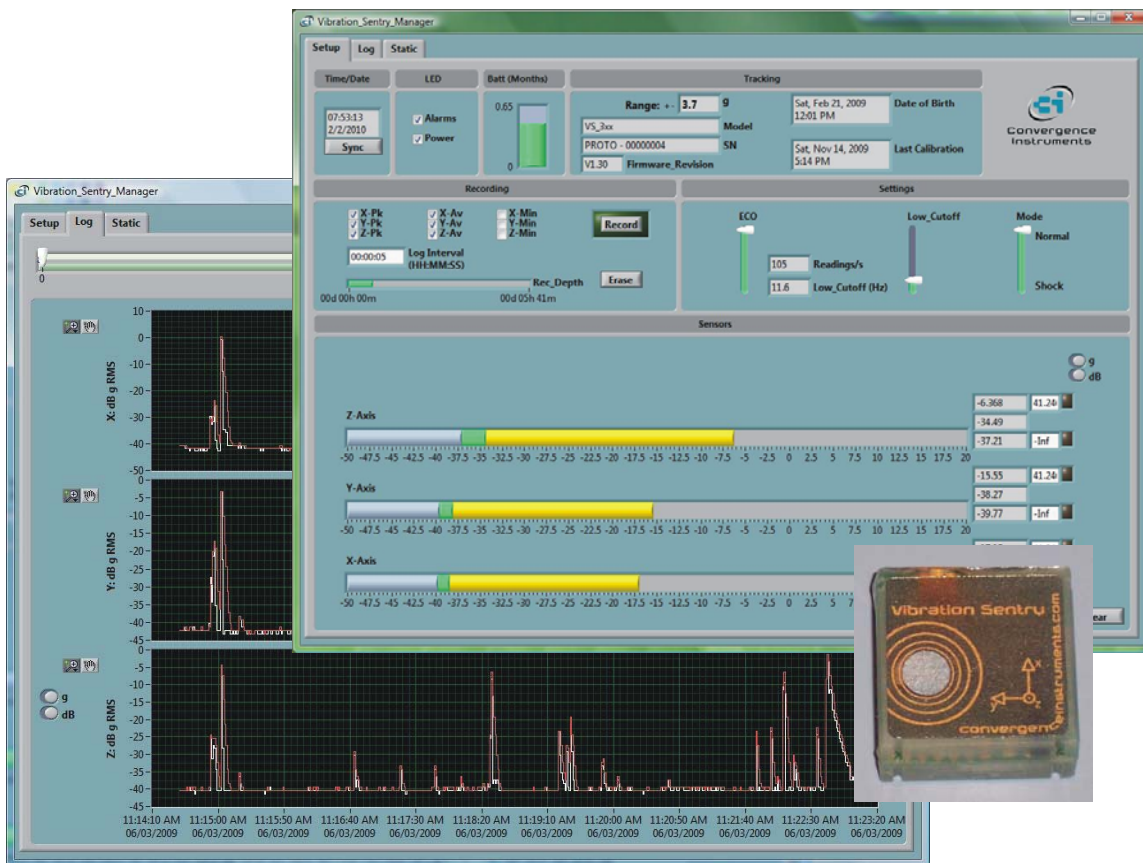


# Vibration Sentry

## User's Manual



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## 1 Introduction

The *Vibration Sentry* is a high-performance Vibration Level Meter and data logger. It includes a 3-axis MEMS accelerometer, an accurate date/time clock and a non-volatile 24000-point recording memory. Depending on the settings it can record vibration levels for months. Its very small size allows it to be attached to or embedded within the monitored equipment.

The *Vibration Sentry* includes the following features:

- All-digital design
- Self-calibrated using the earth's gravity as a reference.
- Measures and records max, average and min levels over adjustable intervals.
- An alarm function activates when the level is outside of a prescribed range.
- Adjustable operating mode and power consumption.
- Can monitor and record vibration levels for years on a small coin battery.
- Non-volatile memory. In case of battery failure, all recorded data is preserved.
- *Vibration\_Sentry\_Manager* application to setup operating and recording parameters, download, visualize and export the recorded data. The application can also be used to monitor vibration levels in real time.

## 2 Applications

- Long-term measurement and recording of vibration levels.
- Detection and recording of impacts and shocks.
- Monitoring of operation and transport conditions of fragile equipment.
- Continuous monitoring of machinery wear.

An alarm function provides a visual indication when the shock or vibration level has been out of the specified bounds.

The *Vibration Sentry* can monitor and record vibration levels for months on a small coin battery. Its weather-proof sealed construction allows it to be used in harsh environments.

It connects to a PC using its USB adapter cable. The *Vibration\_Sentry\_Manager* application is provided to setup its operating parameters and download, visualize and export the recorded data. The application can also be used to monitor vibration levels in real time.

## 3 Warnings



*Do not operate the Vibration Sentry to temperatures exceeding the following limits:*

- -20 degC to 70 degC (-4 degF to 158 degF)
- 
- *Do not expose the Vibration Sentry to temperatures exceeding the absolute safe limits:*
- -30 degC to 80 degC (-22 degF to 176 degF)



*Do not submerge the Vibration Sentry in liquids so that liquids may enter the battery compartment or MLI connector.*



If used outdoors make sure the Vibration Sentry has the battery compartment and MLI connector facing down, so water will not accumulate inside the battery compartment.



Only use the MLI cable provided with the Vibration Sentry.



Do not expose the Vibration Sentry to high electro-magnetic fields such as arc welders, induction heaters... etc. Do not expose the Vibration Sentry to static electricity.



If possible do not remove the battery while the Vibration Sentry is recording as this may adversely affect the long-term reliability of the recording memory.



Only use the Vibration Sentry as specified in this manual.

## 4 Getting Started

### 4.1.1 Software Installation

- 1 Run *Vibration\_Sentry\_Manager\_Installer.exe*. This installs the *Vibration\_Sentry\_Manager* application, as well as its *MLI* cable driver and documentation.

**Note:** Perform the software installation above *BEFORE* connecting the *MLI* cable into the *PC*.

### 4.1.2 Hardware Installation

- 1 Connect the *MLI* cable into an available USB port of the *PC*
- 2 Verify that the *PC* properly detects the cable and loads the driver. In case of doubt see the *Troubleshooting* section.

### 4.1.3 Initial Test and Configuration

- 1 If this is not already the case, insert a fresh CR2450 battery in the battery compartment. Be careful about battery polarity. See the *Battery Change* subsection in the *Maintenance* section for detailed instructions.
- 2 Upon battery insertion the LED starts blinking at a rate of once every two seconds. If this is not the case remove the battery, perform the reset procedure (see below) and insert the battery again.
- 3 Connect the *MLI* cable into an available USB port of the *PC*.
- 4 Connect the other end of the *MLI* cable into the *Vibration Sentry*.
- 5 Go into *Start\All Programs\Vibration\_Sentry* and run *Vibration\_Sentry\_Manager.exe*. The front-panel described in figure 5 appears, and the application tries to connect to the instrument. If it fails to find the instrument it indicates *No Device Found* and closes. If this is the case see the *Troubleshooting* section. Otherwise the application switches-on the *Vibration Sentry* and starts communicating with it.
- 6 If the Time and Date in the upper right corner of the application window are not properly adjusted the application asks if you want the time to be synchronized with the *PC* time. Only say yes if you know that the *PC* time is correct.

- 7 Upon stopping the application there is a choice of keeping the *Vibration Sentry* ON or switching it OFF. Switching it OFF preserves battery life, but prevents any off-line measurement. The *Vibration Sentry* is automatically forced ON every time it connects to the *Vibration\_Sentry\_Manager* application.

## 5 Instrument Functions and Description

The instrument measures and optionally records:

- Maximum Vibration Level, X, Y and Z axes
- Minimum Vibration Level, X, Y and Z axes
- Average Vibration Level (Equivalent Level), X, Y and Z axes
- Time

The instrument connects to a PC via its *MLI* adapter cable. The *Vibration\_Sentry\_Manager* application is used to set its operating parameters and download recordings.

*Note: Only use the MLI cable provided with the Vibration Sentry.*



Figure 1: *Vibration Sentry* front

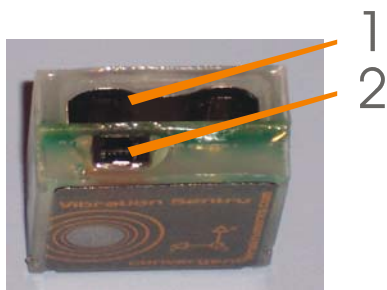


Figure 2: *Vibration Sentry* MLI cable socket and battery compartment

1. Battery compartment
2. *MLI* cable connector



Figure 3: MLI adapter cable

## 6 Principles of Operation

The *Vibration Sentry* starts working as soon as the battery is installed. Upon battery insertion the LED starts blinking at a rate of once every two seconds. The *Vibration Sentry* starts measuring current, minimum, and maximum vibration levels. However it does not record until configured to do so by the *Vibration\_Sentry\_Manager* application. Also its date and time are initially adjusted to December 1903.

The setup of the *Vibration Sentry* is done via the *Vibration\_Sentry\_Manager* application. The application performs clock and vibration alarm setup and optionally configures the *Vibration Sentry* for recording.

The *Vibration Sentry* can operate and record vibration statistics for months on a small coin lithium battery. For instance with its reading frequency set to 1s and the recording interval set to 1H, the *Vibration Sentry* can record the vibration-level maxima for 1 year.

### 6.1 Power-On / Power-Off Behaviour

When the battery is first installed into the instrument, or when the *Vibration\_Sentry\_Manager* application is started and takes control of the *Vibration Sentry* it is switched ON. When the *Vibration\_Sentry\_Manager* application is stopped the user has a choice to switch the *Vibration Sentry* OFF, or leave it ON. If a recording has been started there is no choice, the *Vibration Sentry* is kept ON when the application stops.

When the instrument is ON, even if it is not recording, it continues measuring maximum and minimum vibration levels. These extrema can be accessed the next time the instrument is connected to the *Vibration\_Sentry\_Manager* application. The alarm function is also active when the instrument is ON.

### 6.2 Shock/Vibration Sensor and Signal Processing

#### 6.2.1 Principle of Measurement

The 3-axis MEMS accelerometer inside the *Vibration Sentry* accurately measures static and dynamic acceleration levels.

To save energy the acceleration signals are measured in 6ms bursts with an adjustable reading interval. With longer intervals the measurements are sparser, but the battery life is longer. The average measurement interval is adjusted using the *ECO* selector.

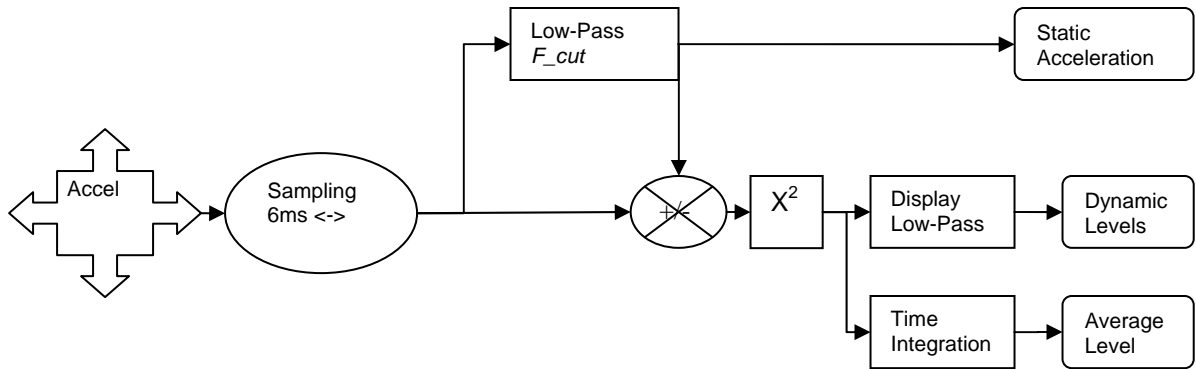


Figure 4: Signal flow-chart

The raw sampled acceleration signals are separated into a static (low-pass) and dynamic (high-pass) components. The dynamic component is squared and the resulting energy is processed into a vibration level. A display low-pass filter with a time constant that is automatically adjusted provides the dynamic levels used for current, maximum and minimum level measurements. A time integration provides the average or equivalent level (*LEQ*), integrated over a predefined time interval.

The average reading frequency, static/dynamic cut-off  $F_{Cut}$  and display time constant are all dependant on the *ECO* setting.

- A higher *ECO* provides a higher number of readings per second and also a higher cut-off frequency and shorter level time constant. This setting is better to monitor rapidly varying levels and shocks. However it is more demanding on the battery.
- A lower *ECO* increases battery life, at the expense of fewer readings per second, a lower cut-off frequency and a longer level time constant. These settings are only adequate if the rate of variation of the measured levels is slow compared to the time constant (stationary signals), or if only the average level is of interest.

*Note: The average vibration level measurement is always correct and unbiased, even when a lower ECO setting is chosen. Choosing a lower ECO setting only diminishes the instrument's ability to respond to rapidly changing vibration levels.*

*Note: In Shock mode the reading frequency is set to the maximum 105 readings per second, the  $F_{Cut}$  frequency is set to 10Hz and the display low-pass filter is disabled. This insures that transient levels are not missed.*

### 6.2.2 Sensor Bandwidth

The raw sensor bandwidth extends from DC to 1 kHz. Vibration levels are always measured within this bandwidth, irrespective of the *ECO* setting.

### 6.2.3 Sensor Dynamic Range

The full 50 dB dynamic range is covered in a single range.

### 6.3 Calibration

The calibration uses the earth's gravity as a 1g reference signal. The calibration procedure is completely automated and can be performed at any time. It requires the user to set the instrument in a stable position with its X, Y and Z axes aligned vertically while the instrument takes the reference measurements.

### 6.4 Recording

When the *Vibration Sentry* is recording it integrates measurements over the specified *Log Interval*. At the end of each interval the selected measurements are written into solid-state memory. The vibration statistics are then cleared and the next log interval is started.

The values that can be recorded are:

- Max Vibration Level (X, Y and Z-axis)
- Min Vibration Level (X, Y and Z-axis)
- Average Vibration Level (*LEQ*) (X, Y and Z-axis)

For instance if the *Log Interval* is set to 10 min, and the Max and Average Vibration Levels are selected for the X and Y axes, then each point in the log indicates the Max and Average Vibration Levels measured over the preceding 10 min.

The *Log Interval* is adjustable in 1 second increments, from 1s to 12H.

The *Vibration Sentry* has a total combined recording depth of 24 000 points. For instance it can record 24 000 average X-axis levels or 8000 combined min, max and average X-axis levels.

Each time the recording is stopped using the *Vibration Sentry Manager* application a new log is created. Each log extends from the time the recording is started to the time it is stopped. Logs are stored sequentially in the recording memory. Each log can include different measurements, and be setup for a different interval. For instance a first log can be created, containing max X and Y vibration level every second for 10 minutes. Then a second log can be created, containing min, max and average X-Y-Z vibration levels every hour for 3 months. The *Vibration Sentry Manager* application provides access to all the logs in memory.

When the recording reaches the end of the memory, the recording is automatically stopped.

The memory is non-volatile. In case of battery failure, the data recorded up to the battery loss is preserved.

### 6.5 LED indicator and Alarms

The LED indicator can be used for two functions:

- Power Indicator: The LED flashes once every two seconds to indicate that the *Vibration Sentry* is ON.
- Alarm: The LED flashes twice every two seconds to indicate that the *Vibration Sentry* has measured a vibration level out of the set limits. The high and a low vibration level limits can be set by the *Vibration Sentry Manager* application.

In addition the LED indicator can be kept always OFF even while the *Vibration Sentry* is ON, to increase battery life.

## 6.6 Battery Life

The battery life depends mainly on the *ECO* setting and on the LED function. When the *Vibration Sentry* is OFF its only function is to keep track of the time. In this state the battery can last for more than 5 Years. The operation of the LED indicator has a large impact on the battery life. This is especially true at low *ECO* settings. The *Vibration\_Sentry\_Manager* application indicates battery life as a function of the settings.

## 7 Vibration\_Sentry\_Manager Application

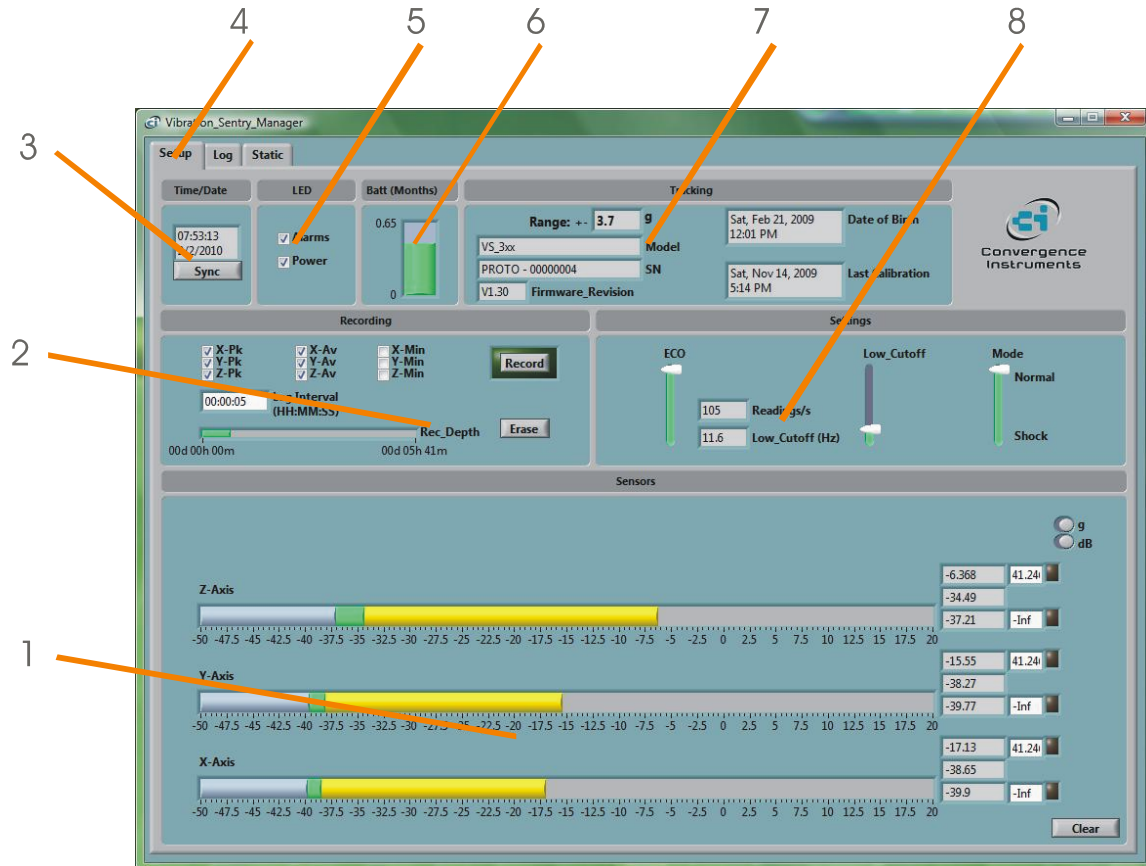


Figure 5: Vibration\_Sentry\_Manager Setup tab

1. Vibration Level Measurements and Alarm Field
2. Recording Setup Field
3. Date/Time Field
4. Tab Selector
5. LED Setup and Alarms Field
6. Battery Condition and Lifetime Field
7. Instrument Tracking Information
8. Measurement Setup Field

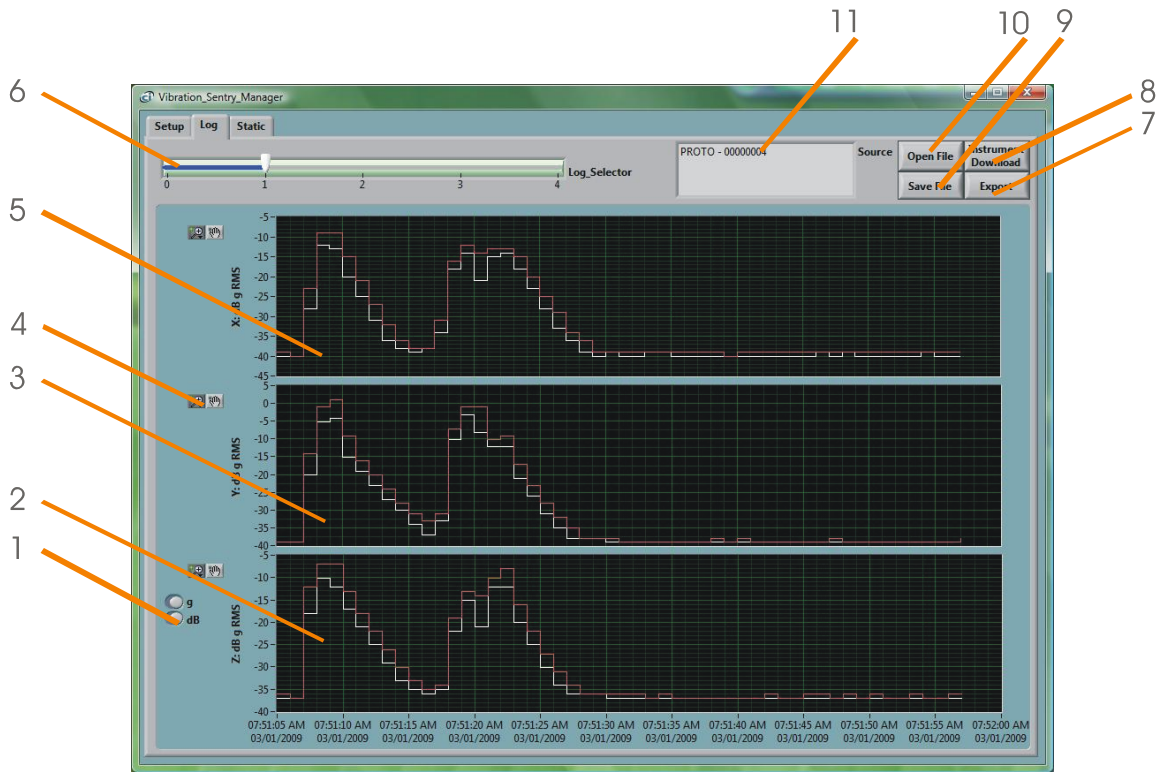


Figure 6: Vibration Sentry Manager Log tab

1. Scale Buttons
2. Z-Axis Level Graph
3. Y-Axis Level Graph
4. Pan and zoom buttons
5. X-Axis Level Graph
6. Log number selector
7. Export button
8. Instrument Download button
9. File Save button
10. File Open button
11. Data Source

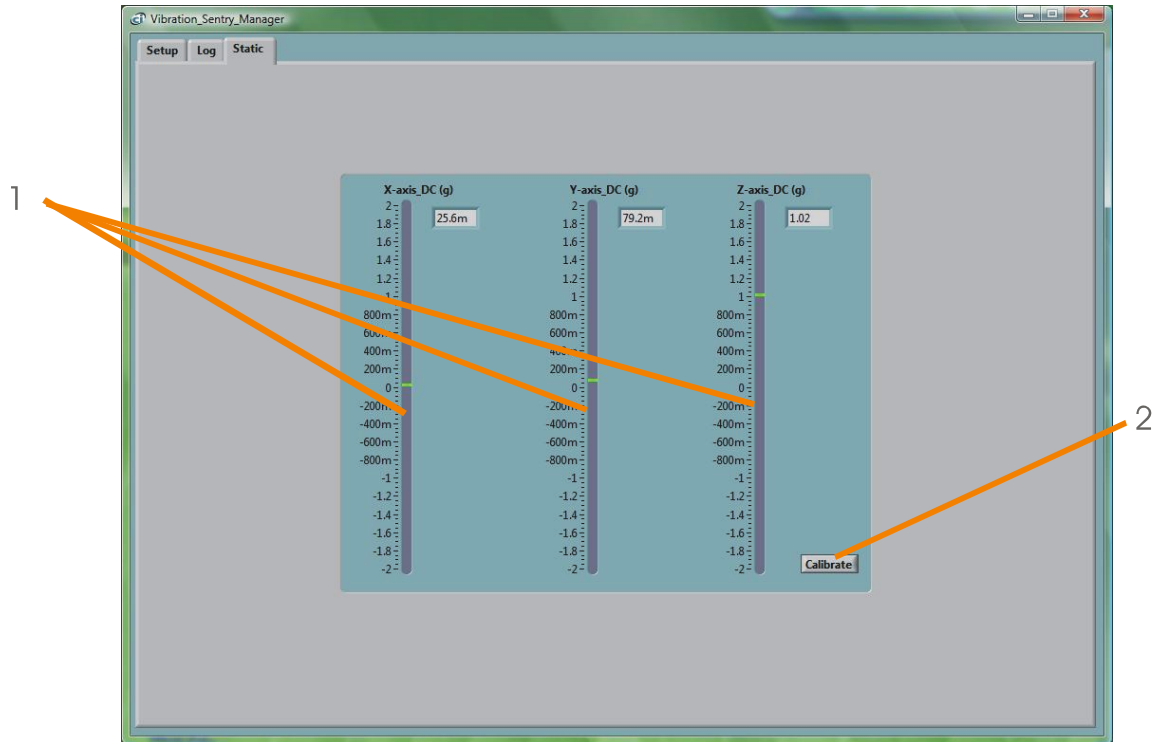


Figure 7: Vibration Sentry Manager Static tab

1. Static Acceleration Along the X, Y and Z axis
2. Calibration Button

### 7.1 Starting the Application

The application can be run with or without a *Vibration Sentry* connected. When a *Vibration Sentry* is not connected the application can only be used to display and analyze a previously saved log file. All the controls and indicators related to the instrument are grayed out.

To use the application to control a *Vibration Sentry* do the following:

1. Connect the *MLI* cable into an available USB connector on the PC
2. Connect the other end of the *MLI* cable into the *Vibration Sentry*. The *MLI* socket is polarized, if it does not insert easily, turn the connector over.
3. Go into *Start\All Programs\Vibration Sentry*, and run *Vibration Sentry Manager.exe*.
4. The front-panel described in figure 5 appears, and the application tries to connect to the instrument. If it fails to find the instrument it indicates *No Device Found* and closes. If this is the case see the *Troubleshooting* section. Otherwise the application immediately starts communicating with the *Vibration Sentry*.

### 7.2 Main Functions

The application has three main tabs:

- **The Setup Tab:** Is used to setup the instrument and read current temperature and motion measurements (see figure 5).
- **The Log Tab:** Is used to read, display and export the data from the *Vibration Sentry* (see figure 6).

- **The *Static Tab*:** Is used to read and display the static accelerations along the three axes and launch the calibration procedure (see figure 7).

### 7.3 Setup Tab

The setup tab is seen in figure 5. The setup tab is divided into seven fields.

#### 7.3.1 Time and Date Field

This field displays the internal time of the instrument. If the instrument time is not properly adjusted, press *Synchronize*. This synchronizes precisely the instrument time to the PC time. Make sure the PC time is accurate before synchronizing the instrument.

*Note: The time synchronization is not allowed while the instrument is recording. Attempting to synchronize the time while a recording is in progress will trigger an error message to that effect.*

#### 7.3.2 LED Field

This field is used to setup the LED for power display, alarm display, or both. Operation of the LED has a large impact on the instrument's power consumption, especially at low *ECO* settings. Keeping the LED OFF while the instrument is working may provide additional months of operation. This is reflected in the battery condition field.

When the LED is set to display alarms, it blinks twice every two seconds whenever a vibration level is out of the specified bounds.

When the LED is set to display the instrument power, it blinks once every two seconds whenever the instrument is ON.

#### 7.3.3 Battery Condition Field

This field indicates the remaining battery capacity, as well as the total battery life (at the upper scale marker). The total battery life changes with the *ECO* and LED settings.

#### 7.3.4 Tracking Field

The tracking field provides instrument information, such as instrument model, serial number and firmware revision.

#### 7.3.5 Recording Setup Field

Check boxes at the top of the recording setup field allow the user to select which values are to be recorded.

The *Recording Depth* bar provides two indications:

- The percentage of memory already used.
- The total memory capacity, in Days-Hours-Minutes. The total memory capacity is calculated as a function of the number of selected measurements and the log interval.

The *Log Interval* can be adjusted in Hours-Minutes-Seconds.

*Note: All these adjustments are only effective when a recording is not in progress. A recording in progress uses the parameters that have been set when the recording was started.*

To start a recording press the *Record* button. To stop a recording press the *Record* button again. A log is defined as a stretch of recording between the moment the recording is started and the moment it is stopped. Each time a recording is started a new log is created and stored in memory after the previous one. New logs can be created at any time, as long as there is some amount of recording memory available.

To erase the contents of all the recording memory and make room for new logs press the *Erase* button.

### 7.3.6 Vibration Level Measurements Field

The vibration levels measurement field provides information about the current vibration level measurements and statistics, as well as alarm settings.

- The three vibration level indicators display the current vibration level, as well as the maximum and minimum observed since the last time the *Clear* button was activated.
- The *Alarm\_High* and *Alarm\_Low* fields are used to set upper and lower limits for the vibration level alarms. The LED indicators to the right of the *Alarm\_High* and *Alarm\_Low* fields are set when the corresponding alarm is in effect.
- The *g / m/s<sup>2</sup>* selector sets the scale for all vibration indicators and controls to either g or m/s<sup>2</sup>.
- The *lin / dB* selector sets the scale for all vibration indicators and controls to either linear or dB scale.
- The *Clear* button resets the vibration level statistics.

### 7.3.7 Settings Field

The *Settings* field includes three controls:

- **ECO** This control adjusts the number of readings per second. The larger the setting the less likely it is to miss short transients. The value of the setting has a major impact on the power consumption, and is reflected on the total battery life indicated in the *Battery* indicator.
- **Low\_Cutoff** This control adjusts the low-frequency cutoff of the *Vibration Sentry*. The actual cutoff is influenced by both the *ECO* and *Low\_Cutoff* controls. The exact cutoff frequency is indicated in the *Low\_Cutoff (Hz)* indicator.
- **Mode** The *Vibration Sentry* is normally operated in *Normal* mode. The *Shock* mode automatically adjusts *ECO* to its highest value, the *Low\_Cutoff* frequency is adjusted to 10Hz and the display low-pass filter is bypassed. This insures that short transients are properly captured.

## 7.4 Log Tab

The log tab is seen in figure 6. It is used to retrieve the recorded information from the *THM Sentry* or from a saved file, and to display and export the recorded logs.

1. **Scale Buttons:** Sets the scale to either g or m/s<sup>2</sup>, and linear or dB
2. **Z-Axis Level Recording Graph:** Displays min, max and/or average Z-axis vibration levels as a function of time. If a particular measurement was not recorded the corresponding curve is absent from the graph.
3. **Y-Axis Level Recording Graph:** Displays min, max and average Y-axis vibration levels as a function of time. If a particular measurement was not recorded the corresponding curve is absent from the graph.
4. **Pan, Zoom and Cursor Buttons:** The magnifier glass has several modes for zooming in X and Y, or to go back to the full size view. The hand is used for panning in X and Y.
5. **X-Axis Level Recording Graph:** Displays min, max and average X-axis vibration levels as a function of time. If a particular measurement was not recorded the corresponding curve is absent from the graph.
6. **Log Number Selector:** Selects a particular log in memory for display. The first recorded log has index 0, the last log has index N-1. When the recording memory is initially read the index is set to the newest (last) log in memory.
7. **Export Button:** Press the button to export the record presently displayed to an Excel Tab-delimited file.
8. **Instrument Download Button:** Press the button to download all the logs from the instrument to the screen for visualization and/or exporting.

9. **File Save Button:** Press the button to save all the data downloaded from the instrument to a file for later recall and analysis. A browser window appears to select the file name and location.
10. **File Open Button:** Press the button to recall data previously saved in a log file.
11. **Data Source Indicator:** Indicates the source of the data being displayed. This is either the serial number of the instrument from which the data was downloaded, or the name of the file from which the data was read.

*Tip: Writing a new value directly to either the first or last marker of the X or Y scale rescales the graph so that this value is at the edge.*

## 7.5 Static Tab

The static tab is seen in figure 8. It displays the measured static acceleration along the three axes. Pressing the *Calibrate* button launches the calibration procedure. Once the calibration is started simply follow the on-screen indications to accurately calibrate the instrument. The calibration can be performed at any time.

In the absence of vibrations, the static acceleration values can be used to assess the calibration of the instrument: Place the instrument on a horizontal surface with one of its axis pointing straight up and verify that the corresponding acceleration is +1g, while the other two are 0 g.

## 8 Improving Communication Speed

When the *MLI* cable is initially connected to the PC, the PC detects it and provides an initial configuration. This configuration is functional, but does not yield the best communication speed.

To improve the communication speed, follow the steps below:

- Connect the *MLI* cable into the PC and wait for the PC to recognize it. The PC normally makes a sound to indicate that the cable is recognized and its driver is loaded.
- Windows Vista: Go into Control Panel>System and Maintenance>Device Manager.  
Windows XP: Go into Control Panel>Performance and Maintenance>System>Hardware>Device Manager.
- In the Device Manager open the *Ports (Com and LPT)* item. Double click on the item named *USB Serial Port*. Make sure that the manufacturer reads *FTDI*. Otherwise find another item named *USB Serial Port*.
- Select the *Port Settings* tab. In this page click the *Advanced* button.
- To the right of the *Latency Timer (ms)*, adjust the latency to the minimum 1ms.
- Click OK to all the windows to close them.

## 9 Maintenance

### 9.1 Battery Change

To change the battery, follow the procedure below:

1. Gently tap the *Vibration Sentry* in the palm of your hand to dislodge the battery. Do not hit a hard surface as this could damage the instrument.
2. Apply the reset procedure (see below).
3. Slide a new battery in, making sure you observe the proper polarity. The positive contact of the battery (outer casing of the battery) should face towards the back of *Vibration Sentry* (see figure below).

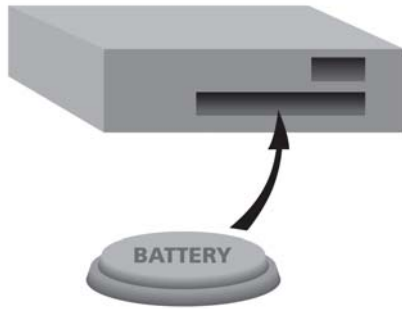


Figure 9: Battery polarity

#### 9.1.1 Reset Procedure

Insert a small coin inside the battery compartment so that it touches the metal on both sides of the compartment. Be gentle to avoid damaging either surface of the battery compartment. Be certain that the coin touches both sides of the compartment; otherwise the reset will not be effective.

#### 9.1.2 Battery Type

A CR2450 should be used to power the device at all times

#### 9.2 Operation Outdoors

Thanks to its molded construction, the *Vibration Sentry* is weather-proof. When using it outdoors with a risk of rain or snow, make sure its battery compartment and *MLI* connector are facing down, so water will not accumulate inside the battery compartment.

#### 9.3 Cleaning

Use soap and water on a damp sponge or soft cloth.

**Note:** Do not use solvents. Do not submerge in water.

#### 9.4 In Case the *Vibration Sentry* is Submerged in Water

1. Remove the battery.
2. Submerge in demineralized water, making sure any salt deposits are properly dissolved. This is especially important if the instrument has been submerged in sea water.
3. Blow-dry using a hair dryer. Make sure the instrument is thoroughly dry. Be careful not to heat-up above the maximum limit of 80 degC.
4. Apply the reset procedure (see above).
5. Install a fresh battery.

#### 9.5 Software and Firmware Upgrades

Software upgrades are found on our web site: [www.convergenceinstruments.com](http://www.convergenceinstruments.com).

After upgrading the software, if a firmware upgrade is required it will be applied automatically when the upgraded *Vibration Sentry Manager* application is started.

## 10 Troubleshooting

### 10.1 Cable Driver Installation

If the *Vibration Sentry Manager* application is unable to communicate with the *Vibration Sentry* it may be because the *MLI* cable driver failed to install properly. To check the cable driver installation follow the procedure below:

1. Disconnect the *MLI* cable.
2. Open the *Device Manager* on the PC. This is usually found in *Control Panel – System and Maintenance*.
3. Open the *Ports (COM and LPT)* item on the right.
4. Connect the *MLI* cable (Make sure you are using the *MLI* cable for the *Vibration Sentry* and not a standard USB cable).
5. Observe that the *Device Manager* window refreshes.
6. Under *Ports (COM and LPT)* verify that an item named *USB Serial Port (COMx)* has been created.
7. If not, disconnect the *Vibration Sentry* USB cable. Then Go into *Start>All Programs\Vibration\_Sentry\_Manager\Driver\_Install*, and run *CDM 2.04.06.exe*. This re-installs the cable driver. Go back to step 4.

## 10.2 Connection Problems

Failure to communicate with the PC can also be caused by poor *MLI* cable contacts. Make sure the *MLI* connector is fully inserted into the socket of the *Vibration Sentry*. Inspect the inside of the plug at the end of the cable, as well as the *MLI* socket on the instrument. If dirt or debris is lodged in the plug or socket, use a can of compressed air to expel it. If compressed air is not enough, use a clean piece of cloth dipped in alcohol. Make sure that cloth particles do not remain in the connector.

## 11 Specifications

<b>Number of axes</b>	3
<b>Acceleration Range (VS_303)</b>	+3 g
<b>Acceleration Range (VS_316)</b>	+16g
<b>Dimensions</b>	33mm x 33 mm x 15.5mm (1.3 in x 1.3 in x 0.6 in)
<b>Weight</b>	24 g (0.8 oz)
<b>Construction</b>	Weather-proof sealed construction
<b>Measurements</b>	<ul style="list-style-type: none"> <li>• Max Vibration Level (linear or dB, g or m/s<sup>2</sup>)</li> <li>• Min Vibration Level (linear or dB, g or m/s<sup>2</sup>)</li> <li>• Average Vibration Level (<i>LEQ</i>) (linear or dB, g or m/s<sup>2</sup>)</li> </ul>
<b>Alarms</b>	<ul style="list-style-type: none"> <li>• Min Vibration Level</li> <li>• Max Vibration Level</li> </ul>
<b>Calibration</b>	<ul style="list-style-type: none"> <li>• Self-Calibrated using the earth's gravity as a reference</li> </ul>
<b>Battery life</b>	<ul style="list-style-type: none"> <li>• Up to 2 Years while recording</li> </ul>
<b>Battery type</b>	<ul style="list-style-type: none"> <li>• CR2450 lithium battery</li> </ul>
<b>Operating temperature range</b>	<ul style="list-style-type: none"> <li>• -20 degC to 70 degC (-4 degF to 158 degF)</li> </ul>
<b>Storage temperature range</b>	<ul style="list-style-type: none"> <li>• -30 degC to 80 degC (-22 degF to 176 degF)</li> </ul>
<b>Noise Floor (VS_303)</b>	<ul style="list-style-type: none"> <li>• X and Y axes: -43 dB g RMS (7 mg RMS)</li> <li>• Z-axis: -40 dB g RMS (10 mg RMS)</li> </ul>
<b>Noise Floor (VS_316)</b>	<ul style="list-style-type: none"> <li>• X and Y axes: -31 dB g RMS (28 mg RMS)</li> <li>• Z-axis: -31 dB g RMS (28 mg RMS)</li> </ul>
<b>Saturation Level (VS_303)</b>	<ul style="list-style-type: none"> <li>• +10 dB g RMS (3 g RMS)</li> </ul>
<b>Saturation Level (VS_316)</b>	<ul style="list-style-type: none"> <li>• +24 dB g RMS (16 g RMS)</li> </ul>
<b>Vibration Level Resolution (VS_303)</b>	<ul style="list-style-type: none"> <li>• X and Y axes: -43 dB g RMS (7 mg RMS)</li> </ul>

<b>Vibration Level Resolution (VS_316)</b>	<ul style="list-style-type: none"> <li>• Z-axis: -40 dB g RMS (10 mg RMS)</li> <li>• While recording: 1dB (12% of reading)</li> <li>• X and Y axes: -31 dB g RMS (28 mg RMS)</li> <li>• Z-axis: -31 dB g RMS (28 mg RMS)</li> <li>• While recording: 1dB (12% of reading)</li> </ul>
<b>Calibration Precision (VS_303)</b>	<ul style="list-style-type: none"> <li>• 10mg</li> </ul>
<b>Calibration Precision (VS_316)</b>	<ul style="list-style-type: none"> <li>• 50mg</li> </ul>
<b>Acceleration Sensor Type</b>	<ul style="list-style-type: none"> <li>• MEMS 3-axes</li> </ul>
<b>Frequency Range</b>	<ul style="list-style-type: none"> <li>• X and Y axes: 1 kHz (-3dB)</li> <li>• Z-axis: 600 Hz (-3dB)</li> </ul>
<b>Linearity</b>	<ul style="list-style-type: none"> <li>• 1dB</li> </ul>
<b>Low-Frequency Cut-off</b>	<ul style="list-style-type: none"> <li>• Adjustable 1.2mHz to 100Hz</li> </ul>
<b>Reading Length</b>	<ul style="list-style-type: none"> <li>• 6ms</li> </ul>
<b>Average Measurement Frequency</b>	<ul style="list-style-type: none"> <li>• Adjustable 1 reading/s to 105 readings/s</li> </ul>
<b>Recording interval</b>	<ul style="list-style-type: none"> <li>• Adjustable 1s to 12H, with 1s resolution</li> </ul>
<b>Recording memory type</b>	<ul style="list-style-type: none"> <li>• Non-Volatile</li> </ul>
<b>Recording/erasure cycles</b>	<ul style="list-style-type: none"> <li>• More than 10 000</li> </ul>
<b>Recording memory Depth</b>	<ul style="list-style-type: none"> <li>• 24 000 individual measurement points</li> </ul>

## 11.1 Frequency Response

### 11.1.1 Medium and High Frequency Responses

The medium and high frequency responses are fixed and limited by the vibro-elastic behaviour of the sensor. The Z-axis has a lower frequency range than the X and Y axes.

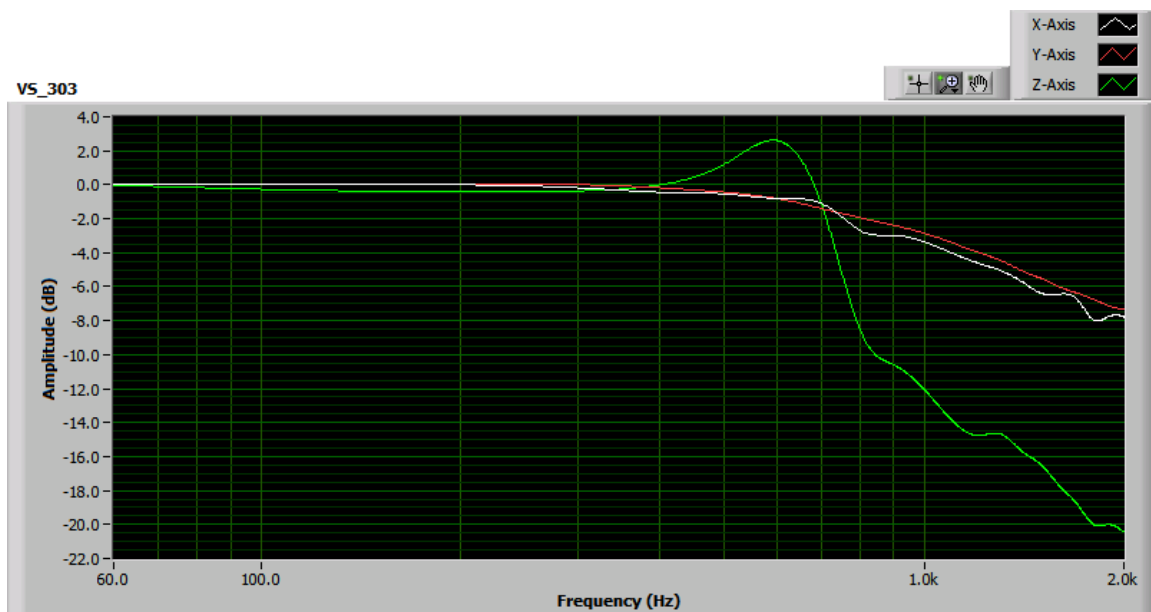


Figure 1: Typical Medium and High Frequency Responses

### 11.1.2 Low Frequency Responses

The low-frequency responses are limited by digital processing. They are adjustable as a function of the *Low-Cutoff* and *ECO* controls. The following figure shows all the possible adjustments at the fastest readings frequency (*ECO* = 7, i.e. 105 readings/s).

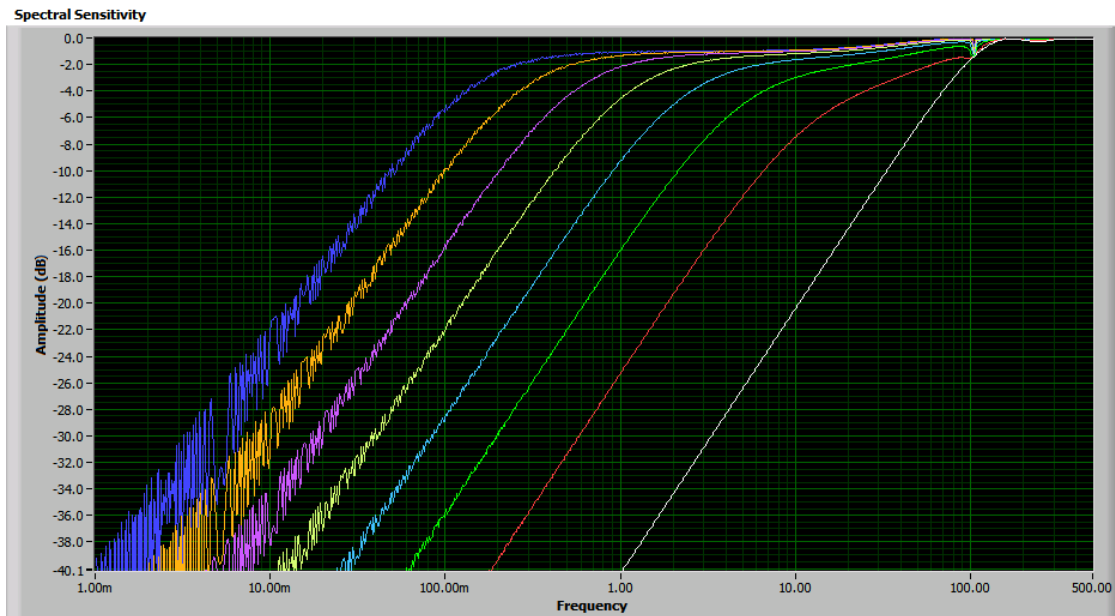


Figure 2: Low Frequency Responses

## 12 Specifications of *Vibration\_Sentry\_Manager* Software

- Windows XP and Windows Vista compatible
- Real-time display of measurements.
- Complete instrument configuration, including date/time, alarms, types of statistics recorded and recording rate.
- Collect and displays data while recording.
- Auto-scale, zoom and pan on temperature and motion graphs
- Export recorded data to Excel format.