

Speaker Design Proposal

Alex Palma

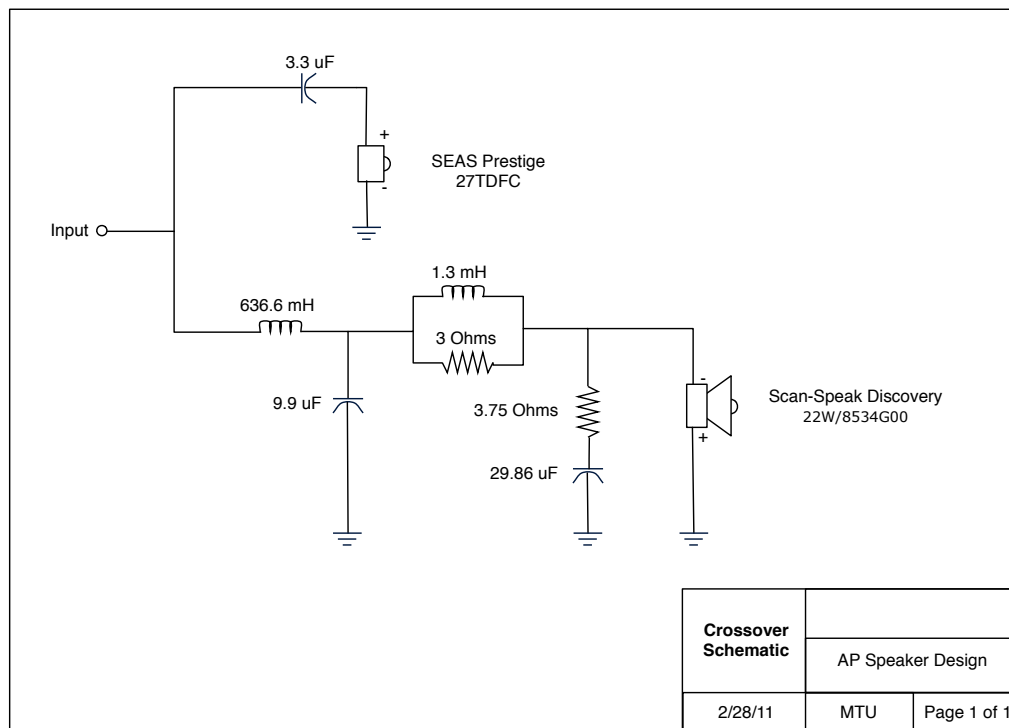
Transducer Theory

Christopher Plummer

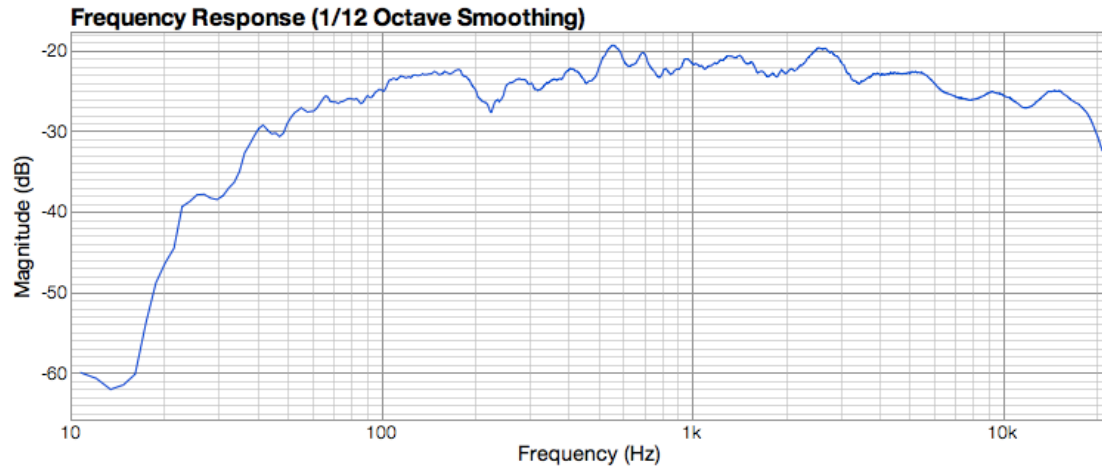
27 April 2011

Initial Crossover

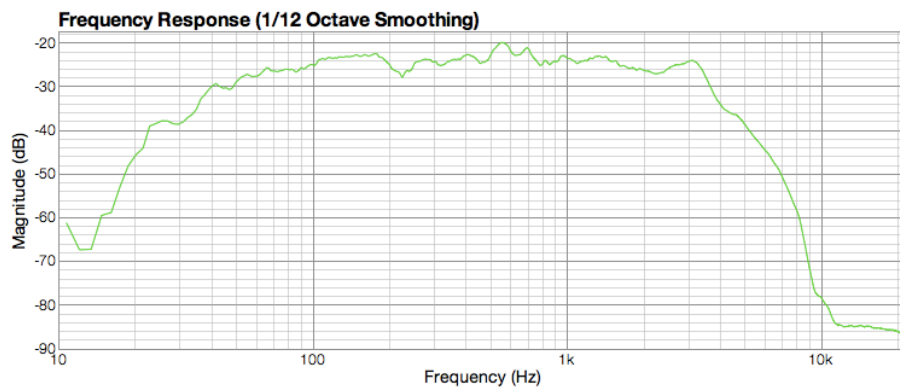
After looking at the responses and specifications of the Scan-Speak Discovery 8" woofer and the SEAS Prestige 27TDFC I had a starting point for my initial crossover. I initially decided to put a first order filter, just a capacitor, on the tweeter in order to get a predicted second order roll off with the waveguide. According to Zaphaudio, a 27TDFC was used with the same waveguide I used on a baffle. He placed a single 3.3 uf capacitor on the tweeter, and as a result of the waveguide, it created a nice second order roll off. I figured I would try this. As for the woofer, I decided to go with a second order filter, to produce a crossover at about 2k. I calculated a Zobel-Network to handle the rising impedance of the woofer, and I also placed a baffle step circuit on just the woofer. Surprisingly the woofer's sensitivity is 2dB higher than the tweeters, which is 90db. I figured the baffle step would pad the woofer a little to even this out. Below is the draft of my initial crossover.



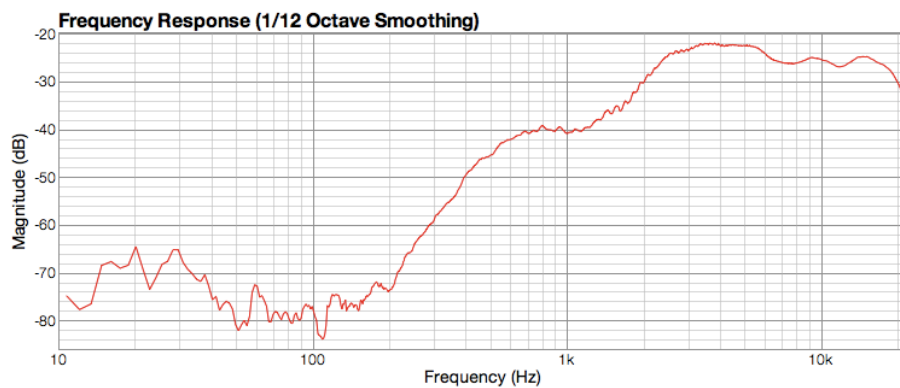
With this crossover, no port in place (just the whole cut in the wood), and no dampening my initial response are displayed below:



Woofer Response:



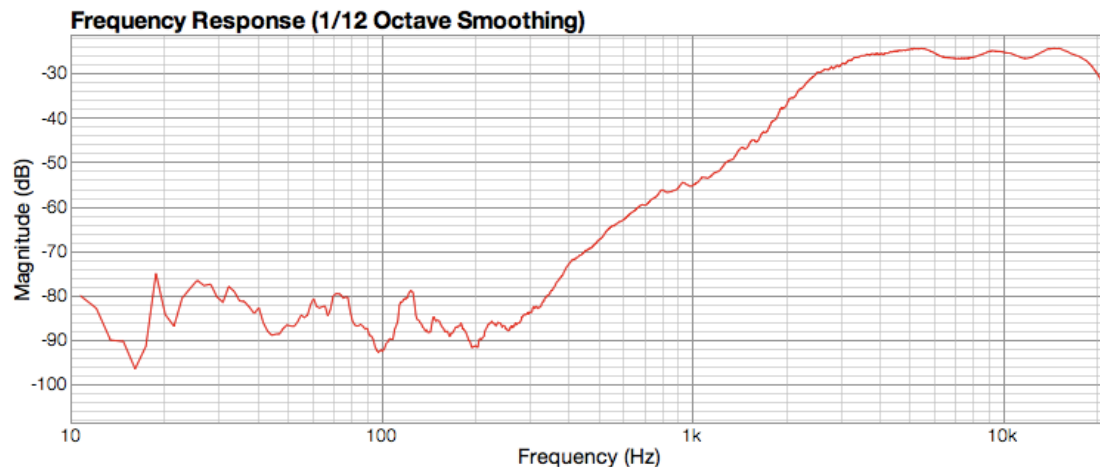
Tweeter Response (with a 5uf cap):



Initial Tuning

After listening to my speakers for the first time I felt they were very harsh and a little too bright. This was due to a 2-3 db boost to the tweeter provided by the waveguide. To help bring the tweeter to the same level as the woofer, I simply moved the baffle step circuit from the woofer to the both of the drivers. This improved the balance significantly, but I planned on coming back to this later.

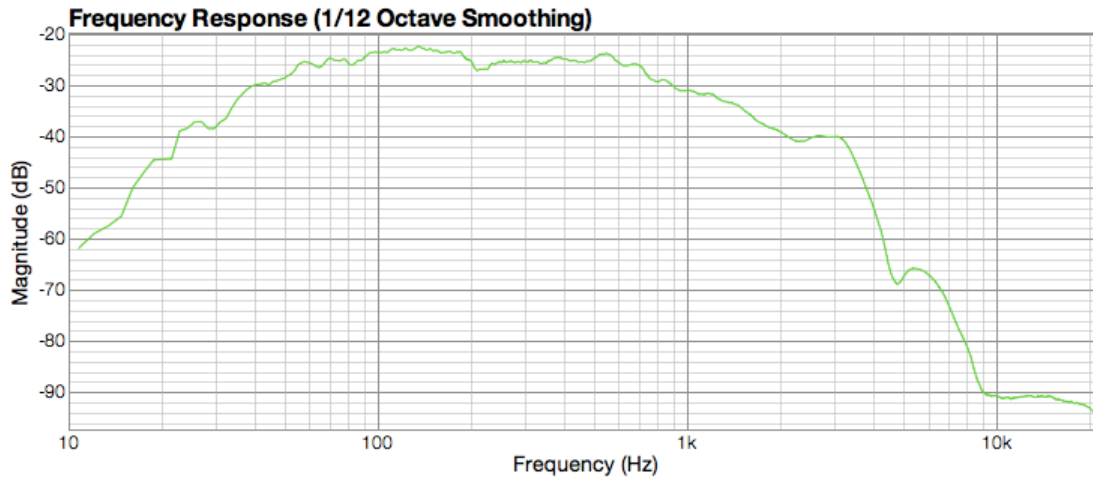
As you can see on the previous page, the crossover has many adjustments to be made. The first problem I dealt with was the tweeter response. The single capacitor in series with the tweeter did not make a smooth second order roll off as predicted. Instead it created an odd step like roll off. To fix this I simply added an inductor to make it a functional 2nd order filter. I then experimented with capacitor and inductor values to improve it. (See below).



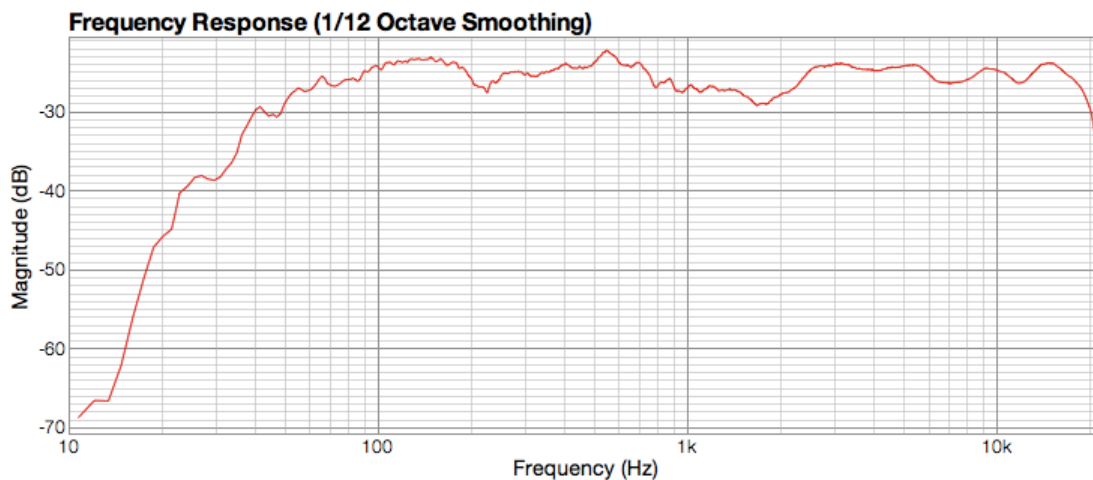
When tuning the woofer to create a smoother crossover point, I began to adjust the inductor values of the woofer and set out to experiment. The Scan Speak woofer extends rather high for a woofer, and it was somewhat difficult to tame this high end. After

messing with the 2nd order roll off for quite some time, I decided it wasn't going to work.

An example of a type of response I was getting can be seen below:

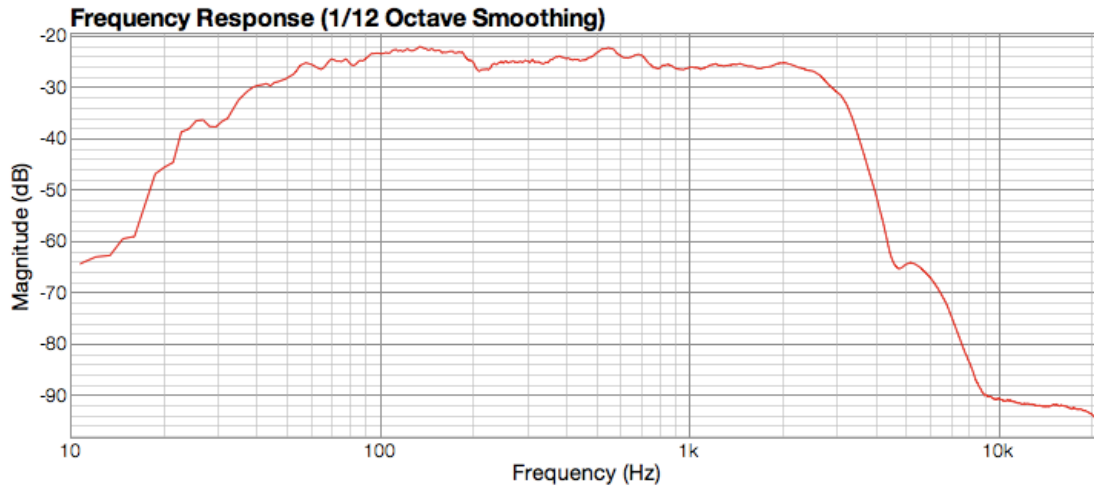


I kept getting poor crossover results with the second order that were either creating big dips and bumps in my crossover, and I just couldn't get it to roll off soon enough. Here is an example of how bad the crossover region is around 2k:

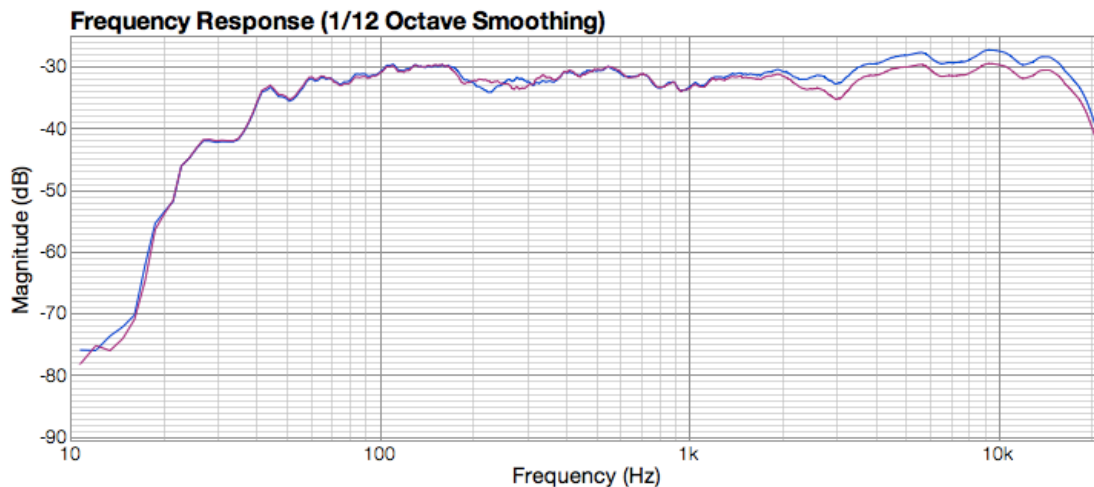


What solved the problem was bumping the filter up to a linkwitz riley 4th order roll off.

After making small adjustments to calculated values I ended up with a nice looking roll off, as can be seen on the next page.

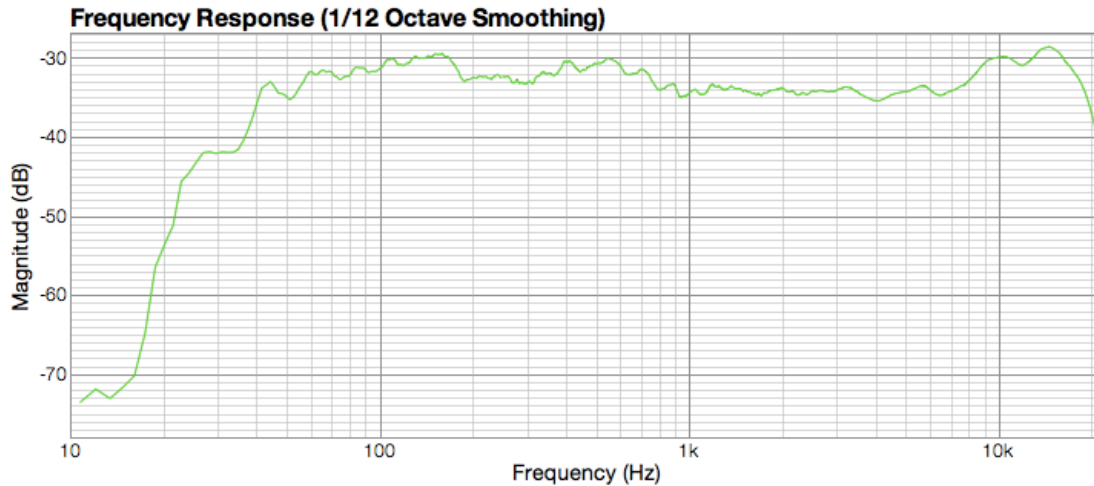


With the tweeter and woofer together it seemed to sum pretty well. On the other hand, the sound was too bright once again. To fix this I simply added a tweeter pad. The graph shows the tweeter without the pad in blue, and with the pad in purple.



Sidetracked

As the response was looking better, I decided to play with the capacitor value of the tweeter to see if I could make the crossover region smoother. With adjusting the cap, and then removing the pad just to see what would happen, I temptingly smooth crossover region.



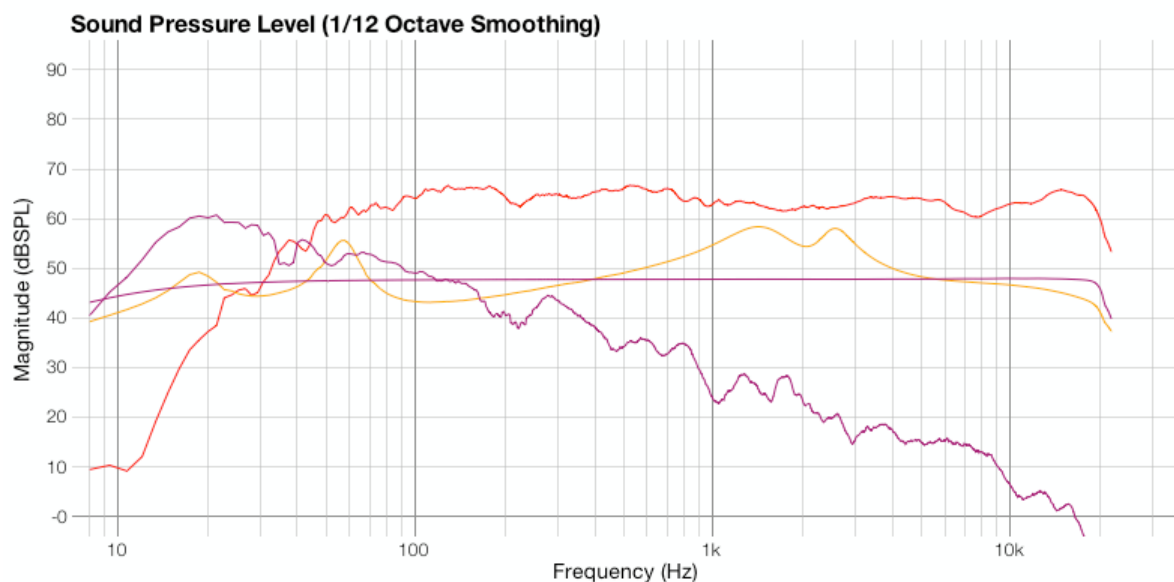
I really liked how flat the response was between 1k and 8k, and I found myself getting sidetracked. I made an attempt to try and tame the upper and lower boosts, but things were not going so well. In pursuit of making this crossover region work, I found myself creating more problems than solutions. In order to effectively make this work I would need a new tweeter pad that would not ruin the crossover region, and potentially two notch filters. After having a hard time getting the high end effectively padded, I decided that it was best to backtrack to my original plan. It would have essentially caused my many less hours of sleep, more money in crossover parts, and potentially never finding a proper solution.

Final Tuning

After backtracking to my former crossover I made a few adjustments to the tweeter pad so that the speakers were not too bright. I then went on to experiment with dampening my speakers. I started with simply adding dense fiberglass to the rear panel of the speakers to reduce reflections directly from the back. This made areas around 200hz a little smoother when looking at the frequency response, but there were no significant impacts on how the response looked. I went on to adjust the dampening,

mostly to manipulate the quality of the sound the speaker produced. I experimented with putting dampening on the sides, top and bottom, and different types of fiberglass. My final dampening choices were based on how open the speaker sounded. I initially had it over dampened with large amounts of pink insulation on the top and bottom, and dense yellow fiberglass on the back. To make it sound less suffocated, but still tight, a quality that dampening can provide, I finalized my dampening choices with a thick piece of fiberglass on the rear panel. This was about 2" thick. I also used pieces of dense fiberglass that were cut down to ½" thick on the top and bottom of the cabinet.

For port tuning, I cut down 1 ½" PVC pipes to about 3". This improved the low end of my speakers drastically, although they do sound a little bit boomy. The response with the impedance and port response can be seen below.



The port is currently tuned a little low, about 30hz. The speakers have plenty of low end, but to make them tighter I may cut the port down in the future, to move its tuning up to 35 or 40 Hz.

Conclusion

Overall I am pretty satisfied with the sound of the speakers. They are not as flat as I hoped for them to be, but even though they are a little biased at certain frequencies they still sound good. I plan on making small adjustments in the future, potentially depending on the space they are being used in. Below are the responses of the whole speaker, woofer, tweeter, and also the final crossover.

