

555 Timer Circuit

Thomas Greenwood

Student Number - 2308349

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Abstract

This report will detail the building of a 555 timer circuit in Proteus simulation software with justifications on how it was built and in depth design calculations which will then be transferred to a physical breadboard circuit. The overall conclusion of this report showed a working breadboard circuit with LEDS that functioned as required and on/off times from the Astable 555 timer displayed on an oscilloscope.

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1.0 – Introduction

This report will detail the steps undertaken and all necessary background information/research used to create a 555 timer on a breadboard. The circuit was initially made on Proteus simulation software then transferred into a physical working circuit with readings from an oscilloscope. This report will detail all steps undertaken from the theory to the physical circuit and evidence all the areas covered in the manufacture of the 555 timer circuit.

1.1 – Circuit description and operation

This circuit was made up of an array of intricate components including resistors, coloured leds, capacitors etc. The main component however is the small 8 bit micro controller called a 555 timer, this component can almost be thought of as the brains of the circuit and has many functions. The hardware has 8 pins and each one has its own function the figure below details what each pin is responsible for.

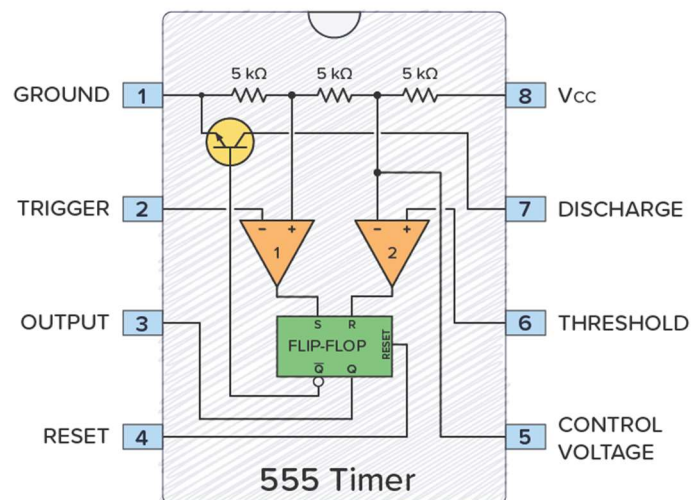


Figure 1 Basic overview of a 555 timer and its operations

As for the overall function of the circuit, its end use is to flash a red led light and then a green led light once the red one has turned off in an alternating pattern. The timer is configured in Astable mode which allows it to change between high and low states without the need for an input externally [1]. This is done so that the lights can function as required automatically. The other components such as the resistors are required to limit the flow of current as this could exceed the required current for the other components and cause damage in the circuit [2].

Another important area of the circuit is the use of capacitors which there are two of. The first capacitor (C1) can be thought of as a timing capacitor, it charges and then discharges and therefore will dictate certain high and low durations of the waveform outputted [3]. What this means in practice is that a reduction in the value of this capacitor will equate in a

faster blinking in the leds being observed, it should be noted that the opposite will happen if said value is increased too.

The second capacitors main purpose is to ensure a stable power supply is delivered to the 555 timer component, therefore this capacitor acts as a bypass and in turn filters out anomaly voltage spikes providing the 555 timer with clean electricity. The danger of having “noise” in a circuit with a timer is that it can cause sporadic and unintentional functions such as the lights not operating as wanted in this example [3].

The last important part of the circuit is the oscilloscope, which is used to give the user a visualisation of how the circuit is behaving. In this specific example it is being used to monitor the high and low outputs which can then be used to determine other factors such as on/off time and generally determine how the circuit is performing. It is a handy tool to have to use in debugging to as the theoretical figures can be cross referenced with the oscilloscope outputs to see where issues may lie [4].

2.0 – Schematic of circuit and simulation in Proteus

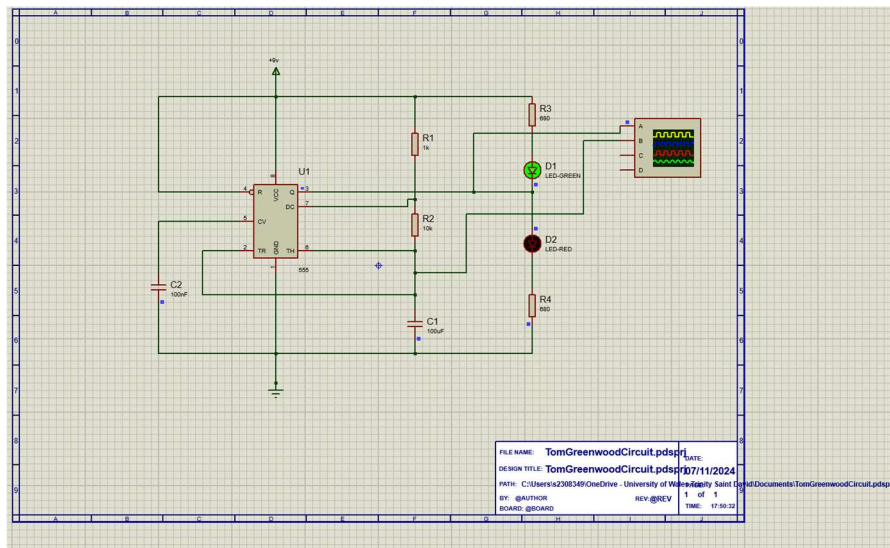


Figure 2 Schematic of Proteus circuit with green light on

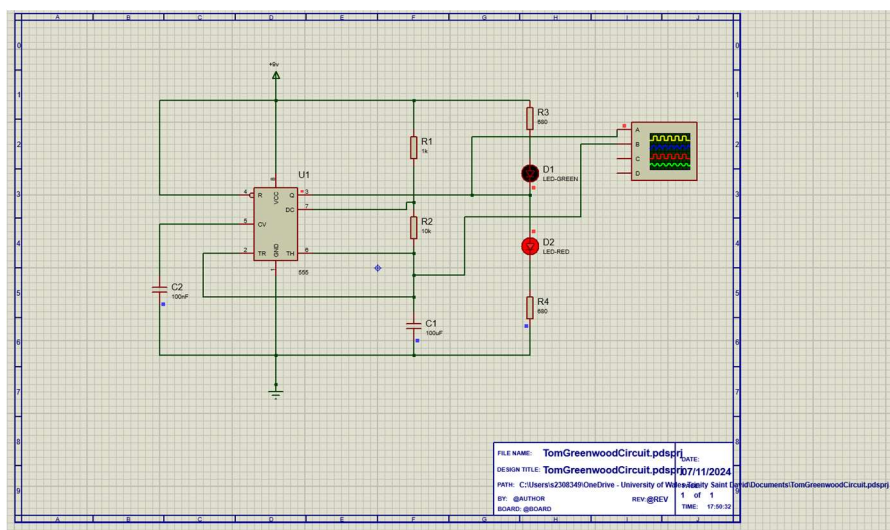


Figure 3 Schematic of Proteus circuit with red light on

The figures above display the schematics of the circuit in Proteus software. It is important to make a theoretical mock up design on a computer as it can be visualised more easily and also helps with trouble shooting as resistor and capacitor values can be adjusted to ensure the circuit works efficiently and as it should. The figures above also show the green and red leds blinking in an alternating pattern as required, which proves that the on/off times are correct.

3.0 – Design calculations

Resistance of R3 = 680 Ω

Resistance of R4 = 720 Ω

On time = 760ms

Off time = 1.46s – 760ms = 700ms

Period = tON + tOFF = 760ms + 700ms = 1.46s

Frequency = $f = 1/T = 1/1.46s = 0.685Hz$

3.1 – Tables of timing measurements in Proteus Simulations

Measurement	Calculations	Definition
On Time (tON)	760ms	Total time the output signal was in a high state
Off Time (tOFF)	700ms	Total time the output signal was in a low state
Period (T)	1.46s	Total time of (tON) + (tOFF)
Frequency (f)	0.685Hz	The repeated rate of output signal

Figure 4 Table of timing measurements in Proteus simulations

State of LED	Time interval	Definition
(tON) Green	760ms	Green LED is on
(tOFF) Red	700ms	Green LED is off therefore Red is on

Figure 5 Table of LED timing measurements in Proteus simulations

3.2 – Graph of Capacitor (C1) voltage and output voltage against time for simulated circuit

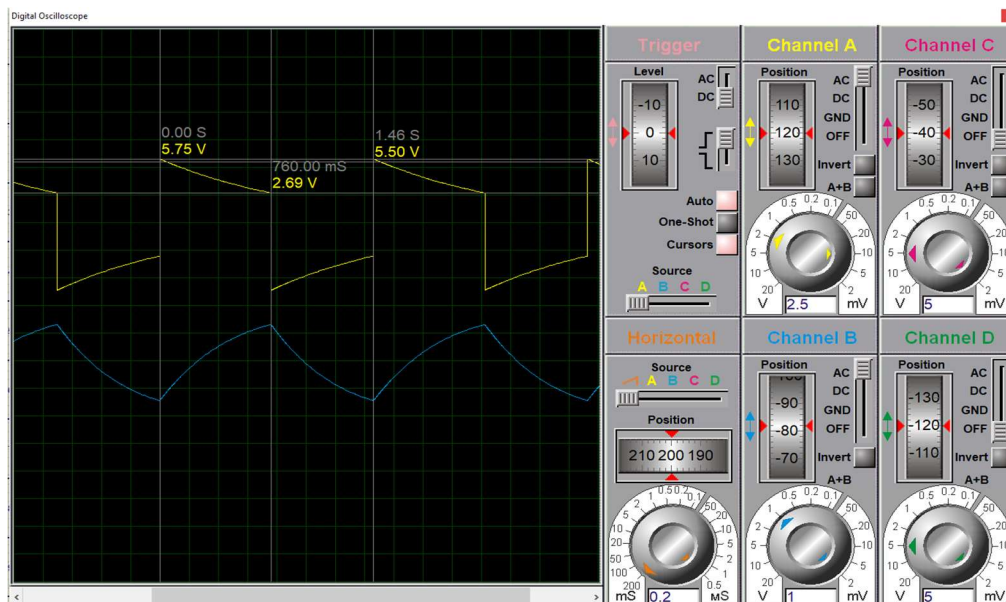


Figure 6 Graph of Capacitor (C1) voltage and output voltage against time for simulated circuit

4.0 – Bread board circuit

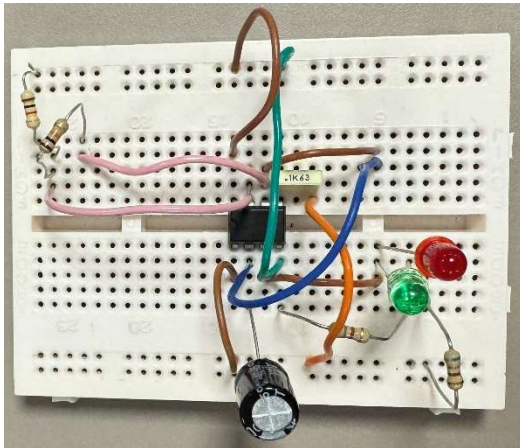


Figure 7 Circuit built on a bread board

As per the figure above the circuit built and simulated on the Proteus software was replicated into a physical example on a breadboard. It is a like for like copy and after multiple attempts at replication this was the final result. A breadboard is a cost effective way to build circuits as the use of a PCB board isn't needed, furthermore each component and wire doesn't need permanently attaching which makes for easier trial and error during the prototype stages. Each hole allows a component to be plugged into it and then be connected to the other necessary components which would take much longer if permanent methods of attachment such as soldering were used [5].

4.1 – Bread board circuit build and testing

To build the circuit and ensure everything worked properly all components had to be correctly connected together. The first areas established in the build was the ground and power, to ensure the power supply to the 555 timer was stable hence the C1 capacitor being connected there. Pin 8 is connected to the positive rail on the breadboard to power the 555 timer which is shown through the brown wire in figure 7.

In terms of LEDs the green is connected to the output pin (3) and also the ground through resistor 3, as previously mentioned it will light up when the output is high. The red LED is connected to the same pin however via resistor 4 and will light up when the output is low.

To test the breadboard circuit it had to be connected to the oscilloscope to determine readings such as on/off times. Below is a figure displaying how it was connected.

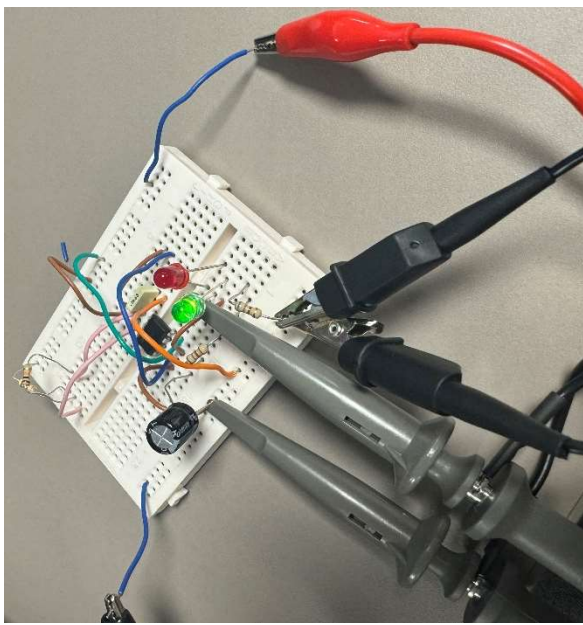


Figure 8 Breadboard connected to oscilloscope

One of the probes is connected to pin 3 output as this will measure the output waveform from the 555 timer which is then displayed on the oscilloscope and the ground crocodile clip is connected to the ground rail of the breadboard. The channel B probe is connected onto capacitor C1 which is responsible for timing and there for will record the charging and discharging of the circuit and again the ground for this probe is connected to the ground rail of the breadboard.

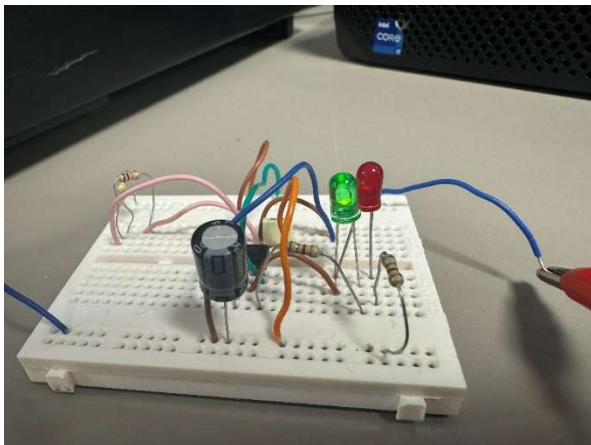


Figure 9 Green LED lit up

Before testing with the oscilloscope it was important to ensure that the circuit worked/functioned properly therefore by providing power the on/off functions of the red and green LEDS could be observed. In this specific test the first trial run did not work which was due to loose connections between the capacitors and the resistors.

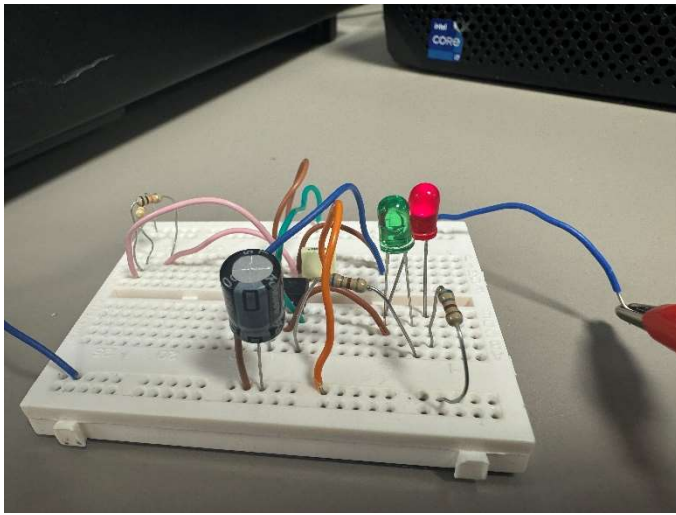


Figure 10 Red LED lit up

5.0 – Tables of timing measurements on bread board

Measurement	Calculations	Definition
On Time (tON)	750ms	Total time the output signal was in a high state
Off Time (tOFF)	690ms	Total time the output signal was in a low state
Period (T)	1.44s	Total time of (tON) + (tOFF)
Frequency (f)	0.694Hz	The repeated rate of output signal

Figure 11 Table of timing measurements in breadboard simulations

State of LED	Time interval	Definition
(tON) Green	750ms	Green LED is on
(tOFF) Red	690ms	Green LED is off therefore Red is on

Figure 12 Table of LED timing measurements in breadboard simulations

It should be noted that the calculations for the breadboard circuit have discrepancies from the simulated Proteus circuit. Some of the factors for this may include noise and interference in the breadboard as it is a physical piece of hardware and therefore when looking at on/off times that are on a small scale the slightest bit of interference may vary the result [6]. Another factor that may have come into play is drops in voltage due to an inconsistent power supply which in turn can create small differences in the overall on/off time and frequency [7].

5.1 - Graph of Capacitor (C1) voltage and output voltage against time for bread board



Figure 13 Graph of Capacitor (C1) voltage and output voltage against time for breadboard circuit



Figure 14 Graph of Capacitor (C1) voltage and output voltage against time for breadboard circuit

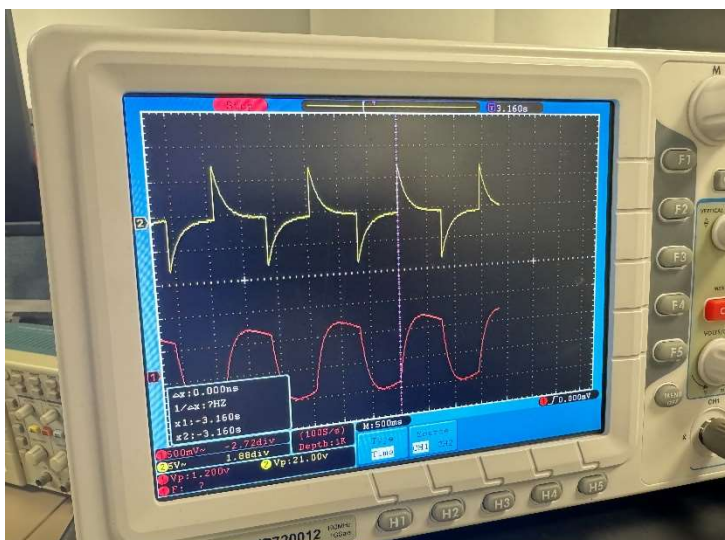


Figure 15 Graph of Capacitor (C1) voltage and output voltage against time for breadboard circuit

6.0 – Conclusions

As an overall conclusion to the report, the 555 timer circuit was modelled in the Proteus simulation software and had the graphs from the oscilloscopes detailing the on/off times which in turn allowed for the calculations of factors such as frequency and resistance to be calculated. This model was then successfully transferred to a physical breadboard which again functioned as required although some initial teething issues. It should also be noted that the similarity in on/off times were extremely similar to one another, while not spot on the reasons for the discrepancies have been researched and discussed with evidence as to why supporting the claims.

While the circuit built has basic operations the research and fundamental skills can be transferred into larger systems that are more complex, specifically in the OME sector where munitions and ordnance require intricate circuits with these basic functions outlined in this report.

7.0 – References

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