Utkarsh Mandavilli
ECEN 5730
2/15/26
Board 1 Report

Project Overview:

Purpose: The purpose of this board is to gain experience with Altium Designer and going from a circuit design to a full PCB. It also gives us an opportunity to practice surface-mount soldering with 1206 components. The board should show you how bright LEDs are with different resistor values when being driven by a 555 Timer Circuit. We are also exposed to reading datasheets and pinouts for selected components to determine if they fit the specifications of the design.

POR:

1. A power plug to use an external 5 V AC to DC charger to power your board
2. A 555 timer chip and circuitry designed for about 500 Hz and 60% duty cycle.
3. Using parts in the JLC integrated library we provide for you. Please remember I only stock 1206 sized parts.
4. Add 4 LEDs of all the same color and series resistors of: 10k, 1k, 300, and 50 Ohms.
5. Use indicator lights, test points and isolation switches as appropriate.
6. Design to measure the 5 V input rail, the 555 output voltage and the current through the 50 Ohm LED.

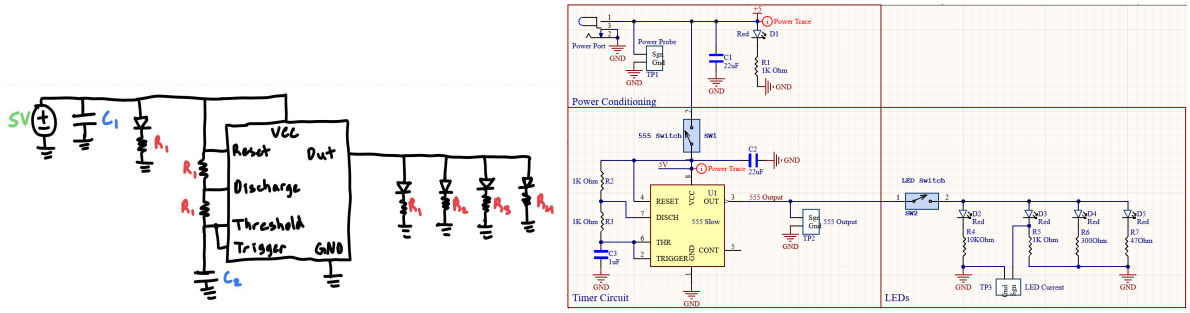
Expectations:

- ➢ Board is receiving power from the 5V power jack
- ➢ LED indicating if the board is powered
- ➢ 555 Timer generates a square wave with a frequency of 500Hz and a duty cycle of approximately 66%
- ➢ The output of the 555 must drive 4 LEDs of varying intensity
- ➢ Ability to measure current through one of the LEDs
- ➢ Ability to measure power rail
- ➢ Ability to measure 555 Timer Output
- ➢ Switches can effectively control the flow of power and signals
- ➢ Components are connected to the board properly and to each other by the traces

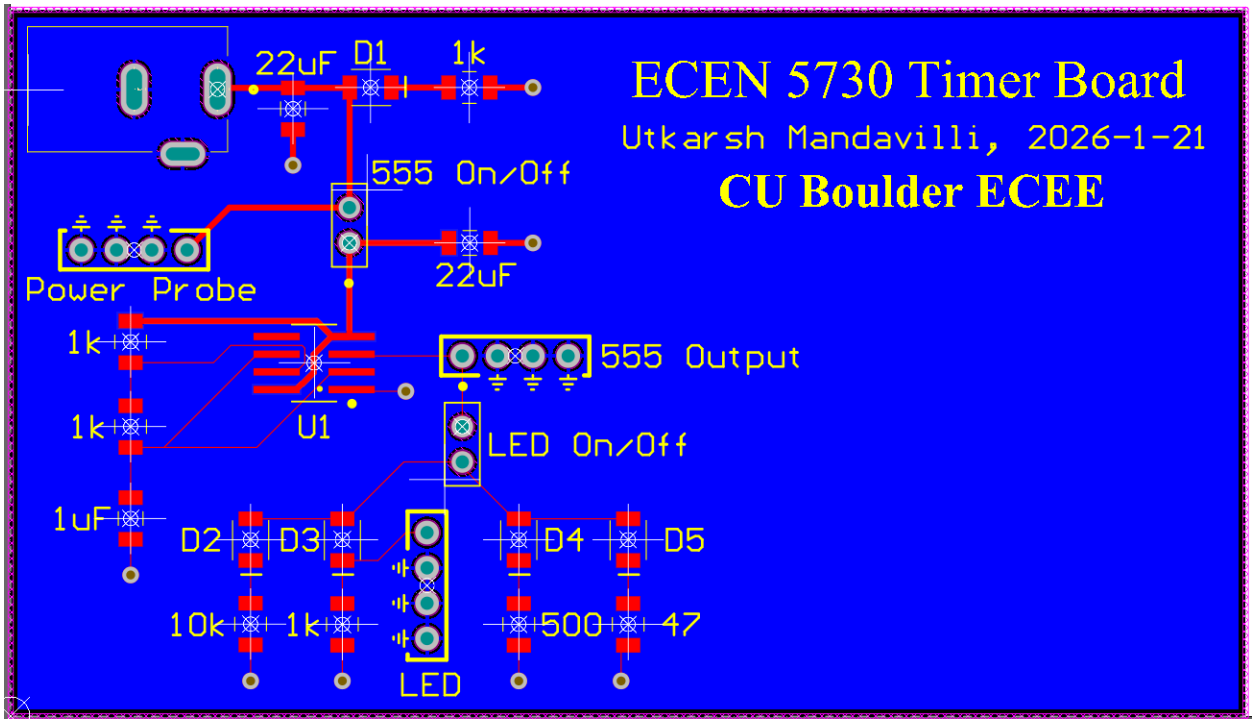
The values chosen for the resistors and capacitors used in the 555 Timer Circuit gave us an expected frequency of 500hz. We also calculated the duty cycle. These values were derived using the following formulas from the datasheet of the LMC 555:

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C} = 480Hz \qquad T_{Duty} = 100\frac{(R_A + R_B)}{(R_A + 2R_B)} = 66\%$$

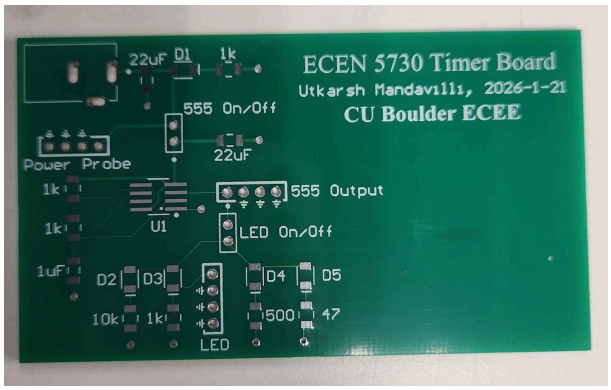
Schematics:

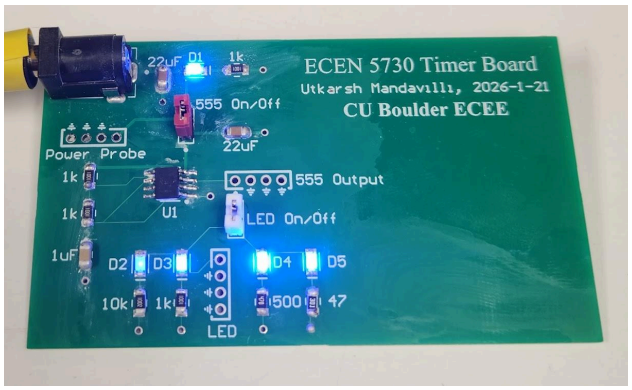


Final Layout:

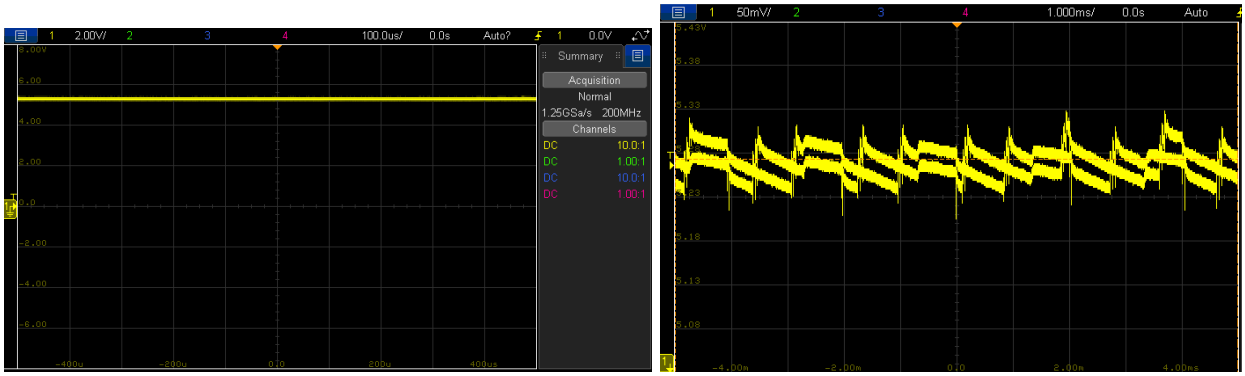


Pictures of the Board:



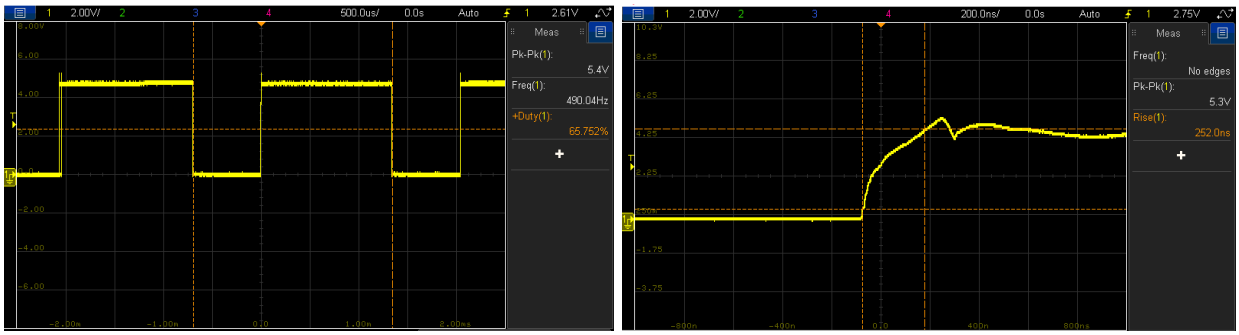


Testing:



Figures 1&2: On the left, we see a capture of the power rail when plugged into a 5V DC Source. On the right, we have the switching noise on the power rail.

The switching noise on the power rail corresponds with the 555 Timer switching on and off. This noise doesn't affect the rest of the circuit.



Figures 3&4: On the left, we see the output of the 555 Timer Circuit with no LEDs connected. It has a measured period of 480Hz with a duty cycle of 66%. On the right, we measure a rise time of roughly 250ns.

These captures verify our expected/calculated values that were determined when designing the circuit.

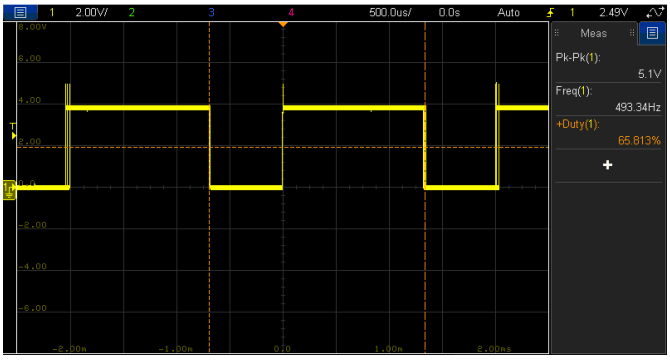


Figure 5: Output of the 555 Timer when all of the LEDs are connected and turned on.

We can see that once the LEDs are connected, we see a voltage of approximately 4V. Since this drives 4 LED+Resistor combinations in parallel, we can determine the equivalent resistance and use that to determine current draw. The equivalent resistance is calculated to be 41.02 Ohms. Finally we use I = V/R = 4/41.02 = 97.5mA. This means that we can estimate a current draw of 97.5mA.

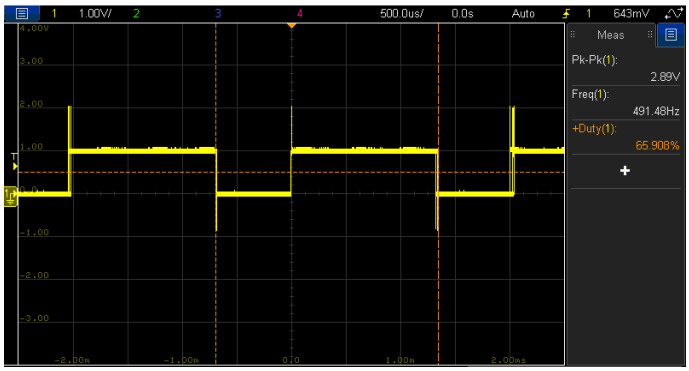


Figure 6: Voltage through the LED in series with the 1k Ohm resistor.

The voltage across this LED is shown to be 1V. Since we have a 4V input we can subtract 1V for the LED and are left with 3V at the resistor. This means we have a current of 3mA through this LED. The same calculations can be done for the other LEDs and resistors. This gives us a current of .3mA through the 10k Ohm resistor, 6mA through the 500 Ohm resistor, and 63.8mA through the 47 Ohm resistor.

We can suggest that a current of 3mA through the LED is a reasonable amount to make it visible as an indicator light. This provides a good balance between light emission and power consumption.

To calculate the thevenin resistance of the 555 Timer Circuit, we use the following formula:

$$R_{th} = R_l * (v_{th} - v_l)/v_l$$

R_{Load} is 41.02 Ohms as previously calculated. The V_{Th} we will use is 5.4V found from using an open load, and the V_L is 3.9V when LEDs are on. This gives us a Thevenin resistance of 15.77 Ohms which is within the expected range.

Conclusion:

The board met all expectations that were previously set and did not have any hard errors. I found that taking time when drawing the schematic made it easier for me to do the board layout, as it gave me a good basis from which to start. Leaving a decent amount of space between components on the board also meant that I was able to solder components easily and quickly without damaging others. Using the design rules and setting constraints ensured that traces did not end up too close to one another which prevented excessive noise and inductance from

impeding the signals. One soft error that I encountered came during assembly of the board when I soldered the 555 Timer component on. One of the legs was not properly soldered to the pad, meaning the output was a low signal. This was diagnosed and resolved quickly, but is something I will note when assembling boards moving forward. Another thing I plan to do in the future to improve my designs is use all of the space available to me on the layout. This board had a decent amount of empty space which happened because I did not lay out all of the larger components first to see how much room they would require. This caused me to try and cram everything together.