The goal of this lab. is to learn how to bias a MOST amplifier and to observe the effect of the bias point on amplification.

Pre-Lab

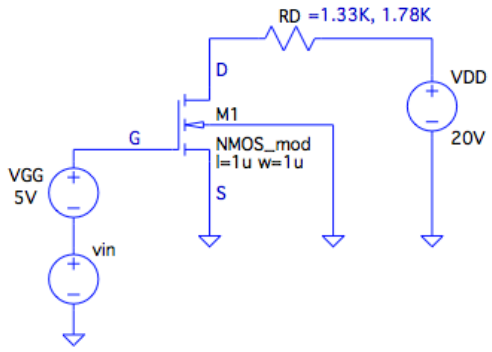


Figure 1. nMOST amplifier

1. Compute the operating point of the amplifier shown in Figure 1 for RD=1.33KΩ and RD=1.78KΩ

   a. RD=1.33KΩ

      ID,Q = _____

      VDS,Q = _____

      VGS,Q = _____

   b. RD=1.78KΩ

      ID,Q = _____

      VDS,Q = _____

      VGS,Q = _____

The MOST has a threshold voltage Vth=2V and $\beta = \mu\, Cox\, W/L = 2mA/V^2$.

Metal-Oxide-Semiconductor FET (MOSFET)

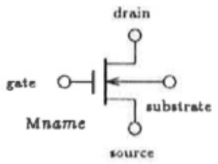
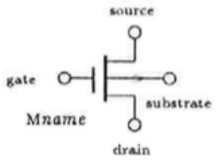
Element	Spice Description
	Mname drain gate source substrate *MOS_model_name* L=*value* W=*value* .MODEL *MOS_model_name* NMOS (*parameter_name=value* ....)
	Mname drain gate source substrate *MOS_model_name* L=*value* W=*value* .MODEL *MOS_model_name* PMOS (*parameter_name=value* ....)

Table 1 Partial listing of the Spice parameters for the level 1 MOSFET model.

Symbol	Spice Name	Model Parameter	Units	Default
	Level	Model type		1
μC_{OX}	kp	Transconductance coefficient	A/V^2	20 μ
V_{t0}	Vto	Zero-bias threshold voltage	V	0
λ	lambda	Channel-length modulation	V^{-1}	0
γ	gamma	Body-effect parameter	$V^{1/2}$	0
$2\phi_f$	phi	Surface potential	V	0.6

2. Build the SPICE model of the MOST.

.MODEL _____

Lab.

1. Assuming a fixed bias of VGS=5V, trace the MOST output characteristics ID vs. VDS for the ideal case of negligible channel length modulation (λ=0) and for the real case with channel length modulation λ=0.01 V^{-1}

   Attach both the plot for lambda=0 and lambda=0.01 V^{-1}

2. Comment on the effect (in terms of the MOST operation mode) that the location of the DC operating point has if the drain resistance RD is increased from 1.33 KΩ to 1.78KΩ?

   _____

3. Draw the load line for both values of RD on the output characteristics ID vs. VDS, and derive the operating points graphically. The task can be done directly in LTSPICE or using MATLAB (see the examples provided in the session "Importing LTspice simulations in Matlab" at http://web02.gonzaga.edu/faculty/talarico/keen/top.html)

4. Verify the correctness of the of the operating points you computed analytically and graphically through SPICE simulation (use SPICE .OP)

		Q_1 (R_D=1.33KΩ)	Q_2 (R_D=1.78KΩ)
VGS,Q	=		
VDS,Q	=		
ID,Q	=		

5. Compute analytically the small signal parameters gm and ro of the MOST and the voltage gain Av of the amplifier at both operating points.

   Symbolic expression for gm:

   Symbolic expression for ro:

   Symbolic expression for Av:

		Q_1 (R_D=1.33KΩ)	Q_2 (R_D=1.78KΩ)
gm	=		
ro	=		
Av	=		

6. Verify the correctness of your computations by running SPICE (you need an .AC and an .OP analysis)

		Q_1 (R_D=1.33KΩ)	Q_2 (R_D=1.78KΩ)
gm	=		
ro	=		
Av	=		

7. Further comment on the effect that the location of the DC operating point has on the behavior of the amplifier, by considering the application of a 1 V peak-to-peak triangular waveform input signal (vin) of 1KHZ frequency in series with the 5V DC voltage applied at the gate of the MOST. Attach a .TRAN analysis plot of the input and output voltages for each of the two RD values.

a. Plot for RD=1.33KΩ

b. Plot for RD=1.78KΩ

c. Comments:

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