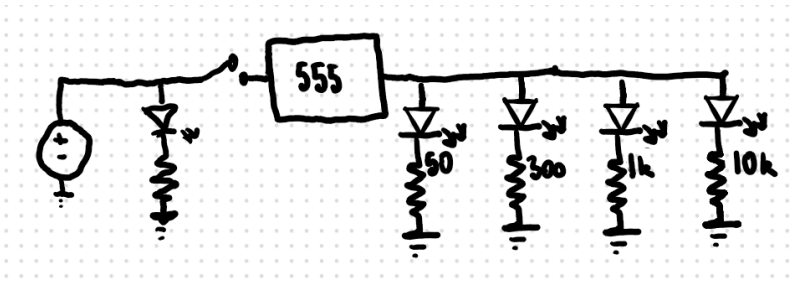
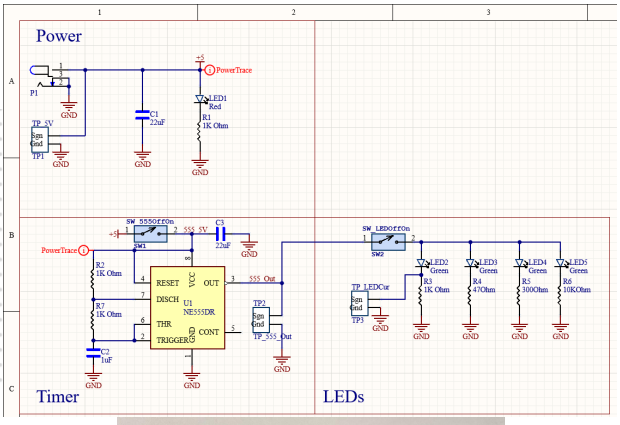
Board 1 Report - Sam Freed

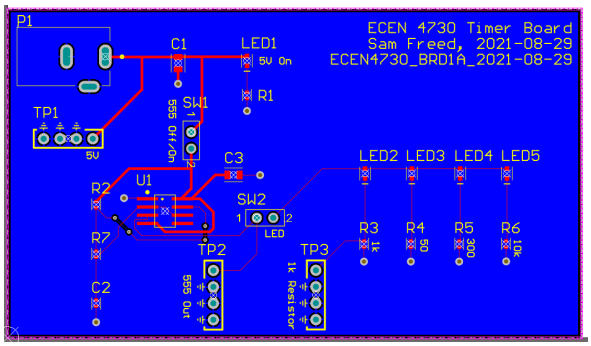
Engineering Requirements

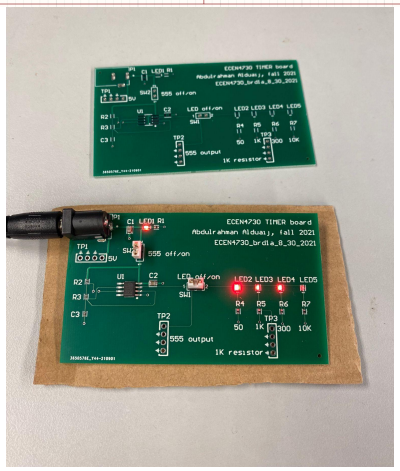
1. Board is powered using a 5V barrel-connector style AC to DC regulator.
2. Indicator LEDs are placed throughout the board to represent the power status of various components.
3. A 555 timer generates a square wave signal at approximately 500Hz and a 65% duty cycle when unloaded.
4. The output of the 555 timer should drive four LEDs of different brightness due to different resistors in series with the LEDs.
5. The current through an LED can be measured using a voltage test point.
6. Switches allow for a division between the different stages of the circuit.

Board Images: From Sketch to Board



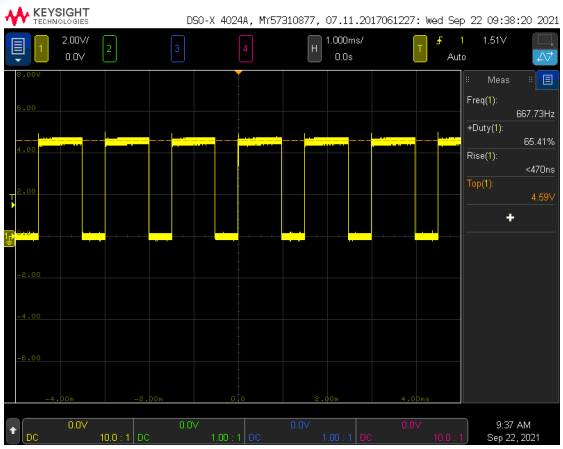


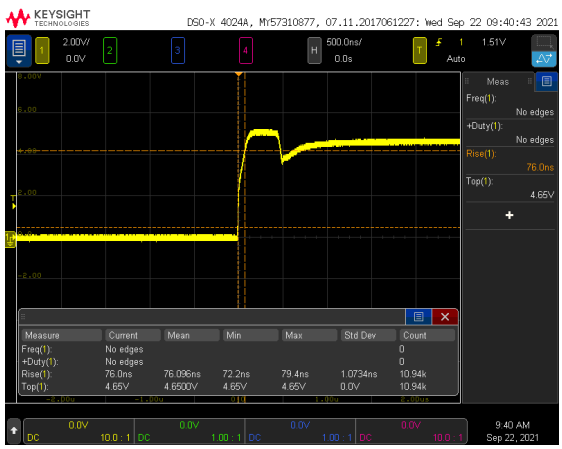




Key Signals

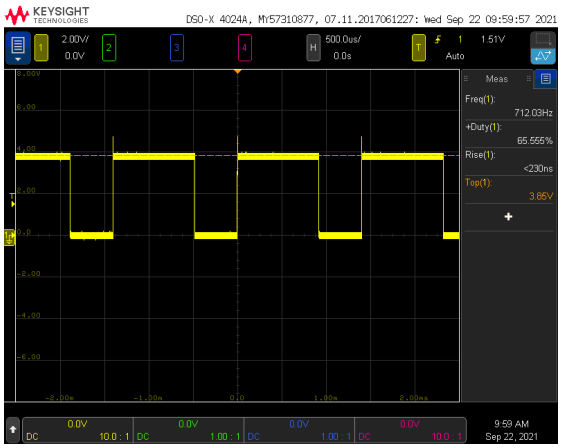
1. 555 Voltage Output, Unloaded

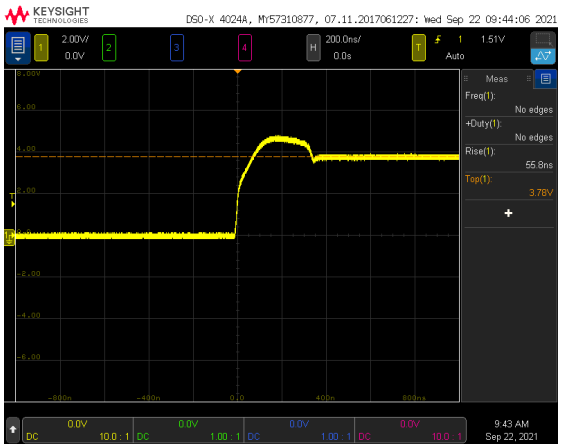




   a. Frequency: 667 Hz - higher than 460Hz from lab 1 but as expected
   b. Duty Cycle: 65% - matches previous expectations
   c. Rise Time: 76ns - matches previous expectations
   d. Top Voltage: 4.59V - matches previous expectations

2. 555 Voltage Output, Loaded





   a. Frequency: 712 Hz - higher due to load changing voltage on 555
   b. Duty Cycle: 65% - matches previous expectations
   c. Rise Time: 55.8ns - higher
   d. Top Voltage: 3.78V - matches expectations

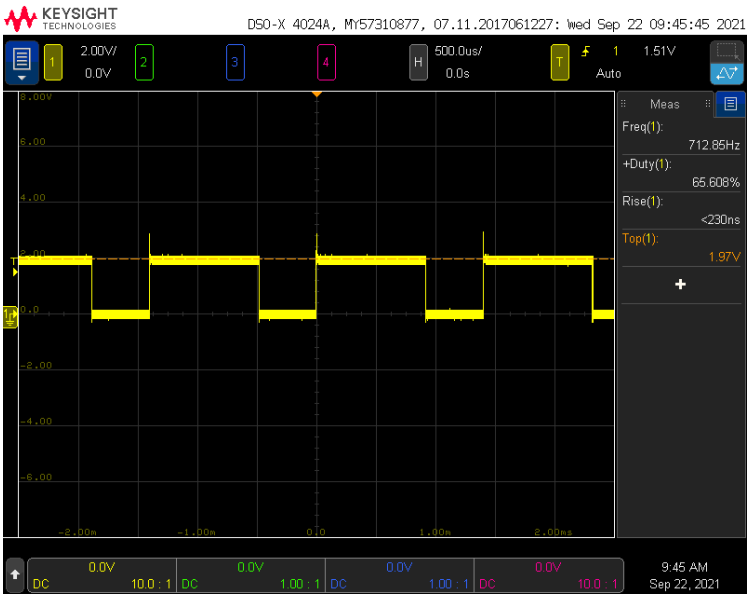
3. Thevenin Output Resistance

$$R_{th} = R_l * \frac{V_{th} - V_l}{V_l}$$

$$\frac{1}{R_l} = \frac{1}{50\Omega} + \frac{1}{300\Omega} + \frac{1}{1k\Omega} + \frac{1}{10k\Omega} \Rightarrow R_l = 40.972\Omega$$

$$R_{th} = 40.972 * \frac{4.59V - 3.78V}{3.78V} = 8.77\Omega$$

4. LED Current Estimation using 1kΩ Resistor Voltage



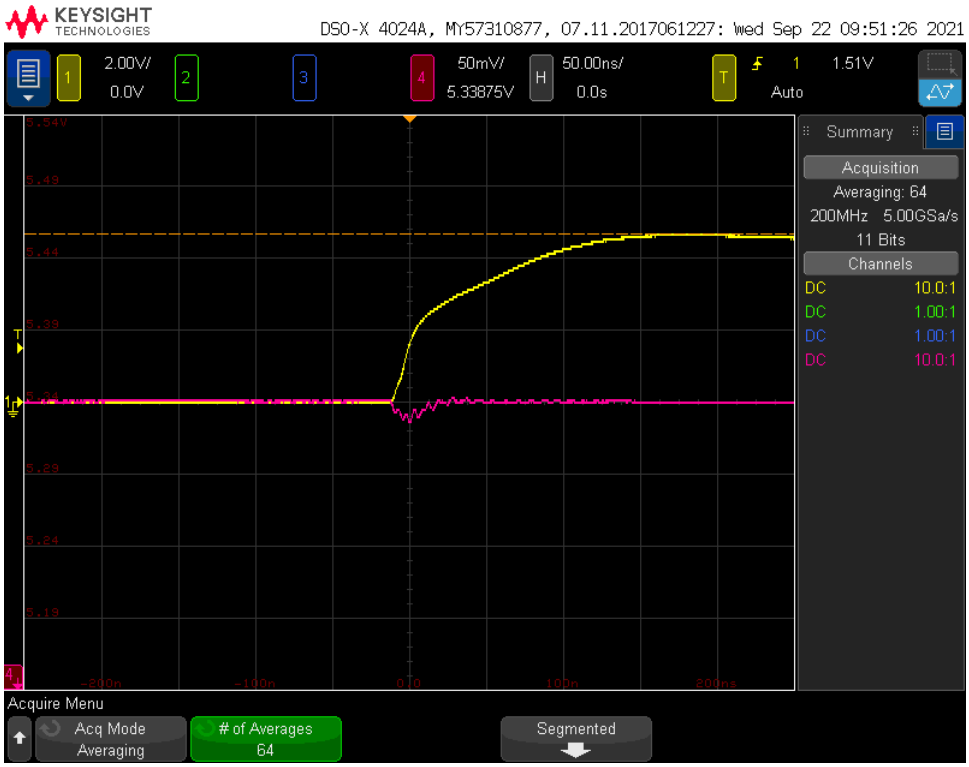
Top Voltage: 1.97V

V = I*R

V / R = I

1.97V / 1000Ω ≅ 2mA

5. Switching Noise on Power Rail



*Note the extremely small scale on the pink 5V signal line

6. Current Through Each Resistor
    a. 50Ω: 1.97V / 50Ω = 39.4 mA
    b. 300Ω: 1.97V / 300Ω = 6.56 mA
    c. 1kΩ: 2mA, as shown above
    d. 10kΩ: 1.97V / 10000Ω = 0.197 mA
7. LED Recommendations: Based on the brightnesses in the image above, a maximum resistance of 1kΩ would be recommended assuming a duty cycle at or larger than 70%, with preference to smaller resistances if the duty cycle is smaller. This will allow the LED to be visible at a glance without drawing too much current.