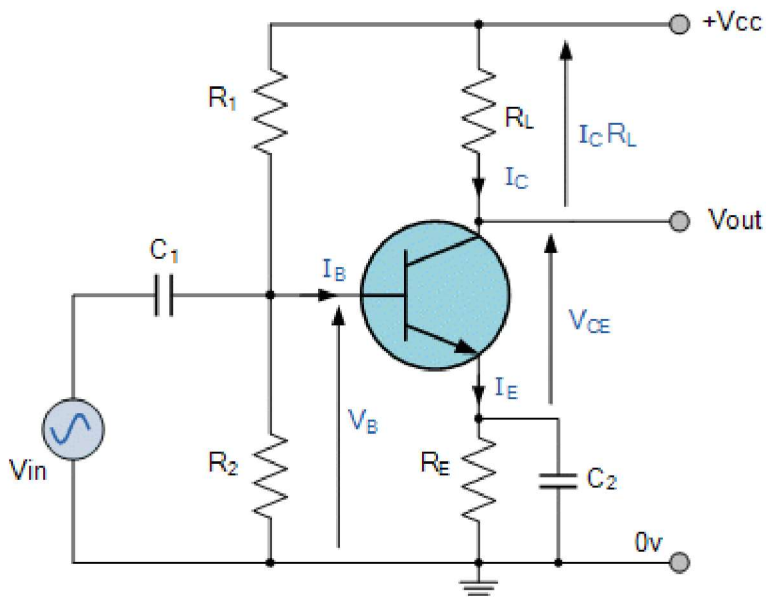


Common Emitter Amplifier

The most common amplifier configuration for an NPN transistor is that of the Common Emitter Amplifier circuit

In the previous introduction to the amplifier tutorial, we saw that a family of curves known commonly as the **Output Characteristic Curves**, relate the transistors Collector Current (Ic), to its Collector Voltage (Vce) for different values of the transistors Base Current (Ib).

All types of transistor amplifiers operate using AC signal inputs which alternate between a positive value and a negative value so some way of "presetting" the amplifier circuit to operate between these two maximum or peak values is required. This is achieved using a process known as **Biasing**. Biasing is very important in amplifier design as it establishes the correct operating point of the transistor amplifier ready to receive signals, thereby reducing any distortion to the output signal.

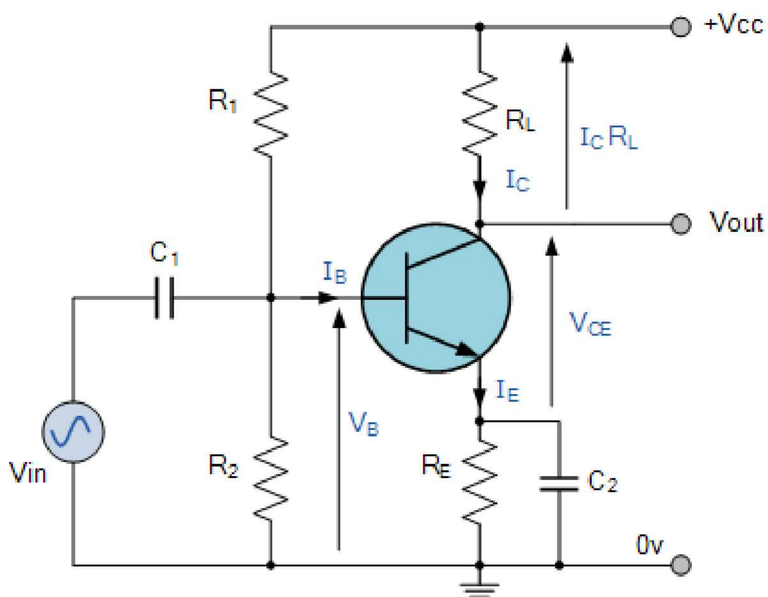
We also saw that a static or DC load line can be drawn onto these output characteristics curves to show all the possible operating points of the transistor from fully "ON" to fully "OFF", and to which the quiescent operating point or **Q-point** of the amplifier can be found.

The aim of any small signal amplifier is to amplify all of the input signal with the minimum amount of distortion possible to the output signal, in other words, the output signal must be an exact reproduction of the input signal but only bigger (amplified).

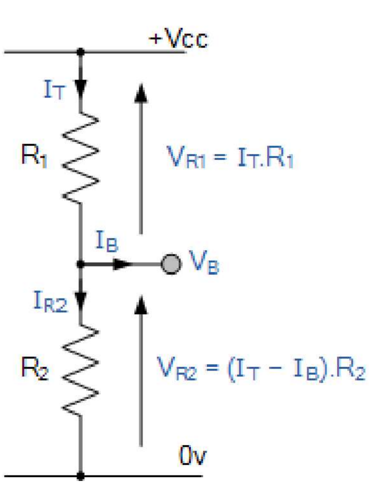
To obtain low distortion when used as an amplifier the operating quiescent point needs to be correctly selected. This is in fact the DC operating point of the amplifier and its position may be established at any point along the load line by a suitable biasing arrangement.

The best possible position for this Q-point is as close to the center position of the load line as reasonably possible, thereby producing a Class A type amplifier operation, ie. Vce = 1/2Vcc. Consider the **Common Emitter Amplifier** circuit shown below.

The Common Emitter Amplifier Circuit



The single stage common emitter amplifier circuit shown above uses what is commonly called "Voltage Divider Biasing". This type of biasing arrangement uses two resistors as a potential divider network across the supply with their center point supplying the required Base bias voltage to the transistor. Voltage divider biasing is commonly used in the design of bipolar transistor amplifier circuits.



This method of biasing the transistor greatly reduces the effects of varying Beta, (β) by holding the Base bias at a constant steady voltage level allowing for best stability. The quiescent Base voltage (Vb) is determined by the potential divider network formed by the two resistors, R1, R2 and the power supply voltage Vcc as shown with the current flowing through both resistors.

Then the total resistance R_T will be equal to R1 + R2 giving the current as i = Vcc/R_T. The voltage level generated at the junction of resistors R1 and R2 holds the Base voltage (Vb) constant at a value below the supply voltage.

Then the potential divider network used in the common emitter amplifier circuit divides the supply voltage in proportion to the resistance. This bias reference voltage can be easily calculated using the simple voltage divider formula below:

Transistor Bias Voltage

$$V_B = \frac{V_{CC} R_2}{R_1 + R_2}$$

The same supply voltage, (Vcc) also determines the maximum Collector current, Ic when the transistor is switched fully "ON" (saturation), Vce = 0. The Base current Ib for the transistor is found from the Collector current, Ic and the DC current gain Beta, β of the transistor.

Beta Value

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

Beta is sometimes referred to as h_{FE} which is the transistors forward current gain in the common emitter configuration. Beta has no units as it is a fixed ratio of the two currents, Ic and Ib so a small change in the Base current will cause a large change in the Collector current.

One final point about Beta. Transistors of the same type and part number will have large variations in their Beta value. For example, the *BC107 NPN Bipolar transistor* has a DC current gain Beta value of between 110 and 450 (data sheet value). So one BC107 may have a Beta value of 110, while another one may have a Beta value of 450, but they are both BC107 npn transistors. This is because Beta is a characteristic of the transistors construction and not of its operation.

As the Base/Emitter junction is forward-biased, the Emitter voltage, Ve will be one junction voltage drop different to the Base voltage. If the voltage across the Emitter resistor is known then the Emitter current, Ie can be easily calculated using Ohm's Law. The Collector current, Ic can be approximated, since it is almost the same value as the Emitter current.

Common Emitter Amplifier Example No1

An common emitter amplifier circuit has a load resistance, R_L of 1.2kΩ and a supply voltage of 12v. Calculate the maximum Collector current (Ic) flowing through the load resistor when the transistor is switched fully "ON" (saturation), assume Vce = 0. Also find the value of the Emitter resistor, R_E if it has a voltage drop of 1v across it.