LOW-VOLTAGE CMOS OPERATIONAL AMPLIFIERS

Theory, Design and Implementation

Low Voltage Cmos Operational Amplifiers Theory Design And Implementation Author Satoshi Sakurai Jan 1995

Giuseppe Palmisano,Gaetano Palumbo,Salvatore Pennisi

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Low-Voltage CMOS Operational Amplifiers Satoshi Sakurai,Mohammed Ismail,2012-12-06 Low Voltage CMOS Operational Amplifiers Theory Design and Implementation discusses both single and two stage architectures Opamps with constant gm input stage are designed and their excellent performance over the rail to rail input common mode range is demonstrated The first set of CMOS constant gm input stages was introduced by a group from Technische Universiteit Delft and Universiteit Twente the Netherlands These earlier versions of circuits are discussed along with new circuits developed at the Ohio State University The design fabrication MOSIS Tiny Chips and characterization of the new circuits are now complete Basic analog integrated circuit design concepts should be understood in order to fully appreciate the work presented However the topics are presented in a logical order and the circuits are explained in great detail so that Low Voltage CMOS Operational Amplifiers can be read and enjoyed by those without much experience in analog circuit design It is an invaluable reference book and may be used as a text for advanced courses on the subject *Design of Low-Voltage Bipolar Operational Amplifiers* M. Jeroen Fonderie,Johan Huijsing,1993-02-28 Design of Low Voltage Bipolar Operational Amplifiers discusses the sub circuits necessary to build a low voltage operational amplifier These include rail to rail input stages rail to rail output stages intermediate stages protection circuitry and frequency compensation techniques Of each of these various implementations are examined Furthermore the book discusses realizations in silicon of the amplifiers The design and implementation of low voltage bipolar Operational Amplifiers OpAmps is fully presented A low supply voltage is necessary because the tendency towards chip components of smaller dimensions lowers the breakdown voltage of these components Further a low supply voltage is favorable because it enables operation of the OpAmp from just one single battery cell The bipolar technology is chosen because it is more suited for operation at low voltages than the MOS technology The common mode input voltage of the OpAmp must be able to have any value that fits within the supply voltage range Input stages are discussed which are able to realize this at supply voltages down to 1 8 V as well as down to 1 V The output voltage of the OpAmp must be able to have any value within the supply voltage range One of the 1 V output stages that is discussed the multi path driven output stage also has a high bandwidth with a high gain In addition to the input and output stage the OpAmp comprises an intermediate stage between the input stage and the output stage to boost the overall gain of the OpAmp and a class AB current control A frequency compensation technique is used to split apart the pole frequencies in the transfer function A disadvantage of this nested Miller compensation is that the resulting bandwidth is reduced by a factor of two A new method multi path driven Miller compensation which does not have this drawback is therefore introduced Several realizations are evaluated and a figure of merit is defined for the performance comparison of the OpAmps One of the OpAmps operates at a 1 V supply has a 3 4 MHz bandwidth with a 100 pF load and has a 700 A supply current The book is an excellent reference for professional designers of amplifiers and may be used as a text for advanced courses on the subject

Design of Rail-to-rail CMOS Operational Amplifiers for a 3-V Supply Satoshi Sakurai,Mohammed Ismail,1994

Operational Amplifiers Johan Huijsing,2016-07-09 This proven textbook guides readers to a thorough understanding of the theory and design of operational amplifiers OpAmps The core of the book presents systematically the design of operational amplifiers classifying them into a periodic system of nine main overall configurations ranging from one gain stage up to four or more stages This division enables circuit designers to recognize quickly understand and choose optimal configurations Characterization of operational amplifiers is given by macro models and error matrices together with measurement techniques for their parameters Definitions are given for four types of operational amplifiers depending on the grounding of their input and output ports Many famous designs are evaluated in depth using a carefully structured approach enhanced by numerous figures In order to reinforce the concepts introduced and facilitate self evaluation of design skills the author includes problems with detailed solutions as well as simulation exercises 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 **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 Operational Amplifier Cells Ron Hogervorst,1996 *Investigation of Low Voltage CMOS Operational Amplifiers* Luis Madrid-Babiano,1996 *CMOS Current Amplifiers* Giuseppe Palmisano,Gaetano Palumbo,Salvatore Pennisi,1999-02-28 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

Ultra-low Voltage CMOS Operational Amplifiers Ayman Umar Shabra,1997 **Advanced Low-voltage and High-speed Techniques for BiCMOS, CMOS and Bipolar Operational Amplifiers** Klaas-Jan de Langen,1999 **Low Voltage CMOS Operational Amplifier Design Towards Maximum CMR** Chee Lam Tan,1999 *A Low-Voltage CMOS Operational Amplifier with Constant-Gm Control and Rail-to-Rail Input/Output Swings* Zheng Qi,Mohammed Imail,1995

Dynamic Offset Compensated CMOS Amplifiers Frerik Witte,Kofi Makinwa,Johan Huijsing,2009-06-29 Dynamic Offset Compensated CMOS Amplifiers describes the theory design and realization of dynamic offset compensated CMOS

amplifiers It focuses on the design of general purpose wide band operational amplifiers and instrumentation amplifiers Two offset compensation techniques are described auto zeroing and chopping Several topologies are discussed with which these techniques can be used in the design of wide band dynamic offset compensated amplifiers Four implementations are discussed in detail two low offset wide band operational amplifiers a low offset instrumentation amplifier and a low offset current sense amplifier which can sense the current drawn from supply voltages up to 28V *A Low Voltage Power CMOS Operational Amplifier* Michael K. Wong,University of California, Berkeley. Department of Electrical Engineering and Computer Sciences, **Low Voltage, Low Power CMOS Operational Amplifier Design for Switched Capacitor Circuits** Priti Manher Naik,1998 **The Design of Low - Voltage Bipolar Operational Amplifiers** Joon Son,1995 **Low Voltage CMOS Constant Transconductance Operational Amplifiers and Linear Voltage-to-Current Converters** Vikas Mehrotra,Mohammed Ismail,1995 **500mV Low-voltage Operational Amplifier Design** Jian Zhou,1997 With the dramatic increase in the number of transistors on a chip and the increasing needs for battery powered applications low voltage circuit design techniques have been widely studied in recent year However these low supply voltage research efforts have been focused mainly on digital circuits especially on high density memory circuits Reported success in achieved high performance low voltage operation in analog circuits lags far behind Recent results have been presented on CMOS low voltage operational amplifiers where the supply voltage has been reduced to less than 2 5V in which the complementary input stages were used to keep the gm constant SI95 HL85 Recently the floating gate MOS transistor has attracted considerable interest as a nonvolatile analog storage device and as a precision analog trim element because it has threshold voltage programming ability YU93 RC95 *Design of Low-Voltage Low-Power CMOS Delta-Sigma A/D Converters* Vincenzo Peluso,Michiel Steyaert,Willy Sansen,2013-02-09 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 VtMOST 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 VtMOST 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 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 W Design of Low Voltage Low Power CMOS Delta Sigma A D Converters is essential reading for analog design engineers and researchers

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Low Voltage Cmos Operational Amplifiers Theory Design And Implementation Author Satoshi Sakurai Jan 1995 Introduction

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