Larson Davis

HVM200

Reference Manual

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If the equipment is used in a manner not specified by Larson Davis, the protection provided by the equipment may be impaired.

HVM200 Purchase Information

Record the serial number and date of purchase below.

Serial Number:________________________ Date of Purchase:____________________

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For warranty information, refer to our *Terms and Conditions of Sale* on our website, www.larsondavis.com/TermsConditions.aspx.

i.1 Contact Larson Davis

Website

www.larsondavis.com

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i.2 Using A Digital Reference Manual

Larson Davis is committed to the green practices of limited paper waste. In this effort, we only offer reference manuals in a digital PDF format. Digital notes and comments can be made in certain readers, and you are encouraged to print any procedures or sections for quick references that fit your needs. Each page is drafted on A4 size, and can be easily scaled to fit most printers. When printing, set the scale to “Fit to Printable Area”.

FIGURE I-1 PDF View on Adobe Acrobat Pro

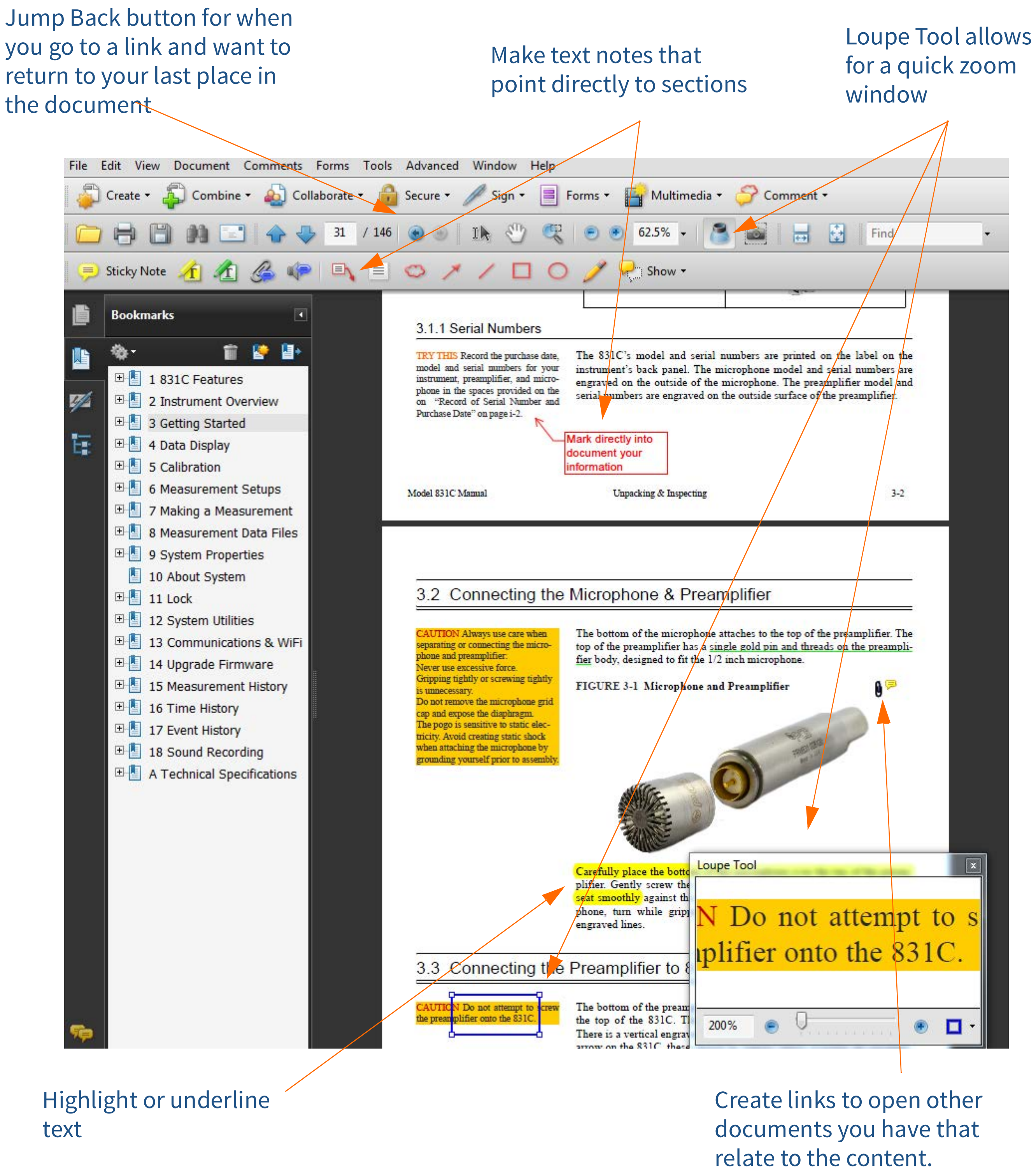


Table of Contents

Module 1 Introduction

1.1 Features

The Larson Davis HVM200 Human Vibration Meter is designed for use in assessing vibration as perceived by human beings.

The HVM200 provides the following features for vibration measurement:

- Whole body, hand-arm, and general vibration applications
- Wireless mobile interface
- Compact design for easy wear and convenient placement
- Mobile application for configuring, measuring, and viewing vibration data on multiple meters
- Connection and control of multiple meters through WiFi access
- Support for optional 1/1 and 1/3 Octave Band Analysis
- Data analysis and visualization using optional G4 LD Utility software

1.2 Standard Contents

TRY THIS Record the meter serial number and date of purchase in a safe place where it can be retrieved in case you require customer support.

The HVM200 package includes the following contents:

- HVM200 Human Vibration Meter and certificate
- BAT018 Rechargeable Lithium Battery
- PSA035 Power Supply and Adapters
- CBL218 USB Type A to micro-B USB Cable
- CBL217-01 Accelerometer Cable (1/4-28 4-pin connection)
- Larson Davis USB drive with G4 LD Utility Software and manual
- Removable 8 GB SD Memory (in meter)
- Optional license document for HVM support in G4 LD Utility, if purchased

1.2.1 Optional Kits

Larson Davis also provides the following HVM200 kits:

- HVM200-HA-41F: Standard contents with CCS047 Hard Shell Case, CCS048-L Hand/Arm Vibration Arm Band, SEN041F accelerometer, ADP081A Hand Adapter, and SWW-G4-HVM software license
- HVM200-WB: Standard contents with CCS047 Hard Shell Case, SEN027 Whole Body Vibration Seat Adapter, and SWW-G4-HVM software license
- HVM200-ALL-41F: Standard Contents with CCS047 Hard Shell Case, CCS048-L Hand/Arm Vibration Arm Band, SEN041F accelerometer, ADP081A Hand Adapter, and SWW-G4-HVM software license

1.2.2 Optional Accessories

Optional CCS047 Hard Shell Case

SWW-G4-HVM
License to enable HVM100 and HVM200 support in G4 LD Utility

HVM200-OB3
1/1 and 1/3 Octave Band Analysis firmware

HVM200-RAW
Feature to record sampled raw data files

SWW-G4-SDK
G4 software development kit

CCS047
Hard Shell Case for transport and protection of HVM200 and accessories

CCS048-L (large) and CCS048-S (small)
Arm Band for wearing the HVM200

Accelerometer Options (A, B, C, and D):

A. SEN026
Accelerometer for ADP063 palm adapter.

B. SEN040F & SEN041F
Accelerometers for Hand-Arm vibration measurement

C. SEN020
Accelerometer for Hand-Arm and general vibration measurements

D. SEN027
Seat Adapter, accelerometer, and adapter for whole-body vibration measurements

LEARN MORE For more information on HVM200 accessories, including sensors, "Adapter Resonance & Frequency Response" on page B-1.

ADP063, ADP080A, ADP081A, and ADP082A
Adapters for accelerometer placement

CBL217-05, CBL216, and CBL217-01
Cables for connection between accelerometers and HVM200 meter

394C06
Hand-held Shaker for vibrational measurement verification

Section 2 Getting Started

This module provides instructions for setting up and configuring HVM200 meters for use with the HVM200 Control app and G4 LD Utility.

2.1 Charging the HVM200

To get an accurate reading, the HVM200 must be fully charged. When this is the case, the **Power LED** displays a solid green color. Time to fully charge is 3 to 6 hours. We recommend that you charge your meter as described here before each measurement.

Step 1. Slide and remove the back battery cover from the HVM200 meter.

FIGURE 2-1 Remove Battery Cover

Step 2. To insert the supplied battery into the HVM200, do the following:

a. Slide the battery contacts against the meter power contacts.

b. Lower the other end of the battery into the tray.

TAKE NOTE Make sure the battery contacts are fully seated against the power contacts in the meter and that the battery lies flat in the tray.

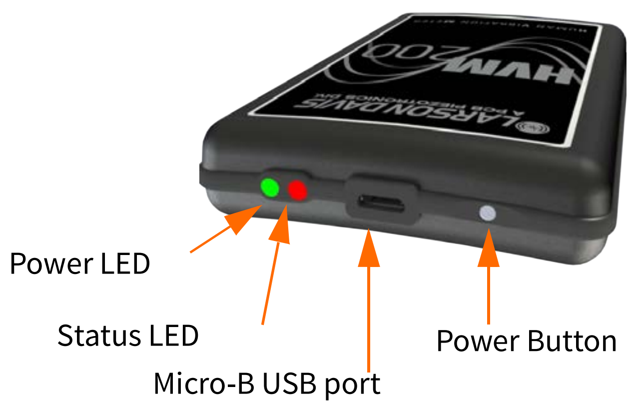
FIGURE 2-1 Insert Battery

Step 3. Slide the back battery cover onto the HVM200.

Step 4. Insert one end of the supplied USB cable into the HVM200 Micro-B USB port and the other end to the PSA035 charger.

TAKE NOTE Avoid leaving the battery drained for extended periods of time in order to maximize overall battery life. The Power LED displays a yellow color while charging.

FIGURE 2-2 HVM200 Communication



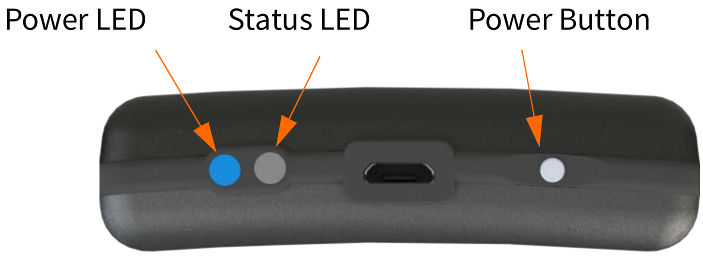
The back label of your HVM200 shows the state of each LED indicator.

For more detailed information, see "LED Indications" on page A-3.

2.2 Power Button Operation

The HVM200 has one button, which provides each of the following functions:

FIGURE 2-3 HVM200 Power Button



Turn Meter On

Press the **power** button until the Power LED shows blue.

Start Measurement

Press the **power** button once and the Status LED will show green. It may flash to indicate run pending. When the green light stops flashing and periodically winks, this means the meter is working and collecting data.

LEARN MORE For further help with the LED indicators, refer to the label on the back of the meter, or see *“LED Indications” on page A-3*.

Stop Measurement

Press the **power** button once and the Status LED will show red to indicate that the measurement has stopped. In this state the red LED will periodically blink.

Turn Meter Off

Press and hold the **power** button just until the Power LED shows blue, then release. Next, wait until both LEDs go dark, this indicates that the meter is now off.

2.3 Installing the HVM200 Control App

Use your mobile device to find and download the HVM200 Control app from the Google Play®[1] Store or the Apple App Store®[2]. To find the app, search for “HVM200”.

Table 2.1 Mobile Requirements

	Apple	Android
Space	2.5MB	2.8M
OS Version	7.0 or later	4.0 and up

2.4 Installing the G4 LD Utility

The G4 LD Utility software (G4) enhances the features, flexibility, and ease-of-use of Larson Davis instruments. It provides the following benefits:

- Measurement setup workspace
- Instrument calibration
- Computer-based control of the instrument
- Data download and manipulation
- Printing
- Data export to third-party software for post processing and analysis.

Locate the G4 installer on the Larson Davis USB drive that came with the meter, or at http://www.larsondavis.com/G4.

The install program prompts you for any required information. It creates a PCB Piezotronics item in the Program menu in your Start menu, and creates a shortcut to G4 on the Desktop.

1. The Google Play Store is a trademark of Google LLC.
2. The Apple Store is a trademark of Apple Inc., registered in the U.S. and other countries.

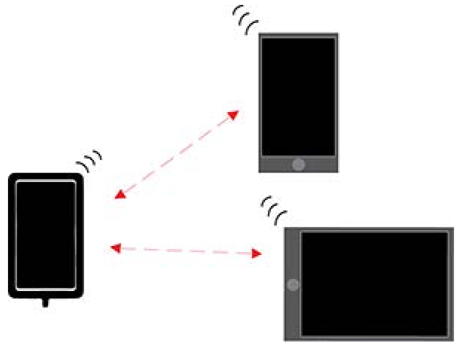
2.5 Connecting the HVM200 to a Mobile Device

With the HVM200 Control app on your mobile device, you can connect directly over WiFi.

2.5.1 Mobile Device Connection Options

One HVM200 to Multiple Mobile Devices.

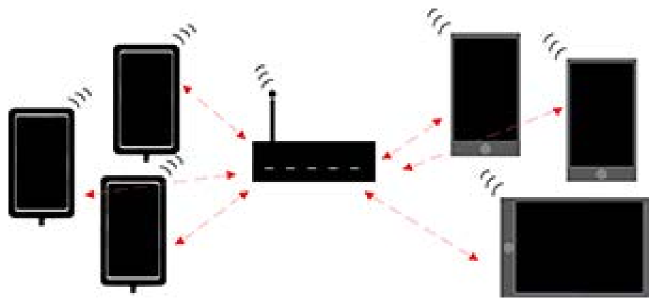
FIGURE 2-4 Mobile Connection



Use HVM200 Access Point to connect your meter to one or more mobile devices. See *2.5.2 "Connecting to a Mobile Device via Access Point."*

Multiple HVM200 to Multiple Mobile Devices

FIGURE 2-5 Mobile Connections



If a router is within range, connect the HVM200 to the same WiFi network as the mobile device(s). See *2.5.3 "Connecting HVM200 to WiFi Network."*

2.5.2 Connecting to a Mobile Device via Access Point

With the HVM200 Control app on your mobile device, you can connect directly over WiFi.

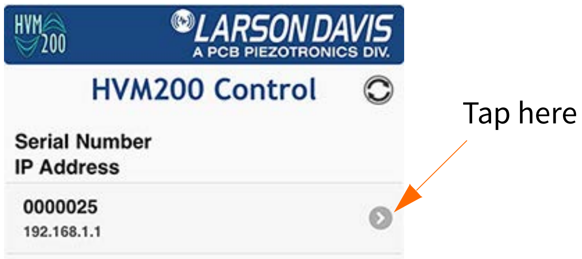
TRY THIS If there is no network showing, power off then power on the HVM200.

Step 1. Open the WiFi settings on your mobile device.

TAKE NOTE Depending on your mobile device, you may need to perform this step each time you want to connect to the HVM200.

Step 2. Connect to the HVM200 WiFi network displaying the serial number of your meter.

FIGURE 2-6 HVM200 Access Point



Step 3. Launch the HVM200 Control app to begin controlling the meter on your mobile device.

Step 4. Connect the HVM200 by selecting the meter with the serial number displayed for your meter.

2.5.3 Connecting HVM200 to WiFi Network

To establish a WiFi connection over a network with the HVM200 meter, connect both devices to the same local wireless network as shown here. The HVM200 supports WPA and WPA2 WiFi security.

Before you begin:

- We recommend connecting the HVM200 to your PC via USB while making the initial WiFi network connection, if possible.

Step 1. Launch the HVM200 Control app or the G4 Live Stream view.
Step 2. Select your meter from the list.

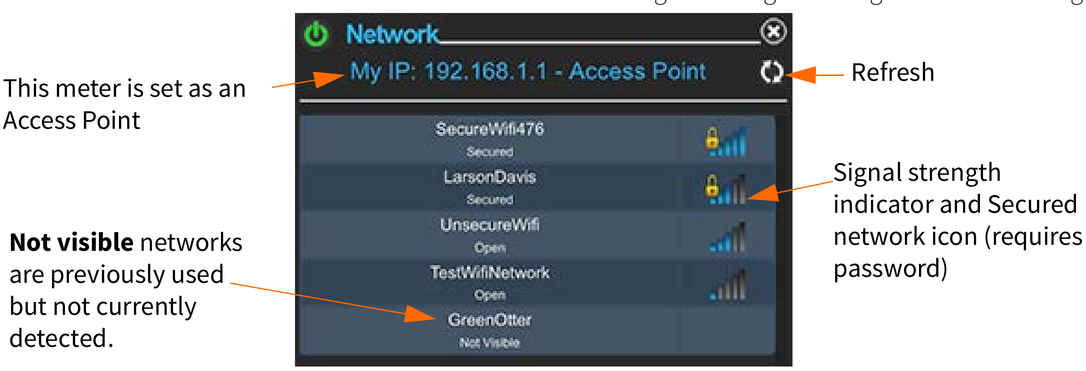
Step 3. Tap the menu icon and select **Setup WiFi** from the list.

Step 4. Select an available network.

TAKE NOTE Networks are listed in the order of greatest signal strength. If no network appears in the list, click the **Refresh** button.

To connect to a hidden network, click **Add Network** and provide network name. See Figure 2-8 "Network Connection Details."

If you have already entered a password and saved a network, the HVM200 automatically connects to the network with the greatest signal strength.Network Settings.



Step 5. Enter the network password if required and click **Add.**

FIGURE 2-7 Enter Network Password

Step 6. Verify your network connection details by clicking on the newly added network in the list.

FIGURE 2-8 Network Connection Details

Step 7. If the HVM200 and your mobile device are both on the same local network, you will see the network on the connect screen of the HVM Control App. Tap the network name to connect.

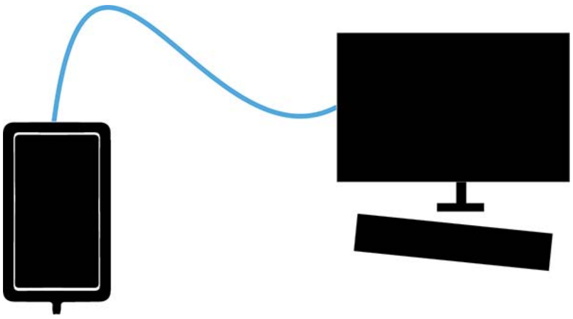
2.6 Connecting HVM200 to G4 LD Utility

G4 LD Utility (G4) for HVM software provides features for setup, measurement, data download, and data viewing. Using G4 with an HVM200 requires a license from Larson Davis.

2.6.1 G4 LD Utility Connection Options

HVM200 to PC via USB Cable

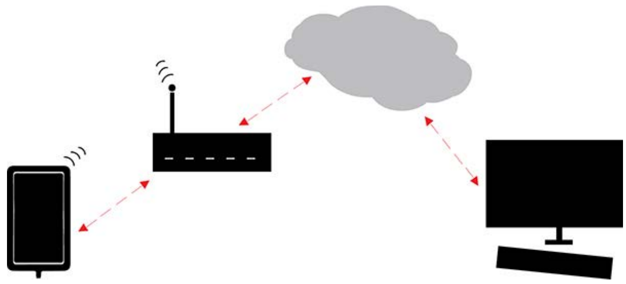
FIGURE 2-9 USB Cable Connection



Using a Micro-B USB cable, you can directly connect your PC to the meter and operate it using G4. See *2.6.2 "Connecting the HVM200 meter to G4 LD Utility via USB."*

HVM200 to PC via TCP/IP

FIGURE 2-10 TCP/IP Connection



With the meter connected to a WiFi network that has Internet access, a PC can access the meter as long as it is currently connected to the Internet and you have the IP address to enter into G4 LD Utility. You will also need to set up Port Forwarding on your gateway or router. See *2.6.3 "Connecting the HVM200 meter to G4 LD Utility via IP Address."*

2.6.2 Connecting the HVM200 meter to G4 LD Utility via USB

LEARN MORE For more information on working with G4 refer to the **G4 LD Utility Software Manual**. In G4, go to **Help > Manuals**.

Step 1. Connect the HVM200 to a PC with the provided USB to Micro-B cable (CBL218).

Step 2. Launch G4 and click 

.

Step 3. Select HVM200 as the device.

Step 4. Select connection type as USB.

Step 5. Select your meter from the list, then click **Connect**.

Step 6. Click **Live View**. The **Live View** presents the same interface as the HVM200 App for working with measurements.

2.6.3 Connecting the HVM200 meter to G4 LD Utility via IP Address

LEARN MORE For more information on working with G4, refer to the G4 LD Utility Software Manual. In G4, go to **Help > Manuals**.

Step 1. Using previous instructions, connect meter to a WiFi network with Internet access.

Step 2. Launch G4 and click 

.

Step 3. Select HVM200 as the device.

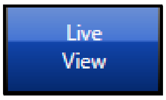
Step 4. To connect via TCP/IP, click the **Add Meter** button.

Step 5. Click inside the text field, and enter the IP address. The Connect button turns blue.

Step 6. Click **Connect**.

TAKE NOTE IP address is the only field required to add a meter, unless a password has been created.

Step 7. Click **Live View**. The **Live View** presents the same interface as the HVM200 App for working with measurements.



2.7 Connecting the Accelerometer

LEARN MORE To view accelerometer options for the HVM200 meter, see "Accelerometer Options (A, B, C, and D):" on page 1-2.

Step 1. Insert the accelerometer cable into the 4-pin connector on the HVM200 and then rotate the nut on the cable until the connection is tight.

Step 2. Insert the other end of the accelerometer cable into the 4-pin connector on the accelerometer and tighten the cable nut.

Step 3. If the HVM200 is not already turned on, press the power button once. The Power LED should turn blue.

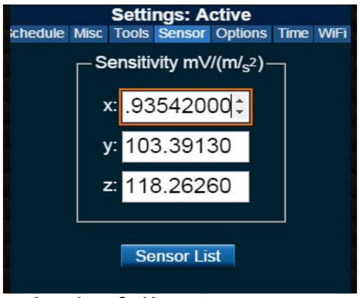
Step 4. Connect the HVM200 to G4 via USB.

LEARN MORE For more information on working with G4 tabs and settings, refer to the **G4 LD Utility Software Manual**. In G4, go to **Help > Manuals**.

Step 5. Click the **Setup Manager** tab in G4.

Step 6. Under the meter settings (displaying the meter serial number), click the **Sensor** tab, and then click **Sensor List**. This opens the Sensor List page.

FIGURE 2-11 Sensor Settings



Step 7. On the **Sensor List** page, do the following:

a. Enter the model and serial number of your accelerometer.

b. Enter the sensitivity for the x, y, and z axes.

TAKE NOTE Sensor information, including model, serial number, and sensitivity specifications are usually listed on the calibration certificate that comes with an accelerometer.

c. Click **Add**.

Step 8. Select the accelerometer when it appears in the list and click **Select**. The sensitivity values automatically appear on the Sensor tab.

Step 9. Click **Save**. For future measurements, access the Sensor List page to quickly select your configured sensors.

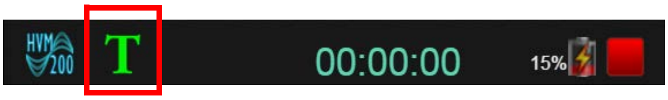
2.7.1 Transducer Electronic Data Sheet (TEDS)

If you are using an accelerometer with Transducer Electronic Data Sheet (TEDS) capabilities, the x, y, and z values for sensitivity will automatically display. Additionally, TEDS sensitivity overrides any sensitivity values you enter manually.

If TEDS is successfully found in the accelerometer, the T icon appears in the top display as shown below.

FIGURE 2-1 TEDS

Orange TEDS icon indicates that not all sensitivity values are discovered.



Green TEDS icon indicates all sensitivity values are discovered and functioning.

Section 3 Making Measurements

This module shows you how to perform a vibration measurement with the HVM200 Control app and the G4 LD Utility.

3.1 Setting Up the Measurement

In this section:

- *3.1.1 Performing a Calibration Check*
- *3.1.2 Selecting a Setup File by Using Your Mobile Device*

3.1.1 Performing a Calibration Check

Before you begin:

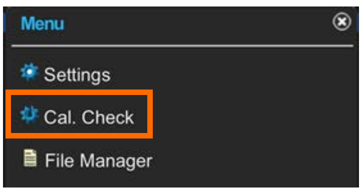
- A calibration check requires a hand-held shaker, such as the PCB Model 394C06. To view shaker options, go to http://www.pcb.com/Sensor-Calibration/Portable-Vibration.
- Set sensitivity values for the x, y, and z axes on the **Sensor** tab as shown in *2.7 Connecting the Accelerometer*.
- If needed, stop the measurement in progress.

Step 1. Launch G4 or the HVM Control app on your mobile device.

Step 2. Connect to your HVM200, then click the **Live View**. For help connecting, see *2.6 Connecting HVM200 to G4 LD Utility*.

Step 3. Click the menu icon , then select **Cal. Check** in the menu that appears.

FIGURE 3-1 **Cal. Check Option**



Step 4. Enter the **Reference** value for the shaker you will use to perform the calibration check, then click **Set**.

TAKE NOTE The reference value is usually provided in the shaker documentation.

Step 5. Attach the transducer to your shaker so that the axis you wish to check is oriented properly.

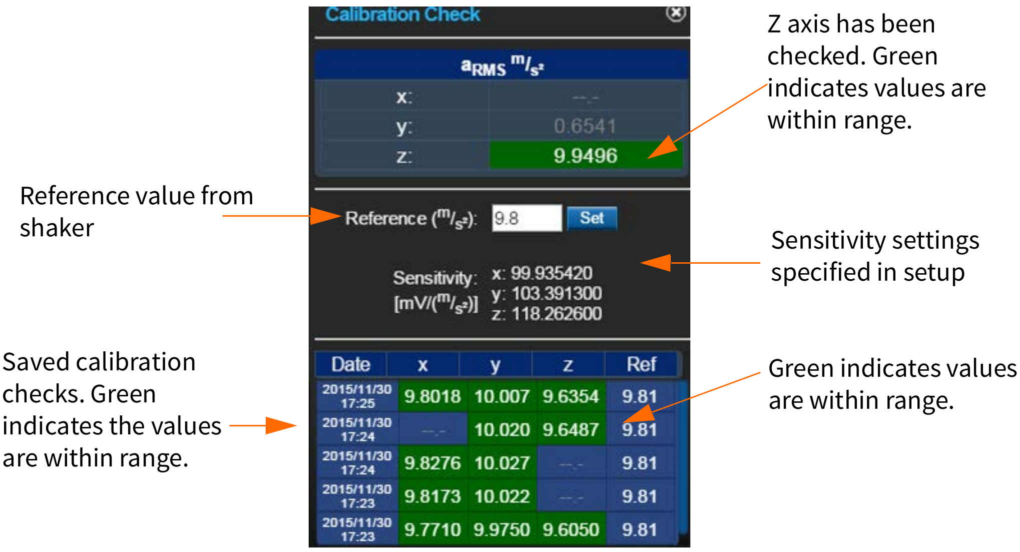
Step 6. Start the shaker and note the $\mathbf{a_{rms}}$ values for each axis as shown in *Figure 3-2 Calibration Check*, according to the following criteria:

TAKE NOTE During the calibration check, the filter is automatically set to the Fb weighting measurements and restored when the check is complete.

- Values are gray when the level has not been checked.
- Values are white when the level is being checked.
- Values are red if the axis measurement is complete and the level varies from the reference value by more than ± 5%.
- Values are green if the axis measurement is complete and the level is within ± 5% of the reference value.

Step 7. Repeat the process for each axis on the accelerometer.

FIGURE 3-2 **Calibration Check**



LEARN MORE If you are using G4 (with a license for HVM), the last 2 saved calibration checks are displayed in measurement spreadsheets. For more information, in G4 go to Help > Manuals and choose *G4 LD Utility Software Manual*.

Step 8. To save the calibration check, close the **Calibration Check** dialog box.

3.1.2 Selecting a Setup File by Using Your Mobile Device

The HVM200 includes 9 default measurement setups in the **Settings** list. You can also create your own custom setup file. This section describes this process.

In this section:

- *Creating the Setup File*

- *Setting Measurement Options*
- *Setting the Measurement Schedule*
- *Setting Misc Measurement Options*
- *Selecting Tools Settings*
- *Verifying Sensor Settings*
- *Verifying Installed Options*

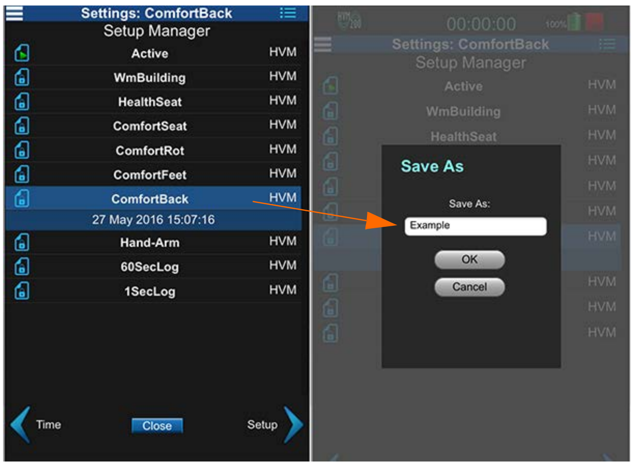
Creating the Setup File

TRY THIS The easiest way to create a new setup file is to modify an existing default setup and save it with a different name.

Step 1. Tap the menu icon on the HVM200 app, then tap **Settings**.

Step 2. Tap and hold on a default Setup File in the **Settings** list. In the pop-up that appears, tap **Save As** and enter a name for the measurement setup.

FIGURE 3-3 Naming the Setup File



TAKE NOTE If you return to the Setup Manager tab from a Settings tab, the app prompts you to save settings. Click Yes to apply the changes to the setup.

Step 3. Scroll through the Setup Manager list to locate your custom setup file. Tap the blue file icon in-line with your new setup file.

FIGURE 3-4 Select New Setup File

Setting Measurement Options

TAKE NOTE The interval time values represent the span that data is collected, averaged, and stored before starting a new sample.

Step 1. Tap the menu icon on the HVM200 app, then tap **Settings**.

Step 2. Use the arrow in the bottom right to move to the **Setup** tab.

Step 3. Specify any changes to your settings and click **Save**.

Settings Options

About Store Raw Data: The supplied HVM200 memory card stores individual file sizes up to 2 GB and more than 6 hours of data with the **Store Raw Data** option enabled. When not enabled, the card can store approximately 8000 hours of data.

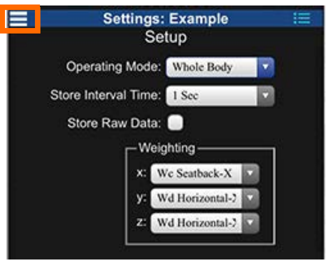
a. If you have the Store Raw Data option installed, select **Store Raw Data**. For more information about the result of storing raw data, see *3.3.1 Working with RAW Data Files*.

b. Select an Operating Mode.

TAKE NOTE The Wh weighting is automatically specified for all axes with the Hand/Arm mode. For more information on operating mode options and weighting curves, see "Specifications" on page A-1.

FIGURE 3-1 **Operation Settings**

Settings Menu
Tap to jump to any of the settings options at anytime.



Setting the Measurement Schedule

If needed, complete this section to schedule the HVM200 to automatically take a measurement.

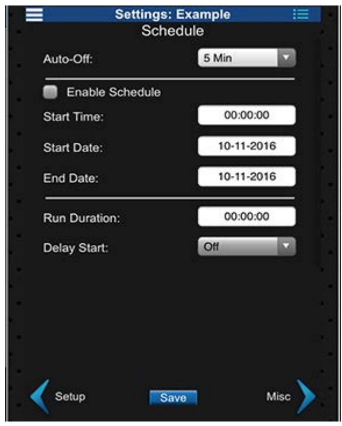
Step 1. Tap the menu icon on the HVM200 app, then tap **Settings**.

Step 1. Use the arrow in the bottom right to move to the **Schedule** tab.

Step 2. Select **Enable Schedule**.

Step 3. Enter options for any applicable settings, including **Auto-Off**, **Start Time**, **Start Date**, **End Date**, **Duration**, and **Delay Start**.

TAKE NOTE 1. If a manual measurement runs into the start time of a scheduled measurement, the scheduled measurement will not occur.
2. Auto-Off is the amount of time the HVM200 will remain on and inactive. If a measurement begins, the time to Auto-Off resets.
3. When Run Duration is set to 00:00:00, the HVM200 runs until manually stopped. If Run Duration is set to any other time, the HVM200 stops after acquiring data for the selected amount of time.



Setting Misc Measurement Options

Step 1. Tap the menu icon on the HVM200 app, then tap **Settings**.

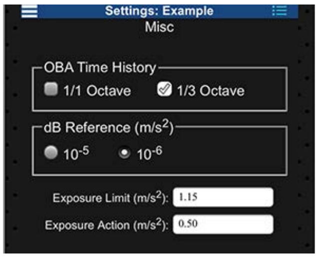
Step 2. Use the arrow in the bottom right to move to the **Misc** tab.

Step 3. If you've purchased the Octave Band Analysis feature, select **1/1 Octave** or **1/3 Octave**.

Step 4. If you want to choose dB reference units as the **Display Units**, select a **dB Reference** option.

Step 5. If desired, specify an **Exposure Limit** and **Exposure Action**.

TAKE NOTE The exposure settings show default values according to the EU Physical Agents Directive (2002/44/EC), but you can modify them here for other standards or your custom requirements.



Selecting Tools Settings

Step 1. Tap the menu icon on the HVM200 app, then tap **Settings**.

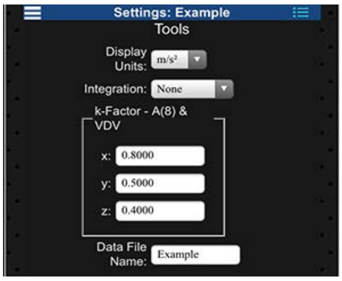
Step 2. Use the arrow in the bottom right to move to the **Tools** tab.

Step 3. To customize the **Display Units**, see *Step 4.* in the section *Setting Misc Measurement Options*.

Step 4. If desired, select a new option from the **Integration** drop-down, specify the **k-Factor** for each axis, and enter a **Data File Name**.

TAKE NOTE 1. For whole body measurements, the HVM200 multiplies the specified k-Factor by the instantaneous acceleration for each axis to produce the summation (Σ) value in the Overall view of the app. K-factors are ignored for general vibration and hand/arm measurements. For more information, see "Glossary of Terms" on page C-1.

2. Single integration calculations convert acceleration values into velocity values; double integration converts acceleration values into displacement values.



The data files for this Setup will be saved with the Data File Name as a prefix.

Verifying Sensor Settings

If you load a new setup with different sensitivity information than the Active setup, the Active sensitivity settings are overwritten with the new sensitivity information. However, if you're using an accelerometer with TEDS capability, the **Sensor** tab settings are automatically specified for the meter with the serial number shown. If your accelerometer does not have TEDS capability and you have not specified the settings, see *"Connecting the Accelerometer" on page 2-8.*

In either case, always verify the sensor settings after loading a new setup file.

Verifying Installed Options

Step 1. Tap the menu icon  on the HVM200 app, then tap **Settings**.

Step 1. Use the arrow in the bottom right to move to the **Options** tab.

Step 2. Verify that your purchased option is displayed and selected in the list. You can also deselect this feature if the a measurement does not require the optional data.

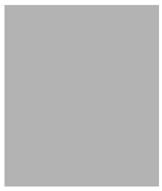
3.2 Making the Measurement

In this section:

3.2.1 Positioning to Measure Hand/Arm Vibration

For Hand/Arm vibration measurement, follow these steps:

Step 1. Attach the Larson Davis CCS048 Arm Band on the person being monitored. The end with the transparent cover should be the farthest from the hand.



Step 2. Insert the HVM200 into the arm band so that the accelerometer connector is nearest the hand.

Step 3. Connect the accelerometer to the HVM200.

TAKE NOTE For more information, see "Mounting and Installation Details" on page B-1.

Step 4. Attach the accelerometer to an appropriate adapter and place it so that hand vibration can be most accurately measured.

3.2.2 Positioning to Measure Whole Body Vibration with Seat Adapter

For whole body vibration measurements using the Larson Davis SEN027 Seat Adapter, follow these steps:

TAKE NOTE The Seat Adapter is sold with the SEN027 accelerometer already installed in the adapter and with the cable already connected to the accelerometer.

Step 1. Place the seat adapter where the person being monitored will sit.

Step 2. Connect CBL217-01 to the HVM200 on one end and the seat adapter cable on the other end.

Step 3. Set the HVM200 meter in a secure location where it won't fall.

3.2.3 Starting or Stopping the Measurement

In this section:

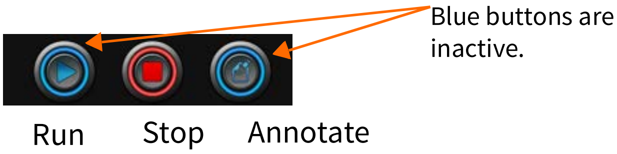
- *Starting a Measurement*
- *Stopping a Measurement*
- *Viewing Live Data*
- *Monitoring a Measurement*

Starting a Measurement

TRY THIS You can also start the measurement manually by pushing the Power button on the HVM200 for at least 1 second after the Status LED is red. For more information, see *"Power Button Operation" on page 2-2.*

Step 1. In the HVM200 Control app or G4, click or tap the Run button that appears when the meter is connected.

FIGURE 3-2 Meter is stopped

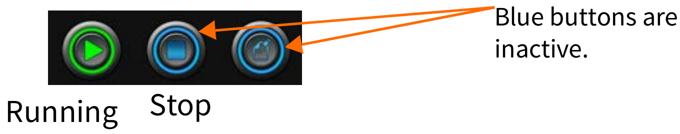


TRY THIS If you don't need to monitor the measurement, you can schedule it to begin automatically on the Schedule tab.

Stopping a Measurement

In the HVM200 Control app or G4, click the **Stop** button.

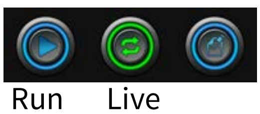
FIGURE 3-3 Meter is running a measurement



Viewing Live Data

While the meter is stopped, click the red **Stop** button. The green **Live** button appears. To return to stop, press **Live** again.

FIGURE 3-4 Viewing Live Data & Meter is stopped



Monitoring a Measurement

The HVM200 Control app provides the following data displays:

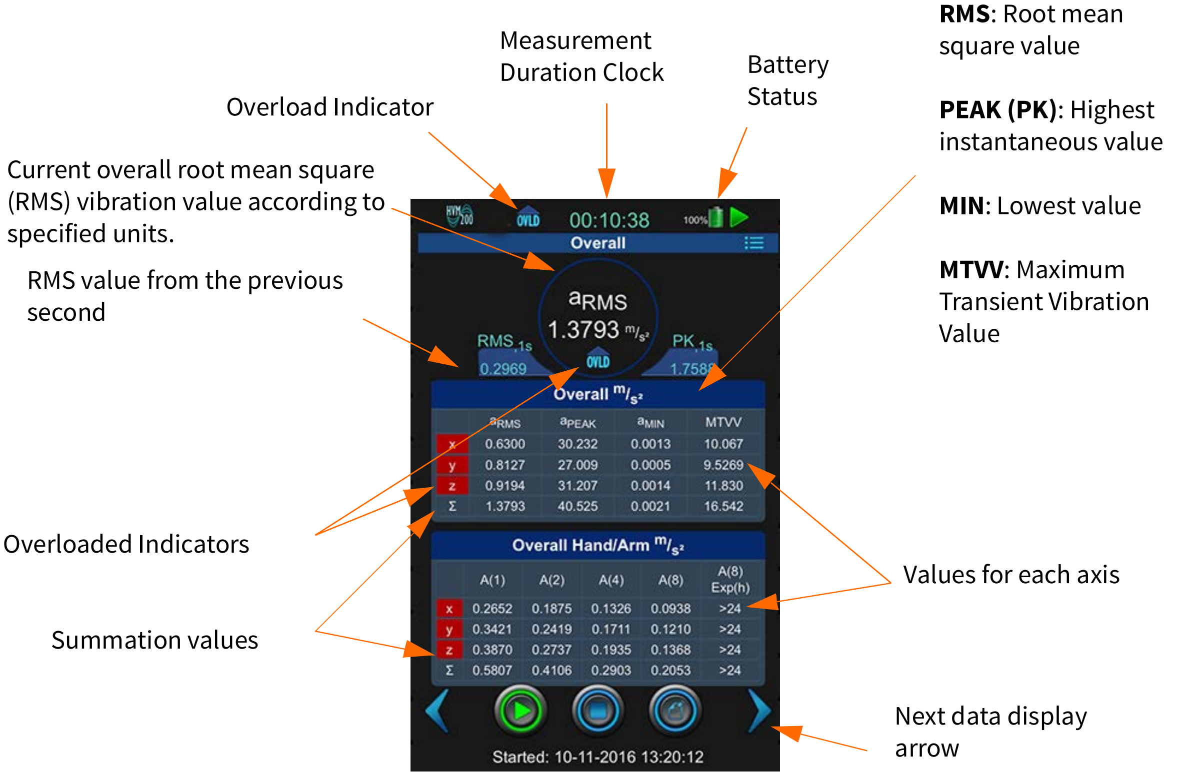
- Overall
- Summation

- X-axis
- Y-axis
- Z-axis

To advance from one data display to the next, click the **Next Arrow**. To enlarge a data display, click the **Zoom** button.

The **Overall** display shows cumulative data for all 3 axes and their summation for the measurement.

FIGURE 3-5 Overall Data Display

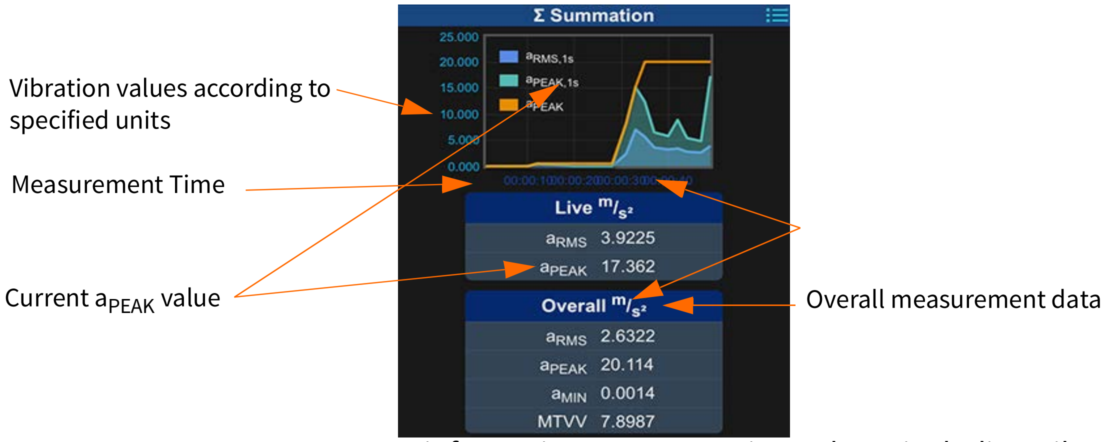


MIN and **MTVV** are the minimum and maximum whole body and hand/ arm values of the vibration signal with a 1 second exponential time weighting. **MIN** and **MAX** are the minimum and maximum general vibration values.

Σ represents the summation of vibration values taken from the X, Y, and Z axes.

The **Summation** display provides a real-time graphical representation of the current summed values from all three axes.

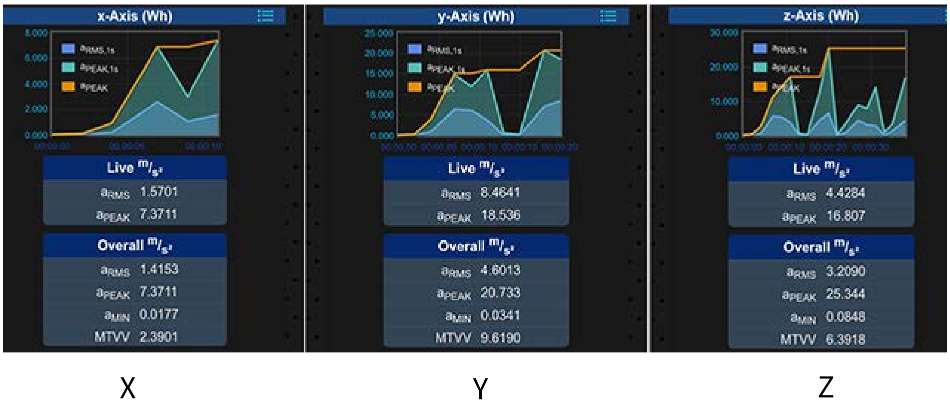
FIGURE 3-6 **Summation Data Display**



For more information on summation values, including Vibration Dose Value (VDV) and the daily vibration exposure value over 8 hours A(8), see the *"Glossary of Terms" on page C-1.*

The Axes displays provide real-time graphical and tabular representations of current and overall values for each axis.

FIGURE 3-7 **X, Y, and Z Axes Data Displays**

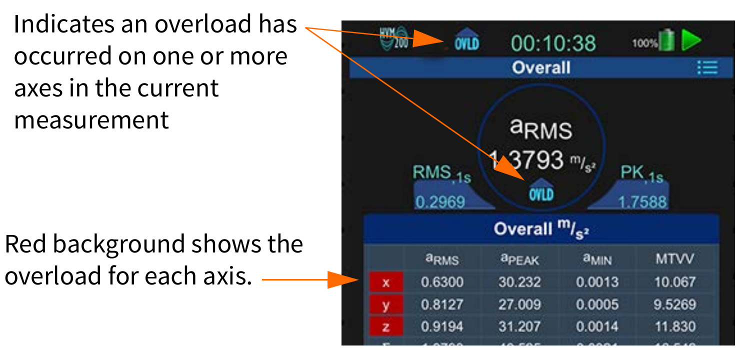


Overload Indicator

LEARN MORE For information on overload indications on the Status LED, see "Operational Characteristics" on page A-2.

An overload occurs when the signal from the accelerometer exceeds the input range of the meter.

FIGURE 3-8 **Overload Indicators**



Under-range Indicator

An under-range condition occurs when the signal from the accelerometer is below the input range to the point it cannot be measured accurately.

FIGURE 3-9 Under-range Indicators

Gray background shows the under-range condition for the Y and Z axes.

Annotating the Measurement

Click the **Annotate** button and type a note to include with the measurement (you do not need to stop the measurement to annotate).

FIGURE 3-10 Annotate Button

TAKE NOTE An annotation note may be made before the measurement is started and will be added as an overall measurement note; only one such note may be applied to the measurement, but it can be overwritten if needed.

FIGURE 3-11 Annotate Measurement

3.3 Downloading Data

Once you have clicked the **Stop** button and the measurement is completed, you can download and work with data by using any of the following methods:

TAKE NOTE Refer to the *G4 LD Utility Manual* for information on downloading and viewing data with G4. In G4, go to **Help > Manuals**.

LEARN MORE For tips on working with raw data, see "Working with RAW Data Files" on page 3-10.

- Download and view **.hvm2** files in G4. The HVM functionality in G4 requires a license.
- Download raw data files. When you set up a measurement on the Setup tab, you need to specify that you want to store raw data files. For more information, see *3.1.2 Selecting a Setup File by Using Your Mobile Device*.
- Use a third-party tool that's JSON compatible. **HVM2** files are stored in JavaScript Object Notation (JSON) format. Copy the data file from the removable SD memory card and work with it in any JSON-compatible tool.

3.3.1 Working with RAW Data Files

TAKE NOTE The RAW data is not frequency weighted, not integrated if integration is selected, and includes a DC bias. However, all of these factors can be added after the code is parsed.

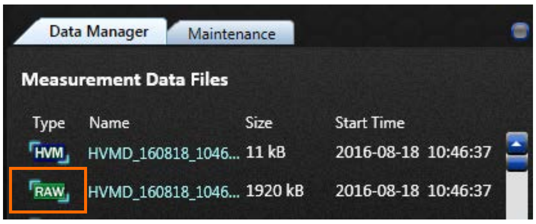
The analog converter outputs a raw data file. This is a binary file that contains raw data samples in a float format for the x, y, and z axes after sensitivity has been applied. The samples represent scaled ADC samples in m/s^2 with a DC bias. Each sample contains 12 bytes in the following format:

Byte	0	1	2	3	4	5	6	7	8	9	10	11
Definition	X Axis Sample				Y Axis Sample				Z Axis Sample			

The byte order within each float is little endian.

You can create raw data files with each measurement if you checked **Store Raw Data** in the Setup File. For more information, see *3.1.2 Selecting a Setup File by Using Your Mobile Device*. While the HVM200 is connected to G4, you can download a raw file from the Data Manager tab. This file will always be much larger than an HVM file.

FIGURE 3-12 **Raw Data File**



TAKE NOTE If using GNU Octave, the bi-linear function takes period instead of frequency as a parameter. Wherever used, replace:
`fs` with `1/fs`

In order to work with a raw file, you will need MATLAB, GNU Octave, or similar program. The following script can be used to parse the data. Consider the following items when using the script:

- You must adjust the file name to match the file name of your raw file.
- Remove the DC bias from data.
- After the file is parsed, you can adjust the weighting filters for hand/arm or whole body vibration purposes. For more information, see *3.3.2 Weighting Filters for Raw Data*.

Raw Data Script

```
%% Example Matlab / GNU Octave code for parsing HVM200 raw data format
close all; clear all; clc;
%% Number of Samples to read
Sample_Rate = 7161.45833;% Hz (Hard wired sample rate)
Sample_Time = 10; %second
num_samples_to_read = Sample_Rate*Sample_Time;

%% Open file, Read, Close
```

```
%% filename = 'HVM_SERIAL_NUMBER_BASENAME_DATESTAMP.00.raw';
filename = 'HVM_0000056_HVMD_151216_180801.00.raw';
rawsavename = 'HVM_0000056';
filteredsavename = 'HVMFilt_0000056';
FID = fopen(filename,'r');
A = fread(FID,[num_samples_to_read*3],'float');
fclose(FID);

%% Build Axis data
axis_counter = 1;
x_axis = zeros(1,floor(num_samples_to_read));
y_axis = zeros(1,floor(num_samples_to_read));
z_axis = zeros(1,floor(num_samples_to_read));
x_axis = A(1:3:end);
y_axis = A(2:3:end);
z_axis = A(3:3:end);
%% Remove DC bias from data (optional)
x_axis = x_axis - mean(x_axis);
y_axis = y_axis - mean(y_axis);
z_axis = z_axis - mean(z_axis);

%% Plot
figure(1);
plot(x_axis,'-b');
hold on;
plot(y_axis, '-r');
plot(z_axis, '-k');
hold off;
legend('x','y','z');
title('HVM200 Data');

save(rawsavename,'x_axis','y_axis','z_axis','Sample_Rate','Sample_Time')
;

%% Further processing through ISO 8041 Wk filter
x_axis_filt = isofilwk(x_axis, Sample_Rate);
y_axis_filt = isofilwk(y_axis, Sample_Rate);
z_axis_filt = isofilwk(z_axis, Sample_Rate);
figure(2);
plot(x_axis_filt,'-b');
hold on;
plot(y_axis_filt, '-r');
plot(z_axis_filt, '-k');
```

```
hold off;
title('HVM200 Data with Wk filter');
legend('x','y','z');

save(filteredsavename,'x_axis_filt','y_axis_filt','z_axis_filt','Sample_
Rate','Sample_Time');
```

3.3.2 Weighting Filters for Raw Data

The "isofilwk()" function comes from sample code taken from the ISO 8041 standard. You can modify it for other weighting filters using the desired parameters from *Table 3.1, "Parameters and transfer functions of the frequency weightings (source: ISO 8041)," on page 14-3*.

Use the following script and table to adjust the raw data file for hand arm or whole body vibrations.

```
isofilwk() Sample Code (ISO 8041 standard)
function y = isofilwk(x, fs)

% ISOFILWK
% Filter ISO 8041 Wk
%       y = isofilwk(x,fs)
%       y output signal, acceleration
%       x input signal, acceleration
%       fs sampling frequency Hz
%       bilinear transformation algorithm is used
f1 = 0.4;
f2 = 100;
f3 = 12.5;
f4 = 12.5;
Q4 = 0.63;
f5 = 2.37;
Q5 = 0.91;
f6 = 3.35;
Q6 = 0.91;

% Note that in the function "butter" the variables Q1 and Q2 are
% effectively set to equal to 1/sqrt(2), therefore they don't need
% to be explicitly set here.

w3 = 2*pi*f3;
w4 = 2*pi*f4;
w5 = 2*pi*f5;
w6 = 2*pi*f6;

nyq = fs/2; % Nyquist frequency
```

```
% determine parameters for band limiting high pass and low pass
[b1,a1] = butter (2,f1/nyq, 'high' ); % High pass
[b2,a2] = butter (2,f2/nyq); % Low pass

% determine parameters for a-v transition
B3 = [1/w3 1];
A3 = [1/w4/w4 1/Q4/w4 1];
[b3,a3] = bilinear (B3, A3, fs);

% determine parameters for upward step
B4 = [1/w5/w5 1/Q5/w5 1]*w5*w5/w6/w6;
A4 = [1/w6/w6 1/Q6/w6 1];
[b4,a4] = bilinear (B4, A4, fs);

% Apply filter to input signal vector x (output to signal vector y)
y = filter (b2, a2, x); % Apply low-pass band limiting
y = filter (b1, a1, y); % Apply high-pass band limiting
y = filter (b3, a3, y); % Apply a-v transition
y = filter (b4, a4, y); % Apply upward step

end
```

Table 3.1 Parameters and transfer functions of the frequency weightings (source: ISO 8041)

Weighting	Band-limiting				a-v-transition			Upward step				Gain
	f_1 Hz	Q_1	f_2 Hz	Q_2	f_3 Hz	f_4 Hz	Q_4	f_5 Hz	Q_5	f_6 Hz	Q_6	K
W_b	0,4	$1/\sqrt{2}$	100	$1/\sqrt{2}$	16	16	0,55	2,5	0,9	4	0,95	1,024
W_c	0,4	$1/\sqrt{2}$	100	$1/\sqrt{2}$	8	8	0,63	∞	1	∞	1	1
W_d	0,4	$1/\sqrt{2}$	100	$1/\sqrt{2}$	2	2	0,63	∞	1	∞	1	1
W_e	0,4	$1/\sqrt{2}$	100	$1/\sqrt{2}$	1	1	0,63	∞	1	∞	1	1
W_f	0,08	$1/\sqrt{2}$	0,63	$1/\sqrt{2}$	∞	0,25	0,86	0,0625	0,80	0,10	0,80	1
W_h	$10^{8/10}$	$1/\sqrt{2}$	$10^{31/10}$	$1/\sqrt{2}$	100/(2π)	100/(2π)	0,64	∞	1	∞	1	1
W_j	0,4	$1/\sqrt{2}$	100	$1/\sqrt{2}$	∞	∞	1	3,75	0,91	5,32	0,91	1
W_k	0,4	$1/\sqrt{2}$	100	$1/\sqrt{2}$	12,5	12,5	0,63	2,37	0,91	3,35	0,91	1

NOTE 1 For weighting *W*b, Table A.1 of ISO 2631-4:2001 rounds the value of parameter Q_1 to 2 decimal places. The parameter specified here is the exact value.

NOTE 2 For weighting *W*h, Table A.1 of ISO 5349-1:2001 rounds the values of parameters f_1, f_2, f_3 and f_4 to 5 significant figures and parameter Q_1 to 2 decimal places. The parameters specified here are the exact values.

Table 3.1 Parameters and transfer functions of the frequency weightings (source: ISO 8041)

Weighting	Band-limiting				a-v-transition			Upward step				Gain
	f_1 Hz	Q_1	f_2 Hz	Q_2	f_3 Hz	f_4 Hz	Q_4	f_5 Hz	Q_5	f_6 Hz	Q_6	K
W_m	$10^{-0,1}$	$1/\sqrt{2}$	100	$1/\sqrt{2}$	1/(0,028 × 2π)	1/(0,028 × 2π)	0,5	∞	1	∞	1	1

NOTE 1 For weighting *W*b, Table A.1 of ISO 2631-4:2001 rounds the value of parameter Q_1 to 2 decimal places. The parameter specified here is the exact value.

NOTE 2 For weighting *W*h, Table A.1 of ISO 5349-1:2001 rounds the values of parameters f_1, f_2, f_3 and f_4 to 5 significant figures and parameter Q_1 to 2 decimal places. The parameters specified here are the exact values.

Section 4 Changing Features

This module provides instructions for setting and disabling features, and upgrading the HVM200.

4.1 Setting/Syncing Meter Time and Date

The HVM200 has a time feature that allows the meter's internal clock to be either manually set or synced with your PC or mobile device.

4.1.1 Setting/Syncing Time via G4 LD Utility

Before you begin:

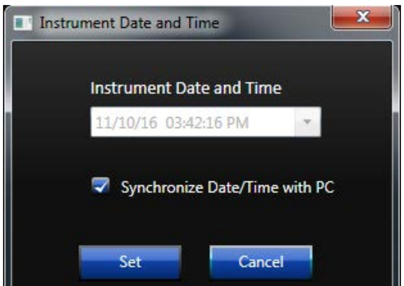
- Make sure the meter is powered on.
- Launch G4 and connect the HVM200 meter. For more information, see *2.6 Connecting HVM200 to G4 LD Utility*.
- Be sure you're in the Active setting. You're in Active setting if you can see the **Time** tab in G4.

Step 1. In G4, go to **Meter Manager ▸Maintenance**. This opens the Maintenance tab.

Step 2. Click on **Sync PC and Meter Clocks**.

Step 3. Select **Set** to use the PC clock as the new time for the meter. If you uncheck this option, you can set the date and time manually.

FIGURE 4-1 Date and Time



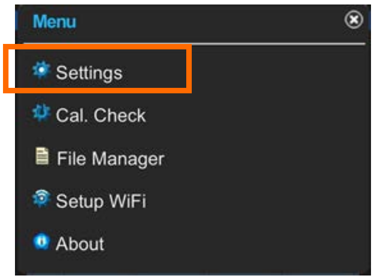
4.1.2 Setting/Syncing Time via HVM200 Control app

Before you begin:

- Power on the HVM200.
- Launch the Control app and connect the HVM200 meter to your device. For more information, see *2.5 Connecting the HVM200 to a Mobile Device*.

Step 1. In the Control app, go to **Menu** ▸**Settings**.

FIGURE 4-2 **HVM200 Menu**



Step 2. On the HVM screen, click the menu icon , and choose **Time** from the menu that appears.

FIGURE 4-3 **HVM200 Time Tab**

Step 3. Tap Sync Time to sync the time on the meter with the time on your mobile device.

Setting the Meter Time Manually
If desired, complete these steps instead of using Sync Time.

a. Tap inside the **Time** field and enter the time.

b. Tap inside the **Date** field and enter the date.

c. Click **Set Time**.

4.2 Enabling the WiFi Signal

In this section:

- *4.2.1 Turning WiFi Off*
- *4.2.2 Turning WiFi On*

4.2.1 Turning WiFi Off

This section shows how to disable the WiFi signal on the HVM200 meter. Once complete, you can only re-enable WiFi from G4 with the meter connected via USB.

Step 1. Launch the HVM200 Control app or the G4 LD Utility Live View.

Step 2. Click the menu icon , and select **Setup WiFi** from the menu that appears. This opens the Network screen.

Step 3. Click the power icon  in the top left.

Step 4. The app displays a WiFi Alert. Select **Confirm** to continue. WiFi is now disabled.

4.2.2 Turning WiFi On

To enable the WiFi signal on the HVM200, complete the following steps.

Before you begin:

- Launch G4 on your PC.
- Connect the HVM200 via USB cable to your PC. For help with this, see, *2.6.2 Connecting the HVM200 meter to G4 LD Utility via USB*. The USB connection is required for this process.

Step 1. In G4, go to the Setup WiFi screen.

Step 2. Click the red power icon  in the top left.

Step 3. G4 displays a WiFi Alert. Click **Confirm** to continue.

Step 4. Select the **Reboot** button, then click **Confirm** in the pop-up window to continue.

TAKE NOTE You can also press and hold the power button on the meter.

Step 5. G4 displays a second alert. Wait 30 seconds.

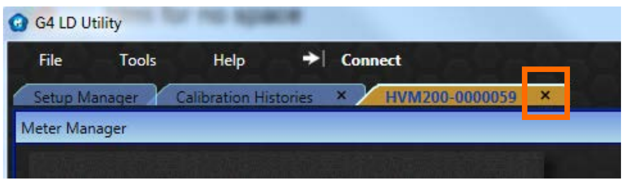
Step 6. Reconnect your meter to G4 or the Control app.

4.3 Upgrading Firmware or Options

Before you begin:

- Launch G4 on your PC.
- Power on and connect the HVM200 via USB cable to your PC. For help with this, see, *2.6.2 Connecting the HVM200 meter to G4 LD Utility via USB*. The USB connection is required for this process.
- Close any open HVM tabs by clicking the × on the tab.

FIGURE 4-1 Disconnect Meter



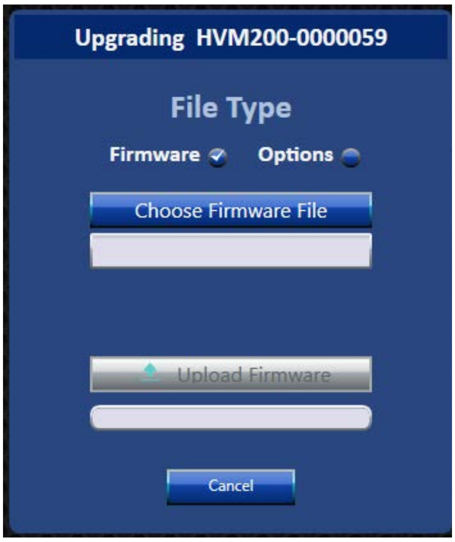
Step 1. In G4, navigate to **File ▸Upgrade Firmware or Options**.

Step 2. Select your meter from the drop-down menu, then click **Connect.**

Step 3. In the Upgrading window, select **Firmware** or **Options**.

Step 4. Press **Choose Firmware File** (or **Choose Options File)**. This opens the File Explorer.

FIGURE 4-2 Upgrade Firmware



Step 5. Open the available file.

Step 6. Click **Upload Firmware** (or **Upload Options**). G4 displays a success message. Close the window to continue.

Appendix A Specifications

Specifications are subject to change without notice.

A.1 General Characteristics

Measurement modes

- Hand-arm, Whole-body, Vibration

Table A.1 Metrics by mode:

Vibration	RMS, Peak, Min, Max (x, y, z & Σ)
Hand-arm	RMS, Peak, Min, MTVV, A(8) (x, y, z & Σ)
Whole-body	RMS, Peak, Min, MTVV, A(8) Act, A(8) Exp, EP VDV (x, y, z & Σ)

- Measurement units: m/s^2, cm/s^2, ft/s^2, in/s^2, g, dB

Time History (Logging)

- Store interval (user-selected): 1, 2, 5, 10, 20, 30 s; 1, 2, 5, 20, 30 min; 1 hr
- Stored values: RMS and Peak for x, y, and z axes and for Σ.

Run Modes

- Manual: Run/stop with app or meter button
- Timed: Start at time specified in setup
- Delayed: Start after delay specified in setup of 5, 10, 20, 30, or 60 seconds

Clock/Calendar

- 24 hour clock format: hh:mm:ss
- Run-time resolution: 1 second
- 5 minute (typical) clock retention during battery change

Time of Day Drift

Worst case: 6.91 seconds per day (-10 °C to + 50 °C).

Effects of Temperature and Humidity

- Operating temperature: 14°F to 122°F (-10 °C to 50 °C)
- The RMS level of the HVM200 varies up to ±1% when exposed to temperatures of - 10 °C to 50 °C and relative humidity (RH) 20 to 90% (non-condensing).
- Tested at 159.4 Hz and 9.81 m/s^2.

Effects of Magnetic Fields

Complete instrument RMS level varies up to ± 1.4% when exposed to an 80 A/m, 60 Hz magnetic field (worst case orientation).The complete instrument is defined as the HVM200 meter, CBL217-01, and SEN041F.

Effects of Mechanical Vibrations

Complete instrument RMS level varies up to ± 0.4% when exposed to mechanical vibrations of 30 m/s^2 at 79.58 Hz (worst-case orientation).

Stabilization Time

- 60 seconds
- Measurements with integration settings require up to one minute additional stabilization time before initiating (the Power LED may display a solid green color during this additional stabilization time).

Data Storage

- Removable micro SD memory card up to 32 GB.
- 2 GB file size limit. Files are truncated at 2 GB. No limit to number of files or setups.
- Data and settings are stored in non-volatile memory
- Swapping limitation: Device must be off while replacing Micro SD card or battery.

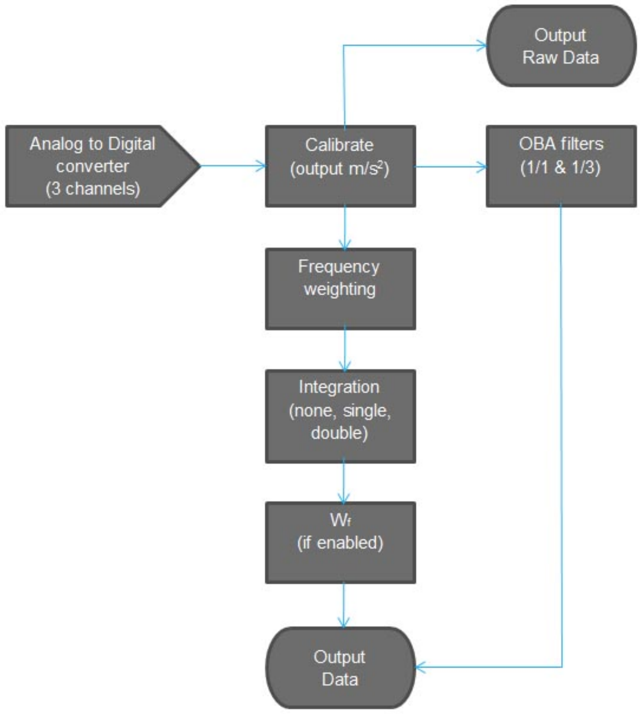
Transducer Electronic Data Sheets (TEDS) Support

- Chips supported by HVM200: DS2430 and DS2431
- Versions supported: 0.9 (only DS2430 chip) and 1.0
- Templates supported: 0 (version 0.9), 25 (version 1.0)

WiFi Connectivity

IEEE 802.11g protocol

Data Flow



A.2 Physical Characteristics

Dimensions/Weight

- Length: 4.6 inches (11.8 cm)
- Width: 2.6 inches (6.7 cm)
- Depth: 0.7 inches (1.8 cm)
- Weight: 4.6 ounces (130 grams) - including battery
- Ingress Protection Rating: IP42

Communication Interface

- USB 2.0 Hi-Speed
- WiFi 802.11 b/g/n with WPA and WPA2 security

Connections

- Micro-B USB cable (Communication and power)
- 1/4-28 4-pin 3-channel sensor connector

A.3 Operational Characteristics

HVM200 Memory

The HVM200 has two memory cards: 2 GB internal and 8 GB removable. If the memory card is removed or not working then the HVM200 will automatically switch to storing data on the internal memory. Troubleshooting removable SD card:

Step 1 Delete all the files on the internal memory (download first if needed).

Step 2 Turn off the HVM200.

Step 3 Insert the SD card.

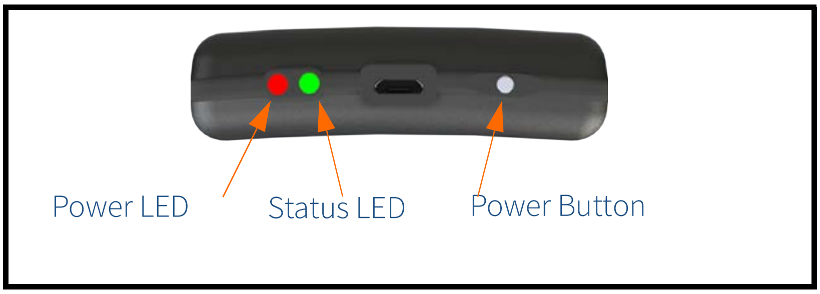
Step 4 Turn the HVM200 on.

If the problem persists, then the memory card may have a corrupt file system. The most likely cause of a corrupt file system is the card was removed while the meter was turned on. To correct this, put the card into a PC and reformat or repair the file system; put the card back into the HVM200 while it is off; restart the HVM200.

LED Indications

The following tables shows HVM200 LED indications, states, and additional information.

FIGURE A-1 LED Indications



Power LED		
Indication	**State**	**Additional Information**
	System Warning	Click the Warning Icon on the G4 LD Utility Live View. The "About This Meter" information shows if there is a sensor/cable connection error, battery connection error, or SD memory card error. To avoid system errors, do not hot swap SD memory cards. G4 Live View Warning Icon
(Blinking)	**Battery Low**	Charge the HVM200 via USB from your computer or from the PSA035 power supply. If not charged, the HVM200 will shut down when the remaining battery life approaches the threshold for safe shut down. If the HVM200 shuts down mid-measurement, the file is truncated and G4 LD Utility may not be able to display summary information for the file.
	Battery Charging	Allow the battery to charge fully to maximize overall battery life.
	Battery Charged	N/A
	Power On	Power On is displayed both on start up and shut down. When turning on the HVM200, press the power button for about one second until the blue LED is displayed. When shutting down, press the power button until the blue LED is displayed and the Status LED is dark. Power On is also displayed when the HVM200 is running on battery power (not simultaneously charging through USB connection).

Status LED		
Indication	**State**	Additional Information
	Measurement Stopped	The HVM200 is not running a measurement. The red LED will periodically blink while in this state.

Status LED		
	Measurement Running	The HVM200 is in the process of taking a measurement.
(Blinking)	**Measurement Run Pending**	The HVM200 is stabilizing for an impending measurement, which may last up to 60 seconds, or is awaiting a delayed start set from the scheduling tab.
	Overload	A signal from the accelerometer is currently exceeding the calibrated input range of the HVM200.
(Blinking)	**Overloaded**	An overload has occurred in this measurement.

Power Button Functions

Power Button Functions	
Action	**Press Power Button**
Turn on power	At least one second until Power LED is blue
Turn off power	Until Power LED is blue and Status LED is dark
Start or stop toggle for manual measurement	After turning on meter, less than three seconds
Shut down (if unresponsive)	At least 16 seconds

A.4 Electrical Characteristics

Power Consumption

- USB Power: 130 mA in station mode; 180 mA in access point mode
- Battery run time: 12 hours in station mode; 9 hours in access point mode

Power Supply

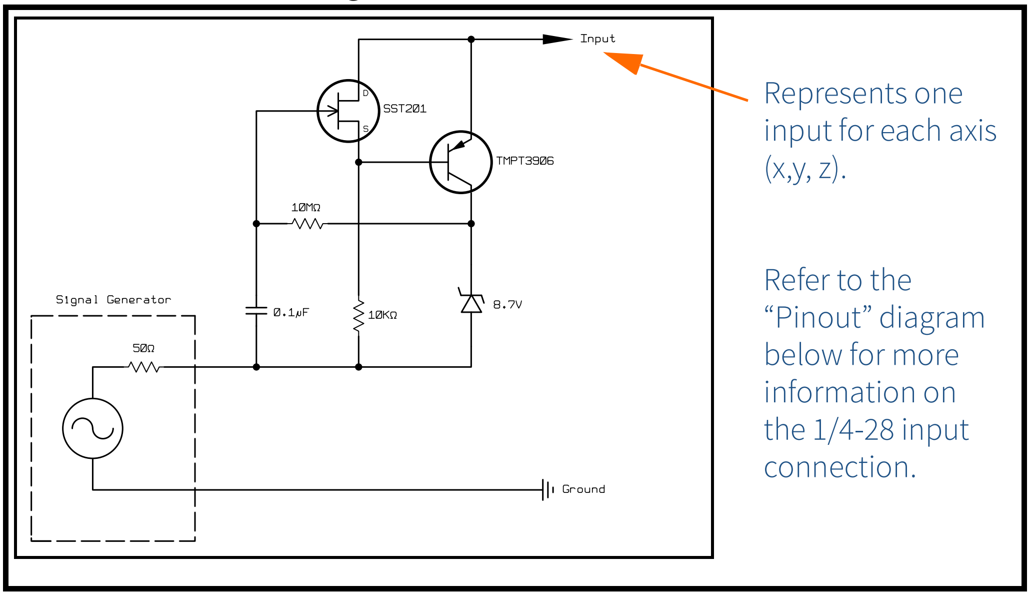
- User replaceable rechargeable lithium-ion battery
- Charge time: 3.5 hours with Larson Davis PSA035 power supply
- External Power:

USB Type A to Micro-B USB cable, 3 ft (1 m)
Larson Davis Power Supply PSA035 (universal 100-240 VAC to 5 V USB power adapter)

Electrical Testing

During electrical testing, the following circuit was used:

FIGURE A-2 Circuit for electrical testing



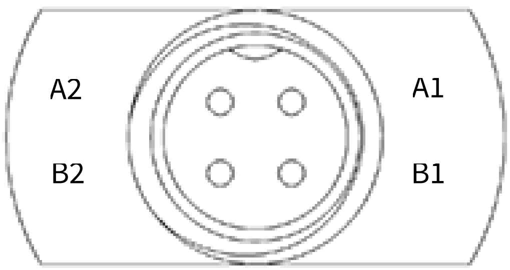
Circuit to Inject Electrical Signal into HVM200 ICP®[1] Inputs

Input

- Input type: ICP, IEPE, or CCP
- Excitation current: 2 mA
- Input connector: 1/4-28 4-pin male (the input connection is also the transducer connection)
- Measurement input voltage range: 1.8 to 16 Vdc
- Measurement AC reference bias voltage: 9 Vdc
- Absolute voltage range (min to max): 0 to 28 V
- Bandwidth: 0.4 Hz to 3000 Hz
- Range: Single range
- Sample rate: 7161.45833 Hz

1. ICP is a registered trademark of PCB Piezotronics, Inc.

FIGURE A-3 Pinout



Pin	Signal
A1	GND
A2	X Axis
B1	Y Axis
B2	Z Axis

Anti-alias Filter Performance
The anti-alias filter attenuates all frequencies above the stop band frequency at 100 dB.
Sample Rate: 7161.45833 Hz
Stop Band Frequency: 3917.318 Hz
Stop Band Rejection: 100 dB
Pass Band -3db Frequency: 3509.115
Pass Band Frequency: 3244.141

A.5 Reference Values

The following values represent the primary frequencies and amplitudes at which weighting filters are specified and tested.

Operating Mode	Frequency Weighting	Reference Frequency	Reference Amplitude
Vibration	Fa (0.4 Hz to 100 Hz) Fb (0.4 Hz to 1250 Hz) Fc (6.3 Hz to 1250 Hz)	50 rad/s (7.958 Hz) 500 rad/s (79.58 Hz) 500 rad/s (79.58 Hz)	10 m/s^2 10 m/s^2 10 m/s^2
Hand Arm	Wh	500 rad/s (79.58 Hz)	10 m/s^2
Whole Body	Wm Wb Wc Wd We Wj Wk Wf (Severity)	100 rad/s (15.915 Hz) 2.5 rad/s (0.3979 Hz)	1.0 m/s^2 1.0 m/s^2 1.0 m/s^2 1.0 m/s^2 1.0 m/s^2 1.0 m/s^2 1.0 m/s^2 0.1m/s^2

A.6 Measurement Ranges

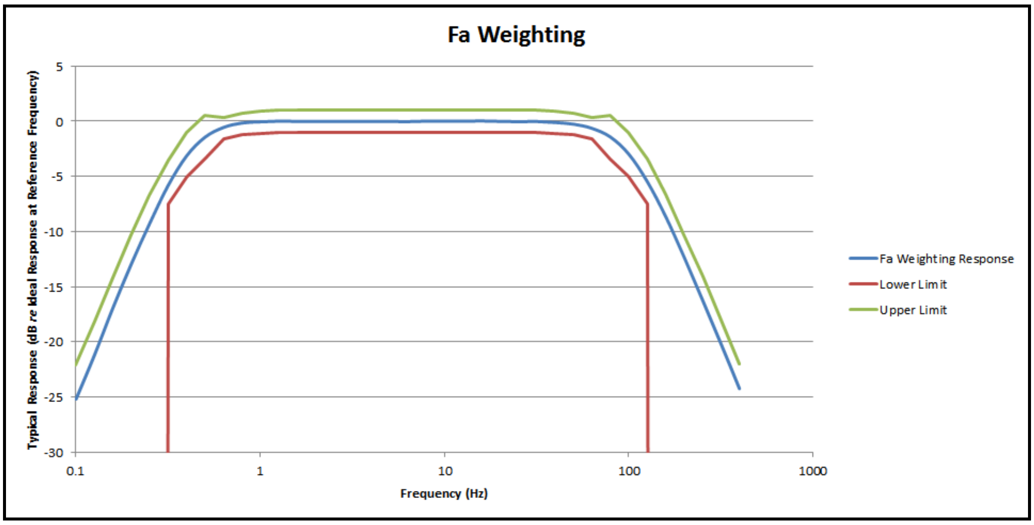
The following table shows the HVM200 dynamic and linearity ranges in root-mean square values. (Peak values are 1.414 times higher.)

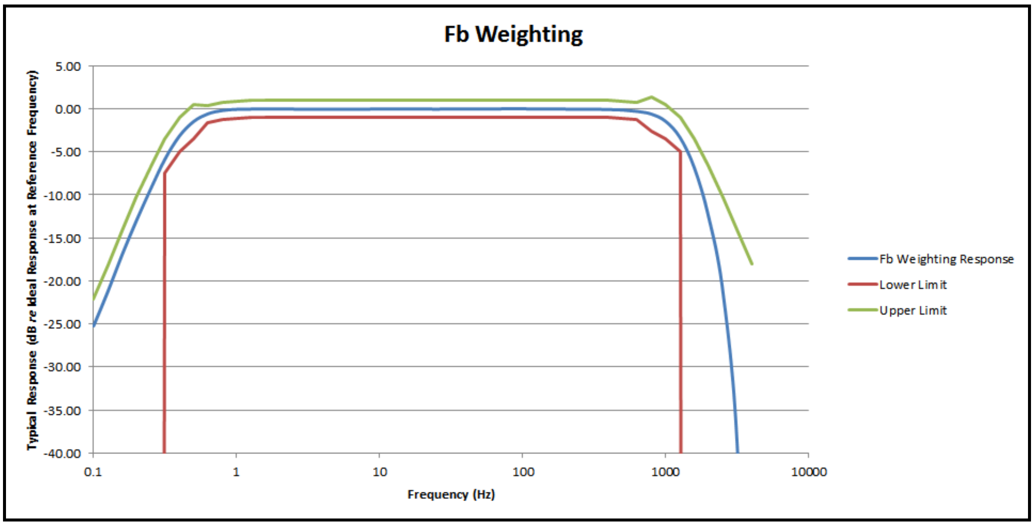
Frequency Weighting	Noise Floor (typical mV)	Lower Limit (Under-range mV)	Lower Limit Linearity Range (typical mV)	Lower Limit Linearity Range (maximum mV)	Upper Limit (Overload V)
Fa	0.028	0.204	0.092	0.178	5.01
Fb	0.046	0.232	0.133	0.176	5.01
Fc	0.041	0.205	0.116	0.152	5.01
Wb	0.016	0.167	0.073	0.137	5.01
Wc	0.021	0.184	0.089	0.150	5.01
Wd	0.014	0.181	0.072	0.175	5.01
We	0.012	0.193	0.073	0.161	5.01
Wf	0.009	0.185	0.100	0.147	5.01
Wh	0.014	0.087	0.042	0.090	5.01
Wj	0.023	0.167	0.077	0.151	5.01

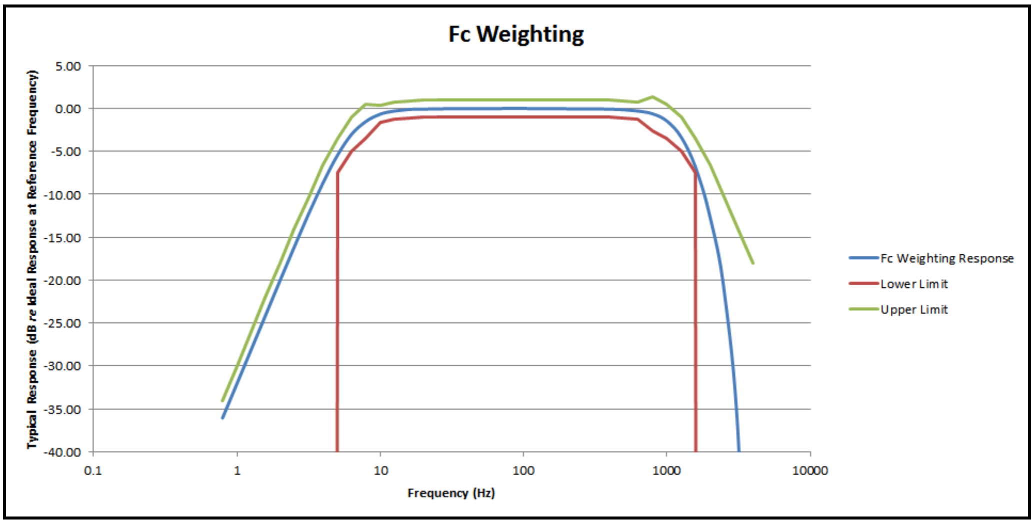
Frequency Weighting	Noise Floor (typical mV)	Lower Limit (Under-range mV)	Lower Limit Linearity Range (typical mV)	Lower Limit Linearity Range (maximum mV)	Upper Limit (Overload V)
Wk	0.018	0.144	0.073	0.121	5.01
Wm	0.017	0.103	0.060	0.077	5.01

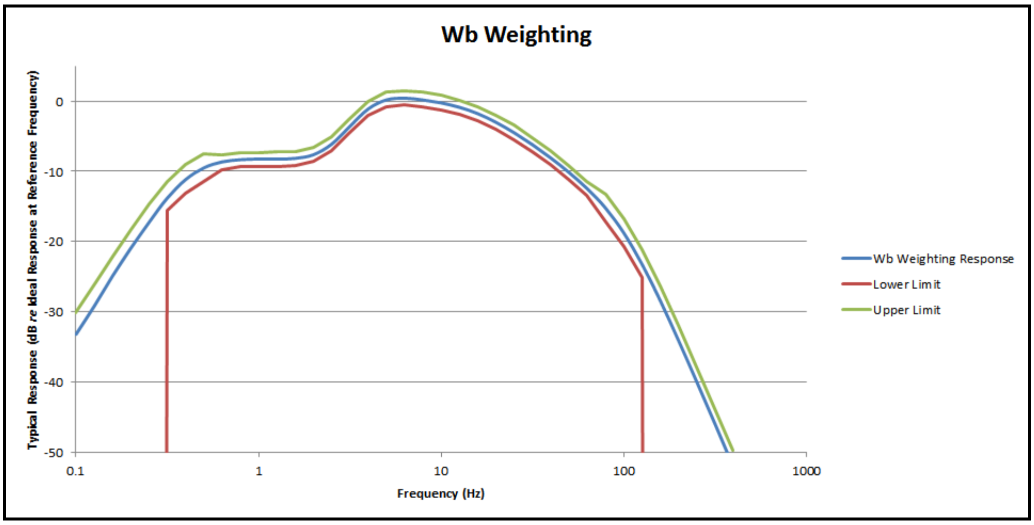
A.7 Frequency Weighting Curves

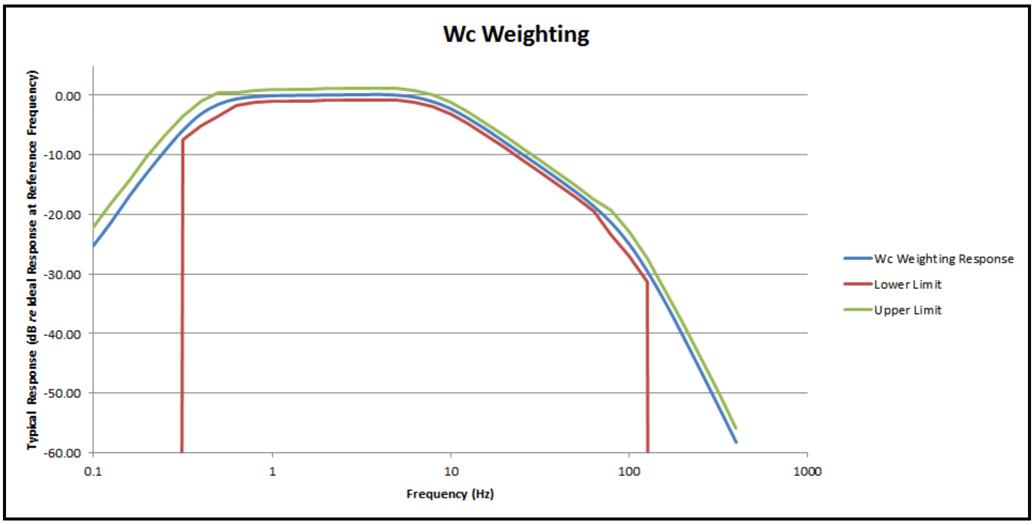
The following graphs show frequency weighting curves for the HVM200.

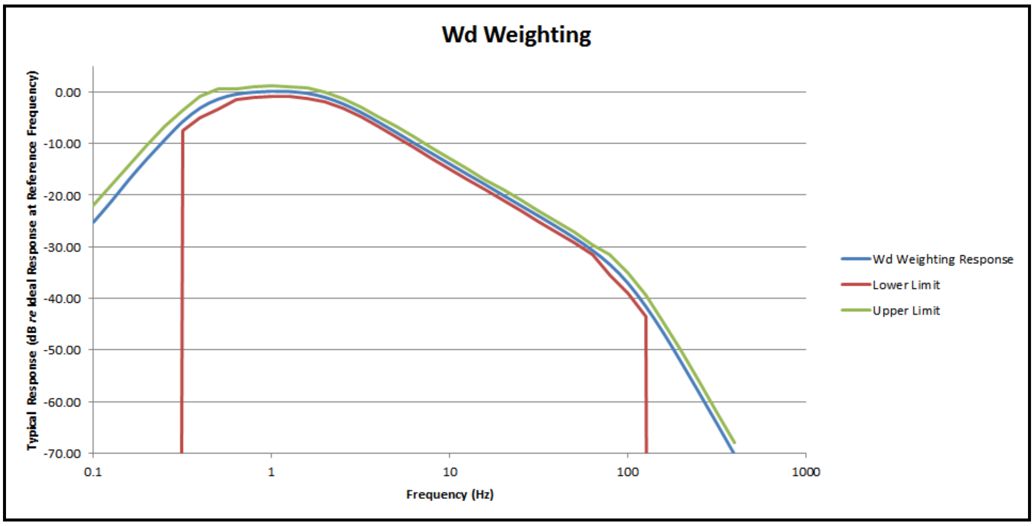


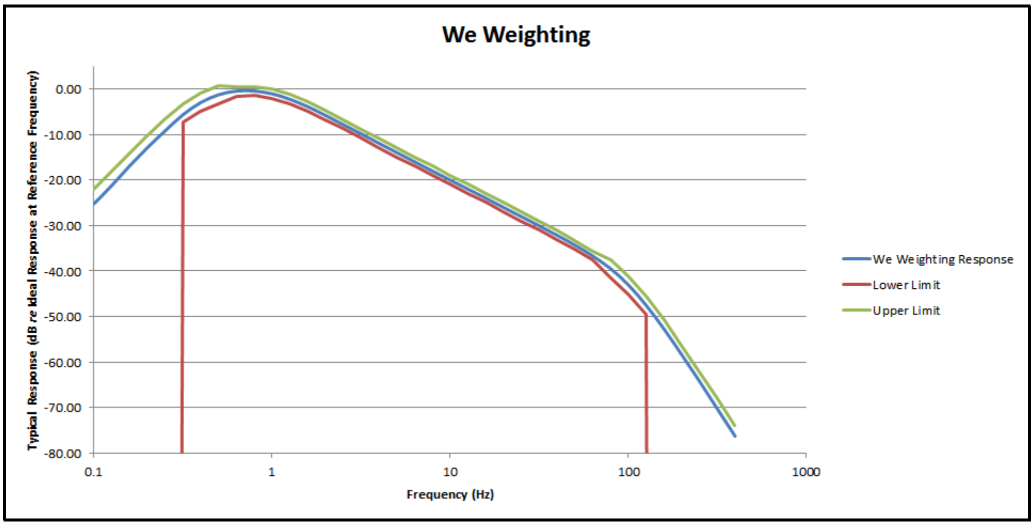


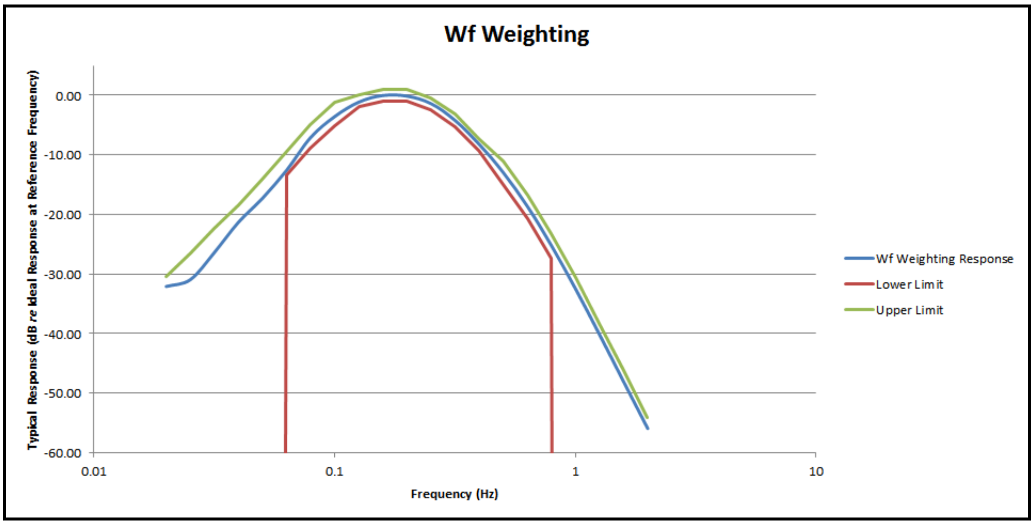

Fc Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
0.1
1
10
100
1000
10000
Frequency (Hz)
Fc Weighting Response
Lower Limit
Upper Limit

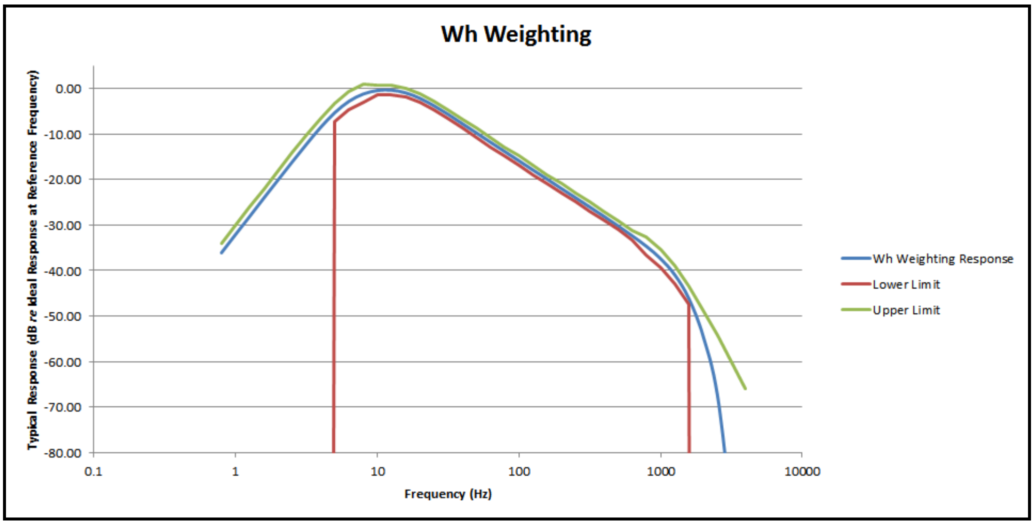

Wb Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0
-10
-20
-30
-40
-50
0.1
1
10
100
1000
Frequency (Hz)
Wb Weighting Response
Lower Limit
Upper Limit

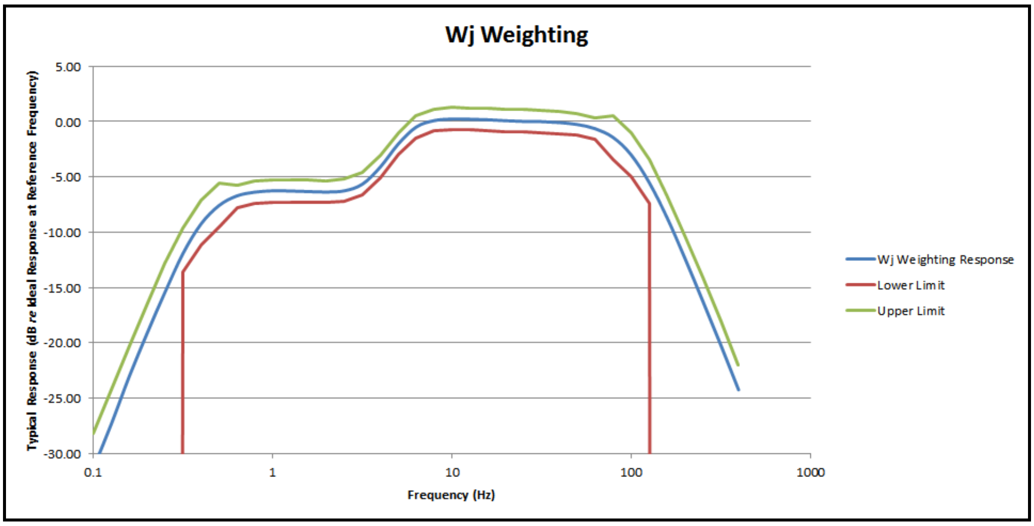

Wc Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
0.1
1
10
100
1000
Frequency (Hz)
Wc Weighting Response
Lower Limit
Upper Limit

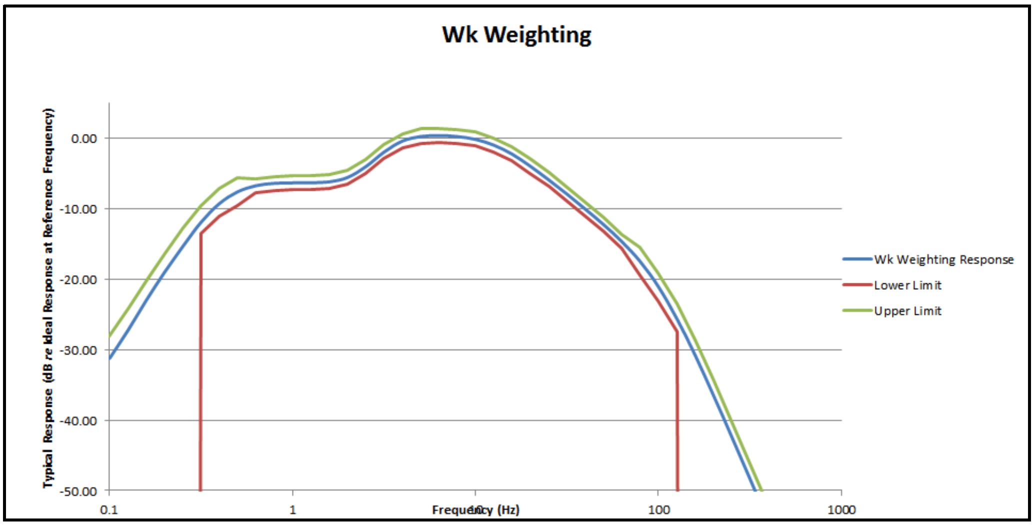

Wd Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
0.1
1
10
100
1000
Frequency (Hz)
Wd Weighting Response
Lower Limit
Upper Limit

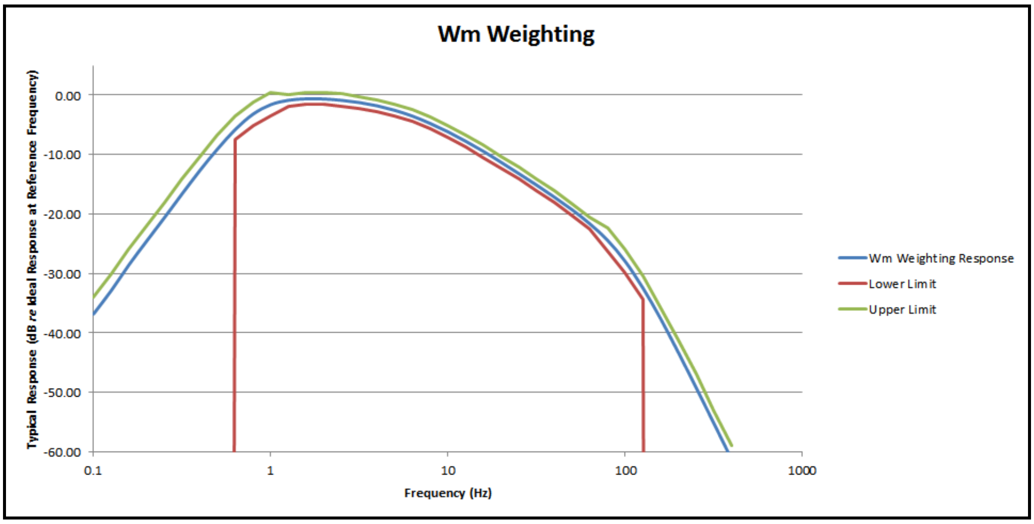

We Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
0.1
1
10
100
1000
Frequency (Hz)
We Weighting Response
Lower Limit
Upper Limit


Wf Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
0.01
0.1
1
10
Frequency (Hz)
Wf Weighting Response
Lower Limit
Upper Limit


Wh Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
0.1
1
10
100
1000
10000
Frequency (Hz)
Wh Weighting Response
Lower Limit
Upper Limit


Wj Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
0.1
1
10
100
1000
Frequency (Hz)
Wj Weighting Response
Lower Limit
Upper Limit


Wk Weighting
Typical Response (dB re Ideal Response at Reference Frequency)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
0.1
1
Frequency (Hz)
100
1000
Wk Weighting Response
Lower Limit
Upper Limit



A.8 Frequency Weighting Tables

The following tables show frequency weighting values for the HVM200.

Table A.2 Fa (Flat 0.4 Hz to 100 Hz)

Freq (Hz)	Fa Ideal (dB)	Fa Typical (dB)	Tolerance (dB)
0.1000	-24.10	-25.19	+2/-∞
0.1259	-20.12	-21.21	+2/ -∞
0.1585	-16.19	-16.92	+2/ -∞
0.1995	-12.34	-12.95	+2/ -∞
0.2512	-8.71	-9.26	+2/-∞
0.3162	-5.51	-5.84	+2/-2
0.3981	-3.05	-3.15	+2/-2
0.5012	-1.48	-1.46	+2/-2
0.6310	-0.65	-0.57	+1/-1
0.7943	-0.27	-0.17	+1/-1
1.000	-0.11	0.06	+1/-1
1.259	-0.04	0.00	+1/-1
1.585	-0.02	-0.02	+1/-1
1.995	-0.01	-0.03	+1/-1
2.512	0.00	-0.03	+1/-1
3.162	0.00	-0.03	+1/-1
3.981	0.00	-0.02	+1/-1
5.012	0.00	-0.03	+1/-1
6.310	0.00	-0.04	+1/-1
7.943	0.00	0.00	0
10.00	0.00	-0.01	+1/-1

Freq (Hz)	Fa Ideal (dB)	Fa Typical (dB)	Tolerance (dB)
12.59	0.00	0.00	+1/-1
15.85	0.00	0.02	+1/-1
19.95	-0.01	-0.02	+1/-1
25.12	-0.02	-0.05	+1/-1
31.62	-0.04	-0.03	+1/-1
39.81	-0.11	-0.12	+1/-1
50.12	-0.27	-0.27	+1/-1
63.10	-0.64	-0.65	+1/-1
79.43	-1.46	-1.44	+2/-2
100.0	-3.01	-2.99	+2/-2
125.9	-5.46	-5.47	+2/-2
158.5	-8.64	-8.65	+2/ -∞
199.5	-12.27	-12.32	+2/ -∞
251.2	-16.11	-16.20	+2/ -∞
316.2	-20.04	-20.16	+2/ -∞
398.1	-24.02	-24.22	+2/ -∞

Table A.3 Fb (Flat 0.4 Hz to 1260 Hz) Frequency Weighting

Freq (Hz)	Fb Ideal (dB)	Fb Typical (dB)	Tolerance (dB)
0.1000	-24.10	-25.24	+2 / -∞
0.1259	-20.12	-21.23	+2 / -∞
0.1585	-16.19	-16.94	+2 / -∞
0.1995	-12.34	-12.99	+2 / -∞
0.2512	-8.71	-9.29	+2 / -∞
0.3162	-5.51	-5.84	+2 / -2
0.3981	-3.05	-3.18	+2 / -2
0.5012	-1.48	-1.49	+2 / -2
0.6310	-0.65	-0.59	+1 / -1
0.7943	-0.27	-0.21	+1 / -1
1.000	-0.11	-0.08	+1 / -1
1.259	-0.04	-0.05	+1 / -1
1.585	-0.02	-0.04	+1 / -1
1.995	-0.01	-0.04	+1 / -1
2.512	0.00	-0.04	+1 / -1
3.162	0.00	-0.07	+1 / -1

Freq (Hz)	Fb Ideal (dB)	Fb Typical (dB)	Tolerance (dB)
3.981	0.00	-0.05	+1 / -1
5.012	0.00	-0.05	+1 / -1
6.310	0.00	-0.07	+1 / -1
7.943	0.00	-0.06	+1 / -1
10.00	0.00	-0.03	+1 / -1
12.59	0.00	-0.03	+1 / -1
15.85	0.00	-0.01	+1 / -1
19.95	0.00	-0.03	+1 / -1
25.12	0.00	-0.05	+1 / -1
31.62	0.00	-0.02	+1 / -1
39.81	0.00	-0.02	+1 / -1
50.12	0.00	-0.03	+1 / -1
63.10	0.00	-0.03	+1 / -1
79.43	0.00	0.00	0
100.0	0.00	-0.01	+1 / -1
125.9	0.00	-0.04	+1 / -1
158.5	0.00	-0.02	+1 / -1
199.5	0.00	-0.05	+1 / -1
251.2	-0.01	-0.06	+1 / -1
316.2	-0.02	-0.05	+1 / -1
398.1	-0.04	-0.10	+1 / -1
501.2	-0.11	-0.15	+1 / -1
631.0	-0.27	-0.31	+1 / -1
794.3	-0.64	-0.63	+2 / -2
1000	-1.46	-1.47	+2 / -2
1259	-3.01	-3.35	+2 / -2
1585	-5.46	-6.86	+2 / -∞
1995	-8.64	-12.55	+2 / -∞
2512	-12.27	-21.30	+2 / -∞
3162	-16.11	-39.09	+2 / -∞
3981	-20.04	-85.43	+2 / -∞

Table A.4 Fc (Flat 6.3 Hz to 1260 Hz), Wh, and Wf Frequency Weighting.

Freq (Hz)	Fc Ideal (dB)	Fc Typ (dB)	Wh Ideal (dB)	Wh Typ (dB)	Tolerance (dB)	Wf Ideal (dB)	Wf Typ (dB)	Tolerance (dB)
0.7943	-36	-36.06	-36	-36.10	+2 / -∞	-32.37	-32.08	+2 / -∞
1.000	-32	-32.08	-31.99	-32.08	+2 / -∞	-28.40	-30.95	+2 / -∞
1.259	-28.01	-28.08	-27.99	-28.09	+2 / -∞	-24.41	-26.39	+2 / -∞
1.585	-24.02	-24.08	-23.99	-24.07	+2 / -∞	-20.34	-21.30	+2 / -∞
1.995	-20.04	-20.09	-20.01	-20.08	+2 / -∞	-16.06	-17.28	+2 / -∞
2.512	-16.11	-16.16	-16.05	-16.12	+2 / -∞	-11.45	-12.58	+2 / -2
3.162	-12.27	-12.31	-12.18	-12.26	+2 / -∞	-6.86	-7.07	+2 / -2
3.981	-8.64	-8.70	-8.51	-8.56	+2 / -2	-3.16	-3.56	+2 / -2
5.012	-5.46	-5.50	-5.27	-5.32	+2 / -2	-0.92	-1.13	+4 / -1
6.310	-3.01	-3.02	-2.77	-2.83	+2 / -2	0.04	-0.02	+1 / -1
7.943	-1.46	-1.52	-1.18	-1.25	+2 / -2	-0.06	-0.12	+1 / -1
10.00	-0.64	-0.67	-0.43	-0.46	+1 / -1	-1.41	-1.39	+1 / -1
12.59	-0.27	-0.31	-0.38	-0.39	+1 / -1	-4.22	-4.21	+1 / -1
15.85	-0.11	-0.12	-0.96	-0.99	+1 / -1	-8.22	-8.22	+1 / -1
19.95	-0.04	-0.08	-2.14	-2.17	+1 / -1	-13.05	-12.96	+2 / -2
25.12	-0.02	-0.06	-3.78	-3.83	+1 / -1	-18.73	-18.63	+2 / -2
31.62	-0.01	-0.02	-5.69	-5.71	+1 / -1	-25.30	-25.22	+2 / -2
39.81	0	-0.03	-7.72	-7.75	+1 / -1	-32.57	-32.49	+2 / -∞
50.12	0	-0.03	-9.78	-9.80	+1 / -1	-40.26	-40.20	+2 / -∞
63.10	0	-0.03	-11.83	-11.86	+1 / -1	-48.14	-48.11	+2 / -∞
79.43	0	0.00	-13.88	-13.88	0	-56.11	-55.96	+2 /-∞
100.0	0	-0.01	-15.91	-15.92	+1 / -1			
125.9	0	-0.04	-17.93	-17.97	+1 / -1			
158.5	0	-0.02	-19.94	-19.97	+1 / -1			
199.5	0	-0.05	-21.95	-22.01	+1 / -1			
251.2	-0.01	-0.06	-23.96	-24.04	+1 / -1			
316.2	-0.02	-0.05	-25.98	-26.06	+1 / -1			
398.1	-0.04	-0.10	-28	-28.13	+1 / -1			
501.2	-0.11	-0.15	-30.07	-30.21	+1 / -1			
631.0	-0.27	-0.31	-32.23	-32.40	+1 / -1			
794.3	-0.64	-0.63	-34.6	-34.70	+1 / -1			
1000	-1.46	-1.47	-37.42	-37.41	+2 / -2			
1259	-3.01	-3.35	-40.97	-40.97	+2 / -2			

Freq (Hz)	Fc Ideal (dB)	Fc Typ (dB)	Wh Ideal (dB)	Wh Typ (dB)	Tolerance (dB)	Wf Ideal (dB)	Wf Typ (dB)	Tolerance (dB)
1585	-5.46	-6.86	-45.42	-46.21	+2 / -2			
1995	-8.64	-12.55	-50.6	-54.40	+2 / -∞			
2512	-12.27	-21.30	-56.23	-67.23	+2 / -∞			
3162	-16.11	-39.09	-62.07	-92.87	+2 / -∞			
3981	-20.04	-86.14	-68.01	-101.37	+2 / -∞			

Table A.5
Table A.6 Wm, Wc, and Wd Frequency Weightings

Freq (Hz)	Wm Ideal (dB)	WmTyp (dB)	Wc Ideal (dB)	Wc Typ (dB)	Wd Ideal (dB)	Wd Typ (dB)	Tolerance (dB)
0.100	-36	-36.81	-24.10	-25.20	-24.09	-25.23	+2 / -∞
0.1259	-32	-32.86	-20.12	-21.23	-20.12	-21.21	+2 / -∞
0.1585	-28.01	-28.53	-16.19	-16.93	-16.18	-16.96	+2 / -∞
0.1995	-24.02	-24.53	-12.34	-13.00	-12.32	-13.00	+2 / -∞
0.2512	-20.05	-20.60	-8.71	-9.30	-8.68	-9.28	+2 / -∞
0.3162	-16.12	-16.58	-5.51	-5.88	-5.47	-5.78	+2 / -2
0.3981	-12.29	-12.67	-3.05	-3.17	-2.98	-3.10	+2 / -2
0.5012	-8.67	-9.04	-1.47	-1.50	-1.37	-1.40	+2 / -2
0.6310	-5.51	-5.76	-0.64	-0.60	-0.5	-0.45	+1 / -1
0.7943	-3.09	-3.18	-0.25	-0.23	-0.08	-0.06	+1 / -1
1.00	-1.59	-1.59	-0.08	-0.06	0.1	0.12	+1 / -1
1.259	-0.85	-0.85	+0.00	-0.01	0.06	0.06	+1 / -1
1.585	-0.59	-0.61	+0.06	0.02	-0.26	-0.28	+1 / -1
1.995	-0.61	-0.64	+0.10	0.05	-1	-1.06	+1 / -1
2.512	-0.82	-0.86	+0.15	0.09	-2.23	-2.30	+1 / -1
3.162	-1.19	-1.24	+0.19	0.12	-3.88	-3.93	+1 / -1
3.981	-1.74	-1.78	+0.21	0.14	-5.78	-5.84	+1 / -1
5.012	-2.5	-2.55	+0.11	0.04	-7.78	-7.85	+1 / -1
6.310	-3.49	-3.52	-0.23	-0.31	-9.83	-9.92	+1 / -1
7.943	-4.7	-4.76	-0.97	-1.06	-11.87	-11.91	0
10.0	-6.12	-6.16	-2.20	-2.25	-13.91	-13.95	+1 / -1
12.59	-7.71	-7.75	-3.84	-3.88	-15.93	-15.98	+1 / -1
15.85	-9.44	-9.44	-5.74	-5.74	-17.95	-17.95	+1 / -1
19.95	-11.25	-11.30	-7.75	-7.81	-19.97	-20.02	+1 / -1

Freq (Hz)	Wm Ideal (dB)	WmTyp (dB)	Wc Ideal (dB)	Wc Typ (dB)	Wd Ideal (dB)	Wd Typ (dB)	Tolerance (dB)
25.12	-13.14	-13.19	-9.80	-9.85	-21.98	-22.04	+1 / -1
31.62	-15.09	-15.12	-11.87	-11.91	-24.01	-24.05	+1 / -1
39.81	-17.1	-17.14	-13.97	-14.00	-26.08	-26.12	+1 / -1
50.12	-19.23	-19.26	-16.15	-16.20	-28.24	-28.28	+1 / -1
63.10	-21.58	-21.62	-18.55	-18.59	-30.62	-30.67	+1 / -1
79.43	-24.38	-24.40	-21.37	-21.39	-33.43	-33.45	+2 / -2
100.0	-27.93	-27.95	-24.94	-24.96	-36.99	-37.02	+2 / -2
125.9	-32.37	-32.43	-29.39	-29.45	-41.43	-41.50	+2 / -2
158.5	-37.55	-37.60	-34.57	-34.63	-46.62	-46.68	+2 / -∞
199.5	-43.18	-43.28	-40.20	-40.32	-52.24	-52.36	+2 / -∞
251.2	-49.02	-49.17	-46.04	-46.21	-58.09	-58.25	+2 / -∞
316.2	-54.95	-55.16	-51.98	-52.19	-64.02	-64.23	+2 / -∞
398.1	-60.92	-61.23	-57.95	-58.29	-70	-70.30	+2 / -∞

Table A.7 We, Wj, and Wk Frequency Weighting

Freq (Hz)	We Ideal (dB)	We Typ (dB)	Wj Ideal (dB)	Wj Typ (dB)	Wk Ideal (dB)	Wk Typ (dB)	Tolerance dB
0.100	-24.08	-25.22	-30.18	-31.27	-30.11	-31.20	+2 / -∞
0.1259	-20.09	-21.22	-26.20	-27.28	-26.14	-27.24	+2 / -∞
0.1585	-16.14	-16.91	-22.27	-22.99	-22.21	-22.98	+2 / -∞
0.1995	-12.27	-12.92	-18.42	-19.08	-18.37	-19.00	+2 / -∞
0.2512	-8.60	-9.20	-14.79	-15.37	-14.74	-15.32	+2 / -∞
0.3162	-5.36	-5.66	-11.60	-11.89	-11.55	-11.88	+2 / -2
0.3981	-2.86	-2.99	-9.15	-9.25	-9.11	-9.24	+2 / -2
0.5012	-1.27	-1.28	-7.58	-7.59	-7.56	-7.57	+2 / -2
0.6310	-0.55	-0.48	-6.77	-6.72	-6.77	-6.71	+1 / -1
0.7943	-0.52	-0.47	-6.42	-6.38	-6.44	-6.37	+1 / -1
1.00	-1.11	-1.08	-6.30	-6.26	-6.33	-6.30	+1 / -1
1.259	-2.29	-2.29	-6.28	-6.28	-6.29	-6.28	+1 / -1
1.585	-3.91	-3.92	-6.32	-6.33	-6.13	-6.16	+1 / -1
1.995	-5.80	-5.82	-6.34	-6.37	-5.50	-5.54	+1 / -1
2.512	-7.81	-7.85	-6.22	-6.26	-3.97	-4.01	+1 / -1
3.162	-9.85	-9.87	-5.60	-5.66	-1.86	-1.93	+1 / -1
3.981	-11.89	-11.95	-4.08	-4.11	-0.31	-0.38	+1 / -1
5.012	-13.93	-13.98	-1.99	-2.04	+0.33	0.28	+1 / -1
6.310	-15.95	-16.00	-0.47	-0.51	+0.46	0.42	+1 / -1

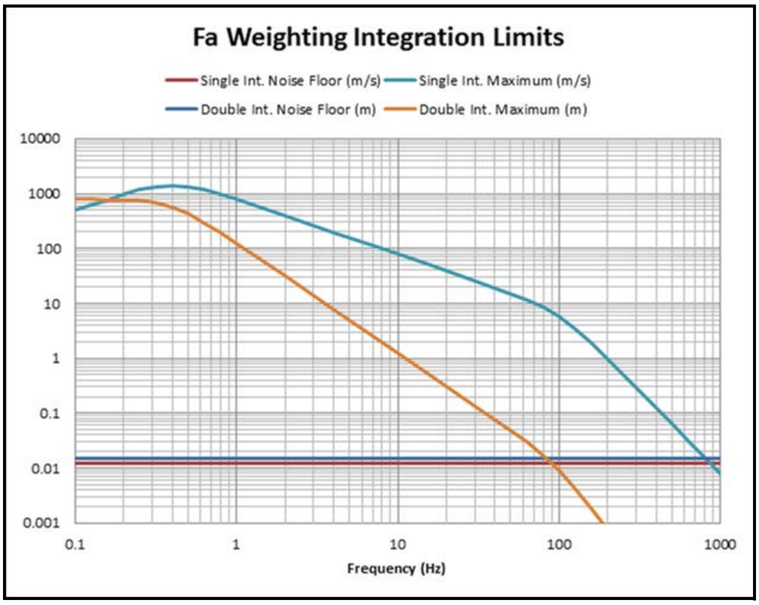
Freq (Hz)	We Ideal (dB)	We Typ (dB)	Wj Ideal (dB)	Wj Typ (dB)	Wk Ideal (dB)	Wk Typ (dB)	Tolerance dB
7.943	-17.97	-18.04	+0.14	0.08	+0.32	0.28	0
10.0	-19.98	-20.02	+0.26	0.23	-0.10	-0.14	+1 / -1
12.59	-21.99	-22.01	+0.22	0.21	-0.93	-0.95	+1 / -1
15.85	-23.99	-23.99	+0.16	0.16	-2.22	-2.22	+1 / -1
19.95	-26.00	-26.05	+0.10	0.07	-3.91	-3.95	+1 / -1
25.12	-28.01	-28.06	+0.06	0.01	-5.84	-5.88	+1 / -1
31.62	-30.04	-30.06	+0.00	-0.01	-7.89	-7.90	+1 / -1
39.81	-32.11	-32.14	-0.08	-0.10	-10.01	-10.04	+1 / -1
50.12	-34.26	-34.30	-0.25	-0.27	-12.21	-12.24	+1 / -1
63.10	-36.64	-36.68	-0.63	-0.65	-14.62	-14.66	+1 / -1
79.43	-39.46	-39.47	-1.45	-1.44	-17.47	-17.48	+2 / -2
100.0	-43.01	-43.03	-3.01	-3.01	-21.04	-21.05	+2 / -2
125.9	-47.46	-47.51	-5.45	-5.49	-25.50	-25.55	+2 / -2
158.5	-52.64	-52.69	-8.64	-8.66	-30.69	-30.73	+2 / -∞
199.5	-58.27	-58.37	-12.26	-12.34	-36.32	-36.42	+2 / -∞
251.2	-64.11	-64.21	-16.11	-16.22	-42.16	-42.32	+2 / -∞
316.2	-70.04	-70.24	-20.04	-20.18	-48.10	-48.30	+2 / -∞
398.1	-76.02	-76.29	-24.02	-24.25	-54.08	-54.40	+2 / -∞

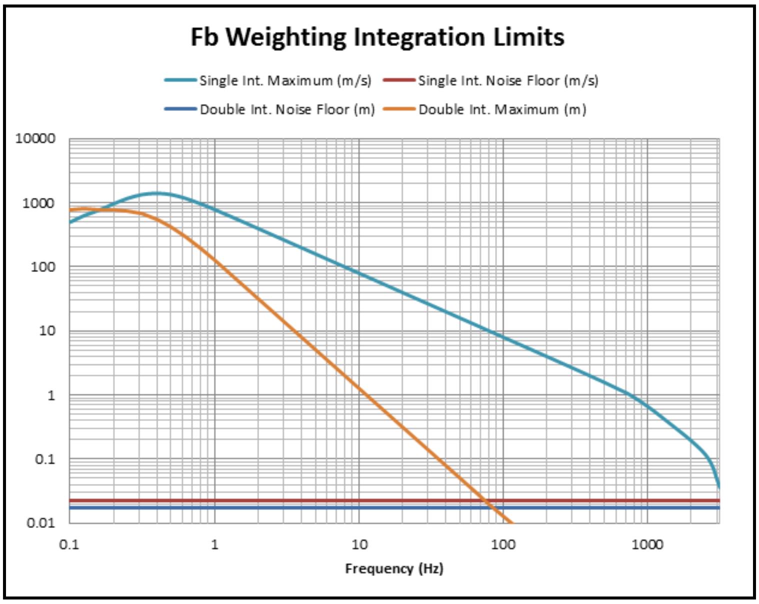
A.9 Integration Weighting Limits

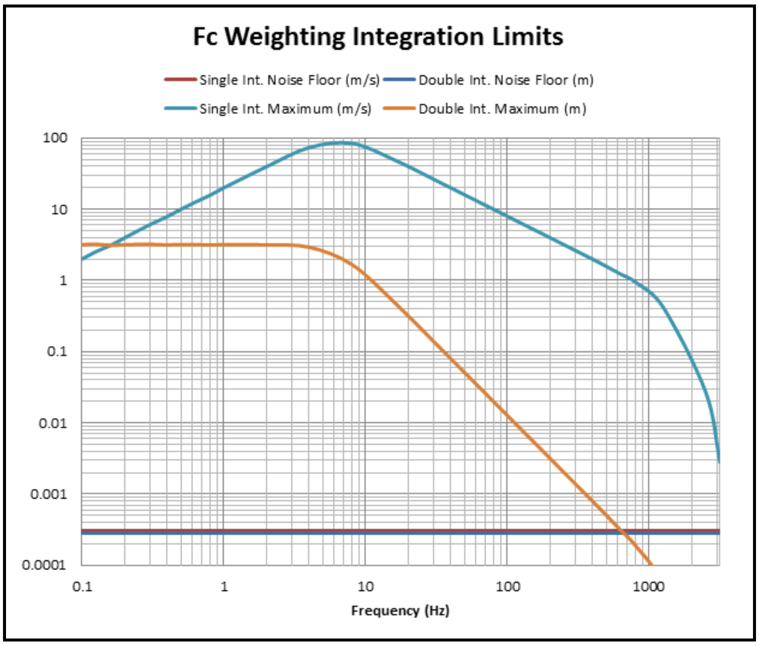
All data presented is with a reference sensitivity of 1 mV/m/s^2. The amplitude values on the tables and figures scale according to the ratio of selected sensor sensitivity values to 1 mV/m/s^2.

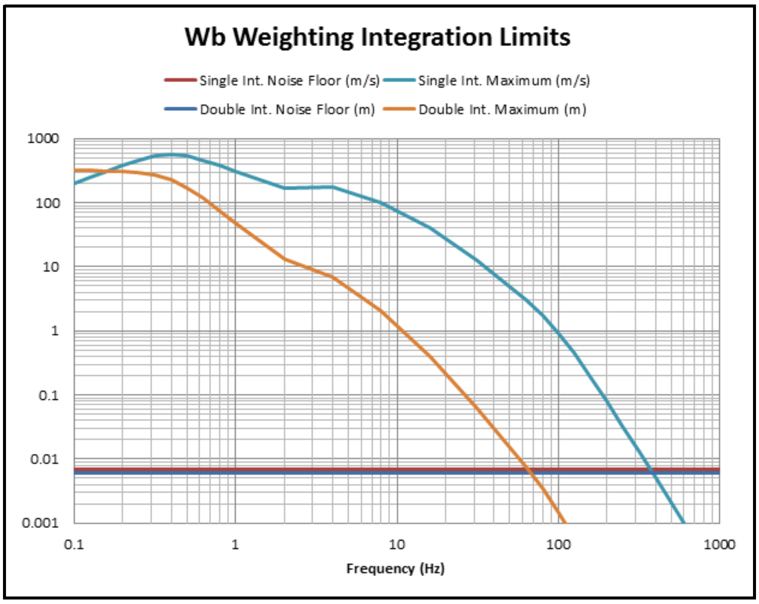
	Single Integration		Double Integration	
Weighting	Noise Floor (m/s)	Max (m/s)	Noise Floor (m)	Max (m)
Fa	0.0121	1403.690	0.0150	801.367
Fb	0.0220	1403.690	0.0173	801.367
Fc	0.0003	84.283	0.0003	3.235
Wb	0.0068	563.341	0.0060	317.432
Wc	0.0163	1403.690	0.0143	801.367
Wd	0.0155	1415.048	0.0111	801.367
We	0.0108	1434.733	0.0102	804.139
Wf	0.0802	5740.123	0.1707	8823.712
Wh	0.0003	87.044	0.0002	3.235
Wj	0.0080	695.458	0.0077	397.953
Wk	0.0083	698.669	0.0067	400.711
Wm	0.0049	698.620	0.0034	204.094

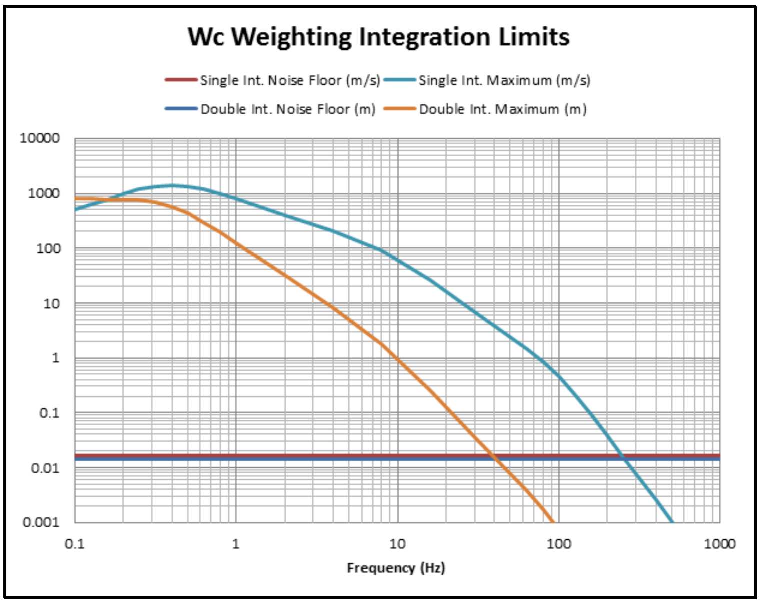
For the following charts, the valid measurement range for each weighting is shown between the noise floor and the maximum.

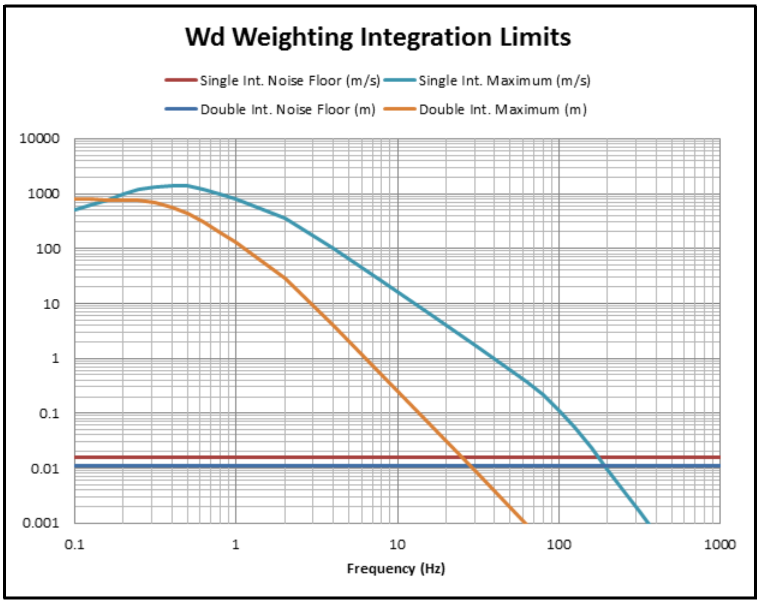


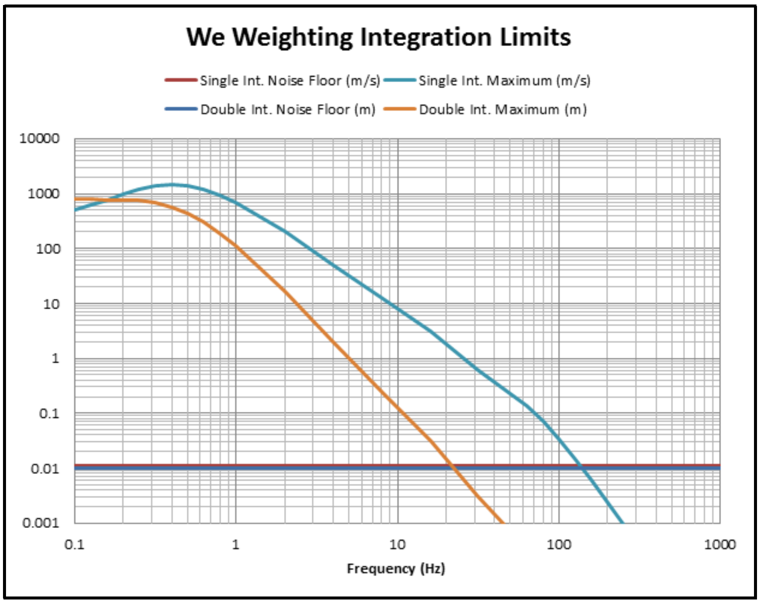


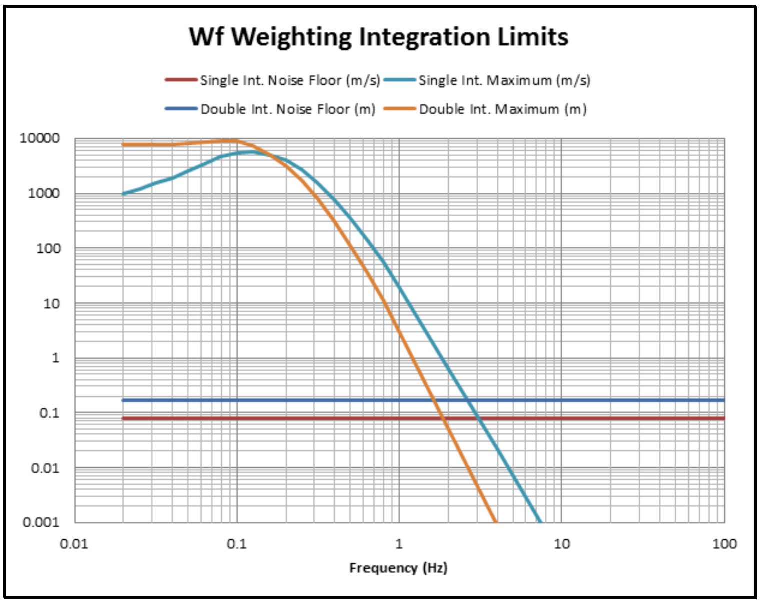

Fc Weighting Integration Limits
Single Int. Noise Floor (m/s)
Double Int. Noise Floor (m)
Single Int. Maximum (m/s)
Double Int. Maximum (m)
100
10
1
0.1
0.01
0.001
0.0001
0.1
1
10
100
1000
Frequency (Hz)

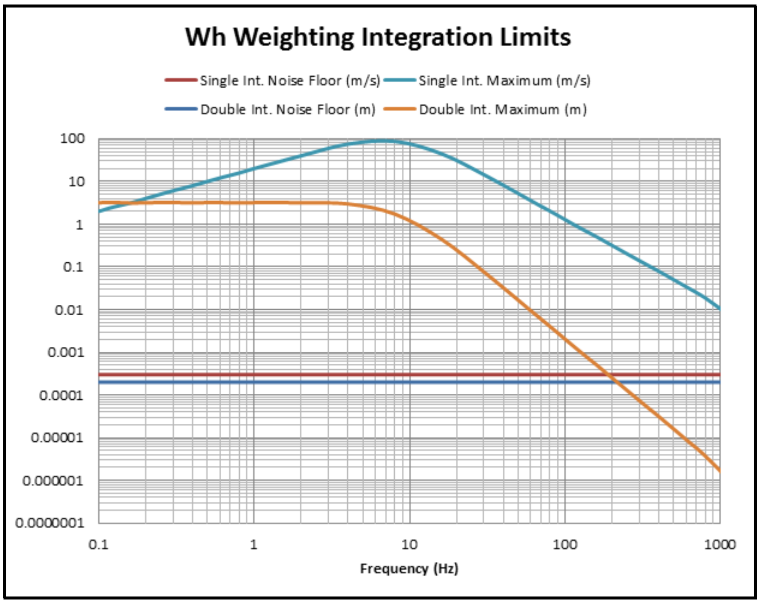

Wb Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)

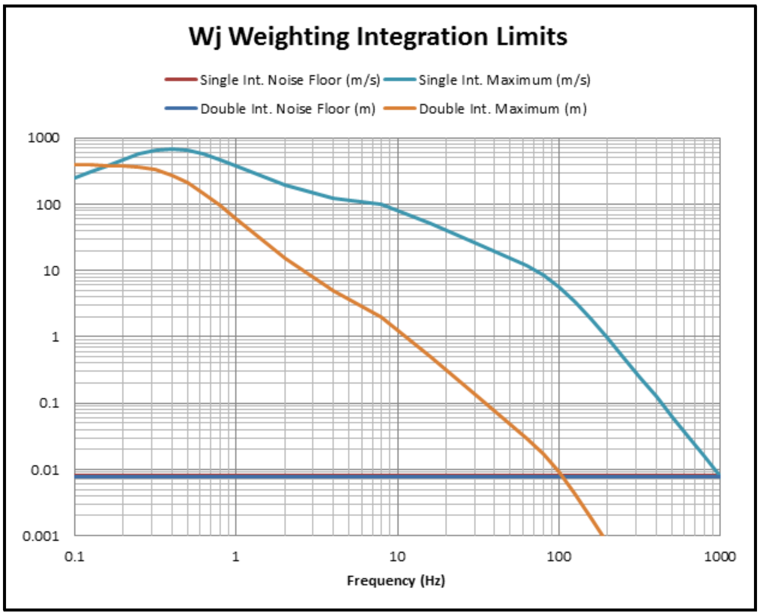

Wc Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
10000
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)

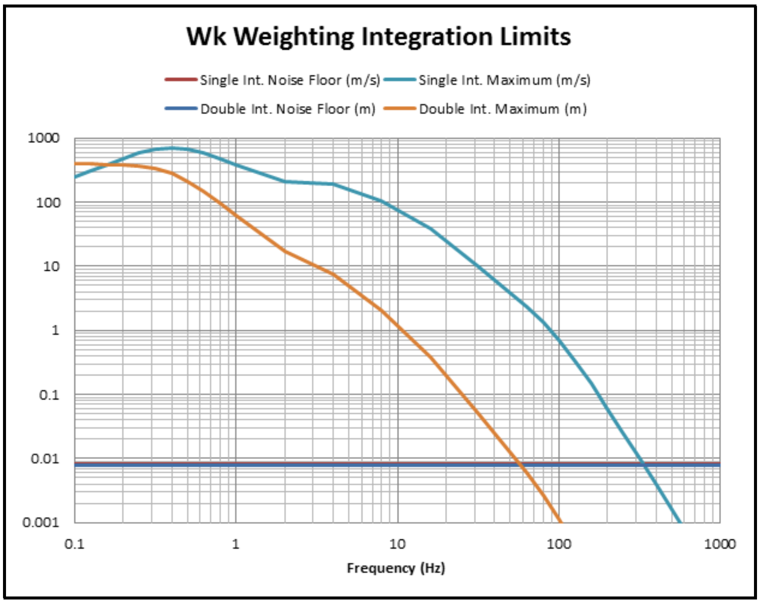

Wd Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
10000
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)

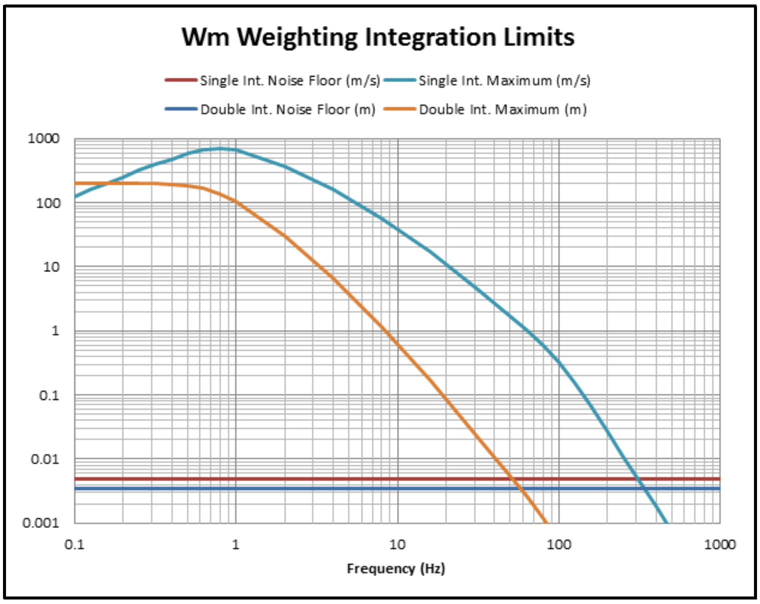

We Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
10000
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)


Wf Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
10000
1000
100
10
1
0.1
0.01
0.001
0.01
0.1
1
10
100
Frequency (Hz)


Wh Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
100
10
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
0.0000001
0.1
1
10
100
1000
Frequency (Hz)


Wj Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)


Wk Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)


Wm Weighting Integration Limits
Single Int. Noise Floor (m/s)
Single Int. Maximum (m/s)
Double Int. Noise Floor (m)
Double Int. Maximum (m)
1000
100
10
1
0.1
0.01
0.001
0.1
1
10
100
1000
Frequency (Hz)

A.10 1/1 & 1/3 Octave Band Filters

Octave Band Analysis (OBA) is an optional feature for the HVM200.

OBA Compliance

- IEC 61260-1:2014 Class 1
- ANSI S1.11-2014 Part 1, Class 1

OBA General Specifications

- 1/1 Octave Filters: 0.5 Hz to 2000 Hz
- 1/3 Octave Filters: 0.4 Hz to 2500 Hz
- Weighting: Unweighted
- Measured Values: RMS and Peak OBA Filter Responses

Table A.8 1/1 OBA Filter Responses

1/1 Octave Measurement Range			
Frequency (Hz)	Maximum Noise Floor (mV)	Lower Limit Linearity (mV)	Overload (V)
0.5	0.022	0.14	5.01
1	0.017	0.21	5.01
2	0.0144	0.17	5.01
4	0.0143	0.14	5.01
8	0.01415	0.13	5.01
16	0.01405	0.13	5.01
31.5	0.01408	0.09	5.01
63	0.0149	0.085	5.01
125	0.0171	0.08	5.01
250	0.0205	0.07	5.01
500	0.02417	0.08	5.01
1000	0.02973	0.08	5.01
2000	0.0385	0.14	5.01

FIGURE A-4 1/1 Octave Filter Response Summary Graph

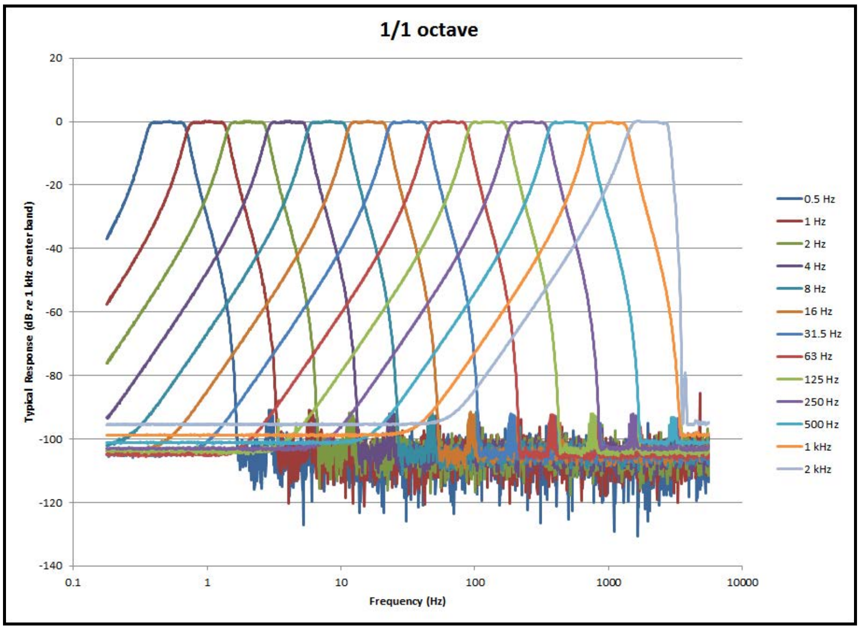


FIGURE A-5 1/1 OBA 8.0 Hz Filter Response

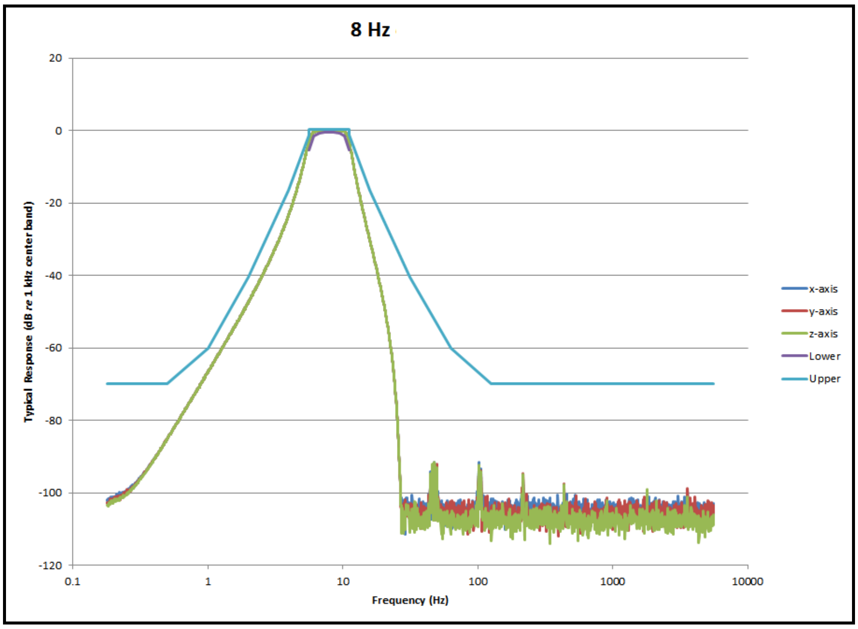


FIGURE A-6 1/1 OBA 8.0 Hz Filter Response: Pass-band

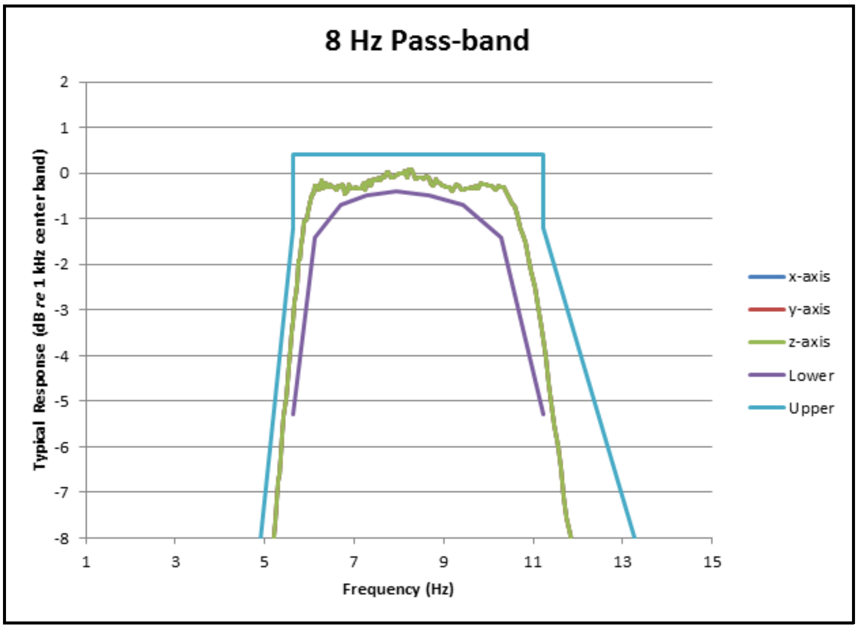


FIGURE A-7 1/1 OBA 16.0 Hz Filter Response

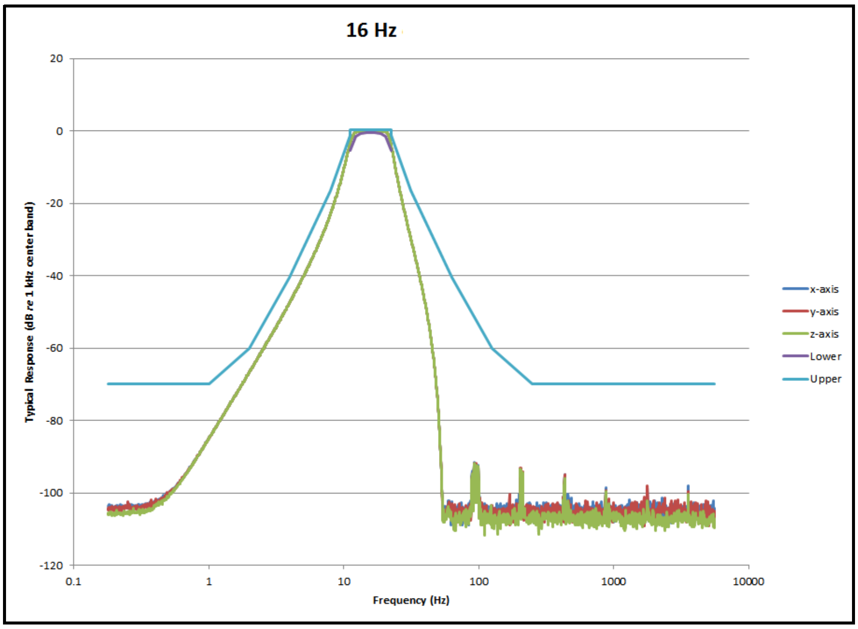


FIGURE A-8 1/1 OBA 16.0 Hz Filter Response: Pass-band

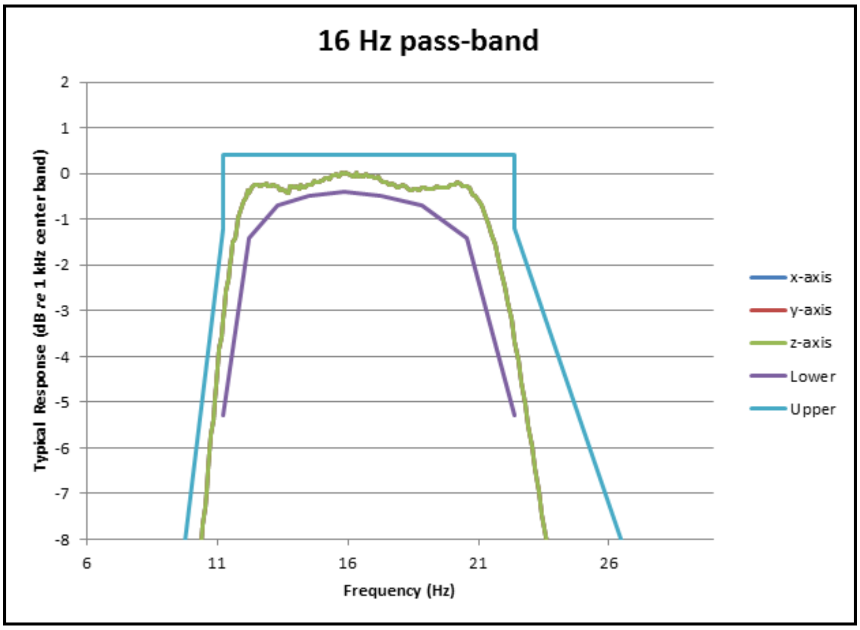


Table A.9 1/3 OBA Filter Responses

1/3 Octave Filter Measurement Range			
Frequency (Hz)	Maximum Noise Floor (mV)	Lower Limit Linearity (mV)	Overload (V)
0.4	0.022	0.13	5.01
0.5	0.02	0.13	5.01
0.63	0.018	0.14	5.01
0.8	0.017	0.15	5.01
1	0.0155	0.18	5.01
1.25	0.0148	0.21	5.01
1.6	0.0144	0.17	5.01
2	0.01435	0.14	5.01
2.5	0.01432	0.14	5.01
3.15	0.0143	0.14	5.01
4	0.01425	0.14	5.01
5	0.0142	0.13	5.01
6.3	0.01415	0.13	5.01
8	0.0141	0.13	5.01
10	0.01407	0.13	5.01
12.5	0.01405	0.13	5.01
16	0.01403	0.11	5.01
20	0.01401	0.1	5.01
25	0.014	0.09	5.01
31.5	0.01401	0.085	5.01
40	0.01408	0.085	5.01
50	0.01418	0.085	5.01
63	0.0143	0.08	5.01
80	0.0149	0.08	5.01
100	0.0155	0.08	5.01
125	0.0162	0.075	5.01
160	0.0171	0.07	5.01
200	0.018	0.07	5.01
250	0.019	0.07	5.01
315	0.0205	0.07	5.01
400	0.0215	0.07	5.01
500	0.02258	0.07	5.01
630	0.02417	0.08	5.01
800	0.02574	0.08	5.01
1000	0.02753	0.08	5.01
1250	0.02973	0.08	5.01
1600	0.03231	0.08	5.01
2000	0.035	0.08	5.01
2500	0.0385	0.085	5.01

FIGURE A-9 1/3 Octave Filter Summary Graph

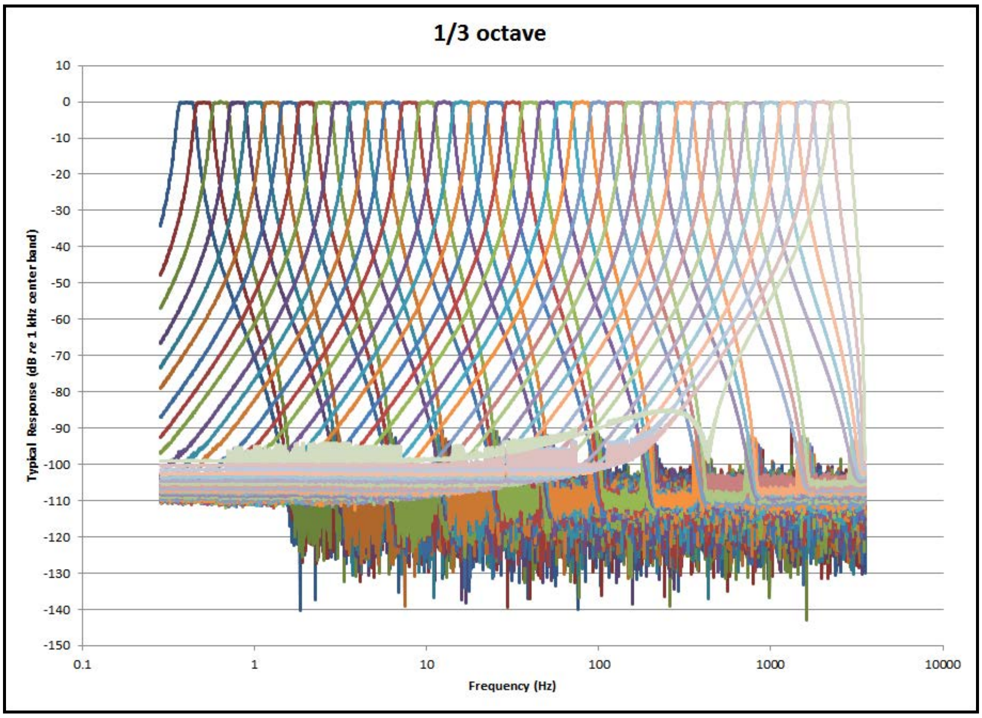


FIGURE A-10 1/3 OBA 0.4 Hz Filter Response

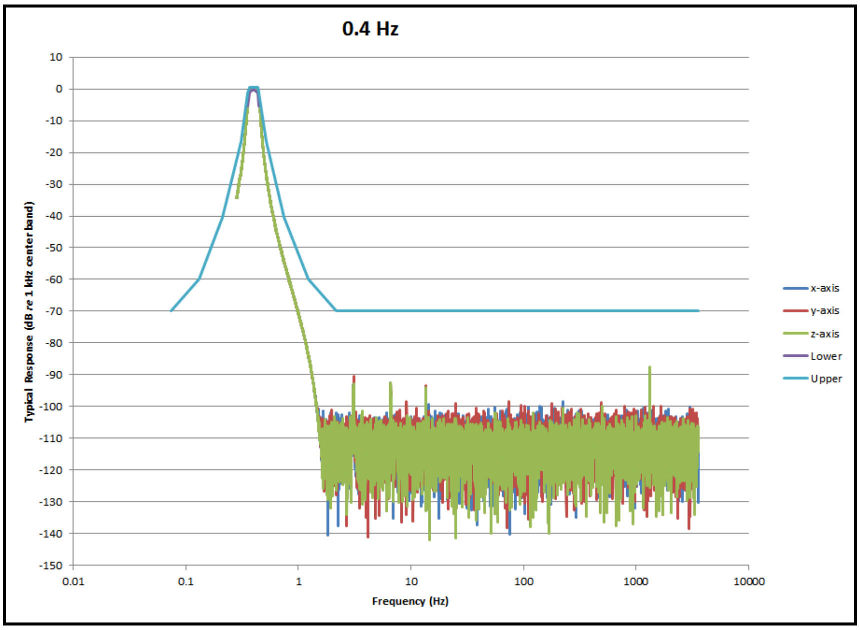


FIGURE A-11 1/3 OBA 0.4 Hz Filter Response: Pass-band

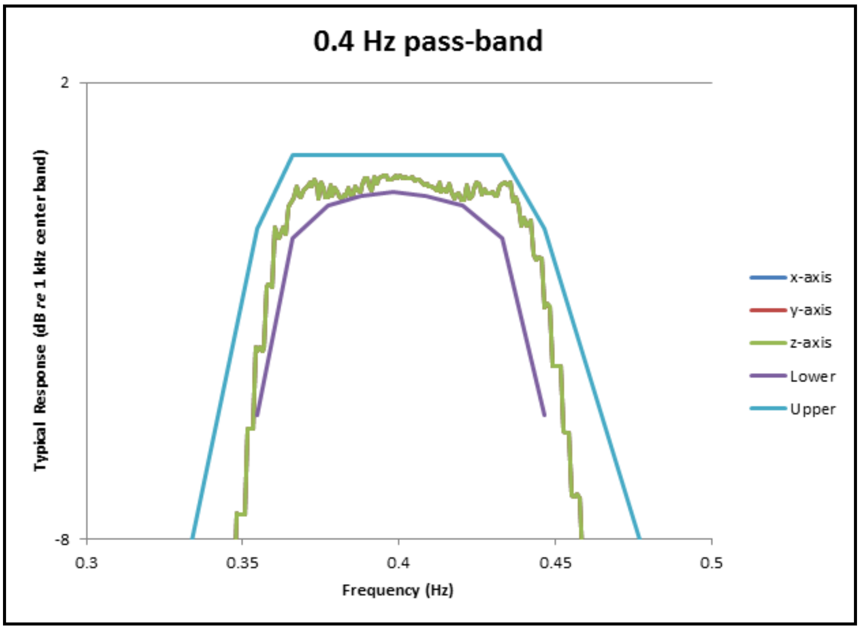


FIGURE A-12 1/3 OBA 8.0 Hz Filter Response

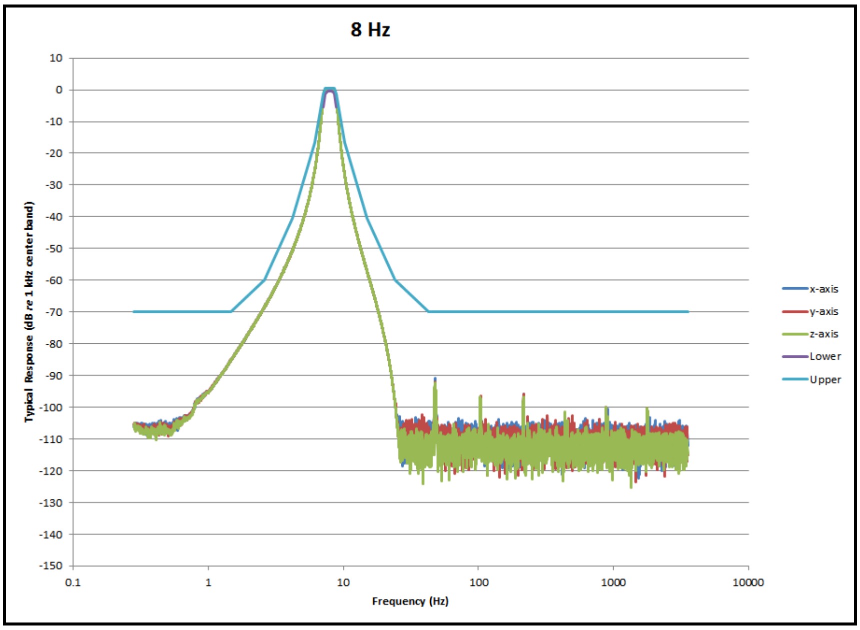


FIGURE A-13 1/3 OBA 8.0 Hz Filter Response: Pass-band

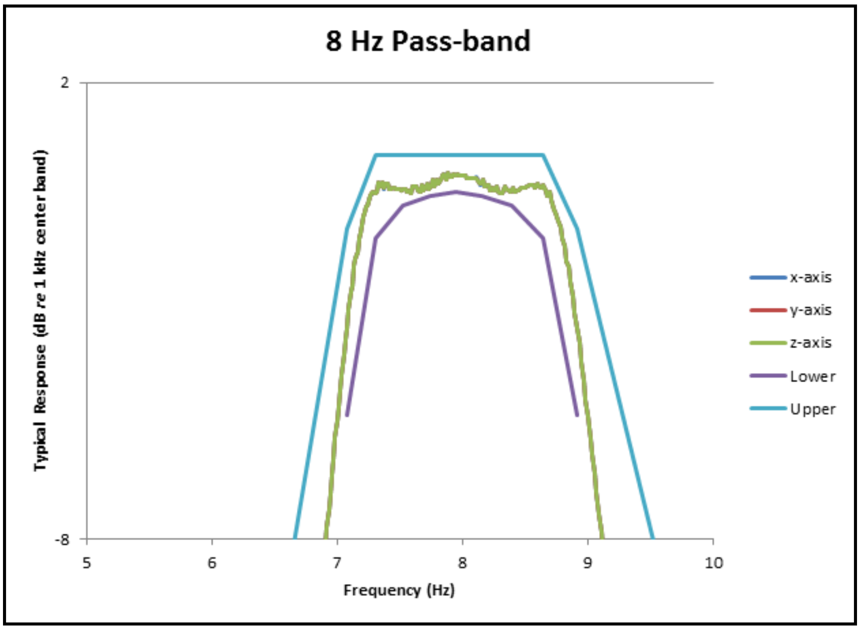


FIGURE A-14 1/3 OBA 16.0 Hz Center Band Filter Response

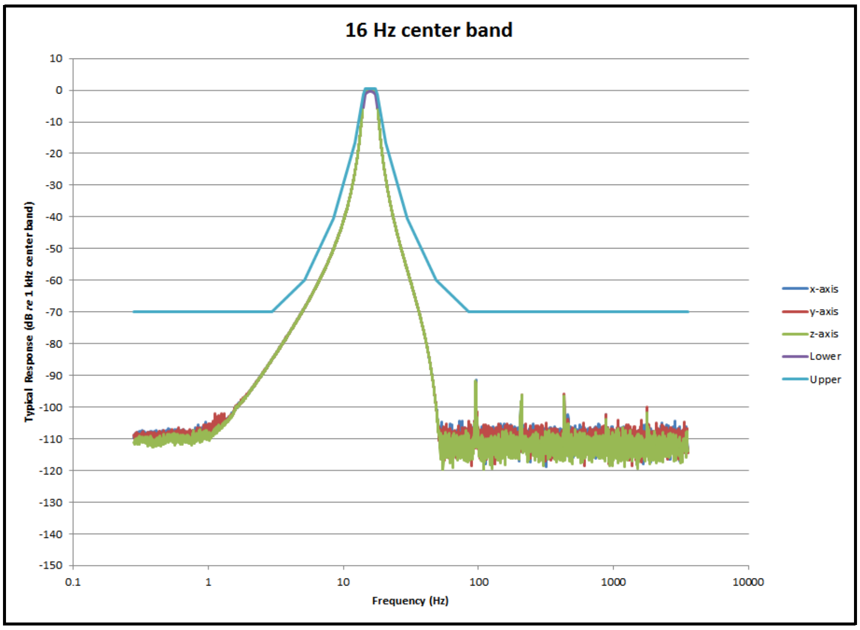


FIGURE A-15 1/3 OBA 16.0 Hz Filter Response: Pass-band

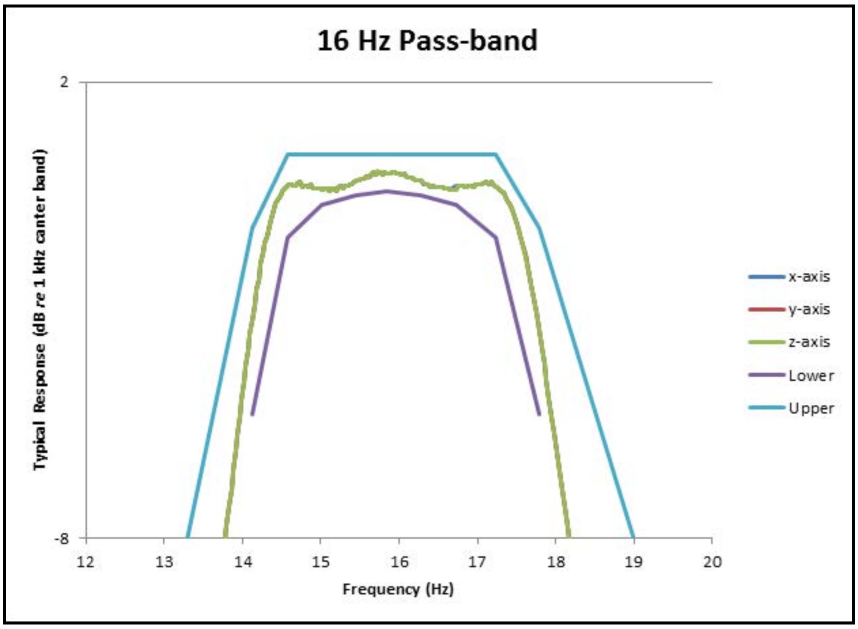


FIGURE A-16 1/3 OBA 80.0 Hz Filter Response

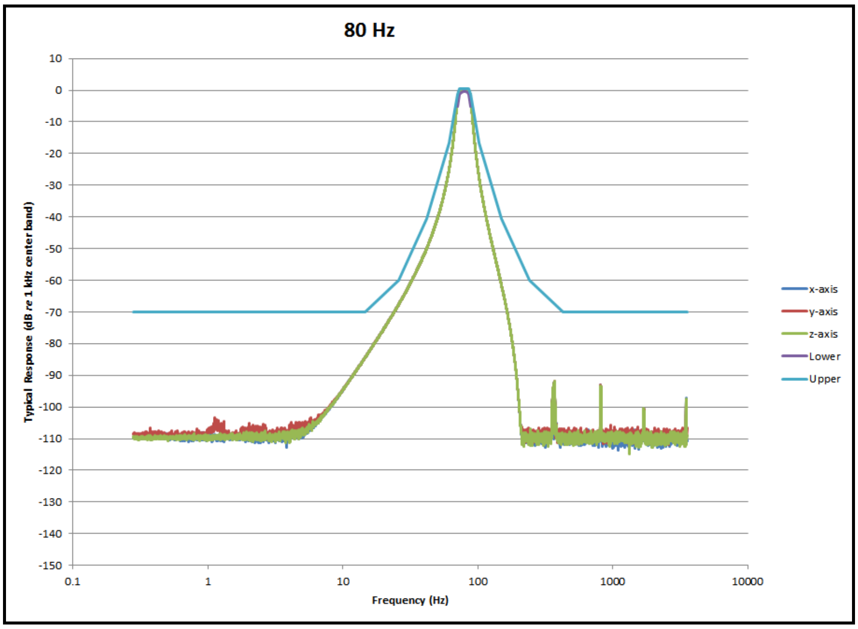
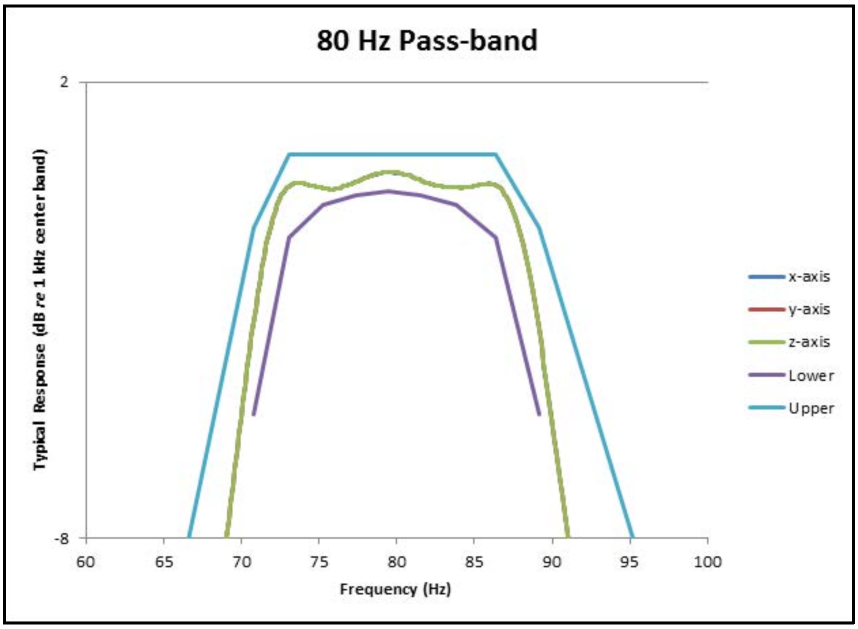


FIGURE A-17 1/3 OBA 80.0 Hz Passband Filter Response



A.11 Standards Met

Type Precision

The Larson Davis HVM200 Human Vibration Meter is a Type 1 instrument designed for use in assessing vibration as perceived by human beings. The instrument meets the requirements of ISO 8041:2005(E).

Additionally, because the HVM200 meets the current ISO 8041:2005 standard, it is also compatible with the standards listed below. These standards define methods for the measurement of whole-body and hand-arm vibration.

- ISO 2631-1:1997 Mechanical vibration and shock -- Evaluation of human exposure to whole-body vibration -- Part 1: General requirements
- ISO 2631-5:2004 Evaluation of human exposure to whole-body vibration -- Part 5: Method for evaluation of vibration containing multiple shocks
- ISO 2631-2:2003 Evaluation of human exposure to whole-body vibration -- Part 2: Continuous and shock-induced vibrations in buildings (1 to 80 Hz)
- ISO 2631-4:2001 Mechanical vibration and shock -- Evaluation of human exposure to whole-body vibration -- Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guide-way transport systems
- ISO 5349-1:2001 Mechanical vibration -- Measurement and evaluation of human exposure to hand-transmitted vibration -- Part 1: General requirements
- ISO 5349-2:2001 Mechanical vibration -- Measurement and evaluation of human exposure to hand-transmitted vibration -- Part 2: Practical guidance for measurement at the workplace
- EN 1032:2003 Mechanical vibration -- Testing of mobile machinery in order to determine the vibration emission value
- ANSI S2.70 Guide for the Measurement and Evaluation of Human Exposure to Vibration Transmitted to the Hand

Appendix B Adapter Resonance & Frequency Response

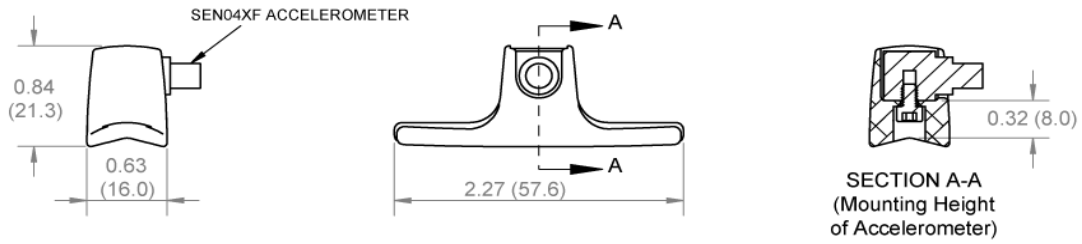
Experimental measurements indicate no resonances within the Wh frequency range for the adapters ADP080A, ADP081A and ADP082A.

B.1 Mounting and Installation Details

Specification	Unit	ADP080A	ADP081A	ADP082A
Total Mass of Vibration Sensor & Mounting System (including sensor, adapter, & mounting screw)	ounces (grams)	0.67 (19)	0.74 (21)	0.35 (10)
Mounting Height of Vibration Sensor (distance between sensor and mounting surface)	inches (mm)	0.32 (8.0)	0.18 (4.6)	0.32 (8.1)
Adapter dimensions	inches (mm)	Shown Below	Shown Below	Shown Below

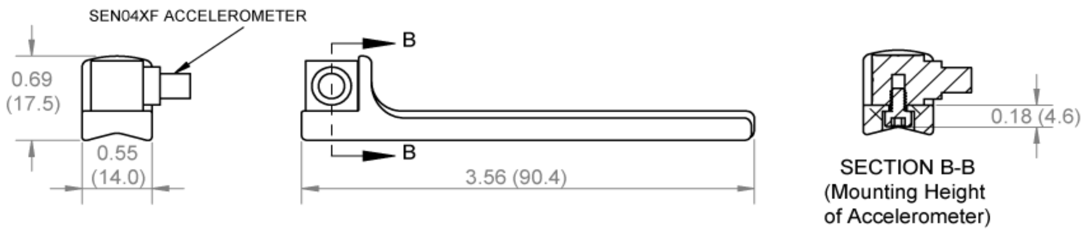
B.1.1 Installing the ADP080A

FIGURE B-1 (Hand Adapter with SEN04XF Accelerometer)



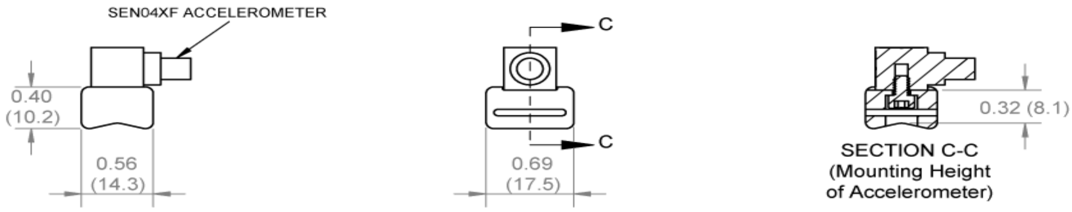
B.1.2 Installing the ADP081A

FIGURE B-2 (Handle Adapter with SEN04XF Accelerometer)



B.1.3 Installing the ADP082A

FIGURE B-3 (Clamp Adapter with SEN04XF Accelerometer)



B.1.4 Measurements

Frequency Response

The frequency response measurements were performed by suspending the test object and exciting it with a modal hammer. The responses were measured in x, y and z directions using a triaxial accelerometer connected to the test object using the specified adapter. A graphic is included to illustrate the test configuration.

Triaxial Accelerometer

The triaxial accelerometer used for these tests was a Larson Davis Model SEN041F having a sensitivity of 10 mV/g.

B.1.5 ADP080A + SEN041

FIGURE B-4 ADP080A + SEN041

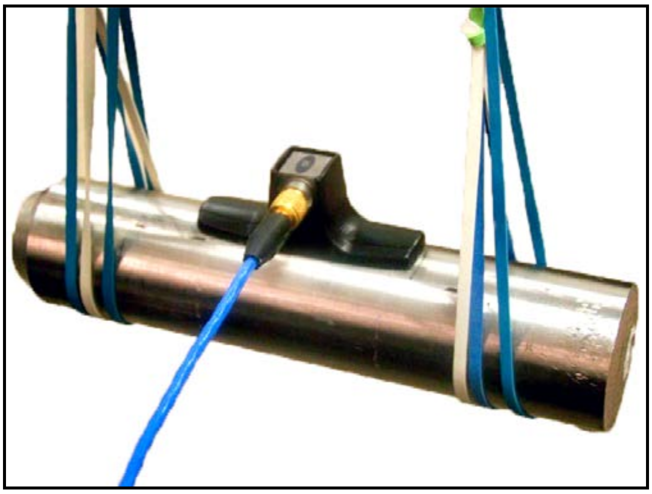
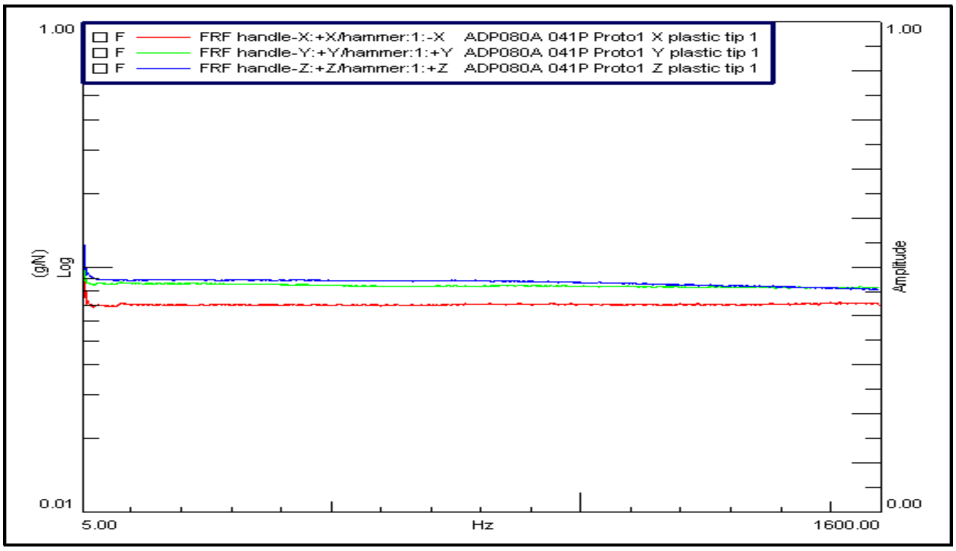


FIGURE B-5 Frequency Response Function X, Y and Z



B.1.6 ADP081A + SEN041

FIGURE B-6 Frequency Response Function X, Y and Z

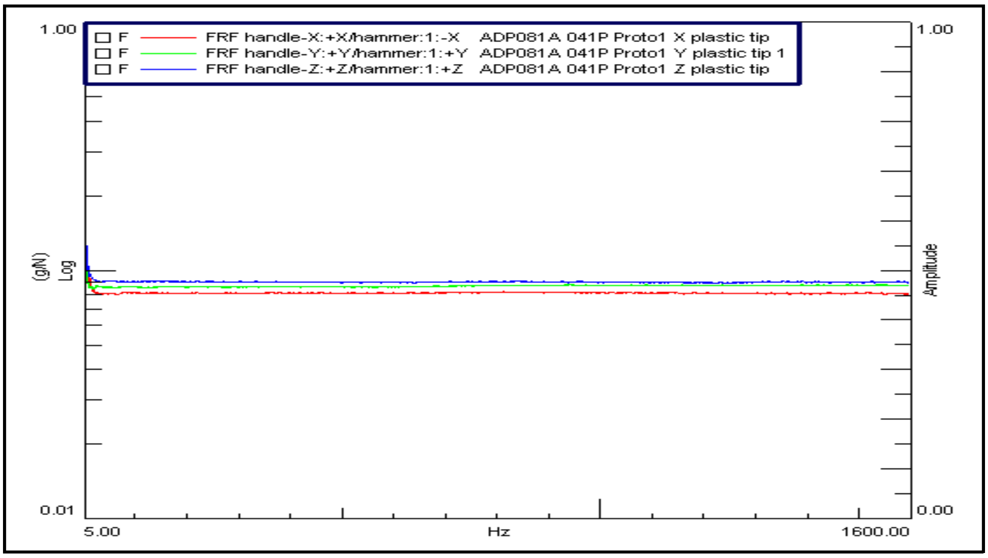
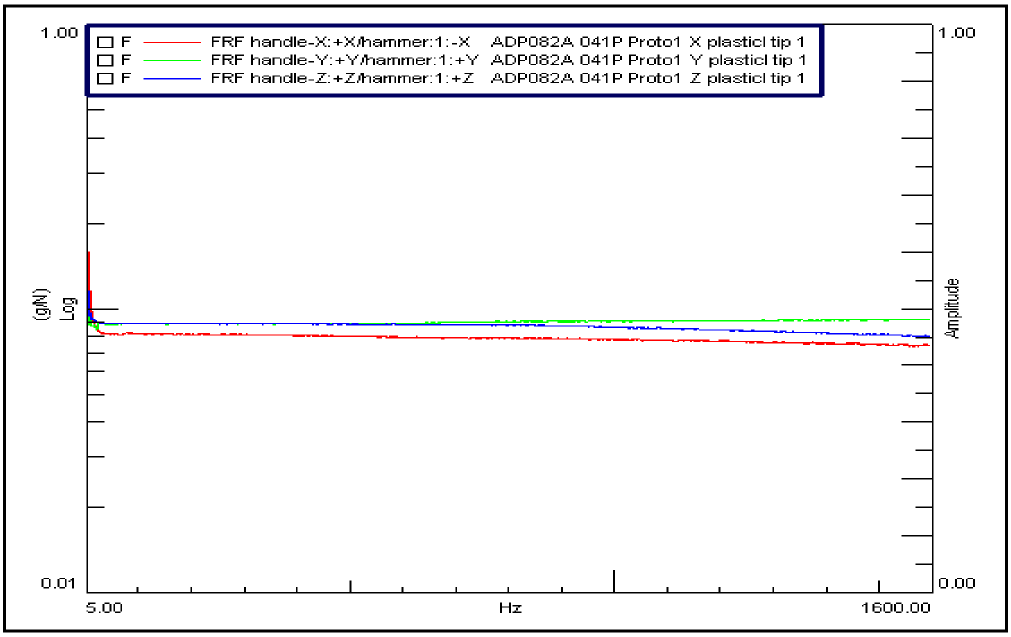


FIGURE B-7 Frequency Response Function X, Y and Z



Appendix C Glossary of Terms

The following table contains definitions and calculations for terminology used in the HVM200 manual.

Term	Equation Description
RMS Acceleration	$$Aeq = \sqrt{\frac{1}{T}\int_0^T a_w^2(t)dt}$$ T= Integration time in seconds. $a_w(t)$ = instantaneous acceleration. t = Time, in seconds. The Aeq integration time is from Run to Reset; the display is updated once per second.
RMS Acceleration in Decibels	$$Aeq = 20Log\sqrt{\frac{1}{T}\int_0^T \frac{a_w^2(t)}{a_o^2}(dt)} \quad dB$$ a_o = reference acceleration, 10^{-6} m/s^2 or 10^{-5} m/s^2 (user selectable)
Allowed Exposure Time	$$\left[\left(a_L m/s^2\right)/(Aeq)\right]^2 \times 8hours$$ a_L is user selectable. A8Exp: a_L typically = 5 A8Act: a_L typically = 2.5

Term	Equation Description
Energy Equivalent RMS Acceleration	The HVM200 measures the following quantities: $$A(8) = \sqrt{\frac{1}{8Hours}\int_0^T a_w^2(t)dt}$$ $$A(4) = \sqrt{\frac{1}{4Hours}\int_0^T a_w^2(t)dt}$$ $$A(2) = \sqrt{\frac{1}{2Hours}\int_0^T a_w^2(t)dt}$$ $$A(1) = \sqrt{\frac{1}{1Hours}\int_0^T a_w^2(t)dt}$$
Exposure Points (P_E)	$$P_E = \left(\frac{ka_w}{a_{\exp}}\right)^2 \frac{T}{8\ \ hours}100$$ a_w = the vibration magnitude in m/s^2. T= the exposure time in hours. k = the multiplying sum factor for the individual axis. a_{exp} = the exposure action value. The summation measurement exposure points will be the maximum of the three axes exposure points.
Running RMS Acceleration LINEAR	$$Arms = \sqrt{\frac{1}{\tau}\int_{t_0 - \tau}^{t_0} a_w^2(t)dt}$$ τ = Integration time, in seconds. t_o = Observation time The linear Arms integration time is controlled by the Averaging time setting; a new linear Arms value is calculated and displayed at the end of each integration period.

Term	Equation Description
Running RMS Acceleration EXPONENTIAL	$$Arms = \sqrt{\frac{1}{\tau}\left(\int_{-\infty}^{t_0} a_w^2(t)\exp\left(\frac{t-t_0}{\tau}\right)dt\right)}$$ τ = Time constant of the measurement. An averaging time of SLOW is equivalent to a time constant of 1 second.
Vibration Dose Value	$$VDV = \left(\int_0^T a_w^4(t)dt\right)^{\frac{1}{4}}$$ The *VDV* integration time is from Run to Reset; the display is updated once per second. The *VDV* is not calculated for units of dB or g. For whole body vibration mode: $VDV_{sum} = max(VDV_x + VDV_y + VDV_z)$
Maximum Transient Vibration Value	Amax = maximum reading of all Arms readings from Run to Reset. The display is updated at the end of each Averaging time period.
Minimum Transient Vibration Value	Amin = minimum reading of all Arms readings from Run to Reset. The display is updated at the end of each Averaging time period.
Long Term Maximum Peak	Amp = peak level of the instantaneous weighted acceleration, $a_w(t)$; measured over the entire measurement period, from Run to Reset. The displayed Amp value is updated once per second.
Short Term Maximum Peak	Peak = peak level of the instantaneous weighted acceleration, $a_w(t)$; measured during one Averaging time period. The peak measurement period is controlled by the Averaging time setting; a new Peak value is calculated and displayed at the end of each Averaging time period.
Summed Instantaneous Acceleration	$$\sqrt{[K_x a_{wx}(t)]^2 + \left[K_y a_{wy}(t)\right]^2 + [K_z a_{wz}(t)]^2}$$ $a_{w\Sigma}(t)$ = instantaneous, summed acceleration $a_{wx}(t)$, $a_{wy}(t)$, $a_{wz}(t)$ = X, Y, and Z axis instantaneous acceleration K_x, K_y, K_z = X, Y, and Z axis Sum Factors The HVM200 uses the formula above to calculate the instantaneous, summed acceleration, $a_{w\Sigma}(t)$. This value is then used to calculate a sum quantity for the A_{rms}, A_{min}, A_{max}, A_{mp}, A_{eq}, Peak, VDV, and PE. K factors affect only sum value and not individual axis data.

Appendix D Regulatory Compliance Statement

FCC
This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications not expressly approved by manufacturer could void the user's authority to operate the equipment.
IMPORTANT! Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada
This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.
IMPORTANT! Tous les changements ou modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actioner cet équipment.

47 CFR 15.505- FCC
Class B
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

Class A- FCC
NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Appendix E Declaration of Conformity

PCB PIEZOTRONICS
LARSON DAVIS
A PCB PIEZOTRONICS DIV.

EU Declaration of Conformity PS142
In Accordance with ISO/IEC 17050

Manufacturer:	PCB Piezotronics, Inc. 3425 Walden Avenue Depew, New York 14043 USA	**Authorized European Representative:**	PCB Piezotronics Europe GmbH Porschestrasse 20-30 41836 Hückelhoven,Germany

Certifies that type of equipment: Human Vibration Meter

Whose Product Models Include: Larson Davis HVM200 and associated accessories and cables

Conform to the following EU Directive(s) when installed per product documentation:	2014/30/EU 2014/35/EU 2014/53/EU 2013/35/EU 2011/65/EU	EMC Directive Low Voltage Directive Radio Equipment Directive (RED) EMF Directive RoHS Recast Directive

Standards to which Conformity is Declared:

Harmonized Standards	EN 61326-1:2013 EN 61326-2-3:2013 EN 61010-1:2010 EN 300 328 V 1.9.1 EN 62209-2:2010 EN 50581:2012	Electrical Equipment for Measurement, Control and Laboratory Use- EMC Electrical Equipment for Measurement, Control and Laboratory Use- EMC Safety Standard Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz) Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.
Emissions Test Standards	EN 55022:2010	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement Class B
Immunity Test Standards	EN 55024:2010	Information technology equipment - Immunity characteristics - Limits and methods of measurement
Industry Standards	ISO 8041-1:2017	Human response to vibration — Measuring instrumentation
Test Reports	Transmitter Report Immunity Report Emissions Report EMC/Safety Report SAR Report	D1244.0030(A) HVM200 Nemko EN 300 328 Test Report D1244.0029(A) HVM200 Nemko EN 55024 Test Report D1244.0028(A) HVM200 Nemko EN 55022 Test Report D1247.0023(A) HVM200 Internal EMC and Safety Test Report D1244.0031(A) HVM200 RF Exposure Lab EN 62209-2 Test Report

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) Standard(s)

Place: Provo, UT **Date:** 10/10/17

Signature: Carrie Termin

Name: Carrie Termin

Title: Regulatory Affairs and Product Certification Specialist

- ISO 9001 Certified PCB Piezotronics, Inc. Phone: 716-684-0001 FAX: 716-684-0987

PS142 Rev. A 10/10/2017

Larson Davis - a PCB Piezotronics division LarsonDavis.com

P/N IHVM200.01 Rev I

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