#### 8. Design of Latches and flip flops: D-latch SR, D,JK, T

Aim: Design of Latches and flip flops (D-latch SR, D,JK, T) using Verilog and simulates the design

Apparatus required: - Electronics Design Automation Tools used: -

- Xillinx Spartan 3 FPGA
- Xilinx ISE Simulator tool
- Xilinx XST Synthesis tool
- Xilinx Project Navigator 8.1i
- JTAG cable
- Adaptor 5v/4A.

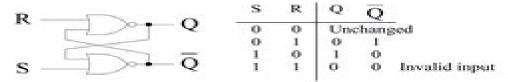
#### Theory:

#### LATCH AND FLIP-FLOP

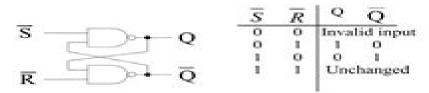
Latch and flip-flop are memory devices and implemented using bistable circuit - its output will remain in either 0 or 1 state. The output state of a latch is controlled by its excitation input signals. A flip-flop (FF) is predominately controlled by a clock and its output state is determinted by its excitation input signals. Note that if the clock is replaced by a gated control signal, the flip-flop becomes a gated latch.

#### a. RS (reset-set) latch circuit

When S (set) is set to 1, the output Q will be set to 1. Likewise, when R (reset) is set to 1, the output Q will be set to 0. It is invalid to set both S and R to 1.



#### NOR gate implementation



#### NAND gate implementation

Note that the input is <u>active high</u> for NOR gate implementation, whereas the input is <u>active low</u> for NAND gate implementation.

#### b. Clocked RS FF

Composed by Dr. Swaminathan,

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**IM Harris** 

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The Verilog PLI Handbook Stuart Sutherland, 2013-04-18 The Verilog Programming Language Interface commonly called the Verilog PU is one of the more powerful features of Verilog The PU provides a means for both hardware designers and software engineers to interface their own programs to commercial Verilog simulators Through this interface a Verilog simulator can be customized to perform virtually any engineering task desired Just a few of the common uses of the PU include interfacing Veri log simulations to C language models adding custom graphical tools to a simulator reading and writing proprietary file formats from within a simulation performing test coverage analysis during simulation and so forth The applications possible with the Verilog PLI are endless Intended audience this book is written for digital design engineers with a background in the Verilog Hardware Description Language and a fundamental knowledge of the C programming language It is expected that thereader Has a basic knowledge of hardware engineering specifically digital design of ASIC and FPGA technologies Is familiar with the Verilog Hardware Description Language HDL and can write models of hardware circuits in Verilog can write simulation test fixtures in Verilog and can run at least one Verilog logic simulator Knows basic C language programming including the use of functions pointers structures and file I O Explanations of the concepts and terminology of digital Verification Methodology Manual for SystemVerilog Janick Bergeron, Eduard Cerny, Alan Hunter, Andy Nightingale, 2005-09-28 Offers users the first resource guide that combines both the methodology and basics of SystemVerilog Addresses how all these pieces fit together and how they should be used to verify complex chips rapidly and thoroughly Unique in its broad coverage of SystemVerilog advanced functional verification and the combination of the two

another situation a different coding style is best As with any high level language Verilog often provides engineers several

ways to accomplish a specific task Wouldn t it be wonderful if an engineer first learning Verilog could start with another engineer s bag of tricks without having to go through years of trial and error to decide which style is best for which circumstance That is where this book becomes an invaluable resource The book presents dozens of Verilog tricks of the trade on how to best use the Verilog HDL for modeling designs at various level of abstraction and for writing test benches to verify designs The book not only shows the correct ways of using Verilog for different situations it also presents alternate styles and discusses the pros and cons of these styles **Digital System Design and Verification Using System Verilog** Mr. Rohit Manglik,2024-03-06 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels

<u>Digital VLSI Design with Verilog</u> John Michael Williams, 2014-06-17 This book is structured as a step by step course of study along the lines of a VLSI integrated circuit design project The entire Verilog language is presented from the basics to everything necessary for synthesis of an entire 70 000 transistor full duplex serializer deserializer including synthesizable PLLs The author includes everything an engineer needs for in depth understanding of the Verilog language Syntax synthesis semantics simulation and test Complete solutions for the 27 labs are provided in the downloadable files that accompany the book For readers with access to appropriate electronic design tools all solutions can be developed simulated and synthesized as described in the book A partial list of design topics includes design partitioning hierarchy decomposition safe coding styles back annotation wrapper modules concurrency race conditions assertion based verification clock synchronization and design for test A concluding presentation of special topics includes System Verilog and Verilog AMS **SystemVerilog Assertions** Handbook Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari, 2005 Embedded Systems Handbook Richard Zurawski, 2018-09-03 Considered a standard industry resource the Embedded Systems Handbook provided researchers and technicians with the authoritative information needed to launch a wealth of diverse applications including those in automotive electronics industrial automated systems and building automation and control Now a new resource is required to report on current developments and provide a technical reference for those looking to move the field forward yet again Divided into two volumes to accommodate this growth the Embedded Systems Handbook Second Edition presents a comprehensive view on this area of computer engineering with a currently appropriate emphasis on developments in networking and applications Those experts directly involved in the creation and evolution of the ideas and technologies presented offer tutorials research surveys and technology overviews that explore cutting edge developments and deployments and identify potential trends This first self contained volume of the handbook Embedded Systems Design and Verification is divided into three sections It begins with a brief introduction to embedded systems design and verification It then provides a comprehensive overview of embedded processors and various aspects of system on chip and FPGA as well as

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Microprocessor System Design using FPGAs Uwe Meyer-Baese, 2025-05-29 This textbook for courses in Embedded Systems introduces students to necessary concepts through a hands on approach It gives a great introduction to FPGA based microprocessor system design using state of the art boards tools and microprocessors from Altera Intel and Xilinx HDL based designs soft core parameterized cores Nios II and MicroBlaze and ARM Cortex A9 design are discussed compared and explored using many hand on designs projects Custom IP for HDMI coder Floating point operations and FFT bit swap are developed implemented tested and speed up is measured New additions in the second edition include bottom up and top down FPGA based Linux OS system designs for Altera Intel and Xilinx boards and application development running on the OS using modern popular programming languages Python Java and JavaScript HTML CSSs Downloadable files include all design examples such as basic processor synthesizable code for Xilinx and Altera tools for PicoBlaze MicroBlaze Nios II and ARMv7 architectures in VHDL and Verilog code as well as the custom IP projects For the three new OS enabled programing languages a substantial number of examples ranging from basic math and networking to image processing and video animations are provided Each Chapter has a substantial number of short quiz questions exercises and challenging projects

A Practical Guide to Analog Behavioral Modeling for IC System Design Paul A. Duran, 2012-11-14 A Practical Guide to Analog Behavioral Modeling for IC System Design presents a methodology for abstracting an IC system so that the designer can gain a macroscopic view of how sub systems interact as well as verify system functionality in various applications before committing to a design This will prevent problems that may be caused late in the design cycle by incompatibilities between the individual blocks that comprise the overall system This book will focus on the techniques of modelling IC systems through analog behavioral modeling and simulation It will investigate a practical approach by which designers can put together these systems to analyze topological and architectural issues to optimize IC system performance Highlights Discussions on modeling and simulation from SPICE to behavioral simulators Comparison of various hardware description languages and a discussion on the effects of language standardization Explanation on how to reduce time to market by decreasing design cycle time through modeling and simulation Contains more than 25 building block examples that can be used to construct mixed signal IC system models Analysis of 4 different IC systems using various levels of model detail This book is intended for the practicing engineer who would like to gain practical knowledge in applications of analog behavioral modelling for IC system design **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

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SystemVerilog Examples Pong P. Chu, 2018-05-04 A hands on introduction to FPGA prototyping and SoC design This is the successor edition of the popular FPGA Prototyping by Verilog Examples text It follows the same learning by doing approach to teach the fundamentals and practices of HDL synthesis and FPGA prototyping The new edition uses a coherent series of examples to demonstrate the process to develop sophisticated digital circuits and IP intellectual property cores integrate them into an SoC system on a chip framework realize the system on an FPGA prototyping board and verify the hardware and software operation The examples start with simple gate level circuits progress gradually through the RT register transfer level modules and lead to a functional embedded system with custom I O peripherals and hardware accelerators Although it is an introductory text the examples are developed in a rigorous manner and the derivations follow the strict design quidelines and coding practices used for large complex digital systems. The book is completely updated and uses the SystemVerilog language which absorbs the Verilog language It presents the hardware design in the SoC context and introduces the hardware software co design concept Instead of treating examples as isolated entities the book integrates them into a single coherent SoC platform that allows readers to explore both hardware and software programmability and develop complex and interesting embedded system projects The new edition Adds four general purpose IP cores which are multi channel PWM pulse width modulation controller I2C controller SPI controller and XADC Xilinx analog to digital converter controller Introduces a music synthesizer constructed with a DDFS direct digital frequency synthesis module and an ADSR attack decay sustain release envelope generator Expands the original video controller into a complete stream based video subsystem that incorporates a video synchronization circuit a test pattern generator an OSD on screen display controller a sprite generator and a frame buffer Provides a detailed discussion on blocking and nonblocking statements and coding styles Describes basic concepts of software hardware co design with Xilinx MicroBlaze MCS soft core processor Provides an overview of bus interconnect and interface circuit Presents basic embedded system software development Suggests additional modules and peripherals for interesting and challenging projects FPGA Prototyping by SystemVerilog Examples makes a natural companion text for introductory and advanced digital design courses and embedded system courses It also serves as an ideal self teaching guide for practicing engineers who wish to learn more about this emerging area of interest

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