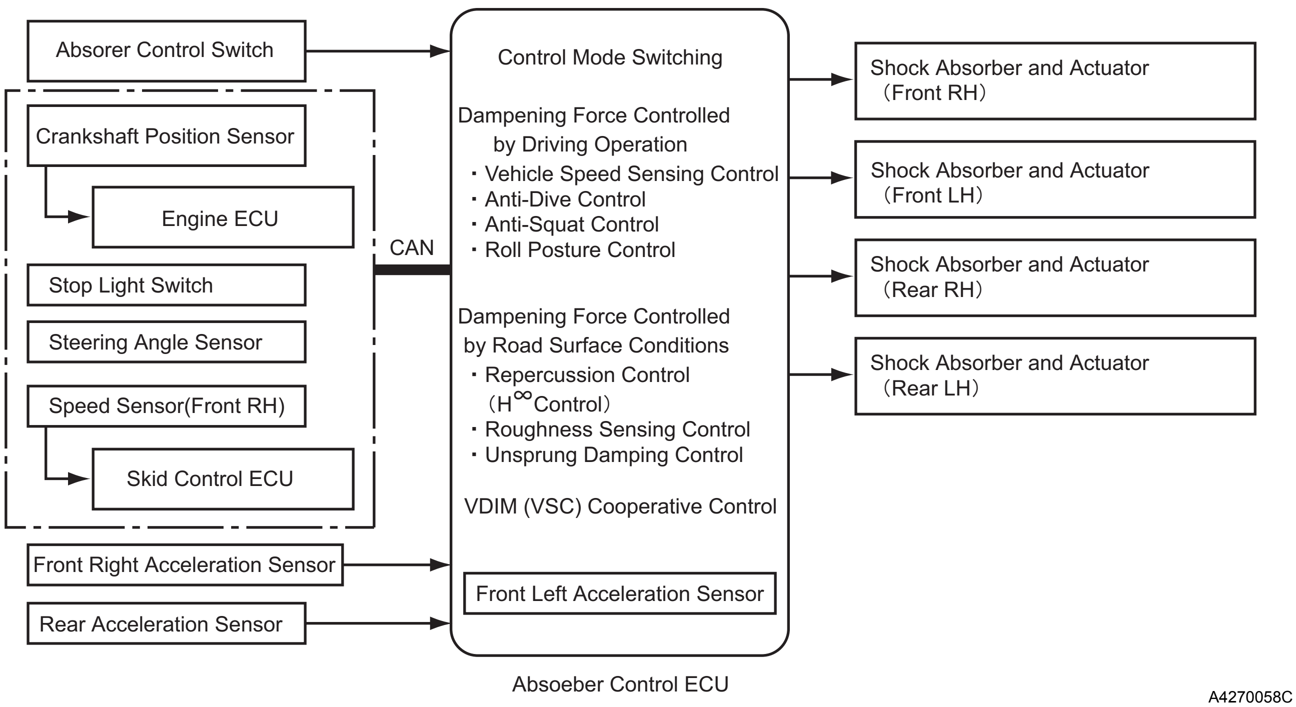
Absorber Control ECU

- Based on the setting mode selected at the absorber control switch and the data received from various types of sensors, the absorber control ECU changes the damping force of the shock absorbers independently at the four wheels.
- The following controls are available for changing the damping force: the vehicle speed-sensing control, anti-dive control, anti-squat control, and roll posture control that are effected in accordance with driving maneuvers; and repercussion control (H∞ control), roughness sensing control, and unsprung damping control that are effected in accordance with the vehicle movement (road surface conditions). In addition, a VSC cooperative control is available to support the operation of the VSC.
- The repercussion control uses nonlinear H∞ (H infinity) control that is based on a modern control logic to realize a finely tuned damping force control. This control detects the acceleration sensor signals in order to monitor the frequencies in which repercussions can be felt, as well as the frequencies in which roughness can be felt. Also, it detects the wheel speed sensor signals in order to monitor the frequencies of the unsprung vibrations, thus realizing a smooth damping performance that suits the driving conditions.

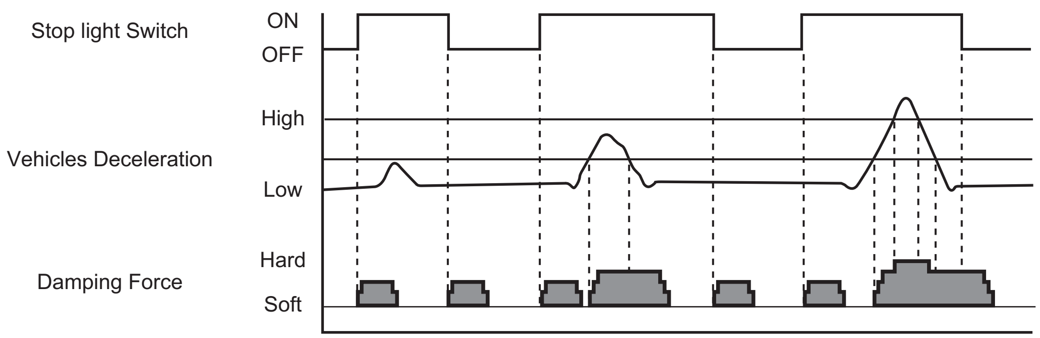


Vehicle Speed Sensing Control

- This control optimally sets the damping force to suit the vehicle speed, based on the data received from the wheel speed sensors. Thus, it realizes the proper ride comfort at low speeds and drivability and stability at high speeds.

Anti-Dive Control

- The absorber control ECU forecasts the extent of the dive of the vehicle caused by a brake application, based on the stoplight switch signal and the wheel speed signal. Then, it moderates the dive speed of the vehicle during deceleration by delicately controlling the damping force in accordance with the extent of the dive. Thus, it ensures the proper drivability and stability.
- Even when the driver releases the brake pedal or the deceleration increases, this control sets the damping force high to ensure a comfortable ride, while ensuring the proper drivability and stability during braking.



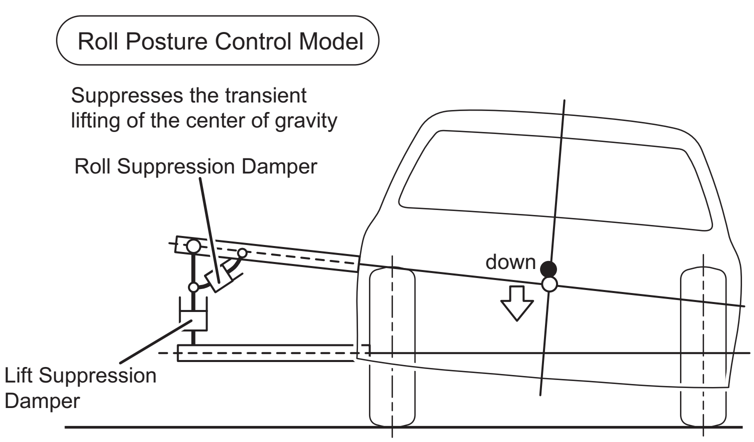
A4270059C

Anti-Squat Control

- The absorber control ECU forecasts the squat of the vehicle during acceleration based on the engine speed data. Then, it finely controls the damping force in order to reduce the changes in the vehicle posture and ensure the proper drivability and stability.

Roll Posture Control

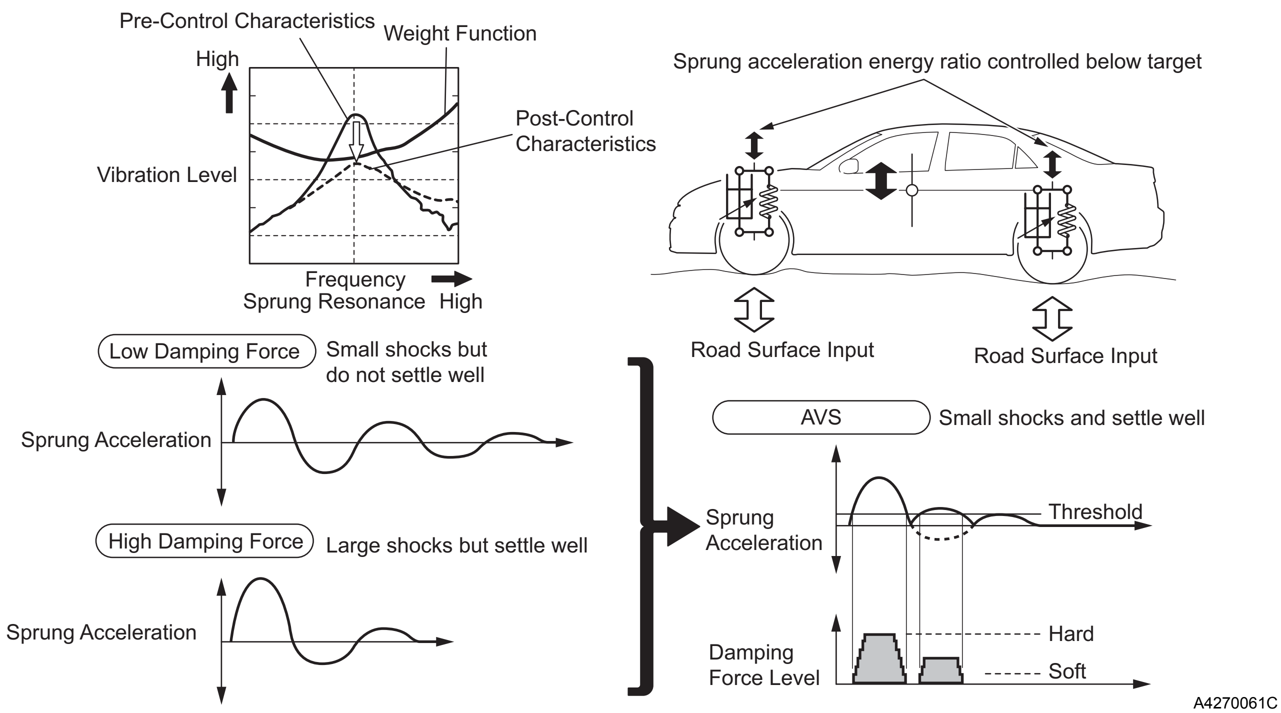
- The absorber control ECU calculates the lateral acceleration rate based on the vehicle speed signal provided by the wheel speed sensors and the steering signal provided by the steering sensor. Then, the ECU controls the damping force in accordance with the extent of the lateral acceleration rate. Thus, it realizes excellent drivability and stability while the vehicle is making a turn.
- As illustrated, a control logic based on a roll posture control model is used for controlling the damping force inside and outside of the turn (independently at four wheels). In the roll posture control model, shock absorbers (for roll suppression and lift suppression) for suppressing the movements in two directions are located in the virtual points inside of the turn. Thus, this control optimizes the posture of the vehicle while making a turn. As a result, it ensures the proper ground holding performance and turn following performance, in order to realize excellent drivability and stability.



A4270060C

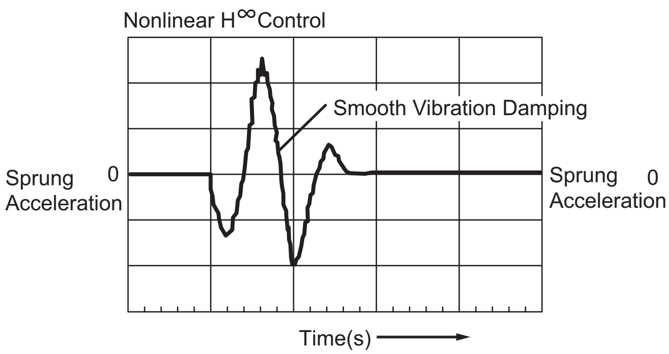
Repercussion Control (H∞ Control)

- When the repercussion is small in the rolling and pitching directions, the repercussion can be dampened by increasing the damping force for a certain length of time. However, if the repercussion becomes greater, merely increasing the damping force to a corresponding level will lead to a poor ride comfort. For this reason, repercussion control utilizing a nonlinear H∞ control logic is used in order to realize both a comfortable ride comfort and a high level of damping performance.
- This control uses three acceleration sensors to detect the sprung acceleration rate that corresponds to the bumps on the road surface and applies the modern control logic to calculate the condition of the stroke of the suspension. Based on these conditions, it uses the H∞ control logic to calculate the target damping force and controls the damping force independently at four wheels.
- By setting a frequency weight function to the sprung acceleration rate in the vibration frequency band of the repercussion, the damping performance can be raised positively in the target frequency band. In that case, this function controls the sprung acceleration rate by varying the damping force so as to suppress the energy ratio of the sprung acceleration rate (which counters the input from the road surface) below a predetermined value.



- If the vehicle posture is controlled only by controlling the damping force of the shock absorbers, the sprung acceleration rate is likely to be disturbed when the damping force is changed significantly.
- Even in this case, a natural and smooth repercussion damping can be achieved through the application of the nonlinear H∞ control logic.

Comparison of Sprung Vibration Dampening While Passing Through an Offset



Comparison of Sprung Vibration Dampening While Passing Through an Offset

A4270062C

❖REFERENCE❖

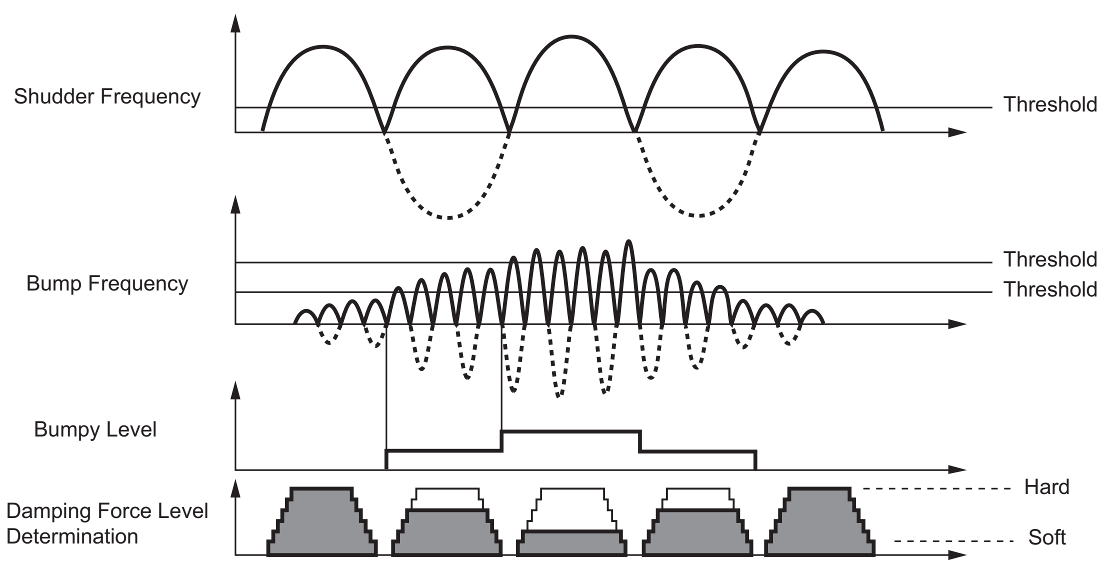
*1 : Generally speaking, H∞ control is a logic used for designing a controller that meets the control specifications represented by the H∞ norm (a standard for measuring the communication speed of a system), which was brought to completion in 1989.

*2 : In the 1990s, this has been expanded for nonlinear systems, resulting in the nonlinear H∞ control. In the past, this control was considered difficult to use and its application examples were few. However, we have succeeded in its application on the damping force suspension control, and put it into practical use.

*3 : The letter "H" stands for the name of the mathematician Hardy (Godfrey Harold Hardy: a researcher of stability of control systems), who advocated the mathematical space that is applied in this control logic. The "∞" symbol represents the ∞ norm, which is one of the mathematical evaluation standards for measuring the size of a signal.

Roughness Sensing Control

- If the absorber control ECU detects a frequency between the sprung vibration and unsprung vibration (roughness frequency) from the acceleration sensor signals while the vehicle is being driven on a rough road surface that generates both repercussions and roughness, the system sets the damping force slightly low. Thus, the vehicle is able to realize a flat feel without impairing the ride comfort.



A4270063C

Unsprung Damping Control

- If the absorber control ECU detects unsprung vibration based on the data from the wheel speed sensors, it sets the damping force slightly high for a certain length of time, in order to suppress the unsprung vibration. Thus, the vehicle is able to realize a high level of ground holding performance without impairing the ride comfort.

VDIM (VSC) Cooperative Control

- Based on the signals received from the skid control ECU, this control appropriately changes the damping force to suit the state of the lateral slippage of the vehicle or the changes in the slippage of the road surface, in order to maximize the effects of the VDIM (VSC).