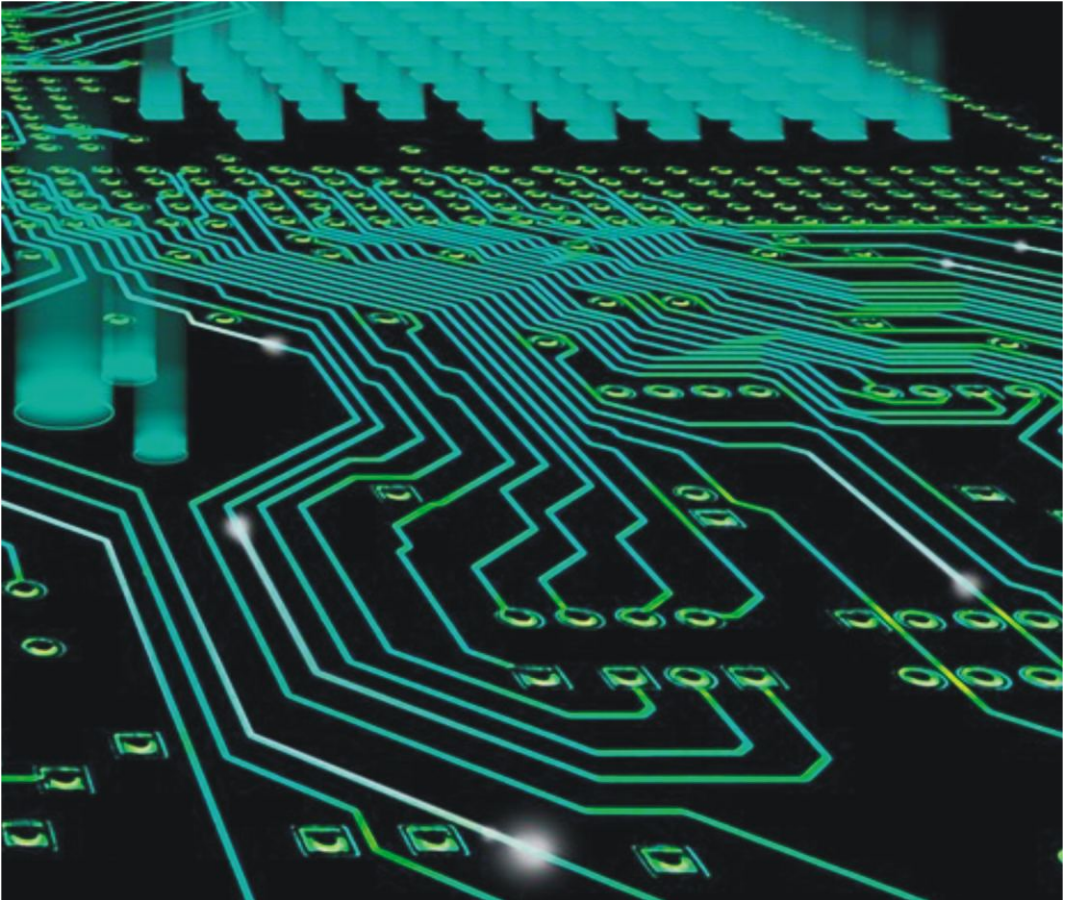


Integrated Circuit Design Using Open Cores and Design Tools

Achieving integrated circuit designs, by using open source hardware blocks and royalty free design tools, is now available for electronic engineers with a general purpose computer and internet access. Keep up with the trend!



Integrated Circuit Design Using Open Cores and Design Tools

Martha Salomé López de la Fuente

Science Publishing Group

548 Fashion Avenue
New York, NY 10018

www.sciencepublishinggroup.com

Published by Science Publishing Group 2015

Copyright © Martha Salomé López de la Fuente 2015

All rights reserved.

First Edition

ISBN: 978-1-940366-44-9

This work is licensed under the Creative Commons Attribution-NonCommercial 3.0 Unported License. To view a copy of this license, visit

<http://creativecommons.org/licenses/by-nc/3.0/>



or send a letter to:
Creative Commons
171 Second Street, Suite 300
San Francisco, California 94105
USA

To order additional copies of this book, please contact:
Science Publishing Group
book@sciencepublishinggroup.com
www.sciencepublishinggroup.com

Printed and bound in India

Preface

This book presents and explains the design of Integrated Circuits using open cores and open source design tools. It covers design aspects for all of the circuit elements: a processor (the Open RISC 1200 or OR1200), program memory, data memory, external address and data buses, communication port, interrupt controller, internal bus, clock, reset, and GPIO ports. For this purpose, all the hardware cores are open source and the fabrication technology is low cost. Detailed aspects of the design process are explained, such as application software optimization, small memory usage, memory intensive algorithms versus computation intensive algorithms. Also, an analysis of several application and research fields is presented, so the designed and implemented circuit used in this book as an example, can be used in other applications, with little or no modifications. Besides, a detailed design flow is explained, showing calculations for every design stage; the design flow covers synthesis process, area optimization, power and speed calculations, IO ring definition, and Place&route of the components and connections. Finally, two different implementations are presented: low-cost high volume, and medium-cost low volume: a) Technical data of the Integrated circuit implementation is presented and explained. b) An alternate implementation is also presented, using a development board with an ARM processor, especially useful for one-shot implementations. We hope that this book can help those electronic engineers with innovative ideas that can be implemented in an integrated circuit, without needing a big brand behind them.

Contents

Preface	III
Chapter 1 Introduction	1
1.1 Integrated Circuits	3
1.2 Digital and Analog Components.....	5
1.3 Combinational and Sequential Circuits	6
1.4 Clocked or Timed Circuits.....	6
1.5 Circuit Size	7
1.6 Design Process.....	7
1.7 Simulation Process	8
1.8 Implementation.....	9
1.9 Fabrication Process.....	10
1.10 Marketing Process	11
Chapter 2 Processor Based Integrated Circuits.....	13
2.1 Relevance and Potential Uses.....	15
2.2 Design Variables	17
2.3 Chips and Intelligent Systems	17
2.4 Opportunity Areas	21
2.5 Systems and Labs on a Chip.....	22
Chapter 3 System Design	25
3.1 System Definition and Specifications.....	27
3.1.1 Motivation	28
3.1.2 Statement of the Problem	29
3.1.3 Proposed System	31
3.1.4 Frequency Synthesis	33

3.1.5 Comprehensive System	34
3.1.6 Scope and Limitations	35
3.2 Software Architecture	37
3.2.1 Processor Based Implementation.....	38
3.2.2 SoC Components	39
3.3 Challenges for Variable Optimization	45
3.4 System-on-Chip Specifications	46
3.5 Signal Generation	49
3.5.1 Frequency Synthesis Methodology	51
3.5.2 Output Data	53
3.5.3 Frequency Sweep and Superposition.....	54
3.5.4 Methodology Software Architecture	55
3.6 ASIC Design Flow.....	58
3.6.1 Design Methodology	58
3.6.2 CAD Tools	59
3.6.3 Synthesis and Timing	60
3.6.4 Place and Route	65
3.6.5 Power Analysis	66
3.6.6 IO Ring	69
3.6.7 Clock Tree Synthesis	73
3.6.8 Integration.....	74
3.7 Design Evaluation	77
3.8 Application Software	80
3.8.1 Program Flow	80
3.8.2 Standard Version.....	81
3.8.3 Extended Version.....	82
Chapter 4 The Open Source Design Tools	85
4.1 Chip Design Flow	87
4.2 Open Source Design Tools	88

4.3 Open Source EDA Tools.....	88
4.4 Open Cores Library	89
Chapter 5 Sample Implementation	95
5.1 The Running Application Program.....	97
5.2 Experiment Definition	99
5.3 Simulations.....	101
5.4 Experimental Environment.....	103
5.5 System Potential	108
Chapter 6 Integrated Circuits for Intelligent Systems	119
6.1 The Smart Systems and the Integrated Circuits.....	125
6.2 ASIC for Customized Applications	127
6.3 Design and Market Trends.....	128
Glossary	133
References	137
Appendixes	139

