Ultra-Small Humidity Sensors for Consumer Electronics

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Today, sensors make many new applications possible that were inconceivable just a few years ago. Sensors such as the SHTW2 humidity and temperature sensor from Sensirion are microscopic in size, cost-effective, use little energy and, as a result, can very easily be integrated in numerous interesting, new applications in the consumer electronics and wearables sectors.

The development of microelectronics has influenced modern society in recent decades more than almost any other technology. The advances in electronics have today made computing power as well as wireless communication inexpensive and, thus, available nearly everywhere. If information about environmental conditions shall be processed and communicated, sensors are needed that record this data. Technologies from the field of microelectronics are being used in this area as well. This has led to sensors that are smaller, more powerful, consume less energy and are even more affordable.

Miniaturization in Sensor Technology

Sensirion is a pioneer in the miniaturization of environmental and flow sensors and has made significant steps in the technological leadership in the area of microsensors in the past 20 years. In 2001 the company launched the world’s first integrated, digital humidity and temperature sensor. With dimensions of just 5 x 7.5 x 2.5 mm³, it was extremely small compared to all other sensors available on the market at that time and had a much greater performance range. And progression has continued in miniaturization over the past 16 years. The smallest humidity and temperature sensor from Sensirion currently available measures just 1.3 x 0.7 x 0.5 mm³. This corresponds to less than one fifth the size of the next smallest humidity sensors available on the market. This miniaturization was made possible by manufacturing the sensors on the basis of standard CMOS technologies. The sensor element, a “micro-machined” finger electrode system that operates on the capacitive principle, is integrated in the CMOS circuit here. This so-called CMOSens® Technology results not only in miniaturization, but also offers a number of other advantages: the microsensor systems have a high level of integration and functionality as the analog and digital signal processing, the calibration data as well as a digital interface are located on the semiconductor chip together with the sensor element. As a result, the sensors are very accurate, insensitive to interference and extremely stable over the long term. The sensors, which are based on CMOSens® Technology, can also be produced in large quantities and, thus, cost effectively.

Sensor in Chip-Scale Package Opens New Application Fields

The latest development from Sensirion is the SHTW2 humidity and temperature sensor, which was developed as a chip-scale package. This means that the finished sensor product that the customer purchases and integrates into his device is no larger than the sensor chip itself. Sensirion opted for an existing chip that has already been used in another product more than 150 million times in the field and combined it with flip-chip packaging. This approach makes it possible to offer an extremely cost-effective and yet very reliable product. Sensirion’s innovation here is to merge this standard packaging technology with the humidity sensor chip without affecting its function. With the SHTW2, a sensor is now available that can very easily be integrated in a wide range of...
applications. As any other component, it can be processed with standard SMD production processes and with its dimensions of $1.3 \times 0.7 \times 0.5 \text{mm}^3$, it can also be used in applications in which there is very limited available space. The SHTW2 operates with a supply voltage of 1.8 V and has a fully optimized ASIC design which, among other things, results in extremely low energy consumption. The sensor needs just 1 ms to power up from from stand-by mode and perform a measurement. At one measurement per second, which is sufficient for nearly all applications, the average power consumption is just 8.6 µW. With a lower measurement rate, this value can be significantly reduced even further. This makes the humidity and temperature sensor ideally suited for mobile applications. In addition to portable devices in the consumer electronics sector, wearable applications are also of great interest here.

The idea of using sensors directly on the human body is not new. Heart-rate measurement during sport – originally more of a medical application – is widespread, even among recreational athletes. With the development of high-performance environmental sensors, many other new applications will become possible. The SHTW2 can, for example, be implemented in headphones to detect whether or not they are currently being worn by the user. Playback or noise cancellation can then be interrupted if the user takes off the headphones. This is achieved by integrating two humidity and temperature sensors in the headphones. One of these is directed towards the ear, the other to the outside. Since the ear has a higher humidity than the ambient air, one sensor measures a higher value if the headphones are being worn. Using the two sensor values in combination with a corresponding algorithm – another one of Sensirion’s strengths – it is possible to reliably detect when headphones are put on and taken off. The small size of the SHTW2 makes this application possible even in very small in-ear headphones and enables smarter battery management that corresponds to the individual use of battery-operated devices, such as headphones, fitness trackers, VR glasses, etc. Sensirion’s developer website “developer.sensirion.com” offers tutorials for these application examples for the creation of a prototype as well as source code for developing the algorithms.

The moisture of the human skin plays an important role in two other applications as well. Motorcycle drivers and skiers as well as users of VR glasses often suffer from a problem: due to moisture – caused by perspiration – the visor of a helmet, ski glasses or even the lenses of VR glasses can fog up. An application from the automotive sector shows how this problem can be solved: every year, millions of humidity sensors from Sensirion, which meet the quality standards of the automotive industry and are, thus, larger as well as more expensive, are used for detecting condensation on the windscreen of vehicles. The humidity and temperature sensor determines the dew point and controls the air conditioning or ventilation as necessary. Thanks to the low power consumption, the microscopically small size as well as the cost effectiveness of the SHTW2 humidity sensor, such functions can now also be realized in more price-sensitive applications in the consumer electronics sector.

The direct measurement of perspiration on the skin is another possible application of the SHTW2 in the wearables sector. The water that a human body loses through perspiration must be replaced to prevent dehydration. Elderly people, in particular, can quickly be at risk if the fluid balance is not maintained. Direct determination of the perspiration can easily be realized with the SHTW2 by means of a device that is worn on the wrist. Here, two of the humidity and temperature sensors are mounted in a channel of sorts, one end of which is in contact with the skin. The perspiration rate can thereby be precisely determined using diffusion equations. The device can then remind the wearer to drink adequate fluids as necessary.
Development Platforms and Example Applications
Sensirion supports developers in making the implementation and testing of their applications as simple as possible. Evaluation kits are available for all of Sensirion’s humidity sensors for quick and easy initial measurements. Specifically, for the SHTW2 humidity sensor, the sensor expert offers a so-called Xplained Pro Dual Humidity and Temperature Extension Board that is equipped with two SHTW2 humidity sensors and is compatible with the Xplained Pro Platform from Atmel. For the development of mobile communication applications, the SHTW2 is also available on a Qualcomm DragonBoard. Not only does Sensirion make available the appropriate boards with sensors for various platforms, the company also supplies example source codes on the “developer.sensirion.com” developer website that developers can use to immediately start their own projects. In general, the developer website offers a platform for the maker community in which possible uses of environmental and flow sensors are presented to serve as a source of inspiration for the realization of one’s own projects.

Summary: Cost-Effective Sensor and Optimal Development Support
With the new SHTW2, a high-performance humidity and temperature sensor is available in a chip-scale package. It can be used to implement even price-sensitive applications, e.g., for wearables, though many new possibilities will open. Sensirion supports the developers of such applications both with corresponding development kits as well as with example applications for which the source code is freely available.

About Sensirion – Experts for Environmental and Flow Sensor Solutions
Sensirion, headquartered in Staefa, Switzerland, is a leading manufacturer of digital microsensors and systems. The product range includes gas and liquid flow sensors, differential pressure sensors and environmental sensors for the measurement of humidity and temperature, volatile organic compounds (VOC), carbon dioxide (CO₂) and particulate matter (PM2.5). An international network with sales offices in the US, Europe, China, Taiwan, Japan and Korea supplies international customers with standard and custom sensor system solutions for a vast range of applications. Sensirion sensors can commonly be found in the medical, industrial and automotive sectors, analytical instruments, consumer goods and HVAC products.

One of the hallmark features of Sensirion products is the use of its patented CMOSens® Technology, which permits intelligent system integration of the sensor element, logic, calibration data and a digital interface on a single chip. Sensirion’s credentials as a reliable supplier are underscored by its loyal customers, quality reputation (ISO/TS 16949) and top customer pedigree.

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