X-Viber

Instrument Manual

Ver. 1.01
12 April 2007

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Handling security

Safety precautions

Vibration measurement and balancing involves measurement on rotating machines.
Always keep a safe distance to rotating parts and secure transducers and transducer cables from rotating parts.

Balancing involves mounting of trial and balancing weights on the rotor. Always secure the start switch with a locker and also use the emergency switch for double safety before working with the rotor. This is especially important when the machine is remote controlled.

VMI AB can not take responsibility for any accidents on people and machines.

VMI AB and our authorized dealers will take no responsibility for damages on machines and plants as the result of the use of X-Viber™ measurements.

Even though great efforts are made to make the information in this manual free from errors and to make the information complete for the user, there could be things we have missed, because of the large amount of information. As a result of this, we might change and correct these things in later issues without further information.
Also changes in the X-Viber™ equipment may take place that affect the accuracy of the information.

Warranty disclaimer

VMI AB warrants the products to be free from defects in material and workmanship under normal use and service within two years from the date of purchase and which from our examination shall disclose to our reasonable satisfaction to be defective.
Warranty claimed products shall be returned prepaid to VMI AB for service. We reserve the right to repair or to replace defective products.
Always try to explain the nature of any service problem, at best by fax, e-mail or letter. Check first all natural problems, like empty batteries, broken cables, etc. When returning the product, be sure to indicate that the purpose is to make repairs and indicate the original invoice number and date of shipment to you, if possible.

Declaration of conformity

Declaration of Conformity

Equipment: **X-Viber**

VMI AB declares that the X-Viber™ is manufactured in conformity with national and international regulations.

The system complies with and is tested according to, following requirements:

EMC Directive:	**89/336/EEC**
Low Voltage Directive:	**73/23/EEC**
	including amendments by Directive 93/68/EEC.

Switching the instrument ON and OFF

ON
Keep the **ON/OFF**  button pressed until the instrument starts. Do this also, if the instrument of some other reason is switch of or the display is empty.

OFF
Keep the **ON/OFF**  button pressed in three seconds until the instrument is switched off.

Introduction

Thank you for buying X-Viber: We have put a lot of efforts to make this instrument easy to use and to give you valuable measuring results. The instrument is manly intended for predictive maintenance work without the need for frequency analysis and “expert” interpretation.

X-Viber has two main functions:

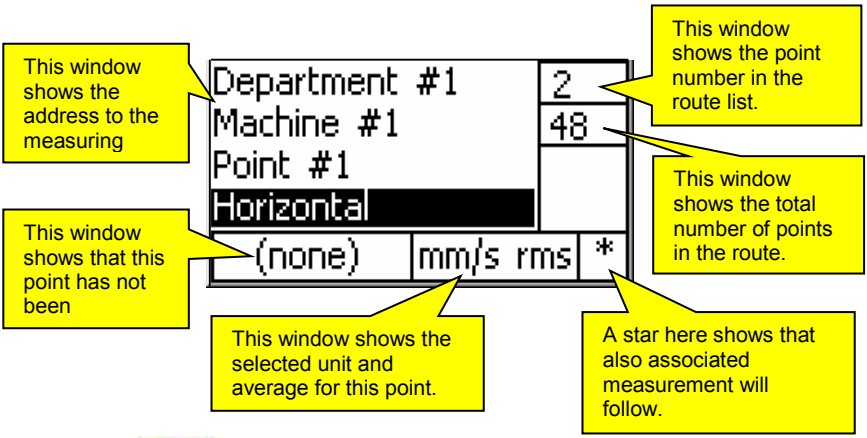
- Route downloaded from the X-Trend PC software. With this function you can measure 999 different measuring points and transferring the data back to the X-Trend software for trend analysis and comparison with preset alarm values. The address to the each measuring point is shown on the display.
  In route you can measure and store:
  - The total vibration level within the selected frequency range
  - The total Bearing condition value within the selected frequency range
  - The total Envelope value within the selected frequency range
  - The speed of the machine because vibrations are highly dependent of the speed
  - Bearing temperature

- Analysis is a function to make temporary measurement on the machine but the values are not stored.
  In analysis you can measure:
  - The total vibration level within the selected frequency range
  - Analysis of the 5 highest vibrations with level and frequency. With this function it is possible to make a simple analysis of the cause of the vibration.
  - The total Bearing condition value within the selected frequency range
  - The total Envelope value within the selected frequency range
  - The speed of the machine because vibrations are highly dependent of the speed
  - Bearing temperature

Route measurement

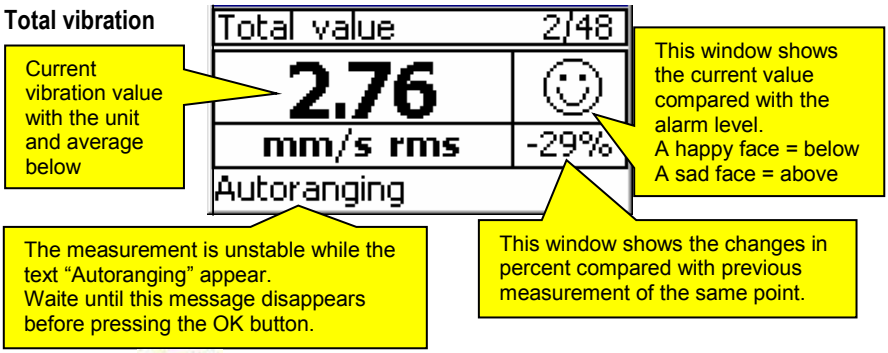
Move the black line over **Route** with the ***Up*** or the ***Down*** button and press the ***OK*** button.

A measuring point in the route that has not yet been measured



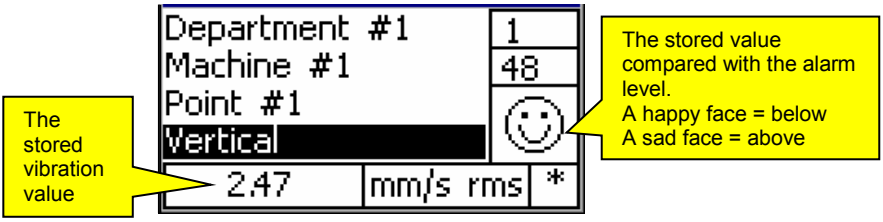
Press the ***OK***  button to start the measurement.

A point in the route in time of measurement



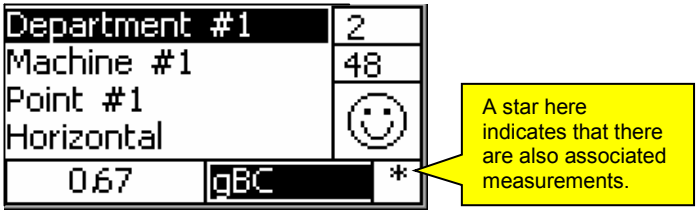
Press the ***OK***  button to save the measurement and move to next measurement.

A measured point in the route



Both the Bearing condition value and the Envelope value are measured at the same time as the Vibration value if the instrument is set to measure these values in the X-Trend route settings.

View all associated measurements stored in this point



The star indicates that there are associated measurements together with the Total vibration value.

To view also the other values the Bearing condition and Envelope values you have to

press the ***AUX***  (or ***MODE***) button.

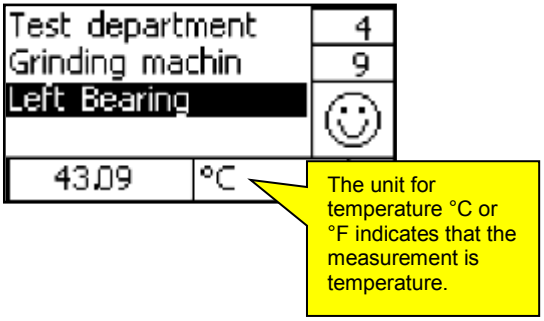
Then use ***Left*** or ***RIGHT***  arrow button to browse between the measurements.

Press the ***ESC***  button to exit to the normal route function.

Note!
Because it is impossible to re-calculate a total velocity value to acceleration or displacement X-Viber is always measuring and storing all these three values on the same measuring point.
These three values are also transferred to the X-Trend software so the user can change the unit at a later stage.
In METRIC mode the values are stored with the units "g", mm/s and µm.
In IMPERIAL mode the values are stored with the units "g", in/s and mils.

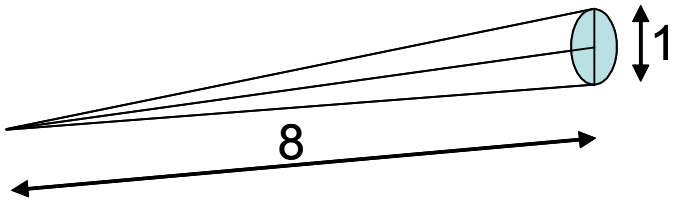
Temperature measurements in the route

A temperature measurement is a separate point on the bearing level because it is enough to measure once on each bearing.



Press the ***OK*** button and th ll start.

Direct the laser towards the surface you want to measure.
Keep a distance of approximately 200-500mm between the instrument and the object.
Make the distance between the object and the instrument shorter the smaller the surface you want to measure is.



Measuring surface related to distance 8:1

Move the laser point slowly until you find the highest temperature reading.

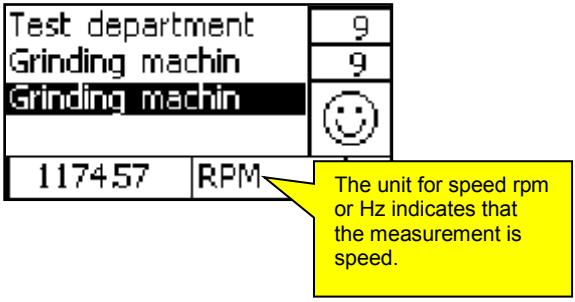
Press the OK button and the measurement is stored.

Note!
This temperature sensor is measuring the heat radiating from the object.
A shiny or white surface will radiate less and will thus give a lower value.
To compensate for this the emissisivity factor can be changed but must be set in the Temperature Settings in X-Trend and can not be adjusted in the Route.

Warning!
This instrument is radiating laser light. Do not stare into the beam and do not

Speed in the route

A speed measurement is a separate point on the bearing level because it is enough to measure once on each shaft.



Press the ***OK*** button and the laser will start.

Direct the laser beam towards the reflex mark on the shaft.
Keep a distance of approximately 200-500mm between the instrument and the shaft.

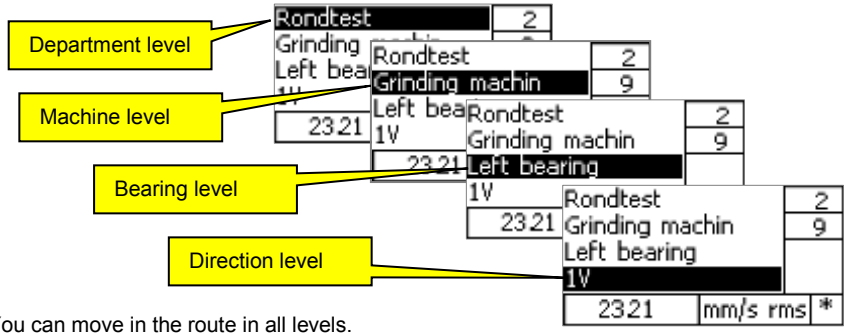
Move the laser point slowly until you find the stabile speed reading.

Press the OK  button and the measurement is stored.

Note!
Direct the laser light in an angle towards the shaft reflex mark. This will give a more stabile reading. Avoid directing the light in a perpendicular angle towards the surface.

Warning!
This instrument is radiating laser light. Do not stare into the beam and do not direct the laser beam to someones face.

View all points or move back- and forwards in the route



You can move in the route in all levels.

Select the level you want to move within by moving the black line with the

Up or ***Down***  buttons.

The higher level you choose the larger is the steps in the Route.

Press ***Left*** or ***Right*** buttons to move in the route.

With the ***Left*** button you will move backwards and with the ***Right*** button you will move forwards in the route.
In the lowest level you will pass all directions in the route.

This message will appear when you move backwards and you reach the first point in the route.

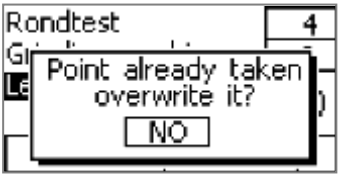
Press the ***OK*** button and this message disappears.

This message will appear when you move forwards and you reach the last point in the route.

Press the ***OK*** button and this message disappears.

Re-measure a single point in the route

Move to the point you want to measure again.



Press the ***OK*** button and this message will appear.

Change to **Yes** with ***Left*** or ***Right*** buttons and press the ***OK*** button and the instrument starts to measure.

Spectra in the route (optional)

To be able to see more than ten frequencies, the function must be activated. Do the following:

From the main menu select ***Route***

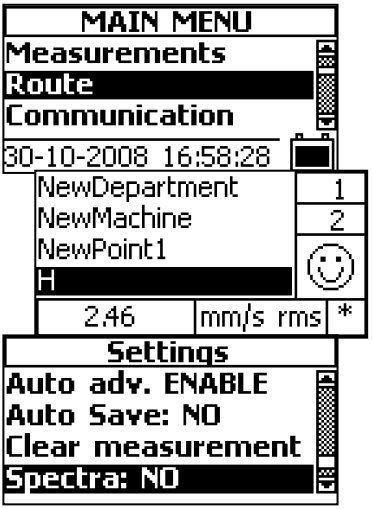
Go to the line ***Direction***

Press the ***Menu*** button

Go to the line ***Spectra***:

With the ***Left*** or the ***Right*** button select YES and press OK.

Press the ***Escape*** button twice to come back to the main menu

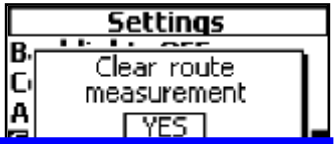


Delete all the measurements in the route

If you are measuring the same machines repeatedly and you seldom change to another route you can keep the route in the instrument and only delete the measurements.

Press the ***Info***  button while you are somewhere in the route and this window will appear.

Move the line with the ***Up*** or the ***Down*** button to **Clear measurement** and change to Yes with ***Left*** or ***Right*** button and press the ***OK*** button



Note!
When the measurements are deleted in this way, the comparison with previous measurements will be false, because they will not be updated. The update can only happen, when a new route is downloaded from the X-Trend software.

Transferring a route to the X-Trend software

Start the transfer program in X-Trend.

Move the line with the ***Up***

Or the ***Down***  button in the **MAIN MENU** to **Communication**

and press the ***OK***  button.

This message will appear if the communication fails.
Check that the cables are connected and that the USB driver for X-Viber is installed.

The Route settings menu

Press the ***Info***  button while you are somewhere in the route and this window will appear.

Move the line with the ***Up*** or the ***Down***  button to the function you want to change.

Press the ***Left*** or ***Right***  button to change the settings.

Turns the backlight ON or OFF

Change the contrast ratio.
A low number gives a higher ratio.

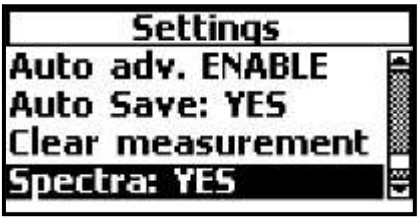
When enabled, the instrument will automatically move to the next point after the measurements are finished.

Clear measurements are already described on previous page.

Note!
If you have the option with spectra in route this function must be activated.

Move the line with the ***Up*** or the ***Down*** button to **Spectra**. 

Press the ***Left*** or the ***Right***  button to change to **YES**.



The X-Viber will not store the spectra in route if **NO** is selected.

Note!
You can not see a spectrum in route in the X-Viber, but after transferring to the SpectraPro software it is available.

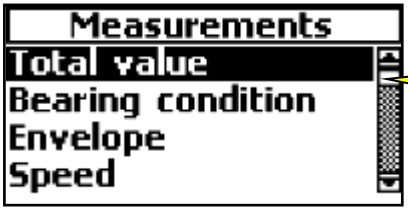
Press the ***ESC***  button to exit to the normal route function.

Press the ***ESC***  button to leave the route function and go back to the Main menu.

Off Route Measurements

Warning!
You can not store the measurements made in the Measurements mode.
This part is only for temporary measurements.
Take notes if you want to record some measurements.

Move the line with the ***Up*** or the ***Down*** button in the **MAIN MENU** to **Measurements** and press the ***OK*** button.



This bar will appear when there are more lines than shown in the window.

In the Measurements window you can select between the following functions:

- **Total value**, this value is the RMS average of all vibrations within the selected frequency range. You can select both unit and frequency range.
- **Bearing condition**, this value is the RMS average in “g” of all high frequencies within the selected frequency range.
- **Envelope**, this value is the RMS average in “gE” within the frequency range 2-1000Hz of the low pass filtered and rectified high frequencies between 500 to 7200Hz. You can select between different frequency ranges.
- **Speed**, X-Viber is remotely measuring the shaft speed between 30 to 12000 rpm by sensing the infrared reflex from a target on the shaft. The target can be any reflex tape.
- **Temperature**, X-Viber is remotely measuring the object temperature within the temperature range 0-120°C or -32 to 184°F by sensing the infrared radiation.
- **Analysis**, This function is similar to the Total value but with an additional analysis of the 5 dominating frequencies in the signal. This function is especially useful to find the cause of the vibration and at balancing. You can select both unit and frequency range.

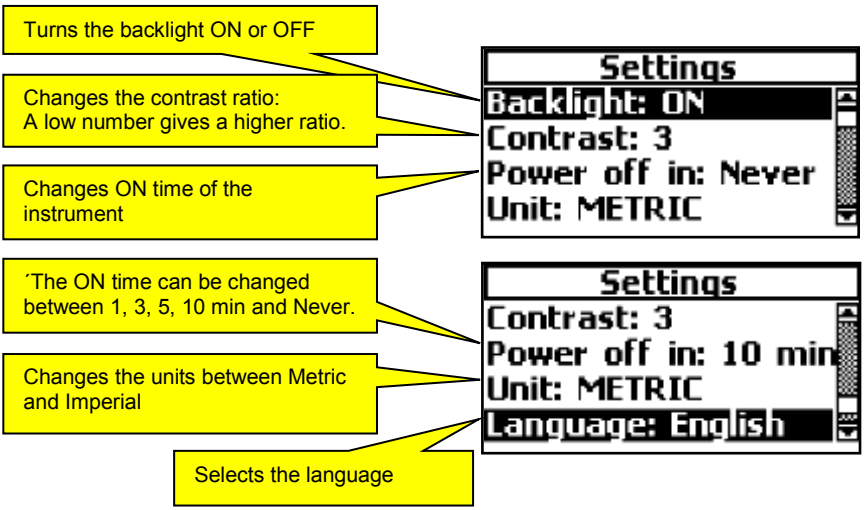
MAIN MENU settings

Press the ***Info*** button and this window will appear.

Move the line with the ***Up*** or the ***Down*** buttons to the function you want to change.

Press the ***Left*** or the ***Right*** button to change the settings.

The settings in the MAIN MENU settings menu will automatically be used as soon as this window is closed.



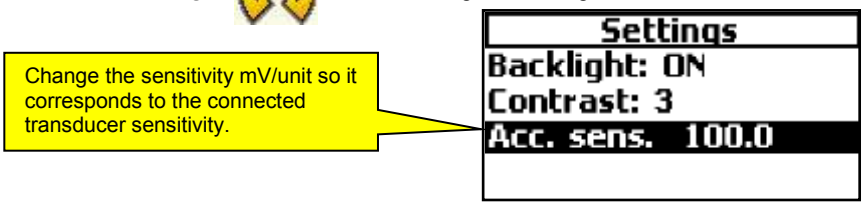
Press the ***ESC*** or ***OK*** button to exit to the MAIN MENU.

Measurement settings menu

Press the ***Info*** button and this window will appear.

Move the line with the ***Up*** or the ***Down*** button to the function you want to change.

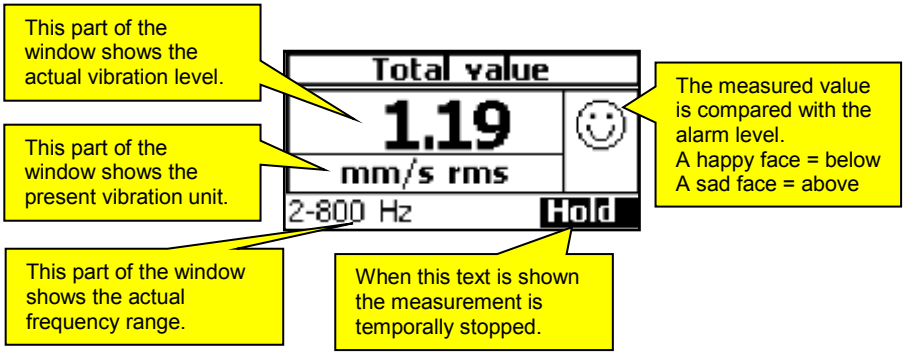
Press the ***Left*** or ***Right*** button to change the settings.



Total level

Move the line with the ***Up*** or the ***Down*** button to **Total value.**

Press the ***OK*** button and the X-Viber starts to measure.



Press the ***Left*** or ***Right***  button to change the unit or average.

The list below shows available units.

Metric	**Imperial**
g rms	g rms
g Peak	g Peak
g P-P	g P-P
mm/s rms	in/s rms
mm/s Peak	in/s Peak
mm/s P-P	in/s P-P
µm rms	mils rms
µm Peak	mils Peak
µm P-P	mils P-P
mm rms	thou rms
mm Peak	thou Peak
mm P-P	thou P-P
m/s rms	
m/s Peak	
m/s P-P	

The instrument will automatically select the unit and average from the Settings menu.

Press the ***Up*** or ***Down***  button to change the frequency range.

The list below shows available frequency ranges.

Frequency range in Hz
2 to 800
4 to 1600
8 to 3200
10 to 6400
old ISO range 10 to 1000Hz

Press the ***AUX***  button to hold the measurement.

Press the ***AUX*** button again or the ***OK*** button to continue measuring.

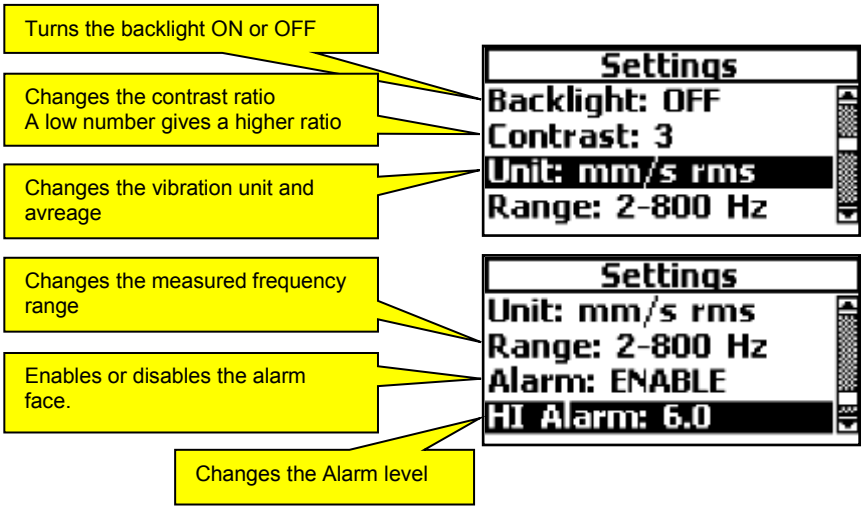
The Total value settings menu

Press the ***Info***  button and this window will appear.

Move the line with the ***Up*** or ***Down***  buttons to the function you want to change.

Press the ***Left*** or ***Right***  button to change the settings.

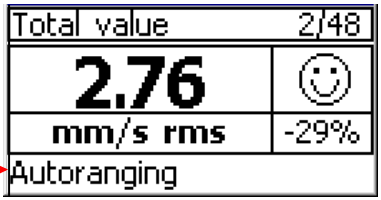
The settings in the Total value Settings menu will automatically be used when the Total value window is opened the next time.



Press the ***ESC***  or ***OK***  button to exit to the Total level function.

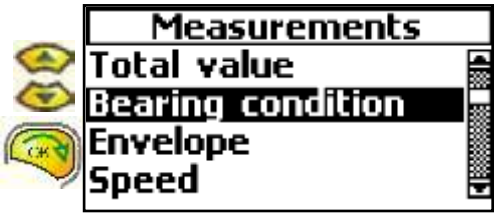
Press the ***ESC***  button to leave the Total level function and go back to the Measurement menu.

Warning!
When the text "Autoranging" appears, the measurement is unstable. The operator must wait until this message disappears before using the measurement



Bearing condition

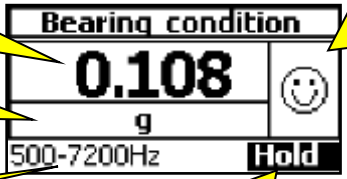
Move the line with the ***Up*** or the ***Down*** button to the **Bearing condition.**
Press the ***OK*** button and the X-Viber starts to measure.



This part of the window shows the actual bearing condition value.

The unit g is the only available unit for this measurement.

This part of the window shows the present frequency range.



When this text is shown the measurement is temporally stopped.

The measured value is compared with the alarm level.
A happy face = below
A sad face = above

Press the ***Up*** or ***Down***  button to change the frequency range.

The list below shows available frequency ranges.

Frequency range in Hz
500 to 7200
1000 to 7200
2000 to 7200
3000 to 7200

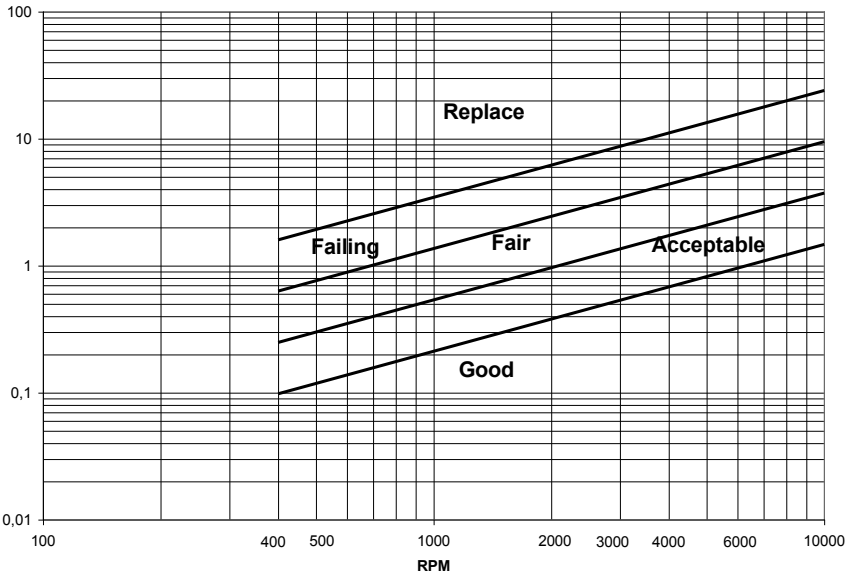
Use a low frequency range at slow rotating (below 600rpm) machines and a high frequency range at high speed (above 6000rpm) machines.

Press the ***AUX***  button to hold the measurement.

Press the ***AUX*** button again or the ***Ok*** button to continue measuring.

Recommended bearing condition levels

Bearing condition value with the unit “g” RMS



Find the machine speed. Follow this line up to the judgment lines and read the value on the left axis.

The diagram above is **only a guide** to interpret the bearing condition value. If vibrations of other causes (e.g. flow surge, gear mesh) are within in the selected frequency range, this can give a high bearing condition value without the bearing being damaged.

A high bearing condition value can also be acquired, if the bearing is poorly lubricated or is overloaded (e.g. by misalignment, or large belt forces).

Compare this value with Envelope value and the bearing temperature. If all are high or pointing upwards in the trend analysis you might have a bearing problem.

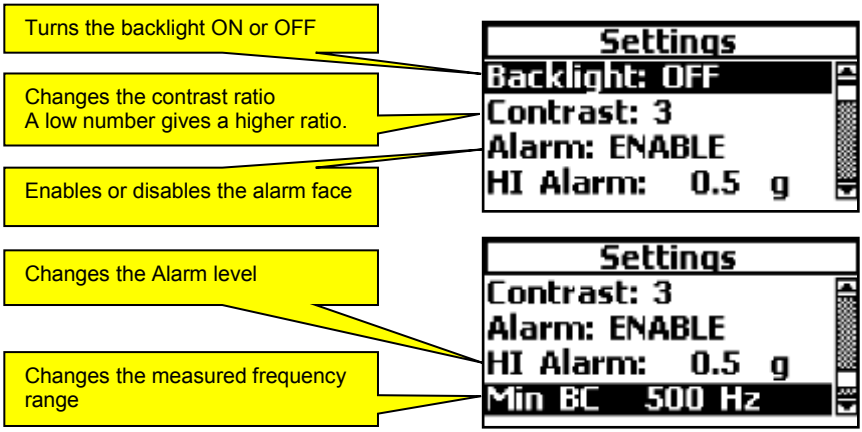
Bearing condition settings menu

Press the ***Info*** button and this window will appear.

Move the line with the ***Up*** or the ***Down*** button to the function you want to change.

Press the ***Left*** or ***Right*** button to change the settings.

The settings in the Bearing condition Settings menu will automatically be used, when the Bearing condition window is opened the next time.

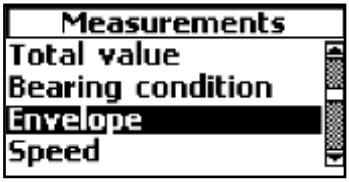


Press the ***ESC*** or ***OK*** button to exit to the Bearing settings menu.

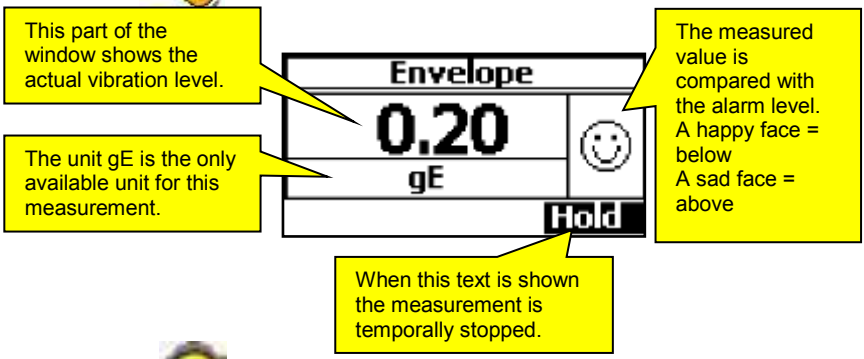
Press the ***ESC*** button to leave the Bearing condition function and go back to the Main menu.

Envelope

Move the line with the ***Up*** or the ***Down*** button to **Envelope.**



Press the ***OK***  button and the X-Viber starts to measure.

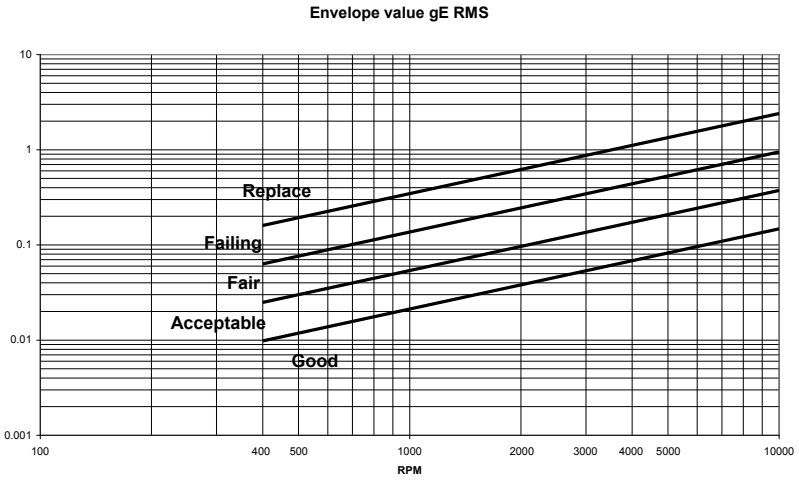


Press the ***AUX***  button to hold the measurement.

Press the ***AUX*** button again or the ***Ok*** button to continue measuring.

The frequency range for the envelope measurement is 500 - 6400Hz.

Band pass and peak detection range of Envelope measurements is 400 - 7200Hz.
Low pass filter range of the peak signal is 1500Hz.
Envelope level range 2 – 1000Hz.



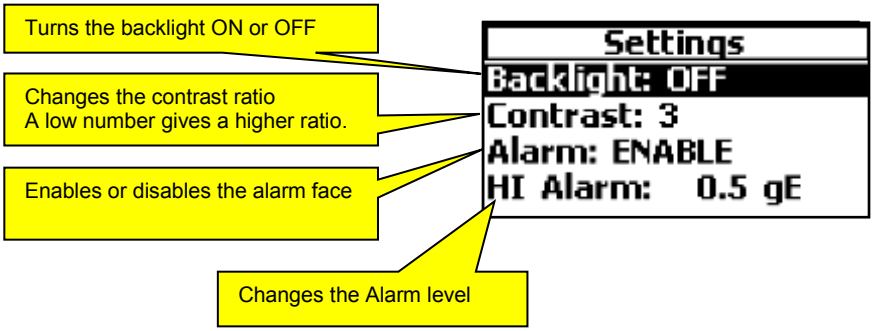
Envelope settings menu

Press the ***Info***  button and this window will appear.

Move the line with the ***Up*** or ***Down***  buttons to the function you want to change.

Press the ***Left*** or ***Right***  button to change the settings.

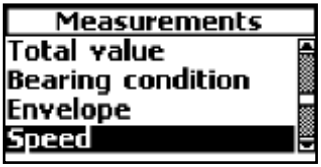
The settings in the Envelope Settings menu will automatically be used when the Envelope window is opened the next time.



Press the ***ESC***  or ***OK***  button to exit to the Envelope function.

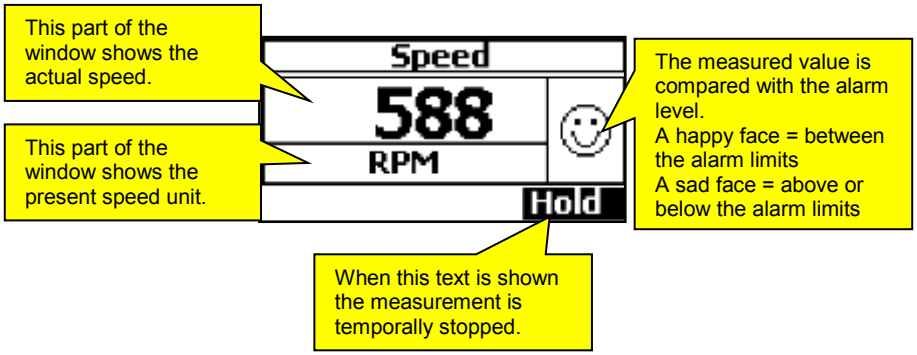
Press the ***ESC***  button to leave the Envelope function and go back to the Measurement menu.

Speed



Move the line with the ***Up*** or the ***Down*** button to **Speed.**

Press the ***OK***  button and the X-Viber starts to measure.

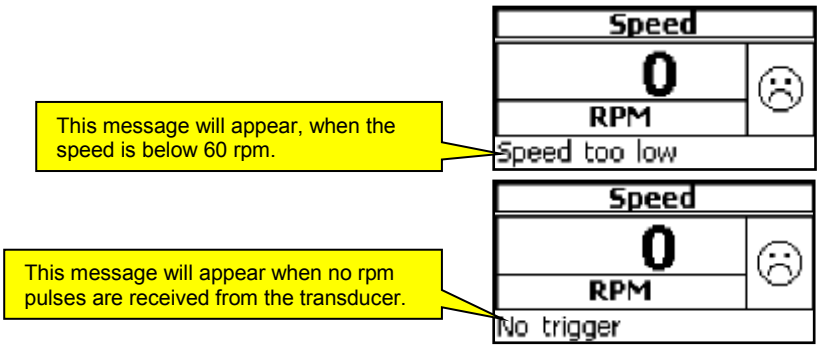


Press the ***AUX***  button to hold the measurement.

Press the ***AUX*** button again or the ***Ok*** button to continue measuring.

Note!
Direct the laser light in an angle towards the shaft reflex mark. This will give a more stabile reading. Avoid directing the light in a perpendicular angle towards the surface.

Warning!
This instrument is radiating laser light. Do not stare into the beam and do not direct the laser beam to someones face.



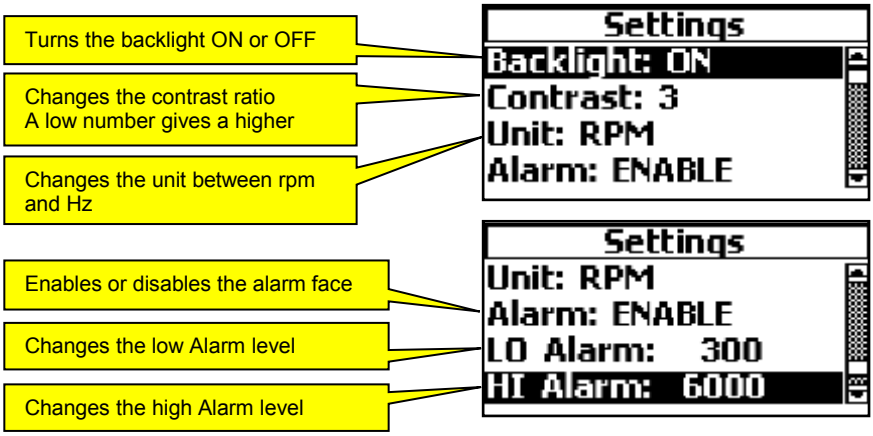
Speed settings menu

Press the ***Info***  button and this window will appear.

Move the line with the ***Up*** or the ***Down***  button to the function you want to change.

Press the ***Left*** or the ***Right***  button to change the settings.

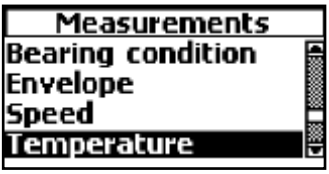
The settings in the Speed Settings menu will automatically be used when the Speed window is opened the next time.



Press the ***ESC***  or ***OK***  button to exit to the Speed function.

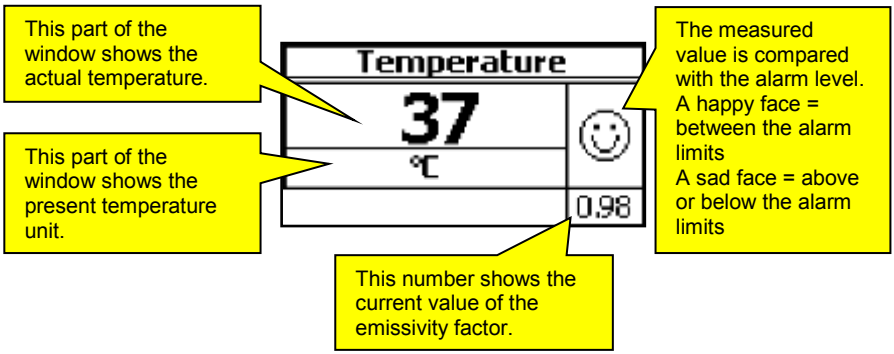
Press the ***ESC***  button to leave the Speed function and go back to the Measurement menu.

Temperature

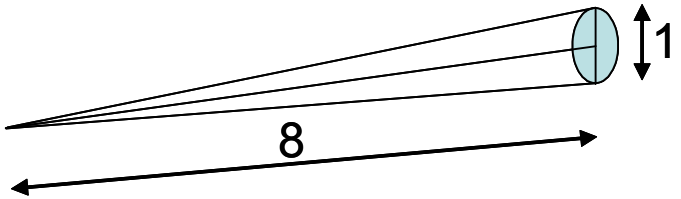


Move the line with the ***Up*** or the ***Down*** button to **Temperature.**

Press the ***OK***  button and the X-Viber starts to measure.



Direct the laser towards the surface you want to measure. Keep a distance of approximately 200-500mm between the instrument and the object.
Make the distance between the object and the instrument shorter the smaller the surface you want to measure is.



Measuring surface related to distance 8:1

Press the ***AUX***  button to hold the measurement.

Press the ***AUX*** button again or the ***Ok*** button to continue measuring.

Note!
Direct the laser light in an angle towards the shaft reflex mark. This will give a more stabile reading. Avoid directing the light in a perpendicular angle towards the surface.

Warning!
This instrument is radiating laser light. Do not stare into the beam and do not direct the laser beam to someones face.

The ***Up*** or ***Down***  buttons will change the value of the emissivity factor. This change in the value is only temporally and the value in the temperature settings menu will be used the next time.

The ***Left*** or ***Right***  buttons will change the temperature unit between °C and °F.

Warning!
Incorrect setting of the emissivity factor can lead to considerable errors.

Set the emissivity factor using the table below or check via a contact probe.

Material	Emissivity. factor
Heat sink, black anodised	0.98
Paper	0.97
Black paint, matt	0.97
Ice, smooth	0.97
Wood	0.94
Glass	0.94
Rubber, hard	0.94
Transformer paint	0.94
Concreate	0.93
Brick, mortar, plaster	0.93
Porcelain	0.92
Steel, oxidised	0.79
Copper, oxidised	0.76
Steel, heat treated surface	0.52
Copper	0.04
Aluminium, bright	0.04

It is very difficult to get an accurate temperature reading on untreated metals.
A coating like paint, oil or emission adhesive tape applied to the object will considerably improve the accuracy of the measurement.

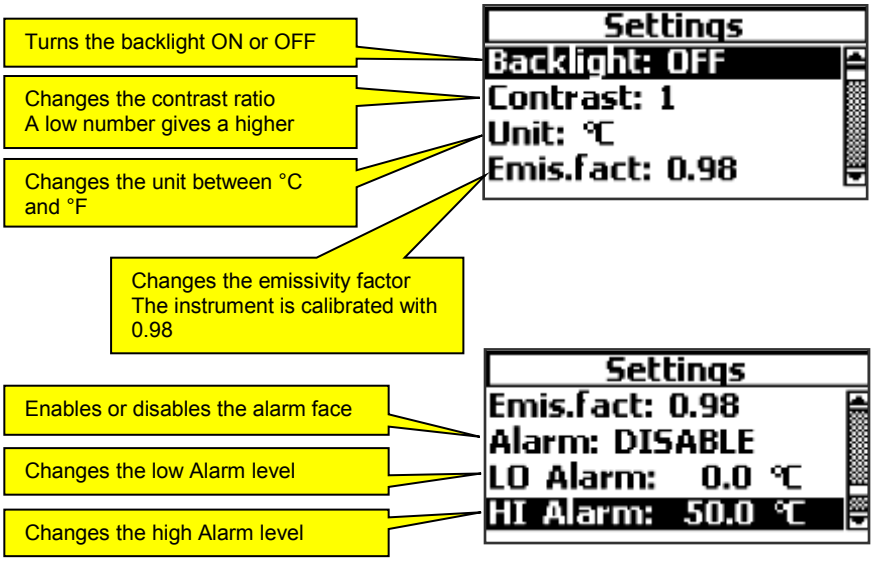
Temperature settings menu

Press the ***Info*** button and this window will appear.

Move the line with the ***Up*** or the ***Down*** buttons to the function you want to change.

Press the ***Left*** or the ***Right*** button to change the settings.

The settings in the Temperature Settings menu will automatically be used when the Temperature window is opened the next time.



Press the ***ESC*** or ***OK*** button to exit to the Temperature function.

Press the ***ESC*** button to leave the Temperature function and go back to the Measurement menu.

How to interpret vibration levels

A user with no previous experience to interpret the results is recommended to use the ISO 10816-3 standard together with a good portion of common sense.

Be prepared to find exemptions making the judgements harder than the standards, rather than finding exemptions allowing for higher vibrations.

The standard normally calls for a measure in velocity based on mm/s RMS. To better understand what this measure means it can be helpful to consider the reading as a mean value of the back and forward motion. This measure gives a good understanding of the amount of "break down energy", causing mainly wear and fatigue work, in the machine or the structure being measured.

The instrument is measuring the total RMS-value of the vibration within the instrument frequency range. This RMS-value is a special sum or average of all the different causes of vibration.

EXAMPLE:
If the simultaneous vibration caused by unbalance is (4mm/s), by misalignment (2 mm/s) and by the gear mesh (5 mm/s) then the total vibration measured on the VIBER-A is 6.7 mm/s.

Total vibration = $\sqrt{4^2 + 2^2 + 5^2} \approx 6.7 mm/s$

ISO standard 10816-3

The ISO standard 10816-3 is classifying the machines differently if the machines are considered as flexible or rigid mounted. This reflects the location of the machines stiff-body resonance's related to the basic running speed of the machine.

For instance, a machine supported by rubber or springs often have resonance's at low running speeds. The machine starts vibrate at a certain, low rpm. When the speed is increased above these resonance frequencies the vibration is reduced. This machine is considered flexible.

A resonance can easily be found when a flexible machine is running up or down in speed. The resonances are located at the rpm´s where the vibration has a local maximum level.

Group 1:
Large machines with rated power above 300kW.
Electrical machines with shaft height H > 315mm
Operating speed ranges from 120 to 15000 rpm

Group 2:
Medium-sized machines with a rated power above 15kW up to and including 300kW
Electrical machines with shaft height between 160 and 315 mm
Operating speed normally above 600 rpm

Group 3:
Pumps with multivane impeller and with separate driver with rated power above 15kW.

Extraction's from ISO 10816-3

Industrial machines with power above 15kW and nominal speeds between120 -15000 r/min

Unit	Group 1 and 3		Group 2 and 4	
mm/s	Rigid	Flexible	Rigid	Flexible
0-1.4				
1.4-2.3				
2.3-2.8				
2.8-3.5				
3.5-4.5				
4.5-7.1				
7.1-11				
11--				

Group 4:
Pumps with multivane impeller and with integrated driver with rated power above 15kW.

Modern machines have high rpm´s and flexible bearing-supports and foundations and can be treated as flexible even when it is not mounted on rubber or springs.

The ISO 10816-3 standard allows for slightly higher limits when a foundation is considered flexible than when if it is rigid. A conclusion from this is also that a resonant condition in principle is not allowed or at least should be avoided at operating speeds. In practice this also includes the double speed as well as any other natural excitation frequency such as blade passage etc.

A great advantage with proper vibration measurements and the use of vibration standards is that you can judge the future maintenance cost very reliably already at first start-up. If you find levels above 3 mm/s RMS, you can be rather sure that the machine will cause increased activities in maintenance. The specific cost and action is of course individual to the machine design.

As always when using schematic judgement like this, be very careful to use common sense in the application of the recommendations.
A certain machine is producing its specific vibration frequency pattern depending on the transducer location and the machine properties.

The next logical step is therefore to apply filtering of the transducer signal to learn the frequency behind the vibration and thus the mechanical fault. Use the Analysis function to find the cause of the vibrations.

Looseness

By measuring the vibration on both sides of a bolt joint it is possible to find looseness in the connection. Two machine parts joined together should have the same vibration level on both sides of the joint.
Bolts fixed in concrete foundations should have the same vibration level as the concrete if they are not loose.

Recommended vibration levels in mm/s and common findings

The following is in part an extraction of the old standard ISO 2372 class 4, large machines on flexible foundations, with some common findings added.

This simplified list can be used, as a first consideration, when you approach a machine newly commissioned or after some time in operation.
Take as a good housekeeping rule to investigate the reason for any machine that vibrates above 3 mm/s RMS. Do not leave them above 7mm/s without being assured that they will sustain long term operation without increased wear since the machines capable of that are very few.

0 – 3 mm/s
Small vibrations, none or very small bearing wear, rather low noise level

3 – 7 mm/s
Noticeable vibration levels often concentrated to some specific part as well as direction of the machine. Noticeable bearing wear. Seal problems occur in pumps etc. Increased noise level. Try to investigate the reason. Plan action during next regular stop. Keep the machine under observation and measure at smaller time intervals than before to detect a deterioration trend if any. Compare vibrations to other operating variables.

7 – 18 mm/s
Large vibrations. Bearings running hot. Bearing wear-out cause frequent replacements. Seals wear out, leakage of all kinds evident. Cracks in welding and concrete foundations. Screws and bolts are loosening. High noise level. Plan action soonest. Do your best to reveal the reason. You are wearing down investments quickly.

18 – mm/s
Very large vibrations and high noise levels. This is detrimental to the safe operation of the machine. Stop operation if technically or economically possible considering the plant stop cost. No known machine will withstand this level without internal or external damage. Reduce any further running time to an absolute minimum.

Resonance

When working with vibrations in machine maintenance, you will soon find that resonance is a common but rather unknown problem in modern machinery.

To understand a resonance you can compare with the string of a guitar. The string has its natural basic tune that will ring as soon as the string is struck. The actual frequency of the tune depends on the stiffness and the distributed mass of the string.

All machines have similar built in "tunes" with corresponding properties consisting of stiffness and a mass in the form of mechanical strings such as shafts, beams and floors and in all mechanical parts.
If any natural excitation (= alternating force) in the machine has the same or nearly the same frequency as a resonance frequency the vibration will be amplified in this machine part, a much higher level will occur than would be the case if the resonance would be shifted away from the excitation frequency.

One common resonance frequency is the critical speed of a shaft which depends on the stiffness and mass of the shaft, but resonances exist in all machine parts as well as in supporting beams and concrete floors.

A natural excitation force is for example unbalance at the running speed, misalignment on mainly twice the speed, gear mesh forces etc.

THE BASIC RULE IS THAT THE RESONANCE'S OF ANY PART IN THE MACHINE SHOULD NOT COINCIDE WITH ANY NATURAL IMPULSE IN THE MACHINE.

To identify the presence of a resonance, measure the vibration levels in three perpendicular directions at the bearings. If you find a measurement with at least three times higher level than in the other directions you should consider a resonance a likely possibility. The resonance is amplifying the mechanical force and thus gives a high vibration in that direction. The resonance makes the machine unnecessarily sensitive to mechanical forces.

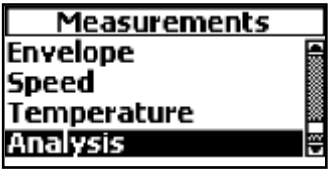
It is possible to locate the resonance peak while the speed of the machine is changing. The resonance frequency is located at that rpm where the vibration has a local maximum.

The proper action against a resonance is very different depending on its location, operating conditions etc. It will normally require good experience to alter the situation. One reason is that the modification affects the basic mechanical design of the machine and where you normally require the competence of the machine designer.

We recommend you however not to hesitate to consider such modifications since the change of the resonance frequency normally is cheap compared to the high maintenance cost that will follow any attempt to run a machine in long term operation under the influence of a resonance.

A TEMPORARY AND SOMETIMES PERMANENT SOLUTION TO A RESONANCE PROBLEM IS TO CHANGE THE SHAFT SPEED OF THE MACHINE, IF POSSIBLE.

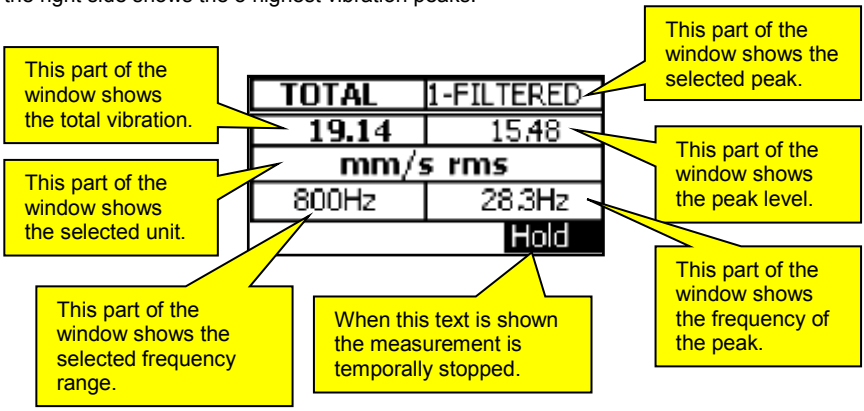
Analysis



Move the line with the ***Up*** or the ***Down*** button to **Analysis.**

Press the ***OK***  button and the X-Viber starts to measure.

The analysis window is used when the vibration has to be analysed more in detail and at balancing.
The Analyse window is divided in to two parts. The left side shows the total vibration while the right side shows the 5 highest vibration peaks.



Press the ***AUX***  button to hold the measurement.

Press the ***AUX*** button again or the ***Ok*** button to continue measuring.

Press the ***Up*** or the ***Down***  button to change the frequency range.

The list below shows available frequency ranges.

Frequency range in Hz
2 to 800
4 to 1600
8 to 3200
10 to 6400
old ISO range 10 to 1000Hz

Press the ***Left*** or the ***Right***  button to change the unit or average.

The table besides shows the available units.

Metric	Imperial
g rms	g rms
g Peak	g Peak
g P-P	g P-P
mm/s rms	in/s rms
mm/s Peak	in/s Peak
mm/s P-P	in/s P-P
µm rms	mils rms
µm Peak	mils Peak
µm P-P	mils P-P
mm rms	thou rms
mm Peak	thou Peak
mm P-P	thou P-P
m/s rms	
m/s Peak	
m/s P-P	

The instrument will automatically select the unit and average from the Settings menu.

The highest peak is pre-selected in the right side of the window.

Press the ***OK***  button to change to the next filtered peak.
The peaks are presented according to the level of the peaks with the highest peak as number 1.

Note!
With this function you can find the cause of the vibration by comparing the measured frequencies with calculated fault frequencies.

Use lowest possible frequency range this will increase the accuracy of the frequency measurement.

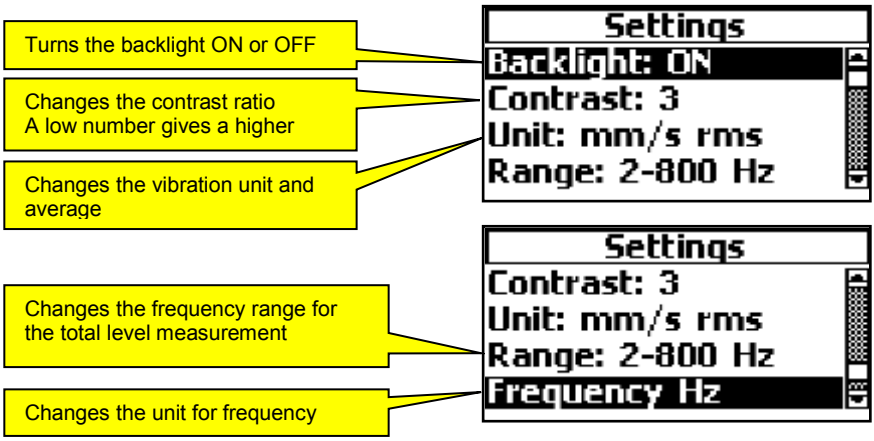
Analysis settings menu

Press the ***Info***  button and this window will appear.

Move the line with the ***Up*** or the ***Down***  button to the function you want to change.

Press the ***Left*** or ***Right***  button to change the settings.

The settings in the Analysis Settings menu will automatically be used when the Analysis window is opened the next time.



Press the ***ESC***  button to exit to the Analysis function.

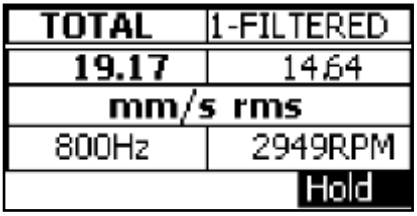
Press the ***ESC***  button to leave the Analysis function and go back to the Measurement menu.

Balancing

Balancing with X-Viber

First check that dominating vibration is caused by an unbalance.

The 1-FILTERED vibration should have the same frequency or Hz as the running speed of the machine.



Do not change the position of the vibration transducer after the start of the balancing procedure.

Balancing using this method requires only three consecutive trial runs and changing the balance status of the rotor.
Only measurement of the vibration level is needed.

Balancing will of course only reduce the vibration caused by unbalance.

A balancing round will often be a good approach and a first attempt to find the reason for increased vibration. If the balancing attempt is not successful, the cause can be loose rotor parts etc.

If the machine speed is variable, be sure to choose the same speed during every trial run. Do not search the speed that gives the highest vibration. Such speeds mostly show non-linear results.

Start the procedure by measuring on the bearings looking for high levels in major directions. Choose a point that should have a good connection to a balancing plane where you can put in a weight in the machine. You must use the same radius for the trial weights and the balancing weights.

This is the procedure for the TWO-POINT BALANCING METHOD:

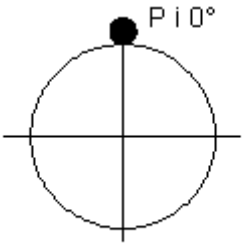
TRIAL RUN 1:

TOTAL	1-FILTERED
19.17	14.64
mm/s rms	
800Hz	2949RPM
	Hold

Select the running speed and choose the measuring point. Measure and note the vibration level and stop the machine. Note this vibration as **reading A.**

In this example the vibration is 14.64mm/s at 2949rpm

TRIAL RUN 2:



Put in a trial weight in the balancing plane. Note the location and size of the balancing weight. Use its weight, volume or length (if you have a band material) as a measure of the size of the trial weight.

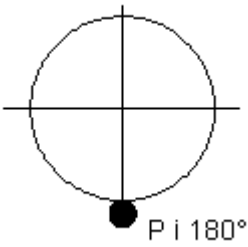
Call the trial weight P in any measure proportional to the weight.

Measure and note the vibration level and stop the machine.
Note this vibration as **reading 2**.

TOTAL	1-FILTERED
13.01	9.58
mm/s rms	
800Hz	2952RPM
	Hold

In this example we added 40grams at the radius 320mm in position 0°.
The vibration becomes 9.58mm/s and the speed was almost the same 2952rpm.

TRIAL RUN 3:



Move the trial weight 180 degrees to a position opposite to the first location.

Measure and note the vibration level and stop the machine.

Note this vibration as **reading 3.**

TOTAL	1-FILTERED
26.71	21.34
mm/s rms	
800Hz	2953RPM
	Hold

In this example we added 40grams at the radius 320mm in position 180°.
The vibration becomes 21.34mm/s and the speed was almost the same 2953rpm.

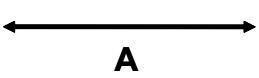
CALCULATION

We now have all the necessary machine information to start the calculations.

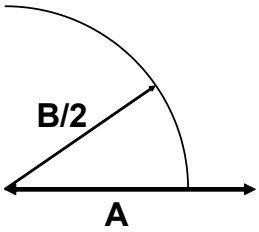
Compare the vibration levels **reading 2** and **reading 3.**
Call the highest of **reading 2** and **reading 3** for **B** and the smallest for **C**.

In our example **reading 3** (21.34) is the highest and we call it **B** and **reading 2** (9.58) is the smallest and we call it **C.**

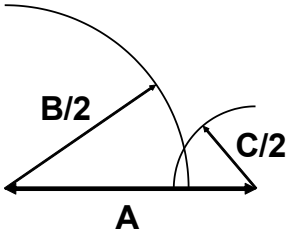
Draw a figure where you use a length measure proportional to the actual vibration level measured on each reading **A**, **B** and **C** respectively. Use a scale that gives you as large a figure as possible. The accuracy depends largely on the size of the figure.



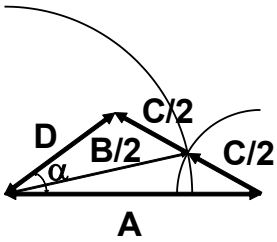
STEP 1: Draw **A** as a horizontal line. Use a scale so you make a large figure and good use of the paper.



STEP 2: Draw an arc centred at the left end of **A** having the radius equalling to 1/2 (HALF) the length of **B**.



STEP 3: Draw an arc centred at the right end of **A** having the radius equalling to 1/2 (HALF) the length of **C**. Mark the crossing of the two arcs. Draw a line starting from the right end of **A** through the crossing of the two arcs and with the length proportional to **C**.



STEP 4: Join the upper tip of **C** with the left end of **A** so that a triangle shaped figure is made. Mark this new line as **D**. The angle position of the balancing weight is the angle (α) in the left corner of the figure between line **D** and base line **A**.

In our example the angle (α) is measured to be 38°.

THE SIZE OF THE BALANCING WEIGHT

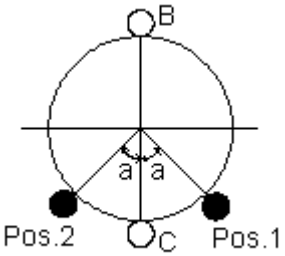
The SIZE of the balancing weight that you should put on the balancing plane is proportional to the size of the trial weight with the same relation as the line **A** to **D** in the figure. In other words:

$$\text{Balancing weight } \mathbf{BW} = \frac{\text{the trial weight } \mathbf{P} \ * \ \text{the length of } \mathbf{A}}{\text{the length of } \mathbf{D}}$$

In our example will the balancing weight BW = 40grams x 14.64 / 7.5 = 78grams on the same radius 320mm.

You can measure **A** and **D** in the figure. You may soon realise that best results are obtained when the triangle has approximately equal sides.

THE ANGLE POSITION OF THE BALANCING WEIGHT



When we had the trial weight in position C we had a lower vibration than in position B. The trial weight in position C must therefore be on the proper half of the rotor.
The balancing weight should be positioned (α) degrees from the position of the trial weight C.

The angle (α) can be measured on your rotor in either the direction against or with rotation. You must make a qualified guess and try one alternative. If the vibration is not reduced the other location may be the better.

TOTAL	1-FILTERED
22.82	18.16
mm/s rms	
800Hz	2954RPM
	Hold

In our example we first placed 78grams 38 degrees in the direction of the rotation.

The result was not good.

TOTAL	2-FILTERED
5.22	1.64
mm/s rms	
800Hz	2952RPM
	Hold

We then moved the 78grams 38 degrees in the direction against the rotation.

The result was very good.

The vibration became that low that the unbalance vibration became the second highest peak and we hade to select the 2-FILTERED to find the same frequency as the running speed.

The balancing may be stopped when the highest radial direction is below 3 mm/s rms.

MISCELLANEOUS

If you prefer to calculate the balancing weight, this is the formula:

$$BV = \frac{\sqrt{2} + A + P}{\sqrt{B^2 + C^2 - 2A^2}} \; ; \; \cos\alpha = \frac{B^2 - C^2}{2 \cdot \sqrt{2} + A \cdot \sqrt{B^2 + C^2 - 2 \cdot A^2}}$$

TROUBLE HINTS

The most difficult task in balancing is to guess a suitable size of the trial weight because we do not know the unbalance sensitivity of the machine. The whole balancing procedure depends on the changes in vibration level that occur when we add a trial weight. If the trial weight is too small compared to the unbalance we can not measure any changes in the vibration levels and the measurements **A**, **B** and **C** become almost equal. The triangle in our figure becomes flat.

If the trial weight is too large compared to the unbalance the measurements **B** and **C** become very large compared to the measurement **A** and the triangle in our figure becomes very high and narrow.

This produces an uncertainty in our calculations.

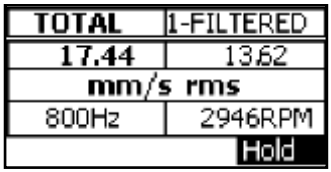
If the triangle can not be formed well, use the results to guess a better size of the trial weight or try a location of the trial weight a quarter turn away from the first position.

If the triangle can not be formed at all there are often two major reasons:
Something is loose. Check the fit between the rotor and shaft. Check bolt joints.
Is dirt gradually falling off during each run?
The vibrations in these cases are not caused by an unbalance. You are trying to balance a machine where the unbalance is very small and where the vibration comes from other faults, e.g. misalignment, gearbox, cavitations in pumps etc.

This is the procedure for the THREE-POINT BALANCING METHOD:

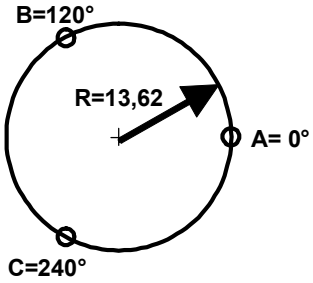
The three point method gives you both the size and the location angle (a) without guessing the position of the balancing weight. Be sure to choose the same speed during all trial runs and the same radius for all trial weights and the balancing weight.

Step 1:



With the rotor operating at normal speed, measure and note the original vibration level as **R1**.

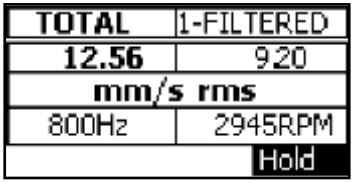
In our example we measured the vibration at the running speed 1-FILTERED to be : **R1** = 13.62 mm/s



Draw a circle with a radius proportional to **R1** and then use the same scale for the rest of the procedure.

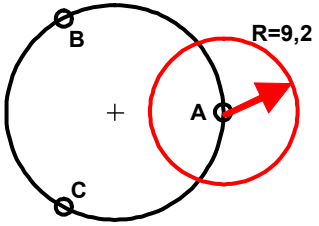
Stop the rotor. Mark three points on the rotor, approximately 120 degrees apart where we later will add trial weights. Call these points **A**, **B** and **C**. These three points do not need to be exactly 120 degrees apart but the accuracy decreases the more you leave equal spacing. You have to measure your chosen angle position as accurate as possible.

Step 2:



Put in a trial weight in position **A**.
Start the rotor and measure the vibration level **R2**.

In our example we added 40 grams at 320 mm radius and the vibration became **R2** = 9.2 mm/s.



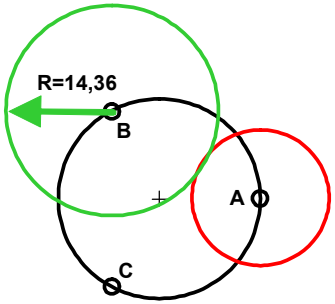
Draw a circle proportional to **R2** with the centre in position **A**, the red circle.

Step 3:

TOTAL	1-FILTERED
18.91	14.36
mm/s rms	
800Hz	2947RPM
	Hold

Move the same trial weight to position **B**.
Start the rotor and measure the vibration level **R3**.

In our example we moved the 40 grams at 320 mm radius to position **B** and the vibration became **R3** = 14.36 mm/s.



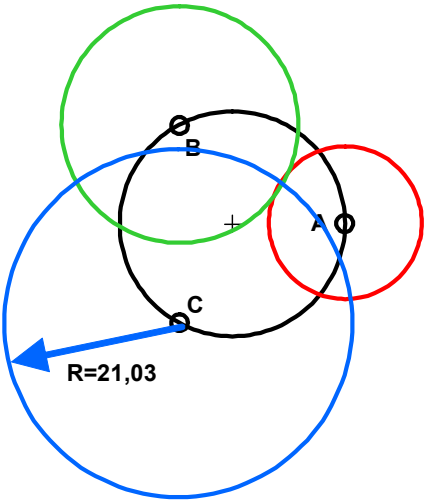
Draw a circle proportional to **R3** with the centre in position **B**, the green circle.

Step 4:

TOTAL	1-FILTERED
26.33	21.03
mm/s rms	
800Hz	2948RPM
	Hold

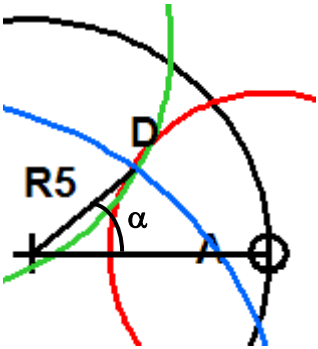
Move the trial weight to position **C**.
Start the rotor and measure the vibration level **R4**.

In our example we moved the 40 grams at 320 mm radius to position **C** and the vibration became **R4** = 21.03 mm/s.



Draw a circle proportional to **R4** with the centre in position **C**, the blue circle.

Step 5:



All the three circles **R2**, **R3** and **R4** intersect in a common point **D**.
Draw a line from the centre of the circle **R1** to the point **D**. Call this line **R5**. Measure the length of this line using the same scale as before.

In our example **R5** = 7.52 and it is the vibration level caused by the trial weight **P** if **P** was the only unbalance in this rotor.

Measure the angle **α** in the drawing. This is the angular position of the balancing from position **A**

Step 6:
Calculate the size of the balancing weight using the formula:

$$BalancingWeight = \frac{Trial\,Weight \times Length\,of\,R1}{Length\,of\,R5}$$

In our example the balancing weight will be:

$$BW = \frac{40 \times 13.62}{7.52} = 72.4 grams$$

TOTAL	3-FILTERED
8.03	2.78
mm/s rms	
800Hz	2955RPM
	Hold

The balancing weight 72.4 grams was placed 38 degrees from position A.

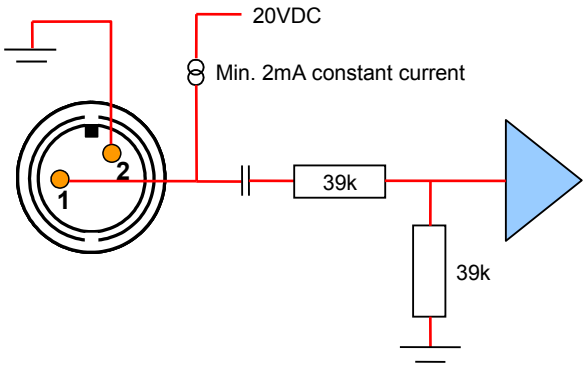
The result was very good.

The vibration became that low that the unbalance vibration became the third highest peak and we hade to select the 3-FILTERED to find the same frequency as the running speed.

The balancing may be stopped when the highest radial direction is below 3 mm/s rms.

If you want to further improve the balancing status you must start from the beginning and use a smaller trial weight.

Schematic of the vibration input



Battery

The battery pack consists of 4 NiMH with 2000mAh and fully charged is the capacity enough for 6 hours continued operation.

Type of operation	Max. mA
Instrument switched ON	<100
Additional for back-light	~30
Additional when measuring	~30
Additional at speed or temp. measurement	~20
Instrument switched OFF	<0.1

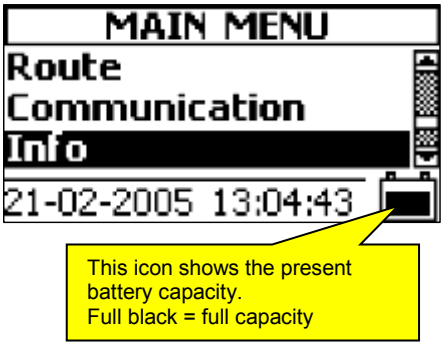
Because the internal discharged in the battery is quite high in NiMH batteries always charge the batteries the day before use.
A full charging process takes about 4 hours.

The instrument can be used with only the battery charger connected even when the battery pack is removed.

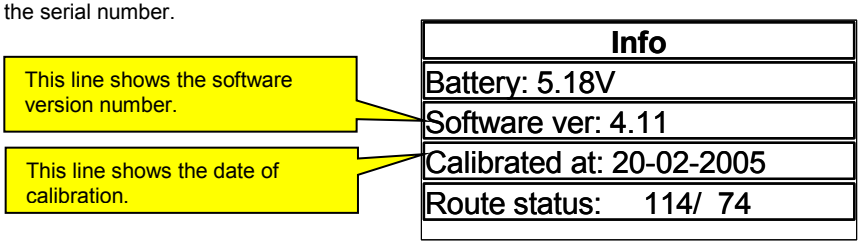
Do not connect another type of charger. This might permanently destroy the instrument.

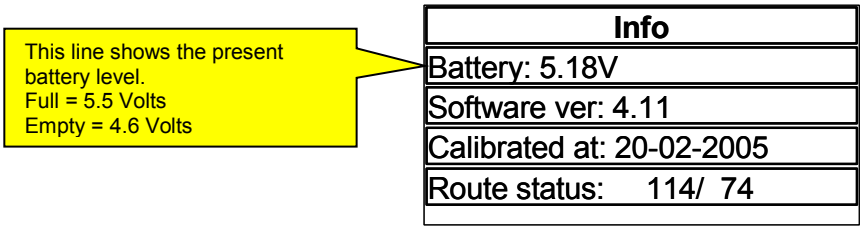
Instrument Info menu

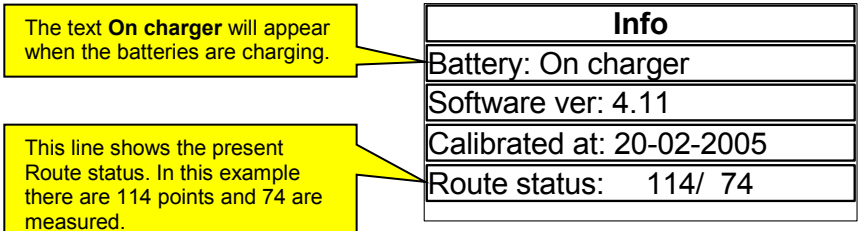
Move the black line over **Info** with the ***Up*** or the ***Down*** button and press the ***OK*** button.

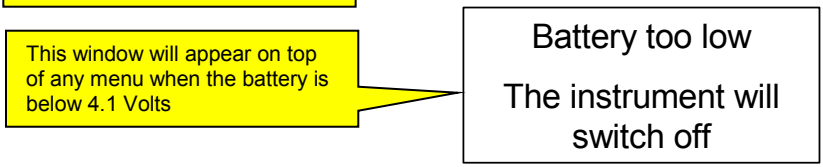


The info menu gives you information about the software version and the date of calibration. If you have problems with the instrument always refer to these numbers and the serial number.





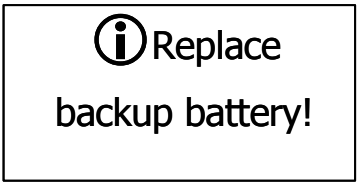




Backup battery

The instrument has an internal Lithium battery mounted on the main pc-board. This battery works as backup battery for the real time clock and the CMOS memory.

This message will appear only when the instrument is switched ON. When this message is shown, the small Lithium battery must be replaced.



The “lifetime” of this battery is approximately 5 years, but will be considerably extended, if you keep the normal battery pack charged and mounted on the instrument.

RESETTING THE INSTRUMENT

The following procedure must be followed to RESET the X-Viber Instrument:

- Switch OFF the instrument.
- Press and keep pressed both the ESC and OK buttons.
- Press at the same time the ON/OFF button for 2 seconds.

The instrument will perform the following task:

- A memory test will be done. In case of a defective memory chip, an alert message will appear and the instrument will not continue the tasks.
- All system variables will be initialized
- All settings will be set to the default values (See next page).
- The route data will be deleted and the route files will be initialized.

The RESET action must be done if any abnormal functionality of the instrument occurs.

NOTE. The instrument LOGO screen will be assembled from separate dots only after a RESET action.

Otherwise, when the instrument is powered ON, the last screen before the shut down will be restored.

NOTE. If the battery pack is removed from the instrument and placed back, no RESET will occur. The route data and other settings will still remain in the memory.

X-VIBER default settings after restart

SETTINGS	DESCRIPTION	DEFAULT VALUE	SCREEN
Contrast	LCD contrast adjustment, a number from 1 to 10	5	ALL
Backlight	LCD backlight – ON or OFF	OFF	ALL
Power off	ENABLES or DISABLES automatic instrument power off, if no key is pressed within a set time period of time.	ENABLE	MAIN MENU
Power off in	Determines the time for automatic instrument power off. Can be any from the following series: 1,2,5, 10 minutes or Never.	2	MAIN MENU
Unit	METRIC or IMPERIAL units	METRIC	MAIN MENU
Acc. sens.	Accelerometer sensitivity in mV/g	100	INFO MENU
Auto advance	YES or NO. YES will trigger an automatically advance to the next point when the measurement is finished.	NO	ROUTE MENU
Unit	Vibration unit for total value measurement.	mm/sec	TOTAL VALUE MENU
Range	Frequency range for total value measurement. Can be selected the following ranges: 2 to 800 Hz, 4 to 1600 Hz, 8 to 3200 Hz or 16 to 6400 Hz.	2 – 1600 Hz	TOTAL VALUE MENU
Alarm	ENABLE or DISABLE. If the alarm is ENABLED in time of the measurement a specific icon will appear according with the Alarm level.	DISABLE	TOTAL VALUE MENU ENVELOPE MENU BC MENU
HI Alarm	Alarm limit for TOTAL value, BC and Envelope measurement.	0.0	TOTAL VALUE MENU ENVELOPE MENU BC MENU
Min Freq	Low pass corner filter for Bearing Condition measurements. Can be set to 500, 1000, 2000 or 3000 Hz.	1000	BC MENU
Emis.fact.	The emissivity factor for temperature measurements that compensates for different surface properties.	0.98	

Technical Data

Transducers	
Standard vibration transducer	**Accelerometer type VMI199-28**
Sensitivity	100mv/g max measuring range ±50g
Frequency range (+/-3db)	0.5-15000Hz
Resonance frequency	34000Hz
Temperature range	-50°C … +121°C
Mounting	Magnet holder, hand held or measuring pointer
Cable length	1m
Vibration input electrical specifications	
Maximum input signal	+/-5V Peak
Sensitivity, standard settings	Accelerometer 100mV/g
Current- and voltage supply to transducer	+2.1mA constant current at max 20V
Built-in speed transducer (tacho)	**Infrared photocell**
Measuring range	30 – 120.000 rpm corresponding to 0.5 -200Hz
Measuring distance	0.15 – 1m
Measuring object	Reflex tape on the shaft
Automatic comparison with selectable alarm levels	Yes, 2 different limit values
Built-in temperature sensor	
Measuring range	-20 to +120°C, adjustable emission factor
Accuracy	±2°C
Resolution	1°C
Measuring distance	0.2 till 0.5m
Automatic comparison with selectable alarm levels	Yes, 2 different limit values
Measuring properties	
Total vibration level:	
Selectable frequency ranges	2-800Hz, 4-1600Hz, 8-3200Hz, 10-6400Hz and ISO 10-1000Hz
Selectable units, Metric	mm/s, um, mm, m/s, g
Selectable units, Imperial	in/s, mils, thou, g
Selectable type of average	RMS, Peak, P-P
Automatic comparison with selectable alarm level	Yes, 1 limit value
Total Envelope level	
Frequency range	500 - 6400Hz
Envelope level within the frequency range	1 – 1000Hz
Unit	gE RMS
Automatic comparison with selectable alarm level	Yes, 1 limit value
Total Bearing Condition value	
Frequency range at Bearing Condition	Selectable between 0.5 – 6.4kHz, 1 -8kHz, 2 – 8kHz, 3 -8kHz
Unit	g RMS
Automatic comparison with selectable alarm level	Yes, 1 limit value
Analysis	Same properties as with Total vibration level
	Automatic analysis of 5 frequencies with the highest levels
Route	Downloaded from the X-Trend PC-software
Memory capacity	Appr. 999 measuring points, including Total vibration level, Bearing Condition level and Envelope level
Balancing	Same properties as with Total vibration level
Methods	Single plane with vector method (standard) and 3-point balancing (option)
Frequency range	2-200 Hz/ 120-12000 r.p.m.
Spectrum in Route (Option)	
Memory capacity	Appr. 999 spectra
Frequency range	2-800Hz, 8-3200Hz, 10-6400Hz
Resolution	1.5Hz, 3.5Hz, 5Hz
Miscellaneous	
Dynamic measuring range	>80dB
Auto scaling	Yes
Main processor	Micro processor 38Mhz
Internal memory	512kb Flash, 512kb RAM, 8MB Memory Card
Graphic Display	68x124 pixels with background light
Real time Clock	Yes
Computer communication	USB max 256kbaud/s
Power supply	4 x R6 2000-2700mAh rechargeable Nimh batteries
Power usage at measurement / sleep mode	120mA / 25uA > 10 hours of continuous operation
Min/max environment temperature while measuring	-20°C … +50°C
Dimensions	180 x 80 x 40mm
Weight	400grams including batteries