

Lab Assignment: MOS/SPICE

1 SPICE PARAMETER EXTRACTION (SEE P-127, SECTION 3.5.1 IN [HODGES])

Problem 1:

(a) Extract V_{T0} , μ , γ for both NMOS ($W/L = 5\mu/1\mu$) [Use $t_{ox} = 7.6\text{nm}$]

The square-root of saturation current can be expressed as

$$\sqrt{I_D} = \sqrt{\frac{\mu C_{OX} W}{2 L}} (V_{GS} - V_{T0})$$

As shown in figure below V_{T0} & μ can be extracted from the intercept and slope of the $\sqrt{I_D} - V_{GS}$ plot.

In order to extract the body-effect coefficient γ , $\sqrt{I_D}$ vs V_{GS} is plotted for a different source-bulk voltage (V_{SB}) and γ can be extracted as

$$\gamma = \frac{V_T(V_{SB}) - V_{T0}}{\sqrt{|2\phi_F| + V_{SB}} - \sqrt{|2\phi_F|}}$$

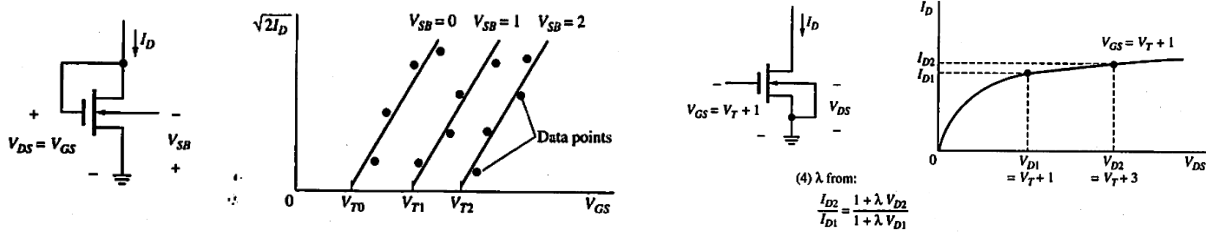


Figure 1: Test setup and measurement method for parameter extraction

(b) Extract λ for the NMOS ($W/L = 5\mu/1\mu$) using the following test setup and extracting the parameter using the expression:

$$\frac{I_{D2}}{I_{D1}} = \frac{1 + \lambda \cdot V_{DS2}}{1 + \lambda \cdot V_{DS1}}$$

2 PERFORMANCE COMPARISON BETWEEN LEVEL-1 AND BSIM3v1 LEVEL-49 MODEL

Using NSUB=1.7E17 (to calculate PHI), and VT0, KP, LAMBDA, PHI GAMMA extracted from the above problem assignment, create a LEVEL 1 SPICE Model with the extracted parameters. For the model syntax, please refer [Hodges] Example 3.3 P-128 or [Kang-2ed] (page: 117-123, Chapter-4).

1. Using the created LEVEL 1 model, plot I_D vs V_{GS} and I_D vs V_{DS} .
2. Compare the LEVEL-1 plot results with the BSIM3v1 LEVEL-49 plot results by overlaying the plots in a single graph. Do this for below two cases.
 - a. Case 1: L=1um and W=5um
 - b. Case 2: L= 0.5um and W=0.5um

Comment on the differences between the two levels of models.

In the above two cases the parameters (VT0, KP, LAMBDA, PHI and GAMMA) values in the LEVEL-1 model will be same, what you have extracted in Q-1

Instruction: For doing the above exercise, modify your SPICE NETLIST file according to the requirements and run the simulations in command prompt. If you have doubt on model file definition in the SPICE NETLIST, please go through any SPICE NELIST FILE and understand thoroughly. To define LEVEL-1 model file in SPICE NETLIST please refer [Hodges] Example 3.3 P-128 or [Kang-2ed] (page: 117-123, Chapter-4).