
CHARACTERIZATION METHODS FOR SUBMICRON MOSFETs

Characterization Methods For Submicron Mosfets

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



Characterization Methods For Submicron Mosfets:

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/SiO₂ 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

Characterization Methods for Submicron Mosfets Hisham Haddara, 1996-01-31 The Metal Oxide Semiconductor Field Effect Transistor MOSFET is a key component in modern microelectronics During the last decade device physicists researchers and engineers have been continuously faced with new elements making the task of MOSFET characterization increasingly crucial as well as more 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 It was thus unavoidable 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 Characterization Methods for Submicron MOSFETs deals with techniques which show high potential for characterization of submicron devices Throughout the book the focus is on the adaptation of such methods to resolve measurement problems relevant to VLSI devices and new materials especially Silicon on Insulator SOI Characterization Methods for Submicron MOSFETs was written to provide help to device engineers and researchers to enable them to cope with the challenges they face Without adequate device characterization new physical phenomena and new types of defects or damage may not be well identified or dealt with leading to an undoubted obstruction of the device development cycle Audience Researchers and graduate students familiar with MOS device physics working in the field of device characterization and modeling Also intended for industrial engineers working in device development seeking to enlarge their understanding of measurement methods The book additionally addresses device based characterization for material and

process engineers and for circuit designers A valuable reference that may be used as a text for advanced courses on the subject

CMOS RF Modeling, Characterization and Applications M. Jamal Deen, Tor A. Fjeldly, 2002 CMOS technology has now reached a state of evolution in terms of both frequency and noise where it is becoming a serious contender for radio frequency RF applications in the GHz range Cutoff frequencies of about 50 GHz have been reported for 0.18 μ m CMOS technology and are expected to reach about 100 GHz when the feature size shrinks to 100 nm within a few years This translates into CMOS circuit operating frequencies well into the GHz range which covers the frequency range of many of today's popular wireless products such as cell phones GPS Global Positioning System and Bluetooth Of course the great interest in RF CMOS comes from the obvious advantages of CMOS technology in terms of production cost high level integration and the ability to combine digital analog and RF circuits on the same chip This book discusses many of the challenges facing the CMOS RF circuit designer in terms of device modeling and characterization which are crucial issues in circuit simulation and design

Leakage Current and Defect Characterization of Short Channel MOSFETs Guntrade Roll, 2012 The continuous improvement in semiconductor technology requires field effect transistor scaling while maintaining acceptable leakage currents This study analyzes the effect of scaling on the leakage current and defect distribution in peripheral DRAM transistors The influence of important process changes such as the high k gate patterning and encapsulation as well as carbon co implants in the source drain junction are investigated by advanced electrical measurements and TCAD simulation A complete model for the trap assisted leakage currents in the silicon bulk of the transistors is presented

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 Progress in SOI Structures and Devices Operating at Extreme Conditions Francis Balestra,Alexei N.

Nazarov,Vladimir S. Lysenko,2012-12-06 A review of the electrical properties performance and physical mechanisms of the main silicon on insulator SOI materials and devices Particular attention is paid to the reliability of SOI structures operating in harsh conditions The first part of the book deals with material technology and describes the SIMOX and ELTRAN technologies the smart cut technique SiCOI structures and MBE growth The second part covers reliability of devices operating under extreme conditions with an examination of low and high temperature operation of deep submicron MOSFETs and novel SOI technologies and circuits SOI in harsh environments and the properties of the buried oxide The third part deals with the characterization of advanced SOI materials and devices covering laser recrystallized SOI layers ultrashort SOI MOSFETs and nanostructures gated diodes and SOI devices produced by a variety of techniques The last part reviews future prospects for SOI structures analyzing wafer bonding techniques applications of oxidized porous silicon semi insulating silicon materials self organization of silicon dots and wires on SOI and some new physical phenomena Semiconductor Material and Device Characterization Dieter K. Schroder,2015-06-29 This Third Edition updates a landmark text with the latest findings The Third Edition of the internationally lauded Semiconductor Material and Device Characterization brings the text fully up to date with the latest developments in the field and includes new pedagogical tools to assist readers Not only does the Third Edition set forth all the latest measurement techniques but it also examines new interpretations and new applications of existing techniques Semiconductor Material and Device Characterization remains the sole text dedicated to characterization techniques for measuring semiconductor materials and devices Coverage includes the full range of electrical and optical characterization methods including the more specialized chemical and physical techniques Readers familiar with the previous two editions will discover a thoroughly revised and updated Third Edition including Updated and revised figures and examples reflecting the most current data and information 260 new references offering access to the latest research and discussions in specialized topics New problems and review questions at the end of each chapter to test readers understanding of the material In addition readers will find fully updated and revised sections in each chapter Plus two new chapters have been added Charge Based and Probe Characterization introduces charge based measurement and Kelvin probes This chapter also examines probe based measurements including scanning capacitance scanning Kelvin force scanning spreading resistance and ballistic electron emission microscopy Reliability and Failure Analysis examines failure times and distribution functions and discusses electromigration hot carriers gate oxide integrity negative bias temperature

instability stress induced leakage current and electrostatic discharge Written by an internationally recognized authority in the field Semiconductor Material and Device Characterization remains essential reading for graduate students as well as for professionals working in the field of semiconductor devices and materials An Instructor's Manual presenting detailed solutions to all the problems in the book is available from the Wiley editorial department

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

Distortion Analysis of Analog Integrated Circuits Piet Wambacq, Willy M.C. Sansen, 2013-04-17 The analysis and prediction of nonlinear behavior in electronic circuits has long been a topic of concern for analog circuit designers The recent explosion of interest in portable electronics such as cellular telephones cordless telephones and other applications has served to reinforce the importance of these issues The need now often arises to predict and optimize the distortion performance of diverse electronic circuit configurations operating in the gigahertz frequency range where nonlinear reactive effects often dominate However there have historically been few sources available from which design engineers could obtain information on analysis techniques suitable for tackling these important problems I am sure that the analog circuit design community will thus welcome this work by Dr Wambacq and Professor Sansen as a major contribution to the analog circuit design literature in the area of distortion analysis of electronic circuits I am personally looking forward to having a copy readily available for reference when designing integrated circuits for communication systems

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

Highly Linear Integrated Wideband Amplifiers Henrik Sjöland, 2012-12-06. Highly Linear Integrated Wideband Amplifiers Design and Analysis Techniques for Frequencies from Audio to RF deals with the complicated issues involved in the design of high linearity integrated wideband amplifiers for different operating frequencies. The book demonstrates these principles using a number of high performance designs. New topologies for high linearity are presented as well as a novel method for estimating the intermodulation distortion of a wideband signal. One of the most exciting results presented is an enhanced feedback configuration called feedback boosting that is capable of very low distortion. Also important is a statistical method for relating the intermodulation distortion of a wideband signal to the total harmonic distortion THD of a single tone. The THD as opposed to the intermodulation distortion of the wideband signal is easy to measure and use as a design parameter. Three different applications where high linearity is needed are identified namely audio power amplifiers wideband IF amplifiers and RF power amplifiers. For these applications high performance integrated amplifier designs using novel topologies are presented together with measurement results. The audio amplifiers are built in CMOS and are capable of driving 8 Ω loudspeaker loads directly without using any external components. One of the designs can operate on a supply voltage down to 1.5V. Both bipolar and CMOS wideband IF amplifiers are built they are fully differential and have linearity from DC to 20 MHz. Finally an RF power amplifier is built in CMOS without using inductors in order to investigate what performance can be achieved without them. Highly Linear Integrated Wideband Amplifiers Design and Analysis Techniques for Frequencies from Audio to RF is an excellent reference for researchers and designers of integrated amplifiers and may be used as a text for advanced courses on the topic.

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

CMOS Current Amplifiers Giuseppe Palmisano, Gaetano Palumbo, Salvatore Pennisi, 2012-12-06 CMOS Current Amplifiers presents design strategies for high performance current amplifiers based on CMOS technology After an introduction to various architectures of operational amplifiers the operating principles of the current amplifier are outlined This book provides the reader with simple and compact design equations for use in a pencil and paper design and the following simulation step Chapter 1 introduces the general aspects of current amplifiers After a preliminary classification of operational amplifiers ideal blocks and models are discussed for different architectures and a first high level comparison is made between traditional amplifiers and current amplifiers Analysis and examples of basic circuits as well as signal processing applications involving current amplifiers are also given Non idealities and second order effects causing limitations in performance are then discussed and evaluated Chapter 2 focuses on low drive current amplifiers Several design examples for current conveyors and class A current amplifiers are discussed in detail and design equations are presented for the main performance parameters which allows a good trade off between requirements High performance solutions for high bandwidth and low voltage capability are also considered and finally current comparators with progressively enhanced performance are reported and analyzed critically Chapter 3 deals with current amplifiers for off chip loads Several class AB current mode output stages are discussed and design strategies which improve performance are presented A detailed analysis of non ideal effect is carried out with particular emphasis on linearity Design examples are given and circuit arrangements for further developments are included CMOS Current Amplifiers serves as an excellent reference for researchers and professionals of analog IC design and may also be used as an advanced text on current amplifiers *CMOS Wireless Transceiver Design* Jan Crols, Michiel Steyaert, 2013-06-29 The world of wireless communications is changing very rapidly since a few years The introduction of digital data communication in combination with digital signal processing has created the foundation for the development of many new wireless applications High quality digital wireless networks for voice communication with global and local coverage like the GSM and DECT system are only faint and early examples of the

wide variety of wireless applications that will become available in the remainder of this decade. The new evolutions in wireless communications set new requirements for the transceivers: transmitter/receivers. Higher operating frequencies, a lower power consumption and a very high degree of integration are new specifications which ask for design approaches quite different from the classical RF design techniques. The integratability and power consumption reduction of the digital part will further improve with the continued downscaling of technologies. This is however completely different for the analog transceiver front end, the part which performs the interfacing between the antenna and the digital signal processing. The analog front end's integratability and power consumption are closely related to the physical limitations of the transceiver topology and not so much to the scaling of the used technology. Chapter 2 gives a detailed study of the level of integration in current transceiver realization and analyzes their limitations. In chapter 3 of this book, the complex signal technique for the analysis and synthesis of multi-path receiver and transmitter topologies is introduced.

Springer Handbook of Electronic and Photonic Materials Safa Kasap, Peter Capper, 2007-08-01. Electronic materials is a truly interdisciplinary subject that encompasses a number of traditional disciplines such as materials science, electrical engineering, chemical engineering, mechanical engineering, physics and chemistry. This unique handbook provides broad coverage of a wide range of electronic and photonic materials, starting from fundamentals and building up to advanced topics and applications. Its wide coverage, with clear illustrations and applications, and its chapter sequencing and logical flow make this a very useful and useable handbook. Each chapter has been prepared either by expert researchers or instructors who have been teaching the subject at a university or in corporate laboratories. Unlike other handbooks that concentrate on a narrow field and have chapters that start at an advanced level, the present handbook starts at a senior undergraduate level and builds up the subject matter in easy steps and in a logical flow. Wherever possible, the sections are logically sequenced to allow those who need a quick overview of a particular topic immediate access to it. Additional valuable features include the practical applications used as examples, details on experimental techniques, useful tables that summarize equations and most importantly, properties of various materials. Each chapter is full of clear color illustrations that convey the concepts and make the subject matter enjoyable to read and understand. An extensive glossary aids readers from adjacent fields. The Handbook constitutes an essential reference for today's electrical engineers, materials scientists and physicists.

The Design of Low-Voltage, Low-Power Sigma-Delta Modulators Shahriar Rabii, Bruce A. Wooley, 2012-12-06. Oversampling techniques based on sigma delta modulation are widely used to implement the analog/digital interfaces in CMOS VLSI technologies. This approach is relatively insensitive to imperfections in the manufacturing process and offers numerous advantages for the realization of high resolution analog-to-digital (A/D) converters in the low voltage environment that is increasingly demanded by advanced VLSI technologies and by portable electronic systems. In *The Design of Low Voltage Low Power Sigma Delta Modulators*, an analysis of power dissipation in sigma delta modulators is presented and a low voltage implementation of a

digital audio performance A D converter based on the results of this analysis is described Although significant power savings can typically be achieved in digital circuits by reducing the power supply voltage the power dissipation in analog circuits actually tends to increase with decreasing supply voltages Oversampling architectures are a potentially power efficient means of implementing high resolution A D converters because they reduce the number and complexity of the analog circuits in comparison with Nyquist rate converters In fact it is shown that the power dissipation of a sigma delta modulator can approach that of a single integrator with the resolution and bandwidth required for a given application In this research the influence of various parameters on the power dissipation of the modulator has been evaluated and strategies for the design of a power efficient implementation have been identified

The Design of Low Voltage Low Power Sigma Delta Modulators begins with an overview of A D conversion emphasizing sigma delta modulators It includes a detailed analysis of noise in sigma delta modulators analyzes power dissipation in integrator circuits and addresses practical issues in the circuit design and testing of a high resolution modulator The Design of Low Voltage Low Power Sigma Delta Modulators will be of interest to practicing engineers and researchers in the areas of mixed signal and analog integrated circuit design

Matching Properties of Deep Sub-Micron MOS Transistors Jeroen A. Croon, Willy M Sansen, Herman E. Maes, 2006-06-20 Matching Properties of Deep Sub Micron MOS Transistors examines this interesting phenomenon Microscopic fluctuations cause stochastic parameter fluctuations that affect the accuracy of the MOSFET For analog circuits this determines the trade off between speed power accuracy and yield Furthermore due to the down scaling of device dimensions transistor mismatch has an increasing impact on digital circuits The matching properties of MOSFETs are studied at several levels of abstraction A simple and physics based model is presented that accurately describes the mismatch in the drain current The model is illustrated by dimensioning the unit current cell of a current steering D A converter The most commonly used methods to extract the matching properties of a technology are bench marked with respect to model accuracy measurement accuracy and speed and physical contents of the extracted parameters The physical origins of microscopic fluctuations and how they affect MOSFET operation are investigated This leads to a refinement of the generally applied 1 area law In addition the analysis of simple transistor models highlights the physical mechanisms that dominate the fluctuations in the drain current and transconductance The impact of process parameters on the matching properties is discussed The impact of gate line edge roughness is investigated which is considered to be one of the roadblocks to the further down scaling of the MOS transistor

Matching Properties of Deep Sub Micron MOS Transistors is aimed at device physicists characterization engineers technology designers circuit designers or anybody else interested in the stochastic properties of the MOSFET

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

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 1.5V 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 1.5 V 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.

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.

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