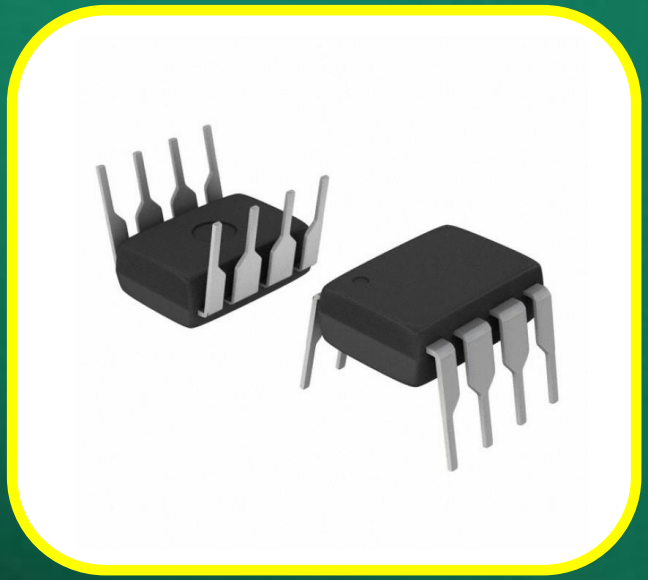
Basic Electronic Circuits (IEC-103)

Lecture-14

555 Timer

555 IC

The IC 555 is an 8-pin Integrated Circuit (IC) that is capable of producing accurate time delays and/or oscillations.



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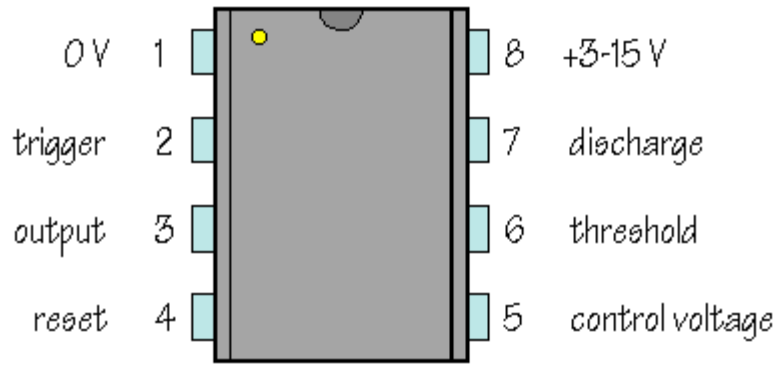
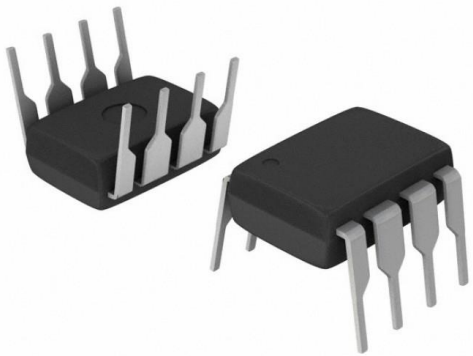
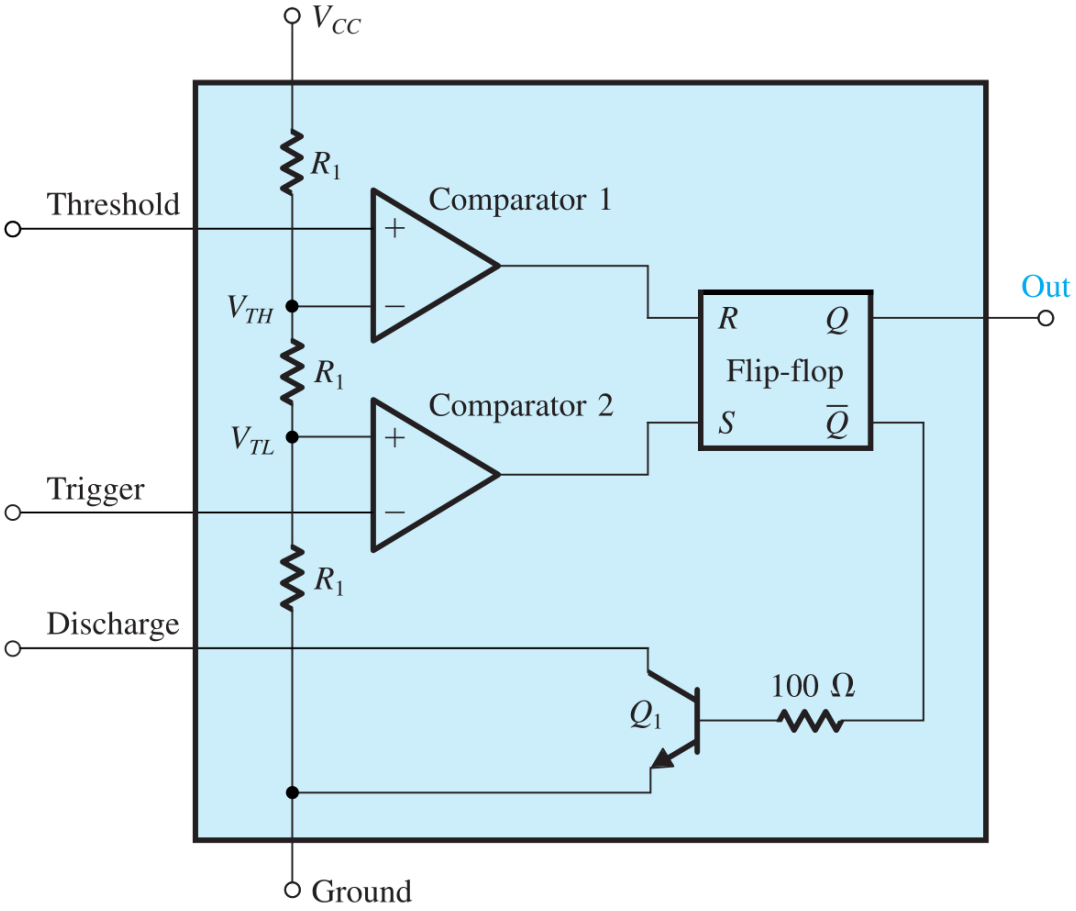
DIP chip (Dual-Inline package)





555 IC (Internal Circuit Diagram)



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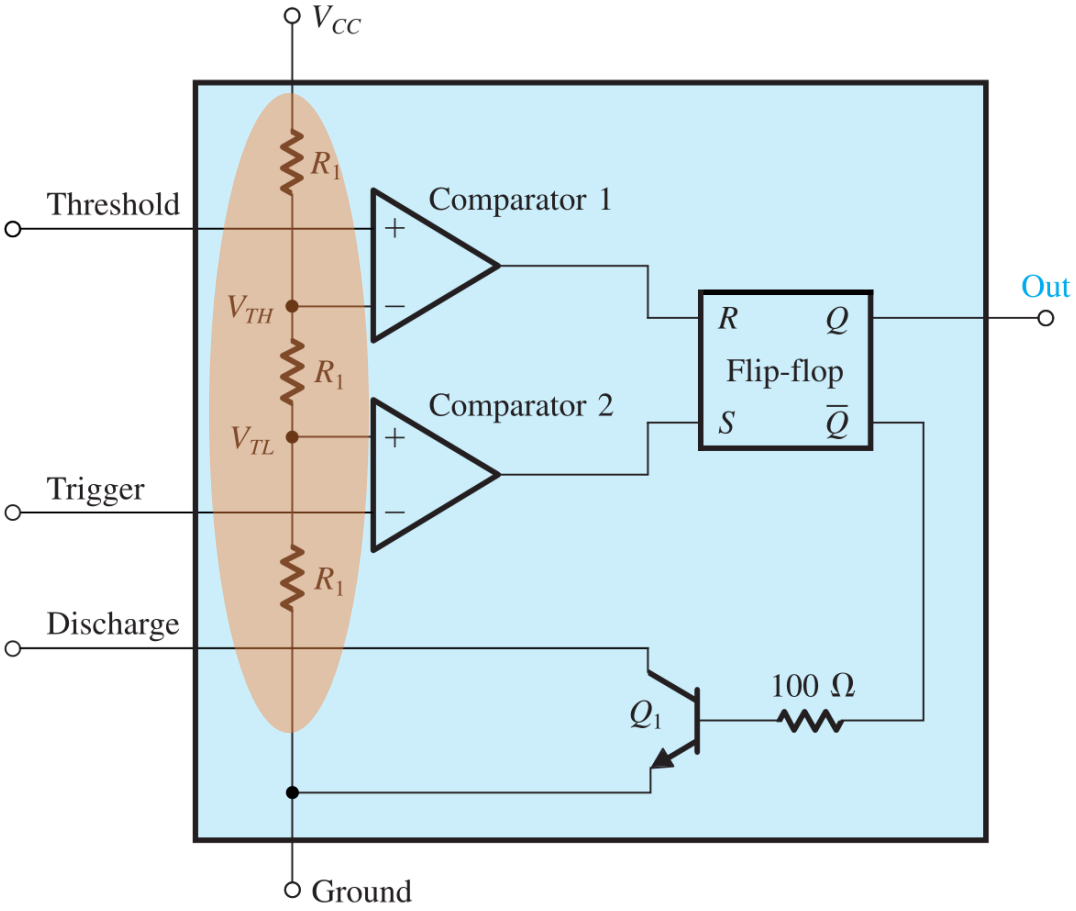

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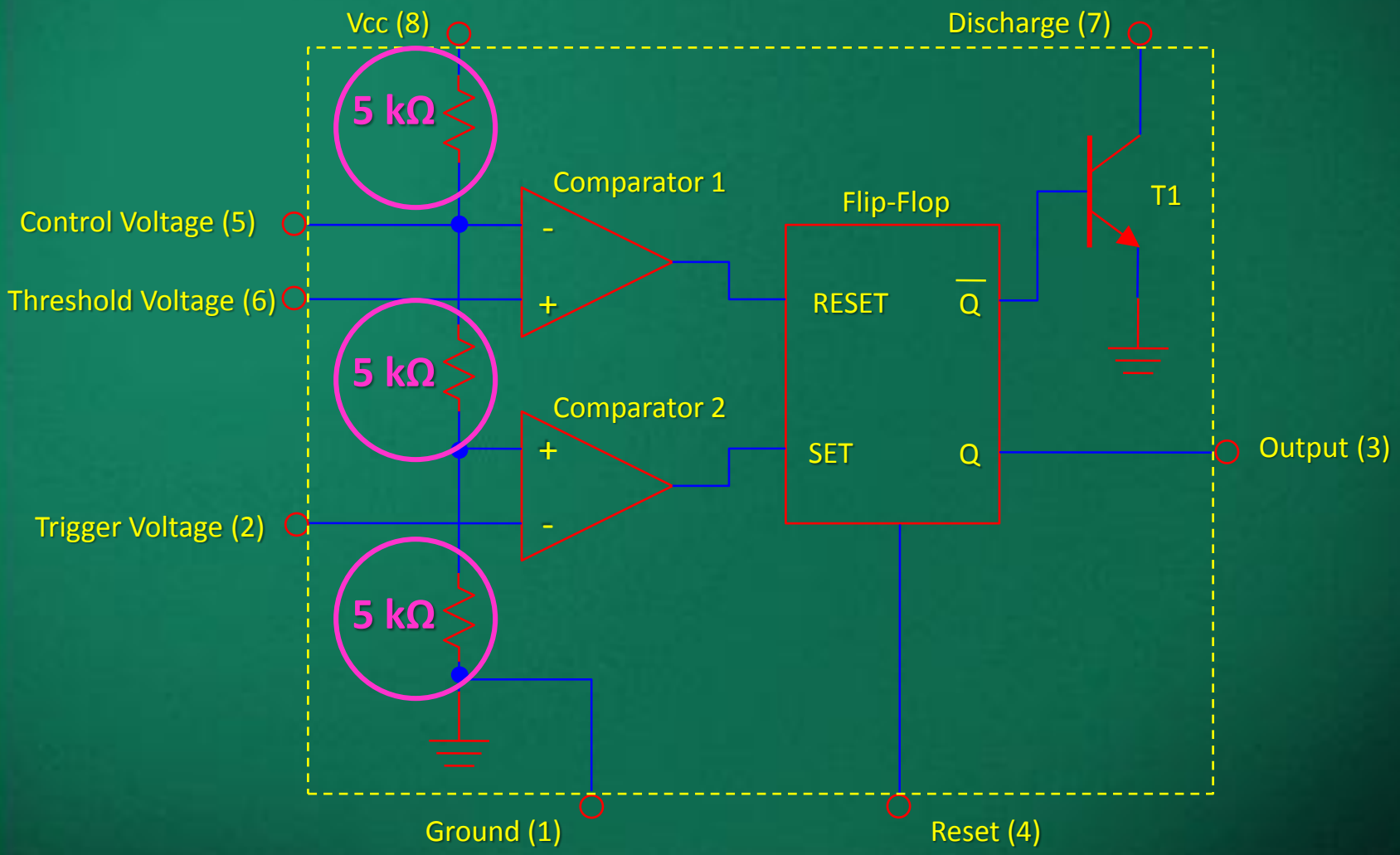

Truth Table of RS Flip Flop

S	R	Q	State
0	0	Previous State	No Change
0	1	0	Reset
1	0	1	Set
1	1	?	Forbidden

Modes of Operation

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In the time delay mode, the delay is controlled by one external resistor and capacitor.

Example: Turn a light on in a delayed amount of time (just turn on or off once)

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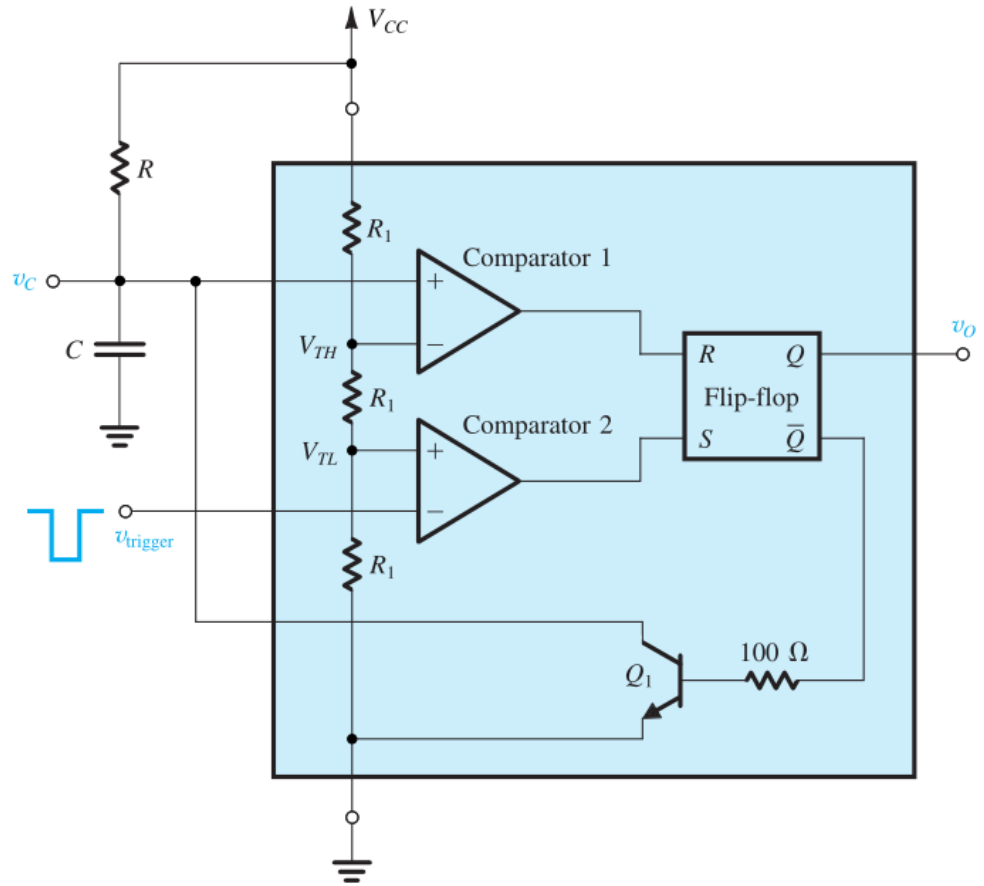
Oscillator Mode

In the oscillator mode, the frequency of oscillation are controlled with two external resistors and one capacitor.

Example: Can make a light flash a specific rate (can turn on and off repeatedly)

Mono stable Multivibrator



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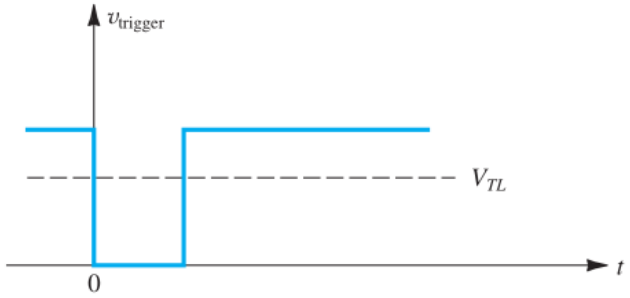

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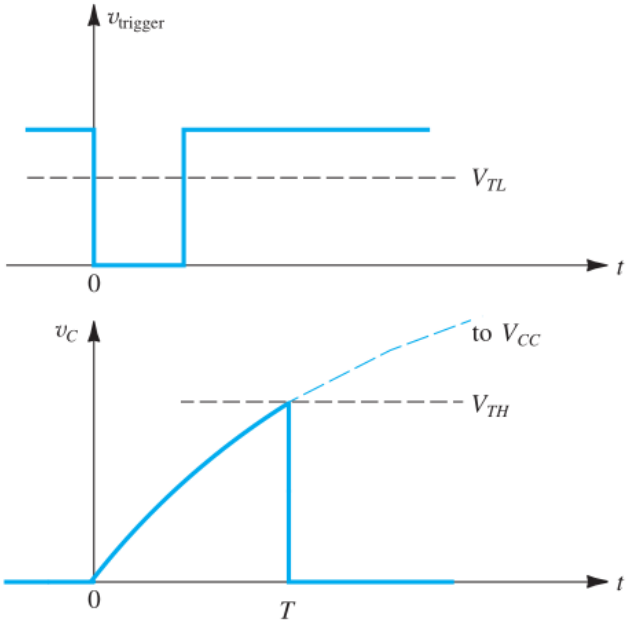

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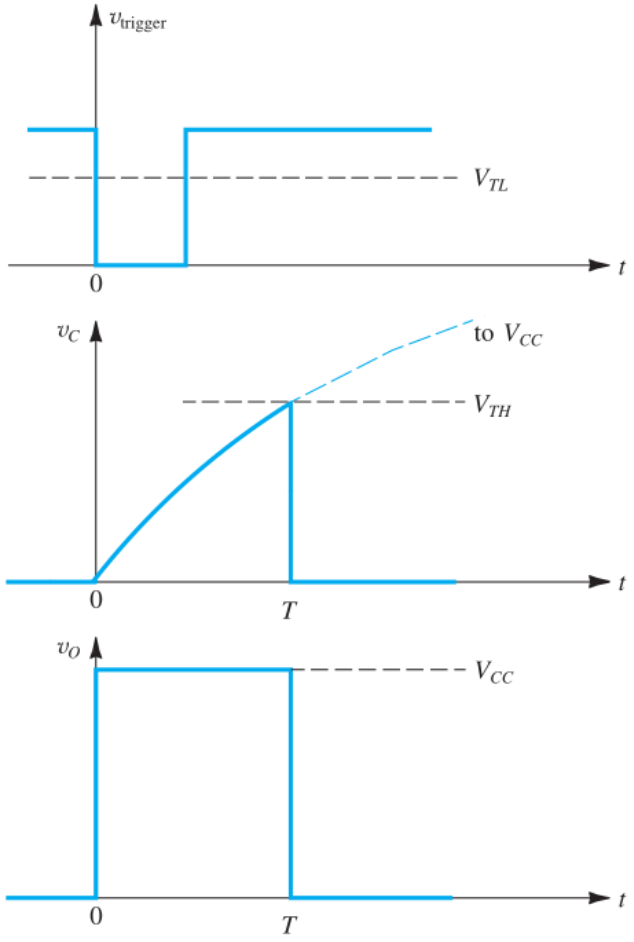

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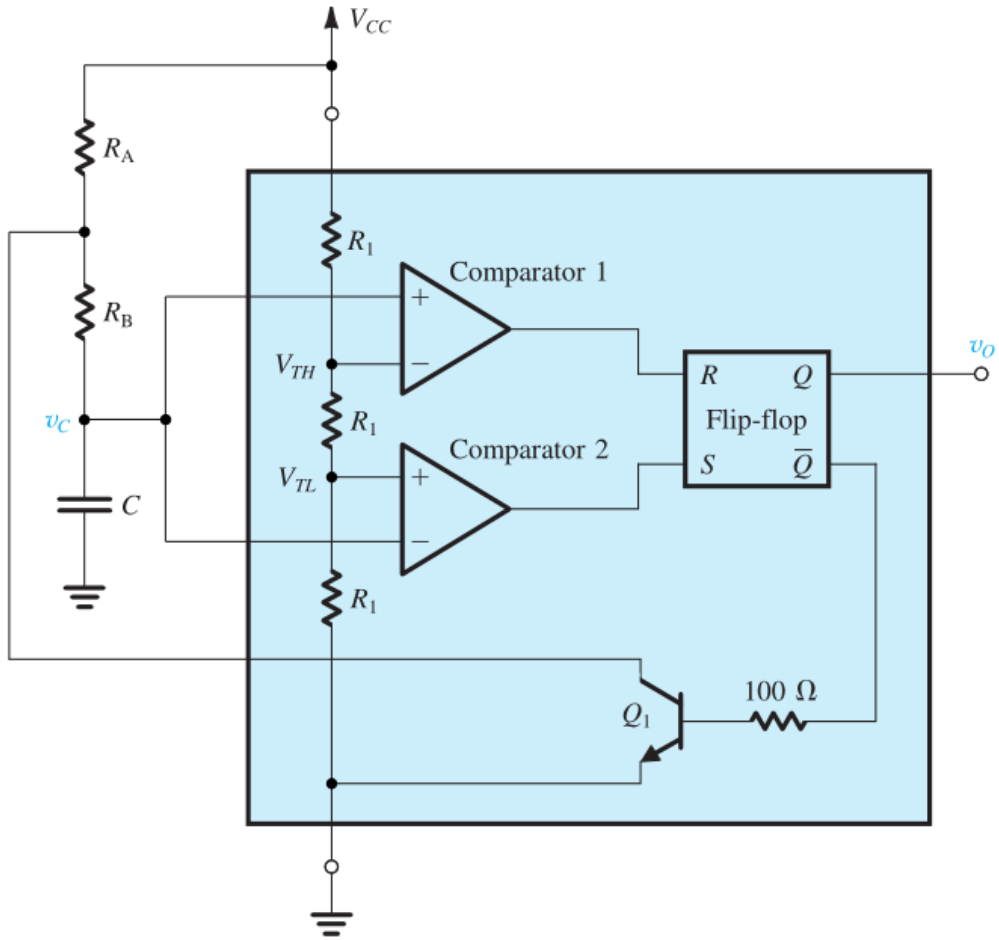
$$\therefore T = RC\ln(3) = 1.1RC$$

Astable Multivibrator



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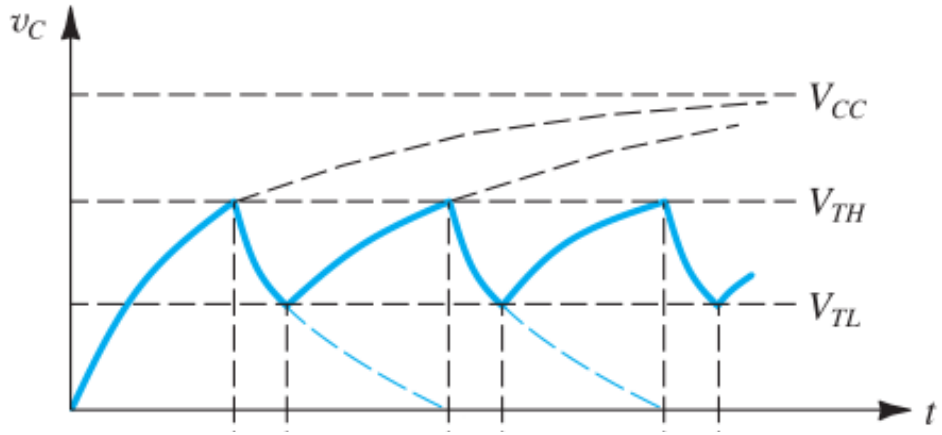

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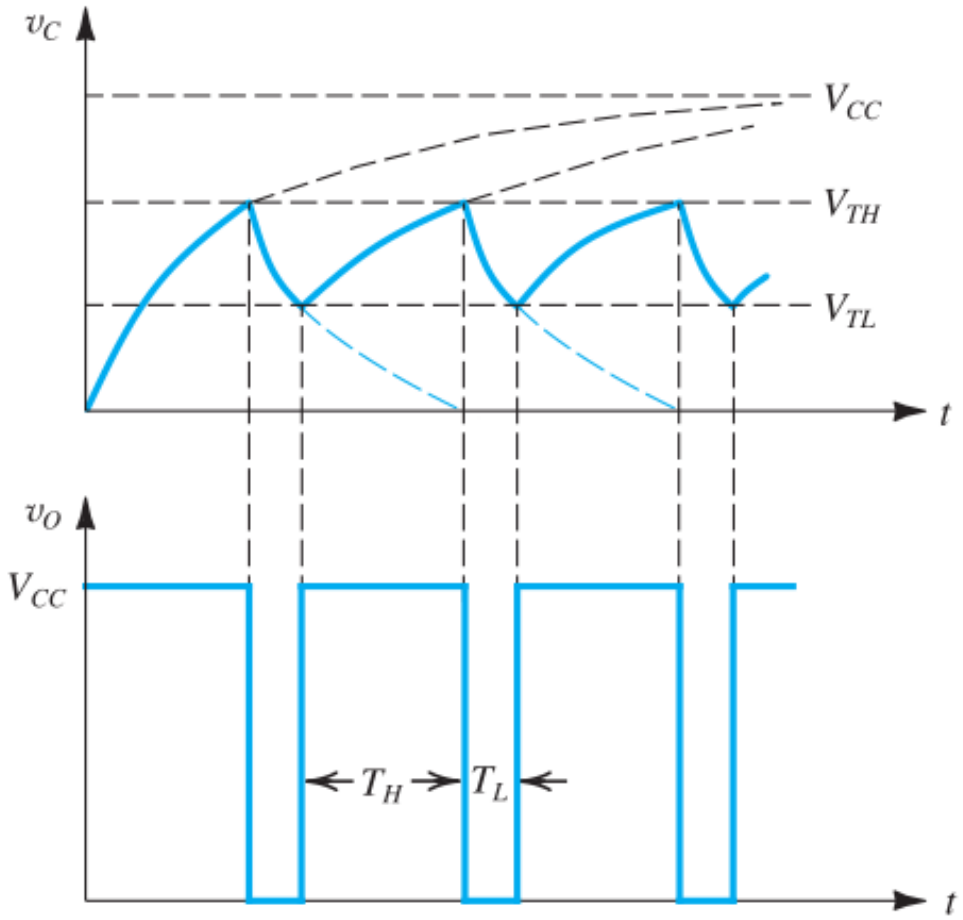

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$$\Rightarrow -T_{ON}/((R_A + R_B)C) = ln(1/2)$$

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$$\text{DutyRatio} = \frac{T_{ON}}{T} = \frac{T_{ON}}{T_{ON} + T_{OFF}} = \frac{0.69(R_A + R_B)C}{0.69(R_A + 2R_B)C} = \frac{(R_A + R_B)}{(R_A + 2R_B)}$$

Transistors

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  - Mechanically strong.
- Invented in 1948 in Bell Labs.

First Working Transistor

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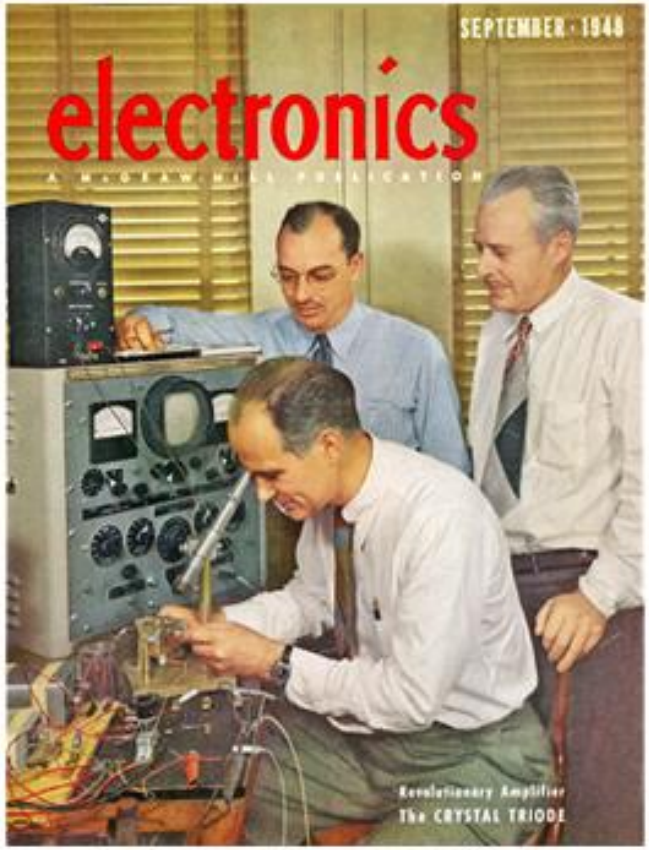

Invented by Shockley, Bardeen, and Brattain.

Jointly awarded Nobel Prize in Physics in 1956.

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- They can be used either as switches or as amplifiers.

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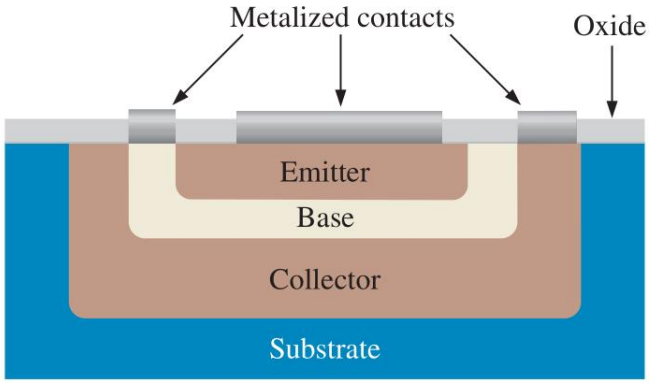
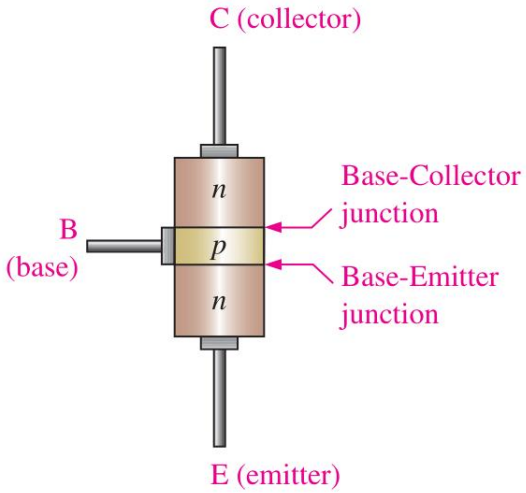
- **Two types BJTs**
  - **NPN Transistor**
  - **PNP Transistor**

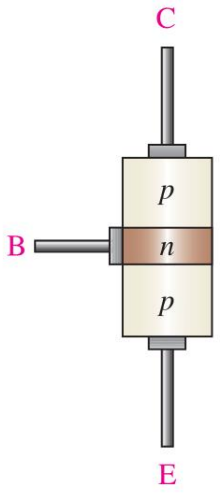
BJT Construction



(a) Basic epitaxial planar structure

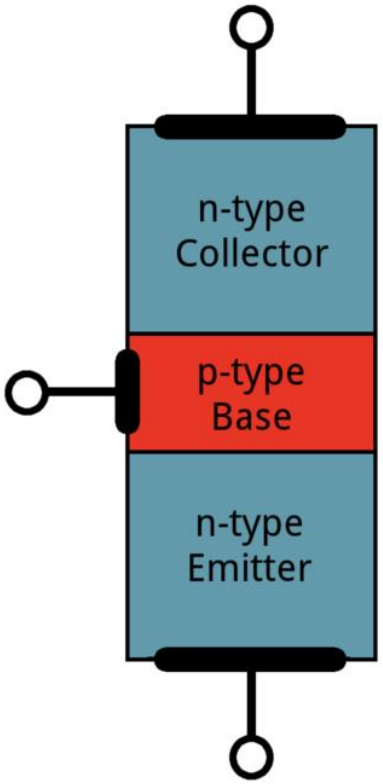


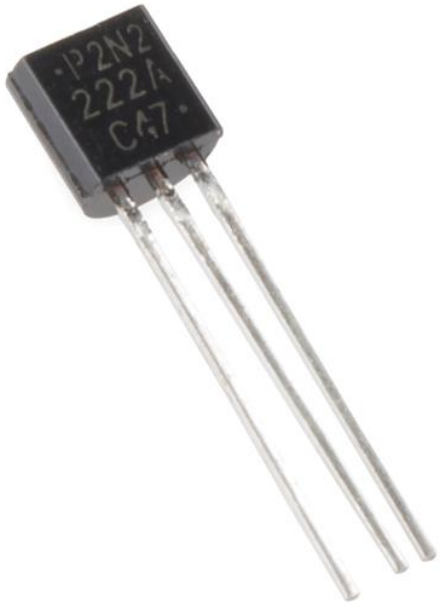
(b) *npn*



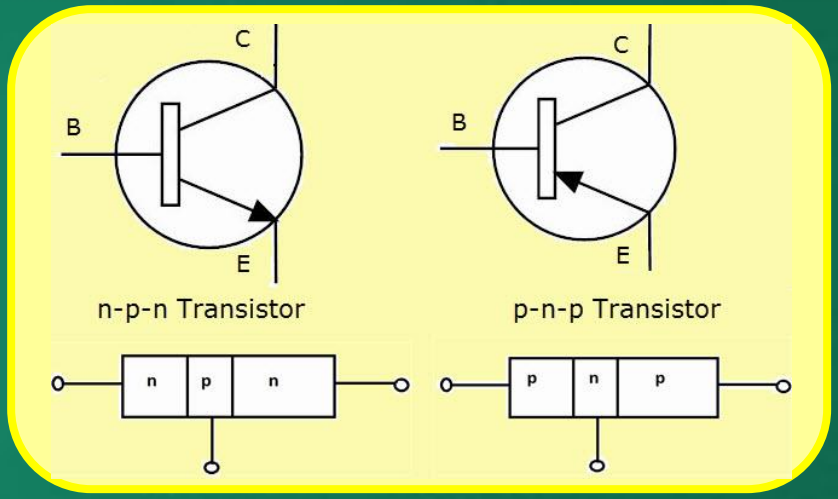
(c) *pnp*

Transistor Symbol





Transistor Construction



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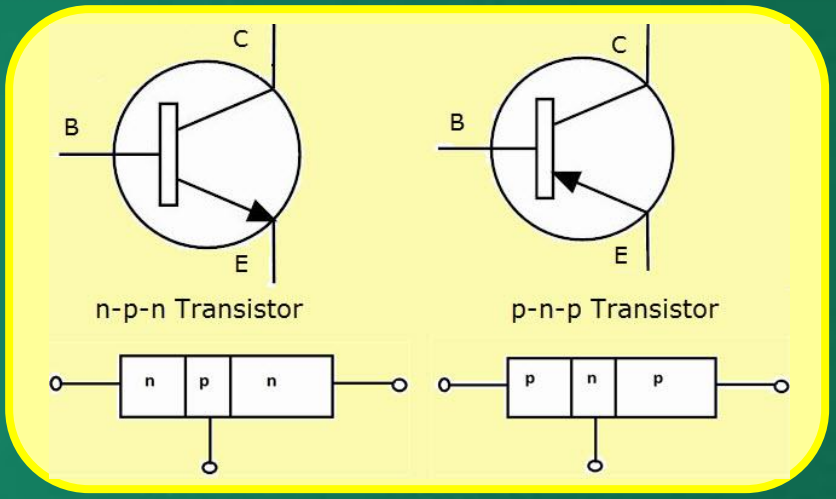
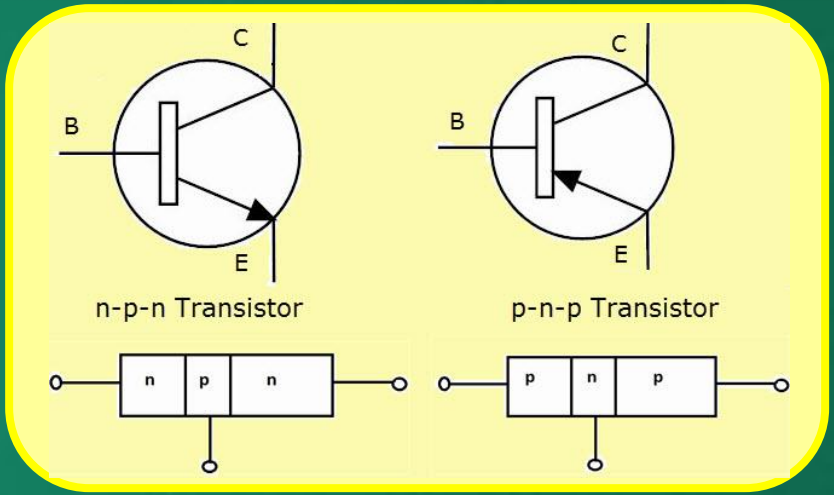


- Consists of 3 sections and 2 junctions.

Transistor Construction



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- 3 sections are Emitter, Base, and Collector

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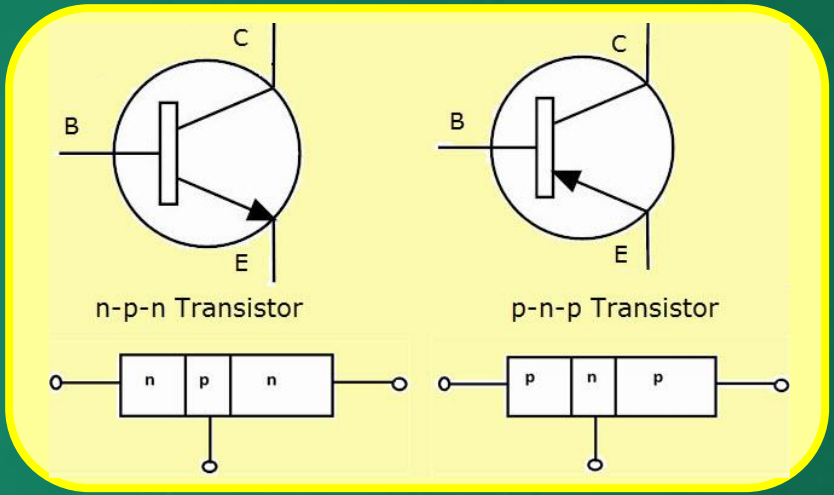

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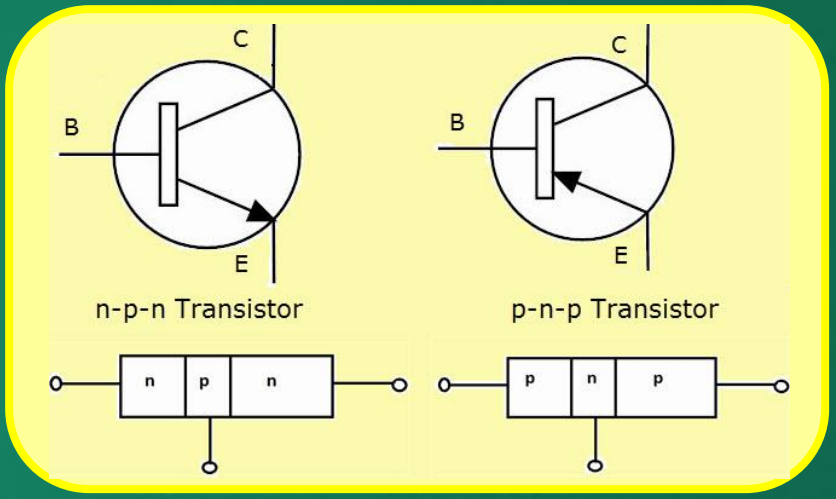
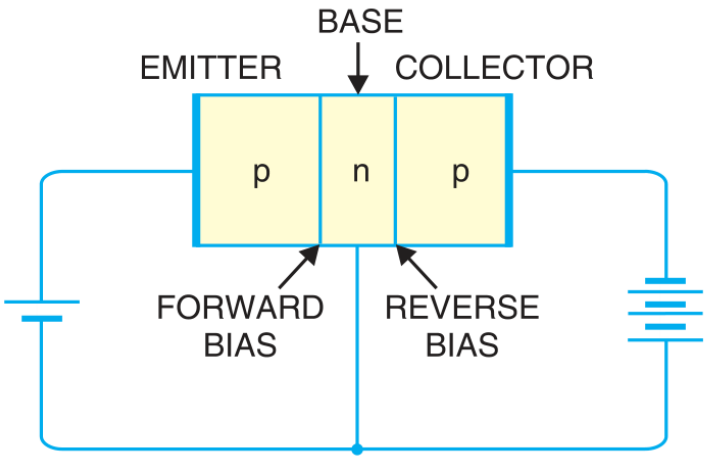


- Consists of 3 sections and 2 junctions.
- 3 sections are Emitter, Base, and Collector
- The base is very thin and collector is much wider then emitter
- The base is very lightly doped, emitter is heavily doped and collector is moderately doped.

Transistor Junction Biasing



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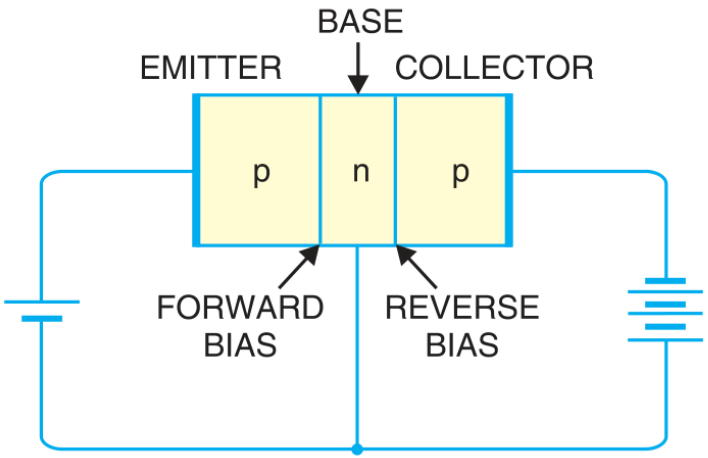

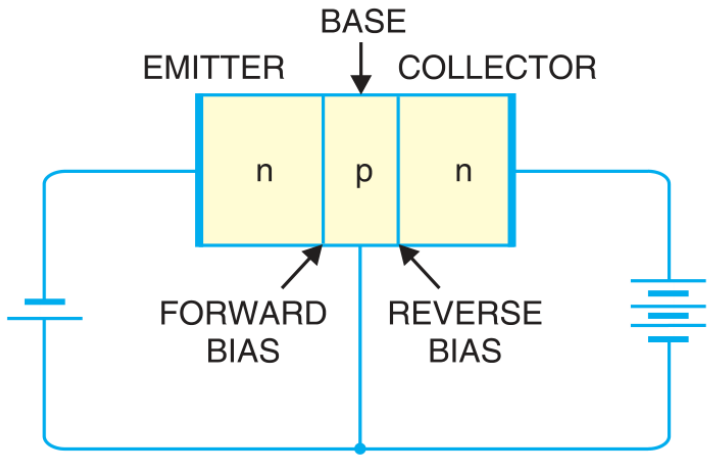

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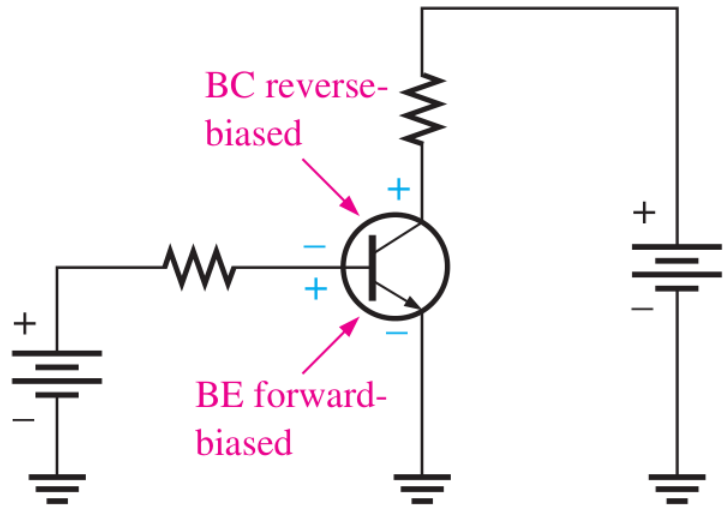

(a) *npn*

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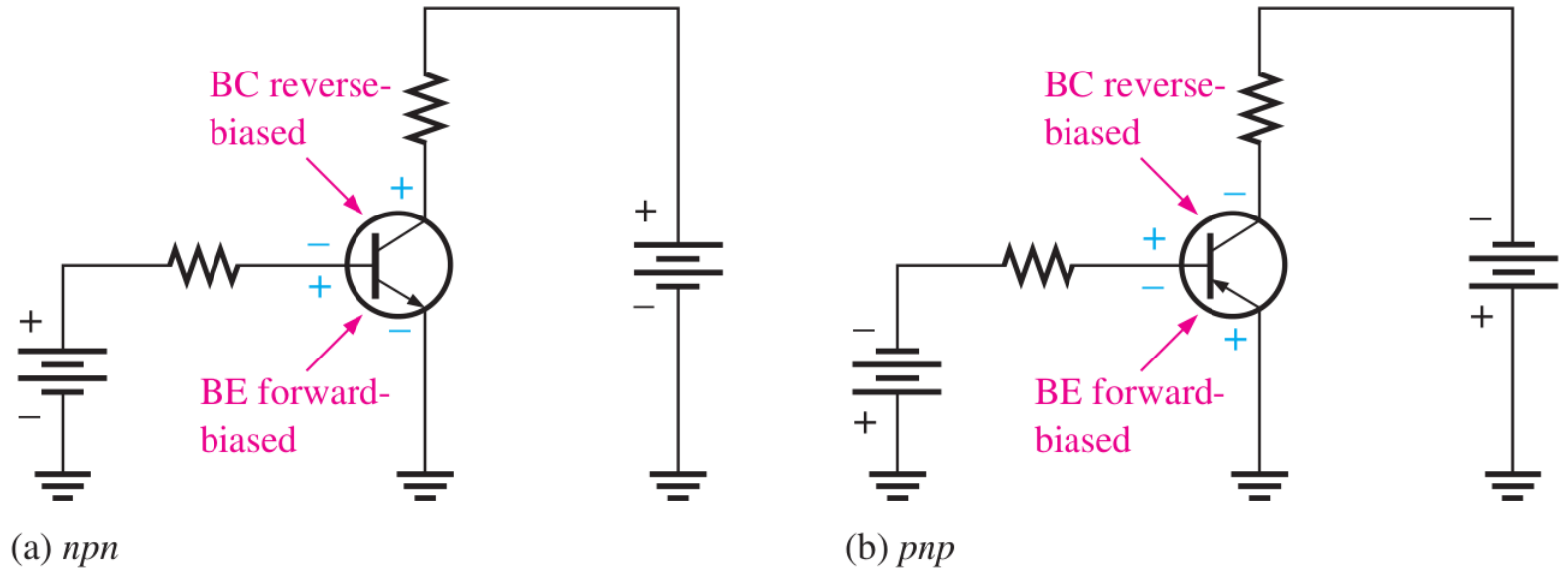
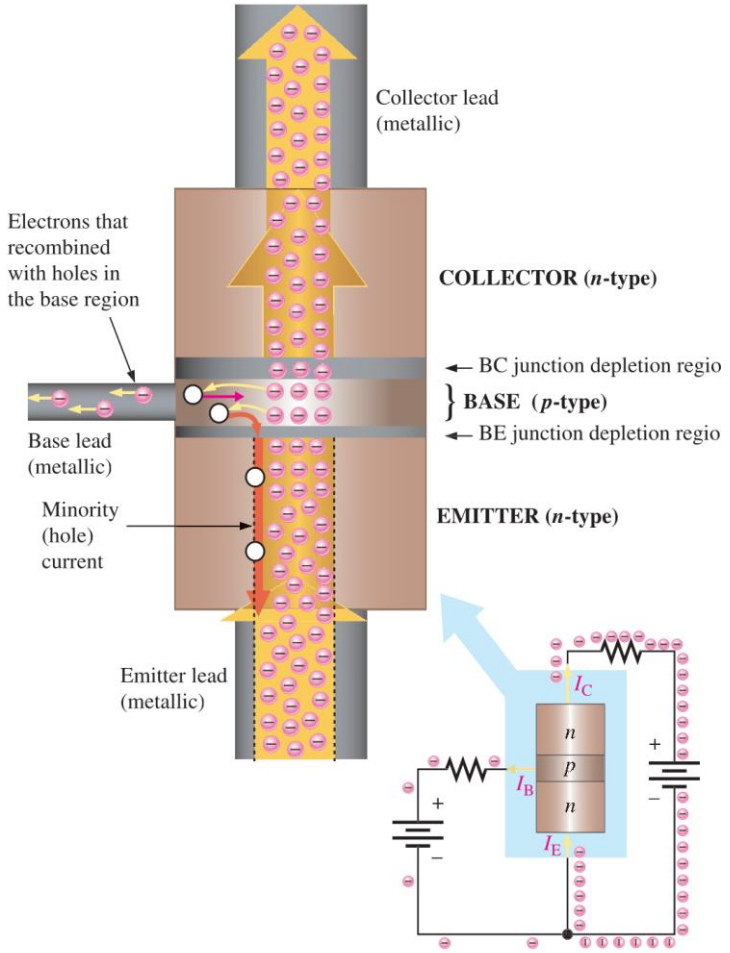


BJT Operation showing Electron Flow



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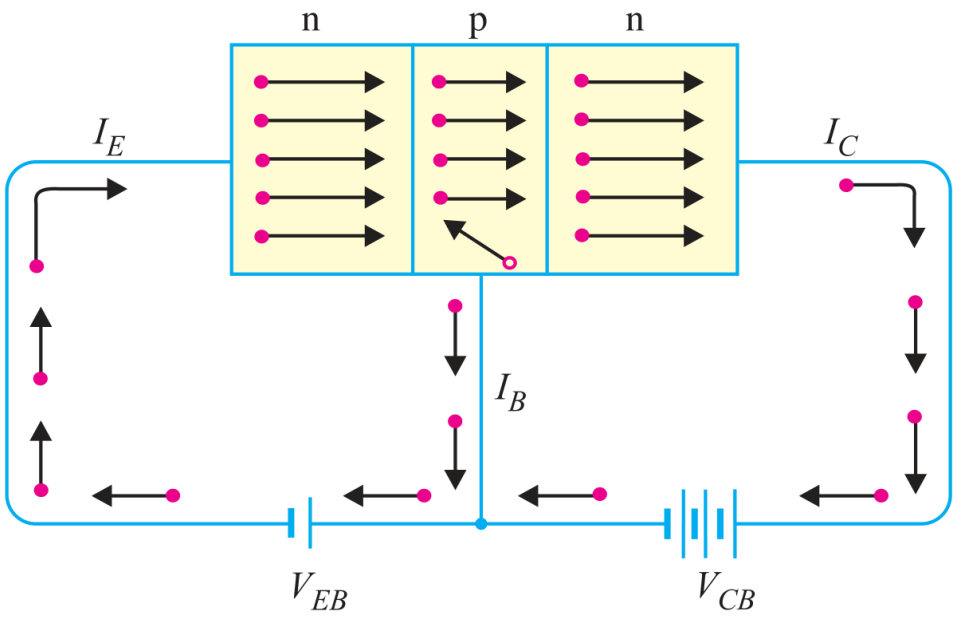

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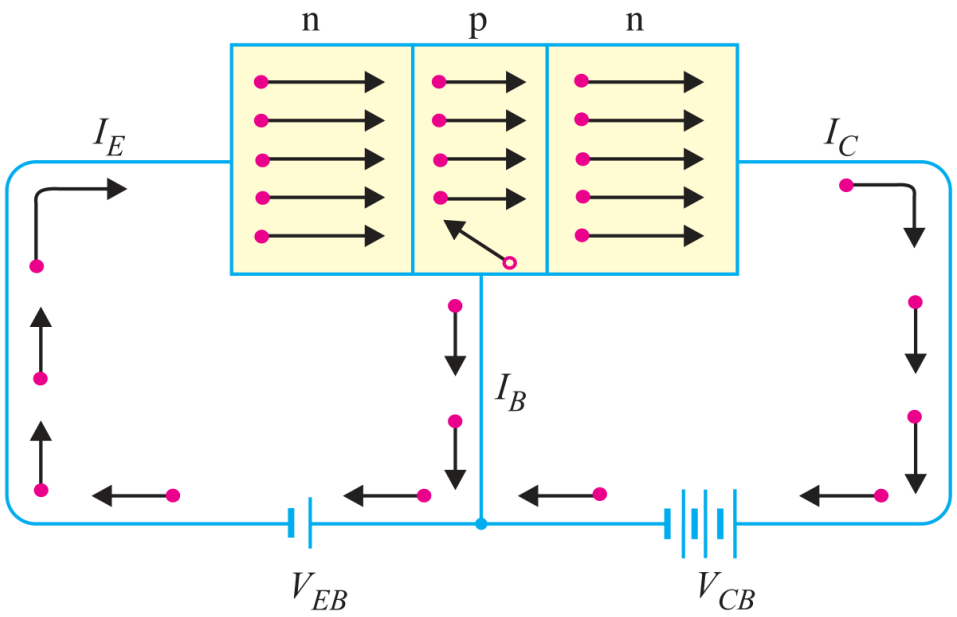
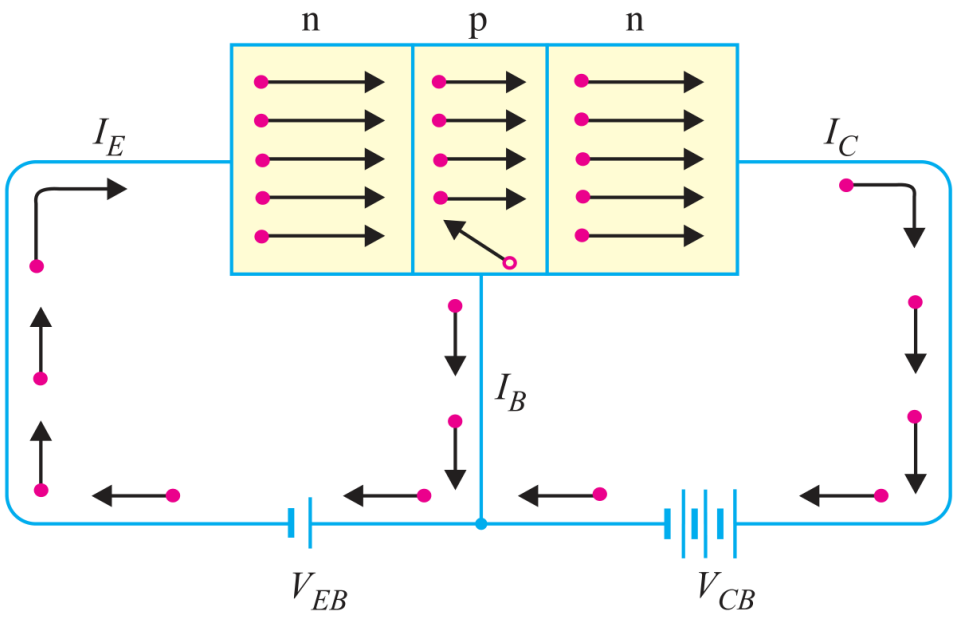


$$I_E = I_B + I_C$$

Transistor Junction Biasing

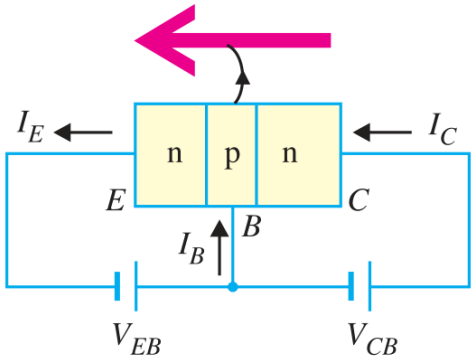


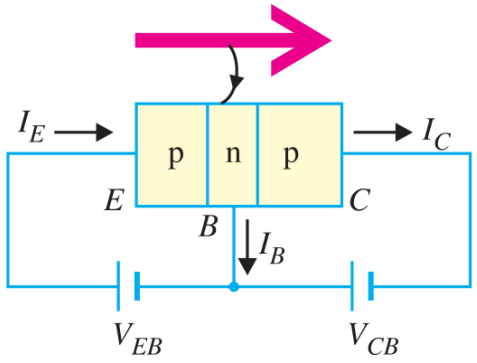
$$I_E = I_B + I_C$$

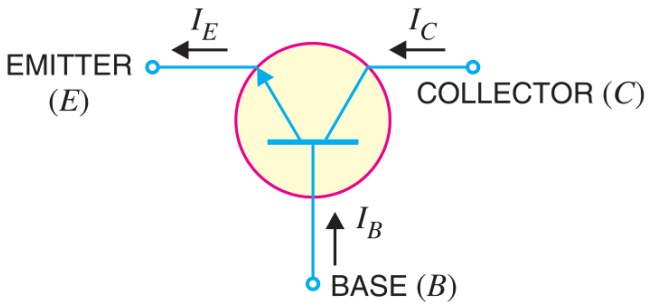
$$I_C = \alpha I_E$$

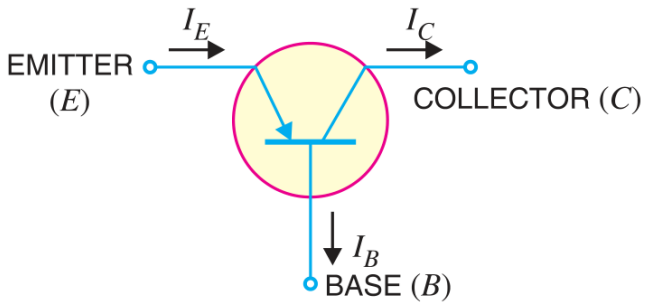
$$I_C = \beta I_B$$

Transistor Symbols

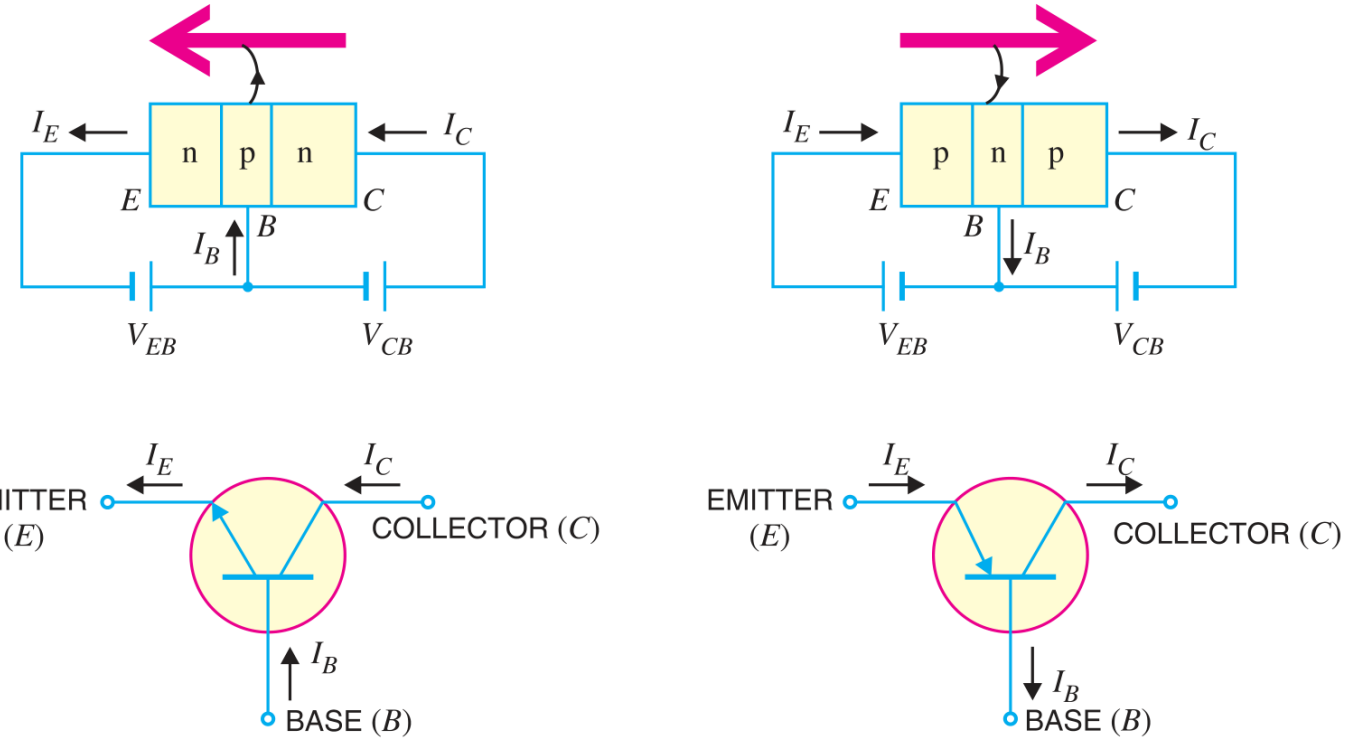








Transistor Symbols



Arrow indicates the direction of conventional current flow with forward bias.