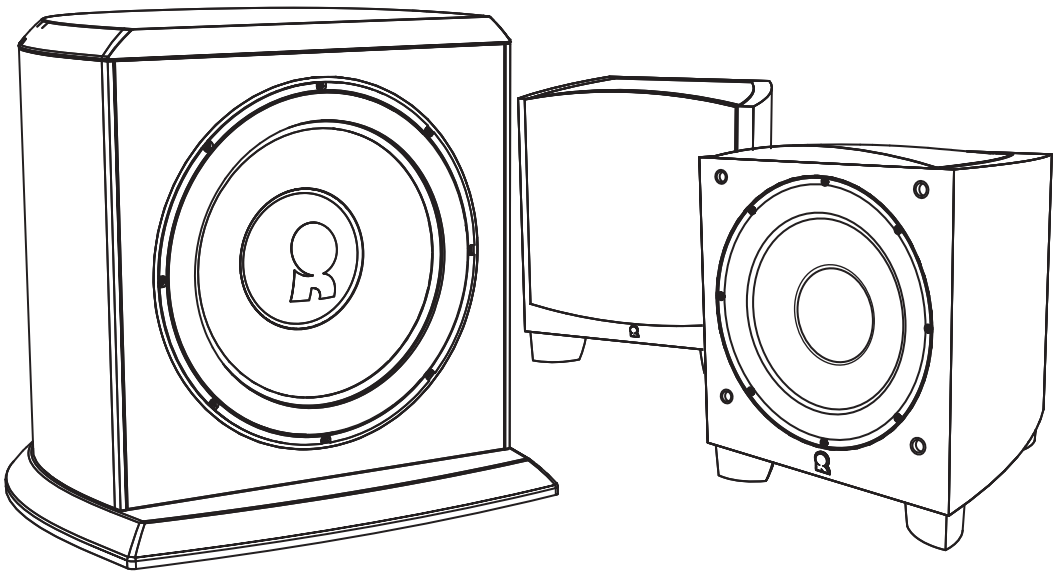
REVEL®

LFO

(Low-Frequency Optimizer)

Software User Guide



REVEL®

by HARMAN

ABOUT THIS DOCUMENT

Your Revel subwoofer contains an ultra high-quality DSP-based signal processor that can maximize the subwoofer's low-frequency performance (and in a 2.x-channel music system, the performance of the main left and right speakers). The subwoofer's DSP processor offers sophisticated user-configurable crossover functions, multi-band parametric equalization (EQ), and individual speaker delay and polarity settings, all of which are configurable with your computer via the downloadable Revel LFO (Low-Frequency Optimizer) software (LFO software).

This *Revel LFO Software User Guide* is a comprehensive guide to the installation and use of the Revel LFO software. This guide also details the recommended audio measurement equipment and procedures you will use in the optimization process, how to load the test results into the Revel LFO software, and how make equalization adjustments to your system. Before attempting to use the Revel LFO software you should thoroughly and completely read this user guide.

The first part of this document provides instructions for optimizing the performance of subwoofers being used in a multi-channel surround-sound system. The second part provides instructions for optimizing the performance of subwoofers being used in a two-channel audio system.

To enjoy the maximum performance that your Revel subwoofer can deliver, first read and perform the setup instructions found in the quick-start guide that was included with it, particularly the placement recommendations. (For reference, the placement recommendations are repeated directly below, and the Ultima Rhythm2 and Performa3 B112/B110 quick-start guides are repeated in their entirety in the Appendix section at the end of this document). You should also read the instructions found in the owner's manuals of the associated components in your audio system.

SYSTEM OPTIMIZATION BY YOUR REVEL DEALER

If the kind of precise audio tuning described in this guide is not something you want to undertake, we recommend that you talk with your authorized Revel dealer about having them professionally calibrate your system. If you wish to optimize your system yourself read on for detailed instructions.

BEFORE YOU BEGIN

Before using the Revel LFO software, review the following placement information to ensure that your subwoofer(s) are optimally located in your listening room; download and install the LFO software in your computer and connect your computer to your Revel subwoofer.

SUBWOOFER PLACEMENT CONSIDERATIONS

When using subwoofers within the limited confines of a typical home theater or listening room, the reflections, standing waves and absorptions generated within the room will create peaks and dips in the bass response that can vary greatly depending on where the listeners are located in the room – a listener seated in one location may hear an overabundance of bass created by a response peak at that location, while another listener only a few feet away may hear a considerable lack of bass created by a response dip at that location.

The subwoofers' locations within the room (along with the room's dimensions) also have a profound effect on the creation of these bass response peaks and dips. Careful subwoofer placement alone cannot compensate for all bass response peaks and dips throughout a room, but careful subwoofer placement can eliminate or significantly reduce the largest response dips.

It is very important to reduce response dips throughout the room as much as possible via proper subwoofer placement because equalization cannot be used to compensate for large response dips. For example, using equalization to attempt to restore a 13dB response dip requires that the subwoofer amplifier delivers twenty times the power at that frequency. This can quickly overdrive the subwoofer amplifier into clipping, which will significantly degrade audio quality and reduce the system's overall dynamic range.

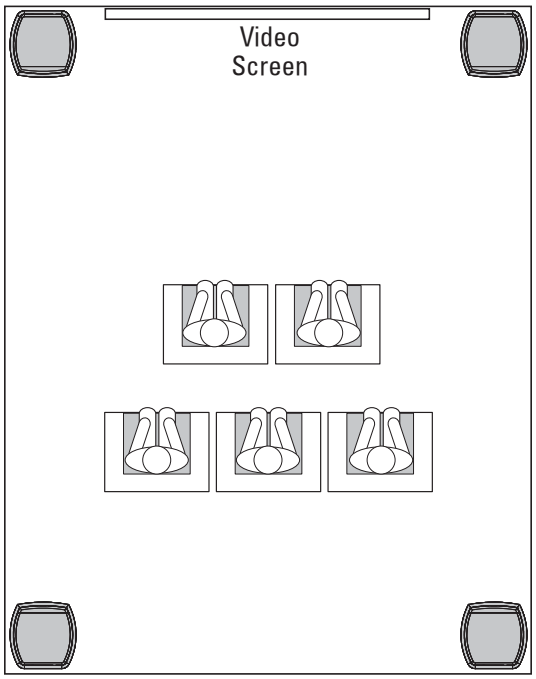
In almost any room, placing the subwoofers in corners will produce the fewest large bass response dips and will also produce the most large bass response peaks. With the subwoofers so placed, you can then use the Revel LFO software's sophisticated room equalization capability to compensate for the response peaks, resulting in superb bass performance.

How Many Subwoofers Do I Need?

Revel strongly recommends that you install multiple subwoofers regardless of your room's size. Even after using the LFO software's room equalization to remove the response peaks, installing a single subwoofer will result in the least consistent bass performance throughout the room. Using multiple subwoofers can cancel some room modes at the various listening locations, resulting in much more consistent low-frequency sound quality throughout the listening area. Additionally, it is often impossible to locate a single subwoofer such that large response dips, which cannot usually be corrected via equalization, are not present. The use of two or more properly placed subwoofers can almost always eliminate or significantly reduce such dips in response.

Placing Four Subwoofers

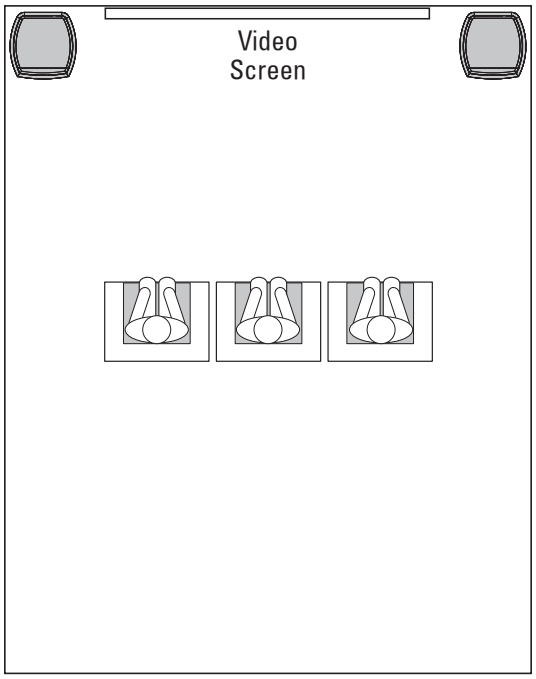
When installing four subwoofers, place each one in a room corner. In rooms with more than four corners, use the four corners closest to the listening area.



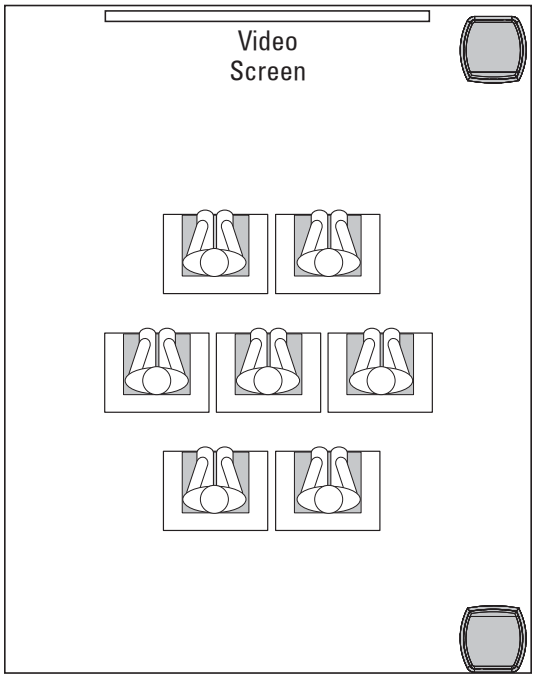
Placing Two Subwoofers

Placement of two subwoofers will be determined by your room's seating arrangement.

For Rooms with a single row of seating, placing the subwoofers in the two front corners will produce the most consistent bass performance throughout a single row of seating.

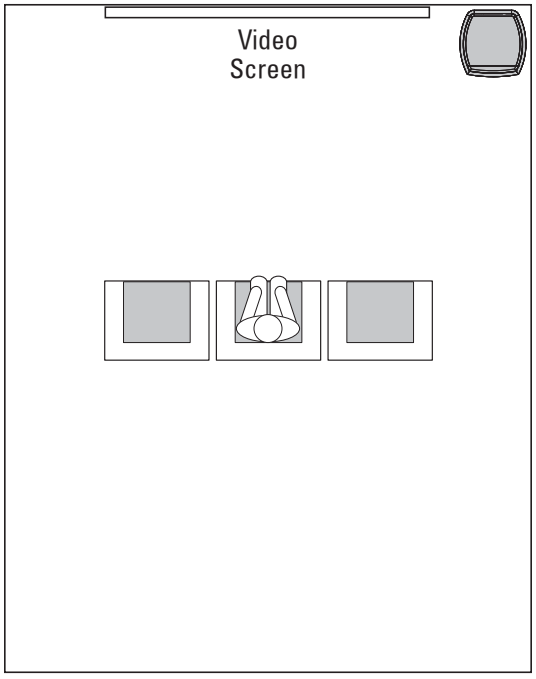


For rooms with multiple seating rows, placing one subwoofer in a front corner and the other subwoofer in the rear corner on the same side of the room (as shown below) will produce the most consistent bass performance throughout multiple seating rows. from front-to-back. As explained previously, placement of two subs in the front corners will still improve bass performance consistency from side-to-side. Therefore, if two subwoofers are used with more than one row of seats, you should measure the performance of both subwoofer location options (front-corners and side-corners) from all of the seats, while looking to minimize the presence of response dips throughout the seating area.



Placing a Single Subwoofer

When installing a single subwoofer, be prepared to experiment with different locations to find the one that produces the best results throughout your room's seating area. As in the previous examples, placing the subwoofer in a corner will produce the fewest number of deep response dips, which are difficult to correct with equalization.



When using only a single subwoofer we strongly suggest performing the measurements described in *Measuring a Surround-Sound System's Low-Frequency Response In Your Listening Room*, on page 8, with the subwoofer in each of the room's corners to find the corner that produces the most consistent results at the various listening positions in your room..

Since wall construction is almost never perfectly identical on opposite walls, common formulas such as placing subwoofers at 1/4 points rarely work in practice. The best solution is to make high-resolution measurements from the primary listening area while experimenting with subwoofer placement.

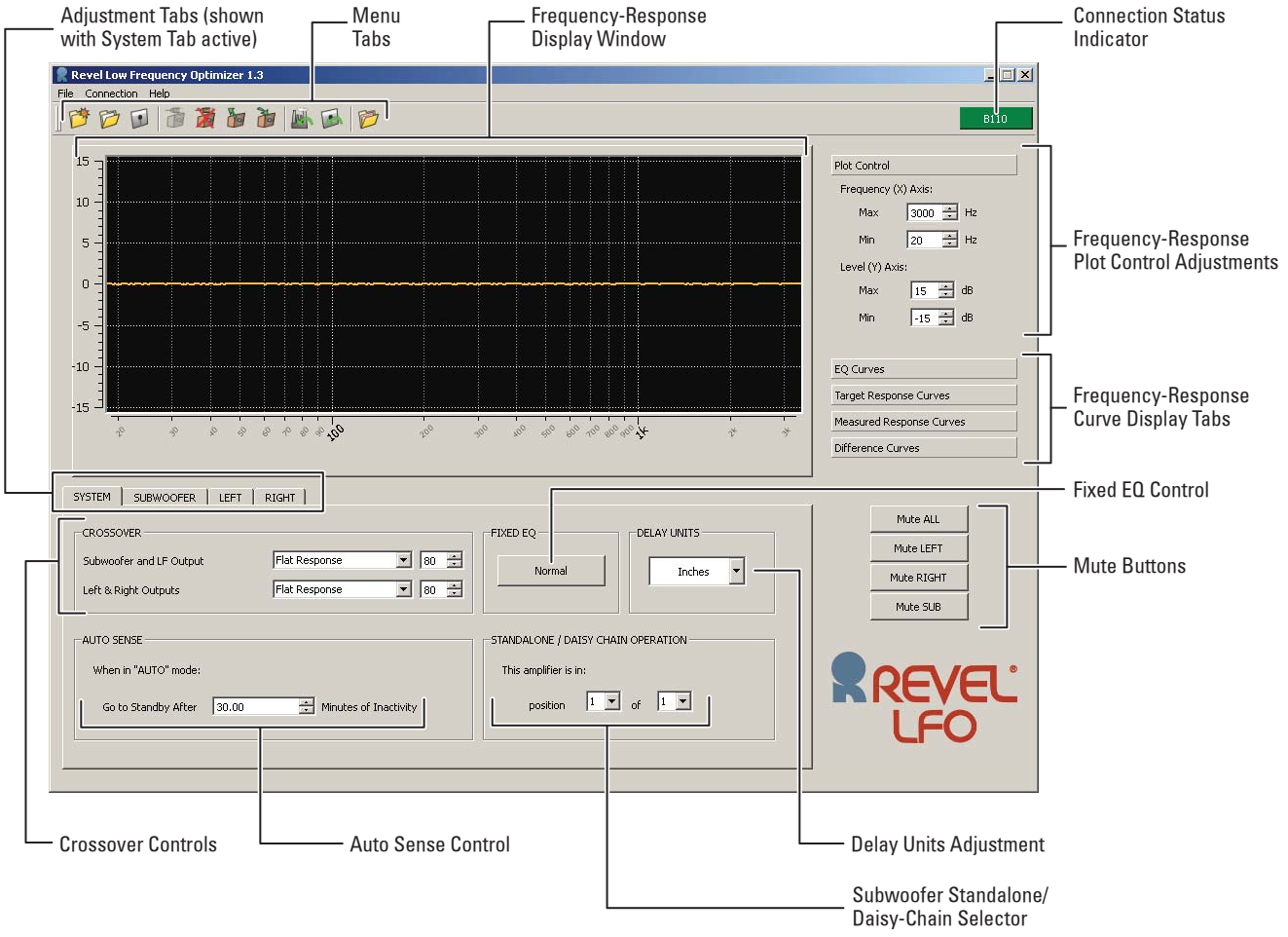
DOWNLOADING AND INSTALLING THE REVEL LFO SOFTWARE

To download the software and test noise, follow the instructions on the Revel Web site, www.revelspeakers.com. Once you have downloaded and uncompressed the files, follow the on-screen installer's instructions to install the software.

Computers running Microsoft® Windows must be running Windows XP (Service Pack 2) or newer; computers running the Mac® OS must be running OS X, 10.6x (Snow Leopard) or newer, with an available USB port.

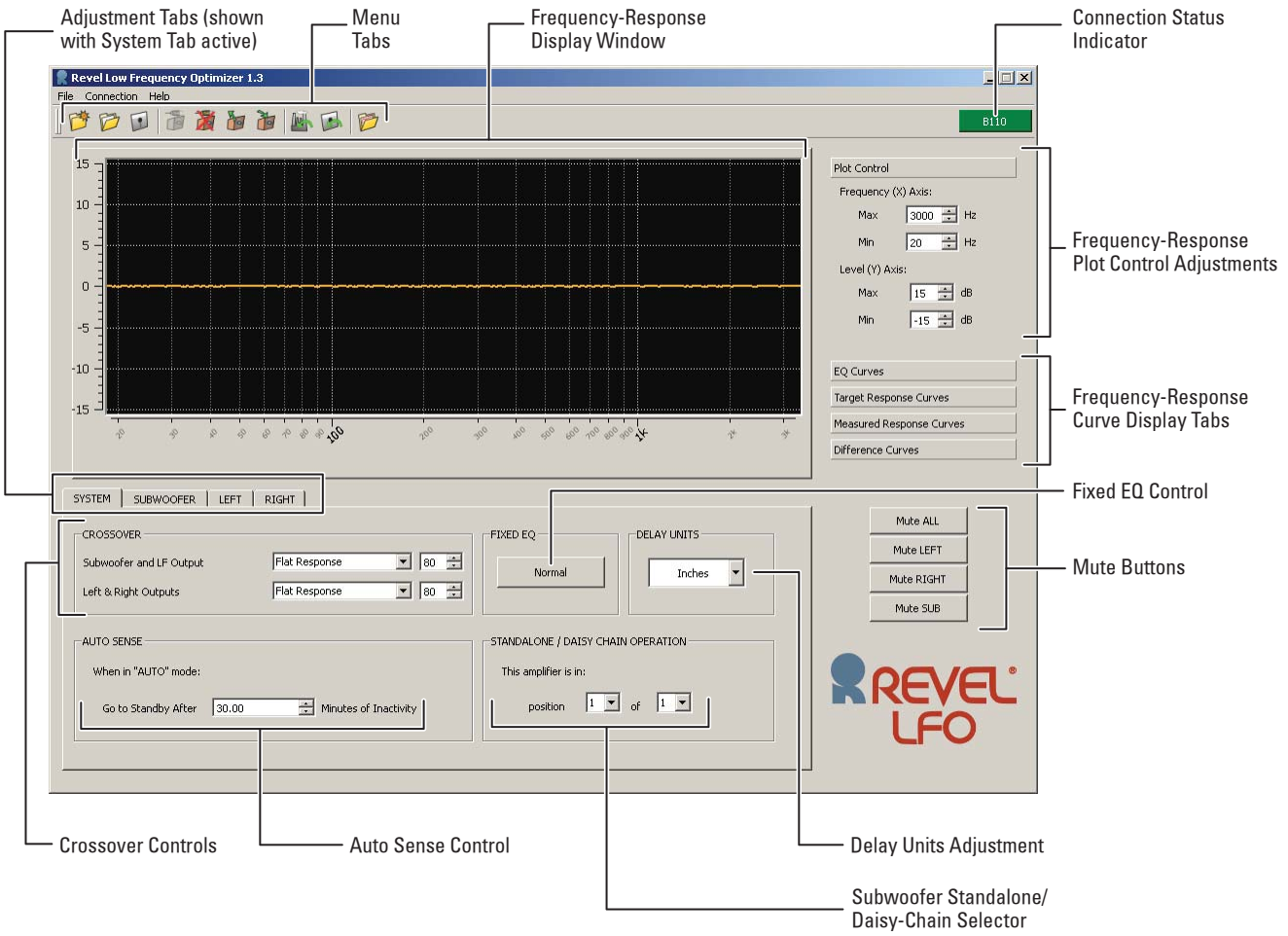
REVEL LFO SOFTWARE INTERFACE

When you launch the LFO software, the interface window shown below will appear:



Adjustment tabs: These tabs let you perform subwoofer system adjustments ("System" tab), apply sophisticated corrective equalization to the subwoofer ("Subwoofer tab), or to the left and right speakers ("Left" and "Right" tabs, only in two-channel systems that use the subwoofer's left and right Hi-Pass Output connections to send the audio signals to your left and right speakers). The subwoofer system adjustments are explained below; for details about the equalization controls see *Determining and Applying Corrective Equalization,* on page 14.

Menu tabs: These tabs provide access to LFO software basic operation, data importation and subwoofer connection functions. From left to right, the tabs are: Create New Design, Load From Disk, Save To Disk, Connect To Amplifier, Disconnect From Amplifier, Load From Amplifier, Save To Amplifier, Reload Factory Settings, Revert To Last Saved and Import Curve.



Frequency-response display window; This window provides graphic display of selected frequency-response curves for comparison and adjustment.

Connection status indicator: This indicator is red when there is no connection between the LFO software and a Revel subwoofer; it is green (and shows the subwoofer's model number) when there is an active connection between the software and a subwoofer.

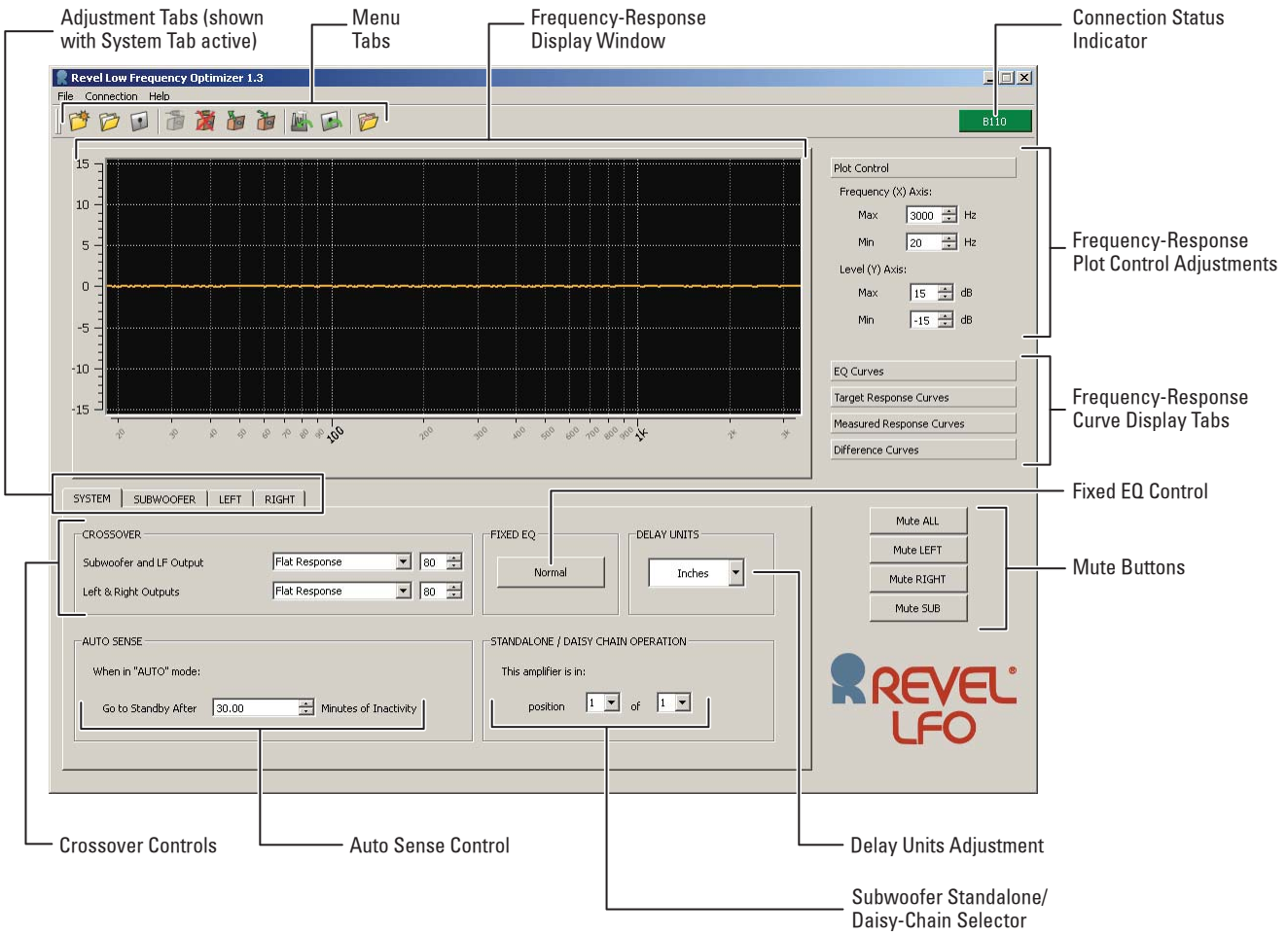
Frequency-response plot control adjustments: These controls allow you to adjust the vertical and horizontal scales of the frequency-response window, and to adjust the positions of the different frequency response curves that are displayed in the window.

Frequency-response curve display tabs: These tabs let you select the different types of frequency-response curves to be displayed in the window.

- **Fixed EQ control:** This lets you determine the subwoofer's performance in the infrasonic region (below 20Hz), where there is little, if any, intentional program content. There are two settings:
  - » "Normal" limits the subwoofer's ability to reproduce infrasonic frequencies. This maximizes the dynamic range throughout most of the audible bass spectrum and reduces the possibility of the subwoofer's amplifier being driven into audible clipping.
  - » "Extended" allows the subwoofer to reproduce infrasonic frequencies. This can increase the possibility of the subwoofer's amplifier being driven into audible clipping, which can limit the dynamic range throughout most of the bass spectrum.

Mute buttons: These buttons allow you to mute the selected output.

- The "Subwoofer" mute button mutes only the subwoofer that is actively connected to the computer via USB cable at the time the button is selected, even if multiple subwoofers are connected together via daisy-chaining.
- If you are not using the subwoofer's left and right Hi-Pass output connections the Left and Right Mute buttons do not function.



Subwoofer System controls: When the "System" adjustment tab is active the following controls are available for the connected subwoofer:

> **NOTE:** The Subwoofer System controls only affect the subwoofer that is actively connected to the computer via USB at the time the adjustments are made. In systems with multiple subwoofers you will need to connect each subwoofer to the computer one at a time and set these controls individually for each subwoofer.

- **Delay units adjustment:** This control lets you set the units for the subwoofer delay adjustment to inches, centimeters or milliseconds (ms). See page 9 for details.
- **Subwoofer standalone/daisy-chain selector:** In systems that have more than one Revel subwoofer, use this control to designate each subwoofer in the chain according to where it is connected within the chain. Always designate the subwoofer that is directly connected to your system's preamp/processor/AVR as "1"; designate the next subwoofer in the chain as "2," and so on.
- **Auto Sense control:** This control lets you determine how long the subwoofer will remain turned on after the audio signal ceases when the subwoofer's Power Mode switch is set in the "Auto" position.
- **Crossover controls:** These controls determine the settings of the subwoofer's internal crossover network.

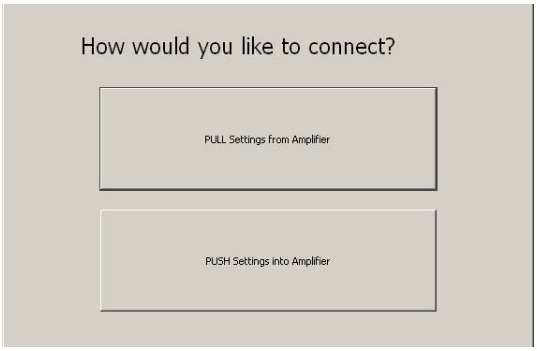
  IMPORTANT: If you have connected the subwoofer to a processor/AVR that has internal bass management (low-pass crossover) for the subwoofer/LFE output, you should set both crossover controls to "Flat Response."

CONNECTING YOUR COMPUTER TO YOUR REVEL SUBWOOFER

Once you've installed the Revel LFO software in your computer you must establish a control connection between your computer and your Revel subwoofer(s).

1. Turn the subwoofer's Power switch to "On." (The Power LED will glow green.)
2. Connect the computer to the subwoofer's USB port using a USB cable.

   IMPORTANT: If your system has more than one subwoofer, connect the computer to the subwoofer that is connected directly to the preamp/processor's Subwoofer Out or LFE Out jack. Make sure this subwoofer is designated as "1" in the Subwoofer standalone/daisy-chain selector (see above). .
3. Launch the Revel LFO software.
4. Select the "Connect to Amplifier" menu tab.
5. A dialog box will appear, presenting two options:



- If this is the first time you are connecting your subwoofer(s) to the LFO software (as it will be for most users), select "PUSH Settings Into Amplifier."
- If you have already used the LFO software to set up the connected subwoofer and you wish to save the settings, select "PULL Settings From Amplifier."

NOTE: In systems with multiple subwoofers you must close the Revel LFO software before connecting the USB cable to each subwoofer for programming.

OPTIMIZING YOUR SYSTEM'S LOW-FREQUENCY PERFORMANCE

Using the LFO software to optimize your system's low-frequency performance consists of the following steps:

1. Obtaining and setting up the measurement hardware and software.
2. Measuring your system's low-frequency response in your listening room.
3. Selecting a target frequency response curve for your system.
4. Determining the corrective equalization required to bring your system as close to the target frequency response curve as is practical.
5. Applying ("pushing") the corrective equalization to your Revel subwoofer(s).
6. Measuring the results, making any required corrections and re-measuring as necessary to achieve the desired results.

OBTAINING THE MEASUREMENT HARDWARE AND SOFTWARE

There are several different audio measurement systems available.

AudioTools

Revel recommends using Studio Six Digital's AudioTools audio measurement app (ver. 5.3 as of this writing) for iOS (iPhone/iPad) devices, which is available at: https://itunes.apple.com/us/app/audiotools/id325307477?mt=8.

- If your iPhone/iPad has iOS 6 or later you can use your iOS device's built-in microphone to make the necessary audio measurements. (although with considerably less accuracy than when used with a high-quality external test microphone).
- If your iPhone/iPad has an operating system earlier than iOS 6, you must purchase a 3rd-party test mic (see list below) to make the necessary audio measurements.
- Your iOS device and the computer running the LFO software must both be joined to the same Wi-Fi network to be able to export your measurement results from the iOS device into the LFO software.

Recommended Test Microphones:

» AudioTools iTest mic. This microphone requires no additional hardware.

» AudioControl CM-20, CM-125 or CM-145 or Josephson C-550H (available at http://www.audiocontrol.com/t37/62294/Standard.html)

» Behringer ECM8000 (see http://www.behringer.com/EN/Products/ECM8000.aspx).

The Audio Control, Josephson and Behringer microphones require the additional purchase of the AudioTools IAudioInterface2 box, a microphone stand (for precise and consistent mic positioning) and an XLR-terminated microphone cable.

Alternative Audio Measurement Systems

If you choose to use an audio measurement system other than AudioTools, to ensure properly precise measurements it must have the following features and capabilities:

- An RTA function with at least 24th-octave resolution or FFT function with at least 16k resolution
- A high-quality measurement microphone and input circuitry
- The ability to output measurement data in standard text format
- The ability to do spatial averaging

Test Noise Requirements:

In addition to the measurement hardware described above, you will also need the test noise CD audio file that was included as part of the LFO software download. Locate the test noise audio file (named "Measurement Stimulus Correlated Pink Noise –20dB"). You need to be able to play this CD on your audio system, either through a disc player in the system (in which case you will need to burn the audio file onto an audio CD), or through your computer, which will need to be connected to your audio system via a digital connection (HDMI, coaxial or TOS-link).

MEASURING A SURROUND-SOUND SYSTEM'S LOW-FREQUENCY RESPONSE IN YOUR LISTENING ROOM

> **NOTE:** These instructions explain how to measure and equalize a multi-channel surround-sound system. For instructions on how measure and equalize a two-channel audio system, please see *Measuring a Two-Channel System's Low-Frequency Response in Your Listening Room,* on page 25..

The Revel LFO software is extremely sophisticated and flexible, and can be used in several different ways. How you use it will depend on the configuration of your audio system, how "hands-on" you're willing to get and how accurate you want the results to be.

SPATIAL AVERAGING

The most accurate measurement results will be obtained by using a spatial average of several measurements made with the measurement microphone (mic) at several different listening locations in the seating area. If your test/measurement system allows for spatially-averaged measurements you should do so.

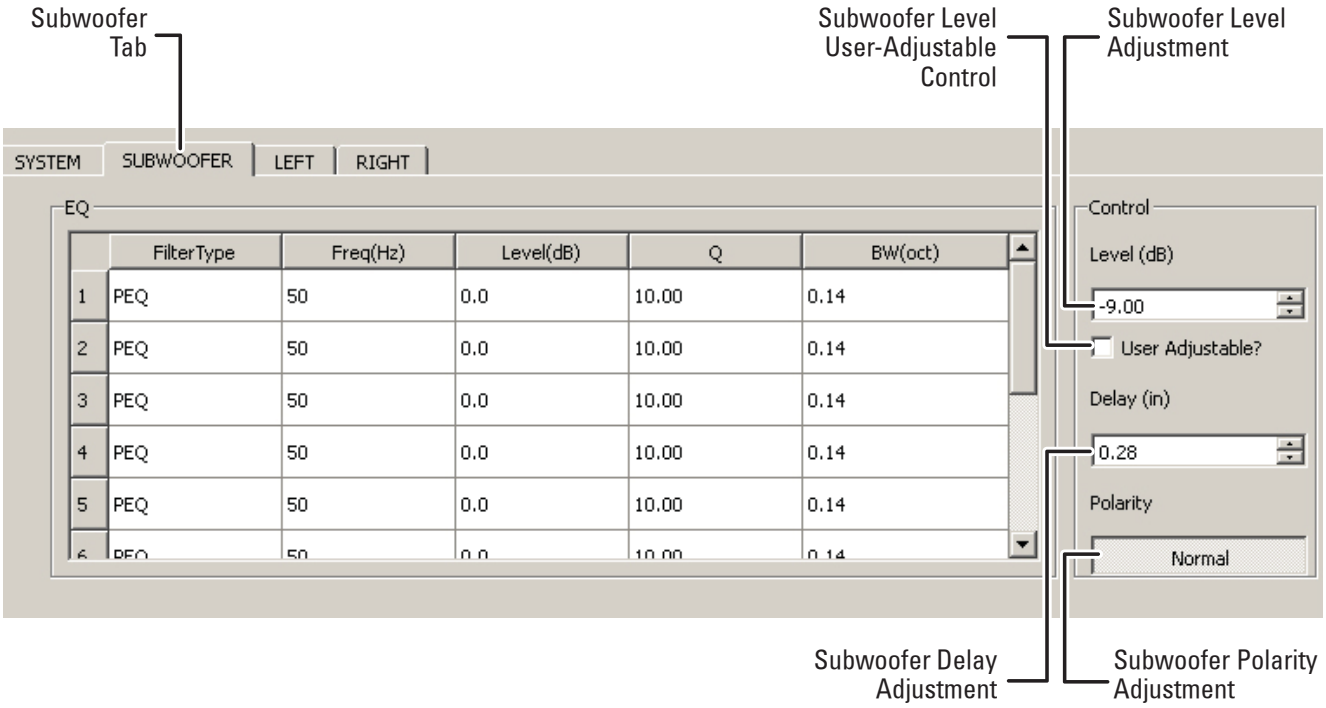
If your test/measurement system does not allow for spatially-averaged measurements you will need to perform a single measurement with the mic placed only at the Primary Listening Position (PLP), but the results will be less than optimal, even at that single listening location. The procedures in this section describe how to measure using a spatial average.

BEFORE YOU BEGIN, PLEASE NOTE THE FOLLOWING.

- If your system processor's bass management crossover has adjustments for crossover frequency and slope, set it to an 80Hz crossover frequency and 4th-order low-pass and high-pass slopes. If your processor can automatically set the crossover frequency and slope, you must disable this function.
- If your system's processor has a built-in equalization function, perform it before you attempt to measure or equalize your system.
- Set the Power Mode switches on all subwoofers to the "On" position.
- Make sure that the test noise *only* plays through your system's subwoofer(s). If your system has a separate processor and power amplifier(s), turn the power amplifiers off. If your system has an AVR you may have to go into its speaker setup menu and temporarily set the system up as if it has only left and right front speakers. Then you will need to disconnect one of the speaker wire conductors each from the left and right front speakers.

  CAUTION: Make sure that the loose conductor does not come in contact with the other conductor or with anything else on the speaker. Touching conductors can create a short-circuit that can damage your amplifier.

• Select the Subwoofer Tab. The subwoofer adjustment screen will appear (see illustration below).



• Ensure that the Subwoofer level User-Adjustable control is not selectd (no check-mark). Adjust the Subwoofer level as follows:

» Performa3 B112/B110: –9dB

» Ultima Rhythm2: –19dB

Once you have completed the entire measurement/equalization process you can re-balance the subwoofer volume with that of the system's other speakers. See *Adjusting Subwoofer Volume,* on page 23.

• Set the delay for each subwoofer in the system as follows:

1. Set your preamp/processor's delay setting *for only the subwoofer* to "0 feet/meters"
2. Measure the distance from each subwoofer to the room's primary listening position (PLP).
3. Select the System tab (see illustration on page 5). Use the Delay Units adjustment to set the units for the distance setting.
4. Select the Subwoofer tab and set the Subwoofer delay adjustment value to what you measured for that subwoofer.

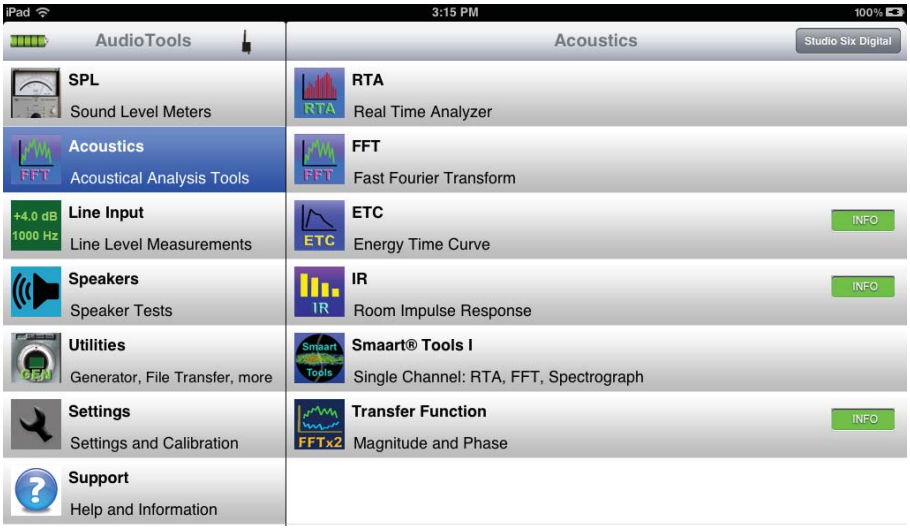
NOTE: In systems with multiple subwoofers you will need to perform the subwoofer level and delay adjustments for each subwoofer. Select the System tab (see illustration on page 5) and use the Subwoofer standalone/daisy-chain selector to select each subwoofer, in turn then perform the adjustments.

• For testing purposes, set the Subwoofer Polarity Adjustment to "Normal" for each subwoofer in the system. You can adjust this after you have completed measuring and equalizing your system. See *Adjusting Subwoofer Polarity,* on page 24.

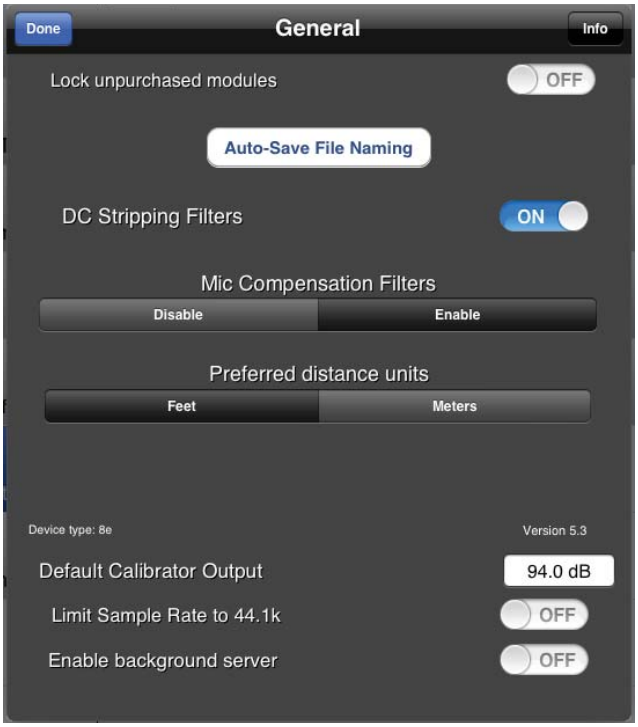
SETTING UP AUDIOTOOLS

NOTE: If you're using a different audio measurement system, go through its setup procedure at this time.

1. Launch AudioTools on your iOS device. The main menu screen will appear.

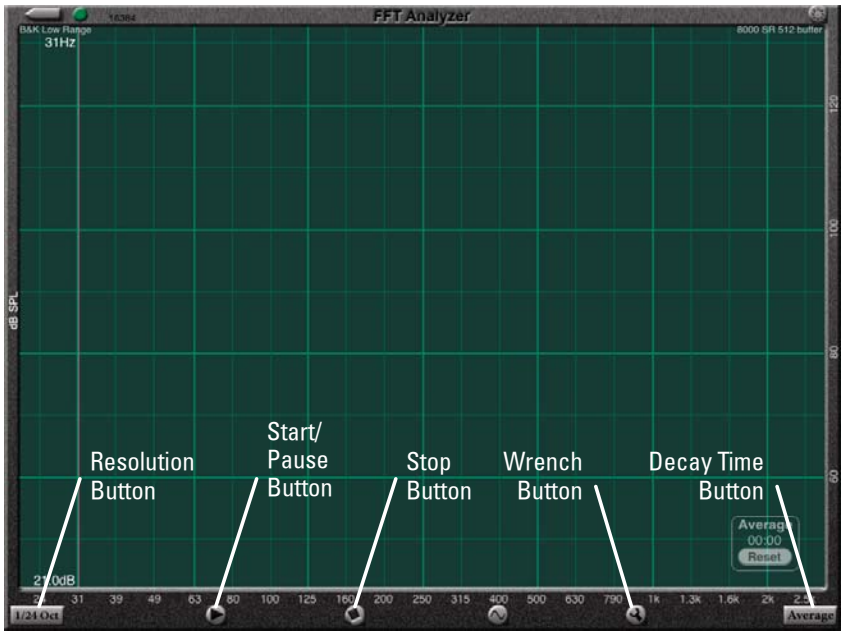


2. Tap Settings, then touch General. The General settings window will appear.



3. If you are using the iOS device's built-in microphone, select "Enable" under Mic Compensation Filters.
4. Set your preferred distance units to either feet or meters.
5. Make sure all of the other settings match those shown in the illustration above, then select Done. The main AudioTools menu screen will return.

6. Select Acoustics, then select FFT (Fast Fourier Transform). The measurement graph screen will appear.



7. Tap the Wrench button. The FFT Setup window will appear. Make sure all the settings match those shown below, then tap Done:

8. Tap the Resolution button. In the slide-in window that appears, set the resolution to 1/24th-octave then tap the button again.
9. Tap the Decay Time button. In the slide-in window that appears, momentarily set the decay time to Fast and then leave it set to Average.

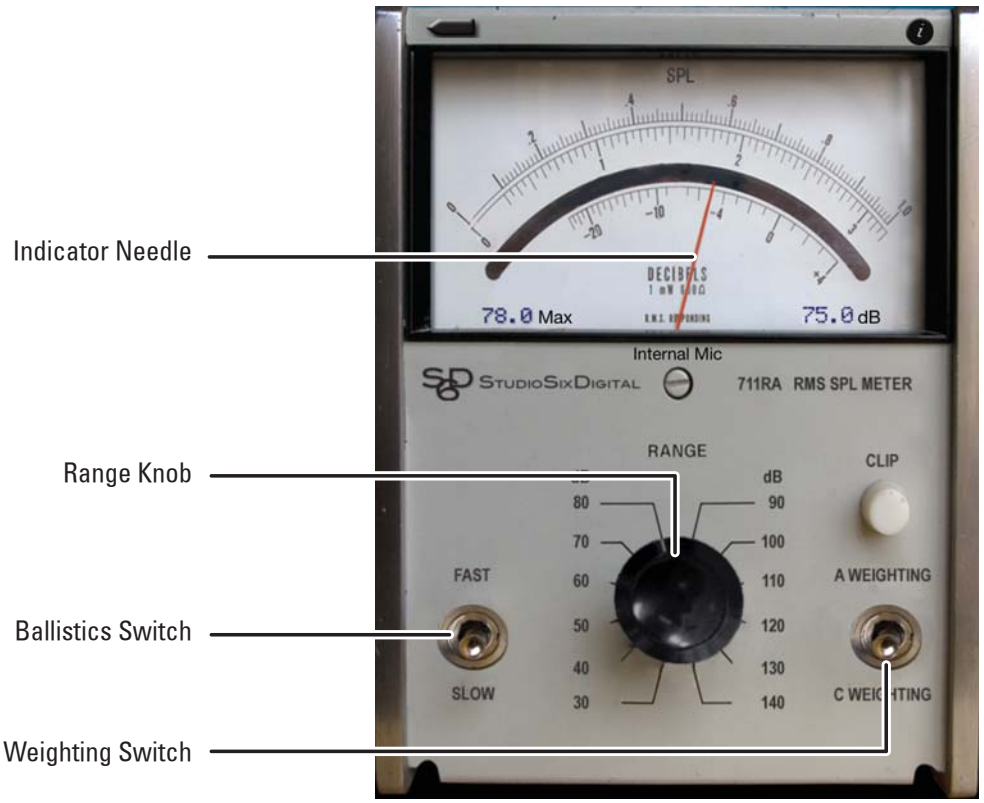
MEASURING YOUR SUBWOOFER(S)

1. Determine the various locations for the measurement microphone. You should optimize the measurements for your room's seating area by taking measurements only within it. (A large seating area will require more measurements.)

   NOTE: You can weight the results to favor the primary listening position (PLP) by measuring for a longer time in that location than at the other mic positions.

2. Play the test noise through the subwoofer(s).
   - If you have previously established your system's reference playback level using the processor's auto setup procedure or using an SPL meter, set the system at the reference volume control setting.
   - If your system's preamp/processor does not provide a method of establishing a reference playback level, you must use the AudioTools SPL Meter function to establish the proper playback level for the test noise you are using to perform these measurements:

     a) On the AudioTools main menu's left column, tap "SPL". In the right column, tap "SPL Meter (Analog Sound Level Meter)". The SPL Meter screen will appear.



     b) Set the meter up as shown above: Range Knob = 80dB, Ballistics Switch = Slow, Weighting Switch = C Weighting.

     c) Hold the iOS device in the PLP while the test noise is playing through the subwoofer(s). Adjust your audio system's main volume control so the meter's indicator needle points to –5dB on the bottom scale and the dB indicator in the meter's lower right indicates 75.0dB, as shown in the illustration above.

     d) Once you have set the volume so the test noise plays at 75dB, we suggest that you write down the system's volume control setting for future reference.

3. Place the microphone in the PLP, tap the AudioTools Start button and measure for at least 1 minute (the AudioTools counter will read 6:00 at the 1-minute point). Measure for a longer time to weight the results to favor the PLP.

   IMPORTANT: Make sure the room remains free of all extraneous noises while you're performing the measurement. We recommend turning-off any HVAC systems, and other sources of noise, such as bar refrigerators, etc. Doors should be opened or closed to match the normal conditions when using the system.

4. Tap the AudioTools Pause button to pause the measurement.
5. Move the mic to the next measurement position, tap the Start button to resume measuring; measure for 1 minute, then tap the Pause button.
6. Repeat Steps 3 – 5 for each mic position.

   NOTE: We recommend using at least five repeatable measurement positions.

DETERMINING AND APPLYING CORRECTIVE EQUALIZATION

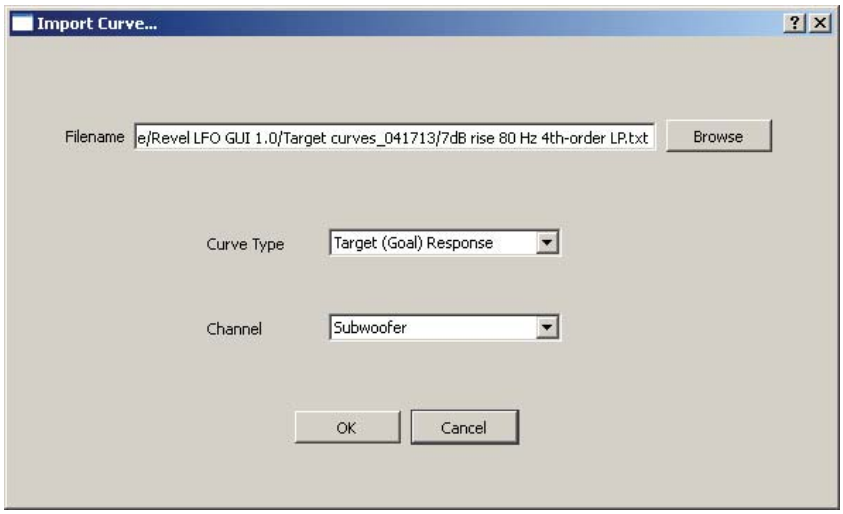
Selecting and importing a Target Response Curve

Before you can correct your system's response you need to select a target response curve that you want for your system. Although it would be natural to assume that a totally flat frequency response curve would be the ideal target, perfectly flat frequency response actually sounds quite unnatural.

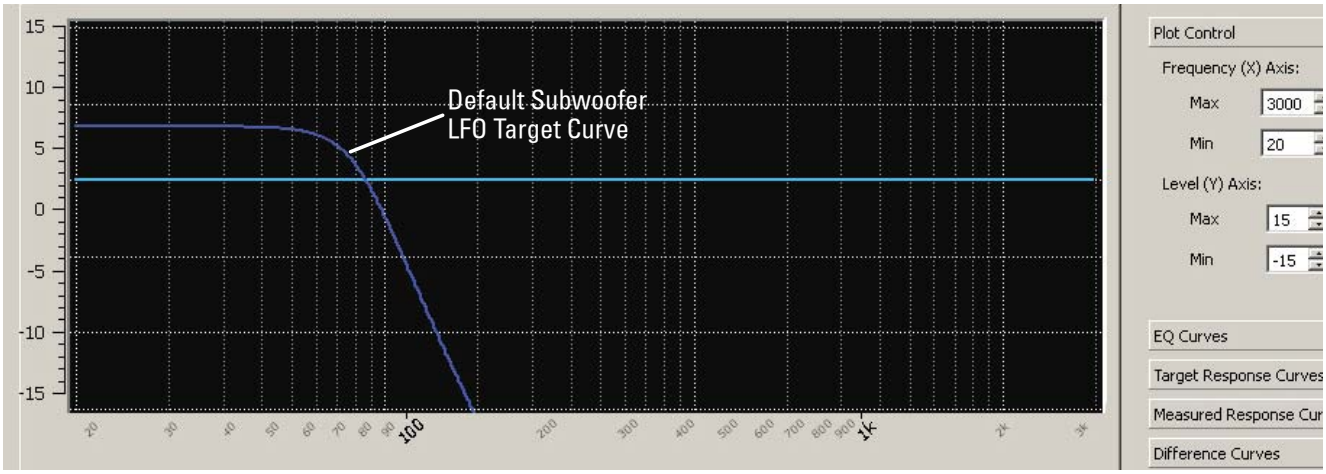
When sound is produced in an enclosed space, low frequencies are reinforced by multiple surface reflections, creating a phenomenon known as "room gain." Equalizing your system to achieve a flat response curve will remove the effect of room gain, and the resulting sound will be unnaturally lacking in bass.

The LFO software ZIP file you downloaded includes a "Target Curves" folder that contains a target curve with the filename "Default Subwoofer LFO Target Curve." Our research shows that this curve produces the most natural-sounding results in most listening rooms.

1. On the LFO screen, select the Import Curve menu tab. The Import Curve window will open.



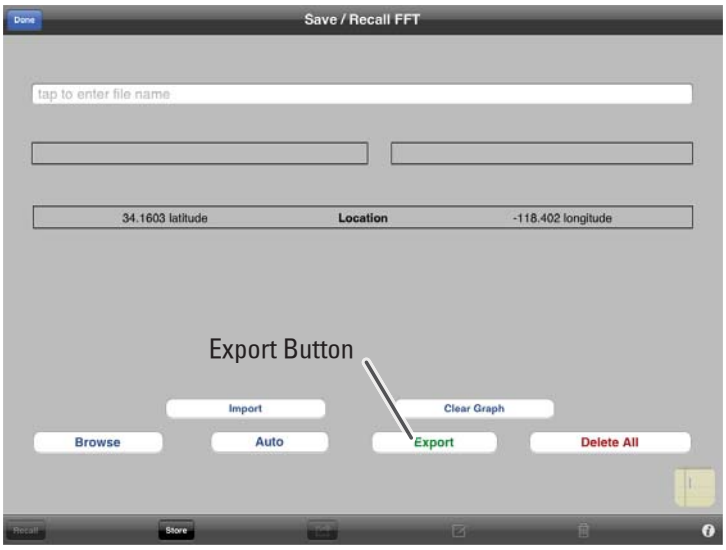
2. Make sure that the Curve Type is set to "Target (Goal) Response" and the Channel is set to "Subwoofer."
3. Use the Browse function to navigate to the Target Curves folder. Open the folder.
4. Select the target curve with the filename "Default Subwoofer LFO Target Curve," click "Open", then click "OK."
5. The Target Response curve will appear in the LFO Frequency Response Display window.



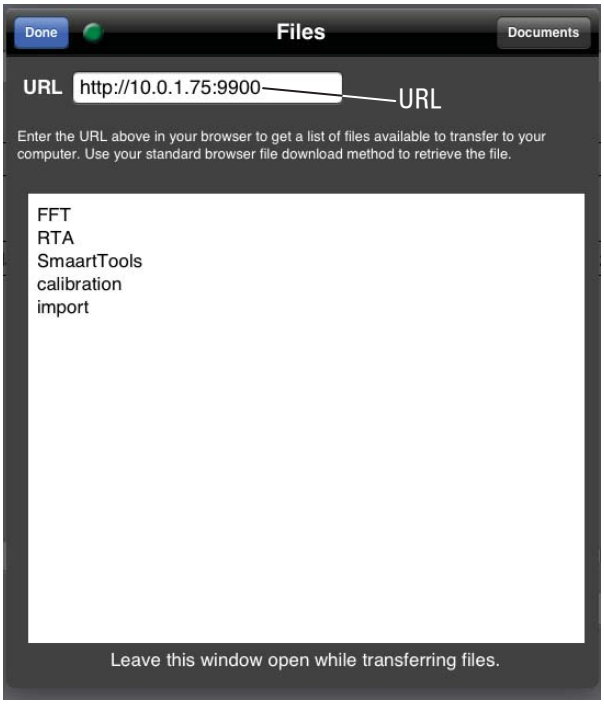
Exporting Measurement Results into LFO Software

Before you can apply corrective equalization you must export your measurement results into the LFO software. The steps below explain how to export the results from AudioTools. (If you are using a different measurement system, follow its exporting instructions.)

1. Make sure your iOS device running AudioTools and your computer running the Revel LFO software are both on same Wi-Fi network and subnet
2. In AudioTools, tap the Stop button. The Save/Recall FFT screen will appear.

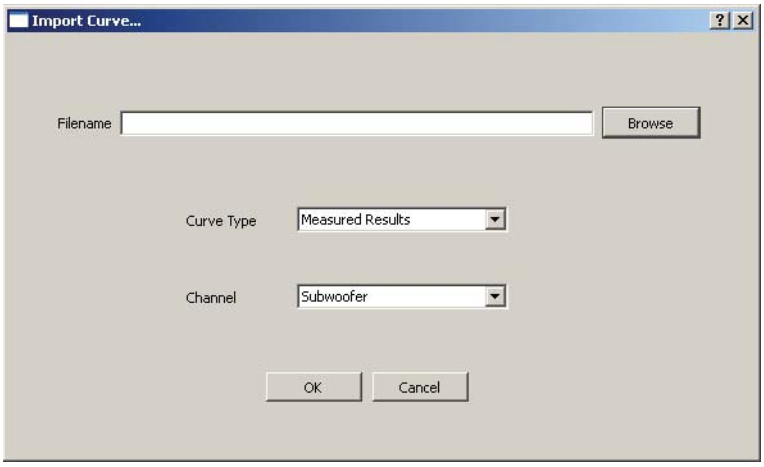


3. Tap Export. A dialog box will appear with a URL at the top.

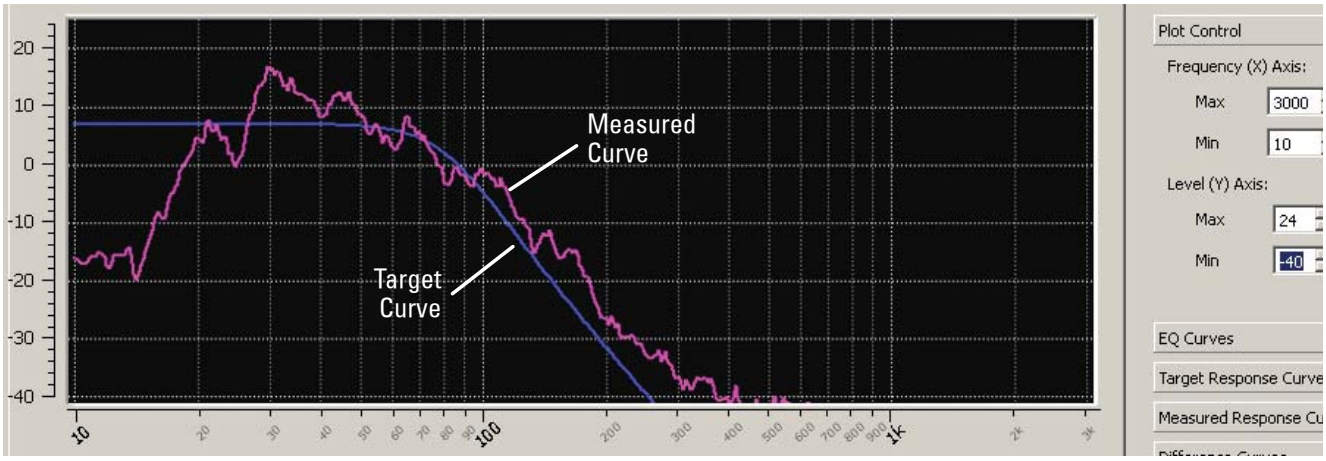


4. Open your computer's Web browser and navigate to the URL indicated in the AudioTools dialog box.
5. Select "FFT Directory."
6. From the list of files that appears on the screen, choose the measurement file you just created. Save the file to your computer in an easily-accessible location.
   - If you're using Safari as your Web browser, right-click on the filename and select "Download Linked File As."
   - If you're using Internet Explorer as your Web browser, right-click on the filename and select "Save Target As."

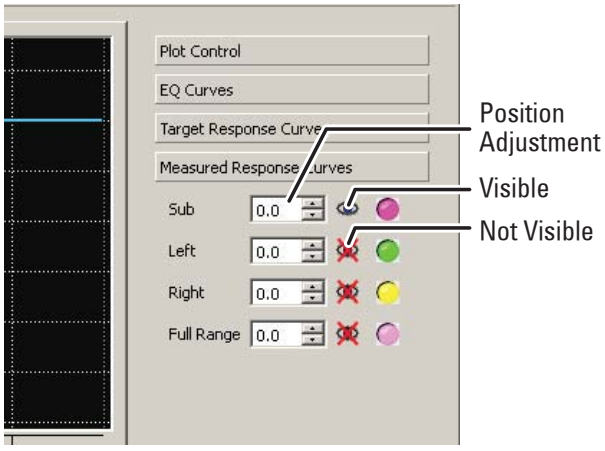
7. In the LFO interface window, select the Import Curve tab. The Import Curve dialog box will appear.



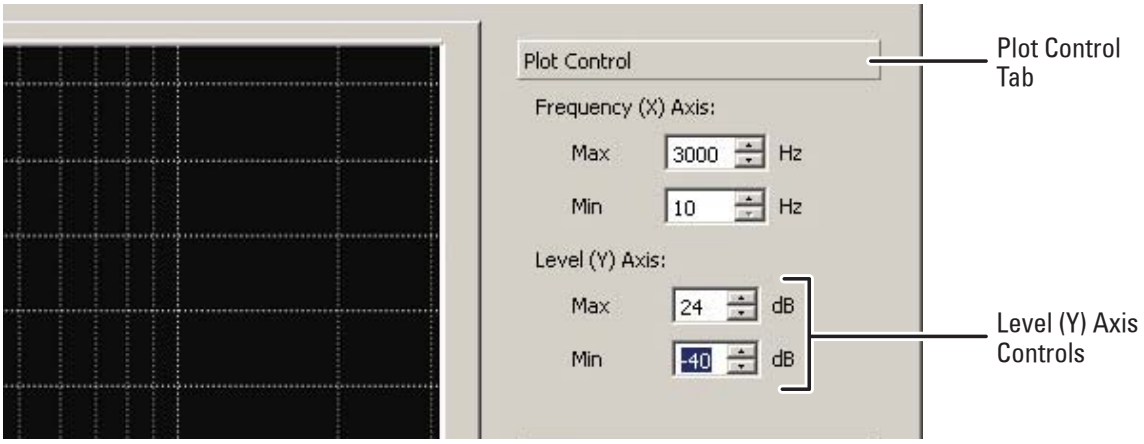
8. Make sure that the Curve Type is set to "Measured Results" and the Channel is set to "Subwoofer", then use the Browse function to select the curve you just saved into your computer from AudioTools.
9. Select OK.
10. The LFO interface window will return, with the Frequency Response Display window showing both the Target Response curve and your system's subwoofer Measured Response curve.



- If additional curves are displayed (usually as flat lines at 0dB level), select "Measured Response Curves" and "Target Response Curves" and make sure that only the Subwoofer curve is set to be visible in each (see illustration below).



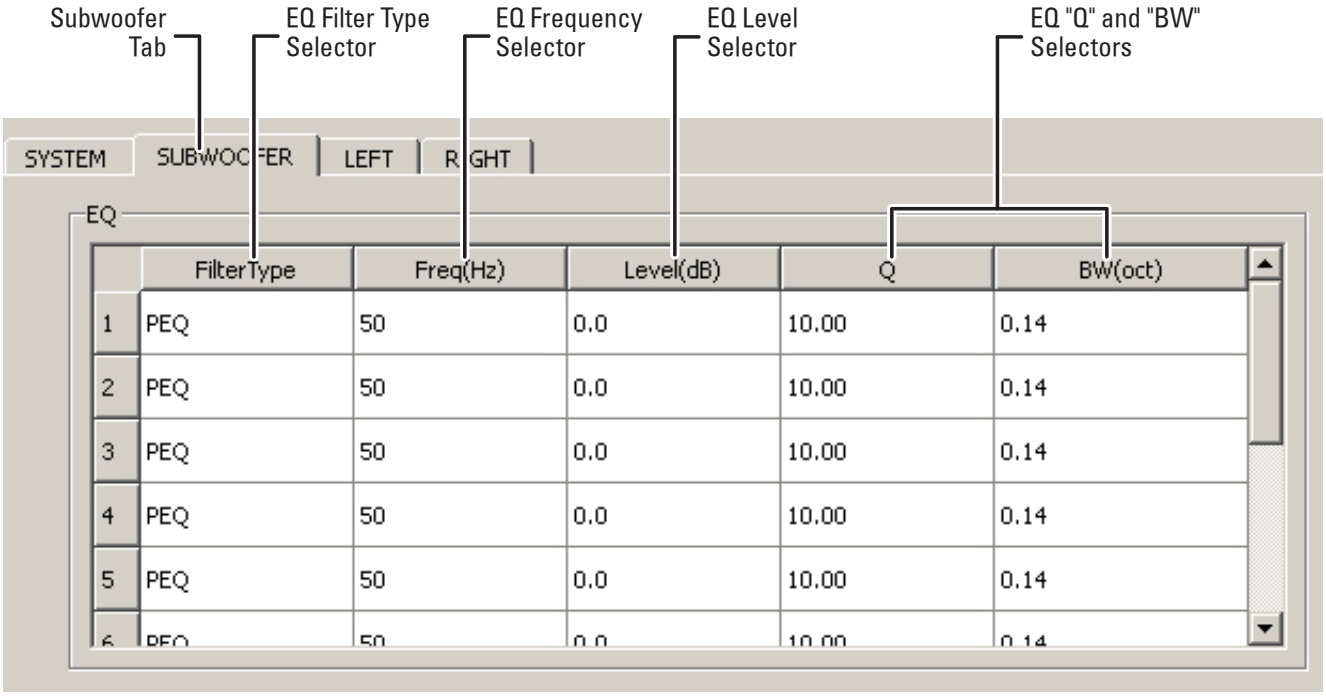
11. Use the Position Adjustment control to move the subwoofer Measured Response curve up or down in the display window so its overall shape overlays the shape of the target curve as closely as possible (see illustration for Step 10).
12. If you need to increase the Frequency Response Display's visual resolution to see the curve details, select Plot Control, then decrease the Level (Y) Axis's Max value and increase its Min value.



Applying Corrective Equalization

To apply corrective equalization to the subwoofer, select the Subwoofer adjustment tab. The subwoofer EQ filter window will appear.

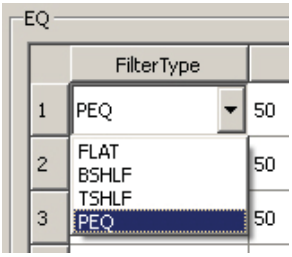
Subwoofer Equalization Filter Controls



Subwoofer tab: Select this tab to perform corrective equalization (EQ) on the subwoofer. (For instructions to perform corrective EQ on the left and right speakers (Left and Right tabs), see *Measuring a Two-Channel System's Low-Frequency Response in Your Listening Room,* on page XX).)

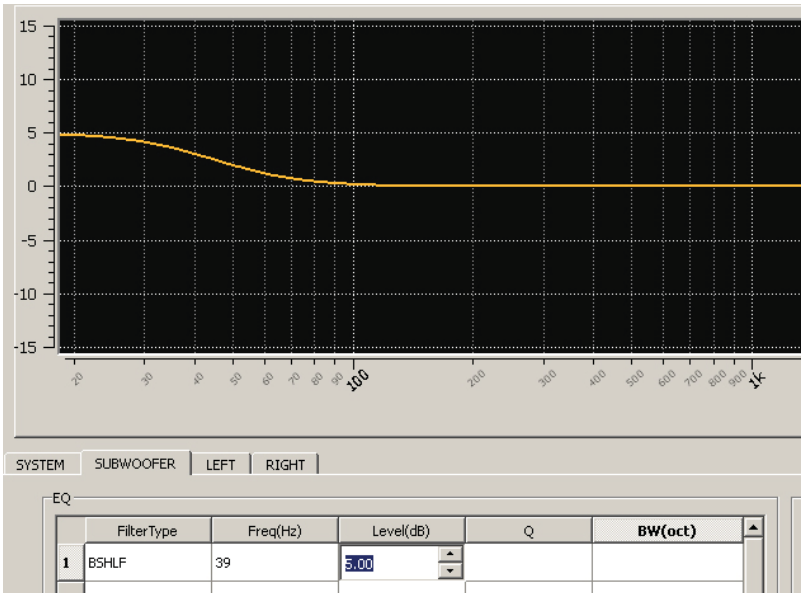
You can apply up to 10 different EQ filters to the subwoofer output. This sophistication makes it possible for you to create complex EQ curves that will correct for a very wide variety of complex frequency-response anomalies.

EQ filter type selector:

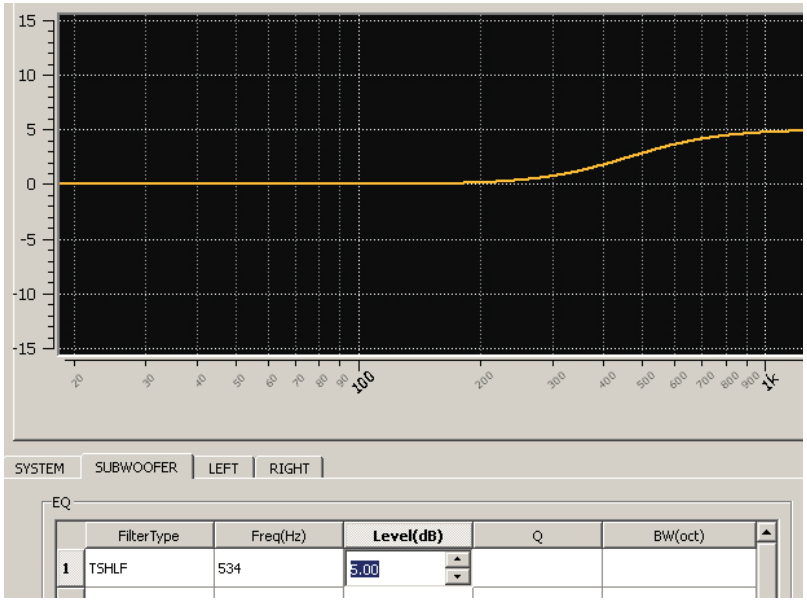


This control lets you choose the type of EQ filter to employ:

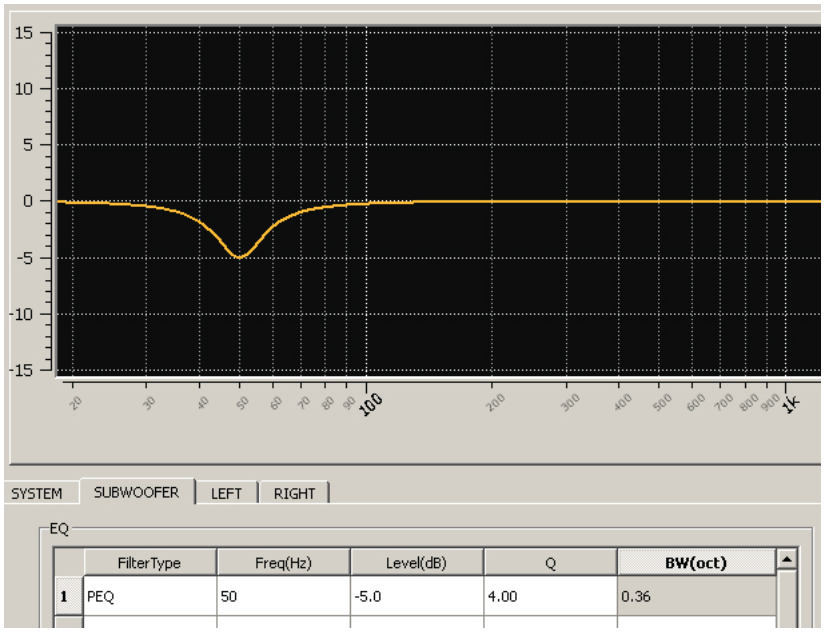
- Flat: No EQ is applied.
- BSHLF (bass shelving): Bass shelving EQ behaves similar to a conventional bass tone control, boosting or cutting all frequencies below the selected EQ frequency (see illustration below). Only EQ frequency and EQ level adjustments are available.



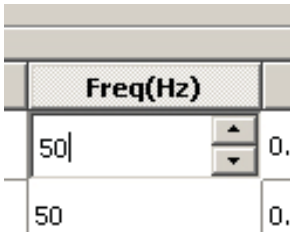
- TSHLF (treble shelving): Treble shelving EQ behaves similar to a conventional treble tone control, boosting or cutting all frequencies above the selected EQ frequency (see illustration below). Only EQ frequency and EQ level adjustments are available.



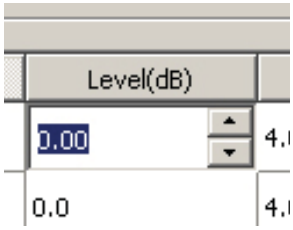
- PEQ (parametric EQ): As implemented in your Revel subwoofer, parametric EQ provides control of EQ frequency, EQ level and the "Q", (bandwidth) of the EQ adjustment. This equalization type is known as "peaking" (also called band-pass), because it allows you to increase or decrease a relatively narrow band of frequencies that centers on the selected EQ frequency, producing an EQ curve that looks like a mountain peak or valley (see illustration below).



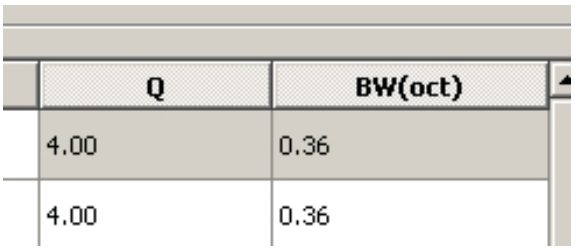
EQ frequency selector: This adjustment allows you to select the frequency affected by the EQ. For BSHLF and TSHLF this is the "corner" frequency, where the EQ begins to take effect; for PEQ this is the frequency where the applied boost/cut is centered, and therefore at has the most effect. Make adjustments by clicking on the up/down arrow buttons or by double-clicking the frequency number, entering a new frequency and then pressing Enter on the keyboard.



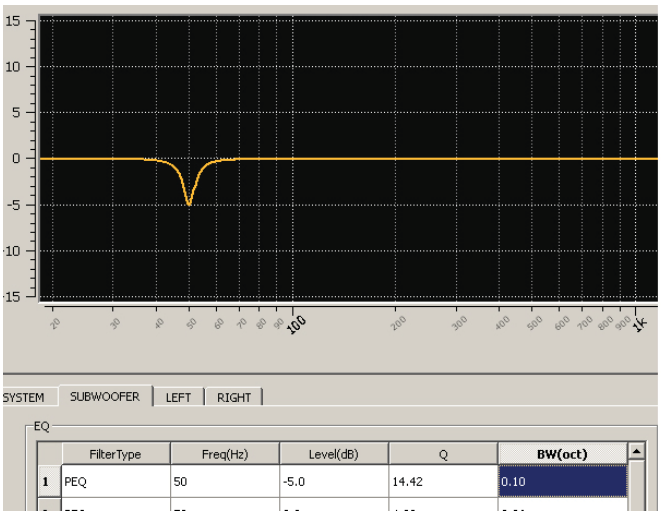
EQ level selector: This control lets you determine how much boost or cut is applied at the selected EQ frequency. Make adjustments by clicking on the up/down arrow buttons or by double-clicking the level number, entering a new level and then pressing Enter on the keyboard.



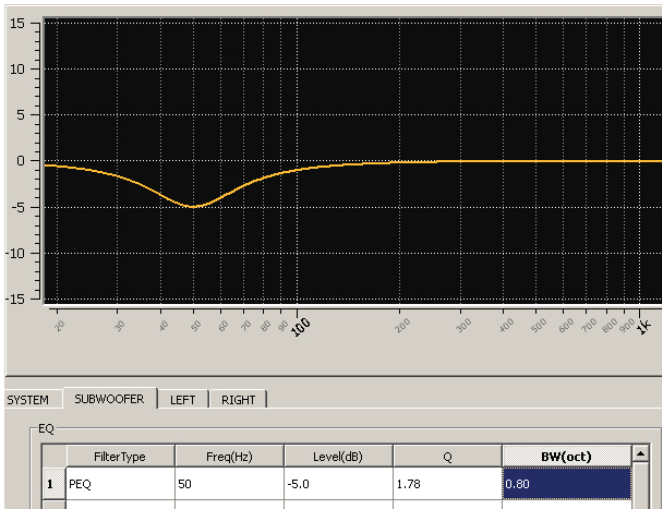
EQ "Q" (quality) and "BW" (bandwidth) selectors: "Q" (quality) and "BW" (bandwidth) are different ways of expressing how broad or narrow a range of frequencies is affected by a PEQ level adjustment. The selectors are interconnected; adjusting the Q will also change the BW, and vice versa. (The Q/BW selectors are inactive for BSHLF and TSHLF filters.)



Increasing the Q/decreasing the BW will narrow the range of frequencies the PEQ adjustment affects (see illustration below).



Decreasing the Q/increasing the BW will widen the range of frequencies the PEQ adjustment affects (see illustration below).



Make adjustments by clicking on the up/down arrow buttons or by double-clicking the Q or BW number, entering a new Q/BW number and then pressing Enter on the keyboard.

We suggest making only the Subwoofer EQ curve visible (see step 10 on page 16) and practicing with the EQ controls to understand how the different EQ filter controls affect frequency response before attempting to equalize your subwoofer. Especially note that multiple EQ filters will interact, requiring that you go back and forth between them making subtle adjustments to get as close as possible to your desired results.

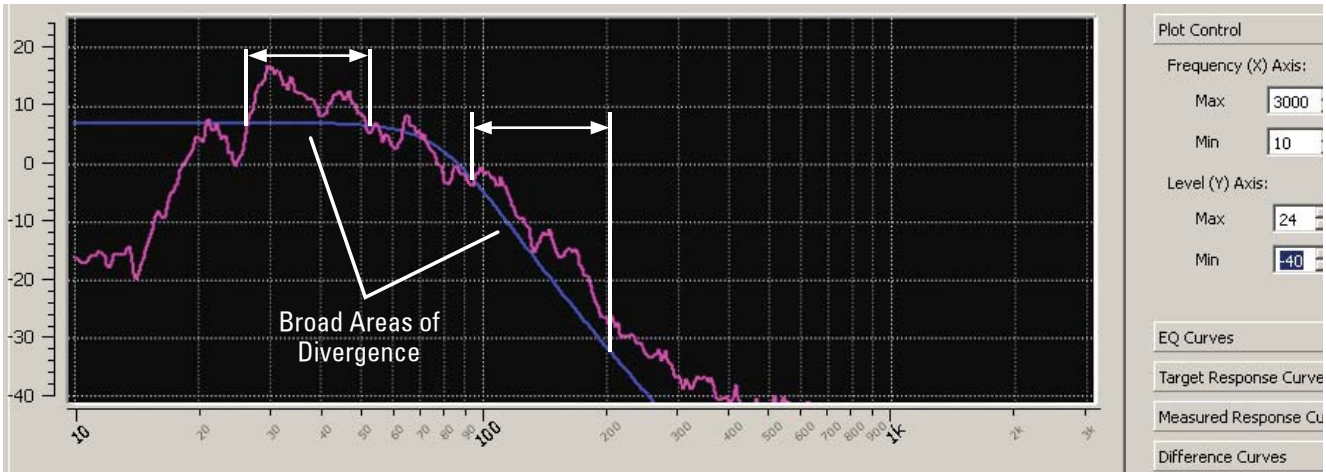
Equalizing Your Subwoofer

We encourage you to experiment and become familiar with how the LFO software's EQ controls operate. You can't hurt anything while making EQ adjustments, so feel free to try different filter combinations even if at first they may seem counter-intuitive.

Note that you will mostly be using PEQ (parametric equalization) filters to equalize the subwoofer's frequency response. The broad effect of shelving filters is useful only in certain circumstances.

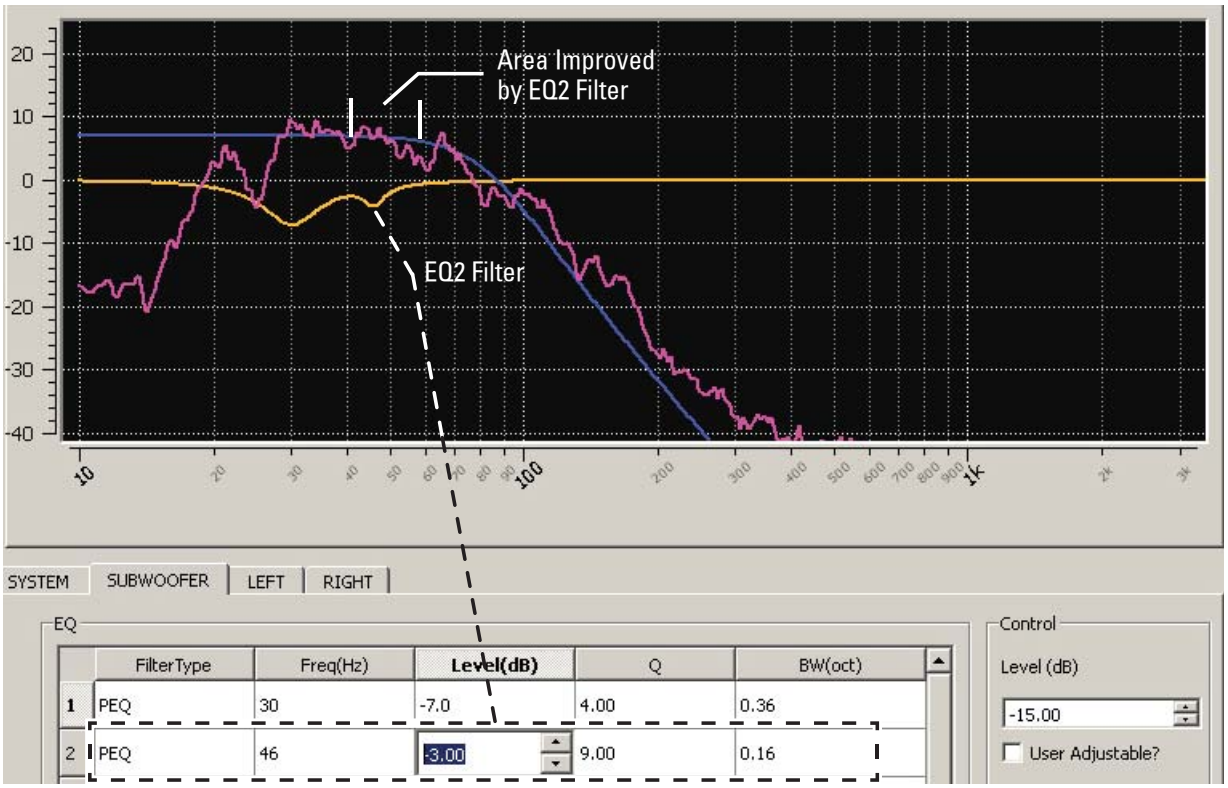
Your first priority should be using EQ to reduce higher-amplitude response peaks that are wide. Very narrow peaks and dips in response are much less audible and can be dealt with after you've fixed the larger ones (or not at all).

1. Make your Target Response and Measured Response curves visible. Examine how they compare. Take special note of any broad areas where the two curves diverge.

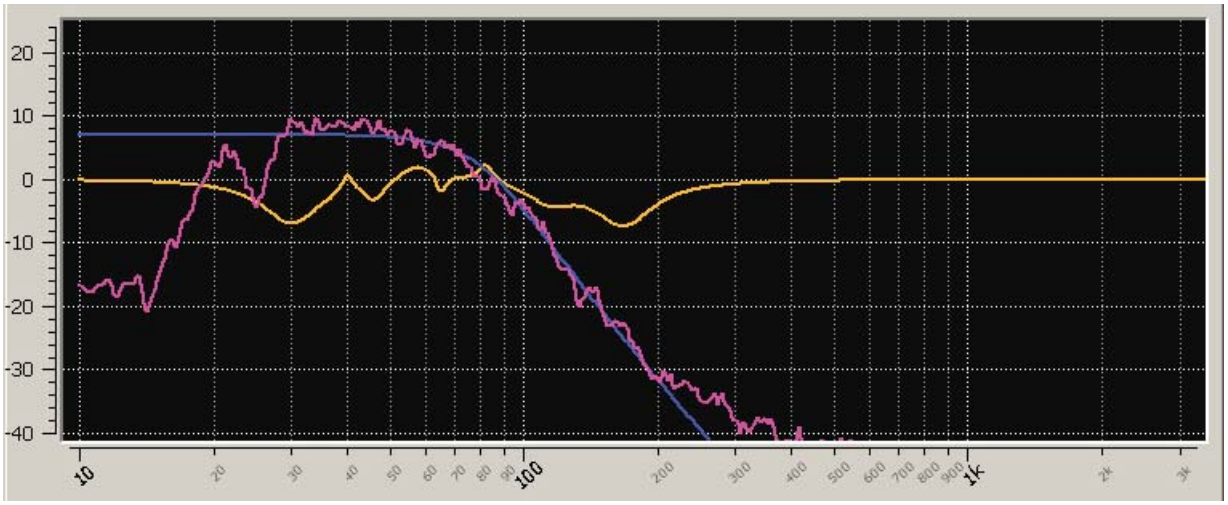


2. Find a broad, high-amplitude peak in the subwoofer's response and use the EQ1 filter's EQ frequency selector to select an EQ frequency that is near the center of the peak. (The frequency doesn't have to be exact – you can fine-tune it later in the process.).
3. Select the EQ1 filter's EQ level control and use the down arrow button to reduce the response by –6dB to – 8dB.
4. Note the effect this has on the subwoofer's Measured Response curve. Adjust the EQ1 filter's frequency, level and Q/BW controls as necessary to bring that part of the Measured Response curve as close as possible to that part of the Target Response curve. (see example below)

5. When you are satisfied with the improvement created by EQ1 filter, repeat steps 3 – 4 with EQ2 filter to reduce the next peak in response. Note that the parameters of the two filters may interact, in which case you will have to adjust each more than once to get the area to match the Target Response curve.

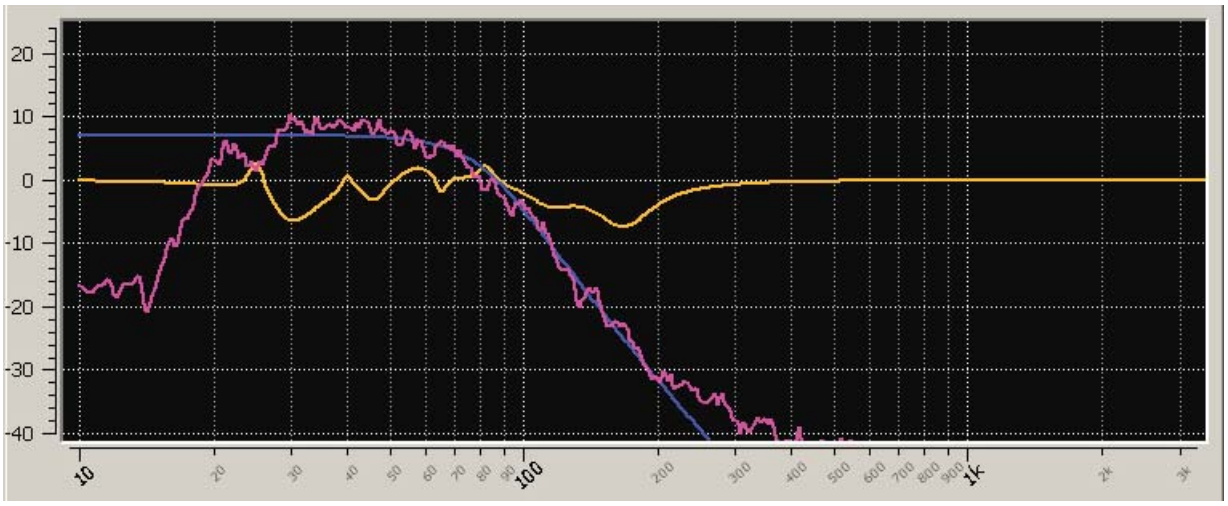


6. Concentrate on the region between 20Hz and 200Hz. Try to make this region correspond to the Target Response curve as closely as is practical. Once you have reduced all the large response peaks the Measured Response curve should be very close to the Target Response Curve. Note that eight EQ filters were required to achieve the results shown below.



7. If any of the LFO software's 10 EQ filters remain unused, you can repeat steps 3 – 5 to reduce any deep dips in response that are above 30Hz.

   NOTE: Using EQ boost for frequencies below 30Hz can quickly exhaust the subwoofer amplifier's power and limit your system's dynamic range. In the example below we've cheated a bit by using the EQ9 filter for a narrow-bandwidth (Q = 12) 6dB EQ peak that reduces the –10dB dip at 25Hz by 6dB.



8. Note that, similar to the Measured Response illustrated in these examples, your system's Measured Response will fall-off steadily below 20Hz. DO NOT TRY TO CORRECT THIS USING EQ. Attempting to do so will severely reduce your system's overall dynamic range and will increase the likelihood of audible amplifier clipping.

Sending the Equalization to Your Subwoofer(s):

1. In the LFO Menu bar, select Save to Amplifier.
2. The subwoofer EQ settings that are currently active on the LFO screen will be uploaded to the connected subwoofer (subwoofer #1 if you're using multiple subwoofers). If you're using multiple subwoofers the audio signal sent from subwoofer #1 to all the other subwoofers in the chain will contain the equalization, so you only need to equalize subwoofer #1.

After applying the equalization to the subwoofer(s) we strongly suggest that you play the test noise again and perform a spatially-averaged measurement of the equalized subwoofer(s) by repeating steps 3 – 7 on pages 12 – 13. If you notice any areas that still diverge from the target response, fine-tune your EQ filters as necessary to minimize the divergences.

- When you're satisfied with the results, repeat steps 1 – 2 in this section, then select Save to Disk in the LFO menu bar, assign a name to the final EQ file and save it.

IMPORTANT: When you're finished be sure to re-connect your left and right speaker wire conductors or turn the system amplifier(s) back on.

- When you're completely finished measuring and equalizing, if you want the subwoofer(s) to automatically turn on and off when an audio signal is present, set the Auto Sense Control time for each subwoofer (see *Auto Sense Control,* on page 6) and set the Power Mode switches on the subwoofer rear panels to "Auto."

ADJUSTING SUBWOOFER VOLUME

If you need to further balance the volume of your subwoofer(s) with the volume of your system's other speakers, use your preamp/processor's subwoofer volume control.

If the preamp/processor's subwoofer volume control does not have enough range – for example, if it is at its minimum level and the subwoofer(s) are still too loud – change the LFO Software's Subwoofer Level Adjustment setting to compensate.

IMPORTANT: If you're using multiple subwoofers you must set the LFO Software's Subwoofer Level Adjustment to the same setting for all subwoofers. Setting one subwoofer to a different level setting will limit your system's dynamic range. See *Before You Begin, Please Note the Following,* on page 8.

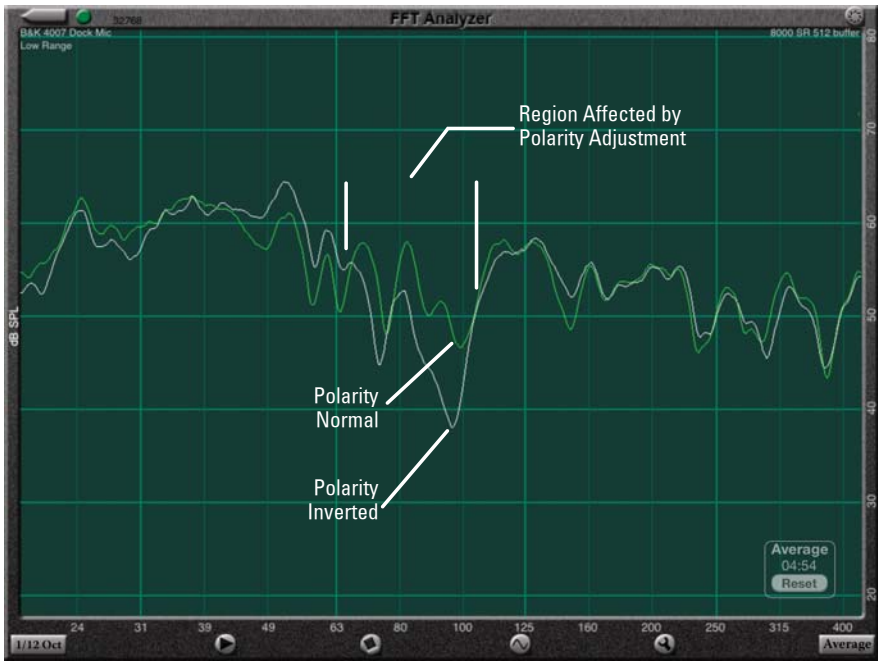
ADJUSTING SUBWOOFER POLARITY

The polarity setting determines if the subwoofer's cone moves towards the room when the subwoofer receives a positive voltage (Normal) or moves away from the room when the subwoofer receives a positive voltage (Inverted).

The audible effect of the subwoofer's polarity setting will depend on a number of factors, including the listening room's size and layout, the listening position, the locations of the subwoofer, the locations of the system's other speakers within the room and the locations of the speakers and subwoofer(s) relative to one another. The setting typically affects the system's performance in the region where the subwoofer crosses-over to the system's other speakers.

While you have your measurement equipment set up you can repeat the measurement process (see *Measuring Your System,* on page 12) with the subwoofer's polarity set to Normal, then again with it set to Inverted and compare the results. Use the setting that produces a flatter response curve.

NOTE: Make sure the test noise plays through all of your system's speakers, not just the subwoofer, when comparing the polarity control settings.



In the example above the Normal setting produces flatter results; in another system the Inverted setting may produce flatter results or there may be little difference between the two settings.

IMPORTANT: In systems with multiple subwoofers you must set the polarity adjustment the same for all the subwoofers in the system.