Department Of Electrical Engineering

Instrumentation Lab EE-702

Experiment No.-7: Design of Timer circuit and its application for alarm annunciation

Objective: Design and application of timer.

Equipment / Apparatus required

555 Timer IC, CRO, Multi meter, Resistances (1MΩ, 1kΩ, 0.5kΩ etc.), capacitor (1µf), power supply (0-15 V DC), breadboard, connecting wire.

Theory:

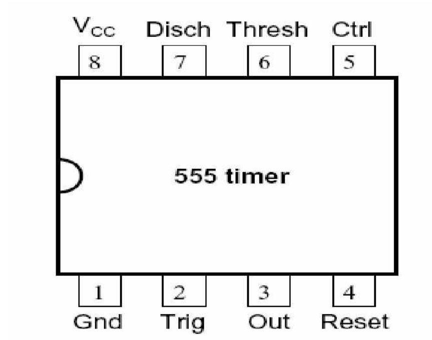
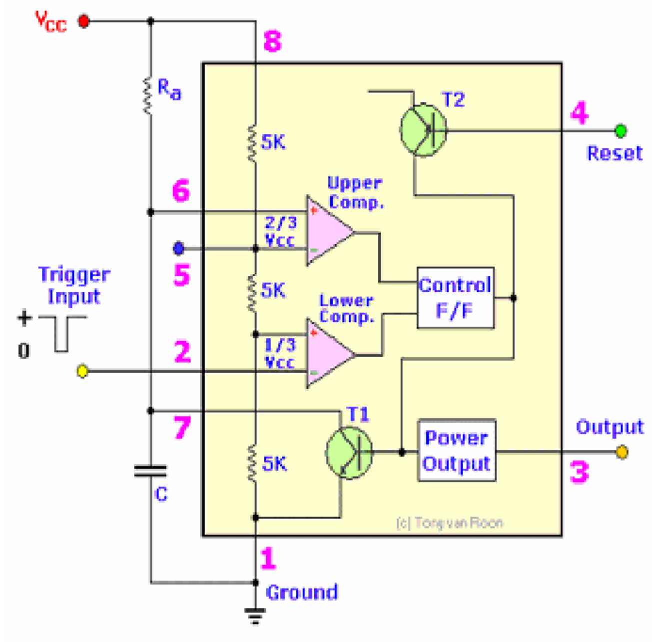


Figure:1 Pin diagram of 555 timer

The 555 timer has two basic operational modes: monostable / 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 fixed time duration each time it receives and input trigger pulse.

The other basic operational mode of the 555 is astable multivibrator. An astable multivibrator is simply an 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.



` Figure 2: Configuration of 555 timer circuit

<u>Monostable Mode</u>:

When a negative-going trigger pulse is applied to the trigger input (fig. 3), the threshold on the lower comparator is exceeded. The lower comparator, therefore, sets the flip-flop. That causes T1 to cut off, acting as an open circuit. The setting of the flip-flop also causes a positive-going output level which is the beginning of the output timing pulse. The capacitor now begins to charge through the external resistor. As soon as the charge on the capacitor equal 2/3 of the supply voltage, the upper comparator triggers and resets the control flip flop. This terminates the output pulse which switches back to zero. At this time, T1 again conducts, thereby discharging the capacitor. If a negative-going pulse is applied to the reset input while the output pulse is high, it will be terminated immediately as that pulse will reset the flip flop. Whenever a trigger pulse is applied to the input, the 555 will generate its single-duration output pulse. Depending upon the values of external resistance and capacitance used, the output timing pulse may be adjusted from approximately one millisecond to as high as on hundred seconds. The duration of the output pulse in seconds is approximately equal to:

$$T = 1.1 \times R \times C \text{ (in seconds)} \qquad \text{------- (1)}$$

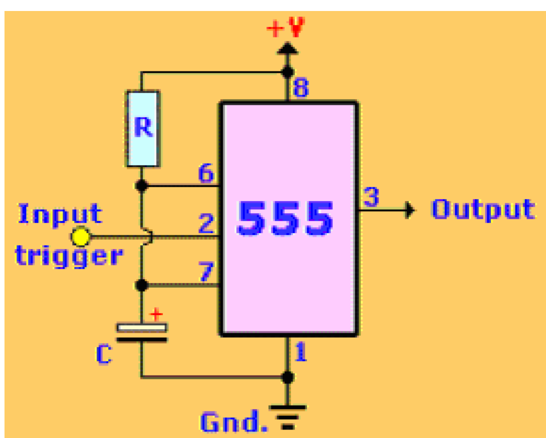


Figure 3: circuit diagram for Monostable mode

Astable operation:

Figure 4 shows the 555 connected as an astable multivibrator. Both the trigger and threshold inputs (pins 2 and 6) to the two comparators are connected together and to the external capacitor. The capacitor charges toward the supply voltage through the two resistors, R1 and R2. The discharge pin (7) connected to the internal transistor is connected to the junction of those two resistors. When power is first applied to the circuit, the capacitor will be uncharged; therefore, both the trigger and threshold inputs will be near zero volts . The lower comparator sets the control flip flop causing the output to switch high. That also turns off transistor T1. That allows the capacitor to begin charging through R1 and R2. As soon as the charge on the capacitor reaches 2/3 of the supply voltage, the upper comparator will trigger causing the flip-flop to reset. That causes the output to switch low. Transistor T1 also conducts. The effect of T1 conducting causes resistor R2 to be connected across the external capacitor. Resistor R2 is effectively connected to ground through internal transistor T1. The result of that is that the capacitor now begins to discharge

As soon as the voltage across the capacitor reaches 1/3 of the supply voltage, the lower comparator is triggered. That again causes the control flip-flop to set and the output to go high. Transistor T1 cuts off and again the capacitor begins to charge. That cycle continues to repeat with the capacitor alternately charging and discharging, as the comparators cause the flip-flop to be repeatedly set and reset. The resulting output is a continuous stream of rectangular pulses. The frequency of operation of the astable circuit is dependent upon the values of R1, R2, and C. The frequency can be calculated with the formula:

$$f = 1/ (.693 \times C \times (R1 + 2 \times R2)) \qquad \text{---------- (2)}$$

The Frequency f is in Hz, R1 and R2 are in ohms, and C is in farads. The time duration between pulses is known as the 'period', and usually designated with a 'T'. The pulse is ON for T1 seconds, then OFF for T2 seconds. The total period (T) is T1 + T2 (see fig. 10). That time interval is related to the frequency by the familiar relationship:

$$f = 1/T$$

or

$$T = 1/f$$

The time intervals for the ON and OFF portions of the output depend upon the values of R1 and R2. The ratio of the time duration when the output pulse is high to the total period is known as the duty-cycle. The duty-cycle can be calculated with the formula:

$$D = T1/T = (R1 + R2) / (R1 + 2R2) \qquad \text{------- (3)}$$

You can calculate T1 and T2 times with the formulas below:

$$T1 = .693(R1+R2)C \qquad \text{------------(4)}$$

$$T2 = .693 \times R2 \times C \qquad \text{------------ (5)}$$

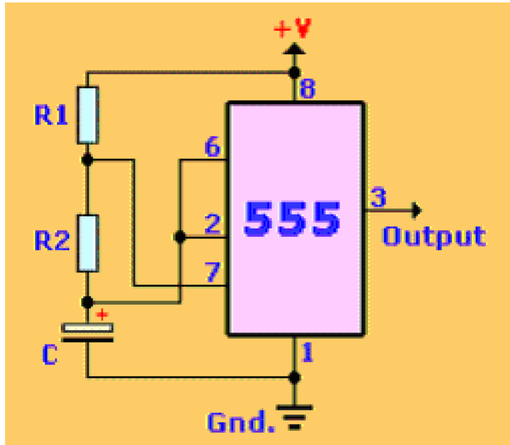


Figure 4: circuit diagram for astable mode

Design and test procedure :

1. Monostable Multivibrator:

Design specification: Pulse width 1.1s.

- Use the eq^n (1) to determine values for R. (Assume C = 1µf).
  Show your calculation---

  R = __________Ω

- Assemble the circuit (refer to figure2a) on the bread board, with a 5-volt DC regulated power supply.

- Observe the output waveform on CRO and record the following features -

  Period = _____________ sec.
  Frequency = ____________ Hz.

2. Astable Multivibrator:

Design specification: Pulse width 1.386ms.
Duty cycle 75%.

- Use the eq^n (2) and (3) to determine values for R1and R2. (Assume C =1µf).
  Show your calculation---

  R1 = __________Ω
  R2 = __________Ω

- Assemble the circuit (refer to figure2b) on the bread board. Use a 5-volt DC power supply

- Use an oscilloscope to display the output waveform. Obtain the following data from the output waveform by using oscilloscope :

  Charging time (output high) = ____________sec.
  Discharge time (output low) = _____________sec.
  Period = _____________sec.
  Frequency = ____________Hz.
  Duty cycle =_____________

Simulation: Simulate on PSPICE / ORCAD and extract main features as T_{on}, T_{off}, Time period, duty cycle and report.

Results:

Sketch the waveforms for Monostable and astable mode. Compare the theoretical and practical results obtained.

Application: Design as monostable for ON period of 5 seconds and interface with LED. Design as ASTABLE with ON period of 5 seconds and OFF period of 10 seconds. Modify the design to glow a red LED during OFF period and green LED during ON period

Discussion:

1. What could be other applications of 555 timer? Show with a conceptual diagram.
2. Is there difference between simulation and test results ? If yes, then what could be the reasons ?

References:
OP-Amps and linear Integrated circuits – Gayakwad, Ramakant A.
Linear integrated circuits – D. Roy Choudhury, Shail B Jain (wiley)