The Right Tool for the Job

Selecting the Proper Accelerometer for Your Application

VIBRATION ANALYSIS HARDWARE

A CTC hivatalos magyarországi képviseletét a Delta-3N Kft. látja el.
Delta-3N Kft. 7030 Paks, Jedlik Á. u. 2. Tel.: +36-75-510115 Fax: +36-75-510114 www.delta3n.hu

Objectives

Selecting the Proper Accelerometer for Your Application, was created and presented by **CTC** (Connection Technology Center, Inc.)

CTC manufactures a full line of Industrial Vibration Analysis Hardware, and Process and Protection Instruments, all backed by the Industry's best warranty.

After taking this training Analysts will understand the general construction of an accelerometer and how those differences make a particular sensor more suited to measuring specific types of applications. Using the right tools will help Analysts to gather better, clearer data, from which to make some very important decisions about machinery health.

Prevent 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.

Don't let this happen to your machines!

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 the most detailed information.

One accelerometer does not fit all applications, and understanding how they work and how to apply them for your 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, as well as the durability and portability that is inherent in their design.

For the purposes of this training, we will limit our discussion to Industrial Accelerometers with the most common construction and material for that market:

- Annular 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)

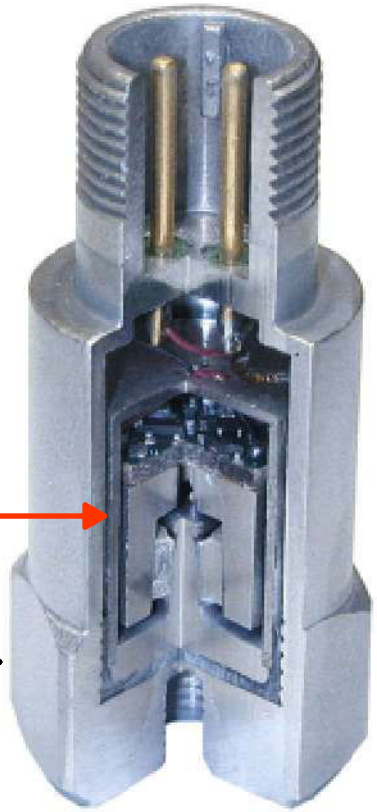
The external housing of the sensor should be made from a material like 316L. This corrosive resistant stainless steel is well suited for industrial environments.

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.



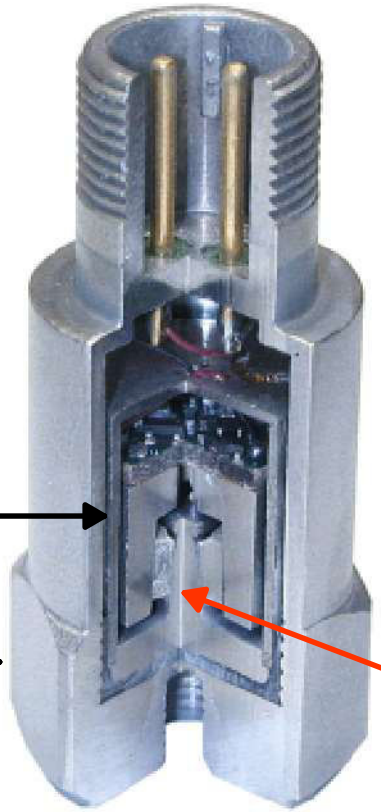
Insulating Material

Stainless Steel 316L housing with ¼-28 threaded mounting.

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.

Insulating Material

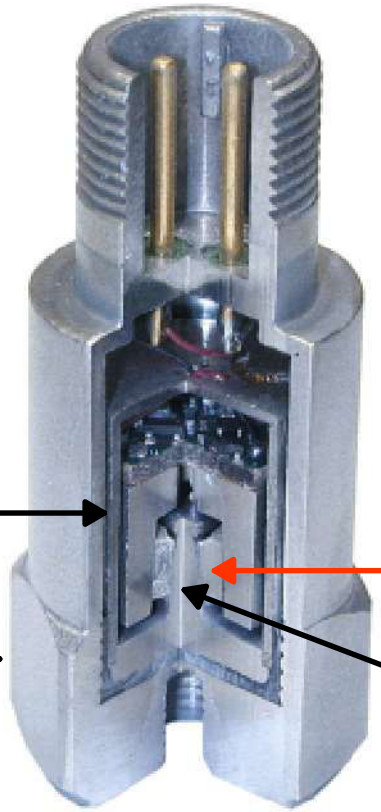
Stainless Steel 316L housing with ¼-28 threaded mounting.

Pedestal (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 force.



The PZT (piezoelectric 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.

Insulating Material

Stainless Steel 316L housing with ¼-28 threaded mounting.

PZT Ceramic

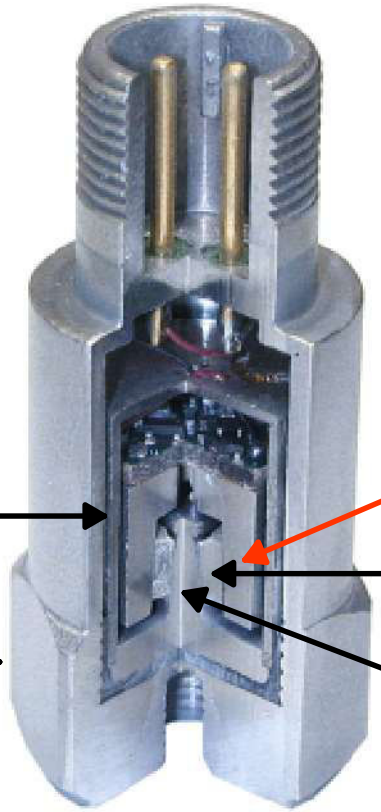
Pedestal (post)

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 vibration forces.



Stainless Steel Mass

Insulating Material

PZT Ceramic

Stainless Steel 316L housing with ¼-28 threaded mounting.

Pedestal (post)

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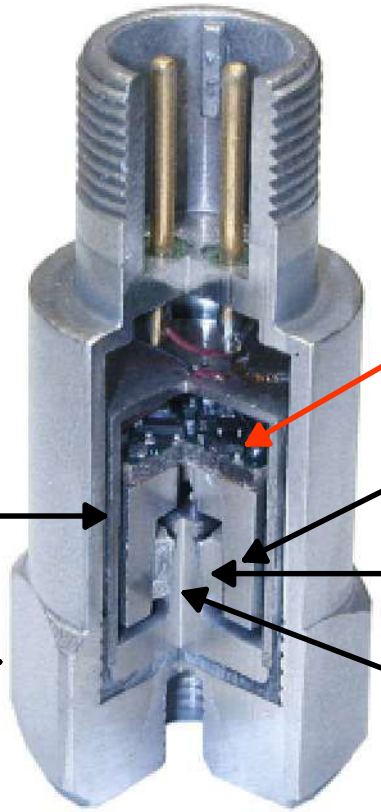
Parts of an IEPE Sensor

(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.



PC Board (electronics)

Stainless Steel Mass

Insulating Material

PZT Ceramic

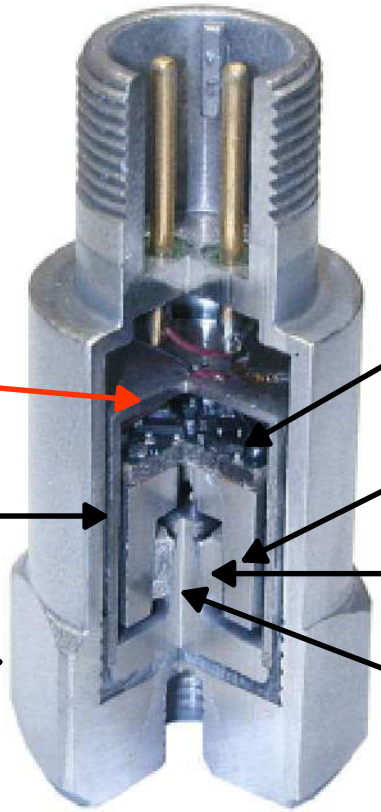
Stainless Steel 316L housing with ¼-28 threaded mounting.

Pedestal (post)

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).



Faraday Shield

Insulating Material

Stainless Steel 316L housing with ¼-28 threaded mounting.

PC Board (electronics)

Stainless Steel Mass

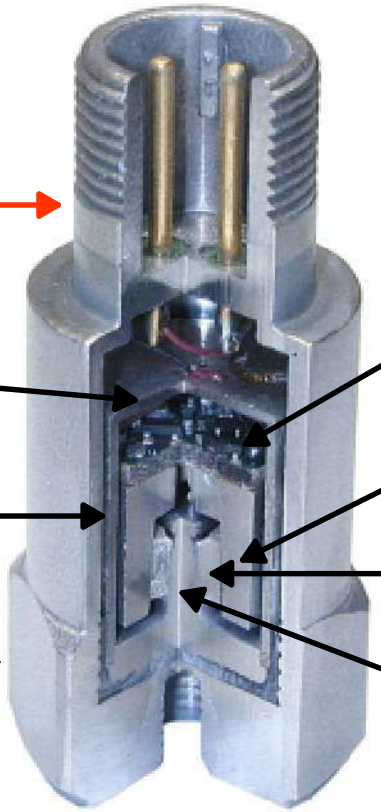
PZT Ceramic

Pedestal (post)

Parts of an IEPE Sensor

(Integrated Electronics Piezo Electric)

The MIL C 5015 connector is the standard connector used in Industrial Vibration Analysis.



2 Pin MIL C 5015 Connector

Faraday Shield

Insulating Material

Stainless Steel 316L housing with ¼-28 threaded mounting.

PC Board (electronics)

Stainless Steel Mass

PZT Ceramic

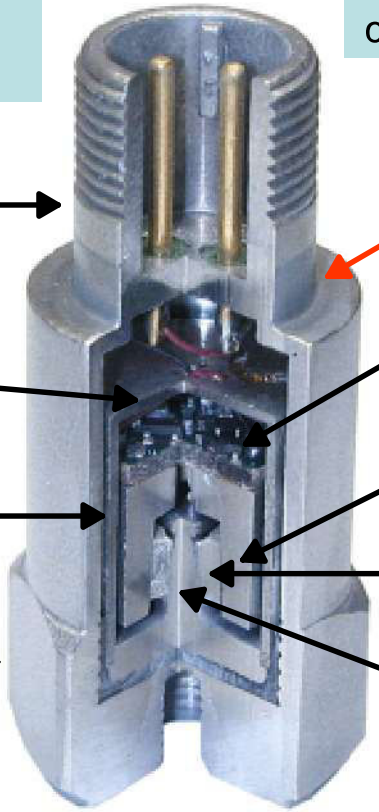
Pedestal (post)

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.



2 Pin MIL 5015 C Connector

Faraday Shield

Insulating Material

Stainless Steel 316L housing with ¼-28 threaded mounting.

Hermetic Seal (weld)

PC Board (electronics)

Stainless Steel Mass

PZT Ceramic

Pedestal (post)

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."

Machine Vibration

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 analyst's 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 the 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.

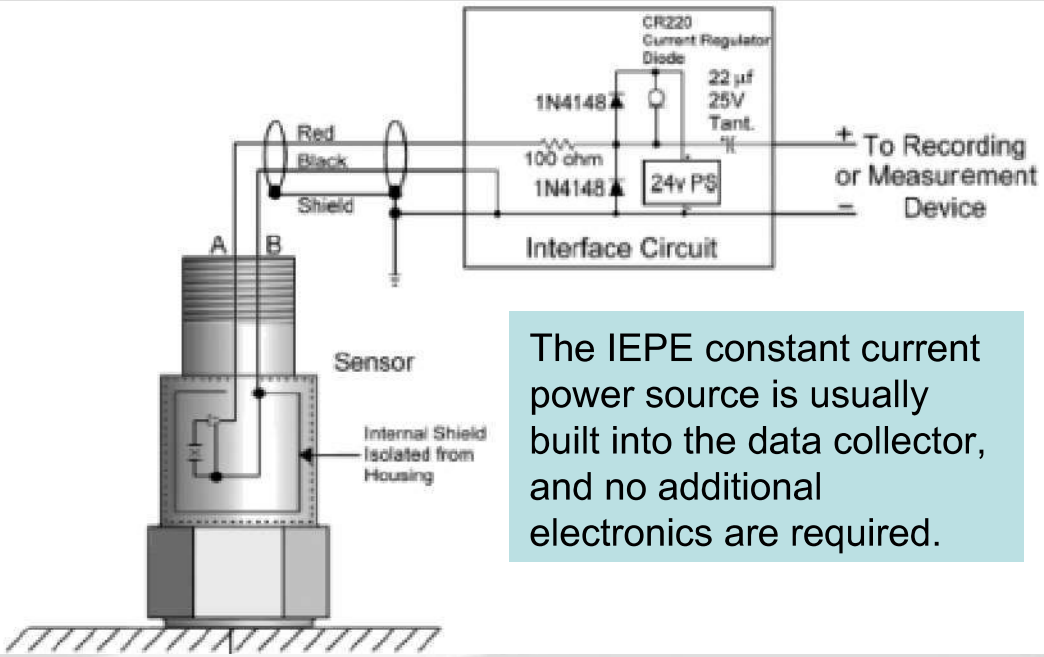
Base Strain

Bias Voltage for IEPE Accelerometers

The IEPE accelerometer is a 2 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 the 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 & Application

Sensitivity	Range	Output	Application
10 mV/g	**+/- 500 g**	**+/- 5 VAC**	A 10 mV/g accelerometer will have a dynamic range of +/- 500 g's, and a dynamic output of +/- 5 volts AC. They are typically used for machinery that is generating high amplitude vibrations. With the 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 & Application

Sensitivity	Range	Output	Application
10 mV/g	+/- 500 g	+/- 5 VAC	A 50 mV/g accelerometer will have a dynamic range of +/- 100 g's, 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 & Application

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

Sensitivity, Range & Application

Sensitivity	Range	Output	Application
10 mV/g	+/- 500 g	+/- 5 VAC	A 500 mV/g accelerometer will have a dynamic range of +/- 10 g's, 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 150^0 C (302^0 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 (gas, oil, mining, dust).

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Specialty Accelerometers

Triaxial sensors are used to measure vibration in three axes (x, y, & 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 current output proportional to overall acceleration & velocity, and 100 mV/g or 100 mV/in/sec dynamic vibration output.

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Delta-3N Kft. 7030 Paks, Jedlik Á. u. 2. Tel.: +36-75-510115 Fax: +36-75-510114 www.delta3n.hu

Industrial Requirements and Use

The top three requirements for an industrial sensor are functionality, durability, and affordability.

Primary industrial uses are trending vibration levels, alarming high vibration amplitudes, and 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 the application.

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Prevent Failures

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

Over heating 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!

Thank You!

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

CTC prides itself on it’s customer and technical support. CTC employs several Vibration Institute Certified Analysts (**Category 2, Category 3** and **Category 4).** It is all part of our commitment to providing the industry’s best service and support.

For more technical information, additional white papers, and training materials, we invite you to visit our website at www.ctconline.com, or contact one of our Analysts at (800) 999-5290 (in the US and Canada); or at +1-585-924-5900 (international).

Thank You !

Next time you need Sensors, Cables, Junction Boxes or Mounting Hardware and accessories, we would appreciate it if you would keep us in mind.

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

- Superior Durability
- Accuracy and Performance
- Quick Service (shipping most orders in 3 days)
- Knowledgeable support staff
- Industry's best warranty

Thanks again for your time.

Contact us at:

www.ctconline.com
Sales@ctconline.com
+1 (800) 999-5290 in US or Canada
+1 (585) 924-5900 international