Filter Simulation with VituixCAD and EQ APO

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Revision History:

Date	Description
Jan 14, 2022	Initial Release
Jan 16, 2022	Added instruction for copying audio channels in EQ APO. Clarified IR export process.

With meticulous passive filter design, it may be beneficial to hear the result before spending money on crossover parts and putting in the time to assemble the crossover. Fortunately, with VituixCAD and EQ APO and filter can be simulated digitally. This process can simulate multiple drivers simultaneously, one driver for each output on a soundcard, for example a 7.1 soundcard could simulate a stereo 3 way system utilizing 6 channels.

Note that an emulated passive filter will reproduce the filter transfer function as a digital filter entered into a DSP, it does not provide exactly the same result as a real passive filter due to different source impedance and component features. Passive filter interaction with the driver non-linearities and back EMF for example will not be present in a digital simulation.

VituixCAD Process

1) Once you have a complete design ready for simulation in VituixCAD, simply select "Impulse Response" under the view menu.
2) Select the sample rate that your soundcard is set to for playback.
3) FFT Length can be set to the maximum value of 262144, any value 65536 or higher is more than enough to cover the low frequency response.
4) Taps can be set quite high as well, 8192 taps should be more than enough to cover most uses.
5) Select IR Window as desired, since we are exporting a full frequency response using a large FFT length, the exported result is essentially "un-gated" so the selection here is not extremely important, however I have used "cosine".
6) Uncheck "Center IR"
7) Set Pre-delay at 1.0ms
8) Under Signals to export, select the "D" button, which will fill in all drivers in the project for export. You should see "Driver in D..." for each driver in your system listed. Up to 6 drivers can be exported at once.
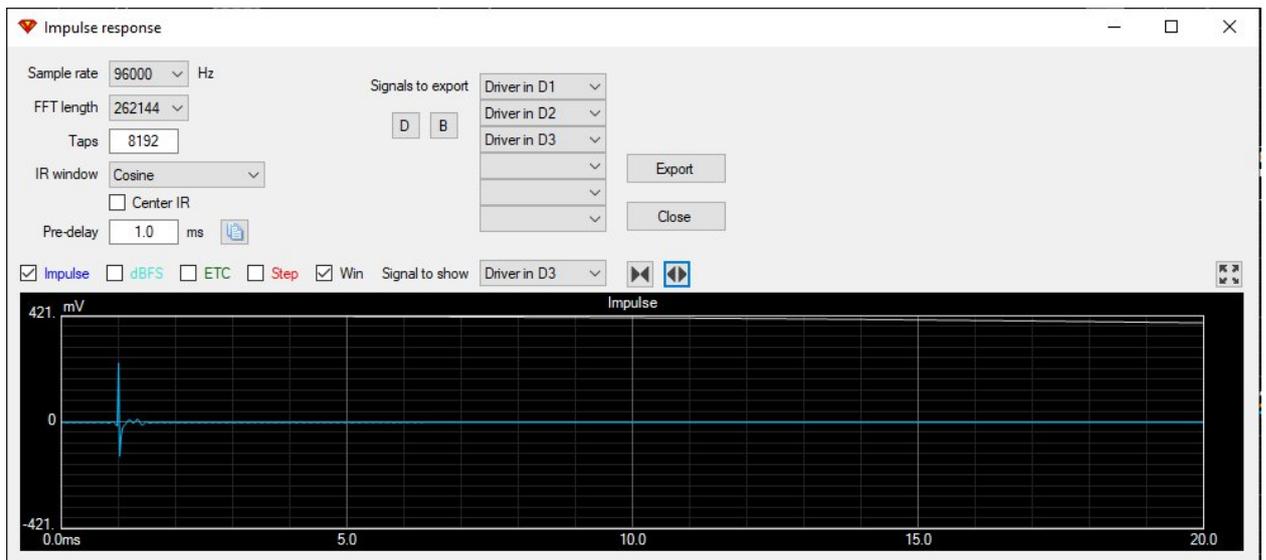9) Select "Export" and export the impulse response as IEEE mono or stereo WAV file.

Figure 1 Impulse Response Window

EQ APO Process

1. Open the EQ APO Configuration Editor and configure the rack:
   1.1. Preamplifier - use to set master gain to avoid clipping audio signal.
   1.2. Copy channels - Use copy channels to copy the left and right audio to other channels used for the crossover configuration. For example, a 3 way you might use L and R channels for bass, SL and SR for midrange, and RL and RR for tweeter, so we must copy the L channel to SL and RL, and the R channel to SR and RR.
   1.3. Select channels - use to define the channels to apply a specific filter to.
   1.4. Convolution with impulse response - load the IR file for your driver here.
   1.5. Repeat channel selection and convolution filter for each driver in your system.
2. Verify that each impulse response is loaded correctly using the analysis panel at the bottom, and select each channel to cycle through each filter transfer function.
3. Adjust the preamplifier if needed to ensure that all responses for all channels are shown at <0dB level. Responses >0dB will be filled in with red to appear obvious.
4. That's it, play some music and enjoy! An example configuration is provided below.
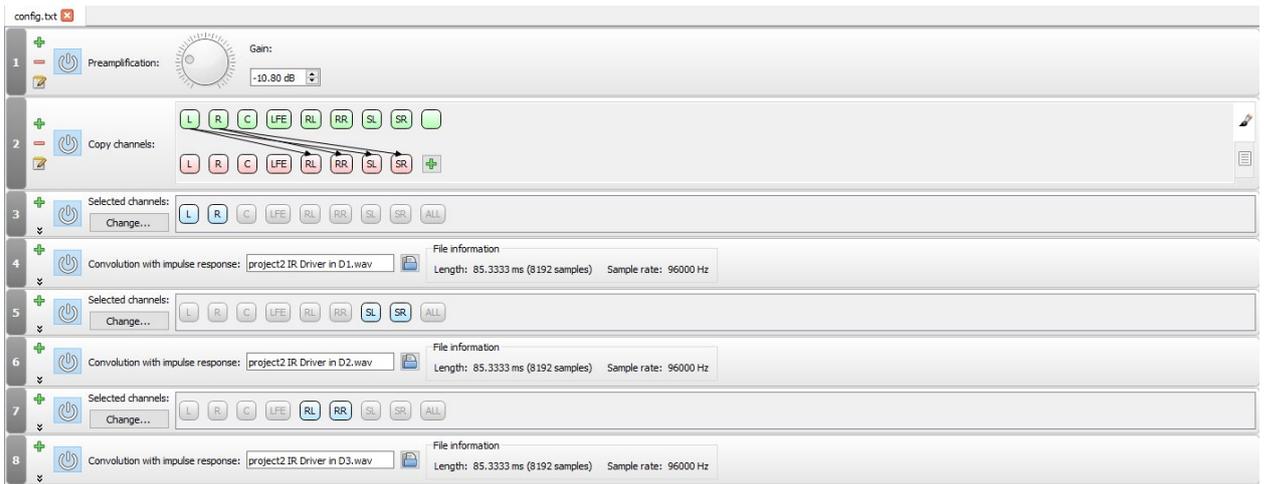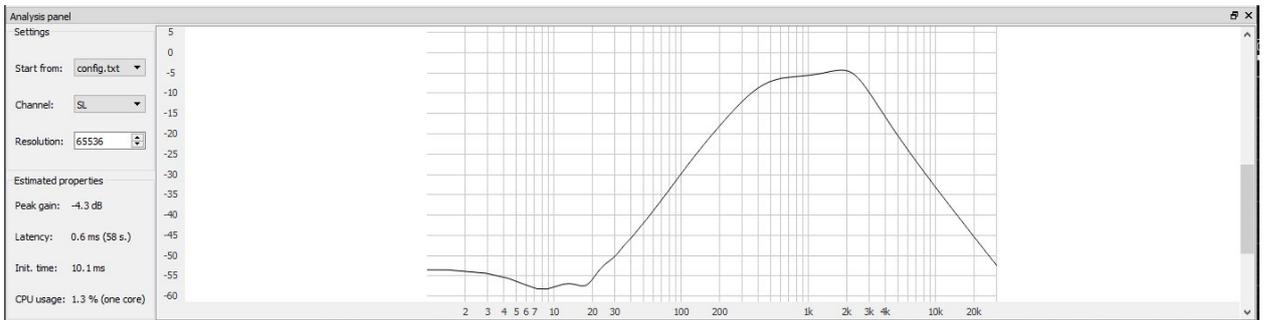
Figure 2 Example EQ APO Configuration

Figure 3 EQ APO Analysis

Example 3-way Configuration:

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Preamp: -10.8 dB

Copy: SL=L RL=L SR=R RR=R

Channel: L R

Convolution: project2 IR Driver in D1.wav

Channel: SL SR

Convolution: project2 IR Driver in D2.wav

Channel: RL RR

Convolution: project2 IR Driver in D3.wav
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