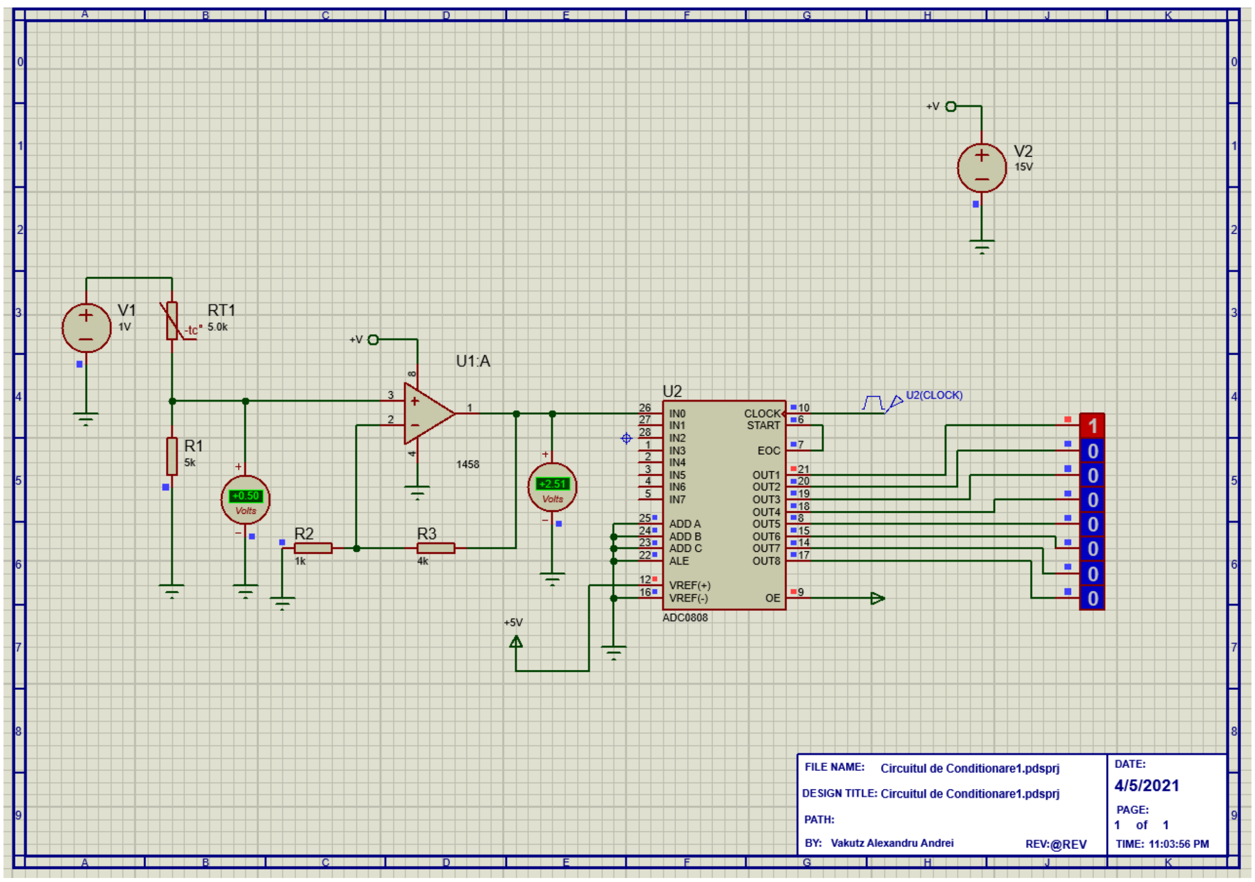
Project µC – Part 3 – Conditioning Circuit

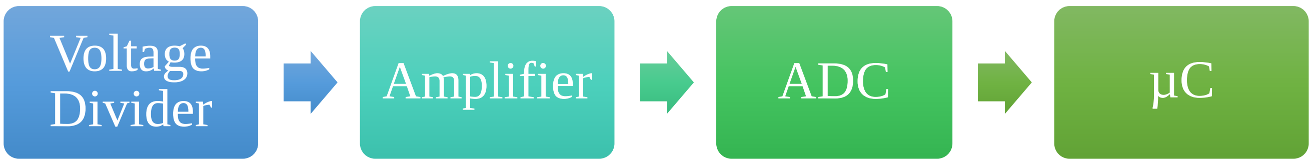
1.Introduction

To further process an analog signal, first it must be prepared. Here intervenes the conditioning circuit. In our case, it takes the output voltage of a voltage divider, amplifies it to fit in the 0-5V range, so that the ADC could read it and send it over to the µC.

For the first sensor, which is an analog temperature sensor, I choose the temperature measurement range to be between 10℃ and 45℃ with a in between value, of 28℃.



2.Block Diagram



3. Components List

- Voltage sources x2
- Resistors x3
- NTC Thermistor x1
- 1458 Op Amp x1
- ADC 0808 x1

4. Calculus, circuit, and simulations

The chosen temperature sensor is the NI24MA0502H which has a R_T at 25℃ of 5k**Ω**. To send data to the µC, it needs to be implemented in a voltage divider. Therefore, we require a second resistance, which I chose to be equal the R_T at 25℃:

$$R_1 = R_T@25 = 5k\Omega \tag{1}$$

$$V_{o1} = \frac{R_1}{R_1 + R_T} * Vcc \tag{2}$$

Where V_{o1} is the output voltage of the voltage divider and the V_{cc} is the input voltage which I chose to be 3.3V. Therefore, $V_{o1} = 1.65V$.

Since the ADC can intake a maximum of 5V I chose the A_v to be 1.51:

$$A_v = 1 + \frac{R_3}{R_2} = 1.51 => \frac{R_3}{R_2} = 0.51 \tag{3}$$

From equation 3 we can choose $R_3 = 51k\Omega\ and\ R_2 = 100k\Omega$.

Now we can determine the ADC input:

$$V_{o2} = A_v * V_{o1} \tag{4}$$

Where V_{o2} is the output of the amplifier and the input to the ADC. Which will be:

$$V_{o2} = 2.49V$$

Now we can compute the value of the ADC:

$$ADC = \frac{V_{o2}}{Vref} * 2^N \tag{5}$$

Where V_{ref} is 5V and N represents the number of output bits of the ADC.

$$ADC = 128 = 10000000_b$$

Which can also be verified by the following formula:

$$ADC = \frac{R_1}{R_1 + R_T} * 2^N \tag{6}$$

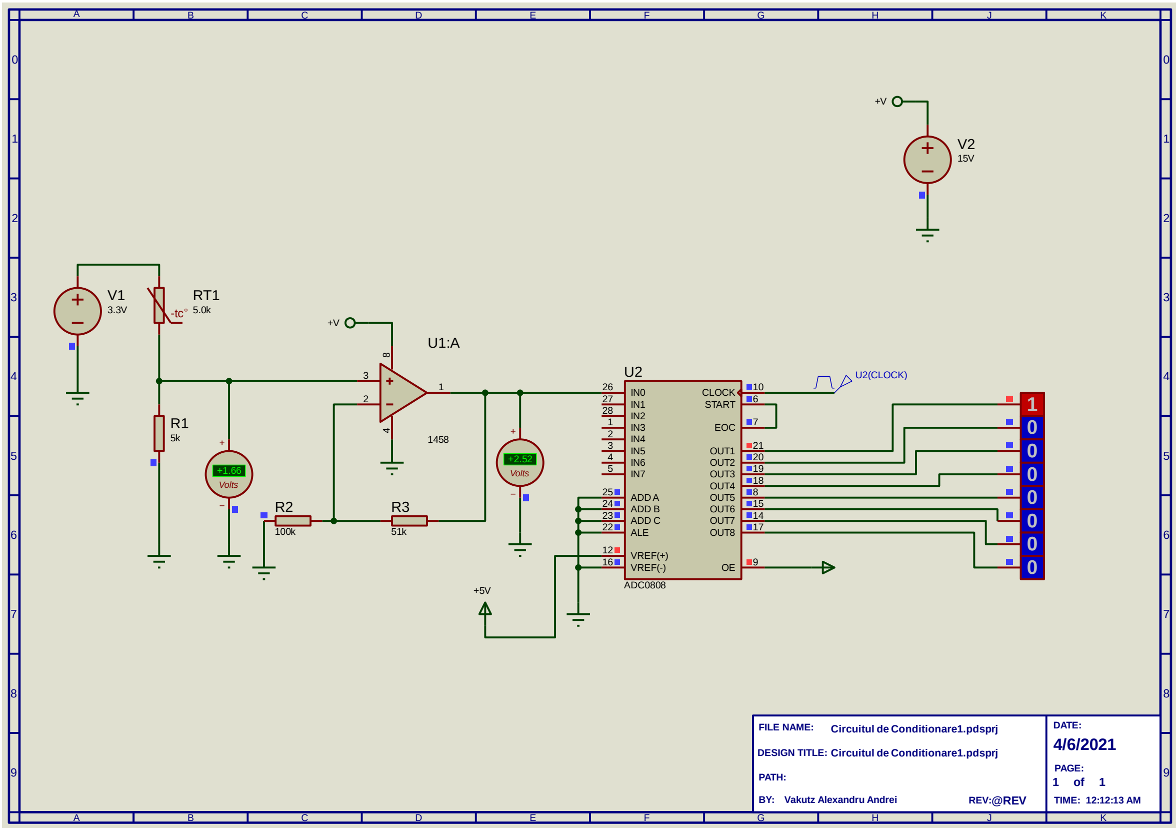


Figure 1.Rt@25°C

For 45°C we will have ADC = 1010 1111$_b$ = 175. With which we can determine the value of the thermistor (which is obtained by rearranging equation 6):

$$R_T = \left(\frac{2^N}{ADC} - 1\right) * R_1 \tag{7}$$

In this case we will have: $R_T = 2.3k\Omega$

Following the same logic, we can determine the value of the thermistor at 10°C and at 28°C:

$$ADC\ when\ R_T@10°C = 01100101 => R_T@10°C = 12.65k\Omega$$

$$ADC\ when\ R_T@28°C = 10001000 => R_T@28°C = 9.4k\Omega$$

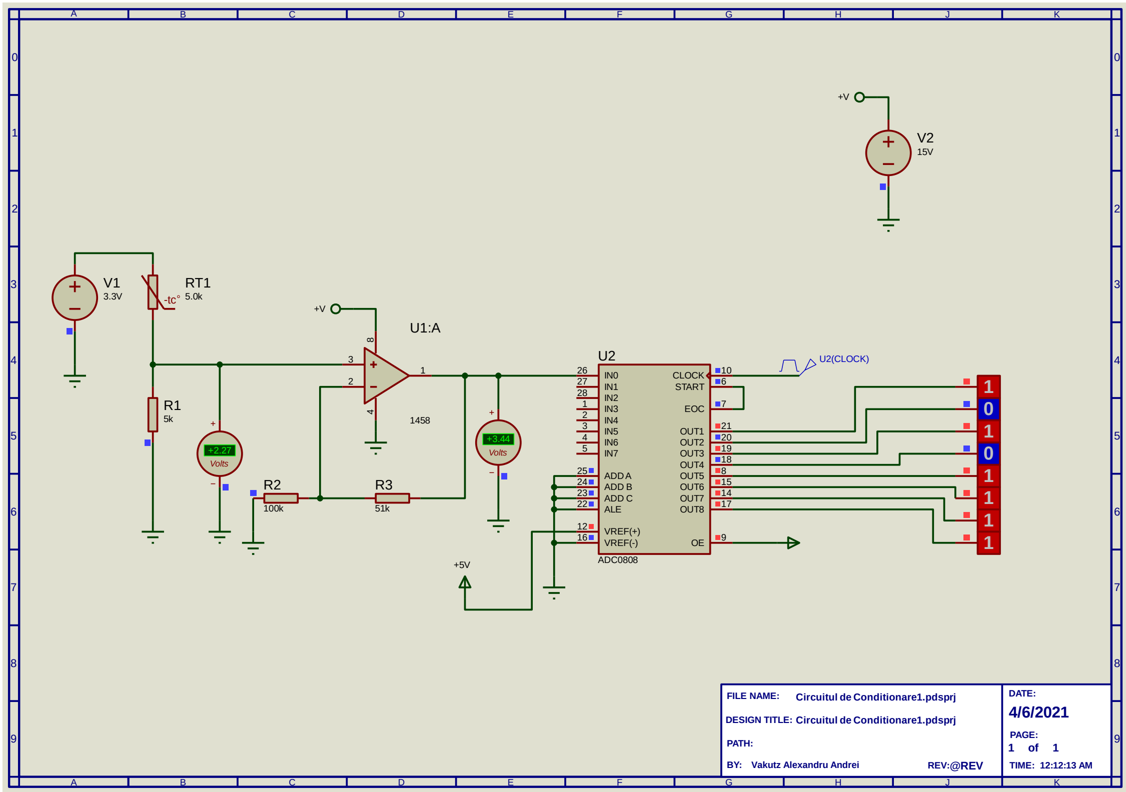


Figure 2.Rt@45°C

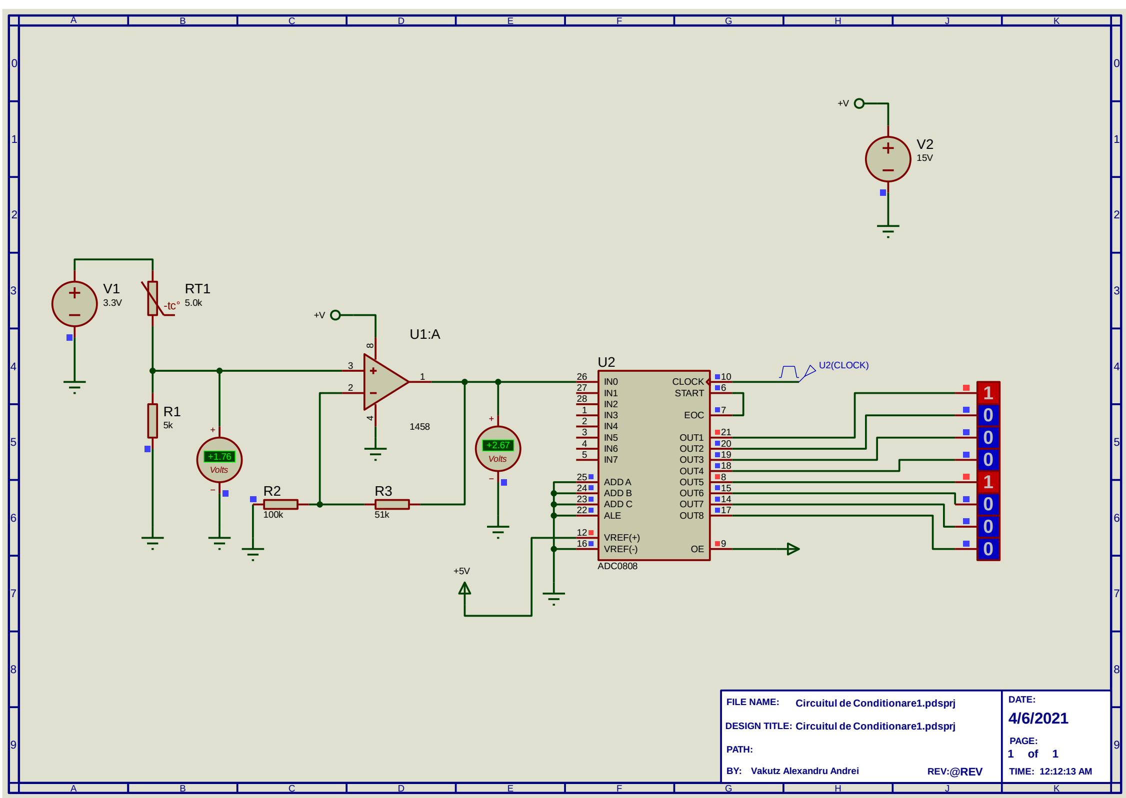


Figure 3.Rt@28°C

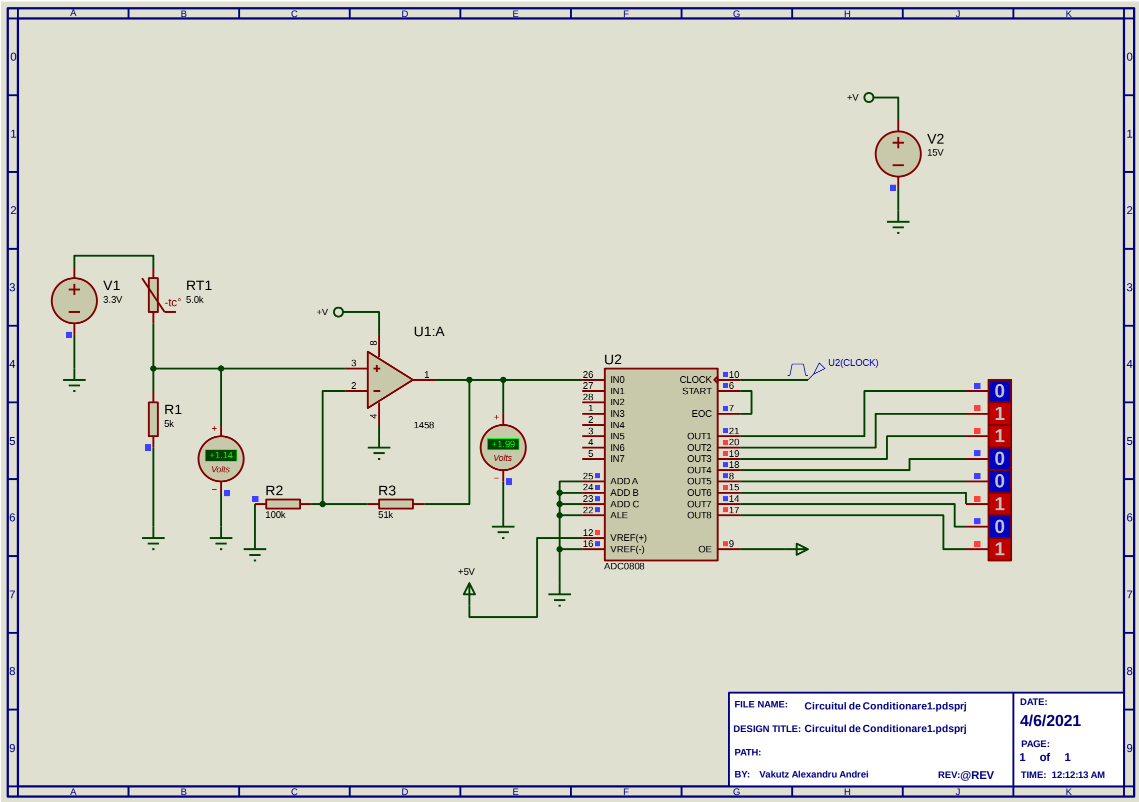


Figure 4.Rt@10°C