A woman in a blue shirt is kneeling on the right side of the image, holding a camera up to take a picture. In the background, a man and a woman are sitting on a grey sofa with red and patterned cushions. The woman is holding a patterned pillow and looking towards the man. The scene is set in a bright room with large windows in the background.

# Enhancing Consumer Experience **MEMS Sensor Solutions**

Bosch Sensortec



**BOSCH**  
Invented for life



# Your Partner in innovation

As the number one global supplier of Micro-Electro-Mechanical Systems (MEMS) sensors for automotive and consumer markets, Bosch is trusted by the world's most innovative companies.



At Bosch Sensortec we are much more than a component supplier. We are your partner in enhancing the consumer experience through MEMS sensor solutions.

## **Focus on consumer electronics**

With a focus on high-volume consumer products, Bosch Sensortec brings a wealth of experience to its consumer electronics customers – meeting the most demanding requirements for quality and reliability.

When partnering with Bosch Sensortec, you gain access to world-class engineering design and support. As the industry's only company to design and manufacture all of its MEMS in house, we have direct control over the entire supply chain and can secure high-volume production.

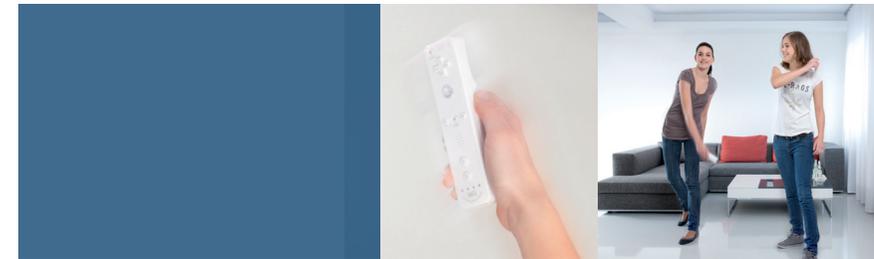
# Connections to our digital world

MEMS sensors are essential for our interaction with the digital world.

## Everyday companions

In this increasingly interconnected world, MEMS sensors are the essential building blocks for interacting with one another and our surroundings in a more natural way. They free us from the constraints of a mouse or a keyboard, empowering us to use speech, gesture and location awareness to manage our interactions with electronic devices.

From smartphones, tablets and game controllers, to sports altimeters, heart rate monitors and home automation systems, hundreds of millions of consumer electronic devices use MEMS technology. Now more than ever, MEMS technology comes from Bosch Sensortec.



## Enhancing consumer experience:

- ▶ Motion detection
- ▶ Free-fall detection for data protection
- ▶ Activity monitoring
- ▶ Altimetry
- ▶ Context awareness
- ▶ Personal well-being
- ▶ Home automation control

# Sensors for boundless possibilities

We provide a variety of MEMS sensors and solutions for a wide range of applications in consumer electronics.



## Our product portfolio:

- ▶ Accelerometer
- ▶ Gyroscope
- ▶ Magnetometer
- ▶ eCompass
- ▶ Barometric Pressure Sensor
- ▶ Inertial Measurement Unit (IMU)
- ▶ Absolute Orientation Sensor (9-axis device)
- ▶ Sensor Fusion Software



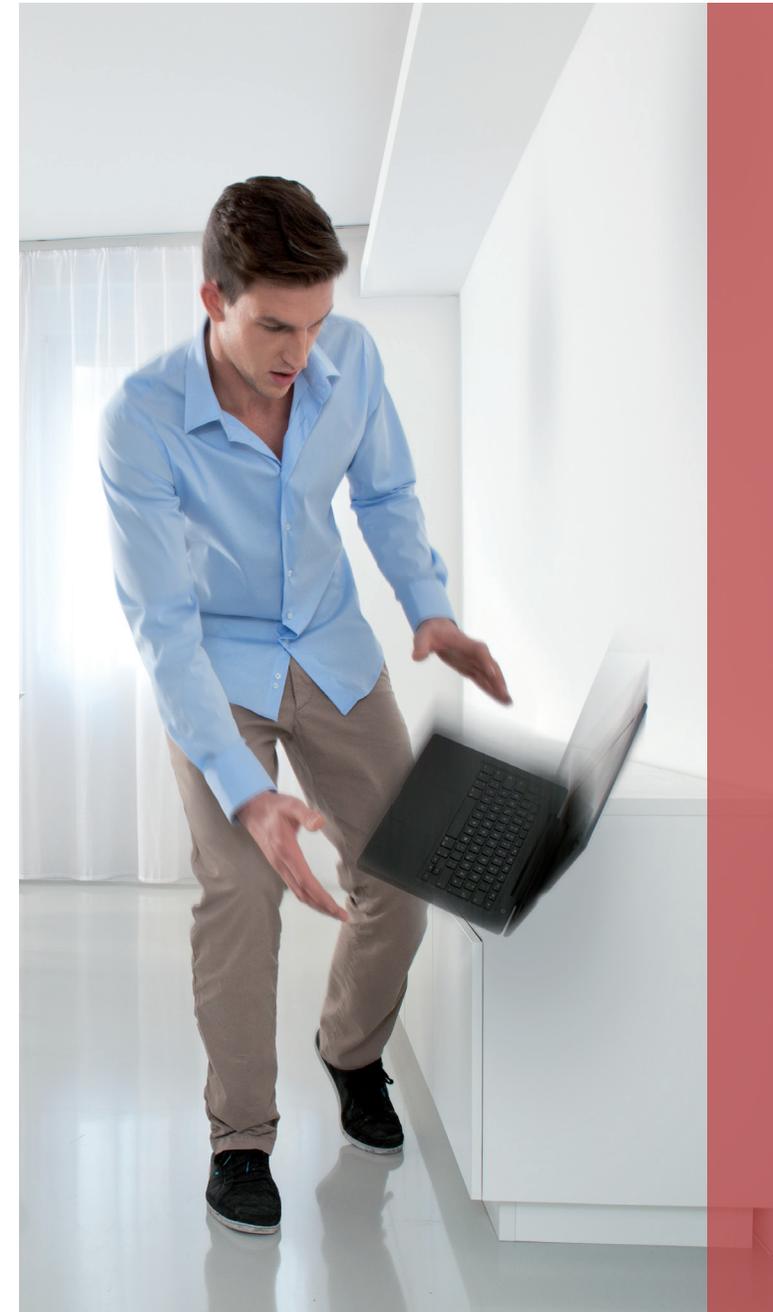
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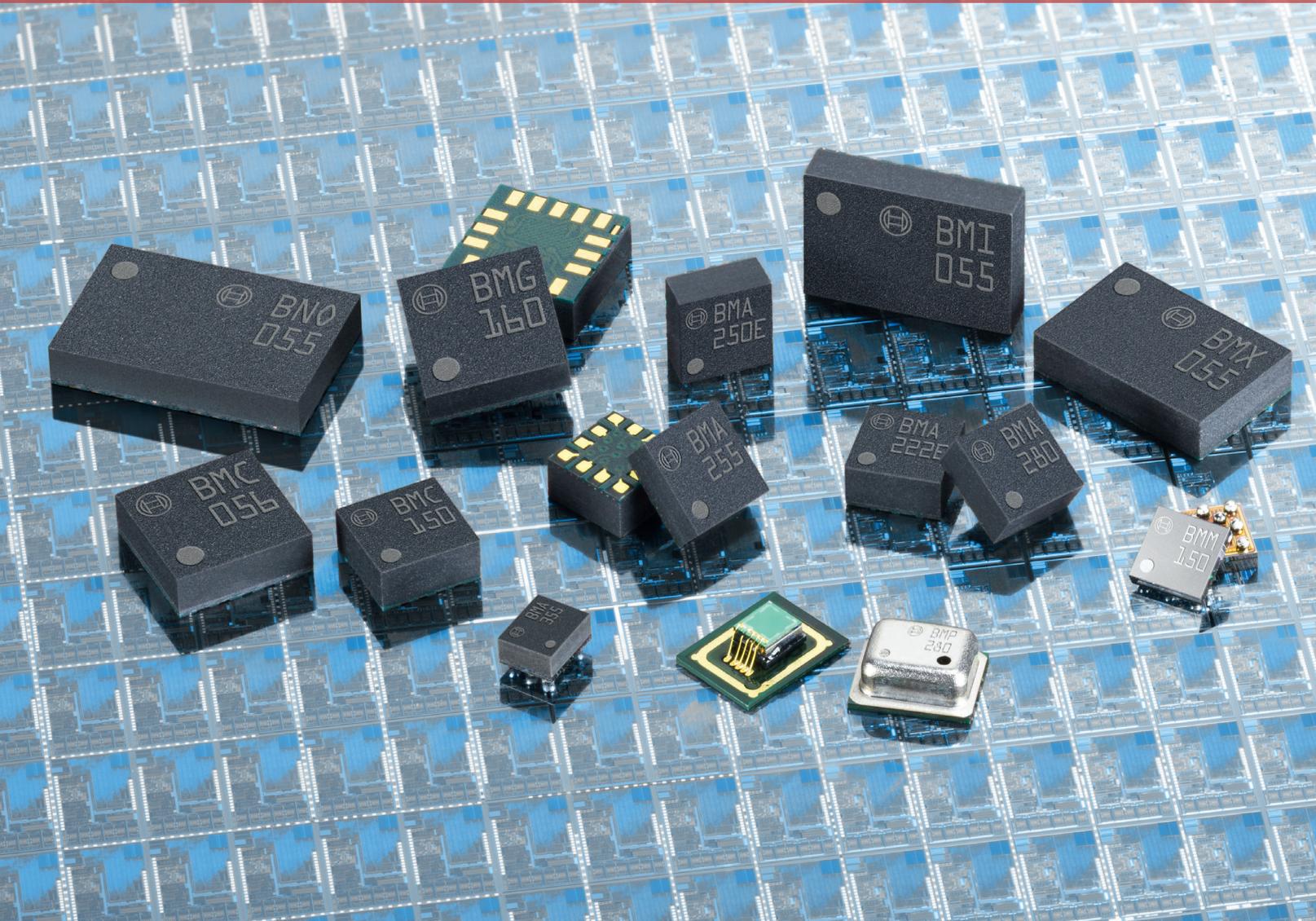


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# Technology leadership in consumer MEMS



## **Trendsetting since the very beginning**

Bosch has been developing and manufacturing MEMS sensors for measuring pressure, yaw rate, acceleration, geomagnetic field and air flow since 1988. More than 3 billion MEMS sensors have been produced, making Bosch the world's leading supplier of MEMS sensors.

## **Bosch Sensortec sets the standard for today's MEMS devices:**

- ▶ Smallest 3-axis consumer electronic accelerometer with only 1.2 x 1.5 mm<sup>2</sup> footprint
- ▶ Lowest power consumption for 6-axis and 9-axis devices
- ▶ Highest reliability across the entire product portfolio

# MEMS Sensors and solutions

We offer the broadest portfolio, make the smallest accelerometers and pressure sensors, set the bar for performance, and provide software that optimizes systems for high performance and low power consumption.



## **A = Accelerometer**

A 3-axis accelerometer measures the change of linear motion as well as gravitational forces. The direction of the gravitational force with respect to the device is used to calculate the orientation of the device.



## **C = eCompass**

A 6-axis eCompass measures the earth's geomagnetic field as well as dynamic and static acceleration in all three dimensions. It also outputs compensated heading and orientation information.



## **G = Gyroscope**

A 3-axis gyroscope measures the rate of rotation in space (roll, pitch and yaw), also referred to as "angular rate".



## **I = Inertial Measurement Unit (IMU)**

An IMU combines a 3-axis accelerometer and a 3-axis gyroscope.



## **M = Magnetometer**

A magnetometer measures the terrestrial earth's magnetic field.



## **O = Absolute Orientation Sensor**

The absolute orientation sensor is a 9-axis device integrating an accelerometer, a gyroscope, and a magnetometer. Optionally it can include a microcontroller and sensor-data fusion software.



## **P = Pressure Sensor**

A pressure sensor measures barometric pressure, and therefore also altitude.



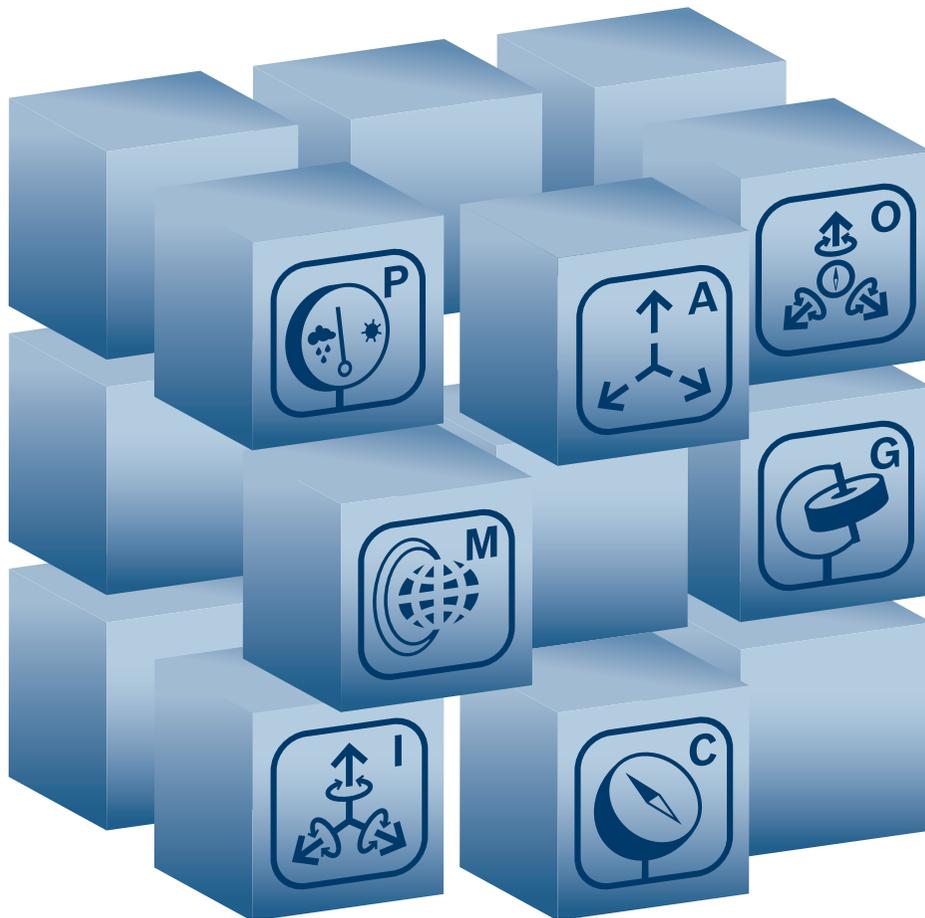
## **S = Sensor Fusion Software**

Sensor fusion software intelligently fuses raw data from multiple sensors for optimal performance.

# Sensor Fusion Software

## for optimized performance

Bosch Sensortec's FusionLib software intelligently processes raw data from multiple sensors into a single optimized solution, characterized by fast response, high data throughput and low power consumption.



### Modular and scalable solutions – all based on in-house technologies

FusionLib software currently supports 9-axis and 6-axis implementations, and can be scaled to run optimally on embedded microcontrollers and application processors. FusionLib supports the latest versions of Android™ and Microsoft Windows® operating systems.

FusionLib provides a ready-to-use advanced sensor-fusion system that reduces the complexity for OEMs and helps in the rapid development of advanced sensor applications, such as augmented reality, image stabilization, pedestrian tracking and gesture recognition.

#### FusionLib features:

- ▶ Fast calibration of all sensor data
- ▶ Enhanced magnetic distortion detection and suppression
- ▶ Real-time motion tracking
- ▶ Drift cancellation

# MEMS

## under the cover

The BMP180 is an absolute barometric pressure sensor specifically designed for mobile applications. Its small dimensions and low power consumption make it ideal for battery-powered devices such as mobile phones and GPS modules or watches.



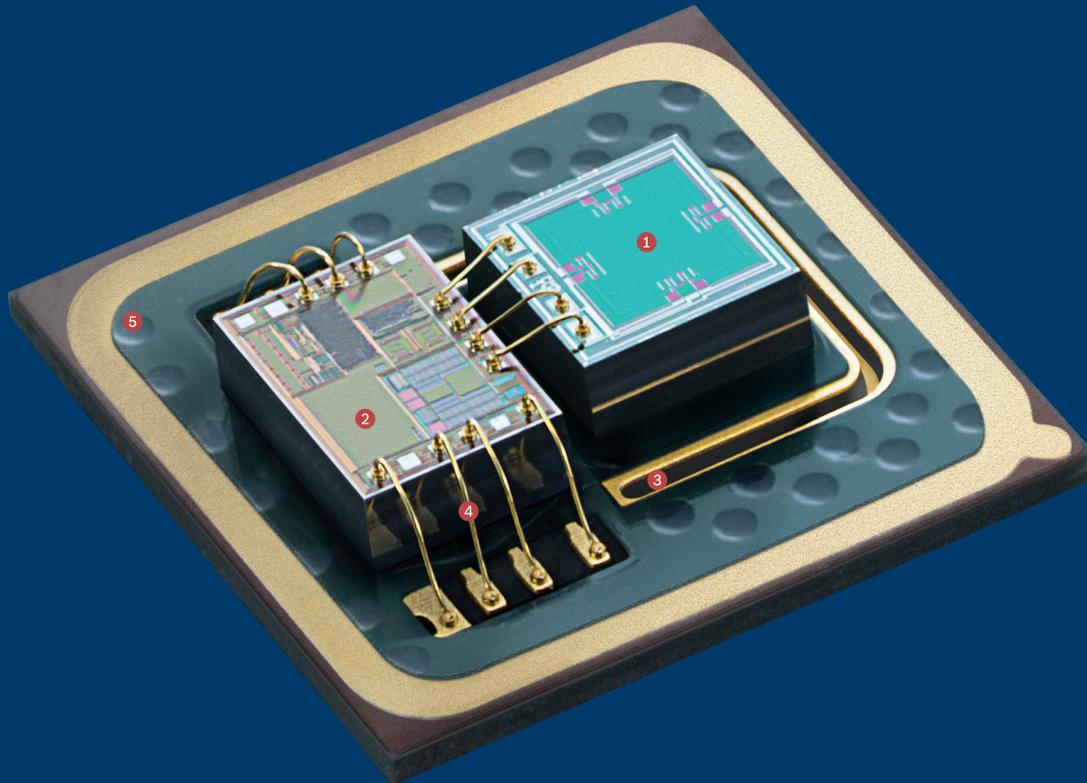
### Take a closer look at the BMP180

- 1 Piezoresistive pressure sensor based on MEMS technology – MEMS is an intelligent component technology that combines **tiny mechanical structures with electronic circuits**. Individual MEMS structures are just a few  $\mu\text{m}$  in size.
- 2 Each MEMS device includes an application-specific integrated circuit (ASIC), which is the **evaluation circuit for conditioning and amplifying the output signal from the MEMS element**; for digital sensors, the ASIC contains an ADC (Analog-Digital-Converter), an interrupt engine and interface logic.
- 3 Decoupling unit
- 4 Bond wires
- 5 Sensor substrate that holds the MEMS and ASIC structure and has **pins on the rear side to connect to the PCB (Printed Circuit Board)** of the end product, such as a tablet or a smartphone.

# MEMS

## under the cover

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# DRIE:

## We invented the MEMS process

Bosch's DRIE is the most widely used MEMS process technology in the industry.

### The "Bosch Process" (DRIE)

Often called "the Bosch process", Deep Reactive Ion Etching (DRIE) is a process technology involving numerous combinations of mask layers, etch stop, cleaning and characterization methods. Almost every microstructure can be created through the large variety of Bosch's DRIE processes, which we continuously improve to deliver best-in-class solutions.

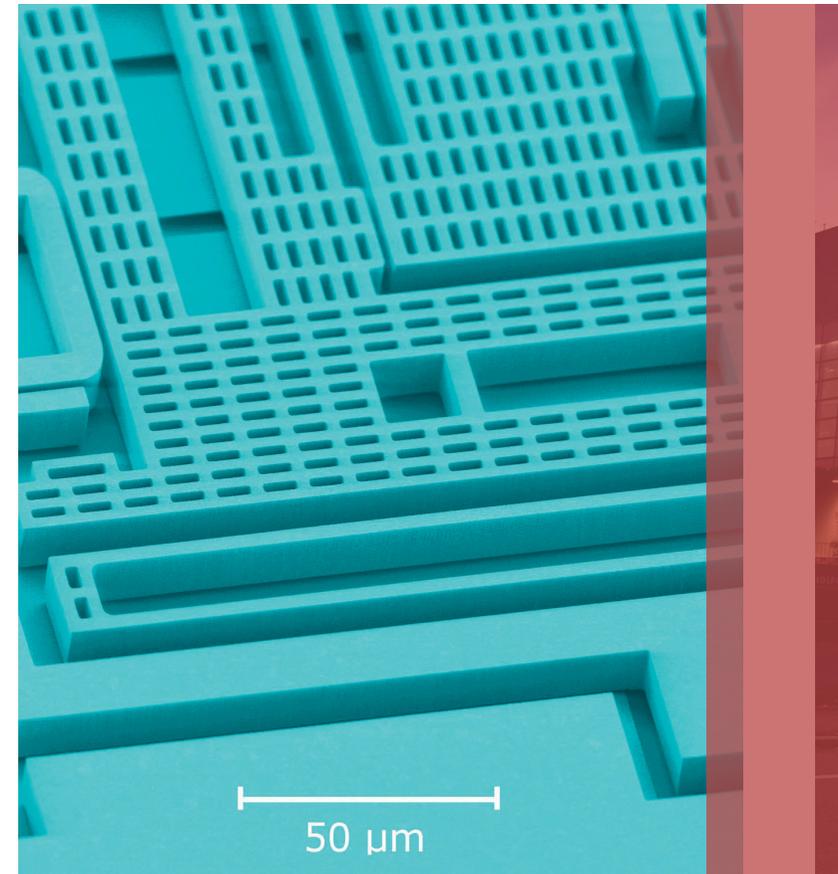
Bosch's DRIE process technology enables the greatest possible functionality. Numerous combinations of mask layers, etch stop, cleaning and characterization methods have been established.

### Bosch Process Technologies

DRIE (The "Bosch Process")  
Sacrificial Etching  
KOH Etching  
Wafer Bonding  
Metallization  
Lithography  
Thin Film Deposition

### Capabilities

- ▶ Maximum process reliability
- ▶ High-volume production
- ▶ Reliable delivery performance
- ▶ Flipcore
- ▶ APSM



# Leveraging manufacturing strength

Bosch manufacturing, testing and packaging solutions ensure quality and reliability for customers, even at the highest volumes.



## **More products use sensors from Bosch than from any other company in the world**

Active in the field of MEMS since 1988, Bosch has shipped more than 3 billion MEMS sensors to date.

## **Our fab is a big part of our foundation**

With an annual production of 600 million MEMS sensors, the Bosch MEMS fab in Reutlingen, Germany is the industry's largest MEMS fab.

## **Bosch Sensortec builds upon this strong foundation**

Founded in 2005 as a one hundred percent subsidiary of Robert Bosch GmbH, Bosch Sensortec leverages Bosch's development and manufacturing competencies for consumer markets.

Beyond MEMS fabrication, we offer a service portfolio tailor-made to each customer's needs. This includes individual testing and packaging solutions as well as ASIC manufacturing.

# Redefining time to market

Time to market is critical in the competitive, fast-moving world of consumer electronics. We have everything you need to meet design-to-delivery deadlines.

## **A strong foundation for accelerated innovation**

Our work with customers starts with an extensive understanding of market influences and their specific application requirements. We leverage design and manufacturing expertise to add unique product differentiators, prizing reliability throughout the process. By combining a world-class foundry and global supply chain to the mix Bosch Sensortec leads the industry in quality, reliability and time to market.



# Global Reach, worldwide support

Bosch Sensortec has sales, engineering and customer application support teams available all over the world.



# The Bosch Group at a glance



## About the Bosch Group

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".

The company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant upfront investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

# Relying upon total availability

## We are where you are

The Bosch Group employs around 306,000 people worldwide. At Bosch we act and think globally and regionally simultaneously—whether in Asia, Europe or North America. With this powerful foundation, Bosch Sensortec is not only capable of rapidly adapting existing sensors for new markets and applications. We are also equally adept at creating new and customized MEMS sensors for each and every system.

Bosch Sensortec has a worldwide presence, with sales offices in Germany, China, Japan, Korea, Taiwan and USA.



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