Islamic University of Technology

EEE 4483
Digital Electronics & Pulse Techniques

Lecture-3

Oscillators

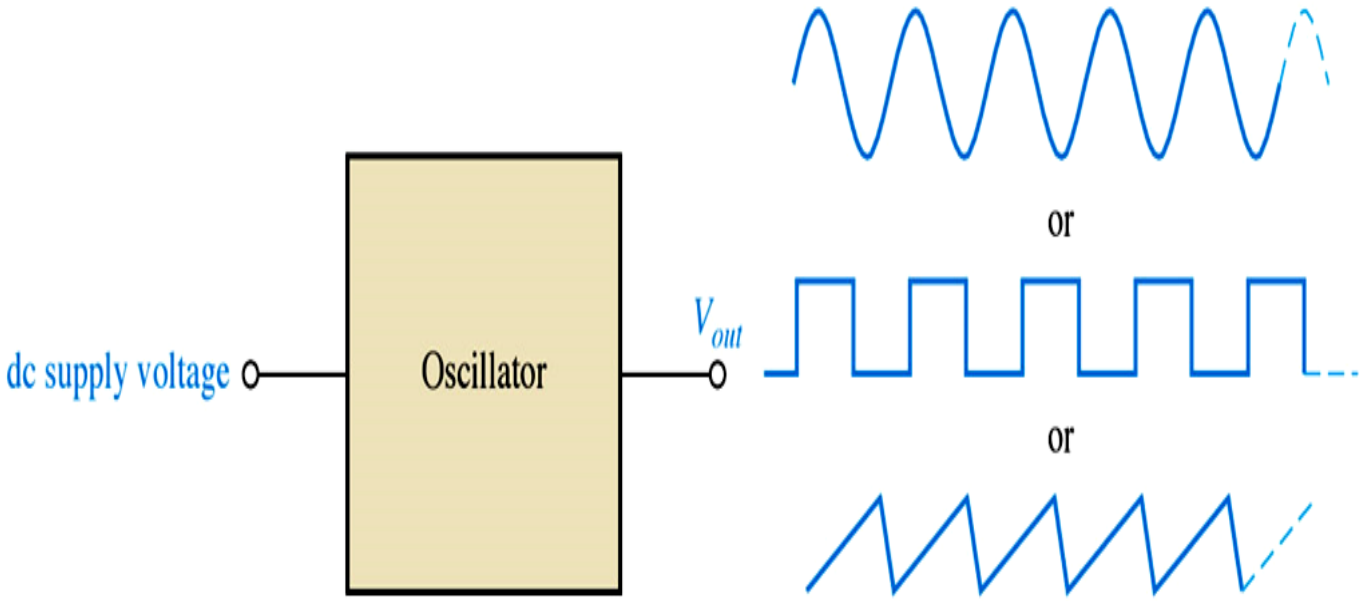
Oscillators are circuits that produce a continuous signal of some type without the need of an input.

These signals serve a variety of purposes such as communications systems, digital systems (including computers), and test equipment

Oscillators: continued..

- An oscillator is a circuit that produces a repetitive signal from a dc voltage.
- The **feedback oscillator** relies on a **positive feedback** of the output to maintain the oscillations.
- The **relaxation oscillator** makes use of an RC timing circuit to generate a non-sinusoidal signal such as square wave.

Oscillators: continued..



Types of Oscillator

1. RC Oscillator - Wien Bridge Oscillator
   - Phase-Shift Oscillator
2. LC Oscillator - Crystal Oscillator
3. Relaxation Oscillator

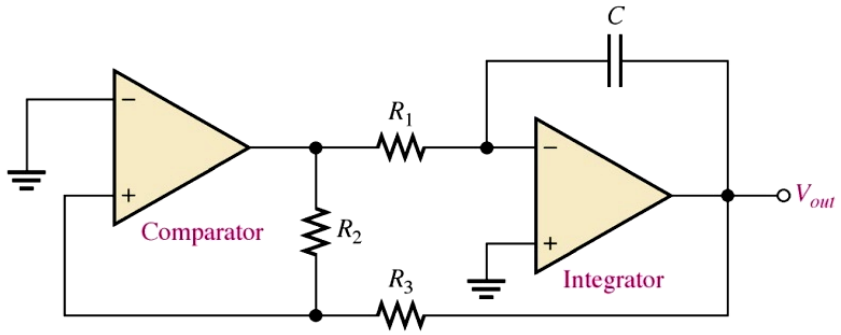
Relaxation Oscillator

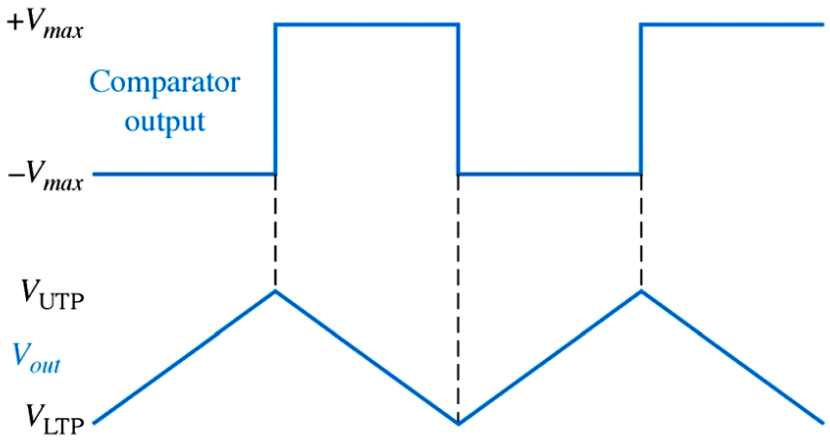
Relaxation oscillators make use of an RC timing and a device that changes states to generate a periodic waveform (non-sinusoidal) such as:

1. Triangular-wave
2. Square-wave
3. Sawtooth

Triangular-wave Oscillator

Triangular-wave oscillator circuit is a combination of a comparator and integrator circuit.





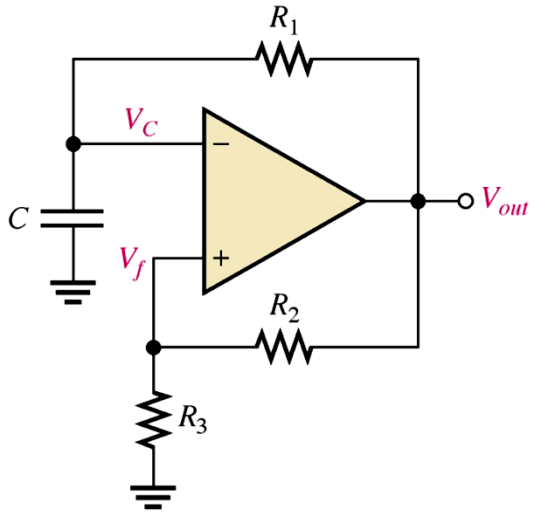
$$f_r = \frac{1}{4CR_1}\left(\frac{R_2}{R_3}\right)$$

$$V_{UTP} = +V_{\max}\left(\frac{R_3}{R_2}\right)$$

$$V_{LTP} = -V_{\max}\left(\frac{R_3}{R_2}\right)$$

Square-wave Oscillator

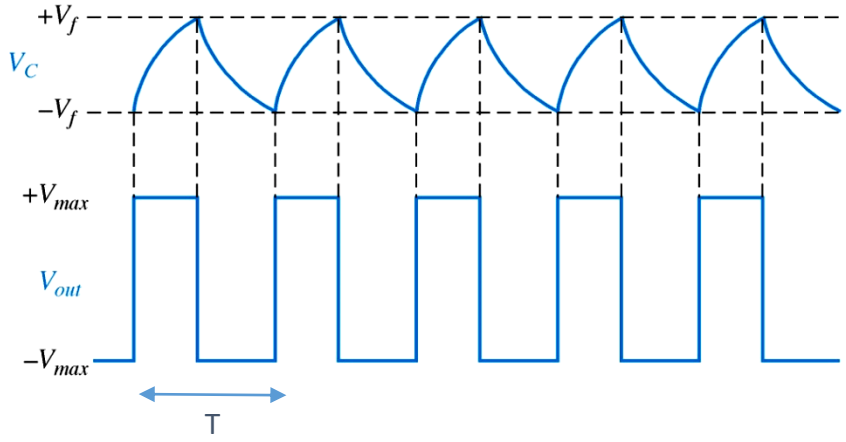
- A square wave relaxation oscillator is like the Schmitt trigger or Comparator circuit.
- The charging and discharging of the capacitor cause the op-amp to switch states rapidly and produce a square wave.
- The RC time constant determines the frequency.



$$\lambda = \frac{R3}{R2 + R3}$$

Voltage Divider

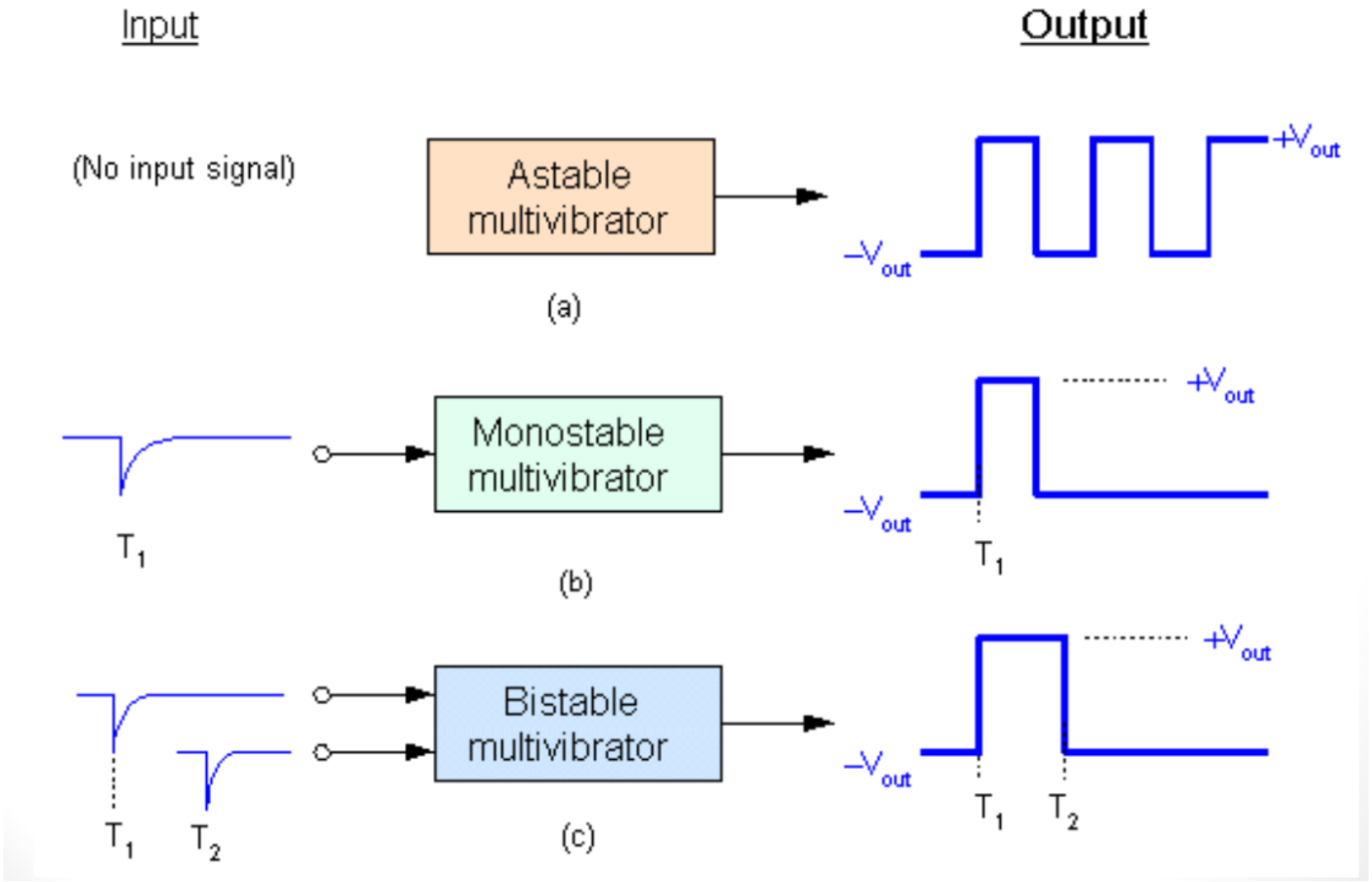
$$T = 2R_f\, C \times \ln\left[\frac{1+\lambda}{1-\lambda}\right]$$



What are Multivibrator circuits?

Multi-vibrator circuits refer to the special type of electronic circuits used for generating pulse signals. These pulse signals can be rectangular or square wave signals. They generally produce output in two states: high or low. A specific characteristic of multi-vibrators is the use of passive elements like resistor and capacitor to determine the output state.

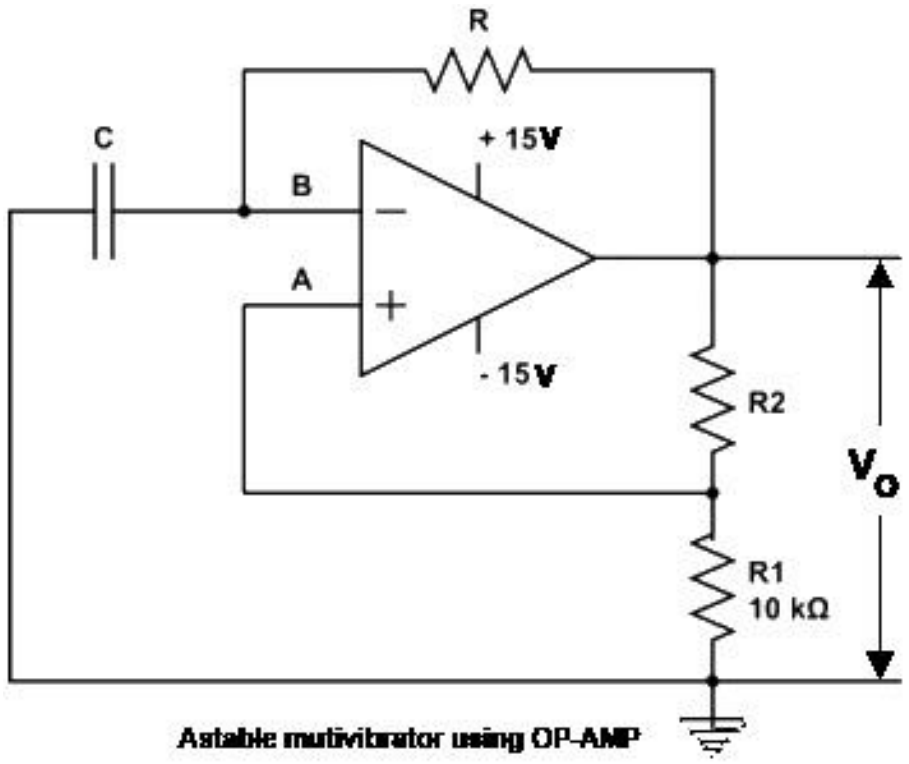
Types of Multivibrators



Astable Multivibrator

- ✓An astable circuit is one that has two states and it is not stable in either cases.
- ✓It continually switches from one state to the other. Suitably tailored in a circuit it can function as an oscillator, regularly switching from one state to another.
- ✓Within the circuit it is normal to use an RC element to determine the frequency of the Astable multivibrator oscillator.
- ✓LC elements can also be used but they are less convenient and more costly in view of the coil, especially as astable oscillators tend to be used for relatively low frequencies and the coils tend to be large for these frequencies

Astable Multivibrator using OpAmp

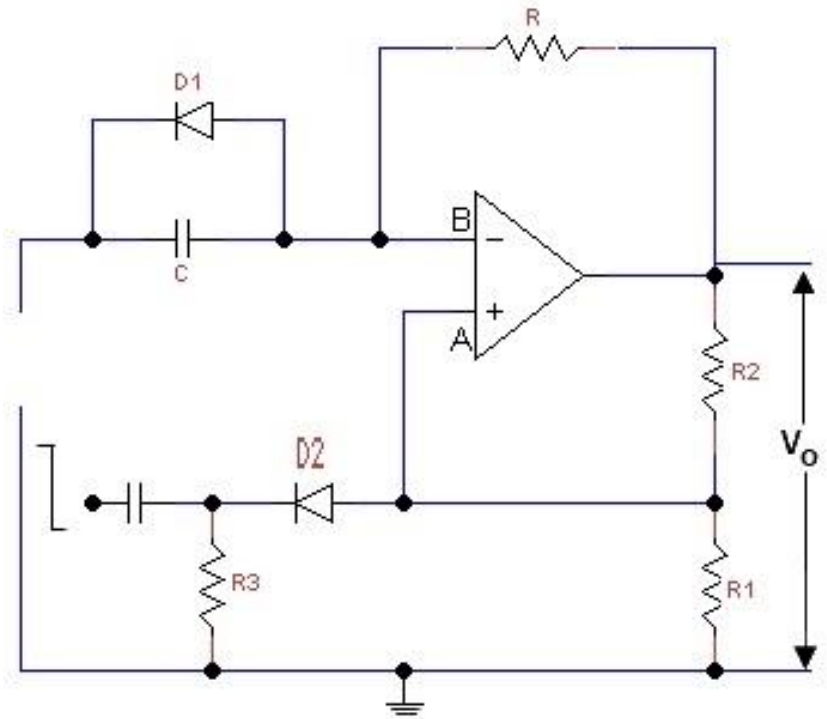


Source: https://sites.google.com/site/simplestudyiti/instrument-mechanic/theory/multivibrator

Monostable Multivibrator

- ✓ The **monostable multivibrator** is also called as **the one-shot multivibrator**.
- ✓ The circuit produces a single pulse of specified duration in response to each **external trigger** signal.
- ✓ For such a circuit, only one **stable state** exists.
- ✓ When an external trigger is applied, the output changes its state. The new state is called as **a quasi-stable state**.
- ✓ The circuit remains in this state for a fixed interval of time. After some time it returns back to its original stable state.

Monostable Multivibrator using OpAmp

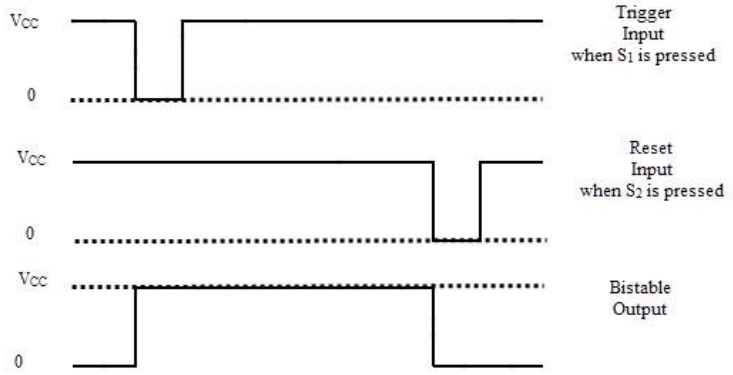


Monostable Multivibrator Using OP-AMP

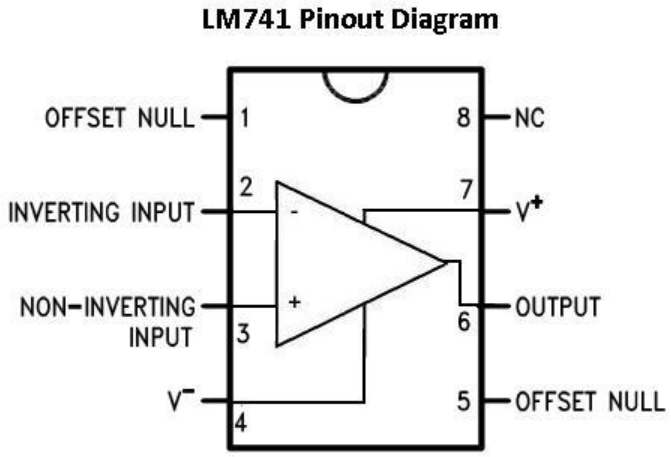
Source: https://sites.google.com/site/simplestudyiti/instrument-mechanic/theory/multivibrator

Bistable Multivibrator

- ✓ Bistable Multivibrators have TWO stable states (hence the name: "Bi" meaning two) and maintain a given output state indefinitely unless an external trigger is applied forcing it to change state.
- ✓ The Bistable multivibrator can be switched over from one stable state to the other by the application of an external trigger pulse thus, it requires two external trigger pulses before it returns back to its original state.
- ✓ As Bistable multivibrators have two stable states they are more commonly known as Latches and Flip-flops for use in sequential type circuits



Pin Diagram of OpAmp IC LM741



Pin 1: Offset Null - This is the pin where we add voltage to if we want to eliminate the offset voltage. This is if we want to completely balance the input voltages. More on this at offset terminals

Pin 2: Inverting Input - This is where the positive part of the input signal that we want to amplify goes if we want our amplified signal inverted. If we don't want it inverted, we place the positive part of the signal into the Non-inverting terminal and place the negative or ground part of our signal here.

Pin 3: Non-inverting Input - This is where the positive part of the input signal that we want amplified goes if we want our signal non-inverted.

Pin 4: V- - The LM741 Op amp is a dual power supply op amp, meaning it must be supplied positive DC voltage and negative DC voltage. Pin 4 is where the op amp gets supplied with negative DC voltage.

Pin 5: Offset Null - This is the pin where we add voltage to if we want to eliminate the offset voltage. This is if we want to completely balance the input voltages. More on this at offset terminals

Pin 6: Output - This is the terminal where the output, the amplified signal, comes out of. Whatever output the amplifier will drive gets connected to this terminal.

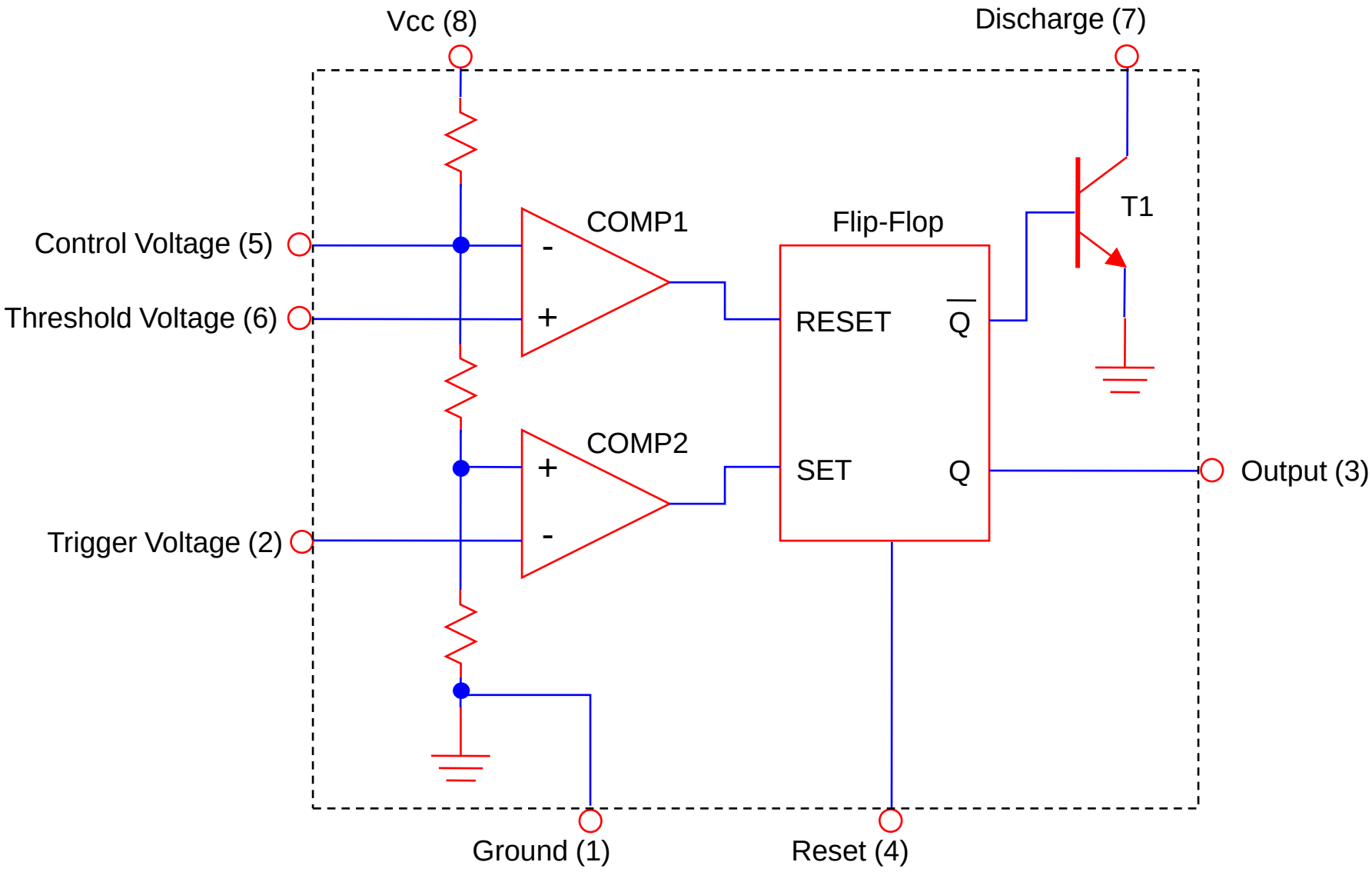
Pin 7: V+ - This is the terminal which receives the positive DC voltage.

Pin 8: NC - This pin stands for Not Connected. It is not used for anything and should be left open.

What is a 555 Timer?

- The 555 timer is an 8-pin IC that is capable of producing accurate time delays and/or oscillators.
- In the time delay mode, the delay is controlled by one external resistor and capacitor.
- In the oscillator mode, the frequency of oscillation and duty cycle are both controlled with two external resistors and one capacitor.

Block Diagram for a 555 Timer



555 Timer : Continued ..