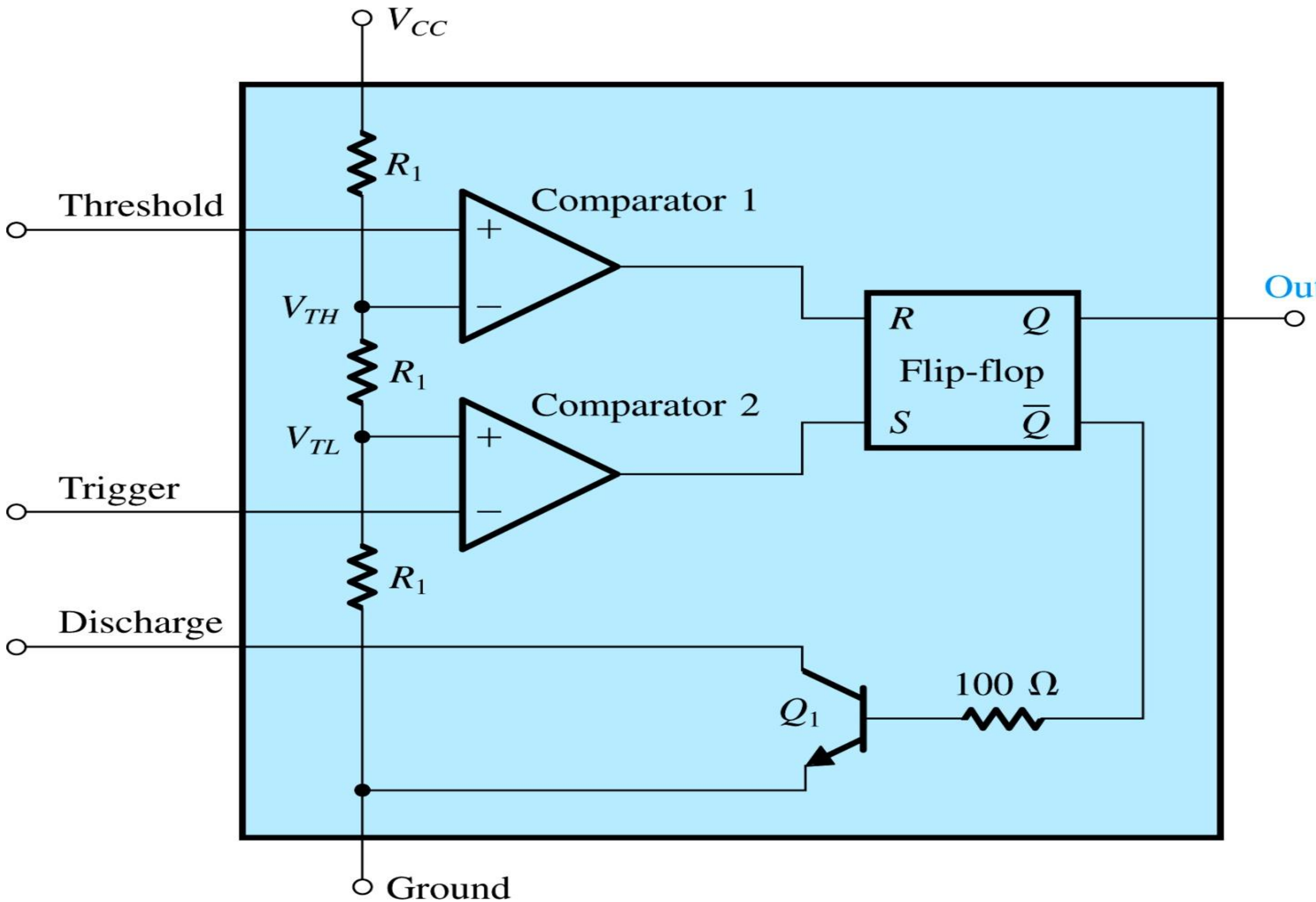
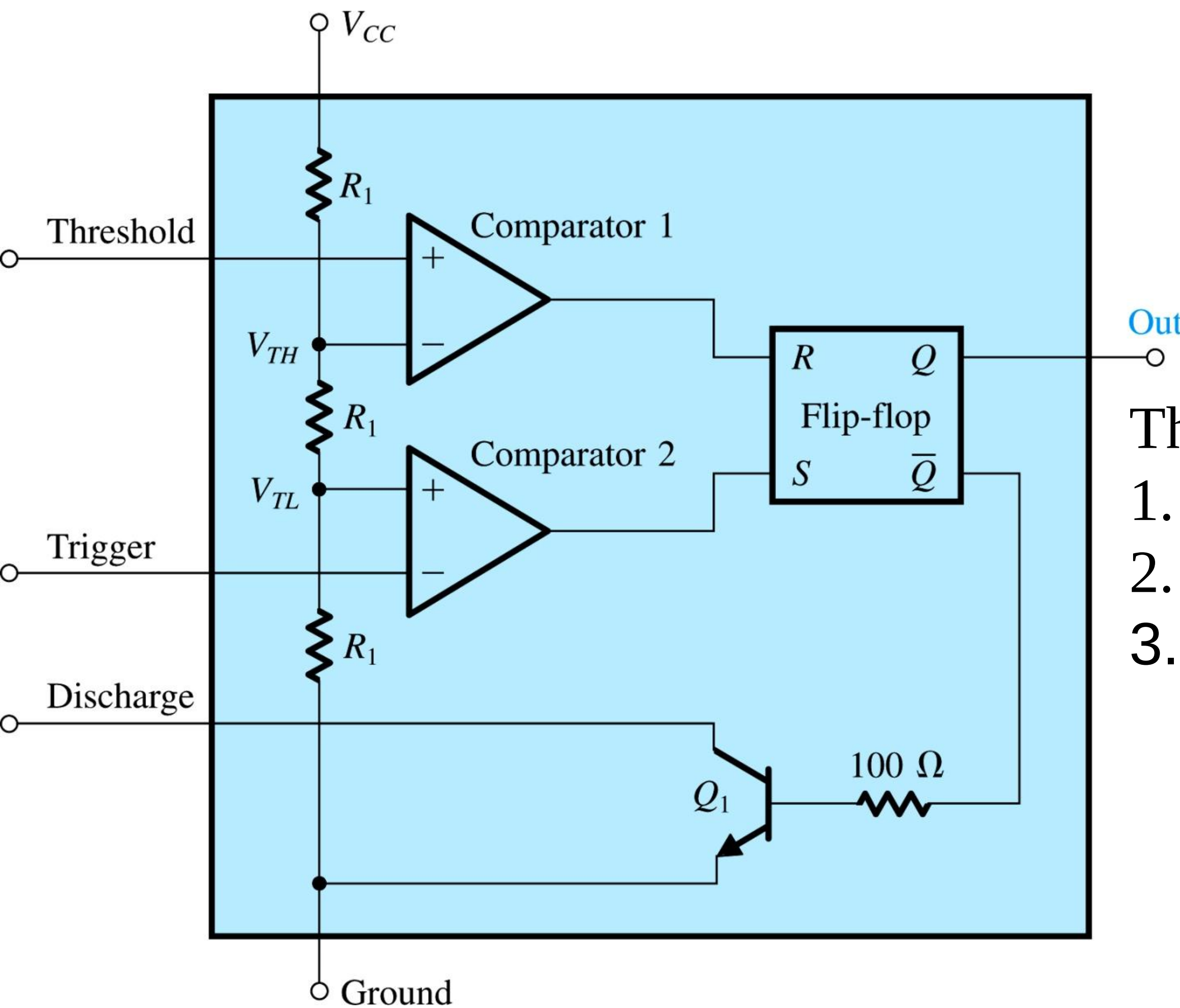
Block Diagram Representation of 555 Timer Circuit



Block Diagram Representation of 555 Timer Circuit



The circuit consists of

1. Two comparators,
2. SR flip-flop,
3. Transistor Q_1 (switch)

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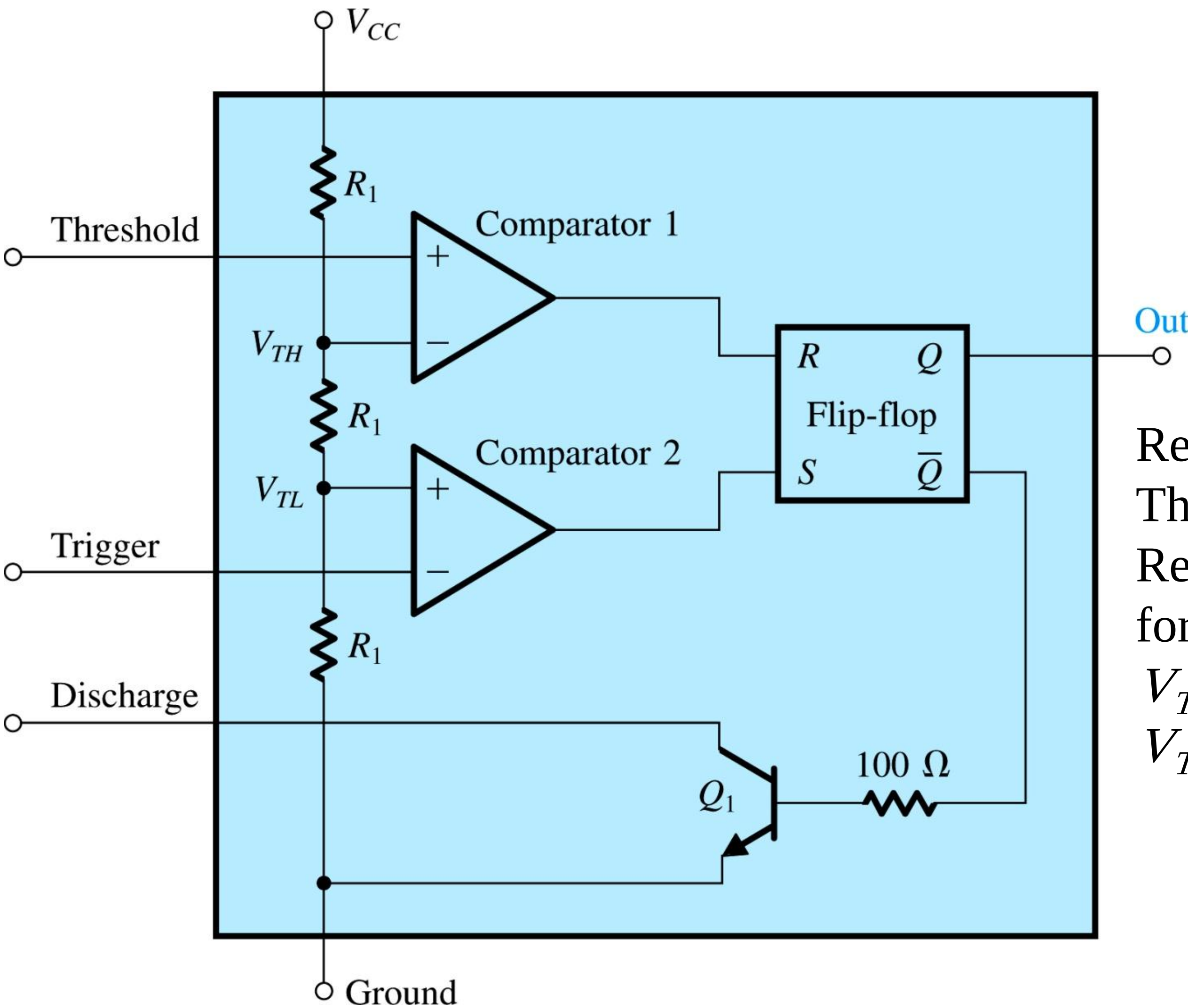
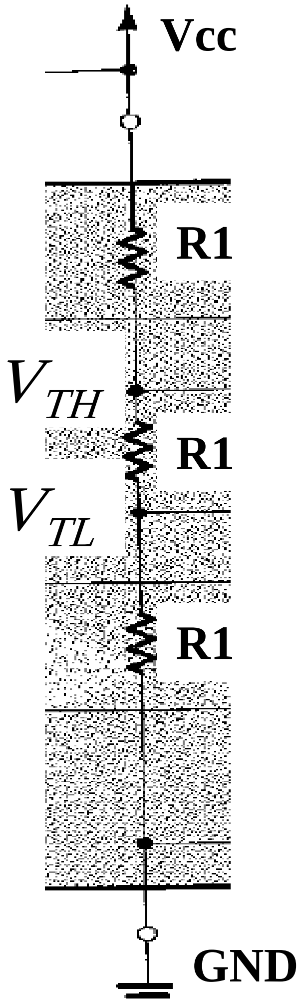


Resistive Voltage Divider,
Three equal-valued resistors
Reference (threshold) voltages
for the two comparators.

$V_{TH} = 2/3\ Vcc$ for comparator 1

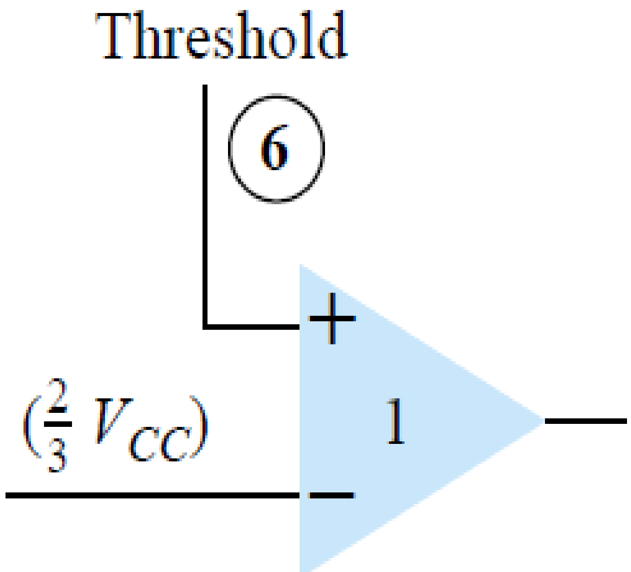
$V_{TL} = 1/3VCC$ for comparator 2

Block Diagram Representation of 555 Timer Circuit



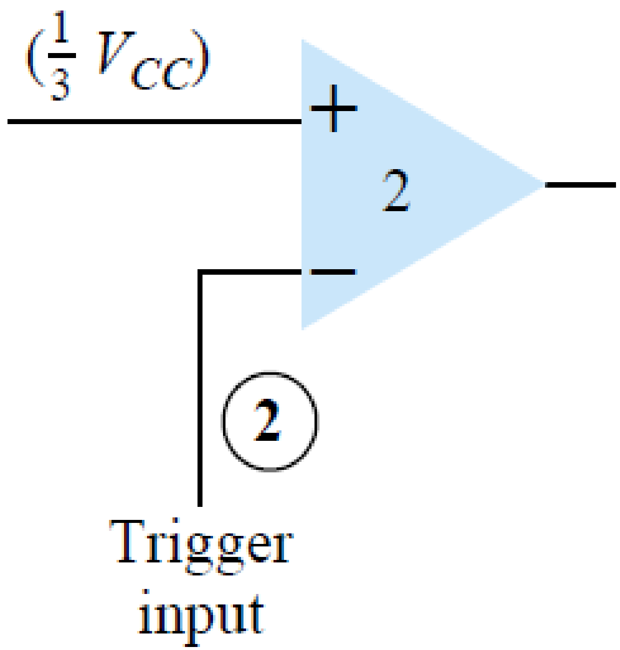
- $V_{TH} = 2/3\ Vcc$ for comparator 1
- $V_{TL} = 1/3Vcc$ for comparator 2

Block Diagram Representation of 555 Timer Circuit



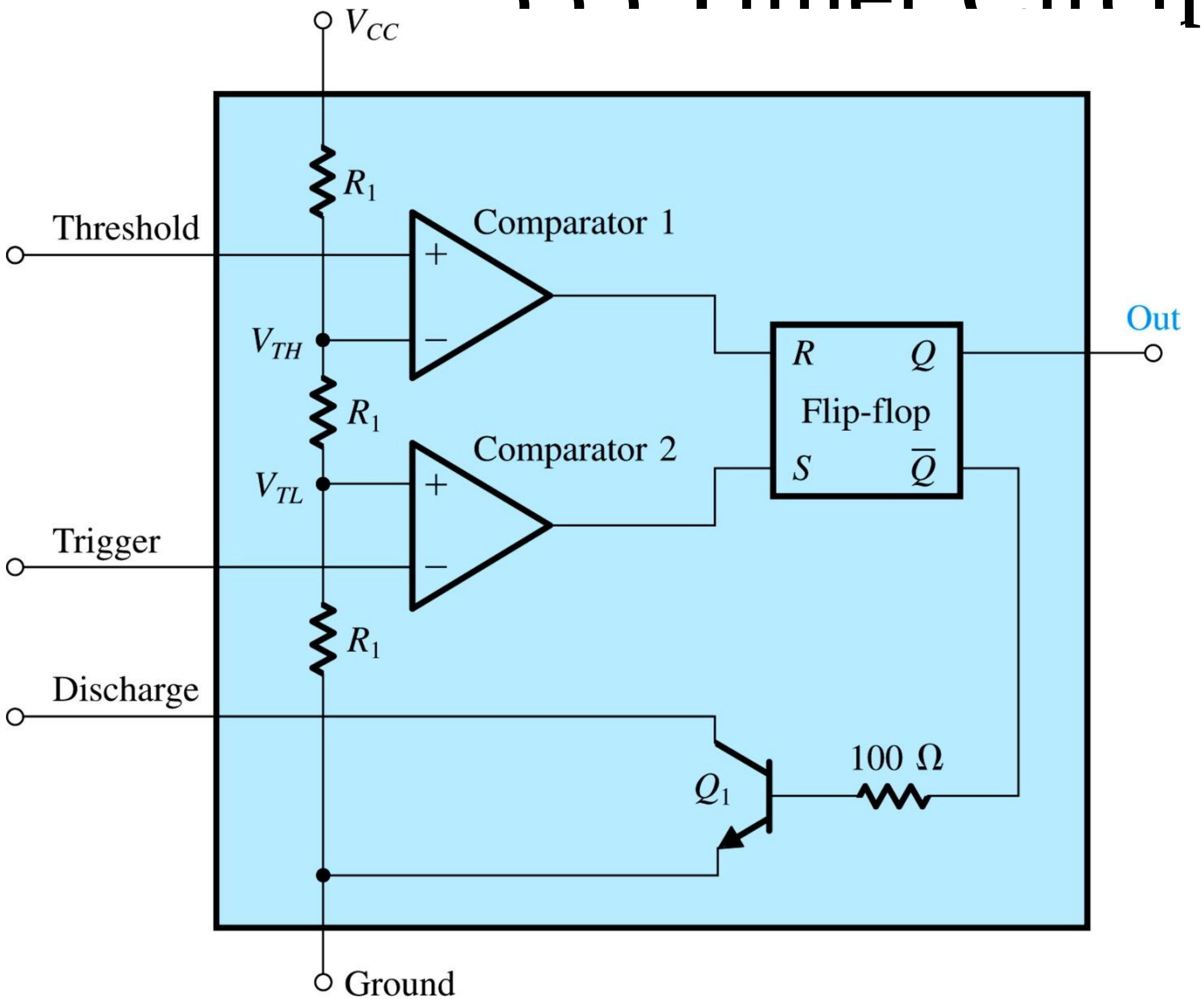
- For Comparator 1
- $V_{TH} = 2/3\ Vcc$
- *IF* $V_6 > V_{TH}$, $V_O = 1$, *High*
- *IF* $V_6 < V_{TH}$, $V_O = 0$, *Low*

Block Diagram Representation of 555 Timer Circuit



- For Comparator 2
- *V_{TL} = 1/3 Vcc*
- *IF $V_2 > V_{TL}$, V_O= 0, Low*
- *IF $V_2 < V_{TL}$, V_O= 1, High*

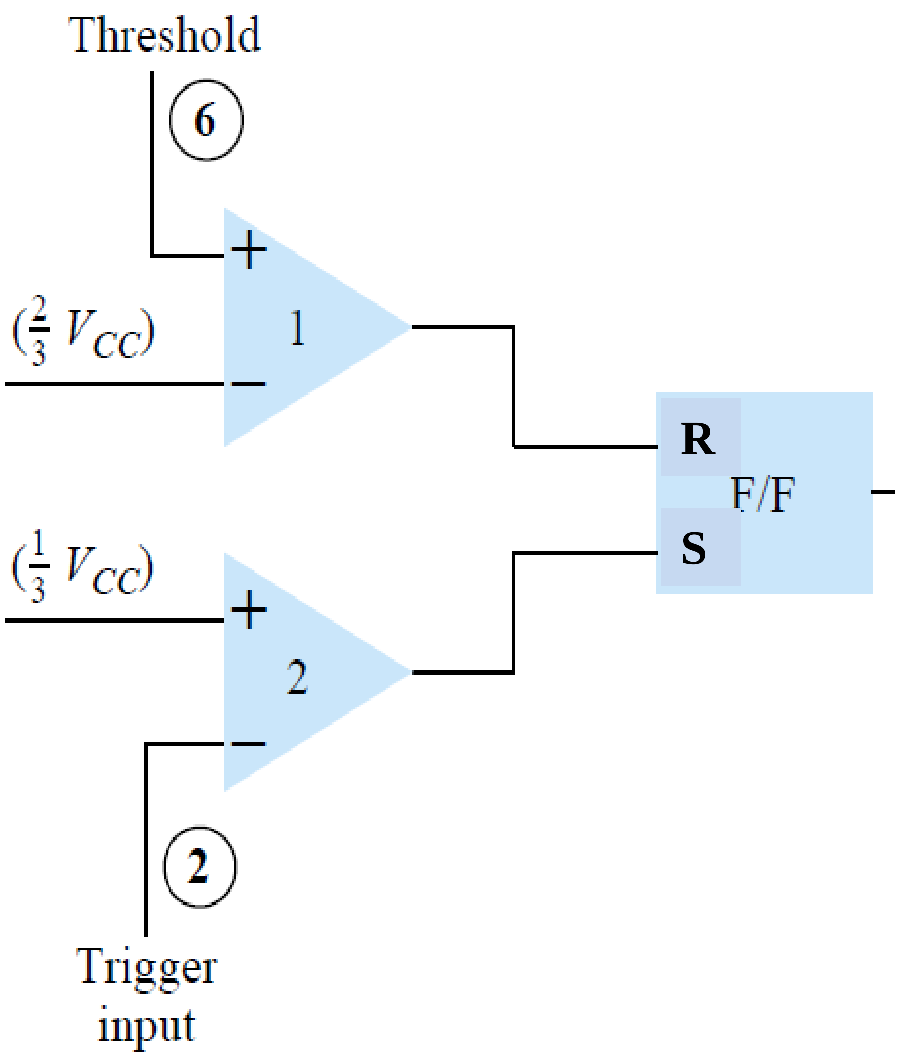
Block Diagram Representation of 555 Timer Circuit



Truth Table for SR Flip Flop

S	R	Q^+
0	0	Q
0	1	0
1	0	1
1	1	X

Block Diagram Representation of 555 Timer Circuit



For Comparator 1

- $V_{TH} = 2/3\ Vcc$
- *IF* $V_6 > V_{TH}$, $V_O = 1$, *High*
- *IF* $V_6 < V_{TH}$, $V_O = 0$, *Low*

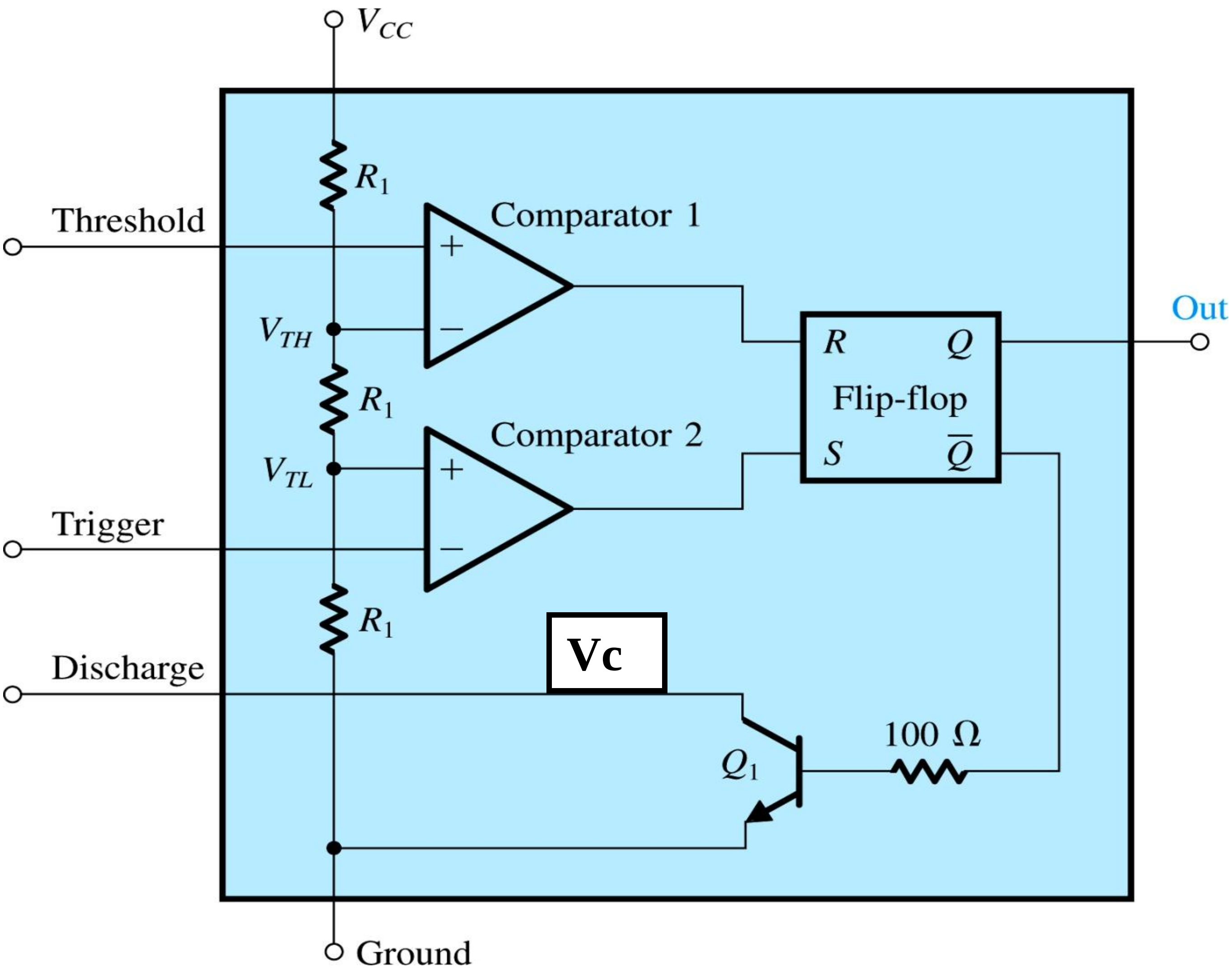
For Comparator 2

- $V_{TL} = 1/3\ Vcc$
- *IF* $V_2 > V_{TL}$, $V_O = 0$, *Low*
- *IF* $V_2 < V_{TL}$, $V_O = 1$, *High*

For RS Latch

- $Q = 0, \bar{Q} = 1$
- $Q = 1, \bar{Q} = 0$

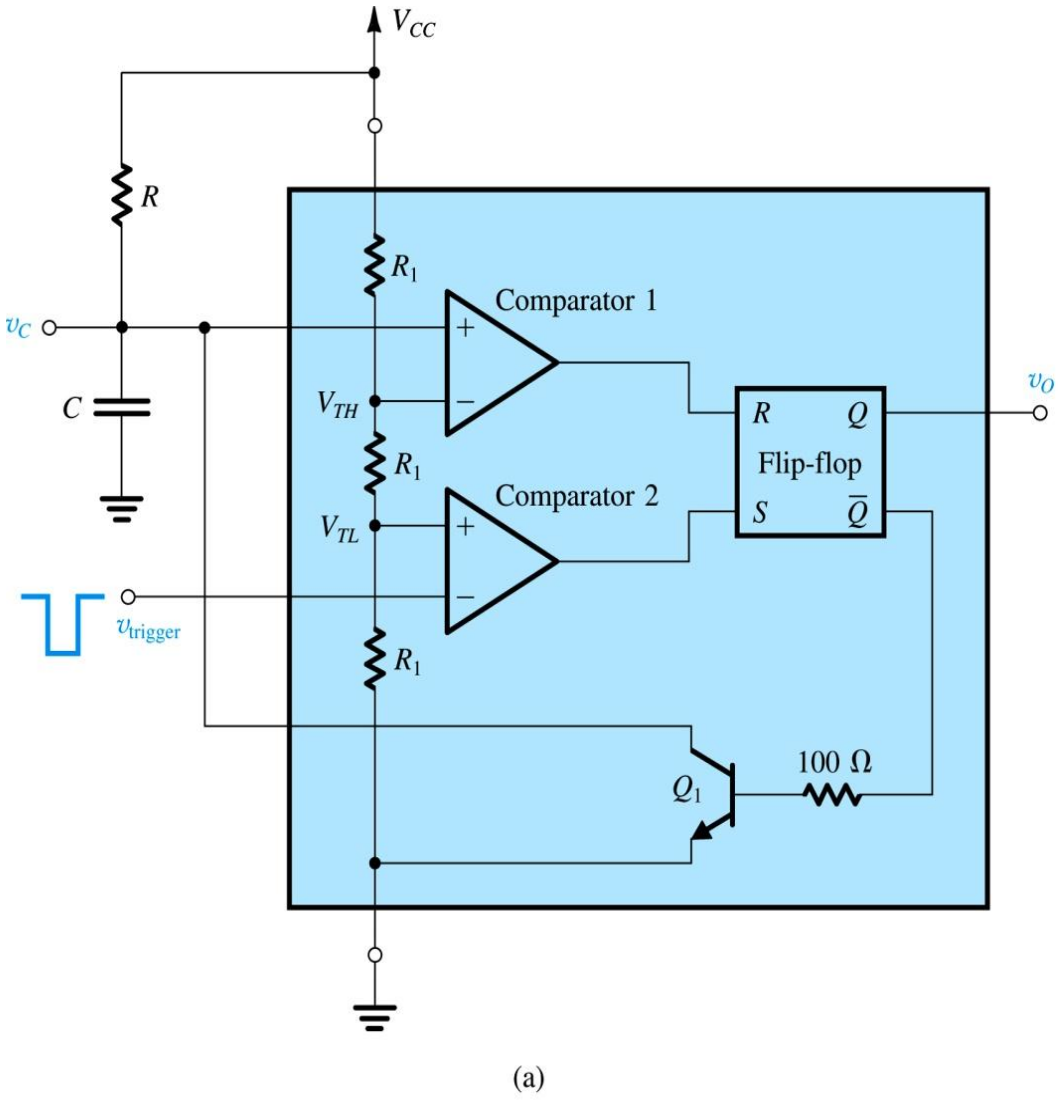
Block Diagram Representation of 555 Timer Circuit

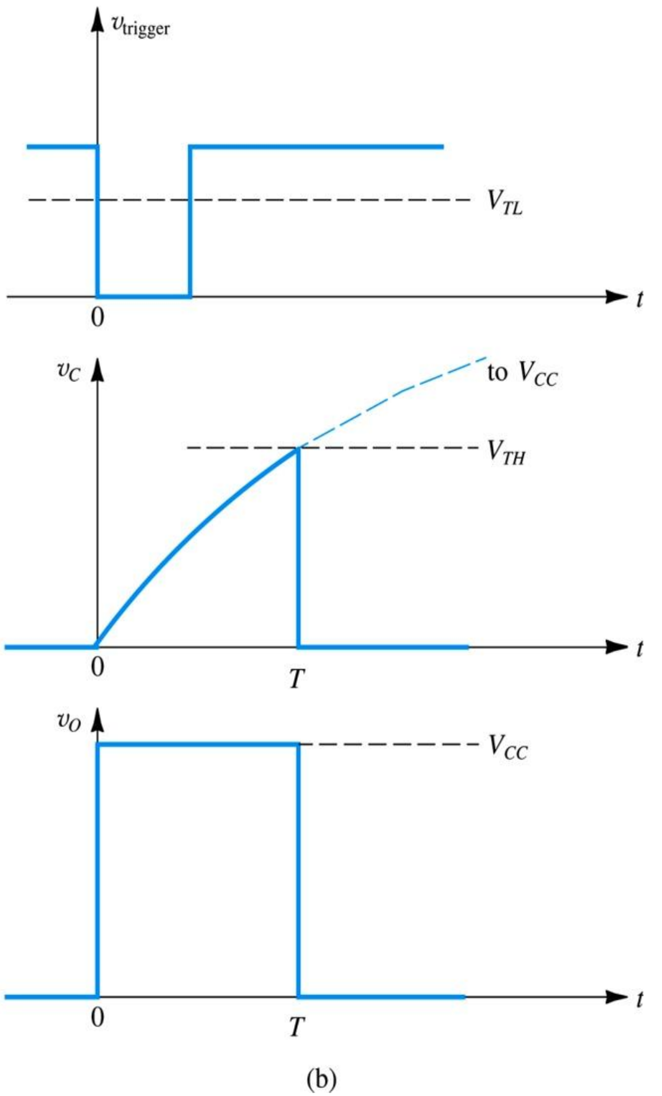


For RS Latch

- $Q = 0, \overline{Q} = 1$
- Vo = 0
- Q1 is ON
- Vc=Vsat= 0.2
- $Q = 1, \overline{Q} = 0$
- Vo = 1
- Q1 is OFF
- $Vc=V_{off}= Vcc$

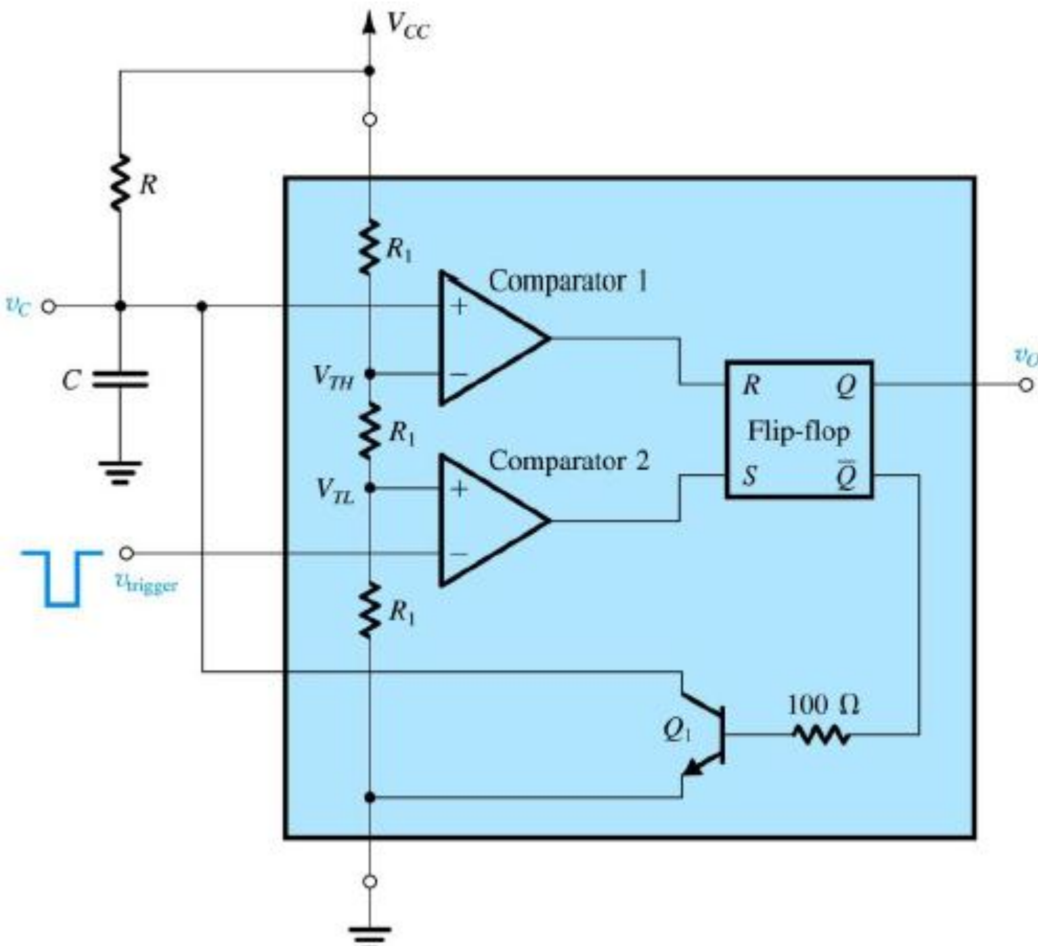
Monostable Multivibrator (555 IC)





(a) The 555 timer connected to implement a monostable multivibrator.
(b) Waveforms of the circuit in.

Monostable Multivibrator (555 IC)

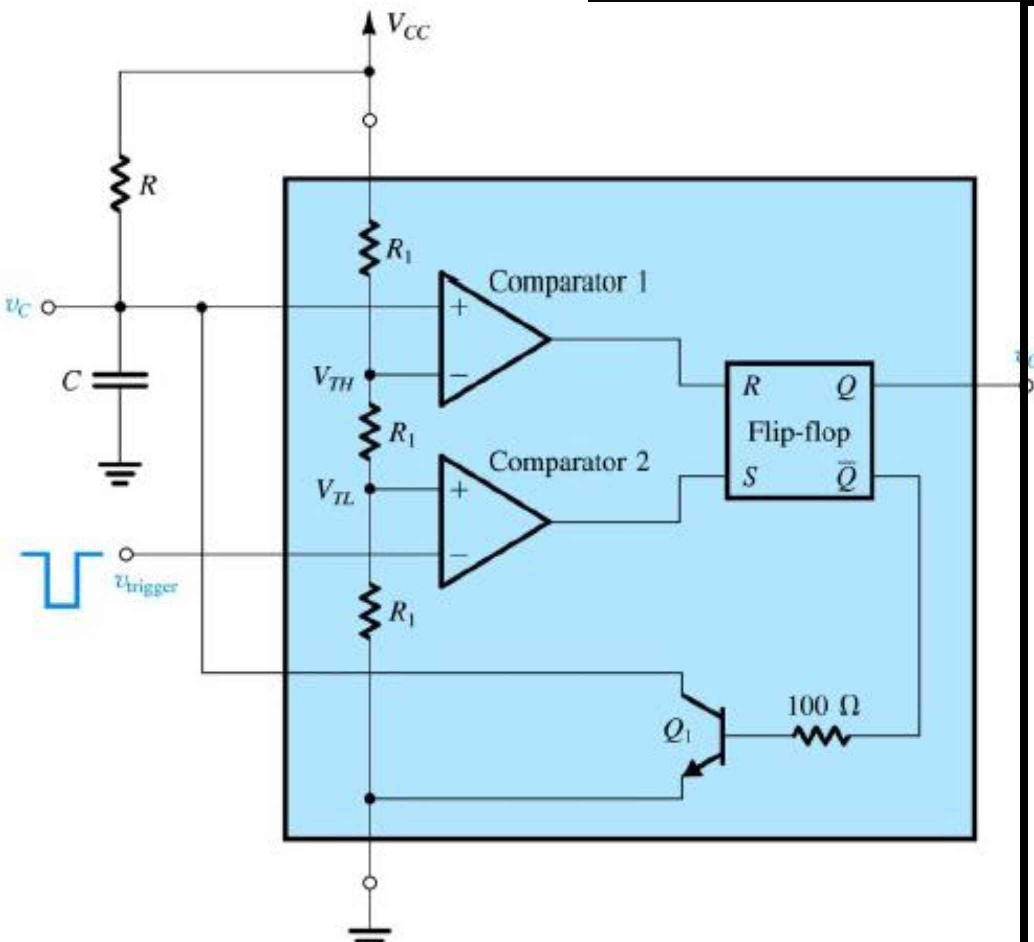


In the stable state , $V_{trigger}$, = *1,* high

SR flip-flop is in the **Reset State**,
Q = 0, output will be low
$\bar{Q}$ = 1, output will be high
Turning ON transistor Q_1
Q_1 ,is saturated
Vc will be close to 0 V,
Comparator1 output will be low
$V_{trigger}$, = *1,* high (greater than V_{TL})
Comparator2 output will be low
SR flip-flop is in the reset state,
Q = 0, low
Vo = 0 V , low

Monostable Multivibrator (555 IC)

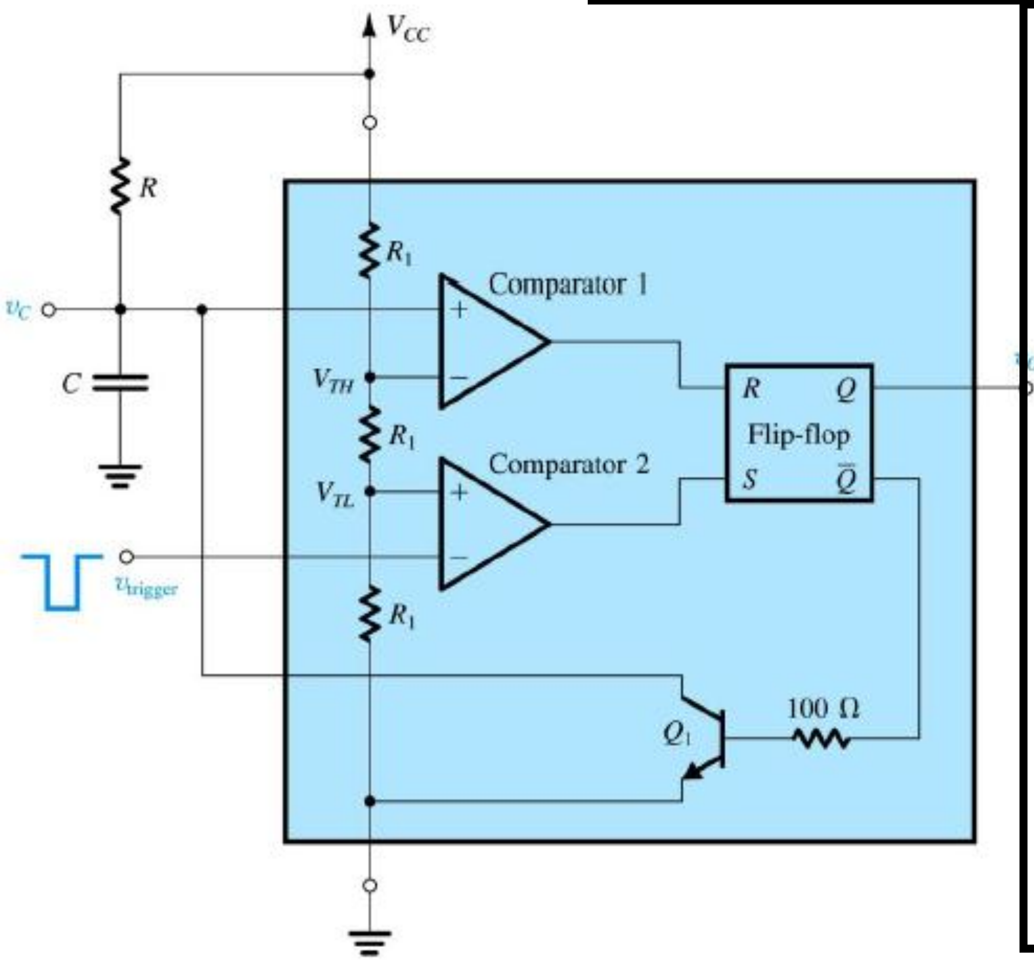
Triggering monostable multivibrator,
a negative input pulse is applied on $V_{trigger}$



$V_{trigger} = 0$, low (lower than V_{TL})
Comparator2 output will be high
SR flip-flop is in the **Set State**,
Q = 1, output will be high
$\bar{Q}$ = 0, output will be low
Turning OFF transistor Q_1
Capacitor C now begins to charge up through resistor R, and its voltage Vc rises exponentially toward Vcc,
Monostable multivibrator is now in its **Quasi-Stable state**.

Monostable Multivibrator (555 IC)

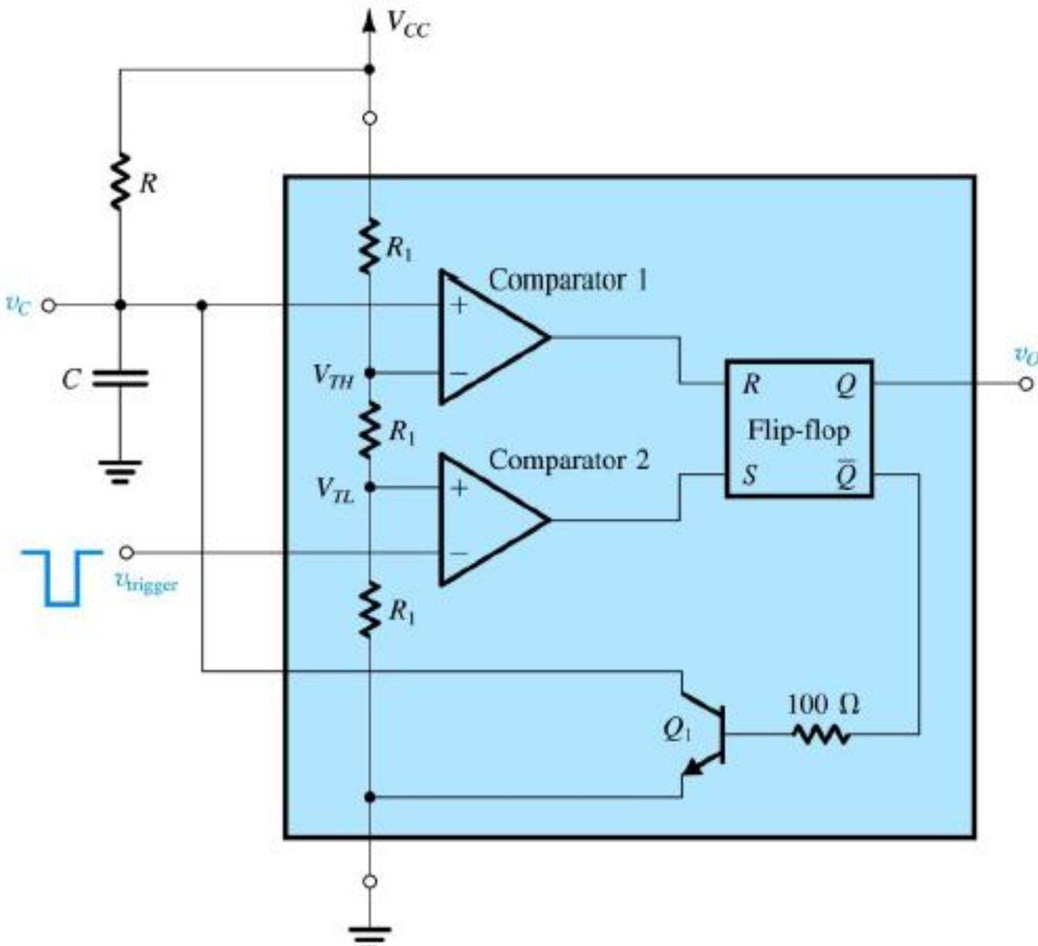
Triggering monostable multivibrator,
a negative input pulse is applied on $V_{trigger}$



Charging *Vc* until reaches, begins to exceed, *VTH,*
Comparator1 output will be high
SR flip-flop is in the **Ret State**,
Q = 0, LOW
$\bar{Q}$ = 1, High
Transistor Q_1 on *(Vsat = 0.2V)*
Transistor Q_1 rapidly discharges capacitor C, causing Vc to go to 0V.
When the flip-flop is reset
Q output goes low,
Vo = 0 V.

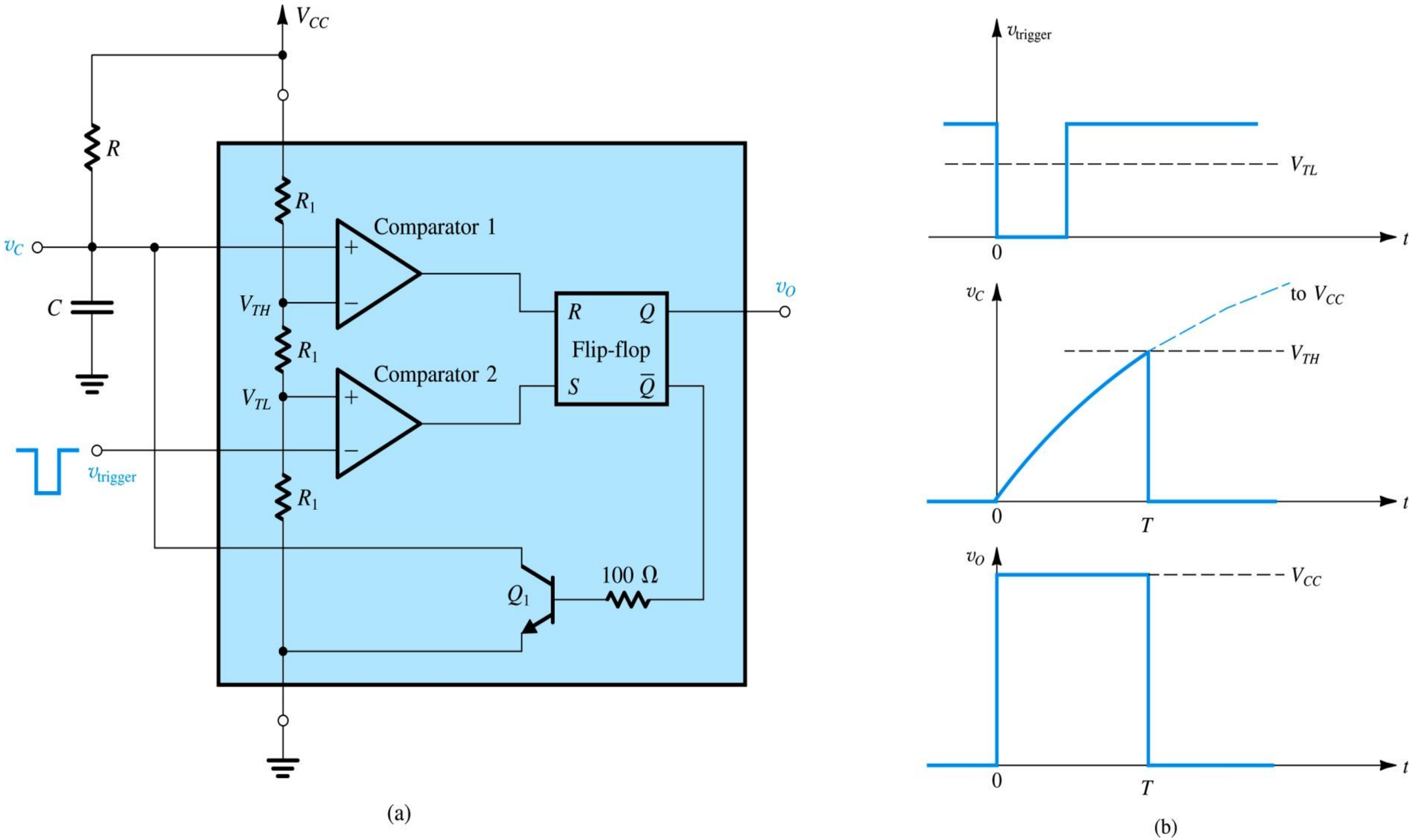
Monostable Multivibrator (555 IC)

Triggering monostable multivibrator,
a negative input pulse is applied on $V_{trigger}$



When the flip-flop is **Reset** its Q output goes low, Vo goes back to 0 V. The monostable multivibrator is now back in its stable state It is ready to receive a new triggering pulse.

Monostable Multivibrator (555 IC)



(a) The 555 timer connected to implement a monostable multivibrator.
(b) Waveforms of the circuit in.

Monostable Multivibrator (555 IC)

The exponential waveform of V_c can be expressed as

$$V_C = V_{final} - (V_{final} - V_{initial})e^{-t/\tau}$$

$$V_C = V_{CC} - (V_{CC} - 0)e^{-t/\tau}$$

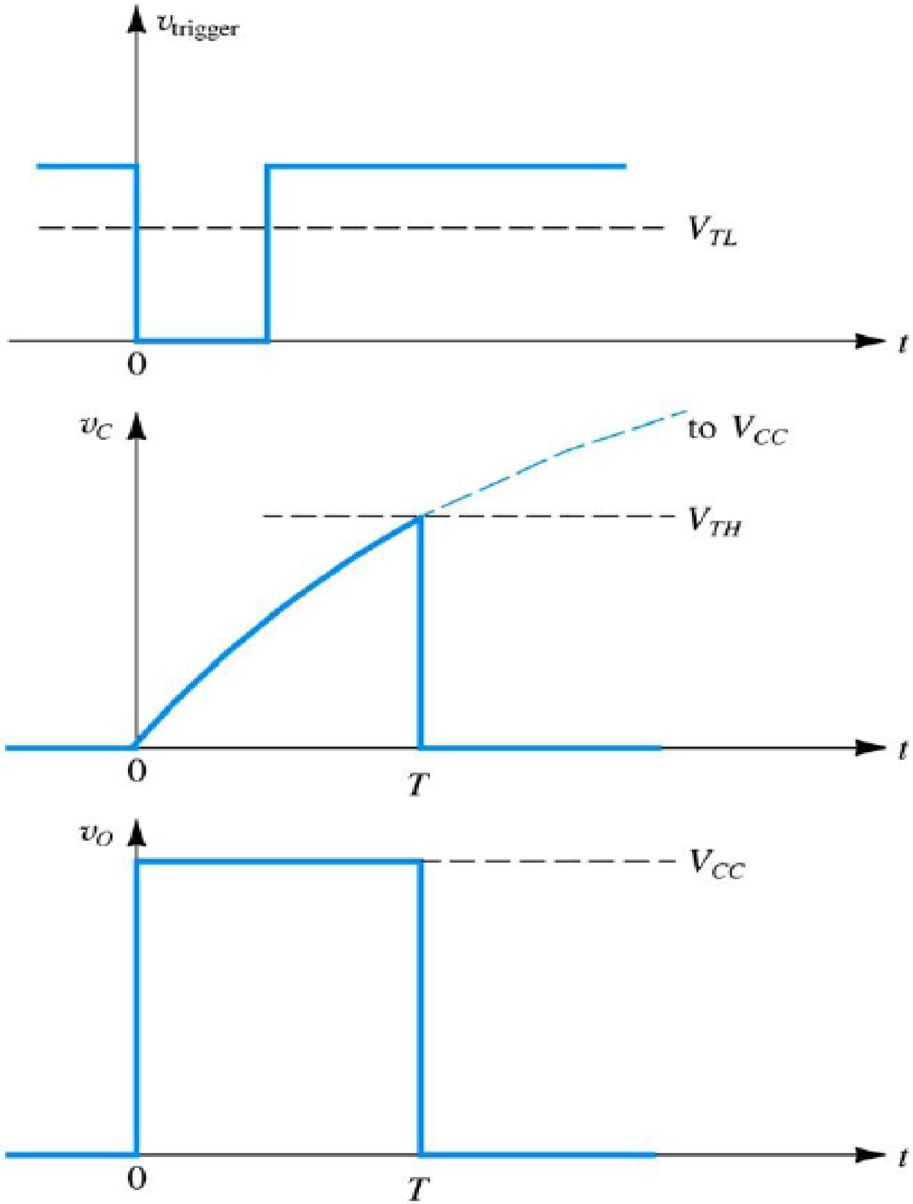
$$V_C = V_{CC}(1 - e^{-t/\tau})$$

$$where \qquad \tau = RC$$

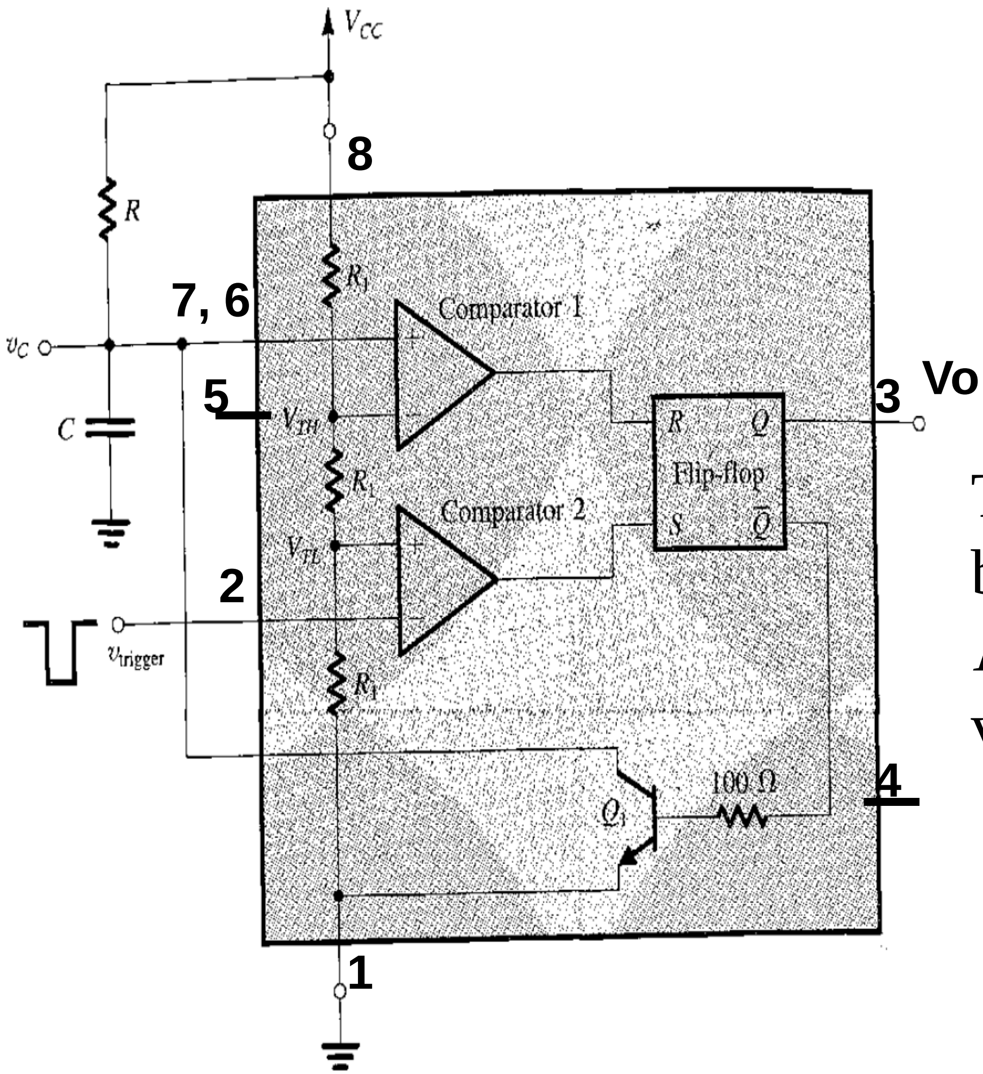
$$V_C = V_{TH} = \frac{2}{3}V_{CC} \qquad at \qquad t = T$$

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

$$T = RC\ln 3 \cong 1.1RC$$



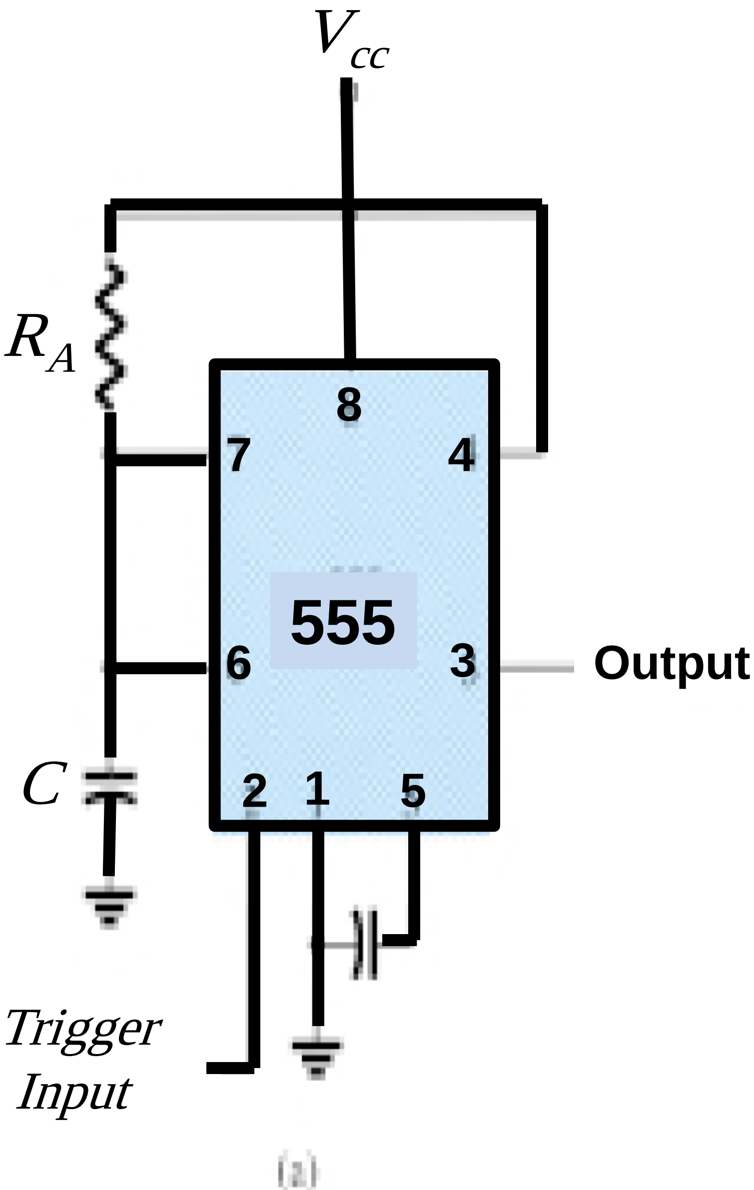
Monostable Multivibrator (555 IC)

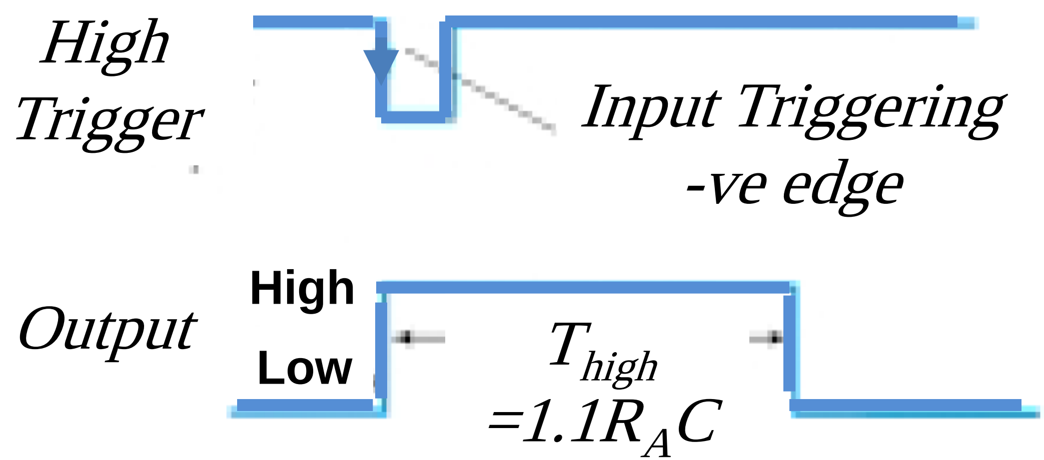


$$\boxed{T = RC\ln 3 \cong 1.1RC}$$

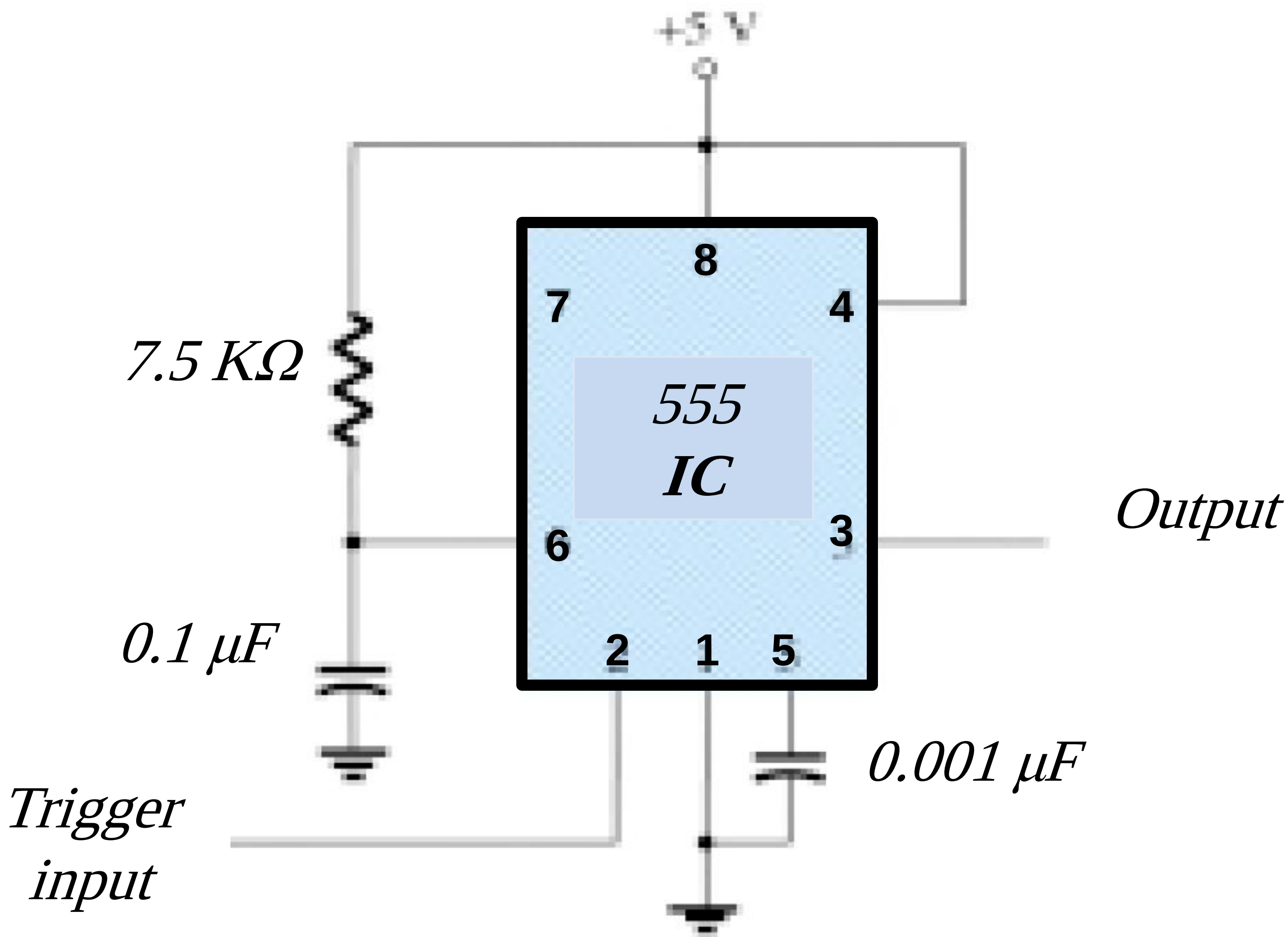
Thus the pulse width is determined by the external components *C* and *R,* which can be selected to have values as precise as desired.

Monostable Multivibrator (555 IC)



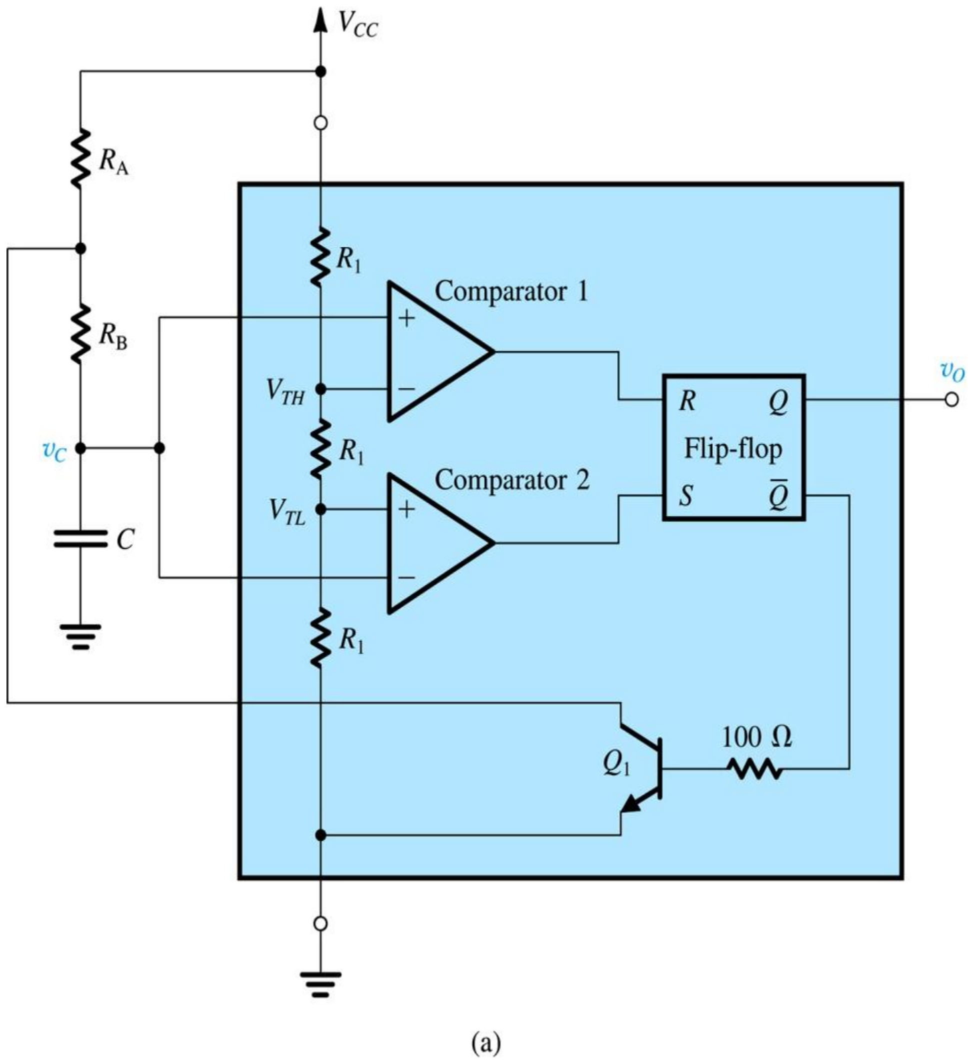


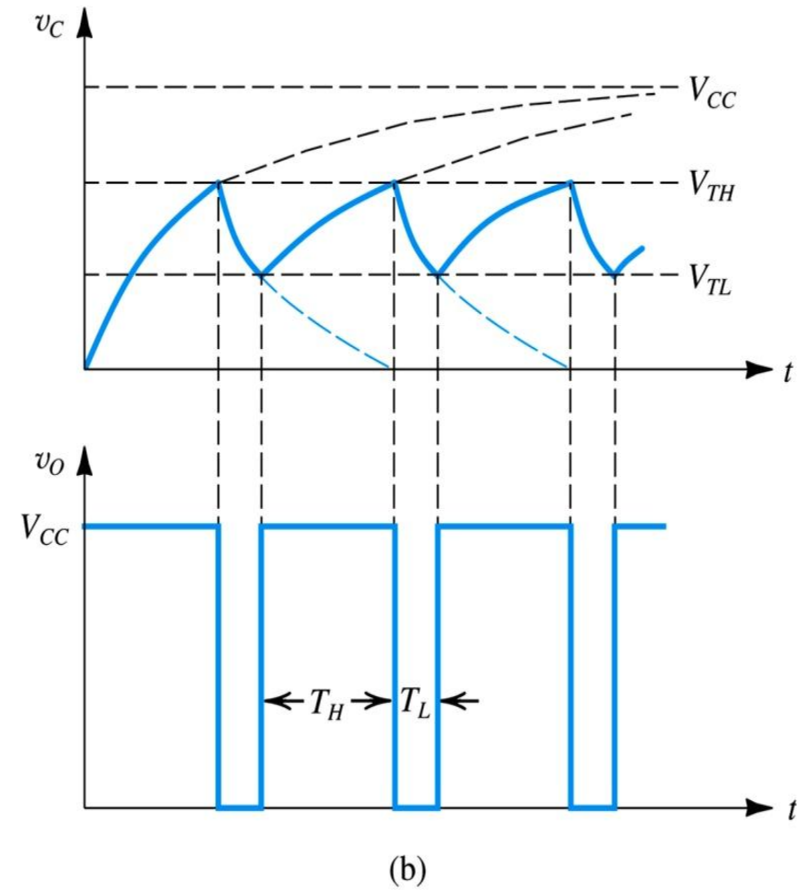
Monostable Multivibrator (555 IC)



$$T_{\text{high}} = 1.1R_AC = 1.1(7.5 \times 10^3)(0.1 \times 10^{-6}) = \mathbf{0.825\ ms}$$

Astable Multivibrator (555 IC)





(a) 555 timer connected to implement an astable multivibrator.
(b) Waveforms of the circuit in.

Astable Multivibrator (555 IC)

The expression of T_H

C charges from V_{TL} *to* V_{cc}

$$V_C = V_{final} - (V_{final} - V_{initial})e^{-t/\tau}$$

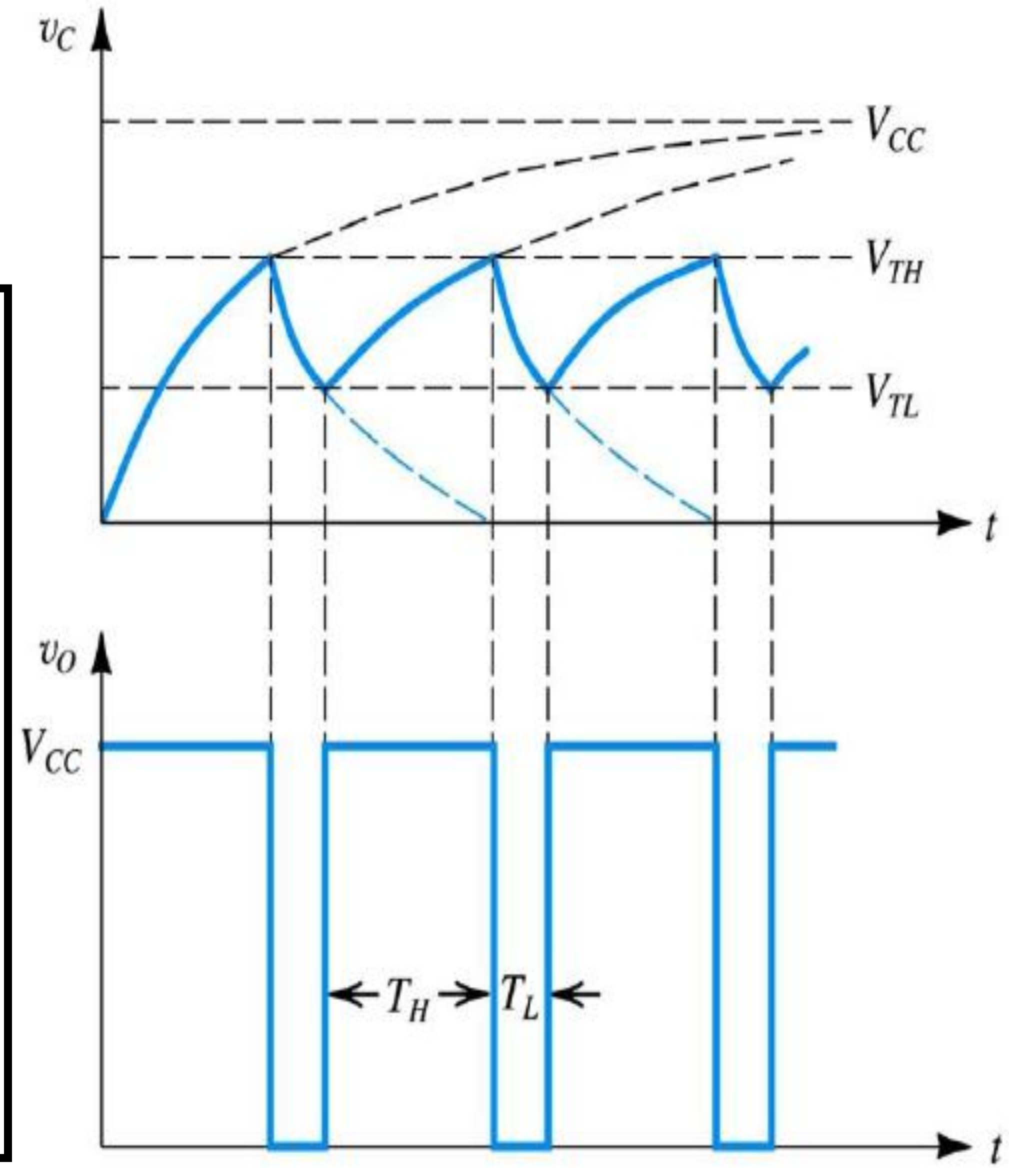
$$V_C = V_{CC} - (V_{CC} - V_{TL})e^{-t/\tau}$$

$$V_C = V_{CC} - (V_{CC} - \frac{1}{3}V_{CC})e^{-t/\tau}$$

$$where \qquad \tau = (R_A + R_B)C$$

$$V_C = V_{TH} = \frac{2}{3}V_{CC} \qquad at \qquad t = T_H$$

$$T_H = 0.69(R_A + R_B)C$$



Astable Multivibrator (555 IC)

The expression of T_L

C discharges from V_{TH} to 0

$$V_C = V_{final} - (V_{final} - V_{initial})e^{-t/\tau}$$

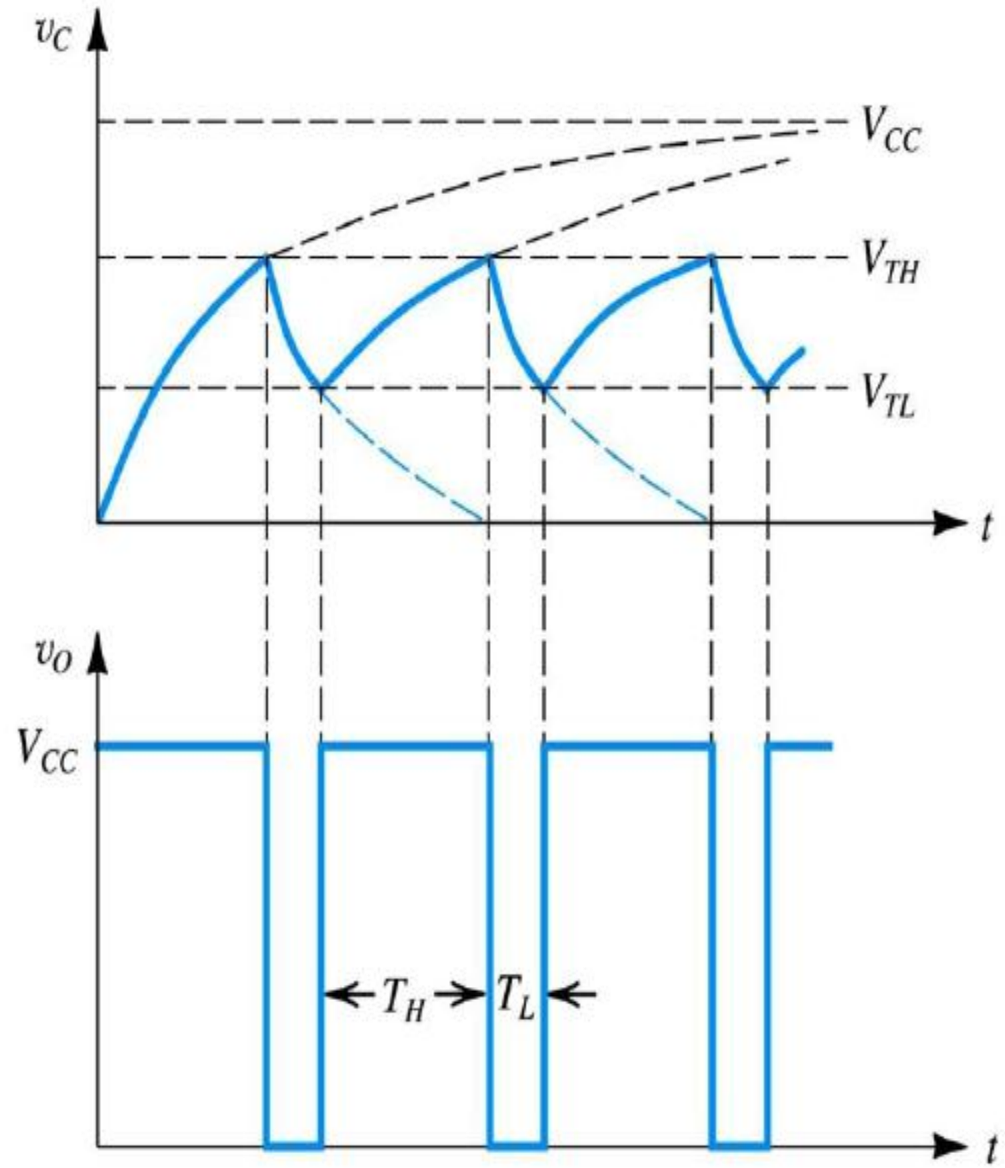
$$V_C = 0 - (0 - V_{TH})e^{-t/\tau}$$

$$V_C = 0 - (0 - \frac{2}{3}V_{CC})e^{-t/\tau}$$

$$where \qquad \tau = R_B C$$

$$V_C = V_{TL} = \frac{1}{3}V_{CC} \qquad at \qquad t = T_L$$

$$T_L = 0.69 R_B C$$



Astable Multivibrator (555 IC)

$$f = \frac{1}{T} = \frac{1}{T_H + T_L}$$

$$f = \frac{1}{0.69(R_A + 2R_B)C}$$

$$Duty\,cycle = \frac{T_H}{T_H + T_L}$$

$$Duty\,cycle = \frac{R_A + R_B}{R_A + 2R_B}$$