Industrial Vibration Sensor

A6096

General Operation
Manual

Windrock, Inc.
431 Park Village Drive C Suite R C Knoxville, TN 37923
Ph: 865-539-5944 C FAX 865-531-6470 C www.windrock.com

TECHNICAL APPLICATION DATA

WRI ASSUMES NO RESPONSIBILITY FOR DAMAGE CAUSED TO THIS PRODUCT AS A RESULT OF PROCEDURES THAT ARE INCONSISTENT WITH THIS OPERATING GUIDE.

1.0 INTRODUCTION

Congratulations on the purchase of a quality industrial sensor. In order to ensure the highest level of performance for this product, it is imperative that you properly familiarize yourself with the correct mounting and installation techniques before attempting to operate this device. If, after reading this manual, you have any additional questions concerning this sensor or its application, feel free to call an Application Engineer at 865-539-5944.

Proper sensor selection requires special attention to three main areas: sensor design, dynamic expectations, and application environment.

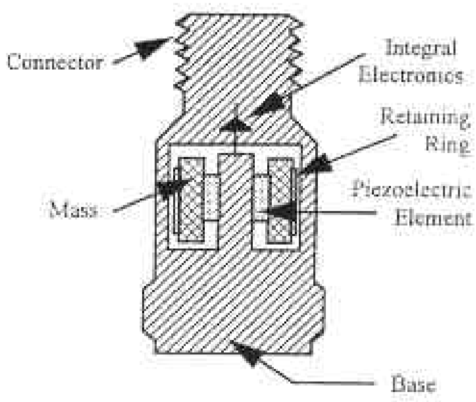


Figure 1. Typical Industrial Shear Mode Accelerometer

Sensor design encompasses the actual sensing element, the physical material, and component selection for the sensor. Preferred industrial accelerometers employ a shear sensing element with either a quartz or ceramic crystal.

Quartz sensing elements are typically used when long-term stability and minimum output shifts due to temperature changes are desired. Ceramic sensing elements provide excellent resolution and durability in noisy environments, and can be designed to supply low-frequency and high-frequency measurements. Shear-design sensors are preferred because of their inherent insensitivity to adverse environmental influences, such as case or base strain and thermal transients. Internal case isolation and shielding is important in avoiding erroneous signals resulting from ground loops and pickup of electromagnetic and radio frequency interference. Other critical material selection criteria include non-magnetic stainless steel housing, hermetic sealing, and industrial military connectors. See Figure 1.

Dynamic expectations are application-specific and refer to the frequency range of measurement and the anticipated amplitudes of vibration. After careful review of the machinery to be monitored, minimum and maximum measurement frequency range may be established. The minimum measurement frequency is normally related to any sub-harmonics of running speed or any lower frequencies where vibration data is to be collected. The maximum measurement frequency of interest is determined by the maximum number of harmonics of an event like running speed, bearing frequencies, or gear mesh. This measurement frequency range should be well within the specified frequency range of the sensor.

Amplitude range refers to the anticipated levels of vibration to be measured. These values are related to the alarm levels set for the machine. By carefully evaluating the idiosyncrasies of the machinery, the predictive maintenance engineer can estimate the minimum expected vibration levels and ensure that the electrical noise floor of the accelerometer is less than those levels.

The environment of the application is a critical consideration during program implementation. The sensor chosen must be capable of surviving the wide range of conditions to ,which it is subjected; therefore, take time to evaluate potential conditions, such as high temperatures and chemical contaminants. The specified temperature range of the sensor must conform to the fluctuations of the environmental temperature. If harsh industrial chemicals are present, the sensor requires hermetic sealing and construction that resists corrosion. Finally, specific location of the sensor within the environment must be sensible, as both cable and sensor may be damaged by imprudent installation in heavily traveled, physically punishing areas.

2.0 ACCELEROMETERS

Enclosed in the back of this guide is a Specification Sheet, which lists the complete performance characteristics of the particular sensor.

The sensor requires a constant current power source for proper operation. A typical sensing system includes a sensor, ordinary two conductor cable and a basic constant current power supply (as shown in Figure 2).

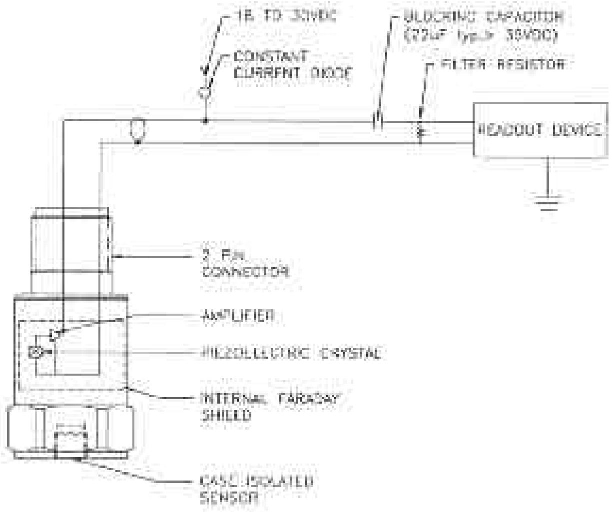


Figure 2.

The signal conditioner consists of a well-regulated 18 to 30 VDC source (battery or line-powered), a current-regulating diode (or equivalent constant current circuit), and a capacitor for decoupling (removing the bias voltage) the signal.

The current-regulating device is used in place of a resistor for several reasons. The very high dynamic resistance of the diode yields a source follower gain which is extremely close to unity and independent of input voltage. Also, the diode can be changed to supply higher currents for driving long cable lengths. Constant current diodes, as shown in Figure 3, should be used in accelerometer signal conditioners. (The correct orientation of the diode within the circuit is critical for proper operation.) Except for special models, standard sensors require a minimum of 2 mA for proper operation.

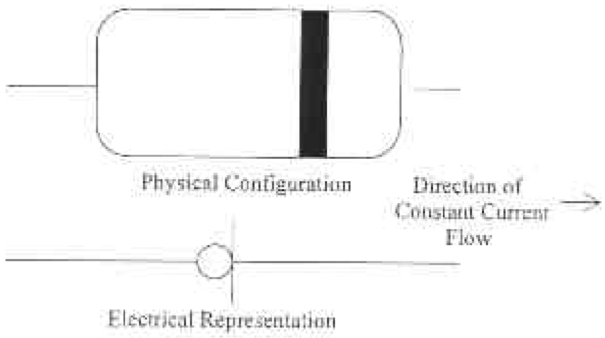


Figure 3. Constant Current Diode

The typical limits for this type of diode are to a 4 mA maximum rating; however, several diodes can be placed in parallel for higher current levels. All line-powered signal conditioners should use higher capacity (up to 20 mA) constant current circuits in place of the diodes, particularly when driving long signal cables (See Section 4).

Decoupling of the data signal occurs at the output stage of the signal conditioner. A 10 to 30 FF capacitor coupled with a resistor shifts the signal level to essentially eliminate the sensor bias voltage. The result is a drift-free AC mode of operation.

3.0 INSTALLATION OVERVIEW

When choosing a mounting method, consider closely both the advantages and disadvantages of each technique. Characteristics like location, ruggedness, amplitude range, accessibility, temperature, and portability are extremely critical. However, the most important and often overlooked consideration is the effect the mounting technique has on the high-frequency operating range of the accelerometer.

Shown in Figure 4 are six possible mounting techniques and their effects on the performance of a typical piezoelectric accelerometer. (Note: *Not all of the mounting methods may apply to your particular sensor.)* The mounting configurations and corresponding graph demonstrate how the high-frequency response of the accelerometer may be compromised as mass is added to the system and/or the mounting stiffness is reduced.

Note: *The low-frequency response is unaffected by the mounting technique. This roll-off behavior is typically fixed by the sensor*s built-in electronics. However, when operating AC-coupled signal conditioners with readout devices having an input impedance of less than one megaohm, the low frequency range may be affected*

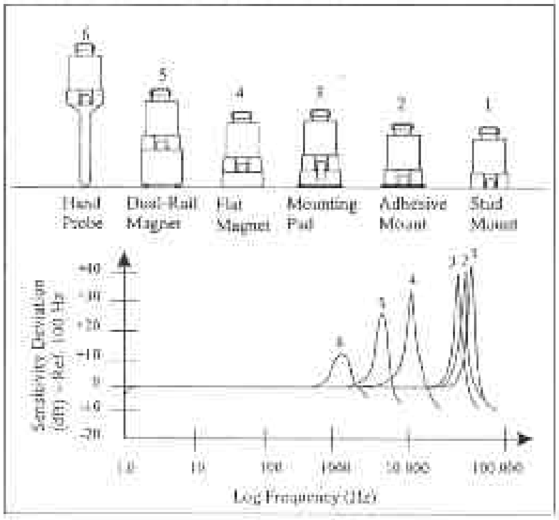
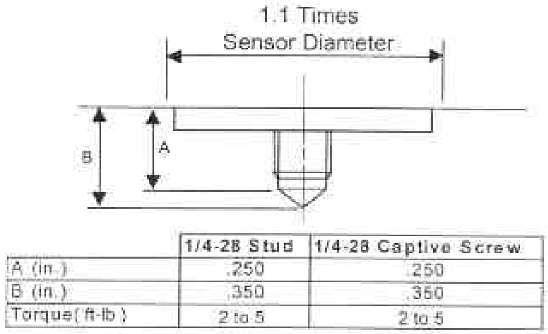


Figure 4. Assorted Mounting Configurations and Their Effects on High Frequency

3.1 STANDARD STUD MOUNT

This mounting technique requires smooth, flat contact surfaces for proper operation and is recommended for permanent and/or secure installations. Stud mounting is also recommended when testing at high frequencies.

Note: *Do NOT attempt mourning on curved, rough, or* *uneven surfaces, as the potential for misalignment and limited contact surface may significantly reduce the sensor 's upper operating frequency range.*



	1/4-28 Stud	1/4-28 Captive Screw
A (in.)	.250	.250
B (in.)	.350	.350
Torque (ft-lb)	2 to 5	2 to 5

Figure 5. Mounting Surface Preparation

STEP 1: First, prepare a smooth, flat mounting surface, and then drill and tap a mounting hole in the center of this area as shown in Figure *5.*

A precision-machined mounting surface with a minimum finish of 63 Fin (0,00016 mm) is recommended. (If it is not possible to properly prepare the machine surface, consider using an adhesive mounting pad as a possible alternative.) Inspect the area, checking that there are no burrs or other foreign particles interfering with the contact surface.

STEP 2: Wipe clean the mounting surface and spread on a light film of grease, oil, or similar coupling fluid prior to installation. (figure 6)

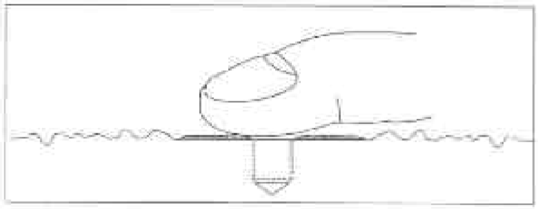


Figure 6. Mounting Surface Lubrication

Adding a coupling fluid improves vibration transmissibility by filling small voids in the mounting surface and increasing the mounting stiffness. For semi-permanent mounting, substitute epoxy or another type of adhesive.

STEP 3: Hand-tighten- the sensor/mounting stud to the machine, then secure the sensor with a torque wrench to the mounting surface by applying the recommended mounting torque (see enclosed specification data sheet for proper mounting torque).

It is important to use a torque wrench during this step. Under-torquing the sensor may not adequately couple the device; over-torquing may result in stud failure and possibly permanent damage.

3.2 ADHESIVE MOUNT

Adhesive mounting is often used for temporary installation or when the machine surface cannot be adequately prepared for stud mounting. Adhesives like hot glue or wax work well for temporary mounts; two-part epoxies and quick-bonding gels provide a more permanent mount.

Note: *Adhesively-mounted sensors often exhibit a reduction in high-frequency range. Generally, smooth surfaces and stiff adhesives provide the best frequency response. Contact the factory for recommended epoxies.*

METHOD 1 - Adhesive Mounting Base

This method involves attaching a base to the machine surface, then securing the sensor to the base. This allows for easy removal of the accelerometer.

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 Fin (0,00016 mm) generally works best.

STEP 2: Stud-mount the sensor to the appropriate adhesive mounting base according to the guidelines set forth in STEPS 2 and 3 of the Stud Mount Procedure.

STEP 3: Place a small portion of adhesive on the underside of the mounting base. Firmly press down on the assembly to displace any extra adhesive remaining under the base. (figure 7)

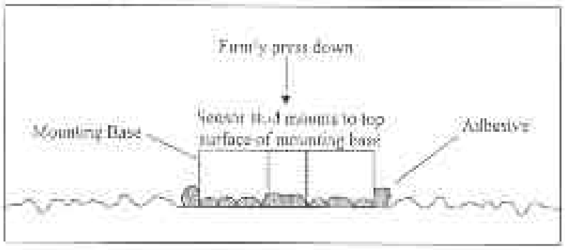


Figure 7. Mounting Base: Adhesive Installation

METHOD 2 - Direct Adhesive Mount

For restrictions of space or for convenience, most sensors (with the exception of integral stud models) can be adhesive-mounted directly to the machine surface.

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 Fin (0,00016 mm) generally works best.

STEP 2: Place a small portion of adhesive on die underside of the sensor. Firmly press down on the top of the assembly to displace any adhesive. Be aware that excessive amounts of adhesive can make sensor removal difficult. (figure 8)

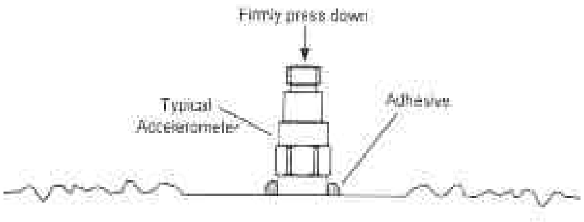


Figure 8. Direct Adhesive Mounting

3.3 MAGNETIC MOUNT

Magnetic mounting provides a convenient means for making portable measurements and is commonly used for machinery monitoring and other portable or trending applications.

Note: *The correct magnet choice and an adequately prepared mounting surface is critical for obtaining reliable measurements, especially at high frequencies. Poor installations can cause as much as a 50% drop in the sensor frequency range.*

Not every magnet is suitable for all applications. For example, rare earth magnets are commonly used because of their high strength. Flat magnets work well on smooth, flat surfaces, while dual-rail magnets are required for curved surfaces. In the case of non-magnetic or rough surfaces, it is recommended that the user first weld, epoxy, or otherwise adhere a steel mounting pad to the test surface. This provides a smooth and repeatable location for mounting. (figure 9)

STEP 1: After choosing the correct magnet type, inspect the unit, verifying that the mounting surfaces are flat and smooth.

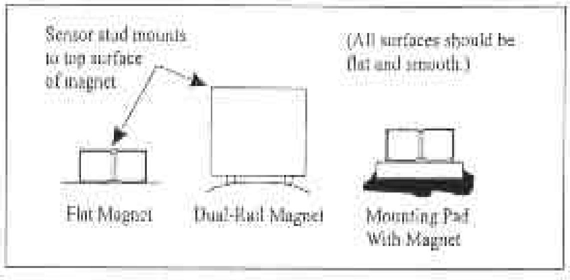


Figure 9. Magnet Types

STEP 2: Stud-mount the accelerometer to the appropriate magnet according to the guidelines set forth in STEPS 2 and 3 of the Stud Mount Procedure.

STEP 3: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 Fin (0,00016 mm) generally works best. After cleaning the surface and checking for burrs, wipe on a light film of silicone grease, machine oil, or similar-type coupling fluid.

STEP 4: Mount the magnet/sensor assembly to the prepared test surface by gently “rocking” or “sliding” it into place. (figure 10)

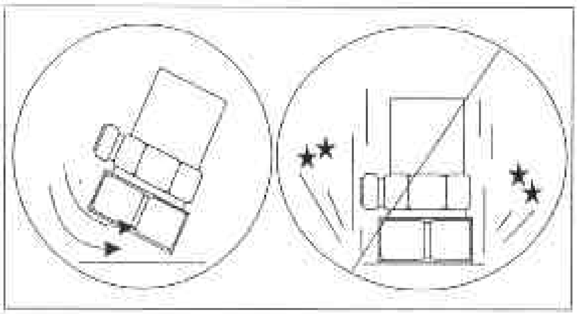


Figure 10. Magnet Mounting

Note: *Magnetically mounting accelerometers carelessly has the potential to generate very high (and very damaging) g levels. To prevent damage, install the assembly gently. If unsure, please contact the factory for assistance.*

3.4 HANDHELD OR PROBE TIP MOUNT

This method is NOT recommended for most applications. It is generally used where access to machinery may be a safety concern. Both the accuracy and repeatability at low (<5 Hz) and high frequency (>1 kHz) ranges are questionable.

4.0 CABLING

The selection of connectors and cables has a direct impact on the ruggedness and reliability of the sensor installation. A consideration when dealing with cables is the way in which the cable conductors are terminated.

The A6096 accelerometer is a internally amplified, two-wire accelerometers. Connections to the sensor requires two leads: one for the power and signal, and the other for the common and signal return. Often, coaxial cables are used since only two conductors are needed. Coaxial cables are less expensive. With coaxial cables, however, erroneous signals can be introduced into sensor systems through ground loops, electromagnetic interference, or radio frequency interference (EMI or RFI). To avoid ground loops, there should only be one ground in the system.

It is recommended for permanent installations that the sensor be case-isolated and internally shielded with a dual-case design and use a two-conductor shielded cables to insure clean vibration signal transmission. Two-conductor shielded cables allow the signal and the signal return (common) to be fully shielded from the sensor to the readout equipment. To insure that ground loop signals are not induced, the shield should only be terminated at one end. Typically, the shield of a two-conductor shielded cable is left open or not connected at the sensor end and is tied to earth ground at the instrumentation end.

Operation over long cables may affect the frequency response of the A6096 accelerometer, and introduce low frequency noise and high frequency distortion when an insufficient current is available to drive cable capacitance.

Unlike charge mode systems, where the system noise is a function of cable length, the A6096 sensor provides a high voltage, low impedance output well-suited for driving long cables through harsh environments. While there is virtually no increase in noise with the A6096 sensor, the capacitive loading of the longer cable may distort or filter higher frequency signals depending on the supply current and the output impedance of the sensor.

Generally, this signal distortion is not a problem with lower frequency testing within a range up to 1,000 Hz. However, when monitoring higher frequency vibrations traveling over cables longer than 500 ft., the possibility of signal distortion exists.

The maximum frequency that can be transmitted over a given cable length is a function of both the cable capacitance and the ratio of the peak signal voltage to the current available from the signal conditioner according to:

C = cable capacitance (picofarads)
V = maximum peak output from sensor (volts)
Lc=constant current from signal conditioner (mA)
10^9 = scaling factor to equate units

Note that in this equation, 1 mA is subtracted from the total current supplied to sensor (L_0). This is done to compensate for powering the internal electronics. Also, note that these are typical values only.

When driving long cables, Equation 1 shows that as the length of cable, peak voltage output or maximum frequency of interest increases, a greater constant current will be required to drive the signal.

4.1 CABLE CONNECTOR PROCEDURE

Care and attention to installation is essential, as the reliability and accuracy of your system is no better than that of the output cable.

STEP 1: Ascertain that you have ordered the correct cable type.

As with sensors, no cable can satisfy all applications. Special low-noise cabling should be used with high-impedance, charge-output devices. The A6096 sensor usually operates with any ordinary two-wire cable. Industrial applications often require twisted/shielded cables to reduce the effects of EMI and RFI. Teflon-jacketed cabling may be necessary to withstand corrosive environments.

STEP 2: Connect the cable to the accelerometer. A small amount of thread-locking compound placed on the connector prior to attachment helps secure the cable during testing. In harsh environments, the connection can be sealed with silicon rubber, 0-rings, and flexible heat-shrink tubing.

STEP 3: Plug the connector of the cable into the mating sensor connector. Then, holding the sensor stationary, secure the connector in place by tightening down the attached threaded cable sleeve.

STEP 4: Route the cable to the signal conditioner, making certain to stress-relieve the sensor/cable connection and minimize motion by clamping the cable at regular intervals.

Common sense should be used to avoid physical damage and minimize electrical noise. For instance, avoid routing cables near high-voltage wires. Do not route cables along floors or walkways where they may be stepped on or become contaminated. Shielded cables should have the shield grounded at one end only, normally at the instrumentation end.

STEP 5: Finally, connect the remaining cable end to the signal conditioner or readout device. To dissipate charge that may have accumulated in the cable, short the signal to the ground prior to attachment.

5.0 POWERING

The A6096 sensor requires constant current excitation for proper operation. For this reason, use only Windrock constant-current signal conditioners or other approved constant-current sources.

Note: *Damage to the built-in electronics resulting from the application of incorrect power or the use of an unapproved power source is NOT covered by warranty.*

The power supply consists of a regulated 18 to 30 VDC source. In general, battery-powered devices offer versatility for portable, low-noise measurements, whereas line-powered units provide the capability for continuous monitoring. This power is regulated by a current-limiting circuit, which provides the constant-current excitation required for proper operation of the A6096 sensor.

Note: *Under no circumstances should a voltage be supplied to the A6096 accelerometer without a current-regulating diode or equivalent electrical circuit.*

Meters or LEDs are used to monitor the bias voltage on the sensor output signal to check sensor operation and detect cable faults. Normally, a “yellow” reading indicates an open circuit; “green” indicates normal operation; and “red” indicates either a short or low bias condition. Finally, a capacitor at the output stage of the device removes the sensor output bias voltage from the measurement signal. This provides a zero-based, AC-coupled output compatible with most standard readout devices.

Note: *Low bias units may be in the “red,” when actually* *they are working properly. Check bias digitally with a multimeter.*

Today, many FFT analyzers, data acquisition modules, and data collectors have constant-current excitation for direct use with the A6096 sensor. However, before using this feature, check that the supply voltage and constant current are adequate for use with your sensor. (Check enclosed Specification Sheet.) Please contact the respective Signal Conditioner Manufacturer or check the product manual for more information.

6.0 OPERATING

After completing the system setup, switch on the conditioner and allow the sensor to power up. If a faulty condition is monitored, first check all system connections, then check the functionality of the cable and signal conditioner. If the system still does not operate properly, consult an Windrock Application Engineer.

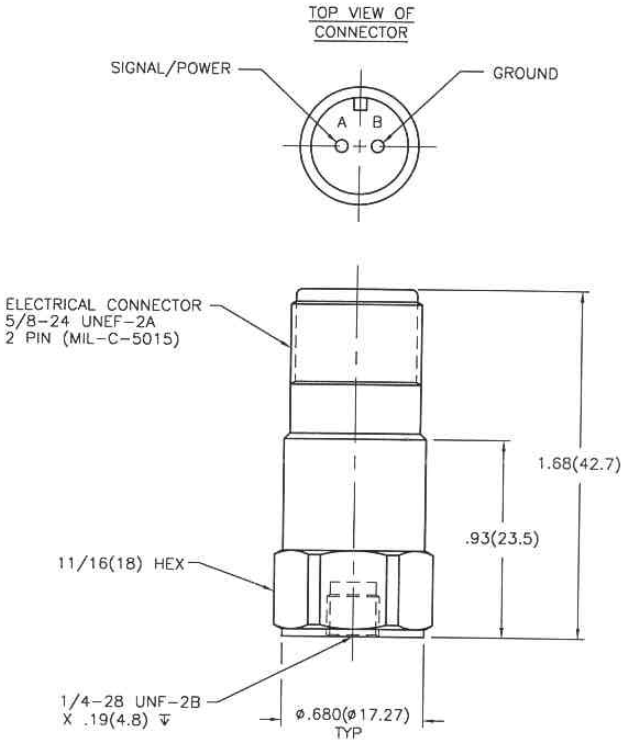
Note: *Always operate the accelerometer within the limitations listed on the enclosed Specification Sheet. Operating the device outside these parameters can cause temporary or permanent damage to the sensor.*

7.0 CONNECTIONS

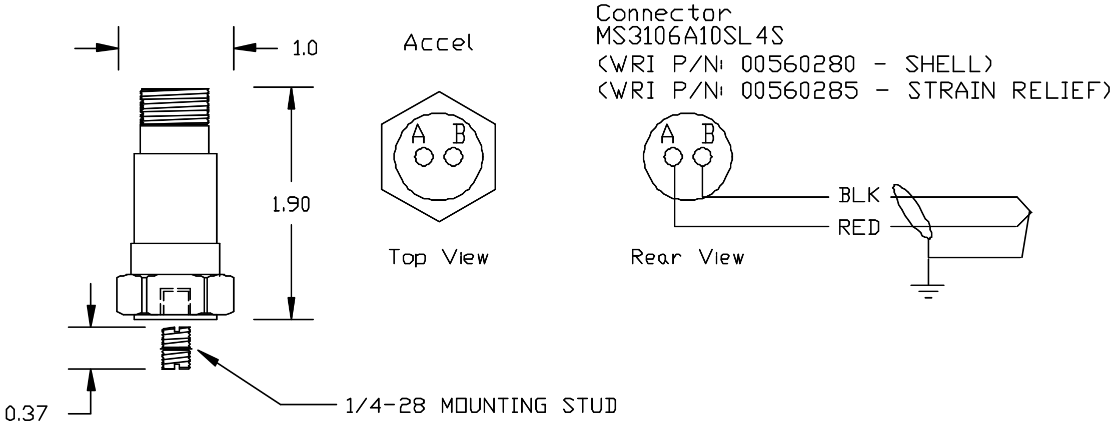
The C-Guard accepts one vibration sensors, the sensor is usually located at the crank-end of the cylinder.

The vibration sensor cable diagram is shown at the end of the manual. Connect pin ‘A’ of the 2 pin connector to the plus accel (+) input of the C-Guard and pin ‘B’ of the 2 pin connector to the accel (-) input of the C-Guard.

The sensor should be connected using shielded twisted pair cable. In some instances, a flexible metal hose can be placed over the cable to provide extra mechanical protection near the sensor.



MECHANICAL DRAWING



INSTALLATION DRAWING

SPECIFICATIONS

DYNAMIC

Sensitivity:
(±20%) 100mV/g
Measurement Range:
± 50g
Frequency Response:
± 3dB 26-780,000 cpm
Mounted Resonant Frequency:
1,680 cpm
Amplitude Linearity:
± 1%

ENVIRONMENTAL

Temperature Range:
Operating: -65EF to +250EF
Shock Limit: 5,000g pk

ELECTRICAL

Settling Time (within 1% of bias):
#2.0 sec
Discharge Time Constant:
$0.4 sec
Excitation Voltage:
+18 to +28VDC
Constant Current:
2 to 20 mA
Output Impedance:
<150 ohms
Output Bias:
8 to 12 VDC
Case Isolation:
$>10^8$ ohms

MECHANICAL

Size(hex x height):
11/16 x 1.66 in
Weight:
1.7 oz
Mounting Thread:
1/4-28 UNF-2B
Mounting Torque:
2 to 5 ft-lb
Sensing Element/Geometry:
Ceramic/Shear
Case Material:
Stainless Steel
Sealing:
Welded Hermetic
Connector Type:
Mil-C-5015/Top

APPROVALS