



Advanced Test Equipment Rentals
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VIBTOOL®
Machine condition
via Bluetooth

Operating instructions

Dear Customer,

If you have any suggestions for improving this instruction manual or the instrument itself or any of its accessories, please let us know.

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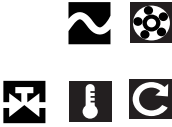
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Introduction

VIBTOOL is a robust hand-held measurement instrument with built-in sensors for vibration, RPM and temperature. These sensors can be used to measure the following 5 parameters:



Vibration acceleration
 Vibration velocity
 Bearing condition (Shock Pulse Method)
 Cavitation
 Temperature
 RPM

Two operating modes are available:

1. 'Bluetooth':

VIBTOOL obtains the measurement parameters from an associated PDA computer via a wireless Bluetooth connection. The measurement results are transferred to the PDA computer and, from there, evaluated and saved using special software.



2. 'Preset measurements'

VIBTOOL contains measurement tasks with preset parameters. The measurement results can only be displayed. It is not possible to store the data on or to transfer them to a PDA.

External vibration or temperature probes can be plugged in to measure at locations that are difficult to reach.

VIBTOOL's primary function is as a 'multimeter' for general on-the-spot measurements. Engineers can walk around the machine hall with VIBTOOL and take immediate measurements of machine conditions. Try it out...

Safety notes

The VIBTOOL housing may only be opened by authorized technical personnel.

Operation and maintenance are to be performed only by properly trained personnel.

Repairs to the VIBTOOL instrument may be carried out only by a PRÜFTECHNIK-authorized service technician.

Only original spare parts and accessories may be used.

Only properly functioning, regularly-maintained electrical equipment may be used. Any defects such as broken plugs or loose sockets must be corrected immediately. Damaged cables must be replaced by an authorized service technician.

Any alterations that affect instrument design or operating safety require explicit prior approval of PRÜFTECHNIK AG.

The relevant safety regulations must be observed during measurements on machines.



Authorized use

- VIBTOOL may only be used to record machine vibration signals, rotational speed and temperature values as well as condition parameters of roller bearings in industrial environments.
- For measurements with external transducers and for data transmission via serial interface, only use the connecting cable provided for this. Transducers and cables may only be used for their respective intended tasks as described in the corresponding product summaries.

Any other use constitutes improper use and is prohibited. PRÜFTECHNIK AG assumes no liability for damage resulting from improper use.

Moreover, the European installation instructions EN 60079-10:2003ff must be followed.



Explosion hazardous areas

- VIBTOOL with intrinsic safety (VIB 2.700 EX) may only be used with rechargeable batteries with the following approval:
ZELM 05 ATEX 0243 U
- Rechargeable batteries must not be charged in explosive environments! Only VIB 2.720 (EU), VIB 2.721 (USA) or VIB 2.722 (UK) charging units may be used.
- The battery should not be removed under any circumstances! To replace a defective battery, VIBTOOL must be sent back to the manufacturer.
- The accessories listed in the 'Sensors & Accessories' product catalog (VIB 9.663-1DG) are not allowed in areas that contain inflammable dust!
- The VIBTOOL case (VIB 2.729) is not allowed in explosion hazardous areas.

- Interface specification:

Analog output circuit: if the intrinsic safety protection is type EEx ib IIC, it is only suitable for connection to devices intended for this

$$\begin{aligned}U_o &= 11.6V \\I_o &= 15mA \\P_o &= 180mW \\C_i &= 70nF \\C_o &= 1.5\mu F \\L_i &= 300\mu H \\L_o &= 60mH\end{aligned}$$

Temperature sensor circuit: if the intrinsic safety protection is type EEx ib IIC, it is only suitable for connection to devices intended for this

$$\begin{aligned}U_o &= 11.6V \\I_o &= 15mA \\P_o &= 180mW \\C_o &= 1.5\mu F \\L_o &= 60mH\end{aligned}$$

Digital output circuit / charging socket: if the intrinsic safety protection is type EEx ib IIC, it is only suitable for connection to devices intended for this

$$\begin{aligned}U_o &= 8.4V & / & & I_o &= 84mA \\P_o &= 180mW & / & & C_o &= 6.8\mu F \\L_o &= 3mH\end{aligned}$$

About this manual

This manual describes the main functions of the VIBTOOL instrument (type: VIB 2.700 EX / firmware version: 1.0x) as well as the most important steps of its operation.

Symbols used in this manual

This symbol denotes information which must be followed in order to avoid damage to the system or other equipment.



Attention!

This symbol denotes general information and tips regarding VIBTOOL operation.



Note

Program overview

Operating modes



Press *M* to switch on VIBTOOL



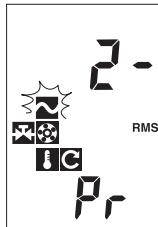

Bluetooth mode

VIBTOOL works in conjunction with a PDA computer. Measurement parameters and results are exchanged via Bluetooth connection.

See page 15 for details.



Press *NEXT*

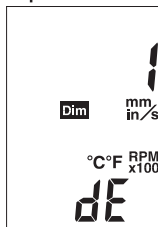
Preset measurement

VIBTOOL works autonomously. Only the preset measurements can be carried out and the results can only be displayed.

See page 17 for details.



Press *NEXT*

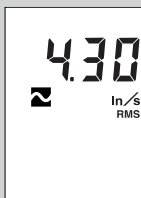
Device setup

Setting up the units and the turn off time. Displaying battery status. See page 20 for details.

Measurement modes

Vibration measurement

Machine vibration at a glance
See page 25 for details.



Bearing diagnosis

Monitors bearing condition
See page 29 for details.



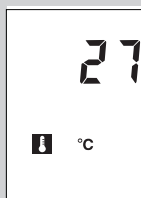
RPM measurement

Accurate non-contact RPM measurement. See page 43 for details.



Temperature measurement

Extremely quick, easy, and accurate
See page 47 for details.



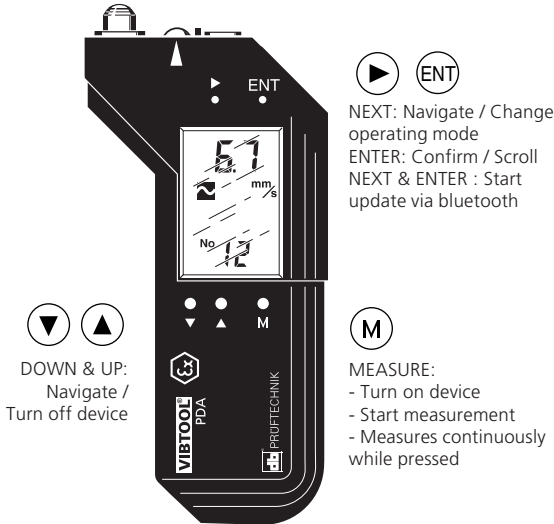
Cavitation measurement

For avoiding damage to pumps
See page 39 for details.



VIBTOOL operation

Operating keys



Turn on VIBTOOL by pressing the ‘M’ key until the LCD lights up. After about one second, the device enters Bluetooth mode, signified by the text ‘bt’ at the bottom of the screen (see page 15 for details).

Turn on VIBTOOL



To display the type of Bluetooth module installed, press and hold the ENTER key before switching on the device with the M key. The following text appears for approx. 2 seconds: “bt|19” or “bt|46”.

bt|19 = WML-C19 module is installed. VIBTOOL instruments with serial number ≤ 999 .

bt|46 = WML-C46 module is installed. VIBTOOL instruments with serial number ≥ 1000 .



Note



Turn off VIBTOOL by pressing the DOWN and UP keys simultaneously. The firmware revision and build number will be briefly displayed before the device turns off (p. 52). VIBTOOL turns off if no key is pressed for more than 10 minutes. VIBTOOL also turns off if any key is continuously pressed for more than 3 minutes.

Turn off VIBTOOL



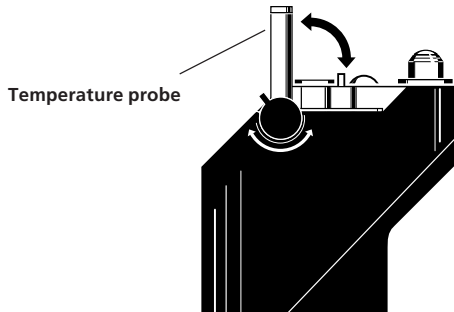
Display

VIBTOOL displays measurement results and status information on the LCD display. Typical measurement screens and the explanation of the individual screen symbols are given in the respective measurement section.

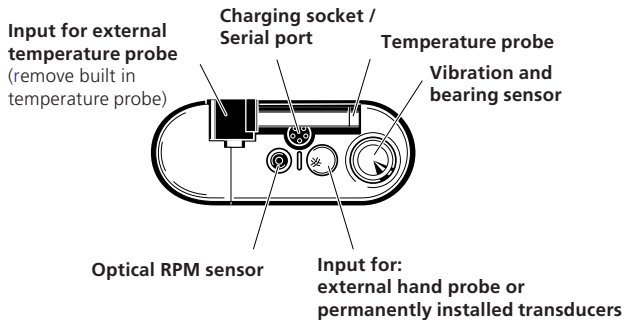
VIBTOOL sensors and connections

Rear view

A rear view of VIBTOOL is shown below. Here, it is possible to extend and retract the temperature probe as indicated by the arrows.



Top view



Rechargeable battery

VIBTOOL is supplied with power by a Lithium-Ion rechargeable battery. The battery is charged in the instrument using the VIBTOOL charger.

The battery should not be removed under any circumstances! To replace a defective battery, VIBTOOL must be sent back to the manufacturer.



Attention!

Battery charge state

The charge status is indicated by the battery ('Batt') icon on the display:



- 'Batt' flashes: battery is almost empty
This continues for a few minutes to enable any measurements that are running to be completed and the battery to be recharged.
- 'Batt' lights up: battery is being charged.
- 'Batt' is not displayed: battery is sufficiently charged.

The charge condition of the battery can also be viewed in the Device Setup (see page 24)



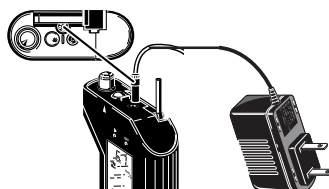
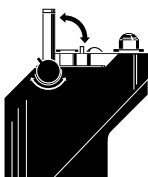
Note

How to connect the VIBTOOL charger

Connect the VIBTOOL charger to the charging socket on the top of the instrument.

Procedure:

1. Flip the VIBTOOL temperature probe out to expose the 5-pin socket.
2. Connect the charger to the 5-pin socket as shown in the diagram below. Check the notch for correct alignment. This is a push fit, do not turn!



VIBTOOL charger
VIB 2.721

While charging VIBTOOL, switch it off to keep the charging time as short as possible.

VIBTOOL behavior during charging

1. VIBTOOL power is off – Power supply unit is plugged in:
If VIBTOOL is not fully discharged, the device switches on and the messages ‘Char’ (= Charge) + ‘Strt’ (=Start) appear consecutively on the display.
VIBTOOL then switches off while battery charging continues.

If the battery is fully discharged, the device switches on and off repeatedly until it continues charging while it is switched on (see also Point 2).

If VIBTOOL is left inactive, it switches off automatically after 10 minutes.

2. VIBTOOL power is off – Power supply unit is removed:
VIBTOOL switches on. The message ‘Char’ - ‘Stop’ appears on the display for 7 seconds. Also, ‘Lo’ or the battery charging level in percent appears before VIBTOOL switches back off.
3. If VIBTOOL is switched on while it is being charged:
VIBTOOL is ready for operation and the ‘Batt.’ symbol lights up steadily to indicate charging.
4. If VIBTOOL is switched off while it is being charged:
The display switches off and charging continues.
5. VIBTOOL power is on – Charging stops (power supply unit is removed or battery is full):
VIBTOOL remains ready for operation and the ‘Batt.’ symbol goes out.
6. VIBTOOL power is off – Charging is completed:
VIBTOOL switches back on and the messages ‘full’ + ‘charge’ appear consecutively on the display.
Press the M key to switch to operating mode, or switch VIBTOOL back off: Unplug the charger from the mains or press the UP/DOWN keys simultaneously.
If VIBTOOL is left inactive, it switches off automatically after 10 minutes.

Typical measurement procedure

Bluetooth operating mode

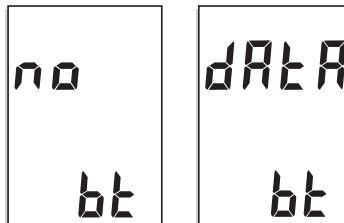
VIBTOOL receives all information for measurement via Bluetooth from a PDA computer. This computer is used to create measurement tasks with the corresponding software.

Bluetooth mode is signified by 'bt' at the bottom of the screen. In this mode the tool is ready to pair* with a host device, or if it is already paired, to begin taking readings. A Bluetooth pairing is not lost when the VIBTOOL is turned off. A VIBTOOL can only be connected with one host device at a time. When the VIBTOOL is communicating with a host device via Bluetooth, the Δ icon appears in the lower left corner of its display.

Once VIBTOOL has been switched on, the 'No data' message appears on the display. VIBTOOL is now ready to receive the first measurement task:

* The host device must *pair* with a Bluetooth peripheral device before they can communicate. Pairing consists of exchanging information that allows the two devices to uniquely identify each other.

'no data' appears when the device is switched on



After the measurement task has been received, the 'rdy' (ready) message appears. At the same time, the corresponding measurement symbol flashes – e.g. for a vibration measurement:



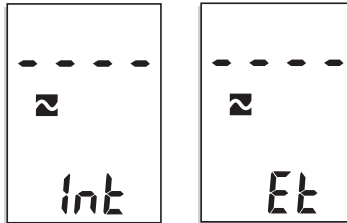
Measurement task received
- ready to measure



- Hold the sensor against the measurement location. Make sure that the direction of measurement and the contact pressure are correct.
- Press the M (Measure) key to start the measurement:

(M)

Int and **Et** indicate whether an internal or external sensor is being used. If they disappear then reappear, this indicates that the measurement is unstable - remeasure!



VIBTOOL carries out several individual measurements which are then averaged to produce a final result. VIBTOOL automatically sends the final result to the PDA.



Note

To extend the measurement recording period, keep the M key pressed. VIBTOOL starts the individual measurement when the M key is released.



Measurement result

The measurement result is shown on the display until the next measurement task is received.



Note

If an external sensor is connected to VIBTOOL, this sensor must also be used to carry out the measurement! In this case, the integrated sensors are not used for measurement.

'Preset measurements' operating mode

VIBTOOL contains the following preset measurement tasks that can be carried out at any time:

- Vibration velocity - 10Hz to 1kHz
- Vibration velocity - 2Hz to 1kHz
- Shock pulse measurement - 36kHz bandpass (bearing condition evaluation)
- Vibration acceleration - 0.5kHz to 10kHz
- Vibration acceleration - 1kHz to 10kHz
- Cavitation measurement - 36kHz bandpass
- RPM
- Temperature

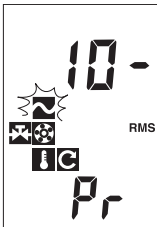
The measurement results are displayed until the next measurement is started. It is not possible to store the results on or to transfer them to a PC.

Measurement selection

1. Vibration velocity



Switch on VIBTOOL and press NEXT until 'Pr' appears in the lower display field.

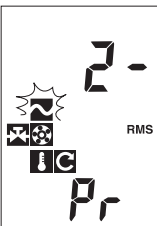


Vibration velocity 10Hz to 1kHz is selected:

The corresponding symbol flashes and the lower frequency (10-) appears on the display.



To change the lower frequency, press ENTER:



Vibration velocity 2Hz to 1kHz is now selected: 2- (Hz).

2. Shock pulse & Vibration acceleration:

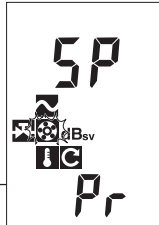
Pr



Switch on VIBTOOL and press NEXT until 'Pr' appears in the lower display field.



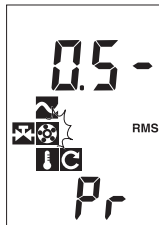
Keep the DOWN key pressed until the following display appears:



Shock pulse is selected when the 'Bearing' symbol flashes and 'SP' (= 'Shock Pulse') appears on the display.



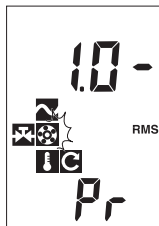
To select the vibration acceleration measurement, press ENTER:



Vibration acceleration 0.5kHz to 10kHz is selected: the 'Bearing' symbol flashes and the lower frequency (0.5) appears on the display.



To change the lower frequency to 1kHz, press ENTER:



Vibration acceleration 1kHz to 10kHz is now selected: 1.0 - (kHz).



To return to the shock pulse measurement again, press ENTER.

3. Temperature / RPM / Cavitation:

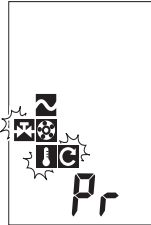


Switch on VIBTOOL and press NEXT until 'Pr' appears in the lower display field.

Pr



Keep the DOWN key pressed until the following display appears and the respective symbol flashes:



- Temperature



- RPM



- Cavitation

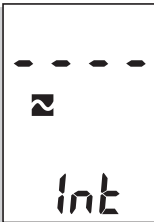


Starting measurement

Hold the sensor against the measurement location. Make sure that the direction of measurement and the contact pressure are correct.



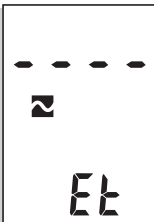
Press the M (Measure) key to start the measurement:



The display that appears on the measurement screen depends on which measurement is selected. More details are given at the end of the relevant chapter on measurement.

Example:

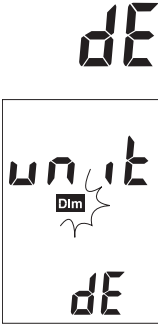
'Int' and 'Er' indicate whether an internal or external vibration sensor is being used. If they disappear then reappear, this indicates that the measurement is unstable - remeasure!



After the measurement, click on the NEXT key to return to the selection screen.

Unit settings (Device setup)

To change the units, proceed as follows:



Switch on VIBTOOL and press NEXT until 'dE' appears in the lower display field:

The VIBTOOL device setup is active when 'unit' and 'dE' appear on the display and the 'dim' symbol flashes.



Press the ENTER key to enter the edit mode.



Press the DOWN key repeatedly to select the units one after the other:

:

1. Vibration velocity
2. Vibration acceleration
3. Temperature
4. Rotational speed



Press ENTER to change the settings:

- | | | |
|-----------------------------|----|--------|
| 1. mm/s | <> | inch/s |
| 2. - - (=m/s ²) | <> | g |
| 3. °C | <> | °F |
| 4. RPMx100 | <> | 1/s |



Navigate back with the UP key and leave the edit mode.

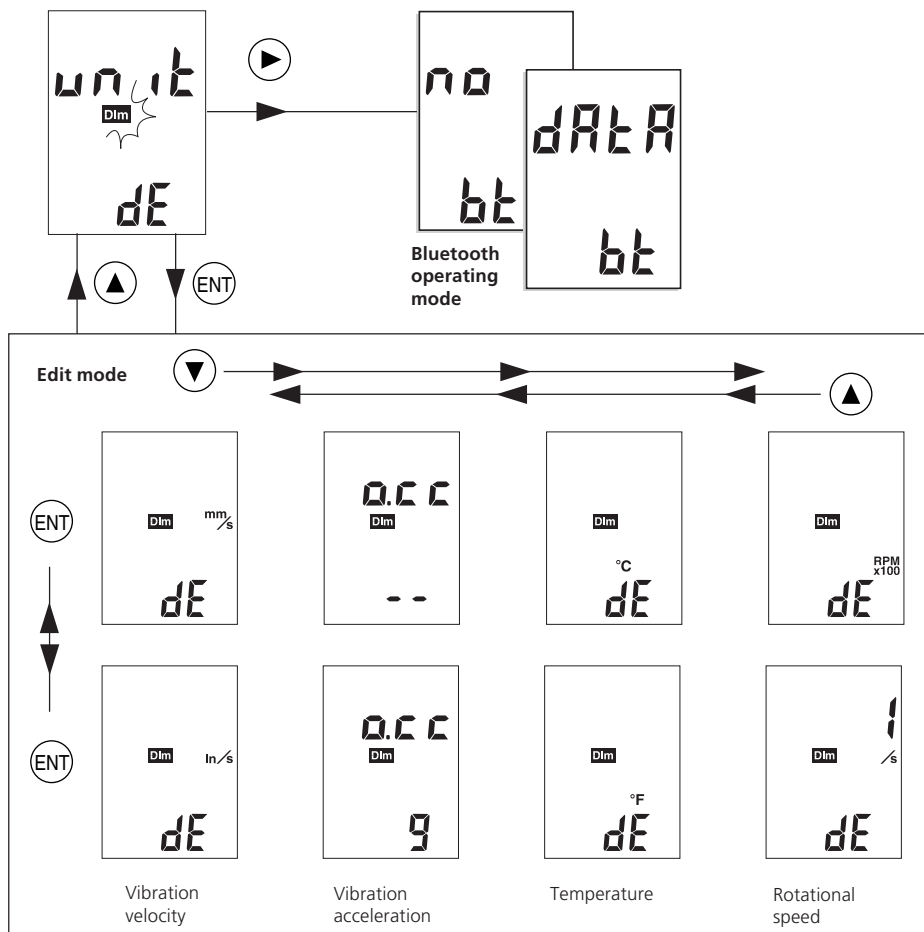


To leave the Device Setup again, press the NEXT key. The 'Bluetooth' operating mode is activated.

Note:

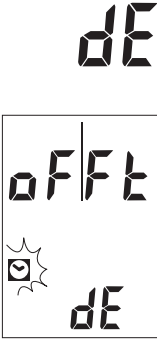
m/s² cannot be displayed:
' - - ' is shown instead!

Overview



Turn off time (Device setup)

To change the turn off time, proceed as follows:



Switch on VIBTOOL and press NEXT until 'dE' appears in the lower display field (see previous pages).



Press the UP key until 'OFFt' appears and the clock icon flashes in the display.



Press the ENTER key to enter the edit mode.



Press the UP key repeatedly to select the turn off time one after the other:

10.⁰⁰ (minutes)

30.⁰⁰ (minutes)

45.⁰⁰ (minutes)

60.⁰⁰ (minutes)

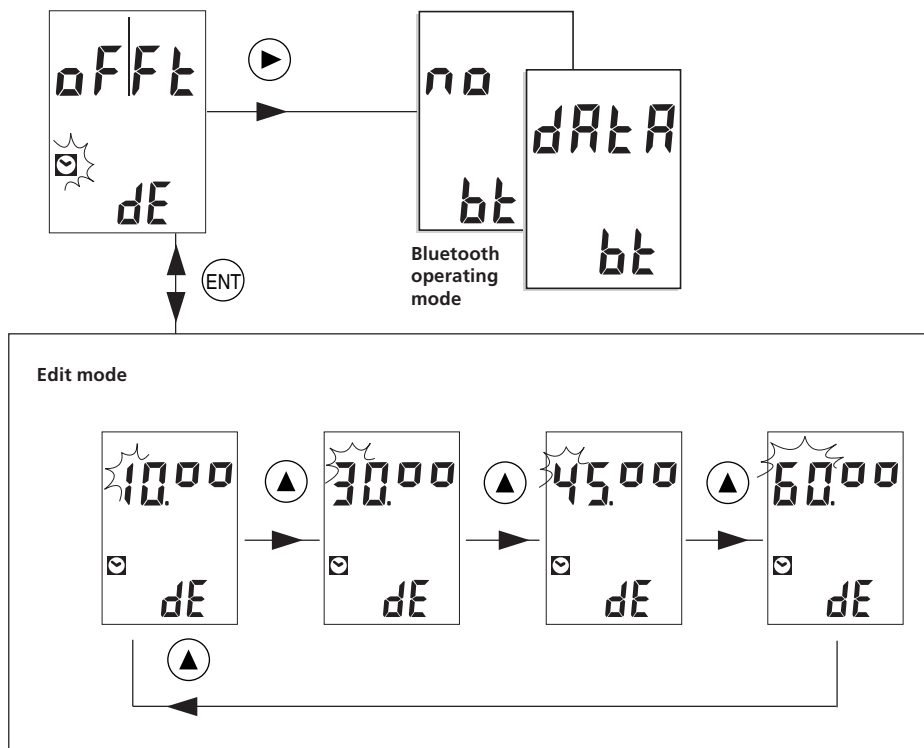


Press ENTER to save the settings and to leave the edit mode.






To leave the Device Setup again, press the NEXT key. The 'Bluetooth' operating mode is activated.

Overview




Display battery status (Device setup)

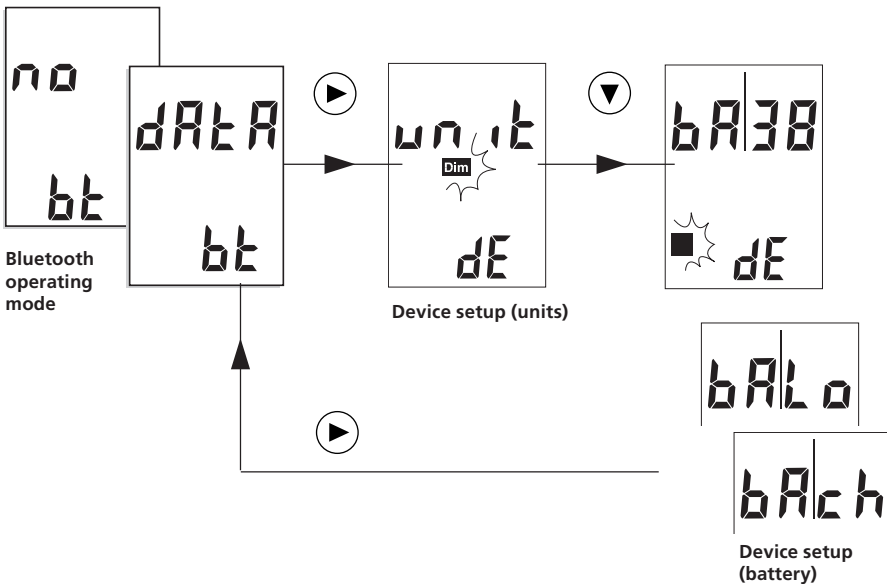
To display the battery status, proceed as follows:

- 
-  Switch on VIBTOOL and press NEXT until 'dE' appears in the lower display field (see previous pages).
 -  Press the DOWN key until 'bA|xx' appears and the square icon flashes in the display.

"xx" shows the battery status:

 - 1 .. 99 = Battery charge in %
 - Lo = Battery empty
 - ch = Battery is being charged OR is fully charged (100%).
 -  To leave the Device Setup again, press the NEXT key. The 'Bluetooth' operating mode is activated.

Overview



Vibration measurements

VIBTOOL is the perfect vibration measurement instrument with a built-in vibration sensor. It uses the same sensor for vibration measurements as it does for the bearing measurements as described in the relevant chapter.

The vibration severity is measured according to ISO 10816-3, as well as other international standards which have been set on the same level.

VIBTOOL fulfills all the known standards for vibration measurement. The RMS vibration value is an international measurement unit which shows whether the vibration of a rotating machine is acceptable.

Besides the built-in sensors, an external sensor can also be connected to VIBTOOL, e.g. mobile or permanently-mounted Tandem-Piezo® accelerometers. This means difficult measurement locations are easy to reach.

The combination of shock pulse measurement and vibration measurement is very helpful when evaluating machine condition - especially of rotating equipment such as fans and compressors. See the separately available vibration handbook (order number VIB 9.443G) for further details on vibration measurements.

What is meant by vibration severity?

Vibration severity is defined as the RMS level of vibration velocity, measured over a frequency of 2 to 1000 Hz or 10 to 1000 Hz. Vibration severity is approximately related to the energy level of machine vibration, and is thus a good indicator of the destructive forces acting on the machine.

The vibration severity measurement is a very efficient monitoring method for detecting such common machine faults as imbalance, structural weakness, loose parts, etc. Few input data are needed and it is easy to apply. The evaluation is based on the international industrial standard ISO 10816. The measurement returns the RMS value of vibration velocity in mm/s or inch/s.



Note

ISO vibration monitoring standard

In order to monitor vibration severity according to the ISO 10816-3 standard, the threshold values must be set according to the appropriate machine classification. This classification is determined according to machine power and foundation characteristics as follows:

ISO 10816-3

Group 1: Large machines, 300 kW to 50 MW

Group 2: Medium-sized machines, 15 kW to 300 kW

Action:

- A: continue to make regular measurements.
- B,C: Take initial steps to locate the source of the vibration. Keep a close watch on the machine and consider a shutdown.
- D: Take immediate steps to locate the problem, shutdown and correct.

Evaluation scale

- A: Newly commissioned
- B: Indefinite continuous service allowed
- C: Short-term operation allowed
- D: Vibration is causing damage

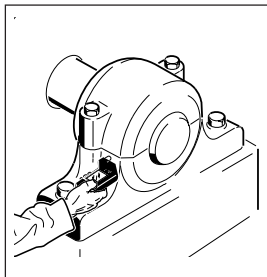
To evaluate the condition of your machine, simply read off the vibration velocity on the right-hand scale and go across the table until the correct machine class is reached.

								Vibration velocity (r.m.s.) (10 - 1000 Hz r > 600 min ⁻¹) (2 - 1000 Hz r > 120 min ⁻¹) mm/s
D								
C								
B								
A								
rigid	elastic	rigid	elastic	rigid	elastic	rigid	elastic	Foundation
Pumps radial, axial, diagonal P > 15 kW				Med.-sized mach. 15 kW < P ≤ 300 kW		Large machines 300 kW < P < 50 MW		Machine type
Direct drive		Intermediate gear/ belt drive		Motors 160 ≤ H < 315 mm		Motors 315 mm ≤ H		
Group 4		Group 3		Group 2		Group 1		Group

Ideal measurement position

When taking vibration measurements using VIBTOOL, care must be taken to position it correctly. If VIBTOOL is not held correctly against the machine, unreliable measurement values and damage can occur. So be sure to observe the following:

- The measurement surface must be metallic, flat and clean (or, preferably, prepared with the VIB 8.610 countersink, see page 56 for details). Otherwise, the frequency range may be reduced due to poor mounting technique.



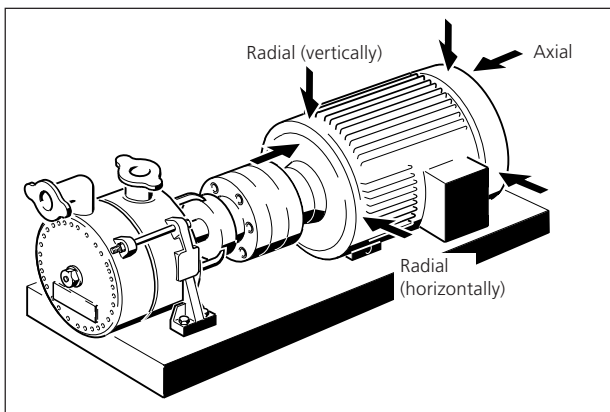
Where to measure

Several measurements should be taken to obtain complete information for vibration analysis: four radial readings (offset from each other by 90°) and one axial reading.

In practice, non-critical machines may only require e.g. two radial measurements to be taken on a regular basis. If vibration increases, measure the other locations as well.

Most machine manufacturers' vibration limits are based upon readings taken directly at the bearing housing. Practical limitations, however, often prevent access to this ideal location so that points some distance away must be chosen. Generally, though, measurements should still be taken as close as possible to the bearings on the stiffest possible section of available machine casing. Of course, cantilevered or poorly-supported housing sections are particularly resonance-prone and therefore unsuitable as measurement locations.

Once the exact measurement locations have been determined, be sure to mark them clearly so that all subsequent measurements can be taken at the same points. This is especially important as vibration readings can vary greatly if the probe location is moved even slightly.

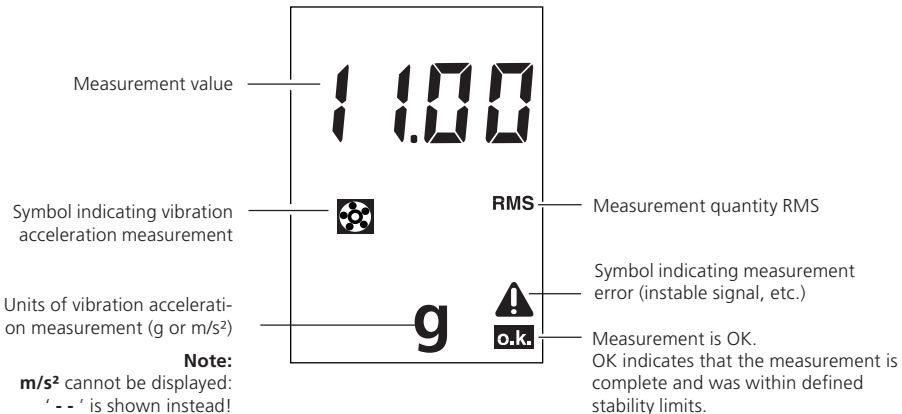
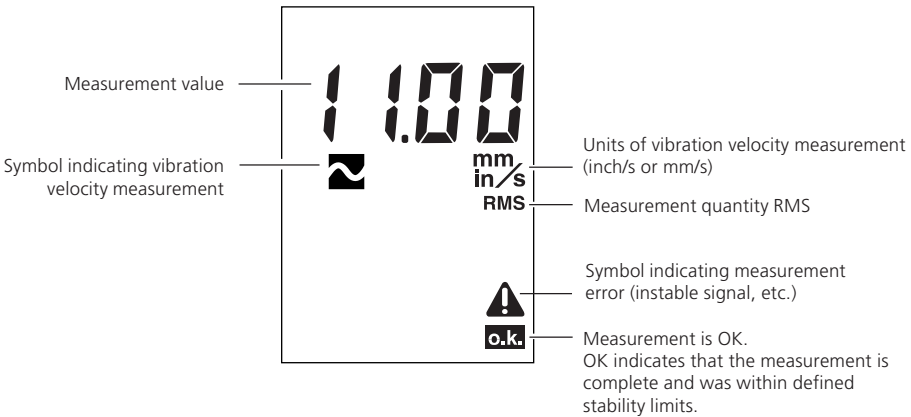


Vibration measurements with VIBTOOL

During measurement keep the sensor firmly pressed against the measurement point and keep it still - measurement duration depends upon signal strength and stability: the stronger and more constant the measurement signal is, the quicker the display response will be.

Vibration display

The following display shows all the symbols which can appear during a vibration measurement. However, the symbols may not all appear simultaneously.



Bearing diagnosis

VIBTOOL uses the Shock Pulse Method to evaluate bearing condition. This method considers shock pulses which arise during the metal to metal contact present in damaged bearings. These shock pulses indicate distinct resulting frequencies and amplitudes. Two values, carpet and maximum value, are used to evaluate the bearing condition. As bearing damage progresses, the overall levels and the difference between these values increases. VIBTOOL measures the carpet value (background noise) and the maximum value. These values generally allow early detection of bearing damage as it progresses, especially when a computer is used for trend observation.

Many bearings are inaccessible for direct measurement with hand-held probes. This is a principle weakness of all meters and data collectors which rely on hand-held measurements. In such cases, the bearing has to be prepared for VIBTOOL measurement by installing permanently mounted transducers. External transducers, such as the Industrial Accelerometer from PRÜFTECHNIK Condition Monitoring, can be connected easily to VIBTOOL, thus allowing access to difficult measurement locations.

For shock pulse measurements using the built-in VIBTOOL probe, the measurement location should be prepared (preferably with countersink bit VIB 8.610, see page 56 for details) in order to achieve maximum measurement repeatability.

The three-band scale of bearing condition ('good,' 'reduced' and 'poor') explained herein is used only as an example to aid in learning. The actual boundaries between 'good,' 'reduced' and 'poor' bearing condition can vary significantly between individual bearings, depending upon their design characteristics and service conditions. Therefore, reliable diagnosis may be made only in conjunction with a series of trend observation measurements made on the bearing under consideration over a period of time.



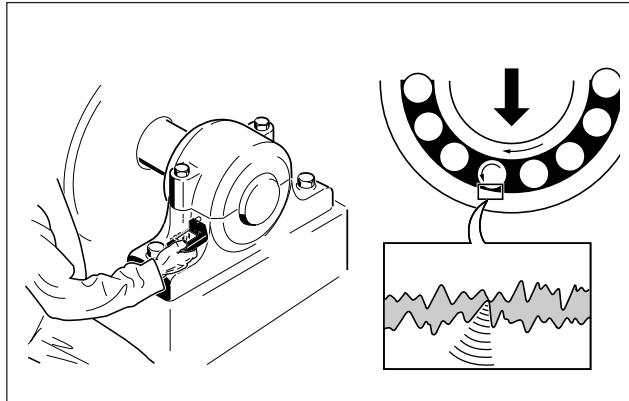
What are shock pulses?

Shock pulses are short duration pressure pulses which are generated by mechanical impacts. Mechanical impacts occur in all rotating rolling bearings because of irregularities in the surfaces of the raceways and rolling elements. The magnitude of the shock pulses depends on the impact velocity and surface area.

Like random vibrations, shock pulses are encountered relatively often in daily life. They can originate from widely different releases of energy such as rough handling of equipment. However, one thing which is noticeable with shock pulses is the short duration. A simple shock pulse can be defined as a transmission of kinetic energy to a system which takes place in a relatively short period of time.

Where do shock pulses occur?

A common place where shock pulses are generated is in bearings. Shock pulses are generated in the rolling interface between the loaded rolling element and the raceway of the bearing. The surface of the bearings is rough. The rough surface gives rise to pressure variations in the oil film which separates the moving surfaces, as well as collisions between peaks in the surface. These factors result in shock pulses which spread through the material of the bearing, the bearing housing and any adjacent machine parts.

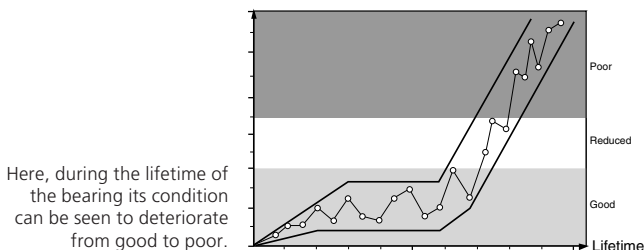


How are shock pulses actually measured?

Shock pulses excite the measurement accelerometer which is mounted in the load zone at its resonant frequency, typically at or around 30 kHz. A high-pass filter is used to eliminate low-frequency components such as those caused by shaft misalignment or unbalance. The remaining signal is processed in order to obtain the various shock pulse parameters explained on the following pages.

How are shock pulses evaluated?

In order for shock pulses to be evaluated, a simple scale has had to be devised. The following scale indicates the extent of bearing damage in three categories (ranging from good to poor):



In this way, it is possible to evaluate bearing condition without introducing complicated terms and factors.

Since surface roughness is constantly being created and rolled down during operation, measurement values can abruptly increase or decrease by considerable amounts for short periods of time. For this reason, a single 'snapshot' measurement of bearing condition is often less useful or reliable than trend measurement and monitoring over a longer time period.

Due to the many factors involved in shock pulse measurement, results may vary between instruments from different manufacturers.



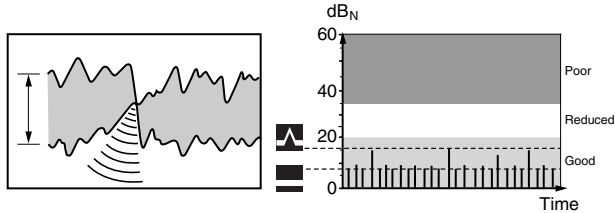
■ The carpet value

The carpet value does not give information regarding damage to the bearings!

Surface roughness causes a rapid sequence of minor shock pulses which together constitute the shock carpet of the bearing. This can be heard as a background noise level when pressing a screwdriver to your ear to listen to the bearing. The magnitude of the shock carpet is expressed by the carpet value. The carpet value gives important information regarding the lubrication of the bearings, how well the bearings have been mounted and the way in which the bearings are being loaded (for example, due to misalignment).

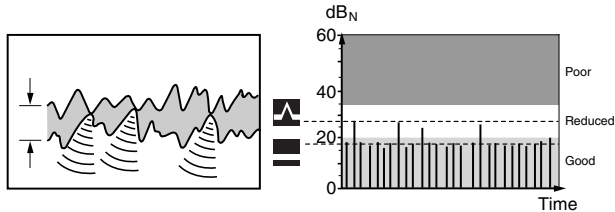
The carpet value is directly related to the thickness of the lubricant film in the rolling interface. The carpet value is low when the surfaces of rolling elements and raceway are completely, or almost completely, separated by a lubricant film (see the diagram below).

Here, the carpet value is low when the rolling elements and raceway are separated by a generous lubricant film.



The carpet value rises when the lubricant film thickness decreases and metal to metal contact increases between the bearing surfaces. The diagram below shows how the carpet value has risen.

The carpet value has risen as a direct result of decrease in lubricant film thickness.

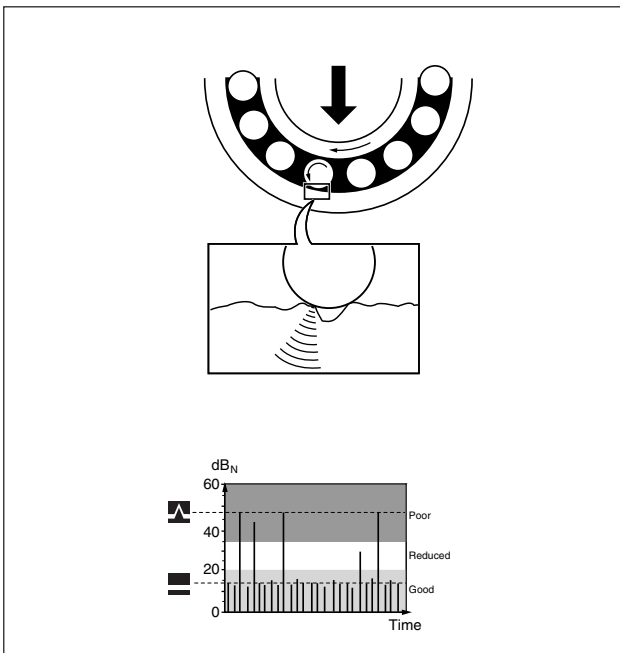


The carpet value helps to analyze the cause of reduced or poor operating condition.

Maximum value

Bearing damage (i.e. relatively large irregularities in the surfaces) causes single shock pulses with higher magnitudes at random intervals (see the diagram below). These can sometimes be heard when pressing a screwdriver to your ear to listen to the bearing. The highest shock pulse value measured on a bearing is called its maximum value.

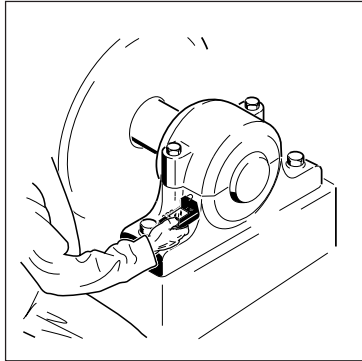
The maximum value is used to determine the operating condition of the bearing as well as the damage already done.



Here, the resulting shock pulse pattern can be seen, indicating a damaged bearing.

The measurement location

The preferred points of measurement are where the vibration energy is transmitted to VIBTOOL as directly as possible. For machines which include rotating masses, the bearings and the mounting points of the machine serve as ideal points of measurement.

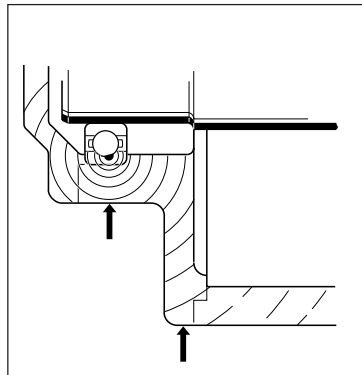


A typical VIBTOOL measurement location.

Five simple rules to follow

1. One mechanical interface

Each interruption (or interface) in the material dampens the signal to be measured. Therefore, the signal path must contain only one mechanical interface, *i.e.* that between the bearing and the bearing housing.

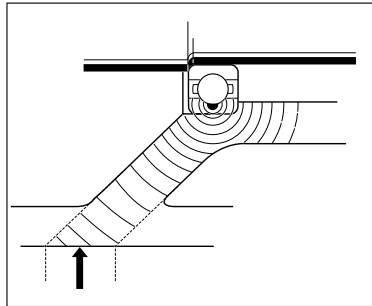


The amount of signal loss at an interface can be considerable. Welds, for example, are regarded as interfaces.

2. Short signal path

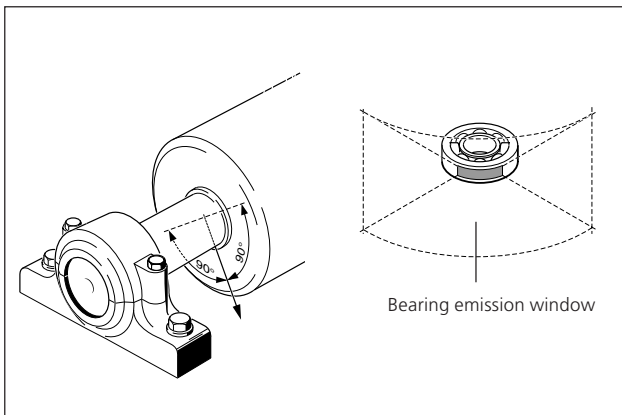
The signal path between the bearing and the measurement point must be as short and straight as possible. Shock pulses lose strength over a long signal path (especially when it has a large cross section) and are dampened when deflected by bends in the path.

Measurement is possible only in the area defined by the dotted lines.



3. Loaded region

Shock pulses are generated mainly in the rolling interface, where the load carrying element touches the raceway. Therefore, the measurement must be located in the loaded region of the bearing housing (as defined by the bearing's emission window). Ideally, the measurement point should be in line with the load direction.





Note

Bearing emission window

Shock pulses are generated mainly in the interface between rolling element and raceway. This occurs in the loaded part of the bearing. For radial bearings, the loaded region covers a sector of 90° centered around the load direction. From the outer raceway, shock pulses are transferred to the bearing housing. As the width of the bearing is limited, direct radiation of shock pulses is limited to a sector of $\pm 60^\circ$ from the perpendicular to the area of contact between the rolling elements and the raceway. This now defines the window of emission of the bearings. Outside the window of emission, reflected and dampened shock pulses can be measured. This measurement can be good enough for trending and comparison, but does not allow an accurate measurement of oil film thickness or damage to be made.

4. Directly at the bearing

Shock pulses are dampened when they pass an interface or are forced from their straight path. It is, therefore, important to pick up the shock pulses before a significant part of the signal strength is lost. A measurement directly at the bearing is, therefore, recommended.

5. Metallic, flat, clean (preferably machine-faced)

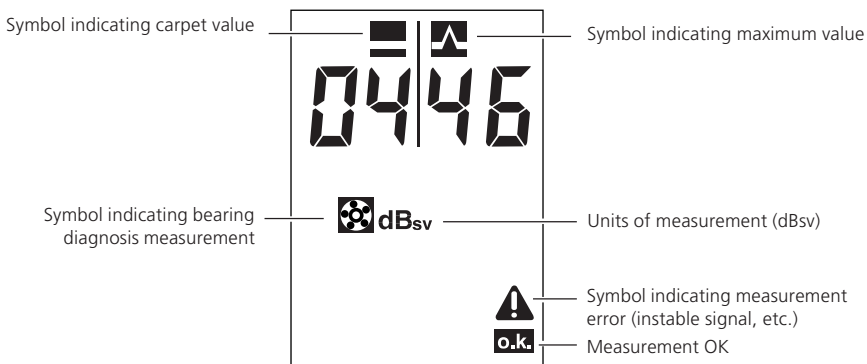
When taking bearing measurements using VIBTOOL, care must be taken to position it correctly. If VIBTOOL is not held correctly against the machine, unreliable measurement values and damage can occur so be sure that the mounting surface is flat and clean (preferably machine-faced). Remove any traces of paint, grease or dirt; otherwise, the frequency range could be reduced due to poor coupling.

Bearing diagnosis with VIBTOOL

During measurement keep the sensor firmly pressed against the measurement point and keep it still - measurement duration depends upon signal strength and stability. VIBTOOL takes four successive individual measurements and uses the maximum value.

Bearing diagnosis display

The following display shows all the symbols which can appear during a bearing diagnosis measurement. However, the symbols may not all appear simultaneously.



Lo or Hi in the display?

If 'Lo' or 'Hi' appear when taking bearing measurements, the measured value is too low or too high to measure correctly, the range being -9 to +80dB. Check that the sensor is correctly in contact with the machine.

Cavitation measurement

What is cavitation?

If the liquid pressure at the inlet of a pump housing becomes less than the vapor pressure, a portion of the liquid turns into saturated vapor and forms bubbles. As the pressure increases, the vapor condenses and the bubbles implode. These implosion forces - known as cavitation - can damage or even destroy the impeller. Fortunately, these cavitation forces exhibit certain characteristics which allow them to be measured quite accurately. Damage can therefore be anticipated well in advance of actual machine failure.

VIBTOOL allows measurement of cavitation in pumps, turbines and other rotating equipment and valves. Cavitation is generally considered to cause a 2-3% loss in efficiency. Before now, some pump manufacturers and pump users have had the wrong opinion of how to prevent cavitation. It has been assumed that cavitation could always be heard and therefore somehow prevented. This is not the case and never will be. Depending on the pump construction and on the running condition of the pump, cavitation cannot normally be heard.

If cavitation is detected in its early stages, damage to impellers and pump housings can be prevented, the condition can be remedied and the lifetime of the pump can be extended. This is why PRÜFTECHNIK Condition Monitoring has developed VIBTOOL with the cavitation measurement function. This function allows the measurement of the high frequency pulses in the pump housing. The source of the pulses can be localized by simply placing the VIBTOOL sensor on the inlet of the pump housing while the pump is running. What is more important is that it is possible to change the pump velocity or the suction height while measuring. The point at which cavitation ceases in the pump can then be clearly seen on VIBTOOL display.

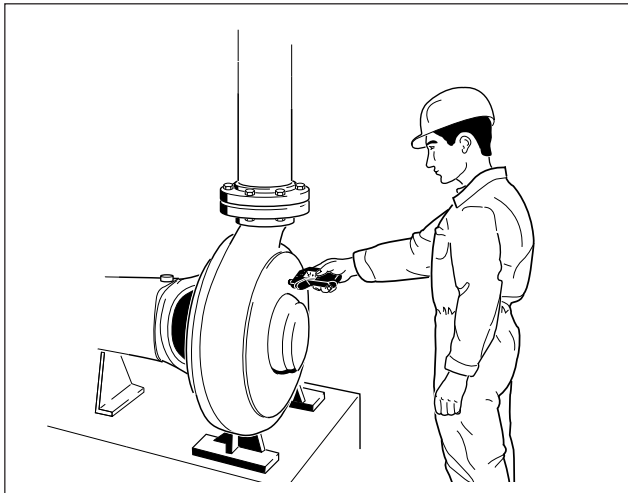
Cavitation evaluation

Cavitation measurements on pumps can only be evaluated using trending analysis or by comparison. When measurements have been taken over a longer period of time, for example during trending, deviations from previous measurements can indicate that cavitation is occurring in the pump.

Comparison between one machine and another of the same type can also give some indication of cavitation: when the cavitation measurement on one pump is higher than that of the second pump, then cavitation is likely to be the cause.

Ideal measurement position

When taking cavitation measurements using VIBTOOL, care must be taken to position it correctly. If VIBTOOL is held improperly against the machine, unreliable measurement values and damage can occur. Ensure that the measurement location is metallic, flat and clean, or if possible, use the VIB 8.610 countersink to prepare the location (see page 56 for details)-.

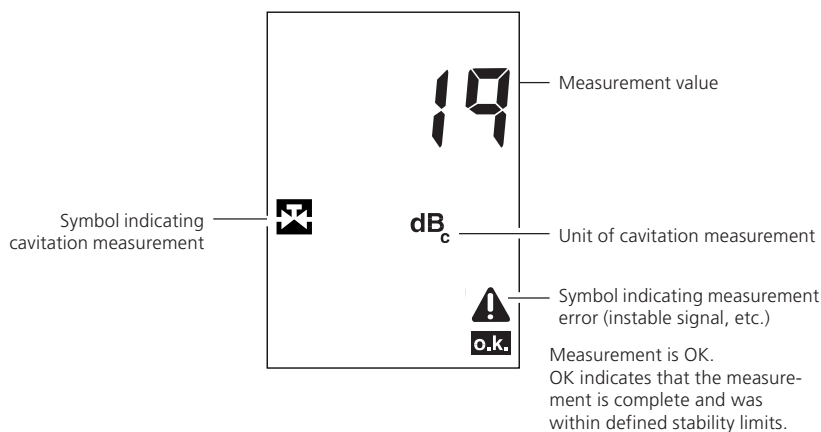


Cavitation measurements with VIBTOOL

During measurement keep the sensor firmly pressed against the measurement point and keep it still - measurement duration depends upon signal strength and stability: the stronger and more constant the measurement signal is, the quicker the display response will be.

Cavitation measurement display

The display below shows all the symbols which can appear during a cavitation measurement. However, not all of these symbols may appear simultaneously.



RPM measurement

VIBTOOL is an accurate non-contact rpm measurement instrument, thanks to the new and patented contrast marker method.

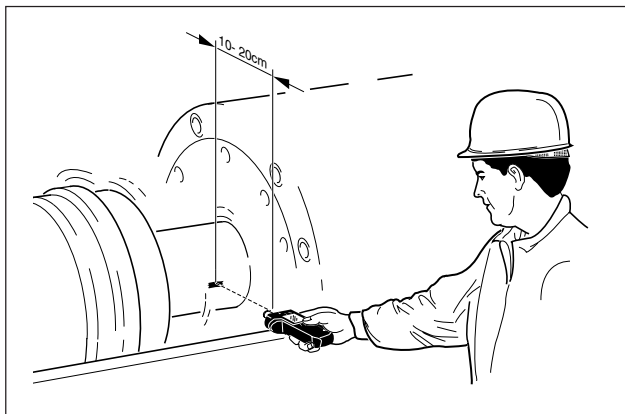
Normal non-contact methods of RPM measurements use the reflection principle. However, the contrast sensor built into VIBTOOL does not use a power-consuming light beam and, as a result, no reflective foil. RPM measurements, therefore, can be undertaken without having to stop the machine to be measured. The optical trigger inside VIBTOOL is capable of recognizing a change in contrast (from light to dark or from dark to light) of the surface towards which it is pointed. You simply locate a mark on the shaft or rotor, such as an oil mark, and point VIBTOOL in that direction. VIBTOOL then adjusts itself accordingly to the contrast between the oil mark and the background. Each time the rotor contrast mark passes by, VIBTOOL registers this as an electric pulse which it uses to calculate the RPM of the machine and then display it on the screen.

In cases where the contrast is not great enough, simply use a black felt-tip pen; or white corrector-fluid (e.g. Tippex®) to mark the rotor to obtain a good contrast. Rotors with larger diameters can also be measured.

Do not use reflective tape as a contrast mark!



Note



Interference from external light sources

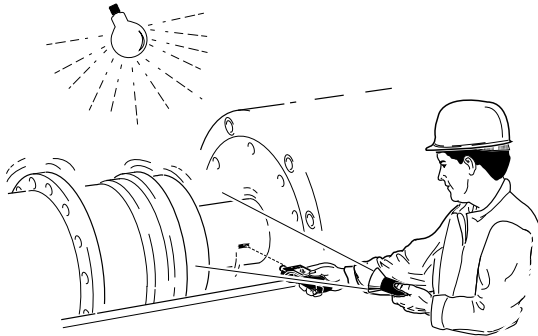
It is important to note the following three points in order for a correct signal to be obtained when taking RPM measurements.

1. Reflections from shiny objects can lead to instable signals because the light which VIBTOOL detects is fluctuating.
2. VIBTOOL must be pointed radially at the shaft and from underneath the shaft wherever possible. This avoids any interference from light coming from above.
3. Make sure that local lighting does not shine directly into the VIBTOOL optical sensor or onto the contrast mark.



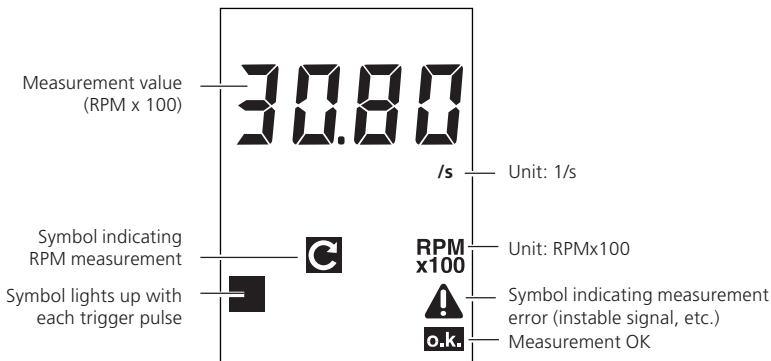
Note

In case of interference from external light sources, such as fluorescent lamps, a flashlight may be used to obtain a stable light signal. Simply illuminate the shaft and contrast mark using the flashlight.



RPM measurement display

The following display shows all the symbols which can appear during an RPM measurement. However, the symbols may not all appear simultaneously.



When a flashing measurement value is seen on the screen, the current measurement is outside preset stability limits. Press 'M' continuously to show a live display where you can observe how stable the measurement is.

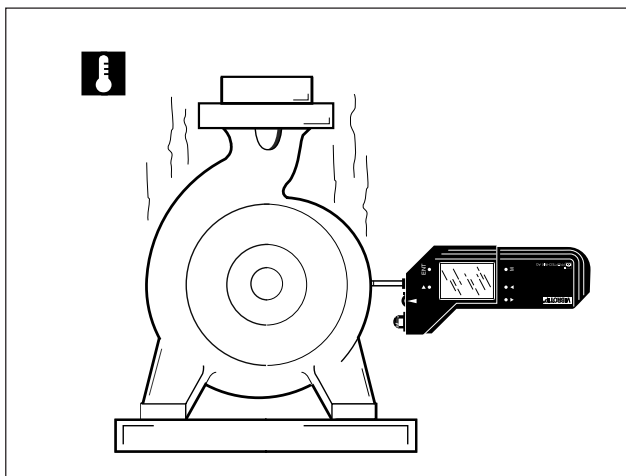
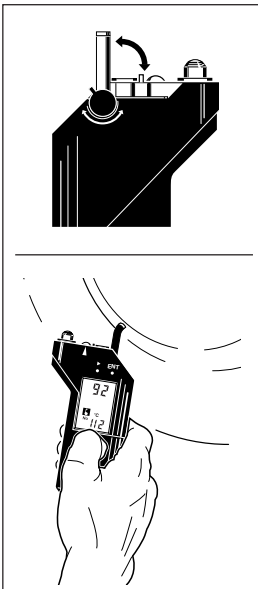


Temperature measurement

VIBTOOL is also a convenient pocket thermometer. A built-in temperature probe makes it possible to measure both surface and liquid temperatures over a range of -30°C - 270°C (-22°F - 518°F).

The temperature probe fits itself to the measurement surface - quickly and accurately from almost any angle. This ensures that the probe transmits energy very quickly, ensuring a very fast reaction time to temperature changes. It also measures fluid temperature with the same ease of use. With this technique it is possible to use a silicone extension piece. A new temperature probe (order number VIB 8.605) is also available for quick and easy replacement of the old one.

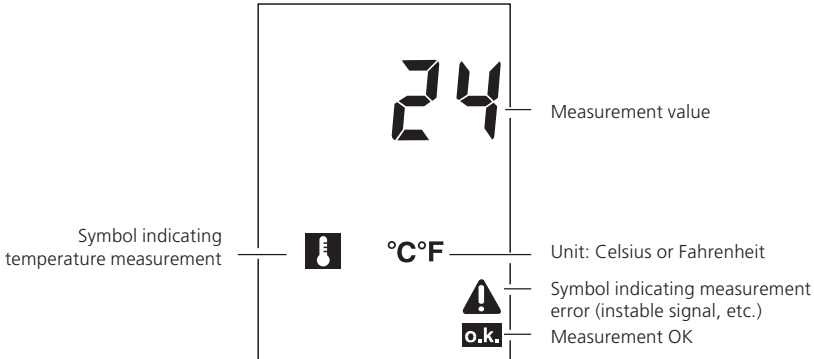
A NiCrNi probe is also available allowing measurement up to 500°C (932°F).



Typical temperature measurement location on a pump.

Temperature measurement display

The following display shows all the symbols which can appear during a temperature measurement. However, the symbols may not all appear simultaneously.



Note

It can take several seconds for the VIBTOOL probe to reach the same temperature as the surface it is measuring. If necessary, press 'M' continuously to show a live display where you can see when the correct temperature has been reached.

(M)

When a flashing measurement level is seen on the screen, the current measurement is outside preset stability limits. Press 'M' continuously to show a live display where you can see how stable the measurement is.

Appendix

Warranty, service and care

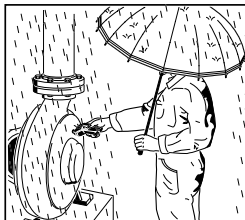
VIBTOOL is a robust hand-held measurement instrument, specially designed for use in harsh industrial environments. Its rubberized housing and built-in measurement sensors ensure lasting reliability even when used under adverse conditions.

Warranty

VIBTOOL is guaranteed for one year for parts and labor.

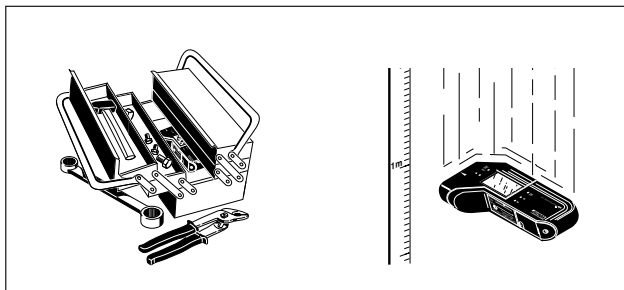
Environmentally protected

VIBTOOL is environmentally protected according to IP 65. This standard specifies water-resistant and dust-resistant conditions. Avoid environments with high humidity if possible as moisture might enter the unit over a period of time and temporarily fog up the display.



Robustness

VIBTOOL can easily be carried in a toolbox without risk of damage. VIBTOOL is very robust and has been drop-tested onto a hard surface from a height of 1 m.

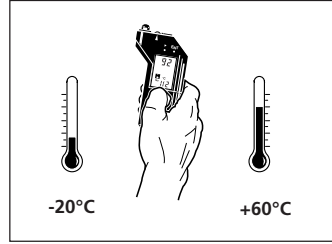


Temperature range

VIBTOOL has an operating temperature range of -20°-60°C (-4°-140°F). If measurements are taken outside this range, the specified accuracy may not be maintained.

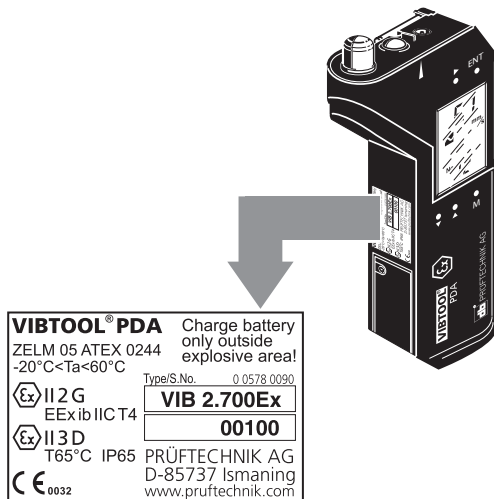
Store your VIBTOOL at temperatures between -20° and 60°C (-4° to 176°F) and do not forget that on a hot day, the temperature inside a locked car can easily surpass 60°C (176°F)! Temperatures between 0° and +20°C are ideal for storing the VIBTOOL for longer periods.

Sudden changes in temperature and humidity (e.g. when VIBTOOL is stored in an office, but used in hot or cold work areas) can cause the optical sensor to fog over with condensation. In that case, give VIBTOOL about 10 minutes to reach the work area temperature before measuring RPM.



Nameplate

The diagram below shows the location and the contents of the instrument nameplate.

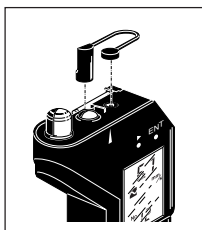


Cleaning

The VIBTOOL optical sensor must be clean and free from dust, etc. to avoid inaccuracy during measurement. Use a soft cotton cloth to remove any dirt from the optical sensor and display window. Also, avoid vigorous polishing to preserve the anti-reflective coating of the glass element. The VIBTOOL housing can be cleaned using a soft cloth dampened with a mild detergent.

When it is not in use, cover the connector for an external sensor with the dust cap to keep it clean.

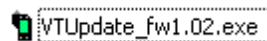
Moreover, it is important to follow the specifications of EN 60079-14 and EN 60079-17 that apply to maintenance and servicing.



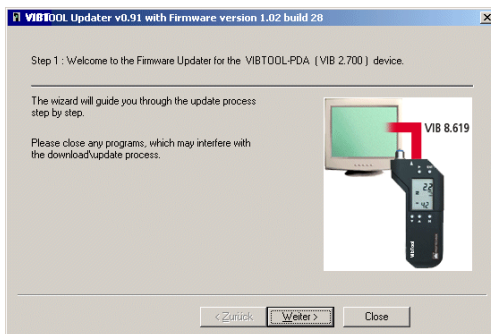
Update via serial cable

The standard method of updating the firmware in VIBTOOL is via serial cable. The VIBTOOL update program is loaded onto a PC with the latest firmware version.

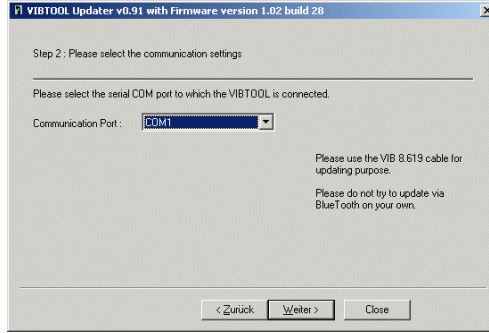
- Start the 'VTUpdate_fwXXX.exe' update program. The firmware version is specified as a three-digit number in the file name - '1.02' in the example.
- Click on 'Continue' in the first screen and connect the appropriate serial PC cable* (part no.: VIB 8.619).



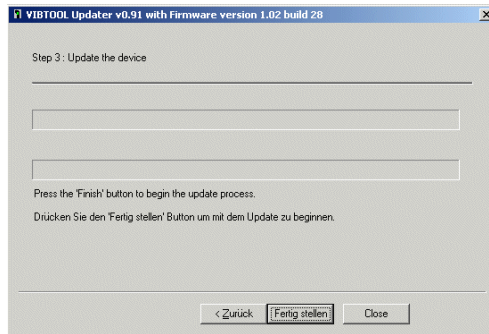
* available as an accessory (see page 55)



- In the second screen select the COM port where the PC cable is connected. Click on 'Continue'.



- In the third screen click on 'Complete'.



Firmware version

The version number is displayed when VIBTOOL is switched off. To do so, press the UP and DOWN keys at the same time (see page 11):



Firmware version (here: 1.00)

Build number (here: 17)

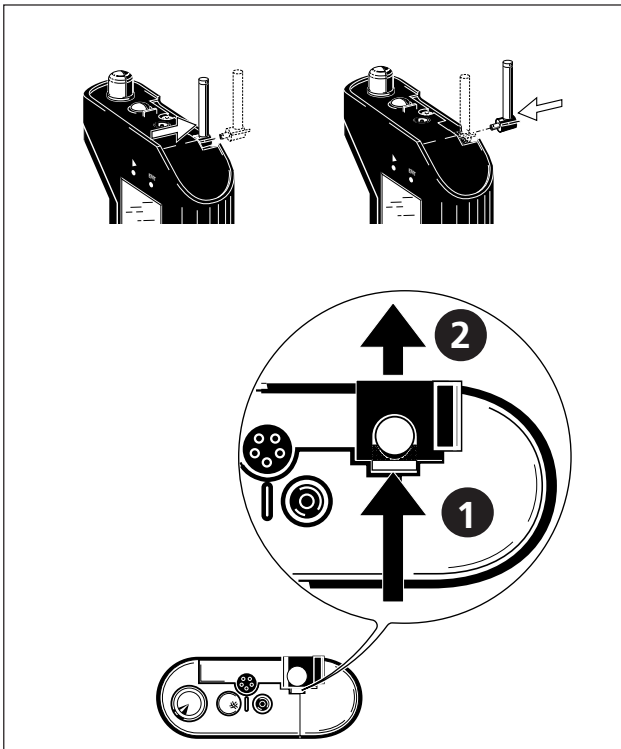
VIBTOOL accessories

The following pages describe a selection of the available VIBTOOL accessories:

Spare temperature probe - VIB 8.605

The VIBTOOL temperature probe may be replaced quite simply:

1. Rotate the temperature probe into the measurement position.
2. Insert a 4 mm (1/8") screwdriver between the base of the probe and the VIBTOOL housing (1).
3. Remove the temperature probe by sliding it gently in the direction shown (2).
4. Gently insert the replacement probe into the socket in the orientation shown.



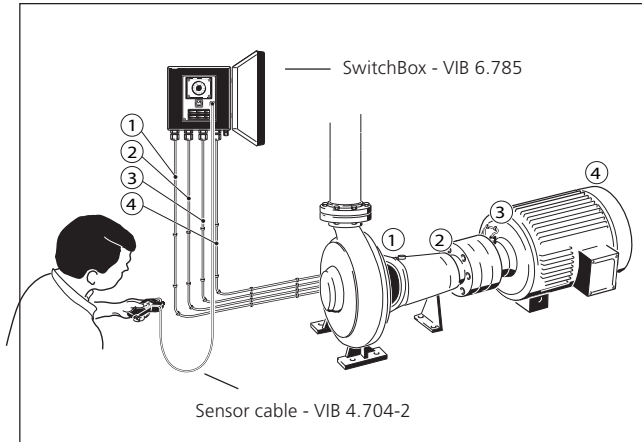
External or permanently installed sensors

Connection to one external sensor

VIBTOOL can be connected to external sensors using cable VIB 4.704-2 (QLA-TNC plugs, 2m). In situations where a single Tandem-Piezo accelerometer (e.g. VIB 6.122R) has been permanently installed on a machine, simply connect your VIBTOOL directly and take the reading.

Connection to more than one sensor

For measurements where more than one external sensor is used, SwitchBox VIB 6.785 can be used to switch between sensors. Here, permanently installed sensors are connected to the connection box. When you need to collect data, simply connect VIBTOOL using cable VIB 4.704-2 (QLA-TNC plug, 2m) and switch between sensors.

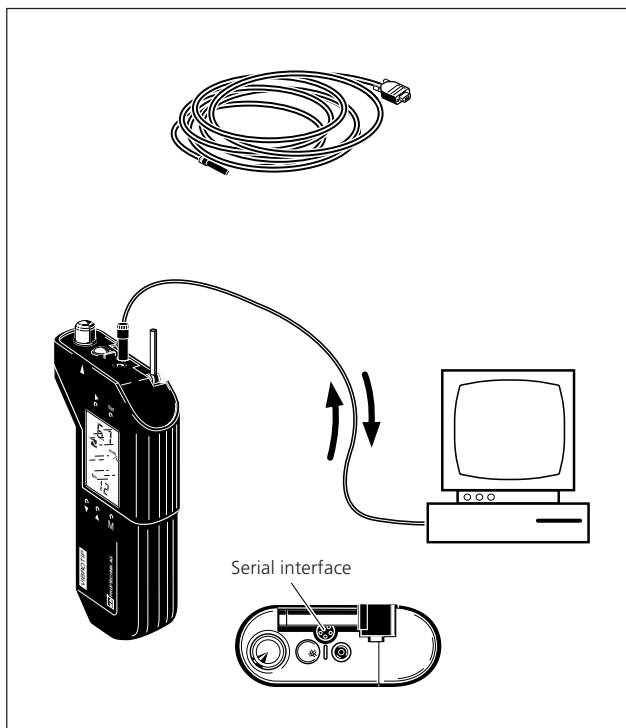


Note

VIBTOOL does not work together with the VIBCODE transducer!

PC cable - VIB 8.619

This cable connects VIBTOOL to the 9-pin RS232C serial interface of the PC for firmware update. Length 2 m / 6' 6".

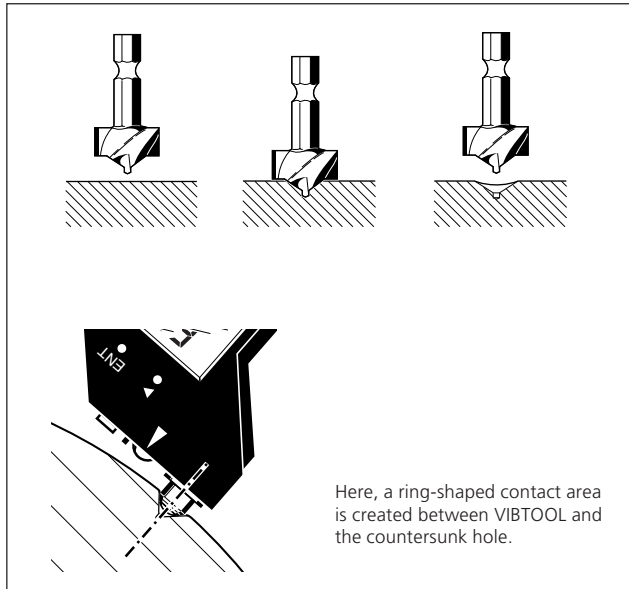


Countersink bit - VIB 8.610

The measurement location may not always be ideal for your vibration or bearing measurements. If the best available measurement location has a curved surface, PRÜFTECHNIK's countersink bit VIB 8.610 can help to prepare the measurement location surface for measurement. The countersink produces a hole smaller than the VIBTOOL vibration and shock pulse sensor. A ring-shaped contact area is, therefore, created between the sensor and the measurement surface, providing the best transmission of signal.

Procedure:

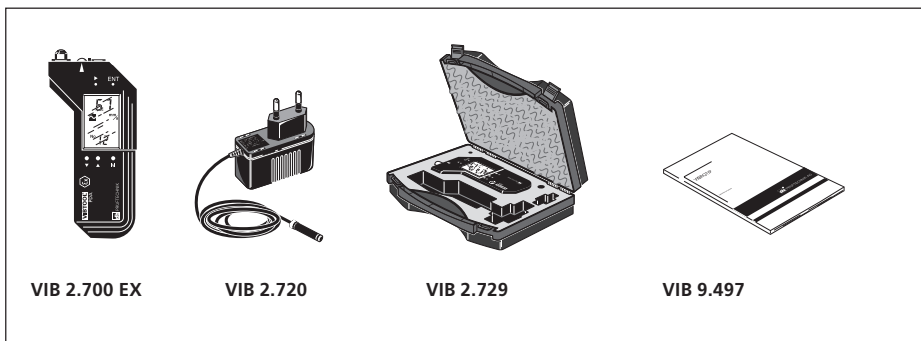
1. Clean and then mark the exact measurement location required.
2. Drill with a battery operated screwdriver until the rim of the countersink is level with the measurement surface.
3. Blow any shavings out of the hole with compressed air (using a thin hose or tube). Make sure that the hole is completely free of metal particles which could otherwise contact the VIBTOOL sensor and interfere with proper signal transmission.



VIBTOOL delivery package

The delivery package contains the parts listed below. If you discover that a part is missing or is damaged, please contact your PRÜFTECHNIK agent immediately.

VIB 2.760 EU: VIBTOOL delivery package, EC



- VIB 2.700EX VIBTOOL PDA instrument,
incl. rechargeable battery, intr. safe
- VIB 2.720 Charger, EC version
- VIB 2.729 Case
- VIB 9.497 Operating instructions

VIB 2.760 UK: VIBTOOL delivery package, UK

VIB 2.760 US: VIBTOOL delivery package, U.S.A.

The delivery packages for UK (VIB 2.760 UK) and the USA (VIB 2.760 US) have the same contents, except that the charger is equipped with the appropriate plug for these countries:

- VIB 2.721 Charger, U.S. version
- VIB 2.722 Charger, UK version

Technical data

Measurement

Vibration velocity

Meas. quantity	Sensor built in; external Tandem-Piezo® sensor available
Frequency range	RMS 2/10Hz – 1/10kHz
Measurement range	0 - 50 mm/s RMS (max. value depends on sensor type and signal frequency)
Accuracy	± 5% (DIN 45662)

Vibration acceleration

Meas. quantity	Sensor built in; external Tandem-Piezo® sensor available
Frequency range	RMS 2/10/500Hz – 1/10kHz ; 1kHz – 10kHz
Measurement range	0 - 961 m/s ² (98g) (max. value depends on sensor type and signal frequency)
Accuracy	± 5% (DIN 45662)

Bearing condition

Meas. quantity	Sensor built in; external Tandem-Piezo® sensor available
Measurement range	dB _{svr} , carpet value, maximum value -9 - 80 dB _{sv}
Accuracy	3 dB _{sv}

Cavitation

Range	Sensor built in; -9 - 80 dB _C
Accuracy	3 dB _C

Tachometer

Measurement range	Sensor built in 60 - 100000 rpm
Accuracy	1 rpm / 0.1%
Max. distance	0.2 m

Temperature



Measurement range	Sensor built in; external thermocouple available
internal probe	-30° - 270° C (-22° - 518° F)
external probe	-50°C – 500°C (-22° - 932° F)
Units	°C, °F (selectable)
Accuracy	± 3% / ± 1 digit

General characteristics

Interfaces	Bluetooth - class 2 / RS-232
Battery type	Li-Ion
Charging time	< 6 h
Operating time	8 h
Display	LCD (5x10mm digits)
Environmental protection	IP 65 (waterproof and dustproof), chemical protection
Temperature range	
Operation	-20°C – 60°C (-4° - 140° F)
Charging	0°C – 40°C (32° - 104° F)
Automatic shutoff	yes
Shock resistance	1 m , drop test
Weight incl. battery	approx. 300 g

Intrinsic safety

 0032

ZELM 05 ATEX 0244



CERTIFICATE

Declaration of conformity in accordance with ISO/IEC Guide 22



This is to certify that the following product:

Equipment / designation: **VIBTOOL EX**
 Type / Order-no(s): **VIB 2.700 EX**
 Configuration: **FFT data collector**

corresponds to the fundamental safety requirements as laid down in the guidelines of the advice for the approximation of laws of the member states on electromagnetic compatibility (2004/108/EC) and Annex IV of the Council Directive 94/9/EC.

EC-Type Examination Certification Number:

ZELM 05 ATEX 0244

Marking of the equipment:



II 2G EEx ib IIC T4
 II 3D T65°C IP65

For the appraisal of this certification with respect to the fulfillment of the safety requirements, the following standards were consulted:

- DIN EN 61000-3-2:2001-12
- DIN EN 61000-4-2:2001-12
- DIN EN 61000-4-3:2003-11
- DIN EN 61000-4-4:2002-7
- DIN EN 61000-4-5:2001-12
- DIN EN 61000-4-6:2001-12
- DIN EN 61000-4-8:2001-12
- DIN EN 61000-4-11:2001-12
- DIN EN 55011:2003-08
- DIN EN 61326:2004-05
- EN 50014:1997+A1+A2
- EN 50020:2002
- EN 50281-1-1:1998

The party responsible for this declaration is

PRÜFTECHNIK Condition Monitoring GmbH
 Oskar-Messter Str. 19 - 21
 85737 Ismaning, Germany

issued by:

Ismaning, 9. September 2008
 Place and date of issue

Johann Lösl
 - Managing Director -

PRÜFTECHNIK



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Printed in Germany VIB 9.497.02.09.0G
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Productive maintenance technology