IEPE Accelerometer and Velocity Sensor Operation Manual

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1 Introduction

The following manual will describe typical installation and operational practices for IEPE (Integrated Electronics PiezoElectric) accelerometers and velocity sensors manufactured by Wilcoxon Sensing Technologies. Ranging from general-purpose sensors to those designed for specific applications such as underwater, seismic, high-temperature, high-voltage and more, the information found below can be used as a guide for how to get the best possible results from your Wilcoxon unit.

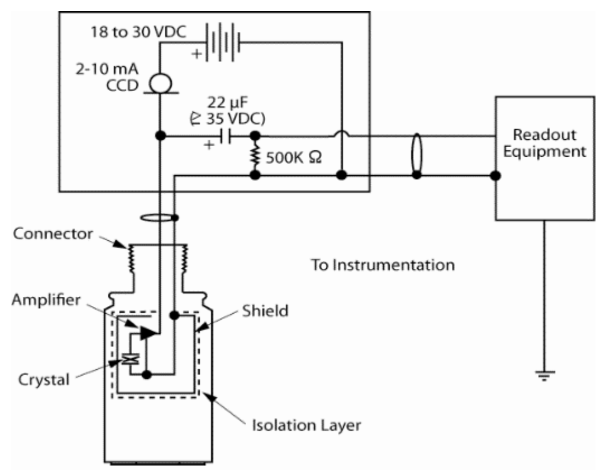
The vibration analyst must evaluate and determine the mounting location of the individual sensor based on the specific machine and vibration source to be monitored. With a firm understanding of the sensor requirements, capabilities, and limitations, the installation can be accomplished. After installation, verification of operation must be made to complete the process. Some techniques will be general to all installations, whereas others may be specific to a particular application. If additional information is required, please consult Wilcoxon Sensing Technologies via the contact information in Technical Assistance, Section 5.0 of this document.

An IEPE sensor is based off the principle of a piezoelectric sensing element, known as a crystal, reacting to an acceleration and outputting a charge proportional to that input. An amplifier circuit is included to convert the high-impedance, low-amplitude signal to a voltage output, which can then be monitored with various data acquisition systems for interpretation.

2 Electrical requirements

2.1 IEPE Sensor

Most internally amplified vibration sensors require a constant current DC power source, known as an IEPE power supply. Generally, the power supply contains an 18 to 30 Volt source with a 2 to 10 mA constant current diode (CCD). When other powering schemes are used, consultation with the sensor manufacturer is recommended. A more thorough discussion of powering requirements follows.



2.2 AC coupling and the DC bias voltage

The sensor output is an AC signal proportional to the vibration applied. This AC signal is superimposed on a DC bias voltage (also referred to as bias output voltage [BOV] or rest voltage). The DC component of the signal is often blocked by a capacitor thereby leaving the AC output signal. Most vibration data collectors, monitors, and sensor power units contain an internal blocking capacitor for AC coupling. If not included, a blocking capacitor must be field installed.

2.3 Constant current diode

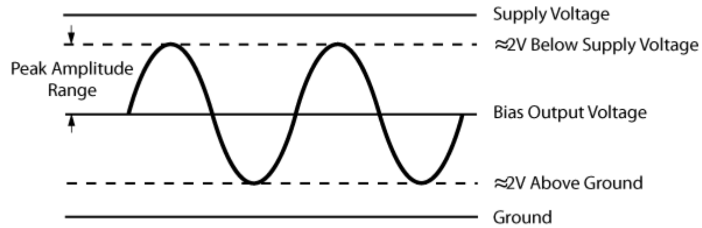
Virtually all internally amplified vibration sensors require power supplies that are regulated by constant current diodes. The CCD limits the current supplied to the sensor. The use of unlimited power supply current will damage most internally amplified sensors.

For this reason, most commercially available data collectors and vibration monitors have power supply circuits that include a CCD to regulate the power supplied to the sensor. The power supplied is almost always in the 2 - 10 mA range. Most battery power supplies contain a 2 mA CCD to ensure long battery life. Line powered supplies (where power consumption is not a concern) should contain 6 to 10 mA CCDs to drive long cables. For operation above 100°C, limit the current to less than 6 mA to reduce self-heating.

If the power supply is not current limited, then a CCD should be placed in series with the voltage output of the supply. Ensure that proper diode polarity is observed.

2.4 Amplitude range and supply voltage

The sensor manufacturer usually sets the bias voltage halfway between the lower and upper cutoff voltages (approximately 2 V above ground and approximately 2 V below the minimum supply voltage). The difference between the bias and cutoff voltages determines the voltage swing available at the output of the sensor. This output voltage swing then determines the peak vibration amplitude range. Thus, an accelerometer with a sensitivity of 100 mV/g and a peak output swing of 5 Volts will have an amplitude range of 50 g peak.

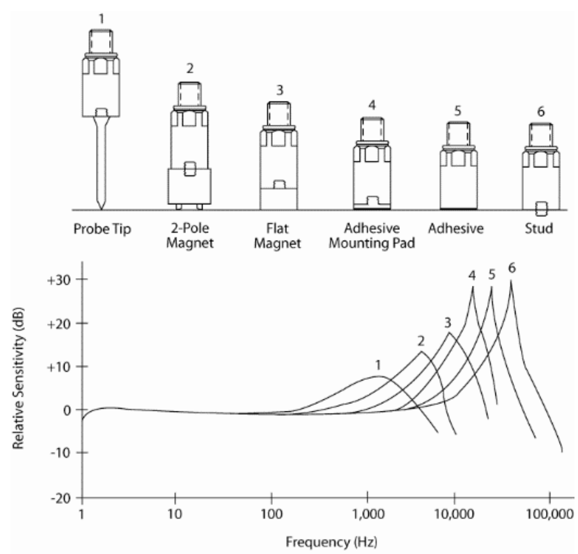


If a voltage source lower than 18 Volts is used, the amplitude range will be lowered accordingly. Custom bias voltages are available for lower or higher voltage supply applications.

3 Mounting

3.1 Overview

The mounting configuration depends primarily upon dynamic measurement requirements such as frequency response and amplitude range. Other factors to be considered are mounting location, prohibitions, accessibility, and temperature. In general, there are four techniques for mounting vibration sensors: threaded studs or screws, adhesives, magnets, and probe tips. The figure to the right shows the effect on mounting resonance and typical usable frequency range associated with each of these mounting techniques. Read more about accelerometer mounting techniques online.



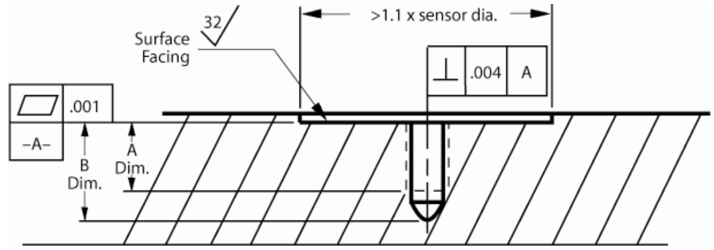
3.2 Stud/screw mounting

Threaded stud or screw mounting allows the widest dynamic measurement range. It is recommended for permanent monitoring systems, high frequency testing, and harsh environments. The mounting surface should be spot-faced 1.1 times greater than the diameter of the mounting surface of the sensor. For measurements involving frequencies above 1 kHz, the surface should be flat within 1 mil and have surface texture no greater than 32 microinches.

The tapped hole must be perpendicular to within 1° of the mounting point and at least two threads deeper than the stud. This will prevent a gap between the sensor base and the mounting surface.

Proper torque on the mounting stud is also required. Under-torquing the sensor reduces the stiffness of the coupling. Over-torquing can cause permanent thread damage to the sensor. See the figure to the right for the surface preparation and torque value that applies to your application.

Before stud-mounting the accelerometer, a coupling fluid should be applied to the mating surfaces. The coupling fluid protects the mounting surface and optimizes the frequency response by increasing the coupling stiffness. Suggested coupling fluids are machine oil, beeswax or vacuum grease. It is recommended that a thread adhesive such as Loctite 222 be used on the mounting stud.



Stud	Stud Size	A in. (min)	B in. (min)	Torque (in-lbs)
SF1	10-32 UNF	.188	.250	20
SF6	1/4-28 UNF	.250	.350	26
1/4 - 28 captive screw		.250	.350	30

NOTE: The above chart is based on the Wilcoxon Research standard stud length.

3.3 Adhesive mounting

If the machine cannot be drilled as described in the section above, adhesive mounting would be the next best alternative. The accelerometer could be attached to the machine with adhesive, although this method will usually damage the accelerometer if removal is ever required. An adhesive mounting pad is the best alternative after stud mounting.

The adhesive mounting pad is a disk, typically stainless steel, which is flat on one side and has an integral stud on the other side. Other mounting pads are available that have a threaded hole to mate with side-exit accelerometers using a captive screw.

For optimum performance, the surface of the machine should be spot-faced in the same manner described in the previous section. If this is not possible, prepare the mounting surface of the machine by removing rust, loose paint or dirt. Abrade the surface to allow maximum adhesion. Clean the prepared area with solvent. Attach the mounting pad to the machine with an ample amount of adhesive (follow manufacturer’s direction for use of adhesive). There are a variety of different adhesives that may be used, but a medium- or high-strength bond should be chosen that can mate the metal pad to the mounting surface. After the adhesive has cured, apply a thin film of coupling fluid to the accelerometer seating area of the mounting pad. Thread the accelerometer onto the mounting pad and torque to the recommended value as noted in the image above.

Typically, when attaching the mounting pad in this configuration, the mounting pad may not be electrically connected to the machine. This could potentially be a problem if the application requires the accelerometer case to be connected to ground. Test the continuity between the mounting pad and the bare machine surface to determine connectivity or isolation. Based on the results, you may need to change mounting methods or choose a particular cable assembly to ensure proper connectivity and wiring.

3.4 Magnetic mounts and probe tips

In walk-around monitoring programs, magnetic mounts and probe tips may be used. The frequency range of both mounting methods is dramatically reduced when compared to stud or adhesive mounts. Magnetic mounts are available with flat surfaces for flat locations or two pole configurations for curved surfaces. Probe tips should be made of steel and be no longer than six inches, but will severely hamper attempts for repeatable measurements.

4 Cabling

4.1 Cable length

Proper powering will reduce signal distortion in long cable applications. For cable lengths over 100 feet, it is recommended that the constant current source be increased up to 6-10 mA to ensure all no high-frequency signal loss occurs. Even when using very short cables, the current source should be increased if amplifier overload signals are present or suspected.

For most industrial applications, cable lengths of several hundred feet are normally usable with the current provided by today's monitoring equipment - as long as the sensor is not mounted on a structure with high vibration amplitudes. In environments with temperatures at or above 100°C (212°F), the current should be no more than 6 mA to prevent damage to the accelerometer.

Wilcoxon has a cable calculator tool that can help determine the maximum cable length depending on the current supply, frequency range of interest, maximum sensor output voltage swing and cable capacitance.

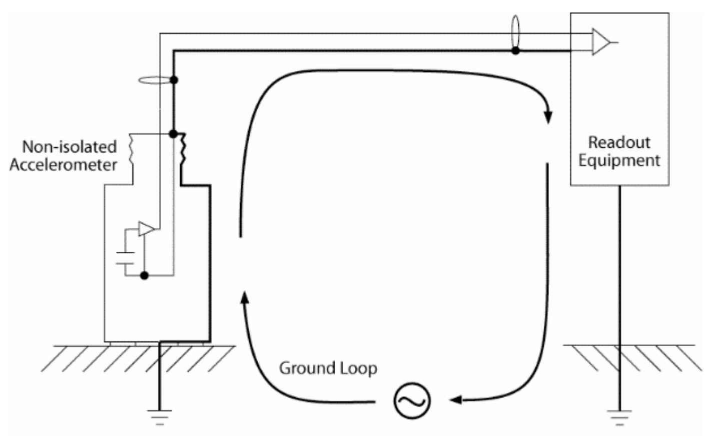
4.2 Cable routing and EMI

Walky-talkies, power lines, or even electrical sparks are sources of signal interference. The following guidelines will eliminate many measurement errors due to electromagnetic interference (EMI) and electro-static discharge (ESD).

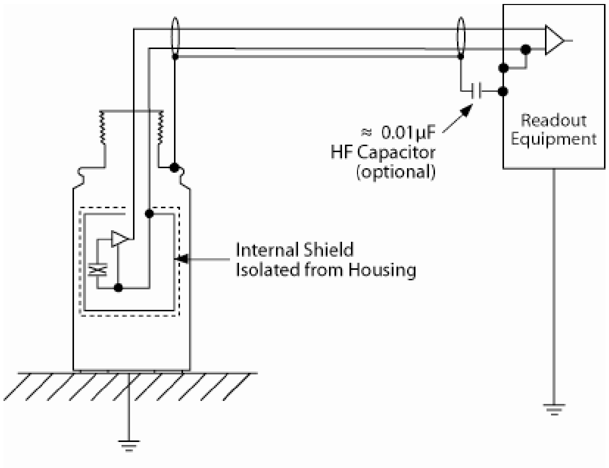
Ensure that high quality, well-shielded cables are used. For most single-axis sensors, this means a twisted, shielded pair cable. Coaxial cables may be used in contained environments where interference is minimized. Dual-output and triaxial sensors should all have the appropriate amount of conductors with foil or braid shielding. If cable splices are made then complete shielding must be maintained. Proper cable routing is also recommended. Avoid routing sensor cables alongside AC power lines; cables should cross AC power lines at right angles. Where possible, provide a separate, grounded conduit to enclose the sensor cable. In addition, route the cable away from radio transmission equipment, motors/generators, and transformers. Finally, avoid routing the cable through areas prone to ESD. Even though the sensor is protected against ESD failure, temporary signal distortion may occur as the result of severe ESD.

4.3 Cable grounding and ground loops

In order to provide proper shielding and prevent ground loops, cable grounding should be carefully considered. Ground loops are developed when a common line (i.e. signal return/shield) is grounded at two points of differing electrical potential.



For sensors with coaxial cable, the center conductor carries the signal and power, while the outer braid provides shielding and signal return. Normally, the cable shield is electrically isolated from the sensor housing. This isolates the shield from the mounting point of the machine and prevents ground loops. If a non-isolated sensor is used, it is recommended that an isolated mounting pad be used to break possible ground loops.

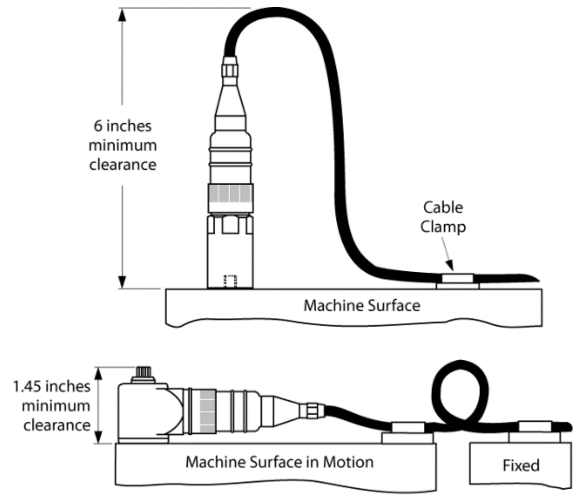


For sensors using two conductor/shielded cable, the signal and power are carried on one lead and the signal common on the other. The cable shield serves to protect the signal from EMI and ESD. The shield should be grounded at only one point, normally to the readout equipment as shown in the image to the left. In all cases, it is very important that the cable shield terminations be properly grounded. Failure to do so in high EMI/ESD environments can result in damage to the sensor electronics.

4.4 Cable anchoring

A buffered, unfiltered version of the AC vibration sensor signal, riding on the BOV, is available as a terminal block output. This output is in parallel with the front-panel BNC connector.

A buffered and low-pass-filtered version of temperature sensor signal is also available as a terminal block output.



5 Technical assistance

For technical assistance, please contact Wilcoxon Sensing Technologies at 301-330-8811, fax 301-330-8873, or email info@wilcoxon.com.