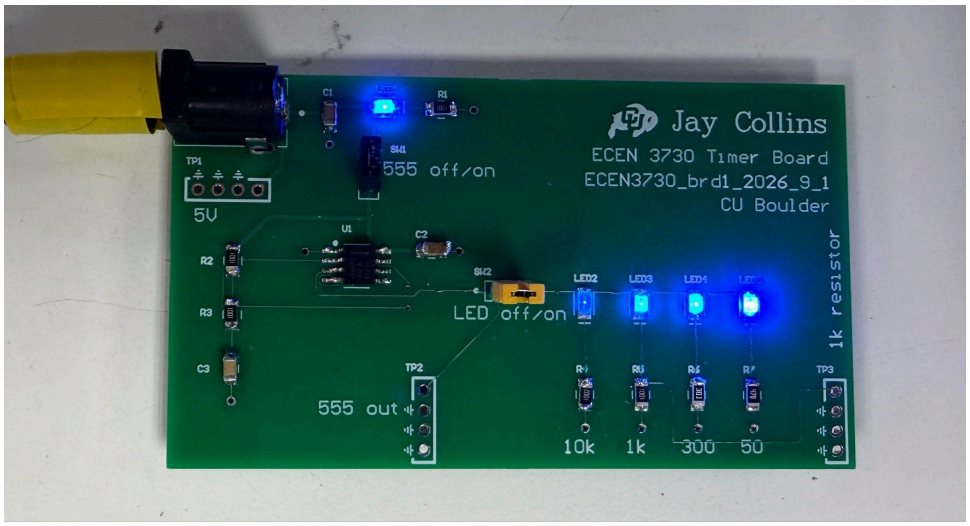
ECEN 3730: Board 1 Report

555 Astable Vibrator Circuit



Jay Collins

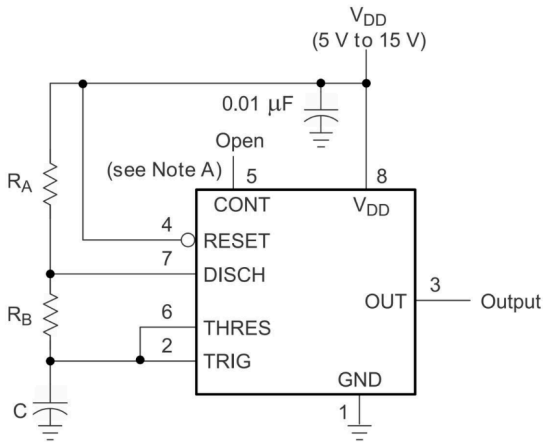
Description:

This board will be a 555 timer used in an astable vibrator circuit that will drive four different LEDs with different series resistors. This will show how bright an LED will be with different series resistors. It will be powered by a 5 V AC to DC charger and will include isolation switches, indicator LEDs and test points for measurements.

Plan of Record:

The circuit board will contain:

1. A power plug to use an external 5 V AC to DC charger to power the board
2. A 555 (TI NE555P) timer chip and circuitry designed for about 500 Hz and 60% duty cycle.

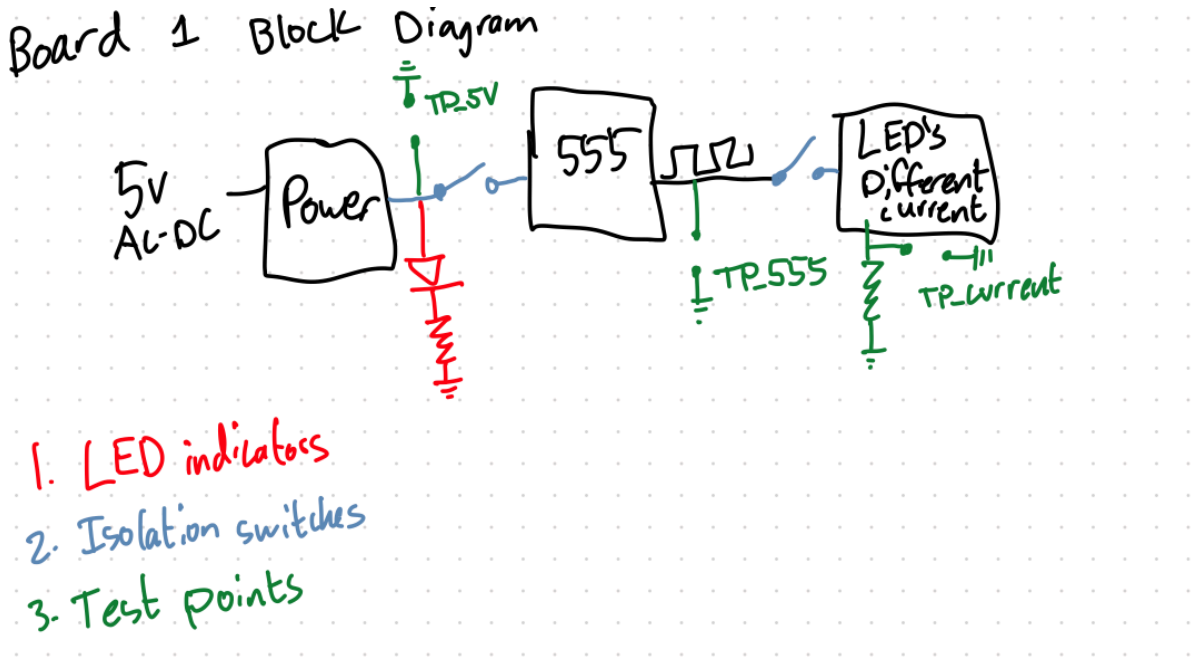


Ra/Rb = 1k Ohms, C = 1µF

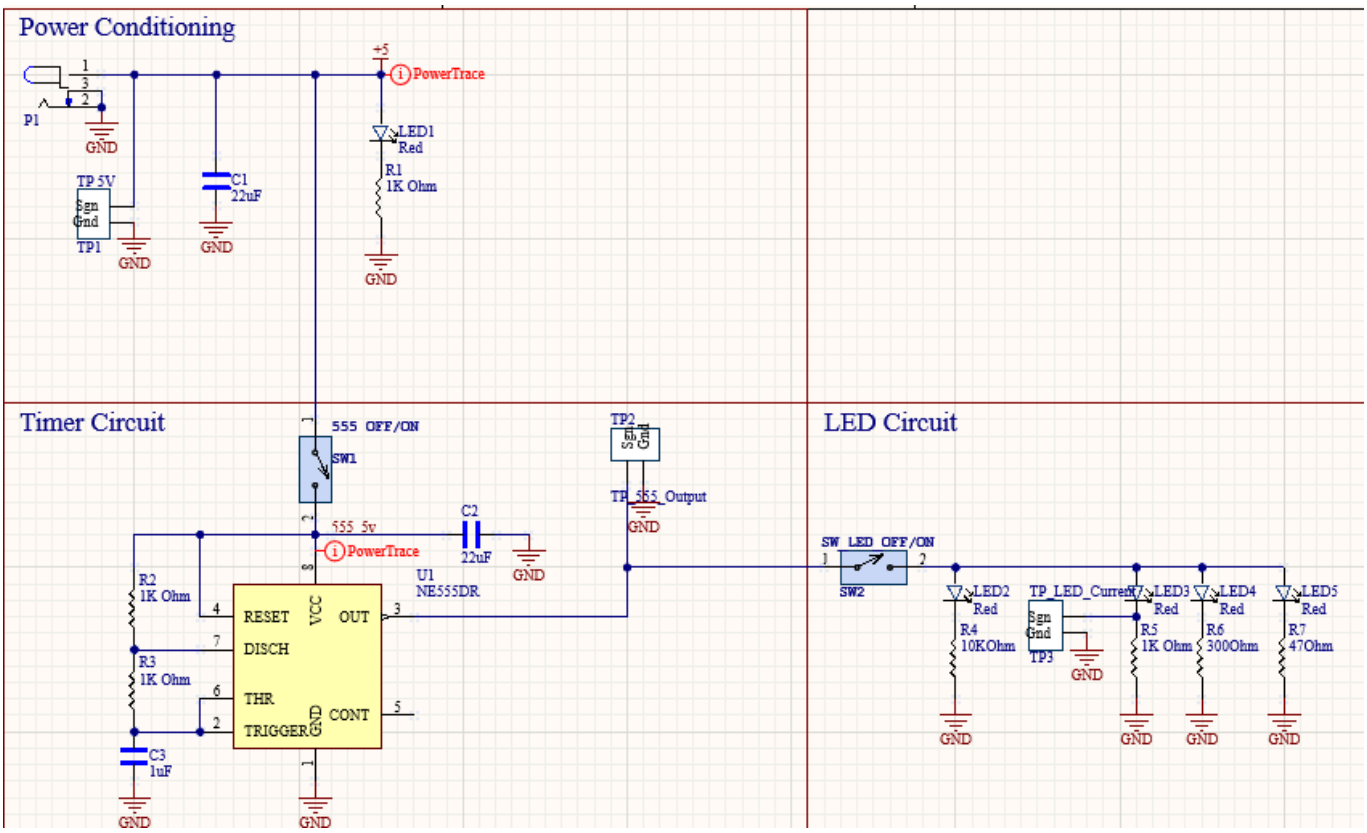
3. 1206 parts.
4. 4 LEDs of all the same color and series resistors of: 10k, 1k, 300, and 50 Ohms.
5. Indicator lights, test points and isolation switches as appropriate.
6. Design to measure the 5 V input rail, the 555 output voltage and the current through the 50 Ohm LED.

The NE555P timer was selected to ensure that there would be enough current output. It is also cheaper than the faster alternative.

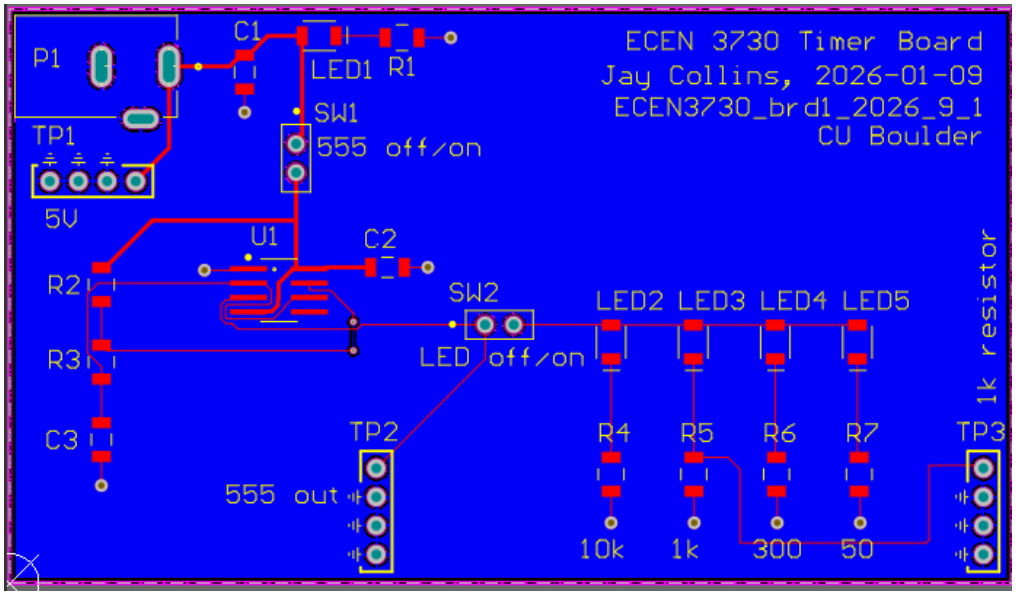
Block Diagram:



Schematic:

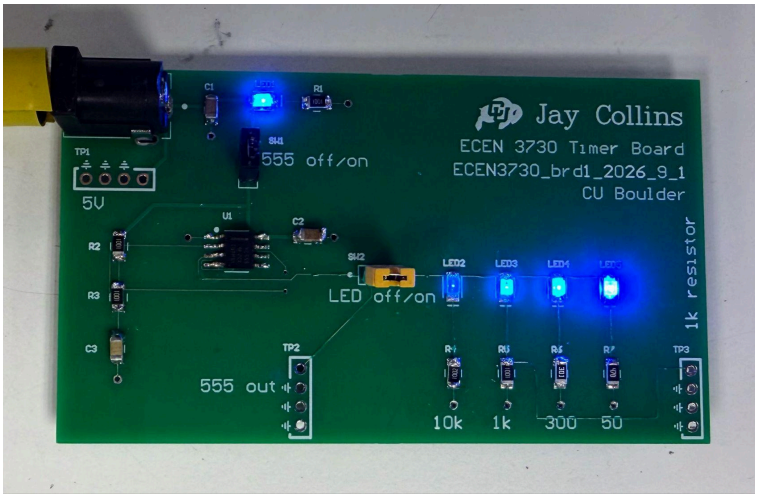


Layout:



Requirements to "work":

- When powered with a 5V AC to DC regulator, all the LEDs should turn on, including the indicator on the power rail.
- The 555 timer generates a square wave signal with a frequency and duty cycle of about 500 Hz and 60% duty cycle.
- The LEDs should have varying levels of brightness and one of them's current should be measurable.
- Switches that control the 555 timer being on as well as the LEDs.

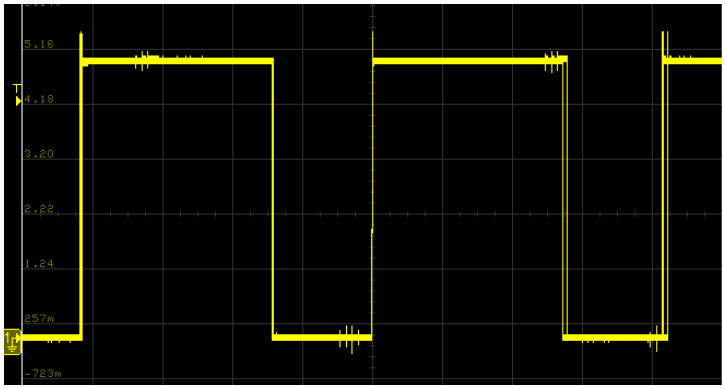


Implementation:

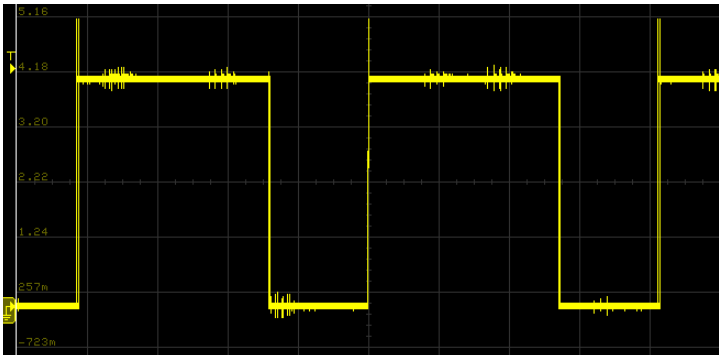
As expected, the board worked once assembled, shown both visually, and through measurements below.

Scope Measurements and Calculations:

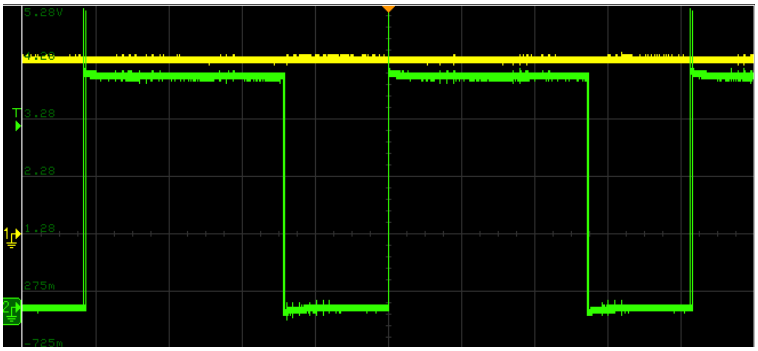
The first measurement is the 555 timer output without the load attached. The duty cycle is roughly 60%, the frequency is almost exactly 500hz, and the peak voltage is about 5V. It works.



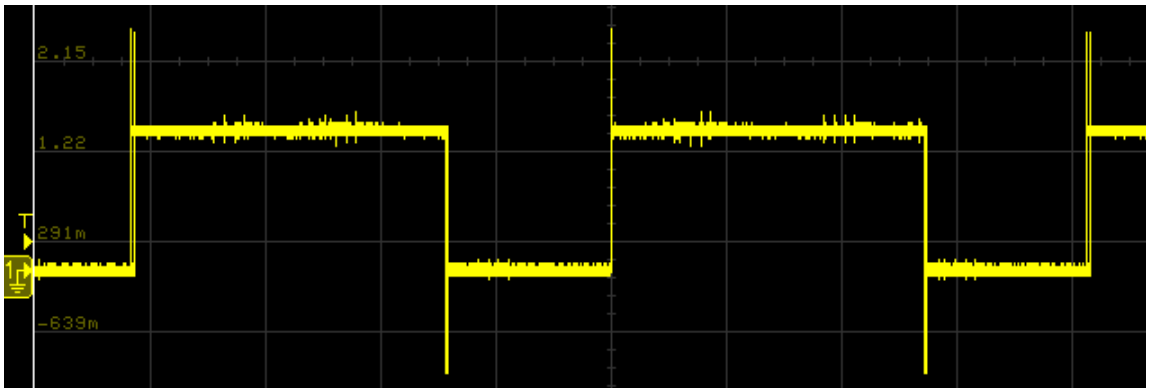
The next measurement is the 555 timer output with the load connected. There is about 1 full volt of difference when the load is attached, which will be used later to calculate Thevenin resistance.



Another measurement I took was the power rail compared to the 555 output, checking for switching noise, which there is not much at all, meaning the decoupling capacitor was placed well.



Up next, I will use the measurements below to calculate the 555 timer's Thevenin resistance and the total current being drawn from the timer. First, I measured the current through the LED attached to the 1k Ohm resistor. When comparing the peak voltage of this to the 555 output with load, I will have an estimate of the voltage drop across the LEDs and can use this to calculate the other LED's currents without measuring. Below is the 1k Ohm resistor's measured voltage.



At 1.4V peak voltage, the LED drop is 2.6V, and the current is 1.4mA. The rest of the calculations are shown in the table below.

Resistor Value	Estimated Current
10kΩ	0.14mA
1kΩ	1.4mA (measured)
300Ω	4.6mA
50Ω	28mA
555 Timer Output	34.14mA Total

If the total current from the 555 timer is 34.14mA, and the load voltage drop is 1V, the Thevenin resistance is 1V/34.14mA = **29Ω**.

In order to make a recommendation on the lowest amount of current to have flowing through an LED, I must first consider that the duty cycle is about 65% meaning the LED is at 65% brightness.

The 10k resistor set a good lower limit, as any dimmer would be hard to see in broad daylight. Therefore, the minimum constant current recommendation would be 0.14mA*0.65 = 0.091mA.

Project Analysis:

Practices that worked well:

- Labeling the individual components on the board made it easy to assemble.
- Labeling the test points helped avoid any confusion when testing.
- Writing the exact file name of the board made it easy to go back in and modify later.
- Proper placement of the decoupling capacitor reduced any potential noise.
- The use of indicator LEDs, test points, and switches made it very easy to obtain accurate measurements.

What I would have differently if done again:

- When measuring, I should have used the oscilloscope's measuring tools to get accurate numbers for the calculations. I do not think it was that big of a deal but it is something.
- I should have adjusted the y-axis on the measurements to be a more readable scale.

Conclusion:

This project went very smoothly and was great practice for my first PCB board. It went smoothly because I used so many great practices that I learned from the tutorials and I will continue to use them in the future. There were no major or minor errors at any point in testing. The board successfully used a 555 timer to output a 500Hz 60% duty cycle square wave which powered four LEDs, demonstrating the varying levels of brightness when combined with different resistor values. In the future, I will use the design and measurement practices learned here to successfully design and assemble PCBs.