



国外经典教材·电子信息

PEARSON  
Prentice  
Hall

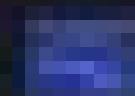
# Modern Electronic Communication Eighth Edition

# 现代电子通信 (第8版)

Jeffrey S. Beasley 著  
Gary M. Miller  
肖善鹏 张 喆 译



清华大学出版社



Modern Electronic  
Communication 现代电子通信

现代电子通信

现代电子通信  
教材



国外经典教材·电子信息

# 现代电子通信

## (第8版)

Jeffrey S. Beasley

Gary M. Miller 著

肖善鹏 张 蕾 译

清华大学出版社  
北京

Simplified Chinese edition copyright © 2005 by **PEARSON EDUCATION ASIA LIMITED and TSINGHUA UNIVERSITY PRESS**.

Original English language title from Proprietor's edition of the Work.

Original English language title: *Modern Electronic Communication*, 8th by Jeffrey S. Beasley & Gary M. Miller,

Copyright © 2005

EISBN: 0-13-113037-4

All Rights Reserved.

Published by arrangement with the original publisher, Pearson Education, Inc., publishing as **Prentice-Hall**.

This edition is authorized for sale only in the People's Republic of China (excluding the Special Administrative Region of Hong Kong and Macao).

本书中文简体翻译版由 **Prentice-Hall** 授权给清华大学出版社在中国境内(不包括中国香港、澳门特别行政区)出版发行。

北京市版权局著作权合同登记号 图字: 01-2004-5632 号

版权所有，翻印必究。举报电话: 010-62782989 13501256678 13801310933

本书封面贴有 Pearson Education (培生教育出版集团) 激光防伪标签，无标签者不得销售。

#### 图书在版编目(CIP)数据

现代电子通信: 第 8 版 / (美)碧丝蕾 (Beasley, J. S.), (美)米勒 (Miller, G. M.) 著; 肖善鹏, 张雷译。  
—北京: 清华大学出版社, 2006.3

书名原文: *Modern Electronic Communication*  
(国外经典教材·电子信息)

ISBN 7-302-12443-4

I. 现… II. ①碧… ②米… ③肖… ④张… III. 通信技术—教材 IV. TN91

中国版本图书馆 CIP 数据核字 (2006) 第 005792 号

出版者: 清华大学出版社 地址: 北京清华大学学研大厦  
<http://www.tup.com.cn> 邮编: 100084

社总机: 010-62770175 客户服务: 010-62776969

责任编辑: 常晓波

印刷者: 清华大学印刷厂

装订者: 三河市李旗庄少明装订厂

发行者: 新华书店总店北京发行所

开本: 185×260 印张: 55.5 字数: 1384 千字

版次: 2006 年 3 月第 1 版 2006 年 3 月第 1 次印刷

书号: ISBN 7-302-12443-4/TP · 7982

印数: 1 ~ 3000

定价: 108.00 元(含光盘)

谨以本书献给我至爱的家人

Kim, Damon 和 Dana

——Jeffrey S. Bwasley

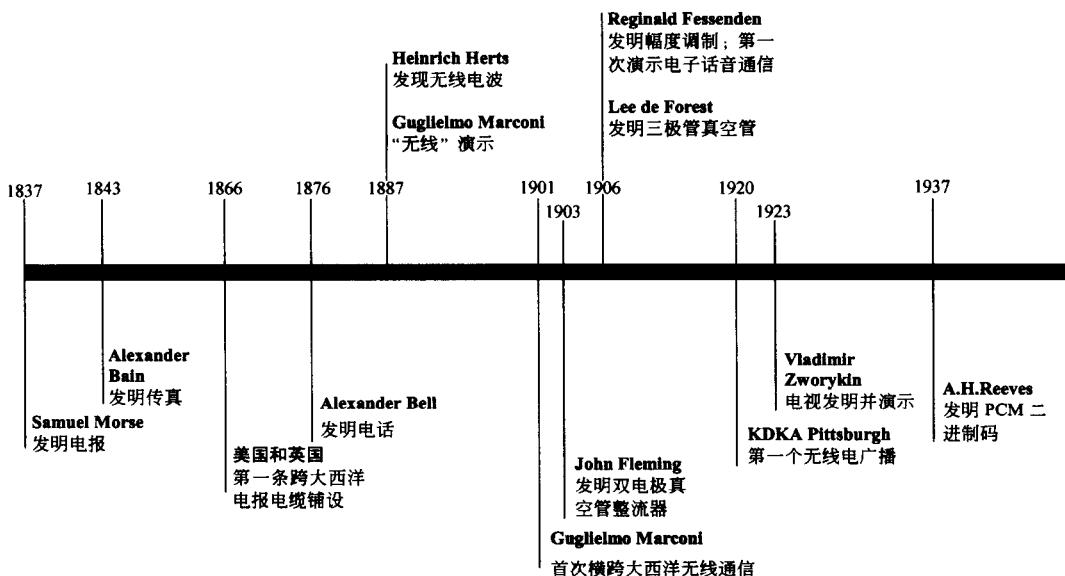
将本书送给世界上所有的年轻人

尤其是这几位我喜欢的

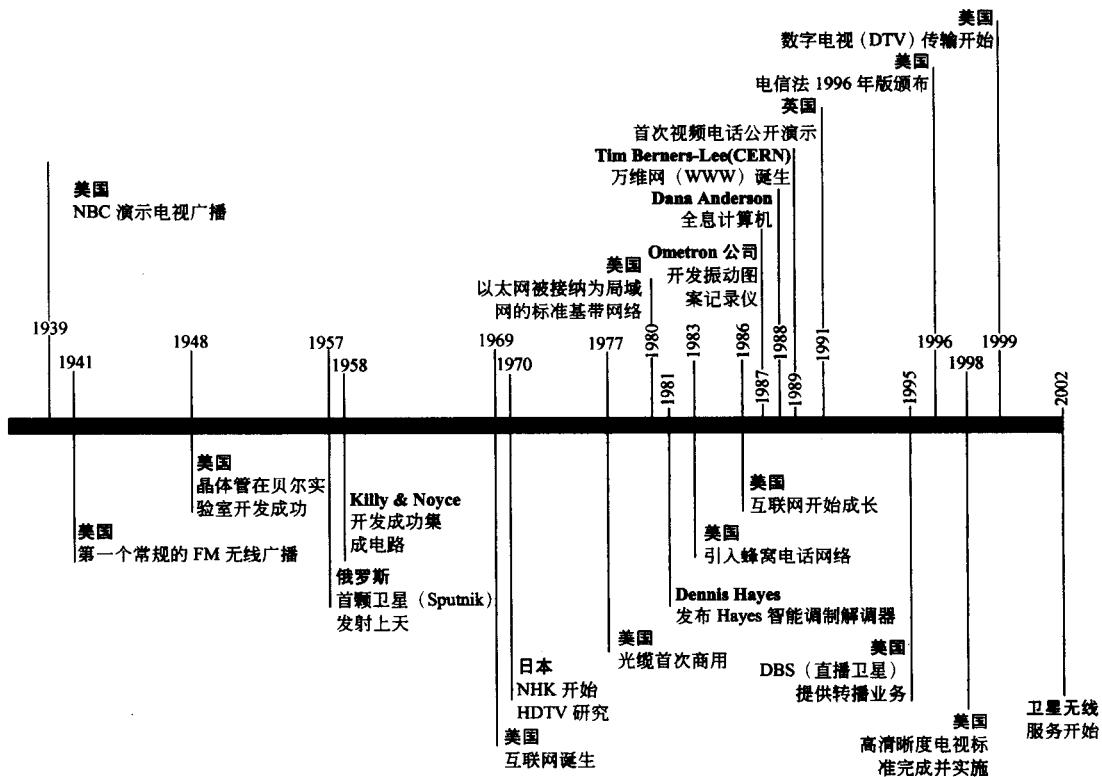
Evan, Maia, Willo, Kevin, Richard 和 Luca

——Gary M. Miller

# 电子通信



# 发展简史



# 译 者 序

随着电子通信产业的高速发展，越来越多的人才投入到这一非常有发展前途的行业，并进一步推动了该领域的技术进步。而掌握系统的电子通信基础知识和实用有效的工程应用能力是从事通信行业的工程技术人员最重要的两个基本素质。

《现代电子通信》是一本经典的电子通信方面的教科书，迄今已经出版到第8版。《现代电子通信》（第8版）共由18章组成，全面系统地介绍电子通信技术领域的基础知识、基本概念，并且及时补充了目前最新的技术进展，每章最后附有 Electronics Workbench Multisim 仿真工具应用实例，用于解决实践中常遇到的故障分析与检测问题。本书的内容大致可分为三个方面，第1到第6章介绍了电子通信技术的基础知识，主要讲述了通信中常用的各类调制方式；第7到第11章是对通信技术的深入探讨，包括有线和无线数字通信，以及网络通信方面的技术；第12到第18章讨论了信息传递方式，包括信号在有线和无线介质中的传播、电视接收技术，以及光纤。这些内容基本上涵盖了电子通信技术的各个方面，在本书最后还附有完备的缩略语表和词汇表，便于读者查阅参考。

本书结构严谨、概念清楚、文字通俗易懂、内容由浅入深、理论与实践紧密结合，非常适合电子通信方向的专科生、本科生和低年级研究生作为教材使用。同时本书面向工程应用，对于从事电子通信技术服务的工程技术人员，也是一本很好的参考文献。

目前国内众多电子通信方面的教材，在内容上并不足以反映该领域的最新发展，覆盖范围也有限，所以清华大学出版社引进这本书是一件非常有意义的事情。出版社的各位老师为本书的出版付出了辛勤的劳动，借此机会，表示诚挚的感谢。

本书由肖善鹏、张蕾主译，先后参与翻译工作的还有蔡启明、陈利兵、陈志兵、吴江、朱江、马杰等多位同志。由于本书涉及面广、内容新、翻译难度较大，加之译者水平有限，时间仓促，难免有疏漏和错误，欢迎广大读者批评指正。

译 者

2005.9.2

---

注：由于本书图多由原版书扫描而来，故图中的单位符号等多为正体，特此说明。

# 序　　言

对于《现代电子通信（第 8 版）》的许多改进，我们感到非常兴奋，相信在以下的简要介绍中，大家会和我们一起分享这份热忱。第 8 版仍旧保留了第 7 版的一些风格，包括电子通信领域的最新发展、易读性和许多能够帮助学生加深理解的内容。

本版大大地扩充了关于数字通信的讨论。事实上，本版新增加了一章专门来讨论无线数字通信。第 10 章“无线数字通信”集中讨论了扩频通信技术，今天这项技术被用于传输无线数字数据，这一章包括了扩频通信技术主要组成部分的 Electronics Workbench™ Multisim 仿真。同时本书还包括专门介绍正交频分复用（OFDM）系统的一节，这项无线数字通信技术在无线联网中经常用到。

## 本书特色

- 数字和数据通信的最新发展
- 在扩频通信中对 Electronics Workbench™ Multisim 的扩展应用
- 深入的故障分析章节
- 每一章都有非常多的习题，包括一些思考题，目的是用来培养读者的分析技能
- 文中的电路图经过全功能的 Electronics Workbench(EWB) Multisim CD 进行了仿真。其余的电路图提供了交互式的触手可及的故障分析练习
- 关键的术语和定义在它们出现地方的页边着重标出
- 深入的习题集
- 最新的典型的工业设备
- 在每一章开头，给出了这一章的“本章概要”、“学习目标”和“关键术语”
- 每一章的结尾是这一章的关键点总结
- 缩略语和缩写的完整目录
- 详尽的词汇表

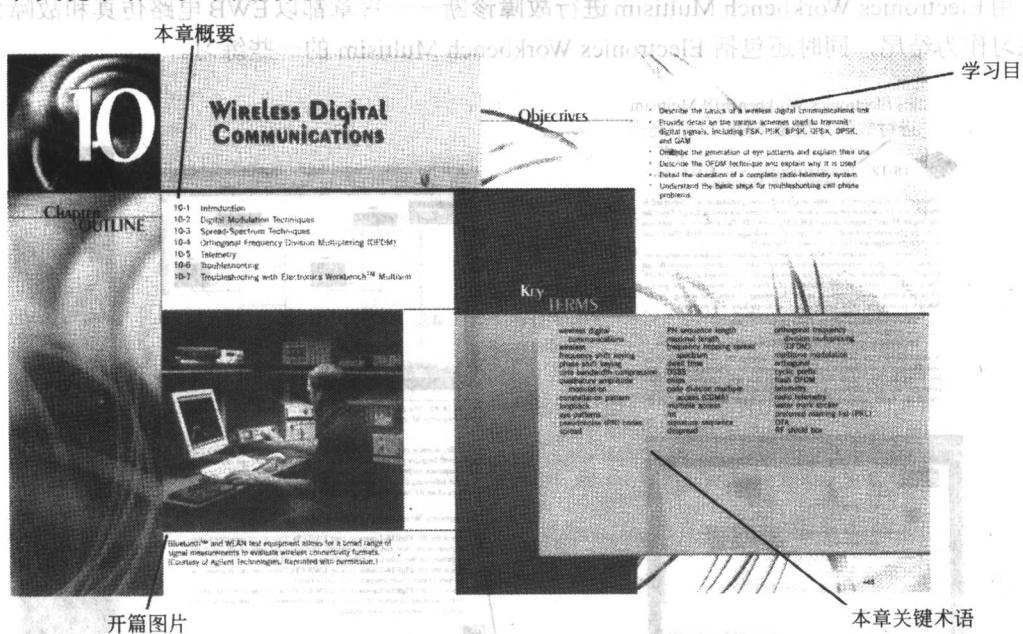
## 第八版新增的部分内容

- 无线数字通信的范围更广
- 对伪随机（PN）码的更广泛的讨论
- 直接序列扩频（DSSS）的详细分析
- 数字信号扩频的深入讨论
- 利用 Electronics Workbench Multisim 对关键的扩频通信技术进行仿真

- 包含了正交频分复用（OFDM）
  - 众多的 OFDM 传输数据的例子
  - 更新的数据表、电路示例以及对下列问题的讨论：
- TDA1572T AM 接收机  
AD630 平衡调制解调器  
MAX2606 单片 FM 发射机  
静噪技术  
AD8369 数控可变增益放大器  
MT8964 编解码器  
MAX3451 USB 发射器  
TDA8961 ATSC 数字陆地电视解调码器
- 光纤的范围更广

## 图例

**开篇**——每一章都由一幅与本章内容相关的图片作为开始，然后是本章概要、学习目标和关键术语，以下图为例。



**例题解答**——每章都有非常丰富的例题和解答，如下图所示。这些例题强化了关键的概念，并有助于课程的掌握。

**故障诊断**——每章都包含一个扩展的故障诊断部分。下面提供了一个例子，应注意学生应该掌握的部分都得到了强调。学生们对应用所学到的知识去解决现实世界的问题总是非常感兴趣的。通过这个过程，他们的理解得到了提高。同样重要的是，雇主和毕业生评

定机构非常看重故障分析的能力。

### 每章都有一节专门讲述故障分析

#### 7-8 TROUBLESHOOTING

Transceivers, or two-way radios, are found in many commercial applications. In this section we will look at troubleshooting the transmitter portion of a mobile transceiver. General troubleshooting techniques are presented in this section. You should always refer to the manufacturer's manual before disassembling a transceiver and making any adjustments or repairs to it.

Today's communication equipment includes digital logic circuits in control various functions. We will learn to troubleshoot some basic logic circuits. We'll also learn how to troubleshoot a frequency synthesizer.

After completing this section you should be able to:

- Describe the signal flow in a mobile FM transmitter circuit
- Describe common mobile transmitter failures
- Troubleshoot basic logic circuits
- Troubleshoot a frequency synthesizer

#### TRANSMITTER TRANSMITTER

The block diagram in Fig. 7-32 depicts the transmitter portion of a mobile transceiver. Mobile transmitters may differ somewhat in design. For example, this particular transmitter uses several frequency multiplier circuits in the exciter stage to step up the frequency to the necessary operating frequency. A press-to-talk microphone provides the audio signal to the AF amplifier. The AF signal is then converted and sent to the phase modulator. The phase modulator is also fed by a crystal-controlled oscillator. The signal driving the power amplifier is FM from the phase modulator. The power amplifier is controlled by the driver stage. The driver stage is controlled by the RF driver. The power amplifier delivers a specified output power to the antenna via the harmonic filter and the antenna-switching relay. Typical output power ratings are 20 to 25 W.

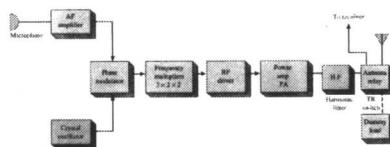


FIGURE 7-32 Block diagram of a mobile FM transceiver, transmitter portion.

352 Chapter 7 • Communications Techniques

用 Electronics Workbench Multisim 进行故障诊断——每章都以 EWB 电路仿真和故障分析练习作为结尾，同时还包括 Electronics Workbench Multisim 的一些练习。

### 用 Electronics Workbench™ Multisim 进行故障分析是本版的一个亮点



#### 18-12 TROUBLESHOOTING WITH ELECTRONICS WORKBENCH™ MULTISIM

The concept of preparing a system design for a fiber installation was presented in the Fiber Optics chapter in your CD. This exercise provides you with the opportunity to practice a fiber-optic system design in depth. The circuit for the light-budget simulation is shown in Fig. 18-10.

Electronics Workbench™ Multisim does not contain a commercially available component library for optical components. However, with little creativity, a system design for a fiber installation can be modeled. This example is patterned after Fig. 18-23. 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 (ESL) = -27 dBm

2. The minimum received signal level (ESL) = -34 dBm

3. The minimum received signal level (ESL) for a BER of  $10^{-10}$  = -40 dBm

A 10-dB T-type attenuator has been provided to simulate the fiber cable and splice loss. The system is terminated with a 600- $\Omega$  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 for the voltage-controlled sine-wave oscillator are shown in Fig. 18-11.

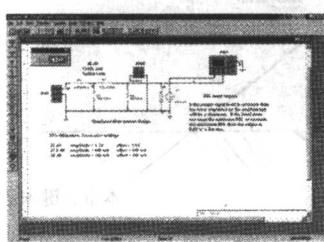


FIGURE 18-11 The Multisim circuit for the light-budget simulation.

872 Chapter 18 • Fiber Optics

丰富的例题解答有助于课程的掌握

#### EXAMPLE 7-8

The receiver from Ex. 7-7 has a preamplifier at its input. The preamp has a 24-dB gain and a 3-dB NF. Calculate the new sensitivity and dynamic range.

#### Solution

The first step is to determine the overall system noise ratio (NR). Recall from Chapter 1 that

$$NR = \log \frac{NP}{10}$$

Letting NR<sub>1</sub> represent the preamp and NR<sub>2</sub> the receiver, we have

$$NR_1 = \log \frac{12 \text{ dB}}{10} = 3.16$$

$$NR_2 = \log \frac{20 \text{ dB}}{10} = 1.31$$

The overall NR is

$$NR = NR_1 + \frac{NR_2 - 1}{P_{in}}$$

and

$$P_{in} = \log \frac{24 \text{ dB} + 25.1}{100} = 3.51$$

$$NR = 3.16 + \frac{1.31 - 1}{3.51} = 3.51$$

$$NF = 10 \log 3.51 = 5.5 \text{ dB}$$

$$S = -174 \text{ dBm} + 5.5 \text{ dB} + 60 \text{ dB} = -108.5 \text{ dBm}$$

The third-order intercept point of the receiver chain had been +5 dBm. It is now preceded by an NF of 3.51 dB. The new intercept point is 3 dB less than the receiver without any appreciable intermodulation distortion. In other words, third-order intercept is +5 dB = 24 dB = -19 dBm. Thus,

$$\text{dynamic range} = \frac{2}{3}(-19 \text{ dBm}) - (-108.5 \text{ dBm}) \\ = 59.7 \text{ dB}$$

#### EXAMPLE 18-8

The 24-dB preamp in Ex. 18-8 is replaced with a 10-dB gain preamp with the same 5-dB NF. What are the system's sensitivity and dynamic range?

Section 18-4 • Receiver Noise, Sensitivity, and Dynamic Range Relationships

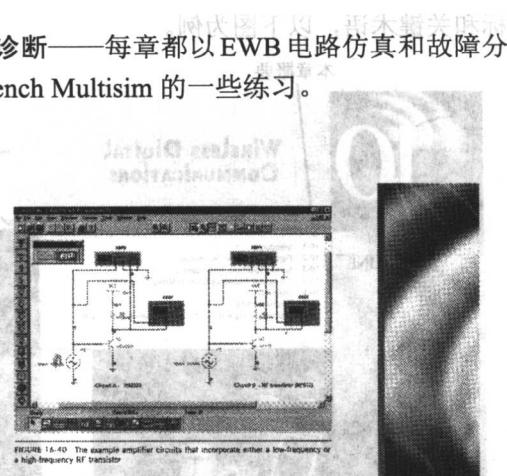


FIGURE 18-10 The example amplifier circuits that incorporates either a low-frequency or a high-frequency RF preamplifier.

183 MHz, whereas circuit B, which is using one HEMT RF transistor, has a 5-dB upper limit frequency of about 240 MHz. This demonstrates the vast improvement in the frequency response of an amplifier with the use of an RF circuit.

The following exercises provide you with an opportunity to explore the characteristics of an RF inductor and troubleshoot an RF amplifier.

#### ELECTRONICS WORKBENCH™ EXERCISES

1. Open the file Fig8k1-1.msim in your EWB CD. This circuit provides a comparison of circuit A and an RF inductor. Determine the upper 3-dB cutoff frequency for the inductor. (104 kHz, approx. 1.5 GHz)
2. Open the file Fig8k2-1.msim in your EWB CD. Determine the resonant frequency of that diode antenna. ( $f = 1.07$  GHz)
3. Open the file Fig8k3-1.msim in your EWB CD. Determine if the RF amplifier is working properly. If it isn't, locate and correct the fault and retry the simulation. Report on your findings.

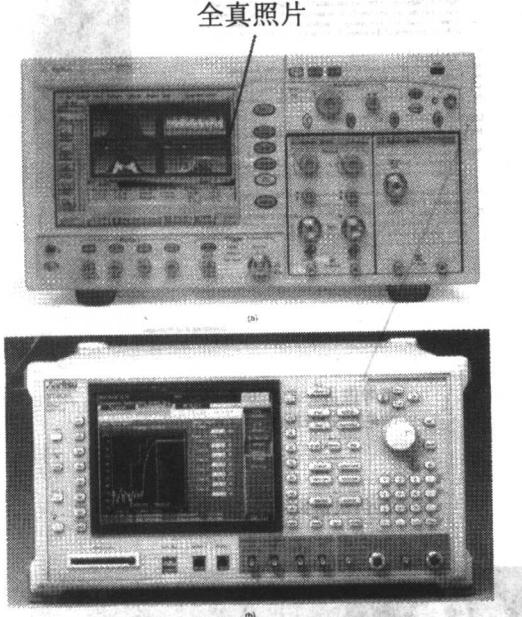
#### SUMMARY

In Chapter 16 we studied microphones and lasers. We learned that microphones share many properties with light waves. The major topics you should now understand include:

• Microphones convert sound waves into electrical signals. Lasers convert electrical signals into light waves.

**关键术语定义**——关键的新名词和概念在文中使用它们的页边附近进行了定义。例子如下所示。以这种方式描述关键的术语使得学生可以快速地接受、复习和理解新的概念和词汇。

**每章结尾的材料**——每章在结束的时候都包含一个对关键概念的总结、一个全面的习题集、一节“思考题”和一节 Electronics Workbench™ Multisim 练习。下面的例子给出这些材料的组织方法。这些题目都是非常全面的，并且针对特定的章节。题目后边的星号表示这个题目曾经被 FCC 提供为认证考试的学习辅导。另外，部分问题的答案在括号中给出。



(a) The 86100C digital communications analyzer with jitter analysis offers breakthrough speed, accuracy, and affordability. (Courtesy of Agilent Technologies. Reprinted with permission.) (b) The MT8802A radio communications analyzer was designed to support the test needs of the manufacturing, R&D, and maintenance markets. (Courtesy of Anritsu Company. Reprinted with permission.)

242 Chapter 5 • Frequency Modulation: Transmission

Section 14-4 Antenna Feed Lines

655

**词汇表和缩略语**——本书的最后包括了一个详尽的词汇表和缩略语表。这些重要的工具以下页图为例。电子通信领域中广泛地使用着缩略语，这对于学生来讲常常会造成混淆。这个列表提供了一个快速查找的途径，解决了这个问题。

**光盘中的材料**——随本书所提供的 Electronics Workbench Textbook Edition for Multisim 7 给出了超过 90% 的文中所用电路以及故障分析所用的电路。

在学生们学习电子和电气工程的课程中，Multisim 是一个系统的捕获、仿真和可编程逻辑工具。本书光盘中的电路都是由 Multisim 软件生成的。

## 术语边注

**antennas.** This method of connection produces no standing waves on the line when the line is matched to a generator. Coupling to a generator is often made through a simple untuned transformer secondary.

Another method of transferring energy to the antenna is through the use of a

twisted-pair line, as shown in Fig. 14-10(b). It is used as an untuned line for low-

frequencies. Due to excessive losses occurring in the insulation, the twisted pair is

not used at higher frequencies. The characteristic impedance of such lines is about

70 Ω.

**Delta Match**

When a line does not match the impedance of the antenna, it is necessary to use spe-

cial impedance matching techniques such as those discussed with Smith chart appli-

cations in Chapter 12. An example of an additional type of impedance matching

device is the **delta match**, shown in Fig. 14-10(c). Due to inherent characteris-

tics, the open, two-wire transmission line does not have a characteristic impedance

**Delta Match**  
an impedance matching  
device that spreads the  
transmission line as it  
approaches the antenna

九月一义家丁合此世被数贝印中用中文五念群麻同各深馆频大——义家丁木翻关  
城名湖山海湖湖山海复包括故障分析练习

### 关键概念总结



### SUMMARY

In Chapter 6 we discussed the basic of an FM receiver and showed the similarities and differences compared to an AM receiver. The major topics you should now understand include:

- the operation of an FM receiver using a block diagram at a guide, including complete descriptions of the demodulator, the demodulation network, and the local oscillator function;
- the basic characteristics of receivers, including image frequency interference and local oscillator frequency effects;
- the detailed functioning of a transistor limiter circuit;
- the detailed comparison of slope detector, Foster-Seeley discrimination, ratio detection, and quadrature detection;
- the description and operation of a phase-locked-loop (PLL) FM demodulator, including its three possible states;
- an analysis of the FM demodulation process using a block diagram;
- the operation of the proprietary communication decoder (SCA) decoder operations;
- the operation of a complete 88–108-MHz stereo FM receiver by analysis of the schematic.

### QUESTIONS AND PROBLEMS

#### Section 6-1

1. What is the purpose of a discriminator in an FM broadcast receiver?
2. Explain why the automatic frequency control (AFC) function is usually not used in today's FM receivers.
3. Draw a block diagram of a superheterodyne receiver designed for reception of FM signals.
4. The local oscillator source station is at 98.5 MHz. Calculate the local oscillator frequency and the image frequency for a 10.7-MHz IF receiver. (107.2 MHz, 117.9 MHz)

#### Section 6-2

5. Explain the desirability of an RF amplifier stage in FM receivers as compared to AM receivers. Why is this not generally true at frequencies over 1 GHz?
6. Describe the meaning of *local oscillator regeneration*, and explain how an RF stage helps to prevent it.
7. Why are square-law devices preferred over other devices as elements in RF amplifiers?

An asterisk preceding a number indicates a question that has been provided by the FCC as a study aid for licensing examinations.

294 • Frequency Modulation: Reception

曾被FCC用做认证考试学习辅导的思考题

3. The antenna load consists of a  $50\ \Omega$  characteristic line to a  $22\ \Omega \sim 100\ \Omega$ . Determine the length and position of a short-circuited stub necessary to provide a match. Repeat Problem 53 for a  $50\ \Omega$  line and an antenna of  $25\ \Omega \sim 50\ \Omega$ .

#### Section 12-9

55. Calculate the length of a short-circuited  $50\ \Omega$  line necessary to simulate an impedance of  $2\ \Omega \pm 1\ \Omega$  at 1 GHz.

56. Calculate the length of a short-circuited  $50\ \Omega$  line necessary to simulate a capacitor of  $50\ \text{pF} \pm 10\ \text{pF}$ .

57. Describe two types of baluns, and explain their function.

58. How may harmonic radiation of a transmitter be prevented?

59. Explain how to determine the frequency of harmonics of a transmitter.

60. Draw a simple schematic diagram of a receiver circuit for coupling the mid-frequency output of the final power amplifier stage of a transmitter to a two-wire transmission line with a method of suppression of second and third harmonics.

61. Explain the construction of a slotline line and some of its uses.

62. Explain the principle of TDR and some uses for this technique.

63. A pulse is sent down a  $50\ \Omega$  line that is not terminated properly. It has a propagation velocity of  $2 \times 10^8\ \text{m/s}$ , and the reflected pulse (equal in magnitude to the incident path) is apparent in 0.75 ms. What is wrong with the line, and how far from the generator does the fault exist?

64. A 100- $\Omega$  10-V rms voltage is applied to a  $50\ \Omega$  line terminated with an  $80\ \Omega$  resistive load. Determine  $I_s$ ,  $E_d$ , and  $G_{dS}$  (2.231, 12.3 V, 2.3 V).

#### Section 12-10

65. Describe some of the causes of crosstalk and the possible solutions.

66. Explain why coupling should not be too close on power lines.

67. List some of the causes of magnetic field losses in a cable.

68. Explain the effects of extreme temperature (radiation) on cables.

#### Options for Critical Thinking

69. With the help of Fig. 12-12, provide a step-by-step explanation of how a dc voltage propagates through a transmission line.

70. An open-circuited line is 1.75λ. Sketch the incident, reflected, and resultant waves for both voltage and current at the instant the generator is in its inductive state. Show the corresponding waveforms for a short-circuited line.

71. You are asked to design a low-pass filter to reduce intermodulation effects. You design one with a  $1/V$  slope. How would you justify this design?

72. Match a load of  $25\ \Omega \pm 7\%\ \Omega$  to a  $50\ \Omega$  line using a quarter-wavelength matching section. Determine the proper location and characteristic impedance of the matching section. Repeat this problem for a  $Z_L = 110\ \Omega \pm 50\ \Omega$  load. Provide two possible solutions.

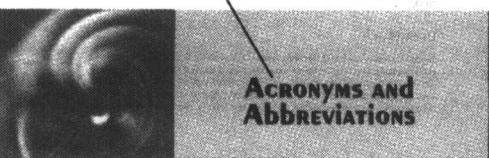
Questions and Problems 509

思考题进一步开发了  
学生们的分析能力

### 全面的常用缩略语列表

### ACRONYMS AND ABBREVIATIONS

全面的常用缩略语列表



### Glossary

**amplitude coupler** supports a telephone bandwidth and uses several transductors to send and receive audio tones to each subscriber in a local area; for the first few miles to each subscriber's residence, the device converts the amplitude of the intelligence produced corresponding changes in the amplitude of the high-frequency carrier.

**ACR** manufacturer combination of attenuation and reflection coefficient; ACR indicates greater than 10 dB.

**ACLS** the Delta Laboratory's audio compression technique for digital televisions.

**ADM** add/drop multiplexer; 1.4-Mbps fiber from the network to the service provider and up to 6 Mbps back to the user from the service provider.

**ADPCM** adaptive differential pulse code modulation; ratio that uses 12-bit peak deviation channels, which are spaced 30-140 apart in the 2048-3000-kHz band.

**Advanced Communications Technology Center (ACTC)** developed to make accommodations for advanced telecommunications in the United States.

**airline** air traffic control system; in PCN systems, the manager of information.

**algorhythms** a plan or set of instructions to achieve a specific goal.

**alias frequency** an additional frequency produced when the sampling rate is not an integer multiple of the input frequency.

**alias sampling rate** is not attained.

**aliased difference tone** alias difference tone.

**aliased distortion** the distortion that results if Nyquist sampling rate is not attained.

**aliased noise** noise in the output signal resulting from aliasing.

**alias sampling** sampling of the information signal, the resulting alias frequency equals the difference between the original intelligence frequency and the sampling frequency.

**AM** alternate mark inversion.

**amplitude companding** a form of volume compensation by compression-expansion.

**amplitude expansion after decoding** amplitude compensated single sideband (ACSSB) sideband expansion with equalization in the transmitter and speech expansion in the receiver.

**amplitude limitation (AM)** the process of impressing low-frequency intelligence onto a high-frequency carrier.

**amplitude-modulated wave** a wave whose amplitude is varied sinusoidally.

**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.

**analog device** a device that generates and/or collects electronic analog data.

**antenna array** group of antennas or antenna elements arranged to provide the desired directional characteristics.

**antenna beam** the main lobe of the radiation pattern of an antenna.

**antenna beamwidth** the width of the main lobe of the radiation pattern of an antenna.

**antenna gain** the ratio of how much power is in the directivity of an antenna to that which would be radiated as a reference antenna.

**antenna noise** noise in the antenna system.

**antenna noise factor** the noise figure of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

**antenna noise resistance** the noise resistance of an antenna system.

**antenna noise temperature** the noise temperature of an antenna system.

**antenna noise voltage** the noise voltage at the terminals of an antenna system.

**antenna noise current** the noise current at the terminals of an antenna system.

Multisim 被广泛认为是教室和实验室学习的优秀工具。但是，本书的任何一部分都是独立于 Multisim 软件或其所提供的文件的。这些文件无偿提供给消费者，选择使用 Multisim 软件的人可以使用它。在 **Textbook Edition for Multisim 7** 中，**Electronics Workbench** 提供了光盘所包含的前 25% 的完整电路，这意味着你可以：

- 控制交互的元件并调整任何一个虚拟元件的值。
- 在现有的电路上进行交互式仿真，并使用预先放置的仪器。
- 进行分析。
- 对预先定义的可视电路进行仿真、打印并保存仿真结果。
- 创建自己的电路，但最多只能有 15 个元件。

## 辅助材料

- 光盘中附带了本书的《实验室手册》，由 Mark E. Oliver 和 Jeffrey S. Beasley 著 (ISBN 0-13-170265-3)
- 在线的教师手册包括：
  - 章节概览
  - 文中部分习题的答案
  - 文中图片的 PowerPoint 幻灯片
- Prentice Hall TestGen 提供的计算机化的测试库

## 致谢

许多人对《现代电子通信》的前 7 版给出了建设性的批评意见，我们发自内心的感激来自每一个人的反馈。特别感谢 Jim Andress、Russ Jedliuka 博士、Ray Lyman 博士和 Shannon Gunaji，他们为第 8 版的出版做出了突出的贡献。我们要感谢本书的评阅者，他们是：来自 Southern University LA 的 Pradeep Bhattacharya、来自 South Georgia Technical College 的 David Mayo、来自 Pennsylvania College 的 Randall Moser、来自 Perry Technical Institute, WA 的 Michael Smith，以及来自 Education America, TX 的 Nick Smith。他们提供了非常有价值的建议。

我们要感谢我们的出版商 Charles Stewart、助理编辑 Mayda Bosco 和产品编辑 Alex Wolf，他们为本书提供了编辑支持和产品协调。

最后，我们要感谢我们的家庭，是他们给了我们持续的支持和耐心。

**Jeffery S. Beasley 和 Gary M. Miller**

# 简要目录

第 1 章 绪论 .....	1
第 2 章 幅度调制：发射 .....	60
第 3 章 幅度调制：接收 .....	101
第 4 章 单边带通信 .....	144
第 5 章 频率调制：传输 .....	179
第 6 章 频率调制：接收 .....	227
第 7 章 通信技术 .....	263
第 8 章 数字通信：编码技术 .....	322
第 9 章 有线数字通信 .....	366
第 10 章 无线数字通信 .....	410
第 11 章 网络通信 .....	446
第 12 章 传输线 .....	490
第 13 章 波的传播 .....	541
第 14 章 天线 .....	573
第 15 章 波导和雷达 .....	611
第 16 章 微波与激光 .....	646
第 17 章 电视 .....	688
第 18 章 光纤 .....	731
缩略语 .....	782
词汇表 .....	800

# 目 录

<b>第 1 章 绪论</b>	1		
1-1 简介	2	克拉普 (Clapp) 振荡器	42
调制	2	晶体振荡器	43
通信系统	3	晶体测试	45
1-2 通信中的分贝	4	1-9 故障诊断	46
分贝值的应用	5	常用的故障诊断技术	46
1-3 噪声	9	电子电路故障原因	47
外部噪声	10	故障诊断计划	48
内部噪声	10	晶体测试	49
1-4 噪声表示和计算	14	振荡器电容测试	49
信噪比	14	振荡器电感测试	50
噪声系数	15	理解数字示波器波形	50
电抗噪声效应	17	1-10 用 Electronics Workbench™ Multisim 进行故障诊断	51
多级放大器噪声	17	Electronics Workbench™ 练习	53
等效噪声温度	20	小结	53
等效噪声电阻	21	习题	54
SINAD	21	思考题	59
1-5 噪声测量	22		
二极管噪声发生器	22	<b>第 2 章 幅度调制：发射</b>	60
正切噪声测量技术	23	2-1 简介	61
1-6 信息和带宽	24	2-2 幅度调制基础	61
理解频谱	25	AM 波形	62
1-7 LC 电路	30	AM 信号的矢量表示法	66
实际应用中的电感和电容	30	2-3 调制率	67
共振	32	过调制	68
LC 带通滤波器	34	2-4 AM 信号分析	69
并联 LC 电路	36	高调制率的重要性	70
LC 滤波器的类型	38	2-5 AM 信号产生电路	73
高频效应	38	高电平和低电平调制	74
1-8 振荡器	39	中和	75
LC 振荡器	39	晶体管高电平调制器	76
哈特利 (Hartley) 振荡器	40	PIN 二极管调制器	77
考比慈 (Colpitts) 振荡器	41	线性集成电路调制器	77

2-6 AM 发射机系统	80	像频	116
民用波段发射机	81	RF 放大器	118
天线耦合器	83	混频器/本机振荡器	119
发射机装配和调整	83	IF 放大器	121
2-7 发射机测量	85	3-6 自动增益控制	123
梯形图	85	获得 AGC 电平	123
仪表测量	86	控制晶体管的增益	123
频谱分析	86	IF/AGC 放大器	125
谐波失真测量	87	3-7 AM 接收系统	127
RF 信号测量特别注意事项	89	LIC 调幅接收机	127
2-8 故障诊断	89	调幅立体声	130
检视	90	接收机分析	131
维修策略	90	3-8 故障诊断	133
RF 放大器故障诊断	91	混频器电路	134
检查发射机	92	无 AM RF 信号	134
测量发射机输出电压	93	转换器的本机振荡器部分出错	135
2-9 用 Electronics Workbench <sup>TM</sup>		调幅接收微弱	135
Multisim 进行故障诊断	94	故障表现和可能的原因	135
Electronics Workbench <sup>TM</sup> 练习	96	电源故障检测	136
小结	97	检测音频放大器故障	137
习题	97	检测超外差式接收机 RF	
思考题	100	部分的故障	138
<b>第3章 幅度调制：接收</b>	101	3-9 用 Electronics Workbench <sup>TM</sup>	
3-1 接收机特性	102	Multisim 进行故障诊断	138
灵敏度和选择性	103	Electronics Workbench <sup>TM</sup> 练习	140
TRF 选择性	103	小结	140
3-2 AM 检波	105	习题	141
二极管检波器	106	思考题	143
检波二极管的类型	108	<b>第4章 单边带通信</b>	144
对角削波畸变	108	4-1 单边带特征	145
同步检波	108	功率分布	145
3-3 超外差接收机	110	边带传输类型	146
频率转换	111	SSB 的优点	147
调谐电路的调节	112	4-2 边带的生成：平衡调制器	147
3-4 超外差调谐	113	LIC 平衡调制器	148
跟踪	113	4-3 单边带滤波器	151
电子调谐	114	晶体滤波器	152
3-5 超外差分析	116	陶瓷滤波器	153