Instruction Manual

Vibration Meters

VM12
VM13
VM14

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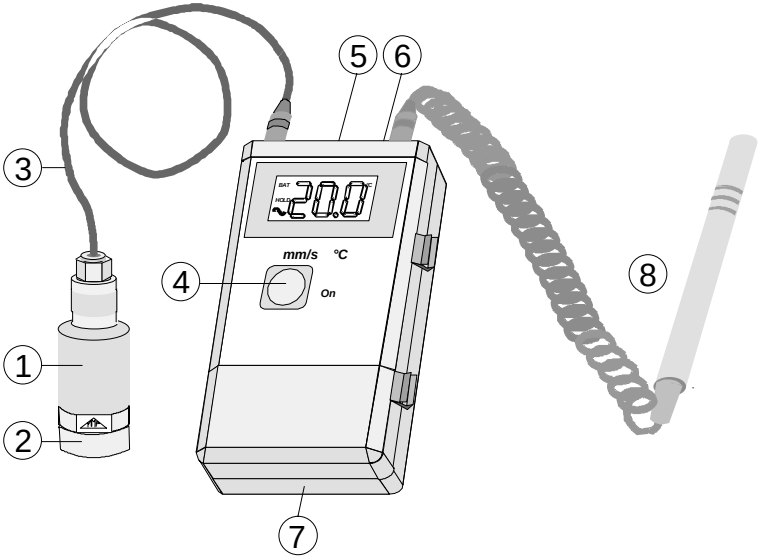
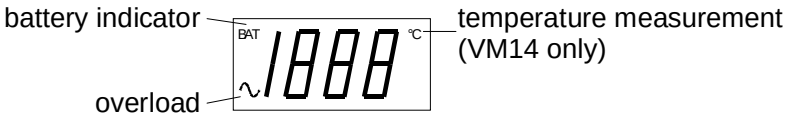


1	piezoelectric accelerometer		
2	clamping magnet		
3	low noise transducer cable		
4	ON button		
5	selector switch	v / a	(VM13)
		v / T	(VM14)
6	wide band signal output		(VM12 / 13)
7	battery compartment		
8	temperature probe		(VM14)

Display:



1. Purpose

The vibration meters VM12, VM13 and VM14 are suitable for routine check of vibration in rotating machines. The 3 models have the following features:

- VM12: vibration velocity (severity)
- VM13: vibration velocity (severity) and vibration acceleration
- VM14: vibration velocity (severity) and temperature

Vibration velocity or severity is mainly used to evaluate vibrations due to unbalance. Reasons for unbalances can be for instance loose bolts, worn bearings or dirt layers on fan blades. Some effects may reinforce each other. Vibration severity is a measure of the energy content of vibrations and is thus an indicator of machine-health.

Several national and international standards define the measurement procedure.

The **vibration acceleration** range was especially designed for bearing noise. Low frequency signal components caused by unbalance do not affect the measurement.

Additionally, the VM14 provides a **temperature** probe. Bearing or gear box temperatures may also be an indicator of wear.

The vibration meters are useful tools in the pocket of the maintenance engineer. Used for routine vibration checks they can prevent unexpected breakdown and thereby save investment.

2. How it Functions

A block diagram is shown in Figure 1.

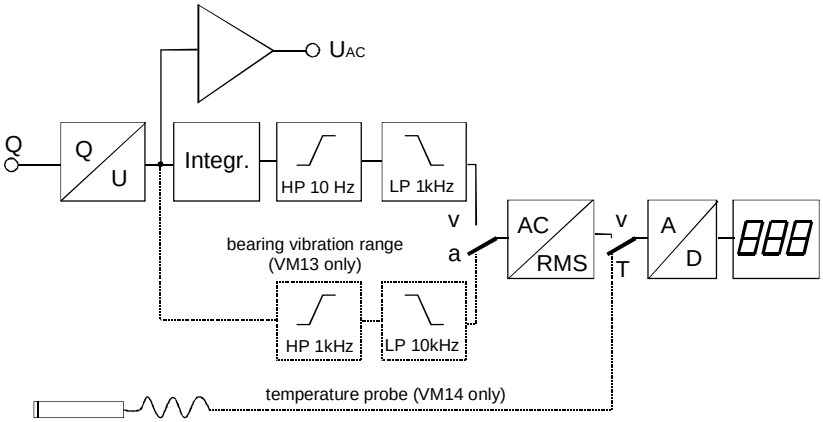


Figure 1: Block Diagram

Vibration Severity

The instrument measures vibration severity or velocity according to ISO 10 816 and corresponding standards. Vibration severity is shown in mm/s over a frequency range of 10 .. 1000 Hz.

The charge output signal of the accelerometer is transformed into voltage by a charge converter stage. An integrator transforms acceleration into velocity, followed by a band-pass filter of 10 .. 1000 Hz. The band-pass amplitude response is illustrated in Figure 2.

The root-mean-square value of the filtered velocity signal is displayed on the LCD.

Models VM13 and VM14 measure vibration severity between 0.2 and 200 mm/s. The VM12 is available in two versions:

- VM12-1 with 0.2 ... 200 mm/s
- VM12-2 with 2 .. 2000 mm/s.

The model number of your VM12 is shown on the label at the back.

Vibration Acceleration

In the acceleration mode the VM13 measures vibration acceleration between 1 and 10 kHz. Two models are available:

- VM13-1 with 0.2 .. 200 m/s²
- VM13-2 with 2 .. 2000 m/s²

The label at the back of the instrument shows the model number of your VM13.

The only differences between velocity and acceleration signal processing are the bypass of the integrator stage and different filter frequencies.

The frequency range 1 .. 10 kHz is especially suited for bearing vibrations. The lower limit of 1 kHz cuts off spectral parts which are contributed by unbalances. These signal components usually have higher amplitudes than the bearing noise and would it make difficult to measure the latter.

Figure 2 shows the typical amplitude response.

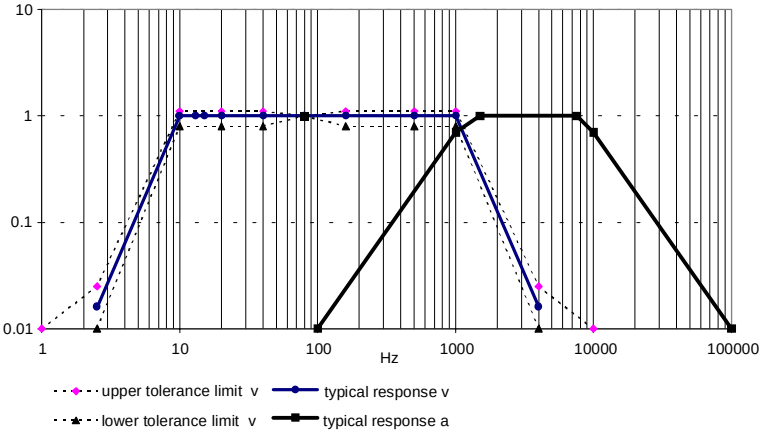


Figure 2: Amplitude Response of Vibration Severity and Acceleration

Temperature

The temperature probe of the VM14 is suitable for measurements within the range of -20 .. 150 °C. The temperature / vibration selector switch is at the top of the instrument. If the temperature range is selected a "°C“ symbol appears at the display. The temperature probe can be attached to the enclosure of the instrument for convenient transport.

3. Operation

3.1. Selecting Vibration Measurement Points

Location Before making measurements, you will need to select suitable attachment points on the machine for the sensor. Experience in machine condition maintenance is advantageous for selecting optimum points.

Dynamic forces are normally transmitted via bearings and their housings into the machine frame. Therefore bearing housings or points close to bearings are well suited. Less suitable are light or flexible machine parts.

Note that scratched, uneven or too small surfaces are major causes of error, especially at higher frequencies.

Attachment For optimum coupling conditions, we recommend attaching polished steel chips with a diameter of 20 mm / 0.8 in or more to the surface of the selected points of the machine using epoxy glue or welding.

The easiest way to attach the accelerometer is the supplied clamping magnet. Another way is the M5 mounting stud if an M5 thread exists at the measurement point.

A thin coat of grease or silicone gel on the coupling surfaces may improve the transmission of high frequencies.

For making quick estimated vibration severity measurements we have supplied a probe which can be screwed on to the base of the accelerometer.

However, some experience is required for reproducible results. The probe is not recommended for measuring bearing noise (range a).

Figure 3 shows the coupling resonance of the described methods.

a: Probe

b: Clamping magnet on polished surface

c: Mounting stud

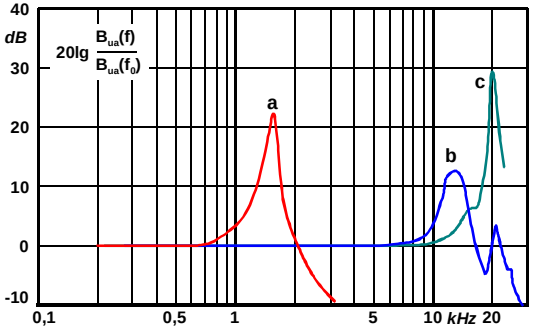


Figure 3: Coupling Resonance

The next step is to determine typical and maximum allowable values. A simple way is to use standards specifying limits depending solely on machine power and foundation type as given for example in ISO 10816. (Figure 4).

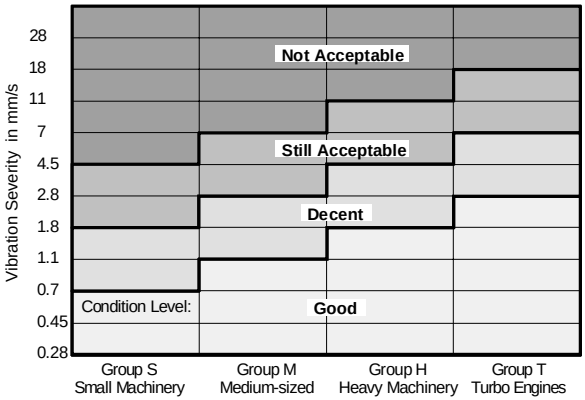


Figure 4: Machine Condition to ISO 10816

The diagram above is based on the following classification:

- Group S: machine components and motors which are rigidly connected to the machine body, e.g. electric motors up to 15 kW
- Group M: electric motors 15 to 75 kW without special foundation, rigidly installed motors or machines up to 300 kW with special foundation

- Group H: big driving and other machinery with rotating parts at rigid and heavy foundation which is relatively stiff in the measured vibration axis
- Group T: big driving and other machinery with rotating parts and foundation which is relatively pliable in the measured vibration axis, e.g. turbo generators and gas turbines over 10 MW

3.2. Temperature Measurement Points

If possible, use the same steel chips as for the vibration sensor for temperature measurement. Only a smooth, even and metallic surface will result in a low time constant for quick and precise temperature readings. On good coupling conditions the measurement value will be stable after some seconds. If temperature is taken at painted parts, uneven, dirty or rusty surfaces, measurement gets usually very slow because of insufficient heat conduction.

3.3. Measurement

Day-to-day measurements can be made by persons without any particular experience. The instrument is very easy to use:

1. Choose range v (vibration severity),
   a (acceleration, VM13 only) or
   T (temperature, VM14 only).
2. Attach the accelerometer to the prepared point or press the thermometer probe vertically at the prepared point
3. Push ON button
4. After a few seconds the reading will be stable and can be read and noted

Small input signals may take a few seconds longer to stabilize due to internal time constants.

Overload Under extreme conditions output overload can occur. In this case the display shows ”1 .“ In case of major high frequency signal components (particularly in the v range) a possible overload of the input stage is indicated by a ”~“ symbol.

Shut-off Timer After 2 minutes the instrument shuts off automatically.

☞ Notice: Loose accelerometer cable connectors may cause considerable measurement errors.

3.4. Signal Output

The unfiltered acceleration output signal of the VM12 and VM13 is available at the wide-band signal output. Frequency analyzers, scopes and other equipment can be connected to the meter’s output using a cable we supply. The output connector is a 3.5 mm phone jack. A BNC / 3.5 mm cable belongs to the supplied accessories.

The sensitivity of the signal output in relation to the accelerometer input is

- 10 mV/pC for VM12 and VM13-1
- 1 mV/pC for VM13-2.

The output swing is $\hat{u}_{OUT}$ > 3 V. The lower frequency limit is 3 Hz. The upper frequency limit is limited by the accelerometer. The linear frequency range of the supplied transducer is about 10 kHz. The sensitivity of the accelerometer was determined individually (see chapter Technical Data).

Thus the signal output voltage can be directly converted into acceleration.

Example:

Accelerometer sensitivity (see Technical Data):	B_{qa}= 2.5 pC/ms^{-2}
Measured output voltage:	U_{OUT} = 500 mV
Instrument:	VM12 (B_{uq}= 10mV/pC)
Measured acceleration:	$a = \frac{U_{OUT}}{B_{uq} \cdot B_{qa}}$
	$\underline{\underline{a = 20\ ms^{-2}}}$

4. Battery

The instruments are powered by a 9 V battery IEC 6F22. Battery life depends on battery type. Usually between 2000 and 3000 measurements of 2 minutes duration can be made. The shut-off mode supply current is extremely low and in the range of battery self-discharge. A low battery (7 V) is indicated by a ”BAT“ symbol on the LCD.
Even at battery voltage of 6.5 V the instrument works with less than 5 % error.

5. Calibration

Vibration Severity

The accuracy of the vibration severity range can be tested easily using a vibration calibrator, for instance the Metra VC10. Such calibrators excite the accelerometer with a specified vibration velocity of 10 mm/s. Then the display can be compared to the rated value.

Vibration Acceleration

The acceleration calibration of the VM13 is more complex. We recommend a method using an input voltage instead of mechanical vibration. This approach does not require a costly high frequency vibration exciter and can be carried out with regular laboratory equipment. All you need is a shielded calibration capacitor (recommended 1 nF, 0.5 %) and a sine wave generator. The calibration capacitor replaces the internal piezo-capacitor of the accelerometer. By connecting the capacitor between generator and VM13 input an accelerometer signal can be simulated. Figure 5 shows the circuit. Note that the ground terminals of the generator and the VM13 need to be connected.

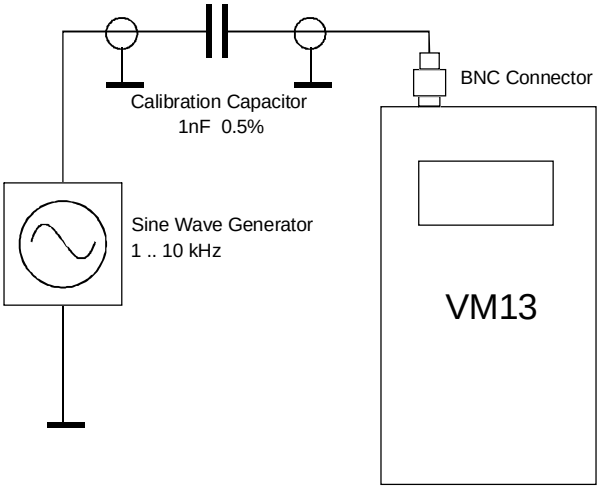


Figure 5: Calibration of the acceleration range

If a 1nF capacitor is used the following relation is obtained: 1mV generator voltage corresponds to 1pC charge input.
Please take into consideration the accelerometer sensitivity (mV/ms^{-2}) as noted in the Technical Data chapter.

Example: The sensitivity of the supplied accelerometer is 2.5 mV/ms^{-2}. To obtain a charge input corresponding to 100 m/s² the generator has to supply 250 mV.
All quantities are RMS values.

☞ Please note that the achieved calibration is only valid with the supplied accelerometer. To avoid confusion the serial number of the accelerometer is noted in the Technical Data chapter.

Calibration Service

Annual re-calibration is recommended by the manufacturer. Metra also offers a calibration certification service. We adjust your instrument corresponding to a reference accelerometer of the German National Authority of Metrology (PTB). On demand we provide a Calibration Certificate.

6. Technical Data

Ranges			
Vibration severity	0.2 .. 200	mm/s	VM12-1, VM13, VM14
	0.02 .. 20	mm/s	VM12-2
Vibration acceleration	0.2 .. 200	m/s²	VM13-1
	2 .. 2000	m/s²	VM13-2
Temperature	-20 .. 150	°C	VM14
Accuracy	± 5%, ± 2 Digits		vibration
	± 3 K		temperature
Inputs	charge input, BNC socket temperature probe, Binder 711 socket		
Frequency ranges			
Vibration severity	10 .. 1000 Hz to ISO / DIN / VDI		
Vibration acceleration	1 .. 10 kHz (-3 dB)		
Display	3½ digits, LCD		
Indicator functions	overload, battery discharge		
Signal output (VM12, VM13)	acceleration signal, 10 mV/pC 1 mV/pC $\hat{u}_{OUT}$ >3 V, R_{OUT} =600 Ω; 3.5 mm phone plug		 VM12, VM13-1 VM13-2
Battery	9V block IEC 6F22; life time 2000 .. 3000 measurements of 2 minutes each		
Operating temperature range	-10 .. 50°C / 32 .. 130 °F rel. humidity 95 %, no condensation		
Dimensions	120 x 60 x 30 mm³ / 4.7 x 2.4 x 1.2 in³ 120 x 75 x 30 mm³ / 4.7 x 3 x 1.2 in³		 VM12, VM13 VM14
Weight incl. battery, without accelerometer	approx. 150 g / 5.3 oz		

Serial no. (instrument)

No. .....

Accelerometer:

Serial no. (sensor)

No. .....

Model	piezoelectric shear accelerometer
Sensitivity	..... pC/ms²
Resonant frequency	> 28 kHz
Transverse sensitivity	<5 %
Mounting	clamping magnet, M5 stud bolt adapter, probe
Dimensions	∅ 25 mm, height 55 mm ∅ .98 in, height 2.2 in
Weight	approx. 50 g / 1.8 oz
Sensor cable	1.5 m low noise cable with TNC / BNC plugs
Accessories (included):	accelerometer, clamping magnet, M5 stud bolt adapter, vibration probe, temperature probe (VM14 only) sensor cable BNC/TNC, signal cable 1.5 m BNC / 3.5 mm phone plug (VM12, VM13 only), instruction manual

Limited Warranty

Metra warrants during a period of
12 months
that its products will be free from defects in material or workmanship and shall conform to the specifications current at the time of shipment.

The warranty period starts with the date of purchase. Customer has to provide the dated bill of sale as evidence. The warranty period ends after 12 months.

Repairs do not extend the warranty period.

This limited warranty covers only defects which arise as a result from normal use according to the instruction manual.

Metra's responsibility under this warranty does not apply to any improper or inadequate maintenance or modification and operation outside the product's specifications.

Shipment to Metra has to be paid by the customer. The repaired or replaced product will be sent back at Metra's expense.

CE

Declaration of Conformity

Product: Vibration Meters

Models: VM12 / 13 / 14

The products mentioned above
meet the requirements
pursuant to the following rules:

- EN 50081-1
- EN 50082-1

responsible for the manufacturer

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Manfred Weber
Radebeul, March 1997