Transducers or measurement systems are not perfect systems. Design engineer must know the capability and shortcoming of a transducer or measurement system to properly assess its performance. There are a number of performance related parameters of a transducer or measurement system. These parameters are called as sensor specifications.

Sensor specifications inform the user to the about deviations from the ideal behavior of the sensors. Following are the various specifications of a sensor/transducer system.

1. Range

The range of a sensor indicates the limits between which the input can vary.

For example, a thermocouple for the measurement of temperature might have a range of 25-225 °C.

2. Span

The span is difference between the maximum and minimum values of the input. Thus, the above-mentioned thermocouple will have a span of 200 °C.

3. Error

Error is the difference between the result of the measurement and the true value of the quantity being measured.

A sensor might give a displacement reading of 29.8 mm, when the actual displacement had been 30 mm, then the error is –0.2 mm.

4. Accuracy

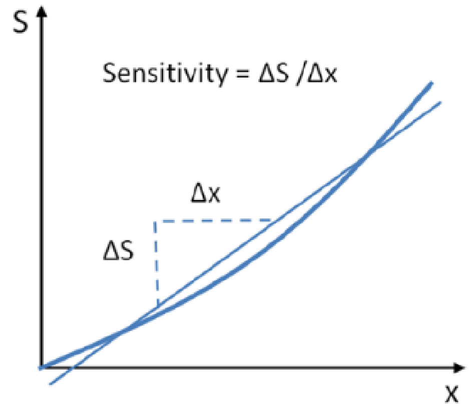
The accuracy defines the closeness of the agreement between the actual measurement result and a true value of the measurand. It is often expressed as a percentage of the full range output or full–scale deflection.

A piezoelectric transducer used to evaluate dynamic pressure phenomena associated with explosions, pulsations, or dynamic pressure conditions in motors, rocket engines, compressors, and other pressurized devices is capable to detect pressures between 0.1 and 10,000 psig (0.7 KPa to 70 MPa). If it is specified with the accuracy of about ±1% full scale, then the reading given can be expected to be within ± 0.7 MPa.

5. Sensitivity

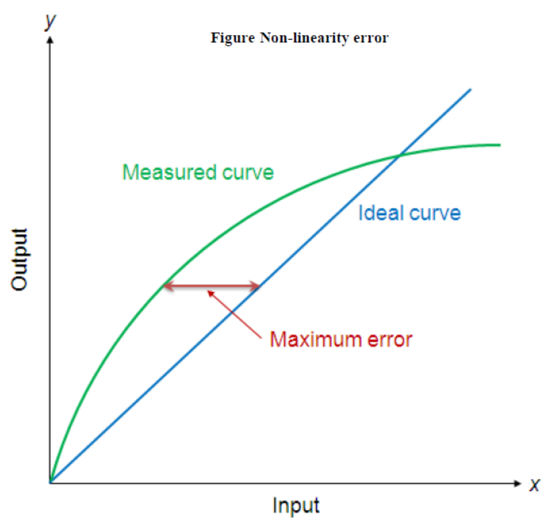
Sensitivity of a sensor is defined as the ratio of change in output value of a sensor to the per unit change in input value that causes the output change.

$$S = \frac{\text{output change value}}{\text{intput change value}}$$



For example, a general purpose thermocouple may have a sensitivity of 41 μV/°C.

6. Nonlinearity



The nonlinearity indicates the maximum deviation of the actual measured curve of a sensor from the ideal curve.

Above Figure shows a somewhat exaggerated relationship between the ideal, or least squares fit, line and the actual measured or calibration line.

Linearity is often specified in terms of percentage of nonlinearity, which is defined as:

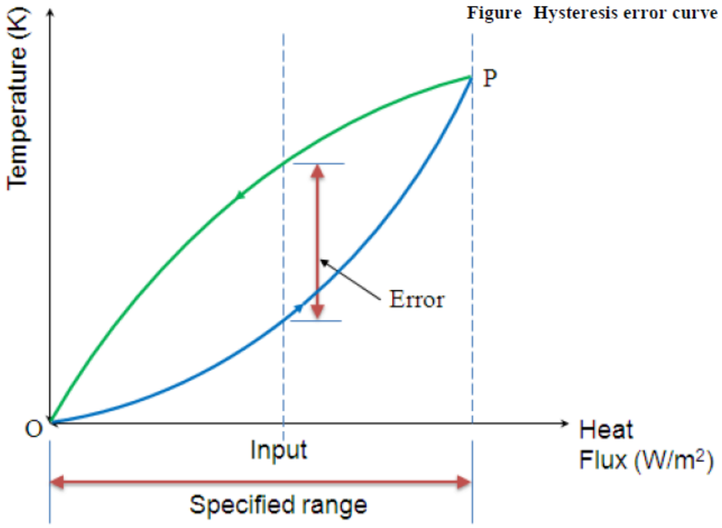
$$\text{Nonlinearity (\%)} = \frac{\text{Maximum deviation in input}}{\text{Maximum full scale input}}$$

The static nonlinearity defined by above Equation is dependent upon environmental factors, including temperature, vibration, acoustic noise level, and humidity.

Therefore it is important to know under what conditions the specification is valid.

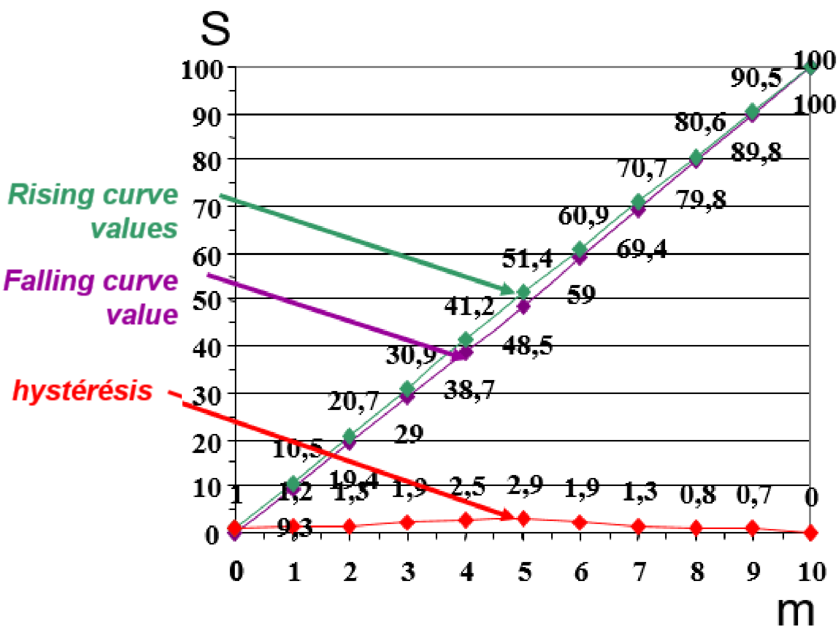
7. Hysteresis

The hysteresis is an error of a sensor, which is defined as the maximum difference in output at any measurement value within the sensor's specified range when approaching the point first with increasing and then with decreasing the input parameter.



Above Figure shows the hysteresis error might have occurred during measurement of temperature using a thermocouple.

The hysteresis error value is normally specified as a positive or negative percentage of the specified input range.



$$\text{Repeatability (\%)} = \frac{\text{Maximum deviation between rising and falling curves}}{\text{Full range output}}$$

8. Resolution

Resolution is the smallest detectable incremental change of input parameter that can be detected in the output signal. Resolution can be expressed either as a proportion of the full-scale reading or in absolute terms.

$$R = \frac{\text{Smallest detectable value}}{Full\ scale\ output}$$

For example, if a LVDT sensor measures a displacement up to 20 mm and it provides an output as a number between 1 and 100 then the resolution of the sensor device is 0.2 mm.

9. Stability

Stability is the ability of a sensor device to give same output when used to measure a constant input over a period of time.

The term ‘drift’ is used to indicate the change in output that occurs over a period of time. It is expressed as the percentage of full range output.

10.Dead band/time

The dead band or dead space of a transducer is the range of input values for which there is no output.

The dead time of a sensor device is the time duration from the application of an input until the output begins to respond or change.

11.Repeatability

It specifies the ability of a sensor to give same output for repeated applications of same input value.

It is usually expressed as a percentage of the full range output:

$$\text{Repeatability (\%)} = \frac{maximum - \ minimum\ values\ given\ for\ the\ same\ input}{\text{Average values}}$$

12.Response time

Response time describes the speed of change in the output on a step-wise change of the measurand.

It is always specified with an indication of input step and the output range for which the response time is defined.