Capacitor is commonly used to provide the timing in a multivibrator circuit

A digital electronic circuit known as a multivibrator produces digital signals like pulses, square waves, and other types of signals. It often consists of passive elements like resistors and capacitors as well as digital logic gates. Multivibrator can be created with .BJT(active element) / OPAmp(active element) / 555 timer IC

## What is multivibrator circuit? / nonlinear oscillator / Function generator

A MULTIVIBRATOR is an electronic circuit that generates square, rectangular, pulse waveforms, also called nonlinear oscillators or function generators. They are utilized for data storage, synchronization between various components, clock signal generation, timing control, and data transfer time.

he three basic types of multivibrators are astable, monostable, and bistable, each with distinct properties and uses.

- A multivibrator circuit oscillates between a "HIGH" state and a "LOW" state producing a continuous output.
- In a multivibrator, the two transistors are connected in feedback so that one transistor controls the state of the other. mirror image, back-to-back
- Multivibrators are used are widely used to implement two-state devices like Relaxation Oscillators, Timers, and flip-flops.

## Astable Multivibrator

An astable multivibrator, also called a free-running multivibrator, is a circuit that continuously produces square waves or pulses without the use of an external trigger. The term "astable" refers to the absence of a stable state in this particular type of multivibrator.

## Applications

1. Used in square wave frequency generator.
2. Used as a timing oscillator in the computer system.
3. Used in flashing lights.

## Monostable Multivibrator

A monostable multivibrator, also called a one-shot multivibrator, is a circuit that responds to an external trigger by producing a single pulse with a set duration. A pulse from outside causes this sort of multivibrator to flip from its stable state to an unstable one.

## Applications

1. Used for regenerating weak signals.
2. Used in the pulse generator.
3. Used in memory.
4. pulse shaping, debouncing, and time delay functions
5. Other circuits can use it as a trigger as well.

- The circuit returns to its stable condition after a certain amount of time and generates a single output pulse.

- By altering the values of the resistors and capacitors in the circuit, the output pulse's duration can be changed.
- In digital circuits, the monostable multivibrator is frequently used for pulse shaping, debouncing, and time delay functions.
- Other circuits can use it as a trigger as well.

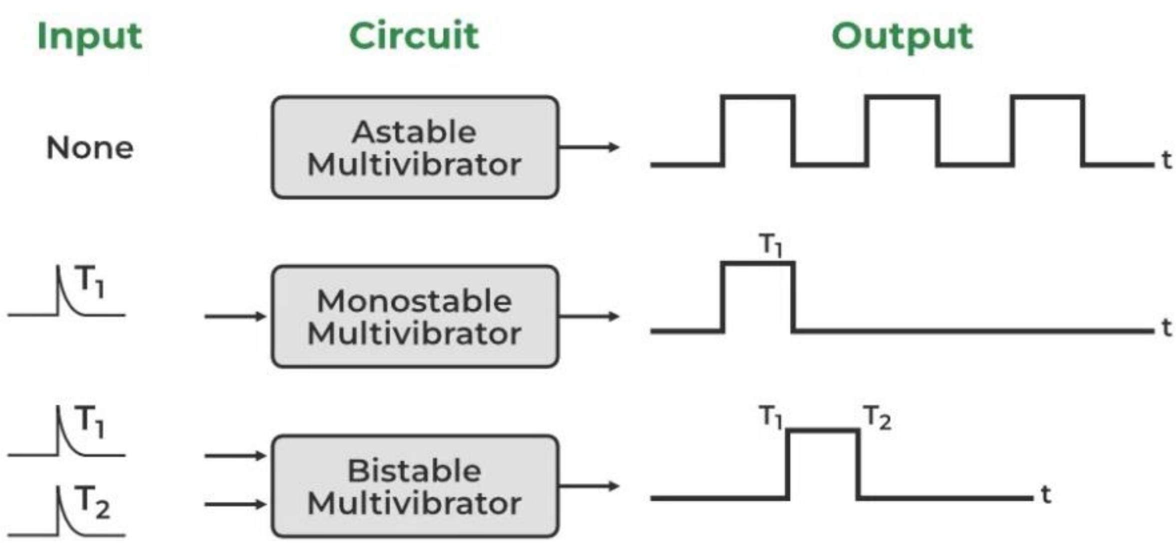
## Bistable Multivibrator

A flip-flop, or bistable multivibrator, is a circuit with two stable states that can alternately exist indefinitely.

1. Also known as a flip-flop multivibrator.
2. It has two stable states and can remain in either state indefinitely without any input signal.
3. It requires two transistors, two capacitors, and a few resistors.
4. It is commonly used in digital circuits as a memory element, latch, or flip-flop.
5. It is also used in applications where a simple on/off switch is required.

## Applications

1. Used for changing the supply to two circuits.
2. Used in digital operation in computers.

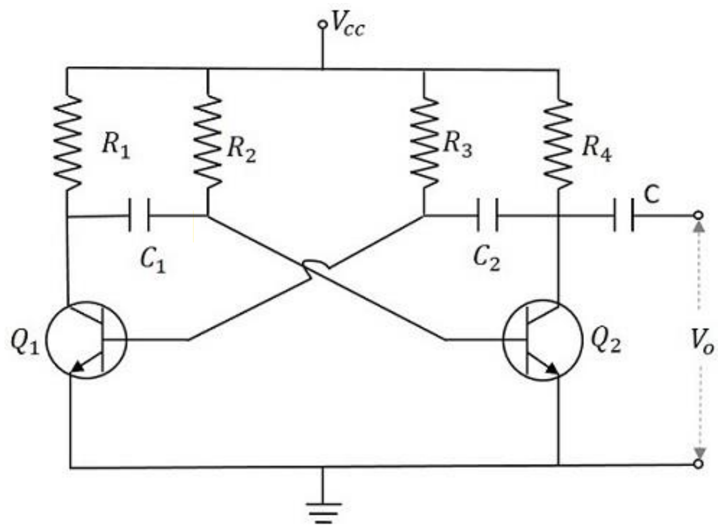


# Astable Multivibrator

## Construction of Astable Multivibrator

Two transistors named $Q_1$ and $Q_2$ are connected in feedback to one another. The collector of transistor $Q_1$ is connected to the base of transistor $Q_2$ through the capacitor $C_1$ and vice versa. The emitters of both the transistors are connected to the ground. The collector load resistors $R_1$ and $R_4$ and the biasing resistors $R_2$ and $R_3$ are of equal values. The capacitors $C_1$ and $C_2$ are of equal values.

The following figure shows the circuit diagram for Astable Multivibrator.




## Operation of Astable Multivibrator

When $V_{cc}$ is applied, the collector current of the transistors increases. As the collector current depends upon the base current,

$I_c = \beta I_B$

As no transistor characteristics are alike, one of the two transistors say $Q_1$ has its collector current increase and thus conducts. The collector of $Q_1$ is applied to the base of $Q_2$ through $C_1$. This connection lets the increased negative voltage at the collector of $Q_1$ to get applied at the base of $Q_2$ and its collector current decreases. This continuous action makes the collector current of $Q_2$ to decrease further. This current when applied to the base of $Q_1$ makes it more negative and with the cumulative actions $Q_1$ gets into saturation and $Q_2$ to cut off. Thus, the output voltage of $Q_1$ will be $V_{CE\,(sat)}$ and $Q_2$ will be equal to $V_{CC}$.

The capacitor $C_1$ charges through $R_1$ and when the voltage across $C_1$ reaches 0.7v, this is enough to turn the transistor $Q_2$ to saturation. As this voltage is applied to the base of $Q_2$, it gets into saturation, decreasing its collector current. This reduction of voltage at point B is applied to the base of transistor $Q_1$ through $C_2$ which makes the $Q_1$ reverse bias. A series of these actions turn the transistor $Q_1$ to cut off and transistor $Q_2$ to saturation. Now point A has the potential $V_{CC}$. The capacitor $C_2$ charges through $R_2$. The voltage across this capacitor $C_2$ when gets to 0.7v, turns on the transistor $Q_1$ to saturation.

Hence the output voltage and the output waveform are formed by the alternate switching of the transistors $Q_1$ and $Q_2$. The time period of these ON/OFF states depends upon the values of biasing resistors and capacitors used, i.e., on the $R_C$ values used. As both the transistors are operated alternately, the output is a square waveform, with the peak amplitude of $V_{CC}$.

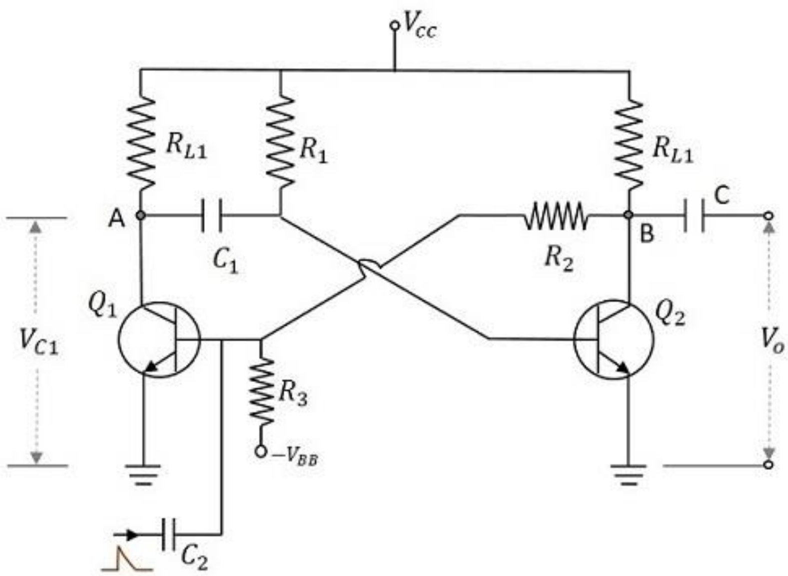
# Monostable Multivibrator

## Construction of Monostable Multivibrator

Two transistors $Q_1$ and $Q_2$ are connected in feedback to one another. The collector of transistor $Q_1$ is connected to the base of transistor $Q_2$ through the capacitor $C_1$. The base $Q_1$ is connected to the collector of $Q_2$ through the resistor $R_2$ and capacitor C. Another dc supply voltage $-V_{BB}$ is given to the base of transistor $Q_1$ through the resistor $R_3$. The trigger pulse is given to the base of $Q_1$ through the capacitor $C_2$ to change its state. $R_{L1}$ and $R_{L2}$ are the load resistors of $Q_1$ and $Q_2$.

One of the transistors, when gets into a stable state, an external trigger pulse is given to change its state. After changing its state, the transistor remains in this quasi-stable state or Meta-stable state for a specific time period, which is determined by the values of RC time constants and gets back to the previous stable state.

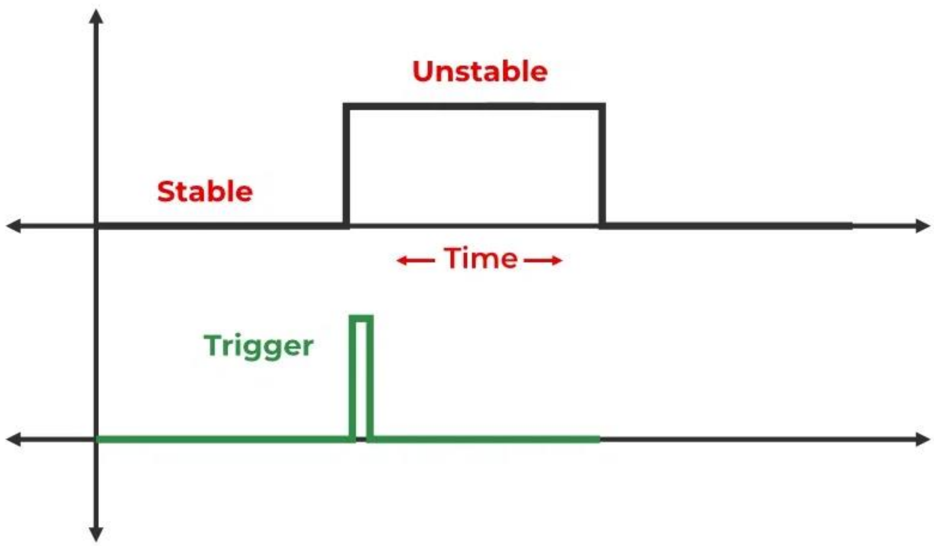
The following figure shows the circuit diagram of a Monostable Multivibrator.



## Operation of Monostable Multivibrator

Firstly, when the circuit is switched ON, transistor $Q_1$ will be in OFF state and $Q_2$ will be in ON state. This is the stable state. As $Q_1$ is OFF, the collector voltage will be $V_{CC}$ at point A and hence $C_1$ gets charged. A positive trigger pulse applied at the base of the transistor $Q_1$ turns the transistor ON. This decreases the collector voltage, which turns OFF the transistor $Q_2$. The capacitor $C_1$ starts discharging at this point of time. As the positive voltage from the collector of transistor $Q_2$ gets applied to transistor $Q_1$, it remains in ON state. This is the quasi-stable state or Meta-stable state.

The transistor $Q_2$ remains in OFF state, until the capacitor $C_1$ discharges completely. After this, the transistor $Q_2$ turns ON with the voltage applied through the capacitor discharge. This turn ON the transistor $Q_1$, which is the previous stable state.



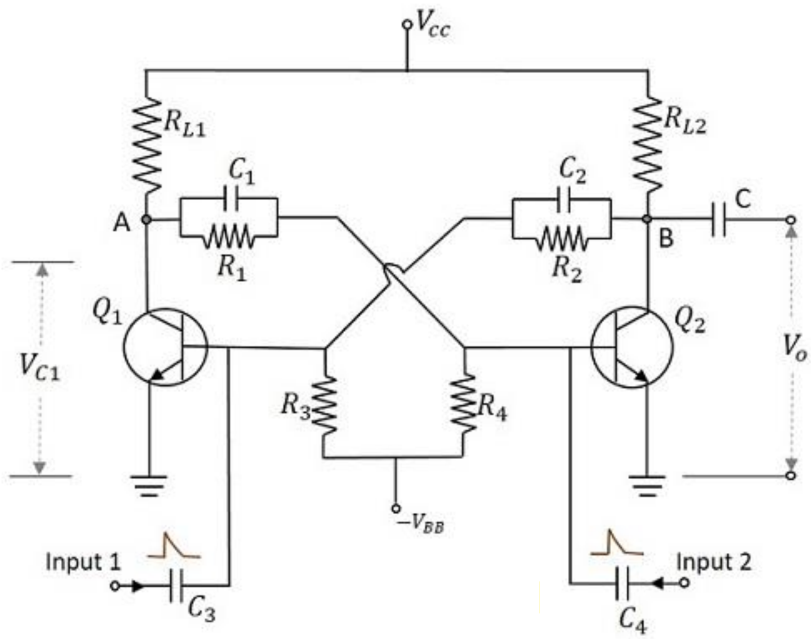

# Bistable Multivibrator

## Construction of Bistable Multivibrator

Two similar transistors $Q_1$ and $Q_2$ with load resistors $R_{L1}$ and $R_{L2}$ are connected in feedback to one another. The base resistors $R_3$ and $R_4$ are joined to a common source $-V_{BB}$. The feedback resistors $R_1$ and $R_2$ are shunted by capacitors $C_1$ and $C_2$ known as **Commutating Capacitors**. The transistor $Q_1$ is given a trigger input at the base through the capacitor $C_3$ and the transistor $Q_2$ is given a trigger input at its base through the capacitor $C_4$.

The capacitors $C_1$ and $C_2$ are also known as **Speed-up Capacitors**, as they reduce the **transition time**, which means the time taken for the transfer of conduction from one transistor to the other.

The following figure shows the circuit diagram of a self-biased Bistable Multivibrator.

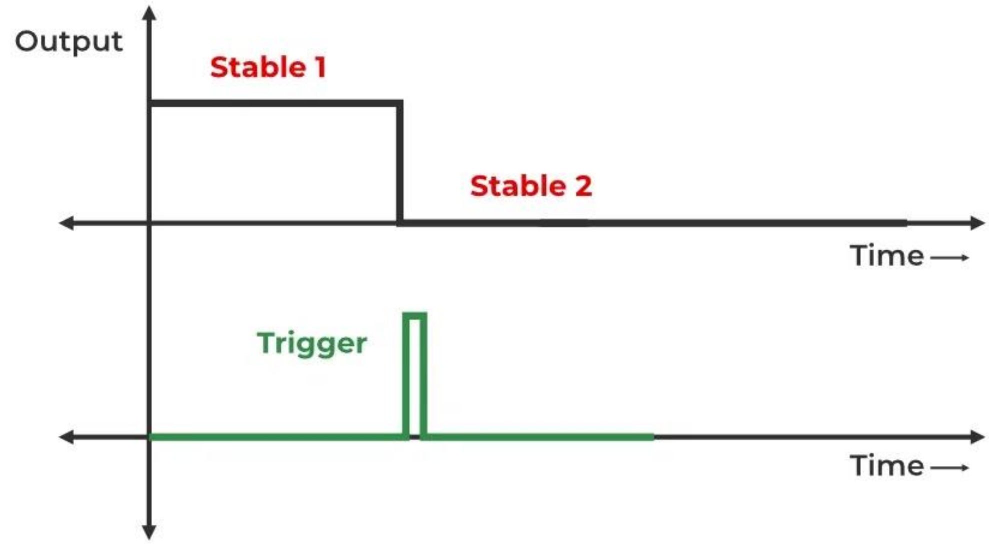


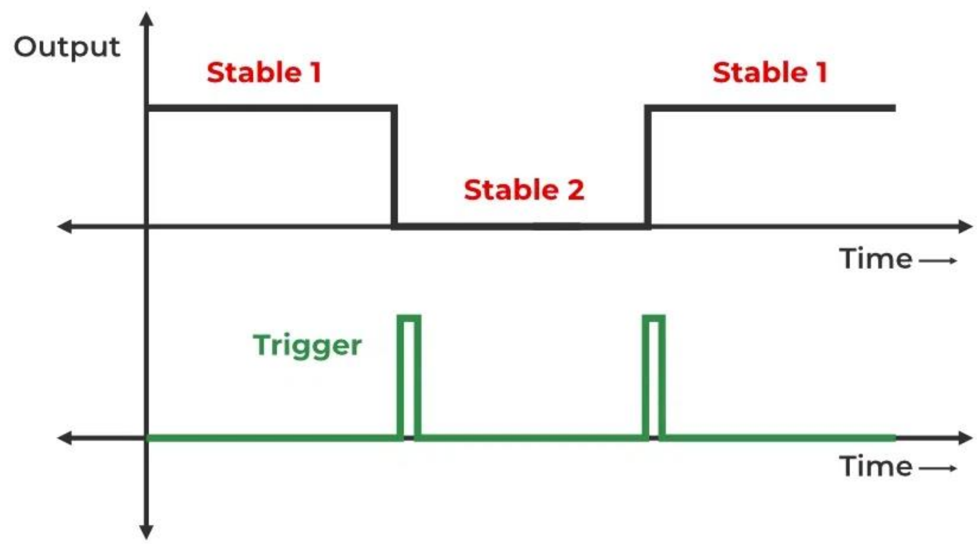

## Operation of Bistable Multivibrator

When the circuit is switched ON, due to some circuit imbalances as in Astable, one of the transistors, say $Q_1$ gets switched ON, while the transistor $Q_2$ gets switched OFF. This is a stable state of the Bistable Multivibrator.

By applying a negative trigger at the base of transistor $Q_1$ or by applying a positive trigger pulse at the base of transistor $Q_2$, this stable state is unaltered. So, let us understand this by considering a negative pulse at the base of transistor $Q_1$. As a result, the collector voltage increases, which forward biases the transistor $Q_2$. The collector current of $Q_2$ as applied at the base of $Q_1$, reverse biases $Q_1$ and this cumulative action, makes the transistor $Q_1$ OFF and transistor $Q_2$ ON. This is another stable state of the Multivibrator.

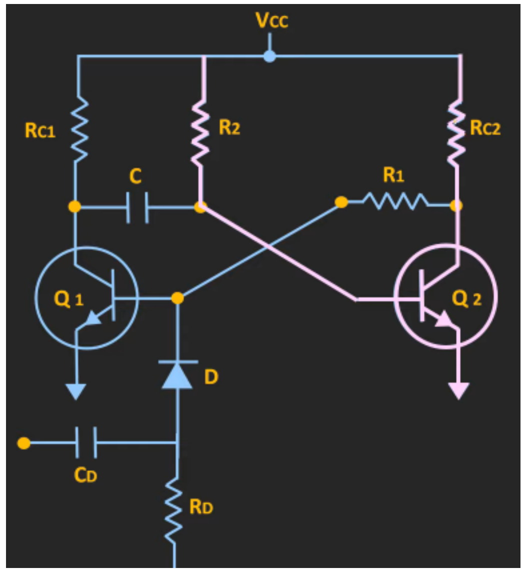
Now, if this stable state has to be changed again, then either a negative trigger pulse at transistor $Q_2$ or a positive trigger pulse at transistor $Q_1$ is applied.




# Numerical:

1. An astable circuit to produce a series of pulses at a frequency of 500 Hz, with a mark to space ration 1:5, $R_1=R_2=100$ kilo-ohm. Calculate $C_1$ and $C_2$.
2. An astable multivibrator is constructed using two timing capacitors of 3.3 micro-farad and two base resistors of 10 kilo-ohm. Calculate maximum and minimum frequency if 100k dual gang potentiometer is connected in series with two resistors.
3. For the following circuit, if the input signal is 1 kHz square wave pulse with 50% duty cycle then find the approximate frequency of duty cyle.



Vcc
Rc1
R2
Rc2
C
R1
Q 1
Q 2
D
CD
RD