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6.S092 Track 2 Writeup

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My PCB is a voltage-controlled oscillator that is part of a Eurorack-style synthesizer. The purpose of a synthesizer is to make sounds (preferably fun ones) and to allow the user to control the pitch and other features of the sound. Sound, of course, takes to form a sine wave, where the frequency is the pitch and the amplitude is loudness, and other features of the sound are controlled by the shape of the wave. For example, a sawtooth wave will make a rather different sound than a triangle wave will. So, the goal is to output a sine wave where the shape of the wave, frequency, and amplitude are all able to vary. The final unit is a modular analog synthesizer; often you have multiple units with some serving as low frequency oscillators, producing a soundwave at a frequency that is not audible to plug into other units producing actual sound to use the low frequency wave to control, for instance, the attack rate of the audible wave. Thus, an input can be another wave, and that is a reason why there are four jacks in the design, but since I have only a single unit, I won't address that topic.

The inputs are power (12V) and the output is a sine wave. The synthesizer will need to be plugged into headphones, speakers, or another audio device. The input voltage is linear, and then one of the transistors converts the linear voltage to an exponential change in current. The nearby capacitors "eats" the current (I am using terminology from the hungry shark example) at a certain level, then causing it to drop low, creating a sawtooth shape wave (a rise and then sudden drop). The principle of voltage control is using continuous voltage to have complete control over the various characteristics of the sound, instead of being controlled in various discrete states

The other parts of the board can turn the wave into other basic shapes. A triangle wave is converted to a ramp wave using an “inverting non-inverting circuit” which is what the TL072 does. The LM13700 converts the triangle wave to a sine wave. The output wave types are indicated by net labels on the schematic. In this way, many of the basic wave types are obtained.

The design is from this project: https://djerickson.com/synth/. I made the schematic in Altium myself, which required some modifications are some symbols are different in Altium than in ExpressPCB. Additionally, some of the original parts’ footprints did not exist in Altium and some were out of stock (as the design is from 2013). Thus, during the first part of the class I spent a lot of time looking at datasheets, pin diagrams, and technical specifications to find suitable replacement parts. It was mainly the large transistors that I had to do this for, along with the oscillator.

I did not get as far in the layout as I would have liked in part due to how long I spent on remaking the schematic, and also due to that there was an issue that prevented me from working much in the second week. My progress on the layout is saved to the server and can be viewed there (or if that doesn’t work I can send the file). The layout is also a bit complicated and cannot be taken directly from the schematic because many of the transistors are represented as 2-4 subparts in the schematic, which are physically distant in the schematic but in layout are obviously the same chip. This results in many connections where crossed wires cannot be avoided and vias, etc. are necessary.

To understand the circuit and electronics/electricity in general better, I sought help from friends who were more familiar with such things than I, so here I acknowledge Shruti Siva and June Kayath as resources that I used. I also consulted the provided textbook. Of course, all of the credit for the design goes to the source that I linked above. I had a previous understanding of how synthesizers basically worked cobbled together from YouTube videos.