Joseph Abroquah
ECEN 5730 – Fall 2025

Board 2 Report

Objective

The objective of this project was to extend a solderless breadboard (SSB) prototype of a 555 timer into a fully fabricated printed circuit board (PCB). The manufactured board implements an astable 555 timer oscillator designed to generate a square wave of approximately 500 Hz with a 60% duty cycle.

Plan of record

- Solder a fabricated PCB.
- Perform laboratory measurements of frequency, duty cycle, rise/fall times, and output voltage.
- Assess the performance of LEDs connected with different series resistors.

Component Listing

The bill of materials is listed in the table below.

Name	Description	Designator	Quantity
22uF	22uF ±10% 25V X5R 1206 Multilayer Ceramic Capacitors MLCC - SMD/SMT RoHS	C1, C3	2
1uF	MULTILAYER CERAMIC CAPACITORS MLCC - SMD/SMT 1UF 50V 1206 ROHS	C2	1
Red	Red 621~631nm 1206 Light Emitting Diodes (LED) RoHS	LED1, LED2, LED3, LED4, LED5	5
Power Jack	Power Barrel Connector Jack 2.10mm ID (0.083"), 5.50mm OD (0.217") Through Hole, Right Angle	P1	1
1k	CHIP RESISTOR - SURFACE MOUNT 1KOHMS ±1% 1/4W 1206 ROHS	R1, R3, R4, R7	4
47	CHIP RESISTOR - SURFACE MOUNT 1MOHMS ±1% 1/4W 1206 ROHS	R2	1
510Ohm	CHIP RESISTOR - SURFACE MOUNT 300OHMS ±1% 1/4W 1206 ROHS	R5	1
10k	CHIP RESISTOR - SURFACE MOUNT 1MOHMS ±1% 1/4W 1206 ROHS	R6	1
SW_2Pin_100mil_Switch	2Pin Header	SW1, SW2	2
TP_5V	Test Point 300 mil centers	TP1	1
50_Ohm_res.	Test Point 300 mil centers	TP2	1
555out	Test Point 300 mil centers	TP3	1

LMC555CMX/NOPB	555 Type, Timer/Oscillator _Single_ IC 3MHz 8-SO	U1	1

Circuit Diagram

A sketch of the major components of the circuit is shown in Fig.1.(a) and the astable vibrator circuit shown in Fig.1.(b).

Theoretical analysis

The duty cycle and frequency of operation are controlled by the resistors and capacitors according to equation 1 as specified in the datasheet. The capacitance has no effect on the duty cycle but affects the frequency. A higher capacitance reduces the frequency and vice versa.

$$DC = \frac{R_A}{R_A + 2R_B};\ f = \frac{1.44}{(R_A + 2R_B)C} \tag{1}$$

To obtain 50% duty cycle and 500 Hz, we choose C, R_A ($R_A = R_B$) to be $1\mu F$ and 1k Ω respectively based on the availability of the components. The calculated duty cycle and frequency are 33% and 481 Hz.

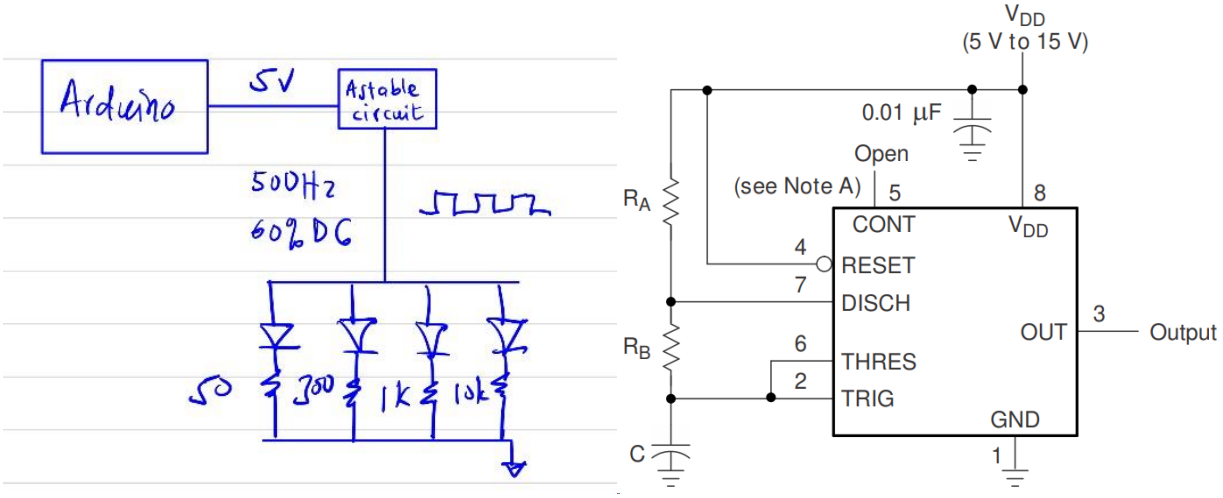

Fig. 1. Napkin sketch (a), Astable vibrator circuit (b)

Measurement and Discussion

Fig. 2. shows the frequency and duty cycle of the 555 timer. The frequency and duty cycle is 500 Hz and 65.9% respectively. We see that the measured values deviate from the calculated values. This could be attributed to tolerances of the components. The rise time is approximately 50ns illustrated in Fig. 3. The peak to peak voltage across the 1k Ω branch is measured to be about 3.5 V. This means that the peak voltage is 1.75V. The root mean square voltage for the square waveform is then 1.75V.

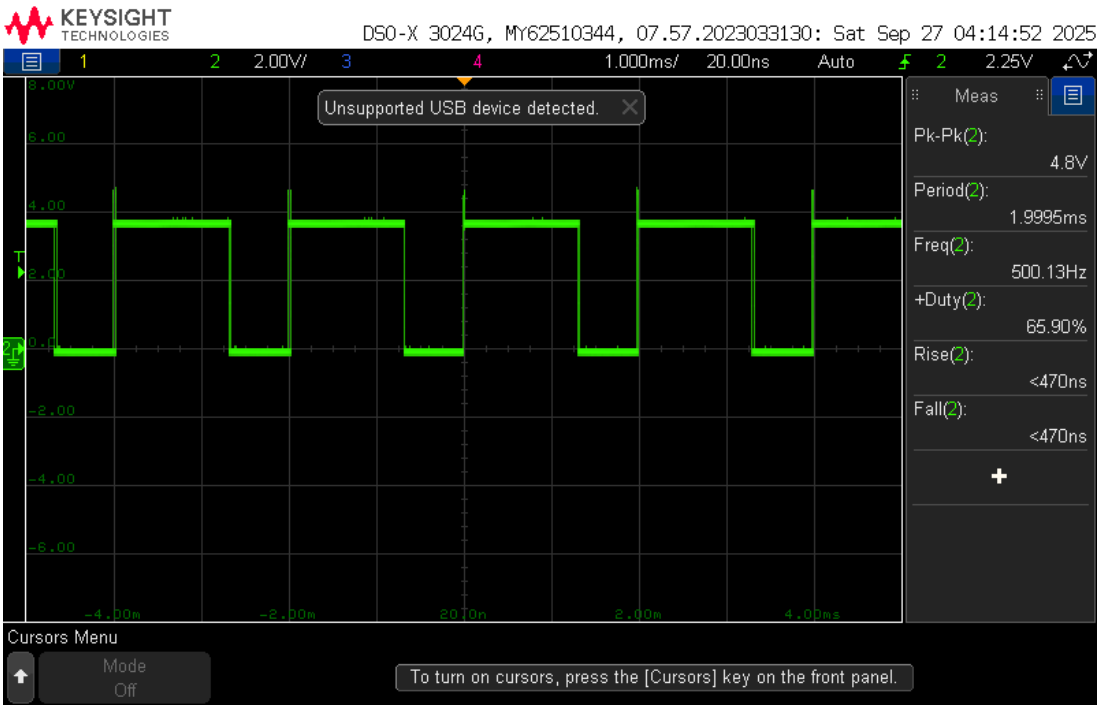

Fig. 2. Frequency and duty cycle of the 555 timer

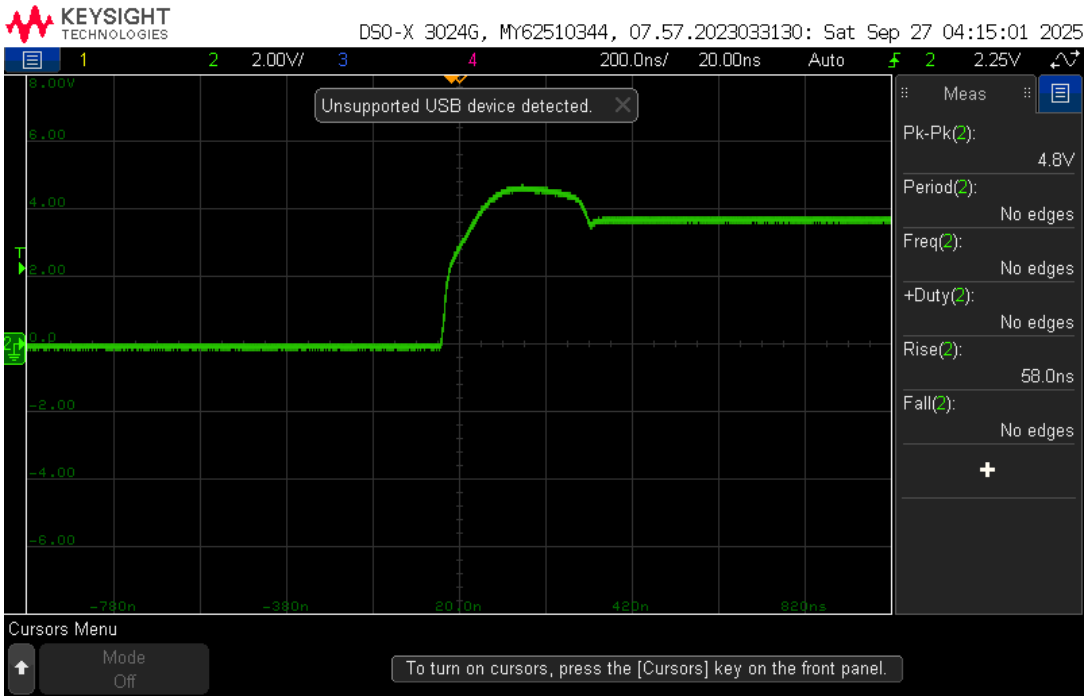

Fig. 3. Rise time

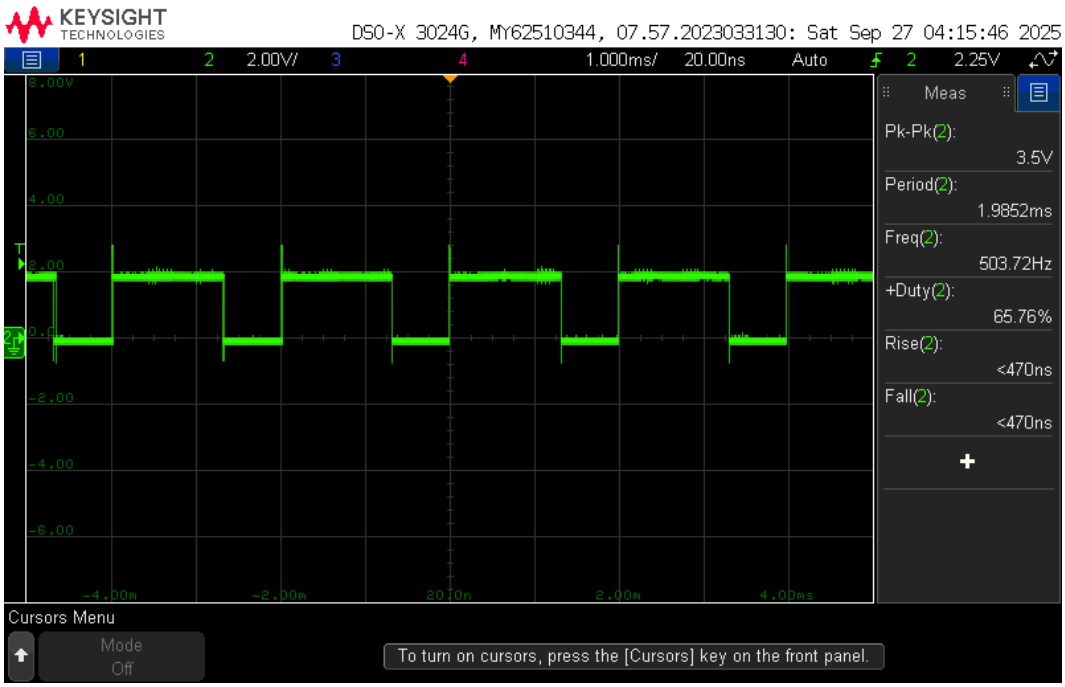

Fig. 4. Voltage across the 1k series resistor

The current through the limiting resistors are given in the table below. From Ohm's law, the higher the resistance, the lower the current through the branch. This is seen in Fig.5. through the brightness level of the LEDS, LED brightness directly correlates with branch current.

Compared to the SBB prototype, the fabricated PCB demonstrated improved stability, with the breadboard circuit exhibiting more noise and less consistent duty cycles, likely due to loose connections and parasitic effects. During board assembly, minor soldering issues prevented some LEDs from functioning. These were resolved by reworking the affected parts. It is important to note LED polarity. Incorrect orientation will prevent the LED from turning on.

Current Limiting Resistor [Ω]	Current Through Branch [mA]
47	37.23
510	3.43
1k	1.75
10k	0.18

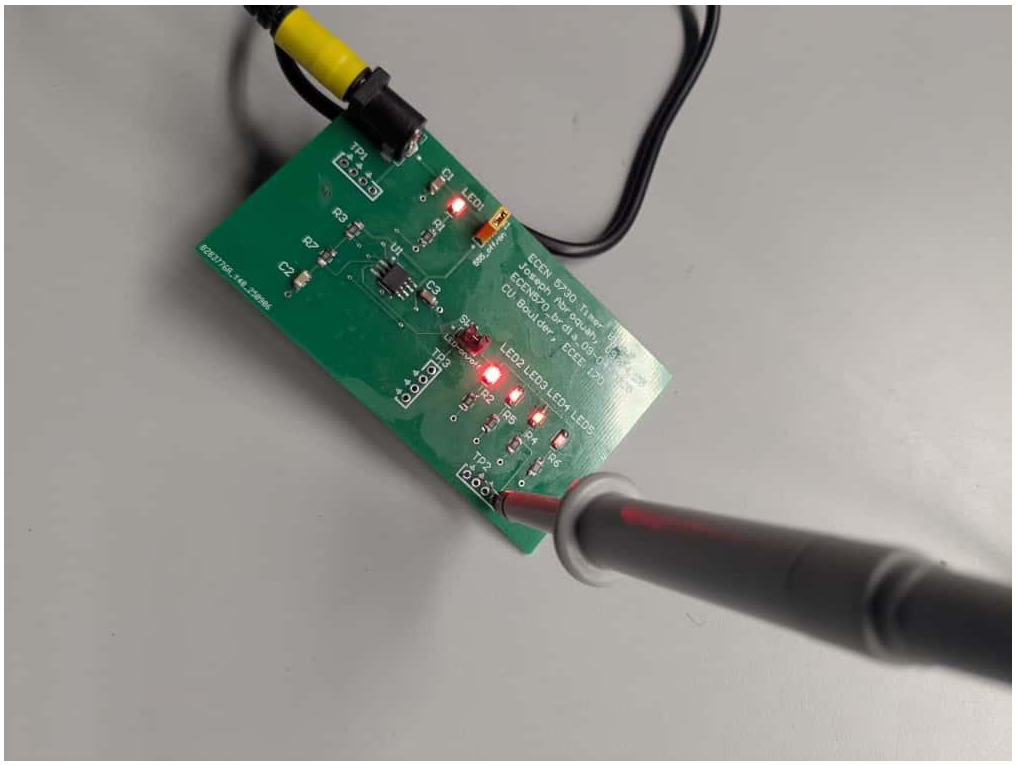

Fig. 5. Brightness of the four LEDs

Conclusion

Through this project, I successfully designed, fabricated, and tested a PCB implementing a 555-timer astable oscillator. I learned that soldering quality is critical.