Accelerometer Selection Guide

How to choose the correct Accelerometer for Vibration Monitoring!

Analog accelerometers provide an output that is a continuous voltage proportional to the acceleration. This technical note covers most of the aspects when selecting a piezoelectric accelerometer.

The step-by-step guide is intended to explain the sensor options and for a better understanding of the accelerometer specifications.

The mounting method used, and the sensor location can affect the operating frequency range of an accelerometer. The advertised operating range is achievable only by stud mounting, please refer to our Accelerometer Installation Guide for a more detailed explanation.

Accelerometer Options

Sensor with Top Exit or Side Exit

The first choice is more of a preference. Side Exit Sensors require less clearance and accommodate a flush installation. Due to their higher mass, they provide a lower mounted base resonance frequency (22 KHz) than sensors with top exit (27 KHz), but are still above the usual measurement frequency (10 KHz). Although the cost of a Side Exit Sensor is about 10% higher, in recent years they became the leading type in sensor sales.

Shown above: Top Exit and Side Exit Accelerometer

Connector Options

The most common connector for standard accelerometers is the 2 Pin MS 5015 (Military Style). Another option is the circular M12 style connector, which is used primarily in factory automation applications.

Shown above: Top Exit MS 5015 & M12 Connector; Side Exit MS 5015 & M12

Connector versus Integral Cable

Selecting a sensor with integral cable can save the cost for the cable connector assembly. The disadvantage is that when the cable gets compromised (nicked) the entire sensor may have to be replaced. Sensors with integral cables are great for submersible applications, due to their excellent sealing.

Shown above: Accelerometers with Overbraided & Integral Cables

For increased mechanical protection, choose a sensor with an overbraid integral cable. The sealing might not be as good (check on the ingress protection, IP rating) as when using a PUR jacketed integral cable (polyurethane: a halogen-free and self-extinguishing thermoplastic elastomer).

Accelerometer Specifications

Acceleration Range and the Expected Vibration Level

The Vibration Level of the rotating machinery determines the Acceleration Range of the sensor. Accelerometer specification often state this Measurement Range as the Dynamic Range in [+/- g]; -a standard measurement range (for a sensor with 100 mV/g sensitivity) is +/- 80 g.
The highest vibration levels of the machine should never exceed the acceleration range of the sensor, due to sensor overload that leads to signal clipping and distortion.

- As a rule of thumb, the vibration level should be lower than 20% of the maximum acceleration (peak g level), or smaller than 25 g.
- A quick measurement with a Data Analyzer or Vibration Pen will provide the current vibration level.

The range can be extended by selecting a sensor with a lesser sensitivity, which is explained next.

Sensitivity

Sensitivity is the ratio of change in acceleration (input) to the change in the output signal (Voltage).
The sensitivity of industrial accelerometers typically varies between 10 and 500 mV/g; with 100 mV/g being the standard. The range of vibration amplitude levels to which the sensor will be exposed during measurements drives the sensitivity selection.
As a general approximation, if the machine produces high amplitude vibrations (greater than 16 g rms) at the measurement point, select a low sensitivity (10 or 30 mV/g) sensor. If the vibration is less than 16 g rms, a 100 mV/g sensor is best.

General Relationship: Sensitivity – Range – Resonance Frequency

Sensitivity	Measurement Range	Mounting Base Resonance Frequency
10 mV/g	+/-800 g	33 KHz (1,980 kcpm)
30 mV/g	+/-250 g	31 KHz (1,860 kcpm)
50 mV/g	+/-160 g	29 KHz (1,740 kcpm)
100 mV/g	+/-80 g	27 KHz (1,620 kcpm)
250 mV/g	+/-32 g	26 KHz (1,560 kcpm)
500 mV/g	+/-16 g	25 KHz (1,500 kcpm)

Higher sensitivity accelerometers, such as 250 and 500 mV/g are for special applications such as slow speed machinery (6 t0 60 rpm) with low frequency or low amplitude measurements.

- In general, higher sensitivity accelerometers have limited high frequency operating ranges.

Low-sensitivity sensors are for monitoring high frequency applications such as roller element defects in bearings and measuring gear mesh fault frequencies.

Sensitivity Precision

The Sensitivity precision is given as a tolerance, typically +/-5% or +/-10%. The sensor should be supplied with a Calibration Certificate that states the exact sensitivity. This can be used to offset the tolerance by setting the actual mV/g value in the data acquisition device (e.g., Data Analyzer, Control System).

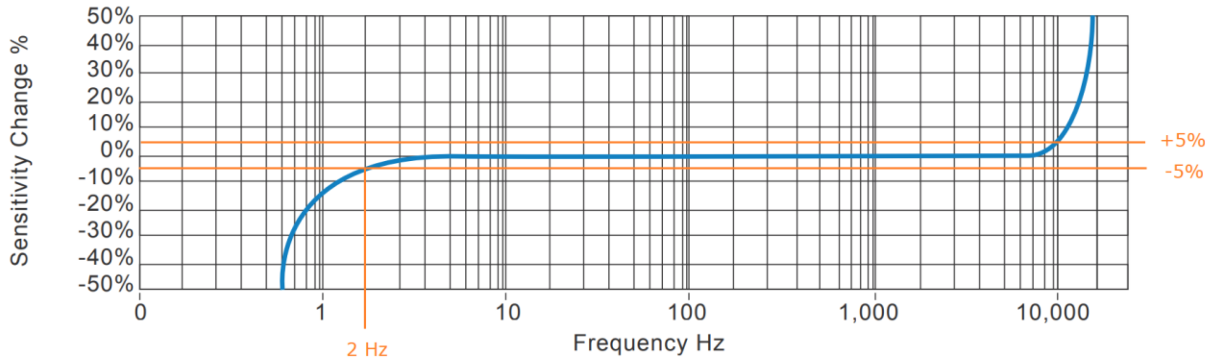
Frequency Response

Frequency response, or Bandwidth, is the specification that shows the maximum deviation of sensitivity over a frequency range.
The bandwidth is usually specified as a tolerance band, relative to the reference frequency sensitivity (usually 100 Hz). The tolerance band can be specified in percentage and/or Decibels (dBs) with typical bands being ±5%, ±10%, and ±3 dB (with -3dB being 30%)
Bandwidth information reveals if the accelerometer can measure slow accelerations and defines the upper frequency limit where the accelerometer will still be accurate. If the frequency is higher than what the sensor can measure, the signal becomes corrupted, and readings are unreliable.

Most vibrations of industrial machinery contain frequencies below 1,000 Hz (60,000 CPM), however signal components of interest often exist at higher frequencies. For example, if the running speed of a rotating shaft is known, the highest frequency of interest may be a harmonic (or multiple) of the running speed. The goal is to determine the high frequency requirement of the application and choose a sensor with an adequate frequency range, while also meeting sensitivity and amplitude range requirements.

Typical Frequency Response for a 100 mV/g sensor, top exit, specified with
2 Hz (120 cpm) to 10 kHz (600 kcpm) at **± 5%**
1.5 Hz (90 cpm) to 12 kHz (720 kcpm) at ± 10%
0.8 Hz (48 cpm) to 15 kHz (900 kcpm) at ± 3dB

The flat section of the horizontal response curve in blue defines the usable area.



General Vibration of rotating machinery with running speeds of 300 rpm to 7,200 rpm can be measured including defect frequencies at a fraction (BPFO, Ball Pass Frequency Outer Ring) and multiples (BPFI, Ball Pass Frequency Inner Ring) of running speed.

Environmental Requirements

Environmental characteristics include temperature, maximum acceleration levels, and humidity.

The hermetic seal standard on modern accelerometers helps prevent the intrusion of contaminants or moisture.

The Operating Temperature of the accelerometer should match the requirements. General Purpose Accelerometers have an upper temperature limit of 140°C (284°F) and Premium accelerometers even go out to 150°C (302°F).

For higher temperature applications of up to 250°C (480°F), select a charge mode accelerometer. The piezoelectric sensor with charge output and external charge amplifier can be used at higher temperatures than those with internal electronics.

Noise Level

Noise levels can be defined in several ways. Some accelerometers will define residual noise as a broadband RMS value, in [µV] or [µg]. This is calculated by taking the root mean square of the signal without any mechanical excitation.

Some accelerometer datasheets provide a spectral noise parameter which will be specified as µV/√Hz or µg/√Hz. When this value is multiplied by the square root of the measurement bandwidth, this result is the nominal RMS acceleration noise of the sensor. Many accelerometers will specify this spectral noise density for different ranges because noise levels tend to drop at higher frequencies.

Threshold [g rms] = Noise [mV] / Sensitivity [mV/g]

- To assure a low enough noise floor, -the lowest g level to be measured should be 10 times the threshold level.

Other Considerations

Sensor **Weight** and **Size** constraints, check out Compact Accelerometers.

Machine Grounding, match cable connector assemblies with the applied grounding method. Grounded at the Machine side, use Non-Isolated assemblies; or standard grounding at the Instrument side, use Isolated assemblies.

Mounting, the best mounting method uses a threaded stud for top exit and captive mounting bolts for side exit sensors. Select thread size of studs/bolts to fit mounting requirements.

In **Hazardous Areas,** if there are *flammable* contaminants (dusts, vapors or gases, fibers) present where the sensor will operate, the sensor must have the appropriate hazardous location certification. The two methods of protection used in designing electrical equipment for hazardous areas are intrinsically safe and explosion proof housing.

There are more considerations, like corrosive chemicals or the presence of electrostatic discharge, and intense acoustic or electromagnetic fields.

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Common Specifications

Examples, -please refer to the individual sensor data sheets for specific information.

Technical Performance

Mounted Base Resonance:	27 kHz (nominal) top exit and 22 kHz for side exit
Sensitivity:	100 mV/g Standard, optional 10, 30, 50, 250 or 500 mV/g
Isolation:	Base Isolated
Transverse Sensitivity:	Less than 5%

Electrical

Electrical Noise:	0.1 mg max
Current Range:	0.5 mA to 8 mA
Bias Voltage:	10-12 Vdc
Output Impedance:	200 Ohms max.
Case Isolation:	>10^8 Ohms at 500 Volt

Environmental

Sealing:	IP68 and IP65 for sensors with Integral Overbraided Cable
Maximum Shock:	5000 g
Operating Temperature:	130°C, 140°C or 150°C maximum, depending on sensor category
Approvals:	CE Approved

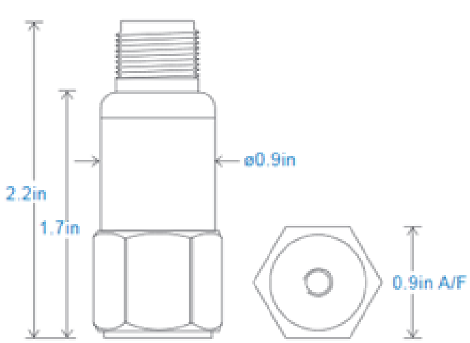
Hazardous Location Ratings, Example

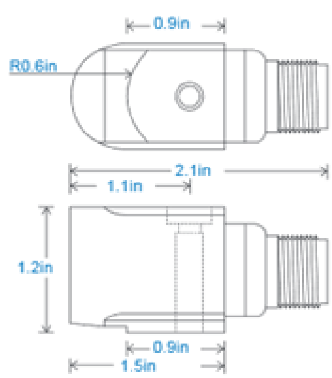
CSA/UL Class 1 Division 2 Groups B, C and D Approved
CSA/UL Class 1 Division 1 Approved with IS Barrier or Isolator

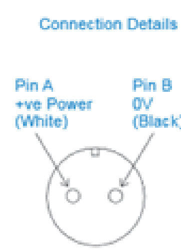
Mechanical

Case Material:	Stainless Steel
Sensing Element:	PZT/Compression
Mounting Torque:	5.9 lbs-ft (8 Nm)
Weight:	4.9 oz (139 gram) for top and 6.5 oz (185 gram) for side exit
Mounting, top exit:	1/4-28 UNF **and** M8x1.25 Mounting Studs Provided
Mounting, side exit:	1/4-28 UNF **or** M8x1.25 Captive Mounting Bolt

Example for Dimensions







Top Exit **Side Exit** **Connector**

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