THE “B” BOOK GUIDE
TO VIBRATION MEASUREMENTS

HOW TO MEASURE MACHINE VIBRATION
WITH A VIBRATION METER

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The “B” Book Guide To Vibration Measurements

Why Use Vibration Measurements?

Vibration measurement is an effective method for looking at the condition, or “health”, of rotating machinery in commercial and industrial applications. Periodically checking machine conditions (known as “trending”) is easy to do with vibration meters.

Vibration meters help operators spot deteriorating machine conditions before they become critical. By identifying and quantifying a vibration problem, corrective action can be taken before the problem becomes significant and expensive.

Trending with vibration meters allows maintenance technicians to plan repairs during normal work hours rather than scheduling costly overtime or even shutting down production or an entire HVAC system.

Practical Uses for Vibration Measurements

- Pinpoint Vibration Problems
- Identify Mechanical Looseness
- Detect Bearing Wear
- Spot Bent Shafts
- Condition Monitoring
- Predictive and Preventive Maintenance
- Troubleshoot Machinery
- Quality Control

Applications for Vibration Measurements

- Bearings
- Blowers
- Centrifuges
- Compressors
- Conveyors
- Cooling Towers
- Fans
- Grinders
- HVAC Systems
- Mixers
- Motors
- Pumps
- Spindles
**WARNING**

Exercise extreme caution when performing any task around rotating machines. Failure to do so may result in equipment damage and personal injury. Operators are encouraged to become familiar with the equipment and operating procedures before attempting vibration analysis.

**How To Use a Vibration Meter**

**Step 1: Attach the Standard Accessories**

Typical Vibration Meters have standard accessories that are included with the Meter. They include: a vibration Transducer or Accelerometer (often called the Sensor), a connecting cable (Pickup Cable), a Magnetic Clamp (for securely attaching the transducer or accelerometer to the surface of the application being measured) and a Vibration Probe Tip (sometimes called a “Stinger.”)

Attach one end of the Pickup Cable to the Meter and the other end to the transducer (or accelerometer). One connector matches the transducer and one matches the connector on the meter.

Select either the Magnetic Clamp Base or Probe Tip. The advantages of each are discussed below. Both accessories have a 1/4-20 or 1/4-28 studs and attach to the mounting holes in the base of the transducer or accelerometer.

**Magnetic Clamp (Recommended) or Probe Tip**

The Magnetic Clamp Base is recommended to provide a secure, stable mounting for the transducer. The magnet has a 12 lb pull, but allows an operator to detach it without difficulty. Vibration readings are affected by the stability of the transducer mounting.

The 7” Probe Tip is typically used in hard-to-reach areas. It is convenient for operators to use on vibration points on machines because it is not as bulky as a magnet. However, some practice is required to achieve consistent, repeatable readings.
Step 2 - Select a Mode

The Mode is a vibration parameter you want to measure. Balmac Vibration Meters have three modes:
Displacement = DISP, Velocity = VEL and Acceleration = ACC.

Fig 3 - Modes are DISP, VEL and ACC.

Velocity

Velocity is read in inches per second (Peak). Velocity measures the rate of change of displacement. Velocity is more proportional to the destructive forces generated in a machine than either displacement or acceleration. Velocity readings reveal more about vibration at all machinery speeds (RPMs).

Fig 4 - VEL selected.

Displacement

Displacement measures the distance the part moves read in Mils (one Mil = .001 inch) (Peak to Peak). It is necessary to know the RPM of the equipment to establish a vibration limit in Displacement (Mils).

Fig 5 - DISP selected.

Acceleration

Acceleration is the rate of change of velocity read in g’s (Peak). G’s are useful when measuring very high frequency vibrations such as signals generated in rolling element bearings or gear trains.

Fig 6 - ACC selected.

Step 3 - Select a Range

Ranges on Balmac meters are:

<table>
<thead>
<tr>
<th>Range</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 (very rough vibration)</td>
<td>199.9</td>
<td>19.0</td>
</tr>
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Most applications will never be this rough. Used with extremely large primary movers (Class 4) type of equipment.

<table>
<thead>
<tr>
<th>Range</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 (moderate vibration)</td>
<td>19.99</td>
<td>1.9</td>
</tr>
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</table>

Recommended starting range for most measurements. Go to 2 for smaller vibration levels.

<table>
<thead>
<tr>
<th>Range</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (smooth to moderate vibration)</td>
<td>1.999</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Use for small vibration levels and for QC levels for motors and fans.

Very Low Range

Multiply reading on display by number on label that corresponds to Mode used.

Example: Mode is Velocity Model = Vel. Display reading = 197.6. Answer: 197.6 x .001 = .19 in/sec.
Step 4 - EXAMPLE: Taking a Measurement in Velocity

1. Complete Step 1. Attach Magnetic Clamp (or Probe Tip) to Transducer. Connect Transducer to proper cable end and then connect the other cable end to the Meter.

2. Complete Step 2. Select Velocity Mode.


4. Secure Magnetic Clamp/Transducer assembly to first measurement point. (See Vibration Directions and Measurement Points later in this brochure)

5. Depress OFF/ON button until it latches. (Power ON - Display comes on)

6. Depress VEL button until it latches. (Mode = Velocity)

7. Depress 20 button until it latches. (Range = 20)

8. Allow readings to stabilize. (Do not be concerned if the digits to the far right of the display vary up or down, this is normal operation.)

9. Record reading.

Step 5 - What Direction to Measure?

Vibration is measured in Vertical, Horizontal and Axial directions. Test all three to find the direction of the strongest signal. Typically, the Horizontal (Radial) direction provides the strongest signal.

Machine mountings can influence readings. Spring isolator mounted machines may have strong vertical readings.

Strong axial readings often indicate a bent shaft or loose bearings. Take measurements in all three directions whenever possible.

Step 6 - Where To Measure Vibration?

Vibration signals are strongest at or near bearings. They tend to weaken as you move farther away from bearings. Example: the vibration signal is strongest on a direct drive motor/fan assembly on the bearing closest to the fan.

CAUTION: Extreme care must be taken when working around rotating machinery belts, pulleys, sheaves and shafts.

Step 7 - What Does the Reading Mean?

Refer to the Vibration Severity Chart.

Example: an operator has set the Vibration Meter to Velocity (VEL) on the 20 Range and has measured the vibration level on a bearing in the Horizontal direction. The reading is: 00.15 (Inches Per Second, Peak):

The operator would record the reading and then compare the recorded reading with the Severity Chart to determine the vibration severity.
Looking at the left side of the Severity Chart (see Fig 16), the operator would see these numbers representing Velocity in inches per second.

The operator’s reading of 0.15 would fall exactly halfway between .1 and .2 and the operator could conclude the vibration level was in the GOOD zone on the chart.

0.15 ips = GOOD

Measuring vibration in Velocity is the easiest method to learn machine condition. Velocity readings do not require knowing the RPM of the machine. A reading of .1 is SMOOTH whether the machine is running at 100 RPMs, or 100,000 RPMs.

Other Examples of readings in Velocity:

0.08 ips = SMOOTH

0.4 ips = ROUGH.

**Displacement Measurements (Mils Peak-to-Peak)**

Displacement (Mils) readings run across the top and down the right side of the chart. (See Fig 16) Match your reading with the same number at the top or right hand column on the chart.

Next to that number is a diagonal line running right to left down to the bottom of the chart.

Follow the diagonal line down until it crosses a vertical line coming up from the bottom that corresponds to machine RPM. (RPM is at the bottom of the chart.)

Determine if this reading falls in the SMOOTH, GOOD, FAIR or ROUGH range.

Example: a reading of .5 mils (top right corner of chart) intersecting at 2000 RPM (middle bottom of chart) is in the SMOOTH range. A reading of 3 mils (top middle of chart) at 2000 RPM is ROUGH.

Displacement readings require knowing the machine running speed (RPM).

**Acceleration Measurements (g’s, Peak):**

Acceleration readings are represented by diagonal lines running from the top left to the bottom right of the chart. Acceleration numbers are found in the middle of these lines. Like Displacement readings, Acceleration readings require knowing the machine RPM.

Example: .1 g at 1000 RPM = ROUGH.

0.1 g at 10,000 RPM = SMOOTH.

**Over Range**

Vibration signal strength to strong for setting. If display shows a 1. (see photo), select next higher range.

**Fig 16 - Displacement readings run across the top and down the right side of the Severity Chart. Acceleration is shown in lines running diagonally left to right.**

**Fig 18 - Over Range**
Vibration Maintenance Records

Recorded vibration levels:
- provide machine history
- trend machine conditions
- help schedule maintenance

Recording intervals vary from machine to machine. Age and machine condition are important factors, but a general rule of thumb is readings should be made more frequently as soon as machinery deterioration is noticed.

Vibration Maintenance Records Samples may be downloaded from the Balmac Inc. website.

Directions:
1. Sketch basic machine configuration in upper left grid.
2. Record operator identification, dates, times, etc.
3. Include critical machine information such as type of equipment, RPM and special notes.
4. Record vibration readings in HORIZONTAL, VERTICAL and AXIAL directions in appropriate columns. Record both VELOCITY and DISPLACEMENT readings.

Vice Grip Pliers

The Model 158 Pickups may be attached to Vice Grip Pliers for non-magnetic surfaces.

Fish Tail Shaft Sticks

The Fishtail Shaft is used to measure vibration on rotating shafts.

Headphones

Headphones are useful for listening to machinery vibrations. With experience, an operator can learn to identify vibration sources by listening to the pitch and intensity of the vibration noise. This can be useful when analyzing defective bearings. Headphones may be used with Model 200, 205 and 211 Vibration Meters.

WARNING

Rotating machinery have potentially dangerous moving parts. Potential hazards to the operator or the surrounding area may exist. Operators should use extreme caution when working around moving parts.

DISCLAIMER

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