Design Proposal

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2/19/12

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Introduction

Designing speakers is a battle of the minds. This battle can prove to be long and drawn out but when you reach the end it is very rewarding. There are so many different designs that can be implemented it is very challenging to select something and stick with it. As I have found out you can have a design and then see another design and immediately want to incorporate or change to the new design. I relate it to a kid in a candy store. The kid has his eye set on a jaw breaker going in but when all is said and done he walks out with a giant gummy bear. As long as the end product fully satisfies what you want it to than you have completed the mission.

Design Goals

My design for these speakers is to create a pair of speakers that will be the start of a home theater system. The speakers are going to be used by me and in my spaces therefore all of my decisions will be made in order to satisfy my personal preferences. In my home theater system I want to make sure that I have god off axis response because not everyone is in the sweet spot, full range of frequency as well as high SPL capabilities.

I will also be using the speakers to play music, watch television as well as do some final listening on. There for the speakers must have an enjoyable relaxing sound. I don't want anything harsh or too forward. I also will be making the sound space seem as large as possible. I am looking for the bandwidth of the speakers to extend throughout the audible frequency range and be as flat of a response as possible.

In order to reach my sound pressure level(SPL) preferences I will be using multiple drivers. In order to meet my preferences I will need to select quality drivers as well as make good design decisions. I also will be working to get my low frequency extension as low as possible as well as keeping the transient response as tight as possible.

Other than making them sound good and stay within my budget I am able to put them anywhere so the problem of size and weight is not a foreseen problem. When designing my speakers I have my present living room space in mind which is a standard square living room, which I feel that future living space will be very similar to. My listening positions very a lot from the couch to my other two reclining chairs. This is because of how many people are in the room as well as what kind of chair I want to sit in that day.

Therefore my design must also have great off axis response to get the sound accurately to all of the listening positions.

Listening Environment

Currently I am in an apartment that has a living room with the rough dimensions of 16' wide and 20' deep. This space seems to be very happy medium between many different living rooms that I have seen in the past. For this reason I will be designing my speakers for this room and making adjustments to what ever the room size and shape are in the future.

Currently my sitting space is about 10' from my television. This is the furthest that I want to be from my current TV. I have a few chairs closer that are about 7' from the TV and these are about as close as I like to get to the TV. Everything for my speakers is in relationship to the TV because of my home theater design and the speakers will be flush with the front of the TV.

My current Listening height moves from 3' off the ground to about 6' depending on standing, sitting position and sitting style, slouching, laying and sitting up straight. The way that my speakers will be mounted I will be able to focus them in on my listening heights but I do need them to cover a 3' horizontal plain very effectively.

Bandwidth

These speakers will be used to watch many movies and listen to a lot of music so the frequency bandwidth is very important. I need to be able to cover the entire audible frequency range with accuracy. This translates into +/- 3dB from 40Hz to 20kHz. I will also be looking to get a small bump in the low end at 40-80Hz. The reason for this is because I enjoy a little more low end in the system. I feel that especially in movies it adds more life to the film.

Media	Time	SPL
Television	Anytime	70dB
Movies	Night	85-90dB
Music	Morning	70dB
Music	Afternoon	78dB
Music	Night	90dB

SPL Relationships

I will be using the speakers for my personal home theater so I am looking at my personal

SPL preferences. When watching movies I do have them up quite loud in order to get the sound that I want. As far as Television and music goes I do have them on lightly in the back ground during the day. Further into the day I do enjoy turning up the music while I do other things. All of these measurements were taken from my room mate Dan Bluhms speakers, 2.1 system feeding from an Onkyo receiver.

Doing the SPL preference sheet has made me aware that I will need to use a three way system in order to get my frequency extension as well as SPL preferences. If I were to use a two way system I would over work the drivers and possibly blow them during a long intense move.

Size

The size of my speakers is not a restriction. The size of my speakers will be determined by visual esthetics as well as what volumes each box must have. Because of my decision to do a three way design I will need to build a larger size system. The maximum size that I would go with is about five feet tall because they still must be able to move as well as look proportional to my TV.

I also concerned about the weight of the system because I will be hanging it I can't build a system that weighs 500lbs per box because that would effect how much framing or added strength I will need to add to my hanging points. Another reason for looking at the weight is because I will be moving a few more times in my life. So I don't want something that I need to get a crew of guys just to get out of my living space.

Visual Aesthetics

My speaker will be in the living room so they need to be a focal point and and accent to the room. The first thing that will accomplish this is them hanging. I haven't seen anyone rig their speakers from the ceiling before. The second visual cue is the box design. For this I am using a line array as my inspiration. Each box will consist of 3 panels each at a two degree angle. With the three way design I will also have a sub box which will look identical and have the same sides as the other boxes.

The third visual part is the finish. For the boxes I will be doing a satin black with a satin clear coat over to help with protection. The sides will be made out of 1" rough sawn maple. This will add a warm feeling of the raw wood but will also brighten the sides up to contrast the black centers. This maple will be sprayed with many coats of high gloss lacquer to make the sides pop.

Evaluation Criteria

To evaluate my speakers I will be using a three different systems. The first will be to use FuzzMeasure. With this system I will be able to get my system within my frequency range that I am trying to achieve. Second I will be using my peers and a test cd with songs that everyone knows. This will give me other peoples feed back on how they sound playing music which will help in my determination of dampening materials. The third and final evaluation will be me listening to them and adjusting things till they are how I like them.

Driver Selection

During my driver selection I was looking for many things that the individual drivers could deliver. First was a fairly flat frequency response this is very important in order to get my +/- 3dB over the audible frequency range. Second was sensitivity, it was important to me to have a higher sensitivity driver in order to reach my SPL preferences with less work which results in a smaller amp. The third component that each driver needed to deliver is a fair price. In order for me to stay within my budget I split my drivers into the three sections of subwoofer, midrange and tweeter and then assigned them amounts that I was willing to put into those drivers. Finally I looked at the company producing them as well as the product reviews. The drivers can look great on paper but without being able to test them in any way I need to be sure that I am getting what the spec sheet says.

Subwoofer

The subwoofer is the base of my system. The most important thing to me in a subwoofer is the transient response. Because there is so much moving mass I wanted to make sure that I can get a big, solid, and crisp low end. This is what bothers me the most, if there is a notice tight kick drum but the subwoofer just muddies up the sound.

Woofers	Sensitivity	X-Max	Qts	VAS	Size	Fs	Price
Morel UW1258 Ultimate	87dB	12.5mm	0.43	138.38	12”	21Hz	$499.60
Peerless 830452 XLS	83.2dB	12.5mm	0.23	66.903	10”	22Hz	$194.20
SB Acoustics SB34SWNRX	88dB	11mm	0.33	183	12”	18Hz	$188.30
Eminence Definimax 4012HO	94dB	6.2mm	0.35	59.4	12”	46Hz	$199.99
Peerless SLS 830668	88.1dB	8.25mm	0.59	75.71	10”	32.64Hz	$73.95
Seas Prestige A26RE4	89dB	8mm	0.41	161	10”	25Hz	$138.65
Dayton Audio TIT320-4	89dB	18.7mm	0.45	64.28	12”	25Hz	$167.35

Dayton Audio RSS315HF-4	86dB	14.3mm	0.49	84.95	12”	25HZ	$149.29
Peerless 8305000	90.6dB	12.5mm	0.20	139.04	12”	18.1Hz	$190.93
TC Sounds Epic DVC	**86.6dB**	**22.9mm**	**0.39**	**91.18**	**12”**	**24Hz**	**$169.00**

I have five different subs that are ranked from lowest to highest:

1. TC Sounds Epic DVC 12”
2. Peerless 8305000 12”
3. Dayton Audio TIT320-4 12”
4. Eminence Definimax 4012HO

The sub that I have decided on is the TC Sounds Epic. There were many reasons for choosing this driver. The first is the good transient response. Second I used the chart above to compare all of the drivers. From the chart I was able to look at how each driver compared with the others. All of the drivers were very good and well matched. What it came down to off the chart was the X-Max, Fs, and VAS. All of these fit my design perfectly.

For more info I read the reviews. The reviews were very helpful because there wasn't anything bad that was said about the speakers at all. The one part of the reviews that helped was that people have pushed the driver to high SPL’s and it is still clean. Even though most of the reviewers we hobbyists and amateurs they were still able to give good feedback about the quality and some performance aspects that are not in the spec sheet or information provided from the manufacture. [1]

To power these speakers I will be using Dayton Audio 300 watt plate amps. These will be able to provide plenty of power to get the speakers to reach levels that I will be happy with. Because there are dual voice coils per driver I will be experimenting with which will give me better performance either the parallel or series hook up. Some other aspects that I will be implementing with this driver is it will not be flush mounted. The reason for this is because the speaker frame is so deep there wouldn't be enough wood to attach it to.

The other speakers that I had in my top five are great subs but just didn’t seem to fit in my system. Wether it was cost, size or how it was reviewed the TC Sounds just seemed to hit good marks in all the places that I was looking for it to.

Midrange

For my midrange I am implementing a vertical Mid-Tweeter-Mid(MTM) design, so I will be using two of the midrange drivers. This will allow me to get more SPL without having

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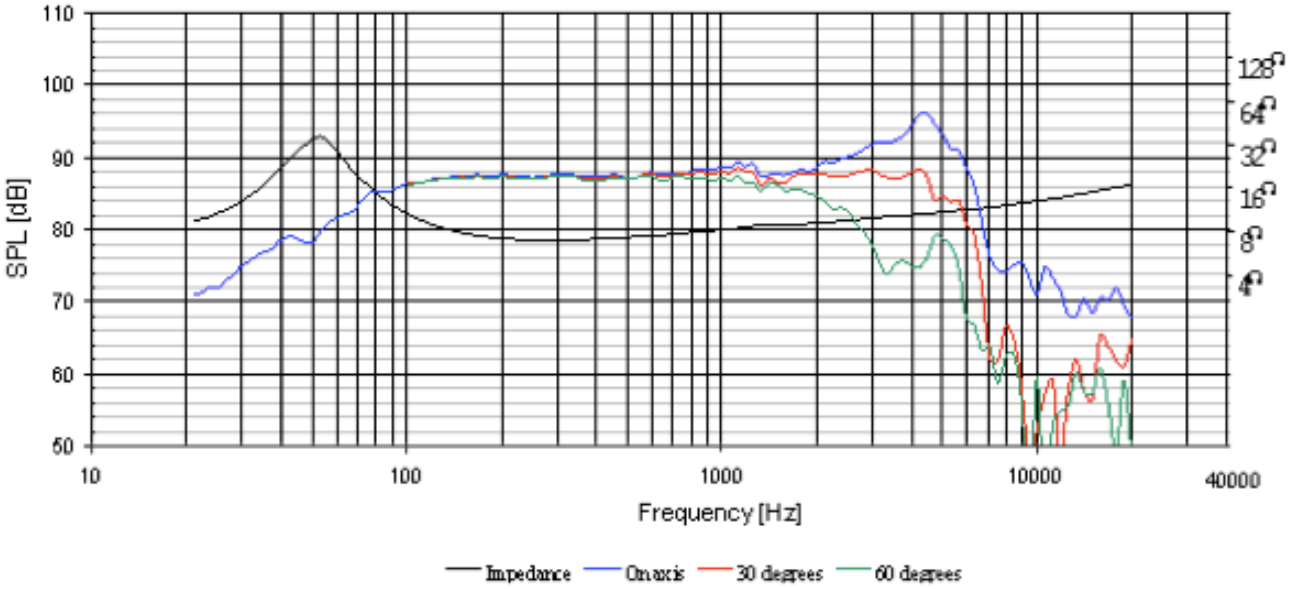
[1] TC Sounds Epic 12” DVC Subwoofer, Accessed 1/25/12 http://www.parts-express.com/pe/showdetl.cfm?Partnumber=293-650

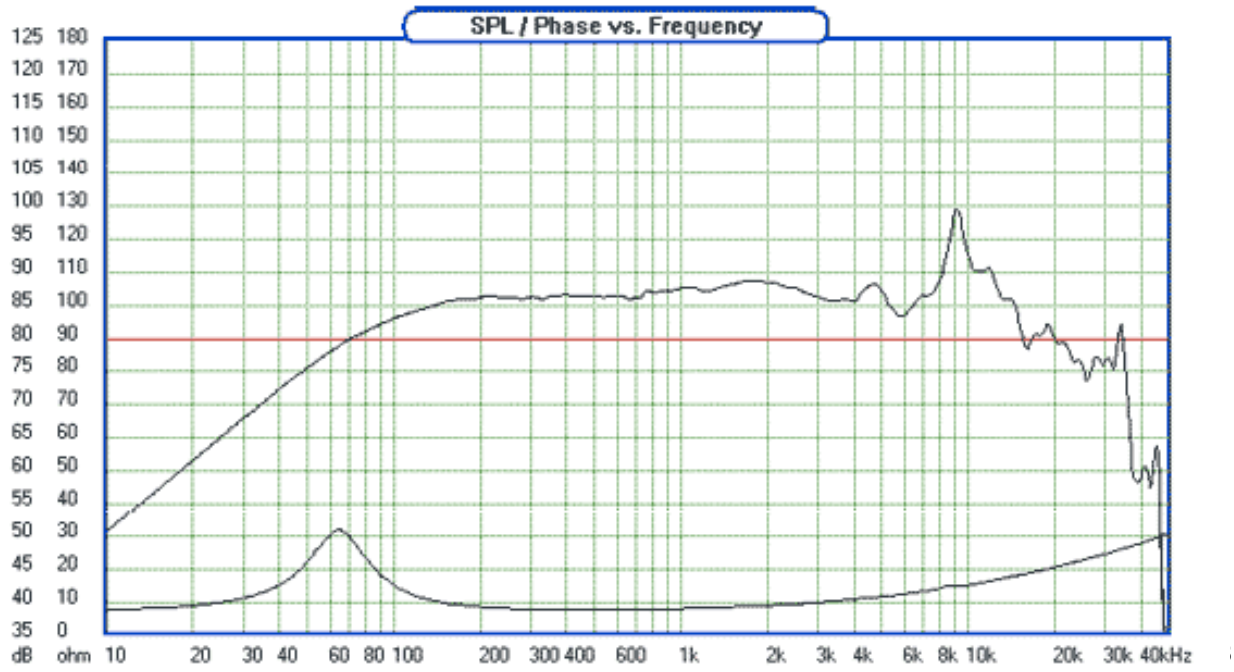
to take sensitivity into a decision making or breaking problem. But because I am using four drivers the cost will become a large factor. In looking at drivers I am looking at many different sizes as well as prices to get an idea of what I will be able to get. My top five choices came from the size range of 5.25” to 6.5”. These drivers also were able to reach a fairly low frequency.

Here are the drivers ranked in order from first to last:

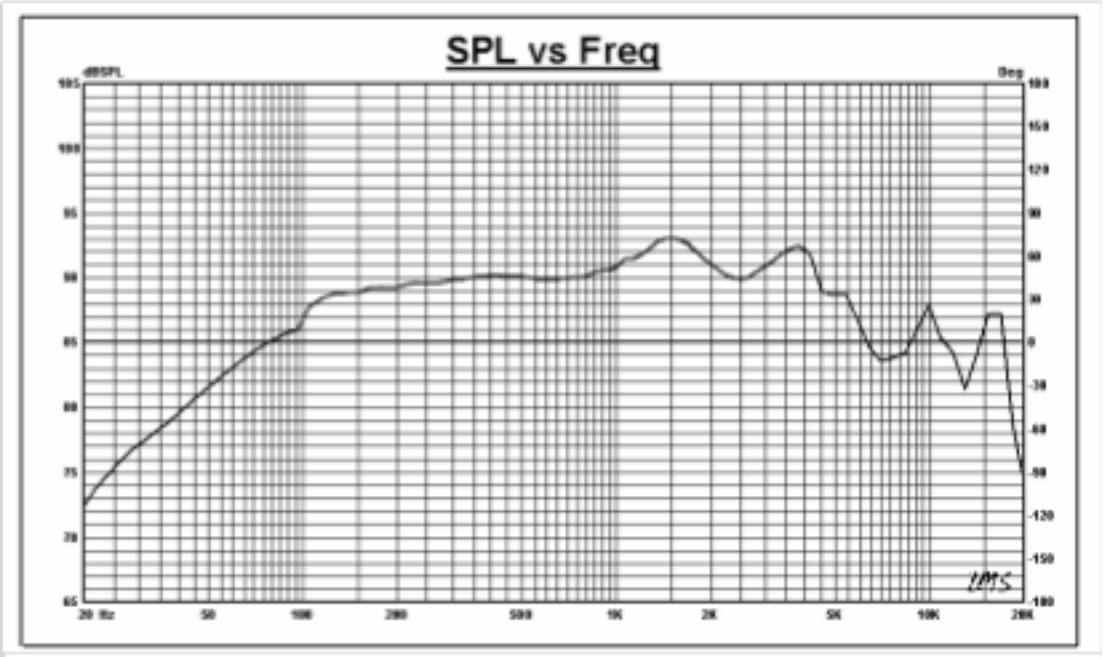
1. Peerless HDS 830883



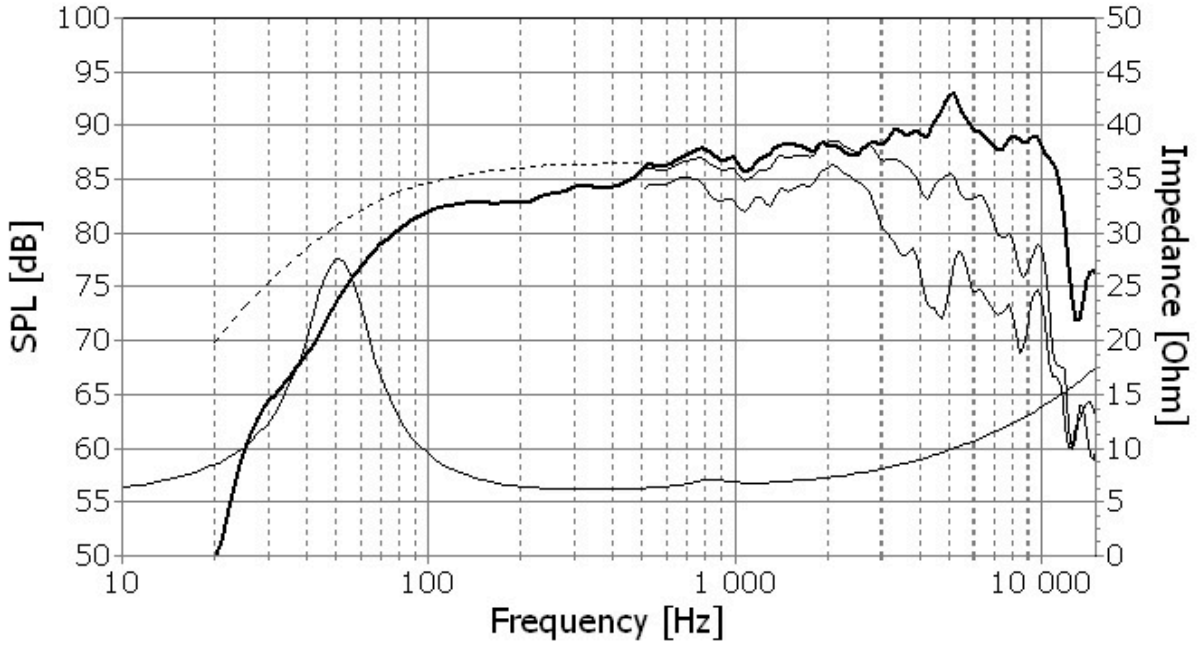
2. Zaph Audio ZA14W08



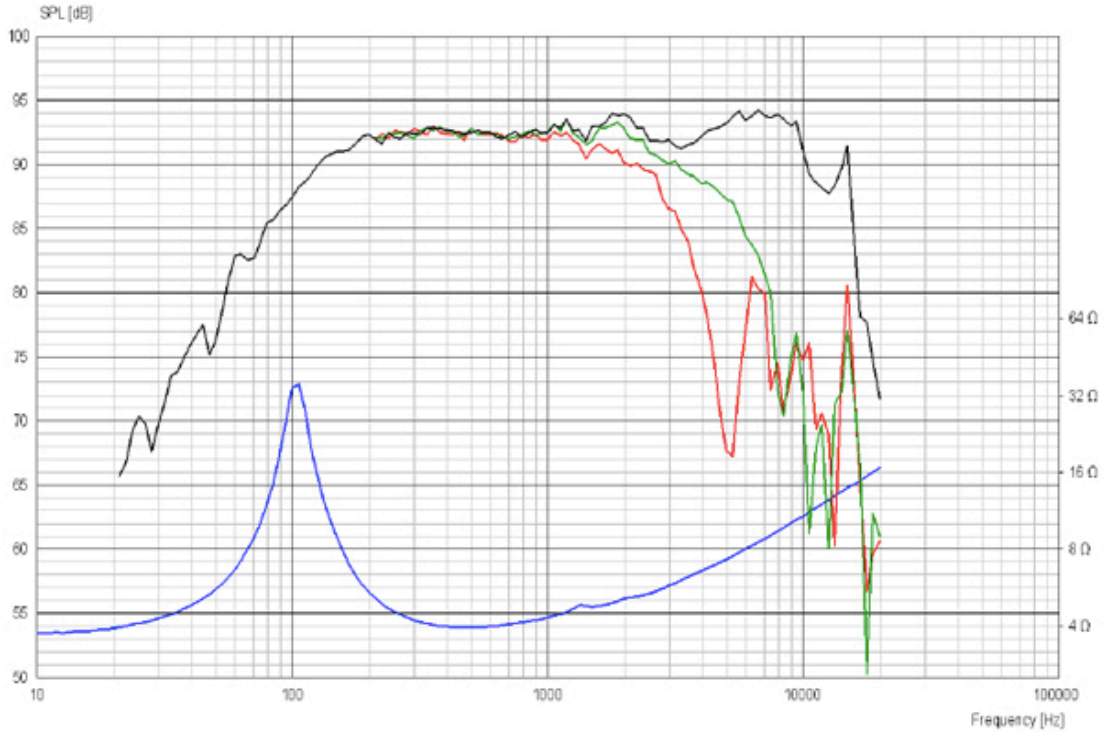
3. Aurum Cantus AC120/50CK



4. Seas Excel W15LY-001 (H1141)



5. ScanSpeak 15M/4624G Discovery



Mid Ranges	Sensitivity	X-Max	Qts	VAS	Size	Fs	Price
Peerless HDS 830883	**87.5dB**	**5.5mm**	**0.43**	**13**	**6.5”**	**52.3Hz**	**$68.50**
Wavecor W120BD04	86dB		0.45	4.25	4.75”	71.5Hz	$102.00
Aurum Cantus AC120	90dB	6mm	0.18	11.89	5”	43Hz	$84.05
Seas Excel W15LY-001	86.5dB	10mm	0.45	12	5.5”	49Hz	$156.55
Eaton 5-200/A8	88dB		0.37	7.81	5”	54Hz	$154.85
Seas Prestige L15RLY/P	86dB	10mm	0.35	12	5.5”	44Hz	$78.25
Zaph Audio ZA14W08	87dB	6.5mm	0.44	5.23	5”	65.8Hz	$39.95
ScanSpeak 15M/4624G	92.4dB	1.5mm	0.43	3.7	5.25”	100Hz	$71.20
ScanSpeak Discovery 10F	86.6dB	2.6mm	0.37	2.1	4”	90Hz	$100.95
ScanSpeak 15M/4531K	90dB	3mm	0.23	23.8	5.5”	35Hz	$223.80
Tang Bang W5-1685	86dB		0.46	12.74	5”	50Hz	$65.70
SB Acoustics SB17MFC35-8	88dB	5.5mm	0.37	38	6”	33Hz	$65.05

I have chosen the Peerless. This driver fits my design perfectly. After reviewing the frequency response graph it seems that the speakers is very flat from 100Hz to 2kHz. This will work very well because I am planning on putting my crossover at 2kHz. I feel that this is a good point to cross over so that I can use a 2nd order and fall enough to get the break up lower than audible level. The second reason for this choice is the cost. This driver is only $68.50 which puts it in my price range. The third reason is that the

box size. Madisound recommends a vented box of .35 cubic feet. This is very good because my current box volume is just under 2 cubic feet. [2]

This was a hard decision to make. The other drivers brought a lot of the things that I was looking for. The first driver that I eliminated was the ScanSpeak. This driver was in my top five because of the brand and reputation I also like the driver because of the frequency response it is nice and flat and takes a natural roll off at 1.5kHz which I can put with my tweeter very nicely. But the reason that I didn't choose this driver is because it was the most expensive as well as its lower sensitivity which I want to match my tweeters sensitivity.

The second driver that I unlimited was the Seas Excel. The reason I eliminated this driver was because of the rising response from 2kHz up. This would make my spend more money on the crossover and possibly have more problems with summation.

The Aurum Cantus was the third driver out. This one came down to the peak at 1k on the frequency graph. If this one was the best one I could have dealt with the peak but I had better drivers so I was able to put it aside.

The final driver out was the Zaph Audio. This driver went out for two reasons. The first the Peerless had a better low frequency response. Second was the size I felt that the 5" would have more distortion on the low end when I drive the system without the sub woofer.

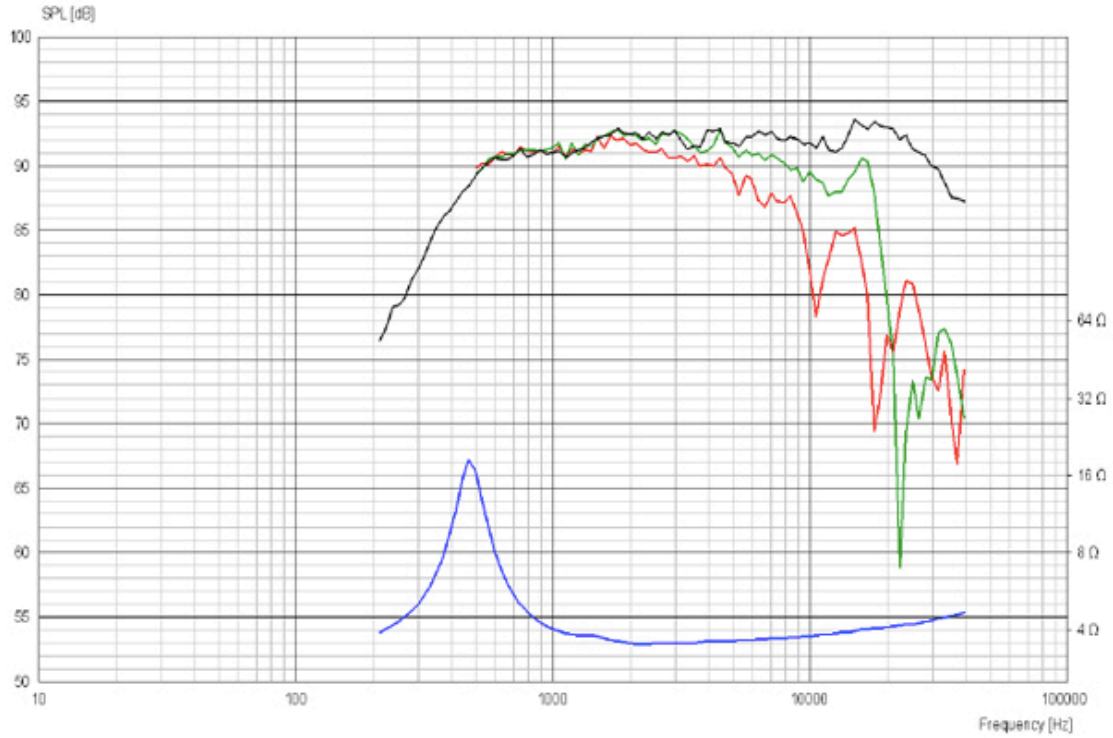
Tweeter

For my tweeters there was a lot of decisions to be made. Because the speakers are used for home theater I have decided not to go with a ribbon. Instead I have chosen to go with a soft dome tweeter. My decision for this driver came down to the sensitivity. I will need something with a sensitivity around 90dB in order to fulfill my SPL preferences. The second spec that I was looking at is the free air response. Finally it came down to recommendations from other students and what I have listened to.

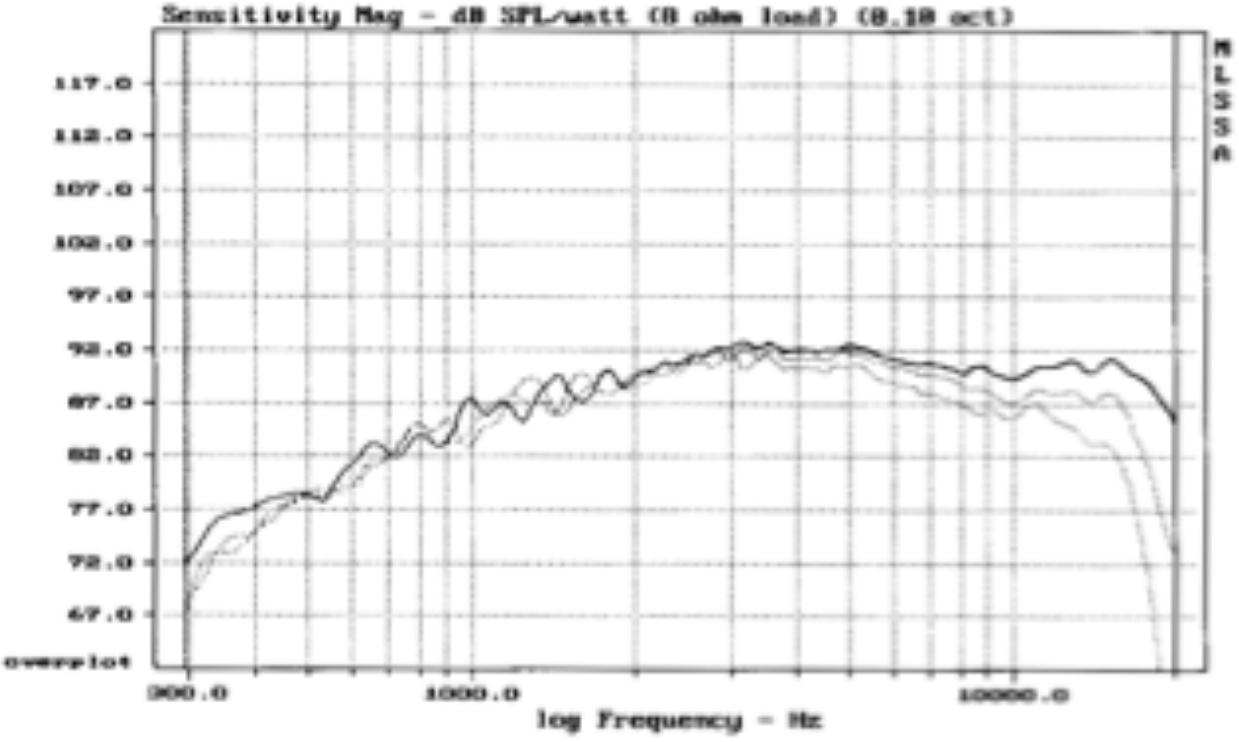
Here are my choices for a tweeter ranked in order from first to last:

[2] Peerless 830883 Spec Sheet Accessed 1/25/12 http://meniscusaudio.com/peerless-830883-p-497.html

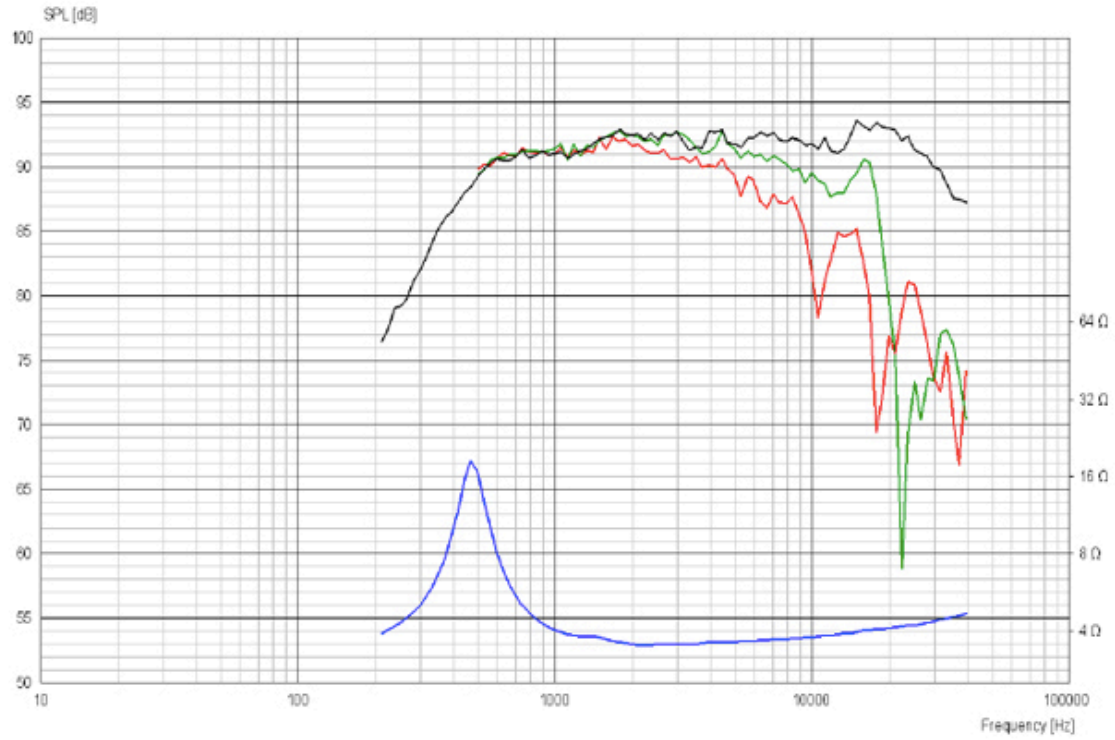
1. ScanSpeak Illuminator D3004/6600



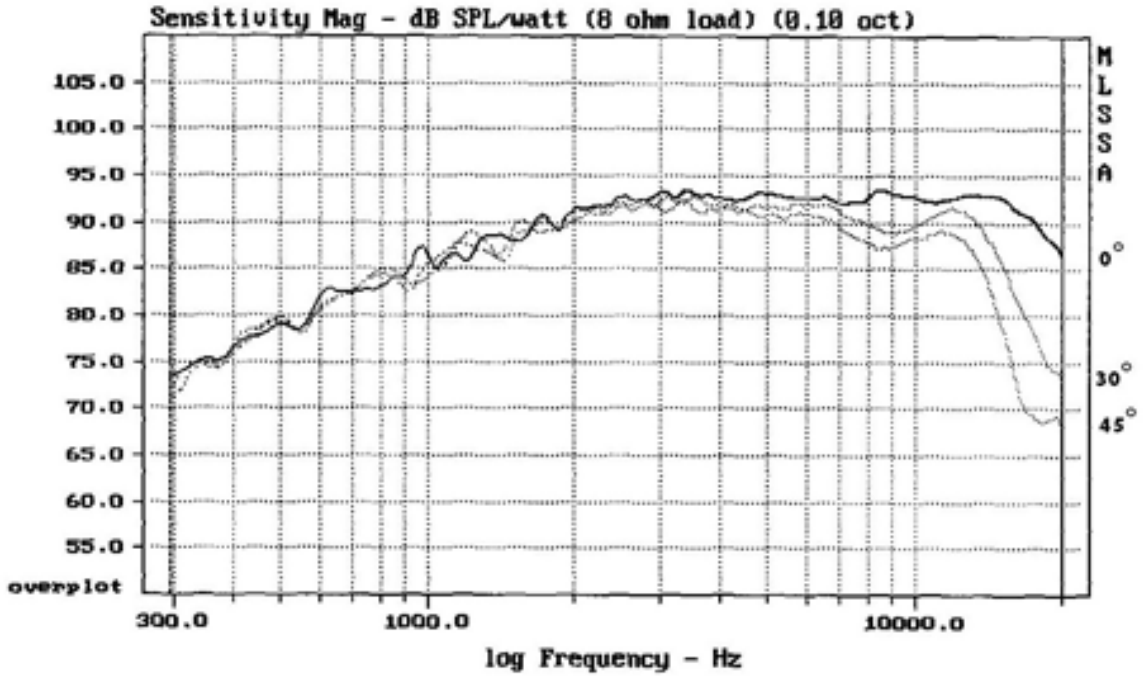
2. Morel Supreme 130



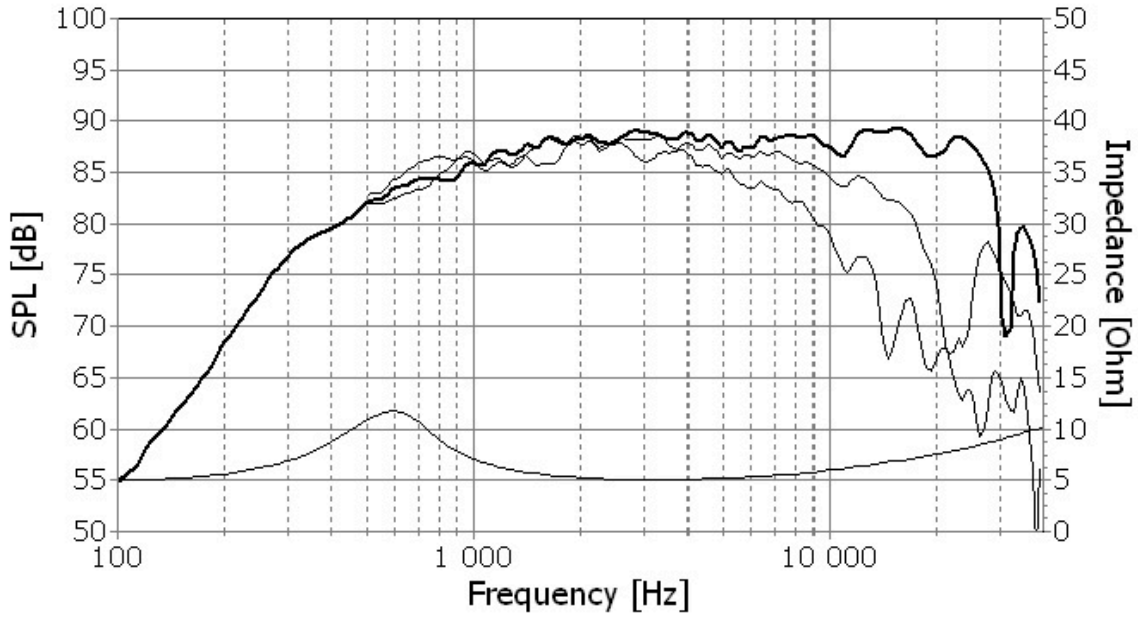
3. ScanSpeak Illuminator D3004/6620-001



4. Morel ST1048 Supreme



5. Seas Excel T25CF-002



Tweeters	Sensitivity	Size	F3	Fs	Price
Fostex T250D	89dB	.98”	900Hz		$199.90
Seas Excel T25CF-002	89dB	1”	1000Hz	500Hz	$232.10
ScanSpeak Illuminator D3004	**91.5dB**	**1”**	**400Hz**	**470Hz**	**$212.95**
Morel MDT 30S	90dB	1.125”	1200Hz	650Hz	$70.50
Morel Supreme 130	91.5dB	1.125”	2000Hz	680Hz	$278.87
Seas Prestige H1318	92dB	1”	900Hz	950Hz	$44.00
ScanSpeak Illuminator 6620	90.4dB	1”	600Hz	520Hz	$271.35
ScanSpeak Discovery R2604	90dB	1”	500Hz	500Hz	$54.45
ScanSpeak Discovery D2606	91.4dB	1”	900Hz	1100Hz	$36.65
Morel ST1048 Supreme	91.5dB	1.125”	1500Hz	680Hz	$246.80

I have chosen the ScanSpeak Illuminator over the Morel Supreme based on Christopher's recommendations. The first reason for this choice is the reputation of these drivers. Because I have heard them before I know what I am getting and I do enjoy listening to them. The second reason is the sensitivity is 91.5dB which is very high and allows me to reach my SPL preferences very easily. The third reason is the super low Fs which is 470Hz. This allows me to move my crossover point anywhere from 1.5kHz to 3 or 4kHz. I will be putting the crossover at 2kHz which will work very well with my midranges as well as the entire system. Finally the price, these are the most

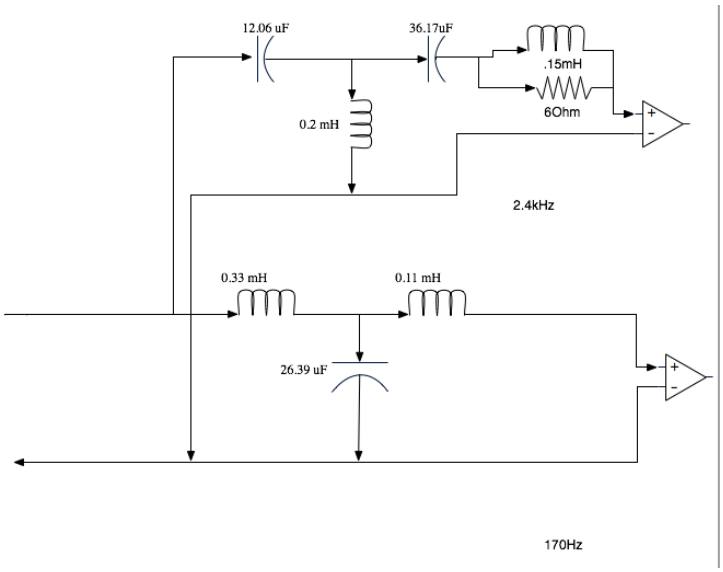
expensive drivers out of the entire system but I think that they carry the entire system load and without a good tweeter you loose so much sound quality. [3][4]

My entire decision to not go with the other tweeters came down to the fact that I have listened to the ScanSpeak Illuminator in my room mates system for the year and I love it. So it was hard to go against a tweeter that I know, love and can afford

Crossover Design

My crossover design is fairly simple. By Sub is an active crossover build into the plate amp that I will be using. For my crossover on the low side of the midrange I am going to use a 1st order crossover starting at 180Hz. This will work with the natural roll of of the driver. For the high side I will be crossing over a 2.2kHz. At this point I have put in a 3rd order Butterworth crossover to move into my tweeter. On my tweeter my crossover will be a third order Butterworth as well.

After doing testing I ended with a high self on my tweeter at 12kHz in order to knock down a large bump that was caused my my tweeter. I also ended up adding a 2dB L-Pad to my mid range driver to get them down to the tweeters level. Other than that there was a lot op playing with the plate amp knobs in order to get it to crossover in the right places.



[3] ScanSpeak Illuminator D3004/6620-00 1" Tweeter Black Pace Plate, Accessed 1/24/12 http://www.madisoundspeakerstore.com/scanspeak-soft-dome-tweeters/scanspeak-illuminator-d3004/6600-aircirc-tweeter-textile-dome/

[4] Christopher Plummer, Personal Meeting 2/5/12

Cabinet Construction

My cabinet construction is very complicated, regarding the design and how things fit together. As for the materials and how things stack up it is very simple. The speakers will be separated into two different boxes. The first contains my two midrange and single tweeter drivers. These will be set up in an MTM pair vertically. Between each driver there will be a four degree angle that sets up the look of a speaker array or curve. This will help get the tweeter out in front of the midrange drivers.

The second cabinet contains the subwoofer. The baffle for this cabinet is on solid sheet with no angle cuts in it so that the entire driver will be able to fit on it. Because the Sub has such a thick mounting ring I will not be able to flush mount it. The rear panel will also be flat to incorporate the plate amp that needs to go on the back.

The speakers will be build with 1/2" Birch, 3/4" MDF, Mass Loaded Vinyl, Hard Board, and rough sawn maple. All of these are ver solid and very heavy which helps box resonance.[5]

Bracing

In my cabinets I will be using a lot of bracing. The reason for this is to strengthen the structure of the box. The first box is my mid and tweeter box. This box will have three I shaped braces that go across the back to each side and along the side to the front. These will help link the back to the front. They will be staggered so one will run top right the next middle left and the third will run the bottom right. The design of the braces comes from the thought to do a brace that goes all the way around but I feel that it isn't need to go all the way around if I use more than one.

My second box is the Sub woofer enclosure. The design for this bracing has a bigger job than just bracing the box together. It is also used to help support the massive voice coil on my subwoofers. There is a circular piece cut out of the middle of it to slide the voice coil in and rest on. Around that there are legs that shoot out to the top, bottom and both sides bracing all the sides to the coil and to each other. I think that this will strengthen the box as well as provide support for the coil helping to relive it from my baffle.[6]

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[5] "Wood Selections" A-MAX Hardwood. 2009. Web 16 Jan. 2012 http://www.a-maxhardwood.com/images/woods/rough_sawn_oak_oil.jpg

[6] Philip Newel and Keith Holland, Loudspeakers for Music Recording and Reproduction (Oxford: Elzevier 2007) pg 87

Dampening

My boxes are slightly larger than needed so I will be using a lot of dampening material. For this I will be using the recycled cotton batting. The reason for using this is because of the of the absorption qualities. It is a soft moldable product that also carries weight which helps absorb sound. You are also able to touch this product and work with it without gloves making it great if you have to go in and out of the speaker cabinets like I will need to be able to do.

Another acoustical dampening idea that I will be implementing is a layer of mass loaded vinyl between my MDF and hardboard on the inside of my boxes. This has proven to help with box resonance. A final part of my design that will eliminate the coupling of the boxes and floor at low frequencies. I will be able to do this because I will be hanging the speakers and they will be able to vibrate in the free air.

Price

For this project I have a budget of $2,000 to purchase drivers, building materials as well as other odds and ends

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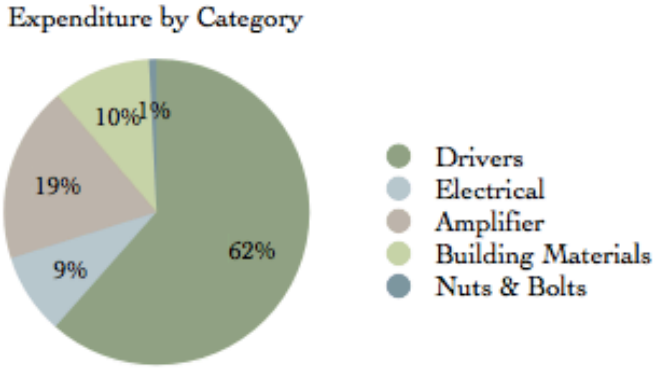

ACCOUNT CATEGORIES

Category	Amount	
Drivers	$	1,117.50
Electrical	$	156.41
Amplifier	$	339.00
Building Materials	$	189.40
Nuts & Bolts	$	14.53
Total	$	1,816.84

TRANSACTIONS

Dealer	Date	Description	Category	Amount	Balance
Madisound	2/7/12	Mid Range	Drivers	$ 314.20	$ 314.20
Madisound	2/7/12	Tweeters	Drivers	$ 465.30	$ 779.50
Parts Express	2/7/12	Sub Woofers	Drivers	$ 338.00	$ 1,117.50
Parts Express	2/7/12	Speakon Connectors	Electrical	$ 13.06	$ 1,130.56
Parts Express	2/7/12	Speaker Cable	Electrical	$ 112.40	$ 1,242.96
Parts Express	2/7/12	Plate Amps	Amplifier	$ 339.00	$ 1,581.96
Amazon	2/12/12	Swell Banana Plugs	Electrical	$ 30.95	$ 1,612.91
Amazon	2/12/12	Threaded Inserts	Nuts & Bolts	$ 8.53	$ 1,621.44
Amazon	2/12/12	Port Tube	Building Materials	$ 5.34	$ 1,626.78
Amazon	2/12/12	T-Nuts	Nuts & Bolts	$ 6.00	$ 1,632.78
Amazon	2/12/12	Magnets	Building Materials	$ 24.98	$ 1,657.76
Super Sound Co	2/12/12	Mass Loaded Vinyl	Building Materials	$ 31.64	$ 1,689.40
Menards	2/18/12	Birch Plywood	Building Materials	$ 75.94	$ 1,765.34
Menards	2/18/12	MDF	Building Materials	$ 37.00	$ 1,802.34
Menards	2/18/12	Hardboard	Building Materials	$ 14.50	$ 1,816.84

Bibliography

[1] TC Sounds Epic 12" DVC Subwoofer, Accessed 1/25/12 http://www.parts-express.com/pe/showdetl.cfm?Partnumber=293-650

[2] Peerless 830883 Spec Sheet Accessed 1/25/12 http://meniscusaudio.com/peerless-830883-p-497.html

[3] ScanSpeak Illuminator D3004/6620-00 1" Tweeter Black Pace Plate, Accessed 1/24/12 http://www.madisoundspeakerstore.com/scanspeak-soft-dome-tweeters/scanspeak-illuminator-d3004/6600-aircirc-tweeter-textile-dome/

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