White Paper On

Pressure Sensor Accuracy — How To Avoid The Gotchas

A practical paper focused on helping users ensure the sensor they specify will perform as expected in their application by determining true accuracy.

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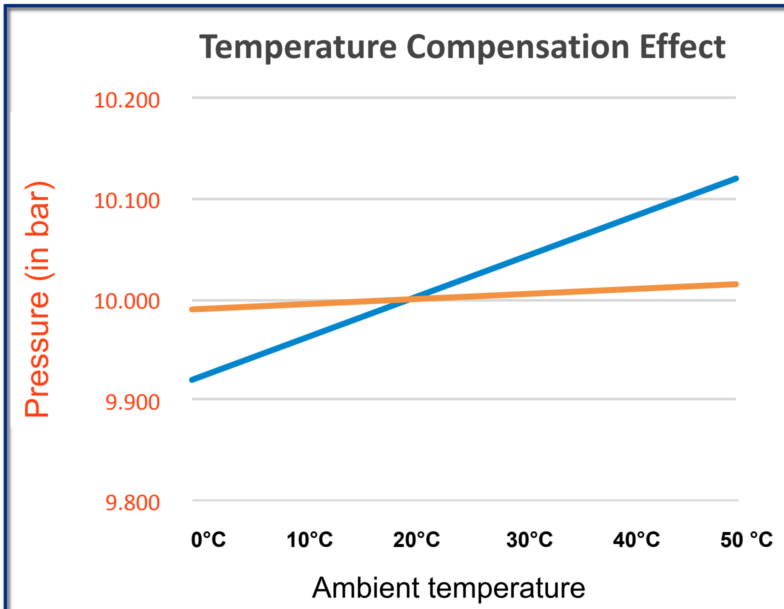
Pressure Sensor Accuracy — How To Avoid The Gotchas

Absolute accuracy of pressure sensors is a combination of factors including linearity, temperature stability, repeatability, offset and gain.

Repeatability is a specification of how closely the sensor will output the same value repeatedly, when cycling up or down to the same pressure value.

The accuracy specification published in many manufacturers' data sheets is typically a static value that states what the sensor will meet or be better than, under certain conditions. Those conditions are when the accuracy is measured in an environment at ambient or "room temperature" and relatively soon after the sensor was calibrated for offset and gain.



Orange line – Pressure Sensor with temperature compensation 0.05% / 10 k
Blue line – Pressure Sensor without temperature compensation

Temperature compensation: 0.05% / 10 K
Temperature drift without compensation: 0.4% / 10 K

In practical use, sensor users need to concern themselves with the accuracy of a sensor will meet in their application. This often includes other factors besides the static accuracy specification, especially the environment it will be used in. Room temperatures can change and when sensors are used near heat producing equipment or outdoors, the environment can affect the overall or absolute accuracy of the sensor.

Manufacturers usually specify a temperature range the sensor should be used in. However, if there is no temperature compensation, the sensor's accuracy specification may not be met when the environment the sensor is used in — even if it is still within the temperature range specification, but significantly greater or less than ambient temperature.

When in use, the external surfaces of a pressure sensor is exposed to the environment around the application it is being used in. In manufacturers specifications, the change in value output by the sensor due to the temperature difference in the surrounding environment from the ambient temperature is called temperature drift. This is typically specified as temperature coefficient or something similar.

To calculate the true or absolute accuracy, a user needs to take the square root of the sum of the squared values of specified accuracy, repeatability, stability (when first multiplied by a timeframe) and temperature drift (first multiplied by the maximum environment temperature variation expected in an application) — all with the same units, such as percentages.

For sensors with temperature compensation, a temperature compensation range is specified. The SD-36 pressure sensor, from Suchy Technology company, specifies two temperature ranges — medium and ambient. The medium range refers to the temperature the sensor element measuring pressure is exposed to. The ambient temperature range refers to the temperature of the environment surrounding external surfaces of the sensor, not the measurement portion.

For the SD-36, medium temperature range is specified at -30°C to +100°C. This is the range the sensor element can be exposed to and perform properly and within specifications. The ambient temperature is specified at -25°C to +80°C. This is the temperature range the external sensor can be exposed to and operate properly.

The SD-36 also has a temperature compensation range of -20°C to +80°C and temperature drift specification of 0.05%/10°K (also called temperature influence or temperature coefficient). Together, these specifications mean that the SD-36 has built-in compensation for temperature drift that limits errors due to temperature drift affects to 0.05% per 10 degrees Kelvin over in an environment temperature range within 0°C to +80°C.

As an example, let's say a pressure sensor had no temperature compensation and was used in an environment varying from 20°C to 30°C, with a temperature drift of 2.5%/°K and a static accuracy of 0.05% of full scale that includes linearity, offset, gain and stability errors.

The absolute accuracy actually occurring in use would be:

$\mathrm{SQRT}\ [(\pm 0.05\%)^2 + ((2.5\%/10°K) \cdot 10°C)^2] = \pm 2.50\%$.

Where, SQRT means square root and degrees Kelvin (°K) and Celsius (°C) are interchangeable in this case.

As a second example, the absolute accuracy of the SD-36 would be:

$\mathrm{SQRT}\ [(\pm 0.25\%)^2 + ((0.05\%/10°K) \cdot 10°C)^2] = \pm 0.25\%$, ten times better.

Suchy pressure sensors have internal temperature compensation utilizing an RTD (resistance temperature device) sensor. It measures the current temperature and together with electronic circuitry, provides the correct compensation to the reading of the pressure cell accordingly. Additionally, some models contain additional proprietary temperature compensation technology that enables them to deliver better absolute accuracy than many competitive sensors.