

Robust three-axis sensor in engine compartment **First combined inertial sensor with integrated vibration damper for ESP® from Bosch** SMI650 senses yaw rate and acceleration

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- ▶ Immune to interference thanks to integrated mechanical vibration damper
- ▶ Designed for the harsh conditions in the engine compartment
- ▶ First application in generation 9 ESP® electronic control units

The new Bosch SMI650 combined inertial sensor is designed to cope with the harsh environment found in a car's engine compartment. It can withstand operating temperatures of up to +140 °C and is able to deal with even strong broadband vibrations thanks to a special vibration damper. This is the first time that an electronic control unit for the ESP® electronic stability program has featured a sensor with integrated vibration damper. ESP® electronic control units with integrated inertial sensors have no need for complicated wiring to connect to external sensors. A biaxial acceleration sensor (a_y and a_z) and a monoaxial yaw sensor (Ω_x) together give the SMI650 fully fledged ESP® senses for monitoring a vehicle's three axes of motion. The first series-production version of the new combined inertial sensor will be incorporated in Bosch's current generation 9 ESP® electronic control units.

Keeping the sensor elements free of interference

The current trend in automotive sensor technology is to use combination sensors. This makes sense because integrating various sensor elements in one housing makes their handling, fitting, and electrical connections considerably more straightforward – with a resulting reduction in costs. But a combination sensor such as the SMI650 has to be able to cope with more challenging conditions, since it has to make the transition from the comfort of the passenger compartment to a car's "torture chamber": the engine compartment.

Here, temperatures can swing wildly from way below freezing to way above the boiling point of water, while the sensors must avoid misinterpreting the strong vibrations caused by a huge variety of engine types as unstable driving conditions. In order to shield the SMI650's sensor elements against such sources of interference, the PM28D sensor housing has been fitted with a vibration damper. Its base plate is enveloped in a specially developed silicone material, isolating the sensors from background vibrations. But that is not all: Bosch engineers have also provided the tiny acceleration sensor structures with micromechanical dampers. Together with the optimized component's own ASIC an up to now unmatched robustness of the sensor was realized. Therefore it is well suited for the integration in units.

Background: the ESP® electronic stability program

A microcomputer in the ESP® electronic control unit monitors the signals transmitted by the ESP® sensors and compares the driver's steering input to the vehicle's actual motion 25 times every second. If the values diverge, the ESP® reacts in a flash, applying metered braking to generate the counteracting force necessary to ensure the vehicle continues to follow the driver's steering input to the extent physically possible. Bosch launched ESP® in 1995, and the sensors that measure yaw rate and lateral acceleration were first integrated into the electronic control unit in 2008. Up to then, they had been fitted separately within the passenger compartment.

Technical data – SMI650 (excerpt)		
Sensor axis	Ω_x	a_y, a_z
Measurement range	$\pm 100 \text{ }^\circ/\text{s}$	$\pm 2,0 \text{ g}$
Sensitivity	100 LSB/ $^\circ/\text{s}$	5000 LSB/g
Sensitivity variation	$\pm 3 \%$	$\pm 5 \%$
Nonlinearity	$\pm 0.5 \text{ }^\circ/\text{s}$	$\pm 30 \text{ mg}$
Offset variation	$\pm 3 \text{ }^\circ/\text{s}$	$\pm 70 \text{ mg}$
Noise (RMS at 60 Hz)	0.6 $^\circ/\text{s}$	10 mg
Bandwidth (-3 dB)	57 Hz	-
Supply voltage	5 V	
Current draw, maximum	25 mA	
Ambient temperature	-40 °C to +140 °C	

Background: MEMS technology

Bosch was one of the pioneers in the development of micro-electromechanical systems (MEMS) technology, and the company has produced well over two billion MEMS sensors since the start of production in 1995. Production volumes reach new record levels every year, with around half a billion sensors leaving the Reutlingen plant in 2011. This makes Bosch the world market leader, with a product range that comprises pressure, acceleration, yaw-rate, and inertial sensors for many applications in the automotive industry and in consumer electronics. For more information about Bosch automotive sensors, visit www.bosch-sensors.com.

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