Khulna University of Engineering & Technology

Project Report

Department : Electrical and Electronic Engineering

Course No : EE2110

Project Name : **Astable Multivibrator Circuit**

Remarks

09/02

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Objectives:

The main objectives of this project are:

- To recognise BJT astable multivibrator circuits.
- To design a multivibrator circuit using **BC 547 transistors.**
- To understand the working principle of an astable multivibrator.
- To control the timing and switching of **LEDs** with a frequency determined by **resistor** and **capacitor** values.
- To gain practical experience in building circuits on a **breadboard.**

Introduction:

The basic bipolar transistor (BJT) version of an astable multivibrator. It has two outputs that repeatedly change state at a rate determined by the time constants of its feedback network. Although largely superseded by its equivalent op amp or timer IC versions in many applications, it is still a useful and flexible design for square wave and pulse generation. The circuits shown on this page will operate from a DC supply between 3.3V and 9V. Whilst the voltages and waveforms in the operational descriptions refer to the circuit working from a 9V supply, this supply voltage may be a little high as the base/emitter voltages on the transistors produces negative going spikes on each cycle of about -8.4V (see Fig-10.1) and the data sheet for the 2N3904 specifies a maximum base/emitter voltage of 6V. Therefore a 5V supply can be recommended for greater reliablity.

The circuit switches continuously from one state (TR1 on and TR2 off) to the other (TR1 off and TR2 on) and back again at a rate determined by the RC timing components CI/R2 and C2/R3. The circuit produces two anti-phase square wave signals, with an amplitude almost equal to its supply voltage, at its two transistor collectors as shown in Fig-10.1

Astable Operation :

Suppose that at switch on, TR1 is conducting heavily and TR2 is turned off. The collector of TR1 will be almost at zero volts as will the left hand plate of C1. Beause TR2 is turned off at this time, its collector will be at supply voltage and its base will be at almost zero potential, the same as TR1 collector, because C1 is still un-charged and its two plates are at the same potential.

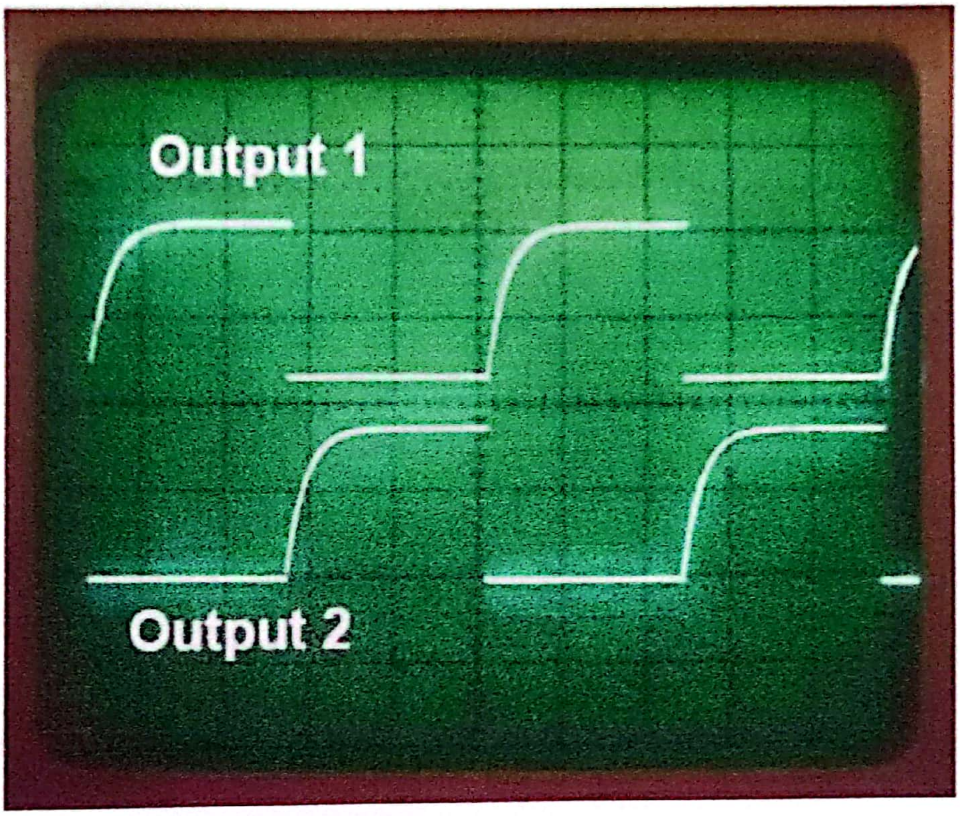

Figure-10.1:Antiphase Outputs

C1 now begins to charge via R2 and its right hand plate becomes increasingly positive until it reaches a voltage of about +0.6V. As this plate of the capacitor is also connected to the base of TR2, this transistor will begin to conduct heavily. The rapidly increasing collector current through TR2 now causes a voltage drop across R4, and TR2 collector voltage falls, causing the right hand plate of C2 to fall rapidly in potential.

It is the nature of a capacitor that when the voltage on one plate changes rapidly, the other plate also undergoes a similar rapid change, therefore as the right hand plate of C2 falls rapidly from supply voltage to almost zero, the left hand plate must fall in voltage by a similar amount.

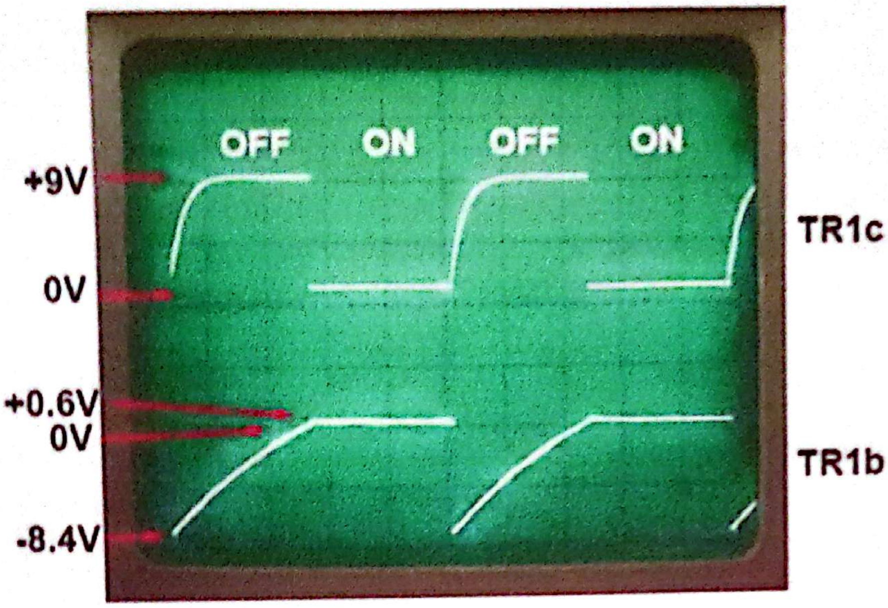

Figure-10.2:Switching Action (on TR1)

With TR1 conducting, its base would have been about 0.6V, so as TR2 conducts TR1 base falls to 0.6 −9V = −8.4V, a negative voltage almost equal and opposite to that of the +9V supply voltage.

This rapidly turns off TR1 causing a rapid rise in its collector voltage. Because a **sudden** voltage change on one plate of a capacitor causes the other plate to change by a similar amount, this sudden rise at TR1 collector is transmitted via C1 to TR2 base causing TR2 to rapidly turn on as TR1 turns off. A change of state has occurred at both outputs.

This new state does not last however. C2 now begins to charge via R3, and once the voltage on the left hand plate (TR1 base) reaches about +0.6V another rapid change of state takes place. This switching action produces the collector and base waveforms shown in Fig. 4.1.3.

Applications:

1.LED flasher circuits

2.Pulse generators

3.Clock signals in Digital Circuits

4.Tone Generation in audio circuits

Frequency Calculations :

The circuit keeps on changing state in this manner producing a square wave at each collector. The frequency of oscillation can be calculated, as the time for the relevant capacitor to charge sufficiently for a change of state to take place, will be approximately 0.7CR and, as two changes of state occur in each cycle the periodic time T will be:

$T = 0.7(C1R2+C2R3)$

If C1 = C2 and R2 = R3 the mark to space ratio will be 1:1and in this case the frequency of oscillation will be:

$F = 1/1.4CR$

Apparatus Required:

Table-10.1: Apparatus table for astable multivibrator

Serial No.	Apparatus Required	Ratings	Quantity
01	DC power supply	5V - 9V	1
02	Transistor	BC547(n-p-n)	2
03	Resistor	220 ohms,23kohm	4
04	Capacitor	10microfarad	2
05	LED	5mm(Any color)	2
06	Breadboard	_	1
07	Connecting wires and probes	_	As required

Circuit Diagram:

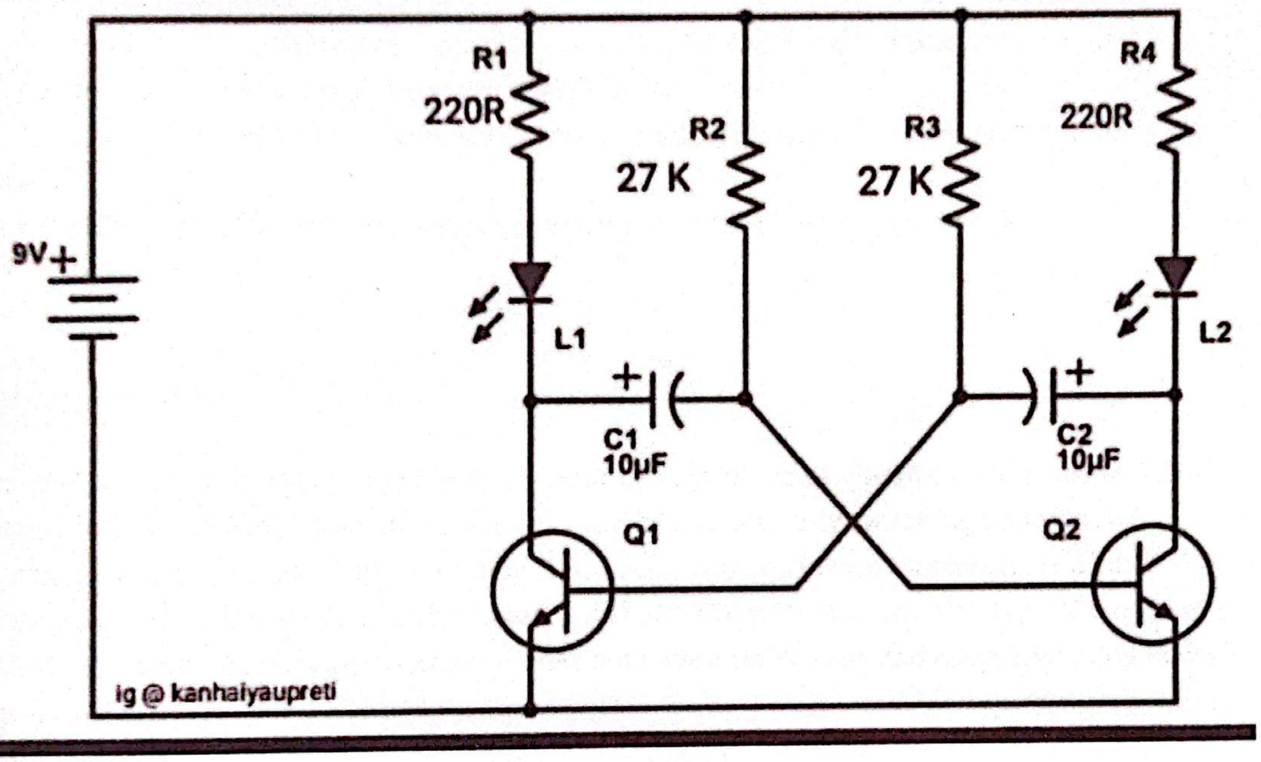

Figure-10.3: Equivalent circuit diagram for BJT astable multivirator

Working Principle:

An astable multivibrator is a type of oscillator that doesn't have a stable state. It continuously switches between two states: ON and OFF. Here's how it works:

- The circuit is made up of two transistors connected in a cross-coupled configuration. Each transistor is connected to the capacitor of the other.
- When the circuit is powered on, one of the capacitors starts charging through the resistor, causing the transistor to switch on.
- As the capacitor charges, the transistor turns off, causing the capacitor to discharge. This process repeats, generating a continuous square wave output.
- The LEDs blink alternately, turning on and off as the two transistors switch between their ON and OFF states.

The frequency of oscillation depends on the resistor and capacitor values. Using 23kΩ resistors and 10µF capacitors, the blinking frequency of the LEDs can be adjusted.

Practical implementations :

- First, mount the components on the breadboard and make sure to connect the transistors in the correct orientation.
- Connect the resistors and capacitors to set the timing for the oscillation.
- Attach the LEDs to the circuit to visualize the output.
- Use jumper wires to connect the components and ensure that all connections are correct.

After building the circuit, power it up and observe the LEDs blinking alternately.

Discussion:

From this project, we successfully learned about BJT astable multivibrator circuits using BC547 transistors. We observed how the circuit operates by continuously switching between two states, making two LEDs blink alternately. The circuit consists of two transistors, resistors, capacitors, and LEDs, which together create a self-sustaining oscillation. This type of circuit is called an astable multivibrator because it does not have a stable state and keeps switching on its own.

The circuit works based on the charging and discharging of capacitors, which control the switching of the transistors. When one transistor turns ON, the other turns OFF, and this cycle keeps repeating. As a result, the two LEDs connected to the transistors blink one after the other. The speed of blinking depends on the values of the resistors and capacitors, which determine the oscillation frequency. By changing these values, we can increase or decrease the blinking rate.

This project helped us understand the working of transistors as electronic switches and how simple components like resistors and capacitors can be used to build a timing circuit. The astable multivibrator is useful in many real-world applications. It is commonly used in LED flashers, clock pulse generators, sirens, and alarms. In digital electronics, it plays a key role in waveform generation, pulse generation, and signal processing.

One of the key advantages of this circuit is that it operates without an external trigger, meaning it runs continuously once powered. This makes it ideal for applications where a repeating signal is needed.

Conclusion :

In this project, the astable multivibrator using BJT was successfully implemented. This project has provided a deeper understanding of digital electronics and has enhanced our practical skills in circuit building, troubleshooting, and component selection. In future work, the multivibrator circuit could be expanded for more complex applications, such as driving multiple LEDs or acting as a timing component for other circuits.This project has provided valuable hands-on experience with transistor-based oscillators and timing circuits.Overall,this project provides us with a solid understanding of the fundamentals of transistor circuits and their applications.

References :

1."Electronic Devices and Circuit Theory"
- by Robert L. Boylestad and Louis Nashelsky.

2. https://learnabout-electronics.org/Oscillators/osc41.php