



CONNECTION TECHNOLOGY CENTER, INC.

LEVEL 3 – LESSON 5

INDUSTRIAL VIBRATION ANALYSIS FOR PREDICTIVE MAINTENANCE AND IMPROVED MACHINE RELIABILITY



INTRODUCTION

Welcome to **Level 3, Lesson 5** of CTC's free online vibration analysis training. We're glad you have taken the time to view this self-paced lesson. We hope you enjoy the training and will continue to build your vibration analysis knowledge as you progress through Level 3.

'Industrial Vibration Analysis for Predictive Maintenance and Improved Machine Reliability' is created and presented by CTC for complimentary educational use only. This training presentation may not be edited or used for any other purposes without express written consent from CTC.



OBJECTIVES

Upon completing the following lesson, you will understand how industrial vibration analysis is used to identify, predict, and prevent failures in rotating machinery in a variety of industrial environments.



BACKGROUND

Industrial vibration analysis is a measurement tool used to identify, predict, and prevent failures in rotating machinery.

Implementing vibration analysis on the machines will:

- Improve the reliability of the machines
- Lead to better machine efficiency
- Reduce down time by eliminating mechanical or electrical failures

Vibration analysis programs are used throughout industries world wide to:

- Identify faults in machinery
- Plan machinery repairs
- Keep machinery functioning for as long as possible without failure



INDUSTRIAL VIBRATION ANALYSIS - TYPICAL MACHINERY

Industrial vibration analysis is often used on:

- Motors
- Pumps
- Gear Boxes
- Compressors
- Turbines
- Conveyors
- Rollers
- Engines
- Other machine tools
that have rotational elements



INDUSTRIAL VIBRATION ANALYSIS



The rotating elements of these machines generate vibrations at specific frequencies that identify the rotating elements.

The amplitude of the vibration indicates the performance or quality of a machine.

An increase in the vibration amplitude is a direct result of failing rotational elements such as bearings or gears.

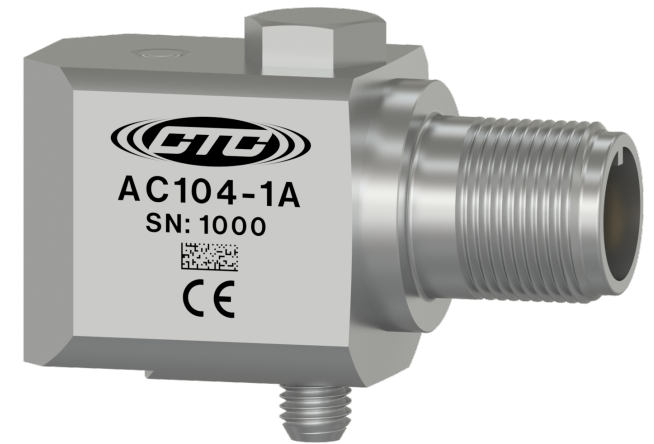
Based on the machine speed, the rotational frequencies can be calculated and compared to the measurements to identify the failure mode.

INDUSTRIAL VIBRATION SENSORS

The practice of vibration analysis requires measurement and analysis of rotating machines utilizing different vibration sensors, including:

- Accelerometers
- Velocity Transducers
- Displacement Probes

Accelerometers are the most common sensor used in industrial vibration monitoring.



INDUSTRIAL VIBRATION SENSORS



Accelerometers are case **mounted using a permanent bolt or portable magnet** to hold them in place.

They will measure the vibration of the machine and output a voltage or current proportional to the vibration and relative to a "g" level (unit of gravitational pull).

This signal can also be integrated to provide a measured output of velocity (inches / second or mm / second).

INDUSTRIAL VIBRATION SENSORS

It is very important to **choose the correct accelerometer, cable, connector, and mounting method** for a specific application.

This will provide quality measurements and accurate vibration data for identifying faults in rotating machinery.

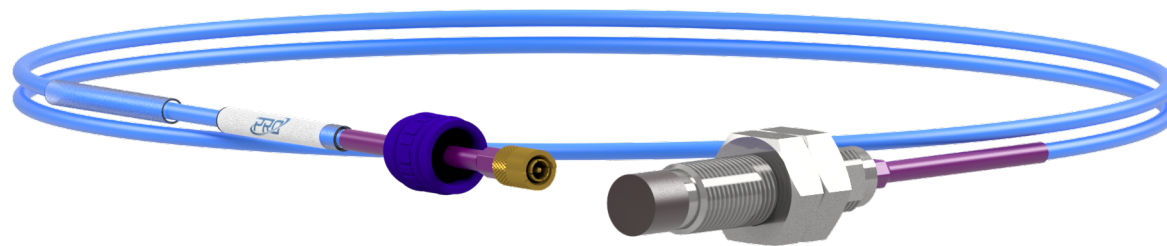


DISPLACEMENT PROBES

Sleeve bearing applications require displacement probes to measure the actual movement of the shaft inside the sleeve bearing.

These non-contact probes measure the vibration of the shaft and the gap between the shaft and the internal diameter of the bearing.

Using an eddy current process, these probes will provide an output voltage proportional to displacement (inches or mm).



VIBRATION ANALYSIS – WHAT FAULTS CAN BE IDENTIFIED?

There are several faults in rotating machinery that can be identified by measuring and analyzing the vibrations generated by a machine, including:

- Machine out of balance
- Machine out of alignment
- Resonance
- Bent shafts
- Gear mesh disturbances
- Blade pass disturbances
- Vane pass disturbances
- Recirculation and cavitation
- Motor faults (rotor and stator)
- Bearing failures
- Mechanical looseness
- Critical machine speeds



DYNAMIC VIBRATION ANALYSIS

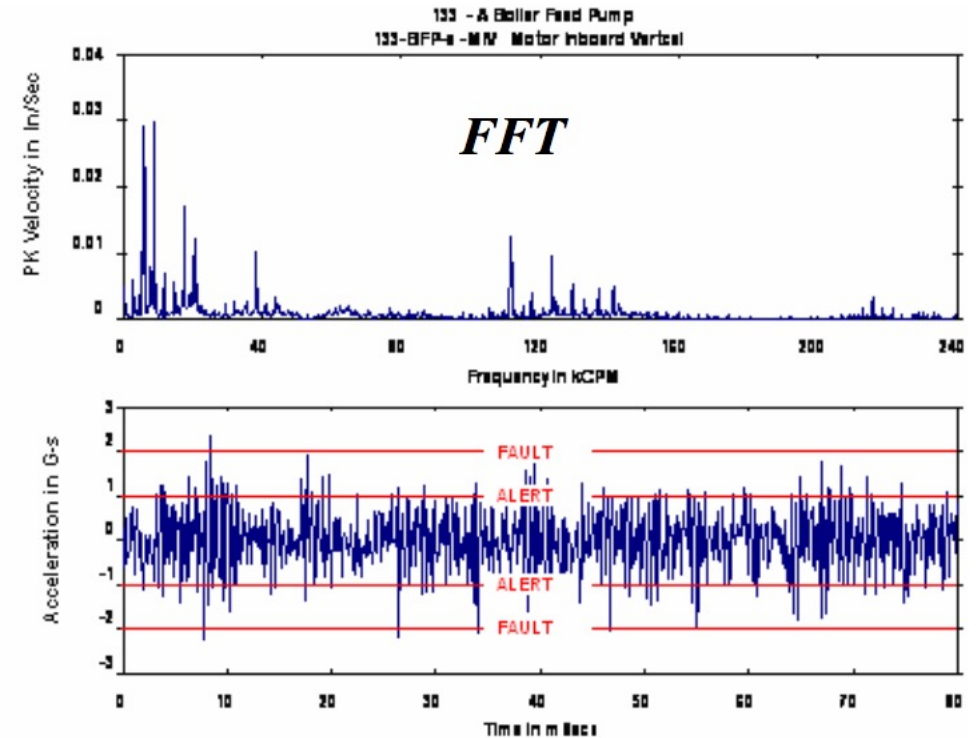
The measurement and analysis of dynamic vibration **involves accelerometers** to measure the vibration, **and a data collector or dynamic signal analyzer** to collect the data.

Analysis is usually completed by a technician or engineer trained in the field of rotating machinery vibration.



DYNAMIC VIBRATION ANALYSIS

The analog voltage output of the accelerometer, 100 mV/g, is measured by the data collector and presented as a **time waveform** and **FFT** (Fast Fourier Transformer) for frequency identification.



DYNAMIC VIBRATION ANALYSIS

The plots **of amplitude vs. time (time waveform)** and **amplitude vs. frequency (FFT)** are required for the trained technician or engineer to analyze and determine the machine fault.

Since each rotating element generates an identifying frequency, **analyzing the frequency disturbances will identify the faulty element.**

Once the fault is identified, parts can be ordered and repairs can be scheduled.



DYNAMIC VIBRATION ANALYSIS

Dynamic vibration analysis can be accomplished in several different manners:

- ❑ **Portable sensors and portable data collection** following a predetermined route of machinery measurements
- ❑ **Permanent sensors and portable data collection** following a predetermined route of machinery requirements
- ❑ **Permanent sensors and permanent data collection** that provides machinery protection 24 hours per day, 7 days per week, 52 weeks per year.



PROCESS VIBRATION ALARMS



A recent development in the predictive maintenance and reliability market is to **leverage the investment already made in process control systems** (PLC, DCS, and SCADA).

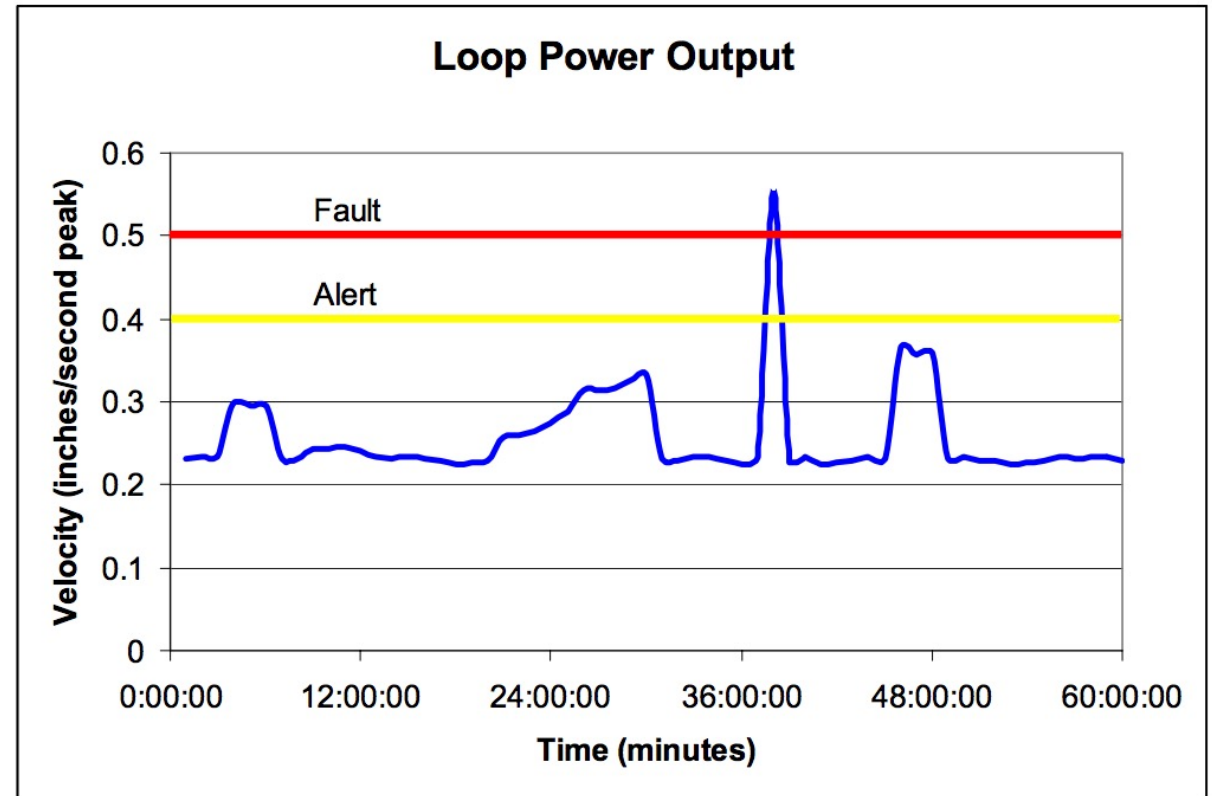
This allows the operations, maintenance, and process control teams to monitor and alarm vibration levels on critical machines.

Using a standard 4-20 mA output, the loop power vibration transmitters and sensors provide a current output proportional to the overall value of the machine vibration.

This is **not a dynamic analog signal**, and it cannot be used to analyze the machine fault, **but it can be used to alarm the machine** and indicate when vibration levels are too high.

PROCESS VIBRATION ALARMS

When high vibrations are measured by the process control system, **action can be initiated to determine the cause of the vibration or to shut the machine down** to prevent damage or failure.



Process Vibration Alarm Plot

METHODS FOR ACHIEVING LOOP POWER 4-20 mA OUTPUTS

METHOD 1:

A dynamic accelerometer with a 100 mV/g analog output can be connected to a transmitter.

The transmitter provides signal conditioning and a 4-20 mA current output proportional to the vibration.

It offers several different frequency filters to alarm the region of interest.

The dynamic signal, 100 mV/g, is also available for the trained technician or engineer to analyze.



METHODS FOR ACHIEVING LOOP POWER 4-20 mA OUTPUTS

METHOD 2:

A loop power sensor with a direct 4-20 mA output can also be used.

This sensor does not require a transmitter, but the frequency filters are limited to 10 – 1000 Hz and 3 – 2500 Hz.

METHODS FOR ACHIEVING LOOP POWER 4-20 mA OUTPUTS

METHOD 3:

A dual output sensor with a direct 4-20 mA output and secondary 100 mV/g dynamic output can also be used.

This sensor does not require a transmitter, but the frequency filters are limited to 10 – 100 Hz and 3 – 2500 Hz.

It does have the dynamic signal, 100 mV/g, available for the trained technician or engineer to analyze.



METHODS FOR ACHIEVING LOOP POWER 4-20 mA OUTPUTS

No matter what method you choose, standard 4-20 mA outputs proportional to machine vibration are available for process control.

This allows the factory to leverage typical process control monitoring methods and alarm schemes.

Convenient alarms for critical machines!



CONCLUSION

Vibration analysis is not a new technology. The Piezo effect and charge output of certain materials was discovered in 1880 by the Curies, and the first **accelerometer** was built in 1923.

Over the last 100 years, this technology has been refined for today's industrial market to provide fast and efficient measurements of rotating machinery vibration.

Sensors are designed to withstand harsh industrial environments and provide critical measurements year after year.



CONCLUSION



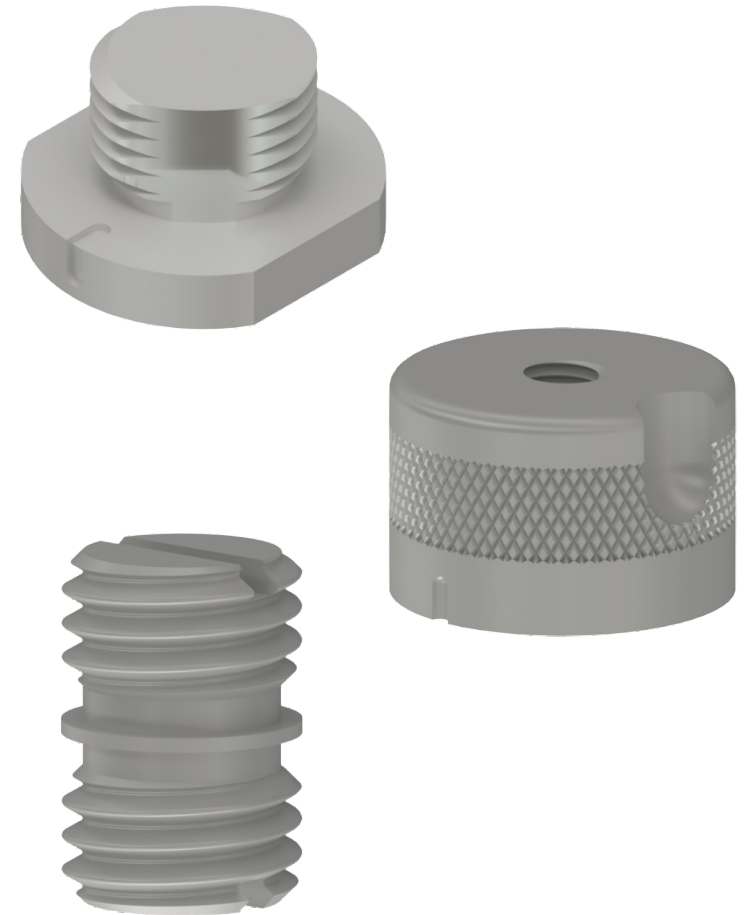
Cables and connectors are constructed of the most rugged materials available, and provide the critical link from the sensor to the data collector.

Designed for all types of environments, the proper cable and connector combination will eliminate any concerns for data transfer.

CONCLUSION

Mounting hardware is available for a broad range of applications. Measurements are accomplished quickly with portable magnet mounts or quick disconnects.

Permanent sensor installation can be accomplished with epoxy, stud mounting, or an array of special mounts designed for permanent applications.



CONCLUSION



Junction boxes are extremely useful in collecting multiple cables and organizing them in a manner that protects them and makes them accessible to the user. They prevent tangled cables and identify each measurement point.

CONCLUSION

Dynamic vibration analysis or process vibration alarms will provide a proven technology to predict failures in rotating machinery and improve machine reliability.

Protect your investments by using CTC industrial vibration sensors, cables, connectors, mounting hardware, and junction boxes to:

- Measure**
- Analyze**
- Alarm**
- Repair**



*Failed Motor Bearing
Don't Let This Happen To Your Machines !*

SUMMARY

Thank you for taking the time to review this training lesson.

CTC prides itself on the industry's best customer service and technical support. CTC is proud to employ Vibration Institute Certified Analysts as 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.



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
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