

Design and Verification of AHB Protocol Using System Verilog and Universal Verification Methodology (UVM)

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ABSTRACT :

Recently, VLSI technology has improved significantly and more transistors can be incorporated in a chip. A System on-Chip (SoC) Configuration have number of blocks are integrated on a single chip. Numerous blocks are integrated in single IC, but to access their function, they requires a powerful communication architecture. This can only be achieved by using on-chip bus architecture to meet their requirements. Different Companies has various on-Chip Bus architectures but one of the most suitable architecture is AMBA by ARM. AMBA consist of three buses, namely, Advanced System Bus (ASB), Advanced Peripheral Bus (APB) and Advanced High Performance Bus (AHB); when compared to other two buses AHB is high performance, high bandwidth and for high clock frequency system modules the System designers select AHB as their primary choice. The AHB (Advanced High-performance Bus) is a superior bus in AMBA (Advanced Microcontroller Bus Architecture) family. It is a norm for intercommunication of modules in a framework. The AHB (Advanced High performance) bus Standards are characterized by ARM which supports for the communication of on-chip memories, processors and interfaces of external off-chip memory. Here the basic blocks such as master, slave, decoder, and arbiter are used to design and verify an AHB that supports multiples master and multiples slave. The conventional way of verification is simulation based. As the Technology improves the complexity of IC's has been increased. Thus, time spent on verification has also been increased. The main focus is to design of AHB protocol in Verilog and verify using Hardware verification language such as System Verilog and standard Methodology such as Universal Verification Methodology (UVM). QuestaSim (Advanced verification tool from Mentor Graphics) is an EDA tool used to simulate and verify the design and obtain Coverage report.

Keywords – AMBA, AHB, APB, ASB, OCB, SOC, UVM

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L. INTRODUCTION

1.1 About AMBA bus

The AMBA is an Advanced Microcontroller Bus Architecture defined by ARM, it is an open standard widely used for an on-chip bus system. The standard is intends to simplify the component design by allowing the use of interchangeable parts the within the SoC style. It promotes the use of holding parts, so that a minimum of a neighborhood of the SoC can be reconstructed, instead of having to rewrite it entirely each time. AHB (Advanced High-performance Bus), ASB (Advanced System Bus), and APB (Advanced Peripheral Bus) are the bus groups defined in the AMBA. AHB, The AHB is employed for high-performance, high frequency architecture. These applications includes are ARM cores and high-speed RAM inside the system, Nand Flash, DMA and Bridge links. [1] The APB is used for connecting external devices such as UART, keypad and timer, and has low performance requirements, while it is

used for optimizing power consumption. AMBA is the Standard bus-based microcontroller typical feature a high-performance system hub bus (AHB or ASB) that supports for external memory bandwidth, including CPUs, on-chip memories, and other direct data access (DMA) devices. For most of the transmission between various units, such as CPUs, on-chip memories, and DMA, the bus serves as a high bandwidth interface.

Systemverilog Design Verification Using Uvm

Ray Salemi

Systemverilog Design Verification Using Uvm:

SystemVerilog for Design and Verification using UVM Mark A. Azadpour, 2015-02-04 This book is an A Z guide to using SystemVerilog for ASIC design from conception to RTL coding to synthesis and verification Readers will benefit from a thorough introduction to the powerful constructs and features of SystemVerilog In addition the verification methodology of Universal Verification Methodology UVM is used to build test benches that allow for verification of complicated designs and synthesis basics are discussed using the Synopsys Design Compiler DC To complete this book s package as a practical guide readers are introduced to the fundamentals of static timing analysis

System Verilog Assertions and Functional Coverage Ashok B. Mehta, 2019-10-09 This book provides a hands on application oriented guide to the language and methodology of both SystemVerilog Assertions and Functional Coverage Readers will benefit from the step by step approach to learning language and methodology nuances of both SystemVerilog Assertions and Functional Coverage which will enable them to uncover hidden and hard to find bugs point directly to the source of the bug provide for a clean and easy way to model complex timing checks and objectively answer the question have we functionally verified everything Written by a professional end user of ASIC SoC CPU and FPGA design and Verification this book explains each concept with easy to understand examples simulation logs and applications derived from real projects Readers will be empowered to tackle the modeling of complex checkers for functional verification and exhaustive coverage models for functional coverage thereby drastically reducing their time to design debug and cover This updated third edition addresses the latest functional set released in IEEE 1800 2012 LRM including numerous additional operators and features Additionally many of the Concurrent Assertions Operators explanations are enhanced with the addition of more examples and figures Covers in its entirety the latest IEEE 1800 2012 LRM syntax and semantics Covers both SystemVerilog Assertions and SystemVerilog Functional Coverage languages and methodologies Provides practical applications of the what how and why of Assertion Based Verification and Functional Coverage methodologies Explains each concept in a step by step fashion and applies it to a practical real life example Includes 6 practical LABs that enable readers to put in practice the concepts explained in the book

ASIC/SoC Functional Design Verification Ashok B. Mehta, 2017-06-28 This book describes in detail all required technologies and methodologies needed to create a comprehensive functional design verification strategy and environment to tackle the toughest job of guaranteeing first pass working silicon The author first outlines all of the verification sub fields at a high level with just enough depth to allow an engineer to grasp the field before delving into its detail He then describes in detail industry standard technologies such as UVM Universal Verification Methodology SVA SystemVerilog Assertions SFC SystemVerilog Functional Coverage CDV Coverage Driven Verification Low Power Verification Unified Power Format UPF AMS Analog Mixed Signal verification Virtual Platform TLM2 0 ESL Electronic System Level methodology Static Formal Verification Logic Equivalency Check LEC Hardware Acceleration Hardware Emulation Hardware Software Co verification

Power Performance Area PPA analysis on a virtual platform Reuse Methodology from Algorithm ESL to RTL and other overall methodologies [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

Proceeding of Fifth International Conference on Microelectronics, Computing and Communication Systems Vijay Nath, J. K. Mandal, 2021-09-09 This book presents high quality papers from the Fifth International Conference on Microelectronics Computing Communication Systems MCCS 2020 It discusses the latest technological trends and advances in MEMS and nanoelectronics wireless communication optical communication instrumentation signal processing image processing bioengineering green energy hybrid vehicles environmental science weather forecasting cloud computing renewable energy RFID CMOS sensors actuators transducers telemetry systems embedded systems and sensor network applications It includes papers based on original theoretical practical and experimental simulations development applications measurements and testing The applications and solutions discussed here provide excellent reference material for future product development

Advances in VLSI, Signal Processing, Power Electronics, IoT, Communication and Embedded Systems

Shubhakar Kalya, Muralidhar Kulkarni, Subramanya Bhat, 2023-08-28 This book comprises select peer reviewed papers from the International Conference on VLSI Signal Processing Power Electronics IoT Communication and Embedded Systems VSPICE 2022 The book provides insights into various aspects of electronics and communication engineering as a holistic approach The various topics covered in this book include VLSI embedded systems signal processing communication power electronics and the Internet of Things The contents mainly focus on the most recent innovations trends concerns and practical challenges and their solutions This book is useful for academicians professionals and researchers in the area of electronics and communications and electrical engineering *Next-Generation High-Speed Satellite Interconnect* Pietro

Nannipieri,Gianmarco Dinelli,Luca Dello Sterpaio,Antonino Marino,Luca Fanucci,2021-07-23 This book introduces the space community to the novel SpaceFibre protocol developed under the guidance of the European Space Agency ESA as the forthcoming high speed Gbps communication protocol for satellite on board communication Since SpaceFibre is expected to follow the success of its predecessor SpaceWire protocol Mbps the authors provide a system level perspective for the end user willing to adopt this latest technology for future space missions The authors provide a complete view of the SpaceFibre protocol together with an analysis of all the necessary hardware and software components to integrate this technology onboard a satellite The text guides potential system adopters toward understanding the protocol analyzing strengths weaknesses and performances Practical design examples and prototype performance measurements in reference scenarios are also included [Cognitive Informatics and Soft Computing](#) Pradeep Kumar Mallick,Akash Kumar Bhoi,Paolo

Barsocchi,Victor Hugo C. de Albuquerque,2022-05-30 This book presents best selected research papers presented at the 4th International Conference on Cognitive Informatics and Soft Computing CISC 2021 held at Balasore College of Engineering Technology Balasore Odisha India from 21 22 August 2021 It highlights in particular innovative research in the fields of cognitive informatics cognitive computing computational intelligence advanced computing and hybrid intelligent models and applications New algorithms and methods in a variety of fields are presented together with solution based approaches The topics addressed include various theoretical aspects and applications of computer science artificial intelligence cybernetics automation control theory and software engineering **[Proceedings of the 2nd International Conference on Cognitive and Intelligent Computing](#)**

Amit Kumar,Gheorghita Ghinea,Suresh Merugu,2023-09-26 This book includes original peer reviewed articles from the 2nd International Conference on Cognitive Intelligent Computing ICCIC 2022 held at Vasavi College of Engineering Hyderabad India It covers the latest trends and developments in areas of cognitive computing intelligent computing machine learning smart cities IoT artificial intelligence cyber physical systems cybernetics data science neural network and cognition This book addresses the comprehensive nature of computational intelligence cognitive computing AI ML and DL to emphasize its character in modeling identification optimization prediction forecasting and control of future intelligent systems Submissions are original unpublished and present in depth fundamental research contributions either from a methodological application perspective in understanding artificial intelligence and machine learning approaches and their capabilities in solving diverse range of problems in industries and its real world applications

[Disruptive Information Technologies for a Smart Society](#) Miroslav Trajanović,Nenad Filipović,Milan Zdravković,2024-09-29 This book aims at meeting the challenge of getting along with today's unprecedented rate of innovation supported by disruptive digital technologies which changed the perception of the productivity and effectiveness and opened a gateway to more than ever dynamic advances in solving the important societal challenges Disruptive Information Technologies for a Smart Society is the proceedings book of the 14th International Conference for Information

Society and Technologies that brings together experts from various fields to discuss the latest advancements in industrial AI digitalization in health well being and sport enterprise information systems large language models and security and safety The book and the conference serve as a platform for researchers of all career stages in technical sciences especially Ph D students practitioners and industry experts in health care AI and other areas to share and learn on the cutting edge technologies and stay at the forefront of these rapidly evolving fields

Writing Testbenches using SystemVerilog Janick Bergeron,2007-02-02

Verification is too often approached in an ad hoc fashion Visually inspecting simulation results is no longer feasible and the directed test case methodology is reaching its limit Moore's Law demands a productivity revolution in functional verification methodology Writing Testbenches Using SystemVerilog offers a clear blueprint of a verification process that aims for first time success using the SystemVerilog language From simulators to source management tools from specification to functional coverage from I's and O's to high level abstractions from interfaces to bus functional models from transactions to self checking testbenches from directed testcases to constrained random generators from behavioral models to regression suites this book covers it all Writing Testbenches Using SystemVerilog presents many of the functional verification features that were added to the Verilog language as part of SystemVerilog Interfaces virtual modports classes program blocks clocking blocks and others SystemVerilog features are introduced within a coherent verification methodology and usage model Writing Testbenches Using SystemVerilog introduces the reader to all elements of a modern scalable verification methodology It is an introduction and prelude to the verification methodology detailed in the Verification Methodology Manual for SystemVerilog It is a SystemVerilog version of the author's bestselling book Writing Testbenches

Functional Verification of HDL Models

The Uvm Primer Ray Salemi,2013-10

The UVM Primer uses simple runnable code examples accessible analogies and an easy to read style to introduce you to the foundation of the Universal Verification Methodology You will learn the basics of object oriented programming with SystemVerilog and build upon that foundation to learn how to design testbenches using the UVM Use the UVM Primer to brush up on your UVM knowledge before a job interview to be able to confidently answer questions such as What is a uvm_agent How do you use uvm_sequences and When do you use the UVM's factory The UVM Primer's downloadable code examples give you hands on experience with real UVM code Ray Salemi uses online videos on www.uvmprimer.com to walk through the code from each chapter and build your confidence Read The UVM Primer today and start down the path to the UVM

VLSI Design Methodology Development

Thomas Dillinger,2019-06-17 The Complete Modern Tutorial on Practical VLSI Chip Design Validation and Analysis As microelectronics engineers design complex chips using existing circuit libraries they must ensure correct logical physical and electrical properties and prepare for reliable foundry fabrication VLSI Design Methodology Development focuses on the design and analysis steps needed to perform these tasks and successfully complete a modern chip design Microprocessor design authority Tom Dillinger carefully introduces core concepts and then guides engineers through modeling functional

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Hannibal Height,2012-12-18 With both cookbook style examples and in depth verification background novice and expert verification engineers will find information to ease their adoption of this emerging Accellera standard *SystemVerilog Assertions and Functional Coverage* Ashok B. Mehta,2013-08-13 This book provides a hands on application oriented guide to the language and methodology of both SystemVerilog Assertions and SystemVerilog Functional Coverage Readers will benefit from the step by step approach to functional hardware verification which will enable them to uncover hidden and hard to find bugs point directly to the source of the bug provide for a clean and easy way to model complex timing checks and objectively answer the question have we functionally verified everything Written by a professional end user of both SystemVerilog Assertions and SystemVerilog Functional Coverage this book explains each concept with easy to understand examples simulation logs and applications derived from real projects Readers will be empowered to tackle the modeling of complex checkers for functional verification thereby drastically reducing their time to design and debug **EDN** ,2007 **UVM**

Testbench Workbook Benjamin Ting,2016-02-14 This is a workbook for Universal Verification Methodology **Hardware Verification with System Verilog** Mike Mintz,Robert Ekendahl,2007-05-03 This is the second of our books designed to help the professional verifier manage complexity This time we have responded to a growing interest not only in object oriented programming but also in SystemVerilog The writing of this second handbook has been just another step in an ongoing masochistic endeavor to make your professional lives as painfree as possible The authors are not special people We have worked in several companies large and small made mistakes and generally muddled through our work There are many people

in the industry who are smarter than we are and many coworkers who are more experienced However we have a strong desire to help We have been in the lab when we bring up the chips fresh from the fab with customers and sales breathing down our necks We ve been through software 1 bring up and worked on drivers that had to work around bugs in production chips What we feel makes us unique is our combined broad experience from both the software and hardware worlds Mike has over 20 years of experience from the software world that he applies in this book to hardware verification Robert has over 12 years of experience with hardware verification with a focus on environments and methodology

Verilog and

SystemVerilog Gotchas Stuart Sutherland,Don Mills,2010-04-30 In programming Gotcha is a well known term A gotcha is a language feature which if misused causes unexpected and in hardware design potentially disastrous behavior The purpose of this book is to enable engineers to write better Verilog SystemVerilog design and verification code and to deliver digital designs to market more quickly This book shows over 100 common coding mistakes that can be made with the Verilog and SystemVerilog languages Each example explains in detail the symptoms of the error the languages rules that cover the error and the correct coding style to avoid the error The book helps digital design and verification engineers to recognize these common coding mistakes and know how to avoid them Many of these errors are very subtle and can potentially cost hours or days of lost engineering time trying to find and debug the errors This book is unique because while there are many books that teach the language and a few that try to teach coding style no other book addresses how to recognize and avoid coding errors with these languages

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ernest h shepard was a successful british illustrator and painter best known for his illustrations for the the wind in the willows by kenneth grahame and winnie the pooh by a a milne his work often created through a combination of watercolor and pen and ink is characterized by light washes of color and graphic black outlines

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shepard s illustrations were first published in 1926 and have become an iconic representation of the beloved characters shepard s illustrations of winnie the pooh and his friends piglet eeyore tigger and kanga were characterized by their simple clean lines and expressive cartoon like style

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in less than four months shepard painted 240 drawings for the books an impressive feat at ninety three years of age ernest howard shepard died three years later on march 24 1976 the same year as winnie the pooh s 50th anniversary

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