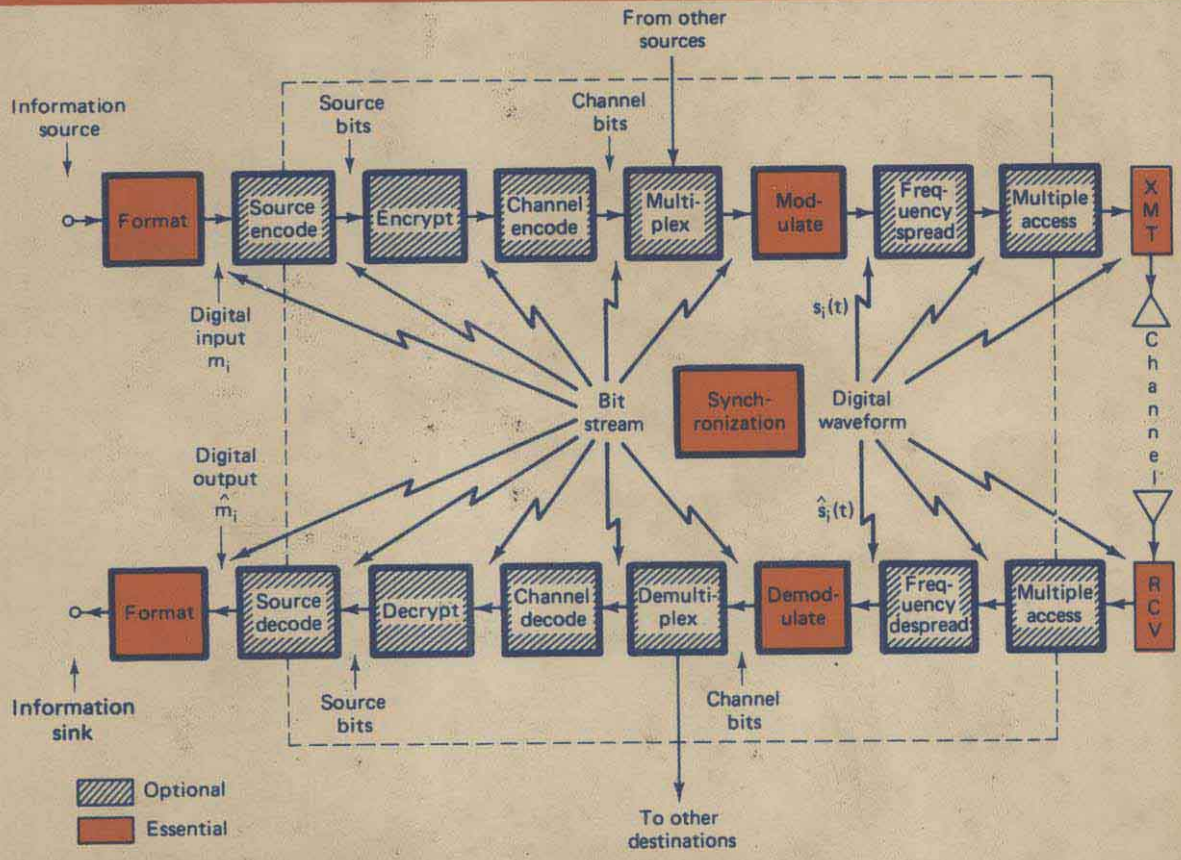
BERNARD SKLAR

DIGITAL COMMUNICATIONS

Fundamentals and Applications



DIGITAL COMMUNICATIONS

Fundamentals and Applications

BERNARD SKLAR

The Aerospace Corporation, El Segundo, California
and
University of California, Los Angeles

PRENTICE HALL

Englewood Cliffs, New Jersey 07632

Library of Congress Cataloging-in-Publication Data

SKLAR, BERNARD (date)
Digital communications.

Bibliography: p.
Includes index.
1. Digital communications. I. Title.
TK5103.7.S55 1988 621.38'0413 87-1316
ISBN 0-13-211939-0

Editorial/production supervision and
interior design: Reynold Rieger
Cover design: Wanda Lubelska Design
Manufacturing buyers: Gordon Osbourne and Paula Benevento

© 1988 by Prentice Hall
A Division of Simon & Schuster
Englewood Cliffs, New Jersey 07632

All rights reserved. No part of this book may be
reproduced, in any form or by any means,
without permission in writing from the publisher.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-211939-0 025

Prentice-Hall International (UK) Limited, *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall Hispanoamericana, S.A., *Mexico*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Simon & Schuster Asia Pte. Ltd., *Singapore*
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*

DIGITAL COMMUNICATIONS

To my mother, Ruth Sklar,
the memory of my father, Julius Sklar,
my wife, Gwen, and our children,
Debra, Sharon, and Dean

试读结束，需要全本PDF请购买 www.ertongbook.com

Preface

This book is intended to provide a comprehensive coverage of digital communication systems for senior-level undergraduates, first-year graduate students, and practicing engineers. Even though the emphasis of the book is on digital communications, necessary analog fundamentals are included, since analog waveforms are used for the radio transmission of digital signals.

The key feature of a digital communication system is that it deals with a finite set of discrete messages, in contrast to an analog communication system in which messages are defined on a continuum. The objective at the receiver of the digital system is *not* to reproduce a waveform with precision; it is, instead, to determine from a noise-perturbed signal which of the finite set of waveforms had been sent by the transmitter. In fulfillment of this objective, an impressive assortment of signal processing techniques has arisen over the past two decades.

The book develops these important techniques in the context of a unified structure. The structure, in block diagram form, appears at the beginning of each chapter; blocks in the diagram are emphasized, as appropriate, to correspond to the subject of that chapter. Major purposes of the book are (1) to add organization and structure to a field that has grown rapidly in the last two decades, and (2) to ensure awareness of the "big picture" even while delving into the details. The signals and key processing steps are traced from the information source through the transmitter, channel, receiver, and ultimately to the information sink. Signal transformations are organized according to functional classes: formatting and source coding, modulation, channel coding, multiplexing and multiple access, spreading, encryption, and synchronization. Throughout the book, emphasis is

placed on system goals and the need to trade off basic system parameters such as signal-to-noise ratio, probability of error, and bandwidth (spectral) expenditure.

ORGANIZATION OF THE BOOK

It is assumed that the reader is familiar with Fourier methods and convolution. Appendix A reviews these techniques, emphasizing those properties that are particularly useful in the study of communication theory. It is also assumed that the reader has a knowledge of basic probability and has some familiarity with random variables. Appendix B builds on these disciplines for a short treatment on statistical decision theory with emphasis on hypothesis testing—so important in the understanding of detection theory. Chapter 1 introduces the overall digital communication system and the basic signal transformations that are highlighted in subsequent chapters. Some basic ideas of random variables and the additive white Gaussian noise (AWGN) model are reviewed. Also, the relationship between power spectral density and autocorrelation, and the basics of signal transmission through linear systems, are established. Chapter 2 covers the signal processing step, known as formatting, the step that renders an information signal compatible with a digital system. Chapter 2 also emphasizes the *transmission* of baseband signals. Chapter 3 deals with bandpass modulation and demodulation techniques. The detection of digital signals in Gaussian noise is stressed, and receiver optimization is examined. Chapter 4 deals with link analysis, an important subject for providing overall system insight; it considers some subtleties usually neglected at the college level. Chapters 5 and 6 deal with channel coding—a cost-effective way of providing improvement in system error performance. Chapter 5 emphasizes linear block coding, and Chapter 6 emphasizes convolutional coding.

Chapter 7 considers various modulation/coding system trade-offs dealing with probability of bit error performance, bandwidth efficiency, and signal-to-noise ratio. Chapter 8 deals with synchronization for digital systems. It covers phase-locked-loop implementation for achieving carrier synchronization; bit synchronization, frame synchronization, and network synchronization; and some fundamentals of synchronization as applied to satellite links.

Chapter 9 treats multiplexing and multiple access. It explores techniques that are available for utilizing the communication resource efficiently. Chapter 10 introduces spread-spectrum techniques and their application in such areas as multiple access, ranging, and interference rejection. This technology is particularly important for most military communication systems. The subject of source coding in Chapter 11 deals with data formatting, as is done in Chapter 2; the main difference between formatting and source coding is that source coding additionally involves data redundancy reduction. Rather than considering source coding immediately after formatting, source coding has purposely been treated in a later chapter. It is felt that the reader should be involved with the fundamental processing steps, such as modulation and channel coding, early in the book, before examining some of the special considerations of source coding. Chapter 12 covers

some basic encryption/decryption ideas. It includes some classical encryption concepts, as well as some of the proposals for a class of encryption systems called public key cryptosystems.

If the book is used for a two-term course, a simple partitioning is suggested: the first six chapters to be taught in the first term, and the last six chapters in the second term. If the book is used for a one-term only course, it is suggested that the course material be selected from the following chapters: 1, 2, 3, 4, 5, 6, 8, and 10.

ACKNOWLEDGMENTS

This book is an outgrowth of my teaching activities at the University of California, Los Angeles, and my work in the Communications Division at The Aerospace Corporation. A number of people have contributed in many ways and it is a pleasure to acknowledge them. Dr. Maurice King, my colleague at Aerospace, carefully reviewed and made important contributions to each chapter. His continual assistance has been invaluable. He also contributed Chapter 8, Synchronization. Professor Fred Harris of San Diego State University suggested many improvements and contributed Chapter 11, Source Coding. I want to pay special thanks to Dr. Marvin Simon of the Jet Propulsion Laboratory for providing me with much encouragement and many valuable suggestions.

I also want to thank Professor Jim Omura of UCLA for sharing with me his considerable knowledge of encryption and thereby helping me improve Chapter 12. Professor Raymond Pickholtz of George Washington University gave me lots of beneficial advice throughout the writing process. Professors William Lindsey and Andreas Polydoros of the University of Southern California suggested important improvements. Professor James Modestino of Rensselaer Polytechnic Institute, Dr. Adam Lender of Lockheed Palo Alto Research Laboratory, and Professor Ron Iltis of the University of California, Santa Barbara, each provided valuable reviews. Dr. Todd Citron of Hughes Aircraft, Dr. Joe Odenwalder of MA/COM Linkabit, and Dr. Unjeng Cheng of Axiomatics were extremely helpful in the chapters on channel coding. Mr. Don Martin and Mr. Ned Feldman of The Aerospace Corporation made numerous suggestions and contributions. I also want to pay special thanks to Professor Wayne Stark of the University of Michigan, whose unique critical talents enhanced the manuscript's continuity.

The block diagrams in Figures 1.2 and 1.3, at each chapter opening, and on the cover of the book, first appeared in the two part paper: © 1983 IEEE; B. Sklar, "A Structured Overview of Digital Communications—A Tutorial Review," *IEEE Communications Magazine*, August and October, 1983. Permission from IEEE to reprint these figures throughout the book is gratefully acknowledged.

My students at UCLA and those at Aerospace used early versions of chapters of this book and made many helpful contributions. I am indebted to all those students who have taken my courses and thus helped me with this project. I also want to express my appreciation to my management at Aerospace, Mr. Hal

McDonnell and Mr. Fred Jones, for their indulgence and moral support. I want to acknowledge and thank Ms. Cynthia Dickson for her diligence and speed in typing the entire manuscript.

Finally, I want to thank my wife, Gwen, for her very unselfish support, her understanding, and her endurance of the many months I had time for only *one* devotion—the writing of this book.

BERNARD SKLAR

Tarzana, California

Contents

试读结束，需要全本PDF请购买 www.ertongbook.com

试读结束，需要全本PDF请购买 www.ertongbook.com