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CMOS Data Converters for Communications distinguishes itself from other data converter books by emphasizing system-related aspects of the design and frequency-domain measures. It explains in detail how to derive data converter requirements for a given communication system (baseband, passband, and multi-carrier systems). The authors also review CMOS data converter architectures and discuss their suitability for communications. The rest of the book is dedicated to high-performance CMOS data converter architecture and circuit design. Pipelined ADCs, parallel ADCs with an improved passive sampling technique, and oversampling ADCs are the focus for ADC architectures, while current-steering DAC modeling and implementation are the focus for DAC architectures. The principles of the switched-current and the switched-capacitor techniques are reviewed and their applications to crucial functional blocks such as multiplying DACs and integrators are detailed. The book outlines the design of the basic building blocks such as operational amplifiers, comparators, and reference generators with emphasis on the practical aspects. To operate analog circuits at a reduced supply voltage, special circuit techniques are needed. Low-voltage techniques are also discussed in this book. CMOS Data Converters for Communications can be used as a reference book by analog circuit designers to understand the data converter requirements for communication applications. It can also be used by telecommunication system designers to understand the difficulties of certain performance requirements on data converters. It is also an excellent resource to prepare analog students for the new challenges ahead.

CMOS Telecom Data Converters compiles the latest achievements regarding the design of high-speed and high-resolution data converters in deep submicron CMOS technologies. The four types of analog-to-digital converter architectures commonly found in this arena are covered, namely sigma-delta, pipeline, folding/interpolating and flash. For all these types, latest achievements regarding the solution of critical architectural and circuit issues are presented, and illustrated through IC prototypes with measured state-of-the-art performances. Some of these prototypes are conceived to be employed at the chipset of newest generation wireline modems (ADSL and ADSL+). Others are intended for wireless transceivers. Besides analog-to-digital converters, the book also covers other functions needed for communication systems, such as digital-to-analog converters, analog filters, programmable gain amplifiers, digital filters, and line drivers.

Accordingly, to meet the stringent ADC specifications imposed by emerging broadband communication applications, this thesis explores

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the following: (1) High-Speed High-Resolution Delta-Sigma (DeltaSigma) ADCs: Oversampling DeltaSigma ADCs can achieve a high-resolution data conversion in low-speed applications using low-accuracy analog components. However, extending these ADCs to high-speed applications requires lowering the oversampling ratio (OSR), due to both power and CMOS technology limitations. Unfortunately, this significantly limits the efficiency of a DeltaSigma ADC in achieving a high-resolution analog/digital (A/D) conversion. Therefore, this thesis presents several techniques to enable the OSR lowering in high-speed DeltaSigma ADCs without compromising the resolution. Specifically, a low-distortion single-stage architecture is proposed for high-order multibit DeltaSigma modulators. Furthermore, a dynamic-element-matching (DEM) technique, called Pseudo Data-Weighted-Averaging (Pseudo DWA), with reduced tone behavior at a low OSR is proposed for the linearization of the digital-to-analog converter (DAC) in a multibit DeltaSigma modulator. (2) Low-Voltage Switched-Capacitor (SC) Circuit Implementation: To demonstrate the practicality of the proposed modulator architecture and DAC-linearization technique when the OSR and the supply voltage are limited by the technology, a DeltaSigma modulator prototype is designed using SC circuit techniques and fabricated in a 0.18- $\mu\text{m}$  standard digital CMOS process. When operated from a 1.8-V supply, it achieves a 13-bit spurious-free dynamic range (SFDR) and a 12-bit signal-to-noise ratio (SNR) over a 3-MS/s conversion bandwidth with a 1.85-V pp input-signal range. The analog and digital power consumptions are, respectively, 32.4 mW and 12.6 mW. The on-chip references dissipate 14.4 mW. Accordingly, this DeltaSigma modulator was one of the few early-reported CMOS DeltaSigma modulators targeting high-speed ( $\geq 2$  MS/s) high-resolution ( $\geq 12$  bits) applications and operating from a low supply voltage ( $\leq 1.8$  V). Furthermore, its measured performance compared favourably to the previously-reported state-of-the-art DeltaSigma modulators. Ironically, the significance of analog integrated-circuit design is growing more prominent in today's "digital" communication age due, in part, to data converters. Specifically, the proliferation of broadband digital communication applications is stimulating the evolving research towards the development of analog-to-digital converters (ADCs) with higher speeds and higher resolutions. These ADCs must be implemented in standard digital CMOS processes for higher system integration and lower fabrication costs. However, in nano-scale CMOS technologies, the decreasing supply voltages and the shrinking devices with poor analog-processing capabilities complicate the low-power design of high-resolution analog circuits.

This book is the first graduate-level textbook presenting a comprehensive treatment of Data Converters. It provides comprehensive definition of the parameters used to specify data converters, and covers all the architectures used in Nyquist-rate data converters. The book uses Simulink and Matlab extensively in examples and problem sets. This is a textbook that is also essential for engineering professionals as it was written in response to a shortage of

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organically organized material on the topic. The book assumes a solid background in analog and digital circuits as well as a working knowledge of simulation tools for circuit and behavioral analysis.

Need to get up to speed quickly on the latest advances in high performance data converters? Want help choosing the best architecture for your application? With everything you need to know about the key new converter architectures, this guide is for you. It presents basic principles, circuit and system design techniques and associated trade-offs, doing away with lengthy mathematical proofs and providing intuitive descriptions upfront. Everything from time-to-digital converters to comparator-based/zero-crossing ADCs is covered and each topic is introduced with a short summary of the essential basics. Practical examples describing actual chips, along with extensive comparison between architectural or circuit options, ease architecture selection and help you cut design time and engineering risk. Trade-offs, advantages and disadvantages of each option are put into perspective with a discussion of future trends, showing where this field is heading, what is driving it and what the most important unanswered questions are.

This text presents the design of data converters for emerging standards and introduces the underlying circuit design principles. It is an excellent reference for IC and mixed signal designers, design managers and project leaders in industry, particularly those in the wireless semiconductor industry.

A revised guide to the theory and implementation of CMOS analog and digital IC design The fourth edition of CMOS: Circuit Design, Layout, and Simulation is an updated guide to the practical design of both analog and digital integrated circuits. The author—a noted expert on the topic—offers a contemporary review of a wide range of analog/digital circuit blocks including: phase-locked-loops, delta-sigma sensing circuits, voltage/current references, op-amps, the design of data converters, and switching power supplies. CMOS includes discussions that detail the trade-offs and considerations when designing at the transistor-level. The companion website contains numerous examples for many computer-aided design (CAD) tools. Using the website enables readers to recreate, modify, or simulate the design examples presented throughout the book. In addition, the author includes hundreds of end-of-chapter problems to enhance understanding of the content presented. This newly revised edition:

- Provides in-depth coverage of both analog and digital transistor-level design techniques
- Discusses the design of phase- and delay-locked loops, mixed-signal circuits, data converters, and circuit noise
- Explores real-world process parameters, design rules, and layout examples
- Contains a new chapter on Power Electronics

Written for students in electrical and computer engineering and professionals in the field, the fourth edition of CMOS: Circuit Design, Layout, and Simulation is a practical guide to understanding analog and digital transistor-level

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design theory and techniques.

Wireless communications is witnessing tremendous growth with proliferation of different standards covering wide, local and personal area networks (WAN, LAN and PAN). The current trends calls for designs that allow: Smooth migration to future generations of wireless standards with higher data rates for multimedia applications; Convergence of wireless services allowing access to different standards from the same wireless device; Cost effective design solutions for intercontinental roaming. This requires designs that work across multiple wireless standards, can easily be reused, achieve maximum hardware share at minimum power consumption levels particularly for mobile battery-operated devices. While serious efforts are currently underway to develop highly integrated solutions for digital basebands covering multiple standards, today's emerging multi-standard, multi-band wireless devices use "stacked" transceivers, i.e. separate transceivers for different standards. This represents a major bottleneck in attempting to achieve higher levels of integration and reduce the bill of material for a multi-standard wireless device. Development of radio architectures and mixed-signal design solutions that support multiple standards is therefore needed. This is one of the main objectives of this book. Multi-Standard CMOS Wireless Receivers: Analysis and Design is the first book on the subject of multi-standard wireless receivers. It covers both the analysis and design aspects of CMOS radio receivers with primary focus on receivers for mobile terminals. The subject of multi-standard data converter design for base stations is also covered. The book is the first to detail a complete analysis of a multi-standard receiver chain from the antenna to the data converter establishing the design specifications of all blocks in both the radio and mixed-signal parts. The specifications are conveniently tabulated throughout the book and span a level of details from the noise figure and linearity requirements of RF blocks down to such circuit details as, e.g., DC gain, settling behavior, noise and matching requirements of amplifiers (OTAs) in the data converter. Multi-Standard CMOS Wireless Receivers: Analysis and Design serves as a reference for RF IC and mixed-signal designers, wireless receiver system designers, design managers and project leaders in industry, particularly those in the wireless semiconductor industry.

A comprehensive overview of Sigma-Delta Analog-to-Digital Converters (ADCs) and a practical guide to their design in nano-scale CMOS for optimal performance. This book presents a systematic and comprehensive compilation of sigma-delta converter operating principles, the new advances in architectures and circuits, design methodologies and practical considerations - going from system-level specifications to silicon integration, packaging and measurements, with emphasis on nanometer CMOS implementation. The book emphasizes practical design issues - from high-level behavioural modelling in MATLAB/SIMULINK, to circuit-level implementation in Cadence

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DesignFrameWork II. As well as being a comprehensive reference to the theory, the book is also unique in that it gives special importance on practical issues, giving a detailed description of the different steps that constitute the whole design flow of sigma-delta ADCs. The book begins with an introductory survey of sigma-delta modulators, their fundamentals architectures and synthesis methods covered in Chapter 1. In Chapter 2, the effect of main circuit error mechanisms is analysed, providing the necessary understanding of the main practical issues affecting the performance of sigma-delta modulators. The knowledge derived from the first two chapters is presented in the book as an essential part of the systematic top-down/bottom-up synthesis methodology of sigma-delta modulators described in Chapter 3, where a time-domain behavioural simulator named SIMSIDES is described and applied to the high-level design and verification of sigma-delta ADCs. Chapter 4 moves farther down from system-level to the circuit and physical level, providing a number of design recommendations and practical recipes to complete the design flow of sigma-delta modulators. To conclude the book, Chapter 5 gives an overview of the state-of-the-art sigma-delta ADCs, which are exhaustively analysed in order to extract practical design guidelines and to identify the incoming trends, design challenges as well as practical solutions proposed by cutting-edge designs. Offers a complete survey of sigma-delta modulator architectures from fundamentals to state-of-the-art topologies, considering both switched-capacitor and continuous-time circuit implementations Gives a systematic analysis and practical design guide of sigma-delta modulators, from a top-down/bottom-up perspective, including mathematical models and analytical procedures, behavioural modeling in MATLAB/SIMULINK, macromodeling, and circuit-level implementation in Cadence Design FrameWork II, chip prototyping, and experimental characterization. Systematic compilation of cutting-edge sigma-delta modulators Complete description of SIMSIDES, a time-domain behavioural simulator implemented in MATLAB/SIMULINK Plenty of examples, case studies, and simulation test benches, covering the different stages of the design flow of sigma-delta modulators A number of electronic resources, including SIMSIDES, the statistical data used in the state-of-the-art survey, as well as many design examples and test benches are hosted on a companion website Essential reading for Researchers and electronics engineering practitioners interested in the design of high-performance data converters integrated in nanometer CMOS technologies; mixed-signal designers.

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