Faculty of Engineering

MEP382: Design of Applied Measurement Systems

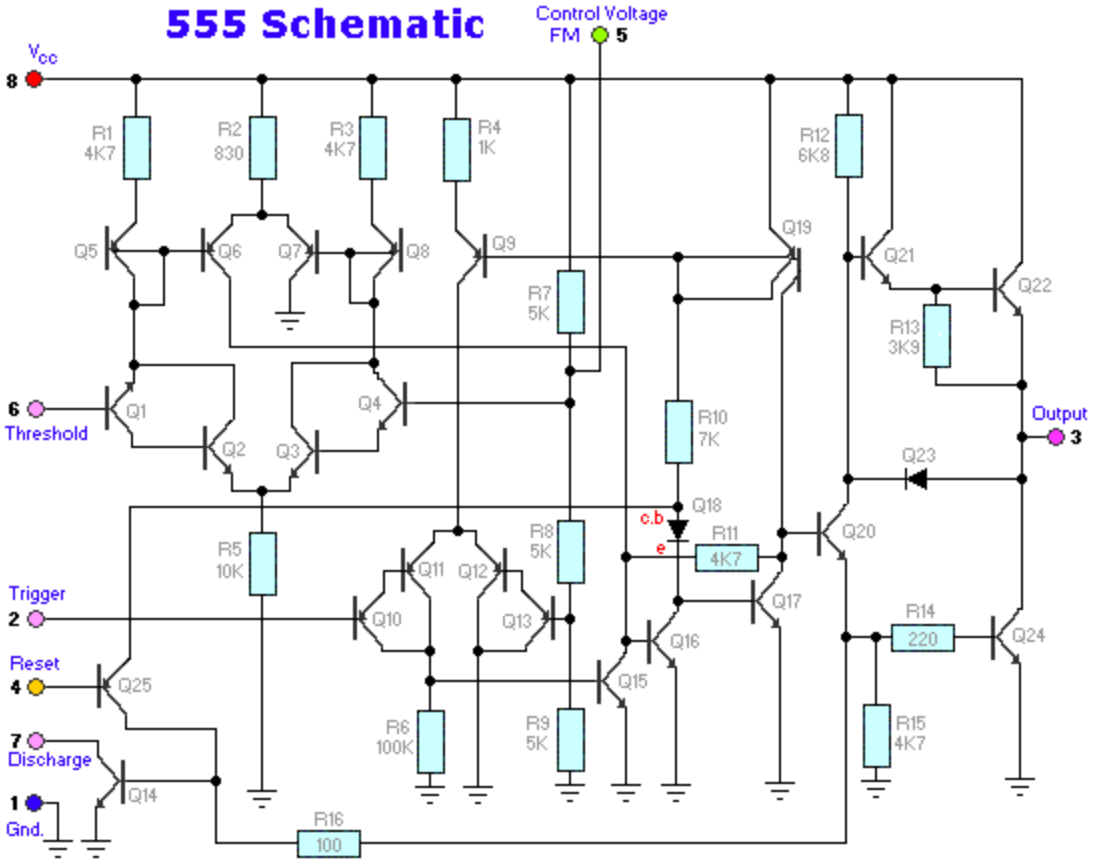
Lecture 14:

555 Timers

555 TIMER IC HISTORY

- The 555 timer IC was first introduced around 1971 by the Signetics Corporation as the SE555/NE555
- Initially it was called "**The IC Time Machine**"
- It provided circuit designers with a relatively cheap, stable, and user-friendly integrated circuit for both ***monostable*** and ***astable*** applications.
- Since this device was first made commercially available, a multitude of novel and unique circuits have been developed
- The past ten years some manufacturers stopped making these timers
- Yet other companies, like NTE (a subdivision of Philips) picked up where some left off

555 Timer Schematic Diagram

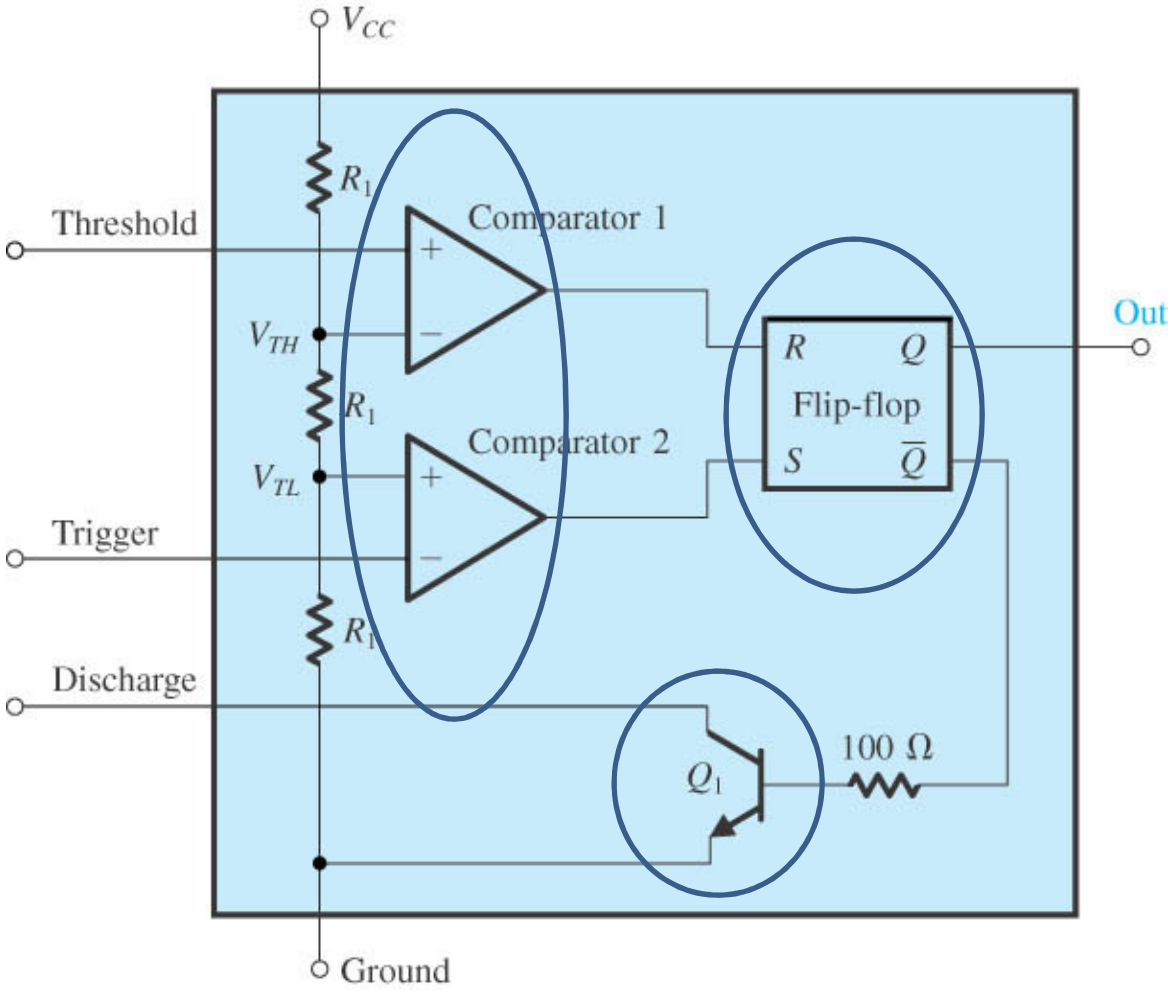


It consists of 23 transistors, 2 diodes, and 16 resistors.

Applications of 555 Timers

- Monostable &Astable Multivibrators
- Waveform generators
- Burglar Alarms
- Measurement ,Process & Control Circuits
- Missing pulse detectors
- Traffic light control
- Automatic Battery chargers
- Logic probes
- DC to DC Converters etc.

Simplified Block Diagram representation of 555 Timer

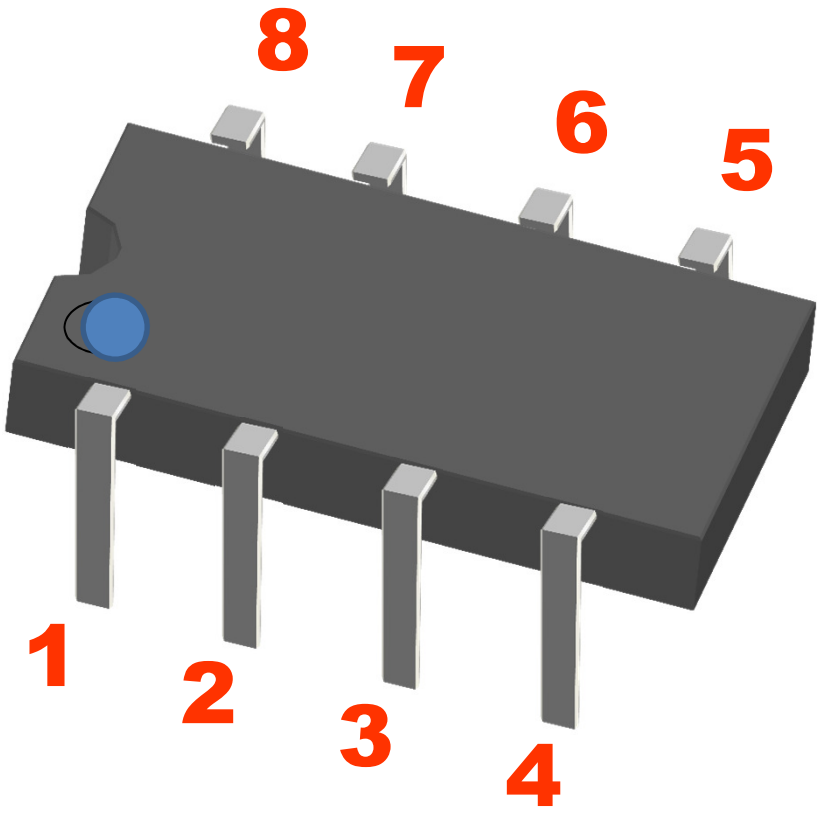


- Consists of two comparators
- Consists of an R-S flip flop
- Consists of Q1 that is operated as a switch

R-S flip Flop Review

R	S	Q	Action
0	0	Last Value	No change
0	1	1	Set
1	0	0	Reset
1	1	?	Indeterminate(forbidden)

555 Timer Pin Configurations

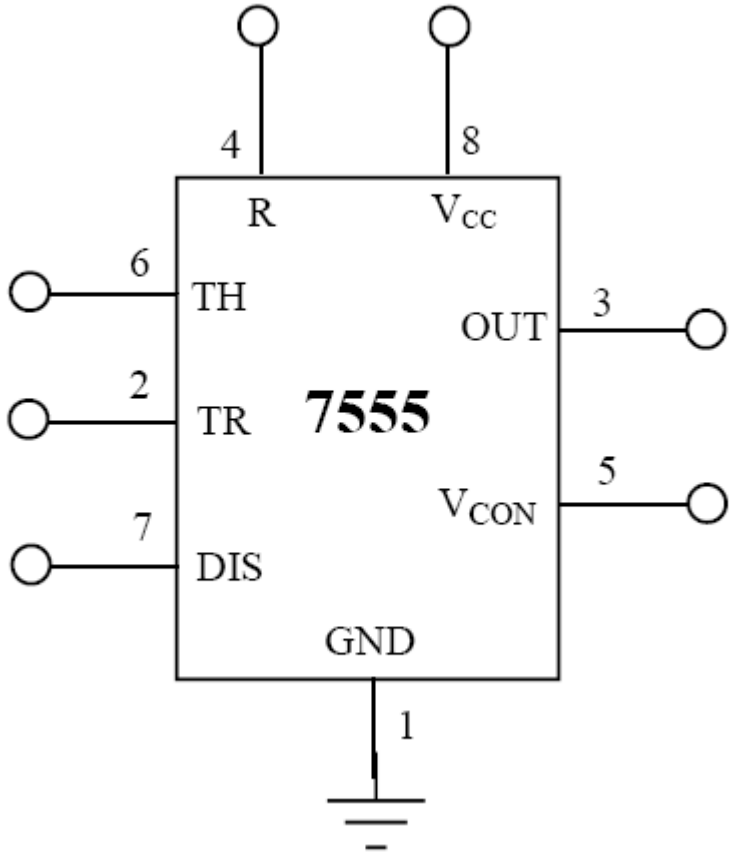


555 Timer Pin Descriptions

•**Pin 1 (Ground):-** All voltages are measured w.r.t. this terminal. This is the most negative supply potential of the device

•**Pin 2 (Trigger Terminal)**
This pin is an inverting input to a lower comparator. This is used to set the flip flop which causes the output to go high

•**Pin 3 (Output Terminal)**
There are 2 ways to connect load to the output terminal.
Pin 3 & Vcc :- Normally On load
Pin 3 & Ground:- Normally off load



555 Timer Pin Descriptions

•**Pin 4 (Reset):-** To disable or reset the timer a negative pulse is applied to this pin. When this pin isn't used, it's connected to Vcc. Why ??

•**Pin 5 (Control Voltage)**

The function of terminal is to control the threshold and trigger levels. The external voltage or a pot connected to this pin determines the pulse width of the output waveform. *When not in use, it should be connected to ground through a 0.01uF capacitor* to avoid any noise problem.

•**Pin 6 (Threshold):-** This is an input to the upper comparator. Used to reset the flip-flop which drives the output low.

•**Pin 7 (Discharge)**

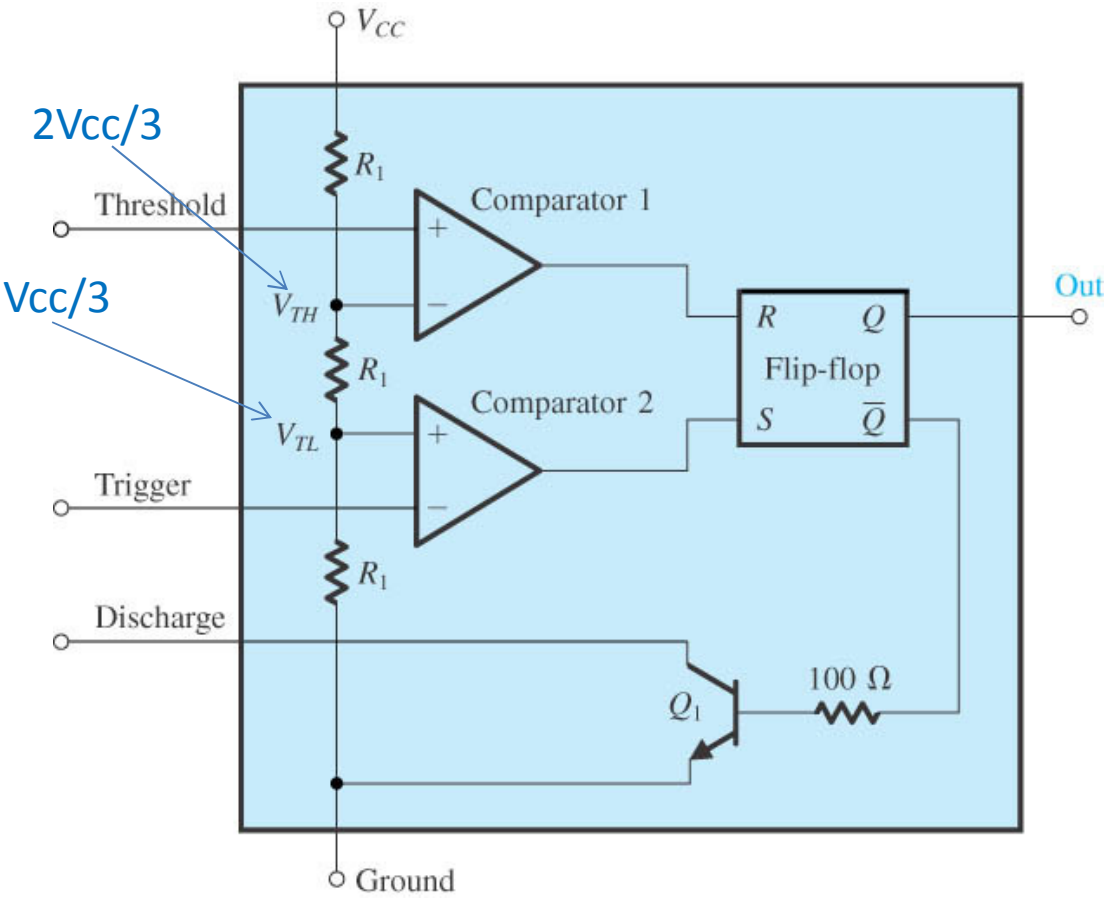
-When the npn transistor connected to it is turned "on," the pin is shorted to ground

– The timing capacitor is usually between pin 7 and ground and is discharged when the transistor turns "on"

•**Pin 8 (Supply Voltage):-** A positive supply voltage is applied to this terminal

BASIC TIMING CONCEPTS

- A resistive voltage divider consisting of 3 equal resistors R1 is employed
- V_{TH}= 2Vcc/3 for comparator 1.
- Flip Flop is reset whenever threshold goes higher than 2Vcc/3.
- V_{TL}=Vcc/3
- Flip Flop is set whenever the trigger goes below Vcc/3.
- In set state output Q is high (approx. equal to Vcc) and in reset the output is low



555 timer as a Monostable Multivibrator

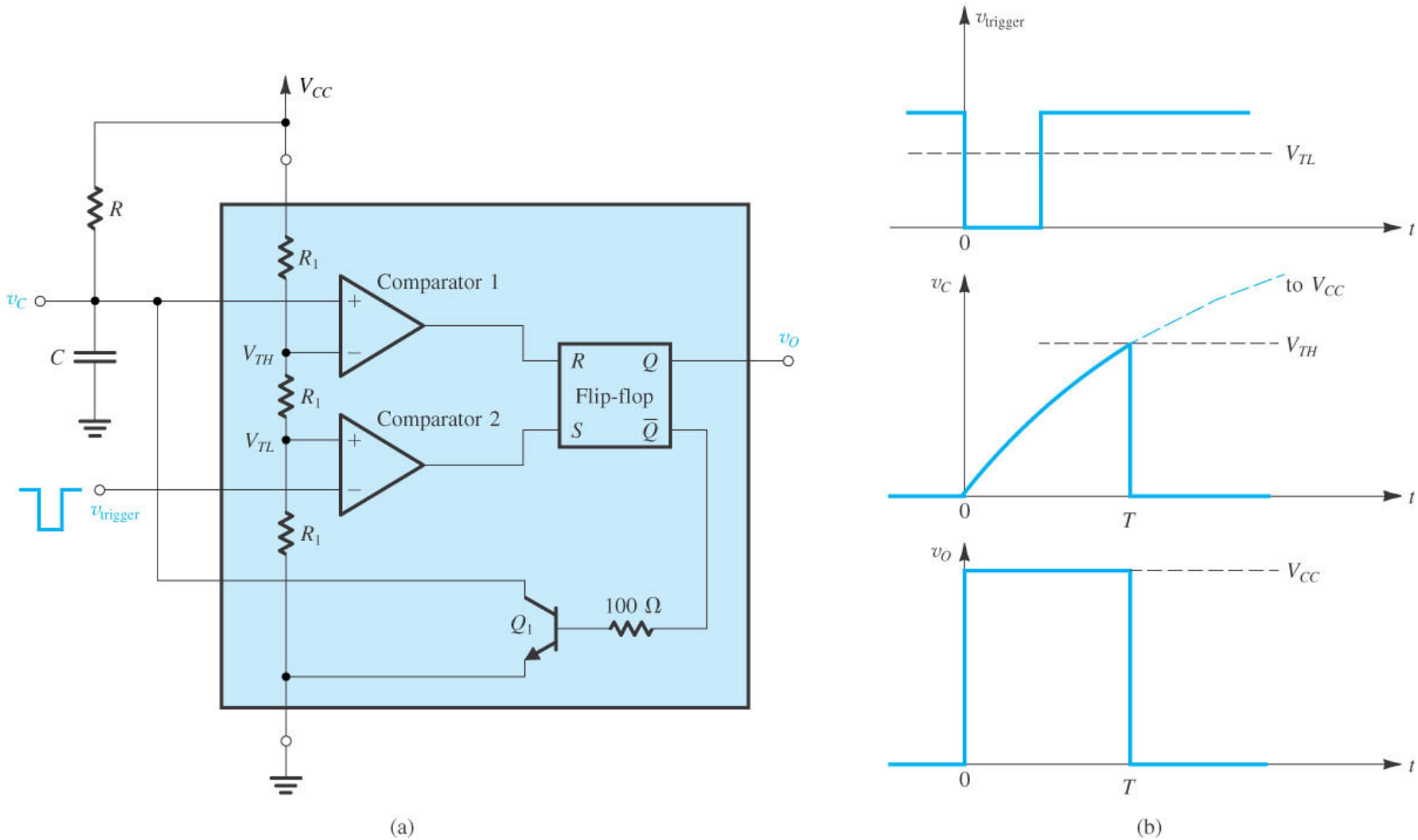
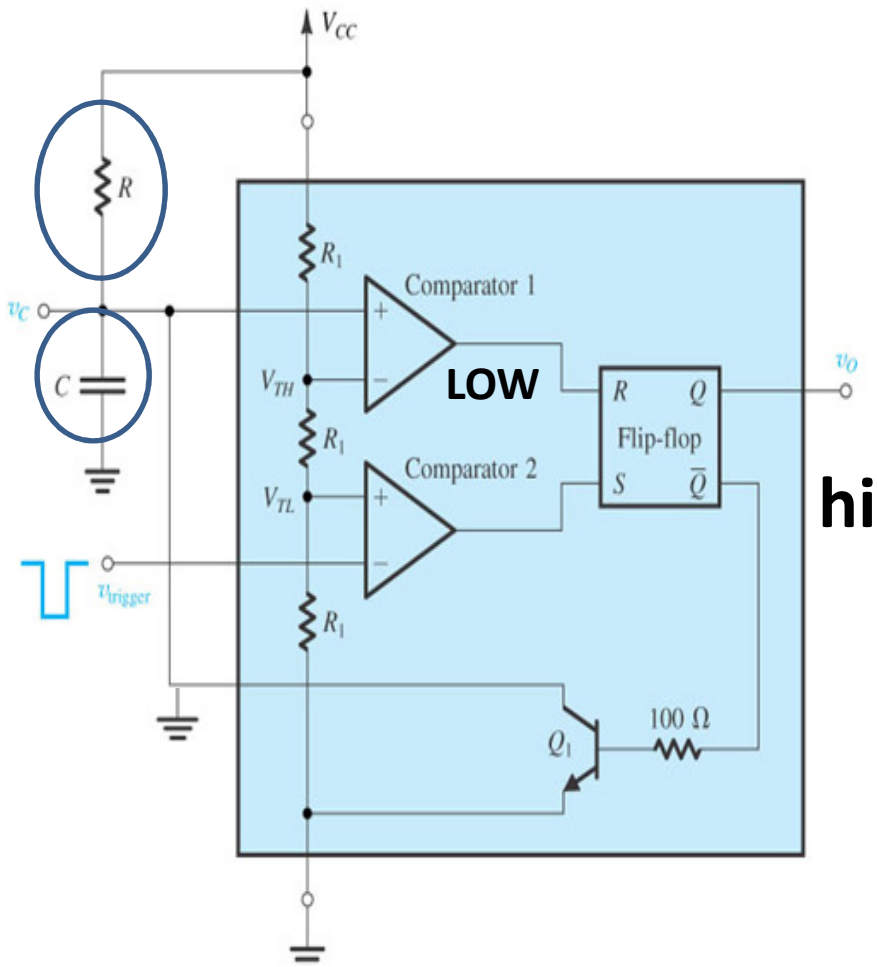


Figure The 555 timer connected to implement a monostable multivibrator. (**b**) Waveforms of the circuit in (a).

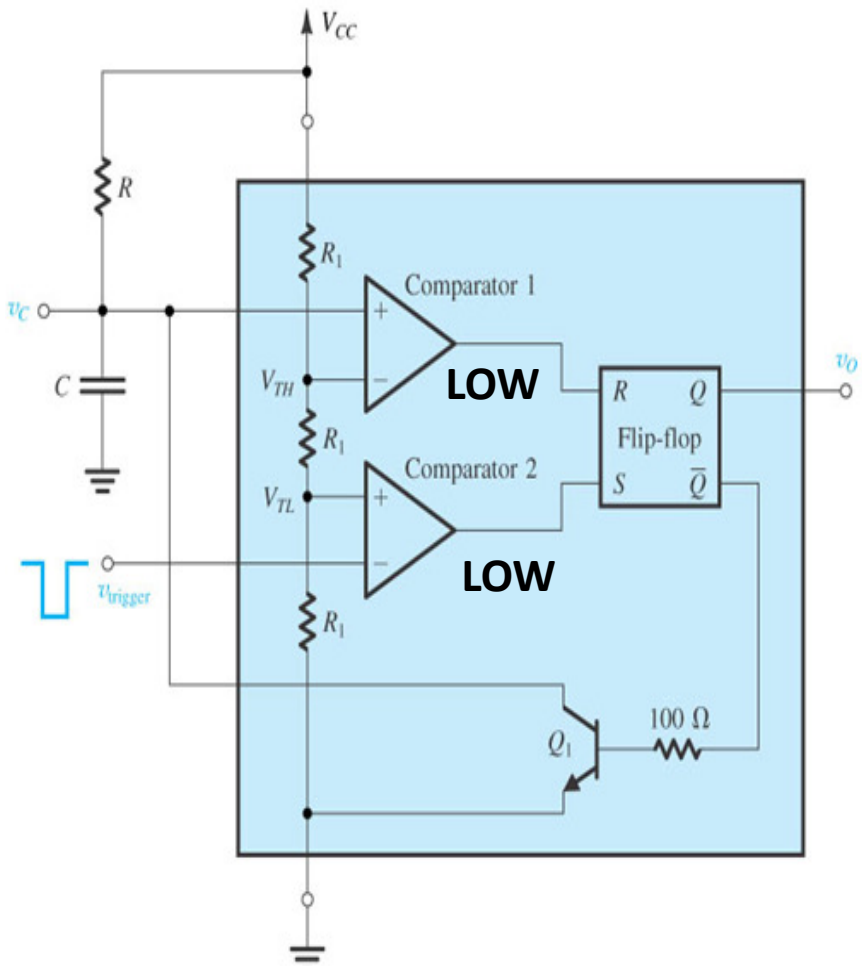
Description of the 555 Timer as a Monostable Multivibrator

- Consists of an external resistor R & capacitor C
- In the stable the flip flop will be in reset state, thus $\overline{Q}$ will be high and Q low.
- Transistor Q1 is driven into saturation
- $V_{CE} \approx 0$ so the capacitor is shorted to ground. i.e. $V_C \approx 0$ and output of comparator 1 is low



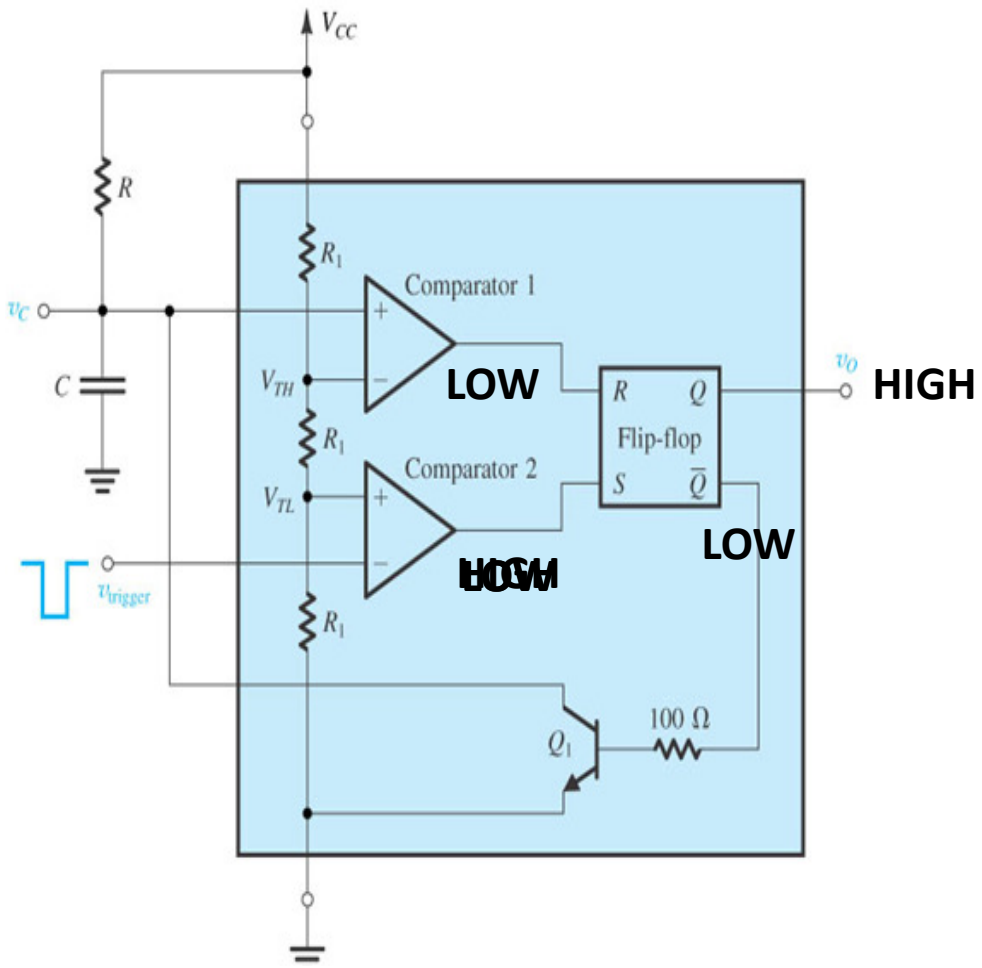
Description of the 555 Timer as a Monostable Multivibrator (contd…)

- $V_{trigger}$ is kept high (higher than V_{TL} i.e. Vcc/3)
- Output of comparator 2 will also be low
- Flip flop is in reset state so Q will also be low i.e. $V_0 \approx 0$
- To trigger the monostable multivibrator , a negative pulse is applied to the trigger input terminal



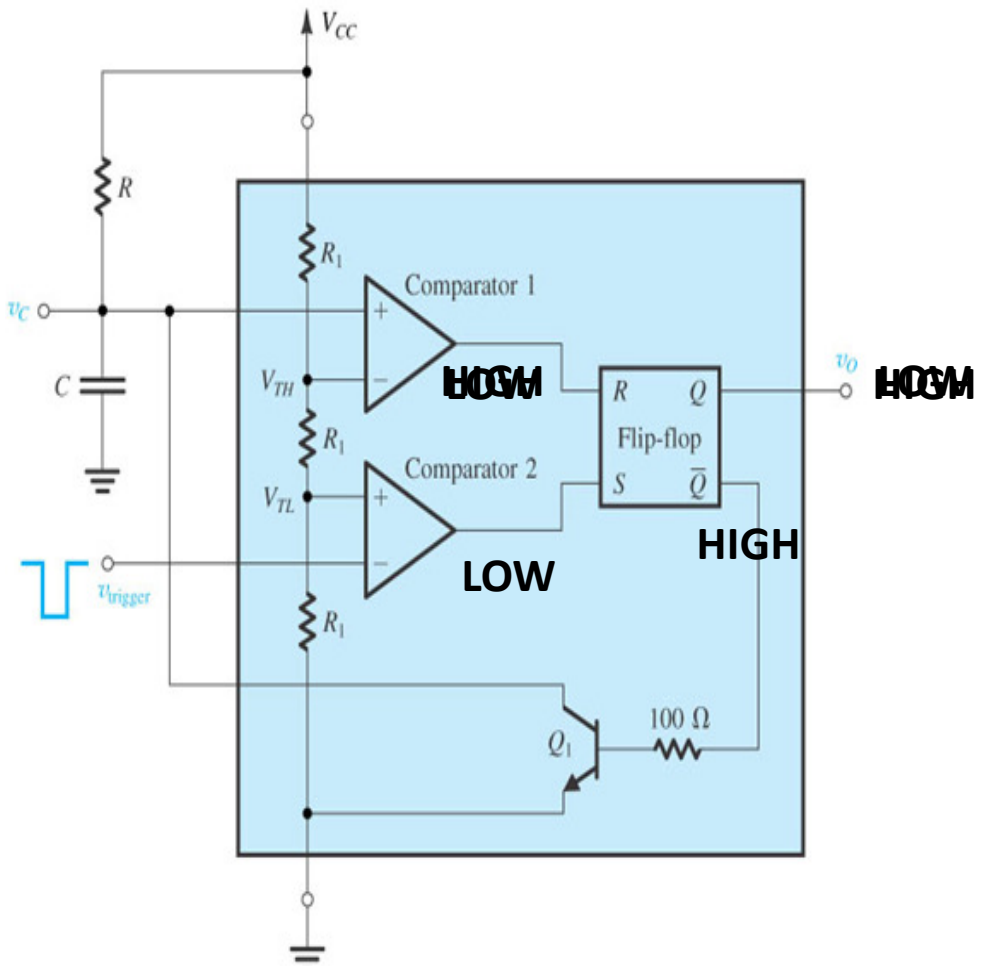
Description of the 555 Timer as a Monostable Multivibrator (contd…)

- As $V_{trigger}$ goes below V_{TL} i.e. Vcc/3, the output of comparator 2 goes high thus setting the flip flop. i.e. Q=1 Q =0, so the transistor is cutoff
- $V_{trigger}$ is given for a short time so output of compartor 2 goes low again.
- Still the ouput is high because R=0 and S=0 result in Q to be in the previous state.
- Capacitor C now begins to charge through resistor R and V_c rises exponentially towards V_{cc}.
- The high voltage at the ouput is retained as long as V_c<VTH

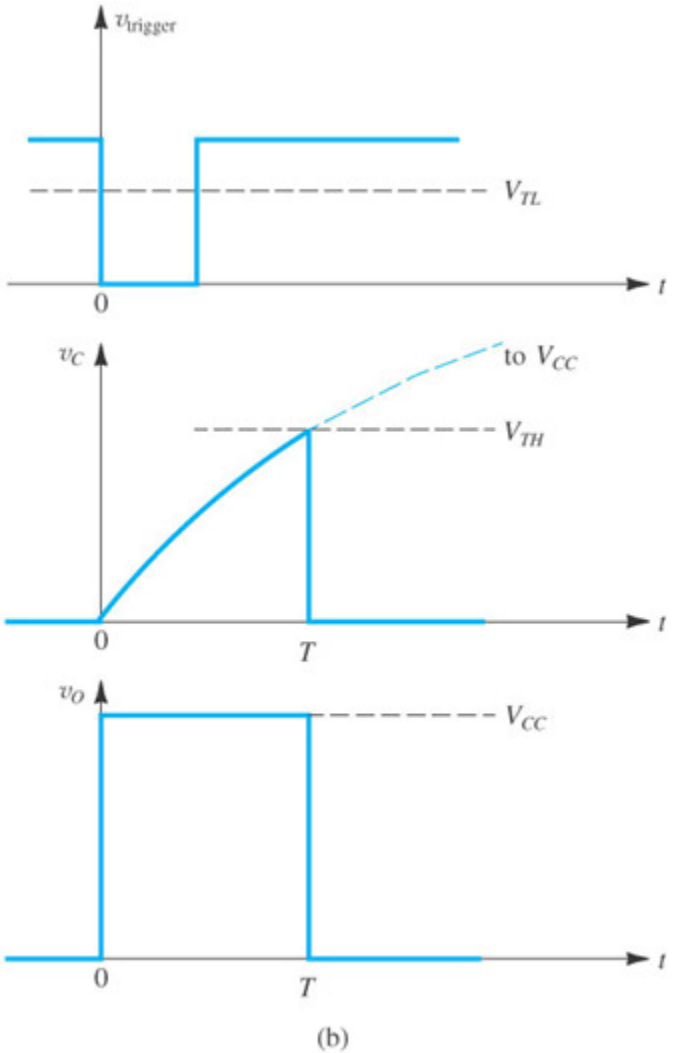


Description of the 555 Timer as a Monostable Multivibrator (contd…)

- Once V_c exceeds V_{TH} , the output of comparator 1 goes high. Now R=1 and S=0 so Q=0
- The monostable multivibrator is now back in its stable state and is ready to receive a new triggering pulse



Derivation for the width of the pulse in monostable multivibrator



(b)

- The width of the pulse , T is the time interval that the monostable multivibrator spends in quasi stable state.
- Denoting the time instant at which the trigger pulse is applied at t=0 , the voltage across capacitor Vc can be expressed as ,

$$Vc=Vcc\ (1-e^{\frac{-t}{RC}})$$

- Substituting Vc=VTH=2/3Vcc at t=T gives,

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

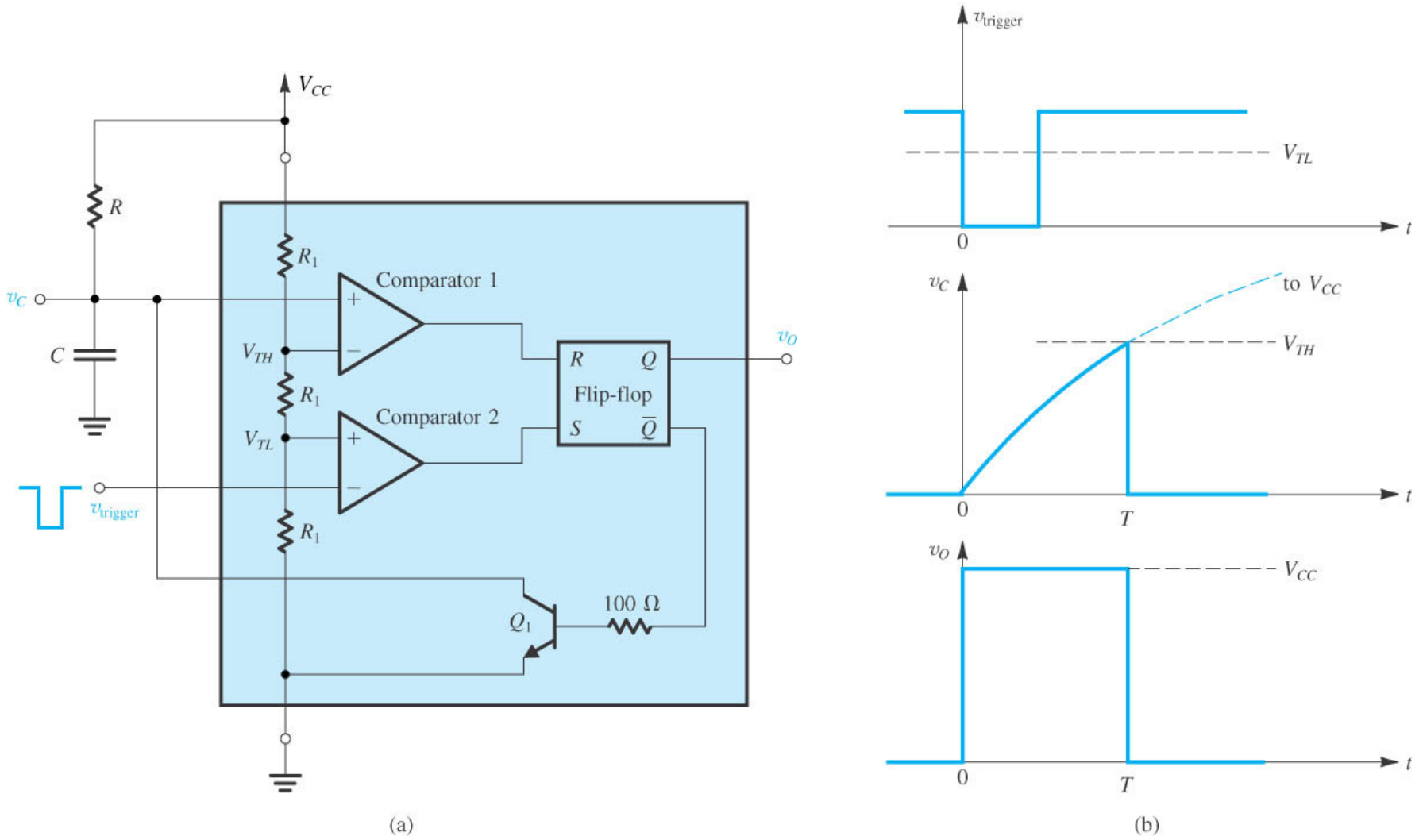
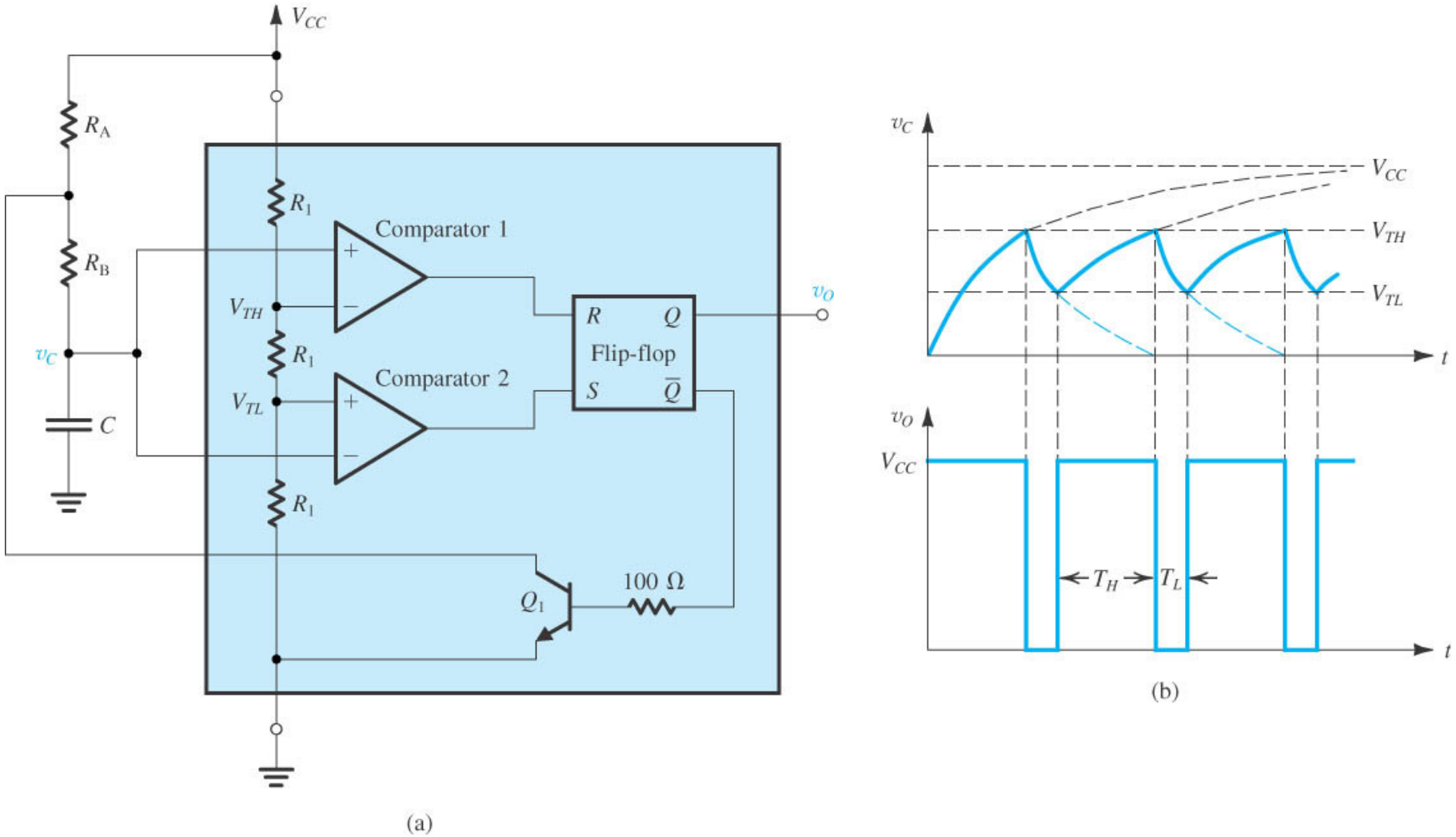


Figure 13.28 (a) The 555 timer connected to implement a monostable multivibrator. (**b**) Waveforms of the circuit in (a).

555 Timer as an Astable Multivibrator



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