

Table of Contents

Foreword	ii
Preface	iii
1. Introduction	1
2. IC Design Tools	4
2.1 Entering Your Design	5
2.2 Hardcopy Output	6
2.3 High-Level Descriptions	6
2.4 Design Rule Checking	8
2.5 Checking for Other Errors	10
2.6 Simulation as an IC Design Tool	11
2.7 Designing for Testability	17
3. Silicon Patterning	20
3.1 An Introduction to Photolithography	20
3.2 Mask Generation	21
3.2.1 Optically Generated Masters	21
3.2.2 E-Beam Masters	22
3.2.3 Working Plates	23
3.2.4 Mask Specification	25
3.3 Wafer Fabrication	27
3.3.1 The Si-Gate NMOS Process	28
4. Practical Considerations in IC Pattern Preparation	31
4.1 Merging Many Projects	31
4.2 Physical Constraints	33
4.3 The Starting Frame	33
5. When the Wafers Are Delivered...	39
5.1 Process Testing	39
5.2 Wafer Separation	40
5.3 Chip Packaging	41
5.4 Functional Testing	42
5.5 Simple Test Systems	44
5.6 A Concluding Remark	48

6. An Example Starting Frame and Project Chip	50
6.1 The PARC Starting Frame	50
6.2 Test Patterns	56
6.3 Example Project: A Transformational Memory Array	64
7. A CIF Primer	79
7.1 Definition of CIF 2.0	81
7.1.1 Syntax	81
7.1.2 Semantics	83
7.1.2.1 <i>Non-geometric Commands</i>	83
7.1.2.2 <i>Geometric Primitives</i>	85
7.1.2.3 <i>Symbols</i>	90
7.1.2.4 <i>Symbol Interpretation Rules</i>	92
7.1.3 The Relationship Between CIF and Fabricated Chips	94
7.1.4 Common Conventions for Using CIF	95
7.1.5 Future Plans for CIF	101
7.2 Ways to Generate CIF	102
7.2.1 Keyboard Interface	102
7.2.2 Programming Languages	103
7.2.3 Interactive Graphical Layout Systems	103
7.2.4 Standard-cell and Gate-array Systems	104
7.2.5 Silicon Compilers	104
7.3 Processing CIF Files	105
7.3.1 CIF Implementation Guidelines	105
7.3.1.1 <i>Parser</i>	105
7.3.1.2 <i>Interpreter</i>	108
7.3.1.3 <i>Output</i>	111
7.3.2 A Program for Processing CIF	114
7.3.2.1 <i>Parser</i>	118
7.3.2.2 <i>Interpreter</i>	119
7.3.2.3 <i>Output</i>	121
7.4 A Final Note	122
Appendices	
A. Optical and E-Beam Mask Specifications	124
B. Index of Manufacturers	132
C. Mann 3000 Pattern Generator Format	133
D. A Basic Library of Symbol Layouts	137
E. Additional References	157

