PINT personal assignment report

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CHAPTER 1

INTRODUCTION

I had to make a PCB that was centered around the ESP32-WROOM-32E (referred to as ESP32 from now on) chip. I was tasked with connecting it to power, making it programmable and integrating two sensors (one digital and one analog) while keeping the design as modular as possible.

CHAPTER 2

BASIC CIRCUITRY

To program the ESP32 chip we need a programmer, which serializes the data coming from the USB. For this I will be using the CP2102N chip. We also need a power supply, which can convert 5V to 3,3V and some GPIO header pins.

2.1 Programmer

As you can see in 2.1, the power is supplied by the USB and the data lines we use are the ones which are compatible with older USB standards. The rest of the components ensure the proper operation of the programmer.

2.2 Power supply

The power supply (2.2) provides 3,3V from a 5V battery or an external power supply. As you can see in 2.4 you can use the power header to connect the external 5V.

2.3 ESP32

In 2.3) you can see how the ESP32 chip is wired. Some of the connections (marked with NC) should not be used. For more on

2.4 Headers

The header connections are shown in 2.4. There are headers for the GPIO pins, the battery/power supply and external programmer.

2.4.1 GPIO headers

The GPIO pins are not ordered so users should reference the pinout every time. The pins which connect to the NC pins on the ESP should not be used (see 2.3)

2.4.2 Power headers

You can see the net labels for the 5V pins in 2.5. The 3,3V is looks the same, but it does not go through a voltage regulator (see 2.6). Do not connect a 5V and a 3,3V at the same time. Use this paragraph and the accompanying pictures for wiring.

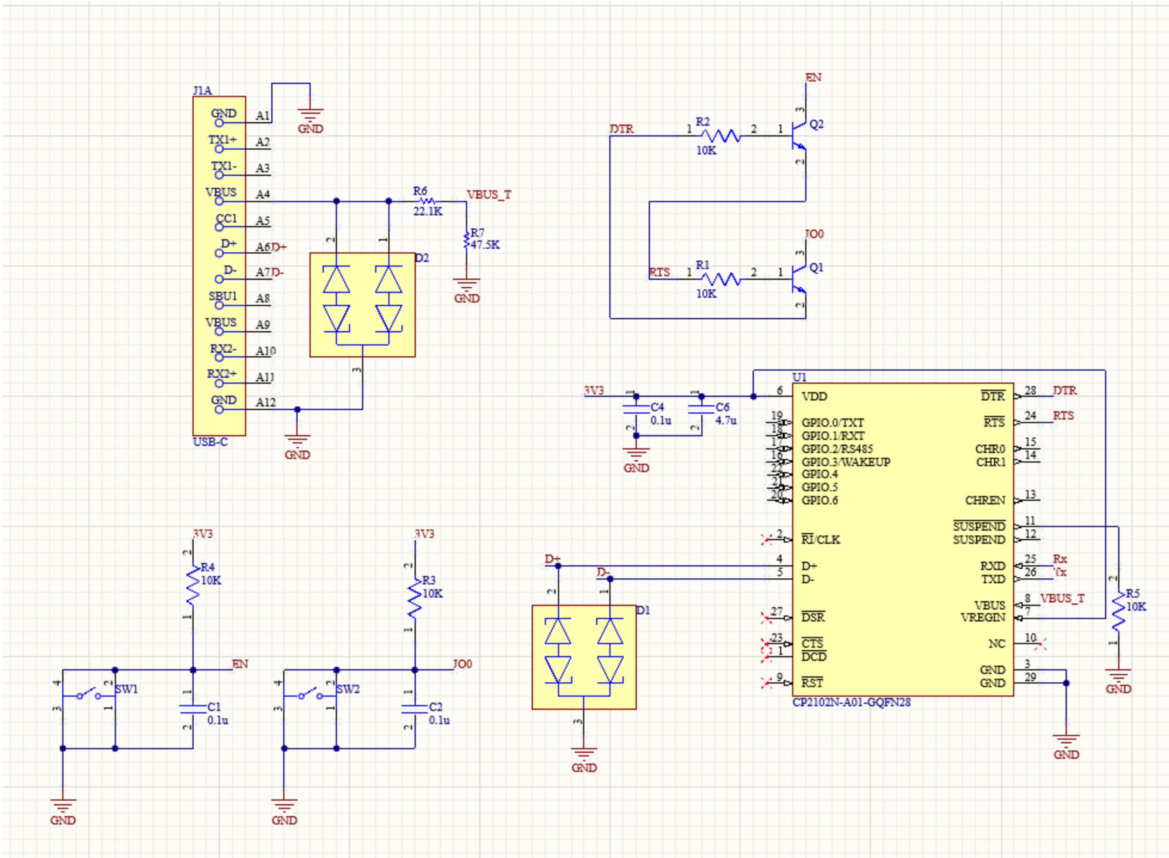

Figure 2.1: Programmer circuit

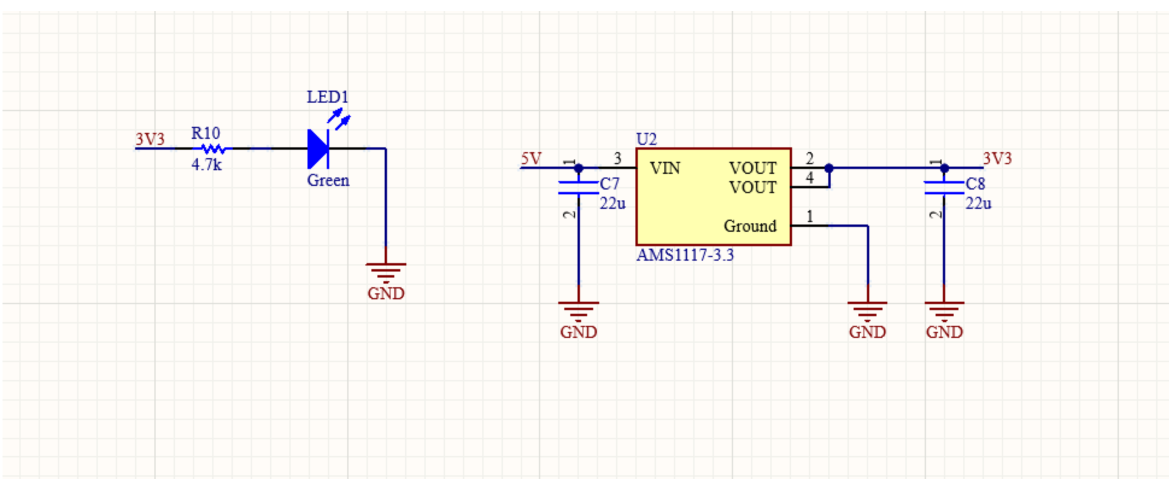

Figure 2.2: Power supply circuit

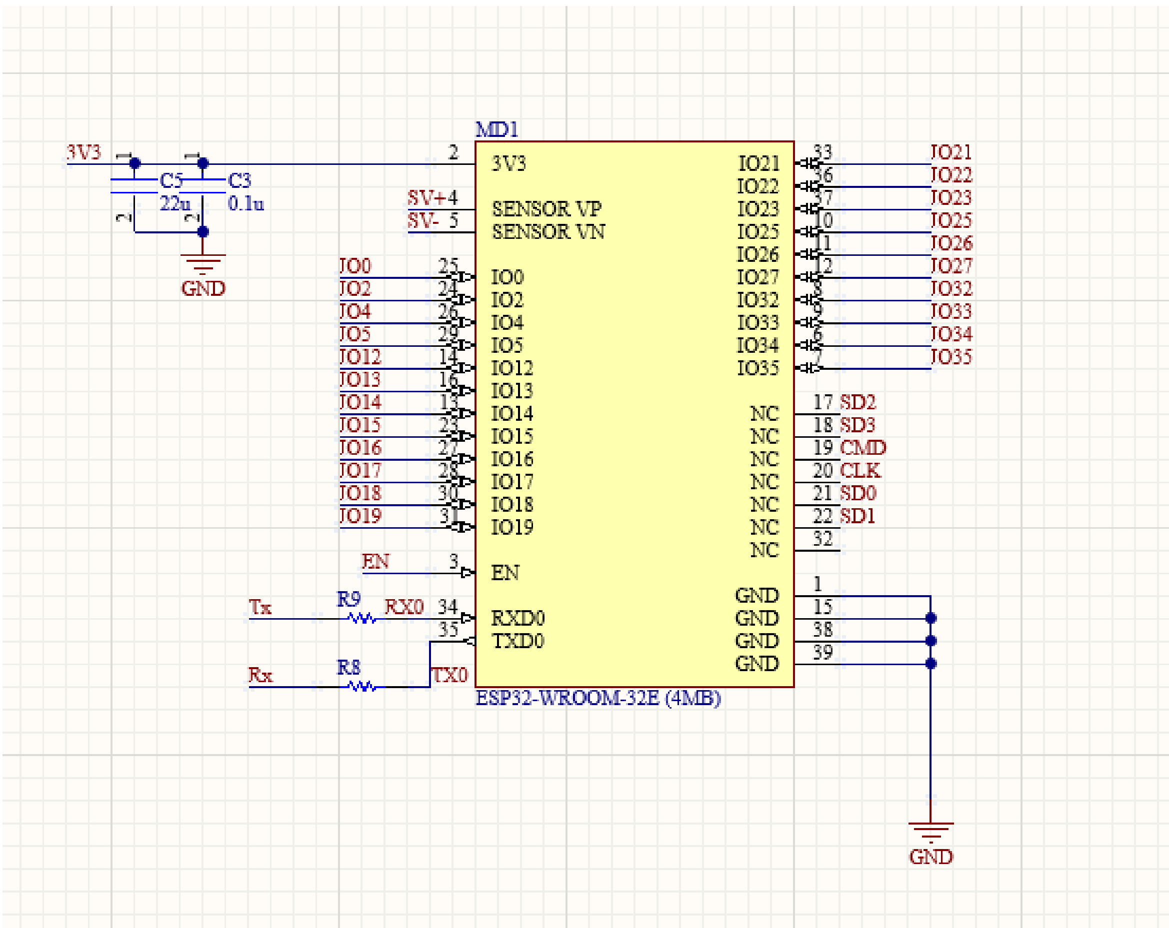

Figure 2.3: ESP32 wiring

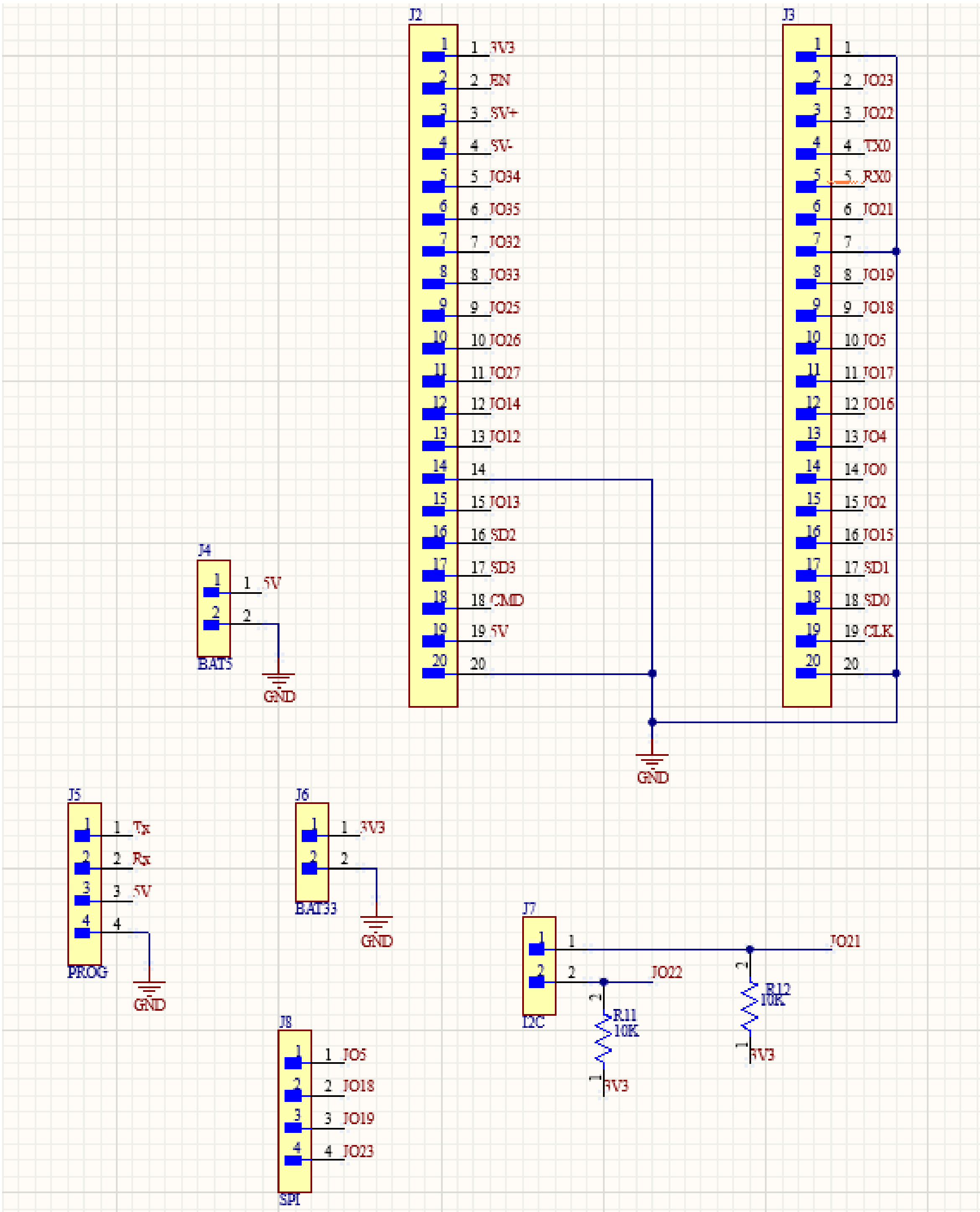

Figure 2.4: Headers

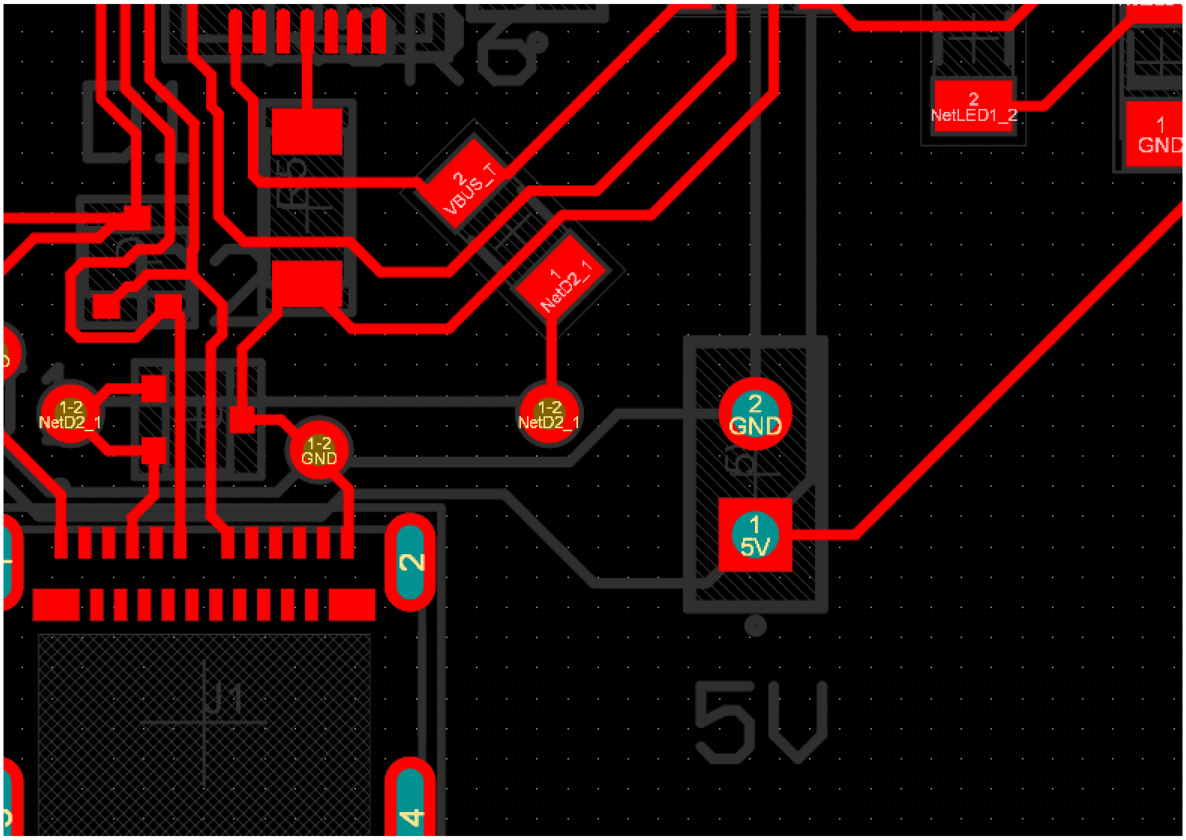

Figure 2.5: External 5V pins

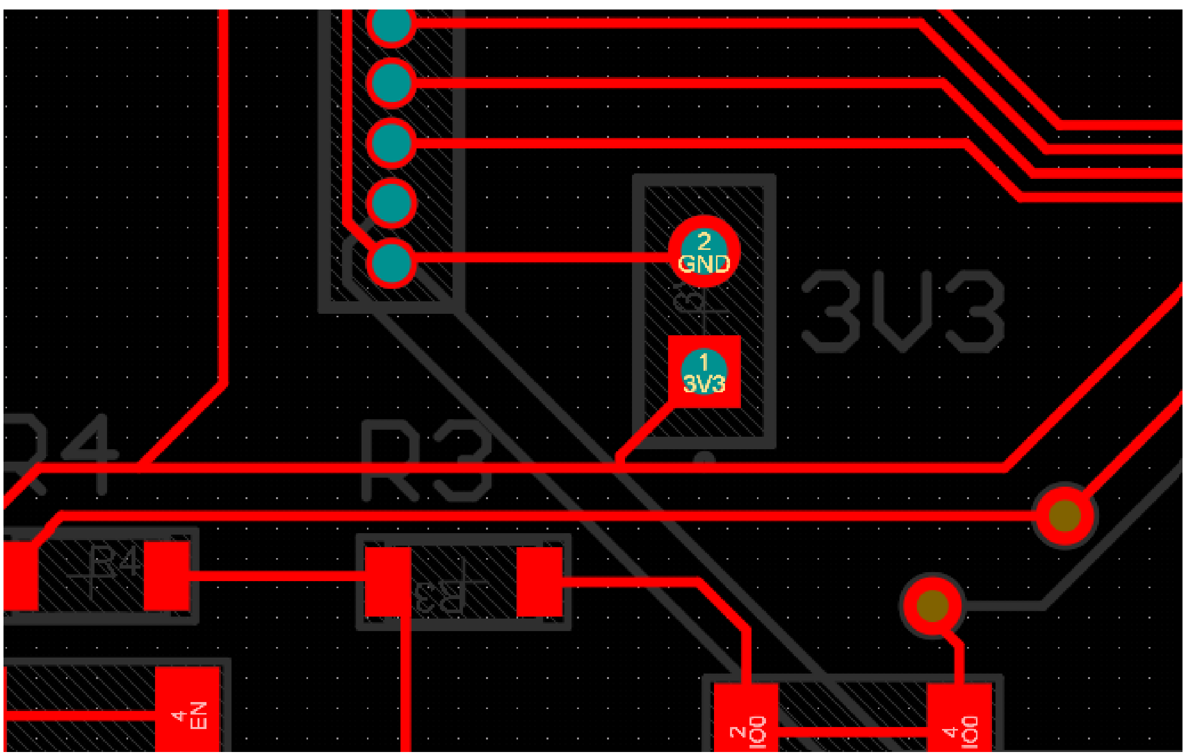

Figure 2.6: External 3,3V pins

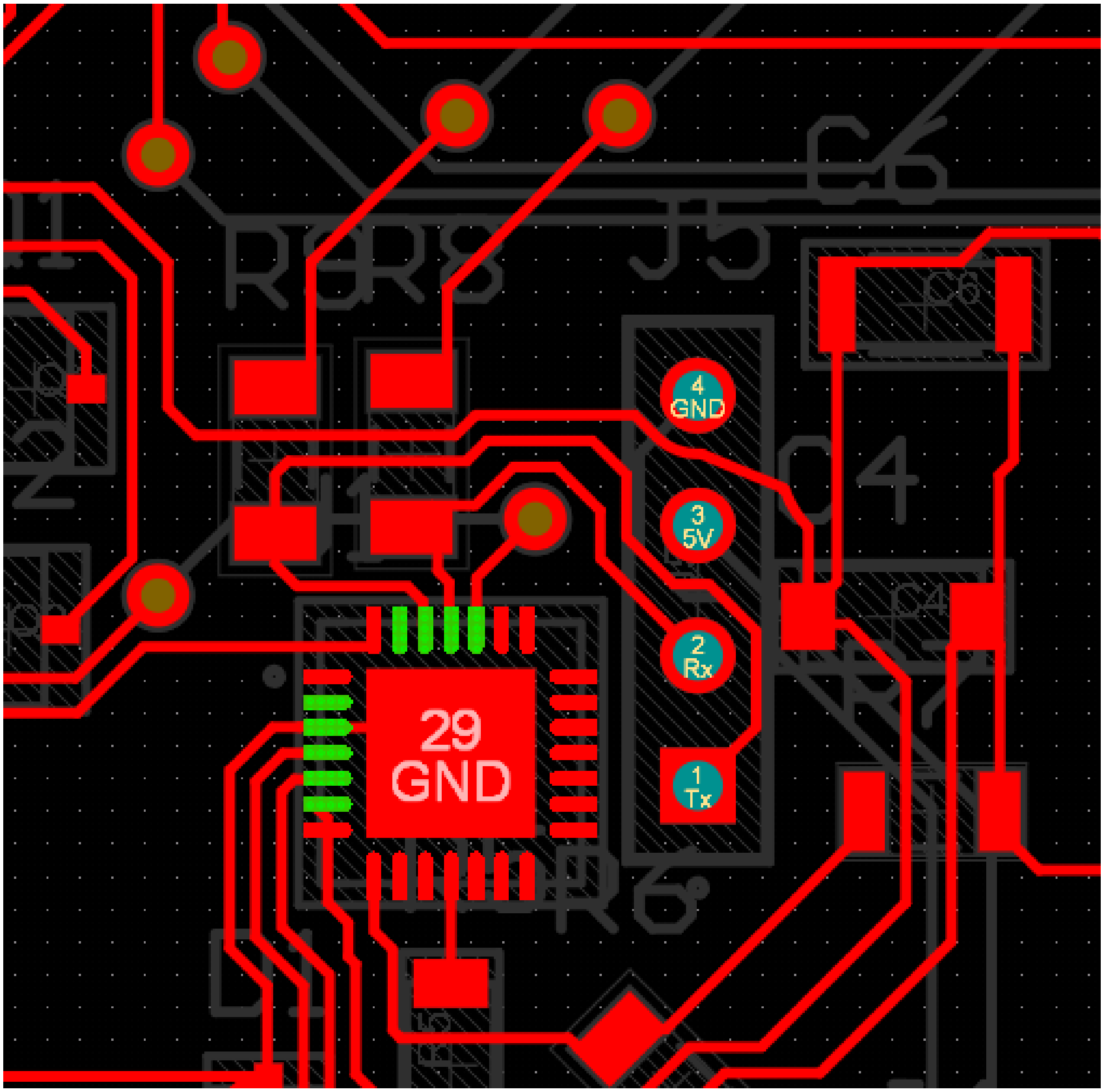

Figure 2.7: External programmer pins

2.4.3 External programmer header

You can see the net labels in 2.7. Use this for wiring.

2.4.4 Other headers

The rest of the headers are meant for serial communication using SPI and I2C. Those require more attention when plugging in so their pins have been labelled. See 2.8. The I2C has pull-up resistors which is the only addition to any header.

2.5 PCB

In the end, the PCB looks like this

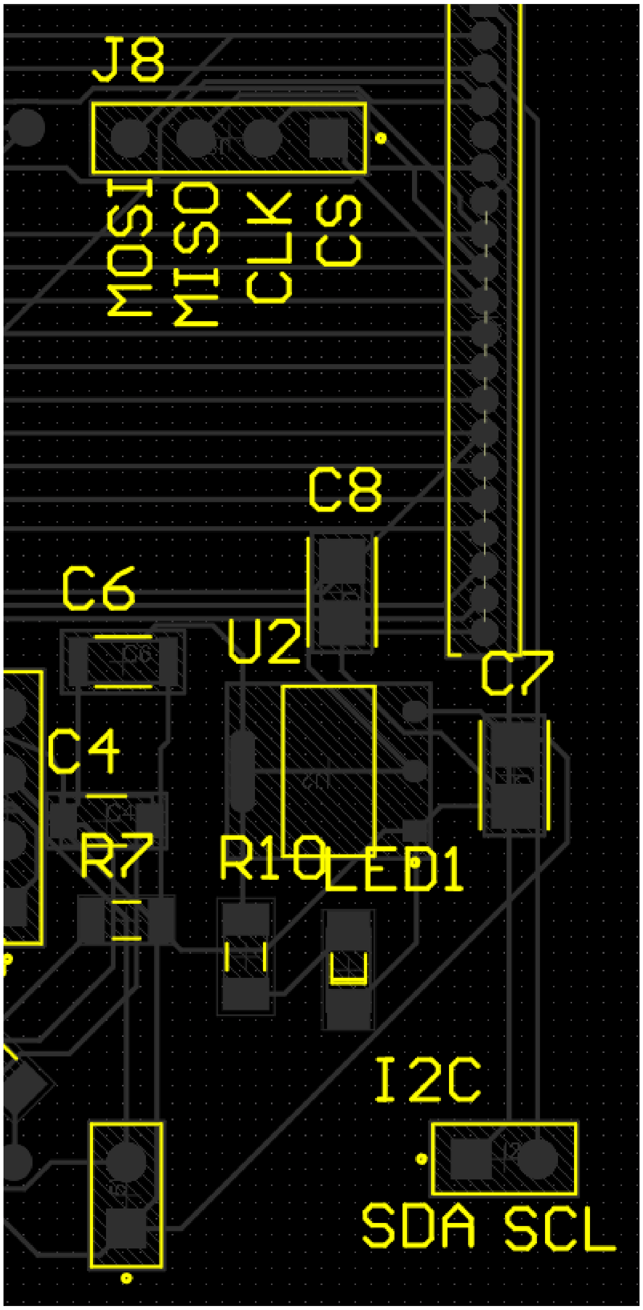

Figure 2.8: SPI and I2C headers

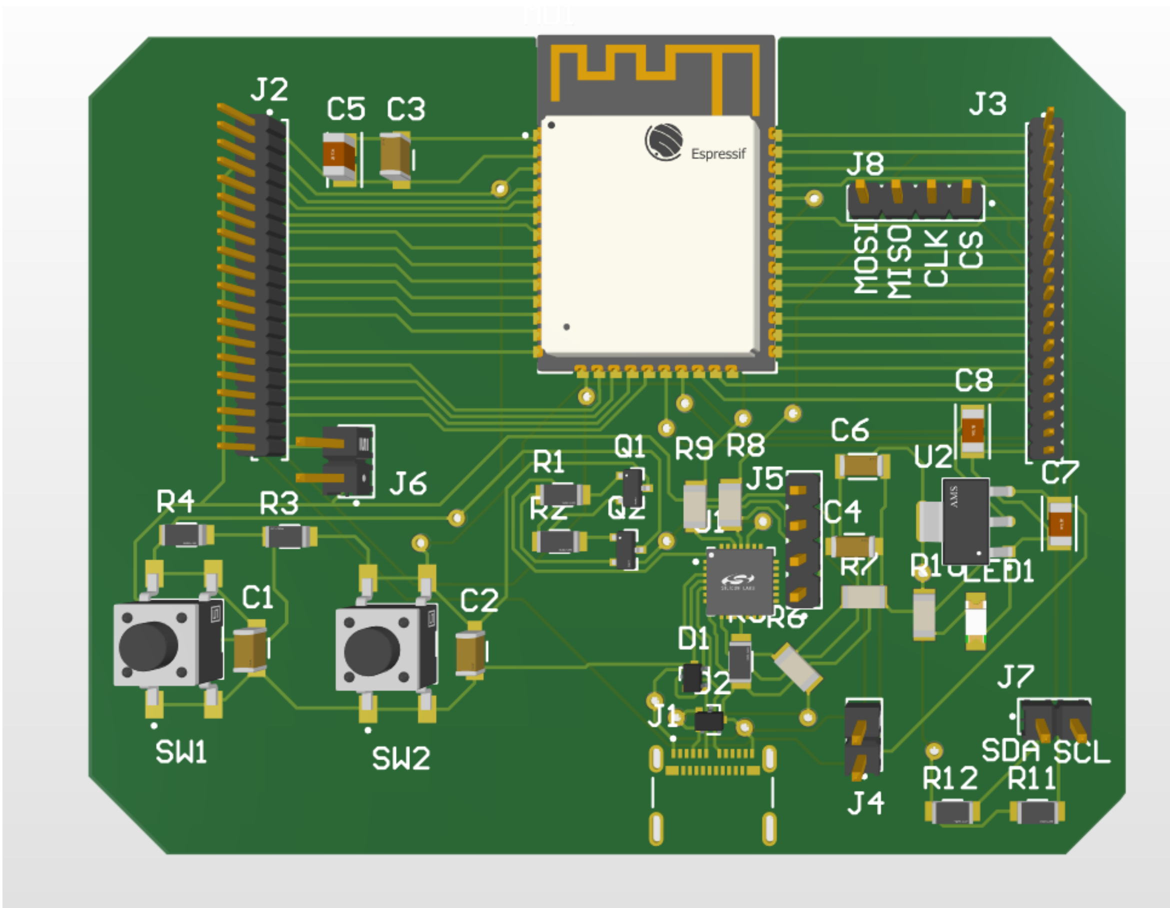

Figure 2.9: 3D model of the PCB

CHAPTER 3

MICROPHONE

To design the microphone some things needed fine adjustments and that is why a simulation is needed. The main things we want to observe are the frequency response and gain of the circuit. Note: The filter used are the same as in this video

3.1 Simulation

The circuit I came up with can be seen in 3.1. The main focus are the filters (C1 + C2 + R3 and C3 + R4), which filter out unwanted frequencies. The voltage divider, which provides 1,65V on the positive input pin of the amplifier is there because the ADCs in the ESP32 need a signal between 0 and 3,3V and a 1,65V offset is the optimal way of achieving that.

3.1.1 Ideal simulation

In the simulation (see 3.2) we can see that the signal is slightly distorted. This is to be expected, as 0,1V is relatively high for a microphone. If we test on the lower side, we see (3.3) that the signal is not distorted at all.

Now we also want to find out if the frequency responce is good. For that we can reference 3.4. The gain is around 25 for all the important frequencies. The phase is inverted, for the most part, which was expected, considering the amplifier setup we are working with.

3.1.2 LM358 simualtion

Up until now the simulations were done with an ideal amplifier, but because we are in Tina-TI (Texas Instuments' software) we can also test it with the LM358. This is the chip we will be using in real life.

I will forgo the bode plot and 10mV transient in this report, as they were identical to the previous simulations. The 0,1V peak-to-peak test went a bit worse (as seen in 3.5).

3.2 Schematic

The schematic (3.6) is the same as the simulation, except for the capacitor connected to power.

3.3 PCB

The PCB does not have anything special about it, but you can see it in 3.7

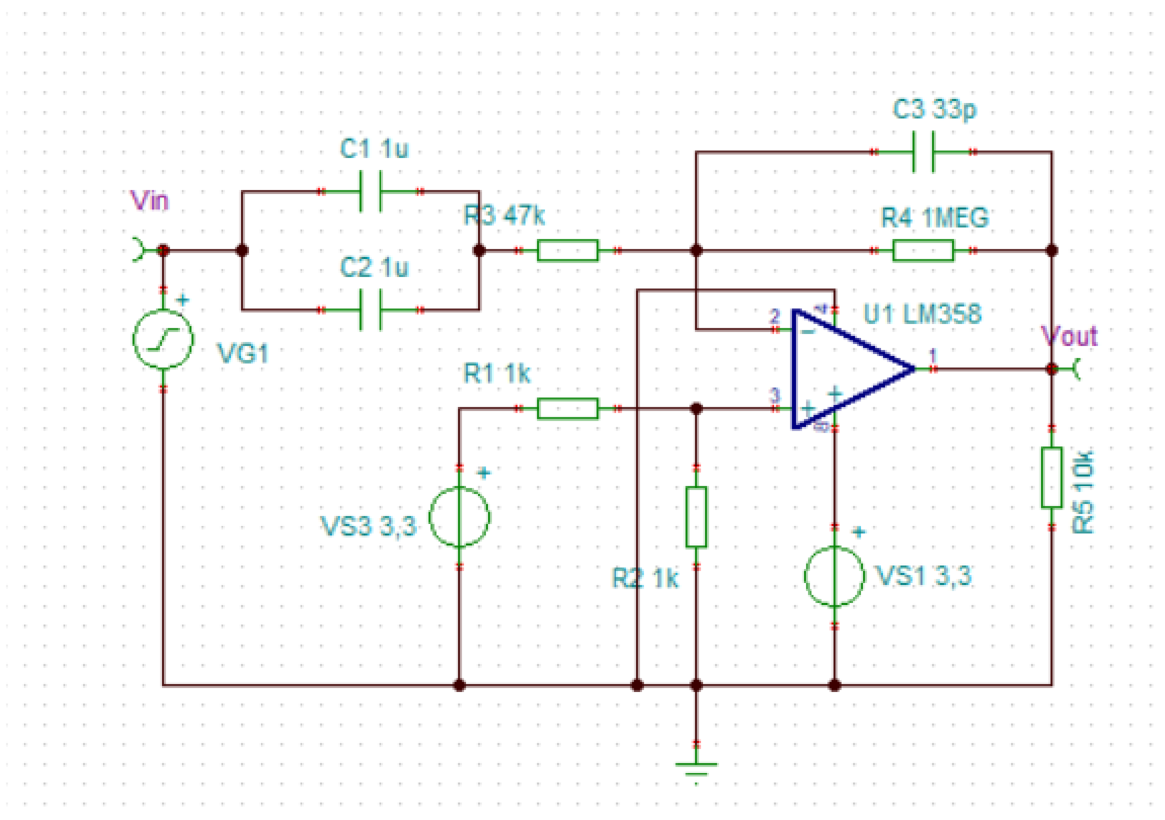

Figure 3.1: The simulated circuit

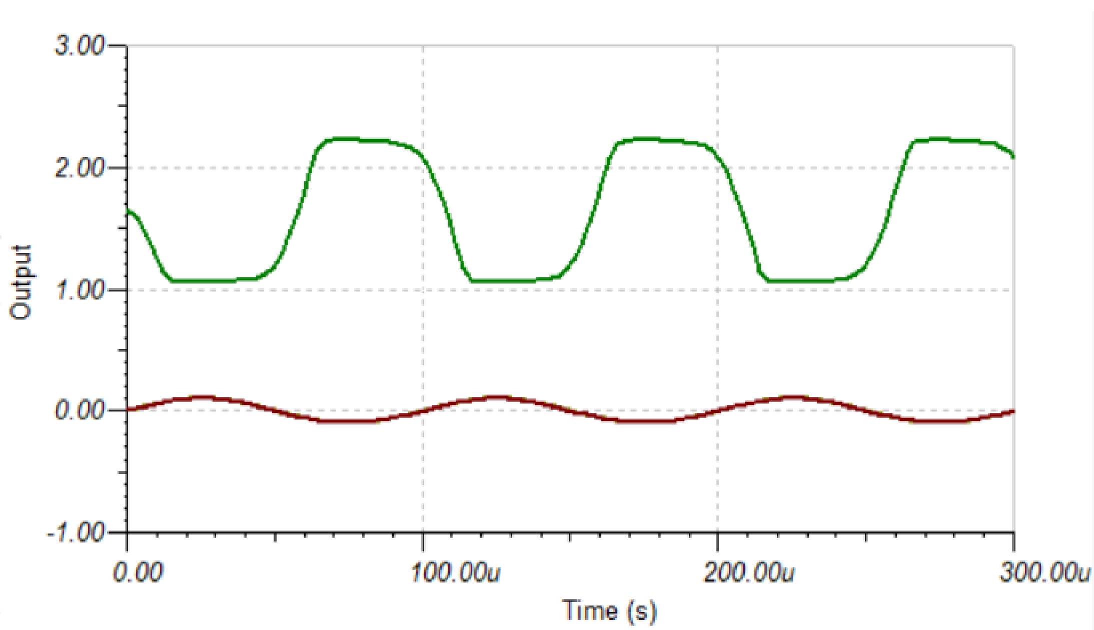

Figure 3.2: Ideal simulation result at 0,1V 10kHz

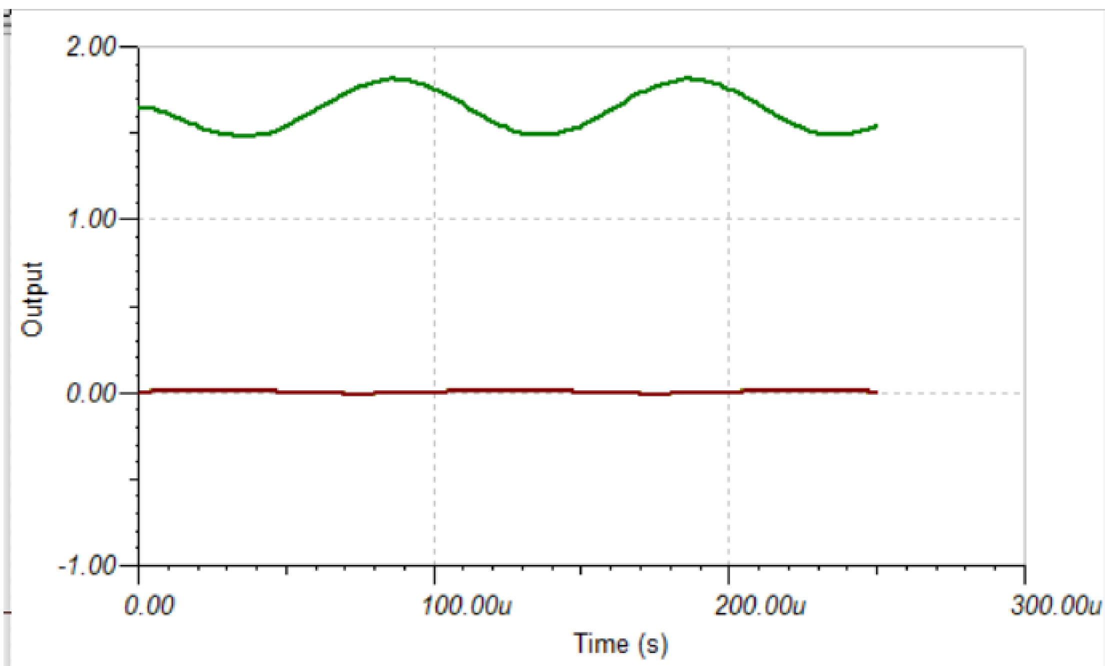

Figure 3.3: Ideal simulation result at 10mV 10kHz

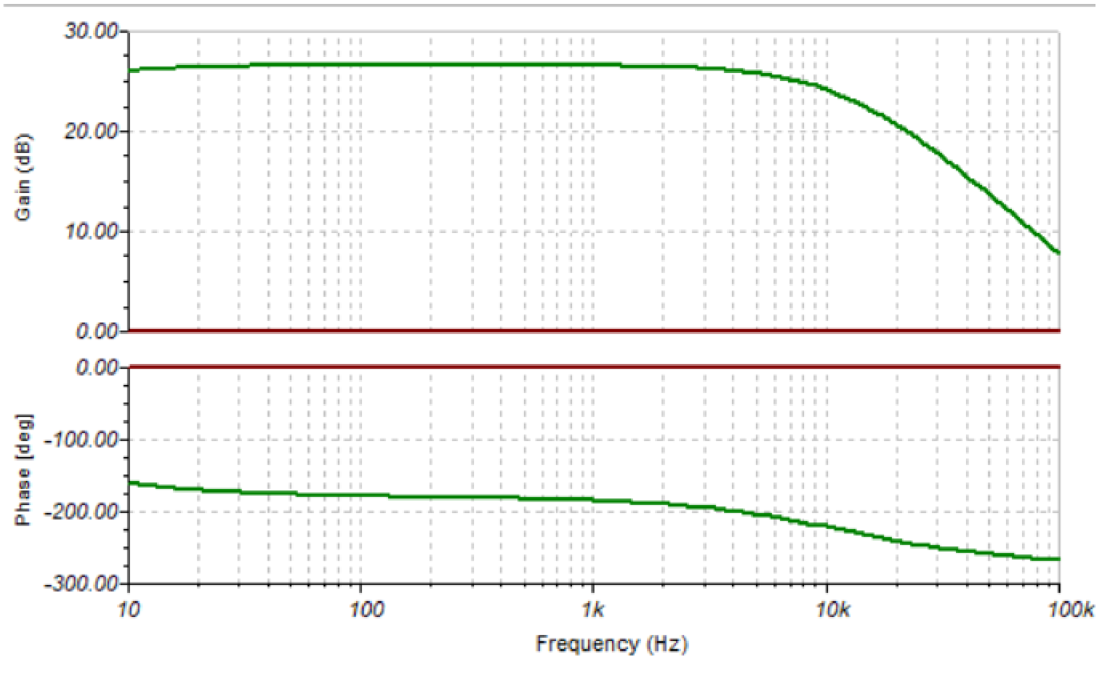

Figure 3.4: Simulation result at 10mV 10kHz

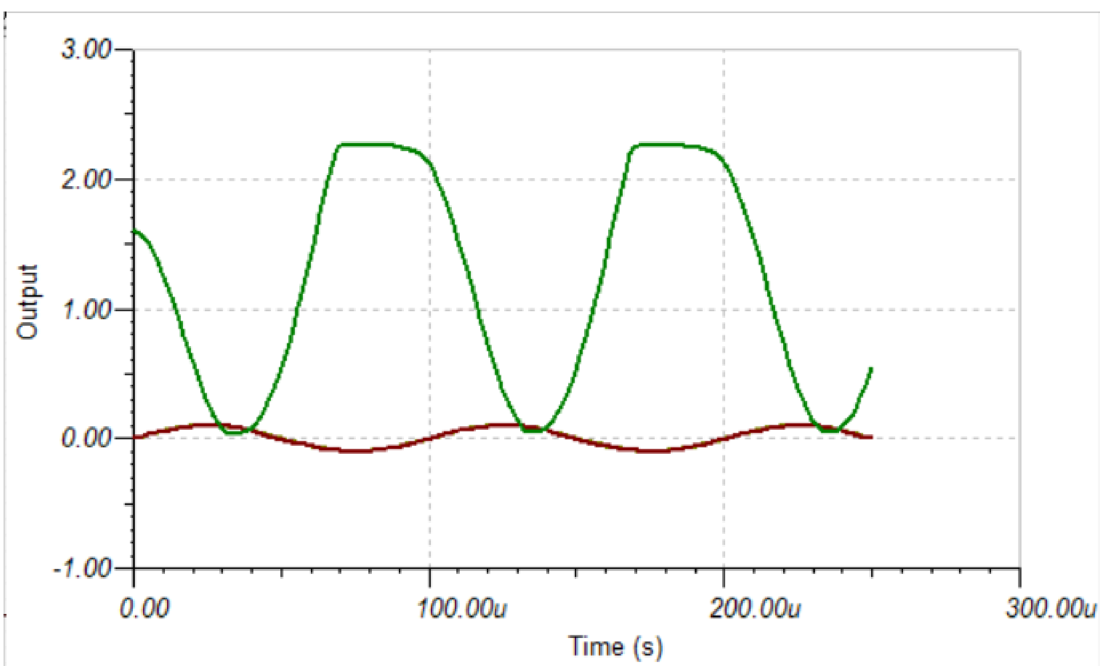

Figure 3.5: LM358 simulation result at 0,1V 10kHz

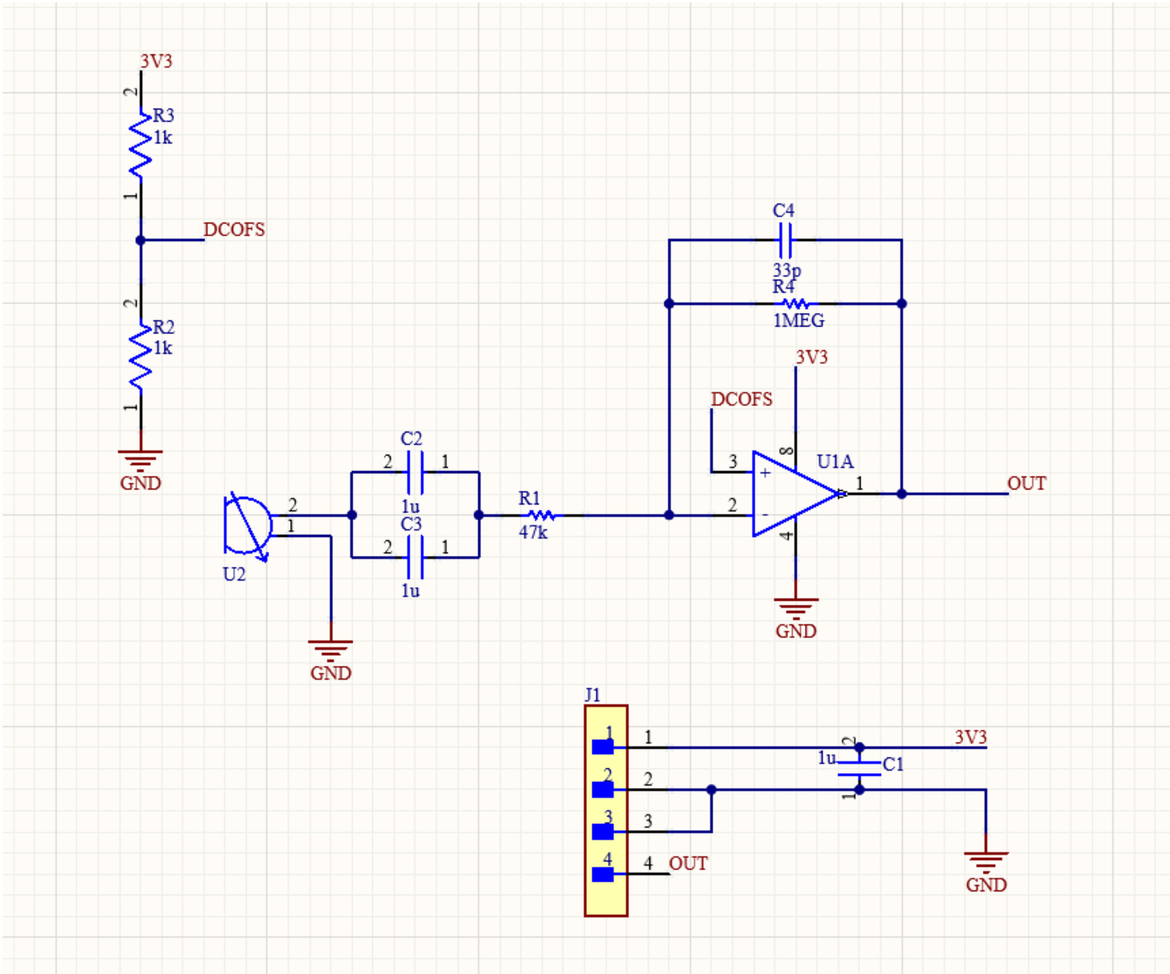

Figure 3.6: Circuit for the microphone

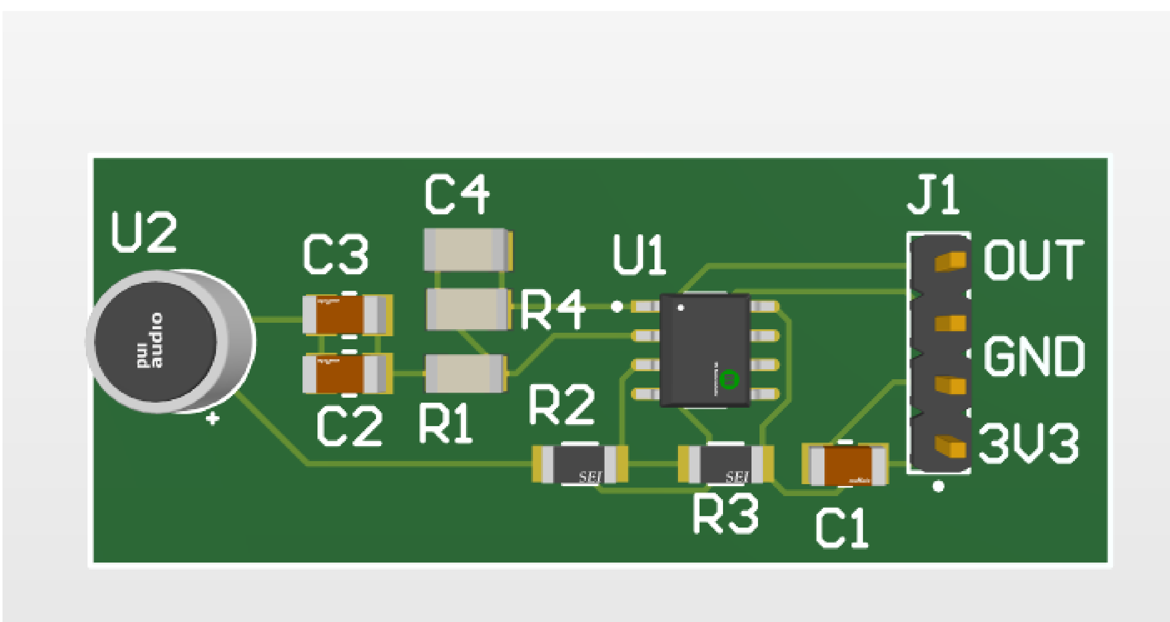

Figure 3.7: Microphone PCB