Lab 2: 555 Timer

Friday, August 29, 2025 1:29 PM

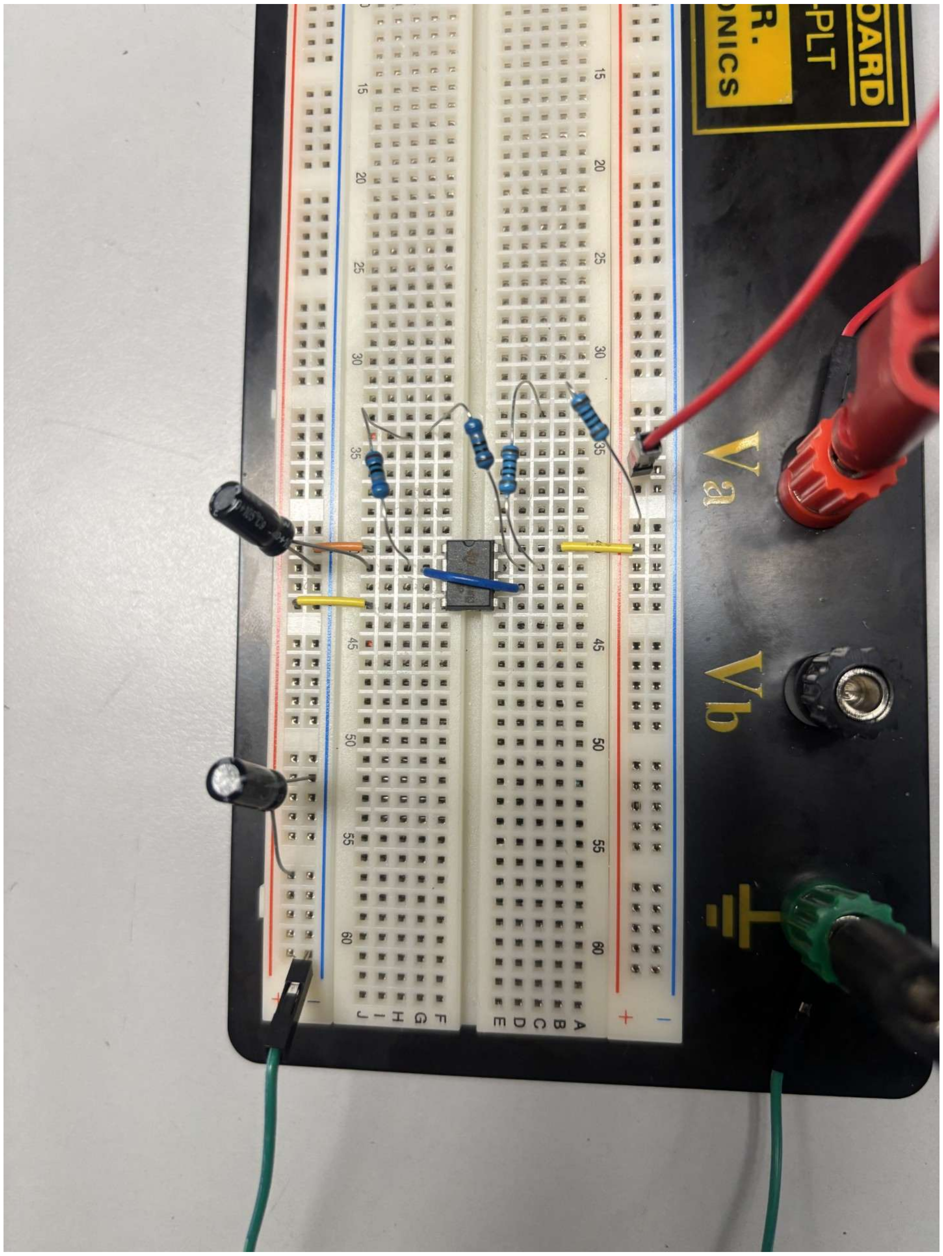
Objective

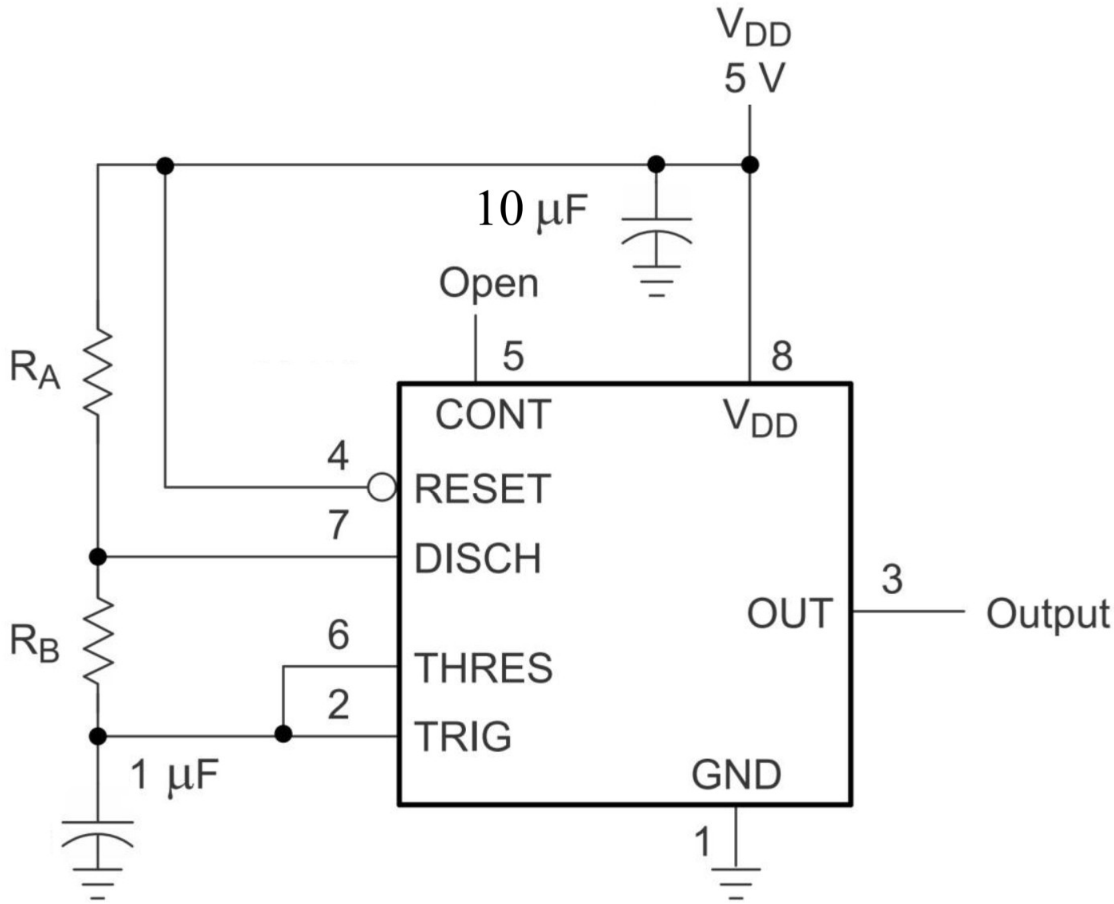
The objective of this lab is to familiarize ourselves with assembling onto a solderless breadboard circuit, and utilizing rule #9 to know what we expect to see before we measure it. The circuit in question is centered around a fast (TLC555) and slow (NE555) timer, where we compare performance of rise and fall times of a 500 Hz, 50% duty cycle signal.

Component List

- NE555 timer
- TLC 555 timer
- x2 680 ohm resistor
- x2 100 ohm resistor
- Extra resistors for tuning
- Jumper wires
- Solderless breadboard
- 1 uF capacitor
- 10 uF capacitor
- Oscilloscope
- Scope probe
- DC power supply
- Power supply cables

Circuit Photo and Back of Napkin Sketch


Va
Vb



Calculations

To calculate a 50% duty cycle output square wave for 500 Hz, we can use the following formulas with a 1 uF capacitor selected for C:

$$Output\ driver\ duty\ cycle = 50\% = \frac{R_B}{(R_A + 2R_B)}$$

$$Frequency = \frac{1.44}{(R_A + 2R_B)C}$$

$$500\ Hz = \frac{1.44}{(R_A + 2R_B)1 \times 10^{-6}}$$

$$3.472 \times 10^{-4} = \frac{1}{(R_A + 2R_B)}$$

$$2880 = R_A + 2R_B$$

Where we can select R_A = 220 Ohm and R_B = 1330 Ohm. Two 680 Ohm resistors in series were chosen for R_B (1360 Ohm), and after tuning, the value of R_A that worked best was 200 Ohms. From an online 555 timer calculator, the following was observed:

Choose Configuration

(●) Astable ( ) Monostable

R_1 Resistor Value

200 Ω

R_2 Resistor Value

1.360 kΩ

C_1 Capacitance Value

1 µF

Formula

$$T_h = 0.693(R_1 + R_2)C_1 \quad T_l = 0.693R_2C_1$$

$$f = \frac{1.44}{(R_1 + 2R_2)C_1}$$

Time High

1.1 ms

Time Low

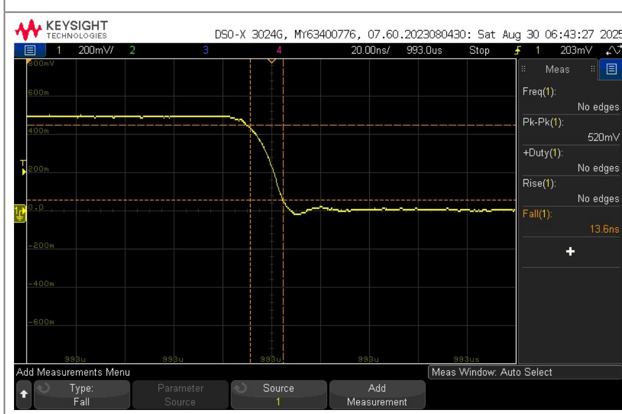
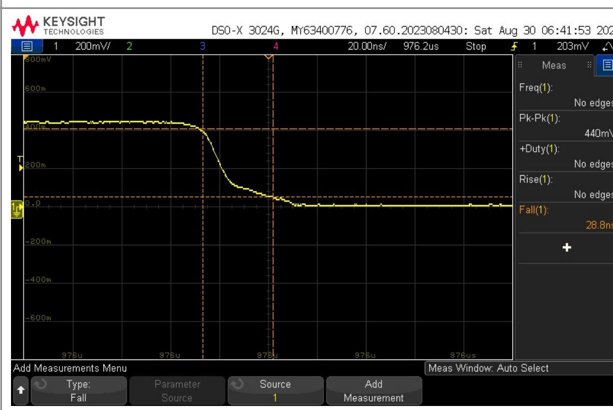
0.9425 ms

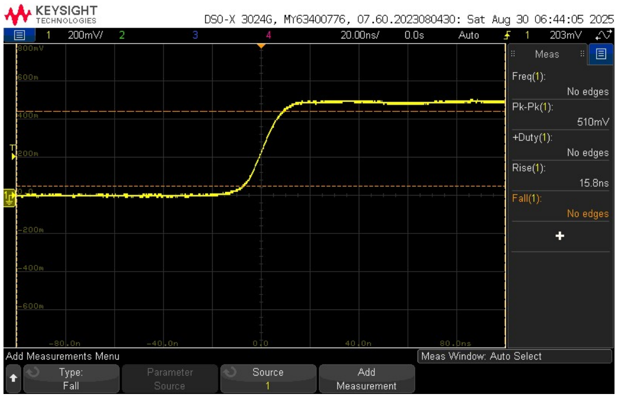
Frequency

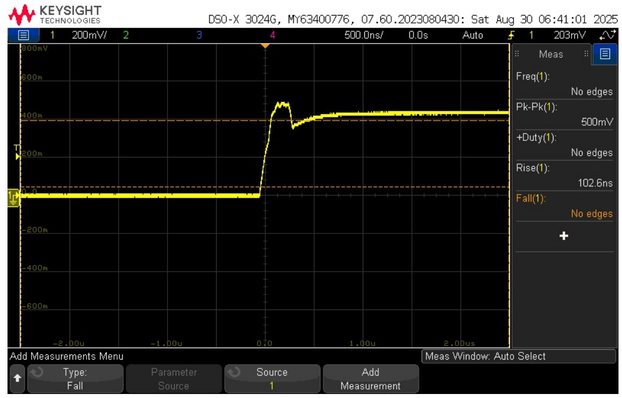
493 Hz

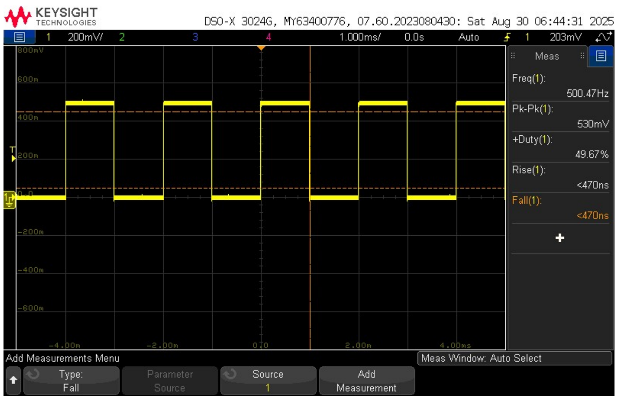
Which gives the expected ~500 Hz duty cycle with approximately 50% duty cycle.

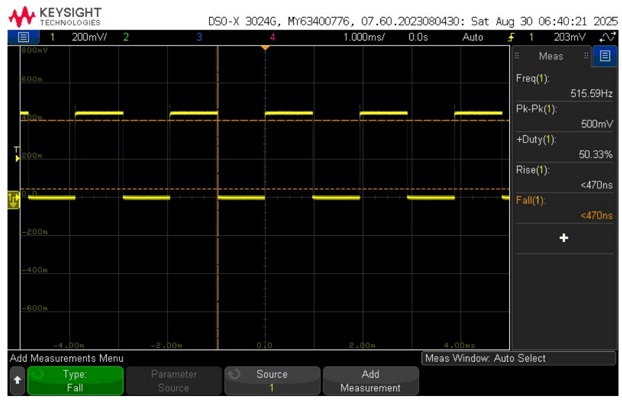
Scope Shots

Fast	Slow
	









Key Findings & Conclusion

The scope traces indicate that the 50% duty cycle at 500 Hz was achieved for both the fast and slow 555 timer. They have comparable peak to peak voltage values as well. The rise and fall times for each, however, show that the rise and fall times of the slow 555 did in fact have longer rise and fall times than that of the fast 555. The datasheet of the TLC555 indicates the typical rise time is 20 ns, and 15 ns for the fall time. With 15.8 ns and 13.6 ns rise and fall times, respectively, for the TLC555, the measured values are well within what we would expect to see. For the NE555, typical rise and fall times are 100 ns. The measured values for rise and fall times for this 555 were 102.6 and 28.8 respectively. The fall time is lower than what would be expected from the datasheet. When migrating this circuit to a PCB, the decoupling capacitor is placed much closer to the Vcc input of the 555 timer. There will also be multiple LEDs at the output of the 555 timer with various resistance values to see how the output is affected. Test points and switches are also included in the final design to confirm everything is working as expected.