

■ ELECTRIC MODULATED SUSPENSION

1. General

Through electronic control, this system automatically controls the damping force of the shock absorbers, thus realizes excellent riding comfort and controllability.

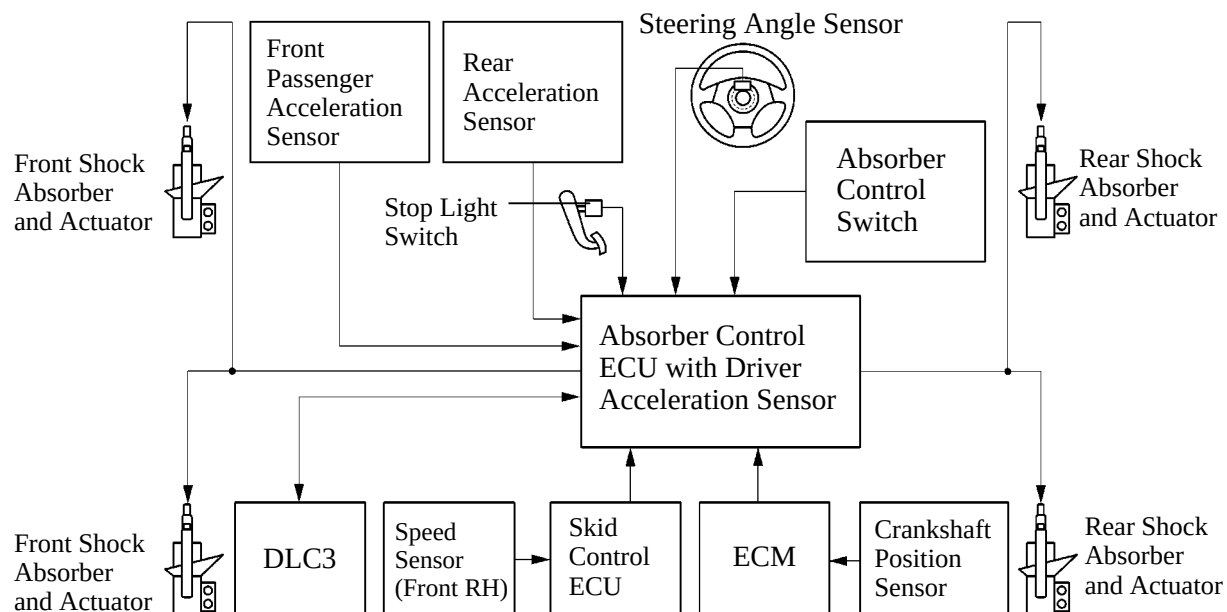
– Main Changes –

Construction and Operation of Component	• 2 acceleration sensors (front passenger and rear) have been provided. • The construction of the steering angle sensor has been changed. • The damping force of the shock absorbers has been changed.
System Control	• The semi-active control of the damping force has been changed from sky-hook control to non-linear H^∞ control in order to effect 4-wheel independent control that constantly achieves an optimal damping force in relation to the bumpiness of the road surface. As a result, excellent ride comfort has been realized. • Imaginary roll damper control has been adopted for damping force control to optimize the vehicle roll attitude during cornering. As a result, excellent cornering stability and controllability have been realized.
Diagnosis	• Outputs a 5-digit DTC (Diagnosis Trouble Code) and a 2-digit DTC to support the M-OBD (Multiplex On-Board Diagnosis) system. • The DLC1 has been discontinued. • The method for erasing the DTCs has been changed.

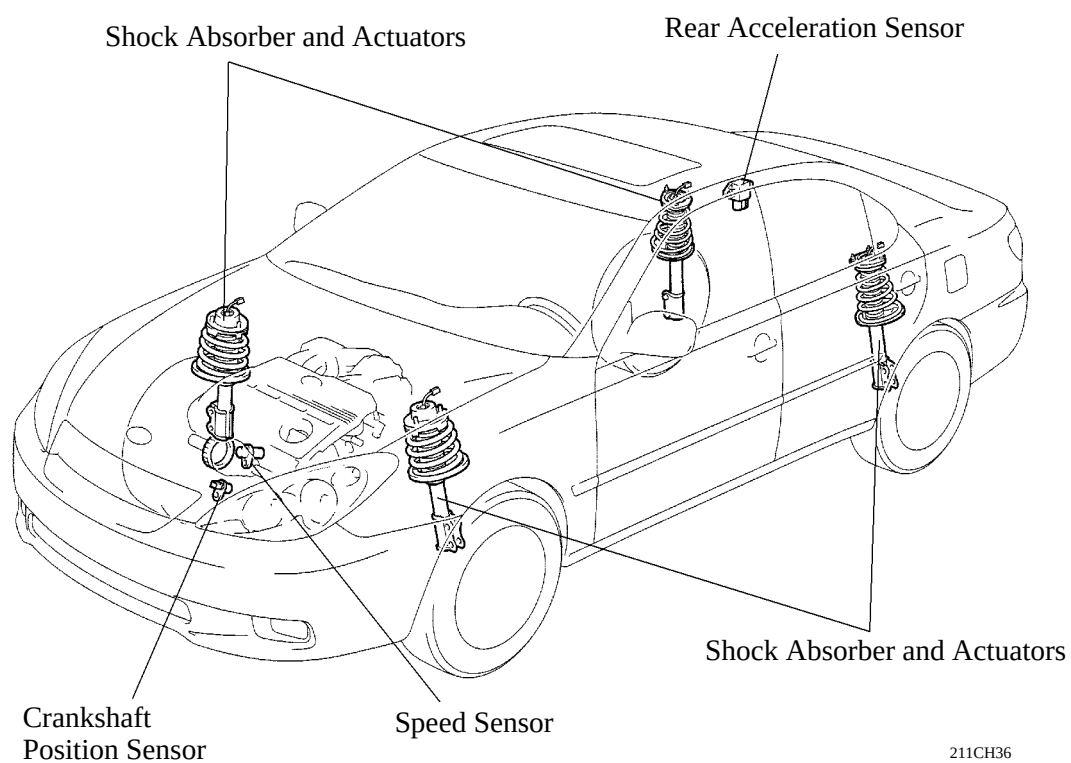
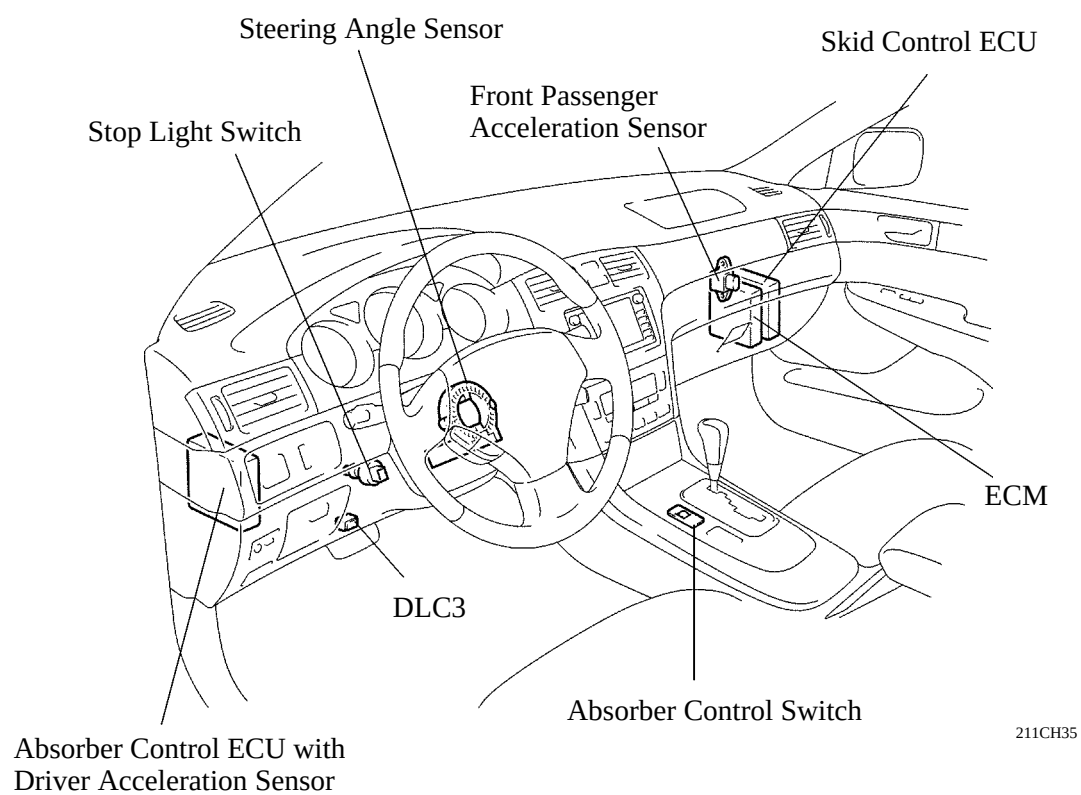
–Reference–

- 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 theory. The “ ∞ ” represents the “ ∞ norm”, which is one of the mathematical units used for measuring the size of the signals.

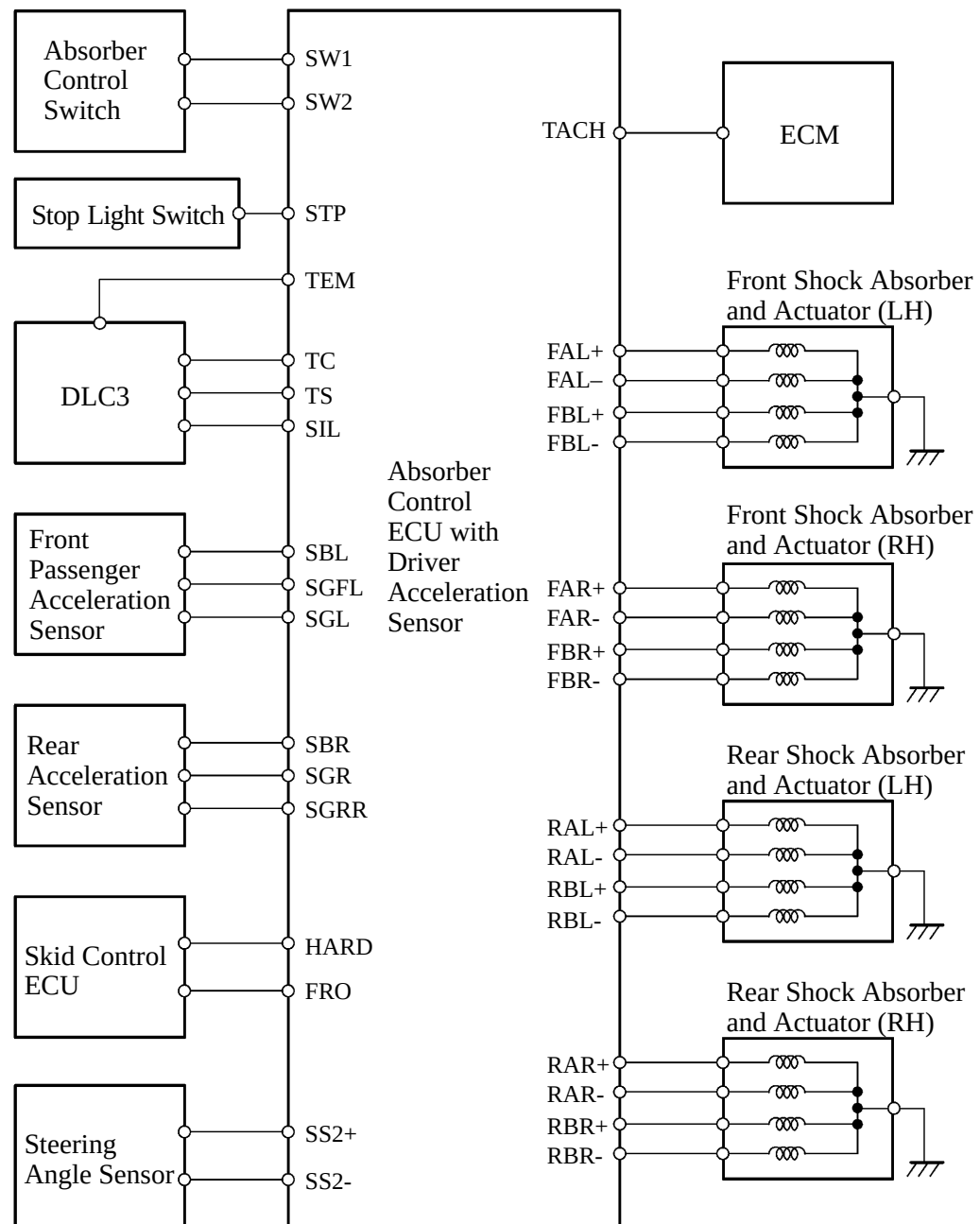
2. System Diagram



3. Layout of Component



4. Wiring Diagram



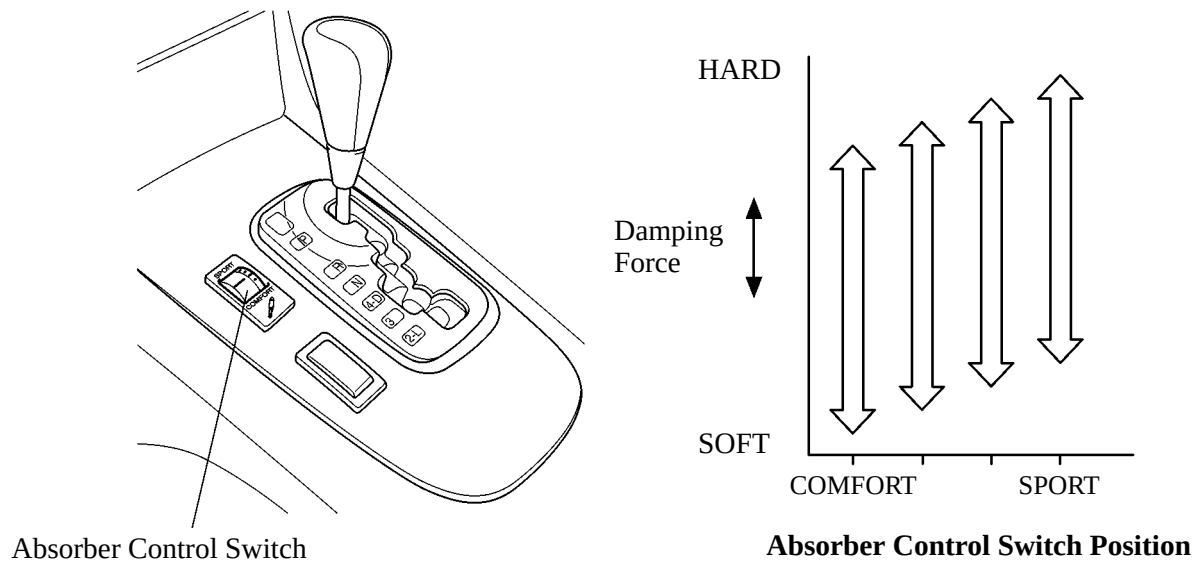
5. Function of Component

Component	Function
Steering Angle Sensor	Detects the steering direction and angle of the steering wheel.
Front Passenger Acceleration Sensor	Detects the vehicle's vertical (front passenger side) acceleration rate.
Rear Acceleration Sensor	Detects the vehicle's vertical acceleration rate.
Speed Sensor (Front Right)	Detects the wheel speed of front right wheel.
Shock Absorber and Actuator	Changes the damping force by the absorber control ECU signal.
Skid Control ECU	Converts the wheel speed signal from the speed sensors and sends it to the absorber control ECU.
Crankshaft Position Sensor	Detects the engine speed.
ECM	Sends the engine speed signal from the crankshaft position sensor to the absorber control ECU.
Absorber Control ECU with Driver Acceleration Sensor	● Determines the condition of the vehicle based on the signals received from the sensors and switches and sends a control signal to the actuator located in the shock absorber. ● Uses an internal acceleration sensor to detect the vehicle's vertical (driver side) acceleration rate.
Stop Light Switch	Detects the brake condition.
Absorber Control Switch	Selects the damping force of the shock absorber.

6. Construction and Operation of Component

Absorber Control Switch

As in the '01 ES300, the absorber control switch uses a rotary type switch. By operating this switch, the driver can select 4 types of damping forces of the shock absorbers.

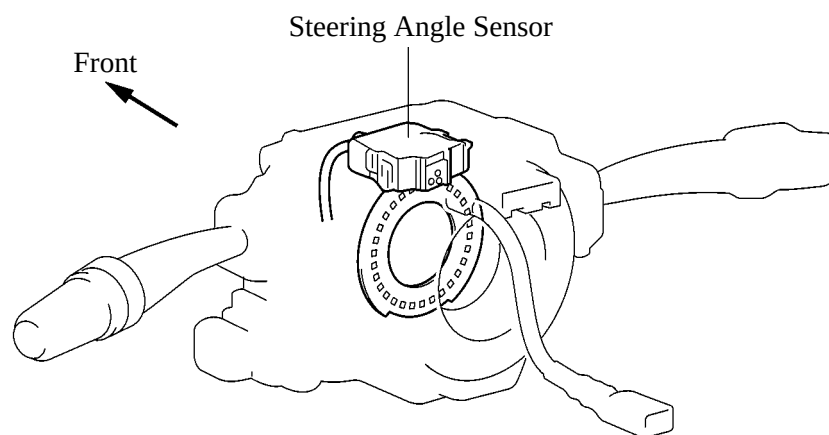


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Steering Angle Sensor

This sensor contains 3 photo interrupters with phases, and a slotted disc interrupts the light to turn the photo transistor ON and OFF to detect the steering direction and angle.

This steering angle sensor is the same steering angle sensor as used for ABS with EBD & Brake Assist & TRAC & VSC system.



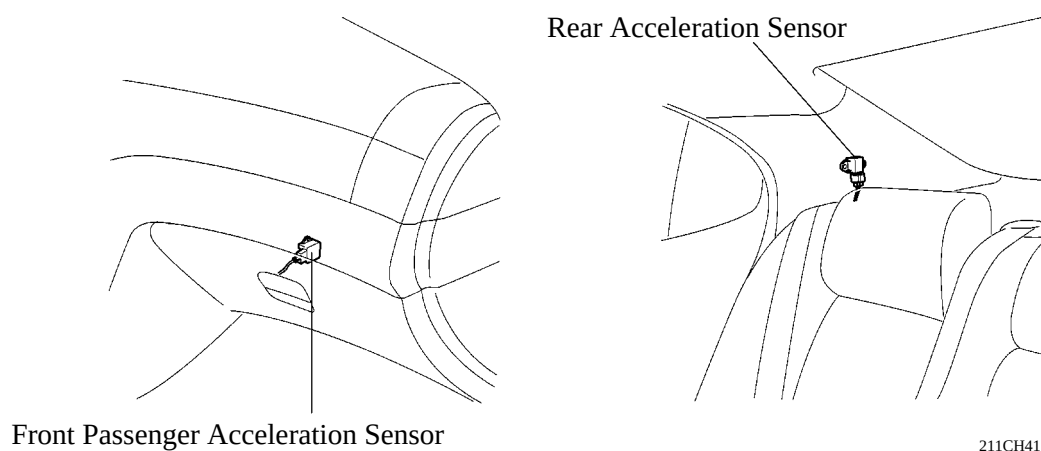
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Acceleration Sensor

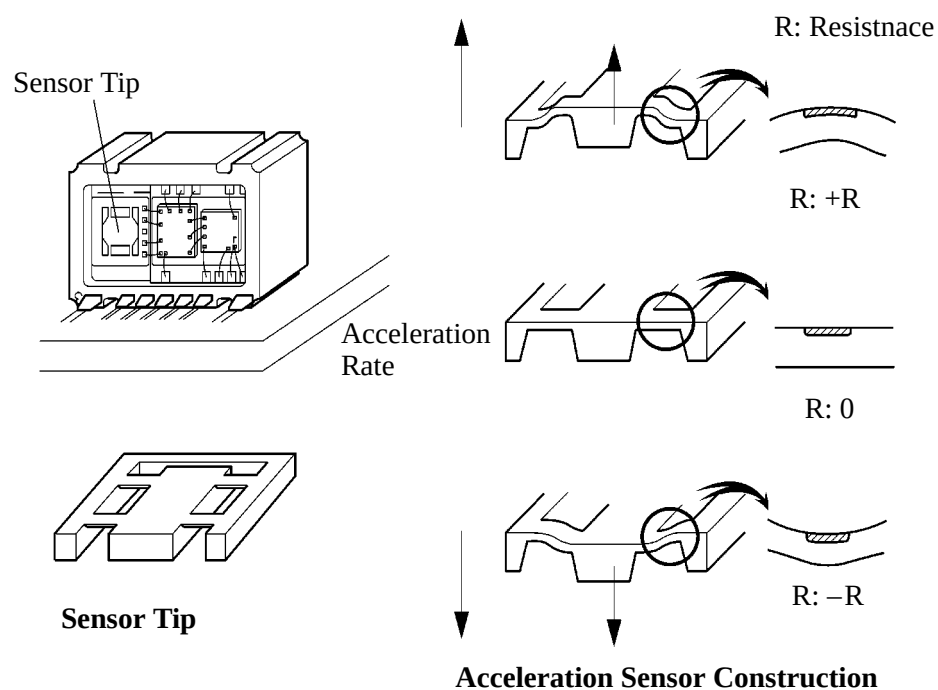
The driver acceleration sensor is built into the absorber control ECU.

The front passenger acceleration sensor is fitted to the instrument panel reinforcement.

The rear acceleration sensor is fitted to the right roof side inner.



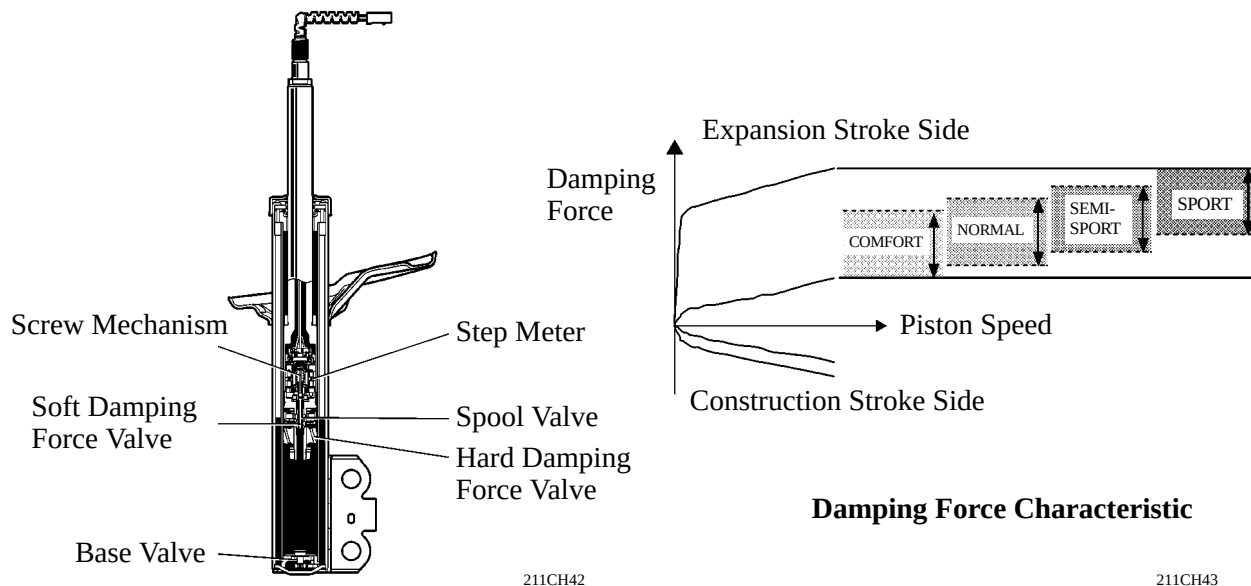
These sensors are the piezoresistive type. When the vehicle accelerates, a piezoresistive sensor deflects, thus changing its resistance. The resistance is then converted into an electrical signal in order to output a voltage that is proportionate to the acceleration rate.



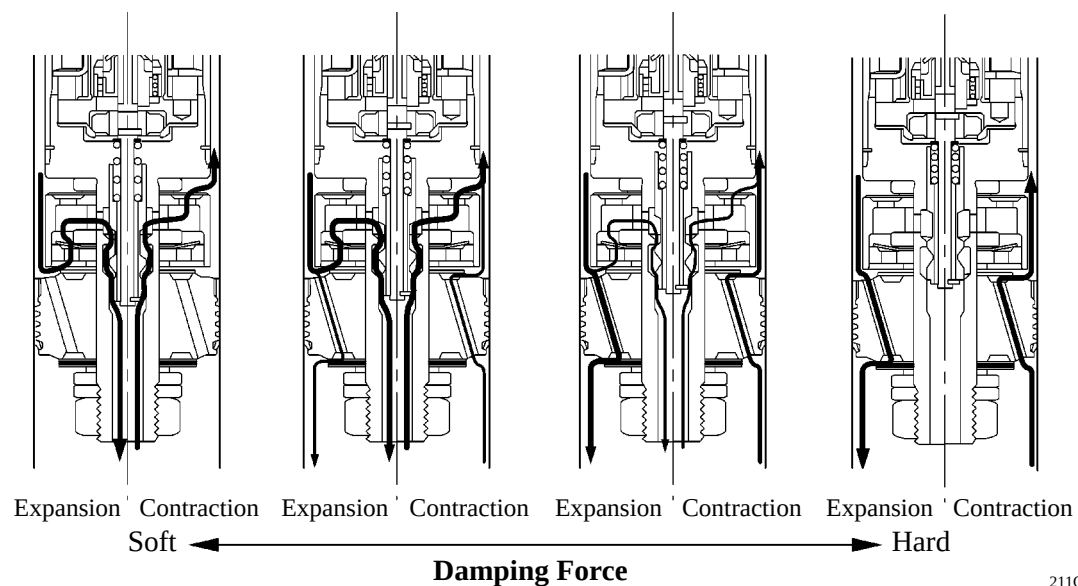
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Front and Rear Shock Absorber

- The basic construction and operation of the shock absorbers on the '02 ES300 are the same as those of the '01 ES300. However, the damping force of the shock absorbers has been changed for the '02 ES300.
- The piston rod of the shock absorber is equipped with an internal actuator. The actuator consists of a step motor, a screw mechanism (which converts the rotational movement to a linear movement) and a spool valve. Also, the piston rod is equipped with a soft damping force valve and a hard damping force valve.
- Signals from the absorber control ECU activate the actuator causing the spool valve to switch the oil passage. Thus, the volume of oil that passes through each valve is varied in order to control the damping force in 16 steps.



► Flow of Oil ◀

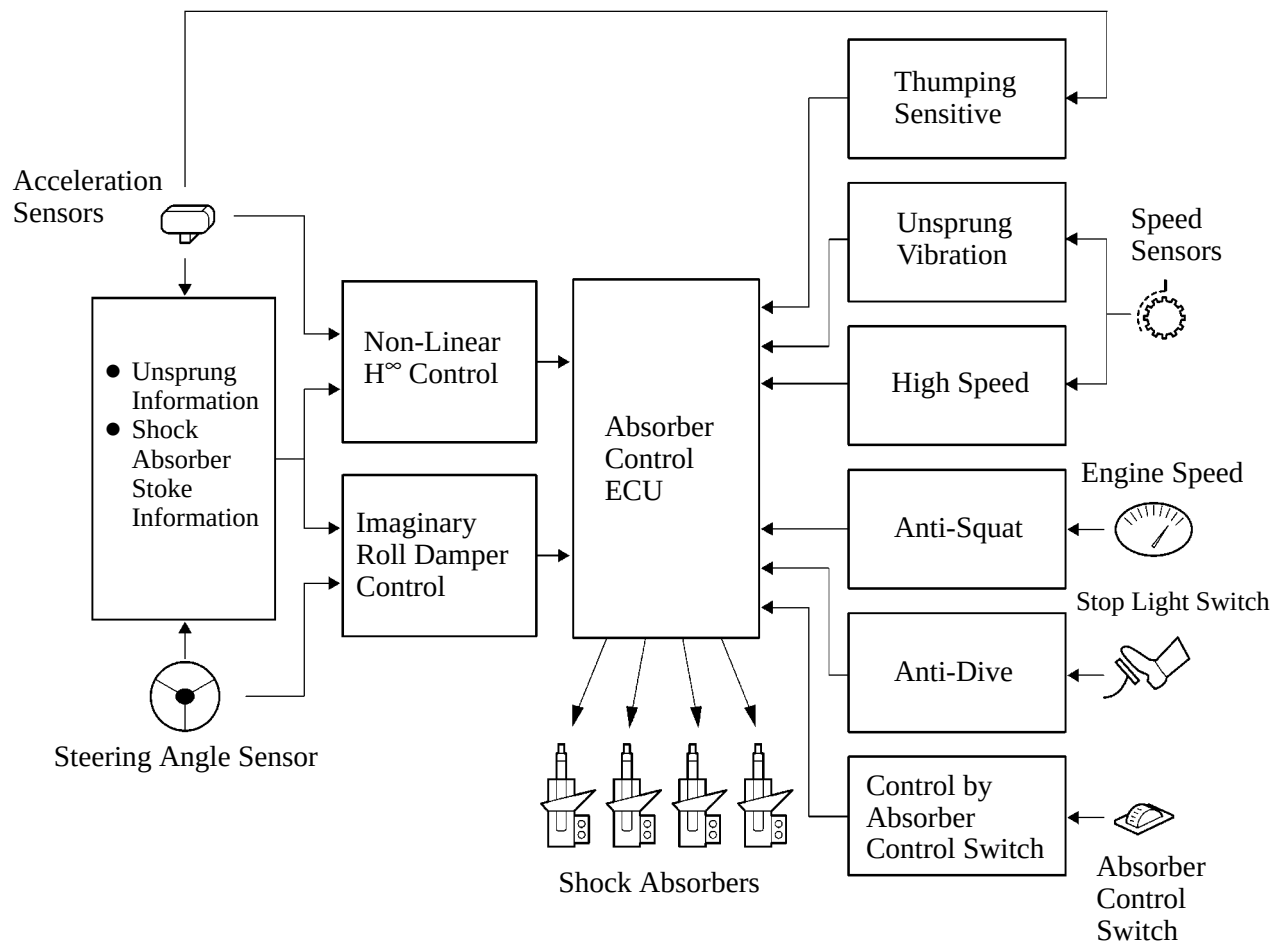


7. Electronic Modulated Suspension System Control

General

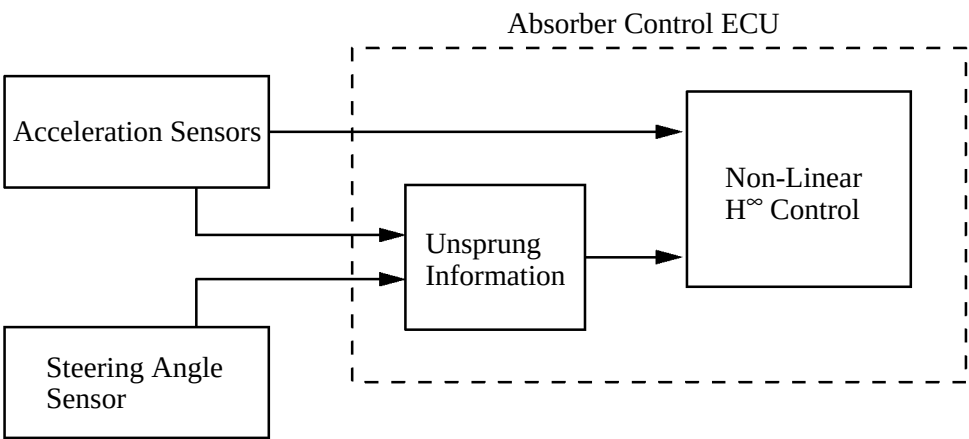
The electronic modulated suspension system of '02 ES300 and '01 ES300 are compared below.

Control		Function	'02 ES300	'01 ES300
Semi-Active Control	Non-Linear H^∞ Control	Smoothly changes the damping force to a target value in accordance with the changes in the road surface or driving conditions. Thus, excellent ride comfort has been realized while ensuring a level of vibration damping performance that is higher than the sky-hook control of the '01 ES300.	○	—
	Sky-Hook Control	Changes the damping force to a target value in accordance with the changes in the road surface or driving conditions. Thus, excellent ride comfort has been realized while ensuring a high level of vibration damping performance.	—	○
Thumping Sensitive Control		When the road surface condition does not require a damping force, this function controls the shock absorbers so that their damping force will not increase.	○	○
Unsprung Vibration Control		If unsprung resonance is detected, this function controls so that the damping force will not decrease below a certain level, in order to reduce the unsprung resonance.	○	○
Imaginary Roll Damper Control		Changes the damping force to control the vehicle posture during cornering. As a result, excellent stability and controllability have been realized during cornering.	○	—
Anti-Roll Control		During cornering, this function makes the damping force firmer, thus restraining the body roll speed in order to realize excellent stability and controllability.	—	○
Anti-Dive Control		During braking, this function makes the damping force firmer to restrain the body dive, thus ensuring excellent stability and controllability.	○	○
Anti-Squat Control		During acceleration, this function makes the damping force firmer to minimize the changes in the vehicle body posture.	○	○
High Speed Control		This function varies the variable range of the damping force according to vehicle speed in order to realize a soft and comfortable ride and a stable driving condition. The damping force is controlled at a softer variable range at low speeds, and at a firmer variable range at high speeds.	○	○
Control by Absorber Control Switch		The absorber control switch enables the driver to select a desired damping force from the 4 modes.	○	○
Fail-Safe		When the absorber control ECU detected a malfunction, the control of the damping force will be limited.	○	○
Diagnosis		When the absorber control ECU detects a malfunction, the absorber control ECU makes a diagnosis and memorizes the failed section.	○	○

Control Diagram

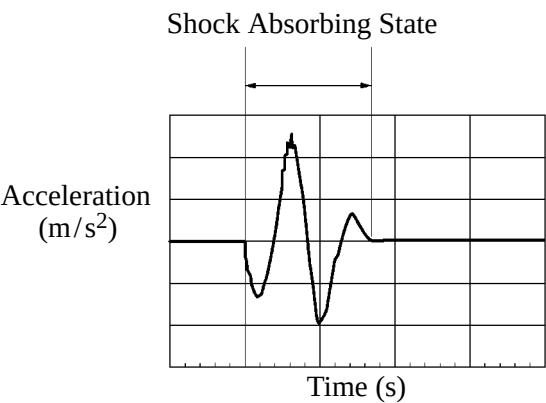
Semi-Active Control (Non-Linear H^∞ Control)

- To effect this control, the unsprung information is calculated based on the sprung acceleration rate from the 3 acceleration sensors and the information from the steering angle sensor. Thus, the driving conditions of the vehicle are detected.



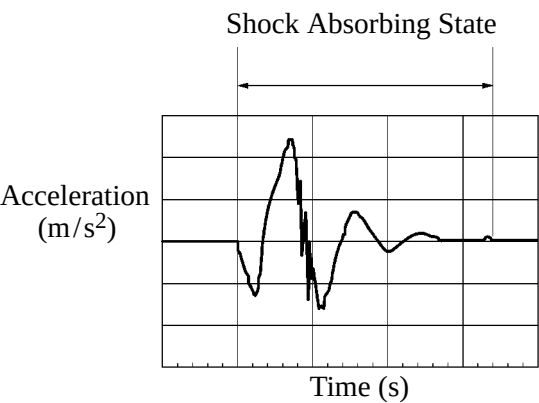
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- This control smoothly changes the damping force to a target value in accordance with the changes in the road surface or driving conditions. Thus, excellent ride comfort has been realized while ensuring a high level of vibration damping performance.



**'02 ES300
(Non-Linear H^∞ Control)**

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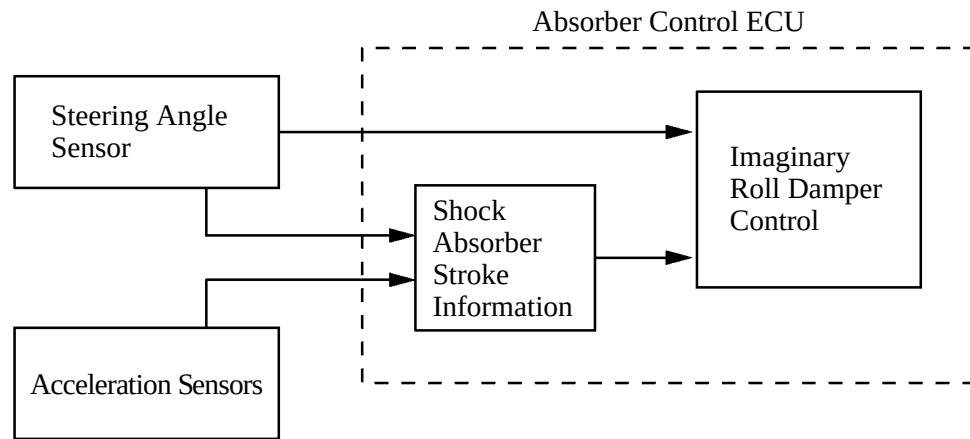


**'01 ES300
(Sky-Hook Control)**

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Imaginary Roll Damper Control

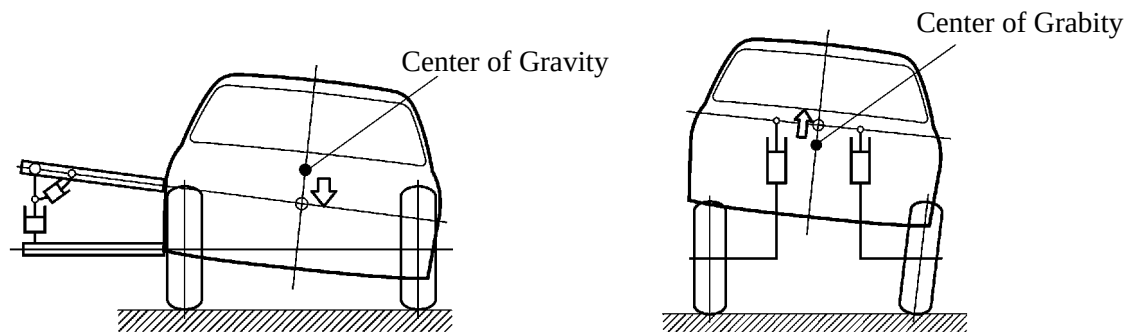
- To effect this control, the stroke information of the shock absorbers is calculated based on the information from the 3 acceleration sensors and a steering angle sensor. Thus, the driving conditions of the vehicle are detected.



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- Changes the damping force to control the vehicle posture during cornering. As a result, excellent stability and controllability have been realized during cornering. This control assumes that two types of shock absorbers, (one for restraining roll and the other for restraining lift) are provided at an imaginary point on the inside of the turn of the vehicle. The function of these shock absorbers is to prevent the center of gravity of the vehicle from rising.

The damping force of the front and rear shock absorbers is controlled in order to control the vehicle's posture as in this imaginary condition.



'02 ES300

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'01 ES300

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Diagnosis

When the absorber control ECU detected a malfunction, the absorber control ECU makes a DTC (Diagnosis Trouble Code) of that malfunction is stored in memory.

– Changes –

- The method for erasing the DTCs has been changed as follows (the DTCs on the '01 ES300 were erased by turning the ignition switch OFF):
Using the SST (09843-18040), short terminals Tc and CG of DLC3. Turn the ignition switch ON, and press the brake pedal 8 or more times within approximately 5 seconds.
- The DTCs can also be erased through the use of a hand-held tester.
- The DLC1 has been discontinued.
- M-OBD (Multiplex On-Board Diagnosis) system has been adopted. This system can output 5-digit DTC to the hand-held tester, which are more detailed than the previous 2-digit DTC.

► DTC Chart ◀

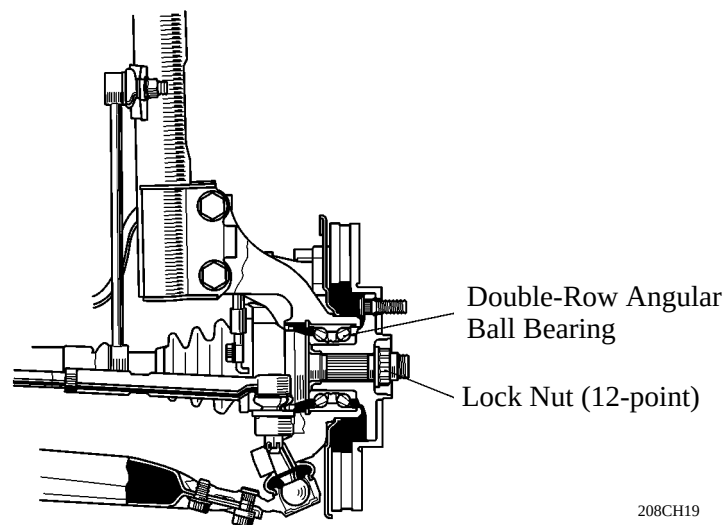
DTC No.	Detection Item	DTC No.	Detection Item
C1715/15	Front driver acceleration sensor malfunction	C1777/77	Steering angle sensor signal malfunction
C1716/16	Front passenger acceleration sensor malfunction	C1779/79	Engine speed signal malfunction
C1717/17	Rear acceleration sensor malfunction	C1782/82	Stop light switch signal does not input
C1725/21	Short/open circuit in front right absorber control actuator circuit	C1787/87	Absorber control switch signal malfunction
C1726/22	Short/open circuit in front left absorber control actuator circuit	C1791/91	Front driver acceleration sensor malfunction
C1727/23	Short/open circuit in rear right absorber control actuator circuit	C1792/92	Front passenger acceleration sensor malfunction
C1728/24	Short/open circuit in rear left absorber control actuator circuit	C1793/93	Rear acceleration sensor malfunction
C1774/74	Low battery positive voltage or abnormally high positive voltage	C1794/94	Front right speed sensor malfunction
C1776/76	Vehicle speed sensor signal malfunction	C1797/97	Engine speed signal malfunction

Refer to the 2002 LEXUS ES300 Repair Manual (Pub. No. RM 911U).

■ AXLE

1. Front Axle

- The front axle use a double-row angular ball bearing which offers low rolling resistance.
- A lock nut (12-point) has been adopted and staked for tightening the axle hub in order to ensure the tightening performance.
This nut cannot reused.
- A lead-free material is used in the front axle hub to address environmental concerns.



2. Rear Axle

- The rear axle use a double-row angular ball bearing which offers low rolling resistance.
- Part of the inner race is integrated with the shaft, thus optimizes the high rigidity.

