Charge Pump Circuit Design

Design state-of-the-art charge pumps Charge Pump IC Design delivers an advanced systematic approach to charge pump circuit design—from building blocks to final pump. The book describes how to achieve high power efficiency and low supply noise. Negative feedback control, compensation, and stability are discussed and real-world design examples with schematics are included. The proven techniques presented in this practical, cutting-edge guide will help you to provide the efficient power conversion needed for today's portable electronic devices. Comprehensive coverage includes: Regulators and power converters Charge pump design specifications and design metrics Single stage charge pump Multi-stage charge pump Charge pump clock driver Charge pump stability analysis Charge pump design, regulation, and control by examples Charge pump applications

Charge Pump IC DesignMcGraw Hill Professional

A typical CMOS gate draws charge equal to C[subscript L]Vdd2 from the power supply (Vdd) where C[subscript L] is the load capacitance. Half of the energy is dissipated in the pull-up p-type network, and the other half is dissipated in the pull-down n-type network. Adiabatic CMOS circuit reduces the dissipated energy by providing the charge at a rate significantly lower than the inherent RC delay of the gate. The charge can also be recovered with an RLC oscillator based power supply. However, the two main problems with adiabatic design style are the design of a high frequency RLC oscillator for the power supply, and the need to slow down the rate of charge supply for lower energy. This reduction in

speed of operation renders this adiabatic technique inapplicable in certain situations. A new approach incorporating an adiabatic charge pump that moves the slower adiabatic components away from the critical path of the logic is proposed in this work. The adiabatic delays of a charge pump are overlapped with the computing path logic delays. Hence, the proposed charge pump based recycling technique is especially effective for pipelined datapath computations (digital signal processing, DSP, is such a domain) where timing considerations are important. Also the proposed design style does not interfere with the critical path of the system, and hence the delay introduced by this scheme does not reduce the overall computational speed. In this work, we propose one implementation schema that involves tapping the ground-bound charge in a capacitor (virtual ground) and using an adiabatic charge-pump circuit to feed internal virtual power supplies. As the design relies on leakage charge to generate virtual power supplies, it is most effective in large circuits that undergo considerable switching activity resulting in substantial charge tapping by the proposed scheme. The proposed method has been implemented in DSP applications like FIR filter, DCT/IDCT filters and FFT filters. Simulations results in SPICE indicate that the proposed scheme reduces energy consumption in these DSP circuits by as much as 18% with no loss in performance, paving way for a new approach towards conserving energy in complex digital systems.

Praise for CMOS: Circuit Design, Layout, and SimulationRevised Second Edition from the Technical Reviewers "A refreshing industrial flavor. Design concepts are presented as they are needed for 'just-in-time' learning. Simulating and designing circuits using

SPICE is emphasized with literally hundreds of examples. Very few textbooks contain as much detail as this one. Highly recommended!" --Paul M. Furth, New Mexico State University "This book builds a solid knowledge of CMOS circuit design from the ground up. With coverage of process integration, layout, analog and digital models, noise mechanisms, memory circuits, references, amplifiers, PLLs/DLLs, dynamic circuits, and data converters, the text is an excellent reference for both experienced and novice designers alike." --Tyler J. Gomm, Design Engineer, Micron Technology, Inc. "The Second Edition builds upon the success of the first with new chapters that cover additional material such as oversampled converters and non-volatile memories. This is becoming the de facto standard textbook to have on every analog and mixed-signal designer's bookshelf." --Joe Walsh, Design Engineer, AMI Semiconductor CMOS circuits from design to implementation CMOS: Circuit Design, Layout, and Simulation, Revised Second Edition covers the practical design of both analog and digital integrated circuits, offering a vital, contemporary view of a wide range of analog/digital circuit blocks, the BSIM model, data converter architectures, and much more. This edition takes a two-path approach to the topics: design techniques are developed for both long- and short-channel CMOS technologies and then compared. The results are multidimensional explanations that allow readers to gain deep insight into the design process. Features include: Updated materials to reflect CMOS technology's movement into nanometer sizes Discussions on phase- and delay-locked loops, mixed-signal circuits, data converters, and circuit noise More than 1,000 figures, 200 examples, and over 500 end-of-chapter problems In-depth coverage of both analog and

digital circuit-level design techniques Real-world process parameters and design rules The book's Web site, CMOSedu.com, provides: solutions to the book's problems; additional homework problems without solutions; SPICE simulation examples using HSPICE, LTspice, and WinSpice; layout tools and examples for actually fabricating a chip; and videos to aid learning

Design of CMOS Phase-Locked Loops

ICICT 2015, Volume 2

Electronic Devices and Circuit Design

Edn Series for Design Engineers

Design Methodology for Charge Pumps

Simplified Design of Micropower and Battery Circuits

Current-Mode digital circuits have been extensively analyzed and used since the early days of digital ICs. In particular, bipolar Current-Mode digital circuits emerged as an approach to realize digital circuits with the highest speed. Together with its speed performance, CMOS Current-Mode logic has been rediscovered to allow logic gates implementations which, in contrast to classical VLSI CMOS digital circuits, have the feature of low noise level generation. Thus, CMOS Current-Mode gates can be efficiently used inside analog and mixed-signal ICs, which require a low noise silicon environment. For these reasons, until today, many works and results have been published which reinforce the importance of Current-Mode digital circuits. In the topic of Current-Mode digital circuits, the authors spent a lot of effort in the last six years, and their original results highly enhanced both the modeling and the related design methodologies.

Since the fundamental Current-Mode logic building block is the classical differential amplifier, the winning idea, that represents the starting point of the authors' research, was to change the classical point of view typically followed in the investigation and design of Current-Mode digital circuits. In particular, they properly exploited classical paradigms developed and used in the analog circuit domain (a topic in which one of the authors maturated a great experience).

Power Aware Design Methodologies was conceived as an effort to bring all aspects of power-aware design methodologies together in a single document. It covers several layers of the design hierarchy from technology, circuit logic, and architectural levels up to the system layer. It includes discussion of techniques and methodologies for improving the power efficiency of CMOS circuits (digital and analog), systems on chip, microelectronic systems, wirelessly networked systems of computational nodes and so on. In addition to providing an in-depth analysis of the sources of power dissipation in VLSI circuits and systems and the technology and design trends, this book provides a myriad of state-of-the-art approaches to power optimization and control. The different chapters of Power Aware Design Methodologies have been written by leading researchers and experts in their respective areas. Contributions are from both academia and industry. The contributors have reported the various

technologies, methodologies, and techniques in such a way that they are understandable and useful. Charge pumps are finding increased attention and diversified usage in the new era of nanometer-generation chips used in different systems. This book explains the different architectures and requirements for an efficient charge pump design and explains each step in detail. It's filled with extra hands-on design information, potential pitfalls to avoid, and practical ideas harnessed from the authors' extensive experience designing charge pumps.

With growing consumer demand for portability and miniaturization in electronics, design engineers must concentrate on many additional aspects in their core design. The plethora of components that must be considered requires that engineers have a concise understanding of each aspect of the design process in order to prevent bug-laden prototypes. Electronic Circuit Design allows engineers to understand the total design process and develop prototypes which require little to no debugging before release. It providesstep-by-step instruction featuring modern components, such as analog and mixed signal blocks, in each chapter. The book details every aspect of the design process from conceptualization and specification to final implementation and release. The text also demonstrates how to utilize device data sheet information and associated application notes to design an electronic system. The hybrid nature of

electronic system design poses a great challenge to engineers. This book equips electronics designers with the practical knowledge and tools needed to develop problem free prototypes that are ready for release.

Ultra-low Voltage Circuit Techniques for Energy Harvesting

From Circuit Level to Architecture Level

Proceedings of the International Congress on Information and Communication Technology

Monolithic Phase-Locked Loops and Clock Recovery Circuits

Charge Pump Circuit Design

VLSI Modulation Circuits - Signal Processing, Data Conversion, and Power Management

This new volume offers a broad view of the challenges of electronic devices and circuits for IoT applications. The book presents the basic concepts and fundamentals behind new low power, high-speed efficient devices, circuits, and systems in addition to CMOS. It provides an understanding of new materials to improve device performance with smaller dimensions and lower costs. It also looks at the new methodologies to enhance system performance and provides key parameters for exploring the devices and circuit performance based on smart applications. The chapters delve into myriad aspects of circuit design, including MOSFET structures depending on their low power

applications for IoT-enabled systems, advanced sensor design and fabrication using MEMS, indirect bootstrap techniques, efficient CMOS comparators, various encryption-decryption algorithms, IoT video forensics applications, microstrip patch antennas in embedded IoT applications, real-time object detection using sound, IOT and nanotechnologies based wireless sensors, and much more.

This modern, pedagogic textbook from leading author Behzad Razavi provides a comprehensive and rigorous introduction to CMOS PLL design, featuring intuitive presentation of theoretical concepts, extensive circuit simulations, over 200 worked examples, and 250 end-of-chapter problems. The perfect text for senior undergraduate and graduate students.

'Simplified Design of Micropower and Battery Circuits' provides a simplified, step-by-step approach to micropower and supply cell circuit design. No previous experience in design is required to use the techniques described, thus making the book well suited for the beginner, student, or experimenter as well as the design professional. The book concentrates on the use of commercial micropower ICs by discussing selections of external components that modify the IC-package characteristics. The basic approach

is to start design problems with approximations for trial-value components in experimental circuits, then to vary the component values until the desired results are produced. Although theory and mathematics are kept to a minimum, operation of all circuits is described in full.
EDITOR'S CHOICE - Electronics (The Maplin Magazine), May 1996 John D. Lenk has been a technical author specializing in practical electronic design and troubleshooting guides for more than 40 years. An established writer of international best-sellers in the field of electronics, Mr. Lenk is the author of more than 80 books on electronics, which together have sold well over two million copies in nine languages. Uses commercially available micropower ICs. No design experience required. Minimal theory and mathematics; full circuit operation described.
This comprehensive book focuses on DC–DC switching power supply circuits, which are receiving attention as a key technology in green IT, especially in the automotive and consumer electronics industries. It covers buck converters, isolated converters, PFC converters, their modeling and analysis, several control methods, passive components, and their several recent applications (on-chip power supplies, DC–DC

and AC–DC converter applications, single-inductor multi-output DC–DC converters, energy harvest applications, wireless power delivery, charge pump circuits, and power amplifiers). The contents are well balanced as the authors are from both academia and industry and include pioneers and inventors of hysteretic PWM control.

Electronic Circuit Design

Electronic Circuit Design Ideas

Theory and Design

Practical Design Techniques for Power and Thermal Management

Challenges and Applications in the Internet of Things

Circuit Design, Layout, and Simulation

A Flash memory is a Non Volatile Memory (NVM) whose "unit cells" are fabricated in CMOS technology and programmed and erased electrically. In 1971, Frohman-Bentchkowsky developed a folating polysilicon gate tran sistor [1, 2], in which hot electrons were injected in the floating gate and removed by either Ultra-Violet (UV) internal photoemission or by Fowler Nordheim tunneling. This is the "unit cell" of EPROM (Electrically Pro grammable Read Only Memory), which, consisting of a single transistor, can be very densely integrated. EPROM memories are electrically programmed and erased by UV exposure for 20-30 mins. In the late 1970s, there have been many efforts to develop an electrically erasable EPROM, which resulted in EEPROMs (Electrically Erasable Programmable ROMs). EEPROMs use hot electron tunneling for program and Fowler-Nordheim tunneling for erase. The EEPROM cell consists of two transistors and a tunnel oxide, thus it is two or three times the size of an EPROM.

Successively, the combination of hot carrier programming and tunnel erase was rediscovered to achieve a single transistor EEPROM, called Flash EEPROM. The first cell based on this concept has been presented in 1979 [3]; the first commercial product, a 256K memory chip, has been presented by Toshiba in 1984 [4]. The market did not take off until this technology was proven to be reliable and manufacturable [5].

Electronic Circuit Design Ideas covers a wide variety of electronic circuit design, which consists of a circuit diagram, waveforms, and an explanation of how the circuit works. This text contains 14 chapters and starts with a review of the principles of digital circuits and interface circuits frequently used in circuit design. The next chapters describe the commonly used timer, op-amp, and amplifier circuits. Other chapters present some examples of waveform generators and oscillators used in circuit design. This work also looks into other classifications of circuits, including phase-locked loop, power-supply, and voltage regulator circuits. The final chapters are devoted to the methods of controlling DC servomotors and stepper motors. These chapters also examine other design ideas, specifically the use of slotted optical sensor based revolution detector, photodiode and magnetic transducer detector, and FSK circuit. This book will prove useful to electrical engineers, electronics professionals, hobbyists, and students.

CMOS DC-DC Converters aims to provide a comprehensive dissertation on the matter of monolithic inductive Direct-Current to Direct-Current (DC-DC) converters. For this purpose seven chapters are defined which will allow the designer to gain specific knowledge on the design and implementation of monolithic inductive DC-DC converters, starting from the very basics.

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.
Integrated Circuit and System Design. Power and Timing Modeling, Optimization and Simulation
Design and Implementation of Fully-Integrated Inductive DC-DC Converters in Standard CMOS
On-chip High-Voltage Generator Design
Charge Pump IC Design

A Low Power FinFET Charge Pump for Energy Harvesting Applications
This book provides various design techniques for switched-capacitor on-chip high-voltage generators, including charge pump circuits, regulators, level shifters, references, and oscillators. Readers will see these techniques applied to system design in order to address the challenge of how the on-chip high-voltage generator is designed for Flash memories, LCD drivers, and other semiconductor devices to optimize the entire circuit area and power efficiency with a low voltage supply, while minimizing the cost. This new edition includes a variety of useful updates, including coverage of power efficiency and comprehensive optimization methodologies for DC-DC voltage multipliers, modeling of extremely low voltage Dickson charge pumps, and modeling and optimum design of AC-DC switched-capacitor multipliers for energy harvesting and power transfer for RFID. Design Note Collection, the third book in the Analog Circuit Design series, is a comprehensive volume of applied circuit design solutions, providing elegant and practical design techniques. Design Notes in this volume are focused circuit explanations, easily applied in your own designs. This book includes an extensive power management section, covering switching

regulator design, linear regulator design, microprocessor power design, battery management, powering LED lighting, automotive and industrial power design. Other sections span a range of analog design topics, including data conversion, data acquisition, communications interface design, operational amplifier design techniques, filter design, and wireless, RF, communications and network design. Whatever your application -industrial, medical, security, embedded systems, instrumentation, automotive, communications infrastructure, satellite and radar, computers or networking; this book will provide practical design techniques, developed by experts for tackling the challenges of power management, data conversion, signal conditioning and wireless/RF analog circuit design. A rich collection of applied analog circuit design solutions for use in your own designs. Each Design Note is presented in a concise, two-page format, making it easy to read and assimilate. Contributions from the leading lights in analog design, including Bob Dobkin, Jim Williams, George Erdi and Carl Nelson, among others. Extensive sections covering power management, data conversion, signal conditioning, and wireless/RF.

This is a texbook developed for a VLSI circuit design course series (EEE598) that the author has been offering in the Schools of Engineering at Arizona State University. The materials are organized into eighteen special topics covering the principles, the circuit design techniques and the applications of VLSI modulation in signal processing, data conversion, power amplification and power management.

This book provides readers specializing in ultra-low power supply design for self-powered applications an invaluable reference on reconfigurable switched capacitor power converters. Readers will benefit from a comprehensive introduction to the design of robust power supplies for energy harvesting and self-power applications, focusing on the use of reconfigurable switched capacitor based DC-DC converters, which is ideal for such applications. Coverage

includes all aspects of switched capacitor power supply designs, from fundamentals, to reconfigurable power stages, and sophisticated controller designs.

Reconfigurable Switched-Capacitor Power Converters

Design Note Collection

Internally Compensated LDO Regulators for Modern System-on-Chip Design

Pll Performance, Simulation and Design

An Adiabatic Charge Pump Based Charge Recycling Design Style

An Effective Threshold Voltage (Vth) Model of Dickson Charge Pump Circuit and Its Circuit Area Minimization Design Using Varactor

A Charge pump circuit provides a voltage that is higher than the voltage of the power supply or a voltage of reverse polarity. Increased voltage levels are obtained in a charge pump as a result of transferring charges to a capacitive load, and do not involve amplifiers or regular transformers. Charge pumps usually operate at a high- frequency level in order to increase their output power within a reasonable size of total capacitance used for charge transfer. This operating frequency may be adjusted by compensating for changes in the power requirements and saving the energy delivered to the charge pump. Among many approaches to the charge pump design, the switched-capacitor circuits such as Dickson charge pump are very popular, because they can be implemented on the same chip together with other components of an integrated system. An extensive research focused on the design and timing scheme of Dickson, Static, Dynamic charge pump had been accomplished. A better charge Pump is proposed which have a better gain and threshold than other charge pumps discussed.

In this thesis, the literature relating to charge pump dc-dc converters and their uses is reviewed. Charge pumps are useful in many circuits, including low-voltage circuits, dynamic random access memory circuits, switched-capacitor circuits, EEPROM's and transceivers. The important issues relating to charge pump design are power efficiency, output voltage ripple and area efficiency. This thesis describes the operation of three types of charge pump circuits. Power efficiency theory of charge pumps is discussed in detail. A method of estimating the output ripple of a charge pump from the size of the capacitors used is described. The optimal distribution of available capacitance for minimizing output ripple or maximizing power efficiency is derived. The tradeoffs between output ripple, power efficiency and total capacitance are discussed. The considerations involved in the design of charge pump circuits are described. A new charge pump circuit that uses two cascoded buffer transistors to improve the area efficiency is proposed. An implementation consisting of one of each of the three types of charge pumps was simulated for a 0.35-micron CMOS process. The simulation results verify the improved area efficiency of the double cascode charge pump.

This book provides various design techniques for switched-capacitor on-chip high-voltage generators, including charge pump circuits, regulators, level shifters, references, and oscillators. Readers will see these techniques applied to system design in order to address the challenge of how the on-chip high-voltage generator is designed for Flash memories, LCD drivers, and other semiconductor devices to optimize the entire circuit area and power efficiency with a low

voltage supply, while minimizing the cost.

This book presents a thorough state-of-the-art review for internally compensated Low Dropout Regulators (IC-LDO). It serves as a useful guide for circuit designers. The advantages and disadvantages of each cell proposed are highlighted. The authors describe an alternative to the classical topology; the Flipped Voltage Follower (FVF), which has been recently applied in the design of internally compensated LDOs to enhance their performances. This book provides novel circuits enhancing those parameters of LDO related with frequency behavior and power consumption. These solutions, as well as their appropriate design methodology, are properly described within the text.

Model and Design of Bipolar and MOS Current-Mode Logic

Circuit Design for RF Transceivers

Low Power Sense Amplifier & Charge Pump Circuits for Readerless RFID

Handbook of Power Management Circuits

13th International Workshop, PATMOS 2003, Torino, Italy, September 10-12, 2003, Proceedings

Low Threshold and Better Gain Charge Pump

This comprehensive book deals with feedback and feedback amplifiers, presenting original material on the topic of feedback circuits. After describing the fundamental properties of feedback, the book illustrates techniques of analysis for greater insight into feedback amplifiers and design strategies to optimise their performance.

This book is intended for the reader who wishes to gain a solid understanding of Phase Locked Loop architectures and their applications. It provides a unique balance between both

theoretical perspectives and practical design trade-offs. Engineers faced with real world design problems will find this book to be a valuable reference providing example implementations, the underlying equations that describe synthesizer behavior, and measured results that will improve confidence that the equations are a reliable predictor of system behavior. New material in the Fourth Edition includes partially integrated loop filter implementations, voltage controlled oscillators, and modulation using the PLL.

Newnes has worked with Marty Brown, a leader in the field of power design to select the very best design-specific material from the Newnes portfolio. Marty selected material for its timelessness, its relevance to current power supply design needs, and its real-world approach to design issues. Special attention is given to switching power supplies and their design issues, including component selection, minimization of EMI, toroid selection, and breadboarding of designs. Emphasis is also placed on design strategies for power supplies, including case histories and design examples. This is a book that belongs on the workbench of every power supply designer! *Marty Brown, author and power supply design consultant, has personally selected all content for its relevance and usefulness *Covers best design practices for switching power supplies and power converters *Emphasis is on pragmatic solutions to commonly encountered design problems and tasks

This book provides design-oriented models for the implementation of ultra-low-voltage energy harvesting converters, covering the modeling of building blocks such oscillators, rectifiers, charge pumps and inductor-based converters that can operate with very low supply voltages, typically under 100 mV. Analyses based on the diode and

MOSFET models are included in the text to allow the operation of energy harvesters from voltages of the order of 100 mV or much less, with satisfactory power efficiency. The practical realization of different converters is also addressed, clarifying the design trade-offs of ultra-low voltage (ULV) circuits operating from few millivolts. Offers readers a state-of-the-art revision for ultra-low voltage (ULV) energy harvesting converters; Provides analog IC designers with proper models for the implementation of circuits and building blocks of energy harvesters, such as oscillators, rectifiers, and inductor-based converters, operating under ultra-low voltages; Addresses the design of energy harvesters operating from ultra-low voltages, enabling autonomous operation of connected devices driven by human energy; Demonstrates design and implementation of integrated ULV up-converters; Includes semiconductor modeling for ULV operation.

CMOS

Analog Circuit Design Volume Three

CML, ECL and SCL Digital Circuits

Power Sources and Supplies: World Class Designs

Feedback Amplifiers

Design of High Performance Regulated Charge Pump Circuit

Featuring an extensive 40 page tutorial introduction, this carefully compiled anthology of 65 of the most important papers on phase-locked loops and clock recovery circuits brings you comprehensive coverage of the field-all in one self-contained volume. You'll gain an understanding of the analysis, design, simulation, and implementation of phase-locked loops and clock recovery circuits in CMOS and bipolar technologies

along with valuable insights into the issues and trade-offs associated with phase locked systems for high speed, low power, and low noise.

This book presents state-of-the-art analog and power management IC design techniques for various wireless power transfer (WPT) systems. To create elaborate power management solutions, circuit designers require an in-depth understanding of the characteristics of each converter and regulator in the power chain. This book addresses WPT design issues at both system- and circuit-level, and serves as a handbook offering design insights for research students and engineers in the integrated power electronics area.

Applicable for bookstore catalogue

Instead of the costly RFID reader, WNIC can be used to communicate with the RFID transponder. However, the memory block, which is one of the major parts in RFID transponder, has to be redesigned. This book is concentrated on designing an improved CMOS Sense Amplifier (SA) and Charge Pump (CP) circuits, which are compatible for readerless RFID transponder EEPROM. Memory read access time; power dissipation and the reliability of an EEPROM are strongly influenced by the performance of the SA. Moreover, to reduce the continuous power supply in integrated circuits, CP circuit is widely used to direct charge flow and to generate boosted output voltage higher than VDD in EEPROM. The SA is designed to work in low voltage while the CP

is designed for achieving low power, free from threshold voltage loss and parasitic capacitance effect. Mentor Graphics EldoSpice software package is used to simulate the circuitry. The entire design of the row decoder, SA and clock generator are based on 0.18- m CMOS process. Therefore, the design of the SA and the CP circuits are better suited for low power read and write operation in EEPROM, which will be compatible with the readerless RFID transponder.

From Concept to Implementation

Power Aware Design Methodologies

Flash Memories

Principles and Designs for Self-Powered Microsystems

Area Efficiency Improvement of CMOS Charge Pump Circuits

Chapter 18. Designs for high performance voltage-to-frequency converters

With the growing popularity and use of devices under the great umbrella that is the Internet of Things (IoT), the need for devices that are smaller, faster, cheaper and require less power is at an all time high with no intentions of slowing down. This is why many current research efforts are very focused on energy harvesting. Energy harvesting is the process of storing energy from external and ambient sources and delivering a small amount

of power to low power IoT devices such as wireless sensors or wearable electronics. A charge pumps is a circuit used to convert a power supply to a higher or lower voltage depending on the specific application. Charge pumps are generally seen in memory design as a verity of power supplies are required for the newer memory technologies. Charge pumps can be also be designed for low voltage operation and can convert a smaller energy harvesting voltage level output to one that may be needed for the IoT device to operate. In this work, an integrated FinFET (Field Effect Transistor) charge pump for low power energy harvesting applications is proposed. The design and analysis of this system was conducted using Cadence Virtuoso Schematic L-Editing, Analog Design Environment and Spectre Circuit Simulator tools using the 7nm FinFETs from the ASAP7 7nm PDK. The research conducted here takes advantage of some inherent characteristics that are present in FinFET technologies, including low body effects, and faster switching speeds, lower threshold

voltage and lower power consumption. The lower threshold voltage of the FinFET is key to get great performance at lower supply voltages. The charge pump in this work is designed to pump a 150mV power supply, generated from an energy harvester, to a regulated 650mV, while supplying 1uA of load current, with a 20mV voltage ripple in steady state (SS) operation. At these conditions, the systems power consumption is 4.85uW and is 31.76% efficient. Under no loading conditions, the charge pump reaches SS operation in 50us, giving it the fastest rise time of the compared state of the art efforts mentioned in this work. The minimum power supply voltage for the system to function is 93mV where it gives a regulated output voltage of $25mV. FinFET technology continues to be a very popular design choice and even though it has been in production since Intel's Ivy-Bridge processor in 2012, it seems that very few efforts have been made to use the advantages of FinFETs for charge pump design. This work shows though simulation that FinFET charge pumps can match the

performance of charge pumps implemented in other technologies and should be considered for low power designs such as energy harvesting.

This book constitutes the refereed proceedings of the 13th International Workshop on Power and Timing Modeling, Optimization and Simulation, PATMOS 2003, held in Torino, Italy in September 2003. The 43 revised full papers and 18 revised poster papers presented together with three keynote contributions were carefully reviewed and selected from 85 submissions. The papers are organized in topical sections on gate-level modeling and characterization, interconnect modeling and optimization, asynchronous techniques, RTL power modeling and memory optimization, high-level modeling, power-efficient technologies and designs, communication modeling and design, and low-power issues in processors and multimedia.

Analog Circuit Design Volume 2

CMOS Integrated Circuit Design for Wireless Power Transfer

A Radiation-hardened-by-design Charge Pump for Phase-locked Loop Circuits