

# **Low-Power CMOS Circuits**

Technology, Logic Design  
and CAD Tools

**Christian Piguet**



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# Low Power Cmos Circuits Technology Logic

**Itamar Levi,Alexander Fish**



## **Low Power Cmos Circuits Technology Logic:**

**Low-Power CMOS Circuits** Christian Piguet, 2018-10-03 The power consumption of microprocessors is one of the most important challenges of high performance chips and portable devices In chapters drawn from Piguet s recently published Low Power Electronics Design Low Power CMOS Circuits Technology Logic Design and CAD Tools addresses the design of low power circuitry in deep submicron technologies It provides a focused reference for specialists involved in designing low power circuitry from transistors to logic gates The book is organized into three broad sections for convenient access The first examines the history of low power electronics along with a look at emerging and possible future technologies It also considers other technologies such as nanotechnologies and optical chips that may be useful in designing integrated circuits The second part explains the techniques used to reduce power consumption at low levels These include clock gating leakage reduction interconnecting and communication on chips and adiabatic circuits The final section discusses various CAD tools for designing low power circuits This section includes three chapters that demonstrate the tools and low power design issues at three major companies that produce logic synthesizers Providing detailed examinations contributed by leading experts Low Power CMOS Circuits Technology Logic Design and CAD Tools supplies authoritative information on how to design and model for high performance with low power consumption in modern integrated circuits It is a must read for anyone designing modern computers or embedded systems

**Low Power Vlsi Design And Technology** Farid N Najm, Garey K-h Yeap, 1996-08-30 Low power and low energy VLSI has become an important issue in today s consumer electronics This book is a collection of pioneering applied research papers in low power VLSI design and technology A comprehensive introductory chapter presents the current status of the industry and academic research in the area of low power VLSI design and technology Other topics cover logic synthesis floorplanning circuit design and analysis from the perspective of low power requirements The readers will have a sampling of some key problems in this area as the low power solutions span the entire spectrum of the design process The book also provides excellent references on up to date research and development issues with practical solution techniques

**Low-Power Digital VLSI Design** Abdellatif Bellaouar, Mohamed Elmasry, 2012-12-06 Low Power Digital VLSI Design Circuits and Systems addresses both process technologies and device modeling Power dissipation in CMOS circuits several practical circuit examples and low power techniques are discussed Low voltage issues for digital CMOS and BiCMOS circuits are emphasized The book also provides an extensive study of advanced CMOS subsystem design A low power design methodology is presented with various power minimization techniques at the circuit logic architecture and algorithm levels Features Low voltage CMOS device modeling technology files design rules Switching activity concept low power guidelines to engineering practice Pass transistor logic families Power dissipation of I O circuits Multi and low VT CMOS logic static power reduction circuit techniques State of the art design of low voltage BiCMOS and CMOS circuits Low power techniques in CMOS SRAMS and DRAMS Low power on chip voltage down converter design

Numerous advanced CMOS subsystems e.g. adders multipliers data path memories regular structures phase locked loops with several design options trading power delay and area Low power design methodology power estimation techniques Power reduction techniques at the logic architecture and algorithm levels More than 190 circuits explained at the transistor level

MOS Devices for Low-Voltage and Low-Energy Applications Yasuhisa Omura, Abhijit Mallik, Naoto Matsuo, 2017-02-28

Helps readers understand the physics behind MOS devices for low voltage and low energy applications Based on timely published and unpublished work written by expert authors Discusses various promising MOS devices applicable to low energy environmental and biomedical uses Describes the physical effects quantum tunneling of MOS devices Demonstrates the performance of devices helping readers to choose right devices applicable to an industrial or consumer environment Addresses some Ge based devices and other compound material based devices for high frequency applications and future development of high performance devices Seemingly innocuous everyday devices such as smartphones tablets and services such as on line gaming or internet keyword searches consume vast amounts of energy Even when in standby mode all these devices consume energy The upcoming Internet of Things IoT is expected to deploy 60 billion electronic devices spread out in our homes cars and cities Britain is already consuming up to 16 per cent of all its power through internet use and this rate is doubling every four years According to The UK's Daily Mail May 2015 if usage rates continue all of Britain's power supply could be consumed by internet use in just 20 years In 2013 U.S. data centers consumed an estimated 91 billion kilowatt hours of electricity corresponding to the power generated by seventeen 1000 megawatt nuclear power plants Data center electricity consumption is projected to increase to roughly 140 billion kilowatt hours annually by 2020 the equivalent annual output of 50 nuclear power plants Natural Resources Defense Council USA Feb 2015 All these examples stress the urgent need for developing electronic devices that consume as little energy as possible The book MOS Devices for Low Voltage and Low Energy Applications explores the different transistor options that can be utilized to achieve that goal It describes in detail the physics and performance of transistors that can be operated at low voltage and consume little power such as subthreshold operation in bulk transistors fully depleted SOI devices tunnel FETs multigate and gate all around MOSFETs Examples of low energy circuits making use of these devices are given as well The book MOS Devices for Low Voltage and Low Energy Applications is a good reference for graduate students researchers semiconductor and electrical engineers who will design the electronic systems of tomorrow Dr Jean Pierre Colinge Taiwan Semiconductor Manufacturing Company TSMC The authors present a creative way to show how different MOS devices can be used for low voltage and low power applications They start with Bulk MOSFET following with SOI MOSFET FinFET gate all around MOSFET Tunnel FET and others It is presented the physics behind the devices models simulations experimental results and applications This book is interesting for researchers graduate and undergraduate students The low energy field is an important topic for integrated circuits in the future and none can stay out of this Prof Joao A Martino University of Sao Paulo

Brazil     **Ulsi Front-end Technology: Covering From The First Semiconductor Paper To Cmos Finfet Technology**  
Wai Shing Lau,2017-08-23 The main focus of this book is ULSI front end technology It covers from the early history of semiconductor science technology from 1874 to state of the art FINFET technology in 2016 Some ULSI back end technology is also covered for example the science and technology of MIM capacitors for analog CMOS has been included in this book

*Electronic Design Automation for IC Implementation, Circuit Design, and Process Technology* Luciano Lavagno,Igor L. Markov,Grant Martin,Louis K. Scheffer,2017-02-03 The second of two volumes in the Electronic Design Automation for Integrated Circuits Handbook Second Edition Electronic Design Automation for IC Implementation Circuit Design and Process Technology thoroughly examines real time logic RTL to GDSII a file format used to transfer data of semiconductor physical layout design flow analog mixed signal design physical verification and technology computer aided design TCAD Chapters contributed by leading experts authoritatively discuss design for manufacturability DFM at the nanoscale power supply network design and analysis design modeling and much more New to This Edition Major updates appearing in the initial phases of the design flow where the level of abstraction keeps rising to support more functionality with lower non recurring engineering NRE costs Significant revisions reflected in the final phases of the design flow where the complexity due to smaller and smaller geometries is compounded by the slow progress of shorter wavelength lithography New coverage of cutting edge applications and approaches realized in the decade since publication of the previous edition these are illustrated by new chapters on 3D circuit integration and clock design Offering improved depth and modernity Electronic Design Automation for IC Implementation Circuit Design and Process Technology provides a valuable state of the art reference for electronic design automation EDA students researchers and professionals     **Green Mobile Devices and**

**Networks** Hrishikesh Venkataraman,Gabriel-Miro Muntean,2016-04-19 While battery capacity is often insufficient to keep up with the power demanding features of the latest mobile devices powering the functional advancement of wireless devices requires a revolution in the concept of battery life and recharge capability Future handheld devices and wireless networks should be able to recharge themselves automaticall     **Practical Low Power Digital VLSI Design** Gary K.

Yeap,2012-12-06 Practical Low Power Digital VLSI Design emphasizes the optimization and trade off techniques that involve power dissipation in the hope that the readers are better prepared the next time they are presented with a low power design problem The book highlights the basic principles methodologies and techniques that are common to most CMOS digital designs The advantages and disadvantages of a particular low power technique are discussed Besides the classical area performance trade off the impact to design cycle time complexity risk testability and reusability are discussed The wide impacts to all aspects of design are what make low power problems challenging and interesting Heavy emphasis is given to top down structured design style with occasional coverage in the semicustom design methodology The examples and design techniques cited have been known to be applied to production scale designs or laboratory settings The goal of Practical Low

Power Digital VLSI Design is to permit the readers to practice the low power techniques using current generation design style and process technology Practical Low Power Digital VLSI Design considers a wide range of design abstraction levels spanning circuit logic architecture and system Substantial basic knowledge is provided for qualitative and quantitative analysis at the different design abstraction levels Low power techniques are presented at the circuit logic architecture and system levels Special techniques that are specific to some key areas of digital chip design are discussed as well as some of the low power techniques that are just appearing on the horizon Practical Low Power Digital VLSI Design will be of benefit to VLSI design engineers and students who have a fundamental knowledge of CMOS digital design

**Integrated Circuit and System Design. Power and Timing Modeling, Optimization and Simulation** José L. Ayala, Delong Shang, Alex Yakovlev, 2013-01-03 This book constitutes the refereed proceedings of the 22nd International Conference on Integrated Circuit and System Design PATMOS 2012 held in Newcastle UK Spain in September 2012 The 25 revised full papers presented were carefully reviewed and selected from numerous submissions The paper feature emerging challenges in methodologies and tools for the design of upcoming generations of integrated circuits and systems including reconfigurable hardware such as FPGAs The technical program focus on timing performance and power consumption as well as architectural aspects with particular emphasis on modeling design characterization analysis and optimization *Integrated Circuit and System Design. Power and Timing Modeling, Optimization and Simulation* Jose L. Ayala, Braulio Garcia-Camara, Manuel Prieto, Martino Ruggiero, Gilles Sicard, 2011-09-15 This book constitutes the refereed proceedings of the 21st International Conference on Integrated Circuit and System Design PATMOS 2011 held in Madrid Spain in September 2011 The 34 revised full papers presented were carefully reviewed and selected from numerous submissions The paper feature emerging challenges in methodologies and tools for the design of upcoming generations of integrated circuits and systems and focus especially on timing performance and power consumption as well as architectural aspects with particular emphasis on modeling design characterization analysis and optimization *The Computer Engineering Handbook* Vojin G. Oklobdzija, 2001-12-26 There is arguably no field in greater need of a comprehensive handbook than computer engineering The unparalleled rate of technological advancement the explosion of computer applications and the now in progress migration to a wireless world have made it difficult for engineers to keep up with all the developments in specialties outside their own **Scientific and Technical Aerospace Reports** ,1994 *Progress in VLSI Design and Test* Hafizur Rahaman, Sanatan Chattopadhyay, Santanu Chattopadhyay, 2012-06-26 This book constitutes the refereed proceedings of the 16th International Symposium on VSLI Design and Test VDAT 2012 held in Shibpur India in July 2012 The 30 revised regular papers presented together with 10 short papers and 13 poster sessions were carefully selected from 135 submissions The papers are organized in topical sections on VLSI design design and modeling of digital circuits and systems testing and verification design for testability testing memories and regular logic arrays embedded systems hardware software co design

and verification emerging technology nanoscale computing and nanotechnology

*Dual Mode Logic* Itamar Levi, Alexander Fish, 2020-12-15 This book presents Dual Mode Logic DML a new design paradigm for digital integrated circuits DML logic gates can operate in two modes each optimized for a different metric Its on the fly switching between these operational modes at the gate block and system levels provide maximal E D optimization flexibility Each highly detailed chapter has multiple illustrations showing how the DML paradigm seamlessly implements digital circuits that dissipate less energy while simultaneously improving performance and reducing area without a significant compromise in reliability All the facets of the DML methodology are covered starting from basic concepts through single gate optimization general module optimization design trade offs and new ways DML can be integrated into standard design flows using standard EDA tools DML logic is compatible with numerous applications but is particularly advantageous for ultra low power reliable high performance systems and advanced scaled technologies Written in language accessible to students and design engineers each topic is oriented toward immediate application by all those interested in an alternative to CMOS logic Describes a novel promising alternative to conventional CMOS logic known as Dual Mode Logic DML with which a single gate can be operated selectively in two modes each optimized for a different metric e g energy consumption performance size Demonstrates several techniques at the architectural level which can result in high energy savings and improved system performance Focuses on the tradeoffs between power area and speed including optimizations at the transistor and gate level including alternatives to DML basic cells Illustrates DML efficiency for a variety of VLSI applications

The Art and Science of Microelectronic Circuit Design Anatoly Belous, Vitali Saladukha, 2022-02-10 This book guides readers through the entire complex of interrelated theoretical and practical aspects of the end to end design and organization of production of silicon submicron integrated circuits The discussion includes the theoretical foundations of the operation of field effect and bipolar transistors the methods and peculiarities of the structural and schematic design basic circuit design and system design engineering solutions for bipolar CMOS BiCMOS and TTL integrated circuits standard design libraries and typical design flows

VLSI Design and Test Anirban Sengupta, Sudeb Dasgupta, Virendra Singh, Rohit Sharma, Santosh Kumar Vishvakarma, 2019-08-17 This book constitutes the refereed proceedings of the 23st International Symposium on VLSI Design and Test VDAT 2019 held in Indore India in July 2019 The 63 full papers were carefully reviewed and selected from 199 submissions The papers are organized in topical sections named analog and mixed signal design computing architecture and security hardware design and optimization low power VLSI and memory design device modelling and hardware implementation

**Integrated Circuit and System Design** Enrico Macii, Vassilis Paliouras, Odysseas Koufopavlou, 2004-08-24 Welcometothe proceedings of PATMOS 2004 the fourteenth in a series of international workshops PATMOS 2004 was organized by the University of Patras with technical co sponsorship from the IEEE Circuits and Systems Society Over the years the PATMOS meeting has evolved into an important European event where industry and academia meet to discuss power and

timing aspects in modern integrated circuit and system design PATMOS provides a forum for researchers to discuss and investigate the emerging challenges in sign methodologies and tools required to develop the upcoming generations of integrated circuits and systems We realized this vision this year by providing a technical program that contained state of the art technical contributions a keynote speech three invited talks and two embedded tutorials The technical program focused on timing performance and power consumption as well as architectural aspects with particular emphasis on modelling design charac rization analysis and optimization in the nanometer era This year a record 152 contributions were received to be considered for p sible presentation at PATMOS Despite the choice for an intense three day m ting only 51 lecture papers and 34 poster papers could be accommodated in the single track technical program The Technical Program Committee with the sistance of additional expert reviewers selected the 85 papers to be presented at PATMOS and organized them into 13 technical sessions As was the case with the PATMOS workshops the review process was anonymous full papers were required and several reviews were received per manuscript

#### **Technologies for Wireless Computing**

Anantha P. Chandrakasan, Robert W. Brodersen, 2012-12-06 Research over the last decade has brought about the development of high performance systems such as powerful workstations sophisticated computer graphics and multimedia systems such as real time video and speech recognition A significant change in the attitude of users is the desire to have access to this computation at any location without the need to be connected to the wired power source This has resulted in the explosive growth of research and development in the area of wireless computing over the last five years Technologies for Wireless Computing deals with several key technologies required for wireless computing The topics covered include reliable wireless protocols portable terminal design considerations video coding RF circuit design issues and tools display technology energy efficient applications specific and programmable design techniques energy efficiency metrics low voltage process technology and circuit design considerations and CAD tools for low power design at the behavior logic and physical design level

Technologies for Wireless Computing is an edited volume of original research comprising invited contributions by leading researchers This research work has also been published as a special issue of the Journal of VLSI Signal Processing Systems Volume 13 Numbers 2 3

#### **Mechatronics**

David Allan Bradley, 2018-04-27 Mechatronics Electronics in Products and Processes identifies the concepts which underpin the mechatronic approach to engineering design and brings together its principle components sensors and transducers embedded microprocessors actuators and drives to explore their interrelationships The text focuses primarily on hardware elements and the impact of system architecture Modern technology is set in an historical background and each chapter comes with learning objectives and chapter outlines The book includes numerous case studies illustrating the concepts applied in such areas as automatic cameras aerospace parts manufacturing fly by wire systems and boat autopilot

#### **Advances in AI for Biomedical Instrumentation, Electronics and Computing**

Vibhav Sachan, Shahid Malik, Ruchita Gautam, Parvin Kumar, 2024-06-13 This book contains the proceedings of 5th



International Conference on Advances in AI for Biomedical Instrumentation Electronics and Computing ICABEC 2023 which provided an international forum for the exchange of ideas among researchers students academicians and practitioners It presents original research papers on subjects of AI Biomedical Communications Computing Systems Some interesting topics it covers are enhancing air quality prediction using machine learning optimization of leakage power consumption using hybrid techniques multi robot path planning in complex industrial dynamic environment enhancing prediction accuracy of earthquake using machine learning algorithms and advanced machine learning models for accurate cancer diagnostics Containing work presented by a diverse range of researchers this book will be of interest to students and researchers in the fields of Electronics and Communication Engineering Computer Science Engineering Information Technology Electrical Engineering Electronics and Instrumentation Engineering Computer applications and all interdisciplinary streams of Engineering Sciences

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