Semiconductor Devices

Multivibrators

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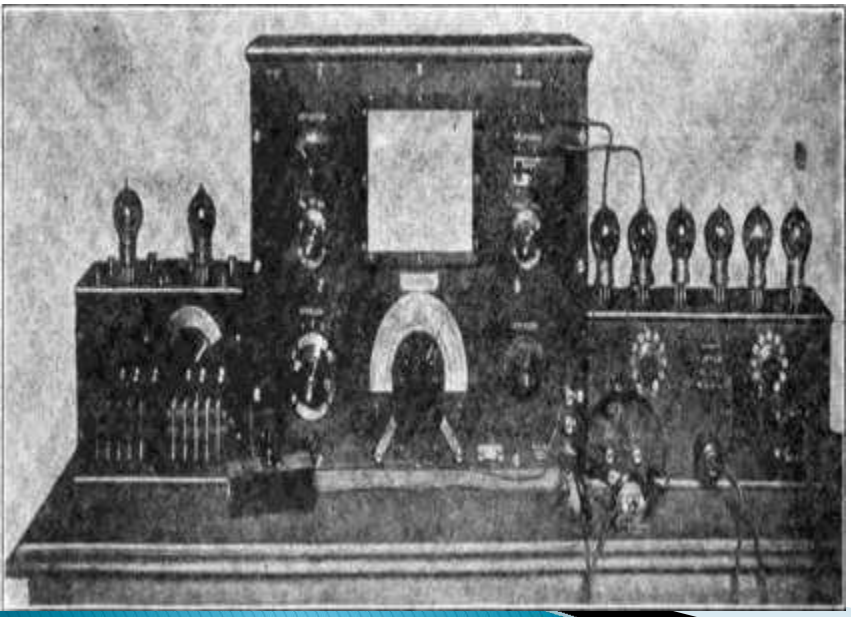
Introduction

- A multivibrator is a high gain transistor coupled amplifier. It is an electronic circuit that is used to implement two state systems like oscillators, timers and flip-flops.
- It is characterized by two amplifying devices (transistors or other devices) cross- coupled by resistors or capacitors.

Invention of Multivibrator

A vacuum tube Abraham-Bloch multivibrator oscillator, France, 1920.



Henri Abraham and Eugene Bloch described the first multivibrator circuit in 1920, also called a plate-coupled multivibrator.

It was made from vacuum tubes and its harmonics are being used to calibrate a wavemeter .

Classification of Multivibrator

There are three types of multivibrator circuits depending on the circuit operation:

Astable – neither state is stable, two quasi stable states, free running**.**

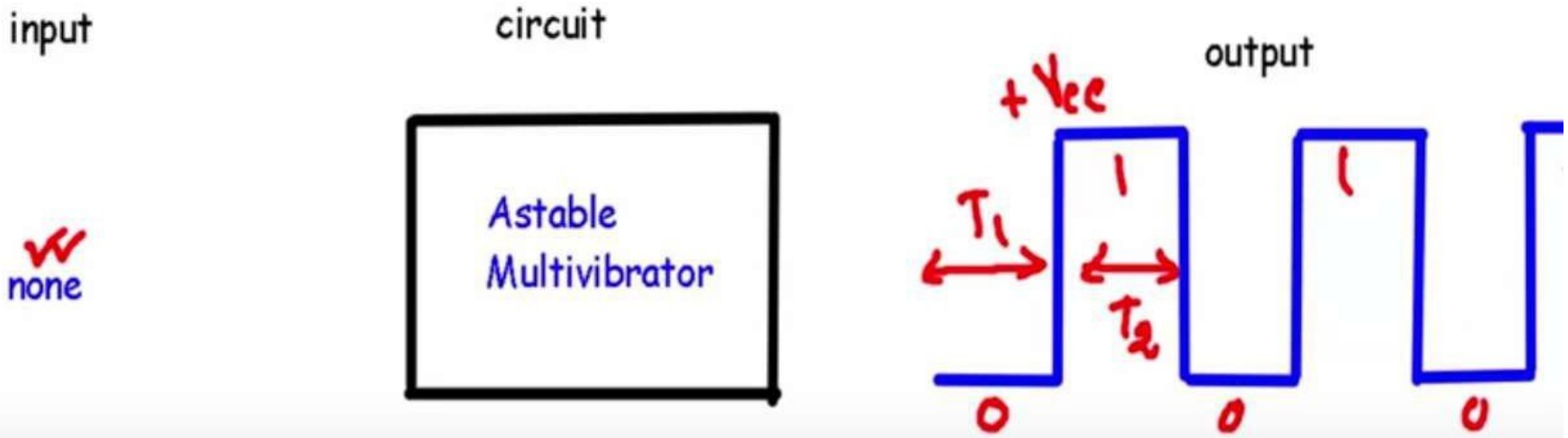
Monostable - One of the states is stable, and the other is quasi stable state. External triggering is needed.

Also called One shot multivibrator

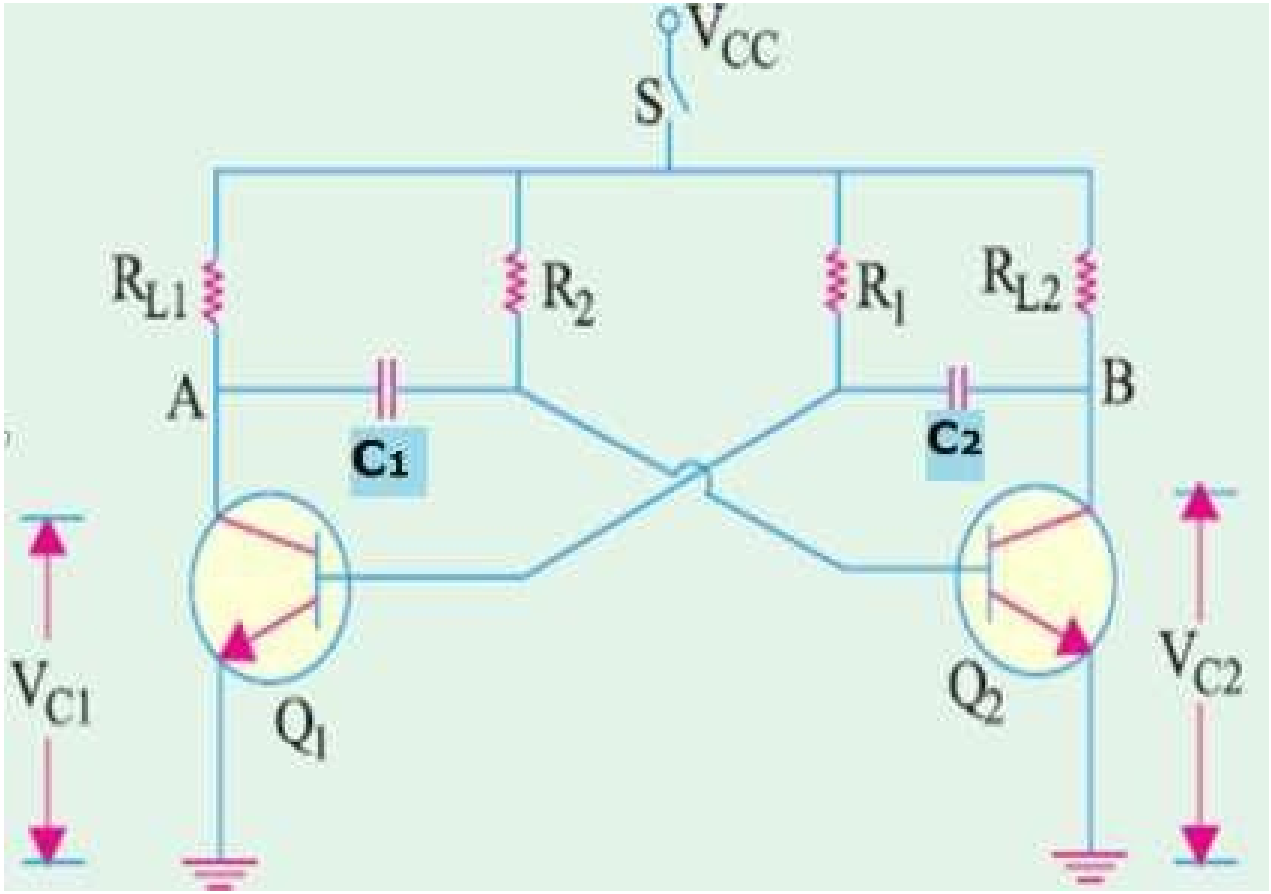
Bistable – Both stable states. it remains in either state indefinitely. External triggering is needed. Also called Flip flop

Astable Multivibrator

A Multivibrator that generates square waveform without using external triggering pulse is known as Astable multivibrator. It also known as **Free-running Multivibrator .**



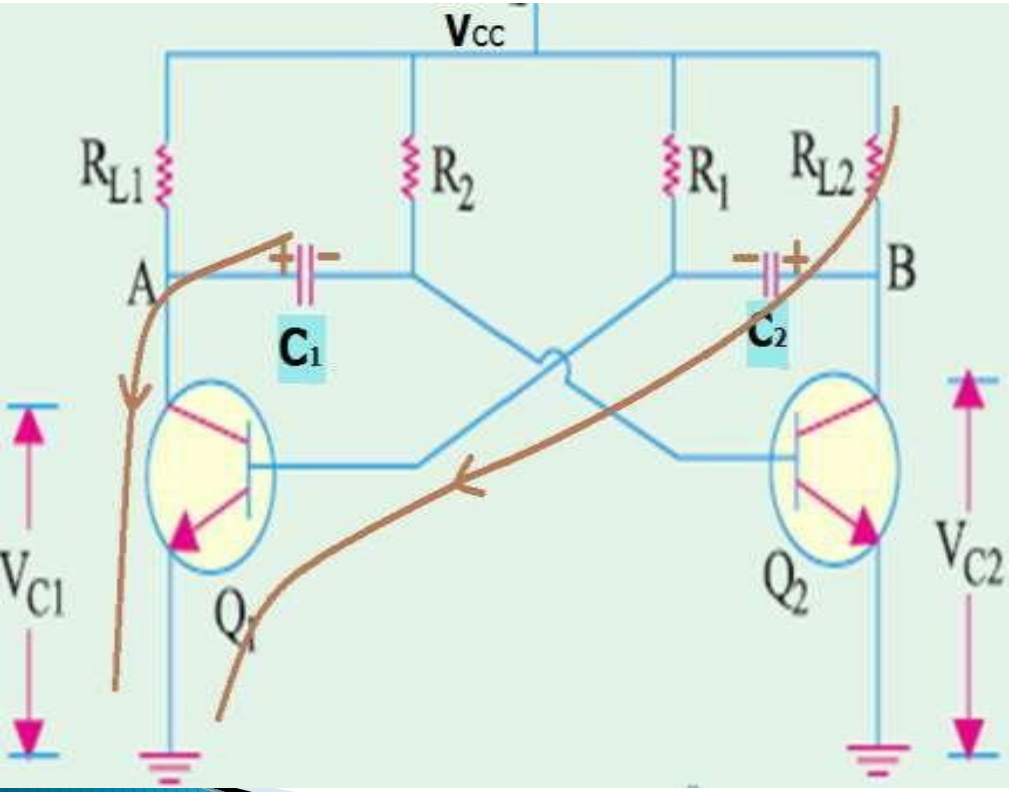
Circuit diagram of Astable Multivibrator

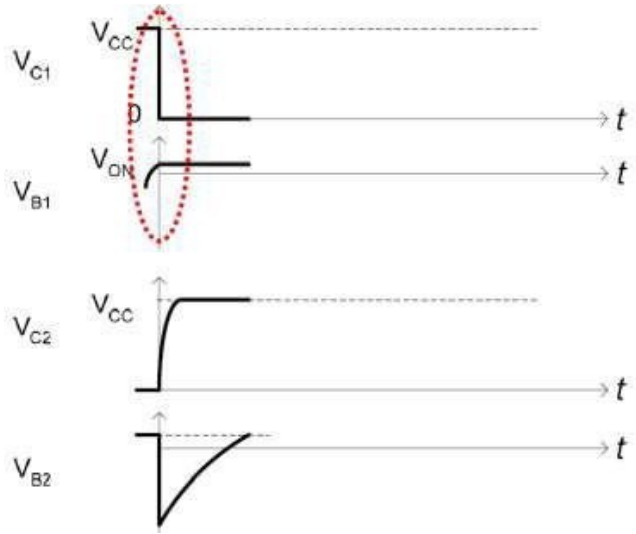


This astable circuit consists of two transistors, a cross coupled
Feedback network, and two capacitors and four resistors.

Astable Multivibrator

Consider Q1 is ON and Q2 is OFF:
V_{CC} drops across RL_1. Hence, $V_{C1} = 0$ and point A is at ground potential and $V_{c2}=V_{cc}$.
C_1 discharging and C_2 charging.



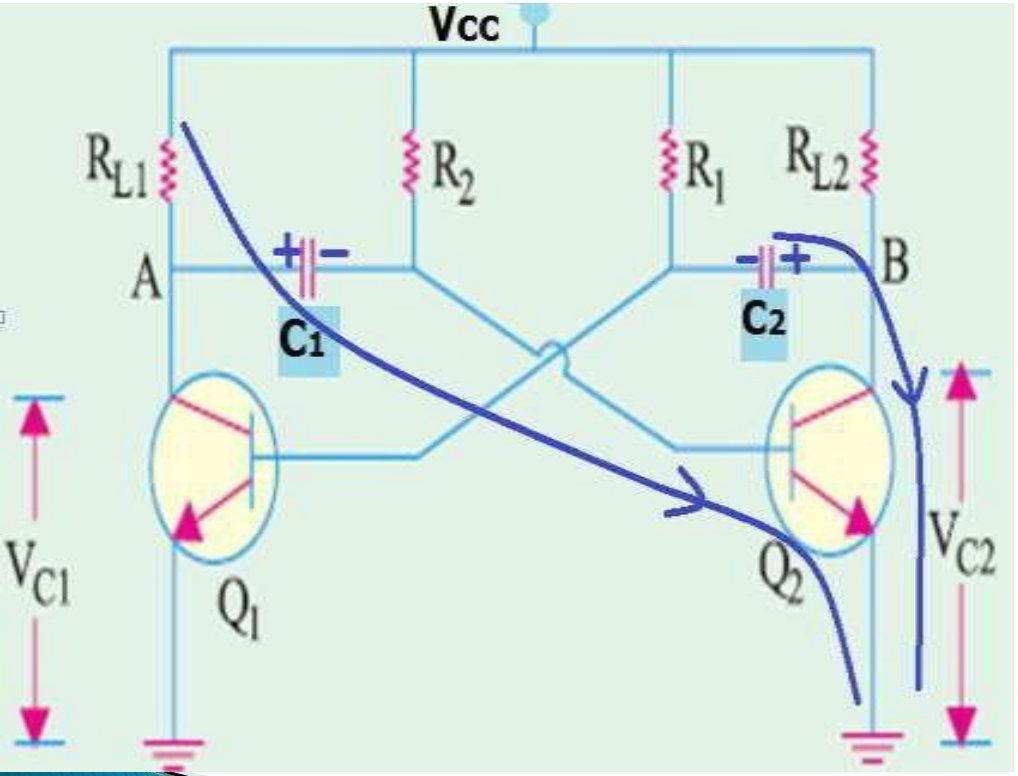


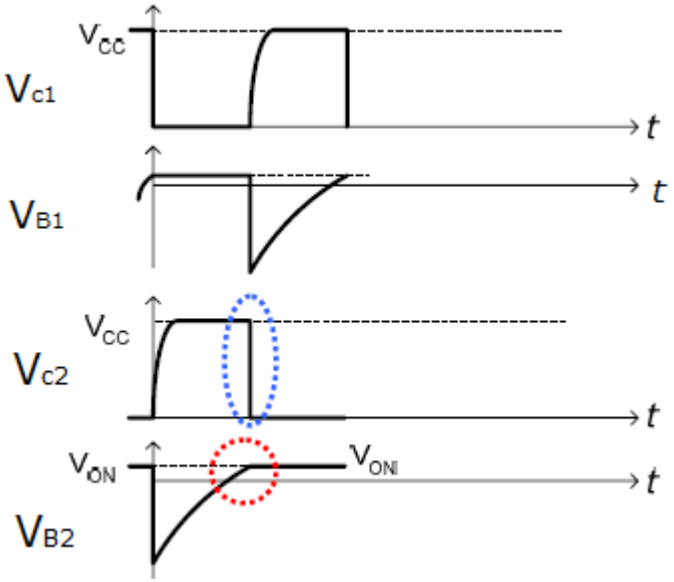
Astable Multivibrator

Consider Q2 is ON and Q1 is OFF:

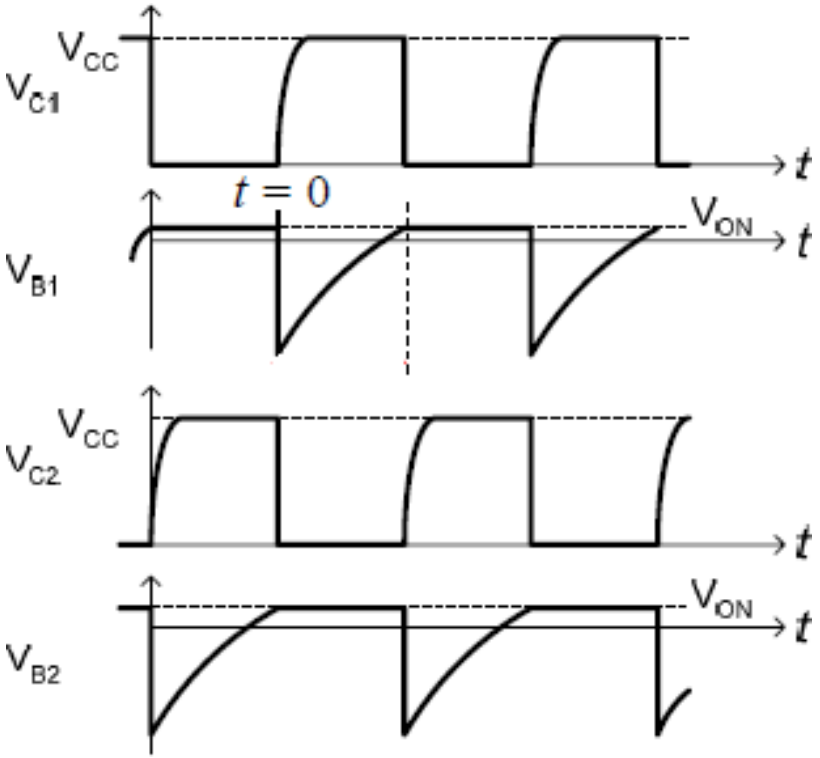
V_{CC} drops across R_{L2}. Hence, $V_{C2} = 0$ and point B is at ground potential and Vc_1=Vcc.

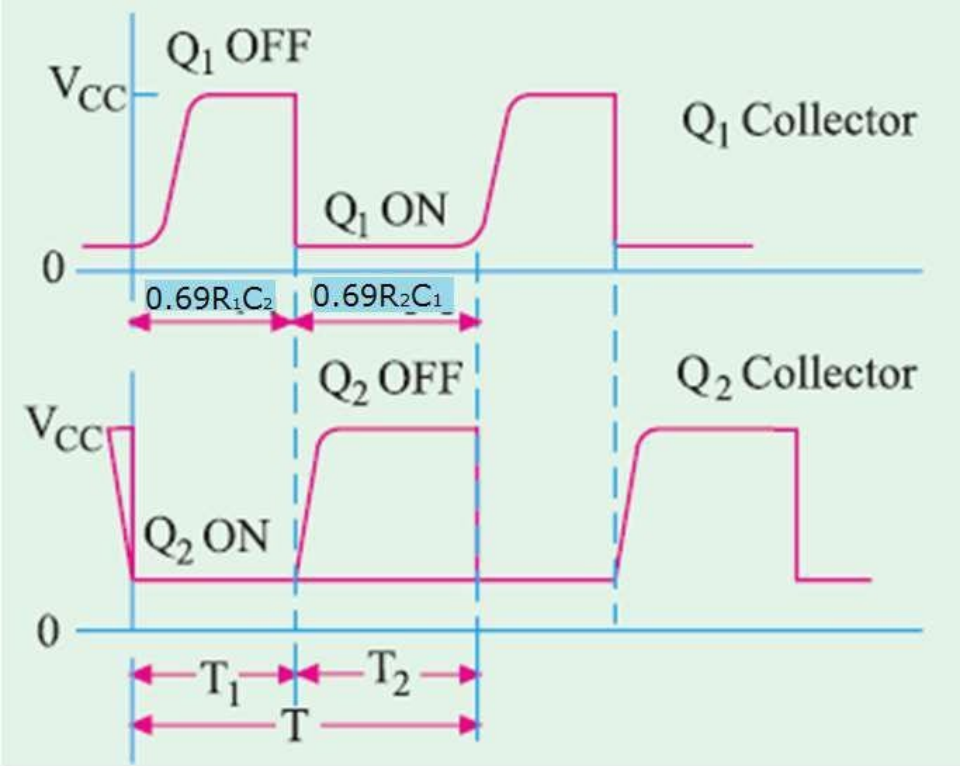
C_2 discharging and C_1 charging.





Astable Multivibrator





Frequency of Oscillation

- It can be proved that off-time for Q_1 *is* $T_1 = 0.69\ R_1C_2$ *and that for* Q_2 *is* $T_2 = 0.69\ R_2C_1$.
- Hence, total time-period of the wave is $T = T_1 + T_2 = 0.69\ (R_1C_2 + R_2C_1)$.
- If *R1 = R2 = R and C1 = C2 = C i.e. the two stages* are symmetrical, then $T = 1.38\ RC$.

It is given by the reciprocal of time period,

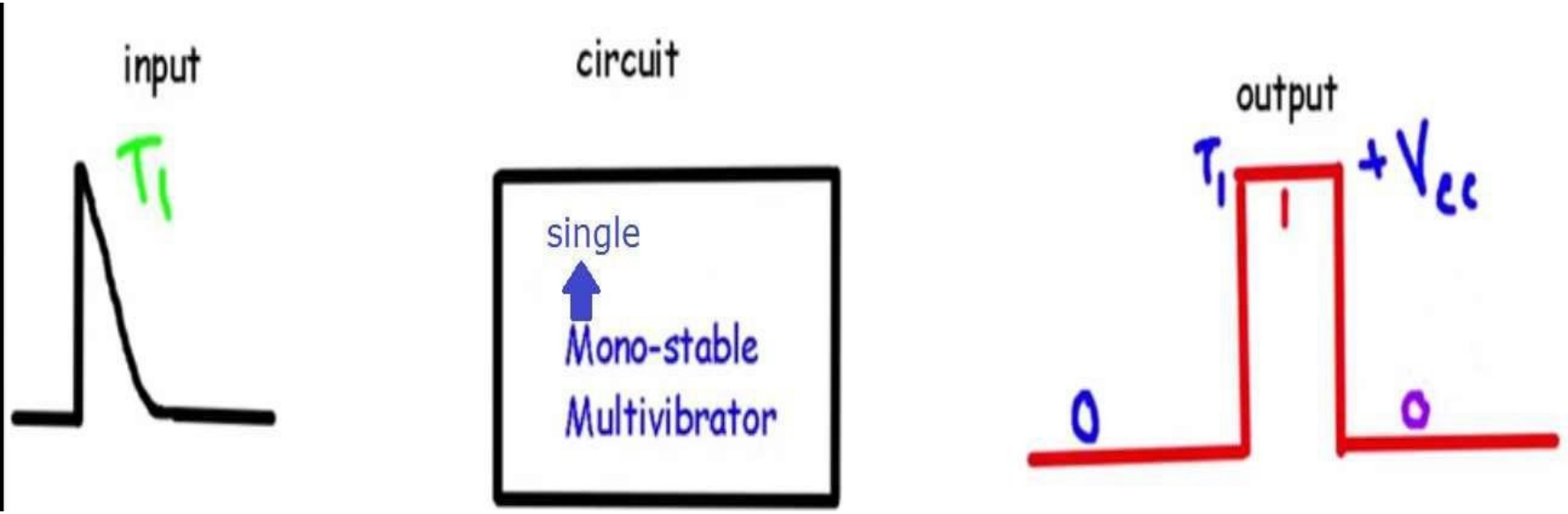
$$f = \frac{1}{T} = \frac{1}{1.38\,RC} = \frac{0.7}{RC}$$

Application

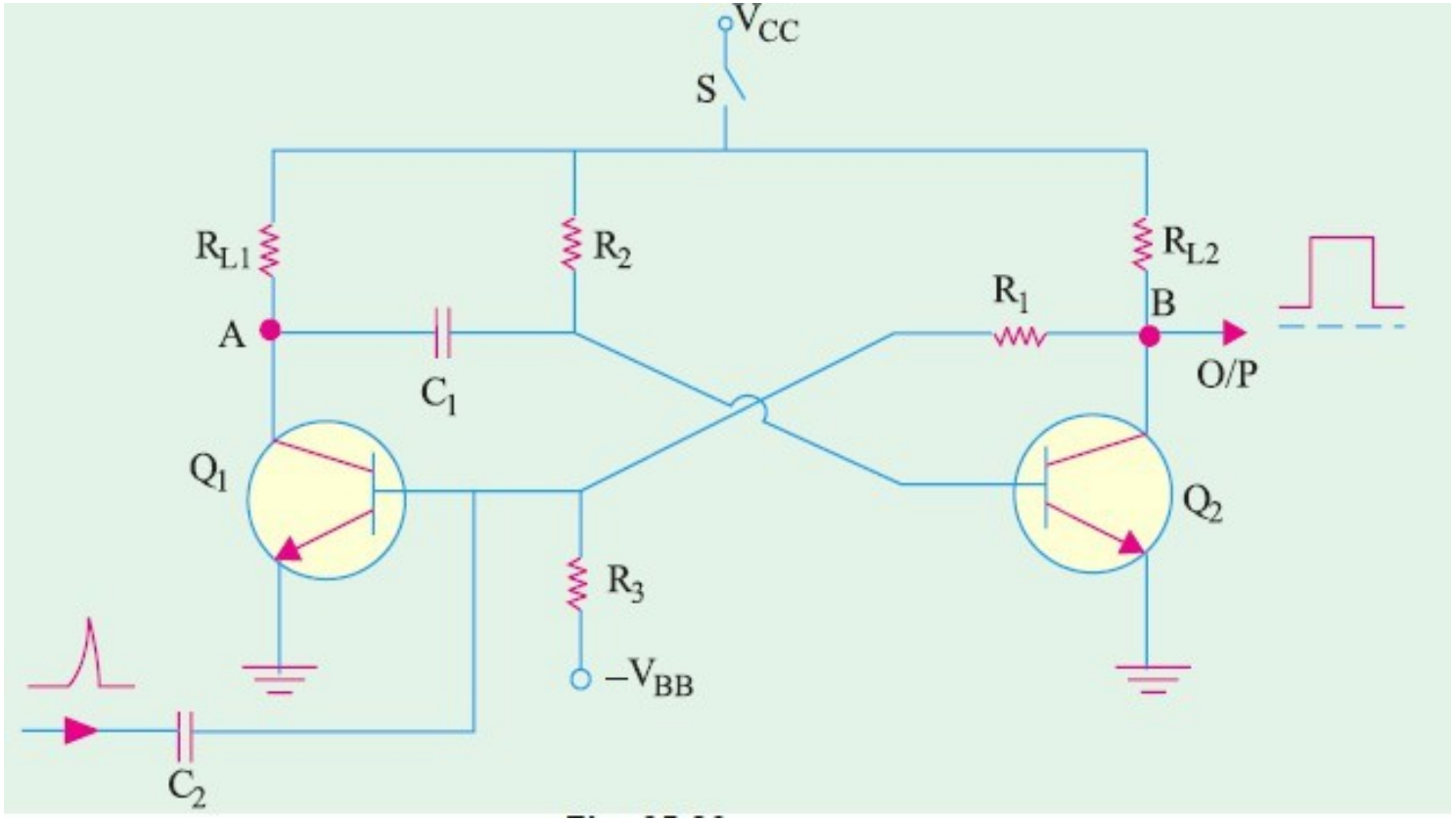
- Used in applications where low clock frequency clock pulse train is required.
- Relaxation oscillators, which are parts of vehicle indicator lights, early oscilloscopes and television receivers.
- Timing signals.

Monostable Multivibrator

- A Multivibrator which has one stable state and one temporary quasi-stable state and level transition depends on external triggering pulse is known as Monostable Multivibrator.

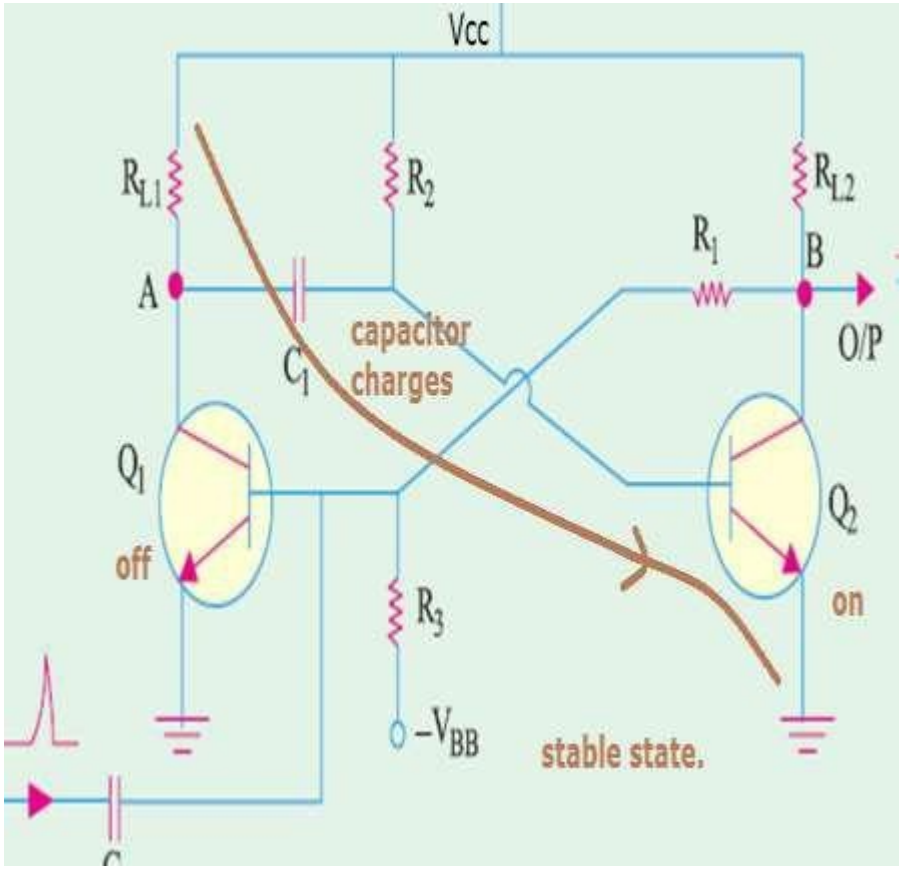


Circuit diagram of Monostable Multivibrator



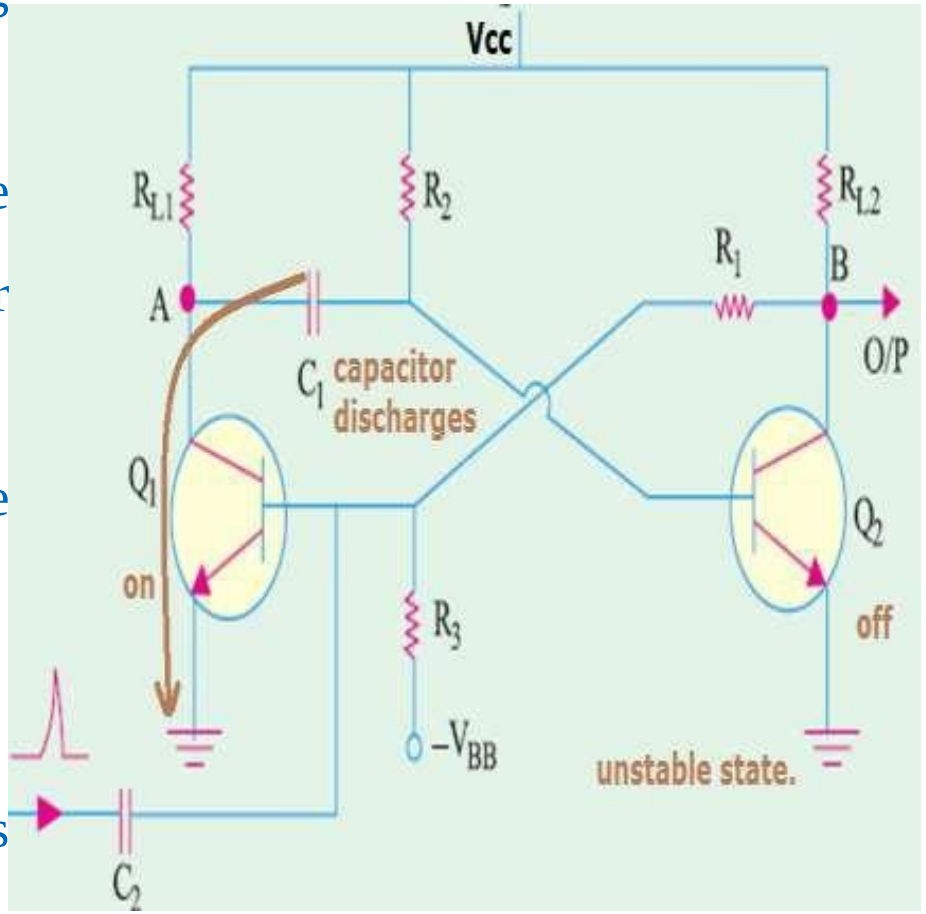
Monostable Multivibrator

- When the circuit is switched ON, transistor Q_1 will be OFF and Q_2 will be ON.
  - Capacitor C_1 gets charged during this state.
  - When a positive trigger is applied to the base of transistor Q_1 it turns ON, which turns OFF the transistor Q_2



Monostable Multivibrator

- Capacitor C_1 starts discharging during this state.
- Transistor Q_1 remains in ON state due the positive voltage from the collector of transistor Q_2 which is in OFF state.
- Transistor Q_2 remains in OFF state until the capacitor C_1 discharges completely.
- When the capacitor C_1 discharged completely, transistor Q_2 turns ON, which turns transistor Q_1 OFF.

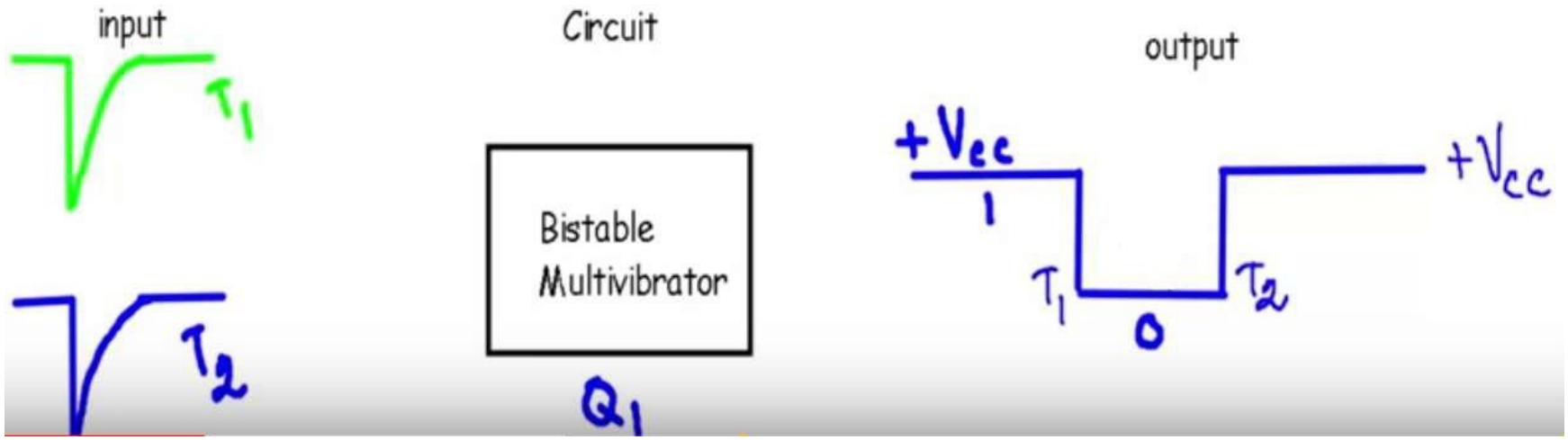


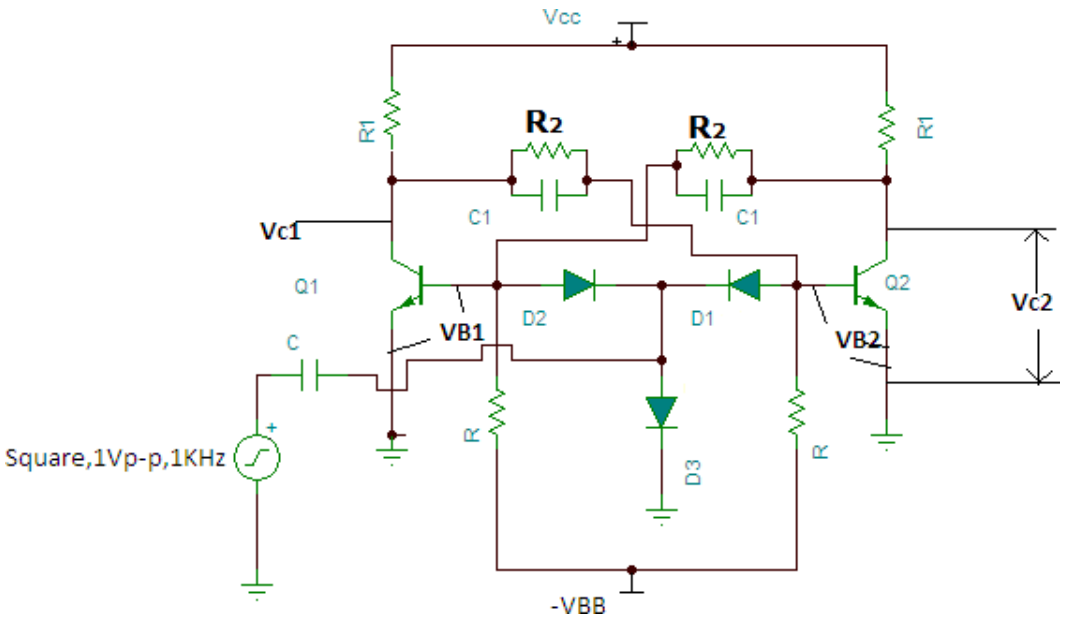
Applications

- Monostable Multivibrator are used in analog systems to control an output signal frequency.
- To synchronize the line and frame rate of television broadcasts.
- To hold output voltages in its unstable state for a certain period of time.
- To moderate the tunes of different octaves with electronic organs.

Bi-stable Multivibrator

A multivibrator that has two absolute stable state and can stay in one of two states indefinitely is known as Bi-stable multivibrator. It changes its state when it gets triggering pulse and stay in that state until it gets another triggering pulse. Acts as a flip flop or memory storage unit.





- When VCC is applied, one transistor will start conducting slightly more than that of the other. Let Q2 be ON and Q1 be OFF.
- When Q2 is ON, The potential at the collector of Q2 decreases, which in turn will decrease the potential at the base of Q1 due to potential divider action of R1 and R2. The potential at the collector of Q1 increases which in turn further increases the base to emitter voltage at the base of Q2. The voltage at the collector of Q2 further decreases, which in turn further reduces the voltage at the base of Q1. This action will continue till Q2 becomes fully saturated and Q1 becomes fully cutoff.
- Thus the stable state of binary is such that one device remains in cut-off and other device remains at saturation. It will be in that state until the triggering pulse is applied to it. It has two stable states. For every transition of states triggering is required. At a time only one device will be conducting.

Applications

- It is used for the performance of many digital operations such as counting and storing binary information.
- It is also used in the generation and processing of pulse-type waveforms.
- It is widely used in digital logic and computer memory

Thanks