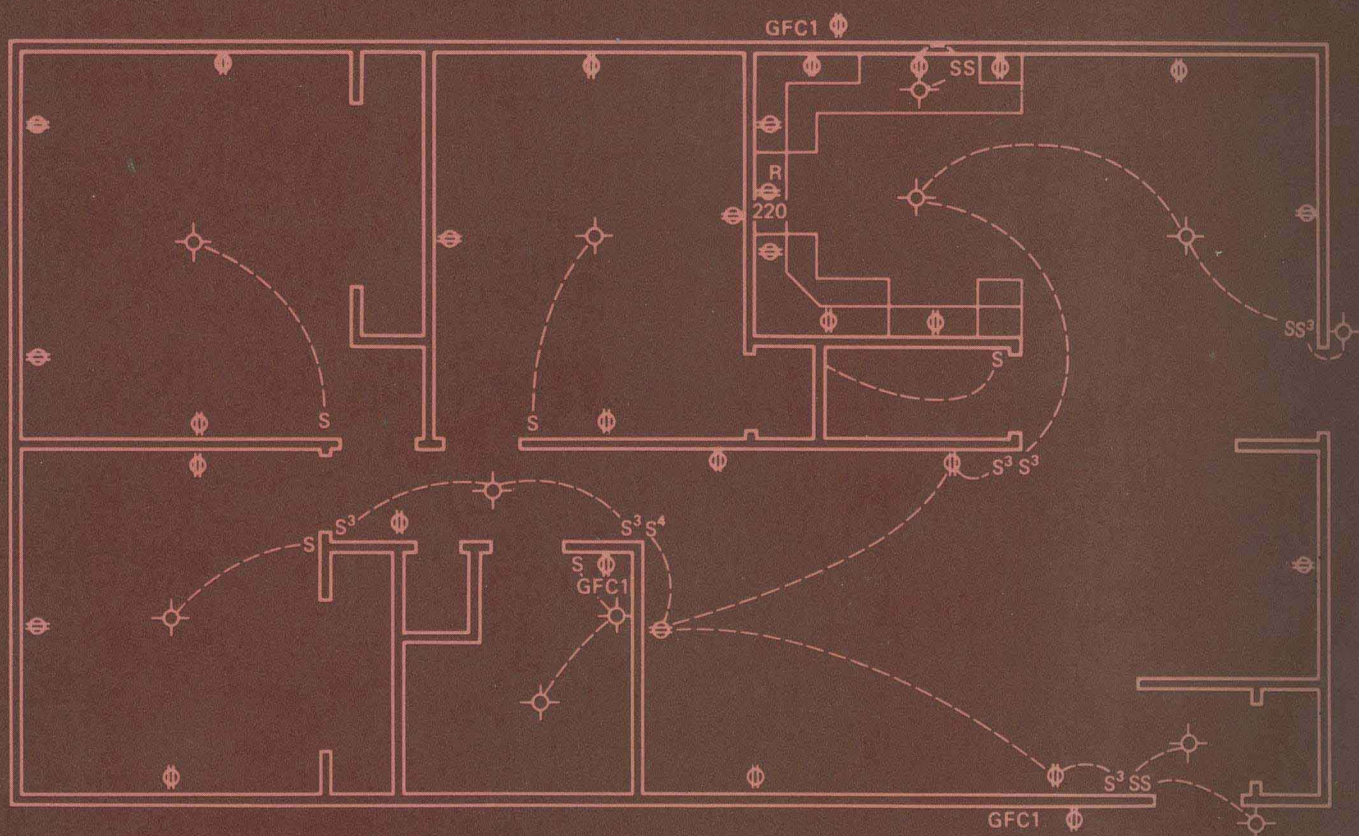
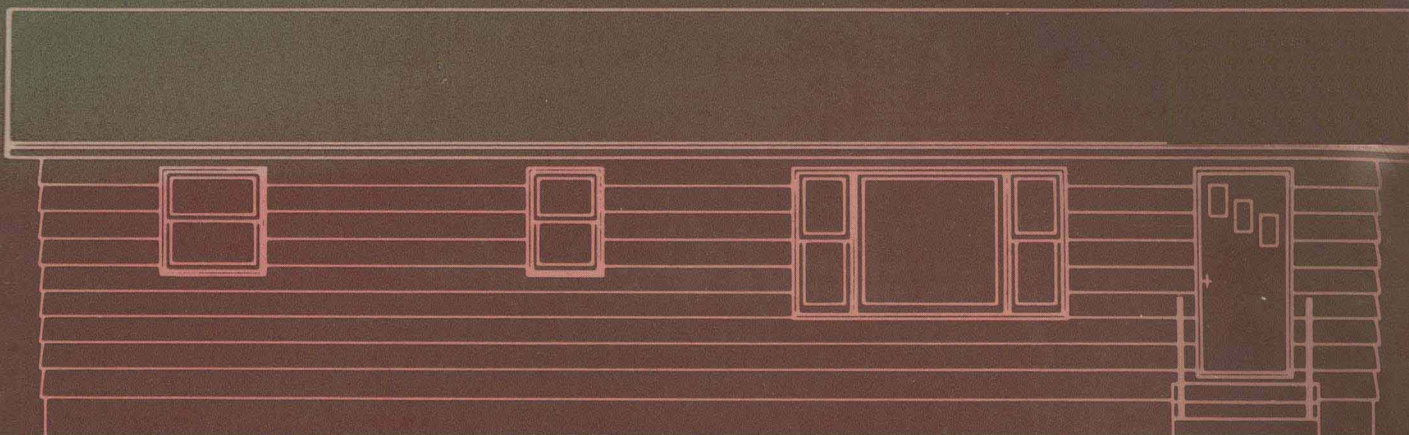


WILLIAM J. WHITNEY



# RESIDENTIAL AND COMMERCIAL ELECTRICAL WIRING

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# RESIDENTIAL AND COMMERCIAL ELECTRICAL WIRING

William J. Whitney

*Albert Lea Area Vocational Technical Institute  
Albert Lea, Minnesota*

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RESIDENTIAL AND  
COMMERCIAL  
ELECTRICAL WIRING

*To my wife Elizabeth  
My active partner  
for 40 years*

## PREFACE

---

The purpose of this book is to aid you in your study of residential and commercial wiring. The text presents in nontechnical terms the mathematical theory behind the electrical devices and equipment used in residential and commercial construction. I draw on my experience as a journeyman electrician, electrical contractor, apprentice, adult educator, and vocational technical institute instructor, to explain, as simply as possible, electrical wiring as it applies to single- and multiple-family dwellings, farm operations, store buildings, mobile and recreational vehicle parks, and commercial industry. My aim has been to downplay the use of complex technical terms and to emphasize the reasons for electrical installations and practices. Much of the text and many of the illustrations and examples have been reviewed by manufacturers and others to ensure that the content is up to date and corresponds with the 1981 National Electrical Code.

Because of our changing times, I place emphasis on intermediate metal conduit, PVC conduit, and other new materials and equipment now available to the electrical industry.

It is my hope that high school students, vocational students, Vocational Technical Institute students, apprentices, tradespeople, adult classes, and newcomers to the industry will find this book a useful tool for understanding residential and commercial wiring.

I think you will enjoy the book's format. It includes instructional objectives and several self-evaluation questions at the beginning of each chapter, text discussion with a summary, and problems at the end of each chapter. This book is designed to focus your attention on what's important, point you in the right direction, and make you sure you understand the material in each chapter.

As you read the book, you will notice that the National Electrical Code is included in the text material; however, it is suggested that a copy of the 1981 National Electrical Code be referred to while studying this material.

The material covered in this text has been classroom tested by second-year construction electrician students at the Albert Lea, Minnesota Area Vocational Technical Institute.

I gratefully acknowledge the support of the Wiley staff and the tireless work of Mrs. Irene Holz, who typed the manuscript and its many revisions.

*William J. Whitney*

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# CONTENTS

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## PART 1 INTRODUCTION

---

### **chapter 1 Basic Electricity 3**

Instructional Objectives 3  
Self-Evaluation Questions 3  
1-1 Ohm's Law 3  
1-2 Application of Ohm's Law to  
Parts of Circuits 6  
1-3 Effect of Internal Resistance of  
Source 7  
1-4 Wiring Calculations 8  
Summary 8  
Problems 10

### **chapter 2 General Information 13**

Instructional Objectives 13  
Self-Evaluation Questions 13  
2-1 The Working Drawing 14  
2-2 Specifications 18  
2-3 Symbols and Notations 21  
2-4 Electrical Standards 22  
2-5 Permits and Inspections 23  
2-6 Testing Laboratories 24

2-7 National Electrical Manufacturers  
Association 27

2-8 OSHA 27

Summary 28

Problems 28

### **chapter 3 Electrical Symbols and Outlets 31**

Instructional Objectives 31  
Self-Evaluation Questions 31  
3-1 Electrical Symbols 32  
3-2 Fixtures and Outlets 33  
3-3 Switch Outlets 34  
3-4 Junction Boxes 35  
3-5 Special Purpose Outlets 35  
3-6 Number of Conductors  
in a Box 36  
3-7 Location of Outlets 37  
Summary 38  
Problems 38

## PART 2 METHODS AND MATERIALS

---

### **chapter 4 Conductors—Materials, Sizes, and Types 43**

Instructional Objectives 43  
Self-Evaluation Questions 43  
4-1 Types of Conductors 44  
4-2 Conductor Size 51  
4-3 Conductor Insulation 52  
4-4 Ampacity 54  
Summary 58  
Problems 58

### **chapter 5 Methods of Conduit Wiring 61**

Instructional Objectives 61  
Self-Evaluation Questions 61  
5-1 Types of Raceway Systems 62  
5-2 Methods of Installation 83  
5-3 Fishing Conductors in  
Raceway 87  
Summary 88  
Problems 88

<b>chapter 6 Calculating Number of Conductors in Conduit</b>	<b>91</b>	8-7 Lighting Branch Circuits	126
Instructional Objectives	91	8-8 Lighting Branch Circuit for Bedrooms	127
Self-Evaluation Questions	91	8-9 Lighting Branch Circuit for Bathrooms	127
6-1 National Electrical Code	92	8-10 Outlets in Closets	129
6-2 Calculations	94	8-11 Living Room Circuit	130
Summary	96	8-12 Hall, Front Entry, and Outside	132
Problems	96	8-13 Kitchen and Dining Area Lighting	132
<b>chapter 7 Outlets and Wiring Devices</b>	<b>99</b>	8-14 Kitchen Small Appliance Circuits	134
Instructional Objectives	99	8-15 Garage	134
Self-Evaluation Questions	99	8-16 Basement	134
7-1 Outlets	100	Summary	135
7-2 Cubic Capacity and Number of Wires in a Box	102	Problems	136
7-3 Wiring Devices	105	<b>chapter 9 Special Purpose Outlets</b>	<b>139</b>
Summary	109	Instructional Objectives	139
Problems	110	Self-Evaluation Questions	139
<b>chapter 8 Branch Circuit Wiring Methods</b>	<b>113</b>	9-1 Types of Branch Circuits	140
Instructional Objectives	113	9-2 Counter-Mounted Cooking Units	140
Self-Evaluation Questions	113	9-3 Room Air Conditioners	141
8-1 Calculating Occupied Floor Area	114	9-4 Hot Water Heater	142
8-2 Calculating Minimum Number of Lighting Circuits	115	9-5 Clothes Dryer	143
8-3 Determining Number of Small Appliance Branch Circuits	115	9-6 Dishwasher	143
8-4 Calculations Based upon Code Sections	116	9-7 Garbage Disposer	144
8-5 Branch Circuit Wiring Methods	117	9-8 Bathroom Heater	145
8-6 Lighting Circuit Switch Control	123	9-9 Garage Door Opener Outlet	147
		9-10 Attic Ventilator Fan	147
		Summary	149
		Problems	149

## PART 3 SIGNAL CIRCUITS

<b>chapter 10 Signal Systems</b>	<b>153</b>	10-7 Smoke Detectors	160
Instructional Objections	153	Summary	163
Self-Evaluation Questions	153	Problems	163
10-1 Signal Equipment	154	<b>chapter 11 Low-Voltage Systems</b>	<b>167</b>
10-2 Telephones	154	Instructional Objectives	167
10-3 Television	154	Self-Evaluation Questions	167
10-4 Door Chimes	156	11-1 Remote Control Wiring	168
10-5 Radio-Intercom Systems	157		
10-6 Residential Intruder-Fire Alarm Systems	159		

11-2 The Economics Multiple Remote Control	168	<b>chapter 12 Signal and Communication Systems</b>	<b>183</b>
11-3 Automatic Light Control	168	Instructional Objectives	183
11-4 System Components	172	Self-Evaluation Questions	183
11-5 Designing a Remote Control System	174	12-1 Purpose of Fire Alarm System	184
11-6 Installation Procedure	176	12-2 A Fire Alarm System	185
11-7 Roughing-in the Installation	177	12-3 National Fire Protection Association Code	190
11-8 Trouble Shooting Remote Control Installations	179	12-4 Alarm Initiating Circuits	190
11-9 National Electrical Code	180	12-5 Nurse-Call System	195
Summary	180	12-6 Annunciator Systems	195
Problems	181	Summary	196
		Problems	196

## **PART 4 HEATING SYSTEMS**

<b>chapter 13 Electric Space Heating</b>	<b>201</b>	<b>chapter 15 The Heat Pump</b>	<b>235</b>
Instructional Objectives	201	Instructional Objectives	235
Self-Evaluation Questions	201	Self-Evaluation Questions	235
13-1 Electric Heating	202	15-1 The Heat Pump	235
13-2 Electric Heat in Perspective	202	15-2 The Heat Pump Defined	236
13-3 Advantages	203	15-3 Advantages of the Heat Pump	239
13-4 Heat Transfer	204	15-4 Alternatives	239
13-5 Types of Heating Units	205	15-5 Efficiency Loss	240
13-6 Temperature Control	214	15-6 Control	240
13-7 Determining Heating Requirements	218	15-7 Installing the Unit	241
13-8 Calculating Heat Loss	220	15-8 Maintenance	242
Summary	224	Summary	242
Problems	224	Problems	244
 <b>chapter 14 Solar Energy</b>	 <b>227</b>	 <b>chapter 16 Forced Air Heating</b>	 <b>245</b>
Instructional Objectives	227	Instructional Objectives	245
Self-Evaluation Questions	227	Self-Evaluation Questions	245
14-1 Energy from the Sun	228	16-1 Forced Warm Air Furnaces	246
14-2 Solar System Components	228	16-2 Fuel Considerations	246
Summary	232	16-3 Automatic Controls	248
Problems	233	16-4 Electronic Air Cleaner	253
		Summary	254
		Problems	254

## **PART 5 THE ELECTRICAL SERVICE**

<b>chapter 17 Service Entrance Equipment—Residential</b>	<b>259</b>	17-1 Electrical Service—General	260
Instructional Objectives	259	17-2 Service Drop	260
Self-Evaluation Questions	259	17-3 Service-Entrance Conductors	263

17-4 Service Laterals	264
17-5 The Meter Socket	265
17-6 Service Distribution Panel	265
17-7 Grounding	275
17-8 Bonding	276
Summary	276
Problems	277

<b>chapter 18 The Service and Equipment—Commercial</b>	<b>279</b>
Instructional Objectives	279
Self-Evaluation Questions	279
18-1 The Electric Service	280
18-2 Special Requirements for Higher Voltage	281
18-3 Higher Voltages	282
18-4 Metering	283
18-5 Switchboards	284
18-6 Lighting and Power Branch Circuit Panelboards	287
18-7 Steady Burning Loads (Continuous Loads)	290

18-8 Three-Phase Panelboards	291
18-9 Circuit Protective Devices	292
Summary	299
Problems	300

<b>chapter 19 Service Load Calculations</b>	<b>303</b>
Instructional Objectives	303
Self-Evaluation Questions	303
19-1 Importance of Service Calculations	304
19-2 Standards for Service Load Calculations	304
19-3 Calculate the Minimum Service Load	304
19-4 Calculate Service Load for 1500 sq feet Dwelling	306
19-5 Reducing the Feeder Service Neutral	306
Summary	307
Problems	307

## PART 6 WIRING COMMERCIAL BUILDINGS

<b>chapter 20 Multiple-Family Dwelling</b>	<b>313</b>
Instructional Objectives	313
Self-Evaluation Questions	313
20-1 A Multiple-Family Dwelling	314
20-2 Planning an Individual Apartment	315
20-3 Load Calculations for Individual Apartment	318
20-4 Service Calculations	320
Summary	322
Problems	323

<b>chapter 21 Farm Wiring</b>	<b>327</b>
Instructional Objectives	327
Self-Evaluation Questions	327
21-1 Farm Residence	328
21-2 Farm Wiring	328
21-3 Total Load Calculations	330
21-4 Farm Buildings	331
21-5 Selecting the Service Equipment	337

21-6 Service Drops from Meter Pole to Buildings	340
21-7 Current Transformers	340
21-8 Emergency Service	342
21-9 Three-Phase Converters	344
Summary	350
Problems	350

<b>chapter 22 Store Building</b>	<b>353</b>
Instructional Objectives	353
Self-Evaluation Questions	353
22-1 General Lighting	354
22-2 Number of Circuits for General Illumination	358
22-3 Show Window Lighting	360
22-4 Signs	361
Summary	362
Problems	362

<b>chapter 23 Lighting—Lamps, and Controls</b>	<b>365</b>
Instructional Objectives	365
Self-Evaluation Questions	365

23-1 Lighting	366
23-2 Lighting Calculations	366
23-3 Fixture Spacing	369
23-4 Types of Lighting	371
23-5 Fluorescent Dimming Control	376
23-6 Trouble Shooting Hints	380
23-7 Sound Level Control	381
Summary	383
Problems	383

<b>chapter 24 Emergency Power Systems</b>	<b>387</b>
Instructional Objectives	387
Self-Evaluation Questions	387
24-1 Standby Power Generator Systems	388
24-2 Emergency Systems	388
24-3 Installation	389
24-4 Sources of Power	389
24-5 Load Transfer Switch	391
24-6 Exit Signs	393
Summary	396
Problems	397

## **PART 7 MOBILE HOME AND RECREATIONAL VEHICLE PARKS**

---

<b>chapter 25 Mobile Homes and Parks</b>	<b>401</b>
Instructional Objectives	401
Self-Evaluation Questions	401
25-1 Mobile Home Defined	402
25-2 Mobile Home Park	402
25-3 Park Electrical Wiring Systems	402
25-4 Calculating the Load	403
25-5 Mobile Home Service Equipment	403
Summary	405
Problems	405

<b>chapter 26 Recreational Vehicle Parks</b>	<b>409</b>
Instructional Objectives	409
Self-Evaluation Questions	409
26-1 Recreational Vehicle	410
26-2 Recreational Vehicle Park and Lots	410
26-3 Calculating for the Service	412
Summary	413
Problems	413

## **PART 8 ESTIMATING**

---

<b>chapter 27 Estimating Electrical Wiring</b>	<b>419</b>
Instructional Objectives	419
Self-Evaluation Questions	419
27-1 Definition of Estimating	420
27-2 Basic Considerations	420
27-3 Qualifications of an Estimator	420

27-4 Estimating Errors	421
27-5 Successful Bidding	421
27-6 Estimating and Contracting Forms	432
27-7 Takeoff	442
Summary	445
Problems	446

<b>References</b>	<b>448</b>
<b>Glossary</b>	<b>449</b>
<b>Index</b>	<b>457</b>

# PART 1

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## INTRODUCTION

CHAPTER 1 Basic Electricity

CHAPTER 2 General Information

CHAPTER 3 Electrical  
Symbols and Outlets





# chapter 1

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## BASIC ELECTRICITY

### Instructional Objectives

1. To learn how Ohm's law applies to a circuit.
2. To solve simple Ohm's law problems.
3. To understand the formula for making Ohm's law.
4. To name and define the units of current, electromotive force (emf), and resistance.
5. To distinguish between emf and potential difference (pd).

### Self-Evaluation Questions

Test your prior knowledge of the information in this chapter by answering the following questions. As you read the chapter, watch for the answers. When you have completed the chapter return to this section and answer the questions again.

1. State Ohm's law when voltage and resistance are known.
2. State Ohm's law when voltage and current are known.
3. State Ohm's law when current and resistance are known.
4. What effect does resistance have on voltage delivered to the load?
5. What is meant by the term "drop of potential"?
6. Name the three primary circuit elements.

Electricity alone is a subject that would require several chapters to cover the basics. However, in this chapter we discuss basic electricity as it relates to electrical wiring for the construction industry.

### 1-1 OHM'S LAW

---

Experience with direct-current circuits shows that the current established in closed metallic paths is directly proportional to the emf of the source of

electricity in the circuit and inversely proportional to the resistance of the path. These facts were first exposed by Ohm, and the relation between the three factors involved is known as Ohm's law. Since its first phrasing in 1827, this law has had outstanding importance in electrical calculations.

Ohm's law states that the current in a metallic circuit is equal to the emf available in the circuit divided by the resistance of that circuit. In order to unite the formula for this law, let

$I$  = current maintained in the circuit

$E$  = emf of the source of electricity included in the circuit

$R$  = total resistance of the circuit, including the internal resistance of the source

Then, by the foregoing statement of Ohm's law,

$$\text{Current} = \frac{\text{emf}}{\text{resistance}}$$

The value of any one of the three factors can be calculated when the value of the other two are known.

To find the current in a circuit when the emf and resistance are known, divide the emf by the resistance

$$I = \frac{E}{R}$$

Introducing the units in Ohm's law, ampere for current, volt for emf, and ohm for resistance, it follows that in a metallic circuit

$$\text{Amperes} = \frac{\text{volts}}{\text{ohms}}$$

#### EXAMPLE 1

A particular incandescent lamp is connected to an electric generator which develops an emf of 110 volts; under these conditions the lamp has a resistance of 275 ohms. What current will the lamp take?

The current is given by Ohm's law as

$$I = \frac{E}{R} = \frac{110}{275} = 0.40 \text{ ampere}$$

#### EXAMPLE 2

An electric heater has a resistance of 20 ohms and another has a resistance of 40 ohms. Two sources of emf are available, one of 240 volts and the other of 120 volts. Find how much current each heater will take when connected to the source.

The formula  $I = E/R$  is used to complete the results desired; first take  $R = 20$  ohms with  $E = 240$  volts and then  $E = 120$  volts.

(a) For the 20-ohm heater operating on 240 volts

$$I = \frac{240}{20} = 12 \text{ amperes}$$