

13671

ELECTRONIC DEVICES

Conventional Current Version

9th Edition

CONTENTS

1 Introduction to Electronics 1

- 1-1 The Atom 2
- 1-2 Materials Used in Electronics 7
- 1-3 Current in Semiconductors 11
- 1-4 N-Type and P-Type Semiconductors 14
- 1-5 The PN Junction 16
- GreenTech Application 1: *Solar Power* 24

2 Diodes and Applications 30

- 2-1 Diode Operation 31
- 2-2 Voltage-Current (V-I) Characteristics 36
- 2-3 Diode Models 39
- 2-4 Half-Wave Rectifiers 44
- 2-5 Full-Wave Rectifiers 50
- 2-6 Power Supply Filters and Regulators 57
- 2-7 Diode Limiters and Clampers 64
- 2-8 Voltage Multipliers 71
- 2-9 The Diode Datasheet 73
- 2-10 Troubleshooting 76
- Application Activity 85
- GreenTech Application 2: *Solar Power* 108

3 Special-Purpose Diodes 112

- 3-1 The Zener Diode 113
- 3-2 Zener Diode Applications 120
- 3-3 The Varactor Diode 128
- 3-4 Optical Diodes 133
- 3-5 Other Types of Diodes 147
- 3-6 Troubleshooting 153
- Application Activity 155
- GreenTech Application 3: *Solar Power* 170

4 Bipolar Junction Transistors 173

- 4-1 Bipolar Junction Transistor (BJT) Structure 174
- 4-2 Basic BJT Operation 175
- 4-3 BJT Characteristics and Parameters 177
- 4-4 The BJT as an Amplifier 190
- 4-5 The BJT as a Switch 192
- 4-6 The Phototransistor 196

- 4-7 Transistor Categories and Packaging 199
- 4-8 Troubleshooting 201
- Application Activity 208
- GreenTech Application 4: *Solar Power* 224

5 Transistor Bias Circuits 228

- 5-1 The DC Operating Point 229
- 5-2 Voltage-Divider Bias 235
- 5-3 Other Bias Methods 241
- 5-4 Troubleshooting 248
- Application Activity 252
- GreenTech Application 5: *Wind Power* 267

6 BJT Amplifiers 271

- 6-1 Amplifier Operation 272
- 6-2 Transistor AC Models 275
- 6-3 The Common-Emitter Amplifier 278
- 6-4 The Common-Collector Amplifier 291
- 6-5 The Common-Base Amplifier 298
- 6-6 Multistage Amplifiers 301
- 6-7 The Differential Amplifier 304
- 6-8 Troubleshooting 310
- Application Activity 314
- GreenTech Application 6: *Wind Power* 335

7 Power Amplifiers 339

- 7-1 The Class A Power Amplifier 340
- 7-2 The Class B and Class AB Push-Pull Amplifiers 346
- 7-3 The Class C Amplifier 357
- 7-4 Troubleshooting 365
- Application Activity 368

8 Field-Effect Transistors (FETs) 38

- 8-1 The JFET 385
- 8-2 JFET Characteristics and Parameters 387
- 8-3 JFET Biasing 397
- 8-4 The Ohmic Region 408
- 8-5 The MOSFET 412

- 8-6 MOSFET Characteristics and Parameters 417
- 8-7 MOSFET Biasing 420
- 8-8 The IGBT 423
- 8-9 Troubleshooting 425
- Application Activity 427

9 FET Amplifiers and Switching Circuits 451

- 9-1 The Common-Source Amplifier 452
- 9-2 The Common-Drain Amplifier 464
- 9-3 The Common-Gate Amplifier 467
- 9-4 The Class D Amplifier 470
- 9-5 MOSFET Analog Switching 474
- 9-6 MOSFET Digital Switching 479
- 9-7 Troubleshooting 482
- Application Activity 485

10 Amplifier Frequency Response 505

- 10-1 Basic Concepts 506
- 10-2 The Decibel 509
- 10-3 Low-Frequency Amplifier Response 512
- 10-4 High-Frequency Amplifier Response 530
- 10-5 Total Amplifier Frequency Response 540
- 10-6 Frequency Response of Multistage Amplifiers 543
- 10-7 Frequency Response Measurements 546
- Application Activity 549

11 Thyristors 564

- 11-1 The Four-Layer Diode 565
- 11-2 The Silicon-Controlled Rectifier (SCR) 568
- 11-3 SCR Applications 573
- 11-4 The Diac and Triac 578
- 11-5 The Silicon-Controlled Switch (SCS) 582
- 11-6 The Unijunction Transistor (UJT) 583
- 11-7 The Programmable Unijunction Transistor (PUT) 588
- Application Activity 590

12 The Operational Amplifier 602

- 12-1 Introduction to Operational Amplifiers 603
- 12-2 Op-Amp Input Modes and Parameters 605
- 12-3 Negative Feedback 613
- 12-4 Op-Amps with Negative Feedback 614
- 12-5 Effects of Negative Feedback on Op-Amp Impedances 619
- 12-6 Bias Current and Offset Voltage 624
- 12-7 Open-Loop Frequency and Phase Responses 627
- 12-8 Closed-Loop Frequency Response 633
- 12-9 Troubleshooting 636
- Application Activity 638
- Programmable Analog Technology 644

13 Basic Op-Amp Circuits

- 13-1 Comparators 668
- 13-2 Summing Amplifiers 679
- 13-3 Integrators and Differentiators 687
- 13-4 Troubleshooting 694
- Application Activity 698
- Programmable Analog Technology 704

14 Special-Purpose Op-Amp Circuits 718

- 14-1 Instrumentation Amplifiers 719
- 14-2 Isolation Amplifiers 725
- 14-3 Operational Transconductance Amplifiers (OTAs) 730
- 14-4 Log and Antilog Amplifiers 736
- 14-5 Converters and Other Op-Amp Circuits 742
- Application Activity 744
- Programmable Analog Technology 750

15 Active Filters 763

- 15-1 Basic Filter Responses 764
- 15-2 Filter Response Characteristics 768
- 15-3 Active Low-Pass Filters 772
- 15-4 Active High-Pass Filters 776
- 15-5 Active Band-Pass Filters 779
- 15-6 Active Band-Stop Filters 785
- 15-7 Filter Response Measurements 787
- Application Activity 789
- Programmable Analog Technology 794

16 Oscillators 806

- 16-1 The Oscillator 807
- 16-2 Feedback Oscillators 808
- 16-3 Oscillators with RC Feedback Circuits 810
- 16-4 Oscillators with LC Feedback Circuits 817
- 16-5 Relaxation Oscillators 825
- 16-6 The 555 Timer as an Oscillator 830
- Application Activity 836
- Programmable Analog Technology 840

17 Voltage Regulators 851

- 17-1 Voltage Regulation 852
- 17-2 Basic Linear Series Regulators 855
- 17-3 Basic Linear Shunt Regulators 860
- 17-4 Basic Switching Regulators 863
- 17-5 Integrated Circuit Voltage Regulators 869
- 17-6 Integrated Circuit Voltage Regulator Configurations 875
- Application Activity 879