Design Of Cmos Millimeter Wave And Teerahertz Integrated Circuits With Metamaterials

Circuits With Metamaterials

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A broad: The challenges in the design of CMOS millimeter-wave (mm-wave) transceivers for Gbps wireless communication are discussed. To support the Gbps data rate, the link bandwidth of the receiver must be wide enough, which puts a lot of pressure on the mm-wave front-end as well as on the baseband circuit. This paper discusses the effects of the limited link bandwidth on the transceiver system performance and overviews the bandwidth expansion techniques for mm-wave amplifiers and IF programmable gain amplifier. Furthermore, dual-mode power amplifier (PA) and self-healing technique are introduced to improve the PA’s average efficiency and to deal with the process, voltage, and temperature variation issue, respectively. Several fully-integrated CMOS mm-wave transceivers are also presented to give a short overview on the state-of-the-art mm-wave transceivers.

Design and Analysis of Millimeter-Wave CMOS Frequency Dividers and Phase-locked Loop for 60-GHz Wireless

The definitive, comprehensive guide to cutting-edge millimeter-wave wireless design "This is a great book on mm-wave systems that covers many aspects of the technology targeted for beginners all the way to the advanced users. The authors are some of the most credible scholars I know of who are well respected by the industry. I highly recommend studying this book in detail." – Ali Sadr, Ph.D., Sr. Director, Intel Corporation, MCG millimeter wave Standards and Advanced Technologies millimeter wave (mmwave) is today's breakthrough frontier for emerging wireless mobile cellular networks, wireless local area networks, personal area networks, and vehicular communications. In the near future, mm-wave products, systems, theories, and devices will come together to deliver mobile data rates thousands of times faster than today's existing cellular and Wi-Fi networks. In Millimeter-Wave Communications, four of the field's pioneers draw on their immense experience as researchers, entrepreneurs, inventors, and consultants, empowering engineers at all levels to succeed with mm-wave. They deliver exceptionally clear and useful guidance for newcomers, as well as the first complete desk reference for design experts. The book covers comprehensive mm-wave wireless design issues, for Gbps and digital mmwave bands, from channel to antenna to receiver, introducing emerging design techniques that will be invaluable for researchers in both industry and academia. Topics include fundamental communication theory, channel propagation, circuits, antennas, architectures, capabilities, and applications Digital communication and wired and wireless networking, medium access, multimedia data, and advanced telecommunication systems. This book is a great reference for anyone interested in mm-wave wireless technology, from complete beginners to experienced professionals.

CMOS M-millimeter wave Transceivers for Gbps Wireless Communication Project Supported in Part by the National Natural Science Foundation of China (No. 61013003).

The book covers the CMOS-based millimeter wave circuits and devices and presents methods and design techniques to use CMOS technology for circuits operating beyond 1 GHz. Coverage includes a detailed description of both active and passive devices, including modeling techniques and performance optimization. Various mm-wave circuit blocks are discussed, emphasizing their design distinctions from low-frequency design methodologies. This book also covers a device-oriented circuit design technique that is essential for ultra high speed circuits and gives some examples of device/circuit co-design that can be used for mm-wave technology.

Design and Implementation of Millimeter-Wave Transceivers on CMOS

The book provides a detailed review of millimeter wave power amplifiers, discussing design issues and performance limitations commonly encountered in light of the latest research. Power amplifiers, which are able to provide high levels of output power and linearity while being easily integrated with surrounding circuitry, are a crucial component in wireless microwave systems. This book is divided into three parts, the first of which focuses on mm-wave wireless systems and power amplifiers. In turn, the second focuses readers to mm-wave circuits, while the third explores the design of power amplifiers, making it highly suitable for those who want to learn about mm-wave power amplifier design. This book provides essential information on mm-wave power amplifier theory, as well as the application of options and technologies involved in their effective design, equipping readers, circuit designers and practicing engineers to design, model, analyze, test and implement high-performance, spectrally clean and energy-efficient mm-wave systems.

Design of CMOS Millimeter-Wave and Terahertz Integrated Circuits with Metamaterials

Millimeter-Wave Digitally Intensive Frequency Generation in CMOS

This paper describes the design of CMOS millimeter-wave voltage controlled oscillators. V-actor, transistor, and inductor designs are optimized to reduce the parasitic capacitances. An investigation of tradeoffs between quality factor and tuning range for MOS varactors at 24 GHz has shown that the poly-silicon gate lengths between 0.18 and 0.24 micro meter result in both good quality factor (Q) and Cmos/Cm ratio (~1) in the 0.13-micrometer CMOS process used for the study. The components were utilized to realize a VCO operating around 60 GHz with a tuning range of 5.8 GHz. A 99-GHz VCO with a tuning range of 2.5 GHz, phase noise of -102.7 dBc/Hz at 10-MHz offset and power consumption of 7.15 mW from a 1.5-V supply and a 105-GHz VCO are also demonstrated. This is the CMOS circuit with the highest fundamental operating frequency. The lumped element approach can be used even for VCO's operating near 100 GHz and it results in a smaller circuit area.

Ultra High-Speed CMOS Circuits

This book describes the digitally intensive time-domain architectures and techniques applied to millimeter-wave frequency synthesis, with the objective of improving performance and reducing the cost of implementation. Coverage includes system architecture, state level modeling, critical building block design, and digital calibration techniques, making it highly suitable for those who want to learn about mm-wave frequency generation for communication and radar applications, integrated circuit implementation, and time-domain circuit and system techniques. Highlights the challenges of frequency synthesis at mm-wave band using CMOS technology. Compares the various approaches for mm-wave frequency generation (precision and cost) introduces the digitally intensive synthesizer approach and its advantages Discusses the proper partitioning of the digitally intensive mm-wave frequency synthesis design between the mm-wave, RF, analog, digital and software components. This book provides essential information on mm-wave power amplifier theory, as well as the application of options and technologies involved in their effective design, equipping researchers, circuit designers and practicing engineers to design, model, analyze, test and implement high-performance, spectrally clean and energy-efficient mm-wave systems.

Millimeter-Wave Circuits for 5G and Radar

CMOS 60-GHz and E-band Power Amplifiers and Transmitters

The subject of this book is CMOS RF circuit design for reliability. The device reliability and process variation issues on RF transmitter and receiver circuits will be particular interest to the readers in the field of semiconductor devices and circuits. This proposed book is intended to be used as a textbook at the graduate level and then to examine their impact on RF wireless transceiver circuit performance. A logical analytical formulation, experimental, device and circuit simulation results will be given for clear explanation. The main benefit the reader derive from this book will be clear understanding on how device reliability issues affects the RF circuit performance subject to operating aging and process variations.

Cmos Millimeter-Wave Integrated Circuits For Next Generation Wireless Communication Systems

ABSTRACT: The improvement of high frequency capability for silicon devices has made implementation of millimeter-wave (mm-wave) silicon integrated circuits operating at 60 GHz, 77 GHz and even higher feasible. This had led to the proposal of a low-cost 77-GHz CMOS transceiver for automobile radar application and a 60-GHz wireless inter-chip interconnect system. This Ph. D. work demonstrated an 87-dBc/Hz phase noise at 1 MHz offset while consuming 14-mW power. These designs demonstrate that the low-cost, low leakage CMOS process can be used for the design of mmwave circuit blocks and potentially larger integrated system despite the challenges of using the technology such as low voltage headroom, moderate metalization performance and strict metal density filling requirements.
Design of Millimeter-Wave CMOS Power Amplifiers with Multi-Mode Power Combining Techniques

Design and Analysis of Millimeter-wave CMOS Phase Shifter and Low Phase Variation Circuits

This book focuses on the development of design techniques and methodologies for 60-GHz and E-band power amplifiers and transmitters at device, circuit, and layout levels. The authors show the recent development of millimeter-wave design techniques, especially of power amplifiers and transmitters, and present novel design concepts, such as “power transistor layout” and “4-way parallel-series power combiner”, that can enhance the output power and efficiency of power amplifiers in a compact silicon area. Five state-of-the-art 60-GHz and E-band designs with measured results are demonstrated to prove the effectiveness of the design concepts and hands-on methodologies presented. This book serves as a valuable reference for circuit designers to develop millimeter-wave building blocks for future 5G applications.

Design and Analysis of Key Components for Manufacturable and Low-power CMOS Millimeter-wave Receiver Front End

Discover the concepts, architectures, components, tools, and techniques needed to design millimeter-wave circuits for current and emerging wireless system applications. Focusing on applications in 5G, connectivity, radar, and more, leading experts in radio frequency integrated circuit (RFIC) design provide a comprehensive treatment of cutting-edge physical-layer technologies for radio frequency (RF) transceivers - specifically RF, analog, mixed-signal, and digital circuits and architectures. This full design chain is covered, from system design requirements through to building blocks, transceivers, and process technology. Gain insight into the key novelties of 5G through authoritative chapters on massive MIMO and phased arrays, and learn about the most recent technology developments, such as FinFET logic process technology for RF and millimeter-wave applications. This is an essential reading and an excellent reference for high-frequency circuit designers in both academia and industry.

Design of CMOS Voltage-Controlled Oscillator and Mixer for 60GHz Millimeter-Wave Applications

CMOS Front Ends for Millimeter Wave Wireless Communication Systems

Millimeter Wave Wireless Communications

Along with numerous opportunities in communication and imaging applications, the design of emerging millimeter-wave (mm-wave) and terahertz (THz) electronic circuits and systems in CMOS technology faces new challenges and requirements for new devices. Design of CMOS Millimeter-Wave and Terahertz Integrated Circuits with Metamaterials provides alternative solutions using CMOS-on-chip metamaterials. Unlike conventional metamaterial devices on printed circuit boards (PCBs), the presented CMOS metamaterials can be utilized to build many mm-wave and THz circuits and systems on chip. Leveraging the authors' extensive expertise and experience with CMOS-on-chip metamaterials, this book shows that with the use of metamaterials, one can realize coherent THz signal generation, amplification, transmission, and detection of phase-arrayed CMOS transistors with significantly improved performance. Offering detailed coverage from device to system, the book hereby: Describes integrated circuit design with application of metamaterials in CMOS technology Includes real CMOS integrated circuit examples and chip demonstrations with measurement results Evaluates novel mm-wave and THz communication and imaging systems under CMOS-based system-on-chip integration Design of CMOS Millimeter-Wave and Terahertz Integrated Circuits with Metamaterials reflects the latest research progress and provides a state-of-the-art reference on CMOS-based metamaterial devices and mm-wave and THz systems.

Selected Topics in Power, RF, and Mixed-Signal ICs

The aim of this book is to present the modern design and analysis principles of millimeter-wave communication system for wireless devices and to give postgraduates and system professionals the design insights and challenges when integrating millimeter wave personal communication system. Millimeter wave communication system are going to play key roles in modern gigabit wireless communication area as millimeter-wave industrial standards from IEEE, European Computer Manufacturing Association (ECMA) and Wireless High Definition (Wireless HD) Group, are on their way to the market. The book will review up-to-date research results and utilize numerous design and analysis for the whole system covering from Millimeter wave front-end to digital signal processing in order to address major topics in a high speed wireless system. This book emphasizes the importance and the requirements of high-gain antennas, low power transceiver, adaptive equalizer/modulation, channeling coding and adaptive multi-user detection for gigabit wireless communications. In addition, the book will include the updated research literature and patents in the topics of transceivers, antennas, MIMO, channel capacity, coding, equalizer, modem and multi-user detection. Finally, the application of these antennas will be discussed in light of different forthcoming wireless standards at V-band and E-band.

Design and Reliability Studies of CMOS RF/M Millimeter Wave Circuits

This dissertation presents the design and implementation of circuits and transceivers in CMOS technology to enable many new millimeter-wave applications. A simple approach is presented for accurately modeling the millimeter-wave characteristics of transistors that are not fully captured by contemporary parasitic extraction techniques. Next, the integration of a low-power 60-GHz CMOS on-off keying (OOK) receiver in 90-nm CMOS for use in multi-gigabit per second wireless communications is demonstrated. The use of non-coherent OOK demodulation by a novel demodulator enabled a data throughput of 3.5 Gbps and resulted in the lowest power budget (33) of 60-GHz CMOS OOK receivers at the time of publication. Also presented is the design of a high-power, high-efficiency 45-GHz VCO in 45-nm SOI CMOS. The design is a class-E power amplifier placed in a passive feedback configuration. This circuit achieves the highest reported output power (8.2 dBm) and efficiency (15.64%) to date for monolithic silicon-based millimeter-wave VCOs. Results are provided for the standalone VCO as well as after packaging in a liquid crystal polymer (LCP) substrate. In addition, a high-power high-efficiency (5.2 dBm/6.1%) injection locked oscillator is presented. Finally, the design of a 2-channel 45-GHz vector modulator in 45-nm SOI CMOS for LINC transmitters is presented. A zero-power passive IQ generation network and a low-power Gilbert cell modulator are used to enable continuous 360° vector generation. The IC is packaged with a Wilkinson power combiner on LCP and driven by external DACs to demonstrate the first ever 16-QAM generated by outphasing modulation in the Q-band.

Design of Microwave and Millimeter-wave VCOs and Frequency Dividers

Selected Topics in Power, RF, and Mixed-Signal ICs provides a practical overview and state-of-the-art advancements on several selected topics in the areas of power, RF, and mixed-signal integrated circuits and systems.

Millimeter-Wave Voltage-Controlled Oscillators in 0.13-micrometer CMOS Technology

mm-Wave Silicon Power Amplifiers and Transmitters

Microwave and Millimeter-Wave CMOS Characterization, Modeling and Design

Design and Optimization of Configurable Passive Components for CMOS Millimeter-Wave Integrated Circuits

This book compiles and presents the research results from the past five years in mm-wave Silicon circuits. This area has received a great deal of interest from the research community including several university and research groups. The book covers device modeling, circuit building blocks, phased array systems, and antennas and packaging. It focuses on the techniques that uniquely take advantage of the scale and integration offered by silicon based technologies.

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