

# Index

## A

Acceptors, 10, 52  
Alignment marks, 38  
Analog design gap, 20  
Antenna effect, 286  
Antenna-rule check, 204  
Area routing, 185  
Assertion-Based Verification (ABV), 198

## B

Back annotation, 173  
Back-End-of-Line (BEOL), 82  
Band gap, 8  
BCD, 16  
BICMOS, 16  
Blind via (PCB), 4  
Bottom-up design style, 145  
Breakdown voltage, 218  
Buried via (PCB), 4

## C

Calculated layer, 115  
Capacitors, 227  
Carrier substrate (PCB), 3  
Cell generator, 233  
Channel-stop implant, 268  
Channel stopper, 269  
Charged-Device Model (CDM), 278  
Chemical-Mechanical Polishing (CMP), 67  
Circuit design, 22, 130  
Circuit diagram, 87, 169  
Circuit schematic, 87  
Circuit topology, 25  
Clock planning, 179

Clock tree synthesis, 131  
CMOS process steps, 73  
Compaction, 187  
Conduction band, 8  
Congestion-driven placement, 182  
Conics, 93  
Constraint  
    design-methodology, 150  
    electrical, 149  
    functional, 149  
    technological, 149  
Contact holes (IC), 13  
Contacts (IC), 13  
Crosstalk, 275  
Current mirror, 238  
Czochralski process, 33

## D

Damascene technique, 67  
Deep Trench Isolation (DTI), 59  
Defect electrons, 9  
Depletion region. *See* space-charge region  
Derived layer, 107  
Design freedom, 153  
Design gap, 20  
Design-methodology constraints, 150  
Design models, 133  
Design Rule Check (DRC), 202  
Design style, 139  
Detailed routing, 184  
Developer (PCB), 3  
Device, 85  
Differential pair, 238  
Differential-pair routing, 183, 274

Diffusion, 52  
 Diffusion layer. *See* doping layer  
 Diffusion resistors, 224  
 Dishing, 104  
 Donors, 10, 52  
 Donuts, 92  
 Doping, 10, 52  
 Doping layer, 56  
 Drawn layer, 92  
 Dual-Damascene process, 69  
 Dummy error, 196  
 Dummy fill, 104

**E**

Electrical constraints, 149  
 Electrical Rule Check (ERC), 204  
 Electromagnetic Compatibility (EMC), 192  
 Electromigration (EM), 291  
 Electronic Design Automation (EDA), 20  
 Electrostatic Discharge (ESD), 276  
 EMC-compliant layout, 192  
 Epitaxy, 11, 58  
 Equivalence checking, 198  
 ESD design window, 277  
 ESD event (chip), 276  
 ESD protection circuit, 276  
 Extract, extraction file, 205

**F**

Fabricated layer, 92  
 False error, 196  
 Field-Effect Transistor (FET), 73  
 Field-Effect Transistor (MOS-FET), 220  
 Field-Programmable Gate Array (FPGA), 143  
 Floorplan, floorplanning, 175  
 Folding (transistors), 222  
 Footprint library (PCB), 124  
 Footprint (PCB), 190  
 Formal verification, 198  
 FPGA (design), 143  
 Fracturing, 110  
 Front-End-of-Line (FEOL), 78  
 Full-custom design, 140  
 Functional constraints, 149  
 Functional design, 130, 168  
 Functional verification, 199

**G**

Gajski-Kuhn Y-Chart, 136  
 Galvanic isolation, 218

Gate array (design), 142  
 Gcell, 184  
 Geometrical design rules, 111  
 Global routing, 184  
 Guard ring, 260, 263, 266

**H**

Hard block, 175  
 Hardware Description Language (HDL), 166  
 Heteroepitaxy, 58, 61  
 Hole conduction, 9  
 Holes, 9  
 Homoepitaxy, 58  
 Hot carriers, 270  
 Hot electrons, 270  
 Human-Body Model (HBM), 278

**I**

Identification letter (schematic), 170  
 Instance, 86  
 Instantiation (device), 169  
 Ion implantation, 54  
 IPTAT circuit, 238

**J**

Jumper, 289  
 Junction Isolation (JI), 217

**K**

Keepout area (PCB), 191  
 Keep-out zone (TSV), 301

**L**

Landpattern (PCB), 190  
 Latchup, 264  
 Layer, 24  
   calculated, 115  
   derived, 107  
   diffusion, 56  
   doping, 56  
   drawn, 92  
   fabricated, 92  
   logical, 107, 108  
   physical, 107  
 Layout design, 23  
 Layout generator, 234  
 Layout post processing, 102, 208  
 Layout Versus Schematic (LVS), 205

Leaker, 289  
Legalization (placement), 180  
Library, 119  
    footprint (PCB), 124  
    macro cell, 123  
    model (PCB), 125  
    pad cell, 123  
    standard cell, 121  
    symbol (PCB), 123  
Lightly Doped Drain (LDD), 271  
Line losses, 272  
Local Oxidation of Silicon (LOCOS), 49  
Logical layer, 107, 108  
Logic design, 130  
Logic synthesis, 168  
Low Temperature Co-fired Ceramics (LTCC), 5  
Lumped elements, 86

## M

Machine Model (MM), 278  
Macro cell (design), 142  
Macro (cell) library, 123  
Manufacturing documentation (PCB), 193  
Mask (PCB), 3  
Matching, 237  
Matching concepts, 254  
Meet-in-the-middle design style, 145  
Mixed-signal IC, 158  
Model-based OPC, 44  
Model checking, 198  
Model library (PCB), 125  
Module generator, 234  
Moore's law, 19  
MOS-FET, 220

## N

N-doped, 10, 52  
Net, 84  
Netlist, 87, 173  
Node, 84  
NPN transistor, 230

## O

Optical Proximity Correction (OPC), 43, 110, 210  
Oversizing, 100  
Oxidation, 46  
Oxide, 45

## P

Pad, 117  
Pad cell library, 123  
Parasitic effects, 257  
Parasitic Extraction (PEX), 207  
Parasitics, 257  
Partitioning, partition, 175  
PCell, 120, 234  
P-doped, 10, 52  
Photolithography, 34  
Photomask, 36  
Photoresist, 34  
Physical design, 23  
Physical layer, 107  
Physical synthesis, 169  
Physical verification, 132  
Pin, 84  
Pin assignment, 178  
Pinning, 118  
Placement, 180  
Plasma-Induced Damage (PID), 287  
PNP transistor, 232  
Poly resistors, 226  
Port, 84  
Power supply (floorplanning), 177  
Printed Circuit Board (PCB), 2  
Process Design Kit (PDK), 119  
Process nodes, 17

## R

RC element, 273  
RC optimization, 274  
Reactive Ion Etching (RIE), 48  
Register Transfer Level (RTL), 166  
Resist, 34  
Resist mask, 35  
Resistor head, 226  
Resistors, 224  
Resolution Enhancement Techniques (RET), 110, 209  
Reticle, 37  
Reticle layout, 105  
Rip-up and reroute, 186  
Robustness (layout, design rule), 111  
Routing, 183  
Routing layers, 63  
Rule-based OPC, 44

## S

Schematic, 169  
Schematic entry, 169, 189  
Schematic symbols, 172

Semiconductor, 8  
Shallow Trench Isolation (STI), 59  
Shapes, 91  
Sheet resistance, 214  
Shrinking, 18  
Shunt path, 276  
Signal distortions, 273  
Silicon dioxide (SiO<sub>2</sub>), 33, 45  
Silicon (Si), 33  
Simulation, 199  
Simulation Program with Integrated Circuit  
    Emphasis (SPICE), 90  
Sinkers, 217  
Sizing, 100  
Smart power IC, 16  
Soft block, 175  
Space-charge region, 218  
Specification, 21, 129  
Standard-cell design, 140  
Standard cell library, 121  
Standard cells, 141  
Static Timing Analysis (STA), 201  
Stick diagram, 187  
Stimuli (simulation), 199  
Stress Migration (SM), 293  
Subcircuit, 85  
Substrate currents, 258  
Substrate debiasing, 258  
Sub-wavelength lithography, 43  
Surface-Mount(ed) Device (SMD), 4  
Surface-Mount Technology (SMT), 4  
Symbolic compaction, 187  
Symbolic design entry, 169  
Symbolic layout design, 187  
Symbol library (PCB), 123  
System specification, 129

**T**

Tank (well), 217  
Technological constraints, 149  
Technology nodes, 17  
Thermal Migration (TM), 292  
Thermal via, 300  
Thermal wire, 300  
Thick-field threshold, 268

Thick-film technology, 5  
Thin-film technology, 5  
Through contact (IC), 13  
Through-Hole Device (THD), 4  
Through-Hole Technology (THT), 4  
Through-hole via (PCB), 4  
Time constant (RC element), 273  
Timing closure, 131, 202  
Timing-driven placement, 182, 202  
Timing-driven routing, 202  
Timing verification, 200  
Top-down design style, 145  
Tub (well), 217

**U**

Undercut, 48  
Undersizing, 100

**V**

Valence band, 8  
Valence electrons, 8  
Validation (vs verification), 147  
Verilog, 166  
Verilog-AMS, 166  
VHDL-AMS, 166  
VHSIC Hardware Description Language  
    (VHDL), 166  
Via, 13  
Via doubling, 186  
Via minimization, 186  
Via (PCB), 4  
Voltage-dependent spacing rules, 219

**W**

Well, 216

**Y**

Y-chart, 136

**Z**

Zone melting, 33