Transducer Theory

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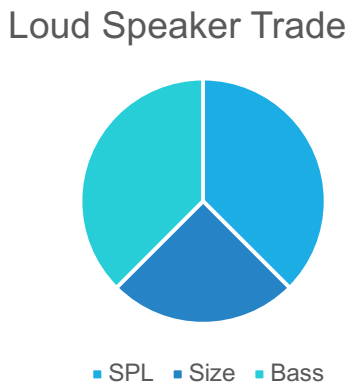
Functional Description

For my speakers, my main goal is to build stereo speakers that are flexible between higher quality mixing monitors and enjoyment home entertainment speakers. Part of my goal is to have the speakers easily moved from a position from standing on the floor around the television to on stands around a desk. The flexibility of them moving from an enjoyment setting, with a decent amount of background/ environment noise to a better controlled room is ideal.

Floor standing, or close to floor standing speakers seem like the most reasonable option, having the speakers be a little shorter when set on the ground then moving them to stands would be a great function of movement of a stereo pair of speakers. For the floor standing stereo speakers portability is a big factor, I would like to keep them relatively easy to move by those who help transport them from place to place when moving around for work. The room which they would be listened to the most will be a common living room, without any sort of acoustic treatment, and will change from location to location, so the room might be super lively so having the ability to adjust between rooms would be a great advantage.

For a lot of the time the use of the speakers would be listening back speakers[1], is something I am hoping to achieve in my speakers. They might not have perfect sound quality and playback transparency but having them enjoyable to listen to and having the ability to use them for my professional work of mixing sound effects and music on them are a preference. Normal home use would be the main goal for the speakers, and so their performance can be less than mastering level of SPL. For the aesthetic design of my speakers a nice wood finish is something I would enjoy the most, with a painted design on part of it. For the weight of the speaker, light enough to move the speaker with little to no help. For ease of construction, I plan for the boxes to be squared off. There wouldn't need a grill over the drivers, due to the lack of smaller kids around and cases would be impractical. One trade off that in considered is the SPL, Size and Bass trade off[2] graph, for me what it comes down to is the SPL and Bass, with a sacrifice in size at the moment.



[1] (Moulton 2000)
[2] (Murphy 2014)

Technical Goals

To achieve the goals set out in the functional description the plan is to build floor standing sealed speakers that have two variable stands to sit on. Now variable stands, push the speakers from floor standing into a different category, but the flexible between mixing monitors and home entertainment, speakers would be improved if they could sit on certain stand to raise or lower them depending on the environment, they will be used in.

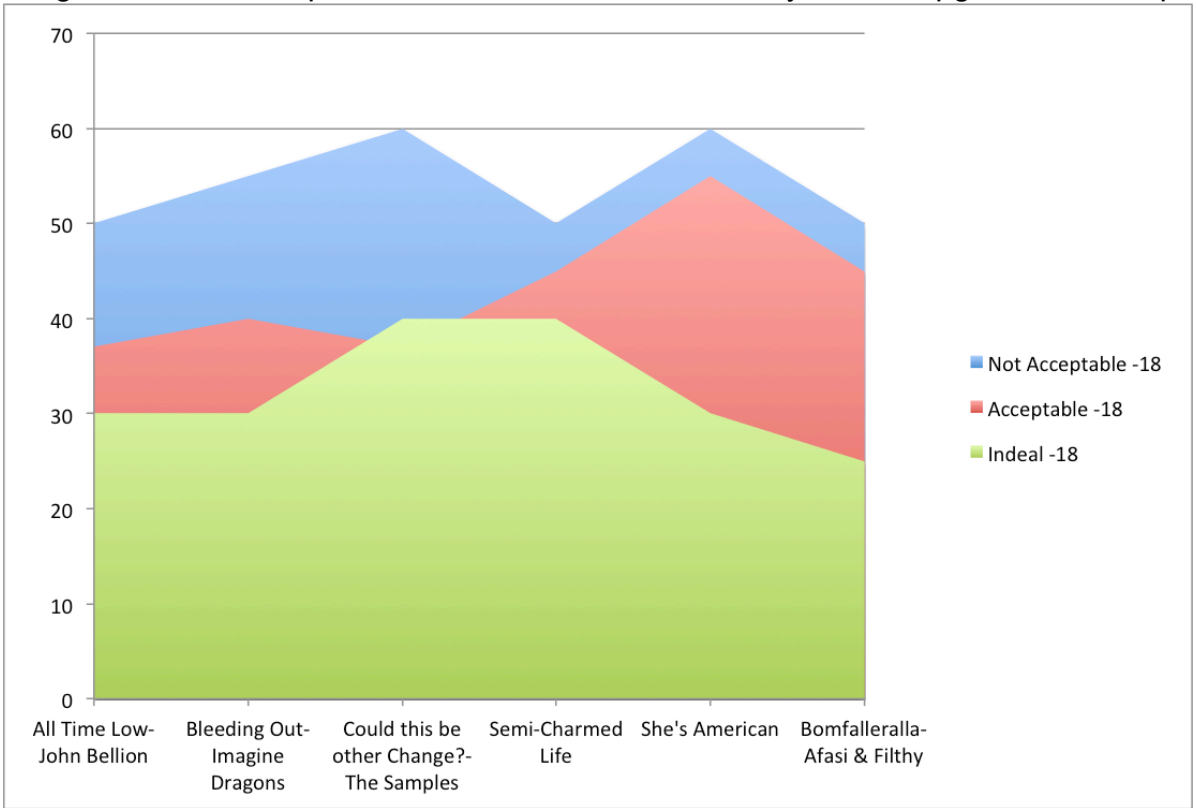
Size

For the flexibility to be achieved in the product, and for movement from one location to another the height would have to be averaged to a height around three feet, but no greater than three feet seven inches, with a width of ten to twelve inches and with a depth around a foot, but no greater than two feet. For ease of mobility the weight of the speakers should be no more than sixty pounds each. On average I would hope to keep them around 30 to 40 pounds. I am looking to build the speakers as sealed boxes so keeping them light enough to move with ease, without the help of a port to carry them with is ideal. The people helping me move would appreciate it if they were lighter but based on what I am planning on building them out of it, that would not be possible. Due to the nature of my career they will be moved not only from the living room to my desk but the house/ apartments will be changing from job to job for a while, so having them be portable and still an average of sitting around the TV on short stands to larger stands around my desk is a big factor of the design.

SPL

My peak SPL for my speaker is going no further than 107.2 dB because of what my amp and my woofer with the lowest sensitivity can produce. Which is the level I found to enjoy listening to the most, form movies and music and on average is my every day mood to mood listening level. Being able to play over that level would be nice for when things need to be really loud, like when my parents come over and are hard of hearing but on average keeping it around 94dB SPL. The listening system I am most interested in is the K-20 system or K-14 system. For amplifiers a class D amp with a high efficacy and long-term running time would help with cost of bills and will help the

budget focus on the speakers themselves with the ability to later upgrade their amps.



Frequency Response

The planed frequency response for the sealed speakers would be a range of 30Hz-22kHz. So, achieving a good range for the speaker to switch between flat monitors to warmer relaxed listening speakers is the goal. The content would range from movie SFX, movie sound tracks, theatre sound effects and wide music range. Since it is a sealed box, the frequency range of the woofers will have to achieve the response I am looking for without extra help.

Coloration and Time Response

The construction would be set to MDF inner layer, with a birch ply outer layer and then a thin layer of mass loaded vinyl, with a last layer of Masonite, and/or MDF inner layer with a birch ply outer layer and a nicer wood finish on the outside. The plan is to build them in a square shape with rounded edges to help with reflections. If I were to have to switch the box to a vented speaker, then a critically dampened speaker is something I could go for.

Mounting

The speakers are planned on being floor standing with stands to sit on, but they need to have a pretty wide throw to cover the seating area of a living room. They will be close to a wall almost at all time due to the positions of TV stands and Desk locations.

Cabinet Design

SPL out would hopefully be around 90dB SPL at the loudest, something on average around 80dB SPL. For driver size, the plan is to build three-way speakers each with an 8-inch driver, a 5- inch mid and a ribbon tweeter. Their spacing will be pretty close to one another to help with localization, but they will not completely line up due to space constraints. It is designed to keep the Baffle as tight to the ribbon as possible, hopefully the baffle step would be minimal, but due to the tweeter being offset there will be an issue to overcome the direction of one side over the other. Have the corners rounded on the edges of the box would help with the dispersion and the aesthetics of the boxes themselves. Speaker Shape is mainly planned on being rectangular with rounded front edges to help smooth out some of the baffle step. The material for building will be a ½" MDF inner with a ½" full Hardwood outer, there will be two internal supports to help with construction and stability, one with separate the sealed box from the ported box while the other will be cored out to add support to the bigger ported box. The woofer box will be ported with a 2" port that is around 4 inches long, with a smaller sealed box integrated on top to house the mid-woofer and tweeter. The construction of the box will consist of rabbit joints made from the two materials themselves with internal dados for the inner supports. For my hardwood selection I choice Honey Locust wood as a good cost alternative to Walnut, Price per board foot worked out to be cheaper and less labor intensive. The construction with Honey Locust will not require biscuit joints, as Walnut would. The wood is just as dense as Walnut and as opposed to Walnut has a more open grain structure, so if staining was in the design it would take it easier than Walnut would.

Initial driver selection was determined to be the Dayton Audio RS225-8, and the SB Acoustic SB23NRXS45-8, but upon further Winspeaker testing the selection has changed due to F3 performance and SPL.

The Box dimensions externally are: 3ft 7ins tall, 10ins wide and 1ft 1in deep. So, the internal dimensions of the boxes are: 2ft 9 ins tall, 8 ins wide and 11 ins deep.

For the Woofer the external box size is 3ft tall, 10ins wide and 1ft 1in deep Internally the Woofer box will lose a ½" for the dado support separating the two boxes

The Mid-woofer and tweeter box dimensions will be 7 inches tall, 10 inches wide and 1ft 1 inch deep.

Based on those dimensions the final driver selections are the Dayton Audio RS225-4 8" Reference Woofer 4 Ohm as the woofer, the mid-woofer selection is Dayton Audio RS125-4 5" Reference Woofer 4 Ohm, and for the ribbon tweeter the Fountek Neo X 1.0 Ribbon Tweeter. Each performed how I wanted my speaker to perform as a whole and they can easily cross over with one another.

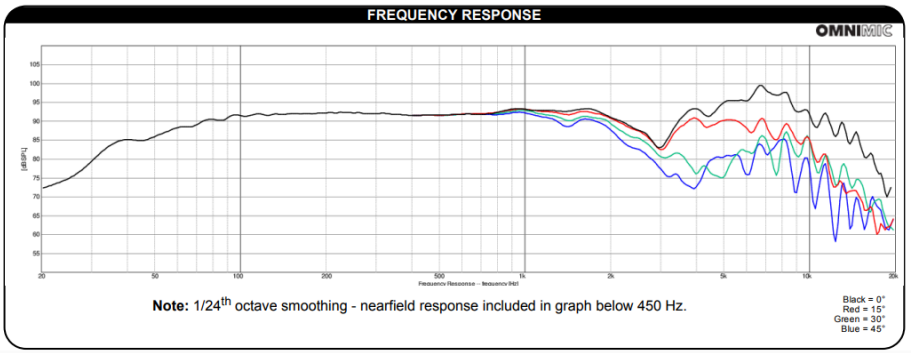
Connection points on my speakers are going to be two pairs of binding post in the back of the speakers, one set for the woofer and the other for the mid-woofer and tweeter. I am going for the minimal looking binding post to give a clean, polished look for my speakers. For the finish of the speakers, I plan on oiling and clear sealing my hardwood to give the speakers a nice natural finish.

Driver Selection

Dayton Audio

RS225-4 8" Reference Woofer 4 Ohm[3]

Price: $58.14
Size: 8”
Breakup starts at 2kHz
Breakup Amplitude peak 95dB
Thermal Power Handling 80watts

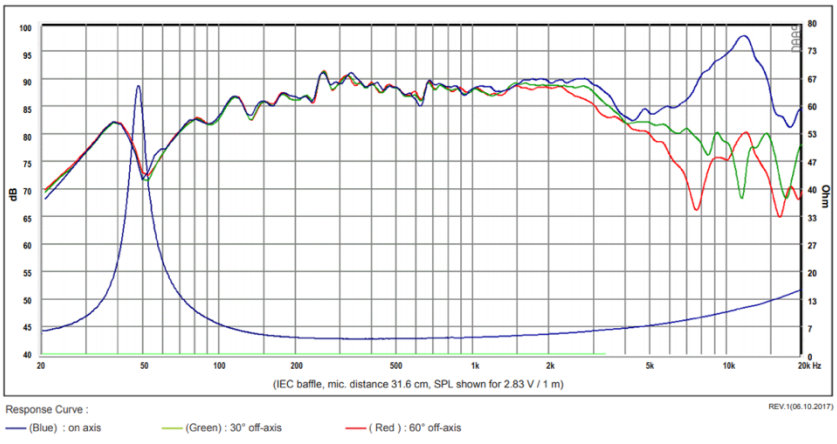


SB Acoustics

SB12CACS25-04 4"ceramic woofer- 4 ohms[4]

Price: $ 62.60
Size: 4”
Breakup starts at 10kHz
Breakup Amplitude peak 99dB
Thermal power handling 30watts

Driver was rejected due to a 5dB drop at 600hz which for the mid-driver is not desirable. The driver was rejected for one with a smoother response.

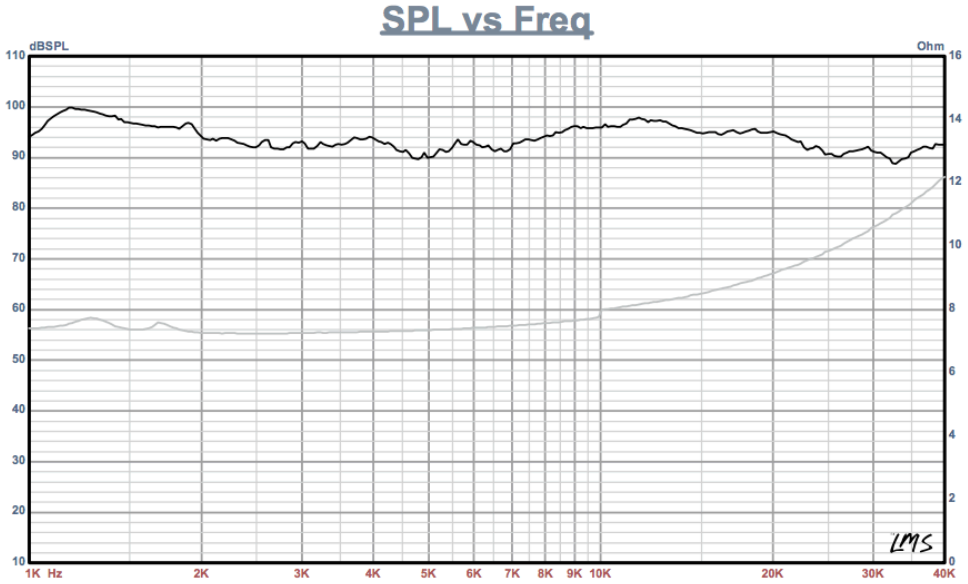


[3] (Dayton Audio n.d.)
[4] (Madisound Sp n.d.)

Fountek

Neo X 1.0 Ribbon Tweeter

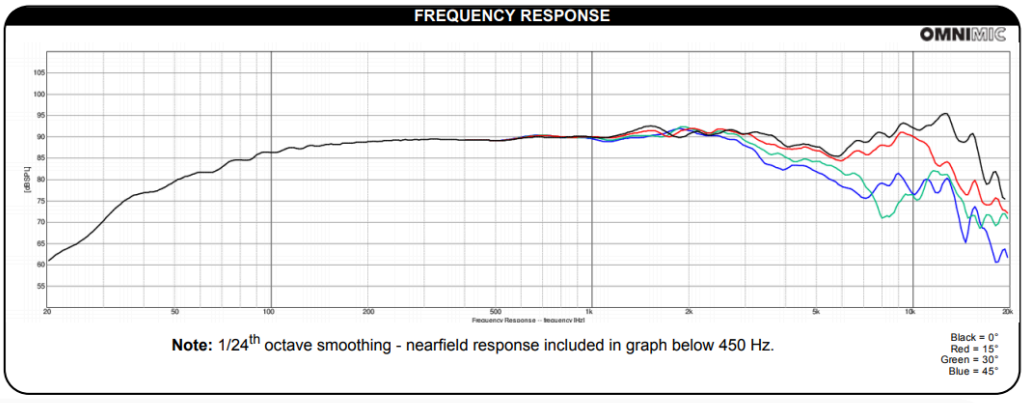
Price:$ 78.90
Size: 3.85”
Breakup Starts at way above end of graph
Breakup Amplitude peak 100dB
Thermal Power Handling 38W



Dayton Audio

RS125-4 5" Reference Woofer 4 Ohm

Price: $31.96
Size: 5”
Breakup starts at 10kHz
Breakup Amplitude peak 95dB
Thermal Power Handling 30 W



Dayton Audio

PS220-8 8" Point Source Full-Range Neo Driver

Price: $104.75

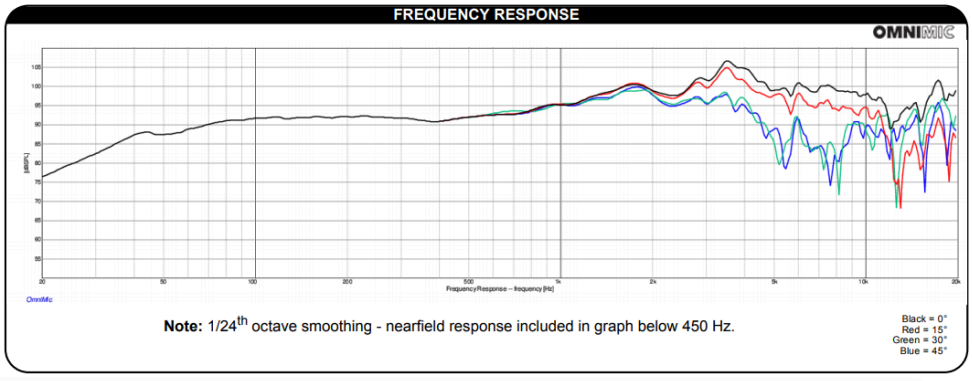
Size: 8”

Breakup starts at 3.5kHz

Breakup Amplitude peak 110dB

Thermal Power Handling 40 W

This driver was rejected as a low woofer due to the F3 response in the cabinet size restraints. The driver’s break up at 3khz is also a factor of rejection due to the cross over that would have to overcome such a high peak amplitude.

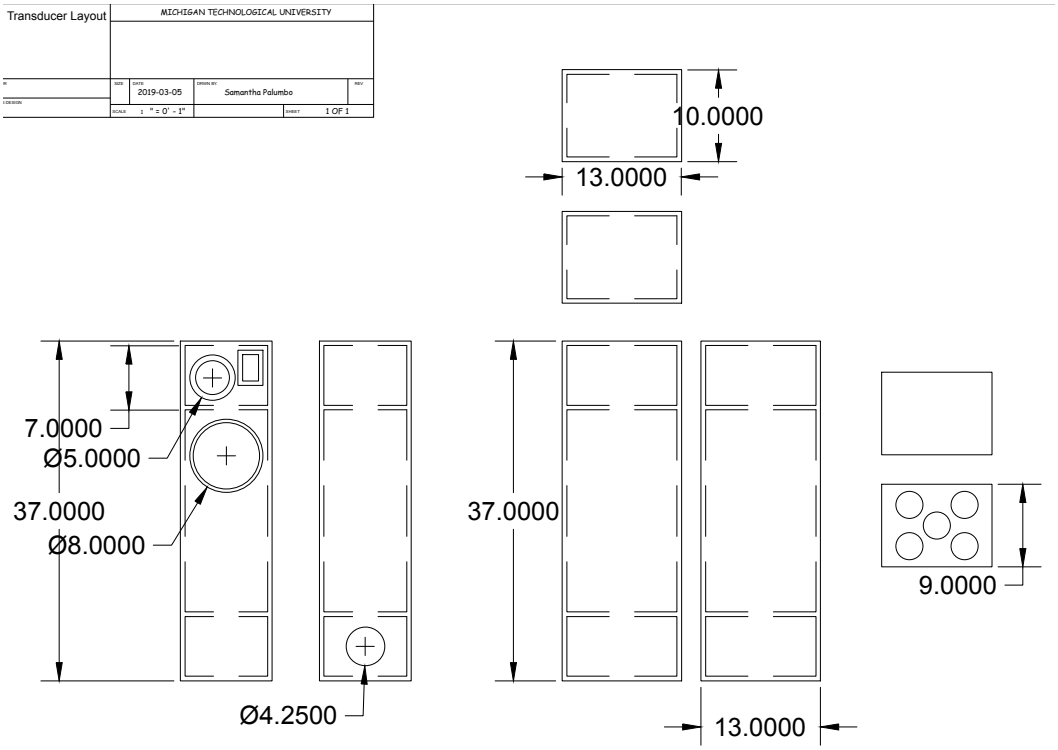


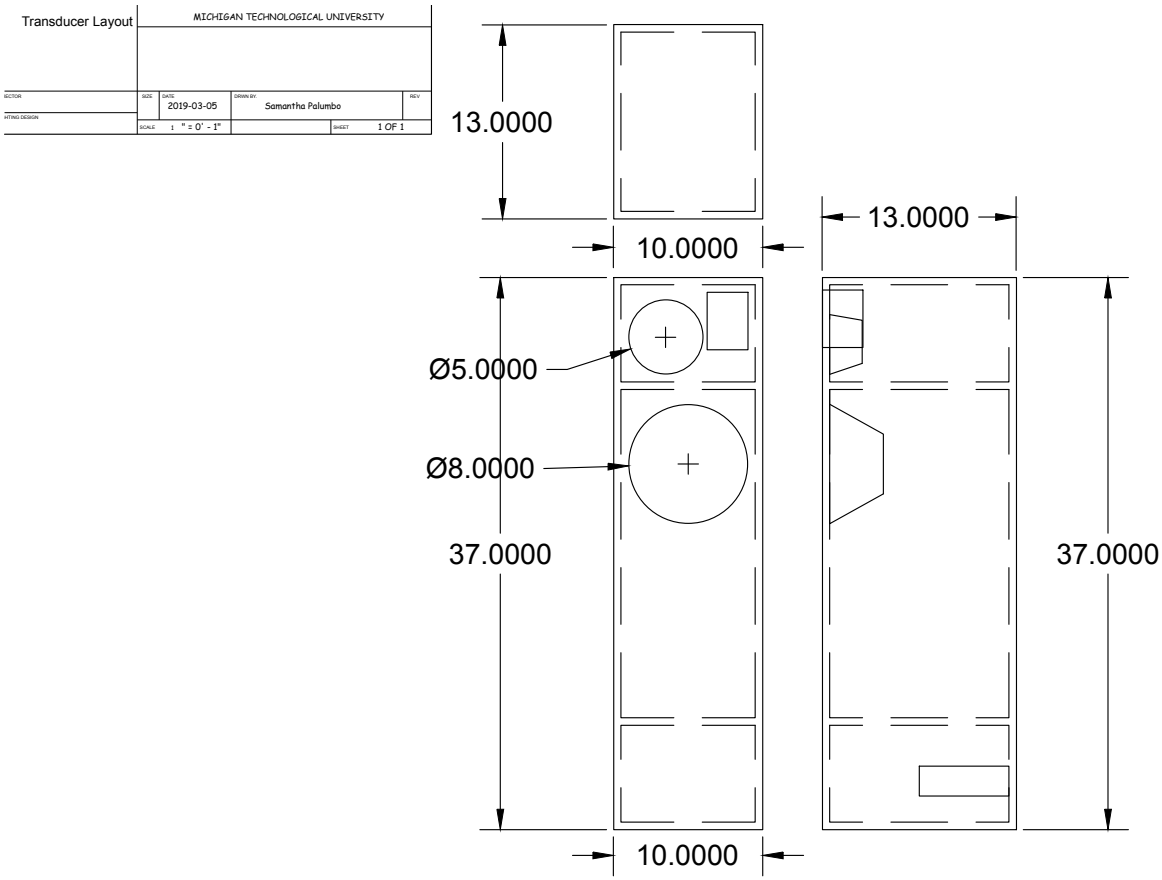
Name	Price	Max SPL	Sensitivity	X-Max	Qts	Power	Fs	Sd (cm^2)	Vas	Qms	Qes	Nominal Size
Scanspeak Discovery 8" Woofer	88.8	109.59	88.8	5.8	0.39	120	30	235	94.2	4.14	0.43	8"
SB Acoustics SB12CACS25-08 4"ceramic woofer	62.6	100.27	85.5	5	0.37	30	51	50	6.5	4.85	0.4	4"
ScanSpeak Classic P21WO20 8" Woofer Poly Cone	85.55	110.03	91		0.33	80	28	235	113	1.6	0.41	8"
SB Acoustics SB20PFC30-8 8" Paper Cone Woofer	39.4	107.49	90.5	11.3	0.37	50	34	216	66.2	2.66	0.43	8"
SB Acoustics SB23NRXS45-8	91.85	106.28	88.5	6.5	0.38	60	27	216	94	5.4	0.41	8"
Dayton Audio RS225-8 8in	57.42	105.83	86.8	7	0.38	80	28.3	213.8	56.8	1.46	0.51	8"
Peerless 850136 8" Composite Cone CSX Woofer 8 Ohm	79.88	112.72	89.5	4	0.27	210	28.2	235	2.82ft^3	3.5	0.29	8"
Peerless by Tymphany P22WO03-08 8" Poly Cone Woofer 8 Ohm	68.16	111.44	89.4	2.7	0.51	160	46.7	237.8	11.18 ft^3	2.49	0.64	8"
Dayton Audio PS220-8 8" Point Source Full-Range Neo Driver	104.75	112.52	96.5	4.8	0.38	40	46.4	216.4	90.2	5.73	0.4	8"

Drivers were rejected based on F3 responses in Winspeakers as well as their price and cone composition. Those that performed poorly in their F3, then the driver was rejected as a candidate. The driver that is highlighted is the driver that was chosen for the speaker.

Cabinet Description

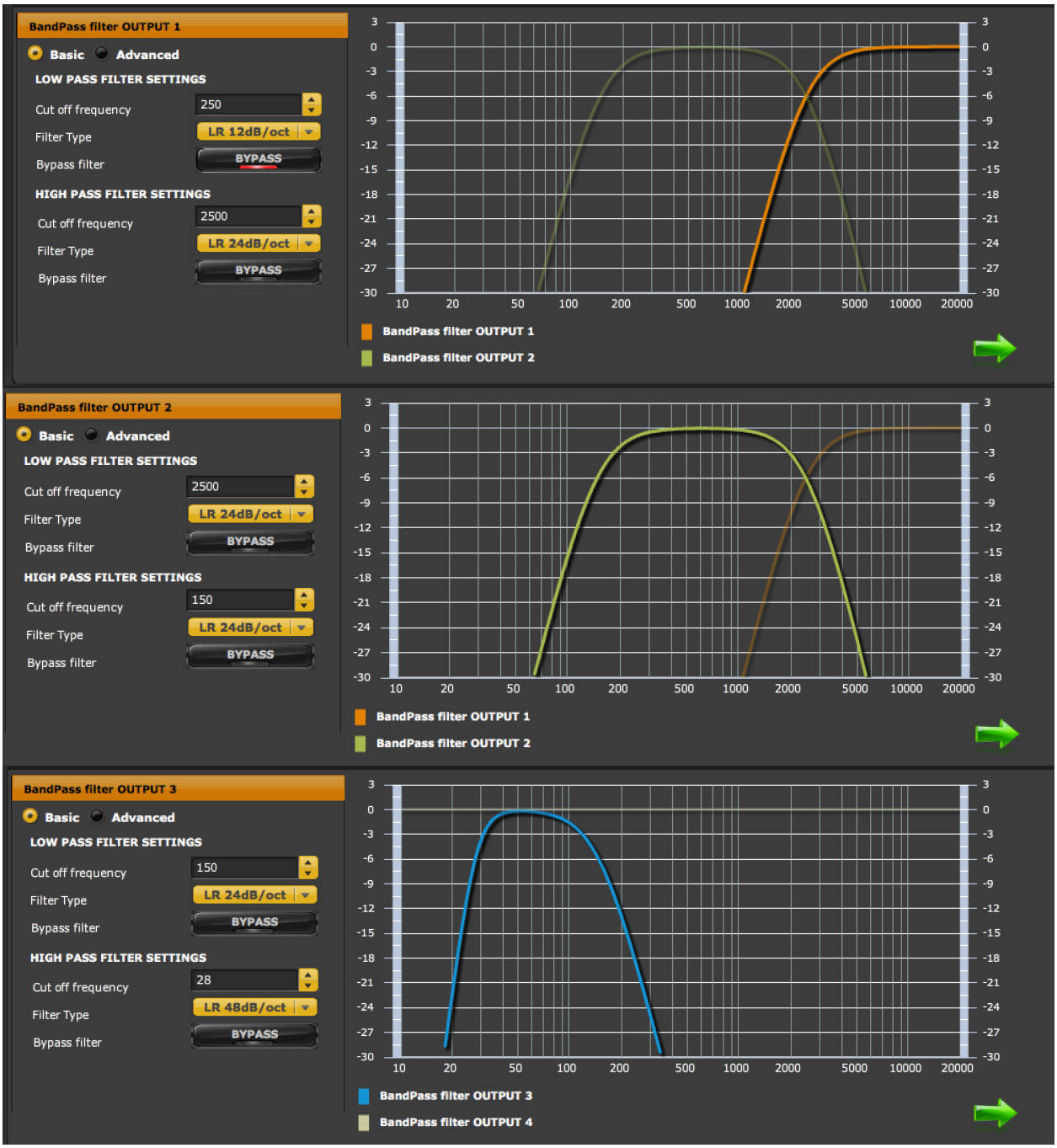
The cabinet design has falling into being a three-way speaker that is 3ft 7inches tall, 10 inches wide and 1ft 1in deep. The cabinet will be constructed out of a Honey Locust hardwood with a MDF inner layer. The joints will be rabbited and has an internal Dado to separate the sub box from the mid-woofer and ribbon tweeter as well as an extra support in the woofer box.





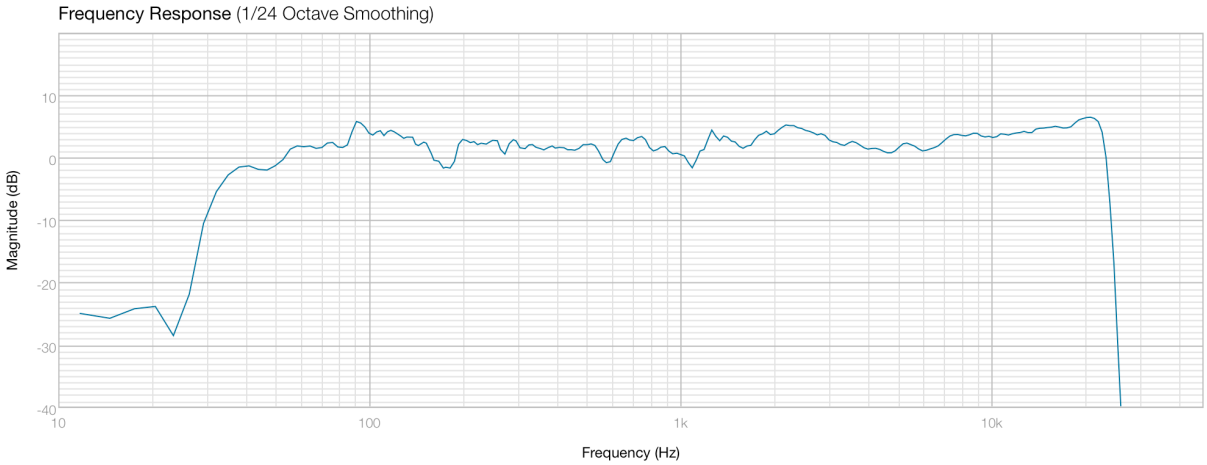
Crossover Design

For my crossover design for my fully active 3-way box the plan was to roll off my mid and woofer at 250 Hz with a 2nd order. That later change to be a roll of at 150 Hz 2nd order to have the mid handle more frequencies. The crossover for my ribbon tweeter is a 3rd order at 2.5 Hz as it was recommended.



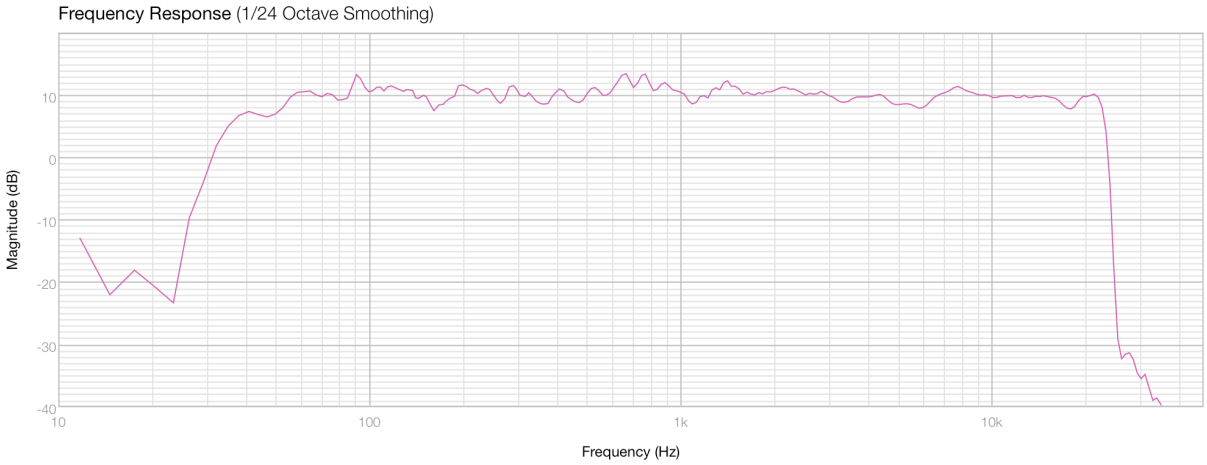
System Tuning

During the first round of tuning, there was a couple problems that needed to be addressed, one of which was the crossover between the mid and the woofer. The crossover that was set at 250Hz was causing a roll off from 250 -100Hz, that was later fixed by changing to150Hz. Another couple of problems that accrued was phase issues from the woofer needing to be delayed instead of the mid and tweeter being delayed back to the woofer.

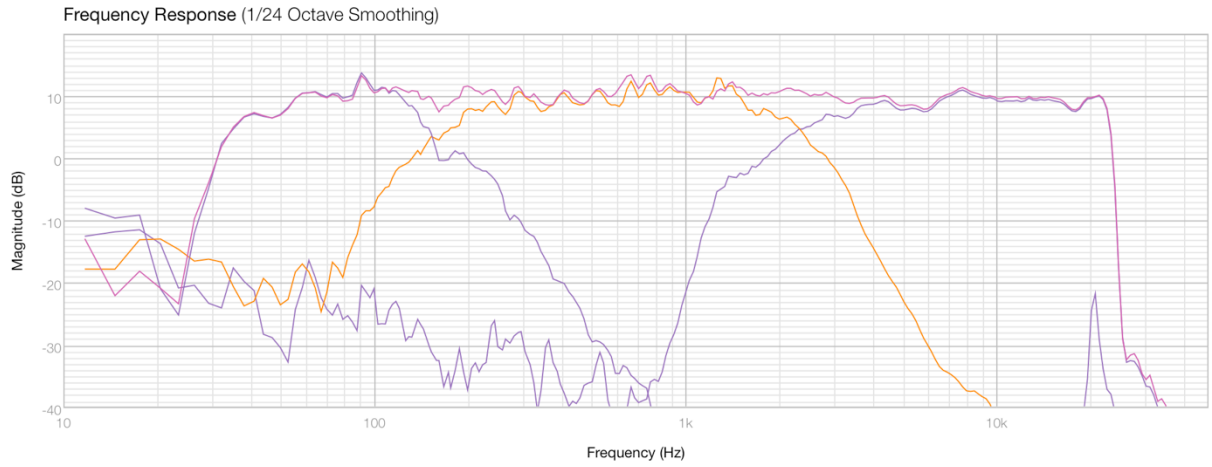


Final Performance Documentation

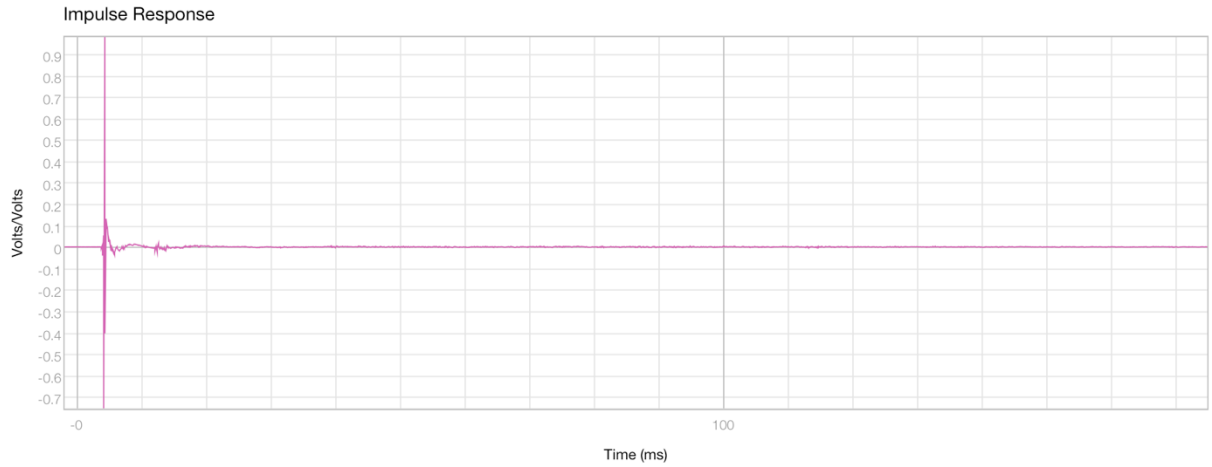
Final Frequency Response



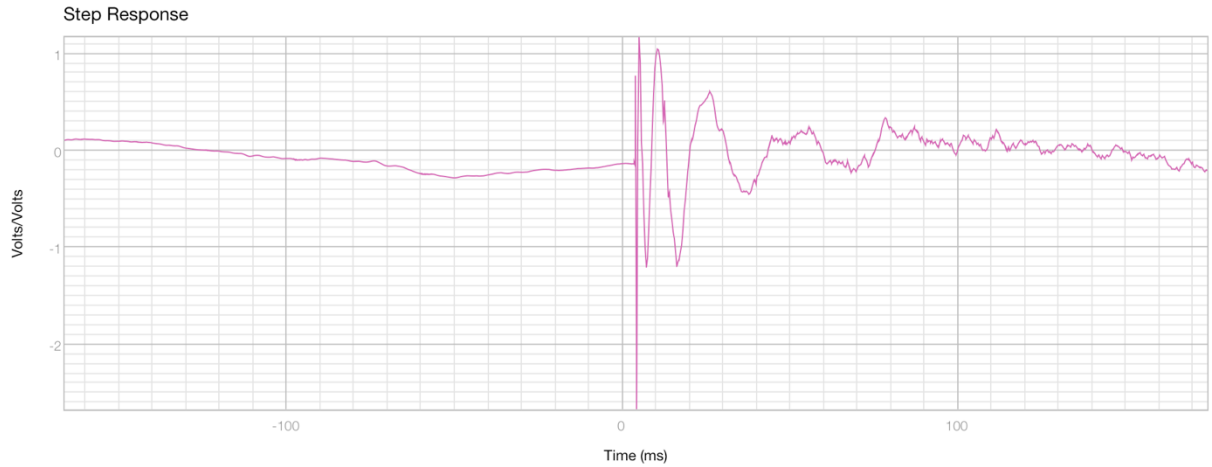
Final Intergraded Response



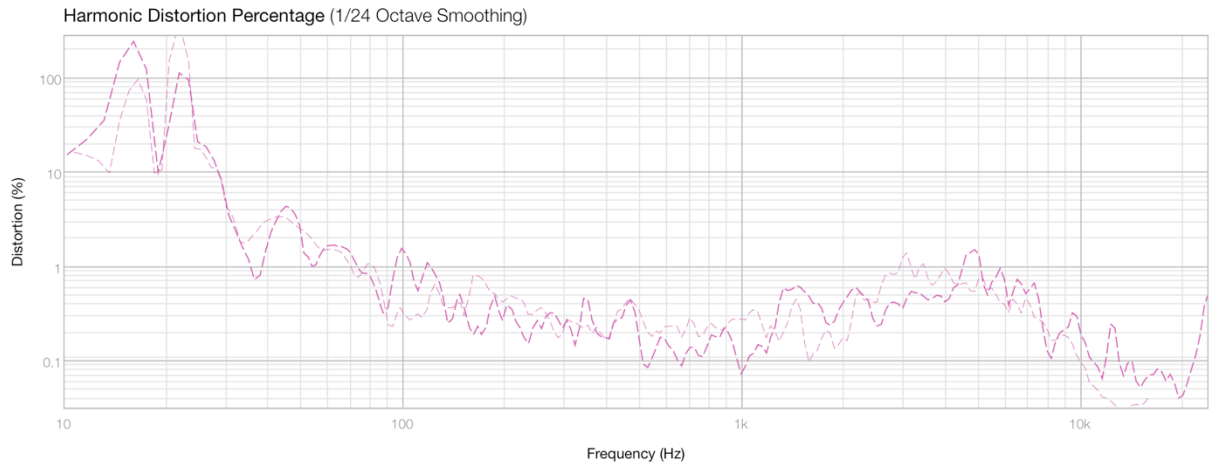
Full Impulse Response



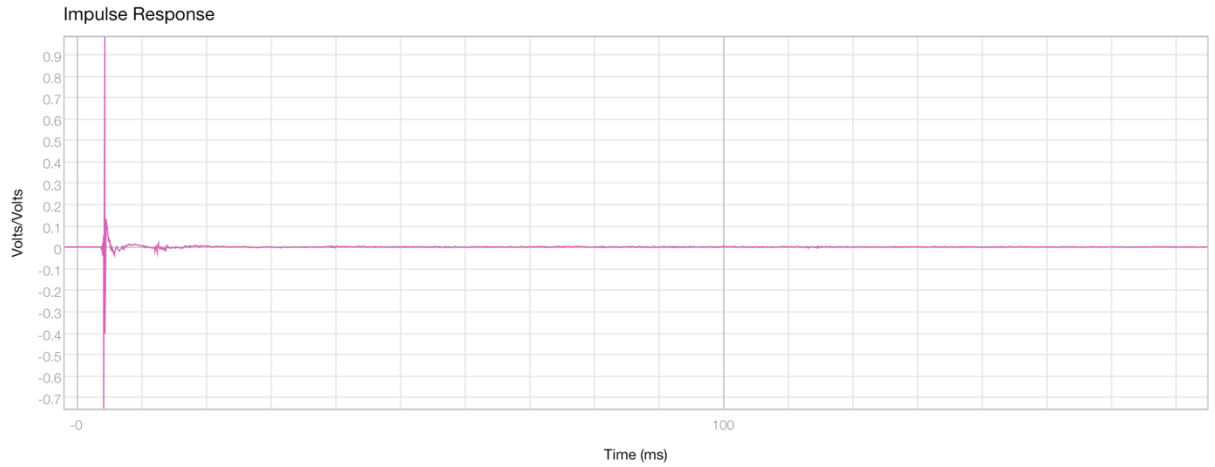
Full Step Response



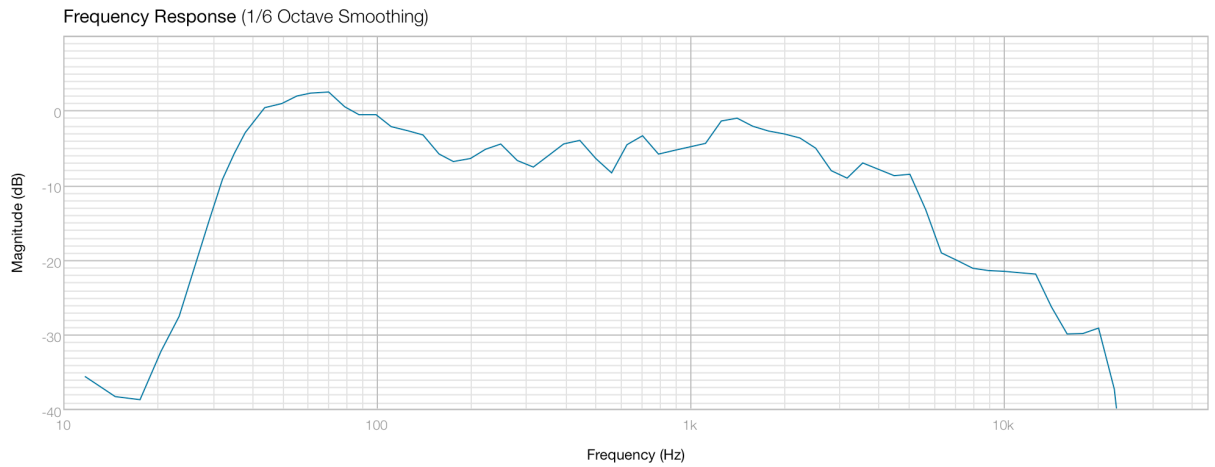
Harmonic Distortion Percentage



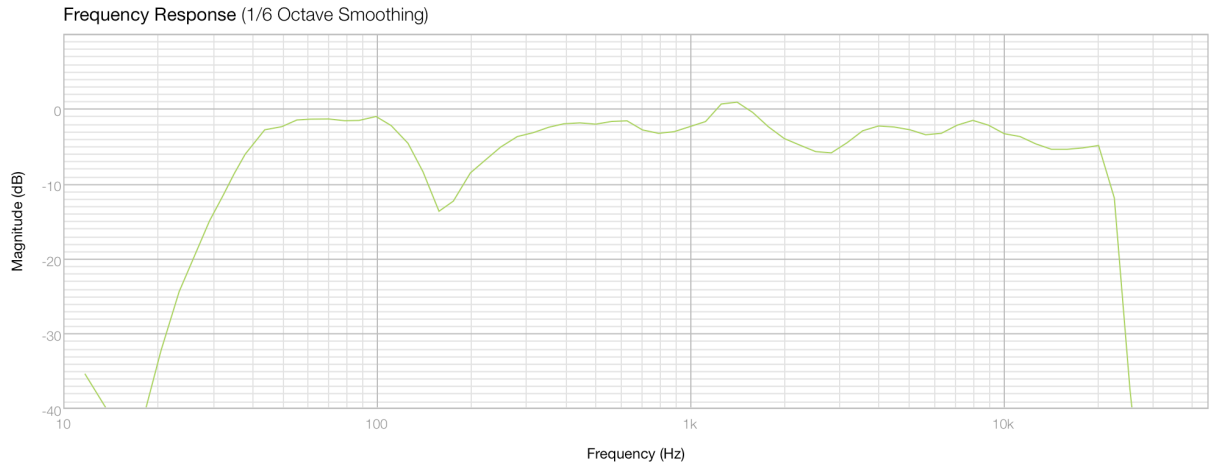
Impulse response



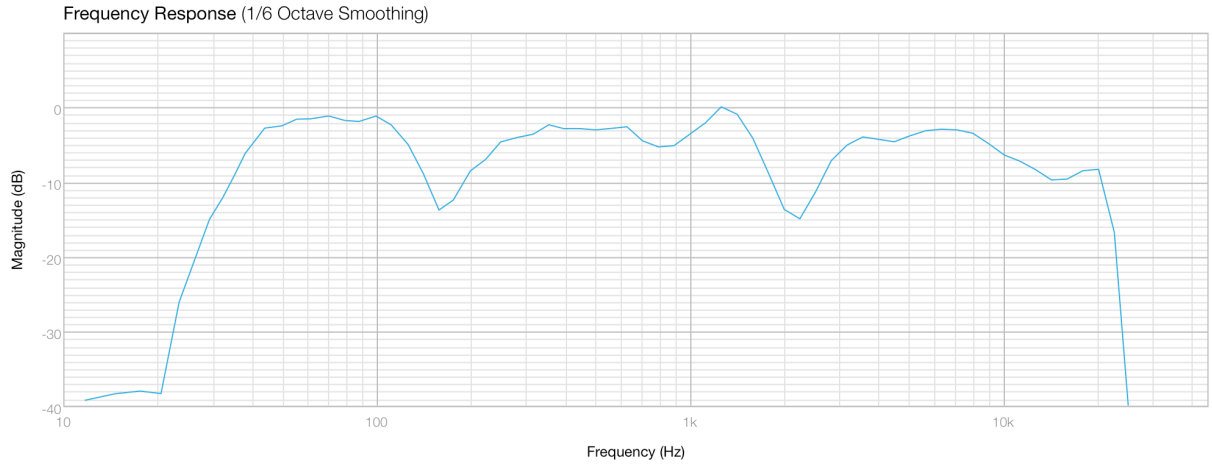
Off axis at 90 degrees Horizontal



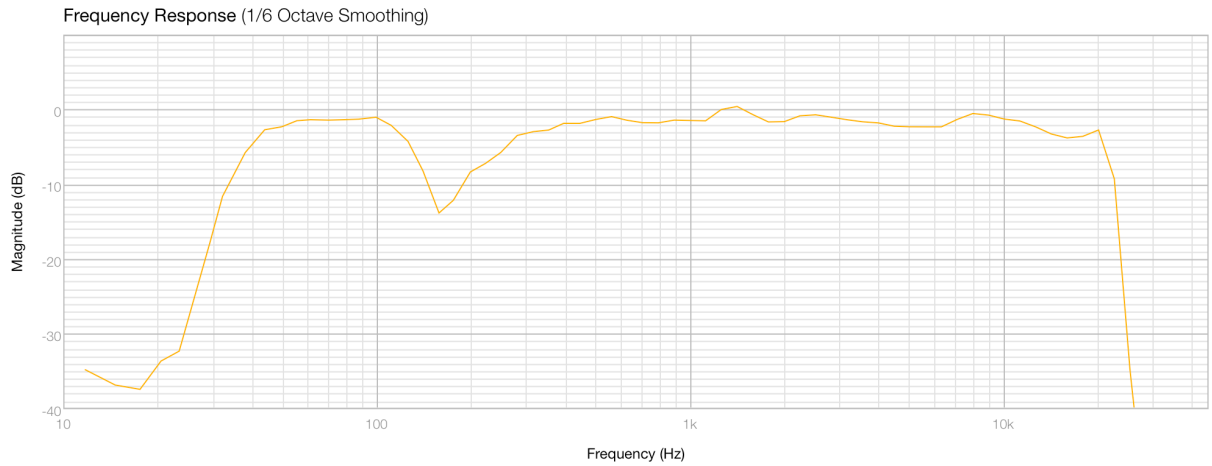
Off axis at 60 degrees Horizontal



Off axis at 30 degrees Horizontal



Off axis at zero degrees Horizontal



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