CTC UNIVERSITY

LEVEL 2, LESSON 4

SELECTING THE PROPER ACCELEROMETER FOR YOUR APPLICATION

Introduction

Welcome to **Level 2, Lesson 4 – Selecting the Proper Accelerometer for Your Application**, part of CTC's free online vibration analysis training series.

We hope you enjoyed and benefitted from the previous course and will continue to build your vibration analysis knowledge as you progress through Level 2.

Training Objectives

Upon completion of this lesson, you will:

1. *Understand the general construction of an accelerometer*
2. *Understand how the differences in construction make a specific sensor more suited to measuring specific types of applications*
3. *Understand 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 the catastrophic bearing failure pictured here.

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 machine failures.

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 your vibration monitoring program.

Measuring Machinery Vibration

Accelerometers are widely used to measure vibration on 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

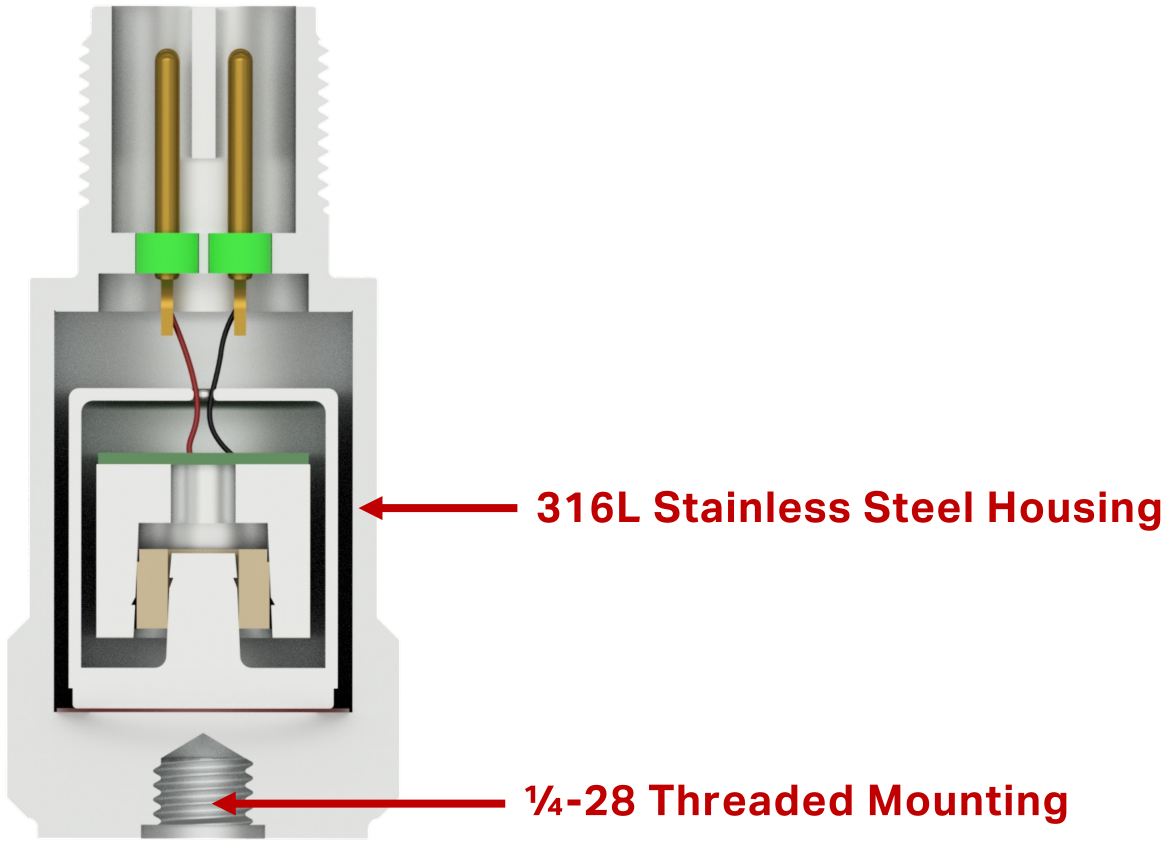
For this training we'll focus on industrial accelerometers with the most common construction on the market – **shear mode design sensors** with PZT ceramic.

This design provides a low-noise solution with a great deal of durability and stability in a wide range of environments.

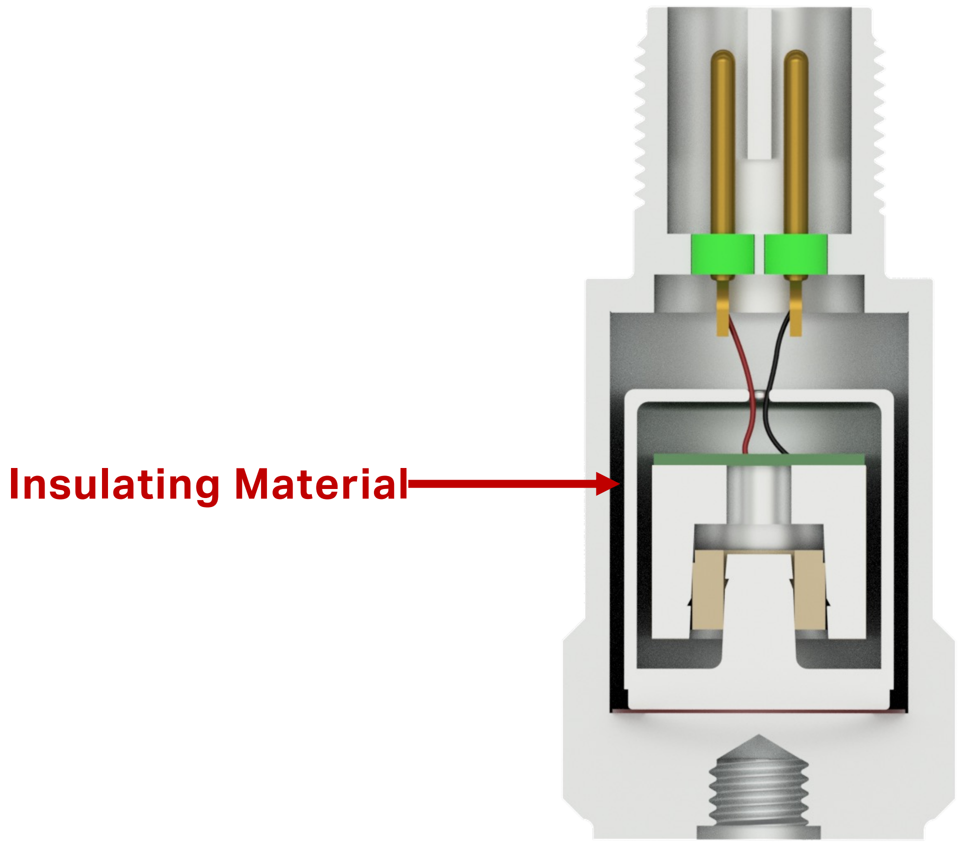
Parts Of An IEPE Sensor – (Integrated Electronics Piezo Electric)

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

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



Parts Of An IEPE Sensor – (Integrated Electronics Piezo Electric)



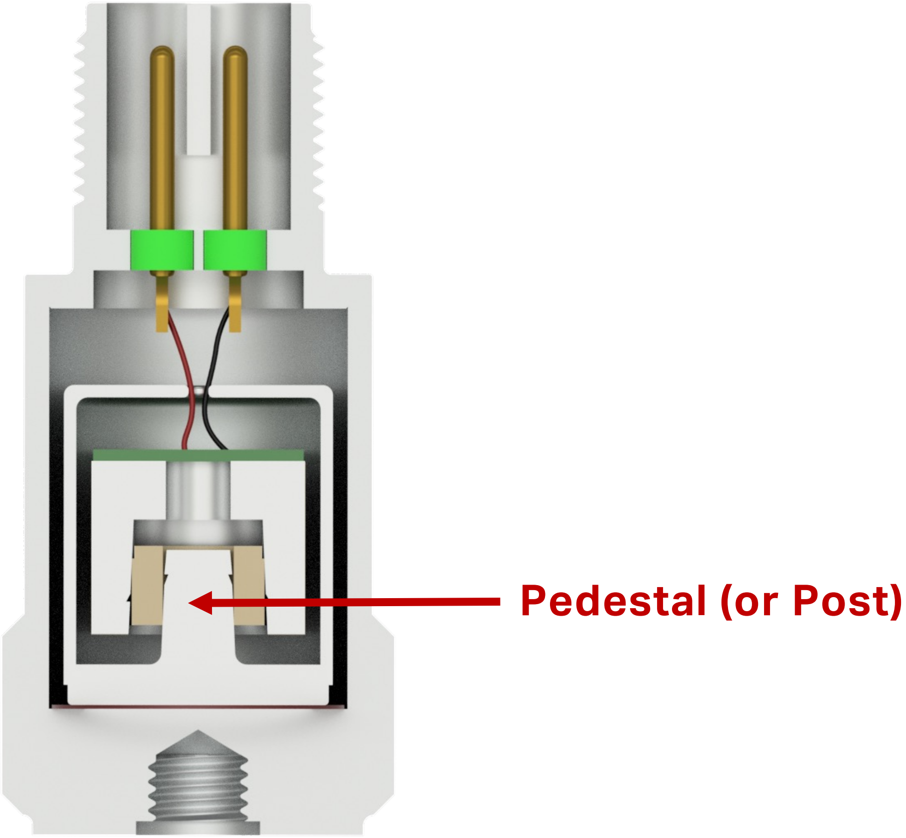
The application of a rigid insulating material between the sensing element and sensor housing will provide case isolation while still providing good transmission of the vibration to the sensing element.

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.

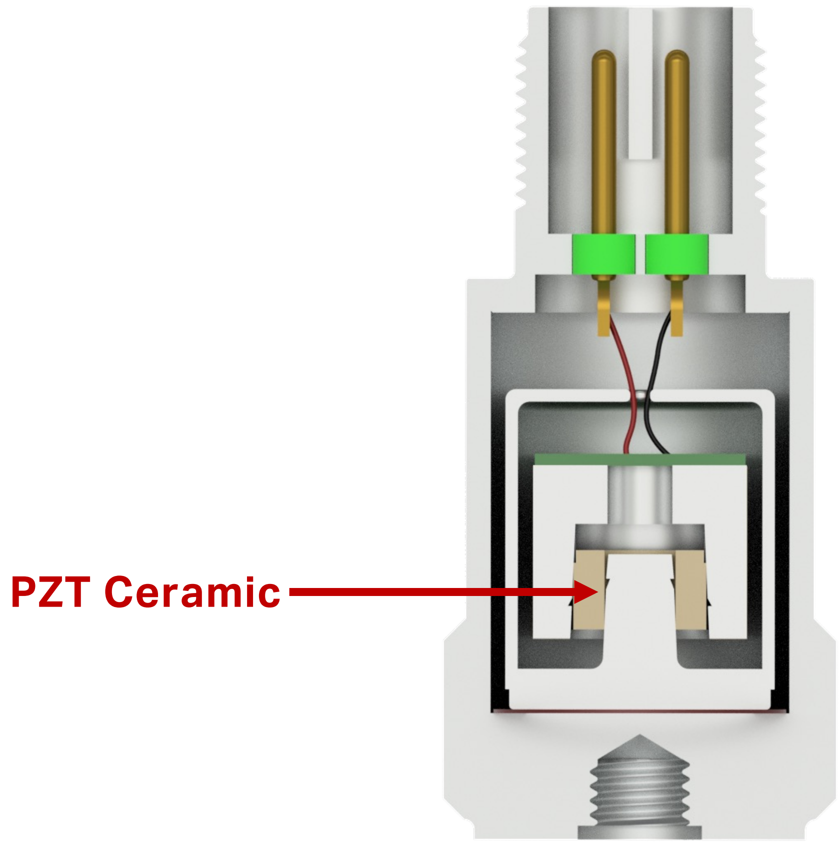
Parts Of An IEPE Sensor – (Integrated Electronics Piezo Electric)

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 (piezoelectrical lead zirconate titanate) 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.

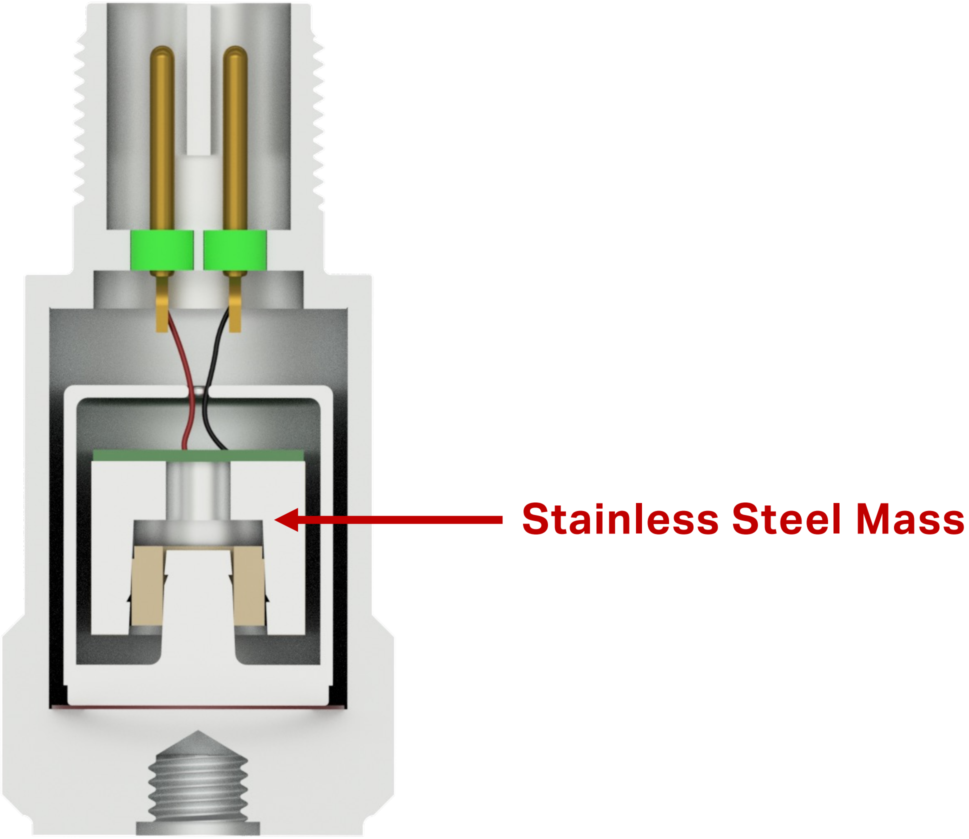
The PZT ceramic is a very high-quality material with excellent mechanical strength and temperature stability.

PZT has extremely low noise characteristics and provides a high signal to noise ratio.

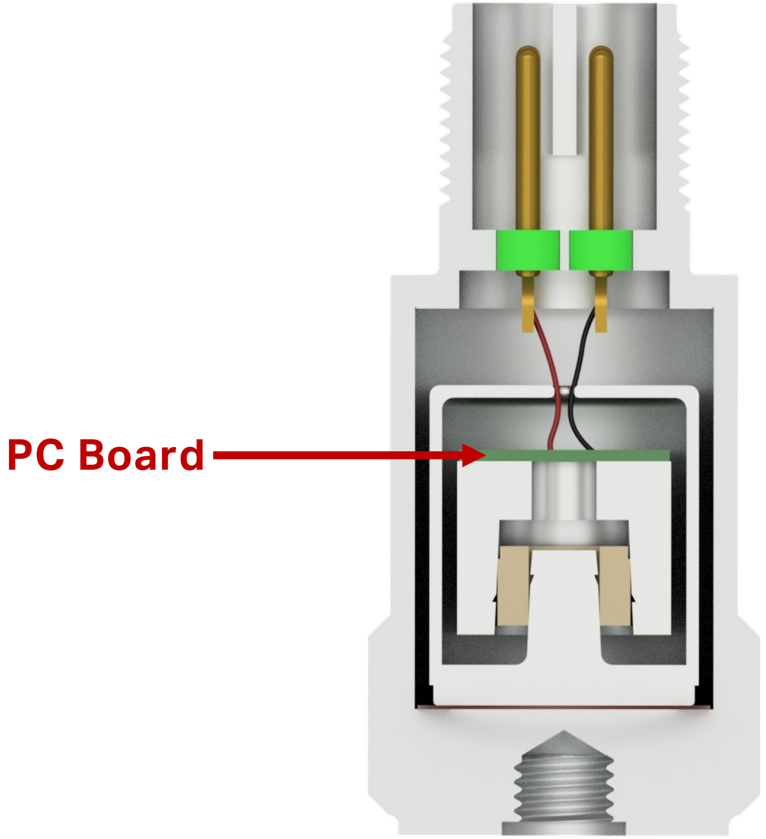
Parts Of An IEPE Sensor – (Integrated Electronics Piezo Electric)

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.



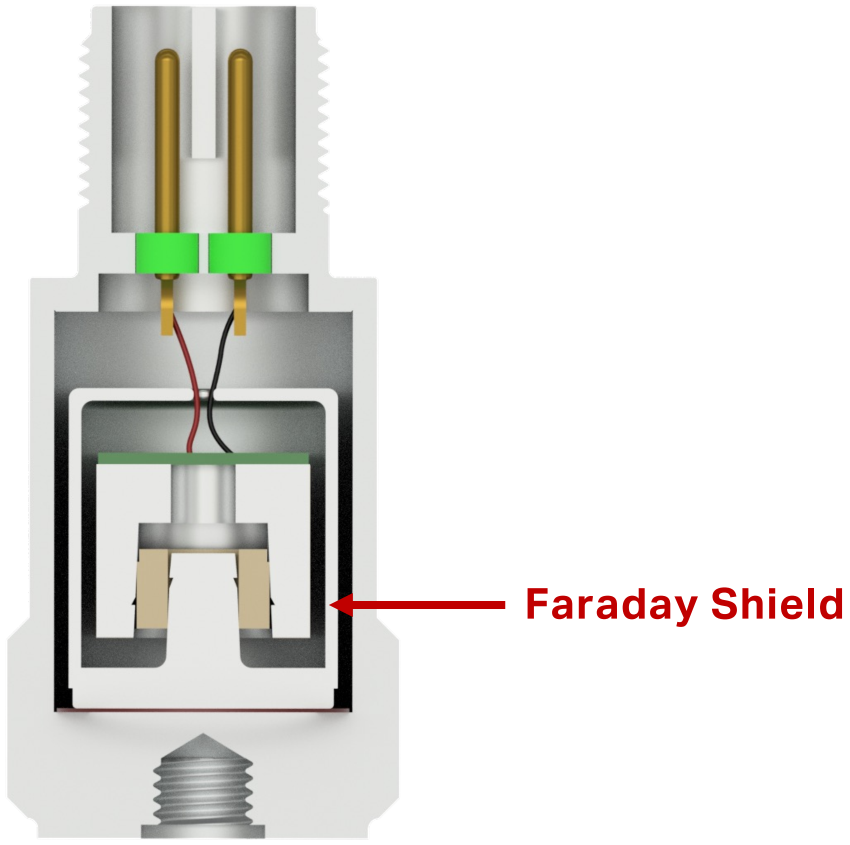
Parts Of An IEPE Sensor – (Integrated Electronics Piezo Electric)



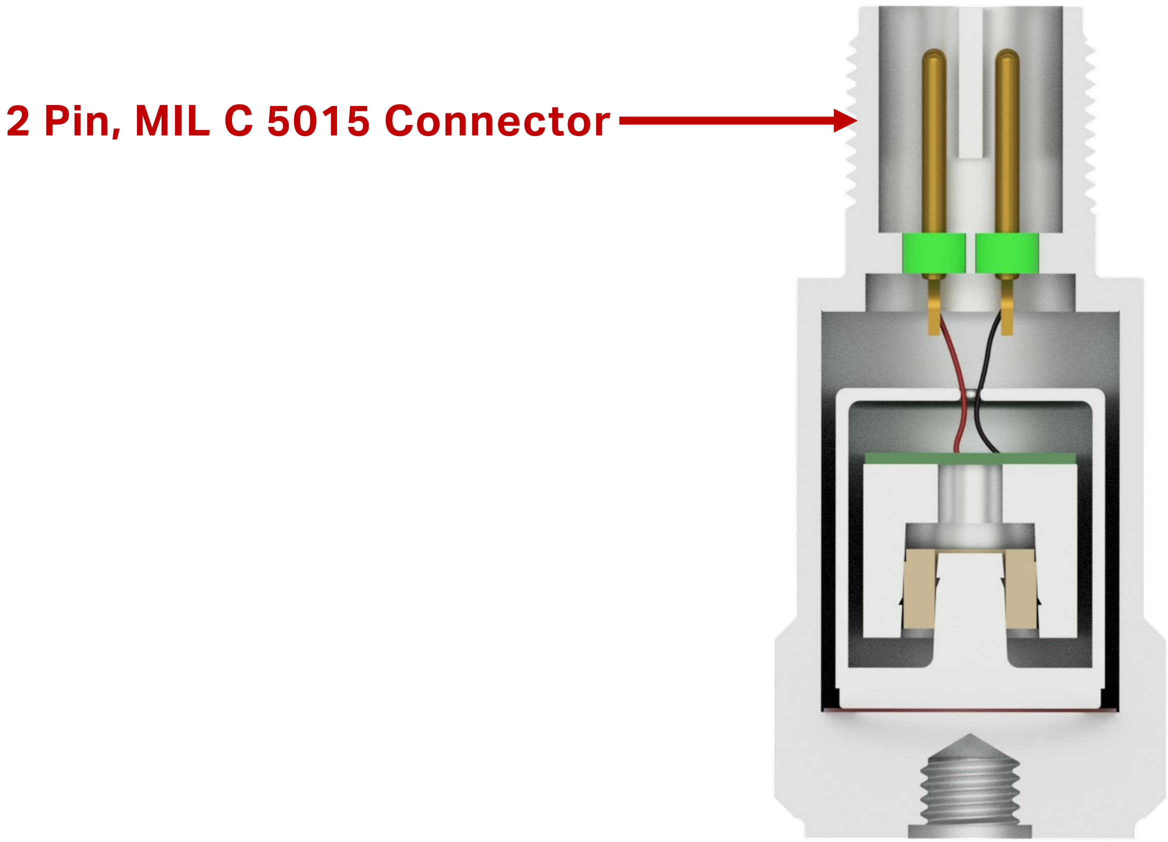
The electronics on the PC board are used to convert the charge output of the PZT ceramic to a voltage, apply filtering, and amplify the output of the sensor.

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)

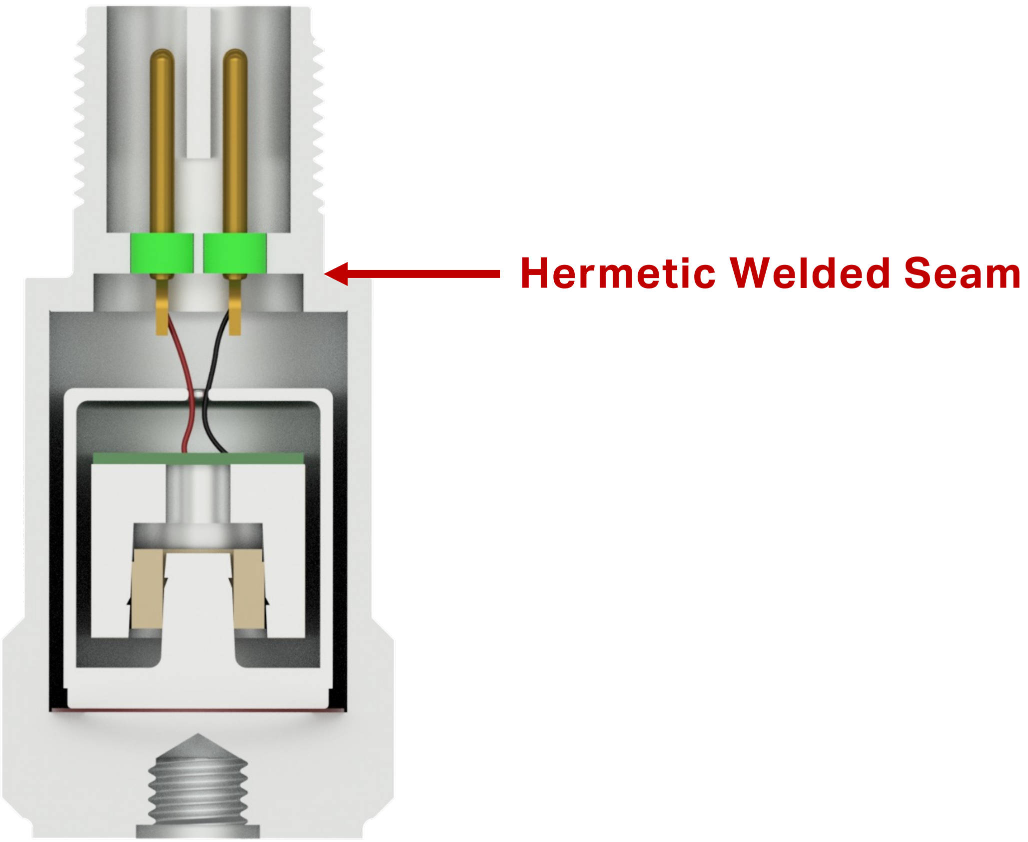


The MIL C 5015 connector is the standard connector used in industrial vibration analysis.

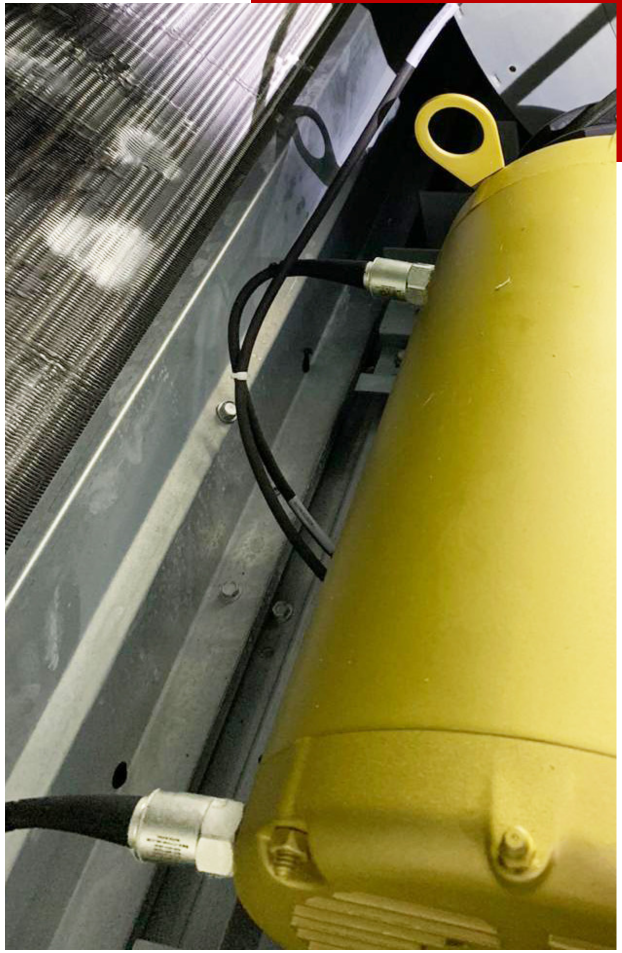
Parts Of An IEPE Sensor – (Integrated Electronics Piezo Electric)

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.
- The stress put 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 senor.
- 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.

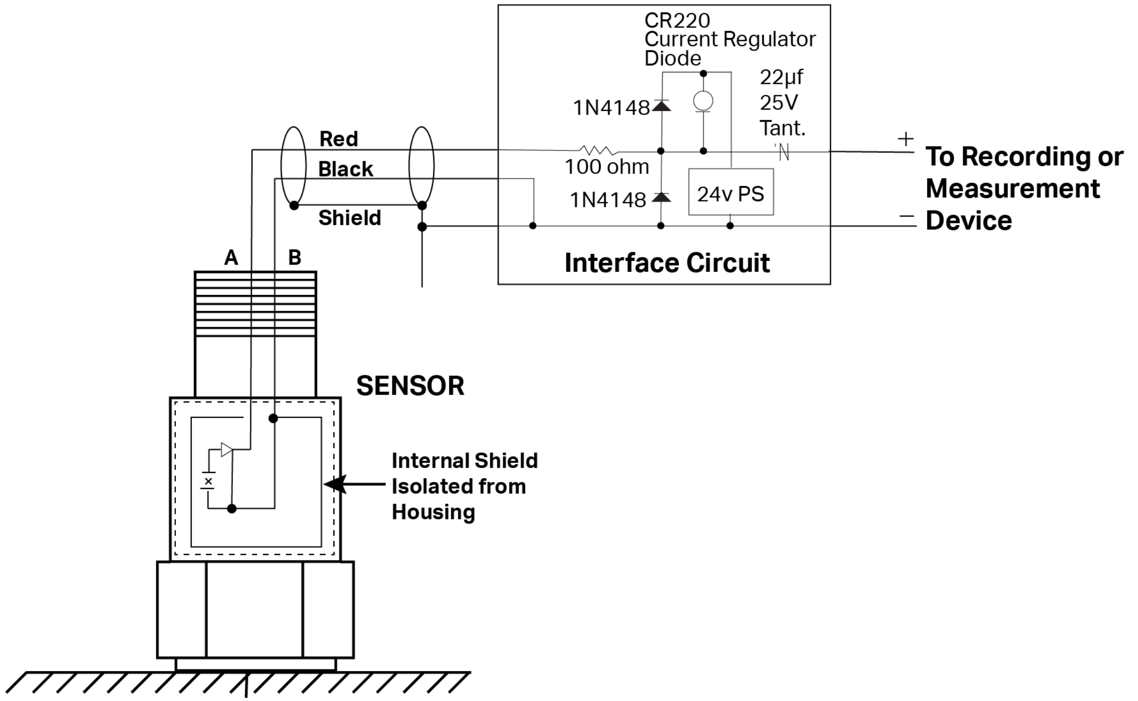
Bias Voltage
For IEPE Accelerometers

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 decoupling 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

	10 mV/g Sensitivity	50 mV/g Sensitivity	100 mV/g Sensitivity	500 mV/g Sensitivity
Dynamic Range	±500 g	±100 g	±50 g	±10 g
Dynamic Output	±5 VAC	±5 VAC	±5 VAC	±5 VAC

10 mV/g accelerometers 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.

Sensitivity, Range, And Application

	10 mV/g Sensitivity	50 mV/g Sensitivity	100 mV/g Sensitivity	500 mV/g Sensitivity
Dynamic Range	±500 g	**±100 g**	±50 g	±10 g
Dynamic Output	±5 VAC	**±5 VAC**	±5 VAC	±5 VAC

50 mV/g accelerometers are typically used for general purpose machinery measurements and are sometimes offered as standard sensors for data collectors.

Sensitivity, Range, And Application

	10 mV/g Sensitivity	50 mV/g Sensitivity	100 mV/g Sensitivity	500 mV/g Sensitivity
Dynamic Range	±500 g	±100 g	**±50 g**	±10 g
Dynamic Output	±5 VAC	±5 VAC	**±5 VAC**	±5 VAC

100 mV/g accelerometers are 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 ±80 g dynamic range for measuring larger signal amplitudes.

Sensitivity, Range, And Application

	10 mV/g Sensitivity	50 mV/g Sensitivity	100 mV/g Sensitivity	500 mV/g Sensitivity
Dynamic Range	±500 g	±100 g	±50 g	**±10 g**
Dynamic Output	±5 VAC	±5 VAC	±5 VAC	**±5 VAC**

500 mV/g accelerometers are high-output sensors 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.

Specialty Accelerometers – High Temperature Accelerometers

High Temperature IEPE Sensors
Internally charged sensors for applications up to 325 °F (162 ° C).

They are not suitable for temperatures over 325 °F (162 °C) due to limitations in components in the amplifier board.

Specialty Accelerometers – Intrinsically Safe Sensors

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

Specialty Accelerometers – Piezo Velocity Sensors

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.

Specialty Accelerometers – Triaxial Sensors

Triaxial sensors are used to measure vibration in three axes (X, Y, and Z) simultaneously with one accelerometer.

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

Specialty Accelerometers – Dual Output Sensors

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

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.

Specialty Accelerometers – Dual Output Loop Power Sensors

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

Industrial Requirements

Top three requirements for industrial sensors:

Functionality

Durability

Affordability

Industrial Uses

Primary industrial uses for sensors include:

Trending Vibration Levels

Alarming High Vibration Amplitudes

Diagnosing Machinery Faults

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!

Why Choose CTC?

- Superior durability
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