



# High Performance Cmos Continuous Time Filters

**Sied Mehdi Fakhraie, Kenneth C. Smith**



## **High Performance Cmos Continuous Time Filters:**

**High-Performance CMOS Continuous-Time Filters** José Silva-Martínez, Michiel Steyaert, Willy M.C.

Sansen, 2013-03-09 High Performance CMOS Continuous Time Filters is devoted to the design of CMOS continuous time filters CMOS is employed because the most complex integrated circuits have been realized with this technology for two decades The most important advantages and drawbacks of continuous time filters are clearly shown The transfer function is one of the most important filter parameters but several others like intermodulation distortion power supply rejection ratio noise level and dynamic range are fundamental in the design of high performance systems Special attention is paid to the practical aspects of the design which shows the difference between an academic design and an industrial design A clear understanding of the behavior of the circuits and techniques is preferred over complex equations or interpretation of simulated results Step by step design procedures are very often used to clarify the use of the techniques and topologies The organization of this text is hierarchical starting with the design consideration of the basic building blocks and ending with the design of several high performance continuous time filters Most of the circuits have been fabricated theoretically analyzed and simulated and silicon measurement results are compared with each other High Performance CMOS Continuous Time Filters can be used as a text book for senior or graduate courses on this topic and can also be useful for industrial engineers as a reference book

**Low-Power High-Resolution Analog to Digital Converters** Amir Zjajo, José Pineda de

Gyvez, 2010-10-29 With the fast advancement of CMOS fabrication technology more and more signal processing functions are implemented in the digital domain for a lower cost lower power consumption higher yield and higher re configurability This has recently generated a great demand for low power low voltage A D converters that can be realized in a mainstream deep submicron CMOS technology However the discrepancies between lithography wavelengths and circuit feature sizes are increasing Lower power supply voltages significantly reduce noise margins and increase variations in process device and design parameters Consequently it is steadily more difficult to control the fabrication process precisely enough to maintain uniformity The inherent randomness of materials used in fabrication at nanoscopic scales means that performance will be increasingly variable not only from die to die but also within each individual die Parametric variability will be compounded by degradation in nanoscale integrated circuits resulting in instability of parameters over time eventually leading to the development of faults Process variation cannot be solved by improving manufacturing tolerances variability must be reduced by new device technology or managed by design in order for scaling to continue Similarly within die performance variation also imposes new challenges for test methods In an attempt to address these issues Low Power High Resolution Analog to Digital Converters specifically focus on i improving the power efficiency for the high speed and low spurious spectral A D conversion performance by exploring the potential of low voltage analog design and calibration techniques respectively and ii development of circuit techniques and algorithms to enhance testing and debugging potential to detect errors dynamically to

isolate and confine faults and to recover errors continuously The feasibility of the described methods has been verified by measurements from the silicon prototypes fabricated in standard 180nm 90nm and 65nm CMOS technology *Top-Down Design of High-Performance Sigma-Delta Modulators* Fernando Medeiro,Belén Pérez-Verdú,Angel

Rodríguez-Vázquez,1998-11-30 The interest for  $\Delta$  modulation based NO converters has significantly increased in the last years The reason for that is twofold On the one hand unlike other converters that need accurate building blocks to obtain high resolution  $\Delta$  converters show low sensitivity to the imperfections of their building blocks This is achieved through extensive use of digital signal processing a desirable feature regarding the implementation of NO interfaces in mainstream CMOS technologies which are better suited for implementing fast dense digital circuits than accurate analog circuits On the other hand the number of applications with industrial interest has also grown In fact starting from the earliest in the audio band today we can find  $\Delta$  converters in a large variety of NO interfaces ranging from instrumentation to communications These advances have been supported by a number of research works that have lead to a considerably large amount of published papers and books covering different sub topics from purely theoretical aspects to architecture and circuit optimization However so much material is often difficultly digested by those unexperienced designers who have been committed to developing a  $\Delta$  converter mainly because there is a lack of methodology In our view a clear methodology is necessary in  $\Delta$  modulator design because all related tasks are rather hard **Low Power and Low Voltage Circuit Design**

**with the FGMOS Transistor** Esther Rodriguez-Villegas,2006-10-02 Motivated by consumer demand for smaller more portable electronic devices that offer more features and operate for longer on their existing battery packs cutting edge electronic circuits need to be ever more power efficient For the circuit designer this requires an understanding of the latest low voltage and low power LV LP techniques one of the most promising of which makes use of the floating gate MOS FGMOS transistor Advances in Solid State Circuit Technologies Paul Chu,2010-04-01 This book brings together contributions from experts in the fields to describe the current status of important topics in solid state circuit technologies It consists of 20 chapters which are grouped under the following categories general information circuits and devices materials and characterization techniques These chapters have been written by renowned experts in the respective fields making this book valuable to the integrated circuits and materials science communities It is intended for a diverse readership including electrical engineers and material scientists in the industry and academic institutions Readers will be able to familiarize themselves with the latest technologies in the various fields **Continuous-Time Sigma-Delta A/D Conversion** Friedel

Gerfers,Maurits Ortmanns,2006-02-27 Sigma delta A D converters are a key building block in wireless and multimedia applications This comprehensive book deals with all relevant aspects arising during the analysis design and simulation of the now widespread continuous time implementations of sigma delta modulators The results of several years of research by the authors in the field of CT sigma delta modulators are covered including the analysis and modeling of different CT modulator

architectures CT DT loop filter synthesis a detailed error analysis of all components and possible compensation correction schemes for the non ideal behavior in CT sigma delta modulators Guidance for obtaining low power consumption and several practical implementations are also presented It is shown that all the proposed new theories architectures and possible correction techniques have been confirmed by measurements on discrete or integrated circuits Quantitative results are also provided thus enabling prediction of the resulting accuracy

#### **Cognitive Radio Receiver Front-Ends** Bodhisatwa

Sadhu,Ramesh Harjani,2013-10-11 This book focuses on the architecture and circuit design for cognitive radio receiver front ends The authors first provide a holistic explanation of RF circuits for cognitive radio systems This is followed by an in depth exploration of existing techniques that can be utilized by circuit designers Coverage also includes novel circuit techniques and architectures that can be invaluable for designers for cognitive radio systems

#### **Trade-Offs in Analog Circuit Design**

Chris Toumazou,George S. Moschytz,Barrie Gilbert,2007-05-08 As the frequency of communication systems increases and the dimensions of transistors are reduced more and more stringent performance requirements are placed on analog circuits This is a trend that is bound to continue for the foreseeable future and while it does understanding performance trade offs will constitute a vital part of the analog design process It is the insight and intuition obtained from a fundamental understanding of performance conflicts and trade offs that ultimately provides the designer with the basic tools necessary for effective and creative analog design Trade offs in Analog Circuit Design which is devoted to the understanding of trade offs in analog design is quite unique in that it draws together fundamental material from and identifies interrelationships within a number of key analog circuits The book covers ten subject areas Design methodology Technology General Performance Filters Switched Circuits Oscillators Data Converters Transceivers Neural Processing and Analog CAD Within these subject areas it deals with a wide diversity of trade offs ranging from frequency dynamic range and power gain bandwidth speed dynamic range and phase noise to tradeoffs in design for manufacture and IC layout The book has by far transcended its original scope and has become both a designer s companion as well as a graduate textbook An important feature of this book is that it promotes an intuitive approach to understanding analog circuits by explaining fundamental relationships and in many cases providing practical illustrative examples to demonstrate the inherent basic interrelationships and trade offs Trade offs in Analog Circuit Design draws together 34 contributions from some of the world s most eminent analog circuits and systems designers to provide for the first time a comprehensive text devoted to a very important and timely approach to analog circuit design

#### **Analog Circuit Design** Arthur H.M. van Roermund,Herman Casier,Michiel Steyaert,2009-12-01

Analog Circuit Design contains the contribution of 18 tutorials of the 18th workshop on Advances in Analog Circuit Design Each part discusses a specific to date topic on new and valuable design ideas in the area of analog circuit design Each part is presented by six experts in that field and state of the art information is shared and overviewed This book is number 18 in this successful series of Analog Circuit Design providing valuable information and excellent overviews of Smart Data Converters

Chaired by Prof Arthur van Roermund Eindhoven University of Technology Filters on Chip Chaired by Herman Casier AMI Semiconductor Fellow Multimode Transmitters Chaired by Prof M Steyaert Catholic University Leuven Analog Circuit Design is an essential reference source for analog circuit designers and researchers wishing to keep abreast with the latest development in the field The tutorial coverage also makes it suitable for use in an advanced design

**Neuromorphic Systems Engineering** Tor Sverre Lande, 2007-08-26 Neuromorphic Systems Engineering Neural Networks in Silicon emphasizes three important aspects of this exciting new research field The term neuromorphic expresses relations to computational models found in biological neural systems which are used as inspiration for building large electronic systems in silicon By adequate engineering these silicon systems are made useful to mankind Neuromorphic Systems Engineering Neural Networks in Silicon provides the reader with a snapshot of neuromorphic engineering today It is organized into five parts viewing state of the art developments within neuromorphic engineering from different perspectives Neuromorphic Systems Engineering Neural Networks in Silicon provides the first collection of neuromorphic systems descriptions with firm foundations in silicon Topics presented include large scale analog systems in silicon neuromorphic silicon auditory ear and vision eye systems in silicon learning and adaptation in silicon merging biology and technology micropower analog circuit design analog memory analog interchipcommunication on digital buses LIST Neuromorphic Systems Engineering Neural Networks in Silicon serves as an excellent resource for scientists researchers and engineers in this emerging field and may also be used as a text for advanced courses on the subject

**Symbolic Analysis in Analog Integrated Circuit Design** Henrik Floberg, 2012-12-06 Symbolic Analysis in Analog Integrated Circuit Design provides an introduction to computer aided circuit analysis and presents systematic methods for solving linear i e small signal and nonlinear circuit problems which are illustrated by concrete examples Computer aided symbolic circuit analysis is useful in analog integrated circuit design Analytic expressions for the network transfer functions contain information that is not provided by a numerical simulation result However these expressions are generally extremely long and difficult to interpret therefore it is necessary to be able to approximate them guided by the magnitude of the individual circuit parameters Engineering has been described as the art of making approximations The inclusion of symbolic analysis in analog circuit design reduces the implied risk of ambiguity during the approximation process A systematic method based on the nullor concept is used to obtain the basic feedback transistor amplifier configurations Approximate expressions for the locations of poles and zeros for linear networks are obtained using the extended pole splitting technique An unusual feature in Symbolic Analysis in Analog Integrated Circuit Design is the consistent use of the transadmittance element with finite linear or nonlinear or infinite i e nullor gain as the only requisite circuit element The describing function method is used to obtain approximate symbolic expressions for the harmonic distortion generated by a soft or hard transconductance nonlinearity embedded in an arbitrary linear network The design and implementation of a program i e CASCA for symbolic analysis of time continuous networks is described The

algorithms can also be used to solve other linear problems e.g the analysis of time discrete switched capacitor networks Symbolic Analysis in Analog Integrated Circuit Design serves as an excellent resource for students and researchers as well as for industry designers who want to familiarize themselves with circuit analysis This book may also be used for advanced courses on the subject Design of Modulators for Oversampled Converters Feng Wang, Ramesh Harjani, 2012-12-06

Oversampled A/D converters have become very popular in recent years Some of their advantages include relaxed requirements for anti alias filters relaxed requirements for component matching high resolution and compatibility with digital VLSI technology There is a significant amount of literature discussing the principle theory and implementation of various oversampled converters Such converters are likely to continue to proliferate in the foreseeable future Additionally more recently there has been great interest in low voltage and low power circuit design New design techniques have been proposed for both the digital domain and the analog domain Both trends point to the importance of the low power design of oversampled A/D converters Unfortunately there has been no systematic study of the optimal design of modulators for oversampled converters Design has generally focused on new architectures with little attention being paid to optimization The goal of Design of Modulators for Oversampled Converters is to develop a methodology for the optimal design of modulators in oversampled converters The primary focus of the presentation is on minimizing power consumption and understanding and limiting the nonlinearities that result in such converters Design of Modulators for Oversampled Converters offers a quantitative justification for the various design tradeoffs and serves as a guide for designing low power highly linear oversampled converters Design of Modulators for Oversampled Converters will serve as a valuable guide for circuit design practitioners university researchers and graduate students who are interested in this fast moving area

*Low-Voltage Low-Power Analog Integrated Circuits* Wouter A. Serdijn, 2012-12-06 Low Voltage Low Power Analog Integrated Circuits brings together in one place important contributions and state of the art research results in this rapidly advancing area Low Voltage Low Power Analog Integrated Circuits serves as an excellent reference providing insight into some of the most important issues in the field Analog Layout Generation for Performance and Manufacturability Koen Lampaert, Georges Gielen, Willy M.C. Sansen, 2013-04-18 Analog integrated circuits are very important as interfaces between the digital parts of integrated electronic systems and the outside world A large portion of the effort involved in designing these circuits is spent in the layout phase Whereas the physical design of digital circuits is automated to a large extent the layout of analog circuits is still a manual time consuming and error prone task This is mainly due to the continuous nature of analog signals which causes analog circuit performance to be very sensitive to layout parasitics The parasitic elements associated with interconnect wires cause loading and coupling effects that degrade the frequency behaviour and the noise performance of analog circuits Device mismatch and thermal effects put a fundamental limit on the achievable accuracy of circuits For successful automation of analog layout advanced place and route tools that can handle these critical parasitics

are required In the past automatic analog layout tools tried to optimize the layout without quantifying the performance degradation introduced by layout parasitics Therefore it was not guaranteed that the resulting layout met the specifications and one or more layout iterations could be needed In Analog Layout Generation for Performance and Manufacturability the authors propose a performance driven layout strategy to overcome this problem In this methodology the layout tools are driven by performance constraints such that the final layout with parasitic effects still satisfies the specifications of the circuit The performance degradation associated with an intermediate layout solution is evaluated at runtime using predetermined sensitivities In contrast with other performance driven layout methodologies the tools proposed in this book operate directly on the performance constraints without an intermediate parasitic constraint generation step This approach makes a complete and sensible trade off between the different layout alternatives possible at runtime and therefore eliminates the possible feedback route between constraint derivation placement and layout extraction Besides its influence on the performance layout also has a profound impact on the yield and testability of an analog circuit In Analog Layout Generation for Performance and Manufacturability the authors outline a new criterion to quantify the detectability of a fault and combine this with a yield model to evaluate the testability of an integrated circuit layout They then integrate this technique with their performance driven routing algorithm to produce layouts that have optimal manufacturability while still meeting their performance specifications Analog Layout Generation for Performance and Manufacturability will be of interest to analog engineers researchers and students

*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

**VLSI – Compatible Implementations for Artificial Neural Networks** Sied Mehdi Fakhraie, Kenneth C. Smith, 2012-12-06 This book introduces several state of the art VLSI implementations of artificial neural networks ANNs It reviews various hardware approaches to ANN implementations analog digital and pulse coded The



analog approach is emphasized as the main one taken in the later chapters of the book. The area of VLSI implementation of ANNs has been progressing for the last 15 years but not at the fast pace originally predicted. Several reasons have contributed to the slow progress with the main one being that VLSI implementation of ANNs is an interdisciplinary area where only a few researchers, academics and graduate students are willing to venture. The work of Professors Fakhraie and Smith presented in this book is a welcome addition to the state of the art and will greatly benefit researchers and students working in this area. Of particular value is the use of experimental results to backup extensive simulations and in depth modeling. The introduction of a synapse MOS device is novel. The book applies the concept to a number of applications and guides the reader through more possible applications for future work. I am confident that the book will benefit a potentially wide readership. M. I. Elmasry, University of Waterloo, Waterloo, Ontario, Canada.

**Preface Neural Networks** NNs generally defined as parallel networks that employ a large number of simple processing elements to perform computation in a distributed fashion have attracted a lot of attention in the past fifty years. As the result many new discoveries have been made.

Switched-Current Design and Implementation of Oversampling A/D Converters Nianxiong Tan, 2012-12-06

Switched Current Design and Implementation of Oversampling A/D Converters discusses the switched current SI technique and its application in oversampling A/D converters design. The SI technique is an analog sampled data technique that fully exploits the digital CMOS process. Compared with the traditional switched capacitor SC technique the SI technique has both pros and cons that are highlighted in the book. With the consideration of similarity and difference of SI and SC techniques oversampling A/D converter architectures are tailored and optimized for SI design and implementation in the book. Switched Current Design and Implementation of Oversampling A/D Converters emphasizes the practical aspects of SI circuits without tedious mathematical derivations and is full of circuit design and implementation examples. There are more than 10 different chips included in the book demonstrating the high speed over 100 MHz and ultra low voltage 1.2 V operation of SI circuits and systems in standard digital CMOS processes. Therefore the book is of special value as a practical guide for designing SI circuits and SI oversampling A/D converters. Switched Current Design and Implementation of Oversampling A/D Converters serves as an excellent reference for analog designers especially A/D converter designers and is of interest to digital designers for real time signal processing who need A/D interfaces. The book may also be used as a text for advanced courses on the subject.

Characterization Methods for Submicron MOSFETs Hisham Haddara, 2012-12-06

It is true that the Metal Oxide Semiconductor Field Effect Transistor MOSFET is a key component in modern microelectronics. It is also true that there is a lack of comprehensive books on MOSFET characterization in general. However there is more than that as to the motivation and reasons behind writing this book. During the last decade device physicists, researchers and engineers have been continuously faced with new elements which made the task of MOSFET characterization more and more crucial as well as difficult. The progressive miniaturization of devices has caused several phenomena to emerge and modify the performance of

scaled down MOSFETs Localized degradation induced by hot carrier injection and Random Telegraph Signal RTS noise generated by individual traps are examples of these phenomena Therefore it was inevitable to develop new models and new characterization methods or at least adapt the existing ones to cope with the special nature of these new phenomena The need for more deep and extensive characterization of MOSFET parameters has further increased as the applications of this device have gained ground in many new fields in which its performance has become more and more sensitive to the properties of its Si/SiO<sub>2</sub> interface MOS transistors have crossed the borders of high speed electronics where they operate at GHz frequencies Moreover MOSFETs are now widely employed in the subthreshold regime in neural circuits and biomedical applications

*Modeling and Simulation of Mixed Analog-Digital Systems* B. Antao, 2012-12-06 Modeling and Simulation of Mixed Analog Digital Systems brings together in one place important contributions and state of the art research results in this rapidly advancing area Modeling and Simulation of Mixed Analog Digital Systems serves as an excellent reference providing insight into some of the most important issues in the field

**Implantable Sensors and Systems** Guang-Zhong Yang, 2018-03-27 Implantable sensing whether used for transient or long term monitoring of in vivo physiological bio electrical bio chemical and metabolic changes is a rapidly advancing field of research and development Underpinned by increasingly small smart and energy efficient designs they become an integral part of surgical prostheses or implants for both acute and chronic conditions supporting optimised context aware sensing feedback or stimulation with due consideration of system level impact From sensor design fabrication on node processing with application specific integrated circuits to power optimisation wireless data paths and security this book provides a detailed explanation of both the theories and practical considerations of developing novel implantable sensors Other topics covered by the book include sensor embodiment and flexible electronics implantable optical sensors and power harvesting Implantable Sensors and Systems from Theory to Practice is an important reference for those working in the field of medical devices The structure of the book is carefully prepared so that it can also be used as an introductory reference for those about to enter into this exciting research and developing field

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