

Contents

Editor's Foreword	viii	3-10 Using Inverters to Convert Gates	59
Preface	ix	3-11 Practical TTL Logic Gates	62
Acknowledgments	xi	3-12 Practical CMOS Logic Gates	65
Walkthrough.....	xii	3-13 Troubleshooting Simple Gate Circuits	69
About the Author	xiv	3-14 IEEE Logic Symbols	72
Safety	xv	3-15 Simple Logic Gate Applications.....	73
Chapter 1 Digital Electronics	1	3-16 Logic Functions Using Software (BASIC Stamp Module).....	77
1-1 What Is a Digital Signal?	2	Summary	82
1-2 Why Use Digital Circuits?	4	Chapter Review Questions.....	83
1-3 Where Are Digital Circuits Used?	7	Critical Thinking Questions.....	86
1-4 How Do You Generate a Digital Signal?	8	Answers to Self-Tests	89
1-5 How Do You Test for a Digital Signal?	15	Chapter 4 Combining Logic Gates	90
1-6 Simple Instruments.....	19	4-1 Constructing Circuits from Boolean Expressions.....	91
Summary	23	4-2 Drawing a Circuit from a Maxterm Boolean Expression	92
Chapter Review Questions.....	23	4-3 Truth Tables and Boolean Expressions.....	93
Critical Thinking Questions.....	25	4-4 Sample Problem	97
Answers to Self-Tests	26	4-5 Simplifying Boolean Expressions.....	99
Chapter 2 Numbers We Use in Digital Electronics	27	4-6 Karnaugh Maps.....	100
2-1 Counting in Decimal and Binary	27	4-7 Karnaugh Maps with Three Variables.....	101
2-2 Place Value	28	4-8 Karnaugh Maps with Four Variables	103
2-3 Binary to Decimal Conversion	30	4-9 More Karnaugh Maps.....	104
2-4 Decimal to Binary Conversion	30	4-10 A Five-Variable Karnaugh Map	105
2-5 Electronic Translators.....	31	4-11 Using NAND Logic	106
2-6 Hexadecimal Numbers	34	4-12 Computer Simulations: Logic Converter ...	108
2-7 Octal Numbers	36	4-13 Solving Logic Problems: Data Selectors ...	112
2-8 Bits, Bytes, Nibbles and Word Size	37	4-14 Programmable Logic Devices (PLDs)	116
Summary	39	4-15 Using De Morgan's Theorems	124
Chapter Review Questions.....	39	4-16 Solving a Logic Problem (BASIC Stamp Module).....	126
Critical Thinking Questions.....	40	Summary	131
Answers to Self-Tests	42	Chapter Review Questions.....	132
Chapter 3 Logic Gates	43	Critical Thinking Questions.....	136
3-1 The AND Gate	43	Answers to Self-Tests	136
3-2 The OR Gate.....	46	Chapter 5 IC Specifications and Simple Interfacing	141
3-3 The Inverter and Buffer.....	48	5-1 Logic Levels and Noise Margin	141
3-4 The NAND Gate.....	50	5-2 Other Digital IC Specifications	146
3-5 The NOR Gate	51	5-3 MOS and CMOS ICs	150
3-6 The Exclusive OR Gate.....	53		
3-7 The Exclusive NOR Gate	54		
3-8 The NAND Gate as a Universal Gate.....	56		
3-9 Gates with More Than Two Inputs	57		

5-4	Interfacing TTL and CMOS with Switches . . .	152	Chapter 8	Counters	262
5-5	Interfacing TTL and CMOS with LEDs . . .	156	8-1	Ripple Counters	262
5-6	Interfacing TTL and CMOS ICs	160	8-2	Mod-10 Ripple Counters	264
5-7	Interfacing with Buzzers, Relays, Motors, and Solenoids	164	8-3	Synchronous Counters	265
5-8	Optoisolators	167	8-4	Down Counters	267
5-9	Interfacing with Servo and Stepper Motors . .	170	8-5	Self-Stopping Counters	269
5-10	Using Hall-Effect Sensors	178	8-6	Counters as Frequency Dividers	270
5-11	Troubleshooting Simple Logic Circuits . . .	185	8-7	TTL IC Counters	272
5-12	Interfacing the Servo (BASIC Stamp Module)	186	8-8	CMOS IC Counters	276
Summary		189	8-9	A Three-Digit BCD Counter	280
Chapter Review Questions		190	8-10	Counting Real-World Events	284
Critical Thinking Questions		194	8-11	Using a CMOS Counter in an Electronic Game	288
Answers to Self-Tests		194	8-12	Using Counters—An Experimental Tachometer	291
Chapter 6	Encoding, Decoding, and Seven-Segment Displays	196	8-13	Troubleshooting a Counter	295
6-1	The 8421 BCD Code	196	Summary		298
6-2	The Excess-3 Code	198	Chapter Review Questions		298
6-3	The Gray Code	199	Critical Thinking Questions		302
6-4	The ASCII Code	202	Answers to Self-Tests		303
6-5	Encoders	204	Chapter 9	Shift Registers	305
6-6	Seven-Segment LED Displays	205	9-1	Serial-Load Shift Registers	307
6-7	Decoders	208	9-2	Parallel-Load Shift Registers	308
6-8	BCD-to-Seven-Segment Decoder/Drivers . .	209	9-3	A Universal Shift Register	311
6-9	Liquid-Crystal Displays	213	9-4	Using the 74194 IC Shift Register	313
6-10	Using CMOS to Drive an LCD Display . . .	218	9-5	An 8-Bit CMOS Shift Register	315
6-11	Vacuum Fluorescent Displays	221	9-6	Using Shift Registers: Digital Roulette . . .	318
6-12	Driving a VF Display	224	9-7	Troubleshooting a Simple Shift Register . .	323
6-13	Troubleshooting a Decoding Circuit	227	Summary		325
Summary		229	Chapter Review Questions		325
Chapter Review Questions		230	Critical Thinking Questions		327
Critical Thinking Questions		233	Answers to Self-Tests		328
Answers to Self-Tests		234	Chapter 10	Arithmetic Circuits	330
Chapter 7	Flip-Flops	236	10-1	Binary Addition	330
7-1	The R-S Flip-Flop	236	10-2	Half Adders	332
7-2	The Clocked R-S Flip-Flop	239	10-3	Full Adders	333
7-3	The D Flip-Flop	241	10-4	3-Bit Adders	335
7-4	The J-K Flip-Flop	243	10-5	Binary Subtraction	336
7-5	IC Latches	247	10-6	Parallel Subtractors	338
7-6	Triggering Flip-Flops	249	10-7	IC Adders	340
7-7	Schmitt Trigger	251	10-8	Binary Multiplication	343
7-8	IEEE Logic Symbols	252	10-9	Binary Multipliers	345
7-9	Application: Latched Encoder-Decoder System	254	10-10	2s Complement Notation, Addition, and Subtraction	348
Summary		257	10-11	2s Complement Adders/Subtractors	353
Chapter Review Questions		258	10-12	Troubleshooting a Full Adder	355
Critical Thinking Questions		259	Summary		357
Answers to Self-Tests		260	Chapter Review Questions		357

Critical Thinking Questions	358	13-4	Microcomputer Address Decoding	454
Answers to Self-Tests	359	13-5	Data Transmission.	457
Chapter 11 Memories	361	13-6	Detecting Errors in Data Transmissions . . .	461
11-1 Overview of Memory	362	13-7	Data Transmission in a Computer System . .	464
11-2 Random-Access Memory (RAM).	365	13-8	Programmable Logic Controllers (PLCs) . .	469
11-3 Static RAM ICs.	367	13-9	Microcontrollers	473
11-4 Using a SRAM	370	13-10	The BASIC Stamp Microcontroller Modules	475
11-5 Read-Only Memory (ROM)	372	13-11	Digital Signal Processing	482
11-6 Using a ROM	375	13-12	DSP in a Digital Camera.	486
11-7 Programmable Read-Only Memory [PROM].	377	13-13	Microcontroller: Photo Input and Servo Motor Output	488
11-8 Nonvolatile Read/Write Memory	381	Summary		493
11-9 Memory Packaging.	384	Chapter Review Questions.		493
11-10 Computer Bulk Storage Devices.	387	Critical Thinking Questions.		496
11-11 Digital Potentiometer: Using NV Memory . .	394	Answers to Self-Tests		498
Summary	398	Chapter 14 Connecting with Analog Devices	499	
Chapter Review Questions.	399	14-1 D/A Conversion	500	
Critical Thinking Questions.	401	14-2 Operational Amplifiers	501	
Answers to Self-Tests	401	14-3 A Basic D/A Converter.	502	
Chapter 12 Simple Digital Systems	403	14-4 Ladder-Type D/A Converters	504	
12-1 Elements of a System	403	14-5 An A/D Converter.	506	
12-2 A Digital System on an IC	406	14-6 Voltage Comparators.	508	
12-3 Digital Games.	407	14-7 An Elementary Digital Voltmeter	510	
12-4 The Digital Clock	412	14-8 Other A/D Converters	512	
12-5 The LSI Digital Clock.	415	14-9 A/D Converter Specifications	516	
12-6 The Frequency Counter.	419	14-10 An A/D Converter IC	517	
12-7 An Experimental Frequency Counter	423	14-11 Digital Light Meter	520	
12-8 LCD Timer with Alarm.	426	14-12 Digitizing Temperature	523	
12-9 Simple Distance Sensing	432	Summary	525	
12-10 JTAG/Boundary Scan	437	Chapter Review Questions.	525	
Summary	441	Critical Thinking Questions.	527	
Chapter Review Questions.	441	Answers to Self-Tests	528	
Critical Thinking Questions.	443	Appendix A Solder and the Soldering Process. . .	530	
Answers to Self-Tests	444	Appendix B 2s Complement Conversions	535	
Chapter 13 Computer Systems	445	Glossary of Terms and Symbols	536	
13-1 The Computer.	445	Credits	549	
13-2 The Microcomputer	447	Index	550	
13-3 Microcomputer Operation.	450			