A Headphone EQ Primer for Mac and Windows
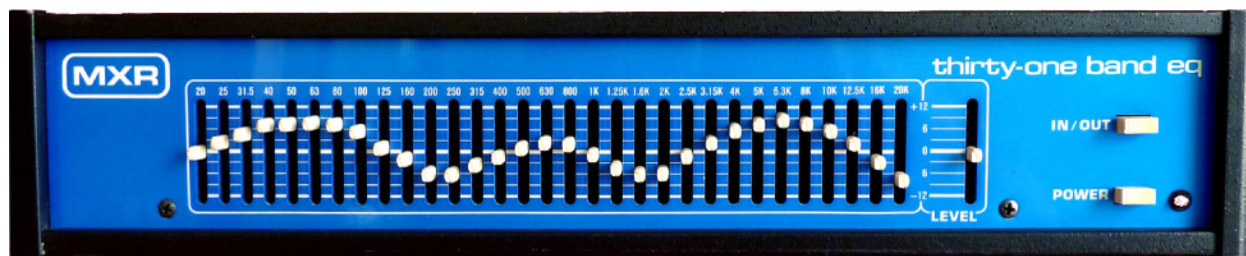
> **Note**: this document is part of a instructional series. If you would like to start with more foundational background information, see *Basics of Musical Sound, Basics of Headphone Sound*, *The Skinny on Headphone Frequency Response Graphs* and *Wrapping your head around the whole flat/neutral/Harman headphone thing* at Headphone Essentials.

EQ, or *equalization*, in audio means modifying the frequency response of an audio device's output. There was a time when any respectable stereo system had a bass and a treble control dial to raise or lower the loudness of the low and high ends of the output sound. This is a very simple form of EQ. Then, ever more sophisticated dedicated hardware EQ boxes were developed to fit into an audio system between the turntable or CD player and the amplifier. Now that we routinely use computers for audio we have software applications to perform the same EQ function.

If you want a very simple, rough-and-ready yet system-wide solution, simply install one of the many 10-band equalizers available, then play with the controls until you have something you like. But if you're ready for a deeper dive, read on. We'll use the software equivalent of the 31-band graphic equalizer pictured above, used for many years by audio professionals for mixing and mastering recordings. This provides an intuitive interface with plenty of power under the hood.

There are many approaches to doing software EQ and many tutorials based on them. I haven't had much luck with any of them, nor with any of several approaches I've tried on my own then moved on from. The following is what's worked for me. And while parts of it may *look* just a bit technical at first blush, I think you'll find it easy to pick up and use. It's actually very simple — we start with what we hear, end with what we hear, and in the middle we season with a sprinkling of numbers to taste.

Getting started

The first thing to do is evaluate the frequency response of your headphone of choice in a relatively objective manner. Listening at the fairly quiet loudness level of normal conversational speech, use the Online Tone Generator (covered in the first unit in this series) in your web browser to gradually move through the entire audio range from the starting 440 Hz position down to 20 Hz. Then up from 440 Hz again to somewhere between 10 and 20 kHz, wherever your hearing stops.

There are two non-problematic changes in loudness you may well hear. One is a potential gradual fall-off as you go to the left of 50 or 60 Hz on down to 20 Hz. This is due to limitations of a common driver technology. The other is a gradual fall-off as you approach the limit of your hearing in the high frequencies. You may also hear a gradual increase followed by a gradual decrease, peaking around 2500 to 3000 Hz. This is due to a natural amplification thanks to the shape of human ears. Our brains normally edit this out, but at louder volumes you'll start to hear it. If you hear it even at a fairly low loudness, it may well be a problem area you'll need to reduce:
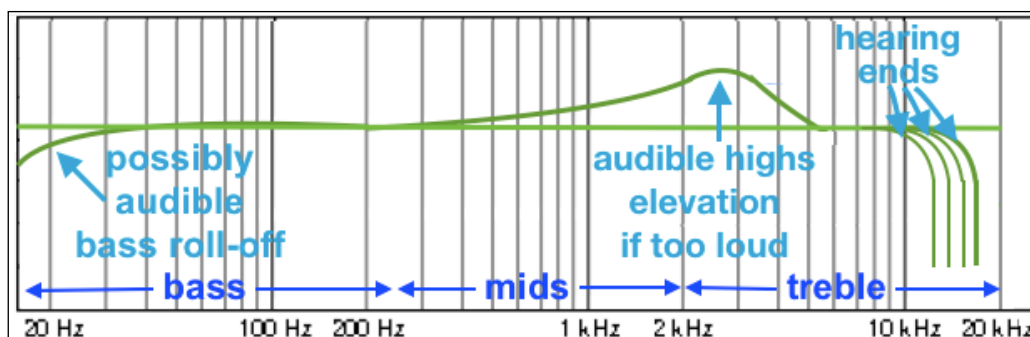

Fig. 1: Perceived rise and fall of loudness for a problem-free headphone

In contrast, many headphones have a built-in bass boost for consumer enjoyment. This is fine. The problem is that too often it extends well past the bass range (20 to 250 Hz) into the midrange, often reaching as high as 1000 Hz. Moving left to right, you'll hear this as a gradual, steady drop-off in loudness beginning somewhere higher than 250 Hz. This distorts the sound of the human voice and many musical instruments.

Another potential problem is that many headphones have dips and rises in loudness at various places throughout the audible range. In particular sharp rises (called spikes) in the high frequencies can be highly irritating. Dips don't call as much attention to themselves, but they can seriously diminish enjoyment.
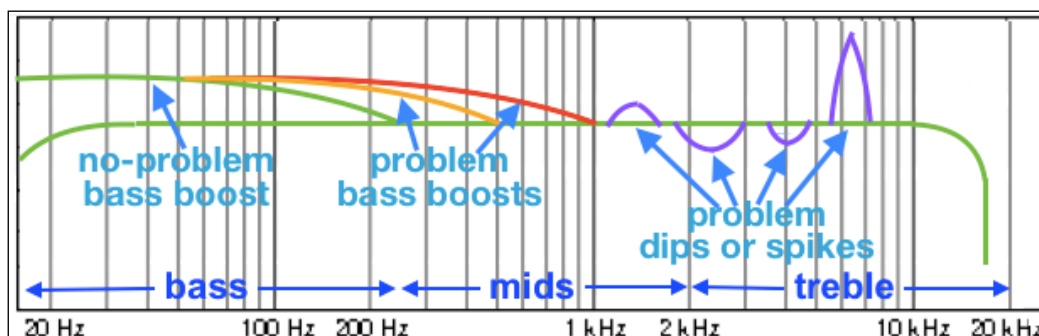

Fig. 2: potential problems (dips and rises only shown on right for visual clarity)

Working with the Online Tone Generator, make notes of any problem areas you hear by noting the approximate start and stop frequencies, whether the sound goes louder or quieter, and whether the change is subtle or prominent. Be sure to distinguish between loudness and the

naturally piercing quality of high frequencies or un-piercing quality of the bass. You might want to switch from the default sine wave to the sawtooth wave form to help minimize this.

For example, let's say your headphone is a Beats Solo3 Wireless. Your notes might read: rise starting from 20 Hz, max loudness at 200 Hz, gradually falling off to max quietness at 700 Hz, rising to max loudness at 3700 Hz, falling to 5800, rising slightly to 7300, then steadily tapering off after that. All the better if you sketch your results like so (graph lines optional):
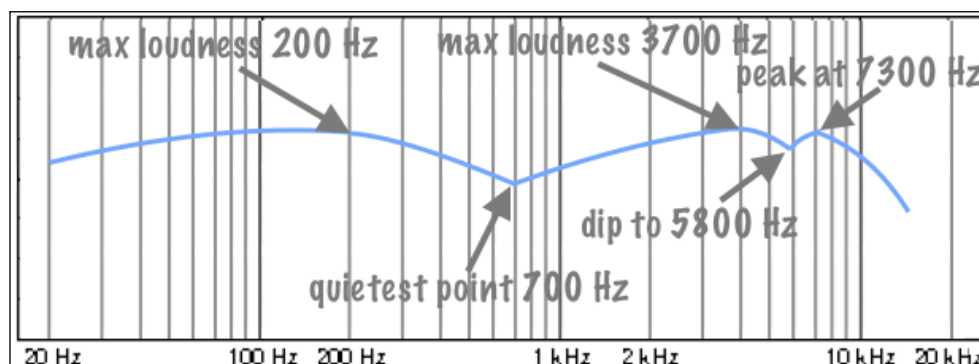

Fig. 3: Perceived rise and fall of loudness for Solo3 Wireless

This tells us that the frequencies between 250 and 700 Hz are falling like we see in Fig. 2, rather than rising or holding steady, like we see in Fig. 1. We may also want to experiment with raising the area around 5800 and/or dropping the area around 7300 Hz.
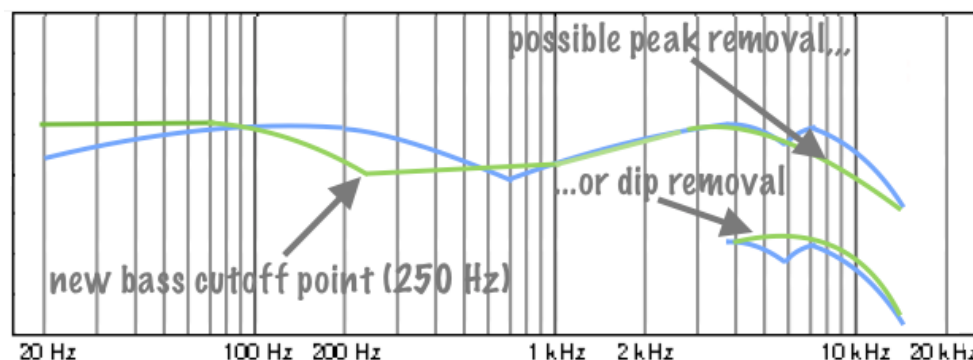

Fig. 4: Perceived loudness curve for Solo3W (blue) with possible correction (green)

In sum, what we want to do is use software EQ to modify the Solo3's sound output from the blue line to the green line in Fig. 4. Keep the same bass elevation. Just confine it to the bass region.

OK, that's it for preparations. Now we need to get down to work. If you're a Mac user, you need to have installed and become a bit familiar with eqMac2. See **For Mac Users** below for instructions. If you're a Windows user, you need to have installed and become a bit familiar with EqualizerAPO and its Peace GUI. See **For Windows Users** below for instructions.

Creating an EQ compensation curve

(From here on, rather than duplicating each illustration with a Peace GUI version and an eqMac2 version, I'll use screen shots from eqMac2 which have more detailed frequency and decibel labeling and ask Peace GUI users to ignore the minor visual differences.)

Looking at <u>Fig. 4</u> above, the first thing we want to do is raise the 20 Hz control point by a moderate amount, raise the 25 Hz control point by a smaller amount, and raise the 31.5, 40, 50, 63, and 80 control points by every diminishing amounts. This will address the gap between the blue and green lines on the far left. Let's start with +4 dB for the 20 Hz control point, about ½ way between 4 and 3 dB for the 25 Hz control point, 3 dB for the 31.5 point, etc. (Half dB increments are about as fine as can be placed and are difficult hear.) The result looks like this:
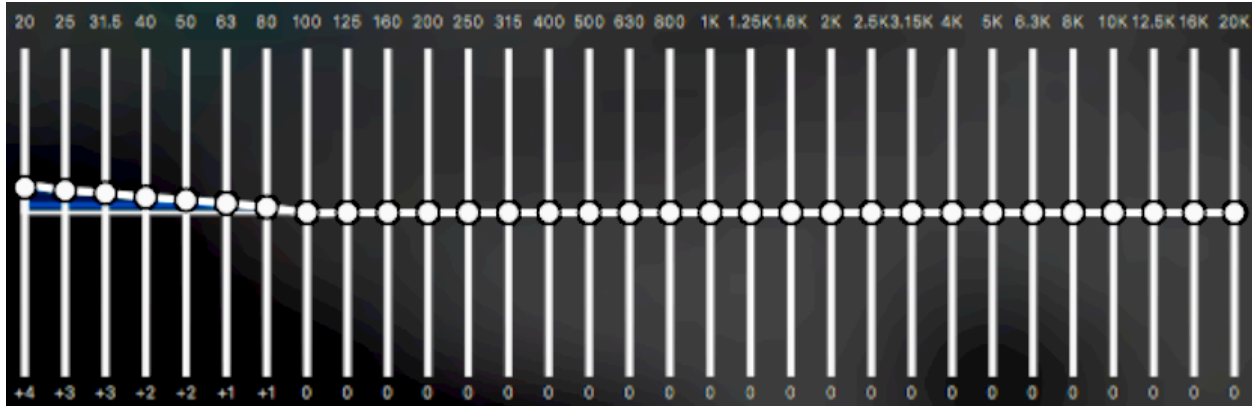

Fig. 5: Initial sub-bass correction for Solo3 Wireless

Listening to the Online Tone Generator in the 20 Hz to 100 Hz region, perhaps we now hear loudness holding steady rather than rising. But if we hear the loudness falling instead of rising as we move the slider to the right, we know we've used too much correction and would dial it back as needed until it holds steady. If instead there is still some rise in loudness, I suggest leaving it that way for reasons we'll discuss later.

Again referring back to <u>Fig. 4</u>, we now need to correct the region between 100 and 250 Hz. The change looks pretty dramatic at 250 Hz, so let's go for a large -6 dB as our initial guess, and use decreasingly smaller corrections until we get back to 100 Hz. The result looks like this:
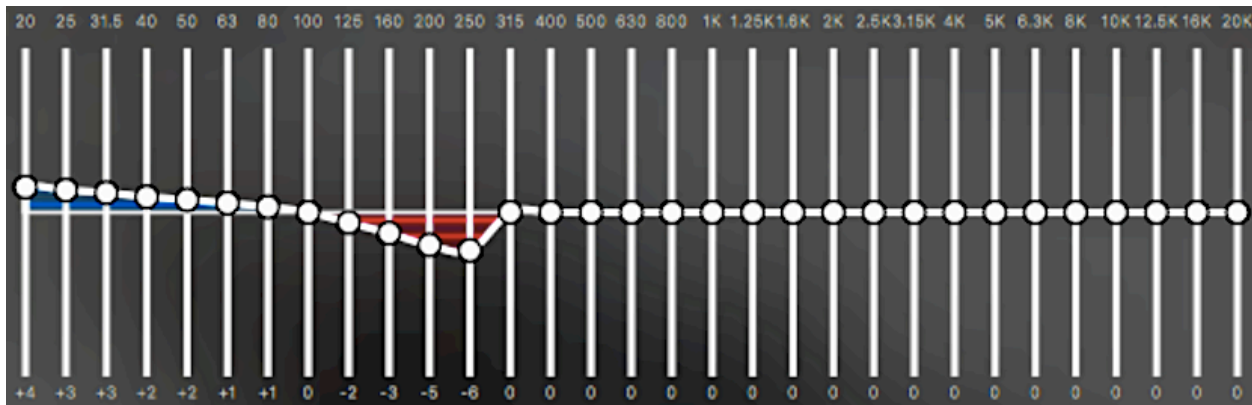

Fig. 6: Added mid and high bass correction for Solo3 Wireless

We now need to taper off our reduction on the right until we get back to 0 at 700 Hz. We don't have a 700 Hz control point so we'll instead target 630 Hz as being 0 dB. The result looks like this:
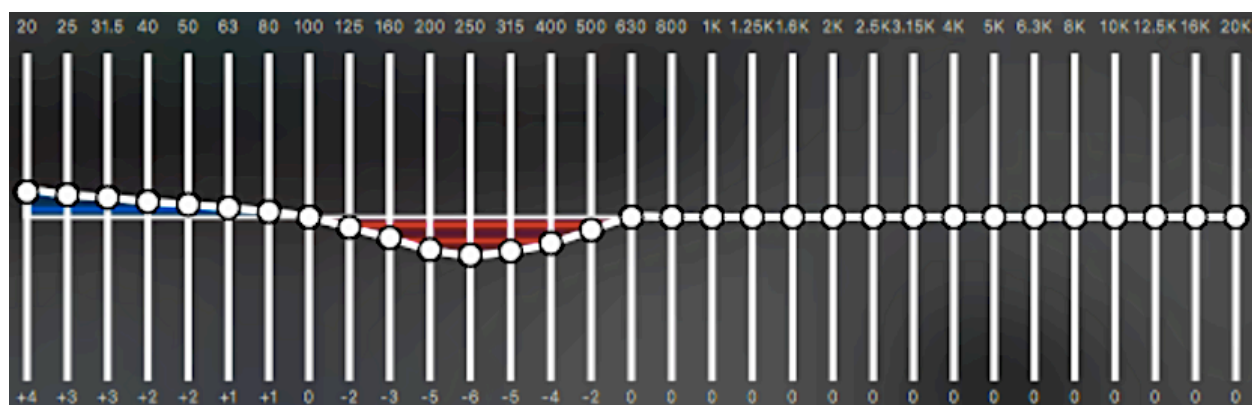
Fig. 7: Added low mids correction

Now we need to test again. Using the Online Tone Generator we need to do something a bit tricky. We need to compare the loudness of the tone at 250 Hz with EQ on to the loudness of 700 Hz with EQ off. In general, to turn EQ off in eqMac2 we simply switch to the Flat EQ. But in this case all the control points to the right of 500 Hz are still at 0, so we can just leave our custom profile in place in eqMacs and do everything in the Online Tone Generator. Going back and forth between the two by toggling sound on and off with the space bar in the Online Tone Generator and moving the slider left and right, perhaps we hear 250 Hz being slightly louder than 600 Hz. So we drop the 250 Hz control point by 2 dB, move the others surrounding it accordingly, then re-test. Now we hear steady loudness from 20 Hz to 600. Continuing the process and opting for peak removal on the right we end up with:
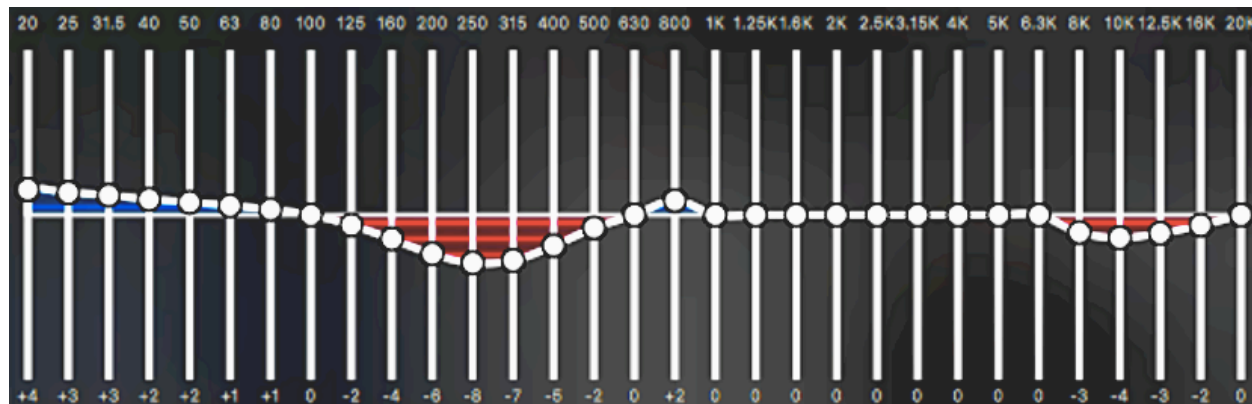

Fig. 8: Final flatness correction

Testing this with the Online Tone Generator we hear thumping loud bass from 20 to 100 Hz. This smoothly tapers down to a low point at 250 Hz then holds the same loudness from there to the end of our hearing. That's what we were aiming for. But what does that do to music and other audio listening? After repeated use over a few days we decide it's a definite improvement overall. Even for EDM we retain plenty of bass kick — but also gain a new clarity in the vocals. This is fine but it seems to come at the cost of the loss of a little sparkle in the highs. Taking out the final dip we tentatively added on the far right of the graph from 8 kHz on restores the sparkle, and now we're good all around.

This is the free-form approach to EQ. Listen for problem areas, such as an over-extended bass boost, dips and spikes. Correct by ear. Now, after much experience, I consistently get my best results this way. But climbing that learning curve takes guidance. The only thing that keeps me from turning raw food ingredients into an unpalatable mess when I have to cook from scratch is a competent recipe. So the next step is to learn the headphone equivalent of following a recipe.

Creating an EQ compensation by matching a target curve

First, you'll need to grab a screen shot or save an image file of a raw measurement graph of the headphone you want to EQ. I explain these graphs and where to find them in Headphone Essentials 4, so review that material now if you're hazy on it. Next, we need what's called a target curve. This is a visual representation of what we want the headphone to sound like. (For more information see Headphone Essentials 5.)

The workhorse Audio-Technica ATH-M50x is probably still one of the most-owned headphones among "serious" listeners. So there's at least a small chance you'll actually have this model. If not, no worry. Again, we're just using it as an example or place-holder for your own headphone. Perhaps read through once, then substitute your own headphone model as you go through a second time.

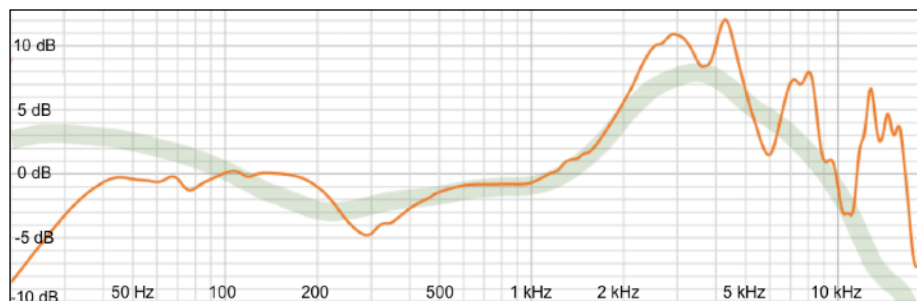First step: I screen-grab or save the PDF of the raw FR graph for the M50x from Oratory1990:

Fig. 9: M50x raw measurement graph screen grab (source: Oratory1990)

The orange line is the actual frequency measurements, showing how loudly or quietly the M50x reproduces sounds from bass through treble, 20 Hz to 20 kHz. The broad green line is the 2018 Harman frequency response target for reference (which we'll ignore). The horizontal grey lines divide the vertical loudness axis into 1 decibel (dB) units, while the vertical grey lines mark frequency (pitch change from bass to treble) in Herz (Hz).

Next, I used the crude mark-up tools in the Mac's Preview app to draw the loudness curve in blue that I want to change the frequency response of the M50x to match. Alternately, you could use some other, more sophisticated, image editing program. But the simplest thing is to draw or print the graph, then pencil in your own compensation curve. I'll explain choosing/creating your own target/compensation curve in the section **Finding your own compensation curve** below**.** For now, simply copy the blue line curve:
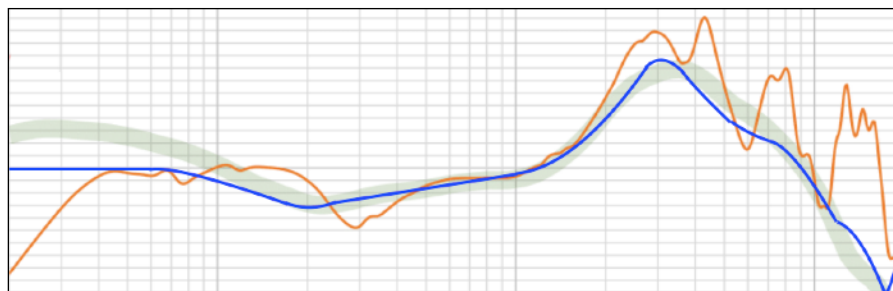

Fig. 10: Target compensation curve added in blue

The particular blue line I added is called the 2013 Harman target response curve (but I reduced the bass on the left from 4 dB to 3 dB to match the height of the graph; the M50x already has plenty of bass for my tastes). The goal is to use EQ to change the frequency response of an M50x headphone to match this target. Thus, any place in Fig. 10 where the blue line rises above the orange line we want to *lower* the frequency response via EQ. And anywhere the blue dips below the orange line we want to *raise* the frequency response.

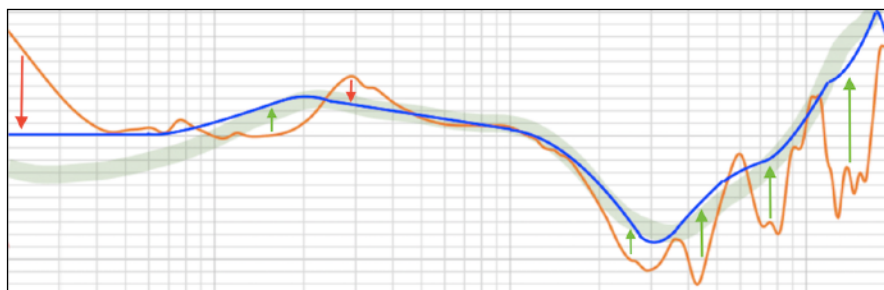To make this clearer, here's an inverted version of Fig. 10:

Fig. 11: Fig. 10 turned upside-down

Inversion literally shows where the orange line is too low or too high compared to the blue line. (It may help if you imagine the blue line being a string, then imagine stretching it taut into a straight line with the orange line obediently following along.) The EQ compensation we want to achieve is simply the dips and rises of the orange line under and over the blue line. So next we need to note how many dB separate the orange line from the blue line at each of the 31 frequency control points we'll be using in our EQ software:
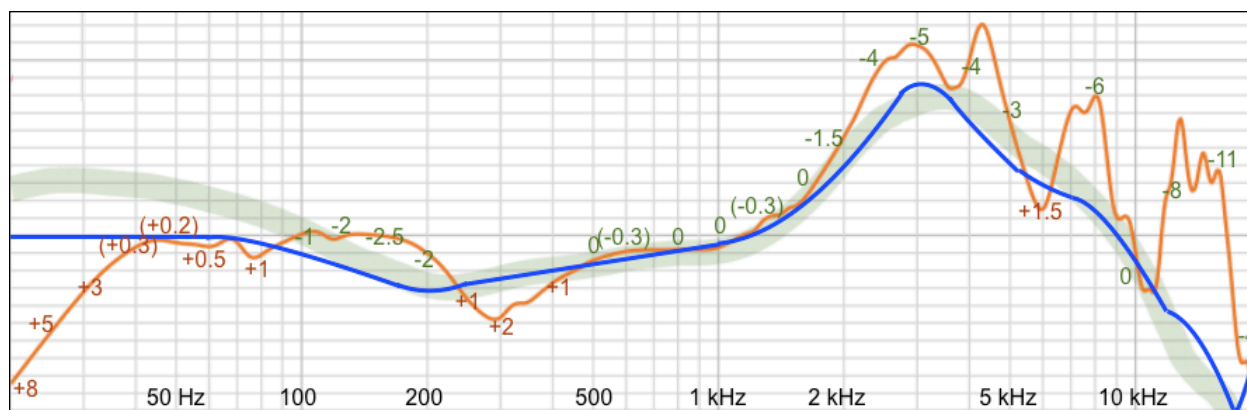

Fig. 12: dB values for 31 control points marked

All I did here was eyeball and record the separation between the orange line and the blue line (by counting the number of horizontal grey lines between them) at each of the following frequencies:

> 20, 25, 31, 40, 50, 63, 80, 100, 125 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000, 10000, 12500 16000 and 20000.

The numbers I marked on the graph are of no great exactness. Between the inexactness of human hearing, unit-to-unit product variation, etc., places where I recorded values smaller than ½ dB are really overkill. Notice also that I put a plus sign in front of numbers where the orange line falls below the blue line and a minus sign in the opposite case. Putting the two sets of numbers together using frequency in Hertz and loudness in decibel pairs we get:

20:**8**, 25:**5**, 31.5:**3**, 40:**0**, 50:**0**, 63:**½**, 80:**1**, 100:**-1**, 125:**-2**, 160:**2½**, 200:**-2**, 250:**1**, 315:**2**, 400:**1**, 500:**0**, 630:**0**, 800:**0**, 1k:**0**, 1.25k:**0**, 1.6k:**0**, 2k:**-1½**, 2.5k,**-4**, 3.15k:**-5**, 4k:**-4**, 5k:**-3**, 6.3k: **1½**, 8k:**-6**, 10k:**0**, 12.5k:**-6**, 16k:**-11**, 20k:**-4**

And that completes our preparations.

Turning 31 numbers into an EQ curve

Choose Flat from the top dropdown again to start with a clean slate. The first two numbers I marked on the left in Fig. 12 are +8 at 20 Hz and +5 at 25 Hz. For reasons I'll explain below, I'm going to drop both of them to +3, at least initially. So first I move the 20 Hz dot up to 3 dB (instead of 8 dB) on the eqMac2 graph. Next, I move the 25 Hz dot barely to 3 dB, then the 31.5 Hz dot also to 3 dB.

The next three dots from 40 to 63 Hz are all fractional values: 0.3, 0.2, 0.4. These can simply be left at zero, as explained above. The next three values are +1, -1 and -2 for 80, 100 and 125 Hz:
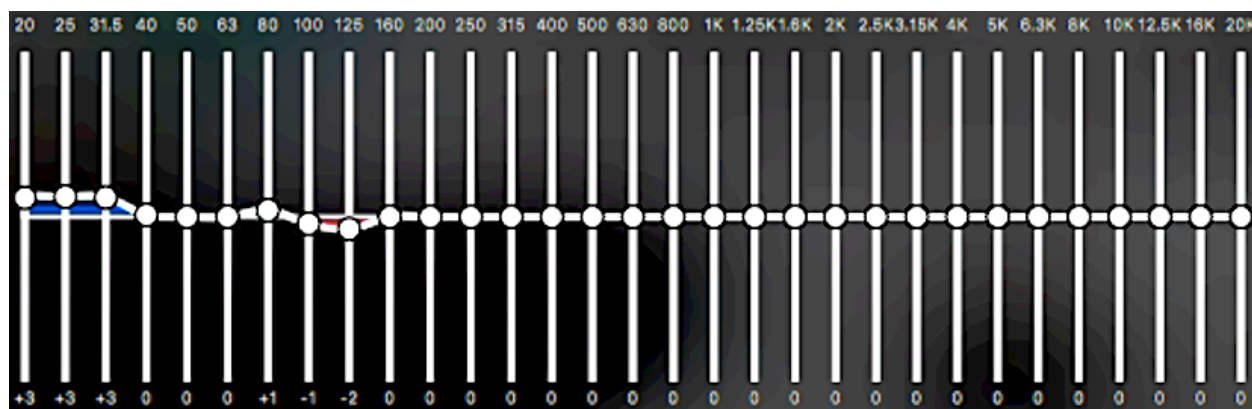

Fig. 13: First nine dots out to 125 Hz have now been positioned

The next value in Fig. 12 for 160 Hz reads -2.5. Here I attempt to place the dot roughly half way between the -2 and -3 positions. A -2 and a +1 take us out to 400 Hz and the next 6 values are either 0 or too close to zero to fuss with. So in fact we've completed out to 1600 Hz:
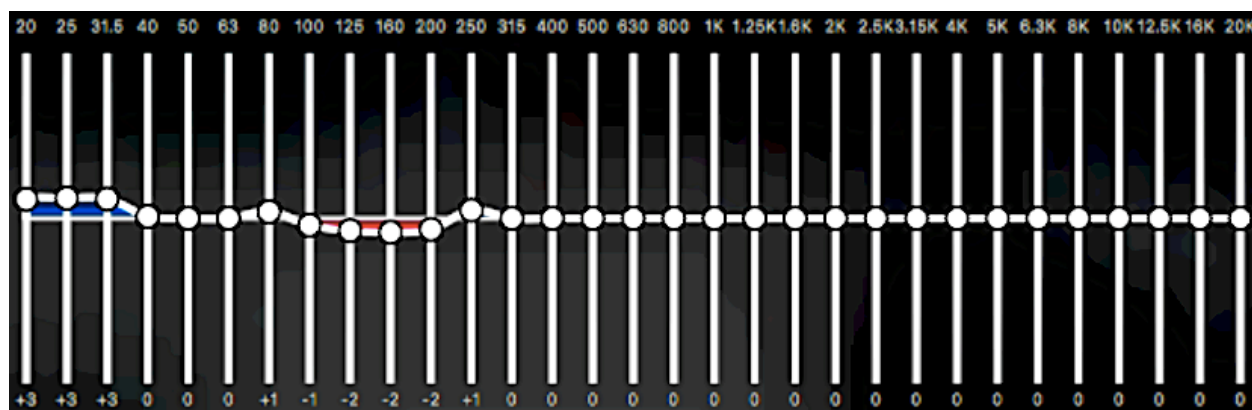

Fig. 14: First half of the EQ curve out to 1.6 kHz is now completed

Proceeding with the rest of the corrections, the completed curve looks like this:
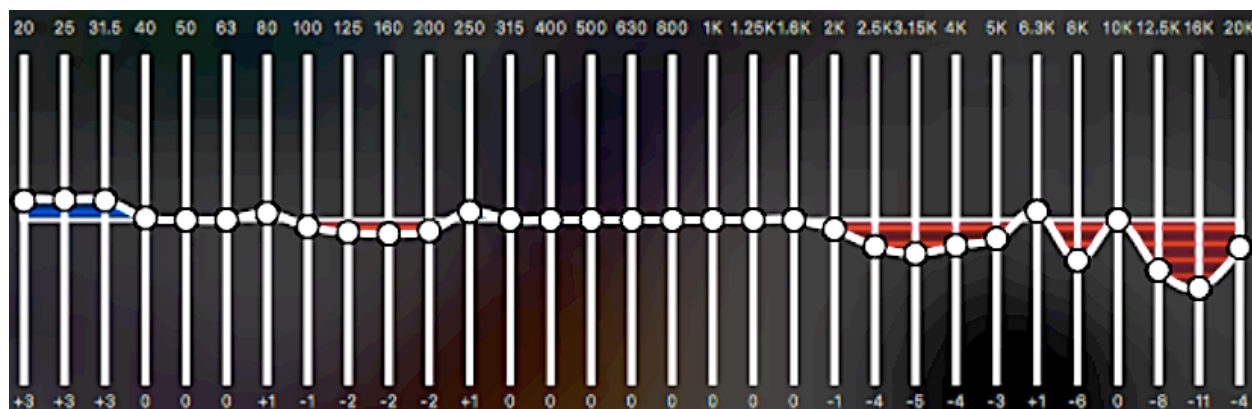
Fig. 15: Finished M50x EQ curve

At this point be sure to save your work using some descriptive name. You may want to include the following in the name you use: the headphone model, the source of the graph you're working from, the name of your target curve, and possibly the current date or some other information to distinguish it from possible variants.

For example, for the EQ curve shown in Fig. 15 I might use the name *M50x -> Harman 2013 -1B (Or)*. (Translated: M50x EQ'ed to match the 2013 version of the Harman response curve but with a 1dB bass drop and based on Oratory1990's measurements.)

Tweaking measurement-based results by ear

Consistency from one unit to the next of the same model headphone varies significantly from manufacturer to manufacturer and model to model. Plus, many headphone ear pads flatten a bit with use, changing the headphone's frequency response to some degree. Plus, the measurements are based on a mythical average human ear, not your or my own ears. This last point especially affects everything from 3 KHz on up.

So, the next step is to listen to music tracks you're familiar with, switching back and forth between your new EQ and the Flat option in eqMac2. This time listen at your normal loudness level. But also use the Online Tone Generator to gradually move through the entire audio range from 20 Hz to somewhere between 10 and 20 kHz, wherever your hearing stops. The only changes in loudness you should hear is a potential increase as you go to the left of 200 Hz down to about 70 Hz due to the modest bass boost built into the Harman target, plus possibly the gradual increase peaking in the 2.5 to 3 kHz range as described previously if you're listening at a fairly loud level.

If you hear other loudness increases or decreases, try tweaking your EQ using the corresponding control points. For example, if you hear a drop in loudness from roughly 650 to 900 Hz, raise the 630 and 800 Hz control points as needed. An exact correction may not be possible, nor are you likely to hear small inaccuracies when listening to actual music instead of a test tone. Just get as close as your can. In my case, the frequency range from 1700 to 3700 Hz drops in loudness rather than remaining the same or increasing in loudness. So I raised the control points in that range by several different decibel amounts, settling on +2 dB. Unit variation? ear pad flattening from use? a combination of the two? In any case, problem solved:
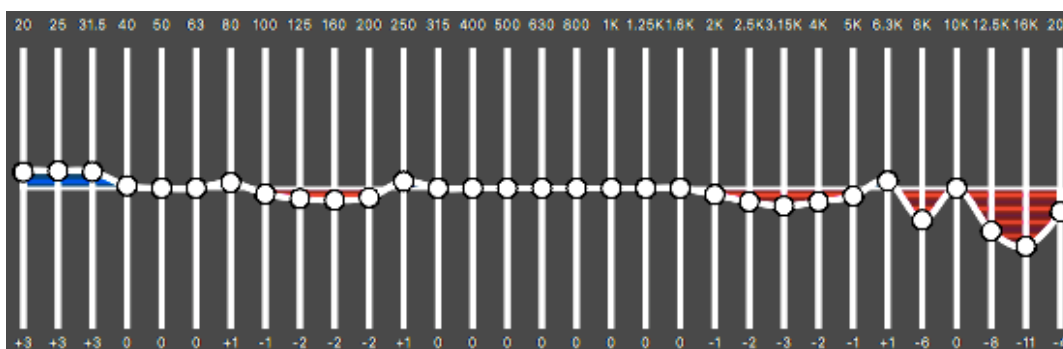
Fig. 16: Tweaked M50x EQ curve

Remember to save any changes you make with a new descriptive name, like *M50x -> 2013 Harman - 1B (Or) adj.*

> **Caveat**: Occasionally EQ can adversely impact soundstage and imaging. If you notice that happening, systematically revert each control point in turn to 0 until you identify the one that is causing the change.

OK, time to repeat all the above but this time substituting your own headphone for the M50x. I've assembled the 31-band numbers for a number of headphones in PDF and CSV formats. You might want to see if your model is there.

Finding your preferred target curve(s)

I used an early version of the Harman curve with a slight drop in bass boost for the above example. Sean Olive, the lead on developing the Harman target, estimates the current, 2018, Harman target will suit about ⅔ of over-ear or on-ear headphone users. A target curve suitable for someone who listens to a lot of metal or synth might involve a reduction to the upper mids of the Harman target. At the opposite extreme someone who mainly listens to vocal and acoustic instruments music — whether singer-songwriter, folk, world, jazz or classical — might lean toward a strictly neutral target, meaning no added bass. Someone with high frequency loss from age or with hearing damage may want to add a boost to the treble and/or elsewhere. Someone with treble sensitivity will want to use the Online Tone Generator to identify the particular high frequencies that irritate then reduce them accordingly.

Finding a single target response curve often means finding a compromise between conflicting desires. Alternately, you can create a bass-heavy curve for listening to electronic dance music or similar, then switch to a more balanced, more neutral curve when listening to other genres. This is all fine, but the question remains: what to use as a starting point as the basis for your customizations? The 2018 Harman is as good a place to start from as any:
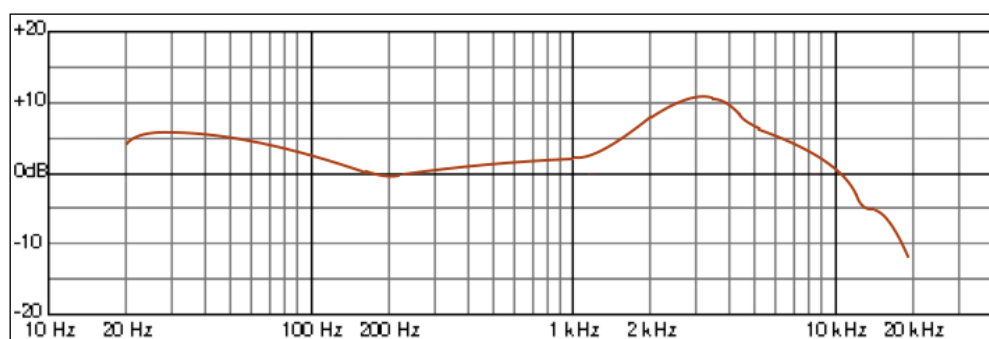

Fig. 17: Harman over-ear and on-ear headphone frequency response target, 2018

(And as a bonus, if you use an Oratory1990 graph as your starting point the Harman target is already right there in green.)

Numerically, the Harman 2018 target looks like this:

20:**5½**, 25:**6**, 31.5:**6**, 40:**6**, 50:**5½**, 63:**5**, 80:**4**, 100:**3**, 125:**2**, 160:**1**, 200:**0**, 250:**0**, 315:**½**, 400:**1**, 500:**1**, 630:**1½**, 800:**2**, 1k:**2**, 1.25k:**2½**, 1.6k:**4½**, 2k:**7**, 2.5k:**9½**, 3.15k:**10½**, 4k:**10½**, 5k:**8½**, 6.3k:**7**, 8k:**4½**, 10k:**1½**, 12.5k:**-3**, 16k:**-6½**, 20k:**-18½**

Two examples: The Harman target isn't neutral but has a built-in bass boost. To reduce this from 6 dB to 3 dB you might use these numbers up to 160 Hz instead:

20:**2½**, 25:**3**, 31.5:**3**, 40:**3**, 50:**3**, 63:**2½**, 80:**2**, 100:**1½**, 125:**1**, 160:**½**

To boost the treble by 2 dB you might use these numbers starting at 2 kilohertz:

2k:**7**, 2.5k:**10**, 3.15k:**10½**, 4k:**10½**, 5k:**9**, 6.3k:**7½**, 8k:**5½**, 10k:**3½**, 12.5k:**-5**, 16k:**-8½** 20k:**-20½**

In fact, the modified 2013 Harman curve we worked with in the previous section is little more than a 3 dB reduction in bass and a 2 dB increase in the upper mids from the 2018 Harman target.

To sum up, the overall process is simple:

1. Make your best guess as to whether you're most likely to prefer the Harman target as is or with more bass or less bass or more treble or less treble.
2. Create a new target curve by modifying the Harman target accordingly.
3. Create and save an EQ for your headphones based on your new target, using the numerical method described in the previous section.
4. Listen to music and other audio over several days using the EQ you just made in step 3. Give your ears a chance to adapt to it.
5. If you feel you need more bass, less treble, etc., repeat steps 2 through 4. You can modify the EQ from your previous attempt according to your new target (remembering to save your changes as a new EQ each time).

Once you achieve satisfaction with a single EQ or set of EQs, you're good to go. That may be all you ever need to do with EQ … or at least until you buy new headphones or eqMac2's creator releases a stable new version … (or until you explore the further avenues for finding preference targets in the next tutorial in this series).

EQ sound degradation?

A persistent headphone enthusiast meme is that software EQ introduces audible timing/phase and/or other distortions. From what I've read this was quite true years ago in the early days of computer audio. But those days are long past.

That said, there is a limit to how much increase in loudness to a frequency area in EQ can be applied before real distortion kicks in (or simply by upping the system Volume, for that matter). Every headphone has a measurable amount of something called *total harmonic distortion + noise* (THD). Measurements for this are available from rtings.com and innerfidelity.com, for example:
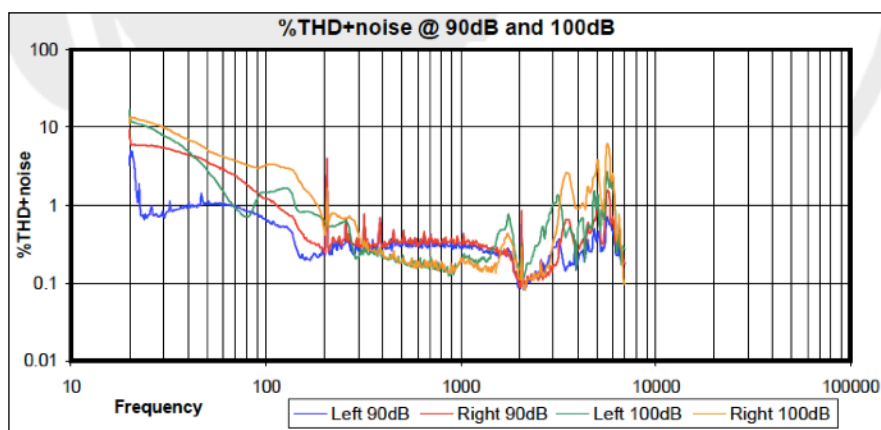
Fig. 18: InnerFidelity distortion measurements for Grado SR60i

While this result will be deemed unacceptably bad by many an objectivist, in fact tests show that distortion levels under 10 dB are essentially inaudible when listening to even quiet music. Plus, we're far less able to distinguish low frequency distortion than higher frequency distortion. However, when you elevate a control point in EQ for a given frequency you're boosting the noise/distortion just as much as you are the rest of the signal. So the lower the THD+N for a given headphone, the more amenable it will be to EQ changes. The Grado is a very old design. Few recent headphones will have distortion numbers as high as we see in Fig. 18. I tend to be especially conservative when upping the EQ of the sub bass (20, 25 an 31.5 Hz), since that's typically where a headphone has its greatest level of distortion, as we see in Fig. 18.

Graphic vs parametric

Both eqMac2 and Peace GUI in graphic mode are 31-band graphic equalizers. They let you select from 31 specific frequency options; you control the loudness for each of those frequencies. A parametric equalizer puts two more parameters under your control: frequency and bandwidth. A parametric equalizer doesn't assign specific frequency numbers like 31.5 Hz or 8000 Hz for you to work with. Instead, you specify any audible frequency number, even something crazy-exact like 272.162 Hz. Then you tell it the loudness you want to assign to that specific frequency. But beyond that you also assign a bell-curve-like range centring around your specific frequency called *Q* or *quality* (inverse bandwidth). In that range your loudness value tapers off to all lower and higher frequencies that fall within range.
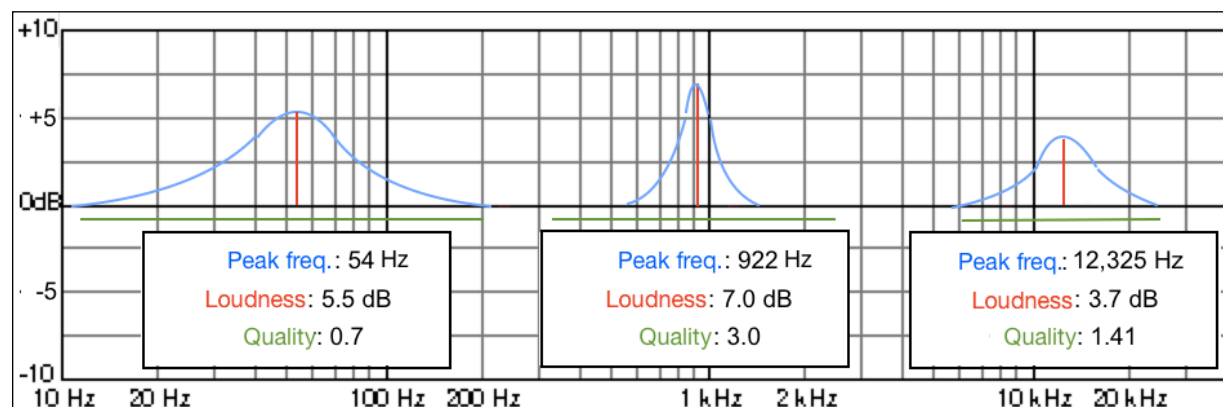

Fig. 19: Parametric EQ examples

Fig. 19 shows three examples of parametric changes. In some ways parametric EQ allows great precision. It also makes it easy to specify smoothly curving shapes. But in practice it becomes

very complex to achieve the irregular curves we've been working with using graphical EQ. Doing so requires overlapping the spread of multiple control points, which in turn causes each loudness value to augment the loudness of each of its neighbours — see Figs. 20 and 21 for an example. To compensate for this issue we typically need to insert yet more control points with gains negative to the original points. So both types of EQ have advantages and weaknesses.

Nevertheless, the creator of eqMac2 is working on an upgrade that he hopes will eventually include the same sort of unlimited control points (technically called *filters*) available in EqualizerAPO. In theory at least, this would enable using the thousands of EQ presets in the new eqMac (it won't be called eqMac3) that have been created for EqualizerAPO.
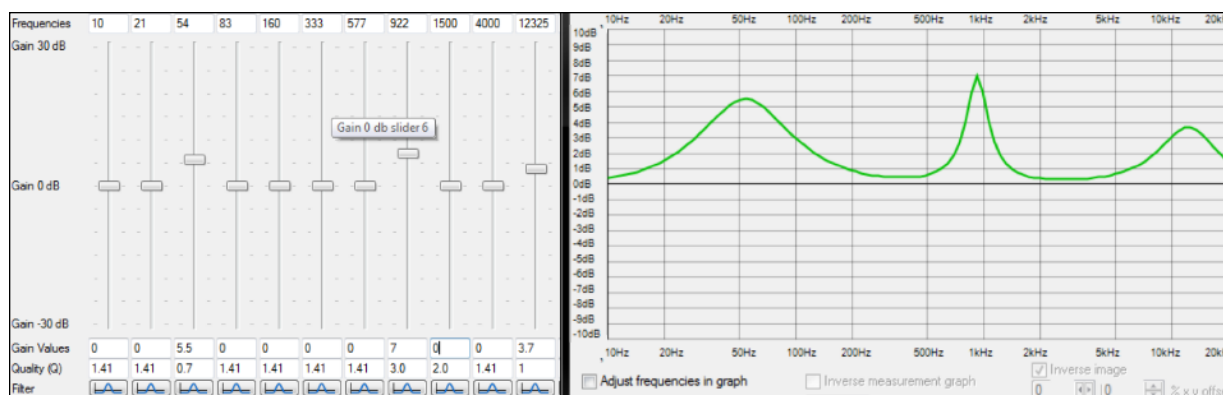

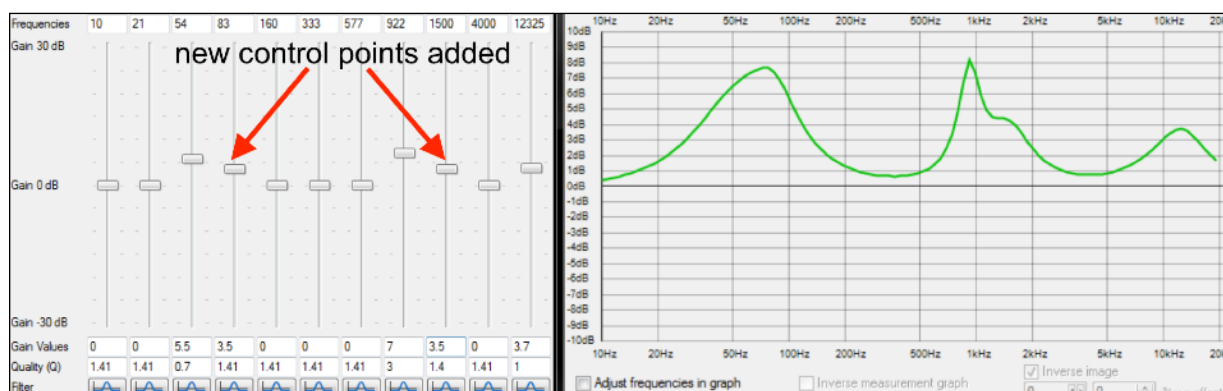Fig. 20: EqualizerAPO screen shot, three separated control points

Fig. 21: two control point added — results in peculiar new shapes and elevations of original peaks.

Final thoughts

There is a pervasive, if gradually dwindling, prejudice against EQ on the part of headphone enthusiasts. They frequently cite the now-outdated idea that EQ introduces audible distortions. An audio purist pursues a holy grail ideal of the minimum number of best-quality components in his/her audio system. To the purist EQ is just another potential source of impurity that should be eliminated.

You'd think, by this reasoning, a purist would confine himself to source, DAC, amp, headphone and connecting cables. One of each. That's rare indeed. Instead, the purist is likely to have multiple sources, DACs, amps, headphones and cables. He then mixes and matches them. One arrangement might reduce the strident treble of a particular headphone. Other arrangements

might provide alternate sound signatures suitable for listening to different musical genres or with better synergy with a particular headphone.

Another anti-EQ meme is that if we EQ every headphone to the same preferred tuning, they'll all sound pretty much the same. But we've repeatedly explored using multiple target curves, whether for different genres or different headphones. And nothing stops us from confining our use of EQ to only eradicating frequency response annoyances — sometimes to a degree and precision that no amp/DAC combination can achieve — and thereby simply *increasing* our enjoyment of the particular sound signatures of each of the headphones we own.

In truth, the real and seldom acknowledged danger from EQ to the audio enthusiast is its insidious effect of eliminating the single most common source of dissatisfaction with a headphone or even loudspeakers: If you can EQ away a frequency response flaw, then you'll need to find another excuse to justify buying a new piece of gear. But take heart — EQ doesn't affect detail, speed, dynamics, sound stage, imaging, fit or comfort. When frequency response issues go away, any weaknesses in these other areas simply stand out more clearly.

In short, rest assured. Gear Acquisition Syndrome is in no danger from so puny an opponent as mere software EQ.

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And for more exciting and fascinating EQ tips and tricks be sure to proceed to the final instalment in this series: *Some practical EQ applications* at Headphone Essentials.

Addenda

For Mac users: introducing eqMac2

Currently, the only decent system-level EQ app for MacOS is called eqMac2, which does 31 bands of graphical EQ (a new version promising multi-channel parametric EQ is under development but not ready for prime time). We'll use eqMac2 throughout this tutorial.

Download and install the open-source, thus malware-safe, eqMac2 (https://sourceforge.net/projects/eqmac2/ or this version for Catalina or later). Since you're not getting it through the App Store, you'll probably have to do the permissions dance in the Security & Privacy dialogue. This should put the eqMac icon in your (upper right) menu bar. Click the eqMac2 icon to open its interface.

The default 10-band input screen is too crude for our needs. So click on the *31 Bands* button to switch to this input screen:
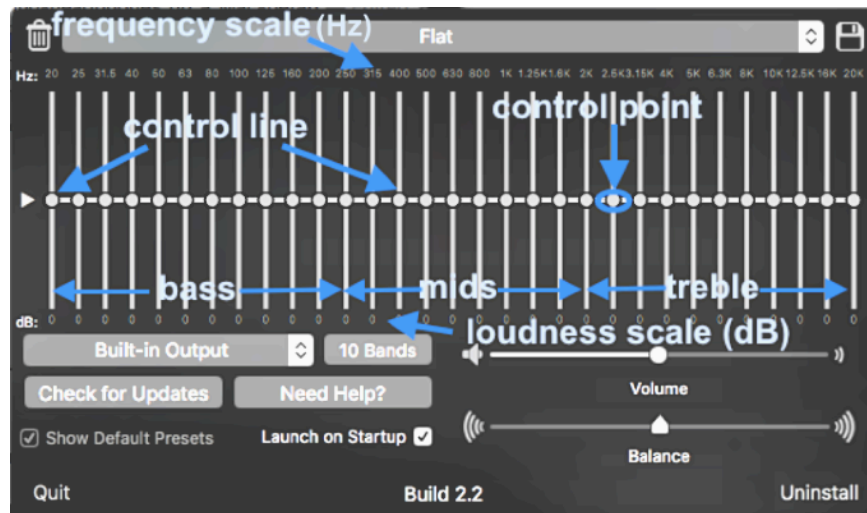
A Headphone EQ Primer

Fig. M1: eqMac2 31-band input screen with added labels

The thick horizontal light grey line with 31 dots at each intersection point is the default EQ control line, fittingly named Flat. The 31 vertical lines divide the audible spectrum into third-octave bands as specified by an ISO standard. Listening to music with a flat EQ in the middle, or 0 dB, level, means eqMac2 has nothing to do. You'll hear what you normally hear with eqMac2 not loaded.
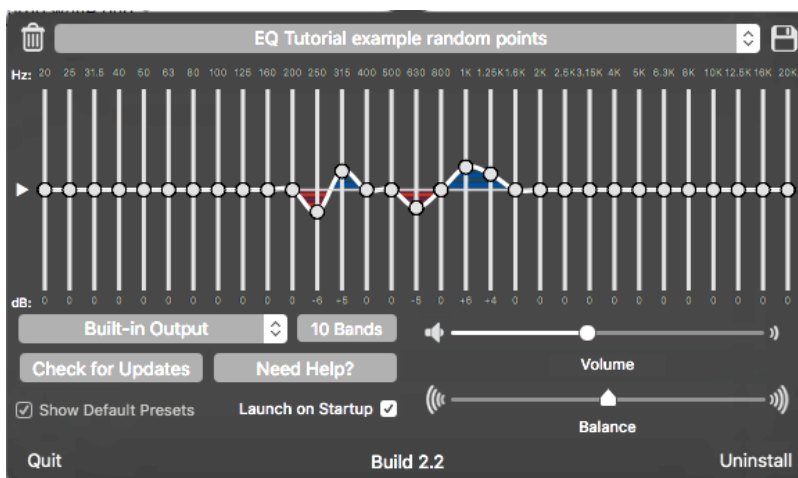

Fig. M2: randomly moving some control points on the graph

But notice the convenient volume and balance sliders that allow easy and fine-grained adjustment to both those sound properties. To the left of the volume slider is a dropdown for choosing among multiple output devices, should you happen to have more than the standard internal speaker and headphone connections installed. Definitely select Launch on Startup to save yourself from some tricky issues that can occur if eqMac2 doesn't get to initialize during the boot sequence.

Two caveats: Clicking anywhere in the graph area relocates the nearest control point. Clicking on the arrowhead to the left of the centre line switches to the Flat EQ (but does not throw away your work, which is still retained as Custom).

The next thing to do is move a few of the white dots in the centre area of the long horizontal line up or down until the number below that point changes to something around plus or minus 5 or 6 dB, as in Fig. M2. Play a piece of music while you do this to hear the sound change that results.

Notice that when you move a control point, the dB value for it that shows below jumps from one whole number to another. For a variety of reasons we don't need decimal point accuracy, but an approximate ½ dB placement is fine. What I do is place a control point at just the point at which the dB number changes — say from 3 to 4 — as representing a whole number value, such as 3.0. And I place the control point roughly in the middle between two whole numbers as representing a ½ dB value, such as 3½ dB.

eqMac2 foibles

The creator of eqMac2 ran into some serious bugs deep in the audio sub-system of MacOS. These only became apparent as the occasional member of an increasingly large user base bumped into one of them. The creator's working on a ground-up re-design to circumvent these issues, but that is likely a few years in the future as I write this.

In the mean time eqMac2 is problem-free for the majority of users. But if you should encounter problem behaviour you'll need to become familiar with an obscure but important MacOS applet increasingly mis-labeled *Audio MIDI Setup*. It should be called simply *Audio Setup*. and it's something every Mac-based headphone enthusiast will sooner or later need to become familiar with. There are two critical things to check:

1. The left and right channel output Master streams, labelled 1 and 2, *should* be at 100% for Built-in Output, for eqMac2 and for any other attached sound devices, such as an amp or DAC you may have.
2. The Master slider on the eqMac2 screen reflects your over-all system loudness setting you probably control with the F11 and F12 function keys. This should be at your normal listening level, *not at* 100%!
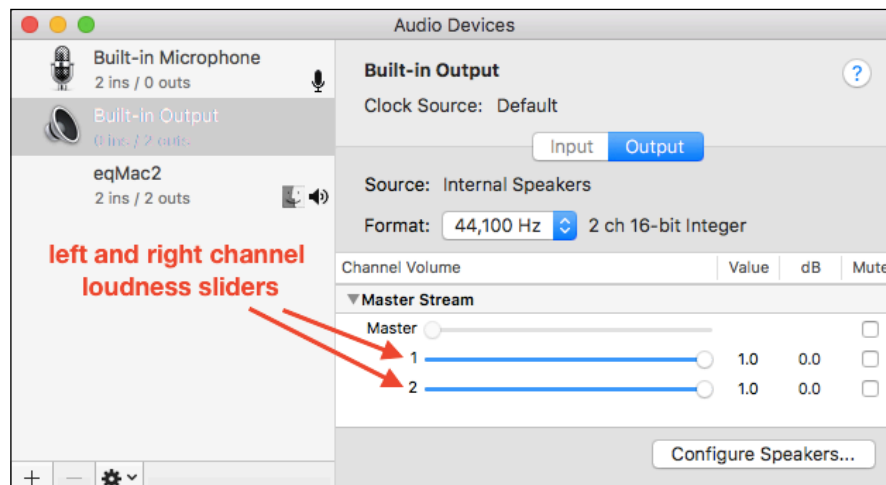

Fig. M3: Audio MIDI Setup Built-in Output screen

What can happen is that when you physically connect or disconnect an audio device, such as plugging in or unplugging a headphone (which typically redirects sound to the built-in speaker), MacOS will occasionally arbitrarily re-set the various left and right channel loudnesses to something other than 100%. Worse, it can re-set the system loudness of the new output device

to 100%. For this reason **always minimize the system volume before changing to a new output device** — even if that's just unplugging a headphone. This is an important habit to form for *any* audio system you may have occasion to use. I've got into the habit of glancing at the speaker icon on the menu bar before and after making any changes.
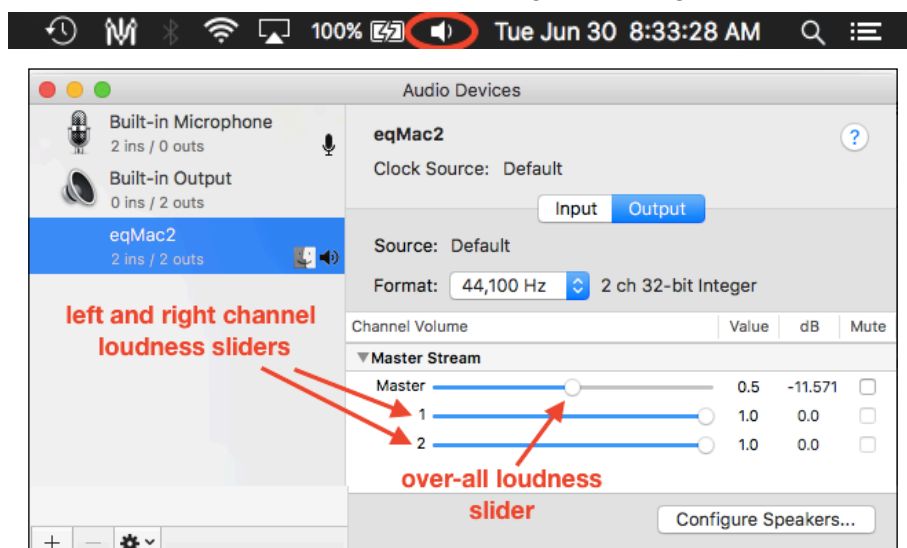

Fig. M4: Audio MIDI Setup eqMac2 screen

When you unplug or plug in an audio device, another possibility is the opposite — that you'll get no sound at all. To address this:

1. Press F10 to mute your audio.
2. Click on the volume (speaker) icon in your menu bar on the right.
3. Click on the entry for the audio device you want to enable.
4. This will likely activate the device but set its loudness to 100%, so use the eqMac2 Volume slider to lower it to your preferred loudness level.
5. Press F10 again to un-mute your audio.

To pre-amp or not to pre-amp

Throughout the EQ'ing material above I'll be assuming you have your overall volume set to a conversational level or not much higher. You **double the amount of power** you're requesting from the amplifier when you up a control point by **10 dB**. When you combine a control point boost **+** a loud Volume setting **+** a loud passage in the music at the affected frequency, the combination of the three can quickly escalate literally to destructive levels.

This is due to an evil called *clipping* that can happen when we drive a headphone (or loudspeaker) too loudly. Manufacturers specify how much power it takes to damage a given audio output device. If you're going to play with high loudness levels make sure you understand how the various numbers add up. Yet another concern regarding large boosts is distortion. See **EQ sound degradation?** for more info.

If you were working with EqualizerAPO or even the EQ app in iTunes, you would have something called a pre-amp control to deal with the above issues. Unlike many EQ programs, eqMac2 does not provide a software pre-amp option. A pre-amp control simply shifts the loudness level of an entire EQ up or down by a user-selected amount to prevent clipping. Technically, you can do the same thing either by building your EQ at a lower dB level or by using the system-level Volume control.

Nevertheless, we can simulate a pre-amp by creating and using your own flat EQ control lines at various dB levels. Fig. M5 shows an example at -5 dB:
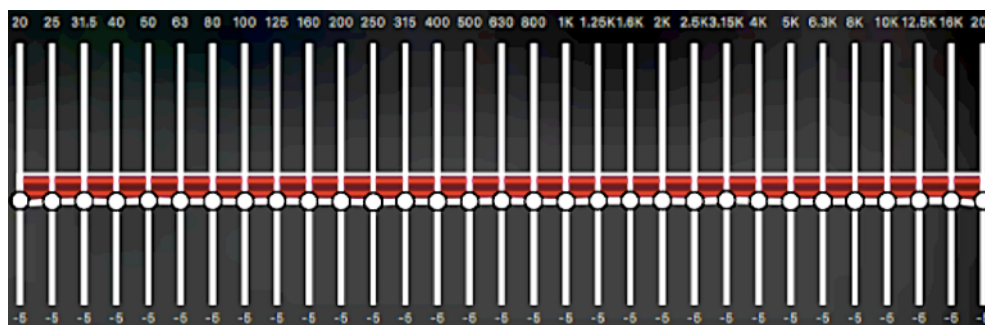

Fig. M5: jury-rigging a -5 dB pre-amp

To use this, first subtract 5 from all your numbers if you're working from measurements, re-create then save the above -5 EQ with a title like Flat -5 or -5 pre-amp, then use that as a starting point for creating your adjustment curve. If you find this useful, you can make a Flat -2, Flat -3, etc. as you need them.

That should be enough background. Jump back to the main tutorial when ready by clicking here.

For Windows users: EqualizerAPO plus Peace

I originally wrote this tutorial focused solely on the Mac and eqMac2. Later, I discovered that EqualizerAPO, when combined with the Peace GUI, allows Windows users to essentially duplicate the same 31-band graphical interface and methodology. The freeware program EqualizerAPO is the EQ solution of choice for Windows. But from my own experimentation plus watching and reading many tutorials, it's default parametric interface is the very thing that balks and frustrates users who want to move beyond the most elementary corrections. I think you'll find the approach in this tutorial to be a good way to move past the frustrations and just get on with achieving sophisticated results.

You'll need to install EqualizerAPO and the Peace add-on, if you don't already have it. There is so much instructional material available on installation, set-up and initial usage that I won't repeat that material here. The tutorial I used and can recommend is the **Peace Equalizer playlist** on YouTube done by its creator, Peter Verbeek. Or just click on Help and read that. There's a lot to digest, so spend as many days as you need to explore and get comfortable with the default interface … from here on I'll assume you're up to speed on the basics and proceed.

Critically for this tutorial, Peace provides a one-third octave template with the same default frequency control points as eqMac2. We'll be using this throughout, so switch to it now:
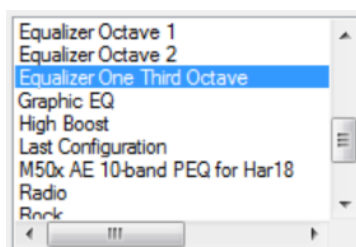

Fig. W1: switching to the one-third octave Peace preset

For example, here's an EQ I made for my Sennheiser HD 579 headphones presented as an eqMac2 screen shot:
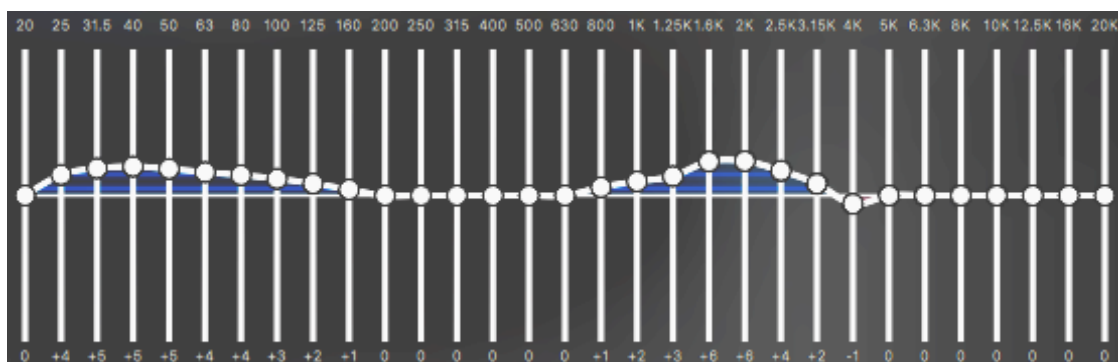
Fig. W2: HD 579 EQ done in eqMac2

To replicate this EQ, I can enter the same dB values (called gain in Peace) by using the sliders or by typing into the white input boxes along the bottom:
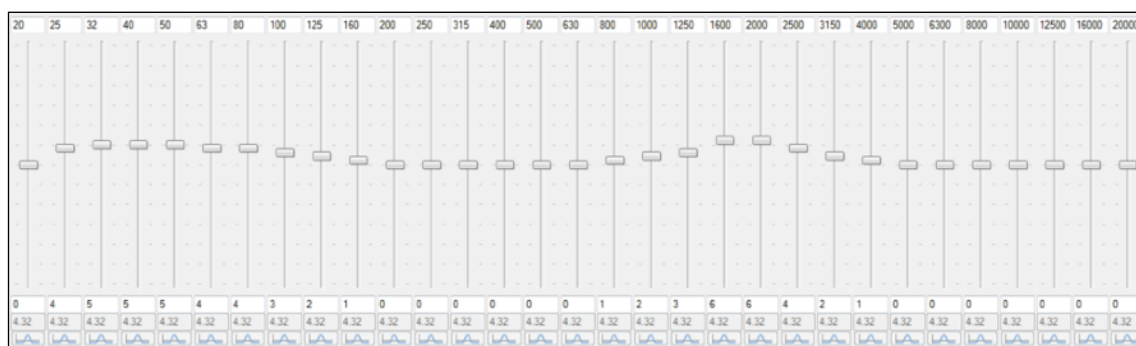

Fig. W3: control points duplicated in EqualizerAPO

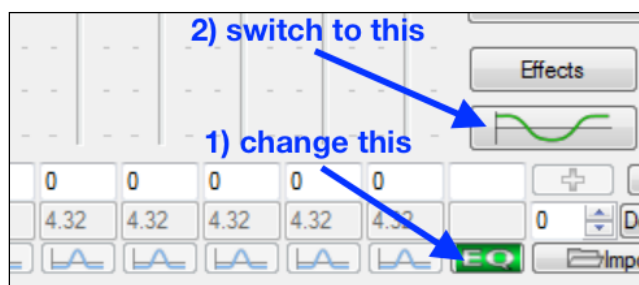Next I change from filters mode to EQ mode, then switch to the graph screen:

Fig. W4: switching to graphic EQ mode

And this results in the following output graph. Don't be fooled by the different horizontal and vertical axis scaling that makes the same EQ curve look taller and squashed left to right compared to Figs. W2 and W3, even though I resized it to vertically to minimize the difference:
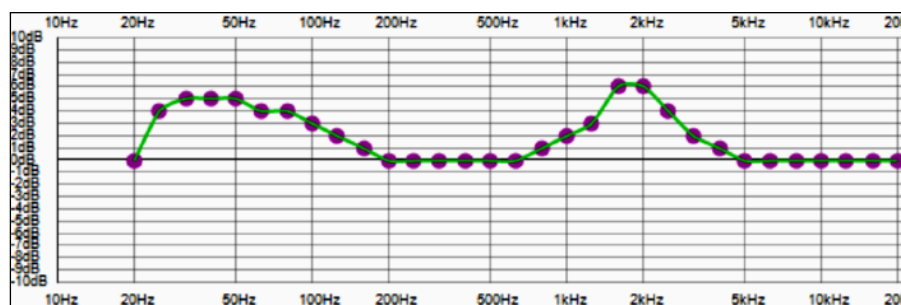

Fig. W5: 31-band graphic EQ in EqualizerAPO

Another way of working, however, is to click on the **Adjust gains in graph** checkbox, then simply move the dots up and down right in the graph. Since this is the only way Mac users have to change loudness values, we'll focus on this form of input in the main part of the tutorial. But of course feel free to type in numbers on the main screen instead.

So far as I know there is currently only one EQ tool available for Macs with adequate control capability (eqMac2). And there are no EQ tutorials for it. Given this gap, given the more concise presentation of information of the eqMac2 screen, and given the visual distraction of showing both Mac and Windows versions of every screen shot, I've opted to continue using just eqMac screen shots in the main body of this tutorial. But the differences are mostly cosmetic — you should have no problem following along. For example, here is the first screen shot used as an illustration (Fig. 5) on the left and the Peace equivalent on the right:
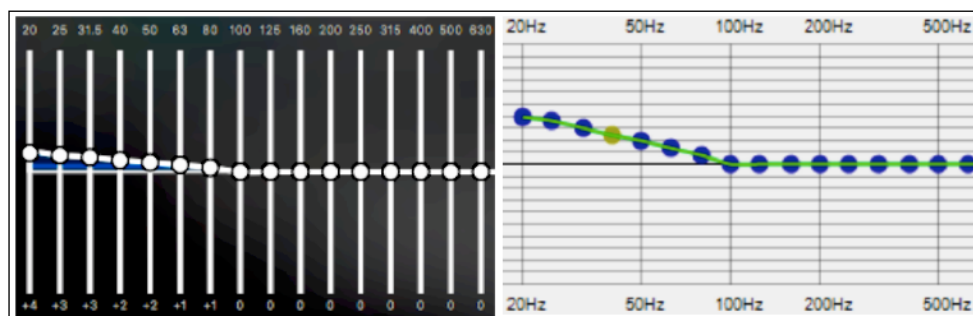

Fig. W6: eqMac2 and Peace versions of (Fig. 5) compared

The Peace version of the slope looks steeper, but that's because the vertical scales are different. You can optionally resize the Peace graph window even further to make it wider and squatter for even greater visual similarity. You can also use the extensive customization options, including setting a dark background, to achieve an even greater visual match:
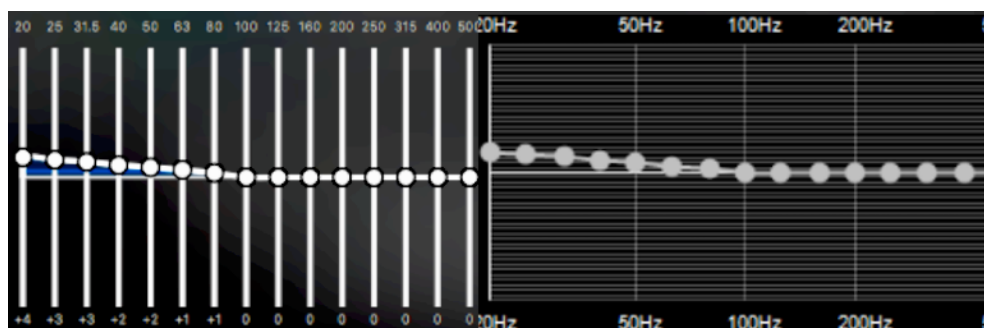

Fig. W7: customized Peace interface

… And that should be enough background information. Jump back to the main tutorial by clicking here when ready. But after working through the tutorial you might want to return to read the following section…

Leveraging EqualizerAPO's extra power

We can also exceed the level of precision we work in this tutorial if we click on the **Adjust frequencies in graph** checkbox or type in specific frequencies in the main screen. In Fig. W5 I've added a narrow dip to counter a peak in the HD 579's treble response at 7.3 kHz, which some might find annoying, and which is pretty much smack in the middle between the default 6300 and 8000 Hz options:
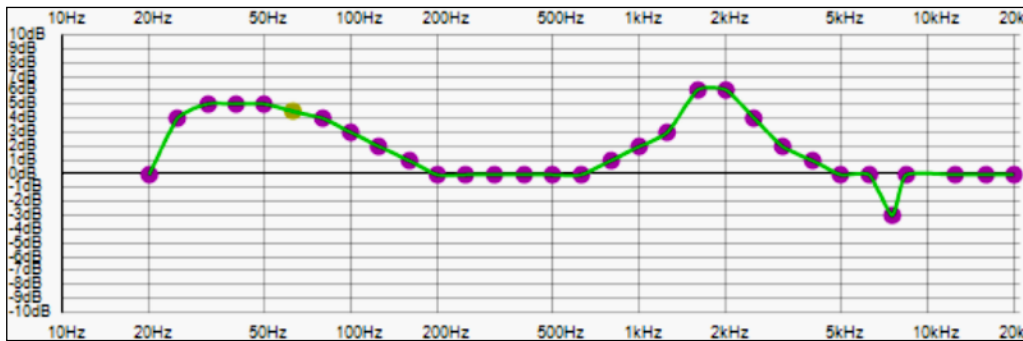
Fig. W8: peak correction added at 7.3 kHz.

I moved the 8 kHz control point to 7.3 kHz by typing 7300 into the default 8000 Hz frequency input box in the main screen. Then I dropped the control point by mouse directly on the graph. The lack of this degree of precision using just the 31 default frequency values is rarely an audible issue when listening to music or other audio, but it's nice to be able to get things just right all the same.

In practice, the use of all 31 control points is typically unnecessary. You can often re-create the shape of a correction area with fewer but more strategically placed control points while still working in the Peace graphic EQ mode (perhaps using a different starting template):
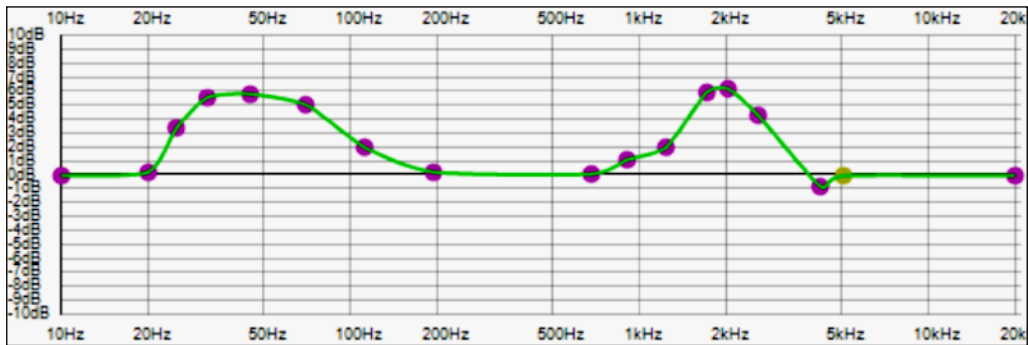

Fig. W9: replicating Fig. W2 using fewer control points