

Fundamentals and Standards in Hardware Description Languages

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Fundamentals and Standards in Hardware Description Languages

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TABLE OF CONTENTS

Part I	Fundamentals	1
	Fundamentals of Hardware Description Languages and Declarative Languages	3
	<i>Raymond Boute</i>	
	Mathematical basis and a declarative language	4
	Functions	4
	Function and object denotations	5
	An intermezzo: lambda terms and combinators	7
	The functional basis for a declarative language	11
	Structural description	14
	Designating location in hardware structure	14
	Directional systems	18
	Adirectional systems: introductory discussion	26
	Sigma terms and the description of adirectional systems	29
	CONLAN: Presentation of Basic Principles, applications and relation to VHDL	39
	<i>Dominique Borrione, Robert Piloty</i>	
	The Genesis	39
	The salient feature of ConLan	39
	Language derivation	44
	Applications of ConLan	65
	The Influence of ConLan on VHDL	75
	Comparison of ConLan with VHDL	75
	Logic and Arithmetic in Hardware Description Languages	79
	<i>Alex Zamfirescu</i>	
	Logic systems	80
	Resolution function design	83
	Language defined types and operators	88
	Towards standard RTL functions and procedures	88
	Floating point types supported by HDLs	92
	Transcendental functions	93
	Complex numbers	95
	The Fuzzy If-Then Rules	99
	HDLs Matching Fuzzy	101
	System Level Design	109
	<i>Franz J.Rammig</i>	
	The Electronics Engineer's Point of View	109
	General Point of View	112
	System Level Design	113
	Specification and Modelling	114
	Towards a Unified System Level Modelling Technique	125
	Design Activities	143
	System Level Design and Concurrent Engineering	144

Part II	Applications to formal proofs, high level synthesis, multilevel simulation and hierarchical testing	153
Formal Proofs from HDL Descriptions		155
<i>Dominique Borrione, Hans Eveking, Laurence Pierre</i>		
Verification of combinational circuits		160
Proof of parameterized circuits against high level specifications		167
Formal proof of Synchronized Sequential Circuits		172
Symbolic Model Checking		179
Inductive proofs of sequential circuits		185
High-Level Synthesis in a Production Environment: Methodology and Algorithms		195
<i>Reinaldo A. Bergamaschi</i>		
High-Level Synthesis Methodology		197
VHDL Modeling for Synthesis		197
Algorithms for High-Level Synthesis from VHDL		202
Integration between High-Level and Logic Synthesis		218
Synthesis Applications of VHDL		231
<i>Eugenio Villar, Pablo Sánchez</i>		
RT and logic synthesis		237
Design Methodologies		238
VHDL combinational Circuit Description		240
Latch, clock and register inference		243
FSM inference		246
Synthesis algorithms		249
VHDL High-level synthesis methodology		256
HDL-Driven Digital Simulation		263
<i>Alec Stanculescu</i>		
Purpose and Background		263
Typical processing steps in HDL-driven Simulations		265
Simulator Kernel		265
Generation of Code for a given circuit		269
Elaboration of Simulator		270
Simulation Cycle		270
Modeling in HDLs		271
Research Topics		279
Analog and Mixed-Level Simulation with Implications to VHDL		281
<i>Alain Vachoux, Kevin Nolan</i>		
Conventional approach		285
New analysis techniques		295
The simulation spectrum		306
Analog and digital modeling requirements		308
Mixed-mode simulation techniques		313
Implications for analog VHDL		325
Rapid Development and Testing of Behavioral Models		331
<i>James R. Armstrong, Alexander Honcharik</i>		
Basic Modeling Approach		332
The Pictorial Representation: The Process Model Graph		332
The Behavioral Model and Model Test Development System		334
Status		355

Part III	Introduction to Hardware Description Languages implemented in the 80's	357
VHDL		359
<i>Paul J. Menchini</i>		
	A Short History of VHDL	359
	Principles of VHDL	364
	VHDL's Semantic Model	368
	Some New Features of VHDL'92	369
	Some Requested Features Not in VHDL'92	382
ELLA		385
<i>John D. Morison, Cleland O. Newton</i>		
	The Reasoning Behind the Design of ELLA	386
	The Underlying Model	386
	Distinguishing Features of the Language	387
	The ELLA system	393
	Application to Hardware Design	393
	Use of ELLA	394
DACAPO III		395
<i>Franz J. Rammig</i>		
	Descriptions at the Algorithmic Level	398
	Descriptions at the System Level	402
	Descriptions at the Register Transfer Level	405
	Descriptions at the Gate/Switch Level	406
	Behavioral Descriptions	408
CASCADE		411
<i>Dominique Borrione</i>		
	Modularity	413
	Behaviour modelling and abstraction levels	416
	Mixed-level modelling	429
REGLAN		431
<i>Robert Piloty</i>		
	The primitive scalar value types	432
	Quatvectors and quatarrays as primitive composite value type	434
	Behavior description	436
	The basic carrier types	437
	Vectors and arrays of carriers	443
	Special functions with carriers as arguments	444
	Structure description	444
	The REGLAN simulation system	445
KARL and ABL		447
<i>Reiner Hartenstein</i>		
	Textual KARL Versions	447
	Interactive Graphic Language ABL	452
	Supporting Structured Design	453
	The intermediate Form RT code	460
	KARL-related CAD Tools	460
	Exploitation Efforts	464

Preface

The second half of this century will remain as the era of proliferation of electronic computers. They did exist before, but they were mechanical.

During next century they may perform other mutations to become optical or molecular or even biological. Actually, all these aspects are only fancy dresses put on **mathematical machines**. This was always recognized to be true in the domain of software, where "machine" or "high level" languages are more or less rigorous, but immaterial, variations of the universally accepted mathematical language aimed at specifying elementary operations, functions, algorithms and processes.

But even a mathematical machine needs a physical support, and this is what hardware is all about. The invention of **hardware description languages** (HDL's) in the early 60's, was an attempt to stay longer at an abstract level in the design process and to push the stage of physical implementation up to the moment when no more technology independant decisions can be taken.

It was also an answer to the continuous, exponential growth of complexity of systems to be designed. This problem is common to hardware and software and may explain why the syntax of hardware description languages has followed, with a reasonable delay of ten years, the evolution of the programming languages : at the end of the 60's they were "Algol like", a decade later "Pascal like" and now they are "C or ADA-like". They have also integrated the new concepts of advanced software specification languages.

Although HDL's can describe some of the constraints associated to a given technology (timing, resolution functions, topology ...), these data can be considered as "outside world" parameters. The domain of HDL's contains abstract objects, which in theory could be mapped onto any technology, if convenient CAD tools were provided. This results into a new situation.

On the one hand side, due to their complexity, which was made them unmanageable even by large human teams since a few years, systems to be designed depend upon available CAD tools. We shall certainly continue to develop CAD tools able to implement more complex systems, but we shall design more and more implement systems that existing CAD tools are able to implement.

On the other hand side, HDL descriptions will remain "implementation free", although increasingly precise and complete, making possible several successive implementations of the same system over several technological generations.

It is interesting enough to know that this property was one of the biggest incentive (together with design documentation maintenance) for the DoD to launch the call for proposals for a VHDL (Very High Speed Intagrated Circuits HDL) because military systems have multi-decade lifespans and then imply reprourement of obsolete part.

It is always fruitful to have regularly a look back to the technological progress, in order to confront its evolution to the fundamental concepts. This is the first aim of this book, and it has been achieved by scientists able to make a synthesis over several decades.

The first part deals with mathematics, high level language concepts and system level methodology. It will help to assimilate the theoretical background for advanced application domains of HDL's :

- Formal proof of designs
- High level synthesis
- Multilevel mixed - mode simulation
- Hierarchical test generation

These topics constitute the second part of the book.

But a sample of the most recently fully implemented HDL's will be also provided in the third part of the book. They demonstrate at the same time how new concepts can become reality, how long it takes and how long it will again take to complete HDL up to the level of knowledge of to day and, what is more, to have them easily used by system engineers and designers. Drawing the lessons of thirty years of Hardware Description Languages, this book is also an incitement to stay modest : new technologies, whether "high" or "ordinary" require a human generation to become widely accepted.

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The support from companies was impressive with, in first rank, SUN Microsystems France and SUN Microsystems Italy, having provided ten workstations with technical assistance and also IBM, Mentor-Graphics and VANTAGE (A VIEWLOGIC Company) having made available one station each with their most advanced application software.

I shall not forget the remarkable contribution of small EDA companies such as Model Technology, ANACAD, FINTRONIC-USA, CLSI, and LEDA whose software and courseware have brought an irreplaceable technology for the hands-on laboratories.

But obviously this book belongs to its authors. I want to thank them warmly for having accepted to publish the best of their outstanding works and for having spent a lot of precious time to do this within severe constraints of size and presentation.

Wojciech Sakowski did the coordination of this collective work defining a unified presentation, collecting, reformatting, cutting and pasting : he deserves a special acknowledgement.

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Grenoble, June 10th, 1993

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