Doc.Ref.No.:mVMT/om/101
Issue No. :00
Model : VM908

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Operator's Manual

VM908-VIBRATION METER

Masibus Automation And Instrumentation Pvt. Ltd.
B/30, GIDC Electronics Estate,
Sector-25, Gandhinagar-382044, Gujarat, India.
Ph: 91 79 23287275 - 79
Fax: 91 79 23287281, 82
Email: support@masibus.com
Web: www.masibus.com

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1. TECHNICAL DETAILS

Masibus VM908 vibration meter is a basic portable vibration measurement product that reads vibration in various modes. It provides essential periodic monitoring of fan, pump, motor and other industrial machines. It measures the vibration to which it is exposed and provides corrective action when vibration exceeds predetermined threshold values.

Vibration meter is a strategic tool for predictive maintenance. It offers digit display of vibration in terms of displacement, velocity and acceleration. It measures off line vibration and provides easy evaluation of health of machines. On this basis further analysis can be done using vibration analyzer for diagnosing the machine problem. Masibus has a proven track record of manufacturing portable instruments and online process monitoring instruments for over 3 decades. Vibration meter makes cost-effective off line vibration monitoring instrument with various important parameter i.e. displacement, velocity, acceleration.

Vibration is measured in terms of R.M.S. and peak. When overall vibration is to be measured, R.M.S. and peak measurement technique is considered best for general machine health.

VM908 is very handy easy to use device for any maintenance crew. It gives very easy understanding of equipment health and guides for repairs.

2. SPECIFICATION

Measurement condition:

- **Temperature :** 5-50°C,
- **Humidity** < 85%,
- Non-causticity environment, without strong electric-magnetic field & strong impact

Amplitude Ranges:

1. **Displacement:** 1–1999μm peak-peak (*)
2. **Velocity:** 0.1–199.9 mm/s true RMS
3. **Acceleration and High Frequency Acceleration:** 0.1–199.9 m/s^2 peak (*)

***Note:** peak-peak and peak are equivalent value means: peak- peak = 2.828*RMS while peak=1.414*RMS

Measurement accuracy:

± 5% of display ± 2 digits

- **Noise Level (without input):** ACC<0.3 m/s^2,
- **VEL**<0.5mm/s,
- **Displacement**<3μm
- **Frequency response accuracy:** ±5%; ±10% for ACC 4.5 kHz-10 kHz
- **Non-linearity:** ±5%

Sensor type: Piezoelectric Accelerometer

Frequency response:

1. 10–1000 Hz (Inside accelerometer)
2. 10–5000Hz (Outside accelerometer, depending on model)
3. High Frequency Acceleration: 1000-5000Hz ±10%

Battery: 9V 6F22, 25 hours of continuous operation.

Configuration:

Standard: Inside accelerometer with 2 handheld probes
Optional: Outside accelerometer with magnetic mount and probe

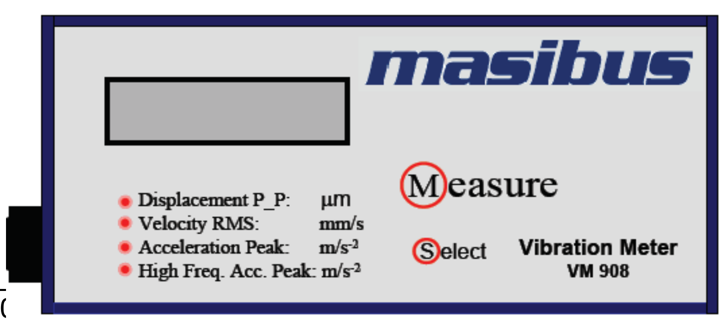
Dimensions: 13×6×2.3 cm;
Weight: 200 g.

3. PREPARATION

1). Functions of the <Measure> key:

Press the key and the power is ON and the instrument is ready for measurement after releasing the key the instrument holds the measured value for twenty seconds and the power is turned off automatically

a. Key press: Power on and begin measuring;
b. Key release: Holds the measured value for twenty seconds and then the power is turned off automatically.



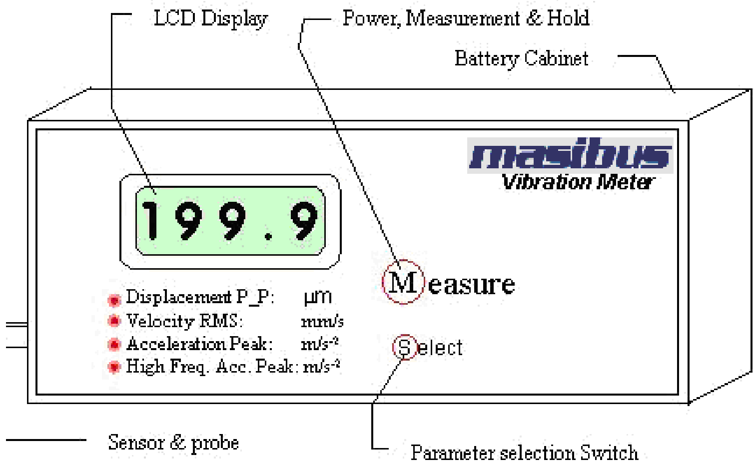
2). Check the voltage of the battery:

a. Press <Measure> key, observe the display on the screen. If there is an arrow on the top left corner, you need to replace the battery with a new one.

3). Set-up probe

a. VM-908 Standard has two probes while outside sensor has 1 probe and 1 magnetic mount. When changing, take hold of the screw cover to avoid rotation and damage of the sensor.

The VM-908 utilizes an external accelerometer and magnetic base to improve frequency response and provide a more repeatable vibration reading.



4. Measurement

1). Select the measure parameters:

VM-908 has 4 vibration parameters. They are:

a. Displacement (unit: μm = 1/1000 mm): Equivalent peak-peak value
b. Velocity (unit: mm/s): True RMS Value;
c. Acceleration (unit: m/s^2): Equivalent peak
d. High Frequency Acceleration (unit: m/s^2): Equivalent peak

2). Functions of the <Measure> key:

Press the key and on the power and begin measuring after releasing the key it holds the measured value for twenty seconds and then the power is turned off

a. Key press: Power on and begin measuring;

b. Key release: Hold the measured value for twenty seconds and then power off automatically.

3). Stick the probe to the measured object (the pressure should be about 0.5-1 kg.)

5. NOTES

1. Avoid intense impact, high temperature and immersion in water.
2. Keep the sensor plug clean and dry, and use it carefully.
3. Installation of the battery:
   a) Open the small back cover of battery cabinet (2 screws at the end far away from the sensor at backside, see figure);
   b) Place a battery (6F22, 9V) correctly according to the polarity;
   c) Close the back cover and screw the screws tightly;
   d) If it has been put aside long-term, please take out the battery in case of the leakage of the battery liquid;
   e) If the sensor has been used for over one year, please re-calibrate the vibration meter to ensure the precision.

The Vibration meter VM-908 is mainly intended for measurements against the housing and bearings of machinery according to the intentions of the standards. You can also use it to measure other parts such as piping, valves, etc. Note that in some cases the mass of the transducer may influence the reading. A good rule is to consider readings on surfaces that are lower in mass than 10 times the mass of the transducer doubtful.

How to interpret vibration measurements

A user with no previous experience to interpret the results is recommended to use the ISO 10816-3 standard together with a good portion of common sense.

Be prepared to find exemptions making the judgments harder than the standards, rather than finding exemptions allowing for higher vibrations.

The standard normally calls for a measure in velocity based on mm/s RMS. To better understand what this measure means it can be helpful to consider the reading as a mean value of the back and forward motion. This measure gives a good understanding of the amount of "break down energy", causing mainly wear and fatigue work, in the machine or the structure being measured.

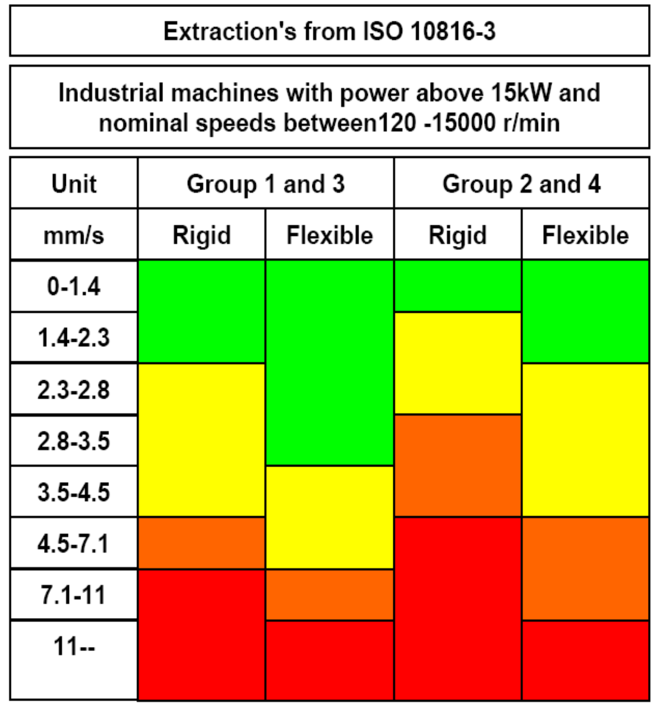
The instrument is measuring the total RMS-value of the vibration within the instrument frequency range. This RMS-value is a special sum or average of all the different causes of vibration.

The ISO standard is classifying the machines differently if the machines are considered as flexible or rigid mounted. This reflects the location of the machines stiff-body resonance’s related to the basic running speed of the machine.

For instance, a machine supported by rubber or springs often have resonance's at low running speeds. The machine starts vibrate at certain low rpm. When the speed is increased above these resonance frequencies the vibration is reduced. This machine is considered flexible.

A resonance can easily be found when a flexible machine is running up or down in speed. The resonance's are located at the rpm's where the vibration have a local maximum level.

Modern machines have high rpm and flexible bearing-supports and foundations and can be treated as flexible even when it is not mounted on rubber or springs.



The ISO 10816-3 standard allows for slightly higher limits when a foundation is considered flexible than when if it is rigid. A conclusion from this is also that a resonant condition in principle is not allowed or at least should be avoided at operating speeds. In practice this also includes the double speed as well as any other natural excitation frequency such as blade passage etc.

A great advantage with proper vibration measurements and the use of vibration standards is that you can judge the future maintenance cost very reliably already at first start-up. If you find levels above 3 mm/s RMS, you can be rather sure that the machine will cause increased activities in maintenance. The specific cost and action is of course individual to the machine design.

As always when using schematic judgment like this, be very careful to use common sense in the application of the recommendations. A certain machine is producing its specific vibration frequency pattern depending on the transducer location and the machine properties.

The next logical step is therefore to apply filtering of the transducer signal to learn the frequency behind the vibration and thus the exact mechanical fault. The practice of this is beyond the scope of this manual.

Looseness

By measuring the vibration on both sides of a bolt joint it is possible to find looseness in the connection. Two machine parts joined together should have the same vibration level on both sides of the joint. Bolts fixed in concrete foundations should have the same vibration level as the concrete if they are not loose.

Recommended vibration levels in mm/s common findings.

The following is in part an extraction of the old standard ISO 2372 class 4, large machines on flexible foundations, with some common findings added.

This simplified list can be used, as a first consideration, when you approach a machine newly commissioned or after some time in operation.

Take as a good housekeeping rule to investigate the reason for any machine that vibrates above 3 mm/s RMS. Do not leave them above 7mm/s without being assured that they will sustain long term operation without increased wear since the machines capable of that are very few.

• 0 – 3 mm/s
Small vibrations. None or very small bearing wear. Rather low noise level.

• 3 – 7 mm/s
Noticeable vibration levels often concentrated to some specific part as well as direction of the machine. Noticeable bearing wear. Seal problems occur in pumps etc. Increased noise level. Try to investigate the reason. Plan action during next regular stop. Keep the machine under observation and measure at smaller time intervals than before to detect a deterioration trend if any. Compare vibrations to other operating variables.

• 7 – 18 mm/s
Large vibrations. Bearings running hot. Bearing wear-out cause frequent replacements. Seals wear out, leakage of all kinds evident. Cracks in welding and concrete foundations. Screws and bolts are loosening. High noise level. Plan action soonest. Do your best to reveal the reason. You are wearing down investments quickly.

• 18 – mm/s
Very large vibrations and high noise levels. This is detrimental to the safe operation of the machine. Stop operation if technically or economically possible considering the plant stop cost. No known machine will withstand this level without internal or external damage. Reduce any further running time to an absolute minimum.

Resonance

When working with vibrations in machine maintenance, you will soon find that resonance is a common but rather unknown problem in modern machinery.

To understand a resonance you can compare with the string of a guitar. The string has its natural basic tune that will ring as soon as the string is struck. The actual frequency of the tune depends on the stiffness and the distributed mass of the string.

All machines have similar built in "tunes" with corresponding properties consisting of stiffness and mass in the form of mechanical strings such as shafts, beams, floors and in all mechanical parts. If any natural excitation (= alternating force) in the machine has the same or nearly the same frequency as a resonance frequency the vibration will be amplified in this machine part, a much higher level will occur than would be the case if the resonance would be shifted away from the excitation frequency.

One common resonance frequency is the critical speed of a shaft which depends on the stiffness and mass of the shaft, but Resonances exist in all machine parts as well as in supporting beams and concrete floors.

A natural excitation force is for example unbalance at the running speed, misalignment on mainly twice the speed etc.

THE BASIC RULE IS THAT THE RESONANCE'S OF ANY PART IN THE MACHINE SHOULD NOT COINCIDE WITH ANY NATURAL IMPULSE IN THE MACHINE.

A broad band Vibration-meter can not recognize the frequencies of the vibration but as a rule most high vibrations are caused by only one mechanical problem.

To identify the presence of a resonance, measure the vibration levels in three perpendicular directions at the bearings. If you find a measurement with at least three times higher level than in the other directions you should consider a resonance a likely possibility. The resonance is amplifying the mechanical force and thus gives a high vibration in that direction. The resonance makes the machine unnecessarily sensitive to mechanical forces.

It is possible to locate the resonance peak while the speed of the machine is changing. The resonance frequency is located at that rpm where the vibration has a local maximum.

The proper action against a resonance is very different depending on its location, operating conditions etc. It will normally require good experience to alter the situation.

One reason is that the modification affects the basic mechanical design of the machine and where you normally require the competence of the machine designer.

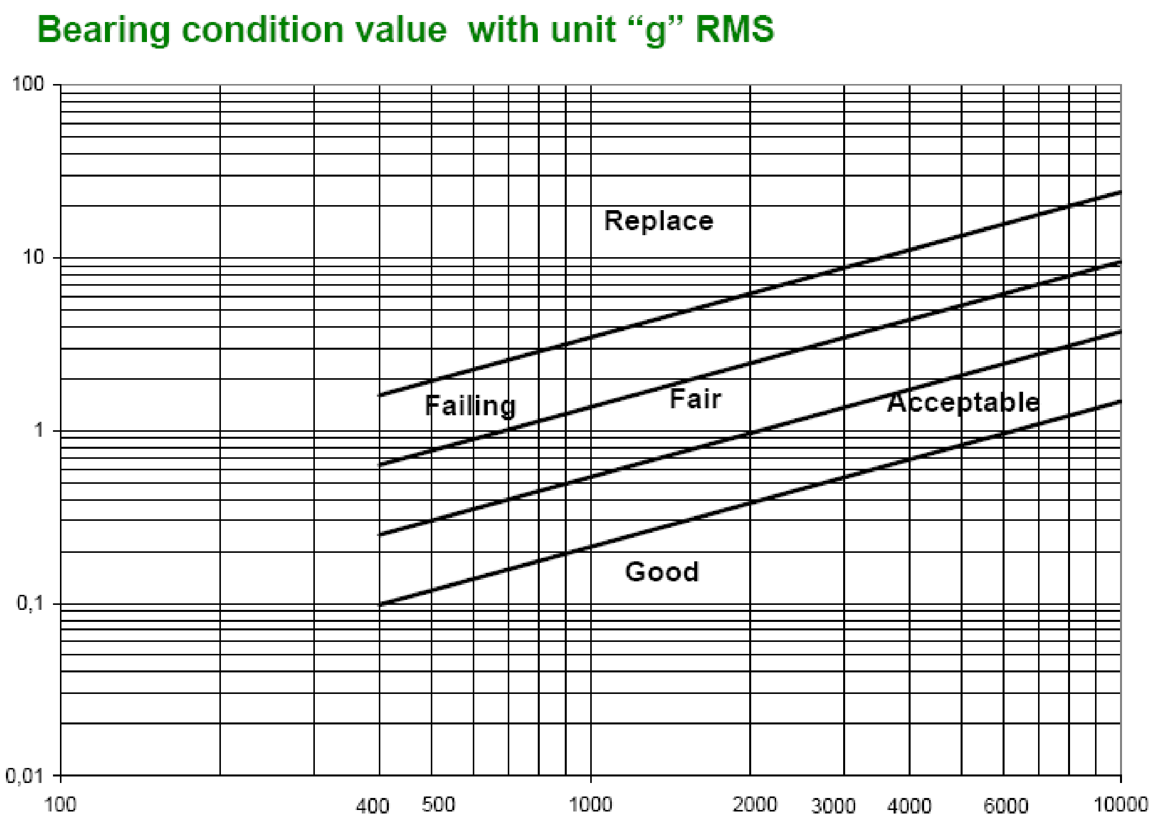
We recommend you however not to hesitate to consider such modifications since the change of the resonance frequency normally is cheap compared to the high maintenance cost that will follow any attempt to run a machine in long term operation under the influence of a resonance.

A TEMPORARY AND SOMETIMES PERMANENT SOLUTION TO A RESONANCE PROBLEM IS TO CHANGE THE SHAFT SPEED OF THE MACHINE, IF POSSIBLE.

What is a bearing condition value?

The bearing condition value in VM-908 is the sum average value, RMS value, of all high frequency vibrations between 1000 Hz to 5000 Hz.

This value is an acceleration average with the unit "**g**" because high frequencies give a large signal if it is measured in acceleration. When the balls or rollers rotate inside the bearing a wide-band noise and vibration arises. This noise and vibration are increased if the bearing is poorly lubricated, overloaded due to misalignment or has a damaged surface.



Because this is a wide-band noise and vibration it is possible to select any frequency or frequency band as a measurement of bearing condition.

If the selected frequency band includes low frequencies the bearing condition value would also include vibrations from unbalances, misalignment, etc. and not purely from bearing vibrations and would therefore be difficult to interpret.

If the selected frequency band only includes very high frequency noise and vibrations we would need special vibration transducers that are very rigidly and closely mounted to the bearing because the machine structure works as a mechanical filter for high frequencies.

VM-908 is measuring the bearing condition value between 1000 Hz to 5000 Hz, similar to many other instruments. Within this frequency range there exist a common experience in the evaluation of the bearing condition level.

Balancing with VIBRATION METER (VM-908)

It is only possible to balance machines where the unbalance is the major cause of vibration.

Do not change the position of the vibration transducer after starting the balancing procedure

Balancing using this method requires only three consecutive trial runs and changing the balance status of the rotor. Only measurement of the vibration level is needed.

Balancing will of course only reduce the vibration caused by unbalance.

A balancing round will often be a good approach and a first attempt to find the reason for increased vibration. If the balancing attempt is not successful, the cause can be loose rotor parts etc.

If the machine speed is variable, be sure to choose the same speed during every trial run. Do not search the speed that gives the highest vibration. Such speeds mostly show non-linear results.

Start the procedure by measuring on the bearings looking for high levels in major directions. Choose a point that should have a good connection to a balancing plane where you can put in a weight in the machine. You must use the same radius for the trial weights and the balancing weights.