

**SELECTIVE
LINEAR-PHASE
SWITCHED-CAPACITOR
AND DIGITAL FILTERS**

Hussein Baher

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Selective Linear Phase Switched Capacitor And Digital Filters

**Vincenzo Peluso, Michiel Steyaert, Willy
M.C. Sansen**



Selective Linear Phase Switched Capacitor And Digital Filters:

Selective Linear-Phase Switched-Capacitor and Digital Filters Hussein Baher, 2012-12-06 Modern high capacity communication systems require filters with simultaneous good amplitude and phase responses Selective Linear Phase Switched Capacitor and Digital Filters is the first coherent treatment of selective linear phase switched capacitor filters written by a leading international authority on the subject Digital realizations of the same characteristics are also treated In both cases emphasis is laid on optimal low sensitivity structures a highly desirable attribute from the practical view point With the increasing interest in high frequency switched capacitor filters the range of operation reaches a point where the phase response becomes a major design consideration thus heightening the importance of this book Selective Linear Phase Switched Capacitor and Digital Filters is an invaluable reference for electronic circuit design engineers and researchers as well as graduate students and may be used as a text for an advanced course on the subject **Analog and Digital Signal**

Processing Professor Hussein Baher, 2001-10-15 Building on the success of the first edition this popular text book has now been updated and revised Covering both analog and digital signal processing techniques in an evenly balanced manner Professor Baher provides an excellent introductory and comprehensive text emphasising how analog and digital techniques complement each other rather than compete Brings the entire area of signal processing within the scope of modern undergraduate curricula Discusses topics such as spectral analysis of continuous and discrete signals deterministic and random Fourier Laplace and z transforms analysis of continuous and discrete systems and circuits design of analog and digital filters fast Fourier transform algorithms and finite word length effects in digital processors Presents a final chapter on advanced signal processing including linear estimation adaptive filters over sampling sigma delta converters and wavelets to encourage further interest Contains numerous solved examples throughout and MATLAB exercises at the end of each chapter Written primarily for undergraduates Analog Digital Signal Processing will also be an authoritative text for postgraduate students and professional engineers *Integrated Analog-To-Digital and Digital-To-Analog Converters* Rudy J. van de Plassche, 2012-12-06 Analog to digital A/D and digital to analog D/A converters provide the link between the analog world of transducers and the digital world of signal processing computing and other digital data collection or data processing systems Several types of converters have been designed each using the best available technology at a given time for a given application For example high performance bipolar and MOS technologies have resulted in the design of high resolution or high speed converters with applications in digital audio and video systems In addition high speed bipolar technologies enable conversion speeds to reach the gigaHertz range and thus have applications in HDTV and digital oscilloscopes Integrated Analog to Digital and Digital to Analog Converters describes in depth the theory behind and the practical design of these circuits It describes the different techniques to improve the accuracy in high resolution A/D and D/A converters and also special techniques to reduce the number of elements in high speed A/D converters by repetitive use of comparators

Integrated Analog to Digital and Digital to Analog Converters is the most comprehensive book available on the subject Starting from the basic elements of theory necessary for a complete understanding of the design of A/D and D/A converters this book describes the design of high speed A/D converters high accuracy D/A and A/D converters sample and hold amplifiers voltage and current reference sources noise shaping coding and sigma delta converters Integrated Analog to Digital and Digital to Analog Converters contains a comprehensive bibliography and index and also includes a complete set of problems This book is ideal for use in an advanced course on the subject and is an essential reference for researchers and practicing engineers

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

Digital Filters Using MATLAB Lars Wanhammar, Tapio Saramäki, 2020-02-18 This textbook provides comprehensive coverage for courses in the basics of design and implementation of digital filters The book assumes only basic knowledge in digital signal processing and covers state of the art methods for digital filter design and provides a simple route for the readers to design their own filters The advanced mathematics that is required for the filter design is minimized by providing an extensive MATLAB toolbox with over 300 files The book presents over 200 design examples with MATLAB code and over 300 problems to be solved by the reader The students can design and modify the code for their use The book and the design examples cover almost all known design methods of frequency selective digital filters as well as some of the authors own unique techniques

Signal Processing and Integrated Circuits Hussein Baher, 2012-03-06 This book provides a balanced account of analog digital and mixed mode signal processing with applications in telecommunications Part I Perspective gives an overview of the areas of Systems on a Chip Soc and mobile communication which are used to demonstrate the complementary relationship between analog and digital systems Part II

Analog continuous time and Digital Signal Processing contains both fundamental and advanced analysis and design techniques of analog and digital systems This includes analog and digital filter design fast Fourier transform FFT algorithms stochastic signals linear estimation and adaptive filters Part III Analog MOS Integrated Circuits for Signal Processing covers basic MOS transistor operation and fabrication through to the design of complex integrated circuits such as high performance Op Amps Operational Transconductance Amplifiers OTA s and Gm C circuits Part IV Switched capacitor and Mixed mode Signal Processing outlines the design of switched capacitor filters and concludes with sigma delta data converters as an extensive application of analog and digital signal processing Contains the fundamentals and advanced techniques of continuous time and discrete time signal processing Presents in detail the design of analog MOS integrated circuits for signal processing with application to the design of switched capacitor filters Uses the comprehensive design of integrated sigma delta data converters to illustrate and unify the techniques of signal processing Includes solved examples end of chapter problems and MATLAB throughout the book to help readers understand the mathematical complexities of signal processing The treatment of the topic is at the senior undergraduate to graduate and professional levels with sufficient introductory material for the book to be used as a self contained reference

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

Analog Interfaces for Digital Signal Processing Systems Frank op 't Eynde, Willy M.C. Sansen, 2012-12-06 It is a great honor to provide an introduction for Dr Frank Op t Eynde s and Dr Willy Sansen s book Analog Interfaces for Digital Signal Processing Systems The field of analog integrated circuit design is undergoing rapid evolution The pervasiveness of digital processing has considerably modified the micro system architectures the analog part of complex mixed systems is more and more pushed at the boundary limits of the processing chain Moreover the increased performance of digital circuits in terms of accuracy and speed are making the specification requirements of analog circuits very strict In addition to this the technology supply voltage and power consumption of analog circuits must be compatible with those typical for digital circuits Therefore in a few words analog circuits are becoming complex and specialised interfaces between the real world and digital signal processing domains This technological evolution should be accompanied by an equivalently fast evolution in designer competencies Knowledge of complicated signal handling should be quickly replaced by know how of simple but very accurate and very fast signal processing and a solid background in data conversion techniques All of this through the use of the CMOS and possibly BiCMOS technology

Analysis and Synthesis of MOS Translinear Circuits Remco J. Wiegerink, 2012-12-06 This book has its roots in an idea first formulated by Barrie Gilbert in 1975 He showed how bipolar analog circuits can realize nonlinear and computational functions This extended the analog art

from linear to nonlinear applications hence the name trans linear circuits Not only did this new principle enable marvellous signal processing functions to be accurately implemented but also the circuits were simple and practical The perennial problems of analog IC design namely temperature sensitivity processing speed device nonlinearity and parasitic capacitance were solved to a large extent Using the trans linear principle in circuit design requires changing your point of view in two ways First the grossly nonlinear characteristic of transistors is viewed as an asset rather than as a harmful property Second no longer are the signals represented by voltages but by currents In fact the attendant voltage changes are distorted but as they are very small they are only of secondary interest Understanding and analyzing a given trans linear circuit is fairly straightforward But what about the converse situation suppose you are given some nonlinear or computational function to implement How to find a suitable translinear circuit realization The general problem of analog circuit synthesis is a difficult one and is receiving much attention nowadays Some years ago I had the opportunity to investigate methods for designing bipolar trans linear circuits It turned out that translinear networks have some unique topological properties Using these properties it was possible to establish heuristic synthesis procedures

Dynamic Translinear and Log-Domain Circuits

Jan Mulder, Wouter A. Serdijn, Albert C. van der Woerd, Arthur H.M. van Roermund, 2012-12-06 Log domain and translinear filters provide a competitive alternative to the challenges of ever increasing low voltage low power and high frequency demands in the area of continuous time filters Since translinear filters are fundamentally large signal linear they are capable of realizing a large dynamic range in combination with excellent tunability characteristics Large signal linearity is achieved by exploiting the accurate exponential behavior of the bipolar transistor or the subthreshold MOS transistor A generalization of the dynamic translinear principle exploiting the square law behavior of the MOS transistor is theoretically possible but not practically relevant Translinear and log domain filters are based on the dynamic translinear principle a generalization of the conventional static translinear principle Besides their application for linear filters dynamic translinear circuits can also be used for the realization of non linear dynamic functions such as oscillators RMS DC converters and phase locked loops Dynamic Translinear and Log Domain Circuits Analysis and Synthesis covers both the analysis and synthesis of translinear circuits The theory is presented using one unifying framework for both static and dynamic translinear networks which is based on a current mode approach General analysis methods are presented including the large signal and non stationary analysis of noise A well structured synthesis method is described greatly enhancing the designability of log domain and translinear circuits Comparisons are made with respect to alternative analysis and synthesis methods presented in the literature The theory is illustrated and verified by various examples and realizations Dynamic Translinear and Log Domain Circuits Analysis and Synthesis is an excellent reference for researchers and circuit designers and may be used as a text for advanced courses on the topic

Integrated Video-Frequency Continuous-Time Filters

Scott D. Willingham, Kenneth W. Martin, 2012-12-06 Advances in the state of the art mean the signal processing ICs of ever increasing complexity are being

introduced While the typical portion of a large IC devoted to analog circuits has diminished the performance of those surviving analog signal processing circuits remains vital and their design challenging Moreover the emerging high definition TV technology has created a new area for IC development one with formidable signal processing requirements The antialiasing filters needed for one proposed HDTV decoder motivated the research documented in this book Sharply selective filters place tight constraints on the permitted excess phase shifts of their constituent circuits Combined with stringent requirements for low distortion at video frequencies these constraints challenge the IC filter designer Integrated Video Frequency Continuous Time Filters High Performance Realizations in BiCMOS deals with what is arguably the mainstay of analog signal processing circuits Prominent applications in computer disk drive read channels video receivers rf circuits and antialiasing and reconstruction in data converters testifies to their importance Moreover they are excellent benchmarks for more general analog signal processors Bipolar and MOSFET transistors freely combined at the lowest circuit levels provide the designer with an opportunity to develop potent variations on the standard idioms The book considers the general principles of BiCMOS circuit design through to a demanding design problem This case study approach allows a concrete discussion of the justification for and practical trade offs of each design decision Audience A reference work for experienced IC designers and a text for advanced IC design students

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

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

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

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

Compact Low-Voltage and High-Speed CMOS, BiCMOS and Bipolar Operational Amplifiers Klaas-Jan de Langen, Johan Huijsing, 2013-03-14 Compact Low Voltage and High Speed CMOS BiCMOS and Bipolar Operational Amplifiers discusses the design of integrated operational amplifiers that approach the limits of low supply voltage or very high bandwidth The resulting realizations span the whole field of applications from micro power CMOS VLSI amplifiers to 1 GHz bipolar amplifiers The book presents efficient circuit topologies in order to combine high performance with simple solutions In total twelve amplifier realizations are discussed Two bipolar amplifiers are discussed a 1 GHz operational amplifier and an amplifier with a high ratio between the maximum output current and the quiescent current Five amplifiers have been designed in CMOS technology extremely compact circuits that can operate on supply voltages down to one gate source voltage and two saturation voltages which equals about 1.4 V and ultimate low voltage amplifiers that can operate on supply voltages down to one gate source voltage and one saturation voltage which amounts to about 1.2 V In BiCMOS technology five amplifiers have been designed The first two amplifiers are based on a compact topology Two other amplifiers are designed to operate on low supply voltages down to 1.3 V The final amplifier has a unity gain frequency of 200 MHz and can operate down to 2.5 V Compact Low Voltage and High Speed CMOS BiCMOS and Bipolar Operational Amplifiers is intended for the professional analog designer Also it is suitable as a text book for advanced courses in amplifier design

Design of Low-Voltage Low-Power CMOS Delta-Sigma A/D Converters Vincenzo Peluso, Michiel Steyaert, Willy M.C. Sansen, 2013-03-09 Design of Low Voltage Low Power CMOS Delta Sigma A/D Converters investigates the feasibility of designing Delta Sigma Analog to Digital Converters for very low supply voltage lower than 1.5 V and low power operation in standard CMOS processes The chosen technique of implementation is the Switched Opamp Technique which provides Switched Capacitor operation at low supply voltage without the need to apply voltage multipliers or low V_t MOST devices A method of implementing the classic single loop and cascaded Delta Sigma modulator topologies with half delay integrators is presented Those topologies are studied in order to find the parameters that maximise the performance in terms of peak SNR Based on a linear model the performance degradations of higher order single loop and

cascaded modulators compared to a hypothetical ideal modulator are quantified An overview of low voltage Switched Capacitor design techniques such as the use of voltage multipliers low V_t MOST devices and the Switched Opamp Technique is given An in depth discussion of the present status of the Switched Opamp Technique covers the single ended Original Switched Opamp Technique the Modified Switched Opamp Technique which allows lower supply voltage operation and differential implementation including common mode control techniques The restrictions imposed on the analog circuits by low supply voltage operation are investigated Several low voltage circuit building blocks some of which are new are discussed A new low voltage class AB OTA especially suited for differential Switched Opamp applications together with a common mode feedback amplifier and a comparator are presented and analyzed As part of a systematic top down design approach the non ideal charge transfer of the Switched Opamp integrator cell is modeled based upon several models of the main opamp non ideal characteristics Behavioral simulations carried out with these models yield the required opamp specifications that ensure that the intended performance is met in an implementation A power consumption analysis is performed The influence of all design parameters especially the low power supply voltage is highlighted Design guidelines towards low power operation are distilled Two implementations are presented together with measurement results The first one is a single ended implementation of a Delta Sigma ADC operating with 1.5V supply voltage and consuming 100 μ W for a 74 dB dynamic range in a 3.4 kHz bandwidth The second implementation is differential and operates with 900 mV It achieves 77 dB dynamic range in 16 kHz bandwidth and consumes 40 μ W Design of Low Voltage Low Power CMOS Delta Sigma A/D Converters is essential reading for analog design engineers and researchers

Top-Down Design of High-Performance Sigma-Delta Modulators Fernando Medeiro, Belén Pérez Verdú, Angel Rodríguez-Vázquez, 2013-04-18 The interest for I 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 I 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 I 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 I converter mainly because there is a lack of methodology In our view a clear methodology is necessary in I modulator design because all related tasks are rather hard

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.

Frequency Compensation Techniques for Low-Power Operational Amplifiers Rudy G.H. Eschauzier, Johan Huijsing, 2013-04-17. Frequency Compensation Techniques for Low Power Operational Amplifiers is intended for professional designers of integrated amplifiers emphasizing low voltage and low power solutions. The book bridges the gap between the professional designer's needs and available techniques for frequency compensation. It does so by explaining existing techniques and introducing several new techniques including Hybrid Nested Miller compensation, Multipath Miller Zero cancellation and Multipath Conditionally Stable compensation. All compensation techniques are treated in a stage number based order progressing from a single transistor to circuits with six stages and more. Apart from discussing the mathematical basis of the compensation methods, the book provides the reader with the factual information that is required for practicing the design of integrated feedback amplifiers and many worked out examples. What is more, many bipolar and CMOS operational amplifier realizations along with their measurement results prove the effectiveness of the compensation techniques in real life circuits. The text focuses on low voltage low power integrated amplifiers. Many of the presented bipolar circuits operate at supply voltages down to 1V while several CMOS amplifiers that function correctly just slightly above this voltage are demonstrated. The lowest measured power consumption amounts to 17μW for a class AB CMOS opAmp with 120dB gain. Despite this attention to low voltage and low power, the frequency compensation strategies provided are universally applicable. The fundamental approach followed leads to efficient compensation strategies that are well guarded against the parameter variations inherent to the mass fabrication of integrated circuits. The book is essential reading for practicing analog design engineers and researchers in the field. It is also suitable as a text for an advanced course on the subject.

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