Final Report

Transducer Theory

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Functional Goals

Since the career that I plan on pursuing is sound editing for film, I want speakers that can help me make my mixes clear and powerful. I plan on designing the speaker based upon my editing habits, which while they do include listening to music, it is not meant for blasting the tunes at a party. I will be focusing intently on the quality of the sounds coming out of the speakers rather than the sounds themselves.

I am a student and have a student's budget to build my speakers. While I dream of having the best system money can buy, I have to limit myself. The budget I set for my drivers is $300. These figures are off of the Madisound website (a loudspeaker parts supplier). I plan on having optimal bookshelf editing loudspeakers for this budget. The budget for my over-all system is at least $350, but I assume that I spend over that much, but hopefully no more than $500.

When editing, I am generally at a desk, no more than a foot away from the current sound source. Additional wattage is not necessary to make up for listening from a distance. After exploring my listening habits I found that, on average I listen to 50dB, with peak levels topping at 70dB. Normally I would be cutting this level down to 65dB, then giving it headroom of about 20dB, which would need about 100 watts extra for the boost in SPL. But from my listening position 70dB of output (measured at 1watt/meter) would actually turn into 76dB. Since most of the drivers I looked at had a sensitivity that was around 80 – 95db I would not need any extra wattage to power my speakers at all.[1]

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[1] McCarthy, Bob. *Sound Systems: Design and Optimization*. Focal Press, 2007. 11

One of the major factors dominating the size of my speakers is that I have to be able to carry them. Since I am of a petit stature, these are going to be bookshelf-sized speakers. The size restriction will also lower the bass response, so I plan on using a passive radiator, which like a port will increase the bass response, but it will have a flatter frequency response than a vented enclosure.[2]

Another reason for the smaller size is that I will use my speakers in a small room (approx. 10ft x 8 ft) and I will be listening to them near field (around 1 to 2 feet away). I plan on placing the speakers on a desktop on either side of a computer screen. In placing the speakers on a bookshelf or desk (and therefore the term "bookshelf") the frequency response would be improved[3].

Cabinet Design

The planned cabinet will be .4 cubic feet in internal volume. The dimensions on the inside (before bracing) will be 14.31" height x 5.46" width x 8.84" depth. The relationship between the three dimensions is a golden ratio (1.62 : 1 : .062), which reduces the amount of cabinet resonance, which occurs from sound waves bouncing back and forth perpendicularly from the cabinet walls. I chose this size, because it was the smallest size that I felt that comfortably fit the drivers that I chose. Also I modeled the drivers I chose with this size and their bass response still held up.

Originally, based on Dr. Harry Olson's diffraction studies, I was interested in creating a truncated pyramid rectangular parallelepiped combination speaker. This would be a speaker with a smaller baffle than the rest of the cabinet. While this has

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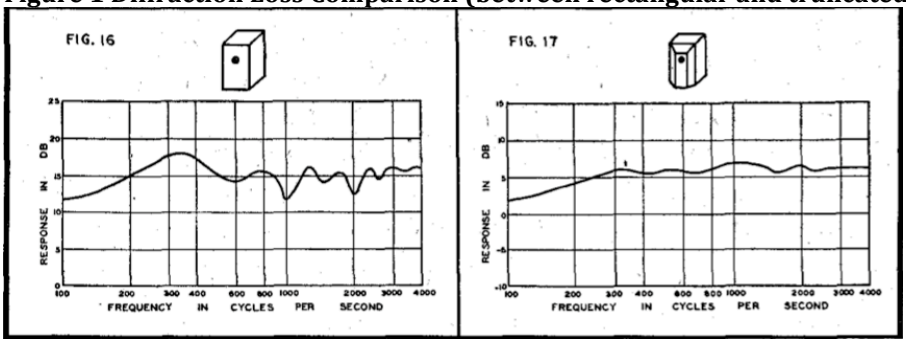
[2] Dickason, Vance. *The Loudspeaker Design Cookbook*. 7th Edition. Audio Amateur Press, 2005. 85.

[3] Holland, Keith and Newell, Phillip. *Loudspeakers: For Music Recording and Reproduction*. Focal Press, 2007. 93.

the best frequency response, is harder to build. While the truncated pyramid is slightly smoother in frequency response[4], other research suggest that this might be because the placement of the driver on the rectangular baffle is placed equidistant from three sides which still has some of the same reflections as the cube.[5] So if I place my drivers (that are effected by the baffle step and diffraction, described later with crossovers) off center, I might get a smoother frequency response than what Olson modeled. Since I do not have a set placement for my drivers, but I am considering placing my tweeters off center; it gives another reason to consider the rectangular shape. My final choice for the shape of the cabinet is a rectangular because of these reasons.

Figure 1 Diffraction Loss Comparison (between rectangular and truncated pyramid)[6]



To keep from making an even larger baffle I will place the passive radiators on the sides of the speakers. I plan on giving my speakers a more rectangular footprint (smaller width, and more depth), and so adding the passive radiators to the side will not affect the baffle width of my cabinets.

To construct the speaker I plan on using ¾" Baltic birch plywood, which is more rigid, but less dense than MDF. The rigidity is a factor for me instead of the

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[4] Olson, Harry. *Direct Radiator Loudspeaker Enclosures*. Audio Engineering Society, 1950. 37.

[5] Murphy. True Audio, 1998. 71.

[6] Olson, Harry. Audio Engineering Society, 1950. 38.

density. This is because the more rigid a material is the less it will resonate; density mainly affects the weight of the material. With the building materials having less density the overall speaker is also lighter.[7] Because of its dampening qualities I would use fiberglass for internal padding inside my cabinet.[8] I will fill it as much as I can, but keep the area around the passive radiator and woofer free so that it has room to breath (like a vent).

My cabinet will be small, so what little bracing I can fit in there has to count. I plan on using a network of bracing (or a brace with holes) to separate the woofer from the tweeter, with the front-back brace off-center. What will also help with leakage is corner bracing and it is less likely to take as much space as other bracings. In order for my passive radiator to work properly I need to make sure my cabinets have very little leaks, these bracings will help with this necessity.[9]

Driver Goals

Based on my listening habits the bandwidth of my speakers should be 60Hz – 20kHz at the worst. I would notice the lack of bass, but would not be overtly bothered by it. Optimally I would like the bass roll-off to start at 50Hz this way the f(3) would be around 40 Hz (which means it is still audible, not quite half the volume), which is still fairly low in frequency (an octave higher than the lowest pitch a human can hear). The highest frequencies would be 40kHz, this would

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[7] Anonymous, *Cabinet Handbook*. North Creek Music Systems, 1992. 7.
[8] Ibid.
[9] Dickason. Audio Amateur Press, 2005. 113.

guarantee a flat frequency response all the way up to 20kHz, and the highest frequency we can hear). [10]

Personal Bass Listening Frequencies		
Song	High Pass Cut-off	Compromise
Roundabout- Yes	30 Hz	40 Hz
97 ways to kill a superhero- Loudermilk	40 Hz	45 Hz
House of the Rising Sun- The Animals	35 Hz	45 Hz
Wasted Words- Allman Brothers	55 Hz	60 Hz
No Rain- Blind Melon	55 Hz	60 Hz

Deciding Woofers

I had three factors in deciding which woofers to use in my speakers from the list of woofers: price range ($25-$55 per driver), size (based on passive radiators of 6.5" or 8", so a range of woofer size from 5" – 8"), and frequency response (especially how smooth the curve is at 100Hz – 4kHz).

The smaller range of driver sizes compensate on bass and smoothness of the frequency response curve. While it is possible to compensate for them by the tuning of the passive radiator the drivers that I eventually chose above the rest have the better driver.

[10] Howard, David and Angus, James. *Acoustics and Psychoacoustics* 2nd Edition. Focal Press, 2001. 80.

Zaph Audio ZA14W08, Size 5”

Figure 2 ZA14W08 Frequency Response[11]

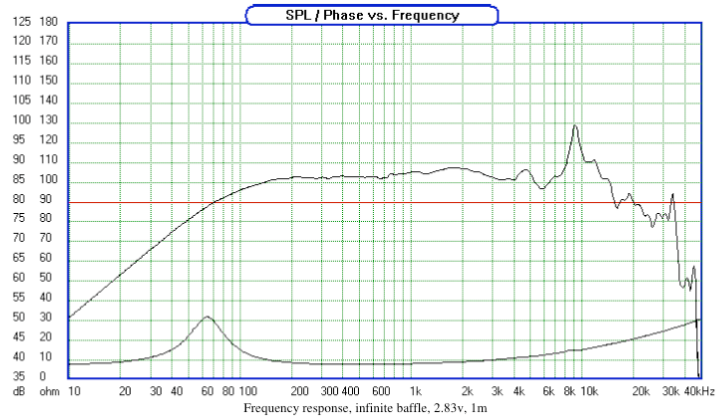
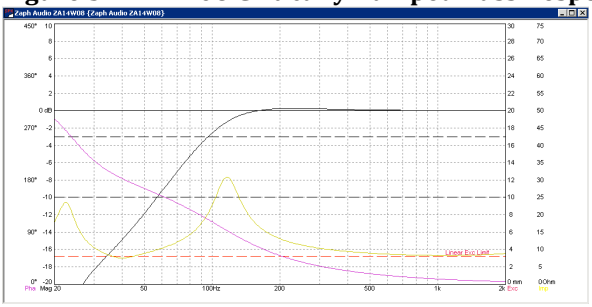


Figure 3 ZA14W08 Critically Damped Bass Response



This woofer has a fairly flat frequency response, and is also pretty small 5”. The compensation for the size shows, however as the bass roll off is around 150Hz. For its size this is acceptable, but not quite the bass response that I need for my woofers.

[11] “Zaph Audio ZA14W08 5” Mid/Woofer”. 2009. Madisound. Available from Audiohttp://www.madisound.com/catalog/product_info.php?products_id=8643 . Internet. Accessed 21 February 2010.

Silver Flute W17RC38-08, Size 6.5”

Figure 4 W17 RC38-08 Frequency Response[12]

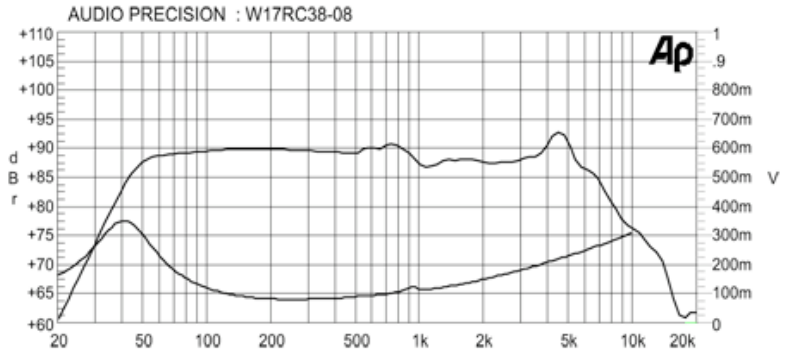
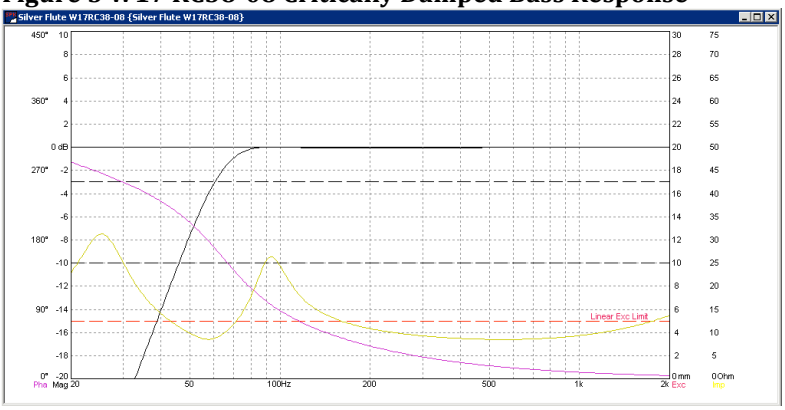


Figure 5 W17 RC38-08 Critically Damped Bass Response



The Silver Flute woofer is, by far, the cheapest woofer on my list. What it lacks in price it also lacks in depth of frequency response. Its bass roll-off start well before 50Hz, and the spec sheet frequency response chart looks suspiciously too smooth. However it is a size that fits my requirements and is in my price range so I gave it a look.

[12] “Silver Flute W17RC38-08 6-1/2” Wool Cone”. 2009. Madisound. Avaliable from http://www.madisound.com/catalog/product_info.php?manufacturers_id=150&products_id=845 . Internet. Accessed 21 February 2010.

Peerless PPB 830874, Size 6.5”

Figure 6 PPB 830874 Frequency Response[13]

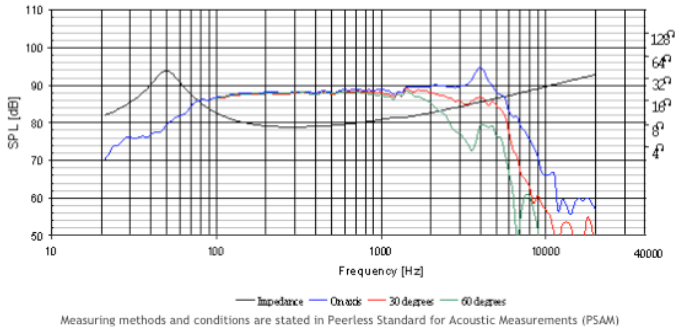
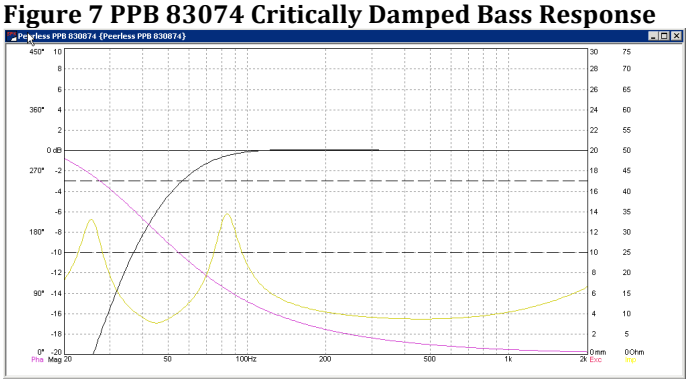


Figure 7 PPB 83074 Critically Damped Bass Response



Once again the small driver falls short on the bass response. Also the driver has a peak at 4kHz, which would interfere with the crossover and the tweeter’s frequency response. What is good about this driver is it does have a flat frequency response (except for the one particular peak) and that it has a truncated frame which would make it easier to fit in my cabinet design, either next to the tweeter or a smaller baffle width.

[13] “Peerless PPB 830874 – 5.6” Poly Cone Woofer”. 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=1609 . Internet. Accessed 21 February 2010.

Peerless SLS 830946, Size 6.5”

Figure 8 SLS 830946 Frequency Response[14]

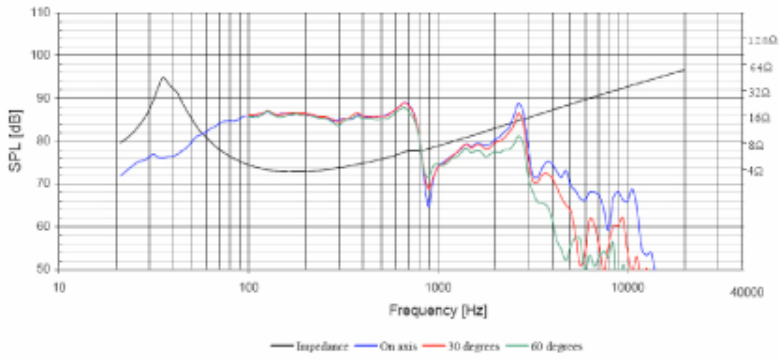
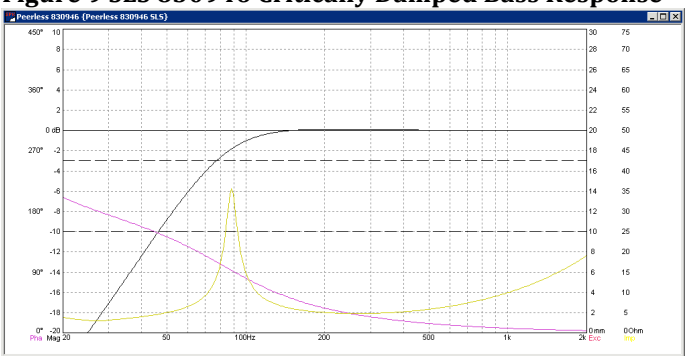


Figure 9 SLS 830946 Critically Damped Bass Response



When I originally looked at the SLS 830946, I thought that its lower frequencies were smooth, and that it had an extended bass response. When I glanced again I saw a break-up frequency at 1kHz, which is where I wanted my crossover, and realized that this is a subwoofer driver, not a mid-ranged woofer. The size and price were right, but not the driver itself.

While I initially looked at larger sized drivers that I looked at required too large of an enclosure for what I desired. Only some have a better bass response than the drivers that I eventually chose. While I could compromise by making my cabinet larger, it became a good opportunity to decide which passive radiator size to go

[14] “Peerless 830946 SLS 6.5” Woofer – 4 Ohm”. 2009. Madisound . Available from http://www.madisound.com/catalog/product_info.php?products_id=8234 . Internet. Accessed 22 February 2010.

with, especially since the two drivers I am leaning towards have a reasonably low frequency roll off at the smaller cabinet size. Another important factor with choosing the smaller drivers is the cost, the larger the drivers the higher the cost. Quite a few of these drivers are higher than the budget that I set for myself. This was to make sure that I was really getting a good driver for the cost I was looking at. Peerless HDS 830883, Size 7”

Figure 10 HDS 830883 Frequency Response[15]

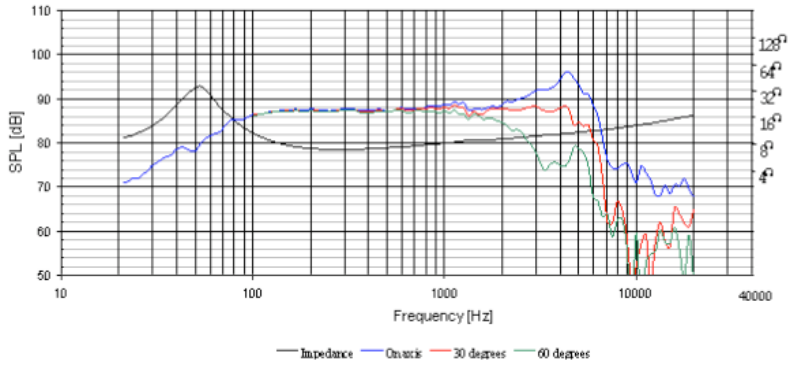
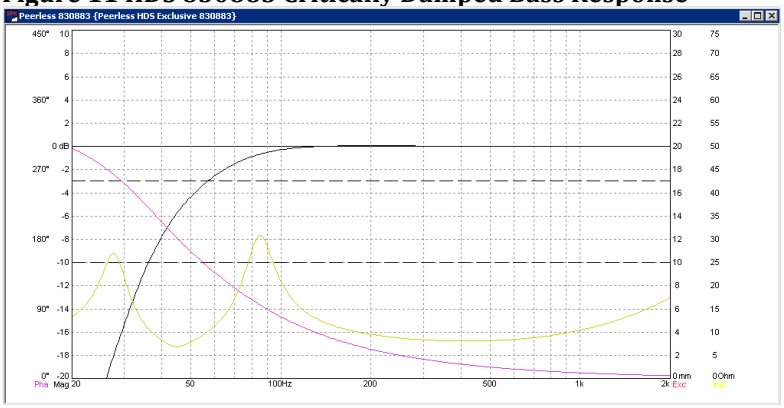


Figure 11 HDS 830883 Critically Damped Bass Response



This driver was beyond the price range that I had set for myself, but I decided to check it out in comparison with some of the other drivers, to see if the cost was worth it. While there is a fairly flat frequency response, there is that peak around

[15] “Peerless Exclusive 830883 – 7” Woofer”. 2009. Madisound. http://www.madisound.com/catalog/product_info.php?products_id=1604 . Internet. Accessed 22 February 2010.

4kHz, and the f(3) of 60Hz. In this case the driver I eventually chose was better in all three of my criteria (size, price and bass response).

Seas Prestige CA18RLY, Size 7”

Figure 12 CA18RLY Frequency Response[16]

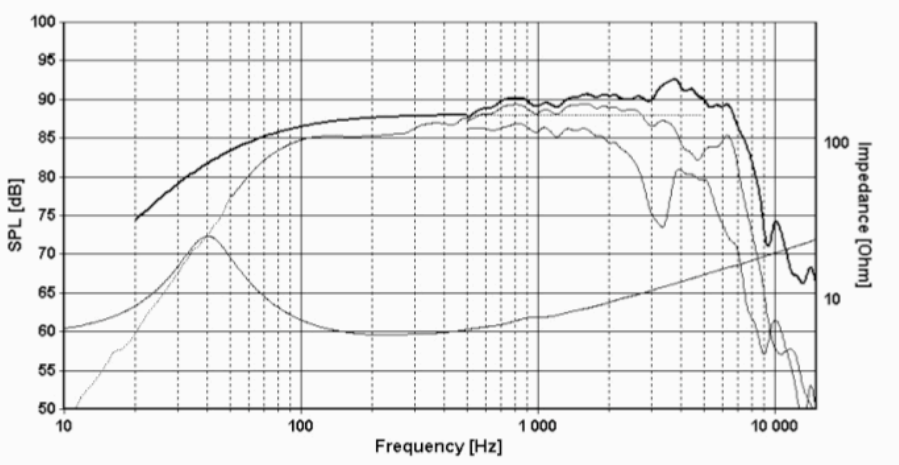
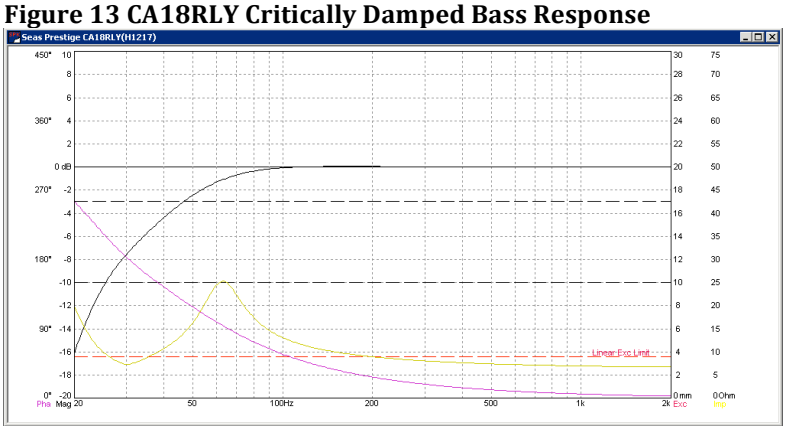


Figure 13 CA18RLY Critically Damped Bass Response



This driver has the f(3) right at 50Hz, which is one of the best for the 7” drivers. The frequency response is pretty flat too, and while it has a peak, it is not too much higher than the rest of the frequencies.

16 “SEAS Prestige CA18RLY (H1217) 7” Coated Paper Cone”. 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=789 . Internet. Accessed 22 February 2010.

Seas Prestige P18RNX, Size 7”

Figure 14 P18RNX Frequency Response[17]

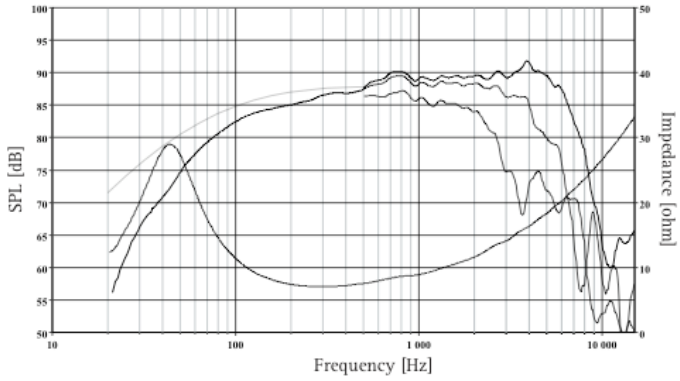
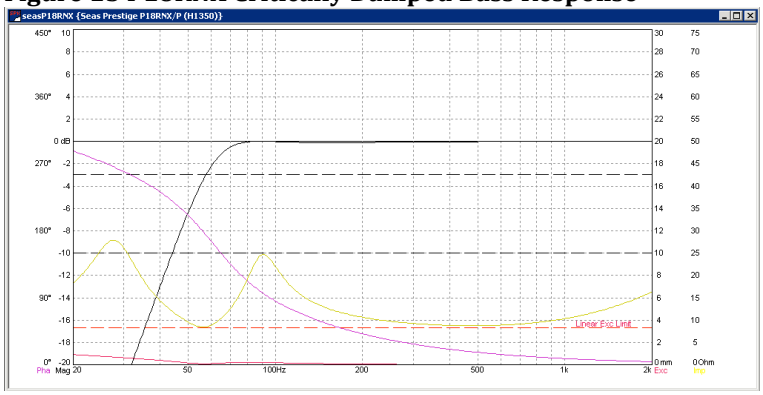


Figure 15 P18RNX Critically Damped Bass Response



This woofer has a fairly flat frequency response, and a smooth break-up, but its bass roll-off is around 70Hz. Of a woofer this size, I was hoping for better. A passive radiator would not help this out as much as I would need it to.

[17] “SEAS Prestige P18RNX/P (H1350) 7” Poly Cone Woofer”. 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=1464 . Internet. Accessed 22 February 2010.

Seas Prestige CA18RNX, Size 7”

Figure 16 CA18RNX Frequency Response[18]

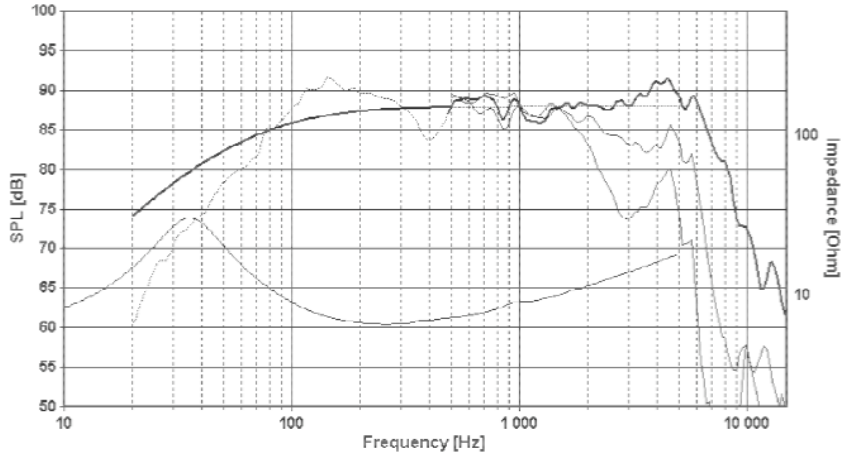
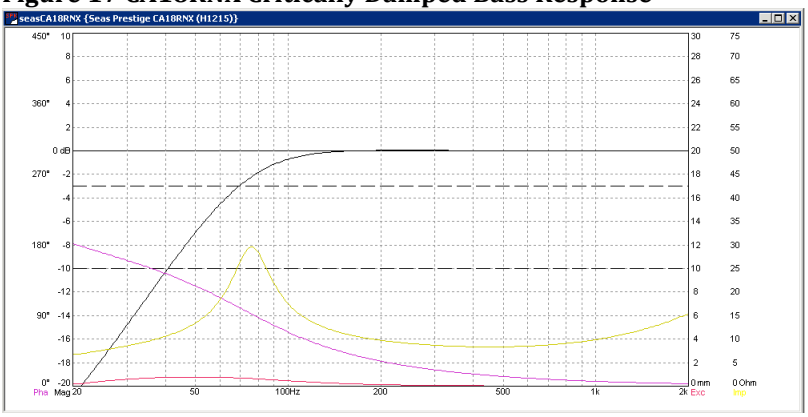


Figure 17 CA18RNX Critically Damped Bass Response



To narrow down my driver selection I modeled them in Winspeakerz to see their particular frequency response when in a cabinet of .4 cubic feet. The values that I am using for the more detailed modeling are from the *Loudspeaker Design Cookbook* table 2.5 Q(L) = 7 on page 67. This is because passive radiators work best with QB(3), B(4), and C(4) (Quasi Third-Order, Fourth-Order Butterworth, Fourth-Order Chebyshev respectively) alignment and tuning. I chose specifically the Quasi

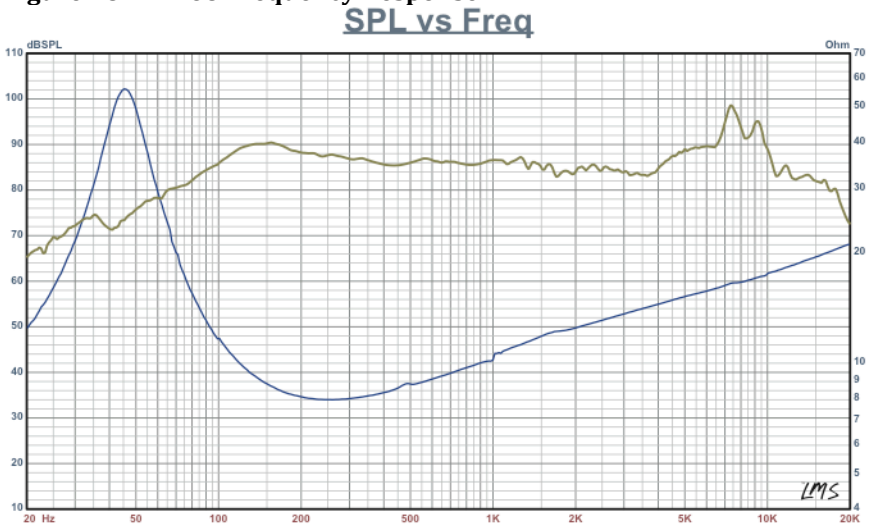
[18] “SEAS Prestige CA18RNX (H1215) 7” Coated Paper Cone”. 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=823 . Internet. Accessed 22 February 2010.

Third-Order, because it is allows for a smaller box size and lower f(3) for the given driver Q(ts).[19]

Fountek FW 168

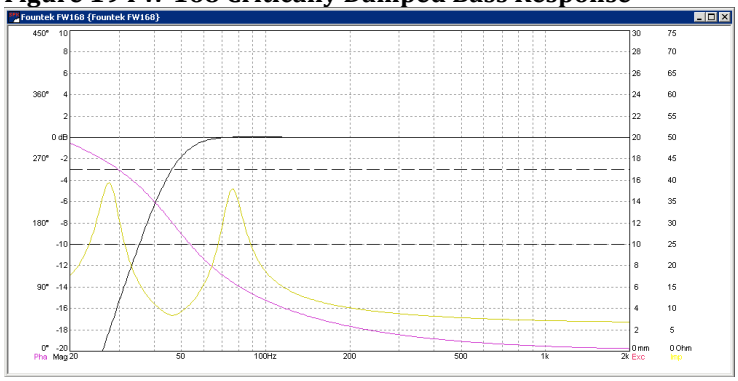
Size 6.5”, Price $40.64 (off of the Madisound Website)

Figure 18 FW 168 Frequency Response[20]



Critically Damped Bass Response

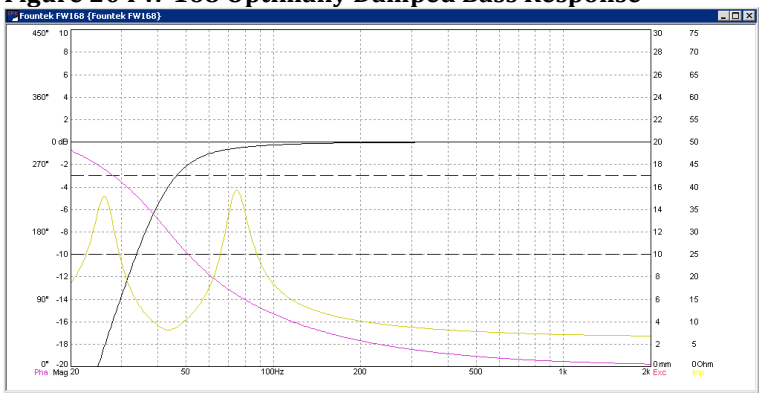
Figure 19 FW 168 Critically Damped Bass Response



[19] Dickason. Audio Amateur Press, 2005. 63.

[20] "Fountek FW 168 6.5” Aluminum Cone Woofer." 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?manufacturers_id=132&products_id=8492. Internet. Accessed 12 February 2010.

Figure 20 FW 168 Optimally Damped Bass Response



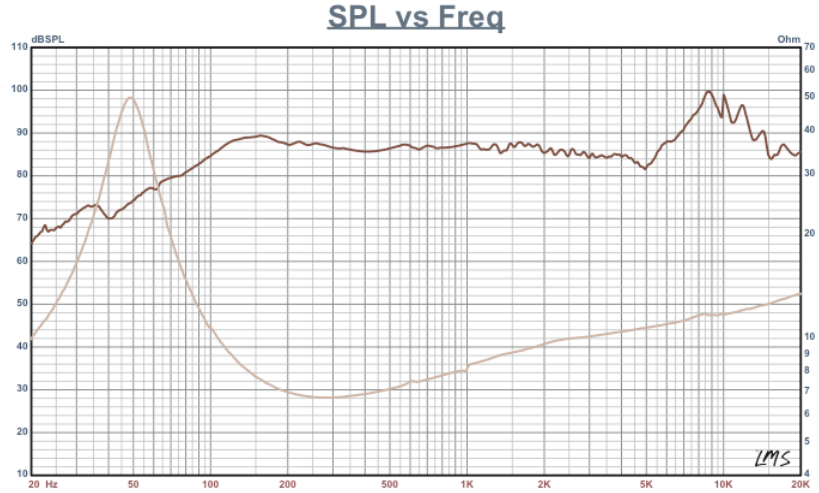
Based on the Q(ts) value of the FW168 (.397). The other values necessary to model an optimally damped bass response are: Q(ts) = .397; f(s) = 42Hz; H = 1.0335; alpha = 1.1141; f(3)/f(s) = .9776; V(B) = (0.58 cu ft)/ 1.1141 = .52 cu ft; f(b) = 1.0335 * 42 Hz = 43.407Hz.

Fountek FW 146

Figure 21 FW 146

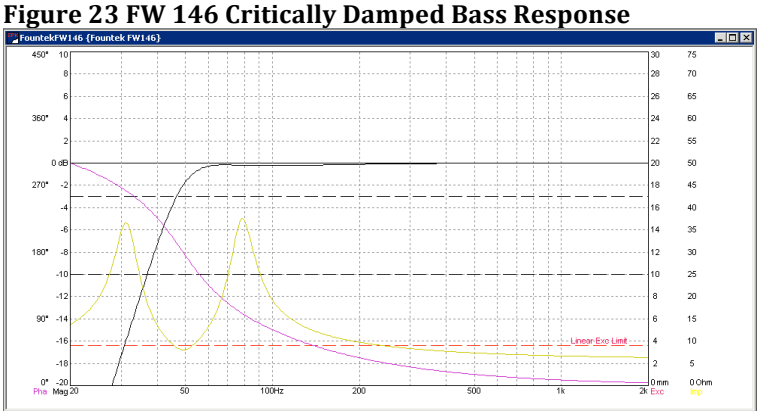
My final driver choice is the FW146, because it is smaller, cheaper and has a better bass response than its larger version the FW168, and its frequency response is better than the rest of the drivers I looked at. Its size is 5.5" and with a price of $38.35 this driver has the best size, price and frequency response of what I found.

Figure 22 FW 146 Frequency Response[21]



Except for the peak starting at 5kHz (making 5kHz the break-up frequency of this woofer) this response is fairly smooth, especially between 200Hz and 5kHz.

Figure 23 FW 146 Critically Damped Bass Response



The f(3) of this driver is around 48 which is better than the majority of the larger drivers, and will also be boosted by the passive radiator.

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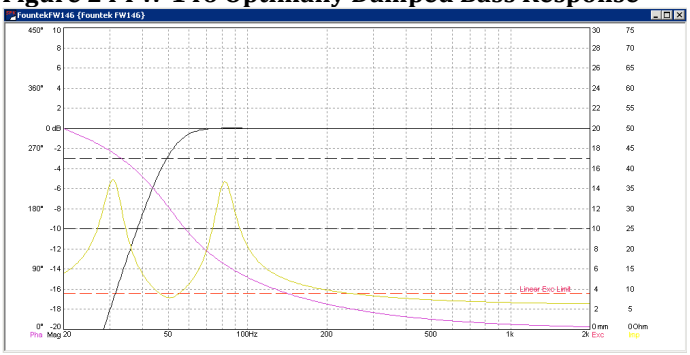
[21] "Fountek FW 146 5.5" Aluminum Cone Woofer. Madisound. Available from http://www.madisound.com/catalog/product_info.php?manufacturers_id=132&products_id=8586 . Internet. Accessed 22 February 2010.

Figure 24 FW 146 Optimally Damped Bass Response



Based on the Q(ts) value of the FW146 (.4). The other values necessary to model an optimally damped bass response are: H = 1.0106; alpha = 1.0065; f(3)/f(s) = .9776; f(s) = 50Hz; V(B) = (0.346 cu ft)/ 1.0065 = .3438 cu ft box volume; f(b) = 1.0106 * 50 = 50.53Hz box tuning frequency.[22]

Passive Radiator

Instead of going with a more expensive woofer of a similar size, I chose to have a less expensive woofer combined with a passive radiator. According to the Madisound catalog the prices of my passive radiator choice and my woofer choice combined are less than the price of a woofer with similar size and frequency response to my designs frequency response. [23]

A passive radiator works in a similar way to a vented loudspeaker cabinet. It extends the bass of the woofer without acting like a separate driver. It is tuned by adding weights on the back in increments of 5 g. A passive radiator does have the possibility of boosting the bass response so that it has a peak right before

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[22] Dickason. Audio Amateur Press, 2005. 66.

[23] "Seas Prestige Passive Radiators." 2009. Madisound. Available from http://www.madisound.com/manufacturers/seas/prestige/passive-coaxial.php#passive. Internet; accessed 12 February 2010.

the low frequency roll off (also called a "boom box" bass response).[24] The passive radiators work with the woofer to extend the bass response naturally. They are especially important if to reach a certain frequency a port longer than the depth of the cabinet is needed. They are in theory a covered port that can be tuned to the desired frequency. [25]

When I researched what options were available I saw that there were three sizes. I opted for choosing either the 6.5" or 8", to keep my cabinet size smaller.[26] Because the woofers used in the cabinet have to be the same size or smaller (within a few inches of the passive radiator size) the size range that is optimal for my system is between 5" to 7". My passive radiator choice is the 6.5", because it is cheaper, smaller and the woofer I chose works better with this size of passive radiator. [27]

Deciding on Tweeters

When I started looking for tweeters I did not know what I was looking for. I began by looking at a variety of designs, especially ones with a flat frequency response and fit within of my price range of $25 - $55 per driver. Sensitivity of the driver was not the most important for me, because my system does not require a lot of amplitude.

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[24] Weems, David and G.B. Koonce. *Great Sound Stereo Speaker Manual* 2nd Edition. McGraw Hill, 2000.102.

[25] Dickason. Audio Amateur Press, 2005. 85.

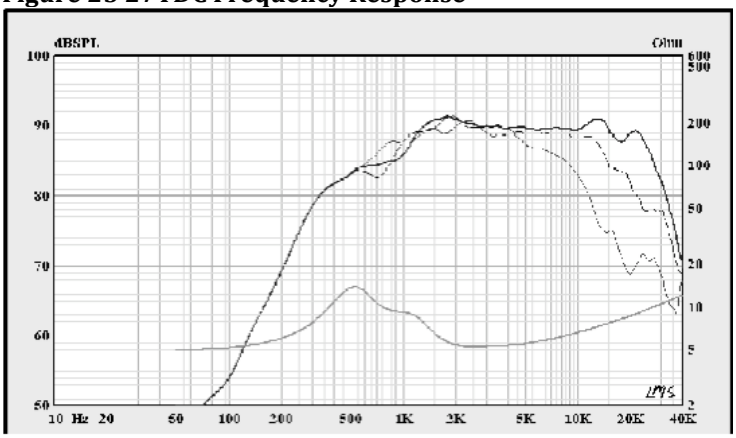
[26] "Seas Prestige Passive Radiators." 2009. Madisound. Internet; accessed 12 February 2010.

[27] Holland, Keith and Newell, Philip. *Loudspeakers: For Music Recording and Reproduction*. 81.

Tweeters I Looked at

Seas 27TDC

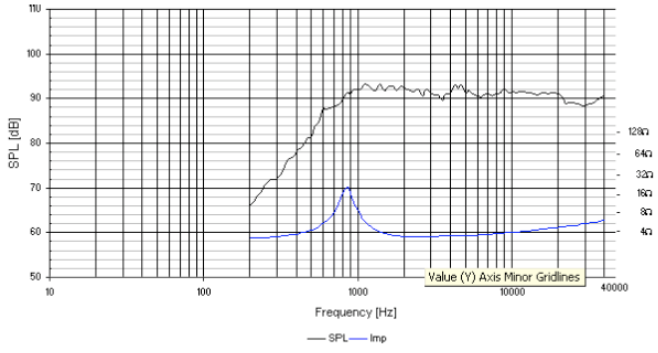
Figure 25 27TDC Frequency Response[28]



I looked at Seas tweeters first, because it was the same brand as my passive radiators. It gave me a place to start. I saw this particular tweeter because of its price—in the middle of my price range—and because of its fairly wide, and relatively flat frequency response. The frequency rolls off at 25kHz, which is higher than the range of human hearing.

Vifa XT25SC90-04

Figure 26 XT25SC90-04[29]



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[28] "Seas Prestige 27TDC (H1149) Textile Dome". 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=791 . Internet. Accessed 21 February 2010.

[29] "Vifa XT25SC90-04 Ring Radiator Tweeter" 2009. Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=1679 . Internet. Accessed 21 February 2010.

I had not heard of a ring radiator tweeter before, so I wanted to check this one out to see what it was. It had a smooth frequency response, and a relatively inexpensive price. One thing that threw me off was the looks. The dome sticks out abnormally far and looks awkward. Also, since I am going to be sitting so close to the driver, would this affect my listening clarity?

Fountek NeoCd1.0

Figure 27 NeoCd1.0 Frequency Response[30]

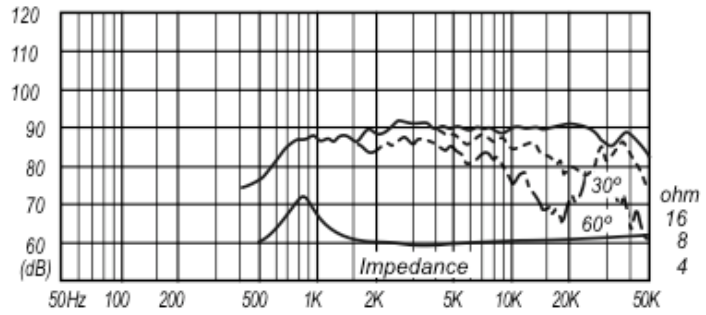
After experiencing ribbon tweeters in the Rozsa Recording studio, I already knew the quality of ribbon tweeters. These were the only ones that were in my price range. It has a solid frequency response—flat up until 20kHz, but the sound dB starts to drop at that point too.

[30] "Fountek NeoCd1.0 1.5" Ribbon Tweeter". Madisound. Available from http://www.madisound.com/catalog/product_info.php?cPath=45_229_236&products_id=8190 . Internet. Accessed 21 February 2010.

Tweeters that I am Considering

Fostex FT28D

Figure 28 FT28D Frequency Response[31]



This tweeter is at the higher end of my price range, but it has a flat frequency response up to 25kHz, but continues on until 50kHz. The felt ring on the tweeter was an interesting notion, and the squared off bevel would make it easier to get the driver and woofer closer together, which makes for a better system frequency response.[32] What made this driver less of a contender was the dropping off of the frequency before the crossover frequency (1kHz).

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[31] "Fostex FT28D 28 mm Dome Tweeter." Madisound. Available from http://www.madisound.com/catalog/product_info.php?products_id=1736 . Internet. Accessed 12 February 2010.

[32] Dickason. Audio Amateur Press, 2005. 106.

SB Acoustics SB29RDCN-C000-4

Figure 29 SB29RDCN-C000-4 Frequency Response[33]

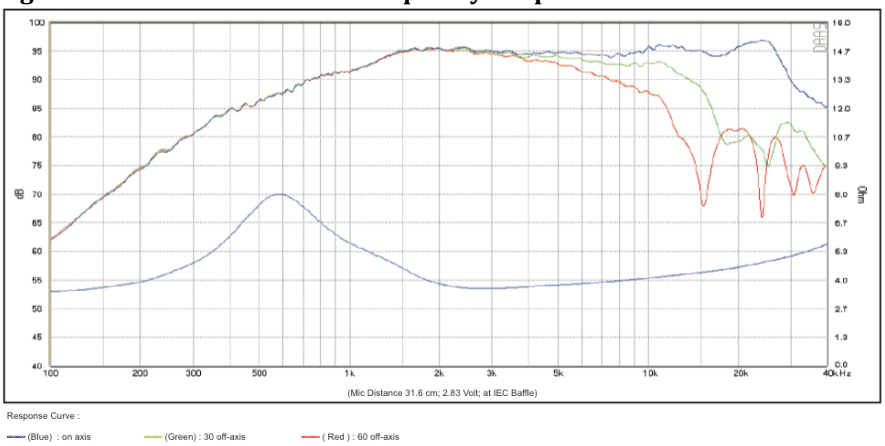

Figure 30 SB Acoustics SB29RDCN-C000-4

The SB Acoustic SB29RDCN-C000-4 ring radiator tweeter has a beautifully smooth, but natural—as shown by the slight dips and peaks—frequency response. The frequency response extends to almost 30kHz before dropping, and has a natural 1st order acoustic crossover built in. It was the best price for its frequency response compared to all the other tweeters I looked at.

Crossover Design

My plan for my crossovers is to create a 1-2dB dip at 2-3kHz, because this is where the majority of conversation frequencies take place.[34] This is called British tuning. This is where the important consonant syllables for film take place. When I mix with this particular frequency curve it will cause me to boost the syllables just enough to guarantee their clarity over the background music and sound effects.

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[33] "SB Acoustics SB29RDCN-C000-4 Neo Magnet, Ring Dome." Madisound. Available from http://www.madisound.com/catalog/product_info.php?manufacturers_id=147&products_id=8664. Internet. Accessed 12 February 2010.

[34] Howard and Angus. Focal Press, 2001. 80.

To maintain a relatively flat frequency response in my overall system I plan on having a 3rd order crossover. This means that the roll off for both the tweeter and the woofer is -18dB per octave (doubling of frequency).[35] In particular this deals with the bleed between the woofer and the tweeter, so the higher the order of crossover the less bleed between the two drivers.[36] My system is a 2-way crossover system because I have two drivers; a passive radiator is more like a vent than an extra driver, because it augments the bass of the woofer's frequency response it does not have its own separate output.[37]

The baffle step is the frequency when the width of the baffle is wide enough to reflect the sound waves in half space, effectively doubling their volume (mainly occurs in the woofer. The Baffle step or diffraction loss equation is: f(3) = 380/W(b). Where f(3) is the -3dB loss from diffraction and W(b) is the width of the baffle in feet. With the dimensions that I chose W(b) = 0.455ft.[38] Based on this equation the baffle step at 835.164 Hz.[39]

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[35] Murphy. True Audio, 1998. 10.

[36] Burnett, John Lenard. "Crossover Basics" Lenard Audio Institute Available from http://www.lenardaudio.com/education/06_x-over.html . Internet accessed 29 January 2010

[37] Dickason. Audio Amateur Press, 2005. 85.

[38] Murphy, John. *Introduction to Loudspeaker Design*. True Audio, 1998. 73.

[39] Murphy, John. *Loudspeaker Diffraction Loss and Compensation*. True Audio, 2007. retrieved Jan 22, 2009 from http://trueaudio.com/st_diff1.htm

Crossover Designs Integrated with Driver Choices

Crossover Plan 1: SB Acoustics SB29RDCN-C000-4 and Fountek FW 146

These two particular drivers are my favorites out of all of the ones I looked at. The woofer (Fountek FW146) is an inch smaller than the FW168, but with a lower bass roll-off. The one anticipated problem I see with it is the extra resonance (from the aluminum of the cone) 7kHz – 10kHz. I plan on fixing this with my baffle step compensation. The tweeter I ended up deciding on has a naturally smooth frequency response with extended highs (up to 40kHz, an octave above the range of human hearing). Its "low" frequency roll-off starts at 2kHz, which will help my British tuning plan. This roll-off is a 1st order acoustic roll off; it is acoustic, because it occurs naturally from the driver, and it is a 1st order because the roll off occurs at a rate of -6dB per octave.[40] So in order to achieve a 3rd order roll off, I only need a 2nd order electrical crossover for my tweeter. This crossover occurs at 2kHz in order to help with the tweeter's power handling, and to use the acoustic crossover to its maximum potential.

[40] Burnett. "Crossover Basics" Lenard Audio Institute. Internet accessed 29 January 2010.

Figure 31 Plotted Crossover

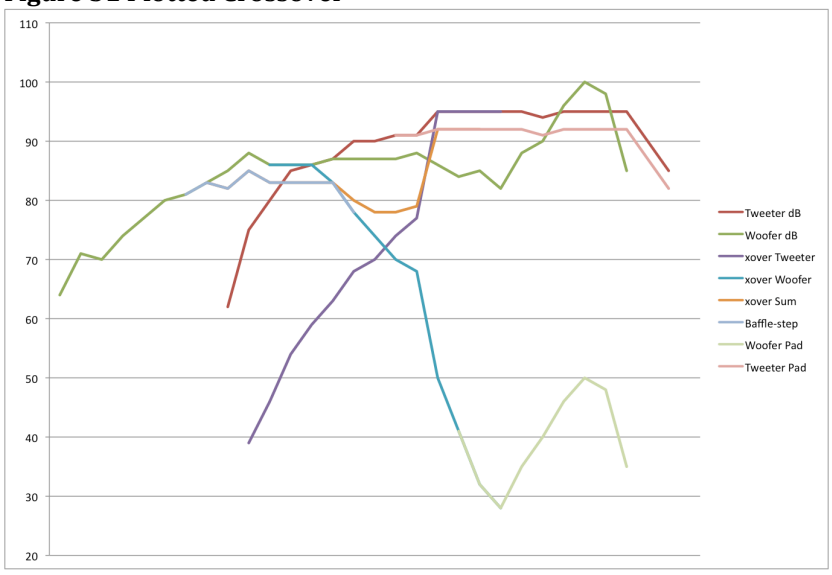
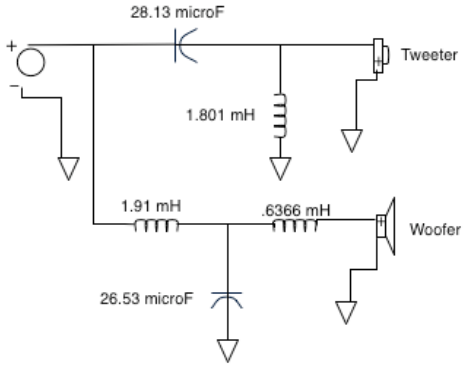


Figure 32 Entire Crossover Schematic



Crossover Plan 2: Fostex FT28D and Fountek FW 168

The FW168 is a 6.5” driver and has a fairly smooth and wide frequency response, but it lacks the extended bass response of the smaller woofer. The one anticipated problem I see with it is the extra resonance (from the aluminum of the cone) 6kHz – 9kHz. I plan on fixing this with my baffle step compensation. The Fostex FT28D tweeter has a slight “low” frequency roll-off (especially in comparison to the SB acoustics tweeter), which means that it will be more difficult to predict its acoustical roll-off order. With this design I am going to have both the woofer and the tweeter’s crossover be a 3rd order electrical crossover.

Figure 33 Plotted Crossover

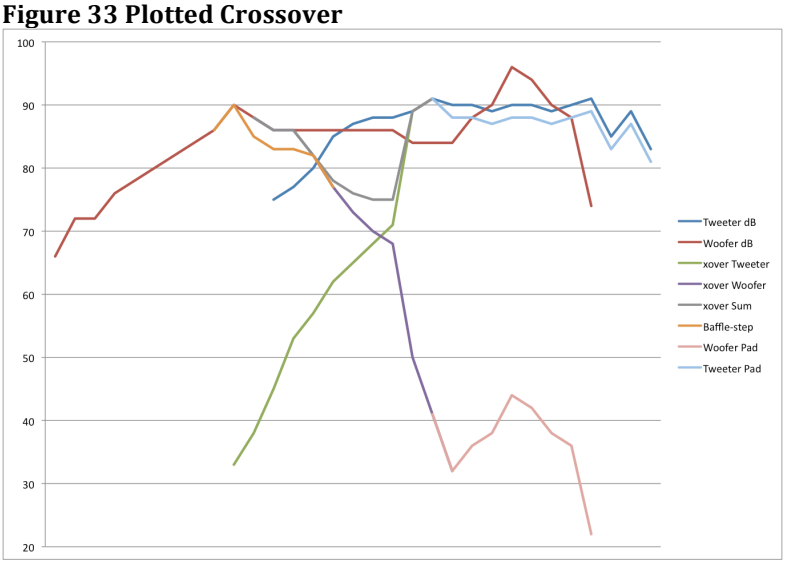
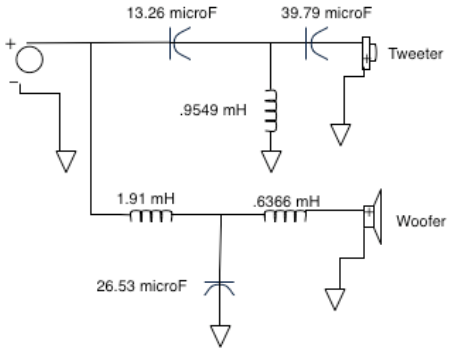


Figure 34 Entire Crossover Schematic



Design Logistics

Overall I feel that the goal for my speaker system is going to be met. The tweeter I chose had a higher sensitivity than I needed, but it did not degrade the frequency response of my system (rather it was better than I expected). The woofer, for its size and price has a fairly low frequency response, even without the help of the passive radiators. The total cost for the drivers I chose were $250, which is below my expected budget for drivers ($300). The crossover components are expected to be around $100, which will bring the total cost of the speakers to be around $400 - $350. The size of the cabinet will be kept small, but large enough to properly house the woofer. Since I am not designing for maximum amplitude, the overall design should fit reasonably in my design expectations.

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12. Murphy, John. *Loudspeaker Diffraction Loss and Compensation*. True Audio, 2007. retrieved Jan 22, 2009 from http://trueaudio.com/st_diff1.htm.