Near-field Monitors

Model: BOSSA NOVA

Assembled and Tuned by: *Aidan Conrade*

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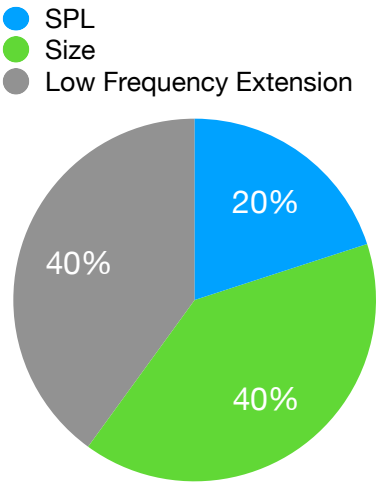
1.0 Functional Description

These speakers will primarily function as near-field monitors for my computer. I want them to serve as my primary mixing speakers and an upgrade from my current speakers, the Dayton Audio *Copperhead Desktop Full-range* kit loudspeakers. I want to replicate my mixes faithfully in these speakers and I want them to be able to sit on stands behind my desk since I do not have enough room on my desk for speakers larger than the Copperheads. I want them to only sit vertically on the stands so they are stable. The tweeter will be positioned so it is above the woofer to ensure reliable and consistent time alignment between the drivers.

These speakers may occasionally be used for room listening as bookshelf speakers so I want them to be relatively compact, and the stands I am looking at for my speakers have a base with dimensions of 10”x10” so I would like them to be able to safely fit on the stands or my desk without risk of falling. Other than this I am not concerned about rigging points as I am currently living in places where I am unable to drill into walls to install rigging points. Since I am only using them for near-field listening, I am not concerned about their SPL output above about 95-100 dB. The loudest I would push them for is to play music for listening in a medium-sized living room so they do not need to be high SPL but I still want them to be able to get fairly loud.

The goal for these speakers is to achieve low distortion with a reasonably flat frequency response, a small low-end lift, and a light lift in the high frequencies. The frequency response deviation will allow for increased listenability and minimized ear fatigue without coloring the sound profile of the audio being reproduced. I want to replicate warm, pleasant consumer/prosumer-grade loudspeakers while still being able to get transparent responses for listening. I also want this sound profile so they can match the bass lift in my current mixing headphones so my mixes can translate easier between headphones and monitors, to be able to listen backward providing accurate windows to what was recorded and/or produced and how the mixing is affecting the audio transparently.[1] This is also important because I wish to be able to monitor my bass guitar through these monitors, accurately.



I want my speakers to be physically sturdy but not incredibly rugged since I will only be concerned about the sturdiness of construction while transporting the speakers as they will primarily be stationary at my desk.

Based on John L. Murphy’s recommended three-point design tradeoffs this speaker will evenly prioritize size and low-frequency output while putting less emphasis on SPL output.[2]

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[1] Moulton, David

[2] [2] John Murphy, *end*. p. 55.

2.0 Reference Systems

2.1 Overview

An examination of multiple powered and unpowered, two-way monitors with woofers of 7” and smaller was done to determine overall performance guidelines in this market segment. The systems reviewed with relevant details are presented in this table:

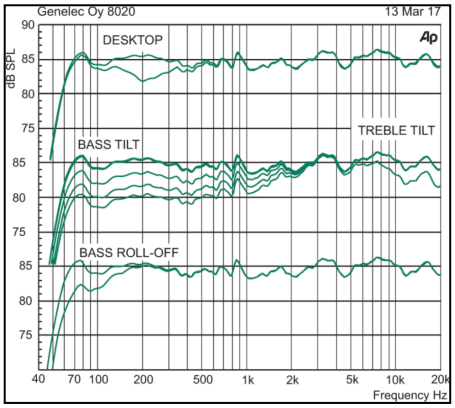
Speaker	Power Type	Woofer Diameter (in)	Peak SPL (dB @ 1 meter)	LF Extension (Hz)	Base Size (in, width x depth)	Price (for pair)
Tom Danley TDS-1	Passive	5 (woofer/ tweeter)	124	70	7.75 x 9	$3,038
Amphion One12	Passive	4.5	???	78	5.20 x 8.66	$1,650
Genelec 8020D	Active	4	107	62	6 x 5.6	$1,100.00
ADAM Audio A7V	Active	7	105	40	7.87 x 11	$1,600
KRK ROKIT 7 G4	Active	7	110	42	8.86 x 11.19	$420
Presonus Eris 4.5	Active	4.5	100	70	6.42 x 7.09	$145.00

2.2 Specific Loudspeakers

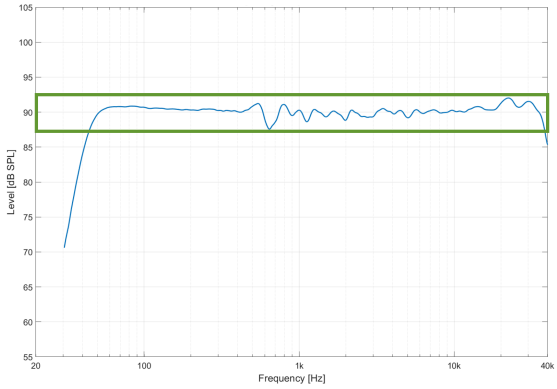
The **KRK Rokit 7** loudspeakers are consumer-grade, front-ported studio monitors with Kevlar cone woofers and dome tweeter. The frequency response is not very even, with a boost in the bass frequencies and cancellation at 680 Hz as a side effect of being front-ported.[3] This can be adjusted with the speaker’s built-in equalization control that can be accessed on the back amp plate and from a smartphone but it is still not ideal, showing I will want to avoid putting a port on the front of my speakers.

[3] Brandon Schock, higherhz.com

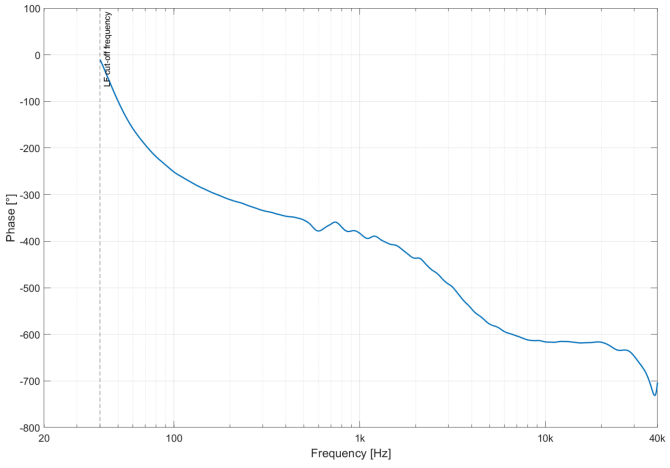
The **Genelec 8020D**[4] loudspeakers boast a very impressive frequency response for their size, and Genelec's waveguide technology ensures that they have great dimensional imaging. It also comes with a variety of rigging points on the bottom and back of the speaker, along with its IsoPod stand that is specially designed to help decouple the speaker from the surface it sits on.



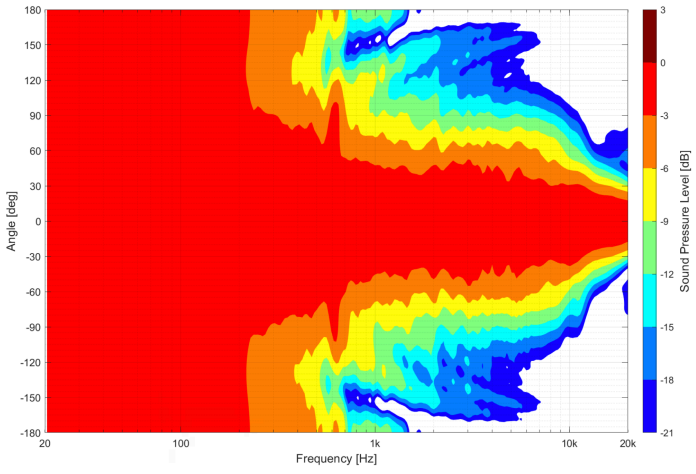
The **ADAM Audio A7V** loudspeaker features ADAM's X-ART ribbon tweeter for extremely smooth, low-distortion high frequencies, and solid frequency response from 41 Hz to 42 kHz. Its integration with Sonarworks' SoundID Reference software for tuning is also a large selling point, outside of its frequency response and performance.



ADAM A7V Frequency Response, ±3 dB on 0 dB, ±1 dB from 60-300 Hz, ±2 dB from 1 kHz-10 kHz



ADAM A7V Phase Response



ADAM A7V Horizontal Isobars

3.0 Technical Specifications and Reference Designs

I have concluded that, with my financial state at the time of doing this paper being sub-optimal for spending a lot of money on speakers, I will be putting together a pair of loudspeaker speaker kits in place of designing to save money. These kits will be the *Samba MT Bookshelf Speaker Kit*s, purchased from parts-express.com. This speaker kit, as detailed below, matches what I want in terms of quality and specifications.

3.1 Cabinet Design

These loudspeakers are a very nice form factor for what I want. The cabinet dimensions are 15” x 8.5” x 11-3/4”, which is initially larger than what I wanted but works for me since this size will still fit on my desk until I get speaker stands for them in the future. Because of the size they seem relatively portable, though a little bit bulky but that is not a concern of mine. The main concern will be waterproofing since the material for the kits is MDF and can get easily water-damaged, but that can be fixed with some water-resistant primer and paint. I want to eventually pick out a nice burgundy color for them, but for the sake of this documentation being purely the functional aspects of these loudspeakers they are still in their natural, untreated MDF state. The boards are 3/4” thick, so the internal volume turns out to be 0.703 ft^3.

3.2 Loudness and Amplification

These loudspeakers do not need to get too loud. Since I will be using them for long-term listening and mixing I will be satisfied with consistent performance from 70-100 dB at 1 meter. I make this distinction for louder volumes than I would listen to at my desk since I may occasionally listen to them as speakers for my television, in which case I will be further than roughly a meter away from them, thus will need to push them a little bit louder to get an even experience between listening at my desk and on my tv in my room while sitting on my bed. The intended listening position will be at my desk where my ears are in line horizontally with the exposed wood in between the tweeter and woofer. They will be at an angle, pointed at my head in such a way that they will form an equilateral triangle with my head. Distance will be about one meter from my head, meaning the speakers will also need to be one meter separated from each other.

For listening forward, I would like my baseline SPL to be around 83 dB, calibrated from my listening position with the K24 pink noise, per Bob Katz’s K-System loudspeaker calibration. This loudness will allow for 14-20 dB of headroom with my mixing/mastering

for music and video game assets while giving me an adequate amount of loudness to listen comfortably for sustained sessions. To accommodate this loudness, my amplifiers will need to be able to output 100 watts to both of my loudspeakers. With a 260-watt amplifier, this should be more than enough to power my speakers, and I already own a 260-watt Fosi Audio TDA7498E Class D stereo amplifier, with two channels of 130 watts. This would work because with the sensitivity of the Samba MT loudspeakers being 90.8 dB, and desiring 83 dB output for my headroom, I would need to be able to supply 21.1 watts over my initial goal of 90.8 watts to power the drivers. This totals 111.9 watts to reach my objective loudness, leaving me just under 20 of surplus headroom and an estimated maximum SPL of ~105 dB, which is more than enough for what I would want out of these speakers.

3.3 Frequency Response

I would ideally like to get these speakers down to 30 Hz but that will not be possible with the woofer alone. I believe that with the proper port tuning, I can get down to 30 Hz so that I would be able to monitor my bass guitar through them. Normally the lowest note on a bass guitar would be E-1 which is 41 Hz, but I own a 5-string bass with a low B-0 string that resonates at ~31 Hz. Being able to get that frequency would be perfect but I would settle for being able to capture the E-1 frequency and still be able to identify the notes by their harmonics. Either way, I would have to be careful with monitoring my bass on these speakers to make sure I do not force them to reach their maximum excursion. I think with the performance of other 7” woofers like the ADAM Audio A7V and the KRK Rocket 7 G4 reaching low-frequency performance down to 40 and 42 Hz, respectively, not including port tuning, I think I can get these speakers to produce the frequencies I want them to.

For the mid and high frequencies, I ideally would like to have a flat response accurate to ±3 dB from 60 Hz to 12 Hz, but after listening to some different profiles I think I would also like if it was slightly not flat. Having a smile curve on them would match what most people would listen to, and having a small bass boost would also mirror the response of my mixing headphones, the Audio Technica M50X closed-back headphones. I also liked the BBC loudspeakers’ pattern of having a little bit of a high-frequency boost to bring out some transients and add a shimmer to the soundscape.

3.4 Driver Selection and the Samba MT Kit

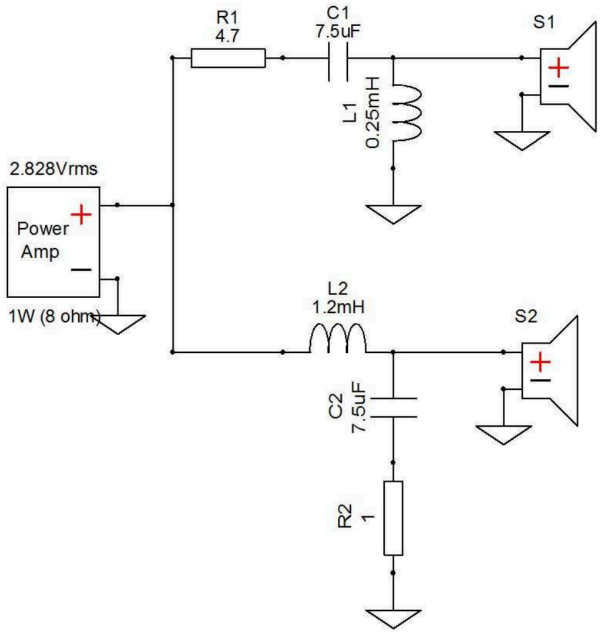
The woofer I am selecting since it is coming with the kit is the **Dayton Audio RS180P-4 7" Reference Series Paper Woofer** in its 4 Ohm configuration. To pair with it I will be using the **Dayton Audio RST28F-4 1-1/8" Reference Series Fabric Dome Tweeter**, also in its 4 Ohm configuration. To pair these together I will be using a passive crossover at 2.4 kHz since the tweeter is effective down to 1.2 kHz before it begins to fall off and its

resonance in free air is at 710 Hz. This works for the woofer as well since it begins to reach its breakup frequencies around 3 kHz, so a crossover at 2.4 kHz would mask the breakup frequencies of the woofer while staying well over an octave above the tweeter's f(s), which would allow the tweeters to function as efficiently as possible.

4.0 Tuning

4.1 Passive Crossover

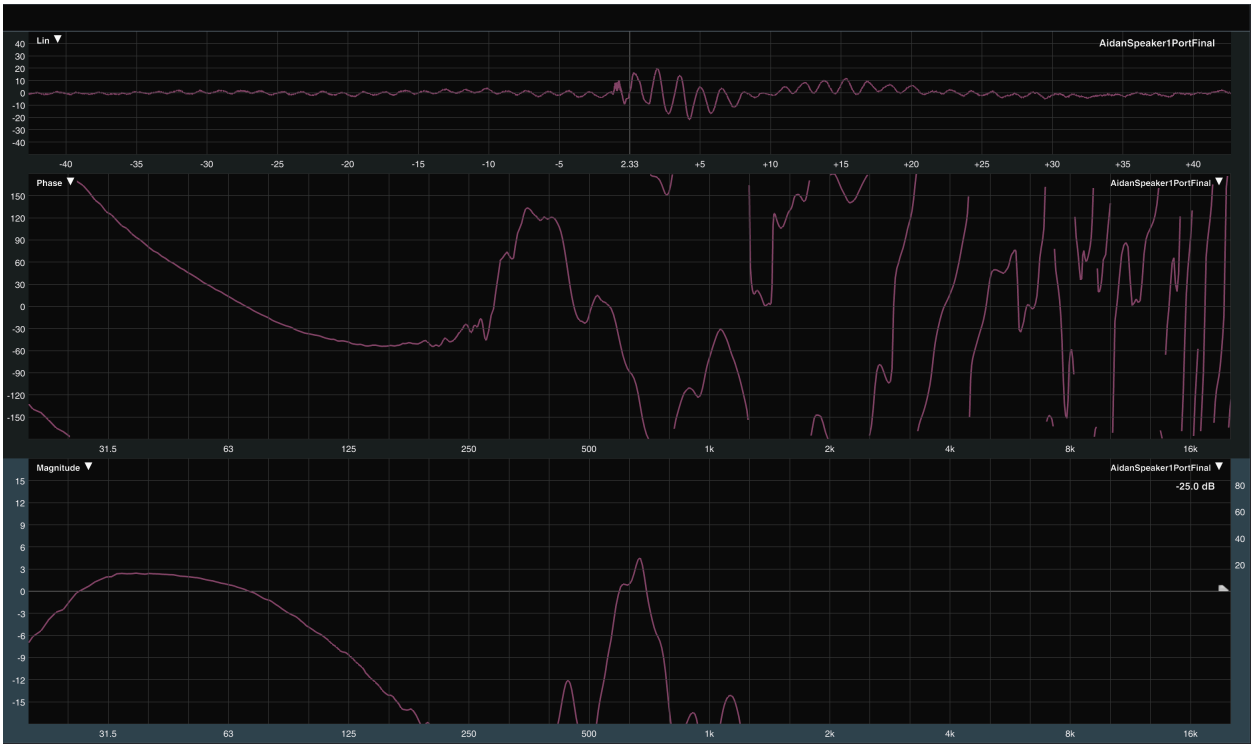
The Samba MT kit came with a crossover that I am using for these speakers. It is tuned to 2.4 kHz and this is the configuration diagram for the crossover below, where S1 is the tweeter and S2 is the woofer.



4.2 Port Tuning

Tuning the port for each loudspeaker was a quick procedure. I had the port length calculations from Winspeakers that told me my ports should be 7.27", and since I had adjustable ports it was only a matter of measuring to that length and securing them. Since I want to experiment later more with port tuning in case I change things inside of

the cabinet, I used gaffe tape to hold them in place. I also made sure to measure my ports through Smaart V8 to make sure that they were doing what I wanted them to do. Below is the measurement I got from the ports upon adjusting them to 7.27”.

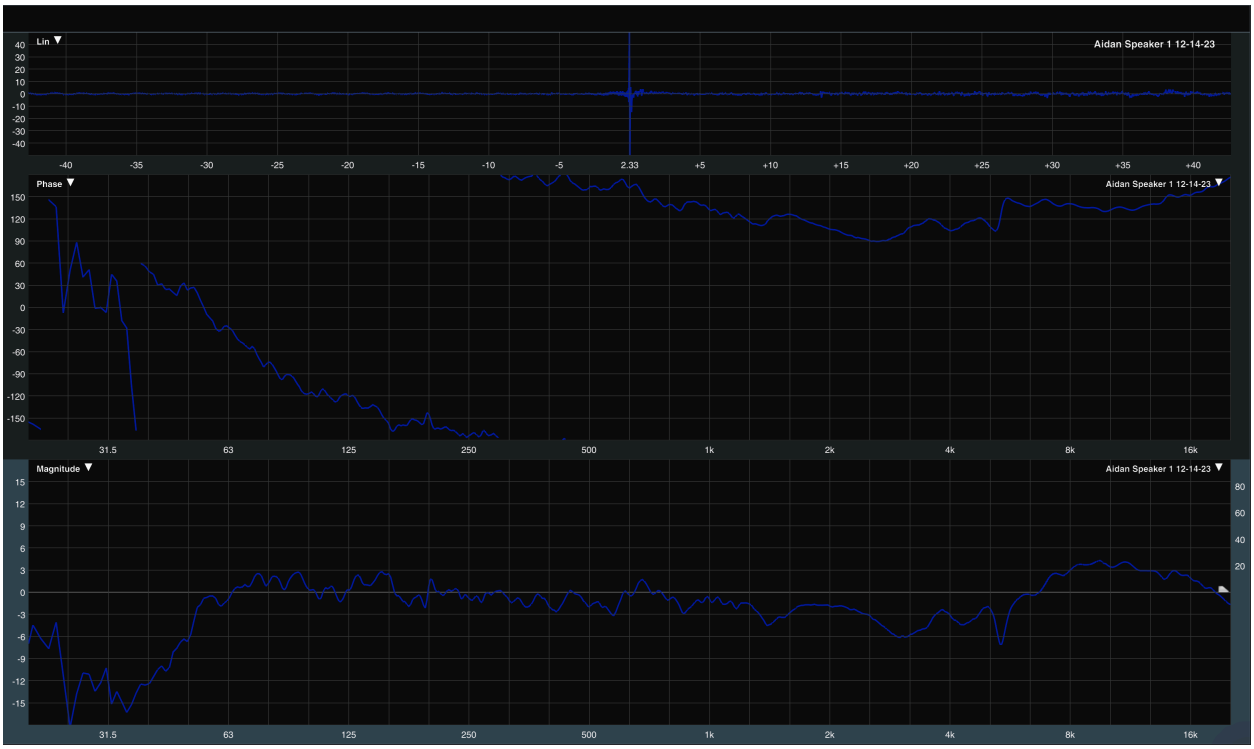


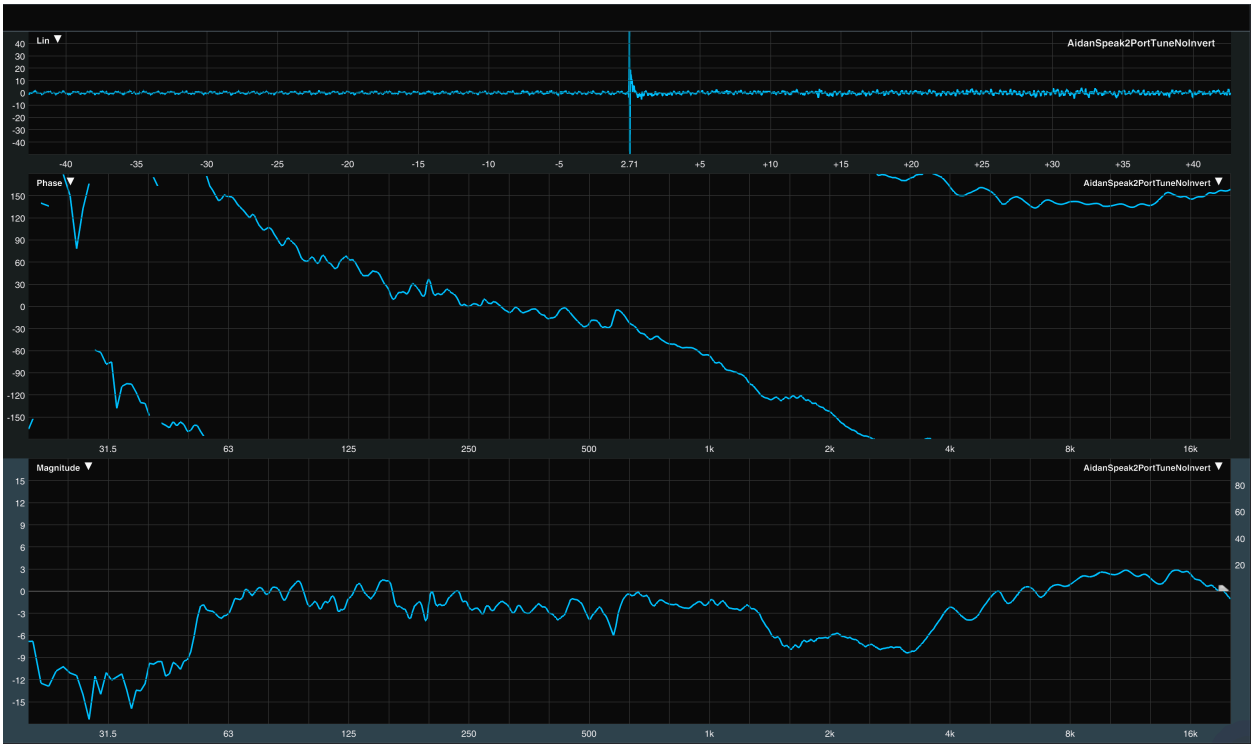
4.3 Internal Dampening

I used Black Hole acoustic foam inside of my speaker cabinets in various places. I mainly wanted to get the sides and back surface of the area behind the woofer. I also placed some along the sides in the upper portion of the cabinet, on either side of the port, and another small rectangle above the port opening to catch reflections bouncing off the top of the inside of the box going into the port. These helped minimize a frequency irregularity I had at 500 Hz due to an exaggerated port resonance. This was my last step in making sure things ended up being solid.

4.4 Smaart Cabinet Measurements and Phase Inversion

I made some measurements in Smaart and recorded them before moving into Fuzzmeasure to grab my final specifications. Here are the measurements of both of the speakers.





I noticed that there was a significant cut in the high mid-frequencies from 1.2 kHz to 4 kHz, and upon consulting Professor Plummer for ideas on fixing this, he suggested that it could be the woofers were phase misaligned from the tweeters, and inverting their phase manually to test if it fixed their response. It made the first speaker look more flat, but upon inverting the woofer in the second speaker the cancellation was made worse. I initially made the judgment that the first speaker being inverted matched the second speaker when it wasn't inverted, but eventually ran into issues when listening because this put the two woofers out of phase with one another. My solution was to un-invert the first woofer and see if they sounded better like that, and the slight difference in the cut between the left and right speakers was not perceptible like I feared it would be so they remain in their current state now.

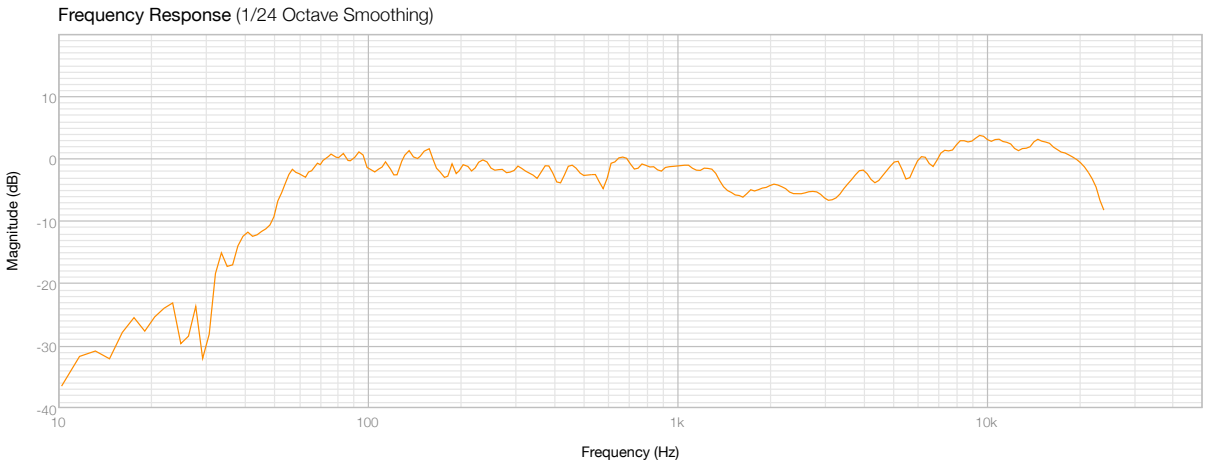
NOTE: I took my Fuzzmeasure readings while the woofer was inverted, so my Integrated Step Response readings do not match up. I plan on editing this paper at a later date with the changes I make to these speakers as they continue to develop.

Appendix

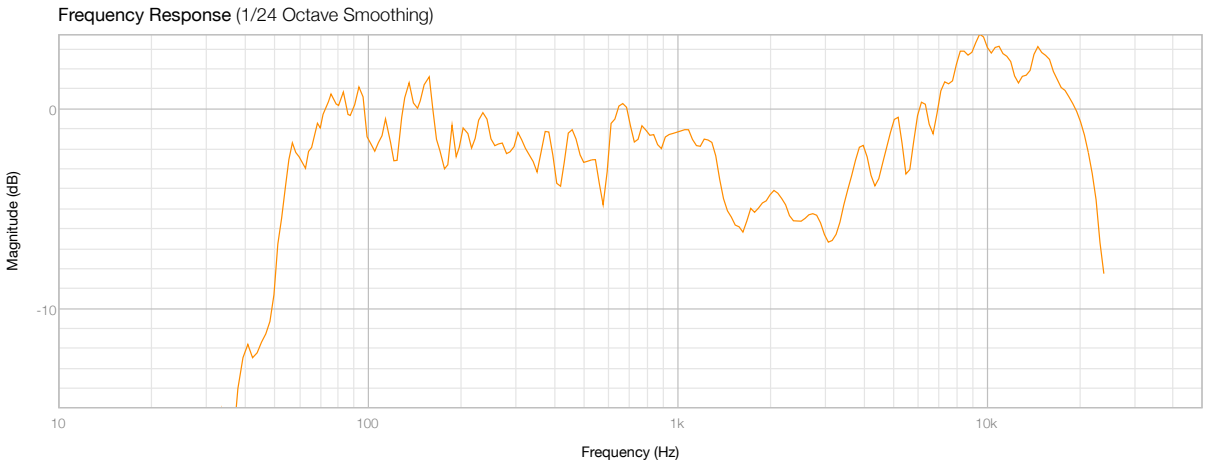
Loudspeaker Measurements

(Impulse Response file got lost, will be added in the next paper update)

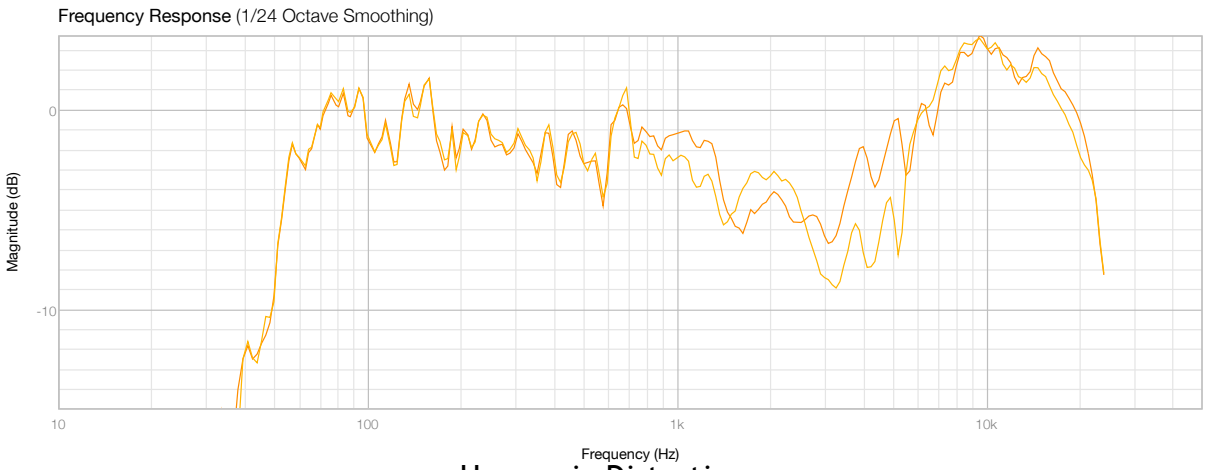
Frequency Response - 60 dB Range



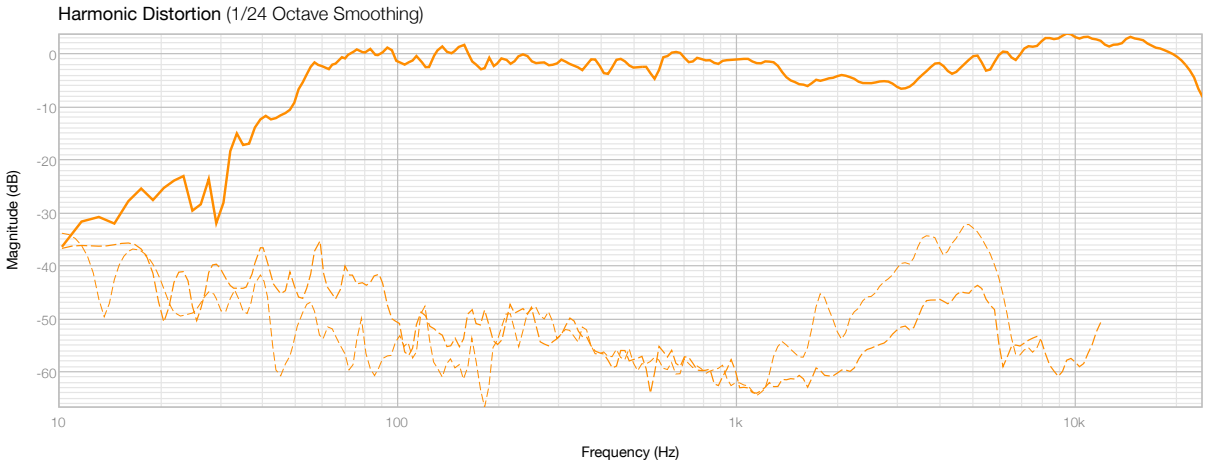
Frequency Response - 20 dB Range



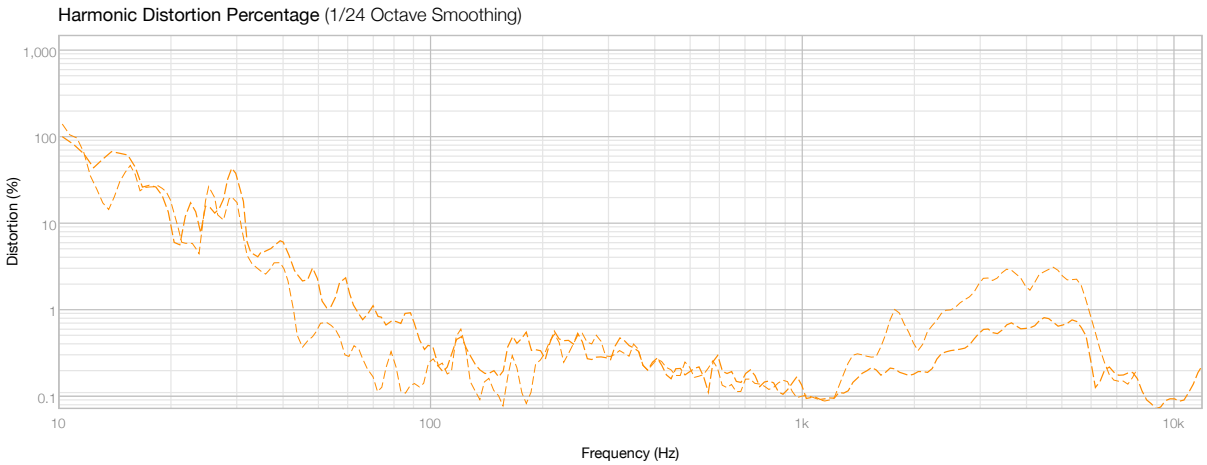
Integrated Frequency Response - 20 dB Range



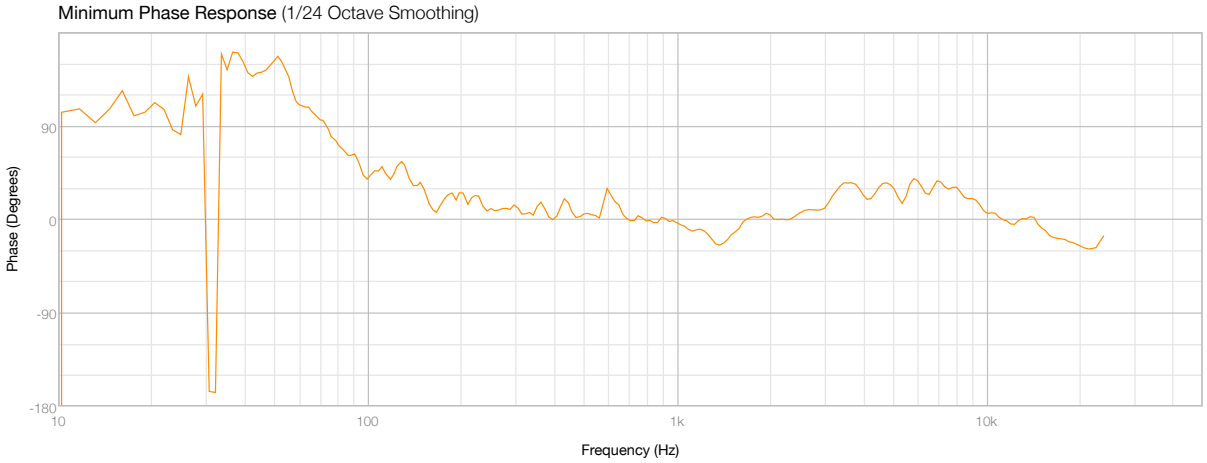
Harmonic Distortion



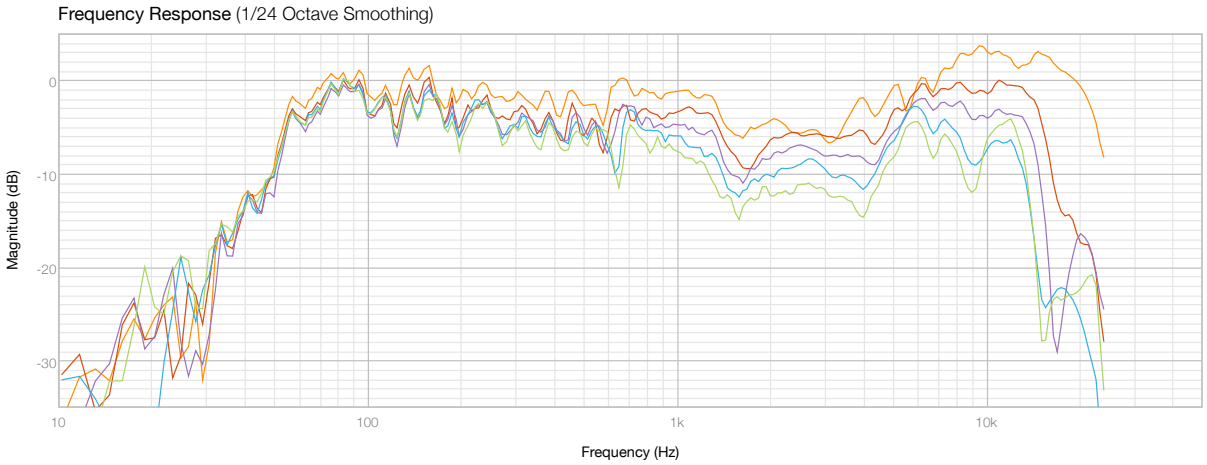
Harmonic Distortion Percentage



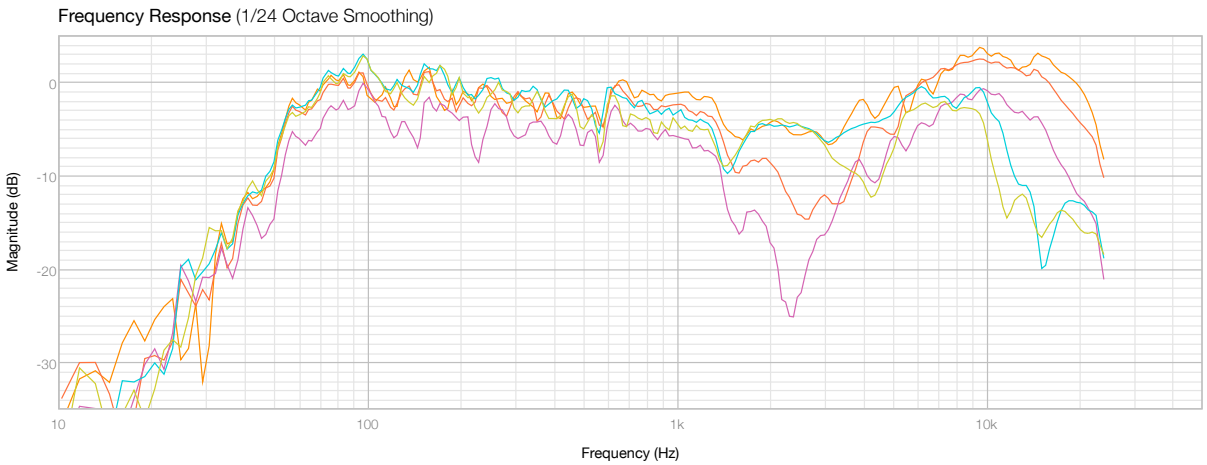
Minimum Phase



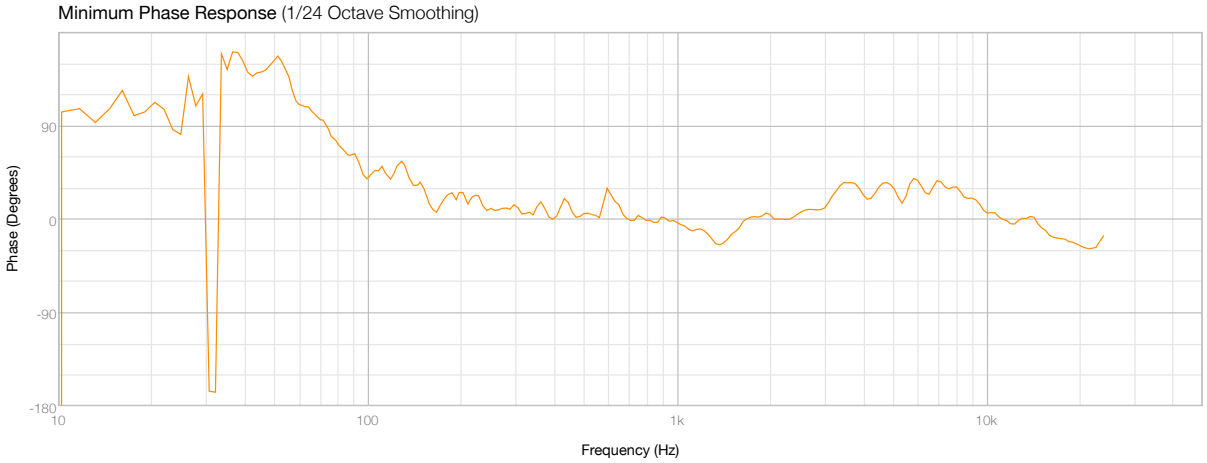
Horizontal Off-Axis Response - 40 dB Range



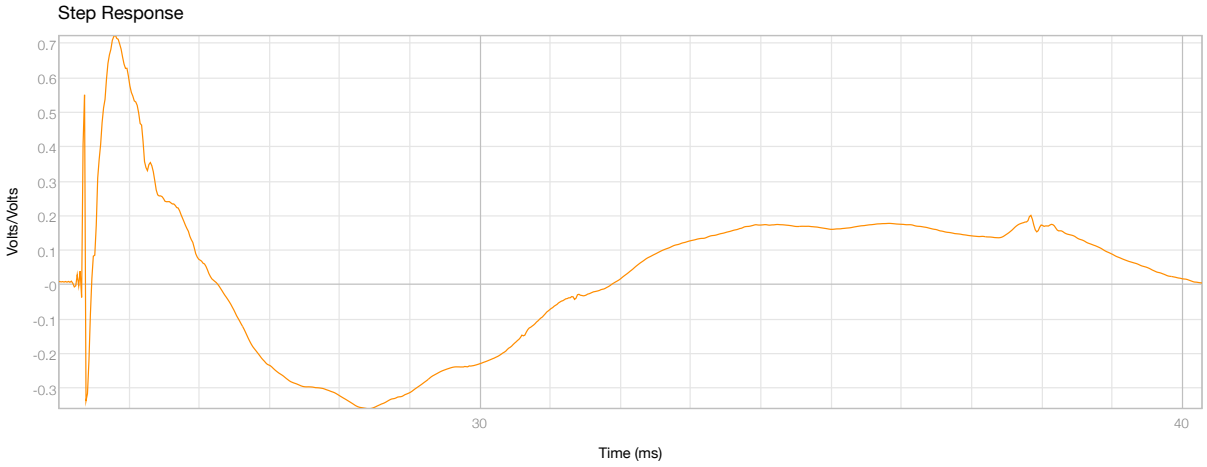
Vertical Off-Axis Response - 40 dB Range



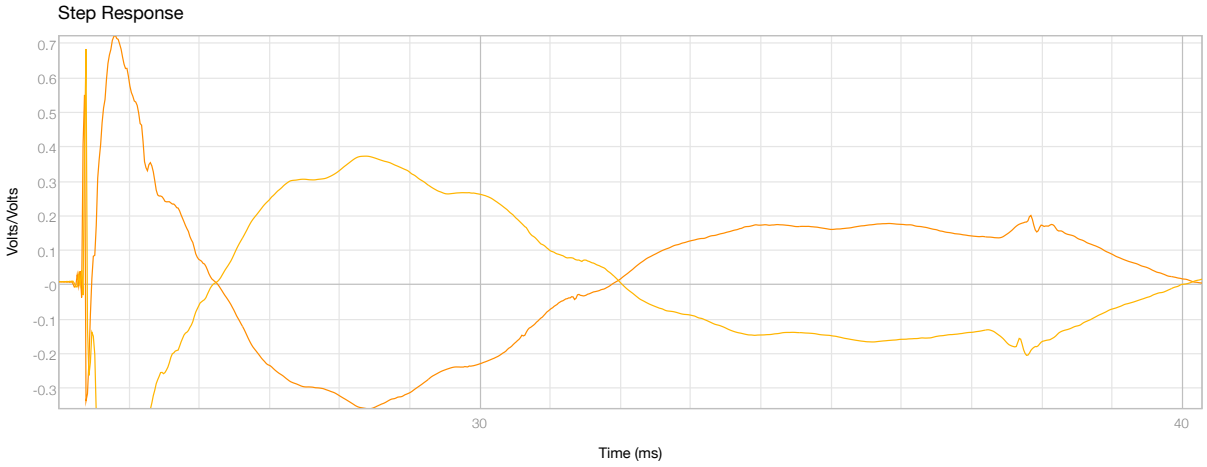
Minimum Phase



Step Response

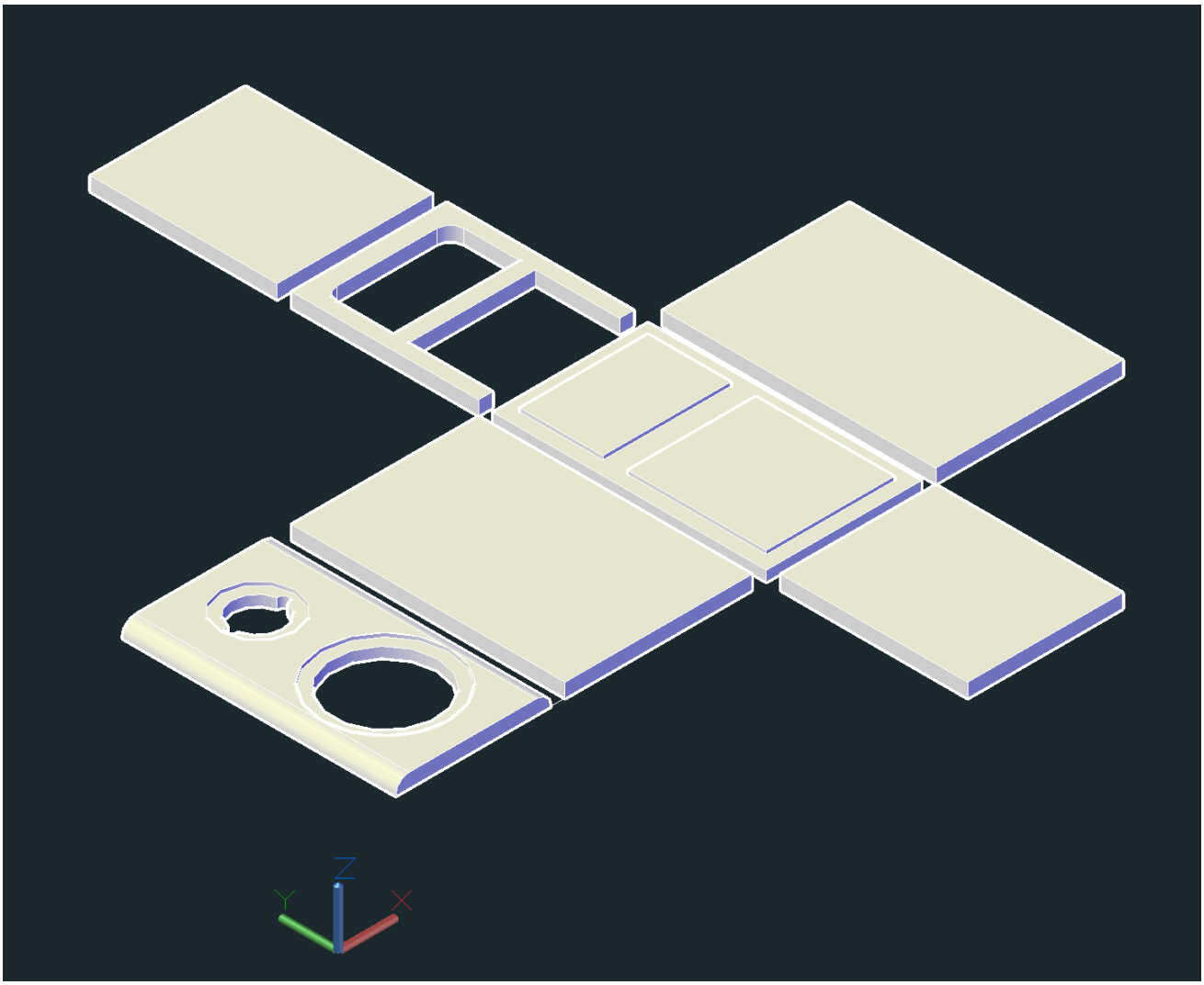


Integrated Step Response



(Will be updated and changed at a later date)

Loudspeaker Drafting



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