Instruction Manual

Vibration Monitor

M10v

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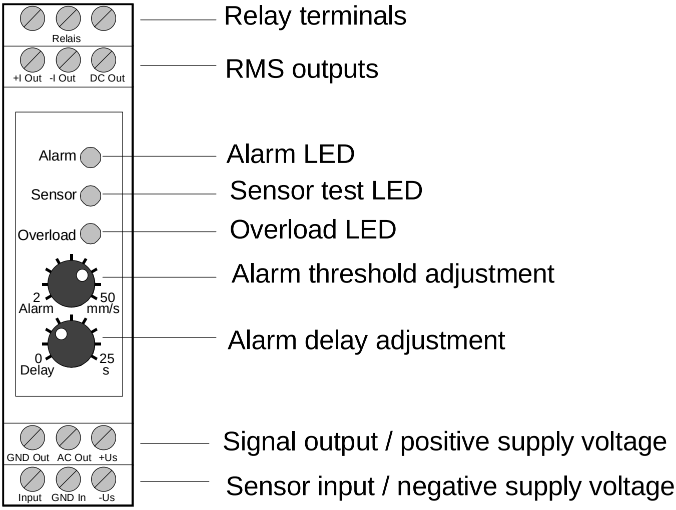
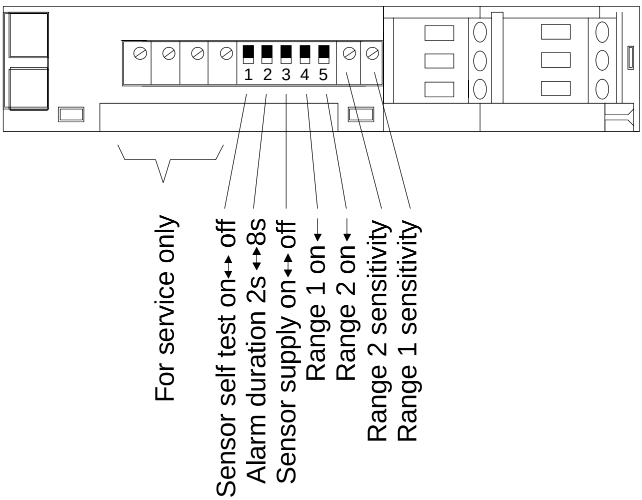
Contents

Front View



Side View



1. Purpose

The M10v is intended for vibration measurement and monitoring. Its modular concept provides optimum adaptation to your application.

The M10v delivers standardized vibration quantities for subsequent processing. Additionally, a relay contact is included which can be used for alarm indicators or emergency shut-off of machines.

The M10v measures and monitors vibration velocity (severity) between 10 and 1000 Hz to DIN/ISO 10816. It is suited for measurement of low frequency vibration of machines with rotating parts. These vibrations can be caused by unbalance due to loose parts, dirty fan blades, bent parts or worn bearings, for example. Often, these effects reinforce each other.

Typical applications are vibration monitoring and predictive maintenance of pumps, compressors, mixers, centrifuges or fans.

The M10v helps the maintenance engineer to predict and recognize wear of machine parts in time. Thereby, it may avoid unexpected breakdown, costly repairs and production loss. The M10v may also contribute to quality improvement.

2. How it Functions

Figure 1 shows the block diagram of the M10v.

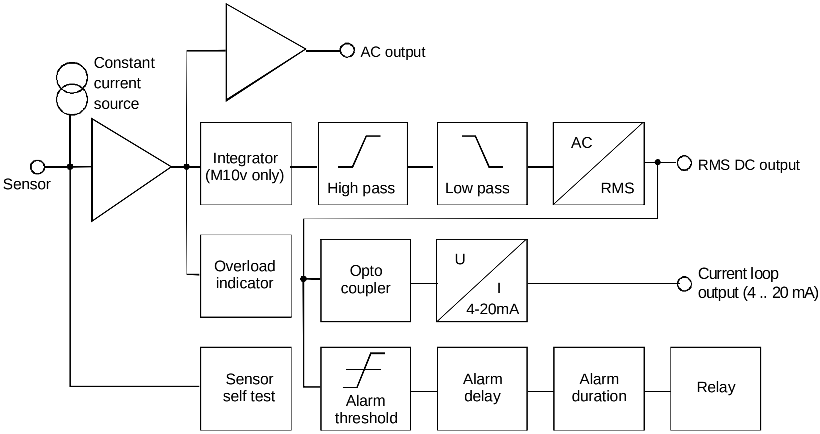


Figure 1: Block Diagram

Sensor The M10v requires a piezoelectric accelerometer with integrated electronics to ICP® standard. We recommend our industrial accelerometers series with insulated base, for example models KS74 and KS80.

The constant current for the integrated sensor electronics is supplied by the unit and can be activated by a switch.

Integrator The M10v features an integrator stage converting vibration acceleration into velocity.

Filter The frequency limits of the built-in 10 to 1000 Hz band filter are according to ISO 10816.

Figure 2 shows the filter amplitude response including standardized tolerances.

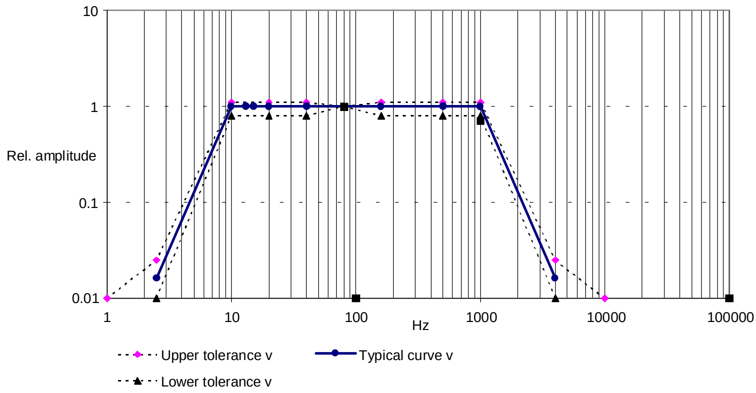


Figure 2: Filter amplitude response

RMS Converter The M10v features a true RMS converter. It also maintains high accuracy while measuring non sine-wave inputs. The RMS converter provides a DC output which is accessible via terminal blocks for processing.

Current Loop Output The RMS of vibration velocity is also available as current loop output (4 to 20 mA). The current loop standard makes it possible to transmit analog signals over long distances. At the destination, for example, PLCs, panel meters or recorders can be connected. Often, different ground potentials make long distance signal transmission difficult. This problem will not occur with the M10v. The current loop output is insulated by an opto coupler which makes the unit independent of any reference potential.

Alarm Tripping The built-in relay is activated when vibration velocity exceeds an adjusted threshold. This can be useful to control external equipment directly. The relay features a change-over contact. Thus electric circuits can be both closed and interrupted.

Relay threshold and trip delay can be adjusted individually. Additionally, two alarm hold times are selectable. Figure 3 illustrates the alarm management.

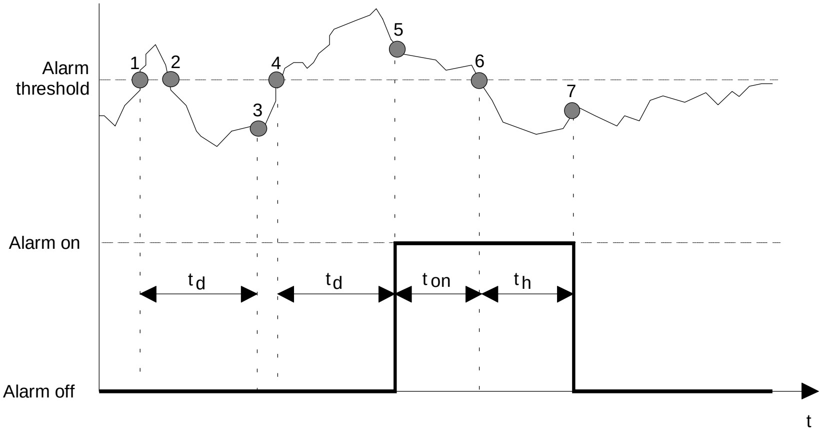


Figure 3: Alarm management

The upper curve of the diagram shows a typical time graph of a vibration signal (RMS). The lower curve shows the relay response.

At point ① the adjusted alarm threshold is exceeded. Now delay time starts. It can be adjusted at the front panel between 0 and 25 seconds. Since the vibration level at point ② has already returned below the alarm threshold before t_d is over no alarm will be tripped at point ③. Thus short vibration peaks which may occur due to machine start, shock momentum or electromagnetic influence will not affect the alarm relay.

At point ④ the alarm threshold is exceeded again and delay time t_d starts once more. This time an alarm will be tripped since the alarm threshold remains exceeded after t_d is over at point ⑤. The relay will stay activated until at point ⑥ vibration level goes below the threshold. Now alarm duration time t_h starts which can be selected between 2 and 8 seconds. When t_h is over the relay contact returns into its normal position. A defined minimum alarm duration ensures save switching of external components.

Self Test Functions It is expected that monitoring equipment has a very high reliability. Unnoticed faults need to be avoided and false alarms as well. Maximum reliability of the M10v is guaranteed by a two-stage self test circuitry:

1. Monitoring of sensor bias voltage recognizes defective accelerometers and broken cables. Defects are indicated by an yellow LED at the front panel and on demand via the alarm relay.
2. Power supply failure causes the relay contact to switch into the alarm position.

Overload Indicator The “Overload” LED at the front panel indicates overload condition of the input stage. When it lights up the signal has reached 80 % of its maximum range. However, at this point the output signal is still undistorted.

☞ The “Overload” LED only indicates overload of the input stage. In rare cases it may happen that at the same time when overload is indicated the RMS output is in the normal range and the relay does not respond. This is due to predominant signal components beyond the filter limits which only affect the input stage but do not pass the band filter. This problem can only be avoided by lowering the sensitivity of the used range (see chapter 3.3).

3. Installation

3.1. Selecting Measurement Points

Sensor 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 recommended measuring points. Less suitable are light or flexible machine parts.

Attachment For best coupling conditions we recommend a stainless steel disk with mounting thread (for instance Metra model 229) which can be epoxy glued or welded onto the machine.

The best way to attach the accelerometer is a stud bolt.

A thin coat of grease on the coupling surfaces will improve the transmission of high frequencies.

For temporary installations also a magnetic base can be used (for instance Metra model 008).

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

Evaluating Limits 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 shows different machine categories with corresponding vibration severity values to ISO 10816.

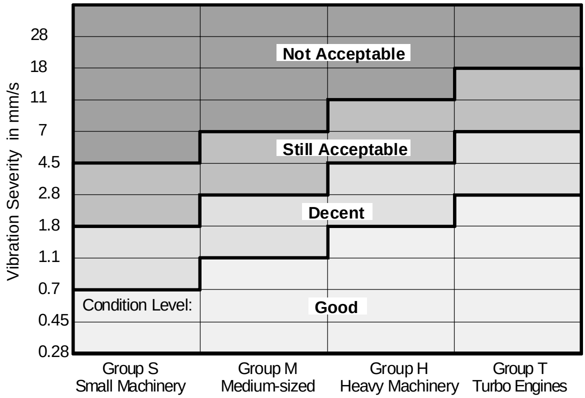


Figure 4: Machine condition to ISO 10816

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. Connection

Mounting The M10v is intended for 35 mm DIN rails. It has been designed for installation in dry and dust protected environments, preferably in switch cabinets.
To attach or remove a module pull out the black lever on the top of the enclosure using a screw driver.

Terminal Blocks All inputs and outputs are accessible via terminal blocks. They are suited for cable diameters of 0.14 to 4 mm² for single wire and 0.14 to 2.5 mm² for stranded wire.

Power Supply The M10v requires a DC supply voltage between 20 and 28 V which is usually available in industrial environments. The maximum current consumption is 50 mA.

Figure 5 shows the power supply connection.

The M10v is protected against false polarization and overvoltage peaks.

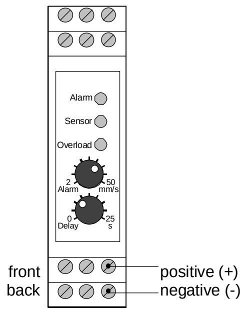


Figure 5: Power supply connection

Sensor Input The M10v is suitable for all kinds of ICP® accelerometers. The built-in constant current supply provides 4 mA supply current. A compliance voltage of >20 V ensures full dynamic input range independent of the sensor bias voltage. The constant current source is activated by pushing the DIP switch “ICP Supply” towards the “ON” position (Figure 6).

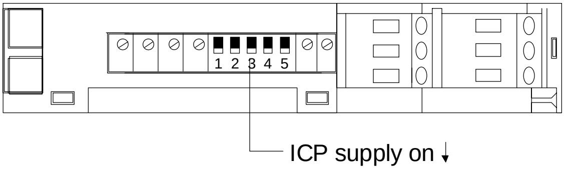


Figure 6: Activating sensor supply

The input is protected against overvoltage. The input ground terminal (“GND Input”) is connected to negative supply voltage.

☞ Ground loops may cause considerable measurement errors. To avoid these problems preferably accelerometers with insulated base or insulating flanges should be employed. Thereby the ground potentials of the machine and the M10v are separated.

The sensor is connected via shielded cable which may have a length of 100 m or more. Limitations are given by cable resistance and electromagnetic immunity.

Figure 7 shows the sensor connection.

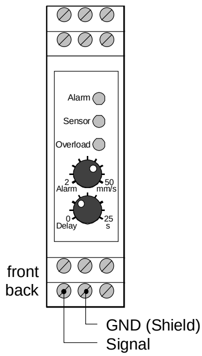


Figure 7: Sensor connection

Operation of two M10v modules with one Sensor

It is possible to operate two M10v modules with one mutual sensor. For example, a monitoring system with 2 alarm levels (pre-alarm and main alarm) can be built in this way (see Figure 8).

☞ When two modules are operated with one sensor only the sensor supply of <u>one</u> module must be activated (Figure 6).

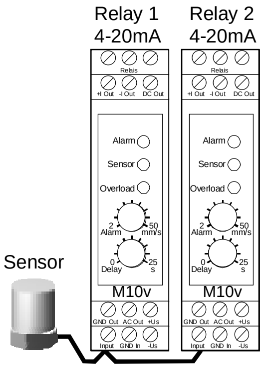


Figure 8: Monitoring with two thresholds using one mutual sensor

☞ The terminals “GND Output”, “DC Output” and “AC Output” of the two modules are not to be connected. When the signals “DC Output” and “AC Output” are required they should be measured referred to terminal “GND Output” of <u>one</u> of the two modules. Instruments with symmetric and ground free inputs can be connected to each “GND Output” terminal.

Relay Output The M10v features a change-over relay contact which transmits the alarm condition. Figure 9 shows the connection of the relay output. In normal condition (O.K.) terminal 2 and 3 are connected. In case of alarm terminal 1 and 2 are short-circuit. In case of power supply failure the relay switches into alarm position where it remains until supply voltage is applied again. By that means power supply failure is indicated as alarm condition (self test function).

The relay contacts are potential-free and capable of switching 40 V AC at 2 A. Relays outputs of several M10v units can be connected in series (logic AND) or in parallel (logic OR) to bundle and save alarm wires.

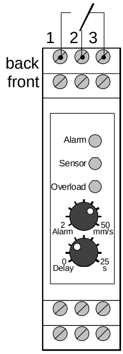


Figure 9: Relay output, shown in O.K. position

Current Loop Output

The M10v provides an analog current loop output of the RMS of vibration velocity between 10 and 1000 Hz. The advantage of a current loop is the possibility to transmit signals over a long distance without accuracy loss using cheap cables.

A current of 4 mA corresponds to zero level (0 mm/s or 0 m/s²). The maximum current of 20 mA is reached at full scale which is 50 mm/s. The vibration level corresponding to a measured current is obtained:

$$v = \frac{50\ \text{mm/s}\ \ (I_{loop} - 4\text{mA})}{16\ \text{mA}}$$

The current loop output is a current drain, i.e. a supply voltage is required in the loop circuit to drive the current. Figure 10 illustrates this principle. The internal current loop circuitry of the M10v requires a minimum compliance voltage of 14 V between the terminals “+I Loop” and “-I Loop”. Therefore, the loop supply voltage should be greater than $U_S > 14\ V + U_L$ where U_L is the total voltage drop of all resistors in the circuit at 20 mA.

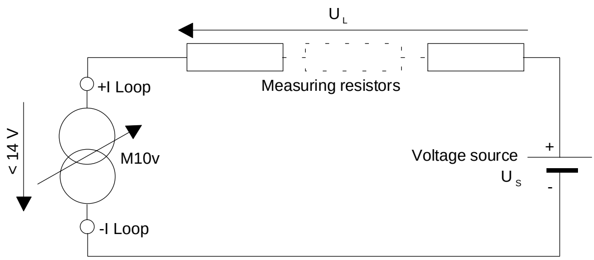


Figure 10: Current loop principle

Figure 11 shows the connection of the current loop output.
The current loop output is insulated from the rest of the M10v circuit and power supply by an opto coupler. This ensures that ground potential differences which often occur when signals are transmitted over long distances do not affect the accuracy of the M10v.

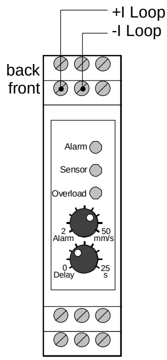


Figure 11: Current loop connection

DC Output Apart from the current loop output the M10v features a DC voltage output of the RMS. The DC Output provides 10 V at full scale representing 50 mm/s.

Consequently, the sensitivity of the DC output of vibration velocity is 200 mV/mms^{-1}.

The reference point of the DC output is not “GND Input” but an internally generated reference voltage which is accessible at terminal “GND Output”.

Figure 12 shows the connection.

☞ **Caution: The terminal “GND Output” has a DC voltage of +10 V referred to “GND Input”, i.e. negative supply. Therefore, “GND Input” and “GND Output” must never be shorted.**

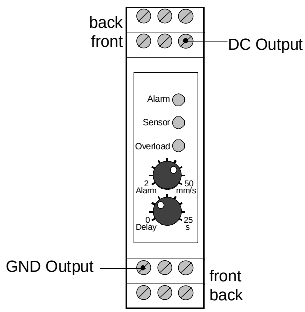


Figure 12: DC output

AC Signal Output Often it can be advantageous to know the wide-band spectral composition of the vibration signal. Observing the signal by means of scopes or analyzers may yield information about the source of vibrations. These measurements can be carried out at the spot or using recording equipment for subsequent processing. For that purpose the M10v provides the unfiltered wide-band acceleration signal of the sensor.

The absolute level at the AC output depends on the adjusted sensitivity. When the M10v has been calibrated the AC output yields 200 mV / g (1 g = 9,81 m/s^2).

The maximum undistorted output voltage is ± 8 V. The lower frequency limit is 1 Hz. The upper limit is above 15 kHz. Take into consideration that most industrial accelerometers become nonlinear at this frequency.
The AC output is referred to “GND Output”.
Figure 13 shows the connection.

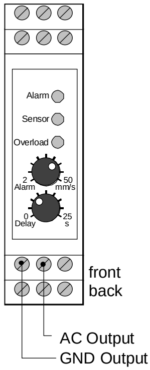


Figure 13: AC signal output

3.3. Adjustments

Factory Calibration

If you have purchased the M10v together with an accelerometer the unit has been calibrated by the manufacturer. If not requested otherwise the following calibration has been carried out:

DC Output	I Loop	AC Output
200 mV/mms^{-1} ± 4 %	4 mA + 16/50 mA/mms^{-1} ± 4 %	200 mV/g ± 10 %

Adjustment Points

The arrangement of the sensitivity adjustment points and range switches is shown in Figure 14.

☞ Factory calibration is only valid together with the original accelerometer and with unaltered range switches and sensitivity adjustment.

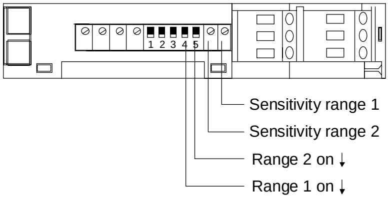


Figure 14: Adjustment points and range switches

Gain Ranges The M10v has two measuring ranges. The optimum range depends on the sensitivity of the connected accelerometer.

- Range 1: Transducer sensitivity 0.8 .. 6 mV/ms^{-2}
- Range 2: Transducer sensitivity 5 .. 20 mV/ms^{-2}

Push the DIP switch towards the "ON" position to activate the corresponding range.

☞ Both ranges must not be activated simultaneously.

Sensitivity Adjustment Sensitivity adjustment is carried out by two trimmers on the right side of the DIP switches. (Figure 14).

A fast and convenient way to calibrate the M10v is a vibration calibrator of Metra's VC series. It supplies a defined stabilized vibration signal into the accelerometer. The output of the M10v can now be adjusted to the nominal vibration level.

Alarm Adjustments The **alarm threshold** is adjusted by the upper trimmer at the front panel. The adjustable range is 2 to 50 mm/s.

The scale gives a rough orientation about the adjusted value.

Alarm delay is adjusted by the lower trimmer. Left stop corresponds to a delay of 0 s or undelayed alarm tripping. Right stop is 25 seconds delay.

Alarm duration can be chosen by one of the DIP switches at the side of the M10. Two durations are available: 2 and 8 seconds. The adjustment is shown in Figure 15.

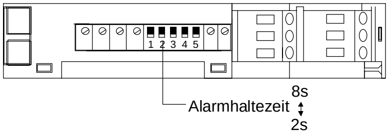


Figure 15: Alarm duration

Sensor Self Test The M10v is capable of detecting defective transducers. For this purpose the sensor bias voltage between the input terminals is monitored. When the bias voltage exceeds a nominal value it means that the constant current source can not drive sufficient current through the sensor. Possible causes are a defective sensor or broken cable. Another reason may be sensor overload. The sensor detection of the M10v responds at 18 V. Figure 16 illustrates sensor bias, maximum, and minimum (saturation) output voltage. The bias voltage is found in the sensor data sheet. The compliance voltage of the M10v is greater than 20 V.

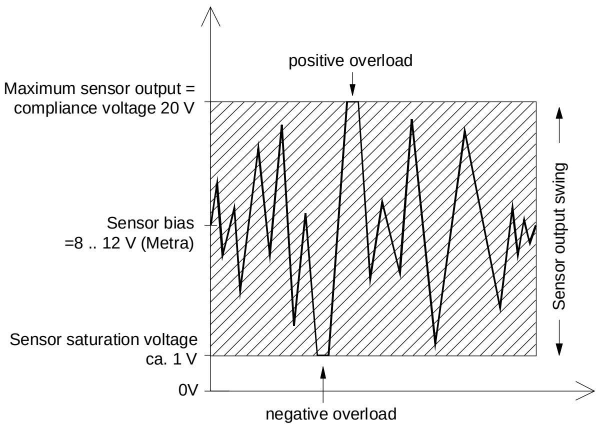


Figure 16: sensor bias and output swing

A defective sensor is indicated by a yellow LED "Sensor" at the front panel. If demanded, the sensor self test function can trigger the alarm relay. For that purpose push the DIP switch "Self Test" towards the

“ON” position (Figure 17). Now a sensor error is treated in the same way as vibration alarm. However, no delay is provided.

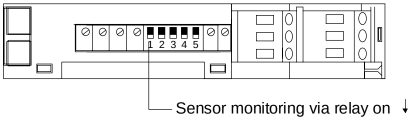


Figure 17: Activating sensor monitoring by the relay

Other Adjustment Points

The trimmers on the left side of the DIP switches are intended for service only. Any manipulation voids the warranty.

4. Technical Data

Ranges (Factory calibration)	0 .. 50 mm/s ± 4 %
Input	voltage input, R_I > 1 MΩ, AC coupled, ICP® compatible
Sensor supply	3.8 .. 5.6 mA constant current, compliance voltage > 20 VDC, activated by DIP switch
Suitable sensors	ICP® compatible accelerometers, sensitivity: range 1: 0.8 .. 6 mV/ms^{-2} range 2: 5 .. 20 mV/ms^{-2}
Band filter	10 .. 1000 Hz (-3 dB), two poles
Relay output	40 V AC / 2A, potential free, change-over contact
Relay threshold range	2 .. 50 mm/s
Relay delay	0 .. 25 s
Relay hold duration	2 or 8 s
Current loop output	4 .. 20 mA, current drain, insulated, loop supply voltage > 14 V
DC output	0 .. 10 VDC true RMS of vibration (with > 24 VDC supply voltage)
Wide-band output	acceleration signal, $\hat{u}_{OUT}$ = ± 8 V, 1 .. 15 000 Hz, impedance 100 Ω, sensitivity when factory calibrated: 200 mV/g
Sensor monitoring	LED, via relay alternatively, threshold: >18 V sensor bias
Overload indicator	LED, at approx. 80 % of full scale output
Power supply	20 .. 28 VDC / 50 mA
Operating temperature range	-10 .. 55 °C relative humidity < 95 %, no condensation
Dimensions (w x h x d)	22 x 76 x 111 mm^3
Weight	approximately 120 g

Limited Warranty

Metra warrants for a period of

24 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 invoice.

The customer must provide the dated bill of sale as evidence.

The warranty period ends after 24 months.

Repairs do not extend the warranty period.

This limited warranty covers only defects which arise as a result
of 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 will be paid by the customer.
The repaired or replaced product will be sent back at Metra’s expense.

Declaration of Conformity

Product: Modular Vibration Monitor
Model: M10v

It is hereby certified that
the above mentioned product
complies with the demands
pursuant to the following standards:

- EN 50081
- EN 50082

Responsible for the manufacturer

Metra Mess- und Frequenztechnik
Meissner Str. 58
D-01445 Radebeul

Manfred Weber
Radebeul, 2nd of October, 1998