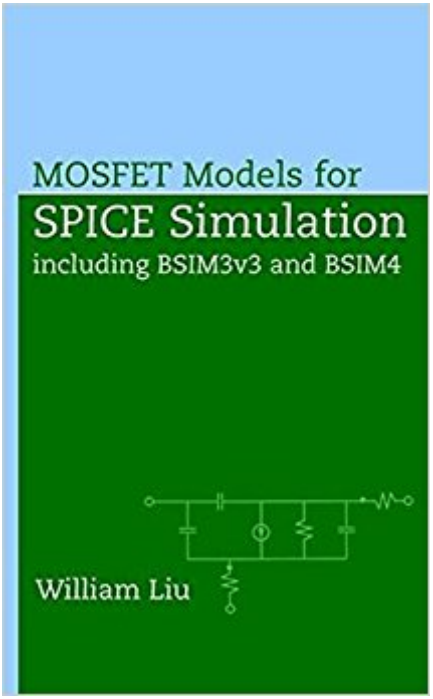
MOSFET Models For SPICE Simulation: Including BSIM3v3 And BSIM4



Synopsis

An expert guide to understanding and making optimum use of BSIM Used by more chip designers worldwide than any other comparable model, the Berkeley Short-Channel IGFET Model (BSIM) has, over the past few years, established itself as the de facto standard MOSFET SPICE model for circuit simulation and CMOS technology development. Yet, until now, there have been no independent expert guides or tutorials to supplement the various BSIM manuals currently available. Written by a noted expert in the field, this book fills that gap in the literature by providing a comprehensive guide to understanding and making optimal use of BSIM3 and BSIM4. Drawing upon his extensive experience designing with BSIM, William Liu provides a brief history of the model, discusses the various advantages of BSIM over other models, and explores the reasons why BSIM3 has been adopted by the majority of circuit manufacturers. He then provides engineers with the detailed practical information and guidance they need to master all of BSIM's features. He: Summarizes key BSIM3 components Represents the BSIM3 model with equivalent circuits for various operating conditions Provides a comprehensive glossary of modeling terminology Lists alphabetically BSIM3 parameters along with their meanings and relevant equations Explores BSIM3's flaws and provides improvement suggestions Describes all of BSIM4's improvements and new features Provides useful SPICE files, which are available online at the Wiley ftp site

Book Information

Hardcover: 600 pages
Publisher: Wiley-IEEE Press; 1 edition (February 7, 2001)
Language: English
ISBN-10: 0471396974
ISBN-13: 978-0471396970
Product Dimensions: 6.4 x 1.2 x 9.3 inches
Shipping Weight: 2.2 pounds (View shipping rates and policies)
Average Customer Review: 5.0 out of 5 stars 5 customer reviews
Best Sellers Rank: #2,717,517 in Books (See Top 100 in Books) #100 inÂ Books > Engineering & Transportation > Engineering > Electrical & Electronics > Circuits > VLSI & ULSI #323 inÂ Books > Computers & Technology > Hardware & DIY > Microprocessors & System Design > Computer Design #793 inÂ Books > Engineering & Transportation > Engineering > Electrical & Electronics > Circuits > Design

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WILLIAM LIU, PhD, is a senior member of the technical staff at Texas Instruments, where he has worked since obtaining his PhD in electrical engineering from Stanford University in 1991. Dr. Liu has been TI's lead contact in mentoring the development of BSIM4 model equations with UC Berkeley, and has been in charge of the modeling development for LDMOS/DEMOS and RF-CMOS in TI's SPICE Modeling Laboratory. Dr. Liu has authored/coauthored five book chapters, and has written more than fifty journal papers on modeling, device characterization, and fabrication. Dr. Liu has also published two books on III-V device technologies. Dr. Liu holds sixteen U.S. patents and is a senior member of IEEE.

This book is the very clearly written. It was straightforward to read, described the math in detail, and also gave meaningful hints about how to actually USE the model during model creation.I appreciate that the author describes HOW the equations are derived, and also WHY they take the form that they do. The chapter that describes each parameter in gory detail is also a big plus, and I find myself referring to it when doing my modeling work.My only wish: that this same book was available with a focus on BSIM4.

Great for students and engineers that want to go into details about BSIM models. It is well written with good references.

I am the author William Liu. I notice there is no link to the book content (as of May, 2001). Therefore, I thought I would add that here. I am sorry to have to rate my own book a five star before I can put put forth the book content in this review space. Nonetheless, it is indeed my view that the book is a five star, an opinion which I believe, can be justified by the content shown next.Anyway, here is the content:CHAPTER 1 MODELING JARGONS 1-1 SPICE Simulator and SPICE Model 1-2 Numerical Convergence 1-3 Digital and Analog Models 1-4 Smoothing Function and Single Equation 1-5 Chain Rule 1-6 Quasi-Static Approximation 1-7 Terminal Charges and Charge Partition 1-8 Charge Conservation 1-9 Non-Quasi-Static and Quasi-Static y-Parameters 1-10 Source-Referencing and Inverse Modeling 1-11 Physical vs. Table-Lookup Models 1-12 Scalable Model and Device BinningCHAPTER 2 BASIC FACTS OF BSIM3 2-1 What Is and What's Not Implemented in BSIM3 2-2 D.C. Equivalent Circuit and Leakage Current 2-3 Large-Signal Equivalent Circuit 2-4 Small-Signal Equivalent Circuit and y-Parameters 2-5 Noise Equivalent Circuit 2-6 Special Operating Conditions: VDS < 0, VBS > 0, VGS < 0, or VBD > 0CHAPTER 3 BSIM3 PARAMETERS 3-1 List of Parameters According to Function 3-2 Alphabetical Glossary of Parameters 3-3 Flow Diagram of SPICE SimulationCHAPTER 4 IMPROVABLE AREAS OF BSIM3 4-1 Lack of Robust Non-Quasi-Static Model; Transient Analysis 4-2 Problem with the 40/60 Partition: The "Killer NOR Gate" 4-3 Lack of Channel Resistance (NQS Effect; Small-Signal Analysis) 4-4 Incorrect Transconductance Dependency on Frequency 4-5 Lack of Gate Resistance (and Associated Noise) 4-6 Lack of Substrate Distibuted Resistance (and Associated Noise) 4-7 Incorrect Source/Drain Asymmetry at VDS = 0 4-8 Incorrect Cgb Behaviors 4-9 Capacitances with Wrong Signs 4-10 Cgg Fit and Other Capacitance Issues 4-11 Insufficient Noise Modeling (No Excess Short-Channel Thermal Noise) 4-12 Insufficient Noise Modeling (No Channel-Induced Gate Noise) 4-13 Incorrect Noise Figure Behavior 4-14 Inconsistent Input-Referred Noise Behavior 4-15 Possible Negative Transconductances 4-16 Lack of GIDL (Gate Induced Drain Leakage) Current 4-17 Incorrect Subthreshold behaviors 4-18 Threshold Voltage Rollup 4-19 Problems associated with a nonzero RDSW 4-20 Other NuisancesCHAPTER 5 IMPROVEMENTS IN BSIM4 5-1 Introduction 5-2 Physical and Electrical Oxide Thicknesses 5-3 Strong Inversion Potential For Vertical Nonuniform Doping Profile 5-4 Threshold Voltage Modifications 5-5 VGST,eff In Moderate Inversion 5-6 Drain Conductance Model 5-7 Mobility Model 5-8 Diode Capacitance 5-9 Diode Breakdown 5-10 GIDL (Gate Induced Drain Leakage) Current 5-11 Bias-Dependent Drain-Source

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This is clearly the best and newest book on MOSFET models. It’s Liu’s third book, and it’s delightful. That’s a strange word for a technical book, but it’s true! This book is both practical (down to earth) and occasionally funny.I must admit... I haven’t read all 588 pages yet, but the sections I have read are all clearly written, well illustrated and there is just enough background information to make the topics interesting. For example when he discusses the possibility of BSIM3 calculating a negative back-gate transconductance, gmb, or a negative mutual transconductance, gm, he points out that a negative gm has actually been reported in a real device, and gives the reference. Then he gives a checklist you can use to help prevent the negative gmb problem in your model.I was particularly interested and amused by his explanation of the "Killer NOR Gate" in section 4.2 "Problems with the 40/60 Partition." This circuit caused a lot of interesting e-mail discussion a couple of years ago.His chapter 3 contains a very good 130-page "ALPHABETICAL GLOSSARY OF BSIM3 PARAMETERS." Anybody who works with BSIM3 knows you need a handy list of all the model parameters and what they mean. Liu devotes a couple of paragraphs to each, and he recommends leaving many of them equal to zero!I’m more of a SPICE model user, not so much a theorist, and I found this book to be exactly what I needed.The other recent classics on this subject are Cheng & Hu’s MOSFET Modeling & BSIM3 User’s Guide (1999), Arora’s MOSFET Models for VLSI Circuit Simulation (1993) and Foty’s MOSFET Modeling with SPICE (1996).

William Liu (SML Modeling Expert/DMTS) has recently authored an excellent text on the BSIM3 and BSIM4 SPICE models. It is a "must have" text for modeling engineers, designers, or PIs who would like a deeper understanding of the BSIM3/4 models. William’s sense of humor is evident throughout the text which makes the deep technical aspects even more fun. Check out "Mosfet Models for Spice Simulation."

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