

DIGITAL INTEGRATED CIRCUITS

A DESIGN PERSPECTIVE
SECOND EDITION



JAN M. RABAEY
ANANTHA CHANDRAKASAN
BORIVOJE NIKOLIC

Digital Integrated Circuits 2nd Edition

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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 is the integration of the MATLAB components Simulink and Stateflow for model building, simulations, system testing, and fault detection, allowing 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 the 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 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

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, 2003

Introduction to VLSI Systems Ming-Bo Lin, 2011-11-28 With the advance of semiconductors and ubiquitous computing the

use of system on a chip SoC has become an essential technique to reduce product cost With this progress and continuous reduction of feature sizes and the development of very large scale integration VLSI circuits addressing the harder problems requires fundamental understanding

FPGA Prototyping by SystemVerilog Examples Pong P. Chu, 2018-05-04 A hands on introduction to FPGA prototyping and SoC design This is the successor edition of the popular FPGA Prototyping by Verilog Examples text It follows the same learning by doing approach to teach the fundamentals and practices of HDL synthesis and FPGA prototyping The new edition uses a coherent series of examples to demonstrate the process to develop sophisticated digital circuits and IP intellectual property cores integrate them into an SoC system on a chip framework realize the system on an FPGA prototyping board and verify the hardware and software operation The examples start with simple gate level circuits progress gradually through the RT register transfer level modules and lead to a functional embedded system with custom I O peripherals and hardware accelerators Although it is an introductory text the examples are developed in a rigorous manner and the derivations follow the strict design guidelines and coding practices used for large complex digital systems The book is completely updated and uses the SystemVerilog language which absorbs the Verilog language It presents the hardware design in the SoC context and introduces the hardware software co design concept Instead of treating examples as isolated entities the book integrates them into a single coherent SoC platform that allows readers to explore both hardware and software programmability and develop complex and interesting embedded system projects The new edition Adds four general purpose IP cores which are multi channel PWM pulse width modulation controller I2C controller SPI controller and XADC Xilinx analog to digital converter controller Introduces a music synthesizer constructed with a DDFS direct digital frequency synthesis module and an ADSR attack decay sustain release envelope generator Expands the original video controller into a complete stream based video subsystem that incorporates a video synchronization circuit a test pattern generator an OSD on screen display controller a sprite generator and a frame buffer Provides a detailed discussion on blocking and nonblocking statements and coding styles Describes basic concepts of software hardware co design with Xilinx MicroBlaze MCS soft core processor Provides an overview of bus interconnect and interface circuit Presents basic embedded system software development Suggests additional modules and peripherals for interesting and challenging projects

FPGA Prototyping by SystemVerilog Examples makes a natural companion text for introductory and advanced digital design courses and embedded system courses It also serves as an ideal self teaching guide for practicing engineers who wish to learn more about this emerging area of interest

Digitally Assisted Pipeline ADCs Boris Murmann, Bernhard E. Boser, 2007-05-08 Digitally Assisted Pipeline ADCs Theory and Implementation explores the opportunity to reduce ADC power dissipation by leveraging digital signal processing capabilities in fine line integrated circuit technology The described digitally assisted pipelined ADC uses a statistics based system identification technique as an enabling element to replace precision residue amplifiers with simple open loop gain stages The digital compensation of analog circuit distortion

eliminates one key factor in the classical noise speed linearity constraint loop and thereby enables a significant power reduction Digitally Assisted Pipeline ADCs Theory and Implementation describes in detail the implementation and measurement results of a 12 bit 75 MSample/sec proof of concept prototype The Experimental converter achieves power savings greater than 60% over conventional implementations Digitally Assisted Pipeline ADCs Theory and Implementation will be of interest to researchers and professionals interested in advances of state of the art in A/D conversion techniques

Embedded SoPC Design with Nios II Processor and Verilog Examples Pong P. Chu, 2012-05-14 Explores the unique hardware programmability of FPGA based embedded systems using a learn by doing approach to introduce the concepts and techniques for embedded SoPC design with Verilog An SoPC system on a programmable chip integrates a processor memory modules I/O peripherals and custom hardware accelerators into a single FPGA field programmable gate array device In addition to the customized software customized hardware can be developed and incorporated into the embedded system as well allowing us to configure the soft core processor create tailored I/O interfaces and develop specialized hardware accelerators for computation intensive tasks Utilizing an Altera FPGA prototyping board and its Nios II soft core processor Embedded SoPC Design with Nios II Processor and Verilog Examples takes a learn by doing approach to illustrate the hardware and software design and development process by including realistic projects that can be implemented and tested on the board Emphasizing hardware design and integration throughout the book is divided into four major parts Part I covers HDL and synthesis of custom hardware Part II introduces the Nios II processor and provides an overview of embedded software development Part III demonstrates the design and development of hardware and software of several complex I/O peripherals including a PS2 keyboard and mouse a graphic video controller an audio codec and an SD secure digital card Part IV provides several case studies of the integration of hardware accelerators including a custom GCD greatest common divisor circuit a Mandelbrot set fractal circuit and an audio synthesizer based on DDFS direct digital frequency synthesis methodology While designing and developing an embedded SoPC can be rewarding the learning can be a long and winding journey This book shows the trail ahead and guides readers through the initial steps to exploit the full potential of this emerging methodology

Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation Robert B. Northrop, 2012-03-02 Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation Second Edition helps biomedical engineers understand the basic analog electronic circuits used for signal conditioning in biomedical instruments It explains the function and design of signal conditioning systems using analog ICs the circuits that enable ECG EEG

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 of the fundamental building blocks of wireless transmitters. In order to support the increasing demand for high data rate 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 new 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.

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.

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

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. Tantziris, 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.

Unveiling the Magic of Words: A Report on "**Digital Integrated Circuits 2nd Edition**"

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