Instruction Manual

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Notice: The current version of this document can be found as PDF at
http://mmf.de/product_literature.htm

Specification subject to change.

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1. Introduction

Thank you for choosing VibroMetra. You have purchased an efficient, expandable and economical solution for vibration measurement. Whether in laboratory, permanent industrial installations or field, VibroMetra can be used for each of these applications.

VibroMetra provides a variety of vibration instruments based on your PC. This approach guarantees a flexibility which is unequaled by conventional instrumentation. Particular advantages are:

- You can operate several instruments with one common vibration sensor – without any disadvantages by electrical connection of measuring instruments. VibroMetra organizes all digital data streams efficiently so that all instruments work with exactly the same raw data.
- Duplicate your instruments during the measurement and watch data live with different settings.
- Operate several M302 or M312 USB interfaces at the same time. Measured data is read absolutely synchronously, as if only one data acquisition device is used.
- Save and restore the screen arrangement of instruments with individual settings in workspaces. The last setup can be restored automatically after starting the software which allows you to continue your last measurement immediately.
- Play measurements again with recorded data. While playing you can modify settings in all instruments to obtain more information than intended during live measurement.

This instruction manual familiarizes you with all VibroMetra functions and can help you to solve your measuring tasks efficiently. If you do not have enough time to read the entire document please proceed to the chapter Before the system is delivered a complete configuration with your purchased sensors and instruments is prepared. During installation this individually created configuration is transferred to your computer an you are immediately ready for measurement. on page 3.

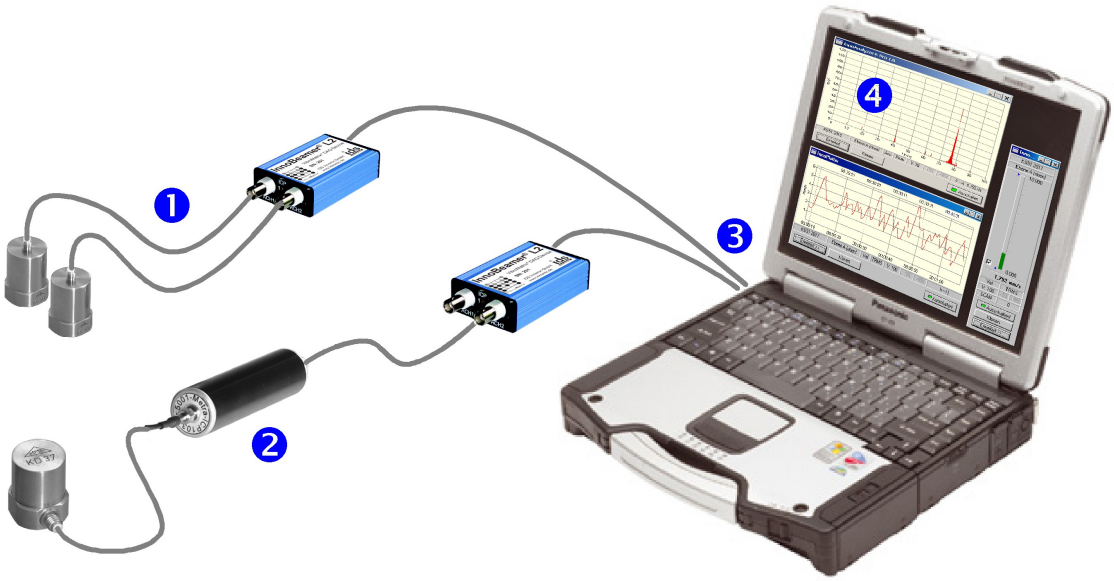
If you have more time to become familiar with VibroMetra, this manual will inform you detailed about both the complete system and the system's components, like control center and instruments. Tips and several exercises finalize the manual.

The current version of the manual can always be downloaded from www.mmf.de

We are at your disposal for increments, complaints and wishes. We are sure you will use VibroMetra successfully.

1.1. Overview

VibroMetra is a PC based vibration measurement system consisting of harmonized hardware and software modules. This measurement system is a complementary solution for your notebook or PC and is therefore very cost-efficient. Until now, your PC has been your typewriter, calendar or drawing board. With VibroMetra, it becomes a high-quality vibration measurement system. You continue using your familiar environment.



1. Piezoelectric sensors with integrated amplifier are directly connected to the PC via the M302 or M312 USB adapter.
2. Piezoelectric sensors with charge output are previously connected with a charge converter of Metra's ICP1x0-series and thereafter are able to transmit their signals to the PC as well.
3. One or more M302 or M312 units are connected to the USB interface of the PC. The PC supplies the M302 or M312 with energy. No external power supply is required.
4. The software instruments have been tailored for various measuring applications. Still, all instruments can work on the PC screen at the same time. You can combine them at will. The operation is performed by mouse. The results are displayed in real-time, high resolution and color (p.).

The operation of VibroMetra is simple, because the system is based on the natural signal flow: sensors → measuring channels → instruments. The software control center VibroMetra Online for example is modeled on this signal path.

2. Quick Start

Before the system is delivered a complete configuration with your purchased sensors and instruments is prepared. During installation this individually created configuration is transferred to your computer an you are immediately ready for measurement.

2.1. What You Need

- PC or notebook with USB interface, CD-ROM drive, operating system Windows 98, Windows ME, Windows 2000 or Windows XP, Windows Vista.
- VibroMetra CD-ROM or program and driver files downloaded from www.mmf.de
- Piezoelectric sensor with IEPE output
- Sensor cable with BNC plug on the M302 or M312 side
- M302 or M312 IEPE / USB adapter
- USB cable

2.2. How to Proceed

- Switch on your PC.
- Insert the VibroMetra CD-ROM.
- Connect the M302 or M312 to your PC via USB cable.
- When Windows asks for driver installation, direct the assistant to your CD-ROM and install the driver (page 4).
- If you have more than one M302 or M312, connect the others as well. Windows will ask again for the driver, just install the driver as described above.
- Start vibrometra_setup.exe in the directory .../Webseiten/download of the CD-ROM and install the software (page 4).
- Connect a sensor with the M302 or M312 and start an instrument.

3. How to Install VibroMetra on Your PC

The installation of the VibroMetra software is executed in two steps. The driver for the M302 or M312 must be installed first. Then the VibroMetra software itself is installed.

3.1. Driver Installation

A driver is a small piece of software controlling the M302 or M312 hardware under Windows. The M302 or M312 driver is a so-called WDM driver supporting Windows 98 (first and second edition), Windows ME, Windows 2000 Windows XP, Windows Vista and Windows 7. For installation under Windows 2000 and later make sure that you have permission to install drivers.

When you connect the M302 or M312 to your PC for the first time, the operating system recognizes the hardware and asks you for an appropriate device driver. The drivers are located in the directory ...Webseiten/download/m3x2_xxbit of your VibroMetra CD-ROM. Select the sub-directory depending on the hardware (M302 or M312) and the Windows version (32 or 64 bits).

The dialog boxes after the fist connection with the M302 or M312 vary, depending on the Windows version you are using.

3.2. VibroMetra Installation

The installation program for VibroMetra Software – vibrometra_setup.exe – is located in the directory ...V/Webseiten/download of your VibroMetra CD-ROM.

Please choose the language for the installation dialogue first.

Older VibroMetra versions will be uninstalled automatically.

In the next step our license agreement informs you about the terms of use for the Vibro-Metra software.

If you agree, choose the upper option to accept the license agreement. Click on Next >.

Now you define which directory the software will be installed in. A default directory has already been preset.

Click Next >.

Even if the directory is already present due to a former installation, you can install Vi-broMetra there.

Click on Yes.

A summary for the upcoming installation is displayed now.

Click on Install.

Now the installation is carried out according to your instructions.

You may choose to start the program in Simulator mode.

Click on Finish.

After installation VibroMetra can be found in the start menu of Windows.

VibroMetra Online	The control center for real-time measurements, also allowing to optionally save the signals in VibroMetra Data Stream format.
VibroMetra Offline	The control center for the replay of data saved in VibroMetra Data Stream format.
VibroMetra Simulator	All instruments can be used without measurement hardware, thus allowing to become acquainted with their functionality. A short training program based on VibroMetra Simulator gives an introduction to vibration measurement.
Remove VibroMetra	Uninstalls the software.

4. Hardware for Vibration Measurement

4.1. Piezoelectric Accelerometers

Overview

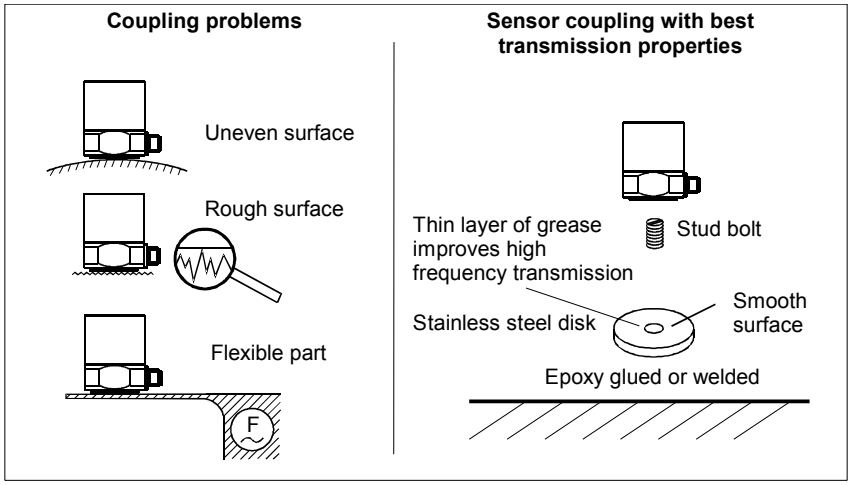
Piezoelectric accelerometers with integrated amplifier are most suitable for vibration measurement. They are available from several producers for different applications. The following Metra sensors are given as example:

- General purpose shear-type accelerometers: e.g. KS76, KS77
- High sensitivity accelerometers (seismic measurements): e.g. KB12V, KS48
- Miniature accelerometers (for small objects): e.g. KS91, KS94, KS95
- Triaxial accelerometers (for measurement in three axes): e.g. KS813, KS943
- Industrial accelerometers: e.g. KS74, KS80

Accelerometers with charge output can be made IEPE compatible by means of an external remote charge converter from the ICP1x0-series.

Sensor mounting

Before making measurements, suitable measuring points need to be found. On rotating machines, vibration forces are normally transmitted into the machine frame via bearings and their housings. Therefore, bearing housings or points close to bearings are recommended as measuring points. Less suitable are light or mechanically flexible machine parts.



An even, smooth surface at the mounting point is indispensable for precise vibration transmission from the machine to the accelerometer. Measuring points that are uneven, scratched or insufficiently sized may cause considerable errors, particularly at frequencies above 1 kHz. For best transmitting conditions, we recommend a stainless steel disk with mounting thread which can be glued or welded onto the machine.

The accelerometer is usually mounted by stud bolts. A thin layer of grease (e.g. silicon grease) will improve the quality of the couple connection. For measurements up to 1 kHz, mounting via clamping magnet is suitable as well.

4.2. M302 and M312 – Connecting Sensor and PC

There is no direct connection for piezoelectric sensors on the PC. That's why the USB adapters M302 and M312 are needed. They digitize the transducer signals and provide USB compatible data for the software instruments on the PC. On the input, sensors are connected directly and supplied. On the output, the transfer of the digitized data via USB interface is carried out.

A safe link mode is used, which transfers all data without dropouts. Scanner, printer or other instruments can be used in parallel on the USB input of the PC. M302 and M312 receive their power supply from the USB interface of the PC. No external power supply is necessary. The complete measuring chain is supplied by PC, which allows an easy use of VibroMetra on notebooks far away from any power outlet.

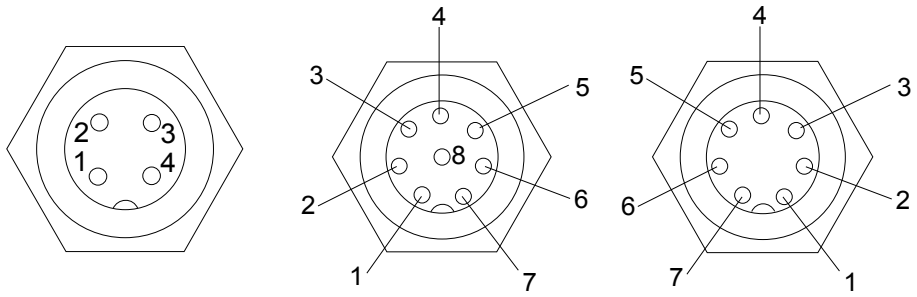
Model	**M302**	**M312**
Inputs	2 IEPE / AC; R_I > 1 MΩ (BNC) 1 digital trigger; 0 .. 15 V (Binder 711)	2 IEPE / AC; R_I > 1 MΩ (BNC) 2 digital trigger; 0 .. 24 V (Binder 711) 2 analog DC ; 0 .. 10 V (Binder 711) 1 microphone (Binder 711)
IEPE supply	4 mA constant current of 24 V	2.8 mA constant current of 21 V
Outputs	USB 1.1	1 analog AC output (Binder 711) USB 2.0
Frequency range	0.3 ..2000 Hz (-3 dB)	0.1 ..40 000 Hz (-3 dB)
Accuracy	< 2 %	< 2 %
Input voltage ranges	±10000 mV, ±1000 mV, ±100 mV, ±10 mV	±8000 mV, ±800 mV, ±80 mV, ±8 mV
Trigger level	3 V	1,5 V
TEDS support	no	IEEE 1451.4
A/D conversion	16 bits, 10 kHz per channel	24 bits, 96 kHz per channel
RMS wide band noise	20 µV (0.3 .. 2000 Hz)	3 µV (0.1 .. 40000 Hz)
Sensor supply	+12 V / 30 mA at DCH1	+13,5 V / 35 mA at SYS1
Power supply	5 V / < 475 mA via USB	5 V / < 475 mA via USB; optionally 10 .. 30 V external
Operating temperat-ure range	-20 .. 55 °C	-20 .. 55 °C
dimensions W x H x D	55 x 24 x 84 mm³ (without sockets)	105 x 22 x 84 mm³ (without sockets)
Weight	130 g	200g

Important notice for applications with more than two channels

☞ The USB interface modules M302 and M312 must not be used together with one PC. Either M302 or M312 are allowed in a VibroMetra system.

☞ The M312 modules must be interconnected by synchronization cables in multichannel systems.

Pin assignment of auxiliary inputs



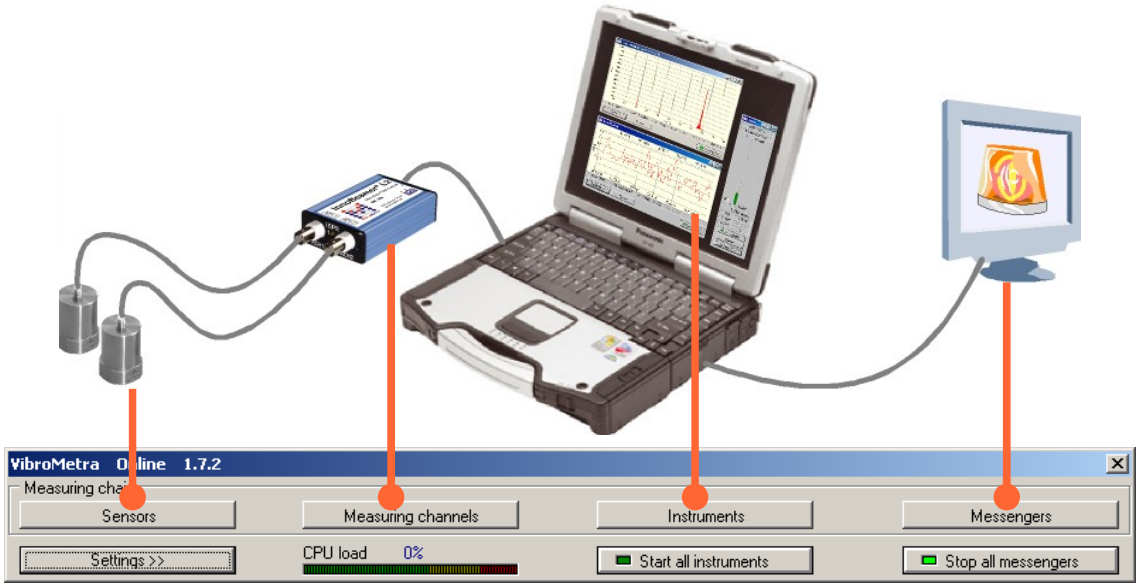
M302, DCH1 M312, SYS1 M312, SYS2

1	+12 V / 30 mA	V_{EXT} (ext. supply)	V_{EXT} (ext. supply)
2	DI_Trig1	GND (0 V)	GND (0 V)
3	-	+13,5 V / 35 mA	microphone input
4	GND (0 V)	Trig_Sync	Trig_Sync
5		DI_ADC_Sync	DO_ADC_Sync
6		DI_Trig1(trigger 1)	DI_Trig2 (trigger 2)
7		GND (0 V)	GND (0 V)
8		Analog_Out	

5. The Control Center VibroMetra Online

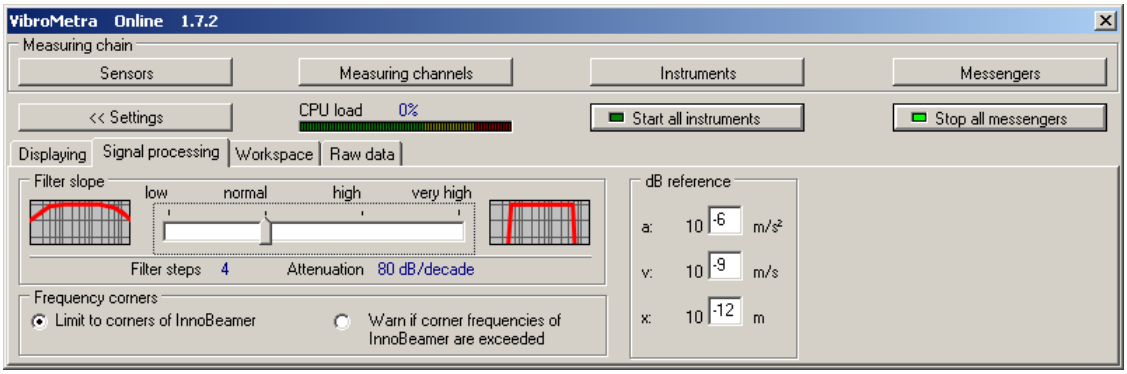
VibroMetra is a modular system. Sensors, measuring channels and software instruments are combined to solve the vibration measurement tasks. The control center VibroMetra Online organizes the communication between these modules.

A sensor is linked to a measuring channel by drag & drop (page 12). This simple method makes all the sensor calibration data available to the measuring channel and its instruments. The instruments are registered in the measurement box M302 or M312. Additional instruments can be registered, too (page 15). Registered instruments can be started from the instrument list (page 14).



After starting VibroMetra, the VibroMetra Online window appears at the lower edge of your screen. VibroMetra Online has two display modes:

- In the basic display mode VibroMetra Online provides access to sensors, measuring channels and instruments
- The extended display mode makes further functions available: Displaying, Signal processing and Workspace.



In both modes the CPU load of the PC is displayed. It shows how much CPU capacity is occupied by the digital signal processing of VibroMetra. If the CPU load exceeds 100%, the instruments cannot work with the required speed. In this case, instruments should be closed or their refresh rate reduced (page 16). However, the optimized program code of VibroMetra will run properly even with older 0.4 GHz PCs, if conventional settings are used.

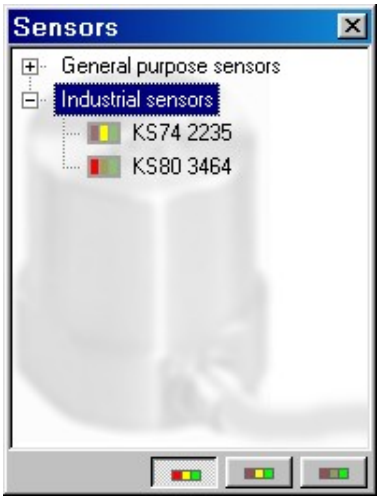
The following section explains the settings of the measuring chain followed by a description of the extended functions of VibroMetra Online (page 16).

5.1. Sensor Management

A measuring chain starts with the sensors. VibroMetra Online allows to acquire and archive the data of your sensors. As soon as a sensor is assigned to a measuring channel, it will make its measured data to all instruments connected to this channel. The data is: sensor name, serial number and calibration to mV.

A click on the Sensors button in VibroMetra Online opens the sensor control window. A clear arrangement of the sensors data can be obtained by sensor groups.

On the left side of the sensor name, there is an activity indicator. It can show 3 states:

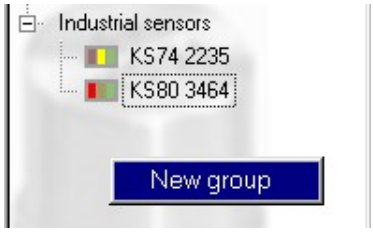


- Red: The sensor is not in use.
- Yellow: The sensor is assigned to a measuring channel but the channel is not active.
- Green: The sensor is assigned to a measuring channel and it is involved in a measurement.

By means of the 3 buttons in the bottom line, the displayed sensors can be filtered. For instance, only active sensors can be displayed.

By a right click in the environment of the sensor list, a context-sensitive menu opens. Its functions are explained in the following section.

Creating a new sensor group



➔ Click right in an empty space of the sensor list. A new menu named New group will open.

➔ Click left on New group. A new sensor group with a default name is generated. You can change this name as described in the next section.

☞ Up to 100 sensor groups can be created.

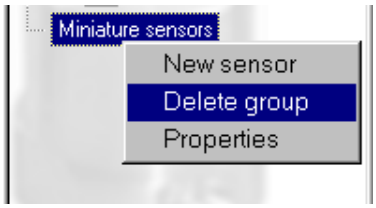
Changing the properties of a sensor group

➔ A property window appears automatically after a sensor group has been created. Otherwise, double-click left on a sensor group to open the property window.

➔ Enter a name for the sensor group and, if desired, a description text.

☞ If an already existing name is entered, a message will appear asking for a different name.

Deleting a sensor group

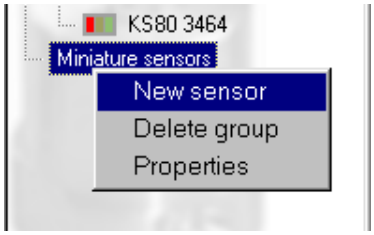


➔ Click right on a sensor group. A context menu opens.

➔ Select Delete group and click left on it.

➔ A confirmation message appears. The deletion can be confirmed or canceled.

Creating a new sensor entry



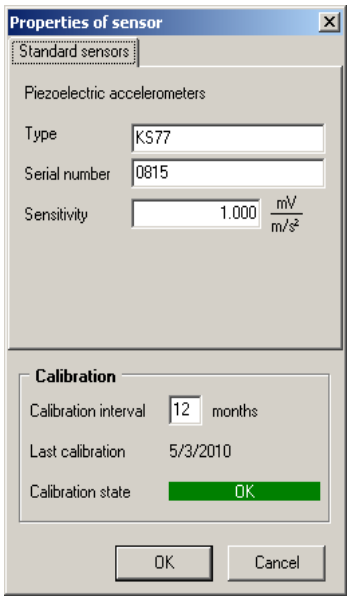
➔ Click right on a sensor group. A context menu opens.

➔ Choose New sensor and click left on it.

➔ A new sensor with a default name in the previously chosen group is generated. You can change this name in Properties.

☞ Up to 100 sensors per group can be created.

Changing sensor properties



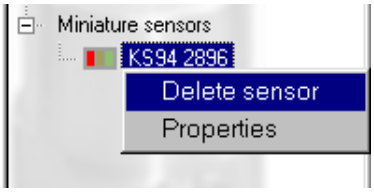
➔ A property window appears immediately after a sensor has been created. Otherwise, double-click left on a sensor to open the property window.

Standard sensors are piezoelectric accelerometers. For these sensors all measuring units, measurands, etc. are pre-set.

- Type: Select one type from the list or type it in.
- Serial number: In order to distinguish the sensors, enter the serial number here.
- Sensitivity: The sensitivity from the data sheet of the sensor can be added here. Another method is to calibrate the sensor with the VibroMetra instrument VM-CAL (page 34). The calibration date (field Last calibration) is also updated, when the sensitivity value is confirmed (i.e. when the enter button is pressed within the field Sensitivity). A regular calibration is recommended, though (12 months for intensively used equipment, 24 months otherwise).
- Calibration interval: Define the calibration interval for the sensor here. VibroMetra Online compares the date of the last calibration with the present one and signals the calibration state automatically.

  - OK (green): Less than 90% of the calibration interval are expired.
  - Calibrate soon (yellow): More than 90% of the calibration interval are expired.
  - Calibrate !!! (red): The calibration interval is expired.

Deleting a sensor



- ➔ Click right on a sensor. A context menu opens.
- ➔ Select Delete sensor and click left on it.
- ➔ A confirmation message appears. The deletion can be confirmed or canceled.

Assigning a sensor to a measuring channel

Specify now which sensor from the sensor list is actually connected to an M302 or M312 measuring channel. This is done with simple "drag and drop" by your mouse.

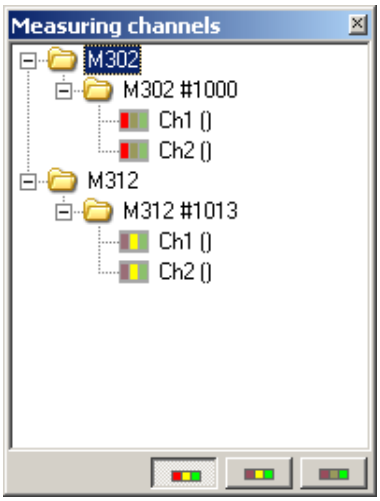
- ➔ Open the windows Sensors and Measuring channels by clicking on the respective buttons in VibroMetra Online.
- ➔ Click left on a sensor and keep the button pressed.
- ➔ Drag the sensor to a measuring channel that is marked yellow or green, i.e. it must be physically connected to an M302 or M312.
- ➔ Release the left mouse button.

The sensor is connected to the measuring channel now. Thus the sensor parameters (e.g. calibrated sensitivity) are accessible for this channel. The sensor will automatically appear in all instruments which are associated with this channel and these instruments will consider the new sensitivity instantaneously.

Disconnecting a sensor from the measuring channel

- ➔ Open the window for the measuring channel management by clicking on the button Measuring Channels in VibroMetra Online.
- ➔ Click right on a measuring channel to which a sensor was assigned previously. A context menu opens.
- ➔ Select the entry Disconnect sensor.

5.2. Measuring Channel Management



In the measuring chain, sensors (page 10) are followed by measuring channels. VibroMetra Online makes it possible to name the channels individually or to register new instruments for this measuring channels.

To view the channel settings, open the Measuring channels window by clicking the respective VibroMetra Online button: Here you find all available M302 or M312 devices with their associated measuring channels. If an M302 or M312 is connected to or disconnected from the USB interface, the list will be updated automatically. The state of each measuring channel is shown by an indicator on the left. 3 states are possible:

- Red: The measuring channel belongs to an M302 or M312 device which is currently not connected to the PC (offline)

- Yellow: The measuring channel belongs to an M302 or M312 device which is connected to the PC but currently not measuring (online/inactive).
- Green: The measuring channel is measuring (online/active).

On the bottom of the Measuring channels window you will find three switches which can be used for filtering the listed channels. For example, only active channels can be listed.

Other setup features are accessible by right mouse click.

Deleting a disconnected M302 or M312

When a new M302 or M312 is connected to the PC, VibroMetra automatically generates a new branch in the measuring channels tree. When the M302 or M312 is removed from the USB interface, it will remain in the list marked as an offline device. Consequently, you have an overview about all your M302 and M312 devices, even if not all devices are connected. M302 or M312 units you not longer use can be removed as follows:

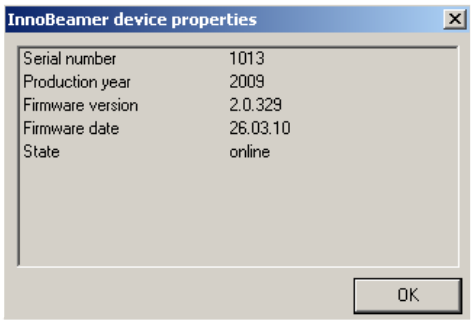
➔ Click right on the offline M302 or M312 (with red mark) you want to remove from the list. A context menu opens.

➔ Select Delete and click left on it. The M302 or M312 and its measuring channels will disappear.

Showing the properties of an M302 or M312 device

In some situations it may be useful to look at the properties of your M302 or M312, for instance, to check its firmware version.

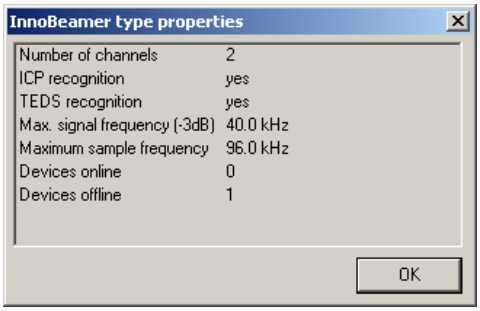
➔ Double-click left on the serial number of an M302 or M312. A property window opens.



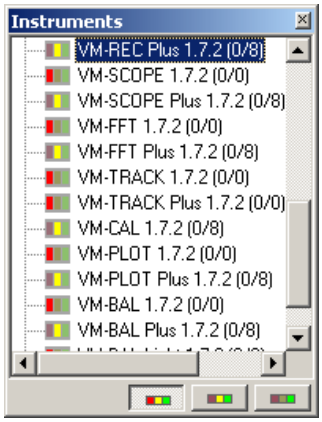
Showing the properties of an M302 or M312 device type

General properties of M302 or M312 device types can also be viewed.

➔ Double-click left on an M302 or M312 device type. A property window opens.



5.3. Instrument Management



The last setup step is the selection of measuring instruments. These software instruments accept signals acquired by sensors and digitized by the M302 or M312 electronics and provide you with real-time value displays, graphic displays and further information. More details about the instruments can be found on page 22.

VibroMetra instruments always belong physically to a measuring channel of a particular M302 or M312 device but not to a certain PC. You can use your M302 or M312 with any PC and will always have your instruments on hand. New instruments can be added when required (p.15).

A left click on the Instruments button in VibroMetra Online opens the instruments window. VM-FFT, VM-PLOT etc. are started from here.

Additionally, the list indicates which instruments are installed on the PC, which of them are ready for a measurement and which of them already are in measuring operation.

The status of each instrument is shown by an indicator on the left:

- Red: The instrument software has been installed on your PC but there is no M302 or M312 available on whose measuring channel this instrument is registered (offline).
- Yellow: The instrument is registered for a measuring channel of a connected M302 or M312 device but is not in use (online, inactive).
- Green: The instrument is switched on and in measuring operation (online, active).

The entries following the instrument's name indicate the version and the number of opened instrument windows. When you acquire an instrument for one channel, you can start it up to 4 times, e.g. to watch signal under different parameters at the same time. For instance if you registered an instrument for 2 channels, you can also open it 6 times for channel 1 and twice for channel 2. The number of the entire usable instrument windows is indicated in the instrument list as the last value of an entry. For example, (2/16) means 2 instrument windows are open, 16 are possible.

On the bottom of the instruments window you find three switches which can be used for filtering the listed instruments. For example, only active instruments can be shown.

Starting an instrument

Instruments can only be started if they are registered on a measuring channel of a connected M302 or M312 device, i.e. their indicator must be yellow or green.

Starting an instrument on the first available measuring channel

➔ Double-click left on an instrument with yellow or green indicator.

You can still change the measuring channel in an instrument later.

Starting an instrument on a particular measuring channel

In some situations, it might be useful to start an instrument on a particular measuring channel. For instance if you registered an instrument on one measuring channel permanently and leased an instrument of the same type for another channel. Every time you start a leased instrument, the first time unit is subtracted from the remaining leasing time. So if you do not want to use the leased instrument at the moment, it is advisable to start the instrument on the measuring channel where it is registered permanently.

- ➔ Move the mouse pointer to an instrument with a yellow or green indicator.
- ➔ Click right on that instrument. A context menu is opened.
- ➔ Select New at channel. A second context menu opens, showing the available measuring channels and the remaining leasing time.
- ➔ Select the desired measuring channel.

Adding an instrument

The latest software versions of the instruments are available from the download section of our website www.mmf.de. They are simply copied into the sub-directory “Instruments” of your VibroMetra path chosen during the installation.

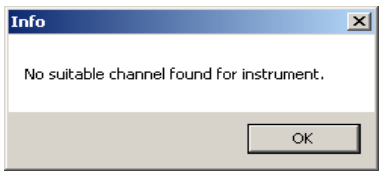
Please note that instruments can only be started when registered on a measuring channel of a connected M302 or M312 device. This registration is carried out by the installation of a software key file. You will receive this file from your dealer. Such a key activates an instrument for a particular measuring channel of a particular M302 or M312.

- ➔ Be sure that your M302 or M312 is connected.
- ➔ Move the mouse pointer in an empty pace of the instrument list.
- ➔ Click right, a context menu opens.
- ➔ Select Add.

A file menu for the installation of the software key appears.

- ➔ Navigate to the key file which you have received from your dealer.
- ➔ Click on Open. All instruments coded in this file will be activated now.

An error message will appear if the M302 or M312 device for whose measuring channels the instruments are to be registered is not connected.

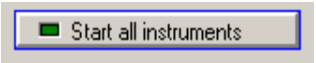


If the registration was successful, a report window will appear showing the new registered instruments.

5.4. Event Messengers

Messengers are used to send messages about measuring values or other events from the software instruments to external receivers. This function is explained in section 7 from page131.

5.5. Central Start/Stop Button



Each instrument has its own start/stop button (p.23). A central start/stop button is useful, when several instruments are active at the same time. VibroMetra Online has the button "Start all" for this purpose. A push on this button switches on all active instruments, at the same time. Thereafter, the button changes its label to "Stop all". All instruments can now be stopped by a single push of this button.

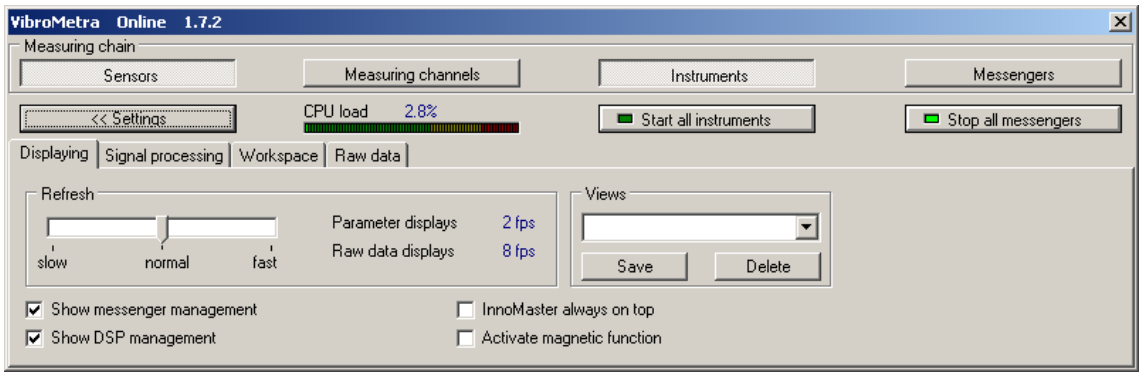
The common start is only possible, when all instruments are stopped. Otherwise, the button function changes to "Stop all".

5.6. Extended VibroMetra Online Settings

Click on the button Settings to activate the central VibroMetra Online settings. By clicking on the respective tab, you can adjust the extended settings for

- Displaying page 16
- Signal Processing page 17
- Workspace page 18
- Measurement data page 20

Display settings



Display refresh rate

VibroMetra allows to choose among three display refresh rates. Generally the refresh rate should be set as high as possible, particularly for graphic outputs. Older PCs however may require a lower refresh rate to avoid CPU overload.

The refresh rate is stated in frames per second (fps).

There are different refresh rates for parameters and raw data. Parameters can be displayed up to 4 times per second. They are based on a lot of raw data. Thus a fast refresh does not increase their significance that much. Raw data in contrast can be displayed up to 16 times per second to ensure a high quality especially in terms of graphics.

The refresh rate can be changed during measurement.

☝ Instruments as well as the measured data within the instruments are reset when the refresh rate is changed.

Instrument views

This function may be useful if the number of instruments in use is too large for your screen. You can save several arrangements of instruments as views. Thus, different views on the measuring task can be obtained. In a view, the positions of all instruments and their window state (minimized or maximized) are saved.

How to save views.

- ➔ Minimize all instruments that are not necessary for the desired view.
- ➔ Arrange the other instruments for a convenient display.
- ➔ Type in a name for the view to be saved in the View list.
- ➔ Click on Save.
- ➔ Repeat the steps for other arrangements of instruments.

☞ Minimized instruments keep on working in the background without interruption.

Selecting views

- ➔ Select a view from the View list. The saved arrangement of instruments is opened.

☞ If you start new instruments after saving a view, they are not saved in this view and do not change their position when loading up views.

☞ Windows allows transition effects for minimizing/maximizing windows. They are disturbing for the fast changing of views because they delay the change. When these transition effects are disabled, quick minimizing/maximizing is possible.

VibroMetra Online displaying

If you want to see the VibroMetra Online window together with the sensors, measuring channels and instruments in the foreground permanently, select the checkbox Vibro-Metra always on top.

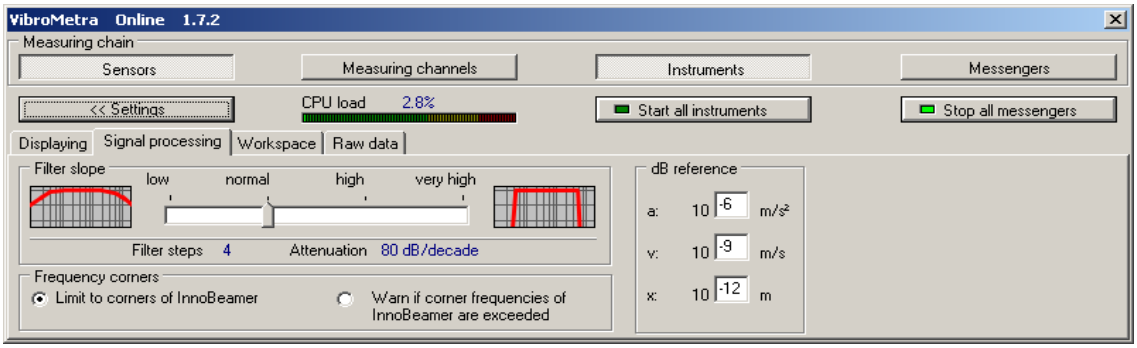
Activating Messenger Management

The checkbox Show Messenger Management activates a fourth button Messengers in VibroMetra Online. Further details can be found in section 7 from page131.

Activating Signal Processing Settings

The checkbox Show DSP management opens a new setup panel as described below.

Signal processing settings



The signal processing settings control filter slope and dB-reference.

Filter slope

VibroMetra' filter slope is far beyond that of conventional instruments. Even the normal filter quality exceeds that of many analog instruments.

In general, an increased filter slope causes an increased CPU load. But with some instruments, an increased filter slope causes a decreased CPU load.

High filter slopes are useful for narrow band studies or to cut a frequency range very sharp. However, high filter slopes need longer time for the transient effect. Therefore they are more suitable for continuous processes than for pulse signals. Pulses are better measured with low filter slopes.

Filter settings can be changed during measuring operation.

☝ Instruments including measured data are reset when filter slope is changed.

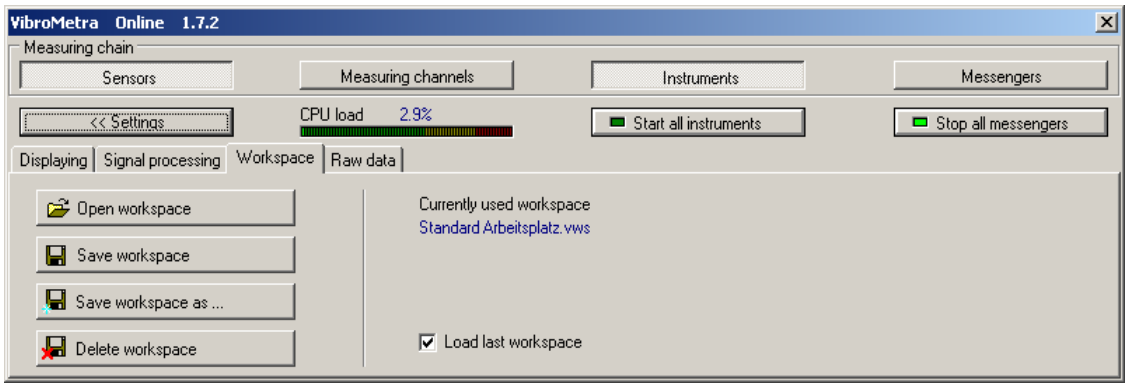
dB-reference

Many instruments support the indication of acceleration, velocity and displacement as logarithmic dB-value. Therefore, a reference has to be defined for the respective measurand. VibroMetra Online automatically defines 10^{-6} m/s², 10^{-9} m/s and 10^{-12} m as references. Or in other words: 1 µm/s², nm/s and pm. These values are given by the international standard ISO 1683. Other references are possible as well. You can change the decimal power for the respective unit from –24 .. +24. The instruments respond to the change immediately and adjust their display.

☝ Instruments including measured data are reset when dB reference is changed., provided dB has been selected as unit.

Workspace settings

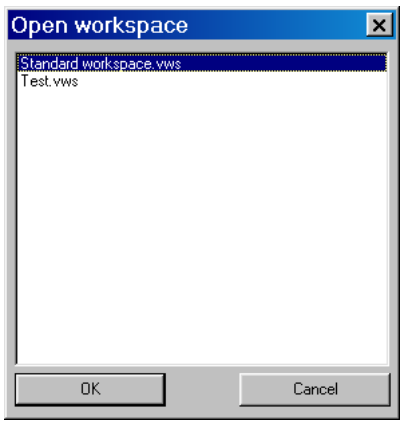
The Workspace function of VibroMetra Online allows to save an entire configuration of all instruments. Thus it is possible to upload a suitable arrangement of instruments for different measuring tasks.



The following information is saved in a workspace:

1. The extended settings of VibroMetra Online including views
2. The assignment of sensors to measuring channels
3. The individual names of the measuring channels
4. All opened instruments, their positions and their settings

Opening a workspace



Click on the button Open workspace. A window is opened showing the available workspaces. At least one prepared workspace is delivered together with VibroMetra. You can add additional workspaces according to your needs.

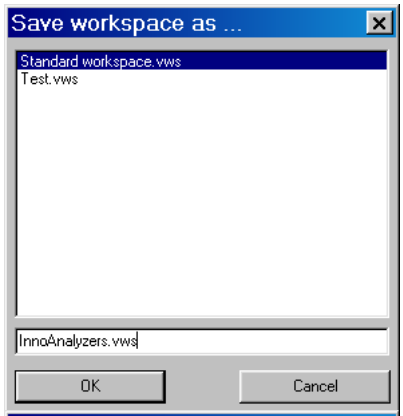
Select the desired workspace and click on OK.

☞ Instruments and sensor connections can only be loaded for measuring channels belonging to actually connected M302 or M312 devices. If no device is connected, the conditions for loading instruments and sensor connections are not fulfilled.

Saving a workspace

One click on the button Save workspace saves the active workspace.

Saving a workspace as ...

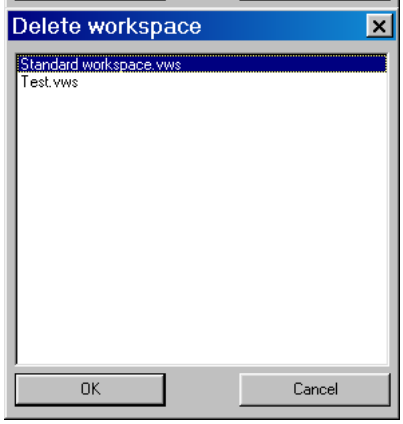


A click on the button Save workspace as... opens a window in which you find all existing workspaces and a line where you can enter a new name.

Select a workspace to be overwritten or type in a name in for a new workspace in which the active settings are to be saved.

Click on OK.

Deleting a workspace



Workspaces should be deleted in VibroMetra Online only. A click on the button Delete workspace opens a window in which you find all existing workspaces.

Choose the workspace you want to delete.

Click on OK.

☞ Deleting the currently opened workspace will automatically cause the load of the Standard workspace.

Load last workspace

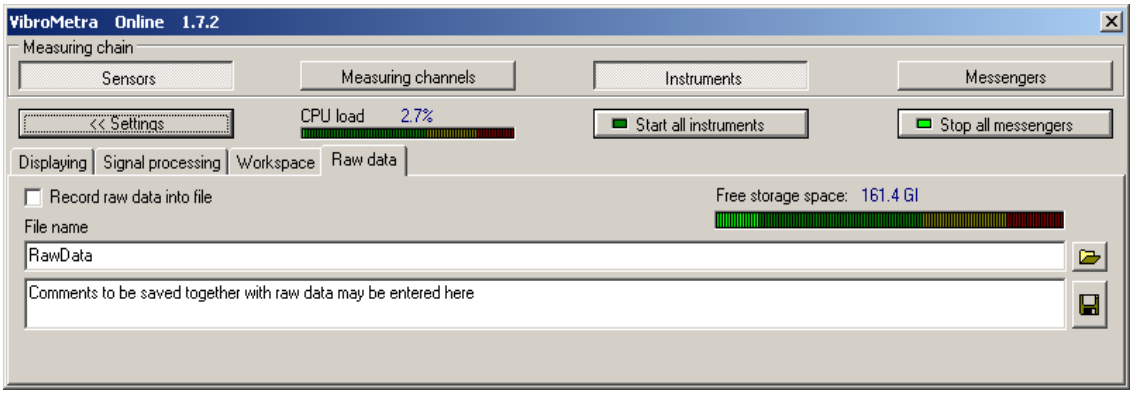
If this checkbox is selected, VibroMetra Online tries to open the most recently used workspace when it is started. This will only be successful if the M302 or M312 units previously used are connected to the PC while loading the workspace.

Raw data recording settings

VibroMetra can record the raw measurement data on hard disk. The unprocessed data stream – still containing its entire information content – is saved to a file before it is processed within the real-time instruments. Using VibroMetra Offline (p.141), another control center, these data can be read back in and transmitted to the instruments for off-line analysis.

Apart from the measurement data proper, numerous other information is saved within the data stream, too. They make it easy to reconstruct, after the fact, what did happen and when did it happen. One example is the current clock time during the measurement. If the file is later replayed, the instruments with wall clock time display will show the time actually related to the measurement.

In VibroMetra Online you can determine if and where the raw data is to be saved. The file length is restricted to a maximum of 2 GB. When a file is filled, a new file is automatically opened.



The checkbox Save measured data to file activates or deactivates the raw data recording. The editable line File name determines the file location. The file name may contain variables, which are set at the moment, when the file is opened for writing. These variables are:

%J the current year as a 4 digit number
%M the current month as a 2 digit number
%d the current day as a 2 digit number
%h the current hour as a 2 digit number
%m the current minute as a 2 digit number
%s the current second as a 2 digit number

An message in blue lettering informs you about the opened file.

☞ If you activate the data recording while no instrument is switched on, opening the raw data file is delayed until a measurement is started.

Adding Notes to the Raw Data Stream

Notes may help to remember the source of data or the measurement conditions. These notes can be entered in a text box and will be saved with the raw data. All notes are saved with a time stamp which will be displayed when replaying the raw data later in VibroMetra Offline.

- ➔ To save notes raw data recording must be enabled (checkbox Record raw data into file).
- ➔ Enter your text.
- ➔ Save the test by the enter key or clicking .
- ➔ The text box will be grayed out to show that it was saved. However, it can still be edited and saved again.

6. VibroMetra Instruments

6.1. Overview

VibroMetra is a modular system. Its software instruments can be loaded and operated separately. But they are designed to complement one another as well. Instead of working in complicated menus of monolithic measurement software, you operate specialized instruments for certain applications here. By combining different instruments you obtain the required complexity for the solution of measurement tasks. But you decide about the complexity level on your own.

For example the FFT Analyzer does not measure sum parameters, VM-METER does it. And the VM-METER in turn does not try to show a rough pixel graph because graphing is the specialty of VM-PLOT. As several instruments can work on the same channel with the same sensor simultaneously, each instrument as a part of a powerful group can bring its specific advantages into that network.

When you arranged and configured instruments for a certain task, you can save this complete arrangement as “workspace” (page 18). You can open it again when a similar measurement is to be carried out and find your arrangement of pre-configured instruments ready for use.

Within workspaces, different view settings are possible. If you operate more active instruments simultaneously as can be displayed on the screen, the instruments can be displayed in groups. These groups can be showed or minimized at the push of a button (page 17).

In addition, VibroMetra supports multiple monitor configuration. This way you can position a high number of instruments clearly arranged.

The instruments at a glance

VM-METER, VM-PLOT and VM-REC are working in the time domain and have the same abilities for signal processing. These are e.g. freely adjustable filters, measurement of different parameters in different units.:

VM-METER	Digital vibration meter	(page 35)
VM-PLOT	Digital strip chart recorder	(page 37)
VM-REC	Logging instrument for vibration parameters	(page 42)

VM-SCOPE (page 50) is a digital oscilloscope and designed for the visualization of fast vibration and shock processes.

VM-FFT (page 57) works as a frequency / vibration analyzer.

VM-TRACK (page 64) is used to measure run-up or coast-down curves. It shows order tracked magnitude and phase of a vibration signal.

VM-BAL (page 68) is used to reduce vibrations by balancing. Single-Plane-Balancing and Two-Plane-Balancing are available as well as up to 7 correction methods.

VM-BODY (page 79) provides measurement and evaluation of human whole-body vibration according to ISO 2631, VDI 2057-1 and 2002/44EU.

VM-HAND (page 79) offers measurement and evaluation of human hand-arm vibration conforming to the ISO 5349, VDI 2057-2 and 2002/44EU.

VM-SHIP (page 106) measures vibrations on passenger and merchant ships according to DIN ISO 6954:2001.

VM-STRUC (page 117) measures vibrations in buildings according to DIN 4150-3.

VM-CAL (page 34) provides the central calibration of sensors in VibroMetra.

6.2. Uniform Control Elements

All VibroMetra instruments have, where possible, a similar design and handling in order to ensure a quick orientation.

Start-/Stop Button

All instruments feature a Start/Stop button, which changes its look depending on the state.

- If an instrument was stopped, the last measured values are displayed but do not change. Instrument can be configured for a new measurement. Status displays (gain, overload etc.) are disabled.

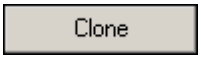
- If an instrument was started, measured values are updated continuously. Status displays are enabled and highlighted according to their state.

Open / close control panel

For a space-saving presentation, the settings can be collapsed. In this mode, only the display and the status indicators remain. Switching is possible with a button which changes its look depending on the status.

Clone function

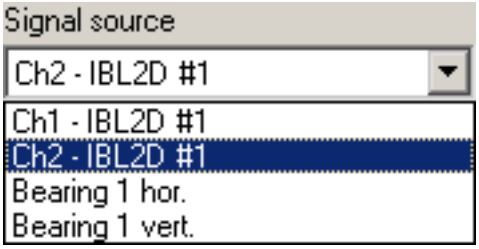
The clone function allows you to multiply an instrument which you have purchased once. The instrument is copied with all settings. Nevertheless each instrument setting may be changed separately. Parent and up to 3 copies can measure simultaneously.



A typical application of this function is the simultaneous measurement of acceleration, velocity and displacement, important for instance when measurements are carried out according to ISO 10816-6. The clone function also enables you to analyze a wide frequency range at a glance and a small frequency range highly resolved with VM-FFT.

Signal source

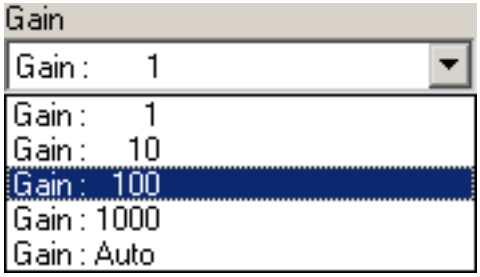
The measuring channels as the instruments' signal source can be switched. The list shows all measuring channels which are available for the instrument, i.e. which the instruments is registered on. A channel can be named individually. If no name is given, a default name is shown, containing channel number, M302 or M312 device type and its serial number.



Gain

The gain of each measuring channel can be changed in an instrument, i.e. the gain in the measurement electronics of a channel is changed. A gain change in one instrument will automatically change the gain in all other instruments connected to the same channel.

Besides fixed gain ranges VibroMetra features an autoranging function. It switches automatically to a higher or lower range when the input signal is too low or too high for more than 1 s. However, gain switching can cause transition effects. If a measurement shall be free of this effect, a fix gain setting is recommended.



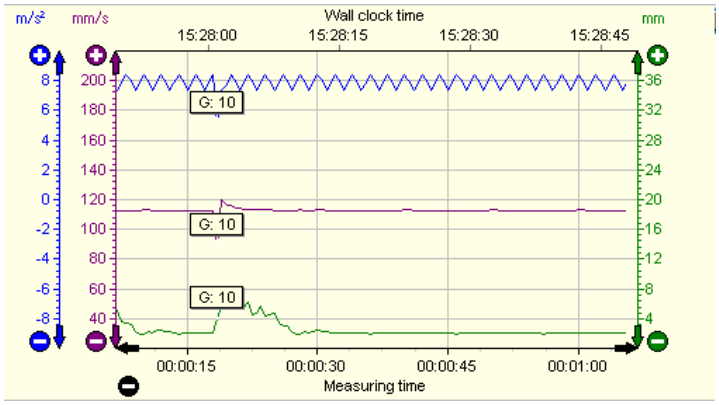
6.3. Controls of Multichannel Graphical Instruments

The multichannel graphical instruments (VM-FFT, VM-TRACK, VM-PLOT and VM-SCOPE) have – despite their different functions – similarly designed controls. This way user's effort to learn the handling of these instruments is minimized.

All instruments are able to display 4 channels simultaneously. It is possible both, displaying signals of different sensors and displaying the signal of one sensor with different settings (e.g. watching acceleration, velocity and displacement of the same sensor at the same time).

Each of the up to 4 channels has its own color, for easy recognition. Controls, values and curves of one channel are identically colored.

Graphic Display



This area shows the measured values graphically. Curves have the same x-axis, but every curve has its own y-axis. Curve and corresponding y-axis are displayed with the same color. Y-axes are arranged left and right from the curves and contain the corresponding unit.

Scrolling and zooming curves

Scroll signal up:	Click on the upper arrow at the desired y-axis.
Scroll signal down:	Click on the lower arrow at the desired y-axis.
Scroll signals left:	Click on the left arrow at the x-axis.
Scroll signals right:	Click on the right arrow at the x-axis.
Scrolling left/right	Left click into the curve area, hold mouse button down, drag the signals left or right to the desired position and release mouse button.

Besides the scroll arrows every y-axis provides zooming buttons. Curve gets larger by clicking on ⊕ and smaller by clicking on ⊖. If the scale of a y-axis reaches a limit during zooming the respective button disappears.

Double click on a y-axis causes an autoscaling of the respective curve. Then, the curve is displayed as large as possible, so that it nearly fills out the height of the graphic.

Zooming the x-axis works similarly. Clicking on ⊕ spreads the curve horizontally. Clicking on ⊖ compresses the curve. A double click on x-axis causes autoscaling. The meaning of autoscaling an x-axis is different for the instruments. The individual behavior is described in the respective instrument's chapter.

Zooming in the x-axis can be done as well by narrowing down the interesting interval using mouse cursor. Right click into the curve area, hold mouse button down, drag the mouse cursor left or right to the desired end position and release mouse button. During drag operation the selected area is inverse colored. Thus an interesting section can be fast and intuitively selected for detailed examination.

Changing the number of active channels

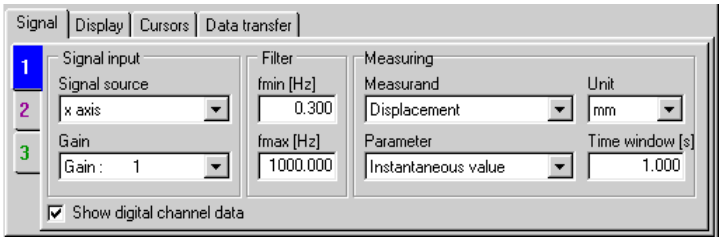
This control changes the number of active channels in multichannel instruments. Current number is shown in the center. Button + increments the number and button – decrements it. Buttons are disabled, if a limit is reached.

☝ Changing the number of channels causes an initialization of the instrument. Measured data are lost.

Export Button

Measured data can be readily exported to other software applications or files by means of the export button. This button does look like the typical copy symbol if Copy to clipboard was selected as export destination (section page 28). A floppy disk symbol appears if Save to file was selected.

Control panel: Signal



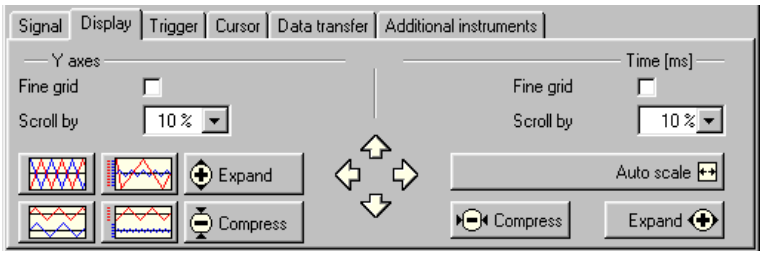
This panel is used for setup of the incoming signal. Every active channel can be set up individually and has its own tab, painted in the channel's color. The order of the controls is conform to a measuring chain:

- **Signal source** Selection of the measuring channel, where the signal comes from.
- **Gain** Selection of signal gain for a proper measurement range
- **Filter** Bandpass filter for the signal to suppress disturbing frequencies. The frequency limits depend on the used IEPE/USB adapter.
- **Measurand** Selection of the vibration quantity to be measured.
- **Unit** Selection of the desired unit for the measurand.
- **Parameter** Selection of the calculated parameter
- **Time window** Free adjustment of the time window for parameter calculation in the range of 0.1 .. 10 sec. VibroMetra instruments work with overlapping. Even if a time window of 10 sec is set up, parameter calculation takes place up to 4 times per second. For every calculation the last 10 sec are considered. Thus a fluent display is guaranteed, independent from the time window.

Depending on the special instrument the controls for signal setting may vary. Those differences are described in the respective instrument chapter.

☝ Except for the unit selection every change of the signal setup causes an initialization of the instrument. Measured data in the instrument are lost.

Control panel: Display

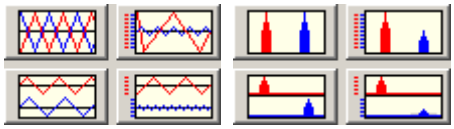


The graphic display (page 24) provides some controls to change the appearance of the curves. This panel provides more controls. The left section controls y-axes the right section controls x-axis. Depending on the instrument, an x-axis can be a time or a frequency axis.

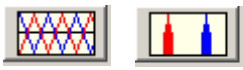
Checkbox Fine grid controls the density of grid lines. Scroll by determines the amount, by which the curves are moved when clicking the directional arrows. Clicking on an arrow of the navigation cross moves all curves in the selected direction.

Buttons Expand and Compress change the scaling of all curves (zoom in and out). Zooming of one curve only is explained on page 24.

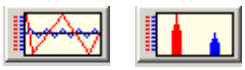
These 4 buttons provide auto scale functions. Design depends on the domain of the displayed signals: time or frequency domain.



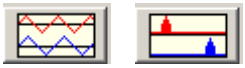
Time domain *Frequency domain*



Maximize each curve: This button scales all y-axes in such a way, that every curve uses the entire height of the graphic display.



Same zero-line, same scale: This button puts all zero lines on top of each other and selects a common scaling in such a way, that almost the entire height of the graphic display is used.



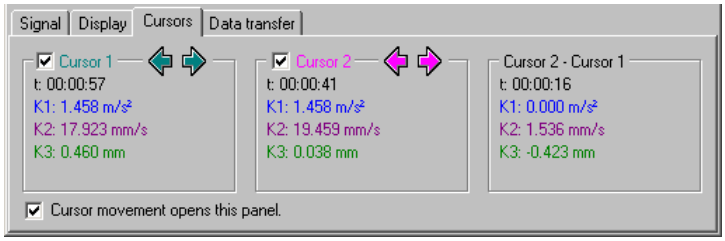
Stacked curves, each maximized: This button maximizes each curve, while the curves are stacked, so that every curve has its own area.

Stacked curves, same scale: This button stacks all curves and uses a common scaling for all curves.

Automatic scaling functions are constricted by maximum and minimum scale values. The maximum scale values is ± 10000.000. The minimum interval (max scale value – min scale value) is 0.01. By changing the unit scale values can be adjusted.

A click on Auto scale causes auto scaling of the x-axis. The meaning of auto scaling the x-axis is different for the instruments. Concrete behavior is described in the respective instrument's chapter.

Control panel: Cursor



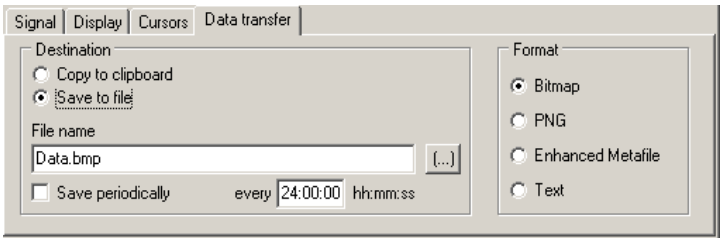
Two differently colored cursors are available for measurements within the curves. Values of x-axis and vibration values of active channels at the cursor position are displayed numerically. Coarse and fast positioning is performed by mouse, fine positioning is featured by cursor buttons.

- ➔ Cursor is enabled by checking the box Cursor 1 or Cursor 2. A vertical Cursor line appears in the graphic.
- ➔ If the mouse cursor is near the cursor line, the mouse cursor changes its icon to ↔.
- ➔ By clicking the left mouse button the cursor can be dragged now to an interesting position. If the mouse button is released cursor remains at the new position.
- ➔ If an examination near the current cursor position is necessary, cursor can be fine positioned by clicking on the respective directional arrow button. The cursor moves now by single data points. In some cases data points can be so close to each other, that a couple of data points share the same pixel line. In this case, numerical data of the cursor can change even if the cursor line doesn't move.

➔ If for every movement of the cursor the numerical values are interesting, then check the box Cursor movement opens this panel.

➔ If both cursors are active a box with difference values Cursor 2 – Cursor 1 is active as well.

Control panel: Data transfer



All instruments with graphic output allow you to export charts. For this purpose a control panel Data transfer is available.

Two export options can be selected for the data: Copy to clipboard or Save to file. The transfer into the clipboard is suitable for interactive operation when other programs are used simultaneously. Saving to a file is necessary if you want to process or analyze the data in other applications later.

Click on (...) to open a directory tree and select the desired path. For the directory name variables can be used to insert information like channel name, time and date automatically (see page 28). A short description is displayed if the cursor is placed over the file name input field.

Measured data can be exported in four different file Formats:

- Bitmap: The curve together with axis, grid and possibly activated cursors is exported as colored bitmap. Below the curve a text line is added showing a short description (sensor, measuring channel, measurand etc.). If cursors are active, their coordinates are added as well. Bitmaps require much hard disc space, but they are very compatible with many other applications used for documentation.
- PNG: A graphic file is created as described in bitmap section above. A PNG file needs around 5% disk memory compared to a bitmap without loss of graphic information. A lot of disk space is saved. Many applications support PNGs, like Paint, which is included in Microsoft Windows XP.
- Enhanced Metafile: A graphic is generated with all the parts as described above. The resulting EMF file contains drawing instructions instead of pixels. Compared to bitmaps it can be enlarged without quality loss. But the used software must have an EMF import function.
- Text: The content of the chart is exported as a table with lines of X/Y values. Each line represents an x-value and the corresponding y-values of the activated channels separated by a tab character. The file starts with a description line (including sensor, measuring channel, measurand, etc.).

File names with variables

Several instruments allow you to export measured data. You can either type in your own file name or use file names with variables. These variables are filled in automatically when the file is saved. Such variables start with a “%” character followed by a letter. They can be inserted at any position of a file name.

%i Channel-ID. This unique channel identifier is generated by VibroMetra and includes the M302 or M312 model, serial number and used channel.

(e.g. IBL2 #204 Ch1)

%k Channel name. The name according to the channel setup (page Fehler: Referenz nicht gefunden). If no name is specified, a default name will be used, for instance Ch1.

%n Channel number. 1 or 2 depending on the used input channel of the M302 or M312.

%J Current year, 4 digits.

%M Current month, 2 digits.

%d Current day, 2 digits.

%h Current hour, 2 digits.

%m Current minute, 2 digits.

%s Current second, 2 digits.

Example

The file name

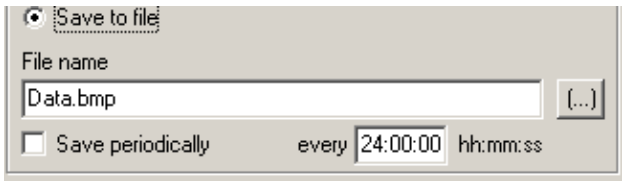
C:\My Documents\VibroMetra\Data\IBL2 #205 Ch1\2006-07-26_14-17-01

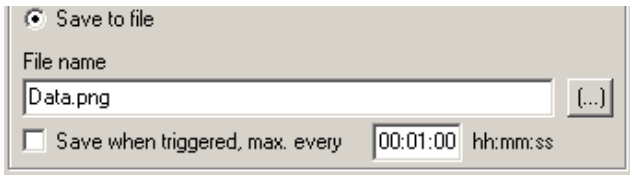
can be produced by a setting like this:

C:\My Documents\VibroMetra\Data\%i\%J-%M-%d_%h-%m-%s

Automatic recording

The placeholders within file names can be profitably combined with another function: the automatic recording feature. It automatically saves the data of the instrument to file, either periodically or trigger-controlled. By simply activating this feature a whole series of diagrams or data files can be created. Thereby, the placeholders provide for the automatic naming of the files.





The feature behaves somewhat differently, depending on the instrument at hand: Event controlled instruments, such as VM-SCOPE, can automatically save a data file, when an event has occurred (Save when triggered). In order to limit the number of files generated in the case of a rapid succession of events, an inhibitory time can be adjusted (from 1 second to 99 hours) within which the data for only one event is saved. Continuously measuring instruments, such as VM-PLOT or VM-FFT, save the data with a specified clock pulse (Save periodically).

6.4. Report Generation

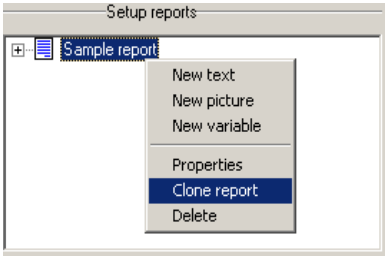
Many instruments feature a report function, the possibility to print the results in a freely chosen format. The report elements are combined into a template. These templates will in the following be called report. Each (applicable) instrument already contains a suitable template. More can be added. Actually printing a report is thereby reduced to a push of a button.

A report can contain the following elements:

1. **Fixed texts**: Define the content of a text, its position on the paper in X-Y coordinates and its format.
2. **Variables**: Variables contain current values from the Instrument, e.g. the measurement result or a pass-/fail-recognition. Similar to the texts, variables can be given a certain position and format. Variables may also be measurement diagrams. Those can be freely positioned and scaled.
3. **Pictures**: Any graphic in Windows Bitmap format (bmp) and PNG format can be included in the report. You define the name and the X-Y coordinates and die scaling for printing the file.

How to clone a report

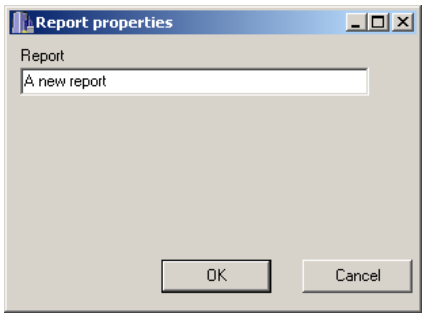
A new report is most easily created by copying an existing report, if only a few modifications are required.



- ➔ Click right onto an existing report. A context menu appears.
- ➔ Select Clone report. The report will be copied.

How to start with an blank report

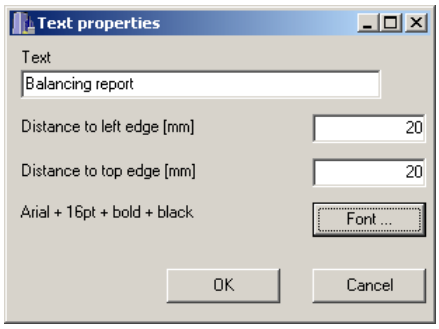
- ➔ Click right into a free space of the report list. A context menu appears.
- ➔ Select New report. A blank report with a default name is generated and its property window opens.
- ➔ Enter a significant name for your new report and confirm with OK.



Defining a fixed text

For instance, a headline is a fixed text. A fixed text is integrated in the report in the following way.

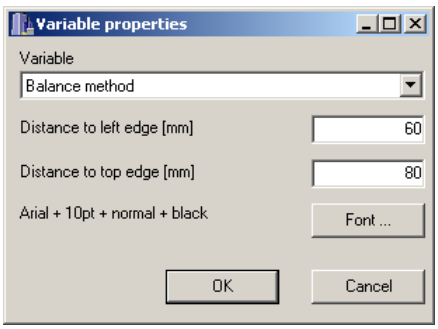
- ➔ Click right on the new report. A context menu appears.
- ➔ Select New text. A default text is generated and the property window opens.
- ➔ Enter the content of the text, define its position and format. Concerning the position please bear in mind that the distances are defined from the left/top edge.
- ➔ Click OK.



The headline has been exemplary defined as a fixed text now. Proceed similarly with other fixed texts, e.g. the address of your company.

Defining a variable

In order to let the report become vivid, it is necessary to fill it with variables. Variables indicate current values from the Instrument, e.g. measuring settings, entered values or the measurement result. Apart from those text variables measurement diagrams (graphical variables) can be incorporated into the report, too.



Adding a new variable is similar to adding a text.

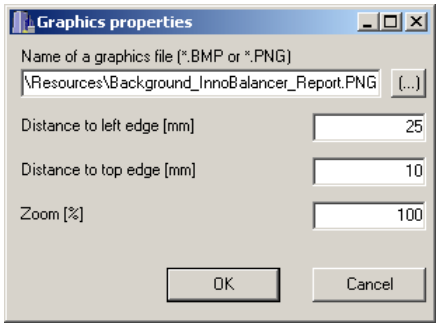
- ➔ Click right on the report, select New variable in the context menu. A default variable is generated and its property window opens.
- ➔ Select the required variable from the list. Additionally, you can define its position and font. For diagrams the zoom factor can be chosen.
- ➔ Finish the dialog with OK.

Defining a picture

Your layout is professionally completed by using your own pictures. Examples for application are for instance your company logo or an often measured object as photograph or drawing.

The report accepts Windows Bitmap (bmp) and PNG files as graphic format. Additionally, the graphic must not exceed 1 MB. No special error messages are indicated when these conditions are not fulfilled. The picture just is not printed.

Adding a new graphic is similar to adding a text:

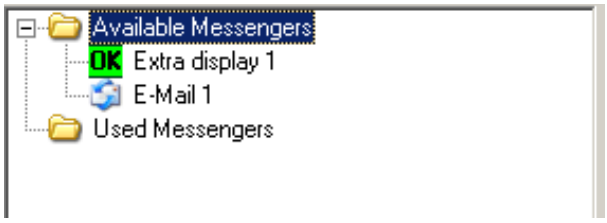


- ➔ Click right on the report, select New picture in the context menu. A default picture entry is generated and its properties window appears.
- ➔ Here you can enter the path for the graphic file and additionally the position and scaling of the picture.
- ➔ Finish the dialog with OK.

After having defined all elements of the report and thus having configured its look, you should save the configuration in a workspace. So you can use your report again later.

6.5. Using Event Messengers

Some instruments feature a function for sending measuring results or other messages to external equipment. More information can be found in section 7 from page 131.



Instruments show the available messengers and the messengers in use.

Activating a Messenger

- ➔ Right click a messenger in the list of Available Messengers.
- ➔ Select Use in the context menu.

The messenger is now used by the instrument and will appear in the list of Used Messengers. It is now unavailable for the use by other instruments.

Releasing a Messenger

- ➔ Right click a messenger in the list of Used Messengers.
- ➔ Select Release in the context menu.

The released messenger will appear again in the list of Available Messengers and becomes available to other instruments.

Configuring a Messenger

To configure an event messenger,

- ➔ Right click the messenger. A context menu will appear.
- ➔ Select Settings.

More information about the configuration of the individual messengers can be found in section 7 from page 131.

6.6. Uniform Status Indicators

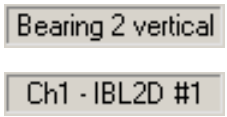
All VibroMetra instruments possess status indicator fields below or above the display to signal the operating state. Some of these indicators can be found in every instrument. The most common ones are described here:

Sensor indicator

This indicator shows you which sensor is connected to the measuring channel the instrument is working with. If the instrument is switched on but no sensor connected to the selected channel, the field will become red. In this case the display unit switches to mV, representing the voltage at the corresponding M302 or M312 input.

Connecting a sensor: page 12

Measuring channel



Next to the sensor indicator there is the measurement channel information. It shows the channel name you have typed in for the signal source or the default name.

Naming a measuring channel: page Fehler: Referenz nicht gefunden

Gain

G:10

The selected gain range on the selected measuring channel is also indicated in each instrument.

Changing the gain: page 24

Overload

>95%

The red indicator responds immediately if the incoming signal exceeds 95% of the measurement range of the M302 or M312. The signals will be further processed but the results can be erroneous due to signal clipping. Switch to a lower gain.

Underload

<1%

When the input signal drops below 5 % of the measuring range for more than 3 sec, this yellow indicator will appear. The measured signal can still be valid but the limited resolution and noise may affect its accuracy. Switch to a higher gain.

It is normal, that in idle periods the <5% status indicator is active. No change is necessary in this case. Only if the indicator is permanently active, even during measurement, should the gain be adjusted.

For instance, if the signal consists of impact-like pulses, the gain should be adjusted so that no overload (>95%) occurs during a pulse. There is no harm, if the underload (<5%) indicator is active between the pulses. However, it should not stay active during a pulse.

Vibration measurand

Acc

As the selected measurand is supposed to be indicated even if the control panel is collapsed, it is indicated with an abbreviation in the status line. The abbreviations are explained as follows:

- Acc Acceleration
- Vel Velocity
- Disp Displacement

Parameter

TRMS

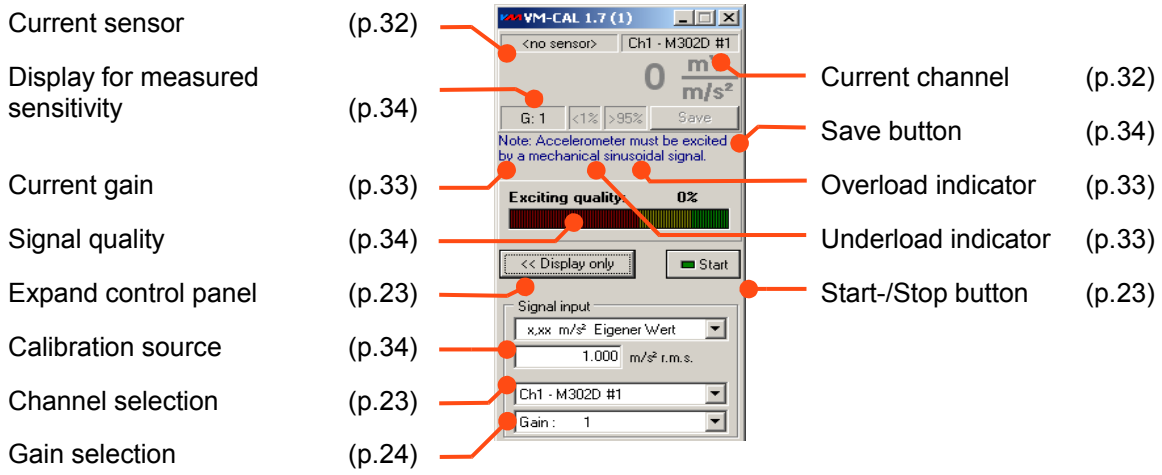
As the selected parameter is supposed to be indicated even if the control panel is collapsed, it is indicated with an abbreviation in the status line. The abbreviations are explained as follows:

- Inst Instantaneous value
- pk abs Absolute peak value (unsigned)
- pk (+) Positive peak value
- pk (–) Negative peak value
- pk-pk Peak-to-peak value
- TRMS True RMS value.

6.7. VM-CAL – The Calibration Tool for all VibroMetra Instruments

The Calibrator function is effective for the entire measuring chain from the sensor to the display. As soon as a sensor in VibroMetra has been calibrated, all instruments work with calibrated data as well. Calibrator function requires a sinusoidal vibration signal in the range between 10 and 1000 Hz generated by an exciter and fed in the accelerometer.

Displays and controls



Display

The calibrated sensitivity is displayed in mV/ms^{-2}. The refresh rate is between 1 and 4 times per second (set refresh rate: page 16).

Signal quality

During calibration the quality of the measured vibration signal is monitored to ensure correct results. Signal quality means the absence of other frequency components besides the calibration frequency. The purer the sinusoidal signal, the higher the signal quality. It is displayed as percentage value and as bar graph. Quality should reach green or at least yellow range.

Calibration source

Three types of vibration exciters are pre-defined as calibration source. They supply a sinusoidal vibration signal with different magnitudes: RMS values of 1 m/s², 9.81 m/s² or 10 m/s².

Save button

Clicking the Save button enters the measured sensitivity into the transducer data base.

6.8. VM-METER – Universal Vibration Meter with Digital Display

Overview

When vibrations have to be measured as significant parameters, VM-METER is used.

Rotating parts in drives, gears, pumps, fans and many other technical products cause perturbing vibrations. Impulse-like loads, e.g. from a vibratory pile driver in the construction-field, generate problems as well.

In numerous vibration standards – work-specific, national or even international – significant vibration parameters are defined for a reliable evaluation of the vibration situation.

These vibration parameters are precisely measured by VM-METER. Consequently, VM-METER informs about the vibration state of the measurement object during the complete product cycle – development, manufacturing, final inspection, service. Weak spots become obvious, the success of counter measures is proven and the compliance with limits is controlled.

The following measurands can be displayed:

- Vibration acceleration [m/s², mm/s², µm/s², nm/s², pm/s², g, mg, dB]
- Vibration velocity [m/s, mm/s, µm/s, nm/s, pm/s, in/s, dB]
- Vibration displacement [m, mm, µm, nm, pm, in, dB]

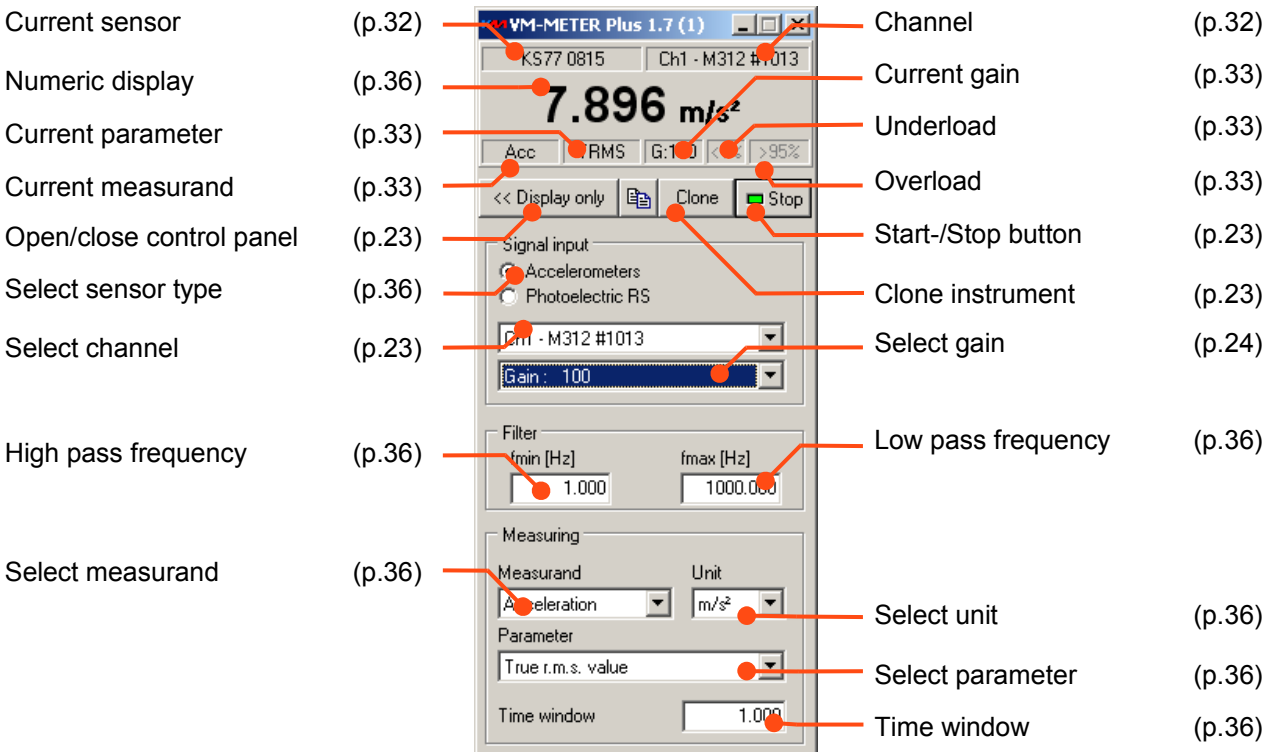
For all vibration measurands, the following parameters are available:

- Instantaneous value
- Positive peak value
- Negative peak value
- Absolute peak value (unsigned)
- Peak-to-peak value
- True RMS value
- Instantaneous value
- Main frequency
- Total harmonic distortion plus noise (THD+n)

High pass and low pass filters are available for all parameters.

If a reflex switch is connected, VM-METER+ can additionally measure rotation speed [1/min, 1/s or Hz].

Displays and controls



Numeric Display

The measured parameter is displayed numerically with the selected unit. If the numeric value becomes too high the display shows >99999. In this case another measuring unit must be selected. The display is refreshed between 1 and 4 times per second (refresh rate settings: page 16)

Control panel

The expanded control panel provides following adjustments for the measuring chain.

- Signal input — Selection of sensor type (Pro version), measuring channel and gain range. Sensor type Accelerometers provides measurement of vibration quantities. Photoelectric reflex switch enables measurement of rotation speed by means of a VM-PS sensor connected to the digital input of your M302 or M312.
- Filter — Freely adjustable high pass frequencies from 0.3 to 1999 Hz and low pass frequencies from 1 to 2000 Hz. Minimum range between fmin and fmax is 1 Hz.
- Measuring — Selection of measurand, unit and parameter to be displayed.
- Time window — Parameters are calculated for a defined time window, the length of which can be defined here.

6.9. VM-PLOT – Digital Strip Chart Recorder for Vibration Parameters

Overview

VM-PLOT is a digital strip chart recorder for visualizing trends of vibration parameters. It features a memory for 24 hours continuous recording and various display modes. Data can be measured with two cursors. Exporting data into other applications as bitmap or text is possible as well.

Rotating parts in drives, gears, pumps, fans and many other technical products cause perturbing vibrations. Impulse-like loads, e.g. from a vibratory pile driver in the construction-field, generate problems as well.

In numerous vibration standards – work-specific, national or even international – significant vibration parameters are defined for a reliable evaluation of the vibration situation.

VM-PLOT measures these vibration parameters and display their trend for a longer time graphically. Thus, they are especially convenient for longer test sequences, which can also run unattended. Weak spots in the continuous operation become obvious, the success of counter measures is proven and the compliance with limits is controlled.

Up to 4 curves can be displayed. They can represent both, signals of different sensors and signals of the same sensor but measured with different parameters.

The following measurands can be displayed:

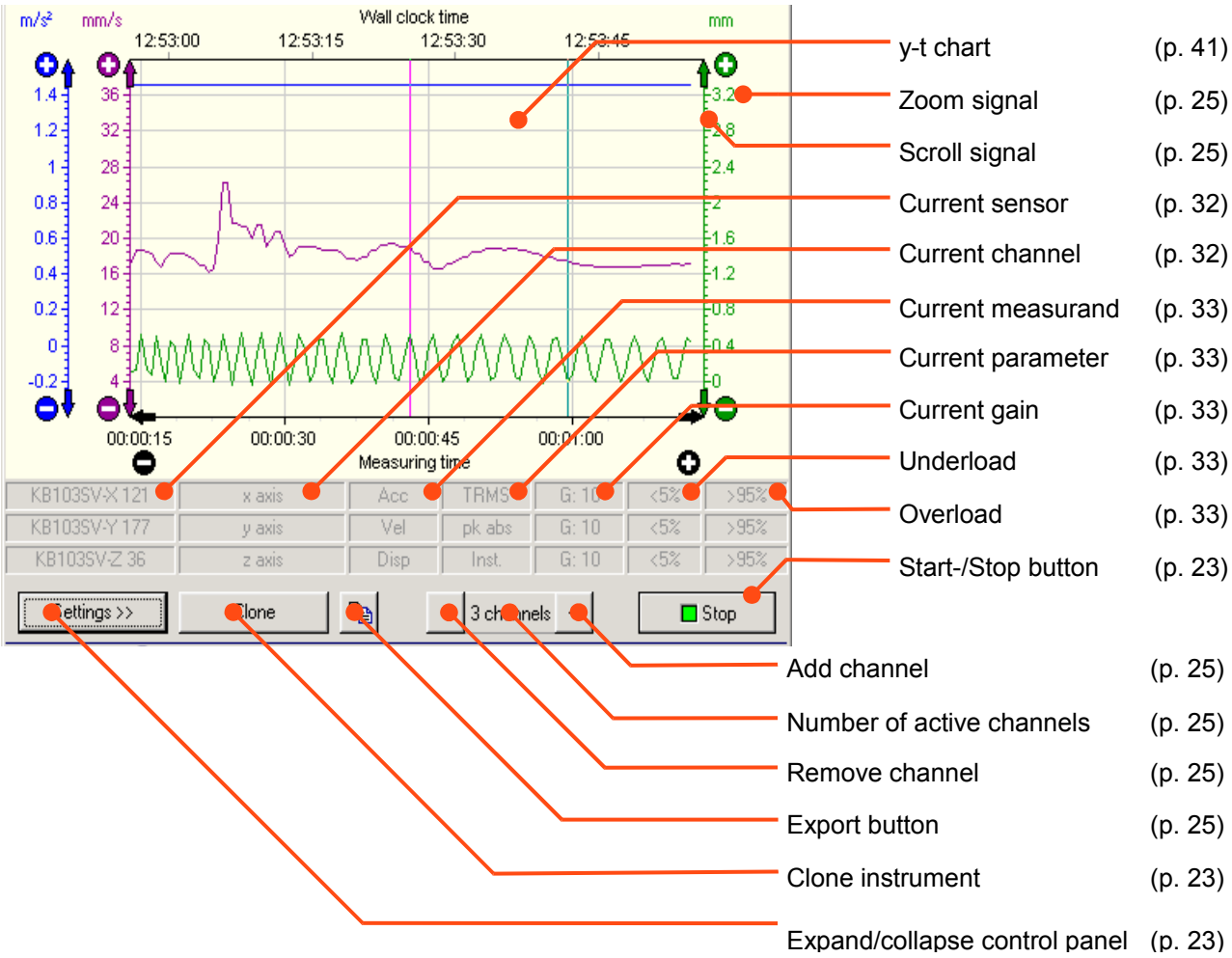
- Vibration acceleration [m/s², mm/s², µm/s², nm/s², pm/s², g, mg, dB]
- Vibration velocity [m/s, mm/s, µm/s, nm/s, pm/s, in/s, dB]
- Vibration displacement [m, mm, µm, nm, pm, in, dB]

For all vibration measurands, the following parameters are available:

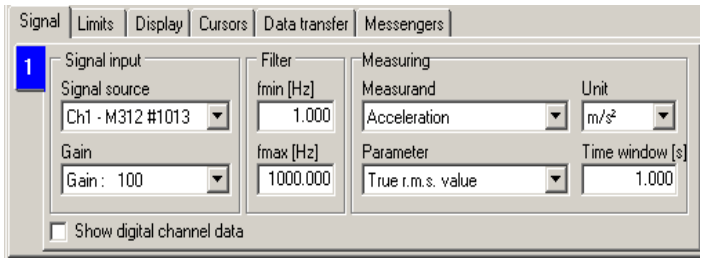
- Instantaneous value
- Positive peak value
- Negative peak value
- Absolute peak value (unsigned)
- Peak-to-peak value
- True RMS value

High pass and low pass filters are available for all parameters.
VM-PLOT shows data for up to 24 hours. If it runs longer then it keeps and shows data of the last 24 hours.

Displays and controls



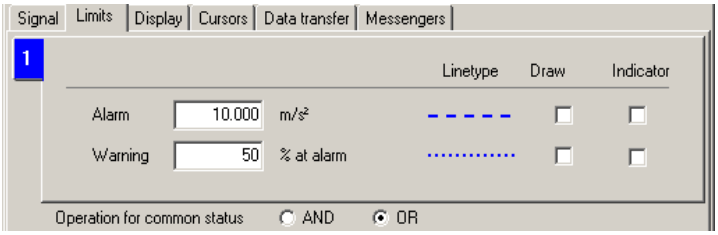
Control panel: Signal



This panel exists similarly in other instruments and is mainly described on page 26. In addition to the usual functions, it is here possible to switch on the display of the digital channel. This helps, e.g., to analyze complex vibrational patterns which are nevertheless repeating. The digital input may be fed a voltage pulse, when such a pattern starts. This pulse appears as a marker in the chart in addition to the measurement curves. Using these markers, significant changes in the vibrational behavior can be associated to certain parts of the motion sequence.

If the checkbox Show digital channel data is activated, the state of the digital channel is displayed near the lower edge of the chart. The digital signal source is the digital input of the M302 or M312, which also provides the analogue signal for the first instrument channel. The graphical display of the digital channel is explained on page 41.

Control panel: Limits



VM-PLOT+ can compare the measured data with limit values. Two limits can be entered by the user.

1. An alarm limit entered in the measured physical unit.
2. A warning limit in percent of the alarm value.

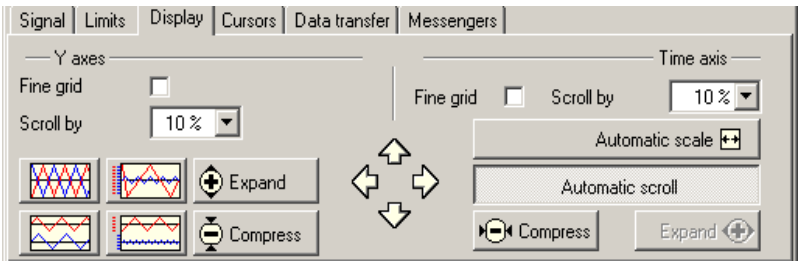
So three conditions can be monitored: good, warning and alarm. By activating the Draw checkbox the limits will be added as a dashed line in the plot diagram. Each time the measuring values cross this line a status change will occur. By activating Indicator such status changes can be used to control event messengers.

The individual settings for the limits of each channel can be combined by AND or OR operators to a common status. Only limits will be included which have been marked by the Indicator checkbox.

AND	Good:	At least one channel is good.
	Warning:	All channels indicate warning or alarm except:
	Alarm:	All channels indicate alarm.
OR	Good:	All channels are good.
	Warning:	At least one channel indicates warning and no other alarm.
	Alarm:	At least one channel indicates alarm.

The common status can control messengers via channel O.

Control panel: Display



This panel is divided into 2 areas. The left area is for the Y-axes, the right for the time axis. Basic operation of this panel is described on page 26.

Button Automatic scale sets time axis to the elapsed plot time.

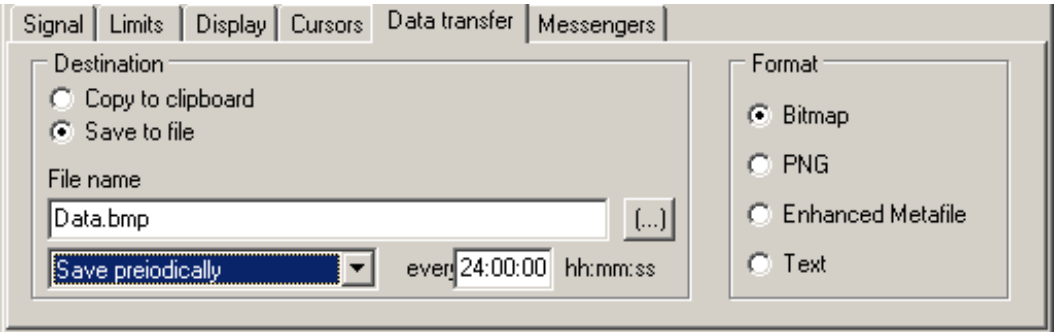
Time axis can be scrolled automatically, by selecting Automatic scroll to show the newest incoming data. Shown time interval of signal can be changed by Compress and Expand.

Control panel: Cursor

This panel exists similarly in other instruments and is described on page 27.

Control panel: Data transfer

This panel exists similarly in other instruments and is described on page 28. If text export is selected, the exported time values represent the elapsed time since starting the plot.



For automatic saving VM-PLOT+ has three modes:

Save manually only	Automatic saving is disabled. Use the Save button.
Save periodically	The instrument saves in time intervals as entered.
Save event controlled (only in VM-PLOT+)	The instrument saves if an event is triggered by crossing a limit.

When exporting saved data in text format, time is saved in seconds since the start of measurement. VM-PLOT+ may also export the limit curves.

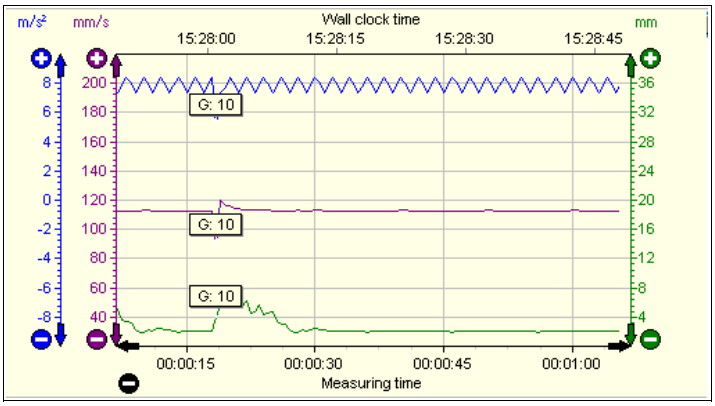
Control panel: Messengers

Event messengers can be used to to send measuring values and status messages to external hardware. For sending graphical data via a messenger, automatic saving must be enabled. Each time if automatic saving takes place, the diagram is transferred to channel O by the email messenger.

Channel O can be used to transmit the combined status of all channels or their measuring values.

The use of messengers is described in section 6.5 on page 31,

Strip chart diagram



The graphic displays the developing of a selected parameter. The refresh rate is equal to the the numeric value display rate, i.e. 1..4 times per second. When the curves reach the right end of the graphic, time axis and curves are scrolled left automatically if Automatic scrolling was selected.

The time axis is labeled with the absolute time at the top and with the past time since the start of measuring at the bottom. Thus, each event can be uniquely identified using two time values.

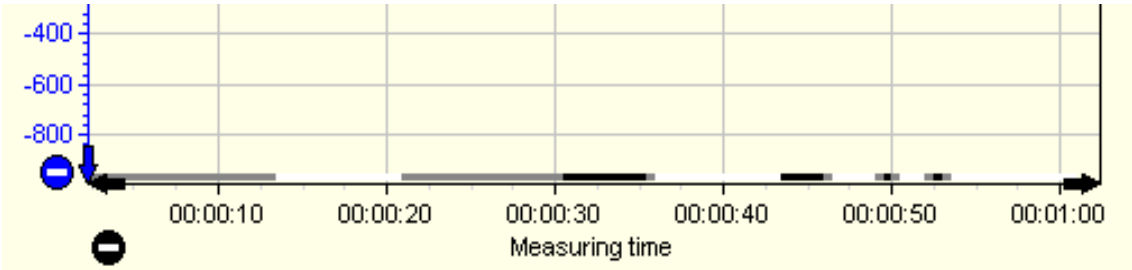
In some cases, VM-PLOT will be reset and restarted in order to avoid inconsistent results, for instance if the measuring channel or the frequency range is changed during operation. Values that were acquired under such different conditions can not be meaningfully displayed together in one curve.

It is different when gain or vibration transducer are changed, because only the level of the input signals is changed here. This is automatically compensated for. However, due to transient effects these events may cause a momentary peak or collapse in the curve.

Still, a gain or sensor change does not cause a reset of the graphic. But a small text label is stuck to the curve informing about the adjustment. For example, G:10 means that the gain changed to 10. These labels scroll together with the curve.

Display of the digital channel in the y-t chart

If it is activated (p.38), the state of the digital channel will be displayed in addition to the vibrational signals. It is shown as a line at the lower edge of the chart, which can take on three colors, depending on the state of digital channel.



The digital channel is binary and is in one of two states (0/1, off/on, low/high) at any time. State 0 is shown in white and state 1 is shown in black. The state can change up to 10 000 times within one display cycle of VM-PLOT. If both states occur within one display cycle, the digital channel is plotted in gray.

6.10. VM-REC – Logging of Vibration Signals and Vibration Parameters

Overview

For the monitoring of vibration parameters and their logging for later analysis, VM-REC is available.

Rotating parts in drives, gears, pumps, fans and many other technical products cause perturbing vibrations. Impulse-like loads, e.g. from a vibratory pile driver in the construction-field, generate problems as well.

In numerous vibration standards - work-specific, national or even international, significant vibration parameters are defined for a reliable evaluation of the vibration situation.

VM-REC measures these vibration parameters and monitor their level regarding the exceeding of limits.

Alarming situations are signaled and allow a fast pass-fail-recognition because of colored bars. In addition, the alarm can initiate the logging of vibration parameters. This data can be used for further analysis.

The following measurands can be monitored:

- Vibration acceleration [m/s², mm/s², µm/s², nm/s², pm/s², g, mg, µg, dB]
- Vibration velocity [m/s, mm/s, µm/s, nm/s, pm/s, in/s, dB]
- Vibration displacement [m, mm, µm, nm, pm, in, dB]

The following parameters are available for all measurands:

- Instantaneous value
- Positive peak value
- Negative peak value
- Absolute peak value
- Peak-to-peak value
- True RMS value

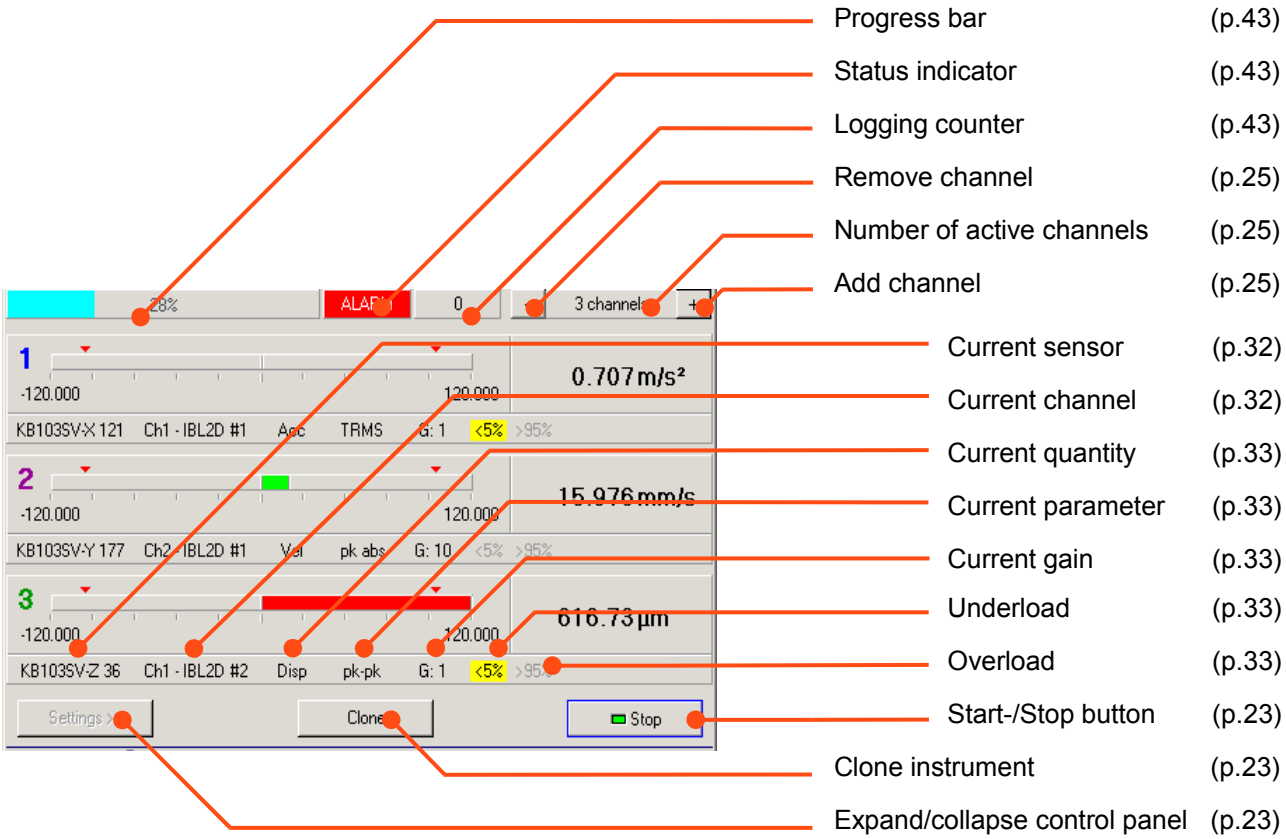
High pass and low pass filters between 0.3 and 2000 Hz are available for all parameters.

VM-REC can not only log raw data (instantaneous values) in full speed (10000 values/sec), but also preconditioned parameters. Additionally, the parameters can be logged in display speed (1..4 values/sec) as well.

VM-REC offers a variety of signal conditioning options before logging. But if the data is to be available for other signal conditioning algorithms as well, the logging of instantaneous values with high logging speed is recommended.

In combination with messengers (section 7) large color indicators or external hardware can be controlled as well as emails can be sent.

Displays and Controls



Status indicator and progress bar

The status indicator displays the total status as described on page 44.

The progress bar has two modes:

- After switching VM-REC on it indicates the memory fill level of the pretrigger.
- If an alarm was tripped and recording has started it indicates the elapsed recording time.

Logging counter

This field indicates the number of records since starting VM-REC. Thus you can check how many alarm conditions occurred during an unattended operation.

Value display

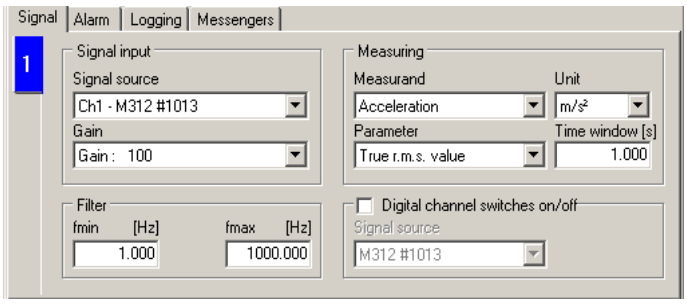
The measured values are presented numerically and in a bar graph. The refresh rate for both displays can be adjusted between 1 and 4 times per second (refresh rate settings: page 16).

The numeric values is shown together with the selected unit. If this numeric value becomes too high the display will show >99999. In this case an appropriate unit should be selected.

The bar graph display shows the measured level based on the adjusted alarm limits. The red triangles above mark these limits. The bar graph length beyond the alarm limits can be changed in Control Panel: Alarm.

Additionally, the bar graph changes its color according to the alarm condition. It is green as long as the signal level is within the alarm limits. The color will change into yellow if an alarm limit was exceeded but no alarm was tripped because of the alarm delay. When this delay time is over and measured value still exceeds a limit, the bar graph turns red.

Control panel: Signal

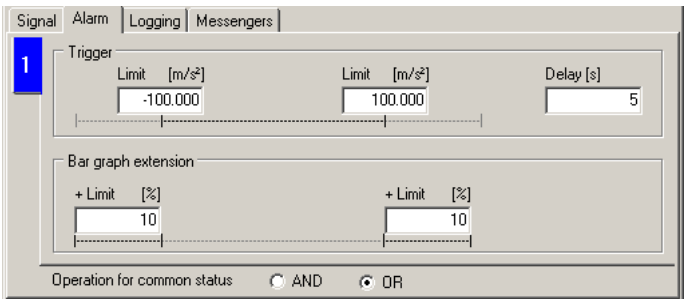


This panel provides adjustments of the signal chain.

- Signal input — Selection of measuring channel and its gain.
- Filter — Freely adjustable high pass frequencies (fmin) and low pass frequencies (fmax). The frequency limits depend on the used IEPE/USB adapter.
- Measuring — Selection of vibration quantity, its unit and of the measured parameter. The time window is for integrated quantities.

Digital channel switches on/off allows external control of VM-REC by a trigger signal from the digital input of the IEPE/USB adapter.

Control panel: Alarm



Two alarm limits can be specified, a maximum and a minimum limit. An alarm is tripped when the signal exceeds the maximum limit or falls below the minimum limit. If short-time peaks are not supposed to cause an alarm, an alarm delay can be defined. An alarm will be only tripped if the signal remains beyond the alarm limits longer than this delay time.

The following states can occur:

OK	Measured value is within the limits.
TRIG	Measured value exceeds the limits but no alarm was tripped due the alarm delay time.
ALARM	Measured value exceeds a limit longer than alarm delay time.

The bar graph is automatically scaled according to the alarm limits. To watch the signal beyond these limits, a bar graph extension can be defined.

The extension of the bar graph display can be specified in percentages. The span between the upper and the lower limit is regarded as 100 %.

Example:

Upper limit:	100 mm/s		
Lower limit:	20 mm/s		
Upper bar graph extension:	10 %		
Lower bar graph extension:	10 %		
Span 100 %:	100 mm/s - 20 mm/s	=	80 mm/s.
Extension 10%:	80 mm/s · 10%	=	8 mm/s
Upper bar graph end:	100 mm/s + 8 mm/s	=	108 mm/s
Lower bar graph end:	20 mm/s – 8 mm/s	=	12 mm/s

Alarms of the single channels are combined by or / and operators to an overall alarm. The overall alarm can be tripped if only one channel triggers (OR gating, disjunction) or when all channels have active alarms (AND gating, conjunction).

Common status

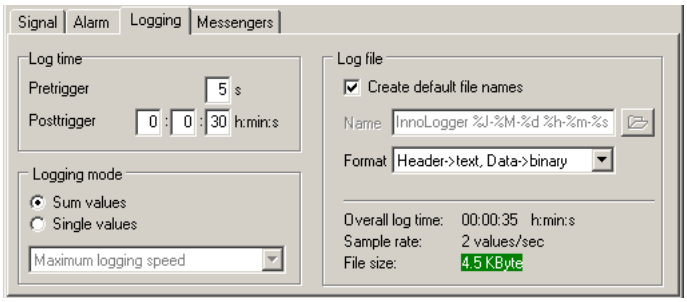
The individual states of each channel can be combined by AND or OR operators to a common status.

AND	OK:	At least one channel is OK.
	TRIG:	All channels indicate TRIG or ALARM except:
	ALARM:	All channels indicate ALARM.
OR	OK:	All channels are OK.
	TRIG:	At least one channel indicates TRIG and no other ALARM.
	ALARM:	At least one channel indicates ALARM.

The common status can control messengers via channel O. Recording is started if the common status changes to ALARM.

Control panel: Logging

Log time



A pretrigger and a posttrigger can be specified for data logging. The pretrigger defines the logging time before alarm tripping whereas the posttrigger defines the logging time after alarm tripping. The pretrigger can log up to 30 seconds, the posttrigger up to 24 hours.

Logging mode

The logging speed defines the data rate which is used for recording. The following 3 modes are available:

1. Sum values: The output of the selected parameter (true RMS value etc.) is the result of summing many single values. These sum values are displayed with a refresh rate between one and four times per second. The same rate is used for recording when the option sum values is selected. In this mode VM-REC produces small log files. It is suitable when only the progress of sum values is important.
2. Single values with maximum logging speed: This mode logs data with a maximum speed of the analog-to-digital converter of the M302 or M312: 10,000 values/sec. Relatively large log files are produced within short time. Not only the instantaneous values can be logged, but also the other parameters available for vibration measurement. Recording of single values allows to obtain a lot of further information about the vibration signal by post-processing. For this purpose, instantaneous values should be recorded because they are the raw material for further analysis.
3. Single values with adaptive logging speed: This mode allows post-processing for further analysis as well. However, the file size is smaller than it would be with maximum logging speed. This logging mode evaluates the adjusted low pass frequency in the VM-REC signal settings and the filter slope in the VibroMetra Online settings. Frequency components that have already been eliminated by the low pass frequency filter are not saved in the file as well. Still, the so-called Nyquist criterion is observed so that the logged data can be used for further analysis unconsidered.

Log file

In order to enable VM-REC to record automatically, it is necessary to define the log file names in advance. If you want to use standard names created by the software activate the Create default file names checkbox. In this mode the log file is named as follows:

```
VibroMetra folder\
        Data\
                M302 or M312 ID\
                    year-month-day hour-minute-second VM-REC-ID
```

This could be resolved to name like this:

C:\Programs\MMF\VibroMetra\Data\M302 #205 Ch 1\2006-07-26 14:17:01 36456

To enter an individual name, deactivate the checkbox Create default file names. You can select the desired directory by clicking on (...).

Enter a fixed file name. You may also use or one or more of the file name variables described on page 28. A short description of these variables can be obtained by placing the mouse pointer above the File name field.

Format: The generated file always contains a head in text format. For the data to be logged you can decide whether you save them in binary or text format. The binary format is more compactly, the file is smaller than in text format. The text format in turn is easier to handle. You can watch the data in a text editor or export it into a spreadsheet uncomplicated.

Additionally, you will find information about log time and required memory space in the Log file. The text color indicates the available disc space. The file size text color indicates the available disc space:

Green	Enough disc space available for at least 10 more log files.
Yellow	Disc space for 1 to 10 log files available.
Red	Disc space for less than 1 log file available. Logging is not possible.

Data format

The log files generated by VM-REC consist of a header in text format and measuring data in binary or text format. If you open the file with a text editor, you will see the header. It provides information about the measurand, the selected parameter etc. In the following, a header is analyzed as an example:

`Version=1.5`
VM-REC version number which allows the software to react on future VM-REC versions

`Pretrigger=5`
Pretrigger time in seconds.

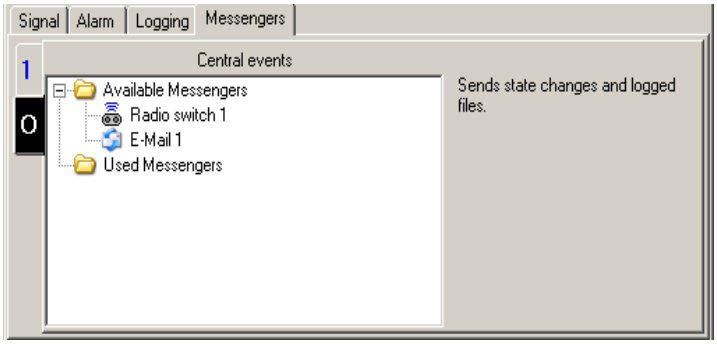
`Posttrigger=30`
Posttrigger time in seconds.

`SampleRate=10000`
Samples per second.

`NumChannels=3`
Number of active channels.

Control panel: Messengers

Event messengers can be used to to send measuring values and status messages to external hardware as described in section 7 on page 131.



Channels 1 to 4 send their current measuring values and alarm states to the connected messengers.

For the transmission of saved data channel O is used. As soon as a file is recorded, it will be sent via the used email messenger. Channel O also indicates the general status.

The use of messengers is described in section 6.5 on page 31,

Channel settings

Settings for channel 1 follows, which are marked by the suffix „_1“.

`InputID_1=Ch1 - IBL2 #1000`
Input-ID is a channel identifier consisting of channel number, M302 or M312 model and serial number.

`InputName_1=Bearing 12`
Channel name as defined in the channel settings (described on page Fehler: Referenz nicht gefunden).

`Sensor_1=KS80 3346`
Sensor name as defined in the sensor settings (described on page 11).

`Measurand_1=0`
Index in a list of vibration measurands, starting with zero.

`MeasurandName_1=Acceleration`
Vibration measurand as text.

`Unit_1=1`
Index in a list of measuring units, starting with zero.

`UnitName_1=mm/s²`
Unit as text.

`Parameter_1=5`
Index in a list of parameters, starting with zero.

`ParameterName_1=True RMS`
Parameter as text.

`fmin_1=0.3`
High pass frequency in Hz.

`fmax_1=200`
Low pass frequency in Hz.

`LimitMax_1=75`
Upper limit.

`LimitMin_1=0`
Lower limit.

`UpperAdd_1=10`
Upper bar graph extension.

`LowerAdd_1=0`
Upper bar graph extension.

If more than 1 channel is active, settings for the next channels will follow. Suffix „_1“ is replaced by „_2“, etc.

Measured data

A few entries follow describing the data format:

`DataType=binary`
DataType can be „binary“ for binary data or „Text“ for text format.

`DataStart=1024`
DataStart describes the byte position of the first value in the file, if binary data are saved. If text format is selected, this value describes the number of the first line containing measurement data.

`DataSize=4`
DataSize describes the data type of logged values, if binary format was selected. DataSize = 4 is for 4 byte wide floating point values, DataSize = 8 stands for 8 byte wide values. 4 byte wide values are often named float type, 8 byte wide values are named double. If text format is selected, the data size entry is not generated.

Data follows in columns for every channel and rows for the chronological saved values (Example for 3 channels):

value 1, channel 1;	value 1, channel 2;	value 1, channel 3;
value 2, channel 1;	value 2, channel 2;	value 2, channel 3;
value 3, channel 1;	value 3, channel 2;	value 3, channel 3;
value 4, channel 1;	value 4, channel 2;	value 4, channel 3;

...

The DataSize parameter informs your analysis software about the used data type. DataStart is used by the software to set the data pointer to the first recorded value. Now all measured values can be read to the end of the log file. The information from the header about vibration measurand (MeasurandName) and measuring unit (UnitName) can be used to label the Y-axis. Time axis information is found in the parameter SampleRate.

To calculate the number of logged values, add the values Pretrigger and Posttrigger and to multiply them by SampleRate and NumChannels.

6.11. VM-SCOPE – Displaying Fast Vibration and Shock Events

Overview

VM-SCOPE allows the signals' shape analysis of fast vibration and shock processes in time domain. Especially shock processes cannot be displayed in detail with the other instruments from the VibroMetra family. By means of VM-SCOPE, the processes can be acquired with high resolution, measured and exported for documentation or further processing.

So products that are exposed to shocks can be optimized. The transport und packaging sector are only two exemplary fields of application. VM-SCOPE is likewise used to measure decay processes and transients, e.g. for saw blades, drive shafts of mixing machines and other machine parts. Together with VM-FFT the natural frequencies can be determined.

VM-SCOPE can work as trigger source for VM-FFT. Thus natural frequencies of objects or structures can be measured as well.

The signals can be displayed for the following vibration measurands.

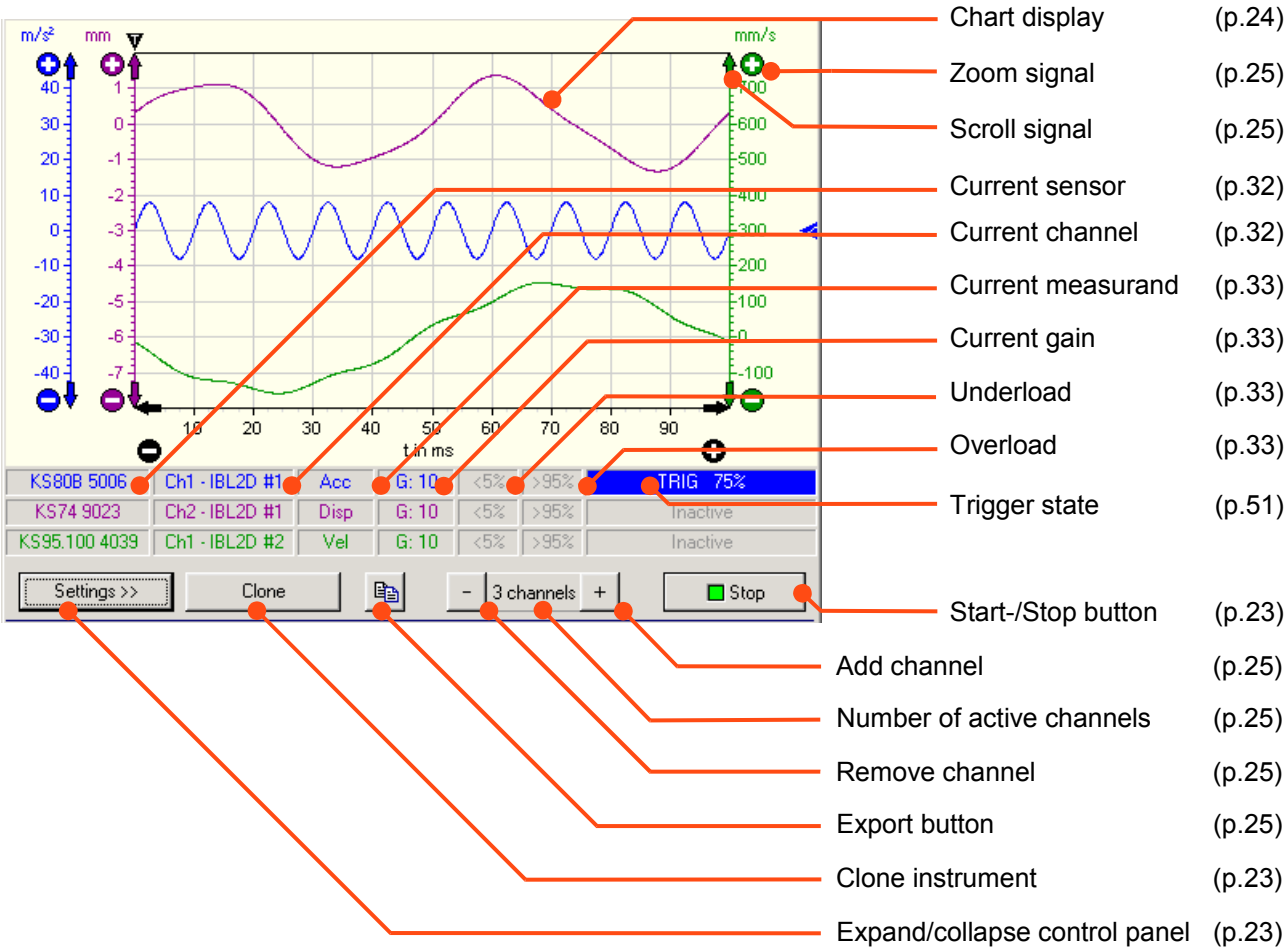
- Vibration acceleration [m/s², mm/s², µm/s², nm/s², pm/s², g, mg]
- Vibration velocity [m/s, mm/s, µm/s, nm/s, pm/s, in/s]
- Vibration displacement [m, mm, µm, nm, pm, in]

Up to 4 curves can be displayed. They can represent both, signals of different sensors and signals of the same sensor but measured with different parameters.

VM-SCOPE has a high memory depth. The acquired signal can be recorded until up to 1 second before and 10 seconds after the trigger event with full resolution of 100 µs.

Two differently colored cursors are available to support you with signal analysis. Time and measured values at the cursor position are presented numerically.

Displays and controls



Trigger state

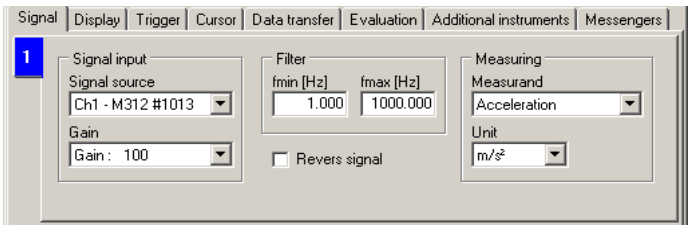
This status field shows the triggers state for the selected channel (p.52). If VM-SCOPE is running, 3 states can be indicated.

- Ready: No trigger process is active and VM-SCOPE waits for a trigger.
- TRIG: Trigger condition was matched and an event was triggered. Elapsed recording process is shown in percent.
- STOP: A single shot trigger finished and no further event can be triggered. Click with left mouse button into the trigger state indicator to release the trigger.

The other channels display Trigger: Inactive.

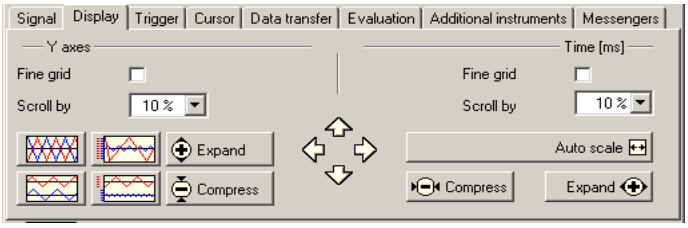
Control panel: Signal

This panel exists similarly in other instruments and is described on page 26.



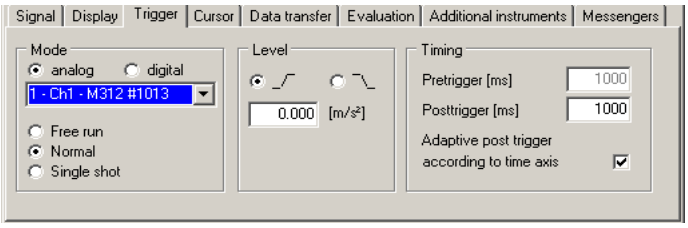
Control panel: Display

This panel is divided into 2 areas. The left area is for the Y-axis, the right for the time axis. Operation of this panel is described on page 26.



Control panel: Trigger

The trigger Mode defines the source and mode of the trigger. VM-SCOPE has two trigger sources. Depending on which one is chosen, the list of selectable trigger channels changes.



- analog: One of the active measurement channels is the trigger source. All present channels are shown in the selection list. For rapid orientation each is shown with its specific background color.
- digital: A digital channel of a connected M302 or M312 is the trigger source. The selection list shows all M302 or M312 units which are equipped with VM-SCOPE.

The trigger Mode defines in which way the display acts after the triggering.

- Free run: The signal runs through the display freely before and after triggering.
- Normal: The signal runs through the display freely after the start and before the first triggering. After a trigger event, the triggered time signal remains in the display. It is refreshed as soon as a new trigger event occurs.
- Single shot: The signal runs through the display freely after the start and before the first triggering. After a trigger event, the trigger record remains in the display. VM-SCOPE does not react to new trigger events anymore. You can click on this field to activate the trigger again (page 51).

The trigger Level is freely adjustable from –10000 to +10000 in the selected unit. Trigger level can be set by mouse as well, if an analog source is selected. Click left on the trigger triangle at the right of the chart, hold the button down and move the triangle up or down to the desired level. After releasing the mouse button, trigger level is set. If a digital source is selected, the level selection and the corresponding triangle are not shown. The digital channel only works with the values 0 and 1 and, therefore, does not need a trigger level.

It is possible to trigger on raising or on falling edges.

The trigger Timing consists of the time before the trigger and the recording time after--wards. The Pretrigger is firmly preset on 1 second. The Posttrigger can be adjusted up to 10 seconds. If such a long recording time is not necessary, we recommend to shorten the posttrigger. Thus it is possible to react to new trigger events quicker.

If you select Adaptive Posttrigger, the posttrigger is coupled with the right window side. Data is always recorded up to the right window side only. If you wish to have more data but keep the time interval, deactivate the adaptive posttrigger. In this case, data is recorded for the time you selected in the posttrigger field, no matter what time interval is displayed currently.

Control panel: Cursor

This panel exists similarly in other instruments and is described on page 27.

Control panel: Data transfer

This panel exists similarly in other instruments and is described on page 28. If text export is selected, the time values are exported in milliseconds.

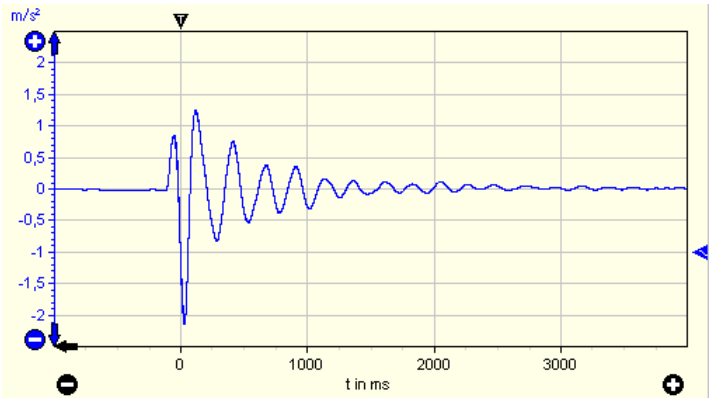
Control panel: Evaluation

VM-SCOPE+ provides functions for the automated evaluation of measured signal traces. These functions can be configured and will be executed immediately after a measurement is triggered. Two evaluations are available:

1. Decay time
2. Head Injury Criterion (HIC)

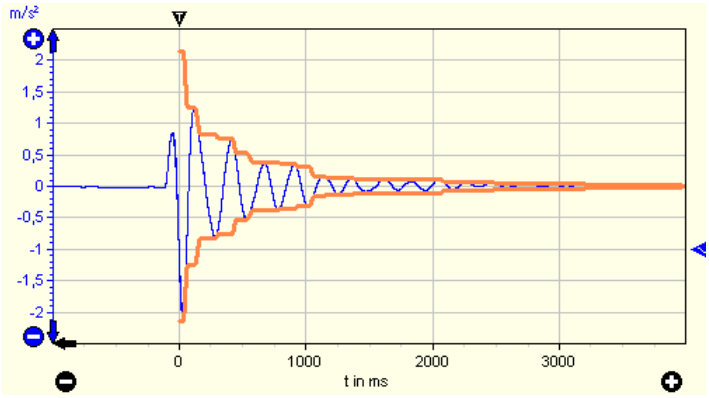
Evaluation of decay time

A vibration impulse often induces decaying vibrations. The decay performance is automatically measured by VM-SCOPE+.



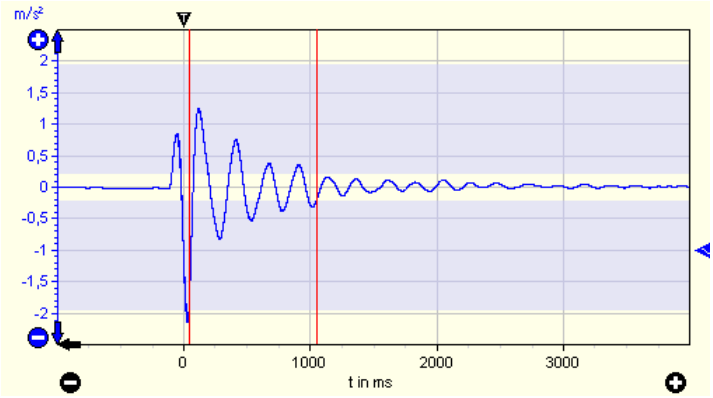
If a measurement is triggered, VM-SCOPE will envelop the signal resulting in a decay curve.

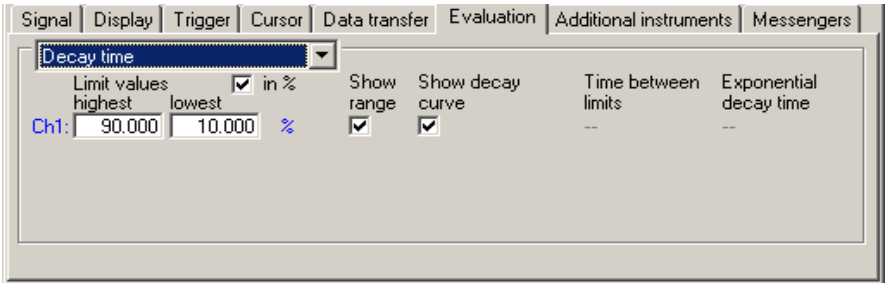
For the measurement of decay time two limits can be set which determine the period of time to be measured. These can be absolute vibration values or percent values of the peak magnitude.



The point of intersection between the decay curve and the highest limit value marks the start at the time axis. The point where the lowest limit value meets the curve is the end of the time interval.

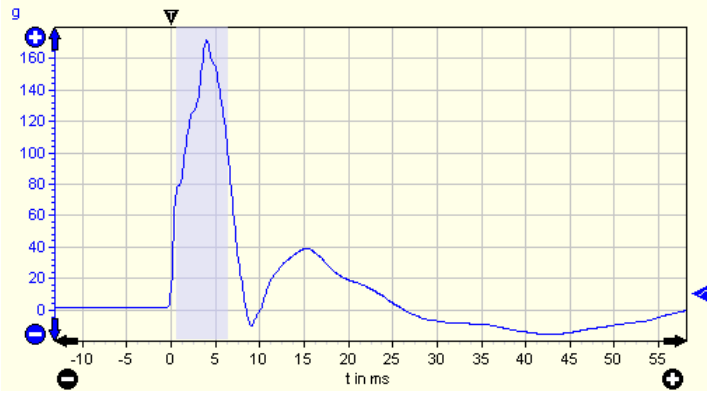
In addition the graphical output of decay measurement can be set for each channel separately. Measurement also takes place for each channel individually.



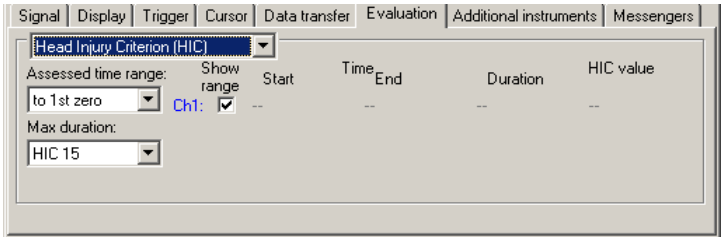


Evaluation of Head Injury Criterion (HIC)

The Head Injury Criterion (abbrev. HIC) is used to evaluate the risk of head injuries caused by car accidents and other impacts. The dimensionless quantity is often stated, depending on the evaluated time interval of 15 or 36 ms, as HIC_{15} or HIC_{36}. The HIC maximum is 1000. Higher values represent a risk of serious head injuries.



Since the impact occurs in relatively short time, it is useful to limit the Assessed time range. Long time ranges extend the duration of evaluation. If necessary long time intervals should be measured in combination with a single shot trigger.



In addition to HIC_{15} or HIC_{36} the duration of measurement can also be entered by the user.

Control panel: Additional instruments

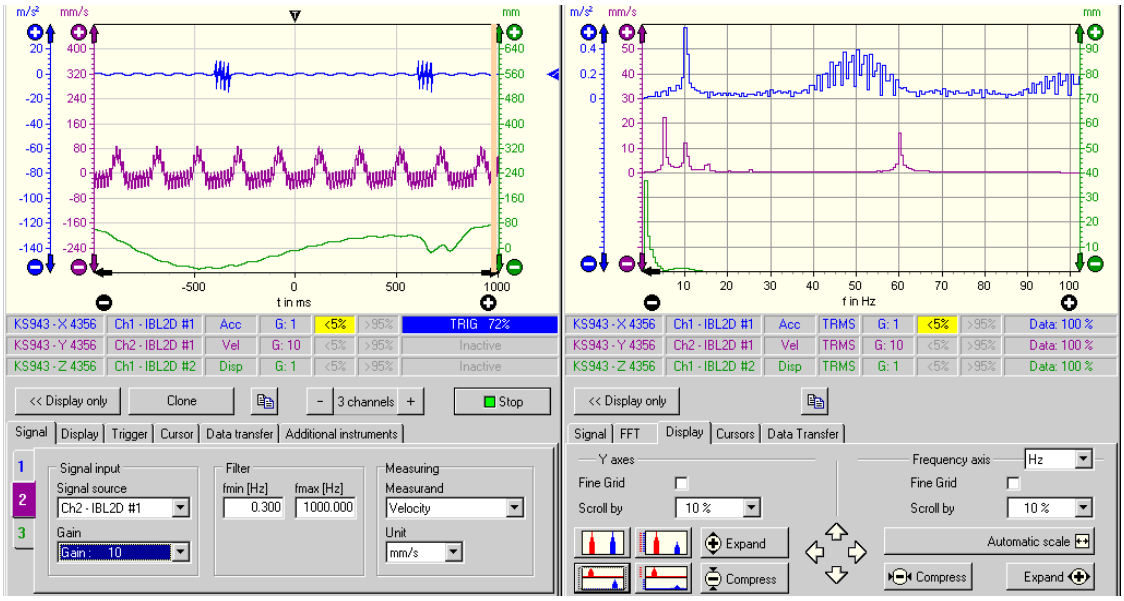
According to the VibroMetra philosophy, the single instruments are not overburdened with functions another VibroMetra instrument can fulfill better. For the detailed visualization of signals in the time domain, VM-SCOPE is available. It offers its services to VM-FFT, which shows signals in frequency domain. Both instruments can work as a

team. VM-SCOPE can act as a trigger source in order to let VM-FFT carry out FFTs only if a trigger event occurs.

The connection between the tow instruments is initiated by VM-SCOPE. Click VM-FFT in the Additional instruments panel.

VM-SCOPE+ can start VM-FFT as well as VM-FFT+ whereas VM-SCOPE can start VM-FFT only. The reason is that VM-SCOPE takes over team control and determines the measurand for example. VM-SCOPE+ is able to display vibration velocity and displacement, VM-FFT is not. That is why VM-FFT could not process the respective data from the VM-SCOPE+.

As soon as you started VM-FFT, it positions itself on the right side of VM-SCOPE and keeps this position when the VM-SCOPE window is moved. Consequently, you have a good view on the time and frequency domain of a signal.



VM-FFT is subordinated to VM-SCOPE now and analyzes exactly the content of VM-SCOPE's time window. For instance if you are interested in the time period 1 to 3 seconds after the trigger event, you make the setting in VM-SCOPE this way and VM-FFT will analyze the time signal exactly one second after the trigger event. The following dependencies have been implemented:

- If you start VM-SCOPE, VM-FFT is started as well.
- If you stop VM-SCOPE, VM-FFT is stopped as well.
- If you move VM-SCOPE, VM-FFT moves as well.
- If VM-SCOPE triggers, VM-FFT analyzes.
- If VM-SCOPE waits for a trigger event, nothing is analyzed.
- If you close VM-SCOPE, VM-FFT is closed as well.
- Changing the signal source in VM-SCOPE means VM-FFT changes its signal source as well. Precondition: VM-FFT is registered for this channel as well. If not, it cannot analyze this signal source.
- Changing the measurand in VM-SCOPE means VM-FFT changes its measurand as well. But the units for this measurand can be selected freely.
- If you adjust fmax in VM-SCOPE, the maximum frequency in VM-FFT is set according to that.

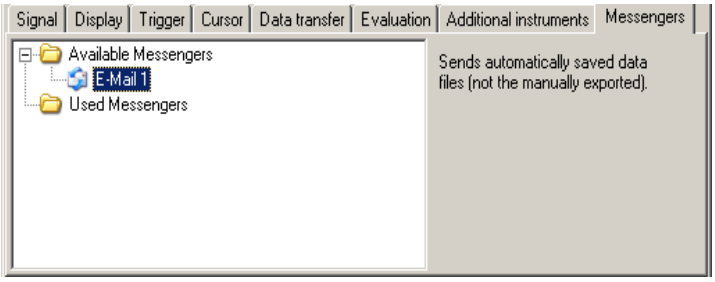
- If you adjust the time period in VM-SCOPE, the time window for 1 FFT is set according to that. Since only discrete time windows are possible in case of having a constant sample rate, the time window of VM-SCOPE is regarded as maximum. Usually a value of >50..100% of the time window is used. The analysis always starts at the point in the time signal which appears on the left window frame of the VM-SCOPE.

If certain settings should prevent an analysis, this is indicated in VM-FFT by yellow marks beside the problematic parameters. Parameters given by VM-SCOPE can only be changed in VM-SCOPE, too.

Control panel: Messengers

Event messengers can be used to to send measured curves by email. Only automatically saved data is transferred.

The use of messengers is described in section 6.5 on page 31,



6.12. VM-FFT – Frequency and Vibration Analysis

Overview

For the frequency analysis of vibrations, VM-FFT is used. Rotating parts in drives, gears, pumps, fans and many other technical products cause perturbing vibrations. Often numerous parts with different rotation speed cause mechanical vibrations so that a superposition of frequencies is generated.

VM-FFT decomposes this superposition into the different frequency components again by Fourier-transformation. So you can detect the parts which are primarily responsible for the vibrations. As a consequence, mechanical malfunctions are precisely and quickly tracked down in development, quality control or service. The success of actions to reduce vibrations, e.g. balancing with VM-BAL, is proven measurably.

Generally, the prejudice of frequency analyzers being difficult to handle still exists. Indeed, in case of an unfavorable configuration, many pieces of information remain hidden. But VM-FFT has a groundbreaking configuration system. By means of VM-FFT, even users with rare contact to digital signal processing achieve significant analyzes. Experienced users will also like the ease with which they can quickly get an overview.

In the automatic mode, you just define the required frequency range and select optimization for either magnitude or frequency – that's all. VM-FFT works on its own now and it always displays more than 400 lines.

On the other hand, many more parameters are available for experienced users so that they can configure the analysis according to their specific demands.

For example, the following window functions are available e.g. to influence the leak effect: Rectangle, Hann, Flattop, Blackman, Hamming, Bartlett.

The frequency components can be displayed for the following measurands:

- Vibration acceleration [m/s², mm/s², µm/s², nm/s², pm/s², g, mg, dB]
- Vibration velocity [m/s, mm/s, µm/s, nm/s, pm/s, in/s, dB]
- Vibration displacement [m, mm, µm, nm, pm, in, dB]

The levels of the respective frequency components can be displayed as the following parameters:

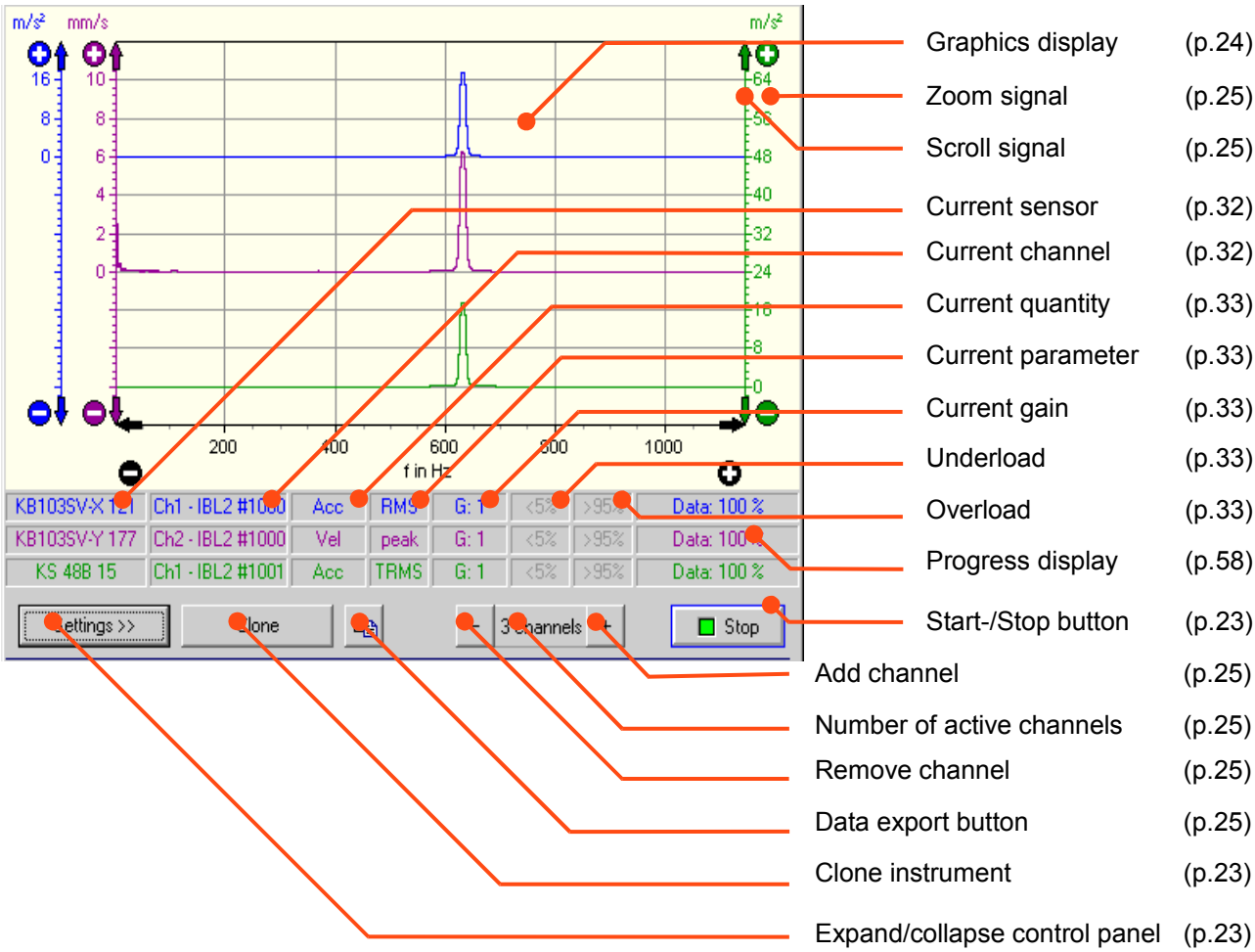
- Positive peak value
- True RMS value

Two differently colored cursors with value display support you during the analysis. The export of the curves into other applications as bitmap or as pairs of X/Y values in text format is easily possible.

Frequency analysis can be carried out continuously as well as in response to a triggered time signal. In this case VM-FFT is working together with VM-SCOPE.

In unattended mode the FFT results can be saved on hard disk or sent by email.

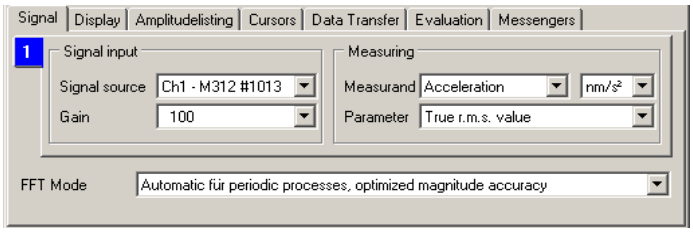
Displays and controls



Progress display

Graphics display shows data immediately after switching on. Displayed data are at first provisional, because not enough data are available for a complete analysis. Progress display shows the current status. Data are valid only when this display shows 100%.

Control panel: Signal



This panel provides parameters for the incoming signal. Operation is similar to other graphical instruments. Therefore a general description can be found at page 26. VM-FFT additionally provides a selection of FFT modes (ref. next chapter).

FFT modes

3 FFT modes are available for VM-FFT, 2 automatic modes and one manual.

- Automatic for periodic processes, optimized magnitude accuracy
- Automatic for periodic processes, optimized frequency accuracy
- Extended settings for FFT

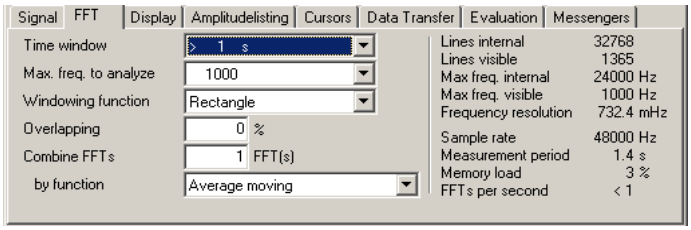
During a FFT analysis, only a section of an infinite signal is analyzed. As a consequence, the frequency analysis does not always indicate the accurate magnitude or frequency. That is why the automatic mode distinguishes between optimized frequency or magnitude accuracy.

In the automatic mode, the user simply defines the desired frequency range. VM-FFT provides an optimized setting of sample rate, measurement duration and overlapping so that there is an optimum line density and a refresh rate according to the central configuration in VibroMetra Online (page 16).

Optimum line density means: The number of lines in the selected frequency range is higher than actually shown is the display due to the limited horizontal pixel number of the display (approx. 440). Whether you watch the range from 0 to 2000 Hz or from 1000 to 1010 Hz, all visible lines are covered by actually calculated FFT lines. Averaging is not applied and overlapping is automatically calculated in a way so that as many FFTs per second are calculated as needed to guarantee the selected refresh rate.

The extended settings on the contrary allow the more experienced user more leeway for further optimizations. For him/her, an additional panel is available, which will only appear if the extended settings for FFT are selected.

Control panel: FFT



This panel offers extended settings for the calculation of the FFT.

When configuring the parameters manually, the user proceeds as follows: Firstly one selects the length of the time period to be analyzed. It can be selected in Time window for 1 FFT. Since an FFT does not allow any time values but only discrete numbers, the time period is not expressed by an exact value, but by a minimum value.

In general, the time signal can be analyzed for the complete frequency range given by the M302 or M312 device (currently 2000 Hz). For some applications, for instance in the civil construction sector or human vibration analysis, only a part of this frequency range is of interest. If the user limits the Max. frequency to analyze, the memory load is minimized. The free capacities are available for the following settings then.

The Windowing function optimizes the time signal before analyzing in order to avoid certain negative effects. Unfortunately, there is no window function which could be considered the best solution for all application. In general, the following characteristics can be mentioned:

- Rectangle: Suitable for the analysis of single impulses, especially if the impulse is at the beginning of the time period.
- Hann: Suitable for the analysis of continuous events which require a high frequency resolution with as little leak effect as possible.
- Flattop: Suitable for the analysis of continuous events with optimized magnitude.

For the frequency analysis, the time signal is divided in successive sections. With Overlapping, the user defines how much these time sections overlap each other. For instance, an overlapping of 10% means that a time section contains 10% time data from the previous section.

The individually calculated FFTs can be combined in a few different ways. The amplitudes of the frequency lines can be calculated from several FFTs using certain functions. The possible functions are the following:

Moving average

The magnitudes of each frequency are arithmetically averaged over. A moving average is calculated, i.e. the average values of the last n FFTs are displayed at any time. n is the selected number of FFTs. If this number of FFTs does not exist in the beginning, the average value is calculated with the existing FFTs.

Moving peak hold

The largest magnitude for each frequency is determined. A moving peak value is calculated, i.e. the peak values of the last n FFTs are displayed at any time. n is the selected number of FFTs. If this number of FFTs does not exist in the beginning, the average value is calculated with the existing FFTs.

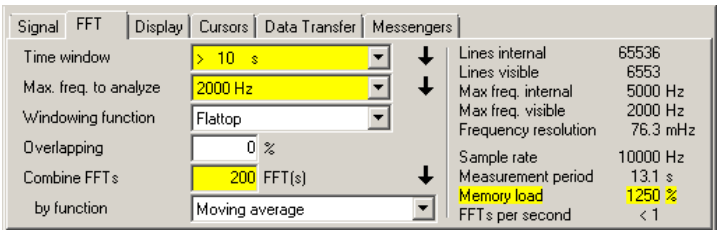
Interval average

The average of the magnitudes extends to all FFTs since switch-on.

Interval peak hold

The amplitude peak values are determined from all FFTs since switch-on.

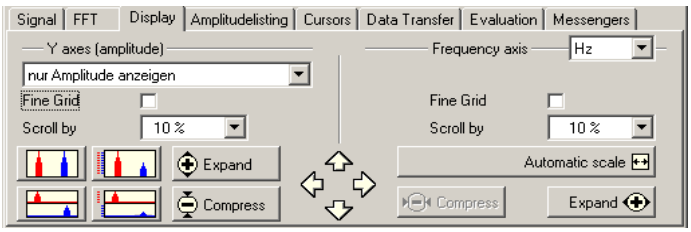
The user is given a clear overview about the results of his/her settings. He/She learns with how many lines the FFT is working, how many FFTs are calculated per second etc. An important parameter here is the Memory load. A capacity of over 1 million FFT lines is available. The user can decide on his/her own whether to use the 1 million lines for an FFT with very high resolution and less averaging or vice versa. The capacity of 1 million lines is in fact enough for most applications. For instance, FFTs can be carried out with 4096 lines and 256 times of averaging or with 65536 lines and only 16 times of averaging.



Thus the user can proceed freely as long as not exceeding the limit of 1 million FFT lines. If that happens, the exceeded parameter is highlighted. The user also receives an indication which settings should be adjusted to get back to the “valid” range. As long as the values are not acceptable, no FFT is carried out.

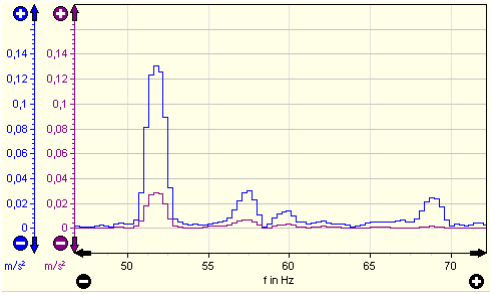
Control panel: Display

This panel is divided in two sections. The left is for the Y-axis, the right for the frequency axis. General operation is described at page 26.

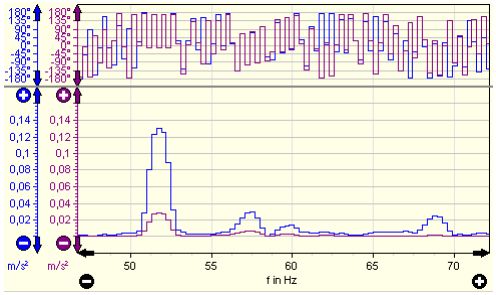


For the Y axes the size of the phase diagram can be adjusted as shown below.

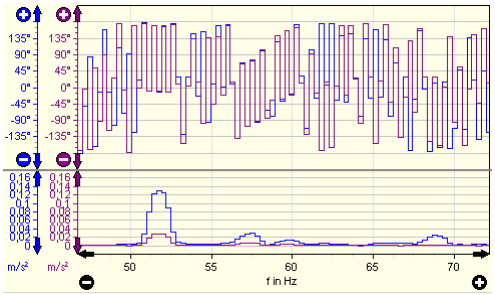
Only amplitude



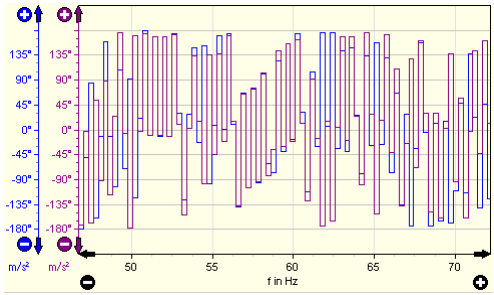
Mainly amplitude



Mainly phase



Only phase



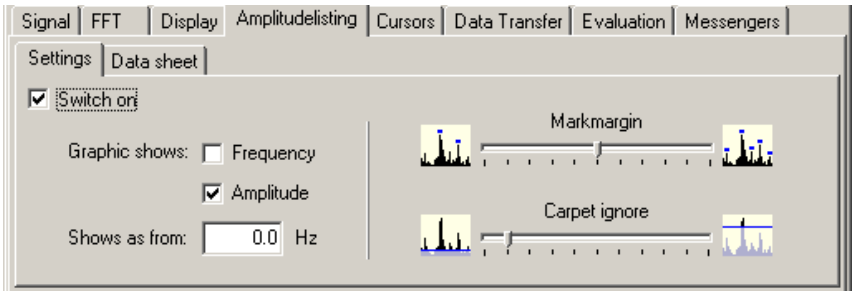
Button Automatic scale sets frequency axis to a range, that all frequencies with magnitudes >5% of maximum magnitude are visible.

Control panel: Amplitude listing

VM-FFT+ features an automatic detection of amplitudes. Amplitudes and their corresponding frequencies are sorted in a list. They can also be displayed in the diagram. The control panel is divided into a Settings panel and a Data sheet listing the results.

Amplitude listing – Settings

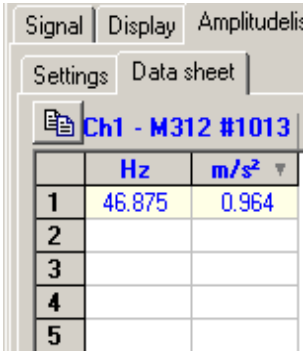
Here you may Switch on the listing function. You may select whether the detected magnitudes and frequencies shall be displayed in the FFT diagram.



To suppress non-relevant amplitudes at low frequencies you may enter a frequency limit at Show as from:.

Two sliders control the threshold of detection (Mark margin) and the suppression of noise (Carpet ignore).

Amplitude listing – Data sheet



Here you find the detected amplitudes. Extended FFT mode allows watching only a portion of the spectrum. The magnitude list, however, will also show the hidden frequencies. This is indicated by different background colors in the table:

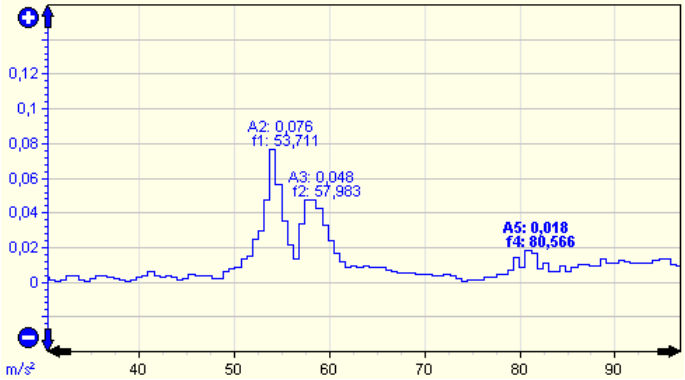
- Values in the visible range have the background color of the diagram
- Hidden values have a white background.

The amplitudes can be sorted by a left click on the header of the desired column.

Other mouse functions in the table are:

- Left mouse click: Sets cursor 1 at the selected amplitude
- Right mouse click: Sets cursor 2 at the selected amplitude
- Middle mouse click: Centers the displayed range around the selected amplitude

Amplitude listing – Diagram



The found magnitudes will be displayed in the FFT diagram if this function was enabled by Graphics shows.

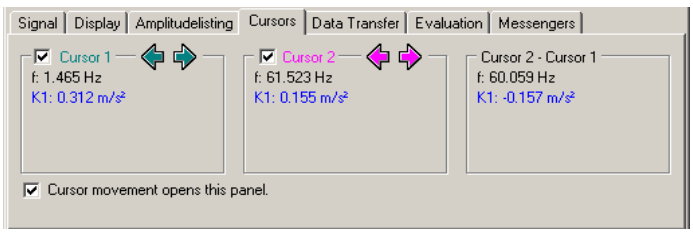
The displayed values are dimensionless. They are scaled according to the currently selected unit.

Amplitudes are marked with A and frequencies with f. The index marks the sorting order. 1 stands for the highest amplitude and the lowest frequency.

Example
A2 and f1 mean: This is the second largest amplitude at the lowest of all frequencies among the values found. Consequently, all other values can be found on the right hand side of the frequency axis.

Bold values indicate several amplitudes which are too closed to each other. The highest value is displayed. You may use the zoom function to examine the other values.

Control panel: Cursors



Two colored cursors are available for displaying of vibration values and frequencies numerically. Operation is described at page 27.

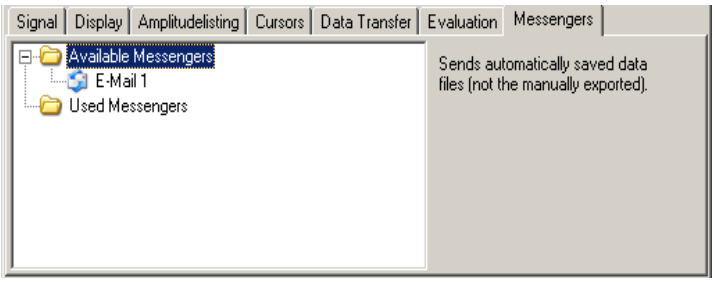
Frequency and amplitude at the cursor position are displayed.

Control panel: Data transfer

Operation is similar to other graphical instruments. Therefore a general description can be found at page 28.

Control panel: Messengers

Event messengers can be used to to send periodically saved spectra by email. The use of messengers is described in section 6.5 on page 31,



VM-SCOPE as external trigger

According to the VibroMetra philosophy, the single instruments are not overburdened with functions another VibroMetra instrument can fulfill better. For the detailed visualization of signals in the time domain, VM-SCOPE is available. It offers its services to VM-FFT as well and can act as a trigger source in order to carry out FFTs only if a trigger event has occurred.

The connection between both instruments is initiated in VM-SCOPE. Further information can be found within the description of VM-SCOPE on page 54.

6.13. VM-TRACK – Measurements at Run-up and Coast-down

VM-TRACK processes the rotation speed (the tacho sensor signal) in addition to the vibration signals. Thus, it provides function for an order analysis. From the composite vibration signal, the amplitude and phase of the component corresponding to the rotation speed is extracted with high precision. The diagrammatic presentation of both quantities allows the detection of resonances in the speed range.

The rotation speed changes, e.g. during run-up from near zero to the nominal speed. Alternatively, the coast-down to standstill can also be used to effect a speed change. The corresponding measurements are then denoted as run-up analysis and coast-down analysis.

For machine diagnostics the vibration velocity is usually used as the predominant measurand. Resonance speeds show up as peaks of the amplitude in the passed through revolution frequency range and are often accompanied by a distinct phase change.

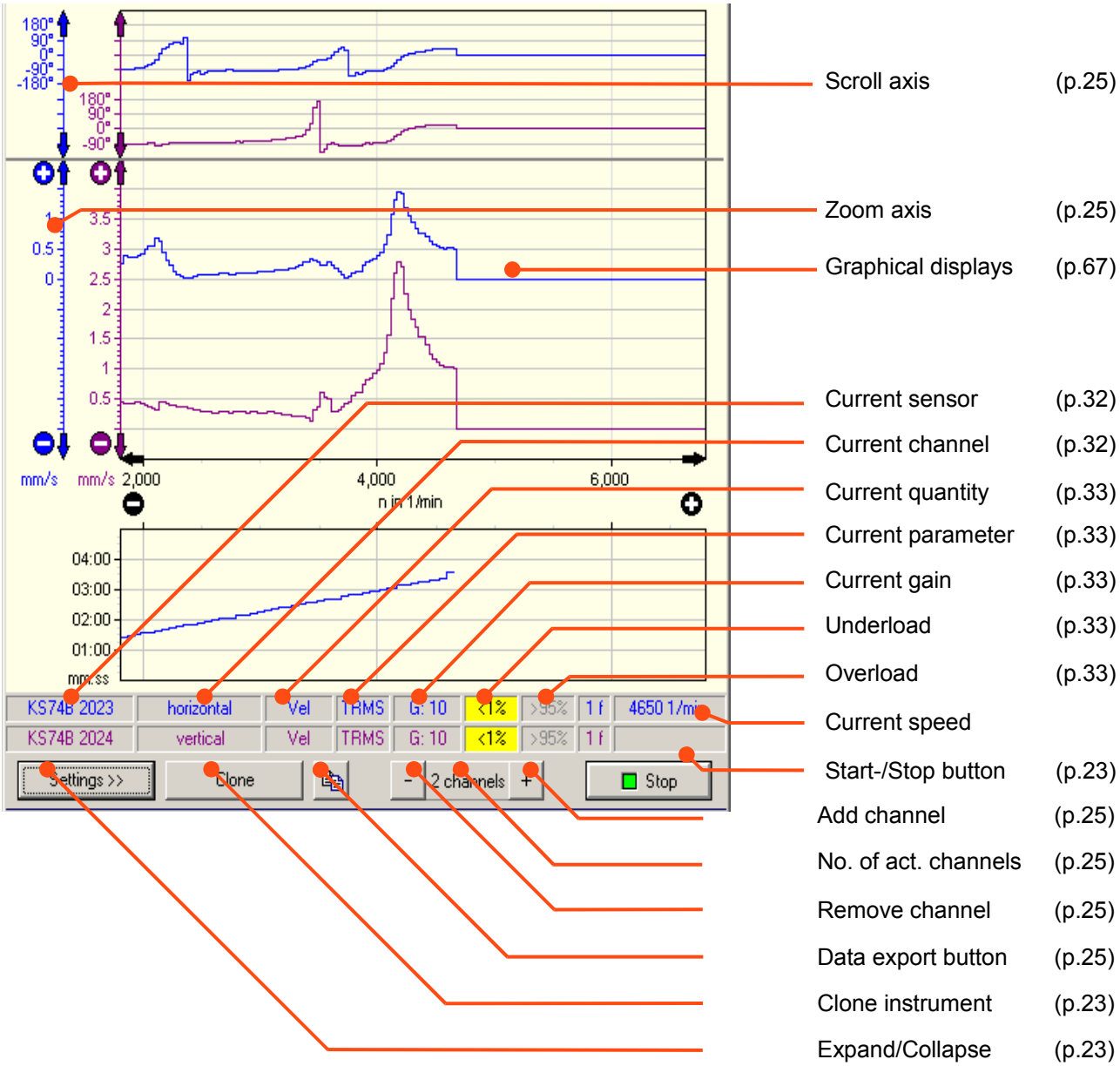
Often, an order analysis tool is based on FFT. VM-TRACK works with another algorithm, which is computationally more efficient and leads to more exact results in a shorter time.

Apart from the vibration component at the revolution frequency, VM-TRACK also displays the components at multiples of the revolution frequency (order analysis). Up to 4 channels can be analyzed simultaneously, either taking their signals from different sensors or from the same sensor, but utilizing different processing parameters.

The signals can be displayed for the following measurands:

- Vibration acceleration [m/s², mm/s², µm/s², nm/s², pm/s², g, mg, dB]
- Vibration velocity [m/s, mm/s, µm/s, nm/s, pm/s, in/s, dB]
- Vibration displacement [m, mm, µm, nm, pm, in, dB]

Displays and controls



Rotary Speed Measurement

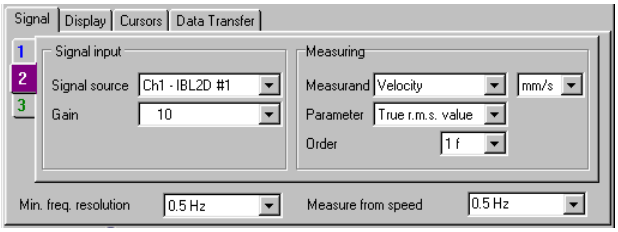
Rotary speed is measured at the digital input of the M302 or M312 which is connected to the first channel of VM-TRACK. Source can be a photoelectric reflex switch VM-PS or another tacho sensor signal.

If there is no rotary speed signal, for example if rotation is stopped, <no data> will be displayed.

In the status line of all channels the order of the displayed signal is indicated: 3f means, for example, 3rd order, i.e. 3 times the rotation frequency.

Control panel: Signal

The basic operation is explained on page 26.

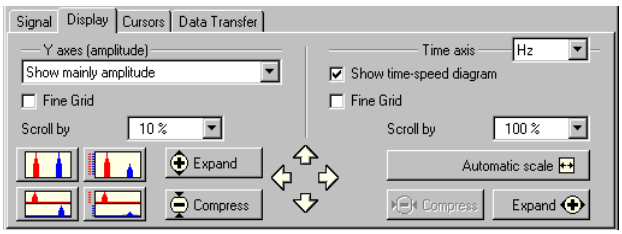


The vibration signal cannot only be analyzed at the rotation frequency, but also at multiples of the rotation frequency (Order). The possible values are ½ of the rotation speed and the integer multiples 1..12.

The values measured at a multiple of the rotation frequency are shown on the frequency axis at the correspondingly multiplied frequency, not at the primary rotation frequency.

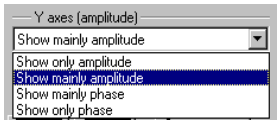
The data acquisition is controlled by the rotation signal. A minimal rotation speed can be specified (Measure from speed) which must be exceeded in order to start data acquisition. The field Minimal frequency resolution sets the width of the data bins. Thus, rotation speeds are treated as the same, if they differ by less than this value.

Control panel: Display

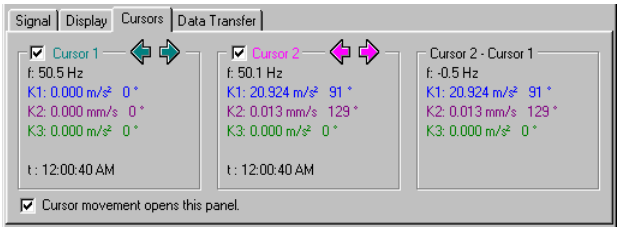


This panel is divided in two sections. The left is for the various Y-axes, the right for the frequency axis. General operation is described at page 26.

On the one hand, the display of the time-dependent rotation speed can be switched on or off. On the other hand, the size of the phase display can be adjusted in relation to the size of the amplitude display. For the ratio between phase and amplitude display the values 0%, 33%, 66% and 100% can be chosen. The control elements for the Y axes act only on the diagram, which currently constitutes the main display (phase or amplitude). The corresponding display is specified in the head line for the Y axes.



Control panel: Cursors



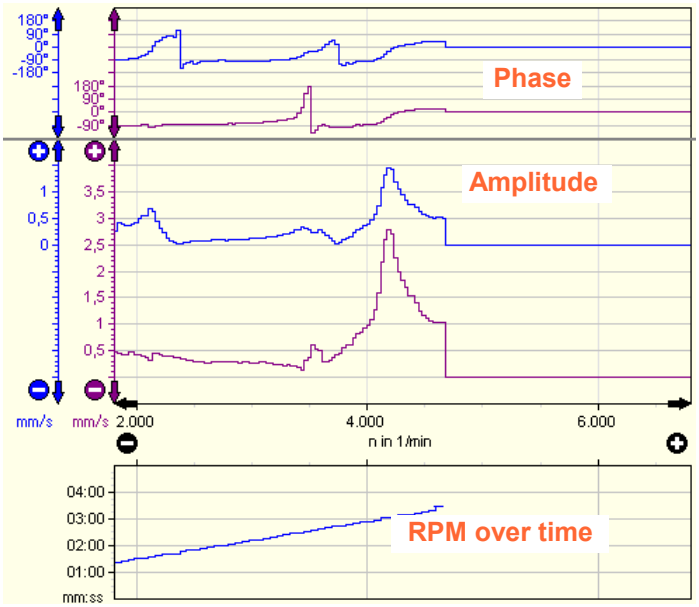
Two colored cursors are available for displaying the measured values and frequencies numerically. General operation is described at page 27.

VM-TRACK provides the phase value at the cursor position in addition to the amplitude. Furthermore, the time is given, at which the rotation speed at the cursor position has first been reached.

Control panel: Data transfer

Operation is similar to other graphical instruments. Therefore a general description can be found at page 28.

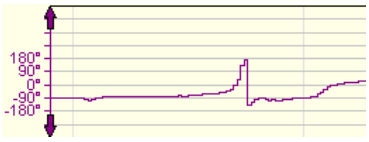
Graphical display



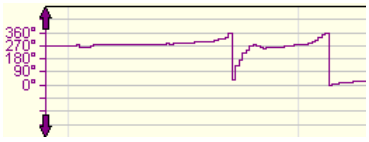
The displayed quantities include the Amplitude and the Phase of the measurand at the corresponding rotation frequencies, as well as a diagram showing the Time-dependent rotation speed. The relative ratio of the sizes of the amplitude and phase display can be changed in the panel Display. Zoom buttons only occur at the axes of the display, which is selected as the main one.

Since phase is defined only up to multiples of 360°, it is not unique and can be shown in different ways. In order to provide a flexible display each phase axis can be switched between three modes:

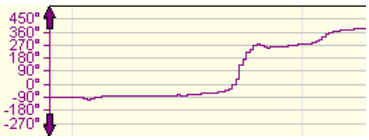
1. All displayed phases fall between -180° and 180°.



2. All displayed phases fall between 0° and 360°.



3. The phase is continued in such a way, that no jumps larger than 180° occur between neighboring display points.



You can switch between these display modes by clicking with the right mouse button on the desired phase axis. The modes are switched through cyclically. In this way, apparent phase jumps, which only result from the representation, can be easily identified.

The Time-dependent rotation speed shows the time evolution of the measured rotary frequency. Time is counted from switch-on of the instrument.

6.14. VM-BAL – Field Balancing

Overview

VM-BAL is a convenient instrument to reduce vibrations. In many cases, rotors can be balanced directly in installed state. So you save the complex dismantling and the transport of the rotor to a balancing machine. Often an acceptable performance can only be achieved by balancing the installed rotor with all parts mounted.

Important conditions for a successful field balancing are:

- The rotor must be able to run with a constant rotation speed with the available drive.
- The rotor must be accessible for attaching calibration weights.
- The rotor must have a defined standing position (e.g. mounted on foundation).

VM-BAL supports Single-Plane-Balancing as well as Two-Plane-Balancing. By giving off-sets, the unbalance can not only be corrected but the rotor can be balanced according to achieve a certain unbalance as well.

VM-BAL guides the user by clear text messages. The auto recognition of stable rotation speed enables VM-BAL to distinguish between the different balancing runs and reduces the operator input to a minimum.

Measurement results and balance information are displayed numerically as well as in a polar chart. A tolerance can be preset for the pass-fail-recognition. Correction instructions are directly displayed at the balancing position in the graphic. Many parameters can be changed after measuring without the need to measure again. The results are simply calculated anew.

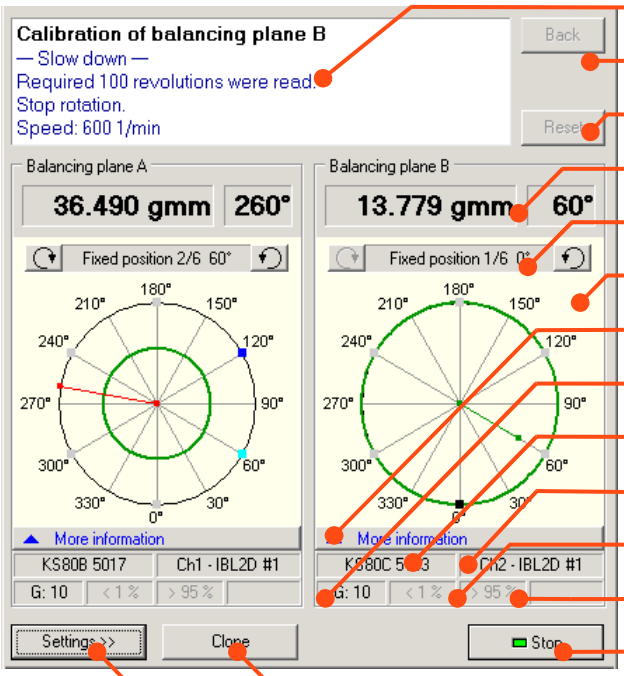
VM-BAL provides up to 7 correction methods. If correction cannot take place at arbitrary angles, fixed positions can be defined. The proposed correctional measures are restricted to the given angle positions, in this case.

With the push of a button a report is printed. A report template is built-in, further templates can be designed by the user.

Rotor configurations can be saved and used again for measurements with other rotors of the same type.

More background information concerning balancing can be found in our Application Note **AN31e**.

Displays and controls



User guidance	(p.69)
1 run back	(p.69)
Reset of balancing procedure	(p.70)
Amount and angle of unbalance	(p.70)
Position display	(p.70)
Polar chart	(p.70)
Detailed information / error messages	(p.70)
Current gain	(p.33)
Current sensor	(p.32)
Current channel	(p.32)
Underload	(p.33)
Overload	(p.33)
Start-/Stop button	(p.23)
Clone instrument	(p.23)
Expand/collapse control panel	(p.23)

A measuring run

Balancing procedure consists of several runs. Every run proceeds as follows. After clicking button Start automatic speed recognition is started. VM-BAL waits now for signals of photoelectric reflex switch and recognizes if a stable speed is reached. Parameters for speed recognition are configurable (page 72). Measurement of a vibration vector takes place at constant speed. After measurement VM-BAL's user guide signals, that rotation may be stopped. Finish of a run is automatically recognized at standstill. A finish can be marked by user as well through clicking the Stop button.

If something went wrong during the finished run, button Back can be used to switch back and repeat the run. If all runs shall be rejected, button Reset initiates a new balancing procedure.

User guidance

VM-BAL guides the user through the entire balancing process. Each balancing run is displayed together with clear instructions about the necessary steps to be done. During the measurement, VM-BAL indicates rotation speed, rotation speed stability and measurement progress.

Switch one run back

By clicking button Back the balancing procedure can be switched one run back. A reason to use this button could be for example a forgotten calibration weight. Thus only one run can be repeated without resetting the entire balancing procedure.

Reset

Button Reset resets VM-BAL. All measurement results are deleted. Now a new object can be balanced.

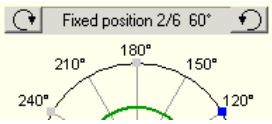
Amount and angle of an unbalance

When all runs necessary for unbalance calculation are finished this field indicates amount and angle of the unbalance. The time before as well as during a measurement, amount and angle of the vibration vector are indicated here.

☞ Angles given in VM-BAL are always measured against the rotary direction of the rotor.

Position display

A decisive parameter for balancing is the angle position of unbalance and correction. In some cases several positions are of interest at the same time. If so, the position can be selected in the position display above the polar chart.

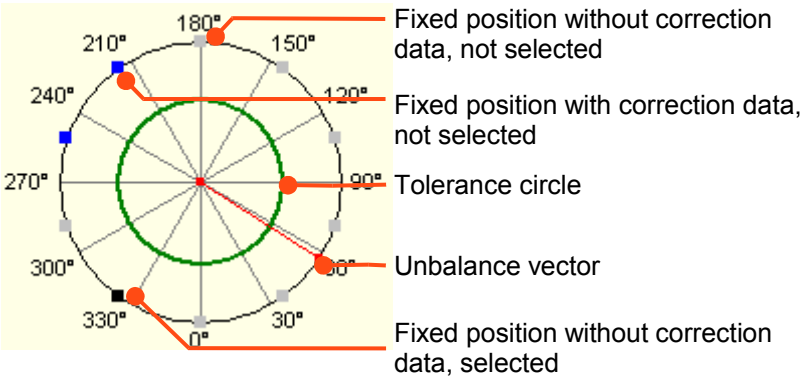


Use the buttons and to navigate through the different positions. Information concerning the selected position is displayed between the two buttons.

Polar chart

As a graphic display of unbalances, correction and fixed positions, a polar chart is one element of VM-BAL.

Different marks and colors ease the orientation. The scale on the measured unbalance indicates the difference between tolerated and measured unbalance.



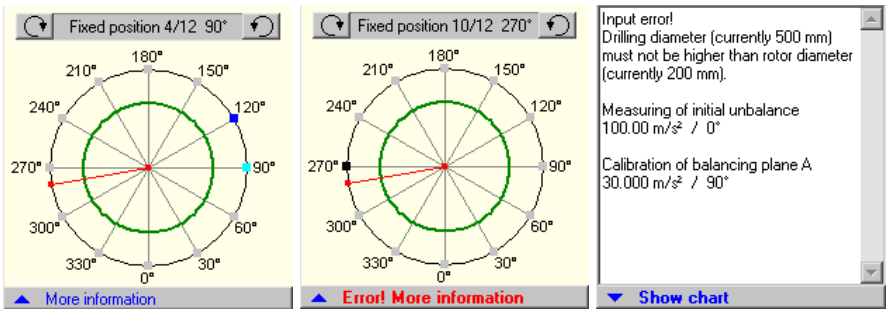
Display more information

Additional information such as the measured vectors or detailed instructions for correction are displayed in a separate window. If such information is available, a button below the polar chart is activated. If additional information is available, button has the caption More Information. If errors occurred the button shows Error! More Info.

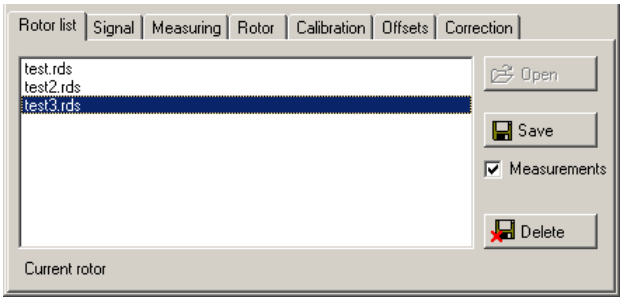
Errors occur if

- the calculation of correction methods failed due to implausible input values
- or in spite of correction methods no sufficient balancing result could be achieved.

A click on the on the button opens the information window as a layer above the polar chart. The button changes its name into Show chart and can minimize that window again.



Control panel: Rotor list



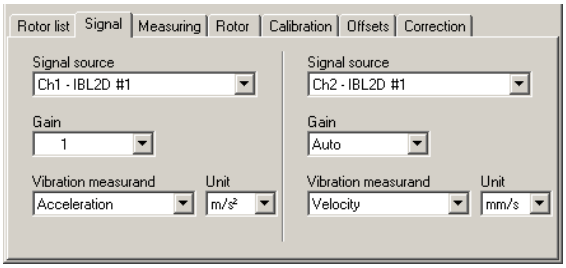
Rotor list is available for VM-BAL+ only. A rotor data set contains all information needed for balancing of a special rotor. This information can be saved and reloaded again later. A rotor data set saves time especially for repeated balance tasks. Additionally measured values can be saved in a rotor data set providing following advantages:

- If a balance procedure lasts several days for instance due to a very heavy rotor with slow run-up, temporary values can be saved and the balance process can be continued on the next day.
- If one has many rotors of the same type and attach them on a defined platform, it is possible to reuse calibration data. Then balancing can be performed with one run only.
- If it is impossible to print a report at the place of balancing, data can be saved, reloaded later in the office and the report can be printed here.

☞ Reuse of measurement values is only valid, if the following runs take place under the same circumstances (standing position, speed etc.).

☞ Reload of rotor data is only possible, if VM-BAL is switched off.

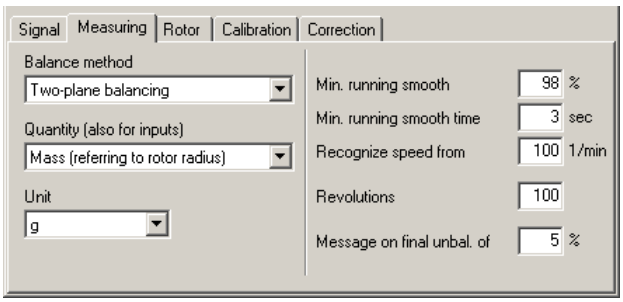
Control panel: Signal



The selection of the signal source differs from other VibroMetra instruments. The channels are not freely selectable. Depending on the selected measuring channel the other channel of the M302 or M312 is automatically chosen as the complementary channel. Channels from different M302 or M312 devices cannot be mixed.

- Signal source — Selection of measuring channel
- Gain — Gain selection for the respective channel
- Vibration measured — Selection of the temporary measured vibration quantity
- Unit — Unit of this quantity

Control panel: Measuring



The adjustments made here will influence the balancing course. Balance method defines whether static or dynamic balancing is used. Measurement of static unbalance takes place in one plane only. In this mode the settings and display functions for the second plane will be invisible. Measuring of dynamic unbalance requires 2 planes. The control elements and displays of both planes are accessible.

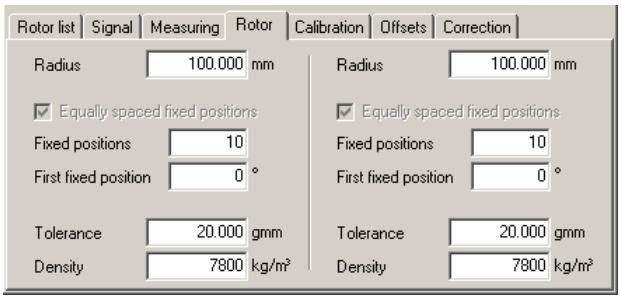
Quantity and Unit are selectable for inputs and results. An unbalance is described either as the product of mass and radius (gmm or gm) or as a mass referring to the balancing radius (g or kg). Changing measurand and/or unit will not change the values of the input fields. But the results are recalculated.

For unbalance measurement a constant rotation speed is important. Only when the Min. running smooth was reached and kept for a certain Min. running smooth time after a run-up, measuring starts.

The number of Revolutions determines the measurement accuracy. A value which is too high will make the measurement slower than necessary. A value that is too low is harmful to the accuracy.

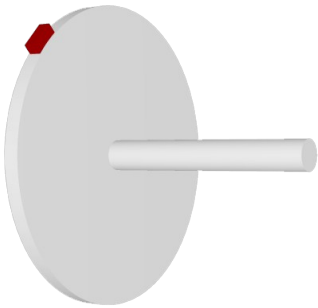
Message on final unbal. of [%]: Some balancing methods do not come up to complete correction. This applies for instance to balancing where a limited number of positions (fixed positions) is available and only a limited set of counterweight is used. In this case not all corrections can be calculated exactly and a final unbalance remains. The final unbalance can be ignored if it is sufficiently low. The user can specify from which final unbalance on an message is required. Below the stated percentage of the measured unbalance no error message will be displayed.

Control panel: Rotor



This menu defines the rotor properties. All settings can be changed after the balancing process. The new settings will then be used for the automatic recalculation of correction measures.

The radius determines the balancing radius, which is the distance between the center line of the shaft and the circumference where the correction mass is attached.



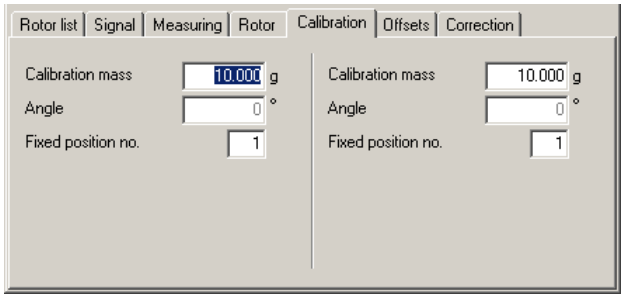
If not every angle location at the rotor circumference can be used for correction , for instance in the case of fan blades, fixed positions should be defined. The number of fixed positions are distributed in regular angles around the rotor. Additionally an offset angle for the first fixed position can be defined if the first position is not located at zero angle.

- Fixed positions — means the number of fixed positions. At least 3 fixed positions are required to activate calculations for fixed positions.
- First fixed position — is the angle between the first fixed position and the zero degree position.

Tolerance is used for the pass-/fail-recognition. It also adapts the radius of the tolerance circle in the polar chart.

Density is only necessary for tooling correction, for instance drilling and milling.

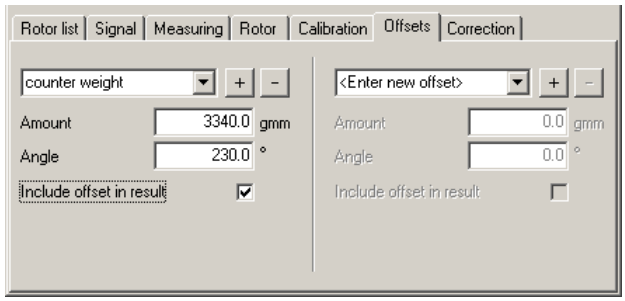
Control panel: Calibration



Calibration runs are necessary to establish a relation between the measured vibration signal and the unbalance. Thus VM-BAL needs to know where and how much calibration mass was attached to the rotor surface. The radial distance between the correction mass and the center line of the rotor must correspond to the radius adjustment made in the rotor settings (page 72).

- Calibration mass — Mass of calibration weight
- Angle — Position of the calibration mass. It is recommended using 0° as the calibration angle, then all angles are based on the position of the calibration weight.
- Fixed position no. — If fixed positions are defined they are used to position the calibration mass. The angle will be calculated automatically and can not be entered directly.

Control panel: Offsets



Sometimes the unbalance is not to be compensated to zero but to have a defined value. That is the case when additional components have to be attached to the rotor after the balancing process. They will generate an unbalance which VM-BAL will consider. After the component is attached, the actual unbalance of the rotor will become nearly zero.

Such later added components are treated as offsets by VM-BAL. Any number of offsets can be added to a list with individual names. Required parameters are the Amount and Angle of the offsets. By the checkbox Include offset in result the user can choose whether offsets are considered or ignored during the balancing calculation.

Adding a new offset:

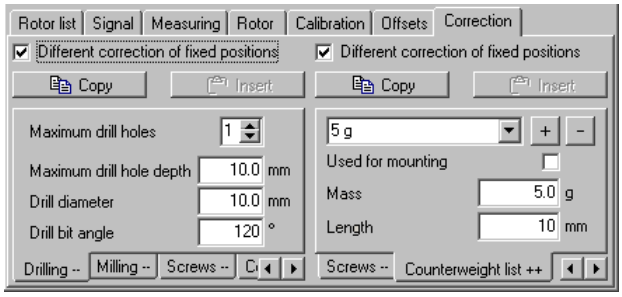
➔ Enter a new name into the offset list and click on the + button.

➔ Enter the Amount and the Angle of the offset and activate the checkbox Include offsets in result.

Deleting an offset:

- ➔ Select the name of the offset to be deleted.
- ➔ Click on the – button.

Control panel: Correction



Up to 7 methods are available for unbalance correction. The settings for these methods can be selected by the tabs at the lower edge of the correction settings window. Each menu provides one or more input fields for the parametrization.

The setting of correction method and the display of balancing results are synchronous. The displayed balancing corrections in the polar chart are always based on the currently selected method.

When fixed positions are used you can select whether all fixed positions are to be treated by the same method or separately (only in the Pro version). In the second case the input work can be reduced by transferring data from one menu to another using the Copy/Insert function.

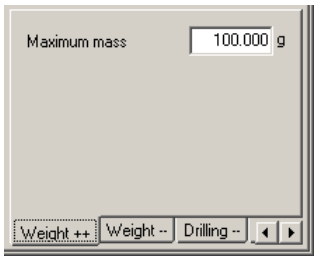
If Different correction of fixed positions is selected, each position is saved with its own method and all belonging parameters. Selecting another fixed position in the position display (page 70) changes the correction method including all parameters as well.

The different corrections allow to mix correction methods or individual adjustment of correction parameters for each fixed position. Thus difficult tasks can be solved without auxiliary calculation or long trying.

Usually only new rotors have equal fixed positions. When a rotor has already been balanced before, each balancing process possibly left traces, for instance, in the form of drills. With mixed correction methods it is possible, to allow e.g. for only one drilling in positions already drilled while other positions can be allowed to have three drillings.

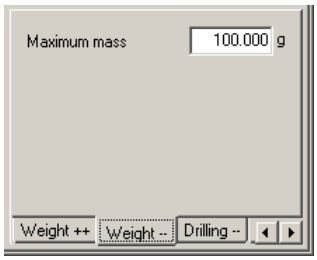
VM-BAL can consider such individual tasks and will find a quick and uncomplicated solution for you.

Control panel: Correction method 1: Adding counterweights



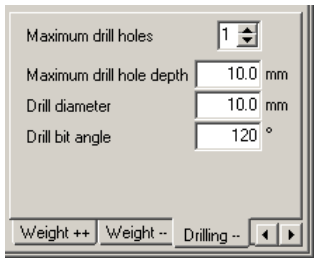
A correction can be achieved by attaching a counterweight opposite to the unbalance position. This is a very common method. You can specify the maximum mass. If the calculated counterweight should exceed this limit, a message will inform you about the remaining unbalance (page 70).

Control panel: Correction method 2: Removing mass



Removing mass at the position of the unbalance is another correction mode. You can specify the maximum mass. If the calculated counterweight should exceed this limit, a message will inform you about the remaining unbalance (page 70).

Control panel: Correction method 3: Drilling



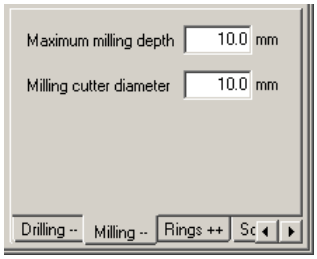
Drilling belongs to the removing correction methods. It is carried out at the unbalance position. For each position the Maximum drill holes can be chosen. If one drilling is not sufficient, up to three drill holes are allowed in the longitudinal axis. VM-BAL optimizes the calculation to a minimum number of drill holes. For example if 3 drill holes are allowed, but only one is necessary for correction, VM-BAL will recommend only one.

Further characterizing parameters of a drilling are the Maximum drill hole depth, the Drill diameter and the Drill bit angle. Based on these parameters VM-BAL calculates the required drill depth and the angle position of the drilling.

The density of the rotor material defined in the rotor settings (page 72) also influences the drilling calculation.

If the calculated drill holes should not yield full compensation, a message will inform you about the remaining unbalance (page 70).

Control panel: Correction method 4: Milling



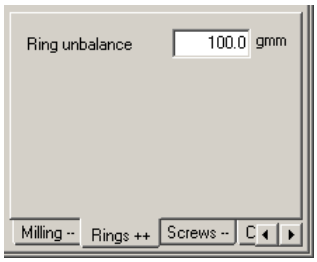
Milling is another removing correction method. Therefore it is also carried out at the position of unbalance.

Characterizing parameters of a milling are the Maximum milling depth and the Milling cutter diameter. Based on these parameters VM-BAL calculates the required milling depth and the angle position of the milling.

The density of the rotor material defined in the rotor settings (page 72) also influences the milling calculation.

If the calculated milling does not yield full compensation, a message will inform you about the remaining unbalance (page 70).

Control panel: Correction method 5: Balancing rings or sliding blocks



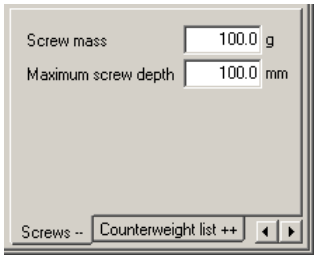
Balancing rings or sliding blocks are weights with a specific unbalance and are attached to the rotor in pairs. Before measuring the initial unbalance, they are brought into a neutral position by placing them with their unbalance 180° opposite to each other. After having calculated the unbalance, VM-BAL indicates the necessary position for the rings. This balancing

method is especially convenient for weights with freely adjustable angle position because there is one fix parameter - the unbalance of the rings.

Although rings or sliding blocks are not used for balancing at fixed positions in practice until now, VM-BAL can calculate the corresponding angles. It is assumed that the rings can be positioned with their unbalance mass in particular angles – fixed positions – only. It is possible, however, that full unbalance compensation cannot be achieved in this way. The more fixed positions, the better the balancing result.

The maximum effect is obtained if both rings are positioned with their with their unbalance mass opposite to the unbalance position. If even this arrangement does not yield full compensation, a message will inform you about the remaining unbalance (page 70).

Control panel: Correction method 6: Set screws (VM-BAL+ and VM-BAL++ only)

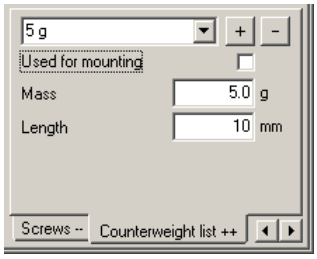


In principle, set screws are weights which can be adjusted in the direction of the rotor radius. They are usually related to fixed positions.

Before balancing the screws are set in a neutral position, i.e. all screws have the same radial distance. This should be a position on the outer radius of the rotor since based on Screw mass and Maximum adjustable screw depth, VM-BAL+ calculates the necessary screw depths towards the center. Thereby, the unbalance is reduced or compensated.

The maximum effect is obtained if all screws within the angle ±90° from the unbalance position are screwed in completely. If even this arrangement should not yield full compensation, a message will inform you about the remaining unbalance (page 70).

Control panel: Correction method 6: Counterweight list (VM-BAL++ only)



The counterweight list is an upgrading of the correction by counterweight. Often it is not possible to have every size of counterweights available. That is why it is more efficient to have a set of graduated prefabricated counterweights in store. The task of VM-BAL++ now is to find the best combination of counterweights.

The software also takes into account the part that holds the counterweights (usually a screw). The available length for the attachment of additional masses is also considered: VM-BAL++ only combines counterweights that can be mounted with one screw.

With a limited set of counterweights, an optimal correction result can not always be achieved. The residual unbalance is kept low if the rotor has many fixed positions and the available counterweights are finely graded. A good model is the Euro coin and banknote system with its always recurring gradations 1, 2, 5. For instance counterweights of … 1, 2, 5, 10, 20, 50 … gr. could be prefabricated and defined.

A minimum residual unbalance is not relevant for the correction result and should not be indicated as an error. Therefore a value can be defined from which on an error message is to shown (page 72).

Adding a new counterweight:

➔ Enter a new name into the counterweight list and click on +.

➔ Type in Mass and Length of the counterweight. Activate the Used for mounting checkbox if the counterweight is to be used for mounting. Only one item per list can be selected for mounting.

Deleting a counterweight from the list:

➔ Select the counterweight to be deleted.

➔ Click on button –.

Immediately after these changes a recalculation is carried out. In some cases VM-BAL may suggest an overcompensation if this will provide a lower residual unbalance. Example: The result is 29.5 gr. The lightest counterweight has a mass of 5 gr. There would be 2 possibilities: 25 gr. or 30 gr. VM-BAL++ will decide in favor of 30 gr. because of the lower residual unbalance.

How VM-BAL calculates the correction

After measuring the unbalance VM-BAL immediately calculates the compensation measures. You can choose between 7 methods of correction (page 74). The procedure is as follows:

- VM-BAL checks the acceptability of the selected correction parameters. The maximum drill depth, for instance, must not exceed the rotor radius. When invalid results are detected the user will be informed. Therefore the button for additional information will be activated. (page 70).
- The next steps depend on whether any point on the rotor surface is available for correction or fixed positions are defined. In any case VM-BAL will check if the maximum possible correction will actually eliminate the unbalance. If the unbalance is too high for correction despite the use of the maximum correction methods, the button for additional information will be activated. (page 70).

Free correction positions

Characteristics

- There are less than 3 fixed positions.

VM-BAL will calculate an unbalance correction at a free angle position.

Fixed positions with equal correction

Characteristics

- There are more than 2 fixed positions.
- Different correction of fixed positions is deactivated in the Correction panel. (page 74).

For infinitely variable correction methods (counterweight, drilling, milling, setscrews) VM-BAL optimizes correction so that as few positions as possible are used for correction.

The methods balancing rings and counterweight list do not allow infinitely variable correction. VM-BAL compensates the unbalance as well as possible under the condition that the residual unbalance remains below the defined limit (page 72).

Fixed positions with different correction

Characteristics

- Available in Pro Version only.
- There are more than 2 fixed positions.
- Different correction of fixed positions is activated. (page 74).

When different correction methods are selected for fixed positions each method is applied in a defined order. VM-BAL starts with methods providing quick compensation. Admittedly these are the methods that are not infinitely variable.

1. Balance rings — fast but relatively coarse correction
2. Counterweight list
3. Set screws
4. Drilling
5. Milling
6. Removed mass
7. Counterweight — fine, but relatively drawn-out correction

A correction method is only applied if a fixed position using this method lies within ±90° right and left from the unbalance.

The optimization of the correction methods works as explained above:

- For infinitely variable correction methods VM-BAL optimizes the correction in order to use as few fixed positions as possible.
- For other correction methods VM-BAL optimizes the correction in order to minimize the residual unbalance.

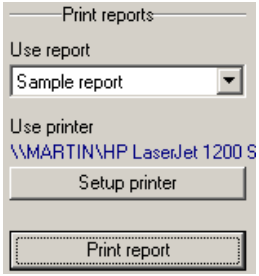
Control panel: Report

Thanks to the report function, you can easily print significant balancing reports in order to document the results of your work. You are free to create a report according to your requirements. Company address, company logo, graphics for the rotor – everything can be integrated in such report. A template for a report is built-in. If a different report is required, simply create a new one as explained on page 30.

Apart from fixed texts, e.g. for headline or service address, and pictures, a report also contains variables which always take on the values currently in effect in VM-BAL.

Printing a report

For printing, just select one of your configured reports from the list, set up the required printer and click on Print report. Your report is printed now.



6.15. VM-BODY – Human Whole-Body Vibration Measurement

Overview

The transmission of large vibrations to humans can negatively affect performance and productivity and may even cause diseases of, e.g., blood vessels, nerves, bones, joints, muscles or connective tissues. Therefore, several regulations demand measurements of vibrational exposure according to EN ISO 2631, which assesses the vibrational impact on human beings. An introduction can be found in our Application Note **AN21e**.

By using VM-BODY, one can easily perform these standards conforming measurements. Additionally, the instrument contains a storage for recent measurement results, it provided for the complete final evaluation and allows for the archiving of the results. The integrated guidance system helps users to fully benefit from the wealth of functions and to reliably carry out the measurements, without requiring detailed knowledge of the standard.

VM-BODY supports measurements according to

- EN ISO 2631-1:1997 (whole-body vibration)
- EN ISO 2631-2:2003 (vibration in buildings)
- EN ISO 2631-4:2001 (vibration in fixed guideway transport systems)

Excluded are measurements to assess motion sickness or which incorporate rotational vibrations.

In most cases, the standard demands simultaneous measurements in all three spatial axes. VM-BODY therefore has three channels.

The characteristic values displayed per channel are

- the RMS value [m/s²]
- the crest factor
- the maximum transient vibration value (MTVV) [m/s²]

of the frequency weighted vibrational acceleration. The frequency weighting is performed with a high-precision filter, which exactly reproduces the transfer function as demanded by the standard. The weighing filters Wb, Wc, Wd, Wj, Wk, Wm, and also unweighted (only band limited) measurements are available. The appropriate filter is selected automatically through the selection of the measurement mode.

The measured values are clearly sorted and displayed in a data storage sheet. An good / acceptable / bad evaluation will be performed according to the standard. You may add your own comments.

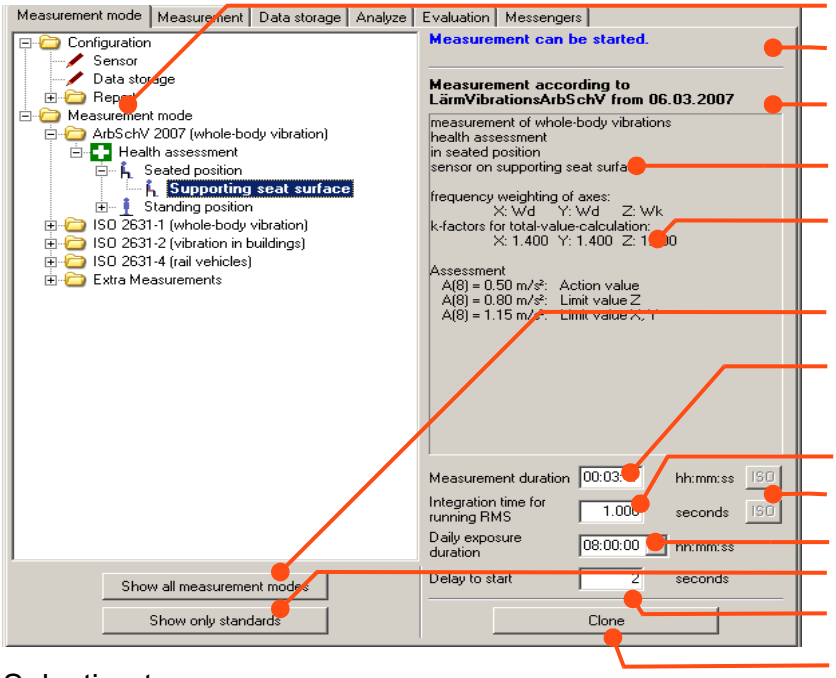
A calculation sheet helps to convert different activity sections into one final dose value. A report can be generated by one mouse click.

In addition, VM-BODY+ features an analysis function which simplifies the search for the source of vibrations.

Preparing the measurement

In the panel Measurement mode the measurement is prepared. This panel allows to

- choose the measurement mode,
- adjust the free parameters of the measurement (e.g., the duration),
- activate the sensor automatic, if required.



Selection tree	(p.80)
User guidance	(p.81)
Chosen standard	(p.83)
Chosen measurement mode	(p.83)
Details of mode	(p.83)
Open choice tree	(p.80)
Set duration	(p.83)
MTVV integration time	(p.83)
Set ISO default value	(p.83)
Exposure duration	(p.83)
Close choice tree	(p.80)
Start delay	(p.83)
Clone instrument	(p.23)

Selection tree

The configuration and measurement modes are arranged in a hierarchical tree-like structure. The hierarchy of the measurement modes contains

- the relevant standard,
  - the assessment criterion,
    - the body posture and
      - the location of the sensor.

To navigate within this tree, sub-trees can be opened or closed. A + sign at the left side signifies that a node of this tree has sub-nodes. They can opened (the sub-tree becomes visible) by clicking on this + sign or by a double click on the node itself. The sub-tree can be closed again by clicking on the – sign or a double click on the node.

A click on the button Show all measurement modes opens the entire tree structure. In contrast, clicking on Show only standards closes the tree structure (nearly) entirely.

The deepest nodes of the tree represent the standardized measurement modes. The corresponding measurement mode is chosen by mouse click. Measurement can only be started if a measurement mode has been selected. A parenthesized number on the right hand side of the node gives the number of such measurements, which are currently in the data storage.

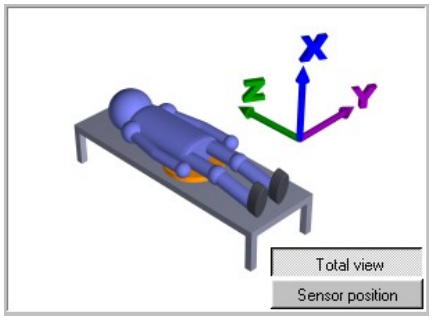
User guidance

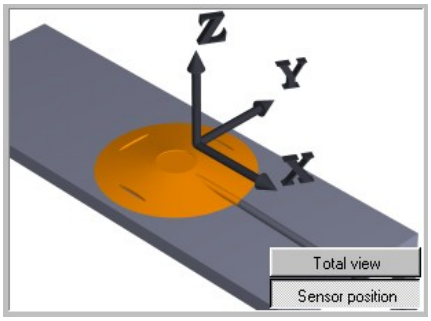
A textual user guidance system provides support by pointing out possible actions. Guiding texts are always displayed in blue lettering.

Sensor configuration

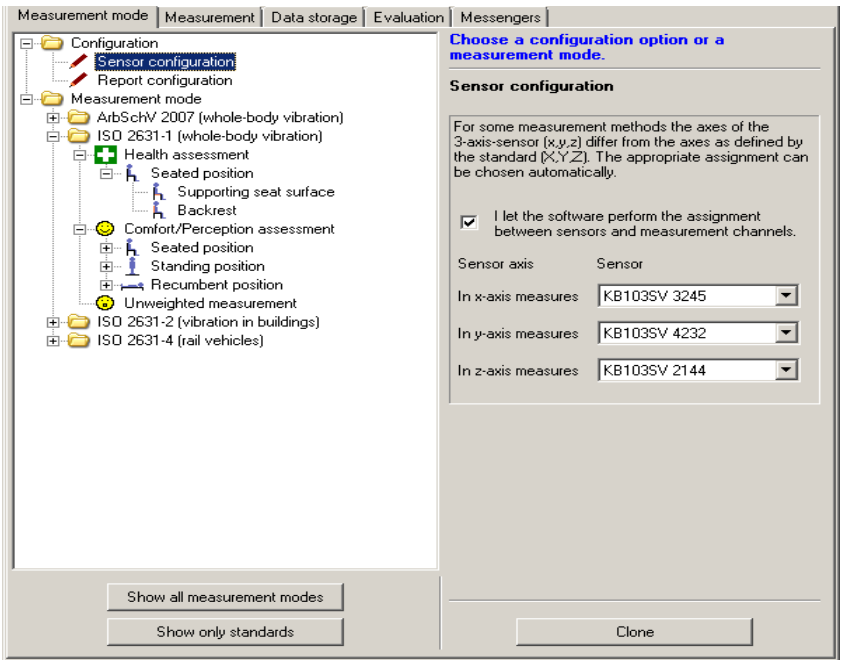
The Sensor automatic of VM-BODY significantly alleviates the problem of correctly assigning the axes as required by the standard. The problem is due to the fact that there are two different coordinate systems to be considered, the system used in the standard, which is related to the human body and another system, which is given by the fixed sensor axes of a triaxial sensor. In certain situations, these coordinate systems do not coincide, which is a serious cause for errors. The Sensor automatic safeguards against these errors. See for yourself:

The next two pictures demonstrate the operation of this automatic in the example of a recumbent body posture.



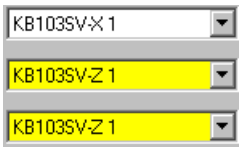


The view Total view (left picture) shows the spatial orientation of the measuring axes as given by the standard. These axes are related to the human body (e.g. the Z-axis is oriented in the direction to the head). The orange circle beneath the lying person indicates the location of the sensor as related to the body for the corresponding measurement (here: sensor under the pelvis). On the other hand, the view Sensor position shows the axes of a triaxial sensor in a seat accelerometer, where the direction of the Z-axis is usually perpendicular to the plane of the pad. Therefore, the Z-axis of the sensor is directed along the X-axis according to the standard. Significant measurement errors result, if this difference is not observed. The Sensor automatic of VM-BODY prevents these kinds of errors, since the instrument adjusts to these cases and automatically assigns the axes correctly. Just activate the Sensor automatic and position the sensor in accord with the diagram in the



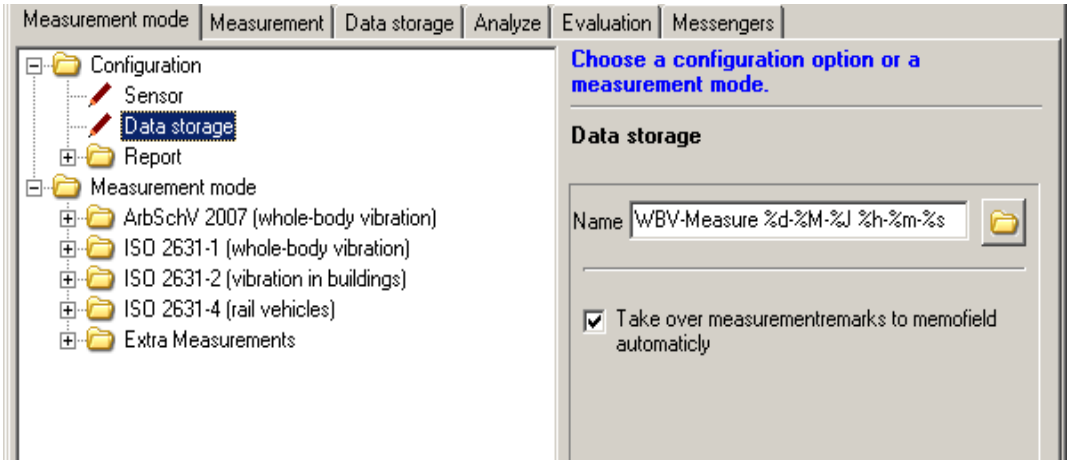
software – then you elegantly avoid this obstacle, where users with other measurement equipment often fail.

If the Sensor Automatic in VM-BODY is inactive, the assignment of the axes is effected as in the other instruments of the VibroMetra series. For each axis a measurement channel is chosen as signal source in the Measurement panel. This choice is not possible if the Sensor automatic is active, since the assignment is done automatically by VM-BODY, as already explained.



If the same sensor is assigned to several axes, the corresponding fields are shown with a yellow background, in order to warn of this error.

Data storage configuration



Measuring data is automatically saved to hard disk after each measurement. You may enter the path and the name of the files. The file name may include variables (see page 28).

An index is attached if the entered file name already exists.

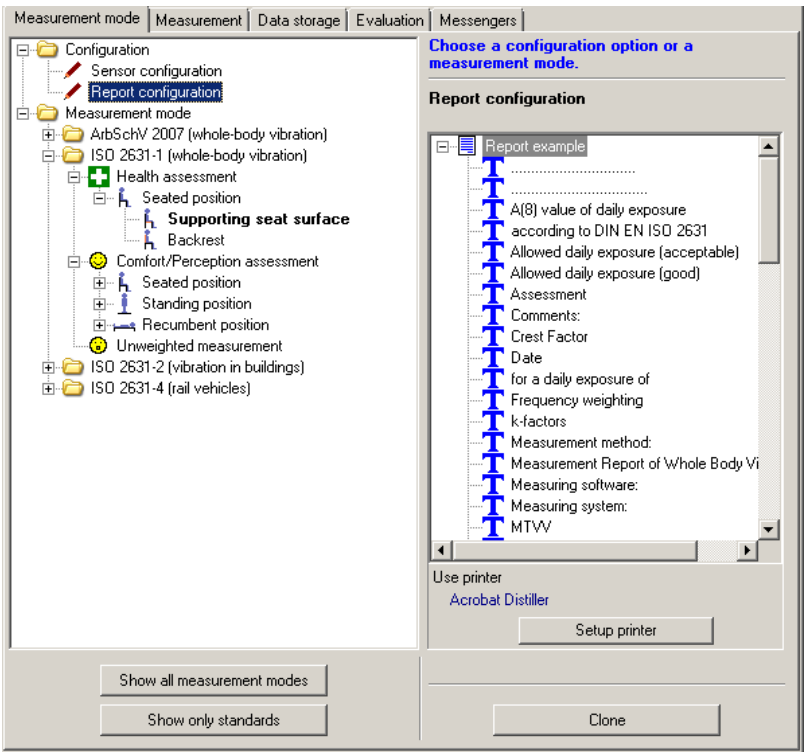
VM-BODY monitors the measurement with auxiliary parameters according to ISO 2631. Potential problems are indicated for each measurement. The option Take over measurement remarks... copies these warnings to the memo field in order to print them in the report.

Report configuration

Thanks to the report function, you can easily print measurement reports in order to document the results of your work. You are free to create a report according to your requirements. Company address, company logo and other information can be added to the report. The generation and adaptation of a report template is described on page 78. The report templates are saved together with a workspace.

Here you may also select the printer for the report. At start-up, the standard printer is chosen by default.

The actual printing of a report is initiated in the panels Data storage and Evaluation.



A report is comprised of fixed text elements (e.g. a heading, service address, etc.), graphic elements (e.g. company logo) and variables, which are adjusted to the values of the current measurement.

Measurement mode selection

The measurements according to EN ISO 2631-1:1997 (whole-body vibration) allow the assessment with respect to health, comfort or perception for sitting, standing and recumbent body posture. The possible locations of the sensor are given by the standard. The weighting filters Wc, Wd, Wj und Wk, as well as the appropriate k-factors are automatically adjusted. An unweighted measurement (only band-limited) is possible, too. The standard considers this as an additional measurement in case of perception assessment. This unweighted measurement is also required for calibration purposes.

The standard EN ISO 2631-2:2003 (vibration in buildings) only considers measurements with undefined body posture, which are to be performed on the floor with weighting filter Wm in all three directions. In the case of a given body postures, it is recommended, that the measurements are performed according to EN ISO 2631-1:1997.

Measurements according to EN ISO 2631-4:2001 (vibration in fixed guideway transport systems) correspond to those of EN ISO 2631-1:1997, with the single difference, that the weighing filter Wk is to be replaced by Wb.

Adjust parameters

Some parameters are not strictly fixed by the standard, as the case may be. They can be adjusted to the current requirements.

Measurement duration

The most important of these parameters is the scheduled Measurement duration. EN ISO 2631-1:1997 specifies, that a measurement should not be shorter than a certain min-

imal duration, in order to achieve a given accuracy. The recommended minimal duration depends on the relevant frequency range, and thus depends on the measurement mode. Clicking on the button ISO sets this recommended minimal duration (mostly 227 seconds). A larger duration may be necessary in order to obtain a representative assessment of the vibrational exposure. Therefore, the measurement duration can be adjusted freely in steps of one second.

Daily exposure duration

Assessing the health impact of vibrations requires the knowledge of the daily duration of the vibrational exposition (with the measured values). This durations must be entered in the field Daily exposure duration.

Integration time for running RMS

A further parameter is the Integration time for running RMS, which is used in the determination of the MTVV. Usual values are 1 or 1/8 seconds. The standard does not fix this value, but it requires, that the value used be recorded in the measurement protocol, if MTVV is measured and recorded. The associated button ISO sets the recommended time constant (1/8 s for vibration in buildings, 1 s otherwise).

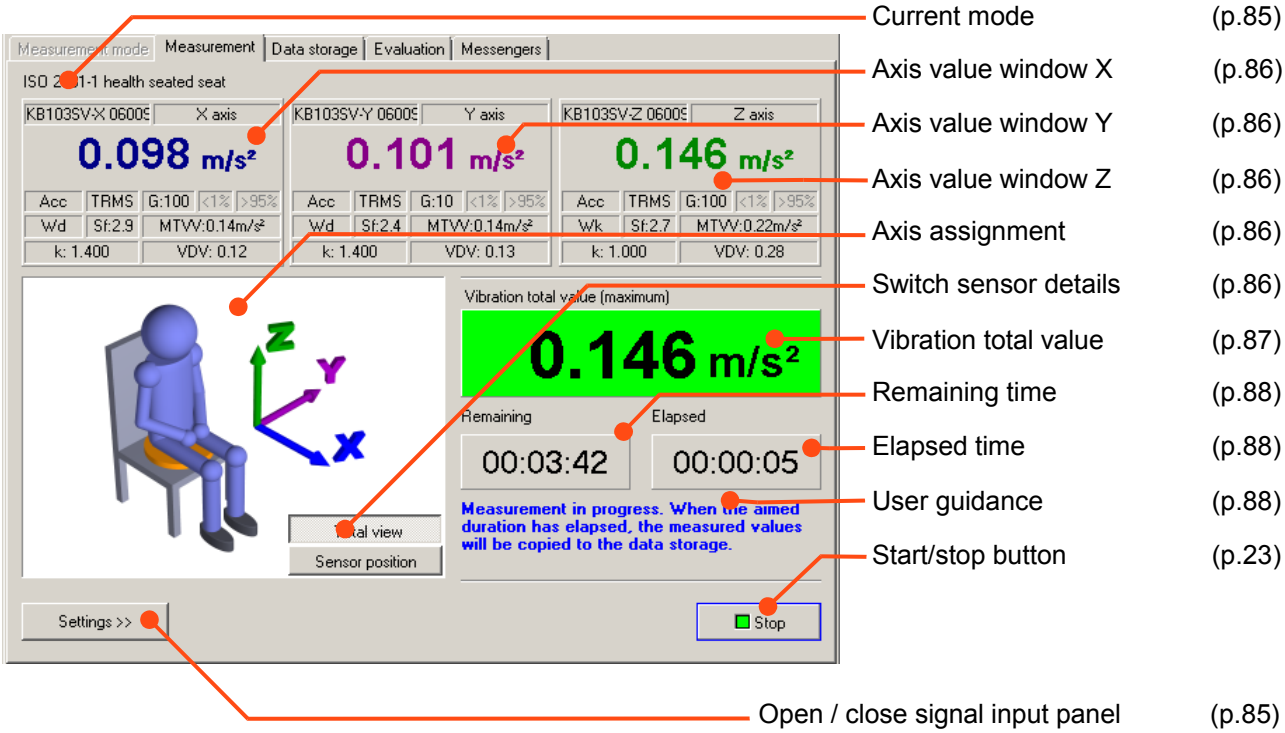
Delay to start

The start of measurement can be delayed by the entered time. This may be useful to exclude preparation time from the actual measurement.

Performing the measurement

The panel Measurement serves for conducting the measurement properly. Basically, a measurement consists of the following steps

- assignment of the measuring channels/sensors,
- placing the sensors,
- conducting the measurement for the preset duration,
- storing the measurement results and their assessment.

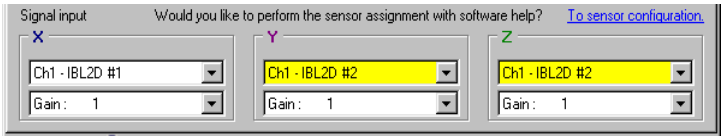


Display of the current measurement mode

For the sake of clarity and to avoid erroneous operation the currently chosen measurement mode is displayed in short form as a header line. The standards conforming weighting factors (k-factors) of the different axes are also shown there. These factors are already accounted for in the display of the measurement values. In this way the relative contribution of the different axes to the total value is readily observable. A dominant axis can easily be recognized.

Signal input

The button Settings >> opens the panel for the signal settings.



Here, the spatial axes can be configured for the measurement. For easy overview, each axis is uniquely distinguished by a color. The same colors are also used in the axis value display and the pictorial display of the axes' orientation. The measuring channel for each axis can be chosen from a list which contains all channels available for VM-BODY. The channel assignment is inactive if the sensor automatic is in use.

In order to avoid the accidental selection of two equal channels, a yellow warning is given in this case.

The gain settings allows to select the appropriate measuring range (p.24). The overload and underload indicators give helpful information in order to find the correct gain setting (p.33).

As a help for new users, a hint is shown in an un-configured instrument, pointing out the sensor automatic (p.81).

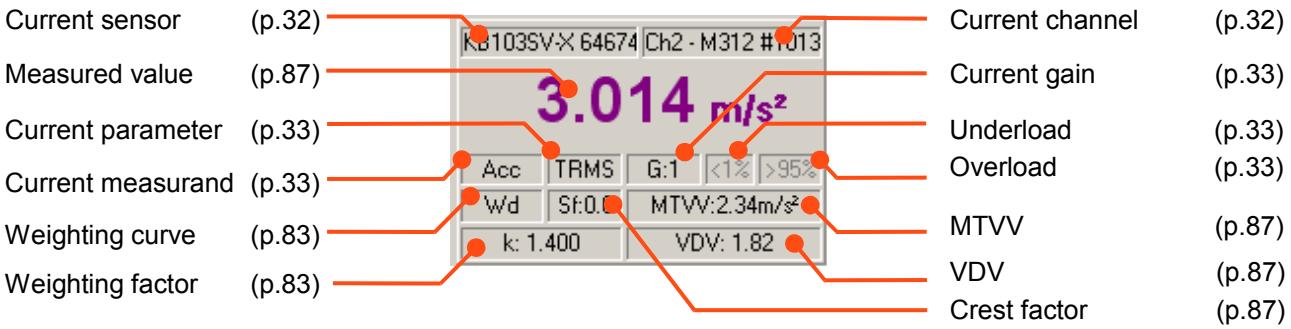
Sensor position

For a standards conforming measurement, the axis assignments must be the same for each measurement. A diagram shows the axis assignments as given by the standard and provides a pictorial help for a correct placement of the sensors.

If the sensor automatic is enabled, which is especially advantageous for the utilization of triaxial sensors, two buttons appear, Total view and Sensor position, which allow to switch between two views.

The view Total view shows the spatial orientation of the axes, as given by the standard. The same diagram is also shown with deactivated sensor automatic. The view Sensor position shows the axes of a triaxial sensor of a seat accelerometer, where the direction perpendicular to the seat is assumed to be the z-axis. Using the sensor automatic, the assignment of the sensors to the axes of the seat accelerometer can be fixed. Placing the sensor/accelerometer according to the diagram Sensor position will then automatically utilize the standards conforming axes assignment (p.81).

Axis value window



The axis value windows display for each axis the currently measured value, as well as status information. The main measured value is the RMS value of the frequency weighted vibrational acceleration. The displayed value already includes the k-factor for the axis.

An important part of the status information is the assignment of the measurement channels, since these have to be done as defined in the standard. The colored display of the measured values eases the fast correlation. When fewer than three channels are used in a measurement, the inactive axis value windows are displayed in gray.

The overload and underload indicators give important status information during a measurement. They ascertain the correct measuring range and are of help in avoiding measuring errors and inaccuracies. Therefore, these indicators are required by the standard. Further information can be found at the given page references.

Measured values

Interval RMS value

The most important characteristic value for the assessment of vibrational exposition according to EN ISO 2631:1997 is the RMS value of the frequency weighted vibrational acceleration. This value is displayed in the axis value window in the color of the respective axis.

Crest factor and MTVV

The standard provides for the possibility, that signal forms occur, whose effects cannot be adequately characterized by the frequency weighted RMS value alone. It recommends to monitor the signal form, in order to detect such situations. To this end, VM-BODY measures two additional parameters of the signal, the crest factor and the maximum transient vibration value (MTVV).

If these parameters exceed certain ranges, the standard EN ISO 2631-1:1997 recommends to note this situation and record the additional parameters in the measurement protocol. In such a case, the respective parameter field is shown in yellow in the axis value window.

VDV

In some countries, mainly in Great Britain, Vibration Dose Value (VDV) is measured in addition to or instead of interval RMS. VDV is also displayed in VM-BODY for each axis. A yellow VDV field indicates that signal shape exceeds the limits of measurement. EN ISO 2631-1:1997 recommends to note this in the report.

Vibration total value

The frequency weighted RMS values of the acceleration of all measured axes are combined to form the vibration total value. VM-BODY always displays the current value of this quantity, without requiring a separate calculation of it.

The method used for the determination of the vibration total value depends on the selected assessment. The applicable quantity in each case is shown above the total value display (e.g., maximum or vector sum), for information, and is also automatically activated.

The display of the vibration total value is shown in color for weighted measurements. To this end, the total value is compared with limiting values as given (informally) by the standard. The meaning is:

- green: good/no risk
- yellow: acceptable/low risk
- red: bad/serious risk

For comfort/perception assessment the vector sum of the weighted axis values is used. For health assessment the energy equivalent dose value is (internally) calculated from the maximum of the weighted axis values and the daily exposure duration. This value is then compared to the limiting values. The result of the health assessment therefore depends on the selected value for Daily exposure duration in the panel Measurement mode.

Time displays

Two time displays show the remaining and the elapsed measurement time. When the preset duration has elapsed, the measurement is stopped and the measuring value displays are frozen. The measuring values are automatically transferred to the data storage.

The automatic transfer to the data storage is also done if a measurement is stopped early. However, in this case the button Erase measurement appears, allowing to cancel the transfer.

User guidance

A textual user guidance helps the user to easily and successfully perform the measurement by indicating the next appropriate step. The text field may also show short warnings (e.g. if the measurement duration is too short, or if limiting values are exceeded).

Data storage

The panel Data storage is designed to

- amend measurements with individual remarks,
- show detailed information for each measurement,
- manage the storage (erase, write, read data),
- export the data for further processing in word processors or spreadsheets,
- print a report.

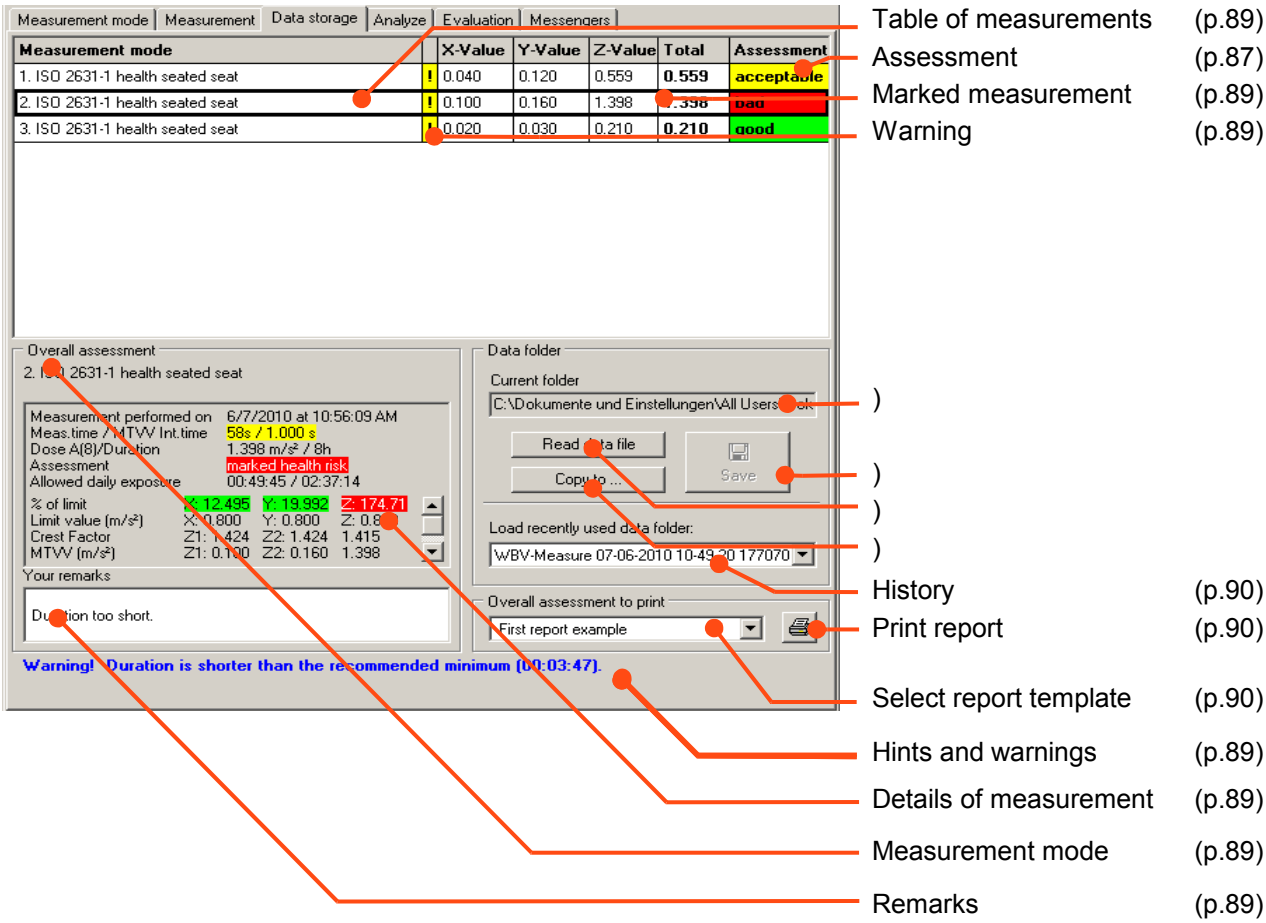


Table of measurements

This table contains all stored measurement results (up to a maximum of 100,000 measurements).

The label given for the measurement mode (the first column of the table) is composed of

1. a running number,
2. the (fixed) description of the measurement mode and
3. the (user-defined, i.e. variable) first line from the field Your remarks.

The running number will change if measurements are deleted from the table.

The second column shows an exclamation mark on yellow background as a Warning, if the measuring duration or the signal form do not comply with the requirements of the standard.

The next columns show the three measuring values of the axes and the vibration total value.

In the right column you see an evaluation of the measurement based on daily exposure time.

Marked measurement

A single measurements can be selected in the table by mouse click. The selected measurement is marked by a black frame. For the marked measurement the following detailed information is provided:

- measurement mode
- details of measurement
- your own remarks
- hints for measurement

Details of measurement

All settings used for measurement will be displayed in this field. In addition you find here detailed measuring results including auxiliary parameters.

This field also indicates:

- the time of measurement
- a verbal evaluation
- a calculated daily exposure time

Remarks

You may add your own remarks to the measurement. These are saved together with the measuring values. In order to ease data management, the first line of the remark is appended to the measurement mode in the first column of the Table of measurements. This can be used to characterize the measurements by, e.g., the measuring location.

Hints and warnings

If there is a warning (indicated by an exclamation mark in the second column of the main table), a short characterization of it is shown in the field for Hints and warnings. Furthermore, the fields (parameters or measured values) relevant for the warning are shown with a yellow background (e.g. the duration in the example above).

Printing a report

You may print a report for the selected measurement. Its design and contents are determined by a template which can be selected from a list. Click the printer icon to start printing.

Action menu

By a right mouse click on a measurement the Action menu opens.

Erase marked measurement

Deletes the marked measurement from the memory irrevocably.

Erase all measurements

Clears the data storage memory completely.

Data folder

You may save or reload the data storage memory from hard disk. Data is saved into separate folders since it may consist of more than one file. The actual measuring data is exported in CSV format (comma separated values). The file name is the same as the folder name. Other data, like frequency analysis in VM-BODY+, may be added to the folder.

The data storage memory is saved automatically to hard disk after finishing the measurement. If no folder name was entered, a name is generated automatically. If you have changed the data storage after measurement, e.g. by adding remarks, save the record manually by the save button. Click Copy to... to save data under a new name.

Furthermore, it is possible to read back data files into VM-BODY which have previously been saved in CSV format. These measurements will be added to the existing content of the data storage. Thereby one may accumulate related measurements and record them together, even if they are performed at different times. The last read folder name determines the folder name used for saving the modified data.

Recently used data folders are shown in a drop-down list.

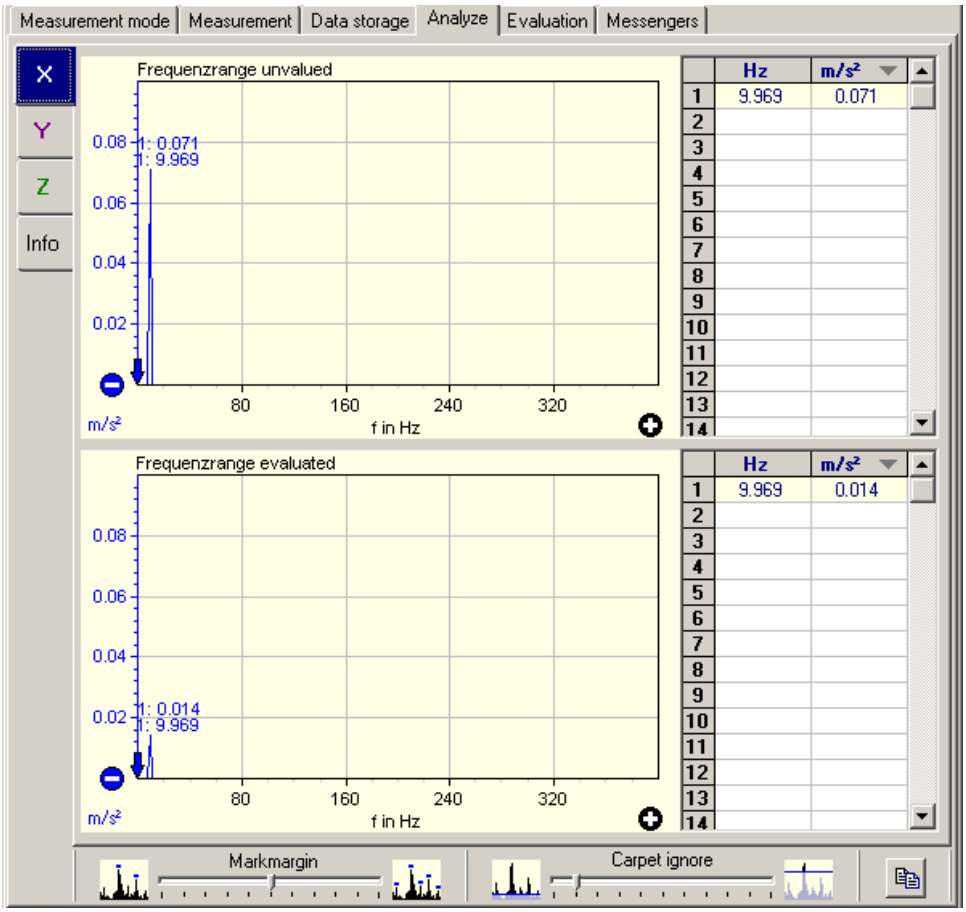
The used CSV format allows simple export into common spreadsheet editors like Microsoft Excel or OpenOffice Calc.

Vibration analysis

VM-BODY+ includes an FFT analyzer. It may help to find the source of vibration by means of dominant frequency components. Analysis is performed simultaneously with human vibration measurement. The spectrum is saved automatically together with the storage memory for each record individually.

For each axis the unweighted and the weighted spectrum are calculated. Zooming and shifting the visible frequency section is possible.

The Info tab shows the file name.



The Analyzer automatically detects dominant frequencies and displays them with the corresponding magnitudes. Two sliders are provided to adjust the threshold of detection and to suppress noise.

The main amplitudes are also displayed in the diagrams. Amplitudes are marked as A and frequencies as f. An index shows the order of the values. Number 1 stands for the highest amplitude and for the lowest frequency. A bold value indicates that the are more than one amplitudes at a frequency. The zoom function will make them visible.

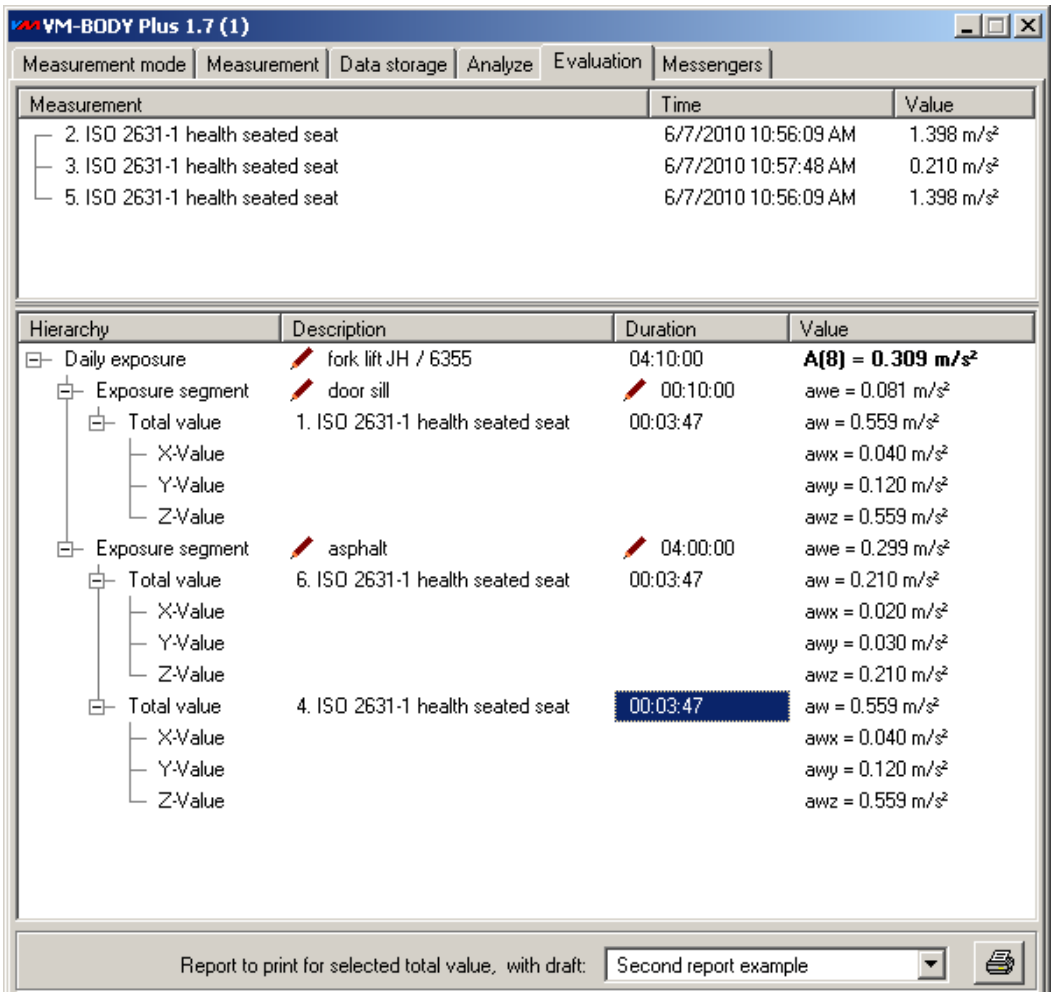
Evaluation with exposure segments

The vibration exposure of a working person may consist of several sections. There are two ways to calculate the total daily exposure value A(8):

1. Measurement is performed during the whole work day over all exposure sections.
2. Each exposure section is measured only for the minimum time according to the standard. The resulting daily exposure can be calculated if the exposure times are known.

The second method is faster and more flexible.

The Evaluation sheet of VM-BODY simplifies the calculation of A(8).



In the upper table you see the measurements you have made. In the lower part is the A(8) calculation table. You may shift the divider between the two tables.

Measurements in the A(8) calculation table are arranged in a tree-like structure. The highest level is called Daily exposure A(8).

Each daily exposure may be composed of several Exposure Segments representing different activities.

Each exposure segment consists of one or more triaxial measurements. If two or more measurements have been assigned to an exposure segment, their contribution to the exposure segment will depend on their individual measuring duration.

To add measurements for A(8) calculation, drag and drop them from the upper into the lower table. Selected measurements are removed from the upper table. Deleting a measurement in the lower table will put it back into the upper table. Deleting a measurement from A(8) calculation is done by a right mouse click at the measurement and Delete entry. Erase values will only erase the measuring value but not the exposure segment entry. You may replace a measuring value by dropping another value at the same position in the table.

Click the pen symbols to add add names or comments to the daily exposure and the exposure segments.

To obtain valid A(8) results the values of the measuring time in the column Duration need to be replaced by the actual durations for these exposure sections during an 8 hours work sift. This is done by clicking the pen symbol.

The calculated daily exposure limit is displayed in bold characters in the first line.

In the A(8) calculation table you find the following values

a_{wx}	Interval RMS of weighted acceleration in X direction
a_{wy}	Interval RMS of weighted acceleration in Y direction
a_{wz}	Interval RMS of weighted acceleration in Z direction
a_w	Vibration total value (vector sum) of weighted acceleration in X/Y/Z direction
a_{we}	Energy equivalent mean value of weighted acceleration of an exposure segment
A(8)	Total daily exposure value A(8) for an 8 hours work shift

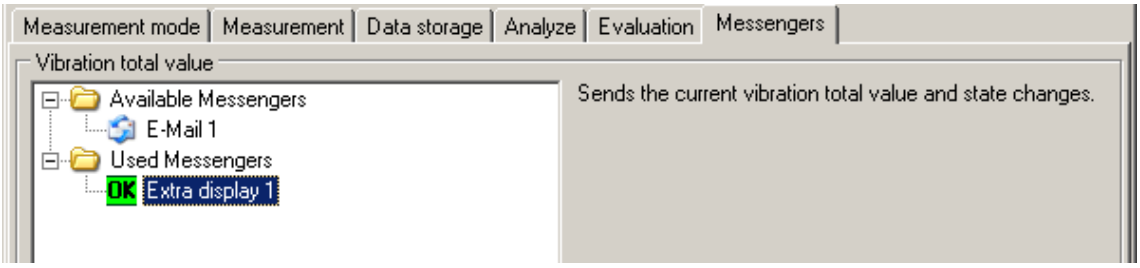
A new A(8) calculation tree can be added by right clicking in an empty space of the calculation sheet and Add A(8) calculation.

Click on the A(8) value and then on the printer button to print a report.

Messengers

Event messengers can be used to to send measuring values and status messages to external hardware as described in section 7 on page 131.

VM-BODY can send messages at exceeding the maximum limits.



The use of messengers is described in section 6.5 on page 31.

6.16. VM-HAND – Human Hand-Arm Vibration Measurement

Overview

If hand held machines or workpieces transmit strong vibrations to the operator, a decreased performance and even diseases in blood vessels, nerves, bones, joints, muscles or connective tissue might develop. For this reason, diverse guidelines stipulate measurements according to EN ISO 5349, which determines the impact on the human hand-arm system.

With VM-HAND, these measurements are carried out conforming to standards. Additionally, the instrument contains a data storage and it provides for the entire evaluation of the daily vibration exposure, the A(8) value.

The integrated guidance system helps users to fully benefit from the wealth of functions and to reliably carry out the measurements, without requiring detailed knowledge of the standard. Four panels lead you through logical steps to an efficient and successful result:

1. The panel Measurement mode permits to select between triaxial and uniaxial measurements.
2. The actual measurement is performed using the panel Measurement.
3. The measured values are managed in the panel Data storage.
4. The calculation of the daily vibration exposure is carried out in the panel Evaluation. A report can be printed based on this evaluation.

The standard recommends the simultaneous measurement in all three spatial axes. However, it is possible to measure the single axes consecutively, if the vibration exposure stays constant during the whole measuring period. Furthermore, it is allowed to completely omit the measurement of some axes, if they contribute only marginally to the total result. These axes may be taken into account by using a correction factor. All these cases are provided for by VM-HAND. Thus, you are free to schedule the measurements in accord with your needs.

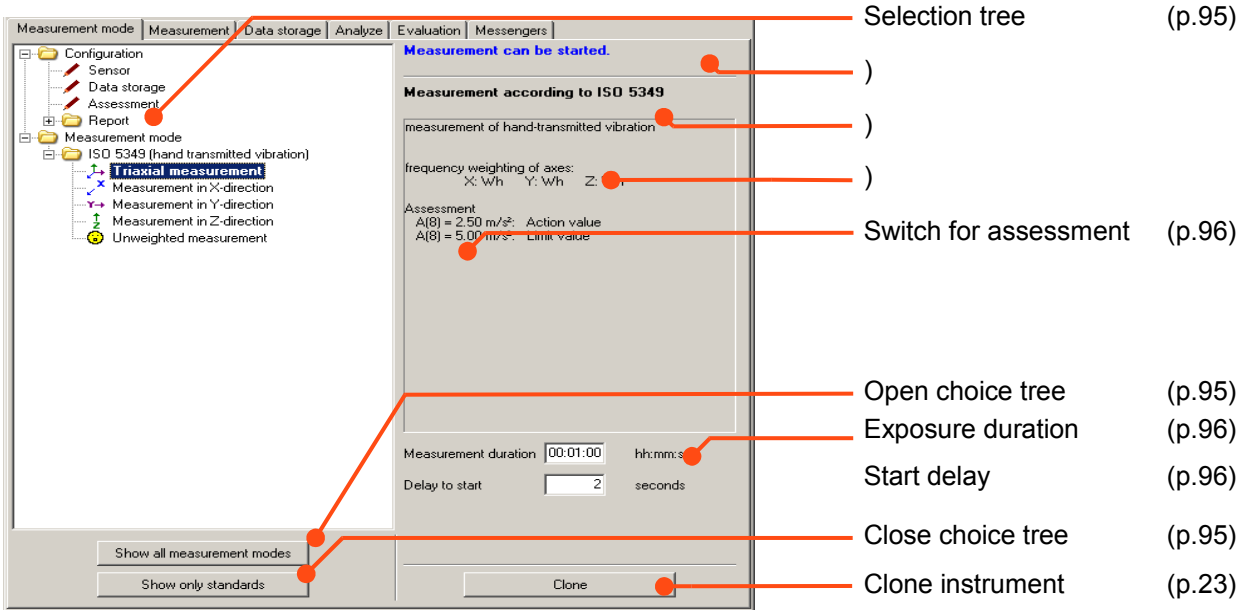
The vibration signal is frequency weighted with a high-precision filter, which exactly reproduces the transfer function as demanded by the standard.

In addition, VM-HAND+ supports the search for the source of high vibration values by means of frequency analysis

Preparing the measurement

The panel Measurement mode serves for preparing the measurement. Here you set

- the measurement mode to ISO 5349
- parameters like measuring time etc.
- the save mode
- report templates



Selection tree

The configuration options and the measurement modes are arranged in a hierarchical tree-like structure. This tree is navigated with the mouse. Sub-trees can be opened or closed by a double click on the corresponding node. Alternatively, one can click on the symbols + and - on the left side of the nodes. Using the buttons Show all measurement modes and Show only standards the tree can be entirely opened or closed with a single click.

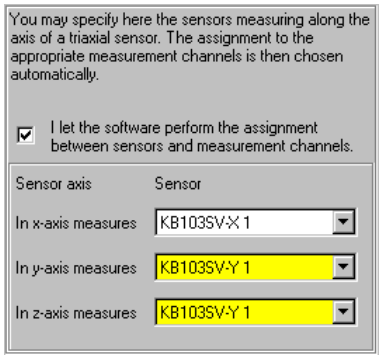
The deepest nodes of the tree represent the standardized measurement modes. The corresponding measurement mode is chosen by mouse click. Measurement can only be started if a measurement mode has been selected. A parenthesized number on the right hand side of the node gives the number of such measurements, which are currently in the data storage.

User guidance

A textual user guidance system provides support by pointing out possible actions. Guiding texts are always displayed in blue lettering.

Sensor configuration

The node Sensor configuration allows to activate a Sensor automatic. It works identically to the one in VM-BODY. Thus, a detailed description can also be found there (p.81).



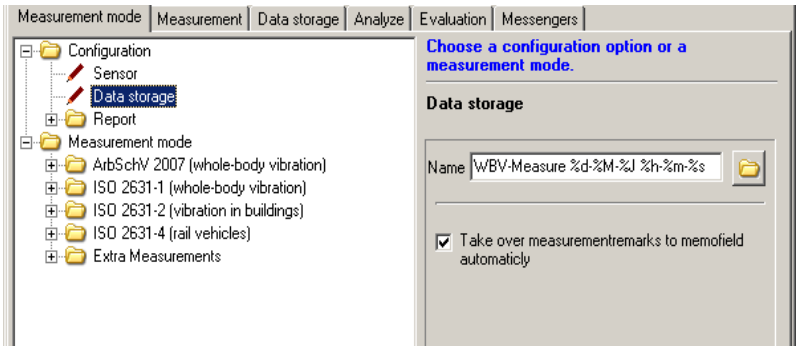
Using the sensor automatic, one can select the sensors – as they are configured in VibroMetra Online – which measure along the x-, y- and z-axis, respectively. This is especially useful, if a triaxial sensor is used. In this configuration option, the correspondence between sensors and axes can be fixed. Then, only the assignment between sensors and device channels (of the M302 or M312 units) must be set (within VibroMetra Online

p.12) in order to get the correct axes configuration. There is no need to find out the – indirect – relation between device channels and spatial directions measured.

The channel assignment in the panel Measurement is inactive and shown in gray, when the sensor automatic is enabled. The channel assignment is done automatically, so that the chosen sensor is connected with the matching measuring channel. A reconfiguration in VibroMetra Online leads to a reconfiguration of VM-HAND, even while in operation.

If the same sensor is assigned to several channels, the corresponding fields are shown with a yellow background, in order to warn of this error.

Data storage configuration

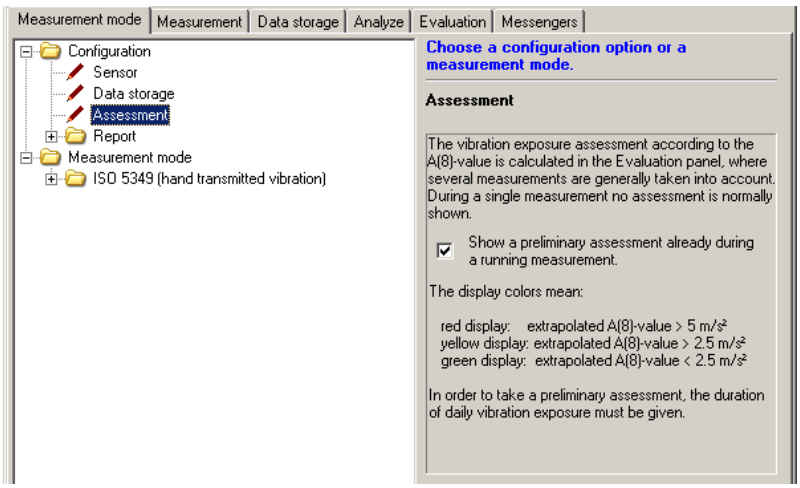


Measuring data is automatically saved to hard disk after each measurement. You may enter the path and the name of the files. The file name may include variables (see page 28).

An index is attached if the entered file name already exists.

VM-HAND monitors the measurement according to ISO 5349. Potential problems are indicated for each measurement. The option Take over measurement remarks... copies these warnings to the memo field in order to print them in the report.

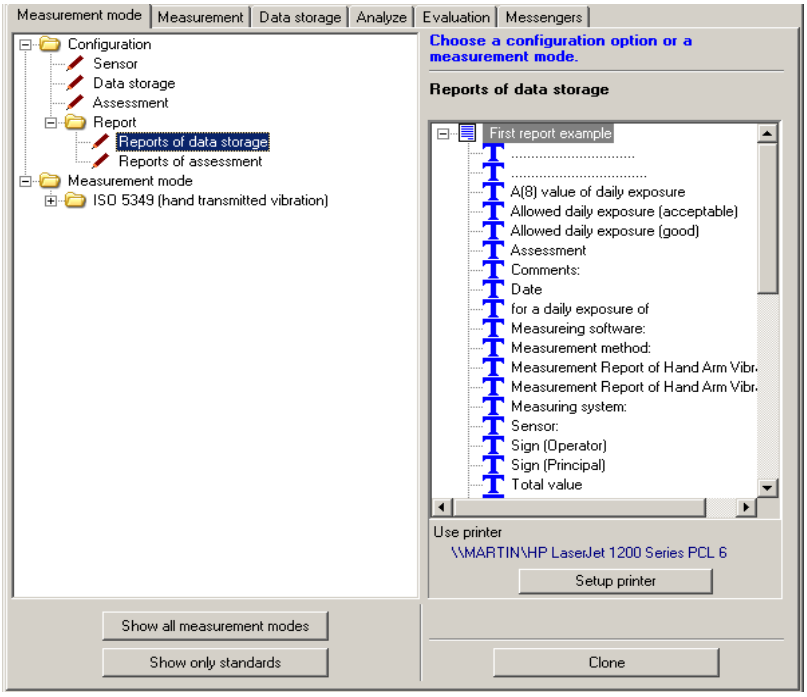
Assessment configuration



The node Assessment configuration contains an option, which, when activated, causes a preliminary assessment to be shown already during a running measurement. The assessment is given by coloring the display for the total vibration value. Thus, one obtains a fast and easily recognizable assessment for the currently measured value. Since the assessment evaluation rests on the comparison with an energy equivalent daily dose, the Daily exposure duration has to specified in order to use the preliminary assessment option. The given duration value is used to extrapolate the currently measured value to the daily vibration exposure A(8), which is the basis for the assessment.

Report configuration

Thanks to the report function, you can easily print measurement reports in order to document the results of your work. You are free to create a report according to your requirements. Company address, company logo – everything can be integrated in such a report. The generation and adaptation of a report template is described on page 78. The report templates are saved together with a workspace.



Here you may also select the printer for the report. At start-up, the standard printer is chosen by default.

The actual printing of a report is initiated in the panels Data storage and Evaluation.

Measurement mode

The available measurement modes are: triaxial measurement of all three spatial directions simultaneously (favored by the standard), and uniaxial measurements along the X, Y and Z axis, respectively. After selecting a measurement mode, the measurement duration should be adjusted. The measurement modes selected here affect only the direct data acquisition. Unmeasured axes are taken into account later during evaluation.

Adjusting parameters

Some parameters are not strictly fixed by the standard, as the case may be. They can be adjusted to the current requirements.

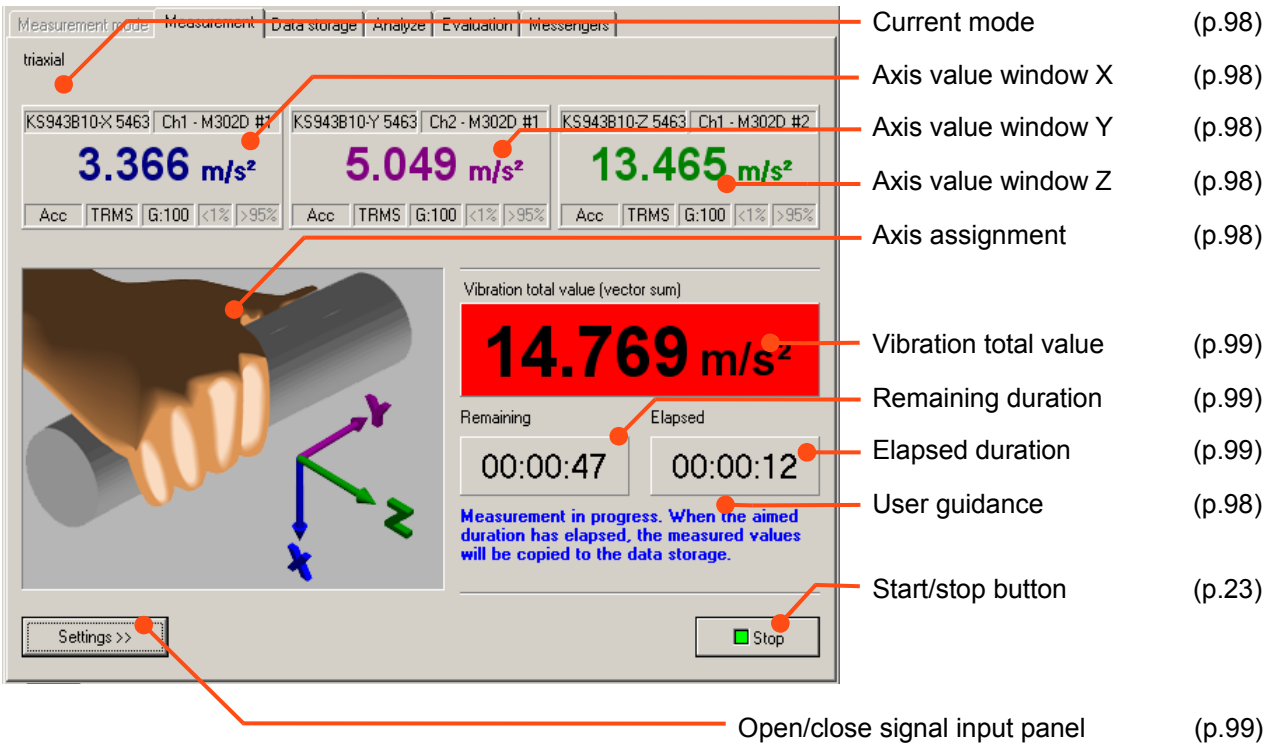
Measurement duration

ISO 5349 specifies, that a measurement should not be shorter than a certain minimal duration, in order to achieve a given accuracy. Clicking on the button ISO sets this recommended minimal duration of 1 minute. In some cases a measuring duration of 1 minute cannot be reached. You may perform several shorter measurements and add them to one exposure segment so that their total duration reaches 1 minute.

Delay to start

The start of measurement can be delayed by the entered time. This may be useful to exclude preparation time from the actual measurement.

Performing the measurement



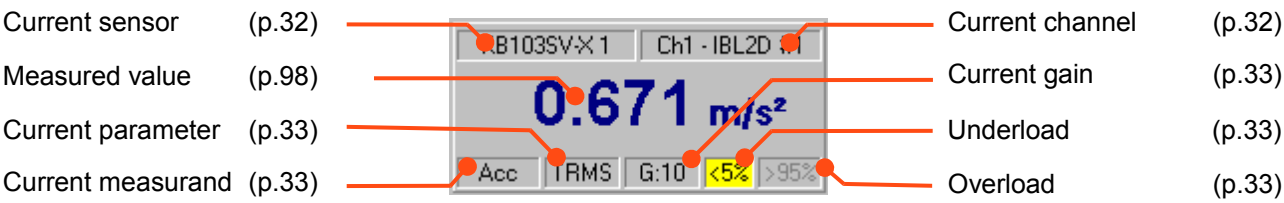
User guidance

The currently selected Measurement mode is displayed in short form as a header line at the top of the panel. A textual User guidance indicates possible actions and points out error conditions.

Axis assignment and handle orientation

In order to obtain a comparable result and perform a standards conforming measurement, the orientation of the sensor axes relative to the hand as it grips the handle must be the same for each measurement. A diagram shows the standardized axis assignments, which helps in correctly aligning the sensors and to properly prepare the measurement.

Axis value window



The axis value windows display for each axis the currently measured value, as well as status information. The main value measured is the RMS value of the frequency weighted vibrational acceleration.

An important part of the status information is the assignment of the measurement channels, since these have to be done as defined in the standard. The colored display of the measured values eases the quick correlation. When fewer than three channels are used in a measurement, the inactive axis value windows are displayed in gray.

The overload and underload indicators give important status information during a measurement. They ascertain the correct measuring range and are of help in avoiding measuring errors and inaccuracies. Therefore, these indicators are required by the standard. Further information can be found at the given page references.

Vibration total value

The frequency weighted RMS values of the acceleration in all measured axes are combined to form the vibration total value. This quantity is denoted by a_{hv} in the standard. VM-HAND always displays the current value of this quantity, without requiring a separate calculation of it.

Time displays

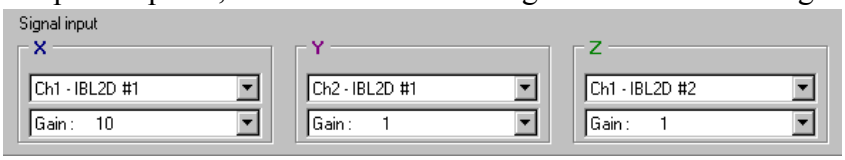
The standard EN ISO 5349-2:2001 requires, that the measurements provide a mean value over a duration, which is representative of a typical usage of the device. The measurement duration should last at least one minute. Therefore, VM-HAND allows to specify the desired measurement duration in advance.

Two time displays show the remaining and the elapsed measurement time. When the preset duration has elapsed, the measurement is stopped and the measured value displays are frozen. The measured values are automatically transferred to the data storage.

The automatic transfer to the data storage is also done if a measurement is stopped early. However, in this case the button Erase measurement appears, allowing to cancel the transfer.

Signal input

The button Settings >> opens a panel, which allows to configure the channel assignment and to set the gain of each channel.



For an easy overview, each axis is uniquely distinguished by a color. The same colors are also used in the axis value display and the pictorial display of the axes' orientation. The measuring channel for each axis can be chosen from a list which contains all channels available for VM-HAND. The channel assignment is inactive if the sensor automatic is in use.

In order to avoid the accidental selection of two equal channels, the affected fields show a yellow warning in this case.

The gain setting is needed to select the appropriate measuring range (p.24). The overload and underload indicators give helpful information in order to find the correct gain setting (p.33).

Data storage

The panel Data storage is designed to

- amend measurements with individual remarks,
- show detailed information for each measurement,
- manage the storage (erase, write, read data),
- export the data for further processing in word processors or spreadsheets.

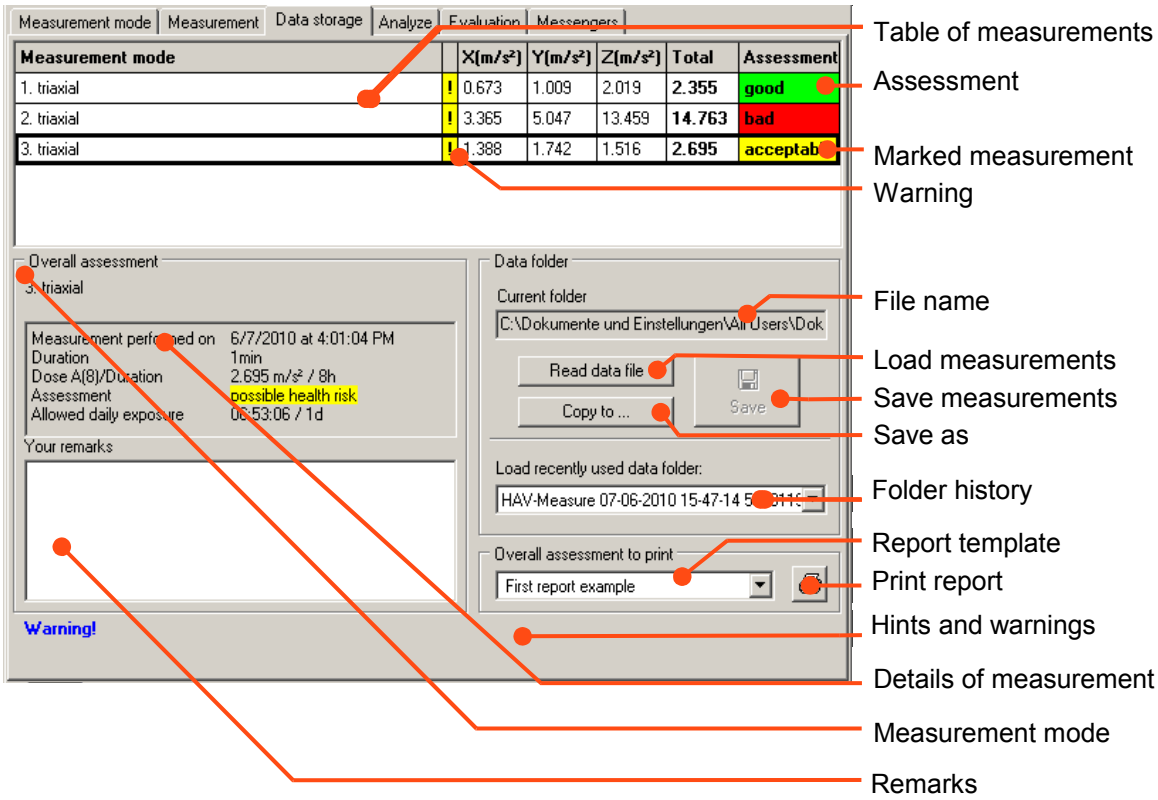


Table of measurements

This table contains all stored measurement results (up to a maximum of 100,000 measurements).

The label given for the measurement mode (the first column of the table) is composed of

1. a running number,
2. the (fixed) description of the measurement mode and
3. the (user-defined, i.e. variable) first line from the field Your remarks.

The running number will change if measurements are deleted from the table.

The second column shows an exclamation mark on yellow background as a Warning, if the measuring duration or the signal form do not comply with the requirements of the standard.

The next columns show the three measuring values of the axes and the vibration total value.

In the right column you see an evaluation of the measurement based on daily exposure time.

Marked measurement

A single measurements can be selected in the table by mouse click. The selected measurement is marked by a black frame. For the marked measurement the following detailed information is provided:

- measurement mode
- details of measurement
- your own remarks
- hints for measurement

Details of measurement

All settings used for measurement will be displayed in this field. In addition you find here detailed measuring results including auxiliary parameters.

This field also indicates:

- the time of measurement
- a verbal evaluation
- a calculated daily exposure time

Remarks

You may add your own remarks to the measurement. These are saved together with the measuring values. In order to ease data management, the first line of the remark is appended to the measurement mode in the first column of the Table of measurements. This can be used to characterize the measurements by, e.g., the measuring location.

Hints and warnings

If there is a warning (indicated by an exclamation mark in the second column of the main table), a short characterization of it is shown in the field for Hints and warnings. Furthermore, the fields (parameters or measured values) relevant for the warning are shown with a yellow background (e.g. the duration in the example above).

Printing a report

You may print a report for the selected measurement. Its design and contents are determined by a template which can be selected from a list. Click the printer icon to start printing.

Action menu

By a right mouse click on a measurement the Action menu opens.

Erase marked measurement

Deletes the marked measurement from the memory irrevocably.

Erase all measurements

Clears the data storage memory completely.

Data folder

You may save or reload the data storage memory from hard disk. Data is saved into separate folders since it may consist of more than one file. The actual measuring data is exported in CSV format (comma separated values). The file name is the same as the folder name. Other data, like frequency analysis in VM-HAND+, may be added to the folder.

The data storage memory is saved automatically to hard disk after finishing the measurement. If no folder name was entered, a name is generated automatically. If you have changed the data storage after measurement, e.g. by adding remarks, save the record manually by the save button. Click Copy to... to save data under a new name.

Furthermore, it is possible to read back data files into VM-HAND which have previously been saved in CSV format. These measurements will be added to the existing content of the data storage. Thereby one may accumulate related measurements and record them together, even if they are performed at different times. The last read folder name determines the folder name used for saving the modified data.

Recently used data folders are shown in a drop-down list.

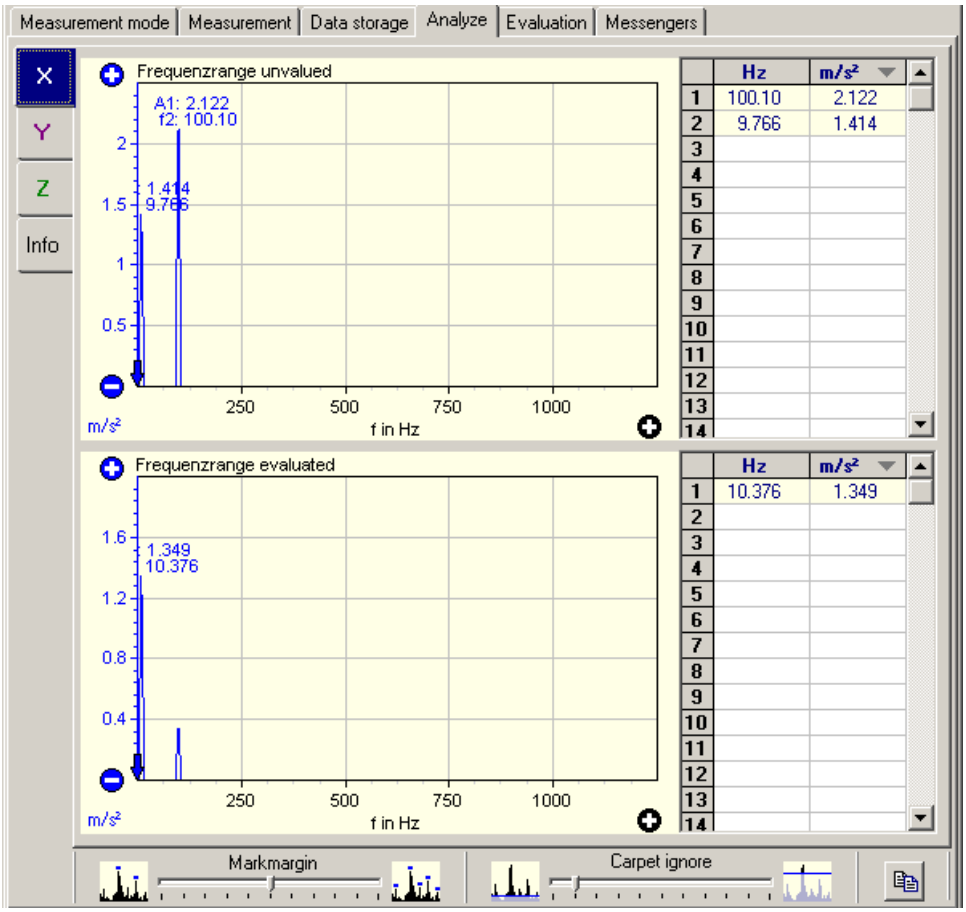
The used CSV format allows simple export into common spreadsheet editors like Microsoft Excel or OpenOffice Calc.

Vibration analysis

VM-HAND+ includes an FFT analyzer. It may help to find the source of vibration by means of dominant frequency components. Analysis is performed simultaneously with human vibration measurement. The spectrum is saved automatically together with the storage memory for each record individually.

For each axis the unweighted and the weighted spectrum are calculated. Zooming and shifting the visible frequency section is possible.

The Info tab shows the file name.



The analyzer automatically detects dominant frequencies and displays them with the corresponding magnitudes. Two sliders are provided to adjust the threshold of detection and to suppress noise.

The main amplitudes are also displayed in the diagrams. Amplitudes are marked as A and frequencies as f. An index shows the order of the values. Number 1 stands for the highest amplitude and for the lowest frequency. A bold value indicates that the are more than one amplitudes at a frequency. The zoom function will make them visible.

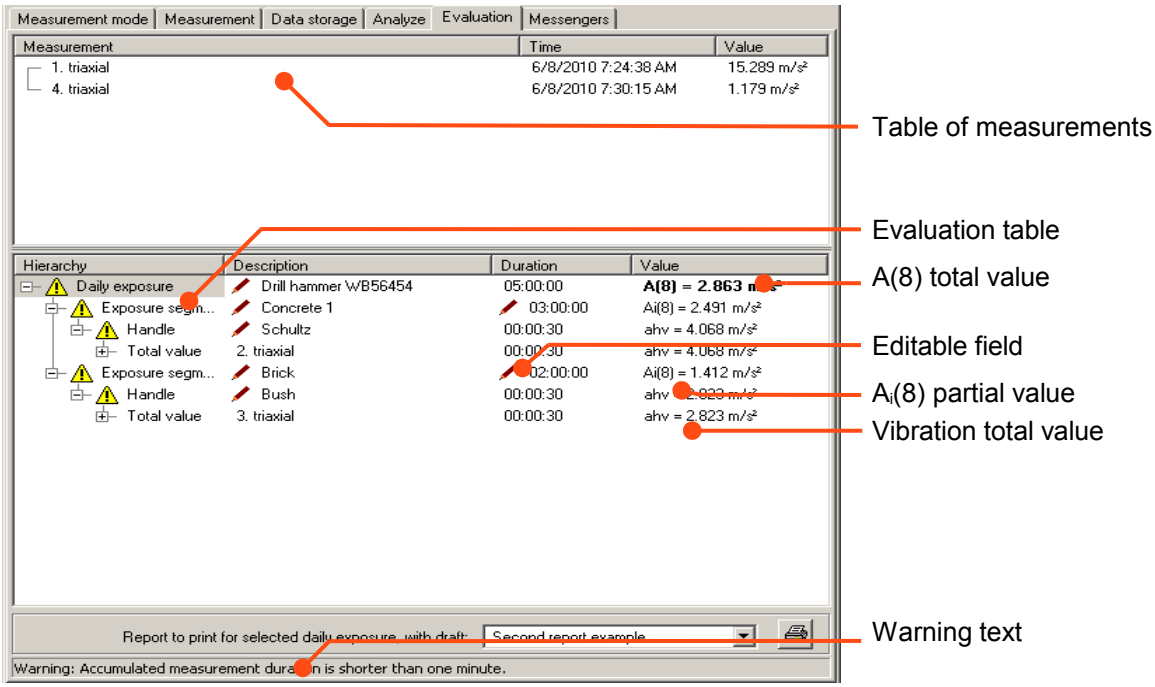
Evaluation with exposure segments

The vibration exposure of a working person may consist of several sections. There are two ways to calculate the total daily exposure value A(8):

3. Measurement is performed during the whole work day over all exposure sections.
4. Each exposure section is measured only for the minimum time according to the standard. The resulting daily exposure can be calculated if the exposure times are known.

The second method is faster and more flexible.

The Evaluation sheet of VM-HAND simplifies the calculation of A(8).



In the upper table of the panel Evaluation you see the measurements you have made. In the lower part is the A(8) calculation table. You may shift the divider between the two tables.

Measurements in the A(8) calculation table are arranged in a tree-like structure. The highest level is called Daily exposure A(8).

Each daily exposure may be composed of several Exposure Segments representing different activities.

Each exposure segment consists of one or more triaxial measurements. If two or more measurements have been assigned to an exposure segment, their contribution to the exposure segment will depend on their individual measuring duration.

To add measurements for A(8) calculation, drag and drop them from the upper into the lower table. Added measurements will be removed from the upper table. Deleting a measurement in the lower table will put it back into the upper table. Deleting a measurement from A(8) calculation is done by a right mouse click at the measurement and Delete entry. Erase values will only erase the measuring value but not the exposure segment entry itself. You may replace a measuring value by dropping another value at the same position in the table.

Click the pen symbols to add add names or comments to the daily exposure and the exposure segments.

To obtain valid A(8) results the values of the measuring time in the column Duration need to be replaced by the actual durations for these exposure sections during an 8 hours work sift. This is done by clicking the pen symbol.

The calculated daily exposure limit is displayed in bold characters in the first line.

In the A(8) calculation table you find the following values

a_{hw} Interval RMS values of weighted acceleration in X / Y / Z direction
a_{hv} Vibration total value (vector sum) of weighted acceleration in X/Y/Z direction
a_{we} Energy equivalent mean value of weighted acceleration of an exposure segment
$A_i(8)$ Contribution of an exposure segment to the daily exposure
A(8) Total daily exposure value for an 8 hours work shift

A new A(8) calculation tree can be added by right clicking in an empty space of the calculation sheet and Add A(8) calculation.

Click on the A(8) value and then on the printer button to print a report.

The standard recommends, that each single measurement should be at least 8 seconds long, and the sum of all measurements of a single exposure segment should be at least 1 minute. If the first condition is not met, VM-HAND issues a warning in the data storage. Missing the second condition leads to a warning in the evaluation table (an exclamation mark on a yellow triangle in the affected rows, and a textual warning below the table).

Remarks with regard to uniaxial measurements

It is possible to measure all three spatial axes with a single sensor. To this end, the measurements are performed consecutively. This procedure is allowed by EN ISO 5349:2001. It has to be ensured, though, that the operating conditions stay the same during the successive measurements, in this case. The three measurements must then be assigned to the same Total value during evaluation.

The standard also allows to omit the measurement of some axes, if there is a clear direction with the strongest vibrations, and at least this direction is measured. In this case any unmeasured axis must be taken into account be a correction factor. This is done by providing a relative weight for unmeasured axes during evaluation, as described above.

Example 1: If a relative weight of 30% is entered in the evaluation table and in the main vibrational direction a value of 10 m/s² is measured, the unmeasured axis is assumed to have a value of 3 m/s², which is then used in the calculation of the triaxial total value.

Example 2: If only one axis is measured out of the three, all of which have the same vibration strength, the proper value for the relative weight for the two unmeasured axes is 100%.

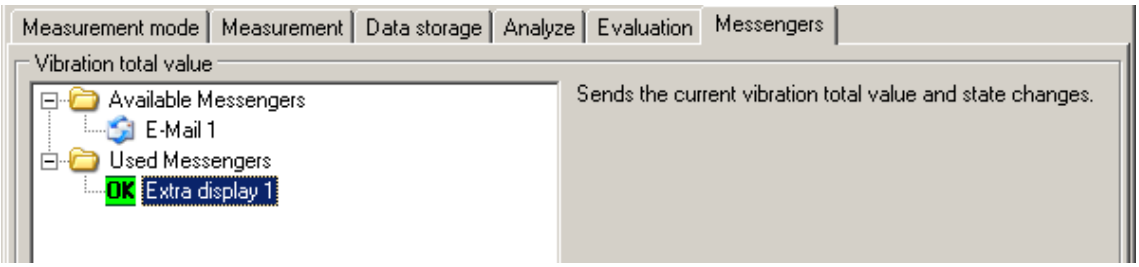
Even if uniaxial measurements are sufficient, it is recommended to perform measurements of all three spatial directions at least once, so that there is a solid basis for the estimation of the correction factors.

Messengers

Event messengers are used to to send measuring values and status messages to external hardware as described in section 7 on page 131.

VM-HAND can send messages at exceeding the maximum limits.

Possible applications are a large colored display output with VM-LARGE or switching an external signal lamp via VM-ADAM.



The use of messengers is described in section 6.5 on page 31.

6.17. VM-SHIP – Vibration Measurement on Ships

Overview

On board passenger and merchant vessels vibrations can occur, which may negatively interfere with the work of the crew or which may diminish the comfort of passengers and crew. In order to assess complaints or to prevent them, measurements according to DIN ISO 6954:2001 are suitable, since they allow the evaluation of the vibration severity with regard to habitability on board ships.

By using VM-SHIP, one can easily perform these standards conforming measurements. Additionally, the instrument contains a storage for recent measurement results.

The integrated guidance system helps users to fully benefit from the wealth of functions and to reliably carry out the measurements, without requiring detailed knowledge of the standard. Three panels lead you to a successful assessment:

1. In the panel Measurement mode the measurement is prepared. The measurement mode is simply chosen from a list. The necessary parameters for a conforming measurement are then already fixed by the program. A few parameters can be varied, e.g. the duration. Furthermore, as a convenience function, the sensor automatic can be activated here.
2. The actual measurement is performed using the panel Measurement. The measured values are automatically copied into the Data storage.
3. The panel Data storage contains the measurement results in a concise way. A standards conforming assessment (good/bad/acceptable) is immediately available and displayed by a colored background. Furthermore, the measurements can be amended with your own remarks, managed, exported and imported. On the press of a button a whole report is generated.

The standard demands simultaneous measurements in all three spatial axes at least at some locations per deck. VM-SHIP therefore has three channels.

The characteristic vibration quantities displayed per channel are – depending on the measurement mode –

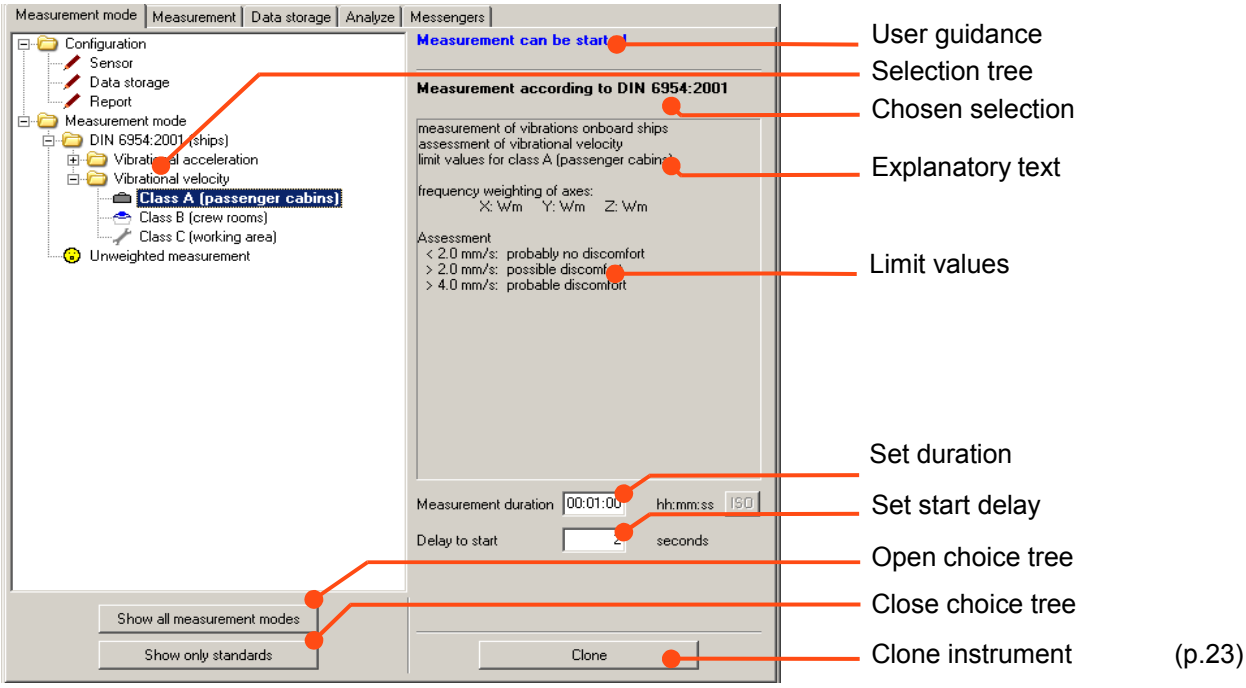
- the RMS value of the weighted vibration velocity [mm/s] or
- the RMS value of the weighted vibration acceleration [mm/s²].

The frequency weighting is performed with a high-precision filter, which exactly reproduces the transfer function as demanded by the standard. The allowable limit values are set automatically by selecting the measurement mode.

Preparing the measurement

The panel Measurement mode serves for preparing the measurement. Here you set

- the measurement mode to ISO 6954
- parameters like measuring time etc.
- the save mode
- report templates



(p.23)

Selection tree

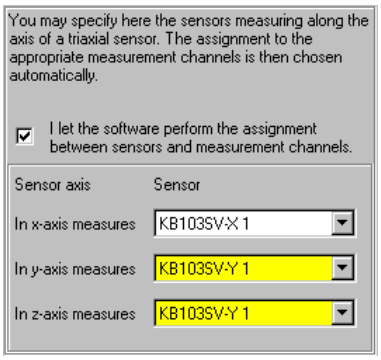
The configuration and measurement modes are arranged in a hierarchical tree-like structure. This tree can be navigated with the mouse. Double clicks open or close the sub--trees. Alternatively, the same is effected by simple clicks on the symbols + and - located left of the nodes. The buttons Show all measurement modes and Show only standards allow to open and close the tree structure.

The deepest nodes of the tree represent the standardized measurement modes. The corresponding measurement mode is chosen by mouse click. A parenthesized number on the right hand side of the node gives the number of such measurements, which are currently in the data storage.

User guidance

A textual user guidance system provides support by pointing out possible actions. Guiding texts are always displayed in blue lettering. Additionally, the currently Chosen selection, a further Explanatory text for the chosen option and the Limit values for the assessment of habitability are displayed, too.

Sensor configuration



The node Sensor configuration allows to activate a Sensor automatic. It works identically to the one in VM-BODY. Thus, a detailed description can also be found there (p.81).

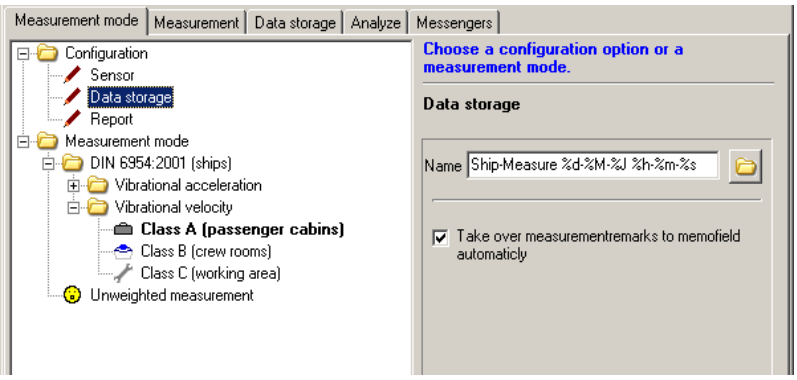
Using the sensor automatic, one can select the sensors – as they are configured in VibroMetra Online – which measure along the x-, y- and z-axis, respectively. This is especially useful, if a triaxial sensor is used. In this configuration option, the correspondence between sensors

and axes can be fixed. Then, only the assignment between sensors and device channels (of the M302 or M312 units) must be set (within VibroMetra Online p. 12) in order to get the correct axes configuration. There is no need to find out the – indirect – relation between device channels and spatial directions measured.

The channel assignment in the panel Measurement is inactive and shown in gray, when the sensor automatic is enabled. The channel assignment is done automatically, so that the chosen sensor is connected with the matching measuring channel. A reconfiguration in VibroMetra Online leads to a reconfiguration of VM-SHIP, even while in operation.

If the same sensor is assigned to several channels, the corresponding fields are shown with a yellow background, in order to warn of this error.

Data storage configuration

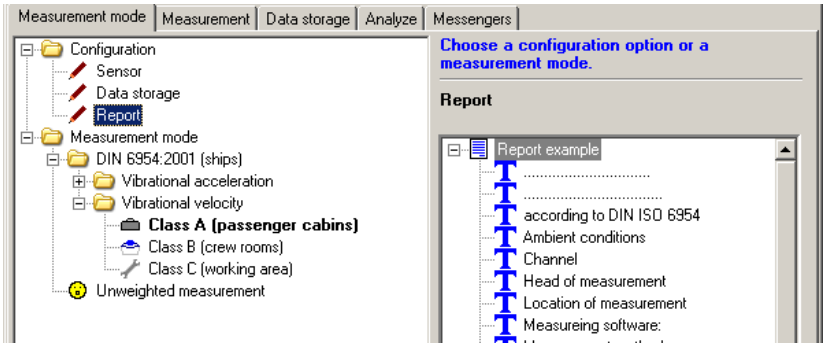


Measuring data is automatically saved to hard disk after each measurement. You may enter the path and the name of the files. The file name may include variables (see page 28).

An index is attached if the entered file name already exists.

VM-SHIP monitors the measurement according to ISO 5349. Potential problems are indicated for each measurement. The option Take over measurement remarks... copies these warnings to the memo field in order to print them in the report.

Report configuration



By means of the report function you can easily print measurement reports in order to document the results of your work. You are free to create a report according to your requirements. Company address, company logo and other information can be added to a report. The generation and adaptation of a report template is described on p.30. The report templates are saved together with a workspace.

Here you may also select the printer for the report. At start-up, the standard printer is chosen by default.

The actual printing of a report is initiated in the panels Data storage and Evaluation.

Measurement mode selection

The available measurement modes comprise the measurement of the vibration velocity and the vibration acceleration, for all three axes in each case. The assessment limit values (Category A, B and C) are chosen here, too.

Adjusting parameters

Some parameters are not strictly fixed by the standard, as the case may be. They can be adjusted to the current requirements.

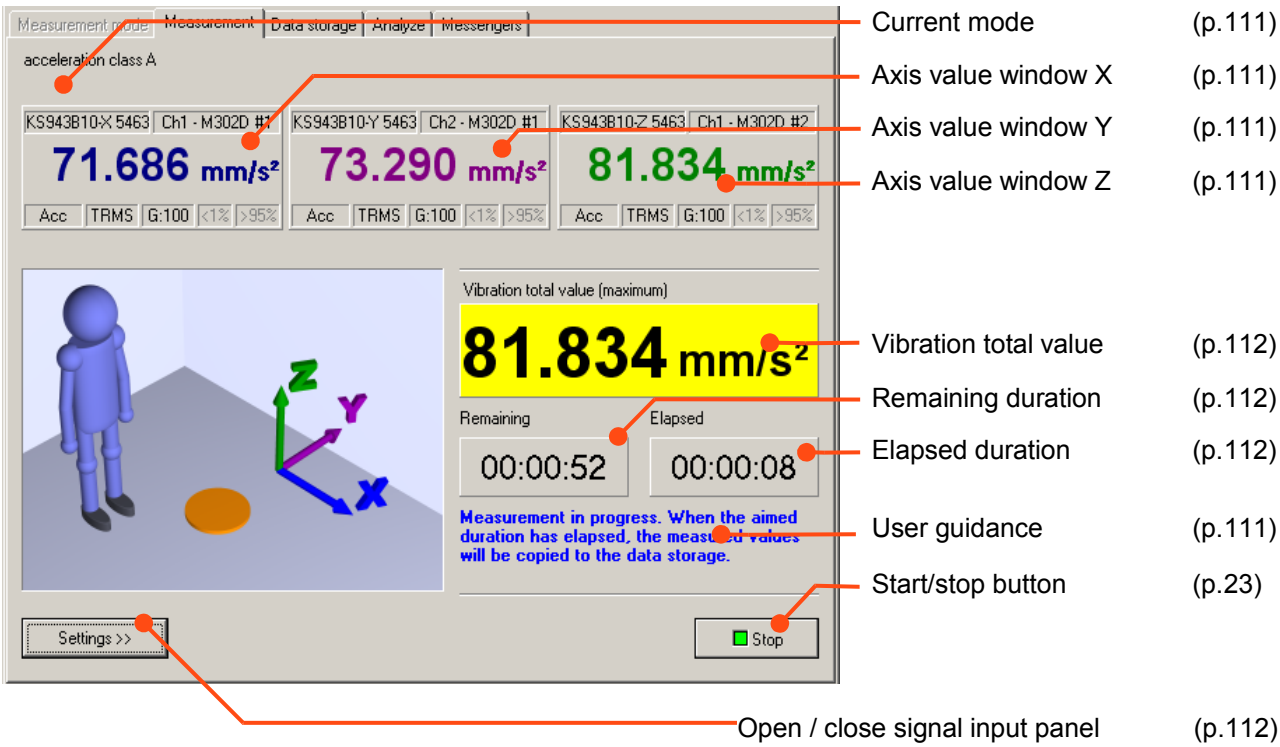
Measurement duration

ISO 6954 specifies, that a measurement should not be shorter than a certain minimal duration, in order to achieve a given accuracy. Clicking on the button ISO sets this recommended minimal duration of 1 minute. In some cases a measuring duration of 1 minute cannot be reached. You may perform several shorter measurements and add them to one exposure segment so that their total duration reaches 1 minute.

Delay to start

The start of measurement can be delayed by the entered time. This may be useful to exclude preparation time from the actual measurement.

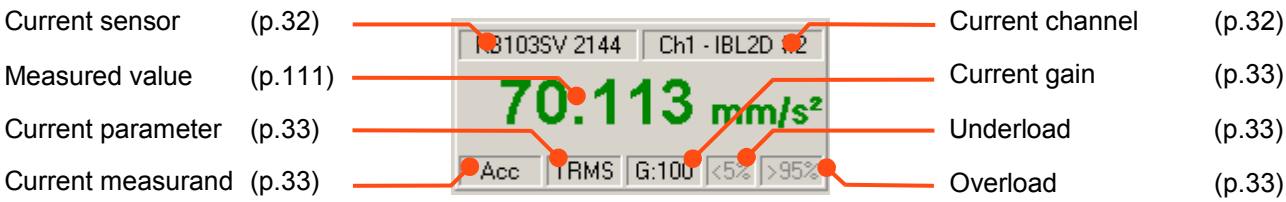
Performing the measurement



User guidance

For the sake of clarity and to avoid erroneous operation the currently chosen Measurement mode is displayed in short form as a header line. A textual User guidance helps the user to easily and successfully perform the measurement by indicating the next appropriate step. The text field may also show short warnings.

Axis value window



The axis value windows display for each axis the currently measured value, as well as status information. The main measured value is the RMS value of the frequency weighted vibrational acceleration or velocity.

An important part of the status information is the assignment of the measurement channels, since these have to be done as defined in the standard. The colored display of the measured values eases the fast correlation.

The overload and underload indicators give important status information during a measurement. They ascertain the correct measuring range and are of help in avoiding measuring errors and inaccuracies. Therefore, these indicators are required by the standard. Further information can be found on page 33.

Vibration total value

The maximum of the measuring values of all axes is the vibration total value.

The display of the vibration total value is shown in color for weighted measurements. To this end, the total value is compared with limiting values as given (informally) by the standard. The meaning is:

- green: good/complaints are not probable.
- yellow: acceptable/complaints are possible.
- red: bad/complaints are probable.

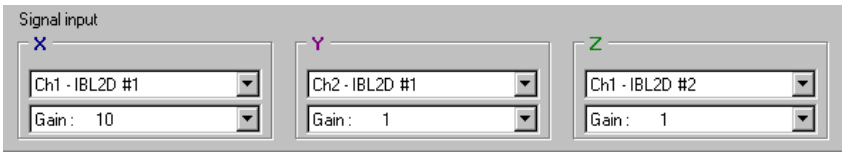
Time displays

Two time displays show the remaining and the elapsed measurement time. When the preset duration has elapsed, the measurement is stopped and the measuring value displays are frozen. The measuring values are automatically transferred to the data storage.

The automatic transfer to the data storage is also done if a measurement is stopped early. However, in this case the button Erase measurement appears, allowing to cancel the transfer.

Signal input

The button Settings >> opens the panel for the signal settings.



Here, the spatial axes can be configured for the measurement. For easy overview, each axis is uniquely distinguished by a color. The same colors are also used in the axis value display and the pictorial display of the axes' orientation. The measuring channel for each axis can be chosen from a list which contains all channels available for VM-SHIP. The channel assignment is inactive if the sensor automatic is in use.

In order to avoid the accidental selection of two equal channels, a yellow warning is given in this case.

The gain settings allows to select the appropriate measuring range (p.24). The overload and underload indicators give helpful information in order to find the correct gain setting (p.33).

As a help for new users, a hint is shown in an un-configured instrument, pointing out the sensor automatic (p.81).

Data storage

The panel Data storage is designed to

- amend measurements with individual remarks,
- show detailed information for each measurement,
- manage the storage (erase, write, read data),
- export the data for further processing in word processors or spreadsheets,
- print a report.

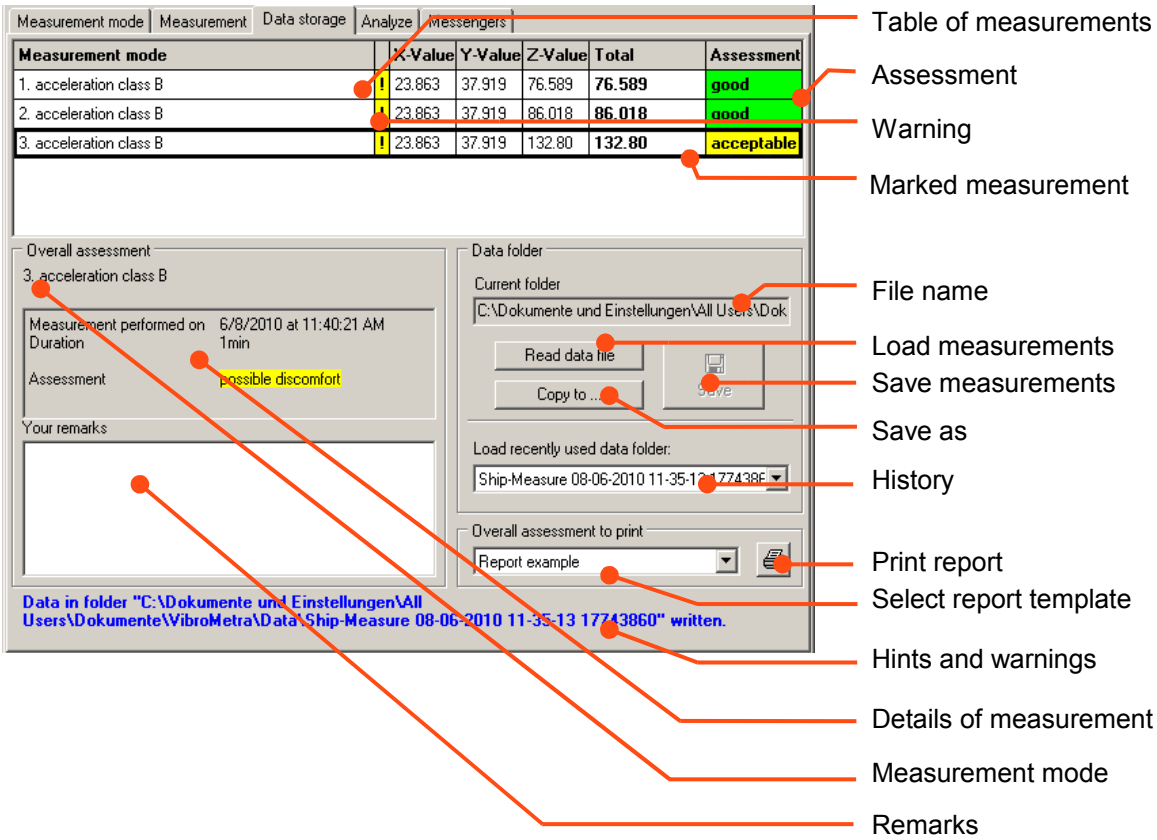


Table of measurements

This table contains all stored measurement results (up to a maximum of 100,000 measurements).

The label given for the measurement mode (the first column of the table) is composed of

1. a running number,
2. the (fixed) description of the measurement mode and
3. the (user-defined, i.e. variable) first line from the field Your remarks.

The running number will change if measurements are deleted from the table.

The second column shows an exclamation mark on yellow background as a Warning, if the measuring duration or the signal form do not comply with the requirements of the standard.

The next columns show the three measuring values of the axes and the vibration total value.

In the right column you see an evaluation of the measurement based on daily exposure time.

Marked measurement

A single measurements can be selected in the table by mouse click. The selected measurement is marked by a black frame. For the marked measurement the following detailed information is provided:

- measurement mode
- details of measurement
- your own remarks
- hints for measurement

Details of measurement

All settings used for measurement will be displayed in this field. In addition you find here detailed measuring results including auxiliary parameters.

This field also indicates:

- the time of measurement
- a verbal evaluation
- a calculated daily exposure time

Remarks

You may add your own remarks to the measurement. These are saved together with the measuring values. In order to ease data management, the first line of the remark is appended to the measurement mode in the first column of the Table of measurements. This can be used to characterize the measurements by, e.g., the measuring location.

Hints and warnings

If there is a warning (indicated by an exclamation mark in the second column of the main table), a short characterization of it is shown in the field for Hints and warnings. Furthermore, the fields (parameters or measured values) relevant for the warning are shown with a yellow background (e.g. the duration in the example above).

Printing a report

You may print a report for the selected measurement. Its design and contents are determined by a template which can be selected from a list. Click the printer icon to start printing.

Action menu

By a right mouse click on a measurement the Action menu opens.

Erase marked measurement

Deletes the marked measurement from the memory irrevocably.

Erase all measurements

Clears the data storage memory completely.

Data folder

You may save or reload the data storage memory from hard disk. Data is saved into separate folders since it may consist of more than one file. The actual measuring data is exported in CSV format (comma separated values). The file name is the same as the folder name. Other data, like frequency analysis in VM-SHIP+, may be added to the folder.

The data storage memory is saved automatically to hard disk after finishing the measurement. If no folder name was entered, a name is generated automatically. If you have changed the data storage after measurement, e.g. by adding remarks, save the record manually by the save button. Click Copy to... to save data under a new name.

Furthermore, it is possible to read back data files into VM-SHIP which have previously been saved in CSV format. These measurements will be added to the existing content of the data storage. Thereby one may accumulate related measurements and record them together, even if they are performed at different times. The last read folder name determines the folder name used for saving the modified data.

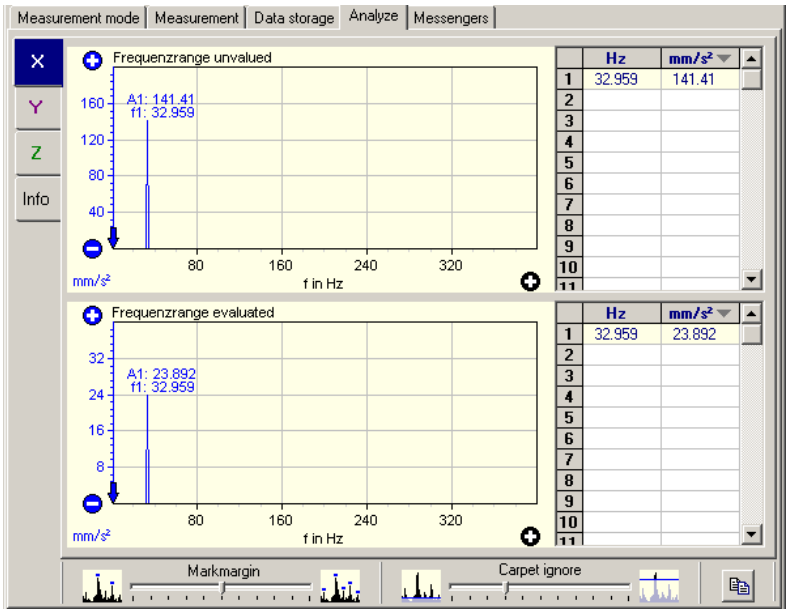
Recently used data folders are shown in a drop-down list.

The used CSV format allows simple export into common spreadsheet editors like Microsoft Excel or OpenOffice Calc.

Vibration analysis

VM-SHIP+ includes an FFT analyzer. It may help to find the source of vibration by means of dominant frequency components. Analysis is performed simultaneously with human vibration measurement. The spectrum is saved automatically together with the storage memory for each record individually.

For each axis the unweighted and the weighted spectrum are calculated. Zooming and shifting the visible frequency section is possible.



The Info tab shows the file name.

The analyzer automatically detects dominant frequencies and displays them with the corresponding magnitudes. Two sliders are provided to adjust the threshold of detection and to suppress noise.

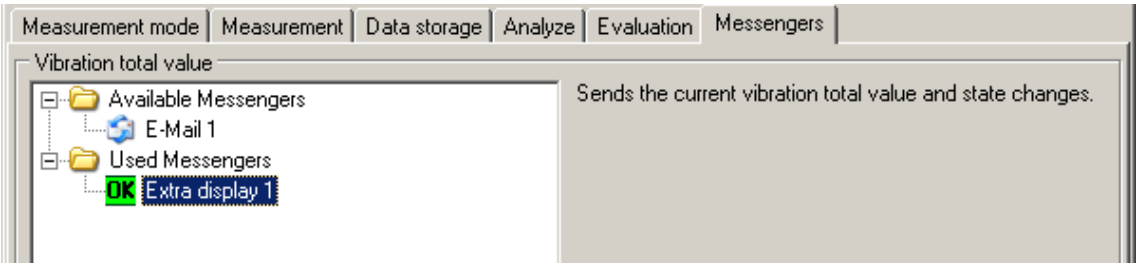
The main amplitudes are also displayed in the diagrams. Amplitudes are marked as A and frequencies as f. An index shows the order of the values. Number 1 stands for the highest amplitude and for the lowest frequency. A bold value indicates that the are more than one amplitudes at a frequency. The zoom function will make them visible.

Messengers

Event messengers are used to to send measuring values and status messages to external hardware as described in section 7 on page 131.

VM-SHIP can send messages at exceeding the maximum limits.

Possible applications are a large colored display output with VM-LARGE or switching an external signal lamp via VM-ADAM.



The use of messengers is described in section 6.5 on page 31.

6.18. VM-STRUC – Vibration Measurement in Buildings and Large Structures

Overview

The transmission of vibrations to buildings and other large structures may cause damages, which can negatively affect the safety and utility value. The corresponding risk of damage can be judged by a vibration measurement according to the standard DIN 4150-3.

By using VM-STRUC, one can easily perform these standards conforming measurements. Additionally, the instrument contains a storage for recent measurement results, it provided for the complete final evaluation and allows for the archiving of the results. The integrated guidance system helps users to reliably carry out the measurements.

VM-STRUC supports measurements according to

- DIN 4150-3:1999 (vibrations in buildings)
- assessment for momentary and sustained vibrational excitation
- assessment for different types of buildings (industrial, residential and listed) and for earth-laid pipelines
- frequency limit of 80 or 315 Hz.

In most cases, the standard demands simultaneous measurements in all three spatial axes. VM-STRUC therefore has three channels.

The characteristic values displayed per channel are

- current maximum value of the frequency-weighted vibration velocity [mm/s]
- current main frequency of the vibration [Hz]
- maximum value of the frequency-weighted vibration velocity taken over the entire measurement [mm/s] and the associated main frequency [Hz].

Saving the sampled time signal of the vibration velocity is also possible. If this feature is activated, the sampled data of the events (limit or warning threshold crossings) are stored, thus allowing for the subsequent manual analysis of the vibration values and frequencies, that occurred.

The frequency weighting is performed with a high-precision filter, which exactly reproduces the transfer function as demanded by the standard. The allowable limit values are selected automatically through the selection of the measurement mode. VM-STRUC automatically determines the main frequency of the vibrations already during the running measurement, a feature which is generally not available in a conventional measuring device.

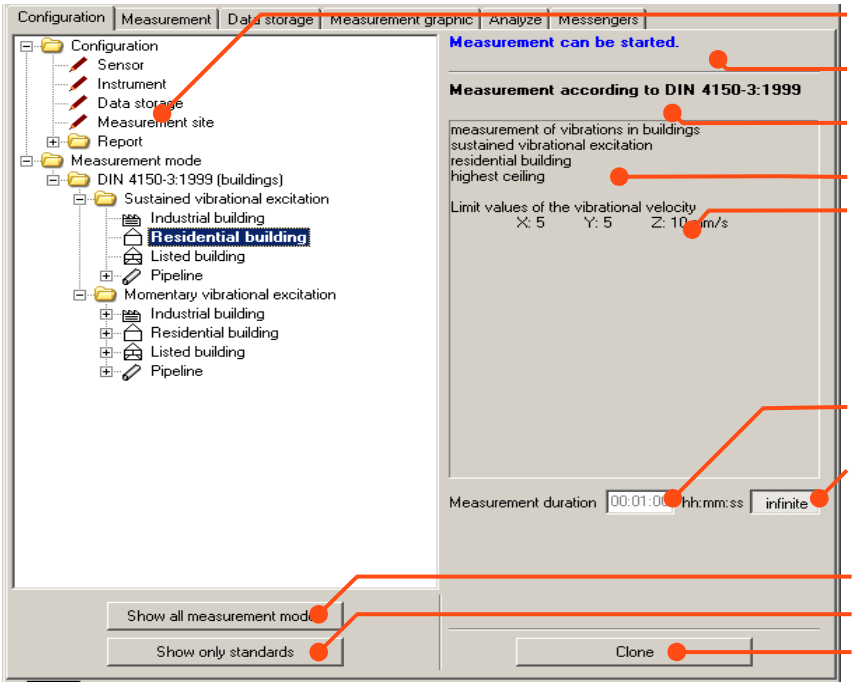
In addition, VM-STRUC+ supports the search for the source of high vibration values by means of frequency analysis.

VM-STRUC generates reports about single vibration events and longer time intervals at the push of a button.

Preparing the measurement

In the panel Measurement mode the measurement is prepared. On this panel you can

- choose the instrument type (1 to 80 Hz or 1 to 315 Hz),
- adjust the recording settings,
- design report templates and
- select the measuring mode.



(p.23)

Selection tree

The measurement modes are arranged in a hierarchical tree-like structure. This hierarchy contains

- the relevant standard,
  - the assessment criterion (momentary and sustained vibrations),
    - the type of building or the material of earth-laid pipelines,
      - the location of the sensor (if applicable).

To navigate within this tree, sub-trees can be opened or closed. A + sign at the left side signifies that a node of this tree has sub-nodes. They can opened (the sub-tree becomes visible) by clicking on this + sign or by a double click on the node itself. The sub-tree can be closed again by clicking on the – sign or a double click on the node.

A click on the button Show all measurement modes opens the entire tree structure. In contrast, clicking on Show only standards closes the tree structure (nearly) entirely.

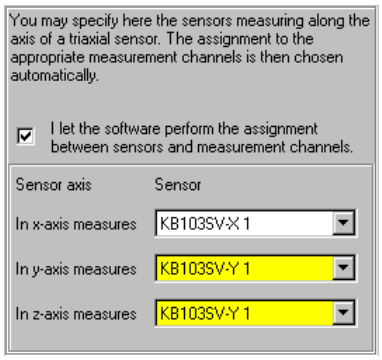
The deepest nodes of the tree represent the standardized measurement modes. The corresponding measurement mode is chosen by clicking on such a node. A parenthesized number on the right hand side of the node gives the number of such measurements, which are currently in the data storage.

User guidance

A textual user guidance system in blue font provides support by pointing out possible actions.

Sensor configuration

The node Sensor configuration allows to activate a Sensor automatic. It works identically to the one in VM-BODY. Thus, a detailed description can also be found there (p.81).

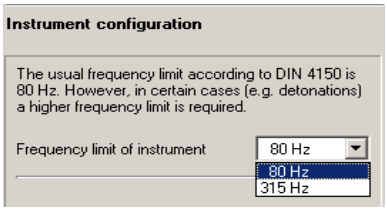


Using the sensor automatic, one can select the sensors – as they are configured in VibroMetra Online – which measure along the x-, y- and z-axis, respectively. This is especially useful, if a triaxial sensor is used. In this configuration option, the correspondence between sensors and axes can be fixed. Then, only the assignment between sensors and device channels (of the M302 or M312 units) must be set (within VibroMetra Online) in order to get the correct axes configuration. There is no need to find out the – indirect – relation between device channels and spatial directions measured.

The channel assignment in the panel Measurement is inactive and shown in gray, when the sensor automatic is enabled. The channel assignment is done automatically, so that the chosen sensor is connected with the matching measuring channel. A reconfiguration in VibroMetra Online leads to a reconfiguration of VM-STRUC, even while in operation.

If the same sensor is assigned to several channels, the corresponding fields are shown with a yellow background, in order to warn of this error.

Instrument configuration

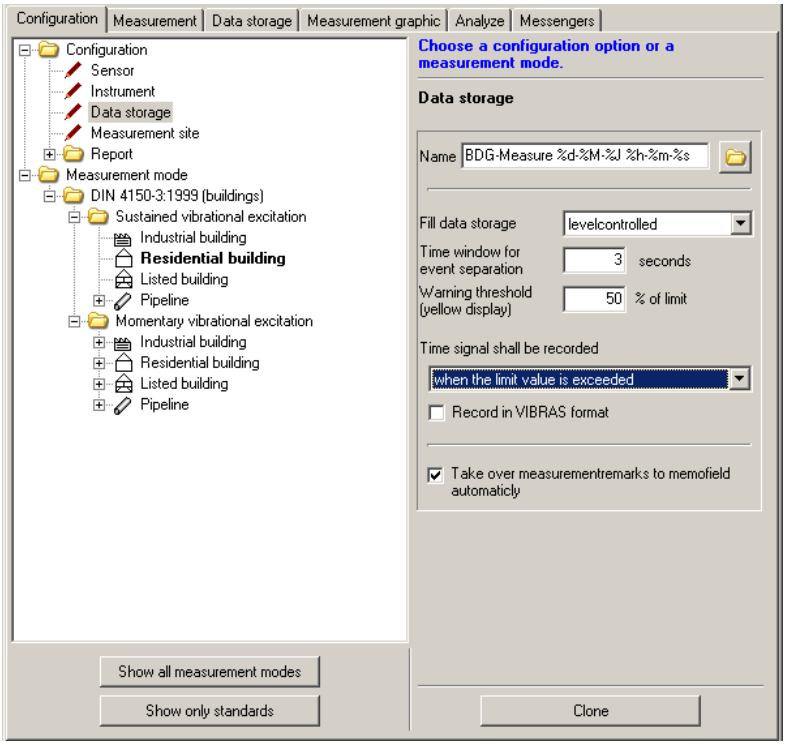


This option allows to switch the frequency limit of the instrument between 80 and 315 Hz. Normally, a frequency limit of 80 Hz is sufficient for a measurement according to DIN 4150-3. But for very impact-like vibration sources, e.g. for detonations, the standard recommends the higher frequency limit.

Recording configuration

The measured values (maximum vibration velocities and corresponding main frequencies of the events) are continuously saved to a file during a running measurement. In this way, a possible data loss (e.g. due to a power outage) is minimized. In this configuration panel the directory can be chosen, into which the file is written. Variables can be used for the file name (see page 28).

An index is attached if the entered file name already exists.



If Use default name is activated, a directory is created within the installation directory of VibroMetra, with a name comprised of date, time and a (variable) number sequence.

The time signal of frequency weighted vibration velocity and the FFT spectrum of critical vibration events (only VM-STRUC+) can be recorded for archiving purposes or for possible subsequent manual analysis. Each record is saved as a separate file, for example Event_21.dat. The numbering of the files agrees with the numbers of the events in the data storage. The files are written in a self-explanatory ASCII table.

For the evaluation of critical events VM-STRUC uses alarm limit values from DIN 4150-3. In addition you may enter a warning threshold in percent of the alarm value. A measuring value exceeding the warning limit is indicated with yellow background. An exceeded alarm limit is indicated as red background.

Recording can be activated for alarms, alarms and warnings or deactivated.

Two recording modes are available:

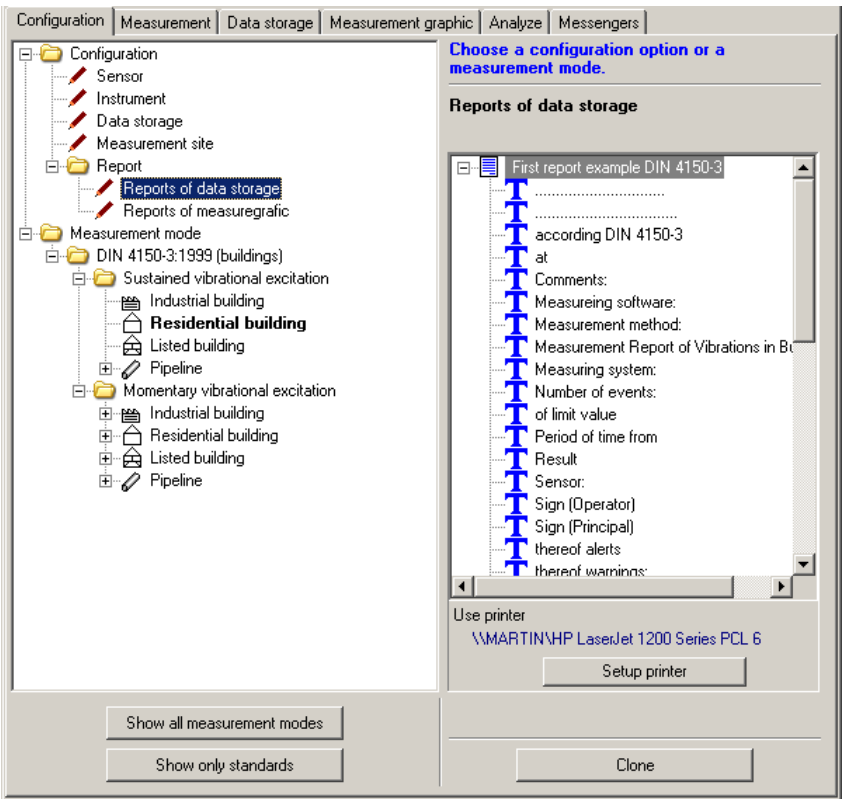
- Level controlled: Recording takes place if a warning or alarm was tripped. Time window for event separation defines the minimum interruption of the warning or alarm event before saving a new record.
- Pulse controlled: Recording in user-defined time intervals

VIBRAS is a file format for users who want to import VM-STRUC data into third-party software.

VM-STRUC monitors the measurement strictly to DIN 4150-3 Potential problems are indicated for each measurement. The option Take over measurement remarks... copies these warnings to the memo field in order to print them in the report.

Report configuration

By means of the report function you can easily print measurement reports in order to document the results of your work. You are free to create a report according to your requirements. Company address, company logo and other information can be added to a report. The generation and adaptation of a report template is described on p.30. The report templates are saved together with a workspace.



Here you may also select the printer for the report. At start-up, the standard printer is chosen by default.

The actual printing of a report is initiated in the panels Data storage and Measurement graphic.

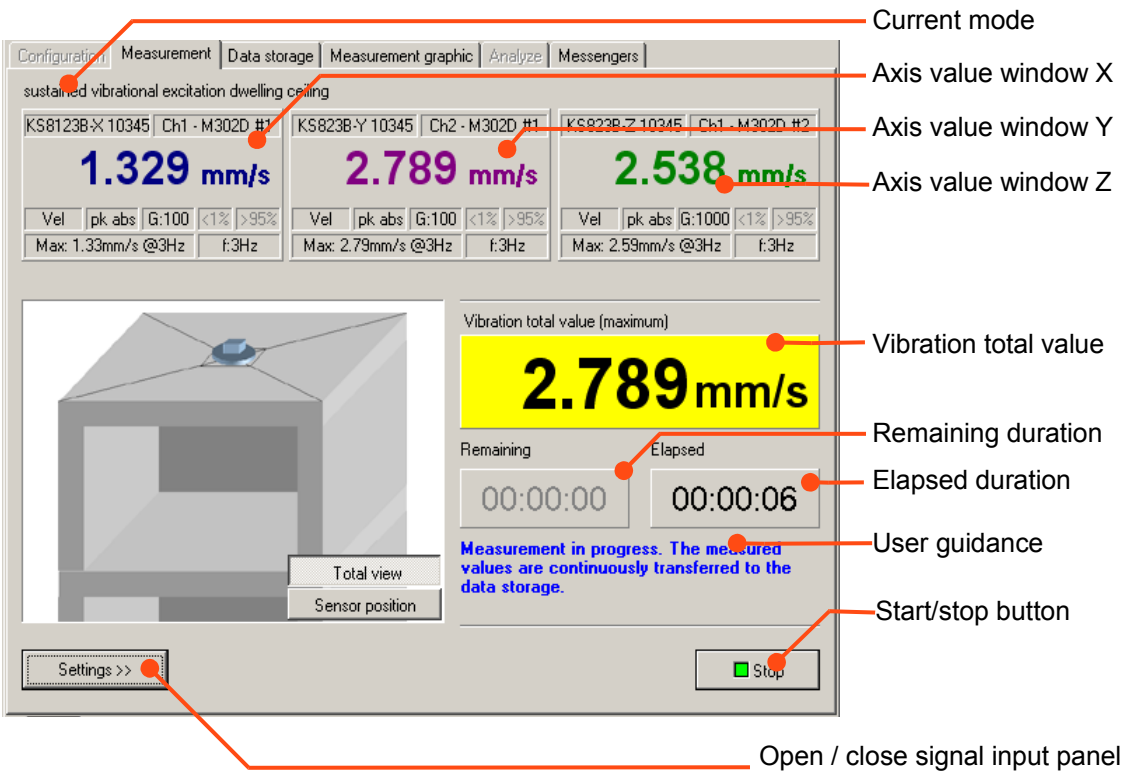
Measurement mode selection

The details of the chosen measurement mode according to DIN 4150-3:1999 are shown in a field on the right-hand side of the panel. The possible locations of the sensor are given, too.

Measurement is stopped after the time entered at Measurement duration. If automatic stopping is not desired you may select infinite.

Performing the measurement

This is the main operating panel. Measurement is started by the Start button.

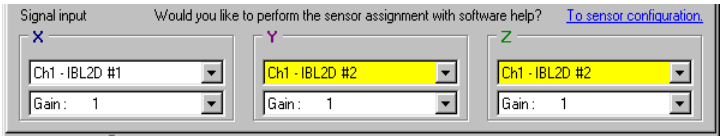


Display of the current measurement mode

For the sake of clarity and to avoid erroneous operation the currently chosen measurement mode is displayed in short form as a header line.

Signal input

The button Settings >> opens the panel for the signal settings.



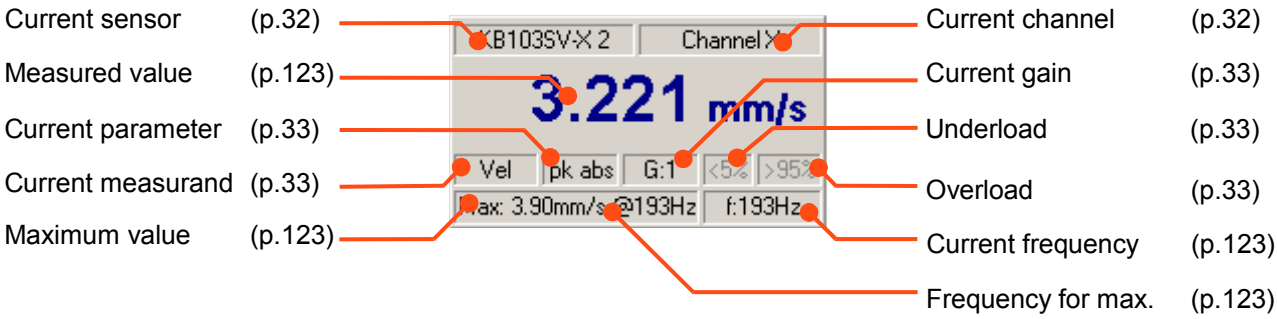
Here, the spatial axes can be configured for the measurement. For easy overview, each axis is uniquely distinguished by a color. The same colors are also used in the axis value display. The measuring channel for each axis can be chosen from a list which contains all channels available for VM-STRUC. The channel assignment is inactive if the sensor automatic is in use.

In order to avoid the accidental selection of two equal channels, a yellow warning is given in this case.

The gain settings allows to select the appropriate measuring range (p.24). The overload and underload indicators give helpful information in order to find the correct gain setting (p.33).

As a help for new users, a hint is shown in an un-configured instrument, pointing out the sensor automatic.

Axis value window



The axis value windows display for each axis the currently measured value, as well as status information. The main measured value is the maximum of the frequency weighted vibration velocity for each axis.

An important part of the status information is the assignment of the measurement channels, since these have to be done as defined in the standard. The colored display of the measured values eases the fast correlation. When fewer than three channels are used in a measurement, the inactive axis value windows are displayed in gray.

The overload and underload indicators give important status information during a measurement. They ascertain the correct measuring range and are of help in avoiding measuring errors and inaccuracies. Therefore, these indicators are required by the standard. Further information can be found on page 33.

Measured values

The main characteristic value for assessing the vibration exposure according to DIN 4150-3:1999 is the maximum of the frequency-weighted vibration velocity. The current magnitude of this velocity is displayed as the main value in the corresponding axis color.

Furthermore, the frequency of the vibration at the occurrence of the maximum value is an important quantity in order to determine the allowable limit value, according to the standard. During a running measurement, the frequency of the part of the signal with the largest magnitude is continuously determined. The value of the frequency determined in this way is displayed in the axis value window, too.

Additionally, the maximum value of all previously measured vibration velocities (total maximum) is shown, together with the associated frequency.

Please note that, as a matter of principle, the frequency determination can not be carried out until a few seconds after the corresponding maximum occurred. Therefore, the maximum value display is – so to speak – early compared with the current frequency display. This time offset is automatically corrected for in the display of the total maximum and in the Data storage, of course.

Vibration total value

The maximum of the frequency weighted vibration velocity in all measured axes is displayed as the vibration total value. The assessment of the currently measured vibrations is based on the value. To this end, the total value is compared with the limit values as given by the standard and the background is colored accordingly. The meaning is:

- green: good/The (worst) value is below the warning threshold.
- yellow: acceptable/The value is above warning threshold (Warning).
- red: bad/The value is above the allowable limit (Alert).

The assessment starts with a delay of 6 seconds after switch-on, in order to allow initial transients to die down without causing a spurious warning.

Time display

Two time displays show the remaining and the elapsed measurement time. When the preset duration has elapsed, the measurement is stopped and the measuring value displays are frozen. The measured values are automatically transferred to the data storage.

If a continuous measurement is activated, the measurement is not stopped automatically and the remaining time display is fixed to zero.

User guidance

A textual user guidance helps the user to easily and successfully perform the measurement by indicating the next appropriate step.

Data storage

The panel Data storage is designed to

- amend measurements with individual remarks,
- show detailed information for each measurement,
- manage the storage (erase, write, read data) and
- print a report.

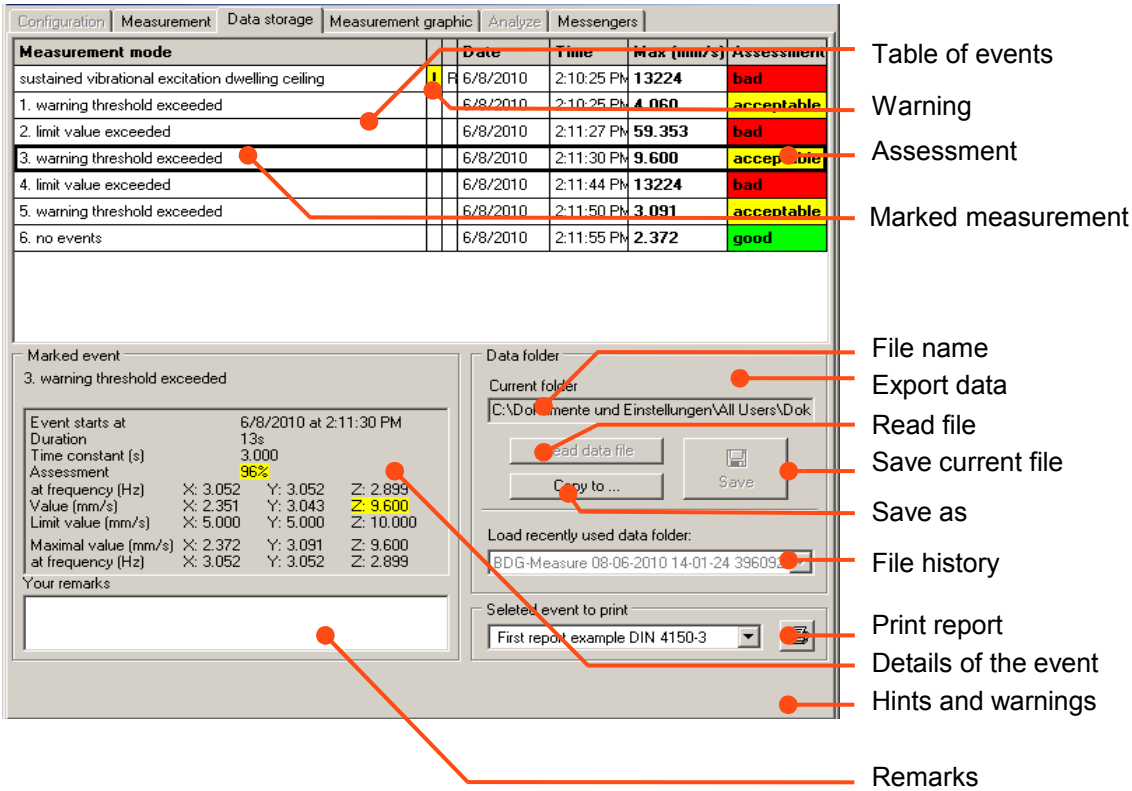


Table of events

The first row of the table contains data, which is relevant for the entire measurement (start time, duration, parameters, total maximum, worst value). All other rows contain the events (warnings and alerts, up to a maximum number of 100,000) which have occurred during the measurement. Events are generated when the measured value exceeds the warning threshold (warnings) or the limit value (alarms) or if a record time interval is over.

The description in the first column of the table is composed of

1. a running number (for events),
2. the (fixed) description of the measurement or the event or interval and
3. the (user-defined, i.e. variable) first line from the field Your remarks.

In order to uniquely label an event, it may be convenient to enter a short description as the first line of the remarks. This is, of course, not mandatory, since the events are always distinguishable by their date and time, which is automatically recorded.

The second and third columns are only relevant for the first row (for the whole measurement). The second row shows a yellow warning (exclamation mark) if the chosen gain is in error, i.e. if overload or underload occurred.

Marked measurement or event

For the (selected) marked measurement detailed information is provided.

Details of the event

This field lists all settings and measuring values for the three axes at the measuring time.

Remarks

You can add remarks to each vibration event. These remarks will be saved with the measurements. The first line is also shown in the table. This can be, for example, a notice to change the gain. A warning of low input signals at shortly after start up, before the first vibration event, can be ignored. However, make sure that this warning does not occur permanently.

Printing reports

For the marked event a report can be printed by clicking the printer symbol. There is a list of print templates which have been defined in the report configuration menu (page 121). If the first line was marked, a report of the most critical event is printed.

Fading out entries

This function is available at right mouse click. The marked event is faded out so that it will be excluded from the main value in the first line.

Data folder

You may save or reload the data storage memory from hard disk. Data is saved into separate folders since it may consist of more than one file. The actual measuring data is exported in CSV format (comma separated values). The file name is the same as the folder name. Other data, like frequency analysis in VM-SHIP+, may be added to the folder.

The data storage memory is saved automatically to hard disk after finishing the measurement. If no folder name was entered, a name is generated automatically. If you have changed the data storage after measurement, e.g. by adding remarks, save the record manually by the save button. Click Copy to... to save data under a new name.

Furthermore, it is possible to read back data files into VM-STRUC which have previously been saved in CSV format. These measurements will be added to the existing content of the data storage. Thereby one may accumulate related measurements and record them together, even if they are performed at different times. The last read folder name determines the folder name used for saving the modified data.

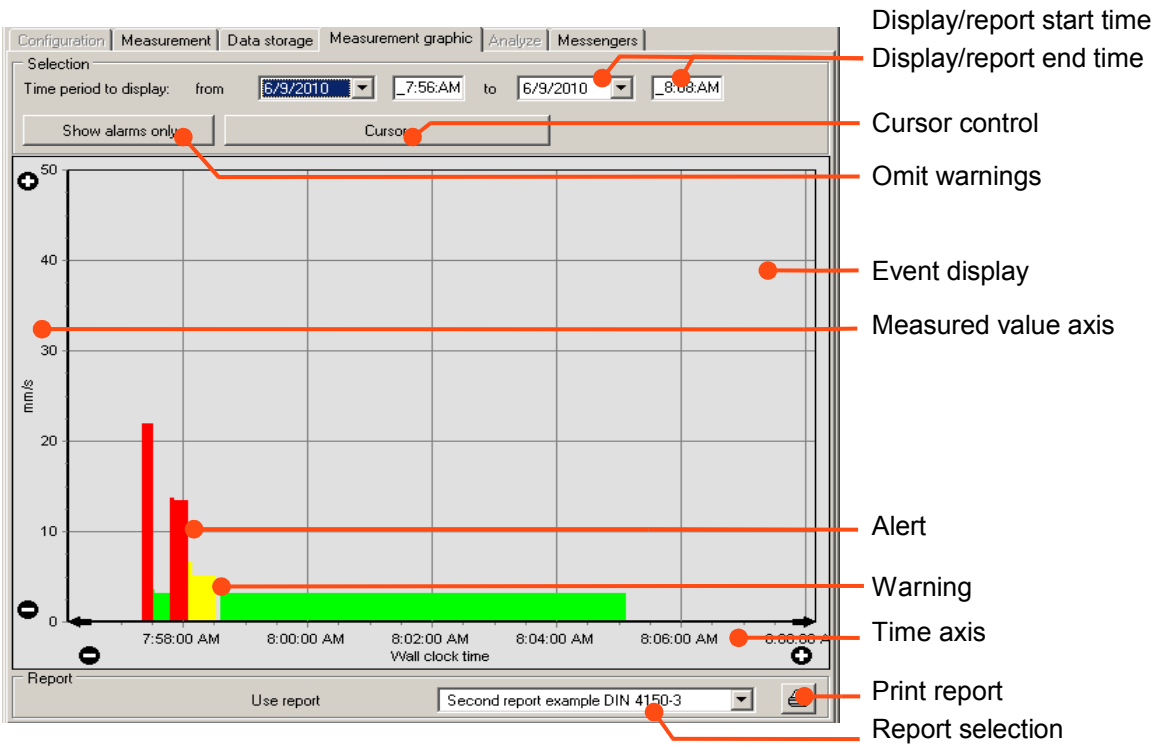
Recently used data folders are shown in a drop-down list.

The used CSV format allows simple export into common spreadsheet editors like Microsoft Excel or OpenOffice Calc.

Graphical display

The panel Graphical Display is designed

- to obtain an overview of the temporal occurrence of the events,
- to select the time period for a report,
- to print a report about the selected time period.



Graphical event display

The graphical display shows a clear diagram of the occurrence of events. An alert, i.e. a time when the limit value is exceeded, is displayed by a red rectangle and a warning, a crossing of the warning threshold, by a yellow rectangle. The width of a rectangle corresponds to the duration of the event. The height of a rectangle is determined by the worst measurement value belonging to this event. The display of warnings can be suppressed by activating the switch Omit warnings.

The measured value axis can be toggled between relative view (% of the limit value) and absolute view (mm/s). The view is toggled by a right click on the axis within the range of the labels.

A mouse click on the symbols ⊖ and ⊕ effect the enlargement or the reduction of the displayed axis segment, respectively. Both axes provide this zoom function. A double click on an axis effects an automatic scaling of the axis resolution. The y-axis is scaled in such a manner, that all measured values can be shown. The possible display range is restricted to a maximum of 1000 % or of 1000 mm/s, though. Auto-scaling the time axis shows the entire time measurement duration present in the data storage.

Display/report time range

The time range to be displayed can be chosen in two different ways:

Begin and end of the time period can be directly adjusted with the numerical fields for date and time in the upper part of the panel. The time axis of the diagram immediately adapts to the selected settings.

Otherwise, shifting or zooming the time axis also affects the display time period. In this case, the numerical fields adapt their values accordingly. A specific time period is most easily selected, if it is simply marked in the diagram with the right mouse button (free zoom function).

Cursor control

By activating the switch Cursor a cursor appears in the diagram, which can be moved with the mouse. The event currently beneath the cursor is always shown as the marked event in the Data storage panel. If there is no event beneath the cursor, the next one to the left (i.e. earlier one) is chosen.

Using this feature, the detailed data of, e.g., graphically prominent events can be found quickly and easily.

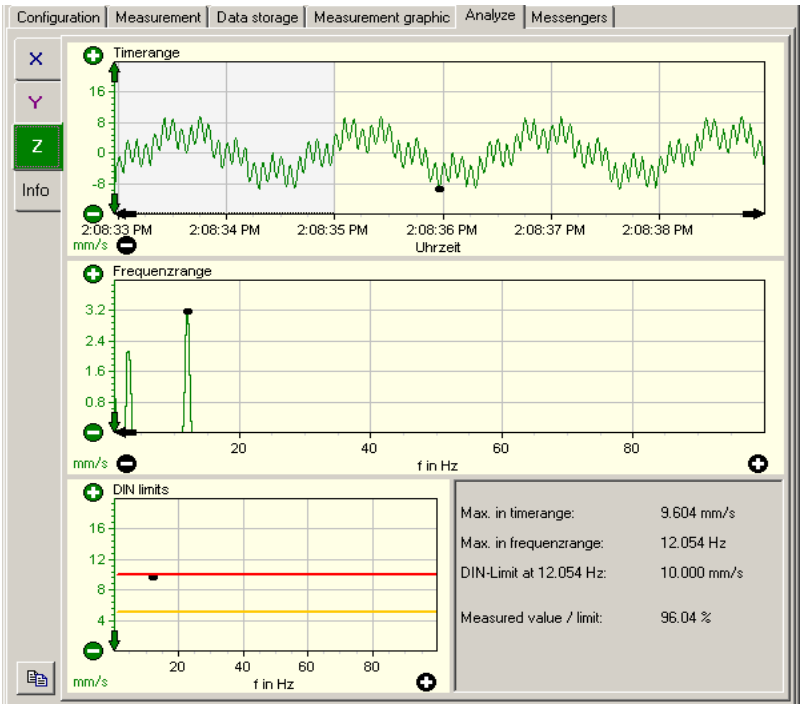
On the other hand, if an event is selected in the Data storage, the cursor position is also updated accordingly.

Printing a report

Clicking on the print button starts the printing process. It uses the report template which is currently selected in the list Use report. The printed report comprises exactly the time range of the diagram, which can also be adjusted in or read off from the date and time fields in the upper part of the panel. If the warnings are hidden, they are omitted from the report.

Vibration analysis

VM-STRUC+ includes an FFT analyzer which allows a deeper insight into the recorded vibration events. For each warning or alarm event in the data storage VM-STRUC+ displays a diagram of weighted vibration velocity in time and frequency domain



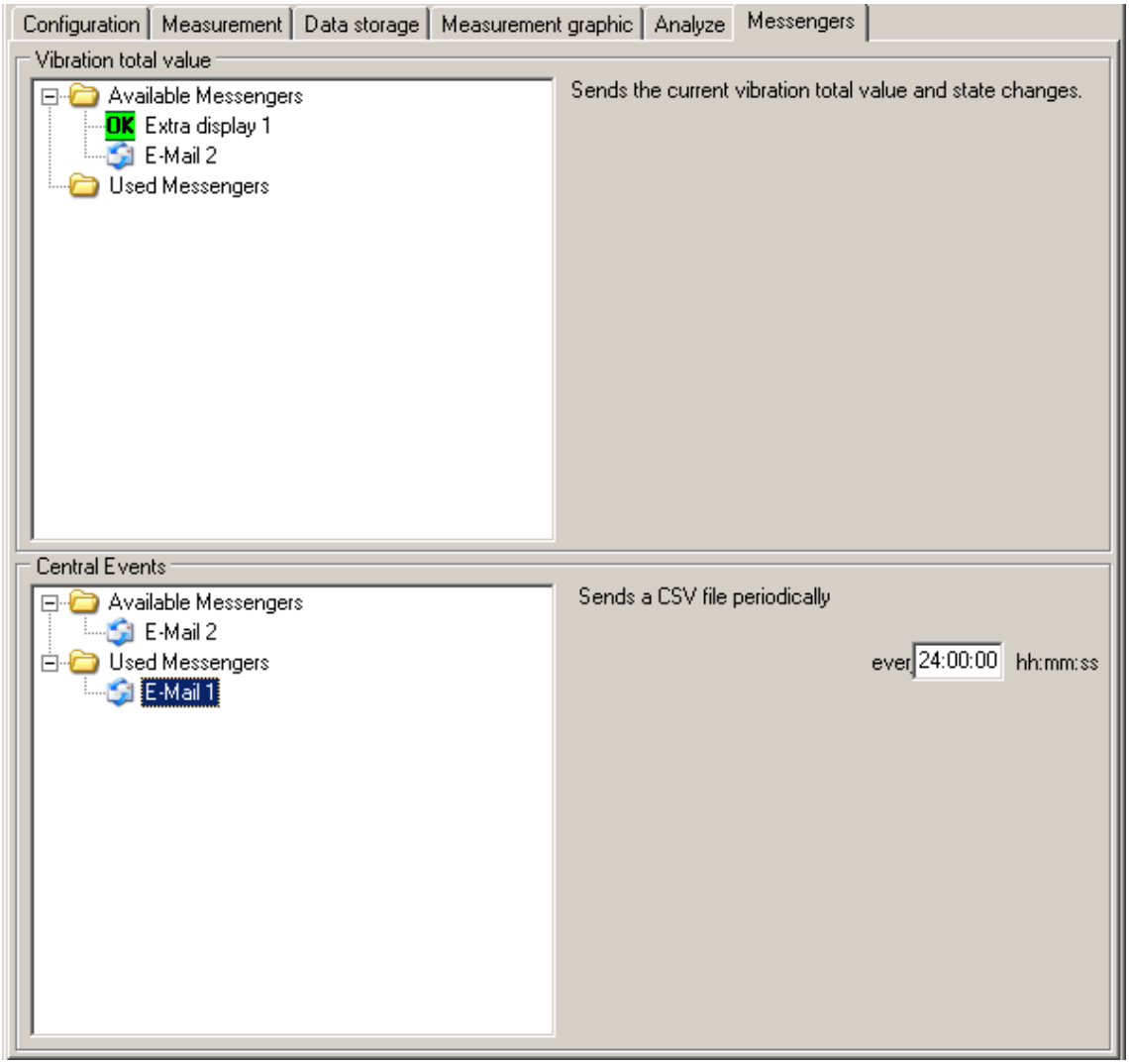
The analyzer automatically detects the maximum vibration amplitude and the relevant frequency and displays them as black dots in the diagrams.

The Info tab shows the file name for exporting the data.

Messengers

Event messengers are used to to send measuring values and status messages to external hardware as described in section 7 on page 131.

VM-STRUC can send messages and measuring values at exceeding the maximum limits as well as periodically.



In the tab Messengers you find two lists.

The upper one lists messengers used for the total vibration value and for alarm messages.

Possible applications are sending an email from a remote measuring point or switching an alarm device at alarm tripping.

The lower list shows messengers which periodically transmit files with the contents of the data storage. These can only be email messengers. Here you can also enter the time interval for transmission. The sent CSV files can be read by the recipient with VibroMetra Simulator or Office software supporting CSV files.

The use of messengers is described in section 6.5 on page 31.

7. Event Messengers

7.1. Introduction

Messengers are used to transmit warnings or measuring data to external hardware.

This includes:

- Email transmission
- Large color display at the screen
- Radio controlled switch system
- ADAM digital control interfaces

Please note that the VibroMetra messengers must not be used for safety relevant purposes.

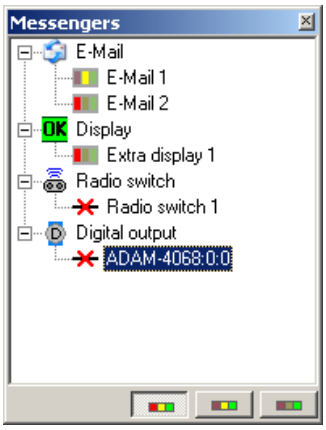
7.2. Messenger Management

The messenger function can be switched off when it is not needed. The checkbox Show messenger management for activating the messenger menu can be found in the Displaying tab of VibroMetra Online.

7.3. List of Messengers

A mouse click at the Messengers tab of VibroMetra Online opens a list of all messengers. Here you can define new messengers. The connection with the instruments is done in the instrument windows.

You see the main types of messengers with sub-entries showing the messengers which have been set up, which are active, passive or interrupted.



Event messenger is interrupted and not available

Event messenger is not in use

Event messenger is in use but inactive because, for example, the respective instrument is switched off.

Event messenger is in use and active.

Main switch

The button Start all messengers of VibroMetra Online enables or disables the transmission of messages for all instruments.

Creating an event messenger

Right click the event messenger type you want to create. Click New messenger. The properties of the new messenger will be displayed. At the same time the new messenger appears in the messenger lists of all instruments. The messenger window can be collapsed by <<Display only after the properties have been entered.

Deleting an Event messenger

An event messenger can only be deleted if its is not in use, i.e. if its indicator is red. Otherwise it needs to be released in the respective instrument. Right click the messenger in the list and click Delete messenger.

7.4. VM-MAIL Email Messenger

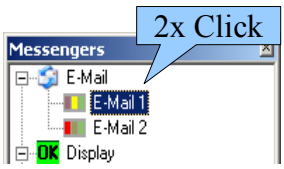
Email transmission of measured data can be particularly useful in unattended applications of the VibroMetra system.

VM-MAIL can transmit

- Single measurements
- Status messages
- Diagrams
- Larger quantities of measured data

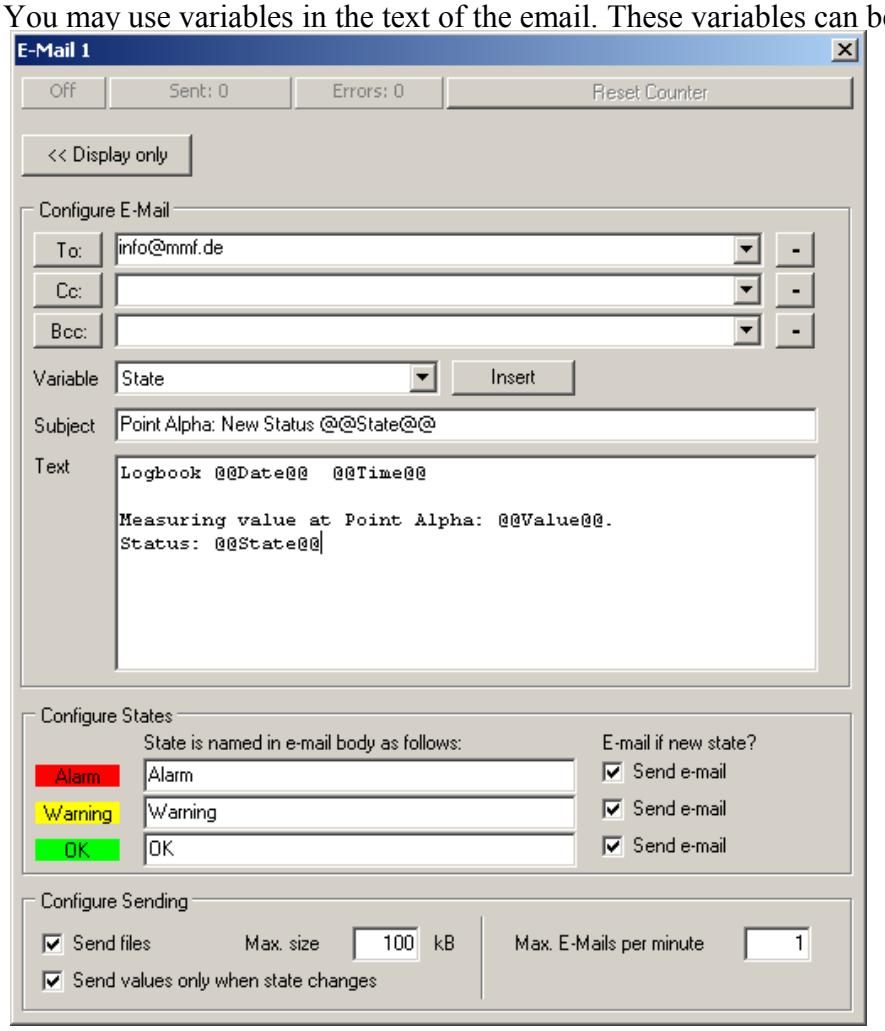
Settings

Double click an email messenger in the list.



Enter the address at To and other recipients receiving a copy at Cc and a blind copy at Bcc, if desired.

You may use variables in the text of the email. These variables can be



- the measuring value: @@Value@@
- the status: @@State@@
- the date: @@Date@@
- the time: @@Time@@

The variables will be filled with the valid content at the moment of sending.

Variables can be entered as text in double @ characters and, more conveniently, from the drop down list Variable and click at Insert while the cursor is at the desired insert position.

Variables can also be used in the subject line.

Some instruments generate status messages like “good” or “bad”. You may enter other names for them which will be used for sending the status variable @@State@@.

Here you can also specify which status changes trigger the email transmission.

Some instruments, for example VM-REC, may transmit both status messages and saved data. Uncheck Send files if you do not want to send saved data. You may also limit the maximum file size. Saved data will not be sent if it is bigger than the entered Max. size.

Status changes may occur up to 4 times per second. VM-MAIL can limit the number of emails sent per minute.

After making these entries the email messenger can be collapsed by <<Display only .

A status line will remain visible showing activity, the number of sent emails and the number of errors. Reset counter clears these values.

Connection with your email program

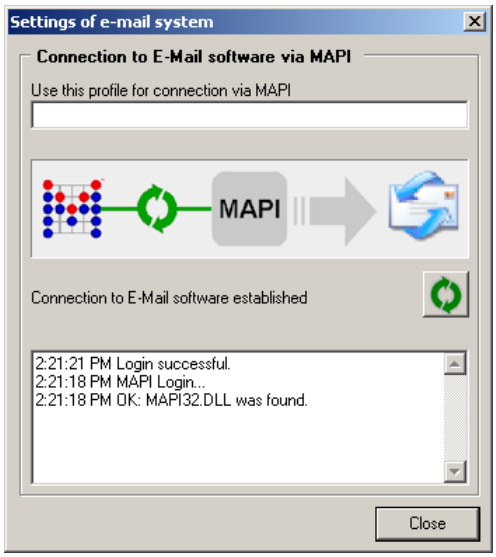
For safety reasons VibroMetra does not directly send email. It uses your existing email program. The connection is made via the Windows email interface MAPI. Most email programs support MAPI.

As soon as you have created an email messenger, it will try to establish a MAPI connection. Usually the email program will start (if not started yet).

The MAPI status can be found in the properties of the messenger type E-Mail.

Double click at the messenger type.

Most email programs do not require a special MAPI profile. However, some email programs, like Outlook, will ask you for a profile. This can be avoided if you enter the profile name in the email settings of VM-MAIL. Valid profile names can be found if you leave the profile field blank and try to establish a MAPI connection. Your email program will show you a drop-down list of profile names. Select one and copy it to the profile field. Next time when establishing a MAPI connection this profile will be used automatically.

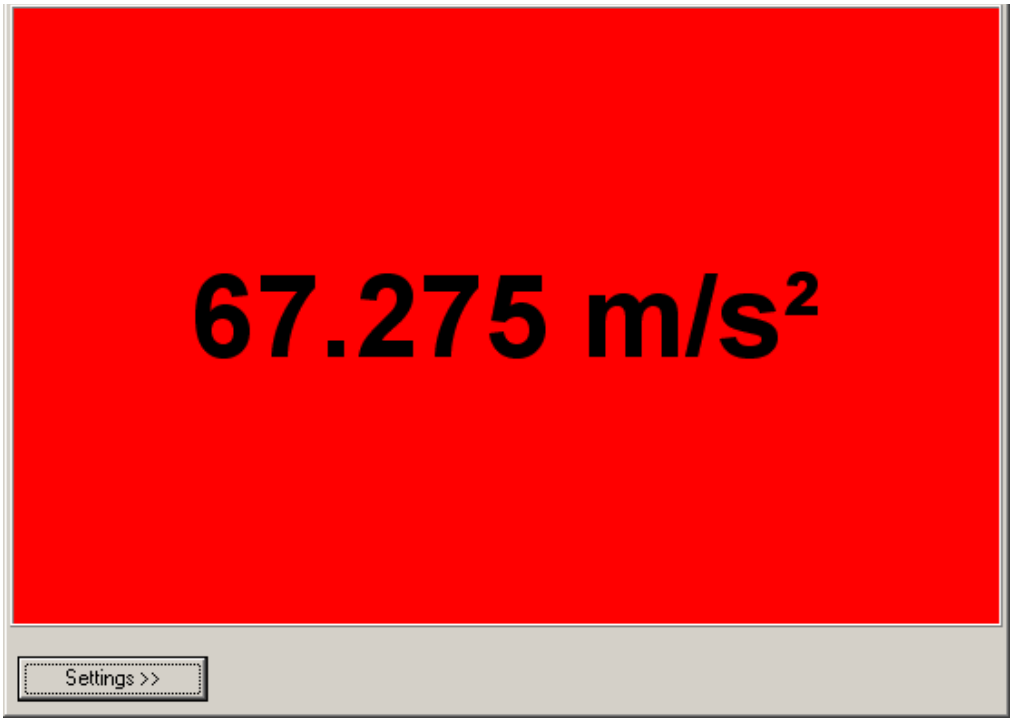


You may repeat the MAPI connection process by clicking  .

A text window shows the steps of MAPI connection and sent emails.

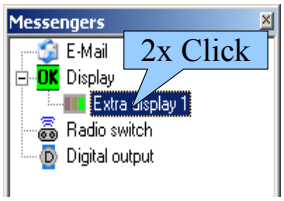
7.5. VM-LARGE – A Large Screen Display

This messenger does actually not send messages to other places. It uses the screen of the PC where VibroMetra is running. VM-LARGE produces large colored status indicators. This can be useful in quality testing, for example.



Settings

Double click a display messenger in the list.



The large display can show three conditions which are called here OK, Warning and Alarm. Each condition can be shown as a text message edited by the user with variable size and background color. If Show text is not selected the large display will show the measuring value instead.

Check Hold display after switch-off if you want to keep the last condition of the instrument after measurement is finished. Otherwise it will show Off.

7.6. VM-RADIO – Wireless Switch Function

This messenger can transmit alarm messages via a radio interface to remote switches for 230 VAC loads like lamps, horns and other devices.

The radio messenger is based on the FS20 home control system which is operated in 868 MHz band.

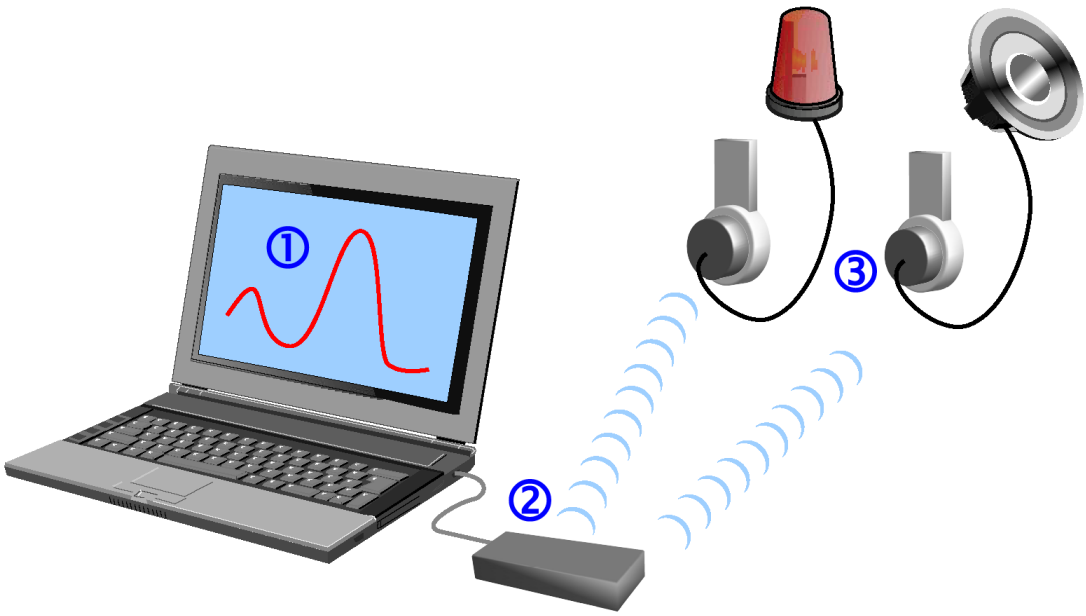
☞ Please make sure that the 868 MHz band is licensed for public use in your country before using VM-RADIO.

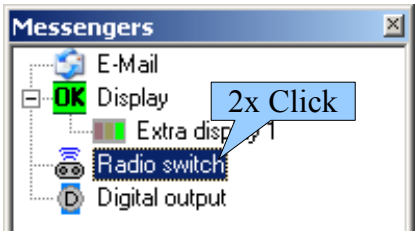
The FS20 system reaches up to 100 m distance in open air.

There is no back channel. VibroMetra cannot verify whether the remote device has actually switched.

A USB radio transmitter FHZ 1000 PC (2) is connected to a USB interface of your PC (1). It will send data to all switch devices (3) having valid addresses. There are 16 channels so that 16 different status messages can be sent by VibroMetra.

Establishing of a radio connection





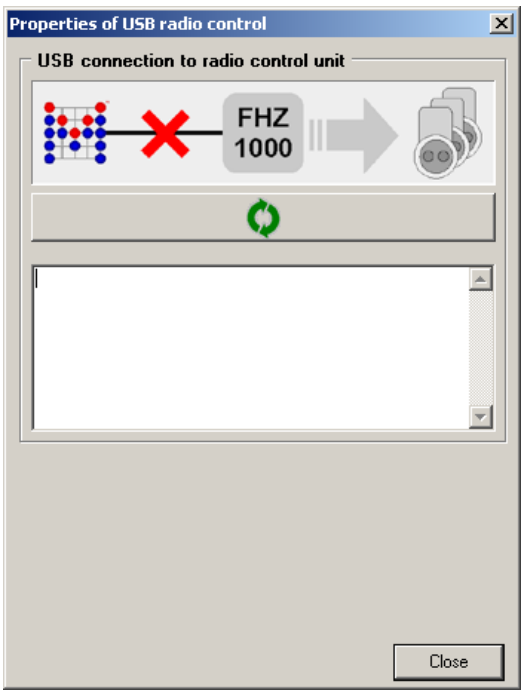
Conflicts with other FS20 systems in the neighborhood are avoided by a random system code which is issued by the manufacturer.

When you connect the FHZ 1000 PC for the first time you will be asked for driver installation. A driver CD is supplied with the FHZ 1000 PC. The driver is also available for downloading from http://www.mmf.de/software_download.htm.

VibroMetra tries to establish a connection with the FHZ 1000 PC automatically. To check the connection double click the entry Radio switch in the Messengers window of VibroMetra Online. A control window will open.

Preconditions for communication are the installed driver and the connected FHZ 1000 PC.

If there should be no connection, click the  symbol.



The next step is programming the address of the remote switch device.

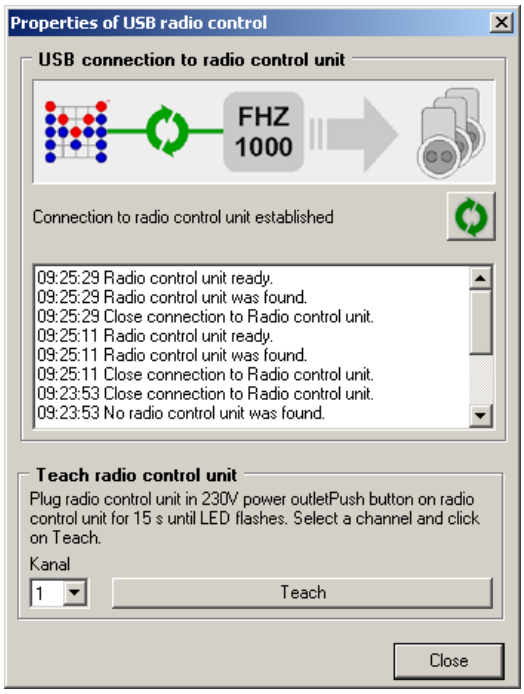
The properties window of the radio switch features a teach-in function.

This function will only be visible if you Stop all messengers in VibroMetra Online.

Metra offers the radio switch box **FS20AS1** and and the radio controlled outlet **FS20ST/2**. Both have relay outputs.

These devices are programmed as follows.

First you need to select a Channel for communication.



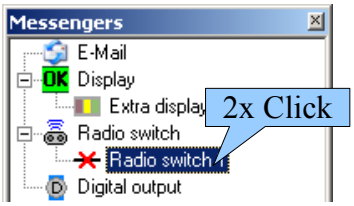
Programming the radio switch box FS20AS1: Open the cover of the box. Connect the terminals L, N and PE with mains voltage. Press the programming button for at least 5 seconds. The LED starts flashing. Select in the VM-RADIO properties the desired channel. Click Teach. The LED at the FS20AS1 stops flashing.

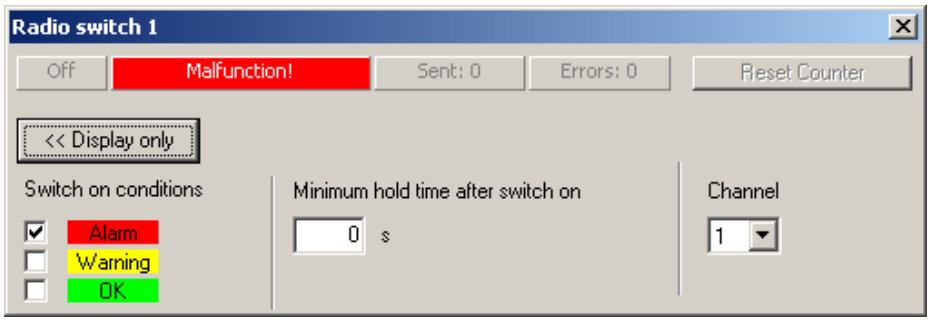
Programming the radio switch box FS20ST/2: Plug the FS20ST/2 into a 230 VAC mains socket. Press the push button for at least 15 seconds. The LED starts flashing. Select in the VM-RADIO properties the desired channel. Click Teach. The LED stops flashing.

The radio switch device is now programmed and ready for receiving commands from VibroMetra.

Settings of the event messenger

Double click a messenger of radio switch type. You may select which events will switch the radio device. A Minimum hold time can be entered to ensure save switching. The Channel number assigns one of the 16 channels to the messenger (channel programming see above). It must be a channel number programmed by the teach function (see above).



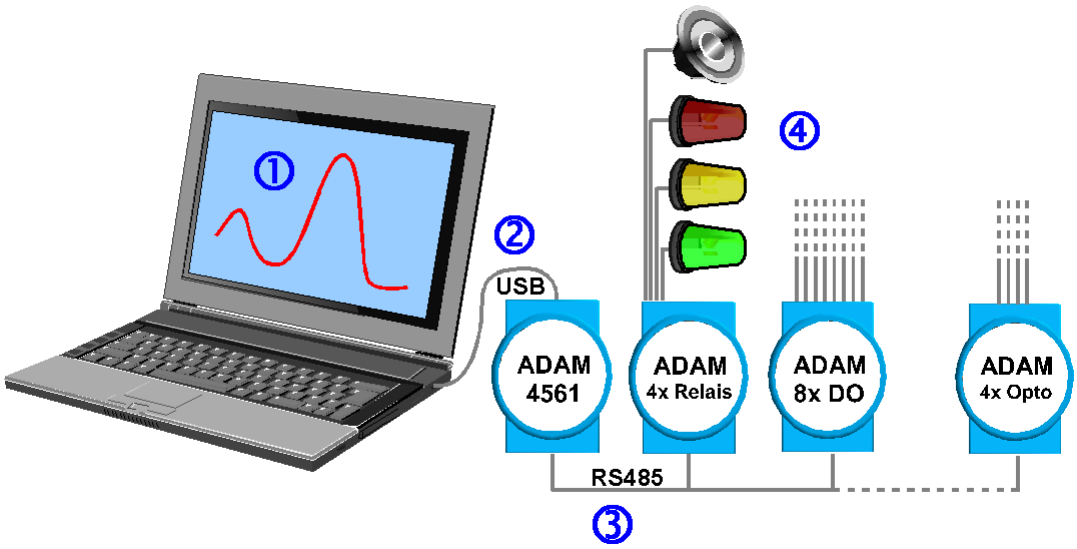


After making these entries the radio switch messenger can be collapsed by <<Display only . A status line will remain visible showing activity (On/Off), a functioning connection, the last sent switch condition (On/Off), the number of sent changes and the number of errors. Reset counter clears these values.

7.7. VM-ADAM – Digital Interface

This messenger is based on the popular industrial interfaces of ADAM[1] series.

It provides switch functions via relays, digital outputs or isolated digital outputs. Due to its modular design ADAM provides high flexibility. More than hundred switch outputs can be controlled by VibroMetra.



The ADAM system has a back channel so that VibroMetra can verify the switch action.

A USB interface module ADAM-4561 (2) is connected to the PC (1) where VibroMetra is running. It converts VibroMetra commands into a 2-wire RS485 bus signal (3). Up to 32 ADAM output modules (4) can be connected to the RS485 bus. The distance between two modules can be up to 1200 m.

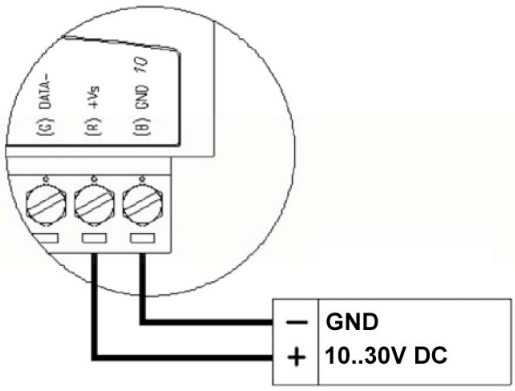
1 The ADAM system is made by Advantech. (http://www.advantech.com)

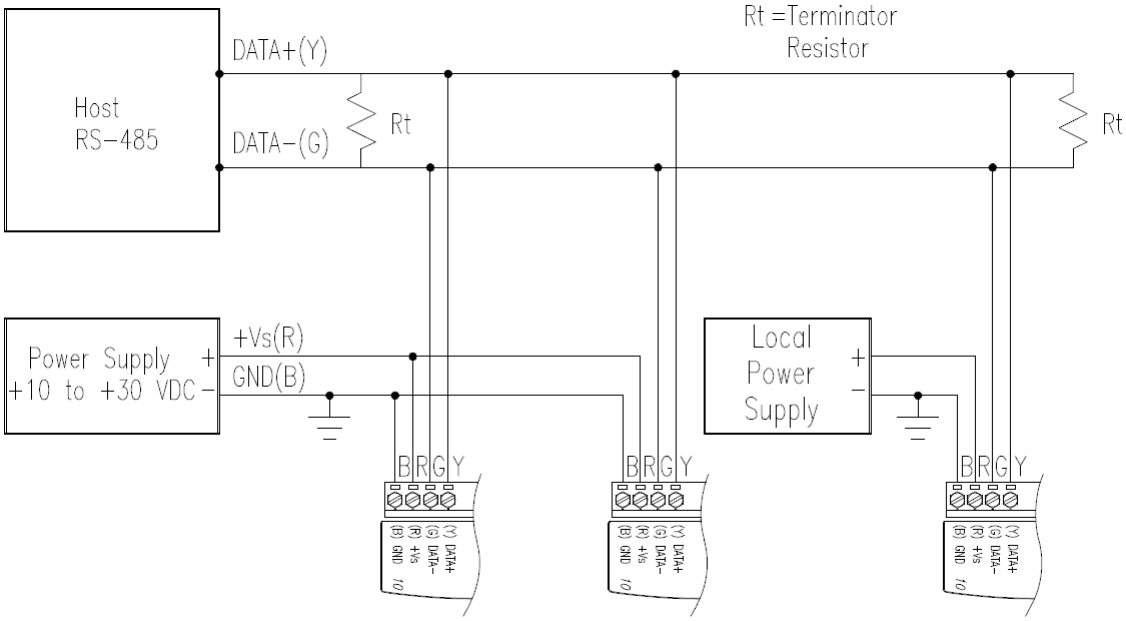
Installation

The ADAM modules are suitable for DIN rail mounting.

The USB interface ADAM-4561 is powered from the PC. The output modules need a supply voltage of 10 to 30 VDC which is connected to +Vs and GND terminals.

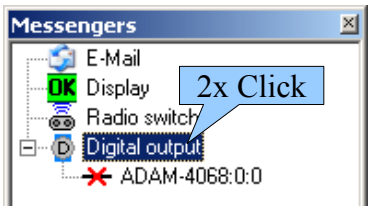
To connect the RS485 bus, wire the DATA+ and DATA- terminals of the output modules with the DATA+ and DATA- terminals of the USB interface module ADAM-4561.





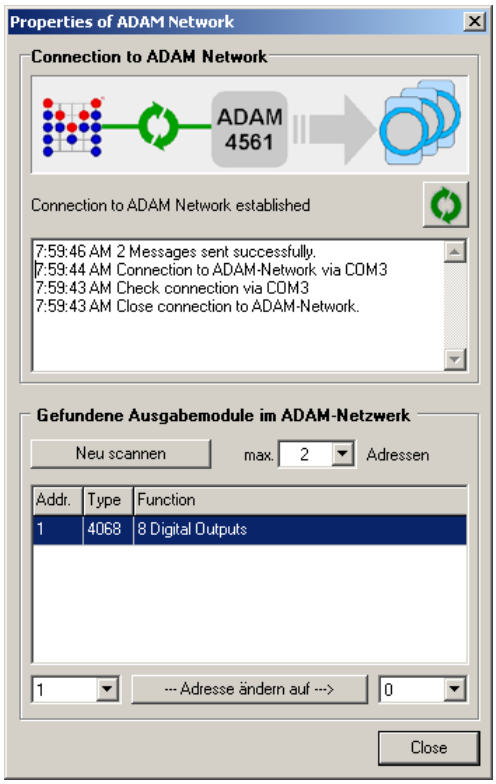
Establishing of a connection

When you connect the USB interface ADAM-4561 for the first time you will be asked for driver installation. A driver CD is supplied with the ADAM-4561. The driver is also available for downloading from http://www.mmf.de/software_download.htm.



VibroMetra tries to establish a connection with the ADAM-4561 automatically. To check the connection double click the entry Digital output in the Messengers window of VibroMetra Online. A control window will open.

Preconditions for communication are the installed driver and the connected ADAM-4561. Output modules must be connected to the ADAM-4561 via RS485 and to the supply voltage in order to be detected by VibroMetra.



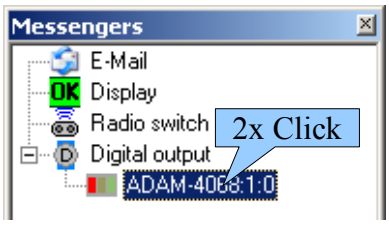
If there should be no connection, click the  symbol.

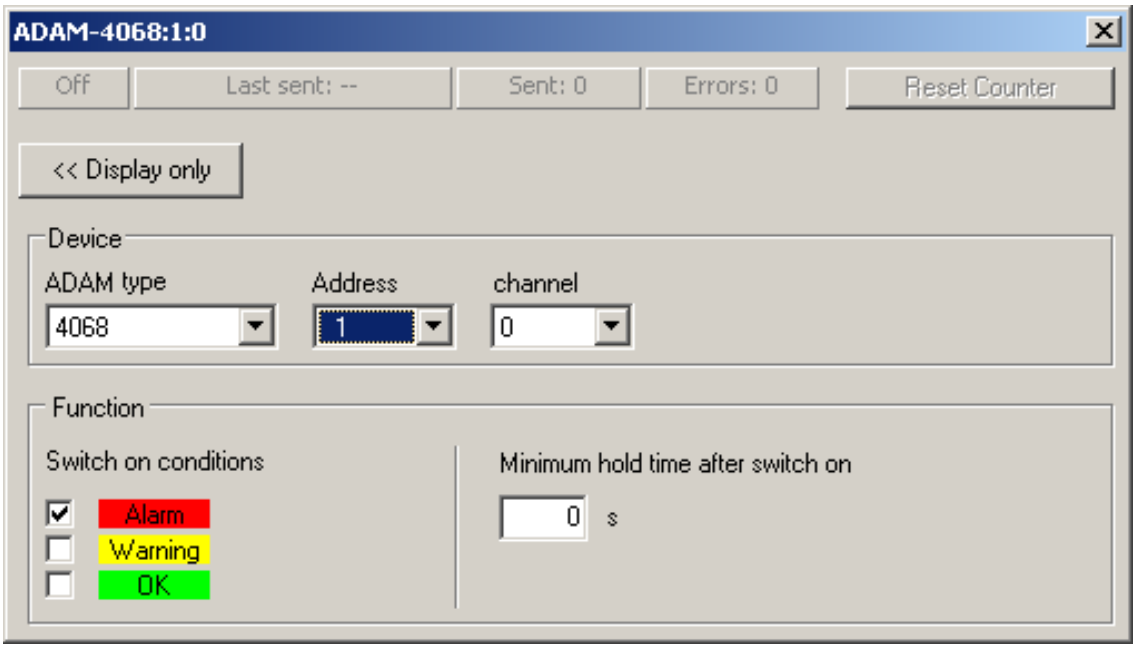
ADAM-4561 communicates with all connected output modules via the same 2-wire interface. Therefore each output module needs an individual address. VM-ADAM has a Scan function to detect the addresses of connected output modules and a function to change the address.

The default address set by the factory is 1. Please connect the output modules one after another, scan the address each time and change it to an address different from 1.

Settings of the event messenger

Double click a messenger of digital output type. In the setup window three parameters need to be entered the switch output: ADAM device type, address and channel. These parameters will identify the name of the messenger.





A switch output can be specified even if the corresponding ADAM device is not connected. In this case the error message Malfunction will be displayed in the upper line.

In the drop-down list for device selection all ADAM modules having switched outputs are listed. Address identifies the device and Channel selects the output.

VibroMetra automatically creates a name for the switch output based on these settings as for example: ADAM-4068:1:0.

Furthermore, you may select which events will switch the output and a Minimum hold time can be entered.

After making these entries the radio switch messenger can be collapsed by <<Display only . A status line will remain visible showing activity (On/Off), a functioning connection, the last sent switch condition (On/Off), the number of sent changes and the number of errors. Reset counter clears these values.

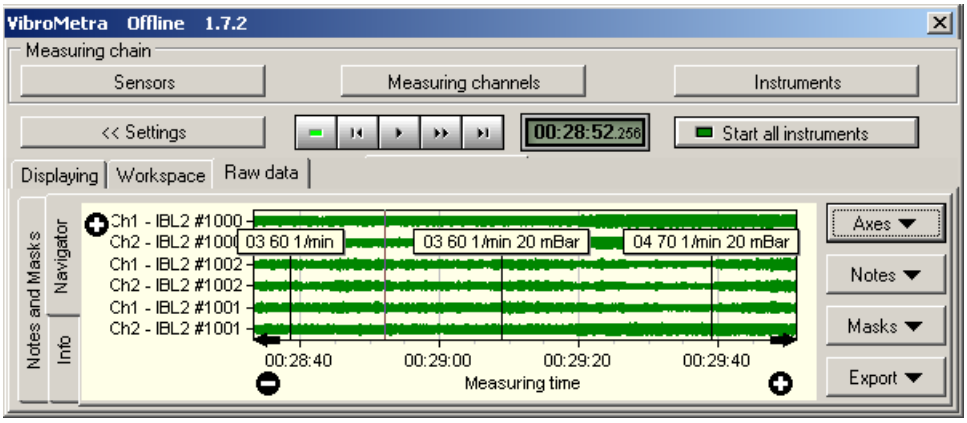
8. VibroMetra Offline

Data files in IDS-format can be played back with the control center VibroMetra Offline. You can analyze the sensor data off-line using different instruments or using differently adjusted parameters, like filters, time windows, etc.

In addition to the measured data further information is saved with the data stream, for example time and notes.

VibroMetra Offline is mostly identical to VibroMetra Online. There are some additional controls and displays for data playback.

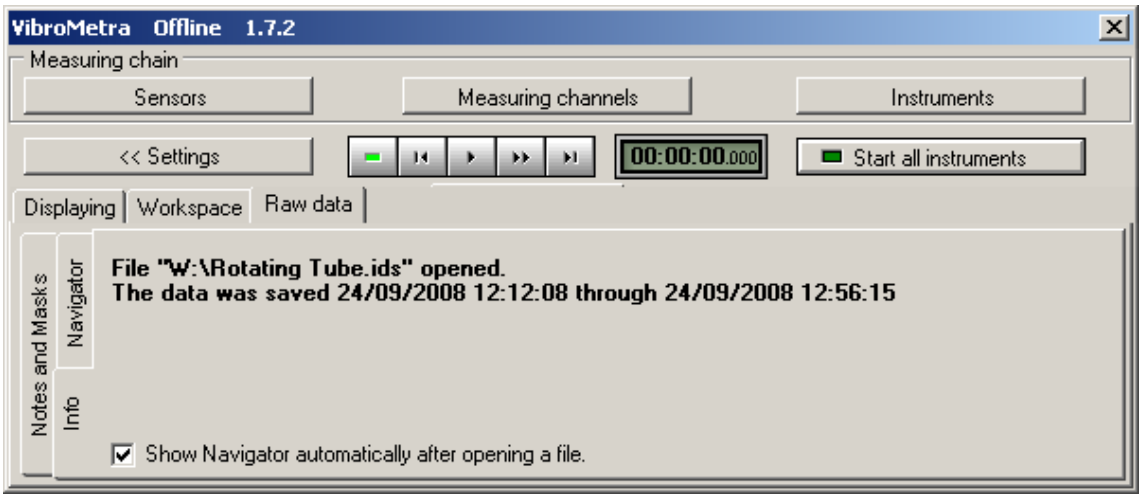
Additional controls and displays for off-line analysis can be found in the panel Measurement data in the extended view:



The panels Displaying and Workspace are identical to those in the VibroMetra Online. There explanation can be found there and is not repeated here.

8.1. Loading a Raw Data File

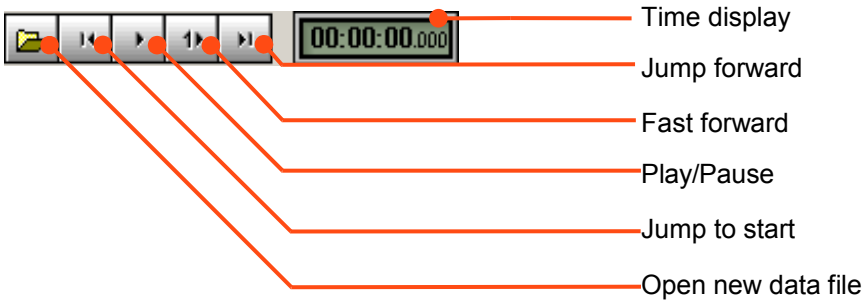
Click the  symbol and select the raw data file. The file name extension is ids. Loading is indicated by some messages in the Raw data panel.



The time display will show the progress of loading. Loading errors are indicated by a red time display. An error description can be found in the Info panel. Successfully loaded raw data will be displayed graphically in the Navigator panel.

8.2. Replay Control

The bar of navigation buttons is the central control for data replay



Time display

The Time display shows, depending on the time axis setting, the measurement time relative to the start of the data file or absolute as the time of measurement. The time is given in hours : minutes : seconds. The final three digits are milliseconds. The displayed time always exactly matches the current data replay position.

Play/Pause

A click on the button Play starts the data replay. It initially proceeds at normal speed (1 second data time corresponds to 1 second clock time) using the display refresh time as set in the panel Displaying. The instruments can be operated as usual. Please note, that the data time proceeds even without active instruments.

In stopped condition single step navigation can be performed by the button .

The navigation bar changes during play back. The button Play is replaced by the button Pause . Pressing this button pauses play back of the measurement data. Pressing the button Play again, data play back is resumed seamlessly from the current position.

When the end of the data file is reached, play back stops automatically. Thereafter, only the buttons Jump to start and Open new data file remain active.

Fast forward

Click the button Fast forward to replay data at maximum speed. The speed of data acquisition will be determined by the processing capacity of the PC. It will not correspond anymore with the time during recording.

During play back at maximum speed the button Fast forward will become a Play button, signaling that pressing it again will switch to play back at normal speed.

Jump to a specific time

You can jump to specific points in time.

The button moves the data replay position

- to the next start time of a measuring channel
- to the next note
- 1 minute ahead, if none of the targets above is available.

The button moves the data replay position

- to the previous start time of a measuring channel
- to the previous note
- to the start of the file (00:00:00.000), if none of the targets above is available.

The cursor in the Navigator panel can also be used to jump to any time position.

Entries in the Notes and Masks panel can be selected in order to jump to their saving time.

☞ Note: A jumps causes all active instruments to be switched off and then on again, since there is no continuous data after the jump.

Hints for Offline Measurement

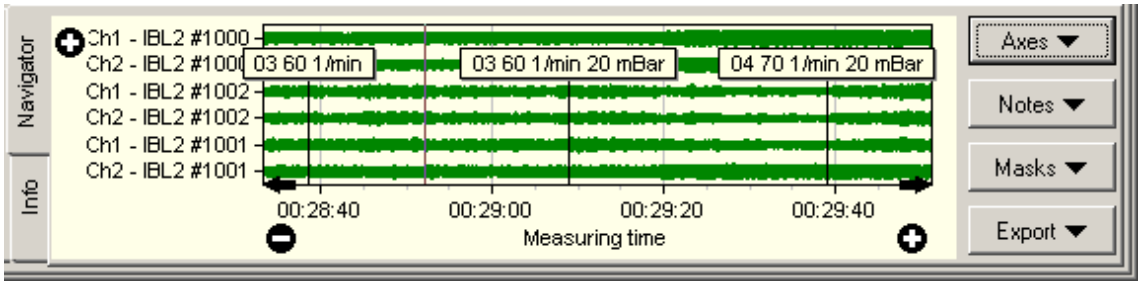
- You may start the instruments before starting data replay. The switched on instrument will stay inactive until data is provided.
- If a channel has no data the instruments will measure the value zero. This is indicated in the instruments by a red channel ID.

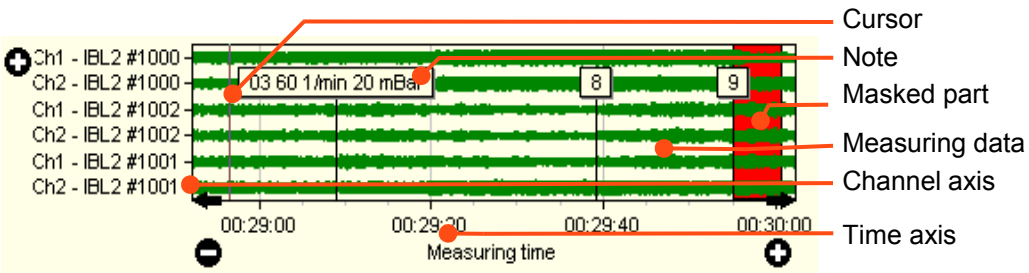
8.3. Navigator Panel

This chart provides an overview of the data present in the currently loaded measurement data file. It also allows navigation within the data.

☞ Note: The navigator panel is only visible if measuring data has been loaded.

☞ Hint: Left mouse click at the time display opens the navigator panel.





Time axis

The time axis either shows the relative time since the start of measurement or the absolute clock time during measurement. The selection is made by right mouse click at the axis or by the axis menu. Zoom and scroll functions are explained on page 25.

Cursor

The current data play back time is marked with a cursor. This cursor can be moved using the left mouse button. In this case, the data play back time is immediately moved to the new position of the cursor.

☞ Hint: The cursor can also be positioned at a certain time by a click with the right mouse button on the time axis (in the area of the axis labeling). This is especially useful, if the cursor is currently not within the visible time range (due to zoom or scroll of the time axis).

Channel axis and magnitude preview

The y-axis comprises all measurement channels which are present in the data file. The graphical preview of measured data informs you about time segments with high or low magnitudes. The magnitude preview is scaled to the complete measuring range of the M302 or M312, including the four gain ranges.

Gaps in the measuring graph indicate time segments with a switched off channel.

In the axis menu the display can be modified. Zoom and scroll functions are explained on page 25.

Notes

Notes can be entered during or after measurement. They will be displayed in the magnitude preview either as full text or short note. The display mode is selected in the Notes menu.

Masked parts

Measuring data from masked time intervals will be suppressed. Red sections mark these parts.

Axis menu

The Axes menu provides functions to adapt the axes to the maximum or minimum occurring values or to the full scale value of the M302 or M312. The time axis can be switched between absolute (clock time) and relative time display.

Notes menu

In addition to the notes saved during measurement, you may enter notes in off-line mode at cursor position (Insert comment at cursor). The panel Notes and masks will open and your entry appears in the table of notes at the selected time. Here you can enter the text.

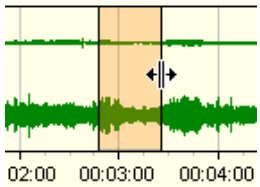
The note function is not available if the cursor is at start position (00:00:00 000).

In the note menu can also be specified which notes are to be displayed. This can be no note or all notes, the note at the cursor position or the selected table line.

Masks menu

The mask function can be used to suppress unwanted sections of measuring data during off-line measurement, such as overload events or environmental influences.

Select Insert masked range. The preliminary mask will appear in the navigator graphics as light red section. Use the mouse to shift its edges. Click Finish masking to activate the mask. The masked section becomes dark red and an entry in the Notes and masks table is created. Here you may also add a description.



A mask can be removed in order to restore the original data.

A masked section can be filled with zeros with the result that the measuring time will not be interrupted. Alternatively masked sections can be omitted so that the included measuring time will be skipped.

Export menu

Export in a **text** file is optionally available (option VM-TXT). Data from the analog or digital inputs can be exported. The values are exported in columns separated by tabs. In the first column is the time axis of the displayed section counted from the start of measurement. For each measuring channel another column is generated. The table header includes channel name, sensor and physical unit. Notes and masks are not exported.

Export in a **binary** file is optionally available (option VM-BIN). Data from the analog inputs is exported in double format (8 byte floating point numbers of double accuracy). In the first column is the time axis of the displayed section counted from the start of measurement. For each measuring channel another column is generated. Notes and masks are not exported.

8.4. Notes and Masks Panel

This panel shows in a table ordered by time all notes and masks. The type of entry is marked as follows:

M: masks

O: saved notes

U: unsaved notes or masks, click Save to keep these entries

The descriptive text of notes and masks can be edited here. You may also Jump to an entry.

8.5. Differences to VibroMetra Online

Due to the nature of off-line analysis, there are some differences in behavior between VibroMetra Offline and VibroMetra Online.

Sensor management

The sensor management lists the sensors, which have been connected with the measured channels during the recording of the measurement data file. These sensors are merged into the sensor group Data Stream Sensors.

The sensor management has the following peculiarities:

- Sensors and sensor groups cannot be created or erased. Instead, the sensors are listed, which have been used during the measurement/recording and which appear in the data stream.
- The sensor properties can be displayed, but not changed.
- The calibration state is undefined.
- The sensors cannot be assigned to a measuring channel. The assignment which was active during measurement is automatically selected.
- Changes of the sensor parameters and the channel assignment during the saved measurement are considered during play back.

Channel management

The channel management has the following peculiarities:

- The properties of the measuring channels can be displayed, but not changed.
- Exactly those M302 or M312 units and measuring channels are displayed, which delivered the data in the measurement data file. The channels and devices cannot be erased manually from the displayed list.
- Instruments cannot be added to the measurement channels in VibroMetra Offline. Please use VibroMetra Online for this purpose (p.15).

Instrument management

Instruments can be started in the same way as with VibroMetra Online (p.14).

The instrument management has the following peculiarities:

- Software instruments cannot be added to the measurement channels in VibroMetra Offline. Please use VibroMetra Online for this purpose (p.15).

Using the Instruments

An instrument can be started off-line when the M302 or M312 is connected which was used for the original measurement. When the option VM-PLAY was installed in your M302 or M312 you may perform off-line analysis without connecting the hardware. All instruments licensed in the originally used hardware will be available off-line.