Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Department of Medical Physics

Analog Electronics

Lecture 4

Biasing Circuits

By

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Biasing

Biasing is the process of providing DC voltage which helps in the functioning of the circuit. A transistor is based in order to make the emitter base junction forward biased and collector base junction reverse biased, so that it maintains in active region, to work as an amplifier.

Transistor Biasing is the process of setting a transistors DC operating voltage or current conditions to the correct level so that any AC input signal can be amplified correctly by the transistor.

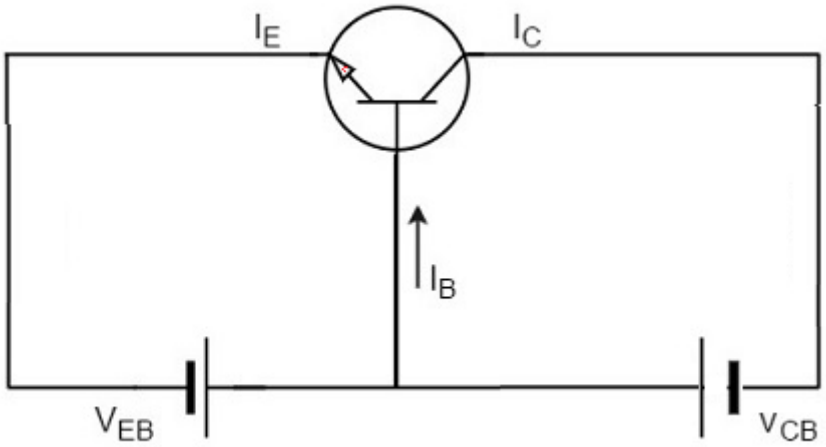


Figure (25) Transistor biasing.

The operating point of a device, also known as a bias point, quiescent point or Q-point, is the DC voltage or current at a specified terminal of an active device such as a transistor with no input signal applied. The circuit which provides transistor biasing is called as Biasing Circuit. The Q-point is typically near the middle of the DC load line, so as to obtain the maximum available peak-to-peak signal amplitude without distortion due to clipping as the transistor reaches saturation or cut-off. The process of obtaining an appropriate DC collector current at a certain DC collector voltage by setting up the operating point is called biasing.

If a signal of very small voltage is given to the input of BJT, it cannot be amplified. Because, for a BJT, to amplify a signal, two conditions have to be met:

- The input voltage should exceed cut-in voltage for the transistor to be ON.
- The BJT should be in the active region, to be operated as an amplifier.

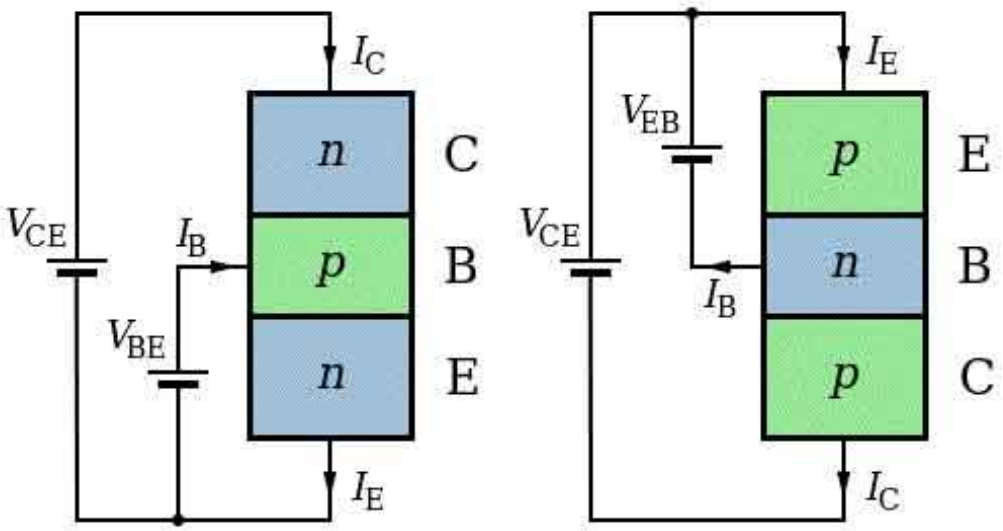


Figure (26) NPN and PNP Transistor biasing.

Common Emitter Amplifier

The common emitter amplifier is a three basic single-stage bipolar junction transistor and is used as a voltage amplifier. The input of this amplifier is taken from the base terminal, the output is collected from the collector terminal and the emitter terminal is common for both the terminals. The basic symbol of the common emitter amplifier is shown below.

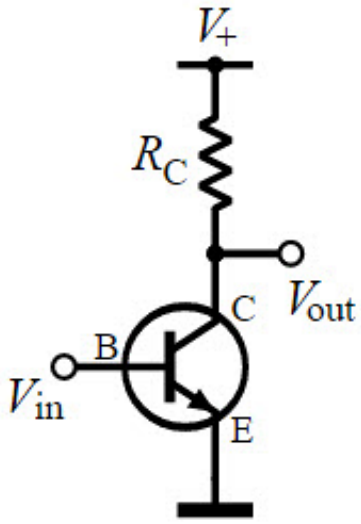


Figure (27) Common Emitter Amplifier.

In electronic circuit design, there are three kinds of transistor configurations are used like common emitter, common base, and common collector, In that, the most frequently used one is common emitter due to its main qualities.

The configuration of a common emitter transistor is widely used in most electronic circuit designs. This configuration is evenly appropriate to both the transistors like PNP and NPN transistors but NPN transistors are most frequently used due to the widespread use of these transistors.

When a signal is applied across the emitter-base junction, the forward bias across this junction increases, this leads to an increase in the flow of electrons from the emitter to a collector through the base, hence increases the collector current. The increasing collector current makes more voltage drops across the collector load resistor. The below circuit diagram shows the working of the common emitter amplifier circuit.

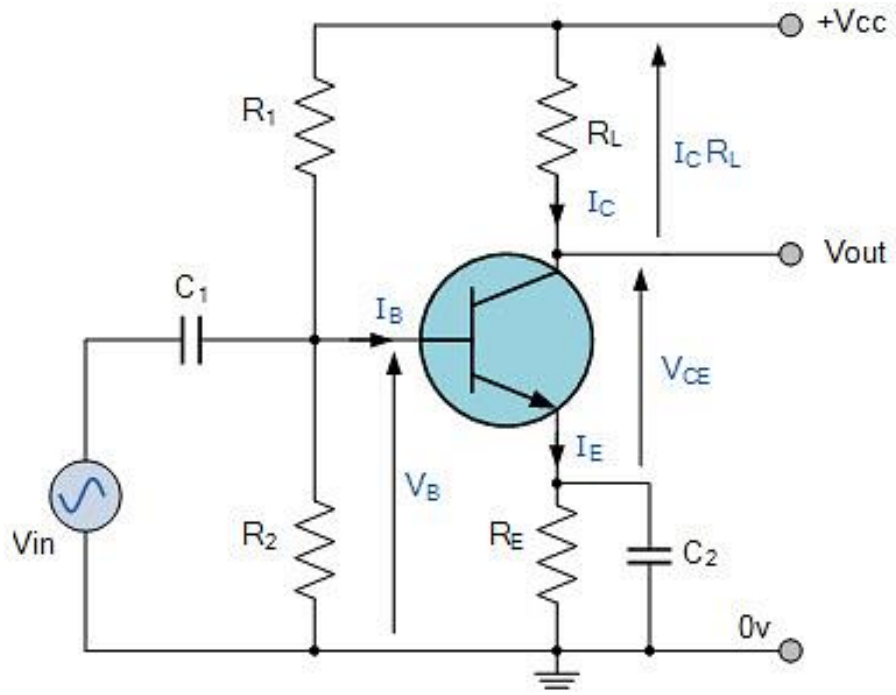


Figure (28) Common Emitter Amplifier Circuit.

Circuit Elements and their Functions

The common emitter amplifier circuit elements and their functions are discussed below:

- **Input Capacitor (C1):** The capacitor C1 is used to couple the signal to the base terminal of the BJT.
- **Coupling Capacitor (C2)**: The coupling capacitor C2 couples one stage of amplification to the next stage. This technique used to isolate the DC bias settings of the two coupled circuits.
- **CE Amplifier Circuit Currents**

  - Base current **iB** = **IB** +**ib** where,

    IB = DC base current when no signal is applied.

    ib = AC base when AC signal is applied.

    iB = total base current.

- Collector current **iC** = **IC**+**ic** where,

  iC = total collector current.

  IC = zero signal collector current.

  ic = AC collector current when the AC signal is applied.

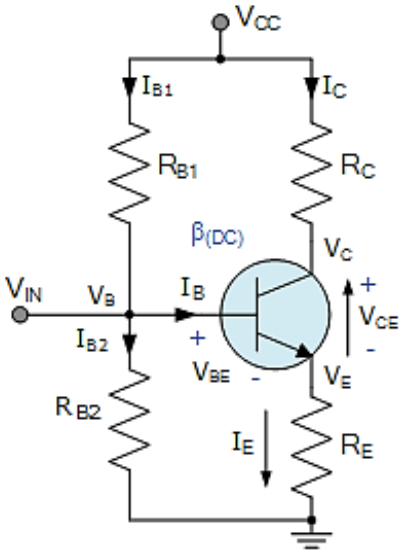
- Emitter Current **iE** = **IE** + **ie** where,

  IE = Zero signal emitter current.

  Ie = AC emitter current when AC signal is applied.

  iE = total emitter current.

- **Biasing Circuit/ Voltage Divider:** The resistances R1, R2, and RE used to form the voltage biasing and stabilization circuit.



$V_C = V_{CC} - R_C I_C = (V_E + V_{CE})$

$V_E = I_E R_E = V_B - V_{BE}$

$V_{CE} = V_C - V_E = V_{CC} - (I_C R_C + I_E R_E)$

$V_B = V_{BE} + V_E = V_{RB2} = \left(\frac{R_{B2}}{R_{B1}+R_{B2}}\right) V_{CC}$

$I_{B2} = \frac{V_B}{R_{B2}}$

$I_{B1} = I_B + I_{B2} = \frac{V_{CC} - V_B}{R_{B1}}$

$R_B = \frac{R_{B1} \times R_{B2}}{R_{B1}+R_{B2}}$ $\quad I_B = \frac{V_B - V_{BE}}{R_B + (1+\beta)R_E}$

$I_C = \beta_{(DC)} I_B$

$I_E = I_C + I_B = \frac{V_E}{R_E}$

Figure (29) Voltage Divider Transistor Biasing.

Characteristics of Common Emitter Amplifier

- The voltage gain of a common emitter amplifier is medium.
- The power gain is high in the common emitter amplifier.
- There is a phase relationship of 180 degrees in input and output.
- In the common emitter amplifier, the input and output resistors are medium.

Advantages

The advantages of a common emitter amplifier include the following:

- The common emitter amplifier has a low input impedance and it is an inverting amplifier.
- The output impedance of this amplifier is high.
- This amplifier has the highest power gain when combined with medium voltage and current gain.
- The current gain of the common emitter amplifier is high.

Disadvantages

The disadvantages of a common emitter amplifier include the following:

- In the high frequencies, the common emitter amplifier does not respond.
- The voltage gain of this amplifier is unstable.
- The output resistance is very high in these amplifiers.
- In these amplifiers, there is a high thermal instability.

Applications

The applications of a common emitter amplifier include the following:

- The common emitter amplifiers are used in the low-frequency voltage amplifiers.
- These amplifiers are used typically in the RF circuits.
- In general, the amplifiers are used in the Low noise amplifiers
- The common emitter circuit is popular because it's well-suited for voltage amplification, especially at low frequencies.
- Common-emitter amplifiers are also used in radio frequency transceiver circuits.
- Common emitter configuration commonly used in low-noise amplifiers.