Why Do We Need Accelerometers?

Vibration and shock are present in all areas of our daily lives. They may be generated and transmitted by motors, turbines, machine-tools, bridges, towers, and even by the human body.

While some vibrations are desirable, others may be disturbing or even destructive. Consequently, there is often a need to understand the causes of vibrations and to develop methods to measure and prevent them.

The sensors we manufacture serve as a link between vibrating structures and electronic measurement equipment.

The Advantages of Piezoelectric Sensors

The accelerometers Metra has been manufacturing for over 40 years utilize the phenomenon of piezoelectricity. “Piezo” is from the Greek word meaning to squeeze. When a piezoelectric material is stressed it produces electrical charge. Combined with a seismic mass it can generate an electric charge signal proportional to vibration acceleration.

The active element of Metra’s accelerometers consists of a carefully selected ceramic material with excellent piezoelectric properties called Lead-Zirconate Titanate (PZT). Specially formulated PZT provides stable performance and long-term stability. High stability similar to quartz accelerometers is achieved by means of an artificial aging process of the piezoceramic sensing element. The sensitivity of ceramics compared to quartz materials is about 100 times higher. Therefore, piezoceramic accelerometers are the better choice at low frequencies and low acceleration.

Piezoelectric accelerometers are widely accepted as the best choice for measuring absolute vibration. Compared to the other types of sensors, piezoelectric accelerometers have important advantages:

- Extremely wide dynamic range, almost free of noise - suitable for shock measurement as well as for almost imperceptible vibration
- Excellent linearity over their dynamic range
- Wide frequency range, high frequencies can be measured
- Compact yet highly sensitive
- No moving parts - long service life
- Self-generating - no external power required
- Great variety of models available for nearly any purpose
- Integration of the output signal provides velocity and displacement

The following table shows advantages and disadvantages of other common types of vibration sensors compared to piezoelectric accelerometers:

Sensor Type	Advantage	Disadvantage
Piezoresistive	• measures static acceleration	• limited resolution because of resistive noise • only for low and medium frequencies • supply voltage required
Electrodynamic		• only for low frequencies
Capacitive	• measures static acceleration • cheap manufacturing with semi-conductor technology	• low resolution • fragile

Instrumentation

The piezoelectric principle requires no external energy.

Only alternating acceleration can be measured. This type of accelerometer is not capable of a true DC response, e.g. gravitation acceleration.

The high impedance sensor output needs to be converted into a low impedance signal first. In the case of ICP® compatible transducers this is the task of the built-in electronics. This electronic circuit is powered by the connected instrument. This can be a simple supply unit, for instance Metra's Model M28, or the signal conditioners M32, M68, M108 and M116. For sensors with charge output, an external charge amplifier is required, for instance Models M68 or ICP100.

For processing the sensor signal, a variety of equipment can be used, such as:

- Time domain equipment, e.g. RMS and peak value meters
- Frequency analyzers
- Recorders
- PC instrumentation

However, the capability of such equipment would be wasted without an accurate sensor signal. In many cases the accelerometer is the most critical link in the measurement chain. To obtain precise vibration signals some basic knowledge about piezoelectric accelerometers is required.

Standards for Vibration Sensors

Selection of standards concerning piezoelectric accelerometers:

- **ISO 5348:** Mechanical vibration and shock - Mechanical mounting of accelerometers
- **ISO 2041:** Vibration and shock - Vocabulary
- **ISO5347:** Methods of the calibration of vibration and shock pick-ups
- **ISO 8042:** Shock and vibration measurements - Characteristics to be specified for seismic pick-ups
- **ISO2954:** Mechanical vibration of rotating and reciprocating machinery - Requirements for instruments for measuring vibration severity