6.101 Final Project Proposal

Class G Audio Amplifier

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1 Introduction

For my final project, I will be constructing a 30V audio amplifier capable of delivering about 150 watts into a network of transformer coupled loudspeakers. My design utilizes a class G (rail switching) output stage for increased efficiency and lessened cooling requirements. To start, I will be using a salvaged multi-tap 60Hz power transformer to generate the voltage rails for my amplifier, but if time allows I plan on building a power supply that I designed in a previous class with this application in mind.

2 System Outline

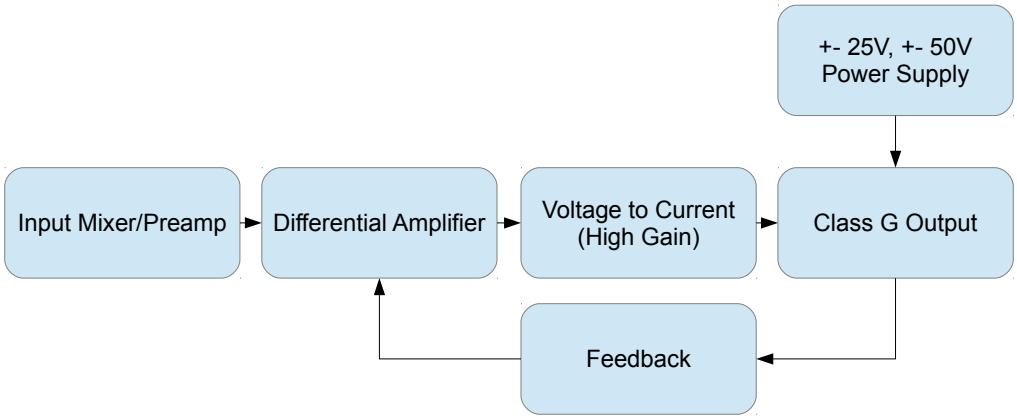

Figure 1: Amplifier Block Diagram

2.1 Input Mixer/Preamp

I would like the amplifier to be able to accept multiple inputs at the same time, say from a computer and someones phone. To achieve this, I'll have a simple op amp circuit at the frontend of my amplifier that will sum together and amplify multiple line level inputs to be fed into the main amplifier. Each of these inputs will also have a volume control knob.

2.2 Differential Amplifier

As in an op-amp, my amplifier will make use of extremely high gain and negative feedback to precisely control its output voltage. For this, a differential input stage is required. I plan on using a long tailed pair configuration with current mirror loads. The current mirror will need to be implemented with a discrete matched transistor pair such as the LM3086 used in 6.301.

2.3 High Gain Stage

The high gain stage is a transconductance amplifier that converts the output voltage from the differential amplifier to a current which drives the output stage. Most of the loop gain is concentrated in this stage. The amplifier is also compensated in this stage.

2.4 Class G Output

The class G output stage is the focus of my project. Essentially, it consists of a class AB amplifier (as constructed in lab 5) with a second set of output transistors wrapped around it. A basic illustration of this topology is shown in figure 2. The outer transistors are connected to a set of voltage rails that are roughly double the rails supplying the inner transistors, and only turn on when the output voltage is about to exceed the voltages available on the inner rails. This results in greatly improved efficiency for output signal amplitudes that do not cause the outer transistors to turn on (as shown in figure 3). This is of great benefit for signals with low average amplitude and high peak amplitude, as is often the case with music. The outer transistors may only turn on for a short instant to prevent clipping on the beat of a song while the rest of the song is efficiently amplified by the inner transistors.

2.5 Power Supply

I originally developed the idea for this project last semester when I was taking 6.UAT and 6.332. 6.UAT required me to propose an arbitrary project, and 6.332 required me to complete a final design project related to power electronics. I ended up proposing a 200W audio amplifier for 6.UAT and designing but not building a 400W ZVS full bridge converter for 6.332. I would like to take this opportunity to build the converter I designed, but since that would be a fairly large project by itself and is not the focus of my 6.101 final project, I am going to start by using a simple 60Hz power transformer (which I already have) for power. I salvaged this transformer from a broken audio amplifier similar to the type I am building. It has a single output winding with five taps. The output voltages are suitable for my four power rails. I'll just need two bridge rectifiers and some very large capacitors to smooth out the output voltage. If time allows, and possibly even after I finish this class, I will look into building my smaller more efficient switching power converter.

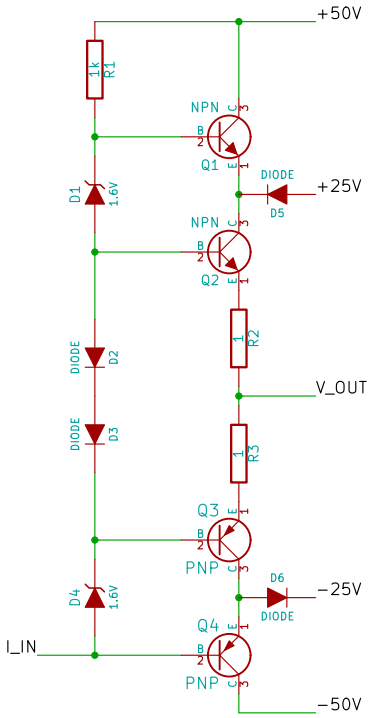

Figure 2: Schematic Class G Output Stage

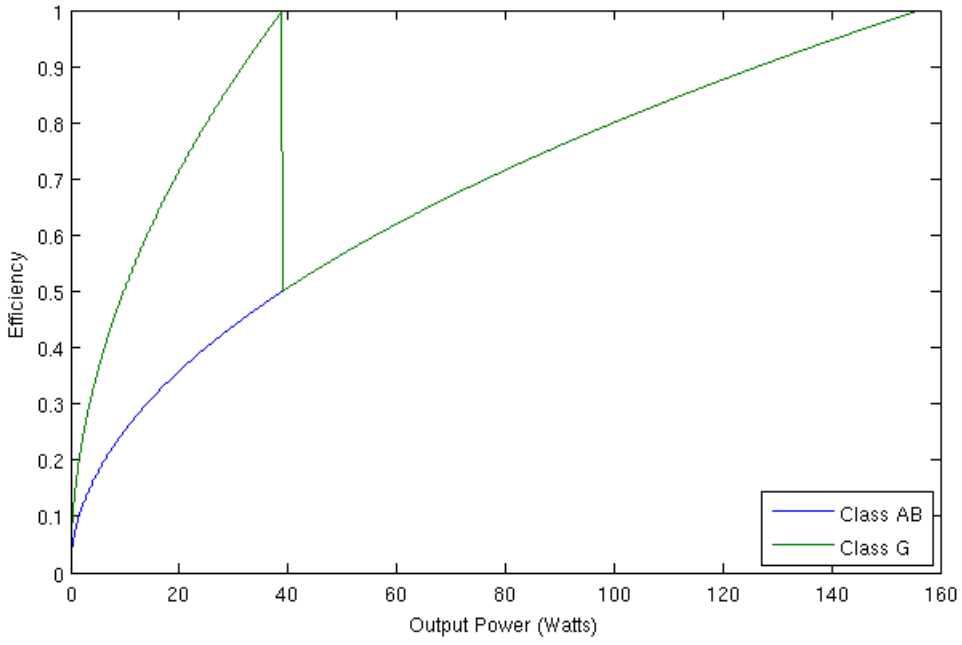

Figure 3: Efficiency Curves For Class AB and Class G amplifiers

3 PCB

Because of the complexity of my project, I think it will be best to design and order a PCB as suggested by the course. I'm running kind of late, so turn time is important. Advanced Circuits has a "barebones" option where the ship the board in one day but don't give you solder mask or silkscreen. The price is pretty fair ($33 + something/sq inch), so this seems like a good option.