

Contents

1	Introduction	1
1.1	Classical Design Flow	1
1.2	Problem Formulation	4
1.3	Overview of the Book	5
	References	6
2	Definitions and Basic Properties	9
2.1	Basic Definitions	9
2.2	Finite State Machines	11
2.3	PAL-Based CPLDs	12
2.4	Term Expansion	14
2.5	Introduction to Technology-Dependent Logic Synthesis	18
	References	22
3	Synthesis of FSMs	25
3.1	Introduction to State Assignment	25
3.2	Elements of Two-Level Minimization	27
3.3	Primary Merging Conditions	28
3.4	Secondary Merging Conditions	31
3.5	Relationship between Merging Conditions	33
3.6	Implicants Distribution Table	36
3.7	Output Level Activity	39
3.8	Elements of Symbolic Minimization	41
3.8.1	State Minimization	41
3.8.2	Symbolic Implicants Minimization	45
3.9	Conclusions	47
	References	47
4	State Assignment Algorithms	49
4.1	Area Oriented State Assignment	49
4.2	Speed Oriented State Assignment	54
4.3	State Assignment by Means of Outputs	63

4.3.1	Matrix for State Assignment by Output Vectors M_E	63
4.3.2	Algorithm	66
4.4	Conclusions	70
	References	70
5	Area Optimization Based on Graphs of Outputs	71
5.1	Introduction to PAL-Oriented Area Optimization	71
5.2	Graph of Outputs	73
5.3	Area-Oriented Optimization Based on Graph of Outputs	77
5.4	Theoretical Background of Technology-Dependent Optimization	79
5.5	The Algorithm of Area Optimization Based on Graphs of Outputs	80
5.6	Conclusions	85
	References	85
6	Speed Optimization Using Tri-state Output Buffers	87
6.1	Introduction	87
6.2	Product Term Expansion Idea	89
6.3	Theoretical Backgrounds of Technology-Depended Speed Optimization Using Tri-State Outputs	92
6.4	Algorithm of Technology-Dependent Speed Optimization of Combinational Block	98
6.5	Conclusions	103
	References	103
7	Complex Strategies for FSMs	105
7.1	Introduction	105
7.2	Area Optimization	106
7.3	Speed Optimization	112
7.3.1	PAL-Oriented Speed Optimization	114
7.3.2	Ultra Fast FSMs	117
7.4	Conclusions	121
	References	122
8	Experiments	123
8.1	Benchmarks	123
8.2	Comparison to Academic Tools	123
8.2.1	Two-Level Logic Experiments	123
8.2.2	Sequential Logic Experiments	127
8.3	Comparison to Vendor Tools	139
8.3.1	Output File Format	139
8.3.2	Experimental Results	150
8.4	Conclusions	157
	References	158

9	Conclusions	161
A	File Formats	163
A.1	Benchmarks	163
A.2	ESPRESSO Format	163
A.3	KISS Format	166
B	ESPRESSO Minimizer	169
Index		171