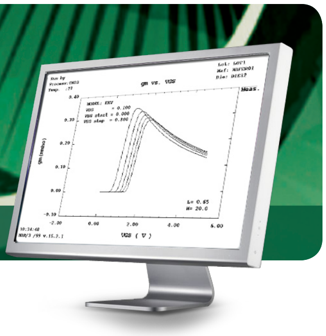
EKV v2.6

Low Power MOSFET Model



Advanced MOSFET Model for Low-Voltage Low-Current Circuit Design

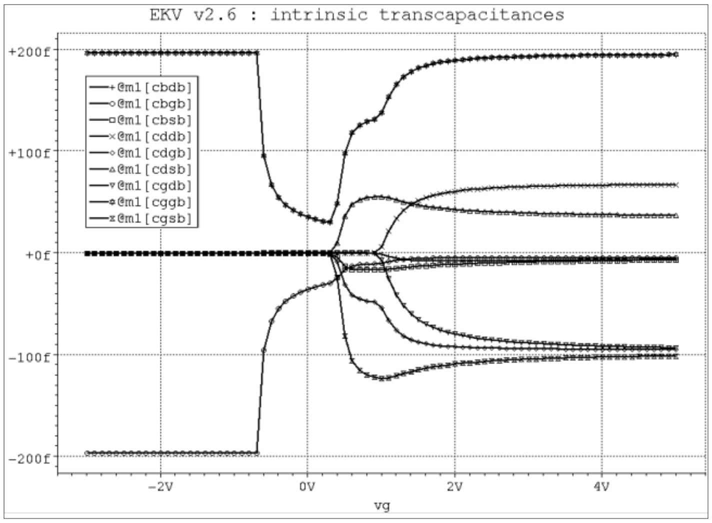
As supply voltage of circuits decreases to reduce power consumption, analog designs require a more physical, accurate and continuous compact MOS model.

Based on a brand new approach to analytical MOSFET modeling, the Enz-Krummenacher-Vittoz (EKV) model is a good candidate model for low-power analog circuit simulation.

As a public domain model, EKV MOSFET model allows product design and technology exchanges among foundries and companies.

Requirements for a Good MOSFET Model for Analog Circuit Design and Simulation

- Provide reasonable I-V characteristic accuracy
- Give accurate values for all small-signal transconductances gm, gms, and output conductance gds and all capacitances (especially intrinsic capacitances). All of these should be continuous with respect to any terminal voltage
- Give good results even when the device operates in Non-Quasi-Static (NQS) mode
- Normalized transconductance: universal behavior, almost independent of technology
- Give accurate prediction of the white noise (and if possible 1/f noise) in any mode of operation
- Well behaved above large bias ranges, including $V_{sb} \neq 0$ in all regions of operations
- Well behaved over the temperature range of interest
- Well behaved over any combination of channel width and length for a given technology
- Have as few model parameters as possible which should be linked strongly to device structure and fabrication process variables to allow meaningful worst-case prediction
- Allow an efficient and simple parameter extraction methodology
- Predict matching
- Be computationally efficient



EKV intrinsic capacitances calculated using charge conservation model

Advanced Physics-Based Model Equations

- Basic geometrical and process related variables
- Non-uniform substrate doping profile
- Mobility reduction due to vertical field
- Carrier velocity saturation
- Short and narrow-channel effects including Reverse Short Channel Effect (RSCE)
- Impact Ionization current
- Short distance matching
- Improved thermal and flicker noise formulation
- Accuracy of weak inversion slope and substrate effect

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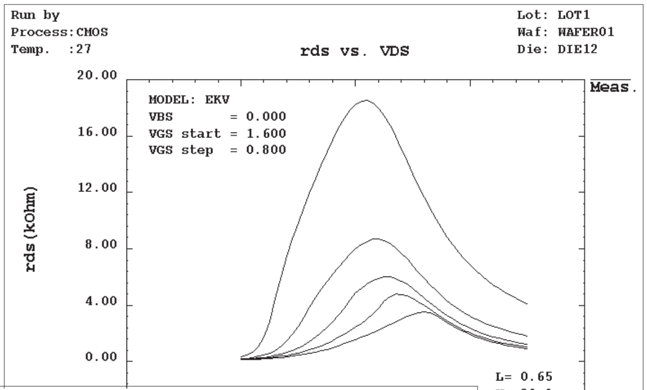
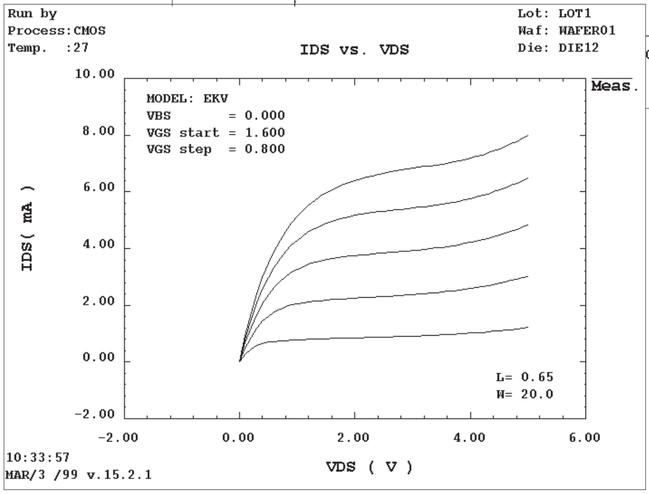
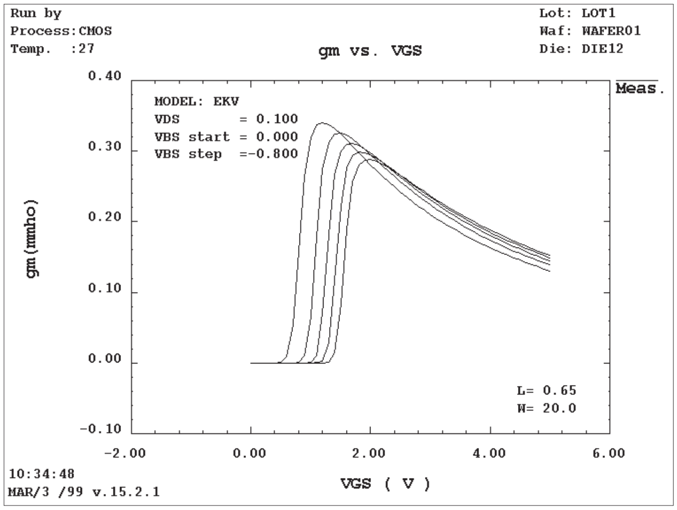
Unique Features

- Substrate node used as the voltage reference point allows the source and drain to be treated symmetrically (suitable for circuits with bi-directional MOS transistors)
- Pinch-off voltage Vp used to describe both the subthreshold region and the channel saturation characteristics (transitions from weak to strong inversion and from linear to saturation region are treated as the same physical phenomenon)
- “Single expression” principle model equation leads to the continuity of simulated currents, charges and related derivatives in all regions of operation
- Reduced set of core model parameters (only 10 parameters)
- Built-in charge-conservation and capacitance model
- Include AC first-order non-quasi-static model
- Simple temperature scaling
- Introduction of device series multiplier







Silvaco Implementation

- EKV MOSFET model is part of the SmartLib product-independent model library. It can be accessed within SmartSpice or UTMOST III as level 44
- The implementation is fully compatible with the more recent model description issued in July 1998 by the EPFL
- Further speed improvements can be gained through the VZERO option and the multi-threading capabilities
- The diagnostics option Expert is supported in EKV to help the designer finding convergence problems
- Parasitic elements are described using SmartSpice Common Equations
- Usual MOS device variables such as currents, conductances, charges and capacitances as well as EKV-specific internal variables can be saved, printed, plotted and/or measured

For more information on the EKV model
please visit the EPFL website:
http://legwww.epfl.ch/ekv/