

# **Amplification of weak electrical signals using a common emitter amplifier and verification voltage gain**

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## **Abstract**

This paper examines the amplification of weak electrical signal using a CE (common emitter) amplifier. It amplifies an AC input signals that alternates between some positive value and a corresponding negative value. This is done by using “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. This paper also explains about biasing, Q-point, Voltage divider bias and also the design of the CE amplifier circuit.

## **Introduction**

The Amplifier is an electronic circuit that is used to increase the strength of a weak input signal in terms of voltage, current, or power. The process of increasing the strength of a weak signal is known as Amplification. The transistor (BJT, FET) is a major component in an amplifier system. 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. In a CE amplifier, during the positive half-cycle of the input signal, the forward bias across the emitter-base junction increases, raising the collector current and voltage drop across the load resistor (RC). In the negative half-cycle, the forward bias decreases, reducing the collector current and voltage drop. This variation produces an amplified output signal across RC.

## Working of Common Emitter Amplifier

The voltage divider biasing in a common emitter amplifier uses two resistors (**R1** and **R2**) to provide a stable base bias voltage. Key components and their roles include: **R1**: Provides forward bias. **R2**: Develops bias voltage. **RE**: Ensures thermal stability. **RL (Load Resistance)**: Located at the output. **C1 (Coupling Capacitor)**: Separates AC signals from the DC biasing voltage.

When the resistor **R2** increases, the forward bias also increases, while **R1** and the bias are inversely proportional. Applying an AC signal to the transistor's base generates a small base current, which leads to a larger collector current due to the high RC resistance (4–10 kΩ). This results in a significant voltage change across RC, amplifying the weak input signal. Thus, the common emitter amplifier is effective for signal amplification

## Circuit Design

A common emitter amplifier circuit has a load resistance,  $R_L$  of  $1.2\text{k}\Omega$  and a supply voltage of  $12\text{V}$ . The maximum Collector current ( $I_c$ ) flowing through the load resistor when the transistor is switched fully “ON” (saturation), assuming  $V_{ce} = 0$ .

$$I_c = \frac{V_{cc} - V_{re}}{R_L} = \frac{12 - 1}{1200} = 9.2\text{mA}$$

$$V_{ce=0} \text{ (Saturation)}$$

In a CE amplifier, when the transistor is fully ON (saturation),  $V_{ce}=0$ , and the maximum collector current ( $I_c$ ) is determined, marking point “A” on the characteristic curves. When the transistor is fully OFF, no current flows, and  $V_{ce}=V_{cc}$  marking point “B.” The quiescent Q-point, with no input signal, is typically set midway along the load line at  $V_{cc}/2$ , providing an optimal balance for the collector current and voltage swing. Therefore, the Collector current at the Q-point of the amplifier will be given as:

$$I_c = \frac{12-1}{2} = \frac{5.5}{1200} = 4.58\text{mA}$$

The Base current  $I_b$  flowing into the transistor will be given as:

$$\beta = \frac{I_c}{I_b} \therefore I_b = \frac{I_c}{\beta} = \frac{4.58\text{mA}}{100} = 45.8\mu\text{A}$$

Transistor Base/Emitter voltage,  $V_{be}$  is fixed at 0.7V (silicon transistor) then this gives the value of  $R_2$  as:

$$R_2 = \frac{V_{re} + V_{be}}{10 \times I_b} = \frac{1 + 0.7}{458 \times 10^{-6}} = 3.71 k\Omega$$

$R_1$  can be calculated as:

$$R_1 = \frac{V_{cc} - (V_{re} + V_{be})}{11 \times I_b} = \frac{12 - 1.7}{504 \times 10^{-6}} = 20.45 k\Omega$$

The current flowing through  $R_E$  is a combination of the Base current,  $I_b$  and the Collector current  $I_c$  and is given as:

$$I_e = I_c + I_b = 4.58 mA + 45.8 \mu A = 4.63 mA$$

The value of the Emitter resistor,  $R_E$  is calculated as:

$$R_e = \frac{V_{re}}{I_e} = \frac{1V}{4.63 mA} = 216 \Omega$$

The preferred values of the resistors chosen to give a tolerance of 5% (E24) are:

$$R_1 = 20 k\Omega, R_2 = 3.6 k\Omega, R_l = 1.2 k\Omega, R_e = 220 \Omega$$

## Circuit Diagram

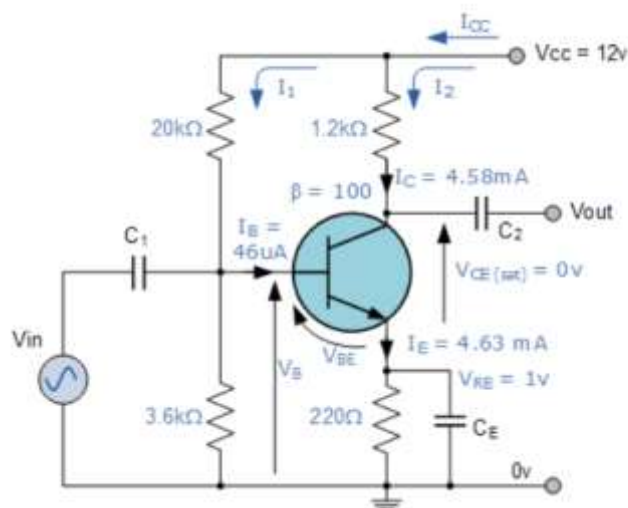
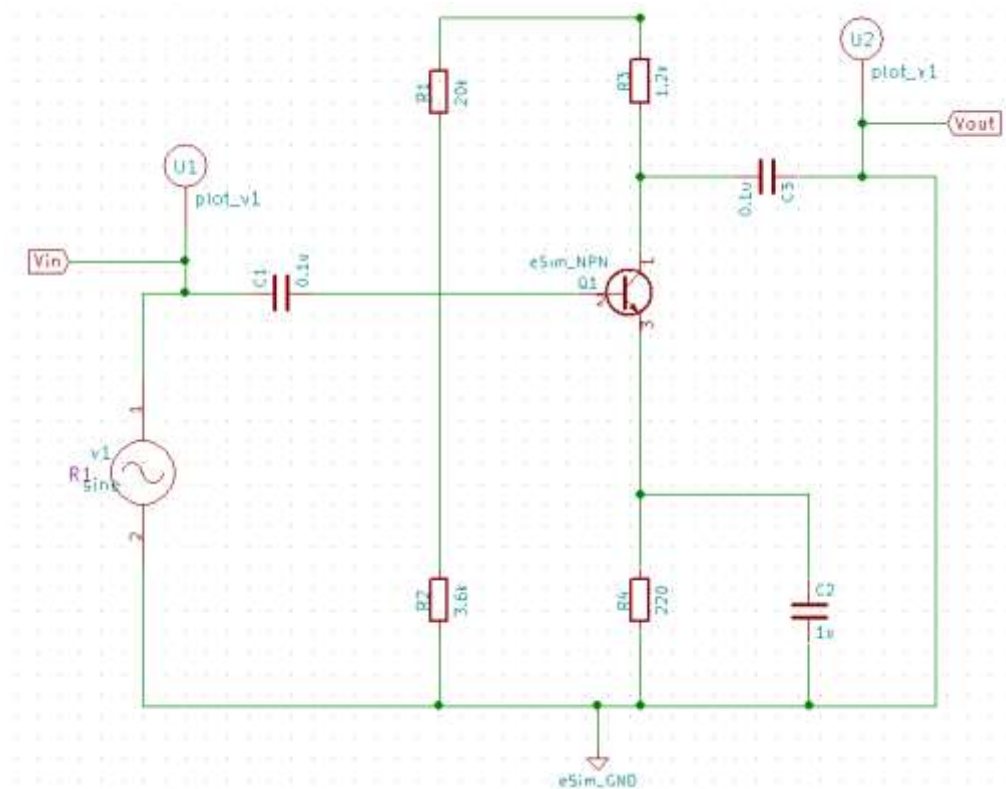


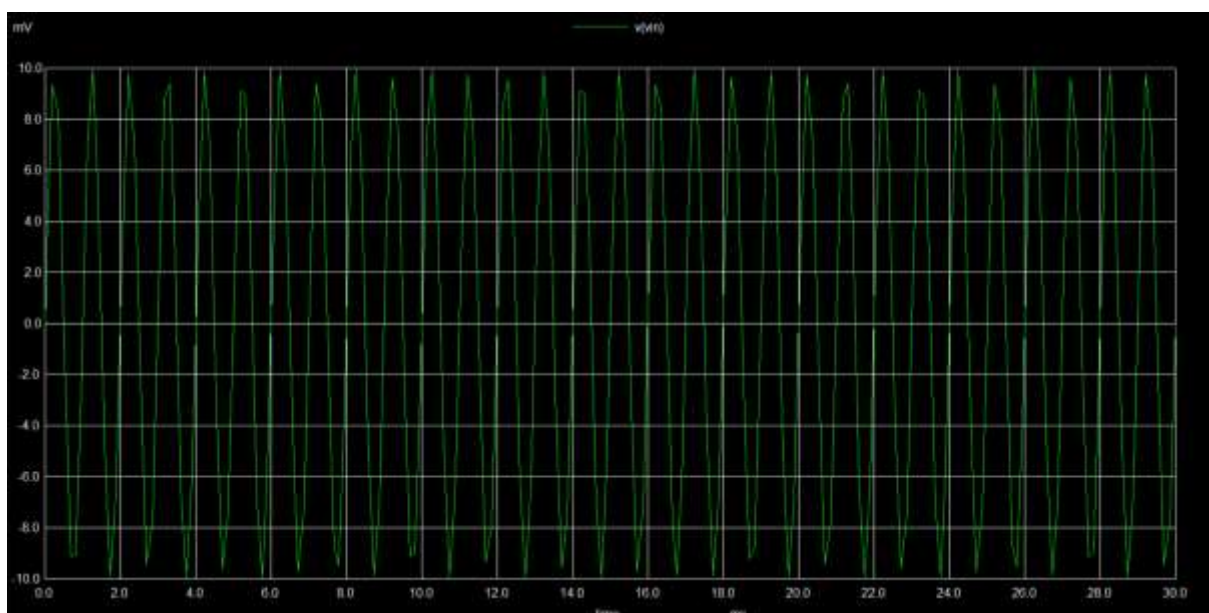
Fig 1: designed CE amplifier

## ESIM Circuit



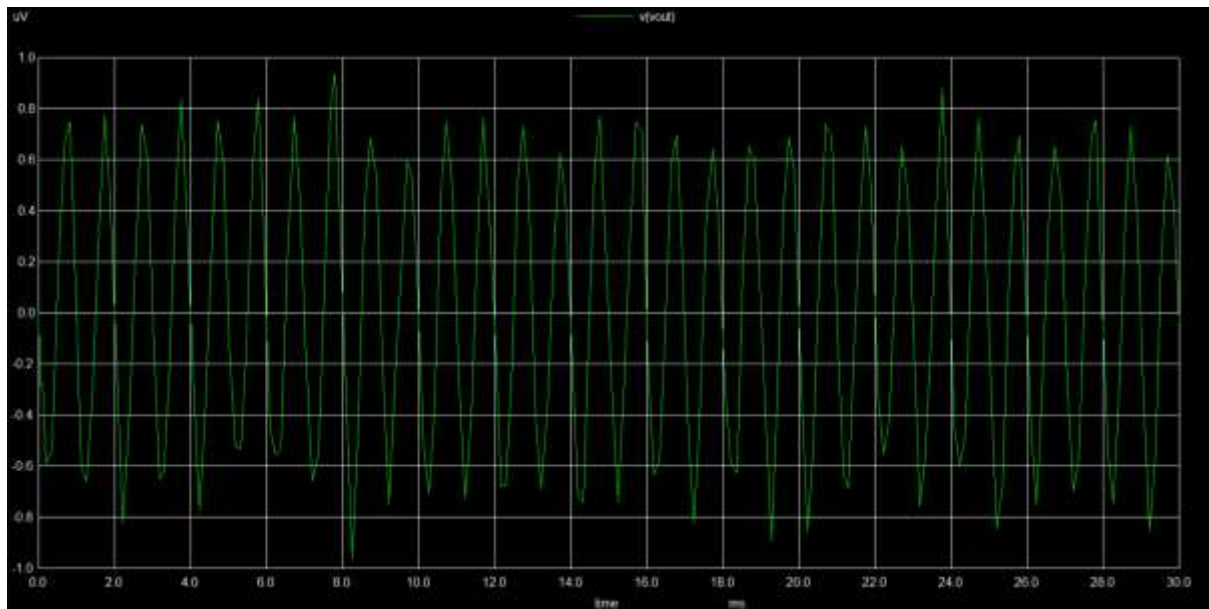
**Fig 2:** shows connection of common emitter circuit as per the designed including voltage divider biasing and the coupling capacitor  $C_1$  couples one stage of amplification to the next stage.

## Input Waveform



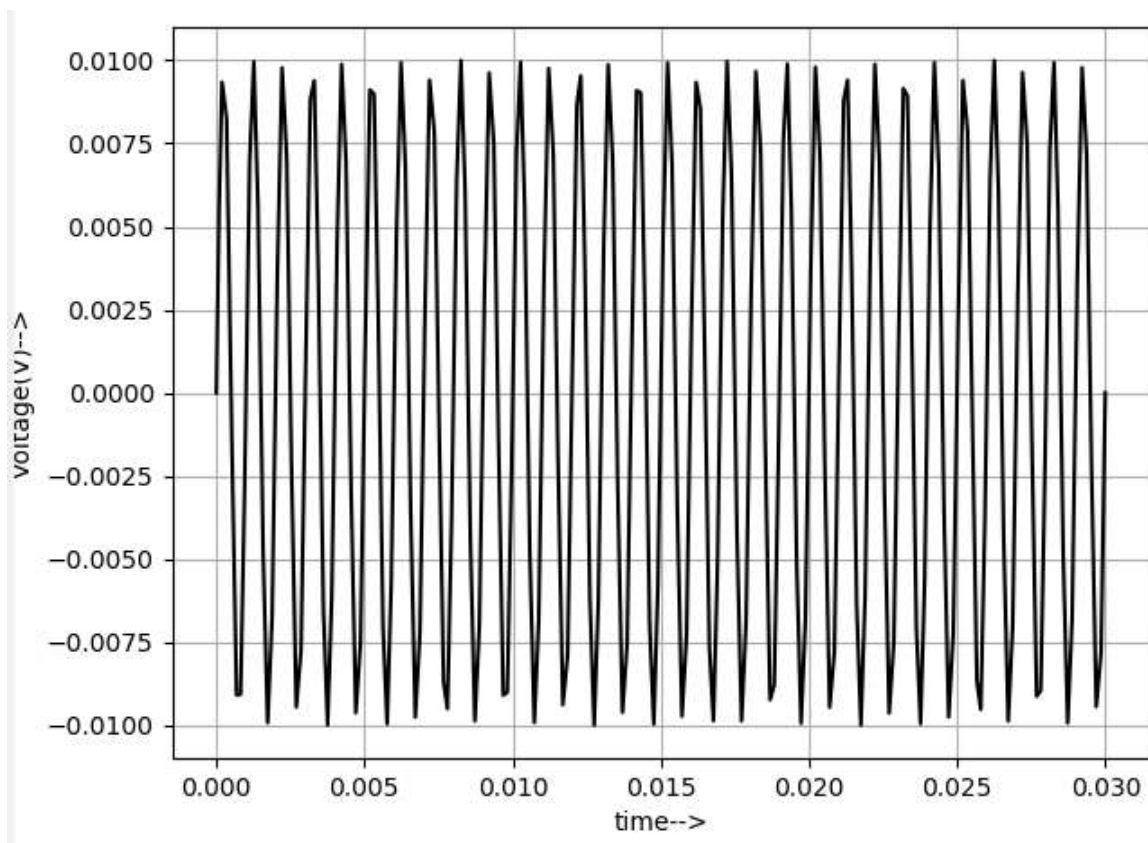
**Fig 3:** shows the input waveform given to the circuit.

## Output Waveform

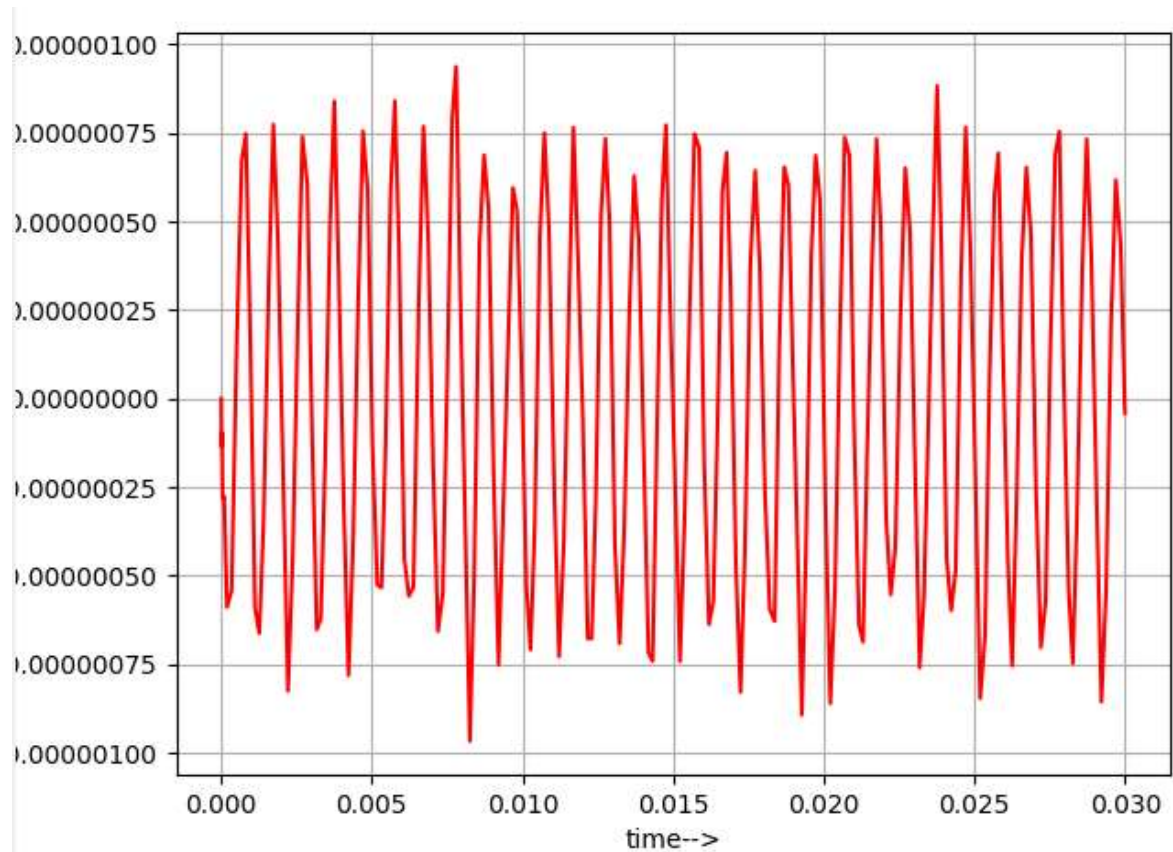


**Fig 4:** shows the amplified output, voltage gain of the common emitter amplifier

## Python Plot



**Fig 5:** shows the Vin of the circuit.



**Fig 6: shows the Vout of the circuit**

## **Conclusion**

The input is given as a sinusoidal wave and the output is obtained as 180 degree out of phase with the input voltage and amplified.

## **Reference**

1. [https://www.electronics-tutorials.ws/amplifier/amp\\_2.html](https://www.electronics-tutorials.ws/amplifier/amp_2.html)
2. <https://www.elprocus.com/common-emitter-amplifier-circuit-working/>