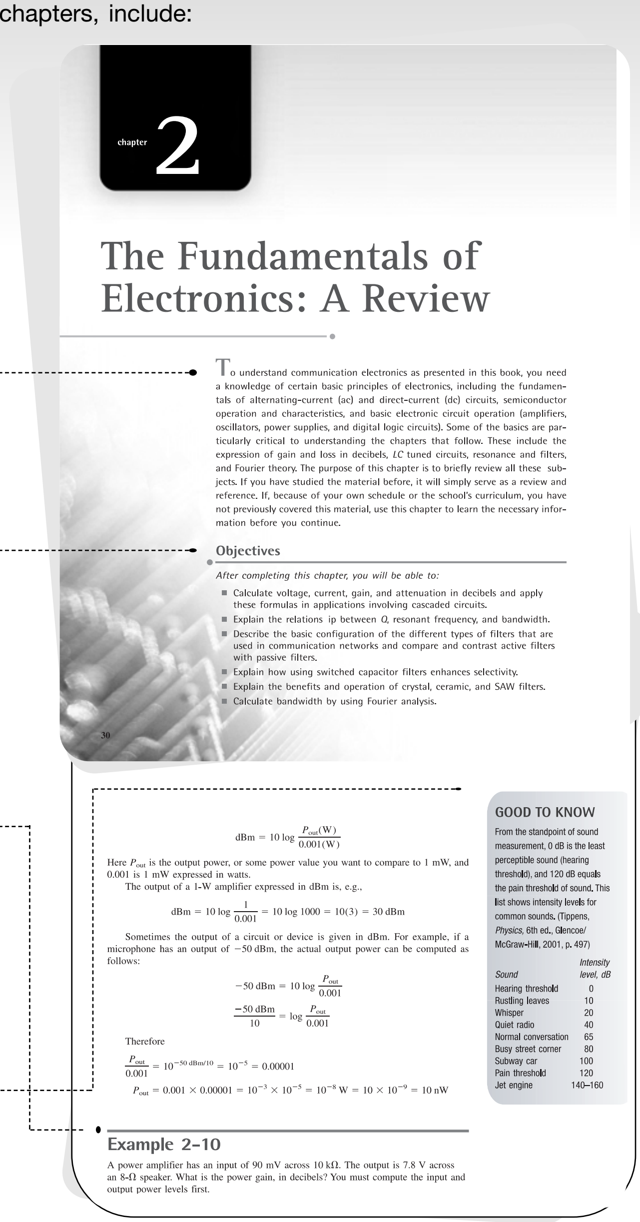
Guided Tour

Learning Features

Many new learning features have been incorporated into the seventh edition of *Electronic Principles*. These learning features, found throughout the chapters, include:



chapter 2

The Fundamentals of Electronics: A Review

To understand communication electronics as presented in this book, you need a knowledge of certain basic principles of electronics, including the fundamentals of alternating-current (ac) and direct-current (dc) circuits, semiconductor operation and characteristics, and basic electronic circuit operation (amplifiers, oscillators, power supplies, and digital logic circuits). Some of the basics are particularly critical to understanding the chapters that follow. These include the expression of gain and loss in decibels, *LC* tuned circuits, resonance and filters, and Fourier theory. The purpose of this chapter is to briefly review all these subjects. If you have studied the material before, it will simply serve as a review and reference. If, because of your own schedule or the school's curriculum, you have not previously covered this material, use this chapter to learn the necessary information before you continue.

Objectives

After completing this chapter, you will be able to:

- Calculate voltage, current, gain, and attenuation in decibels and apply these formulas in applications involving cascaded circuits.
- Explain the relations ip between *Q*, resonant frequency, and bandwidth.
- Describe the basic configuration of the different types of filters that are used in communication networks and compare and contrast active filters with passive filters.
- Explain how using switched capacitor filters enhances selectivity.
- Explain the benefits and operation of crystal, ceramic, and SAW filters.
- Calculate bandwidth by using Fourier analysis.

30

$$dBm = 10 \log \frac{P_{out}(W)}{0.001(W)}$$

Here P_{out} is the output power, or some power value you want to compare to 1 mW, and 0.001 is 1 mW expressed in watts.

The output of a 1-W amplifier expressed in dBm is, e.g.,

$$dBm = 10 \log \frac{1}{0.001} = 10 \log 1000 = 10(3) = 30 \text{ dBm}$$

Sometimes the output of a circuit or device is given in dBm. For example, if a microphone has an output of −50 dBm, the actual output power can be computed as follows:

$$-50 \text{ dBm} = 10 \log \frac{P_{out}}{0.001}$$

$$\frac{-50 \text{ dBm}}{10} = \log \frac{P_{out}}{0.001}$$

Therefore

$$\frac{P_{out}}{0.001} = 10^{-50 \text{ dBm}/10} = 10^{-5} = 0.00001$$

$$P_{out} = 0.001 \times 0.00001 = 10^{-3} \times 10^{-5} = 10^{-8} \text{ W} = 10 \times 10^{-9} = 10 \text{ nW}$$

GOOD TO KNOW

From the standpoint of sound measurement, 0 dB is the least perceptible sound (hearing threshold), and 120 dB equals the pain threshold of sound. This list shows intensity levels for common sounds. (Tippens, *Physics*, 6th ed., Glencoe/McGraw-Hill, 2001, p. 497)

Sound	*Intensity level, dB*
Hearing threshold	0
Rustling leaves	10
Whisper	20
Quiet radio	40
Normal conversation	65
Busy street corner	80
Subway car	100
Pain threshold	120
Jet engine	140–160

Example 2-10

A power amplifier has an input of 90 mV across 10 kΩ. The output is 7.8 V across an 8-Ω speaker. What is the power gain, in decibels? You must compute the input and output power levels first.

Chapter Introduction

Each chapter begins with a brief introduction setting the stage for what the student is about to learn.

Chapter Objectives

Chapter Objectives provide a concise statement of expected learning outcomes.

Examples

Each chapter contains worked-out Examples that demonstrate important concepts or circuit operations, including circuit analysis, applications, troubleshooting, and basic design.

Good To Know

Good To Know statements, found in margins, provide interesting added insights to topics being presented

Pioneers of Electronics

Students can use summaries when reviewing for examinations, or just to make sure they haven't missed any key concepts. are listed to help solidly learning outcomes.

Chapter Review

Students can use summaries when reviewing for examinations, or just to make sure they haven't missed any key concepts. Important circuit derivations and definition are listed to help solidly learning outcomes.

Problems

Students obtain back by Problems that immediately follow most Examples. Answers to these problems are found at the end of each chapter.

Critical Thinking

A wide variety of questions and problems are found at the end of each chapter; over 30% are new or revised in this edition. Those include circuit analysis, trouble shooting, critical thinking, and job interview questions.

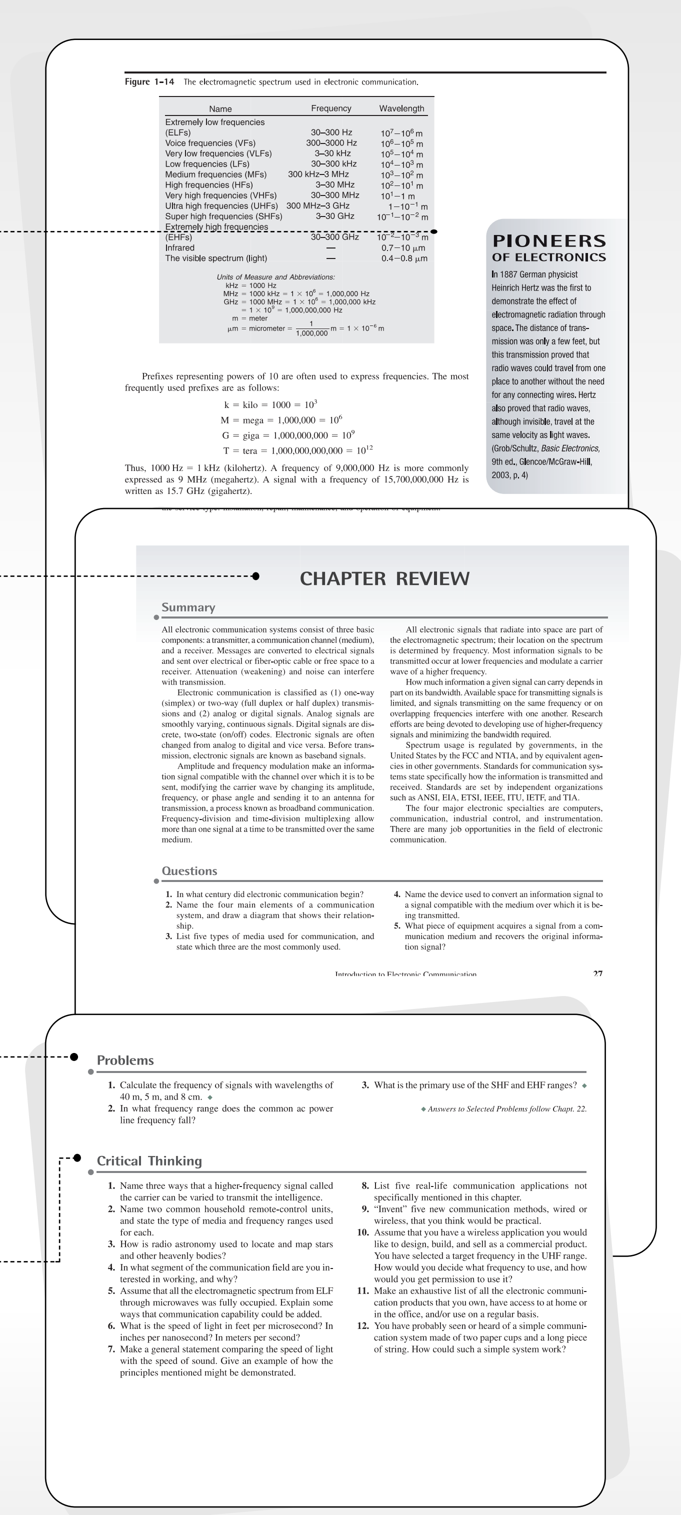


Figure 1–14 The electromagnetic spectrum used in electronic communication.

Name	Frequency	Wavelength
Extremely low frequencies (ELFs)	30–300 Hz	10^7–10^6 m
Voice frequencies (VFs)	300–3000 Hz	10^6–10^5 m
Very low frequencies (VLFs)	3–30 kHz	10^5–10^4 m
Low frequencies (LFs)	30–300 kHz	10^4–10^3 m
Medium frequencies (MFs)	300 kHz–3 MHz	10^3–10^2 m
High frequencies (HFs)	3–30 MHz	10^2–10^1 m
Very high frequencies (VHFs)	30–300 MHz	10^1–1 m
Ultra high frequencies (UHFs)	300 MHz–3 GHz	1–10^{-1} m
Super high frequencies (SHFs)	3–30 GHz	10^{-1}–10^{-2} m
Extremely high frequencies (EHFs)	30–300 GHz	10^{-2}–10^{-3} m
Infrared	—	0.7–10 μm
The visible spectrum (light)	—	0.4–0.8 μm

Units of Measure and Abbreviations:

kHz = 1000 Hz
MHz = 1000 kHz = 1×10^6 = 1,000,000 Hz
GHz = 1000 MHz = 1×10^6 = 1,000,000 kHz
= 1×10^9 = 1,000,000,000 Hz
m = meter
$\mu m = \text{micrometer} = \frac{1}{1{,}000{,}000} m = 1 \times 10^{-6} m$

Prefixes representing powers of 10 are often used to express frequencies. The most frequently used prefixes are as follows:

$$k = \text{kilo} = 1000 = 10^3$$
$$M = \text{mega} = 1{,}000{,}000 = 10^6$$
$$G = \text{giga} = 1{,}000{,}000{,}000 = 10^9$$
$$T = \text{tera} = 1{,}000{,}000{,}000{,}000 = 10^{12}$$

Thus, 1000 Hz = 1 kHz (kilohertz). A frequency of 9,000,000 Hz is more commonly expressed as 9 MHz (megahertz). A signal with a frequency of 15,700,000,000 Hz is written as 15.7 GHz (gigahertz).

PIONEERS OF ELECTRONICS

In 1887 German physicist Heinrich Hertz was the first to demonstrate the effect of electromagnetic radiation through space. The distance of transmission was only a few feet, but this transmission proved that radio waves could travel from one place to another without the need for any connecting wires. Hertz also proved that radio waves, although invisible, travel at the same velocity as light waves. (Grob/Schultz, *Basic Electronics,* 9th ed., Glencoe/McGraw-Hill, 2003, p. 4)

CHAPTER REVIEW

Summary

All electronic communication systems consist of three basic components: a transmitter, a communication channel (medium), and a receiver. Messages are converted to electrical signals and sent over electrical or fiber-optic cable or free space to a receiver. Attenuation (weakening) and noise can interfere with transmission.

Electronic communication is classified as (1) one-way (simplex) or two-way (full duplex or half duplex) transmissions and (2) analog or digital signals. Analog signals are smoothly varying, continuous signals. Digital signals are discrete, two-state (on/off) codes. Electronic signals are often changed from analog to digital and vice versa. Before transmission, electronic signals are known as baseband signals.

Amplitude and frequency modulation make an information signal compatible with the channel over which it is to be sent, modifying the carrier wave by changing its amplitude, frequency, or phase angle and sending it to an antenna for transmission, a process known as broadband communication. Frequency-division and time-division multiplexing allow more than one signal at a time to be transmitted over the same medium.

All electronic signals that radiate into space are part of the electromagnetic spectrum; their location on the spectrum is determined by frequency. Most information signals to be transmitted occur at lower frequencies and modulate a carrier wave of a higher frequency.

How much information a given signal can carry depends in part on its bandwidth. Available space for transmitting signals is limited, and signals transmitting on the same frequency or on overlapping frequencies interfere with one another. Research efforts are being devoted to developing use of higher-frequency signals and minimizing the bandwidth required.

Spectrum usage is regulated by governments, in the United States by the FCC and NTIA, and by equivalent agencies in other governments. Standards for communication systems state specifically how the information is transmitted and received. Standards are set by independent organizations such as ANSI, EIA, ETSI, IEEE, ITU, IETF, and TIA.

The four major electronic specialties are computers, communication, industrial control, and instrumentation. There are many job opportunities in the field of electronic communication.

Questions

1. In what century did electronic communication begin?
2. Name the four main elements of a communication system, and draw a diagram that shows their relationship.
3. List five types of media used for communication, and state which three are the most commonly used.
4. Name the device used to convert an information signal to a signal compatible with the medium over which it is being transmitted.
5. What piece of equipment acquires a signal from a communication medium and recovers the original information signal?

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Problems

1. Calculate the frequency of signals with wavelengths of 40 m, 5 m, and 8 cm. ◆
2. In what frequency range does the common ac power line frequency fall?
3. What is the primary use of the SHF and EHF ranges? ◆

◆ *Answers to Selected Problems follow Chapt. 22.*

Critical Thinking

1. Name three ways that a higher-frequency signal called the carrier can be varied to transmit the intelligence.
2. Name two common household remote-control units, and state the type of media and frequency ranges used for each.
3. How is radio astronomy used to locate and map stars and other heavenly bodies?
4. In what segment of the communication field are you interested in working, and why?
5. Assume that all the electromagnetic spectrum from ELF through microwaves was fully occupied. Explain some ways that communication capability could be added.
6. What is the speed of light in feet per microsecond? In inches per nanosecond? In meters per second?
7. Make a general statement comparing the speed of light with the speed of sound. Give an example of how the principles mentioned might be demonstrated.
8. List five real-life communication applications not specifically mentioned in this chapter.
9. "Invent" five new communication methods, wired or wireless, that you think would be practical.
10. Assume that you have a wireless application you would like to design, build, and sell as a commercial product. You have selected a target frequency in the UHF range. How would you decide what frequency to use, and how would you get permission to use it?
11. Make an exhaustive list of all the electronic communication products that you own, have access to at home or in the office, and/or use on a regular basis.
12. You have probably seen or heard of a simple communication system made of two paper cups and a long piece of string. How could such a simple system work?