



Tiny but highly complex: **Three billion Bosch MEMS sensors** Precision sensors for measuring the world

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- ▶ Bosch remains at the forefront of MEMS sensor technology and is today's leading global supplier
- ▶ Many of the latest automotive and consumer electronics functions would be impossible without MEMS sensors
- ▶ Half the world's smartphones use Bosch sensors

Micro-electro-mechanical systems (MEMS) are the eyes and ears – and every other sense – of modern mobile devices. Bosch is using these tiny high-tech helpers to teach cars and modern electronic devices how to sense the world around them. Originally developed for automotive electronics systems, these components can now be found in smartphones, laptop and tablet computers, games consoles, and sports watches. Many of the latest functions for cars and electronic devices – including the ESP® electronic stability program and the use of gestures rather than keys to operate smartphones – would be unthinkable without these highly sensitive measuring instruments.

Bosch supplies sensors for a wide range of applications in the consumer electronics and automotive industries. These sensors measure pressure, acceleration, rotary motion, mass flow, and the earth's magnetic field. Bosch has been at the forefront of MEMS technology since it first emerged, and today it generates more sales in the extremely dynamic MEMS sensor market than any other supplier. Since the start of production in 1995, the company has manufactured well in excess of three billion MEMS sensors, with production volumes hitting new highs year after year. It took Bosch 13 years to manufacture the first billion, another three years to reach two billion, and only a further 18 months to cross the three-billion mark. In 2012, some 600 million sensors emerged from its state-of-the-art wafer fab in Reutlingen – or 2.4 million each working day.

“It’s no longer possible to imagine automotive or consumer electronics without MEMS sensors. In the future, they will act as the eyes and ears for systems and objects connected via the internet of things and services,” says Klaus Meder, president of the Bosch Automotive Electronics division.

Tiny high-tech helpers for vehicles and smartphones

MEMS sensors are the smallest products Bosch manufactures. Their first application was in automotive electronics and Bosch has been producing these precision sensors for use in vehicles since 1995. A yaw-rate sensor that records the rotary movements of the car around its vertical axis is at the heart of ESP®, for example, and today each modern vehicle is home to up to 50 MEMS sensors. In an automotive context, the key considerations for MEMS are their reliability and robustness, as the sensors have a direct impact on the safety of road users. Size and energy consumption are much less important factors. But the picture is quite different when it comes to smartphones or games consoles, which is why Bosch shrunk its sensors over the years to just one fiftieth of their former size. The latest generation of these sensors unites a host of functions in a casing measuring just a few square millimeters. Meanwhile the sensors’ energy consumption has been reduced by a factor of 100. Of all the suppliers in the market, Bosch is the only one producing sensor types for so many different applications. The company holds or has applied for a total of well over 1,000 patents, thereby safeguarding its innovative strength.

Bosch Sensortec

In order to react quickly and flexibly to requirements in the extremely dynamic consumer electronics market, Bosch Sensortec GmbH in Reutlingen was founded in 2005. This Bosch subsidiary recently brought the world’s first 9-axis sensor to market. The BMX055 is capable of measuring acceleration, yaw rate, and the earth’s magnetic field in all three spatial directions at the same time, which makes it suitable for a whole range of potential applications. The sensor can be put to work wherever there is a need to pinpoint a mobile device’s spatial location and position – or its orientation relative to the earth’s magnetic field – and can be integrated into even the smallest devices.

MEMS sensors – technical background

Engineers create incredibly fine silicon structures inside the sensors that shift by fractions of a micrometer when the casing is moved. This alters their electrical properties, which is something that can be measured and converted into a data stream, telling a cell phone for example what position it is currently in. Bosch engineers are working with dimensions

that are incredibly small: while a human hair has a diameter of 70 thousandths of a millimeter (70 micrometers), some sensor components measure just 4 micrometers – 17 times less than a single hair.

Since micromechanical sensors produce only weak electrical signals, experts have integrated additional electronics either into the component housing beside the sensor or sometimes even directly onto the same chip. These take the weak signal, then process it, amplify it, and convert it into digital data. In this way, MEMS sensors can provide measurements directly to control units. And these precision sensors will soon be able to do much more, whether sewn into articles of clothing to measure your heart rate, serving as mobile weather stations, measuring CO₂ concentrations in the air, or picking up the typical movements we make when pocketing our cell phones so as to deactivate the display.

More information is available online:

Bosch sensors for [automotive electronics](#)

Bosch sensors for [consumer electronics](#)

[Sensors – how technology maps the world around it](#)

[MEMS: the stars of the sensor world](#)

Press images: 1-AE-19175, 1-AE-19176, 1-BST-18783, 1-BST-19182,
1-AE-16245, 2-AE-16452

Video: [Wafer fab and sensor manufacturing](#)

Press contact: Christian Hoenicke, Phone +49 711 811-6285

Automotive Technology is the largest Bosch Group business sector. In 2012, its sales came to 31.1 billion euros, or 59 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. Its roughly 177,000 Automotive Technology associates worldwide mainly work in the following areas of business: injection technology for internal-combustion engines, alternative powertrain concepts, efficient and networked powertrain peripherals, systems for active and passive driving safety, assistance and comfort functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, and concepts, technology, and service for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP® anti-skid system, and common-rail diesel technology.

Bosch Sensortec GmbH is a fully owned subsidiary of Robert Bosch GmbH. It develops and markets micro-mechanical sensors for consumer electronics, mobile phones, safety systems, industrial technology and logistics. The product portfolio includes triaxial geomagnetic and acceleration sensors, triaxial gyroscopes, barometric pressure sensors and a comprehensive software portfolio for various applications. Since its foundation in 2005, Bosch Sensortec has emerged as the technology leader in the addressed markets. The Bosch Group has been the global market leader for MEMS sensors since 1998 and has to date sold more than 3 billion MEMS sensors. For more information, go to www.bosch-sensortec.com.

Akustica is a wholly owned subsidiary of the Bosch Group and a top supplier of silicon microphone products that are improving voice-input quality in a host of voice-enabled applications, from mobile handsets, tablets, and headsets to internet telephony on notebooks and PC camera modules. The company offers worldwide customer support services, from design-in services to post-production quality assurance. Akustica is a global organization with corporate headquarters in Pittsburgh, PA, regional offices in Taiwan and Shanghai, and a worldwide team of distributors. For more information about Akustica, go to: www.akustica.com

*The Bosch Group is a leading global supplier of technology and services. In fiscal 2012, its roughly 306,000 associates generated sales of 52.5 billion euros. Since the beginning of 2013, its operations have been divided into four business sectors: Automotive Technology, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its roughly 360 subsidiaries and regional companies in some 50 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. Bosch spent some 4.8 billion euros for research and development in 2012, and applied for nearly 4,800 patents worldwide. The Bosch Group's products and services are designed to fascinate, and to improve the quality of life by providing solutions which are both innovative and beneficial. In this way, the company offers technology worldwide that is "Invented for life."
More information is available online at www.bosch.com and www.bosch-press.com.*