miniDSP EARS

HEADPHONE MEASUREMENT JIG

User Manual

Revision history

Revision	Description	Date
0.1	First draft	12 Sept 2017
0.2	Second draft	15 Sept 2017
0.5	Fifth draft	15 Dec 2017
0.7	Preliminary version, OK for public release	17 Dec 2017
1.0	First official version	20 Dec 2017

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IMPORTANT INFORMATION

Please read the following information before use. In case of any questions, please contact miniDSP via the support portal at minidsp.desk.com.

DISCLAIMER/WARNING

miniDSP cannot be held responsible for any damage that may result from the improper use or incorrect configuration of this product. Please read this manual carefully to ensure that you fully understand how to operate and use this product, as incorrect use or use beyond the parameters and ways recommended in this manual have the potential to cause damage to your audio system.

Please also note that many of the questions we receive at the technical support department are already answered in this User Manual and in the online application notes on the miniDSP.com website. So please take the time to carefully read this user manual and the online technical documentation. Thank you for your understanding!

WARRANTY TERMS

miniDSP Ltd warrants this product to be free from defects in materials and workmanship for a period of one year from the invoice date. Our warranty does not cover failure of the product due to incorrect connection or installation, improper or undocumented use, unauthorized servicing, modification or alteration of the unit in any way, or any usage outside of that recommended in this manual. If in doubt, contact miniDSP prior to use.

FCC CLASS B STATEMENT

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Warning: 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. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause 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.

Notice: Shielded interface cable must be used in order to comply with emission limits.

Notice: Changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

CE MARK STATEMENT

The MINIDSP EARS has passed the test performed according to European Standard EN 55022 Class B.

A NOTE ON THIS MANUAL

This User Manual is designed for reading in both print and on the computer. If printing the manual, please print double-sided. The embedded page size is 8 ½" x 11". Printing on A4 paper will result in a slightly reduced size.

For reading on the computer, we have included hyperlinked cross-references throughout the manual. In addition, a table of contents is embedded in the PDF file. Displaying this table of contents will make navigation easier.

1 PRODUCT OVERVIEW

Thank you for purchasing a miniDSP *EARS* headphone measurement system. miniDSP EARS is a measurement jig for headphones and IEMs (in-ear monitors) that we've built using the same core technology as our extremely popular UMIK-1 calibrated speaker and room measurement microphone.

EARS designed to be a useful and practical tool for headphone enthusiasts. It is ideal to:

1.   Check that your headphones are operating correctly e.g. balance of left/right frequency response.

2.   Take measurements that you can use as a basis for equalizing your headphones.

3.   Observe the effect on frequency response of different earpads and eartips.

4.   Measure the effect of modifications to the headphones.

5.   Compare your headphone measurements with other EARS users.

Please note that EARS is not an industry-standard measurement head. Even expensive (i.e. tens of thousands of dollars) heads can produce measurements that are different to each other. Our goal with the EARS is to produce something that is affordable and fun to use!

2 GETTING STARTED WITH EARS

In a nutshell, you mount your headphones on the EARS jig (or put your IEMs in the "ear canal") and run a measurement sweep using your headphone amp and favorite measurement program. To get a useful measurement, you will need to first load a suitable calibration/compensation file (which we provide) into the measurement program.

2.1 A NOTE ON MEASUREMENT CONDITIONS

Measurements should be performed under good conditions. While the sweep technique used by modern acoustic measurement programs is quite robust, external noise can still corrupt a measurement. Be aware of external noise sources such as computer fans, air conditioning, traffic noise, aircraft and so on. If necessary, choose a location or time of day for measurement that minimizes noise.

Low frequencies in particular are susceptible to external noise. Even if you cannot hear (or are not aware of) external noise sources, they can still show up in your measurements. If you are not getting consistent measurements at low frequency, external noise is the most likely reason.

Try and keep the space around the EARS clear of other objects, and keep both sides similar. For example, don't position the EARS so one channel is next to a wall and the other is facing into the room.

2.2 CHECK THE EARS GAIN SETTING

There is a bank of DIP switches on the front of the EARS.

Switches 1 to 3 control the internal gain of the microphone amplifier, as shown in Table 1. (Switch 4 is not used.) The default gain as shipped and as indicated in the diagram above is 18 dB. The remainder of this section assumes that the default gain is used. If you change the analog gain setting and want to display correct SPL values, you will also need to read SPL calibration on page 20.

Table 1. Gain switch settings

Gain (dB)	SW1	SW2	SW3
0	Down	Down	Up
6	Down	Up	Down
12	Down	Up	Up
18	Up	Down	Down
24	Up	Down	Up
30	Up	Up	Down
36	Up	Up	Up

2.3 DOWNLOAD THE CALIBRATION FILES

You will need two calibration files, one for the left channel and one for the right. You can download these files from the EARS page on miniDSP.com by entering your EARS serial number.

You will also need to select a compensation curve. Table 2 lists the first two compensation curves available and the downloaded file names. (*xxxyyyy* in the file name is the serial number of your EARS unit.) We will be adding additional compensation curves over time.

Table 2. Naming of calibration files for EARS

Code	Type	Channel	File name
HPN	Over-ear headphone	Left	L_HPN_xxxyyyy.txt
HPN	Over-ear headphone	Right	R_HPN_xxxyyyy.txt
IDF	IEM diffuse field	Left	L_IDF_xxxyyyy.txt
IDF	IEM diffuse field	Right	R_IDF_xxxyyyy.txt

2.4 CONNECT FOR MEASUREMENT

Figure 1 shows a typical connection scheme for headphone measurement. The diagram shows a miniDSP HA-DSP but you can use any other headphone amplifier. If your headphone amplifier doesn't have a USB input, then you will need to adjust accordingly i.e. by using a separate DAC and headphone amplifier. If your headphone amp has DSP or EQ in it, make sure that it is completely disabled when running measurements.
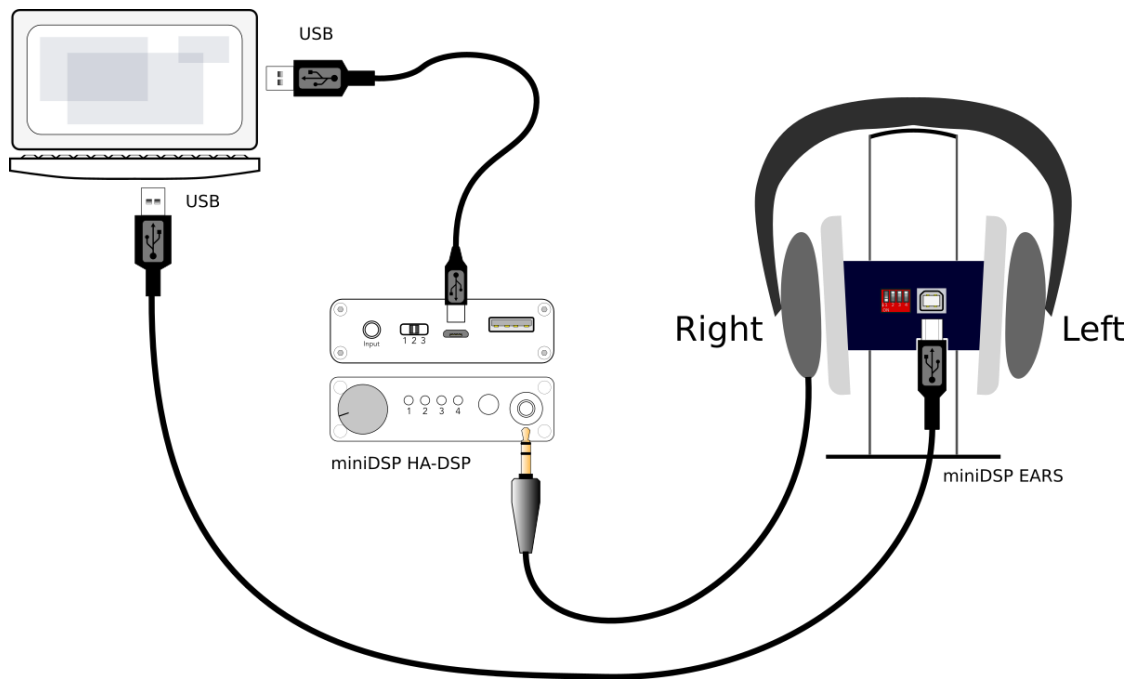

Figure 1. Typical connection for headphone measurement

2.5   CHECK COMPUTER SETTINGS

Some simple settings will need to be checked in your computer:

- The sample rate of your DAC is set to 48 kHz

- The input gain of the EARS is set to 0 dB. On the Mac, use Audio MIDI Setup. On Windows, use the Sound control panel and open its Properties dialog. On the Levels tab, right-click to convert the display to dB and adjust the slider so it reads 0.0 dB.
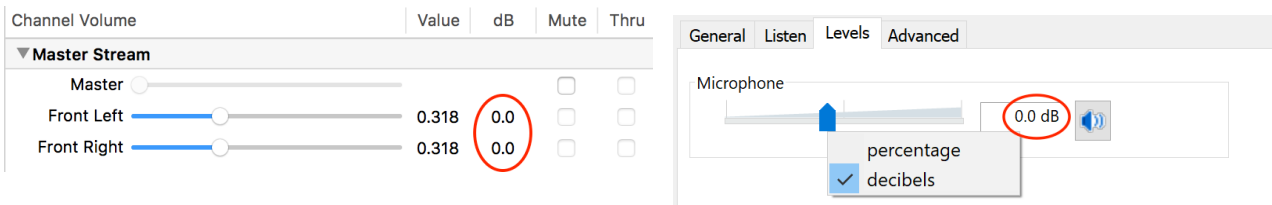
2.6   STEP-BY-STEP: ROOM EQ WIZARD

Room EQ Wizard (REW) is a free acoustic measurement program that runs on Windows, Mac and Linux. This section provides step-by-step instructions with screenshots using REW. Here is the documentation.

If you are already familiar with and plan to use a different acoustic measurement program, use the generic procedure on page 13 instead.
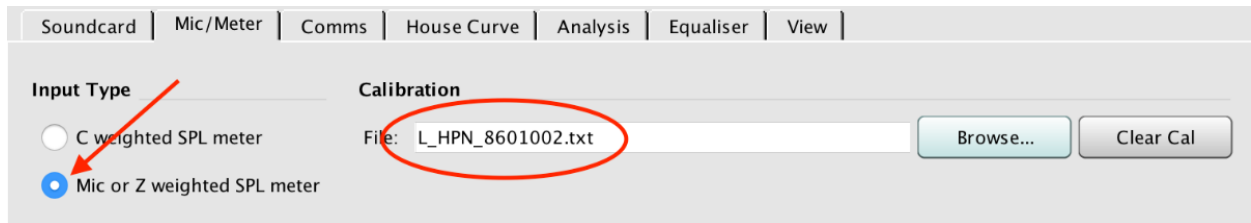
Note: this simplified procedure runs a measurement with a reference SPL level of *about* 84 dB for headphones and *about* 94 dB for IEMs. See page 20 for more accurate SPL calibration.

### 2.6.1   Configure REW

1.   Start REW and open the Preferences window.

2.   On the Soundcard tab, set the sample rate to 48 kHz. Select the headphone amplifier (or DAC) as the output and the EARS as the input source. Choose the Left channel for both output and input, and set the Sweep Level to −20 dBFS.
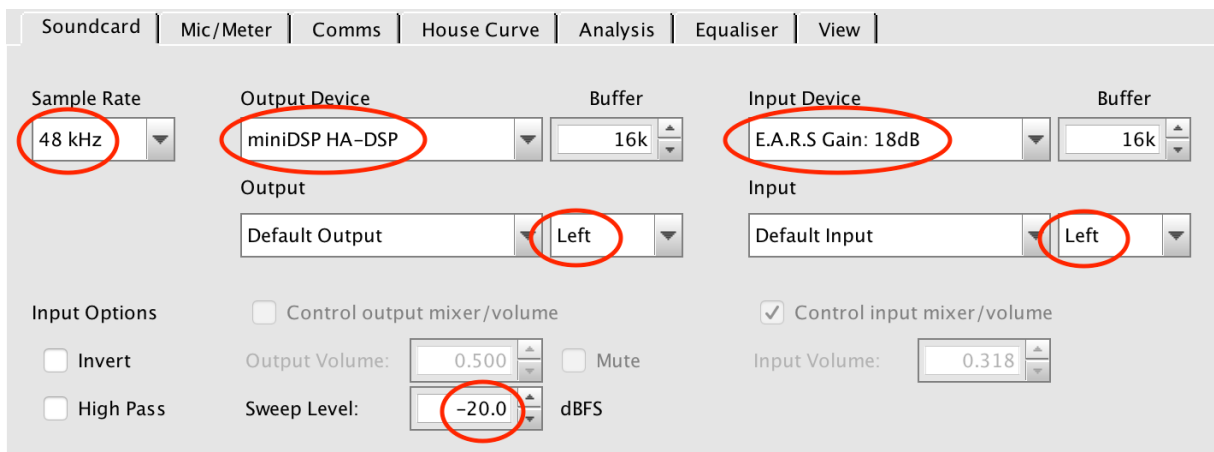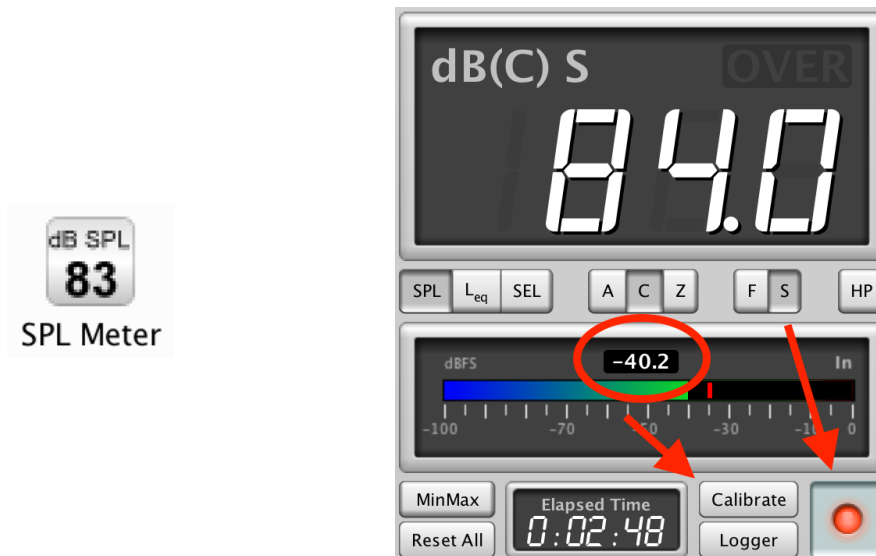
3.	On the Mic/Meter tab, click on Browse. Select the downloaded calibration file for the left channel. Make sure that the "Mic or Z weighted SPL meter" option is set.

| Soundcard | Mic/Meter | Comms | House Curve | Analysis | Equaliser | View |

Input Type

○ C weighted SPL meter

● Mic or Z weighted SPL meter

Calibration

File: L_HPN_8601002.txt   [Browse...] [Clear Cal]

4.	**Turn the volume on the headphone amplifier all the way down**. ⚠

5.	Open the REW Generator window, select Sine Wave output and set the frequency to 300 Hz. Set the RMS Level at −20 dBFS and press the green Play button.

Generator

Sine Wave

300.0
Frequency Hz

RMS Level dBFS
−20.0   WAV   ▶

Output
Default Output   Left
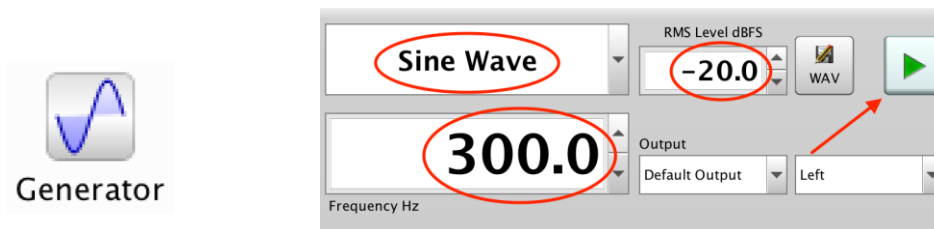
6.	Open the REW SPL Meter window and turn it on (the red button at lower right). Increase the volume on your headphone amplifier until the dBFS meter (lower half of window) reads about −40 for headphones or about −30 for IEMs.

dB SPL
83
SPL Meter

dB(C) S   OVER

84.0

| SPL | L_eq | SEL | | A | C | Z | | F | S | | HP |

dBFS   −40.2   In

−100   −70   −50   −30   −1   0

| MinMax | Elapsed Time | Calibrate | ● |
| Reset All | 0:02:48 | Logger | |

⚠	The very first time you do this, we suggest that you increase the volume with the headphones on your head instead of EARS. This will help ensure that you don't blast your headphones at full power if something is not set up correctly.

7.   Press the Calibrate button. In the dialog that comes up, enter 84 for headphones or 94 for IEMs. Then click Finished.
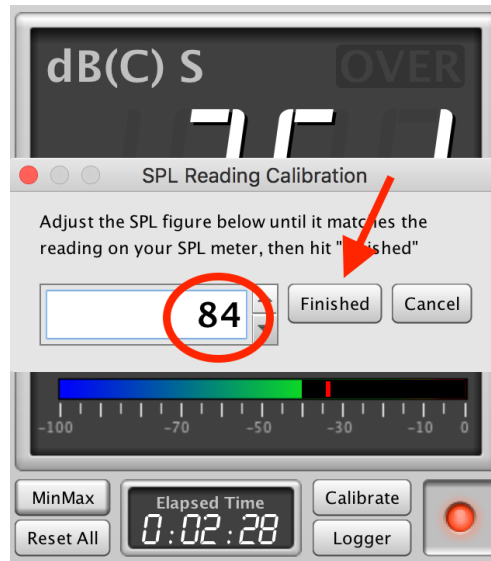
8.   Click on OK on the confirmation dialog that comes up. Close both the Generator and SPL Meter windows.

2.6.2   Measure the left channel

9.   Press the Measure button (top left of the REW main window). Set Start Freq to 20 and End Freq to 20,000. Check that Level is set to –20 dBFS and that **Left** is selected for output. Then press the Start Measuring button.
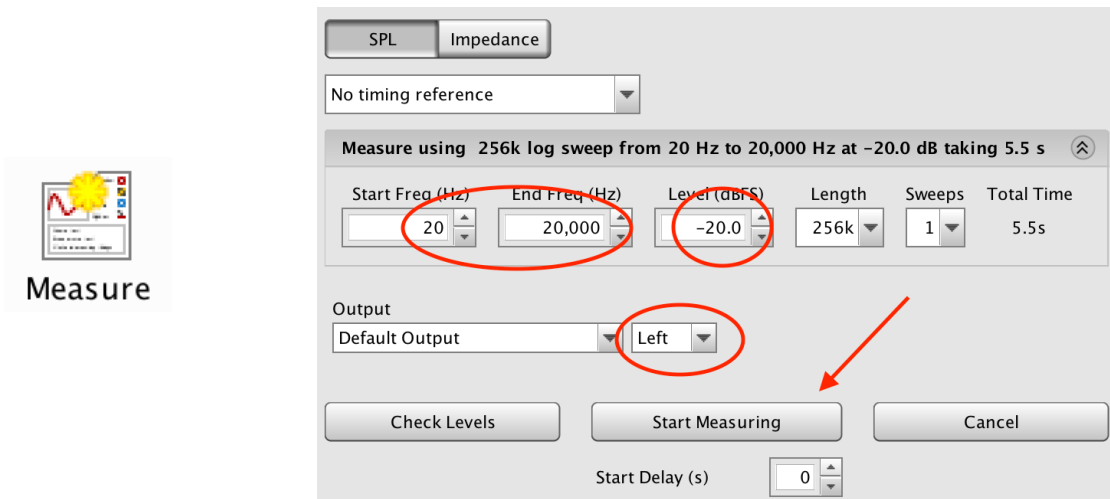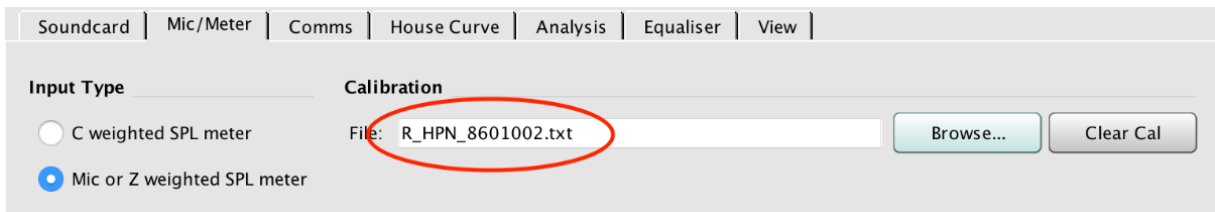
10.   When the measurement process finishes, you will get a new measurement in the REW main window. Rename the measurement so that you don't lose track of which is which.

2.6.3 Measure the right channel

11.   Open the Preferences window. On the Soundcard tab, select the right channel for output and input.
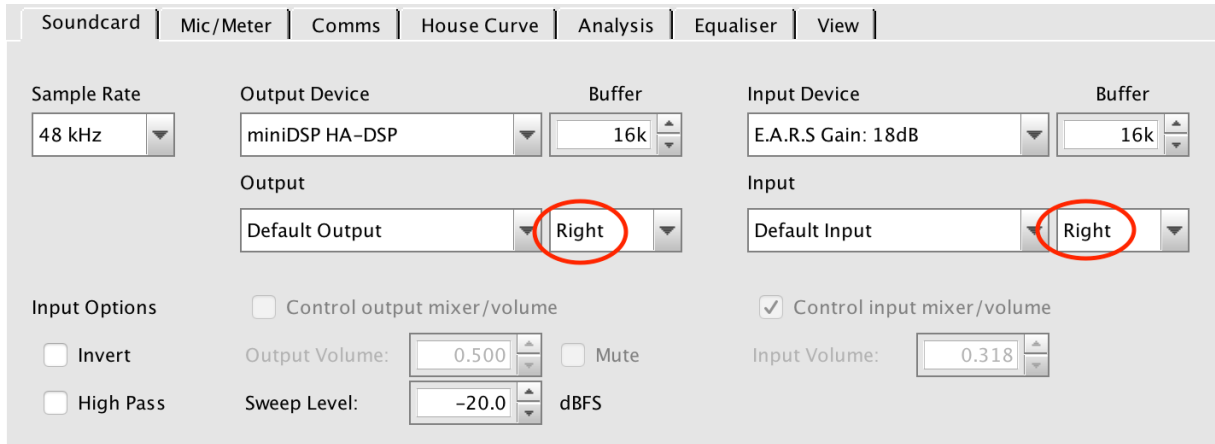
12.   On the Mic/Meter tab, click on Browse. Select the calibration file for the right channel. Make sure that the "Mic or Z weighted SPL meter" option is set.

13.   Press the Measure button and ensure that the **Right** channel output is selected. *Do not change the Level setting or the volume on your headphone amplifier.* Press the Start Measuring button.

14.   When the measurement finishes, you will get a new headphone measurement in the REW main window. Rename the measurement so that you don't lose track of which is which.

2.6.4 Changing the calibration file

If you forgot to load a calibration file or had the wrong one loaded (i.e. left instead of right or vice versa), REW allows you to set or change the calibration file after taking a measurement. Just click on the "Change Cal…" button underneath the measurement thumbnail on the left-hand side. Then select the correct calibration file.

2.7 STEP-BY-STEP: GENERIC

The following steps should work with any measurement program.

1. Set the measurement program and your DAC to operate at a 48 kHz sample rate. (The EARS can only operate at 48 kHz. Setting a different sample rate may appear to work but produce odd results on closer examination. We recommend simply avoiding the problem by ensuring that all software and hardware are set to run at 48 kHz.)

2. Load the left channel calibration file into the program. (Every measurement program will allow you to set a microphone calibration file.)

3. Configure the measurement program to send output to the left channel of your DAC and to read input from the left channel of the EARS.

4. Turn the volume on your headphone amplifier *all the way down*.

5. Play a 300 Hz sine wave signal from your measurement program. Then either:

   1. Monitor your measurement program's level meter and increase the volume control on the amplifier until the level reads approximately –40 dBFS for headphones or –30 dBFS for IEMs. Or,

   2. Listen to the headphones and increase the volume control until the sound is moderately loud.

   Note: at this point your measurement program is not calibrated for SPL, so the actual values of SPL in the measurements should be ignored. For SPL calibration, see page 20.

6. Run a measurement sweep and capture the result. Rename the measurement to indicate that it is the left channel.

7. Repeat steps 2, 3 and 6 for the right channel.

3 MORE ABOUT MEASUREMENT

This section explains various aspects of headphone measurement in more detail. [1]

3.1 THE FREQUENCY RESPONSE GRAPH

Figure 2 shows an example frequency response graph. This is the most common and useful graph correlating to headphone sound. Some of the important controls are highlighted in red. In REW, this is the default display, and is selected with the highlighted button "SPL & Phase." (The specifics here relate to REW, but any measurement program will have similar functions.)

The frequency response graph (in red) shows how the measured SPL of the headphone varies with frequency. For example, at 4 kHz the SPL is 75 dB, as shown by the blue markers overlaid on the graph. Underneath the graph is a set of checkboxes; usually, you will need to display only the amplitude response (named "Left" in this example), and leave Phase and Mic/Meter Cal unchecked.

The frequency range is 20 Hz to 20 kHz, as indicated by the scale along the bottom. The SPL range is 50 to 100 dB, as indicated by the scale on the left. You can set the scales by clicking on the Limits button at the top right.

While it is certainly possible to measure over a larger frequency range e.g. 10 Hz to 24 kHz, note that:

- Low frequency measurements are easily corrupted by noise, and
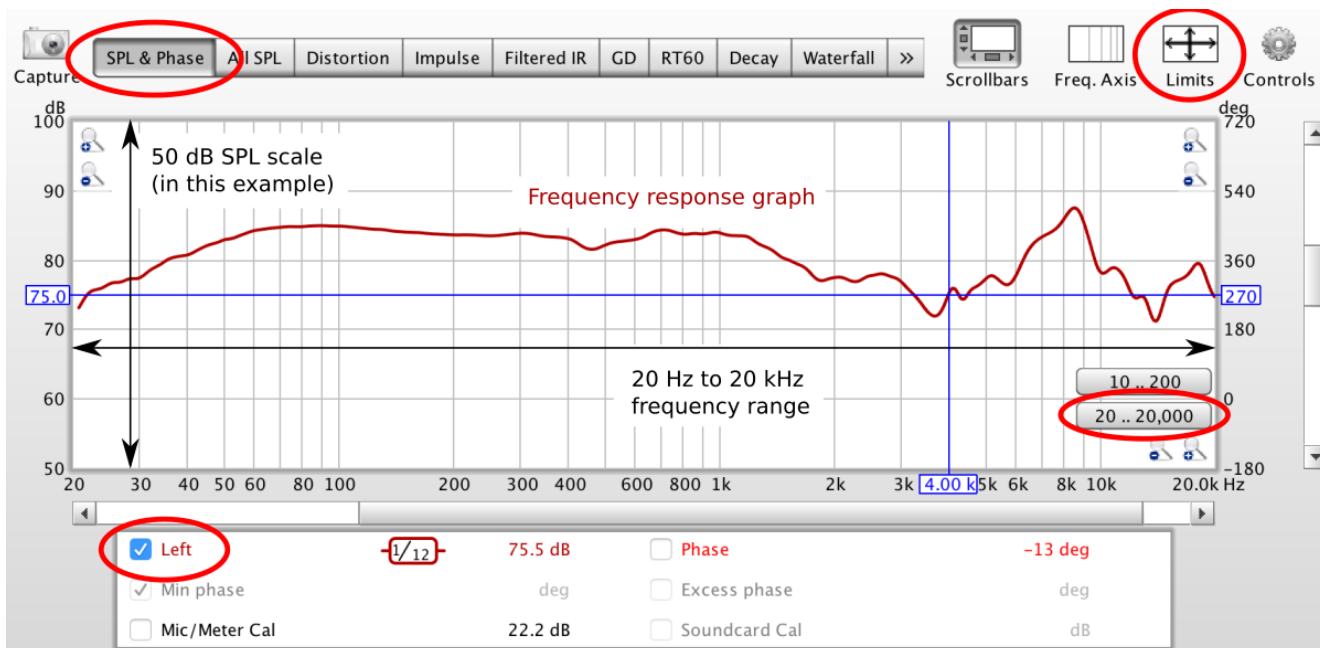- The calibration/compensation files don't go higher than 20 kHz.

Figure 2. An example frequency response measurement

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[1] The measurements in this section are intended to illustrate certain points. They are not intended as reference measurements of the headphones and IEMs mentioned.

Measurements are easier to interpret if some smoothing is applied to the graph. This can be done from the main Graph menu. For most purposes, we suggest using 1/12th-octave smoothing, as illustrated in Figure 3.
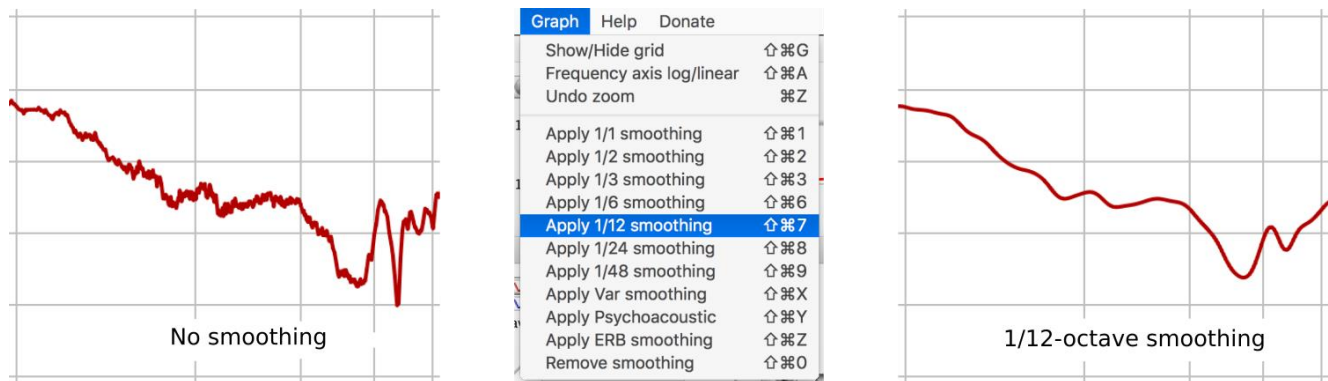

Figure 3. The effect of smoothing on a graph

3.2 OTHER TYPES OF MEASUREMENT

The bar along the top of Figure 2 can be used to select other types of measurement. Some of these will be the subject of future app notes on our web site, but here is a brief overview of the most relevant and useful for headphones (and IEMs):

All SPL   Shows multiple SPL measurements. To take an average of several measurements, click All SPL and select the ones that you want to average using the checkboxes at the bottom. Then click on the Average the Responses button.

Distortion   Displays measured harmonic distortion versus frequency. The graphs are displayed in dB, but you can read off the distortion in percent at any frequency by placing the cursor on the graph, then reading off the distortion % next to the graph names underneath.

Impulse   EARS is not suited for impulse response measurements *unless* the measurement program uses the phase information in the EARS calibration file when it displays the impulse response. REW doesn't currently do this.

Waterfall   The "waterfall" or CSD (cumulative spectral decay) plot is a hybrid time-and-frequency display that is useful to show resonances in the response. Note: while it seems likely that a headphone with a "clean" CSD will sound better than a headphone with a "messy" CSD, we are not currently aware of formally-published research in this area.

Another type of measurement you will see in some online measurement sets is the headphone impedance vs frequency. EARS can **not** be used to make impedance measurements.

EARS is also not well suited for sound isolation measurements, as the omnidirectional microphone capsules pick up sound from the back of the "ear," limiting the maximum attenuation that can be measured.

3.3 MORE ON HEADPHONE MEASUREMENTS

The measurement obtained from a headphone will vary with headphone position and seal. In [Headphone Measurement Procedures - Frequency Response](), Tyll Hertsens explains that he takes measurements at five positions of the headphones on the measurement jig (that is, five on each side).

Figure 5 shows measurements taken at five headphone positions (one channel only) for an open headphone (AKG K702), while Figure 4 shows measurements at five positions for a closed headphone (Audeze LCD-XC). We recommend that you measure your own headphones at several different positions to establish how much variation there is with position.

If you find that you get significant variation, you may wish to use your measurement program to generate an average of several measurements. You may also find that, with practice at headphone positioning, you can consistently get a "center" position measurement that is very close to this average.
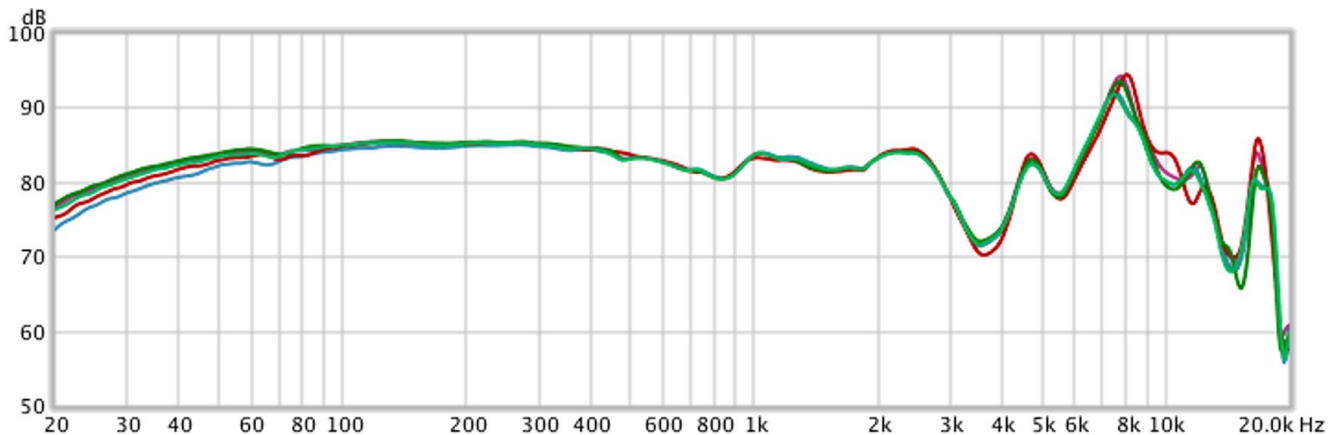

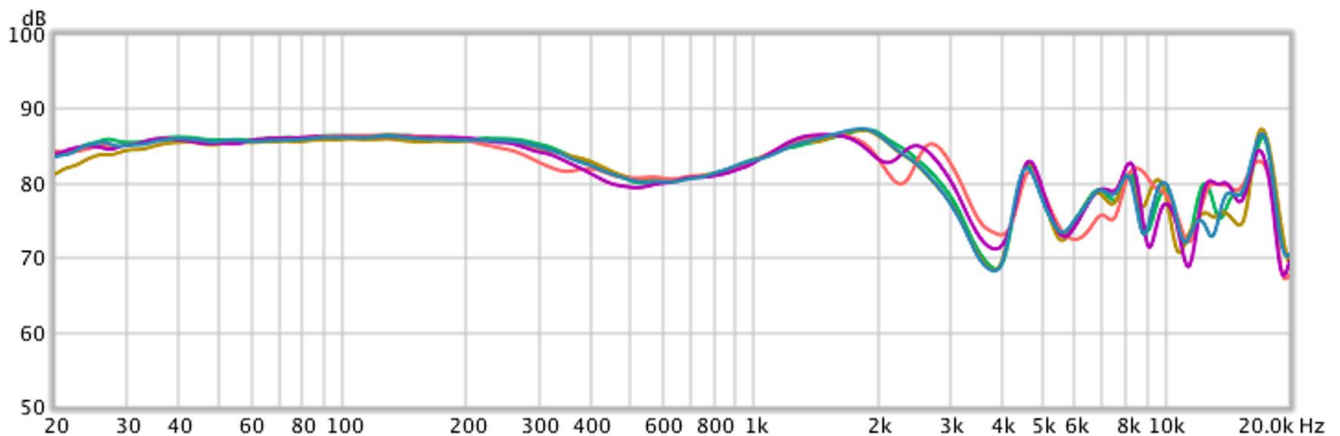*Figure 5. Effect of headphone positioning 1 (K702)*

Figure 4. Effect of headphone positioning 2 (LCD-XC)

Earpads will also make a difference to a headphone measurement. While the EARS can be used to identify the differences in frequency response that you hear with different earpads, this is also information to provide if sharing your measurements with others. For example, the top two traces in Figure 6 show the Massdrop/HIFIMAN HE4XX with FocusPad in green and the FocusPad-A in purple. The lower two traces show the same FocusPad in green compared to an old worn-out FocusPad in red. (The difference in the bass area is most likely due to the old pads being torn and therefore unable to seal properly.)
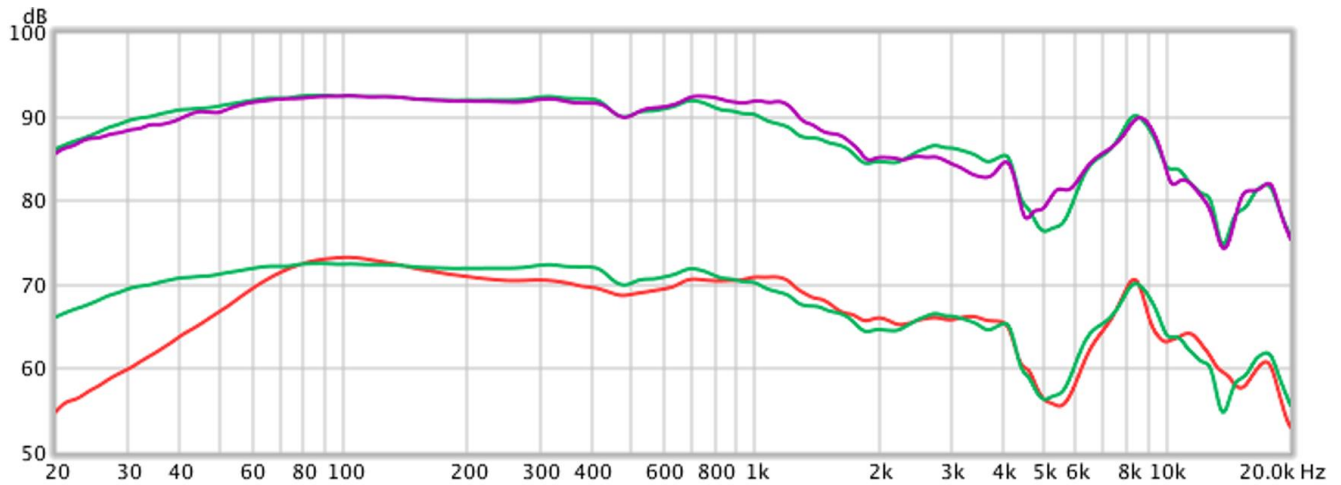

Figure 6. Effect of pad differences (HE4XX)

Some headphones are very sensitive to the amount of seal and/or any pressure applied. Figure 7 shows a small over/on-ear headphone (Bose QuietComfort 35 II in passive mode). The curves in purple and blue are with the headphone positioned so that the headphone doesn't seal to the jig. The curve in red would be considered the normal measurement; the curve in green is with additional pressure applied to the earcup. As you can see, some care will be needed to get consistent and repeatable measurements when measuring a headphone such as this.
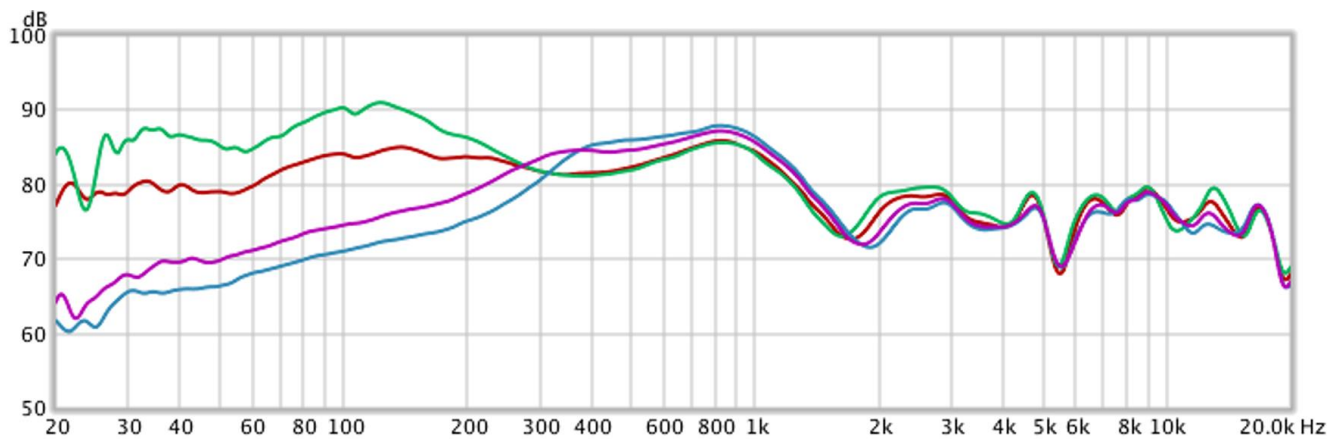

Figure 7. Effect of seal/pressure on small sealed headphone (QC35II)

3.4 MORE ON IEM MEASUREMENTS

Figure 8 shows the effect of different eartips (each graph is the average of left and right on an Etymotic ER4SR). While EARS can be used to measure the frequency response changes that you hear with different eartips, this also means that the eartips you used should be mentioned if sharing or publishing your measurements.

Insertion depth also makes a big difference. Figure 9 shows measurements at three insertion depths (ER4SR with Comply foam isolation tip). It is important to note that not only does the level change with insertion depth, but so does the frequency response.

Because of this, when measuring IEMs that don't have a fixed insertion depth, we recommend that you repeat the reference SPL level check on each insertion and for both sides – that is, don't change the headphone amp volume, just check the level and move the IEM out or in a little until the level is close to your reference level.

Additional notes and things to be aware of when measuring IEMs:

- IEM measurements vary quite a lot at high frequencies, and generally drop off very quickly at 15 kHz or so. Be careful when doing high frequency EQ and don't try and EQ up the frequency response above 15 kHz.

- It's possible with some IEMs to inadvertently obstruct the end of the IEM tube. This will show up as greatly reduced bass response.

- Some IEMs will show strong resonant peaks in the response. Sometimes these are the IEM itself, but other times it's a resonance in the "ear canal" that moves around with insertion depth. Don't EQ the latter.

- Avoid inserting a "deep insertion" IEM in as far as it will go, as the tip will collide with the microphone capsule. This will obstruct the tube and produce a poor measurement. It could also (if done forcibly) potentially damage the capsule.
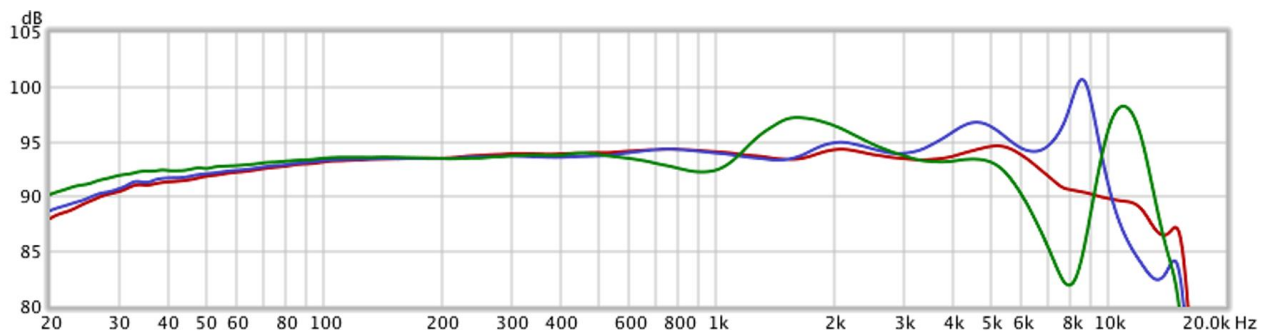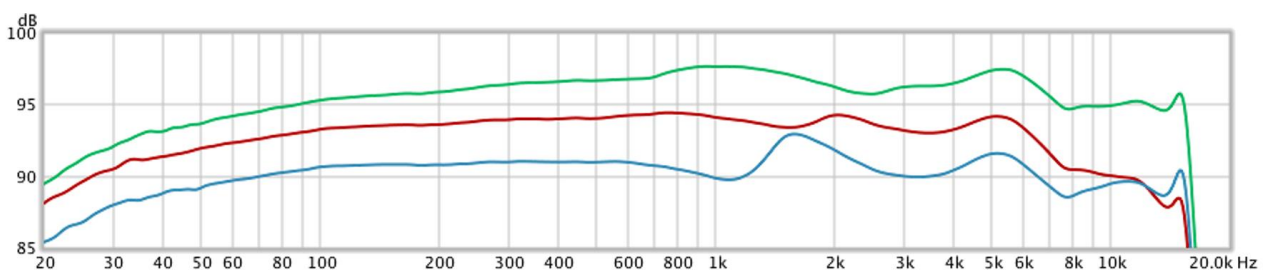

Figure 8. Effect of different IEM eartips

Figure 9. Effect of IEM insertion depth

3.5 EFFECT OF THE AMPLIFIER (AND DAC)

Everywhere else in this manual, it is assumed that the amplifier (and the DAC if you have one in the measurement chain) are perfect. In practice, this may not be the case.

3.5.1 Amplifier frequency response

Figure 10 shows a typical amplifier (and/or DAC) frequency response. If your amplifier (and DAC) "droops" in frequency above 20 Hz or below 20 kHz, this will affect your headphone measurement.
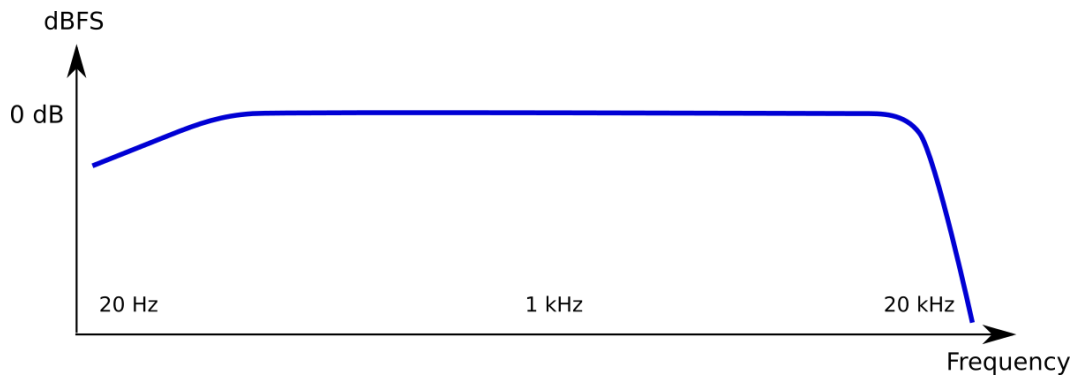

Figure 10. Typical DAC+amplifier frequency response (exaggerated)

3.5.2 Output impedance

If your headphones have a non-constant impedance *and* your amplifier has a high output impedance (say 10% or more of the headphone's nominal impedance), this *may* affect your measurements. The *worst case* variation is given in this table, where Zamp is the amplifier's output impedance and Zphones is the headphone's nominal impedance:

Zamp/Zphones (%)	10	20	50	100
Worst case variation (dB)	1	2	3.6	6

In practice, real headphones will have less variation than this. For example, planars have an almost constant impedance and so will not show variation due to the amplifier output impedance.

3.5.3 What to do

To make headphone measurements that are not affected by the amplifier, a solid-state headphone amplifier with a bipolar power supply (and no coupling capacitor on the output) will usually be a good choice. The criteria are flat frequency response to the measurement limits and an output impedance less than 10% of the headphone's impedance.

In some cases, you may wish to do a measurement and then EQ that *includes* the effect of the amplifier. That way, the EQ compensates for the amplifier as well as the headphones. In that case, measure using the same amplifier that you plan to listen with.

3.6 SPL CALIBRATION

The procedure on page 10 will deliver SPL levels in your measurements of *approximately* 84 dB (give or take a few dB) at 300 Hz for headphones and 94 dB for IEMs. If you need more accurate or repeatable SPL levels, use the following procedure.

3.6.1 Find your sensitive side

Open one of your calibration files (e.g. by double-clicking on it). At the top, you will see two lines like this:

```
"Sens Factor =-1.7dB, EARS Serial 8601001, compensation HPN V1"
"Use this file on the LEFT channel. Your sensitive side is RIGHT."
```

Write down the sensitivity factor ("Sens Factor"), and which channel is the "sensitive side." In the example above, the sensitivity factor is –1.7 and the sensitive side is the right.

3.6.2 Work out your target calibration factor

Use the following formula:

target_calibration_factor = (reference_spl + ears_analog_gain + sens_factor – 142) dBFS

Many measurement programs will require a 94 dB signal for SPL calibration. Here is our example worked out:

target_calibration_factor = 94 + 18 + (–1.7) – 142 = –31.7 dBFS[2]

3.6.3 Calibrate your measurement program

Play a test signal through the "sensitive side" of your EARS. We suggest a 300 Hz sine wave, as this frequency usually avoids "problem areas" in the frequency response of the headphone. Adjust your headphone amp gain so that the program's level meter indicates your target calibration factor, as worked out above.

Then use the SPL calibration function of your measurement program. (See page 10 for an REW example.)

3.6.4 Measuring at higher SPLs

If you measure headphones at a reference SPL higher than 84 dB, or IEMs at a reference level higher than 94 dB, you may find that the measurement signal clips. In that case:

1. Reduce the analog gain of the EARS (see page 7).

2. Work out the target calibration factor again with the new analog gain.

3. Recalibrate your measurement program.

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[2] This is the "dBFS RMS" reading, whereby a full-scale signal actually reads at -3 dB. If your software displays a "dBFS Peak" reading, add 3 dB to the calculated target calibration factor.

![miniDSP logo]

4 CALIBRATION/COMPENSATION CURVES

As explained in Section 2, you will need to load a calibration file before running a measurement. For speaker measurements, the calibration file corrects for frequency response errors in the measurement microphone and (sometimes) in the associated electronics. Headphone measurements are a bit more complicated. For EARS, you will need two calibration files (one for each "ear"). These serve three purposes:

1. Correct the frequency response of the individual (left and right) capsules.

2. Correct for any SPL sensitivity difference between the left and right capsules.

3. Apply a compensation curve so that the produced measurement is "more useful" (see below).

There is more than one type of compensation that can be applied. In particular, headphones and IEMs have different compensation types and you will probably get poor results if you don't use the right type.

4.1 RAW VS COMPENSATED RESPONSE

When a measurement is made of a headphone with the EARS, the "raw" measurement tends to look something like the green curve in Figure 11. This curve is hard to interpret, and so typically a compensation curve is applied to produce a measurement curve that looks more like the curve in blue. (This is a simplified example.)
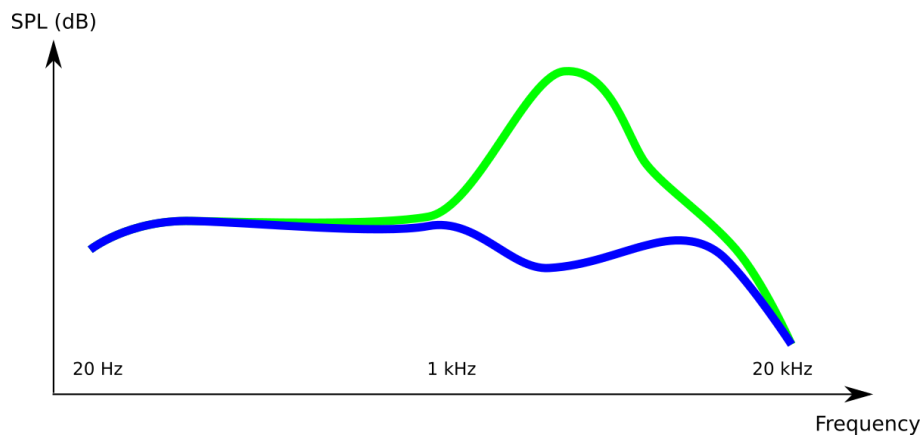

Figure 11. Simplified example of headphone raw response and compensated response

The need for compensation is a characteristic of headphone measurement rigs in general. The "right" compensation curve is a topic of current and on-going research. For an accessible explanation of the topic in general, see the innerfidelity.com article Headphone Measurements Explained - Frequency Response Part One.

The EARS is not an IEEE-standard ear simulator (those are very expensive). So, its compensation curves need to be different from those used with expensive measurement rigs (or published in research papers). We are therefore providing custom compensation curves for different uses, which can be downloaded for your set of EARS from the EARS product page on minidsp.com.

We plan to add new compensation curves in future, as we and others gain more experience with headphone EQ based on EARS measurements.

4.2 DEFAULT HEADPHONE COMPENSATION CURVE ("HPN")

The default headphone compensation curve produces a measurement that is comparable to other published measurements. We have also tailored the curve so that a simple target curve can be used for headphone EQ. With this compensation curve, we suggest a headphone EQ target curve shown in Figure 12. As the diagram indicates, some adjustment to the target based on listening will be required.
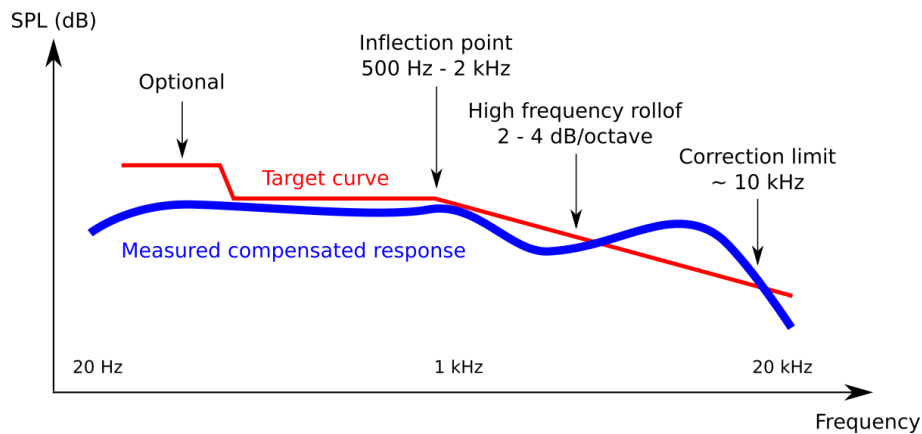

Figure 12. Suggested target curve for headphone EQ based on the HPN curve

4.3 IEM DIFFUSE-FIELD COMPENSATION CURVE ("IDF")

The first compensation curve for IEMs uses a different approach. It is intended to (approximately) equalize an IEM with a diffuse field response to flat. We used the Etymotic ER4SR as the model for this. (Note that this means that you can't directly compare headphone and IEM measurements.)

The suggested target curve when this compensation curve is used for subsequent EQ is therefore flat, as illustrated in Figure 13. As always with EQ, some adjustment based on listening will be required and we've indicated a couple of areas for this on the diagram.

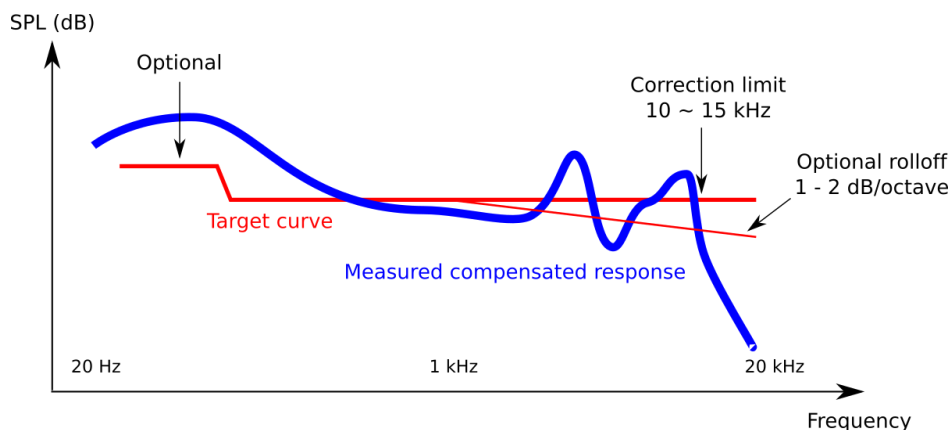This curve is somewhat experimental, so we welcome your feedback in the EARS section of the miniDSP forum.

Figure 13. Suggested target curve for IEM EQ based on the IDF curve

5 FURTHER INFORMATION

5.1 SPECIFICATIONS

Computer connectivity   Driverless USB 2.0 audio interface for Windows and Mac OS X

   Appears as stereo USB input device

Audio sample rate   48 kHz (24 bits)

Power supply   Powered from USB

Calibration file   Unique microphone calibration file for each channel, referenced to serial number

Analog gain   DIP switch to select analog gain, 0 to 36 dB in 6 dB steps

Dimensions (H x W x D)   250 x 180 x 130 mm

5.2 OBTAINING SUPPORT

1. Check the forums on miniDSP.com to see if the issue has already been raised and a solution or solutions provided.

2. Contact miniDSP via the support portal at minidsp.desk.com with:

   a. The product name (miniDSP EARS) and serial number.

   b. A clear explanation of the symptoms you are seeing.

   c. A description of any troubleshooting steps you performed.