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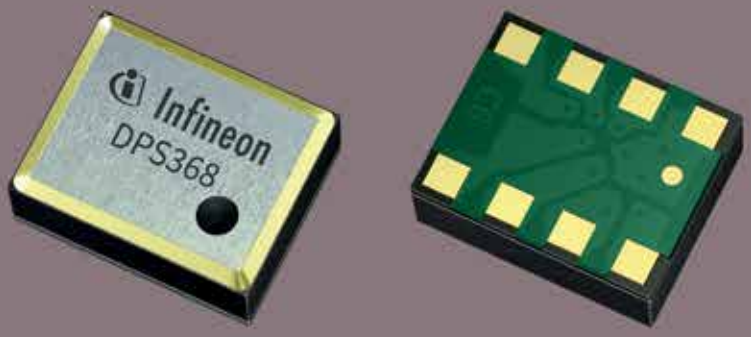

COVER STORY:
Robust and Precise Barometric Pressure Sensor for Wearables in Harsh Environments
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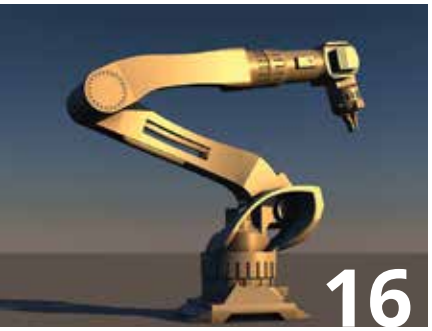

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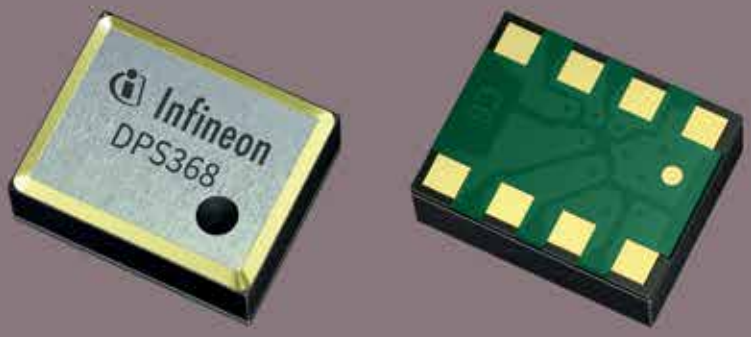
COVER STORY

Robust and Precise Barometric Pressure Sensor for Wearables in Harsh Environments

BY THERESA MÖHRLE, Product Marketing Manager Pressure Sensors at Infineon Technologies

Smartwatches and wearables are often used in harsh environments, and features like motion and activity tracking require high precision, fast read-out, and low power consumption. Related portable devices integrate barometric pressure sensors for accurate elevation gain, vertical speed, and motion detection.



Infineon's new DPS368 digital barometric air pressure sensor is ideal for wearables in harsh environments as it saves up to 80% space compared to other waterproof pressure sensors and offers a precision of ±2 cm and up to 50% power savings compared to piezo-resistive technology. The sensor is robust against water, humidity, and dust as the pads and membranes are protected by gel (**Figure 1**). It is IPx8-certified and can withstand 50 m under water for one hour.

Other challenging applications addressed by the DPS368 are air flow monitoring in vacuum cleaner, air conditioning, or cooker hoods, where pressure sensors have to work in dusty and humid environments to detect malfunctions or performance losses. Medical applications that also benefit from these precise and robust pressure sensors include smart inhalation devices, breathing masks, or non-invasive blood pressure measurements.

The pressure sensor element of the DPS368 uses a capacitive sensing principle, which guarantees high precision during temperature changes. The DPS368 is based on the proven DPS310 but with a very robust and waterproofed package. This combination makes the DPS368 ideal for a variety of applications in harsh environments. Target applications are smartwatches, wearables, and smartphones (e.g., fitness tracking, step counting, fall detection, navigation, altitude detection); home appliances (e.g., air flow control in HVAC/vacuum cleaners, water level detection in washing machines, intruder detection); drones (e.g., flight stability, height control); eCigarettes (heater control); and health care (e.g., fall detection, air flow monitoring).

ROBUST AND SENSITIVE

The DPS368 offers superior resolution, temperature stability, energy efficiency, and high robustness. This combination of benefits makes it particularly attractive in battery-powered applications in which sensing of very small pressure changes is needed — even in harsh environments. The DPS368 integrates both barometric pressure and temperature sensing (**Figure 2**) into a single, extremely compact eight-pin LGA package that measures just 2.0 × 2.5 × 1.1 mm. Average current consumption is 1.7 µA for pressure measurement (only 0.5 µA in standby mode).

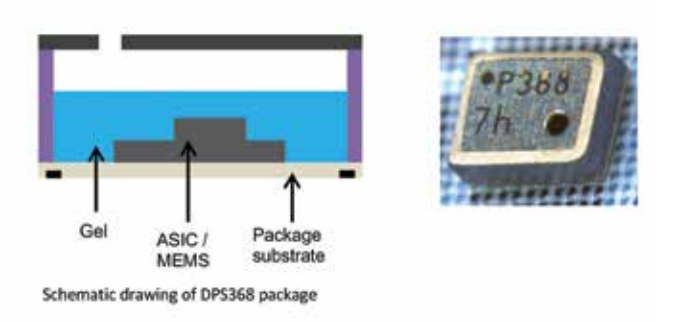


Figure 1: *The ASIC and MEMS of the DPS368 are protected by gel in a very robust package.*

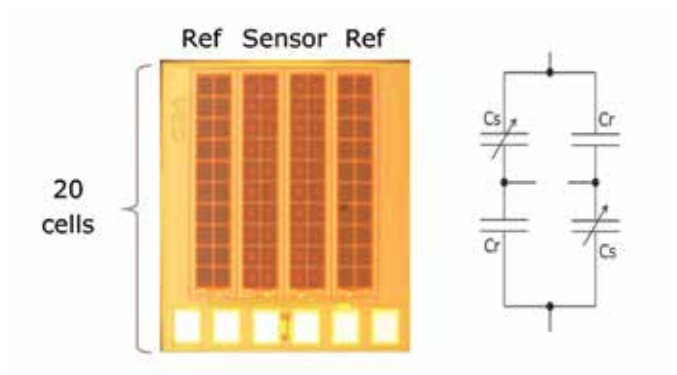


Figure 3: *The cell structure of the capacitive sensor enables differential measurements with very low temperature drift.*

Capable of precision to ±0.002 hPa (equating to ±2 cm), the device can measure air pressure between 300 hPa and 1,200 hPA at a temperature of –40°C to 85°C and has a pressure temperature sensitivity of less than 0.5 Pa/K. The temperature accuracy is specified with ±0.5°C. The sensor is able to detect single stairs, body motions, or gestures. Every sensor is individually calibrated during production, with the calibration coefficients stored in one-time programmable (OTP) memory. Raw data can be transferred using an I²C or SPI interface, with compensated pressure values being calculated in the host device.

The high-efficiency device provides up to 50% less power consumption than competitor products when running in full speed due to its capacitive technology (AC biasing), which leads to longer battery lifetime. Further system power savings are provided by allowing the host processor to remain in sleep mode for long periods between readings. The high measurement rate (up to 200 Hz) and fast read-out enable a quick sensor feedback.

CAPACITIVE TECHNOLOGY

Typical small form-factor microelectromechanical system (MEMS) pressure sensors are built around piezo-resistive measurement techniques. In these cases, the flexing of a diaphragm in relation to changes in pressure is sensed via a strain sensor. However, piezo-resistive sensing elements are particularly susceptible to variation with

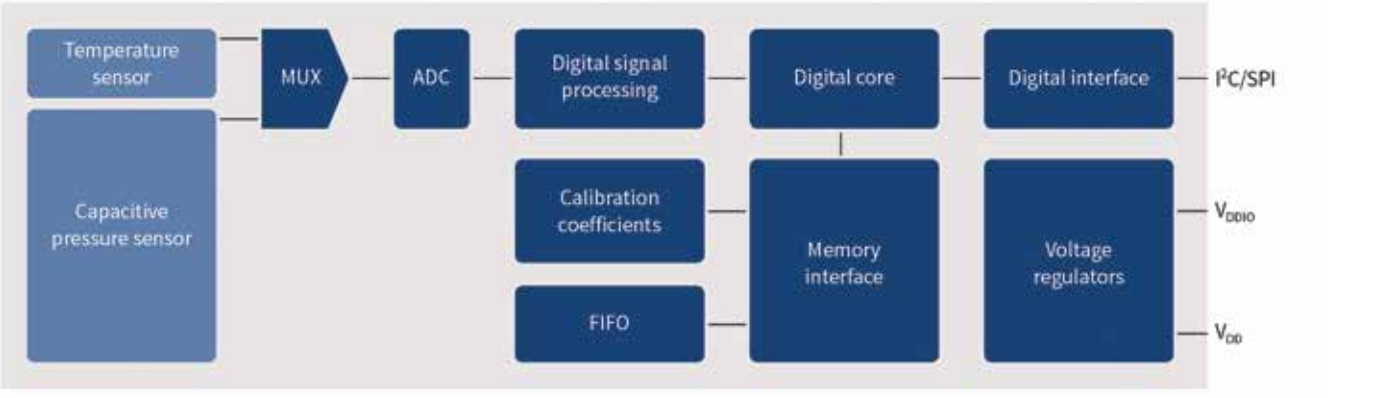


Figure 2: *Block diagram of the DPS368 architecture.*

temperature changes, and they do not respond linearly to temperature. For this reason, piezo-resistive sensors have a need for more complex calibration compared to a capacitive element. In addition, resistive measurement comes with a relatively high current consumption — a particularly important consideration when the target application is battery-powered and operating lifetime is critical.

Because of the limitations of piezo-resistive technology, Infineon developed a capacitive MEMS technology for its pressure sensors. The cell structure and capacitive bridge configuration developed are illustrated in **Figure 3**. The capacitive barometric pressure sensor consists of four arrays of sensing and reference cells. The sensing cells have a flexible membrane that reacts to pressure change and provides the air pressure measurement. The reference cells have a stiff membrane that does not react to pressure changes and provides a stable measurement reference. The benefit of this type of structure is that the pressure measurement can be differential, and both sensing and reference cells are exposed to the same temperature changes negating temperature drift effects. The cell size is optimized for high sensitivity and mechanical reliability. Based on the small MEMS cell, there is no gravity effect. Other key features, besides the very good temperature stability over wide temperature and pressure ranges, are low noise and low power consumption.

OPTIMIZED SYSTEM DESIGN

For flexible system designs, the sensor is configurable for different use cases to optimize the resolution in balance with the energy consumption. Different operation modes (high-precision, standard, low-power, and ultra-low-power) coordinate with different precision (2 cm to 50 cm) and measurement rates (single-shot and up to 200 MHz). For example, one-time measurement can be configured for GPS altitude accuracy, while the option to take several measurements per second will address the needs of gesture recognition or fall detection. The configurable modes (**Figure 4**) also lead to an optimized efficiency, as the power consumption is directly proportional to the measurement frequency. Operating in low-power mode, for example, the current consumption is 3 µA with one measurement/second and less than 1 µA at standby mode. Operating with maximum resolution, the sensor has a current consumption of about 38 µA.

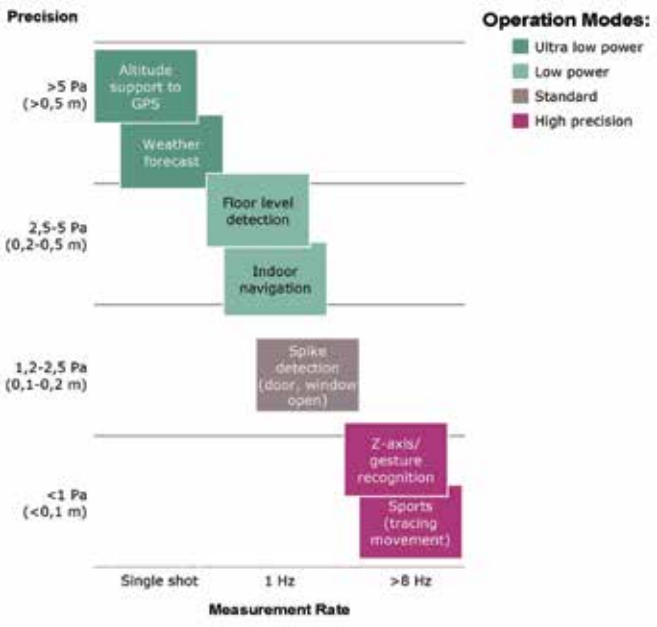
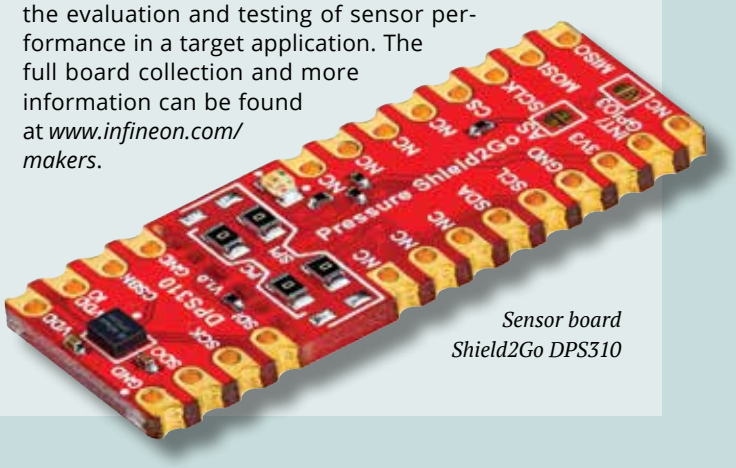


Figure 4: *Different operation modes enable optimized energy consumption and precision, depending on the related application.*

Fast Prototyping

Infineon supports quick evaluation and prototyping with comprehensive IoT solutions, evaluation boards, and software. The sensor board Shield2Go DPS310 can be used either with the microcontroller board XMC2Go or with popular IoT hardware platforms such as Arduino and Raspberry Pi for fast and easy development using the DPS310 or DPS422 sensors. A free, out-of-the-box Arduino library is also available through GitHub (*https://github.com/infineon*). This allows fast and cost-effective evaluation of applications and speeds up the production of prototypes. Furthermore, the Sensor Hub Nano is available for developments with the DPS310/ DPS422. The standalone board, measuring just 30 × 15 × 10 mm³ (including battery), incorporates a pressure sensor that can be evaluated for a variety of applications. Bluetooth connectivity is used to transmit the data to the host. A similar evaluation environment will come for DPS368. As an alternative to using the SES2G sensor evaluation software, the Infineon Pressure Sensor Android app is available free of charge. Compatible with the related sensor hubs, this app connects via Bluetooth and provides access to key sensor functionality to speed the evaluation and testing of sensor performance in a target application. The full board collection and more information can be found at *www.infineon.com/makers*.



Sensor board Shield2Go DPS310

SUMMARY

Barometric pressure sensors are increasingly becoming an important part of mobile and smart devices. With regard to IoT, pressure sensors constitute a key component for integrated sensor solutions in the field of consumer electronics. The DPS368 will be available in the first half of 2019. It is based on proven semiconductor processes and combines ultra-high resolution, fast read-out speed, excellent temperature stability, and low power consumption with a small and very robust package. It allows developers to enhance functionality and ease of use in applications such as indoor and outdoor assisted localization and navigation, sports and fitness apps, drone flight stability, real-time weather monitoring, IoT devices, and health care such as for automatic fall detection.

Further information on the Infineon pressure sensor portfolio can be found at *www.infineon.com/pressuresensor*. ■

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