

# **DSP-BASED TESTING**

## **of Analog and Mixed-Signal Circuits**

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# Dsp Based Testing Of Analog And Mixed Signal Circuits

**Cheng-Ping Wang**



## **Dsp Based Testing Of Analog And Mixed Signal Circuits:**

DSP-Based Testing of Analog and Mixed-Signal Circuits Matthew Mahoney, 1987-05-11 Answers the commonly asked questions about how digital signal processing based machines work and what role DSP plays in the process It shows you how DSP performs in real test situations and uses mathematical concepts rather than derivations The text addresses difficult test problems and their solutions resulting from the union of automatic test equipment ATE and DSP The author establishes a philosophy of DSP based testing describing how to think how to approach a problem how to create a solution and how to determine if it really works properly *An Introduction to Mixed-signal IC Test and Measurement* Mark Burns, Gordon W. Roberts, 2001 Integrated circuits incorporating both digital and analog functions have become increasingly prevalent in the semiconductor industry Mixed signal IC test and measurement has grown into a highly specialized field of electrical engineering It has become harder to hire and train new engineers to become skilled mixed signal test engineers The slow learning curve for mixed signal test engineers is largely due to the shortage of written materials and university level courses on the subject of mixed signal testing While many books have been devoted to the subject of digital test and testability the same cannot be said for analog and mixed signal automated test and measurement This book was written in response to the shortage of basic course material for mixed signal test and measurement The book assumes a solid background in analog and digital circuits as well as a working knowledge of computers and computer programming A background in digital signal processing and statistical analysis is also helpful though not absolutely necessary This material is designed to be useful as both a university textbook and as a reference manual for the beginning professional test engineer The prerequisite for this book is a junior level course in linear continuous time and discrete time systems as well as exposure to elementary probability and statistical concepts Chapter 1 presents an introduction to the context in which mixed signal testing is performed and why it is necessary Chapter 2 examines the process by which test programs are generated from device data sheet to test plan to test code Test program structure and functionality are also discussed in Chapter 2 Chapter 3 introduces basic DC measurement definitions including continuity leakage offset gain DC power supply rejection ratio and many other types of fundamental DC measurements Chapter 4 covers the basics of absolute accuracy resolution software calibration standards traceability and measurement repeatability In addition basic data analysis is presented in Chapter 4 A more thorough treatment of data analysis and statistical analysis is delayed until Chapter 15 Chapter 5 takes a closer look at the architecture of a generic mixed signal ATE tester The generic tester includes instruments such as DC sources meters waveform digitizers arbitrary waveform generators and digital pattern generators with source and capture functionality Chapter 6 presents an introduction to both ADC and DAC sampling theory DAC sampling theory is applicable to both DAC circuits in the device under test and to the arbitrary waveform generators in a mixed signal tester ADC sampling theory is applicable to both ADC circuits in the device under test and to waveform digitizers in a mixed signal tester Coherent multi

tone sample sets are also introduced as an introduction to DSP based testing Chapter 7 further develops sampling theory concepts and DSP based testing methodologies which are at the core of many mixed signal test and measurement techniques FFT fundamentals windowing frequency domain filtering and other DSP based testing fundamentals are covered in Chapter 6 and 7 Chapter 8 shows how basic AC channel tests can be performed economically using DSP based testing This chapter covers only non sampled channels consisting of combinations of op amps analog filters PGAs and other continuous time circuits Chapter 9 explores many of these same tests as they are applied to sampled channels which include DACs ADCs sample and hold S H amplifiers etc Chapter 10 explains how the basic accuracy of ATE test equipment can be extended using specialized software routines This subject is not necessarily taught in formal ATE tester classes yet it is critical in the accurate measurement of many DUT performance parameters Testing of DACs is covered in Chapter 11 Several kinds of DACs are studied including traditional binary weighted resistive ladder pulse with modulation PWM and sigma delta architectures Traditional measurements like INL DNL and absolute error are discussed Chapter 12 builds upon the concepts in Chapter 11 to show how ADCs are commonly tested Again several different kinds of ADC s are studied including binary weighted dual slope flash semi flash and sigma delta architectures The weaknesses of each design are explained as well as the common methodologies used to probe their weaknesses Chapter 13 explores the gray art of mixed signal DIB design Topics of interest include component selection power and ground layout crosstalk shielding transmission lines and tester loading Chapter 13 also illustrates several common DIB circuits and their use in mixed signal testing Chapter 14 gives a brief introduction to some of the techniques for analog and mixed signal design for test There are fewer structured approaches for mixed signal DfT than for purely digital DfT The more common ad hoc methods are explained as well as some of the industry standards such as IEEE Std 1149 1 and 1149 4 A brief review of statistical analysis and Gaussian distributions is presented in Chapter 15 This chapter also shows how measurement results can be analyzed and viewed using a variety of software tools and display formats Datalogs shmoo plots and histograms are discussed Also statistical process control SPC is explained including a discussion of process control metrics such as Cp and Cpk Chapter 16 examines the economics of production testing The economics of testing are affected by many factors such as equipment purchase price test floor overhead costs test time dual head testing multi site testing and time to market A test engineer s debugging skills heavily impacts time to market Chapter 16 examines the test debugging process to attempt to set down some general guidelines for debugging mixed signal test programs Finally emerging trends that affect test economics and test development time are presented in Chapter 16 Some or all these trends will shape the future course of mixed signal test and measurement

**Test and Design-for-Testability in Mixed-Signal Integrated Circuits** José Luis Huertas, 2004-10-18 Test and Design for Testability in Mixed Signal Integrated Circuits deals with test and design for test of analog and mixed signal integrated circuits Especially in System on Chip SoC where different technologies are intertwined analog digital sensors RF test is becoming a

true bottleneck of present and future IC projects Linking design and test in these heterogeneous systems will have a tremendous impact in terms of test time cost and proficiency Although it is recognized as a key issue for developing complex ICs there is still a lack of structured references presenting the major topics in this area The aim of this book is to present basic concepts and new ideas in a manner understandable for both professionals and students Since this is an active research field a comprehensive state of the art overview is very valuable introducing the main problems as well as the ways of solution that seem promising emphasizing their basis strengths and weaknesses In essence several topics are presented in detail First of all techniques for the efficient use of DSP based test and CAD test tools Standardization is another topic considered in the book with focus on the IEEE 1149 4 Also addressed in depth is the connecting design and test by means of using high level behavioural description techniques specific examples are given Another issue is related to test techniques for well defined classes of integrated blocks like data converters and phase locked loops Besides these specification driven testing techniques fault driven approaches are described as they offer potential solutions which are more similar to digital test methods Finally in Design for Testability and Built In Self Test two other concepts that were taken from digital design are introduced in an analog context and illustrated for the case of integrated filters In summary the purpose of this book is to provide a glimpse on recent research results in the area of testing mixed signal integrated circuits specifically in the topics mentioned above Much of the work reported herein has been performed within cooperative European Research Projects in which the authors of the different chapters have actively collaborated It is a representative snapshot of the current state of the art in this emergent field

**VLSI Test Principles and Architectures** Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, 2006-08-14 This book is a comprehensive guide to new DFT methods that will show the readers how to design a testable and quality product drive down test cost improve product quality and yield and speed up time to market and time to volume Most up to date coverage of design for testability Coverage of industry practices commonly found in commercial DFT tools but not discussed in other books Numerous practical examples in each chapter illustrating basic VLSI test principles and DFT architectures

Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits M. Bushnell, Vishwani Agrawal, 2006-04-11 The modern electronic testing has a forty year history Test professionals hold some fairly large conferences and numerous workshops have a journal and there are over one hundred books on testing Still a full course on testing is offered only at a few universities mostly by professors who have a research interest in this area Apparently most professors would not have taken a course on electronic testing when they were students Other than the computer engineering curriculum being too crowded the major reason cited for the absence of a course on electronic testing is the lack of a suitable textbook For VLSI the foundation was provided by semiconductor device technology circuit design and electronic testing In a computer engineering curriculum therefore it is necessary that foundations should be taught before applications The field of VLSI has expanded to systems on a chip which include digital memory and mixed signalsubsystems To our

knowledge this is the first textbook to cover all three types of electronic circuits We have written this textbook for an undergraduate foundations course on electronic testing Obviously it is too voluminous for a one semester course and a teacher will have to select from the topics We did not restrict such freedom because the selection may depend upon the individual expertise and interests Besides there is merit in having a larger book that will retain its usefulness for the owner even after the completion of the course With equal tenacity we address the needs of three other groups of readers

*Analog and Mixed-signal Test* Bapiraju Vinnakota,1998 More and more chips are being designed with both analog and digital circuitry next to each other which makes testing analog circuitry even more challenging This comprehensive guide reviews all the potential testing options helping designers engineers CAD developers and researchers choose the most cost effective accurate solutions for both mixed signal and analog only testing

**The Fundamentals of Mixed Signal Testing** Brian Lowe,2002

High Level Test Approaches for Mixed-signal Systems Sule Ozev,2002

*System-on-Chip Test Architectures* Laung-Terng Wang,Charles E. Stroud,Nur A. Touba,2010-07-28 Modern electronics testing has a legacy of more than 40 years The introduction of new technologies especially nanometer technologies with 90nm or smaller geometry has allowed the semiconductor industry to keep pace with the increased performance capacity demands from consumers As a result semiconductor test costs have been growing steadily and typically amount to 40% of today s overall product cost This book is a comprehensive guide to new VLSI Testing and Design for Testability techniques that will allow students researchers DFT practitioners and VLSI designers to master quickly System on Chip Test architectures for test debug and diagnosis of digital memory and analog mixed signal designs Emphasizes VLSI Test principles and Design for Testability architectures with numerous illustrations examples Most up to date coverage available including Fault Tolerance Low Power Testing Defect and Error Tolerance Network on Chip NOC Testing Software Based Self Testing FPGA Testing MEMS Testing and System In Package SIP Testing which are not yet available in any testing book Covers the entire spectrum of VLSI testing and DFT architectures from digital and analog to memory circuits and fault diagnosis and self repair from digital to memory circuits Discusses future nanotechnology test trends and challenges facing the nanometer design era promising nanotechnology test techniques including Quantum Dots Cellular Automata Carbon Nanotubes and Hybrid Semiconductor Nanowire Molecular Computing Practical problems at the end of each chapter for students

Advances in Electronic Testing Dimitris Gizopoulos,2006-01-22 Advances in Electronic Testing Challenges and Methodologies is a new type of edited volume in the Frontiers in Electronic Testing book series devoted to recent advances in electronic circuits testing The book is a comprehensive elaboration on important topics which capture major research and development efforts today The motivation and inspiration behind this book is to deliver a thorough text that focuses on the evolution of test technology provides insight about the abiding importance of discussed topics records today s state of the art and industrial practices and trends reveals the challenges for emerging testing methodologies and envisages the future of this journey The book consists of eleven

edited chapters written by experts in Defect Oriented Testing Nanometer Technologies Failures and Testing Silicon Debug Delay Testing High Speed Test Interfaces DFT Oriented Low Cost Testers Embedded Cores and System on Chip Testing Memory Testing Mixed Signal Testing RF Testing and Loaded Board Testing Contributing authors are affiliated with in alphabetical order Agilent ARM Balearic Islands Univ IBM Inovys Intel LogicVision Magma Mentor Graphics New Mexico Univ Sandia National Labs Synopsys Teradyne and Texas Instruments Advances in Electronic Testing Challenges and Methodologies is an advanced textbook and reference point for senior undergraduate and graduate students in MSc or PhD tracks professors and research leaders in the electronic testing domain It is also for industry design and test engineers and managers seeking a global view and understanding of test technology practices and methodologies and a dense elaboration on test related issues they face in their development projects There is a definite need for documenting the advances in testing I find the work of this edited volume by Dimitris Gizopoulos and his team of authors to be significant and timely the book provides besides novel test methodologies a collective insight into the emerging aspects of testing This I think is beneficial to practicing engineers and researchers both of whom must stay at the forefront of technology This latest addition to the Frontiers Series is destined to serve an important role From the Foreword by Vishwani D Agrawal Consulting Editor Frontiers in Electronic Testing Book Series *VLSI Circuits and Systems*, 2005 Instrumentation and Measurement Technology and Applications Emil Petriu, 1998 Practical solutions to a range of instrumentation and measurement problems are presented in this volume It offers practical design engineers with technology and applications developments within this area **Analog VLSI** Mohammed Ismail, Terri Fiez, 1994 This book presents the first comprehensive treatment of analog VLSI design for signal and information processing applications by blending the basic design concepts of both traditional and contemporary analog VLSI The breadth and level of details of topics covered are unique reflecting the birth of a new generation of analog VLSI circuits Each chapter provides basic introductory material in a tutorial manner with examples or case studies at the circuit and or system level Outstanding features of the text include coverage of the latest in analog VLSI putting students and practicing engineers on the cutting edge of this exciting field thorough coverage of topics unique to this book including low voltage BiCMOS current mode and neural information processing oversampled data converters statistical design analog testability analog CAD analog layout and analog VLSI interconnects avoids lengthy coverage of device physics and IC fabrication and goes straight to the design and applications of analog VLSI circuits extensive use of SPICE in numerous examples and problem sets worked examples from a realistic silicon chip and end of chapter problems assist reader comprehension and an instructor's manual containing a complete listing of problem solutions and SPICE netlists Proceedings, ... International Symposium on VLSI Design, 2003 Efficient Testability Design Methodology for Analog/mixed Signal Integrated Circuits Cheng-Ping Wang, 1997 **Conference Proceedings**, 1994 **IEEE VLSI Test Symposium**, 2005 **International Test Conference, 1993**, 1993 Annotation Proceedings of the 24th International Test

Conference held in Baltimore October 1993 the premier conference for the testing of electronic devices assemblies and systems including design for testability and diagnostics This year s leading edge topics are mixed signal testing multichip modules systems test automatic synthesis of test structures in design boundary scan and Iddq Core topics represented included ATPG modeling test equipment hardware delay fault testing software testing DFT applied BIST board testing memory and microprocessor testing test economics and test quality and reliability Annotation copyright by Book News Inc Portland OR Proceedings, International Test Conference 1997 ,1997 **An Introduction to Mixed-signal IC Test and Measurement** Gordon W. Roberts,Friedrich Taenzler,Mark Burns,2012 With the proliferation of complex semiconductor devices containing digital analog mixed signal and radio frequency circuits the economics of test has come to the forefront and today s engineer needs to be fluent in all four circuit types Having access to a book that covers these topics will help the evolving test engineer immensely and will be an invaluable resource In addition the second edition includes lengthy discussion on RF circuits high speed I Os and probabilistic reasoning Appropriate for the junior senior university level this textbook includes hundreds of examples exercises and problems



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