CLASS D AMP DESIGN DOCUMENT

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Class D Amp Design Document

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1.1 Contest Summary and Rules

1.2 Project Requirements and Goals

1.2.1 Requirements

The system is designed to take an audio input from an Apple device, such as an iTouch, iPod, iPad, etc. The explicit Class-D amplifier in the system must have a power efficiency of 80%. The system must also output a sound whose signal-to-noise ratio is great than or equal to 96dB. The system should also has some system to implement or mimic a 3-band EQ.

1.2.2 Goals

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1.3 Operational Environment

The system must be operable in normal commercial environments. The audio amplifier is design to be used near humans, so no extraordinary consideration needs to be made about temperature or other operating conditions. The system should be easy enough for a small human to move around with one hand. The system should have measures to ensure it does not bring any hazards to the environment in which it is operating.

1.4 Limitations

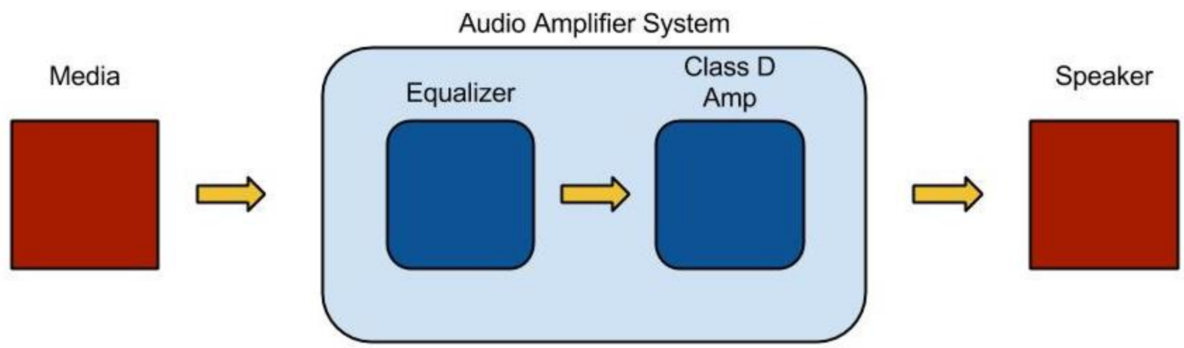
Iowa State University's equipment are currently the only thing that can be used to power and test the equipment. The size is limited by the constraint in section 1.3. The device should be producible at a competitive rate, without the consideration of labor. A wall source of US Standard 120 VoltRMS at 15 amps. The system should utilize as many parts from TI as possible, to increase the TI tournament's score.

1.5 Deliverables

The system should meet or exceed all the requirements (specified in section 1.2.1) and should attempt to meet or exceed all the goals provided in section 1.2.2.

2.1 Concept Sketch

Below is a basic sketch of the system. The blue blocks are what will be designed in the system. The red blocks will not be designed, but the system must be able to handle specific media inputs and drive speakers so they need consideration



2.2 Functional Specifications

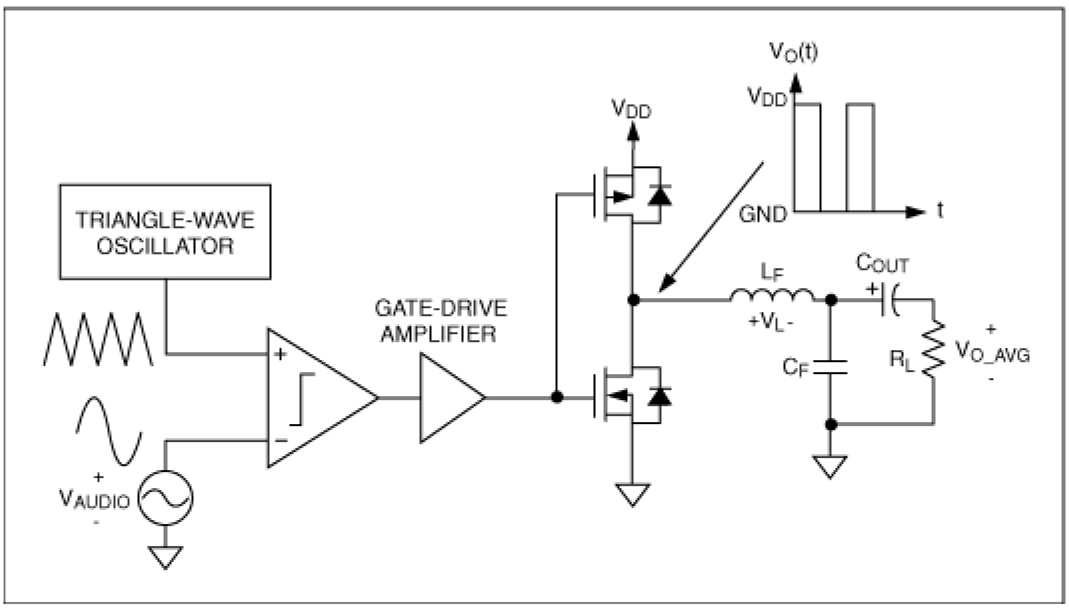
The requirements set in section 1.2.1 are specifically goals the system needs to meet. The system must also be able to take input from different types of media, such as iPods, CD Players, or any type of basic commercial media type. The audio amplifier system must be able to drive the speaker. Speakers have different power ratings and impedance values, so the speakers used in this system must be ones that the amplifier can drive. This is the standard in audio industries; that a customer must ensure the speaker and audio amplifier match correctly. The EQ must be 3-band, and allow changes in the frequency content to the speaker.

3.1 EQ Design

The EQ is a design requirement, and also to add some variability to the audio amplifier system. It allows the user to change the high, middle, or low band of frequencies to change and vary in amplitude. The EQ will be at least 3-bands, which will be selected to reduce crossover to near zero. The bands will be selected to give a functional and audibly notable change in the sound coming out of the speaker. This system will have an active EQ, for the various benefits seen by this type of EQ.

3.2 Class-D Amplifier

The audio signal to be amplified is inputted into one of the terminals of a comparator. The other terminal has a high frequency triangle wave pulsing at a constant frequency and amplitude (the triangle waves frequency must be about 15 times greater than the frequency of the signal to be amplified). This creates a digital pulse wave. Any specific pulse's width is directly related to the audio signals amplitude at that specific time. This pulse wave can physically have this relationship because its frequency is so much higher than the audio signal. After this, the pulse wave modulated signal is inputted into a gate-driver, to help drive the next stage. This next stage is a push-pull power MOSFET configuration. When the inputted digital pulse wave hits the gates of the MOSFETs, the signal gets amplified. When the digital pulse signal is a one, the PUN MOSFET puts VDD as the output. When the digital pulse signal is low, the PDN MOSFET pushes the signal to Vss. This effectively is a digital signal amplifier, whose gain is related to the difference between Vdd and Vss. This digital signal is then put through a low pass filter to kill out the meaningless high frequency components, and the resulting signal is sent to the speaker.



3.3 Other Features

4.1 EQ Design

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4.2.1 Speaker Specifications

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4.3.1 Other Features Designs

4.3.2 Interfacing the Design

5.1 Power Testing and Analysis

Because the power requirements only concern the D Class amplifier, it is the only system that needs to be rigorously tested and compared. The entire system will be tested for power consumption. Measurements will be taken to find and confirm the input voltage and current at RMS values, and the output voltage and current to the speaker. The simple equation of output power over input power will be used to determine the efficiency of the system and the Class-D amplifier by itself.

5.2 Audio Quality Testing and Evaluation

Sin, triangle, square, and other various waves will be inputted to the system and tested for signal to noise ratio. High level quantitative analysis will be done in MATLAB, to ensure the fidelity of the SNR test. Audio waves will also be tested for SNR in MATLAB. Qualitative analysis will be done by inputting an audio wave into the system at various amplitudes to ensure that no distortion can be audible heard by normal humans.

5.3 EQ Functionality Testing and Evaluation

Sin waves will inputted at the corner frequencies of the EQ to verify the corner frequencies are in the correct location. Qualitative testing will be done in the form of a sample audio input and sound verification to confirm that it is boosting high, middle, or low frequencies. White noise will be inputted to the system to also confirm the bands are getting boosted, both quantitatively and qualitatively. White noise will also be used to confirm the flatness of the crossovers to ensure that the filters are not interacting to a destructive degree.

5.4 Whole System Testing and Evaluation