Topics:

- Modes of 555 Timer IC
- Waveform Generation using Astable Multivibrator

Content

- Multivibrator (555 Timer)
- Modes of Multivibrator (555 Timer)
  - Waveform Representation of Astable Multivibrator (555 Timer)
  - Waveform Representation of Monostable Multivibrator (555 Timer)
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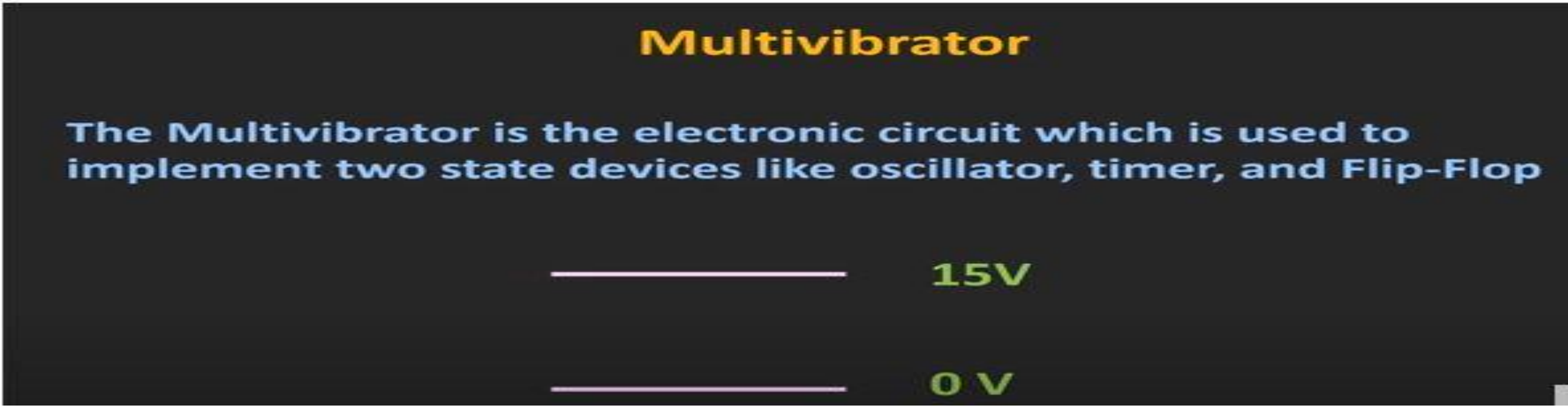
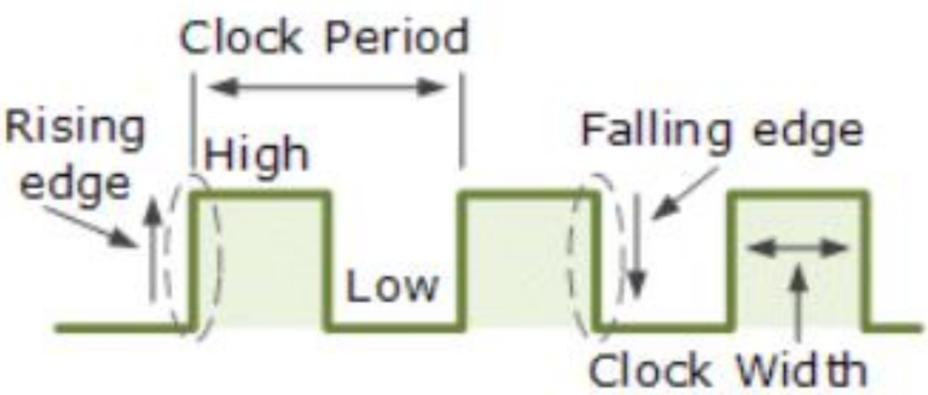
Multivibrator (555 Timer)



✔ **A multivibrator circuit oscillates between a "HIGH" state and a "LOW" state producing a continuous output**



Multivibrator (555 Timer)

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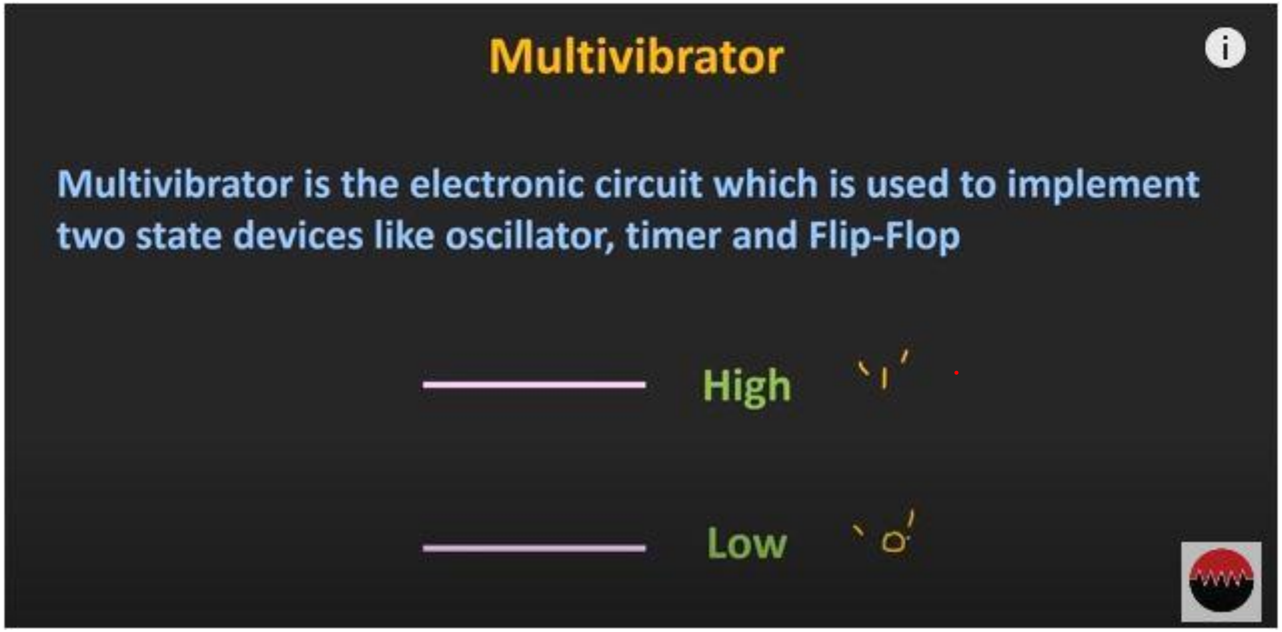

- ✔ Multivibrators produce an output wave shape resembling that of a symmetrical or asymmetrical square wave
- ✔ Multivibrators have two different electrical states, an output "HIGH" state and an output "LOW" state giving them either a stable or quasi-stable state depending upon the type of multivibrator

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Modes of Multivibrator (555 Timer)

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- Astable Multivibrator
- **Monostable Multivibrator**
- Bistable Multivibrator

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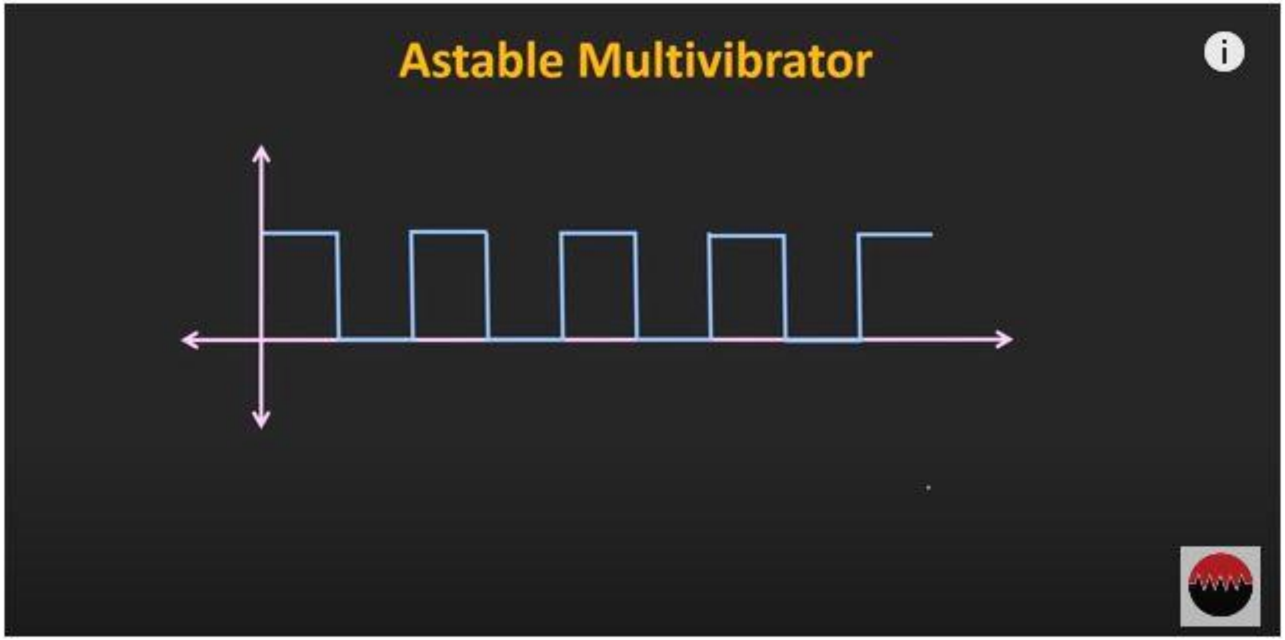
Waveform Representation of Astable Multivibrator (555 Timer)

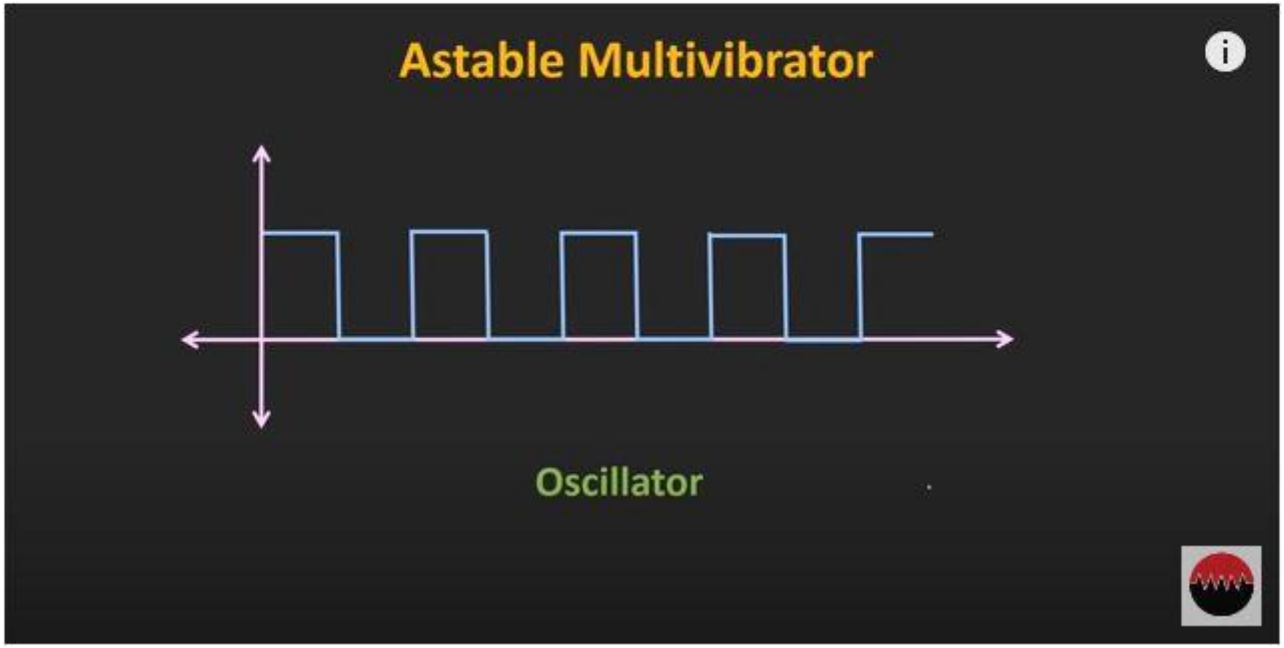


✔ Astable: A free-running multivibrator that has **<u>NO</u>** <u>stable states</u> but switches continuously between two states this action produces a train of square wave pulses at a fixed known frequency

Astable Multivibrator (555 Timer)

- ✓ These circuits are not stable in any state and switch outputs after predetermined time periods
- ✓ The result of this is that the output is a continuous square/rectangular wave with the properties depending on values of external resistors and capacitors
- ✓ Thus, while designing these circuits following parameters need to be determined:
  1. Frequency (or the time period) of the wave
  2. The duty cycle of the wave

Waveform Representation of Astable Multivibrator (555 Timer)



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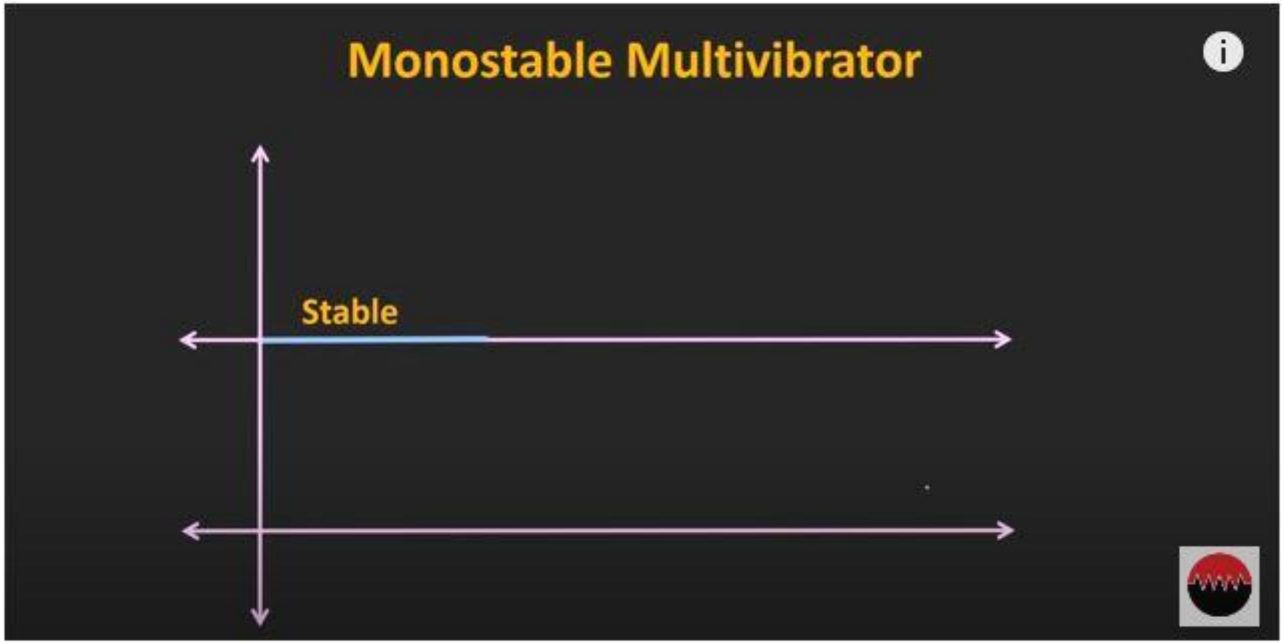
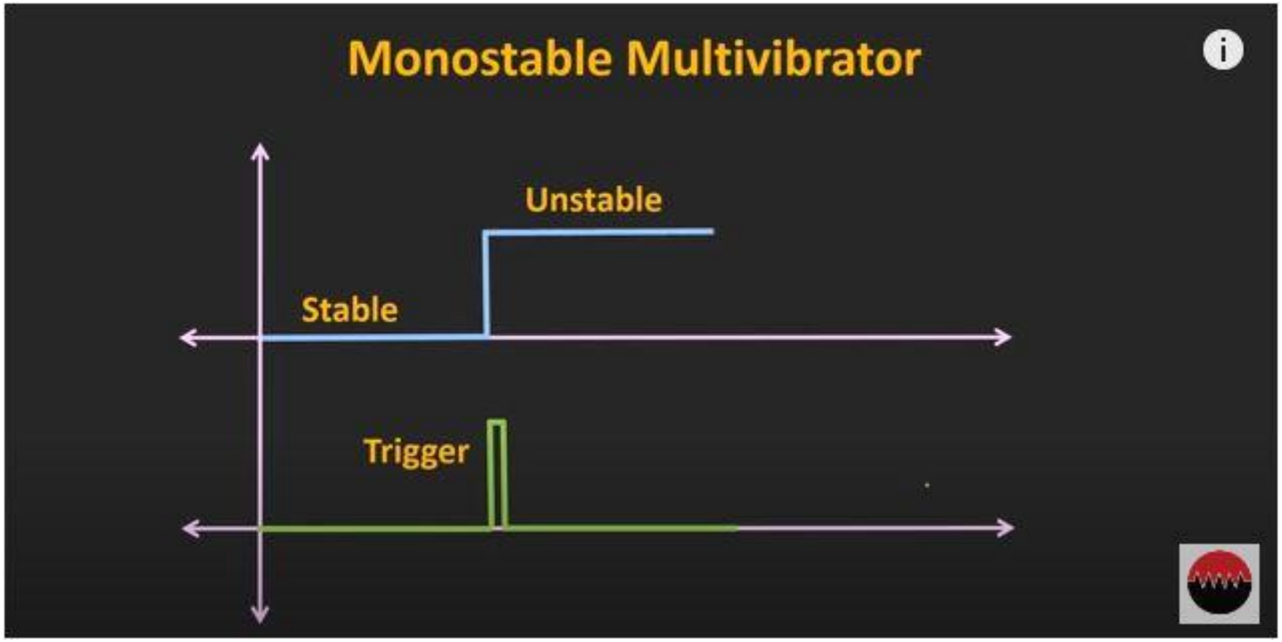
Waveform Representation of Monostable Multivibrator (555 Timer)



✔ **Monostable Multivibrators** have only **ONE** stable state (hence their name: "Mono"), and produce a single output pulse when it is triggered externally

Waveform Representation of Monostable Multivibrator (555 Timer)



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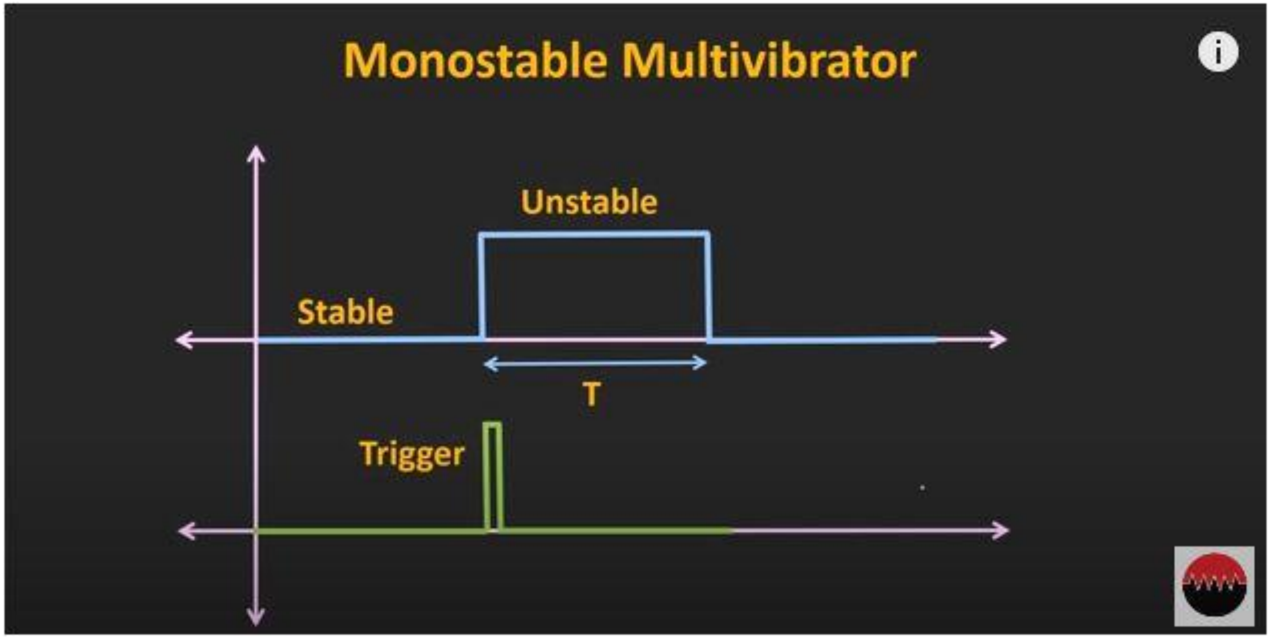
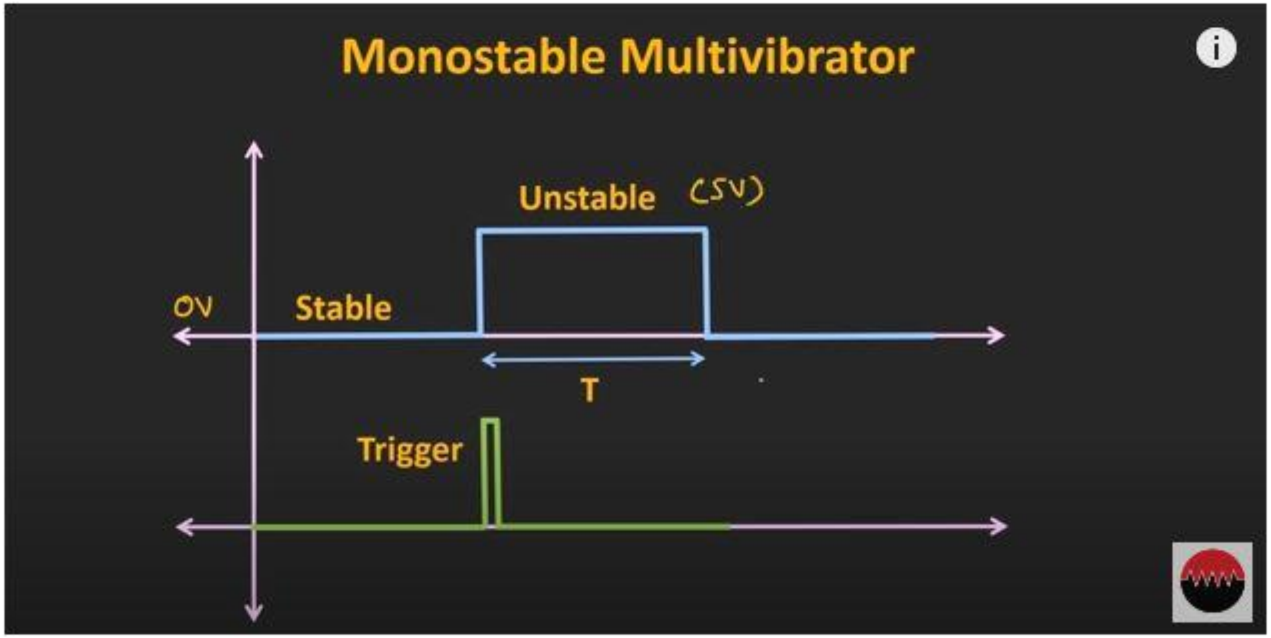


Waveform Representation of Monostable Multivibrator (555 Timer)



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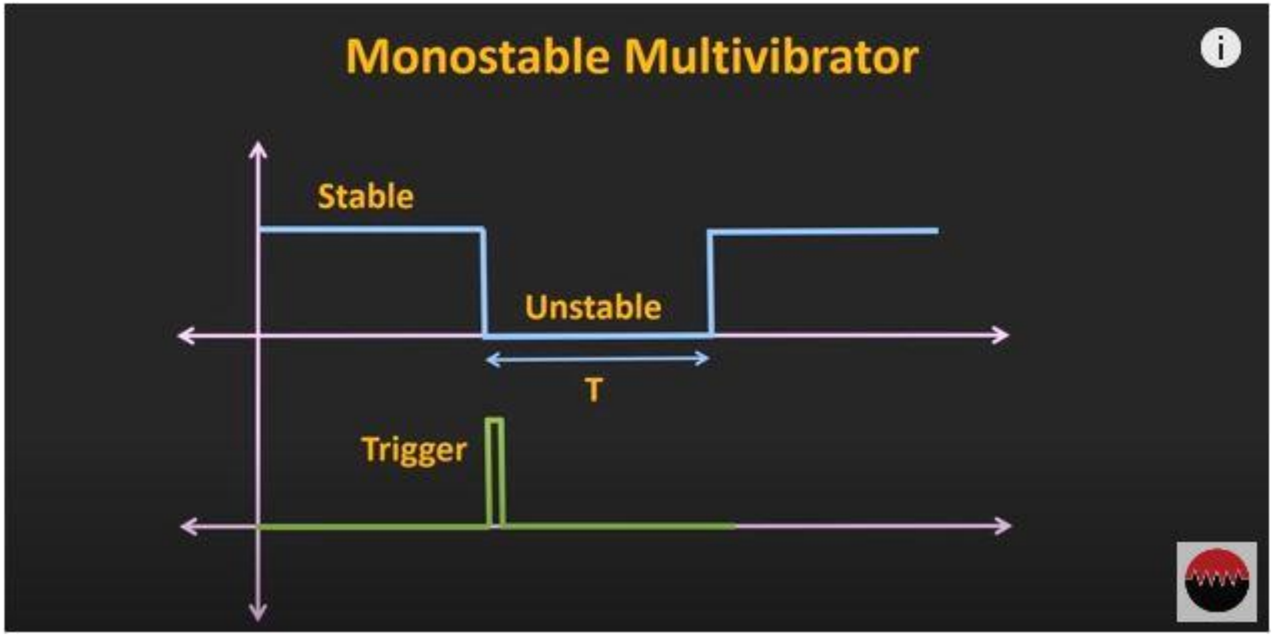

Waveform Representation of Monostable Multivibrator (555 Timer)

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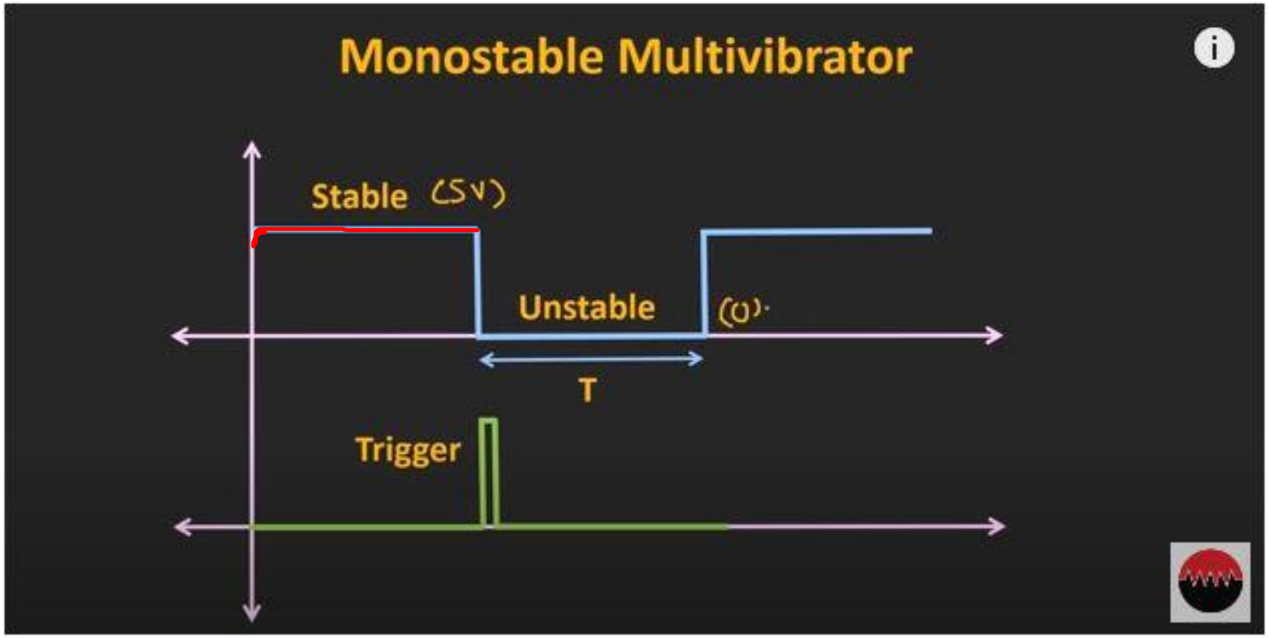

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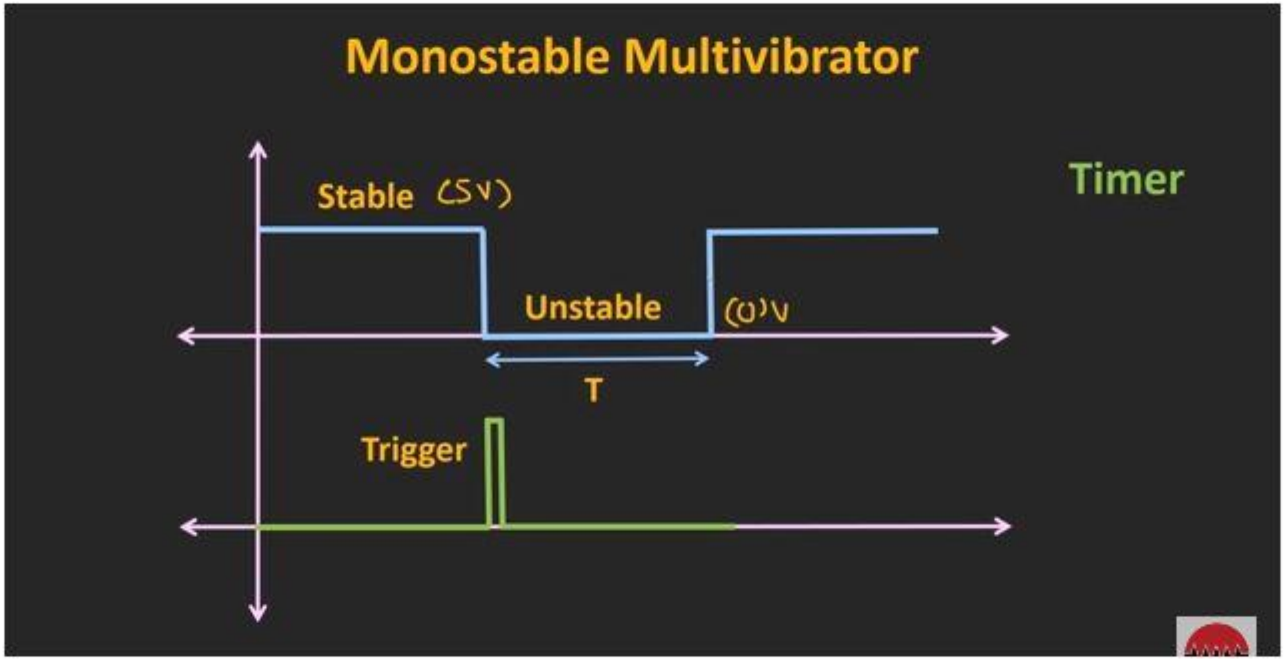

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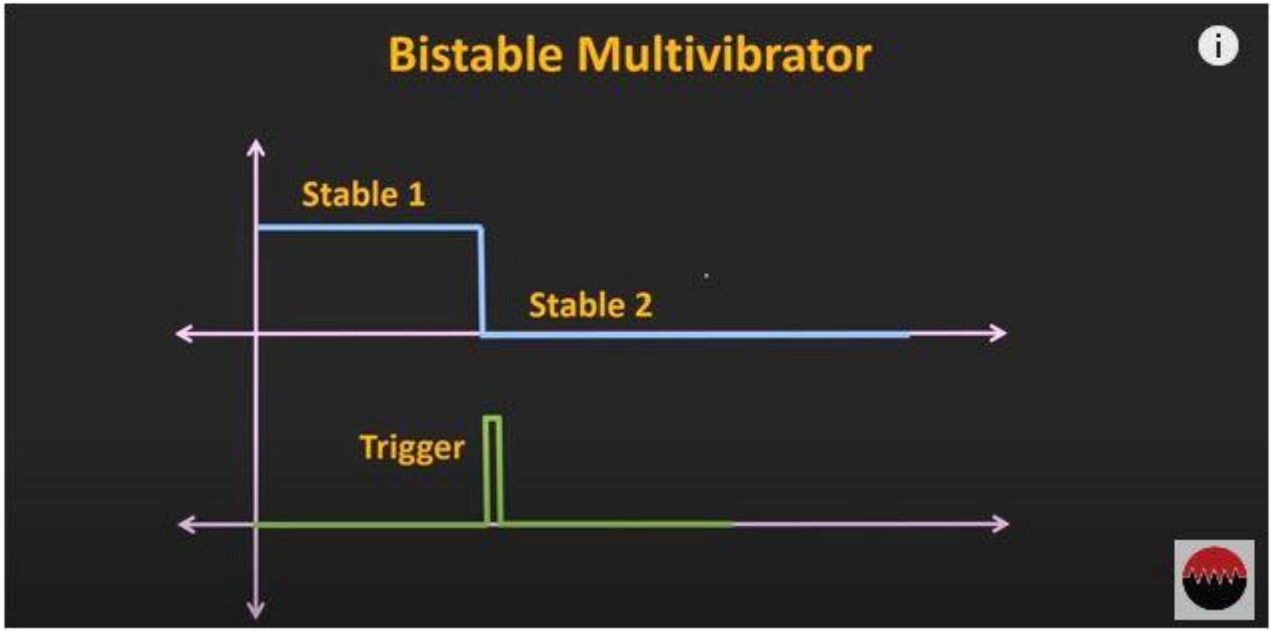
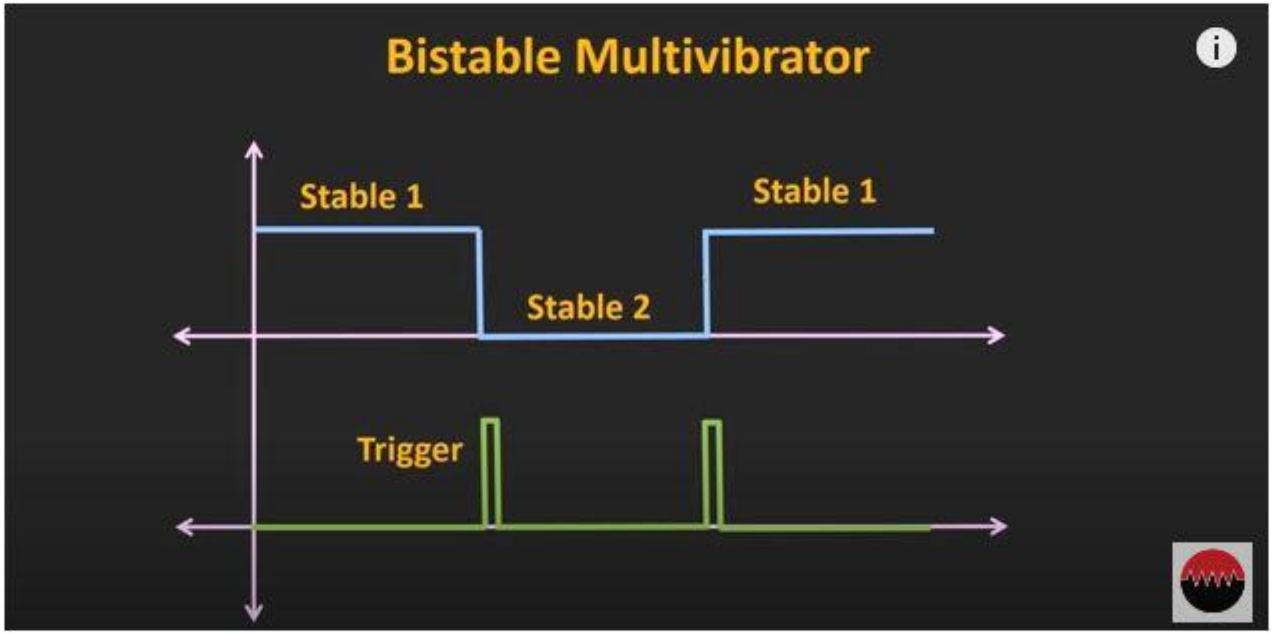
Waveform Representation of Bistable Multivibrator (555 Timer)

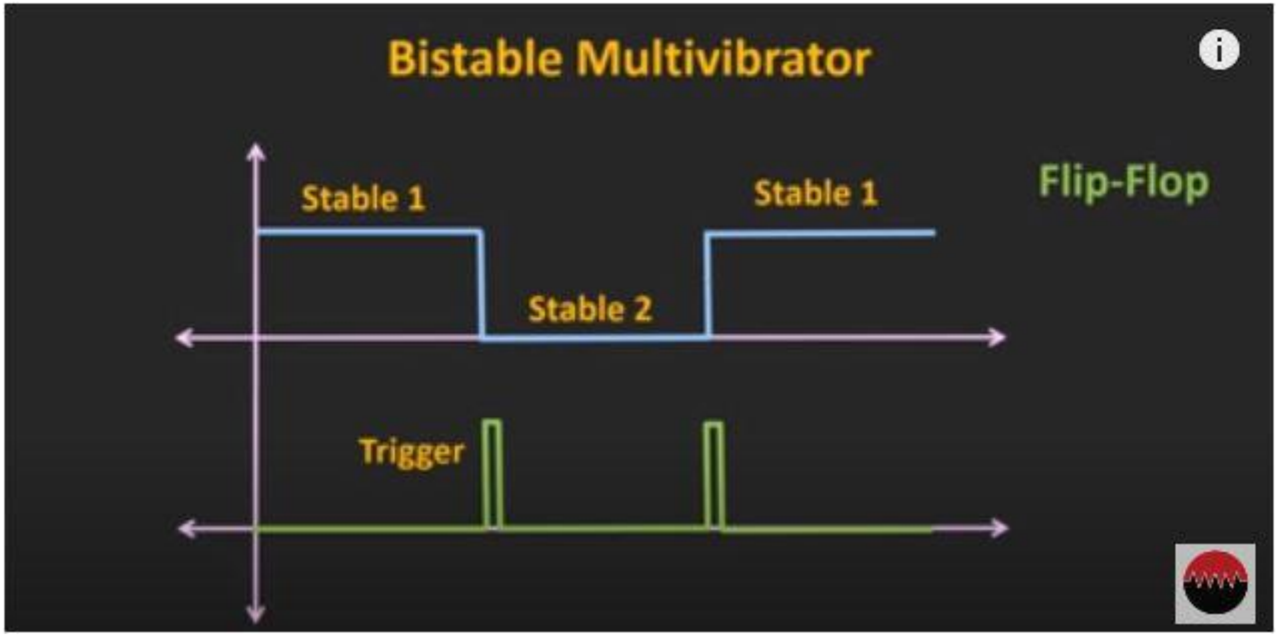


- ✓ The **Bistable Multivibrator** is another type of two state device similar to the Monostable Multivibrator
- ✓ BOTH states are stable

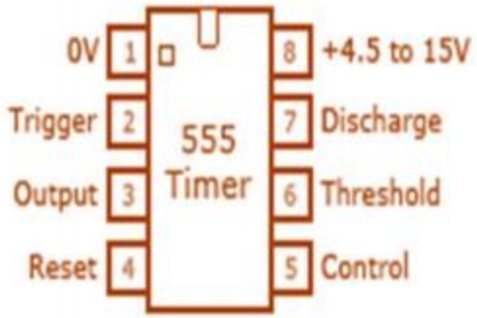
Waveform Representation of Bistable Multivibrator (555 Timer)

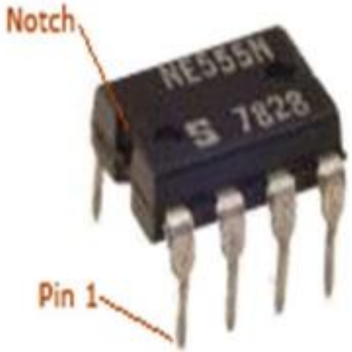


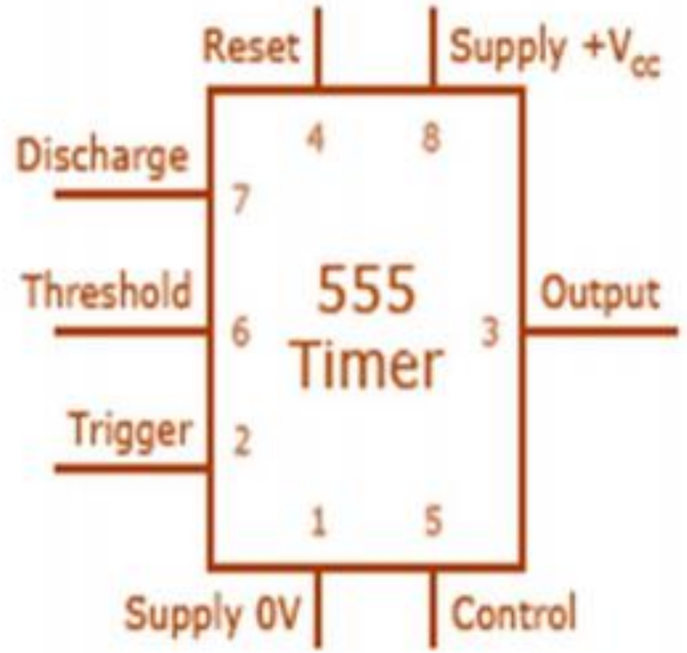
Waveform Representation of Bistable Multivibrator (555 Timer)



Pin Diagram of 555 Timer



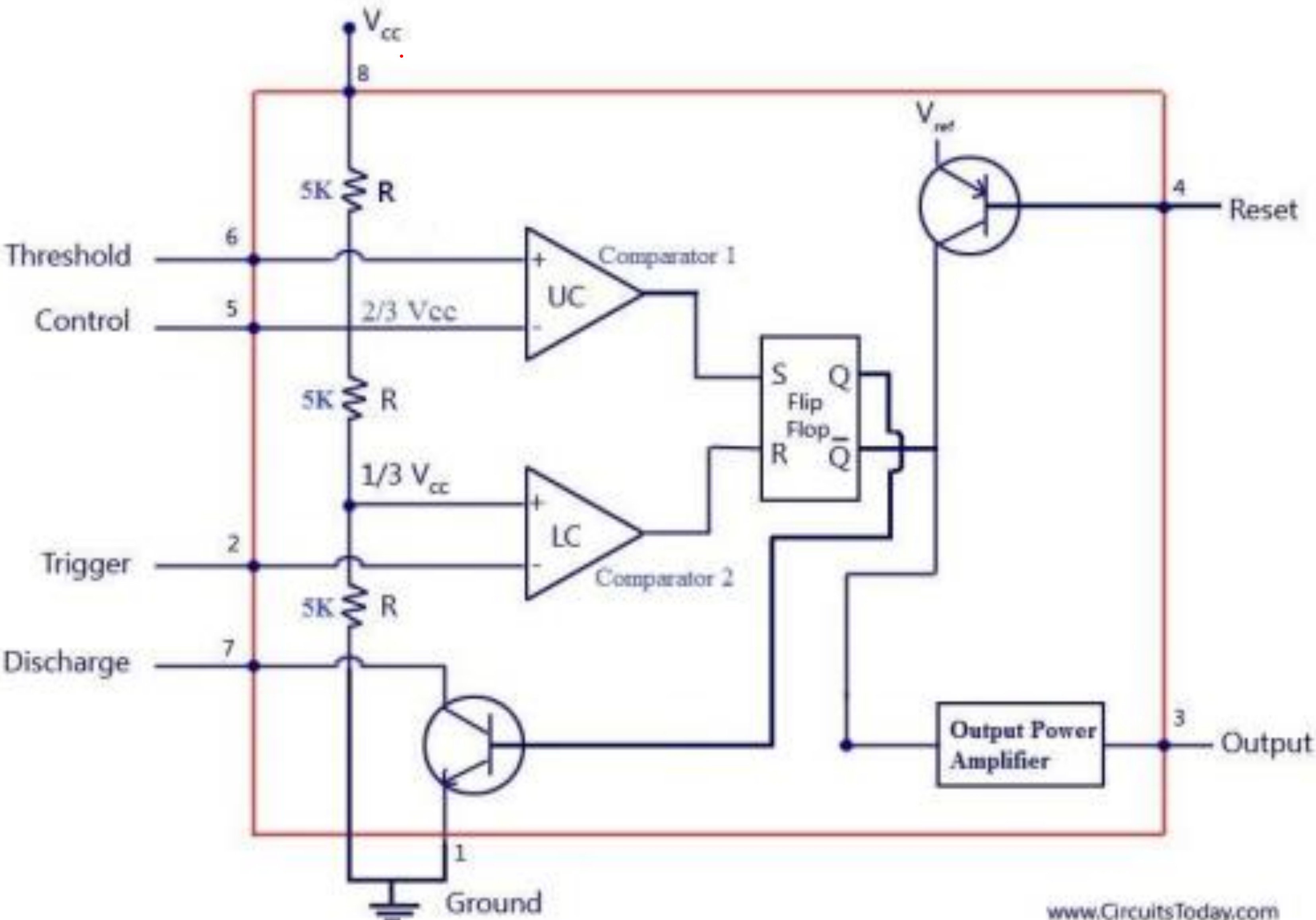




Pin Configuration

- Pin 1. – **Ground**, The ground pin connects the 555 timer to the negative (0v) supply rail.
- Pin 2. – **Trigger**, The negative input to comparator No 1. A negative pulse on this pin "sets" the internal Flip-flop when the voltage drops below 1/3Vcc causing the output to switch from a "LOW" to a "HIGH" state.
- Pin 3. – **Output**, The output pin can drive any TTL circuit and is capable of sourcing or sinking up to 200mA of current at an output voltage equal to approximately Vcc – 1.5V so small speakers, LEDs or motors can be connected directly to the output.
- Pin 4. – **Reset**, This pin is used to "reset" the internal Flip-flop controlling the state of the output, pin 3. This is an active-low input and is generally connected to a logic "1" level when not used to prevent any unwanted resetting of the output.
- Pin 5. – **Control Voltage**, This pin controls the timing of the 555 by overriding the 2/3Vcc level of the voltage divider network. By applying a voltage to this pin the width of the output signal can be varied independently of the RC timing network. When not used it is connected to ground via a 10nF capacitor to eliminate any noise.
- Pin 6. – **Threshold**, The positive input to comparator No 2. This pin is used to reset the Flip-flop when the voltage applied to it exceeds 2/3Vcc causing the output to switch from "HIGH" to "LOW" state. This pin connects directly to the RC timing circuit.
- Pin 7. – **Discharge**, The discharge pin is connected directly to the Collector of an internal NPN transistor which is used to "discharge" the timing capacitor to ground when the output at pin 3 switches "LOW".
- Pin 8. – **Supply +Vcc**, This is the power supply pin and for general purpose TTL 555 timers is between 4.5V and 15V.

555 Timer IC



Vcc
8
5K
R
Threshold
6
Control
5
2/3 Vcc
Comparator 1
UC
S
Q
Flip
Flop
R
Q̄
1/3 Vcc
LC
Comparator 2
Trigger
2
Discharge
7
Vref
4
Reset
Output Power Amplifier
3
Output
1
Ground
www.CircuitsToday.com

555 Timer IC (Cont…)

- ✓ A 555 timer has two comparators (which are basically Two op-amps), an R-S flip-flop, two transistors and a resistive network
- ✓ The Resistive network consists of three equal resistors (5K Ohms each R) and acts as a voltage divider
- ✓ The resistor network is designed in such a way that the voltage at the Inverting terminal of Comparator 1 (Upper comparator) will be 2/3Vcc and the voltage at the Non Inverting terminal of Comparator 2 (Lower comparator) will be 1/3Vcc
- ✓ Comparator 1 – compares the threshold voltage (at pin 6) with the reference voltage + 2/3 V_{CC} volts
- ✓ Comparator 2 – compares the trigger voltage (at pin 2) with the reference voltage + 1/3 V_{CC} volts. In most applications, the control input is not used, so that the control voltage equals +(2/3) V_{CC}

555 Timer IC (Cont…)

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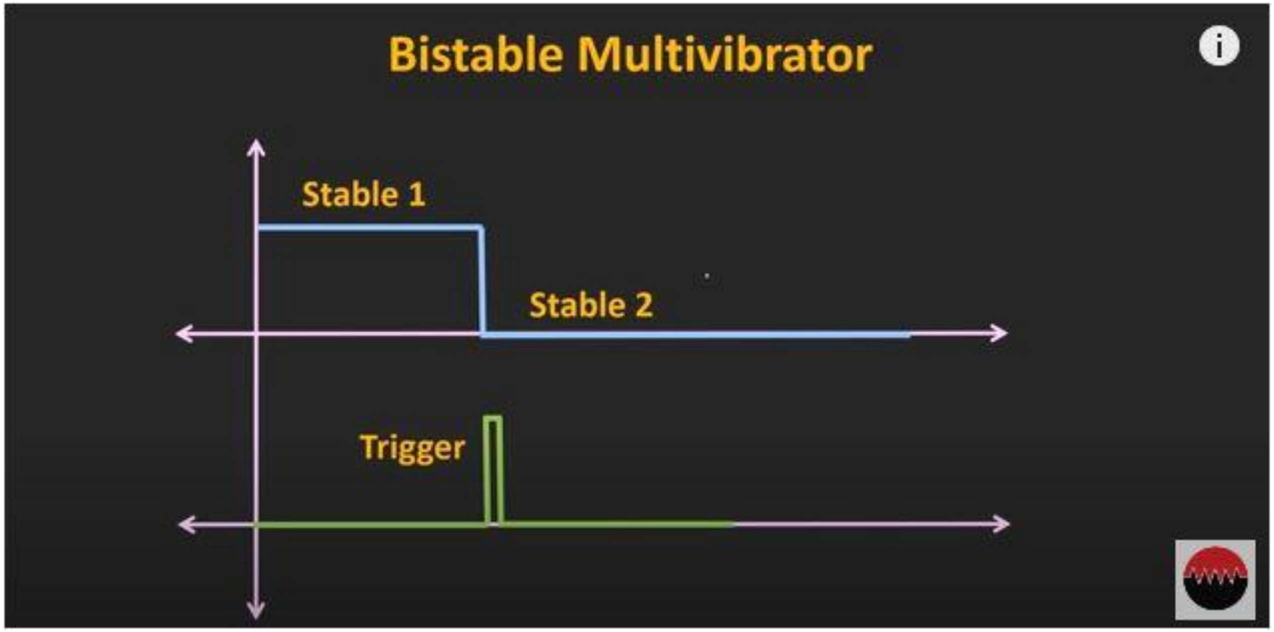
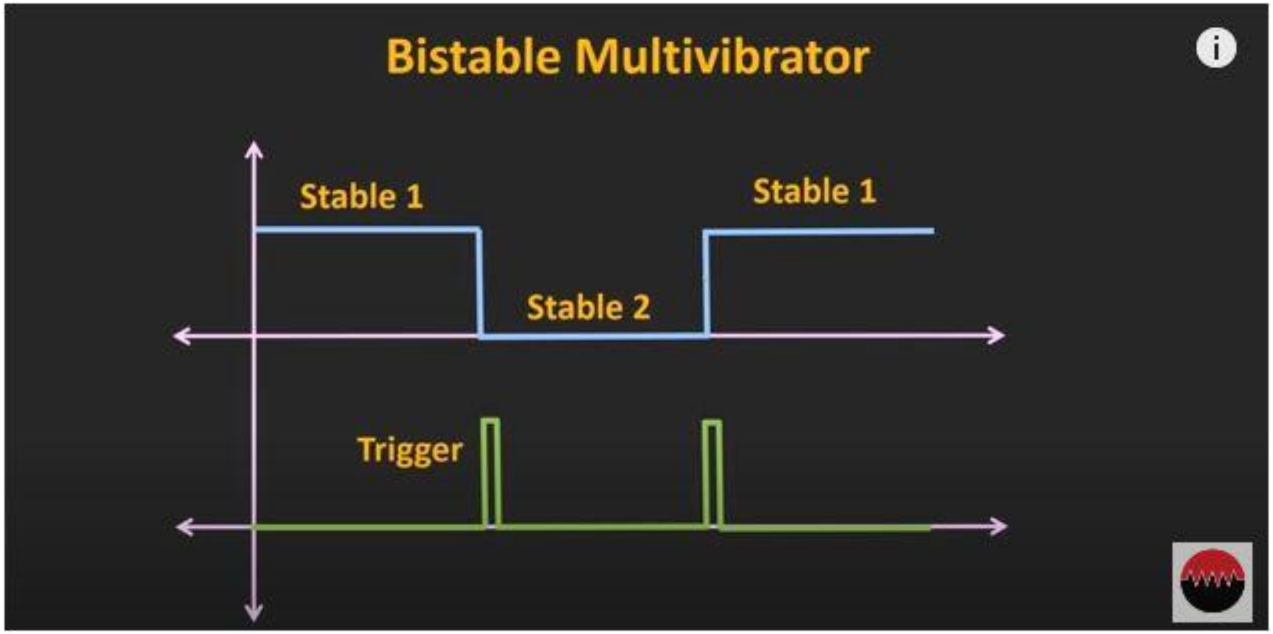
- ✓ Upper comparator has a threshold input (pin 6) and a control input (pin 5)
- ✓ Output of the upper comparator is applied to set (S) input of the flip-flop
- ✓ Whenever the threshold voltage exceeds the control voltage, the upper comparator will set the flip-flop and its output is high
- ✓ A high output from the flip-flop when given to the base of the discharge transistor saturates it and thus discharges the transistor that is connected externally to the discharge pin 7
- ✓ The complementary signal out of the flip-flop goes to pin 3, the output.
- ✓ The output available at pin 3 is low
- ✓ These conditions will prevail until lower comparator triggers the flip-flop
- ✓ Even if the voltage at the threshold input falls below (2/3) VCC that is upper comparator cannot cause the flip-flop to change again
- ✓ To change the output of flip-flop to low, the voltage at the trigger input must fall below + (1/3) Vcc
- ✓ When this occurs, lower comparator triggers the flip-flop, forcing its output low
- ✓ The low output from the flip-flop turns the discharge transistor off and forces the power amplifier to output a high These conditions will continue independent of the voltage on the trigger input
- ✓ Lower comparator can only cause the flip-flop to output low

Waveform Representation of Bistable Multivibrator (555 Timer)



- ✔ A flip-flop that has **TWO** stable states producing a single pulse either HIGH or LOW in value

Waveform Representation of Bistable Multivibrator (555 Timer)



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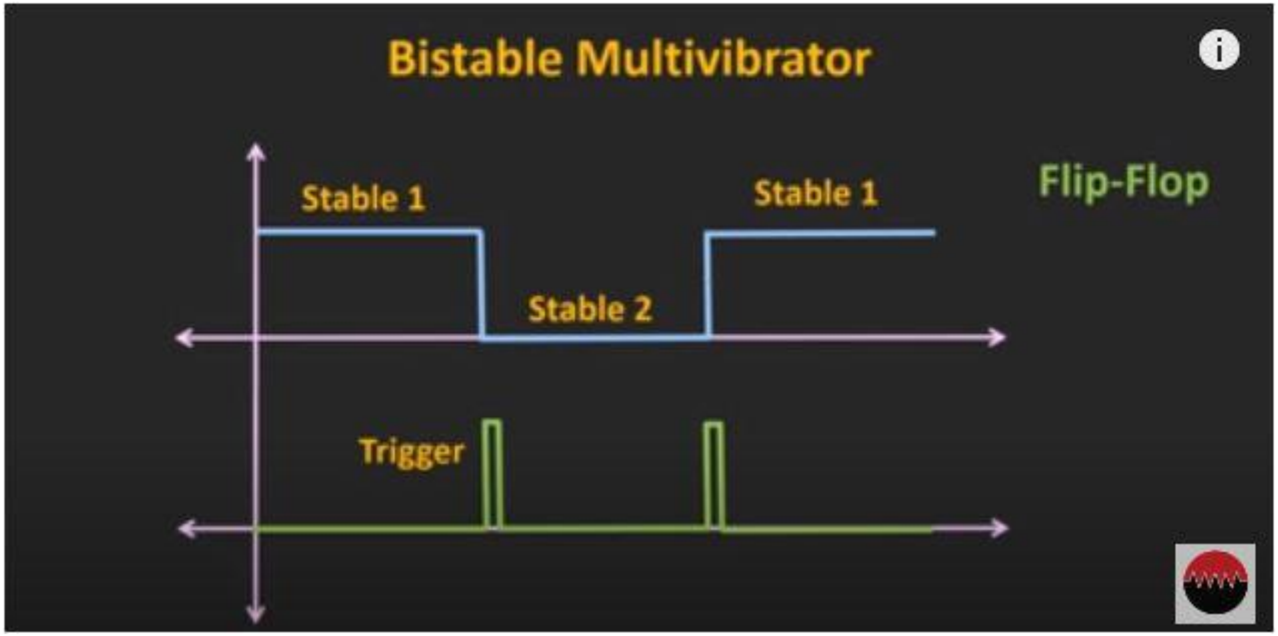
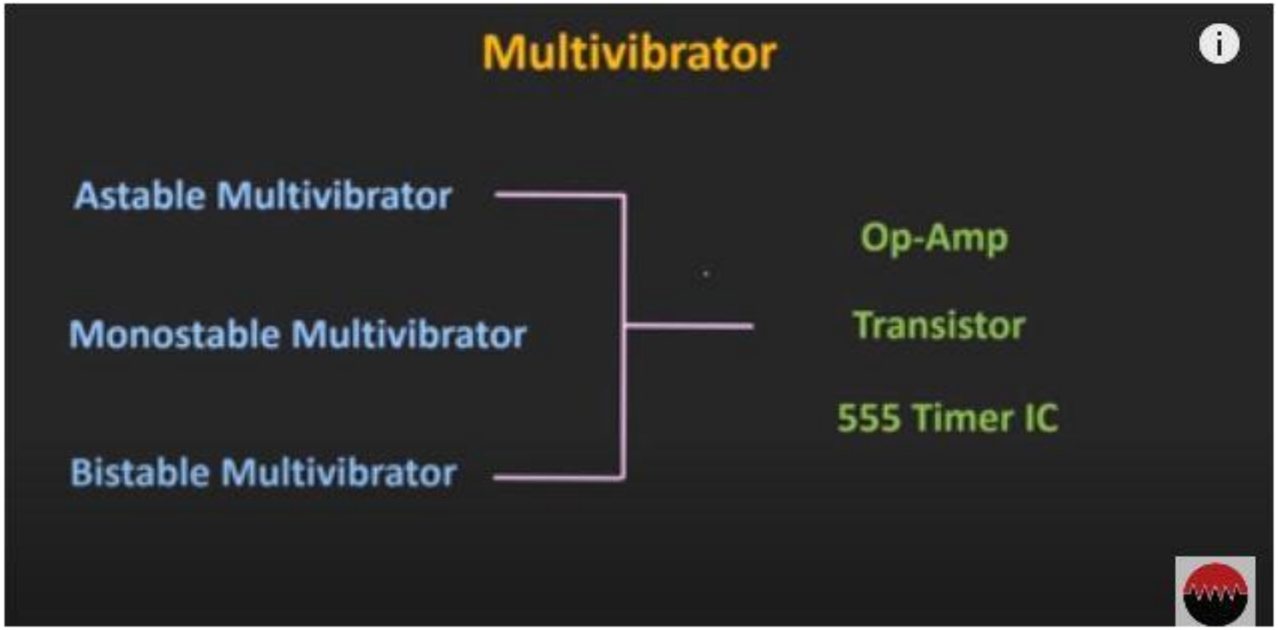


Types of Multivibrator



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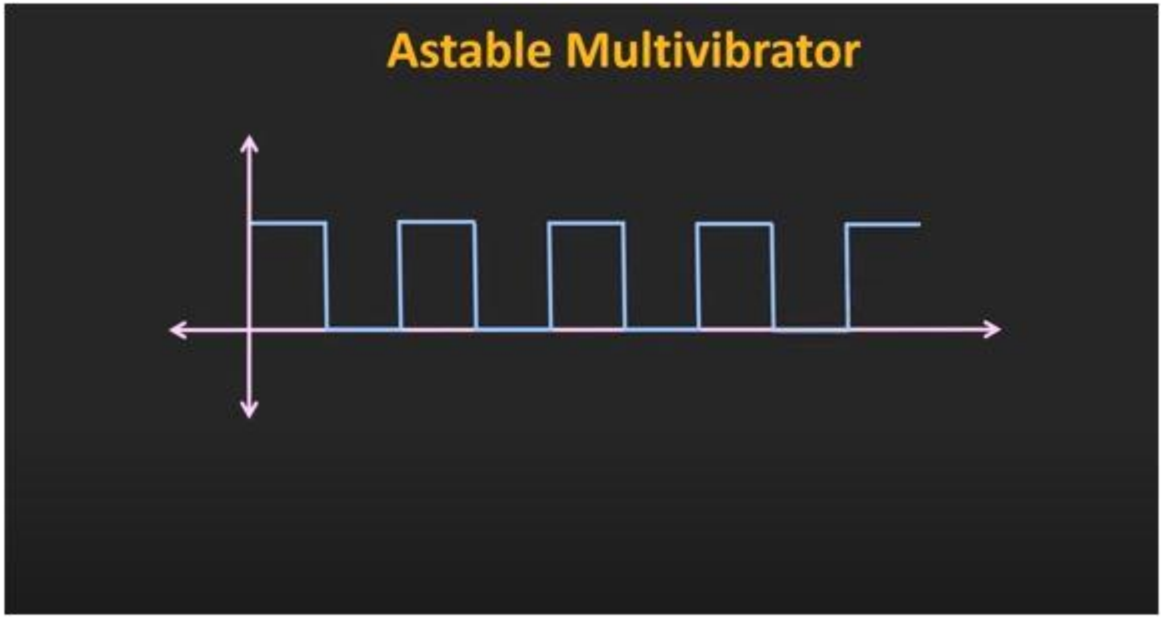

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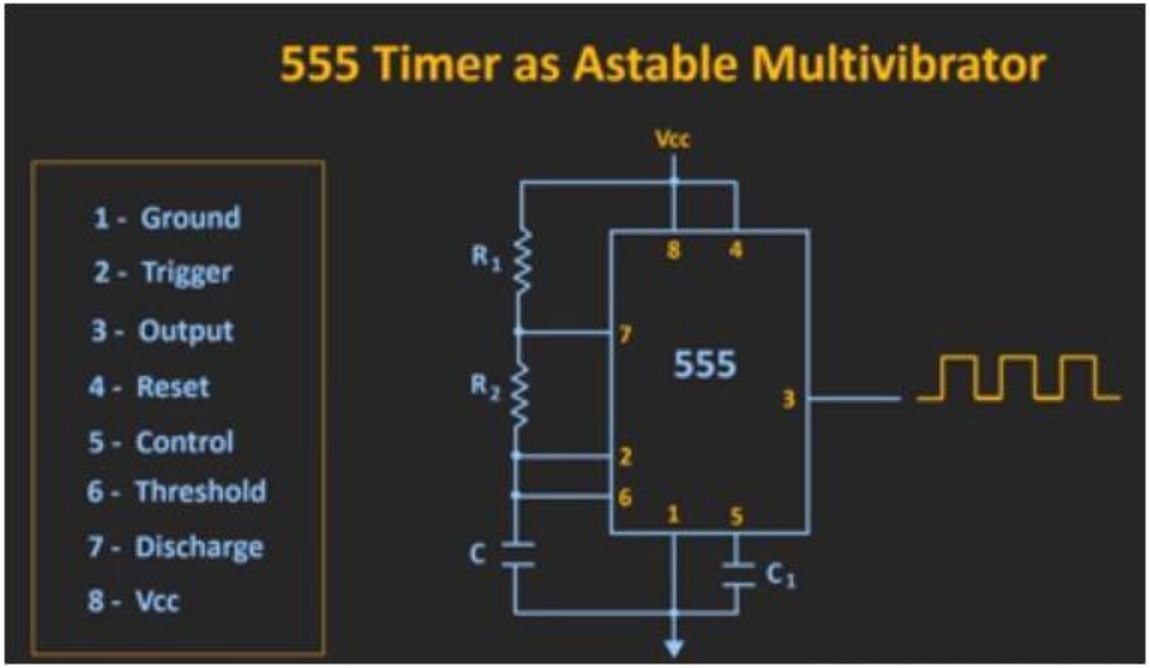
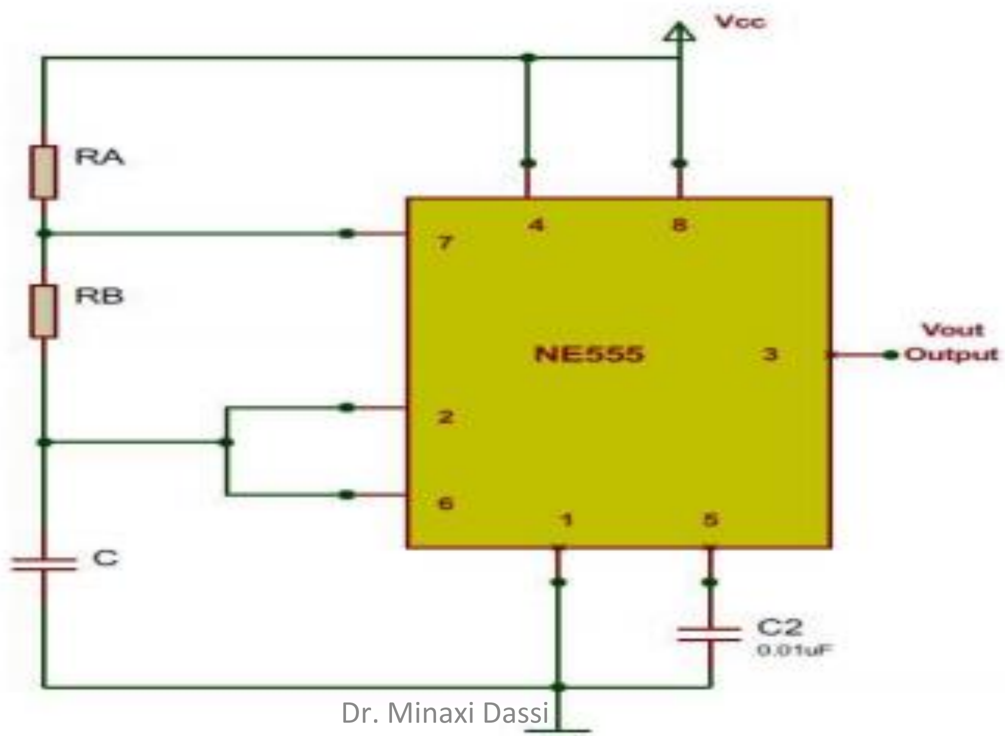


The IC 555 can be made to work as an astable multivibrator with the addition of three external components: two resistors (R_1 and R_2) and a capacitor (C)

Waveform Generation of Astable Multivibrator (555 Timer)

- ✓ An Astable Multivibrator can be designed by adding two resistors a capacitor (RA, RB and C in circuit diagram) to the 555 Timer IC
- ✓ These two resistors and the capacitor (values) are selected appropriately so as to obtain the desired ‘ON’ and ‘OFF’ timings at the output terminal (pin 3)
- ✓ So basically, the ON and OFF time at the output (i.e. the ‘HIGH’ and ‘LOW’ state at the output terminal) is dependent on the values chosen for RA, RB and C



Waveform Generation of Astable Multivibrator (555 Timer)

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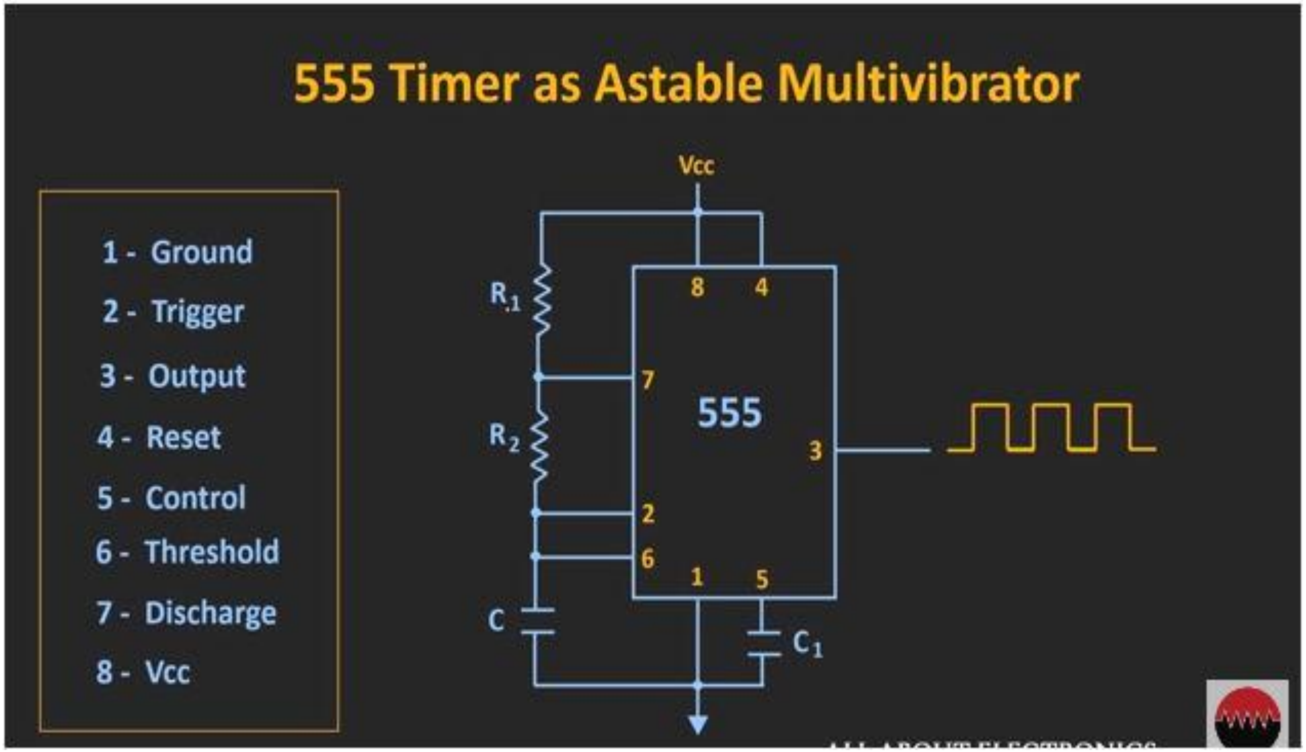
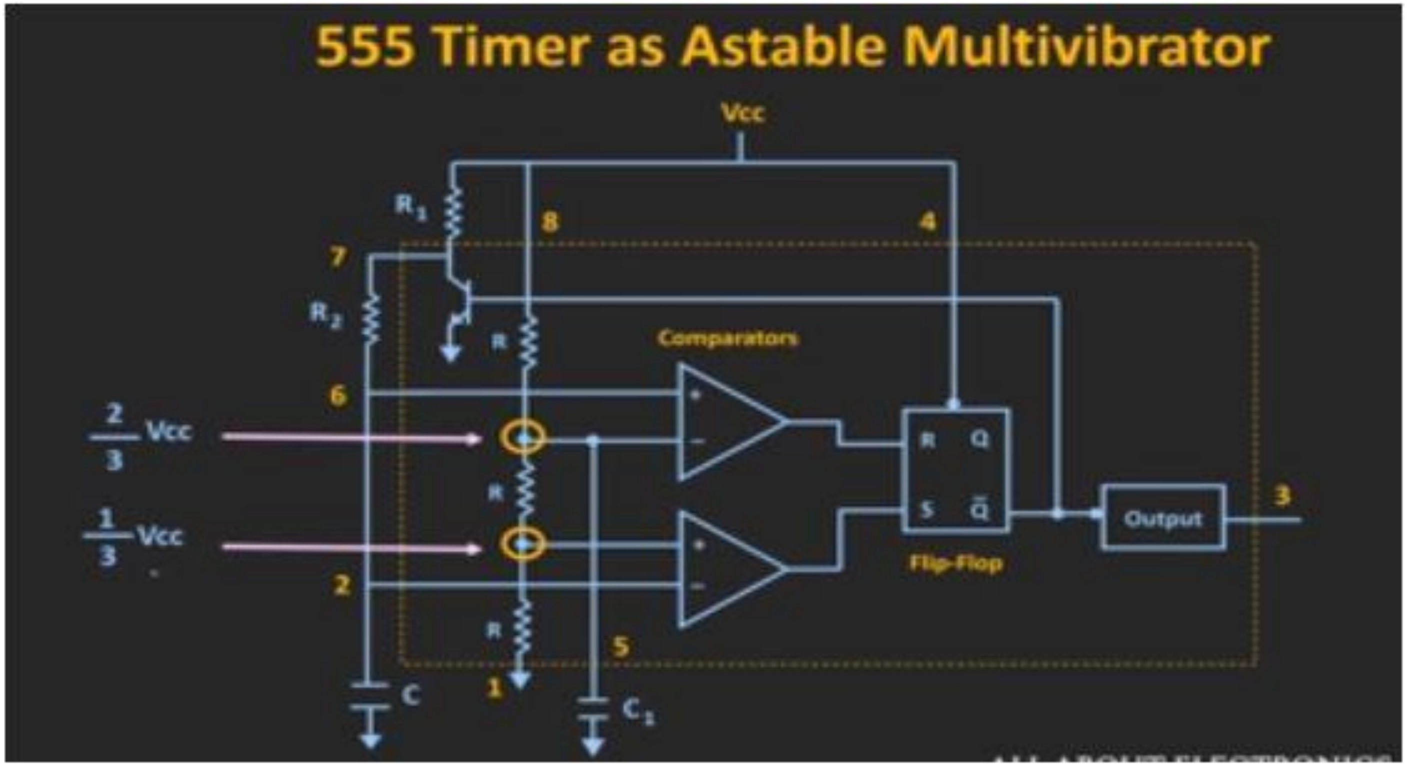


- ✓ Pin 1 is grounded
- ✓ pins 4 and 8 are shorted and then tied to supply +Vcc
- ✓ Output (Vout) is taken from pin 3
- ✓ pin 2 and 6 are shorted and then connected to ground terminal through the capacitor C
- ✓ pin 7 is connected to supply + V_{CC} through a resistor R_1, and between pin 6 and 7, a resistor R_2 is connected
- ✓ At pin 5 a bypass capacitor of 0.01uF is connected (this capacitor is for bypass the noise signals created by resistance divider)

Waveform Generation of Astable Multivibrator (555 Timer)



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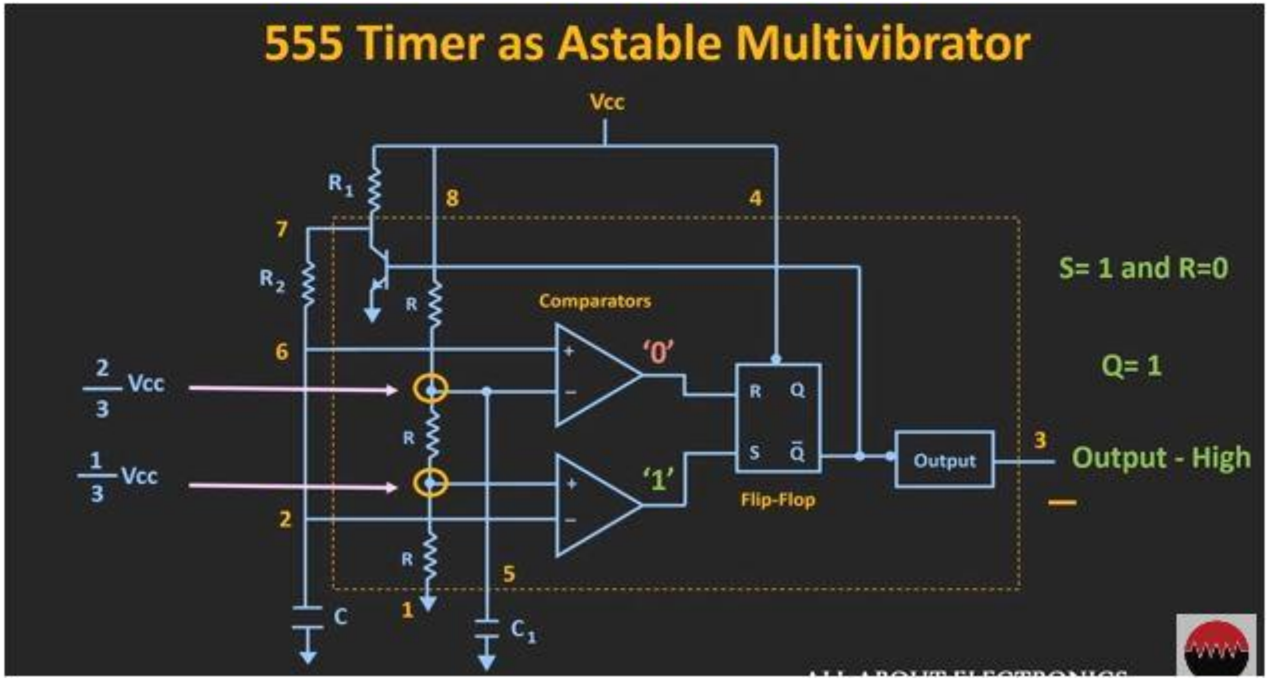

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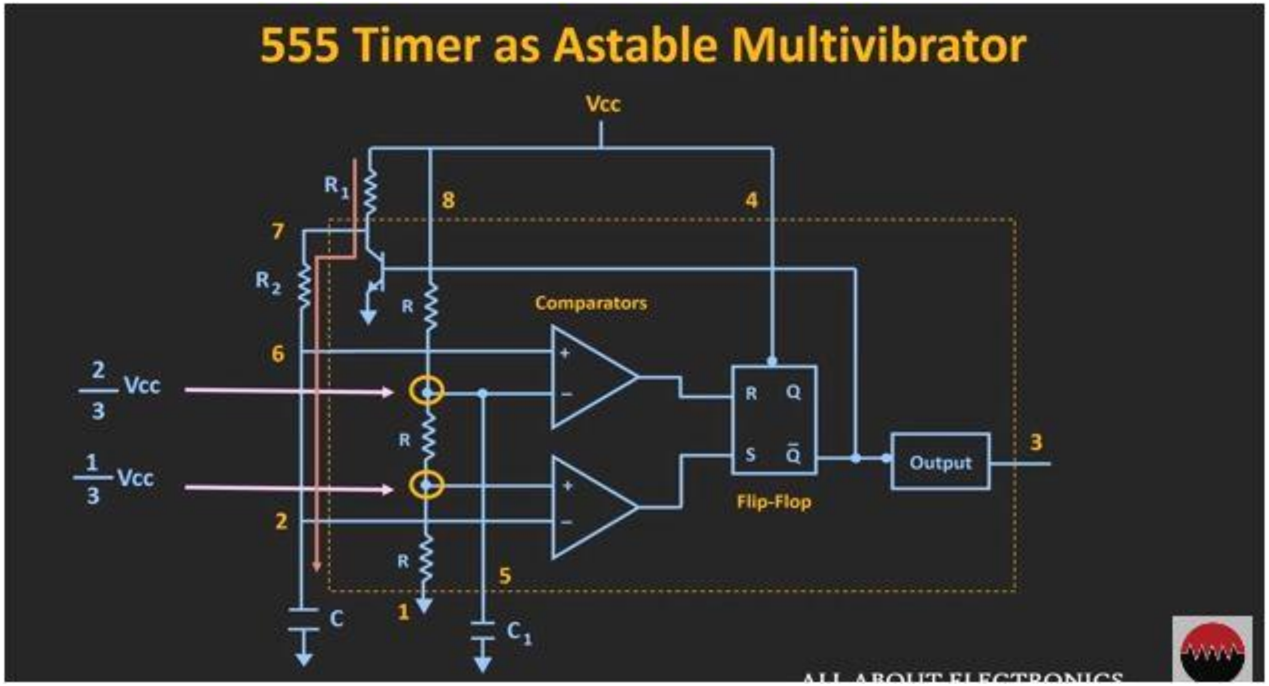

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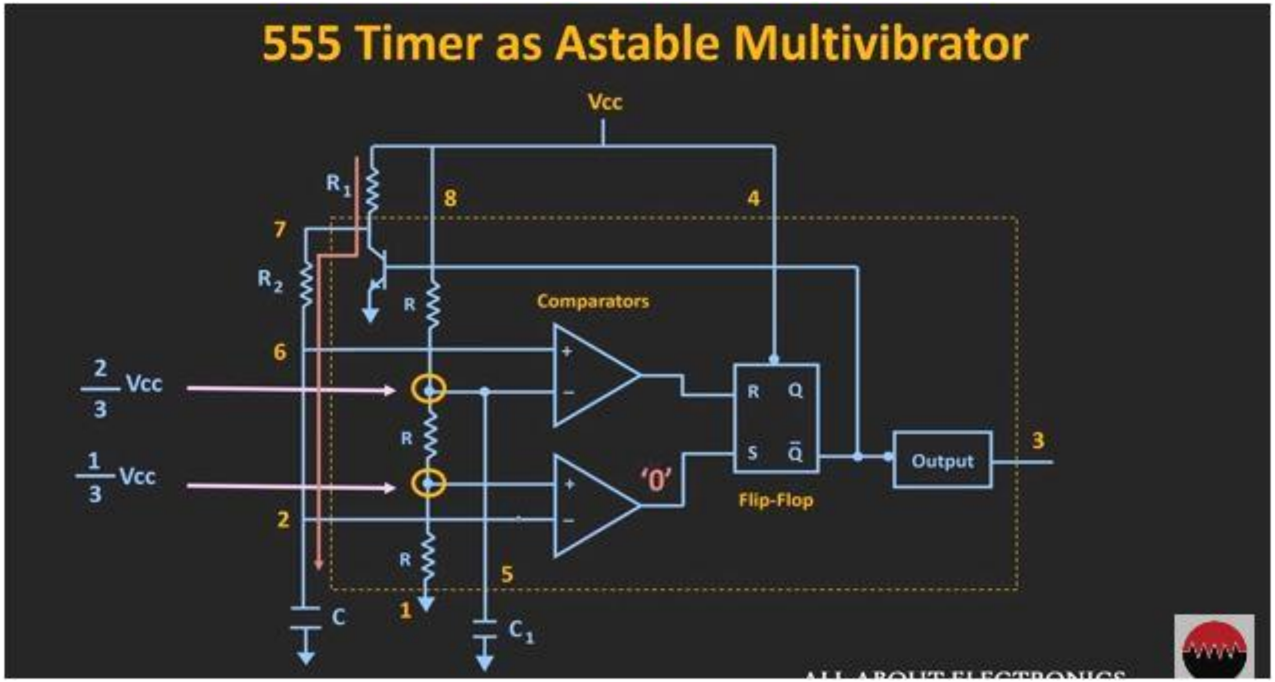

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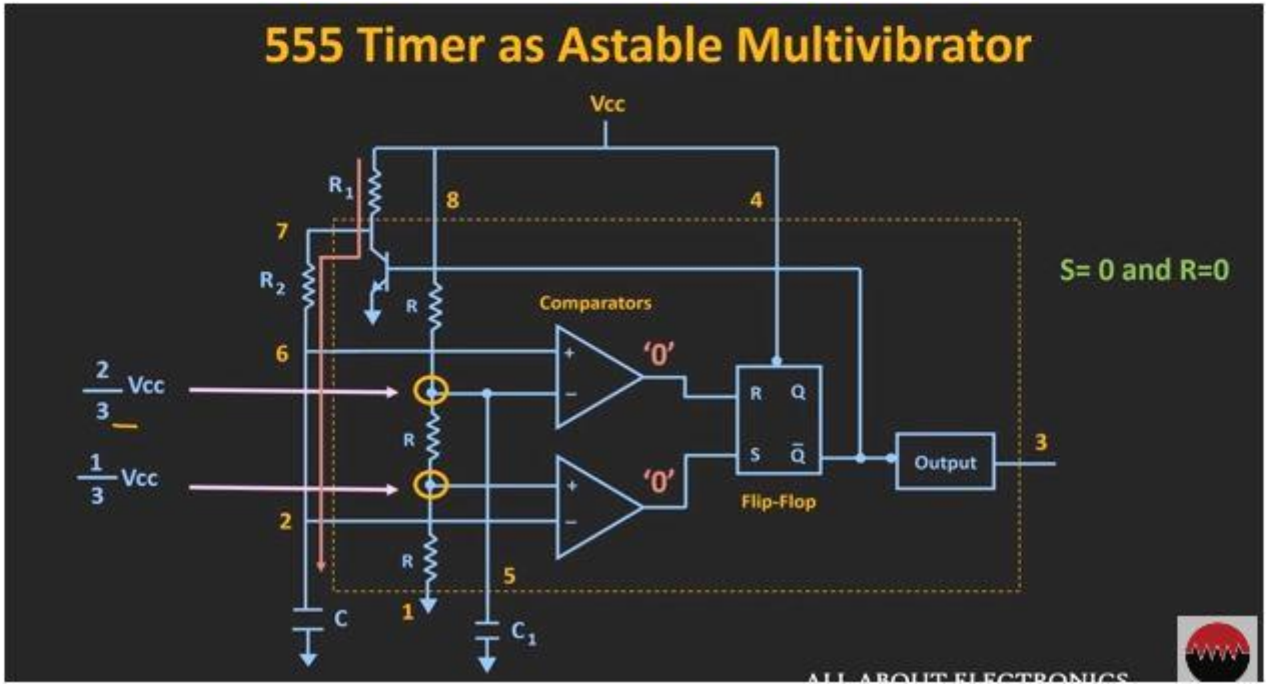

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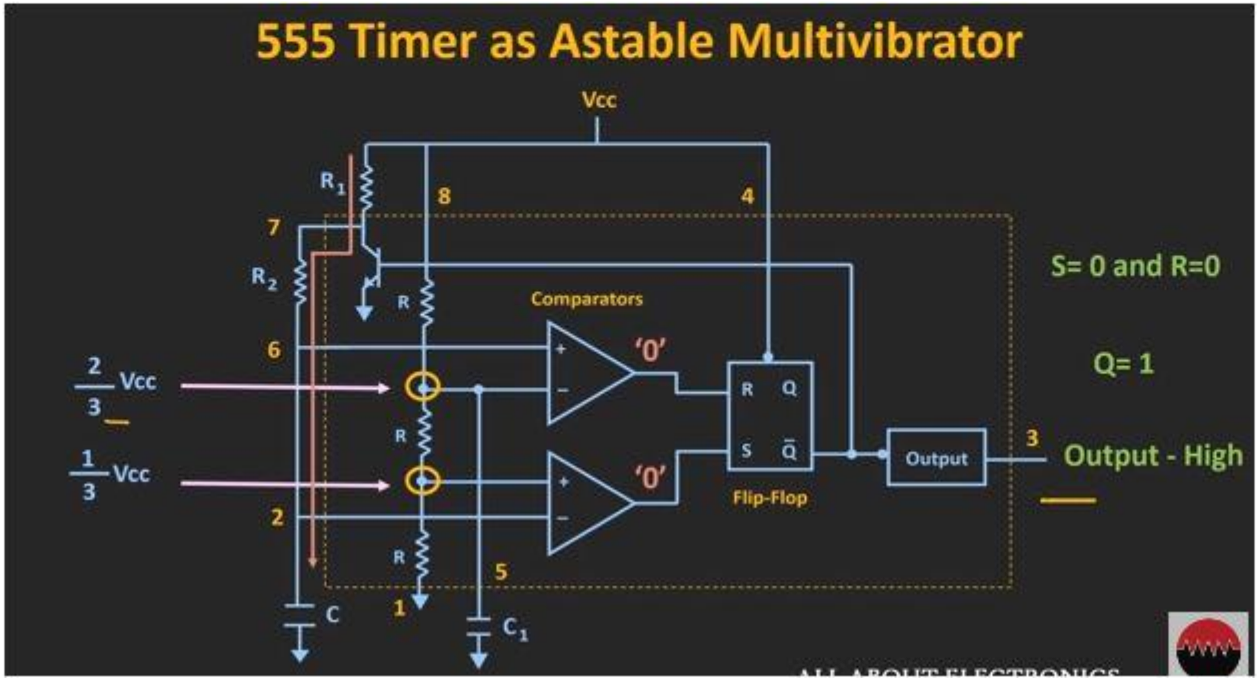

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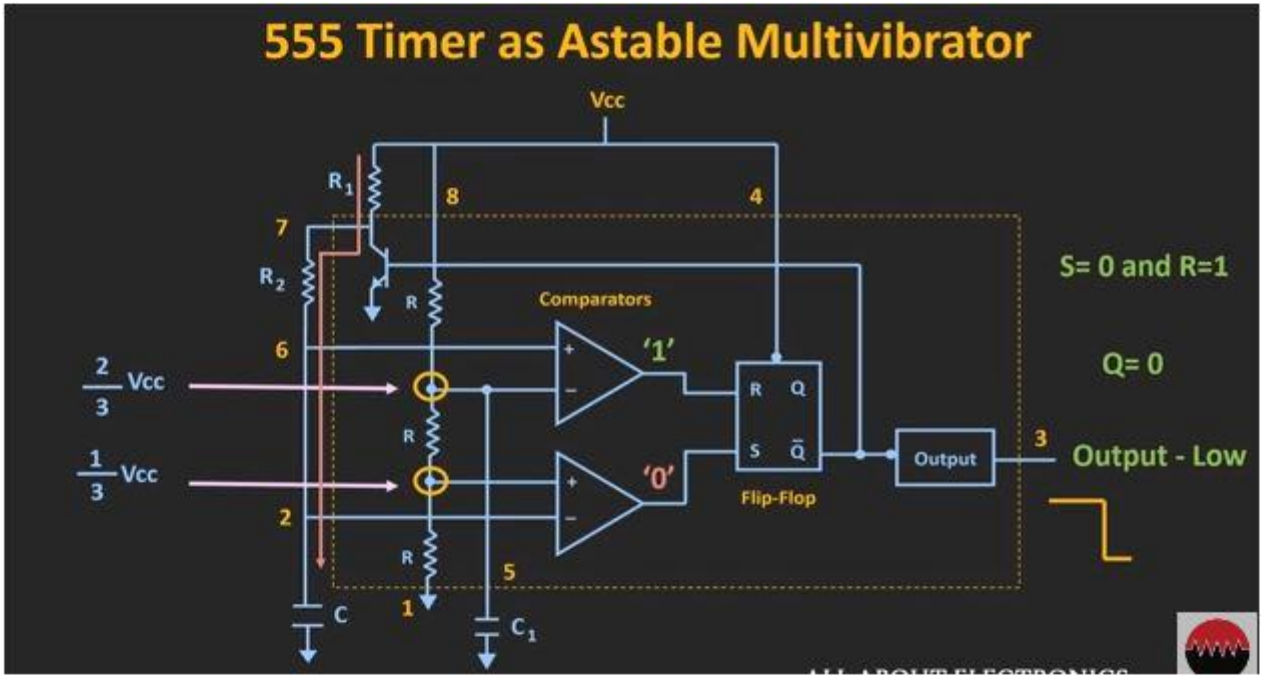

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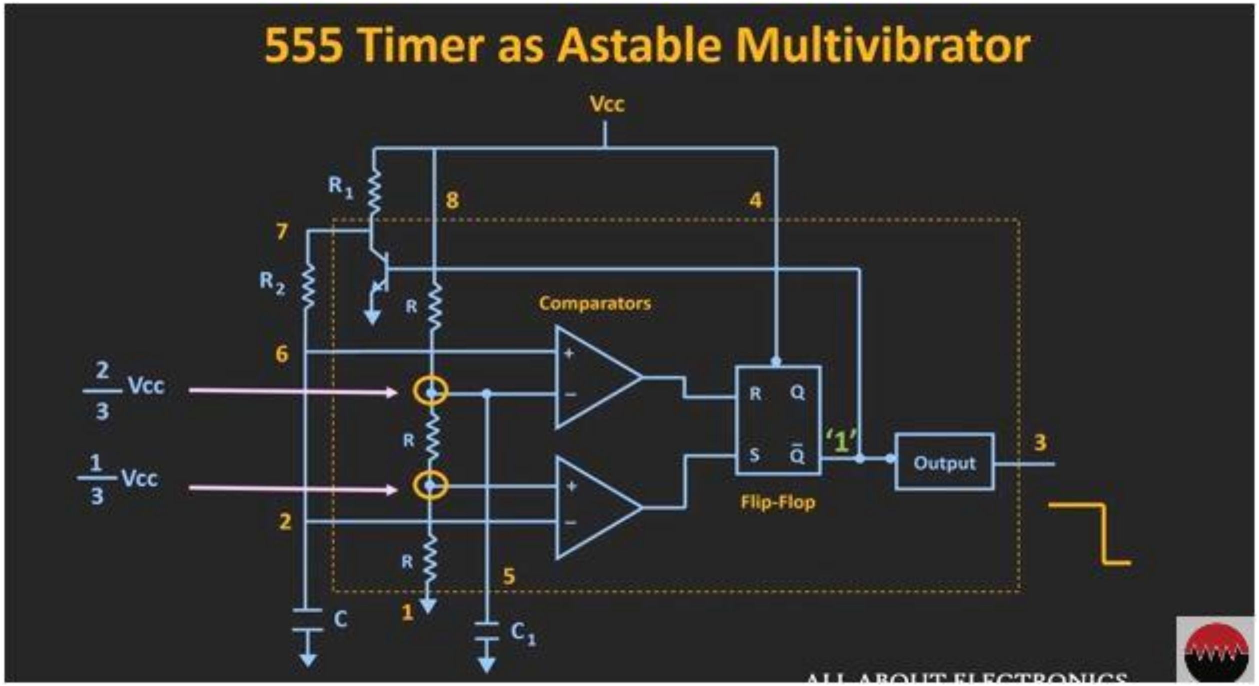

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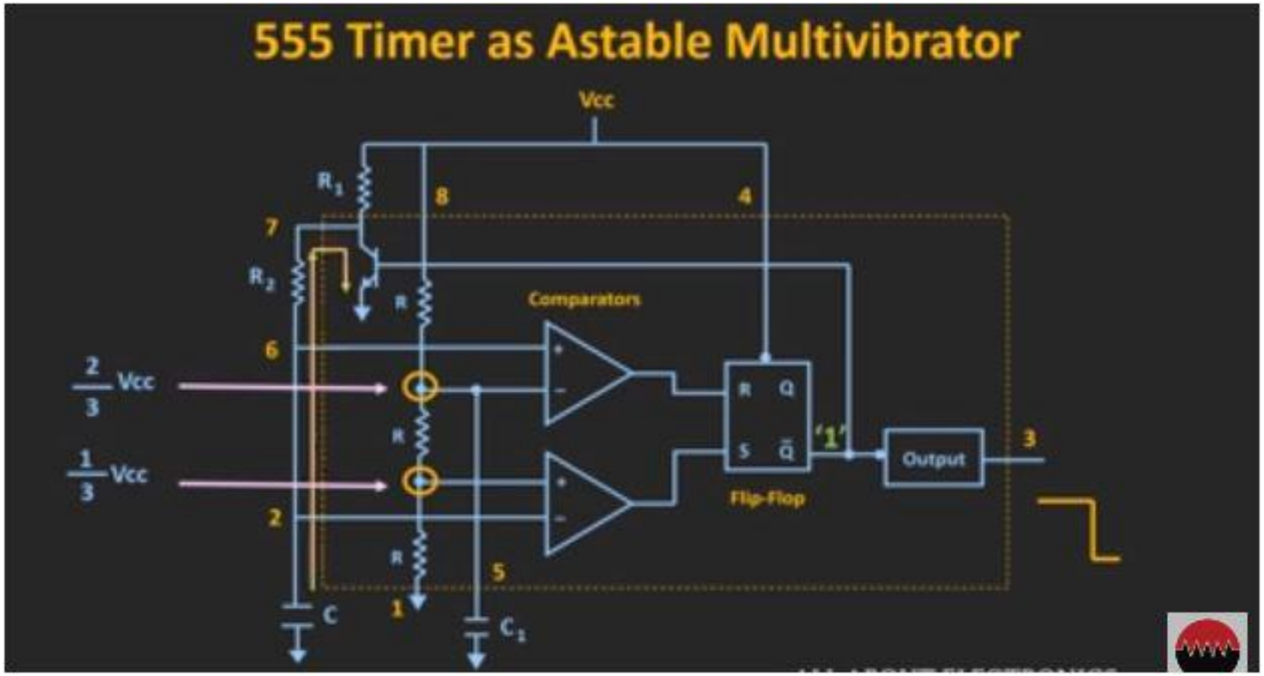

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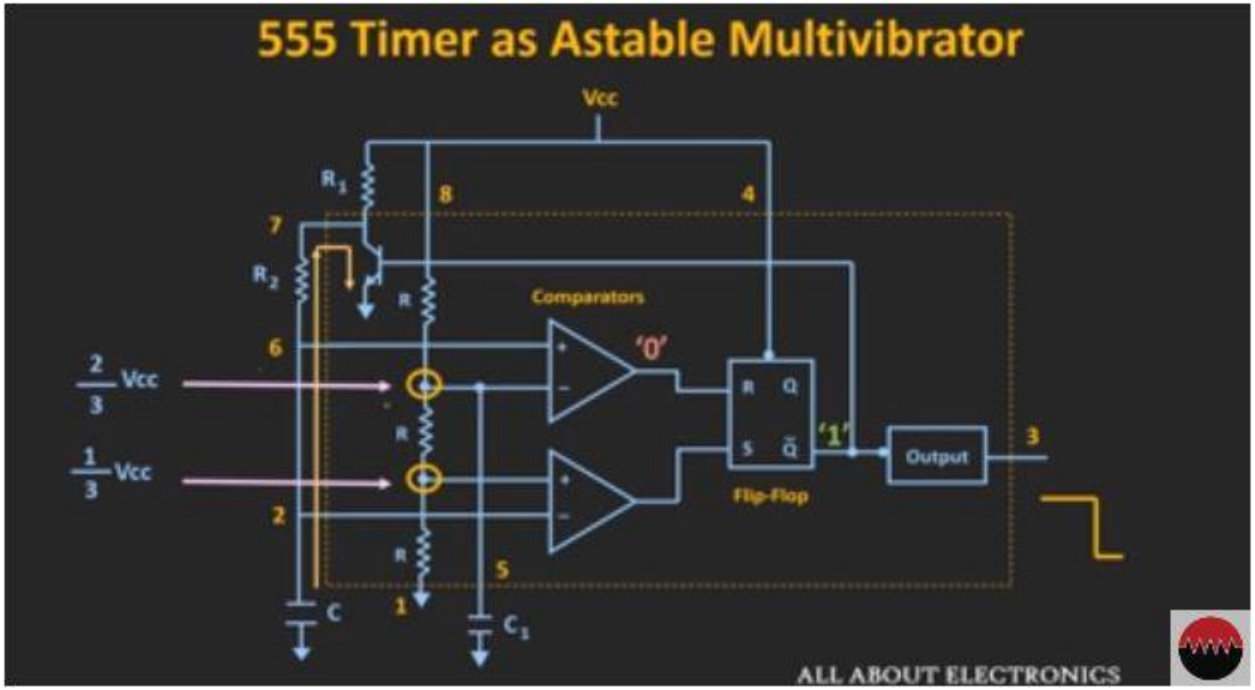

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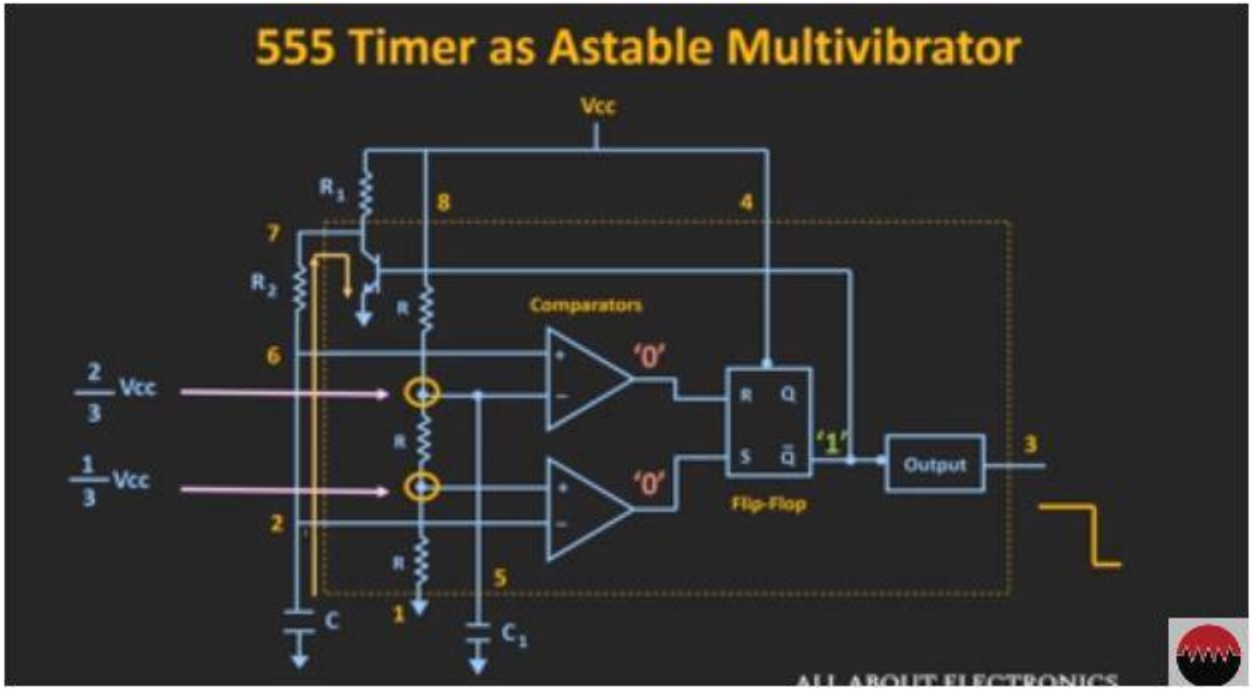

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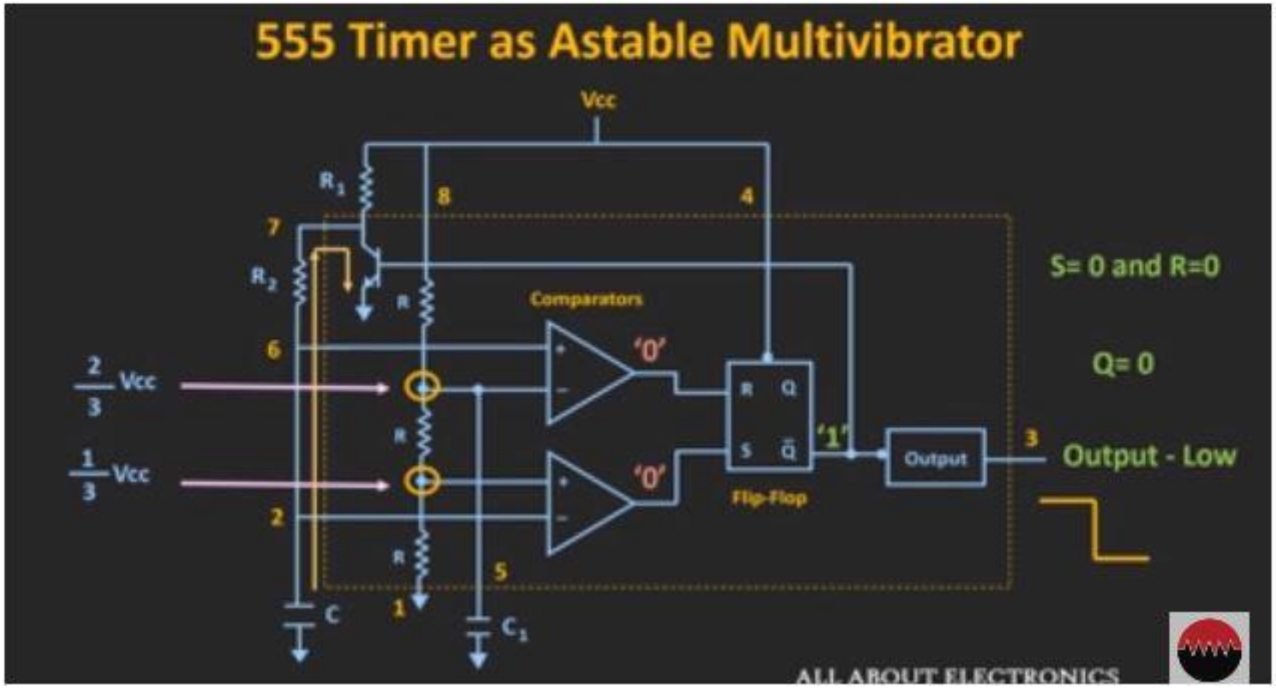

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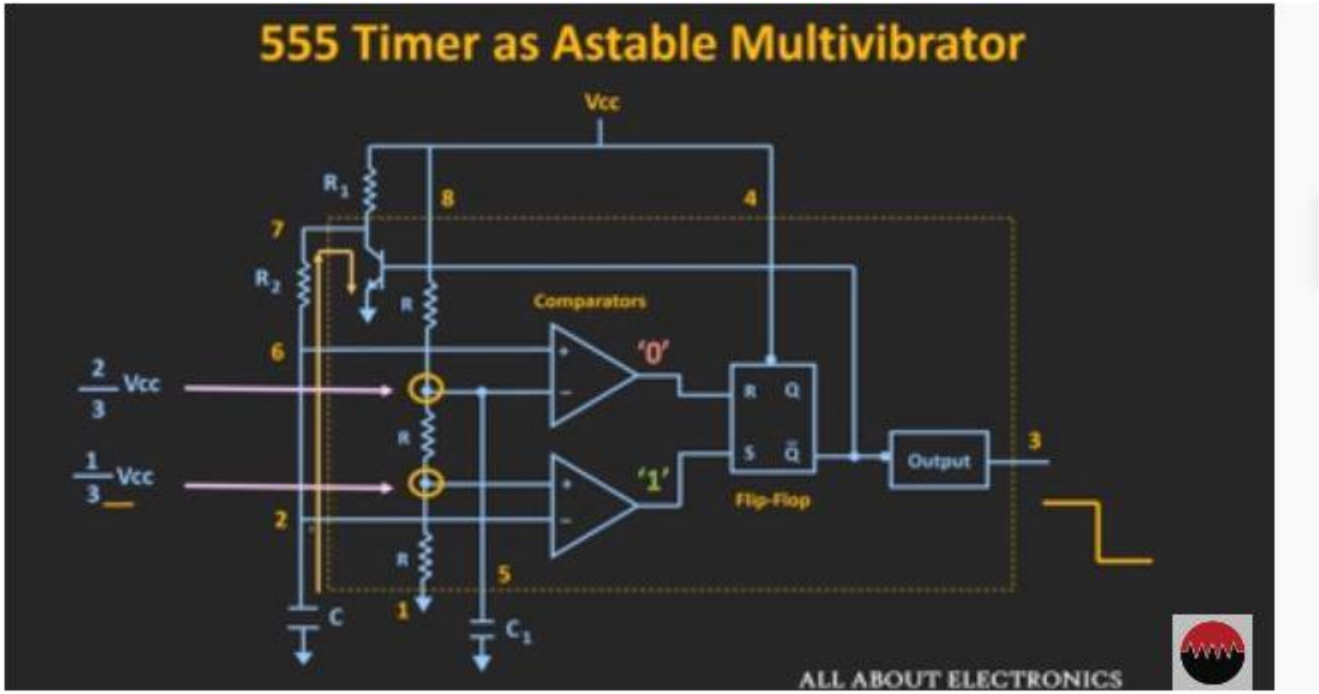

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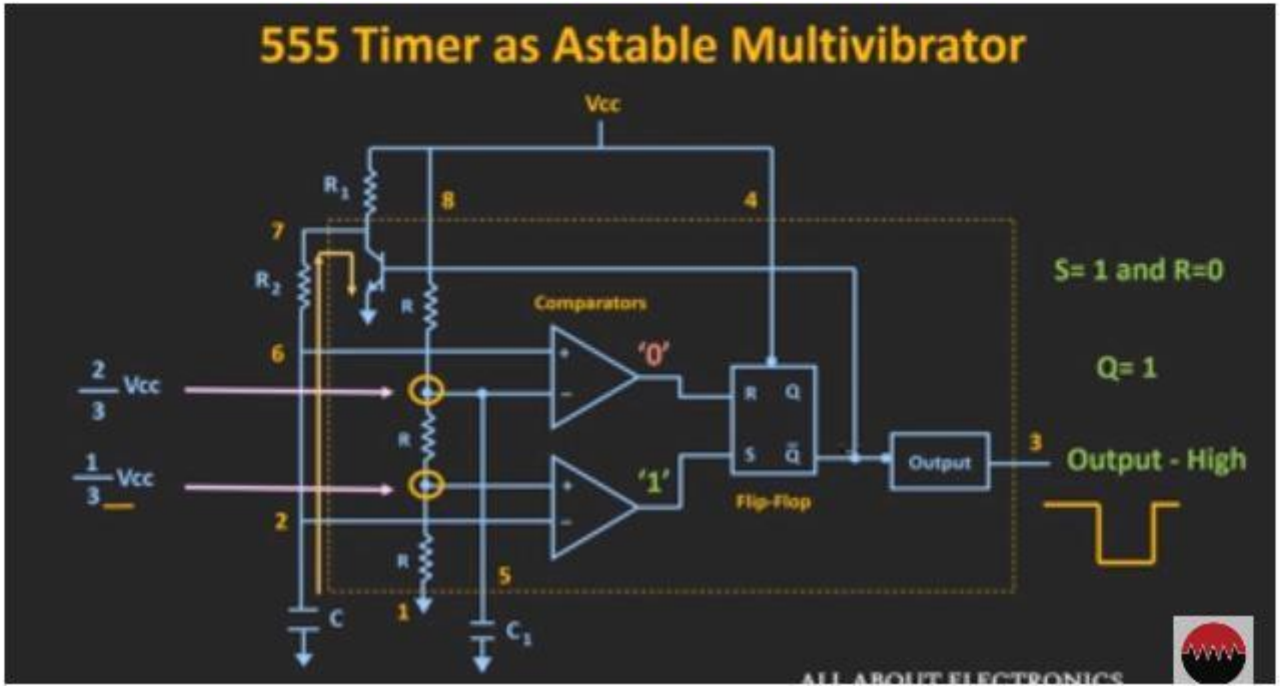

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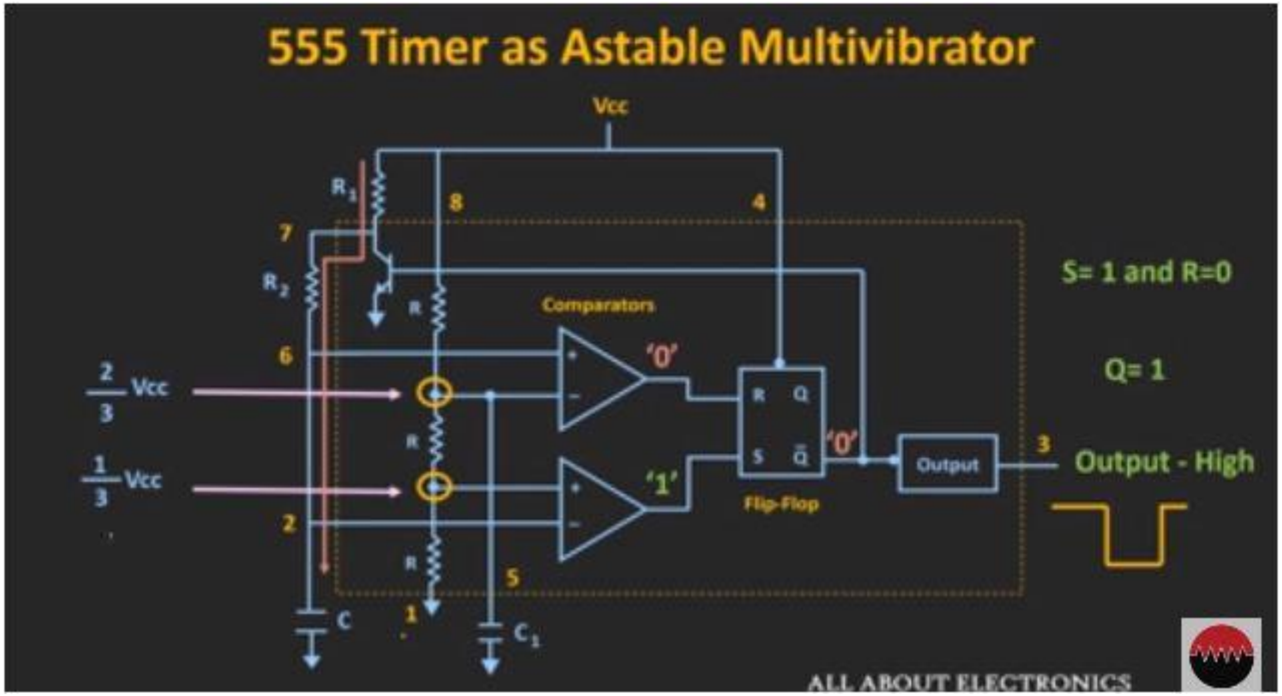

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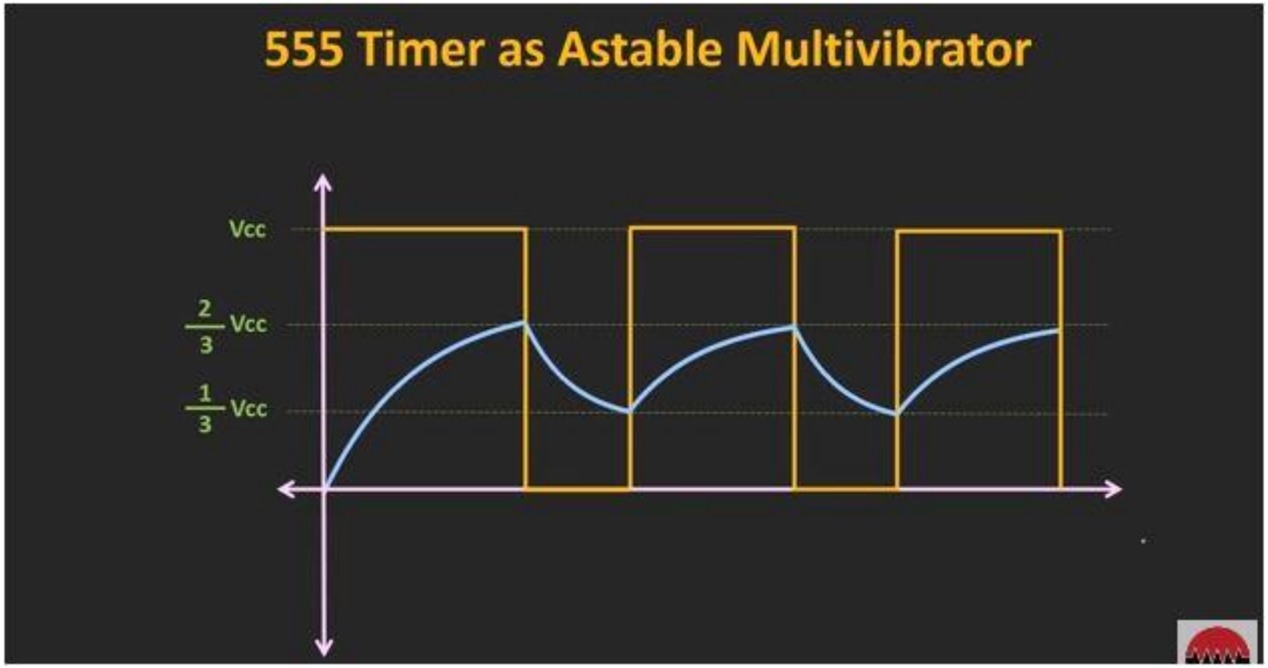

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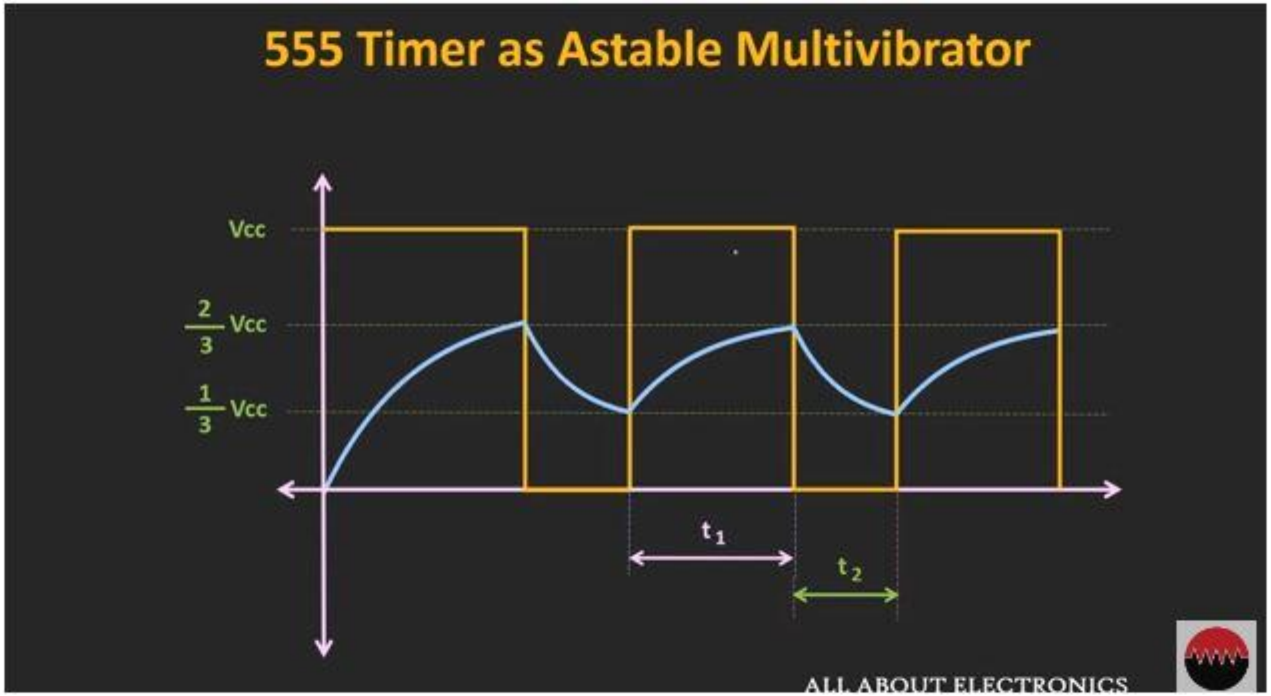

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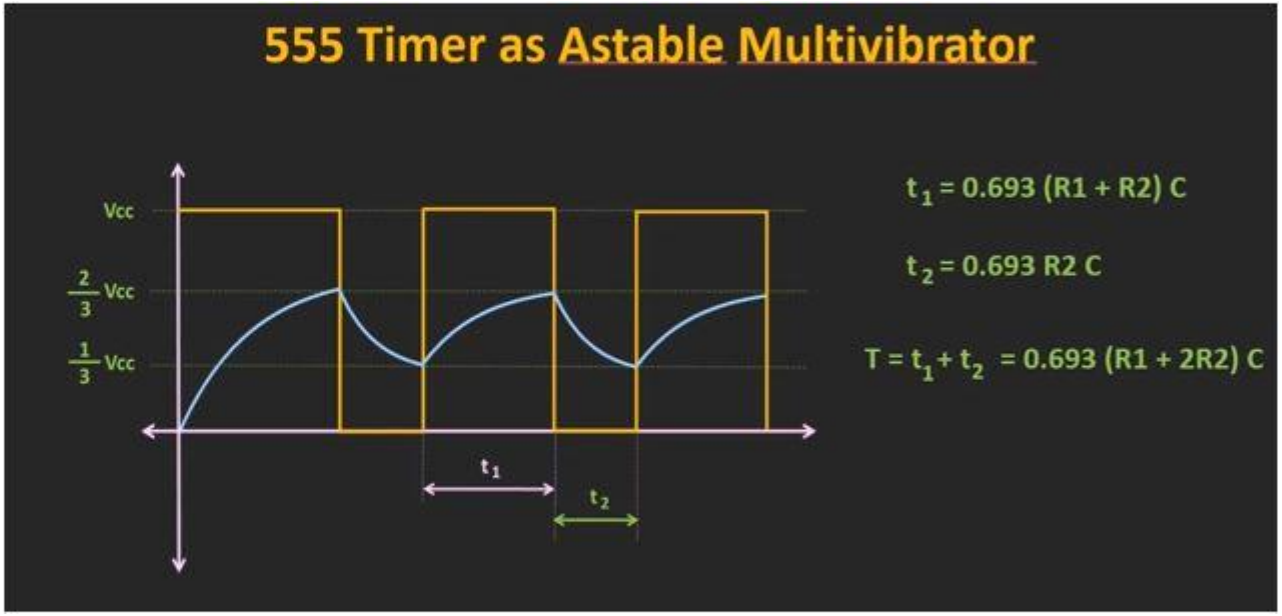

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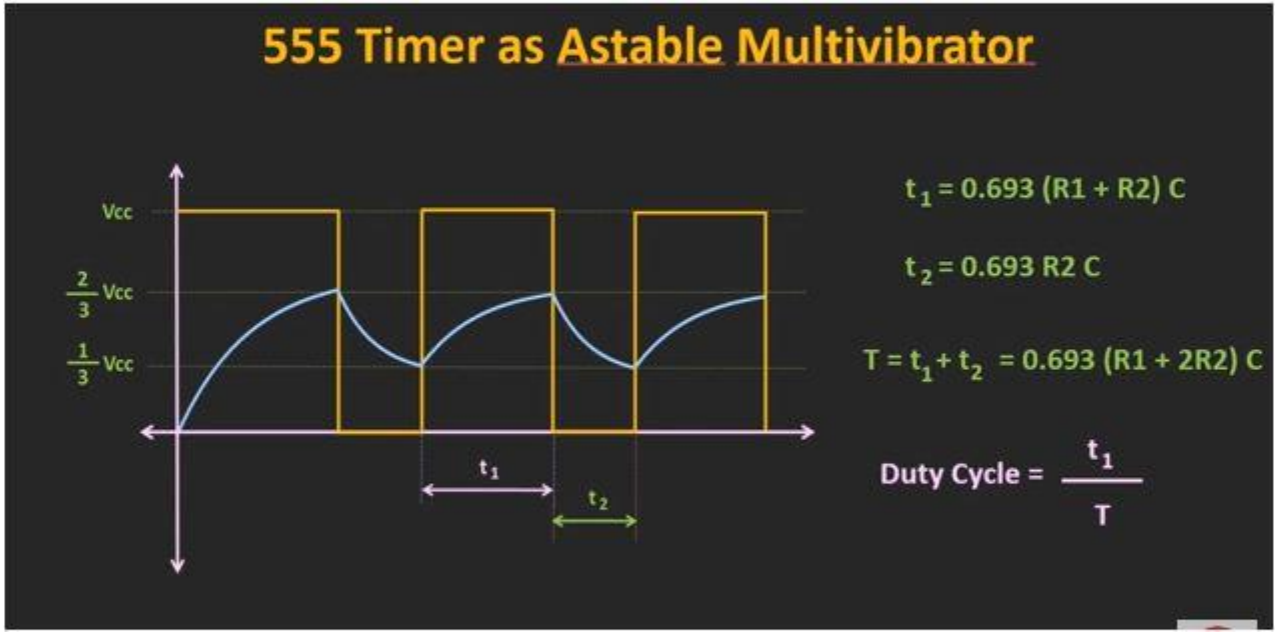
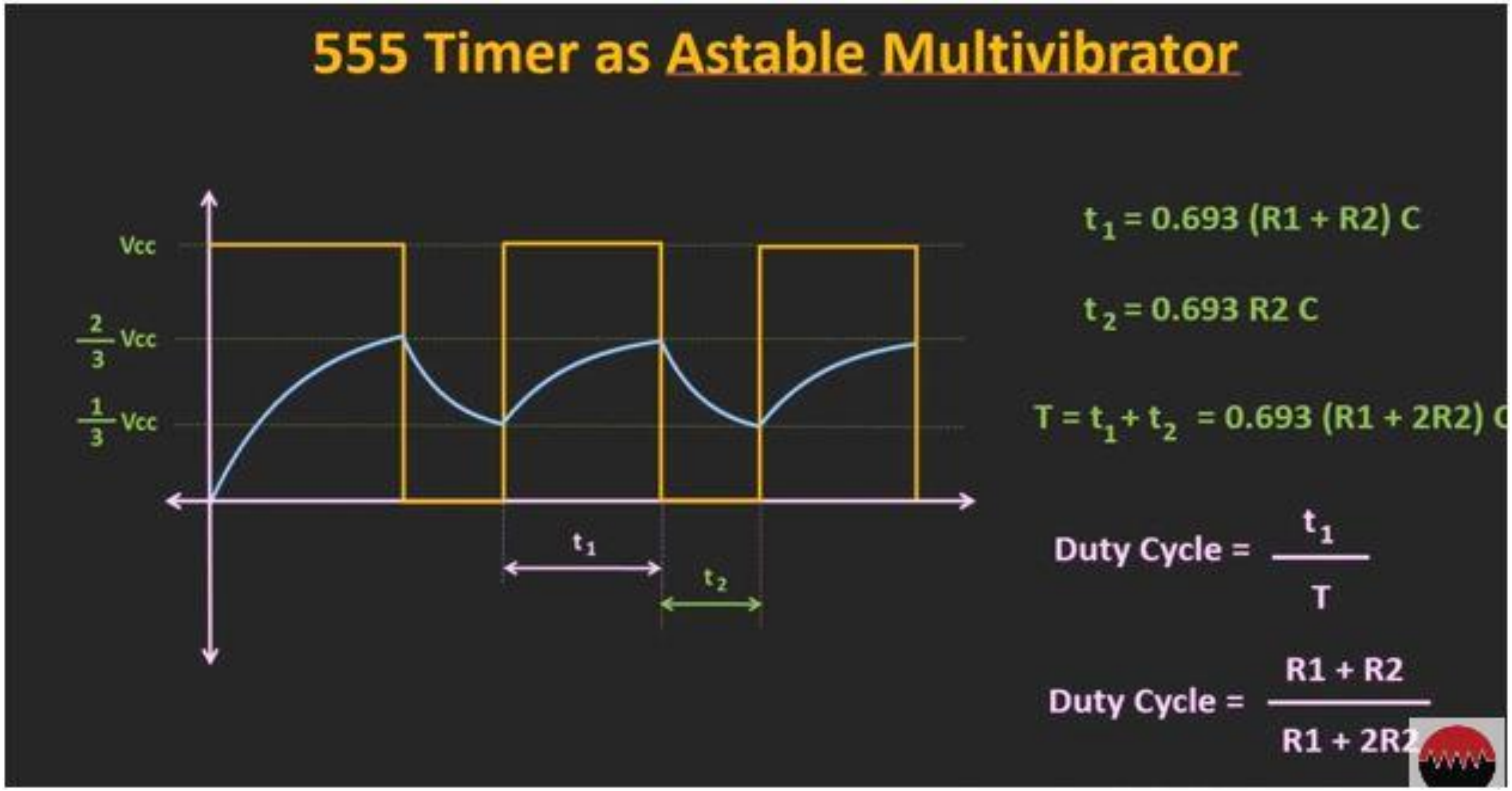


Waveform Generation of Astable Multivibrator (555 Timer)



Numerical Based on Astable Multivibrator (555 Timer)

Q: 1. An **Astable 555 multivibrator** is constructed using the following components, $R_1 = 1k\Omega$, $R_2 = 2k\Omega$ and capacitor C = 10uF. Calculate the output frequency from the 555 multivibrator.

Solution: T_1 – capacitor charge "ON" time is calculated as:

$T_1=0.693\ (R_1+R_2).C$

$T_1=0.693(1x10^3+2x10^3).10x10^{-6}$

$T_1=0.693(3x10^{3)}.10x10^{-6}$

$T_1=0.021$ s

T_2 – capacitor discharge "OFF" time is calculated as:

$T_2=0.693\ (R_2).C$

$T_2=0.693\ (2000).\ 10x10^{-6}$

$T_2=0.014s$

Total periodic time (T) is therefore calculated as:

$T=T_1+T_2=0.021+0.014=0.035$

The output frequency, *f* is therefore given as:

$$f=\frac{1}{T}=\frac{1}{0.035}=28.57\ Hz$$

Numerical Based on Astable Multivibrator (555 Timer)

Q: 2. An **Astable 555 multivibrator** is constructed using the following components, $R_1 = 1k\Omega$, $R_2 = 2\ k\Omega$ and capacitor $C = 10\ \mu F$. Calculate the duty cycle of the output waveform.

Solution:

T_1 – capacitor charge "ON" time is calculated as:

T_1=0.693 $(R_1+R_2).C$

T_1=0.693$(1x10^3+2x10^3).10x10^{-6}$

T_1=0.693$(3x10^{3)}.10x10^{-6}$

T_1=0.021 s

T_2 – capacitor discharge "OFF" time is calculated as:

T_2=0.693 $(R_2).C$

T_2=0.693 (2000). $10x10^{-6}$

T_2=0.014s

Total periodic time (T) is therefore calculated as:

$T=T_1+T_2$=0.021+0.014=0.035

Duty Cycle$=\frac{T_1}{T}=\frac{0.021}{0.035}$**=0.6 or 60%**

Thanks