Home Theater Multi-Subwoofer Setup

Basic System Setup plus REW & Dirac Live

This white paper walks you through the setup of a home theater multi-subwoofer configuration using the miniDSP 2x4 HD, DDRC-24 or Flex (referred to as miniDSP). This process will help optimize the performance of your subwoofer system and their integration into your home theater system.

Once you finish the basic setup, your subwoofer system will be operational and ready for further tuning with Room EQ Wizard (REW) and / or implementation of a Dirac Live project.

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Basic System Setup

System Architecture Concept

This method takes multiple subwoofers and combines them into a single virtual corrected subwoofer. We calibrate the single virtual room corrected subwoofer independently of the audio video receiver or processor (AVR). After this is complete, your single virtual subwoofer reconnects to the AVR and appears as a single monaural subwoofer. Then you can apply your home AVR correction process (Audyssey, ARC, YPAO, Dirac, etc.) to your entire system with its ideal virtual subwoofer attached.

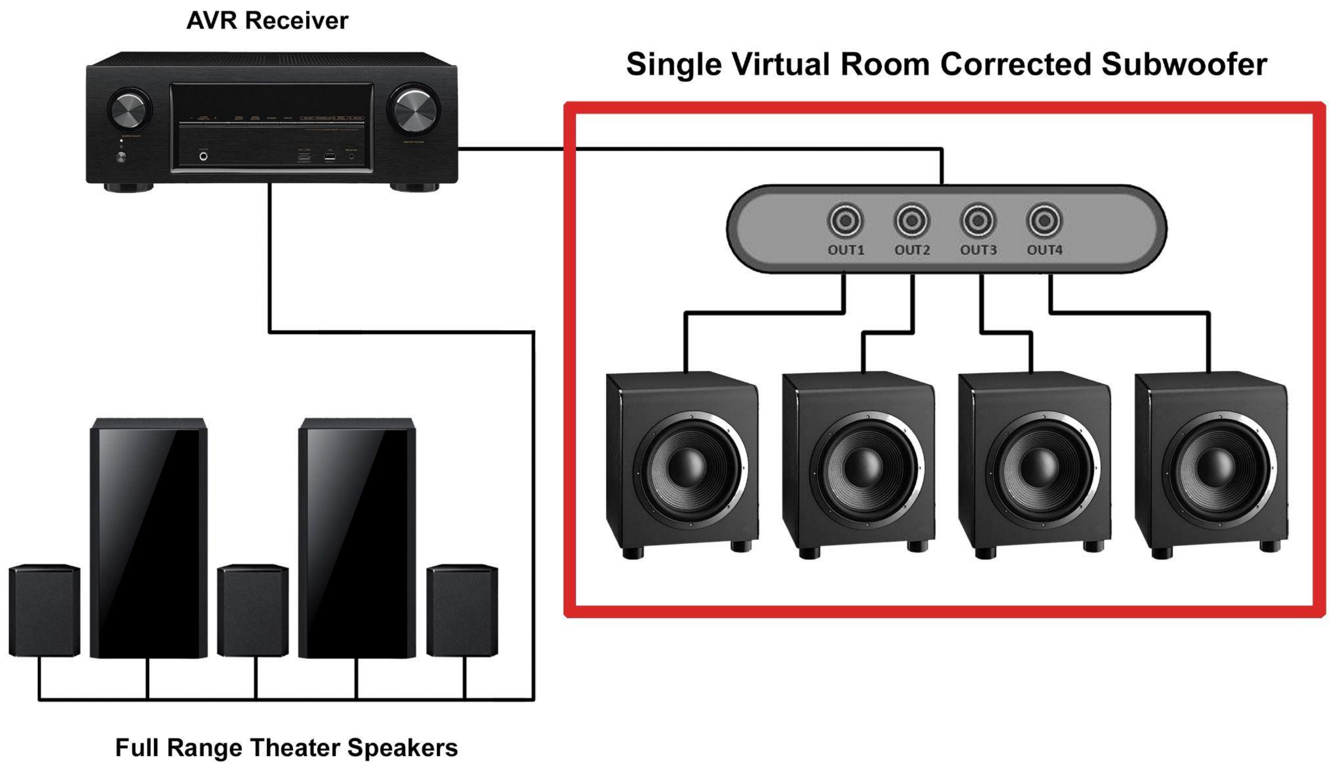

Diagram 1. Home theater with single virtual room corrected subwoofer

Hardware Configuration

Subwoofer placement will be driven by the number of subwoofers in your system, listening room configuration and aesthetics. In general, spatial diversity is preferred.

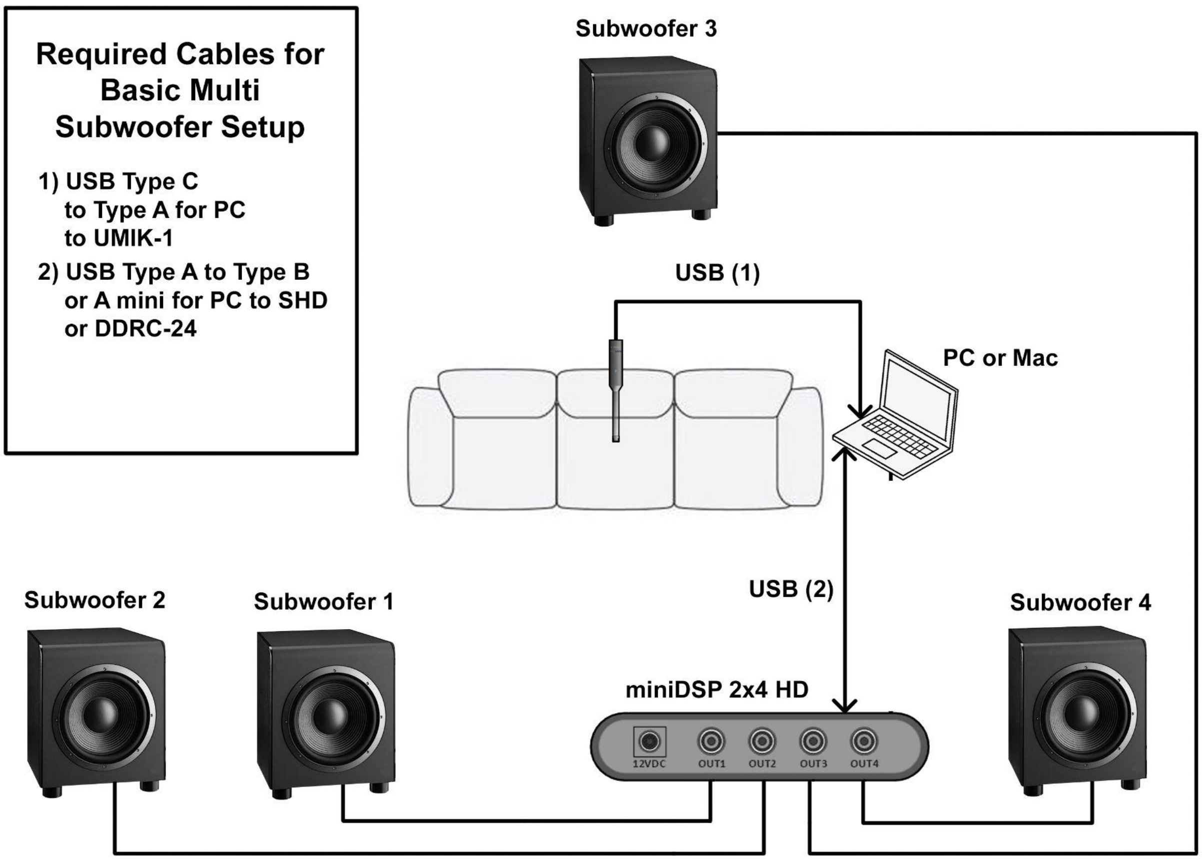

Diagram 2. Required connections and cables for system setup, measurement and correction

Be sure that all of the subwoofer cables are of good quality, adequate length and securely connected. At this time you can check that the built-in level, equalization, inversion and crossover frequencies of the subwoofers are either bypassed or set to nominal. REW signals generated in your computer will be sent to the miniDSP via USB. *See Resources 2, 3, 4 and 5.*

Nominal Subwoofer Settings

Your subwoofer should be set as below, so as to not interfere with the crossover and parametric equalization (PEQ) parameters that will be set up in the miniDSP.

Crossover	Max Hz / off
Phase	0°
Gain	0 dB / mid level / 12 o'clock
EQ / Parametric	Off / bypassed
Parametric EQ	Off / bypassed
Power-mode	Always on

Diagram 3. Baseline subwoofer settings

miniDSP Driver and Plug-in Setup

Follow the miniDSP User Guide instructions to download the plug-in, USB drivers, Dirac Live and REW as appropriate. Be sure to remove any old miniDSP, Dirac Live or REW software. *See Resources 2, 3, 4 and 5.*

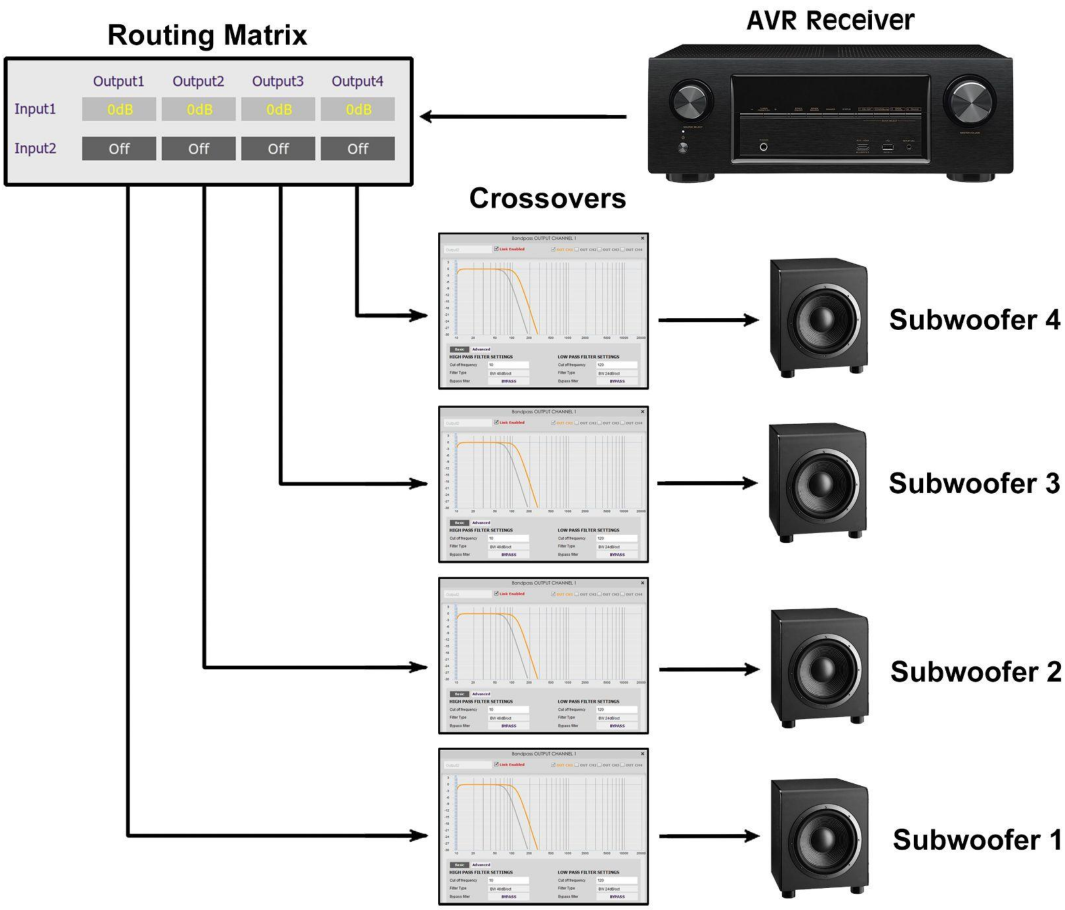

Diagram 4. Signal flow through the miniDSP showing routing, crossover and parametric equalization (PEQ)

Subwoofer Routing

The subwoofers will be configured as a single monaural virtual subwoofer, as shown in the following routing matrix example. These adjustments are made on the input page of the miniDSP. During setup, the input will be USB for REW and Dirac test signals. When the single monaural virtual subwoofer setup is complete, the miniDSP will connect to your AVR's subwoofer out via RCA analog. Set the miniDSP master volume to 0 dB (maximum), this way the miniDSP operates without attenuation.

For an example of other subwoofer routing configurations, see our white paper on [Stereo 2.1 & 2.2 Subwoofer Optimization](#).

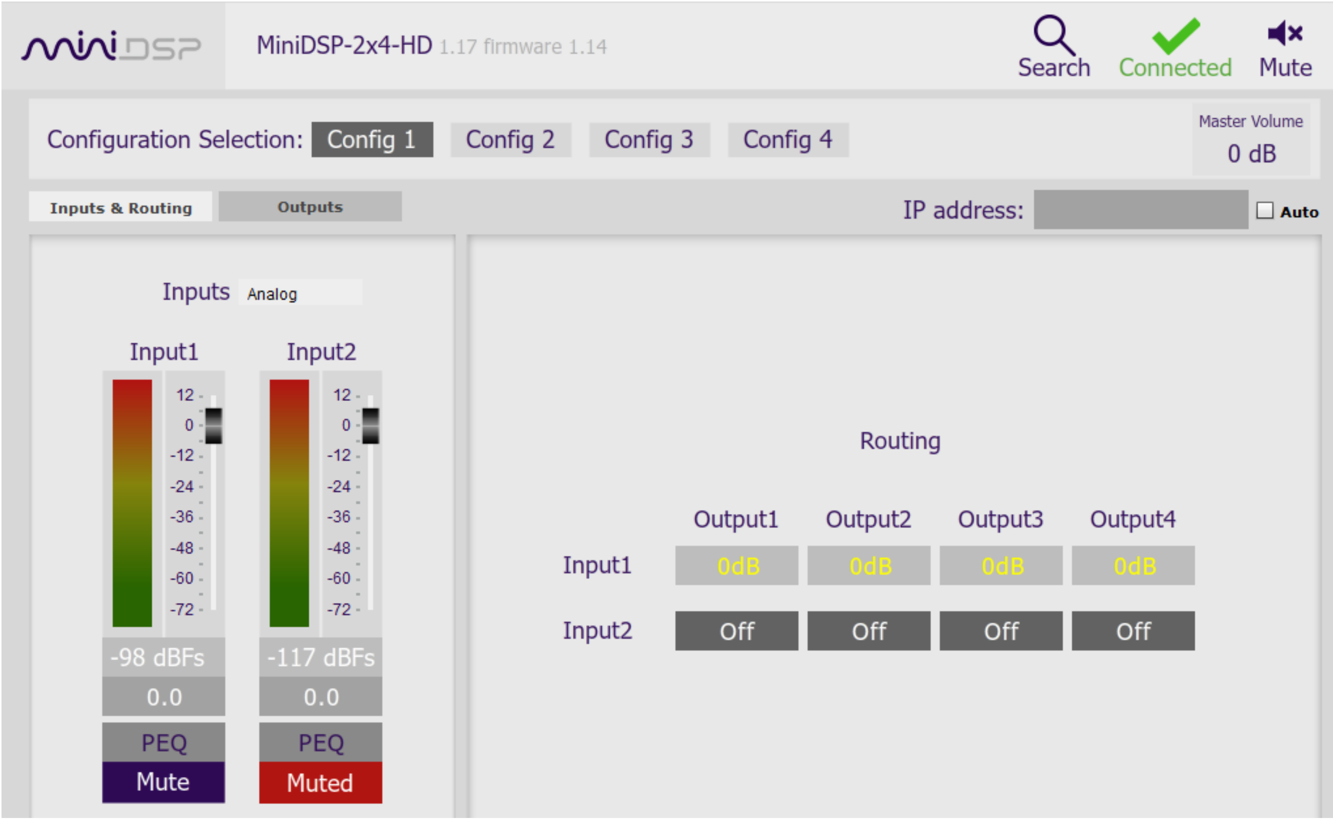

Diagram 5. Virtual monaural subwoofer routing matrix setting

Delay settings

We present two approaches to time aligning all of the subwoofers within the group. The first and simplest approach uses physical distance measurements. This requires that all the subwoofers be of the same design. The second approach uses REW to calculate the delays electronically and is especially suitable when the types of subwoofers vary or some use wireless extenders.

Physical Delay Measurement Method

Using physical measurements for determining the delay offsets from the various subwoofers to the listening position assumes the subwoofers are the same design and have equivalent near-field latency and phase. Otherwise, delay can be set electronically with REW.

From the plug-in output page, enter the individual subwoofer delay settings as follows:

1. Measure the distance of the subwoofers from the central listening area

2. Calculate the difference in distance of each subwoofer from the farthest subwoofer in feet
3. Find the delay in milliseconds by dividing the distance in feet by 1.11
4. Enter the resulting value in the delay section for each respective channel (1 ms = ~1 ft)

Delay Table for Basic Multi Subwoofer Setup

	Sub-woofer	Distance from seating area in feet (ft)	Distance closer than the farthest sub in feet (ft)	Delay in millisecs (ms) from farthest sub
Farthest Sub	2	12	0	
	1	9	3	2.7
	3	6	6	5.4
	4	10	2	1.8

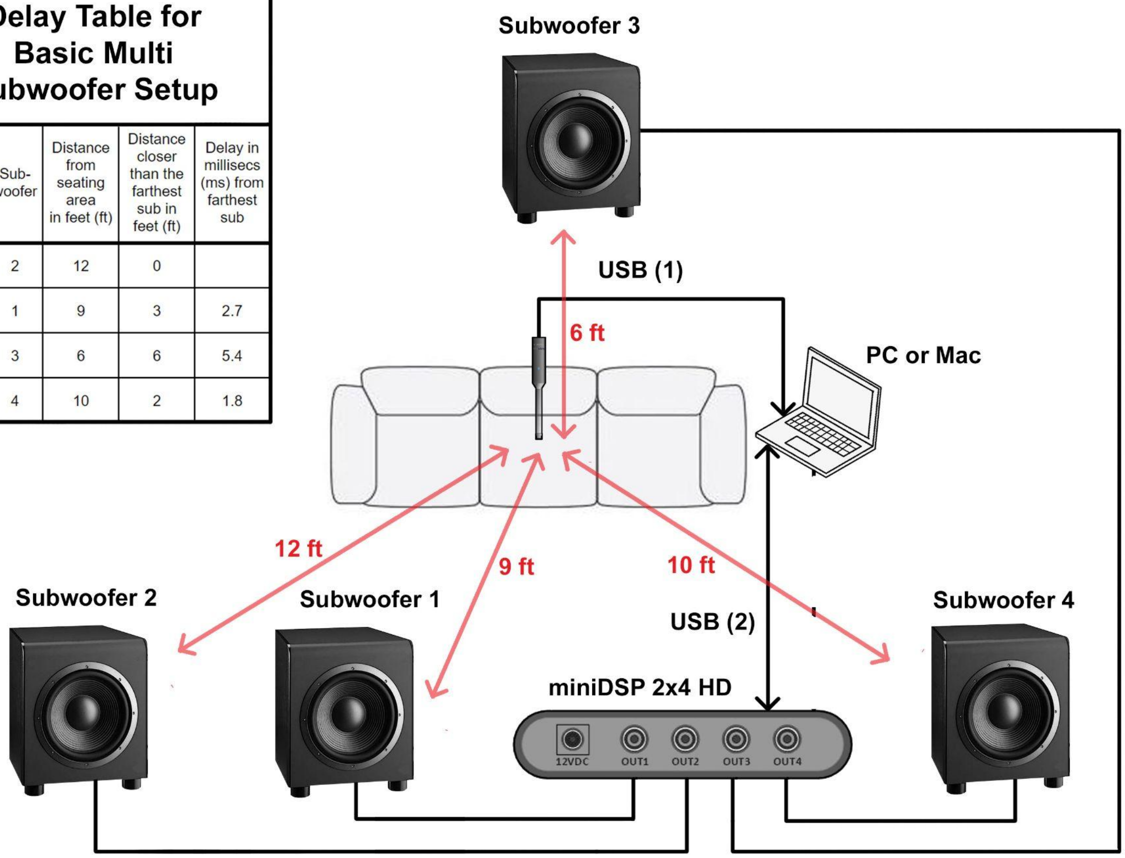

Diagram 6. Delay table for basic multi-subwoofer setup

	A	B	C	D	E
1	Example Delay Calculation table				
2		Sub-woofer #	Distance from seating area in feet (ft)	Difference in distance of each subwoofer from the farthest subwoofer in feet	Required Delay in millisecs (ms) from farthest sub
3			=C4	=C4-Cn	=(C4-Cn)/1.11
4	Farthest Sub	2	12	0	
5		1	9	3	2.7
6	Closest Sub	3	6	6	5.4
7		4	10	2	1.8

Diagram 7. Delay calculation table

Electronic (REW) Delay Measurement Method

Using the REW delay measurement capability, you can determine which speaker is acoustically the closest to the central listening area. This may take a bit of trial and error, as you need to measure a positive delay from the remaining speakers. It’s typical to see a few milliseconds of delay on the subwoofer(s), due to DSP processing and since they are often placed back against the wall.

In the example below we have routed the subwoofer output to the left channel with the main full-range speaker as the reference output on the right channel.

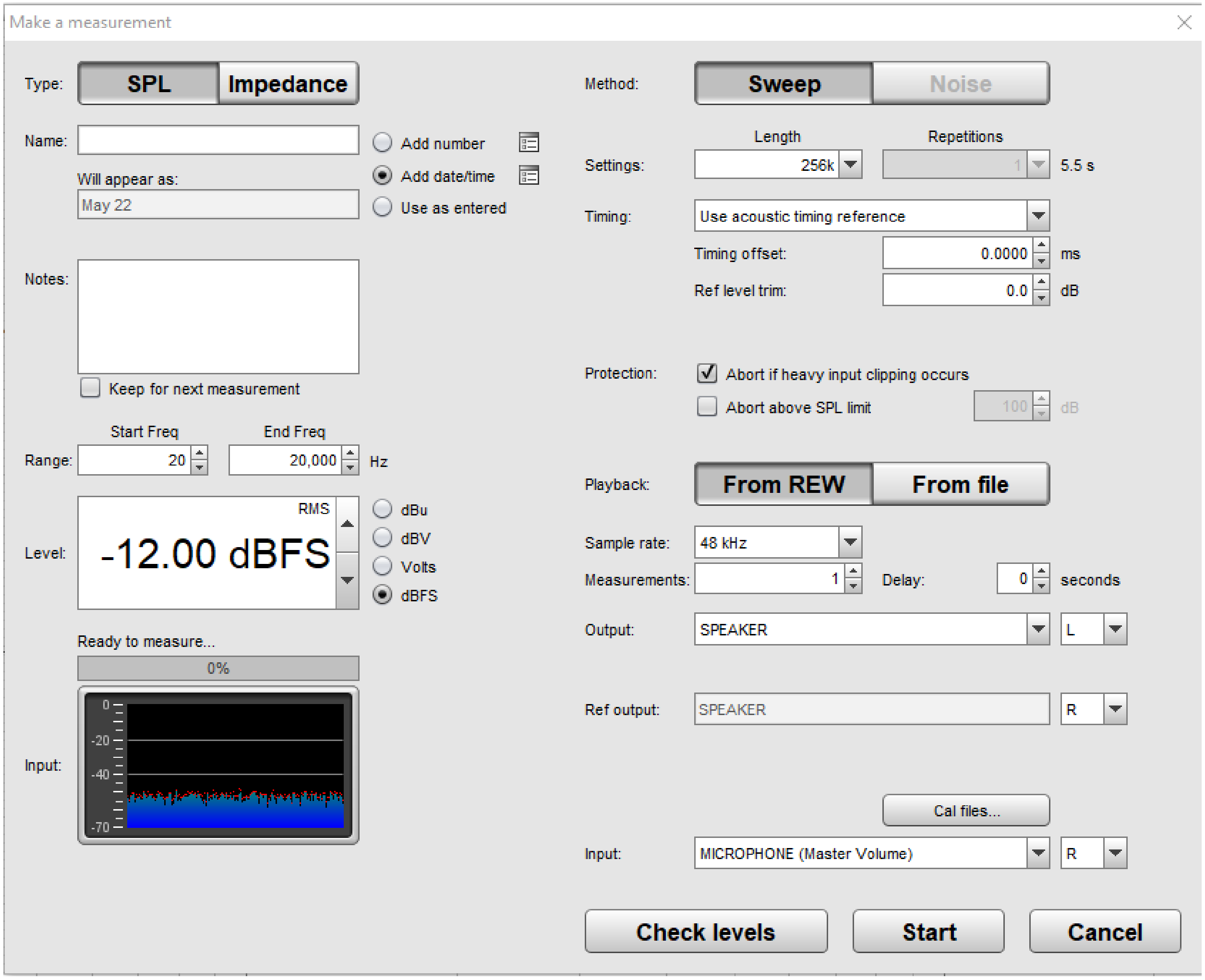

Diagram 8. Subwoofer delay relative to right full-range speaker

If your measurement settings are correct, you'll first hear a sharp chirp from the full-range speaker and then a short sweep of low frequencies from the subwoofer. REW automatically calculates the delay. In the example below the delay is 1.9 milliseconds, or a little more than two feet.

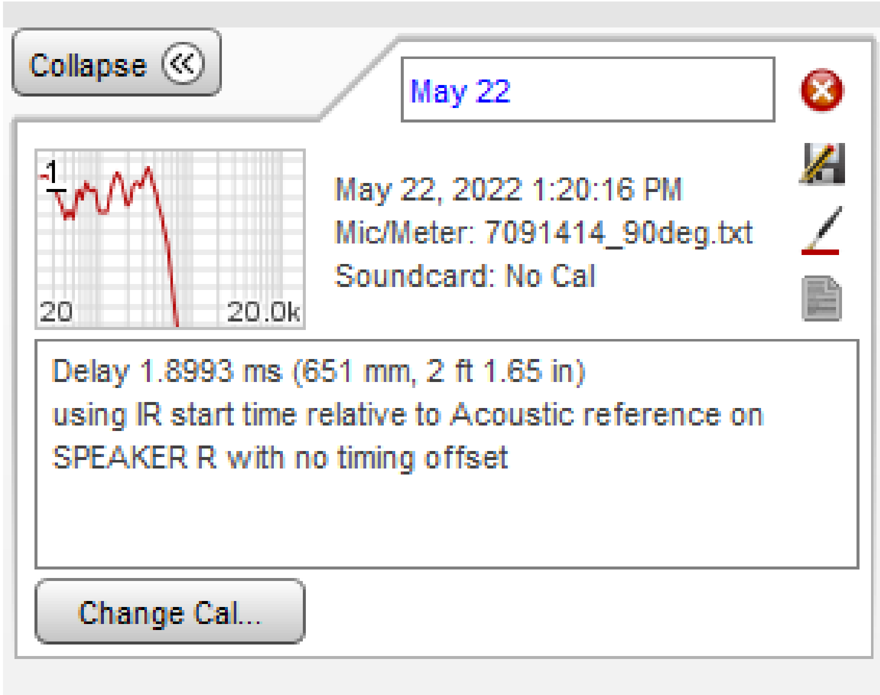

Diagram 9. REW measurement showing subwoofer delay from reference full-range speaker

After you've measured all the delays and are confident that you've got valid numbers, you can enter the correcting delays in the plug-in output section. You then should verify that you have minimized the delays by making the same measurements again.

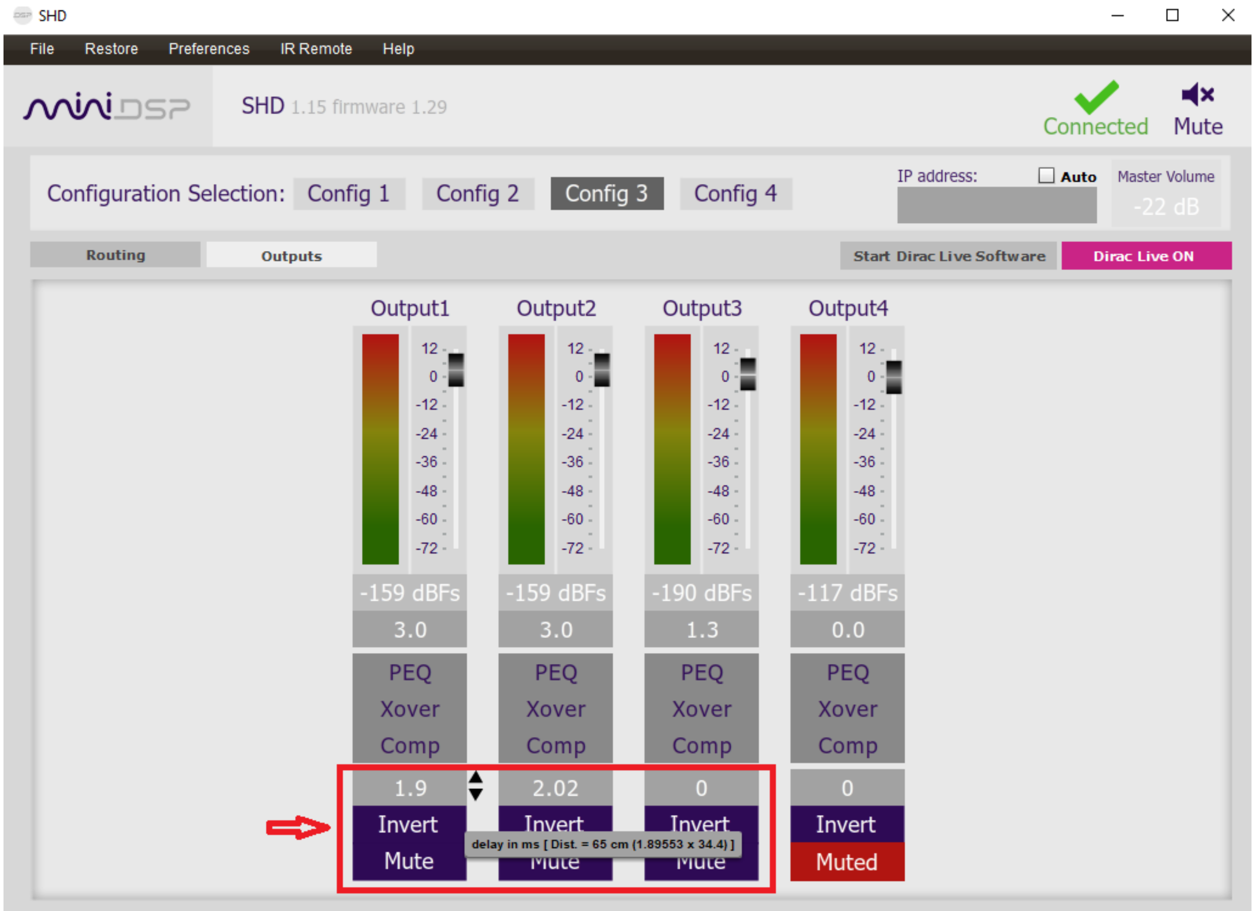

Diagram 10. Inserting time delay for coincident time of arrival

Crossover Settings

Setting of the optimal crossover frequencies is critical to achieving the best overall system performance. Here are the things you need to take into consideration:

- Depending on the size of your main speakers, determine the frequency and slope of the high pass filter your AVR will be applying to your main speakers.
- You can choose a matching low pass frequency and slope for your subwoofers and then later experiment with different slopes and overlapping or underlapping frequencies.
- We also recommend adding a 10 Hz or greater high pass filter to the subwoofers to eliminate unnecessary driver excursion and load on the amplifiers.
- If your subwoofers have differing frequency response ranges, you can set high and low pass filters as shown below to limit amplifier power to their useful frequency range.

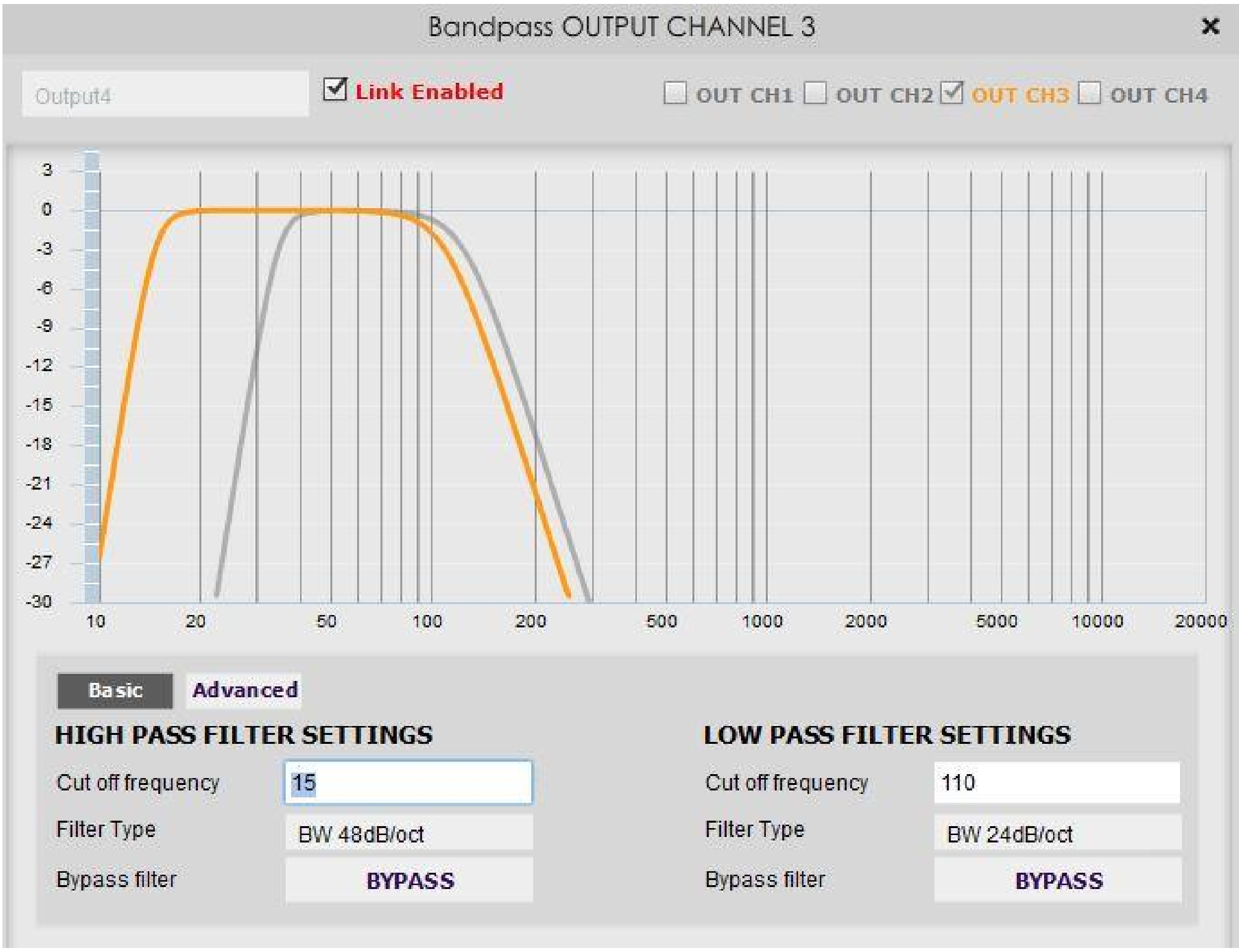

Diagram 11. Multiple subwoofer crossovers with high and low pass filter settings

Relative Amplitude Settings

You can complete the basic setup by adjusting the relative levels of the subwoofers using REW and a miniDSP UMIK-1 or UMIK-2. From the central listening area, adjust the relative levels of the subwoofers to be equal. If you're moving on to a Dirac Live project, these settings will remain in place. If you are new to REW, see *Resources 5 and 6.*

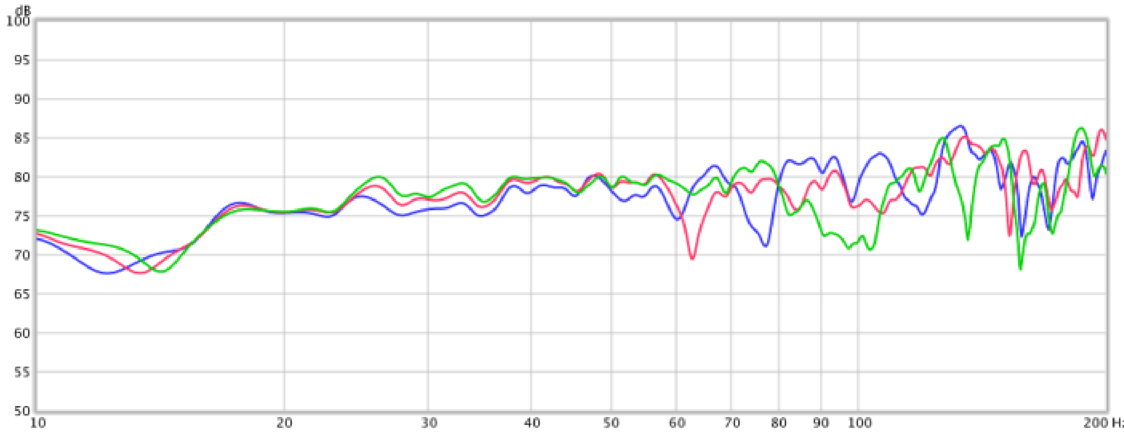

Diagram 12. Three subwoofer relative amplitude overlay plot

Connecting to your AVR

At this point, the basic setup is complete and your virtual subwoofer is ready to be connected to your AVR or home theater processor.

We also suggest you reset your home theater correction software and begin a new system correction session. If you need more gain from the subwoofer setup, you can increase the input gain and output gain settings. It's important to adhere to good gain structure practices. *See Resource 15.*

Using Room EQ Wizard (REW)

Choosing Your Correction Strategy

At this point you need to decide if you want to apply REW room correction filters to the input channel and / or output channels. In this example we will apply the room correction filters to the input channel only, which will allow you to tune to taste in the output channels. If you will be using Dirac Live, you will skip the following section. However, you will be utilizing the level settings and crossovers setup above.

Setting Up for Measurements

Audio Output

Connect audio output from your computer to the miniDSP. REW test signals generated in your computer will be sent to the miniDSP via USB. We recommend USB as opposed to HDMI into the AVR, as it can sometimes be difficult to eliminate all AVR processing and may lead to uncertainty. The direct USB connection approach is ideal as we are calibrating the subwoofers as a single virtual subwoofer and then attaching the miniDSP to the AVR.

Microphone Sample Rates

In Windows, the microphone settings usually auto configure to 48 kHz for the UMIK-1. The UMIK-2 is settable up to 192 kHz. In iOS, it's plug and play, you just need to select the UMIK in the audio devices menu.

Set up Room EQ Wizard (REW)

1. Download the most recent version of Room EQ Wizard from REW - Room EQ Wizard Room Acoustics Software. Be sure to delete any old versions.
2. Using your UMIK serial number, download the calibration files from the miniDSP website. If you are using a UMIK-2, be sure to download the ASIO driver from miniDSP, using the supplied coupon code.
3. Use the dialog box that appears to locate one of your calibration files.
4. Open the REW Preferences window. Select your output device and input device accordingly, and set your smoothing to ⅙ octave.

Making Measurements and Averaging

Begin by making multiple measurements with the UMIK pointed to the ceiling, using the 90-degree calibration file. We recommend a measurement area similar to Diagram 13.

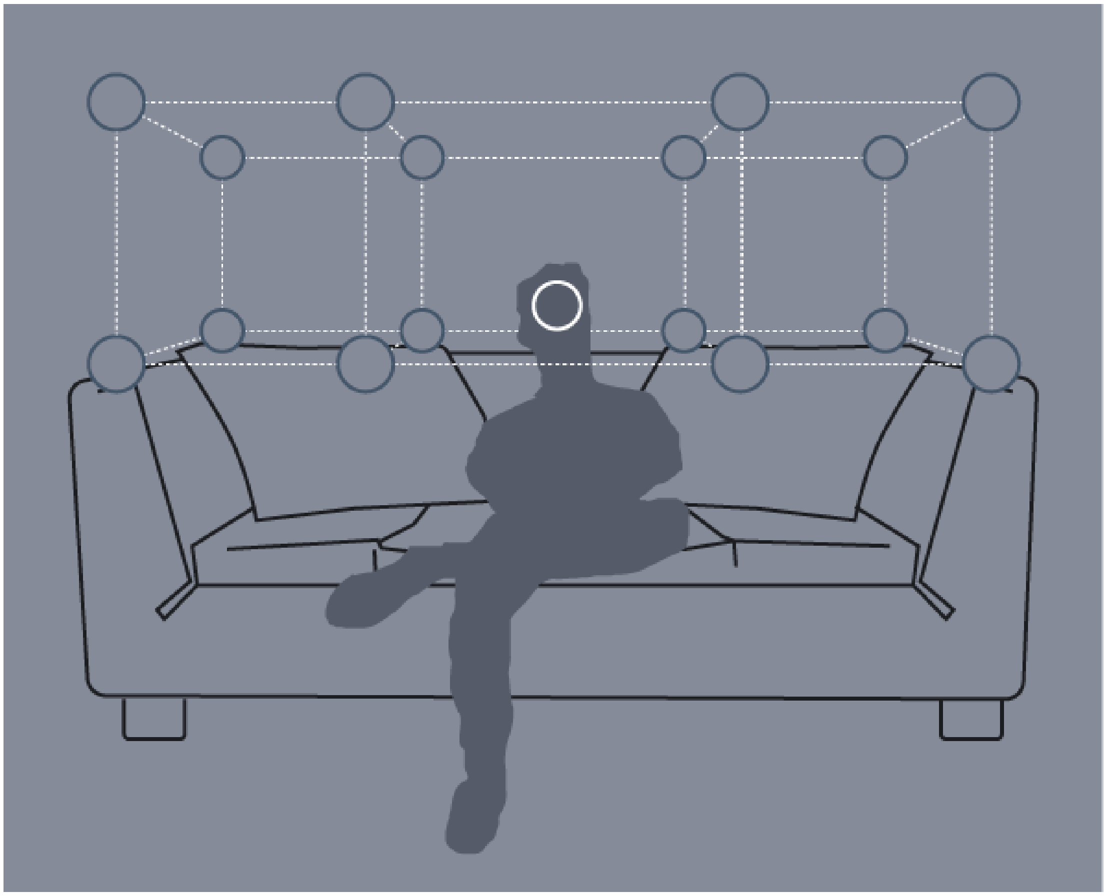

Diagram 13. Three dimensional space and recommended microphone positions

After making at least four measurements, average them to find the composite as shown in Diagram 14 below.

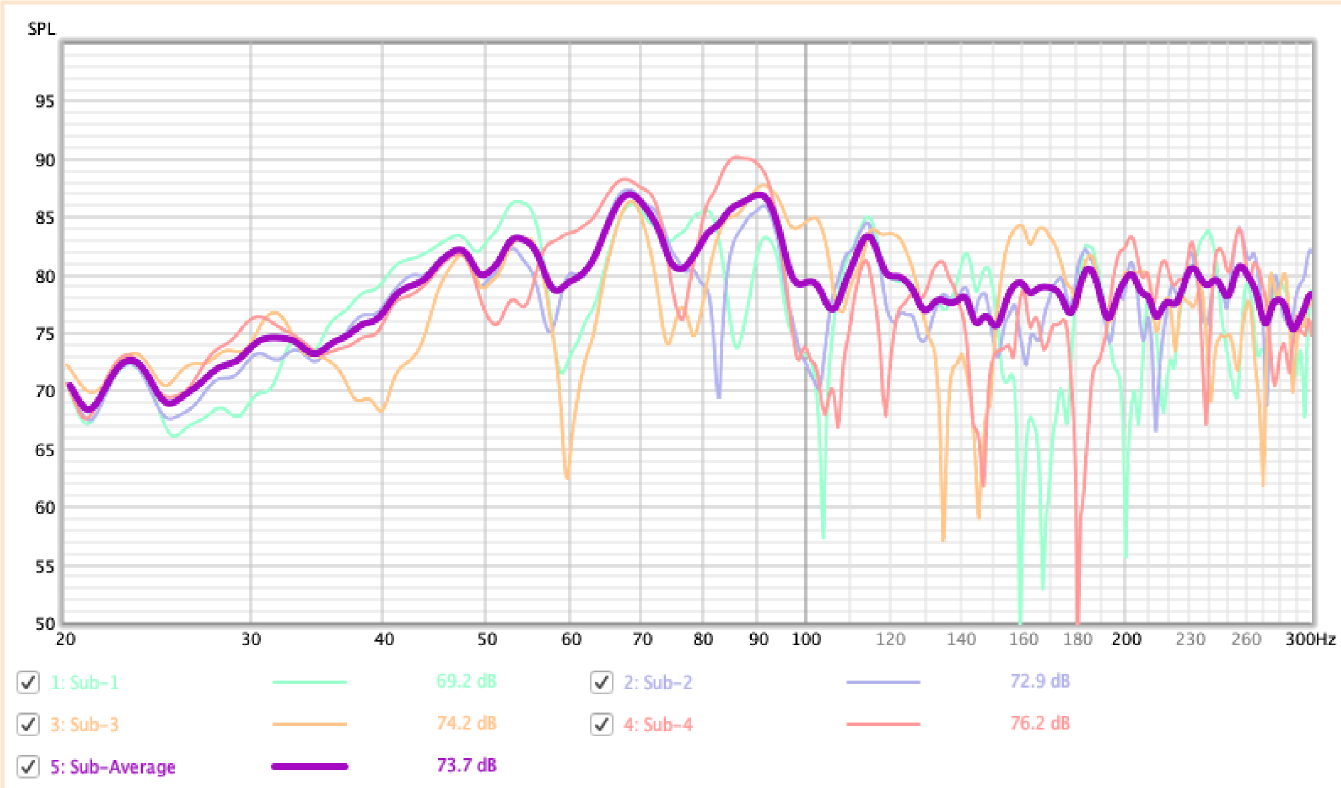

Diagram 14. Averaged multi-subwoofer room measurements

Creating and Loading Room Correction Filters

After completing the measurements, set up REW to generate filters for your miniDSP. Once the appropriate filters are created, download them to your miniDSP. The following diagrams illustrate that process.

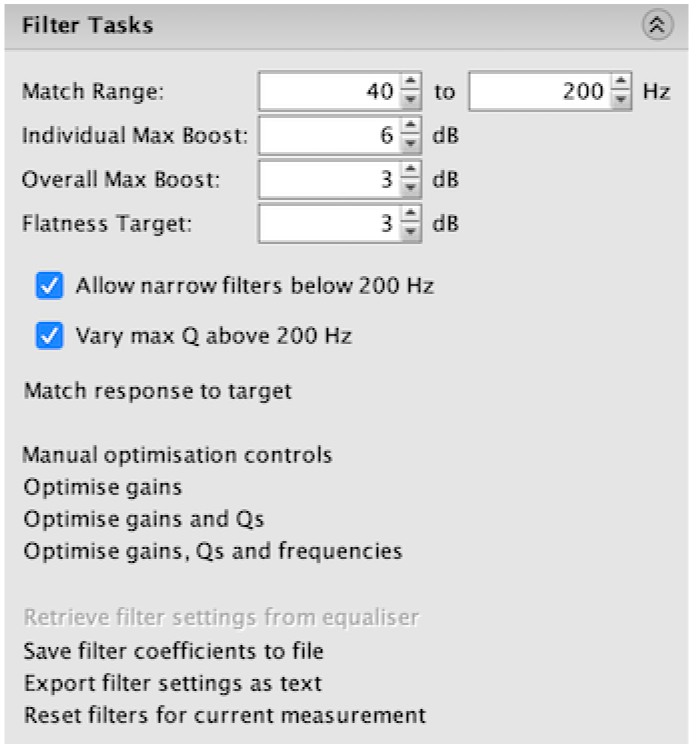

Diagram 15. Setting parameters for REW inverse filter generation

Set the parameters for generating the correction filters. Shown in the screenshot above are the values we found to work best for our example. You should experiment with these values to get the best result.

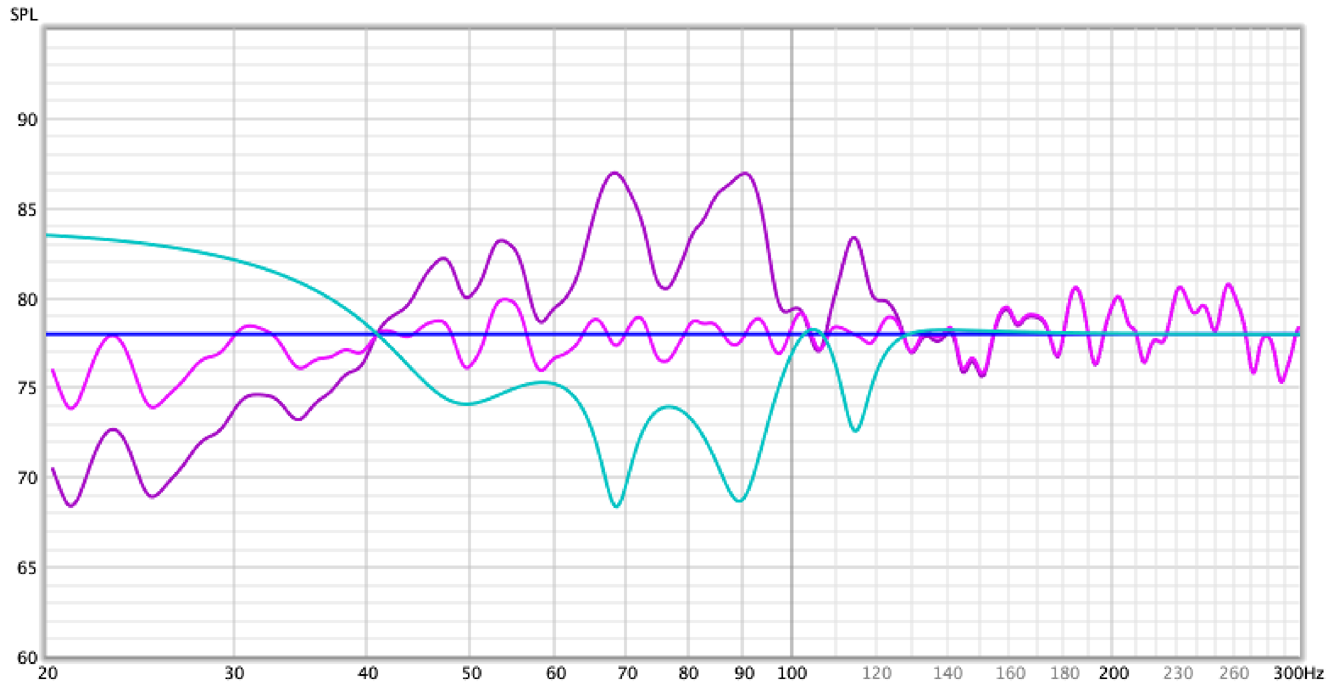

Diagram 16. Measured (purple), predicted (pink) and calculated inverse filter (turquoise) responses

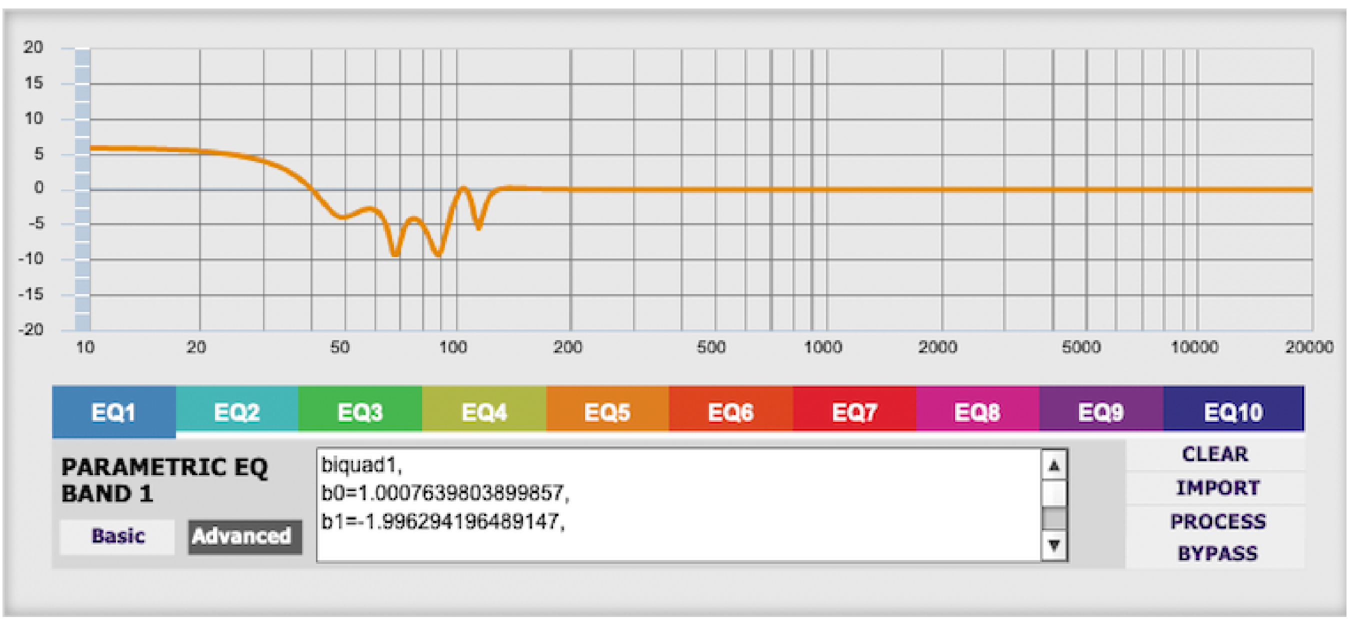

Diagram 17. Inverse filter downloaded and displayed in the miniDSP plug-in

Tuning to Taste

After you have completed this process and you're satisfied with the results, you can go into the individual output channels and adjust the PEQs manually for tuning by taste.

Using Dirac Live

Choosing Your Correction Strategy

Before you begin your Dirac project, be sure that you have completed all of the steps in the Basic Setup section above.

You have the option to run individual REW correction curves for each of the multiple subs in each of the output sections of the plug-in. For this example, we are going to leave those flat so you can tune each of the individual output PEQs to your taste.

Running Dirac Live

This is a brief overview of the Dirac Live process. Please refer to the Dirac Live User Manual for a detailed description of the procedure. *See Resources 8.*

The Routing Matrix example below pertains to a single monaural subwoofer input driving four subwoofers.

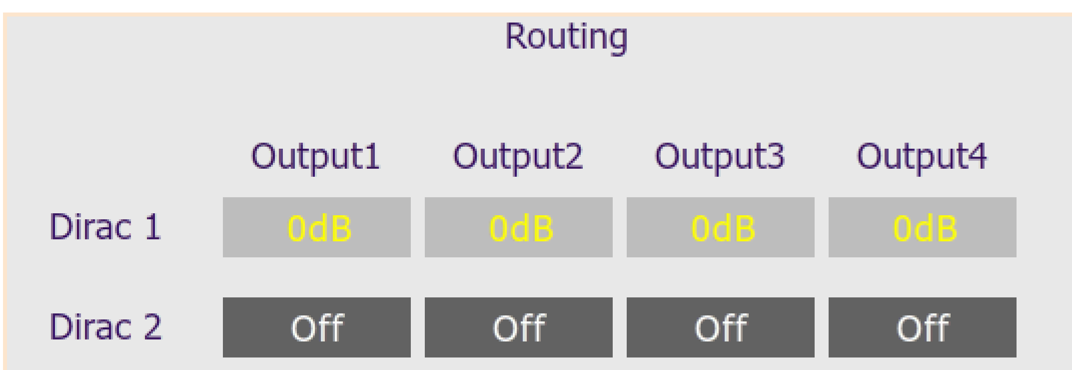

Diagram 18. Routing matrix used during monaural subwoofer Dirac calibration and project

After loading the Dirac Live software in accordance with the miniDSP manual, you will perform the following steps:

1. Verify you have all the proper USB connections in place, with adequate room to see your computer and be able to fully move the microphone around the rectangular cube defining the listening area (see diagram 13)
2. Initiate Dirac Live from the miniDSP plug-in
3. Confirm that you have logged into your Dirac Live account
4. Verify that you have no error messages before you proceed to level calibration
5. Perform level calibration combining both Dirac channels in the routing matrix
6. Select either narrow or wide focus listening area
7. Perform specified measurements (note the person in the diagram is facing the sound stage)
8. Proceed to calculating the Dirac correction waveform
9. Export the Dirac project to the miniDSP unit
10. Save your Dirac project

<u>Tuning to Taste</u>

After you have completed your Dirac project and are satisfied with the results, you can go into the individual output channels and adjust the PEQs manually for tuning by taste. You also can have up to four tuning curves for different types of movies and music.

Making PEQ adjustments in the output section of the plug-in acts as an overlay to your Dirac project. This is a real time activity using peak, high-pass and low-pass filters. For example, you can create a peak filter with either gain or loss and move it around real time to achieve your desired results.

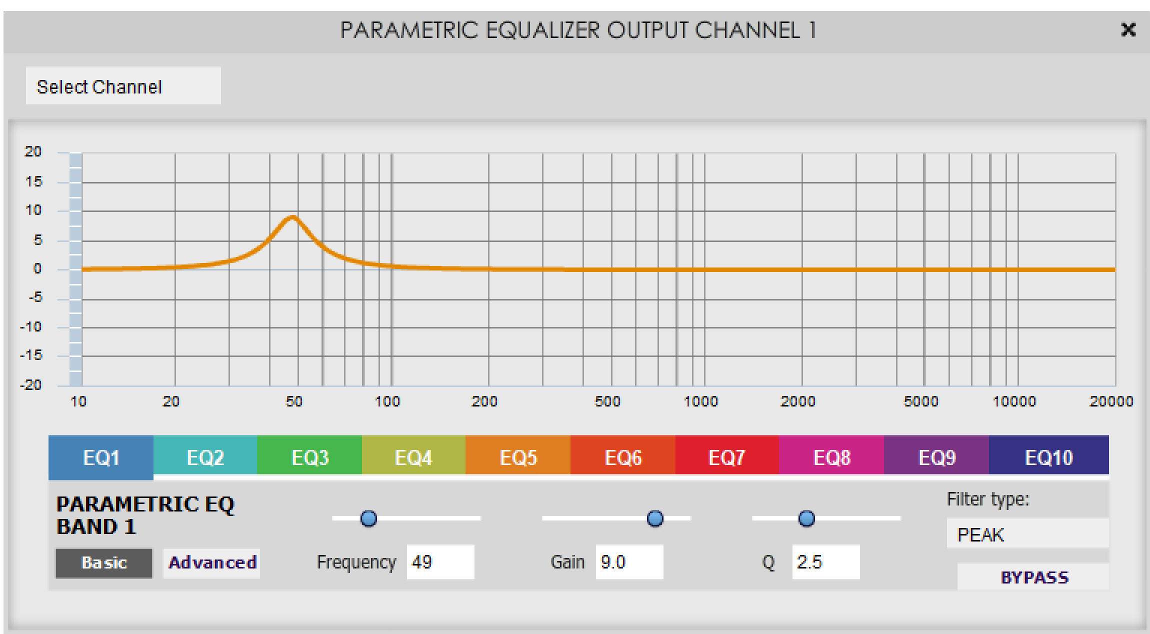

Diagram 19. Example of a tune-to-taste peak filter overlay used for adding some “punch”

Resources

1. A Brief Overview of the miniDSP 2x4 HD
2. miniDSP 2x4 HD User Guide
3. miniDSP DDRC-24 User Guide
4. miniDSP Flex User Guide
5. Room EQ Wizard (REW)
6. UMIK-1 or UMIK-2 setup with REW
7. Acoustic Measurement Tools: UMIK-1
8. miniDSP Dirac Live User Guide
9. Multi-Sub Tuning Basics
10. Sub integration for 2.1
11. Driver time alignment
12. An Array Experiment with Magnetic Variometers Near the Coasts of Southeast Australia
13. Low Frequency Optimization Goals The Crux of the Matter
14. The Misunderstood 0.1 LFE Channel in 5.1 Digital Surround Sound - HomeTheaterHifi.com
15. Gain Structure 101
16. Subwoofer Integration with miniDSP and Stereo Dirac Live

Support

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