Extreme EQ with the MiniDSP 2x4

In this tutorial I will show you how to use the 2x4 to use custom biquads to enter EQ values that the user interface would not otherwise allow.

Room Equalization Wizard (REW) is a great utility to set up a sound system. Explaining how to use it is beyond the scope of this tutorial.

Quoting from REW's help file: "An advantage of [miniDSP's advanced biquad programming] is the very high filter frequency and Q resolution it allows, permitting exact targeting of modal resonances."

I will use the 2x4 to do one thing that REW is very useful for: to find room modes (or resonances) in the bass region and create very narrow "notch" filters to attenuate them. This is the first example of using a filter that is most likely too narrow for the GUI (of the Plug-In).

A second use is to create the extreme EQ curve that the Bose 901 needs. Of course you could emulate the EQ curve of the standard 901 active EQ. However, that is so "1970s." Why not use modern technology to make a custom EQ curve? If you have a measurement tool like REW, many people choose a "flat" (or "house curve") for their system. In my case, I use what I call "1/3 octave pink noise subjective EQ" -- I listened over a long period of time, adjusting each band of noise until it sounds nearly the same level as the others. In either case, and for any kind of speaker, you are EQ-ing the speakers and the room as a system, so you only need one curve.

I only use the "advanced" cryptic biquad formulae when I have a very narrow and/or deep filter that I cannot input using the Plug-In user interface. Of course, you can just use the GUI to enter values that are within its range.

Tools used:

MiniDSP 2x4
Plug-In: PEQ 2 way advanced (need to use custom biquads)
Room Equalization Wizard (REW) from hometheatershack.com (free, registration required)
Testing mic + preamp for the above
Biquad calculators (free, see below) -- to calculate the numbers that MiniDSP wants. I used an Excel spreadsheet named "All-digital-coefs v1.2.xls" I do not have a link but you can Google it or look on the web sites minidsp or diyaudio.

If you need to convert bandwidth to Q, I found good information (and some spreadsheets) on the Rane website:

http://www.rane.com/note170.html
This is the screen showing my "room modes" frequencies. In my case, they were derived from many REW sweeps and fitted using the REW EQ tools. In my case, I simply adapted PEQ filters from my DEQ2496. My settings were:

<table>
<thead>
<tr>
<th>Freq.</th>
<th>Bandwidth*</th>
<th>dB gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>48.2</td>
<td>1/10</td>
<td>-3</td>
</tr>
<tr>
<td>70.2</td>
<td>1/7</td>
<td>-5</td>
</tr>
<tr>
<td>98</td>
<td>1/5</td>
<td>-6</td>
</tr>
<tr>
<td>138</td>
<td>1/10</td>
<td>-13</td>
</tr>
<tr>
<td>151</td>
<td>1/10</td>
<td>-12</td>
</tr>
<tr>
<td>160</td>
<td>1/10</td>
<td>-6</td>
</tr>
<tr>
<td>257</td>
<td>1/10</td>
<td>-5</td>
</tr>
</tbody>
</table>

* I used a spreadsheet that would convert from bandwidth (octaves) to the more common Q format used in REW and MiniDSP software.

If you are putting "room mode" EQ's in, you could have used the first section (if you have six or less). In my case I had more, so I used the "crossover" EQ section (allows up to 8).

For the main EQ curve, here is a summary:

Using REW, I have my main EQ curve. In this case, I had EQ'ed using 1/3 octave pink noise and using the DEQ2496, making it sound subjectively flat (not measurement flat.) The goal here is to find PEQ curve(s) to closely match your desired curve. REW can be used in many different ways. For my uses, I have used it to find room modes (resonances) ... what REW was designed to do. For this tutorial, I call these the "modes" frequencies
(which I notched out using very narrow filters.) The "main" EQ can be anything you want; many people want a ruler-flat response. In my case, I arrived at my target curve, in this case, my preferred subjective EQ that I will try to match in the 2x4.

This is my "target curve" NOT including the "room modes" (< 300 Hz).

Notes: this is in the EQ window: make sure you set EQ type to "generic" (we need more correction than the MiniDSP setting will permit.); for "Target Settings" speaker type I set to "None" and make sure that slopes are both set to 0.0; Target level I set so that it is at highest point, about 40 Hz and 76 dB in my case.

I recommend you set the display options to show filters reversed, don't show predicted curve.

Now the laborious part! You can use the automated tools or manually in REW to find one or more filters that approximate your curve. In my experience, if you are making huge filters, you should probably experiment manually. Unless you are working to a flat line, you may have to "fool" REW and use the manual features. I found a quick basic match as follows:

Click on "EQ Filters at top of screen"; you will get this window:
I selected "manual", "PK", and entered frequency, gain and Q. On the graph screen you can move target level up and down to see how close a fit you can make the curve. As you can see, this is a quite good first guess (actually this was after several guesses, but this is a great fit for just one filter:)

Using REW, it's possible to fit a manual EQ to a curvy curve (as opposed to a ruler line). I won't go into that here. However, For my main EQ, I was able to refine it to a much closer match with just 3 filters (Note! This is just optimistic modeling right now. I will not know how close I came until I run a frequency sweep):
Here are the filters:

1200, -24, 0.10 [use spreadsheet to calculate values and input as "advanced"]
7184, -3, 3.00 [note that this and the next one can be input using the GUI of Plug-In.]
1100, 5.2, 2.00

I have very nice sound through my 2x4. How close to my original curve did I get? Let's take a look:

Not very closely. Here is the original sweep of the DEQ2496 (mode filters + the subjective eq):

I found out how to overlay two different sweeps:
Blue = desired curve (from DEQ2496);  
Purple = the first curve I did for the 2x4 (05-30-2013);  
I rate this not too bad for a first attempt: the 2x4 is, in fact, doing the notch filters < 300 Hz, not perfectly, but trying; the worst part is that between about 500-2K Hz I am about 10 db "cold."

May 31 -- Another try and better results.

The "room mode" filters remain unchanged. This second approach is based on the first apparent success of using a single huge cut. For the 2nd attempt, I had to calculate and insert the values for a biquad that has the values of 1400 Hz, -27 dB, Q=0.1.

I then did some iterative sweeps; add a filter, tweak, measure, etc. The REW "overlay" is very handy to compare the reference and the latest sweep. Doing this, I was able within an hour or so, to get very close to my intended "reference." Here are the additional filters I used in my case:

Filter #1: (advanced biquad) 1400, -27, 0.1  
Filter #2: 1040, +10, 1.0  
Filter #3: 3000, +6, 2.5  
Filter #4: 5300, +6, 2.5  
Filter #5: 12300, +10, 2

I do adjust the offset to make the match as close as possible. Right now, I have come very close to my target curve so I will leave it be for a while and just listen to music. Yes, that was the whole point of this exercise, wasn't it!!!
Red = reference curve
Magenta = victory is mine!

The only disadvantage to this approach, compared to using the DEQ2496, is that it will not be easy to make small changes to the sound...as it is with the DEQ2496. However, once you have arrived at your desired target curve ... no matter how torturous ... this tutorial shows that you can get very close to copying it with the 2x4.

Not really a fault of the 2x4, but I have had noise issues with the need for the huge gain to feed the power amp after the 2x4. I get lowest noise powering the 2x4 from a 12 volt car battery [grin.] This is all an aspect of "gain staging", which you can learn more about at Home Theater Shack.