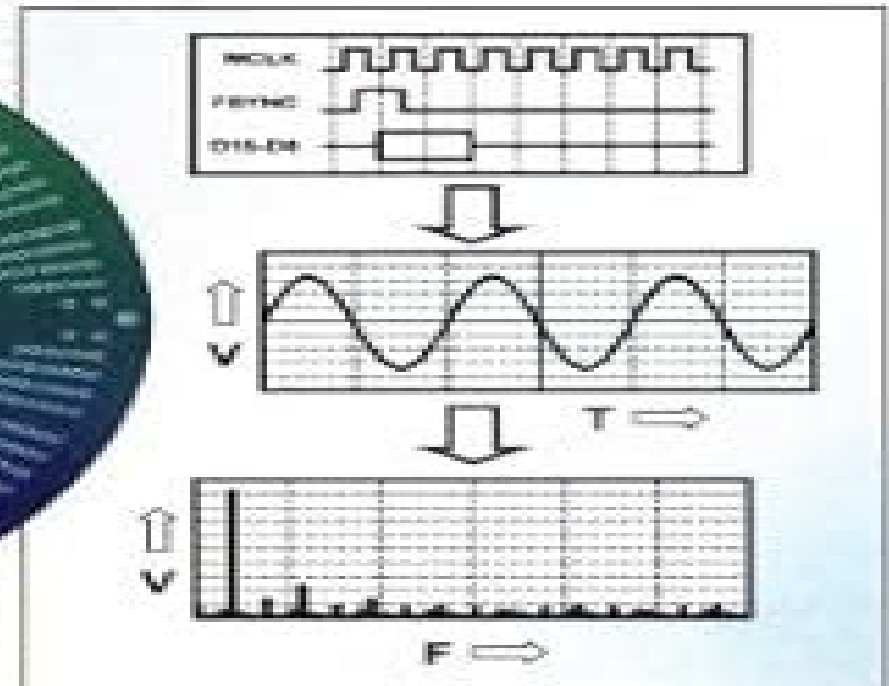


An Introduction to Mixed-Signal IC Test and Measurement



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Mark Burns and Gordon W. Roberts

Introduction To Mixed Signal Ic Test And Measurement

**Gordon W. Roberts, Friedrich
Taenzler, Mark Burns**



Introduction To Mixed Signal IC Test And Measurement:

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 ADCs 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 C_p and C_{pk} 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

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

Test and Design-for-Testability in Mixed-Signal Integrated Circuits Jose Luis Huertas Díaz, 2010-02-23 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

Test and Diagnosis of Analogue, Mixed-signal and RF Integrated Circuits Yichuang Sun, 2008-05-30 This book provides a comprehensive discussion of automatic testing diagnosis and tuning of analogue mixed signal and RF integrated circuits and systems in a single source As well as fundamental concepts and techniques the book reports systematically the state of the arts and future research directions of those areas A complete range of circuit components are covered and test issues from the SoC perspective An essential reference for researchers and engineers in mixed signal testing postgraduate and senior undergraduate students

Oscillation-Based Test in Mixed-Signal Circuits Gloria Huertas Sánchez, Diego Vázquez García de la Vega, Adoración Rueda Rueda, Jose Luis Huertas Díaz, 2007-06-03 This book presents the development and experimental validation of the structural test strategy called Oscillation Based Test OBT in short The results presented here assert not only from a theoretical point of view but also based on a wide experimental support that OBT is an efficient defect oriented test solution complementing the existing functional test techniques for mixed signal circuits

Integrated Circuit Test Engineering Ian A. Grout, 2005-08-22 Using the book and the software provided with it the reader can build his her own tester arrangement to investigate key aspects of analog digital and mixed system circuits Plan of attack based on traditional testing circuit design and circuit manufacture allows the reader to appreciate a testing regime from the point of view of all the participating

interests Worked examples based on theoretical bookwork practical experimentation and simulation exercises teach the reader how to test circuits thoroughly and effectively Wireless Communications Circuits and Systems Institution of Electrical Engineers,2004 This book examines integrated circuits systems and transceivers for wireless and mobile communications It covers the most recent developments in key RF IF analogue mixed signal components and single chip transceivers in CMOS technology Computational Intelligence in Analog and Mixed-Signal (AMS) and Radio-Frequency (RF) Circuit Design Mourad Fakhfakh,Esteban Tlelo-Cuautle,Patrick Siarry,2015-07-14 This book explains the application of recent advances in computational intelligence algorithms design methodologies and synthesis techniques to the design of integrated circuits and systems It highlights new biasing and sizing approaches and optimization techniques and their application to the design of high performance digital VLSI radio frequency and mixed signal circuits and systems This first of two related volumes addresses the design of analog and mixed signal AMS and radio frequency RF circuits with 17 chapters grouped into parts on analog and mixed signal applications and radio frequency design It will be of interest to practitioners and researchers in computer science and electronics engineering engaged with the design of electronic circuits

Electronic Design Automation for IC System Design, Verification, and Testing Luciano Lavagno,Igor L. Markov,Grant Martin,Louis K. Scheffer,2017-12-19 The first of two volumes in the Electronic Design Automation for Integrated Circuits Handbook Second Edition Electronic Design Automation for IC System Design Verification and Testing thoroughly examines system level design microarchitectural design logic verification and testing Chapters contributed by leading experts authoritatively discuss processor modeling and design tools using performance metrics to select microprocessor cores for integrated circuit IC designs design and verification languages digital simulation hardware acceleration and emulation and much more New to This Edition Major updates appearing in the initial phases of the design flow where the level of abstraction keeps rising to support more functionality with lower non recurring engineering NRE costs Significant revisions reflected in the final phases of the design flow where the complexity due to smaller and smaller geometries is compounded by the slow progress of shorter wavelength lithography New coverage of cutting edge applications and approaches realized in the decade since publication of the previous edition these are illustrated by new chapters on high level synthesis system on chip SoC block based design and back annotating system level models Offering improved depth and modernity Electronic Design Automation for IC System Design Verification and Testing provides a valuable state of the art reference for electronic design automation EDA students researchers and professionals

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 **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 **An**

Intro.To Mixed-Signal Ic Test & Measu Mark Burns, 2008-09-04 An Engineer's Guide to Automated Testing of High-Speed Interfaces, Second Edition Jose Moreira, Hubert Werkmann, 2016-04-30 This second edition of An Engineer's Guide to Automated Testing of High Speed Interfaces provides updates to reflect current state of the art high speed digital testing with automated test equipment technology ATE Featuring clear examples this one stop reference covers all critical aspects of automated testing including an introduction to high speed digital basics a discussion of industry standards ATE and bench instrumentation for digital applications and test and measurement techniques for characterization and production environment Engineers learn how to apply automated test equipment for testing high speed digital I O interfaces and gain a better understanding of PCI Express 4 100Gb Ethernet and MIPI while exploring the correlation between phase noise and jitter This updated resource provides expanded material on 28 32 Gbps NRZ testing and wireless testing that are becoming increasingly more pertinent for future applications This book explores the current trend of merging high speed digital testing within the fields of photonic and wireless testing **Lecture Notes in Analog Electronics** Vančo B. Litovski, 2025-01-17

Prof Van o Litovski was born in 1947 in Rakita South Macedonia Greece He graduated from the Faculty of Electronic Engineering in Ni in 1970 and obtained his M Sc in 1974 and his Ph D in 1977 He was appointed as a teaching assistant at the Faculty of Electronic Engineering in 1970 and became a full professor at the same faculty in 1987 He was elected as a visiting professor honoris causa at the University of Southampton in 1999 From 1987 until 1990 he was a consultant to the

CEO of Ei and was the head of the Chair of Electronics at the Faculty of Electronic Engineering in Ni for 12 years From 2015 to 2017 he was a researcher at the University of Bath He received several awards including from the Faculty of Electronic Engineering Charter in 1980 Charter in 1985 and a Special Recognition in 1995 and the University of Ni Plaque 1985

Information Technology Ricardo Reis,2006-04-11 This book contains a selection of tutorials on hot topics in information technology which were presented at the IFIP World Computer Congress WCC2004 took place at the Centre de Congr s Pierre Baudis in Toulouse France from 22 to 27 August 2004 The 11 chapters included in the book were chosen from tutorials proposals submitted to WCC2004 These papers report on several important and state of the art topics on information technology such as Quality of Service in Information Networks Risk Driven Development of Security Critical Systems Using UMLsec Developing Portable Software Formal Reasoning About Systems Software and Hardware Using Functionals Predicates and Relations The Problematic of Distributed Systems Supervision Software Rejuvenation Modeling and Analysis Test and Design for Test of Mixed Signal Integrated Circuits Web Services Applications of Multi Agent Systems Discrete Event Simulation Human Centered Automation We hereby would like to thank IFIP and more specifically WCC2004 Tutorials Committee and the authors for their contribution We also would like to thank the congress organizers who have done a great job Ricardo Reis Editor QUALITY OF SERVICE IN INFORMATION NETWORKS Augusto Casaca IST INESC R Alves Redol 1000 029 Lisboa Portugal Abstract This article introduces the problems concerned with the provision of end end quality of service in IP networks which are the basis of information networks describes the existing solutions for that provision and presents some of the current research items on the subject Key words Information networks IP networks Integrated Services Differentiated Services Multiprotocol Label Switching UMTS

Wavelets and Wavelet Transform Systems and Their Applications Cajetan M. Akujuobi,2022-02-02 This textbook is unique because of its in depth treatment of the applications of wavelets and wavelet transforms to many areas across many disciplines The book is written to serve the needs of a one or two semester course at either the undergraduate or graduate level The author uses a very simplified accessible approach that de emphasizes mathematical rigor The presentation includes many diagrams to illustrate points being discussed and uses MATLAB for all of application code The author reinforces concepts introduced in the book with easy to grasp review questions and problems tailored to each specific chapter for better mastery of the subject matter This book enables students to understand the fundamental concepts of wavelets and wavelet transforms as well as how to use them for problem solutions in digital signal and image processing mixed signal testing space applications aerospace applications biomedical cyber security homeland security and many other application areas

Switched-Capacitor Techniques for High-Accuracy Filter and ADC Design Patrick J. Quinn,Arthur H.M. van Roermund,2007-07-20 This book proposes alternative switched capacitor techniques which allow the achievement of higher intrinsic analogue functional accuracy than previously possible in such application areas as analogue filter and ADC design The validity of the concepts developed and analyzed in Switched

Capacitor Techniques for High Accuracy Filter and ADC Design has been demonstrated in practice with the design of CMOS SC bandpass filters and algorithmic ADC stages *Fault Diagnosis of Analog Integrated Circuits* Prithviraj Kabisatpathy,Alok Barua,Satyabroto Sinha,2006-01-13 System on Chip SOC having both digital and analog circuits has become increasingly prevalent in integrated circuit manufacturing industry Electronic tests are classified as digital analog and mixed signal Current methodologies for the testing of digital circuits are well developed In contrast methodologies for the testing of analog circuits remain relatively underdeveloped due to the complex nature of analog signals Compared to digital testing analog testing lags far behind in methodologies and tools and therefore demands substantial research and development effort Fault Diagnosis of Analog Integrated Circuits is a textbook for advanced undergraduate and graduate level students as well as practicing engineers The objective of this book is to study the testing and fault diagnosis of analog and analog part of mixed signal circuits A background in analog integrated circuit artificial neural network is desirable but not essential The text covers the testing and fault diagnosis of both bipolar and Metal Oxide Semiconductor MOS circuits Fault model of the devices in analog domain has been introduced in the text The test stimulus generations are also discussed in details Experimental verification of some state of the art techniques has also been presented in the book It also contains problems that can be used as quiz or homework This book enables the reader to test an analog circuit that is implemented either in bipolar or MOS technology *Design, Modeling and Testing of Data Converters* Paolo Carbone,Sayfe Kiaei,Fang Xu,2013-10-05 This book presents the a scientific discussion of the state of the art techniques and designs for modeling testing and for the performance analysis of data converters The focus is put on sustainable data conversion Sustainability has become a public issue that industries and users can not ignore Devising environmentally friendly solutions for data conversion designing modeling and testing is nowadays a requirement that researchers and practitioners must consider in their activities This book presents the outcome of the IWADC workshop 2011 held in Orvieto Italy **Design for Maintainability** Louis J. Gullo,Jack Dixon,2021-03-26 How to design for optimum maintenance capabilities and minimize the repair time Design for Maintainability offers engineers a wide range of tools and techniques for incorporating maintainability into the design process for complex systems With contributions from noted experts on the topic the book explains how to design for optimum maintenance capabilities while simultaneously minimizing the time to repair equipment The book contains a wealth of examples and the most up to date maintainability design practices that have proven to result in better system readiness shorter downtimes and substantial cost savings over the entire system life cycle thereby decreasing the Total Cost of Ownership Design for Maintainability offers a wealth of design practices not covered in typical engineering books thus allowing readers to think outside the box when developing maintainability design requirements The books principles and practices can help engineers to dramatically improve their ability to compete in global markets and gain widespread customer satisfaction This important book Offers a complete overview of maintainability engineering as a system

engineering discipline Includes contributions from authors who are recognized leaders in the field Contains real life design examples both good and bad from various industries Presents realistic illustrations of good maintainability design principles Provides discussion of the interrelationships between maintainability with other related disciplines Explores trending topics in technologies Written for design and logistics engineers and managers Design for Maintainability is a comprehensive resource containing the most reliable and innovative techniques for improving maintainability when designing a system or product

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