Change the Effective Spring Rate with the Same Spring
New Hydraulic Suspension Mechanism
Variable Spring Rate

- **A new mechanism that combines the reaction force of a hydraulic jack and the damper rod to switch the effective spring rate of the entire suspension system in two stages while using the same spring**
- **The "specific frequency" that determines the response of the motorcycle body is variable, and character classification that could not be achieved by damping force control alone is now possible.**
- **Application of the hydraulic circuit of the vehicle height adjustment mechanism "HEIGHTFLEX®" to create a mechanism that can be installed in mass-produced vehicles**
- **This technology can be used for both front forks and rear cushions to form an integrated suspension package in combination with a variable damping force mechanism.**



Electronically controlled suspensions have produced differences in vehicle motion characteristics by changing damping forces. Astemo has developed a new "variable spring rate" mechanism that combines a hydraulic jack and a switching valve in the hydraulic circuit to switch the effective spring rate of the entire suspension system

while using the same spring. By changing the specific frequency that determines the response of the vehicle body, the difference in the vehicle body character created by different suspension settings is more clearly established.

Electronically controlled suspension units have produced differences in ride quality by varying the damping force generated by the velocity component of the suspension stroke. However, damping force is not the only factor that determines the motion characteristics of a vehicle body. The specific frequency, which is determined by the weight of the body and the spring rate, is also an important factor in determining the motion characteristics of the body. The spring rate is raised for a sporty and tight ride, and lowered for a relaxed ride.

Astemo has developed a mechanism to change the effective spring rate of the entire suspension system by switching the hydraulic circuit of the suspension without changing the springs. The development of this mechanism was initiated in response to a request from a complete vehicle manufacturer for a function to vary the spring rate, and thus the mechanism and technology were originally devised and established by Astemo. The system is already available in the BMW R 1300 R and R 1300 RS.

The starting point for this technology is the hydraulic circuit of the HEIGHTFLEX®, a vehicle height adjustment mechanism originally developed by Astemo.

The HEIGHTFLEX® spring adjuster which was developed for improved stability of the motorcycle when stopped with the rider’s foot down was shown to the world at the 2018 EICMA as an additional function of the company's original electronically-controlled suspension system "SHOWA EERA®" (Electronically Equipped Ride Adjustment). A stroke sensor detects the vehicle's height and maintains the optimum vehicle height while in motion. When the system detects that the vehicle has stopped, an electronically controlled hydraulic valve switches the flow path and automatically lowers the vehicle height by releasing the oil in the hydraulic jack into a reservoir. When the vehicle starts moving again, oil is pumped into the hydraulic jack built into the suspension by using the pump function (self-level pump) generated by the expansion and contraction of the suspension while in motion, thereby raising the vehicle height.

This system is based on the HEIGHTFLEX® self-level pump height adjustment mechanism and switches the effective spring rate by reconnecting the hydraulic path of the damper unit and hydraulic jack. The technology for driving the hydraulic jack with a self-level pump was developed for vehicle height control, and by applying this technology, we have established a new function of variable spring rate.

Specifically, a solenoid valve switches the hydraulic circuit. In the case of a general suspension, oil in the damper is sent to the reservoir tank side as the damper rod contracts with the suspension stroke. On the other hand, in this system, when the path to the reservoir tank is closed and the damper rod contracts, the pressure generated by the oil movement is received by the hydraulic jack located at the top of the suspension unit. In addition to the amount of spring deflection thus created, the amount of spring deflection is increased further by pushing the hydraulic jack out. The pressure generated when the hydraulic jack is pushed out acts as a reaction force on the damper rod. By combining these two effects, the effective spring rate of the suspension system is increased while the spring itself remains unchanged.

The most important point of this technology is to change the amount of spring deflection during the suspension stroke from the amount of stroke of the suspension itself.
This mechanism is a two-stage switching type that allows setting an additional higher effective rate than the reference spring. In addition, it is equipped on both the front fork and the rear cushion, and by combining it with such functions as the EERA® Damping Force (variable damping force function), it is possible to create a larger and more consistent character difference between the dynamic side and the comfort side of the vehicle as a whole.

For future motorcycles with integrated control of vehicle body motion, actively changing the spring rate, which has been treated as a fixed constant, could also be an advantageous option.

*Information contained in this Technical Information is current as of November 3, 2026, but may be subject to change without prior notice.