

Common Source Amplifier

By Nolan Manteufel with ChatGPT

A common source amplifier is a type of field-effect transistor (FET) amplifier configuration commonly used in electronic circuits to amplify signals. It's called a "common source" because the source terminal of the FET 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 source amplifier:

Components: The common source amplifier consists of an N-channel enhancement-mode FET (such as a metal-oxide-semiconductor FET or MOSFET), resistors, capacitors, and a power supply.

Biasing: Proper biasing is essential to ensure the FET operates in its active region. This typically involves setting a DC voltage at the gate terminal (V_{gg}) and at the drain terminal (V_{dd}) while connecting the source to a common ground (0V or GND). Biasing sets the quiescent operating point (Q-point) of the FET.

Signal Input: The input signal is applied to the gate terminal (V_{in}). This AC signal is superimposed on the DC bias voltage. The input resistor (R_g) limits the gate current and helps match the input impedance of the amplifier.

FET Action: The FET amplifies the input signal. When a positive voltage is applied at the gate (V_{in} increases), it causes an increase in the gate-source voltage (V_{gs}), which in turn, causes an increase in the drain current (I_d). The FET operates in its active region, and its drain current is controlled by the gate-source voltage.

Drain Load Resistor: A drain load resistor (R_d) is connected to the drain terminal. It converts the change in drain current into an amplified output voltage. The voltage across R_d is the amplified signal (V_{out}).

Source Resistor (Optional): In some cases, a source resistor (R_s) is added to stabilize the DC biasing and provide a level of negative feedback, which can improve linearity and stability.

Output Signal: The amplified signal appears at the drain terminal. The output is typically taken as the voltage across the drain resistor ($V_{out} = I_d * R_d$).

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

Gain and Phase: The common source amplifier provides voltage gain that depends on the value of the drain resistor and the transconductance of the FET. The output signal is typically in phase with the input signal.

Common source amplifiers are used in various applications, including as building blocks in radio-frequency (RF) and microwave circuits, as well as in operational amplifiers (op-amps) and audio amplifiers. The choice of component values and biasing conditions is crucial to ensure proper operation and meet specific performance requirements.

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Revision History

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