PH3204: Electronics Laboratory

Study of 555 Timer IC as Astable multivibrator with different frequency

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1   Theory

1.1   554 Timer IC

The 555 timer IC is a widely used integrated circuit designed to produce a variety of output waveforms and timing intervals. The name 555 comes from the fact that it contains three $5k\omega$ rsistances in its internal structure. The 555 timer chip is a 8 pin robust device that can b configured in various modes such namely astable, bistable and multistabe modes. A simplifoed block diagram of the 555 timer is shown in the figure 1
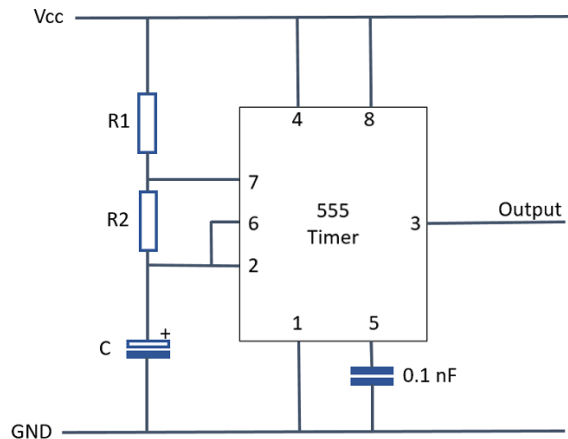

Figure 1: Block diagram of 555 timer IC

The various pin functions are stated below:

- **Pin 1 (GND)**: Ground pin. This pin is connected to the negative terminal of the power supply.

- **Pin 2 (TRIG)**: Trigger pin. This pin is used to trigger the timer and initiate the timing cycle. A negative pulse on this pin starts the timing interval.

- **Pin 3 (OUT)**: Output pin. This pin provides the output signal of the timer. It can sink or source current to drive external loads.

- **Pin 4 (RESET)**: Reset pin. This pin is used to reset the timer and terminate the timing cycle. A low signal on this pin resets the output to low.

- **Pin 5 (CTRL)**: Control voltage pin. This pin is used to control the timing interval by applying an external voltage. It is typically connected to ground through a capacitor to filter noise.

- **Pin 6 (THRESH)**: Threshold pin. This pin is used to monitor the voltage across the timing capacitor. When the voltage on this pin exceeds 2/3 of the supply voltage, the timer resets.

- **Pin 7 (DISCH)**: Discharge pin. This pin is used to discharge the timing capacitor when the timer is in the astable or monostable mode. It is connected to ground when the timer is in the timing cycle.

- **Pin 8 (VCC)**: Supply voltage pin. This pin is connected to the positive terminal of the power supply. The supply voltage can range from 4.5V to 15V.

1.2 Astable Multivibrator

An astable multivibrator is a type of oscillator circuit that continuously switches between its high and low states without requiring any external triggering. The 555 timer can be configured as an astable multivibrator by connecting resistors and capacitors in a specific manner. In this configuration, the 555 timer generates a square wave output signal with a frequency determined by the values of the resistors and capacitor used in the circuit. The output frequency of the astable is given by the formula:

$$f = \frac{1.44}{(R_1 + 2R_2)C_1} \tag{1}$$

where R_1 and R_2 are the resistances in Ω and C_1 is the capacitance in Farads.

2 Data and Observations

We havve chosen different values of R_1 R_2 and C_1 to observe the frequency of the output signal. Using these values we have calculated the theoretical frequency values using the formula given above.
Using the oscilloscope, we measured the time-period of the output wave generated to calculate its frequency and compared it with the theoretical calculations.
The data collected has been tabulated below.

C_1 (nF)	R_1 (kΩ)	R_2 (kΩ)	f_{th} (kHz)	T_m (μs)	T_s (μs)	T (μs)	f_{exp} (kHz)	% Error
1	1.01	10.25	65.0860	8.12	7.34	15.46	64.6831	0.62
1	10	100	6.6667	72.4	65.6	138	7.2464	8.71
1	100	1000	0.6667	724	644	1368	0.7310	9.65
10	1	10	6.6667	74.8	72.4	147.2	6.7935	1.90
10	10	100	0.6667	768	704	1472	0.6793	1.89
10	100	1000	0.0667	8080	7520	15600	0.0641	3.85
100	1	10	0.6667	904	924	1828	0.5470	17.97
100	10	100	0.0667	9700	9000	18700	0.0535	19.78
100	100	1000	0.0067	96000	102000	198000	0.0051	24.24
0.1	100	1000	6.6667	96	82	178	5.6180	15.72
0.1	10	100	66.6667	8.8	8.2	17	58.8235	11.76
0.1	1	10	666.6667	2.6	1.6	4.2	238.0952	64.29

Table 1: Experimental vs Theoretical Frequencies with Percent Error

The above table shows except 1 outlier, the experimental and theoretical obervations matched pretty. Note that on last 6 observations were calculated on a different day and the oscilloscope was showing a lot of noise which made the calculations of the time period and hence frequency difficult. This could have given rise to more errors in the last 6 observations as compared to the first 6.

3 Sources of Error

4 Conclusion