

Verification

Sasan Iman,Sunita Joshi

Formal Verification Erik Seligman, Tom Schubert, M. V. Achutha Kiran Kumar, 2023-05-26 Formal Verification: An Essential Toolkit for Modern VLSI Design, Second Edition presents practical approaches for design and validation, with hands-on advice to help working engineers integrate these techniques into their work. Formal Verification (FV) enables a designer to directly analyze and mathematically explore the quality or other aspects of a Register Transfer Level (RTL) design without using simulations. This can reduce time spent validating designs and more quickly reach a final design for manufacturing. Building on a basic knowledge of SystemVerilog, this book demystifies FV and presents the practical applications that are bringing it into mainstream design and validation processes. Every chapter in the second edition has been updated to reflect evolving FV practices and advanced techniques. In addition, a new chapter, Formal Signoff on Real Projects, provides guidelines for implementing signoff quality FV, completely replacing some simulation tasks with significantly more productive FV methods. After reading this book, readers will be prepared to introduce FV in their organization to effectively deploy FV techniques that increase design and validation productivity. Covers formal verification algorithms that help users gain full coverage without exhaustive simulation Helps readers understand formal verification tools and how they differ from simulation tools Shows how to create instant testbenches to gain insights into how models work and to find initial bugs Presents insights from Intel insiders who share their hard-won knowledge and solutions to complex design problems

Verification Plans Peet James, 2003-10-31 The task of verification is always larger than the task of the design effort. Why? Because the verification system has to encompass the entire functionality of the device under verification. It has to mimic the real world environment that the device will actually operate in. It needs to catch functional errors. It needs to give feedback information to guide further verification. The design effort proceeds from a design specification. Verification systems need to proceed from a verification plan. A comprehensive document that describes the verification system and all its components. A plan that details how the verification system will be built. With the advent of hardware verification languages, today's verifications systems have grown in complexity making verification plans even more paramount. This book is a practical guide on how to get a verification team jumpstarted into verification success by the joint creation of a verification plan. The book includes: -A detailed five day approach that gives day by day, step by step instructions on how to design and document your verification system. -An introduction to hardware verification languages, their pseudo-random mindset, their enabling methodologies (generation, checking and coverage), and how these effect the development of a verification plan. -Practical guidance in common people issues, formatting decisions and information extraction methods to enhance your verification plan brainstorming sessions. -An appendix full of verification plan examples and support documents.

System Verification Jeffrey O. Grady, 2016-05-07 System Verification: Proving the Design Solution Satisfies the Requirements, Second Edition explains how to determine what verification work must be done, how the total task can be broken down into verification tasks involving six straightforward methods, how to prepare a plan, procedure, and report for each of these tasks, and how to conduct an audit of the content of those reports for a particular product entity. This process-centered book is applicable to engineering and computing projects of all kinds, and the lifecycle approach helps all stakeholders in the design process understand how the verification and validation stage is significant to them. In addition to many flowcharts that illustrate the verification procedures involved, the book also includes 14 verification form templates for use in practice. The author draws on his experience of consulting for industry as well as lecturing to provide a uniquely practical and easy to use guide which is essential reading for systems and validation engineers, as well as everyone involved in the product design process. Includes 14 real life templates for use in verification tasks Explains concepts in the context of the entire design lifecycle, helping all project stakeholders engage Contains a process-focused approach to design model verification that can be applied to all engineering design and software development projects

SystemVerilog for Verification Chris Spear, Greg Tumbush, 2012-02-14 Based on the highly successful second edition, this extended edition of SystemVerilog for Verification: A Guide to Learning the Testbench Language Features teaches all verification features of the SystemVerilog language, providing hundreds of examples to clearly explain the concepts and basic fundamentals. It contains materials for both the full-time verification engineer and the student learning this valuable skill. In the third edition, authors Chris Spear and Greg Tumbush start with how to verify a design, and then use that context to demonstrate the language features, including the advantages and disadvantages of different styles, allowing readers to choose between alternatives. This textbook contains end-of-chapter exercises designed to enhance students' understanding of the material. Other features of this revision include: New sections on static variables, print specifiers, and DPI from the 2009 IEEE language standard Descriptions of UVM features such as factories, the test registry, and the configuration database Expanded code samples and explanations Numerous samples that have been tested on the major SystemVerilog simulators SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, Third Edition is suitable for use in a one-semester SystemVerilog course on SystemVerilog at the undergraduate or graduate level. Many of the improvements to this new edition were compiled through feedback provided from hundreds of readers.

Verification and Validation in Scientific Computing William L. Oberkampf, Christopher J. Roy, 2010-10-14 Advances in scientific computing have made modelling and simulation an important part of the decision-making process in engineering, science, and public policy. This book provides a comprehensive and systematic development of the basic concepts, principles, and procedures for verification and validation of models and simulations. The emphasis is placed on models that are described by partial differential and integral equations and the simulations that result from their numerical solution. The methods described can be applied to a wide range of technical fields, from the physical sciences, engineering and technology and industry, through to environmental regulations and safety, product and plant safety, financial investing, and governmental regulations. This book will be genuinely welcomed by researchers, practitioners, and decision makers in a broad range of fields, who seek to improve the credibility and reliability of simulation results. It will also be appropriate either for university courses or for independent study.

Advanced Verification Techniques Leena Singh, Leonard Drucker, Neyaz Khan, 2004-06-08 As chip size and complexity continues to grow exponentially, the challenges of functional verification are becoming a critical issue in the electronics industry. It is now commonly heard that logical errors missed during functional verification are the most common cause of chip re-spins, and that the costs associated with functional verification are now outweighing the costs of chip design. To cope with these challenges engineers are increasingly relying on new design and verification methodologies and languages. Transaction-based design and verification, constrained random stimulus generation, functional coverage analysis, and assertion-based verification are all techniques that advanced design and verification teams routinely use today. Engineers are also increasingly turning to design and verification models based on C/C++ and SystemC in order to build more abstract, higher performance hardware and software models and to escape the limitations of RTL HDLs. This new book, Advanced Verification Techniques, provides specific guidance for these advanced verification techniques. The book includes realistic examples and shows how SystemC and SCV can be applied to a variety of advanced design and verification tasks. - Stuart Swan

The e Hardware Verification Language Sasan Iman, Sunita Joshi, 2004-05-28 I am glad to see this new book on the e language and on verification. I am especially glad to see a description of the e Reuse Methodology (eRM). The main goal of verification is, after all, finding more bugs quicker using given resources, and verification reuse (module-to-system, old-system-to-new-system etc.

) is a key enabling component. This book offers a fresh approach in teaching the e hardware verification language within the context of coverage driven verification methodology. I hope it will help the reader understand the many important and interesting topics surrounding hardware verification. Yoav Hollander Founder and CTO, Verisity Inc. Preface This book provides a detailed coverage of the e hardware verification language (HVL), state of the art verification methodologies, and the use of e HVL as a facilitating verification tool in implementing a state of the art verification environment. It includes comprehensive descriptions of the new concepts introduced by the e language, e language syntax, and its associated semantics. This book also describes the architectural views and requirements of verification environments (randomly generated environments, coverage driven verification environments, etc.), verification blocks in the architectural views (i.e. generators, initiators, collectors, checkers, monitors, coverage definitions, etc.) and their implementations using the e HVL. Moreover, the e Reuse Methodology (eRM), the motivation for defining such a guideline, and step-by-step instructions for building an eRM compliant e Verification Component (eVC) are also discussed.

High-Level Verification Sudipta Kundu, Sorin Lerner, Rajesh K. Gupta, 2011-05-18 Given the growing size and heterogeneity of Systems on Chip (SOC), the design process from initial specification to chip fabrication has become increasingly complex. This growing complexity provides incentive for designers to use high-level languages such as C, SystemC, and SystemVerilog for system-level design. While a major goal of these high-level languages is to enable verification at a higher level of abstraction, allowing early exploration of system-level designs, the focus so far for validation purposes has been on traditional testing techniques such as random testing and scenario-based testing. This book focuses on high-level verification, presenting a design methodology that relies upon advances in synthesis techniques as well as on incremental refinement of the design process. These refinements can be done manually or through elaboration tools. This book discusses verification of specific properties in designs written using high-level languages, as well as checking that the refined implementations are equivalent to their high-level specifications. The novelty of each of these techniques is that they use a combination of formal techniques to do scalable verification of system designs completely automatically. The verification techniques presented in this book include methods for verifying properties of high-level designs and methods for verifying that the translation from high-level design to a low-level Register Transfer Language (RTL) design preserves semantics. Used together, these techniques guarantee that properties verified in the high-level design are preserved through the translation to low-level RTL.

Independent Verification and Validation Robert O. Lewis, 1992 Software in any technical system or product, be it space shuttle, VCR, or database, is an integral and expensive part of that system - if it fails, the system fails. Twenty years ago the U.S. Army sponsored the first significant Independent Verification and Validation (IV & V) program. The idea was to use independent third party experts to test critical components (especially software) and ensure the quality, performance, and reliability of the Safeguard Anti-Ballistic Missile System. The success of that project led to the adoption of IV & V in the design, development, and implementation of numerous other government projects, both military and civilian. Today IV & V is a cost-effective method of ensuring quality in the development of complex industrial and commercial software systems as well. Independent Verification and Validation presents engineers and computer scientists with the methods and techniques for verifying and validating the software components of engineering designs and systems. Unlike other books on this subject, this book covers the entire software life cycle and explains software development and IV & V together. Included in the text is a survey of Computer-Aided Software Engineering (CASE) tools. Comprehensive illustrations support the text throughout. The book also offers guidance on better interaction among IV & V personnel, developers, and managers. Eight case studies provide a look at real life examples of a wide range of applications possible with IV & V. For IV & V engineers, development engineers, and managers this is an ideal handbook and reference text. It is also well designed for use as a textbook for graduate, undergraduate, and professional courses.

Comprehensive Functional Verification Bruce Wile, John Goss, Wolfgang Roesner, 2005-05-26 One of the biggest challenges in chip and system design is determining whether the hardware works correctly. That is the job of functional verification engineers and they are the audience for this comprehensive text from three top industry professionals. As designs increase in complexity, so has the value of verification engineers within the hardware design team. In fact, the need for skilled verification engineers has grown dramatically--functional verification now consumes between 40 and 70% of a project's labor, and about half its cost. Currently there are very few books on verification for engineers, and none that cover the subject as comprehensively as this text. A key strength of this book is that it describes the entire verification cycle and details each stage. The organization of the book follows the cycle, demonstrating how functional verification engages all aspects of the overall design effort and how individual cycle stages relate to the larger design process. Throughout the text, the authors leverage their 35 plus years experience in functional verification, providing examples and case studies, and focusing on the skills, methods, and tools needed to complete each verification task. Comprehensive overview of the complete verification cycle Combines industry experience with a strong emphasis on functional verification fundamentals Includes real-world case studies

Finding Your Way Through Formal Verification Bernard Murphy, Manish Pandey, Sean Safarpour, 2018-03-06 There are already many books on formal verification, from academic to application-centric, and from tutorials for beginners to guides for advanced users. Many are excellent for their intended purpose; we recommend a few at the end of this book. But most start from the assumption that you have already committed to becoming a hands-on expert (or in some cases that you already are an expert). We feel that detailed tutorials are not the easiest place to extract the introductory view many of us are looking for - background, a general idea of how methods work, applications and how formal verification is managed in the overall verification objective. Since we're writing for a fairly wide audience, we cover some topics that some of you may consider elementary (why verification is hard), some we hope will be of general interest (elementary understanding of the technology) and others that may not immediately interest some readers (setting up a formal verification team). What we intentionally do not cover at all is how to become a hands-on expert.

Formal System Verification Rolf Drechsler, 2017-06-21 This book provides readers with a comprehensive introduction to the formal verification of hardware and software. World-leading experts from the domain of formal proof techniques show the latest developments starting from electronic system level (ESL) descriptions down to the register transfer level (RTL). The authors demonstrate at different abstraction layers how formal methods can help to ensure functional correctness. Coverage includes the latest academic research results, as well as descriptions of industrial tools and case studies.

Verification, Validation, and Testing of Engineered Systems Avner Engel, 2010-11-19 Systems' Verification Validation and Testing (VVT) are carried out throughout systems' lifetimes. Notably, quality-cost expended on performing VVT activities and correcting system defects consumes about half of the overall engineering cost. Verification, Validation and Testing of Engineered Systems provides a comprehensive compendium of VVT activities and corresponding VVT methods for implementation throughout the entire lifecycle of an engineered system. In addition, the book strives to alleviate the fundamental testing conundrum, namely: What should be tested? How should one test? When should one test? And, when should one stop testing? In other words, how should one select a VVT strategy and how it be optimized? The book is organized in three parts: The first part provides introductory material about systems and VVT concepts. This part presents a comprehensive explanation of the role of VVT in the process of engineered systems (Chapter-1). The second part describes 40 systems' development VVT activities (Chapter-2) and 27 systems' post-

development activities (Chapter-3). Corresponding to these activities, this part also describes 17 non-testing systems' VVT methods (Chapter-4) and 33 testing systems' methods (Chapter-5). The third part of the book describes ways to model systems' quality cost, time and risk (Chapter-6), as well as ways to acquire quality data and optimize the VVT strategy in the face of funding, time and other resource limitations as well as different business objectives (Chapter-7). Finally, this part describes the methodology used to validate the quality model along with a case study describing a system's quality improvements (Chapter-8). Fundamentally, this book is written with two categories of audience in mind. The first category is composed of VVT practitioners, including Systems, Test, Production and Maintenance engineers as well as first and second line managers. The second category is composed of students and faculties of Systems, Electrical, Aerospace, Mechanical and Industrial Engineering schools. This book may be fully covered in two to three graduate level semesters; although parts of the book may be covered in one semester. University instructors will most likely use the book to provide engineering students with knowledge about VVT, as well as to give students an introduction to formal modeling and optimization of VVT strategy.

Computer Aided Verification Rajeev Alur,2004-06-29 This book constitutes the refereed proceedings of the 16th International Conference on Computer Aided Verification, CAV 2004, held in Boston, MA, USA, in July 2004. The 32 revised full research papers and 16 tool papers were carefully reviewed and selected from 144 submissions. The papers cover all current issues in computer aided verification and model checking, ranging from foundational and methodological issues to the evaluation of major tools and systems.

Verification Handbook Craig Silverman,2014

Constraint-Based Verification Jun Yuan,Carl Pixley,Adnan Aziz,2006-01-13 Covers the methodology and state-of-the-art techniques of constrained verification, which is new and popular. It relates constrained verification with the also-hot technology called assertion-based design. Discussed and clarifies language issues, critical to both the above, which will help the implementation of these languages.

Biometrics: Advanced Identity Verification Julian Ashbourn,2014-01-13 Biometric identity verification (BIV) offers a radical alternative to passports, PIN numbers, ID cards and driving licences. It uses physiological or behavioural characteristics such as fingerprints, hand geometry, and retinas to check a person's identity. It is therefore much less open to fraudulent use, which makes it ideal for use in voting systems, financial transactions, benefit payment administration, border control, and prison access. This is the first book to provide business readers with an easy-to-read, non-technical introduction to BIV systems. It explains the background and then tells the reader how to get their system up and running quickly. It will be an invaluable read for practitioners, managers and IT personnel - in fact for anyone considering, or involved in, implementing a BIV system. Julian Ashbourn was one of the pioneers in integrating biometric technology and has provided input into many prototype BIV systems around the world.

Medical Device Software Verification, Validation and Compliance David A. Vogel,2011 HereOCO the first book written specifically to help medical device and software engineers, QA and compliance professionals, and corporate business managers better understand and implement critical verification and validation processes for medical device software.Offering you a much broader, higher-level picture than other books in this field, this book helps you think critically about software validation -- to build confidence in your softwareOCO safety and effectiveness. The book presents validation activities for each phase of the development lifecycle and shows: why these activities are important and add value; how to undertake them; and what outputs need to be created to document the validation process.From software embedded within medical devices, to software that performs as a medical device itself, this comprehensive book explains how properly handled validation throughout the development lifecycle can help bring medical devices to completion sooner, at higher quality, in compliance with regulations.

Automated Verification of Concurrent Search Structures Krishna Siddharth,Patel Nisarg,Shasha Dennis,Wies Thomas,2022-05-31 Search structures support the fundamental data storage primitives on key-value pairs: insert a pair, delete by key, search by key, and update the value associated with a key. Concurrent search structures are parallel algorithms to speed access to search structures on multicore and distributed servers. These sophisticated algorithms perform fine-grained synchronization between threads, making them notoriously difficult to design correctly. Indeed, bugs have been found both in actual implementations and in the designs proposed by experts in peer-reviewed publications. The rapid development and deployment of these concurrent algorithms has resulted in a rift between the algorithms that can be verified by the state-of-the-art techniques and those being developed and used today. The goal of this book is to show how to bridge this gap in order to bring the certified safety of formal verification to high-performance concurrent search structures. Similar techniques and frameworks can be applied to concurrent graph and network algorithms beyond search structures.

Post-Silicon and Runtime Verification for Modern Processors Ilya Wagner,Valeria Bertacco,2010-11-25 The purpose of this book is to survey the state of the art and evolving directions in post-silicon and runtime verification. The authors start by giving an overview of the state of the art in verification, particularly current post-silicon methodologies in use in the industry, both for the domain of processor pipeline design and for memory subsystems. They then dive into the presentation of several new post-silicon verification solutions aimed at boosting the verification coverage of modern processors, dedicating several chapters to this topic. The presentation of runtime verification solutions follows a similar approach. This is an area of processor design that is still in its early stages of exploration and that holds the promise of accomplishing the ultimate goal of achieving complete correctness guarantees for microprocessor-based computation. The authors conclude the book with a look towards the future of late-stage verification and its growing role in the processor life-cycle.

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