

# Unlocking the Secrets of IP Core Design: A Comprehensive Guide from Specifications to Production

## IP Cores Design from Specifications to Production: Modeling, Verification, Optimization, and Protection

Khalaf Salah  
Mentor Graphics  
Cairo, Egypt  
khalaf\_salah@mentor.com

Mohamed Abdelrazek  
Mentor Graphics  
Cairo, Egypt  
Mohamed\_AbdelRazek@mentor.com

**Abstract**—This paper discusses the IP-core life cycle process from specification to product which includes four major steps: 1) IP Modeling, 2) IP verification, 3) IP optimization, 4) IP protection.

**Index Terms** — IP, Modeling, Verification, Optimization, Protection

### INTRODUCTION

Hardware intellectual property (IP) cores have emerged as an integral part of modern system-on-chip (SoC) design. IP cores are pre-designed and pre-verified complex functional blocks. According to their properties, IP cores can be distinguished into three types of cores: hard, firm, and soft, where Soft-cores are architectural modules which are synthesizable and offer the highest degree of modification flexibility. Firm-cores are delivered as a mix of RTL code and a technology-dependent net-list, and are synthesizable with the use of ASIC tools, and Hard-cores are mask and technology-dependent modules. The main differences in design between IC and IP are that in IC number of I/O pins are limited but in IP it is unlimited. Moreover, in IP we can parallelize IP Design. Let us start with the functionality at HDL code but in production, shared parts in the address translatability. IP core life cycle process from specification to production includes four major steps: 1) IP Modeling, 2) IP verification, 3) IP optimization, 4) IP protection. Their Steps are illustrated in Fig. 1, [1], [11]. In this paper, the IP life cycle process is discussed in details.

978-1-7291-2794-3/18/\$31.00 ©2018 IEEE

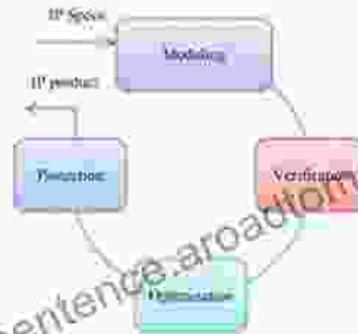


Fig. 1. IP-core life cycle process

## II. IP MODELING

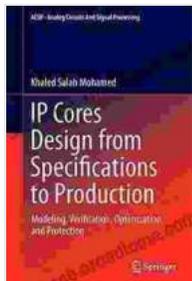
### A. Modeling Methodology

To model an IP, we have four design modeling methodologies as depicted in Fig. 2, [11]

- 1) **EDA-based Modeling**: defined by flood functionality and connectivity of hardware elements.
- 2) **Process-based Modeling**: Advanced routing programs written using a pre-built third set of instructions (ISA).
- 3) **ASIC-based Modeling**: System-level Layout.
- 4) **PCI-based Modeling**: It uses minimal ICs such as gate arrays (GAs), ASICs (CHIPS), or full VLSI or ASIC-based components.

In today's fast-paced world of electronics design, intellectual property (IP) cores play a pivotal role in accelerating product development and reducing

time-to-market. IP cores offer pre-verified, reusable building blocks that can be integrated into complex system-on-chip (SoC) designs, enabling engineers to focus on innovation and differentiation.



## IP Cores Design from Specifications to Production: Modeling, Verification, Optimization, and Protection (Analog Circuits and Signal Processing) by Sue Breeden

★★★★★ 5 out of 5

Language : English  
File size : 9867 KB  
Text-to-Speech : Enabled  
Enhanced typesetting : Enabled  
Print length : 229 pages



This comprehensive guide, "IP Cores Design: From Specifications to Production," provides an in-depth exploration of the entire IP core design process, from defining specifications to mass production. Written by industry experts with decades of experience in IP core development, this book covers every aspect of IP core design, including:

\* Specification development \* Architecture exploration \* RTL coding and verification \* Physical design and layout \* Fabrication and testing \* IP core integration and validation

### Chapter 1: Specification Development

The first step in any IP core design project is to develop a clear and concise specification. This specification should define the functional requirements, performance targets, and interface characteristics of the IP

core. It is essential to involve all stakeholders in the specification development process, including system architects, IP core designers, and end-users.

## **Chapter 2: Architecture Exploration**

Once the specification has been defined, the next step is to explore different architectural options for the IP core. This involves considering various trade-offs, such as performance, power consumption, and area footprint. The goal is to identify the architecture that best meets the requirements of the specification.

## **Chapter 3: RTL Coding and Verification**

With the architecture finalized, the next step is to code the IP core in a hardware description language (HDL), such as Verilog or VHDL. This code defines the logic and behavior of the IP core. Once the code has been written, it must be thoroughly verified to ensure its correctness and functionality. This involves using a combination of simulation, emulation, and formal verification techniques.

## **Chapter 4: Physical Design and Layout**

Once the RTL code has been verified, the next step is to translate it into a physical design. This involves creating a layout of the IP core on a silicon wafer. The layout must be carefully designed to meet the performance, power, and area requirements of the specification.

## **Chapter 5: Fabrication and Testing**

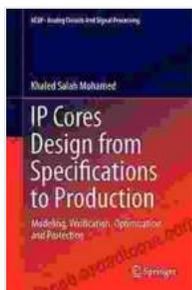
Once the physical design is complete, the IP core is fabricated on a silicon wafer. This process involves several steps, including patterning, etching,

and doping. After fabrication, the IP core is tested to ensure its functionality and performance.

## Chapter 6: IP Core Integration and Validation

Once the IP core has been fabricated and tested, it is ready to be integrated into a larger SoC design. This involves connecting the IP core to other components on the chip and verifying its functionality. The final step in the IP core design process is to validate the SoC design through simulation, emulation, and testing.

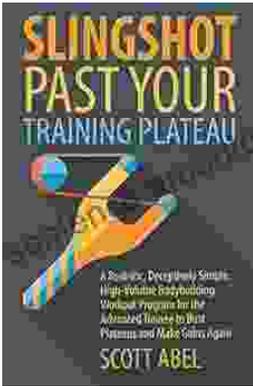
"IP Cores Design: From Specifications to Production" is an essential resource for anyone involved in the design and development of IP cores. This comprehensive guide provides a step-by-step roadmap for the entire IP core design process, from specification development to mass production. By following the principles and practices outlined in this book, engineers can create high-quality IP cores that meet the demands of today's complex SoC designs.



### IP Cores Design from Specifications to Production: Modeling, Verification, Optimization, and Protection (Analog Circuits and Signal Processing) by Sue Breedon

★★★★★ 5 out of 5  
Language : English  
File size : 9867 KB  
Text-to-Speech : Enabled  
Enhanced typesetting : Enabled  
Print length : 229 pages





## **Unlock Your Muscular Potential: Discover the Revolutionary Realistic Deceptively Simple High Volume Bodybuilding Workout Program**

Are you tired of bodybuilding programs that are overly complex, time-consuming, and ineffective? Introducing the Realistic Deceptively Simple High Volume Bodybuilding...



## **Dominate the Pool: Conquer Performance with the DS Performance Strength Conditioning Training Program for Swimming**

As a swimmer, you know that achieving peak performance requires a comprehensive approach that encompasses both in-water training and targeted...