PCE Instruments



User Manual
Vibration Analyser

PCE-VM 25

EN Version 1.0

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1. Purpose

The PCE-VM 25 has been developed, particularly, for the measurement and monitoring of vibrations on rotating machines. The purpose of such measurements is to monitor the condition of the machine in order to avoid unscheduled shut-down. Furthermore vibration measurement is carried out prior to the distribution of new machinery and subsequently to repair with a view to quality control and the issuing of product guarantees.
The basis for successful machine condition monitoring is the measurement of the vibration severity over a longer period of time. Measurements are taken at regular intervals of time and recorded.
The PCE-VM 25 measures and records vibration acceleration, vibration velocity or vibration displacement. The PCE-VM 25 specification complies with the ISO 2954 regulations for machines that measure vibration velocity and is therefore suitable for measuring, among other things, machine vibrations in accordance with ISO 10816.
In addition to vibration quantities the PCE-VM 25 also measures the temperature and the rotation speed with contactless sensors.
An external piezoelectric accelerometer is used as the sensor, and is provided together with the instrument. The PCE-VM 25 is fitted with an electronic measurement point detector (VMID) which enables it to take routine measurements of a large number of measurement points very effectively. A software package for transferring the measurement data to a PC is also available from PCE.
In the common hierarchy of condition monitoring the PCE-VM 25 is equivalent to ‚Level 1'. This represents the long term monitoring of parameters with low technical and personnel requirements.
For fault detection (‚Level 2'), as a further step, spectral diagnostic measurements are taken, which require a large degree of expertise and sophisticated measurement technology.
In the development of the PCE-VM 25 value was placed on simple operation and maintenance requirements, which enable trained personnel to operate the instrument without the need of being specially qualified.

2. Function

2.1. The Vibration Sensor

The PCE-VM 25 operates with a piezo ceramic shear accelerometer. Piezoelectric vibration transducers are characterized by high precision and resolution with great robustness. The accelerometer of the PCE-VM 25 has an integrated electronic circuit for impedance conversion in accordance with the IEPE standard. At the base of the sensor a magnet has been integrated for mounting to the measurement point. In the center of the magnet there is a contact point from which the identification number can be read. The measurement point ID is saved in the available VMID measurement points.
The coupling surface is protected by a metal cap which attaches to the sensors magnetic base.

2.2. The Measuring Instrument

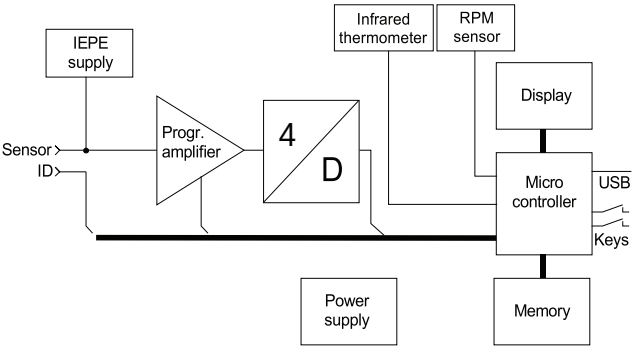


Figure 2: Block Diagram

The Figure shows the block diagram. The PCE-VM 25 supplies the IEPE Sensor with 2 mA constant current. At the sensor output, a vibration acceleration proportional AC voltage arises, which is amplified in the instrument to produce an optimum level. The gain switch-over takes place automatically. The subsequent analogue/digital converter
is a Sigma-Delta converter with 24 bit resolution.
Further signal processing, such as filtering, integration (for calculating velocity and displacement from acceleration) as well as the RMS and peak value rectification is carried out in the micro controller. The micro controller also controls the graphic display, the infrared thermometer, the rotation speed sensor, the USB communication and storing of measurements.

3. Measuring Ranges

3.1. Measurable Vibration Quantities

The PCE-VM 25 can display the vibration quantities acceleration, velocity and displacement. Velocity and displacement are generated by single or double integration of the sensor acceleration signal.
Furthermore, various frequency ranges can be selected.
The display rate adjusts itself according to the selected quantity in order to ensure that the RMS does not fluctuate even at lower frequencies. The following table shows the display rates.

Measurand	Frequency Range	Display Rate	Sample Rate
Vibration acceleration	0,2 Hz – 10 kHz	5.6 s	23.438 kHz
Vibration acceleration	3 Hz – 1 kHz	1.4 s	2.930 kHz
Vibration acceleration	1 kHz – 10 kHz	1.4 s	23.438 kHz
Vibration velocity	2 Hz – 1 kHz	1.4 s	2.930 kHz
Vibration velocity	10 Hz – 1 kHz	1.4 s	11.719 kHz
Vibration displacement	5 Hz – 200 Hz	2.8 s	2.930 kHz

3.2. Vibration Acceleration

The PCE-VM 25 has the following frequency ranges for vibration acceleration:
• 0.2 Hz to 10 kHz: full frequency bandwidth of the accelerometer
• 3 Hz to 1 kHz: lower frequency acceleration
• 1 kHz to 10 kHz: high frequency vibration only
In this way specific signal components can be measured whilst others are attenuated. For example, when taking measurements on machines, at a frequency of 1 kHz to 10 kHz predominantly the running noise of rolling bearings can be monitored, whilst vibrational unbalances are attenuated.

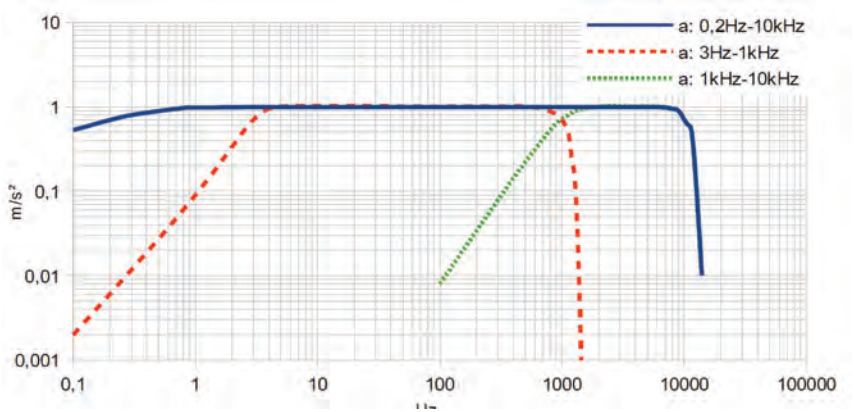


Figure 3: Frequency response curves for acceleration

.3. Vibration Velocity

Measuring vibration velocity is a common procedure for assessing the running smoothness of rotating machines. Vibration velocity, commonly known as vibration severity, represents the energy expenditure of occurring vibrations. Vibrations are caused by rotational unbalances, for example as a result of loose screws, bent parts, worn or slack bearings or dirt residues on the fan blades. Often several factors have a mutually reinforcing effect. Besides rotating machines, the measurement procedure is also suitable for reciprocating machines.
The specifications of vibration velocity measuring instruments are described in ISO 2954. In the ISO 2954 a band filter for the vibration velocity of 10 to 1000 Hz is defined.The displayed value of the vibration severity is the true RMS.
Besides the frequency range of 10 to 1000 Hz, the PCE-VM 25 has a further frequency range for vibration severity measurements from 2 to 1000 Hz. This is suitable for measurements on slow running machines with a nominal speed of less than 120 min-1 and on reciprocating engines according to ISO 10816-6.
The corresponding PCE-VM 25 frequency response graph can be viewed here:

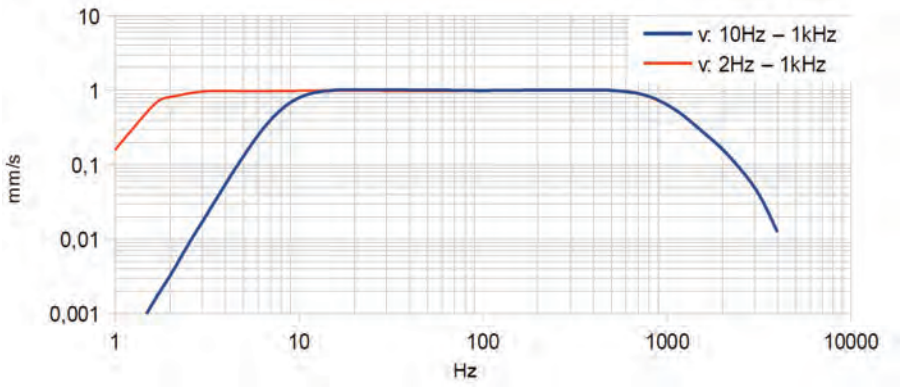


Figure 4: Frequency response curves for velocity

Vibration velocity is formed through integration of the acceleration measured by the sensor.The following formula applies to sinusoidal signals:

$$v = \frac{a}{2\Pi f}$$

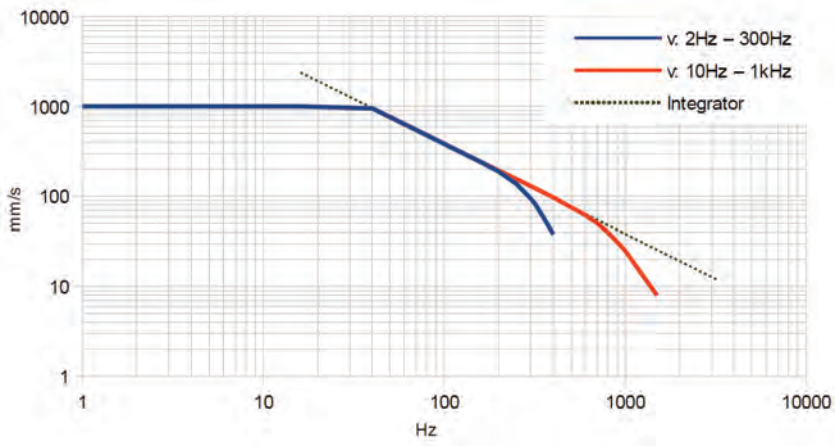


Figure 5: Amplitude range for velocity (RMS)

It is evident that in the case of constant acceleration (a) the value of velocity (v) drops at higher frequencies (f). As a consequence the measuring range limits of the velocity measurements are frequency dependent. (Figure 5).The maximum velocity measurable with the PCE-VM 25 is around 1000 mm/s (RMS). It yields a frequency independent modulation range of up to 40 Hz. At higher frequencies (RMS) the measuring range limits for acceleration of around 240 m/s² take effect. In the attenuation range of the low pass filter the modulation is further restricted.

3.4. Vibration Displacement

The vibration quantity most easily observed is displacement, also known as the deflection of the vibration. It is formed by double integration of the acceleration. In comparison to velocity, the practically usable frequency range is even more restricted. On the one hand it requires a high pass filter in order to attenuate low frequency noise signals, which would otherwise appear amplified in the measurement values because of the double integration. On the other hand, frequencies in the range of less than one hundred Hertz are so strongly dampened that an evaluable display value is no longer recognizable.
Due to these restrictions, displacement measurements should only be applied where acceleration or velocity is not capable of delivering the desired assessment. The PCE-VM 25 measures the vibration displacement from 5 to 200 Hz. The frequency response diagram is shown in Figure 6. The curve ends at 200 Hz because even in the case of a fully modulated sensor only single digit measurement values still occur.

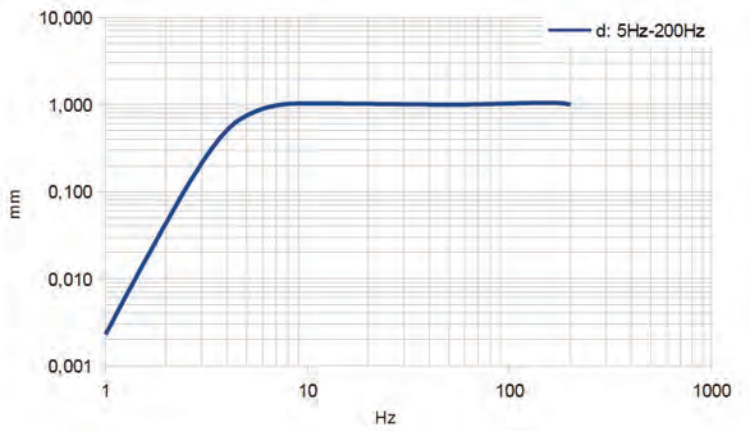


Figure 6: Frequency response curves for displacement

The following formula applies to sinusoidal signals which have been formed through double integration:

$$d = \frac{a}{(2\Pi f)^2}$$

In the case of constant acceleration (a) it is visible that the displacement value (d) decreases quadratically with increasing frequency (f). As a consequence the measuring range limits of displacement measurements are strongly frequency dependent. The next Figure 7 shows the measurement range limits depending on frequency.

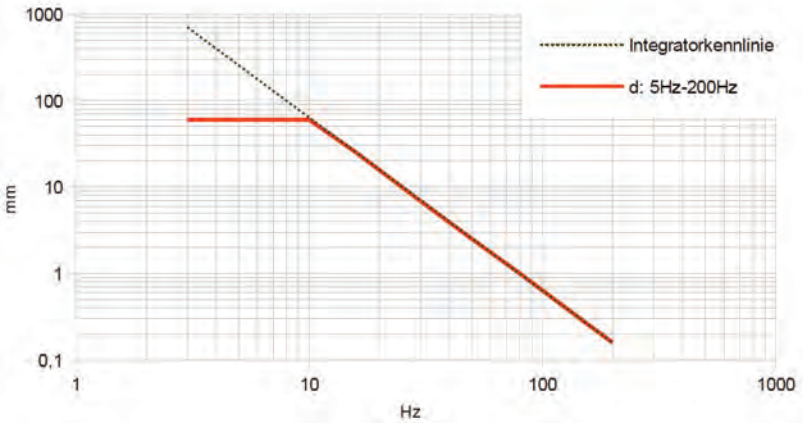


Figure 7: Frequency response curves for displacement (RMS)

The maximum displacement of the PCE-VM 25 that can be measured is around 60 mm (RMS). It yields a frequency independent modulation range of up to 10 Hz. At higher frequencies the measuring range limits for acceleration of around 240 m/s² take effect.

3.5. Rolling Bearing Parameters K(t)

The rolling bearing parameter, also known as the diagnosis coefficient of Sturm K(t), is an approved parameter for the condition analysis of rolling bearings, as defined in the VDI 3832 (and other guidelines). It is formed by the RMS and peak value of acceleration at a frequency range of 1 to 10 kHz. The 1 kHz high pass filter ensures that the rolling bearing signal is not overlapped by the vibration of foreign mechanical parts, such as imbalances.
The K(t) value relates the currently measured RMS and peak values to the RMS and peak values at a starting point in time as follows:

$$K(t)=\frac{a_{rms}(0)\cdot a_{pk}(0)}{a_{rms}(t)\cdot a_{pk}(t)}$$

within this:
$a_{rms}(0)$ RMS for the start point in time (reference point in time)
$a_{pk}(0)$ maximum value (peak value) for start / reference point
$a_{rms}(t)$ current RMS
$a_{pk}(t)$ current maximum value (peak value)
The start or reference measurement is subsequent to first-time operation of the bearing. Ideally after the elapse of a certain running-in time. At this point in time the K(t) value is 1. Following ongoing wear and tear of the machine i.e. running dam-age, the K(t) decreases. During operation the K(t) value may also increase at a low
rate. In this way the condition of the rolling bearing can be classified:

K(t)	Rolling Bearing Condition
> 1	Improvement
1 .. 0.5	Good condition
0.5 .. 0.2	Damage progressive influences
0.2 .. 0.02	Advanced damage process
< 0.02	Damaged

Multiplication of the RMS and peak value indicates the acceleration over the course of time as well as changes caused by shock, local damage (pitting), a general increase in mechanical vibration due to distributed damage (worn race rings, corrosion, wear of rolling elements) or also insufficient lubrication.
The K(t) value only provides a statement about the condition of the bearing when the trends are viewed. One single measurement does not enable a diagnostic statement to be made.
The K(t) value is strongly dependent on the rotational speed. It is therefore important to ensure that the rotational speed is the same, when viewing trends.

3.6. Rotational Speed

Alongside vibration the PCE-VM 25 measures the rotational speed by means of an inbuilt contactless optical sensor (Figure 34 on page 25). To enable this, the instrument needs to be aligned with the rotating part, for which a laser pointer can be used to help with the positioning.
Notice: Please do not cover the sensor apertures on the back of the instrument with your fingers during measurement.

3.7. Temperature

The PCE-VM 25 has an inbuilt infrared thermometer for taking contactless temperature measurements (Figure 34).

4. The Batteries

4.1. Inserting the Batteries

The PCE-VM 25 is supplied by three alkaline standard cell type AAA (LR03) batteries. NiMH batteries (HR03) may also be used. The minimum energy requirement of the PCE-VM 25 enables maximum utilization of the batteries.
Attention: Please switch the instrument off before changing the batteries. When switched off, the contents of the memory are stored for a few minutes, without need of the batteries, and the internal clock continues to run. If the batteries are removed when the instrument is switched on or if they remain in the instrument until the batteries have been completely discharged, the date and time will need to be reset. Further settings as well as the saved measurands, are stored without need of the batteries
To insert the batteries, remove the two screws from the back cover of the device and open the battery compartment (Figure 8). When inserting the batteries, please ensure that their polarity is correct, (see the engraved markings inside the compartment).



Figure 8: Battery Compartment

Important:
• Always use three batteries of the same type and same date of manufacture.
• Remove old batteries from the instrument, and take out the batteries if the instrument will not be used for a long period of time. Otherwise leaking battery acid may cause severe damage to the instrument.

Please use your local collection point to dispose of batteries.
Batteries do not belong to the household waste.

4.2. Switching On and Off

The instrument is switched on by a short press of the ON-OFF button. A start screen will be shown on the display for 3 seconds. (Figure 9).



Figure 9: Start screen

This displays the hardware version number (the 3 digits before the point) and the software version number (the 3 digits after the point) followed by the serial number corresponding to the type label. The month and year of the last calibration are displayed (cf. Section 9) along with the memory capacity.

By pressing the ON-OFF button again the PCE-VM 25 switches itself off. In addition, the instrument has an automatic shut-off timer for saving the battery power (cf. Chapter 4.4).

4.3. Battery Display and Battery Type

In the upper left corner of the PCE-VM 25 display there is a battery level indicator (10). When the green battery symbol is full, the battery is fully charged.





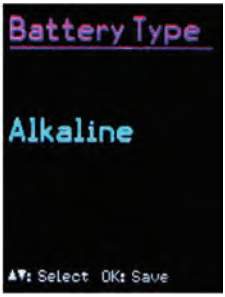


Figure 10: Battery indicator upper left / Figure 11: Select battery type

While non-rechargeable batteries have a cell voltage of 1.5 V, NiMH rechargeable batteries deliver only 1.2 V per cell. The PCE-VM 25 battery indicator can be adjusted to both voltages. To adjust the voltage, open the main menu by pressing F3 and scroll through the menu options by repeatedly pressing the ▼ button until you reach ‚Instrument Settings', then press OK.
Within the sub-menu select "Battery type" (Figure 11) by following the same instructions as before and then by pressing▼ select between "Alkaline" (nonrechargeable, 1.5 V) or "NiMH accu" (rechargeable, 1.2 V). Confirm your choice by pressing OK and exit the menu by pressing F3 repeatedly.
If the power supply drops below 3.3 V when using alkaline batteries or below 3 V with rechargeable batteries, the battery indicator becomes red. Further measurements can be taken until the power supply reaches 2.8 V in keeping with the instrument specifications. At this point the battery level indicator is completely empty and the instrument switches itself off automatically.
If the PCE-VM 25 is connected to a USB port, it will be supplied by the USB voltage in order to spare the batteries. In this case, "external" is displayed on the screen instead of the battery level indicator.

4.4. Shut-off Timer

The PCE-VM 25 has a shut-off timer to help prolong the battery operating life. To set the shut-off timer, open the main menu by pressing F3. Scroll down into the sub-menu ‚Instrument Settings' by pressing▼and OK, and within this sub-menu select the menu option "Shut off Timer". Press keys ▼▲ to select the timer duration from the options 1, 5, 15 and 60 minutes or to deactivate the timer select (‚none'). The switch off timer starts to run after the last press of a button. If any button is pressed then the timer restarts and counts down again according to the duration selected.



5. Preparation of Measuring Points

5.1. General Information on Measurement Point Choice

When monitoring machines it is important to take measurements under the same operating conditions, at the same measurement point. Choosing the suitable measurement point is therefore decisive. Where possible, qualified staff experienced in machine monitoring should be called upon.
It is generally advisable to record machine vibrations near to their source. This helps to reduce distortion of the measuring signal to a minimum when it is being carried through transmission parts. Suitable measurement points include rigid machine components such as bearing housings or gearboxes.
Light or mechanically flexible machine components such as cladding and casing are unsuitable for the measurement of vibrations.

5.2. ISO 10816-1 Recommendations

The standard ISO 10816-1 recommends bearing housings or their immediate surroundings as preferred measuring location points for the measurement of machine vibrations (Figures 13, 14, 15 and 16). For the purpose of monitoring a machine it is normally sufficient to take measurements in only one direction, either vertically or horizontally.
On machines with horizontal shafts and rigid foundations the largest vibration amplitudes occur horizontally. With flexible foundations, strong vertical components also arise.
For the purpose of acceptance tests, measurement values are to be taken from all bearing point locations at the center of the bearing and in all three directions (vertical, horizontal and axial).
The following illustrations give a few examples of suitable measurement point locations.
The Standard ISO 13373-1 also gives recommendations for measurement points on various machine type.



Figure 13: Measuring points on verticalbearings

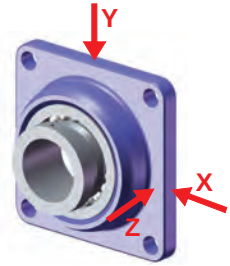


Figure 14: Measuring points on flange bearings

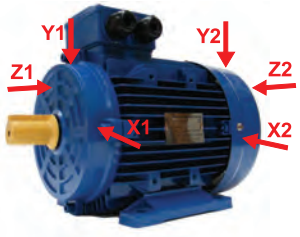


Figure 15: Measuring points on electric motors



Figure 16: Measuring points on machines with vertical rotors

5.3. VMID Measurement Point

5.3.1. How the VMID Measurement Point Functions

The PCE-VM 25 is equipped with an electronic measuring point detector. PCE Instruments offers a type VMID measurement point, which is made of magnetic stainless steel and has aninbuilt memory with an individual serial number.
The serial number stored inside the measurement point is a unique 16-digit hexadecimal number, e.g. “000000FBC52B”.



Figure 17: VMID Measuring point

Each measurand can be easily and reliably allocated to a specific measuring point. To read the serial number, contact is made through the sensor‘s magnetic base.
The maximum permissible operating temperature for the VMID is 80 °C.

5.3.2. Mounting the VMID Measurement Point

A VMID measurement point is mounted onto the machine using two component epoxy adhesive. For an accurate vibration transmission, PCE Instruments recommends the following adhesive:
• LOCTITE Hysol 3430 without filler for even surfaces
• LOCTITE Hysol 3450 with filler for uneven surfaces
Before applying the adhesive ensure that all residues of grease have been thoroughly removed from both contact surfaces. The two component adhesive can be applied directly onto the chosen surface. The adhesive takes 5 minutes to harden and after 15 minutes the first measurement can be taken.

6. Measurement

6.1. Measurement Value Display

In the top margin of the screen (Figure 18) the battery power is displayed. Next to this the date and time are also indicated.



Figure 18: Measurement display

Below the measurand (v: 10 Hz-1 kHz RMS) the currently measured value. The display “No Point ID” indicates that a measurement point number has not been identified.
Note: The decimal point may appear in one of two positions, dependent on the measurand. This is due to the automatic gain switch-over. In this way smaller measurands with high resolutions are sure to be detected

6.2. Selecting the Display Quantity

With keys ◄► you can select from among the six available operation modes:

• Vibration velocity 10 Hz – 1 kHz
• Vibration velocity 2 Hz – 1kHz
• Vibration acceleration 0.2 Hz – 10 kHz
• Vibration acceleration 3 Hz – 1 kHz
• Vibration acceleration 1 kHz – 10 kHz
• Vibration displacement 5 Hz – 200 Hz
• K(t) value for rolling bearing monitoring
• Rotational speed and temperature

By pressing F2 you can switch between RMS and peak value for the acceleration velocity and displacement.
The RMS is the so-called “true” root mean square value.
The peak value, also known as crest or maximum value, is the highest vibration value since the last displayed value.
The crest factor, is the relation between crest value and RMS. It is used to describe the curve form. For a sinusoidal signal it amounts to $\sqrt{2}$ = 1,41. The more impulsive the signal, the higher the crest factor.

Note: When saving measurement values (chapter 6.4) the RMS and peak value are always saved both irrespective of the currently selected setting.

If the sensor locates a VMID measuring point which is already saved in the PCE-VM 25 memory, in order to prevent unintentional switch-over, a warning signal will be displayed when the measurand changes (Figure 19). By pressing OK the measuring range can still be changed. The warning signal will not appear again until the next measuring point is detected.

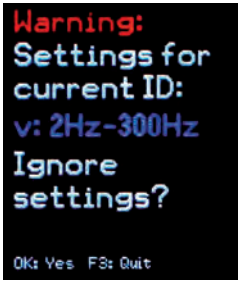


Figure 19: Warning at mode change

6.3. Measurement Point Detection

6.3.1. Reading the VMID Data with the PCE-VM 25

The VMID measurement points are designed, so that the magnetic sensor base centers itself. To avoid mechanical shock do not let the sensor snap onto the measurement point, instead, roll it slowly over the edge. To improve the vibration transmission the measuring point can be lightly lubricated.
As soon as the Sensor base comes into contact with the measurement point, the PCE-VM 25 displays the

measurement point number (Point ID) (Figure 20).



Figure 20: Newly recognized VMID

6.3.2. Entering the Measurement Point Text

If a measurement point has not yet been assigned a text, press the▼ key to reach the text edit menu (Figures 20 and 21). A space of two rows consisting of 10 characters each is assigned for each measurement point text. The text is entered using keys ▼▲. By pressing keys ◄► you can change the character position. Both capital letters (A to Z) and numbers (0 to 9) are available. To move down to the next row press F1. By pressing F1 again and using keys▼▲ the operation mode can be selected.

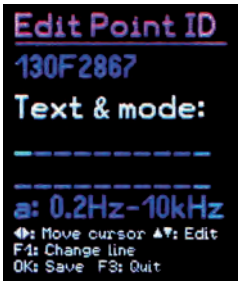


Figure 21: Entering ID text

By pressing OK the entries will be saved and the menu exited.
Press F3 to exit the menu without saving the changes.

Note: More conveniently, the measurement point texts can also be entered using the available computer software.



Figure 22: ID text display

Once you have assigned the VMID serial number a text, the PCE-VM 25 will display the text continually, as soon as the sensor makes contact with the measuring point (Figure22).
Aside from this, the PCE-VM 25 reverts automatically to the saved operation mode. In this way it is ensured that measurements are always taken with the correct settings.

Note: Changing the measuring point data also effects the display of saved measurands (cf. Chapters 6.5 and 6.6). The current saved text of the respective VMID serial number is always displayed in the measurement data. Changing the operating mode of a measuring point only affects measurands saved subsequently and does not have any effect on the measurands that have already been saved in the memory.
The measurement point data is saved in the instrument. If several instruments are used at the same measurement point location, the measurement point data will need to be saved within each instrument. The available PC software enables the convenient management of measurement points.

6.3.3. Editing and Deleting Measurement Point Data

Open the main menu by pressing F3 and select the sub-menu “Point ID memory” by using keys ▼▲.
Within the menu option “Edit Point ID”, as previously explained in section 6.3.2, the measurement point texts and the operating mode allocated to the measuring point can be changed. In the sub menu “Edit Point ID” press or hold down▼▲, until the text you wish to edit is displayed and then press OK to edit.
Within the menu option “Erase Point ID”, measurement point data records, each consisting of a VMID serial number, text and operational mode, can be deleted one by one. In the subsequent menu “Erase Point ID”, press or hold down ▼▲, until the record you wish to delete is shown, then press OK and confirm the warning by pressing OK again(Figure 23).

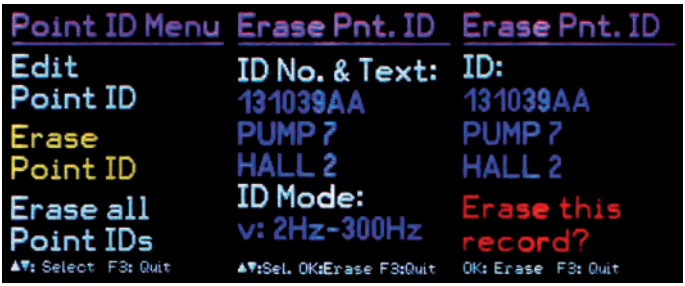


Figure 23: Deleting an ID record

In the same way, the entire measurement point data can be deleted as a whole by selecting “Erase all Point IDs” in the “ID Menu”. The PCE-VM 25 memory can store data for a maximum of 1600 measurement points.

Note: Deleting measurement point data effects the display of saved measurements. (chapter 6.6). Instead of the measurement point serial number and the measurement point text being shown, “none” is displayed. The measurement point data records can always be newly generated, as described in 6.3.2.

6.4. Saving Measurands

Pressing the ▼ key saves the currently displayed measurand. Independently of whether RMS, peak or crest factor display has been selected, the PCE-VM 25 always saves the RMS and peak value. Furthermore the respective measurement point number (if known), the chosen display mode and the date and time are also saved.
Note: If the sensor locates a measurement point which has not yet been assigned a text or operational mode (cf. Chapter 6.3.3), use the ▼ key to enter the text.

6.5. Graphical Trend Display

The purpose of measuring vibration according to ISO 10816 and ISO 13373 is as follows; To make assessments concerning the operating condition of a machine based on changes in its vibration behavior. To achieve this it is imperative, that measurements are taken at regular time intervals, from the same points and under the same conditions.

To deliver the service staff on site a report about the periodic changes in vibration severity and consequently the previous history of the measurement point concerned, the PCE-VM 25 provides a graphical trend display. The prerequisite for retrieving graphical trends is placing the sensor on the relevant VMID. The trend display is obtained by pressing the F1 key (Figure 24).

The trend display only takes values from the data memory into account which belong to the VMID operation mode currently active. If the VMID operation mode is changed (cf. Chapter 6.3.3), the previously saved data with a different operation mode will not be shown in the trend display.

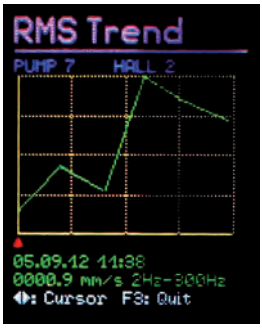


Figure 24: Trend display

The vertical axis indicates the RMS of the vibration quantity and the horizontal axis indicates time. The K(t) values are represented by the vertical axis K(t). Both are scaled to their respective maximum value. The time axis shows the interval between the first and last saved measurement. Below the diagram there is a red marker. This can be moved horizontally to read the magnitude, using the◄► keys. The marker only skips forward to time points which already have a measurand. At each data point the date and time of the measurement as well as the measured RMS or K(t) value are displayed. Above the diagram the text assigned to the measurement point is displayed. In order to be able to display trends, the points are joined together by a line.

Press F3 to exit the trend display.

If only one or zero measurands for a selected measurement point can be located in the memory, the error message “Too few data for trending” will appear instead of the trend graphic.

Note: The available PC software enables you to view the trends more conveniently, even without it being connected to the measuring point .

6.6. Viewing Saved Measurement Values

In addition to the graphical trend readings for current measurement points, saved measurement data can be viewed in text format. Open the main menu by pressing F3, then select the sub-menu option “Meas. data Memory”. From within the submenu select “View meas. data memory”. The measurement data can be viewed in order of the VMID serial number or the date it was saved. Select your preferred menu option using keys ▼▲ and press OK to confirm. The first data record will now be displayed. At the top, a consecutive number and the number of the data record within the memory will also be shown. Below these, the measuring point serial number and its assigned text are also displayed. The RMS and peak value are displayed underneath the date, time, display mode and filter type. (Figure 25).

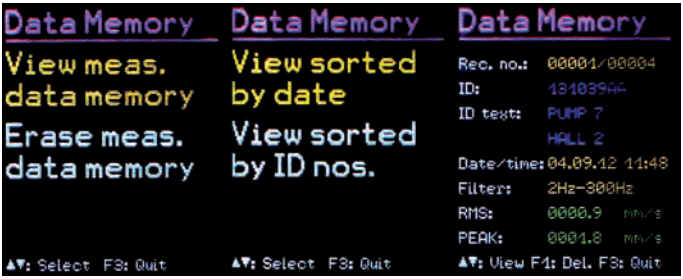


Figure 25: Display of saved measurements

Press ▼▲ to scroll to the next measurand. The currently displayed measurands can be deleted by pressing F1. Press F3 to exit the menu. The PCE-VM 25 memory can hold 16000 measurement values.

6.7. Deleting Saved Measurement Data

In the menu option “Measurement data” / “Erase meas. data Memory” you can delete the entire measurement data. After pressing OK a warning message will appear showing the total number of records.

6.8. K(t) Measurement

The basics of rolling bearing parameters K(t) can be found in section 3.5
First, use keys ◄► to select the operation mode “Roll. bearing” (Figure 26).



Figure 26: PCE-VM 25 in K(t) mode without VMID

K(t) measurements are only intended for use in conjunction with a VMID measurement point. The start / reference values RMS and peak of values which have been measured on the new rolling bearings are required for calculating K(t). These start values are saved in the PCE-VM 25 together with the measuring point ID. Place the sensor on a VMID measuring point of the relevant bearing. If the VMID measurement point ID has not yet been saved in the PCE-VM 25 (Figure 27), then first of all enter the ID name by pressing the ▼ key (cf. Section 6.3.2).



Figure 27: K(t) mode with newly detected VMID

If the VMID point ID has been saved but not the K(t) start values, then this is the next step. By pressing the ▼ key the currently measured RMS RMS(t) and peak value Peak(t) are saved as K(t) the start value RMS(0) and Peak(0) (Figure 28).



Figure 28: Saving K(t) start values

When the sensor is newly placed on the VMID measuring point, the instrument automatically switches to the K(t) display. It then reads the start values from the memory and calculates the K(t) value from the currently measured RMS(t) and Peak(t) values (Figure 29).
Press the ▼ key to save the K(t) values. Press F1 to view the graphic trend display. (cf. Section 7.5)
Note: If the instrument displays OVERLOAD, it is not necessarily the result of a too high acceleration value. It can also be due to a base value of zero, which causes a division through zero.



Figure 29: K(t)-display

To view or delete the saved K(t) start values open the menu “K(t) base memory” (Figure 30). In the sub-menu “View K(t) base memory” you can scroll through the saved start values using the ▼▲ keys. Press F1 to delete an entry. In the sub-menu “Erase K(t) memory” all saved K(t) start values can be deleted as a whole.

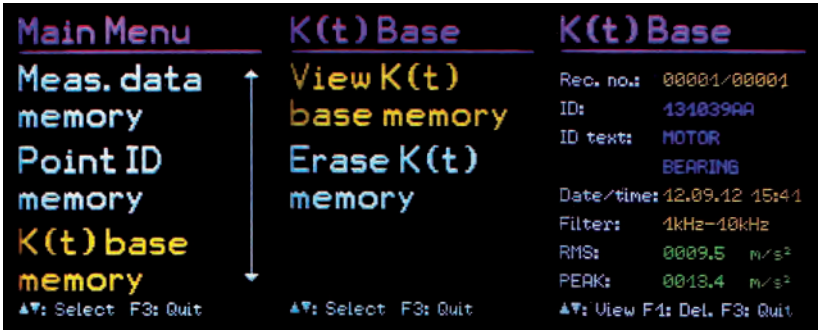


Figure 30: K(t)-base memory menu

6.9. Frequency Analysis

6.9.1. Settings

In addition to the measurement of RMS and peak values the PCE-VM 25 has a simple frequency analysis function. To access this function, switch to the main menu by pressing F3 and select the menu option “Frequency analysis (Figure 31).

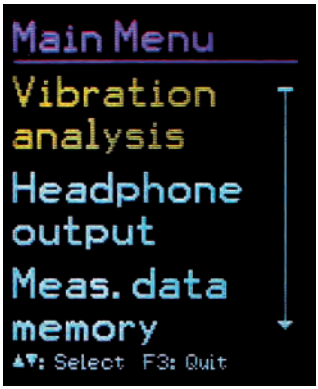
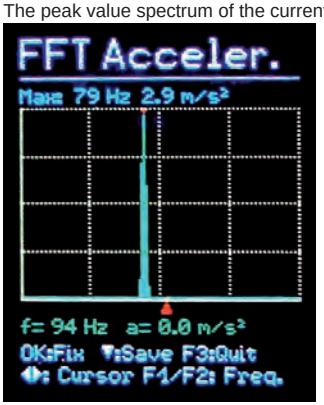


Figure 31: Frequency analysis menu

The peak value spectrum of the currently measured acceleration or velocity is shown in Figure 32).



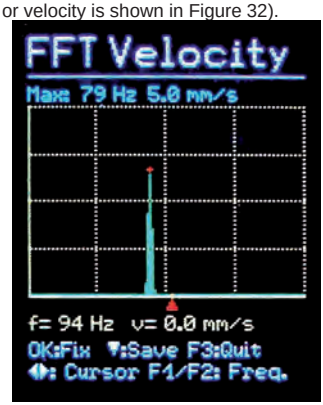


Figure 32: Spectral display for acceleration and velocity

The vertical axis of the diagram represents the peak value with linear scaling and the horizontal axis the frequency. The diagram shows 125 lines. The frequency range in display can be halved by pressing F1 and doubled by pressing F2. The following ranges are available: 23, 46, 91, 188, 366 and 732 Hz for velocity and additionally for acceleration 1466, 2928, 5856 and 11712 Hz. The velocity ranges follow after the accelerations by further pressing F2. Acceleration and velocity spectra can be distinguished by the headline and a different color of the cursor line.
The left end of the frequency axis always represents 0 Hz. However, the 0 Hz line and for velocity also the next line are not displayed to suppress DC and low noise errors.
The line above the diagram shows magnitude and frequency of the main spectral line.To measure the spectral lines the cursor can be moved along using the ◄► keys.
The red pointer below the diagram marks the cursor position. The currently measured spectral line is highlighted red. The frequency and amplitude are also displayed below the diagram.
The amplitudes can be scaled using the Auto-range function. In the case of variable signals this can cause an instable spectrum. If so, select between auto-ranging (“Ampl. auto”) and fixed amplitude scaling (“Ampl. fixed”) by pressing OK repeatedly. In the case of fixed amplitudes, the scaling type most recently selected is retained.
You can save the spectrum by pressing the ▼ key. Press F3 to exit the spectral view.

6.9.2. FFT Memory

To view stored FFTs in the instrument open the main menu, select “Meas. data memory” and “View FFT data memory”. The FFT data can be viewed in order of the VMID serial number or the date it was saved. Select your preferred sorting option and press OK to confirm. After a short waiting time the first FFT record will be displayed (Figure 33).

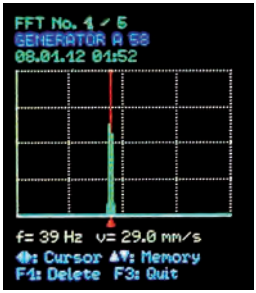


Figure 33: FFT memory

Use the keys ▼▲ to load the next or the previous record in the selected order. Above the diagram you see a record number and the total number of records in the memory. In the second line you find a VMID text if a VMID measuring point was used and a text entered (see section 6.3.2). If no text was entered you will see here the VMID code or “No ID”.
To measure the spectral lines the cursor can be moved along using the ◄► keys. The red pointer below the diagram marks the cursor position. The currently measured spectral line is highlighted red. The frequency and amplitude are also displayed below the diagram.
Press F1 to delete the displayed spectrum from the memory. Saved Spectra can also be transferred via USB to the PC software VM2xMDB.

6.10. Rotation Speed Measurement

The PCE-VM 25 has an inbuilt RPM laser sensor for contactless measurements. This is located in the lower part at the back of the instrument (Figure 34).



Figure 34: Rotation speed and temperature sensor, laser pointer

For taking rotation speed measurements the rotating part needs to be marked with a piece of reflective film. Self-adhesive reflective film can be purchased from Sick, for example the material REF-PLUS.

Press the ◄ or ► key, until rotation speed and temperature are shown (Figure 35). Set the instrument up on the measuring point, without covering the light beam range with your fingers. To help with the positioning, the PCE-VM 25 has a laser pointer which can be switched on and off by pressing F1.

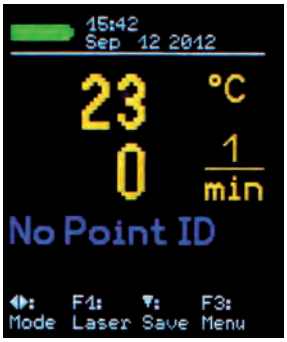


Figure 35: RPM and temperature display

Caution: The laser beam has a radiation power of < 1 mW at 650 nm wavelength. Never look into the light beam! It can cause permanent damage to your eyesight!

Depending on the size of the reflective measurement point the measurement distance can be between 0.3 and 1 m. The measurands can be saved by pressing the ▼ key. The saved data record is auto matically assigned the number of the VMID measurement point on which the sensor is placed.

6.11. Temperature Measurement

The temperature measurement is carried out together with the rotational speed measurement. (Figure 35). The PCE-VM 25 contains an infrared temperature sensor inside the upper part at the back of the instrument (Figure 34) To take a measurement, align the instrument with the relevant point. The inbuilt laser pointer can be used to align the instrument precisely (F1 Key). The best results can be achieved at a distance of 10 to 20 cm. The directionality of the sensor can be seen in Figure 36.
Every infrared temperature sensor shows a dependency on the emissivity of the measuring object. The PCE-VM 25 is calibrated for an emission level of 1. With some materials, such as Aluminum, this can cause measurement errors.

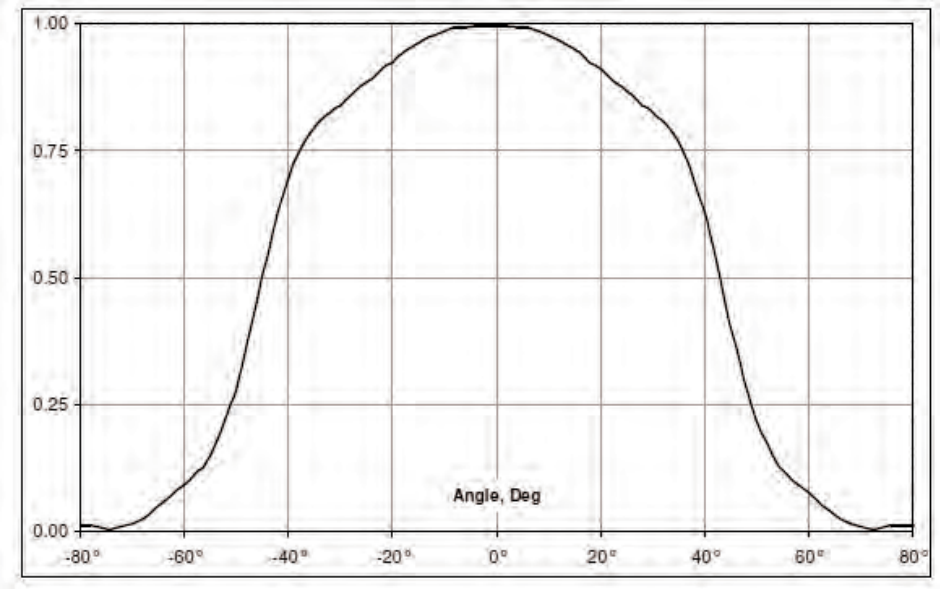


Figure 36: Field of view of the temperature sensor

7. Measurement Evaluation with Standard Values

To be able to derive statements from the measured vibration velocity values about the condition of a machine, experience is necessary. If experienced personnel are not available, in many cases one can refer to the ISO 10816 recommendations. In these sections of the standard, the vibration severity zone limits for various machine types are defined, which can provide an initial evaluation of a machines maintenance condition.The four zone boundary limits characterize the machine in categories according to vibration severity:
A: New condition
B: Good condition for unrestricted continuous operation
C: Poor condition - allows restricted continued operation only
D: Critical condition - Danger of damage to the machine.

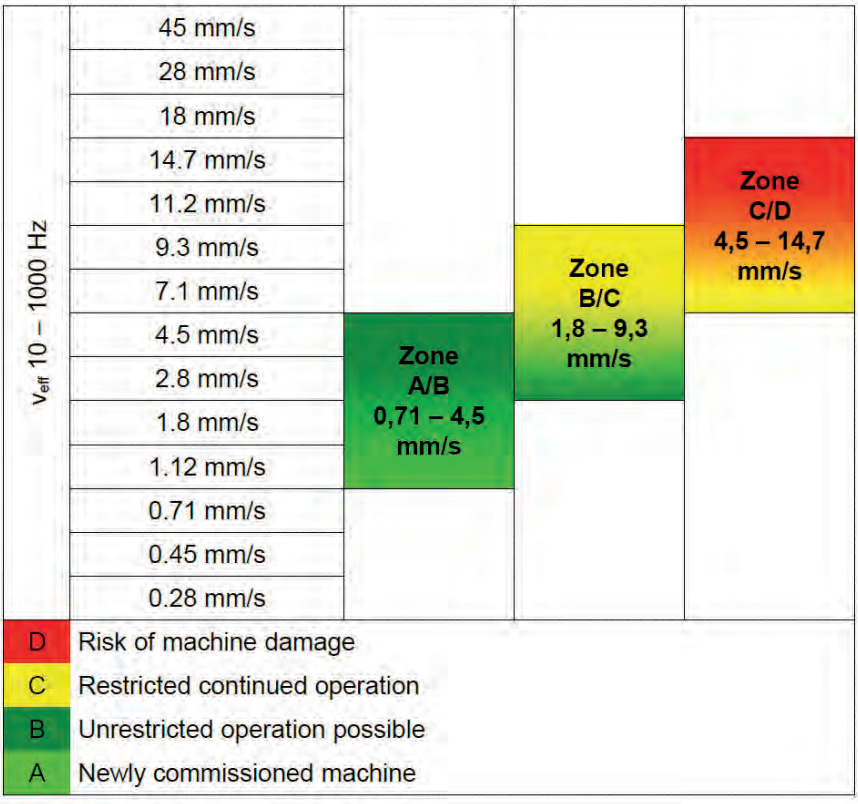


Table 1:Typical zone limit values for vibration severity according to ISO 10816-1

In the standard it is pointed out that small machines, for example electric motors with a power rating of up to 15 kW, tend to lie around the lower zone limits, whereas large machines, for example motors with flexible foundations, lie around the upper zone limits.

In part 3 of ISO 10816, revised in 2009, the zone borders are specified for vibration severity of machines with a power of 15 kW to 50 MW (Table 2).

	Machine type	Large machines with 300 kW to 50 MW		Medium sized machines with 15 to 300 kW	
		Electric motors with a shaft height above 315 mm		Electric motors with a shaft height between 160 and 315 mm	
	Foundation	flexible	rigid	flexible	rigid
v_{eff} 10 – 1000 Hz	> 11 mm/s	D	D	D	D
	> 7.1 mm/s	C	D	D	D
	> 4.5 mm/s	B	C	C	D
	> 3.5 mm/s	B	B	B	C
	> 2.8 mm/s	A	B	B	C
	> 2.3 mm/s	A	B	B	B
	> 1.4 mm/s	A	A	A	B
	< 1.4 mm/s	A	A	A	A

D Risk of machine damage
C Restricted operation
B Unrestricted long-term operation possible
A Newly commissioned

Table 2: Vibration Severity classification in accordance with ISO 10816-3

Part 7 of the ISO 10816 deals specifically with rotodynamic pumps (Table 3).

	Type	Category 1 Pumps with high safety and reliability demands			Category 2 Pumps for general and less critical use	
	Performance	< 200 kW	> 200 kW		< 200 kW	> 200 kW
v_{eff} 10 – 1000 Hz	> 7.6 mm/s	D	D	> 9.5 mm/s	D	D
	> 6.5 mm/s	D	C	> 8.5 mm/s	D	C
	> 5.0 mm/s	C	C	> 6.1 mm/s	C	C
	> 4.0 mm/s	C	B	> 5.1 mm/s	C	B
	> 3.5 mm/s	B	B	> 4.2 mm/s	B	B
	> 2.5 mm/s	B	A	> 3.2 mm/s	B	A
	< 2.5 mm/s	A	A	< 3.2 mm/s	A	A

D Risk of damage to the machine
C Restricted operation
B Lasting operation in safe working operating range without restrictions possible
A Newly commissioned pumps in preferred operating range

Table 3: Classification of the vibration severity of rotodynamic pumps in accordance with ISO 10816-7

8. Setting the Date and Time

When saving measurement values the date and time need to be correctly recorded. To set the date and time, open the main menu by pressing F3. From the main menu scroll down by pressing ▼ to the menu option “Instrument Settings” and press OK. Within this sub menu select “Time and Date”.



Figure 37: Setting time and data

Using keys ▲▼ you can adjust the chosen value. Upon reaching the maximum value, e.g. in the 23rd hour, the counter starts again from the beginning. Press ◄► to skip between hour, minute, month, day and year. The date takes the leap year into consideration. It is, however, important to ensure that no invalid day-month combinations are entered. Additionally, clock inaccuracy can be corrected. This can be done using the setting at “Cal.” in ppm (parts per million). The clock frequency can be increased with positive values and decreased with negative. The sign changes to minus at +254 ppm.
Example: The clock is 5 seconds slow. There are 24 * 60 * 60 s = 86400 seconds in a day. The difference amounts to 5 s / 86400 s = 58 * 10-6 = 58 ppm. The adjustable value is -58 ppm.
To exit the menu press OK followed by F3 repeatedly.

9. Calibration

The PCE-VM 25 comes with with a factory calibration, which is traceable to the reference standard of the Physikalisch-Technischen Bundesanstalt (PTB). The calibration is only valid with the supplied vibration transducer. The serial number of the instrument and the transducer are stated on the calibration certificate. The month and year of the factory calibration are displayed when the instrument is switched on (cf. Figure 10).
The value set upon calibration is the sensor sensitivity in mV/ms-2. This can be viewed in the calibration menu. Open the main menu by pressing F3. From the main menu scroll down with ▼ until you reach the menu option “Sensor calibration” and select OK. Within this sub-menu select ‚By entering sensitivity‘. The displayed value is the sensor‘s calibrated sensitivity (Figure 38). It should not be changed, unless a new calibration is being carried out. Press OK followed by F3 repeatedly to exit the menu.

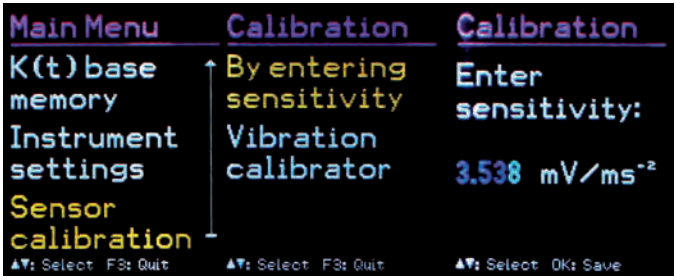


Figure 38: Entering the sensitivity

Apart from the factory calibration an accuracy test or re-calibration can be carried out by the user. For this a vibration calibrator is required. PCE Instruments offers the instruments PCE-VC20 and PCE-VC21 (Figure 39). They can generate one or more vibration amplitudes and frequencies with defined accuracy. For the calibration of the PCE-VM 25 a sufficient acceleration would be 10 m/s² at 159.2 Hz (radian frequency 1000 s-1).



Figure 39: Vibration Calibrator PCE-VC21

To calibrate the instrument, open the “Calibration” menu and select „Vibration calibrator”. You will be requested to mount the sensor on to the vibration exciter (Figure 40). This is done using the magnetic base. Press OK.

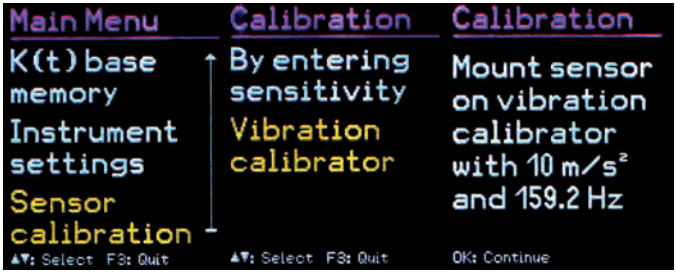


Figure 40: Calibration menu

The PCE-VM 25 is now ready for the reference vibration signal. It displays the measured acceleration (Figure 41).



Figure 41: Calibration

English

With the ▲▼ keys the displayed value can be increased or decreased, until it amounts to 10.00 m/s². To save the setting press OK and exit the menu. By adjusting the transducer sensitivity the instrument has now been calibrated. Check the calibration in the measuring mode. A vibration acceleration of 10.00 m/s² at 159.2 Hz corresponds to a vibration speed of 10.00 mm/s s.

10. Sensor Check

The PCE-VM 25 input is designed for use with a low power IEPE accelerometer. These sensors are supplied by constant current, which produces a positive DC voltage potential at the output. Due to this DC voltage an assessment can be made of the sensor's operating condition. The PCE-VM 25 detects three operational conditions:

< 0.1 V:	short circuit
0.1 – 11 V:	in working order
>11 V:	open input, e.g. broken cable

If a short circuit occurs or the input is open the instrument will display “SENSOR ERROR” instead of the measurand.

11. Headphone Output

Some maintenance technicians possess experience in the acoustic assessment of mechanical vibration on machines. For this purpose the PCE-VM 25 has a headphone connection socket, which is also used for the USB connection. To connect a standard headphone set with a 3.5 mm phone jack to the 8 pin socket, use the PCE-VM2x-HP
adapter cable which is included with the PCE-VM 25 (Figure 42).



Figure 41 Headphone cable PCE-VM2x-HP

To use the headphone connection open the main menu by pressing F3 and select “Headphone output”. Within this operation mode the volume can be adjusted using keys ◄►(Figure 44). Press F3 to finish using the headphones.

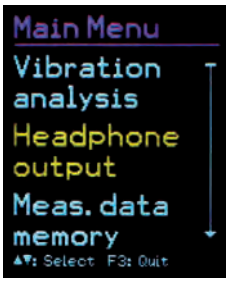


Figure 43: Headphone menu

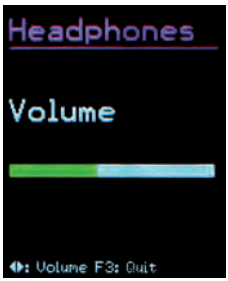


Figure 44: Volume control

Attention: Considerably loud volume levels can occur, especially when the sensor is moved, which can potentially

lead to hearing damage. Before positioning the vibration transducer always reduce the volume level or remove the headphones.

12. Reset Key

If it occurs that the PCE-VM 25 does not respond to the press of any button, press the reset key to restart the instrument. The reset key is reached with a thin object through the aperture next to the type label (Figure 45).



Figure 45: Reset key

Saved data and settings are not lost when the instrument is reset.

13. Connection to a PC

The PCE-VM 25 has a USB port. For connection to a PC the VM2x USB cable is provided (Figure 46), which is connected to the 8 pin socket on the PCE-VM 25. Switch the instrument off before connecting it to the PC.



Figure 46: USB cableVM2x-USB

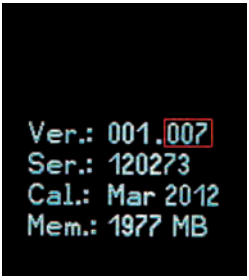
Connect the other end of the cable to a USB port of the computer and switch the PCE-VM 25 on again. If the instrument is being connected with a particular computer for the first time, a driver installation will be necessary. The driver can be found on our website: https://www.pce-instruments.com/english/software-and-driver-download-win_4.htm

Unpack and save both data files in a directory on your computer. When Windows requests details of the source of the device driver, this directory should be entered. The device driver is digitally signed and runs with Windows.

14. Firmware Update

The instrument software (Firmware) can be updated via the USB port. First of all, check whether a more up-to-date version than currently installed is available. To view the latest version visit our ‚Software Download' site: https://www.pce-instruments.com/english/software-and-driver-download-win_4.htm

Here you will see the most recent firmware version available. The version number is composed of three digits for the hardware and three for the software (hhh.sss). Only the last three digits are relevant for the firmware. The version currently installed in your instrument is displayed on the start screen.



If a Firmware version with a higher number is available on the website, proceed as follows:

1. Download the firmware file vm2x.hex from the above named internet address.
2. Also download the program “Firmware Updater” from the above named internet address and install it on your PC.
3. Start the “Firmware Updater”, then select the instrument type “PCE-VM2x” and the virtual COM port assigned by the PC. If you are not sure which of the available COM ports is correct, you can check in the Windows system control manager located within the instrument manager.
4. Click on “Load” in the “Firmware Updater” and enter the path to the file where the downloaded firmware file pce-vm2x.hex is located.



Figure 48: Firmware Updater

5. Connect the PCE-VM 25 to the PC using the USB cable.
6. Within the PCE-VM 25 “Instrument Settings” select the option “Update Firmware” and confirm the warning and subsequent hint messages by pressing OK. By carrying out this step the old firmware is deleted. The PCE-VM 25 will then indicate that it awaits new firmware data from the USB port (Figure 49).

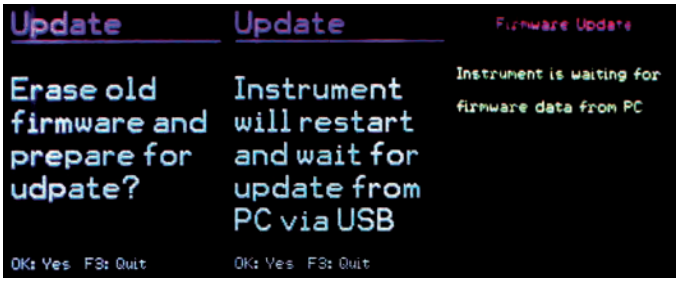


Figure 49: Firmware update

7. Click on “Send” in the “Firmware Updater”. Transfer of the Firmware data has now begun. The transfer progress is displayed as a time bar on the PC ans also on the PCE-VM 25. When the update is finished the PCE-VM 25 will start up and the “Firmware Updater” will close. Please do not interrupt the update process. Following transfer failures the update can be restarted at point 3.

15. Specifications

Displayed measurand	True RMS and peak value (crest value) of vibration acceleration, velocity and displacement, K(t) rolling bearing parameters, rotation speed, temperature
Measuring range at defined accuracy	Acceleration: 0.1 – 240 m/s² Velocity: 0.1 – 1000 mm/s; > 40 Hz frequency dependent Displacement: 0.01 – 60 mm; > 10 Hz frequency dependent
Display resolution	Acceleration: 0.01 m/s² Velocity: 0.1 mm/s Displacement: 0.001 mm temperature: 1 °C rotation speed: 1 min-1
Measurement accuracy	± 5 % ± 2 digits
Frequency Ranges	Acceleration: 0.2 Hz – 10 kHz Acceleration: 3 Hz – 1 kHz Acceleration: 1 kHz – 10 kHz Velocity: 10 – 1000 Hz, Velocity: 2 Hz – 1000 Hz Displacement: 5 Hz – 200 Hz 3rd order Butterworth filter
Overload indication	at > 200 m/s² vibration acceleration on the sensor or >1000 mm/s or > 60 mm after the integrator
Frequency analysis	125 lines, peak value of vibration acceleration or velocity, frequency ranges: 23, 46, 91, 183, 366, 732, 1466, 2928, 5856, 11712 Hz, lowest frequency: 1 Hz refresh rate: 1/s Window type: Hamming
Measurand memory	Flash, 16000 measurement records, 1000 FFT records
Sensor input	low power IEPE, 2 mA / 12 V, socket binder 711, 3 pins
Analog/digital converter	24 bit
Rotation speed sensor	1 – 9999 revolutions / min measuring distance: 0.3 .. 1 m, laser reflex sensor, insusceptible to ambient light
Temperature sensor	infrared, -40 .. 125 °C, ± 2 K
Laser pointer	< 1 mW, 650 nm (class 2)
Display	OLED, colored, 128 x 160 pixels
USB port	USB 2.0, full-speed, CDC-mode, with cable VM2x-USB
Batteries	3 cells type AAA Alkaline (LR03) or NiMH accumulators (HR03)
Battery operating life	7 – 11 hours, depending on battery capacity
Automatic shut down	1 / 5 / 15 / 60 minutes or off
Menu languages	German / English / French / Spanish / Italian / Dutch

Operating Temperature Range	-20 ... +60 °C
Dimensions	125 mm x 65 mm x 27 mm
Weight	140 g (with batteries, without sensor)
Vibration Transducer:	
Type	KS82L
Measuring principle	Piezo electric shear accelerometer
Output	Low power IEPE
Sensitivity	3.5 mV/ms-2 (common)
Operating temperature range	-20 ... +80 °C
Dimensions	Ø = 21 mm, h = 34 mm
Weight	53 g
Sensor cable	spiral cable, extended length 1.6 m
Measurement Point Detection:	
Principle	digitally stored in VMID measuring point, read through sensor base
Coding	16 digit unique hexadecimal number
Measuring point ID memory (PCE-VM 25)	1600 measuring points with serial number and text
Mounting the VMID	Mounting the VMID Mount with two part adhesive, e.g. LOCTITE Hysol 3430 or 3450
Maximum temperature	+80 °C

Declaration of conformity

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EC-Konformitätserklärung
EC- Dichiarazione di conformitá
EC- Déclaration de conformité
EC- Conformiteit-verklaring
EC- Declaração de conformidade
EC- Prohlášení o shode
EC- Declaración de conformidad
EC- Declaration of conformity
EC- Uygunluk Beyanı
EC- Заявление о соответствии
EC- Deklaracja zgodności

D	Konformitätserklärung	Wir erklären hiermit, dass das Produkt, auf das sich diese Erklärung bezieht, mit den nachstehenden Normen übereinstimmt.
E	Declaración de conformidad	Manifestamos en la presente que el producto al que se refiere esta declaración está de acuerdo con las normas siguientes.
I	Dichiarazione di conformitá	Dichiariamo con ciò che il prodotto al quale la presente dichiarazione si riferi-sce è conforme alle norme di seguito citate.
GB	Declaration of conformity	We hereby declare that the product to which this declaration refers conforms with the following standards.
F	Déclaration de conformité	Nous déclarons avec cela responsabilité que le produit, auquel se rapporte la présente déclaration, est conforme aux normes citées ci-après.
TR	Uygunluk Beyanı	Bu bildirime bağlı ürünün aşağıdaki standartlara uygun olduğunu beyan ederiz.
NL	Conformiteit-verklaring	Wij verklaren hiermede dat het product, waarop deze verklaring betrekking heeft, met de hierna vermelde normen overeenstemt.
RUS	Заявление о соответствии	Мы заявляем, что продукт, к которому относится данная декларация, соответствует перечисленным ниже нормам.
P	Declaração de conformidade	Declaramos por meio da presente que o produto no qual se refere esta declaração, corresponde às normas seguintes.
PL	Deklaracja zgodności	Niniejszym oświadczamy, że produkt, którego niniejsze oświadczenie dotyczy, jest zgodny z poniższymi normami.
CZ	Prohlášení o shode	Tímto prohlašujeme, že výrobek, kterého se toto prohlášení týká, je v souladu s níže uvedenými normami.

Schwingungsmessgerät: PCE-VM 25

Mark applied	EU Directive	Standards
CE	2004/108/EC	DIN EN 61010-1:2002 (Sicherheitsbestimmungen) DIN EN 61326-1:2006 (EMV-Anforderungen)

Meschede, 22. März 2012

Ort und Datum

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Specifications are subject to change without notice.