CONNECTION TECHNOLOGY CENTER, INC.

LEVEL 2 – LESSON 4

THE RIGHT TOOL FOR THE JOB:
SELECTING THE PROPER ACCELEROMETER FOR YOUR APPLICATION

INTRODUCTION

Welcome to **Level 2, Lesson 4** of CTC's free online vibration analysis training. We're glad you have taken the time to view this self-paced lesson on monitoring machinery vibration using dynamic and process control signals. We hope you enjoy the training and will continue to build your vibration analysis knowledge as you progress through Level 2.

OBJECTIVES

After completing this training module you will understand:

- The general **construction of an accelerometer**

- How those differences in construction make a **specific sensor more suited to measuring specific types of applications**

- How using the right tools will help analysts **gather better, clearer data** from which to make very important decisions about machinery health

PREVENTIVE FAILURES

A lack of lubrication was the root cause of this catastrophic bearing failure.

If there had been a vibration monitoring program using an accelerometer to measure the vibration, the lack of lubrication would have been detected very early, and many steps could have been taken to prevent this failure.

Condition monitoring programs utilizing vibration analysis techniques will always have a high value when compared to sudden unexpected failures.

MEASURING MACHINERY VIBRATION

The measurement of machinery vibration **using an accelerometer will prevent unexpected failures of the machine**.

Portable or permanent vibration measurements can be trended over time. If vibration levels increase, a detailed analysis of the vibration can be performed, and repairs can be scheduled prior to mechanical, electrical, or process failure.

Choosing **the right accelerometer for the job** will always provide the best measurements and most detailed information.

One accelerometer does not fit all applications. Understanding how they work and how to apply them for your specific application will be very beneficial to the overall success of the vibration monitoring program on your machines.

PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

Accelerometers are widely used to measure vibration in rotating machinery due to:

- The **broad frequency range and dynamic range** that they can be used to monitor
- The **durability and portability** that is inherent in their design

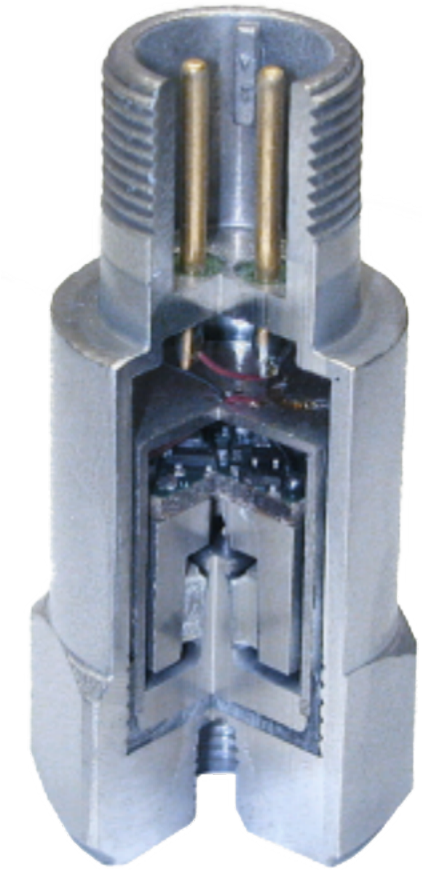
For the purpose of this training, we will limit our discussion to **industrial accelerometers** with the most common construction and material for that market:

- **Annual shear mode design utilizing PZT ceramic**. This design provides a low noise solution with a great deal of **durability and stability** in a wide range of environments

PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

The **external housing** of the sensor should be made from a material like **316L**.

This corrosive-resistant stainless steel is well suited for industrial environments

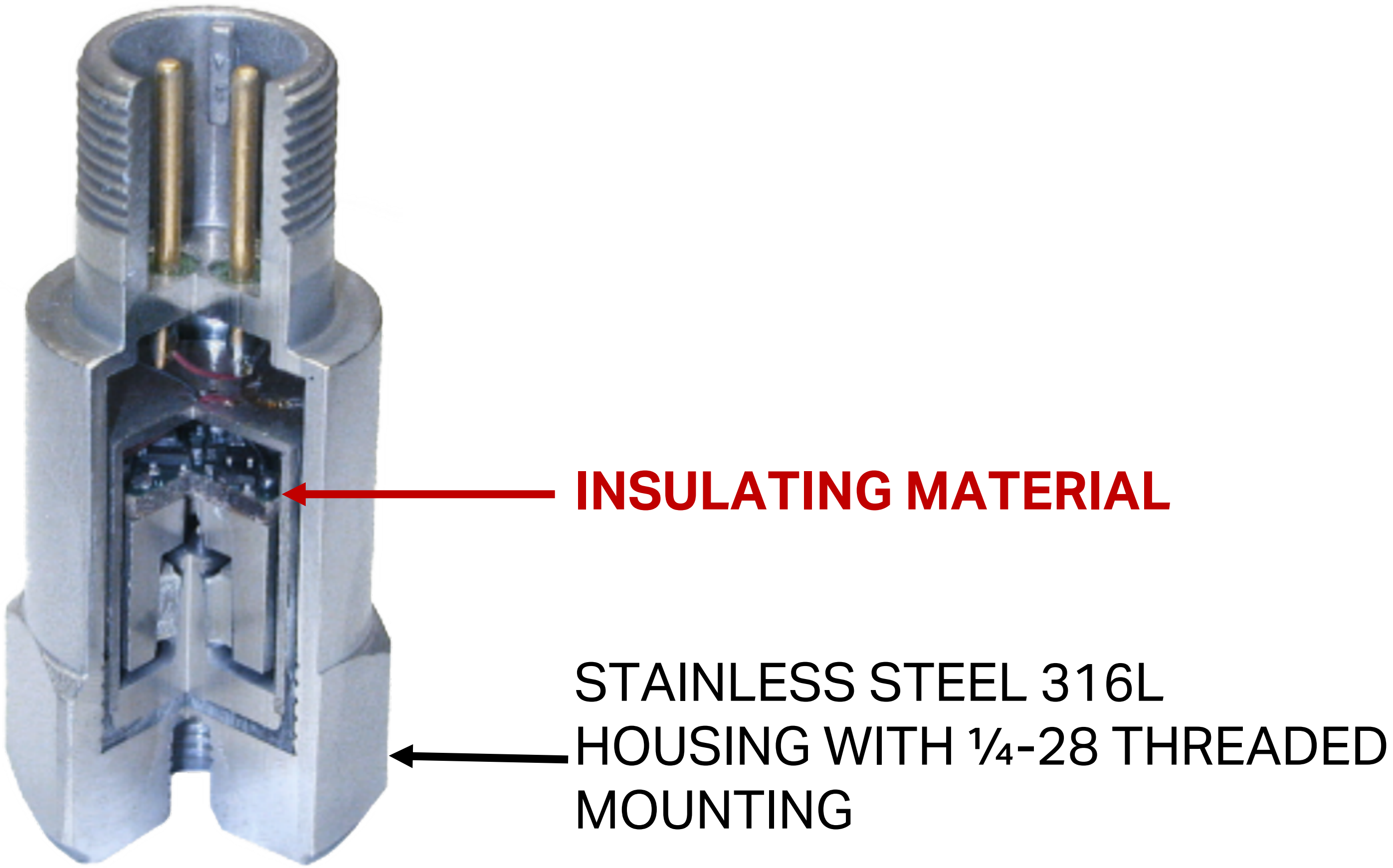


STAINLESS STEEL 316L HOUSING WITH ¼-28 THREADED MOUNTING

PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

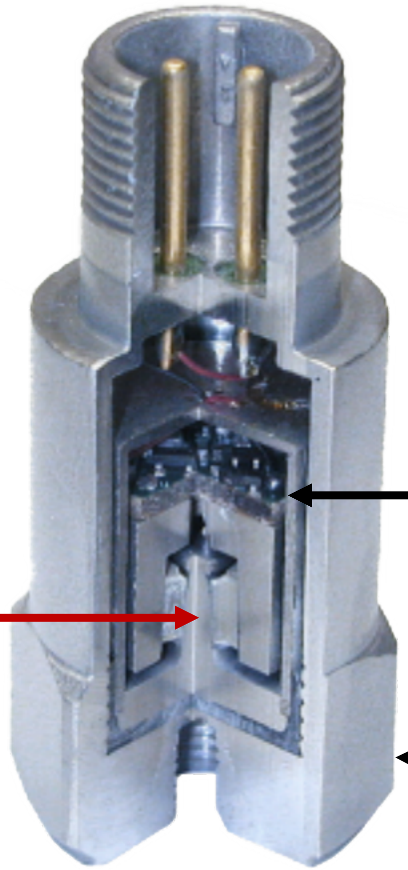
The application of a **rigid insulating material** between the sensing element and sensor housing will provide case isolation while still providing good transmission of the vibration to the sensing element.

Case isolation is important in the industrial environment due to a variety of grounding and interference issues which could be present. **Lack of isolation will lead to data with transient spikes** which are unrelated to vibration.



PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

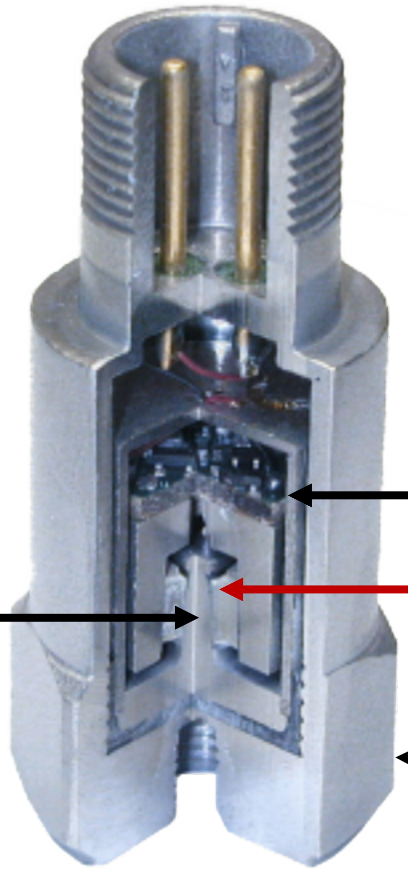
The **pedestal** (**or post**) is attached to the base and holds the PZT ceramic in place. Vibration is transmitted through the base of the sensor to the post.



PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

The **PZT ceramic** acts as the internal stiffness factor in the sensor. When a force acts on the PZT material, an electrical charge is produced proportional to the forces.

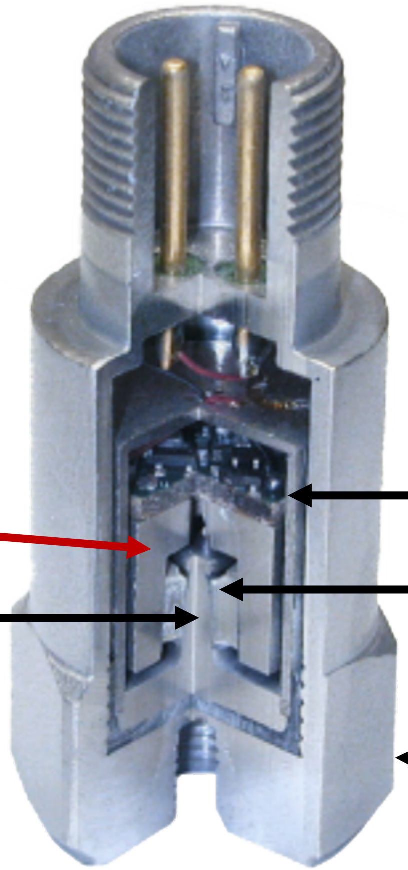
The **PZT** (piezoelectrical lead zirconate titanate) **ceramic** is a very high quality material with excellent mechanical strength and temperature stability. PZT has extremely **low noise characteristics** and provides **a high signal to noise ratio**



PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

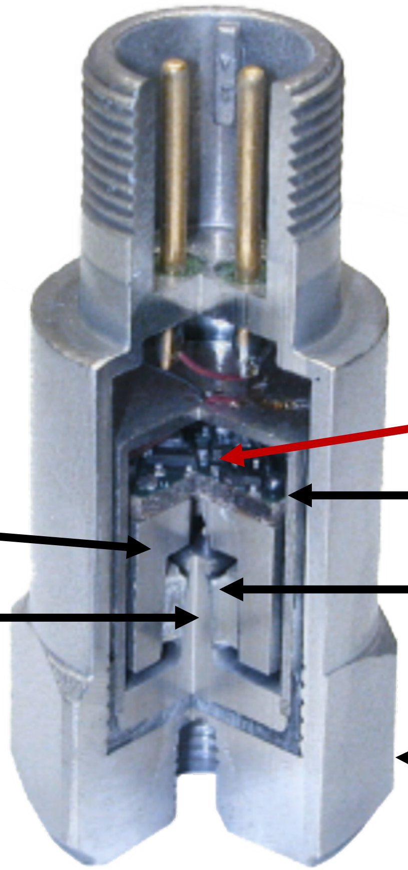
A **mass** is placed on the outside of the PZT ceramic and acts as the internal mass for the sensor.

A high quality (non ferrous) stainless steel mass should be used to prevent magnetic interference and false vibrations.



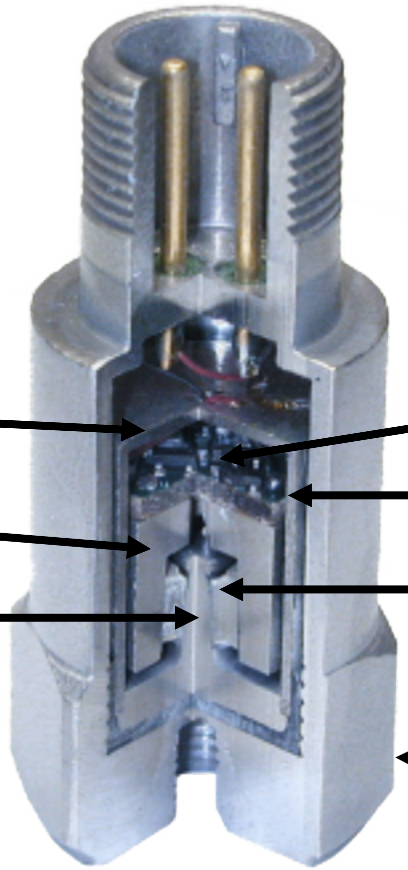
PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

The electronics on the **PC Board** are used to convert the charge output of the PZT ceramic to a voltage, apply filtering, and amplify the output of the sensor.



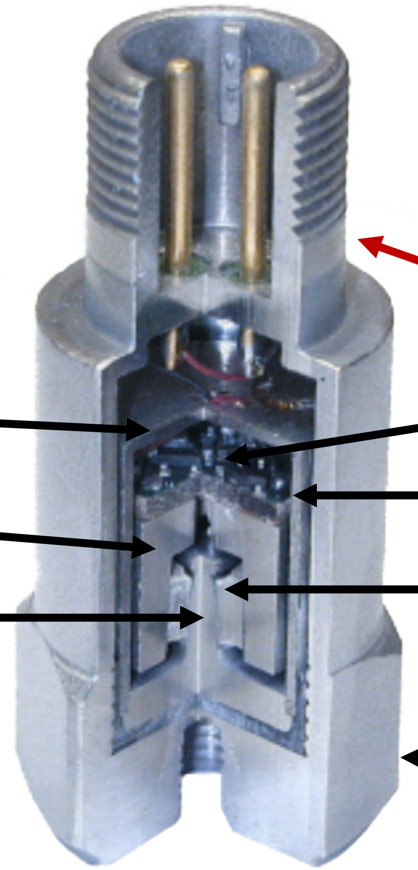
PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

The **faraday shield** protects the sensor electronics from RFI (radio frequency interference) and EMI (electro magnetic interference).



PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

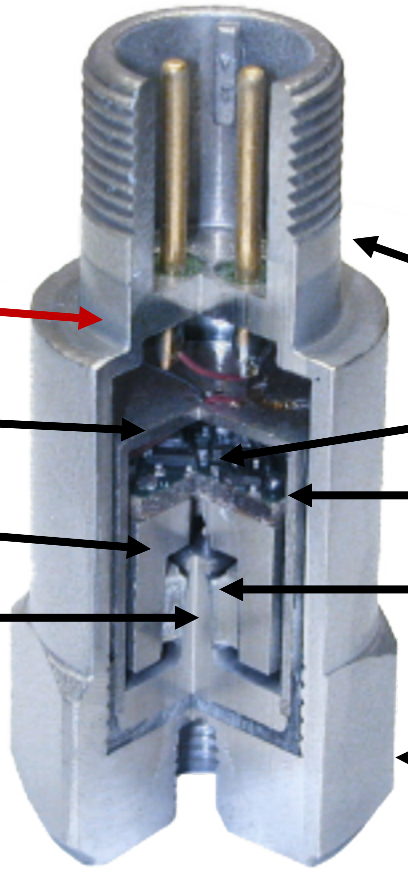
The **MIL C 5015 connector** is the standard connector used in industrial vibration analysis.



PARTS OF AN IEPE SENSOR - (INTEGRATED ELECTRONICS PIEZO ELECTRIC)

A **welded seam** between the connector and the sensor provides a hermetic seal.

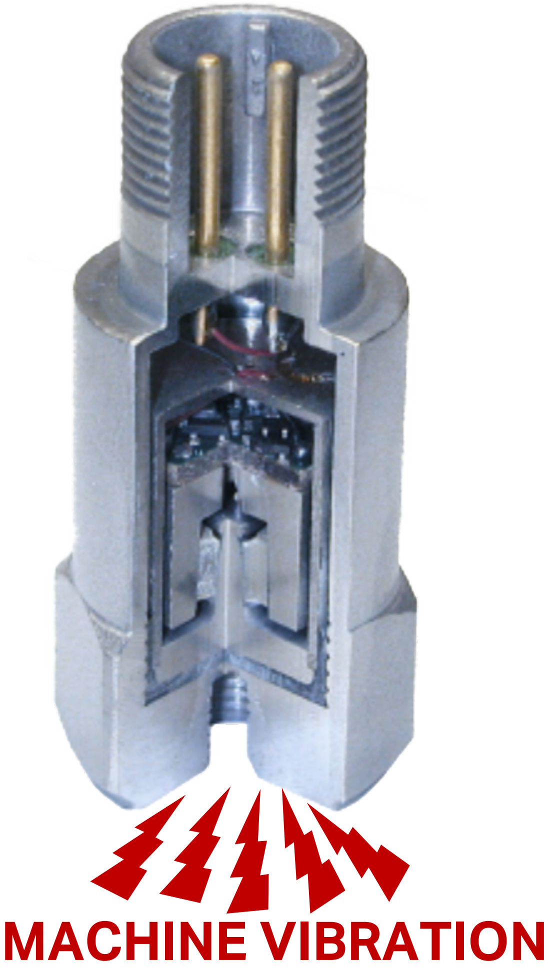
The **hermetic seal** prevents any contamination from entering the sensor.



SHEAR MODE FUNCTIONALITY

When the sensor is mounted to the machine, the **vibration of the machine enters through the base of the sensor** and makes the sensor vibrate.

Part of Newton's first law of motion states: "An object at rest tends to stay at rest."



The **internal mass** of the sensor, located on the outside of the PZT ceramic, is tending to stay at rest.

The **pedestal or post**, located on the inside of the PZT ceramic, is vibrating at the same rate as the machine.

This places the **PZT ceramic** in "shear" between the internal vibration of the post and the external stationary mass.

This stress on the PZT creates a charge output proportional to the vibratory forces. That charge is then filtered and amplified and sent to the analysts' systems.

SHEAR MODE BENEFITS

The **primary benefit of having a shear mode sensor is the resistance of the sensor to base strain**. Because the PZT ceramic is not used in a compression mode, the sensor can be strained at the base with no effects on the output signal of the sensor. Base strain is often caused by temperature transients or a lateral force on the sensor, such as a data collector cable. **Preventing base strain improves measurements**.

Shear mode sensors also have minimal output changes as a result of gravity. The sensor mounting is unidirectional with little or no effect from the earth's gravitational force.

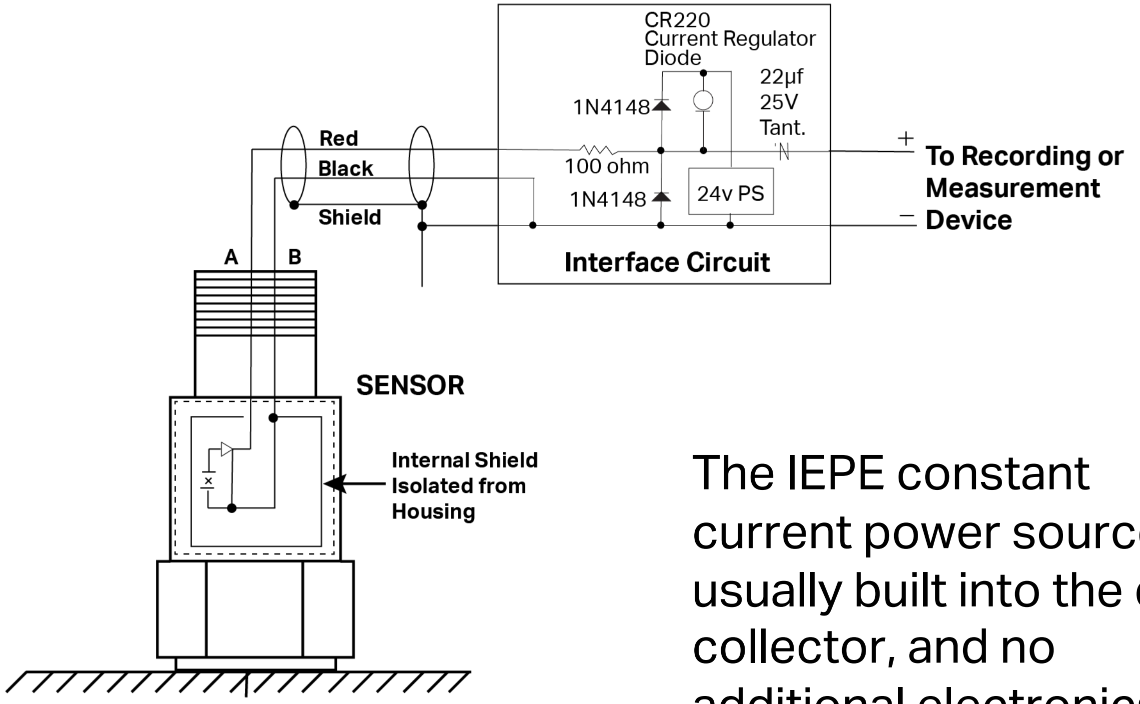
BASE STRAIN

BIAS VOLTAGE FOR IEPE ACCELEROMETERS

The IEPE accelerometer is a two-wire sensor that will function with a constant current power source that provides 2-10 mA with a DC voltage level between 18 and 30 VDC.

The **bias voltage** is the DC operating voltage of the electronics inside the accelerometer. It is typically 7-14 VDC.

The vibration is an AC signal that rides on top of the DC bias voltage. A de-coupling capacitor is used to separate the AC signal (vibration) from the DC bias voltage in most power supplies and data collectors.



The IEPE constant current power source is usually built into the data collector, and no additional electronics are required.

SENSITIVITY, RANGE AND APPLICATION

SENSITIVITY	RANGE	OUTPUT	APPLICATION
10 mV/g	+/- 500 g	+/- 5 VAC	A **10 mV/g accelerometer** will have a dynamic range of +/- 500 gs, and a dynamic output of +/- 5 volts AC. They are **typically used for machinery that is generating high amplitude vibrations**. With large dynamic range, they are much less likely to become saturated as a result of the high amplitude vibrations.
50 mV/g	+/- 100 g	+/- 5 VAC	
100 mV/g	+/- 50 g	+/- 5 VAC	
500 mV/g	+/- 10 g	+/- 5 VAC	

SENSITIVITY, RANGE AND APPLICATION

SENSITIVITY	RANGE	OUTPUT	APPLICATION
10 mV/g	+/- 500 g	+/- 5 VAC	A **50 mV/g accelerometer** will have a dynamic range of +/- 100 gs, and a dynamic output of +/- 5 volts AC. They are **typically used for general purpose machinery measurements**, and are sometimes offered as standard sensors for data collectors.
50 mV/g	**+/- 100 g**	**+/- 5 VAC**	
100 mV/g	+/- 50 g	+/- 5 VAC	
500 mV/g	+/- 10 g	+/- 5 VAC	

SENSITIVITY, RANGE AND APPLICATION

SENSITIVITY	RANGE	OUTPUT	APPLICATION
10 mV/g	+/- 500 g	+/- 5 VAC	A **100 mV/g accelerometer** will have a dynamic range of +/- 50 gs, and a dynamic output of +/- 5 volts AC. This is the **industry leading standard for general purpose machinery measurements**, and are typically offered as standard sensors for data collectors. Approximately 90% of all vibration analysis and data collection is accomplished with a 100 mV/g accelerometer. Note: Some sensors are also available with a +/- 80g dynamic range for measuring larger signal amplitudes.
50 mV/g	+/- 100 g	+/- 5 VAC	
100 mV/g	**+/- 50 g**	**+/- 5 VAC**	
500 mV/g	+/- 10 g	+/- 5 VAC	

SENSITIVITY, RANGE AND APPLICATION

SENSITIVITY	RANGE	OUTPUT	APPLICATION
10 mV/g	+/- 500 g	+/- 5 VAC	A **500 mV/g accelerometer** will have a dynamic range of +/- 10 gs, and a dynamic output of +/- 5 volts AC. This high output sensor is **typically used for low speed equipment, low frequency measurements, and low amplitude analysis.** The high output provides a much better signal to noise ratio for low amplitude signals.
50 mV/g	+/- 100 g	+/- 5 VAC	
100 mV/g	+/- 50 g	+/- 5 VAC	
500 mV/g	**+/- 10 g**	**+/- 5 VAC**	

SPECIALTY ACCELEROMETERS

High temperature sensors can be divided into two categories:

- ❑ **IEPE** (internally amplified) sensors for applications up to 150°C (302°F)
- ❑ **Charge output** (externally amplified) sensors for higher temperature applications such as turbines, boiler feed pumps, and some compressors

IEPE sensors are not suited to temperatures above 150°C (302°F) due to inherent limitations in components of the amplifier board.

In temperatures above 150°C (302°F) , it is necessary to move the amplifier to cooler temperatures. This is made possible with a charge output style of sensor.

SPECIALTY ACCELEROMETERS

Piezo velocity sensors use an analog integration for applications where a velocimeter has traditionally been used for casing measurements. It is helpful in identifying fundamental fault frequencies.

Intrinsically safe sensors are required for vibration measurements in hazardous areas, including gas, oil, mining, dust, etc.

SPECIALTY ACCELEROMETERS

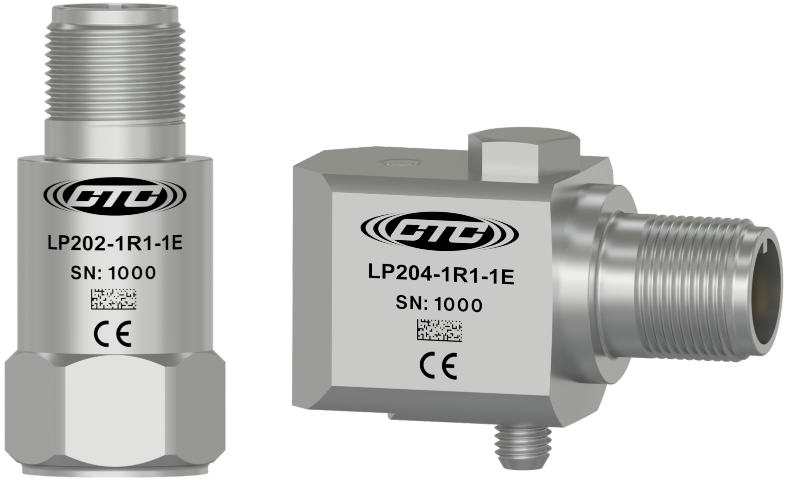
Triaxial sensors are used to measure vibration in three axes (x, y, and z) simultaneously with one accelerometer.

Use of triaxial accelerometers can speed data collection in some cases, and can reduce installation time or provide more complete data in some areas where there are limited mounting options.

Dual output (vibration and temperature) sensors provide the measurement of dynamic vibration and temperature at the same time. The additional data can give analysts information that might be valuable in assessing a machine's condition.

SPECIALTY ACCELEROMETERS

4-20 mA loop power sensors provide current output proportional to overall acceleration or velocity value. This signal can then be used to trigger a variety of alarms, and provide constant monitoring of applications.



Dual output loop power sensors provide 4-20 mA output proportional to vibration in acceleration with °C temperature output.

INDUSTRIAL REQUIREMENTS AND USE

The **top three requirements** for an industrial sensor are:
- ❑ Functionality
- ❑ Durability
- ❑ Affordability

Primary industrial uses are:
- ❑ Trending vibration levels
- ❑ Alarming high vibration amplitudes
- ❑ Diagnosing machinery faults

Always choose the sensor that best fits your application.

Please remember, one sensor does not fit all applications, and several output sensitivities are available along with a wide range of specialty sensors. Always choose the sensor you need for your specific application.

PREVENT FAILURES

Current passing through the bearing caused fluting in the races resulting in rapid deterioration of the bearing.

Overheating eventually destroyed the bearing and the motor.

Vibration measurements with **an accelerometer would have provided early detection** of the problem, and analysis would have triggered further investigation and correction of the root cause prior to catastrophic failure.

Don't let this happen to your machines!

SUMMARY

Thank you for taking the time to review this training lesson. We hope that you learned something that will help you to collect more accurate and quicker data, to allow you to make better "calls."

For more technical information, additional white papers, and training materials, we invite you to visit our website at **www.ctconline.com**.

SUMMARY

CTC offers a full range of vibration analysis hardware and process and protection instruments for industrial use. Our customers choose us time and time again based on:

- ❑ **Superior durability**
- ❑ **Accuracy and performance**
- ❑ **Quick service (shipping most orders in 3 days)**
- ❑ **Knowledgeable support staff**
- ❑ **Industry's only UNCONDITIONAL LIFETIME WARRANTY on all CTC Line products**

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