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An Imprint of IC 555 Timer in the Contemporary World

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Abstract- The paper deals with the basic principle of IC 555 Timer, its working and its application in the present world. 555 Timer is part and parcel of almost every electronics project. It is versatile IC whose applications range from simply making a light blink on and off to pulse-width modulation. From the time of its invention, a myriad of several novel and unique circuits have been developed and presented in several trade, professional, and hobby publications.

Keywords: Monostable mode, Astable mode, Oscillator, Speed Detector, Hygrometer, Invertor, Patents.

I. INTRODUCTION

IC 555 timer is an integrated circuit(IC) or a chip used for various electronic applications. The IC was designed in 1971 by Hans R. Camenzind under a contract to Signetics, which was later acquired by Philips. It has been in wide use ever since. It was the very first commercial timer IC to be designed. IC 555 timer got its name from three 5 kilo ohm resistors connected in series voltage divider. A single IC consists of several transistors, resistors, capacitors, diodes, flip flops and other elements.It is a highly stable device for generating accurate time delays or oscillation[8].

Internal diagram

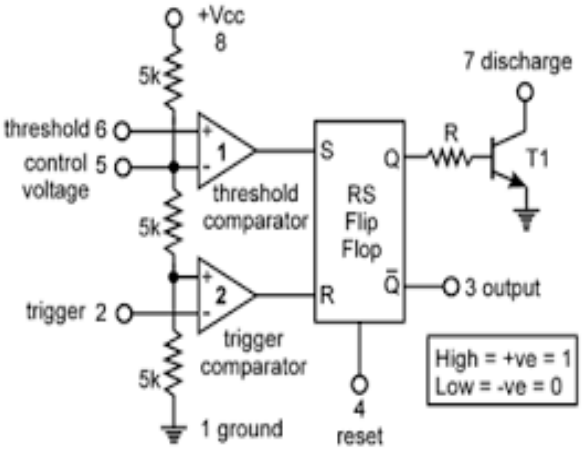

Fig. 1 Internal diagram of 555 Timer

IC 555 timer consists of two comparator elements, which are basically opamps that compare the voltages of inverting and non-inverting input terminals. The input impedance of the comparators is kept very high so that equal voltage is divided between the three 5 kilo ohm resistors, which is equal to one third of VCC.

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There is also a flip flop element which gives high output when 'S' is high and 'R' is low. It gives low when 'R' is high and 'S' is low.

Pin configuration

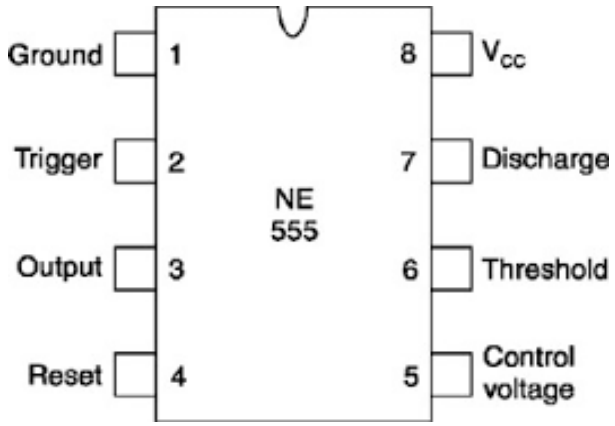

Fig. 2 Pin diagram

1) Ground-Negative terminal of DC power supply or battery is connected to this pin. This pin should be directly connected to ground. If it is connected to ground through any resistor or capacitor, the IC may get damaged.

2) Trigger-It is connected to the input of the inverting terminal of triggering comparator. It triggers the IC when a negative pulse is applied to it up to one third of VCC.

3) Output-Output is obtained through this pin. A maximum of 200mA can be obtained through it.

4) Reset-When the negative terminal of the battery is given to this pin, the output of the IC goes low.

5) Control voltage-The two third of VCC is given as input to this pin. It controls the threshold and trigger levels and determines the pulse width of the output waveform.

6) Threshold-It stops the IC when the voltage crosses more than two third of VCC.

7) Discharge-It allows the external capacitor to discharge through it when it is fully charged.

8) VCC-The positive terminal of the battery is given as input to this pin. The battery voltage cannot exceed 18 V.

II. MODES OF OPERATION

2.1 Monostable Mode

Initially the output is low and the transistor is on. This provides a short circuit path for the capacitor and hence no charging takes place. When a negative pulse is given to the pin number 2, the trigger comparator detects this input and sets the state of the flip flop. So the output changes from low to high because of which the transistor goes off.

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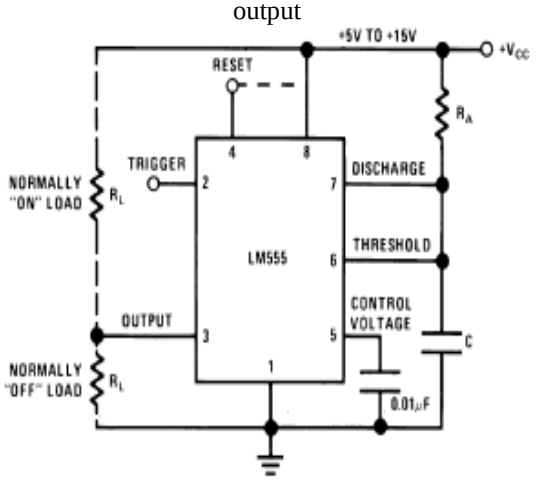
The short circuit path gets removed and the capacitor starts charging up to VCC through R1.When the voltage at the capacitor reaches two third of VCC, the threshold comparator comes into the picture. It resets the flip flop and the output beco



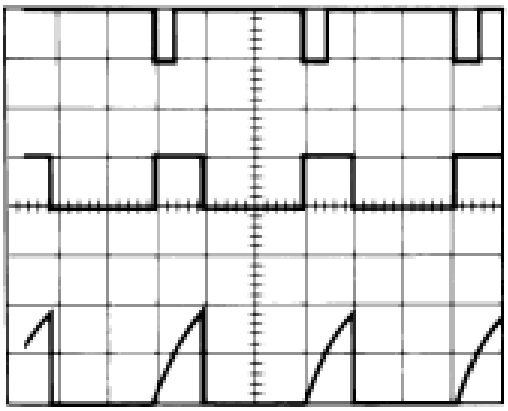
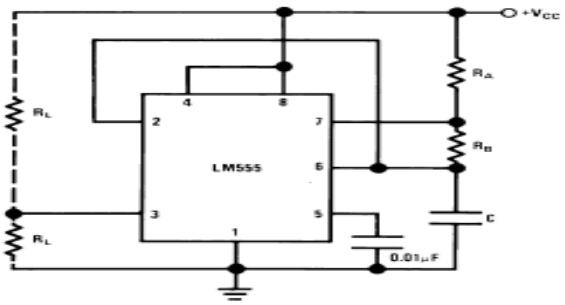


Fig. 3 Monostable circuit design and its waveform

2.2 Astable Mode

Initially the output is high. The transistor is in off state. The capacitor starts charging up to VCC through Ra and Rb. When the voltage is less than one third of VCC, the trigger comparator will be active which sets the flip flop. When the voltage at the capacitor exceeds one third VCC, both the comparators will be low which brings no change. When the voltage exceeds two third of VCC, the output of threshold comparator will become high and this will reset the flip flop. The output goes low and the transistor goes on and the capacitor starts discharging through Rb resistor. The voltage at capacitor goes less than two third of VCC and both the comparators go low. The capacitor continues discharging. As the voltage reaches one third of VCC, the output of trigger comparator becomes high and sets the flip flop and the capacitor starts charging again.



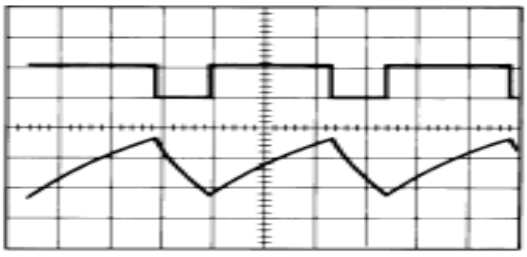


Fig. 4 Astable circuit design and its waveform

III. APPLICATIONS OF IC 555

IC 555 Timer has a wide range of applications. It is used in Precision Timing,Pulse Generation, Sequential Timing, Time Delay Generation, Pulse Width Modulation, Pulse Position Modulation, Linear Ramp Generation etc. Some of its applications are mentioned below.

3.1 Speed control of brushed DC motor for low cost electric cars

In today's world as petrol prices are going up, there is a high need for an alternative source of energy. An Electric Car is a convenient alternative. 555 timer can be used along with a high Boost Converter in making a low cost Electric Car. The high voltage and current required in an Electric Car is supplied by high Boost Converter even with low battery supply[1].

3.2 A voltage-controlled oscillator (VCO) using the timer 555

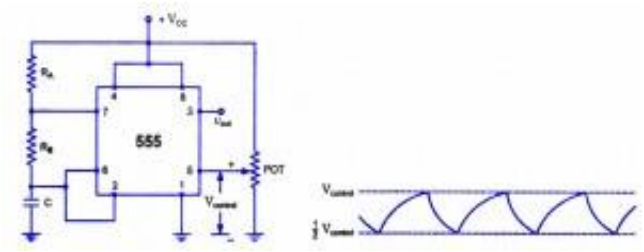


Fig. 5 Voltage Controlled Oscillator and its waveform

Generally the control voltage at 5 terminal of the IC is two third of VCC due to voltage divider network. However the control voltage can be varied by applying an external voltage to this terminal or through a potentiometer. In the figure a potentiometer is adjusted to vary the control voltage. Voltage across the timing capacitor is depicted in figure, which varies between $+V_{control}$ and ½ $V_{control}$. If control voltage increases, the capacitor will take longer time to charge and discharge i.e. frequency decreases and if control voltage decreases frequency increases. The control voltage may be made available through a pot, or it may be output of a transistor circuit, op-amp, or some other device.The circuit is sometimes called a voltage-to-frequency converter because the output frequency can be changed by changing the input voltage.

3.3 Ramp Generator Circuit-using 555 Timer

The Basic idea behind a Ramp generator is that a capacitor charged from a constant current source produces a ramp waveform.

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In the below circuit a PNP transistor is used to produce a constant charging current and the slope of the ramp produced is equal to I/C [2].

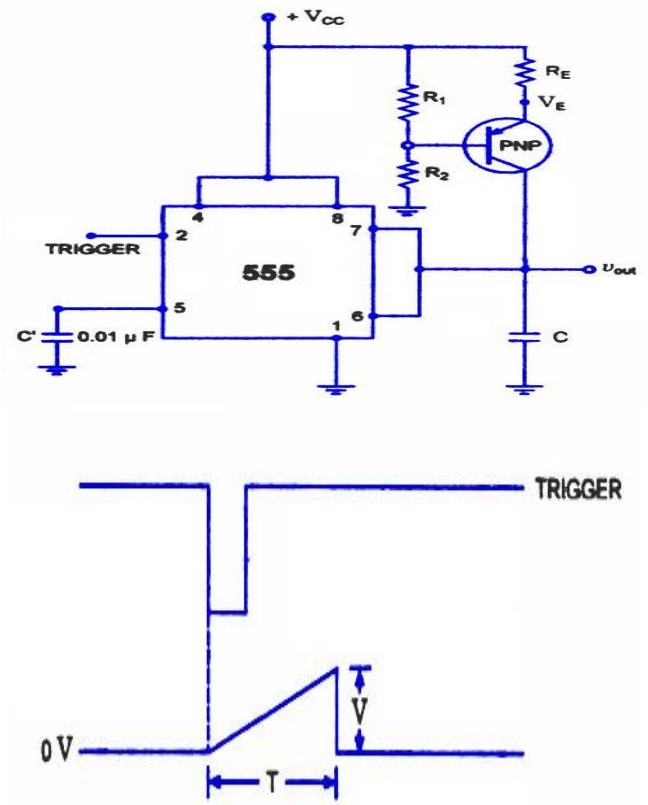

Fig. 6 Ramp generator circuit and its waveform

3.4 Detection of Over Speeding Vehicles on Highways

In today's world where many road accidents occur due to rash driving, there is a need for rash driving detector. Most of the detectors need human concentration and they are not accurate. One of the efficient rash driving detector which calculates the speed of vehicles and creates a buzzing sound on detecting any vehicle crossing the speed limit is discussed below.This device is obtained using an IR transmitter, an IR receiver, IC 555 Timer,a control circuit and a buzzer. Control circuit calculates the time taken by the vehicle to travel from one set point to the other and it displays that on seven segment displays. If the vehicle crosses the speed limit, a buzzer sounds alerting the police. A photodiode used as sensor is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. When a photon of sufficient energy strikes the diode, it excites an electron, creating electrons and holes. The holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced which goes to the Timer 555. Timer is a part of the sensing module. The circuit uses standard power supply comprising of a step-down transformer from 230v to 12v and four diodes forming a bridge rectifier that delivers pulsating dc which is then filtered by an electrolytic capacitor of 1000µf. A buzzer is an audio signaling device, driven by an oscillating electronic circuit or any other audio signal source, driven with a piezoelectric audio amplifier[3].

3.5 A Hygrometer

IC 555 Timer when operated in astablemultivibrator mode is used as the main block in designing a hygrometer. Two thermistors with negative temperature coefficients are given as input to the IC. In 555 Timer having resistors R1 and R2 and capacitor C, the frequency is,

$$f \approx \frac{1.44}{(R_1 + R_2)C}$$

The time interval when the IC is high is,

$$T_1 \approx 0.69(R_1 + R_2)C$$

The time interval when the IC is low is,

$$T_2 \approx 0.69R_2C$$

From the above equations it is evident that time interval of high and low condition depends on the value of the resistors. The two thermistors are used as resistors for sensing dry temperature and wet temperature. As they vary, the time interval T1 and T2 vary. So from these values, we can calculate the value of resistors which will give us the knowledge of the humidity[4].

3.6 LM555 Timer-Based Inverter Low Power Pure Sinusoidal AC Output

IC 555 Timer can be used as ahighly efficient and stable DC to AC inverter in obtaining energy from renewable resources. This method of obtaining energy is simple, cheap and eco-friendly. In the above paper a 220 V AC output with less harmonic and noise distortions are obtained from DC [10].

3.7 3.7IC 555 Timer in a Novel Microprocessor-Controlled Active-R Multifunction Network

In [11], 555 Timer is used in A Novel Microprocessor-Controlled Active-R Multifunction Network. Here the timer along with the inverter (7404 Chip) controls the ON-OFF time of the even/odd phased multiplexing switches which in turn gives a programmable binary code generator that ultimately yields programmable modulated FSK/PSK waves.

3.8 3.8Dark Detector

IC 555 Timer can be used as an alarm when a lamp or a bulb burns out i.e. as a dark detector. Cadium-SulphideLDR(Light Dependent Resistor) is used as a sensor. When there is absence of light, the sensor activates a small speaker through the Timer and hence we get a notification when the amp or bulb burns out[9].

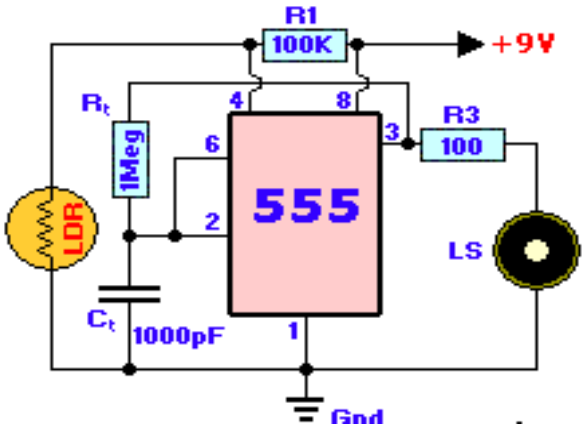

Fig. 7 Dark detector circuit

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3.9 3.9Power Alarm

IC 555 Timer can be used as an alarm when there is a power failure. It uses the 555 Timer as an oscillator which gets biased by the presence of line-based DC voltage. When the line voltage fails, the bias is removed, and the tone will be heard in the speaker. R1 and C1 provide the DC bias that charges capacitor Ct to two third of the voltage keeping the timer output. Diode D1 provides DC bias to the timer-supply pin and, optionally, charges a rechargeable 9-volt battery across D2. And when the line power fails, DC is furnished to the timer through D2[9].

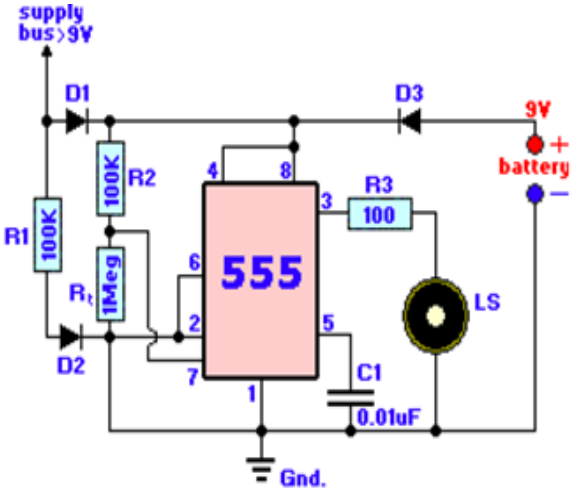

Fig. 8 Power Alarm circuit

3.10. IC 555 Timer to turn on an LED

IC 555 Timer can be used to turn on an LED for a specific time interval in its monostable mode. A pushbutton is used as the trigger to output a high pulse when trigger pin is pulsed low. This simple application can be modified to fit any application requirement [8].

3.11. IC 555 Timer as a Frequency Divider

The monostable mode of the Timer can be used as a frequency divider by adjusting the length of the timing cycle[8].

IV. 555 TIMER IN PATENTS

A US patent (US6629776 B2), "Digital sensor for miniature medical thermometer, and body temperature monitor" uses CMOS 555 timer as the multivibrator circuit [5]. A baby bottle having one or more removable handles which automatically emit a prerecorded sound effect when grasped by a user uses 2 555 timer ICs [6]. A power extractor circuit used to capture the power of a solar cell array during its less-than-optimum conditions also utilizes 555 timer ICs as monostable and astablemultivibrators[7].

V. CONCLUSION

555 Timer is an integrated circuit used in variety of timer, pulse generation and oscillator applications. It can be used to provide time delays and also as a flip-flop element.The fact that it is relatively cheap, stable, and user-friendly makes it the most popular IC ever used. It can be interfaced with other external devices as well to design various electronic circuits making it an ideal IC to be used in practical applications.

REFERENCES

[1] Gupta V., "Speed control of brushed DC motor for lowcost electric cars",Proceedings of IEEE International Conference on Electric Vehicle Conference(IEVC), 4-8 March 2012.
[2] www.circuitstoday.com/555-timer-ramp-generator.
[3] Monika Jain, Praveen Kumar, Priya Singh, Chhavi Narayan Arora, and Ankita Sharma, "Detection of over speeding vehicles on highways", International Journalof Computer Science and Mobile Computing, ISSN 2320–088X, Vol. 4, Issue. 4,pp.613 – 619, April 2015.
[4] DebangshuDey and SugataMunshi, "Simulation studies of a new intelligent scheme for relative humidity and temperature measurement using thermistors in 555 timer circuit", International Journal on Smart sensing and Intelligent systems Vol.3, No.2, June 2010.
[5] http://www.google.com/patents/US6629776.
[6] http://www.google.com/patents/US6037872.
[7] http://www.google.com/patents/US20060001406.
[8] http://www.ti.com, SNAS548D –JANUARY 2015
[9] http://www.sentex.ca/mec1995/gadgets/555/555.html
[10] ZeeshanShahid, Sheroz Khan, AHM ZahirulAlam and MusseMuhamod Ahmed," LM555 Timer-Based Inverter Low Power Pure Sinusoidal AC Output", World Applied Sciences Journal 30, 141-143, 2014 ISSN 1818-4952 © IDOSI Publications.
[11] S.K. Sanyal, U.C. Sarker and R.Nandi, " A Novel Microprocessor-Controlled Active-R Multifunction Network: Design of Programmable Filter, Oscillator, and FSK/PSK Wave Generator", IEEE Transactions on Circuits and Systems, Vol. 37, No.9, 1990.

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