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Applications of IC Building Blocks

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III. Objectives:

The objectives of this experiment were to explore the practical applications of a popular integrated circuit (IC) chip, the LM 555 timer, and to become more familiar with application notes. This experiment aimed to help students understand how new applications are developed for special-function ICs and gain hands-on experience in designing and building circuits using the LM 555 timer. Students were tasked with designing a monostable multivibrator and an astable multivibrator, constructing the respective circuits, and measuring their output characteristics. By achieving these objectives, students would gain a deeper understanding of the applications and versatility of the LM 555 timer IC and the importance of IC building blocks in electronics.

IV. Equipment Used:

- Breadboard

- Various Electronic Components
- Power supply
- Function generator
- Oscilloscope
- Multi-Meter

V. Preliminary Calculations:

In our preliminary calculations, we first focused on the monostable multivibrator. We selected a 10 microfarad capacitor for the circuit and calculated the value of Ra to be 909090.90 ohms. These calculations can be observed below within **Calculation 1**. Next, we turned our attention to the astable multivibrator. For this portion of the experiment, we calculated the values of Ra and Rb to be 1298.7 ohms and 144.3 ohms, respectively. These calculations can be observed below within **Calculation 2**.

Calculation 1

$$t = 1.1(R_A C)$$

$$R_A = \frac{t}{1.1 \cdot C} = \frac{10s}{10\ \mu F \cdot 1.1} = 0.909\ M\Omega$$

Calculation 2

$$t = 0.693(R_B C)$$

$$R_B = \frac{t}{1.1 \cdot C} = \frac{10s}{1\ \mu F \cdot 0.693} = 144.3\ \Omega$$

$$t = (0.693 R_A + 100)C$$

$$R_A = 1298.7\ \Omega$$

VI. Procedure/Result/Analysis:

01. Procedure:

1. Review the LM 555 Timer data sheet and familiarize yourself with the chip, its pin connection diagram, and its applications.
2. Design a monostable multivibrator that delivers a pulse of approximately 10 seconds when triggered, using the nomograph and formula provided.
3. Design an astable multivibrator that generates a negative-going pulse of approximately 100 µs every 1 ms, using a 1 µF capacitor for C and calculating the values for RA and RB.
4. Construct the monostable multivibrator circuit **Figure 1** and apply power to the circuit.
5. Use an oscilloscope to probe the output (pin 3) and observe the output waveform for the monostable multivibrator. Save the oscilloscope screen showing the resulting pulse.
6. Show the operating monostable multivibrator circuit to the TA.
7. Construct the astable multivibrator circuit **Figure 3** and apply power to the circuit.

8. Use an oscilloscope to probe the output and observe the output waveform for the astable multivibrator. Save the oscilloscope screen showing the resulting square wave.
9. Show the operating astable multivibrator circuit to the TA.
10. Carefully vary the power supply voltage between 6 volts and 15 volts for the astable multivibrator circuit and observe the output frequency, duty cycle, and amplitude changes.
11. Observe the waveform across the timing capacitor C with the oscilloscope probe and save the oscilloscope screen showing both capacitor voltage and output voltage waveforms.

02. Experiment:

a. In Part A of the experiment, we constructed the monostable multivibrator circuit as depicted in **Figure 1** shown below. After assembling the circuit and applying power, we used an oscilloscope to probe the output (pin 3) and observed the output waveform. The output of this circuit can be seen below within **Figure 2**. Upon analyzing the output waveform, we found that the output time was 10.63 seconds, which is relatively close to our desired 10-second pulse. This result demonstrates that our calculated parameters were accurate, and our circuit design was successful in achieving the intended output. In response to Q1, the waveform is quite close to the calculated parameters, with only a small deviation from the desired 10-second pulse.

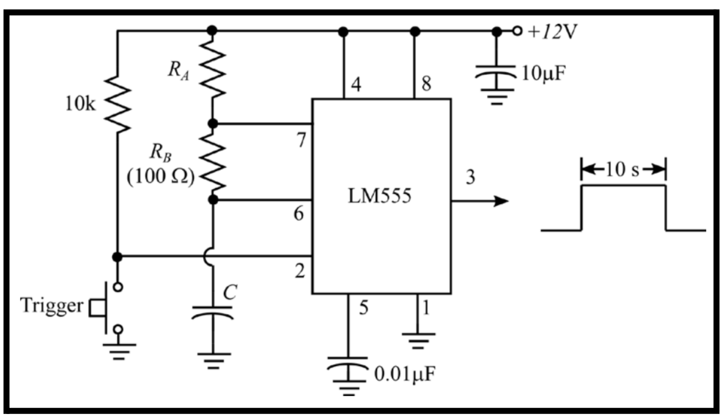

Figure 1: Monostable Multivibrator

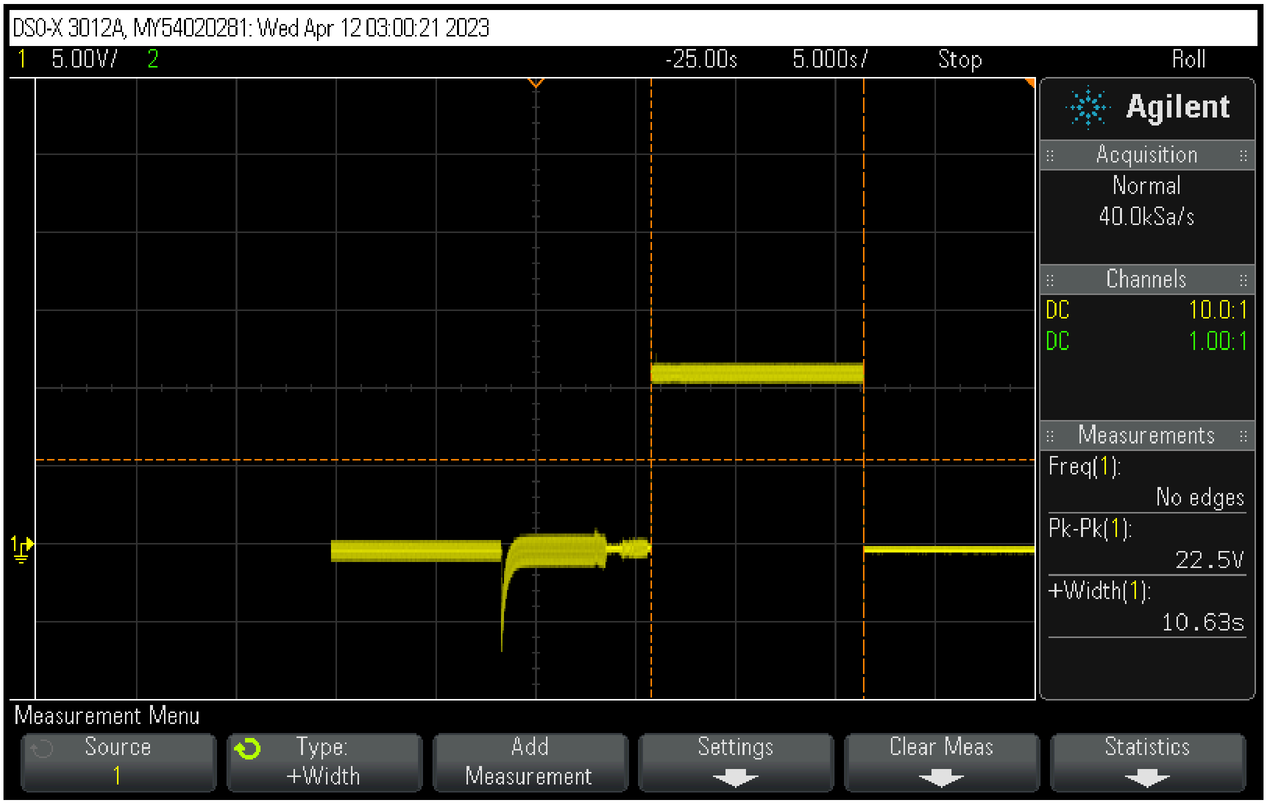

Figure 2: Monostable Output

b. In Part B of the experiment, we constructed the astable multivibrator circuit using **Figure 3** shown below. After assembling the circuit and applying power, we used an oscilloscope to probe the output and observed the output waveform. The output of this circuit can be seen below within **Figure 4**. Upon analyzing the output waveform, we found that the output time had a pulse width of 112 microseconds and a period of 1.05 milliseconds, which is relatively close to our desired pulse width of 100 microseconds and period of 1 millisecond. In response to Q1, the waveform is quite close to the calculated parameters, with only a small deviation from the desired pulse width and period. Next, we used a scope probe to observe the waveform across the timing capacitor C. As expected, we observed a sawtooth waveform. We saved the oscilloscope screen displaying both the capacitor voltage (yellow graph) and output voltage (green graph). This can be seen in **Figure 5**. The peaks of the sawtooth waveform and the output voltage square wave appear to line up, demonstrating the successful implementation of the astable multivibrator circuit. This versatile IC chip offers numerous possibilities, such as transforming the sawtooth waveform into a linear ramp, showcasing its adaptability in various applications.

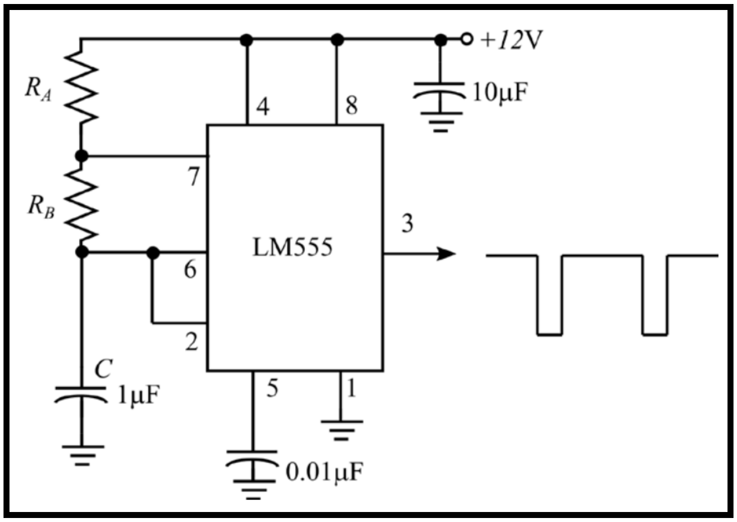

Figure 3: Astable Multivibrator

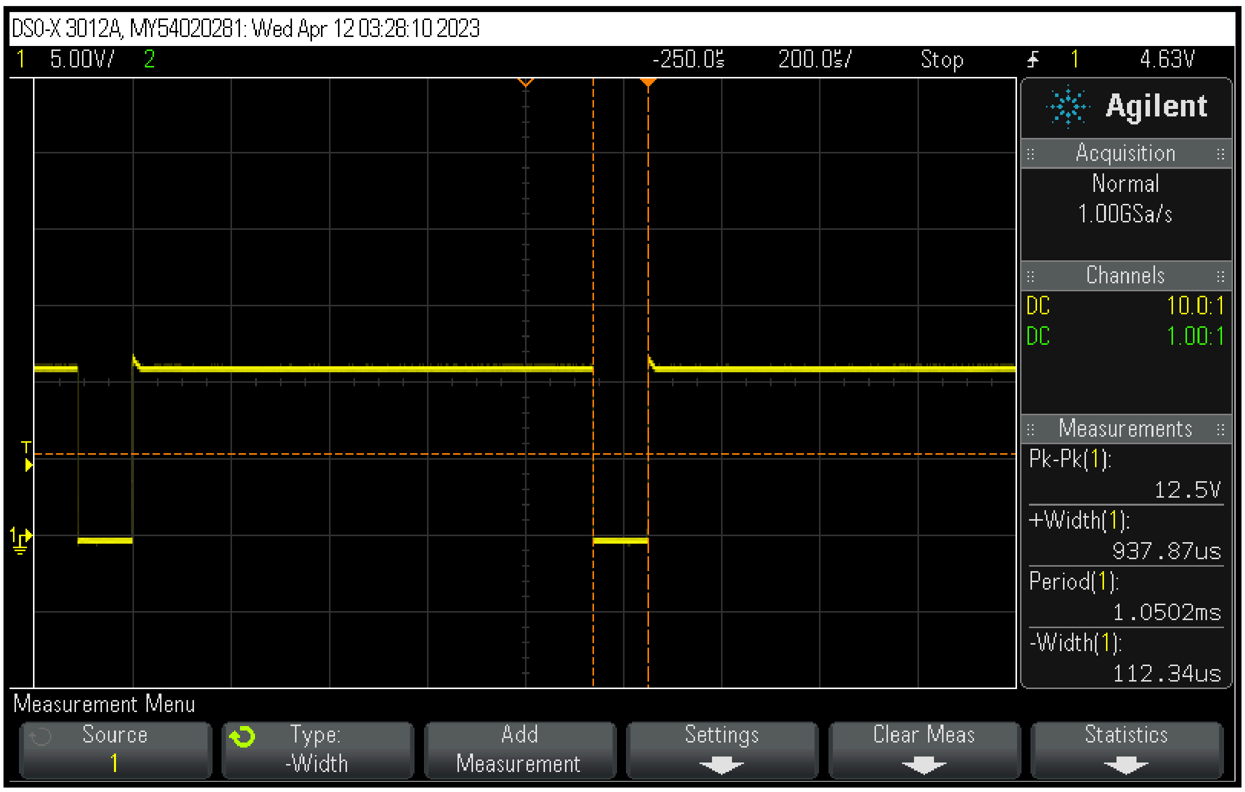

Figure 4: Varying voltage

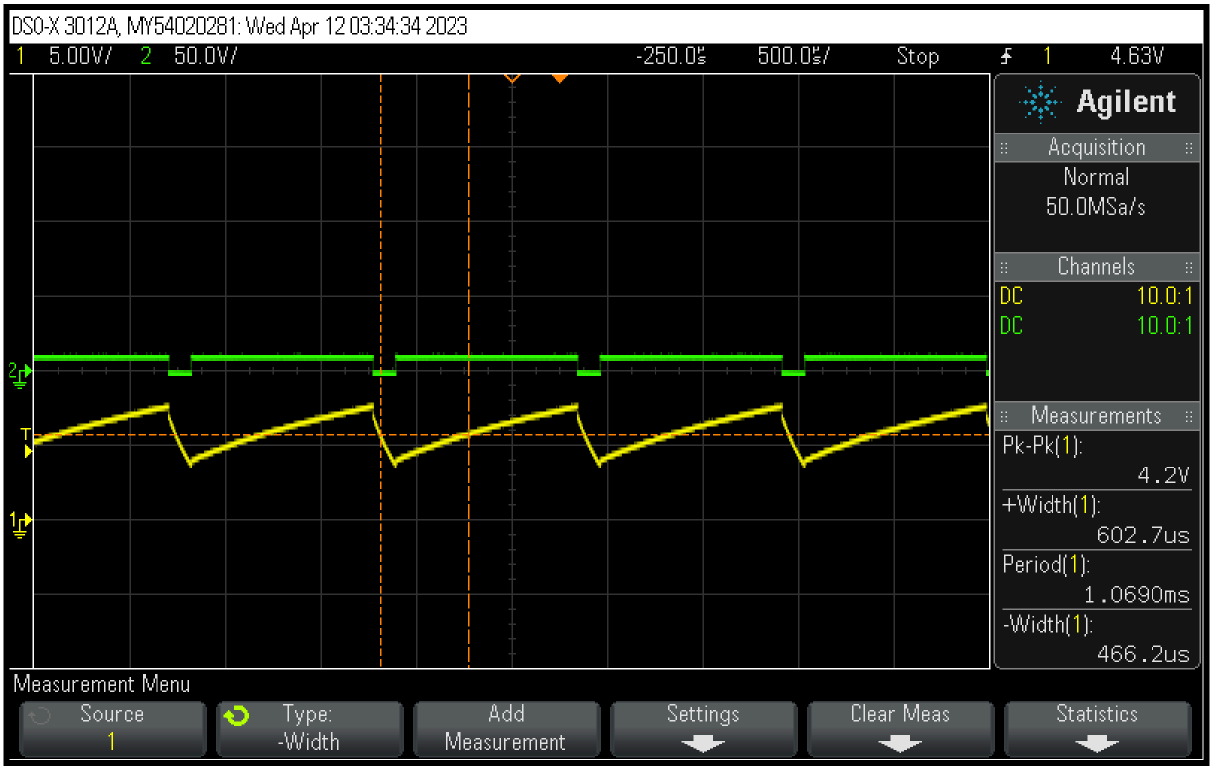

Figure 5: Capacitor Output

VII. Conclusion:

In conclusion, we successfully demonstrated the practical applications and versatility of the LM 555 timer IC, a popular integrated circuit used in various electronic devices. Through designing and constructing monostable and astable multivibrators, we gained hands-on experience with IC building blocks and became familiar with application notes. Our monostable multivibrator provided an output pulse with a duration close to the desired 10 seconds, while the astable multivibrator generated a waveform with a period and pulse width close to the calculated parameters. We observed the sawtooth waveform across the timing capacitor, illustrating the potential for further modifications and applications. Overall, this experiment reinforced the importance of ICs in electronics and showcased the utility of the LM 555 timer in designing versatile and efficient circuits.

VIII. References:

Not applicable

IX. Appendix:

Not applicable