Astable Multivibrator

In the case of an Astable Multivibrator, it is a free-running oscillator that oscillates between two states, continually producing two square wave output waveforms. This device is a two-stage amplifier with positive feedback from one amplifier to the other. As a result of this feedback, the transistor on one end of the circuit is driven to saturation (On state), and the transistor on the other ends up in cut-off(OFF state). After a certain amount of time, the circuit conditions reverse, with the saturated transistor turning off and the cut-off transistor turning on.

Astable Multivibrator Diagram

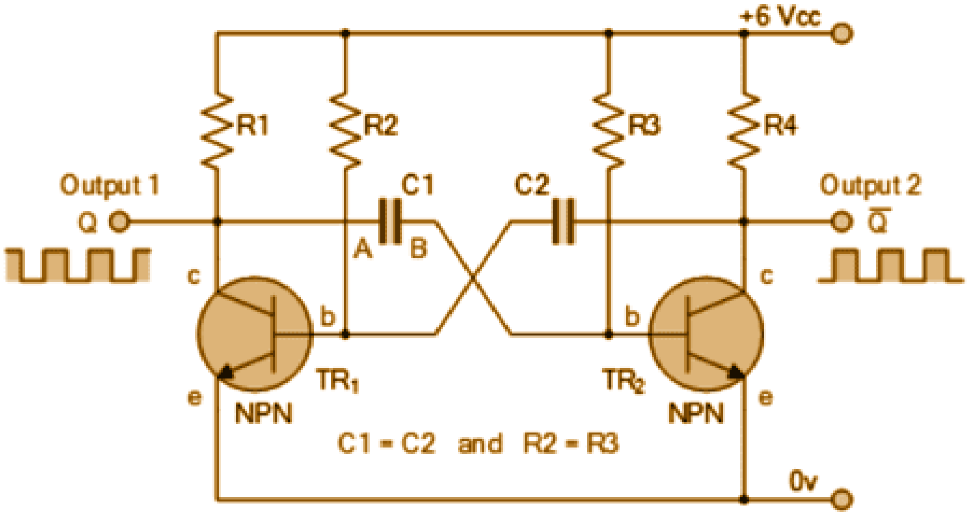
Design and Working of Astable Multivibrator

There are two symmetrical CE amplifier stages, each providing feedback to the other. Because each stage has a 180º phase shift, the feedback ratio between the two is positive and unity. In case, $R_2C_1=R_3C_2$ is the collector load, and $R_2=R_3$ is the biasing resistor.

The output of the transistor further increases the input of transistor Q_2 and the output of transistor Q_2 into transistor Q_1. Q_1 and Q_1 supply the square wave output by driving the transistors to saturation or cut-off.

Circuit Diagram of Astable Multivibrator

There are two switching transistors, a cross-coupled feedback network, and two time-delay capacitors in the stable circuit so that the state can change without external triggering.

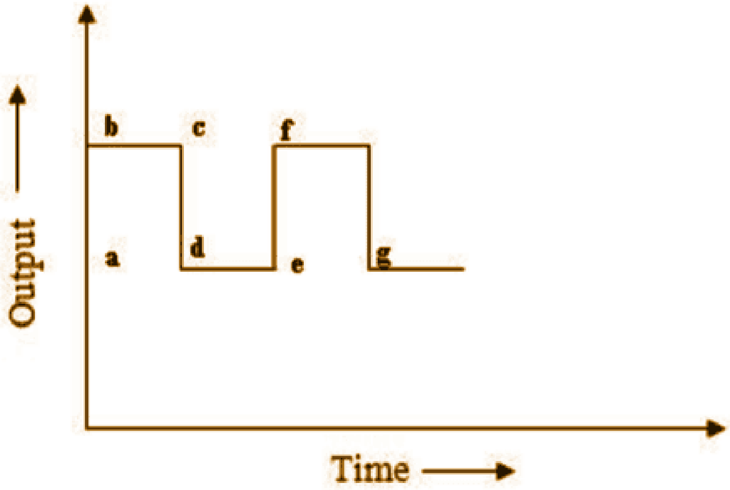


With this circuit, one stage conducts "fully-ON" (saturation). At the same time, the other is switched "fully-OFF"(cut-off), which creates an extremely high level of mutual amplification between the two transistors. The conductivity is transferred from one stage to another through the discharging action of a capacitor through a resistor.

Operation in Astable Multivibrator

In applying V_{cc} to Q_1 and Q_2, collector current starts flowing in both transistors simultaneously. Additionally, the coupling capacitors C_1 and C_2 also start charging up. As Q_1's collector current rises, its positive output is applied to C_1's base, creating a reverse bias on Q_2, thereby decreasing its collector current. In the presence of C_2, the collector of Q_2 connects to the base of Q_1, resulting in Q_1 becoming more forward-biased, further increasing the collector current in Q_2. In this way, the circuit continues to drive Q_1 until saturation occurs, and Q_2 is cut-off. Consequently, Vcc appears across R_2C_1 and R_3C_2appears to be at no voltage. In Q_1 and Q_2, the charges developed across C_1 and C_2 suffice to maintain saturation and cut-off conditions.

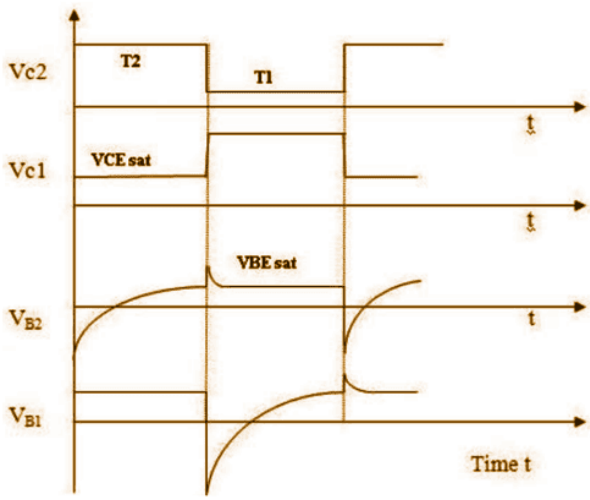
These conditions are represented by the time interval 'bc' in the below figure.



Despite this, tAs a result, the capacitor will not retain the charges forever; instead, they will discharge through respective circuit paths. Where C_2 and R_3 determine the duration determines the time when the forward bias at Q2 is re-established after C_1 discharges, causing the collector current to start at Q_2. As a result, Q_2 will be driven to saturation quickly due to the increasing positive potential at the collector of Q_2. This is done through capacitor C_2. Therefore, the base of Q_1 will become more positive than Q_2. As a result, Q_2 will remain in saturation for a period of time, and Q1 will remain at the cut-off. C_2 R_3 and determine the duration.

Waveform of Astable Multivibrator

A pair of cross-coupled grounded emitter transistors produces the square wave output of an astable multivibrator. As a common emitter amplifier in the multivibrator, both transistors, NPN and PNP, have a bias for the linear operation and are 100% positive feedback transistors.



Frequency and Time Calculations of Astable Multivibrator

At each collector, the circuit keeps changing states in this way, producing a square wave. Since the relevant capacitor takes approximately 0.69CR to charge enough for a state to occur, the frequency of oscillation can be calculated as follows:

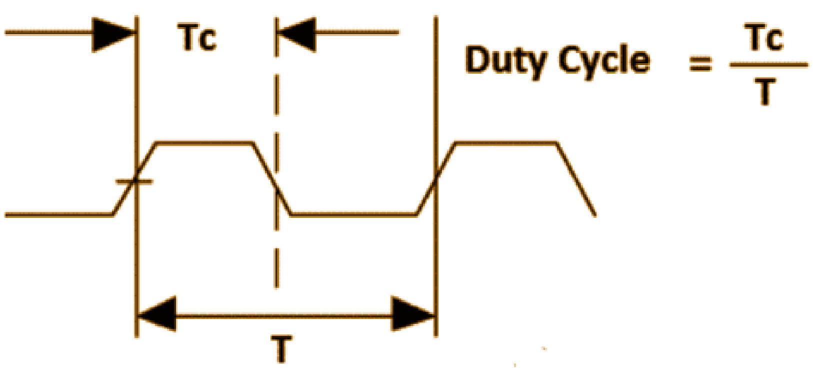
$T=0.69(R_2C_1+R_3C_2)$

When $C_1=C_2=C$ and $R_1=R_2=C$, the mark-to-space ratio will be 1:1, and the frequency of oscillation will be:

$f_0 = 1/(1.4\ RC)$

Duty Cycle

It is the ratio of time Tc during which the output is high to the total time period T of the cycle.



Based on this output rate, Duty Cycle = $T_{ON}/(T_{OFF}+T_{ON})$ when the transistor has a collector output.

Applications of Astable Multivibrator

Astable multivibrators can be used for many applications, such as pulse position modulation, frequency modulation, etc. because they are simple, reliable, and easy to build.

- We use the astable multivibrator to generate waves.
- It is used to convert voltage to frequency.
- Synchronization of pulses is achieved using it.
- Due to its square wave production, it produces harmonic frequencies of higher order.
- This multivibrator is used in the construction of voltmeters and SMPS.
- In addition to operating at a wide range of frequencies, an astable multivibrator can also function as an oscillator.