



World's leading supplier **Four billion Bosch MEMS sensors** Key technology for the internet of things

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- ▶ Technological trends: a greater range of measurable variables and increased intelligence
- ▶ After cars and smart phones, now the internet of things is driving market growth
- ▶ Every second smart phone worldwide uses Bosch sensors

Micro-electro-mechanical systems (MEMS) sensors are indispensable in cars and smart phones today. These tiny sensors are becoming ever smarter, more compact, and more energy efficient. With help from MEMS sensors, even more things can become connected; in fact, anything can connect with anything else on the internet of things – including things that have never before featured electronics, such as windows and doors. This means more comfort, safety, and energy efficiency.

Bosch provides sensors for a range of uses in the automotive and consumer electronics industries. For instance, MEMS sensors measure pressure, acceleration, rotary motion, mass flow, and the earth's magnetic field, and act as the sensory organs for cars or smart phones. Bosch has been producing these sensors for [vehicles](#) since 1995. A yaw-rate sensor that records the rotary moments 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. Thanks to [Bosch Sensortec](#) acceleration sensors, a smart phone or tablet knows how it is being held, and adjusts the image accordingly. Tiny MEMS microphones made by [Akustica](#), a wholly-owned subsidiary of the Bosch Group, detect sounds and speech. Now every second smart phone worldwide uses Bosch sensors.

Bosch has been at the forefront of MEMS technology since it first emerged, and is the world's leading supplier in this extremely dynamic market, as the

experts at [IHS Technology](#) and [Yole Développement](#) have confirmed. Since the start of production in 1995, Bosch has manufactured well in excess of four billion MEMS sensors. In 2013, around one billion sensors emerged from its state-of-the-art wafer fab in Reutlingen – or three million each day. “Bosch is the only supplier that manufactures sensor types for so many different applications itself. Overall, Bosch holds more than 1,000 patents and patent applications related to MEMS technology to ensure we stay on top of our innovative capacity,” says Klaus Meder, president of the Bosch Automotive Electronics division.

Technological trends: smarter and capable of measuring more

MEMS sensors can measure an ever greater range of variables. In early 2014, Bosch Sensortec unveiled a world exclusive in sensor technology – the BME280 integrated unit, which combines sensors for pressure, humidity, and temperature in a single housing. The new unit was specially developed for applications related to environmental monitoring, indoor navigation, smart homes, personalized weather stations, and sports and fitness. Within a second, it can determine humidity – the fastest response time in the industry. It also offers remarkably precise measurement of ambient temperature and impressively low energy consumption. In addition, Bosch is making its sensors increasingly smart. Production is about to begin on the first sensor for measuring physical variables, such as acceleration, rotary motion, and the earth’s magnetic field, and it will also include a micro-controller for evaluating readings.

Key technology for the internet of things

The introduction of MEMS sensors in automotive electronics in the 1980s and 1990s marked the first wave of their surging popularity. The second major wave has been their widespread use in smart phones since the beginning of the 21st century – and the internet of things now heralds the third wave. Sensors, signal processing, batteries, and transmitters have become so small, energy efficient, and economical – even as all-in-one units – that they can be used in their billions. At the same time, radio networks are available almost everywhere. This makes MEMS the key technology for connecting things over the internet. MEMS must be equipped with a radio chip and a battery, and they must possess software intelligence, because only relevant data should be transmitted to the internet, not raw data. This local data processing calls for the special kind of systems expertise that Bosch brings to the table. In 2013, Bosch launched a door sensor that reports suspicious movements to the home owner’s smart phone. In the future, windows will control the heating or alarm system via unobtrusive sensors, and bracelets with embedded

sensors will call for help if their wearer suffers a fall. Web-enabled sensor technology will be in everything that is “smart,” not just in smart phones.

Internet of things offers great business potential

A key aspect of Bosch’s future sales growth is web-enabled products and web-based services. The company considers itself well-positioned for such growth thanks to its hardware know-how and broad technological expertise. To unlock this business area, Bosch founded [Bosch Connected Devices and Solutions GmbH](#) at the end of 2013. It supplies compact electronic products and software expertise designed to make devices intelligent and web-enabled across a broad range of applications. The focus is on the development of connected sensors and actuators. Actuators convert electrical signals from sensors and control units into a physical action, such as automatically switching a light on and off or opening and closing a valve. Initially, business activities are concentrating on sensor-based applications for intelligently networked homes, or “smart homes,” as well as activities in the fields of traffic, transportation, and logistics – because in the future, consignments of critical goods will be able to transmit data on any unusual status changes directly to logistics centers.

Technical information about MEMS sensors

MEMS sensors contain the finest silicon structures. As the casing moves, these structures shift a fraction of a thousandth of a millimeter – and their electrical properties change in the process. These properties can be measured and converted into a data stream. The dimensions are incredibly small; while a human hair has a diameter of 70 thousandths of a millimeter (70 micrometers), some components measure only four micrometers – that is 17 times smaller than the diameter of a single human hair. Since the micromechanical sensor produces only weak electrical signals, the developers built in another electronic component – sometimes in the casing beside the sensor, sometimes even directly on the same chip. This second component processes, amplifies, and converts the weak signal into digital data. In this way, MEMS (micro-electro-mechanical systems) sensors can supply control units directly with readings.

More information is available online:

[Sensors for increased safety in vehicles: new generation of Bosch inertial sensors](#)

[Simplifying development of airbag systems: new Bosch acceleration sensors](#)

[Bosch is top MEMS maker in 2013](#)

[Bosch sensors for automobile electronics](#)

[Bosch sensors for consumer electronics](#)

[MEMS microphones](#)

[Bosch sets up company for internet of things and services](#)

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

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

[Car-to-X: the future is about connectivity](#)

[Greater safety with peripheral sensors](#)

[Internet-enabled MEMS sensors](#)

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Videos:

[Gyroscope for ESP: how it works](#)

[Pressure sensor: how it works](#)

[Acceleration sensor: how it works](#)

[MEMS sensor manufacturing](#)

[Bosch MEMS enabling the Internet of Things and Services](#)

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Bosch Sensortec GmbH is a fully owned subsidiary of Robert Bosch GmbH, dedicated to the consumer electronics world offering a complete portfolio of micro-electro mechanical systems (MEMS) sensors and solutions that enable mobile devices to feel and sense the world around them. Bosch Sensortec develops and markets a wide portfolio of MEMS sensors and solutions for smart phones, tablets, wearable devices and IoT (Internet of Things & Services) applications.

The product portfolio includes 3-axis acceleration, gyroscope and geomagnetic sensors, integrated 6- and 9-axis as well as environmental sensors and a comprehensive software portfolio. Since its foundation in 2005 Bosch Sensortec 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 4 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 phones, laptops, tablets, to small wearable accessories like headsets. 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.

Automotive Technology is the largest Bosch Group business sector. In 2013, its sales came to 30.6 billion euros, or 66 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers (NB: Due to a change in accounting policies, the 2013 figures can only be compared to a limited extent with the 2012 figures). Automotive Technology largely operates in the following areas: 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.

The Bosch Group is a leading global supplier of technology and services. In 2013, its roughly 281,000 associates generated sales of 46.1 billion euros. (NB: Due to a change in accounting policies, the 2013 figures can only be compared to a limited extent with the 2012 figures). Its operations are 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. In 2013, the Bosch Group invested some 4.5 billion euros in research and development and applied for some 5,000 patents. This is an average of 20 patents per day. 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."

Additional information can be accessed at www.bosch.com, www.bosch-press.com and <http://twitter.com/BoschPresse>