Introduction

The famous multivibrator circuit was first introduced in a publication by Henri Abraham and Eugene Bloch in 1919. Multivibrators are electronic circuits designed for the purpose of applying different two-state systems such as oscillators, timers, and flip-flops.

Multivibrators can be divided into 3 typed:

1- Astable: The circuit does not maintain stable in either states; it fluctuates from one state to the other.
2- Monostable: The circuit has only one stable state and the other is an unstable transient state. A trigger pulse causes the circuit to enter the unstable state, but after a set time, the circuit returns to its stable state.
3- Bistable: The circuit is stable in either state. The circuit is also known as a flip flop because it can be switched from one state to the other by an external trigger pulse.

In this experiment, our main concern will be of monostable multivibrators. A monostable multivibrator will be designed and constructed. Its behaviour and performance will also be investigated and evaluated. The monostable multivibrator will operate using a 555 timer. A 555 timer is an integrated circuit that provides time delay or pulse generation which is determined by the time constant of the RC network. The time constant can be given by:

$$\boxed{\tau = 1.1 \times R_1 \times C_1}$$

Where, τ is in seconds, R is in ohms and C in Farads.

Objective of The Experiment

1. To construct the NE555 Monostable Multivibrator
2. To calculate the maximum and minimum output voltage.
3. To calculate the maximum and minimum voltage across the capacitor C1.
4. To find the charging duration of the capacitor C1.
5. To verify the results by calculating the error between theoretical and experimental values.
6. To determine the effect on the charging duration by changing the value of the R1 and C1

Equipments

1- DC Power Supply.

2- Oscilloscope.

3- NE555 Timer.

4- Three Resistors of (10kΩ).

5- Two Ceramic capacitors (22μF).

6- Breadboard.

7- BNC-male-to-2-crocodile-clip.

8- Electrical wires for connection.

Experimental Procedure

1. The circuit diagram in figure 1 was built were $R_1 = 20k\Omega$, $R_2 = 10k\Omega$ and $C_1 = C_2 = 22\mu$F.

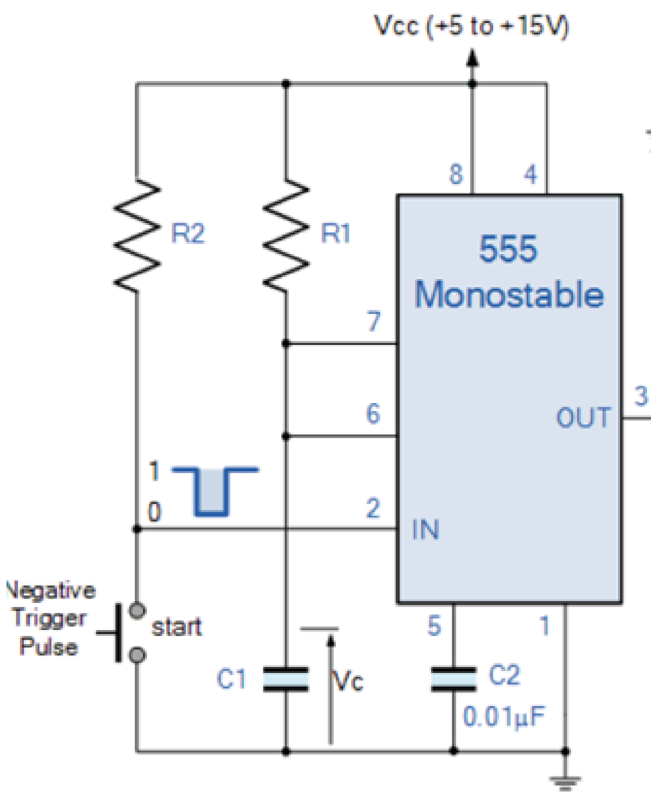

Figure 1. The Monostable Multivibrator Circuit.

2. + 15V supply is applied to the + V_{cc} terminal of the 555 timer.
3. The switch in the circuit was closed until the reading of the voltage was equal to $\frac{2}{3}V_{CC} = 10V$.
4. At pin 3 the output waveform is observed with the help of a CRO.

5. At pin 6 the capacitor voltage is obtained across C1 in the CRO and the voltage and output waveforms are plotted in a graph sheet.
6. The maximum and minimum output voltages ,voltage across C1 and charging duration (t) of C1 were calculated (theoretical value) and they also recorded from the CRO (experimental value) then the error was calculated by the formula:

$$\text{error} = \left|\frac{V_{\text{Theoretical}} - V_{\text{experimental}}}{V_{\text{Theoretical}}}\right| \times 100$$

7. The capacitor C1 was changed to (100μF) and then value of R1 was changed to (10 $k\Omega$) to determine the effect of increasing or decreasing them, next they were showed by sketching the output waveforms.

Result.

The Result of our experiment were written in two parts, the first part is shown the main experiment with R1= 20 kΩ. C1= 22 μF. The second part is shown the effects of increasing or decreasing the values of R1 and C1.

Part 1: Main experiment.

1. Plotting the output waveform and voltage across C1 on the common x-axis.

After closing the switch, the capacitor begin starts charging gradually until it reaches its full capacity. This process takes time equals to, t=RC. Figure 2 shows that.

From the previous waveform, we determined the following:

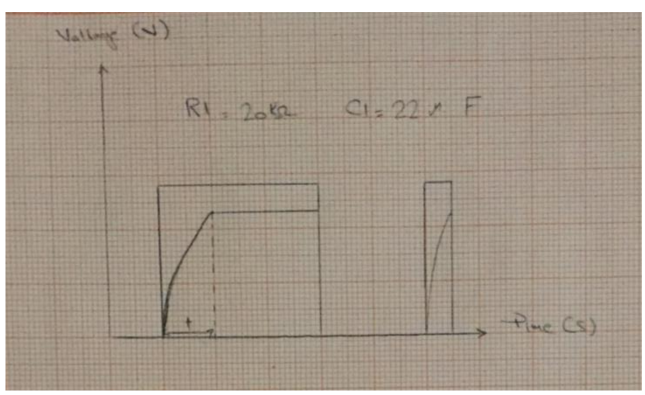

Figure2. The waveform with output voltage and the voltage across C1.

a. The maximum and minimum output voltage.
Table 1 is shown the reading of maximum and minimum output voltage, when $V_{CC} = 15\ V$.

Table 1: Maximum and minimum output voltage.			
Reading	Theoretical (V)	Experimental (V)	Error (%)
V.max	$V = V_{CC} = 15V$	$V = 2.8 \times 5 = 14V$	$\left\lvert\frac{14-15}{15}\right\rvert \times 100 = 6.67\%$
V.min	$V = 0V$	$V = 0V$	0%

b. The maximum and minimum voltage across the C1.
Table 2 is shown the reading of maximum and minimum voltage across C1, when $V_{CC} = 15\ V$.

Table 2: Maximum and minimum voltage across C1.			
Reading	Theoretical (V)	Experimental (V)	Error (%)
V.max	$V = \frac{2}{3}V_{CC} = \frac{2}{3}(15) = 10V$	$V = 2.3 \times 5 = 11.5\ V$	$\left\lvert\frac{11.5-10}{10}\right\rvert \times 100 = 15\%$
V.min	$V = 0V$	$V = 0V$	0%

c. The charging duration (t) of capacitor C1.
Table 3 shows the reading of charging t durations of C_1, when $R1 = 20k\Omega$, and $C1 = 22\mu$F.

Table 3: Charging t1 Durations of C.			
Reading	Theoretical (s)	Experimental (s)	Error (%)
t	$t1 = 1 \times R1 \times C1$ $= 1 \times 20k \times 22\mu$ $= 500\ ms$	$t1 = 1 \times 500\ ms$ $= 500\ ms$	$\left\lvert\frac{500-500}{500}\right\rvert \times 100$ $= 0\%$

Part 2: Determining the effect of increasing or decreasing the value of R_1 and C_1.
This part is shown the result of changing period when increasing and decreasing R1 and C1 (see Figure 3 and 4). This will be explained in the discussion.

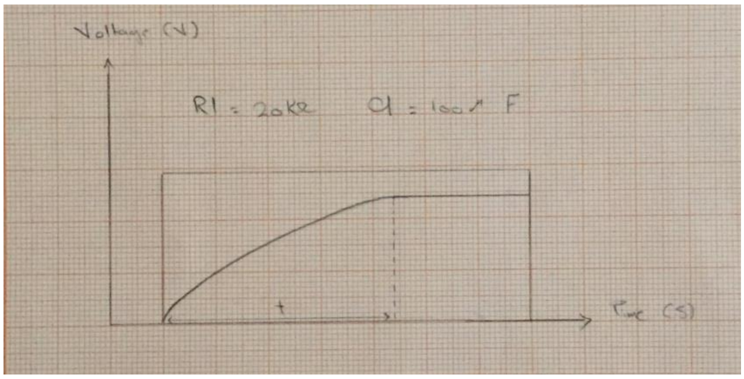

Figure3. The waveform when R1=20kΩ, C1=100 μF.

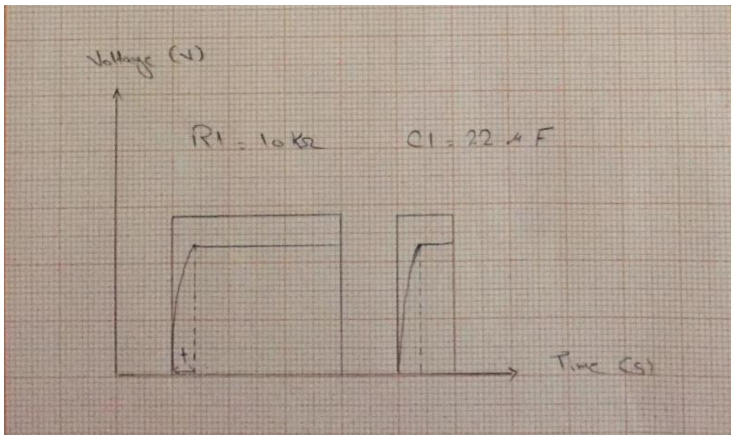

Figure4. The waveform when R1=10kΩ, C1=22 μF.

Discussion

In the monostable multivibrator experiment the effect of the 555 timer on both voltage and charging duration in a certain capacitor was studied. Firstly, the voltage on capacitor C_1 was compared with the output voltage. The result from the previous comparison was that the voltage on C_1 is almost 2/3 of the output voltage which is also given by the theoretical formula. However the %error for both the output and C_1 voltage was quiet large.

The charging duration (t) of capacitor C_1 when $R_1 = 20\text{k}\Omega$ and $C_1 = 22\mu\text{F}$ was obtained by using the formula $[1.1 \times \text{R} \times \text{C}]$. The charging duration (t) was perfectly matching the result we got from the oscilloscope, 0% error was got. The experiment was continued with changing the values of the resistor R_1 and the capacitor C_1.

Firstly, the value of C_1 was changed from $22\mu\text{F}$ to $100\ \mu\text{F}$. The result from this change in the value of the capacitor was that the voltage stayed the same and a great change in the charging duration. The charging duration almost was four times larger. It moved from $500\,ms$ to $2\,s$. So, the charging duration was increased.

Secondly, the value of R_1 was changed from $20k\Omega$ to $10k\Omega$. The result from this change in the value of the resistor was that the voltage stayed the same and a great change in the charging duration. The charging duration was almost half the original. It moved from 500 mS to 240 mS. So, the charging duration was decreased.

In the experiment, there was a drop in the experimental readings of the maximum output voltage and the maximum voltage across capacitance C_1 comparison to the theoretical readings. That might be due to the internal resistance of the 555 timer that caused interruption which lead to the inaccuracy of our reading.

Conclusion:

The objectives of the experiment were successfully achieved. A monostable multivibrator circuit was designed constructed using a 555 timer after multiple failed attempts to do so. The monostable multivibrator's behaviour was investigated by determining the maximum and minimum output voltage and the time it took the capacitors to charge. Further investigations were done by changing the values of the resistor and the capacitors. The performance of the monostable multivibrator was evaluated with each value. When the capacitor was increase, the voltage remained the same but the capacitor took longer time to charge. Ultimately, when the resistance was decreased, the voltage also remained the same but the charging duration was decreased. The students were able to improve their abilities to deduce information from graphs and analyse their findings. Their technical skills were also improved by regenerating their output plots into this report.