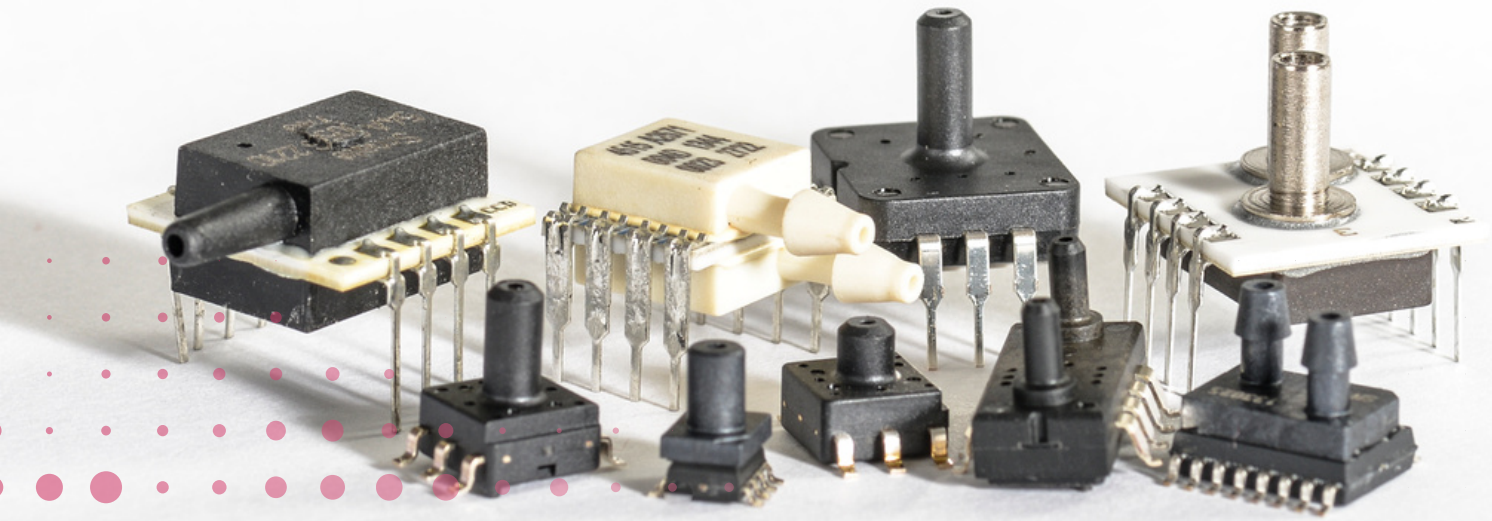
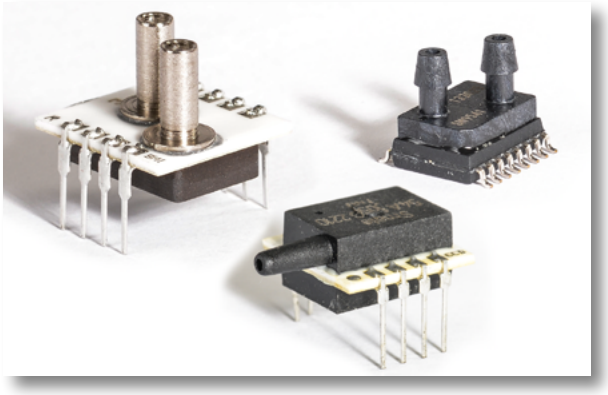
Servoflo CORPORATION

PRESSURE SENSOR SELECTION GUIDE



The advent of microelectromechanical systems (MEMS) technology has resulted in a wide range of pressure sensor style and performance options, allowing for use in an equally wide range of applications, including industrial instrumentation, medical monitoring, HVAC equipment, consumer devices, and many others.



With so many different pressure sensor models, accuracies, and features available from a variety of manufacturers, it's easy to get overwhelmed and choose an inappropriate pressure sensor model that either underperforms or overperforms based on the measurement requirements of the application. Both of these scenarios will result in higher costs; an underperforming sensor requires supporting additional components and labor while an overperforming sensor costs more money than is necessary.

We've created this eBook to help you evaluate your options and avoid unnecessary expenditures. Below are some key considerations to keep in mind when selecting a pressure sensor for your specific project.

Defining Your Application

Different types of sensors are ideal for different industries and applications. Sensors are available in common-off-the-shelf (COTS) varieties or as fully packaged transducers, and can also be modified (or even customized) for your specific needs. To narrow the scope of your prospective purchase, you'll first need to define your application requirements.

Sample Applications

Medical

- Respirator & Breath Detection Equipment
- Sleep Apnea
- Oxygen Concentrators/Conservers
- Infusion Pumps
- Blood Pressure Measurement
- Air Mattresses & Cushions
- DVT Machines
- Wound Therapy

HVAC

- Critical Containment Units
- Cleanroom Management
- VAV Control
- Indoor Air Quality/EMS Systems
- Data Center Sensors
- Refridgerant Monitoring
- Filter Blockage
- Duct Pressure Measurement

Industrial

- Barometric Pressure
- Liquid Level Sensing
- Leak Testing
- Tank Level Measurement
- Vacuum Sensing
- Instrumentation
- Altimeters
- Pressure Transducer Development

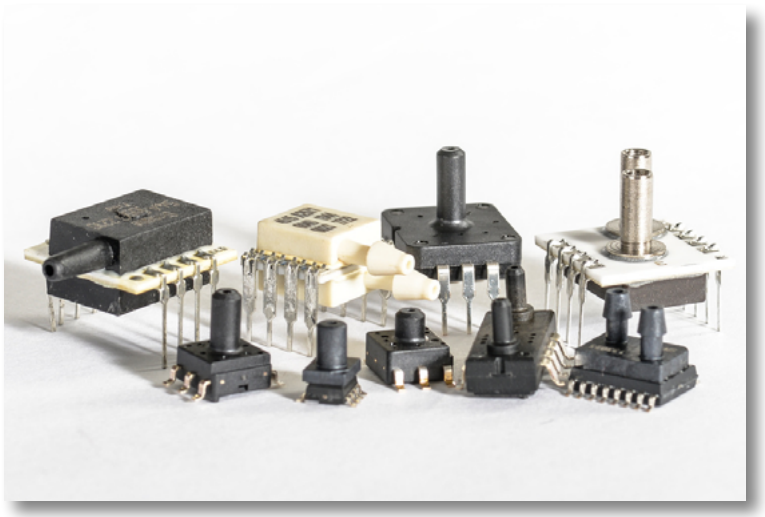
Material Selection

If the media in your application is clean air between 0-85 °C, a board-level pressure sensor — one that's mounted to a printed circuit board (PCB) — is likely the best option unless special packaging requirements are needed. Liquids, extreme temperatures, and harsher media call for ceramic sensors or other media-compatible options.

Pressure Sensor Measuring Range

Selecting the right pressure sensor measuring range will ensure that your measurements offer optimal accuracy (precision) and resolution (smallest detectable change in pressure) while also maintaining any safety boundaries the application requires. To select the correct range, you must determine three factors:

- **Nominal operating pressure of the system** — Under general operating conditions, what is the highest pressure at which you need a meaningful measurement? What is the lowest pressure at which you need a meaningful measurement? Often, a nominal pressure range starts at 0 pressure units (such as psi, kPa, mmHg, etc.) and ends at a positive, higher pressure. However, pressure ranges can also be negative (vacuum) or compound (ranging from the vacuum range to the positive pressure range). Defining this optimal pressure range is a critical step in sensor selection.
- **System dynamics** — Once you've determined the nominal pressure range, consider any system dynamics that could affect operation, such as the impact of starting or stopping pumps and opening or closing valves, as well as sensor response time and the level of accuracy needed during these events.
- **Any additional circumstances that might impact system operation** — These circumstances may include significant changes in operating temperature and potential for overpressure. Many sensors require a "safe overpressure" range to keep from bursting or weakening during these times.



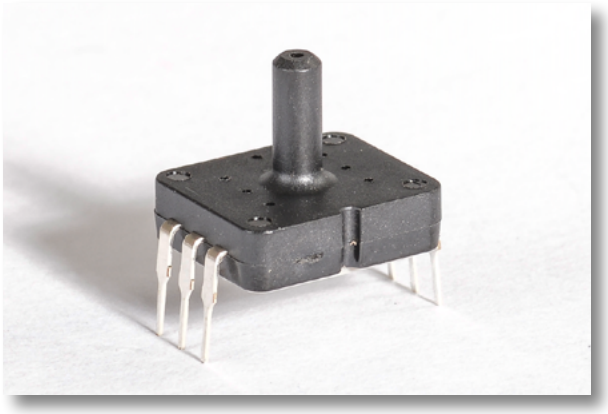
Measurement Type

There are three basic types of pressure measurement. Each offers a reference pressure to the application's applied pressure.

- **Absolute pressure** — Absolute pressure sensors compare the applied pressure to the reference pressure of a perfect vacuum. You may choose an absolute sensor if you want your measurement to be affected by changes in barometric pressure or if it is not possible to provide a reference pressure in the ambient environment of your measurement. For example, changes in barometric pressure affect measurements in some medical applications. Also, submersible sensors may not be able to be exposed to the ambient pressure requiring their own internal references.

- **Differential pressure measurement** — This type of measurement compares the difference between two applied pressures. Either pressure could be larger than the other or one of the pressures might always be larger than the other. Examples include pressures from either side of an air filter, pressures from either side of a flow orifice, or two independent pressures that need to be monitored simultaneously. In the past, it was difficult to measure very low differential pressures due to technological limitations. Now, advances in the silicon sensing element combined with better bonding techniques that reduce mechanical stress susceptibility have allowed for ultra-low differential pressure sensors which can measure down to a few inches of water in small, low-cost packaging.

- **Gauge pressure measurement** — A subtype of differential pressure measurement, a gauge pressure measurement compares the ambient atmospheric pressure to the applied pressure. Changes in atmospheric pressure do not affect the measurement. Thus, when the applied pressure is zero, the sensor will have an output corresponding to the lowest end of its specified range. The applied pressure may be positive or negative (vacuum). Generally, gauge pressure measurements are the most common, such as pump pressures, gas pressures in a pipe, or refrigerants in an HVAC system. Most gauge pressure measurements are "vented," meaning the reference pressure is the ambient atmospheric pressure. Sometimes, venting to the atmosphere is not possible; the sensor manufacturer must then provide a known reference by sealing the reference side of the pressure element within a "chamber." This is called a "sealed gauge" sensor. Sealed gauge pressure sensors are typically used in high-pressure applications in which the effect of altitude on pressure measurement is negligible.



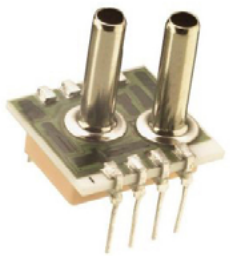
Calibration

While some standard sensors are suitable for simple plug-and-play operation for noncritical functions, applications demanding higher accuracy require sensors that are calibrated to their unique systems. After extended use, especially, systems often require recalibration or need to be reset to zero to safeguard their reliability. As an example, think of a mechanical scale application in which the user must ensure the scale is reading zero when no weight is on it. Users often build in auto-zero capability into their complete product design to allow the end user to auto-zero in the field.

No two sensors — even if they're from the same manufacturer — will produce the exact same readings. It's therefore crucial that sensors employed in critical-use applications are set up in line with the system's distinct environmental factors, including temperature, humidity, and shock. When determining whether or not to calibrate pressure sensors, users have three options:

- **Uncalibrated, uncompensated, and unamplified** — Subject to user's own calibration process; weighs trend of price and performance over accuracy; auto zero is possible and preferable. These sensors are good for tracking trend over precision.
- **Calibrated, compensated and unamplified** — While still requiring amplification, these versions are not as flexible when it comes to modifying pressure ranges or adjusting total error band.
- **Calibrated, compensated, and amplified** — Simpler calibration process; prioritizes reading accuracy; accounts for entire pressure range; some can be used with high-resolution A/D. Most flexible for modified pressure range and adjusting total error band. Fastest time to market for the end design.

> "Understanding the trade-offs between sensor cost, accuracy requirements, and calibration effort needed if you choose an unamplified sensor, is critical."

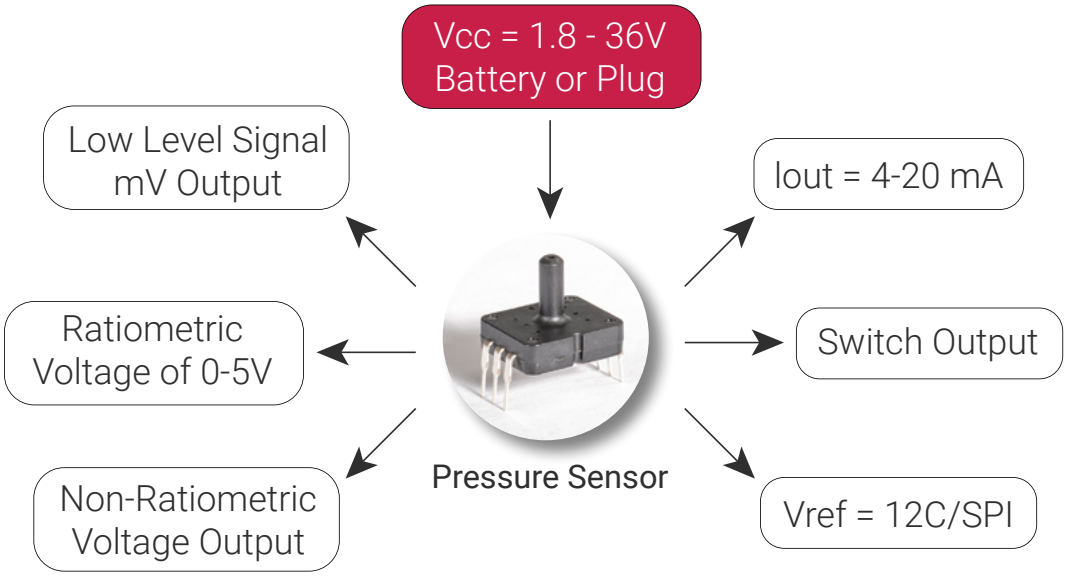


Uncalibrated, uncompensated & *unamplified*	Calibrated, compensated & *amplified*
Own Calibration Process	Simpler Calibration
Trend Over Accuracy	Accuracy Is Important
On/Off Single Point	Whole Pressure Range Important
Auto Zero Possible	Can Be Used With High Res A/D

Amplified, calibrated, and compensated pressure sensors also provide the designer with more output options (voltage or digital output). In these scenarios, design considerations revolve around resolution, total system accuracy, and, in some cases, total power consumption. Generally, this allows designs to be created using the minimum number of total components, keeping the bill of material costs as low as possible.

At the factory, amplified, calibrated, and temperature-compensated sensors can be modified to meet specific performance targets of sensitivity, resolution, and accuracy. This is especially useful in keeping noncomponent costs as low as possible since little or no user calibration will be required.

When choosing an amplified sensor, regulated supply voltage is an important factor; it's good practice to have the sensor and the microprocessor running off the same supply voltage rail. Supply voltage must be considered when optimizing power consumption of the total system. Warm-up time and processing time, especially for digital output sensors, should also be considered.



One final consideration is mechanical packaging. Some manufacturers provide the same electrical performance in a range of mechanical configurations. Connecting the pressure source to the sensor can be done by tubing or connecting directly to a manifold and sealing with an O-ring; other similar strategies may also be employed. Mechanical design considerations are as important as electrical performance needs.

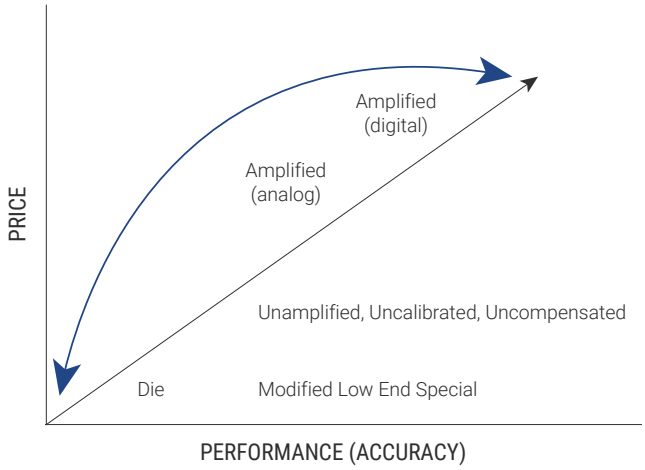
Combining all of these factors may lead a designer to request a more complex assembly; for example, adding cables, flex circuit, and connection schemes may be possible. The ultimate goal is to minimize space usage, component count, and labor content for their application.

What Makes a Good Sensor and a Good Sensor Supplier?

A good sensor provides just the right level of capability at just the right cost for the specific intended application. Standard data sheets and suppliers often cannot provide this level of optimization.

> "A good supplier will work closely with designers to determine where the ideal sensor lies on the price and performance spectrums."

PRICE VS. PERFORMANCE SPECTRUM



Additional Considerations When Evaluating Sensor Manufacturers:

- Current Trends - Some consolidation of manufacturers
- Many options to choose from - Sources are all over the world
- Lead-times - How to make sure you can get parts when you need them
- Price
- Technical Support
- 2nd Source Requirements - Sounds easy on paper but are there pin-to-pin replacements
- Focus on what the application requires versus datasheet claims - don't overdesign
- Focus on cost of measurement, not cost of component

Summary

After reviewing your application basics (type of media, potential contaminants, pressure range, operating temperature, accuracy within a temperature range, overpressure, system accuracy, calibration, and any regulatory considerations such as UL, FDA, and CE), there are still a few more factors to consider regarding application mechanics, electricity, and assembly — all of which are interrelated.

- Shape and size (SMT or thru-hole)
- Supply voltage (3V, 3.3V, 5V, 10-36 VDC)
- Resolution and response time
- Port configuration and orientation
- Output
- Accuracy over temperature
- Mechanical connections
- Electrical connections
- Overall system accuracy required
- Robustness — burst and overpressure
- Power consumption
- Customized accuracy over a defined pressure range and operating environment

Making a Final Decision

Although some manufacturer consolidation has occurred over time, the sheer amount of sensor design options can easily overwhelm customers. Above all, it's critical to focus on the cost of measurement — what your application actually requires — rather than what a data sheet claims your component should cost.

For nearly 30 years, Servoflo Corporation has been helping companies across industries meet their pressure sensing needs. We offer a full line of pressure sensors, environmental sensors, mass flow sensors, and micropumps for a variety of applications, and specialize in helping engineers find the right solution at the right time — at a fair price.

CONTACT SERVOFLO TODAY

About Servoflo

Servoflo Corporation is a provider of pressure sensors, environmental sensors, mass flow sensors, and micropumps. For nearly 30 years, our services have helped companies solve their pressure sensing measurement needs in a variety of applications. With pressure sensors ranging from 0.15 psi to 600 bar (9000 psi) in versions such as compensated, uncompensated, amplified and unamplified modules, no one else can match our wide range of product line and customer expertise.

To learn more about how to get started on your next pressure sensing project, contact us today.

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