SKF®

SKF Reliability Systems

Vibration Sensors

Vibration Sensors

Power Supply Units

Sensor Housings

Cables and Connectors

Accessories

Installation/Mounting

Vibration Sensors

Table of Contents

Vibration Sensors

Table of Contents

Introduction

Despite the advances made in vibration monitoring and analysis equipment, the selection of sensors and the way they are mounted on a machine remain critical factors in determining the success of any monitoring program. Money saved by installing inferior sensors is not a prudent investment since the information provided about the machine of interest often is not accurate or reliable. Poor quality sensors can easily give misleading data or, in some cases, cause a critical machine condition to be completely overlooked.

The Critical Choice

The various rotating machine operating conditions concerning temperature, magnetic field, g range, frequency range, electromagnetic compatibility (EMC) and electrostatic discharge (ESD) conditions and the various parameters measured in the multi-parameter approach necessitates the need for a variety of sensors. Without a proper sensor to supply the critical operating information, the machine can be operating in a most hazardous condition to both the machine as well as the personnel operating the machine. SKF in partnership with one of the worlds leading industrial sensor manufacturers has developed and can provide the epitome of industrial sensors, accelerometers and velocity transducers for your critical machine monitoring.

The key to proper machine monitoring however is the proper choice of sensor for the particular installation. Without the proper sensor, the best instrumentation and software available will not provide the definitive information on which to make a “sound engineering determination” regarding the mechanical operating condition or deficiencies of the machine.

The ability to monitor more than one machine parameter with the same sensor can give added insight to machine performance at a more economical cost than using separate sensors for each (ESD) conditions and the various parameters measured in the multi-parameter approach necessitates the (ESD) conditions and the various parameters measured in the multi-parameter approach necessitates the parameter. Such an approach can be classified as **Multi-Parameter Monitoring.**

Selection of Vibration Sensors

The three parameters representing motion detected by vibration monitors are displacement, velocity, and acceleration. These parameters can be measured by a variety of motion sensors and are mathematically related (displacement is the first derivative of velocity and velocity is the first derivative of acceleration). Selection of a sensor proportional to displacement, velocity or acceleration depends on the frequencies of interest and the signal levels involved.

Figure 1 shows the relationship between velocity and displacement and acceleration. Sensor selection and installation is often the most critical determining factor in accurate diagnoses of machinery condition.

DISPLACEMENT SENSORS

Eddy current probes are non-contact sensors primarily used to measure shaft vibration, shaft/rotor position and clearance. Also referred to as displacement probes, eddy current probes are typically applied on machines utilizing sleeve/journal bearings. They have excellent frequency response with no lower frequency limit and can also be used to provide a trigger input for phase-related measurements.

SKF monitors also have the ability to take the output of an accelerometer and double integrate to obtain a relative displacement; however, except in very special cases, it is inadvisable because of significant low frequency instability associated with the integration process. Eddy current probe systems remain the best solution for shaft position measurements.

(Please refer to SKF Condition Monitoring publication CM2004 for guidance on the selection, application and installation of Eddy Current Probe Systems.)

VELOCITY SENSORS

Velocity sensors are used for low to medium frequency measurements. They are useful for vibration monitoring

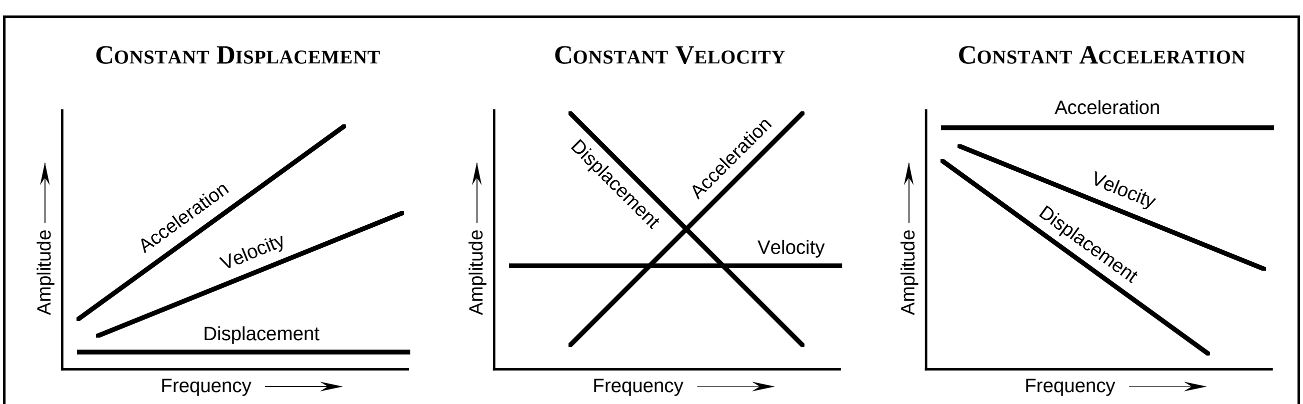


Figure 1. The relationship of acceleration and displacement and velocity.

and balancing operations on rotating machinery. As compared to accelerometers, velocity sensors have lower sensitivity to high frequency vibrations. The mechanical design of the velocity sensor; an iron core moving within a coil in a limited magnetic field, no clipping of the generated signal occurs, but smooth saturation.

In an accelerometer with ICP electronics, sensor resonance excitation can cause saturation and clipping of the electronic circuit generating false low frequency components. Integrating to velocity from the acceleration signal leads to large low frequency components. Resonance damping circuits between sensor element and amplifier can minimize that effect.

Table 1. Electromagnetic Velocity Sensors vs. Piezoelectric Velocity Sensors.

Characteristic	Coil and Magnet Velocity Sensor	Piezoelectric Velocity Sensor
Flat Frequency Response		
20–1,500 Hz	Yes	Yes
2–5,000 Hz	No	Yes
Phase Fidelity		
2–5,000Hz	Acceptable	Excellent
Reduced Noise at		
Higher Frequencies	No	Yes
Linearity	Good	Good
Mounting in Any Orientation	Sensor Dependent	Yes
Temperature Limitation	> +707°F (+375°C)	+248°F (+120°C)
EMI* Resistance	Acceptable	Excellent
Mechanical Durability	Good	Excellent

*EMI–Electro Magnetic Interference

Traditional velocity sensors are of a mechanical design that uses an electromagnetic (coil and magnet) system to generate the velocity signal. Recently, hardier piezoelectric velocity sensors (internally integrated accelerometers) have gained in popularity due to their improved capabilities and more rugged and smaller size design. A comparison between the traditional coil and magnetic velocity sensor and the modern piezoelectric velocity sensor is shown in Table 1.

The electromagnetic (Inductive) velocity sensor does have a critical place in the proper sensor selection. Because of its high temperature capability it finds wide application in gas turbine monitoring and is the sensor of choice by many of the major gas turbine manufacturers.

The high temperature problems for systems using accelerometers can also be solved by splitting sensor and electronics (charge amplifiers). The sensor can have high temperature ranges up to +1,112°F (+600°C).

Some methods of investigating bearing defects and gear problems may require a higher frequency range and because the signals are generated by impact, the sensitivity should be lower. By the same means if the user is using the SKF "Enveloping Technique" then just the opposite is applicable.

ACCELEROMETERS

Piezoelectric accelerometers having a constant signal over a wide frequency range, up to 20 kHz's, for a given mechanical acceleration level, are very useful for all types of vibration measurements.

Acceleration integrated to velocity can be used for low frequency measurements. Acceleration signals in the high frequency range added with various signal processing techniques like ACC ENV, or HFD are very useful for bearing and gear measurements.

The basic acceleration sensor has a good signal to noise ratio over a wide dynamic range.

They are useful for measuring low to very high frequencies and are available in a wide variety of general purpose and application specific designs. The piezoelectric sensor is versatile, reliable and the most popular vibration sensor for machinery monitoring.

When combined with vibration monitors capable of integrating from acceleration to velocity, accelerometers can be a useful component in a Multi-Parameter Monitoring Program. The user is, therefore, able to determine both velocity and acceleration values for the same machine point with a single sensor.

SEE™ SENSORS

As a complementary technology to the sensors discussed above, SKF has developed and patented sensors based on *SEE* Technology. *SEE* (Spectral Emitted Energy) is used to detect acoustic emission signals in the range of 250–350 kHz, well beyond the range of conventional vibration sensors. Such acoustic emission signals are generated by stress-type defects such as metal-to-metal impacts and wear. This can happen when rolling over a local defect or a partical or when there is wear in a dry sliding contact (metal-to-metal contact). For example, when a rolling element of an anti-friction bearing breaks through its lubrication film and slides *SEE* sensors are able to detect the condition. The user then has the opportunity to take proactive steps in order to prevent further damage.

Piezoelectric Sensors

Accelerometers operate on the piezoelectric principal: a crystal generates a low voltage or charge when stressed as for example during compression. (The Greek root word "piezein" means "to squeeze".) Motion in the axial direction stresses the crystal due to the inertial force of the mass and produces a signal proportional to acceleration of that mass. This small acceleration signal can be amplified for acceleration measurements or converted (electronically integrated) within the sensor into a velocity or displacement signal. This is commonly referred as the ICP (Integrated Circuit Piezoelectric) type sensor. The piezoelectric velocity sensor is more rugged than a coil and magnet sensor, has a wider frequency range, and can perform accurate phase measurements.

Most industrial piezoelectric sensors used in vibration monitoring today contain internal amplifiers.

PIEZOELECTRIC MATERIALS: CERAMIC vs. QUARTZ

The two basic piezoelectric materials used in vibration sensors today are synthetic piezoelectric ceramics and quartz. While both are adequate for successful vibration sensor design, differences in their properties allow for design flexibility. For example, modern “tailored” piezoceramic materials have better charge sensitivity than natural piezoelectric quartz materials. Most vibration sensor manufacturers now use piezoceramic materials developed specifically for sensor applications. Special formulations yield optimized characteristics to provide accurate data in extreme operating environments. The exceptionally high output sensitivity of piezoceramic material allows the design of sensors with increased frequency response when compared to quartz.

Much has been said of the thermal response of quartz versus piezoceramics. Both quartz and piezoceramics exhibit an output during a temperature transient (pyroelectric effect) when the material is not mounted within a sensor housing. Although this effect is much lower in quartz than in piezoceramics, when properly mounted within a sensor housing the elements are isolated from fast thermal transients. The difference in materials then becomes insignificant. The dominant thermal signals are caused by metal case expansion strains reaching the base of the crystal. These erroneous signals are then a function of the mechanical design rather than sensing material (quartz or piezoceramic). Proper sensor designs isolate strains and minimize thermally induced signals. (See section on "Temperature Range" page 4.)

High quality piezoceramic sensors undergo artificial aging during the production process. This ensures stable and repeatable output characteristics for long term vibration monitoring programs. Theoretical stability advantages of quartz versus ceramic designs are eliminated as a practical concern.

Development of advanced piezoceramics with higher sensitivities and capability to operate at higher temperatures is anticipated.

Choosing An Industrial Sensor

When selecting a piezoelectric industrial vibration sensor many factors must be considered so that the best sensor is chosen for the application. The user who addresses application and noise floors specific questions will become more familiar with sensor requirements and be more likely to select the proper sensor for the application.

Typical questions include:

- What is the expected maximum vibration level?
- What type of vibration (sinusoidal, pulsed, mixed)?
- What is the frequency range of interest?
- Does the machine use sleeve/journal or rolling element bearings?
- What is the running speed of the machine?
- What is the temperature range required?
- Are any corrosive chemicals or detergents present?
- Is the atmosphere combustible?
- Are intense acoustic or electromagnetic fields present?
- Is electrostatic discharge (ESD) present in the area?
- Is the machinery grounded?

Other questions must be answered about the connector, cable, and associated electronics:

- What cable lengths are required?
- Is armored cable required?
- To what temperatures will the cable be exposed?
- Does the sensor require a splash-proof connector or integrated cable connector?
- What other instrumentation will be used?
- What are the power supply requirements?

Primary Sensor Considerations

Two of the main parameters of a piezoelectric sensor are the sensitivity and the frequency range. In general, most high frequency sensors have low sensitivities and,

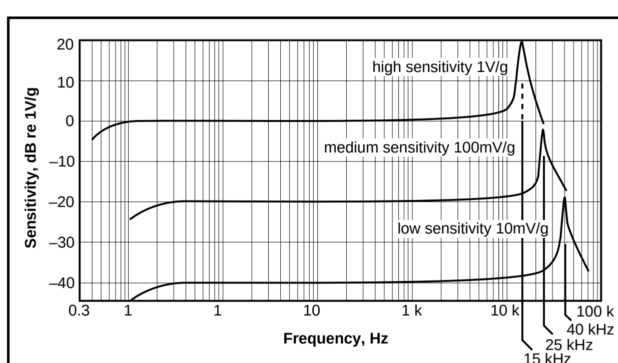


Figure 2. Typical frequency response curves for various

conversely, most high sensitivity sensors have low frequency ranges. The dependence of inertia on mass governs this relationship. As the mass increases the sensitivity is also increased; however, the usable frequency range is reduced since the sensor more quickly approaches its resonance frequency, shown in Figure 2. It is therefore necessary to compromise between the sensitivity and the frequency response.

Another criteria is: "Is the sensor used for bearing defect monitoring?" Because rolling over a defect can generate high g-levels (excitation of the sensor resonance frequency) up to 100 g peak. Therefore it is sometimes wise to select 10 mV/g or 30 mV/g as sensor sensitivity.

THE SENSITIVITY RANGE

The sensitivity of industrial accelerometers typically range between 10 and 100 mV/g; higher and lower sensitivities are also available. To choose the correct sensitivity for an application, it is necessary to understand the range of vibration amplitude levels to which the sensor will be exposed during measurements.

As a rule of thumb, if the machine produces high amplitude vibrations (greater than 10 g RMS) at the measurement point, a low sensitivity (10 mV/g) sensor is preferable. If the vibration is less than 10 g RMS, higher than 10 mV/g up to 100 mV/g should be used. In no case should the peak g level exceed the acceleration range of the sensor. Be aware that signals generated by sensor resonance frequency can be 10 to 20 dB higher. This would result in amplifier overload and signal distortion; therefore generating erroneous data.

Higher sensitivity accelerometers are available for special applications, such as low frequency/low amplitude measurements. In general, higher sensitivity accelerometers have limited high frequency operating ranges. One of the excellent properties of the piezoelectric sensor is its wide operating range. It is important that anticipated amplitudes of the application fall reasonably within the operating range of the sensor. Velocity sensors with sensitivities ranging from 20 mV/in/sec to 500 mV/in/sec (0.8 mV/mm/sec to 20 mV/mm/sec) are available. For most applications, a sensitivity of 100 mV/in/sec (4 mV/mm/sec) is satisfactory.

THE FREQUENCY RANGE

The high frequency range of the sensor is constrained by its increase in sensitivity as it approaches resonance. The low frequency range is constrained by the amplifier roll-off filter, as shown in Figure 3. Many sensors have a passive low pass filter between sensor element and the amplifier in order to attenuate the resonance amplitude.

This extends the operating range and reduces electronic distortion. The user should 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.

– NOTE –

Sensors with lower frequency ranges tend to have lower electronic noise floors. Lower noise floors increase the sensor's dynamic range and may be more important to the application than the high frequency measurements.

The following should be considered when determining the high and low frequency responses of a sensor.

In order to select the frequency range of a piezoelectric sensor, it is necessary to determine the frequency requirements of the application. It is also important to consider the type of analyzing techniques that will be applied and the types of events the user is interested to analyze. For example, determining imbalance and misalignment can be done with a sensor having a lower frequency range and a high sensitivity.

The required frequency range is often already known from vibration data collected from similar systems or applications. The plant engineer may have enough information on the machinery to calculate the frequencies of interest. Sometimes the best method to determine the frequency content of a machine is to place a test sensor (in the direction of the shaft centerline) at various locations on the machine and evaluate the data collected.

In industrial machinery, frequencies related to imbalance, misalignment, looseness are typically lower than 1,000 Hz (60,000 cpm).

Frequencies and harmonics related to bearing and gear defects are a few hundred Hz and higher. The exception is the cage frequency which is approximately one half the shaft speed. As demonstrated in the following example, if the running speed of a rotating shaft is known, the highest frequency of interest is normally a multiple of the product of the running speed and the geometry of the bearing supporting the shaft.

Environmental Requirements

TEMPERATURE RANGE

Sensors must be able to survive temperature extremes of the application environment. The sensitivity variation versus temperature must be acceptable to the measurement requirement.

Temperature transients (hot air, steam, or oil splash) can cause metal case expansion resulting in erroneous output during low frequency measurements (< 5 Hz). In such cases a protective sensor housing should be considered in order to limit the effect of temperature induced transients. Some of these inherent errors may also be overcome with the use of monitors equipped with envelope band pass filters and enveloping techniques in the vibration monitor circuitry.

HUMIDITY

All SKF vibration sensors are sealed to prevent the entry of high humidity and moisture. In addition, integral cables, splash-proof cable connectors and jackets are available to withstand high humidity or wet environments. Contact SKF for recommendations on your application.

HIGH AMPLITUDE VIBRATION SIGNALS

The sensor operating environment must be evaluated to ensure that the sensor's signal range not only covers the vibration amplitude of interest, but also the highest vibration levels present at the measurement point. Exceeding the sensor's amplitude range will cause signal distortion throughout the entire operating frequency range of the sensor. In other words, mechanical shock loading on the sensor or large degrees of machine movement can overload the sensor's response capability. Shaker screens used in materials processing are an example of such an application.

The machine can generate high impacts compared to the "normal" working level, but an impact, a step, also causes excitation of the sensor resonance frequencies. The gain is then 10 to 20 dB higher.

HAZARDOUS ENVIRONMENTS: GAS, DUST, ETC.

Vibration sensors must be agency certified for use in areas subjected to hazardous concentrations of flammable gas, vapor, mist, or combustible dust in suspension. Intrinsic Safety requirements for electrical equipment limit rapid electrical and thermal energy to levels that are insufficient to ignite an explosive atmosphere under normal or abnormal conditions. Even if the fuel-to-air mixture in a hazardous environment is in its most volatile concentration, certified vibration sensors properly installed are incapable of causing ignition. This greatly reduces the risk of explosions in environments where vibration sensors are needed. Many industrial vibration sensors are now certified for Intrinsically-Safe installations by certifying agencies, such as Factory Mutual (FM), Canadian Standards Association (CSA), and CENELEC approved agencies.

For approval to CENELEC standards, SKF uses the Electrical Equipment Certification Service (EECS) (BASEEFA) of the United Kingdom.

Most certifying agencies also require the use of approved safety barriers when a monitoring system is installed in a nonhazardous environment. Safety barriers ensure that the electrical energy passing from the nonhazardous location to the hazardous location does not exceed a safe value. In general, such devices may also reduce the signal amplitude of a sensor.

Please consult SKF for more information on Intrinsic Safety.

In applications such where extreme concentration of caustic chemicals are present that could denigrate the sensor cable and/or connector it may be advisable to use integral polyurethane or teflon cables or purged sensor housings. Please consult SKF for more information when such conditions exist.

CE MARK

Beginning January 1996, the European Community requires equipment sold in their area to be a CE marked product. Because sensors have an active component such as the integrated circuit amplifier, the sensor should have the CE mark.

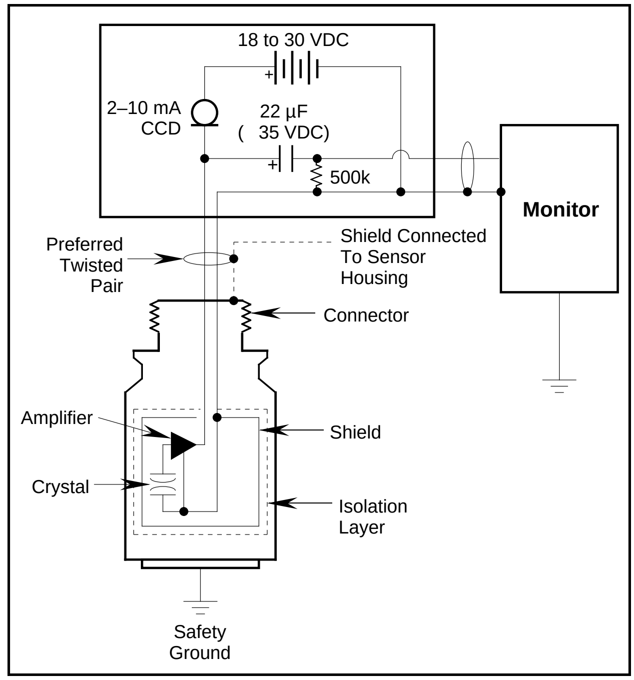


Figure 3. Powering scheme.

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) shown in Figure 3 . When other powering schemes are used, consultation with the sensor manufacturer is recommended. A more thorough discussion of powering requirements follows.

AC COUPLING AND THE DC BIAS VOLTAGE

The sensor output is an AC signal proportional to the vibration of the structure at the mounting point of the sensor. The AC signal is superimposed on a DC bias voltage (also referred to as Bias Output Voltage or Rest Voltage). The DC component of the signal is blocked by a capacitor. The capacitor, however, passes the AC output signal to the monitor. SKF monitors and sensor power supply units contain an internal blocking capacitor for AC coupling. If not included, a blocking capacitor

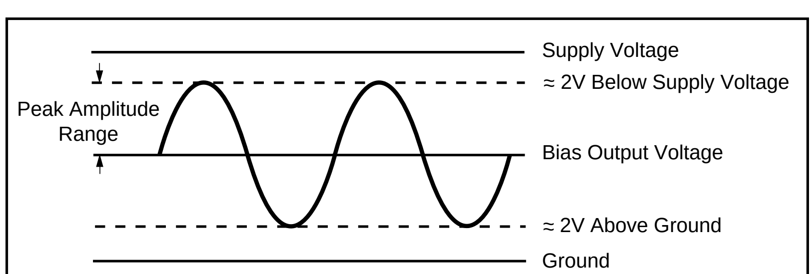


Figure 4. Range of linear operation.

must be field installed. The combination AC coupling capacitance and input defines the low frequency response of the system.

AMPLITUDE RANGE AND THE SUPPLY VOLTAGE

The sensor manufacturer usually sets the bias voltage halfway between the lower and upper cutoff voltages (typically 2V above ground and 2V 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 4.) Thus, an accelerometer with a sensitivity of 100 mV/g and a peak output swing of 5 volts has an amplitude range of 50 g peak.

– NOTE –

If a higher supply voltage is used (22 to 30 VDC), the amplitude range can be extended to 100 g peak. If a voltage source lower than 18 volts is used, the amplitude range will be lowered accordingly.

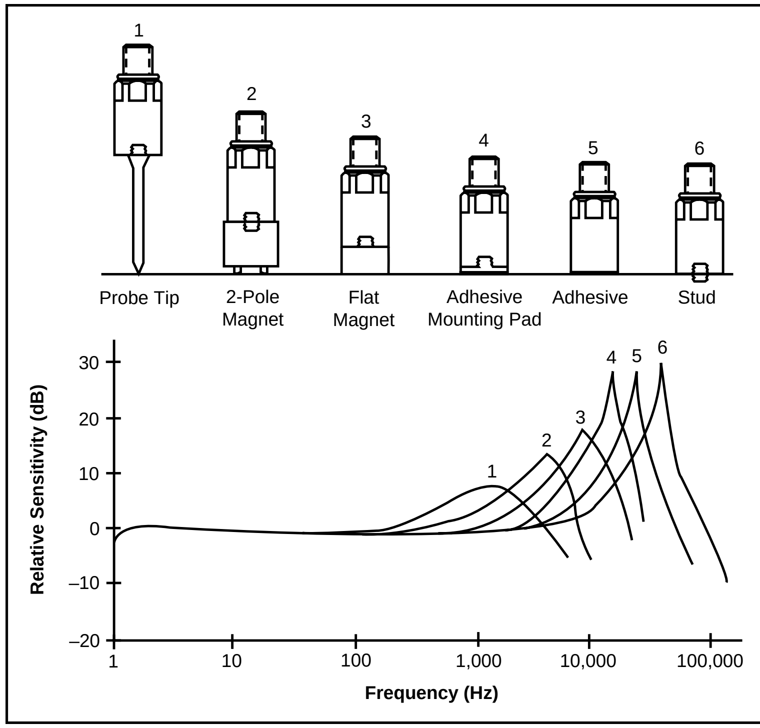


Figure 5. Mounting techniques.

CONSTANT CURRENT DIODES

Constant current diodes (CCD) are required for two wire internally amplified sensors. In most cases, they are included in the companion power supply unit or monitor supplied. Generally, battery powered 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 when driving long cables. For operation above +212°F (+100°C), where amplifier heat dissipation is a factor, the current should be limited to less than 6 mA.

If the power supply does not contain a CCD for sensor powering, one should be placed in series with the voltage output of the supply.

– NOTE –

Ensure that proper diode polarity is observed! Typical CCDs are Motorola and Siliconix (4 mA part number 1N5312 and J510 respectively).

Other Sensor Types

HIGH TEMPERATURE PIEZOELECTRIC VIBRATION SENSORS

High temperature industrial sensors are available for applications up to +707°F (+375°C). Currently, high temperature sensors are not internally amplified above +302°F (+150°C). Above this temperature, piezoelectric sensors are unamplified (charge mode). Charge mode sensors usually require a charge amplifier. The sensitivity of unamplified sensors should be chosen to match the amplitude range of the amplifier selected. The unit of sensitivity for charge mode accelerometers is expressed in pico coulombs/g. It is necessary to use special low-noise, high temperature cables to avoid picking up erroneous signals caused by cable motion.

The electromagnetic (Inductive) velocity sensors available from SKF are rated to maximum operating temperatures of +707°F (+375°C). Research is underway to extend the operating temperature of amplified transducers.

HAND-HELD AND OTHER MOUNTING METHODS FOR INDUSTRIAL SENSORS

Hand-held accelerometers such as the CMSS 92C are popular sensors to do quick and easy data collections. These sensor types however have some disadvantages. The frequency range is limited to approximately 1,000 Hz, thus they are generally okay only for low frequency acceleration and velocity measurements. The contact resonance frequency is low at around 1,000 – 2,000 Hz.

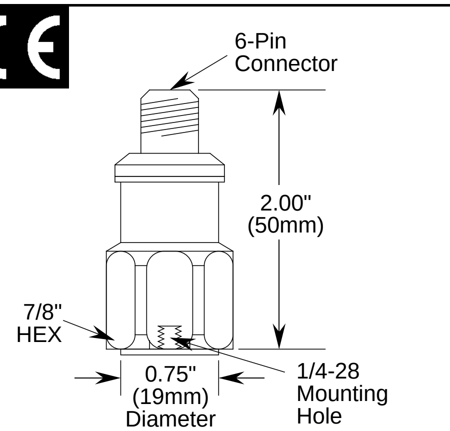
The two-pole curved surface magnet with the two line wedges gives a slightly better frequency response and therefore the contact resonance frequency is slightly higher. It is recommended that neither type be used for Acceleration Enveloping (ACC ENV) measurement in band III and band IV. The flat magnet mounted on a prepared flat measuring surface or methods 4, 5 and 6 (Figure 5 Mounting Techniques) gives an excellent mounting method to provide reliable results for all measuring techniques.

Care should be taken to allow for the resonances inherent with all mounting methods. Because protable data collectors are highly versatile instruments, capable of executing various measuring techniques, including high frequencies, the choice should be the flat magnet mounting techniques and up. Methods 1 and 2 can be used for velocity measurements and low frequency acceleration.

CMSS 786M Dual Sensor-Accelerometer and *SEE*™ Sensor, Piezoelectric

Features

- ***Measures acceleration and SEE units***
- ***Electronic resonance damping***
- ***Miswiring protection***
- ***One second current settling time***
- ***Low sensitivity to thermal gradients and base strain***



Specifications

ACCELEROMETER

DYNAMIC

Sensitivity: ± 10% of 100 mV/g; at +77°F (+25°C)
Acceleration Range: 80 g peak
Amplitude Nonlinearity: 1%
Frequency Response: ± 10%; 1.0–9,000 Hz, ± 20%; 0.5–14,000 Hz
Resonance Frequency, Mounted, Nominal: 22 kHz
Transverse Sensitivity, Maximum: 5% of axial
Base Strain Sensitivity, Maximum: 0.0002 g/µstrain
Electromagnetic Sensitivity, equivalent g: 70 µg/Gauss
Temperature Response: See graph

SEE™ Sensor

DYNAMIC

Sensitivity: 100 kHz to 500 kHz
Nominal: 10 mV/SEE ± 2 dB
Sensor Capacitance, Nominal: 500 pF
Grounding: Case isolated
Coupling Capacitance to Case: < 25 pF

ELECTRICAL

Power Requirement:
Voltage Source *(note 1)*: 18–30 VDC
Current Regulating Diode *(notes 1, 2)*: 2–10 mA
Electrical Noise: 2 Hz; 20 µg/√Hz
Output Impedance, Maximum: 100 Ω
Bias Output Voltage, Nominal: 12 VDC
Grounding: Case isolated, internally shielded

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 500 g peak
Shock Limit, Minimum: 5,000 g peak
Sealing: Hermetic

PHYSICAL

Weight: 95 grams
Case Material: 316L Stainless Steel
Mounting: 1/4-28 UNF Tapped Hole
Mounting Torque: 24 in-lbs (2,9 N-m)
Output Connector: Amphenol PC1H-10-98P
Connections:

Pin A	Case
Pin B	*SEE* Sensor (–)
Pin C	*SEE* Sensor (+)
Pin D	Accelerometer, Common
Pin E	Accelerometer, Power and Signal

Cabling:
Mating Connector (6-Pin): PC06-10-98S (Meets requirements of MIL-C-26482)
Recommended Cable: J9T2PS, Two shielded conductor pairs, clear teflon jacket (100Ω nominal).

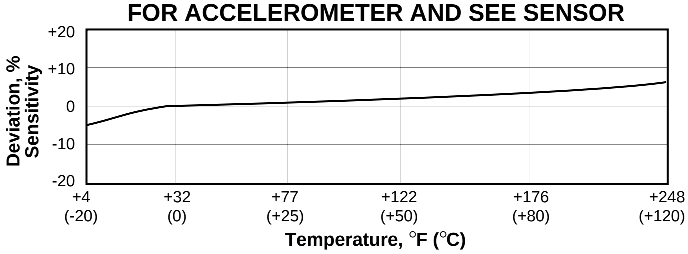
Accessories Supplied

1/4-28 Mounting Stud, Calibration Data.

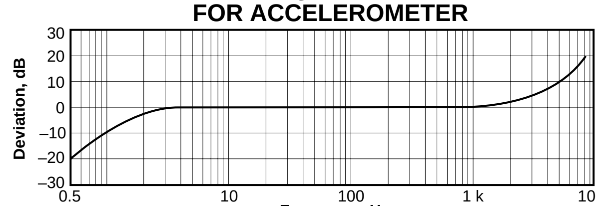
Accessories Available

Metric Thread Mounting Studs, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.

TYPICAL TEMPERATURE RESPONSE FOR ACCELEROMETER AND SEE SENSOR



TYPICAL FREQUENCY RESPONSE FOR ACCELEROMETER

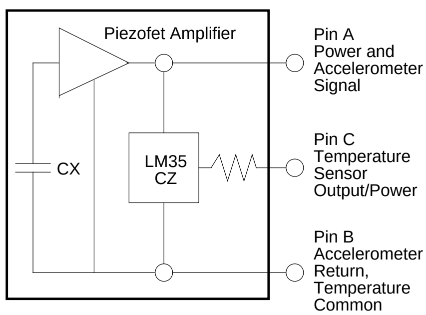


NOTES: *1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).*
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

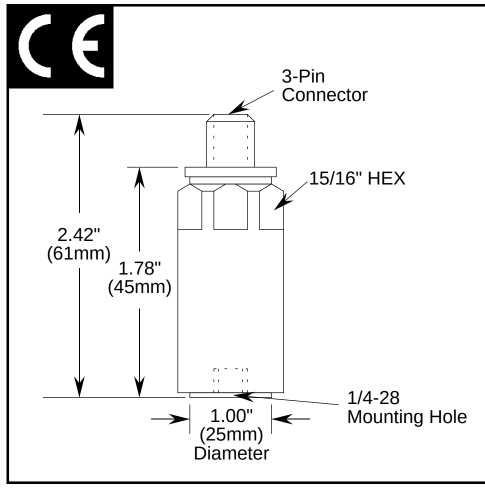
CMSS 793T-3 Multifunction Sensor: Acceleration and Temperature

Features

- ***Measures both temperature and acceleration***
- ***Rugged construction***
- ***Hermetically sealed***
- ***Ground isolated***
- ***ESD protection***
- ***Miswiring protection***



CMSS 793T Block Diagram



Specifications

DYNAMIC

Sensitivity: ± 5% of 100 mV/g; at +77°F (+25°C)
Electrical Noise: 2 Hz; 40 µg/√Hz
Peak Amplitude (+24V supply): 80 g
Frequency Response: ± 5%; 1.5–5,000 Hz
± 10%; 1.0–7,000 Hz
± 3 dB; 0.5–15,000 Hz
Resonance Frequency, Mounted, Nominal: 24 kHz
Transverse Sensitivity, Maximum: 5% of axial
Temperature Response: See graph
Temperature Sensor:
Temperature Output Sensitivity: ± 5% of 10 m Vdc/Kelvin
Temperature Measurement Range: -58°F to +248°F (+223°K to +393°K)

Wiring Scheme

Connector Pin	Function	Cable Conductor Color
Shell	Ground	Shield
A	Accelerometer Power and Signal	Red
B	Accelerometer Return, Temperature Common	Black
C	Temperature Sensor Signal and Power	White

ELECTRICAL

Power Requirement: ***Voltage Source:*** 18–30 VDC
Current Regulating Diode: 2–10 mA
Bias Output Voltage, Nominal: 12 VDC
Turn-On Time: 3 seconds
Shielding: Isolated Faraday

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 500 g peak
Shock Limit: 5,000 g peak
Electromagnetic Sensitivity, equivqlent g: 10 µg/Gauss
Sealing: Hermetic
Base Strain Sensitivity, Maximum: 0.0005 g/µstrain

PHYSICAL

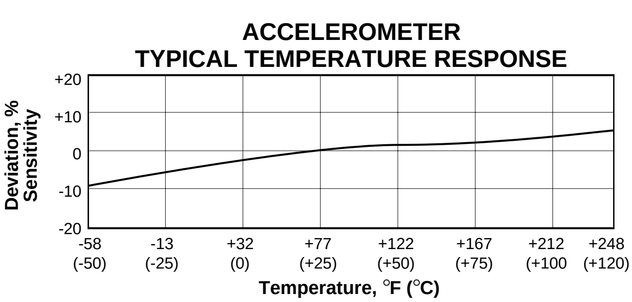
Weight: 115 grams
Case Material: 316L stainless steel
Mounting: 1/4-28 UNF tapped hole
Mounting Torque: 24 in-lbs (2,9 N-m)
Output Connector: 3-Pin, MIL-C-5015
Cabling: ***Mating Connector:*** Amphenol 97-3106A-10SL-4S
Recommended Cable: Three conductor shielded, Teflon jacket, 30 pF/ft; 100 pF/m

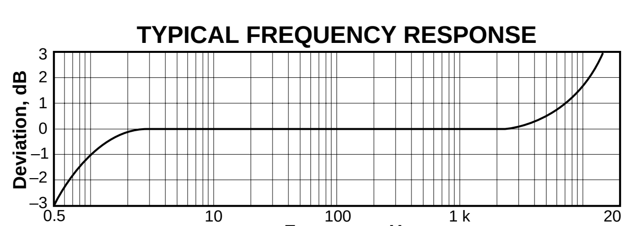
Accessories Supplied

1/4-28 Mounting Stud, Calibration Data.

Accessories Available

Metric Thread Mounting Studs, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.



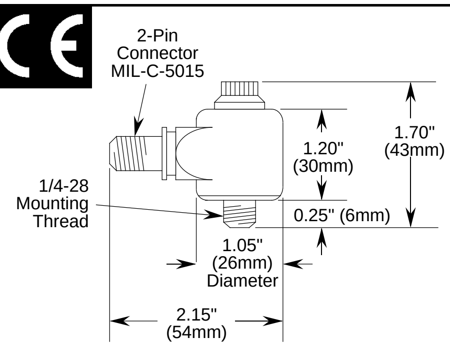


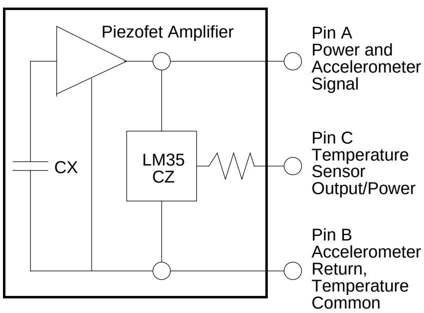
NOTE: *Each channel (acceleration and temperature) requires standard current powering for use with multiplexed sensors and data collector voltage inputs. Common leads are connected together inside the sensor.*

CMSS 797T-1 Low Profile, Industrial IsoRing® Accelerometer with Internal Temperature Sensor

Features

- ***Measures both temperature and acceleration***
- ***Rugged general purpose***
- ***Corrosion resistant***
- ***Hermetically sealed***
- ***Ground isolated***
- ***ESD protection***
- ***Miswiring protection***





CMSS 797T Block Diagram

Specifications

DYNAMIC

Sensitivity: ± 5% of 100 mV/g; at +77°F (+25°C)
Acceleration Range: 80 g peak
Amplitude Nonlinearity: 1%
Frequency Response, Nominal: ± 5%; 3.0–5,000 Hz
± 10%; 2.0–7,000 Hz
± 3 dB; 1.0–12,000 Hz
Resonance Frequency: 26 kHz
Transverse Sensitivity, Maximum: 5% of axial
Temperature Response: See graph

Wiring Scheme

Connector Pin	Function	Cable Conductor Color
Shell	Ground via Sensor	- - -
A	Accelerometer Power and Signal	Red
B	Accelerometer Return, Temperature Common	Black
C	Temperature Sensor Signal and Power	White

Temperature Sensor:
Temperature Output Sensitivity: ± 5% of 10 m Vdc/Kelvin
Temperature Measurement Range: -58°F to +248°F (+223°K to +393°K)

ELECTRICAL

Power Requirement: ***Voltage Source(note 1):*** 18–30 VDC
Current Regulating Diode(notes 1,2): 2–10 mA
Electrical Noise: 2 Hz; 15 µg/√Hz
Output Impedance, Maximum: 100 Ω
Bias Output Voltage, Nominal: 12 VDC
Grounding: Case isolated, internally

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 500 g peak
Shock Limit: 5,000 g peak
Electromagnetic Sensitivity, equivalent g: 30 µg/Gauss
Base Strain Sensitivity, Maximum: 0.002 g/µstrain

PHYSICAL

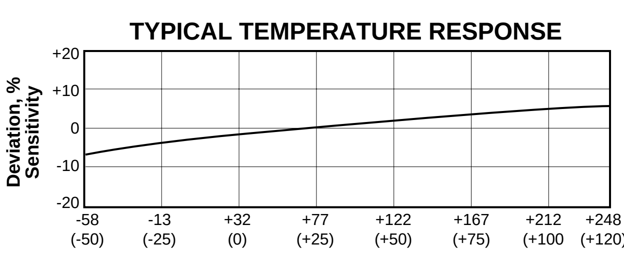
Weight: 135 grams
Case Material: 316L stainless steel
Mounting: 1/4-28 UNF captive screw
Mounting Torque: 30 in-lbs (3,4 N-m)
Output Connector: 3-Pin, MIL-C-5015
Cabling: ***Mating Connector:*** Amphenol 97-3106A-10SL-3S
Recommended Cable: Three conductor shielded, Teflon jacket, 30 pF/ft; 100 pF/m

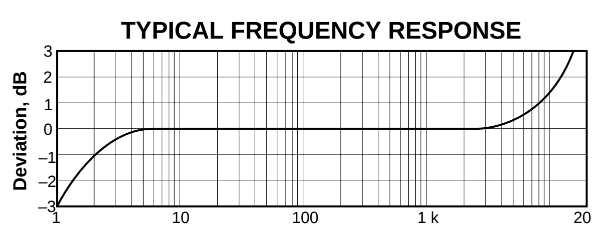
Accessories Supplied

1/4-28 Captive Screw, Calibration Data.

Accessories Available

M6 Captive Screw, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.



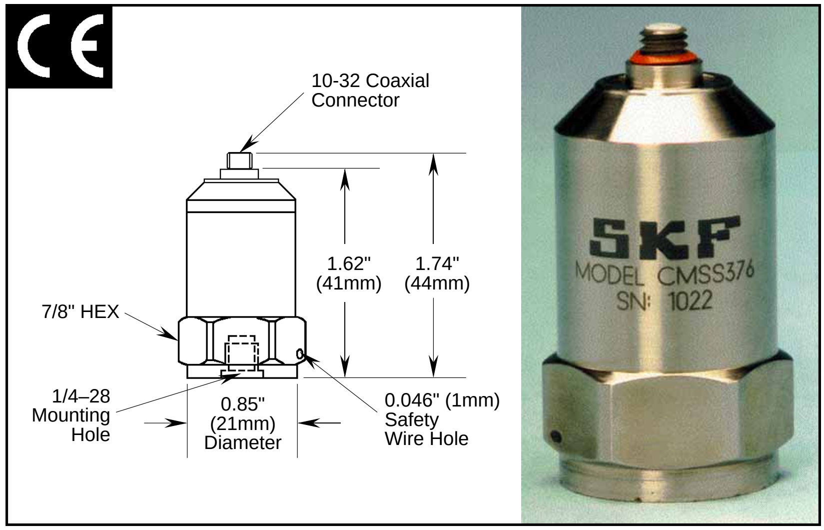


NOTES: *1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).*
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

CMSS 376 High Temperature Accelerometer

Features

- ***Operates Up to +500°F (+260°C)***
- ***Intrinsic safety certified option***
- ***Charge output***
- ***Hermetically sealed***
- ***Ground isolated***
- ***Industrial ruggedness***



Specifications

DYNAMIC

Sensitivity: +500°F (+25°C), nominal, 25 pC/g
Amplitude Nonlinearity, to 250 g: 1%
Frequency Response*(note 1)*: ± 5%; 3.0–7,000 Hz
± 10%; 2.0–10,000 Hz
± 3 dB; 1.0–13,000 Hz
Resonance Frequency: 32 kHz
Transverse Sensitivity, Maximum: 7% of axial
Temperature Response: See graph

ELECTRICAL

Capacitance, nominal*(note 2)*: 500 pF
Resistance, minimum: 1,000 MΩ
Grounding: Case Isolated

ENVIRONMENTAL

Temperature Range: -58°F to +500°F (-50°C to +260°C)
Vibration Limit: 500 g peak
Shock Limit: 5,000 g peak
Base Strain Sensitivity, Maximum: 0.002 g/µstrain
Humidity Limit: 100% relative

PHYSICAL

Weight: 75 grams
Case Material: stainless steel
Mounting: 1/4-28 tapped hole
Mounting Torque: 24 in-lbs (2,9 N-m)
Output Connector: 10-32 coaxial
Cabling: ***Mating Connector:*** R1 (Microdot 10-32)
Recommended Cable: J3, low noise, Teflon jacket, 30 pF/ft; 100 pF/m

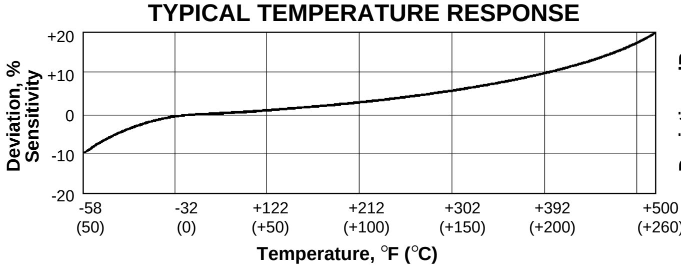
Accessories Supplied

1/4-28 Mounting Stud, Calibration Data.

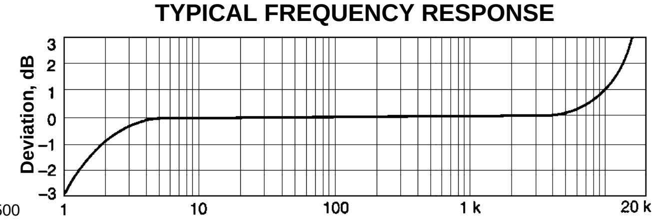
Accessories Available

Magnetic Mounting Bases, Metric Thread Mounting Studs, Cementing Studs, Cable Assemblies, Power Supplies.

TYPICAL TEMPERATURE RESPONSE



TYPICAL FREQUENCY RESPONSE

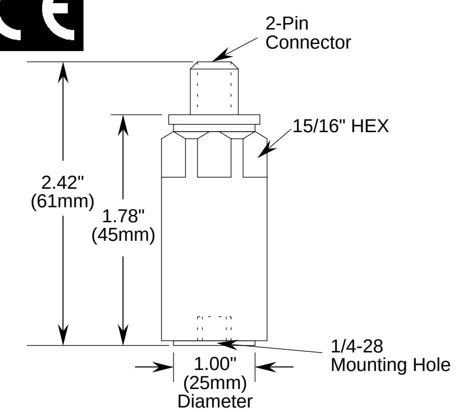


NOTES: *1. As measured through a CMSS 628 charge amplifier.*
2. Tested at output connector.

CMSS 793L Low Frequency Piezoelectric Accelerometer

Features

- ***High sensitivity***
- ***Ultra low-noise electronics for clear signals at very low vibration levels***
- ***Filtered to attenuate high frequencies***
- ***Hermetically sealed***
- ***ESD protection***
- ***Miswiring protection***



Agency Approved Models

CMSS 793L-CA Canadian Standards

CMSS 793L-FM Factory Mutual

C US
Approved

CSA FM

Specifications

DYNAMIC

Sensitivity: ± 5% of 500 mV/g; at +77°F (+25°C)
Acceleration Range: 10 g peak
Amplitude Nonlinearity: 1%
Frequency Response, Nominal: ± 5%; 0.6–700 Hz
± 10%; 0.4–1,000 Hz
± 3 dB; 0.2–2,300 Hz
Resonance Frequency, Mounted, Nominal: 15 kHz
Transverse Sensitivity, Maximum: 5% of axial
Temperature Response: See graph

ELECTRICAL

Power Requirements: ***Voltage Source*** (note 1)**:** 18–30 VDC
Current Regulating Diode (notes 1, 2)**:** 2–10 mA
Electrical Noise: 2 Hz; 1.8 µg/√Hz
Output Impedance, Maximum: 100 Ω
Bias Output Voltage, Nominal: 10 VDC
Turn-On Time: 7 seconds (BOV within 15% of nominal and satisfactory for taking readings)
Grounding: Case isolated, internally shielded

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 250 g peak
Shock Limit: 2,500 g peak
Electromagnetic Sensitivity, equivalent g: 20 µg/Gauss
Sealing: Hermetic
Base Strain Sensitivity, Maximum: 0.0001 g/µstrain

PHYSICAL

Weight: 142 grams
Case Material: 316L stainless steel
Mounting: 1/4-28 UNF tapped hole
Mounting Torque: 24 in-lbs (2,9 N-m)
Output Connector: 2-Pin, MIL-C-5015
Connections: Pin A Signal/Power
Pin B Common
Cabling: ***Mating Connector:*** Amphenol 97-3106A-10SL-4S
Recommended Cable: Two conductor shielded, Teflon jacket, 30 pF/ft; 100 pF/m

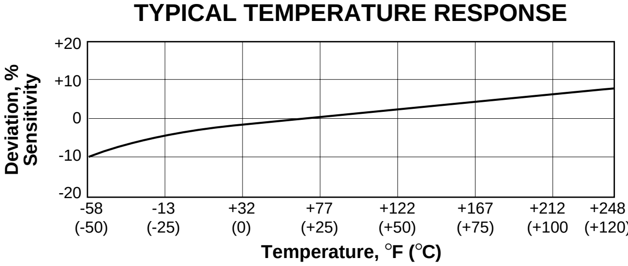
Accessories Supplied

1/4-28 Mounting Stud, Calibration Data.

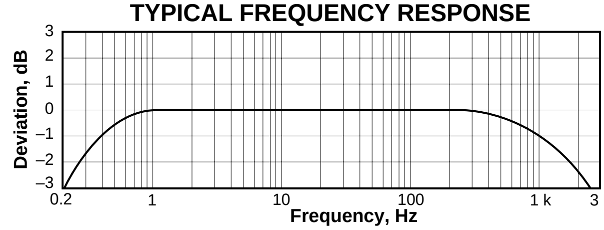
Accessories Available

Metric Thread Mounting Studs, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.

TYPICAL TEMPERATURE RESPONSE



TYPICAL FREQUENCY RESPONSE

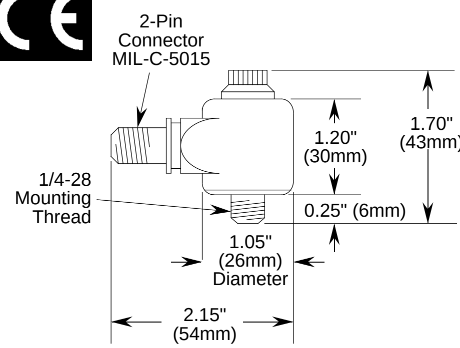


NOTES: *1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).*
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

CMSS 797L Low Profile, Low Frequency, Industrial IsoRing® Piezoelectric Accelerometer

Features

- ***High sensitivity***
- ***Ultra low-noise electronics for clear signals at very low vibration levels***
- ***Low frequency capable***
- ***Filtered to eliminate high frequencies***
- ***ESD protection***
- ***Miswiring protection***



Specifications

DYNAMIC

Sensitivity: ± 5% of 500 mV/g; at +77°F (+25°C)
Acceleration Range: 10 g peak
Amplitude Nonlinearity: 1%
Frequency Response, Nominal: ± 5%; 0.6–850 Hz
± 10%; 0.4–1,500 Hz
± 3 dB; 0.2–3,700 Hz
Resonance Frequency: 18 kHz
Transverse Sensitivity, Maximum: 7% of axial
Temperature Response: See graph

ELECTRICAL

Power Requirement: ***Voltage Source***(note 1)**:** 18–30 VDC
Current Regulating Diode(notes 1, 2)**:** 2–10 mA
Electrical Noise: 2 Hz; 2 μg/√Hz
Output Impedance, Maximum: 100 Ω
Bias Output Voltage, Nominal: 10 VDC
Turn-On Time: 5 seconds (BOV within 15% of nominal and satisfactory for taking readings)
Grounding: Case isolated, internally shielded

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 250 g peak
Shock Limit: 2,500 g peak
Electromagnetic Sensitivity, equivalent g: 5 μg/Gauss
Sealing: Hermetic
Base Strain Sensitivity, Maximum: 0.001 g/μstrain

PHYSICAL

Weight: 148 grams
Case Material: 316L stainless steel
Mounting: 1/4-28 UNF captive screw
Mounting Torque: 30 in-lbs (3,4 N-m)
Output Connector: 2-Pin, MIL-C-5015
Connections: Pin A Signal/Power
Pin B Common
Cabling: ***Mating Connector:*** Amphenol 97-3106A-10SL-4S
Recommended Cable: Two conductor shielded, Teflon jacket, 30 pF/ft; 100 pF/m

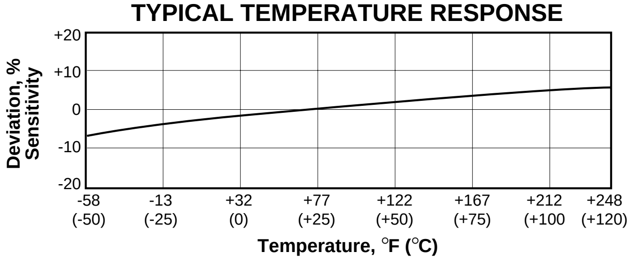
Accessories Supplied

1/4-28 Captive Screw, Calibration Data.

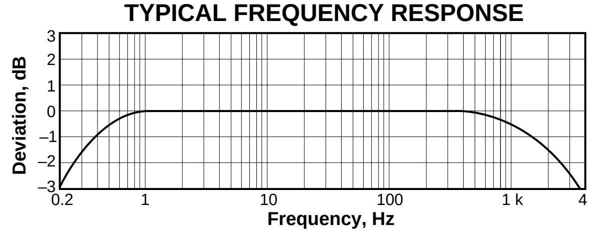
Accessories Available

M6 Captive Screw, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.

TYPICAL TEMPERATURE RESPONSE



TYPICAL FREQUENCY RESPONSE

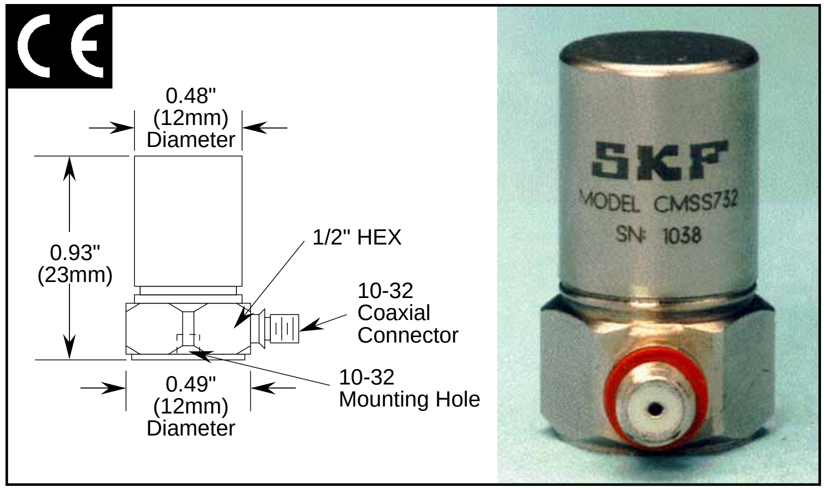


NOTES: *1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).*
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

CMSS 732A High Frequency Accelerometer

Features

- ***Wide dynamic range***
- ***Compact construction to fit in tight spaces***
- ***Wide frequency range***
- ***Small size, lightweight***
- ***Hermetically sealed***



Specifications

DYNAMIC

Sensitivity: ± 5% of 10 mV/g; at +77°F (+25°C)
Acceleration Range*(note 1)*: 500 g peak
Amplitude Nonlinearity: 1%
Frequency Response: ± 5%; 2.0–15,000 Hz
± 3 dB; 0.5–25,000 Hz
Resonance Frequency, Mounted, Nominal: 60 kHz
Transverse Sensitivity, Maximum: 5% of axial
Temperature Response: See graph

ELECTRICAL

Power Requirement: ***Voltage Source(note 1):*** 18–30 VDC
Current Regulating Diode(notes 1, 2): 2–10 mA
Electrical Noise: 2 Hz; 126 µg/√Hz
Output Impedance, Maximum: 100 Ω
Bias Output Voltage: 10 VDC
Grounding: Case Grounded

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 500 g peak
Shock Limit: 5,000 g peak
Electromagnetic Sensitivity, equivalent g: 100 µg/Gauss
Base Strain Sensitivity, Maximum: 0.005 g/µstrain

PHYSICAL

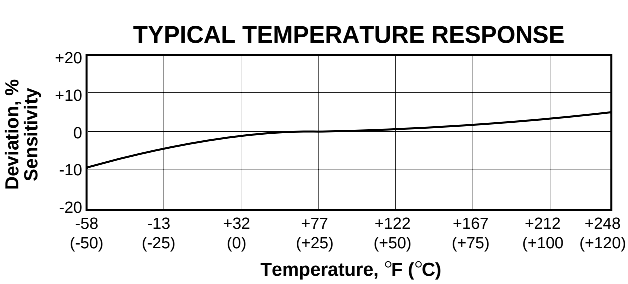
Weight: 13 grams
Material: 316L stainless steel
Mounting: 10/32 UNF tapped hole
Mounting Torque: 20 in-lbs (2,3 N-m)
Output Connector: 10-32 coaxial (female)
Cabling: ***Mating Connector:*** 10-32 coaxial
Recommended Cable: Coaxial, Teflon jacket, 30 pF/ft; 100 pF/m

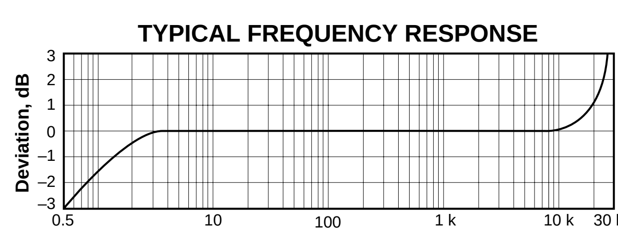
Accessories Supplied

10-32 Mounting Stud, Calibration Data.

Accessories Available

Metric Thread Mounting Studs, Cementing Studs, Magnetic Mounting Bases, Isolating Studs.



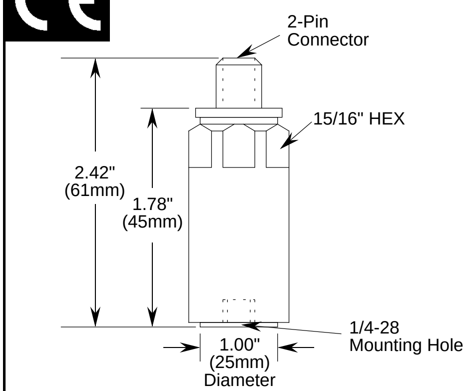


NOTES: *1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).*
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

CMSS 793V Piezoelectric Velocity Transducer

Features

- ***Industrial ruggedness***
- ***Eliminates distortion caused by high frequency signals***
- ***Corrosion-resistant***
- ***Internally integrated to velocity***
- ***Ultra low-noise electronics for clear signals at very low vibration levels***
- ***Miswiring protection***



Agency Approved Models

CMSS 793V-EE EECS (BASEEFA)

CMSS 793V-CA Canadian Standards

CMSS 793V-FM Factory Mutual

EECS (BASEEFA) | CSA | Approved FM

Specifications

DYNAMIC

Sensitivity: ± 10% of 100 mV/in/sec; at +77°F (+25°C)
Velocity Range: 50 in/sec peak
Amplitude Nonlinearity: 1%
Frequency Response: ± 10%; 2.0–3,500 Hz
± 3 dB; 1.5–7,000 Hz
Resonance Frequency, Mounted, Nominal: 15 kHz
Transverse Sensitivity, Maximum: 5% of axial
Temperature Response: See graph

ELECTRICAL

Power Requirement: ***Voltage Source*** *(note 1)*: 18–30 VDC
Current Regulating Diode *(notes 1, 2)*: 2–10 mA
Electrical Noise: 2 Hz; 100 µin/sec/√Hz
Absolute Phase Shift, Nominal, the greater of: tan-1 2/f or 2°
Output Impedance, Nominal 4 mA Supply, the greater of: 5,000/f or 200 Ω
Bias Output Voltage, Nominal: 10 VDC
Grounding: Case isolated, internally shielded

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 250 g peak
Shock Limit: 2,500 g peak
Electromagnetic Sensitivity, equivalent in/sec: 25 µin/sec/Gauss
Sealing: Hermetic
Base Strain Sensitivity, Maximum: 0.0005 in/sec/µstrain

PHYSICAL

Weight: 145 grams
Case Material: 316L stainless steel
Mounting: 1/4-28 UNF tapped hole
Mounting Torque: 24 in-lbs (2,9 N-m)
Output Connector: 2-Pin, MIL-C-5015
Connections: Pin A Signal/Power
Pin B Common
Cabling: ***Mating Connector:*** Amphenol 97-3106A-10SL-4S
Recommended Cable: Two conductor shielded, Teflon jacket, 30 pF/ft; 100 pF/m

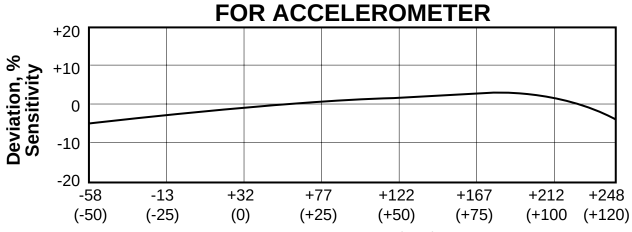
Accessories Supplied

1/4-28 Mounting Stud, Calibration Data.

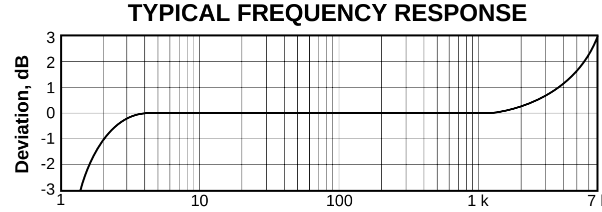
Accessories Available

Metric Thread Mounting Studs, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.

TYPICAL TEMPERATURE RESPONSE FOR ACCELEROMETER



TYPICAL FREQUENCY RESPONSE

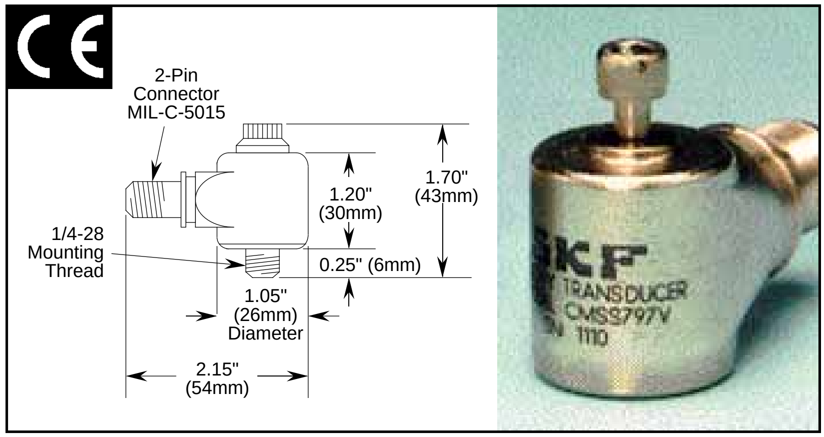


NOTES: 1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

CMSS 797V Industrial IsoRing® Velocity Accelerometer

Features

- ***Industrial ruggedness***
- ***Eliminates distortion caused by high frequency signals***
- ***Corrosion-resistant***
- ***Internally integrated to velocity***
- ***Ultra low-noise electronics for clear signals at very low vibration levels***
- ***ESD protection***
- ***Miswiring protection***



Specifications

DYNAMIC

Sensitivity: ± 10% of 100 mV/in/sec; at +77°F (+25°C)
Velocity Range: 50 in/sec peak; 1,270 mm/sec peak
Amplitude Nonlinearity: 1%
Frequency Response:
± 10%; 2.0–3,500 Hz
± 3 dB; 1.6–7,000 Hz
Resonance Frequency: 18 kHz
Transverse Sensitivity, Maximum: 5% of axial
Temperature Response: See graph

ELECTRICAL

Power Requirement: ***Voltage Source(note 1):*** 18–30 VDC
Current Regulating Diode(note 1,2): 2–10 mA
Electrical Noise: 2 Hz; 100 µin/sec/√Hz
Output Impedance, Nominal 4 mA Supply, the Greater of: 5,000/f or 200 Ω
Bias Output Voltage, Nominal: 10 VDC
Grounding: Case isolated, internally shielded

ENVIRONMENTAL

Temperature Range: -58°F to +248°F (-50°C to +120°C)
Vibration Limit: 250 g peak
Shock Limit: 2,500 g peak
Electromagnetic Sensitivity, equivalent g: 50 µin/sec/Gauss
Base Strain Sensitivity: 0.004 in/sec/µstrain
Sealing: Hermetic

PHYSICAL

Weight: 148 grams
Case Material: 316L stainless steel
Mounting: 1/4-28 UNF captive screw
Mounting Torque: 30 in-lbs (3,4 N-m)
Output Connector: 2-Pin, MIL-C-5015
Pin A Signal/Power
Pin B Common
Cabling: ***Mating Connector:*** Amphenol 97-3106A-10SL-4S
Recommended Cable: Two conductor shielded, Teflon jacket, 30 pF/ft; 100 pF/m

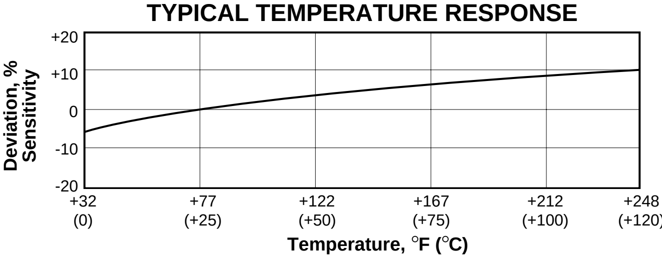
Accessories Supplied

1/4-28 Captive Screw, Calibration Data.

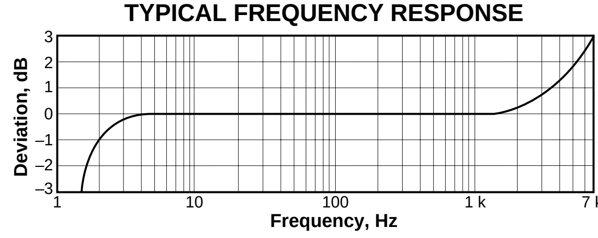
Accessories Available

M6 Captive Screw, Splash-proof Cable Assembly, Magnetic Mounting Bases, Cementing Studs.

TYPICAL TEMPERATURE RESPONSE



TYPICAL FREQUENCY RESPONSE



NOTES: 1. To minimize the possibility of signal distortion when driving long cables with high vibration signals, +24 to +30 VDC powering is recommended. A higher level constant current source should be used when driving long cables (please consult the Manufacturer).
2. A maximum current of 6 mA is recommended for operating temperatures in excess of +212°F (+100°C).

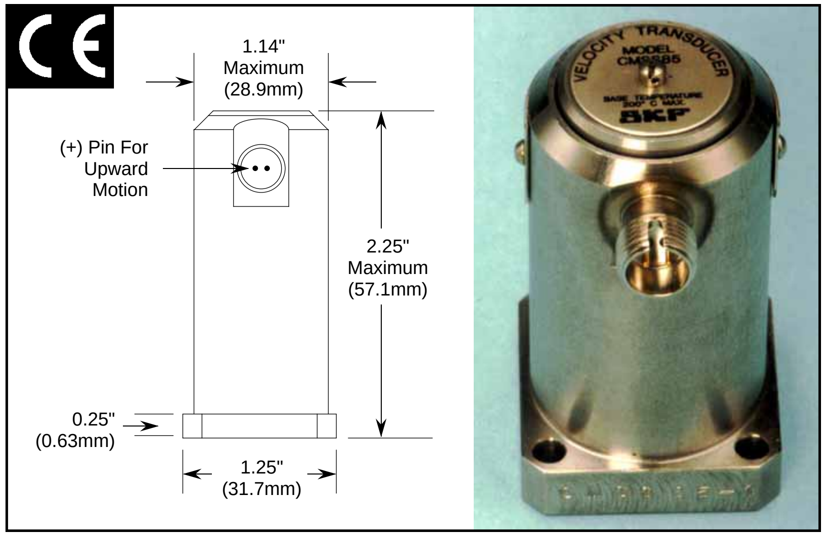
CMSS 85 Series High Temperature Inductive Velocity Transducer

CMSS 85-7 (+392°F/+200°C)

CMSS 85-8 (+392°F/+200°C)

CMSS 85-9 (+707°F/+375°C)

CMSS 85-10 (+707°F/+375°C)



Features

- ***Ideal for Gas Turbine Engines***
- ***Zero Friction Coil***
- ***OEM Standard***
- ***Hermetically sealed***
- ***Approval for Class I, Division 1, Groups A, B, C, D***

Utilizing a zero friction coil suspension, these high temperature velocity transducers provide accurate and repeatable vibration measurements over a wide range of amplitude and frequency. The transducers are constructed of thermally resistant materials which allow for continuous operation at temperatures up to +392°F (+200°C) or +707°F (+375°C) depending on the model selected.

The coil bobbin is suspended by two non-twisting, circular “spider” springs that provide a clean frequency response free of spurious resonances, from 15 Hz to 2,000 Hz. The damping is electromagnetic and purely viscous. Friction prone air damping is not employed. The acceleration threshold is virtually zero, thereby allowing the detection of extremely small vibration at low frequencies.

The velocity transducers are available with an integral 10 feet (3 meters) armored cable or with a 2-pin connector. Separate cables, armored and unarmored are also available. The sealed stainless steel case and rugged internals ensure durability in the most hostile environments.

The sensitive axis of the transducer can be mounted in any direction.

Specifications

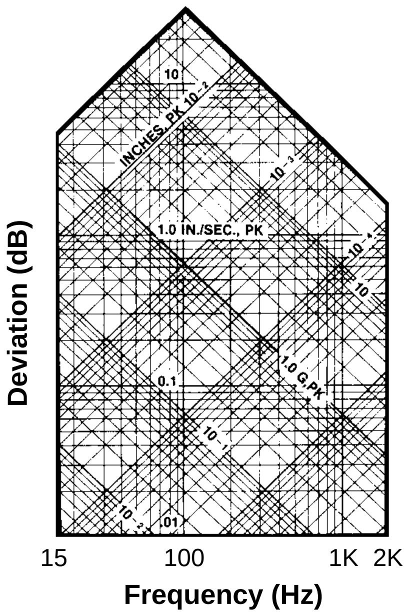
Axis Orientation: Any
Sensitivity: 145 mV/in/sec (5.71 mV/mm/sec), ± 5%
Sensitivity vs. Temperature: Less than 0.01%/°F (0.02%/°C)
Cross Axis Sensitivity: Less than 10%
Temperature Limits: See Temperature Range Table
Frequency Range: 15 Hz to 2,000 Hz
Displacement Limits: 0.07 inches pk-pk, (1.8mm) pk-pk
Acceleration Limits: 0 to 50 g’s
Damping (Electromagnetic): At +68°F (+20°C): 0.8
At +392°F (+200°C): 0.55
At +707°F (+375°C): 0.4
Case to Coil Isolation: At +68°F (+20°C): 100 megohms minimum
At +392°F (+200°C): 10 megohms minimum
At +707°F (+375°C): 1.0 megohm minimum
Case Material: Stainless Steel
Sealing: Hermetic
Weight: 7.5 oz. (0.21 kg)

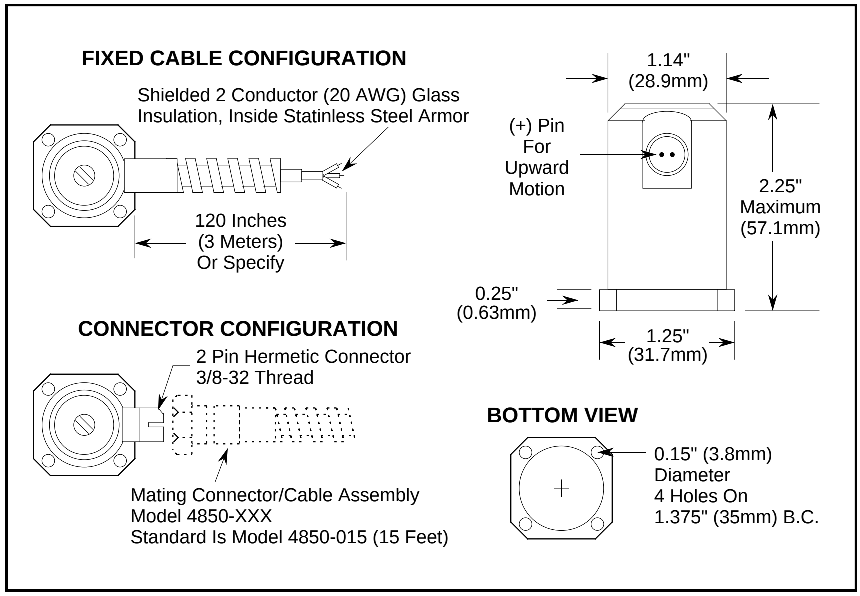
Temperature Range

Model Number	Temperature Range	Coil Resistance	Termination
CMSS 85-7	-65°F to +392°F (-54°C to +200°C)	550 ohms	2-Pin Hermetic Sealed Connector
CMSS 85-8	-65°F to +392°F (-54°C to +200°C)	550 ohms	Integral Cable, 10 feet (3 meters)
CMSS 85-9	-65°F to +707°F (-54°C to +375°C)	125 ohms	2-Pin Hermetic Sealed Connector
CMSS 85-10	-65°F to +707°F (-54°C to +375°C)	125 ohms	Integral Cable, 10 feet (3 meters)

CMSS 85 Series High Temperature Inductive Velocity Transducer

RESPONSE LIMITS





Cables

CMSS 4850-015: Armored 15 feet cable (4.6 meters) that mates to CMSS 85-7 and CMSS 85-9 Velocity Transducers with the 2-pin connector.

CMSS 4850-015-593: Unarmored 15 feet (4.6 meters) cable with only 2 feet of the cable having armor at the velocity transducer end of the cable. This cable mates to the CMSS 85-7 and CMSS 85-9 Velocity Transducers with the 2-pin connector.

The 015 in the model number of the cables designates the cable length. If other cable lengths are desired specify the length in feet, (i.e. 020, 025 etc.). It is preferred that cable lengths be ordered in increments of 5 feet (1.51 meter), (i.e. 015, 020, 025 etc.).

The termination of the cable end opposite that mating to the velocity transducer is trimmed wire only.

The cable mating connectors are custom designed and proprietary assembled by the vendor and consequently are not available for on-site cable fabrication.

CMSS 603A-1 and CMSS 603A-3 Power Supply Units

Features

- ***CMSS 603A-1 has one channel***
- ***CMSS 603A-3 has three channels***
- ***Powers most CMSS 700 Series accelerometers***
- ***Battery powered***
- ***Uses common 9 VDC batteries***
- ***Can drive up to 50 feet (15 meters) of cable***

Specifications

INPUT CHARACTERISTICS

Voltage to Transducer: 27 VDC
Current to Transducer: 2.4 mA DC, ± 20%
Maximum Input Voltage: 10 V RMS

OUTPUT CHARACTERISTICS

Output Impedance (accelerometer attached to input): Same as transducer
Recommended Load Impedance: >100 kΩ

TRANSFER CHARACTERISTICS

Frequency Response: Same as transducer
Channels: ***CMSS 603A-1:*** 1
CMSS 603A-3: 3
Channel Separation: ***CMSS 603A-1:*** Not applicable
CMSS 603A-3: >80 dB

BATTERY TEST CIRCUIT

LED Lights: >18 VDC
Battery Life: ***CMSS 603A-1:*** >120 hours
CMSS 603A-3: >40 hours

POWER REQUIREMENTS

Batteries: Three (3) 9V alkaline

ENVIRONMENTAL

Temperature Range: +32°F to +131°F (0 to +55°C)

PHYSICAL CHARACTERISTICS

Size: 3.0" (W) x 2.4" (H) x 4.0" (D) [76mm (W) x 61mm (H) x 102mm (D)]
Weight: ***CMSS 603A-1:*** 340 grams
CMSS 603A-3: 380 grams
Connectors: **Signal Input:** BNC
Signal Output: BNC

Accessories Supplied

Three (3) 9V alkaline batteries

Vibration Sensor Installation Considerations

CABLING REQUIREMENTS

Cabling is one of the most important aspects of vibration sensor installation. As with sensors and monitoring equipment, money saved by purchasing inferior components is usually a poor investment. Time and effort to troubleshoot problems related to poor cabling can easily cost several times the cost of the original cable. Furthermore, measurement results can be unreliable and inaccurate, thereby defeating the purpose of the condition monitoring program in the first place. Careful attention must be given to six major considerations: cable type, cable length, routing, grounding, anchoring, and environment.

CABLE TYPE AND CHARACTERISTICS

The type of cable used in conjunction with either a hand-held sensor or a permanently mounted sensor is an important factor in determining the quality of the signals that reach the vibration monitor. But typically the consideration of cable type is more important for permanently mounted sensors since the length of the cable is usually longer and, therefore, exposed to more possible sources of noise.

In general, high quality cable is recommended and can be defined as twisted pair, shielded cable. The sensor power and signal are carried on individuals wires and the cable's shield in grounded at either the sensor or the vibration monitor (see section on Cable Grounding).

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, an isolated mounting pad should be used to break possible ground loops.

– NOTE –

In cases where the monitoring equipment uses an instrumentation amplifier and the sensor is not grounded at the monitor, coaxial cables are not recommended since any type of noise will be picked up on the coaxial cable's shield and amplified along with the signal. It should be emphasized that coaxial cables are not recommended for use with vibration monitors in an industrial environment. They are not rugged enough and are susceptible to noise intrusion as discussed above.

CHARACTERISTIC IMPEDANCE

For monitoring vibration at higher frequencies or for applications requiring a cable to carry a signal over a long distance with minimum loss and distortion, the characteristic impedance is possibly the most important cable parameter. The characteristic impedance, Z_o is the combined resistive and reactive components of the cable's resistance to the flow of electrons. Its value depends on the type of conductors, their size, spacing, whether (and how tightly) they are twisted together and the type and amount of insulating material used.

If there is a substantial mismatch between the characteristic impedance of the transducer and the cable, or the cable and the monitoring system, an electrical reflection will occur at the point of the impedance mismatch. This electrical reflection will distort both signal strength and quality. Additionally, if there is a lack of control in the manufacture of the cable then Z_o can vary over the length of the cable causing electrical reflections, distortion, and reduction in signal integrity within the cable itself.

For these reasons it is important to use high quality cable which is matched to both the transducer and the monitoring system. With SKF sensors and monitoring equipment, best results will be obtained with signal cable having a characteristic impedance of 120 ohms.

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 30–45 picofarads per feet (100–130 picofarads per meter), depending on the cable construction. After the cable length has been determined, its effect on the sensor operation should be evaluated. Capacitive loading attenuates the high frequency output of accelerometers.

– NOTE –

Cable lengths for velocity transducers are less important since they are employed at low frequencies and contain filtering of acceleration components.

The use of high quality, twisted pair(s), shielded cable can greatly improve the quality and reliability of vibration measurements, together with permitting the use of longer cable runs in the installation. For example, a twisted pair, shielded cable with < 20 pF/ft (< 60 pF/m) with 100 ohms impedance can be run for twice the distance of a standard cable with twice the capacitance.

AMPLITUDE RANGE VERSUS CABLE CAPACITANCE

When the amplifier drives a long cable, its performance is limited by the current available from the Constant Current Diode (CCD) to charge the cable capacitance at high frequencies. This limits the amount of voltage swing from the amplifier and may reduce the high frequency amplitude range. The reduction of the amplitude range increases the sensor's susceptibility to high frequency amplifier overload. This will cause signal distortion and produce erroneous signals at low frequencies. Sources of high frequency overload could be gear impacts or the broadband hiss of a steam release valve. Most SKF sensors are protected from distortion caused by moderate overloads.

SUMMARY OF RECOMMENDED CABLE CHARACTERISTICS

The recommended cable characteristics can be summarized as follows:

Type: Twisted pair(s), shielded

Capacitance across leads: < 20 picofarads/feet (60 pF/m)

Impedance: 120 ohms for signal cable

Wire gauge: 20–24 AWG (American Wire Gauge)

Shield type: Braided or foil

Insulation material: As required by operating environment. Teflon has a higher temperature tolerance. Tefzel is recommended where fire retardation properties and radiation resistant cables are needed.

POWERING VERSUS CABLE LENGTH

Proper powering will reduce signal distortion in long cable applications. It is recommended that for cable lengths over 100 feet (30 meters), the constant current source should be 6 to 10 mA. In addition, the voltage source should be no less than 24 V for maximum amplitude range. Even when using very short cables, the current source should be increased if amplifier overload signals are present or suspected.

– NOTE –

For most industrial applications, cable lengths of 300-450 feet (100-150 meters) are normally acceptable, as long as the sensor is not mounted on a structure with high level vibrations.

– NOTE –

For European installations of Sensors and Local Monitoring Units (LMU's) the customer is referred to the CMMA 320 EMA Installation Manual available from the SKF Zaltbommel, The Netherlands Office.

CABLE ROUTING AND ELECTROMAGNETIC INTERFERENCE

Walkie-talkies, power lines, or even electrical sparks may cause signal interference. The following guidelines will eliminate many measurement errors due to electromagnetic interference and electrostatic discharge (ESD).

Assure that high quality, well shielded cables are used. In such environments 100% shield coverage is necessary. If cable splices are made, complete shielding continuity must be maintained.

Proper cable routing is imperative. Never run sensor cable alongside AC power lines; cables must cross AC power lines at right angles 3 feet (1 meter) away from the power line. Where possible, provide a separate grounded conduit to enclose the sensor cable. In addition, route the cable away from radio transmission equipment, motors/generators, transformers and other high current charging conductor.

Finally, avoid routing the cable through areas prone to ESD except in applications where it is unavoidable. For example, in the area around a paper machine ESD can not be escaped. Even though SKF sensors are protected against ESD failure, temporary signals distortion may appear at the monitor. Such signals usually appear as an overload or a “ski-slope” shaped FFT.

CABLE GROUNDING AND GROUND LOOPS

The purpose of having one or more shields around a pair of signal lines is to reduce the coupling between the shielded signal line and other signal lines and to reduce the intrusion of external noise. Doing so protects the strength and fidelity of the signal of interest.

Grounding of shields, and the way in which they are grounded, has a dramatic effect on their effectiveness. An improperly grounded shield may actually be worse than no shield at all. In order to provide proper shielding and prevent ground loops, cable grounding should be carefully considered. Ground loops are developed when a common line (signal return/shield) is grounded at two points of differing electrical potential. (See Figure 6.)

For sensors using two conductor/shielded cable, the signal and power are carried on one lead and the signal return on the other. The cable shield serves to protect the signal

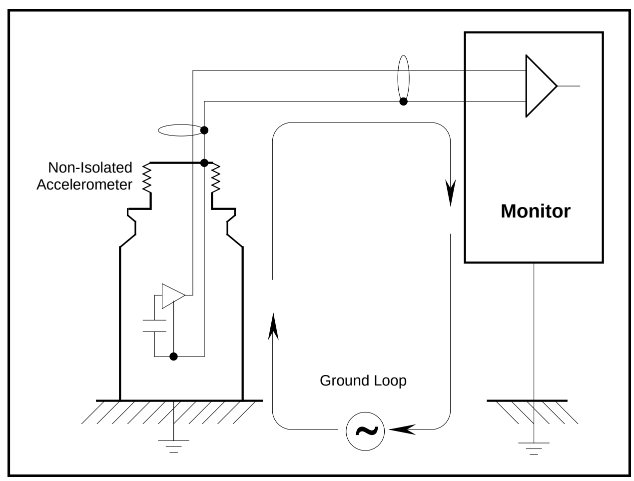


Figure 6. Ground loop from improper grounding.

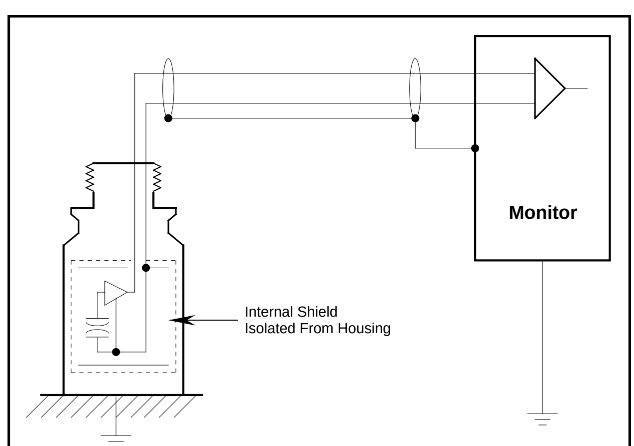


Figure 7. Grounding at the Monitor.

from ESD and electromagnetic interference (EMI). The shield should be grounded at only one point, normally either to the monitor or to the sensor housing. All SKF monitors are designed to accommodate grounding of the sensor cable shield at the monitor. (See Figure 7). In cases where it is either impractical or impossible to establish a ground at the monitor, it is acceptable to ground at the sensor–provided the sensor design allows for such a grounding scheme.

– NOTE –

Sensors mounted in Hazardous area's and equipped with a Zener barrier, may not be grounded at sensor side.

If the machine being monitored is well grounded and the transducer has a case terminal, the shield can be connected there. If the machine is not well grounded, or if there is no terminal available on the transducer, the shield should be connected to a good electrical ground point at the machine. However, if a junction box is used at the machine being monitored, it is acceptable practice to leave the shields open at the transducers and electrically connect all of the shields together in the junction box. A ground wire should then be run from the "daisy chained" shields to a good electrical ground at the machine being monitored.

Some cables contain more than one individually shielded signal pair with the entire cable enclosed by an overall shield. In this case the recommended practice is to ground the individual shields at the transducer and leave them open at the monitor. The overall shield should then be grounded at the monitor and left open at the transducers. If a junction box is used, the overall shield must be electrically continuous through the junction box and not connected to the other shields.

If, when grounding at the sensor, EMI signals are found to affect the vibration signal, a filtering capacitor (0.01 µF, 200 V low loss) should be placed between the shield and the grounded monitor. This capacitor prevents the passage of low frequency ground currents, yet diverts high frequency EMI signals to ground. (See Figure 8.)

Sources producing high levels of electromagnetic noise (such as radio transmitters, static discharge, and motor bush arcing) may require a cable with dual isolated shields. In this configuration, the outer shield is grounded to the sensor housing. The inner shield, which is electrically isolated from the outer, is grounded to the monitor. The double

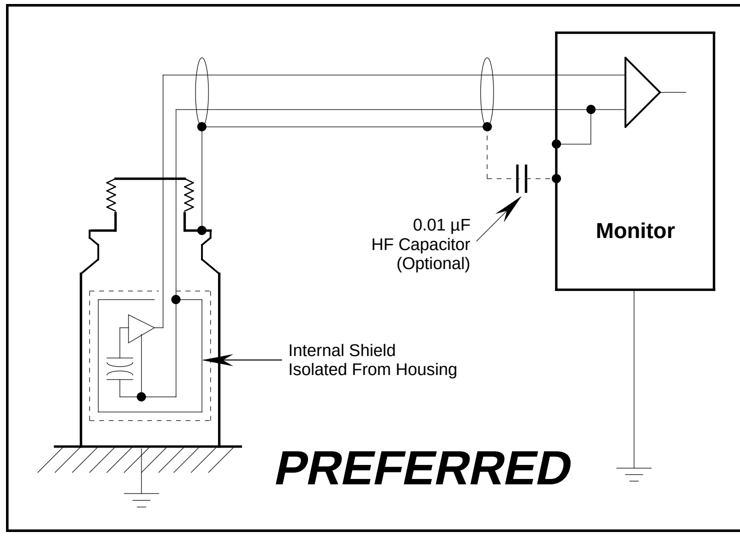


Figure 8. Multiconductor/shield configuration.

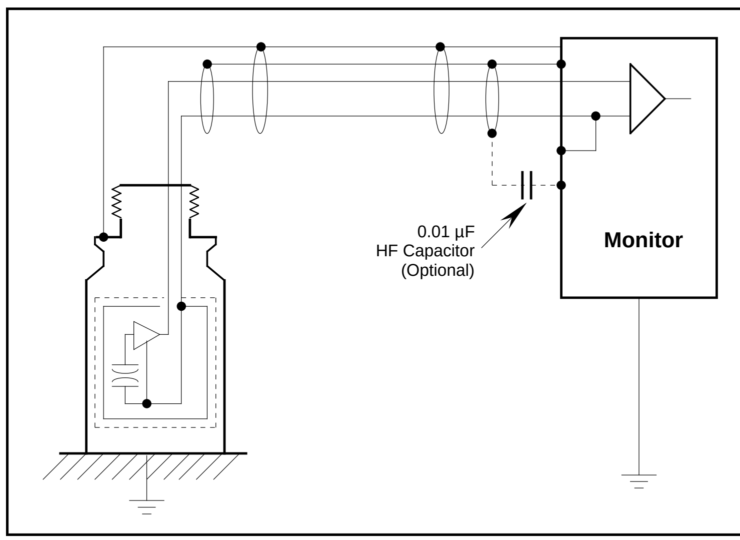


Figure 9. Dual isolated shield configuration.

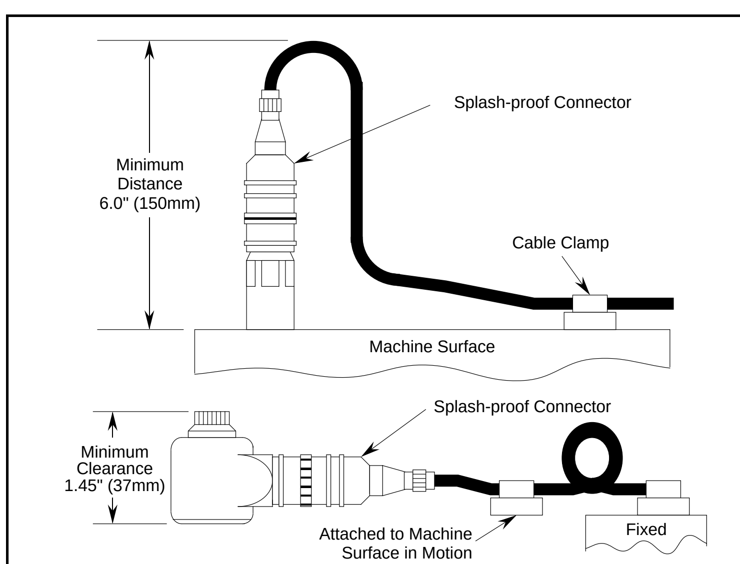


Figure 10. Cable anchoring.

shielding allows electrical charges impressed on the cable to be attenuated twice to minimize influence on the vibration signal. Similar to the previous configuration, it is recommended that a capacitor (0.01 µF, 200 V low loss) be placed in the terminal box between the inner and outer shields to maximize this protection. (See Figure 9.)

– NOTE –

In all cases it is very important that the cable shield be properly grounded. Failure to do so in high EMI / ESD environments can result in damage to the sensor electronics.

CABLE ANCHORING

The cable should be anchored to reduce stress at the cable terminations. When securing the cable, leave just enough slack to allow free movement of the accelerometer. Failure to leave enough slack will cause undo stress on the cable and dramatically influence the sensors output. (See Figure 10.)

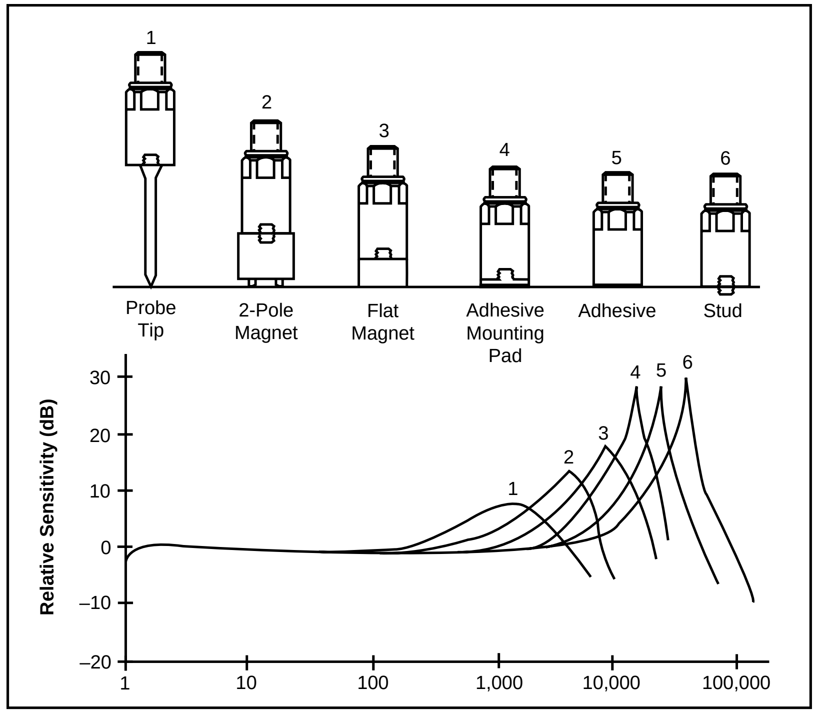


Figure 11. Mounting techniques.

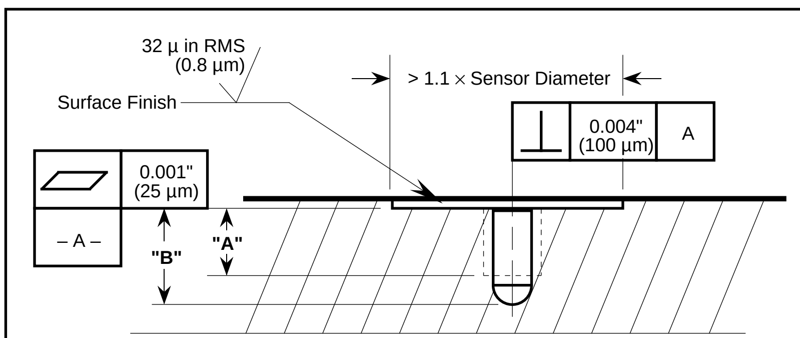
Mounting Requirements

The mounting configuration depends upon the 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 mounting configurations: threaded studs, adhesives, magnets and probe tips (See Figure 11).

STUD MOUNTING

Threaded stud mounting results in the widest frequency measurement range. It is recommended for permanent monitoring systems, high frequency testing, and harsh environments.

The mounting point on the structure 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 0.001" (25 µm) and have surface texture no greater than 32 micro-inches (0.8 µm). The tapped hole must be perpendicular to the mounting surface and at least two threads deeper than the stud. This will prevent a gap between the sensor and the mounting surface, producing optimum frequency response.



Stud	Stud Size	"A" Dimension	"B" Dimension	Torque in-lbs (N-m)
SF1	10-32 UNF	0.188" (4.78mm)	0.250" (6.35mm)	20 (2,3)
CMSS30168700	1/4-28 UNF	0.250" (6.35mm)	0.350" (8.90mm)	24 (2,9)
1/4-28 Captive Screw		0.250" (6.35mm)	0.350" (8.90mm)	30 (3,4)

Figure 12. Stud mounting: surface preparation.

Proper screw 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 12 for recommended nominal mounting torques.

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 be used.

ADHESIVE MOUNTING

If a hole cannot be tapped properly into the machine, an adhesive mount is recommended. When using an

Table 2. Mounting adhesives.

Adhesives	Comments
Loctite Inc.: Number 325 with 707 Activator	Cyanoacrylate adhesive. Single component; sets up quickly; use at temperatures below +200°F (+95°C) and with low humidity. Surface must be clean and smooth. Remove by twisting the sensor.
Lord Chemical Products: Versilok 406	Structural adhesive. Water resistant; useful to +250°F (+120°C); cures to full properties at room temperature in 24 hours.
Hottinger Baldwin Messtechnik: Rapid Adhesive SX	Structural adhesive with short curing time. Temperature range: -328°F to +356°F (-200°C to +180°C). Surface must be cleaned and roughened with medium coarse emery paper (grade 18).

adhesive, the sensor may be directly attached to the machine or onto an adhesive mounting pad. Use of an adhesive mounting pad is recommended if repeated removal of the sensor is required.

– NOTE –

If the circuit grounding scheme requires the sensor case to be grounded to the machine, then the installer must ensure that the adhesive mounting pad is electrically grounded to the machine. If grounding at the adhesive mounting pad is not practical, a suitable option is to place a junction box between the sensor and the monitor. The sensor shields can then be jumpered together and a common ground established at the machine.

The adhesive mounting pad is flat on one side with a threaded stud on the other. After the pad is adhered to the machine, the sensor is torqued onto the stud. A coupling fluid should be applied to the stud face that mates with the sensor.

In order to optimize the frequency response, machine the bonding surface flat within 0.001 inches (25 µm). Following standard adhesive bonding practice is critical to durability. The surfaces should be abraded and carefully cleaned with a solvent. Mixing and application of the adhesive must be in compliance with the adhesive manufacturer. Suggested adhesives are shown in Table 2.

MAGNETIC MOUNTING AND PROBE TIPS

In walk around monitoring programs, magnet mounts and hand-held sensors 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. Because probe tips may have structural resonances in the frequency range of interest, they should be made of steel and should not exceed 6 inches (150mm) length.

Sensitivity Validation

Sensitivity validation is not usually a requirement. For example, the procedure is unnecessary in applications where gross vibrations are being measured and extreme accuracy is not a concern. If high accuracy amplitude measurements are required, sensor calibration should be verified once a year and can normally be done on-site by a qualified technician with vibration generator/shaker device.

It is much better to regularly check or trend:

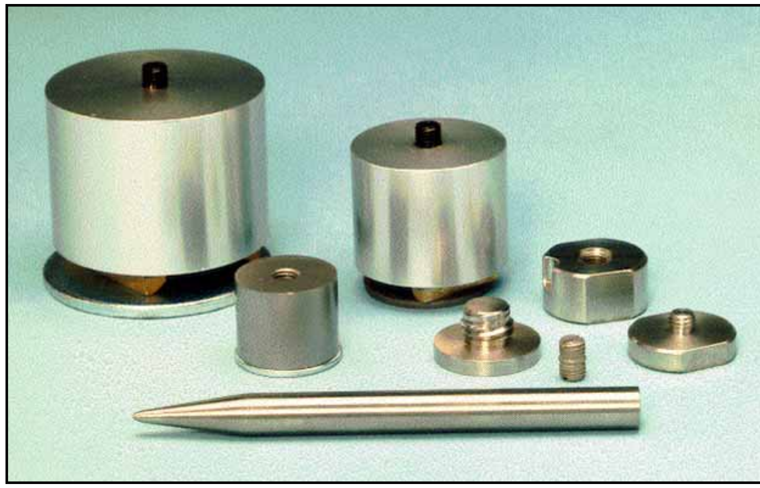
- Bias voltage of accelerometers with built in amplifier.
- Resistance of the inductive velocity meter.

Summary

Vibration sensors are the initial source of machinery information upon which productivity, product quality and personnel safety decisions are based. It is crucial that sensors be properly selected and installed to ensure reliable signal information. Procedures should be implemented to monitor the performance of all measurement channels to further ensure the integrity of the vibration information base. Following this process will increase the effectiveness of your vibration monitoring program and improve productivity of plant personnel and equipment.

Sensor Mounting Accessories

Mounting Hardware



Model CMSS 60139-4 Probe Tip (Stinger)

For hand-held use with sensors having 1/4-28 UNF mounting hole.

Mounting: 1/4-28 UNF Stud
Material: Stainless Steel
Dimensions: 4.50" (114mm) stinger

Model CMSS 30168700 Threaded Mounting Stud (1/4-28 to 1/4-28)

Flanged sensor mounting stud, 1/4-28 thread on both sides.

Material: Stainless Steel
Recommended Mounting Torque: 24 in-lbs (2,9 N-m)
Frequency Response: Proper mounting on clean flat surface can achieve the specified frequency response of sensor.

Model CMSS 30168701 Adaptor Stud (1/4-28 to M8)

Flanged sensor mounting stud, adapts 1/4-28 tapped threads to M8 thread.

Material: Stainless Steel
Recommended Mounting Torque: 24 in-lbs (2,9 N-m)
Frequency Response: Proper mounting on clean flat surface can achieve the specified frequency response of sensor.

Model CMSS 30168703 Adaptor Stud (1/4-28 to M6)

Flanged sensor mounting stud, adapts 1/4-28 tapped threads to M6 thread.

Material: Stainless Steel
Recommended Mounting Torque: 24 in-lbs (2,9 N-m)
Frequency Response: Proper mounting on clean flat surface can achieve the specified frequency response of sensor.

Model CMSS 30205300 Mounting Stud (1/4-28 to 10-32)

Flanged sensor mounting stud, adapts 1/4-28 tapped threads to 10-32 thread.

Material: Stainless Steel
Recommended Mounting Torque: 20 in-lbs (2,3 N-m)
Frequency Response: Proper mounting on clean flat surface can achieve the specified frequency response of sensor.

Model CMSS 910M Cementing Stud with 1/4-28 Male

Model CMSS 910F Cementing Stud with 1/4-28 Female

Cementing studs for sensors with 1/4–28 tapped threads to M6 threads. Includes key notch for consistent triaxial axis orientation.

Material: Stainless Steel
Recommended Mounting Torque: 24 in-lbs (2,9 N-m)
Frequency Response: Flat up to about 80% of the specified response value, using epoxy or similar cement, flat up to about 30% of the specified response value using double sided tape.

– NOTE –

To avoid sensor damage, always remove the sensor from the cementing stud first, then remove the stud from surface by means of a wrench using the flats provided..

Model CMSS 10876700 Captive Screw

Metric Thread Captive Screw M6 x 43mm for CMSS 787 and CMSS 797 Series Accelerometers.

Magnetic Mounting Hardware

Model CMSS 908-RE, Rare Earth, flat bottom magnet base for general purpose measurements. CMSS 908-RE for use with mounting stud sensors.

Model CMSS 908-RE Rare Earth Magnetic Base Flat Bottom

Material: Rare earth cobalt mounted in a stainless steel housing.
Frequency Response: Flat up to about 20% of the specified frequency response.
Holding Power: Approximately 40 lbs of force.
Mounting: 1/4-28 UNF hole
Dimensions: 0.95" (24.1mm) Height x 0.75" (19.0mm) Diameter

Magnetic Bases for Curved Surfaces

Models CMSS 908-MD and CMSS 908-HD are designed in a 2-pole configuration for industrial vibration monitoring applications where flat surfaces are rarely found. Each magnet is supplied with a 1/4-28 mounting stud to allow compatibility with most SKF transducers.

– NOTE–

Two-pole magnet bases are recommended for low frequency measurements only and only for applications where other mounting methods are not practical.

Model CMSS 908-MD Medium Duty Magnetic Base

For use in moderate conditions.

Material: Alnico magnet material mounted in an aluminum housing with steel poles.
Frequency Response: Flat up to about 10% of the specified frequency response.
Holding Power: Approximately 30 lbs of force.
Mounting: 1/4-28 UNF hole
Dimensions: 1.38" (35.0mm) Height x 1.50" (38.0mm) Diameter

Model CMSS 908-HD Heavy Duty Magnetic Base

For use under extreme conditions.

Material: Alnico magnet material mounted in an aluminum housing with steel poles.
Frequency Response: Flat up to about 10% of the specified frequency response.
Holding Power: Approximately 70 lbs of force.
Mounting: 1/4-28 UNF hole
Dimensions: 1.800" (45.0mm) Height x 2.125" (64.0mm) Diameter

Quick Connect/Disconnect Sensor Mounting Pads

Mounting Pads allow vibration technicians using such instruments as the SKF Microlog on walkaround routes to quickly mount vibration sensors in less than one turn. This quick mount design results in a decrease in mounting time as compared to the older style threaded stud mounting pads.

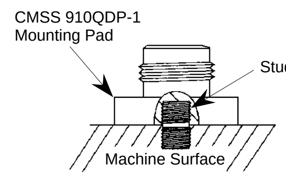
Key Benefits

- Decreased sensor mounting time by 90%.
- Eliminates wrist fatigue from repetitive twisting.
- Combines ease and speed of a magnet mount with the accuracy and repeatability of a permanent mount.
- Ensures the repeatable, reliable vibration data of a permanently mounted sensor.
- Prevents cable twisting.
- Upgrades existing installations.

Features

- Constructed of corrosion resistant 316 stainless steel.
- Convenient cement mounting capability.
- Accepts all 1/4-28 compatible vibration sensors, including SKF's low profile models.
- Compatible with existing 1/4-28 stud mount installations.
- Easily removed to upgrade to permanent mount allowing the sensor to be directly attached to the same measuring point.

Model CMSS 910QDP-1 Stud Mounting Pad

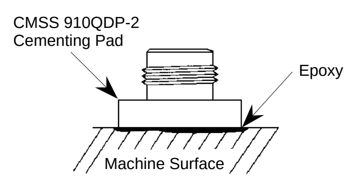


The CMSS 910QDP-1 Mounting Pad is stud mounted to the measuring point or attached to an existing 1/4-28 stud.

Easy conversion to permanently mounted sensors.

Once the CMSS 910QDP-1 is mounted, conversion to permanently mounted sensors is quick and easy. By simply removing the pad and attaching a SKF vibration sensor to the existing 1/4-28 stud, sensor location and vibration data history remains reliable.

Model CMSS 910QDP-2 Cement Mounting Pad



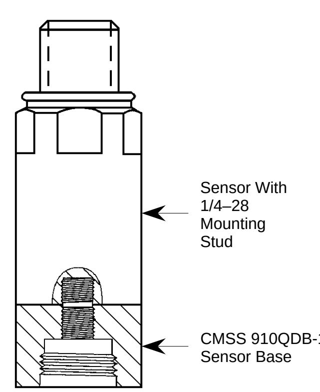
The CMSS 910QDP-2 Cement Mounting Pad is epoxied to the measuring point.

Removable for upgrading to permanently mounted sensors.

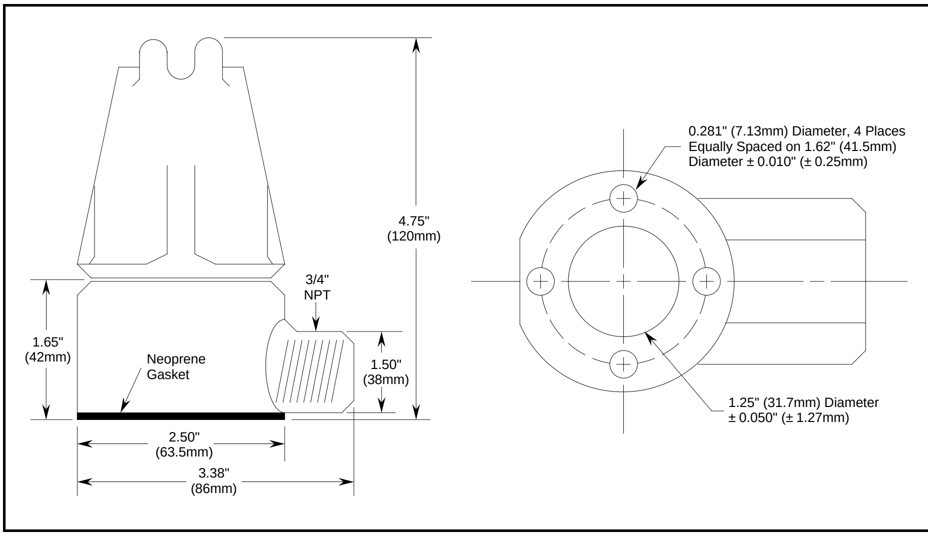
When upgrading to permanently mounted sensors, the cement pad can easily be removed to allow a stud mounted sensor to be installed in the location.

Model CMSS 910QDB-1 Sensor Base

The CMSS 910QDB-1 attaches easily to 1/4-28 compatible sensors. In walkaround data collection, the sensor can be attached in less than one turn to any of the Quick Connect/ Disconnect mounting pads. The CMSS 910QDB-1 can remain on the sensor or be removed and reattached to other popular SKF vibration sensors.



CMSS 50042300 Case Mounted Transducer Housing



Introduction

The CMSS 50042300 Case Mounted Transducer Housing provides physical and environmental protection for the CMSS 766, CMSS 786, and CMSS 793 Series Seismic Sensors. Use in installations where the pickup can be subject to possible damage from adverse conditions. This housing meets API 670 standards when properly installed.

The mounting kit includes a dome cover, mounting base with one (1) 3/4" conduit connection, neoprene gasket, mounting screws, washers, and one (1) 1/2" NPT reducing bushing.

– NOTE –

Seismic sensor must be ordered separately.

Installation

The housing is compatible with 1/2" and 3/4" flex, EMT, and rigid conduit.

1. Select or prepare flat surface for installation of protective housing at the sensor location.

– NOTE –

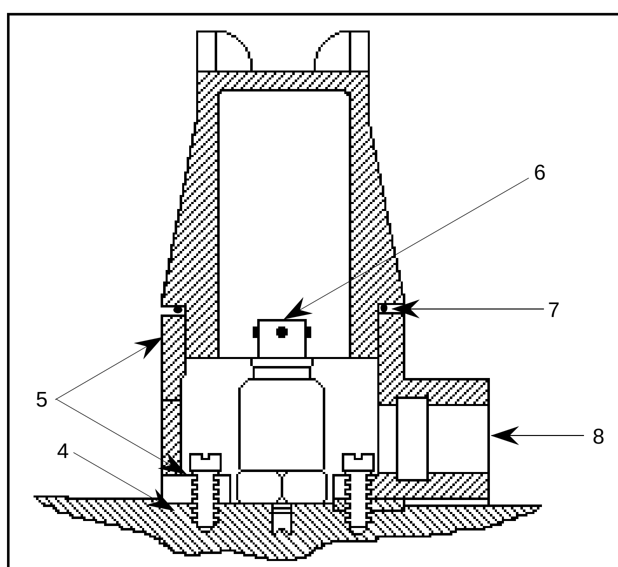
If machine housing is radiused, surface the mounting area flat to maintain a full 360 degree gasket seal in the radiused plane and install with a minimum of two (2) mounting screws 180 degrees apart.

2. Drill center for 7/32" pilot hole 0.313" deep and spotface 1.0" surface to 0.030" deep to 63 RMS finish for direct mounted sensor installation. Tap center of spotfaced surface for 1/4-28 UNF threads.

– NOTE –

A 63 RMS finish cannot normally be achieved using portable power tools typically requiring the machine housing to be removed and milled to the proper specifications in a machine shop. An alternative is to install a mounting pad with the proper finish such as Part Number 70005050.

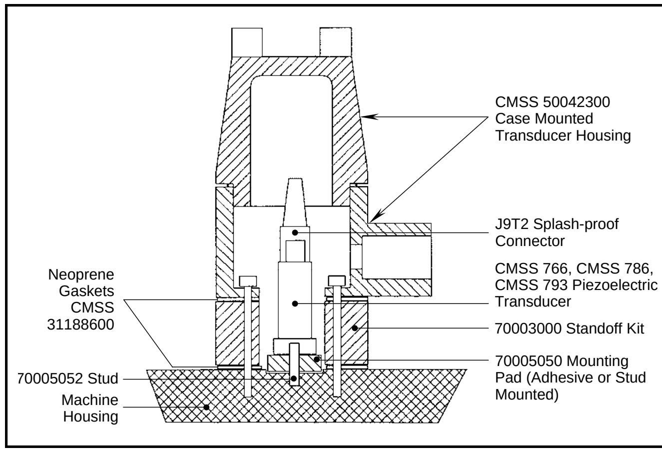
3. Drill and tap four (4) equally spaced 1/4-20 UNC-2B by 0.375" (10.0mm) deep on a 1.62" (42.0mm) diameter bolt circle.
4. Place neoprene gasket in place.
5. Install housing base over gasket, orienting conduit outlet as required for your installation. Secure housing base with four (4) each 1/4-20 UNC cap screws and lockwashers (provided).
6. Screw transducer into the center mounting hole. Do not exceed manufacturer's torque recommendations (23 NM).
7. Place O-ring on dome cover and screw dome cover into housing base until finger tight.
8. Optional 3/4" to 1/2" conduit reducing bushings can now be installed.



70003010 Mounting Kit for Seismic Transducers

Introduction

The 70003010 Mounting Kit for Seismic Transducer incorporates the CMSS 50042300 case mounted housing with high dome cover, neoprene gasket, mounting screws, washers and a 1/2" reducing bushing. It contains all parts necessary to install a permanent stud mounted or adhesive mounted CMSS 766, CMSS 786 and CMSS 793 Series Seismic Sensor. A nylon spacer complete with 1-3/4" long cap screws is included in the kit for installations using cables with the J9T2 Splash-proof connector. Use in installations where the pickup can be subject to possible damage from adverse conditions. When properly installed this kit meets API 670 standards for mounting protective housings independent of the transducer to prevent affecting the frequency response.



The kit includes one (1) each:

- 2.5" Housing with 3/4" conduit hub
- 2.5" Dome cover
- 3/4" to 1/2" RE conduit fitting (reducing bushing)
- Four (4) 1/4-20 UNC x 3/4" cap screws
- Four (4) 1/4-20 UNC x 1-3/4" cap screws (used for installing housing with 1" nylon spacer)
- Permanent/adhesive mounting pad 1/4" thick x 1" OD with 1/4-28 UNF threaded ID
- Permanent mounting stud 1/4-28 UNF x 3/4" hardened steel
- 2.5" nylon spacer 1" thick

Optional Kit Accessories

Part Number 70005010 Piloted End Mill 1" x 7/32" pilot for spot facing machine surface to accommodate accelerometer mounting pad.

Part Number 70005020 406/17 Acrylic Epoxy BiPaks for installation of adhesive mounting pads.

– NOTE –
Use 1/4-28 UNF captive mounting stud supplied with the transducer.

Part Number 70005015 Permanent Mounted Transducer Installation Kit including 1" piloted end mill, two (2) each 7/32" drill bits, 1/4-28 UNF tap set (starter and bottom taps), and ten (10) each 1/4-28 UNF hardened Allen studs.

Part Number 70005015 Permanent Mounted Transducer Installation Kit including 1" piloted end mill, two (2) each 7/32" drill bits, 1/4-28 UNF tap set (starter and bottom taps), and ten (10) each 1/4-28 UNF hardened Allen studs.

– NOTE –
Seismic sensor must be ordered separately.

Installation

The housing is compatible with 1/2" and 3/4" flex, EMT, and rigid conduit.

1. Select or prepare flat surface for installation of protective housing at the sensor location.

– NOTE –
If machine housing is radiused, surface the mounting area flat to maintain a full 360 degree gasket seal in the radiused plane and install with a minimum of two (2) mounting screws 180 degrees apart.

2. Drill center for 7/32" pilot hole 0.313" deep and spotface 1.0" surface to 0.030" deep for installation of permanent mounting pad.

– NOTE –
Use Part Number 70005010 Piloted End Mill or equivalent.

3. Tap center for 1/4-28 UNF threads and install 1/4-28 UNF x 3/4" permanent mounting stud. Stud must be installed maintaining a perpendicularity of ± 1 degree to ensure proper coupling of the mounting pad to the housing.

– NOTE –
If using the adhesive mounting approach, it is not necessary to tap threads and install the permanent mounting stud. Sufficiently degrease the spotfaced surface and mounting pad, apply a release agent, (i.e. silicon grease) to the pad ID threads and install using Part Number 70005020 acrylic epoxy adhesive or equivalent. Allow adequate setup time for adhesive bond before installing the sensor (2 hours minimum curing time required, 24 hours recommended dependent on temperature and humidity).

4. Drill and tap four (4) equally spaced 1/4-20 UNC by 0.313" deep on a 1.62" diameter bolt circle for installation of housing.

5. Screw permanent mounting pad onto the permanent stud and tighten snugly.

   Hint: Apply silicon grease (i.e. DOW 44 or equivalent) to the stud threads and underside of pad to enhance the coupling characteristics and improve corrosion resistance.

– NOTE –
After installation, verify that the exposed threads are at least 3/16" and no more than 7/32". This is to ensure the sensor face contacts the pad surface and prevents the possibility of bottoming out on the sensor threads adversely affecting the response characteristics.

6. Install sensor onto pad using permanent mounting stud or captive stud (adhesive mount). Do not exceed manufacturer's torque recommendations (23 NM).

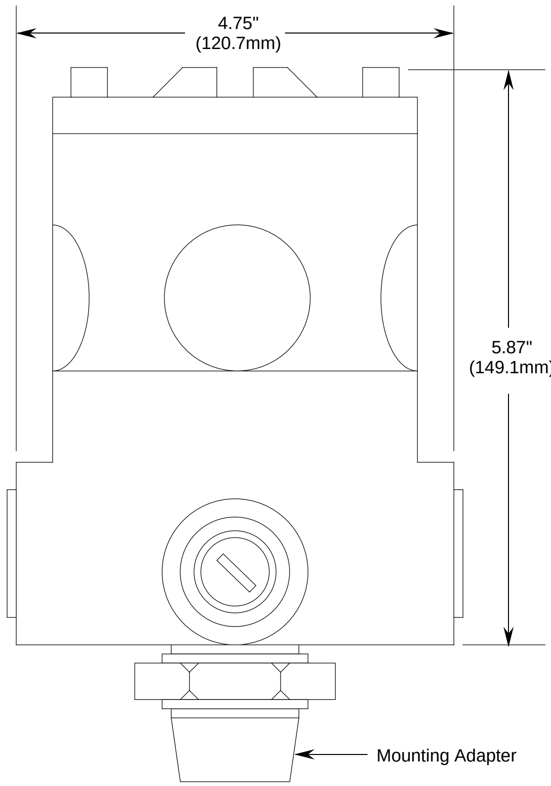
7. Install housing base over neoprene gasket orienting conduit hub as required for your installation. Secure housing base with four (4) 1/4-20 UNC x 3/4" cap screws and lockwashers.

– NOTE –
When using J9T2 type Splash-proof Cable Connectors install 1" nylon spacer and neoprene gasket between the housing base and the machine mounting surface with four (4) 1/4-20 UNC x 1-3/4" cap screws and lockwashers.

8. Place O-ring on dome cover, screw into housing base finger tight making sure sensor cable is not chafed or damaged in the process.

9. Attach conduit using RE reducing bushing if necessary.

Vibration Sensor Housings



The Transducer Housing encloses a seismic transducer, protecting it from mechanical damage and shielding it and the electrical connections from water spray and other environmental hazards. The transducer mounts to the 1/4-28 UNF mounting hole provided on the top of the mounting adapter (provided).

– NOTE –

The operating frequency response of an accelerometer may be affected when mounted in this housing due to the change in mass configuration. It is not recommended for higher speed or light case to rotor weight machinery applications, (i.e. gearbox, gas turbines, etc.).

Ordering Information

CMSS 30266101
Transducer Housing, 3/4" NPT mounting

Hazardous Area Information

Area General Information

Table 3. Agency approvals.

Sensor	Agency Approved Sensors		
	FM Approved	CSA	EECS CENELEC (BASSEEFA)
CMSS 793	Class I, II, III/Division 1/Group A, B, C, D, E, F, G Class I, II, III/Division 2/Group A, B, C, D, F, G	Class 1/Group A, B, C, D	EEx ia IIC T4
CMSS 793L	Class I, II, III/Division 1/Group A, B, C, D, E, F, G Class I, II, III/Division 2/Group A, B, C, D, F, G	Class 1/Group A, B, C, D	
CMSS 793V	Class I, II, III/Division 1/Group C, D, E, F, G Class I, II, III/Division 2/Group A, B, C, D, F, G	Class 1/Group A, B, C, D	EEx ia IIC T4
CMSS 797			EEx ia IIC T4

Review the Hazardous Location Information section to properly define the area in which the sensors and monitoring systems are to be installed, then determine which equipment will meet the specified requirements.

Sensors may either be installed in a Class 1, Division 1 (Zone 0, 1) or a Division 2 (Zone 2) hazardous area. However, for installation in these areas, the sensors must be approved by an appropriate agency.

SKF Condition Monitoring does have vibration sensor systems approved for installation in these areas and specific model numbers assigned to easily identify these agency approved options.

It is strongly recommended that intrinsic safety barriers be used for the hazardous area installations as the means of limiting the thermal and electrical energy to the sensor components in Class 1, Division 1 (Zone 0, 1) and Division 2 (Zone 2) hazardous areas. The agency approved intrinsic safe sensor components, and the intrinsic safety barriers provide for a very high level of safety, and aid in the prevention of fire and explosions in your facility.

It is recommended in field installations, that housings be used to provide physical protection for the SKF Condition Monitoring Vibration Sensors.

SKF does provide a series of standard housings which can be used for these installations.

Agency Approvals

SKF Condition Monitoring has obtained agency approvals from the following:

British Approvals Service for Electrical Equipment in Flammable Atmospheres EECS (BASEEFA)

EECS (BASEEFA) certified equipment is intended for use in Zone 0, 1 as intrinsically safe in accordance with CENELEC European harmonized Standards, [EN50, 014 (1977) and EN50 020 (1977)] and is accepted by member countries of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

Canadian Standards Association – CSA

CSA certified equipment is intended for use in Class 1, Division 1, Groups A, B, C, D.

Factory Mutual Research, USA – FM

Approved

FM certified equipment is intended for use in Class I, Division 1, Groups A, B, C, D, E, F, G.

FM certified equipment is intended for use in Class I, II, III, Division 1 and 2, Groups A, B, C, D, E, F, G as specifically indicated in Table 3.

CE Approval

European Community Declaration of Conformity.

Manufacturer:

SKF Condition Monitoring
4141 Ruffin Road
San Diego, California USA

Product: SKF Sensors

SKF Condition Monitoring, Inc. of San Diego, California USA hereby declares, that the referenced product, to which this declaration relates, is in conformity with the provisions of:

Council Directive 89/336/EEC (3 May 1989), on the Approximation of the Laws of the Member States Relating to Electromagnetic Compatibility, as amended by:

Council Directive 92/31/EEC (28 April 1992);

Council Directive 93/68/EEC (22 July 1993).

The above-referenced product complies with the following standards and/or normative documents:

EN 50081-2, Electromagnetic compatibility–Generic emission standard. Part 2: Industrial environment (August 1993).

EN 50082-2, Electromagnetic compatibility–Generic immunity standard. Part 2: Industrial environment (March 1995).

To order Vibration Sensors with the various agency approvals please refer to Table 3 for determination of the appropriate and specific model number to meet installation requirements.

Technical Notes (Reprinted by permission from Wilcoxon Research)

Piezoelectric Materials for Vibration Sensors– The Technical Advantages of Piezoceramics Versus Quartz

Piezoelectric sensors are used extensively for monitoring structural and machinery vibrations. Piezoceramic PZT and quartz are the most widely used sensing materials for accelerometers and piezovelocity transducers.

Piezoceramics and Quartz

Quartz occurs naturally in a crystalline form, however, the quartz used in sensor fabrication is artificially grown. Piezoceramic material is also produced in a laboratory environment through a highly controlled process specifically designed for accelerometer applications.

Lead-Zirconate Titanate (PZT) is a tailored piezoceramic that is capable of measuring much lower amplitude vibrations than quartz. For this and other reasons, PZT has been carefully selected as the best piezoelectric material for accelerometers by the worlds leading sensor research companies. Specially formulated PZT provides stable performance and long term reliability for modern piezoceramic sensors.

Quartz is used by companies who historically manufactured force gauges and pressure sensors. The lower efficiency of quartz works well in these applications because of the high force levels measured in typical pressure and force gauge applications. However, quartz is not recommended for low frequency accelerometer applications.

APPLICATIONS

Slow Speed Machinery

Slow speed machinery such as paper machines and cooling towers, require the higher charge output and broader frequency range of PZT based sensors. Manufacturers who traditionally used quartz are now using PZT in many of their new accelerometer designs to allow for a variety of low frequency monitoring applications.

LOW FREQUENCY MEASUREMENTS

Very little machinery vibration, in terms of acceleration, is excited at low frequencies. For example: When monitoring a roll at 60 cpm, 10 mils pp of shaft movement (0.03 ips) produces only 0.0005 g of acceleration. These low amplitude levels can approach the electronic noise floor of standard accelerometers. Furthermore, a standard 100 mV/g accelerometer presents only 50 μV of output to the data collector and may introduce instrument noise into the measurement.

Piezoceramics must be used for low frequency 500 mV/g accelerometers and piezovelocity transducers due to its low noise characteristics. PZT enables these higher output voltage sensors to overcome data collector noise and further decrease system noise for low level vibration measurements.

HIGH FREQUENCY MEASUREMENTS

When monitoring higher frequencies the difference between PZT and quartz is less important. In terms of acceleration, the general velocity alarm level of 0.3 ips, is equivalent to 2.5 g at 30,000 cpm (500 Hz). This excitation level is easily measured by most amplifiers and data collectors. However, the resonance frequency of a PZT accelerometer will be much higher than an equivalent charge output quartz sensor. This can extend the frequency range and give more accurate high frequency readings.

Temperature Considerations

Temperature considerations are very important in many industrial applications. Although quartz crystal is known for its temperature stability, once designed into an accelerometer it shares many of the same characteristics as piezoceramic sensors.

As temperature increases, the sensitivity of both types of accelerometers will change. The sensitivity of PZT and quartz accelerometers exhibit 5 to 7% sensitivity shifts from room temperature to +250°F (+121°C) as shown in Figure 13. In very high temperature environments, both materials are used successfully in applications exceeding +500°F (+260°C).

Thermal Transients

Thermal transient effects must be considered in some applications such as low frequency monitoring. Transient changes in temperature cause thermal expansion of the sensor's metal housing. Sometimes mistaken for the "pyroelectric" effect, thermal expansion produces false signals related to the strain sensitivity of the sensor.

Accelerometers, whether PZT and quartz, should be designed for low mechanical strain sensitivity to minimize the effects of thermal transients.

Stability

Recalibration is rarely required for either type of sensor for normal industrial applications unless contractually required. Quartz is naturally stable and will not change unless mechanically overstressed. Modern PZT sensors are heat treated to stabilize the poling process and eliminate changes due to long term temperature and shock exposure. Properly designed and processed sensors of both types have been field proven for many years.

Conclusion

Both piezoceramics and quartz are excellent materials for use in sensor design. Each material has a clear technical advantage over the other for different parameters. Quartz is the better material for measuring pressure and force due to the relatively high forces involved. Piezoceramics are clearly the choice for accelerometer applications due to the higher sensitivities required to monitor low level vibration. Piezoceramics coupled with an internal micro amplifier are the materials of choice for advanced accelerometers.

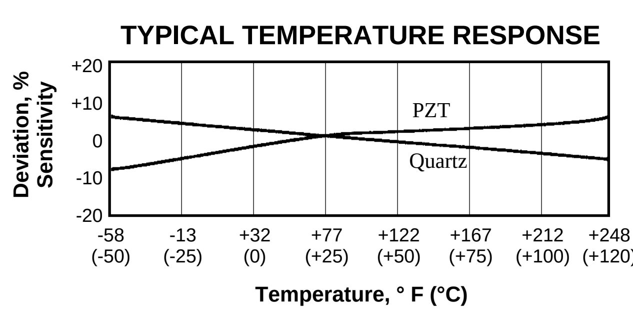


Figure 13. Typical temperature response of PZT and Quartz.

Sensors Solutions for Industrial Cooling Towers and Process Cooler Fans

Cooling towers are a critical component in many power generation, chemical, and other process facilities. Catastrophic equipment failure can result in safety hazards, lowered production, and expensive repairs. Vibration monitoring of cooling tower fans, gear boxes, shafts, and motors provides early warning of machine degradation and impending disaster.

Changes in Cooling Tower Monitoring

In the past, vibration monitoring was a technical challenge due to the slow rotational speeds, variety of support structures, and wet corrosive environments. Mechanical ball/spring vibration cutoff switches were traditionally used to shut down machinery when vibration levels became excessive. These switches have proven unreliable and in many instances allowed extensive machinery damage before motor power was disabled. Furthermore, switches did not allow for advance warning of problems. Walkaround data collection systems have also been found ineffective at measuring fan and gearbox degradation. Today, cooling towers use permanently installed sensors to effectively and safely prevent catastrophic cooling tower failure without unscheduled downtime.

Advanced Sensor Solutions For Early Warning Monitoring

By measuring vibration on a regular schedule, problems can be located and repaired before failure occurs. The most common mechanical problems are:

- Bearing failure.
- Motor soft foot.
- Shaft imbalance from thermal blow.
- Shaft imbalance from corrosion build up.
- Gear lock up from misalignment.
- Blade breakage due to stress corrosion.
- Chlorine corrosion of support structures.

Two types of sensors are recommended for monitoring cooling towers. Multipurpose Models CMSS 793 and CMSS 797 Accelerometers for the motor end, and Models CMSS 793L and CMSS 797L Low Frequency Accelerometers for monitoring the gearbox and fan.

The CMSS 793 and CMSS 797 IsoRing® sensors exhibit the broad frequency range required to simultaneously measure drive speed, bearing harmonics, and high frequency detection (HFD).

The CMSS 793L and CMSS 797L provides a strong 500 mV/g output to overcome data collector noise at the low frequency fan speeds.

Table 5 gives mounting locations and trend indication. Table 6 gives sensor specifications. Figure 14 shows a typical arrangement for vibration monitoring of a cooling tower fan.

The "Payoff" of Vibration Monitoring

Todays predictive maintenance vibration monitoring programs have proven to be both cost effective and reliable. Users of vibration monitoring programs confirm that early detection, accurate problem pinpointing, and scheduled downtimes significantly drops repair bills and increases the return on investment.

Modern machinery health monitoring gives the reliable information needed to confidently plan inspections and equipment maintenance without unexpected failures or wasted time.

Table 5. Mounting locations.

	Location	Frequency/Order	Trend Indication
CMSS 793 or CMSS 797 100 mV/g Industrial Accelerometer	Horizontal on motor outboard and inboard bearings	1x motor	Shaft imbalance
		1x, 2x, 3x, motor	Parallel misalignment, looseness
		2x line	Stator problems, soft foot
		hf harmonics	Bearing wear, looseness
		HFD noise	Bearing fault progression
	Axial on motor outboard bearing	1x, 2x, motor	Bent shaft
		1x, 2x, 3x, motor	Angular misalignment
		hf harmonics	Bearing wear, looseness
CMSS 793L or CMSS 797L 500 mV/g Low Frequency Accelerometer	Horizontal on gear box at mesh	1x fan	Imbalance
		2x, 3x, fan	Looseness
		Blade pass	Blade Failure
		2x mesh	Gear misalignment
		3x	Gear Wear
		Mesh harmonics	Gear fault progression

Table 6. Sensor specifications.

Sensor Specifications	CMSS 793/CMSS 797	CMSS 793L/CMSS 797L
Sensitivity (mV/g)	100	500
Frequency Response (± 3 dB)		
CPM	30 to 900,000	12 to 138,000
Hz	0.5 to 15,000	0.2 to 2,300
Spectral Noise at 1 Hz (60 cpm)		
g/ Hz	0.000056	0.000004
ips/ Hz	0.0034	0.00025
mils/ Hz	0.55	0.039
Voltage Output For 0.03 ips vibration at 60 cpm (µV)	49	244

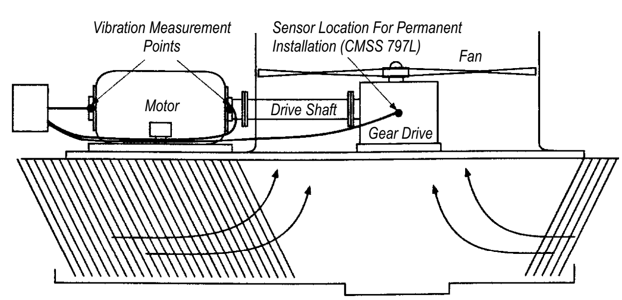


Figure 14. Typical sensor placement.

Accelerometers Measure Slow Speed Rollers and Detect High Frequencies

Successful vibration monitoring of paper machines depends on quality sensors, field proven for reliability. Accelerometers used in paper mill applications must survive harsh thermal, electrical and chemical environments while performing demanding bearing measurements. Piezoceramic accelerometers are the sensor of choice for accurately measuring the broad range of frequencies and low amplitudes occurring in slow speed roller bearing installations.

Accelerometers are specially designed to maximize sensitivity to low level vibrations. Their low electronic noise floor is needed to measure the vibration signature of heavy, slow turning rollers. In addition, their high frequency range allows advanced early detection techniques such as high frequency detection (HFD) and enveloping.

The heart of a paper mill quality accelerometer is lead zirconate-titanante (PZT), the piezoceramic pickup inside the sensor. The charge sensitivity of PZT is over twenty times that of quartz. High charge sensitivity is the critical factor governing electronic noise and the fidelity of slow speed measurements.

Many vibration technicians have experienced the “ski slope” effect when analyzing spectrums. The “ski slope” effect is due to amplification of the low frequency noise. Integration from acceleration to velocity magnifies this effect to produce a steeper “ski slope”. In paper machine monitoring, low frequency noise must be reduced. Piezoceramics accomplish this in two ways.

First, the high sensitivity piezoceramic pickup lowers the spectral amplifier noise. This increase the signal-to-noise ration and prevents the integration noise “ski slope” from hiding running speed information such as misalignment and imbalance. Spectral noise should always be reviewed before selecting sensors for low frequency vibration measurements.

Secondly, for a given low frequency spectral noise, piezoceramic sensors exhibit a higher resonance frequency. Leaks in carbon steam seals and gear mesh on nearby equipment can overload low resonance sensors and cause signal distortion. When integrated, the distortion can “swamp” the running speed and low order bearing fault frequencies in noise.

In addition to improving low frequency measurements, the high resonance allows the sensor to be used for advance monitoring techniques. HFD techniques trend high frequency noise to detect early bearing degradation. Higher detection frequencies result in earlier bearing fault identification.

Newer enveloping techniques capture the very high frequency spectrum, similar to an AM radio detector, the signal is demodulated to extract the low frequency repetition rate of the bearing signature. Higher frequency envelope bands contain less unwanted vibration interference and produce cleaner measurements.

Sensors are the "eyes and ears" of the predictive maintenance system. When millions of dollars may be saved through early fault detection, selection of reliable sensors becomes critical. In paper machine applications, piezoceramics not only provide greater signal fidelity, but can adapt to revolving monitoring techniques and requirements. Quality measurements begin with using the proper sensor for the job.

Glossary

– A –

ACCELERATION. The time rate of change of velocity. Typical units are ft/sec/sec, meters/sec/sec, and G's (1 G = 32.17 ft/sec/sec = 9.81 m/sec/sec). Acceleration measurements are usually made with accelerometers.

ACCELEROMETER. Sensor whose output is directly proportional to acceleration. Most commonly use piezoelectric crystals to produce output.

ACCURACY. The quality of freedom from mistake or error, that is, conformity to truth, a rule or a standard; the typical closeness of a measurement result to the true value; the specified amount of error permitted or present in a physical measurement or performance setup.

ACOUSTIC SENSITIVITY. The parameter quantifying output signal picked up by a motion transducer when subjected to acoustic fields.

ALIASING. A phenomenon which can occur whenever a signal is not sampled at greater than, twice the maximum frequency component, causes high frequency signals to appear at low frequencies. Aliasing is avoided by filtering out signals greater than 1/2 the sample rate.

ALIGNMENT. A condition whereby the axes of machine components are either coincident, parallel or perpendicular, according to design requirements.

AMPLITUDE. The magnitude of dynamic motion or vibration. Amplitude is expressed in terms of peak-to-peak, zero to-peak, or RMS. For pure sine waves only, these are related as follows:

RMS = 0.707 times zero-to-peak;

peak-to-peak = 2 times zero-to-peak.

ANALOG-TO-DIGITAL CONVERTER (A/D, ADC). A device, or subsystem, that changes real-world analog data (as from transducers, for example) to a form compatible with digital (binary) processing.

ANALYSIS RANGE (ANALYSIS BANDWIDTH). (See *FREQUENCY RANGE*.)

ANTI-ALIASING FILTER. A low-pass filter designed to filter out frequencies higher than 1/2 the sample rate in order to prevent aliasing.

ANTI-FRICTION BEARING. (See *ROLLING ELEMENT BEARING*.)

ASCII (AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE). A seven-bit code capable of representing letters, numbers, punctuation marks, and control codes in a form acceptable to machines.

ASYMMETRICAL SUPPORT. Rotor support system that does not provide uniform restraint in all radial directions. This is typical for most heavy industrial machinery where stiffness in one plane may be substantially different than stiffness in the perpendicular plane. Occurs in bearings by design, or from preloads such as gravity or misalignment.

ASYNCHRONOUS. Vibration components that are not related to rotating speed (also referred to as nonsynchronous).

ATTENUATION. The reduction of a quantity such as sensitivity: i.e. through filtering or cable loading.

ATTRIBUTE. An individual field of a SET record or of a POINT record, a characteristic of a POINT.

AVERAGING. In a dynamic signal analyzer, digitally averaging several measurements to improve statistical accuracy or to reduce the level of random asynchronous components. (See *RMS*.)

AXIAL. In the same direction as the shaft centerline.

AXIAL POSITION. The average position, or change in position, of a rotor in the axial direction with respect to some fixed reference position. Ideally the reference is a known position within the thrust bearing axial clearance or float zone, and the measurement is made with a displacement transducer observing the thrust collar.

AXIS. The reference plane used in plotting routines. The X-axis is the frequency plane. The Y-axis is the amplitude plane.

– B –

BACKGROUND NOISE. The total of all noise when no signal is input into the amplifier. (See *BROADBAND NOISE*.)

BALANCE RESONANCE SPEED(s). A rotative speed that corresponds to a natural resonance frequency.

BALANCED CONDITION. For rotating machinery, a condition where the shaft geometric centerline coincides with the mass centerline.

BALANCING. A procedure for adjusting the radial mass distribution of a rotor so that the mass centerline approaches the rotor geometric centerline.

BALL PASS INNER RACE (BPFI). The frequency at which the rollers pass the inner race. Indicative of a fault (crack or spall) in the inner race.

BALL PASS OUTER RACE (BPFI). The frequency at which the rollers pass the outer race. Indicative of a fault (crack or spall) in the outer race.

BALL SPIN FREQUENCY (BSF). The frequency that a roller turns within the bearing. Indicative of a problem with an individual roller.

BANDPASS FILTER. A filter with a single transmission band extending from lower to upper cutoff frequencies. The width of the band is determined by the separation of frequencies at which amplitude is attenuated by 3 dB (0.707).

BAND-REJECT. Also known as band stop and notch; a band-reject filter attenuates signal frequencies within a specified band, while passing out-of-band signal frequencies; opposite to the bandpass filter.

BANDWIDTH. The spacing between frequencies at which a bandpass filter attenuates the signal by 3 dB. In an analyzer, measurement bandwidth is equal to [(frequency span)/(number of filters) x (window factor)]. Window factors are: 1 for uniform, 1.5 for Hanning, and 3.63 for flat top.

BASE STRAIN SENSITIVITY. The parameter quantifying the unwanted output signal picked up by a motion transducer when its mounting surface is subjected to mechanical strains.

BASELINE SPECTRUM. A vibration spectrum taken when a machine is in good operating condition; used as a reference for monitoring and analysis.

BAUD RATE (BIT RATE). The rate in bits per second at which information is transmitted over a serial data link.

BENDER BEAM ACCELEROMETER. An accelerometer design which stresses the piezoelectric element by bending it. This design is used primarily for low frequency, high sensitivity applications. (See *COMPRESSION MODE ACCELEROMETER, SHEAR MODE ACCELEROMETER*.)

BIAS OUTPUT VOLTAGE. abr. BOV. Syns. Bias Voltage, Rest Voltage. The DC voltage at the output of an amplifier on which the AC motion signal is superimposed.

BLADE PASSING FREQUENCY. A potential vibration frequency on any bladed machine (turbine, axial compressor, fan, etc.). It is represented by the number of blades times shaft rotating frequency.

BLOCK SIZE. The number of samples used in a DSA to compute the Fast Fourier Transform. Also the number of samples in a DSA time display. Most DSAs use a block size of 1024. Smaller block size reduces resolution, larger block size increases resolution.

BLOCKING CAPACITOR. A capacitor placed in series with the input of a signal conditioning or measurement device which blocks the DC Bias Voltage but passes the AC Signal.

BODÉ. Rectangular coordinate plot of 1X component amplitude and phase versus running speed.

BOW. A shaft condition such that the geometric centerline of the shaft is not straight.

BRINNELING (FALSE). Impressions made by bearing roiling elements on the bearing race; typically caused by external vibration when the shaft is stationary.

BROADBAND NOISE. The total noise of an electronic circuit within a specified frequency bandwidth. (See *BACKGROUND NOISE*.)

BUFFER. 1) An isolating circuit used to avoid distortion of the input signal by the driven circuit. Often employed in data transmission when driving through long cables. 2) A temporary software storage area where data resides between time of transfer from external media and time of program-initiated I/O operations.

– C –

CAGE (RETAINER). A component of rolling bearings which constrains the relative motion of the rolling elements circumferentially around the bearing.

CALIBRATION. Comparison of the performance of an item of test and measuring equipment with a certified reference standard.

CALIBRATION CURVE. A graphical representative of the measured transducer output or instrument readout as compared to a known input signal.

CALIBRATOR. Verifies that the performance of a device or instrument is within its specified limits.

CAMPBELL DIAGRAM. A mathematically constructed diagram used to check for coincidence of vibration sources (i.e. 1X imbalance, 2X misalignment) with rotor natural resonances. The form of the diagram is a rectangular plot of resonant frequency (Y-axis) versus excitation frequency (X-axis). Also known as an interference diagram.

CAPACITANCE. The ratio of the electric charge stored to the voltage applied across conductive plates separated by a dielectric material (C = q/V).

CARTESIAN FORMAT. A graphical format consisting of two (2) orthogonal axes; typically, Y is the vertical axis and X is the horizontal axis. This format is used to graph the results of one variable as a function of another, e.g., vibration amplitude versus time (Trend), frequency versus amplitude (Spectrum) and 1X amplitude versus shaft rotative speed (Bodé).

CASCADE PLOT. (See *SPECTRAL MAP*.)

CAVITATION. A condition which can occur in liquid-handling machinery (e.g. centrifugal pumps) where system pressure decrease in the suction line and pump inlet lowers fluid pressure and vaporization occurs. The result is mixed flow which may produce vibration.

CENTER FREQUENCY. For a bandpass filter, the center of the transmission band.

CENTERLINE POSITION. (See *RADIAL POSITION*.)

CHANNEL. A transducer and the instrumentation hardware and related software required to display its output signal.

CHARGE AMPLIFIER. Amplifier used to convert charge mode sensor output impedance from high to low, making calibration much less dependent on cable capacitance (also, charge converter).

CHARGE MODE ACCELEROMETER. Any piezoelectric accelerometer that does not contain an internal amplifier and produces a high impedance charge signal.

CHARGE SENSITIVITY. A measure of the amount of charge produced by a charge mode accelerometer per unit of acceleration. Usually given in terms of picocoulombs per g of acceleration; written (pC/g). (See *COULOMB, VOLTAGE SENSITIVITY*.)

CLIPPING. Clipping is the term applied to the generally undesirable circumstance in which a signal excursion is limited in some sense by an amplifier, ADC, or other device when its full scale range is reached. Clipping may be "hard" in which the signal excursion is strictly limited at some voltage; or, it may be "soft" in which case the clipped signal continues to follow the input at some reduced gain above a certain output value.

CLONE. The process of exactly duplicating a SET or a POINT.

CLOSE. A SET or POINT is considered CLOSED if the members below it in its hierarchy are not visible. Use LEFT ARROW to CLOSE a SET or POINT. A SET or POINT that is marked on its left by a hyphen symbol is CLOSED (not OPEN). Its members are not displayed (not visible on screen). (Also, See OPEN.)

– C –

COHERENCE. The ratio of coherent output power between channels in a dual-channel DSA. An effective means of determining the similarity of vibration at two (2) locations, giving insight into the possibility of cause and effect relationships. The real part of a complex function. The component which is in phase with the input excitation. In frequency domain analysis, the coincident terms are the cosine terms of the "Fourier transform."

COHERENCE FUNCTION. Coherence is a frequency domain function generally computed to show the degree to which a linear, noise-free relationship exists between a system input and the output. Values vary between one and zero, with one being total coherence and zero being no coherence between input and output.

COMPRESSION MODE ACCELEROMETER. An accelerometer design which stresses the piezoelectric element in the compressive direction: i.e. the electrode faces move toward and away from each other. (See *BENDER BEAM ACCELEROMETER, SHEAR MODE ACCELEROMETER*.)

CONDITION MONITORING. Determine of the condition of a machine by interpretation of measurements taken either periodically or continuously indicating the condition of the machine.

CONSTANT BANDWIDTH FILTER. A bandpass filter whose bandwidth is independent of center frequency. The filters simulated digitally in a DSA are constant bandwidth.

CONSTANT PERCENTAGE BANDWIDTH. A bandpass filter whose bandwidth is a constant percentage of center frequency. 1/3 octave filters, including those synthesized in DSAs, are constant percentage bandwidth.

CONTINUOUS SPECTRUM. The type of spectrum produced from non-periodic data. The spectrum is continuous in the frequency domain (See *LINE SPECTRUM*).

COULOMB. symbol C. The SI unit of electric charge. The amount of charge transported by one volt of electrical potential in one second of time. One (1) picocoulomb = 10-12 coulombs.

CPM. Cycles per minute.

CPS. Cycles per second. Also referred to as Hertz (Hz).

CREST FACTOR. Relation between peak value and RMS value (Peak divided by RMS.)

CRITERIA. A means of selecting desired items from the database. Very helpful in generating reports or downloading to the MICROLOG. The types of selection criteria that can be set are POINTS IN ALARM, ENABLED POINTS, and OVERDUE POINTS that fit a selectable date range.

CRITICAL MACHINERY. Machines which are critical to a major part of the plant process. These machines are usually unspared.

CRITICAL SPEED MAP. A rectangular plot of system natural frequency (Y-axis) versus bearing or support stiffness (X-axis).

CRITICAL SPEEDS. In general, any rotating speed which is associated with high vibration amplitude. Often, the rotor speeds which correspond to natural frequencies of the system.

CRYSTAL CAPACITANCE. The electrical capacitance across the terminations of a piezoelectric crystal. Usually given in terms of picofarads; written (pF).

CROSS AXIS SENSITIVITY. A measure of off-axis response of velocity and acceleration transducers.

CROSS TALK. Interface or noise in a transducer signal or channel which has its origin in another transducer or channel. When using eddy probes, cross talk can occur when the tips of two (or more) probes are too close together, resulting in the interaction of electromagnetic fields. The effect is a noise component on each of the transducers' output signals.

CURRENT REGULATING DIODE. A semiconductor device which limits and regulates electrical current independent of voltage.

CURVEFITTING. Curvefitting is the process whereby coefficients of an arbitrary function are computed such that the evaluated function approximates the values in a given data set. A mathematical function, such as the minimum mean squared error, is used to judge the goodness of fit.

CYCLE. One complete sequence of values of a periodic quantity.

– D –

DAMPING. The quality of a mechanical system that restrains the amplitude of motion with each successive cycle. Damping of shaft motion is provided by oil in bearings, seals, etc. The damping process converts mechanical energy to other forms, usually heat.

DAMPING, CRITICAL. The smallest amount of damping required to return the system to its equilibrium position without oscillation.

DATABASE. A group of SETs, subSETs, and POINTs arranged in a hierarchy that define a user's facilities (i.e., buildings, areas, machine, data gathering locations). Also a top menu bar function in PRISM^2. Allows add to, change, and delete of data in the database.

DECIBELS (dB). A logarithmic representation of amplitude ratio, defined as 20 times the base ten logarithm of the ratio of the measured amplitude to a reference. DBV readings, for example, are referenced to 1 volt RMS. dB amplitude scales are required to display the full dynamic range of a DSA.

DEFECT BEARING FREQUENCY. Frequency generated as a result of a defect in a bearing.

DEGREES OF FREEDOM. A phrase used in mechanical vibration to describe the complexity of the system. The number of degrees of freedom is the number of independent variables describing the state of a vibrating system.

DELAY. In reference to filtering, refers to the time lag between the filter input and the output. Delay shows up as a frequency-dependent phase shift between output and input, and depends on the type and complexity of the filter.

DIFFERENTIATION. Representation in terms of time rate of change. For example, differentiating velocity yields acceleration. In a DSA, differentiation is performed by multiplication by jw, where w is frequency multiplied by 2π. (Differentiation can also be used to convert displacement to velocity.)

DIFFERENTIAL EXPANSION. The measurement of the axial position of the rotor with respect to the machine casing at the opposite end of the machine from the thrust bearing. Changes in axial rotor position relative to the casing axial clearances are usually the result of thermal expansion during start-up and shutdown. Often incorporated as a measured parameter on a steam turbine.

DIGITAL FILTER. A filter which acts on data after it has been sampled and digitized. Often used in DSAs to provide anti-aliasing protection after internal resampling.

DIGITAL-TO-ANALOG CONVERSION. The process of producing a continuous analog signal from discrete quantized levels. The result is a continuous waveform designed to match as closely as possible a previously sampled signal or a synthesized result. Usually followed by a low pass filter.

DISCRETE FOURIER TRANSFORM. A procedure for calculating discrete frequency components (filters or lines) from sampled time data. Since the frequency domain result is complex (i.e. real and imaginary components), the number of points is equal to half the number of samples.

DISPLACEMENT. The change in distance or position of an object relative to a reference.

DISPLACEMENT SENSOR. A transducer whose output is proportional to the distance between it and the measured object (usually the shaft).

DOWNLOAD. Transferring information to the Microlog from the host computer.

DYNAMIC DATA. Data (steady state and/or transient) which contains that part of the transducer signal representing the dynamic (e.g., vibration) characteristics of the measured variable waveform. Typical dynamic data presentations include timebase, orbit, frequency-based spectrum, polar, Bodé, cascade, and waterfall.

DYNAMIC MOTION. Vibratory motion of a rotor system caused by mechanisms that are active only when the rotor is turning at speeds above slow roll speed.

DYNAMIC RANGE. For spectrum measurements, the difference, in dB, between the overload level and the minimum detectable signal level (above the noise) within a measurement system. The minimum detectable signal of a system is ordinarily fixed by one or more of the following: noise level; low level distortion; interference; or resolution level. For transfer function measurements, the excitation, weighting and analysis approaches taken can have a significant effect on resulting dynamic range.

– E –

ECCENTRICITY, MECHANICAL. The variation of the outer diameter of a shaft surface when referenced to the true geometric centerline of the shaft. Out-of-roundness.

EDDY CURRENT. Electrical current which is generated (and dissipated) in a conductive material in the presence of an electromagnetic field.

ELECTROMAGNETIC INTERFERENCE. abr.: EMI. The condition in which an electromagnetic field produces an unwanted signal.

ELECTROMAGNETIC SENSITIVITY. The parameter quantifying the unwanted output signal picked up by a motion transducer when subjected to electromagnetic fields.

ELECTROSTATIC DISCHARGE. abr.: ESD. A very high voltage discharge, sometimes accompanied by a spark, caused by static electrical charges across a dielectric material, such as air. This is a problem especially to electronic equipment, in hot, dry environments and plants where large rollers transport textiles or paper and build up very large amounts of charge.

ENGINEERING UNITS. In a DSA, refers to units that are calibrated by the user (e.g. in/sec, g's).

ENVELOPING. Screening technique to enhance pure repetitive elements of a signal.

EXTERNAL SAMPLING. In a DSA refers to control of data sampling by a multiplied tachometer signal. Provides a stationary display of vibration with changing speed.

– F –

FAST FOURIER TRANSFORM (FFT). A computer (or microprocessor) procedure for calculating discrete frequency components from sampled time data. A special case of the discrete Fourier transform where the number of samples is constrained to a power of 2.

FIELD. One data item of a record. Examples of fields are first name, middle initial, last name, room number, machine ID, etc.

FILTER. Electronic circuitry designed to pass or reject a specific frequency band.

FLAT TOP WINDOW. DSA window function which provides the best amplitude accuracy for measuring discrete frequency components.

FLUID-FILM BEARING. A bearing which supports the shaft on a thin film of oil. The fluid-film layer may be generated by journal rotation (hydrodynamic bearing), or by externally applied pressure (hydrostatic bearing).

FOLDING FREQUENCY. Equal to one-half of the sampling frequency. This is the frequency above which higher signal frequencies are folded or aliased back into the analysis band.

FORCED VIBRATION. The oscillation of a system under the action of a forcing function. Typically forced vibration occurs at the frequency of the exciting force.

FRAME. Discrete set of elements (numbers) representing a time or frequency domain function. The numerical size of the element set is called the frame, block, or record size and is generally a power of 2, such as 64, 128, 256, etc. The term, frame length or block length, is used to describe the length of the element set in seconds or milliseconds and is equal to N D t where N is the frame size and D t is the sampling interval.

– F –

FREE RUNNING. A term used to describe the operation of an analyzer or processor which operates continuously at a fixed rate, not in synchronism with some external reference event. Analyzers, processors and computing systems are often thought to be operating in a triggered, block synchronous or free running mode of operation.

FREE VIBRATION. Vibration of a mechanical system following an initial force–typically at one or more natural frequencies.

FREQUENCY. The repetition rate of a periodic event, usually expressed in cycles per second (Hz), revolutions per minute (RPM), or multiples of rotational speed (orders). Orders are commonly referred to as 1X for rotational speed, 2X for twice rotational speed, etc.

FREQUENCY COMPONENT. The amplitude, frequency and phase characteristics of a dynamic signal.

FREQUENCY DOMAIN. An FFT graph (amplitude versus frequency).

FREQUENCY RANGE. The frequency range (bandwidth) over which a measurement is considered valid; (i.e., within manufacturer's specifications). Typical analyzers have selectable ranges. Usually refers to upper frequency limit of analysis, considering zero as the lower analysis limit (See *ZOOM ANALYSIS*).

FREQUENCY RESPONSE. The amplitude and phase response characteristics of a system.

FREQUENCY RESPONSE FUNCTION. The transfer function of a linear system expressed in the frequency domain. Commonly defined as the ratio of the Fourier transform of the system's response to the Fourier transform of the system's excitation function as magnitude and phase or real and imaginary parts. Whereas the transfer function of a linear system is, in a strict sense, defined as the ratio of the LaPlace transform of the system response to the LaPlace transform of the LaPlace transform of the system response to the LaPlace transform of the system input, the frequency response function is more generally used.

FTF. Fundamental Train Frequency.

FUNDAMENTAL. The lowest frequency periodic component present in a complex spectrum. At least one complete period of a signal must be present for it to qualify as the "fundamental."

FUNDAMENTAL TRAIN FREQUENCY (FTF). The frequency at which the cage that contains the rollers rotates. Indicative of a fault in the cage.

– G –

g. A standard unit of acceleration equal to one earth's gravity, at mean sea level. The acceleration of free-fall. One g equals 32.17 ft/s2 (FPS) or 9.807 m/s2 (MKS).

GAIN. The factor by which an output signal exceeds an input signal; the opposite of attenuation; usually expressed in dB.

GEAR MESH FREQUENCY. A potential vibration frequency on any machine that contains gears; equal to the number of teeth multiplied by the rotational frequency of the gear.

GLOBAL BEARING DEFECT. Relatively large damage on a bearing element.

GROUND LOOP. Current flow between two or more ground connections where each connection is at a slightly different potential due to the resistance of the common connection.

– H –

HANNING WINDOW. DSA window function that provides better frequency resolution than the flat top window, but with reduced amplitude accuracy.

HARMONIC. Frequency component at a frequency that is an integer multiple of the fundamental frequency.

HEAVY SPOT. The angular location of the imbalance vector at a specific lateral location on a shaft. The heavy spot typically does not change with rotational speed.

HERTZ (Hz). The unit of frequency represented by cycles per second.

HFD. High Frequency Detection. A dynamic high frequency signal from an accelerometer which includes the accelerometer's resonant frequency. For assessing the condition of rolling element ball or roller bearings.

HIGH-PASS FILTER. A filter with a transmission band starting at a lower cutoff frequency and extending to (theoretically) infinite frequency.

HIGH SPOT. The angular location on the shaft directly under the vibration transducer at the point of closest proximity. The high spot can move with changes in shaft dynamics (e.g. from changes in speed).

– I –

IEEE 488 BUS. An industry standard bus that defines a digital interface for programmable instrumentation; it uses a byte-serial, bit-parallel technique to handle 8-bit-wide data words.

IMBALANCE. Unequal radial weight distribution on a rotor system; a shaft condition such that the mass and shaft geometric centerlines do not coincide.

INFLUENCE COEFFICIENTS. Mathematical coefficients that describe the influence of system loading on system deflection.

IN-PHASE (DIRECT) MOTION COMPONENT. (In F) The Cartesian value of the 1X vibration transducer angular location. This may be expressed as: IN F = A cos Q, where A is the peak to peak amplitude, and Q is the base angle of the 1X peak to peak amplitude, and Q is the phase angle of the 1X vector.

INNER RACE. A generally cylindrical component of rolling bearings which is positioned between the shaft and the rolling elements.

INTEGRATED CIRCUIT PIEZOELECTRIC. The industry standard powering scheme using a current limited voltage supply for powering internally amplified accelerometers and PVTs.

INTEGRATION. A process producing a result that, when differentiated, yields the original quantity. Integration of acceleration, for example, yields velocity integration is performed in a DSA by dividing by jw, where w is frequency multiplied by 2π. (Integration is also used to convert velocity to displacement.)

IsoRing®. A bolt through shear mode piezoelectric sensor designs that electrically, mechanically, and thermally isolates the sensing element from the sensor housing. A registered trademark of Wilcoxon Research.

– J –

JITTER. Abrupt and spurious shifts in time, amplitude, frequency or phase with waveforms of either a pulse or continuous nature. Can also be introduced by design as in the case of sample pulse dither.

JOURNAL. Specific portions of the shaft surface from which rotor applied loads are transmitted to bearing supports.

– K –

KEYPHASOR PHASE REFERENCE SENSOR. A signal used in rotating machinery measurements, generated by a sensor observing a once-per-revolution event The keyphasor signal is used in phase measurements for analysis and balancing. (Keyphasor is a Bently-Nevada name.)

– L –

LATERAL LOCATION. The definition of various points along the shaft axis of rotation.

LEAD-ZIRCONATE TITANATE. A piezoelectric ceramic material characterized by a very high activity (sensitivity), broad temperature range, and long term stability.

LEAKAGE. When power from discrete frequency components extends into adjacent frequency bands.

LINEAR RANGE. The portion of a sensor's output voltage versus gap curve within which the slope (linearity) does not vary significantly from the nominal slope.

LINEARITY. The response characteristics of a linear system remain constant with input level. That is, if the response to input a is A, and the response to input b is B, then the response of a linear system to input (a + b) will be (A + B). An example of a nonlinear system is one whose response is limited by a mechanical stop, such as occurs when a bearing mount is loose.

LINES. Common term used to describe the filters of a DSA (e.g. 400 line analyzer).

LINE SPECTRUM. The discrete frequency spectrum produced by the analysis of a periodic time function. Typically presented with fixed bandwidth resolution and normally contains neither broadband noise nor transient characteristics. Not necessarily given as a line or bar display.

LOCAL BEARING DEFECT. Relatively small damage on a bearing element, for example, a crack in an outer ring.

LOW-PASS FILTER. A filter whose transmission band extends from dc to an upper cutoff frequency.

LVDT. Acronym for Linear Variable Differential Transformer. A contacting displacement transducer consisting of a moveable core and a stationary transformer. The core is attached to the part to be measured and the transformer is attached to a fixed reference. Often used for valve position measurements.

– M –

MEMORY LENGTH (PERIOD). The size of storage, typically expressed in units of time for a specified sampling rate. Usually refers to the input memory section of an FFT processing system. Also, sometimes referred to as block or frame length (See FRAME). Defined as the sampling interval (Δt) times the number of samples (N) in the data block.

MEMORY SYNC. A timing pulse coincident with the starting address of a fixed length, recirculating memory. Often refers to an external sync pulse used to clock the loading of a finite length memory with respect to an externally free-running process, such as during a signal averaging operation. Also used to refer to a pulse output, occurring once each time a fixed length memory is updated or recirculated.

MODAL ANALYSIS. The process of breaking complex vibration into its component modes of vibration, very much like frequency domain analysis breaks vibration down to component frequencies.

MODE SHAPE. The resultant deflected shape of a rotor at a specific rotational speed to an applied forcing function. A three-dimensional presentation of rotor lateral deflection along the shaft axis.

MODULATION, AMPLITUDE (AM). The process where the amplitude of a signal is varied as a function of the instantaneous value of another signal. The first signal is called the carrier, and the second signal is called the modulating signal. Amplitude modulation produces a component at the carrier frequency, with adjacent components (sidebands) at the frequency of the modulating signal.

MODULATION, FREQUENCY (FM). The process where the frequency of the carrier is determined by the amplitude of the modulating signal. Frequency modulation produces a component at the carrier frequency, with adjacent components (sidebands) at the frequency of the modulating signal.

MOUNTING STUD. A threaded screw used to rigidly attach a motion sensor to the structure under test.

MOUNTING TORQUE. The optimum torque applied to the sensor when mounting with a threaded stud.

MULTIPLEXER. A hardware device that allows multiple channels to be digitized by a single ADC. In a typical scan, the multiplexer scans the input channels sequentially, pausing only long enough between channels to allow the conversion to be completed.

– N –

NATURAL FREQUENCY. The frequency of free vibration of a system. The frequency at which an undamped system with a single degree of freedom will oscillate upon momentary displacement from its rest position.

NODAL POINT. A point of minimum shaft deflection in a specific mode shape. May readily change location along the shaft axis due to changes in residual imbalance or other forcing function, or change in restraint such as an increased bearing clearance.

NOISE. Any component of a transducer output signal that does not represent the variable intended to be measured.

– N –

NORMAL SENSITIVITY. Syn.: Axial Sensitivity. The sensitivity of a motion sensor in the direction perpendicular to the surface of the mounting structure. (See Transverse Sensitivity.)

NOTCH FILTER. A band-elimination filter used to prevent the passage of specific frequencies.

NULLING. Vector compensation at shaft slow roll speed for 1 X electrical/ mechanical runout amplitude and phase that would otherwise distort vibration measurements at higher shaft speeds.

NYQUIST RATE. The Nyquist rate is equal to twice the highest signal frequency and is the minimum rate at which the data can be sampled and still avoid aliasing.

– O –

OCTAVE. The interval between two frequencies with a ratio of 2 to 1.

OIL WHIRL/WHIP. An unstable free vibration whereby a fluid-film bearing has insufficient unit loading. Under this condition, the shaft centerline dynamic motion is usually circular in the direction of rotation. Oil whirl occurs at the oil flow velocity within the bearing, usually 40–49% of shaft speed. Oil whip occurs when the whirl frequency coincides with (and becomes locked to) a shaft resonant frequency. (Oil whirl and whip can occur in any case where a fluid is between two cylindrical surfaces.)

OPTICAL PICKUP. A non-contacting transducer which detects the level of reflectively of an observed surface. Provides a light source directed out of the tip of the pickup. When this light is reflected back to the pickup from the observed surface, a voltage is generated.

ORBIT. The path of the shaft centerline motion during rotation. The orbit is observed with an oscilloscope connected to X and Y-axis displacement transducers. Some dual-channel DSAs also have the ability to display orbits.

ORDER. A multiple of some reference frequency. An FFT spectrum plot displayed in orders will have multiples of running speed along the horizontal axis. Orders are commonly referred to as 1X for running speed, 2X for twice running speed, and so on.

ORDER ANALYSIS. The ability to study the amplitude changes of specific signals that are related to the rotation of the device under test. Orders are numbered by their relationship to rotational speed, such as second order = 2 times RPM; third order = 3 times RPM.

OSCILLATION. The variation with time of the magnitude of a quantity alternating above and below a specified reference. (See Vibration.)

OUTER RACE. For rolling bearings, a generally cylindrical component which is positioned between the rolling elements and the bearing housing.

OUTPUT IMPEDANCE. The electrical impedance as measured from the output of an electrical system. The impedance at the output of a sensor must be considerably less than that of the input of the measurement system.

OVERLAP PROCESSING. The processing time of an FFT computing device is the total amount of time required to calculate a desired parameter once the loading of input data memory or memories has been accomplished. If the time required to process and display the results is equal to, or less than, the time required to sample the data signals and load input memories, the processing is said to be performed on a real time basis. If the processing can be performed significantly faster than the time required to sample and load signal inputs, it is then possible to perform multiple analyses of the input signals on a segmented basis. The concept of performing a new analysis on a segment of data in which only a portion of the signal has been updated (some old data, some new data) is referred to as overlap processing.

– P –

PALOGRAM. Waterfall plot turned 90 degrees for easier frequency specific trend identification.

PASSBAND ANALYSIS. Analysis of signals (information) that occur in a known, usually restricted bandwidth. Normally applies to frequency domain analysis which does not include dc. (See *BASEBAND ANALYSIS*.)

PEAK SPECTRA. A frequency domain measurement where, in a series of spectral measurements, the one spectrum with the highest magnitude at a specified frequency is retained.

PEAK-TO-PEAK VALUE. The difference between positive and negative extreme values of an electronic signal or dynamic motion. (See *AMPLITUDE*.)

PERIOD. The time required for a complete oscillation or for a single cycle of events. The reciprocal of frequency.

PERIODIC IN THE WINDOW. Term applied to a situation where the data being measured in a sampled data system is exactly periodic (repeats an integral number of times) within the frame length. Results in a leakage-free measurement in digital analysis instrumentation if a rectangular window is used. Real signals are typically not periodic in the window unless sampling is synchronized to the data periodicity.

PERIODIC RANDOM NOISE. A type of noise generated by digital measurement systems that satisfies the conditions for a periodic signal, yet changes with time so that devices under test respond as though excited in a random manner. When transfer function estimates are measured with this type of noise for the excitation, each individual measurement is leakage free and by ensemble averaging, the effects of system non-linearities are reduced, thus providing benefits of both pseudorandom and true random excitation.

PERIODIC WAVEFORM. A waveform which repeats itself over some fixed period of time.

PERIODICITY. The repetitive characteristic of a signal. If the period is T (sec), then this results in a discrete frequency or line spectrum with energy only at frequencies spaced at 1/T (Hz) intervals.

PHASE. A measurement of the timing relationship between two signals, or between a specific vibration event and a key phasor pulse.

PHASE ANGLE. ***1)*** Time displacement between two currents or two voltages (or their mechanical analogs) or between a current and a voltage measured in electrical degrees where an electrical degree is 1/360 part of a complete cycle of the frequency at which the measurement is made. ***2)*** The angle A given by A = tan1 x/ y, where x and y are the real and imaginary parts of a complex number.

PHASE REFERENCE. A signal used in rotating machinery measurements, generated by a sensor observing a once-per-revolution event.

PHASE RESPONSE. The phase difference (in degrees) between the filter input and output signals as frequency varies; usually expressed as lead and lag referenced to the input.

PHASE SPECTRUM. Phase-frequency diagram obtained as part of the results of a Fournier transform.

PICKET FENCE EFFECT. In general, unless a frequency component coincides exactly with an analysis line, there will be an error in both the indicated amplitude and frequency (where the highest line is taken as representing the frequency component). This can be compensated for, provided it is known (or assumed) that one is dealing with a single stable frequency component.

PIEZOELECTRIC. Any material which provides a conversion between mechanical and electrical energy. For a piezoelectric crystal, if mechanical stresses are applied on two opposite faces, electrical charges appear on some other pair of faces.

PIEZOELECTRIC ACCELEROMETER. A sensor which employs piezoelectric materials to transduce mechanical motion into an electrical signal proportional to the acceleration.

PIEZOELECTRIC VELOCITY TRANSDUCER. A piezoelectric accelerometer with on board signal integration into velocity.

POINT. An ID established in the database. This ID names an entity which is one specific and unique data collection location. One POINT is required for each specific measurement. Both vibration and process POINTs can be established.

POLAR PLOT. Polar coordinate representation of the locus of the 1X, 2X, 3X, ... vector at a specific lateral shaft location with the shaft rotational speed as a parameter.

POLARITY. In relation to transducers, the direction of output signal change (positive or negative) caused by motion in a specific direction (toward or away from the transducer) in the sensitive axis of the transducer. Normal convention is that motion toward the transducer will produce a positive signal change.

PRELOAD, BEARING. The dimensionless quantity that is typically expressed as a number from zero to one where a preload of zero indicates no bearing load upon the shaft, and one indicates the maximum preload (i.e., line contact between shaft and bearing).

PRELOAD, EXTERNAL. Any of several mechanisms that can externally load a bearing. This includes “soft” preloads such as process fluids or gravitational forces, as well as “hard” preloads from gear contact forces, misalignment, rubs, etc.

PROCESS POINT. POINT type used to monitor values other than vibration. Readings can be manually entered from the keyboard collected directly from certain types of instruments. Data values can be trended by the software for comparison of these process variables with vibration data.

PROCESSING GAIN. In a digital Fourier analysis system, the improvement in signal-to-noise ratio between periodic components and broadband noise obtained by transformation to the frequency domain and observation in that domain. The effect is caused by the noise power being spread out over all frequencies while the discrete signal power remains constant at fixed frequencies. Doubling the number of frequency resolution lines provides 3 dB of processing gain; (i.e., the noise floor will appear to be reduced by 3 dB in each cell).

PROM. Programmable Read Only Memory computer chip.

PSEUDORANDOM NOISE. A period signal generated by repeating a data record consisting of a series of random values. This noise has a discrete spectrum with energy at frequencies spaced at 1/ record length (sec).

PYROELECTRIC EFFECT. A property of most piezoelectric materials whereby a change in temperature produces a corresponding electrical signal.

– R –

RADIAL. Direction perpendicular to the shaft centerline.

RADIAL POSITION. The average location, relative to the radial bearing centerline, of the shaft dynamic motion.

RANDOM. Describing a variable whose value at a particular future instant cannot be predicted exactly.

RANDOM VIBRATION (RANDOM NOISE). Vibration whose instantaneous value cannot be predicted with complete certainty for any given instant of time. Rather, the instantaneous values are specified only by probability distribution functions which give the probable fraction of the total time that the instantaneous values lie within a specified range.

– NOTES –

“Random” means not deterministic.

“White” means uncorrelated (flat PSD).

“Gaussian” describes the shape of the PDF.

“Noise” usually means not the signal.

These are all different, though related.

REAL. In a complex signal, the component that is in phase with the excitation. In frequency domain analysis, it is the magnitude of the cosine terms of the Fourier series, “Coincident, Co”, as in CO-QUAD analyzer.

REAL-TIME ANALYSIS. Analysis for which, on the average, the computing associated with each sampled record can be completed in a time less than, or equal to, the record length. In digital analyzers, the functions accomplished during the computing time should be specified; (e.g., Fourier transform, calibration, normalizing by the effective filter bandwidth, averaging, display, etc.).

– R –

REAL TIME RATE. For a DSA, the broadest frequency span at which data is sampled continuously. Real time rate is mostly dependent on FFT processing speed.

RELATIVE MOTION. Vibration measured relative to a chosen reference. Displacement transducers generally measure shaft motion relative to the transducer mounting.

REPEATABILITY. The ability of a transducer or readout instrument to reproduce readings when the same input is applied repeatedly.

RESOLUTION. The smallest change in stimulus that will produce a detectable change in the instrument output.

RESONANCE. The condition of vibration amplitude and phase change response caused by a corresponding system sensitivity to a particular forcing frequency. A resonance is typically identified by a substantial amplitude increase, and related phase shift.

ROLL-OFF FREQUENCY. syn.: cutoff frequency. The frequency at which a filter attenuates a pass band gain by 3 dB.

ROLL-OFF RATE. Usually refers to a filter characteristic. The best straight-line fit to the slope of the "filter transmissibility characteristic" in the "transition band," usually expressed in dB per octave.

ROLLING ELEMENT BEARING. Bearing whose low friction qualities derive from rolling elements (balls or rollers), with little lubrication.

ROLLOFF RATE. Also known as "ultimate slope;" filter's attenuation rate at frequencies well outside the passband. Expressed as a positive rate of change of amplitude (in dB/octave or dB/decade of frequency) for a low-pass filter; as a negative attenuation rate for a high-pass filter.

ROOT MEAN SQUARE IRMSR. Square root of the arithmetical average of a set of squared instantaneous values. DSAs perform RMS averaging digitally on successive vibration spectra.

ROOT MEAN SQUARE RMS. Square root of the arithmetic average of a set of squared instantaneous values. This can be expressed by an integral as: where x is the dependent variable, t is the independent variable and T is the period. (See *AMPLITUDE*.)

ROTOR, FLEXIBLE. A rotor which operates close enough to, or beyond its first bending critical speed for dynamic effects to influence rotor deformations. Rotors which cannot be classified as rigid rotors are considered to be flexible rotors.

ROTOR, RIGID. A rotor which operates substantially below its first bending critical speed. A rigid rotor can be brought into, and will remain in, a state of satisfactory balance at all operating speeds when balanced on any two arbitrarily selected correction planes.

RPM SPECTRAL MAP. A spectral map of vibration spectra versus RPM.

RTD. An acronym for Resistance Thermal Device; a sensor which measures temperature and change in temperature as a function of resistance.

RUNOUT COMPENSATION. Electronic correction of a transducer output signal for the error resulting from slow roll runout.

RS-232C. A de facto standard, originally introduced by the Bell System, for the transmission of data over a twisted-wire pair less than 50 feet in length; it defines pin assignments, signal levels, and so forth, for receiving and transmitting devices. Other RS-standards cover the transmission of data over distances in excess of 50 feet (RS-422; RS-485).

– S –

SAMPLING. The process of obtaining a sequence of instantaneous values of a function at regular or intermittent intervals.

SAMPLING RATE. The rate, in samples per second, at which analog signals are sampled and then digitized. The inverse of the sampling interval.

SCALE FACTOR. The Factor by which the reading of an instrument must be multiplied in order to result in the true final value, when a corresponding (but inverse) scale factor was used initially to bring the signal amplitude within range of the instrument.

SEISMIC. Refers to an inertially referenced measurement or a measurement relative to free space.

SCREENING. Transformation of a measurement to such a form that it enhances the information about a certain defect.

***SEE™* (SPECTRAL EMITTED ENERGY).** Technology developed by SKF to measure high frequencies (250-350 kHz) associated with metal-to-metal contact in rolling element bearings.

SEISMIC TRANSDUCER. A transducer that is mounted on the case or housing of a machine and measures casing vibration relative to free space. Accelerometers and velocity transducers are seismic.

SENSITIVITY. The ratio of magnitude of an output to the magnitude of a quantity measured (for example, sensitivity of measuring voltage with an oscilloscope is specified in centimeters/volt or divisions/volt). Also, the smallest input signal to which an instrument can respond.

SENSOR. A transducer which senses and converts a physical phenomenon to an analog electrical signal.

SHEAR MODE ACCELEROMETER. An accelerometer design which stresses the piezoelectric element in the shear direction: i.e. the electrode faces move parallel to each other. (See *BENDER BEAM ACCELEROMETER, COMPRESSION MODE ACCELEROMETER*.)

SHOCK LIMIT. The maximum amount of short duration mechanical shock that a sensor can be subjected to before the possibility of permanent damage can occur. (See *MECHANICAL SHOCK*.)

SIDEBANDS. Additional frequencies generated by frequency modulation.

SIDE LOBE. A response separated in frequency from the main or desired response. Usually refers to a filter shape, particularly in digital filters that have complex structure (many notches and peaks) in the filter transition band

SIGNAL ANALYSIS. Process of extracting information about a signal's behavior in the time domain and/or frequency domain. Describes the entire process of filtering, sampling, digitizing, computation, and display of results in a meaningful format.

SIGNAL CONDITIONER. A device placed between a signal source and a readout instrument to change the signal. Examples: attenuators, preamplifiers, signal converters (for changing one electrical quantity into another, such as volts to amps or analog to digital), and filters.

SIGNAL-TO-NOISE RATIO. A measure of signal quality. Typically, the ratio of voltage or power of a desired signal to the undesired noise component measured in corresponding units.

SIGNATURE. A vibration frequency spectrum which is distinctive and special to a particular machine or component, system or subsystem at a specific point in time, under specific machine operating conditions. Used for historical comparison of mechanical condition over the operating life of the machine.

SIGNATURE ANALYSIS. The method whereby a physical process or device is identified in terms of the invariant frequency characteristics of the signal it generates.

SIGNATURE ANALYZER. Compares stored patterns (signatures) against received patterns.

SIMULTANEOUS SAMPLE and HOLD. In data acquisition systems, the technique of using separate sample and hold amplifiers for each channel. This allows simultaneous sampling on all channels, thereby eliminating any SKEW due to use of a multiplexer.

SLEW RATE. The large-signal rate-of-change of output of a filter under specific operating conditions, expressed in volts/microsecond; expresses the fastest rate at which a filter output can execute voltage level output excursions to within predicted tolerances.

SLOW ROLL SPEED. Low rotative speed at which dynamic motion effects from forces such as imbalance are negligible.

SPALL. In rolling bearings, a flake or chip of metal removed from one of the bearing races or from a rolling element. Spalling is evidence of serious bearing degradation and may be detected during normal bearing operation by observing increases in the signal amplitude of the high frequency vibrations signals.

SPECTRAL MAP. A three-dimensional plot of the vibration amplitude spectrum versus another variable, usually time or RPM.

SPECTRUM. The distribution of the amplitude of the components of a time domain signal as a function of frequency.

SPECTRUM ANALYZER. An instrument which displays the frequency spectrum of an input signal.

STATIC DATA. Data which describes the quantitative characteristics of the measured parameter. Static data can also include quantitative values describing the conditions under which the parameter was measured. For condition monitoring purposes, static data is typically presented in various forms of trend graphs and displays/lists of current values. Examples of static data include vibration amplitude, phase lag angle, frequency, vector, average shaft position, shaft rotative speed, time, date, monitor alarm and OK status.

STEADY STATE DATA. Data (static and/or dynamic) acquired from a machine which is on-line, under (relative) constant operating conditions (shaft rotative speed, load).

STIFFNESS. The spring-like quality of mechanical and hydraulic elements to elastically deform under load.

STRAIN. The physical deformation, deflection, or change in length resulting from stress (force per unit area).

STRAIN GAUGE. A transducer which reacts to changes in load, typically through changes in resistance.

SUBHARMONIC. Sinusoidal quantity of a frequency that is an integral submultiple of a fundamental frequency.

SUBSYNCHRONOUS. Component(s) of a vibration signal which has a frequency less that shaft rotative frequency.

SYNC PULSE. A trigger pulse which is used to synchronize two or more processes.

SYNCHRONOUS. The component of a vibration signal that has a frequency equal to the shaft rotative frequency (1X).

SYNCHRONOUS TIME DOMAIN. A dynamic amplitude vs. time graph (time domain) of data averaged in relation to a synchronous trigger pulse.

SYSTEM IDENTIFICATION. The process of modeling a dynamic system and experimentally determining values of parameters in the mathematical model which best describes the behavior of the system.

– T –

TEMPERATURE RANGE. The temperature span, given by the temperature extremes, over which the sensor will perform without damage. Specifications within the temperature range may vary as a function of temperature.

TEMPERATURE RESPONSE. A measure of the change in a quantity, usually sensitivity, as a function of temperature.

THERMOCOUPLE. A temperature sensing device comprised of two dissimilar metal wires which, when thermally affected (heated or cooled), produce a proportional change in electrical potential at the point where they join.

THRESHOLD. The smallest change in a measured variable that will result in a measurable change in an output signal.

THROUGH-PUT. Amount of work performed by a system (e.g., number of batch jobs per hour processed by a computer).

THRUST POSITION. (See *AXIAL POSITION*.)

TIME AVERAGING. In a DSA, averaging of time records that results in reduction of asynchronous components.

TIMEBASE DISPLAY/PLOT. A presentation of instantaneous amplitude of a signal as a function of time. A vibration waveform can be observed on an oscilloscope in the time domain.

TIME DOMAIN. A dynamic amplitude versus time graph.

TIME LAG. In correlation analysis one calculates an integral of the product of one signal and a temporally displaced signal. The time difference between the two signals is referred to as the time-lag.

– T –

TIME RECORD. In a DSA, the sampled time data converted to the frequency domain by the FFT. Most DSAs use a time record of 1024 samples.

TIME RECORD LENGTH. The total length of time over which a time history is observed. This total time may be broken up into several shorter data blocks.

TIMESTAMP. Current date assigned at time of data collection or event.

TIME SYNCHRONOUS. A data sampling and/or processing technique in which the beginning or ending of a data block is synchronized with an external event.

TIME WINDOW. The time record is often divided into segments and each segment is analyzed as a unit or frame of data. Each frame is called a block or time window. (See *WINDOW*.)

TORQUE. A measure of the tendency of a force to cause rotation, equal to the force multiplied by the perpendicular distance between the line of action of the force and the center of rotation.

TORSIONAL VIBRATION. Amplitude modulation of torque measured in degrees peak-to-peak referenced to the axis of shaft rotation.

TRACKING FILTER. A low-pass or bandpass filter which automatically tracks the input signal. A tracking filter is usually required for aliasing protection when data sampling is controlled externally.

TRANSDUCER. (See *SENSOR*.)

TRANSIENT ANALYSIS. When the excitation of a system is of finite duration, the analysis of the data is a transient analysis. A transient analysis can also be used to study the change from one steady-state to a second steady-state condition.

TRANSIENT VIBRATION. Temporarily sustained vibration of a mechanical system. It may consist of forced or free vibration or both. Typically this is associated with changes in machine operating condition such as speed, load, etc.

TRANSVERSE SENSITIVITY. syn.: Cross Axis Sensitivity. The parameter quantifying the unwanted output signal picked up by a motion transducer when subjected to motion perpendicular to the normal axis of operation. The transverse sensitivity is usually given in terms of the maximum percent of the normal axis sensitivity.

TRIBOELECTRIC EFFECT. Electrical noise caused by cable motion. When a cable is bent, the displacement of one conductor relative to the other introduces a spurious signal. Particularly problematic with high impedance electrical systems, such as charge mode accelerometers.

TRIGGER. Any event which can be used as a timing reference. In a DSA, a trigger can be used to initiate a measurement.

TRIP MULTIPLIER. That function provided in a monitor system to temporarily increase the alarm (Alert and Danger) set point values by a specific multiple. This function is normally applied by manual (operator) action during start-up to allow a machine to pass through critical speed ranges without nuisance monitor alarm indications.

TSI. Acronym for Turbine Supervisory Instrumentation. A TSI system is a continuous monitoring system generally used on turbogenerator sets. It can include such measurement parameters as shaft radial vibration, axial thrust position, differential expansion, case expansion, valve position, and shaft rotative speed. The TSI system consists of measurement sensors, monitors, interconnecting wiring and a microprocessor-based monitoring/ data acquisition system.

TTL (TRANSISTOR-TRANSISTOR LOGIC). A logic family characterized by high speeds, medium power consumption, and wide usage.

– U –

UNBALANCE. (See *IMBALANCE*.)

UNIFORM WINDOW. In a DSA, a window function with uniform weighting across the time record. This window does not protect against leakage, and should be used only with transient signals contained completely within the time record.

UPLOAD. Transferring collected data from the MICROLOG to the host computer.

– V –

VALVE POSITION. A measurement of the position of the process inlet valves on a machine, using expressed as a percentage of the valve opening; zero percent is fully closed, 100 percent is fully open. Often incorporated as a measured parameter on steam turbines.

VANE PASSING FREQUENCIES. A potential vibration frequency on vaned impeller compressors, pumps, and other machines with vaned rotating elements. It is represented by the number of vanes (on an impeller or stage) times shaft rotative frequency.

VECTOR. A quantity which has both magnitude and direction (phase).

VELOCITY. The time rate of change of displacement. This if often expressed as V, x or dx/dt; velocity leads displacement by 90 degrees in time. Typical units for velocity are inches/second or millimeters/ second, zero to peak. Velocity measurements are usually obtained with an accelerometer and integrated to velocity or a mechanically activated velocity transducer and are used to evaluate machine housing and other structural response characteristics. Electronic integration of a velocity signal yields displacement.

VELOCITY SENSOR. An electromechanical transducer, typically of seismic design, used for measuring bearing housing and other structural vibration. This transducer measures absolute vibration, relative to a fixed point in space.

VIBRATION. Magnitude of cyclic motion; may be expressed as acceleration, velocity, or displacement. Defined by frequency and timebase components.

VIBRATION LIMIT. The maximum amount of vibration that a sensor can be subjected to before the possibility of permanent damage can occur.

– W –

WATERFALL PLOT. (See *SPECTRAL MAP*.)

WAVEFORM. A presentation or display of the instantaneous amplitude of a signal as a function of time. A vibration waveform can be observed on an oscilloscope in the timebase mode.

WINDOW. When a portion only of a record is analyzed, that portion is called a window. A window can be expressed in either the time domain or in the frequency domain, although the former is more common. To reduce the edge effects, which cause leakage, a window is often given a shape or weighting function. A window in the time domain is represented by a multiplication and, hence, is a convolution in the frequency domain. A convolution can be thought of as a smoothing function. This smoothing can be represented by an effective filter shape of the window; energy at a frequency in the original data will appear at other frequencies as given by the filter shape. Since time domain windows can be represented as a smoothing function in the frequency domain, the time domain windowing can be accomplished directly in the frequency domain.

– Z –

ZERO TO PEAK VALUE. One-half of the peak to peak value. (See *AMPLITUDE*.)

ZOOM. Feature to magnify portions of a selected spectrum plot for more detailed examination.

ZOOM ANALYSIS. A zoom analysis is a technique for examining the frequency content of a signal with a fine resolution over a relatively narrow band of frequencies. The technique basically takes a band of frequencies and translates them to a lower band of frequencies, where the signals can be decimated to reduce the sample size. A standard analyzer can then be used to analyze the data.

– NOTE –

That the increased resolution of this technique requires a corresponding increase in the time record length. The sample rate is decreased by decimation, to reduce the number of samples in the time window, only after the demodulation.

Conversion Charts

Acceleration

1 g = 32.174 ft/sec^2
1 g = 9.807 m/sec^2
1 in/sec^2 = 0.0254 m/sec^2

Displacement

1 mil = 0.001 in
1 mil = 0.0254 mm
1 in = 25.4 mm
1 cm = 10 mm

Frequency

1 Hz = 1 cps
1 Hz = 0.159 rad/sec
1 Hz = 60 rpm
1 rpm = 0.0167 Hz
1 rpm = 1 cpm

Temperature

°F	°C
-58	-50
-40	-40
+32	0
+77	+25
+176	+80
+248	+120
+392	+200
+500	+260

°F = (°C) 9/5 + 32
°C = 5/9 (°F – 32)

Decibel Scale

dB	Gain
60	1000.000
40	100.000
20	10.000
10	3.160
6	2.000
3	1.410
1	1.120
0	1.000
-1	0.891
-3	0.708
-6	0.501
-10	0.316
-20	0.100
-40	0.010
-60	0.001

$$dB = 20 \log (V_{out}/V_{ref})$$
$$V_{out}/V_{ref} = \log^{-1} (dB/20)$$

Weight

1 ounce = 28.35 grams
1 kilogram = 2.205 lbs
1 Newton = 0.2245 lbs

Sinusoidal Motion (zero–peak).

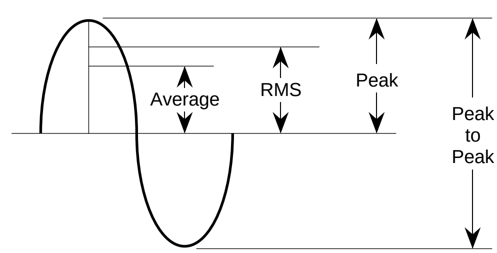
	Displacement (D) (in)	Velocity (V) (in/sec)	Acceleration (A) (g)
Displacement (D) (in)	----------	D = 0.159 V/ƒ	D = 9.78 A/ƒ2
Velocity (V) (in/sec)	V = 6.28ƒD	----------	V = 61.4 A/ƒ
Acceleration (A) (g)	A = 0.102 ƒ2D	A = 0.0163 ƒ V	----------

ƒ = frequency, Hz

Sinusoidal Wave Forms Multiplier* x *(A =* x*B).

B

A		Peak	Peak to Peak	RMS	Average
	Peak	1.000	0.500	1.414	1.570
	Peak to Peak	2.000	1.000	2.828	3.140
	RMS	0.707	0.354	1.000	1.110
	Average	0.637	0.319	0.901	1.000



Average Value = 0.637 x Peak Value
RMS Value = 0.707 x Peak Value
Peak Value = 1.414 x RMS Value
Peak to Peak Value = 2.000 x Peak Value
Peak to Peak Value = 2.828 x RMS Value

Sensor Selection Checklist

For assistance in selecting a vibration sensor, specific application and measurement requirements should be provided to the application engineer. Completing the checklist below will help ensure that the proper sensor is chosen.

Describe the Vibration Measurement Application (check all that apply):

INDUSTRY

- ❒ Pulp and Paper
- ❒ Petrochemical
- ❒ Power Plant
- ❒ Oil Exploration
- ❒ Mining
- ❒ Military
- ❒ Automotive
- ❒ Laboratory Research
- ❒ Microelectronics
- ❒ Civil Engineering
- ❒ Other ________________________

MACHINERY TYPE

- ❒ Cooling Towers
- ❒ Shipboard Machinery
- ❒ Rotating Machinery
- ❒ Bearings
- ❒ Pumps
- ❒ Turbines
- ❒ Compressors
- ❒ Engines
- ❒ Machine Tools
- ❒ Other ________________________

MEASUREMENT TYPE

- ❒ Balancing
- ❒ Diagnostic Testing
- ❒ Trend Analysis
- ❒ Predictive Maintenance
- ❒ Alarm Condition
- ❒ High Frequency Testing
- ❒ Other ________________________

Please describe the application: ____

____

____

Dynamic Measurement Requirements of the Application:

What is the approximate vibration amplitude level to be measured? __________ g peak (rms), ______ in/sec/peak (mm/sec/rms), ______ mil peak (µm peak)

What is the maximum vibration amplitude level expected to be present? ______ g peak (rms), ______ in/sec/peak (mm/sec/rms), ______ mil peak (µm peak)

What is the minimum vibration amplitude level of interest? ________________ g peak (rms), ______ in/sec/peak (mm/sec/rms), ______ mil peak (µm peak)

What is the maximum frequency of interest? ____________ Hz, ____________ RPM

What is the minimum frequency of interest? ____________ Hz, ____________ RPM

Mechanical and Chemical Environment of the Application:

Continuous temperature range (minimum to maximum): __________ to __________ °C, __________ to __________ °F

Intermittent temperature range (minimum to maximum): __________ to __________ °C, __________ to __________ °F

What is the expected humidity level? _______________ % relative

What fluids contact the accelerometer? ____

If submerged, what fluid pressure will be present? _______________ psi/nm

Are high amplitude mechanical signals present? (i.e. Steam valve release, gear chatter, impacts) ____

What is the highest shock level expected to be present? _______________ g peak

What chemicals or gases contact the accelerometer or cable? (Check all that apply)

- ❒ Water (i.e. salt water, heavy water, steam) *Describe:* ____
- ❒ Halogens (i.e. chlorine, fluorine, halogenated compounds) *Describe:* ____
- ❒ Gases (i.e. ozone, chemical fumes) *Describe:* ____
- ❒ Acids (i.e. hydrochloric, sulfuric, nitric) *Describe:* ____
- ❒ Bases (i.e. ammonia, caustic soda) *Describe:* ____
- ❒ Solvents (i.e. methyl ethyl keytone, freon, alcohol) *Describe:* ____
- ❒ Fuels (i.e. gasoline, kerosene) *Describe:* ____
- ❒ Oil (i.e. lubricating, crude) *Describe:* ____
- ❒ Detergents *Describe:* ____
- ❒ Other Chemicals *Describe:* ____

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