Two-wheeler & Powersports – Riding innovation: Comprehensive system solutions and passion for two-wheelers
Two-wheeler system solutions make riding safer, cleaner and more fun

**Passion meets expertise** Worldwide demand for powered two-wheelers is on the rise. Motorcycles and scooters are chosen for their fun riding experience and their affordable mobility. Studies indicate that by 2021, around 160 million two-wheelers will be produced annually – a third more than today. To better meet increasing demand and individual manufacturer requirements, Bosch is pooling its two-wheeler and powersports activities into one global organization: the newly formed Two-wheeler & Powersports business unit. The unit brings together passionate two-wheeler and powersports experts from the areas of safety systems, powertrain technology, and connectivity, and offers components as well as complete system solutions that service the entire two-wheeler and powersports spectrum: from those in the lower price segment to powerful machines with over 1,000 cc displacement.

**Assistance systems**

**Comprehensive safety systems** Bosch is the market leader for two-wheeler safety systems. These systems reduce the risk of accidents, especially in hazardous riding conditions, by intervening in critical situations without compromising on riding dynamics. The modular and scalable antilock braking system (ABS) was especially designed for the braking characteristics of two-wheelers and can be adapted to models ranging from the lower power segment to high-end sports bikes. ABS constantly monitors the wheels using wheel-speed sensors and regulates braking pressure accordingly, thereby maximizing riding stability and shortening stopping distances. The motorcycle stability control (MSC) forms the next step in safety and is used primarily in high-performance bikes. The MSC provides assistance by continuously monitoring all essential vehicle values – including torque, lean angle, and acceleration – to detect critical situations and intervene if necessary. This represents a marked improvement in both riding stability and braking performance, especially in bends – without reducing the fun of riding. Bosch’s side view assist is the world’s first assistance system for two-wheelers. This system uses four ultrasonic sensors that monitor their surroundings to help riders change lanes safely.

**Connectivity systems**

**Connecting vehicle systems** Bosch brings connectivity to two-wheelers – internally and externally. Intelligently connected on-board systems make life easier for the rider and increase safety. Furthermore, the ability to communicate with other vehicles and the wider infrastructure offers riders entirely new possibilities. One such innovative system is Bosch’s connectivity control unit (CCU), which uses sensor and cloud data to increase dynamics while also raising safety, comfort and more fun of riding.

**Connecting services and information** The secure transfer of vehicle data to external services and their providers is the basis for new, future-ready services and business models. What’s more, connected mobility involves processing large volumes of data and presenting the results to riders in a clear way. Bosch’s integrated connectivity cluster (ICC) is an innovative information display designed especially for motorcycles. The ICC uses a Wi-Fi connection to provide access to additional features such as the mySPIN smartphone integration solution as well as access to and storage of a wealth of vehicle data.

**Powertrain systems and electrification**

**Powertrain solutions for motorcycles** Bosch brings new energy to the two-wheeler powertrain and offers comprehensive systems expertise for vehicles ranging from commuter two-wheelers to high-performance bikes. The combination of an engine management system (EMS) with sophisticated sensor systems is significantly more efficient than conventional carburetor systems. Bosch offers the full range of EMS technology with components customized especially for two-wheelers. This includes components for fuel injection and supply, air management, ignition, and exhaust gas treatment as well as engine control units. Integrated Bosch modular systems offer both a better cost/benefit ratio and a more enjoyable and dynamic two-wheeler experience.
The main benefits of Bosch two-wheeler technology

- **Increased riding enjoyment**
- **Less CO₂ emissions and fuel consumption**
  - Compared to carburetor engines with engine management system (EMS)
- **Increased safety**
  - Up to 67% of all powered two-wheeler accidents in Germany caused by two-wheelers could be positively influenced through MSC (Bosch research based on GIDAS database 2001–2009)
  - Up to 26% of all powered two-wheeler accidents with casualties could be prevented through ABS*.
    - Source: Bosch Accident Research studies in Germany, India, and ASEAN (GIDAS 2001–2004, RASSI 2009–2013, PTW ABS study based on India 2014), assuming 100% installation rate
  - ABS could reduce collision speed by 66% on average, resulting in much less severe consequences*

Additional benefits:

- **Efficiency optimization**
  - Regardless of engine capacity, the EMS optimizes efficiency and riding enjoyment
- **Safety improvements**
  - 2 million Bosch motorcycle ABS systems have been sold until 2015, increasing safety for as many riders.

Technical components:

- Engine control unit
- Crankshaft speed sensor
- Camshaft speed sensor
- Knock sensor
- Electric fuel pump and pressure regulator
- Fuel injector
- Electronic throttle body
- Canister purge valve
- Manifold air-pressure and temperature sensor
- Temperature sensor
- Spark plug
- Lambda sensor
- MSC hydraulic unit with attached control unit
- Inertial measurement unit
- Wheel-speed sensor
- Ultrasonic sensor
- Electronic control unit for ultrasonic sensors
- Connectivity control unit
- Integrated connectivity cluster
- ABS hydraulic unit with attached control unit
- Wheel-speed sensor
- Components for small bikes
- Components for high-performance bikes

Communication:

- 10 times per second is how often the CCU exchanges information – like location and speed data – through vehicle-to-vehicle communication in order to make other drivers aware of the motorcycle's presence, thus increasing safety.
Engine management
Molded electronic control unit

Product benefits
- Low weight and small size
- Fast and easy calibration
- Easy to maintain
- Good thermal conductivity and temperature stability
- Vibration resistance

Vehicle segments

1. Direct plug connector with ≤44 pins
2. DMC (data matrix code)
3. Sealing
4. Guiding
5. Lever area
6. Molded housing
**Task**  The electronic control unit (ECU) collects all necessary information for the engine, for example sensor signals, prioritizes them, and then goes about implementing them. Furthermore rider demands and exhaust-system requirements related to the mixture composition are computed. Torque is the key factor in implementing these requests. For instance, the air-fuel ratio is adjusted in such a way that torque is provided as economically and cleanly as possible. Doing so also allows active safety systems such as ABS and motorcycle stability control (MSC) to affect engine torque.

**Function**  The electronic control unit is realized as a printed circuit with various types of housing possible; in this case, molded housing. It is also able to manage upcoming features such as on-board diagnostics (OBD), a start-stop function, ISO 26262 (Road vehicles – Functional safety), knock control, connectivity, and enhanced user experience, enabled by Bluetooth-compatible communication.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>inductive or Hall</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>32 bit</td>
</tr>
<tr>
<td>Housing</td>
<td>molded</td>
</tr>
<tr>
<td>Thermal concept</td>
<td>proper heat dissipation</td>
</tr>
<tr>
<td>Connector</td>
<td>≤ 44 pins</td>
</tr>
<tr>
<td>Possible applications</td>
<td>1 cyl. with electronic throttle control (ETC) or 2 cyl. with idle speed actuator (ISA)</td>
</tr>
<tr>
<td>Emissions legislation</td>
<td>up to Euro 5 and comparable</td>
</tr>
<tr>
<td>Software</td>
<td>specific SW platform covering complete two-wheeler functionality</td>
</tr>
<tr>
<td>Optional software features</td>
<td>digital knock control, flex fuel</td>
</tr>
<tr>
<td>Fault handling</td>
<td>with service interface</td>
</tr>
<tr>
<td>End-of-line (EoL) programming</td>
<td>possible, including data variant handling</td>
</tr>
</tbody>
</table>
Product benefits

- Robust and compact design
- Large engine speed range
- High measurement accuracy
- High signal accuracy
- Large air gap range
- Contactless measurement
- Compatible with start-stop and hybrid applications

Vehicle segments

- Engine management
  - Crankshaft speed sensor

1. Mounting flange
2. Connector
3. Cable
4. Sensing unit
Task  The crankshaft speed sensor measures the speed, position and, optionally, the direction of rotation of the crankshaft. This data is used by engine management systems for controlling injection and/or ignition timing.

Function  The sensor is a Hall or inductive sensor. The crankshaft is fitted with a target wheel that the sensor scans using a non-contact method. A missing element in the target wheel determines the reference point.

Technical characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Hall or inductive</td>
</tr>
<tr>
<td>Temperature range</td>
<td>−40 °C to +150 °C</td>
</tr>
<tr>
<td>Operating principle</td>
<td>Hall or inductive</td>
</tr>
<tr>
<td>Air gap</td>
<td>&lt; 1.8 mm</td>
</tr>
</tbody>
</table>

Due to its **high accuracy**, the crankshaft speed sensor helps reduce emissions and fuel consumption.
**Engine management**

**Camshaft speed sensor**

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**Product benefits**

- High measurement accuracy
- Large air gap range
- Rapid-start capability with TPO function
- Compact and robust design, small sensor diameter
- High electromagnetic compatibility
- Resistant to mineral-based oils
- Can be installed in various positions

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**Vehicle segments**

- Engine management
  - Camshaft speed sensor

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**Mounting flange**

**Sensing unit**

**Connector**

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**Task** The camshaft speed sensor measures the position of the camshaft. Due to its accurate measurements, the sensor allows for exact injection and a precise and variable positioning of the camshaft. This improves performance and reduces emissions.

**Function** The camshaft sensor is designed as a non-contact Hall sensor. Due to the true power-on function (TPO), the sensor is quick-start capable: it provides position information immediately after engine start.

### Technical characteristics

<table>
<thead>
<tr>
<th>Technology</th>
<th>single-Hall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power-on function</td>
<td>true power-on (TPO) for rapid-start capability</td>
</tr>
<tr>
<td>Installation</td>
<td>various positions possible</td>
</tr>
<tr>
<td>Temperature range</td>
<td>up to 150 °C (max. 250 h at 160 °C)</td>
</tr>
</tbody>
</table>
**Product benefits**

- Increased torque, maximum engine performance
- Protection of the engine from uncontrolled combustion
- Reliable engine operation even at various levels of fuel quality

**Vehicle segments**

1. Connector
2. Cable
3. Sensing unit
**Task** “Knocking” occurs when the air-fuel mixture self-ignites prematurely. Sustained knocking causes damage primarily to the cylinder head gasket and cylinder head. Knock control can help avoid this by detecting knocking using a knock sensor and then adjusting the ignition time accordingly. The aim of knock control is to obtain the maximum energy yielded from various levels of fuel quality.

**Function** The knock sensor is mounted on the engine body and measures the structure-borne noise using a piezoelectric measuring element. Once it detects the characteristic knocking frequencies, the sensor translates them into electrical signals and sends these to the control unit.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Linear over a large frequency range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range</td>
<td></td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td>−40°C to +130°C</td>
</tr>
<tr>
<td><strong>Optional</strong></td>
<td>≤ 150°C</td>
</tr>
<tr>
<td>Technology</td>
<td>Piezo ceramic ring</td>
</tr>
<tr>
<td>Types</td>
<td>Plug-in or cable</td>
</tr>
</tbody>
</table>
Fuel supply
Electric fuel pump and pressure regulator

Product benefits

- Compact design, small size, and low weight
- Low power consumption
- Compatible with a wide range of fuels (gasoline, ethanol, “bad fuel”)
- Pressure regulator: for port fuel injection and gasoline direct injection systems with regulated or non-regulated fuel supply (wide pressure range)

Vehicle segments

Electric fuel pump
1. Pump outlet with check valve
2. Pressure relief valve
3. Electrical connector
4. End support cover
5. Pump housing
6. Suction cover

Pressure regulator
7. Housing
8. Filter screen
9. O-ring
10. Pin
11. Set screw
Task The fuel pump is built into the fuel tank and supplies the right amount of fuel from the tank to the fuel injector. The integrated pressure regulator ensures that the fuel path has the required pressure.

**Technical characteristics of fuel pump**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commutator</td>
<td>carbon or copper</td>
</tr>
<tr>
<td>Pump parts</td>
<td>metal</td>
</tr>
<tr>
<td>Compatibility</td>
<td>gasoline up to E20, “bad fuel”</td>
</tr>
<tr>
<td>Lifetime</td>
<td>&gt; 3,000 h</td>
</tr>
<tr>
<td>Flow rate</td>
<td>16 l/h @ 12 V, 300 kPa up to 55 l/h @ 13.5 V, 400 kPa</td>
</tr>
</tbody>
</table>

**Technical characteristics of pressure regulator**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulator type</td>
<td>coil spring</td>
</tr>
<tr>
<td>Valve seat sealing</td>
<td>rubber</td>
</tr>
<tr>
<td>Valve protection</td>
<td>filtration</td>
</tr>
<tr>
<td>Housing</td>
<td>metal</td>
</tr>
<tr>
<td>Pressure range</td>
<td>variable, 250 – 900 kPa</td>
</tr>
</tbody>
</table>
**Fuel injection**

**Fuel injector**

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**Product benefits**

- Adaptable to different engine displacements
- Ready for future emissions requirements
- Reduced weight and size
- Large dynamic flow rate
- Various spray patterns with small droplet size
- Functionality and manufacturing processes of a highly experienced international production network (quality & reliability)

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**Vehicle segments**

```markdown
- O-Ring seal
- Grommet seal
- Orifice plate
- Electrical connector
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Task The fuel is injected so that it forms a homogeneous mixture with the air; this mixture is fed into the area of the combustion chamber most favorable for combustion. The aim is to prevent excessive fuel condensation on the wall of the intake manifold or intake valve.

Function The fuel injector is installed in the intake manifold in front of the intake valve, where its solenoid valve controls injection start and duration. Several ultra-precisely manufactured orifices ensure fine fuel atomization. The shape of the fuel spray is determined for each engine by the position of the injector as well as the configuration and number of orifices. For small engines in particular, the reduced size allows for more flexible mounting. A low-noise injector is relevant for operators of two-wheelers, as they are more exposed to noise from the vehicle and from the environment.

<table>
<thead>
<tr>
<th>Technical characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sealing</td>
<td>grommet (manifold side) + O-Ring (fuel side)</td>
</tr>
<tr>
<td>Connector</td>
<td>standard mini-trapezoid at a 30° angle other connectors available</td>
</tr>
<tr>
<td>Design</td>
<td>adapted for smaller size and two-wheeler-specific mounting</td>
</tr>
<tr>
<td>Tip</td>
<td>flat or extended</td>
</tr>
</tbody>
</table>
Air management
Electronic throttle body

Product benefits

- Modular design
- Best-in-class Hall IMC (response time, temperature-independent characteristics)
- Smooth engine shutdown and minimal NVH (noise, vibration, and harshness)

Vehicle segments

1 Air channel with variable diameter
2 Standard DC electric motor (ready for brushless)
3 Hall sensor
Air management Electronic throttle body

Task For the combustion of the air-fuel mixture, the air supply to the engine cylinder is just as important as the fuel supply. The air-to-fuel ratio, air movement, and composition of the intake air contribute to clean, economical, and dynamic engine operation. Electric actuators allow high levels of precision in air intake adjustment. In gasoline engines, the air supply to the cylinder is controlled by means of a throttle body, which reduces or enlarges the intake manifold cross section.

Function The electronic throttle body comprises an electrically driven throttle body and a non-contact angular-position sensor for position feedback. The electronic engine management system triggers the throttle body electrically. Trigger input variables are the accelerator grip position and the requirements of systems that can influence engine torque, including adaptive cruise control or active safety systems such as the motorcycle stability control (MSC).

optimized for
two-wheelers

Design of electronic throttle body optimized to meet weight and size requirements for two-wheeler applications

Technical characteristics

<table>
<thead>
<tr>
<th>Platform design</th>
<th>modular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throttle diameter</td>
<td>32 – 62 mm</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>−40 °C to +120 °C</td>
</tr>
<tr>
<td>Actuation time</td>
<td>$t_{90} &lt; 110$ ms</td>
</tr>
<tr>
<td>Excess torque (ice breaking)</td>
<td>≤ 1.8 Nm</td>
</tr>
<tr>
<td>Idle air leakage (ø 57 mm)</td>
<td>&lt; 3.5 kg/h</td>
</tr>
<tr>
<td>Target weight</td>
<td>≤ 600 g</td>
</tr>
<tr>
<td>Interfaces</td>
<td>analog and SENT capable</td>
</tr>
<tr>
<td>Options</td>
<td>water-heating pipes, NiRo bearing, EMC package (motor and sensor)</td>
</tr>
</tbody>
</table>
Air management
Throttle position sensor

Product benefits
- Better calculation of the filling quantity
- Improves fulfillment of emission requirements
- Increased dynamics of engine response to changes in operator input
- High mounting flexibility for different applications
- Packaging advantage due to small size

Vehicle segments

Bosch
Invented for life
Task The throttle position sensor measures the throttle valve’s angle of rotation at gasoline engines. The signal is used to enhance the filling prediction.

Function The throttle position sensor is a potentiometer with a linear characteristic curve. The rotor arm, which is connected to the throttle valve shaft, runs its wipers over the corresponding resistance tracks. Then the throttle valve’s angle of rotation is translated into a proportional voltage ratio.

Technical characteristics

<table>
<thead>
<tr>
<th>Angle sensor</th>
<th>potentiometer with linear functional characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal</td>
<td>ratio metric with diagnostic limits</td>
</tr>
<tr>
<td>Measureable electrical angle</td>
<td>0 – 96°</td>
</tr>
<tr>
<td>Rotation direction</td>
<td>clockwise and counterclockwise</td>
</tr>
<tr>
<td>Construction</td>
<td>two-hole mounting system</td>
</tr>
<tr>
<td>Throttle shaft interface</td>
<td>8 mm, D-shaped cross-section</td>
</tr>
<tr>
<td>Temperature range</td>
<td>−40 °C to +130 °C</td>
</tr>
</tbody>
</table>
Air management
Canister purge valve

Product benefits

- Precise control of the air mass and small tolerances due to pressure equalization
- Modular design (plug, inlet and outlet arrangement, variable air flow rate)
- Compact design and low weight

Vehicle segments

1 Inlet port
2 Interface for electrical connector
3 Outlet port
Air management Canister purge valve

**Task** With limits for evaporative hydrocarbon (HC) emissions being introduced into major two-wheeler markets, these vehicles require evaporative systems. Such systems minimize evaporative HC emissions by trapping the HC vapors from the tank using an activated charcoal filter. Some of the intake air is routed through this filter and carries the HC vapors into the combustion chamber, where they are burned as part of the air-fuel mixture. The solenoid canister purge valve meters this air flow according to the engine’s operating state. Solenoid valves are required to meet strict limits on HC emissions in the exhaust gas and to improve driving behavior.

**Function** The canister purge valve is a solenoid in a plastic housing and is controlled by the engine control unit.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. flow rate range</td>
<td>3 – 5 m³/h at Δp = 700 mbar</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>9 – 16 V</td>
</tr>
<tr>
<td>Electrical resistance</td>
<td>17 ohms</td>
</tr>
<tr>
<td>Frequency range</td>
<td>6.25 – 30 Hz</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>−40 °C to 140 °C</td>
</tr>
<tr>
<td>Lifetime</td>
<td>200 million cycles</td>
</tr>
</tbody>
</table>
Air management
Combined charge sensor

Product benefits
- Less packaging needed
- Smaller interface in combination with throttle housing
- Reduced effort for connector, wiring harness

Vehicle segments
1. Sensor housing for pressure and throttle position
2. Mounting flange
3. Temperature sensor shaft
4. Connector
The sensor enables **precise engine management**, resulting in cleaner emissions and fuel savings under various riding conditions.

**Task** The sensor monitors the position of the throttle, intake air pressure, and intake air temperature. The engine control unit uses this data to determine the cylinder charge, which is the basis for calculating fuel injection.

**Function** The combined charge sensor is a combination sensor for fuel-injected gasoline engines with mechanical throttle body. It integrates the functionalities of a throttle position sensor, intake manifold air pressure sensor, and manifold air temperature sensor in one housing.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Integrated sensor elements</th>
<th>throttle position (angle), T-MAP (temperature + manifold absolute pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle sensor</td>
<td>linear output</td>
</tr>
<tr>
<td>Air pressure sensor</td>
<td>linear output</td>
</tr>
<tr>
<td>Temperature sensor</td>
<td>NTC (negative temperature coefficient)</td>
</tr>
</tbody>
</table>
Air management
Manifold air-pressure and temperature sensor

Product benefits
- Compact, lightweight sensor
- High EMC (electromagnetic compatibility)
- Customized connector and mounting
- High accuracy, long-term durability
- Fast response time

Vehicle segments

1. Connector
2. Temperature sensor
3. Mounting flange
4. Pressure sensing unit
**Task** The manifold air-pressure sensor with optional temperature sensor measures the air pressure and temperature in the intake manifold. The volume of air that reaches the engine cylinder can be calculated from the measured air pressure and the engine speed. This input variable is used to calculate the amount of fuel that needs to be injected. The temperature sensor measures the intake air temperature, allowing the engine management system to adjust the injected fuel mass.

**Function** The micromechanical sensor contains a piezoresistive sensor element that generates a measurable electrical voltage when pressure is applied. The air pressure can be measured via the voltage.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Measurement of</th>
<th>Intake air pressure, boost pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure range</td>
<td>115, 250, 300, and 400kPa</td>
</tr>
<tr>
<td>Technology</td>
<td>Silicon micromechanics, 1-chip concept</td>
</tr>
<tr>
<td>Optional</td>
<td>Integrated temperature sensor</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>−40 °C to +140 °C</td>
</tr>
<tr>
<td>Output</td>
<td>Analog</td>
</tr>
</tbody>
</table>
Air management
Mechanical throttle body assembly

Product benefits
- Modular design, optimized solution for two-wheeler applications
- Customer-specific throttle diameters
- Optional customized spray targeting
- Idle assist possible as add-on feature
- Data matrix of air flow curve in bar-code form

Vehicle segments

1. CAM profile and back plate
2. Bracket
3. TPS-C (throttle position sensor connector)
4. Housing
5. Torsion spring
Task For the combustion of the air-fuel mixture, the air supply to the engine cylinder is just as important as the fuel supply. The air-to-fuel ratio, air movement, and composition of the intake air contribute to clean, economical, and dynamic engine operation. In gasoline motorcycle engines, the air supply to the cylinder is controlled by means of a throttle body, which reduces or enlarges the intake manifold cross section.

Function The throttle body assembly is mechanically attached to the throttle and can be flexibly equipped with various components. An angular-position sensor for position feedback is included in all variants.

Technical characteristics

<table>
<thead>
<tr>
<th>Platform design</th>
<th>modular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throttle diameter</td>
<td>22 – 44 mm</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>−20°C to +100°C</td>
</tr>
<tr>
<td>Idle air leakage</td>
<td>1 – 1.2 kg/h</td>
</tr>
<tr>
<td>Idle bypass</td>
<td>not available, seal required</td>
</tr>
<tr>
<td>Options for integration</td>
<td>throttle position sensor</td>
</tr>
<tr>
<td></td>
<td>combined charge sensor</td>
</tr>
<tr>
<td></td>
<td>fuel injector</td>
</tr>
<tr>
<td></td>
<td>idle speed actuator</td>
</tr>
</tbody>
</table>
Air management
Temperature sensor

Product benefits

- Helps manage cold starts, warming up, fan control, etc.
- Media resistant (e.g. water, fuel, oil, battery acid)
- Wide temperature range

Vehicle segments

1. Hexagon
2. Connector
3. Thread
4. Sensing unit
**Task** The temperature sensor measures the temperature of the coolant, oil, or fuel. This value is used to improve cold-start capability and for engine cooling and protection.

**Function** To measure the temperature of coolant, oil, or fuel, the temperature sensor uses an NTC sensor element (Negative Temperature Coefficient). As the temperature increases, the element’s electrical resistance is reduced.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Application</th>
<th>Measures coolant, oil, or fuel temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range</td>
<td>−40°C to 130°C</td>
</tr>
<tr>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Temperature range</td>
<td>≤ 150°C</td>
</tr>
<tr>
<td>Optional</td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V</td>
</tr>
<tr>
<td>Sensor element</td>
<td>NTC (Negative Temperature Coefficient)</td>
</tr>
<tr>
<td>Vibration-proof</td>
<td>≤ a(sin) = 300 m/s²</td>
</tr>
</tbody>
</table>
Ignition
Spark plugs

Product benefits

- Smooth operation
- Consistent performance over the entire service life
- Reliable cold starting
- Complete combustion and thus low fuel consumption

Vehicle segments

1. Ground electrode
2. Housing with hexagon and mounting thread
3. Ceramic
4. Insulators
5. Terminal nut
Gasoline engines require an ignition spark to start combustion of the air-fuel mixture in the combustion chamber. Reliable ignition not only optimizes fuel economy but provides comfortable cold starting. This means the spark plug in a motorcycle or scooter has to be warm enough that it doesn’t get sooty, even at low engine speeds. At the same time, it can’t get too hot at high engine speeds, in order to prevent auto-ignition. The spark plug’s main task is to generate the spark to ignite the compressed air-fuel mixture inside the combustion chamber.

**Function** The air-fuel mixture in the combustion chamber is ignited by a spark. The spark plug requires an ignition voltage of up to 30,000 volts, which is transferred from the ignition coil to generate the spark.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrode temperature</td>
<td>450 °C – 900 °C</td>
</tr>
<tr>
<td>Ignition voltage</td>
<td>15 kV – 30 kV</td>
</tr>
<tr>
<td>Thread diameter</td>
<td>M 10, M 12, M 14</td>
</tr>
</tbody>
</table>
Exhaust gas treatment
Lambda sensor

Product benefits

- Highly robust signal and fast sensor readiness
- Strong functional reliability, robust design
- High temperature resistance

Vehicle segments

1 Connector
2 Sensing unit
3 Thread
4 Hexagon
5 Cable protection
6 Cable
The lambda sensor works reliably for max. 250 h at this temperature.

**Task** By measuring the oxygen content in the exhaust gas, the lambda sensor provides the ECU with relevant information for controlling the air/fuel ratio in the combustion chamber.

**Function** The planar switching-type lambda sensor reacts to an exhaust gas transition from lean to rich (or rich to lean) with an immediate output signal jump. The goal is to detect the switching point at lambda = 1, the so-called stoichiometric point. Precisely adjusting the stoichiometric point enables the catalytic converter to work at the highest level of efficiency. The result is reliable adherence to the strictest exhaust gas and diagnostic regulations.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Planar sensor element with integrated central heater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak temperature robustness</td>
<td>Up to 1,030°C (250 h)</td>
</tr>
<tr>
<td>Permanent operating temperature</td>
<td>930°C</td>
</tr>
<tr>
<td>Resistance to environmental influences</td>
<td>Vibration, water, salt, oil, totally submersible</td>
</tr>
<tr>
<td>Application-specific variants</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Cleaner cold and warm engine starts due to fast sensor readiness and a highly robust signal.

Reduced emissions 1,030 °C
Active safety systems
ABS 9 light

Product benefits

- Improved safety through front-wheel control
- Intelligent rear-wheel lift-up control
- Increased vehicle stability and riding comfort
- Best possible deceleration without wheel lockup
- Reduced stopping distance under certain conditions
- Reduction in severe and fatal accidents
- Optimized box volume and product design specifically for two-wheelers

Vehicle segments

1 Hydraulic unit
2 DC motor
3 Connector
4 Electronic control unit
Active safety systems ABS 9 light

up to 18% of two-wheeler accidents in Germany could be avoided by the 1-channel ABS 9 light (front wheel).

-9 m

The ABS reduces the stopping distance and therefore the risk of collision. For example, when an average rider has a starting speed of 100 km/h, ABS decreases the stopping distance from 58.5 to 49.5 m.
Source: Austrian Road Safety Board

Task Bosch’s antilock braking system light (ABS light) is the cost-efficient, entry-level version of the ninth generation of Bosch brake control systems for two-wheelers. The system assists the rider while braking in critical riding situations. It prevents wheel lockup and ensures vehicle stability as well as optimal deceleration while braking. ABS 9 light therefore significantly reduces the risk of falling and shortens the stopping distance.

Function The hydraulic unit comprises two control valves, a storage chamber, and a pump element. As in more powerful ABS systems, the electric motor that drives the return pump is mounted here, as is the control unit – in this case a circuit board. The wheel-specific reference velocity is calculated by the system on the basis of speed information transmitted by a sensor on the front wheel. For the highest possible stability during braking, the wheel-specific reference velocity is continuously adapted to the vehicle’s actual speed. More precise braking control is possible if a second sensor is installed on the rear wheel. With this setup, deceleration rates match those of the two-channel system, and counteract lifting of the rear wheel.

Variants Two-wheeler manufacturers can optionally integrate an on-off switch.

Technical characteristics

<table>
<thead>
<tr>
<th>Size (w × h × d)</th>
<th>89.6 × 59.7 × 92.7 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>0.63 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>0.496 liters</td>
</tr>
<tr>
<td>Channels</td>
<td>1</td>
</tr>
<tr>
<td>Exchangeable ECU</td>
<td>no</td>
</tr>
<tr>
<td>Connector</td>
<td>18 pins</td>
</tr>
</tbody>
</table>
Active safety systems
ABS 9 base and ABS 9 plus

Product benefits

- Product design specifically for two-wheelers, meets highest demands regarding box volume and weight
- Fits all vehicle classes, including small two-wheelers and scooters
- High vibration resistance
- Increased comfort through excellent brake lever/pedal feel
- Intelligent rear-wheel lift-up control
- Options include off-road control and traction control

Vehicle segments

1. Hydraulic unit
2. DC motor
3. Connector
4. Electronic control unit
Active safety systems ABS 9 base and ABS 9 plus

**Task** The Bosch antilock braking system (ABS) for two-wheelers assists the rider while braking in critical riding situations. It prevents wheel lockup and ensures vehicle stability and optimal deceleration while braking. ABS therefore significantly reduces the risk of falling and reduces stopping distance. Ninth-generation ABS base and ABS plus have been specifically designed to fulfill two-wheeler size and weight requirements. The ABS 9 base variant is suitable for all powered two-wheelers with hydraulic front- and rear-wheel brakes and already offers full antilock protection, even in case of sudden changes in road surface, caused for example by grit or oil. This allows even inexperienced riders to brake safely.

**Function** Speed sensors on both wheels register the rotational speed. If a wheel is at risk of locking due to intense braking or slippery road conditions, the ABS hydraulic unit reduces the braking pressure applied by the rider and controls wheel speed as well as vehicle deceleration. This preserves the gyrostatic effect of the wheel and keeps the vehicle stable, even on varying surfaces. This is how the rider can safely achieve the shortest possible stopping distance.

**Variants** The ABS 9 plus variant contains an additional pressure sensor. As the system takes effect even when pressure is being built up during emergency braking, it is especially suitable for powerful two-wheelers.

**Value-added functions** ABS base and ABS plus can easily be equipped with additional functions. When combined with Bosch traction control, ABS can prevent the rear wheel from spinning during acceleration, and counteract front wheel lift. It can be integrated into all current 2-channel systems. If the two-wheeler manufacturer adds the Bosch inertial measurement unit to the system, traction control will also control the maximum possible driving power in bends. Bosch off-road control can be integrated into the ABS 9 plus version and is designed for loose surfaces. This means all-terrain two-wheelers now have the benefit of additional safety. In the off-road control function, slip thresholds and other parameters have been adjusted to provide riders with optimum braking performance over rough terrain as well.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Size (w × h × d)</th>
<th>89.6 × 59.7 × 92.7 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>0.65 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>0.496 liters</td>
</tr>
<tr>
<td>Channels</td>
<td>2</td>
</tr>
<tr>
<td>Pressure sensor</td>
<td>integrated (ABS plus)</td>
</tr>
<tr>
<td>Valve</td>
<td>2 × inlet, 2 × outlet</td>
</tr>
<tr>
<td>Exchangeable ECU</td>
<td>no</td>
</tr>
<tr>
<td>Connector</td>
<td>18 pins</td>
</tr>
</tbody>
</table>

To prevent the rear wheel from lifting during full braking, all two-wheeler versions of the ninth-generation ABS use the rear-wheel lift-up control to evaluate how much each of the two wheels is slipping. If the two-wheeler is in danger of falling over, braking pressure on the front wheel is reduced. For earlier detection, Bosch has integrated an additional pressure sensor into ABS 9 plus.

**enhanced protection**

ABS 9 plus uses the additional pressure sensor to offer enhanced rear-wheel lift-up control.

**additional comfort**

ABS 9 base and ABS 9 plus allow the addition of value-added functions for increased riding and safety performance.

---

26%*

of all two-wheeler accidents in Germany involving a fall or collision could be prevented through ABS.*

*Based on a case-by-case analysis of 228 representative GIDAS cases (2001–2004)
Active safety systems
ABS 9 enhanced

Product benefits

- Improved ABS performance
- Optimized brake force distribution through eCBS
- Excellent vehicle stability during braking with significant reduction in stopping distance
- eCBS switches off automatically at low speeds so there is no impact on the handling in tight curves
- Intelligent rear-wheel lift-up control
- Improved comfort due to value-added functions

Vehicle segments

1. Hydraulic unit
2. DC motor
3. Connector
4. Electronic control unit
Active safety systems ABS 9 enhanced

**26%**

of all two-wheeler accidents in Germany involving a fall or collision could be prevented through ABS.*

*Based on a case-by-case analysis of 228 representative GIDAS cases (2001–2004)

---

**Task** For increased riding safety, especially on large and heavy two-wheelers, Bosch has developed ABS 9 enhanced, which includes the electronic combined brake system (eCBS). With a weight of approximately 1.4 kilograms and a volume of 1.11 liters, this antilock braking system is one of the smallest and lightest hydraulic units with eCBS worldwide. ABS 9 enhanced allows riders to enjoy a safe and more comfortable ride by efficiently distributing the rider’s braking force between the front and rear wheel – independent of which brake is activated.

**Function** ABS 9 enhanced is available as a 2-channel system for active pressure buildup on the rear wheel, or as a 3-channel system for active pressure buildup on both wheels. For the eCBS function, additional valves and up to four pressure sensors are integrated into the ABS hydraulic unit. Measuring the rider’s brake input and other parameters such as speed, the system calculates the optimal brake force distribution in every braking situation. ABS 9 enhanced automatically applies the second brake without the rider having to apply more pressure and without changing braking force. The two-wheeler can thus brake safely both on wet and dry surfaces with a good grip.

**Value-added functions** ABS 9 enhanced can easily be expanded with additional functions. When combined with Bosch traction control, ABS 9 enhanced can prevent the rear wheel from spinning during acceleration, and counteract front-wheel lift. The traction control can even be adapted to motocross machines for dirt racing. Bosch off-road control is designed for loose surfaces. In this function, slip thresholds and other parameters have been adjusted to give riders optimum braking performance on rough terrain as well, without compromising the off-road experience.

To prevent lifting of the rear wheel during full braking, ABS 9 enhanced uses the rear-wheel lift-up control to evaluate how much each of the two wheels is slipping. If the two-wheeler is in danger of falling over, braking pressure on the front wheel is reduced. The hill hold control function prevents the two-wheeler from accidentally rolling backward. Based on information from a longitudinal-acceleration sensor, hill hold control determines if the two-wheeler is on a slope and at a standstill.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (w × h × d)</td>
<td>124.6 × 83.5 × 106.8 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.4 kg (2-channel system) 1.5 kg (3-channel system)</td>
</tr>
<tr>
<td>Volume</td>
<td>1.11 liters</td>
</tr>
<tr>
<td>Channels</td>
<td>2 or 3</td>
</tr>
<tr>
<td>Pressure sensor</td>
<td>integrated (3 or 4)</td>
</tr>
<tr>
<td>Longitudinal-acceleration sensor</td>
<td>optional</td>
</tr>
<tr>
<td>Valve</td>
<td>3 × inlet, 3 × outlet, 2 × switching, 2 × high-pressure switching valve (3-channel system)</td>
</tr>
<tr>
<td>Exchangeable ECU</td>
<td>yes</td>
</tr>
<tr>
<td>Connector</td>
<td>26 pins</td>
</tr>
</tbody>
</table>
Active safety systems
ABS 10 light

Product benefits

- Best possible deceleration without front-wheel lockup
- Increased vehicle stability and riding comfort with excellent brake lever feel
- Integrated rear-wheel lift-up control
- Traction control as optional value-added function
- Entirely new design meets the most stringent box volume and weight requirements for small two-wheelers
- High vibration resistance

Vehicle segments

1. Electronic control unit with integrated motor
2. Hydraulic unit
3. Connector
Active safety systems

ABS 10 light

Task
ABS 10 light is the cost-efficient, entry-level version of the tenth generation of Bosch’s antilock braking system for small two-wheelers. The system assists the rider when braking in critical riding situations. It prevents wheel lockup and ensures vehicle stability as well as optimum deceleration during braking. ABS 10 light therefore significantly reduces the risk of falling and shortens stopping distances. It has been specifically designed to fulfill the size and weight requirements for small two-wheelers. ABS 10 light is suitable for all two-wheelers with hydraulic front-wheel brakes. It offers antilock protection for the front wheel, even in case of sudden changes in road surface, caused for example by grit or oil. This allows even inexperienced riders to brake safely.

Function
Speed sensors on the wheels register the rotational speed. If the front wheel is at risk of locking due to intense braking or slippery road conditions, the ABS hydraulic unit reduces the braking pressure applied by the rider and controls wheel speed as well as vehicle deceleration. This preserves the wheel’s gyrostatic effect and keeps the vehicle stable, even on varying surfaces. It also allows the rider to safely achieve the shortest possible stopping distance.

Value-added functions
ABS light can easily be equipped with additional functions. When combined with Bosch traction control, ABS can prevent the rear wheel from spinning during acceleration. Bosch off-road control can be integrated into ABS 10 light and is designed for loose surfaces. This means all-terrain two-wheelers now have the benefit of additional safety. For the off-road control function, slip thresholds and other parameters have been adjusted to provide riders with optimum braking performance over rough terrain as well.

To prevent the rear wheel from lifting during full braking, ABS 10 light has the integrated rear-wheel lift-up control function to evaluate how much each of the two wheels is slipping. If the two-wheeler is in danger of overturning, braking pressure on the front wheel is reduced.

ABS 10 light allows the addition of value-added functions for increased riding safety and performance.

of all relevant accidents could be prevented if every powered two-wheeler were equipped with the 1-channel ABS light (front wheel)*.

* Source: Bosch Accident Research studies Germany & India (GIDAS 2001-2004, RASSI 2009-2013)

Additional comfort

up to 18%

Technical characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (w × h × d)</td>
<td>81 × 51 × 70mm</td>
</tr>
<tr>
<td>Weight</td>
<td>0.45 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>0.29 liters</td>
</tr>
<tr>
<td>Channel</td>
<td>1</td>
</tr>
<tr>
<td>Valves</td>
<td>1 × inlet, 1 × outlet</td>
</tr>
<tr>
<td>Exchangeable ECU</td>
<td>no</td>
</tr>
<tr>
<td>Connector</td>
<td>16 pins</td>
</tr>
</tbody>
</table>

Bosch Corporation | Two-wheeler & Powersports | 3-9-1, Ushikubo | Tsuzuki-ku, Yokohama | Kanagawa 224-8501 | Japan | www.bosch-motorcycle.com
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Active safety systems
ABS 10 base

Product benefits

- Best possible deceleration without wheel lockup
- Increased vehicle stability and riding comfort with excellent brake lever/pedal feel
- Integrated rear-wheel lift-up control
- Options include off-road control and traction control
- Entirely new design meets the most stringent box volume and weight requirements for small two-wheelers
- High vibration resistance

Vehicle segments

1 Electronic control unit with integrated motor
2 Hydraulic unit
3 Connector
**Task** Bosch ABS 10 base antilock braking system for small two-wheelers assists the rider when braking in critical riding situations. It prevents wheel lockup and ensures vehicle stability and optimum deceleration during braking. It therefore significantly reduces the risk of falling and shortens stopping distances. The tenth-generation ABS base has been specifically designed to fulfill the size and weight requirements for small two-wheelers. ABS 10 base is suitable for all two-wheelers with hydraulic front- and rear-wheel brakes. It offers full antilock protection, even in case of sudden changes in road surface, caused for example by grit or oil. This allows even inexperienced riders to brake safely.

**Function** Speed sensors on both wheels register the rotational speed. If a wheel is at risk of locking due to intense braking or slippery road conditions, the ABS hydraulic unit reduces the braking pressure applied by the rider and controls wheel speed as well as vehicle deceleration. This preserves the wheel's gyrostatic effect and keeps the vehicle stable, even on varying surfaces. It also allows the rider to safely achieve the shortest possible stopping distance.

**Value-added functions** ABS base can easily be equipped with additional functions. When combined with Bosch traction control, ABS can prevent the rear wheel from spinning during acceleration, and counteract front-wheel lift. Bosch off-road control can be integrated into ABS 10 base and is designed for loose surfaces. This means small all-terrain two-wheelers now have the benefit of additional safety. For the off-road control function, slip thresholds and other parameters have been adjusted to provide riders with optimum braking performance over rough terrain as well.

To prevent the rear wheel from lifting during full braking, ABS 10 base features the integrated rear-wheel lift-up control function to evaluate how much each of the two wheels is slipping. If the two-wheeler is in danger of overturning, braking pressure on the front wheel is reduced.

---

### Technical characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (w × h × d)</td>
<td>99 × 51 × 70mm</td>
</tr>
<tr>
<td>Weight</td>
<td>0.59 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>0.35 liters</td>
</tr>
<tr>
<td>Channels</td>
<td>2</td>
</tr>
<tr>
<td>Valves</td>
<td>2 × inlet, 2 × outlet</td>
</tr>
<tr>
<td>Exchangeable ECU</td>
<td>no</td>
</tr>
<tr>
<td>Connector</td>
<td>16 pins</td>
</tr>
</tbody>
</table>

---

ABS 10 base allows the addition of value-added functions for increased riding safety and performance.

---

*$ Source: Bosch Accident Research studies Germany, India & ASEAN (GIDAS 2001-2004, RASSI 2009-2013, PTW ABS Study based on India 2014)
**Active safety systems**
Inertial measurement unit

**Product benefits**
- Small size and low weight for easy integration
- Built-in calculation of lean and pitch angles for minimum signal latency
- Availability of 6D inertial signals in the vehicle coordinate system on the CAN bus
- Excellent resilience of output signals to vibration
- Option of customized adjustments, such as to the CAN interface

**Vehicle segments**

1. Housing
2. Connector
3. Lid
4. Bush
Active safety systems

Inertial measurement unit

Task
The inertial measurement unit supplies information about the motorcycle’s current dynamic status. This creates the basis for numerous safety and comfort functions that make riding safer, more comfortable, and more dynamic. The data can be used to implement or improve functions, such as: motorcycle stability control (MSC), traction control, launch control, wheelie control, cornering light, hill hold control, semi-active chassis control, accident detection for engine switch-off, and accident detection.

Function
100 times a second, the inertial measurement unit measures three accelerations and two yaw rates: the longitudinal, lateral, and vertical acceleration and, depending on the sensor’s installation position, the yaw rate and the roll or pitch rate of the motorcycle. An algorithm integrated in the microcontroller uses these 5D sensor values to calculate the 6D inertial sensor values in the motorcycle’s coordinate system, as well as the angles of lean and pitch. To make these calculations, the system uses the wheel speeds and other motorcycle-specific parameters. The inertial measurement unit can be combined with a Bosch motorcycle ABS or systems by third-party providers.

Technical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature range</td>
<td>−20°C to +85°C</td>
</tr>
<tr>
<td>Supply voltage range</td>
<td>7 to 16V</td>
</tr>
<tr>
<td>Current consumption at 12 V</td>
<td>65 mA (typically)</td>
</tr>
<tr>
<td>Service life</td>
<td>15 years</td>
</tr>
<tr>
<td>Service duration</td>
<td>10,000 h</td>
</tr>
<tr>
<td>CAN interface</td>
<td>in acc. with ISO 11898 configurable baud rate (125/250/500/1,000 kBaud)</td>
</tr>
<tr>
<td>Initial low-pass filter</td>
<td>configurable (15/30/60 Hz at −3dB)</td>
</tr>
<tr>
<td>Weight</td>
<td>40 g</td>
</tr>
<tr>
<td>Start-up time</td>
<td>≤ 1 s</td>
</tr>
</tbody>
</table>

Sensing axes

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Measuring range</th>
<th>Resolution</th>
<th>Digital resolution</th>
<th>Sensitivity errors</th>
<th>Zero-point errors</th>
<th>Non-linearity</th>
<th>Signal noise (at 15 Hz bandwidth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yaw-rate sensor</td>
<td>±163°/s</td>
<td>±0.1°/s</td>
<td>200 LSB/°/s</td>
<td>≤ ±4% (typically ±2.5%)</td>
<td>≤ ±3.0°/s (typically ±1.5°/s)</td>
<td>≤ ±1°/s (typically ±0.5°/s)</td>
<td>0.2°/s rms (typically 0.1°/s rms)</td>
</tr>
<tr>
<td>Longitudinal acceleration sensor</td>
<td>±4.2 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Angle of lean and pitch

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>angle of lean ±90°</td>
</tr>
<tr>
<td>angle of pitch ±90°</td>
<td></td>
</tr>
</tbody>
</table>
**Active safety systems**

Motorcycle stability control (MSC) base

---

**Product benefits**

- Improved stability in all riding situations based on lean- and pitch-angle-dependent brake control, even at steep lean angles
- More efficient power transmission, especially on difficult, slippery road surfaces
- Reduced risk within the physical limits
- Dynamics and riding pleasure remain unchanged

---

**Vehicle segments**

1. Sensor housing  
2. Connector  
3. Lid  
4. Bush  
5. MSC control unit  
6. Hydraulic unit  
7. Motor  
8. Connector
Active safety systems Motorcycle stability control (MSC) base

67% of all accidents in Germany that are caused by two-wheelers and occur in curves could be positively influenced by MSC.

all-in-one safety

MSC is the world’s first “all-in-one” safety system for two-wheelers and makes riding as safe as possible.

Task The technical basis of motorcycle stability control (MSC) is the ABS 9 plus system. When braking on a curve, MSC reduces the two-wheeler’s tendency to return to an upright position, providing the safest deceleration possible. The MSC also reduces the risk of “lowsiders”. These accidents occur when the rider brakes too hard on a curve and the wheels are no longer able to transfer enough side force to the road. MSC can detect the risk of a lowside and applies the braking pressure needed to ensure the best possible braking performance.

Function MSC uses an array of sensors to register the riding dynamics of the two-wheeler. Wheel-speed sensors measure the rotational speed of the front and rear wheels, and the inertial measurement unit measures the vehicle’s acceleration and angular rate more than 100 times per second. The MSC system offers two kinds of control, both of which depend on the vehicle’s lean and pitch angles: brake control and traction control. Brake control improves stability and braking effectiveness in all riding situations. By analyzing the sensor data, the difference in speed between front and rear wheels, and other parameters specific to the two-wheeler such as tire size, tire shape, and sensor location, the MSC control unit calculates the physical limits of brake force. If MSC detects that a wheel is starting to lock, it activates the pressure modulator in the hydraulic brake circuit. This lowers the brake pressure and then builds it up again within a fraction of a second, resulting in exactly as much brake pressure as is necessary to keep each wheel from locking and to minimize braking distance. Traction control regulates the maximum engine torque so that driving force is efficiently transferred to the road, even on variable or slippery road surfaces.

Value-added functions MSC offers a whole range of safety functions. Drag torque control counteracts critical situations that arise when driving torque suddenly increases or drops. MSC detects the lean angle and the risk of traction loss, and instantly computes the best possible values for acceleration and braking. The wheelie control function regulates the engine torque, preventing the front wheel from lifting uncontrollably, while ensuring maximum acceleration. The rear-wheel lift-up control function keeps the rear wheel on the road by reducing the maximum brake force on the front wheel. This maintains riding stability and braking distances. The off-road control function allows optimum braking performance on unpaved roads without any restriction on riding dynamics and pleasure.

The slope dependent control function detects the danger of the rear wheel lifting up on a downhill and adjusts the brake pressure to keep it on the road. When riding uphill, this function optimizes braking control to shorten braking distance.
Product benefits

- Improved stability in all riding situations based on lean- and pitch-angle-dependent brake control, even at steep lean angles
- Optimized brake force distribution through eCBS
- More efficient power transmission, especially on difficult, slippery road surfaces
- Reduced risk within the physical limits
- Dynamics and riding pleasure remain unchanged

Vehicle segments

1. Sensor housing
2. Connector
3. Lid
4. Bush
5. MSC control unit
6. Hydraulic unit
7. Motor
8. Connector
Active safety systems Motorcycle stability control (MSC) enhanced

67% all-in-one safety

of all accidents in Germany that are caused by two-wheelers and occur in curves could be positively influenced by MSC.


**Task** The technical basis of the motorcycle stability control (MSC) is the ABS 9 enhanced system. When braking on a curve, MSC reduces the two-wheeler’s tendency to return to an upright position. It adapts the braking force between the front and rear wheel, providing the safest deceleration possible. The MSC also reduces the risk of “lowsiders”. These accidents occur when the rider brakes too hard on a curve and the wheels are no longer able to transfer enough side force onto the road. MSC can detect the risk of a lowsider and applies the braking pressure needed to ensure the best possible braking performance.

**Function** MSC uses an array of sensors to register the riding dynamics of the two-wheeler. Wheel-speed sensors measure the rotational speed of the front and rear wheels, and the inertial measurement unit measures the vehicle’s acceleration and angular rate more than 100 times per second. The MSC system offers two kinds of control, both of which depend on the vehicle’s lean and pitch angles: brake control and traction control. Brake control improves stability and braking effectiveness in all riding situations. By analyzing the sensor data, the difference in speed between front and rear wheels, and other parameters specific to the two-wheeler such as tire size, tire shape, and sensor location, the MSC control unit calculates the physical limits of brake force. If MSC detects that a wheel is starting to lock, it activates the pressure modulator in the hydraulic brake circuit. This lowers the brake pressure and then builds it up again within a fraction of a second, resulting in exactly as much brake pressure as is necessary to keep each wheel from locking and to minimize braking distance. Traction control regulates the maximum engine torque so that driving force is efficiently transferred to the road, even on variable or slippery road surfaces. The eCBS (electronic combined brake system) function ensures optimum distribution of brake force at all times – even when the rider mistakenly uses only one of the two brakes, or brakes with too much force.

**Value-added functions** MSC offers a whole range of safety functions. Drag torque control counteracts critical situations that arise when driving torque suddenly increases or drops. MSC detects the lean angle and the risk of traction loss, and instantly computes the best possible values for acceleration and braking. The wheelie control function regulates the engine torque, preventing the front wheel from lifting uncontrollably, while ensuring maximum acceleration. The rear-wheel lift-up control function keeps the rear wheel on the road by reducing the maximum brake force on the front wheel. This maintains riding stability and braking distances. The hill hold control function continues to hold the brake pressure constant after the rider has released the brake, which prevents the vehicle from rolling back unintentionally. The off-road control function allows optimum braking performance on unpaved roads without any restriction on riding dynamics and pleasure. The slope dependent control function detects the danger of the rear wheel lifting up on a downhill and adjusts the brake pressure to keep it on the road. When riding uphill, this function optimizes braking control to shorten braking distance.

MSC is the world’s first “all-in-one” safety system for two-wheelers and makes riding as safe as possible.
Infotainment and connectivity
Connectivity control unit

Product benefits

- Central multi-standard communications unit
- Addresses the safety concerns of motorcyclists
- Flexible hardware and software platform
- Compact housing makes it easier to find a suitable installation location
- Voice and data transmission, also provides other vehicle control units with internet access
- Enables value-added services (e.g. eCall)

Vehicle segments

1. Housing with main PCB and integrated GNSS and radio antennas
2. Connector for power supply, sensors, and HMI interface
3. Connector for optional external antenna configurations
**Task** The connectivity control unit (CCU) by Bosch addresses the increasing safety concerns of motorcyclists. Using cloud data and information from various sensors, the unit continuously computes how stable the vehicle is and, if necessary, triggers appropriate action. The exchange of data through vehicle-to-vehicle communication technology results in an awareness of the motorcycle’s presence, ensuring drivers of other vehicles know the motorcycle is in the vicinity, even without seeing it directly. Other features, such as stolen vehicle tracking and connected horizon, enhance safety and convenience, and track telemetry monitoring makes motorcycling even more fun.

**Function** The CCU is connected to various control units via the CAN bus and to the vehicle’s sensors via a serial interface, enabling the connectivity control unit to read out the information it requires. By evaluating information from sensors on the motorcycle and utilizing a crash algorithm, the CCU is able to detect critical driving maneuvers. A secure radio communications link to the cloud makes it possible to provide a wide range of functions and services. The CCU also comes with an embedded SIM card and supports various Bluetooth functions. An integrated backup power supply further improves reliability.

**Enhanced driving experience**
The CCU enables features such as **stolen vehicle tracking** and **connected horizon** and makes motorcycling safer and more fun while enhancing convenience for the motorcyclist. **10 times** per second is how often the CCU exchanges **information** – like location and speed data – through vehicle-to-vehicle communication in order to make other drivers aware of the motorcycle’s presence, thus increasing safety.

**Technical characteristics**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced rider assistance systems (ARAS)</td>
<td>connected horizon</td>
</tr>
<tr>
<td>Safety functions</td>
<td>eCall, bCall, ITS G5, speed alert, stationary vehicle, bend and dangerous spot warning, etc.</td>
</tr>
<tr>
<td>Remote functions</td>
<td>diagnostics, control functions, etc.</td>
</tr>
<tr>
<td>Location-based functions</td>
<td>stolen vehicle tracking, find my bike, geofencing, etc.</td>
</tr>
</tbody>
</table>
Infotainment and connectivity
Integrated connectivity cluster

Product benefits

- Information communicated clearly to the rider at all times
- Enhanced screen readability
- Wi-Fi and Bluetooth connectivity
- Smartphone integration via mySPIN
- Easy customization for individual models and markets

Vehicle segments

1. TFT display with bonded glass cover
2. Mounting flanges integrated in the rear cover (not visible)
3. Housing
4. Bluetooth and Wi-Fi antennas inside the housing (not visible)
Infotainment and connectivity
Integrated connectivity cluster

fully informed

Thanks to the innovative mySPIN technology, the integrated connectivity cluster allows numerous mobile applications to be used safely and easily.

always connected

The highly customizable integrated connectivity cluster displays a wide range of information to enhance safety and convenience.

Task
Developed specially for two-wheelers, the integrated connectivity cluster (ICC) is an all-in-one information and communication center. With a screen size and resolution that can be customized to suit OEM requirements, the ICC displays relevant information related to convenience and safety functions. In addition to a wealth of information presentation options, this compact Bluetooth- and Wi-Fi-enabled unit features a broad range of communication functions in a single device. Riders who enjoy a sporty driving style can use the ICC to track the vehicle data and dynamic parameters of their ride, such as lean angles, routes, and cornering speeds.

Function
Optical bonding and an anti-reflection coating assure enhanced screen readability. Innovative features, like OS-independent mySPIN smartphone integration, can be utilized thanks to the built-in Wi-Fi connectivity. The unit also includes USB, Ethernet and CAN bus interfaces.
Passion and competence for two-wheelers
Bosch – your partner for two-wheeler technology

Global presence Bosch has experts with passion for two-wheelers in EMS, safety, and connectivity technology on three continents at hand. The newly formed Two-wheeler & Powersports business unit has locations in Japan (headquarters), the U.S., India, Europe, and China. This proximity to two-wheeler manufacturers makes for close, flexible collaboration and provides the best service possible. The short distances also save time and help reduce costs.

Tried and tested components connected to innovative system solutions Systems competence and comprehensive know-how As a systems provider with more than 30 years of experience, Bosch knows the precise technical demands placed on each of the various components and how to reconcile these as part of a functioning whole. This optimum system integration means that Bosch maximizes system benefits so as to reduce fuel consumption and CO₂ emissions plus improve engine performance, safety, and connectivity.

Optimal support for the entire lifecycle Long-term partnership Bosch has teams of experts working intensively and exclusively on two-wheeler developments. As a solid partner to two-wheeler manufacturers, Bosch offers end-to-end support throughout the entire lifecycle of vehicles with EMS, safety, and connectivity technology.

Comprehensive technology for individual configurations and solutions Comprehensive portfolio and extensive expertise Through its Two-wheeler & Powersports business unit, which pools all two-wheeler and powersports activities worldwide, Bosch offers a comprehensive range of technology for two-wheelers from a single source. This includes components for fuel injection, air management, ignition, fuel supply, exhaust gas treatment, safety systems, infotainment, and connectivity. In addition to individual components, Bosch also offers integrated complete solutions.

An innovative team of experts committed to improving two-wheelers Driving innovation and technology As a driver of innovation and a technology leader within the mobility sector, Bosch is continuously fine-tuning technology for two-wheelers with technical innovations that are suitable to large-scale production. The company’s absolute commitment to research and development allows it to offer innovative system solutions for two-wheelers and consistently improve vehicle characteristics.

Ensuring quality and reliability The quality and reliability of Bosch technology are major factors in bringing technically sophisticated two-wheelers to market. Bosch has extensive expertise in developing automotive systems, more than 30 years of experience in the two-wheeler market, and is able to transfer its expertise to its system solutions for two-wheelers.

Transferring automotive expertise to sophisticated two-wheelers

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