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Five Key Design Considerations for Pressure Sensors

Engineers have a lot of options when it comes to sensors, but not all sensors are equal. Here's how to choose the right pressure sensor for your application.

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Pressure sensors are finding their way into industrial machinery, biomedical equipment, automation systems and personal electronics. With a slew of these handy transducers available, engineers have numerous choices available. Which attributes are most important when choosing a pressure sensor?

Engineering.com caught up with Honeywell product manager Simon Anderson, who offered some insight into the key factors—accuracy, stability, configurability, portability and affordability—that drive an engineer's choice of sensor for a particular design.

The importance of accuracy

First and foremost, you need to select a sensor pressure range that is the best fit for the intended application and identify the critical pressure range where accuracy is of the greatest importance. Design engineers also need to consider the importance of sensor accuracy over the life of the product. In other words, the sensor must be accurate and stable.

Depending on your application, accuracy can be the most important factor for pressure sensors. High-accuracy sensors are more effective at diagnosing medical conditions, allowing physicians to determine the best course of treatment. The low cost of today's sensors enables designers to place them into home-care products, such as real-time heart and breathing monitors, facilitating continuous *in situ* measurements over a period of time, rather than relying on occasional sampling performed in a medical facility. This allows for a faster and more accurate diagnosis, which is obviously good for the patient, and could also reduce the treatment time and cost.

Medical facilities can reduce the spread of infections by pressurizing certain rooms to prevent germs from entering the area, improving patient care and reducing potential liabilities. Likewise, in areas where infectious disease is prevalent, as in the COVID wards that sprung up during the pandemic, rooms can be depressurized in order to prevent the virus from escaping the ward. In both cases, accurate pressure sensors are needed to regulate the system.

Air filtration systems use pressure sensors to detect when filters are becoming clogged and need to be cleaned or replaced. This significantly improves HVAC system efficiency, since the fan doesn't have to expend as much energy to maintain a certain volume of air, and increases the blower's life as the motor doesn't have to work as hard. Since the differential pressure across a filter is relatively low, a pressure sensor needs to have a high degree of accuracy at these ultra-low pressures.

Related to accuracy, sensitivity is the ability of the sensor to detect very small changes in pressure quickly and accurately. Ultrasensitive sensors allow devices to go above and beyond their original purposes. For example, blood pressure monitors containing pressure sensors offering high sensitivity and a fast sampling rate can not only give the systolic and diastolic numbers, but can also detect how the heart valves are opening and closing, which can offer insight into the patient's overall cardiovascular health. Likewise, a breathing monitor with a highly sensitive pressure sensor gives a better picture of a patient's respiratory condition. When tracking a person's breathing, someone with asthma or COPD will have a different graph than a person who is not afflicted by a breathing disorder. This allows physicians to see the results of various treatments, enabling them to tweak or change medications accordingly.

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The Honeywell HSC Trustability series pressure sensor. (Image: Honeywell.)

Take, for example, Honeywell's HSC series and ABP2 series provide high levels of accuracy and sensitivity over a wide pressure range from 1.6mbar to 12bar and an extended temperature range from minus 40°C to 110°C, supporting a wide range of applications.

Pressure sensor stability

Stability is a measure of how the sensor's accuracy may change (or drift) over time, specified as a percentage of the full-scale span. Designers should consider a sensor's stability very carefully—how consistently it performs over the long haul (life of the product)—when choosing components for their designs. If you're designing a product that comes with a ten-year warranty, such as a piece of medical equipment, then you'll need a sensor that guarantees that stability over the product's warranty period and beyond. Medical devices often come with a ten-year warranty.

The Honeywell ABP2 series pressure sensor. (Image: Honeywell.)

Honeywell says that its ABP2 series pressure sensors deliver a worst-case drift of 0.6% FSS over 1,000 hours. "This is simply a measure of the stability over 1,000 hours and is the worst case across all pressure ranges," Anderson explained. "It's important to note that stability is not linear. The majority of drift within Honeywell sensors typically occurs within the first 500 hours of operation, whereas over 10,000 hours of life cycle testing, the stability of the sensor may only increase to 0.7% or 0.8%."

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Configurability is crucial

The pressure sensor as we know it was introduced in 1930. (Barometric pressure "meters" have been around since the 1600s, but it wasn't until 1930 that a sensor with an electrical output was invented.) In less than a century, the industry has gone from basic analog sensors to customizable digital smart sensors.

Honeywell's HSC, APB2 and MPR pressure sensors come in three versions: absolute, gage (pressure relative to atmospheric pressure), and differential (difference in pressure between two points). All series come in a variety of through-hole and surface-mount packages.

The Honeywell MPR series pressure sensor. (Image: Honeywell.)

The industry is quickly trending toward digital sensors due to their ease of integration into a digital system. When a sensor is mounted within a device it could be a distance from the main board/controller, and it's beneficial to digitize the sensor output signal to minimize signal distortion. Once digitized, a sensor needs to send its data somewhere, which is why the ABP2, MPR and HSC series include SPI and I^2C connectivity options, making them adaptable and IoT ready.

Portable pressure sensors

The medical industry is also showing a demand for small, often disposable, pressure sensors to regulate the delivery of fluids or medications for patients at home. For example, a patient with a respiratory condition may wear a mask connected to a breathing monitor device. A large sensor would need to be placed on the machine, which could be at the end of a tube several meters away. Instead, a small lightweight sensor can be attached to the mask, allowing the readings to be taken closer to the point of interest, increasing the measurement accuracy. Honeywell's HSC series offers a footprint of 10 x 13 mm and a 14 mm height. The APB2 and MPR series are even more compact, coming in at just 7 x 6 x 6 mm and 5 x 5 x 6 mm, respectively.

Single-use sensors could enable a medical infusion pump to deliver medications over a 24-hour period, or attach to a smart inhaler that ensures that the drugs are being delivered at the correct rate. Also, a pressure sensor can measure a patient's inhalation to determine whether they are inhaling deeply enough to send the medicine to the correct part of the lungs. In these cases, the single-use sensors can be active for a few months at a time before being discarded. Honeywell plans to offer a complete line of disposable pressure sensors sometime in the near future.

From a sustainability standpoint, disposable single-use sensors don't exactly fit the green model, but the sensors can't withstand the sterilization process and hospitals are not willing to risk patient health, not to mention liability, in order to reduce solid waste. Perhaps the next innovation in disposable sensors will be one that is partially or completely biodegradable.

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Sensor affordability at the bleeding edge

In an ideal world, at least from an engineering perspective, the above four factors would be the main considerations. But in this world, we have to deal with economic realities, too. Marketing determines the price of the product you're designing based on the competition. Accounting establishes the expected profit margin that the product will generate. So, be sure to appease the fiscal types by choosing components that do the job *and* fit the budget.

Not long ago, medical companies were inclined to use only technology that was tried-and-tested—in other words, old. Since the pandemic, many companies have been more amenable to incorporating leading-edge technology into their products in order to take advantage of the improved accuracy, stability and portability that today's sensors provide. But the leading edge is called the "bleeding edge" for a reason. To minimize risk while still taking advantage of innovative technology, manufacturers are willing to trust newer technologies—even in medical devices—from well-established, reputable companies.

Honeywell offers a host of engineering design utilities, including evaluation boards, CAD models and technical notes. An array of application notes and selection guides help engineers to choose the right sensor for the job and see how it's used in other designs. The company also works with customers to design and build custom sensors and modules to be integrated into their clients' devices.

Visit Honeywell from TTI, Inc. to learn more.