High-power Class-D Amplifier With Five Band Equalizer

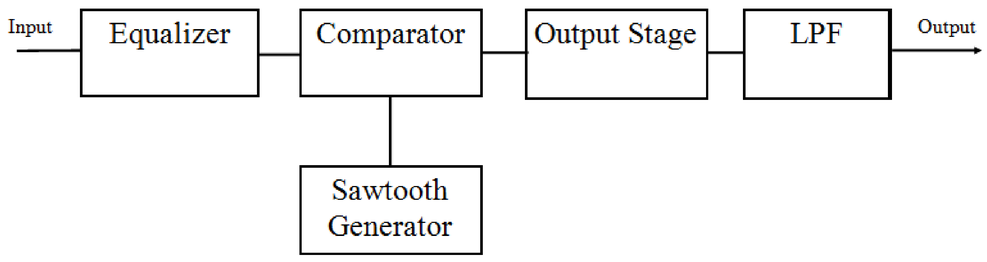
May15-24: Alan Stewart, Dana Conrad, Jing Li, Kyle Maginot, Troy Bowers, Xilu Wang

Adviser/Client: Ayman Fayed

Problem Statement

The objective of this project is the implementation of a Class-D audio amplifier system coupled with a five band equalizer. The audio signal is to be sent through an equalizer system that can amplify or attenuate certain frequency bands. The equalized audio signal will then be amplified via a switching amplifier.

Block Diagram



Equalizer: Allows the user to adjust overall frequency response

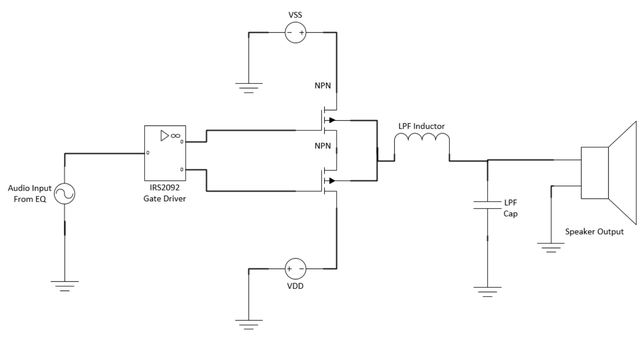
Comparator: Generates Pulse-Width Modulated signal via Equalizer and Sawtooth Generator output

Sawtooth Generator: Allows for analog signal to be turned into a digital output, oscillates at 300kHz

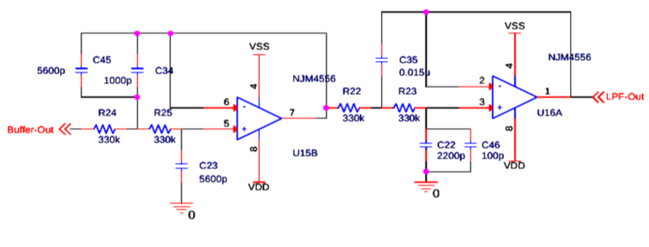
Output Stage: High Current MOSFETs that provide a high powered signal to the speaker

Low Pass Filter: Greatly attenuates switching noise generated from high frequency oscillator

Circuit Schematics



Simplified version of the MOSFET output



Example of a 4th order Butterworth filter

Test Procedure

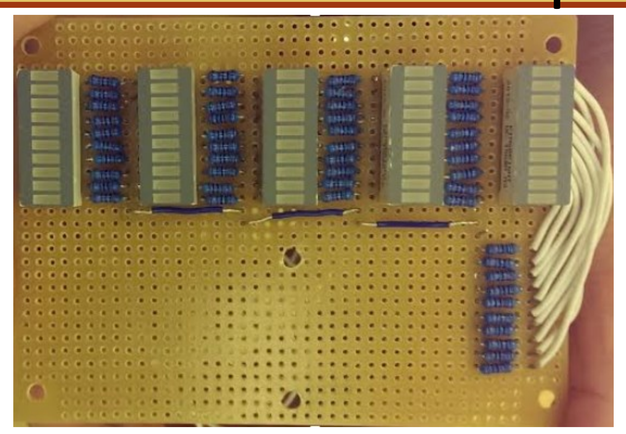
Signal to Noise Ratio: Measured at the output with a $1.228V_{RMS}$, 1 kHz sine wave input. Must be greater than 96 dB.

Power Efficiency: The ratio of Output Power to Input Power must be greater than 0.85.

Functional Requirements

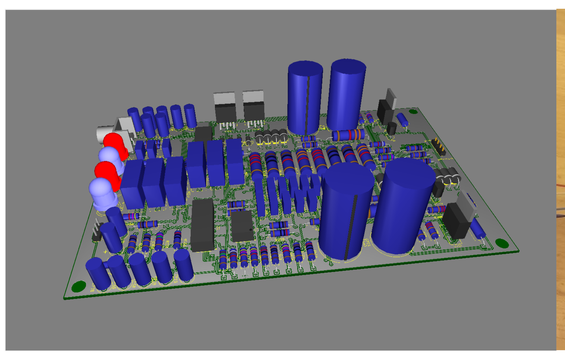
- High Power (200 Watts) output amplifier
- Equalizer can emphasize or attenuate individual frequency bands of the input signal
- 85% or greater Power Efficiency
- Better than 96 dB Signal to Noise Ratio (SNR)

Non-Functional Requirements

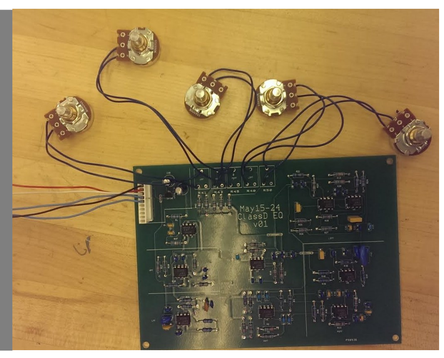


LED interface for showing individual band attenuation levels

PCB Designs

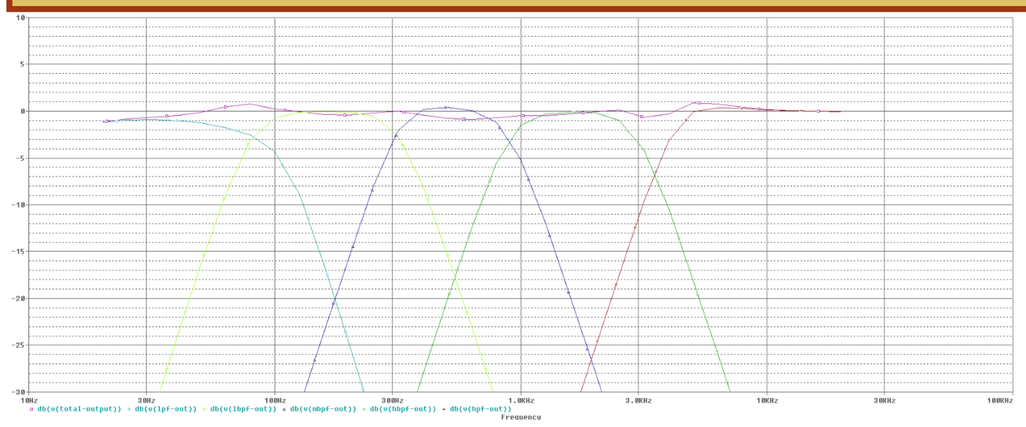


3D Render of Amplifier Board

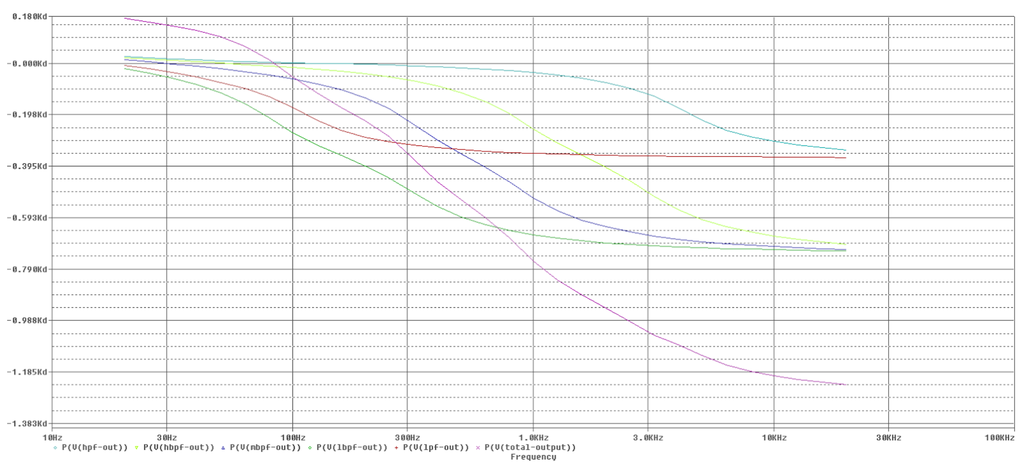


Equalizer Board

Simulation Results



Frequency Response of all five filter bands and output signal



Phase Diagram of equalizer bands and output phase shift

- Equal output magnitude across audio spectrum
- No constructive or deconstructive interference due to phase differences