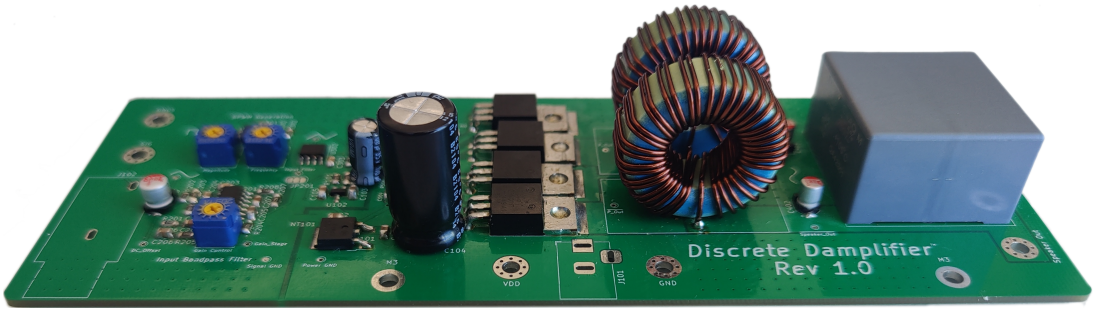
ECEN405 D-Class Amplifier

'What a buck converter would say if it could talk'

Niels Clayton : 300437590
Team Members: Daniel Eisen & Nickolai Wolfe



1 Introduction

Audio amplifiers facilitate the driving of high power speakers from small signal audio outputs. Common amplifier types for high fidelity audio are the class A and AB amplifier. These amplifiers provide high power outputs and very little distortion, with the limitation of low power efficiency. In contrast, the class D amplifier is a high efficiency power amplifier with the limitation of design complexity and requiring large amounts of output filtering.

The operation of a class D amplifier can be broken down into discrete sections that can be seen outlined in Figure 1. From this figure we can see that the input audio signal is first filtered to remove unwanted components. This signal is then sampled at high frequency and amplified to a high power output. Finally this sampled signal is then filtered to remove the sampling frequency, providing a low distortion high efficiency output.

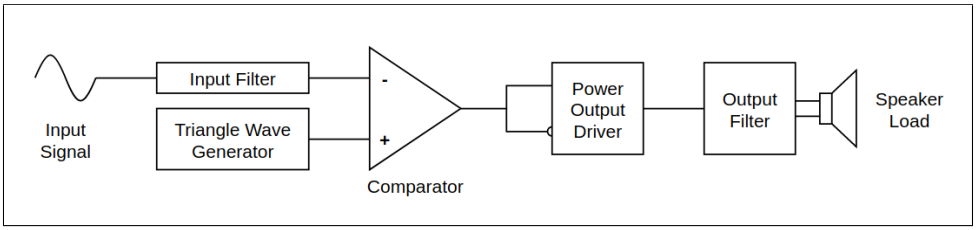


Figure 1: D-Class amplifier high level block diagram

The purpose of this reports is to discuss the design and implementation of a class D amplifier for use in driving a sub-woofer speaker to given specifications outlined in Section 1.1. This project was completed in a group of three, where I have taken responsibility for the audio sampling and sinusoidal pulse width modulation (SPWM) generation designs. We have all contributed equally to the final PCB and schematic designs.

1.1 Specifications

- Supply 80W of power into a 4Ω load.
- Have a 10Hz to 200Hz operating bandwidth.
- Have an input sensitivity of 1V for maximum output.
- Cost a maximum of $50 per unit.

2 Design

Here you should describe how your class D amplifier works, giving details of each subsection. In detail, you should describe the section you designed and the design choices you made. If your team broke up the design of the amplifier in a way that doesn't suit individual parts being discussed, you will need to talk about the whole design in a bit more detail but you should also describe how the work was delegated and why.

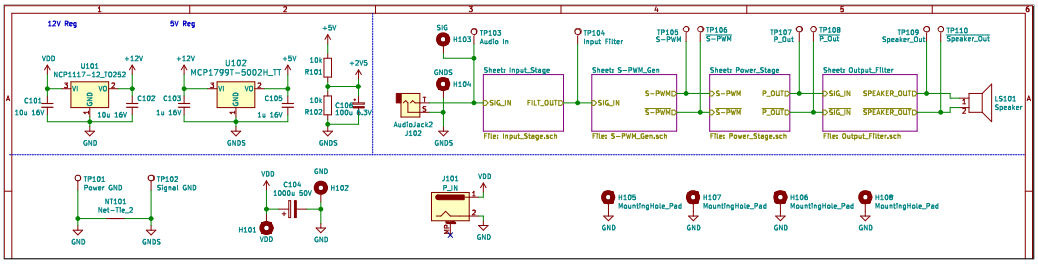


Figure 2: High level design schematic

2.1 Input Filter

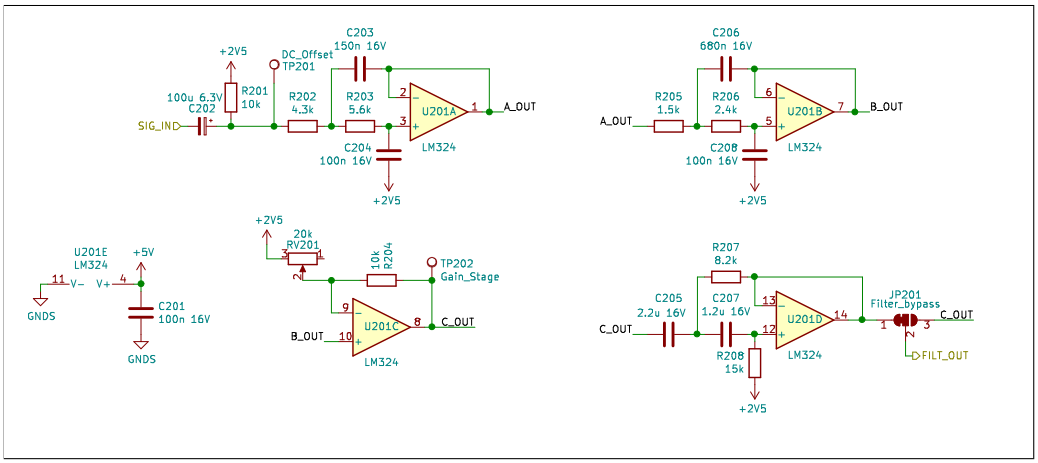


Figure 3: Input filtering schematic

2.2 Audio Sampling & SPWM

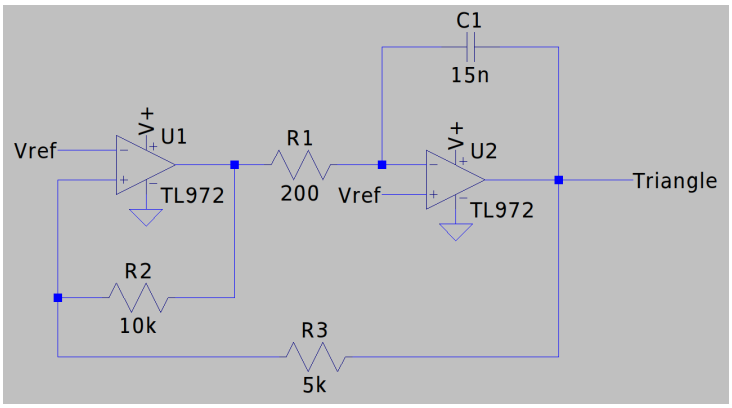


Figure 4: Triangle waveform generation citcuit

2.3 Power Stage & Output Filter

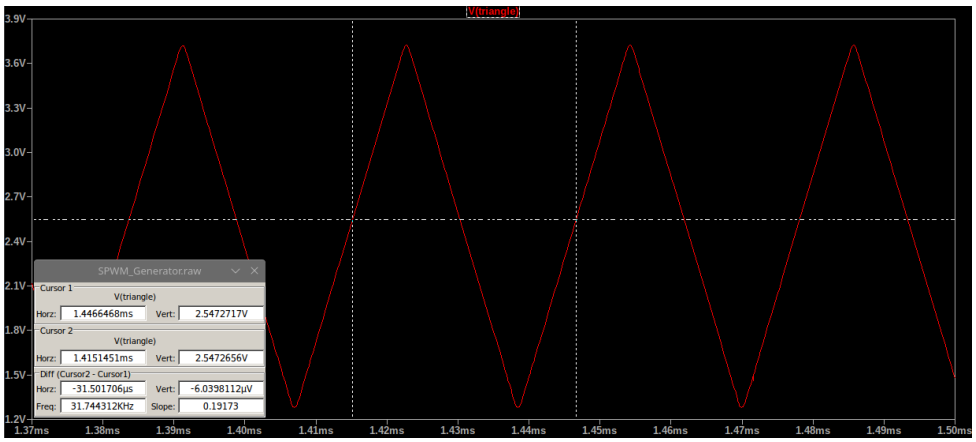


Figure 5: Simulation of the generated 32kHz triangle waveform

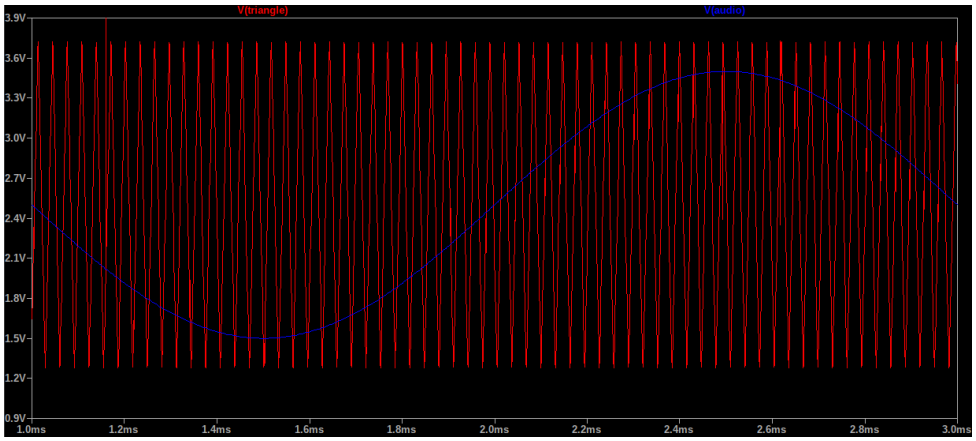


Figure 6: Simulation of a 1V peak to peak input signal sampling

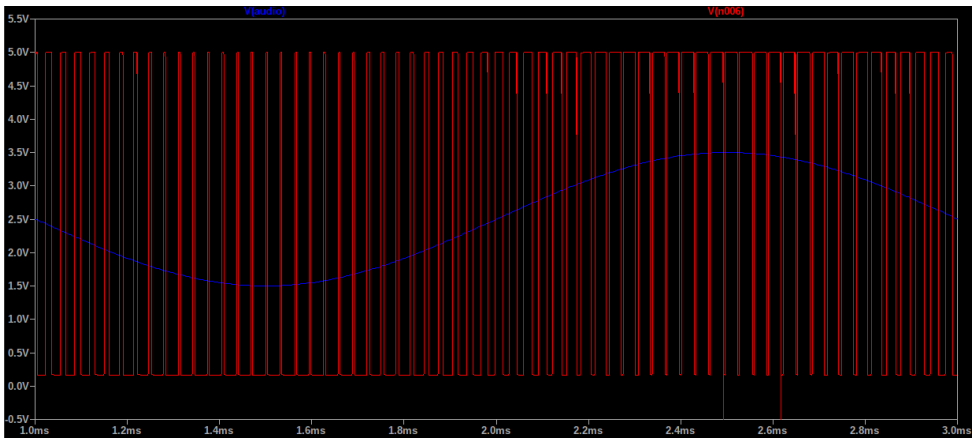


Figure 7: Simulation of the SPWM comparator output

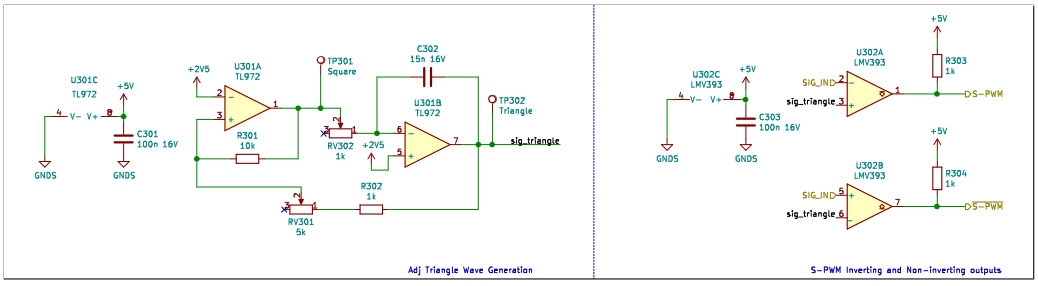


Figure 8: Sampling triangle wave & SPWM generation schematic

2.4 PCB Design and Layout

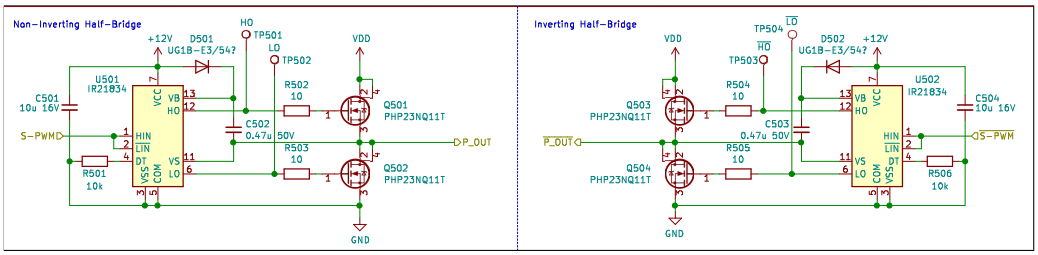


Figure 9: Gate driver schematic

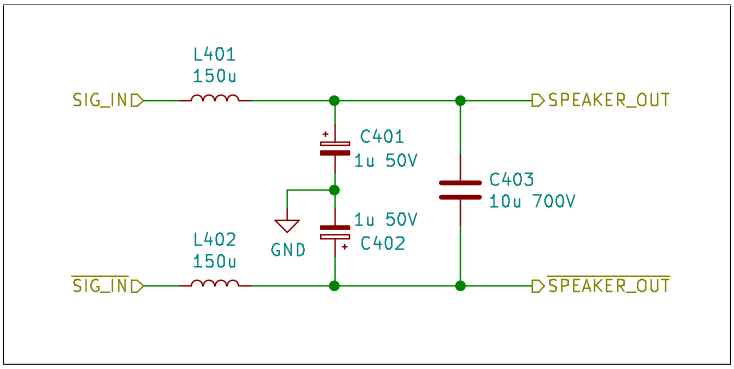


Figure 10: Output filter schematic

3 Implementation

Here you should discuss the assembly of the amplifier and any problems you faced as a team building the amplifier.
Here, the individual components should also be characterised. For example: if you have a filter, what is the response and how does it compare to the calculated? If you have a triangle wave, how does it look? Is it doing what I should? Why? Why not? How do the inputs/outputs of your comparator look? How does the square wave on the gate of the MOSFETs look?

4 Results

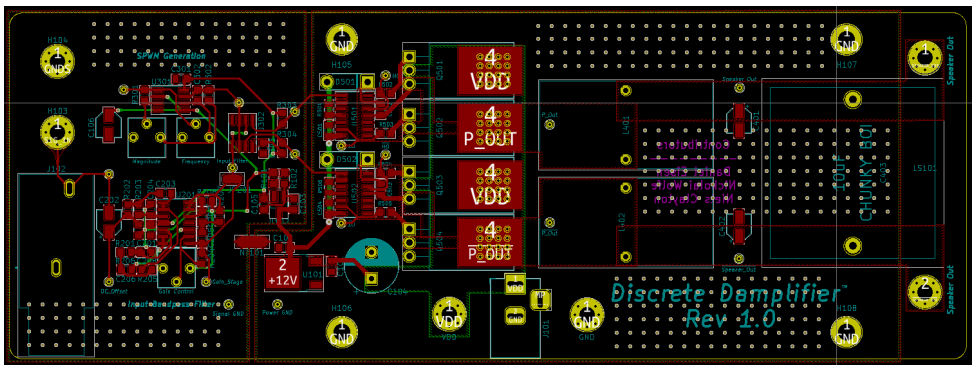
Here I would expect to see the results of the whole amp, for example: an output wave, analysis of the efficiency, discuss maximum power output (which may be frequency dependent), and THD.

Frequency (Hz)	THD (%)
30	1.8
50	2.2
100	3.2
200	3.3
300	3.5
500	3.2

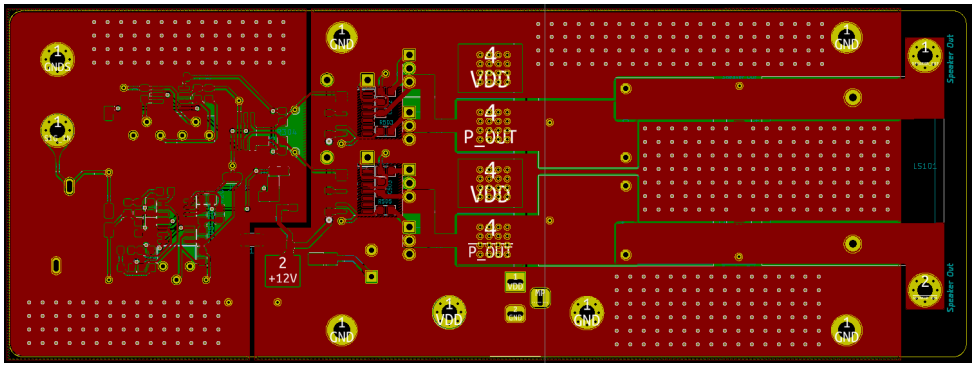
Table 1: Output total harmonic distortion across frequency

5 Conclusions

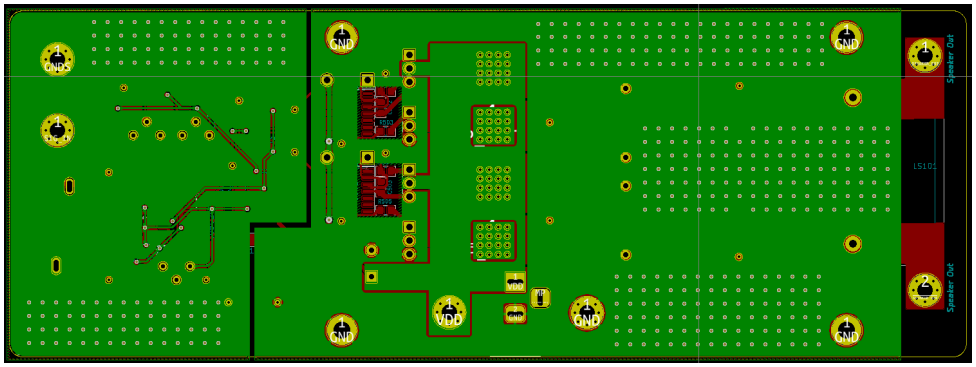
What worked, didn't work? How would you change your approach? Any interesting insights?



(a)

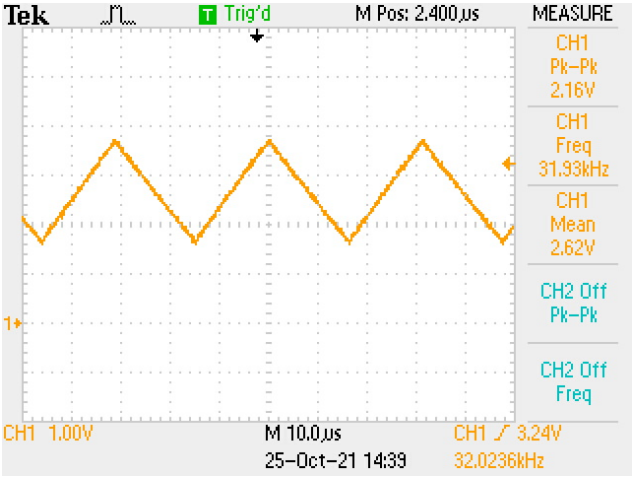


(b)

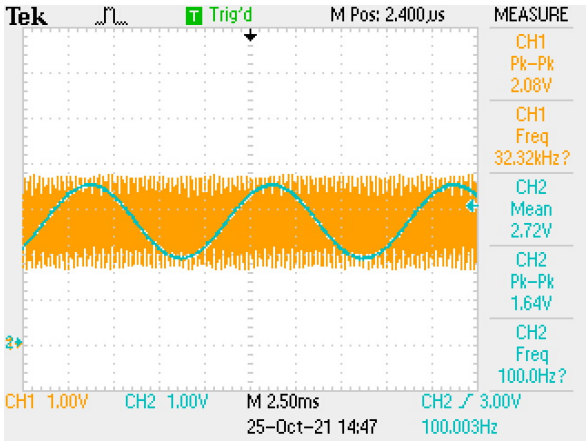


(c)

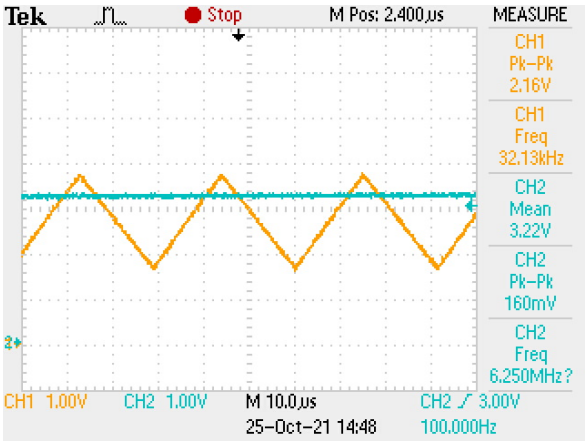
Figure 11



(a)



(b)



(c)

Figure 12

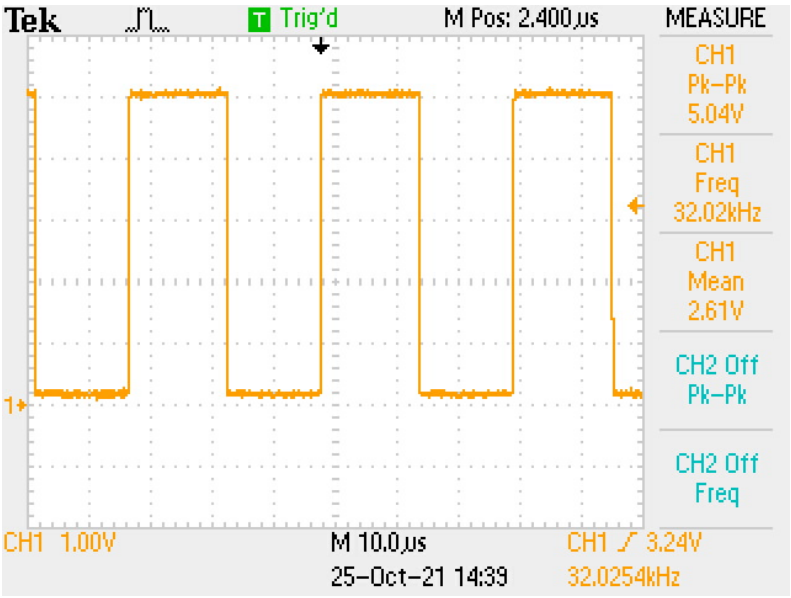
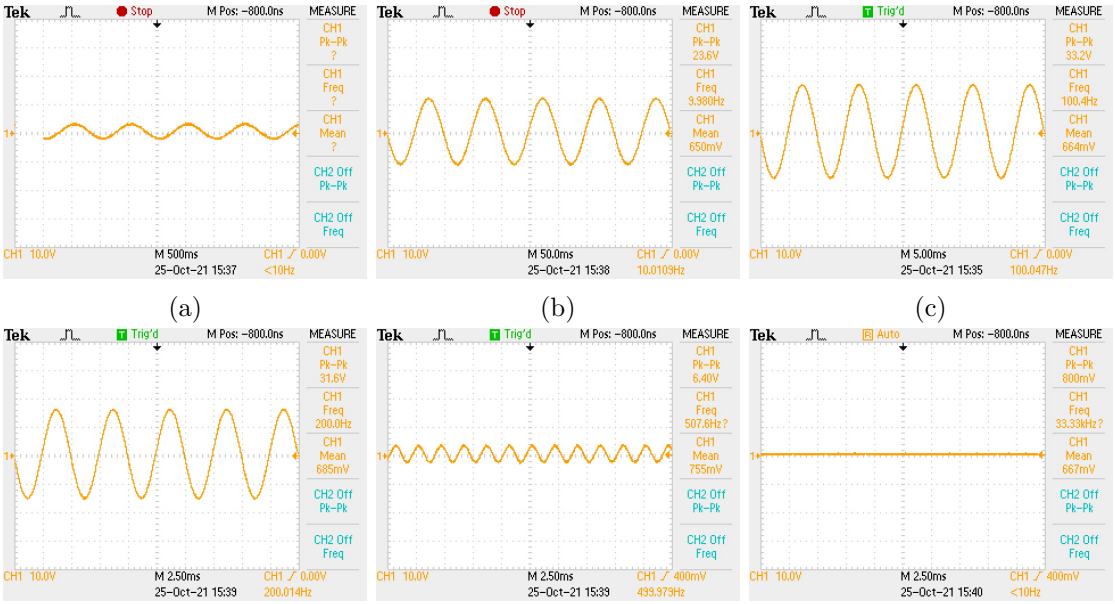


Figure 13: Amplifier output bode plot



(a) (b) (c)

(d) (e) (f)

Figure 14

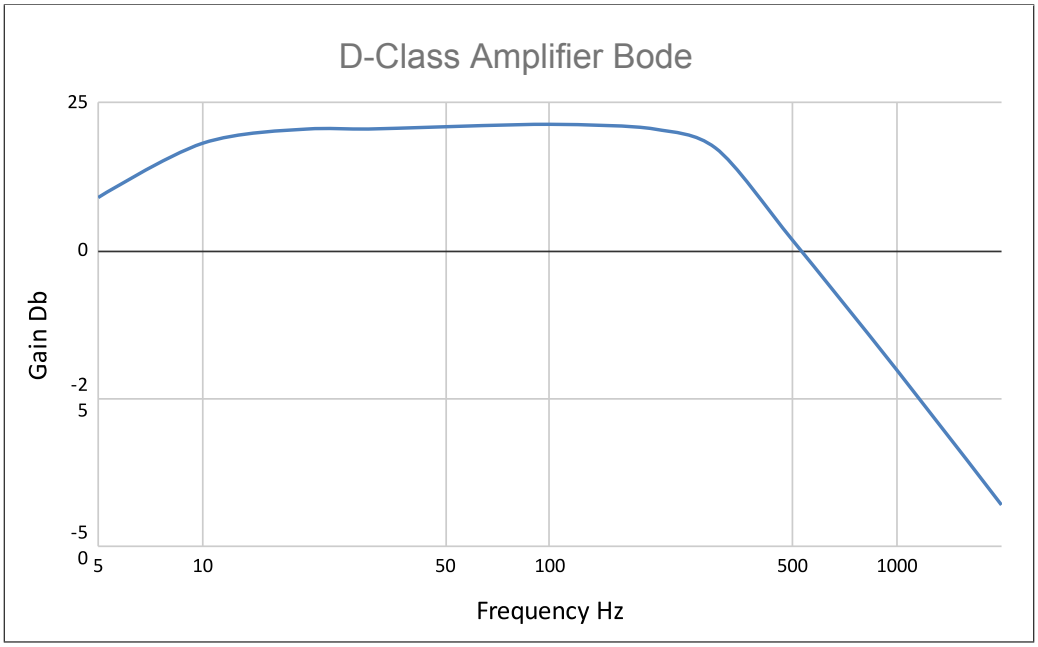


Figure 15: Amplifier output bode plot

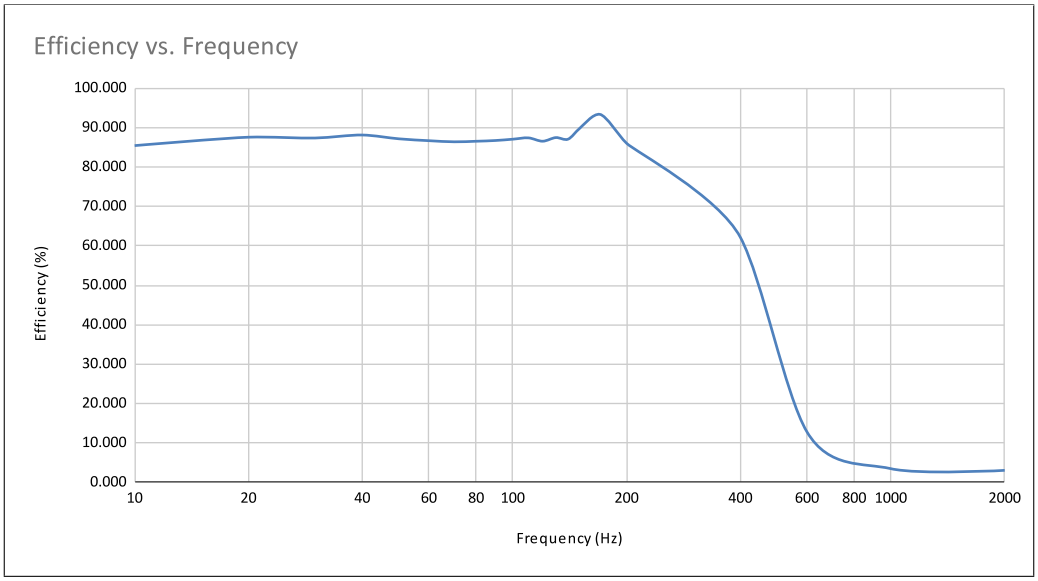
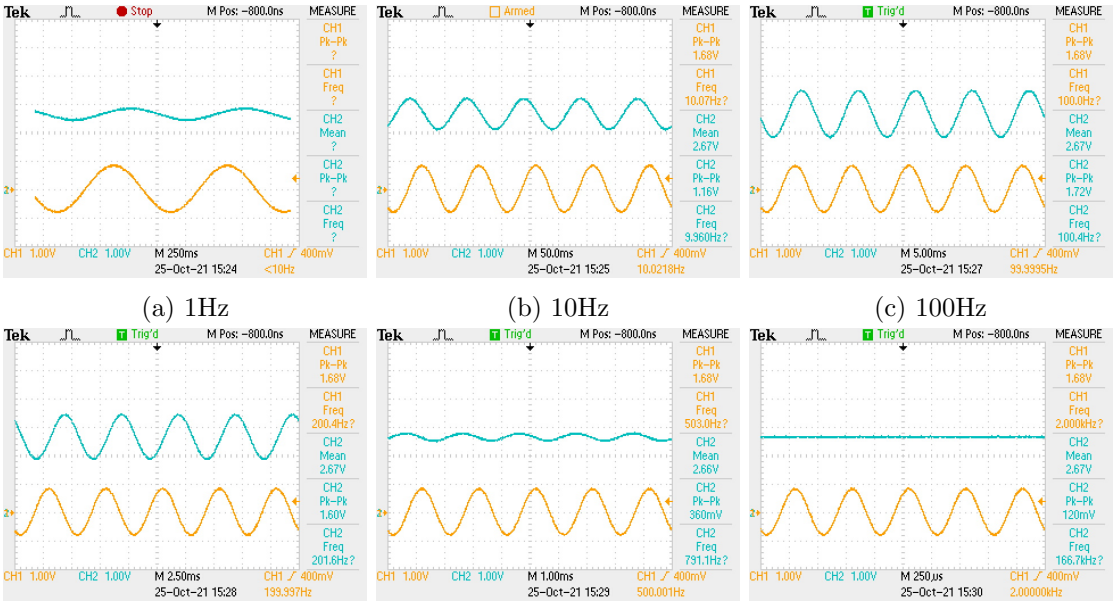


Figure 16: Amplifier output efficiency vs frequency

Appendix

Input Filter



(a) 1Hz (b) 10Hz (c) 100Hz

(d) 200Hz (e) 500Hz (f) 2kHz

Figure 17: Input filter operation across frequencies, input signal (yellow) vs filter output (blue)