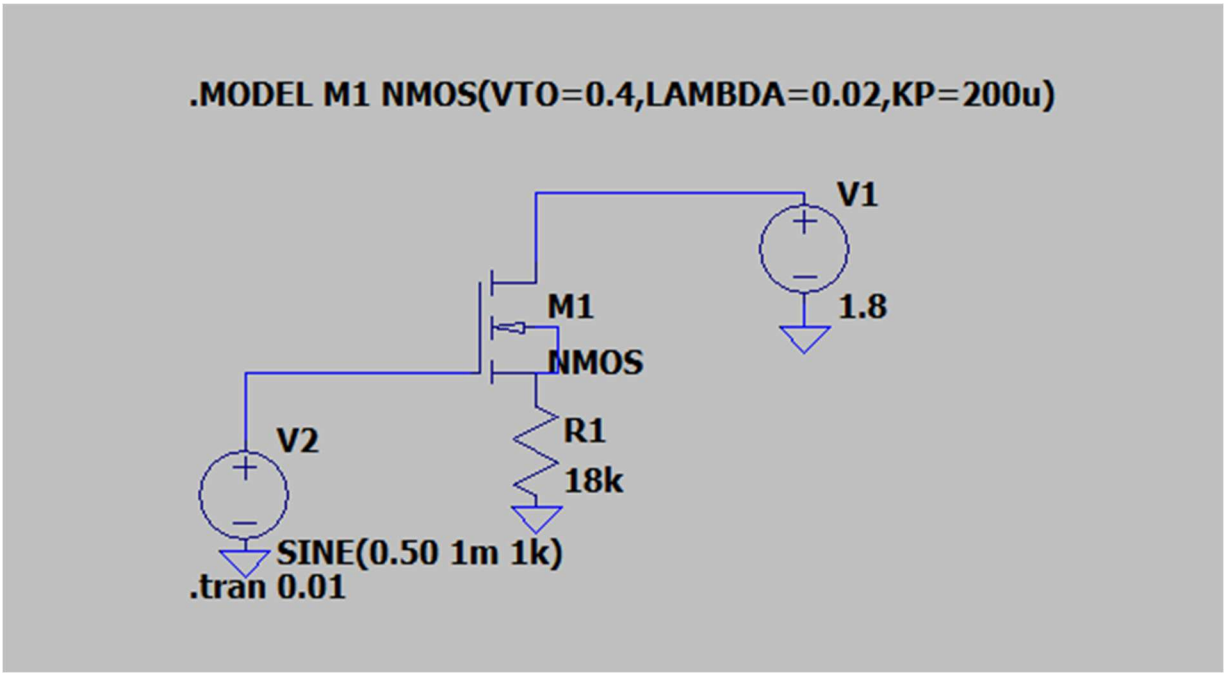
Design and Transient Analysis of Source Follower

1. Introduction

This report presents the design and transient analysis of a source follower (common-drain) NMOS amplifier using a resistive source load. The objective is to study the voltage transfer characteristics, output impedance, 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-drain (source follower) topology. The drain of the transistor is connected to a DC supply voltage, and the source terminal is connected to ground through a resistive load. A small-signal sinusoidal voltage is applied at the gate terminal, and the output is taken from the source node.
This configuration provides a voltage gain close to unity with no phase inversion between the input and output signals, and it offers low output impedance and buffering capability.



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 width, $W = 350\ \mu$m

- Channel length, $L = 1\ \mu$m

The model is defined as:

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

4. Simulation and Results

4.1 Small-Signal Gain

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

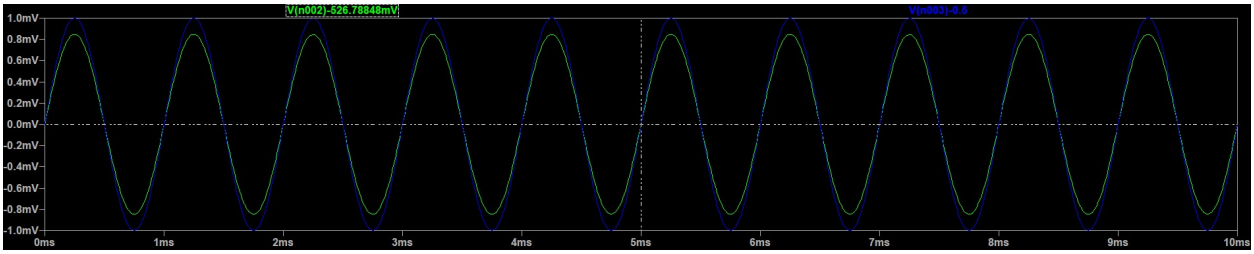
$$A_v = \frac{g_m R_S}{1 + g_m R_S}$$

where $g_m$is the transconductance of the NMOS transistor and $R_S$is the source resistance.

The gain is positive and slightly less than unity, indicating that the output follows the input without phase inversion.

4.2 Transient Response

The transient analysis was performed by applying a sinusoidal input voltage at the gate. The output waveform observed at the source follows the input signal with no phase inversion, confirming proper operation of the source follower (common-drain) amplifier. The output exhibits slightly reduced amplitude and improved drive capability due to the low output impedance of the stage.



5. Conclusion

The source follower (common-drain) NMOS amplifier with a resistive load was successfully designed and simulated. The circuit exhibited a voltage gain close to unity with no phase inversion, consistent with theoretical expectations. The simulation results validate the theoretical behavior of the source follower and demonstrate its suitability as a buffer stage for driving loads and isolating circuit stages.