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# Power/ HV MOS Devices Compact Modeling



Springer

# Power Hvmos Devices Compact Modeling

**Sherief Reda, Abdullah Nowroz**



## **Power Hvmos Devices Compact Modeling:**

POWER/HVMOS Devices Compact Modeling Wladyslaw Grabinski, Thomas Gneiting, 2010-07-20 Semiconductor power electronics plays a dominant role due its increased efficiency and high reliability in various domains including the medium and high electrical drives automotive and aircraft applications electrical power conversion etc Power HVMOS Devices Compact Modeling will cover very extensive range of topics related to the development and characterization power high voltage HV semiconductor technologies as well as modeling and simulations of the power HV devices and smart power integrated circuits ICs Emphasis is placed on the practical applications of the advanced semiconductor technologies and the device level compact spice modeling This book is intended to provide reference information by selected leading authorities in their domain of expertise They are representing both academia and industry All of them have been chosen because of their intimate knowledge of their subjects as well as their ability to present them in an easily understandable manner *Scientific Computing in Electrical Engineering SCEE 2010* Bastiaan Michielsen, Jean-René Poirier, 2012-01-06 Selected from papers presented at the 8th Scientific Computation in Electrical Engineering conference in Toulouse in 2010 the contributions to this volume cover every angle of numerically modelling electronic and electrical systems including computational electromagnetics circuit theory and simulation and device modelling On computational electromagnetics the chapters examine cutting edge material ranging from low frequency electrical machine modelling problems to issues in high frequency scattering Regarding circuit theory and simulation the book details the most advanced techniques for modelling networks with many thousands of components Modelling devices at microscopic levels is covered by a number of fundamental mathematical physics papers while numerous papers on model order reduction help engineers and systems designers to bring their modelling of industrial scale systems within the reach of present day computational power Complementing these more specific papers the volume also contains a selection of mathematical methods which can be used in any application domain *Springer Handbook of Semiconductor Devices* Massimo Rudan, Rossella Brunetti, Susanna Reggiani, 2022-11-10 This Springer Handbook comprehensively covers the topic of semiconductor devices embracing all aspects from theoretical background to fabrication modeling and applications Nearly 100 leading scientists from industry and academia were selected to write the handbook s chapters which were conceived for professionals and practitioners material scientists physicists and electrical engineers working at universities industrial R D and manufacturers Starting from the description of the relevant technological aspects and fabrication steps the handbook proceeds with a section fully devoted to the main conventional semiconductor devices like e g bipolar transistors and MOS capacitors and transistors used in the production of the standard integrated circuits and the corresponding physical models In the subsequent chapters the scaling issues of the semiconductor device technology are addressed followed by the description of novel concept based semiconductor devices The last section illustrates the numerical simulation methods ranging from the fabrication processes to the device

performances Each chapter is self contained and refers to related topics treated in other chapters when necessary so that the reader interested in a specific subject can easily identify a personal reading path through the vast contents of the handbook

*3D TCAD Simulation for Semiconductor Processes, Devices and Optoelectronics* Simon Li,Suihua Li,2011-10-01

Technology computer aided design or TCAD is critical to today s semiconductor technology and anybody working in this industry needs to know something about TCAD This book is about how to use computer software to manufacture and test virtually semiconductor devices in 3D It brings to life the topic of semiconductor device physics with a hands on tutorial approach that de emphasizes abstract physics and equations and emphasizes real practice and extensive illustrations

Coverage includes a comprehensive library of devices representing the state of the art technology such as SuperJunction LDMOS GaN LED devices etc

**Compact Modeling** Gennady Gildenblat,2010-06-22 Most of the recent texts on compact modeling are limited to a particular class of semiconductor devices and do not provide comprehensive coverage of the field Having a single comprehensive reference for the compact models of most commonly used semiconductor devices both active and passive represents a significant advantage for the reader Indeed several kinds of semiconductor devices are routinely encountered in a single IC design or in a single modeling support group Compact Modeling includes mostly the material that after several years of IC design applications has been found both theoretically sound and practically significant Assigning the individual chapters to the groups responsible for the definitive work on the subject assures the highest possible degree of expertise on each of the covered models

*Electrical & Electronics Abstracts* ,1989

**Compact Models for Integrated Circuit Design** Samar K. Saha,2018-09-03 Compact Models for Integrated Circuit Design Conventional Transistors and Beyond provides a modern treatise on compact models for circuit computer aided design CAD Written by an author with more than 25 years of industry experience in semiconductor processes devices and circuit CAD and more than 10 years of academic experience in teaching compact modeling courses this first of its kind book on compact SPICE models for very large scale integrated VLSI chip design offers a balanced presentation of compact modeling crucial for addressing current modeling challenges and understanding new models for emerging devices Starting from basic semiconductor physics and covering state of the art device regimes from conventional micron to nanometer this text Presents industry standard models for bipolar junction transistors BJTs metal oxide semiconductor MOS field effect transistors FETs FinFETs and tunnel field effect transistors TFETs along with statistical MOS models Discusses the major issue of process variability which severely impacts device and circuit performance in advanced technologies and requires statistical compact models Promotes further research of the evolution and development of compact models for VLSI circuit design and analysis Supplies fundamental and practical knowledge necessary for efficient integrated circuit IC design using nanoscale devices Includes exercise problems at the end of each chapter and extensive references at the end of the book Compact Models for Integrated Circuit Design Conventional Transistors and Beyond is intended for senior undergraduate and graduate courses in electrical and electronics

engineering as well as for researchers and practitioners working in the area of electron devices. However, even those unfamiliar with semiconductor physics gain a solid grasp of compact modeling concepts from this book.

**Introduction to Device Modeling and Circuit Simulation** Tor A. Fjeldly, Trond Ytterdal, Michael S. Shur, 1998. This book is a useful reference for practicing electrical engineers as well as a textbook for a junior senior or graduate level course in electrical engineering. The authors combine two subjects: device modeling and circuit simulation by providing a large number of well-prepared examples of circuit simulations immediately following the description of many device models.

**Charge-Based MOS Transistor Modeling** Christian C. Enz, Eric A. Vittoz, 2006-08-14. Modern large scale analog integrated circuits (ICs) are essentially composed of metal oxide semiconductor (MOS) transistors and their interconnections. As technology scales down to deep sub-micron dimensions and supply voltage decreases to reduce power consumption, these complex analog circuits are even more dependent on the exact behavior of each transistor. High performance analog circuit design requires a very detailed model of the transistor describing accurately its static and dynamic behaviors, its noise and matching limitations, and its temperature variations. The charge-based EKV Enz-Krummenacher-Vittoz (EKV) MOS transistor model for IC design has been developed to provide a clear understanding of the device properties without the use of complicated equations. All the static, dynamic, noise, non-quasi-static models are completely described in terms of the inversion charge at the source and at the drain, taking advantage of the symmetry of the device. Thanks to its hierarchical structure, the model offers several coherent description levels from basic hand calculation equations to complete computer simulation model. It is also compact with a minimum number of process-dependent device parameters. Written by its developers, this book provides a comprehensive treatment of the EKV charge-based model of the MOS transistor for the design and simulation of low power analog and RF ICs. Clearly split into three parts, the authors systematically examine the basic long channel intrinsic charge-based model, including all the fundamental aspects of the EKV MOST model such as the basic large signal static model, the noise model, and a discussion of temperature effects and matching properties; the extended charge-based model presenting important information for understanding the operation of deep submicron devices; the high frequency model setting out a complete MOS transistor model required for designing RF CMOS integrated circuits. Practising engineers and circuit designers in the semiconductor device and electronics systems industry will find this book a valuable guide to the modelling of MOS transistors for integrated circuits. It is also a useful reference for advanced students in electrical and computer engineering.

**Integrated Power Devices and TCAD Simulation** Yue Fu, Zhanming Li, Wai Tung Ng, Johnny K.O. Sin, 2017-12-19. From power electronics to power integrated circuits (PICs), smart power technologies, devices, and beyond, *Integrated Power Devices and TCAD Simulation* provides a complete picture of the power management and semiconductor industry. An essential reference for power device engineering students and professionals, the book not only describes the physics inside integrated power semiconductor devices such as lateral double-diffused metal oxide semiconductor (LDMOS) field effect transistors (FETs),

lateral insulated gate bipolar transistors LIGBTs and super junction LDMOSFETs but also delivers a simple introduction to power management systems Instead of abstract theoretical treatments and daunting equations the text uses technology computer aided design TCAD simulation examples to explain the design of integrated power semiconductor devices It also explores next generation power devices such as gallium nitride power high electron mobility transistors GaN power HEMTs Including a virtual process flow for smart PIC technology as well as a hard to find technology development organization chart Integrated Power Devices and TCAD Simulation gives students and junior engineers a head start in the field of power semiconductor devices while helping to fill the gap between power device engineering and power management systems

**Modeling and Simulation of Custom Power Devices** Raxit A. Kagalwala,1996      Modeling Needs for Power Semiconductor Devices and Power Electronics Systems Ramchandra Kotecha,2020      *Advanced High Voltage Power Device Concepts* B. Jayant Baliga,2011-09-21 The devices described in Advanced MOS Gated Thyristor Concepts are utilized in microelectronics production equipment in power transmission equipment and for very high power motor control in electric trains steel mills etc Advanced concepts that enable improving the performance of power thyristors are discussed here along with devices with blocking voltage capabilities of 5 000 V 10 000 V and 15 000 V Throughout the book analytical models are generated to allow a simple analysis of the structures and to obtain insight into the underlying physics The results of two dimensional simulations are provided to corroborate the analytical models and give greater insight into the device operation

**Harmonic Modeling of Voltage Source Converters using Basic Numerical Methods** Ryan Kuo-Lung Lian,Ramadhani Kurniawan Subroto,Victor Andrean,Bing Hao Lin,2021-11-01 Harmonic Modeling of Voltage Source Converters using Basic Numerical Methods One of the first books to bridge the gap between frequency domain and time domain methods of steady state modeling of power electronic converters Harmonic Modeling of Voltage Source Converters using Basic Numerical Methods presents detailed coverage of steady state modeling of power electronic devices PEDs This authoritative resource describes both large signal and small signal modeling of power converters and how some of the simple and commonly used numerical methods can be applied for harmonic analysis and modeling of power converter systems The book covers a variety of power converters including DC DC converters diode bridge rectifiers AC DC and voltage source converters DC AC The authors provide in depth guidance on modeling and simulating power converter systems Detailed chapters contain relevant theory practical examples clear illustrations sample Python and MATLAB codes and validation enabling readers to build their own harmonic models for various PEDs and integrate them with existing power flow programs such as OpenDss This book Presents comprehensive large signal and small signal harmonic modeling of voltage source converters with various topologies Describes how to use accurate steady state models of PEDs to predict how device harmonics will interact with the rest of the power system Explains the definitions of harmonics power quality indices and steady state analysis of power systems Covers generalized steady state modeling techniques and accelerated methods for

closed loop converters Shows how the presented models can be combined with neural networks for power system parameter estimations Harmonic Modeling of Voltage Source Converters using Basic Numerical Methods is an indispensable reference and guide for researchers and graduate students involved in power quality and harmonic analysis power engineers working in the field of harmonic power flow developers of power simulation software and academics and power industry professionals wanting to learn about harmonic modeling on power converters

*Compact Device Modeling Using Physics and Machine Learning*, 2021

Power Integrity Modeling and Design for Semiconductors and Systems Madhavan Swaminathan, A. Ege Engin, 2008 Madhavan Swaminathan received his B E in Electronics and Communication from Regional Engineering College Tiruchirapalli in 1985 and his M S and Ph D degrees in Electrical Engineering from Syracuse University in 1989 and 1991 respectively He is currently the Joseph M Pettit Professor in Electronics in the School of Electrical and Computer Engineering and Deputy Director of the Packaging Research Center Georgia Tech He is also the cofounder of Jacket Micro Devices a company specializing in RF modules for wireless applications Prior to joining Georgia Tech he was with IBM where he worked on packaging for super computers His work on Power Integrity has won several awards and he was made an IEEE Fellow for his contributions in this area Ege Engin received his B S and M S degrees in electrical engineering from Middle East Technical University Ankara Turkey and from University of Paderborn Germany From 2001 to 2004 he was with the Fraunhofer Institute for Reliability and Microintegration in Berlin During this time he also received his Ph D from the University of Hannover Germany He is currently a Research Engineer in the School of Electrical and Computer Engineering and an Assistant Research Director of the Packaging Research Center at Georgia Tech He has more than 40 publications in refereed journals and conferences in the areas of signal and power integrity modeling and simulation

The First Comprehensive Example Rich Guide to Power Integrity Modeling Professionals need to thoroughly understand signal and power integrity issues in order to successfully design packages and boards for high speed systems Now for the first time there s a complete guide to power integrity modeling everything you need to know from the basics through the state of the art Using realistic case studies and downloadable software examples two leading experts demonstrate today s best techniques for designing and modeling interconnects to efficiently distribute power and minimize noise The authors carefully introduce the core concepts of power distribution design systematically present and compare leading techniques for modeling noise and link these techniques to specific applications Their many examples range from the simplest using analytical equations to compute power supply noise through complex system level applications The authors Introduce power delivery network components analysis high frequency measurement and modeling requirements Thoroughly explain plane modeling including plane behavior lumped modeling distributed circuit based approaches and much more Offer in depth coverage of simultaneous switching noise including modeling for time and frequency domain analysis Introduce three leading time domain simulation methods rational function methods signal flow graphs and MNA Present these and other advanced

case studies high speed servers high speed differential signaling chip package analysis embedded decoupling capacitors and electromagnetic bandgap structures This book's system level focus and practical examples will make it indispensable for every professional concerned with power integrity including electrical engineers system designers signal integrity engineers and materials scientists It will also be valuable to developers building software that takes advantage of high speed systems During my M S undergraduate days in a little town called Tiruchirapalli in Southern India we used to have frequent voltage and current surges that knocked out all the electrical equipment such as fans and lights in our rooms Frustrated my friend once remarked We are Powerless to solve the Current problem Of course he meant this in jest but little did I realize that this would become the theme of my research for many years Though my area is on Semiconductors and computer system

**Power Modeling and Characterization of Computing Devices** Sherief Reda,Abdullah Nowroz,2012-05 Outlines modern research directions for pre silicon power modeling and post silicon power characterization An invaluable reference for anyone with an interest in power consumption and how it affects the performance of future computing systems

**Modeling Power Electronics and Interfacing Energy Conversion Systems** M. Godoy Simoes,Felix A. Farret,2016-10-24 Discusses the application of mathematical and engineering tools for modeling simulation and control oriented for energy systems power electronics and renewable energy This book builds on the background knowledge of electrical circuits control of dc dc converters and inverters energy conversion and power electronics The book shows readers how to apply computational methods for multi domain simulation of energy systems and power electronics engineering problems Each chapter has a brief introduction on the theoretical background a description of the problems to be solved and objectives to be achieved Block diagrams electrical circuits mathematical analysis or computer code are covered Each chapter concludes with discussions on what should be learned suggestions for further studies and even some experimental work Discusses the mathematical formulation of system equations for energy systems and power electronics aiming state space and circuit oriented simulations Studies the interactions between MATLAB and Simulink models and functions with real world implementation using microprocessors and microcontrollers Presents numerical integration techniques transfer function modeling harmonic analysis and power quality performance assessment Examines existing software such as MATLAB Simulink Power Systems Toolbox and PSIM to simulate power electronic circuits including the use of renewable energy sources such as wind and solar sources The simulation files are available for readers who register with the Google Group power electronics interfacing energy conversion systems googlegroups com After your registration you will receive information in how to access the simulation files the Google Group can also be used to communicate with other registered readers of this book *Power Electronics Step-by-Step: Design, Modeling, Simulation, and Control* Weidong Xiao,2021-02-05 Explore the latest power electronics principles practices and applications This electrical engineering guide offers comprehensive coverage of design modeling simulation and control for power electronics The book describes real



world applications for the technology and features case studies worked out in both MATLAB and Simulink Presented in an accessible style Power Electronics Step by Step Design Modeling Simulation and Control focuses on the latest technologies such as DC based systems and emphasizes the averaging technique for both simulation and modeling You will get photos diagrams flowcharts graphs equations and tables that illustrate each topic Circuit components Non isolated DC DC conversion Power analysis DC to single phase AC conversion Single phase AC to DC conversion Galvanic isolated DC DC conversion Power conversion for three phase AC Bidirectional power conversion Averaging model for simulation Dynamic modeling of DC DC converters Regulation of voltage and current

*Research on Modern Power Semiconductor Modelling Methodology for Efficiency Evaluation of Power Electronic Systems in Electromagnetic Transient Simulation* Yanming Xu, 2021 Power electronics technology has rapidly developed during the past decades Power electronics systems aim to achieve high efficiency as power conversion interfaces while fulfilling the performance and reliability requirements The key to achieving these objectives is power semiconductors which dictate the power electronics system s efficiency power density and reliability In recent years traditional Silicon Si devices are reaching their material limits Meanwhile new Wide Bandgap WBG devices such as Silicon Carbide SiC and Gallium Nitride GaN devices have been commercialized featuring high breakdown voltage fast switching speed and high thermal capability On the other hand semiconductor devices are typically exposed to repetitive heat pulses and are often the most critical components affecting system reliability Consequently a comprehensive modelling method for modern power semiconductors that can describe various devices switching behaviors is highly desirable by power electronics engineers and manufacturers This research focuses on developing a simulation based modelling methodology for modern power semiconductors to evaluate the power electronics system s efficiency A multi level simulation strategy has been proposed and implemented in PSCAD EMTDC A generalized transient semiconductor model has been developed which can reproduce the device s switching behaviors Subsequently the power losses are obtained to form a multi dimensional power loss look up table under a wide range of operating conditions A dynamic thermal model for temperature estimation and a typical electrical network using simple switch models for semiconductor devices have been implemented The junction temperature is updated every switching cycle by the power loss with a thermal model and influence back to the electrical simulation In this way a closed loop electro thermal simulation is formed to evaluate both electrical and thermal performances in a single simulator with a range of acceptable accuracy A double pulse test platform has been designed and built for device characterizations and power loss verifications Moreover a single phase grid tied buck boost type inverter application has been selected as a case study and built to study the proposed method The measured results indicate that the proposed approach is highly promising for power electronics engineers to evaluate and optimize a system during the early design stage

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