MOSFET Modeling and Circuit Design: Re-Establishing a Lost Connection

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Amid the blizzard of design-automation technologies, the analytical MOSFET models (and their associated model parameter sets) receive scant attention from the design community. However, these models and parameter sets are fundamental to the design process, since they represent the critical "communication link" between a design group and its wafer foundry.

The first part of this tutorial will examine the present "infrastructure" of MOS modeling for circuit simulation, with particular emphasis on how history has played a role at least as large as that of engineering. The viewpoint will be that of a circuit design "consumer" of MOS models who must make the best possible use of a badly flawed infrastructure. In recent years, the entire structure of MOS models has been evolving into continually more complicated and empirical forms, opening up a "reality gap" between a model's mathematical structure and circuit design usage.

The second part of this tutorial will demonstrate the connection between MOSFET modeling and a modern approach to designing analog and digital integrated circuits. A methodology is presented which permits MOSFET sizing for optimal bandwidth, optimal dc matching, balanced compromises in bandwidth and dc matching, and other combinations of circuit performance. The methodology permits operation anywhere in the continuum of MOSFET operation through weak, moderate, and strong inversion. The methodology is particularly compatible with the EKV MOSFET model, as will be shown.