Installation of vibration sensors

This technical note describes basic installation techniques for accelerometers and other vibration sensors. It will allow qualified field technicians to install vibration sensors in a variety of applications and environments. Some techniques will be general to all installations, whereas others may be specific to a particular application. If additional information is required, please consult the sensor manufacturer.

The process of installation begins with verifying that the proper sensor was selected for the measurement point. Refer to the Wilcoxon Research “Sensor selection guide” for assistance.

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 sensors requirements, capabilities, and limitations the installation can now be accomplished. After installation, verification of operation must be made to complete the process.

Electrical powering requirements

Most internally amplified vibration sensors require a constant current DC power source. Generally, the power supply contains an 18 to 30 Volt source with a 2 to 10 mA constant current diode (CCD) (see figure 1). When other powering schemes are used, consultation with the sensor manufacturer is recommended. A more thorough discussion of powering requirements follows.

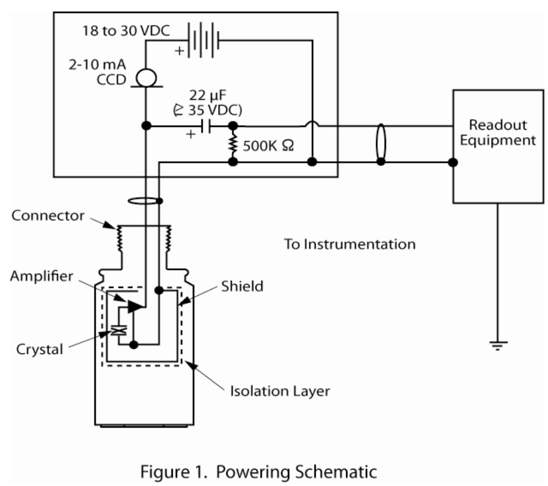

Figure 1. Powering Schematic

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 blocked by a capacitor thereby leaving the AC output signal. Most vibration data collectors, monitors, and sensor power units contain an internal

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blocking capacitor for AC coupling. If not included, a blocking capacitor must be field installed.

Amplitude range and the supply voltage

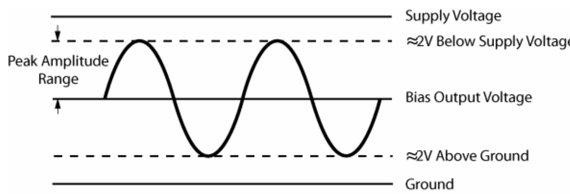


Figure 2. Area of Linear Operation

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. The output voltage swing determines the peak vibration amplitude range. (See figure 2.) 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.

Constant current diodes

Virtually all internally amplified vibration sensors require power supplies that are regulated by constant current diodes (CCD). 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.

Cabling requirements

Cabling is one of the most important aspects of vibration sensor installation. Careful attention must be given to four major considerations: cable length and capacitance, routing, grounding, and anchoring.

Cable length and capacitance

All cables have capacitance across their leads, therefore the capacitance load on the output of the sensor increases with cable length. Generally this capacitance is about 30 picofarads (pF) per foot, depending on the cable construction. After the cable length has been determined, its effect on the sensor operation should be evaluated. Capacitive loading causes of high level, high frequency vibration signals.

Normal industrial applications are generally measuring frequency ranges of less than 10,000 Hz and powered with 2 - 10 mA. For these normal industrial applications, the effect of this capacitive loading is not a problem for cables less than 250 feet in length between the sensor and the power source. For cables with a capacitance of more than 30 pF per foot, or for measuring frequencies greater than 10,000 Hz, additional analysis should be performed before installing cables longer than 250 feet. Contact your local Wilcoxon representative for additional information on calculating maximum cable lengths, or to evaluate your specific application.

Amplitude range versus cable capacitance

When the sensor amplifier drives a long cable, its performance is limited by the current available from the CCD in the power supply to charge the cable capacitance at high frequencies. If the cable capacitance cannot be charged fast enough to follow the vibration signal, it will produce signal distortion and cause false signals to appear at low frequencies. Sources of high frequency overload could be gear impacts or the broadband hiss of a steam release valve. Most Wilcoxon sensors are protected from distortions from moderate overloads by a washover filter.

Powering versus 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 should be 6 to 10 mA. 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 level vibrations. 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.

Cable routing and electromagnetic interference

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).

Assure that high quality, well shielded cables are used. 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.

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 (see figure 3).

For sensors with coaxial cable, the center conductor carries the signal and power, while the outer braid provides shielding and signal

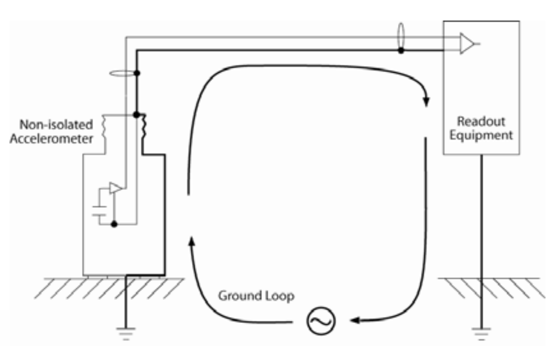


Figure 3. Ground Loop From Improper Grounding

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.

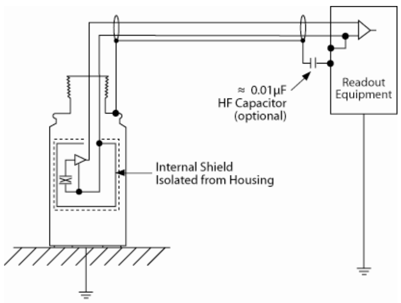


Figure 4. Multiconductor/Shield Configuration

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 (see figure 4). 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.

Cable anchoring

After mounting the sensor, the cable should be anchored to reduce stress at the cable terminations and to prevent false signals due to cable vibration and slapping. When securing the cable, leave enough slack to allow free movement of the accelerometer. (See figure 5.)

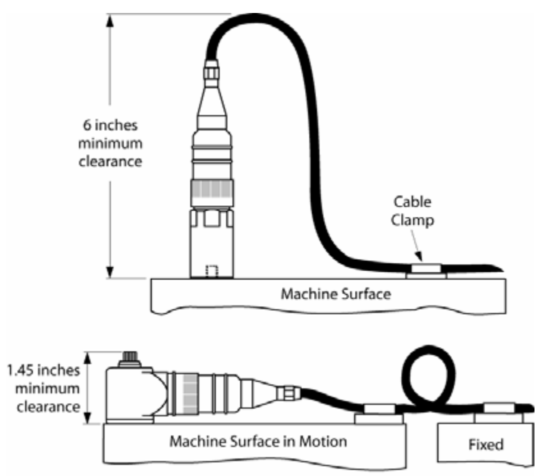


Figure 5. Cable Anchoring

Mounting

The mounting configuration depends primarily upon dynamic measurement requirements such as frequency 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, adhesives, magnets, and probe tips. Figure 6 shows the effect on mounting resonance and typical usable frequency range associated with each of these mounting techniques.

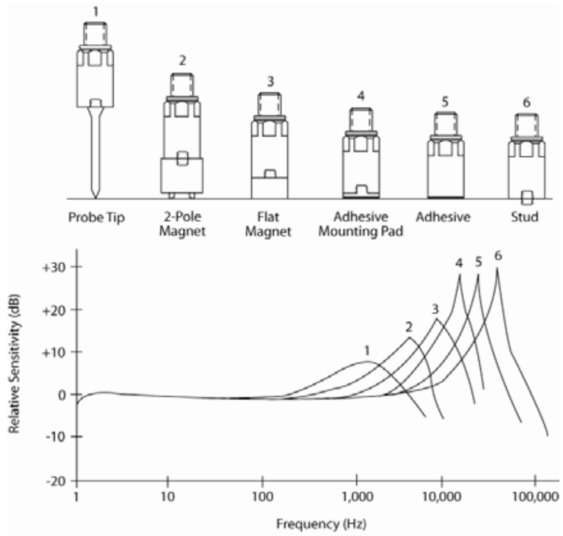
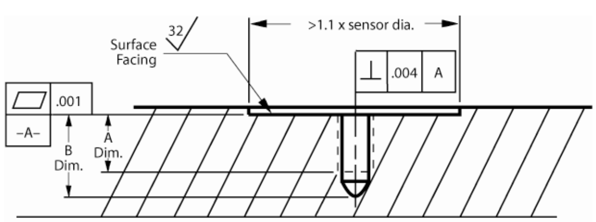


Figure 6. Mounting Techniques

Stud mounting

Threaded stud mounting allows the widest dynamic measurement range. It is recommended for permanent monitoring systems, high frequency testing, and harsh environments. The surface should be 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 microinchs.

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 and the mounting surface.



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.

Figure 7. Stud Mounting: Surface Preparation

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 figure 7 for 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 or vacuum grease. It is recommended that a thread adhesive such as Loctite 222 serviceable thread adhesive be used.

Adhesive mounting

If the machine can not be drilled as described in the section above, adhesive mounting would be the next 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 except accelerometers with a captive screw.

For optimum performance, the surface of the machine should be faced in the same manner described in stud mounting. If this is not possible, prepare the mounting surface of the machine be removing a 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 manufacture's direction for use of adhesive). There are a variety of different adhesives that may be used. 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 figure 7.

Typically, when attaching the mounting pad in this configuration, the mounting pad may not be electrically attached 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. If case grounding is required and the mounting pad is electrically isolated from the machine, you should use a cable assembly that will allow you to make this connection. Typically, this would be a two conductor shielded cable, with the shield tied electrically to the housing of the sensors. If the mounting pad is electrically tied to the machine, it is crucial that case grounding is not provided by the cable assembly.

Magnetic mounting 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.

Operation verification

Once installation is complete, it is recommended that the vibration sensor be tested for proper operation. Measure the DC bias output voltage (BOV) by powering the sensor and connecting a voltmeter across the sensor's signal and common leads. The BOV should rest within ± 2 V of the value note on the specification sheet (usually 8 to 12 V).

Diagnostic hints

If the BOV equals 0 V and the power supply is properly connected the circuit may be shorted; test the cable connections and power supply. If the BOV equals the supply voltage, the circuit may be open; test the cable connections. If the cable and power supply check as normal, then the sensor amplifier may be defective. To confirm sensor amplifier operation, temporarily replace the suspect sensor with a new unit and recheck the BOV. If the BOV is correct, then the sensor must be checked for vibration sensitivity.

To test for vibration sensitivity, tap the machine surface near the sensor. Observe the signal on an oscilloscope to ensure that the sensor is picking up vibrations. Monitor the measurements of a newly installed sensor to determine if its output is reasonable.

For more detailed information or assistance, contact your local Wilcoxon representative. For a listing of local representatives, please visit our web site at www.wilcoxon.com or contact Wilcoxon directly at 301-330-8811 or email techasst@wilcoxon.com.