

## Preliminary Report – Pressure Sensor

### 3.4 Sensor terminology and considerations

In this paragraph basic sensor terminology is explained and practical considerations, related to the upcoming laboratory work, are discussed:

#### 3.4.1 Definitions

Characteristic curve:

The characteristic curve of a sensor describes the behavior of the sensor respectively the sensors output due to a certain input.

Calibration:

Calibration is a measurement processes to ensure respectively determine the accuracy of a measurement device e.g. a sensor. Therefore the measured data delivered by the sensor, which is to be calibrated, is compared to the measured data of a sensor with known accuracy and correctness called the standard. The results of this comparison can be used to adjust the sensor and thus improve its performance.

Linearity:

The linearity of a transducers output describes the extent to which the measured characteristic curve of a sensor differs from the ideal curve. Linearity can therefore be defined as percentage of nonlinearity:

$$\text{Nonlinearity} [\%] = \frac{D_{Out[max]}}{IN_{f.s.}}$$

Where  $D_{Out[max]}$  is the maximum output deviation and  $IN_{f.s.}$  is the full range of the input.[1]

Hysteresis:

Hysteresis describes the phenomenon that the behavior of a system depends not only on the value of its input signal but also on the earlier state of its output signal. Systems with hysteresis behavior can therefore show different output values for one defined input parameter. The response of the system is conditioned by whether the desired input value is approached from a higher or lower initial value. A well known example for hysteresis behavior is the magnetization of ferrite.

A sensor which shows hysteresis behavior can produces different output signals for a single input value. This naturally corrupts the accuracy of the measurement system. Adequate arrangements have to be applied in order to cope with hysteresis behavior and to improve the overall performance of measurement system.

To avoid the negative effect of the hysteresis behavior of the pressure sensor, the output of the signal should be recorded at least two times. Once while the pressure is rising and once while the pressure is falling. Thus a average output signal can be calculated and the accuracy of the measurement device can be improved.

Analog Digital conversion:

Analogue-Digital conversion is the process of transforming an analogue input signal into a set of digital data which can then be further processed or saved. Analogue-Digital converters are widely used, low-cost integrated circuits (ICs).

Typically the input quantity of an AD converter is either voltage or current, for example produced by a sensor or measurement device, and therefore the input units are Volts or Ampere. The AD converter generates a digital number which is proportional to the input signal.

Aliasing:

Aliasing is an effect which occurs during the digitalization of analogue signals. To display the analogue signal correctly it is necessary to scan this signal with a sampling rate which is at least twice as high as the highest frequency of the signal (Theorem of Nyquist). If the sampling rate is insufficient, frequencies higher than the Nyquist-frequency will be interpreted as low frequencies, and thus the digital signal is distorted. Established methods to avoid this undesired effect are the usage of lowpass filter and higher sampling rates. Note that the filtering must be done before the digitalization.

### 3.4.2 Practical issues

Calibration of the pressure sensor:

To calibrate the pressure sensor in the laboratory, the characteristic curve of the sensor is being measured and compared to a reference measurement which is provided by a Beamex pressure calibrator. The measurement of the characteristic curve is being performed in a pressure chamber. The pressure inside the chamber can be varied and thus the changes respectively the absolute output of the sensor can be recorded. For this, a 16-bit Analogue-Digital converter is used, which will store the produced data in the form of a Matlab-file for further computing.

[1] Joseph J. Carr John M. Brown, Introduction to Biomedical Equipment Technology, Third Edition, 2010,  
<http://zone.ni.com/devzone/cda/ph/p/id/227>