APPLICATION NOTE

FLUKE Reliability

Reveal machine fault causes more quickly with the Fluke 3563

Identify the four most common faults faster and easier with the 3563 Analysis Vibration Sensor

Many vibration sensors enable users to screen critical assets to determine overall machine health. The Fluke 3563 Analysis Vibration Sensor is different because it combines sophisticated piezoelectric and MEMS technology with robust software enabling a reliability professional to analyze a machine's condition versus simply screening for it.

The 3563 Analysis Vibration Sensor provides:

1. A high-frequency, high-resolution piezoelectric sensor for more in-depth vibration readings and early fault detection
2. eMaint condition monitoring software application, where reliability team members review data and determine critical next steps
3. Expert vibration support to ensure easy, low-risk implementation and the ability to jumpstart and expand a condition-based maintenance program

What is vibration analysis?

Vibration analysis is a process for measuring machinery vibration levels and frequencies and using the data to evaluate the health of assets and their components. Every machine component produces a unique vibration signal. Knowing how to recognize if the signal belongs to a particular piece of equipment can be challenging.

The 3563 Analysis Vibration Sensor enables reliability professionals to generate vibration readings quickly, identify various vibration signals, and act on the information early, ultimately preventing downtime.

- Monitors machinery health constantly at fixed intervals
- Identifies a specific fault and the component causing the fault
- Determines the fault severity
- Enables analysis and recommended next steps

What's the best way to identify the four most common machine faults?

Nearly 90 percent of machine faults fall into one of four main categories:

- Imbalance
- Misalignment
- Looseness
- Bearing damage

The more effective way to detect these and other machine faults is by using an analysis vibration sensor such as the Fluke 3563.

Why are narrowbands and motor speed critical to identifying faults?

The speed of the motor shaft is the reference for all analyses. A rotating shaft typically causes the most vibration, and the expression "1X" means the vibration is at the same frequency as the running speed of the machine (or one times the motor shaft speed). The device's other components that rotate in sync with the motor speed produce various other peaks in the spectrum.

Conversion Table		
RPM	Orders	Frequency (RPM/60)
1,775	1x	29.6 Hz
3,550	2x	59.2 Hz
5,325	3x	88.8 Hz
10,650	6x	177.6 Hz
35,500	20x	592 Hz

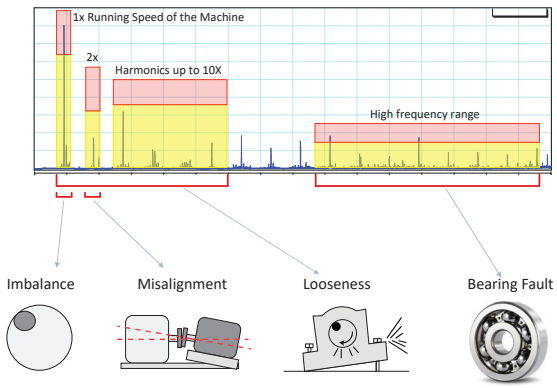


Figure 1. *This is an example of machine characteristics and band alarming. Not all equipment fit this pattern but alarm banding follows the principle of monitoring specific frequencies, regardless of asset design.*

A spectrum is a graphical display of the frequencies at which a machine component vibrates. When analyzing vibration data, the first step is to find the significant peaks in the spectrum and associate these peaks with the sources inside the machine.

An example of machine characteristics and band alarming is shown in Figure 1, but not all equipment fits this pattern. Alarm banding follows the principle of monitoring specific frequencies, regardless of asset design.

The 3563 sensor uses narrowband alarming to detect patterns within a particular area of the spectrum, indicating a specific fault, e.g., 1X band = imbalance. Narrowband alarms trigger alerts at particular frequencies and deliver machine diagnostics that offer more precise and insightful information about machine changes.

Having this information helps maintenance teams identify any one of the four common faults within a spectral graph.

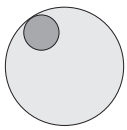
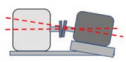
Machine fault	Fault description	Example	Fault symptom
Imbalance 	**Imbalance** – This fault happens when the geometric center of a machine shaft and the center of mass do not coincide. A heavy spot on the shaft causes forces in all radial directions, leading to increased wear of bearings, seals, etc.	Forces from the imbalance show up on one shaft only, i.e., the motor shaft.	• High 1X, one shaft only (motor or pump) • All radial directions (not axial)
Misalignment 	**Misalignment** - When two rotating shafts are not parallel to one another, a misalignment occurs. Machine vibration increases with misalignment and can cause defects in other machine components leading to premature machine failure.	Forces from the misalignment show up on both sides of the coupling, i.e., both the motor and the pump shaft.	Angular • High 1X, axial only • Both sides of the coupling Parallel • High 2X, vertical and horizontal • Both sides of the coupling
Looseness 	**Looseness** – This fault can be caused by a structural defect such as a loose anchor bolt holding a motor to a mount or excessive play in rotating elements such as bearings, impellers, etc.	Forces from the looseness show up on one shaft only, i.e., pump shaft.	• Multiples of 1X, one shaft only (motor or pump) • All three directions
Bearing fault 	**Bearing damage** – Rolling element bearings are present in most rotating machines. Their useful life is affected by many factors, including load, running speed, lubrication, assembly, temperature, and external forces caused by misalignment, unbalance, etc. A piezoelectric vibration sensor increases the ability to recognize and identify a bearing defect.	Forces from the bearings show up on one shaft only, i.e., the pump shaft.	• High non-integer peaks (not multiples of shaft speed), one shaft only (motor or pump) • All three directions • First in the high frequency and then in the low frequency

Figure 2. *Descriptions, examples, and symptoms of the four faults*

What happens when the 3563 analysis sensor detects a fault?

If a vibration threshold level is breached, a reliability professional is automatically notified. Users can view and analyze the vibration data from a smart device, including a PC, mobile phone, or laptop, to determine if a fault exists.

The sequence of events:

1. The 3563 Analysis Vibration Sensor measures machine vibrations and temperature in three different directions.
2. The data is sent to the Fluke gateway and then to the cloud-based eMaint condition monitoring.
3. A reliability professional analyzes the data, event, and machine condition via a PC, laptop, or mobile phone.

Once a fault is detected, a correction such as these can be applied:

- Balance the machine
- Check the shaft alignment
- Inspect mounting base, grease bearing, replace the bearing, etc.

Early vibration detection gives maintenance teams time to act

The 3563 Analysis Vibration Sensor empowers your technicians and engineers, regardless of experience, to immediately gather insights from the sensor's high-quality data. You have time to evaluate critical next steps for avoiding unscheduled downtime.

When combined with setup and our vibration training services and technical support, including configuration, commissioning, and installation, the sensor seamlessly integrates into existing plant operations to increase asset reliability. The result is extended peak operating performance, more effective use of your maintenance team resources, and increased business value from your operations.

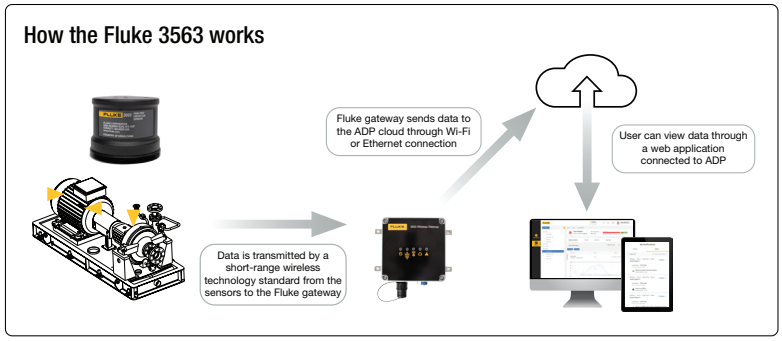


Figure 3. *Data transmission sequence for the 3563 Analysis Vibration Sensor*

Glossary of important terms

- **Detection:** If a measurement value exceeds the alarm limit, the software notifies a reliability professional of a problem.
- **Analysis:** Once a fault is detected, an analyst examines the data and uses the right information to find the root cause.
- **Narrowband alarms:** Enables users to filter vibration within a narrow frequency band, allowing for better identification of a specific machine fault.
- **Piezoelectric sensor:** A high-frequency, high-resolution sensor that enables more in-depth vibration readings than typical MEMS sensors.
- **eMaint Condition Monitoring:** A software application empowering reliability professionals to analyze overall values, velocity, and acceleration band values. With the information, users can determine which fault is causing a problem and assess the next steps.
- **Fluke 3503 Wireless Gateway:** This gateway has dual network connection capabilities — Wi-Fi and Ethernet — that connect multiple 3563 Analysis Vibration Sensors to a single gateway.
- **Spectrum analysis:** This technique is used for dividing signals into primary groups in the frequency area enabling pattern recognition. The spectrum peaks are created by components in the machine moving repetitively, such as turning, pressing, pumping, etc., and creating vibrations.

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