Design and Transient Analysis of a Common-Source MOSFET Amplifier with Resistive Load

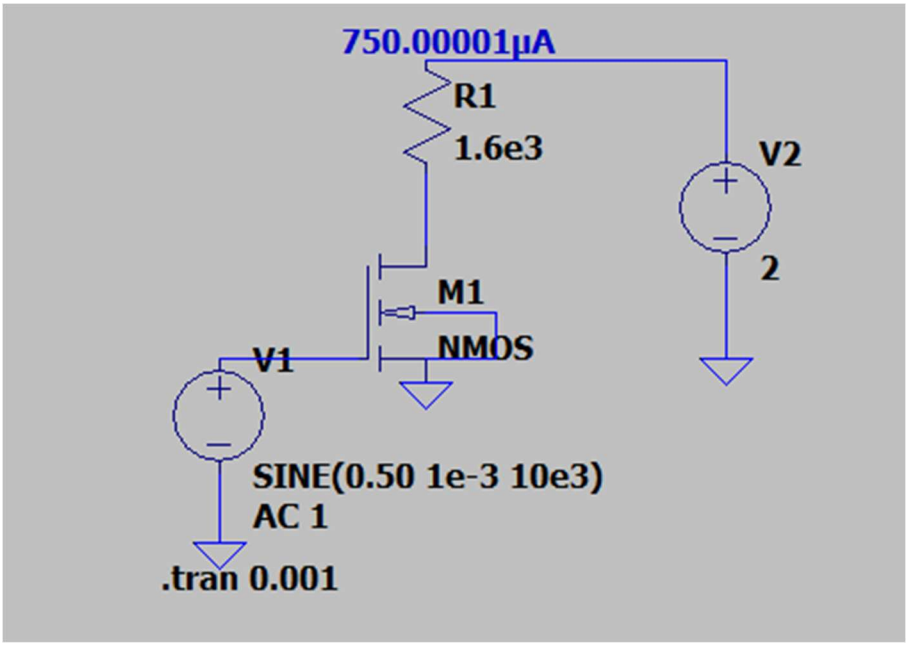
1. Introduction

This report presents the design and transient analysis of a common-source NMOS amplifier using a resistive load. The objective is to study the voltage gain and transient response of the amplifier under small-signal sinusoidal excitation.

2. Circuit Description

The amplifier consists of an NMOS transistor configured in a common-source topology. The drain of the transistor is connected to a resistive load, and a DC supply voltage is applied at the drain. A small-signal sinusoidal voltage is applied at the gate terminal, while the source terminal is connected to ground.

This configuration provides voltage amplification with a phase inversion between the input and output signals.



3. Device Model and Parameters

The NMOS transistor is modeled using the following Level-1 SPICE parameters:

- Threshold voltage, $V_{TO} = 0.4$ V
- Transconductance parameter, $K_P = 200\ \mu$A/V^2

- Channel-length modulation parameter, $\lambda = 0.02$
- Channel width, $W = 300\ \mu$m
- Channel length, $L = 1\ \mu$m

The model is defined as:

.model M1 NMOS (VTO = 0.4, KP = 200u, LAMBDA = 0.02)

4. Simulation and Results

4.1 Small-Signal Gain

The small-signal voltage gain of the amplifier is given by:

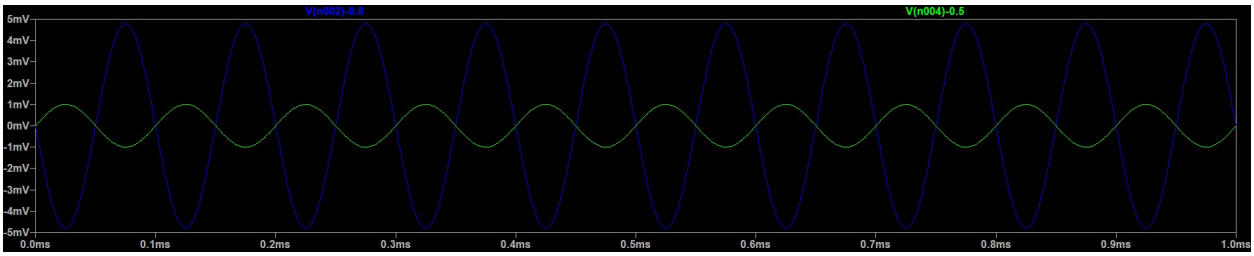
$$A_v = -g_m R_D$$

where $g_m$is the transconductance of the NMOS transistor and $R_D$is the drain resistance.

The negative sign indicates a 180° phase shift between the input and output signals.

4.2 Transient Response

The transient analysis was performed by applying a sinusoidal input voltage at the gate. The output waveform observed at the drain shows an amplified version of the input signal with a phase inversion, confirming proper operation of the common-source amplifier.



5. Conclusion

The common-source NMOS amplifier with a resistive load was successfully designed and simulated. The circuit exhibited voltage gain with phase inversion as expected from theory. The simulation results validate the theoretical behavior of the common-source amplifier and demonstrate its suitability for small-signal amplification applications.