Clock Ticking Sound Generator Circuits Using NE555 Timer in Contemporary World

Dinesh S[1], Aditya Sankaran G[2], Arun Kumar S[3], Bhargav Chandar T[4], Santhoshini.P[5]
[1,2,3,4]*U.G Student, R.M.D. Engineering College, Tiruvallur*
[5]*Assistant Professor, ECE, R.M.D. Engineering College, ,Tiruvallur*

***Abstract*—In Recent years, we have seen a tremendous increase in the development of embedded system technology, which has also contributed to developing the home appliances which are sleek, silent and high energy efficient. The NE555 model is a low-power, general purpose CMOS design version of the standard 555, also with a direct pin-for-pin compatibility with the regular 555. Its advantages are very low timing/bias currents, low power dissipation operation and an even wider voltage supply range of as low as 2.0 volts to 18 volts. At 5 volts the NE555 will dissipate about 400 microwatts, making it also very suitable for battery operation. The internal schematic of the IC is however totally different from the normal 555 version because of the different design process with CMOS technology. It has much higher input impedances than the standard bipolar transistors used. The CMOS version removes essentially any timing component restraints related to timer bias currents, allowing resistances as high as practical to be used. This very versatile version should be considered where a wide range of timing is desired, as well as low power operation and low current syncing appears to be important in the particular design.**

***Index Terms*—CMOS Technology, NE555 Model.**

I. INTRODUCTION

The ICM7555 and ICM7556 are CMOS RC timers providing significantly improved performance over the standard SE/NE 555/6 and 355 timers, while at the same time being direct replacements for those devices in most applications. Improved parameters include low supply current, wide operating supply voltage range, low THRESHOLD, TRIGGER and RESET currents, no crowbarring of the supply current during output transitions, higher frequency performance and no requirement to decouple CONTROL VOLTAGE for stable operation.

Specifically, the ICM7555 and ICM7556 are stable controllers capable of producing accurate time delays or frequencies. The ICM7556 is a dual ICM7555, with the two timers operating independently of each other, sharing only V+ and GND. In the one-shot mode, the pulse width of each circuit is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled by two external resistors and one capacitor. Unlike the regular bipolar SE/NE 555/6 devices, the CONTROL VOLTAGE terminal need not be decoupled with a capacitor.

The circuits are triggered and reset on falling (negative) waveforms, and the output inverter can source or sink currents large enough to drive TTL loads or provide minimal offsets to drive CMOS loads. These CMOS low-power devices offer significant performance advantages over the standard 555 and 556 bipolar timers. Low-power consumption, combined with the virtually non-existent current spike during output transitions, make these timers the optimal solution in many applications. The output inverter can source or sink currents large enough to drive TTL loads or provide minimal offsets to drive CMOS loads.

II. HARDWARE COMPONENT

The external component count is decreased when replacing a bipolar timer with the ICM7555 or ICM7556. The bipolar devices produce large crowbar currents in the output driver. To compensate for this spike, a capacitor is used to decouple the power supply lines. The CMOS timers produce supply spikes of only 2-3mA vs.300-400mA (Bipolar), therefore supply decoupling is typically not needed. Another component is eliminated at the control voltage pin. These CMOS timers, due to the high impedance inputs of the comparators, do not require decoupling capacitors on the control voltage pin.

Thus, for many applications, 2 capacitors can be saved using an ICM7555. The IC NE555 timer was selected for this project because of its ability to produce square wave pulse Reset The reset function is significantly improved over the standard bipolar 555 and 556 in that it controls only the internal flip-flop, which in turn simultaneously controls the state of the Output and Discharge pins. This avoids the multiple threshold problems sometimes encountered with slow-falling edges of the bipolar devices. This input is designed to have essentially the same trip voltage as the standard bipolar devices to 0.6 to 0.7 v. At all supply voltages this input maintains an extremely high impedance. In this article, NE555 IC can be effectively used to design an alarm circuit. The NE555 timer is an integration of components like flip flops, comparators in dual in-line package (DIP) which is connected to external components like resistors and capacitors together they work as a timer, precise selection of resistors and capacitors will execute desired functional operation.

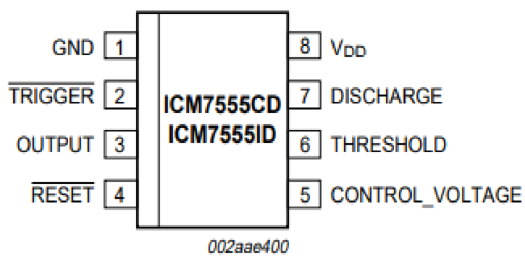

Fig. 1 Pin Diagram

Symbol	Pin	Description
GND	1	supply ground
TRIGGER	2	start timer input; (active LOW)
OUTPUT	3	timer logic level output
RESET	4	timer inhibit input; (active LOW)
CONTROL_VOLTAGE	5	timing capacitor upper voltage sense input
THRESHOLD	6	timing capacitor lower voltage sense input
DISCHARGE	7	timing capacitor discharge output
V_{DD}	8	supply voltage

Fig. 2 Pin Description

All the major hardware components used in the development of this work are the NE555 IC, SN7404 IC, Potentiometer, LED, and buzzer. The design proposed gives access to the operator to redesign by changing resistor and capacitor values thereby achieving desired sound alarm indication like continuous beeping alarm indication or OFF delay alarm triggering operation.

III. PROJECT DESCRIPTION

An astable multivibrator is nothing but a free-running oscillator to achieve this operation the pin 2 The control voltage regulates the two trip voltages for the THRESHOLD and TRIGGER internal comparators. This pin can be used for frequency modulation in the astable mode. By varying the applied voltage to the control voltage pin, delay times can be changed in the monostable mode.

When the supply voltage Vcc is connected to the circuit the capacitor C charges up to 2/3Vcc value till then the output of the circuit is HIGH, once the capacitor charges up to 2/3Vcc value, the discharge transistor in the NE555 IC is triggered and then capacitor C starts to The CMOS output stage is capable of driving most logic families including CMOS and TTL. The ICM7555 and ICM7556 will drive at least two standard TTL loads at a supply voltage of 4.5V or greater. When driving CMOS, the output swing at all supply voltage levels will equal the supply voltage. The amount of time in which the output of the IC remains high or low determined by the values of resistors and capacitors to be used in the circuit, the desired timing operation can be achieved by implementing the following formula.

The charge time (output high) is given by:

$$t_1 = 0.693\ (R_A + R_B)\ C$$

and the discharge time (output low) by:

$$t_2 = 0.693\ (R_B)\ C$$

Thus, the total period is: $T = t_1 + t_2$

$$= 0.693\ (R_A + 2R_B)\ C$$

Operating Modes: The 555 timer has two basic operational modes: one shot and astable. In the one-shot mode, the 555 acts like a monostable multivibrator. A monostable is said to have a single stable state--that is the off state. Whenever it is triggered by an input pulse, the monostable switches to its temporary state. It remains in that state for a period of time determined by an RC network. It then returns to its stable state. In other words, the monostable circuit generates a single pulse of a fixed time duration each time it receives and input trigger pulse. Thus the name oneshot. One-shot multivibrators are used for turning some circuit or external component on or off for a specific length of time. It is also used to generate delays. When multiple one-shots are cascaded, a variety of sequential timing pulses can be generated. Those pulses will allow you to time and sequence a number of related operations. The other basic operational mode of the 555 is as and astable multivibrator. An astable multivibrator is simply and oscillator. The astable multivibrator generates a continuous stream of rectangular off-on pulses that switch between two voltage levels. The frequency of the pulses and their duty cycle are dependent upon the RC network values. One-Shot Operation: Fig. 4 shows the basic circuit of the 555 connected as a monostable multivibrator. An external RC network is connected between the supply voltage and ground. The junction of the resistor and capacitor is connected to the threshold input which is the input to the upper comparator. The internal discharge transistor is also connected to the junction of the resistor and the capacitor. An input trigger pulse is applied to the trigger input, which is the input to the lower comparator. With that circuit configuration, the control flip-flop is initially reset. Therefore, the output voltage is near zero volts. The signal from the control flip-flop causes T1 to conduct and act as a short circuit across the external capacitor. For that reason, the capacitor cannot charge. During that time, the input to the upper comparator is near zero volts causing the comparator output to keep the control flip-flop reset. Notice how the monostable continues to output its pulse regardless of the inputs swing back up. That is because the output is only triggered by the input pulse, the output actually depends on the capacitor charge.

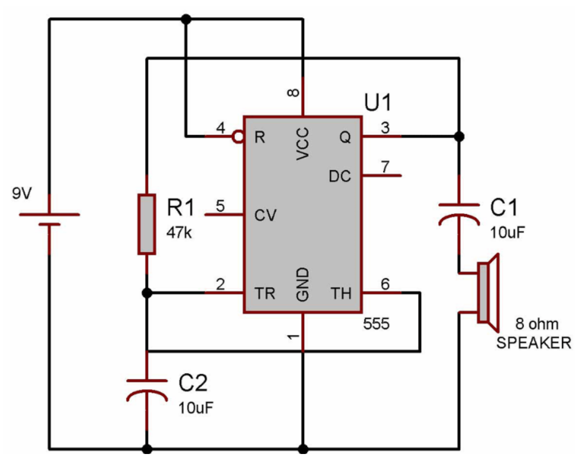

Fig 3. Circuit Diagram

Ticking sound circuit is a good example of Astable mode of 555 timer IC. Here we are using a speaker which is used to convert electrical signal into sound. We are not using discharge PIN 7, and we have connected capacitor C2 to the OUTPUT PIN 3 of the 555 IC. Generally, we used to connect the Capacitor to the voltage source, through resistors, but here we are connecting capacitor C2 directly to the OUPUT PIN 3, through a 47k ohm resistor. Capacitor will be charged through the output at PIN 3, when output PIN 3 will be HIGH. And capacitor C2 will be discharged to the Speaker when PIN 3 is LOW. When capacitor charge and discharge, speaker produce the sound of TIC-TIC.

INPUTS			OUTPUTS	
Pin 4 (LOW)	Pin 6 (HIGH)	Pin 2 (LOW)	National LM555H	Signetics NE555V
⊔	0	1	Resets ʃ	Resets ʃ
⊔	1	1	0	0
⊔	0	0	⊔	⊔
⊔	1	0	0	⊔
1	⊓	1	Resets	Resets
1	⊓	0	⊔	1
0	⊓	1	0	0
0	⊓	0	0	0
1	0	⊔	sets ʃ	sets ʃ
1	1	⊔	0	⊓
0	0	⊔	0	0
0	1	⊔	0	0

Pin 2 = Trigger, Pin 4 = Reset, Pin 6 = Threshold

Fig 4:Clock Outputs

In burglar detection systems that are based on changes in static charges. In capacitive touch detection circuits. As a replacement for momentary push button switch (The same circuit without the transistor and feedback loop).

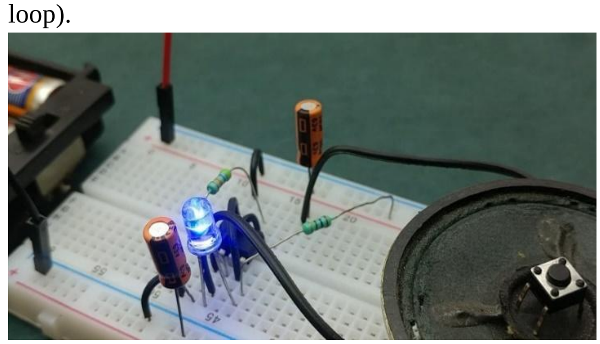

Fig 5.Breadboard Connection

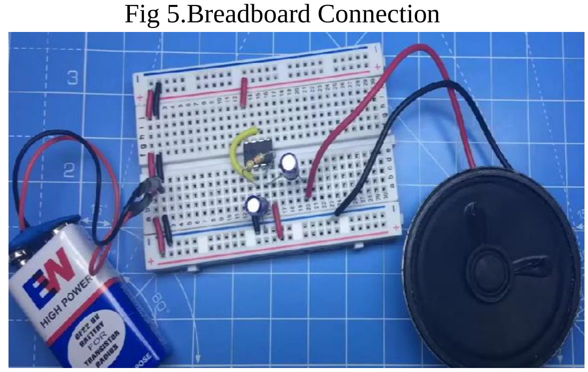

Fig 6.Project Execution

In OFF delay timing operation the output is triggered after a set a time period, as we know the output of the astable multivibrator is first found to be high first then low after a set period of time this acts as a simple ON delay timer which is inverse of the OFF delay timer, therefore to achieve OFF delay timing operation we simply invert the output signal of the circuit by connecting the NOT gate, the NOT gate IC SN7404 is available in dual in-line (DIP) package in the market, it has six NOT gates embedded in one IC, here we use only one gate to achieve the desired result. The output from the astable multivibrator is fed as an input to the NE555 which inverts the input signal, which is till the output of astable multivibrator remains HIGH the output of the NE555 remains LOW and vice versa. To the output pin of NE555is connected to LED for visual indication and parallel to LED, a potentiometer is connected, when a set time threshold exceeds the circuit triggers the LED and buzzer thereby initiating the alarm operation. The upper limit for R(t) is in the order of about 15 MΩ but should be less than this if all the accuracy of which the 555 is capable is to be achieved. The absolute upper limit of R(t) is determined by the threshold current plus the discharge leakage when the operating voltage is +5 volt.

For example, with a threshold plus leakage current of 120nA, this gives a maximum value of 14MΩ for R(t) (very optimistic value). Also, if the C(t) leakage current is such that the sum of the threshold current and the leakage current is in excess of 120 nA the circuit will never time-out because the upper threshold voltage will not be reached. Therefore, it is good practice to select a value for R(t) so that, with a voltage drop of 1/3 V+ across it, the value should be 100 times more, if practical. So, it should be obvious that the real limit to be placed on C(t) is its leakage, not it's capacitance value, since larger-value capacitors have higher leakages as a fact of life. Low-leakage types, like tantalum or NPO, are available and preferred for long timing periods. Sometimes input trigger source conditions can exist that will necessitate some type of signal conditioning to ensure compatibility with the triggering requirements of the 555. This can be achieved by adding another capacitor, one or two resistors and a small signal diode to the input to form a pulse differentiator to shorten the input trigger pulse to a width less than 10uS (in general, less than T).

Their values and criterion are not critical; the main one is that the width of the resulting differentiated pulse (after C) should be less than the desired output pulse for the period of time it is below the 1/3 V+ trigger level. There are several different types of 555 timers. The LM555 from National is the most common one these days, in my opinion. The Exar XR-L555 timer is a micro power version of the standard 555 offering a direct, pin-for-pin (also called plug-compatible) substitute device with an advantage of a lower power operation. It is capable of operation of a wider range of positive supply voltage from as low as 2.7volt minimum up to 18 volts maximum. At a supply voltage of +5V, the L555 will typically dissipate of about 900 microwatts, making it ideally suitable for battery operated circuits. The internal schematic of the L555 is very much similar to the standard 555 but with additional features like 'current spiking' filtering, lower output drive capability, higher nodal impedances, and better noise reduction system.

IV. CONCLUSION

The 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. In Future, A metal door knob can be used in place of touch probe in order to turn on an alarm whenever someone tries to open/touch the door knob Can be re-purposed as a simple touch detector circuit by removing the feedback loop and adding a smoothing capacitor at Pin-2.

ACKNOWLEDGMENT

We express our sincere gratitude to the Principal, R.M.D Engineering College and thank all the teaching and non- teaching staff of Electronics and communication Department, for their blessing and support throughout the dissertation.

REFERENCE

[1] Goyal, H. (2015). Understanding of IC 555 Timer and IC 555 Timer Tester. International Journal of Inventive Engineering and Sciences, 3(2), 4-6.

[2] Abrar, M. M. (2017). Design and implementation of astable multivibrator using 555 timer. IOSR J. Electr. Electron. Eng, 12(1), 22-29.

[3] Cameron, N. (2021). Signal generation with 555 timer IC. In Electronics Projects with the ESP8266 and ESP32 (pp. 467-503). Apress, Berkeley, CA.

[4] Tuwanut, P., Koseeyaporn, J., Wardkein, P. (2005, November). A novel monostable multivibrator circuit. In TENCON 2005-2005 IEEE Region 10 Conference (pp. 1-4). IEEE.

[5] H.R. Camenzind. “Redesigning the old 555”, IEEE Spectrum (Volume: 34, Issue: 9, Sept. 1997) DOI: 10.1109/6.619384

[6] Frank Everest. “The characteristics and use of the 555 timer” IEEE Electronics Education (Volume:2000 , Issue: 3 , Autumn 2000) DOI: 10.1049/ee.2000.0051

[7] Hex Inverters SDLS029C − DECEMBER 1983 − REVISED JANUARY 2004 Datasheet, Texas Instruments.

[8] LM555 Datasheet, SNAS548D –FEBRUARY 2000–REVISED JANUARY 2015, Texas Instruments.

[9] Nur Faizal Kasri; Mohamed Afendi Mohamed Piah “A Compact and Reliable Pulse Generator Using Dual 555-Timer IC to Produce PWM Method” 2017 IEEE Conference on Energy Conversion DOI: 10.1109/CENCON.2017.8262466

[10] D. S. Yu ; C. Y. Zheng; H. H. C. Iu ; T. Fernando “A Memristive Astable Multivibrator Based on 555 Timer” 2015 IEEE International Symposium on Circuits and Systems (ISCAS), DOI: 10.1109/ISCAS.2015.7168769