

Design of Low Voltage Folded Cascode Operational Transconductance Amplifier with Optimum Range of Gain and GBW in 0.18 μ m Technology

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Abstract- An optimum OTA topology is done in order to optimize MOS transistor sizing. Also, the design of Folded Cascode OTA, which works for frequencies that lead to a baseband circuit design for RF application, is based on transistor sizing methodology. Simulation results are performed using CADENCE software and virtuoso spectre model for CMOS 0.18 μ m process technology. BSIM3V3 model simulator show that the designed folded cascode OTA has a 80.5dB DC gain and provides a gain bandwidth product 4.52MHz.

Keywords- CMOS IC design, optimization, folded cascode OTA, gm/ID methodology, Wilson current mirror, Optimization.

INTRODUCTION

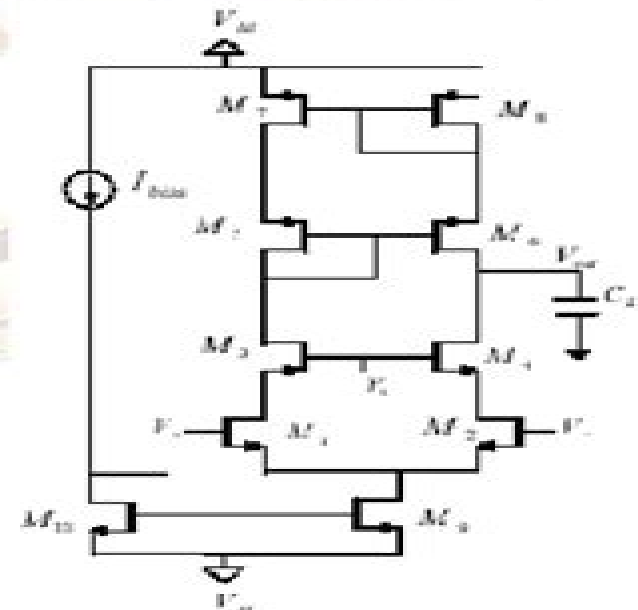
The evolution of the microelectronics industry is distinguished by the raising level of integration and complexity. It aims to decrease exponentially the minimum feature sizes used to design integrated circuits. The cost of design is a great problem to the continuation of this evolution. Senior designer's knowledge and skills are required to ensure a good analogue integrated circuit design. To fulfil the given requirements, the designer must choose the suitable circuit architecture, although different tools partially automating the topology synthesis appeared in the past [1]-[4]. The optimization becomes an important method; a heuristic process was developed in [5]. Designing high-performance baseband analog circuits is still a hard task toward reduced supply voltages and increased frequency. Current tendency focus on some radio-software receivers which suppose a RF signal conversion just after the antenna. Thus, a very higher sampling frequency and resolution analog-to-digital converter design is required. The Operational Transconductance Amplifier (OTA) is a basic element in this type of circuit whether switched capacitors technique is kept for ADC design. Our target was to design a folded cascode OTA circuit insight of Sigma Delta analog-to-digital converter design using for wide band radio applications.

This paper is organized as follows. An optimum Architecture of the folded cascode OTA was introduced in section II and its function was analyzed to extract the circuit performances. Section III describes an approach for designing this OTA, clarifies specific design issues, and results. While section IV provides concluding remarks.

II.OPTIMUM TOPOLOGY OTA ARCHITECTURE

Several fundamental issues exist when selecting an optimal architecture for the operational transconductance amplifier. This choice aimed both at large gain and large bandwidth performances. In order to achieve high gain, the differential telescopic topologies can be used. This topology cascade both the differential pair transistors and current mirror to increase load resistance (Fig.1)[6].

The telescopic architecture is a better candidate for a low power consumption and low noise OTA. [7] The performance of simple OTA is limited by its input and output voltage swing. To overcome these limits of simple OTA and have an improved performance a Folded Cascode OTA is used. Although, telescopic OTA has a limited



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Design of Low-Voltage Bipolar Operational Amplifiers M. Jeroen Fonderie, Johan Huijsing, 1993-02-28 Design of Low Voltage Bipolar Operational Amplifiers discusses the sub circuits necessary to build a low voltage operational amplifier These include rail to rail input stages rail to rail output stages intermediate stages protection circuitry and frequency compensation techniques Of each of these various implementations are examined Furthermore the book discusses realizations in silicon of the amplifiers The design and implementation of low voltage bipolar Operational Amplifiers OpAmps is fully presented A low supply voltage is necessary because the tendency towards chip components of smaller dimensions lowers the breakdown voltage of these components Further a low supply voltage is favorable because it enables operation of the OpAmp from just one single battery cell The bipolar technology is chosen because it is more suited for operation at low voltages than the MOS technology The common mode input voltage of the OpAmp must be able to have any value that fits within the supply voltage range Input stages are discussed which are able to realize this at supply voltages down to 1.8 V as well as down to 1 V The output voltage of the OpAmp must be able to have any value within the supply voltage range One of the 1 V output stages that is discussed the multi path driven output stage also has a high bandwidth with a high gain In addition to the input and output stage the OpAmp comprises an intermediate stage between the input stage and the output stage to boost the overall gain of the OpAmp and a class AB current control A frequency compensation technique is used to split apart the pole frequencies in the transfer function A disadvantage of this nested Miller compensation is that the resulting bandwidth is reduced by a factor of two A new method multi path driven Miller compensation which does not have this drawback is therefore introduced Several realizations are evaluated and a figure of merit is defined for the performance comparison of the OpAmps One of the OpAmps operates at a 1 V supply has a 3.4 MHz bandwidth with a 100 pF load and has a 700 A supply current The book is an excellent reference for professional designers of amplifiers and may be used as a text for advanced courses on the subject

Design of Low-Voltage, Low-Power Operational Amplifier Cells Ron Hogervorst, Johan Huijsing, 2013-03-09 Design of Low Voltage Low Power CMOS Operational Amplifier Cells describes the theory and design of the circuit elements that are required to realize a low voltage low power operational amplifier These elements include constant gm rail to rail input stages class AB rail to rail output stages and frequency compensation methods Several examples of each of these circuit elements are investigated Furthermore the book illustrates several silicon realizations giving their measurement results The text focuses on compact low voltage low power operational amplifiers with good performance Six simple high performance class AB amplifiers are realized using a very compact topology making them particularly suitable for use as VLSI library cells All of the designs can use a supply voltage as low as 3V One of the amplifier designs dissipates only 50 W with a unity gain frequency of 1.5 MHz A second set of amplifiers run on a supply voltage slightly above 1V The amplifiers combine a low power consumption with a gain of 120 dB In addition the design of three fully

differential operational amplifiers is addressed Design of Low Voltage Low Power CMOS Operational Amplifier Cells is intended for professional designers of analog circuits It is also suitable for use as a text book for an advanced course in CMOS operational amplifier design Low-Voltage CMOS Operational Amplifiers Satoshi Sakurai, Mohammed Ismail, 1994-12-31 Low Voltage CMOS Operational Amplifiers Theory Design and Implementation discusses both single and two stage architectures Opamps with constant gm input stage are designed and their excellent performance over the rail to rail input common mode range is demonstrated The first set of CMOS constant gm input stages was introduced by a group from Technische Universiteit Delft and Universiteit Twente the Netherlands These earlier versions of circuits are discussed along with new circuits developed at the Ohio State University The design fabrication MOSIS Tiny Chips and characterization of the new circuits are now complete Basic analog integrated circuit design concepts should be understood in order to fully appreciate the work presented However the topics are presented in a logical order and the circuits are explained in great detail so that Low Voltage CMOS Operational Amplifiers can be read and enjoyed by those without much experience in analog circuit design It is an invaluable reference book and may be used as a text for advanced courses on the subject

Design of CMOS Operational Amplifiers Rasoul Dehghani, 2013 CMOS operational amplifiers Op Amps are one of the most important building blocks in many of today's integrated circuits This cutting edge volume provides you with an analytical method for designing CMOS Op Amp circuits placing emphasis on the practical aspects of the design process This unique book takes an in depth look at CMOS differential amplifiers explaining how they are the main part of all Op Amps The book presents important details and a design method for the different architectures of single ended Op Amps You find complete chapters dedicated to the critical issues of CMOS output stages fully differential Op Amps and CMOS reference generators This comprehensive book also includes an introduction to CMOS technology and the basics of the physical aspects of MOS transistors providing you with the foundation needed to fully master the material **Information Science and Electronic Engineering** Dongxing Wang, 2016-12-08 Information Science and Electronic Engineering is a collection of contributions drawn from the International Conference of Electronic Engineering and Information Science ICEEIS 2016 held January 4 5 2016 in Harbin China The papers in this proceedings volume cover various topics including Electronic Engineering Information Science and Information Technologies Computational Mathematics and Data Mining Image Processing and Computer Vision Communication and Signal Processing Control and Automation of Mechatronics Methods Devices and Systems for Measurement and Monitoring Engineering of Weapon Systems Mechanical Engineering and Material Science Technologies of Processing The content of this proceedings volume will be of interest to professionals and academics in the fields of Electronic Engineering Computer Science and Mechanical Engineering **CMOS Analog Circuit Design** Phillip E. Allen, Douglas R. Holberg, 2012-07-19 This work presents an effective overview of the principles and techniques for designing circuits to be implemented in CMOS technology It explains the methodology of analogue integrated

circuit design by using a hierarchically organised approach Advancements in VLSI Design, Microelectronics Devices and Circuits Pradeep Kumar, William Navaraj, Fernando Moreira, 2025-10-15 This volume presents selected peer reviewed papers from the 12th International Conference on Signal Processing and Integrated Networks SPIN 2025 It offers a comprehensive overview of cutting edge research and developments in signal processing IoT sensors and systems cloud computing wireless communication and wireless sensor networks The collection serves as a valuable resource for researchers practitioners and professionals in both academia and industry **The Circuits and Filters Handbook (Five Volume Slipcase Set)** Wai-Kai Chen, 2018-12-14 Standard setting groundbreaking authoritative comprehensive these often overused words perfectly describe The Circuits and Filters Handbook Third Edition This standard setting resource has documented the momentous changes that have occurred in the field of electrical engineering providing the most comprehensive coverage available More than 150 contributing experts offer in depth insights and enlightened perspectives into standard practices and effective techniques that will make this set the first and most likely the only tool you select to help you with problem solving In its third edition this groundbreaking bestseller surveys accomplishments in the field providing researchers and designers with the comprehensive detail they need to optimize research and design All five volumes include valuable information on the emerging fields of circuits and filters both analog and digital Coverage includes key mathematical formulas concepts definitions and derivatives that must be mastered to perform cutting edge research and design The handbook avoids extensively detailed theory and instead concentrates on professional applications with numerous examples provided throughout The set includes more than 2500 illustrations and hundreds of references Available as a comprehensive five volume set each of the subject specific volumes can also be purchased separately The Design of Low - Voltage Bipolar Operational Amplifiers Joon Son, 1995 **Advanced Informatics for Computing Research** Ashish Kumar Luhach, Dharm Singh, Pao-Ann Hsiung, Kamarul Bin Ghazali Hawari, Pawan Lingras, Pradeep Kumar Singh, 2018-11-28 This two volume set CCIS 955 and CCIS 956 constitutes the refereed proceedings of the Second International Conference on Advanced Informatics for Computing Research ICAICR 2018 held in Shimla India in July 2018 The 122 revised full papers presented were carefully reviewed and selected from 427 submissions The papers are organized in topical sections on computing methodologies hardware information systems networks security and privacy computing methodologies **A New Family of CMOS Cascode-Free Amplifiers with High Energy-Efficiency and Improved Gain** Ricardo Filipe Sereno Póvoa, João Carlos da Palma Goes, Nuno Cavaco Gomes Horta, 2018-08-10 This book addresses the need for energy efficient amplifiers providing gain enhancement strategies suitable to run in parallel with lower supply voltages by introducing a new family of single stage cascode free amplifiers with proper design optimization fabrication and experimental evaluation The authors describe several topologies using the UMC 130 nm CMOS technology node with standard VT devices for proof of concept achieving results far beyond what is achievable with a classic single stage folded cascode amplifier Readers will learn about a

new family of circuits with a broad range of applications together with the familiarization with a state of the art electronic design automation methodology used to explore the design space of the proposed circuit family

Passive, Active, and Digital Filters Wai-Kai Chen, 2018-10-08 Upon its initial publication The Circuits and Filters Handbook broke new ground It quickly became the resource for comprehensive coverage of issues and practical information that can be put to immediate use Not content to rest on his laurels in addition to updating the second edition editor Wai Kai Chen divided it into tightly focused texts that made the information easily accessible and digestible These texts have been revised updated and expanded so that they continue to provide solid coverage of standard practices and enlightened perspectives on new and emerging techniques Passive Active and Digital Filters provides an introduction to the characteristics of analog filters and a review of the design process and the tasks that need to be undertaken to translate a set of filter specifications into a working prototype Highlights include discussions of the passive cascade synthesis and the synthesis of LCM and RC one port networks a summary of two port synthesis by ladder development a comparison of the cascade approach the multiple loop feedback topology and ladder simulations an examination of four types of finite wordlength effects and coverage of methods for designing two dimensional finite extent impulse response FIR discrete time filters The book includes coverage of the basic building blocks involved in low and high order filters limitations and practical design considerations and a brief discussion of low voltage circuit design Revised Chapters Sensitivity and Selectivity Switched Capacitor Filters FIR Filters IIR Filters VLSI Implementation of Digital Filters Two Dimensional FIR Filters Additional Chapters 1 D Multirate Filter Banks Directional Filter Banks Nonlinear Filtering Using Statistical Signal Models Nonlinear Filtering for Image Denoising Video Demosaicking Filters This volume will undoubtedly take its place as the engineer's first choice in looking for solutions to problems encountered when designing filters

CMOS Analog Design Using All-Region MOSFET Modeling Márcio Cherem Schneider, Carlos Galup-Montoro, 2010-01-28 The essentials of analog circuit design with a unique all region MOSFET modeling approach

Electronic Devices, Circuits, and Systems for Biomedical Applications Suman Lata Tripathi, Kolla Bhanu Prakash, Valentina Emilia Balas, Sushanta Kumar Mohapatra, Janmenjoy Nayak, 2021-04-28 Electronic Devices Circuits and Systems for Biomedical Applications Challenges and Intelligent Approaches explains the latest information on the design of new technological solutions for low power high speed efficient biomedical devices circuits and systems The book outlines new methods to enhance system performance provides key parameters to explore the electronic devices and circuit biomedical applications and discusses innovative materials that improve device performance even for those with smaller dimensions and lower costs This book is ideal for graduate students in biomedical engineering and medical informatics biomedical engineers medical device designers and researchers in signal processing Presents major design challenges and research potential in biomedical systems Walks readers through essential concepts in advanced biomedical system design Focuses on healthcare system design for low power efficient and highly secured biomedical

electronics **Proceedings, 1997 International Symposium on Low Power Electronics and Design** IEEE Circuits and Systems Society, 1997 Fully-Integrated Low-Dropout Regulators Xiangyu Mao, Yan Lu, Rui P. Martins, 2025-05-11 This book discusses in detail the key specifications of fully integrated low dropout regulators LDOs It covers the various LDO architectures including the classic analog architectures and the state of the art digital and switching control methods The design insight and comparison are discussed according to the key performance index Readers will be enabled to find a suitable architecture when designing a fully integrated LDO *Amplifiers, Comparators, Multipliers, Filters, and Oscillators* Tertulien Ndjountche, 2018-09-03 The book presents design methods for analog integrated circuits with improved electrical performance It describes different equivalent transistor models design methods and fabrication considerations for high density integrated circuits in nanometer CMOS processes and it analyzes circuit architectures that are suitable for analog building blocks Highlighting various design challenges the text offers a complete understanding of architectural and transistor level design issues of analog integrated circuits It examines important trends in the design of high speed and power efficient front end analog circuits that can be used for signal conditioning filtering and detection applications Offers a comprehensive resource for mastering the analysis of analog integrated circuits Describes circuit level details of high speed and power efficient analog building blocks Explores design methods based on various MOS transistor models MOSFET FinFET Provides mathematical derivations of all equations and formulas Emphasizes practical aspects relevant to integrated circuit implementation Includes open ended circuit design case studies **CMOS Data Converters for Communications** Mikael Gustavsson, J. Jacob Wikner, Nianxiong Tan, 2005-12-15 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

Circuit Techniques for Low-Voltage and High-Speed A/D

Converters Mikko E. Waltari, Kari A.I. Halonen, 2005-12-30 For four decades the evolution of integrated circuits has followed Moore's law according to which the number of transistors per square millimeter of silicon doubles every 18 months. At the same time transistors have become faster making possible ever increasing clock rates in digital circuits. This trend seems set to continue for at least another decade without slowing down. Thus in the near future the processing power of digital circuits will continue to increase at an accelerating pace. For analog circuits the evolution of technology is not as beneficial. Thus there is a trend to move signal processing functions from the analog domain to the digital one which besides allowing for a higher level of accuracy provides savings in power consumption and silicon area. Increases in robustness speed up the design process, brings flexibility and programmability and increases the possibilities for design reuse. In many applications the input and output signals of the system are inherently analog preventing all digital realizations. At the very least a conversion between analog and digital is needed at the interfaces. Typically moving the analog/digital boundary closer to the outside world increases the bit rate across it. In telecommunications systems the trend to boost bit rates is based on playing wider bandwidths and a higher signal to noise ratio. At the same time radio architectures in many applications are evolving toward software defined radio one of the main characteristics of which is the shifting of the analog/digital boundary closer to the antenna.

Sigma-Delta Converters: Practical Design Guide

Jose M. de la Rosa, 2018-08-22 Thoroughly revised and expanded to help readers systematically increase their knowledge and insight about Sigma Delta Modulators. Sigma Delta Modulators (SDMs) have become one of the best choices for the implementation of analog/digital interfaces of electronic systems integrated in CMOS technologies. Compared to other kinds of Analog to Digital Converters (ADCs), SDMs cover one of the widest conversion regions of the resolution versus bandwidth plane being the most efficient solution to digitize signals in an increasingly number of applications which span from high resolution low bandwidth digital audio sensor interfaces and instrumentation to ultra low power biomedical systems and medium resolution broadband wireless communications. Following the spirit of its first edition *Sigma Delta Converters: Practical Design Guide* 2nd Edition takes a comprehensive look at SDMs: their diverse types of architectures, circuit techniques, analysis, synthesis methods and CAD tools as well as their practical design considerations. It compiles and updates the current research reported on the topic and explains the multiple trade offs involved in the whole design flow of Sigma Delta Modulators from specifications to chip implementation and characterization. The book follows a top down approach in order to provide readers with the necessary understanding about recent advances, trends and challenges in state of the art SDMs. It makes more emphasis on two key points which were not treated so deeply in the first edition. It includes a more detailed explanation of SDMs implemented using Continuous Time (CT) circuits going from system level synthesis to practical circuit limitations. It provides more practical case studies and applications as well as a deeper description of the synthesis methodologies and CAD tools employed in the design of

converters Sigma Delta Converters Practical Design Guide 2nd Edition serves as an excellent textbook for undergraduate and graduate students in electrical engineering as well as design engineers working on SD data converters who are looking for a uniform and self contained reference in this hot topic With this goal in mind and based on the feedback received from readers the contents have been revised and structured to make this new edition a unique monograph written in a didactical pedagogical and intuitive style

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