

CONTENTS

Contents	v
List of Figures	viii
List of Tables	ix
Preface	xiii
Acknowledgments	xv
1. INTRODUCTION	1
1.1 Book Motivation and Objectives	1
1.2 Book Organization	4
2. DESIGN OF PROCESSOR-BASED SOC	7
2.1 Integrated Circuits Technology	7
2.2 Embedded Core-Based System-on-Chip Design	8
2.3 Embedded Processors in SoC Architectures	11
3. TESTING OF PROCESSOR-BASED SOC	21
3.1 Testing and Design for Testability	21
3.2 Hardware-Based Self-Testing	32
3.3 Software-Based Self-Testing	41
3.4 Software-Based Self-Test and Test Resource Partitioning	46
3.5 Why is Embedded Processor Testing Important?	48
3.6 Why is Embedded Processor Testing Challenging?	49
4. PROCESSOR TESTING TECHNIQUES	55
4.1 Processor Testing Techniques Objectives	55
4.1.1 External Testing versus Self-Testing	56
4.1.2 DfT-based Testing versus Non-Intrusive Testing	57
4.1.3 Functional Testing versus Structural Testing	58
4.1.4 Combinational Faults versus Sequential Faults Testing	59
4.1.5 Pseudorandom versus Deterministic Testing	60
4.1.6 Testing versus Diagnosis	62
4.1.7 Manufacturing Testing versus On-line/Field Testing	63
4.1.8 Microprocessor versus DSP Testing	63
4.2 Processor Testing Literature	64
4.2.1 Chronological List of Processor Testing Research	64
4.2.2 Industrial Microprocessors Testing	78
4.3 Classification of the Processor Testing Methodologies	78
5. SOFTWARE-BASED PROCESSOR SELF-TESTING	81
5.1 Software-based self-testing concept and flow	82
5.2 Software-based self-testing requirements	87
5.2.1 Fault coverage and test quality	88
5.2.2 Test engineering effort for self-test generation	90

5.2.3	Test application time	91
5.2.4	A new self-testing efficiency measure	96
5.2.5	Embedded memory size for self-test execution	97
5.2.6	Knowledge of processor architecture	98
5.2.7	Component based self-test code development	99
5.3	Software-based self-test methodology overview	100
5.4	Processor components classification	107
5.4.1	Functional components	108
5.4.2	Control components	111
5.4.3	Hidden components	112
5.5	Processor components test prioritization	113
5.5.1	Component size and contribution to fault coverage	115
5.5.2	Component accessibility and ease of test	117
5.5.3	Components' testability correlation	119
5.6	Component operations identification and selection	121
5.7	Operand selection	124
5.7.1	Self-test routine development: ATPG	125
5.7.2	Self-test routine development: pseudorandom	133
5.7.3	Self-test routine development: pre-computed tests	137
5.7.4	Self-test routine development: style selection	139
5.8	Test development for processor components	141
5.8.1	Test development for functional components	141
5.8.2	Test development for control components	141
5.8.3	Test development for hidden components	143
5.9	Test responses compaction in software-based self-testing	146
5.10	Optimization of self-test routines	148
5.10.1	"Chained" component testing	149
5.10.2	"Parallel" component testing	152
5.11	Software-based self-testing automation	153
6. CASE STUDIES – EXPERIMENTAL RESULTS		157
6.1	Parwan processor core	158
6.1.1	Software-based self-testing of Parwan	159
6.2	Plasma/MIPS processor core	160
6.2.1	Software-based self-testing of Plasma/MIPS	163
6.3	Meister/MIPS reconfigurable processor core	168
6.3.1	Software-based self-testing of Meister/MIPS	170
6.4	Jam processor core	171
6.4.1	Software-based self-testing of Jam	172
6.5	oc8051 microcontroller core	173
6.5.1	Software-based self-testing of oc8051	175
6.6	RISC-MCU microcontroller core	176
6.6.1	Software-based self-testing of RISC-MCU	177

6.7	oc54x DSP Core	178
6.7.1	Software-based self-testing of oc54x	179
6.8	Compaction of test responses	181
6.9	Summary of Benchmarks	181
7. PROCESSOR-BASED TESTING OF SOC		185
7.1	The concept	185
7.1.1	Methodology advantages and objectives	188
7.2	Literature review	190
7.3	Research focus in processor-based SoC testing	193
8. CONCLUSIONS		195
References		197
Index		213
About the Authors		217