1. 12-bit ADC (Vref = 5 V)

a. Discrete Values:

$$2^{12} = 4096$$

b. Smallest Voltage Step (Resolution):

$$\frac{5\,\text{V}}{2^{12}} = \frac{5\,\text{V}}{4096} \approx 0.001\,22\,\text{V} = 1.22\,\text{mV}$$

c. Output for 3.11 V Input:

$$\left(\frac{3.11\,\text{V}}{5\,\text{V}}\right) \times 4096 = 0.622 \times 4096 \approx 2547.97 \rightarrow \lfloor 2547.97 \rfloor = 2547$$

2. Square Wave

a. Duty Cycle ($t_{on} = 5\,\text{ms}$, $t_{off} = 10\,\text{ms}$):

$$T = t_{on} + t_{off} = 5\,\text{ms} + 10\,\text{ms} = 15\,\text{ms}$$

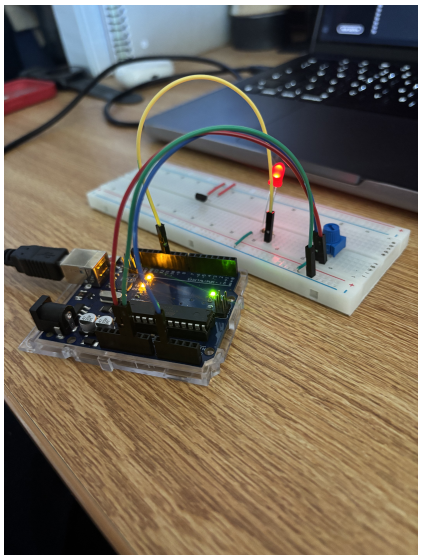
$$\text{Duty Cycle} = \frac{t_{on}}{T} \times 100\% = \frac{5\,\text{ms}}{15\,\text{ms}} \times 100\% \approx 33.3\%$$

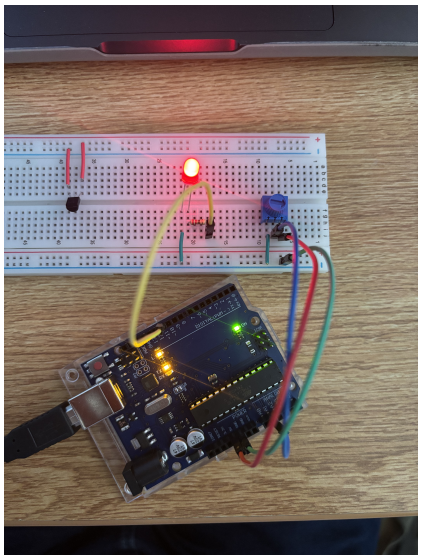
b. Increasing t_{on} to 10 ms (assuming T changes to 20 ms):

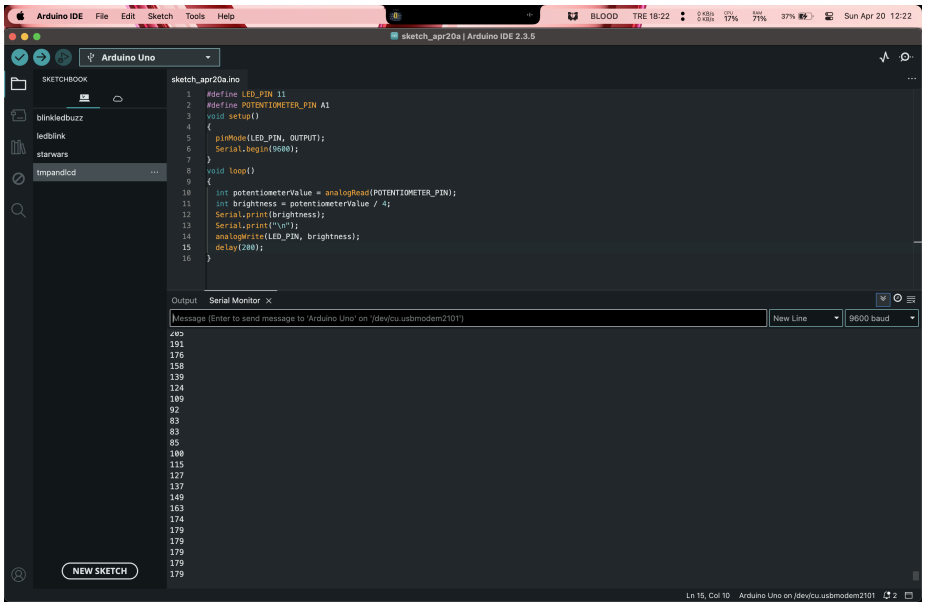
$$\text{New Duty Cycle} = \frac{10\,\text{ms}}{20\,\text{ms}} \times 100\% = 50\%$$

Effect: LED brightness increases (higher average power).

3. Potentiometer LED Demo







4. TMP36 Reading

$$V_{temp} = V \times (ADC_{in}/1023)$$

$$V_{temp} = 5(205/1023) = 1,0019550342$$

$$t_C = 100 * (V_{temp} - 0.5)$$

$$t_C = 100 * (1.0019550342 - 0.5) = 50,2\,C$$

5. Thermistor Circuit

$$V_{A0} = \frac{\text{ADC Reading}}{\text{Total Levels}} \times V_{ref} = \frac{615}{1024} \times 5\,\text{V} \approx 3.003\,\text{V}$$

$$V_{A0} = V_{supply} \times \frac{R}{R_T + R}$$

$$3.003\,\text{V} = 5\,\text{V} \times \frac{10\,\text{k}\Omega}{R_T + 10\,\text{k}\Omega}$$

$$R_T = \left(\frac{V_{supply}}{V_{A0}} - 1\right) R$$

$$R_T = \left(\frac{5\,\text{V}}{3.003\,\text{V}} - 1\right) \times 10\,\text{k}\Omega$$

$$R_T \approx (1.665 - 1) \times 10\,\text{k}\Omega \approx 0.665 \times 10\,\text{k}\Omega$$

$$R_T \approx 6.65\,\text{k}\Omega$$

$$\text{Temperature} \uparrow \implies R_T \downarrow$$

R_T will **decrease**.