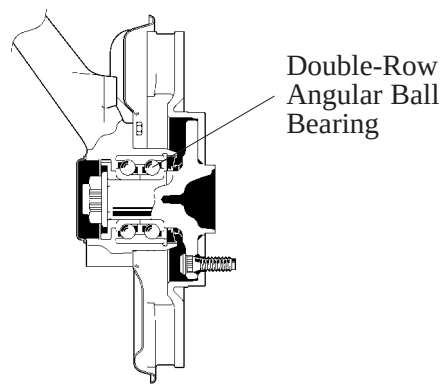
152CH07

## AXLES

CH

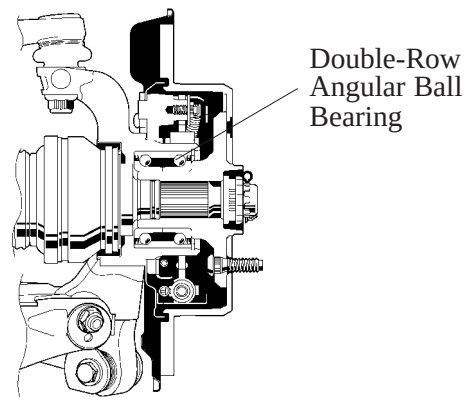
### ■ DESCRIPTION

The double-row angular ball bearing is used both front and rear axles as in the previous model. The size of the rear axle bearing has been changed for this new model.



152CH08

Front Axle



152CH09

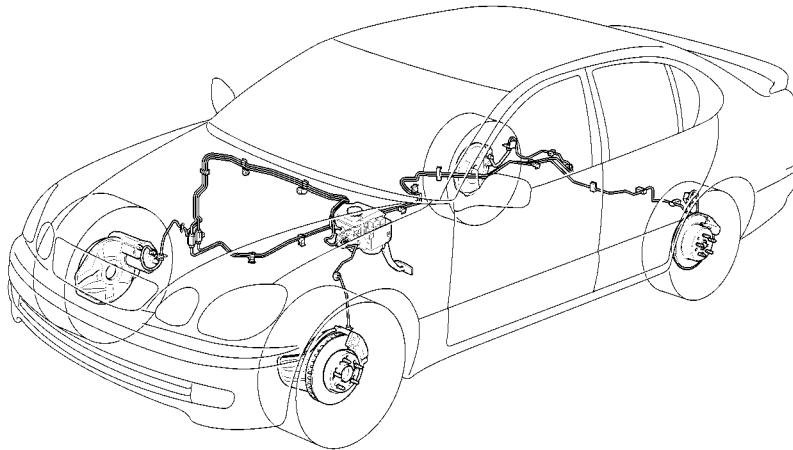
Rear Axle

## BRAKES

### ■ DESCRIPTION

The brakes of the new model provide the following features:

- The ventilated disc brake and the 2-piston type caliper are used for the front brakes as in the previous model.
- The solid disc brake and the 2-piston opposed type caliper are used for the rear brakes.
- The drum in disc duo servo brake is used for the parking brake as in the previous model.
- A mechanism that helps to prevent the brake pedal from retracting during a collision has been adopted.
- A friction-type lock mechanism is used for the lock mechanism of the parking brake pedal.
- The center port type single master cylinder is used.
- A hydraulic brake booster, in which the brake actuator and master cylinder are integrated, is used.
- ABS and TRC system are standard equipment on all models.
- A new VSC (Vehicle Stability Control) system is standard equipment on all models.
- The brake control valve has been discontinued.



152CH30

**LHD Model**

## ► Specifications ◀

| Model                           |                                              | New                                       | Previous                   |
|---------------------------------|----------------------------------------------|-------------------------------------------|----------------------------|
| Item                            |                                              |                                           |                            |
| Master Cylinder                 | Type                                         | Single                                    | Tandem                     |
|                                 | Diameter mm (in.)                            | 22.2 (0.87)                               | 27.0 (1.06)                |
| Brake Booster Type              |                                              | Hydraulic                                 | Vacuum                     |
| Front Brake                     | Type                                         | Ventilated Disc                           | ←                          |
|                                 | Pad Area cm <sup>2</sup> (in. <sup>2</sup> ) | 57.6 (8.93),<br>59 (9.15)* <sup>1</sup>   | ←                          |
|                                 | Wheel Cylinder Dia. mm (in.)                 | 44.4 (1.75) × 2                           | ←                          |
|                                 | Rotor Size (D × T)* <sup>2</sup> mm (in.)    | 296 × 32<br>(11.65 × 1.26)                | ←                          |
| Rear Brake                      | Type                                         | Solid Disc                                | Ventilated Disc            |
|                                 | Pad Area cm <sup>2</sup> (in. <sup>2</sup> ) | 21 (3.26)                                 | 33 (5.12)                  |
|                                 | Wheel Cylinder Dia. mm (in.)                 | 40.4 (1.59),<br>34.9 (1.38)* <sup>1</sup> | 40.4 (1.59)                |
|                                 | Rotor Size (D × T)* <sup>2</sup> mm (in.)    | 307 × 12<br>(12.09 × 0.47)                | 307 × 16<br>(12.09 × 0.63) |
| Brake Control Valve Type        |                                              | —                                         | P & B Valve                |
| Parking Brake                   | Type                                         | Duo-Servo                                 | ←                          |
|                                 | Size mm (in.)                                | 190 (7.48)                                | ←                          |
|                                 | Lever Type                                   | Pedal                                     | ←                          |
| ABS (Anti-Lock Brake System)    |                                              | STD* <sup>3</sup>                         | STD                        |
| TRC (Traction Control)          |                                              | STD* <sup>3</sup>                         | STD* <sup>4</sup>          |
| VSC (Vehicle Stability Control) |                                              | STD                                       | —                          |

\*1: Models for General Countries

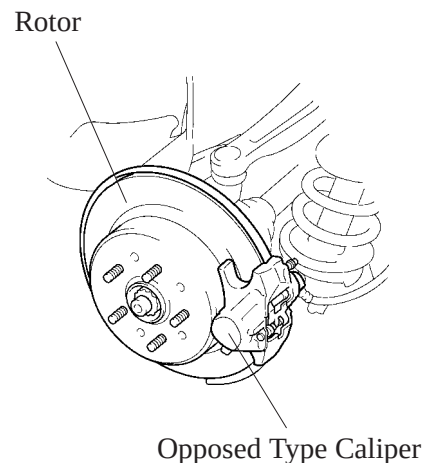
\*2: D: Outer Diameter, T: Thickness

\*3: Included in VSC system

\*4: LHD Model

## ■ REAR BRAKE

- A compact and lightweight opposed type caliper is used.
- A brake caliper, in which the brake pads can be replaced by removing the pad springs and pad pins, has been adopted for improved serviceability.



## ► Specifications ◀

| Model                           |                                              | New                                       | Previous                   |
|---------------------------------|----------------------------------------------|-------------------------------------------|----------------------------|
| Item                            |                                              |                                           |                            |
| Master Cylinder                 | Type                                         | Single                                    | Tandem                     |
|                                 | Diameter mm (in.)                            | 22.2 (0.87)                               | 27.0 (1.06)                |
| Brake Booster Type              |                                              | Hydraulic                                 | Vacuum                     |
| Front Brake                     | Type                                         | Ventilated Disc                           | ←                          |
|                                 | Pad Area cm <sup>2</sup> (in. <sup>2</sup> ) | 57.6 (8.93),<br>59 (9.15)* <sup>1</sup>   | ←                          |
|                                 | Wheel Cylinder Dia. mm (in.)                 | 44.4 (1.75) × 2                           | ←                          |
|                                 | Rotor Size (D × T)* <sup>2</sup> mm (in.)    | 296 × 32<br>(11.65 × 1.26)                | ←                          |
| Rear Brake                      | Type                                         | Solid Disc                                | Ventilated Disc            |
|                                 | Pad Area cm <sup>2</sup> (in. <sup>2</sup> ) | 21 (3.26)                                 | 33 (5.12)                  |
|                                 | Wheel Cylinder Dia. mm (in.)                 | 40.4 (1.59),<br>34.9 (1.38)* <sup>1</sup> | 40.4 (1.59)                |
|                                 | Rotor Size (D × T)* <sup>2</sup> mm (in.)    | 307 × 12<br>(12.09 × 0.47)                | 307 × 16<br>(12.09 × 0.63) |
| Brake Control Valve Type        |                                              | —                                         | P & B Valve                |
| Parking Brake                   | Type                                         | Duo-Servo                                 | ←                          |
|                                 | Size mm (in.)                                | 190 (7.48)                                | ←                          |
|                                 | Lever Type                                   | Pedal                                     | ←                          |
| ABS (Anti-Lock Brake System)    |                                              | STD* <sup>3</sup>                         | STD                        |
| TRC (Traction Control)          |                                              | STD* <sup>3</sup>                         | STD* <sup>4</sup>          |
| VSC (Vehicle Stability Control) |                                              | STD                                       | —                          |

\*1: Models for General Countries

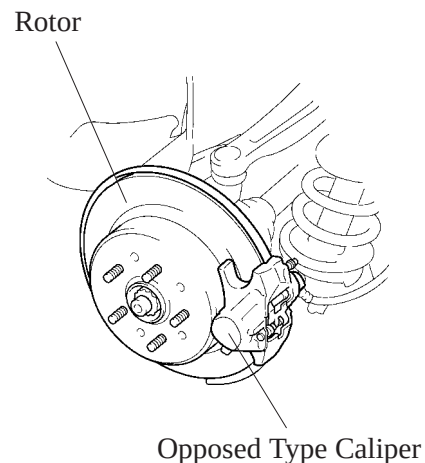
\*2: D: Outer Diameter, T: Thickness

\*3: Included in VSC system

\*4: LHD Model

## ■ REAR BRAKE

- A compact and lightweight opposed type caliper is used.
- A brake caliper, in which the brake pads can be replaced by removing the pad springs and pad pins, has been adopted for improved serviceability.

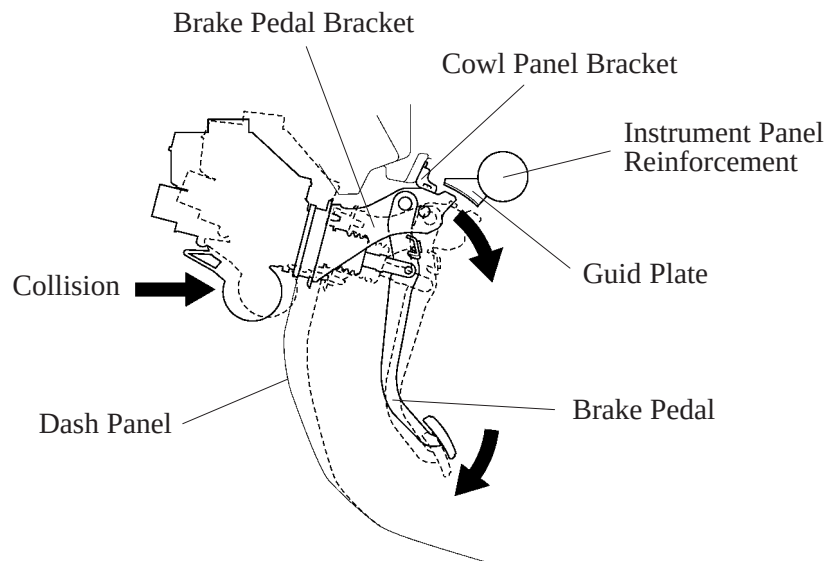


## ■ BRAKE PEDAL

A brake pedal retract prevention mechanism has been adopted to be able to secure the driver's footwell space during a collision.

The brake pedal retract prevention mechanism consists of a brake pedal bracket, a guide plate attached to the instrument panel reinforcement, a bracket attached to the cowl panel, etc.

If the dash panel deforms rearward in a collision, the brake pedal bracket detaches from the bracket of the cowl panel. Furthermore, the brake pedal bracket moves rearward and downward along the guide plate of the instrument panel reinforcement. Consequently, the step surface of the brake pedal moves forward and downward.

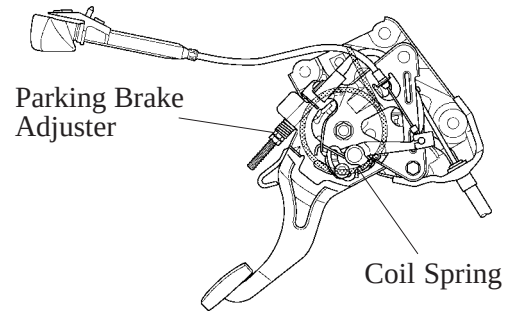


152CH31

## ■ PARKING BRAKE PEDAL

### 1. General

- The parking brake pedal's lock mechanism has been changed to a coil spring and drum friction type in place of the pawl and sector gear meshing type that was used on the previous model. Also, the pedal return absorber has been discontinued.
- The parking brake adjust mechanism has been re-located from under the floor to the parking brake pedal assembly to improve serviceability.



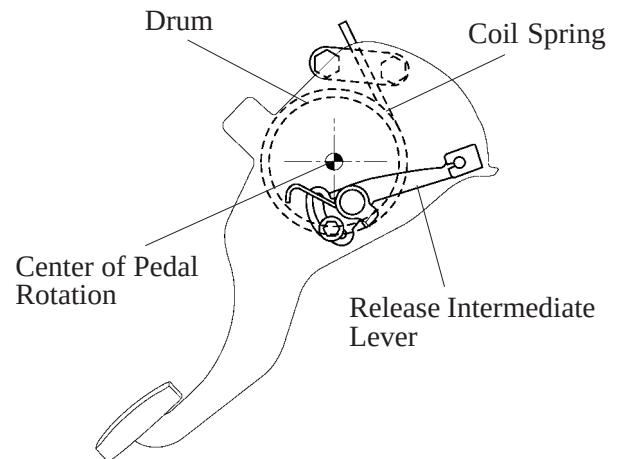
**LHD Model**

152CH18

### 2. Lock Mechanism

#### Construction

- The lock mechanism consists of a drum that is integrated with the pedal, a coil spring with one end fixed to the bracket, an intermediate release lever, etc.



152CH19

#### Operation

##### 1) During Applying

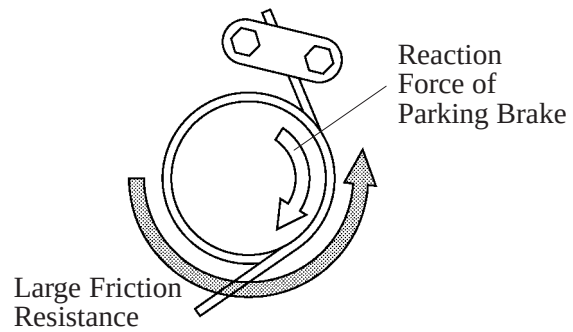
The contact between the drum and the coil spring is slight because the direction of the drum rotation is opposite to the direction in which the coil spring is wound. This allows the drum to rotate smoothly.



152CH20

## 2) Locked State

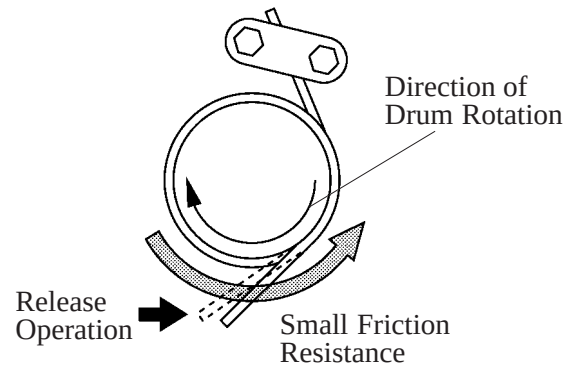
The reaction force of the parking brake applies a force to the drum in the releasing direction. Because that force has the same direction as the direction in which the coil spring is wound, it creates a tighter contact between the drum and the coil spring. As a result, a large friction resistance is generated between the drum and coil spring. This friction resistance causes the pedal to lock.



152CH21

## 3) During Releasing

When the release lever is operated to push and expand the free end of the coil spring, the contact between the drum and the coil spring loosens. Then, the friction resistance between the drum and the coil spring decreases, which releases the lock and allows the drum to rotate. At this time, the friction resistance between the drum and coil spring is not completely eliminated and restrains the pedal return speed (to create a dampening effect).



152CH22

### NOTICE

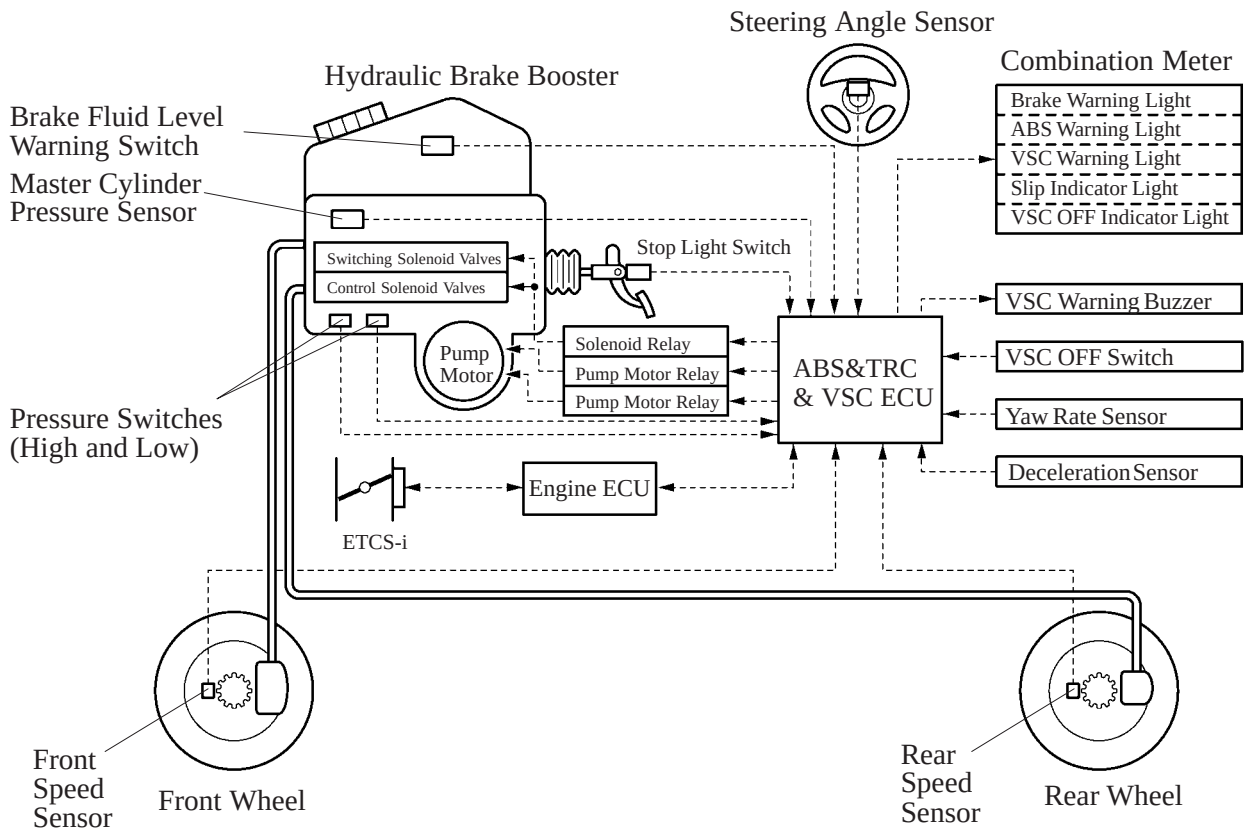
- Do not disassemble the portions other than the parking brake cable and the parking brake switch because the parking brake pedal assembly contains a precision-fitted mechanism.
- The parking pedal locks due to the friction resistance that is created by the drum and coil spring. As such, make sure that the drum and coil spring are not exposed to oil other than that which is provided.

## ■ VSC SYSTEM

### 1. General

- In addition to the ABS and TRC systems, the VSC system has been adopted on all models.
- The hydraulic brake booster is adopted on all models.
- The brake actuator (ABS, TRC and VSC) and the hydraulic brake boosters have been integrated to form a compact actuator.
- In case the vehicle's behavior becomes unstable during an emergency avoidance maneuver, the VSC system generates a yaw moment that applies a braking force to the appropriate wheel in order to stabilize the vehicle.
- The hydraulic brake booster uses the brake fluid that has been stored under high pressure to provide a power assist to the pedal effort that is applied to the brake pedal. Furthermore, the brake fluid that has been stored under high pressure is also used as the hydraulic pressure for controlling the ABS, TRC and VSC systems.

### 2. System Diagram

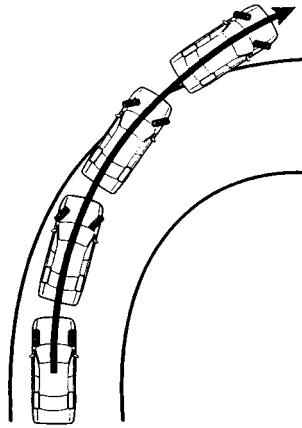


### 3. Outline of Control Performance

#### General

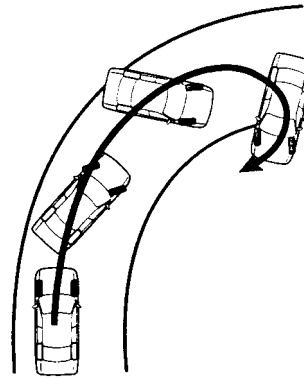
The followings are two examples that can be considered as circumstances in which the tires overcome their lateral grip limit.

- 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**

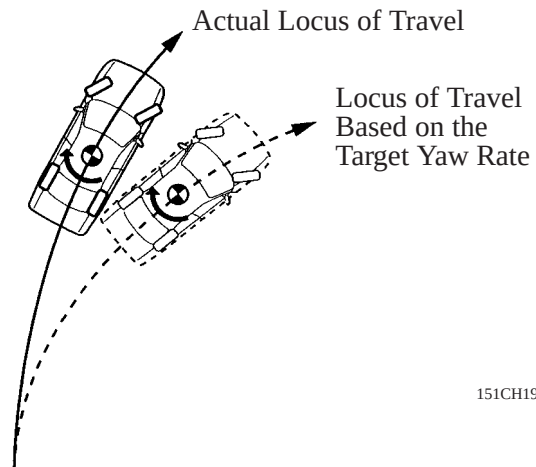
151CH16

#### 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 ABS & TRC & VSC ECU.

##### 1) Determining Understeer

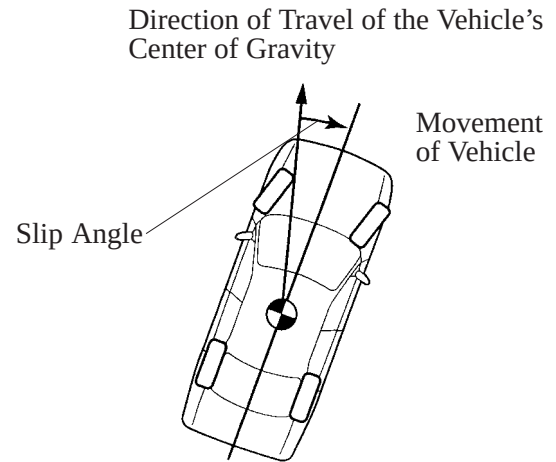
Whether or not the vehicle is in the state of understeer is determined by the difference between the target yaw rate and the vehicle's actual yaw rate. If the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) that should be rightfully generated when the driver operates the steering wheel, it means that the vehicle is making a smaller turn. Thus, the ECU determines that there is a large tendency to understeer.



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## 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.



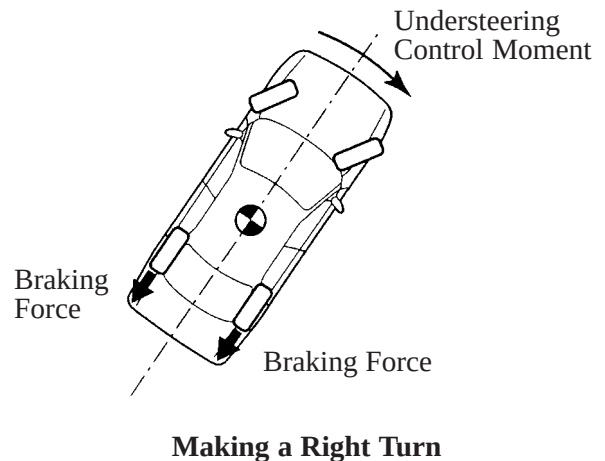
151CH18

## Method of VSC Operation

When the ABS & TRC & VSC ECU determines that the vehicle exhibits a strong 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, thus dampening the effects that are not desirable for the vehicle.

### 1) Dampening a Strong Understeer

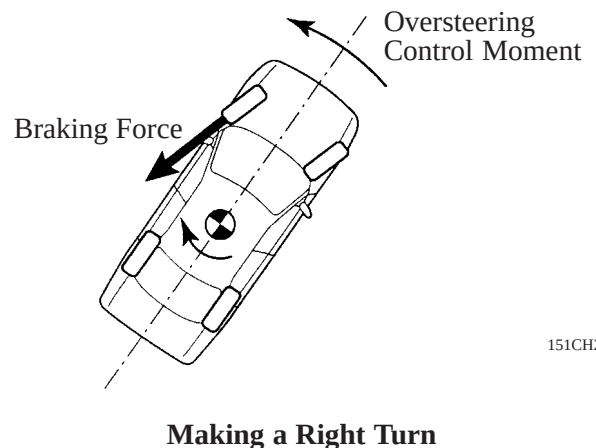
When the ABS & TRC & VSC ECU determines that the vehicle exhibits a strong tendency to understeer, depending on the extent of that tendency, it controls the engine output and applies the brakes of the rear wheels, thus providing the vehicle with an understeer control moment, which helps dampen its tendency to understeer.



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### 2) Dampening a Strong Oversteer

When the ABS & TRC & VSC 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 brake of the front wheel of the outside of the turn, thus generating an inertial moment in the vehicle's outward direction, which helps dampen its tendency to oversteer. Also, there are instances in which the brake is applied to the rear wheels.



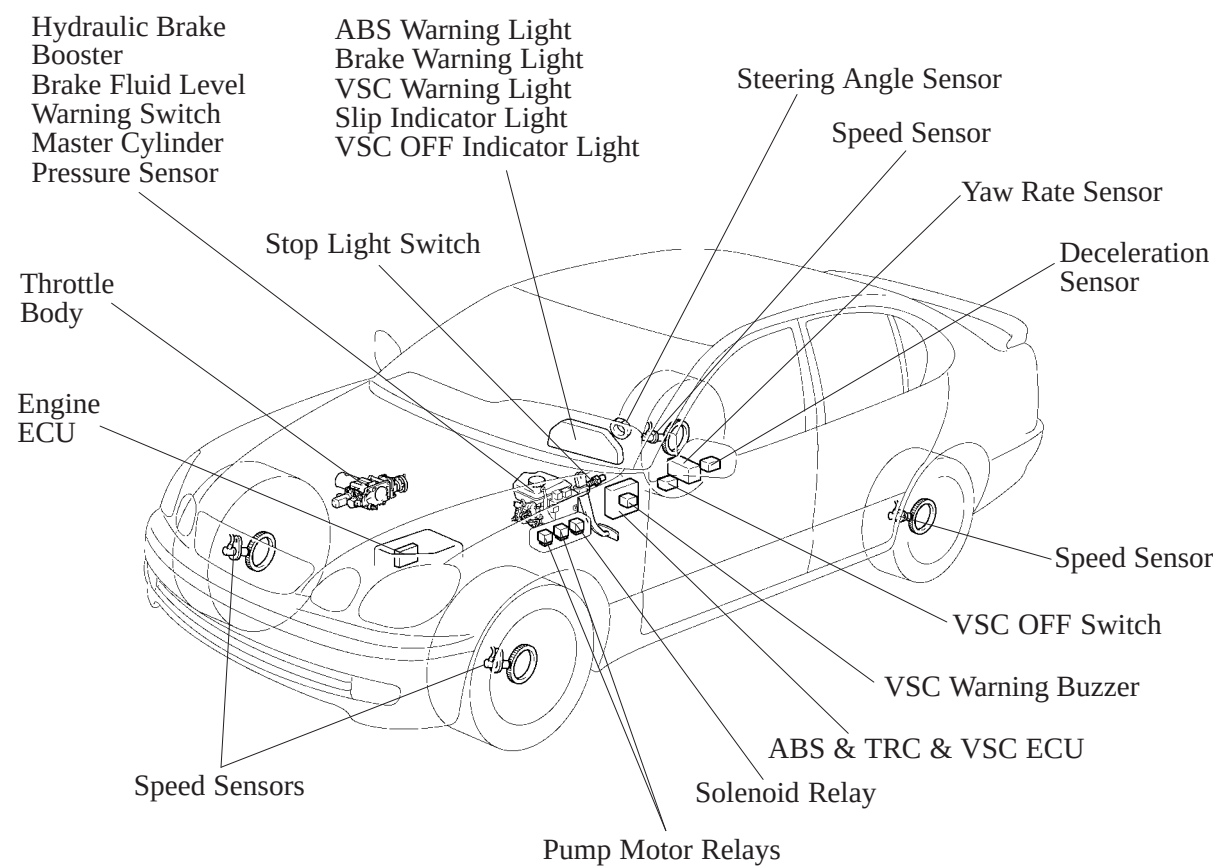
151CH20

System Cooperative Control

In order to bring the effectiveness of the VSC system control into full play, the methods for controlling other control systems are changed when the VSC is active.

| System                 | Description of Control                                                                                                                                                   |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Throttle Valve Control | Controls the throttle valve opening angle and the engine output so that the engine drive force and the braking force of the VSC system do not interfere with each other. |
| ABS Control            |                                                                                                                                                                          |
| TRC Control            |                                                                                                                                                                          |
|                        |                                                                                                                                                                          |

4. Layout of Components



LHD Model

## 5. Function of Components

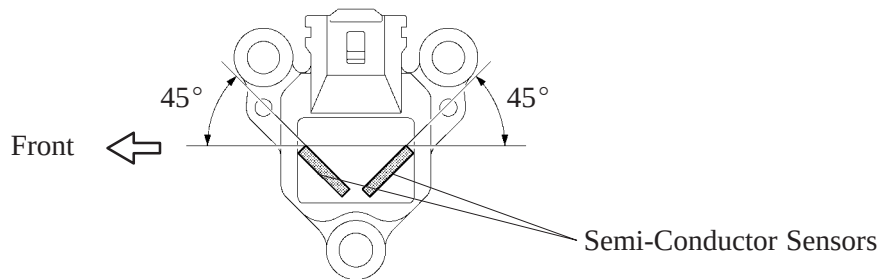
| Components                       | Function                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Speed Sensors                    | Detect the wheel speed of each of four wheels.                                                                                                                                                                                                                                                                                                   |
| Yaw Rate Sensor                  | Detects the vehicle's yaw rate.                                                                                                                                                                                                                                                                                                                  |
| Deceleration Sensor              | Detects the vehicle's acceleration in the longitudinal and lateral directions.                                                                                                                                                                                                                                                                   |
| Steering Angle Sensor            | Detects the steering direction and angle of the steering wheel.                                                                                                                                                                                                                                                                                  |
| ABS & TRC & VSC ECU              | Judges the vehicle driving condition based on signals from each sensor, and sends brake control signal to the hydraulic brake booster. Also, sends the throttle opening angle demand signal and other control signals to the engine ECU.                                                                                                         |
| Brake Fluid Level Warning Switch | Detects the brake fluid level.                                                                                                                                                                                                                                                                                                                   |
| Hydraulic Brake Booster          | <ul style="list-style-type: none"> <li>Assists with the pedal effort applied to the brake pedal.</li> <li>Changes the fluid path based on the signals from the ABS &amp; TRC &amp; VSC ECU during the operation of the ABS &amp; TRC &amp; VSC system, in order to control the fluid pressure that is applied to the wheel cylinders.</li> </ul> |
| Master Cylinder Pressure Sensor  | Assembled in the hydraulic brake booster and detects the master cylinder pressure.                                                                                                                                                                                                                                                               |
| Pump Motor Relays                | Control the pump motor operation in the hydraulic brake booster.                                                                                                                                                                                                                                                                                 |
| Solenoid Relay                   | Supply power to the solenoid valves in the hydraulic brake booster.                                                                                                                                                                                                                                                                              |
| ABS Warning Light                | Lights up to alert the driver when the ECU detects the malfunction in the ABS.                                                                                                                                                                                                                                                                   |
| VSC Warning Light                | Alert the driver when the ECU detects the malfunction in the TRC system and VSC system.                                                                                                                                                                                                                                                          |
| Slip Indicator Light             | Blinks to inform the driver when the TRC system or the VSC system, is operated.                                                                                                                                                                                                                                                                  |
| Brake Warning Light              | Lights up to alert the driver when the accumulator pressure is low.                                                                                                                                                                                                                                                                              |
| VSC Warning Buzzer               | <ul style="list-style-type: none"> <li>Emits an intermittent sound to inform the driver that the ECU detects a strong understeer or oversteer tendency.</li> <li>Emits a continuous sound to inform the driver that the ECU detects a malfunction in the hydraulic brake booster.</li> </ul>                                                     |
| Engine ECU                       | Controls the throttle valve opening angle based on the signals received from the ABS & TRC & VSC ECU, in order to control the engine output. Also, sends the throttle valve opening angle signal, accelerator pedal position signal, etc., to the ABS & TRC & VSC ECU.                                                                           |
| Throttle Body                    | Controls the throttle valve to control the engine output.                                                                                                                                                                                                                                                                                        |
| VSC OFF Switch                   | Turns the TRC and VSC system inoperative.                                                                                                                                                                                                                                                                                                        |
| VSC OFF Indicator Light          | Lights to inform the driver when the TRC and VSC system is turned OFF by the VSC OFF switch.                                                                                                                                                                                                                                                     |
| Stop Light Switch                | Detects the brake signal.                                                                                                                                                                                                                                                                                                                        |

## 6. Construction and Operation of Components

### Deceleration Sensor

Located behind the shift lever, the deceleration sensor detects the acceleration, and sends this signal to the ABS & TRC & VSC ECU. The deceleration sensor consists of 2 semi-conductor sensors. These semi-conductor sensors are opposed  $90^\circ$  to each other, and installed so that each has an angle of  $45^\circ$  in the longitudinal direction. Each semi-conductor sensor is provided with a weight which is moved by the deceleration force applied to the vehicle. The semi-conductor sensor itself converts the weight's movement into electronic signals, and outputs them to the ABS & TRC & VSC ECU.

These electronic signals have linear output characteristics; and the ABS & TRC & VSC ECU combines the signals received from both of these semi-conductor sensors to calculate the acceleration of all horizontal movements. This makes it possible to provide detailed each control in accordance with various road surface conditions.



151CH25

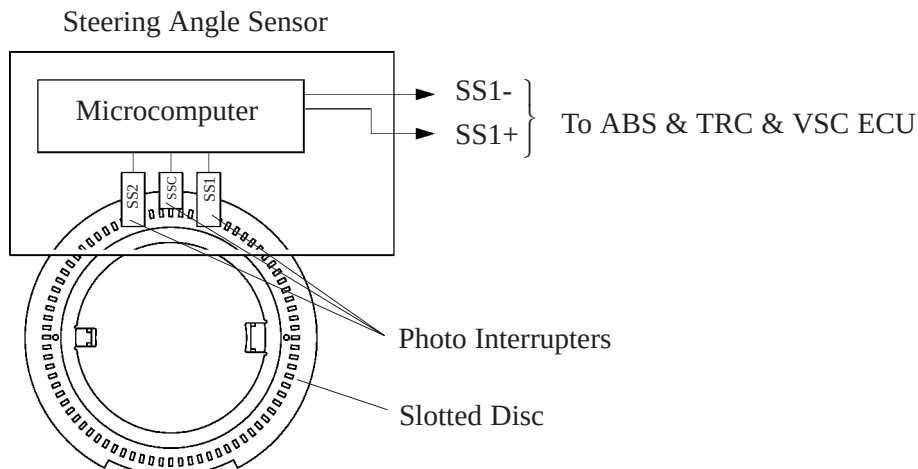
### Steering Angle Sensor

To accommodate the VSC, a high-precision steering angle sensor has been adopted.

The steering angle sensor consists of a microcomputer and three photo interrupters (SS1, SS2 and SSC). The slotted disc passes the dent of the photo interrupters.

The signals that are detected by the SS1 and SS2 photo interrupters are converted by the micro computer into serial signals that are output to the ABS & TRC & VSC ECU.

The SSC photo interrupters are used for detecting the neutral position of the steering wheel and for performing a self-check of the steering angle sensor.



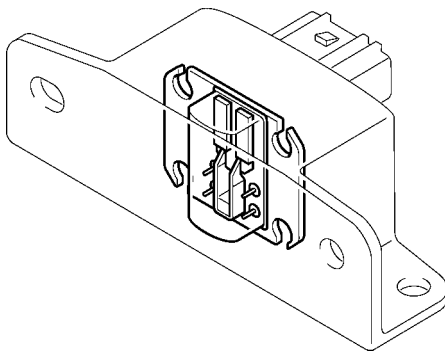
151CH24

## Yaw Rate Sensor

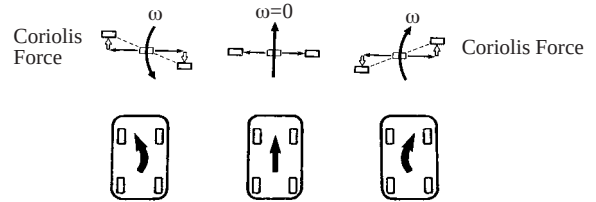
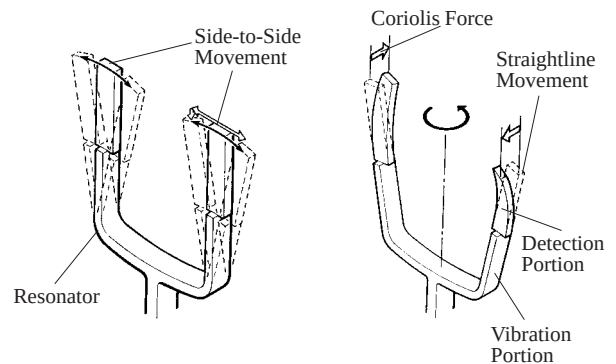
The yaw rate sensor is mounted behind the shift lever.

The yaw rate sensor uses a tuning-fork shaped vibration type rate gyro. Each resonator consists of a vibrating portion and a detecting portion that are shifted 90 degrees to form one unit. A piezoelectric ceramic piece is affixed to both the vibration and detection portions. The characteristic of the piezoelectric ceramic piece is to become distorted when voltage is applied to it, and to generate voltage when an external force is applied to distort the ceramic piece.

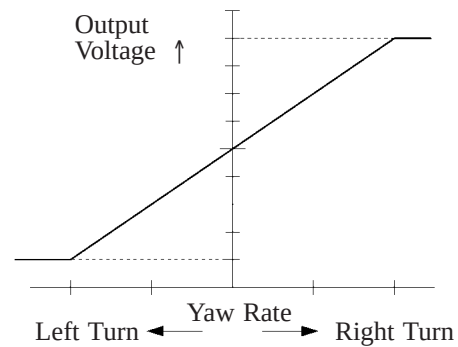
To detect the yaw rate, alternating current voltage is applied to the vibration portion, which causes it to vibrate. Then, the yaw rate is detected from the detection portion according to the amount and direction of distortion of the piezoelectric ceramic piece, which is caused by the coriolis force that is generated around the resonator.



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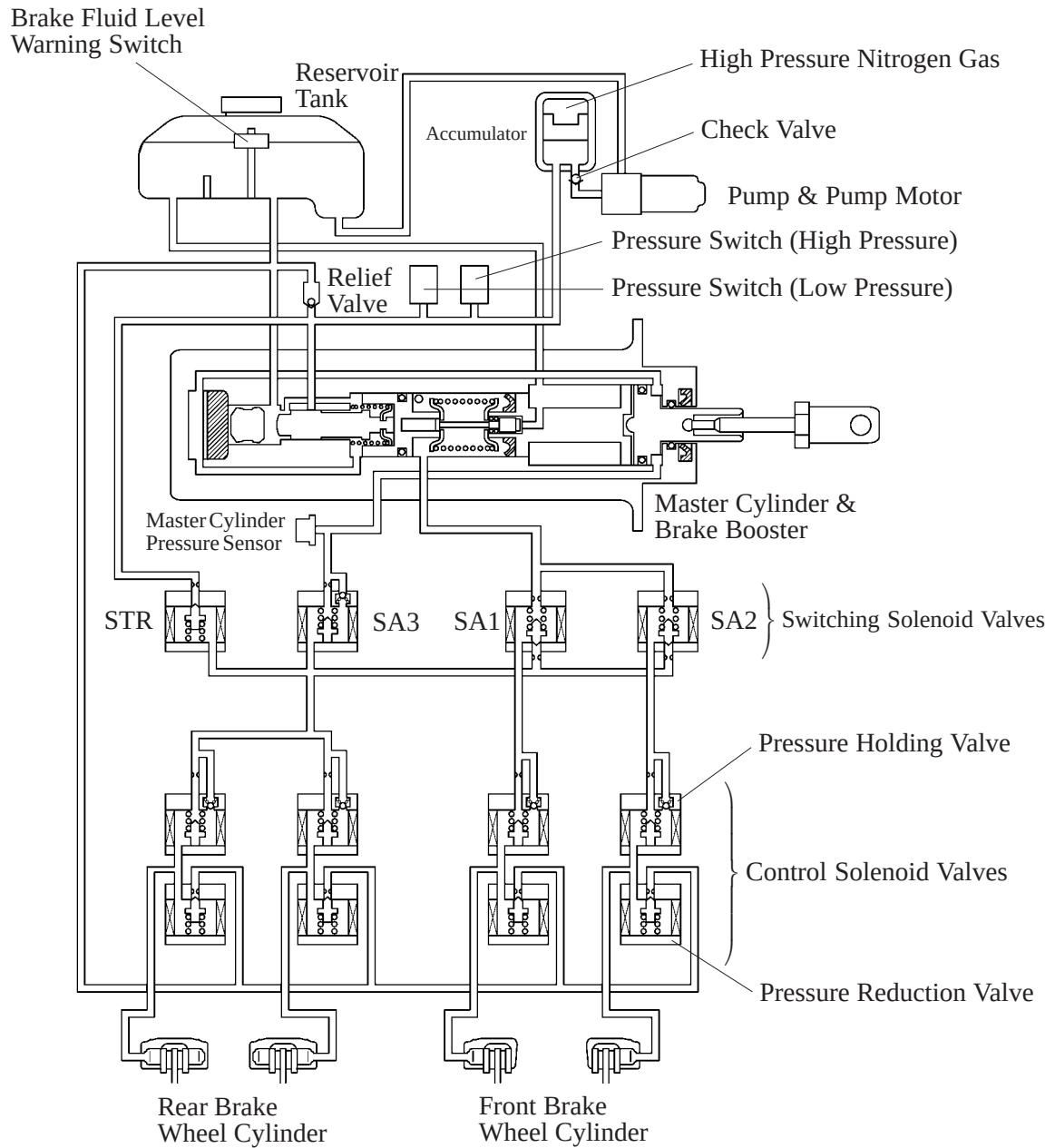


151CH49

## Hydraulic Brake Booster

The hydraulic brake booster consists of the following components:

| Components                                                                           | Function                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                                                              |
| Pressure Switches                                                                    | Monitors the hydraulic pressure of the accumulator and outputs control signals for the pump motor.<br>There are two types: the pressure switch PH for controlling the pump, and the pressure switch PL for giving a warning when the pressure is low. |
| 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.                                                                                            |
| Reservoir Tank                                                                       | Stores the brake fluid.                                                                                                                                                                                                                               |
| Brake Fluid Level Warning Switch                                                     | Detects the brake fluid level.                                                                                                                                                                                                                        |
| Master Cylinder                                                                      | Generates the hydraulic pressure that is provided to the wheel cylinders during normal braking.                                                                                                                                                       |
| Brake Booster                                                                        | Regulates the accumulator pressure in accordance with the pedal effort that is applied to the brake pedal and introduces this pressure to the booster chamber in order to provide a power assist to the brakes.                                       |
| Master Cylinder Pressure Sensor                                                      | Detects the hydraulic pressure that is generated in accordance with the pedal effort applied to the brake pedal and outputs the signals to the ABS & TRC & VSC ECU.                                                                                   |
| Switching Solenoid Valves (SA1, SA2, SA3, STR)                                       | Switches the brake hydraulic path when the ABS, TRC or VSC is activated, or normal braking is applied.                                                                                                                                                |
| Control Solenoid Valves<br>(Pressure Holding Valves<br>Pressure Reduction<br>Valves) | Controls the hydraulic pressure that is applied to the wheel cylinders during ABS, TRC and VSC control.                                                                                                                                               |



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152CH15

Hydraulic Circuit

1) Pump, Pump Motor, Accumulator, Pressure Switches and Relief Valve

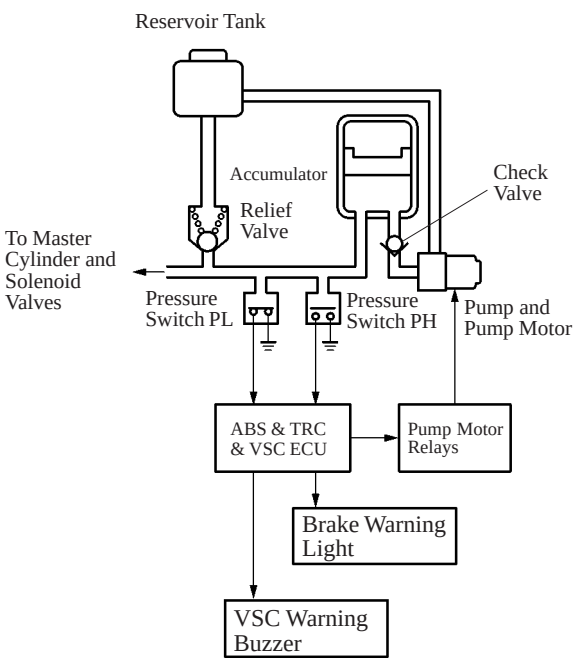
If the accumulator pressure becomes lower than the pressure that is specified in the pressure switch PH, which is used for detecting high pressure, the pressure switch PH turns OFF. Then, the ABS & TRC & VSC ECU turns ON the pump motor relays to operate the pump motor and the pump. The brake fluid that 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 ABS, TRC and VSC systems.

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 ABS & TRC & VSC ECU turns OFF the pump.

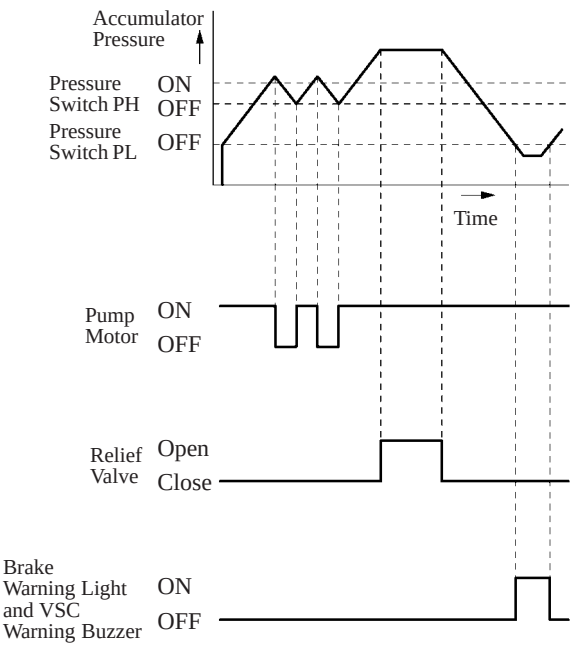
At this time, if the pressure switch PH malfunctions and causes the pump to operate continuously, the relief valve opens to prevent excessive pressure from being generated.

Moreover, 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 ABS, TRC and VSC systems are prohibited from operating.



152CH16



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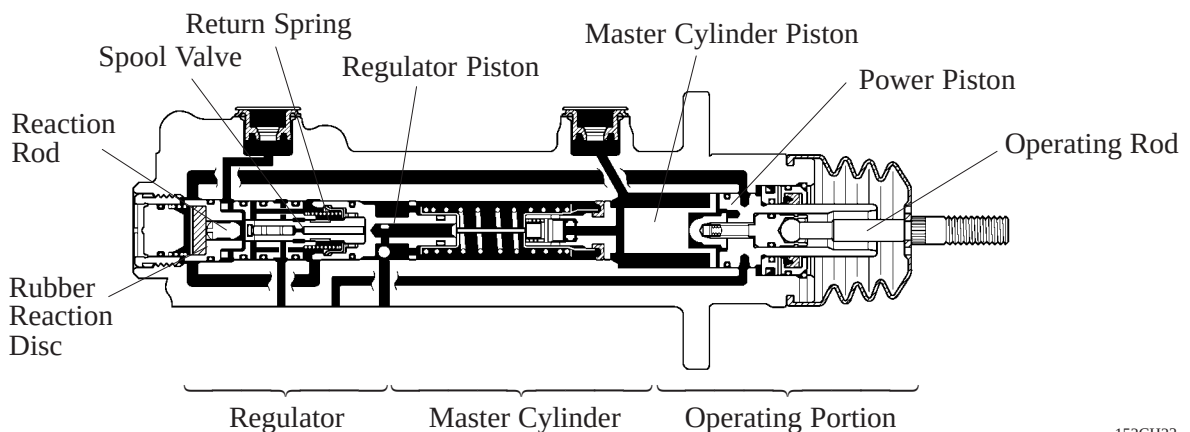
## 2) Master Cylinder and Brake Booster

### a. Construction

- This construction enables the hydraulic pressure that is generated by the brake booster to be applied directly to the rear brakes.
- The master cylinder is the center port type single master cylinder, which is used for the front brakes only.
- The brake booster is integrated with the master cylinder. The operating portion, master cylinder, and regulator are positioned coaxially to achieve a simple and compact construction.
- The master cylinder and brake booster consists of an operating rod, a power piston, a master cylinder piston, a regulator piston, a spool valve, a reaction rod and a rubber reaction disc.
- The operating rod and the power piston are linked directly to transmit the pedal effort that is applied to the brake pedal.
- The regulator piston and the spool valve are linked directly. A forward (leftward) force generated by the master cylinder pressure and a rearward (rightward) force generated by the power assist of the booster are applied to the regulator piston. Both forces maintain a balance.
- A return spring is provided for the regulator piston to ensure the return of the spool valve in case there is no pressure.

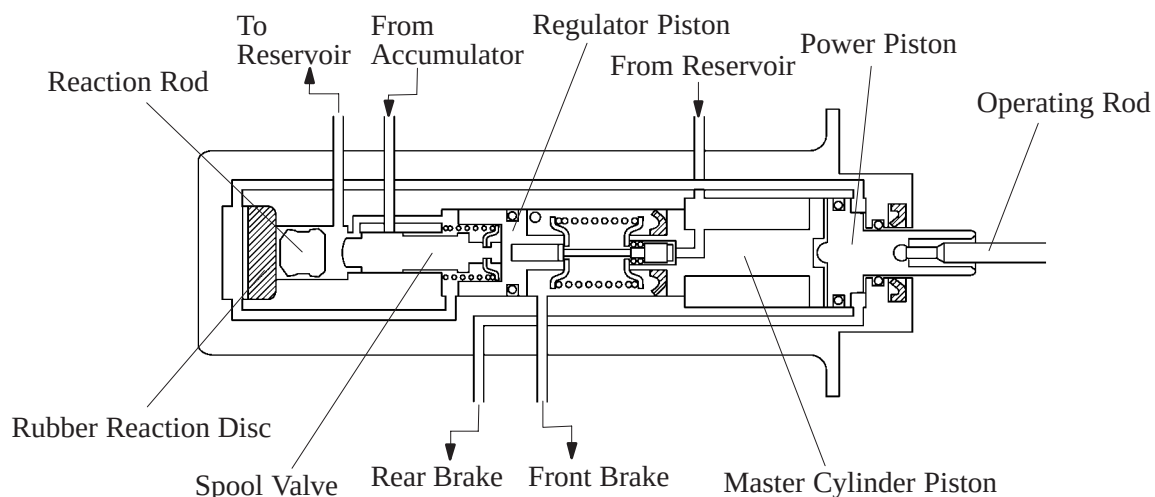
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### ► Cross-Sectional Drawing ◀



152CH23

### ► Simplified Drawing ◀

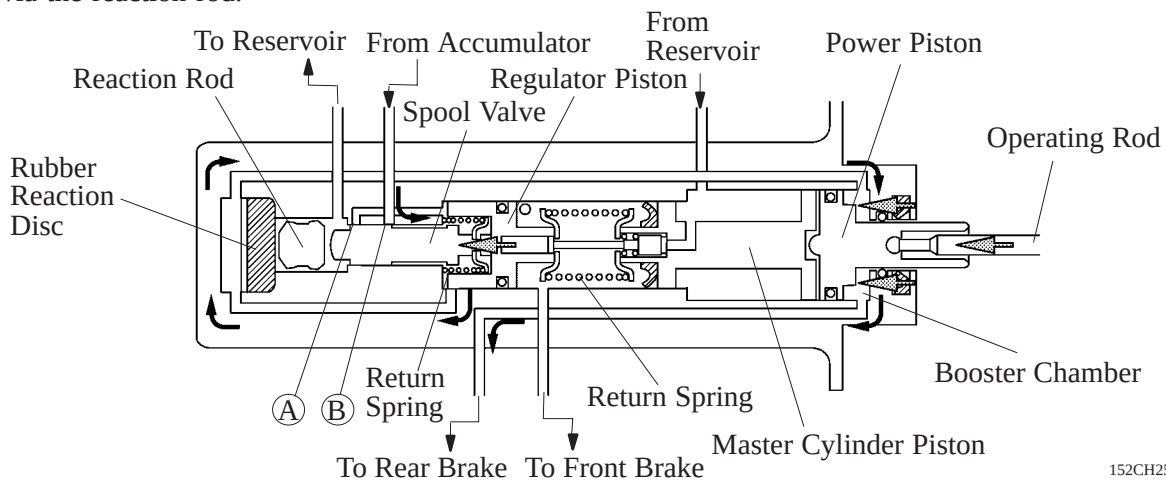


152CH24

## b. Operation

### i) Pressure Increase (Low Pressure)

The pedal effort that is applied to the brake pedal is transmitted via the operating rod, power piston, and master cylinder piston. However, because the load setting of the master cylinder's return spring is lower than that of the regulator piston's return spring, the regulator piston gets pushed before the volume in the master cylinder becomes compressed. As a result, the spool valve moves forward. The spool valve closes the path (A) between the reservoir and the booster chamber (behind the power piston) and opens the path (B) between the accumulator and the booster chamber. Then, the pressurized brake fluid is introduced into the booster chamber to provide a power assist to the pedal effort. When the pressure is introduced into the booster chamber, 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 increases 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. 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.

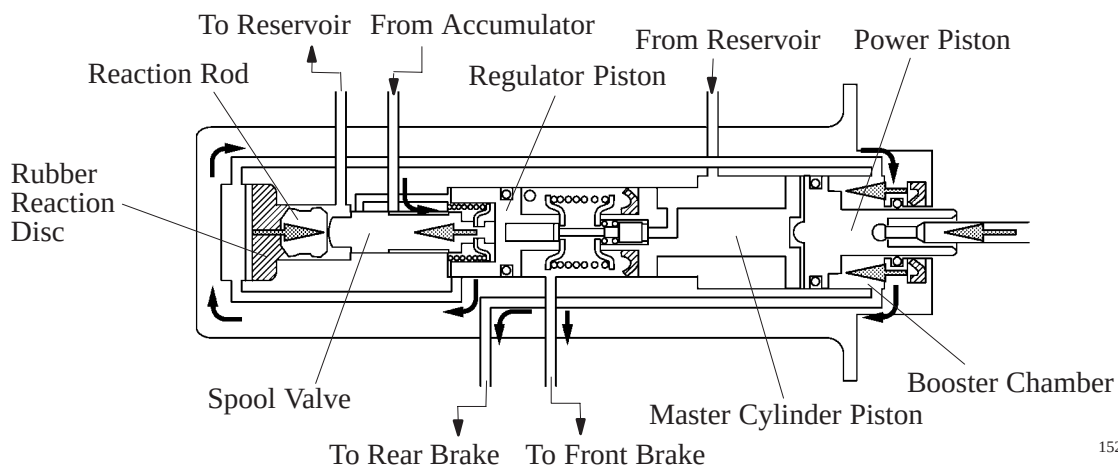


152CH25

### 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.

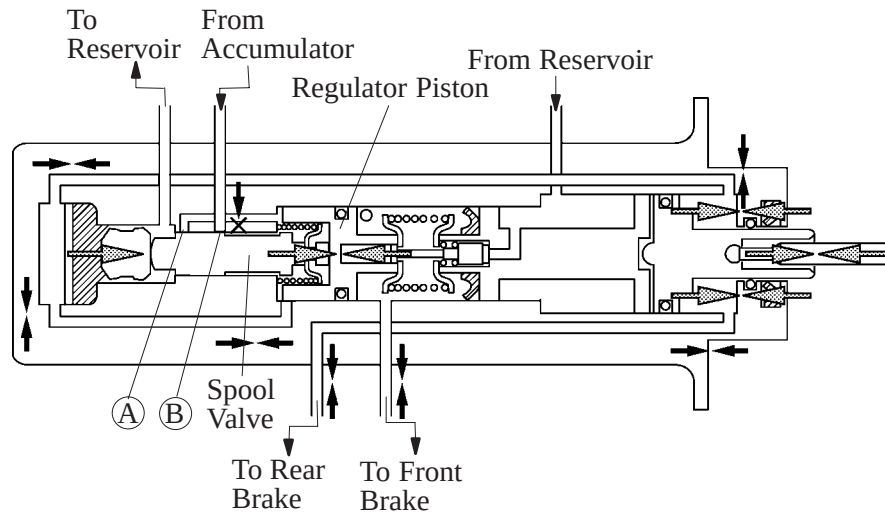


152CH26

### 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 path (B) from the booster chamber to the accumulator and path (A) to the reservoir. As a result, the brake system is in the holding state.



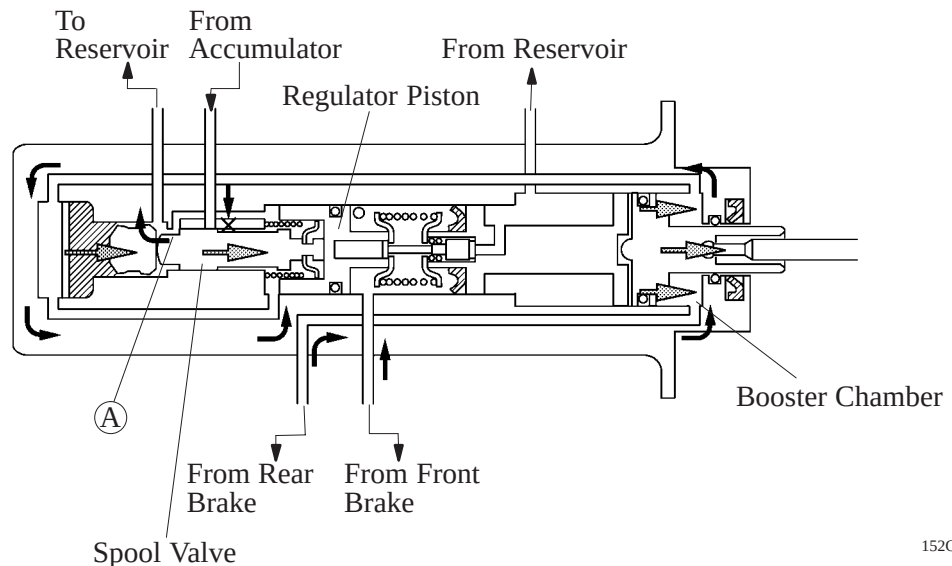
152CH27

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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 path (A) between the reservoir 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.

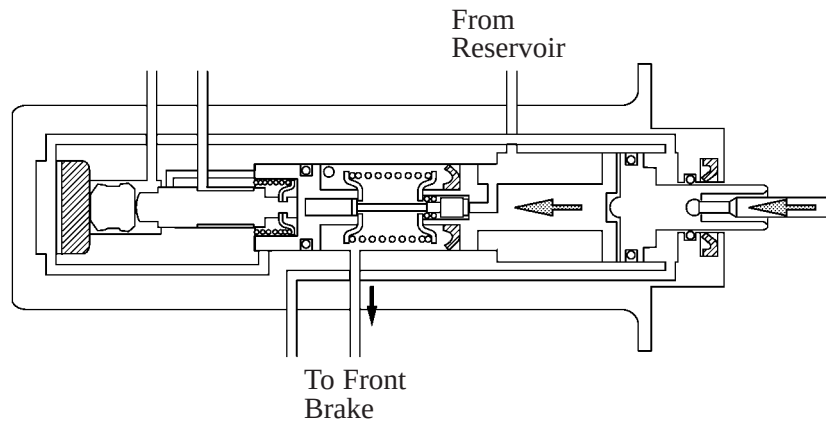


152CH28

### v) During Power Supply Malfunction

If the accumulator pressure is affected due to some type of malfunction, no pressure will be supplied by the regulator. Then, 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.

The pressure to the front brakes will be increased by the master cylinder in accordance with the pedal effort applied to the brake pedal.



152CH29

## 3) Solenoid Valves

### a. Switching Solenoid Valves

Four switching solenoid valves (SA1, SA2, SA3, and STR) are provided.

The control signals from the ABS & TRC & VSC ECU open and close the switching solenoid valves to switch the brake fluid paths.

The solenoid valves SA1 and SA2 switch during normal braking of the front brakes and during the activation of the ABS and VSC. During normal braking, the path to the master cylinder side is opened, and the path to the hydraulic pressure supply side is opened during the activation of the ABS and VSC. The solenoid valve SA3 is switched during normal braking of the rear brakes, during the activation of the ABS, and during the activation of the TRC and VSC. The path to the booster side is opened during normal braking and during the activation of the ABS, and the path is closed during the activation of the TRC and VSC.

The solenoid valve STR opens the path to the accumulator side during the activation of the TRC and VSC.

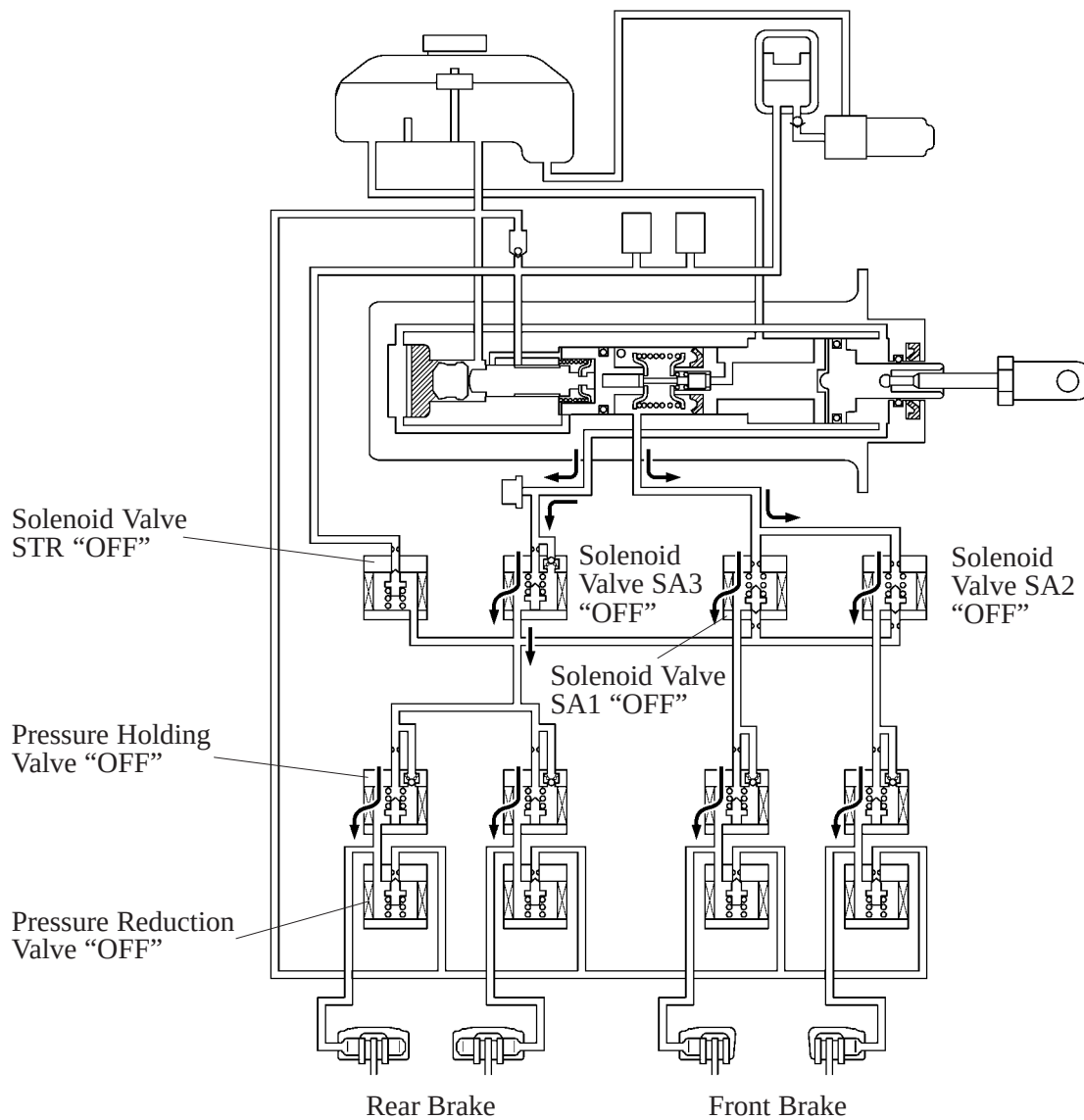
### b. Control Solenoid Valves

The control solenoid valve consists of 4 pressure holding valves and 4 pressure reduction valves.

Each of the brake circuits consists of a pressure holding valve and a pressure reduction valve. The valves are turned ON and OFF during the activation of the ABS, TRC, and VSC. 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.

**c. System Operation****i) Normal Braking**

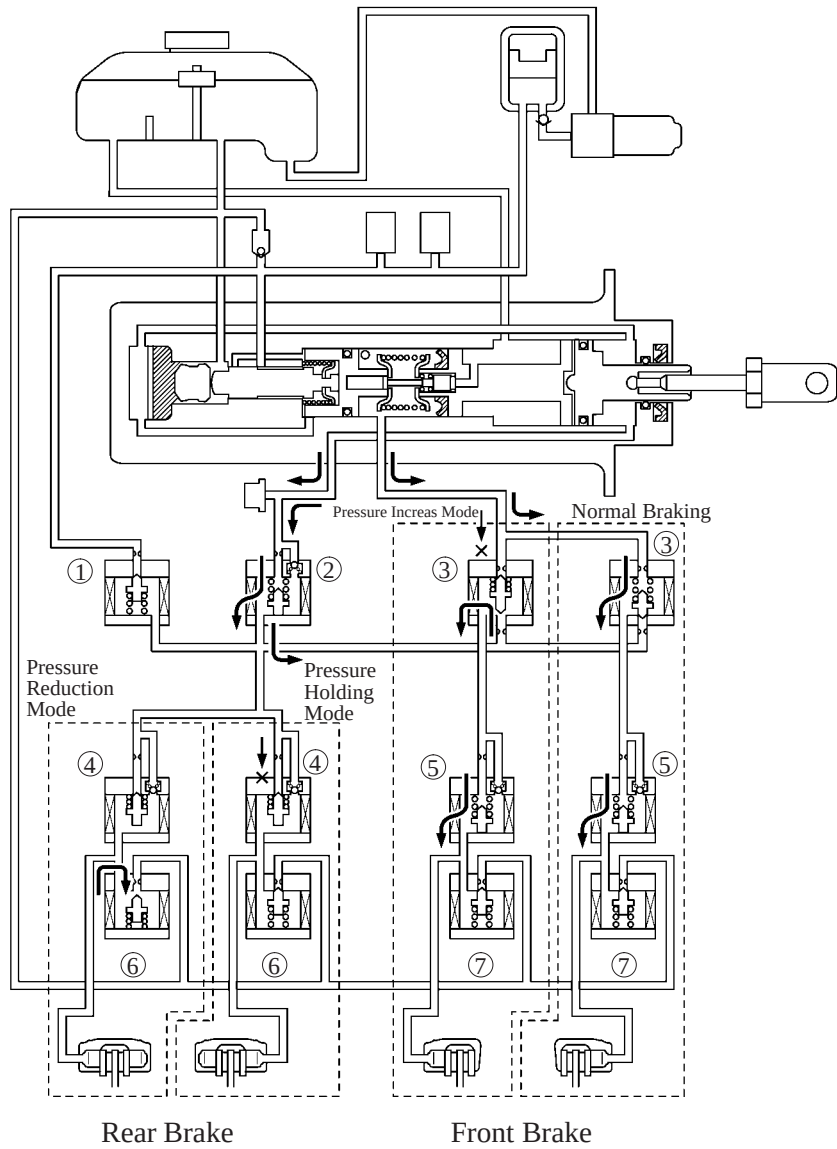
During normal braking, all solenoid valves are turned OFF.



ii) ABS Operation

The solenoid valves are turned ON and OFF as described below to switch the fluid paths in order to control the brakes.

At this time, the hydraulic path between the master cylinder and the front brakes is shut off to prevent the brake pedal from vibrating and to improve the feeling during brake application.

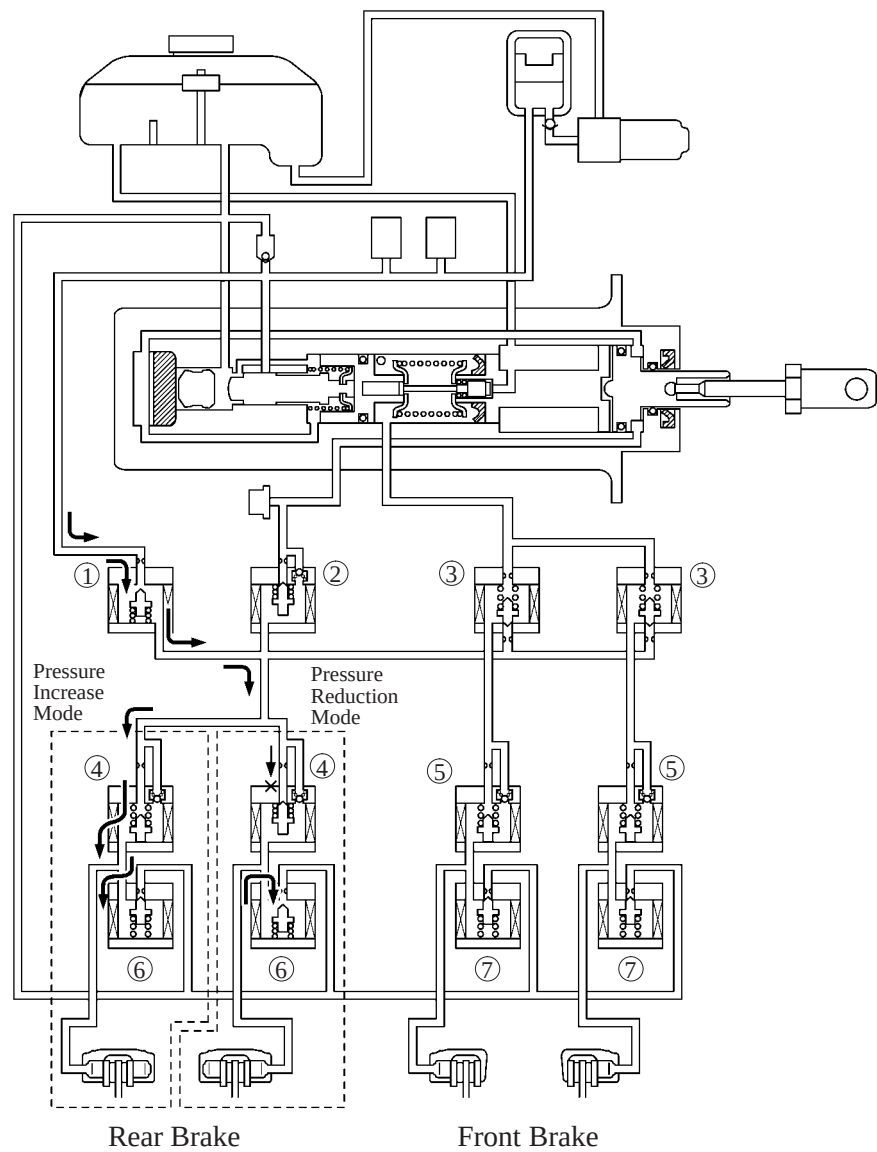


152CH33

| Mode<br><br>Solenoid Valves |                               | Normal<br>Braking | ABS Activated             |                          |                            |
|-----------------------------|-------------------------------|-------------------|---------------------------|--------------------------|----------------------------|
|                             |                               |                   | Pressure<br>Increase Mode | Pressure<br>Holding Mode | Pressure<br>Reduction Mode |
| ① Solenoid Valve STR        |                               | OFF               | OFF                       | OFF                      | OFF                        |
| Front<br>Brake              | ③ Solenoid Valves SA1 and SA2 | OFF               | ON                        | ON                       | ON                         |
|                             | ⑤ Pressure Holding Valve      | OFF               | OFF                       | ON                       | ON                         |
|                             | ⑦ Pressure Reduction Valve    | OFF               | OFF                       | OFF                      | ON                         |
|                             | Wheel Cylinder Pressure       | Increase          | Increase                  | Hold                     | Reduction                  |
| Rear<br>Brake               | ② Solenoid Valve SA3          | OFF               | OFF                       | OFF                      | OFF                        |
|                             | ④ Pressure Holding Valve      | OFF               | OFF                       | ON                       | ON                         |
|                             | ⑥ Pressure Reduction Valve    | OFF               | OFF                       | OFF                      | ON                         |
|                             | Wheel Cylinder Pressure       | Increase          | Increase                  | Hold                     | Reduction                  |

iii) TRC Operation

The TRC system control consists of an engine output control and a brake hydraulic control. As described below, this system turns the solenoid valves ON and OFF to switch the fluid paths in order to control the rear brakes.



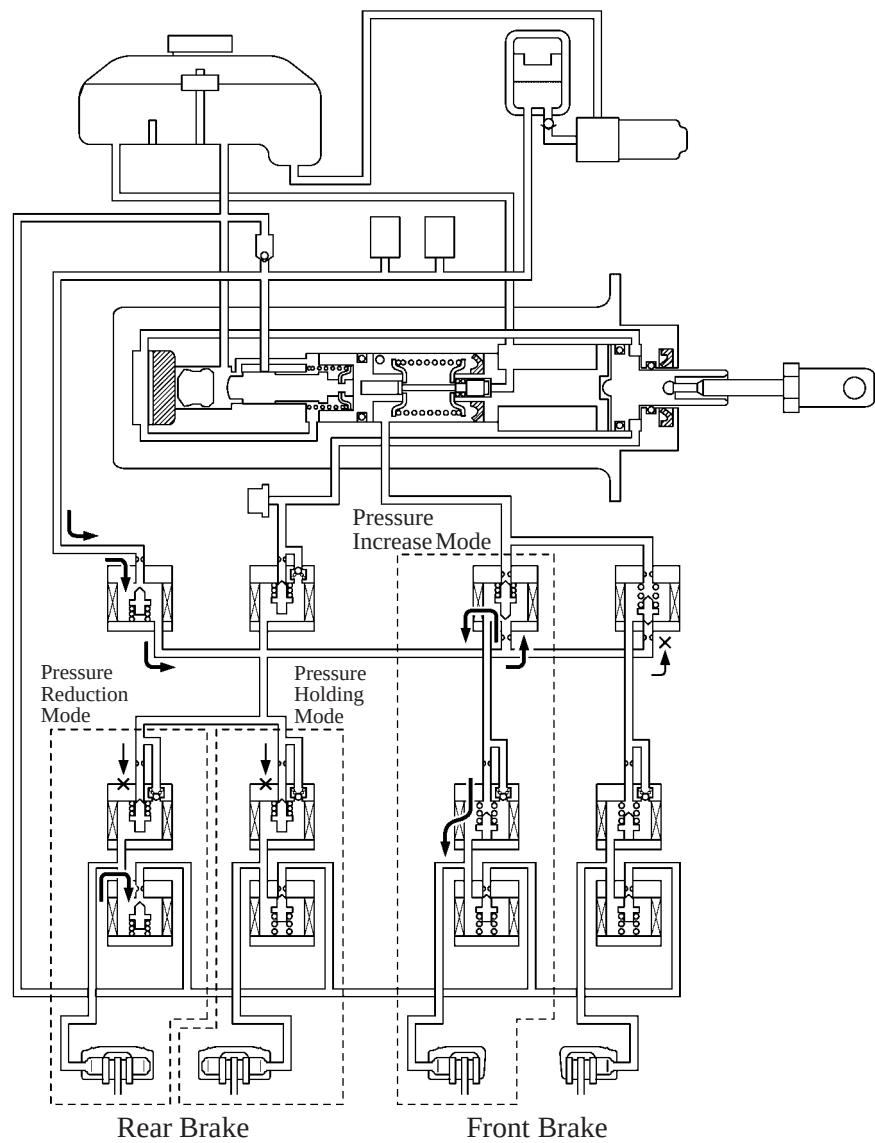
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152CH34

| Mode<br><br>Solenoid Valves |                               | TRC Not<br>Activated | TRC Activated             |                          |                            |
|-----------------------------|-------------------------------|----------------------|---------------------------|--------------------------|----------------------------|
|                             |                               |                      | Pressure<br>Increase Mode | Pressure<br>Holding Mode | Pressure<br>Reduction Mode |
|                             | ① Solenoid Valve STR          | OFF                  | ON                        | ON                       | ON                         |
| Front<br>Brake              | ③ Solenoid Valves SA1 and SA2 | OFF                  | OFF                       | OFF                      | OFF                        |
|                             | ⑤ Pressure Holding Valve      | OFF                  | OFF                       | OFF                      | OFF                        |
|                             | ⑦ Pressure Reduction Valve    | OFF                  | OFF                       | OFF                      | OFF                        |
|                             | Wheel Cylinder Pressure       | —                    | —                         | —                        | —                          |
|                             |                               |                      |                           |                          |                            |
| Rear<br>Brake               | ② Solenoid Valve SA3          | OFF                  | ON                        | ON                       | ON                         |
|                             | ④ Pressure Holding Valve      | OFF                  | OFF                       | ON                       | ON                         |
|                             | ⑥ Pressure Reduction Valve    | OFF                  | OFF                       | OFF                      | ON                         |
|                             | Wheel Cylinder Pressure       | —                    | Increase                  | Hold                     | Reduction                  |

iv) VSC Operation

- The VSC system control consists of an engine output control and a brake hydraulic control.
- When the system activates to restrain oversteer, it controls the front brake of the outer wheel in the turn. It also regulates the rear brakes as needed.
- When the system activates to restrain understeer, it controls the rear brakes.



152CH35

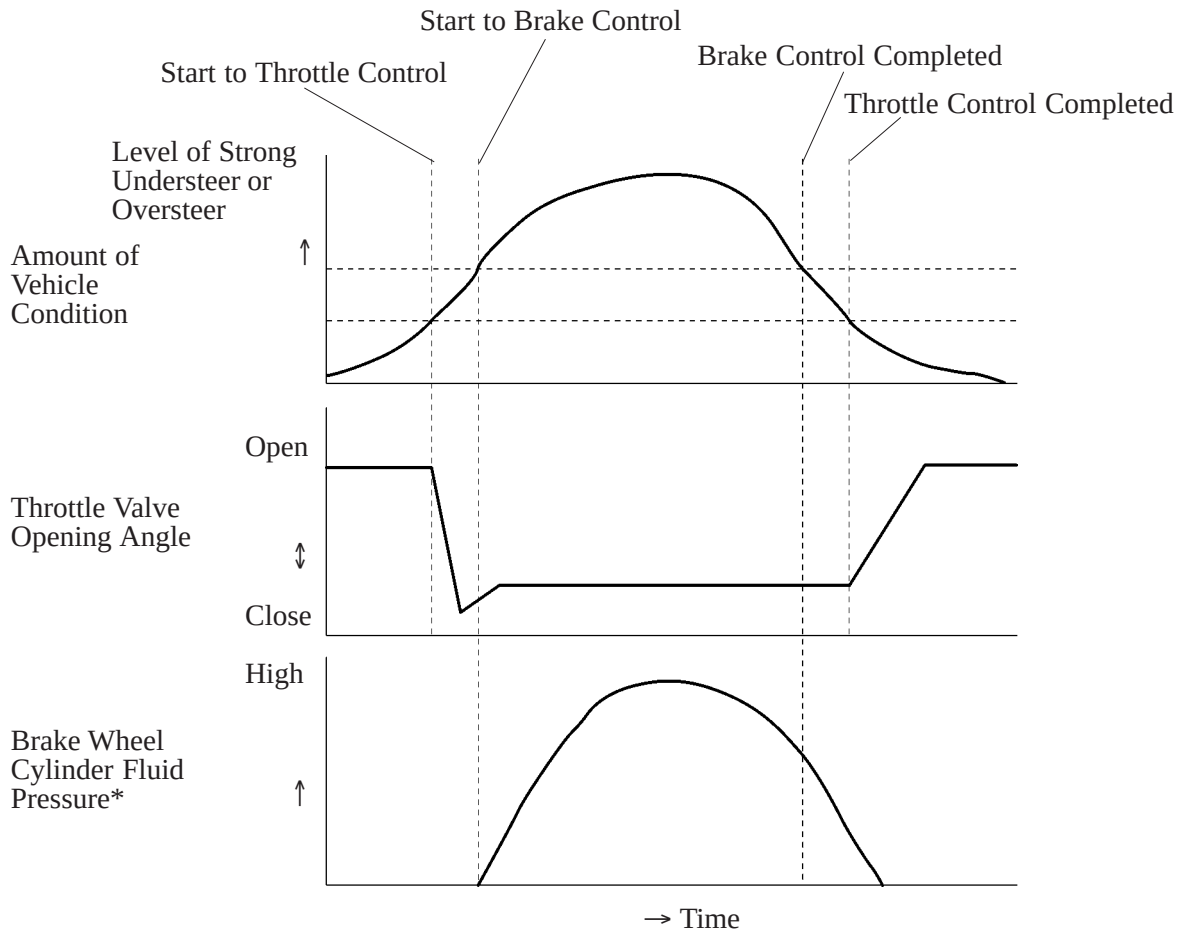
| Mode<br><br>Solenoid Valves |                               | VSC Not<br>Activated | VSC Activated             |                          |                            |
|-----------------------------|-------------------------------|----------------------|---------------------------|--------------------------|----------------------------|
|                             |                               |                      | Pressure<br>Increase Mode | Pressure<br>Holding Mode | Pressure<br>Reduction Mode |
| ① Solenoid Valve STR        |                               | OFF                  | ON                        | ON                       | ON                         |
| Front<br>Brake              | ③ Solenoid Valves SA1 and SA2 | OFF                  | ON                        | ON                       | ON                         |
|                             | ⑤ Pressure Holding Valve      | OFF                  | OFF                       | ON                       | ON                         |
|                             | ⑦ Pressure Reduction Valve    | OFF                  | OFF                       | OFF                      | ON                         |
|                             | Wheel Cylinder Pressure       | —                    | Increase                  | Hold                     | Reduction                  |
|                             |                               |                      |                           |                          |                            |
| Rear<br>Brake               | ② Solenoid Valve SA3          | OFF                  | ON                        | ON                       | ON                         |
|                             | ④ Pressure Holding Valve      | OFF                  | OFF                       | ON                       | ON                         |
|                             | ⑥ Pressure Reduction Valve    | OFF                  | OFF                       | OFF                      | ON                         |
|                             | Wheel Cylinder Pressure       | —                    | Increase                  | Hold                     | Reduction                  |

## ABS & TRC & VSC ECU

### 1) Vehicle Stability Control

Based on the 4 types of sensor signals received from the speed sensors, yaw rate sensor, deceleration sensor, and steering angle sensor, the ABS & TRC & VSC ECU calculates the amount of vehicle condition.

If a strong understeer or oversteer tendency is created during an emergency avoidance maneuver or cornering, and the ABS & TRC & VSC ECU determines that the amount of vehicle condition exceeds a prescribed value, it controls the throttle valve opening angle and the brake fluid pressure according to the amount of the vehicle condition.



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

## **2) Initial Check**

After the ignition is turned ON and only at the initial time, ABS & TRC & VSC ECU performs an initial check when the vehicle attains an approximate speed of 6 km/h (4 mph) and more or when the stop light switch is turned OFF from ON.

The functions of each solenoid valve in the hydraulic brake booster are checked in order.

## **3) Self-Diagnosis**

If the ABS & TRC & VSC ECU detects a malfunction in the hydraulic brake booster, ABS, TRC and/or VSC system, it turns on the ABS warning light and the VSC warning light to alert the driver the malfunction. The ECU will also store the codes of the malfunctions. The diagnostic code can be accessed from the ABS warning light and the VSC warning light. A hand-held tester can be used to access the diagnostic code and to perform an active test. See the GS300 Repair Manual (Pub. No. RM588E) for the diagnostic code check method, diagnostic code and diagnostic code clearance.

## **4) Fail Safe**

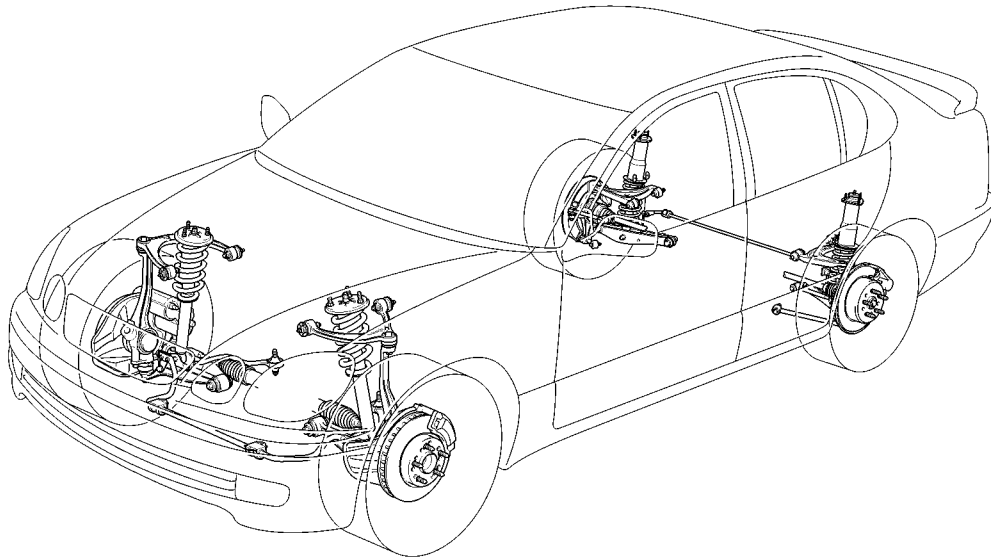
In the event of a malfunction in the ABS, TRC or VSC system, the ABS & TRC & VSC ECU prohibits the ABS, TRC and VSC system.

Thus, the brake and throttle valve opening angle control will be operated in the same conditions as those without the ABS, TRC and VSC system.

## SUSPENSION

### DESCRIPTION

- The double-wishbone type independent suspension is used for the front as in the previous model.
- A double-wishbone type independent suspension, in which coil springs are located underneath, has been adopted for the rear.



CH

150CH10

### ► Specifications ◀

| Suspension<br>Item    |          | Front        | Rear         |
|-----------------------|----------|--------------|--------------|
| Tread                 | mm (in.) | 1535 (60.43) | 1510 (59.45) |
| Caster*               | degrees  | 7°28'        | —            |
| Camber*               | degrees  | −0°18'       | −0°30'       |
| Toe-In*               | mm (in.) | 1.5 (0.06)   | 0.5 (0.02)   |
| King Pin Inclination* | degrees  | 8°54'        | —            |

\*: Unloaded Vehicle Condition

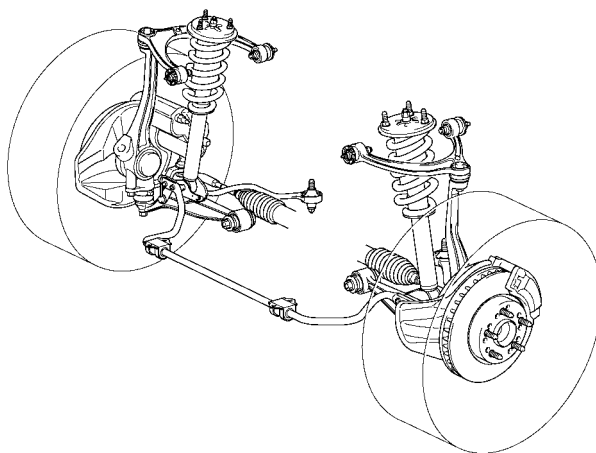
## ■ FRONT SUSPENSION

### 1. General

A double-wishbone type independent suspension with high-mount upper arm has been adopted as in the previous model. The basic construction and operation are the same as those of the previous model.

However, to match optimally with the newly designed rear suspension, the location of the suspension arms has been revised, thus achieving an optimal suspension geometry.

In addition, shock absorbers in which a rebound spring is enclosed have been adopted.



152CH11

### 2. Geometry

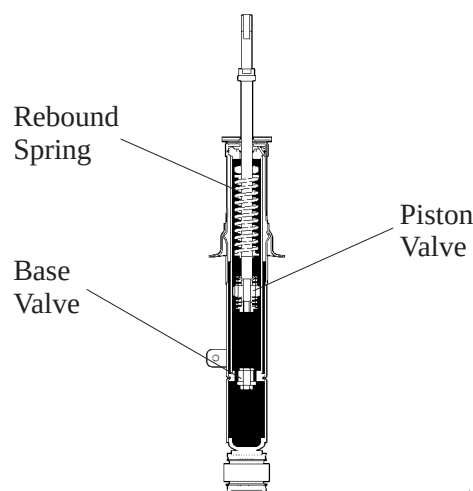
- The suspension arms have been optimally located and the roll center height has been finely tuned to minimize the vertical fluctuation of the vehicle's center-of-gravity height during cornering. As a result, excellent riding comfort and stability have been realized.
- The steering gear and tie rods have been optimally located so that the toe angle changes in the toe-out direction during braking. As a result, excellent stability has been achieved, even in instances in which the brakes are applied suddenly during cornering.

### 3. Shock Absorber

A rebound spring that operates in the entire rebound stroke range is provided in the shock absorber.

This feature helps to restrain the body lift on the inner wheel side of the turn.

As a result, excellent riding comfort and stability are realized.



152CH41

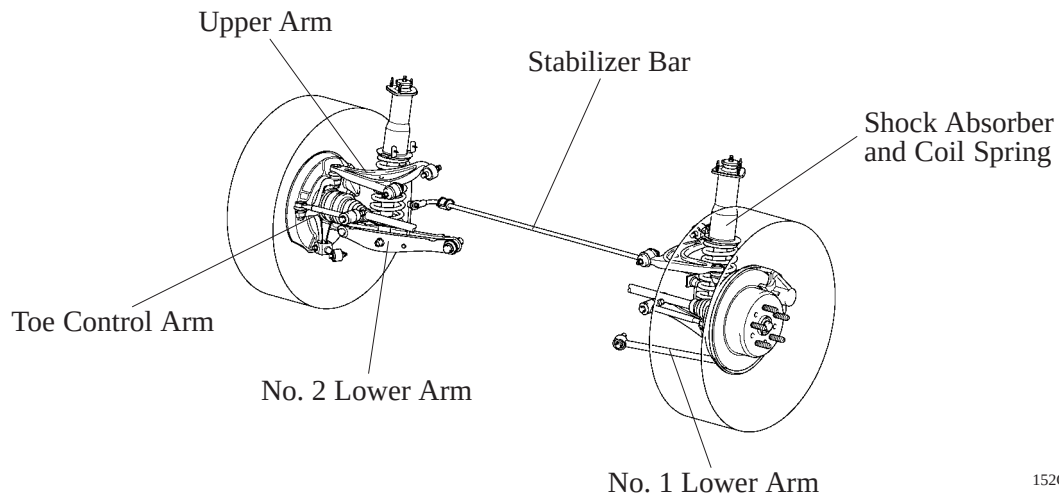
## ■ REAR SUSPENSION

### 1. General

A double-wishbone type independent suspension has been adopted. It consists of coil springs that are located underneath, A-shaped upper arms, 2 non-parallel lower arms that are unequal in length, and toe control arms that determine the toe angle.

A larger luggage compartment has been achieved by locating the coil springs underneath.

By optimizing the location of the suspension arms, the roll center height has been finely tuned to minimize the vertical fluctuation of the vehicle's center-of-gravity height during cornering. As a result, excellent riding comfort and stability have been realized.



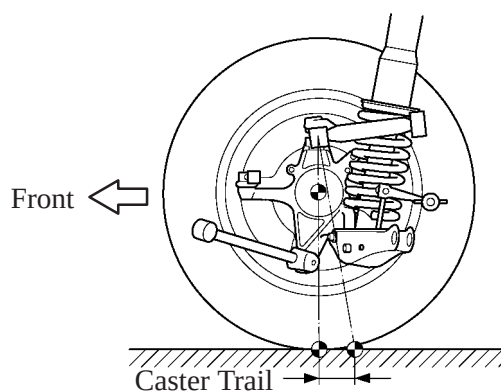
152CH12

CH

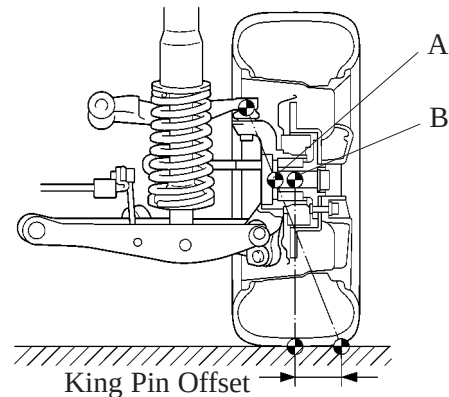
### 2. Virtual King Pin Axis

The upper arm and the 2 lower arms form a virtual kingpin axis, which provides the following characteristics:

- The caster trail has been brought to the negative side to achieve a toe-in tendency in relation to the lateral force that is applied to the tire-to-ground contact point.
- The king pin offset has been brought to the negative side to achieve a toe-in tendency during braking.
- The distance between points A and B illustrated below has been minimized in order to minimize the fluctuation of the toe angle that is associated with the changes in the drive force.



152CH49



152CH50

### 3. Longitudinal Compliance

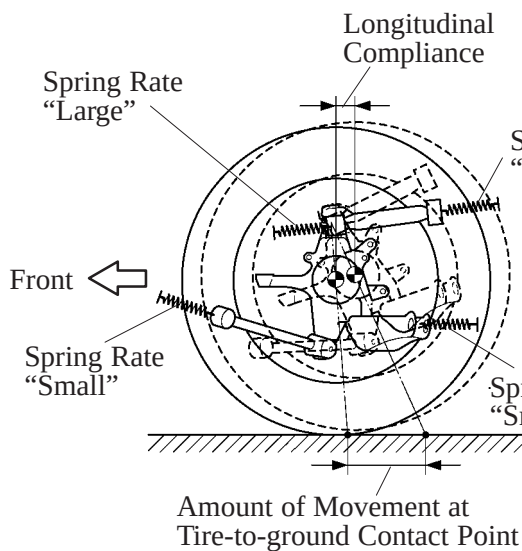
When a resistance created by the bumps on the road is encountered, this suspension system relieves the wheels longitudinally to improve the riding comfort on rough roads.

The longitudinal compliance is the amount of movement of the axle center per given load. Increasing this amount generally results in a soft ride.

The methods for achieving longitudinal compliance are broadly divided into the following two types:

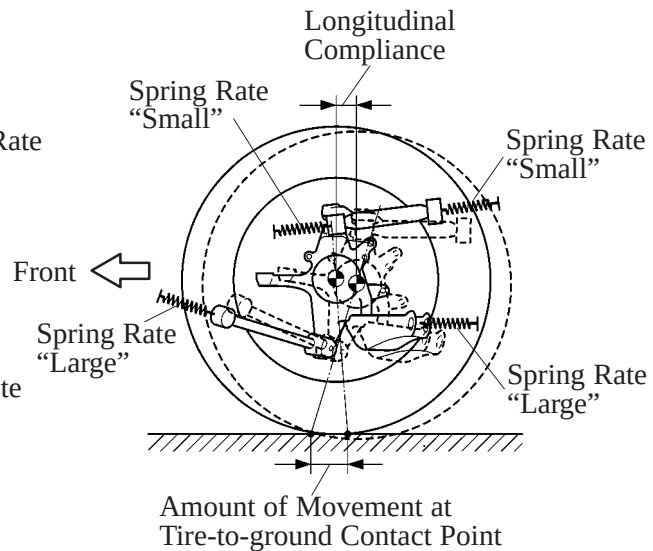
With the same amount of longitudinal compliance, the lower side compliance "A" results in a greater amount of movement of the tire-to-ground contact point than the upper side compliance "B". If this situation occurred during actual driving, it will cause the tire's rotational speed to fluctuate frequently and affect the riding comfort.

The new model has adopted the upper side compliance "B" to improve the vehicle's riding comfort on rough roads.



**A. Lower Side Compliance**

152CH51



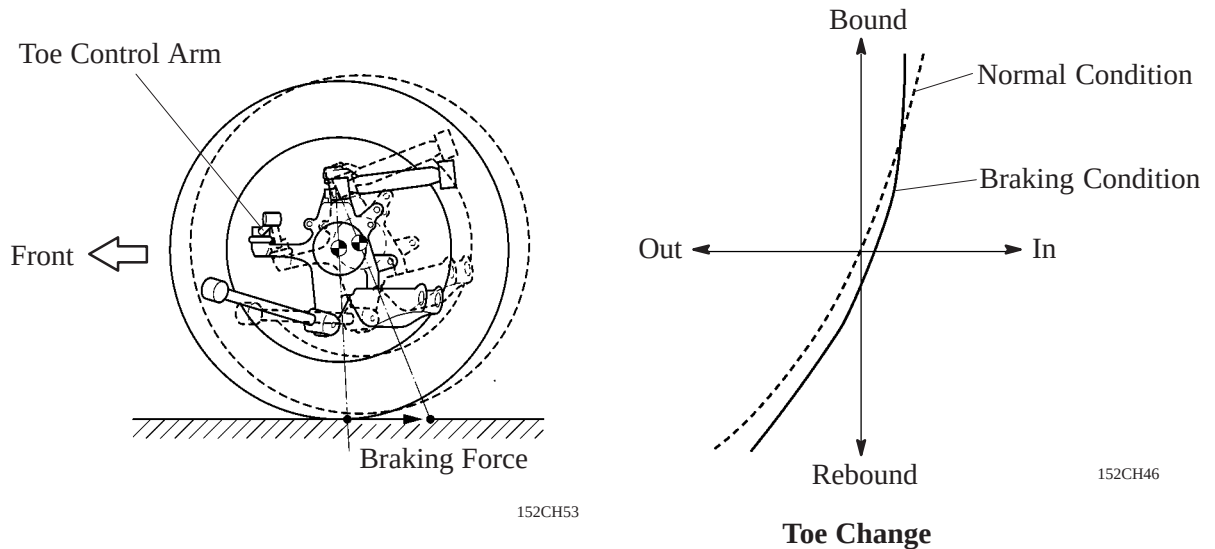
**B. Upper Side Compliance**

152CH52

#### 4. Toe Change

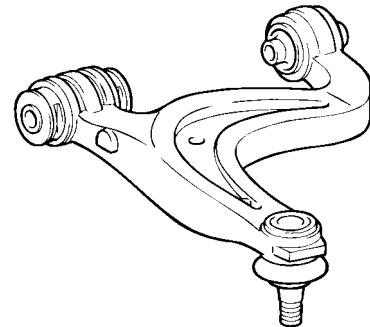
During braking, a braking force that pulls the tire-to-ground contact point rearward is generated as illustrated below. This causes the rear axle carrier to rotate and changes the angle in which the toe control arms and the like are mounted. If the suspension is moved vertically in this state, the line graph of the change of the toe angle will differ from that of the normal operation.

Therefore, the suspension of the new model has increased the torsional rigidity in relation to the braking force to minimize the toe angle fluctuations during braking. As a result, excellent rear suspension stability has been realized when the brakes are applied during cornering.



#### 5. Upper Arm

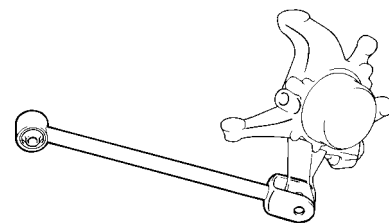
The upper arm is an A-shaped arm made of forged aluminum to reduce the weight.



152CH54

#### 6. No. 1 Lower Arm

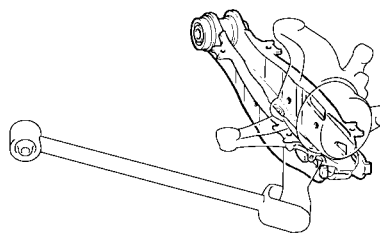
The No. 1 lower arm is made of hollow bar to reduce the weight and to realize excellent rigidity.



152CH55

## 7. No. 2 Lower Arm

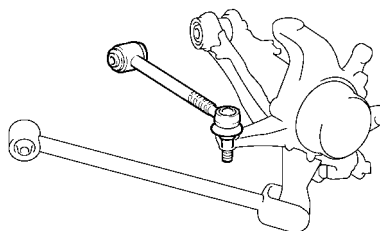
The No. 2 lower arm is made of pressed sheet steel to reduce the weight and to realize excellent rigidity.



152CH56

## 8. Toe Control Arm

The toe control arm is made of hollow bar to reduce the weight and to realize excellent rigidity.



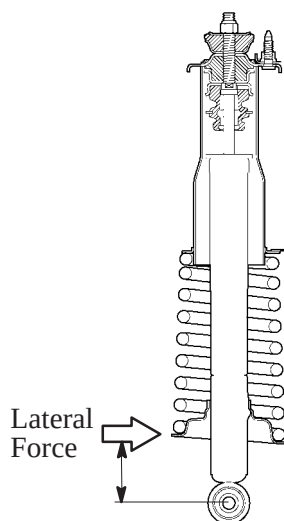
152CH57

## 9. Coil Spring and Shock Absorber

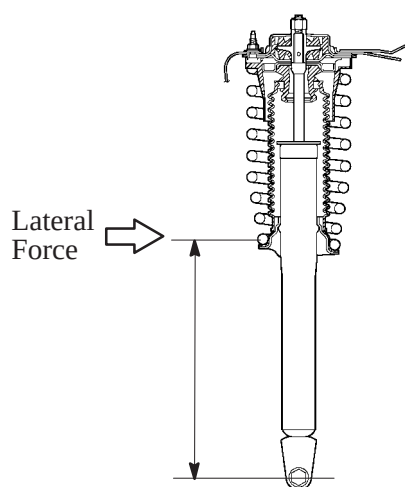
No matter how precisely the coil spring is constructed, a lateral force is created in the coil spring due to the contraction and the elongation of the spring, which differs from the vertical force for which the coil spring was originally intended.

When the lateral force is great, it prevents the smooth travel of the shock absorber and affects the riding comfort. As illustrated below, the amount of bending moment that is applied to the shock absorber varies according to the position of the spring seat.

On the new model, to reduce the amount of bending moment that is applied to the shock absorber, the spring seat has been located at the bottom. As a result, the smooth travel of the shock absorber has been realized.



152CH47

**New**

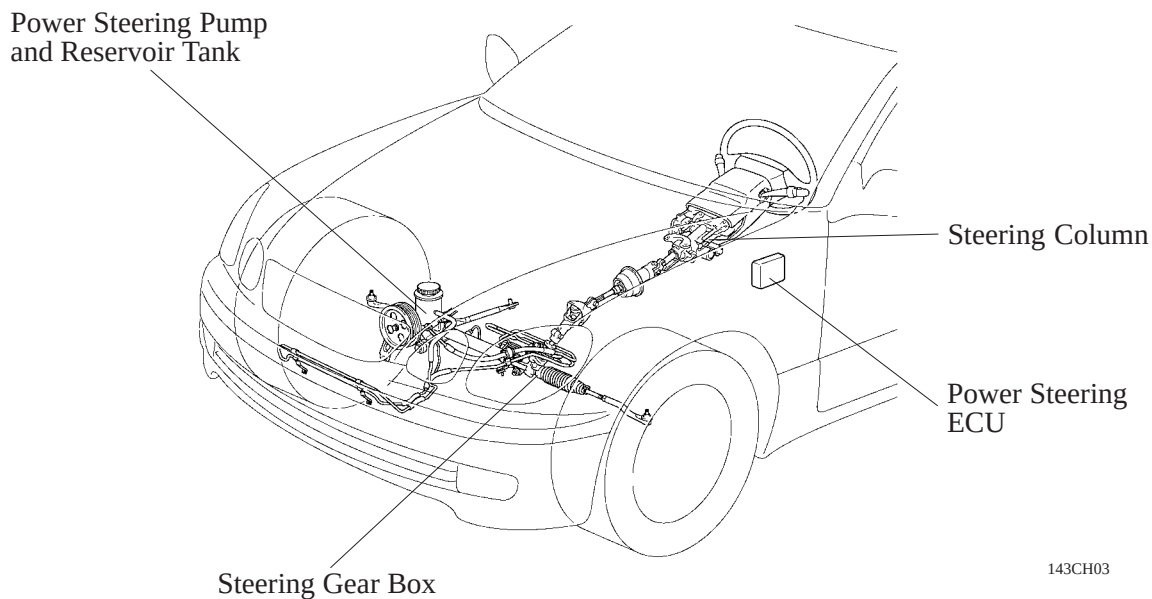
152CH48

**Previous**

## STEERING

### ■ DESCRIPTION

- Newly developed vehicle-speed sensing flow control type electronically-controlled PPS (Progressive Power Steering) is adopted.
- A power tilt and power telescopic mechanism with memory function is used.
- The steering column has adopted an energy absorbing mechanism that uses energy absorbing plate.



143CH03

### LHD Model

### ► Specifications ◀

| Model<br>Item                   | New                        | Previous                    |
|---------------------------------|----------------------------|-----------------------------|
| Power Steering Type             | Flow Control Type PPS      | Hydraulic Reaction Type PPS |
| Steering Gear Type              | Rack and Pinion            | ←                           |
| Gear Ratio (Overall)            | 17.2                       | 16.5                        |
| No. of Turns Lock to Lock       | 3.38                       | 3.23                        |
| Rack Stroke            mm (in.) | 145.4 (5.72)               | 139 (5.47)                  |
| Fluid Type                      | ATF Type DEXRON® II or III | ←                           |

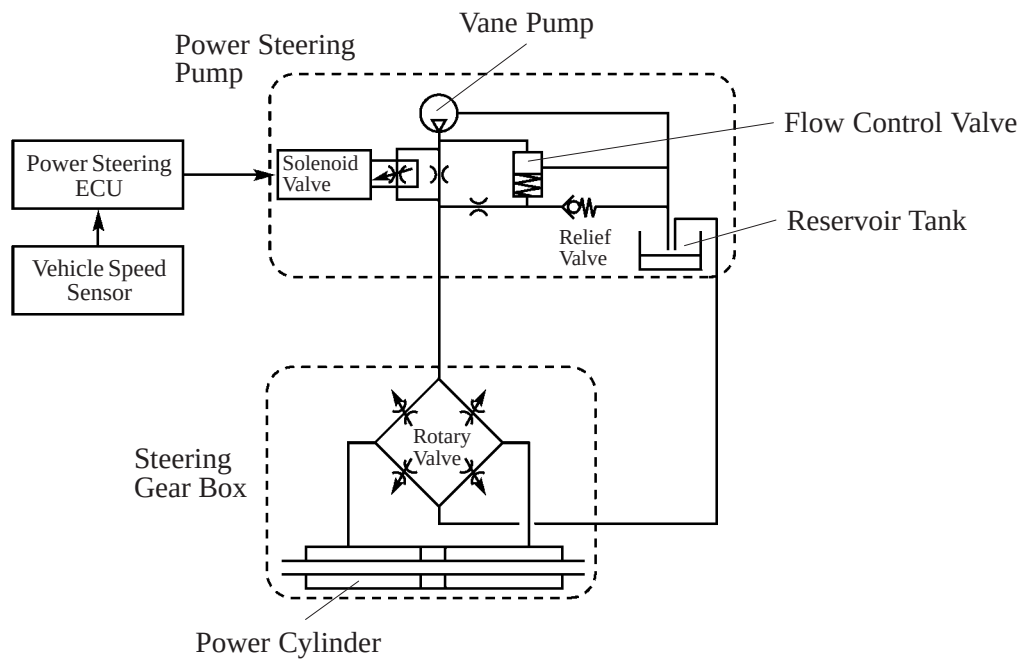
## ■ VEHICLE SPEED SENSING FLOW CONTROL TYPE PPS

### 1. General

On the previous model, the PPS controls the hydraulic pressure that is applied to the steering gear's hydraulic reaction chamber according to vehicle speed. However, on the new model, the PPS has been changed to the type that controls the amount of fluid in the power steering pump according to vehicle speed.

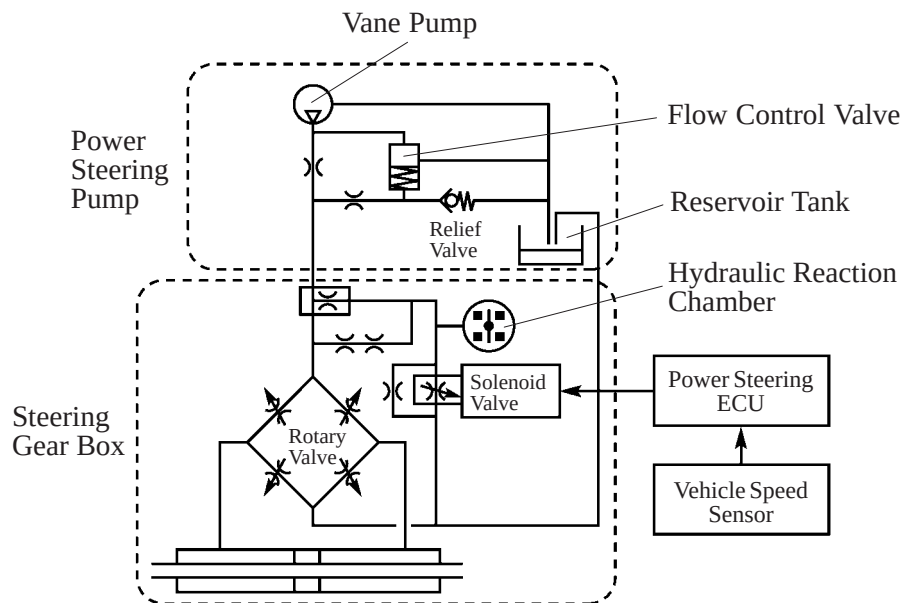
This function is carried out by the solenoid valve that has been added to the power steering pump's flow control portion, which is based on the engine revolution sensing type power steering.

### 2. System Diagram



152CH42

New



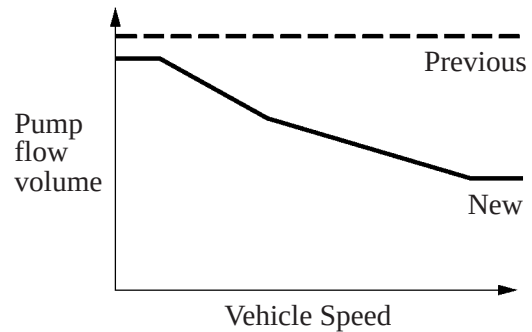
152CH43

Previous

### 3. Operation

The pump flow volume is reduced as the vehicle speed increases in order to increase the steering effort.

Moreover, the engine load is reduced due to the reduction in the pump flow volume. As a result, fuel economy is improved.



152CH44

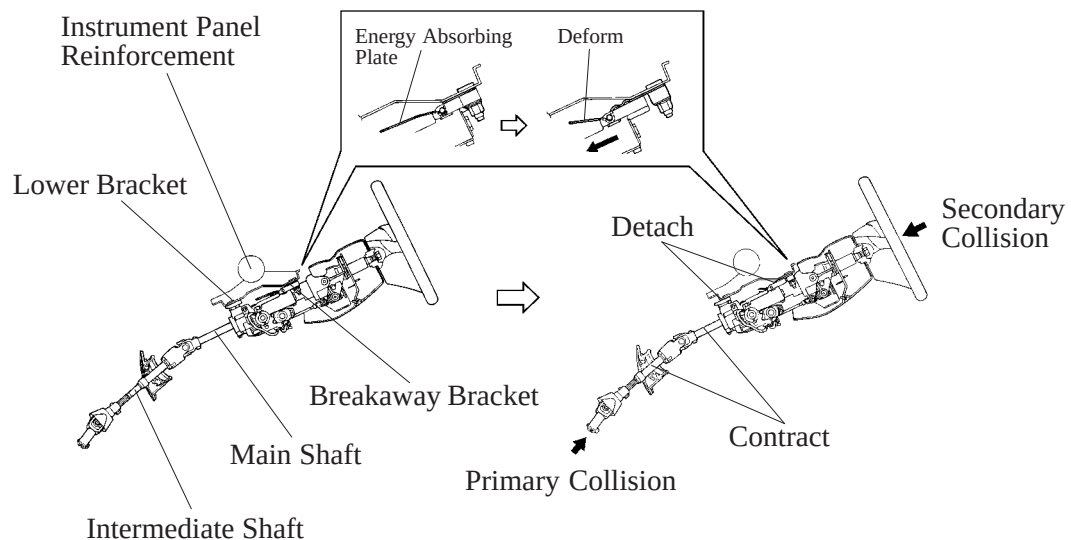
### ■ STEERING GEAR

Excellent steering feeling has been realized through the adoption of the roller type rack guide, the cutting processing of the pinion gear, and the adoption of the rubber bushings to mount the steering gear box.

### ■ ENERGY ABSORBING MECHANISM

The energy absorbing mechanism in the steering column consists of a lower bracket, breakaway bracket, energy absorbing plate and a contractile main shaft. The steering column is mounted onto the instrument panel reinforcement via a lower bracket and breakaway bracket which is supported via a capsule and energy absorbing plate. The steering column and the steering gear box are connected with a contractile intermediate shaft. When the steering gear box moves during a collision (primary collision), the main shaft and the intermediate shaft contract, thus reduce the chance that the steering column and the steering wheel protrude into the cabin. When an impact is transmitted to the steering wheel in a collision (secondary collision), the steering wheel and the steering wheel pad help absorb the impact. In addition, the breakaway bracket and the lower bracket separate, causing the entire steering column to move forward.

At this time, the energy absorbing plate becomes deformed to help absorb the impact of the secondary collision.



Before Collision

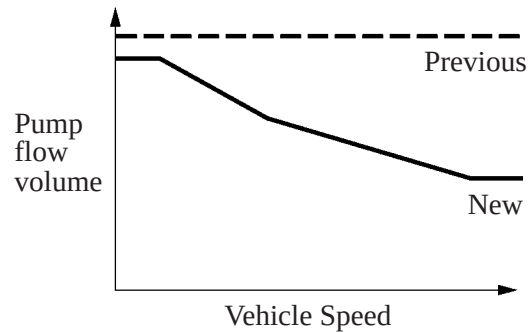
After Collision

152CH58

### 3. Operation

The pump flow volume is reduced as the vehicle speed increases in order to increase the steering effort.

Moreover, the engine load is reduced due to the reduction in the pump flow volume. As a result, fuel economy is improved.



152CH44

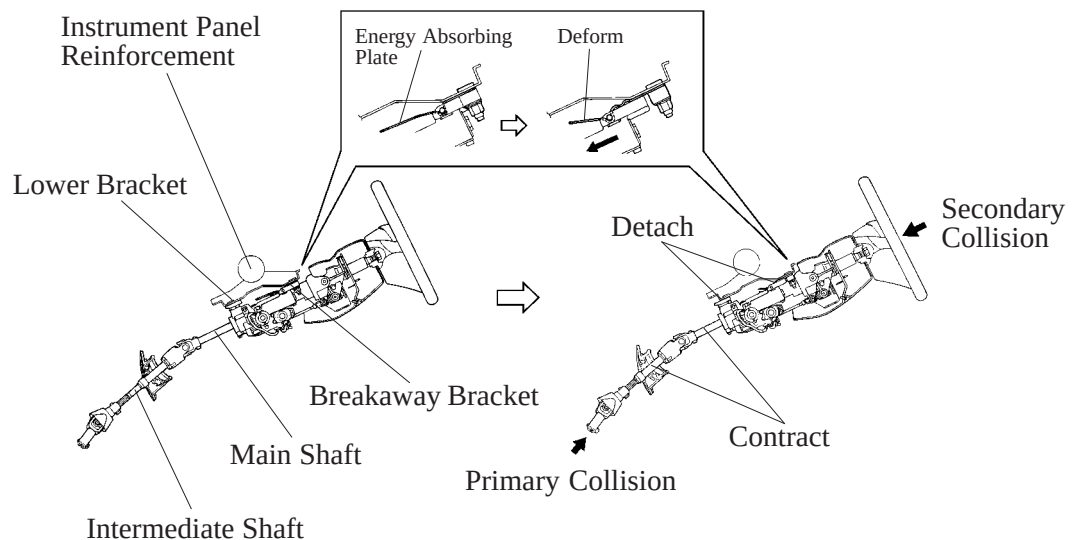
### ■ STEERING GEAR

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At this time, the energy absorbing plate becomes deformed to help absorb the impact of the secondary collision.



152CH58

Befor Collision

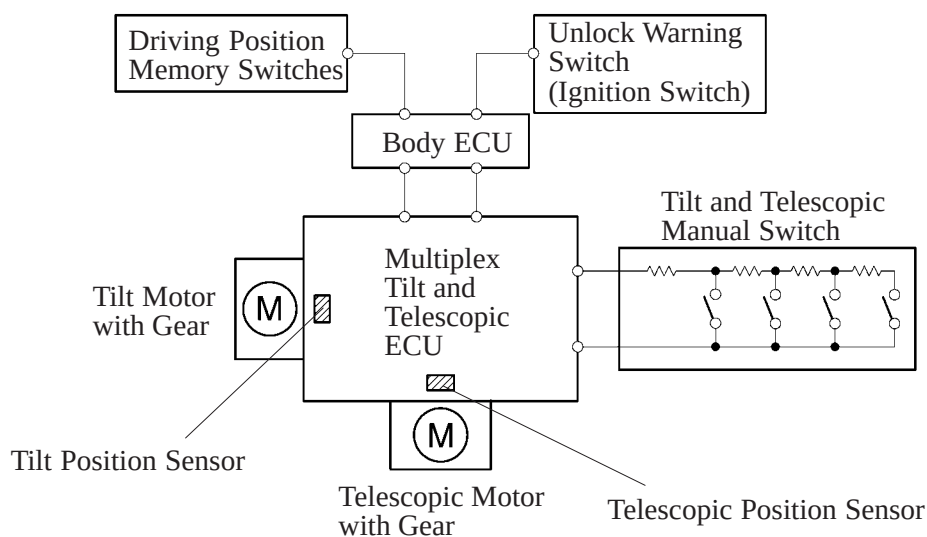
After Collision

## ■ POWER TILT AND POWER TELESCOPIC STEERING COLUMN

### 1. General

- A compact and lightweight power tilt and telescopic steering column is used on all models.
- The auto set function has been adopted as on the previous model.
- The steering column can be set to 2 positions in conjunction with the driving position memory function.

### 2. System Diagram

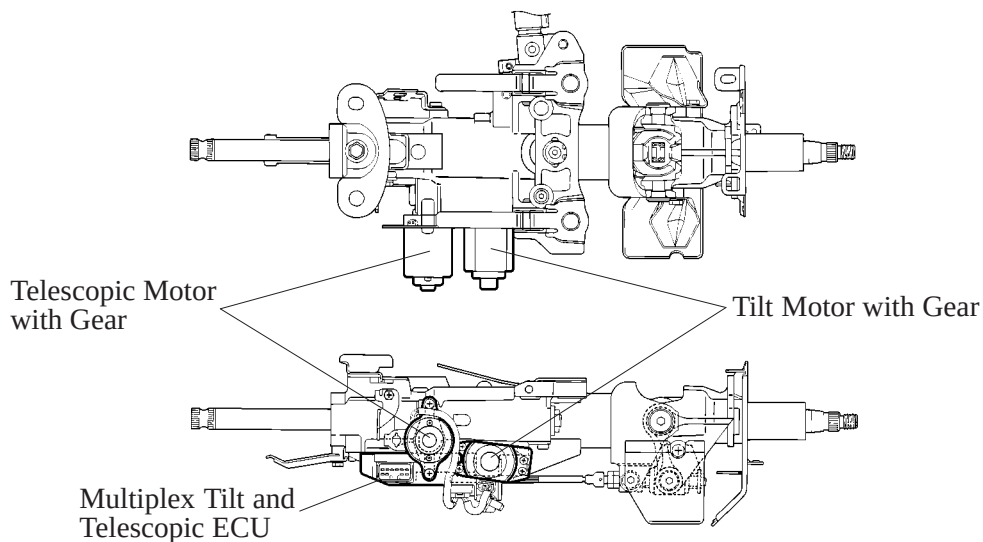


152CH36

### 3. Construction

The power tilt and power telescopic steering column consists of the multiplex tilt and telescopic ECU, a tilt motor, telescopic motor and gears.

The multiplex tilt and telescopic ECU contains position sensors that use hall elements.



152CH59

## 4. Operation

### Tilt Operation

The signals from the multiplex tilt and telescopic ECU cause the tilt motor to rotate, and this rotational movement is transmitted via the gear, shaft and etc. to move the steering wheel vertically.

### Telescopic Operation

The signals from the multiplex tilt and telescopic ECU cause the telescopic motor to rotate, and this rotational movement is transmitted via the gears to contract or to extend the column tube.

### Auto Set Function

When the ignition key is removed, the steering column moves forward away from the driver and also tilts up for easy exit and entry.

When the ignition key is inserted in the ignition switch, the steering column returns to the previously set position.

### Driving Position Memory Function

The steering column moves to the previously set position by pressing the driving position memory switches that are located on the driver's door.

### Position Detection

To detect the position of the tilt and telescopic steering column, a position sensor that utilizes a hall element is located in the ECU and is used to detect the changes in the magnetic field of the magnets, which are attached to the shafts of the motors.