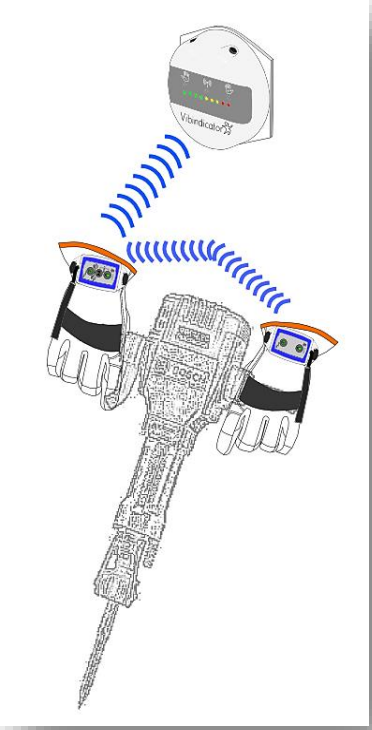
CVK
Vibration & Noise



Hand and Arm vibration measurement

Manual

HealthVib® HAV Measurement System

a CVK product

Table of Contents

Manual – HealthVib® HAV100 measurement system

Version: 15.04

Revised: May 4th, 2015

Aurorum Science Park 1C

SE- 977 75 Luleå
Phone: +46 (0) 920 560 000
E-mail: info@cvk.se
www.cvk.se

Short notice to the user

This manual describes how to use the HealthVib HAV vibration measuring system.

All products are patented and product names are registered trademarks.

Limited warranty

CVK-Vibration & Noise AB guarantee their products free from material and function defects 2 years from date of purchase, if the product is used under normal circumstances. This warranty includes products bought within EU as well outside EU. The warranty is limited to repair or exchange of the product according to what CVK finds necessary. To claim warranty CVK needs to be contacted and written report about problems that occurred and receipt where date and location for purchase can be cleared from.

CVK supply free repair or exchange of product if the product has not been exposed to violence due to incorrect management or been taken apart by unauthorized personnel. CVK does not take responsibility to damage or misplacement that occurred during delivery, if the delivery I taken care of others then CVK. CVK do not take responsibility for any shipment costs regarding warranty matters.

Terms and conditions

HealthVib HAV measurement system is designed for measurement of hand and arm (HAV) vibrations in three

directions in accordance to ISO 5349, ISO 8041:2005 and EU 2002/44/EG.

Before start of measurement, please make sure that the units are inharmed, fully functional, are not used in unsuitable environment, are properly placed and battery level is sufficient.

Recommendations

- The recommened mode of use of the equipment is a HealthVib HAV Active and a Pasiive unit with the special gloves and the Vibindicator HAV data logger and indicator and analyse results with CVK VibNoiseView.
- The normal mode of use of the equipment is one HealthVib HAV Active with the special glove and the Vibindicator HAV data logger and indicator and analyse results with CVK VibNoiseView.
- The minimal mode of use of the equipment is one HealthVib HAV Active with the special glove and analyse results wit hCVK VibView light.
- An alternative mode of use of the equipment is to fasten the HealthVib HAV (Active and Passive) to the machine or vibrating surface with the adapters included.
- HealthVib HAV units (Active and Passive) are IP-classes to IP44 (There are models with IP65). The sensor itself IP-class 65.
- Vibindicator HAV is IP-classed to IP40.
- Do not expose the product for harmful damage.

- Mount the products properly before measurement either with the special gloves or the adaptors.
- Do not exceed the 2 meter transmission range between HealthVib HAV and Vibindicator HAV.

Available systems

Available systems	HealthVib HAV Active	HealthVib HAV Passive	HAV Gloves	Vibindicator HAV	Adaptor	VibView light	VibNoiseView	USB-Cable and chargers	Calibration software	Calibration Certificates
HealthVib HAV101-3ch	●		●			●		1	●	●
HealthVib HAV 100-6ch	●	●	●			●		2	●	●
HealthVib complete HAV100-3ch	●		●	●	●	●	●	3	●	●
HealthVib HAV complete HAV100-6ch	●	●	●	●	●	●	●	3	●	●

Equipment list

HealthVib HAV measurement system is developed to meet the requirements of 2002&44&EG in order to measure harmful hand and arm vibrations caused by handheld equipment.

HealthVib HAV measurement systems contains:

HealthVib® HAV Active
Measures and calculates hand and arm vibrations according to ISO 5349 and ISO 8041. Data can be exported to a PC or sent to a Vibindicator HAV.

HealthVib® HAV Passive
Measures and calculates hand and arm vibrations according to ISO 5349 and ISO 8041. The result is sent to a HealthVib HAV Active and Vibindicator HAV.

HAV Gloves
Special adapted to fit a HealthVib HAV Active and Passive unit where sensor is placed in palm of hand according to ISO 5349.

Vibindicator HAV
Data logger for a more detailed analysis in CVK VibNoiseView. The results are simultaneously displayed on an intuitive scale of LED's.

Velcro patches
Mounting the vibindicator on suitable place.

Calibration software
Calibrate all three axis separately for HealthVib HAV Active and Passive units.

USB-cable
The USB-cable is used for recharging battery and export data to a PC.

Battery charger
100-240 V to 5 Volt.

Metal adaptor
For mounting the sensor onto a machine. 2 sizes with nylon cable ties.

Compact disc containing computer software and manuals

CE-declaration and calibration certificate for HealthVib® HAV Active

CE-declaration and calibration certificate for HealthVib® HAV Passive

CE-declaration for Vibindicator ™ HAV

Specifications

The HealthVib HAV measurement systems is designed to measure hand transmitted vibrations according to 2002/44/EG, ISO5349 and ISO 8041. The quantities measured are the frequency weighted I second root mean square (RMS) values of three axis on each hand (equation 1). Filter used are bandpass filter 5-1500 Hz with weightings described in ISO 5349 (Wh). The RMS value is then recalculated as a vector sum (equation 2) of the three axis. Value according to the daily (dose A(8)) value described by ISO 5349 and 2002/44/EC is calculated (equation 3). On the Vibindicator HAV a three second moving window is used to display the real time indication of the weighted RMS vibration levels.

$$a_{hw(x,y,z)} = \sqrt{\int_0^T a_{hw(x,y,z)}^2\,(t)dt}$$

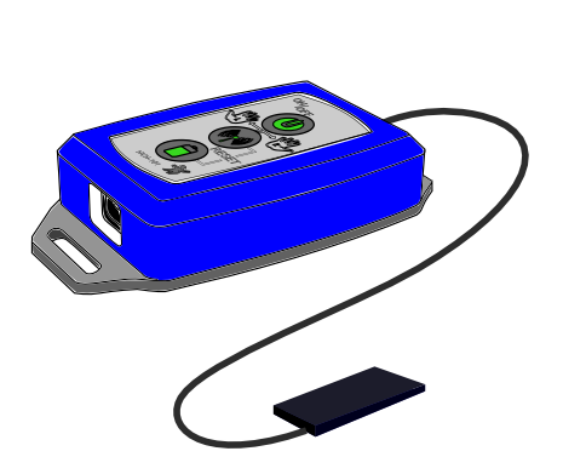
Where $a_{hw(x,y,z)}(t)$ =instantaneous single-axis acceleration of the frequency-weighted hand-transmitted acceleration at time t, in meters per second square (m/s^2).

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2}$$

$$A(8) = \sqrt{\frac{T}{8}}$$

Where$T = time\ (h)$.

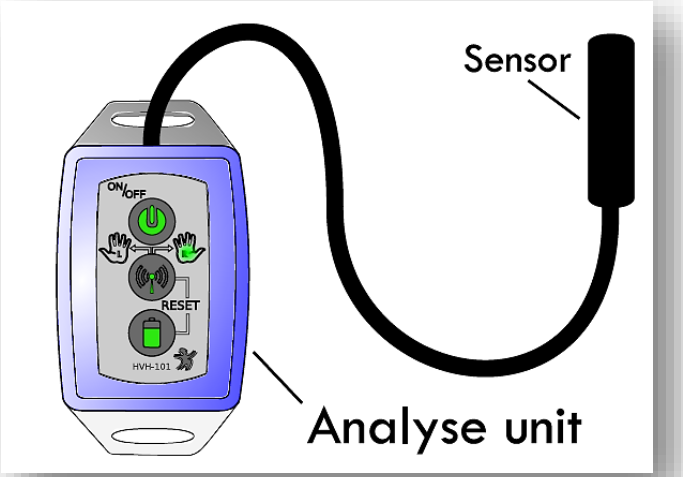
HealthVib® HAV Active



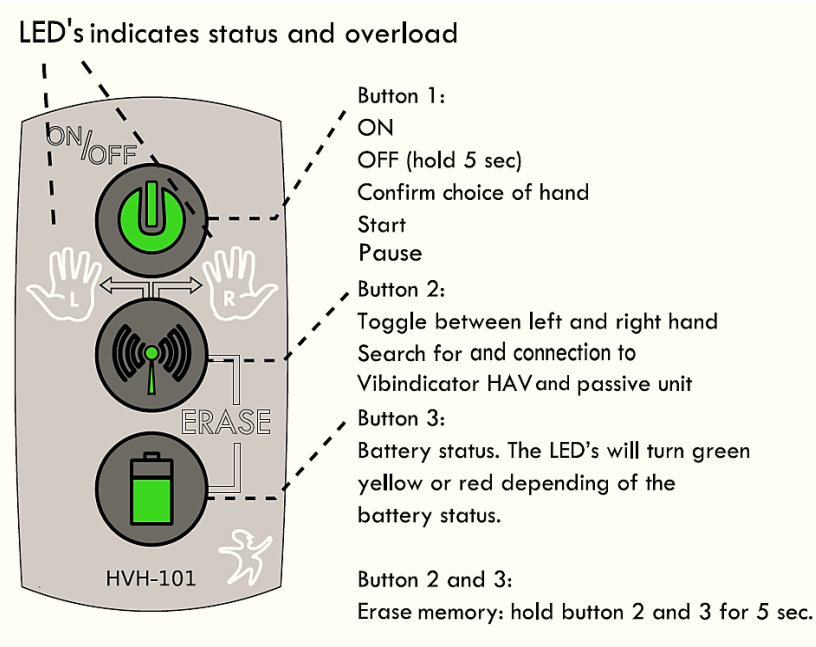
- Measures hand and arm vibrations in three directions.
- Measures and analyses vibrations to meet 2002/44/EG and ISO-standard, 5349 and 8041.
- Designed for short measurements or a whole working day.
- Data is exported to PC as a measurement files.
- Data can sent to a Vibindicator HAV (optional)

Functions- HealthVib® Active

The HealthVib HAV Active consists of a sensor and an analyse unit connected with a cable. A USB-connector found at bottom of the analyse unit for charging and connection to PC.



The HealthVib HAV Active has three buttons and two LED’s for operating the unit.



***Note**: See quick guide for operating example*

Mounting instructions

It is recommended to place the sensor inside the palm of the HAV glove. The cable is then secured in the space on the side of the hand. Fasten the analysis unit to the wrist.

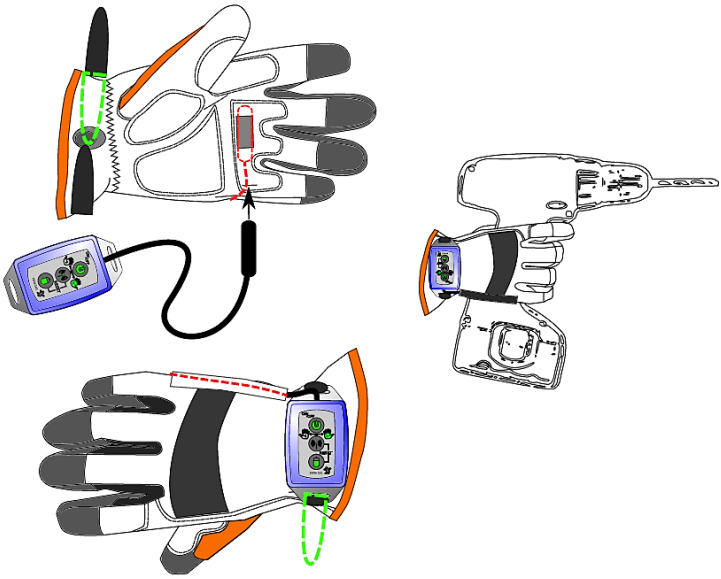


Figure1: Place the sensor inside the palm. Mount the cable inside the canal. Fasten the analysis unit to the wrist.

Turn on

By pressing button 1 once the unit turns on. The right LED will become white, indicating that the unit will be mounted on the right hand. By pressing button 2, toggle between right and left hand. Press button1 to confirm hand. The chosen LED will start flashing red indicating it is ready for measurement.

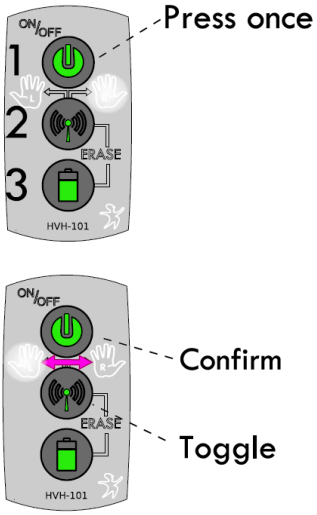


Figure 2: Press button 1 to turn on the unit.

Connecting

The HealthVib HAV Active can be connected to a HEalthVib HAV Passive and/or Vibindicator HAV. By pressing button2; the unit starts to search for passive and vibindicator unit. This is indicated by the LED's chaning colour to blue for 1 second. If a HealthVib HAV Passive is ready to be paired, a connection will be established and both LED's will be lit indicating bpth hands are ready to be measured. If an unconnected Vibindicator HAV is available; the LED for the actual hands on the Vibindicator HAV will be lit.

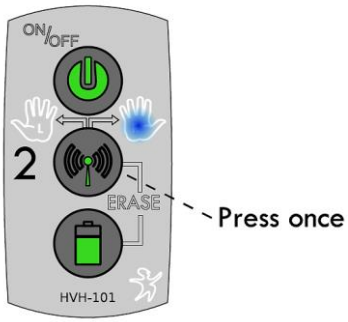


Figure 3: Press button 2 to start searching for other units.

Start and Pause measurement

When HealthVIb HAV Active is turned on and ready (indicated by one or both LED's flashing red); press button 1 to start measurement. The LED(s) will start flashing green indicating measurement is running. By pressing button 1 repeatedly; it will pause and continue measurement.

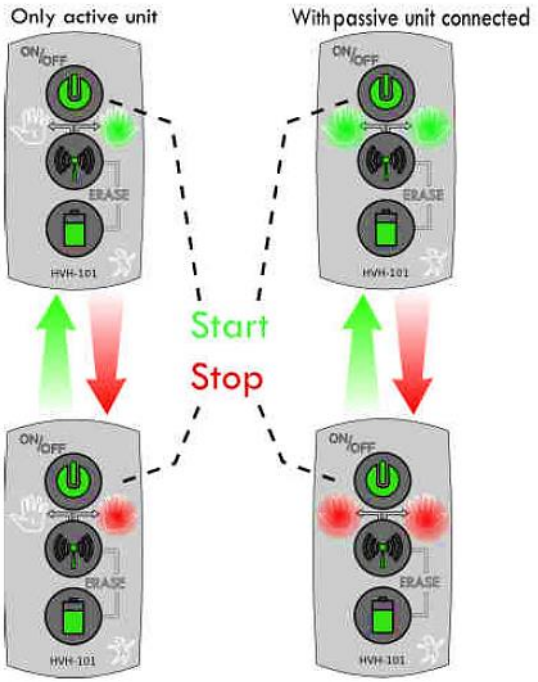


Figure 4: Press button 1 to start and stop measurement

Overload indication

If the HealthVib HAV Active is expected to high level peaks and higher than measurement range, an overload will occur. The LED will indicate this by flashing red and then keep notifying the overload by flashing red short after the green flash during measurement. When the measurement is paused; the main red flash indication will be shortly followed by another red flash. Reset the overload indication by pausing the measurement and restart measurement again.

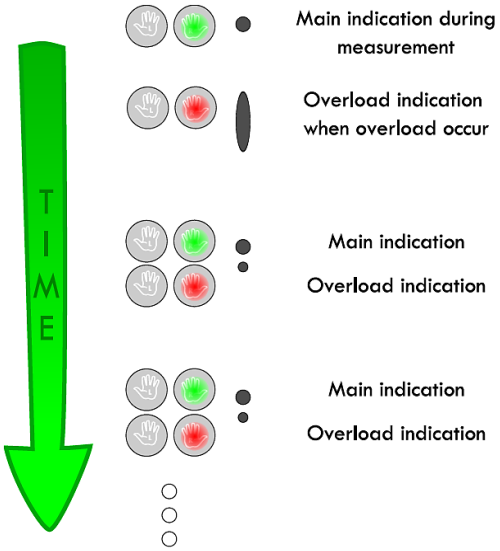


Figure 5: Overload in indicated by flashing red shortly after the main indication of measurement or paused.

Check battery status

To check battery status, the unit needs to be turned on. Press and hold button 3and the colour of the LED's will indicate green, yellow or red depending on battery status.

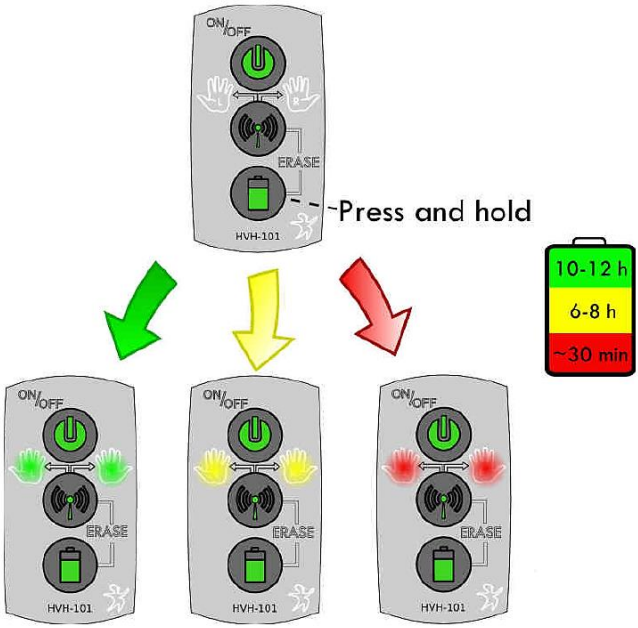


Figure 6: Press button 3 to see battery status. The LED's will turn green, yellow or red.

Turn off

To turn of the HealthVib HAV Active unit, press and hold button 1 for 5 seconds until the LED(s) flashes red.

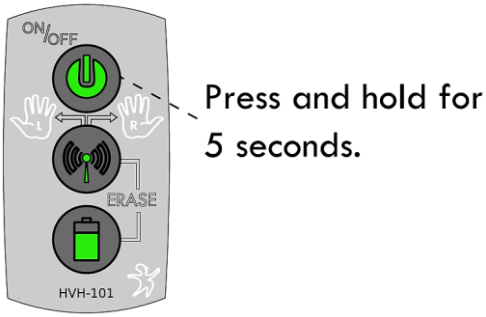


Figure 7: Press and hold button 1 for 5 seconds.

Charge

The HealthVib HAV Active is charged by USB-connector port.

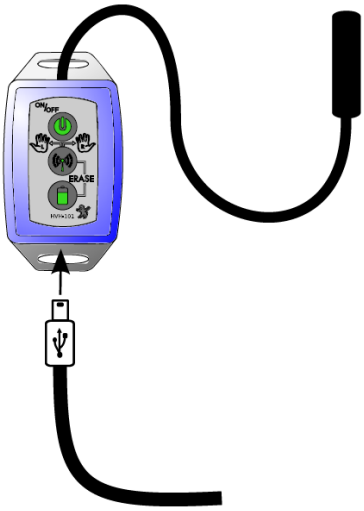


Figure 8: Connect USB-cable to unit and charger to wall socket.

CVK VibView HAV Light

CVK VibView HAV Light is a PC software developed to import dafa from a HealthVib HAV Active.

Data can be imported from the HealthVib HAV Active to PC with the software CVK VibView Light. Iti is compatible with MS Windows 2000, XP, Vista, 7 and 8.

CVK VibView light needs the Silicon Laboratories CP210x drivers installed onto the PC to be able to communicate with the HealthVib HAV Active. This driver is installed by the CVk VibView setup. Press cancel when then prompt ask to install this driver only if the driver is already installed onto the computer. Start the set-up file and go through the installation procedure.

Update firmware

To update the firmware; go to **Setup** menu and choose **Update firmware** and follow the instructions that appears. By this, you can ensure that you have the latest firmware for your unit.

CVK VibView HAV Light Overview

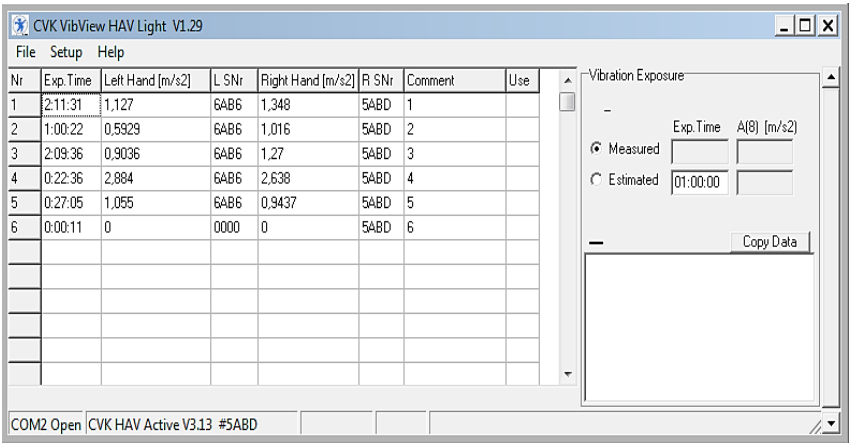


Figure 9: An overview of CVK VibView HAV Light

Connection & Import Data

Connect the HealthVib HAV Active to the computer by the USB-cable. Start CVK VibView HAV Light. The software will now try to search for a connected HealthVib HAV Active. If not automatically connected, go to **Setup** menu and choose **Set COM Port.** Then go to **File** menu and choose **Acquire** option to get data from the unit.

Measurement files will now appear in the table. Add comments in the comment field. Desired measurement file or analysis are chosen by mark 'x' in the last column, named ***Use.***

A '**x**' mark will denote that it will be used for calculation of daily dose in the right table named "Vibration Exposure" window.

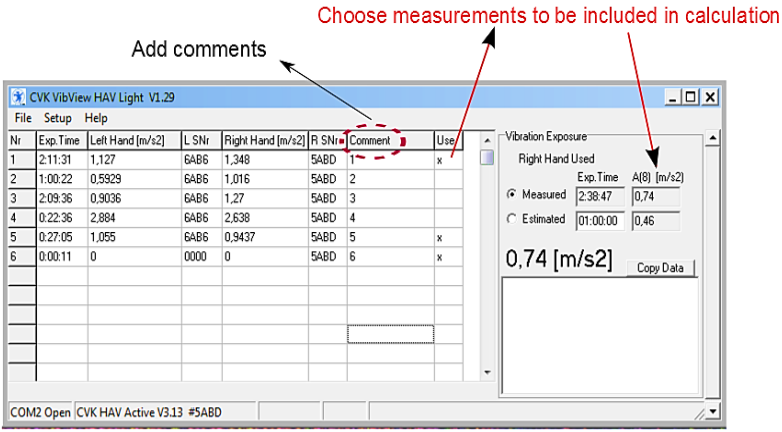
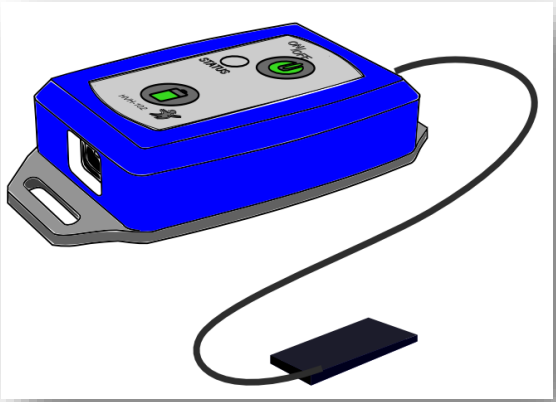


Figure 10: Chosen files will be used for calculation in the "Vibration Exposure" window.

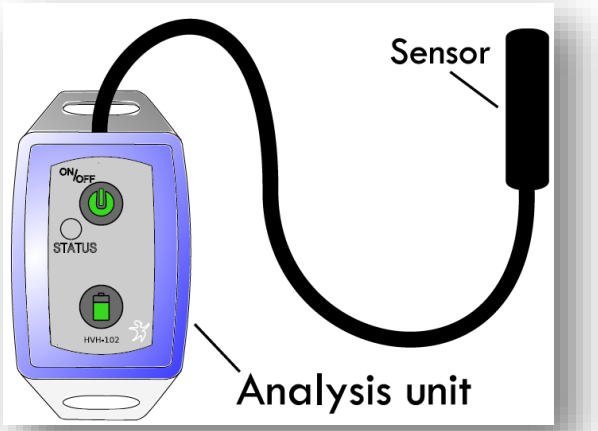
HealthVib® HAV Passive



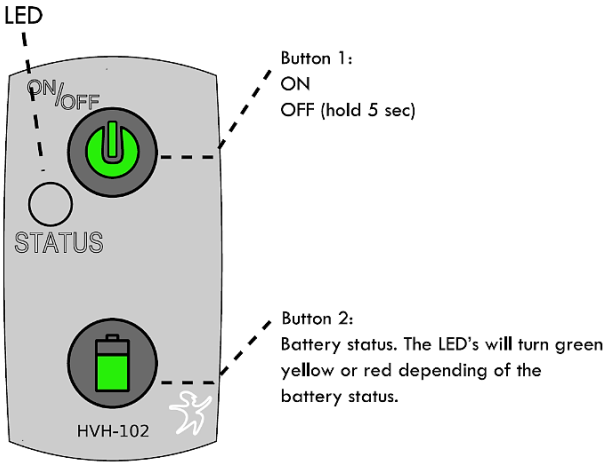
- Measure hand and arm vibrations in three directions.
- Measures and analysis vibrations according to 2002/44/EG and ISO-standards, 5349-1, -2 and 8041.
- Allows measurement on both hands simultaneously (6 channels).

Functions- HealthVib® Passive

The healthVib HAV Passive consists of a sensor and an analyse unit connected with a cable. A USB-connector for charging are found on bottom of the analyse unit.



The HealthVib HAV Passive has two buttons and a LED for operating the unit.



***Note**: See quick guide for operating example*

Mounting instructions

It is recommended to place the sensor inside the palm of the HAV glove. The cable is then secured in the space on the side of the hand. Fasten the analysis unit to the wrist.

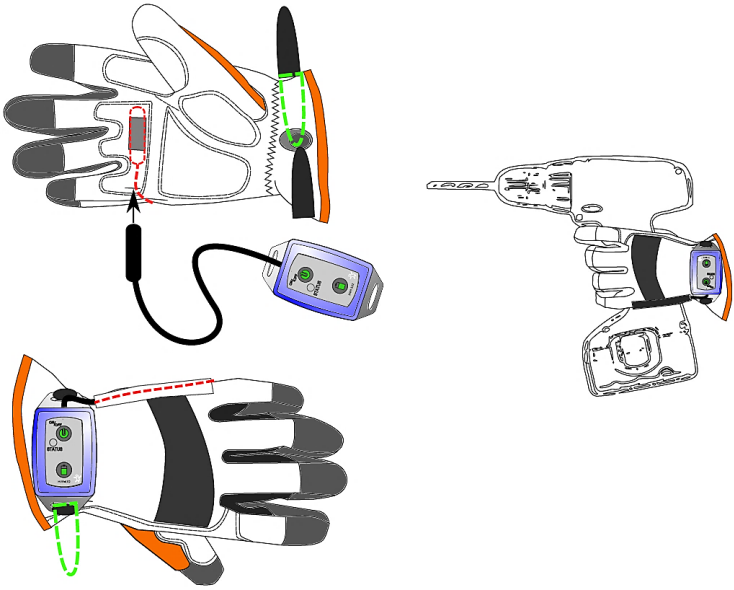


Figure 11: Place the sensor inside the palm. Mount the cable inside the canal. Fasten the analysis unit to the wrist.

Alternative mounting

By using adaptors, sensors can be directly mounted to vibrating tool and surfaces.

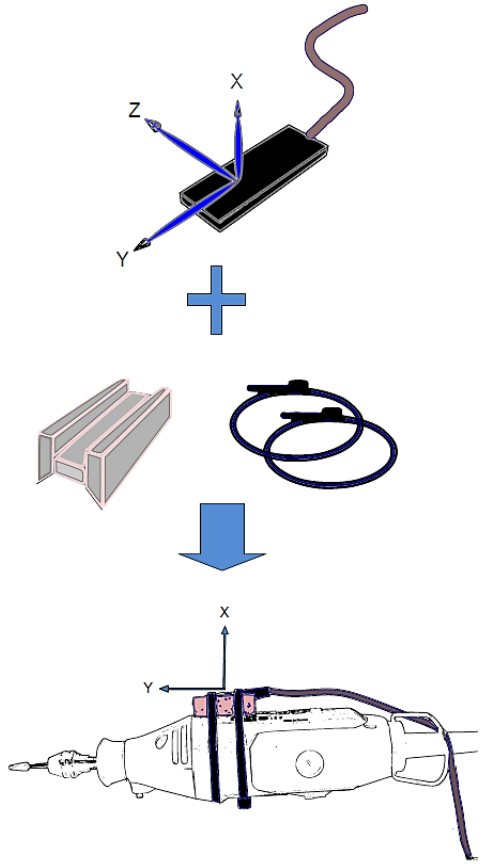


Figure 12: Example of alternative (Adaptor + machine) mounting.

Turn on and connect

By pressing button 1 once, the unit will start. The LED will start flashing red.

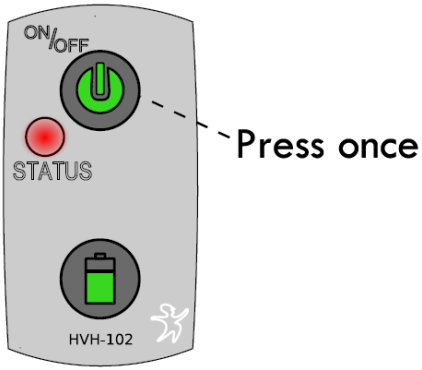


Figure 13: Turn on the unit by pressing button 1

The HealthVib HAV Passive needs to be connected to a HealthVib HAV Passive needs to be connected to a HealthVib HAV Active to work. By pressing button; the unit is turned on and starts to search for an Active unit. This is indicated with a red LED. When a measurement is performed (by starting a measurement with the active unit) the LED will start flashing green.

Paused measurement is indicated by LED flashing Red.

Overload indication

If the HealthVib HAV Passive is exposed to vibration levels higher than measurement range; an overload will occur. The LED will indicate this by flashing red and then keep notifying the overload by flashing red short after the green flash during measurement. When the measurement is paused, the main red flash indication will be shortly followed by another red flash. Reset the overload indication by pressing button 1.

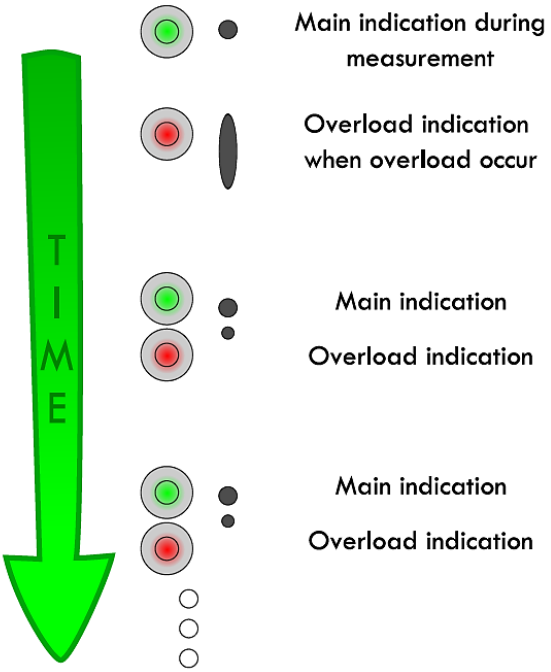


Figure 14: Overload is indicated by flashing after the main indication (either measurement or paused mode.)

Check battery status

To check battery status, the unit needs to be on. Press and hold button 2 and the colour of the LED's will indicate green, yellow or red depending on the battery status.

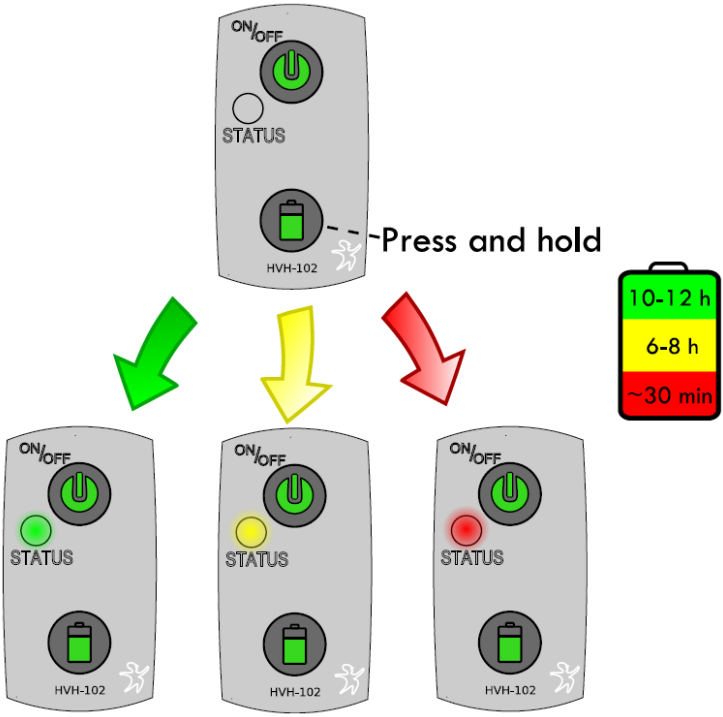


Figure 15: Press and hold down button 2 for battery status. The LED will turn green, yellow or red.

Turn off

To turn off the HealthVib HAV Passive, press and hold button 1 for 5 seconds until the LED is turned off.

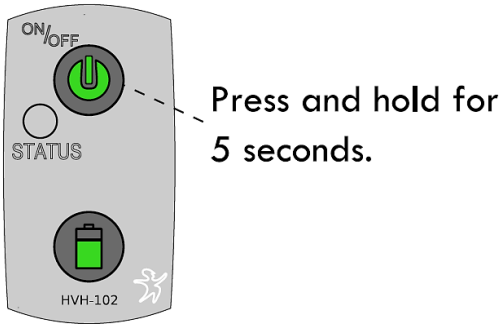


Figure 16: Press and hold button 1 for 5 seconds.

Charge

The healthVib HAV Passive is charged by connecting the charger with the USB-connector port.

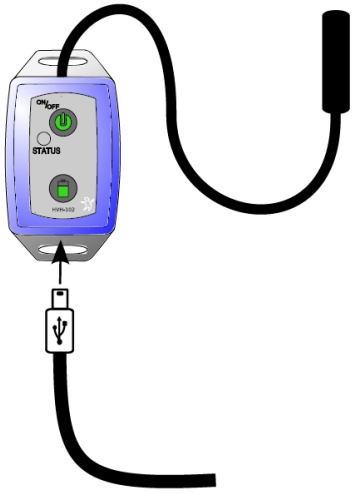
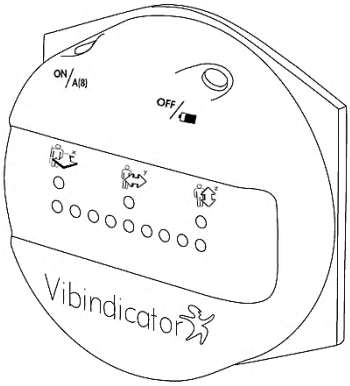


Figure 17: Connect USB-cable to unit and charger to wall socket.

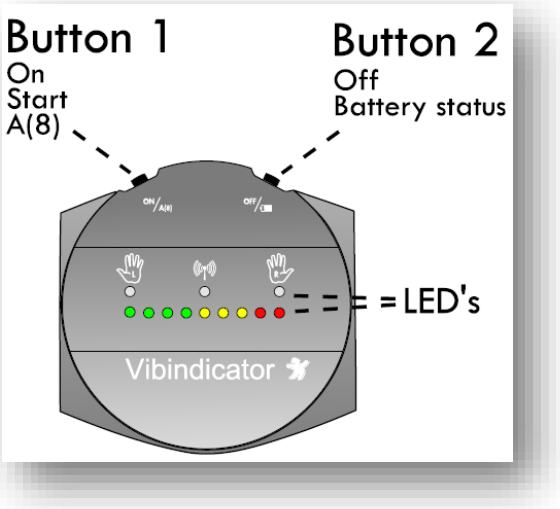
Vibindicator™ HAV



- Stores 1 second RMS vibration data for three directions, vector sum and peak values.
- Displays momentary vibration dose and accumulated dose (A(8)-value). By using green, yellow and red LED's.
- Collects data from HealthVib HAv Active and Passive unit.
- Export data to a PC with CVK VibNoiseView.

Functions- Vibindicator™ HAV

The Vibindicator is a logger and indicator unit. The Vibindicator HAV has two buttons and two rows of LED's (3+9 LED's) for operating the unit. A USB-connector for charging and importing data to a PC are found on bottom of the analyse unit.



Turn on and connect

By pressing button 1 once, the unit will start. The LED's will start flashing.

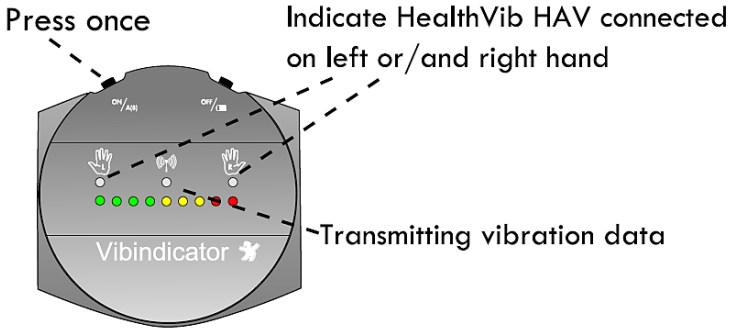


Figure 18: Press button 1 to start the unit.

The Vibindicator needs to be connected to a HealthVib HAV Active to work. It can also be connected to a HealthVib HAV Passive. By Pressing button 1, the unit turns on and starts to search for HealthVib units. If the antenna button on the HealthVib HAV Active is pressed; connection will be created. If one or two HealthVib HAV's are connected; the upper LED(s) will be lit indicating if the HealthVib HAV is connected to the left or right hand (or both).

When data is transferred to the Vibindicator HAV, the middle LED marked with a small antenna will flash once every second. Alternatively; it flashes twice every second if a passive unit is also connected.

Read Vibration levels

When a HealthVib HAV Active and Passive (optional) are connected and measuring; the vibration level (Ahv) is momentary displayed on the LED's. This level is based on a running average of three seconds and is updated once every second.

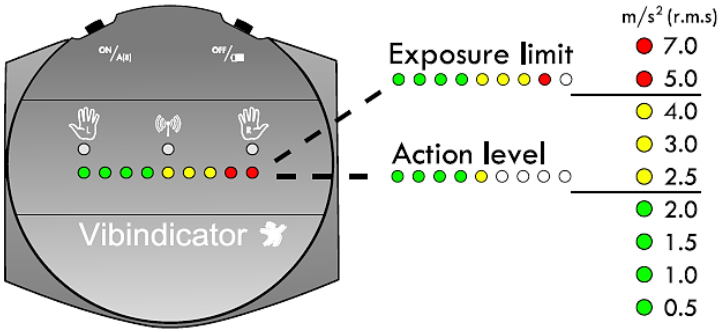


Figure 19: Vibration level is displayed as color and number of LED's.

Check daily dose

To display the accumylated and daily dose (A(8)-value); press and hold button 1. The LED's will now indicate if the vibration dose exceed the action level or exposure limit according to the legislation.

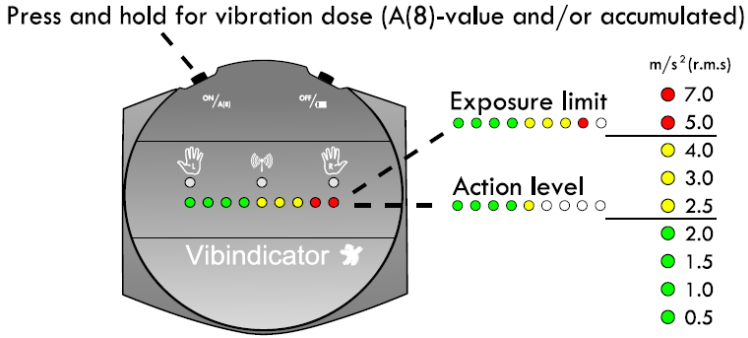


Figure20: Press button1 to display the daily dose.

Check battery status

To check battery status; the unit needs to be on. Press and hold button 2 and the number of LED's will indicate the battery status.

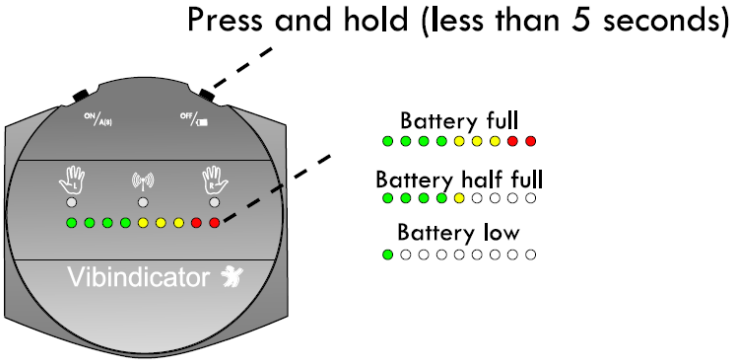


Figure21: Press and hold button2 to check battery status.

Erase memory

To erase memory, the unit needs to be on. Press and hold both buttons 1 and button 2. The LED's will start to be turned off one by one. Then all LED's are turned off; the memory is erased.

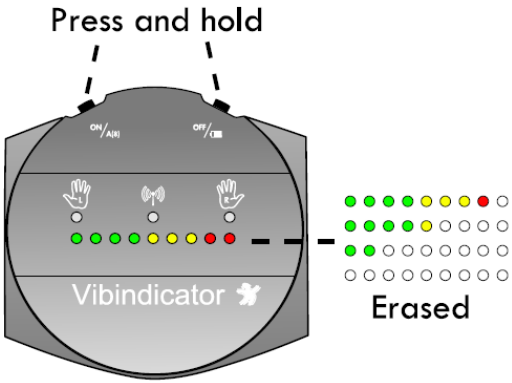


Figure22: Press & hold both left & right button until the LED's are turned off.

Turn off

To turn off the Vibindicator HAV, press and hold button 2 for 5 seconds until the LED's flashes and turned off.

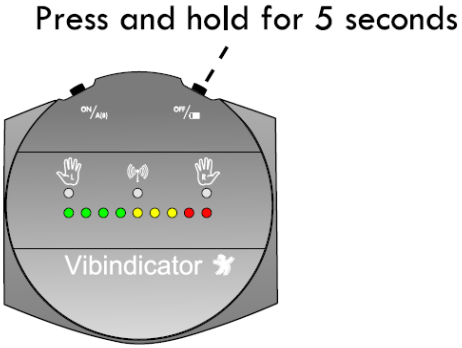


Figure23: Press & hold button2 for more than 5 seconds to turn off the unit.

Charge

The Vibindicator is charged by connecting the charger to the USB-connector port on the Vibindicator. After about 6 hours, the unit is fully recharged.

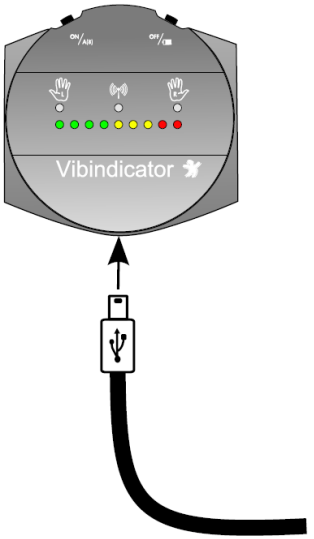
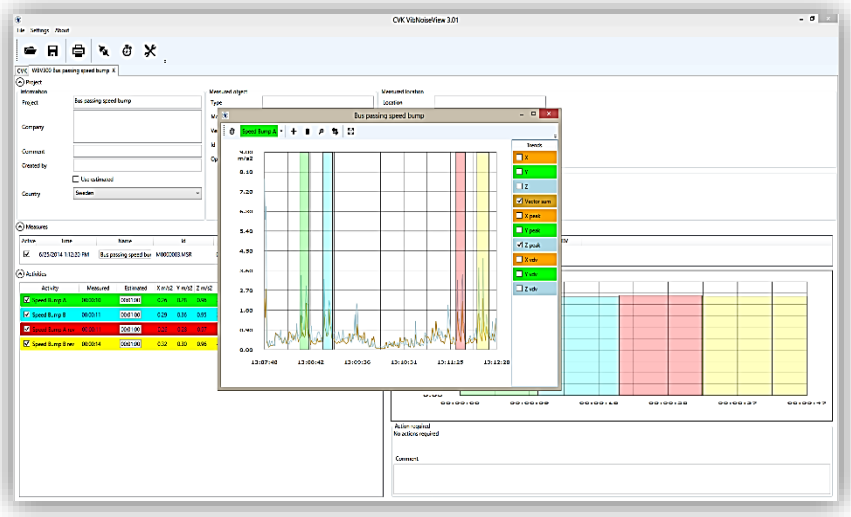


Figure24: Insert USB-cable & connect it to charger.

CVK VibNoiseView 3.0



- Import and manage measurements from CVK products. Data export to text format is possible.
- Perform different analysis as RMS, 1sec RMS, VDV and Peak.
- Cut and trim measured data.
- Synchronize data from CVK products.
- Creates exposure reports.
- Store measured data and create projects.

Terms and Conditions

CVK VibNoiseView 3.0 ™ is a measurement analysis software for hand and arm vibration (HAV), Whole body vibration (WBV) and Noise in accordance to ISO 5349, ISO 2631-1, requirements of 2002/44/EG, and ISO 60491, requirements of 2003/10/EG. The software is compatible with windows 7 and 8.

Before installation, please make sure that you have approvement from computer administration and right to install this software onto the computer. User license is included in instrument package.

To be able to have software updates and support, the support license purchase is needed.

Recommendations

- Do backup of important data before installation.
- Close all programs before installation.

Installation guide

Run the CVK VibNoiseView 3.0 setup-file provided. This will install the necessary files to the computer and create a start menu icon.

When the CVK VibNoiseView setup is launched:

1. The serial number will show up in License window.
2. In order to receive the License key, please provide your supplier with the serial number.

OBS! *Without License key, the software can be used for 10 days.*

3. Once entered the license key; the software is activated.

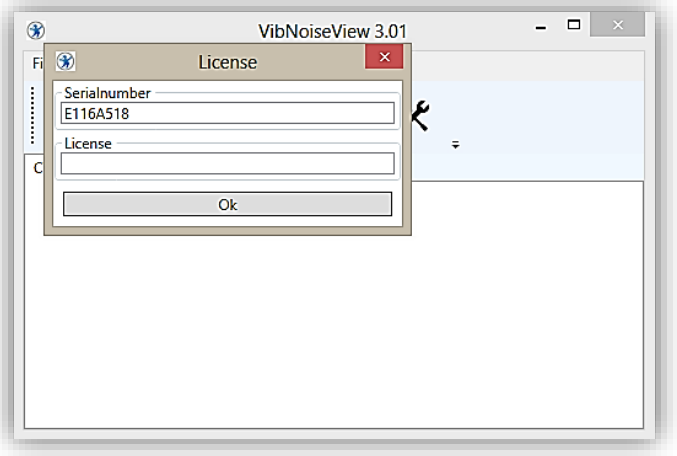


Figure25: VibNoiseView Start- up

Acquire Data from Vibindicator HAV

First, run the software; VibNoiseView and connect unit to computer using USB cable:

1. Open a New HAV/WBV/Noise measure from ‘File’ menu.
2. Click on ‘Connect’ button on top of the main window or Select ‘Read from hardware’ from ‘File’ menu to import the measurements.

Functions – CVK VibNoiseView 3.0

CVK VibNoiseView 3.0 main functions:

1. Manage and store measurement files in the file management window. Export data as .txt-file or .xls-file.
2. Cut, trim and organize measurements in the graph window.
3. Create, activities in the Activity list and calculate exposure using measured or estimated exposure time.
4. Print or save report by using report button.

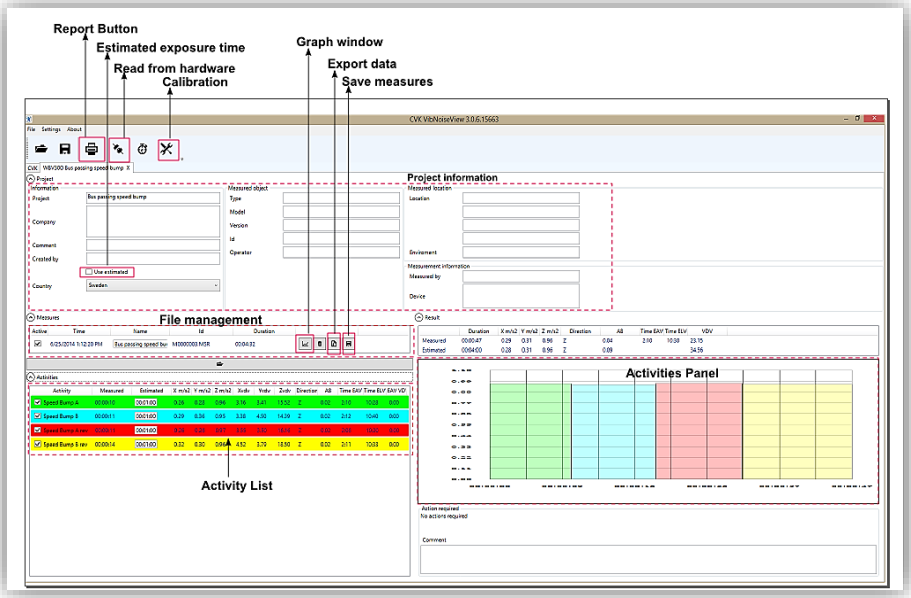


Figure26: VibNoiseView OverView

File management

In *file management window* all measurement files are shown. Date, time, name, duration and ID file numbers are found and names can be altered in *Name* panel.

There are four options for each measurement file:

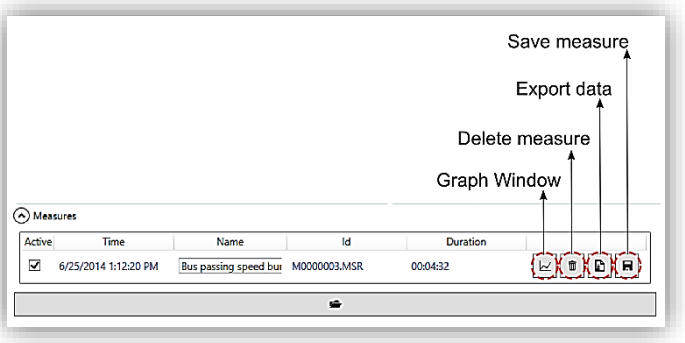


Figure27: VibNoiseView File management

Graph window, Delete file, export file, save measurement

In “graph window”; activities are found and can be created.

It is possible to delete each measurement file by using “Delete” button and export data to other file formats such as excel or text file.

To save the specific file as a single measurement file, press “Save” in front of the each measurement file.

Activity List

In activity list, different activities are presented. Different activities are created in the graph window, popping up by pressing graph window button.

Marked activities in created activity list will be included in report and calculations.

Measured exposure time is the default but estimated exposure time can be used by selecting ‘’use estimated’’ box in ‘’project information’’ window.

Estimate time

Different activities can also be time estimated by choosing “*use estimated*”. By this it is possible to calculate vibration exposure i.e. when using different machines during different exposure times. It is also possible to recalculate allowed exposure time.

Graph window

In graph window; chosen file is displayed. There are tools for zoom in/out, pan and creating activities, cut and trim measurements. And activity is created in activity list.

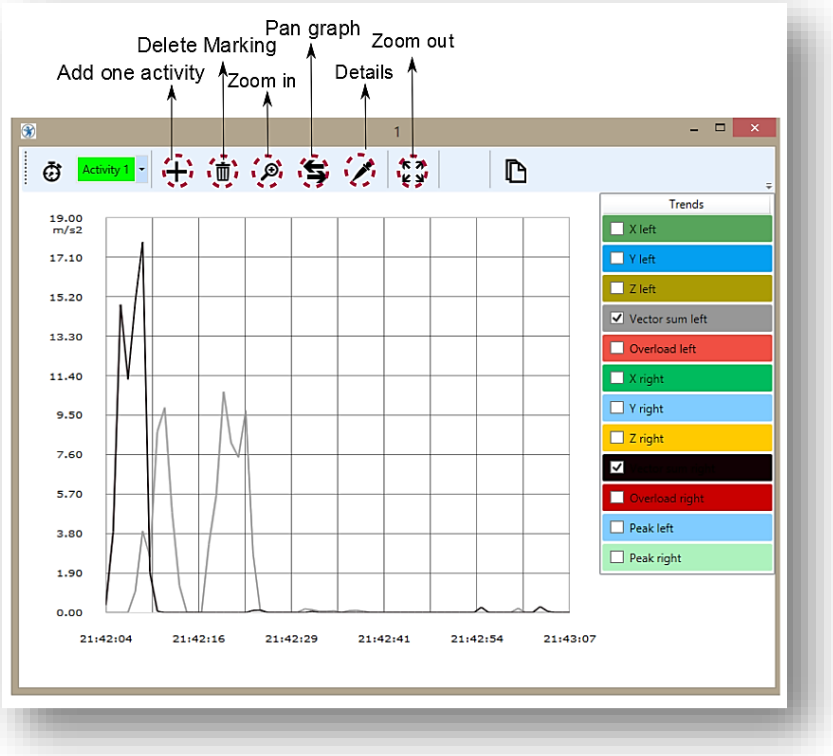


Figure28: HAV Graph Window

Graph- Zoom, and manage data

a) It is possible to choose to display R.M.S (X, Y, Z, and Vector sum), Peak (X, Y, Z) and VDV (X, Y, Z) values by checking them on the left side of the graph window.
b) To define activity(s) in each measurement graph

1. Choose activity panel by clicking on  .
2. It is possible to rename, add, and choose different colors for activities (please see figure 29&30).

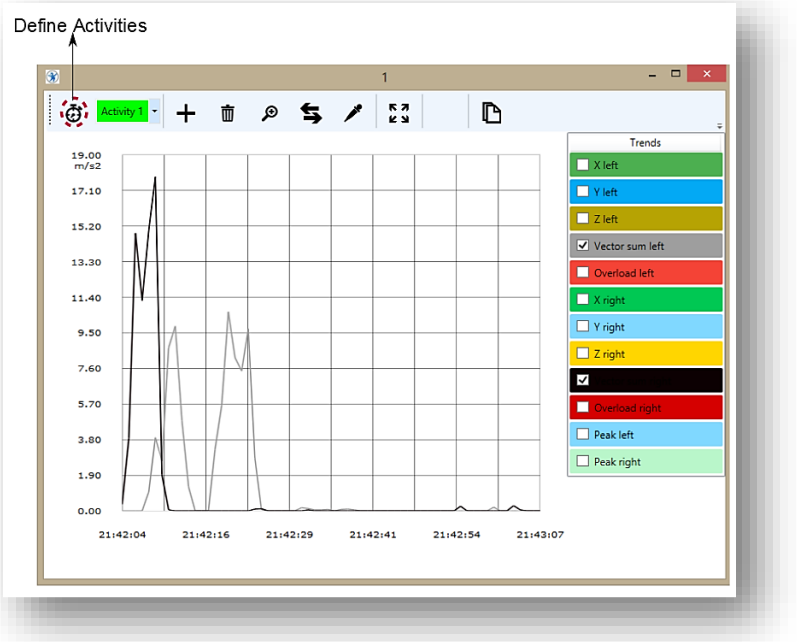


Figure29: Graph window- Define activities

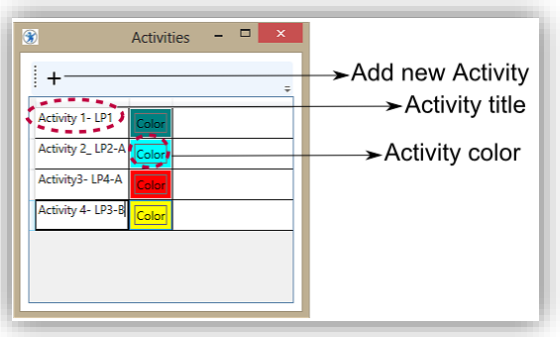


Figure30: Define and/or add new Activities

c) To select area of each activity in the graph;

1. Select the activity you are interested from top of the graph window.
2. In graph window; select “add activity” by clicking on 
3. Drag and mark the area (See figure31)

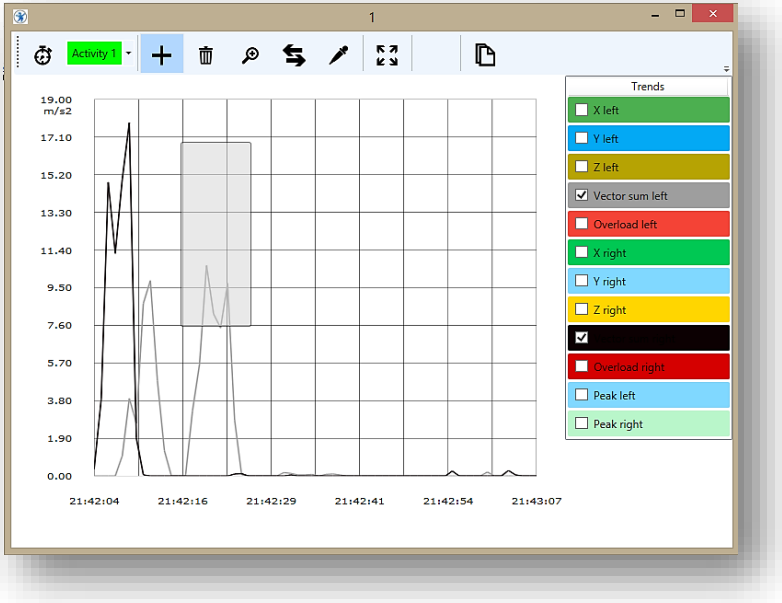


Figure 31: select the area of each activity

Note! *It is possible to select the whole measurement as only one activity.*

d) To delete area(s) of each activity in the graph;

1. In graph window; select “delete activity” by clicking on 
2. Select (click) the marked area to delete it.

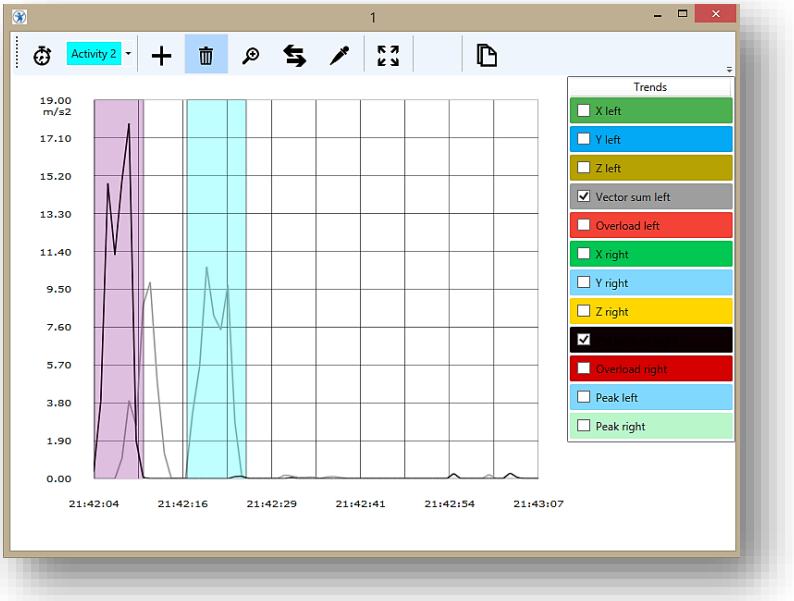


Figure32: Graph window- With 2 activities defined.

Analysis methods

Different analysis methods can be chosen depending on the vibration characteristics- *RMS, VDV, and Peak.* By this, it is possible to calculate vibration exposure in accordance to ISO 2631.

Report

Report can be printed or saved as pdf.

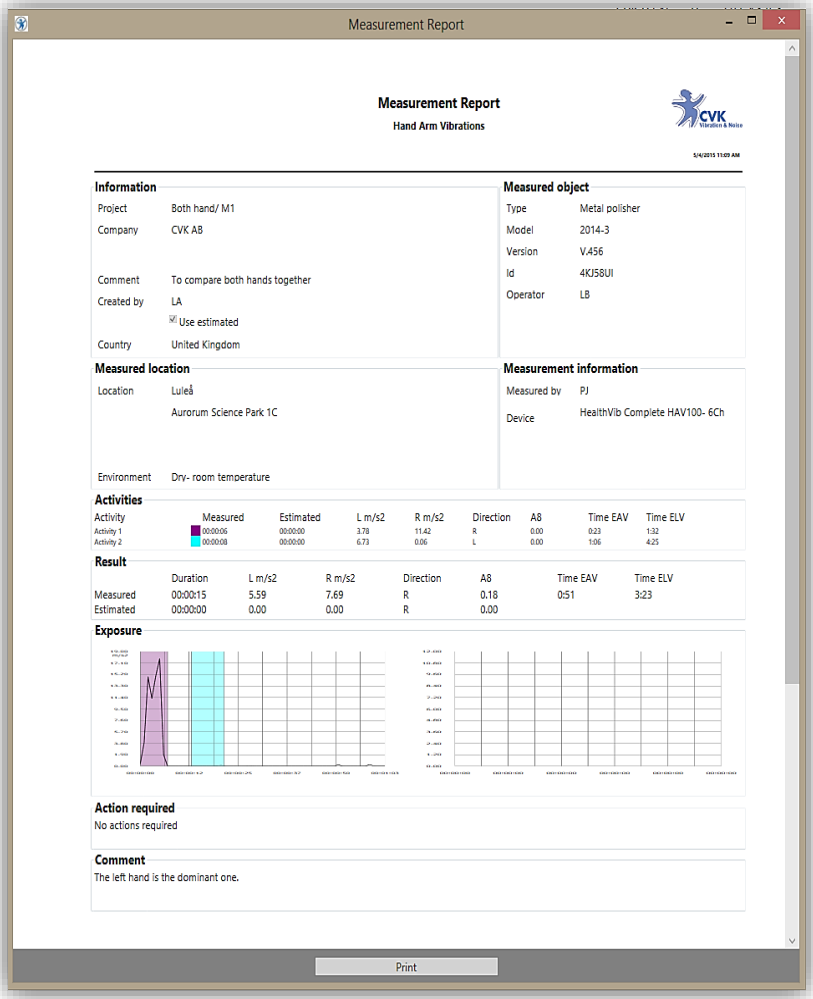


Figure33: VibNoiseView Report preview

Open previous saves measurement files

1. Open a New HAV project tab from ‘File’ menu.
2. Click on ‘Open button’ in “Measures” section to open your saved measurement files. (see figure34)

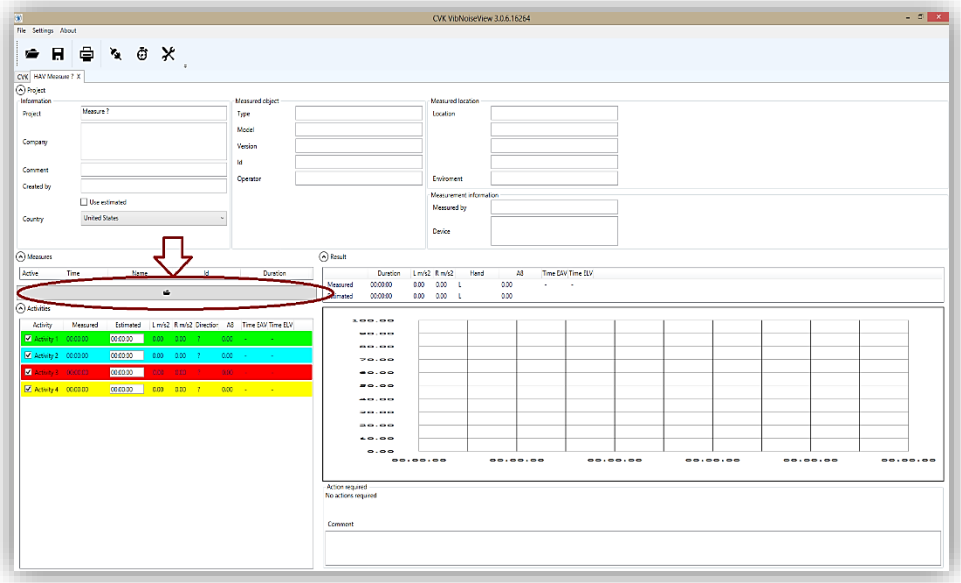


Figure34: Open a saved measurement file

Adjust time

To change date and time in your unit:

1. Connect the unit to the computer and run VibNoiseView.
2. Start Calibration software by click on icon 

   And the ''Calibrate'' window will show up.
3. Press ''Set Clock'' to synchronise your unit time and date with your computer.

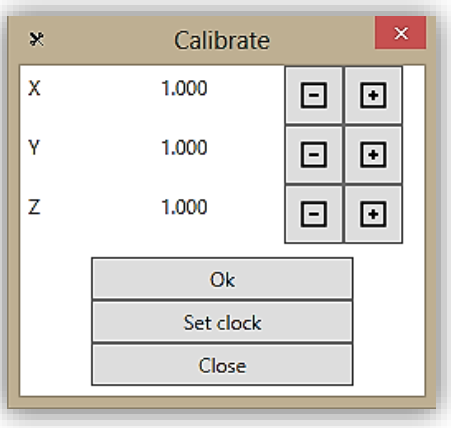


Figure35: Adjust date and time on unit

Calibration

In order to calibrate HealthVib HAV (Active & Passive); calibration software, shaker or calibrator reference accelerometer and CVK calibrator adaptor are needed. It is recommended to use a shaker or calibrator to create a steady state sine wave of 15.92, 80 or 159.2 Hz and an efficiency level of 2-10 m/s^2 root mean square (R.M.S).

Contact your supplier for further information about recommended shaker or calibration.

Calibration equipment

Equipment recommended to use for calibration by CVK:

Shaker or calibrator 15.92, 80 or 159.2 Hz at 2-10 m/s^2 root mean square (R.M.S).

Suitable reference accelerometer with one axis or more. (Only when using a shaker).

Adaptor to fasten HealthVib HAV sensor in three directions.

Computer with calibration software to display r.m.s value or peak level data from HealthVib HAV (Only when using a shaker).

Calibration procedure

Run a sine wave at 15.92 Hz, 80 or 159.2 Hz. At 2-10 m/s^2 r.m.s. Connect active/passive unit to computer and calibration software by using USB-cable.

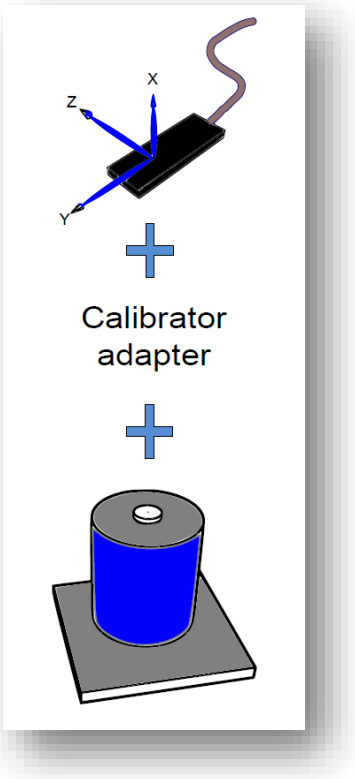
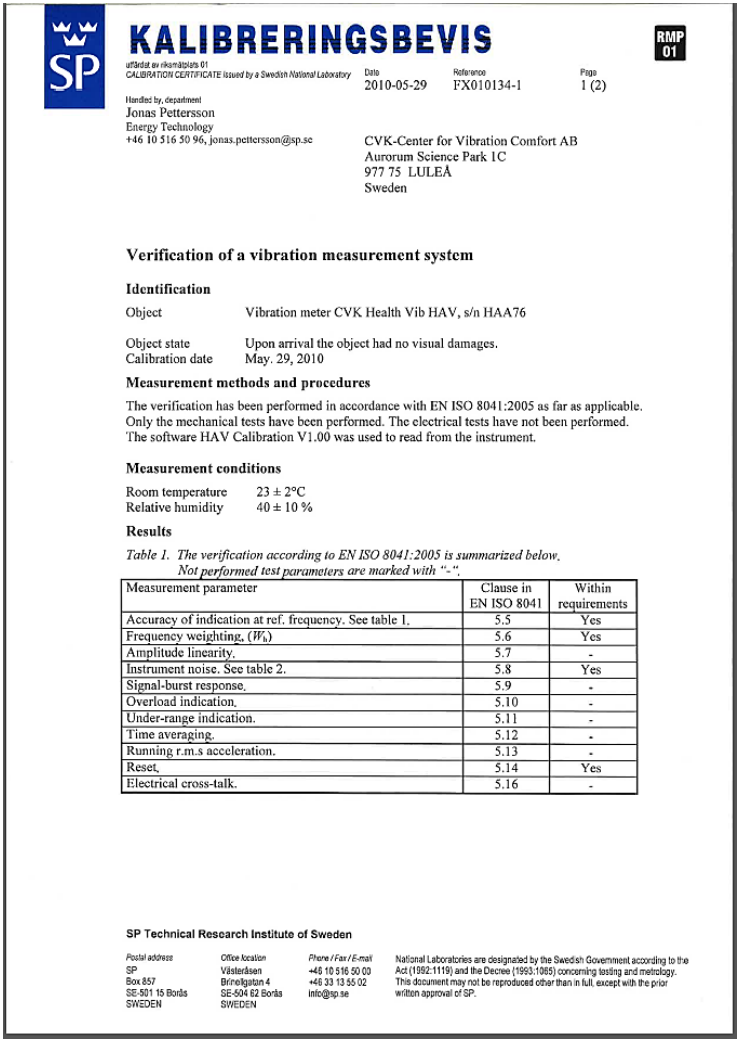


Figure36: Mounting the HealthVib HAv to the shaker for calibration

Certificates

SP Technical Research Institute of Sweden has validated the HealthVib HAV measurement system in conformity to the specifications of *ISO- 8041.*



KALIBRERINGSBEVIS

RMP 01

utfärdat av riksmätplats 01
CALIBRATION CERTIFICATE issued by a Swedish National Laboratory

Date 2010-05-29 | Reference FX010134-1 | Page 1 (2)

Handled by, department
Jonas Pettersson
Energy Technology
+46 10 516 50 96, jonas.pettersson@sp.se

CVK-Center for Vibration Comfort AB
Aurorum Science Park 1C
977 75 LULEÅ
Sweden

Verification of a vibration measurement system

Identification

Object — Vibration meter CVK Health Vib HAV, s/n HAA76

Object state — Upon arrival the object had no visual damages.
Calibration date — May. 29, 2010

Measurement methods and procedures

The verification has been performed in accordance with EN ISO 8041:2005 as far as applicable. Only the mechanical tests have been performed. The electrical tests have not been performed. The software HAV Calibration V1.00 was used to read from the instrument.

Measurement conditions

Room temperature 23 ± 2°C
Relative humidity 40 ± 10 %

Results

Table 1. The verification according to EN ISO 8041:2005 is summarized below. Not performed test parameters are marked with "-".

Measurement parameter	Clause in EN ISO 8041	Within requirements
Accuracy of indication at ref. frequency. See table 1.	5.5	Yes
Frequency weighting, (W_h)	5.6	Yes
Amplitude linearity.	5.7	-
Instrument noise. See table 2.	5.8	Yes
Signal-burst response.	5.9	-
Overload indication.	5.10	-
Under-range indication.	5.11	-
Time averaging.	5.12	-
Running r.m.s acceleration.	5.13	-
Reset.	5.14	Yes
Electrical cross-talk.	5.16	-

SP Technical Research Institute of Sweden

Postal address: SP, Box 857, SE-501 15 Borås, SWEDEN
Office location: Västeråsen, Brinellgatan 4, SE-504 62 Borås, SWEDEN
Phone / Fax / E-mail: +46 10 516 50 00, +46 33 13 55 02, info@sp.se

SP

KALIBRERINGSBEVIS
CALIBRATION CERTIFICATE

Date 2010-05-29 | Reference FX010134-1 | Page 2 (2)

Table 1. Deviation from correct acceleration at the reference frequency with frequency weighting. Requirements: ≤4 % deviation.

Weighting	Reference freq. (Hz)	Deviation (%)			Uncertainty (%)
		Ch. 1	Ch. 2	Ch. 3	
W_h	80	+3,8	+2,1	+2,5	1,5
Sensitivity setting		1,000	0,980	1,000	

Table 2. Instrument noise.

Weighting	Instrument noise (mm/s^2)		
	Ch. 1	Ch. 2	Ch. 3
W_h	39	30	20

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been determined in accordance with EA Publication EA-4/02 (formerly EAL-R2). The long term stability of the calibrated object is not included in the reported expanded uncertainty of measurement.

Traceability

The measurement results are by regular calibrations of the laboratory's standards traceable to the Swedish National Standards for acceleration, electrical quantities and time and frequency. To ensure international equivalence and acceptance of the established traceability, interlaboratory comparisons are made between national laboratories.

Equipment

Reference accelerometer Endevco 7290A, ser.no. 19196
Reference accelerometer Endevco 2270M8, ser.no. AD7T4
Signal generator Stanford Research Systems DS2360, ser.no. 61240
Voltmeter Agilent 3458A, ser.no. MY45044050
Signal analyser Hewlett-Packard 3562A, ser.no. 3216A05549

SP Technical Research Institute of Sweden
Energy Technology - Acoustics

Håkan Andersson
Technical Manager

Jonas Pettersson
Technical Officer