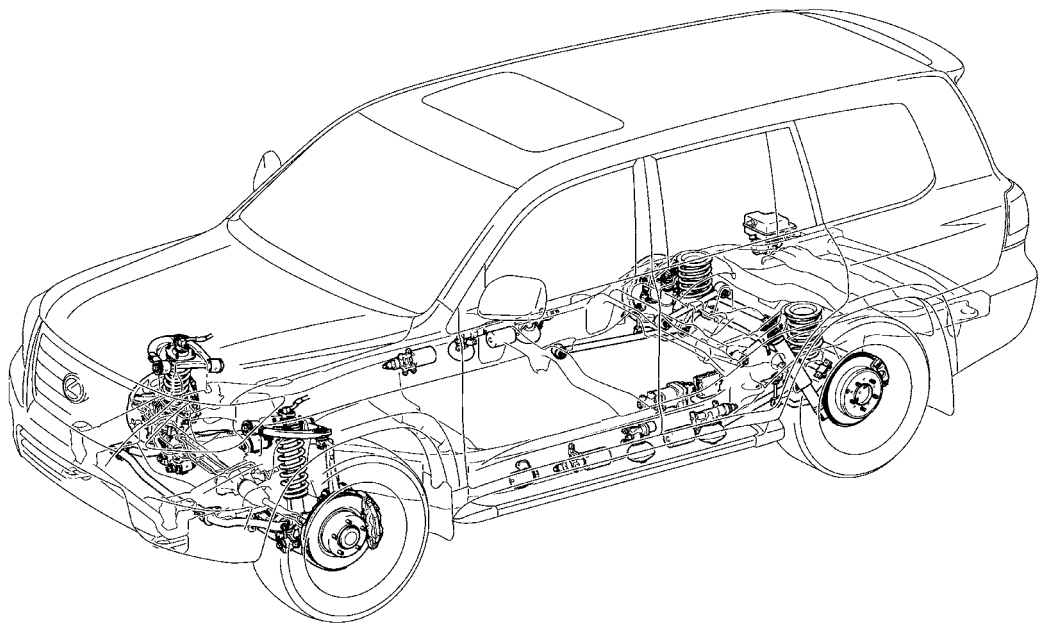


SUSPENSION AND AXLE

DESCRIPTION

- The coil spring type double-wishbone independent suspension is used for the front suspension, and the 4-link coil spring with lateral rod type suspension is used for the rear suspension.
- A 4-wheel active height control suspension and an adaptive variable suspension are used.



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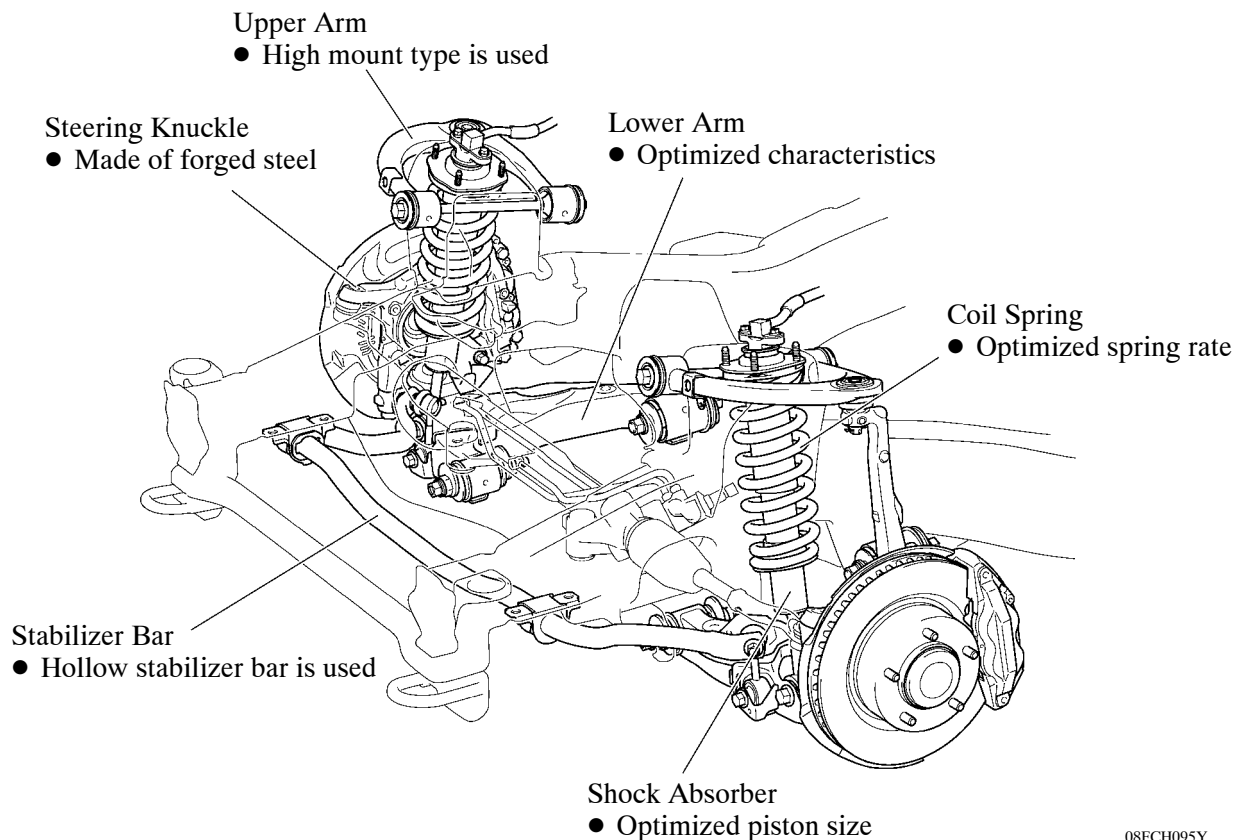
Specifications

Tire Size			285/60 R18	285/50 R20
Tread*	Front	mm (in.)	1640 (64.6)	←
	Rear	mm (in.)	1635 (64.4)	←
Front Wheel Alignment*	Caster	degrees	3°20'	←
	Camber	degrees	0°00'	←
	Toe-in	mm (in.)	0 (0.0)	←
	King Pin Inclination	degrees	13°00'	←

*: Unloaded Vehicle Condition

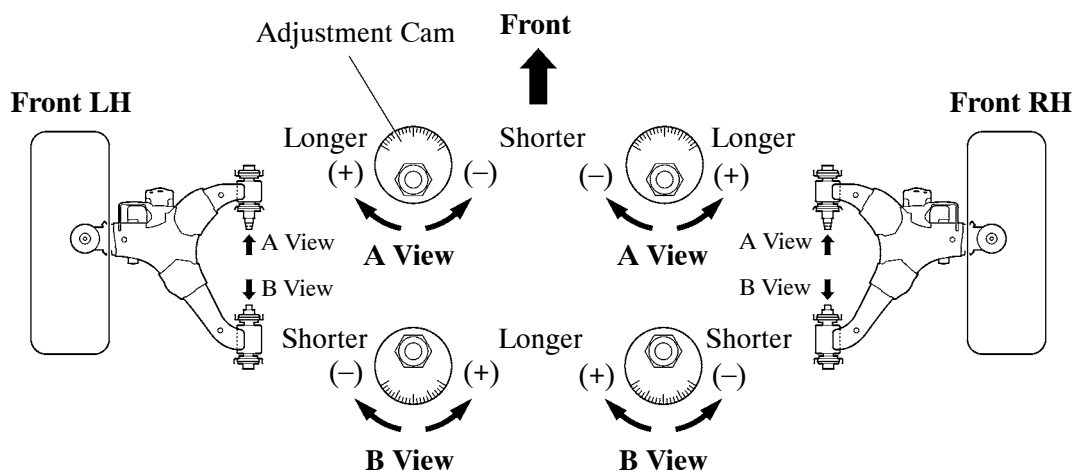
FRONT SUSPENSION

Through the optimal allocation of components, the front suspension realizes excellent riding comfort, controllability, and off-road drivability.



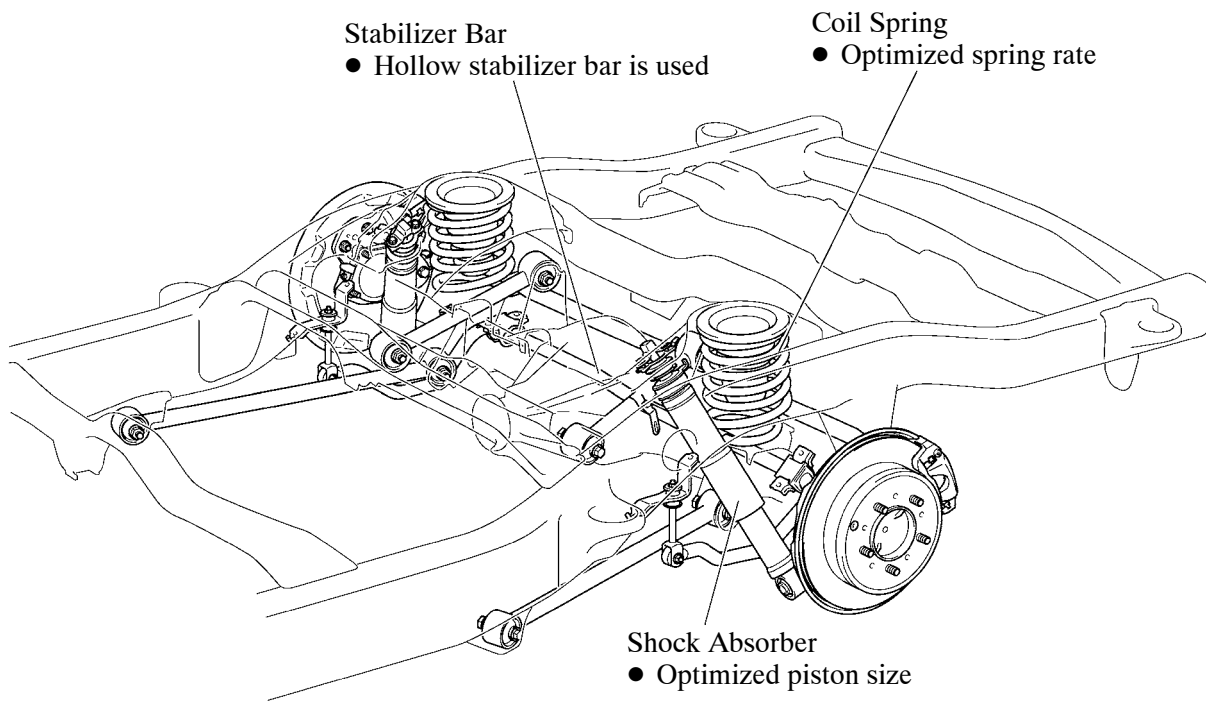
Service Tip

The camber and caster of the front suspension can be adjusted using the adjustment cams of the lower arms. For details, see the 2008 LEXUS LX 570 Repair Manual (Pub. No. RM08F0U)



■ REAR SUSPENSION

Through the optimal allocation of components, the rear suspension realizes excellent riding comfort, controllability, and off-road drivability.



08FCH096Y

■ 4-WHEEL ACTIVE HEIGHT CONTROL SUSPENSION AND ADAPTIVE VARIABLE SUSPENSION

1. General

The suspension system, which consists of 4-wheel active height control suspension and adaptive variable suspension, offers both comfort and convenience to achieve high driving performance for on-road and off-road driving.

- The front suspension uses spring rate control to improve driving performance during on-road driving.
- 4-wheel related control is used to improve driving performance during on-road and off-road driving.
- The vehicle height control is provided with an easy access control function for improved convenience.
- The damping force control uses non-linear H^∞ control.

Control	Outline	'08 LX 570	'07 LX470
Vehicle Height Control	The amount of fluid to be sent through the height control valve into the shock absorbers for each of the wheels is regulated in accordance with the manual switch operation and driving conditions.	○	○
Damping Force Control	The optimum damping force can be obtained by controlling the damping force control actuators arranged on each of the wheels in accordance with the manual switch operation and driving conditions.	○	○
Spring Rate Control (for Front Suspension)	The spring rate can be controlled by switching the fluid passage to the gas chambers arranged on both the left and right front shock absorbers.	○	—
4-wheel Related Control	The hydraulic tubes for the shock absorbers are channeled through the center suspension control cylinder, therefore, the amount of hydraulic pressure for each of the shock absorbers can be individually adjusted via the center suspension control cylinder in accordance with the driving conditions.	○	—

— REFERENCE —

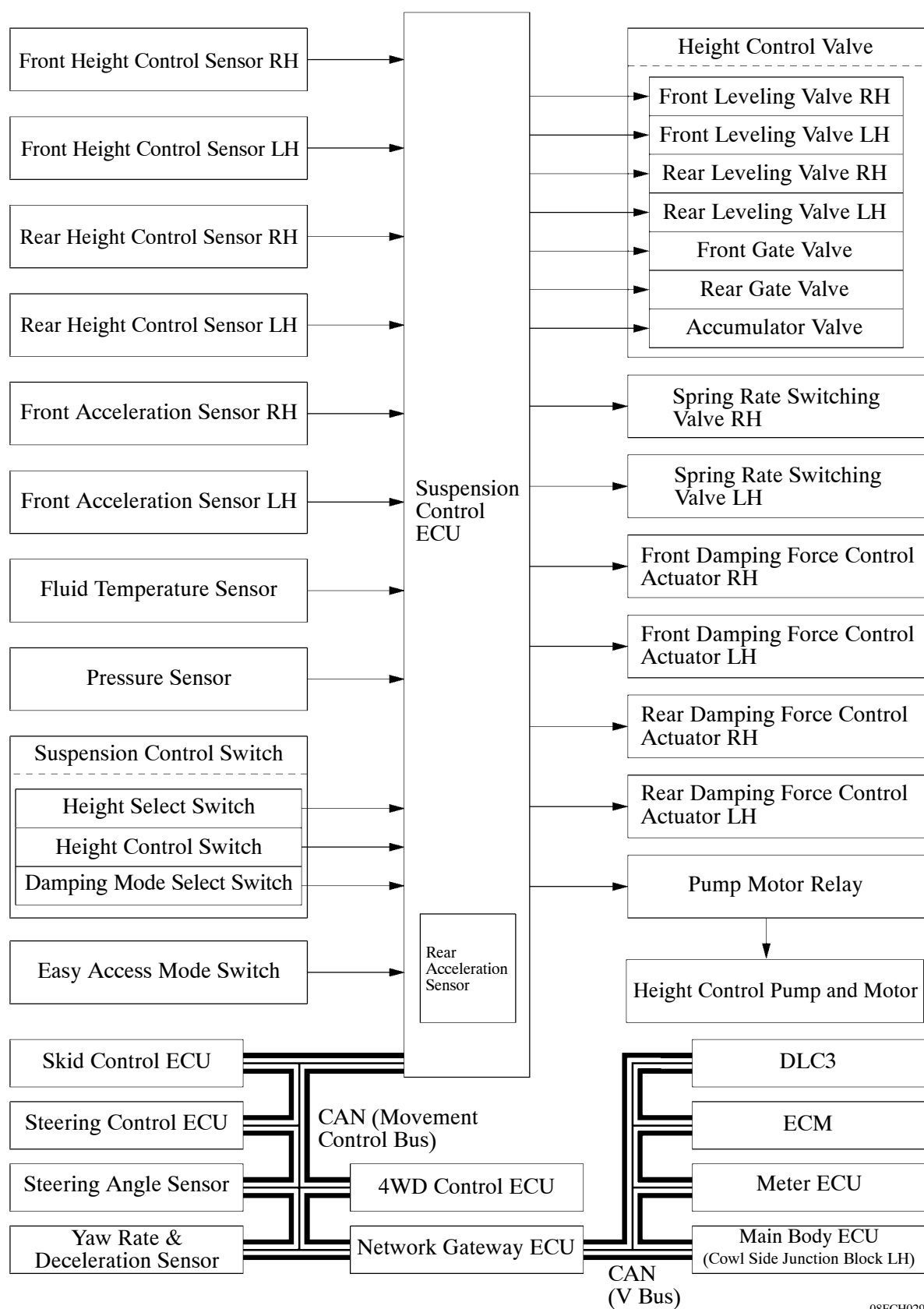
- To summarize, H^∞ control is a theory for designing a controller that meets the control specifications that are represented by the H^∞ norm (a unit of measurement of the transfer function of the system). When this is expanded into a non-linear system, it is called “non-linear H^∞ control”.
- The “H” is the initial letter of the mathematician named Hardy (who studied the stability of control systems) who advocated the mathematical space that is handled by this control logic. The “ ∞ ” represents the ∞ norm, which is one of the mathematical units used for measuring the size of the signals.

Service Tip

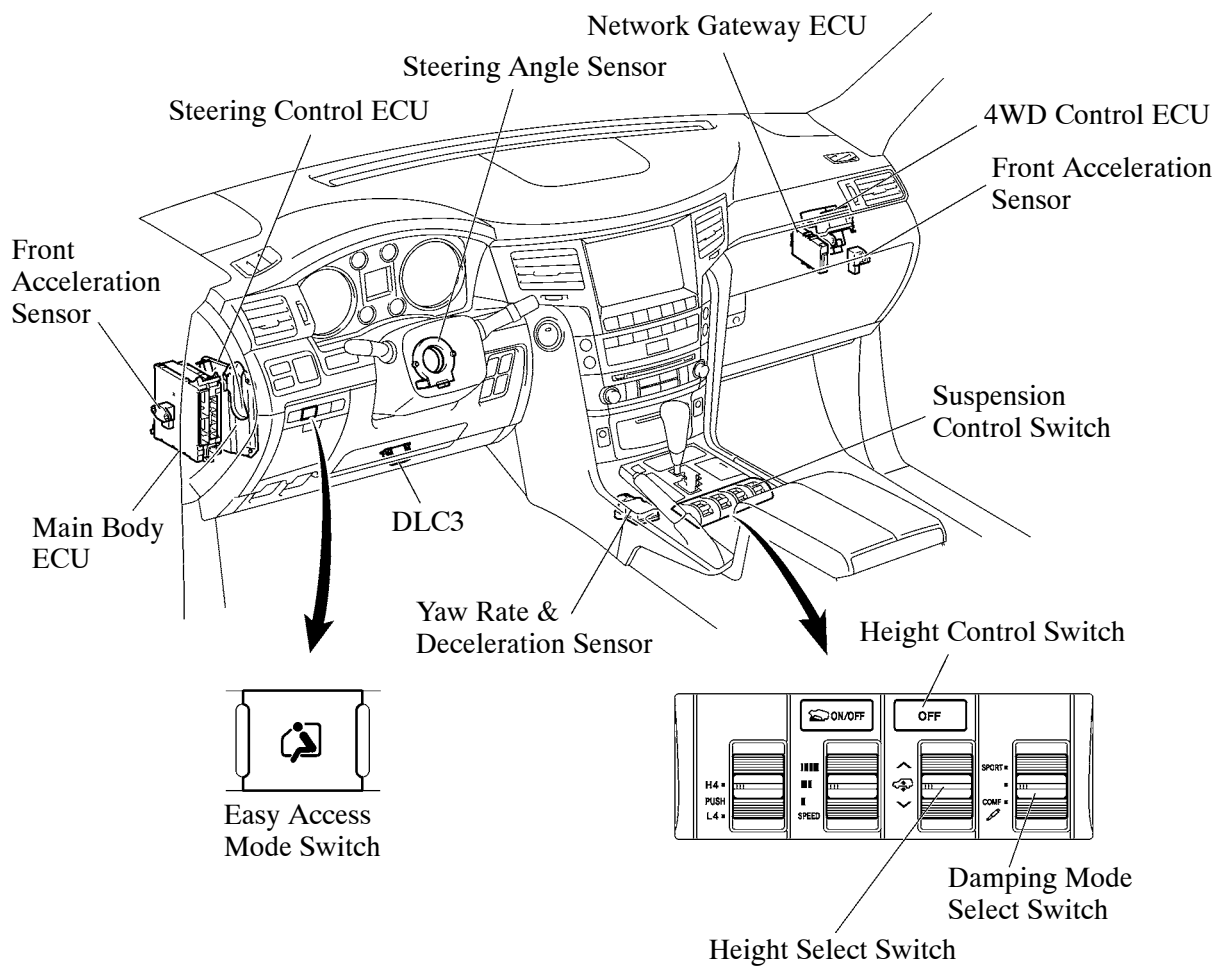
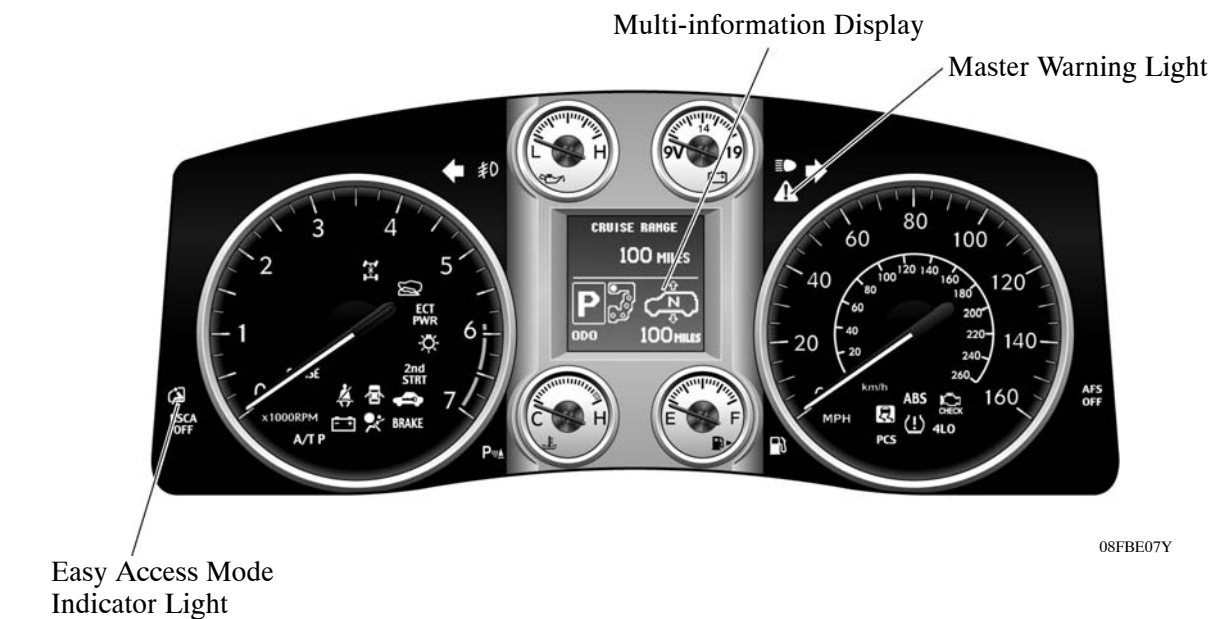
Before jacking the vehicle or raising it on a hoist, make sure that the engine switch is OFF.

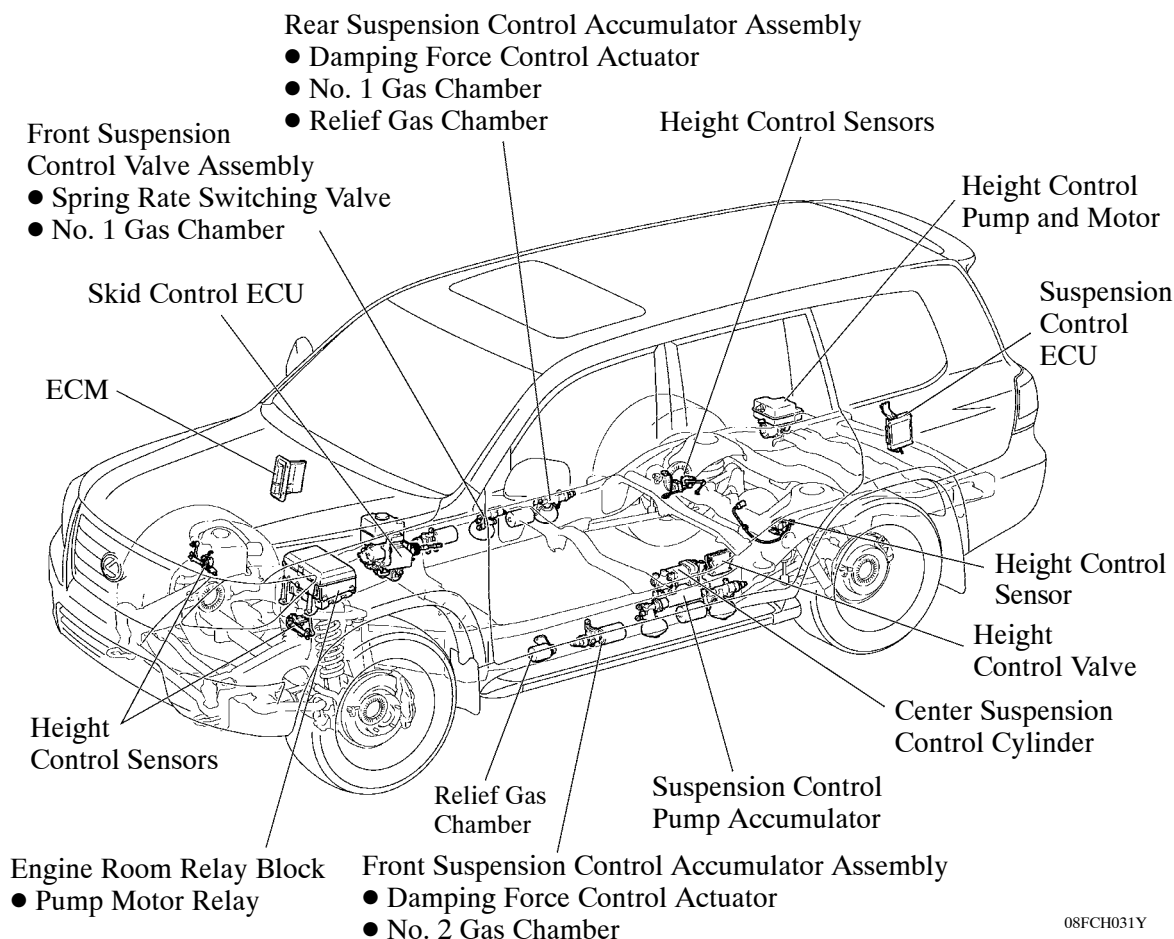
If the vehicle must be lifted up when the engine switch is ON (IG), turn the height control switch OFF to suspend vehicle height control operations in the suspension control ECU.

2. System Diagram

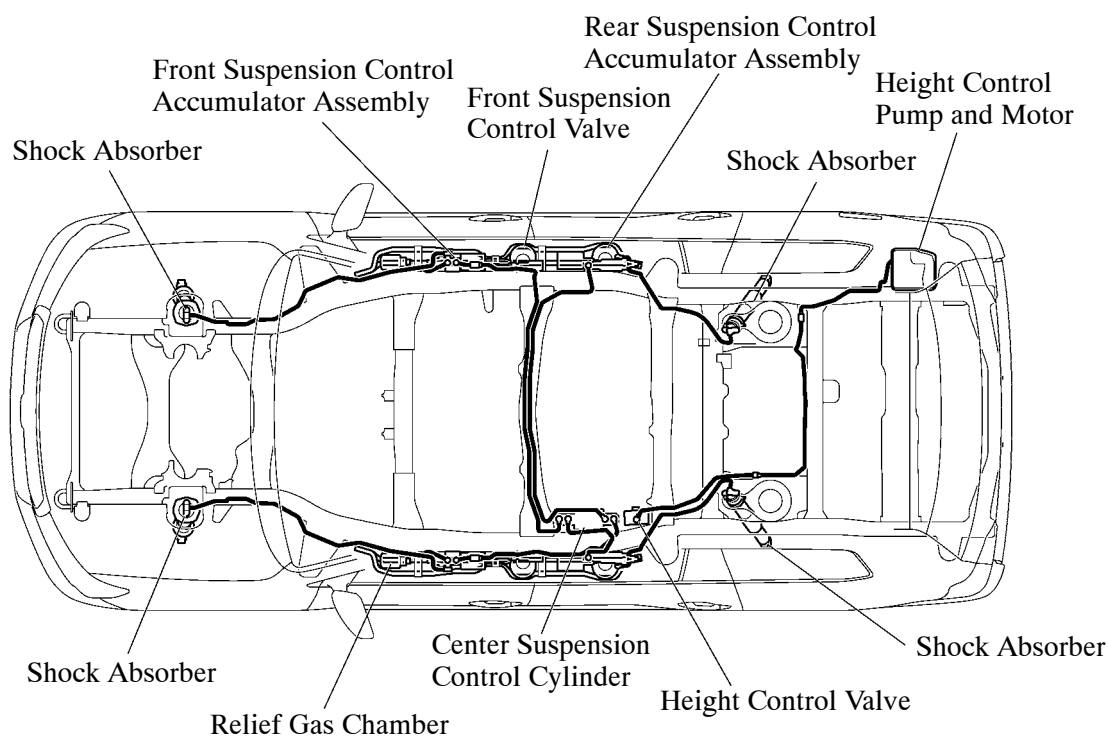


3. Layout of Main Components

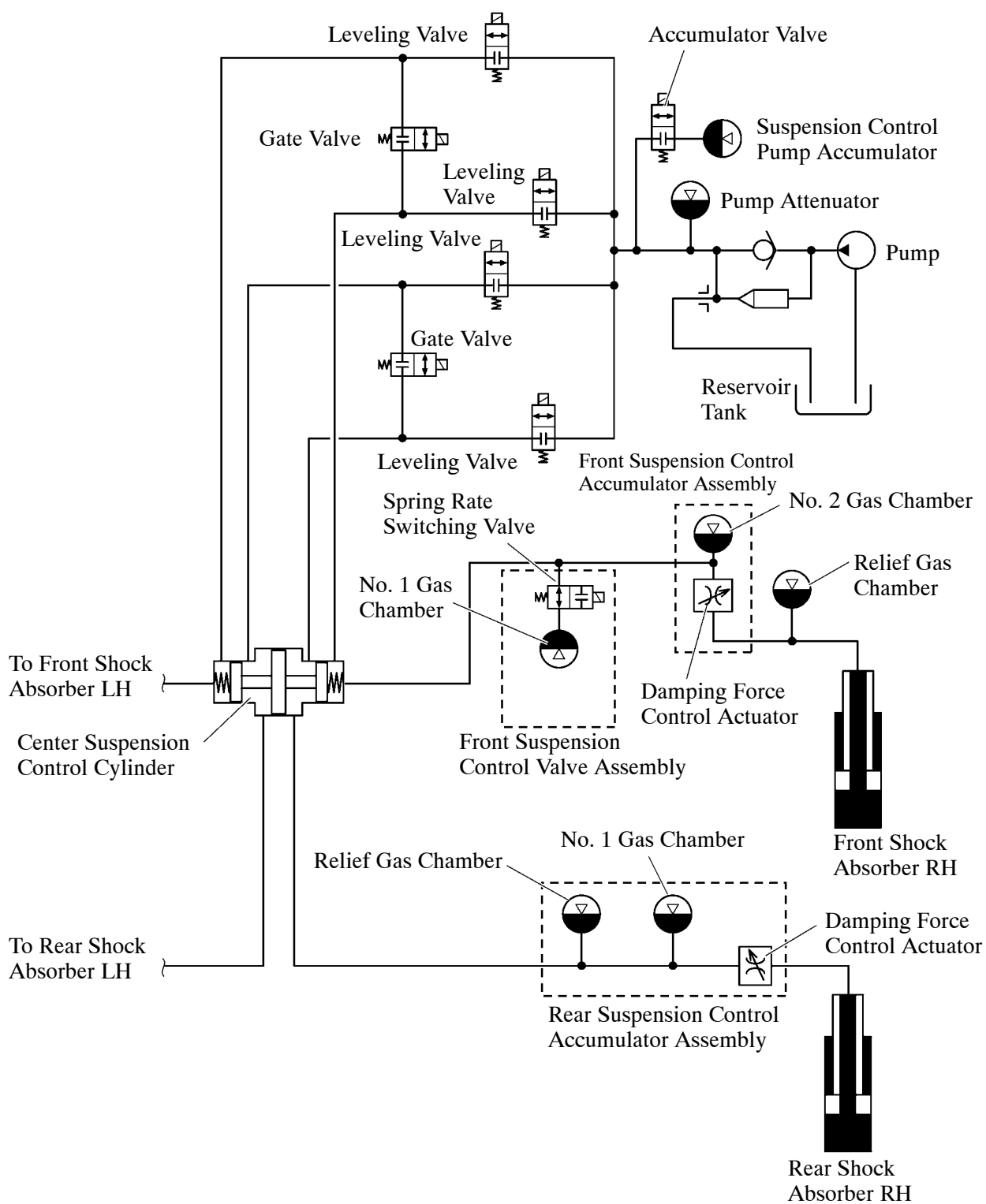




4. Suspension Tubing Diagram



5. Hydraulic Circuit



6. Function of Main Components

Component		Function
Height Control Pump and Motor		Generates the high hydraulic pressure that is necessary for raising the vehicle height.
	Reservoir Tank	Maintains the amount of fluid that is returned during the LO position and the amount of fluid that is discharged during the HI position.
	Return Valve	Opens and closes the fluid passage between the height control valve and the reservoir tank.
	Pressure Sensor	Detects the pump's discharge pressure.
	Fluid Temperature Sensor	Detects the fluid temperature.
	Pump Attenuator	Dampens the hydraulic pulsation of the fluid that is discharged by the pump.
Suspension Control Pump Accumulator		Stores the hydraulic pressure to accelerate the speed in which the vehicle height is raised.
Height Control Valve	Leveling Valve	Opens and closes the fluid passage between the pump and the gas chamber on the wheel.
	Gate Valve	Opens and closes the fluid passage between the right and left shock absorbers.
	Accumulator Valve	Opens and closes the fluid passage to the suspension control pump accumulator.
Center Suspension Control Cylinder		Mechanically operates in accordance with the pressure applied to the shock absorbers and optimally distributes the hydraulic pressure to each of the wheels.
Front Suspension Control Valve Assembly	Spring Rate Switching Valve	Opens and closes the fluid passage to the No. 1 gas chamber.
	No. 1 Gas Chamber (Low spring rate)	Acts like a gas spring by partially utilizing coil spring force. This is provided on the front wheels.
Front Suspension Control Accumulator Assembly	No. 2 Gas Chamber (High spring rate)	Acts like a gas spring by partially utilizing coil spring force. This is provided on the front wheels.
	Damping Force Control Actuator	Switches the damping force.
Relief Gas Chamber (for Front Suspension)		Protects hydraulic systems by restricting increase in the hydraulic pressure inside the hydraulic tubes.
Rear Suspension Control Accumulator Assembly	No. 1 Gas Chamber	Acts like a gas spring by partially utilizing coil spring force. This is provided on the rear wheels.
	Relief Gas Chamber	Protects hydraulic systems by restricting increase in the hydraulic pressure inside the hydraulic tubes.
	Damping Force Control Actuator	Switches the damping force.
Shock Absorber		<ul style="list-style-type: none"> Generates a damping force similar to the conventional shock absorber. Includes a high-pressure main seal and high-pressure oil seal for friction reduction and further improvement of the sealing performance.

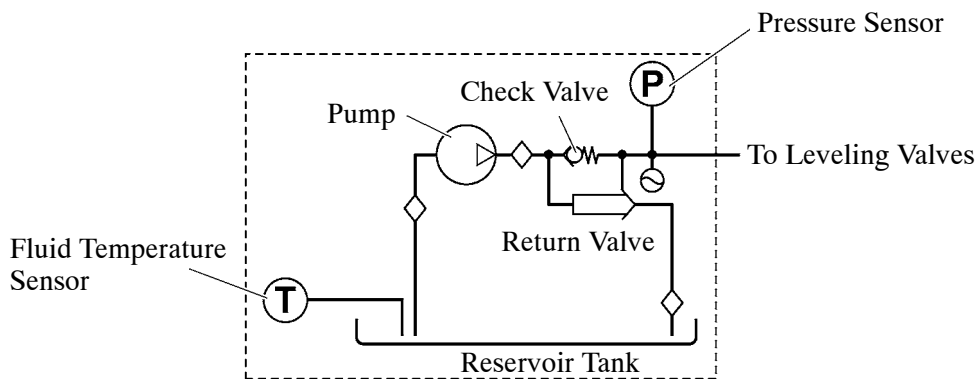
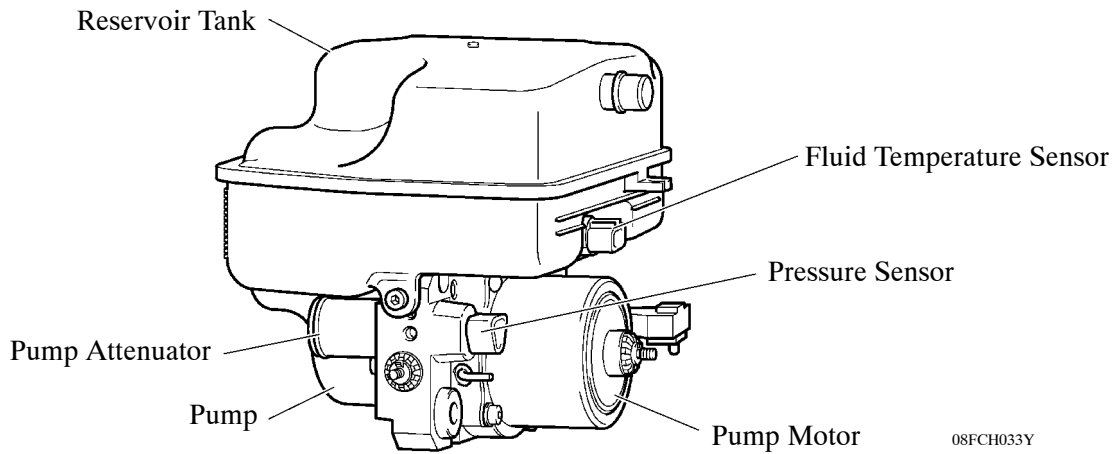
(Continued)

Component		Function
Combination Meter	Multi-information Display	<ul style="list-style-type: none"> ● Displays the vehicle height and control conditions. ● Displays a warning message when a system malfunction occurs.
	Master Warning Light	Illuminates when the warning message is displayed.
	Buzzer	Sounds when the warning message is displayed.
	Easy Access Mode Indicator Light	<ul style="list-style-type: none"> ● Illuminates when the easy access mode switch is turned ON. ● Blinks while the easy access control is operating.
Suspension Control Switch	Height Select Switch	Selects the target vehicle height.
	Height Control Switch	Prohibits the vehicle height control.
	Damping Mode Select Switch	Selects a damping force control mode.
Easy Access Mode Switch		Switches the easy access control between ON and OFF.
Height Control Sensor		Detects the vehicle height.
Steering Angle Sensor		Detects the steering direction and angle of the steering wheel.
Yaw Rate & Deceleration Sensor		<ul style="list-style-type: none"> ● Detects the vehicle's yaw rate. ● Detects the vehicle's longitudinal and lateral acceleration and deceleration.
Acceleration Sensor		3 acceleration sensors are provided in total. The two of them are provided in the front of the vehicle and one is built into the suspension control ECU located in the rear of the vehicle. Thus, the acceleration sensors independently detect the vertical acceleration rate of the vehicle.
Pump Motor Relay		Controls the pump motor operation.
Suspension Control ECU		Controls the entire system by performing the calculations for height control, damping force control and spring rate control based on the signals received from the sensors and switches.
Steering Control ECU		Sends the VGRS control status signal to the suspension control ECU.
Skid Control ECU		Sends the speed sensor signal and brake control status signal to the suspension control ECU.
4WD Control ECU		Sends the 4WD control status signal to the suspension control ECU.
ECM		Sends the engine speed signal to the suspension control ECU.
Main Body ECU (Cowl Side Junction Block LH)		Sends the engine switch status signal, door courtesy switch signal and suspension control switch signal to the suspension control ECU.

7. Construction and Operation of Main Components

Height Control Pump and Motor

A system in which the pump, pump motor, reservoir tank, return valve, pump attenuator, pressure sensor, and fluid temperature sensor are integrated is used.

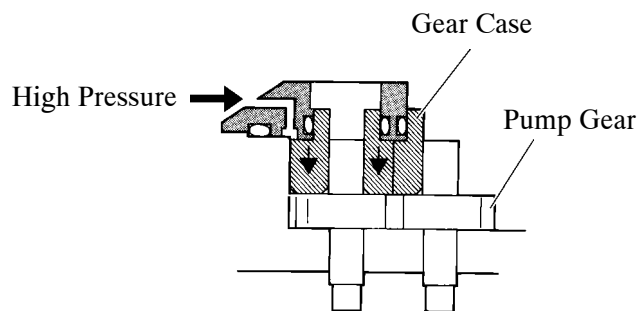
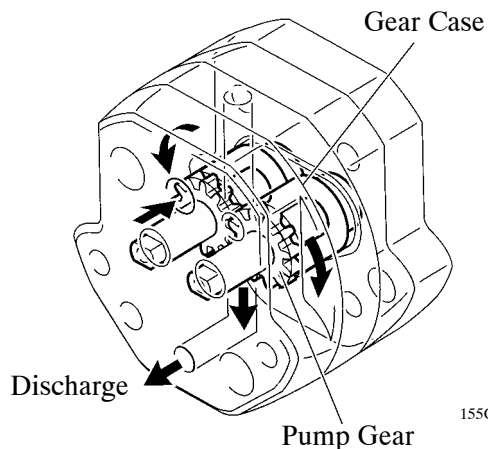


Pump and Motor Hydraulic Diagram

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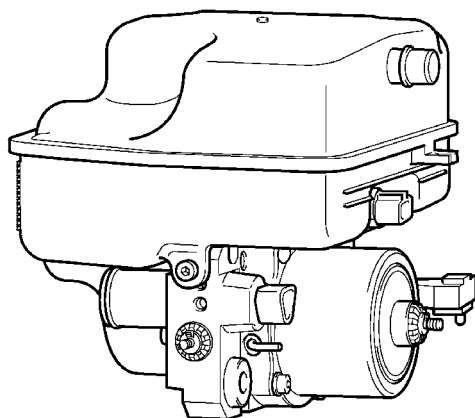
1) Pump

An external gear pump that contains less parts and excels in durability is used. Also, the pump is a pressure-loading type in which the discharge pressure of the pump itself is utilized and routed via the gear case to push on the side of the pump gear in order to reduce the internal leakage, thus making high-pressure discharge possible.

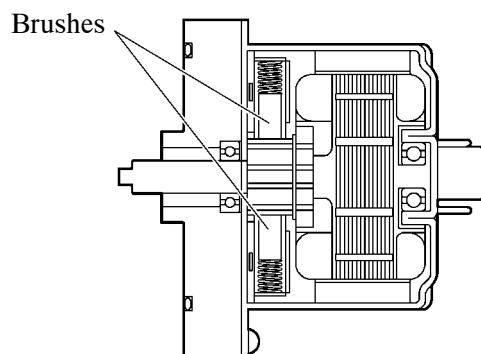


2) Motor

A DC motor with 4-pole brushes is used to realize excellent durability and high torque.



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Cross Section

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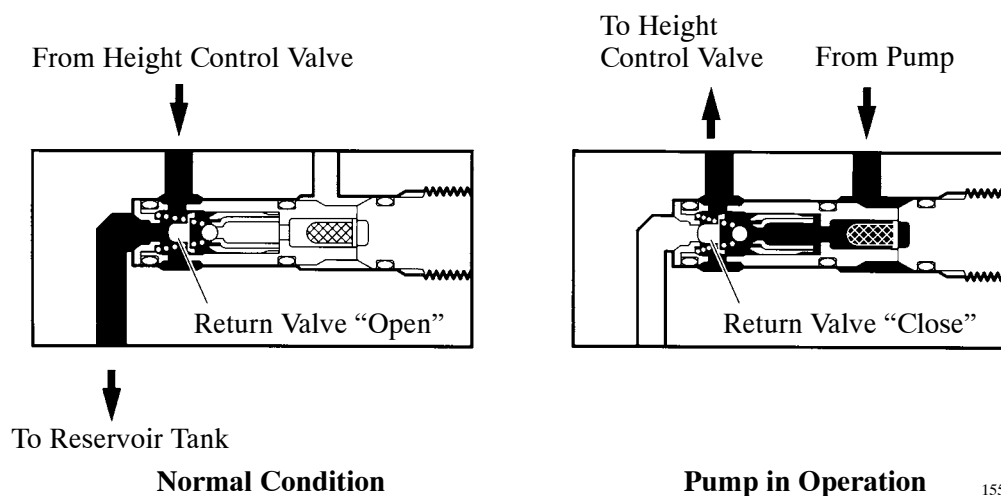
3) Return Valve

The return valve opens and closes the fluid passage between the height control valve and the reservoir tank. The return valve has been simplified by adopting a construction in which the valve is closed by the flow of the discharged fluid.

Normally, a spring force is applied to the return valve to maintain the fluid passage between the height control valve and the reservoir tank open.

When the pump operates in order to raise the vehicle height, the pressure of the fluid that is discharged by the pump causes the return valve to move to the left of the diagram as illustrated.

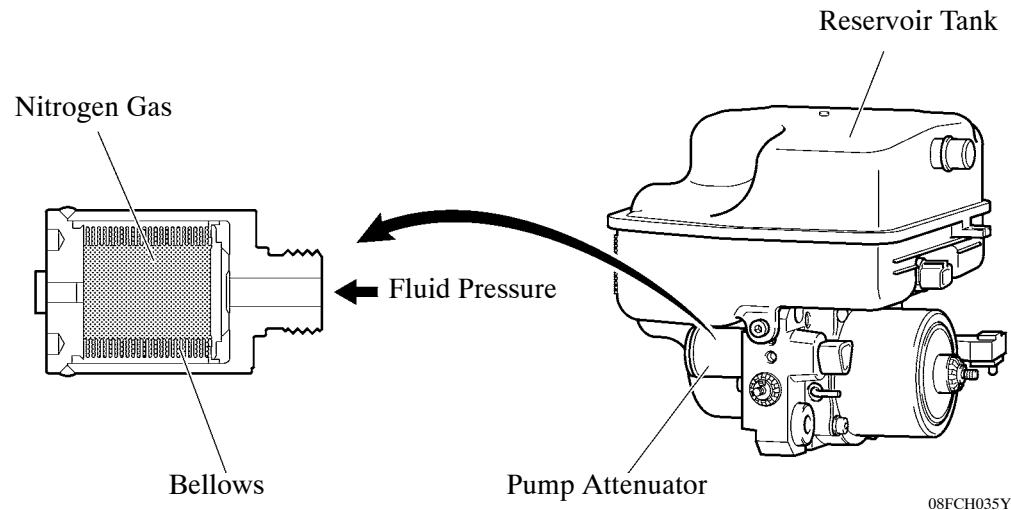
Accordingly, the fluid passage between the height control valve and the reservoir tank closes, and the fluid that is discharged from the pump flows towards the height control valve.



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4) Pump Attenuator

The pump attenuator dampens the hydraulic pulsation of the fluid that is discharged by the pump. A bellows type accumulator that is made of stainless steel, which offers excellent gas penetration resistance and good pulsation absorption performance, is used.



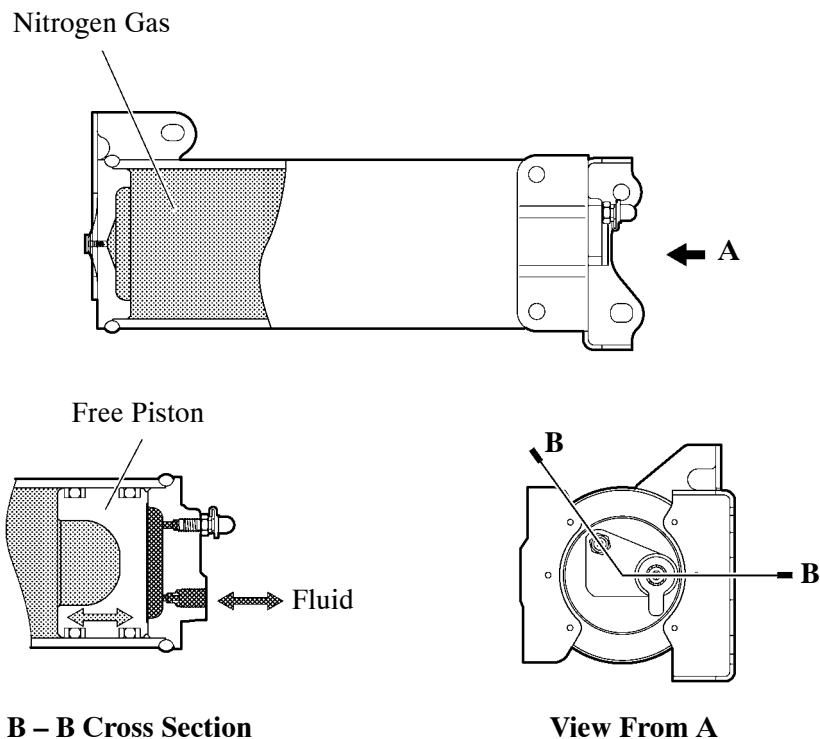
► Specifications ◀

Sealed Gas		Nitrogen Gas
Gas Chamber Volume	cc (cu in.)	1.75 (0.11)
Sealed Gas Pressure	MPa (kgf/cm ² , psi)	2.0 (20.4, 290.1)

Suspension Control Pump Accumulator

A free piston type accumulator, which provides a large gas chamber capacity, is used for the suspension control pump accumulator.

When the vehicle height is being raised, the accumulator discharges the stored fluid to accelerate the raising speed.



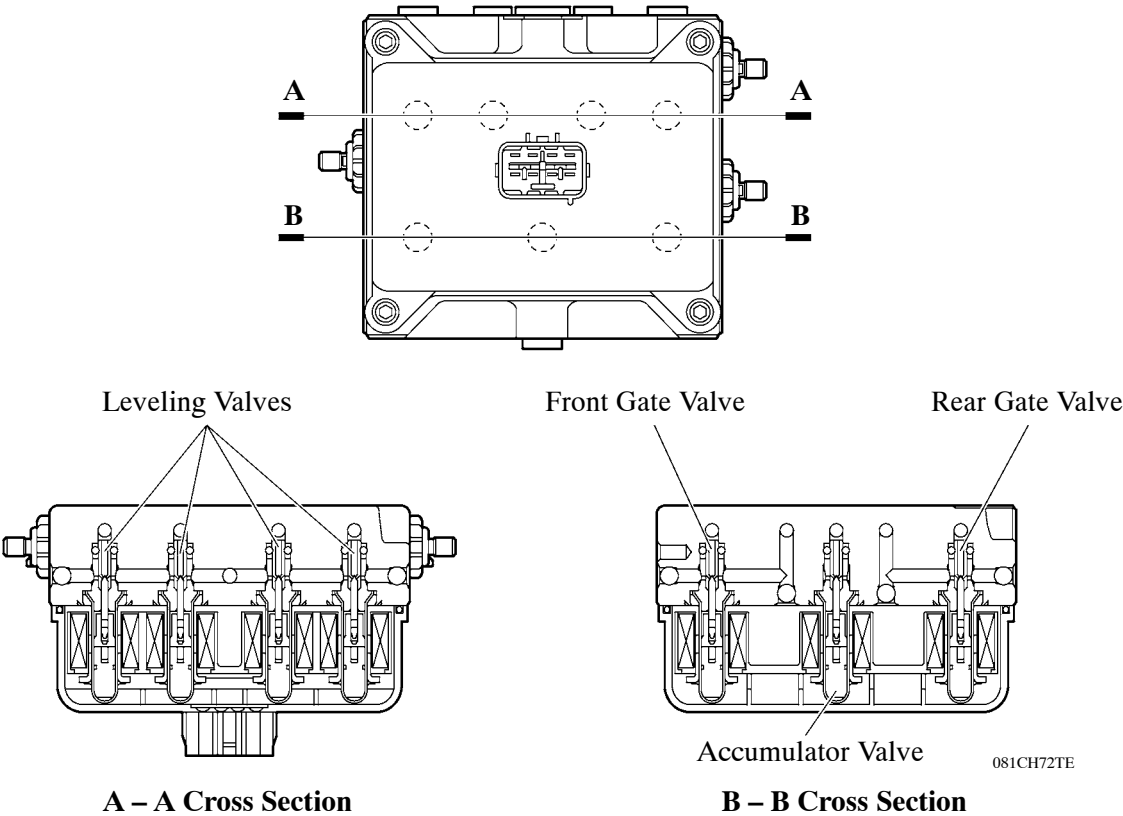
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► Specifications ◀

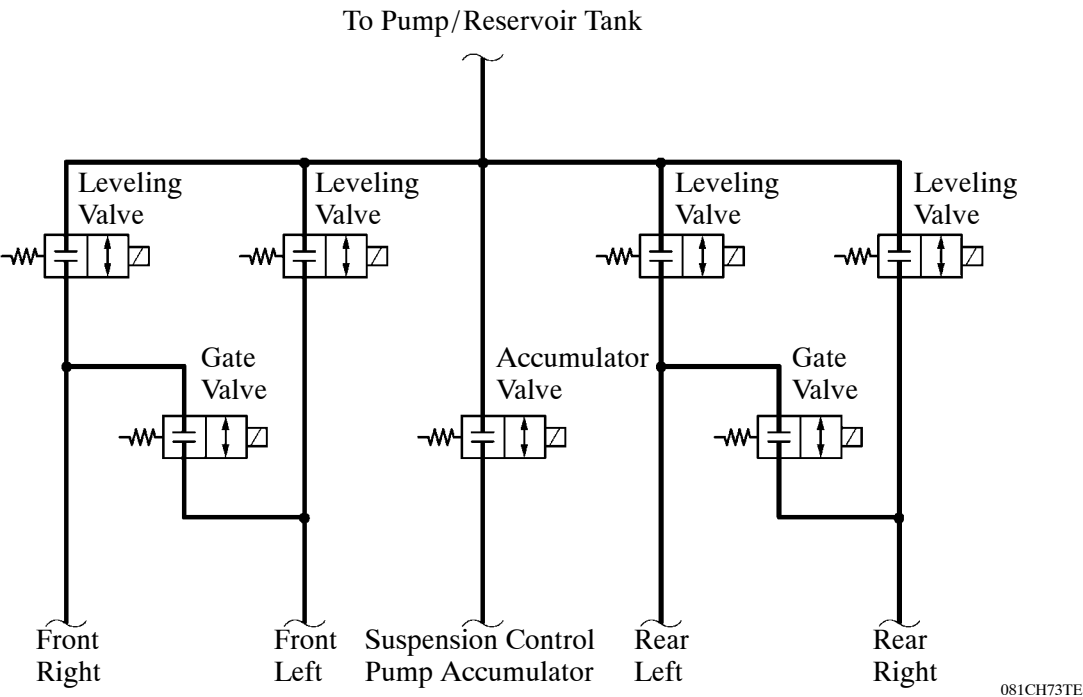
Sealed Gas		Nitrogen Gas
Gas Chamber Volume	cc (cu in.)	945 (57.7)
Sealed Gas Pressure	MPa (kgf/cm ² , psi)	5.9 (60, 856)

Height Control Valve

The height control valve is comprised of four leveling valves, two gate valves and an accumulator valve.

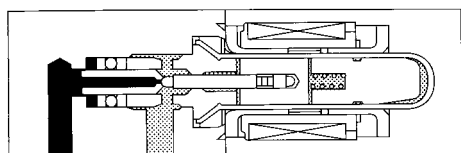


► Arrangement Layout of Hydraulic Tubes ◄



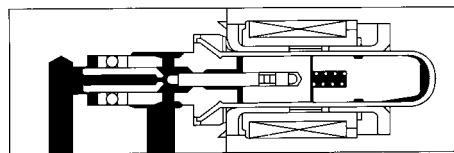
1) Leveling Valve

This valve opens and closes the fluid passage between the pump and the gas chamber located at each wheel. Normally, the fluid passage remains closed. During vehicle height control, the fluid passage opens in accordance with the signal received from the suspension control ECU.



Wheel Side Pump Side

Close



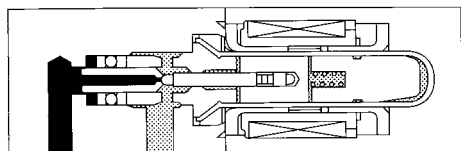
Wheel Side Pump Side

Open

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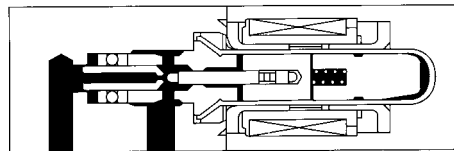
2) Gate Valve

This valve is provided for both the front and rear sides. This valve opens and closes the fluid passage to both the left and right leveling valves. Normally, the fluid passage is closed. The fluid passage opens in accordance with signals from the suspension control ECU, thereby balancing the fluid pressure for both the left and right gas chambers.



Left Side Right Side

Close



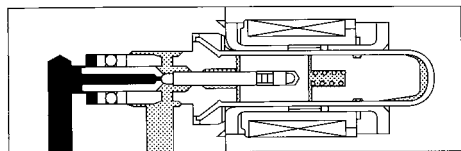
Left Side Right Side

Open

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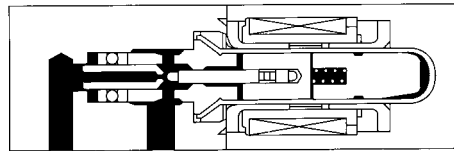
3) Accumulator Valve

This valve opens and closes the fluid passage between the pump and the suspension control pump accumulator. Normally, the fluid passage remains closed. When the vehicle height is being raised or the fluid is being stored in the suspension control pump accumulator, the solenoid valve opens in accordance with the signal received from the suspension control ECU.



Accumulator Side Pump Side

Close



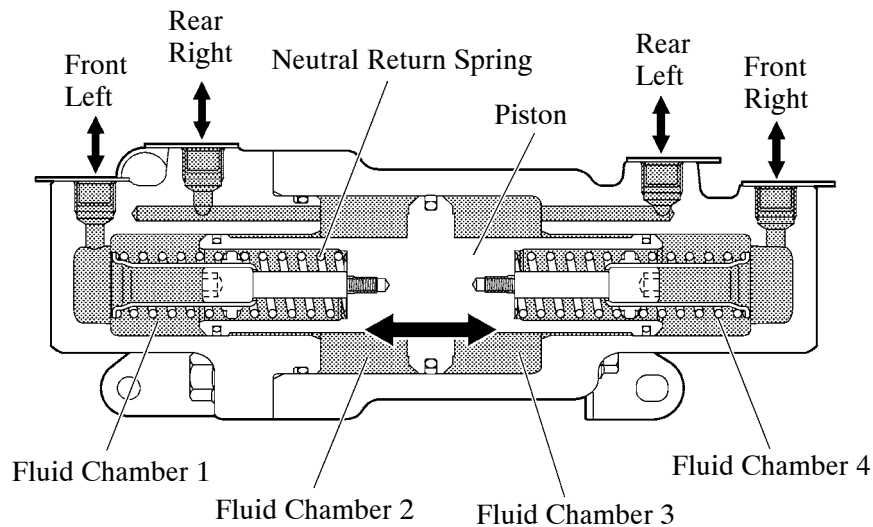
Accumulator Side Pump Side

Open

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Center Suspension Control Cylinder

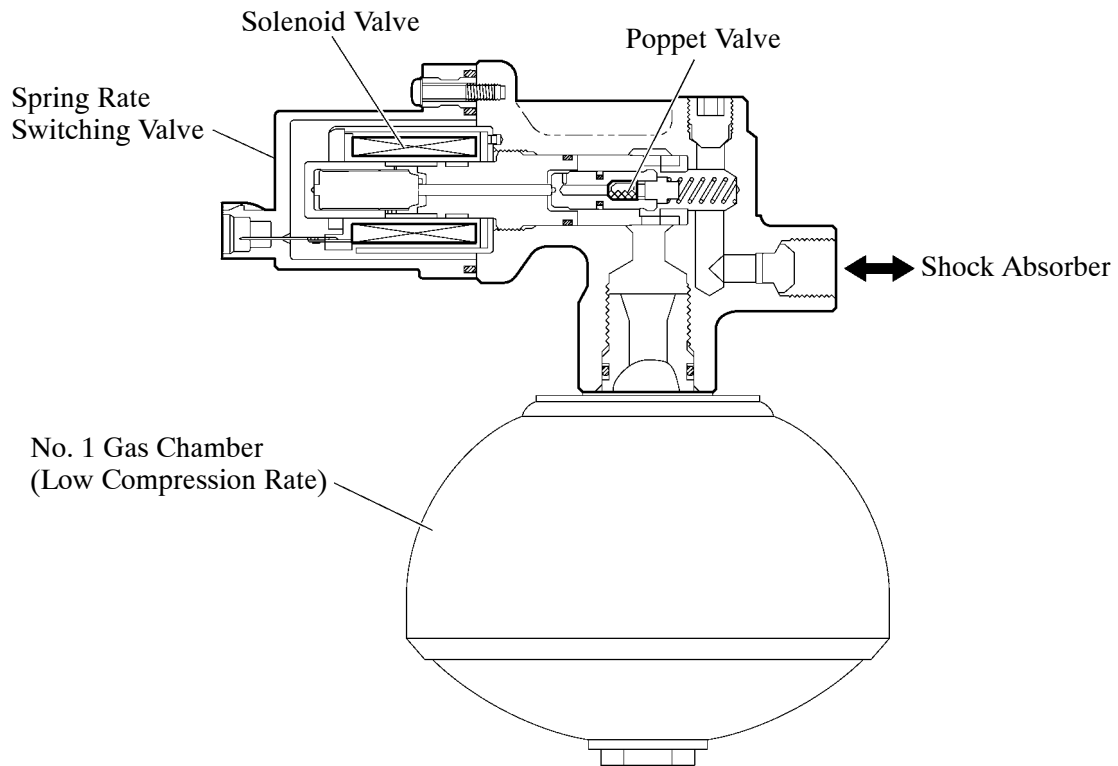
- The center suspension control cylinder is comprised of four fluid chambers and a piston.
- The fluid chambers are connected to each other via the hydraulic tubes from each of the shock absorbers. The center suspension control cylinder optimally distributes the hydraulic pressure for each of the wheels through the piston which operates in accordance with the input hydraulic pressure.



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Spring Rate Switching Valve

- This valve is provided in the front suspension control valve assembly, and it opens and closes the fluid passage to the No. 1 gas chamber to perform spring rate control.
- Normally, the fluid passage remains opened. During spring rate control, the fluid passage closes in accordance with the signal received from the suspension control ECU.

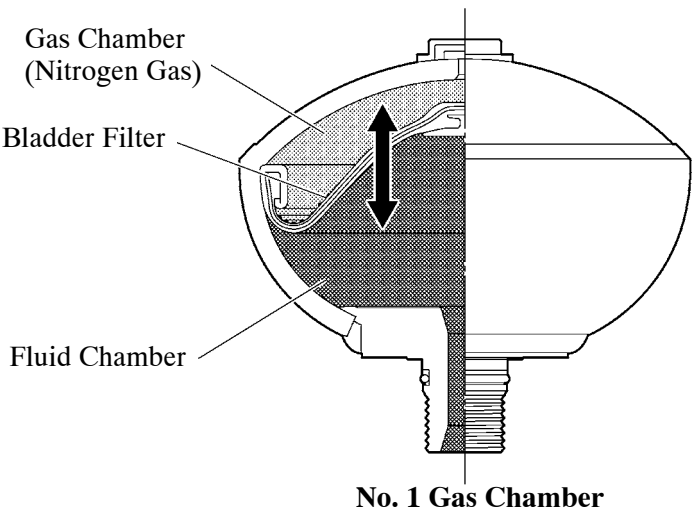
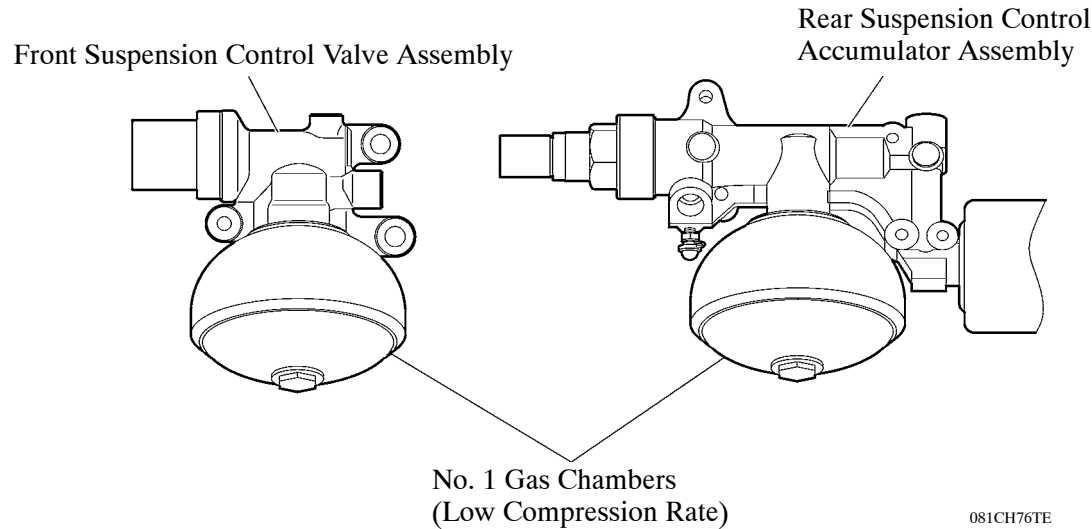


Front Suspension Control Valve Assembly

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No. 1 Gas Chamber

- The No. 1 gas chamber is provided for each of the wheels. This gas chamber is designed with a low compression rate utilizing a large-volume gas chamber.
- The front No. 1 gas chamber is provided for the front suspension control valve assembly.
- The rear No. 1 gas chamber is provided for the rear suspension control accumulator assembly.
- The No. 1 gas chamber uses the bladder filter type hydro-pneumatic accumulator. A resin membrane is sandwiched between rubber layers to realize excellent gas penetration resistance.
- The internal pressure of the gas chamber is varied by allowing the fluid to flow in and out of this gas chamber in order to raise or lower the vehicle height.

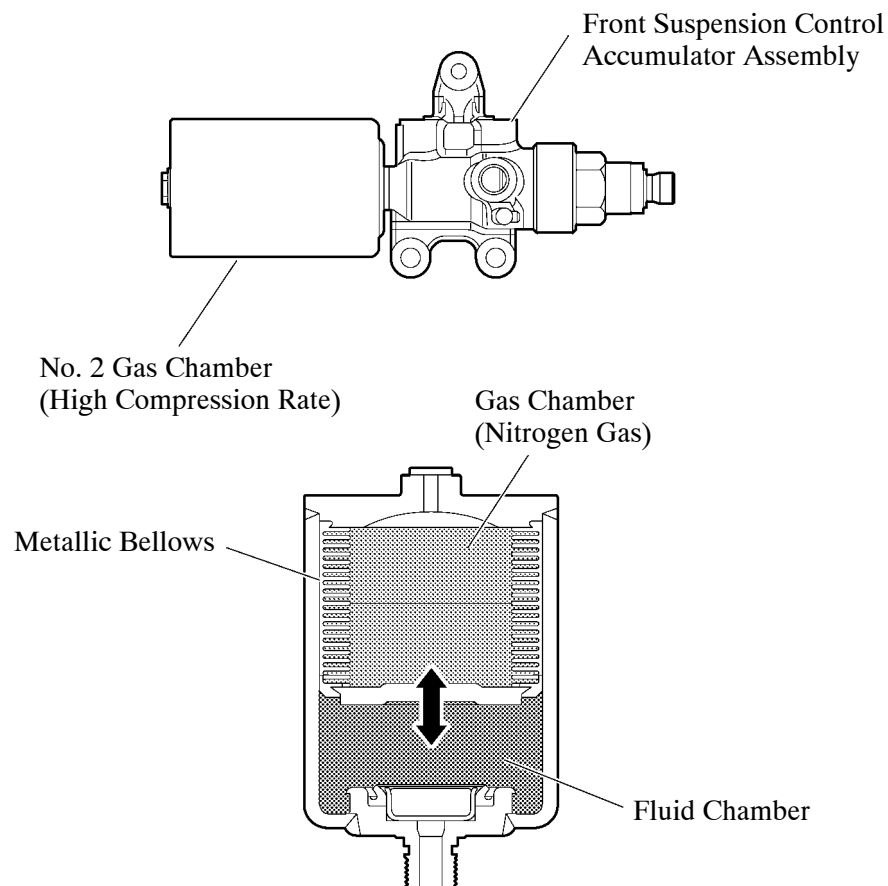


► Specifications ◀

No. 1 Gas Chamber	Front	Rear
Sealed Gas	Nitrogen Gas	←
Gas Chamber Volume cc (cu in.)	400 (24.4)	←
Sealed Gas Pressure MPa (kgf/cm ² , psi)	2.26 (23, 328)	1.90 (19, 276)

No. 2 Gas Chamber

- A No. 2 gas chamber is provided for the front suspension control accumulator assembly. This gas chamber is designed with a high compression rate utilizing a small-volume gas chamber.
- The No. 2 gas chamber uses a metallic bellows type hydro-pneumatic accumulator, to prevent gas leakage.
- The internal pressure of the gas chamber is varied by allowing the fluid to flow in and out of this gas chamber in order to raise or lower the vehicle height.



No. 2 Gas Chamber

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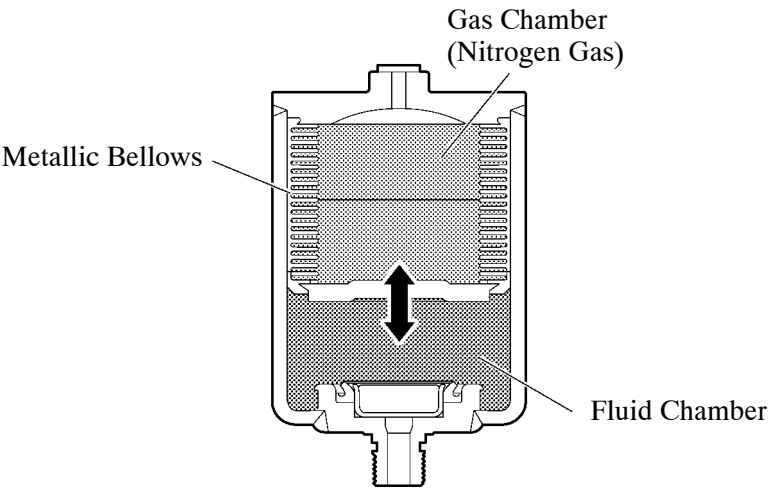
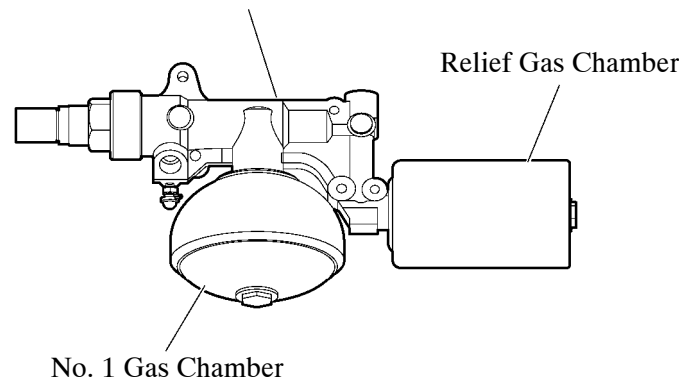
► Specifications ◀

Sealed Gas		Nitrogen Gas
Gas Chamber Volume	cc (cu in.)	120 (7.3)
Sealed Gas Pressure	MPa (kgf/cm ² , psi)	1.8 (18, 261)

Relief Gas Chamber

- A relief gas chamber is provided for each of the wheels. This protects the hydraulic system by reducing increases in the fluid pressure inside the hydraulic tubes for the 4-wheel active height control suspension.
- The front relief gas chamber is placed directly over the front hydraulic tubes.
- The rear relief gas chamber is provided for the rear suspension control accumulator assembly.
- The relief gas chamber uses a metallic bellows type hydro-pneumatic accumulator likewise with the No. 2 gas chamber.
- The fluid inside the hydraulic tubes is allowed to flow into the relief gas chamber when the fluid pressure inside the hydraulic tubes exceeds the pressure of the nitrogen gas sealed in the relief gas chamber. Thus, fluid pressure increases inside the hydraulic tubes can be reduced.

Rear Suspension Control Accumulator Assembly



Relief Gas Chamber

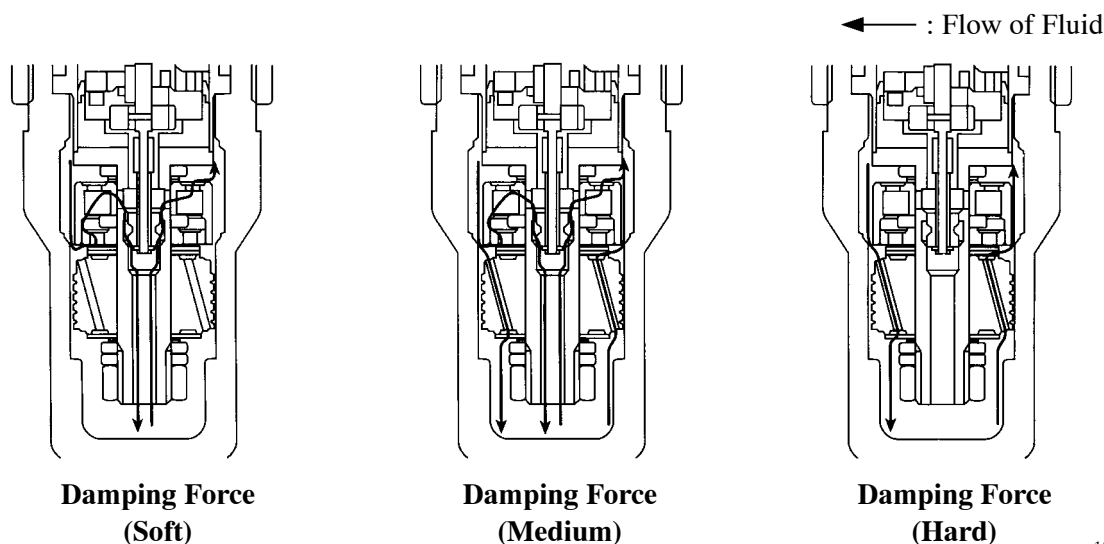
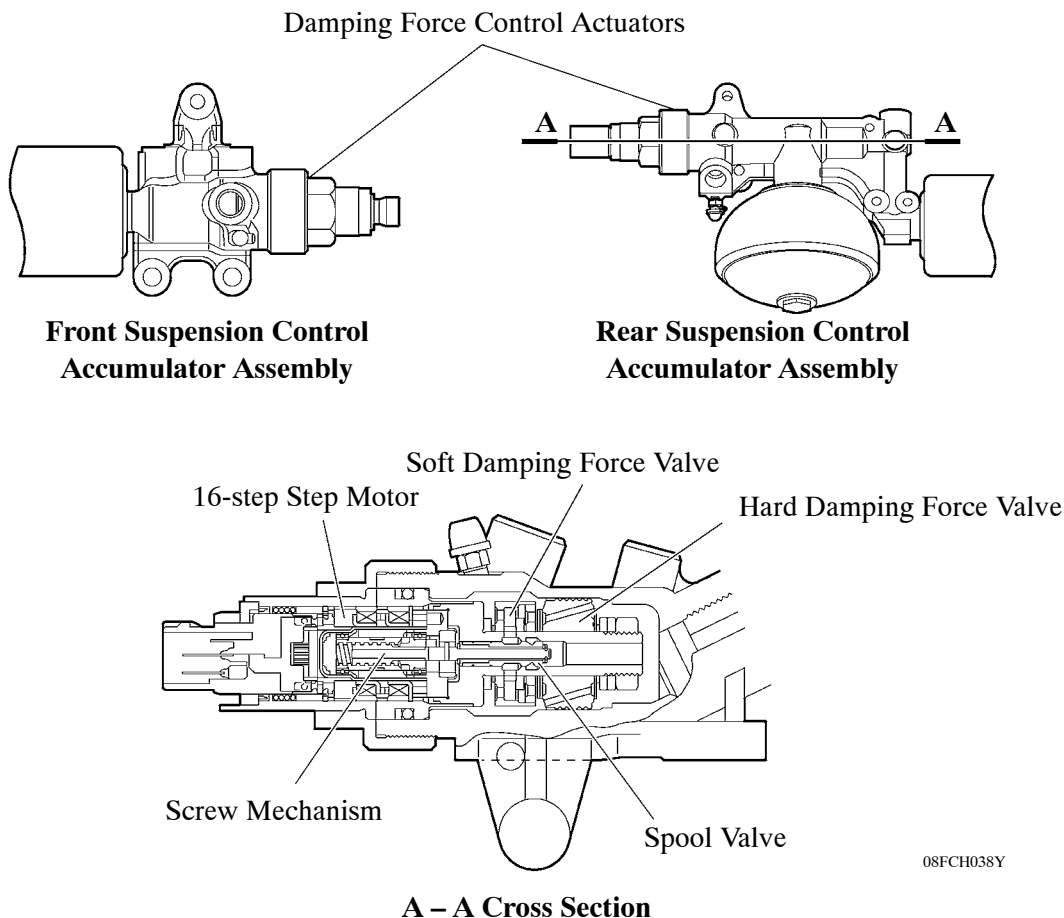
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► Specifications ◀

Relief Gas Chamber		Front	Rear
Sealed Gas		Nitrogen Gas	←
Gas Chamber Volume	cc (cu in.)	120 (7.3)	150 (9.2)
Sealed Gas Pressure	MPa (kgf/cm ² , psi)	13.5 (138, 1958)	10 (102, 1450)

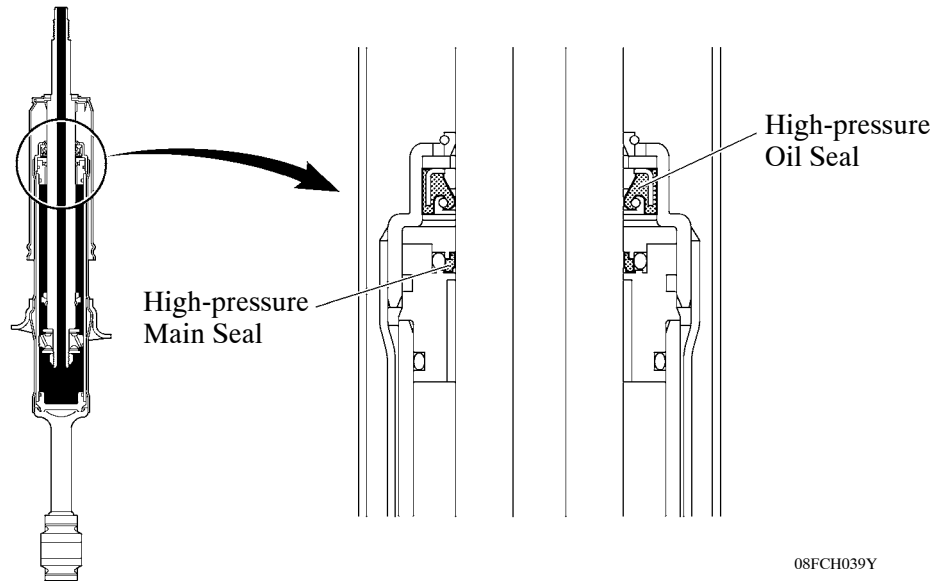
Damping Force Control Actuator

- The damping force control actuator is provided for each of the suspension control accumulator assemblies.
- This actuator consists of a 16-step step motor, a screw mechanism (which converts the rotational movement to a linear movement), a spool valve, a soft damping force valve and a hard damping force valve.
- Signals from the suspension control ECU activate the actuator, causing the spool valve to switch the fluid passage. Thus, the volume of fluid that passes through each valve is varied in order to control the damping force in 16 steps.

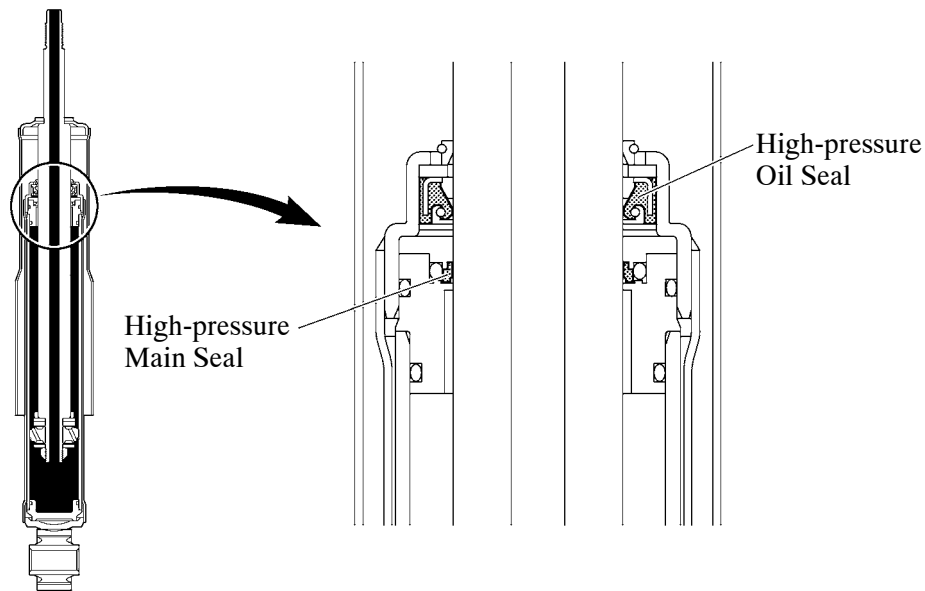


Shock Absorber

- The shock absorber has a dual construction using a high-pressure main seal made of fluoroethylene resin and a high-pressure oil seal made of nitrile rubber and provided with a backup ring in order to ensure sealing performance and reduce friction.
- The piston size has been increased to improve response, drivability, and ride comfort.



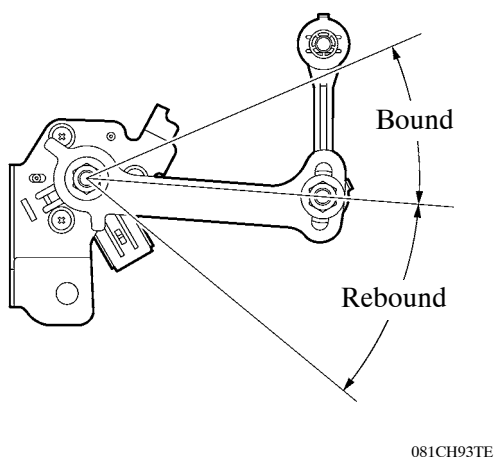
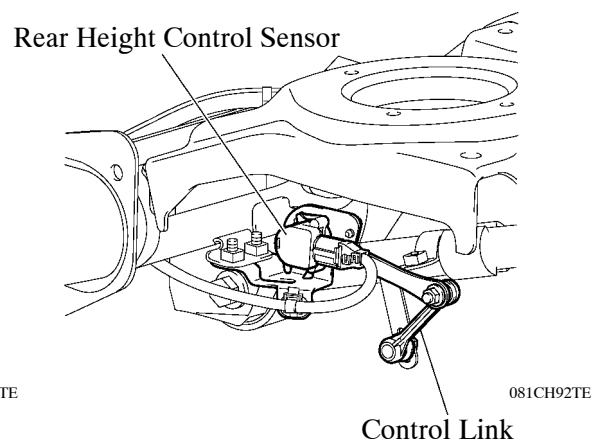
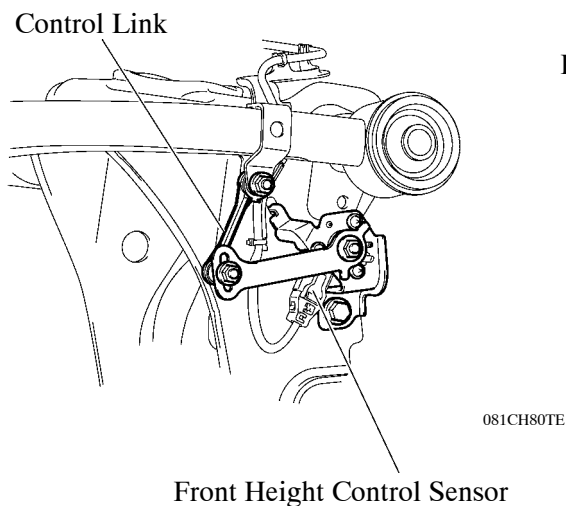
Front Shock Absorber



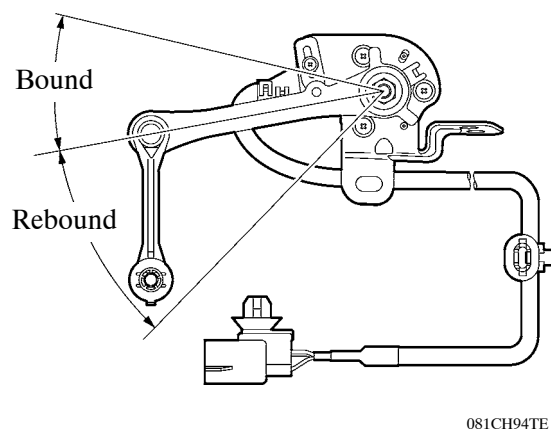
Rear Shock Absorber

Height Control Sensor

- Hall IC type height control sensors have been provided. The Hall IC converts the changes in the magnetic flux that occur at that time into electrical signals, and outputs them in the form of height control sensor effort to the suspension control ECU.
- There are two front height control sensors, one for the right, and the other for the left. They are mounted via the control links to the upper arms of the front suspension and to the body.
- There are also two rear height control sensors, one for the right, and the other for the left. They are mounted via the control links to the upper control arms of the rear suspension and to the body.
- Through the use of a height control sensor link and shaft, each height control sensor converts the rectilinear movement of the control link into a rotational movement, and the result is detected in the form of a rotational angle.



Front Height Control Sensor

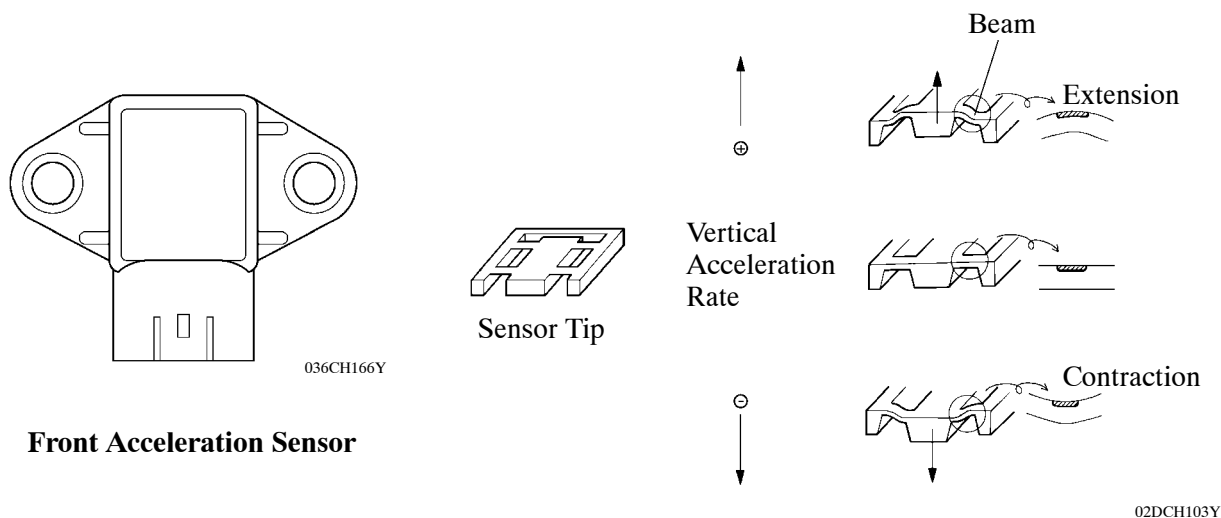


Rear Height Control Sensor

Acceleration Sensor

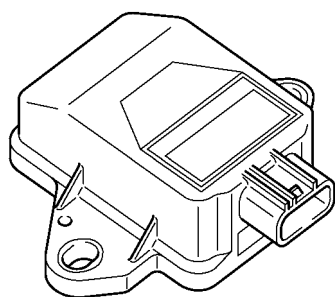
- The acceleration sensors detect the vertical movement above the body.
- The front acceleration sensors are placed on the right and left sides of the instrument panel and the rear acceleration sensor is placed inside the suspension control ECU. Thus, the acceleration sensors independently detect the vertical acceleration rate of the vehicle.

► Method for Detecting Vertical Acceleration ◀



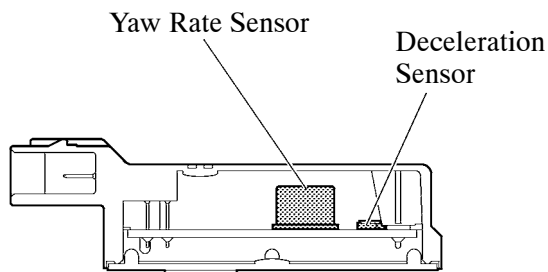
Yaw Rate and Deceleration Sensor

- A deceleration sensor is built into the yaw rate sensor.
- This sensor detects the yaw rate and lateral and longitudinal acceleration and deceleration, and sends this signal to the suspension control ECU.



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Yaw Rate and Deceleration Sensor

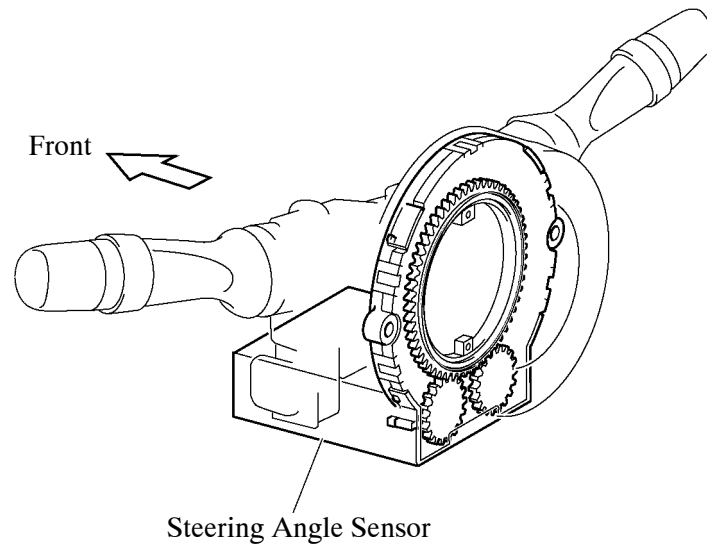


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Cross Section

Steering Angle Sensor

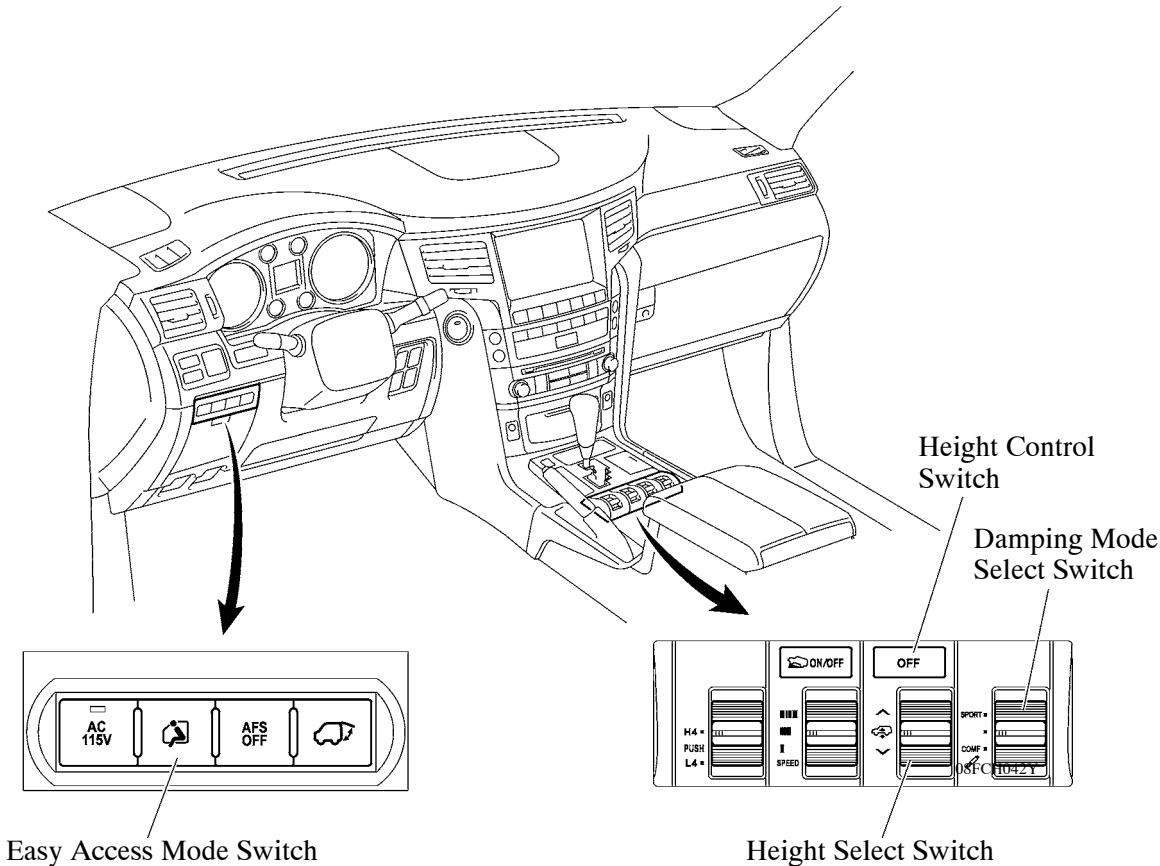
- A steering angle sensor is provided in the combination switch area. This sensor detects the amount of steering effort and the direction of steering wheel.
- The sensor assembly contains two sets of magnetic reluctance elements that detect the rotational movement of a magnet that is built into the detection gear. Thus, the sensor detects the changes that occur in the magnetic reluctance elements along with the rotational movement of the detection gear, in order to detect the rotational movement of the steering wheel.



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Suspension Control Switch and Easy Access Mode Switch

- The suspension control switch (the height select switch, height control switch, and damping mode select switch) is placed on the center console.
- The easy access mode switch is placed on the left side of the instrument panel.



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Switch		Function
Suspension Control Switch	Height Select Switch	Selects vehicle height between three levels by operating this switch. When the height control switch is ON, vehicle height cannot be changed.
	Height Control Switch	Prohibits the vehicle height control by operating this switch.
	Damping Mode Select Switch	Selects damping force between three levels by operating this switch.
Easy Access Mode Switch		Switches the easy access control between ON and OFF by operating this switch.