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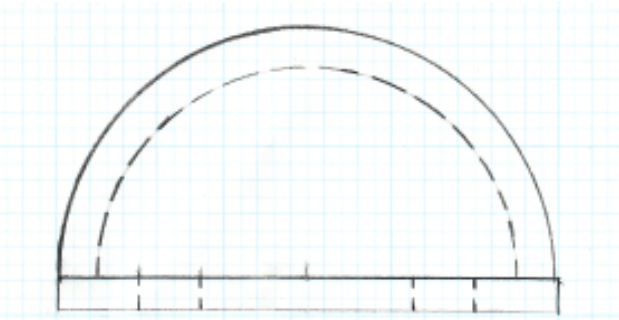

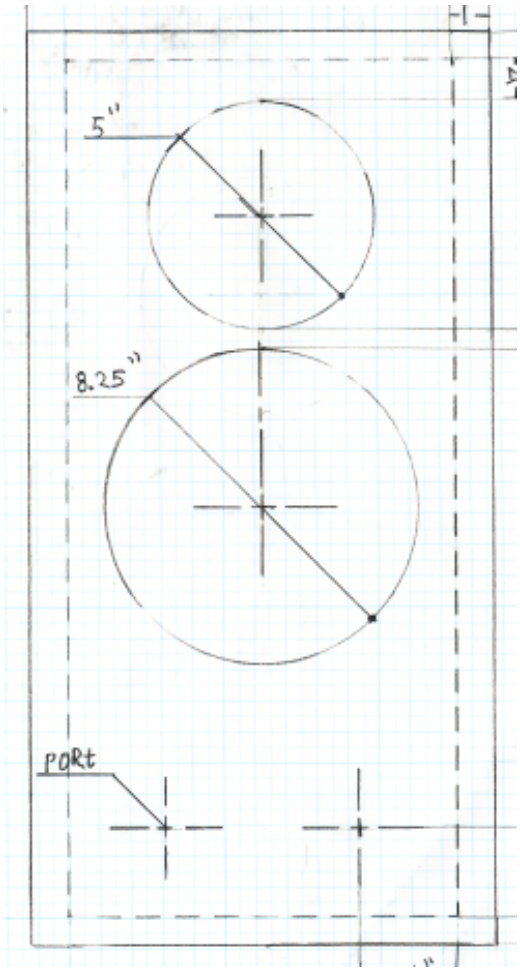

Will Fruin

Design proposal

Functional Goals

USE

These speakers will be used for home Hi-Fi bedroom listening and extended listening while playing videogames, cleaning or doing what ever around the house. I plan on constructing some speaker stands for these that can handle the weight of concrete for my room this summer after they are done.

Bandwidth

I want this to be a full range system going down to at least 50 Hz and up to 20 kHz. I also want coloration that will prevent my speakers from being fatiguing to listen to. Time was taken to listen to many of the speakers around walker and at home, and I found that I like a warmer tone out of speakers. At home I have a cheep set of ribbons that are very bright and harsh in tonality as well as fatiguing to listen to. I listened to the speakers in the ensemble room, and they seem to lack clarity and definition, and offered a muddy tone. The speakers in room 212 of Walker are well balanced for mixing, but the tone that they carry is a bit too even for every day listening, and they don't sparkle due to lack of high-end clarity. The speakers in the studio have an amazing low end tone that I would love to reproduce. Unfortunately, making bookshelves and reproducing the sound of 5 foot towers with a one cubic foot box would be difficult if not impossible. What I did like, that I can replicate, is how clear and detailed the high end was. I looked in to these tweeters and found that they can achieve 40kHz which is a huge part of why they sound so clear.

Because of this level of clarity I plan on using tweeters with a range that goes above 20 kHz.

I want a transducer that can reach well above 20kHz because it affects our perception of sound according to some studies the brain will actually react to sounds above 22kHz, even though we cannot hear them[1]. So, I will be looking at drivers with very high frequency extension for my project.

SPL

After some measurements I took with a dB meter at about one meter away from my home stereo, I found that I usually listen to music around 80 to 85 dB when I'm working around the house. Due to the fact that the K 20 system of measurement is based on 20 dB of headroom, I logically concluded that I would need 20 dB of headroom in my speakers. I will need to be able to make 105 dB peak with my drivers with my 35 watt amplifier. As seen in Figure 1, a 35watt amp will add around an extra 15 dB. With my 90 dB SPL woofers, I should just barely be able to achieve this output out of one of my speakers. In short I need a minimum of 90 dBspl for my woofer and my tweeter.

[1] "Inaudible High-Frequency Sounds Affect Brain Activity: Hypersonic Effect -- Oohashi et al. 83 (6): 3548 --." Journal of Neurophysiology. Web. 10 Feb. 2010. <http://jn.physiology.org/cgi/content/abstract/83/6/3548>.

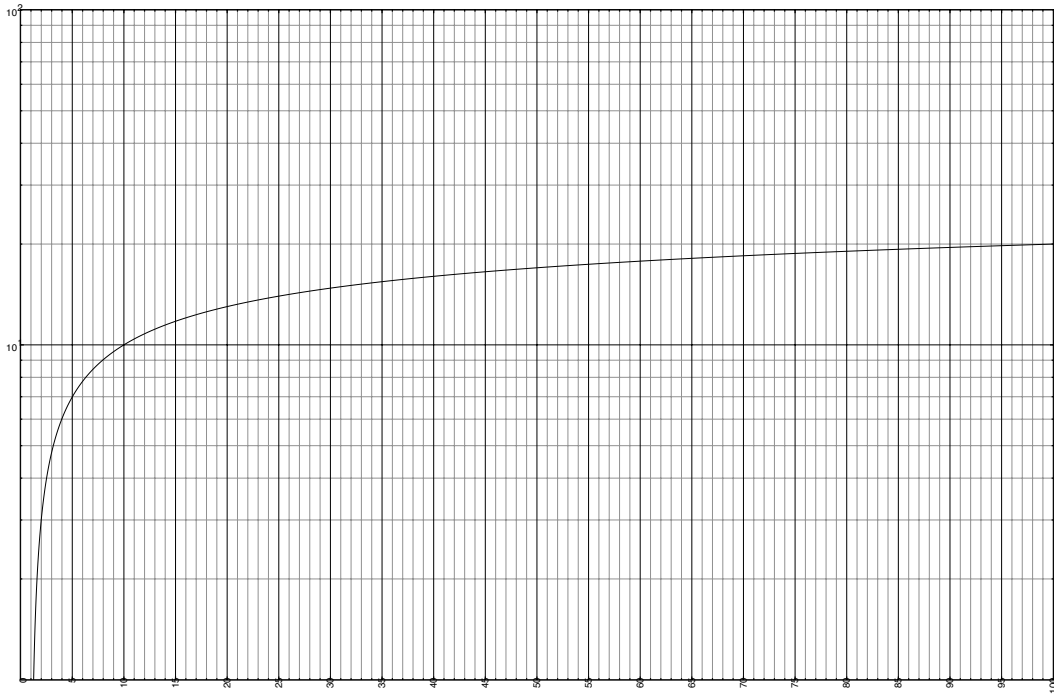

Figure 1. Gain in dB per watt of power added

Concrete

I am using concrete to construct my speakers because concrete is hard. This will make for an amazing speaker enclosure due to its rigidity. I've found this really useful 'Do It Yourself'[2] article from some one that has already made a set of concrete enclosures. I found that there are some chemicals and materials that I can use to make my concrete stronger and easier to pour. The set that I found used high-grade concrete to build the speakers, as well as a plasticizer to make the concrete more fluid. This is so I won't have to add more water, which weakens concrete construction. Pro-mesh which is a plaster reinforcement material was used in strengthening the speaker cabs, which is

[2] "Concrete Speakers." PrismNet : Austin TX VOIP, Broadband Colocation, Web Hosting. http://www.prismnet.com/~dylan/speakers/ (accessed January 22, 2010).

something that I am a little concerned about because I don't want my speakers breaking in half.

Room size

This system will likely be placed in a bedroom. The room will have sound dampening material, being my bed, carpet, pillows, and other furniture. Since it will end up in my bedroom, I want these speakers to remain small in size. This is so they can be placed on a reinforced bookshelf or on speaker stands that will have a small footprint.

Aesthetics

My inspiration for this was taken from a 'Do It Yourself' article on partsexpress.com about a set of speakers that was made from a set of cardboard tubes see image 1.

Image 1. Tube speakers

These speakers looked sleek and elegant, and this is something that I was hoping to accomplish with my design. My goal is to create a set of speakers that are modern looking and aesthetically pleasing. I want to use some sort of exotic wood, or perhaps a veneer to finish my cabinet's front baffle. Then I would stain it an outrageous color like

green or blue. The rear concrete will be left its natural color; however, it will be sanded down and made smooth. If I can, I would like to sand blast it for a courser look. In short, I want to create concrete half cylinders with an elegant wooden front baffle.

Technical goals

SPL

I selected the Arum cantus AC-200MK2 woofer, which has a sensitivity of 90 dB. This will be the limiting factor in my system, and should pair nicely with my 35 watt per channel amp to give a final theoretical output of 105 dB. The Fostex FT48D tweeter has a sensitivity of 93 dB, which I will have to pad this driver in my crossover network.

Driver

I have selected the Arum Cantus AC-200MK2 eight-inch woofer, and the Fostex FT48d 33 mm soft dome tweeter.

Woofer #1

The Arum Cantus woofer features a nonwoven carbon fiber cone that helps with dispersion in the driver. As we were shown in the B&W video from class, the standing waves in a driver could cause some resonance problems in a woofer. The non-woven carbon fiber is a non-uniform material, which will cut down on these standing waves significantly. These drivers also have a flat frequency response of plus or minus 1.5 dB, seen in Figure 2. The woofers also boast a 90 dB sensitivity,

which is rather high without having to go into a professional line of drivers, and is also high considering the price of about 110 dollars. [3]

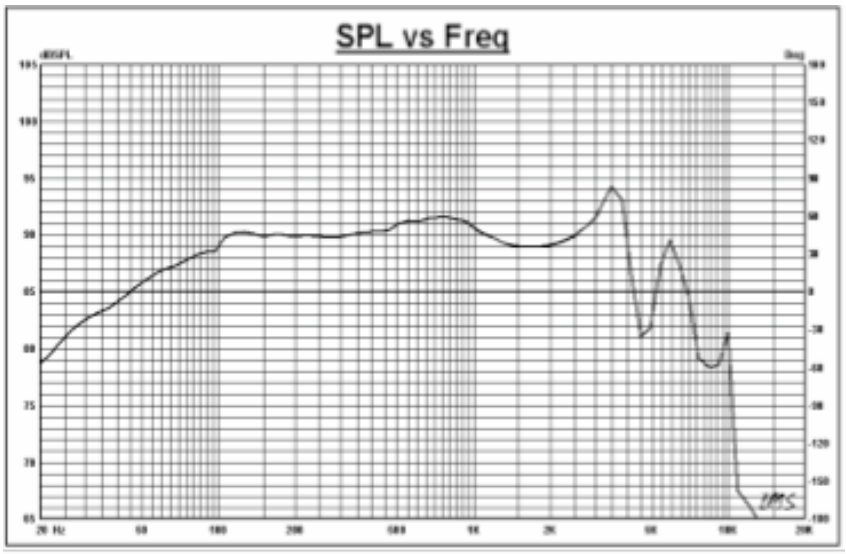

Figure 2. Arum Cantus AC-200MK2 woofer

Image 2. Arum Cantus AC-200MK2 woofer

[3] "Parts-Express.com:." Parts-Express.com - Speakers, Speaker Building, Home Audio and Video, Pro Audio, Electronic Parts & Accessories PARTS EXPRESS, Speakers, Speaker Parts, Guitar speakers, Bass speakers, Woofers, Drivers, speaker upgrades and replacement speakers. Eminence Speaker, JBL speakers, B&C, EV, Peavey, Pyle, Tang Band, Hi Vi, Peavey, Usher, Dayton Audio, Selenium, Goldwood, Morel, Vifa, Peerless, JBL speakers, Eminence woofers, WOOFER. Web. 12 Feb. 2010. <http://www.parts-express.com/pe/showdetl.cfm?Partnumber=296-420>.

Woofer #2

Eton 8-800/37 Hex 8” woofer looking at this drivers frequency response I noticed that it was remarkably flat and like the Arum Cantus it has a 90 dBspl. So they are very similar how ever I ruled it out due to the sharp break up frequency. It has a 10 dB increase in volume at its break up resonance at 3 kHz see Image 3. This is a noticeable breakup frequency and would add a lot of unwanted coloration to my frequency response.

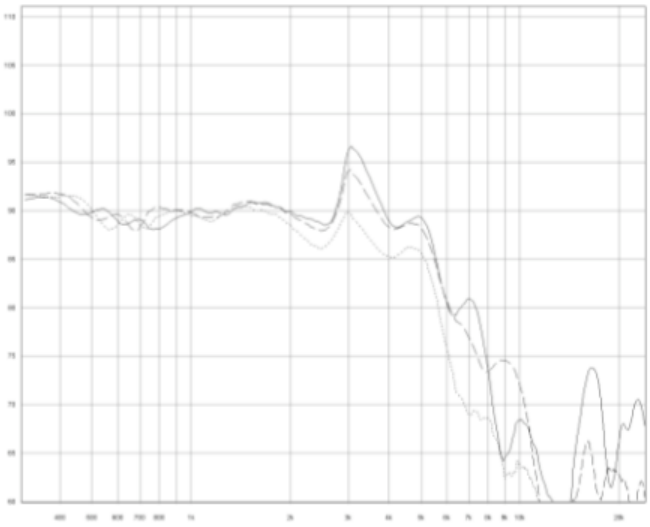

Image 3. Eton 8-800/37 Hex woofer

Woofer #3

Usher audio 8137A these woofers also had a higher sensitivity at 88 however it was not as high as the other two drivers that I reviewed. What did concern me was the 5 db high shelf that this woofer has before 1 kHz see Image 4 and continues until the break up. This large shelf will make my speakers sound brighter which is a quality I do not want in my system. This would make an excellent sub woofer potentially. If I was to make a sub woofer I would not be considering an 8” cone. I would instead

consider a larger one that would be able to reach lower frequencies while having a higher dBspl.

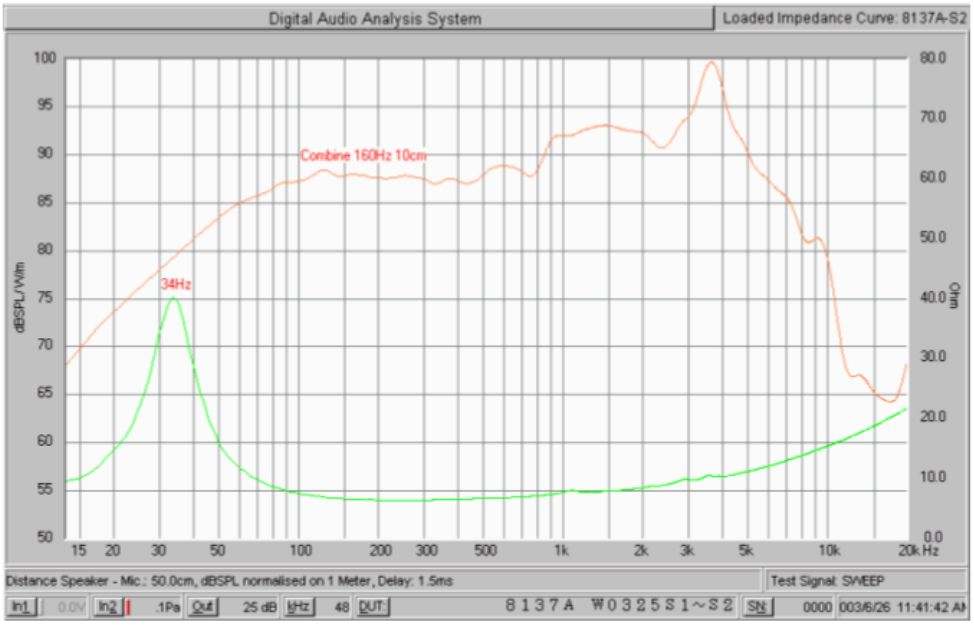

Image 4: Usher Audio 8137A

Tweeter

The Fostex FT48D soft dome tweeter gives fantastic frequency response up to 30kHz and remains fairly flat up to 20kHz. The range of up to 30kHz will also help keep detail in my high end, which I want in a tweeter. This driver also offers a natural roll off starting at 3kHz, as seen in Figure 3. This will offer a warmer vocal tone. This tweeter will need to be padded with because of its 93 dB sensitivity, which places it slightly above my woofer's 90 dB.[4]

[4] "Fostex FT48D 33 mm Dome Tweeter from Madisound." Madisound Speaker Components | Assisting speaker builders for more than 25 years. Web. 12 Feb. 2010. <http://www.madisound.com/catalog/product_info.php?manufacturers_id=131&products_id=288>.

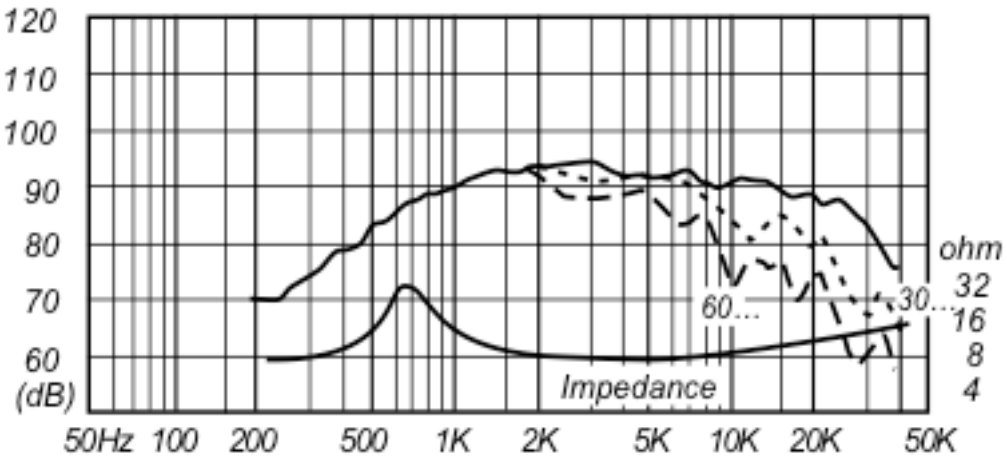

Figure 3. Fostex FT48D tweeter

Image 5. Fostex FT48D tweeter

Tweeter #2

Due to how much I liked the studio ribbons I also considered the Fountek NEOCD3 ribbon tweeter. This tweeter offered flat frequency response up to 40 kHz, which would have been a fantastic tweeter. However, after modeling the Fostex with the Arum Cantus, I found that the crossover frequency worked perfectly at 2000 Hz

using a first order crossover. I decided against it due to how well the Fostex and the Cantus worked together.

Tweeter #3

HiVi RT2II this plainer transducer was one that I considered for some time due to its excellent frequency response curve and extreme high-end frequency extension. However there is a 10 dB drop 30 degrees off axes which would make them undesirable for ordinary listening in my home perhaps if I was building a set of monitors these would be a better choice.

Crossover

After using Excel to decide on a first order cross over at 2kHz, I found that the crossover with a 3 db on the tweeter yielded a flat frequency response, seen in Figure 4. This crossover will be more affordable than other form of a crossover with one 9.9microfarad capacitor and one .64 milli-Henry inductor, as seen in Figure 5.[5]

[5] McCarthy, Bob. Sound Systems: Design and Optimization Modern Techniques and Tools for Sound System Design and Alignment. New York: Focal, 2007. Print.

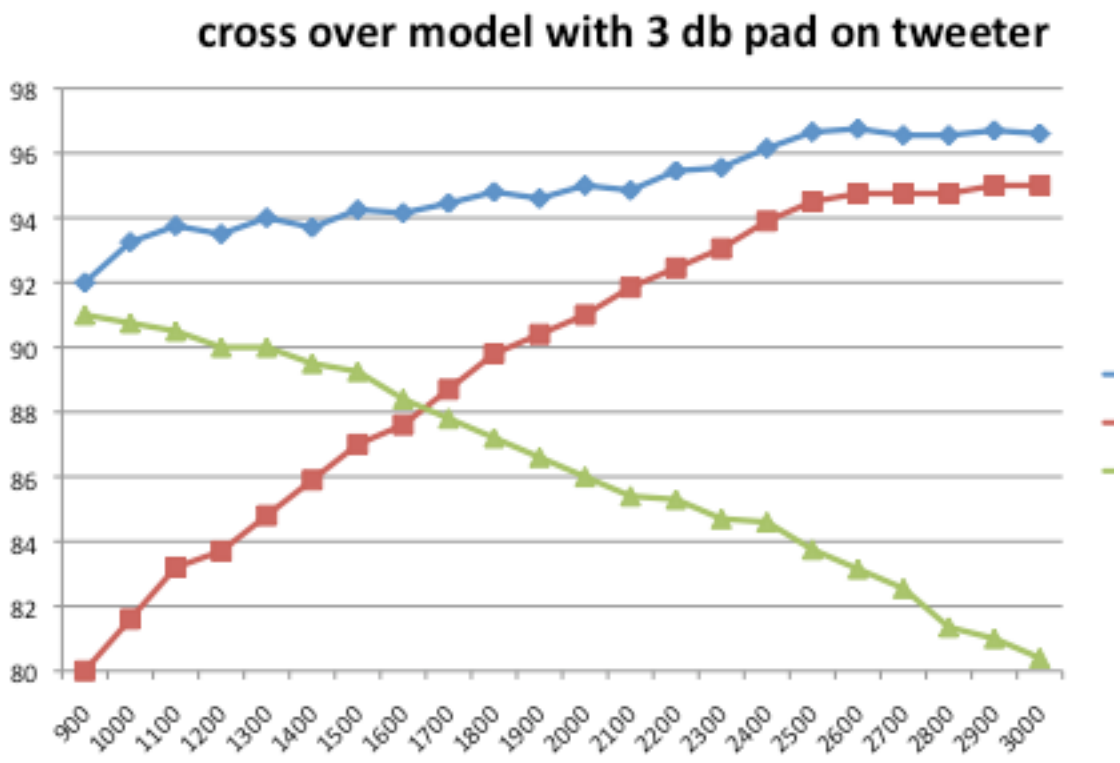

Figure 4. Crossover

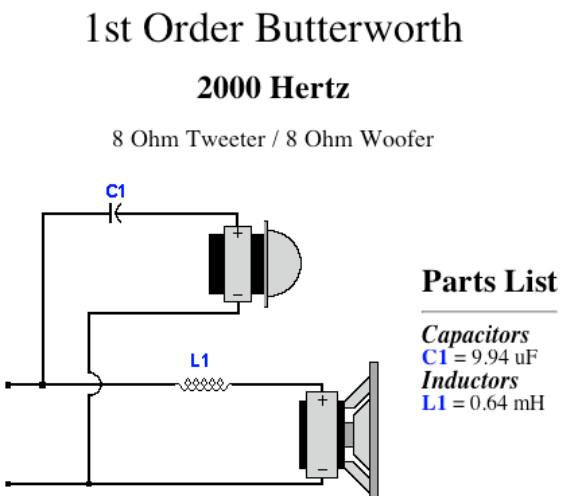

Figure 5. Crossover[6]

Cabinit design

[6] Crossover calculator Web http://www.diyaudioandvideo.com/Calculator/XOver/

I calculated my cab to be .95 cubic feet in volume using the equations in the Loudspeaker Design Cookbook, seen in Figure 4[7] on the previous page. This gives me a SBB4 frequency response for my cabinet, which drops down to 50Hz before a dramatic roll off occurs. I also calculated a port frequency set at 47Hz, seen in Figure 5. I favored this set up over the SQB3 that I calculated because of its extended roll off pattern. The SQB3 only went down as far as 50Hz before rolling off.

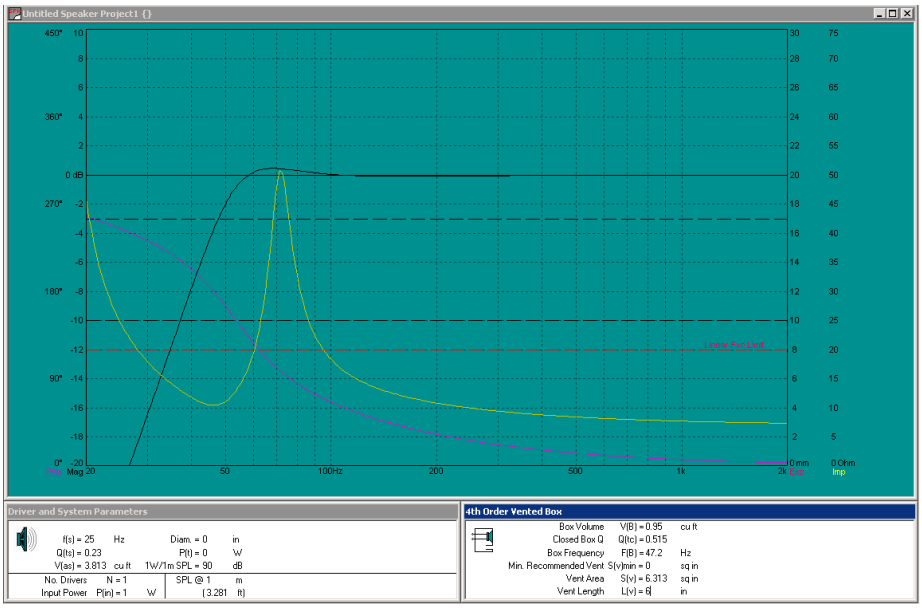

Figure 6. Cab Plot

Diffraction

I am using a unique design for my cabs with which there isn't a lot of information about. We will find out how a half cylinder behaves after they are constructed I am expecting a lot of inner reflections focusing the sound back at the driver I will expect to use a strip of triangle shaped foam down the back of the cab. I am hoping that they will be a preferable shape for speaker cabs.

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[7] Dickason, Vance. Loudspeaker Design Cookbook. 7th ed. New York: Audio Amateur Pubns, 2005. Print.

Baffle step F=13,560/inches

By baffle step was calculated to be at 380 Hz given a 10-inch wide cabinet.[8] 13,560/10'=380.[9] I calculated the baffle step compensation circuit on Diyaudioprojects.com to require a 2.2 mH inductor and a 6.2 ohm resistor set up in parallel see figure 7.[10]

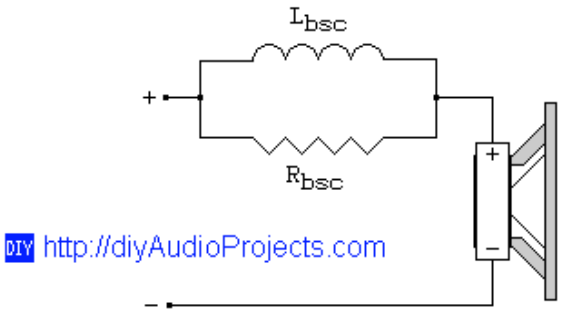

Figure 7. baffle step compensation circuit

Compromises

I want these cabs to remain somewhat small. So, I'm limiting my woofer size; in turn, I will be losing bass. I will be making a sub woofer later to give my stereo a bit more punch. I will also be sacrificing an accurate frequency response for a set of speakers that is not fatiguing to listen to.

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[8] "Baffle Step Compensation." Elliott Sound Products - The Audio Pages (MainIndex).Web.22Jan.2010. <http://sound.westhost.com/bafflestep.htm>.

[9] Murphy, John L. Introduction to Loudspeaker Design. 2nd ed. True audio, 1998. Print.

[10] "Baffle Step Correction / Compensation (BSC) Circuit Calculator for Speakers." DIY AUDIO PROJECTS - Do-It-Yourself Hi-Fi for Audiophiles. Web. 12 Feb. 2010. <http://diyaudioprojects.com/Technical/Baffle-Step-Correction-Circuit-Calculator/>.

Use- home Hi-Fi

- **Bandwidth goal-100Hz-above 20kHz**
- **dB- 105dB**
- **Appearance- half cylinders of concrete with a wooden front baffle**
- **Room size- bedroom**
- **Woofer- Arum Cantus AC-200MK2 8' woofer**
- **Tweeter- Fostex FT48D**
- **Crossover- first order Butterworth @ 2kHz**

  Cabinet size- .95 cubic feet with a 10inch wide front baffle
- **Baffle step – 2713**

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