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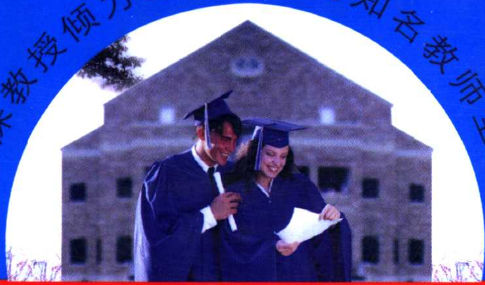


国外高校电子信息类优秀教材

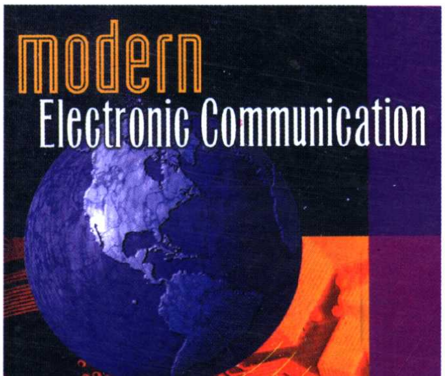
现代电子通信

（第七版）

Modern Electronic Communication

(Seventh Edition)

（英文影印版）



Gary M. Miller Jeffrey S. Beasley 著

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内 容 简 介

本书为国外高校电子信息类优秀教材(英文影印版)之一。

本书在每一章结合 Electronic Workbench Multisim 阐述了电子通信的关键概念。内容包括:幅度调制,单边带通信,频率调制,通信方法,数字通信,网络通信,传输线,波的传播,天线,波导与雷达,微波与激光,电视,光纤等。

本书可作为电子信息工程、通信工程专业本科生教材,也可作为相关领域工程技术人员的参考书。

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Dedicated to the youth of the world,
especially my favorites,
Evan and Maia
Gary M. Miller

Dedicated to my family,
Kim, Damon, and Dana
Jeffrey S. Beasley

Preface

We are excited about the many improvements to this edition of *Modern Electronic Communication* and we trust you will share our enthusiasm as they are briefly described. The seventh edition maintains the tradition of the sixth, including up-to-date coverage of the latest in electronic communications, readable text, and many features that aid student comprehension.

This edition has expanded the Troubleshooting section by including ***Troubleshooting with Electronics Workbench™ Multisim***. This is accompanied by an Electronics Workbench Multisim CD-ROM, which is packaged with the text. The CD now contains all circuits from the text based on the latest version of Electronics Workbench Multisim. These valuable tools enable the student to simulate laboratory conditions at any convenient time and to stimulate the learning process.

Features

- The most up-to-date treatment of digital and data communications
- The addition of "Troubleshooting with Electronics Workbench™ Multisim" in each chapter
- Extensive troubleshooting sections
- Numerous questions and problems, including a section for each chapter entitled "Questions for Critical Thinking" designed to sharpen analytical skills
- All circuits from the book are simulated on a full-function Electronics Workbench (EWB) Multisim CD. Additional circuits provide interactive, hands-on troubleshooting exercises.
- Key terms and definitions highlighted in the margins as they are introduced in the text
- Complete directory of acronyms and abbreviations at the end of the book
- Numerous worked-out examples
- Extensive problem sets
- Color photos of typical industrial equipment

- Chapter outlines, objectives, and key terms identified at the beginning of each chapter
- Summary of key points following each chapter
- Comprehensive glossary at the end of the book

Partial Listing of New Material in the Seventh Edition

- The dB in communications
- Understanding the frequency spectra
- Explanation and examples of the FFT (fast Fourier transform)
- Digital sampling oscilloscope waveforms
- Updated review of single-sideband communications
- CRC coding
- Hamming distance
- Expanded digital communications coverage
- Time-division multiple access
- Data transmission
- Updated section on modern telephone networks
- PCS (personal communication services)
- Updated coverage of local area networks
- xDSL (digital subscriber line services)
- Voiceover IP (Internet telephony)
- WAP (wireless application protocol)
- Updated discussion of UTP (unshielded twisted pair)
- Introduction to the basics of DTV (digital television)
- Significantly updated fiber-optics chapter
- System design of a fiber installation
- Optical networking
- OTDR measurements and trace analysis
- Appendix A: Electronics Workbench™ Multisim Tutorial

Illustration of Features

CHAPTER OPENER—Each chapter begins with a color photo related to content, a chapter outline, a list of objectives, and key terms being introduced. An example is shown in Figure P-1.

WORKED EXAMPLES—Numerous worked-out examples are included in every chapter, as shown in Figure P-2. These examples serve to reinforce key concepts and aid in subject mastery.

TROUBLESHOOTING—Every chapter contains an extensive troubleshooting section. An illustration is provided in Figure P-2. Notice that areas of expected student mastery are highlighted. Students are very interested in applying knowledge gained by "fixing" real-world systems. Their comprehension is improved in this process. Equally important, employers and accrediting agencies strongly encourage emphasis on troubleshooting skills.

Chapter Outline

Chapter Objectives

8 CHAPTER Digital Communications: Coding Techniques

CHAPTER OUTLINE

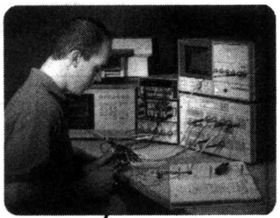
8-1 Introduction
8-2 Alphanumeric Codes
8-3 Pulse-Code Modulation
8-4 Digital Signal Encoding Formats
8-5 Coding Principles
8-6 Code Error Detection and Correction
8-7 Troubleshooting
8-8 Troubleshooting with Electronics Workbench™ Multisim
SUMMARY

OBJECTIVES

- Describe the quantization process in a PCM system in terms of how it is created, how to determine the Nyquist sampling frequency, and how to define quantization levels
- Determine the dynamic range and signal-to-noise ratio of a PCM system
- Describe the common digital signal encoding formats
- Understand the concept of Hamming distance as applied to the technique of error detection and correction
- Describe the various techniques for code error detection and correction, including parity, block check character, cyclic redundancy check, Hamming code, and Reed–Solomon codes.

KEY TERMS

regeneration
digital signal processing
algorithms
ASCII
parity
EBCDIC
Baudot code
Gray code
acquisition time
aperture time
natural sampling
flat-top sampling
Nyquist rate
aliasing, or foldover distortion
antialiasing filter
quantization
quantile
quantile interval
quantization levels
quantization error
quantization noise
dynamic range
uniform quantization level
linear quantization level
nonlinear coding
nonuniform coding
idle channel noise
amplitude companding
codec
multilevel binary
Hamming distance
minimum distance (D_{min})
symbol substitution
block check character (BCC)
longitudinal redundancy check (LRC)
cyclic redundancy check
BCC
systematic code
(n, k) cyclic code
generating polynomial
syndrome
pseudonoise (PN) codes
forward error-correcting
Hamming code
interleaving



A digital test set using the Agilent 71612A 12 Gbps pattern generator and detector. (Courtesy of Agilent Technologies.)

Chapter Opener photo

Key Terms for this chapter

FIGURE P-1

$$1 + \frac{m^2}{2} = \left(\frac{13}{12}\right)^2$$
$$m^2 = 2\left[\left(\frac{13}{12}\right)^2 - 1\right] = 0.34$$
$$m = 0.59$$
$$\%m = 0.59 \times 100\% = 59\%$$

Numerous worked-out examples aid in subject mastery

Example 2-7

An intelligence signal is amplified by a 70% efficient amplifier before being combined with a 10-kW carrier to generate the AM signal. If it is desired to operate at 100% modulation, what is the dc input power to the final intelligence amplifier?

Solution

You may recall that the efficiency of an amplifier is the ratio of ac output power to dc input power. To fully modulate a 10-kW carrier requires 5 kW of intelligence. Therefore, to provide 5 kW of sideband (intelligence) power through a 70% efficient amplifier requires a dc input of

$$\frac{5\ \text{kW}}{0.70} = 7.14\ \text{kW}$$

If a carrier is modulated by more than a single sine wave, the effective modulation index is given by

$$m_{eff} = \sqrt{m_1^2 + m_2^2 + m_3^2 + \cdots} \tag{2-9}$$

The total effective modulation index must not exceed 1 or distortion (as with a single sine wave) will result. The term m_{eff} can be used in all previously developed equations using m.

Example 2-8

A transmitter with a 10-kW carrier transmits 11.2 kW when modulated with a single sine wave. Calculate the modulation index. If the carrier is simultaneously modulated with another sine wave at 50% modulation, calculate the total transmitted power.

Solution

$$P_t = P_c\left(1 + \frac{m^2}{2}\right) \tag{2-7}$$
$$11.2\ \text{kW} = 10\ \text{kW}\left(1 + \frac{m^2}{2}\right)$$
$$m = 0.49$$
$$m_{eff} = \sqrt{m_1^2 + m_2^2} \tag{2-9}$$

82 Chapter 2 • Amplitude Modulation: Transmission

3-8 TROUBLESHOOTING

Every chapter contains a Troubleshooting section

In this section we are going to analyze and troubleshoot the AM mixer circuit. The mixer circuit, also known as an autodyne circuit, is a combination of the local oscillator and the mixer in a single stage. We're also going to discuss power supply and audio amplifier problems in this section.

Upon completing this section you should be able to

- Troubleshoot an AM mixer circuit
- Identify an open input circuit
- Identify a dead or intermittent local oscillator circuit
- Identify causes for a dead or intermittent local oscillator
- Troubleshoot the receiver's power supply
- Troubleshoot the receiver's audio amplifier

The Mixer Circuit

In Sec. 3-3 it was shown that the local oscillator and the mixer play a very important part in AM reception. Figure 3-27 shows the mixer stage (autodyne circuit) of an AM radio. The received RF input signal is fed into the base of Q_1 from coils L_1 and L_2. The input AM radio signal is selected by tuning C_1; notice also that C_1 and C_4 are ganged. When C_1 is adjusted, C_4 will be adjusted by the same amount. The

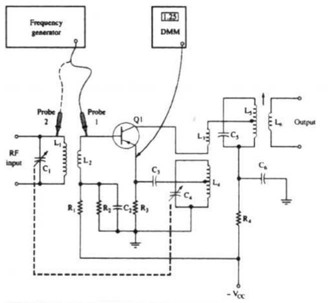


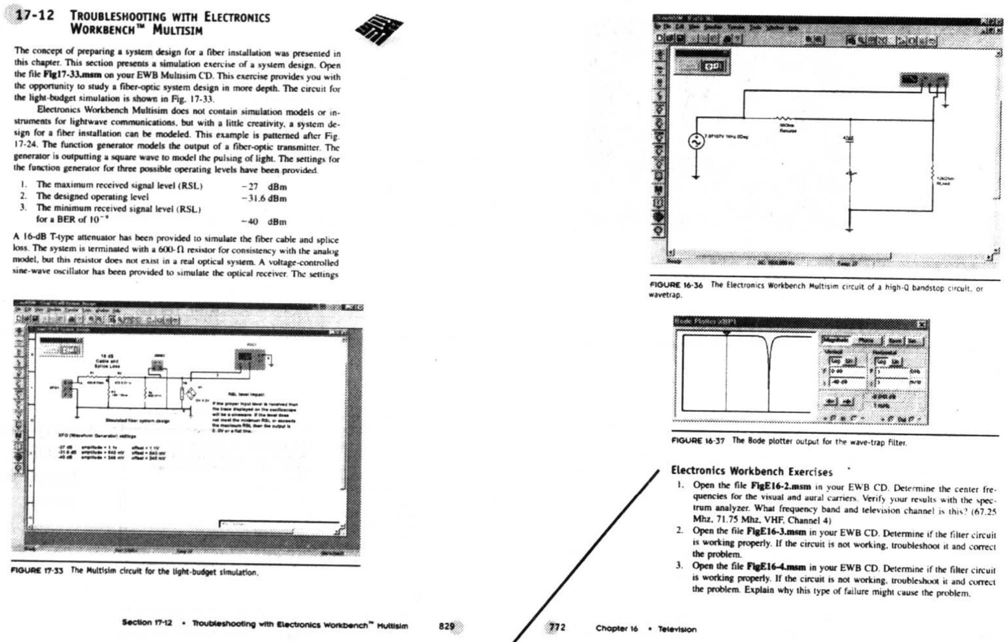
FIGURE 3-27 Troubleshooting a self-excited mixer.

Section 3-8 • Troubleshooting 149

FIGURE P-2

TROUBLESHOOTING WITH ELECTRONICS WORKBENCH™ MULTISIM— Every chapter ends with an EWB circuit simulation and troubleshooting exercise as well as end-of-chapter exercises incorporating Electronics Workbench Multisim (Figure P-3).

Troubleshooting with Electronics Workbench™ Multisim is a new feature in this edition



17-12 TROUBLESHOOTING WITH ELECTRONICS WORKBENCH™ MULTISIM

The concept of preparing a system design for a fiber installation was presented in this chapter. This section presents a simulation exercise of a system design. Open the file **Fig17-33.msm** on your EWB Multisim CD. This exercise provides you with the opportunity to study a fiber-optic system design in more depth. The circuit for the light-budget simulation is shown in Fig. 17-33.

Electronics Workbench Multisim does not contain simulation models or instruments for lightwave communications, but with a little creativity, a system design for a fiber installation can be modeled. This example is patterned after Fig. 17-24. The function generator models the output of a fiber-optic transmitter. The generator is outputting a square wave to model the pulsing of light. The settings for the function generator for three possible operating levels have been provided.

1. The maximum received signal level (RSL) −27 dBm
2. The designed operating level −31.6 dBm
3. The minimum received signal level (RSL) for a BER of 10^{-9} −40 dBm

A 16-dB T-type attenuator has been provided to simulate the fiber cable and splice loss. The system is terminated with a 600-Ω resistor for consistency with the analog model, but this resistor does not exist in a real optical system. A voltage-controlled sine-wave oscillator has been provided to simulate the optical receiver. The settings

FIGURE 17-33 The Multisim circuit for the light-budget simulation.

Section 17-12 • Troubleshooting with Electronics Workbench™ Multisim 829

FIGURE 16-36 The Electronics Workbench Multisim circuit of a high-Q bandstop circuit, or wavetrap.

FIGURE 16-37 The Bode plotter output for the wave-trap filter.

Electronics Workbench Exercises

1. Open the file **FigE16-2.msm** in your EWB CD. Determine the center frequencies for the visual and aural carriers. Verify your results with the spectrum analyzer. What frequency band and television channel is this? (67.25 Mhz, 71.75 Mhz, VHF, Channel 4)
2. Open the file **FigE16-3.msm** in your EWB CD. Determine if the filter circuit is working properly. If the circuit is not working, troubleshoot it and correct the problem.
3. Open the file **FigE16-4.msm** in your EWB CD. Determine if the filter circuit is working properly. If the circuit is not working, troubleshoot it and correct the problem. Explain why this type of failure might cause the problem.

772 Chapter 16 • Television

Each chapter contains Electronics Workbench™ exercises

FIGURE P-3

FULL COLOR FORMAT—Color is used throughout as an aid to comprehension and to make the material more visually stimulating. A representative use of color is shown in Figure P-4.

KEY TERMS DEFINED—The important new terms and concepts are defined in the margins near where they are introduced in the text. An illustration is shown in Figure P-4. Having the key terms presented in this way allows the student to quickly access, review, and understand new concepts and terminology.

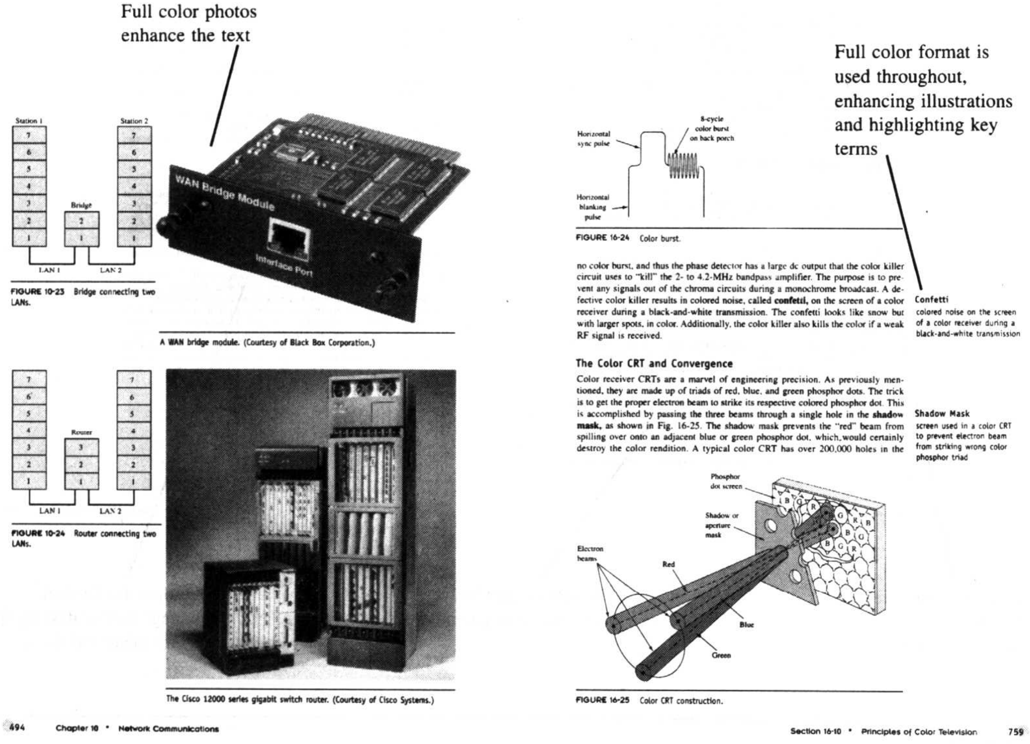


FIGURE P-4

END-OF-CHAPTER MATERIAL—Each chapter concludes with a summary of key concepts, an extensive problem set, a section entitled "Questions for Critical Thinking," and chapter exercises incorporating Electronics Workbench™ Multisim. An illustration of how this material is presented can be seen in Figure P-5. The questions and problems are very comprehensive and are keyed to the appropriate chapter section. An asterisk next to the question number indicates that a particular question has been provided by the FCC as a study aid for licensing examinations. In addition, the answer to quantitative problems is provided in parentheses following the question. Worked-out solutions to selected problems are available in the Instructor's Manual.

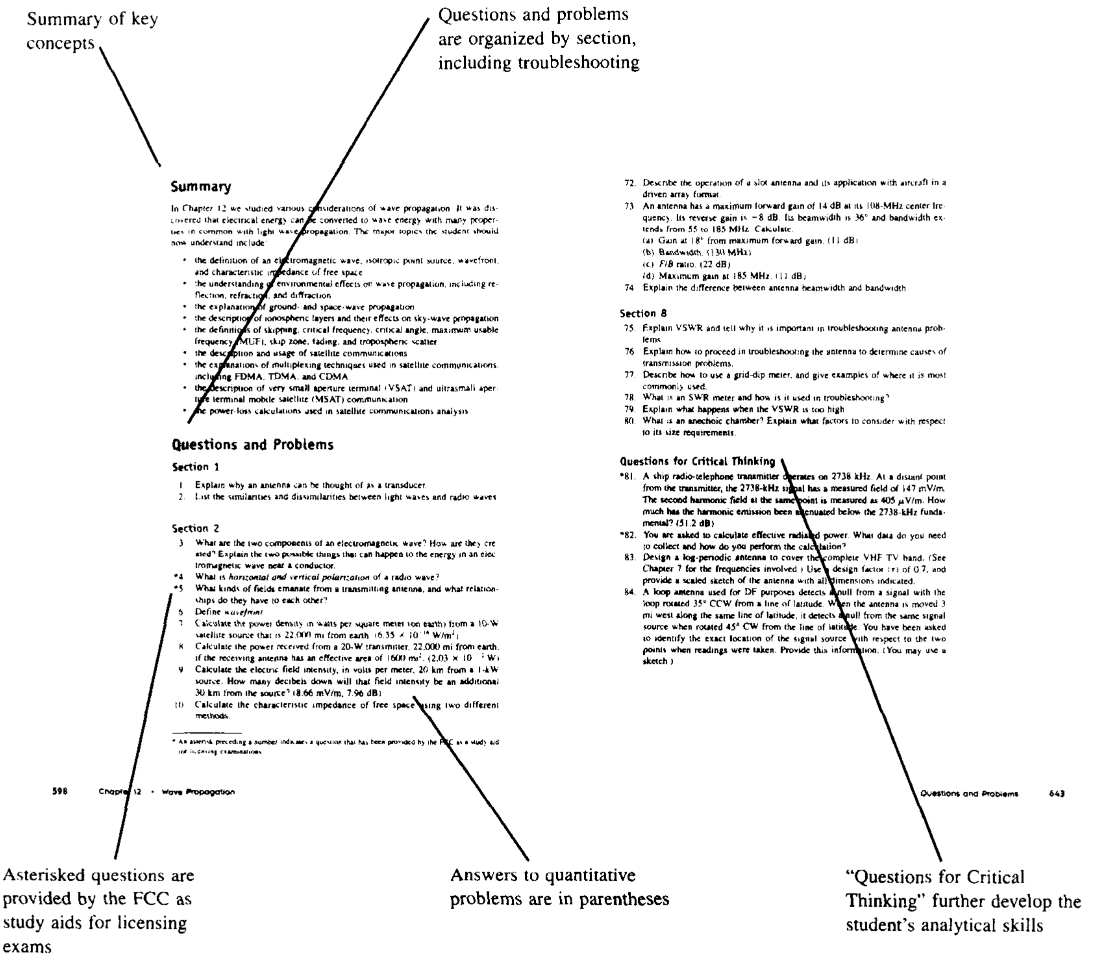
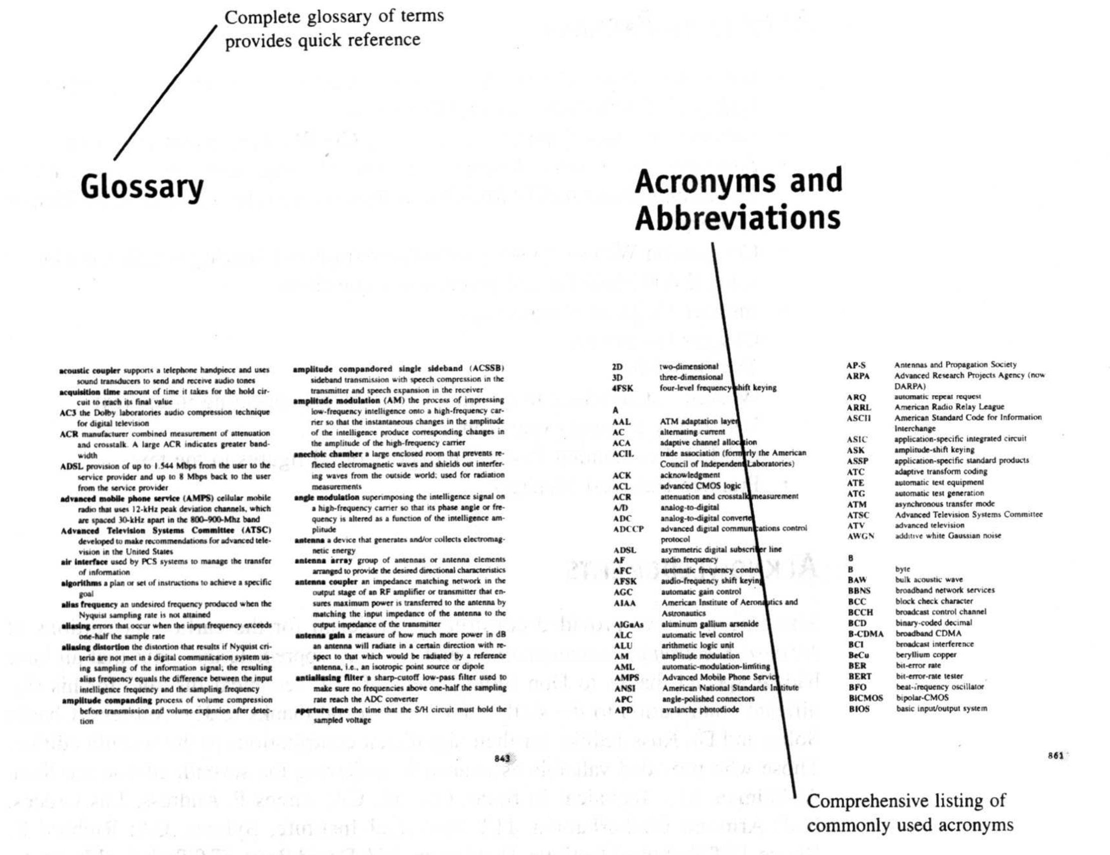


FIGURE P-5

GLOSSARY AND ACRONYMS—The end-of-book material includes an extensive glossary and list of acronyms. These important tools are illustrated in Figure P-6. Acronyms are widely used in electronic communications and are often a source of confusion for students. This listing solves the problem by offering a quickly accessible description.



acoustic coupler supports a telephone handpiece and uses sound transducers to send and receive audio tones
acquisition time amount of time it takes for the hold circuit to reach its final value
AC3 the Dolby laboratories audio compression technique for digital television
ACR manufacturer combined measurement of attenuation and crosstalk. A large ACR indicates greater bandwidth
ADSL provision of up to 1.544 Mbps from the user to the service provider and up to 8 Mbps back to the user from the service provider
advanced mobile phone service (**AMPS**) cellular mobile radio that uses 12-kHz peak deviation channels, which are spaced 30-kHz apart in the 800–900-Mhz band
Advanced Television Systems Committee (**ATSC**) developed to make recommendations for advanced television in the United States
air interface used by PCS systems to manage the transfer of information
algorithms a plan or set of instructions to achieve a specific goal
alias frequency an undesired frequency produced when the Nyquist sampling rate is not attained
aliasing errors that occur when the input frequency exceeds one-half the sample rate
aliasing distortion the distortion that results if Nyquist criteria are not met in a digital communication system using sampling of the information signal; the resulting alias frequency equals the difference between the input intelligence frequency and the sampling frequency
amplitude companding process of volume compression before transmission and volume expansion after detection
amplitude compandored single sideband (**ACSSB**) sideband transmission with speech compression in the transmitter and speech expansion in the receiver
amplitude modulation (**AM**) the process of impressing low-frequency intelligence onto a high-frequency carrier so that the instantaneous changes in the amplitude of the intelligence produce corresponding changes in the amplitude of the high-frequency carrier
anechoic chamber a large enclosed room that prevents reflected electromagnetic waves and shields out interfering waves from the outside world; used for radiation measurements
angle modulation superimposing the intelligence signal on a high-frequency carrier so that its phase angle or frequency is altered as a function of the intelligence amplitude
antenna a device that generates and/or collects electromagnetic energy
antenna array group of antennas or antenna elements arranged to provide the desired directional characteristics
antenna coupler an impedance matching network in the output stage of an RF amplifier or transmitter that ensures maximum power is transferred to the antenna by matching the input impedance of the antenna to the output impedance of the transmitter
antenna gain a measure of how much more power in dB an antenna will radiate in a certain direction with respect to that which would be radiated by a reference antenna, i.e., an isotropic point source or dipole
antialiasing filter a sharp-cutoff low-pass filter used to make sure no frequencies above one-half the sampling rate reach the ADC converter
aperture time the time that the S/H circuit must hold the sampled voltage

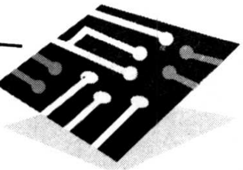
843

2D	two-dimensional
3D	three-dimensional
4FSK	four-level frequency shift keying
A	
AAL	ATM adaptation layer
AC	alternating current
ACA	adaptive channel allocation
ACIL	trade association (formerly the American Council of Independent Laboratories)
ACK	acknowledgment
ACL	advanced CMOS logic
ACR	attenuation and crosstalk measurement
A/D	analog-to-digital
ADC	analog-to-digital converter
ADCCP	advanced digital communications control protocol
ADSL	asymmetric digital subscriber line
AF	audio frequency
AFC	automatic frequency control
AFSK	audio-frequency shift keying
AGC	automatic gain control
AIAA	American Institute of Aeronautics and Astronautics
AlGaAs	aluminum gallium arsenide
ALC	automatic level control
ALU	arithmetic logic unit
AM	amplitude modulation
AML	automatic-modulation-limiting
AMPS	Advanced Mobile Phone Service
ANSI	American National Standards Institute
APC	angle-polished connectors
APD	avalanche photodiode
AP-S	Antennas and Propagation Society
ARPA	Advanced Research Projects Agency (now DARPA)
ARQ	automatic repeat request
ARRL	American Radio Relay League
ASCII	American Standard Code for Information Interchange
ASIC	application-specific integrated circuit
ASK	amplitude-shift keying
ASSP	application-specific standard products
ATC	adaptive transform coding
ATE	automatic test equipment
ATG	automatic test generation
ATM	asynchronous transfer mode
ATSC	Advanced Television Systems Committee
ATV	advanced television
AWGN	additive white Gaussian noise
B	
B	byte
BAW	bulk acoustic wave
BBNS	broadband network services
BCC	block check character
BCCH	broadcast control channel
BCD	binary-coded decimal
B-CDMA	broadband CDMA
BCI	broadcast interference
BeCu	beryllium copper
BER	bit-error rate
BERT	bit-error-rate tester
BFO	beat-frequency oscillator
BiCMOS	bipolar-CMOS
BIOS	basic input/output system

861

FIGURE P-6

CD-ROM INCLUDED—Over 90 percent of the circuits from the text plus additional circuits for troubleshooting are provided on this EWB Multisim software, available free of charge.



Ancillary Package

- *Laboratory Manual with System Projects* and accompanying CD-ROM, by Jeffrey S. Beasley and Michael Fairbanks
- *Laboratory Manual* with accompanying CD-ROM, by Mark E. Oliver
- *Learning Electronics Communications Through Experimentation Using Electronics Workbench™ Multisim* with accompanying CD-ROM, by Richard H. Berube
- Companion Website (www.prenhall.com/miller) featuring simulation circuits using EWB Multisim and practice test questions
- Instructor's Manual featuring:
  Chapter Overviews
  Test Item File
  Worked-out solutions to quantitative problems appearing in the text
  Laboratory Manual experiment results
  CD-ROM containing PowerPoint slides of all figures in the text
- Prentice Hall Test Manager

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Gary M. Miller and Jeffrey S. Beasley

A Brief History of

1837
Samuel Morse
Invention of the telegraph

1843
Alexander Bain
Invention of facsimile

1866
U.S. and England
The first trans-Atlantic telegraph cable laid

1876
Alexander Bell
Invention of the telephone

1887
Heinrich Hertz
Discovery of radio waves

Guglielmo Marconi
Demonstration of "wireless"

1901
Guglielmo Marconi
First trans-Atlantic radio contact made

1903
John Fleming
Invention of the two-electrode vacuum tube rectifier

1906
Reginald Fessenden
Invention of amplitude modulation; first electronic voice communications demonstrated

Lee de Forest
Invention of the triode vacuum tube

1920
KDKA Pittsburgh
First radio broadcast

1923
Vladimir Zworykin
Invention and demonstration of television

Electronic Communication

- **1937** — **A. H. Reeves**: Invention of binary code PCM
- **1939** — **United States**: Television broadcast demonstrated by NBC
- **1941** — **United States**: First regular FM radio broadcasting
- **1948** — **United States**: Transistor developed at Bell Labs
- **1957** — **Russia**: First satellite (Sputnik) launched
- **1958** — **Kilby & Noyce**: Integrated circuits developed
- **1969** — **United States**: Origin of the Internet
- **1970** — **Japan**: NHK began research on HDTV
- **1977** — **United States**: First commercial use of fiber-optic cable
- **1980** — **United States**: Ethernet accepted as standard baseband network for LANS
- **1981** — **Dennis Hayes**: Release of the Hayes Smart Modem
- **1983** — **United States**: Cellular phone networks introduced
- **1986** — **United States**: Growth of the Internet
- **1987** — **Ometron Inc.**: Development of Vibration Pattern Imager
- **1988** — **Dana Anderson**: Holographic computer
- **1989** — **Tim Berners-Lee (CERN)**: Birth of World Wide Web (WWW)
- **1991** — **United Kingdom**: First UK public demonstration of videophone
- **1995** — **United States**: DBS (Direct Broadcast Satellite) feeds offered
- **1996** — **United States**: Telecommunications Act of 1996
- **1998** — **United States**: High Definition TV Standards and Implementation
- **1999** — **United States**: Digital television (DTV) transmission begins

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