SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

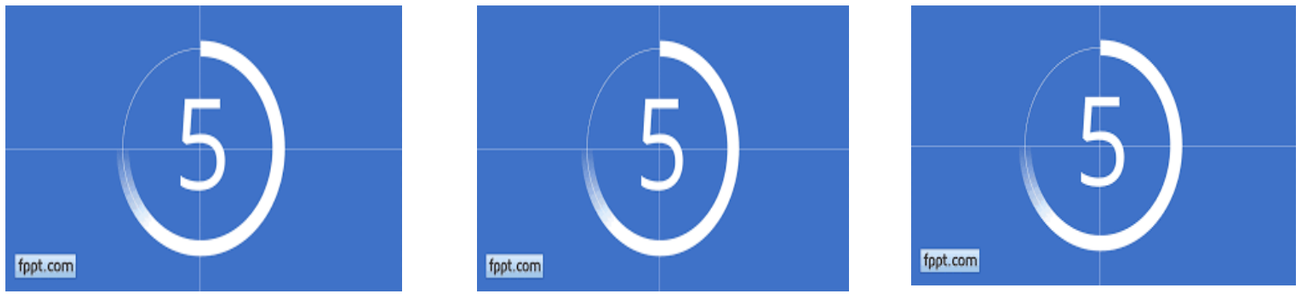
19ECB202 – LINEAR AND DIGITAL CIRCUITS

II YEAR/ III SEMESTER

UNIT 2 – **COMPARATORS AND SPECIAL FUNCTION IC's**

TOPIC 2 – **Timer IC 555**

GUESS?????



555 IC TIMER?

❖The 555 Timer is one of the most popular and versatile integrated circuits ever produced!

❖“Signetics” Corporation first introduced this device as the SE/NE 555 in early 1970

❖It is a combination of digital and analog circuits

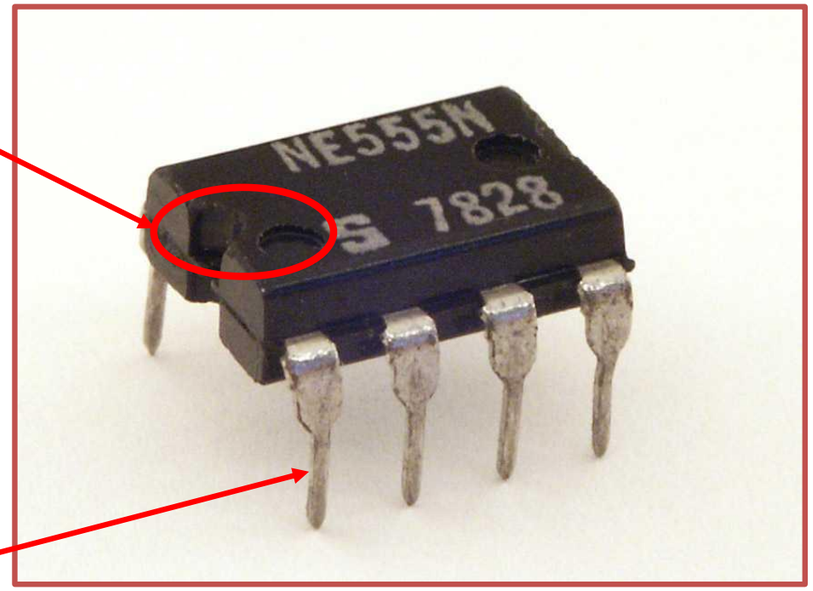
❖It is known as the **“Time Machine”** as it performs a wide variety of timing tasks.

❖The **555 Timer IC** got its name from the three 5KΩ resistors that are used in its voltage divider network

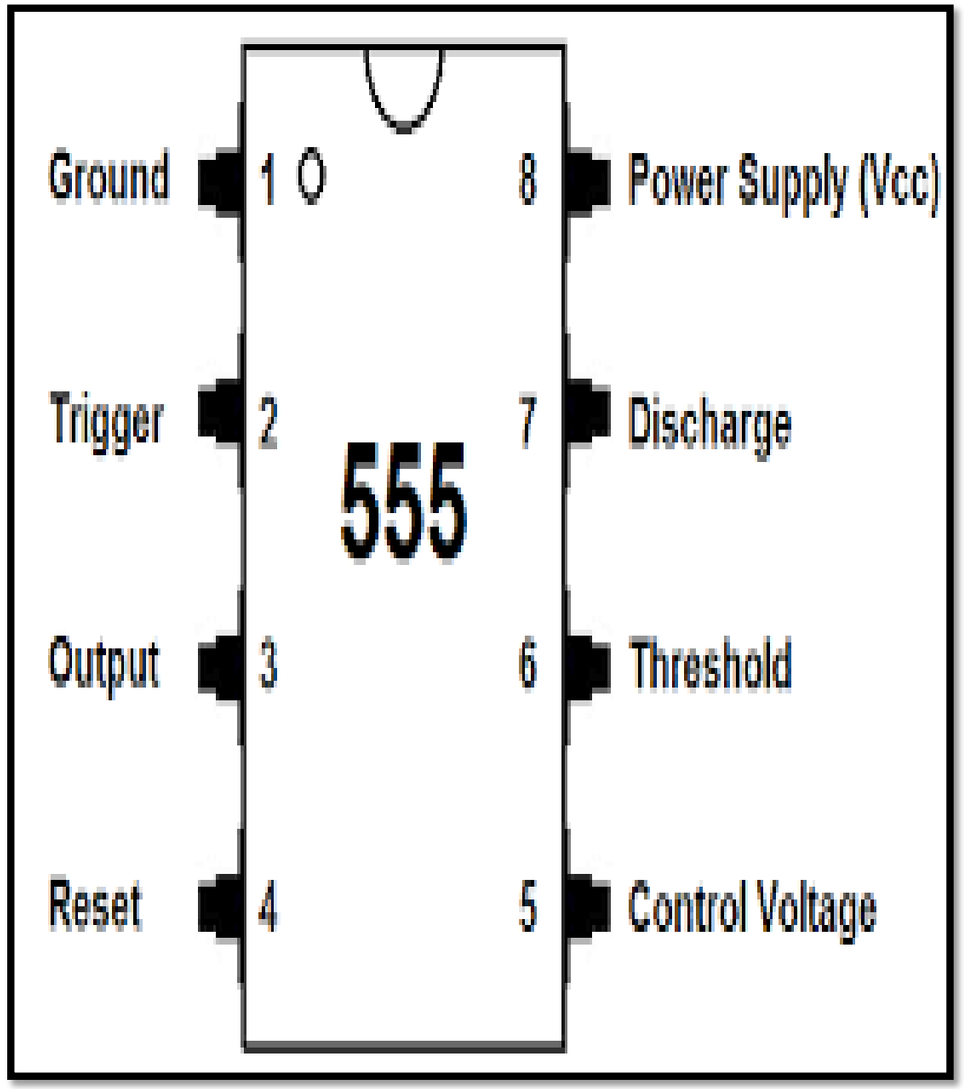
❖This **IC** is useful for generating accurate time delays and oscillations

IC 555 PIN DIAGRAM

Notch



Pin 1

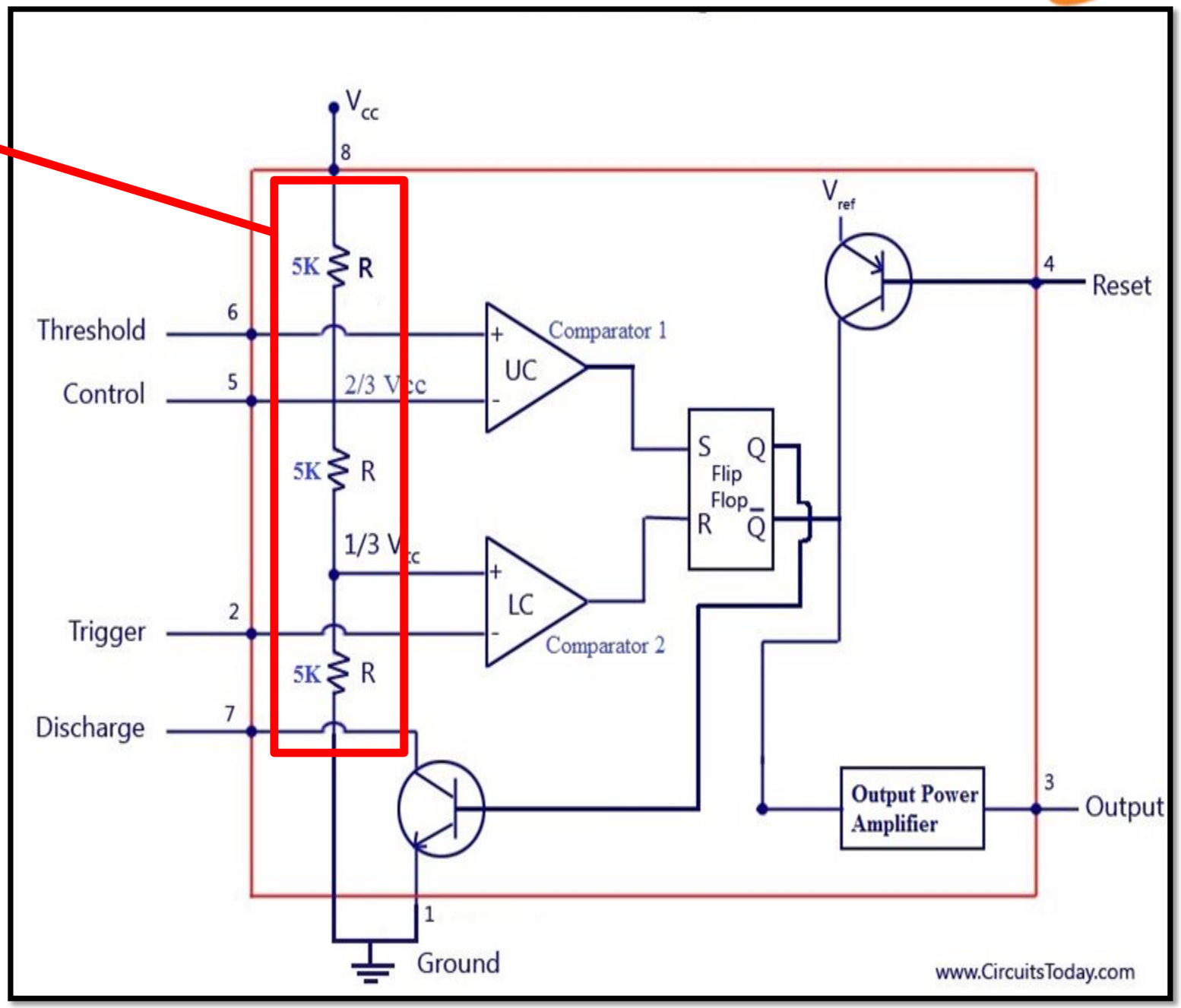


PIN DETAILS

Pin	Name	Purpose
1	GND	Ground, low level (0 V)
2	TRIG	OUT rises, and interval starts, when this input falls below 1/3 V_{CC}.
3	OUT	This output is driven to approximately 1.7V below $+V_{CC}$ or GND.
4	RESET	A timing interval may be reset by driving this input to GND, but the timing does not begin again until RESET rises above approximately 0.7 volts. Overrides TRIG which overrides THR.
5	CTRL	"Control" access to the internal voltage divider (by default, 2/3 V_{CC}).
6	THR	The interval ends when the voltage at THR is greater than at CTRL.
7	DIS	Open collector output; may discharge a capacitor between intervals. In phase with output.
8	$V+$, V_{CC}	Positive supply voltage is usually between 3 and 15 V.

BLOCK DIAGRAM

The three 5KΩ resistors that are used in its voltage divider network so it called IC 555 timer.



WORKING PRINCIPLE

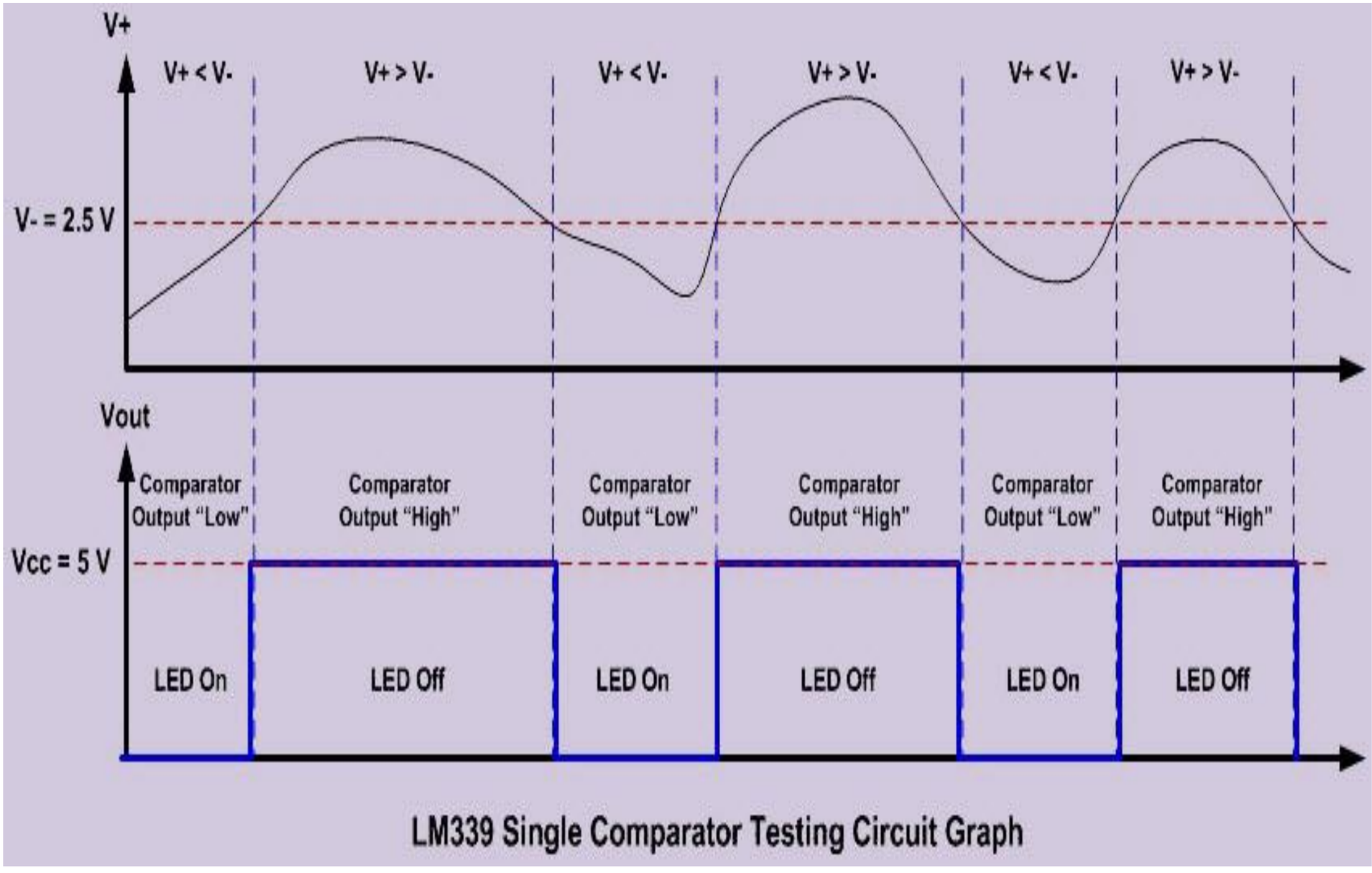
- The voltage divider has three equal 5K resistors. It divides the input voltage (V**cc**) into three equal parts.
- The two comparators are op-amps that compare the voltages at their inputs and saturate depending upon which is greater.
  - The Threshold Comparator saturates when the voltage at the Threshold pin (pin 6) is greater than (2/3)V**cc**.
  - The Trigger Comparator saturates when the voltage at the Trigger pin (pin 2) is less than (1/3)V**cc**

WORKING PRINCIPLE

- The flip-flop is a bi-stable device. It generates two values, a "high" value equal to V**cc** and a "low" value equal to 0V
  - When the Threshold comparator saturates, the flip flop is Reset (R) and it outputs a low signal at pin 3
  - When the Trigger comparator saturates, the flip flop is Set (S) and it outputs a high signal at pin 3

- The transistor is being used as a switch, it connects pin 7 (discharge) to ground when it is closed.
  - When Q is low, Q bar is high. This closes the transistor switch and attaches pin 7 to ground.
  - When Q is high, Q bar is low. This open the switch and pin 7 is no longer grounded

COMPARATOR OUTPUT



LM339 Single Comparator Testing Circuit Graph

USES OF 555 TIMER

- To switch on or off an output after a certain time delay

  i.e. Games timer, Childs mobile, Exercise timer

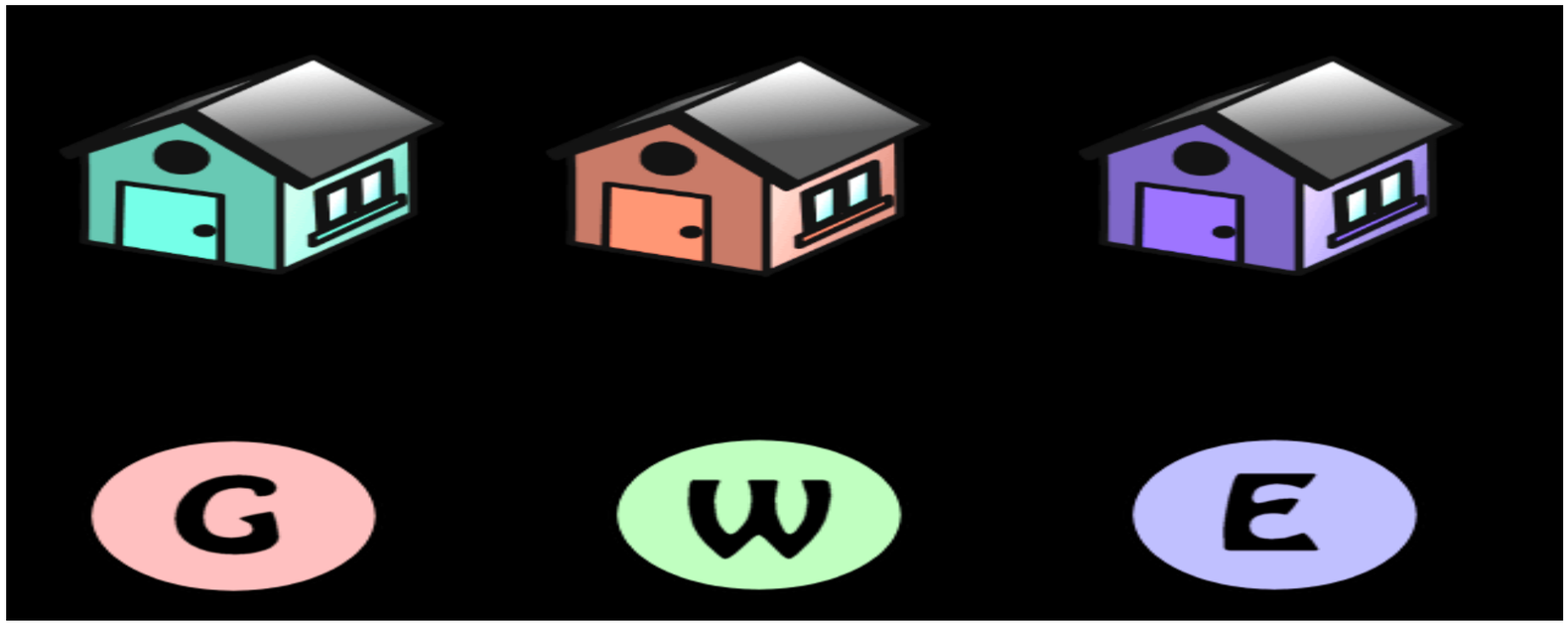
- To continually switch on and off an output

  i.e. Warning lights, Bicycle indicators

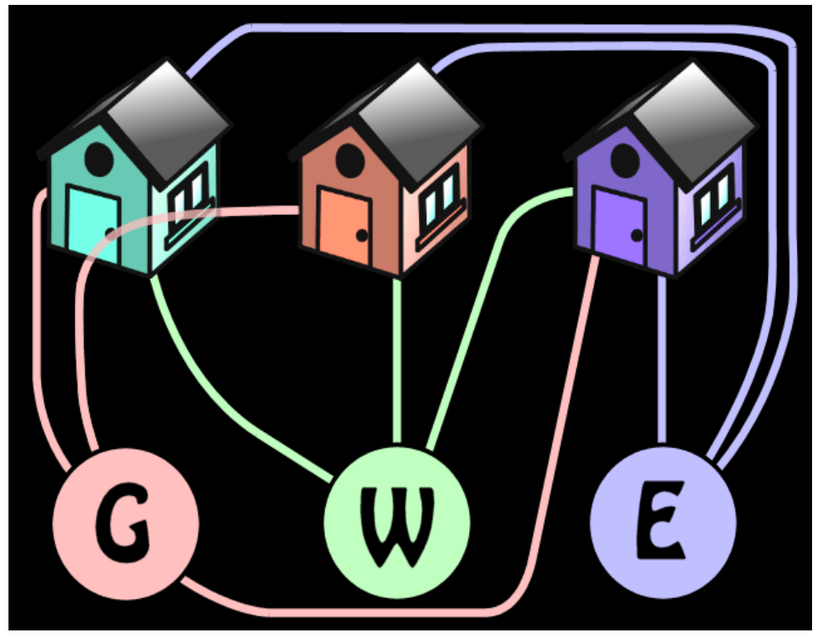
- As a pulse generator

  i.e. To provide a series of clock pulses for a counter

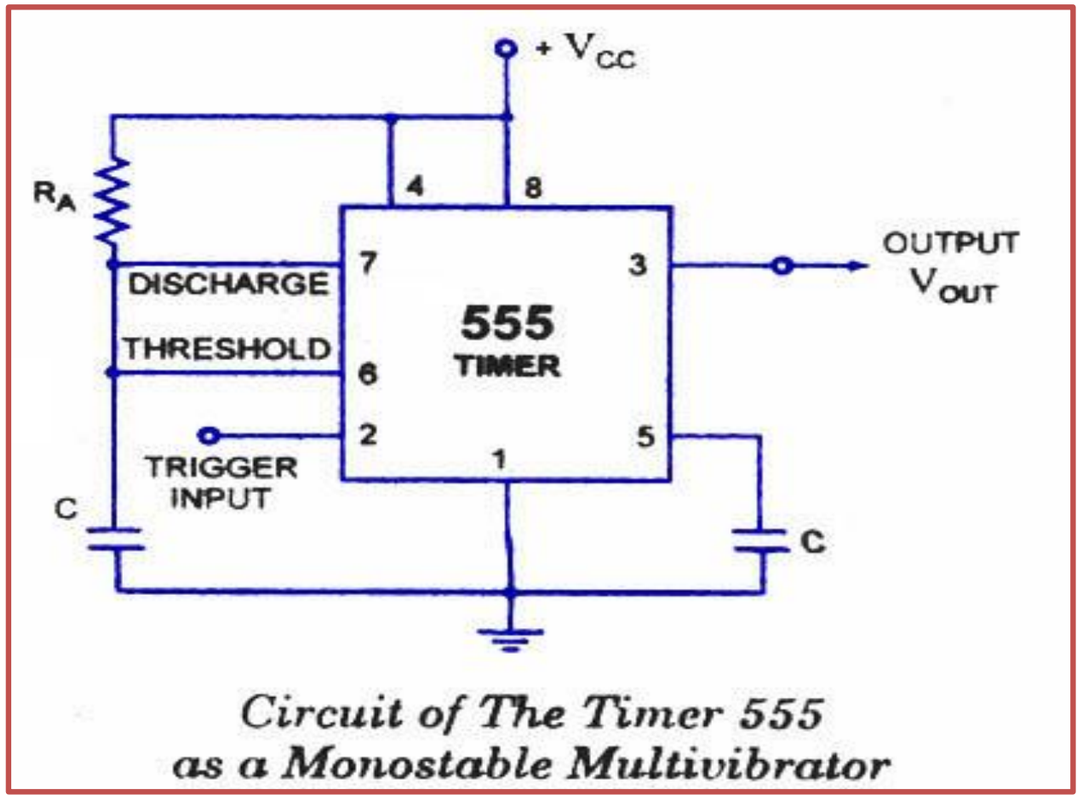
Activity



- A man has built three houses. Nearby there are gas water and electric plants.
- The man wishes to connect all three houses to each of the gas, water and electricity supplies.
- Unfortunately the pipes and cables must not cross each other.
- How would you connect each of the 3 houses to each of the gas, water and electricity supplies?



555 TIMER AS MONOSTABLE MULTIVIBRATOR

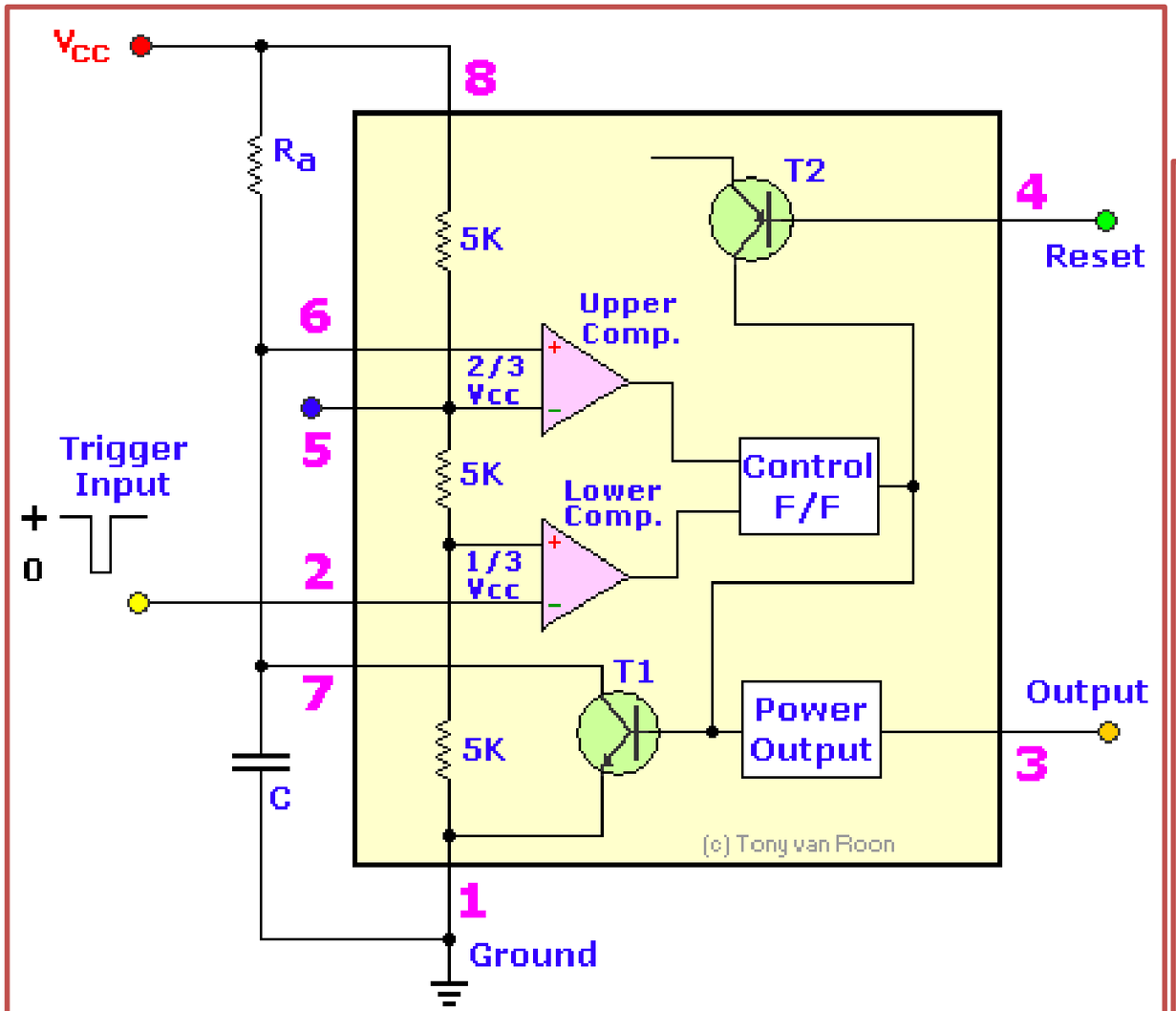


Circuit of The Timer 555 as a Monostable Multivibrator

Description:

- In the standby state, FF holds transistor Q**1** ON, thus clamping the external timing capacitor C to ground. The output remains at ground potential. i.e. Low
- As the trigger passes through V**CC**/3, the FF is set, i.e. Q bar=0, then the transistor Q**1** OFF and the short circuit across the timing capacitor C is released. As Q bar is low , output goes HIGH

MONOSTABLE MULTIVIBRATOR



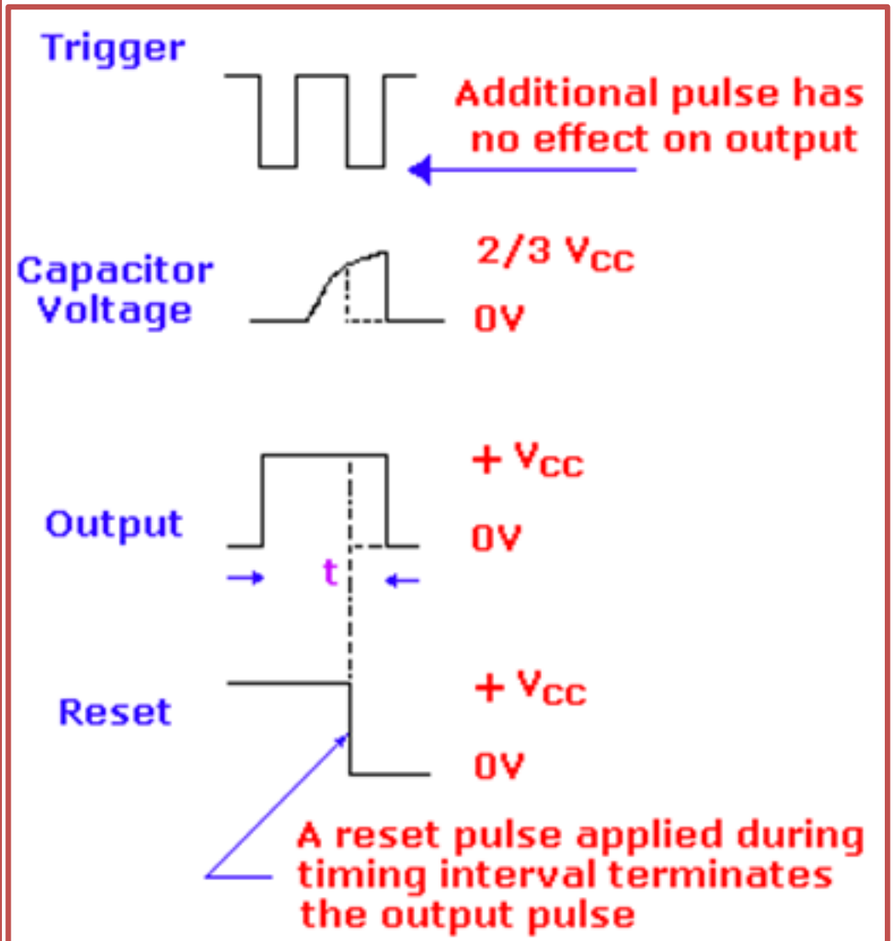


Fig (a): Timer in Monostable Operation with Functional Diagram
Fig (b): Output wave Form of Monostable

OUTPUT

- Voltage across it rises exponentially through R towards V**cc** with a time constant RC.
- After Time Period T, the capacitor voltage is just greater than 2V**cc**/3 and the upper comparator resets the FF, i.e. R=1, S=0. This makes Q bar =1, C rapidly to ground potential.
- The voltage across the capacitor as given by,

$$v_C = V_{CC}(1 - e^{-t/RC})$$

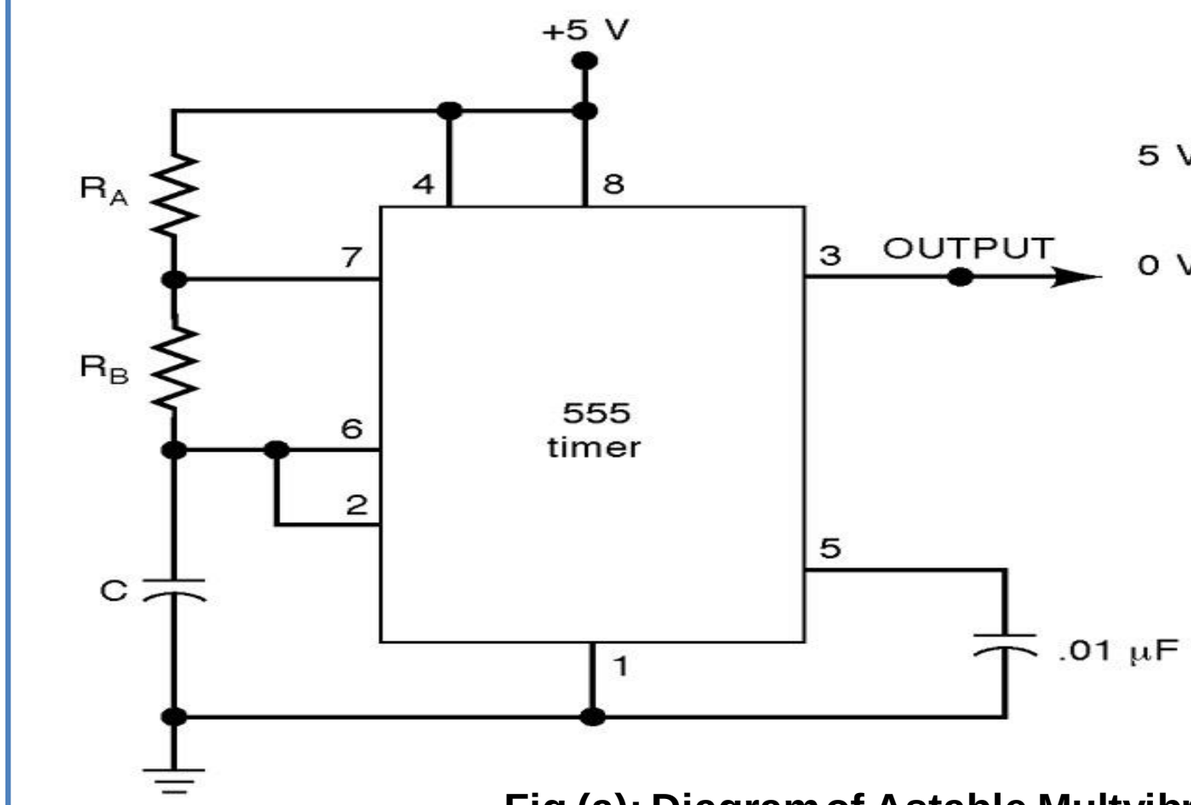
$$t = T, v_C = \frac{2}{3}V_{CC}$$

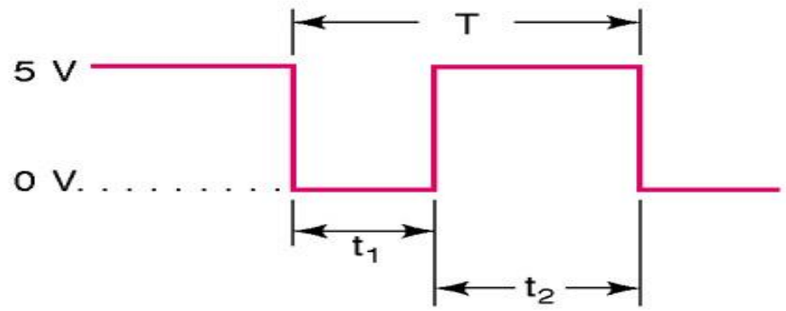
$$\frac{2}{3}V_{CC} = V_{CC}(1 - e^{-T/RC})$$

$$T = RC\ln(\frac{1}{3}) => T = 1.1RC \sec$$

- If –ve going reset pulse terminal (pin 4) is applied, then transistor Q**2-**> OFF, Q**1-**> ON & the external timing capacitor C is immediately discharged.

ASTABLE MULTIVIBRAOR



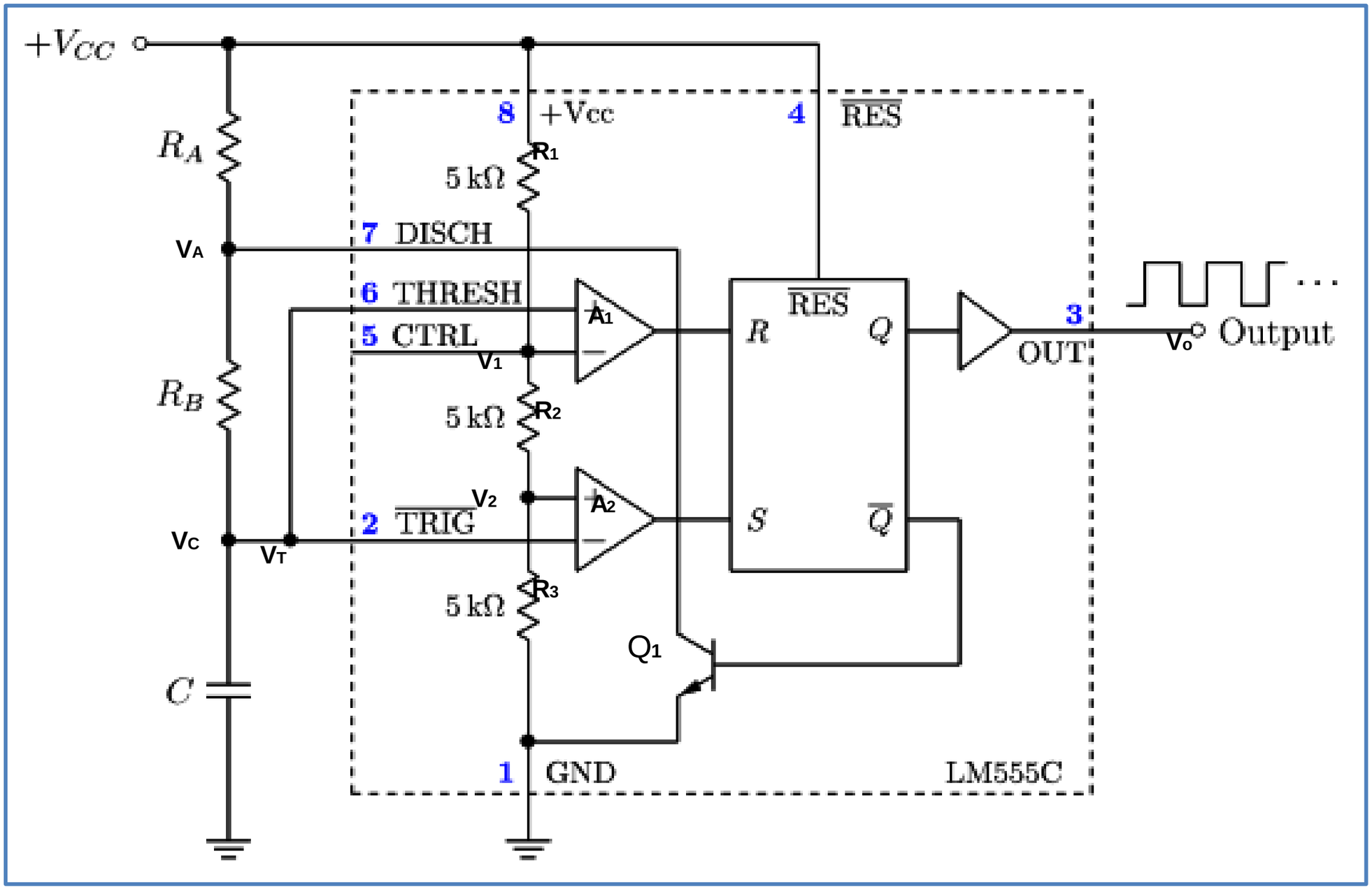


$t_1 = 0.693\ R_B C$
$t_2 = 0.693\ (R_A + R_B)C$
$T = t_1 + t_2$
frequency = 1/T
duty cycle = $t_2/T \times 100\%$
$R_A \geq 1\ k\Omega$
$R_A + R_B \leq 6.6\ M\Omega$
$C \geq 500\ pF$

Fig (a): Diagram of Astable Multvibrator

1 – Ground
2 – Trigger
3 – Output
4 – Reset
5 – FM Input (Tie to ground via bypass cap)
6 – Threshold
7 – Discharge
8 – Voltage Supply (+5 to +15 V)

ASTABLE MULTIVIBRATOR



ASTABLE MULTIVIBRATOR

- Connect external timing capacitor between trigger point (pin 2) and Ground.
- Split external timing resistor R into R**A** & R**B**, and connect their junction to discharge terminal (pin 7).
- Remove trigger input, monostable is converted to Astable multivibrator.
- This circuit has no stable state. The circuits changes its state alternately. Hence the operation is also called free running oscillator

ASTABLE MULTIVIBRATOR

- Resistive voltage divider (equal resistors) sets threshold voltages for comparators

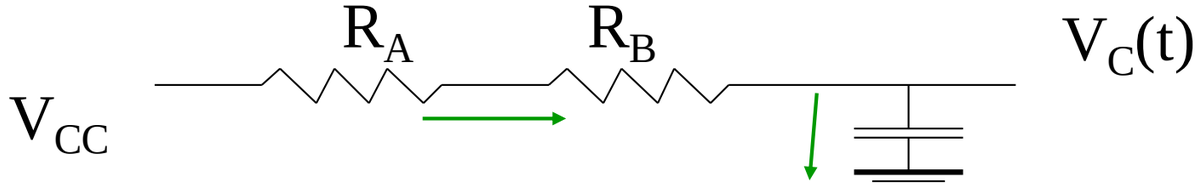
  $V_1 = V_{TH} = 2/3\ V_{CC}$ $V_2 = V_{TL} = 1/3\ V_{CC}$

- Two Voltage Comparators
  - For A**1**, if $V_+ > V_{TH}$ then R =HIGH
  - For A**2**, if $V_- < V_{TL}$ then S = HIGH
- RS FF
  - If S = HIGH, then FF is SET, = LOW, Q**1** OFF, V_{OUT} = HIGH
  - If R = HIGH, then FF is RESET, = HIGH, Q**1** ON, V_{OUT} = LOW
- Transistor Q_1 is used as a Switch

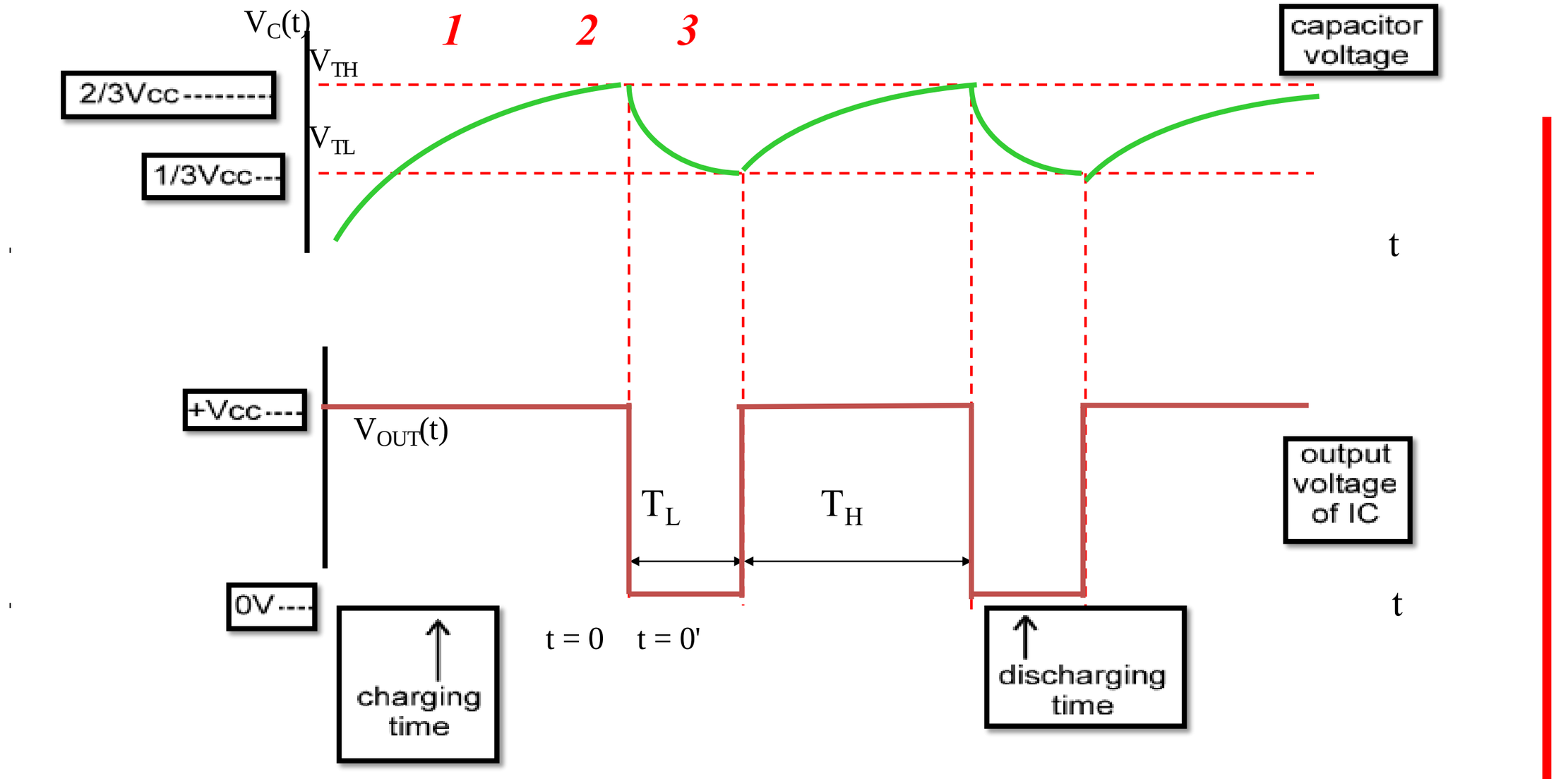
ASTABLE MULTIVIBRATOR

1) Assume initially that the capacitor is discharged.
   a) For A**1**, $V_+ = V_C = 0V$ and for A**2**, $V_- = V_C = 0V$, so R=LOW, S=HIGH, = LOW , Q1 OFF, $V_{OUT} = V_{CC}$
   b) Now as the capacitor charges through R_A & R_B, eventually $V_C > V_{TL}$ so R=LOW & S=LOW.

      FF does not change state.
2) Once $V_C \geq V_{TH}$
   a) R=HIGH, S=LOW, = HIGH ,Q1 ON, $V_{OUT} = 0$
   b) Capacitor is now discharging through R_B and Q_1 to ground.
   c) Meanwhile at FF, R=LOW & S=LOW since $V_C < V_{TH}$.
3) Once $V_C < V_{TL}$
   a) R=LOW, S=HIGH, = LOW , Q1 OFF, $V_{OUT} = V_{CC}$
   b) Capacitor is now charging through R_A & R_B again.



TIMING DIAGRAM OF A 555 ASTABLE MULTIVIBRATOR



BEHAVIOR OF THE ASTABLE MULTIVIBRATOR

- The astable multivibrator is simply an oscillator. The astable multivibrator generates a continuous stream of rectangular off-on pulses that switch between two voltage levels.
- The frequency of the pulses and their duty cycle are dependent upon the RC network values.
- The capacitor C charges through the series resistors R_A and R_B with a time constant $(R_A + R_B)C$.
- The capacitor discharges through R_B with a time constant of R_BC

USES OF THE ASTABLE MULTIVIBRATOR

- Flashing LED’s
- Pulse Width Modulation
- Pulse Position Modulation
- Periodic Timers
- Uses include LEDs, pulse generation, logic clocks, security alarms and so on.

Assessment

1. A555 timer in monostable application mode can be used for
   a) Pulse position modulation
   b) Frequency shift keying
   c) Speed control and measurement
   d) Digital phase detector
   Answer: c
2. How to obtain symmetrical waveform in Astable multivibrator?
   a) Use clocked RS flip-flop
   b) Use clocked JK flip-flop
   c) Use clocked D-flip-flop
   d) Use clocked T-flip-flop
   Answer: b

THANK YOU