Instruction Manual

Vibration Meter
for
Wind Energy
Plants

VM30-W

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Jun/ 11

Inhalt

Appendix: Warranty
        Declaration of Conformity

1. Purpose

Thank you for choosing a vibration meter from Metra!

The VM30-W was developed for vibration monitoring of wind energy plants to VDI 3834 Part 1. This guideline deals with the particular requirements of wind energy plants.

The VM30-W measures, on the one hand, the vibrations generated by the machine set to ISO 10816-3 and, on the other hand the random low frequency vibration of tower and nacelle induced by changing wind and motion of the sea (offshore only). VDI 3834 Part 1 gives practical reference values for the evaluation of possible risks for the wind generator.

The effective instrument with its high sensitivity triaxial accelerometer is suitable for measurements at tower, nacelle, rotor bearing, gearbox and generator.

Particular attention has been paid to simple operation, compact design and long battery operating time.

2. The Instrument at a Glance

MENU: Setup
LIGHT: Display backlight
RANGE: Change / save signal settings
INFO: Memory occupancy, time, date, version
ON / OFF: On (hold 2 s) / Off

SAVE: Record measuring values
ESC: Leave menues without change, Reset maximum and long-term values
LOAD: Load user-defined setups
LOCK: Key lock on / off

Battery cover

Press strongly to open the battery compartment

Figure 1: Key functions

Sensor input | External supply | Analog output | RS-232 interface

Figure 3: Connections

Battery compartment
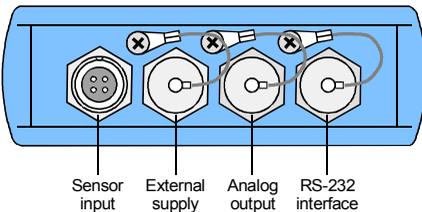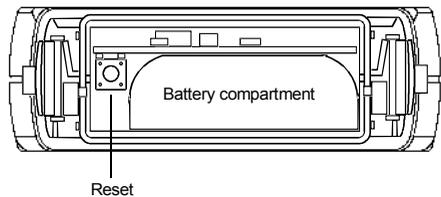
Reset

Figure 2: Battery compartment and reset button

3. The Guideline VDI 3834 Part 1

3.1. Scope

VDI 3834 Part 1 gives practical advice on the measurement and evaluation of the mechanical vibrations of wind energy plants. It is applicable for generators with gearbox between 100 kW and 3 MW in onshore locations.

VDI 3834 Part 1 does not deal with torsional vibration of the power train and with the condition of roller bearings and cogwheels.

The reference values given in this guideline are not intended for predictive maintenance.

3.2. Measurement Method

Wind energy plants are exposed to changeable wind speeds and wind directions. resulting in variable vibrations with high magnitude changes. The known methods of machine condition monitoring, for example to ISO 10816, are only applicable with restrictions.

For wind energy plants averaging of the measured vibration values over a defined period is necessary. The energy equivalent mean value, also called interval RMS, is calculated. It indicates the total vibration stress during the measuring period T_0.

$$a_{W0} = \sqrt{\frac{1}{T_0} \int_0^{T_0} a_w^2(t)\,dt} \qquad \text{Equation 1}$$

with:

$a_W(t)$ vibration quantity (acceleration or velocity) as function of time t

T_0 measuring period

For the aerodynamically induced vibrations of tower and nacelle with main frequencies between 0.1 and 10 Hz and relatively high magnitudes a measuring period of 10 minutes is recommended. This ensures exact measurement of frequencies below 1 Hz.

In the case of different operation conditions it can be necessary to divide the total measuring period of 10 minutes into several sections. The total vibration value is then calculated as follows:

$$a_{W0} = \sqrt{\frac{1}{T_0} \sum_{e=1}^{n} a_{we}^2 \cdot T_e} \qquad \text{Equation 2}$$

with

$$T_0 = \sum_{e=1}^{n} T_e$$

At gearbox and generator characteristic vibrations between 10 and 1000 Hz may occur. Here a measuring period of 1 minute is sufficient.

The following table shows the characteristics to be measured for the different components:

Component	Characteristics	Measuring period	Measuring location	Direction
Nacelle and Tower	Acceleration ≤ 0.1 to 10 Hz Velocity ≤ 0.1 bis 10 Hz	10 minutes	• In the nacelle on both sides of the rotor bearing base and on both sides of the main frame near the generator • At the tower below the azimuth bearing	Axial, horizontal und vertical direction of rotor shaft
Rotor bearing with rolling elements[1]	Acceleration ≤ 0.1 to 10 Hz Velocity 10 to 1000 Hz	10 minutes 1 minute	• In designs with two separate rotor bearings on both bearing cases • In three-point bearing designs at the case of the front bearing	Axial, horizontal und vertical direction of rotor shaft
Gearbox	Acceleration ≤ 0.1 to 10 Hz Acceleration 10 to 2000 Hz Velocity 10 to 1000 Hz	10 minutes 1 minute 1 minute	• In designs with separately mounted gearbox and gearboxes with integral rotor bearing at the gearbox case near the rotor or main bearing	Axial, horizontal und vertical direction of rotor shaft
Generator	Acceleration 10 to 5000 Hz Velocity 10 to 1000 Hz	1 Minute 1 Minute	• In designs with integrated gearbox and generator at the case near the input and outer bearings • In designs with flexibly coupled generators at the case of both bearings	Axial, horizontal und vertical direction of rotor shaft

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1 For journal bearings vibration displacement is to be measured by means of proximity probes. This measurement cannot be performed with the VM30-W.

3.3. Operating Conditions for Measurement

The criteria given in section 3.4 are applicable under normal operating conditions, i.e. stable operation with at least 20 % nominal power. The reference values are valid for the entire power range of the wind energy plant. It can be useful, however, to take measurements at certain conditions where increased vibration occurs.

3.4. Evaluation Criteria and Reference Values

VDI 3834 Part 1 evaluates the vibration by two criteria which have been derived on the basis of a sufficient number of measurements at different types of existing wind energy plants.

The first criterion is the machine component, like tower, nacelle, gearbox or generator. Each component can be divided into different designs.
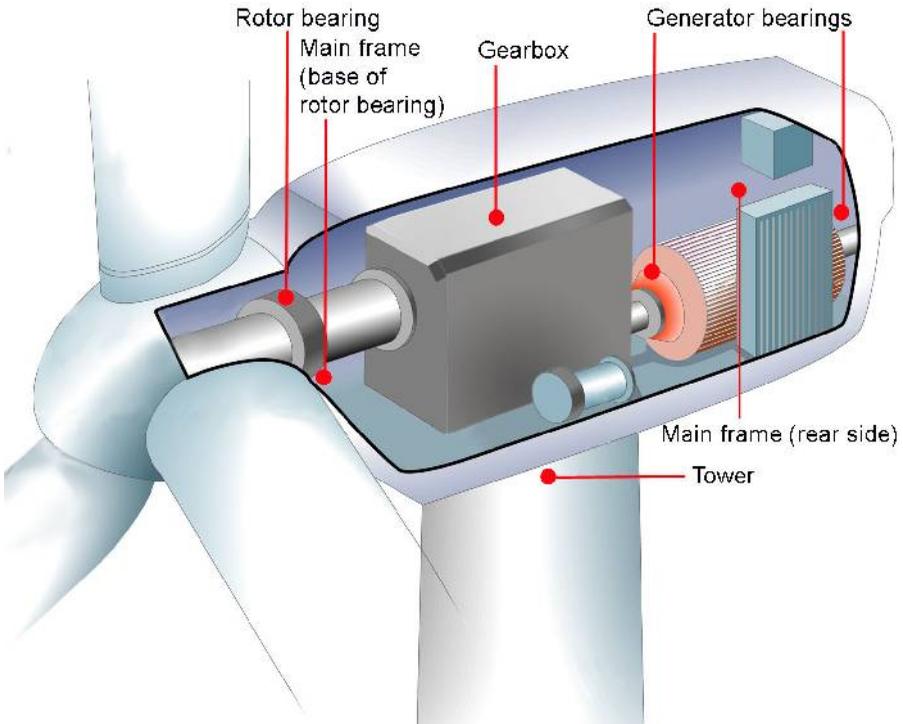

Figure 4: Components and measuring points to VDI 3834 part 1

The second criterion are the values of the characteristics measured at these components. The measured values are classified into three zones. This allows a qualitative evaluation and gives information about possible risks.

The evaluation is performed on the basis of acceleration and velocity measurements at different locations. The worst zone value is the relevant one.

Zone 1: Good for continuous operation.

Zone 2: Possibly not good for continuous operation. An examination of the source of vibration is recommended.

Zone 3: Danger of damage.

The following table shows statistically-derived reference values of acceleration and velocity for different components.

Component	Acceleration		Velocity	
Nacelle and Tower	Frequency range ≤ 0.1 to 10 Hz		Frequency range ≤ 0.1 to 10 Hz	
	Zone limit I/II	Zone limit II/III	Zone limit I/II	Zone limit II/III
	0.3 m/s²	0.5 m/s²	60 mm/s	100 mm/s
Generator	Frequency range ≤ 0.1 to 10 Hz		Frequency range 10 to 1000 Hz	
	Zone limit I/II	Zone limit II/III	Zone limit I/II	Zone limit II/III
	0.3 m/s²	0.5 m/s²	2.0 mm/s	3.2 mm/s
Gearbox	Frequency range ≤ 0.1 to 10 Hz		Frequency range 10 to 1000 Hz	
	Zone limit I/II	Zone limit II/III	Zone limit I/II	Zone limit II/III
	0.3 m/s²	0.5 m/s²	3.5 mm/s	5.6 mm/s
	Frequency range ≤ 10 to 2000 Hz			
	7.5 m/s²	12.0 m/s²		
Generator	Frequency range ≤ 10 to 5000 Hz		Frequency range 10 to 1000 Hz	
	Zone limit I/II	Zone limit II/III	Zone limit I/II	Zone limit II/III
	10 m/s²	16 m/s²	6.0 mm/s	10 mm/s

4. Measurement with the VM30-W

4.1. Sensor Input

The VM30-W is suited for the connection of three individual or one triaxial piezoelectric IEPE accelerometers with a sensitivity between 40 and 60 mV/g which work at a constant current of 2 mA. The relatively low supply current was chosen to save battery power. The three built-in constant current sources have a compliance voltage of 20 V.

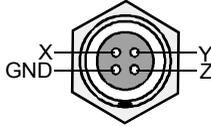The input socket Model *Binder* 711 (4 pins, female) is located at the front side of the case.

Figure 5: Pin assignment of the input socket (view from outside)

The VM30-W automatically recognizes the connected sensor by its bias voltage. The respective channel is disabled if the bias voltage exceeds the limit of 19 V. Only the results of the other channels will be displayed. If all three inputs are disconnected, the message "No sensor connected." is displayed.

The maximum input voltage is 6 V (peak-peak). At higher voltages the instrument switches itself off.

4.2. Sensor Mounting

In the table on page 3 you find the locations for the installation of the accelerometer. The sensor simultaneously measures in three directions (X, Y and Z) reducing the number of measurements to a minimum. Particularly for vibrations above 10 Hz a rigid and flat surface at the measuring point is important. There must be no gap between the sensor and the measuring point since this can result in self-oscillation.

Metra supplies with the VM30-W accessories kit the following mounting parts for the included accelerometer KS823B:

	Model 508: Rare-earth magnetic base for flat and curved surfaces with M8 thread **Note:** The magnet has a very strong pulling force. Please note that careless dropping of the magnet onto the measuring point may generate high g levels which can overload and damage the accelerometer. Put on the sensor with the magnetic clamp to the measuring point gently rolling it over the edges.

	Model 629: Mounting disk for permanent installation by screw or adhesive. The sensor is attached by the supplied ring nut. The mounting disks are available individually without ring nut as Model 529.
	Model 043: Stud bolt M8 x 10 for the tapped hole in the sensor base.

4.3. Switching the Instrument On and Off

To switch on the VM30-W, push the ON/OFF key and hold it for 2 seconds. The instrument displays its software version and starts to display measuring values using the last settings.

To switch it off, press again the ON/OFF key. Switching off by accidental key press can be avoided with the key lock function. Press the LOCK key and confirm by OK to lock all keys. The keys can be unlocked by pressing the LOCK key and OK again.

Please note that the VM30-W can only be switched off in the measuring mode. You must escape from the data logger mode and the menus by using the ESC key before the unit can be switched off.

If the shut-off timer was activated (MENU → "8/8: Device settings" → "2/5: Shut-off timer"), the instrument switches off after 1, 10 or 30 minutes.

4.4. Display

The VM30-W has a graphical LCD with a resolution of 32 x 120 dots. It displays clearly the measuring values of three channels simultaneously including units and additional information.

Pressing the LIGHT key switches on the back light. By repeated key press the light is switched off again. Otherwise the light switches off automatically after 30 seconds. Please note, in order to save battery power, use the back light only when necessary. It increases the total current consumption by 30 %.

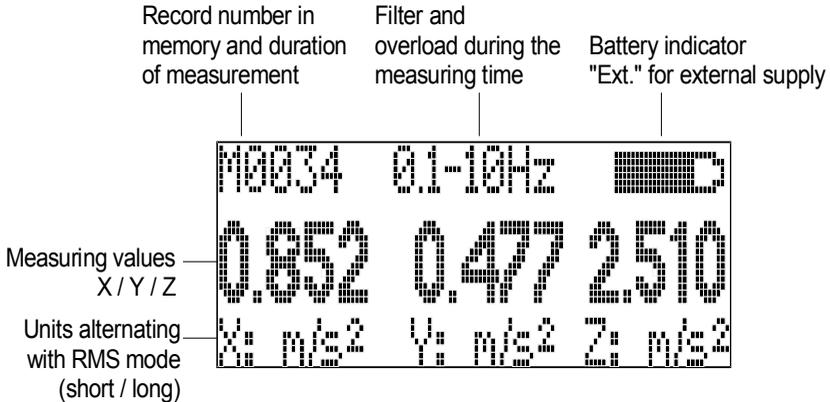A typical display in the measuring mode is shown in 6.

Figure 6: Display in measuring mode

Depending on the connected sensor, one, two or three measuring values are displayed side by side. Below you will find the respective channel identifier (X / Y / Z) and the measuring units alternating with the RMS mode. **Short** means that the averaging time of the RMS is 1 second, i.e. the displayed value only includes events since the previous value. This mode shows quick changes. It is suitable for steady vibration signals from 10 Hz up.

For measurements at wind energy plants to VDI 3834 part 1 mainly the RMS mode **Long** will be used. The measuring time T_0 (see section 3.2) starts after pressing the ESC key and ends in the moment of reading the result. The elapsed measuring time, alternating with the record number, can be seen in the upper left corner of the display.

In opposition to **Short** the RMS with **Long** will be less sensitive to short vibration peaks.

In the upper left corner you can see the number of stored values in the memory **Mxxxx**. In the data logger mode this number is incremented each time the instrument saves a measuring value. A message **instable** in this place indicates for RMS mode **Long** that the display has not settled yet. It will disappear after 10 equal measuring values have been displayed.

In the center of the upper line you see the selected filter. In RMS mode Long the filter text will alternate with Overload if there was an overload condition on one of the three channels during the measuring time. It can be reset by pressing ESC.

The battery indicator is in the upper right corner. If the battery is fully discharged, the message **Bat!** is indicated accompanied by a beep sound.

The messages **GAIN UP** and **GAIN DOWN** instead of the measuring value indicate a change in the measuring range by the autoranging function. The VM30-W may also display **OVER LOAD** instead of the measuring value.

4.5. Settings and Presets for Measurement

The signal settings can be changed by pressing ▲ (RANGE). The following options are selectable by the ▲ ▼ keys:

- Acceleration with filters
    0.1 - 10 Hz
    10 - 1000 Hz
    10 - 2000 Hz
    10 - 5000 Hz

- velocity (single integrated acceleration) with filters
    0,1 - 10 Hz
    10 - 1000 Hz

The filter 0.1 to 10 Hz automatically invokes the RMS mode Long. For the other filters you can choose between **Long** and **Short** (see section 4.4).

After this you will be asked whether you want to save these settings. The VM30-W provides 10 presets (0 to 9) which can be activated by pressing the ▼ key.

Saving can be skipped by pressing ESC.

By pressing OK you may enter a 20 characters name for the preset using the ◄ ▲ ▼ ► keys.

After loading the default settings (key MENU, "6/8: Load defaults") the original presets will be restored. These are:

Setup 0: „NACELLE_TOWER_ACC"   Tower and nacelle, acceleration , 0.1 to 10 Hz

Setup 1: „NACELLE_TOWER_VEL"   Tower and nacelle, velocity , 0.1 to 10 Hz

Setup 2: „ROTOR_BEARING_ACC"   Rotor bearing, acceleration , 0.1 to 10 Hz

Setup 3: „ROTOR_BEARING_VEL"   Rotor bearing, velocity, 10 to 1000 Hz

Setup 4: „GEAR_ACC_LOW"   Gearbox, acceleration , 0.1 to 10 Hz

Setup 5: „GEAR_ACC_HIGH"   Gearbox, acceleration, 10 to 2000 Hz

Setup 6: „GEAR_VEL"   Gearbox, velocity, 10 to 1000 Hz

Setup 7: „GENERATOR_ACC"   Generator, acceleration, 10 to 5000 Hz

Setup 8: „GENERATOR_VEL"   Generator , velocity, 10 to 1000 Hz

Setup 9: „GENERATOR_VEL"   Generator, velocity, 10 to 1000 Hz

4.6. Measuring Ranges and Autoranging

The VM30-W has four measuring ranges which can be selected in menu "1/8: Gain". Choose one after the other the measuring ranges for X, Y and Z. The ranges displayed in the menu depend on the selected vibration quantity.

⇨ The measuring ranges refer to the peak amplitude before filtering and integration. The actually displayed values may be higher when very low frequencies are measured in velocity mode. On the other hand, the actually displayed values may not reach the range limits when signal frequencies in the attenuating band of the filters or integrator are measured.

The following table shows the available measuring ranges depending on the vibration quantity and the transducer sensitivity:

Internal Gain	Acceleration	Velocity
100	0.12 m/s²$_{peak}$	1.2 mm/s $_{peak}$
10	1.2 m/s²$_{peak}$	12 mm/s $_{peak}$
1	12 m/s²$_{peak}$	120 mm/s $_{peak}$
0.1	120 m/s²$_{peak}$	1200 mm/s $_{peak}$

The measuring ranges are selected with the ▲▼ keys and confirmed with OK.

⇨ Gain setting is not available for the measurement of velocity from 0.1 to 10 Hz. In this mode the VM30-W uses a fixed gain.

For the RMS mode **Short** an Autoranging function is available. The autoranging function switches to a higher measuring range at 95 % of full scale and to a lower range at 8 % of full scale.

If you have chosen autoranging, the display will show in the measuring mode GAIN UP if the measuring range is being lowered or GAIN DOWN if the measuring range is being increased. During the settling time of approximately 5 seconds after changing the range the VM30-W will display OVER LOAD.

Notice for the use of autoranging: If the measured vibration level should be very changeable, it may be advisable to use fixed measuring ranges instead of autoranging to avoid continuously changing ranges. This may also be the case if the vibration level should be near the switch limits of 8 % or 95 % of full scale.

4.7. Starting the Measurement

Please wait about 1 Minute after attaching the sensor and switching on the VM30-W until the signal has settled.

Measurement is started by pressing the ESC key. This will reset the RMS and start the counter for the measuring time in the upper left corner.

4.8. Saving Measurements

4.8.1. General

The VM30-W can store between 1000 and 3000 measurements, depending on the selected recording mode.

The following recording modes are available:

• **Manual recording** of a single measurement in X / Y / Z direction by the SAVE key. You may specify whether a comment, the clock time and the date are to be added to the saved measuring values.

• Time-controlled recording in the **data logger** mode in a user-defined time interval between 1 second and some hours.

The selection of the recording mode is made in the menu "2/8: Recording setup". Select manual recording (manually by SAVE key) or time-controlled recording (by data logger).

The two recording modes cannot be mixed in the memory. The VM30-W can either hold manually recorded or logger data. If the instrument should detect data of the other type in its memory, a warning will inform you that the memory will be overwritten.

4.8.2. Manual Recording by Pressing the SAVE key

After the selection of manual recording in the submenu "2/8: Recording setup" you will then be asked if you want to add a comment. The comment with up to 20 characters may contain, for example, information about the measuring point or the test conditions. Recording without comment may save approximately 40 % memory space.

In the next step you can decide whether you want to add the clock time and the date to each record. They occupy approximately 10 % of the memory space.

The actual recording is done by pressing the SAVE key when the instrument shows measuring values. If the comment function has been enabled, you will be asked to enter a text by means of the ◄ ▲ ▼ ► keys. The comment may consist of up to 20 capital letters and numbers.

After pressing OK, the measurement is saved while the display shows date, time and available memory space for two seconds.

Should the memory contain data which was saved in the time-controlled (logger) mode, a warning indicates that the memory will be overwritten.

Each recorded measurement gets a consecutive number. The next available number is displayed in the upper left corner as "Mxxxx" (see section 4.4.).

If the memory is full, a message "Data memory full." appears after pressing the SAVE key.

The available memory space can be checked by the ◄ (INFO) key during measurement. Occupied memory is indicated as a black bargraph.

4.8.3. Automatic Recording in the Data Logger Mode

After selecting the data logger mode in the menu "2/8: Recording setup" you are asked to select a time unit. Using the ▲▼ keys you may choose between seconds, minutes or hours. After pressing OK you may enter a time interval between 1 and 9999 using the ◄▲▼► keys. In the next step you enter the log duration. It must be longer than at least one log interval. Otherwise an error message will be displayed. If you confirm the preset value "0000", the maximum log duration of 10 000 seconds, minutes or hours will be used. In the last step enter a name for the log file using the ◄▲▼► keys. It may consist of up to 20 capital letters and numbers. Now the settings for the data logger functions are complete.

The logger is started by the SAVE key. First the log interval, the log duration and the available memory are displayed for your information. Confirm by pressing OK. Should the VM30-W memory still contain manually saved data, a warning will inform you that this data must be overwritten.

Data logger operation can be recognized by the increasing record number "M0000" in the upper left display corner. While the data logger is running, the MENU, RANGE and LOAD keys are disabled. When pressing one of these keys or the ESC key, a message "Logger halted." appears. You may resume logging by OK or finish by ESC.

The VM30-W can hold several independent log files in its memory. A new log file can be appended by pressing the SAVE key again. Before saving a new log file, you can also change the settings in the menu "2/8: Recording setup" if desired.

It is useful to lock the keys of the VM30-W when it is in the log mode to avoid interruption by accidental key pressure. Press the LOCK key and confirm by OK. Now all keys are disabled. To unlock, press the LOCK key again and confirm by OK.

4.8.4. Reading Saved Measurements on the Display

After pressing the MENU key and selecting „3/8: Scroll memory" you can watch the recorded measurements in the memory. You will see, for example in the case of manually recorded data, the following screen:

> X0001: 10.3 mm/s
>
> Y0001: 1.57 mm/s
>
> Z0001: 0.86 mm/s

A record is shown with the three axis values. The index after the coordinates shows the record number (see section 4.4). By the ▲▼ keys you can navigate back or forward. Pressing ◄ shows date, time, filter, RMS mode and comment text of the record.

Data stored in data logger mode looks as follows:

> X+0000 sec: 5.68 m/s²
>
> Y+0000 sec: 0.006 m/s²
>
> Z+0000 sec: 18.98 m/s²

You see again the three axis values. The coordinates are followed by the elapsed time since the start of recording. Again, by pressing the ▲▼ keys you can navigate back or forward. Pressing ◄ shows start date, start time, filter, RMS mode and comment text of the record.

Press ESC to leave the data display.

4.8.5. Erasing the Memory

To delete the entire memory, select the menu function "4/8: Erase memory". An empty memory can be recognized by the record "M0000".

5. Data Transfer to a PC

Microsoft Excel is a widely used software for calculation and visualization of data in table form. It also enables data to be converted into other formats. Therefore the data transmission from the VM30-W to the PC is based on Excel.

5.1. Preparations for Excel Import

The instrument uses a serial (RS-232) interface for PC connection (section 7). A commercially available RS-232 / USB adapter can also be used.

For processing, displaying and saving data, a Microsoft Excel file is provided. It is compatible with Excel 2000 and higher versions under Windows 2000, XP, Vista or 7. The Excel file includes a Visual Basic Macro which enables Excel to read data from the serial interface and to sort it into table fields.

To give the macro access to the serial interface, the file **vm30.dll** must be copied into the system folder:

…/WINNT under Windows 2000 or

…/WINDOWS under Windows XP

Please copy the Excel table file **vm30-w_english.xls** into your working directory.

Notice: The latest versions of the files vm30-w_english.xls and vm30.dll can be downloaded free of charge from our web site at **http://www.mmf.de/software_download.htm.**

5.2. Importing Data with the Excel Macro

Before you open the file vm30-w_english.xls please make sure that the use of macros is enabled. Open the menu Tools / Macro / Security. If you select the security level „Medium" you will be prompted to enable macros each time you open the file VM30.XLS. The security level "Low" presents no prompt and macros are allowed. However, be aware of the potential risk of macro viruses when using low security.

In Excel 2007 the macro security settings can be found in the "Trustcenter".

Open the file vm30-w_english.xls and save it under a new name to avoid overwriting.
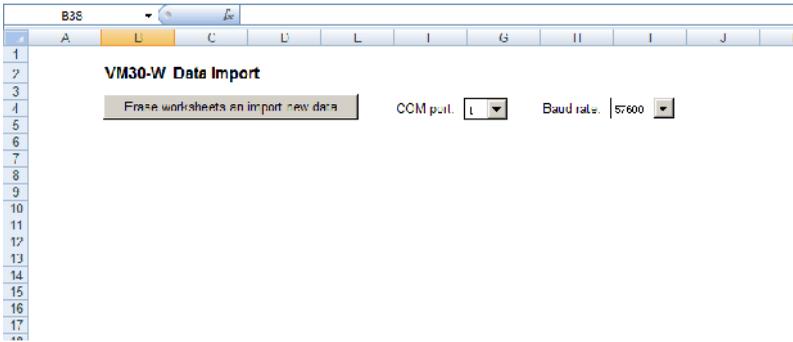
Figure 7: Excel file vm30-w_english.xls - import worksheet

Before importing data from the VM30-W adjust the baud rates of the instrument and the PC interface. Select the correct baud rate from the drop-down menu of the Excel software. In most cases 57600 baud is a good choice for quick and reliable transmission.

At the VM30-W the baud rate is selected as follows: Press the MENU key. Select by the ▲▼ keys "8/8: Device settings". Go to submenu "5/5: Baud rate" and choose the desired baud rate by ▲▼.

Connect the VM30-W to the RS-232 interface of your PC via the supplied interface cable VM30-I. You may also use a Serial-to-USB converter which simulates a serial interface on your PC. Select the used interface in the drop-down menu "COM-Port" of the Excel file.

The VM30-W must be switched on and in measuring mode (close all menus).

Click "Erase worksheets and import new data" in the Excel file. Excel will now import all data from the VM30-W memory.

At a higher amount of data a bargraph shows the progress of transmission. A message will be displayed on your PC screen after successful transmission.

Figure 8: Transmission successful

One or more new worksheets will be created for the data. Each data logger file will be put into a separate worksheet.

Figure 9: Worksheet with manually saved data

Figure 10: Worksheet with logger data

If transmission has failed, the following message will appear:

Figure 11: Transmission error

Please check if you have selected the correct COM port in the Excel file (see section 5.2) and if the selected baud rate corresponds with the VM30-W setting. This error message will also appear when the VM30-W is not in measuring mode.

You can restart the transmission. Data will remain in the memory until it is erased (section 4.8.5)

5.3. Function of the Excel Macro

Excel macros are programmed in Visual Basic. Via the Excel menu Tools / Macro / Visual Basic Editor you may view and modify the source code of the VM30-W macro.

The only specific part for the VM30-W is the function declaration for RS-232 communication which is embedded by means of the file VM30-DLL:

> Declare Sub OPENCOM Lib "VM30.DLL" (ByVal COM_Parameter$)
> Declare Sub CLOSECOM Lib "VM30.DLL" ()
> Declare Sub TIMEOUT Lib "VM30.DLL" (ByVal ms%)
> Declare Sub STRLENGTH Lib "VM30.DLL" (ByVal B%)
> Declare Function STRREAD Lib "VM30.DLL" (ByVal D$) As Integer
> Declare Sub SENDSTRING Lib "VM30.DLL" (ByVal S As String)

These commands have the following meaning:

OPENCOM (Parameter$) opens a serial interface using the parameter string in the form „COM1:57600,E,7,1" (COM port number, baud rate, parity, data bits, stop bits).

CLOSECOM closes the serial interface.

TIMEOUT (ms) is the maximum waiting time when receiving data from the serial interface in milliseconds. Transmission is stopped if no data is received before the waiting time is over.

STRLENGTH (Length) is the length of a character string to be received.

STRREAD (String) receives a character string with the length defined by STRLENGTH. When the time defined in TIMEOUT is exceeded, the function returns the string "Fehler". The string variable must be filled with space characters before reception.

Example: SRLENGTH 8
                  Data$ = "   "
                  STRREAD (Data$)

SENDSTRING (String) sends the specified character string to the VM30-W.

The program code of the VM30-W macro consists mainly of the reception of character strings from the instrument and their interpretation and display in table fields.

Feel free to modify the macro or the Excel file according to your requirements.

5.4. Transmission to PC by a Terminal Program

The VM30-W transmits the stored data as formatted text. Therefore it is also possible to use a terminal program for the display of measured data. The following example explains how to use the program HyperTerminal which is distributed with Windows.

Open HyperTerminal and click File / Properties to make a new connection with the serial interface. Enter the desired baud rate (Bits per second), 7 data bits, even parity, 1 stop bit and no flow control.
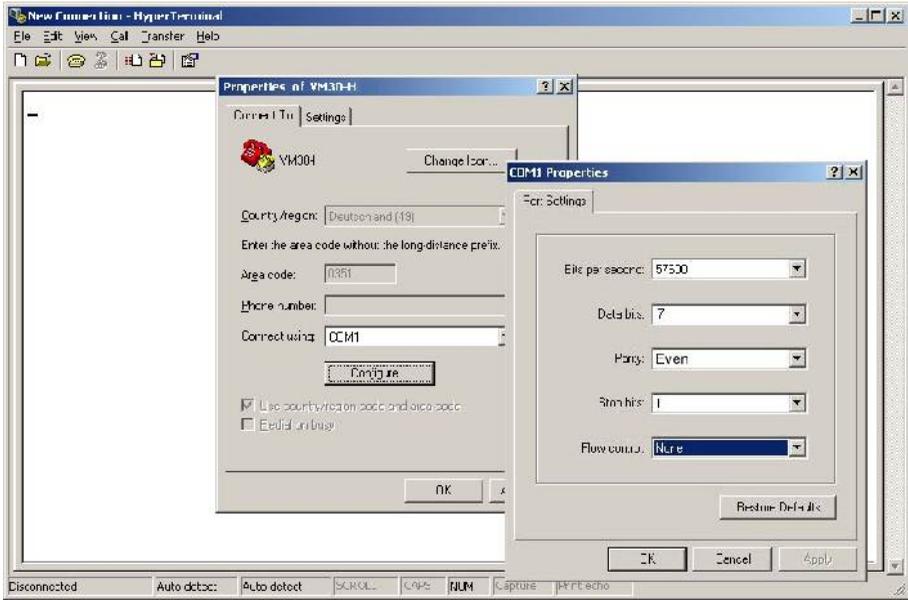
Figure 12: Configuration of HyperTerminal for data from the VM30-W

Open the new connection. In the bottom line of the HyperTerminal window you will see "con-nected". The terminal is now ready for data reception. Data is received as soon as you enter a "#" character in the terminal window.
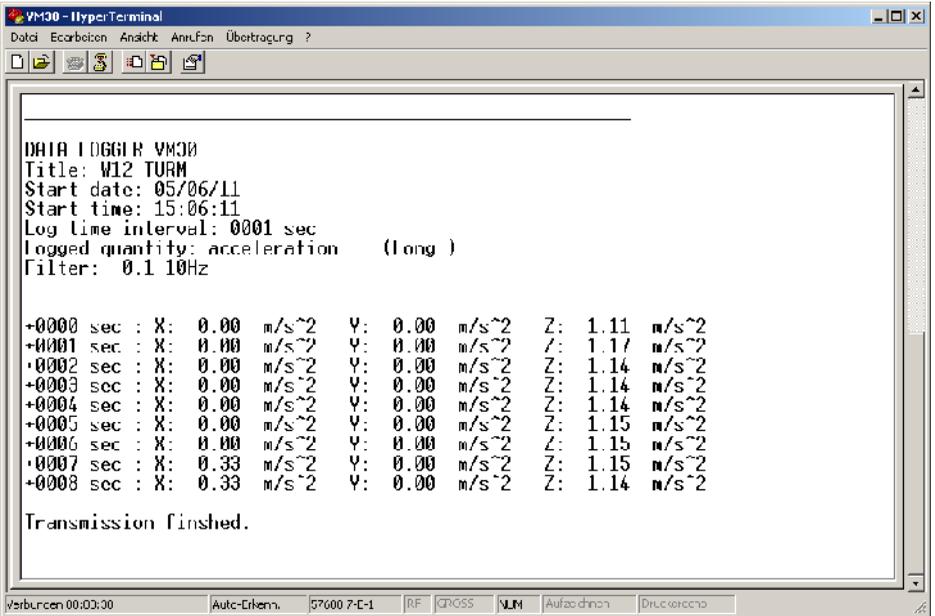
Figure 13: Import of VM30-W data into HyperTerminal

6. Other Settings

6.1. Time and Date

The VM30-W has a real-time clock providing time and date for data recording.

It can be changed in the menu "5/8: Time and Date". Successively enter hours, minutes, seconds, year, month and day using the ▲▼ keys. Each value becomes effective as soon as you press OK. By pressing ESC you may leave the menu without changes.

The correct time settings can be checked by the INFO key.

The real-time clock continues operation if the batteries are removed for replacement. Only after several hours without batteries will the settings disappear.

6.2. Beep Sound On / Off

In the menu "8/8: Device settings", submenu "1/5: Beeper on/off" you may switch the beep sound on or off.

6.3. Automatic Shut-Off Timer

Select the menu "8/8: Device settings", submenu "2/5: Shut-off timer" to activate the shut-off timer and to select between 1, 10 or 30 Minutes. The timer is restarted after pressing a key, i.e. the instrument only switches off after the selected time if no operation was made.

The shut-off timer is only active in the measuring mode. In the data logger mode it is disabled.

The default shut-off time is 10 minutes.

6.4. Battery Type

For proper function of the battery indicator the correct battery type must be entered. In the menu "8/8: Device settings", submenu "3/5: Battery type" you may choose between Alkaline cells and NiMH accumulators. This setting takes into account the different nominal voltages of both battery types.

6.5. Baud Rate

Select the menu "8/8: Device settings", submenu "5/5: Baud rate" to choose the baud rate of the RS-232 interface. Available are 19200, 38400, 57600 and 115200 bits per second. Default value is 57600. If you have problems with faulty data transmission, e.g. with older PC models, lowering the baud rate may be helpful.

7. Serial Interface

The connector of the serial (RS-232) interface is located at the front of the instrument. It is a *Binder* 711 female socket with 5 pins. It provides the Rx (receive), Tx (transmit) and GND (ground) signal.

Figure 14: Pin assignment of the serial interface socket (view from outside)

A protective cover makes the socket waterproof (IP65) when not in use.

For connection with the Sub-D9 socket of a PC serial interface the interface cable VM30-W is supplied with the instrument. For PCs without serial interface a commercially available serial-to-USB converter can be used which simulates a serial interface on the PC.

8. Signal Output

The VM30-W provides the three AC signals of the accelerometer via a *Binder* 711 socket (4 pins, female) at the front of the case. The AC output is buffered and unfiltered. Depending on the selected measuring range (Menu 1/8: Gain) the sensor signal will appear at the output either with -20 dB attenuation or undamped:

Acceleration	Velocity	Output Attenuation
0,12 m/s²$_{peak}$	1,2 mm/s$_{peak}$	0 dB
1,2 m/s²$_{peak}$	12 mm/s$_{peak}$	-20 dB
12 m/s²$_{peak}$	120 mm/s$_{peak}$	0 dB
120 m/s²$_{peak}$	1200 mm/s$_{peak}$	-20 dB

The output source impedance is $< 100 \ \Omega$. The dynamic range is ± 2 V, i.e. at higher magnitudes of the sensor signal the AC output will be clipped.
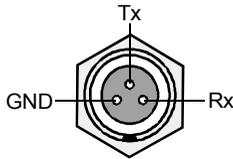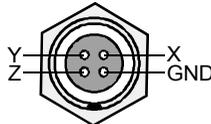

Figure 15: Pin assignment of the AC output socket (view from outside)

A protective cover makes the socket waterproof (IP65) when not in use.

9. Power Supply

9.1. Battery Operation

The VM30-W is powered from three Mignon / LR6 / AA type cells. It was designed particularly with regard to a long battery life time.

Both Alkaline cells and NiMH accumulators can be used. A battery indicator with 20 segments is displayed in the upper right display corner. For proper battery indication it is necessary to select the correct battery type. Go to menu „8/8: Device settings" and submenu „3/5: Battery type". Select the used battery type by the ▲ ▼ keys and confirm by OK.

If the battery voltage drops below a minimum value of 3.3 V, the text "Bat!" is displayed instead of the battery indicator along with a beep sound (provided the beep sound is switched on, see menu "1/5: Beeper on / off"). If the battery voltage drops further below 3.1 V, then the instrument will switch itself off.

Important: Switch off the VM30-W by the ON/OFF key before replacing the battery. Otherwise the user settings may get lost.

Firmly press the two gray buttons on the side of the case (see page 1) and pull out the battery holder. After replacing the batteries, put the battery holder back into the case with the cable ahead and snap in the cover.

If the instrument cannot be switched on after replacing the batteries, press the RESET button as described in section Fehler: Referenz nicht gefunden.

Important:

- Use three batteries of the same type and manufacturing date.
- Be sure to insert the batteries with the correct polarity as stamped on the battery holder.
- Replace discharged batteries immediately and remove the batteries if the instrument is not used for an extended period. Otherwise leakage may cause irreversible damage.

Please use your local collection or recycling system for the disposal of batteries. Do not throw batteries into domestic waste.

9.2. External Supply

The VM30-W can be supplied externally via a socket type *Binder* 711 (5 pins, female). The supply voltage range is 8 to 12 VDC with a current consumption below 200 mA. The voltage source must be able to supply a peak current of 1 A in the moment after switching on the VM30-W. The power supply input is protected against false polarization.

Operation with external supply is indicated as "Ext." instead of the battery indicator.

Charging the internal batteries by an external supply voltage is not possible.
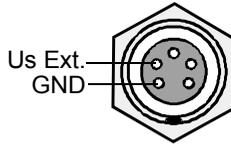
Figure 16: Pin assignment of the power supply socket (view from outside)

A protective cover makes the socket waterproof (IP65) when not in use.

10. Loading Default Settings

The instrument can be reset to the initial factory settings by choosing the menu item "6/8: Load defaults".

This effects:

- Reset of the transducer sensitivities to 50.00 mV/ms^{-2}
- Reload of the factory calibration values
- Overwriting the user-defined setups with their default values (see section 4.5)
- Reset of time and date
- Reset of other variables like baud rate, beep sound, measuring range, shut-off timer and battery type
- Erasing the data memory

11. Hardware Reset

If the VM30-W should not start after longer storage without batteries, it may be necessary to re-set the software. This can be done by pressing the RESET button which is located in the battery compartment (see Figure 2). After this it may be necessary to load the default settings as described in section 10. Please check also time and date.

12. Hardware and Firmware Version

The hardware and firmware versions of the VM30-W are coded as follows:

HHH.FFF

HHH is the hardware version
FFF is the firmware- version

You may identify the hardware and firmware version when you press the INFO key.

13. Calibration

The VM30-W is supplied in calibrated condition. That means the displayed vibration is within the tolerance range provided that the sensitivity of the used transducer was entered correctly. When the instrument was purchased with one or two sensors, the sensitivities are stored in the VM30-W memory. The entered transducer sensitivities can be found in the supplied calibration certificate.

The calibration interval depends on the intensity of use. Metra recommends to recalibrate the equipment every 1 to 2 years. You may send the instrument for recalibration to the manufacturer or to an independent lab.

In addition to calibration the standards for human vibration measurement demand a regular function check.

After changing the accelerometer, its sensitivities must be entered. When you connect the sensor cable, the calibration menu will open automatically. There you can select between two sensor types. These will be usually a hand-arm and whole-body accelerometer. After selecting the sensor you may either skip the calibration if the sensitivities have already been entered or you may calibrate the sensor in two different ways:

- Sensitivity input as numbers in mV/ms^{-2} for each axis
- Calibration of each axis by a reference shaker which supplies a constant sinusoidal vibration signal of known magnitude.

13.1. Entering Transducer Sensitivities

The menu for entering sensitivities opens either when you connect a transducer or when you press the MENU key and select "7/8: Sensor". After selecting "By transducer sensitivity" enter the sensitivities in mV/ms^{-2} from the supplied calibration certificate successively for X, Y and Z using the ◄▲▼► keys. The permissible range is 40.00 to 60.00 mV/ms^{-2} An error message is displayed if higher or lower values are entered.

You may check the entered values anytime when you open the menu "7/8: Sensor". If you do not want to change the calibration values, only press the OK key.

13.2. Sensitivity Calibration by a Vibration Calibrator

The menu for mechanical calibration of transducer sensitivities may be reached either by pressing the MENU key and selecting "7/8: Sensor". Press OK and choose the calibration mode "By vibration calibrator".

The calibration feature of the VM30-W is based on a reference vibration signal of 10 m/s² (RMS) with a frequency of 159.2 Hz. Particularly suited are the vibration calibrators VC20 and VC21 because of their high mass loading capacity. For the calibration in X and Z direction a 90° mounting adapter is needed which can be ordered from Metra.

Calibration starts with the X axis. Mount the sensor facing towards direction X onto the shaker head of your calibrator and switch the calibrator on. Contact Metra for suitable mounting accessories. The VM30-W will now display the measured vibration level in m/s². Adjust the display exactly to 10.0 m/s² by means of the ▲▼ keys.

Subsequently calibrate the other two channels in the same way.

You may finish calibration without changing the active channel by pressing ESC. The calibration of other channels which have been changed before remains stored.

Enter a sensor name with up to 20 characters using the ◄▲▼► keys and confirm with OK.

The VM30-W may store the sensitivities of two transducers. You may check the entered values anytime when you open the menu "7/8: Sensor", choose "Edit this sensor?", confirm the nominal sensitivity by OK and choose "By transducer sensitivity". If you do not want to change the calibration values, only press the OK key.

14. Firmware Update

This function is used to replace the instrument's firmware with a newer version.

⇨   Use this function carefully! All settings you have made will get lost. Before starting the update process, the old firmware will be erased. Consequently the instrument will not function until installing new firmware.

Please go to our web site

http://www.mmf.de/software_download.htm

to check availability of a newer firmware version than the one installed on your VM30-W. You may check the installed version by pressing the key ◄ in the measuring mode (see section 12).

At first you need to download the program "MMF Firmware Updater" and to install it on your PC. This update utility runs under all Windows versions.

After this, download the firmware file vm30-w.hex and save it in your working directory.
Connect your VM30-W via a serial interface cable to your PC. If your PC has no serial interface, you may use an USB/RS-232 converter. Please verify that this converter is recognized as COM port in the device manager of your PC.

Start the "MMF Firmware Updater" from the Windows start menu.
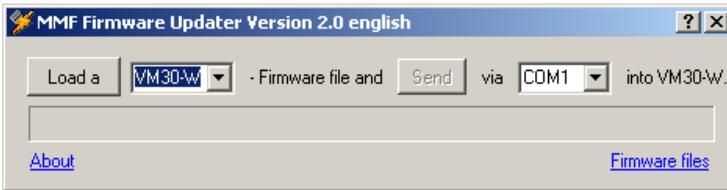
Figure 17: Firmware update utility

Select the instrument name (VM30-W) from the pull-down menu.

Click the button "Load a" and load the firmware file vm30-w.hex from your working directory.

Select the COM port of your PC where you have connected the cable or the USB converter.

At the VM30-W select the menu "8/8: Device settings" and the sub-menu "5/5: Firmware update". If you confirm the subsequent warnings by OK, the old firmware will be erased and the VM30-W will be waiting for data from the serial interface.

Click the "Send" button in the firmware updater utility. The update takes two to three minutes. Progress is indicated at the VM30-W by the display back light flashing.

⇨   The update process must not be interrupted!

Reception errors are signaled by a PC error message. If an error has occurred, restart the firmware update utility.
A successful update is indicated by a PC message.

Figure 18: Update successful

The VM30-W will restart automatically. All variables will be reset to their default values (see section 10).

15. Frequently Asked Questions

Question	Answer
Why does the VM30-W display only one or two measuring values although I have connected a triaxial accelerometer?	The VM30-W recognizes open inputs and blanks the respective channels. Check the sensor connectors. Replace the cable or the sensor, if necessary.
The VM30-W displays continuously overload or invalid results.	Press the MENU key and select "6/8: Load defaults". After this the transducer sensitivities from the calibration certificate, time and date must be entered again. Stored data and user-defined setups will be lost.
What can I do if the instrument cannot be switched on after replacing the batteries?	Press the Reset button behind the battery cover (. After this check time and date.
Why doesn't the instrument display react to changes of the vibration magnitude after a longer measuring time in the RMS mode Long?	As a result of averaging over the entire measuring time do short vibration events not change significantly the displayed value.
What can I do if the Excel macro stops data transmission or receives invalid data?	Reduce the baud rate in the Excel worksheet „Import" and in the VM30-W menu "8/8: Device settings".
My instrument displays erroneous data instead of time, date and user-defined setups.	The instrument has been stored without batteries over a longer period. Perform a reset as described in chapter 11 and reload the default settings (chapter 10).

16. Technical Data

Measuring ranges
  with sensor 50 mV/ms^{-2}
    Acceleration: 0.001-0.12 / 0.01-1.2 / 0.1-12 / 1-120 m/s²$_{peak}$
    Velocity: 0.01-1.2 / 0.1-12/ 1-120 / 10-1200 mm/s²$_{peak}$

                                 Full scale values valid only for filter / integrator attenuation 0 dB.

Accuracy: < 3 % and ± 2 digits at reference conditions

Amplitude linearity: < 5% of measuring value in all ranges

RMS modes: Short: running RMS (1 s)
                                 Long: interval RMS (up to 10 hours)

Filters (3 dB limits):   0.08 – 10 Hz (acceleration and velocity)
                                 10 -1000 Hz (acceleration and velocity)
                                 10 – 2000 Hz (acceleration)
                                 10 – 5000 Hz (acceleration)
                                 The filters are 2nd order Butterworth filters.

Display: Graphical LCD with 32 x 120 dots and LED back light
                                 3 vibration values with unit and mode

Sensor inputs: 3 IEPE inputs, socket type *Binder* 711, female, 4 pins

IEPE supply: 3 constant current sources, 2 mA, compliance voltage 20V
                                 automatic sensor detection

Transducer sensitivity: Nominal 50 mV/ms^{-2}, adjustable 40 – 60 mV/ms^{-2}

Recommended sensor: KS823B

Cross-talk between X / Y / Z: < 0.5 % at ± 3 V input voltage, filter 0.4 – 10 000 Hz

Signal output: 33 AC sensor signals, buffered and unfiltered,
                                 peak output voltage ± 2 V, output impedance < 100 Ω
                                 Socket type *Binder* 711, male, 4 pins

User-defined setups: 10 individually selectable parameter sets for vibration quant-
                                 ity, filter and display mode

Overload indication: Separately for each channel, at inputs and after integrators.
                                 Thresholds for measuring ranges:
                                 ±1.2 mV / ±12 mV / ±120 mV / ±6 V

Memory: Flash memory for 1000 to 3000 measuring values, depending
                                 on the recording mode, optionally with time, date and com-
                                 ment

Recording modes: Manually by SAVE key or
                                 Logging, time controlled, time interval 1 second to 10 hours

Serial interface: Socket type *Binder* 711, female, 3 pins
                                 Baud rates: 19200 / 38400 / 57600 / 115200
                                 Parity: even, data bits: 7, stop bits: 1

Batteries: 3 Alkaline cells or NiMH accumulators type IEC LR6
                                 (Mignon)

Battery operating time: 15 to 25 hours

Battery indication: 20 segments, nominal battery voltage selectable, acoustical low
                                 voltage warning

External power supply: 8 to 12 V DC, < 200 mA, peak current: 1 A
                                 socket type *Binder* 711, female, 5 pins

Shut-off timer: After 1, 10, 30 minutes or no shut-off

Operating temperature range:	-10 to 50 °C, < 95 % relative humidity without condensation	
Deviation over temperature and humidity range:	Instrument: Sensor KS823B:	$< \pm 1$ % of reading $< \pm 2$ % of reading
Protection grade:	Instrument Sensor KS823B:	IP65 IP67
Dimensions:	165 x 92 x 31 mm³	
Weight including batteries:	350 g	
Supplied accessories:	Sensor KS823B with 5 m cable (088) and data sheet Magnetic base 508 Mounting disk with ring nut 629 VM30-I: RS-232 interface cable 034: Signal cable, 0.5 m, *Binder* 711 / 3 x BNC VM30-P: Mains plug adapter 115 / 230 V	

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.

$C\epsilon$

Declaration of Conformity

Product: Human Vibration Meter

Model: VM30-W

It is hereby certified that the above mentioned product

complies with the demands pursuant to the following standards:

EN 55022: 1998

EN 55024: 1998

Responsible for this declaration is the producer

Manfred Weber
Metra Mess- und Frequenztechnik in Radebeul e.K.

Meißner Str. 58

D-01445 Radebeul

Declared by

Michael Weber

Radebeul, May 4, 2006