

Choosing the right pressure sensor – a guide for designers and product specifiers

Today's pressure sensors are called on to work within the harshest of environments - with the most hostile and corrosive media – or sometimes to take the simplest of pressure readings.

Selecting the right one for the right job is not necessarily an easy feat. Whether a particular pressure sensor is suitable for a specific application will depend in great part on the sensor's attributes, the environment it's being specified for, and the job it's being asked to perform.

So, how do you select sensors that address multiple customer-specific performance requirements? Here is a guide to finding just what you're looking for based on your performance requirements or design needs.

First, decide what the application for the sensor is. Then, you'll need to ask some of these basic questions, such as, how extreme are the temperatures or corrosive nature of the media being measured? Is the environment a vibration challenge? What is the pressure range that needs to be measured in psi, bar, inches of water, etc.? How much time are you willing to devote to the integration of the sensor, or must it be ready to implement and forget? What is the pressure type (gage, absolute, differential)? How accurate does the pressure measurement need to be? And, just as important, what are the size and price constraints?

Historically, there have been issues of stability such as drift over time, or how the sensors reacted to temperature and humidity extremes. Until recently, OEMs would have to calibrate their sensors, and end-users did the same. This was a major drain on time and effort, and the end application repeatability and reliability suffered. Product design sizes continued to shrink, yet sensor miniaturization often lagged. It was difficult to find modular designs and flexibility in a wide range of package styles and options. Figuring out if a specific sensor actually met accuracy specifications took longer than it should have. Finally, whenever recalibration was necessary, or when the sensors were changed out or upgraded, the process of recalibration started all over again.

Then pressure sensor design began to change. A new breed of silicon pressure sensors was unveiled that would radically affect the experience of design engineers because sensors could come pre-calibrated and temperature compensated. Advances in sensor technology meant that these devices were consistent, reliable and accurate. Of great importance to designers, these sensors also began to be more affordable.

Board mounted pressure sensor varieties

Deciding on the right sensor involves knowing what you need, and not paying for what you don't. From basic board mounted sensors to heavy-duty pressure transducers, each type addresses specific needs, requirements and cost restrictions.

For example, if you require ease of integration on a PCB, porting and housing options, and small size at an economical price point, a basic board mounted pressure sensor is for you.

These basic pressure sensors are used in applications that require a simple, cost-effective, unamplified, uncompensated, mV output but still need a high quality solution for medical and industrial applications. It's the smallest package sensor available, designed for customers who don't need compensation, amplification, calibration, or who want to design in these capabilities themselves.

All basic sensors, however, are not created equal. For example, after soldering, some versions lack stability — and for some, don't stop drifting for weeks. There are also situations where gel used in some basic sensors can be burned during the soldering process, leading to poorer performance. Finally, based on the plastics used, some devices soak up too much humidity before reflow – and fall apart (popcorning) as a result.

Fortunately, there are new basic sensors on the market that do not have these issues. They meet the latest processing standards including long life after the package is opened. Their ceramic base is thick and is less susceptible to stress. Easy to solder, they stay on the board, stabilizing in hours versus weeks. This is a quality sensor for an economical price.

Figure 1. Ported versions can be offered with or without gel fill.



Potential applications include such medical and industrial uses as hospital bed systems, wound therapy, and industrial applications like transmitters.

Continuing to move up the performance-level requirements chain, let's look for a moment at what design engineers wanted that prompted the recent breakthroughs in pressure sensor technology. For those selecting and implementing pressure sensors into their designs, high on the list of critical features include:

- Very low drift over time or temperature and humidity extremes
- No need to calibrate after mounting to a PCB
- Temperature compensated and calibrated
- Custom calibration availability
- An extremely tight and consistent accuracy specification
- A wide variety of package styles and options with the same performance specifications
- Provides a true measurement of accuracy that could be used to really evaluate, rather than having to test

After basic pressure sensors, the next level of board mounted pressure sensors are designed for those wishing to leverage a custom algorithm and perform their own compensation, calibration and amplification. What they do provide in comparison to the basic sensor is the ability to retain a high degree of stability, accuracy and repeatability. Ranging from 1 psi to 150 psi (60 mbar to 10 bar), these sensors will operate as specified from -40 °C to 85 °C.

These sensors are used when an extremely tight accuracy and miniature form factor are required. Their extremely low power consumption provides extended battery life, and promotes energy efficiency. This type is used for monitoring and control of industrial and medical pneumatic flow and system pressure for precise and efficient performance.

When the highest level of accuracy is needed for applications where stability and repeatability are also required, very high-accuracy compensated, calibrated, and amplified board mounted pressure sensors are the best choice.

Offering ratiometric analog and digital output for reading pressure over a full-scale pressure span and temperature range, these sensors are fully temperature compensated and calibrated over the temperature range of 0 °C to 50 °C

Of greatest importance for those tasked with selecting pressure sensors, this version first introduced the concept of always indicating total error band—a comprehensive, clear and meaningful measurement that shows the sensor's true accuracy over a compensated range – versus a variety of different potential errors. This type of specification allows the design engineer to proceed with confidence that all of the potential errors have been considered when implementing this type of sensor into the application.

Today's higher-end board mounted pressure sensors should adhere to the moisture sensitivity level 1 requirement to avoid the thermal and mechanical damage during solder reflow processes that lesser rated products often incur. Extremely low power consumption, typically less than 10mW, provides extended battery life. Applications for the compensated, calibrated, and amplified pressure sensors span such medical and industrial uses as ventilators, anesthesia machines, HVAC control, and indoor air quality.

These high-end sensors can often provide the lowest system cost for an end application. It is very important when selecting a sensor to include the costs of all required support components and

processes. More 'basic' sensors typically require stable, low-noise amplifier circuitry and analog-to-digital converters to provide a useful signal to the application microprocessor. The additional cost of a microprocessor with an on-board ADC (analog digital converter) should be taken into account. This is especially true for systems with multiple sensors where external ADCs are needed. Also, consider the production time and expense needed to temperature compensate the sensors in the end application. It is often much more cost-effective to buy a compensated sensor than to test a complex PCB assembly or high-mass device over temperature.

Figure 2. TruStability® HSC Series and SSC Series comparison chart

	HSC Series	SSC Series
Pressure range	1 psi to 150 psi	1 psi to 150 psi
Accuracy	±0.25 %FSS BFSL	±0.25 %FSS BFSL
Total Error Band	±1 %FSS	±2 %FSS
Compensated temperature range	0 °C to 50 °C [32 °F to 122 °F]	-25 °C to 85 °C [-13 °F to 185 °F]
Output accuracy	12 bit	12 bit
Response time	0.46 ms	1 ms

Source: Honeywell Sensing and Control

Heavy Duty Options

At the other end of the pressure sensor spectrum are heavy-duty pressure sensors and transducers. Heavy-duty pressure sensors tend to be smaller and can be used individually or as the building blocks of a complete transducer. Constructed of stainless steel for increased corrosion resistance as well as increased strength at temperature extremes, these sensors are built to go where other sensors don't – typically to measure hostile media in harsh environments. Potential applications include industrial and hydraulic controls, tank pressure, pressure transmitters and process control systems.

Heavy-duty pressure transducers, in comparison, are complete compensated, calibrated, amplified and packaged pressure measurement solutions. With a choice of ports, connectors, outputs and pressure ranges, they can be configured to meet the needs of such applications as air compressors, general system and factory automation, pump valves and fluid pressure, and transportation (heavy equipment and alternative fuel vehicles), system pneumatics, and hydraulics.

Summary

Features that will help designers make an accurate sensor selection include:

- Leading long-term stability
- Insensitivity to vibration
- High burst pressures and high working pressure ranges
- Flexibility and excellent repeatability
- Onboard signal conditioning
- Insensitivity to mounting orientation
- Custom calibration availability
- Internal diagnostic functions
- Energy efficient
- PC- or SPI-compatible digital output or analog output
- Small form factor

One aspect of selecting the correct pressure sensor for your job is finding a supplier that is truly a one-stop shop. Making sure that the best in quality and reliability filters down throughout all of its product offerings, no matter the price, is extremely critical.

There are many considerations when selecting pressure sensors to meet the requirements at hand. Fortunately, today's sensors span a wide range of options—from basic “no frills” pressure sensors to heavy-duty pressure transducers ideal for the harshest of environments. For the vast majority of applications, Honeywell Sensing and Control's TruStability® HSC, SSC, and NSC board mounted products have solved a myriad of industry challenges for designers, providing accuracy, reliability, repeatability and a wide range of features to meet their particular requirements, while Honeywell's new NBP series of basic board mounted pressure sensors provide quality and reliability at an affordable price.