International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | June 2022 www.irjet.net p-ISSN: 2395-0072

Time Controlled DC Power Supply Using 555 Timer

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***Abstract*—In today's world, the need for electronic gadgets has increased significantly. In a lithium-ion battery, overcharging can create unstable conditions inside the battery, increase pressure and cause thermal runaway. Most phone manufacturers preach "Do not leave your phone connected to the charger for long periods or overnight" and "Keeping your battery level as close to the middle (30% to 70%) as possible can effectively prolong the battery life". So, to solve this problem, we should have a timing mechanism that automatically shuts the power after the desired time. To make this timing mechanism we used a 555 Timer IC as a monostable multivibrator which has one stable state and a quasi-stable state. The output of the power supply is given to the 555 timer and whenever the trigger pulse is given the timer is activated, which in turn gives power to the load only for that desired time. The time delay of the circuit is determined by the resistor and capacitor value. The potentiometer is used here to vary the resistor value and in turn the time delay. The 16 x 2 LCD will display the time delay at the current instant for the corresponding potentiometer value.**

Keywords—555 Timer, power supply, 16 x 2 LCD

I. INTRODUCTION

In today's world, we are very much dependent on electronic gadgets like mobile phones and laptops, which have become a significant part of our life. So it is essential to know how we can effectively utilize these devices to have a longer life. The one main reason a device ages is its battery and to sustain good battery health we need to avoid overcharging it as overcharging decreases the battery health significantly. Many phone manufacturers have said that overcharging your phone overnight can significantly reduce battery life, and also keeping the battery percentage between 30 - 70 % results in good battery health. To solve this problem, we have a solution. The basic idea is to control the output of a power supply using a 555 timer and making the electronic device charge to a specific set time by the user, by doing this the power supply terminates to charge the device after a specific amount of time, which eventually prevents overcharging and improves the battery life of the electronic devices.

II. METHODOLOGY

The system consists of two blocks namely

A. *Power supply*

This block contains a transformer that steps down 230V AC to 5V DC, followed by which we have a rectifier section that removes the ripples from the input signal, the next section has a capacitor filter to reduce the voltage fluctuations, and the last section of power supply block is a voltage regulator which gives a constant voltage of 5V in the output despite the variations in the input voltage.

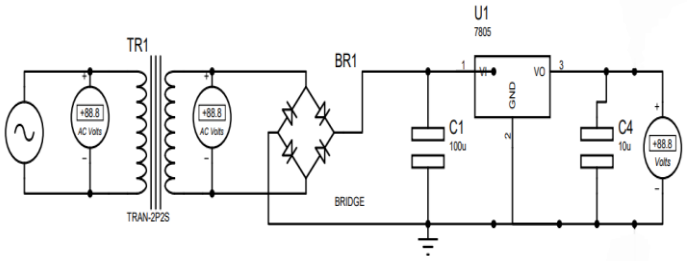

Figure 1: Power supply-Circuit diagram

B. *Timer Block*

The 555 timer used here is in monostable multivibrator mode with one stable and quasi-stable state. The input voltage to the timer is 5V DC which is taken from the power supply block. Whenever a trigger pulse is applied to the trigger pin of the 555 timer, the timer produces the output voltage to the load circuit with a specific time delay based on the potentiometer value and the capacitor value.

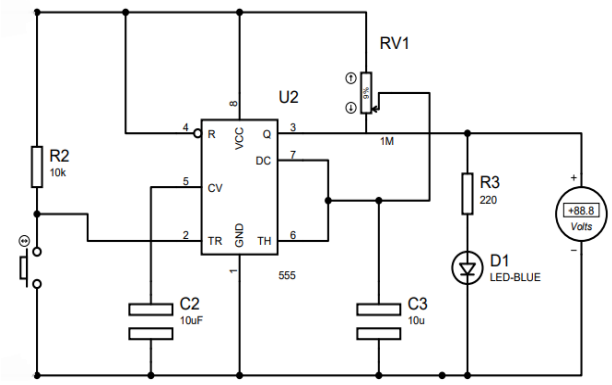

Figure 2: 555 timer (Monostable mode) Circuit diagram

III. DESCRIPTION

A. 555 Timer

555 Timer is an IC that is used to introduce various types of time delays in the circuit based on our needs.

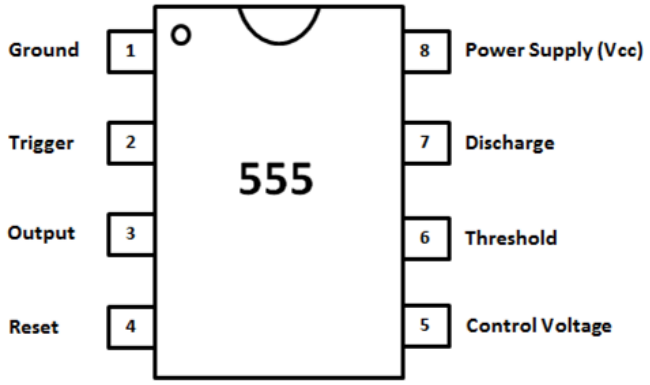

Figure 3: Pin Diagram

• Ground (Pin 1) – Connected to the ground (0V).

• Trigger (Pin 2) – trigger pin is an active low pin which means whenever the trigger pin goes below 1/3 of the main supply voltage it gets activated and the output is set to High.

• Output (Pin 3) – It goes to a High state only when the trigger pin is triggered based on its condition. It can supply/source a maximum of 200 mA to the load.

• Reset (Pin 4) – It is an active low pin, when we need to use the 555 timer it needs to be connected to Vcc and when we ground that pin the timer resets its timing operation and waits until we get another trigger input from pin 2.

• Control Voltage (Pin 5) – This pin is mostly connected to the ground via a small capacitor which is used to eliminate any fluctuations in the voltage to save the timer from its operation.

• Threshold (Pin 6) – This pin is used to check the voltage discharged by the capacitor in pin 7, so when the voltage reaches above 2/3 of the main supply voltage the timing cycle ends and goes to a stable state.

• Discharge (Pin 7) – It is mostly connected with a capacitor that is connected to supply voltage via a resistor and another end is connected to the ground. This helps control the time interval of the 555 timer.

• Vcc (Pin 8) – Connected to the power supply (5V), which can also be in the range of 4.5 V to 15 V.

B. Modes of Operation

- Astable multivibrator:

In this mode of operation, the timer has no stable state, it keeps on fluctuating between Low and High states.

- Monostable multivibrator:

In this mode of operation, the timer has only one stable state and another quasi-stable state, whenever the trigger pulse is applied there is a transition from one state to another state and after the specified time delay it returns to the stable state.

- Bi-stable multivibrator:

In this mode of operation, the timer has two stable states and whenever there is a trigger pulse, the current state is changed and it moves to another stable state until we get another trigger pulse.

C. Equations

The equation used to calculate the time delay of the circuit is given below:

$$At\ t = 0, trigger\ pulse\ is\ applied\ and\ the\ capacitor\ starts\ charging$$

$$V_c(t) = V_{\max} + (V_{initial} - V_{\max})e^{(-t/T)}$$

$$V_C = V_{CC}(1 - e^{-t/RC})$$

$$At\ t = T, V_C = V_{TH} = \frac{2}{3}V_{CC}$$

$$V_C = \frac{2}{3}V_{CC} = V_{CC}(1 - e^{-T/RC})$$

$$\frac{2}{3} = (1 - e^{-T/RC})$$

$$e^{-T/RC} = \frac{1}{3}$$

$$e^{T/RC} = 3$$

$$\ln(e^{T/RC}) = \ln(3) = 1.1$$

$$T = 1.1 \times RC, Where\ T\ is\ the\ time\ period\ for\ which\ o/p\ is\ high.$$

IV. WORKING

The circuit starts with a 230V AC supply which is given to the step-down transformer, after the transformer it is given to a rectifier which removes ripples in the wave. After this part, it is given to a filter circuit which removes the remaining AC components from the wave which is then given to a voltage regulator (LM7805) so that the output voltage from the power supply block will be constant even when there are any fluctuations in input voltage. In the circuit, we used the voltage after the voltage regulator as 5V.

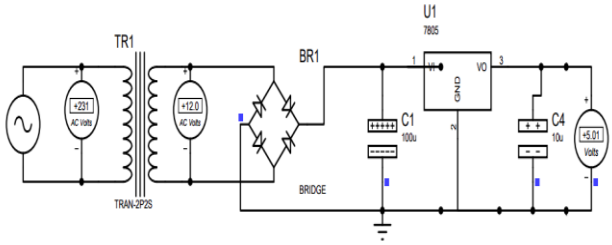

Figure 4: Power supply block (with value)

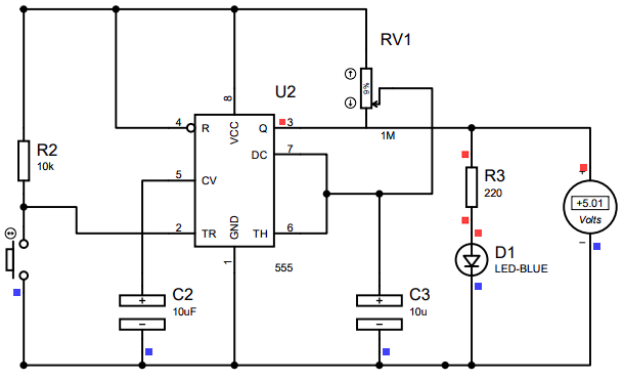

Figure 5: 555 Timer block (with value)

In addition to this block, we have introduced one more block where we use an Arduino UNO and a 16 x 2 LCD display which helps in displaying the time delay value based on the potentiometer value dynamically. So, whenever the user changes the potentiometer value, we then calculate the time delay using a formula and display the exact time delay produced by the circuit.

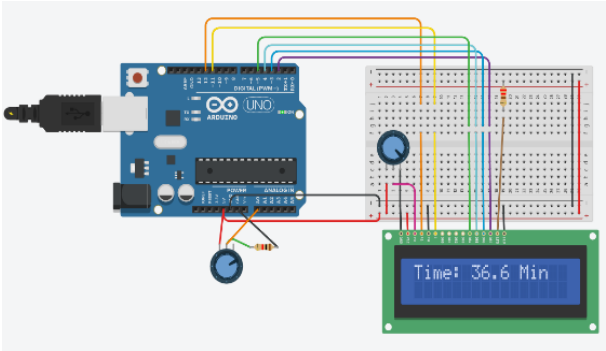

Figure 6: LCD interfacing with Arduino

After giving the output from the power supply block to the 555 timer, we have to give an appropriate connection to make the 555 timer run in a monostable multivibrator mode. To vary the time delay of the circuit dynamically, we need to use a potentiometer in place of a fixed resistor, by tuning the potentiometer the time delay of the circuit is changed, and on applying a trigger pulse to the 555 timer the circuit is on (quasi-stable state) for a desired amount of time which can be found out by the formula mentioned in the above section.

V. CONCLUSION

Thus, with the help of this model users can dynamically control the time in which the circuit should be turned off, by tuning the potentiometer value and the user can see the updated time for the updated potentiometer value in the LCD display (interfaced with Arduino). Therefore, using this model we can prevent overcharging and increase the battery longevity of our electronic gadgets.

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