

DIGITAL INTEGRATED CIRCUITS

A DESIGN PERSPECTIVE
SECOND EDITION



JAN M. RABAEY
ANANTHA CHANDRAKASAN
BORIVOJE NIKOLIC

Digital Integrated Circuits 2nd Edition

Jan M. Rabaey



Digital Integrated Circuits 2nd Edition:

Digital Integrated Circuits John E. Ayers, 2018-09-03 Exponential improvement in functionality and performance of digital integrated circuits has revolutionized the way we live and work. The continued scaling down of MOS transistors has broadened the scope of use for circuit technology to the point that texts on the topic are generally lacking after a few years. The second edition of *Digital Integrated Circuits Analysis and Design* focuses on timeless principles with a modern interdisciplinary view that will serve integrated circuits engineers from all disciplines for years to come. Providing a revised instructional reference for engineers involved with Very Large Scale Integrated Circuit design and fabrication, this book delves into the dramatic advances in the field, including new applications and changes in the physics of operation made possible by relentless miniaturization. This book was conceived in the versatile spirit of the field to bridge a void that had existed between books on transistor electronics and those covering VLSI design and fabrication as a separate topic. Like the first edition, this volume is a crucial link for integrated circuit engineers and those studying the field, supplying the cross disciplinary connections they require for guidance in more advanced work. For pedagogical reasons, the author uses SPICE level 1 computer simulation models but introduces BSIM models that are indispensable for VLSI design. This enables users to develop a strong and intuitive sense of device and circuit design by drawing direct connections between the hand analysis and the SPICE models. With four new chapters, more than 200 new illustrations, numerous worked examples, case studies, and support provided on a dynamic website, this text significantly expands concepts presented in the first edition. **Digital**

Integrated Circuits Jan M. Rabaey, 2003 Contents: p. p. Chapter 1 Introduction p. p. Chapter 2 The Manufacturing Process p. p. Chapter 3 The Devices p. p. Chapter 4 The Wire p. p. Chapter 5 The CMOS Inverter p. p. Chapter 6 Designing Combinational Logic Gates in CMOS

Digital Integrated Circuits Evgeni Perelroyzen, 2018-10-03 A current trend in digital design, the integration of the MATLAB components Simulink and Stateflow for model building, simulations, system testing, and fault detection, allows for better control over the design flow process and ultimately for better system results. *Digital Integrated Circuits Design for Test Using Simulink and Stateflow* illustrates the construction of Simulink models for digital project test benches in certain design-for-test fields. The first two chapters of the book describe the major tools used for design-for-test. The author explains the process of Simulink model building, presents the main library blocks of Simulink, and examines the development of finite state machine modeling using Stateflow diagrams. Subsequent chapters provide examples of Simulink modeling and simulation for the latest design-for-test fields, including combinational and sequential circuits, controllability, and observability, deterministic algorithms, digital circuit dynamics, timing verification, built-in self-test (BIST) architecture, scan cell operations, and functional and diagnostic testing. The book also discusses automatic test pattern generation (ATPG), process, the logical determinant theory, and joint test action group (JTAG) interface models. *Digital Integrated Circuits* explores the possibilities of MATLAB's tools in the development of application-specific integrated circuit (ASIC) design systems. The

book shows how to incorporate Simulink and Stateflow into the process of modern digital design **Digital Integrated Circuits** Jan M. Rabaey, 2003 **Space Microelectronics Volume 2: Integrated Circuit Design for Space Applications**

Anatoly Belous, Vitali Saladukha, , Siarhei Shvedau, 2017-07-31 This invaluable second volume of a two volume set is filled with details about the integrated circuit design for space applications Various considerations for the selection and application of electronic components for designing spacecraft are discussed The basic constructions of submicron transistors and schottky diodes during the technological process of production are explored This book provides details on the energy consumption minimization methods for microelectronic devices Specific topics include Features and physical mechanisms of the effect of space radiation on all the main classes of microcircuits including peculiarities of radiation impact on submicron integrated circuits Special design technology and schematic methods of increasing the resistance to various types of space radiation Recommendations for choosing research equipment and methods for irradiating various samples Microcircuit designers on the composition of test elements for the study of the effect of radiation Microprocessors circuit boards logic microcircuits digital analog digital analog microcircuits manufactured in various technologies bipolar CMOS BiCMOS SOI Problems involved with designing high speed microelectronic devices and systems based on SOS and SOI structures System on chip and system in package and methods for rejection of silicon microcircuits with hidden defects during mass production

Digital Integrated Circuits Jan M. Rabaey, 1996 Beginning with discussions on the operation of electronic devices and analysis of the nucleus of digital design the text addresses the impact of interconnect design for low power issues in timing and clocking design methodologies and the effect of design automation on the digital design perspective **FPGA**

Prototyping by VHDL Examples Pong P. Chu, 2011-09-20 This book uses a learn by doing approach to introduce the concepts and techniques of VHDL and FPGA to designers through a series of hands on experiments FPGA Prototyping by VHDL Examples provides a collection of clear easy to follow templates for quick code development a large number of practical examples to illustrate and reinforce the concepts and design techniques realistic projects that can be implemented and tested on a Xilinx prototyping board and a thorough exploration of the Xilinx PicoBlaze soft core microcontroller

Design and Test Technology for Dependable Systems-on-Chip Ubar, Raimund, Raik, Jaan, Vierhaus, Heinrich Theodor, 2010-12-31 This book covers aspects of system design and efficient modelling and also introduces various fault models and fault mechanisms associated with digital circuits integrated into System on Chip SoC Multi Processor System on Chip MPSoC or Network on Chip NoC **Design of High-Speed Time-Interleaved Delta-Sigma D/A Converters** Ameya Bhide, 2015-08-19 Digital to analog D A converters or DACs are one the fundamental building blocks of wireless transmitters In order to support the increasing demand for highdata ate communication a large bandwidth is required from the DAC With the advances in CMOS scaling there is an increasing trend of moving a large part of the transceiver functionality to the digital domain in order to reduce the analog complexity and allow easy reconfiguration for multiple radio standards DACs can

fit very well into this trend of digital architectures as they contain a large digital signal processing component and offer two advantages over the traditionally used Nyquist DACs. Firstly, the number of DAC unit current cells is reduced, which relaxes their matching and output impedance requirements, and secondly, the reconstruction filter order is reduced. Achieving a large bandwidth from DACs requires a very high operating frequency of many GHz from the digital blocks due to the oversampling involved. This can be very challenging to achieve using conventional DAC architectures even in nanometer CMOS processes. Time interleaved TIDSM DACs have the potential of improving the bandwidth and sampling rate by relaxing the speed of the individual channels. However, they have received only some attention over the past decade and very few previous works have been reported on this topic. Hence, the aim of this dissertation is to investigate architectural and circuit techniques that can further enhance the bandwidth and sampling rate of TIDSM DACs.

The first work is an 8 GS/s interleaved DAC prototype IC with 200 MHz bandwidth implemented in 65 nm CMOS. The high sampling rate is achieved by a two-channel interleaved MASH 1/1 digital modulator with 3-bit output, resulting in a highly digital DAC with only seven current cells. Two-channel interleaving allows the use of a single clock for both the logic and the analog multiplexing. This requires each channel to operate at half the sampling rate, i.e., 4 GHz. This is enabled by a high-speed pipelined MASH structure with robust static logic. Measurement results from the prototype show that the DAC achieves 200 MHz bandwidth, 57 dBc IM3, and 26 dB SNDR with a power consumption of 68 mW at 1 V digital and 1.2 V analog supplies. This architecture shows good potential for use in the transmitter baseband. While a good linearity is obtained from this DAC, the SNDR is found to be limited by the testing setup for sending high-speed digital data into the prototype. The performance of a two-channel interleaved DAC is found to be very sensitive to the duty cycle of the half-rate clock. The second work analyzes this effect mathematically and presents a new closed-form expression for the SNDR loss of two-channel DACs due to the duty cycle error (DCE) for a noise transfer function (NTF) of $1/z(1-n)$. It is shown that a low-order FIR filter after the modulator helps to mitigate this problem. A closed-form expression for the SNDR loss in the presence of this filter is also developed. These expressions are useful for choosing a suitable modulator and filter order for an interleaved DAC in the early stage of the design process. A comparison between the FIR filter and compensation techniques for DCE mitigation is also presented.

The final work is a 11 GS/s 1.1 GHz bandwidth time interleaved DAC prototype IC in 65 nm CMOS for the 60 GHz radio baseband. The high sampling rate is again achieved by using a two-channel interleaved MASH 1/1 architecture with a 4-bit output, i.e., only fifteen analog current cells. The single clock architecture for the logic and the multiplexing requires each channel to operate at 5.5 GHz. To enable this, a new look-ahead technique is proposed that decouples the two channels within the modulator feedback path, thereby improving the speed as compared to conventional loop unrolling. Full-speed DAC testing is enabled by an on-chip 1 Kb memory whose read path also operates at 5.5 GHz. Measurement results from the prototype show that the DAC achieves 53 dB SFDR, 49 dBc IM3, and 39 dB SNDR within a 1.1 GHz bandwidth while consuming 117 mW from 1 V digital, 1.2 V analog supplies. The proposed DAC can

satisfy the spectral mask of the 60 GHz radio IEEE 802.11ad WiGig standard with a second order reconstruction filter

Electronic Components & Technology, 2nd Edition S. J. Sangwine, 1994-06-30 Since its inception the Tutorial Guides in Electronic Engineering series has met with great success among both instructors and students. Designed for first and second year undergraduate courses, each text provides a concise list of objectives at the beginning of every chapter, key definitions and formulas highlighted in margin notes, and references to other texts in the series. Electronic Components and Technology begins with an introduction to electronic interconnection technology, followed by a concise study of integrated circuits, their fabrication, packaging, and handling. The next two chapters look at various components including power supplies, resistors, capacitors, and inductors. The author devotes considerable attention to parasitic electrical effects, including the non-ideal properties of passive components, heat, and its management, and parasitic electromagnetic effects. He also emphasizes good engineering practice in relation to reliability and maintainability, two important aspects of design often overlooked by circuit designers, and includes a chapter on safety. This volume not only builds a solid foundation in properties, behavior, and use of electronic components, but also opens students' eyes to the practical problems encountered in electronics engineering practice.

The Gateway to Understanding Matthew M. Radmanesh Ph.D., 2005-03-03 The study of electronic waves has been broken down into artificial subdivisions where most texts cover a small part of the subject mathematically while ignoring the rest. In our scientific community, there has been a need for a coherent one-stop approach that covers the breadth of this material in a manner that allows a total comprehension of the subject. I believe this book finally fills this void by delivering this long-awaited material.

The Gateway to Understanding Matthew Radmanesh, 2005-05 MEET BENJAMIN FRANKLIN FRIDDLE The hero of this narrative is a precocious schoolboy who was given a dictionary by his parents when he was very young. In spite of learning the meaning of many new words, he and Jamie conspired to speak like the young man they idolized, who spoke with very bad grammar. This gradually became harder, but they both tried very hard not to sound like a girl. Frankie is persuaded to adopt a different imperative through his teacher, who had more understanding of the boys than they could have supposed. In 1987, the book was written to amuse my mother, who seemed to enjoy hearing each episode as it developed. The narrative was rejected by several publishers, so I recorded it on an audio tape, which I gave to my grandchildren. And I made a hard copy, which stayed on a shelf until after I received word from 1stBooks. The interest of my grandchildren interested me. Several parts were extremely funny when read aloud to them. Although it is fiction, it might be useful in persuading readers that the uses of good grammar might be necessary for success in modern society. Recent gaps in SAT scores could easily be society's heritage from an erroneous assumption. No language is likely to equal proper English in the American job market. This book may help readers to realize that bad grammar could limit the perception of academic perfectionists, who happen to hear job applicants speak. Please let me know whether I should develop another thing I regard as fact. True wisdom is often overlooked in persons who differ from ourselves.

The Gateway to Understanding: Electrons to

Waves and Beyond Workbook Matthew M. Radmanesh, 2005-05-24 324 Pages Learning the subject of electricity and electronics through the study of this workbook is tremendously more beneficial than simply purchasing and reading the book on your own The workbook provides many advantages including a A step by step approach presenting a series of lessons which are bite sized pieces of information taken from the book b The lessons act like a trail or a road to knowledge with a definite beginning and a finite end This prevents possible frustration of the reader from aimlessly reading the book or getting overwhelmed by the enormity of the subject c Solutions to many of the end of chapter quizzes provide an excellent check out to the readers comprehension of the material d A streamlined approach to learning electricity electronics which takes irrelevant materials off the direct path of achieving the final goal of total comprehension e Authors numerous comments exercises and summary adds clarity and understanding and brings simplification to a very complicated subject **CMOS** Angelo Rivetti, 2018-09-03 CMOS Front End Electronics for Radiation Sensors offers a comprehensive introduction to integrated front end electronics for radiation detectors focusing on devices that capture individual particles or photons and are used in nuclear and high energy physics space instrumentation medical physics homeland security and related fields Emphasizing practical design and implementation this book Covers the fundamental principles of signal processing for radiation detectors Discusses the relevant analog building blocks used in the front end electronics Employs systematically weak and moderate inversion regimes in circuit analysis Makes complex topics such as noise and circuit weighting functions more accessible Includes numerical examples where appropriate CMOS Front End Electronics for Radiation Sensors provides specialized knowledge previously obtained only through the study of multiple technical and scientific papers It is an ideal text for students of physics and electronics engineering as well as a useful reference for experienced practitioners **Computer Methods for Analysis of Mixed-Mode Switching Circuits** Fei Yuan, Ajoy Opal, 2007-05-08 Computer Methods for Analysis of Mixed Mode Switching Circuits provides an in depth treatment of the principles and implementation details of computer methods and numerical algorithms for analysis of mixed mode switching circuits Major topics include Computer oriented formulation of mixed mode switching circuits Network functions of linear and nonlinear time varying systems Numerical Laplace inversion based integration algorithms and inconsistent initial conditions Time domain analysis of periodically switched linear and nonlinear circuits including response sensitivity noise clock jitter and statistical quantities Time domain analysis of circuits with internally controlled switches and over sampled sigma delta modulators Tellegen s theorem frequency reversal theorem and transfer function theorem of periodically switched linear circuits and their applications Frequency domain analysis of periodically switched linear and nonlinear circuits including response sensitivity group delay noise and statistical quantities **Advanced Integrated Communication Microsystems** Joy Laskar, Sudipto Chakraborty, Anh-Vu Pham, Manos M. Tantzzeris, 2009-02-10 Learn the fundamentals of integrated communication microsystems Advanced communication microsystems the latest technology to emerge in the semiconductor sector after

microprocessors require integration of diverse signal processing blocks in a power efficient and cost effective manner Typically these systems include data acquisition data processing telemetry and power management The overall development is a synergy among system circuit and component level designs with a strong emphasis on integration This book is targeted at students researchers and industry practitioners in the semiconductor area who require a thorough understanding of integrated communication microsystems from a developer s perspective The book thoroughly and carefully explores Fundamental requirements of communication microsystems System design and considerations for wired and wireless communication microsystems Advanced block level design techniques for communication microsystems Integration of communication systems in a hybrid environment Packaging considerations Power and form factor trade offs in building integrated microsystems Advanced Integrated Communication Microsystems is an ideal textbook for advanced undergraduate and graduate courses It also serves as a valuable reference for researchers and practitioners in circuit design for telecommunications and related fields

Computer-Aided Design of Analog Integrated Circuits and Systems Rob A. Rutenbar, Georges G. E. Gielen, 2002-05-06 The tools and techniques you need to break the analog design bottleneck Ten years ago analog seemed to be a dead end technology Today System on Chip SoC designs are increasingly mixed signal designs With the advent of application specific integrated circuits ASIC technologies that can integrate both analog and digital functions on a single chip analog has become more crucial than ever to the design process Today designers are moving beyond hand crafted one transistor at a time methods They are using new circuit and physical synthesis tools to design practical analog circuits new modeling and analysis tools to allow rapid exploration of system level alternatives and new simulation tools to provide accurate answers for analog circuit behaviors and interactions that were considered impossible to handle only a few years ago To give circuit designers and CAD professionals a better understanding of the history and the current state of the art in the field this volume collects in one place the essential set of analog CAD papers that form the foundation of today s new analog design automation tools Areas covered are Analog synthesis Symbolic analysis Analog layout Analog modeling and analysis Specialized analog simulation Circuit centering and yield optimization Circuit testing Computer Aided Design of Analog Integrated Circuits and Systems is the cutting edge reference that will be an invaluable resource for every semiconductor circuit designer and CAD professional who hopes to break the analog design bottleneck

Proceedings of the International Congress on Information and Communication Technology Suresh Chandra Satapathy, Yogesh Chandra Bhatt, Amit Joshi, Durgesh Kumar Mishra, 2016-06-08 This volume contains 69 papers presented at ICICT 2015 International Congress on Information and Communication Technology The conference was held during 9th and 10th October 2015 Udaipur India and organized by CSI Udaipur Chapter Division IV SIG WNS SIG e Agriculture in association with ACM Udaipur Professional Chapter The Institution of Engineers India Udaipur Local Centre and Mining Engineers Association of India Rajasthan Udaipur Chapter This volume contains papers mainly focused on ICT for

Managerial Applications E governance IOT and e Mining *Materials Chemistry* Bradley D. Fahlman, 2018-08-28 The 3rd edition of this successful textbook continues to build on the strengths that were recognized by a 2008 Textbook Excellence Award from the Text and Academic Authors Association TAA *Materials Chemistry* addresses inorganic organic and nano based materials from a structure vs property treatment providing a suitable breadth and depth coverage of the rapidly evolving materials field in a concise format The 3rd edition offers significant updates throughout with expanded sections on sustainability energy storage metal organic frameworks solid electrolytes solvothermal microwave syntheses integrated circuits and nanotoxicity Most appropriate for Junior Senior undergraduate students as well as first year graduate students in chemistry physics or engineering fields *Materials Chemistry* may also serve as a valuable reference to industrial researchers Each chapter concludes with a section that describes important materials applications and an updated list of thought provoking questions **Advanced Radio Frequency Identification Design and Applications** Stevan Preradovic, 2011-03-22 Radio Frequency Identification RFID is a modern wireless data transmission and reception technique for applications including automatic identification asset tracking and security surveillance This book focuses on the advances in RFID tag antenna and ASIC design novel chipless RFID tag design security protocol enhancements along with some novel applications of RFID

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