



Backpack Speaker

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Responsibility Breakdown

Connor: Background and goals

Andy: Structure of the case

Power

David: Amplifier selection

Jack: Tweeter and woofer selections

Alex: Microcontroller requirements and options



Introduction

- Backpack speaker system
 - Portable
 - Goal is <40 lbs
 - High quality with subwoofer
 - Durable
 - Withstand outdoor conditions and frequent transportation
 - Ideally not too expensive
 - Budget is ~\$500
 - Ability to run on battery(ideally)
 - RGB Lighting
 - User Interface
 - On the system as well as through Bluetooth app
 - Control equalization through both



Background

- Motivation
 - No speaker systems on the market that are both portable and good quality
 - Can be carried around(with some effort) and has good frequency response
 - Battery powered speakers on the market are typically unimpressive
- Amplification
 - Typically the Tweeter, Woofer, and Subwoofer all connect to external amplifier
 - Internal Class D Amplifier
 - Housed in Subwoofer box
 - 3.5mm, RCA, or Bluetooth
 - Allows for more portability and less cables
 - Standalone system



Physical Case

Dependent on speaker selection:

2 Mid Speaker dimensions: 12" tall x 7" wide x 10" deep (maximum)

Subwoofer dimensions: 14" tall x 14" wide x 10" deep (maximum)

Materials:

- ¼" MDF (for dimensions above, weighs 14.67lbs) - \$42.25 for 48"x 96"
- Aluminum bracing possibly for support
- reduce standing waves with polyfill



Power System

Don't have funds or weight for full battery power - demonstration instead

Will be plugged in for most of the time

Can unplug and go on battery power to show viability

- 7S Li-Po battery, to get voltage required (24V)
- C rating in order to supply current necessary
- Don't need huge capacity

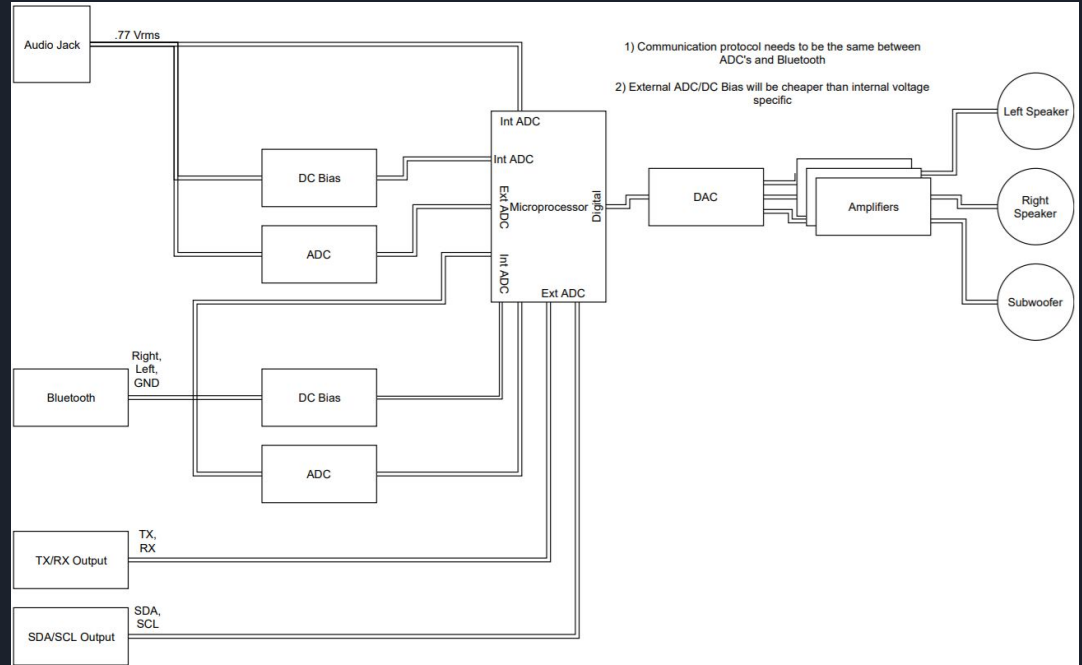
Parts

Microcontroller with I2C and I2S

Class D Audio Amplifiers

2 Layer PCB

Switching power supply



Amplifier

Subwoofer and Midrange Speakers

TAS3251DKQR

175W-Stereo, 350W-Mono, Ultra-HD Digital-Input Class-D Burr-Brown™ audio amplifier

Audio inputs:

I2S, TDM, left or right justified

Fixed function processing

SmartEQ (up to 15x BiQuads per channel)

Crossover EQ (2x5 BiQuads)

12-V to 36 V supply voltage operation

Error reporting, integrated protection





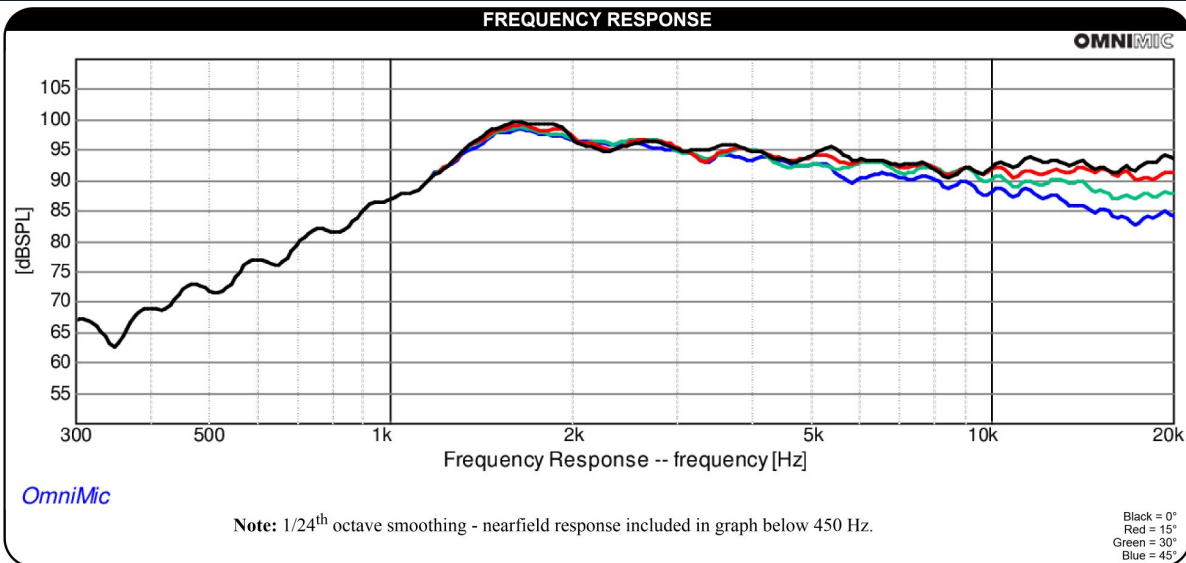
Speaker Selection Guidelines

- Minimal ripple within operating range
- High dispersion with little signal degradation within 45 degree cone in front of speaker
- Sensitivity of 90 dB 1W/m
- Minimal weight if possible

Tweeter



NHP25Ti-4 1" Titanium Dome High Power Neodymium Tweeter
4 Ohm



Re = 3.23 Ohms

SPL = 94dB

2.83V/1m (2W)

40 Wrms power
handling

.25 lbs

\$20.48



Midrange

Ideally 4-6" diameter

4 Ohm

Flat response between 100 Hz and ~1.5kHz

Problem: most speakers so far have a significant bump around 1kHz to 2kHz or have other significant ripples in the passband

Possible solution: smaller speaker that's less efficient / has lower W_{rms}

One Possibility for Midrange



ND140-4 5-1/4" Aluminum Cone Midbass Driver 4 Ohm

ND140-4

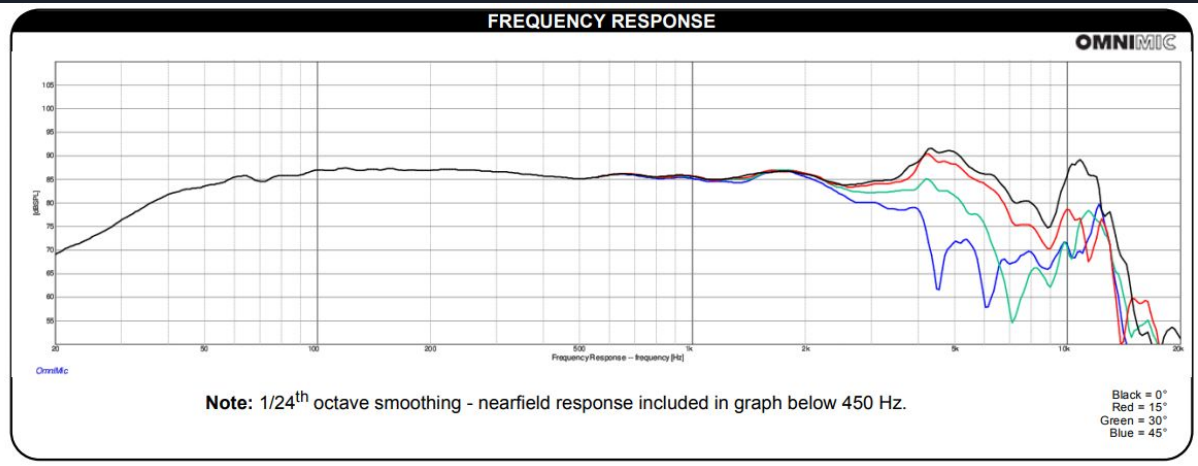


$V_b = .1403 \text{ ft}^3$ $F_l = 93.9 \text{ Hz}$ (assuming $Q_{mc} = 3.5$ for sealed box)

88.4 dB 2.83 V/1m (2 W)

1 lbs

\$29.98



Second Possibility for Midrange



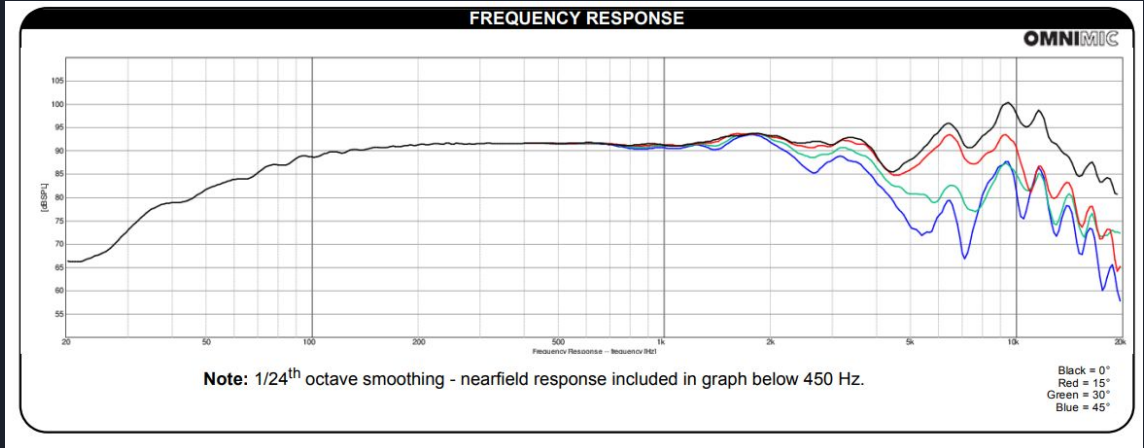
RS150-4 6" Reference Woofer 4 Ohm

RS150-4



$F_1 = 109.62 \text{ Hz}$ $V_b = .0983 \text{ ft}^3$

91.8 dB 2.83 V/1m (2W) 2.8 lbs \$35.98



Third Possibility for Midrange



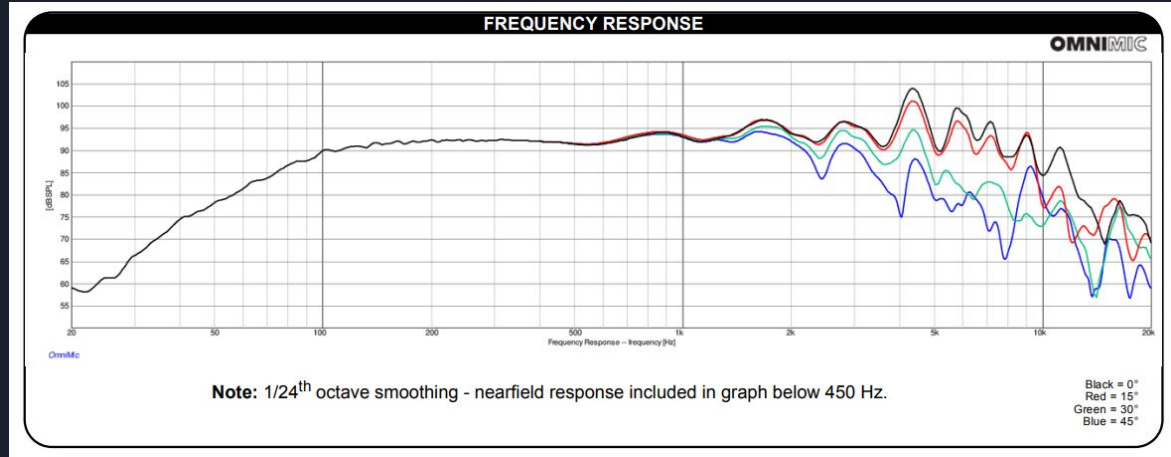
PK165-8 6" Professional Kevlar/Paper Cone Midrange 8 Ohm

PK165-8



$V_b = .1709 \text{ ft}^3$ $F_l = 139.5 \text{ Hz}$ 91.4 dB $2.83\text{V}/1\text{m}$ (1 W!!!!) ->

Twice as efficient as previous! \$32.98 4.2 lbs



Infrawoofer



MTX audio T5512-44

It was \$4

Dual 4 Ohm voice coils

$f_l = 49.20 \text{ Hz}$

$V_b = 1.06 \text{ ft}^3$

$92.89 \text{ dB } 2.83 \text{ V/1m } (@2 \text{ Ohms} \rightarrow 4\text{W}) = 89.89 \text{ dB } @ 2\text{W}$

Microcontroller

- Analog input pins
 - ADC: 16-bit resolution
- I2S and I2C for Amps
 - Communicate with 3 Amps
- DSP not needed on Microcontroller
 - Amplifiers have the ability to do DSP



- Teensy
 - Four I2C ports
 - I2S audio port, 4-channel digital audio input and output
 - 25 analog inputs to two ADCs with 12 bit resolution
 - Two analog outputs (DACs) with 12-bit resolution
 - \$36.88

Bluetooth Module

KC-6112 BlueAudio Module

- Specific Protocols for Audio
- Internal Class 2 Antenna
- I2C and I2S Ports
- 25 meter range
- Vdd: 2.9 - 4.4V
- Cost: \$25





Current Status

- Ordered: Test Amplifiers (2 different types)
- Research:
 - Bluetooth Modules
 - Microcontrollers
 - ADC - if Microcontroller doesn't have right bit rate
 - Switching Power Supply
 - Matching Speakers' frequency response
- Next Steps
 - Microcontroller
 - Bluetooth Module
 - Switching Power Supply
 - Block Diagram
 - PCB Design