VLSI Handbook

Edited by

NORMAN G. EINSPRUCH

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College of Engineering
University of Miami
Coral Gables, Florida

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Preface

This one-step reference handbook offers engineers and scientists the concise critical facts they need on VLSI (very large scale integration) microelectronics. The entire book is a ready source of information on VLSI circuits, fabrication, and systems applications.

It is now generally recognized and broadly accepted that microelectronics has brought our civilization past the threshold of the second industrial revolution. The first industrial revolution, based on the steam engine, enabled man to multiply his capability to do physical work. In a comparable manner, semiconductor electronics is enabling man to multiply his capacity for performing intellectually based tasks. VLSI is the current embodiment of advanced semiconductor electronics technology. The "VLSI Handbook" is published in an effort to satisfy the need for a systematic compilation of knowledge at the leading edge of this technology to satisfy the needs of those who require readily available answers to rather specifically defined questions.

This handbook is a comprehensive compilation to provide data, performance application information, and guidelines for the entire range of VLSI technology. It will be of value as well to basic and applied researchers interested in the physics and chemistry of materials and processes, to device designers, and to systems designers.

This handbook is organized in a manner wherein chapters are grouped into the fields of design, materials and processes, and examples of specific systems applications. Each of the chapters is prepared by an expert in the field and is written in a way that promotes stand-alone comprehension.

Since it is anticipated that this work will evolve as it goes through future editions, the editor welcomes suggestions for quality enhancement and for other topics for inclusion.

Acronyms

ACU	Array control unit
AES	Auger electron spectroscopy
ARU	Array unit
ASTM	American Society for Testing and Materials
BER	Bit-error rate (modems)
BFL	Buffered FET logic (GaAs)
BIGFON	Broadband integrated glass fiber optic network
C-V	Capacitance-voltage (technique for measuring spreading resistance)
CAD	Computer-aided design
CAE	Computer-aided engineering
CAL	Computer-aided layout
CAM	Content addressable memory
CAM	Computer-aided manufacturing
CAS	Column address strobe
CAT	Computer-aided test
CCD	Charged coupled device (imager)
CD	Dimensional control
CE	Chip enable
CID	Charge injection device (imager)
CIF	Caltech Intermediate Form (database)
CIL	Current injection logic (superconductor junctions)
CML	Current mode logic (bipolar VLSI logic circuit)
CMOS	Complementary metal-oxide semiconductor
CMRT	Cellular mobile radio telephone
CPD	Charge primary device (imager)
CRT	Cathode ray tube
CSMA/CD	Carrier-sense multiple access with collision detection (distributed communications)
CVD	Chemical vapor deposition (epitaxy)
CVE	Chemical vapor (growth) epitaxy
DCL	Direct coupled logic gate
DES	Data encryption standard
DFT	Discrete Fourier transform

DI	Dielectric isolation
DIIC	Dielectric isolated integrated circuit
DLTS	Deep level transient spectroscopy
DMA	Direct memory access
DPSK	Differential phase shift keying
DRAM	Dynamic random access memory
DSP	Digital signal processing
EBIC	Electron beam induced conductivity
ECB	Electronic code book (encryption, DES)
ECL	Emitter coupled logic (bipolar VLSI logic circuit)
EEPROM	Electrically erasable programmable ROM
EPROM	Erasable programmable ROM
FET	Field effect transistor
FFT	Fast Fourier transform
FIIR	Fourier transform infrared spectroscopy(?)
FIPOS	Full isolation by porous oxidized silicon
FLOTOX	Floating gate tunnel oxide
FSK	Frequency shift keying
FTIR	Fourier transform infrared spectrometry (technique for measuring low-level impurities in films)
HBT	Heterojunction bipolar transistor
HEMT	High electron mobility transistor
HMOS	High performance metal oxide semiconductor
ICHD	Intersociety Commission for Heart Disease
IC	Integrated circuit
IGFET	Insulated gate field effect transistor
IMPATT	Impact ionization avalanche transit time
IR	Infrared
ISI	Intersymbol interference (modems)
ITL	Integrated injection logic (bipolar VLSI logic circuit)
JAWS	Josephson Atto-Weber switch
JFET	Junction field effect transistor
JIIC	Junction isolated integrated circuit
LAN	Local area network (patient monitoring, distributed communications)
LDM	Linear delta modulation
LEC	Liquid-encapsulated Czochralski wafers
LEGO	Lateral epitaxial growth over oxide
LLR	Lower level resist
LOCOS	Local oxidation of silicon
LPC	Linear predictive coding
LPC	Linear prediction coefficient (speech processing)
LPCVD	Low pressure chemical vapor deposition
LPE	Liquid phase epitaxy

LSI	Large scale integration
MAC	Multiplier-accumulator (part of a fast Fourier transform)
MBE	Molecular beam epitaxy
MESFET	Metal semiconductor field effect transistor
MF	Metal ion-free developers
MIPS	1 million instructions per second
MMU	Memory management unit
Modem	Modulator–demodulator
MOSFET	Metal-oxide semiconductor field effect transistor
MOS	Metal-oxide semiconductor
MPP	Massively parallel processor
MSI	Medium scale integration
MTBF	Mean time between failures
MTF	Modulation transfer function
MTL	Merged transistor logic (Bipolar VLSI logic circuit)
NAA	Neutron activation (Technique for measuring low-level impurities in films)
NASPE	North American Society for Pacing and Electrophysiology
NES	Noise equivalent signal
NMOS	*n*-channel metal oxide semiconductor
NVRAM	Nonvolatile random access memory
PCM	Portable conformable masks
PDC	Precipitate dislocation complex
PE	Processing element (pattern recognition)
PECVD	Plasma-enhanced chemical vapor deposition
PG	Pattern generation
PLA	Programmable logic array
PMIPK	(proximity wafer printing)
PMMA	Polymethyl methacrylate
PMOS	*p*-channel metal oxide semiconductor
PROM	Programmable read-only memory
PSG	Phosphorous doped glass
PSK	Phase shift keying
QAM	Quadrature amplitude modulation
QUITERON	Quasiparticle injection tunneling effect device
RAM	Random access memory
RAS	Row-address strobe
RBS	Rutherford backscattering
RC	Resistance-capacitance
rf	Radio frequency (heating)
ROM	Read only memory
RTL	Register transfer level
SAT	Self-aligned transistor

SBT	Silicon bipolar transistor (bipolar VLSI logic circuit)
SDFL	Schottky diode FET logic (GaAs)
SEM	Scanning electron microscope
SEU	Single event upset (radiation damage to ICs)
SIMD	Single instruction-multiple data streams
SIMS	Secondary ion mass spectrometry (technique for measuring low-level impurities in films)
SOI	Silicon-on-insulator
SOS	Silicon-on-sapphire
SPE	Solid phase epitaxy
SPICE	Simulation program for integrated circuit emulation
SQUID	Superconducting quantum interference device
SRP	Spreading resistance probe
SSI	Small scale integration
STL	Schottky transistor logic (bipolar VLSI logic circuit)
SUPREM	A computer simulation program
TDI	Time delay and integrative imagers
TFT	Thin film transistors
TLR	Top level resist
TTL	Transistor-transistor logic (bipolar VLSI logic circuit)
UART	Universal asynchronous receiver-transmitter
ULSI	Ultra large scale integration
V_{FB}	Flatband voltage
V_T	Threshold voltage
VHSIC	Very high speed integrated circuits
VLSI	Very large scale integration
VPE	Vapor phase epitaxy

Contents