

# Pressure Sensors Types

A practical guide to pressure sensors types, covering the reader intent, the relationship to pressure sensors types, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



Main topic: Main Page  
<https://www.level-meters.com/>

In the landscape of industrial automation and process control, pressure sensors serve as the fundamental sensory organs for monitoring system health and fluid dynamics. For engineers and procurement specialists, understanding the various pressure sensors types is critical not only for measuring line pressure but also for calculating liquid levels, flow rates, and filter performance. In industrial level measurement, pressure sensing—specifically hydrostatic pressure—remains one of the most reliable and cost-effective methods for determining the volume of liquids in tanks and reservoirs.

Selecting the correct sensor requires a deep dive into the underlying physics of the sensing element, the reference pressure used, and the environmental conditions of the application. This guide provides a technical overview of the different technologies available and how they apply to modern industrial requirements.

## **Fundamental Principles of Pressure-Based Level Measurement**

Before exploring specific pressure sensors types, it is essential to understand the principle of hydrostatic pressure. In a static liquid, the pressure at a specific depth is directly proportional to the height of the liquid column above it, the density of the liquid, and the force of gravity. This is expressed by the formula:

$$P = \rho \times g \times h$$

Where:

P is the hydrostatic pressure (Pa).

$\rho$  (rho) is the density of the liquid (kg/m<sup>3</sup>).

g is the gravitational acceleration (approximately 9.81 m/s<sup>2</sup>).

h is the height of the liquid (m).

By measuring the pressure at the bottom of a tank, a sensor can accurately determine the liquid level, provided the density of the fluid remains relatively constant. This principle is the foundation for many industrial level measurement solutions found on the Main Page of leading instrumentation providers.

## **| Classification by Pressure Reference**

Pressure sensors are primarily categorized by the reference point against which they measure pressure. Choosing the wrong reference can lead to significant errors, especially in low-pressure applications or varying atmospheric conditions.

### **| 1. Gauge Pressure Sensors**

Gauge pressure sensors measure pressure relative to the local atmospheric pressure. The back of the sensing diaphragm is vented to the atmosphere through a small tube or vent in the cable. This ensures that changes in barometric pressure do not affect the level reading. These are the most common sensors used in vented or open-top tanks.

### **| 2. Absolute Pressure Sensors**

Absolute pressure sensors measure pressure relative to a perfect vacuum sealed within the sensor housing. These are used in applications where atmospheric pressure changes must be included in the measurement or in high-altitude environments where barometric fluctuations are extreme. In level measurement, absolute sensors are rarely used alone unless the tank is sealed and the headspace pressure is also known.

### **| 3. Differential Pressure (DP) Sensors**

Differential pressure sensors measure the difference between two pressure points. In level measurement, they are indispensable for pressurized tanks. One side of the sensor measures the total pressure (liquid + gas headspace), while the other side measures only the gas headspace pressure. The sensor subtracts the headspace pressure to provide the true hydrostatic pressure of the liquid.

## **| 4. Sealed Gauge Pressure Sensors**

Similar to gauge sensors, but the reference side is sealed with a fixed pressure (usually sea-level atmospheric pressure) rather than being vented. These are typically used in high-pressure applications (above 35 bar) where atmospheric fluctuations are negligible compared to the measured pressure.

## **| Pressure Sensors Types by Sensing Technology**

The internal mechanism that converts mechanical force into an electrical signal determines the sensor's accuracy, durability, and suitability for specific media.

## **| Piezoresistive Strain Gauge Sensors**

This is the most widely used technology in industrial level transmitters. It utilizes a silicon or metal diaphragm with strain gauges etched onto the surface. When pressure is applied, the diaphragm deforms, changing the electrical resistance of the gauges.

Pros: High sensitivity, excellent linearity, and compact size.

Cons: Sensitive to temperature fluctuations, requiring integrated compensation circuits.

## **| Capacitive Pressure Sensors**

Capacitive sensors use a thin diaphragm as one plate of a capacitor. As pressure moves the diaphragm, the capacitance changes. This change is converted into a voltage or current signal.

Pros: Extremely robust, high overpressure resistance, and excellent long-term stability.

Cons: Generally more expensive and larger than piezoresistive units.

## | Ceramic Thick-Film Sensors

These sensors utilize a ceramic base (often 96% Al<sub>2</sub>O<sub>3</sub>) with a thick-film strain gauge. Ceramic is chemically inert, making these sensors ideal for aggressive chemicals.

Pros: High corrosion resistance, no oil filling required (dry cell), and high abrasion resistance.

Cons: Lower sensitivity compared to silicon-based piezoresistive sensors.

## | Resonant Wire/Silicon Sensors

These sensors measure pressure by detecting changes in the resonant frequency of a vibrating wire or silicon beam attached to a diaphragm. Pressure changes the tension on the resonator, altering its frequency.

Pros: Extremely high accuracy and stability over long periods.

Cons: Complex electronics and higher cost; typically reserved for laboratory or high-precision custody transfer applications.

## | Selection Criteria for Industrial Applications

When evaluating pressure sensors types, engineers must consider the following technical parameters to ensure reliable performance:

| Criteria            | Considerations                                                                                                               |
|---------------------|------------------------------------------------------------------------------------------------------------------------------|
| Media Compatibility | Ensure the diaphragm material (316L SS, Tantalum, Ceramic) is compatible with the process fluid.                             |
| Pressure Range      | The sensor's operating range should be 1.5x to 2x the maximum expected pressure to handle surges.                            |
| Temperature Range   | Industrial processes can range from -40°C to over 200°C. High-temp applications may require cooling fins or capillary tubes. |
| Output Signal       | Common standards include 4-20mA (current loop), 0-10V, or digital protocols like HART, Modbus, or Profibus.                  |
| Accuracy (F.S.)     | Standard industrial accuracy is 0.5% or 0.25% of Full Scale (F.S.). High-precision tasks may require 0.1% or better.         |
| Ingress Protection  | For submersible sensors, IP68 is required. For external sensors in wash-down areas, IP66 or IP67 is standard.                |

## | Installation and Engineering Considerations

Proper installation is as critical as sensor selection. Even the highest quality sensor will provide inaccurate data if installed incorrectly.

1. Venting and Moisture: For gauge pressure sensors, the vent tube must remain unobstructed. In humid environments, a desiccant filter should be attached to the vent tube to prevent moisture from condensing inside the sensor housing, which can cause drift or short circuits.
2. Mounting Position: Sensors should be mounted in areas of low turbulence. If installed near an agitator or an inlet pipe, the sensor may experience "noise" or physical damage. Using a stilling well (a perforated pipe) can protect the sensor in turbulent tanks.

3. **Diaphragm Protection:** In wastewater or slurry applications, solids can build up on the diaphragm. Use a "flush diaphragm" design or a large-diameter clog-resistant sensor to prevent buildup from affecting the measurement.

4. **Hydrostatic Submersion:** Submersible transmitters must have a cable jacket material compatible with the liquid (e.g., PUR for water, FEP for corrosive chemicals). The cable weight or a dedicated suspension wire should support the sensor to prevent strain on the electrical connections.

## | Limitations and Risks

While pressure-based level measurement is versatile, it has inherent limitations:

**Density Sensitivity:** Since the measurement relies on the formula  $P = \rho gh$ , any change in liquid density (caused by temperature changes or concentration shifts) will directly result in a level error. If the density varies significantly, a temperature-compensated system or a different technology (like radar) may be required.

**Mechanical Fatigue:** Diaphragms are moving parts. Over time, repeated pressure cycling can lead to material fatigue and zero-point drift.

**Overpressure Events:** Exceeding the "burst pressure" of a sensor will cause permanent damage, while exceeding the "proof pressure" may cause a permanent shift in calibration.

## | Frequently Asked Questions (FAQ)

Q: Can I use a pressure sensor for boiling liquids?

A: It is challenging. Boiling creates bubbles (changing the effective density) and turbulence. Additionally, the high temperature may exceed the sensor's limits. A remote diaphragm seal with a capillary tube is often used to isolate the sensor from the heat.

Q: How often should pressure sensors be calibrated?

A: For most industrial applications, an annual calibration check is sufficient. However, in critical safety or high-precision processes, semi-annual or quarterly checks may be necessary.

Q: What is the difference between a pressure transducer and a pressure transmitter?

A: While the terms are often used interchangeably, a transducer typically outputs a low-level voltage signal (e.g., mV), whereas a transmitter includes signal conditioning electronics to output a standardized industrial signal like 4-20mA.

## **| Conclusion**

Understanding the nuances of pressure sensors types is a prerequisite for successful industrial process control. Whether you are monitoring water levels in a deep well or managing complex chemical reactions in a pressurized vessel, the choice between piezoresistive and capacitive sensing, or gauge and differential reference, will dictate the longevity and accuracy of your system. For those seeking to explore specific hardware options and technical support for level measurement, consulting specialized resources like the Main Page of an experienced manufacturer can provide the necessary application-specific guidance.