NE 555 Timer as an Astable Multivibrator

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Abstract

This report discusses the operation of the NE 555 timer configured as an astable multivibrator. The NE 555 timer is a versatile integrated circuit used in various applications, including timers, pulse generation, and oscillators. In this configuration, it generates a continuous square wave output without requiring any external triggering.

1 AIM

To study the operation of the NE 555 timer in astable mode and to get a square wave as an output.

2 APPARATUS

- NE 555 Timer IC
- Resistors (R1, R2)
- Capacitor (C1)
- Breadboard
- Connecting wires
- Power supply (5V DC)
- Oscilloscope or multimeter for output measurement
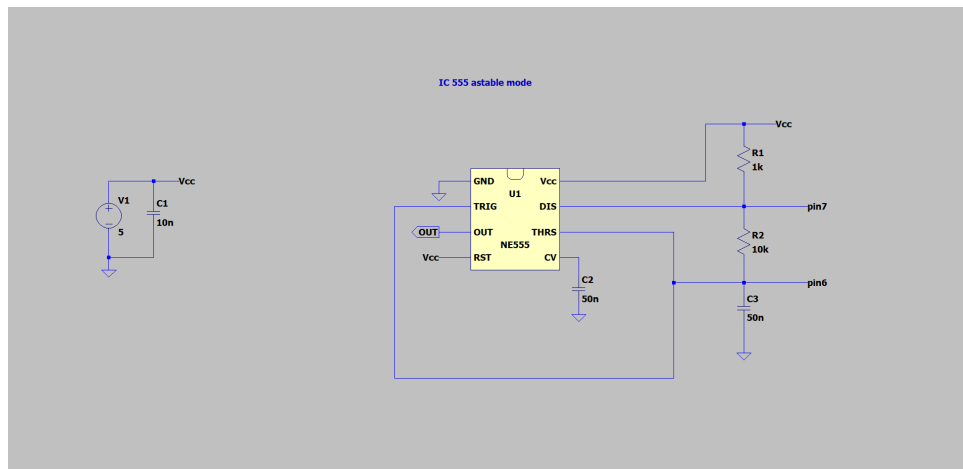
3 circuit diagram

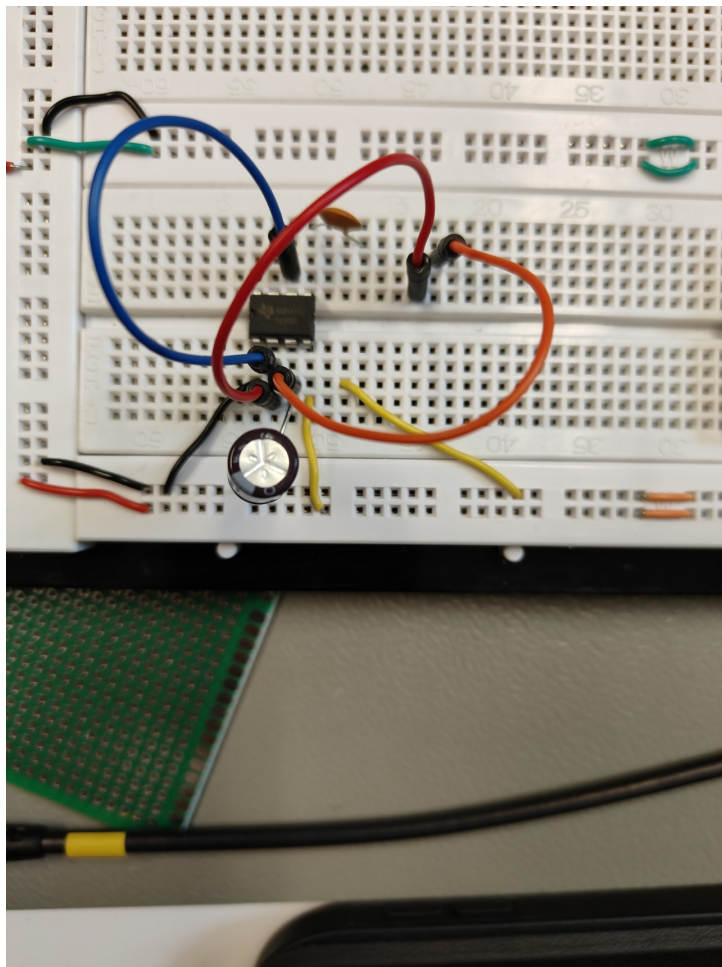Figure 1: Circuit Diagram of NE 555 Timer in Astable Mode made in LT spice

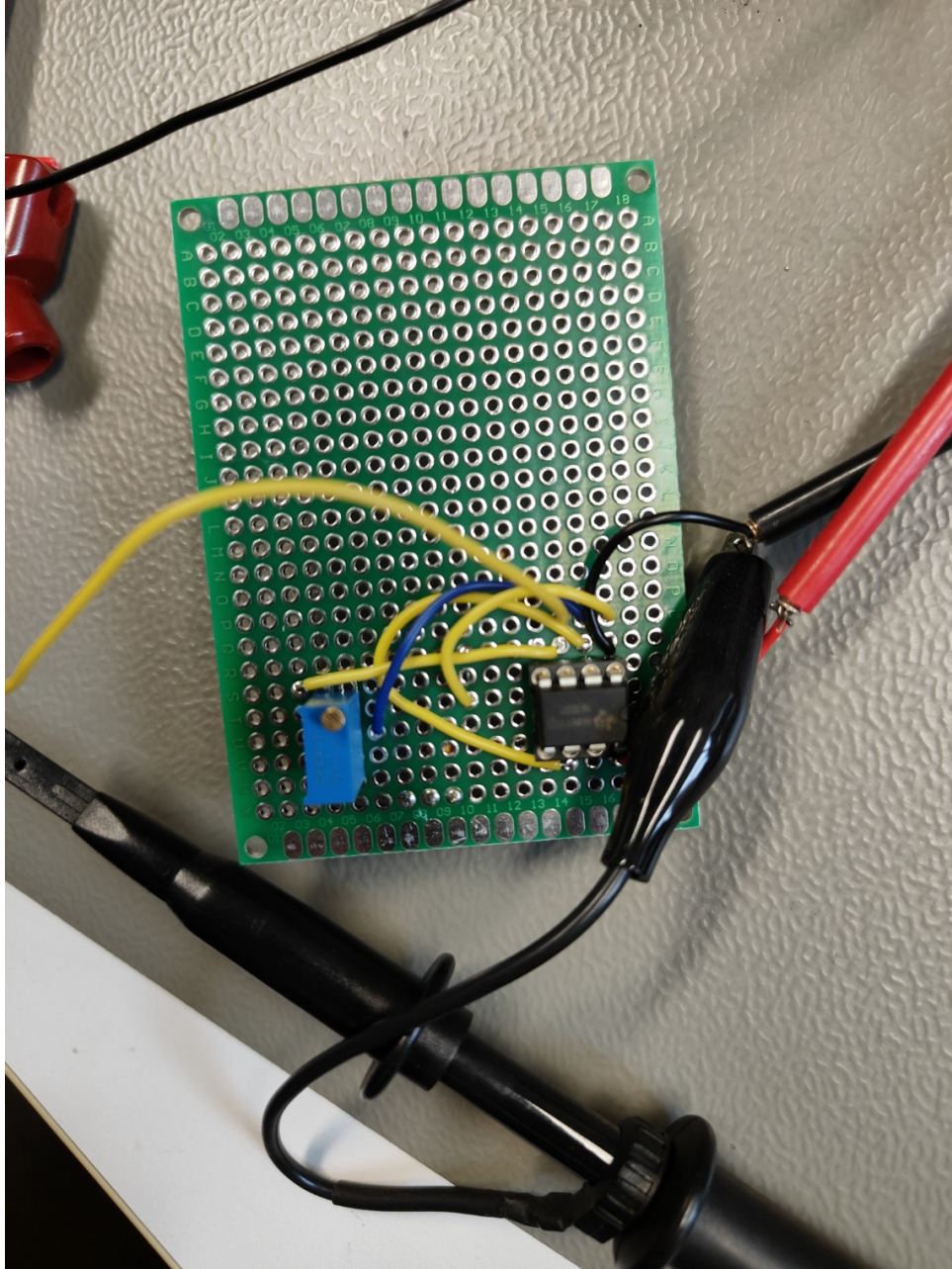Figure 2: Circuit Diagram of NE 555 Timer in Astable Mode on Breadboard

Figure 3: Circuit Diagram of NE 555 Timer in Astable Mode on PCB. The Capacitors are connected on the other side of the PCB.

4   Working

The 555 timer IC configured in **astable mode** operates as an oscillator generating a continuous square wave without any external trigger. It alternates between HIGH and LOW output states automatically, making it useful for applications like pulse generation, LED blinking, tone generation, and clock signals.

Circuit Operation

In astable mode, the 555 timer uses two resistors, R_1 and R_2, and a capacitor C (in this case, C_3) to determine the timing of the output waveform.

Charging Phase

- When the circuit is powered on, the capacitor C_3 starts charging through both R_1 and R_2.

- The voltage across C_3 increases exponentially.

- When the voltage across the capacitor reaches $\frac{2}{3}V_{cc}$, the internal comparator of the 555 timer sets the output to LOW.

Discharging Phase

- Once the output goes LOW, the discharge pin (pin 7) is connected to ground internally.

- Capacitor C_3 discharges through resistor R_2.

- When the voltage across C_3 falls to $\frac{1}{3}V_{cc}$, the output goes HIGH again, restarting the cycle.

Output Waveform

The output at pin 3 is a continuous square wave with: Given the component values:

- $R_1 = 1\,\text{k}\Omega$

- $R_2 = 10\,\text{k}\Omega$

- $C = 50\,\text{nF}$

The output at pin 3 is a continuous square wave with:

- **HIGH state duration ($\text{T}_{\textbf{HIGH}}$):**

$$T_{HIGH} = 0.693 \cdot (R_1 + R_2) \cdot C = 0.693 \cdot (1\,\text{k}\Omega + 10\,\text{k}\Omega) \cdot 50\,\text{nF} = 0.381\,15\,\text{ms}$$

- **LOW state duration ($\text{T}_{\textbf{LOW}}$):**

$$T_{LOW} = 0.693 \cdot R_2 \cdot C = 0.693 \cdot 10\,\text{k}\Omega \cdot 50\,\text{nF} = 0.3465\,\text{ms}$$

- **Total time period (T):**

$$T = T_{HIGH} + T_{LOW} = 0.727\,65\,\text{ms}$$

- **Frequency (f):**

$$f = \frac{1}{T} = \frac{1}{0.72765\,\text{ms}} \approx 1.374\,\text{kHz}$$

- **Duty Cycle (D):**

$$D = \frac{T_{HIGH}}{T} \cdot 100 = \frac{0.38115}{0.72765} \cdot 100 \approx 52.37\,\%$$

IC555 astable mode ✕

Cursor 1

V(out)

Horz: 552.51641µs   Vert: 29.99985µV

Cursor 2

V(out)

Horz: 1.285558ms   Vert: 29.99985µV

Diff (Cursor2 - Cursor1)

Horz: 733.04158µs   Vert: 0V
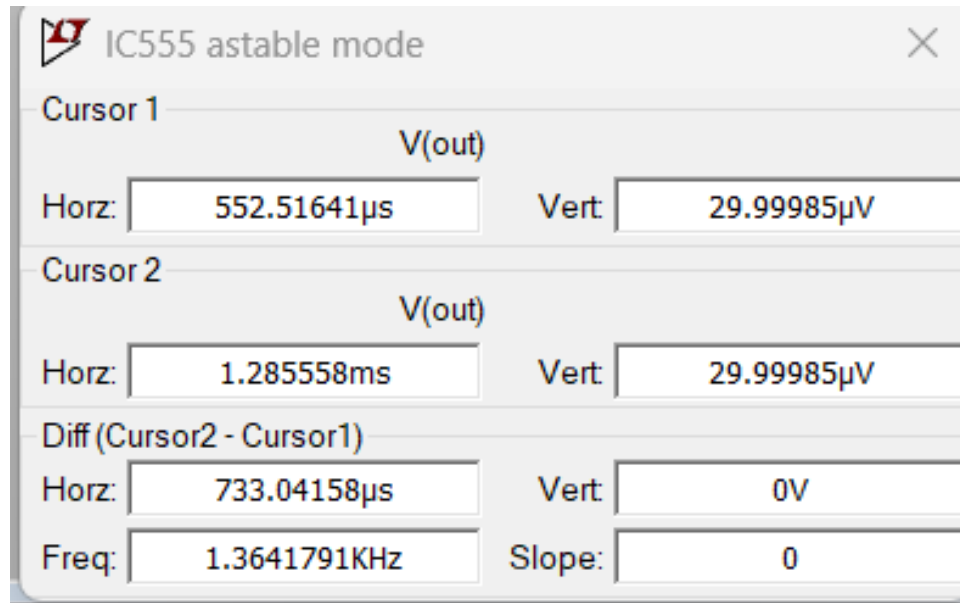
Freq: 1.3641791KHz   Slope: 0

Figure 4: cursor 1 is kept on the rising edge of the output waveform and cursor 2 is kept on the next rising edge of the output waveform. The time difference between the two cursors is the time period of the output waveform.

The theoretical values calculated above are verified by the simulation in LT Spice. The output waveform shows a frequency of approximately $1.374\,\mathrm{kHz}$, which matches the theoretical calculations.

Application

This circuit is used in:

- LED blinkers

- Pulse and clock generators

- Tone generators

- Frequency counters

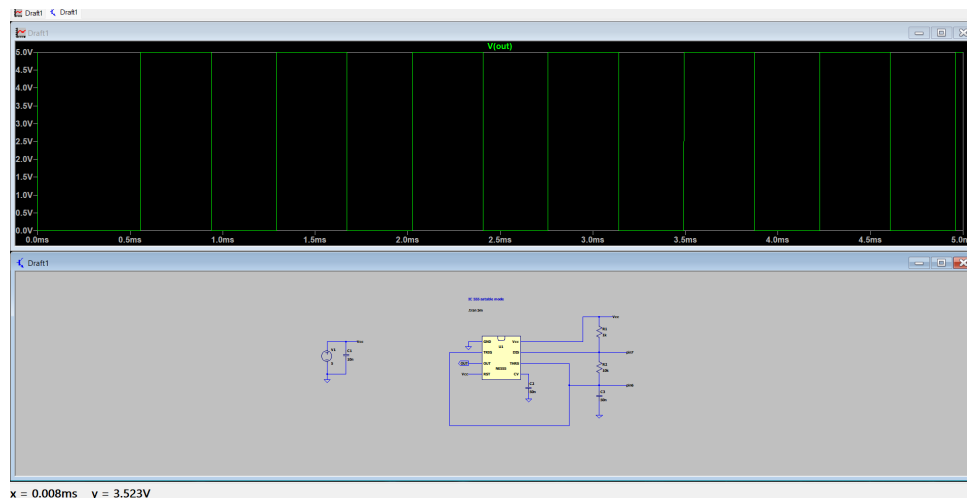- PWM signal generation

5 RESULTS

Figure 5: Output of NE 555 Timer in Astable Mode from LT Spice Simulation

6 Conclusion

The NE 555 timer in astable mode successfully generates a continuous square wave output. The frequency and duty cycle of the output can be adjusted by changing the values of resistors R1, R2, and capacitor C1. This configuration is widely used in applications such as clock pulses, LED flashers, and tone generation.

Note: I did not use the picoscope to measure the output of the circuit as I did not have time to take the output screenshot on the last lab day.