Calibration

Under normal conditions, piezoelectric sensors are extremely stable and their calibrated performance characteristics do not change over time. However, often sensors are exposed to harsh environmental conditions, like mechanical shock, temperature changes, humidity etc. Therefore it is recommended to establish a recalibration cycle. For applications where high accuracy is required, we recommend to recalibrate the accelerometer every time after use under severe conditions or at least every 2 years. In some less critical applications, for example in machine monitoring, recalibration may be unnecessary.

For factory recalibration service, send the transducer to Metra. Our calibration service is based on a transfer standard which is regularly checked at Physikalisch-Technische Bundesanstalt (PTB).

Many companies choose to purchase own calibration equipment to perform recalibration themselves. This may save calibration cost, particularly if a larger number of transducers is in use. It may also be desirable to calibrate the vibration sensor including all measuring instruments as a complete chain by means of a constant vibration signal. This can be performed using a Vibration Calibrator of Metra's **VC10** series. The VC10 calibrator supplies a constant vibration of 10 m/s² acceleration, 10 mm/s velocity, and 10 µm displacement at 159.2 Hz controlled by an internal quartz generator.

The **VC100** Vibration Calibrating System has an adjustable vibration frequency between 70 and 10,000 Hz at 1 m/s² vibration level. It can be controlled by a PC software. An LCD display shows the sensitivity of the sensor to be calibrated. The VC100 is also suitable for measuring frequency sweeps.

If no calibrator is at hand, a measuring chain can be calibrated electrically either by

- Adjusting the amplifier gain to the stated accelerometer sensitivity.
- Typing in the stated sensitivity when using a PC based data acquisition system.
- Replacing the accelerometer by a generator signal and measuring the equivalent magnitude.

Understand the limitations of transducer calibration. Do not expect the uncertainty of calibration to be better than ± 2 %.

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Evaluation of Measuring Errors

For the evaluation of measuring results it is very important to assess the measuring errors. The following three groups of errors occur with piezoelectric accelerometers:

- **Sensitivity Errors:**
  calibration errors, linearity errors, frequency and phase response errors, aging errors, temperature coefficients
- **Coupling Errors:**
  influence of transducer weight, quality of the coupling surfaces, transverse sensitivity
- **Noise and Environmental Influences:**
  noise, base strain, magnetic fields, temperature transients, sound pressure, cable motion, electromagnetic interference in cables, triboelectric effect in cables

Systematical errors can be corrected arithmetically if their process of formation is known. The effect of these errors has been diminished and well described by the manufacturer.

Most of the systematical errors can be neglected if the measuring results are compared with another measurement under similar environmental conditions. This is of particular importance for unknown and undescribed systematical errors.

Most errors, however, will occur accidentally in an unpredictable manner. They cannot be compensated by a simple mathematical model since their amount and their process of formation is unknown.

For practical measurements, systematical errors and accidental errors are combined in one quantity called measuring uncertainty.

The following example illustrates the contribution of several error components and their typical amounts:

- Accelerometer:

Basic error	2 %
Frequency error (band limits at 5 % deviation)	5 %
Linearity error	2 %
External influences	5 %

- Instrument with RMS calculation:

Basic error	1 %
Frequency error (band limits at 5 % deviation)	5 %
Linearity error	1 %
Waveform error	1 %

The addition of the squared error components yields for this example an uncertainty of $u = 9\ \%$.

Please note that an uncertainty below 10 % can only be reached if all relevant errors are considered and if the used measuring equipment is of good quality.

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