# Live Demonstration: A 5-DC-parameter MOSFET model for circuit design and simulation using open-source EDA tools

Gabriel Maranhão[1], Deni Germano Alves Neto[1], Marcio Cherem Schneider[1] and Carlos Galup-Montoro[1]

[1]Department of Electrical and Electronics Engineering, Federal University of Santa Catarina, 88040-900 Florianópolis, Brazil

## I. Introduction

A 5-DC-parameter model presented in [1], the ACM2.0 [2], was carried out with the description language Verilog-A [3], to simulate circuits using open-source EDA tools ngspice/Xschem with the help of the conversion tool *OpenVAF* [4].

The description of the ACM was written in less than 300 lines of code, while the BSIM-BULK version carried out in Verilog-AMS is composed of over 4,500 lines of code [5]. The live demonstration will be on ngspice/xschem software to provide easy access to the visitors.

## II. Demonstration Setup

The setup required for the live demonstrations consists of one laptop with pre-installed and configured open-source EDA tools. Fig. 1-2 present the simulator's interface with examples of simulation results.

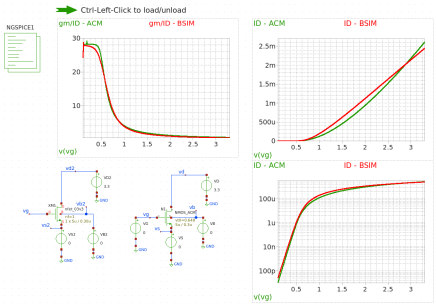


Fig. 1. DC characteristics $I_D \times V_{GB}$ at $V_{DB} = 13$ mV of n-channel MOSFET with $W/L$ = 5 $\mu$m/0.3 $\mu$m from the *GlobalFoundries* 180 nm open-PDK [6].

## III. Visitor Experience

The visitor will first experience the process of extracting the five parameters using a set of simple circuits that will be presented on Xschem. Next, the five parameters extracted by the visitor will be employed in the ACM2.0. Simulations of DC characteristics of the transistor will be presented for ACM2.0 and BSIM.

A set of circuit topologies (flip-flops, Schmitt triggers, amplifiers, oscillators, current sources, etc.) will be available to the visitor. The visitor will make the choice of the circuit of his/her interest, compare simulation results from ACM2.0 and BSIM, compare simulations using either three, four, or five ACM parameters, experiment the implementation of the chosen topology in different technologies and observe the effects of the variations of transistor geometries and/or of the technological parameters. The goal of the proposed demo is to let the designer enjoy the freedom of comparing technologies, models, and transistors sizing of an integrated circuit in the blink of an eye.

By the end of the demonstration, the visitor will realize how powerful and easy it is to incorporate the ACM2.0 into the design flow of integrated circuits.

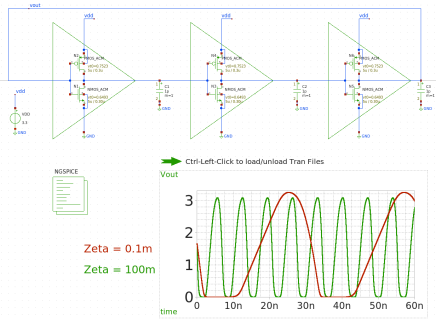


Fig. 2. Output voltage waveform for a 3 stage ring oscillator.

For the initial demonstration short video click here or go to the next URL: https://youtu.be/-8fJh0FcjWs.

## References

[1] D. G. A. Neto, C. M. Adornes, G. Maranhão, M. K. Bouchoucha, M. J. Barragan, A. Cathelin, M. C. Schneider, S. Bourdel, and C. Galup-Montoro, "A 5-DC-parameter MOSFET model for circuit simulation in QucsStudio and SPECTRE," in *2023 21st IEEE Interregional NEWCAS Conference (NEWCAS)*, 2023, pp. 1–5. [Online]. Available: https://ieeexplore.ieee.org/document/10198173

[2] Advanced Compact MOSFET model (ACM) repository. [Online]. Available: https://github.com/ACMmodel/MOSFET_model

[3] A. Technologies. Verilog-A reference manual. [Online]. Available: https://edadownload.software.keysight.com

[4] OpenVAF a Next-Generation Verilog-A compiler. [Online]. Available: https://github.com/pascalkuthe/OpenVAF

[5] BSIM Group. [Online]. Available: http://bsim.berkeley.edu/models/

[6] GlobalFoundries 180 nm Open Source PDK [Source Code]. [Online]. Available: https://gf180mcu-pdk.readthedocs.io/en/latest/index.html