Common Emitter Amplifier

By Nolan Manteufel with ChatGPT

A common emitter amplifier is a type of bipolar junction transistor (BJT) amplifier configuration that is widely used in electronic circuits to amplify signals. It's called a "common emitter" because the emitter terminal of the transistor is common to both the input and output of the amplifier. This configuration provides voltage amplification, high input impedance, and low output impedance.

Here's the theory of operation for a common emitter amplifier:

Components: The common emitter amplifier consists of an NPN transistor (like the 2N3904 or 2N2222), resistors, and a power supply.

Biasing: Proper biasing is essential to ensure the transistor operates in its active region. This typically involves setting a DC voltage at the base terminal (Vbb) and at the collector terminal (Vcc) while connecting the emitter to a common ground (0V or GND). Biasing sets the quiescent operating point (Q-point) of the transistor.

Signal Input: The input signal is applied to the base terminal (Vin). This AC signal is superimposed on the DC bias voltage. The input resistor (Rb) limits the base current to protect the transistor and helps to match the input impedance of the amplifier.

Transistor Action: The transistor amplifies the input signal. When a positive voltage is applied at the base (Vin increases), it causes an increase in the base current. This leads to an increase in collector current due to the transistor's current gain (Beta or hfe). The collector current flows from the collector to the emitter.

Collector Load Resistor: A collector load resistor (Rc) is connected to the collector terminal. It converts the change in collector current into an amplified output voltage. The voltage across Rc is the amplified signal (Vout).

Emitter Resistor (Optional): In some cases, an emitter resistor (Re) is added to stabilize the DC biasing and to provide negative feedback, which helps in improving the linearity and stability of the amplifier.

Output Signal: The amplified signal appears at the collector terminal. The output is typically taken as the voltage across the collector resistor (Vout = Ic * Rc).

Output Coupling Capacitor (Optional): If a DC component is present at the collector, it is blocked using an output coupling capacitor (Cout) to ensure that only the AC component of the signal is passed to the next stage of the circuit.

Gain and Phase Inversion: The common emitter amplifier provides a voltage gain that is approximately equal to the ratio of the collector resistor to the emitter resistor (Av ≈ -Rc / Re). Additionally, the output signal is phase-inverted with respect to the input signal.

Common emitter amplifiers are widely used due to their high voltage gain and can be found in various applications like audio amplifiers and intermediate frequency (IF) amplifiers in radio receivers. The biasing and component values need to be carefully chosen to ensure proper operation and meet specific performance requirements.

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