Design and Performance Analysis of a Common Source MOSFET Amplifier Using eSim

V. Bhavya, ECE Department
BVRIT Hyderabad College Of Engineering For Women

ABSTRACT

With the increasing demand for high-performance analog circuits, MOSFET-based amplifiers play a crucial role in modern electronic systems. Among various configurations, the Common Source (CS) MOSFET amplifier is widely used due to its high voltage gain and simple design structure.
This project focuses on the design and performance analysis of a Common Source MOSFET amplifier using eSim simulation software. The amplifier circuit is designed using an NMOS transistor with proper biasing network to ensure operation in the saturation region. Transient analysis is performed to evaluate voltage gain, phase shift, and signal amplification characteristics.
Simulation results confirm successful amplification with expected phase inversion and stable operation, validating theoretical calculations.
Keywords: MOSFET, Common Source Amplifier, Voltage Gain, eSim, Analog Circuits, Frequency Response

INTRODUCTION

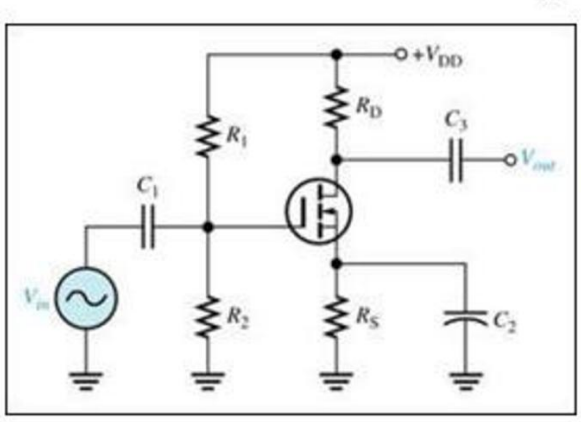
MOSFET amplifiers are fundamental building blocks in analog electronics. The Common Source (CS) configuration is one of the most commonly used MOSFET amplifier circuits due to its high voltage gain and moderate input and output impedance.

In a CS amplifier, the input signal is applied at the gate terminal, the output is taken from the drain, and the source terminal is typically grounded (common reference). The circuit provides:

- High voltage gain
- 180° phase shift between input and output
- Good amplification performance

This project aims to design, simulate, and analyze the performance of a Common Source MOSFET amplifier using eSim.

CIRCUIT DIAGRAM



eSim IMPLEMENTATION

The amplifier circuit was implemented in eSim using:

- NMOS transistor model
- Passive components (resistors and capacitors)
- AC input signal source
- DC power supply

Simulation Settings:

- Transient analysis performed
- Input sine wave applied
- Output waveform observed at drain

Proper biasing ensured that the MOSFET operated in saturation region during simulation.

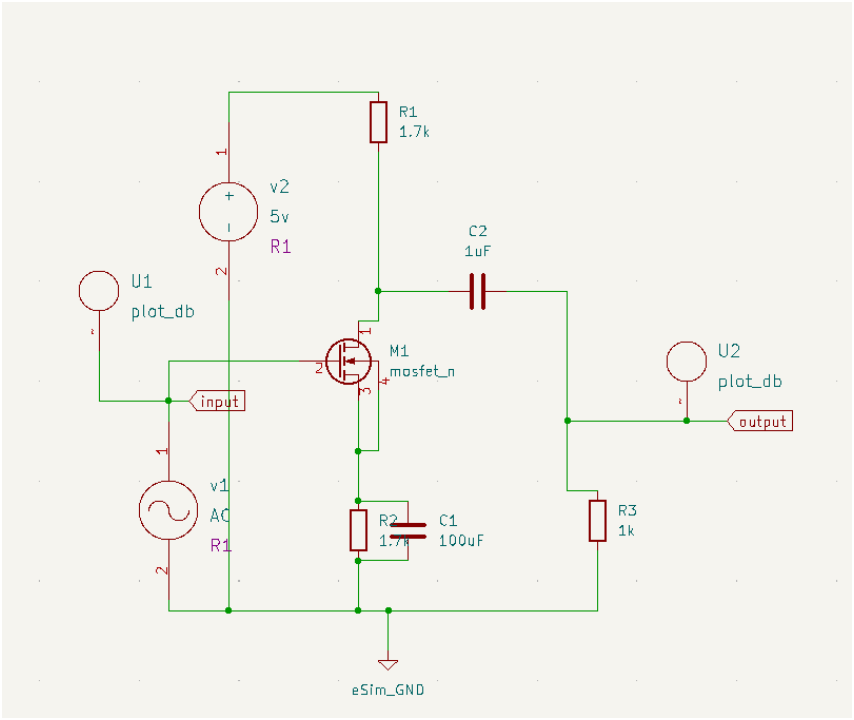


Figure: Common Source MOSFET Amplifier Implementation in eSim.

SIMULATION RESULTS

Simulation waveforms confirm:

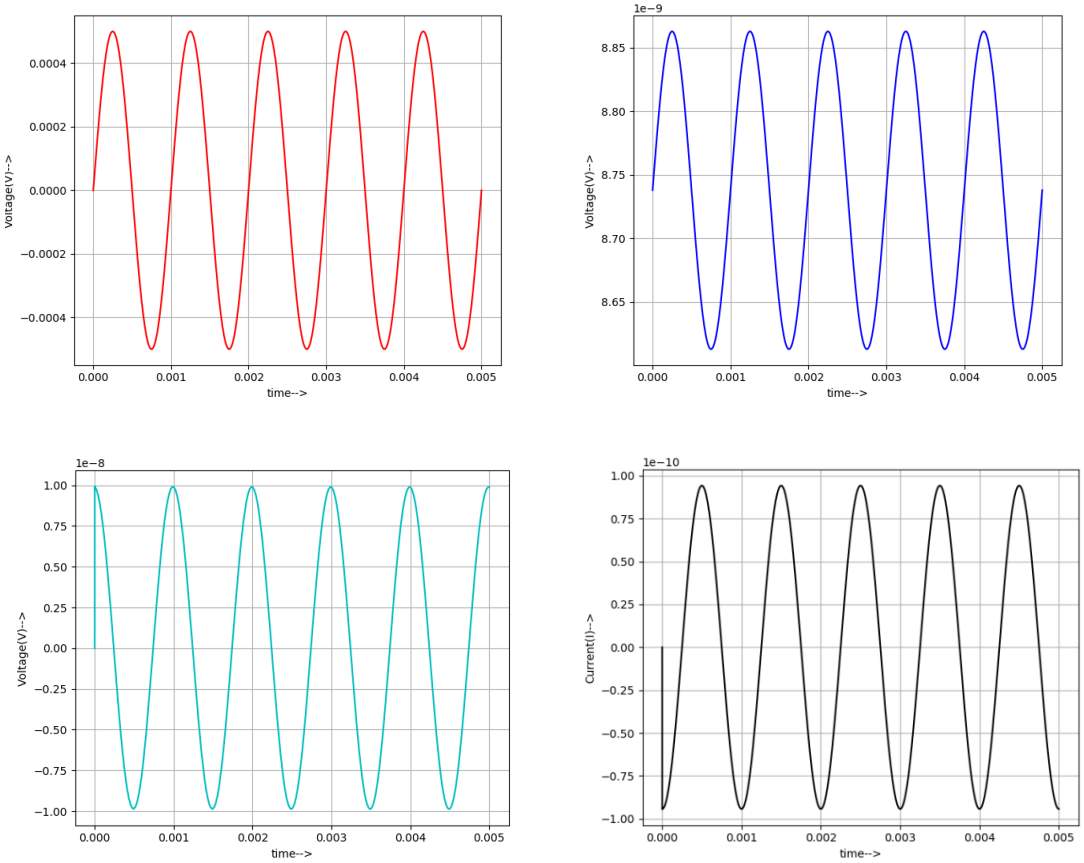
- Amplification of input signal
- 180° phase shift between input and output
- Stable operation without distortion (within limits)

Performance Analysis:

- Voltage Gain (Av) ≈ - (RD / RS') (approximate theoretical relation)
- Output signal amplitude greater than input
- Phase inversion observed

The results validate theoretical expectations of Common Source amplifier behavior.

Figures: Input and Output Waveforms



APPLICATIONS

Common Source MOSFET amplifiers are used in:

1. Audio amplification systems
2. RF circuits
3. Analog signal processing
4. Sensor signal amplification
5. Communication systems

CONCLUSION

This project presented the design and performance analysis of a Common Source MOSFET amplifier using eSim. The amplifier was successfully designed with proper biasing and simulated using transient analysis.

Results confirmed:

- Proper voltage amplification
- 180° phase inversion
- Stable operating condition

The implemented design serves as a strong foundation for advanced analog circuit design and can be extended to multi-stage amplifiers or frequency response analysis in future work.

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