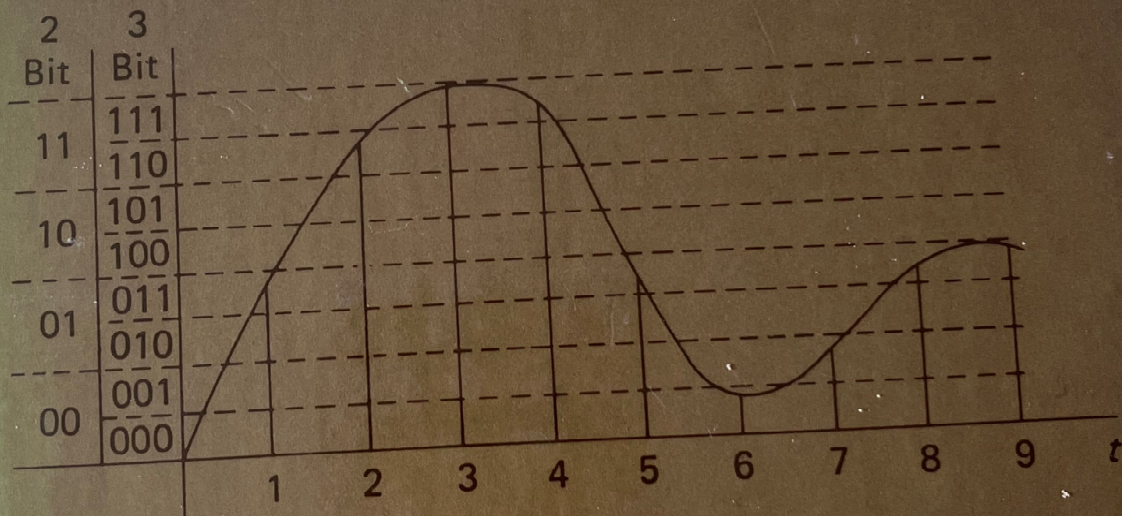
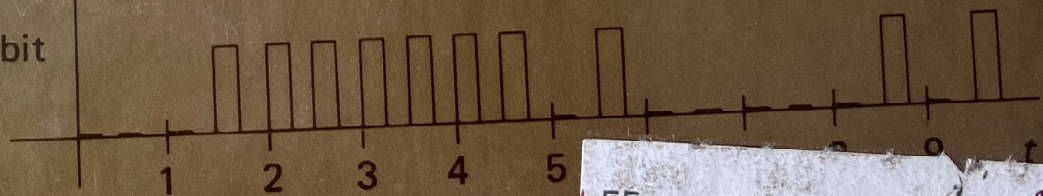


Second Edition
Martin S. Roden

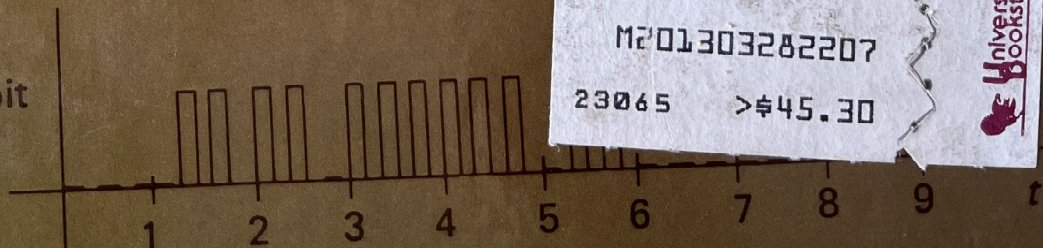
Analog and Digital Communication Systems



2-bit



3-bit



EE 3702 P10
M201303282207
23065 >\$45.30
University Bookstore

Library of Congress Cataloging in Publication Data
RODEN, MARTIN S.

Analog and digital communication systems.

Bibliography: p. 439
Includes index.

1. Telecommunication. 2. Digital communications. I. Title.
TK5105.R64 1985 621.38'0413 84-18114
ISBN 0-13-032822-7

Editorial/production supervision and
interior design: Tom Aloisi
Cover design: 20/20 Services, Inc.
Manufacturing buyer: Tony Caruso

© 1985, 1979 by Prentice-Hall, Inc., 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

ISBN: 0-13-032822-7 01

Prentice-Hall International, Inc., *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*
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*
Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*
Whitehall Books Limited, *Wellington, New Zealand*

Analog and Digital Communication Systems

SECOND EDITION

Martin S. Roden

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
CALIFORNIA STATE UNIVERSITY, LOS ANGELES

PRENTICE-HALL., Englewood Cliffs, N.J. 07632

TIME DIVISION MULTIPLEXING

We have continually stressed that signals could be separated from each other if they are non-overlapping in either time or frequency. Since the bandwidth of the pulse modulated waveform is extremely high (theoretically, it is infinity), frequency separation is not practical. Fortunately, the ideal pulse modulated waveform possesses portions of the time axis where the waveform is identically zero. Therefore, time separation is possible. When signals are added together such that they do not overlap in time, this is known as *time division multiplexing (TDM)*.

We can easily illustrate time division multiplexing (TDM) by returning to our original example of transmitting a signal by reading the list of sample values over a telephone.

Suppose that the reader is capable of reading two numbers every second, but the maximum frequency of $s(t)$ is only $\frac{1}{2}$ Hz. The sampling theorem tells us that at least one sample must be sent every second. If one sample per second is sent, the reader is idle for one half of every second. During this half second, a sample of another signal could be sent. Alternating between samples of the two signals is called *time division multiplexing*. The person at the receiver will realize that every other number is a sample of the second signal. The two signals can therefore be easily separated.

This operation can be described schematically with two switches, one at the transmitter and one at the receiver. The switches alternate between each of two positions making sure to take no longer than one sampling period to complete the entire circle. (See Fig. 6.13.)

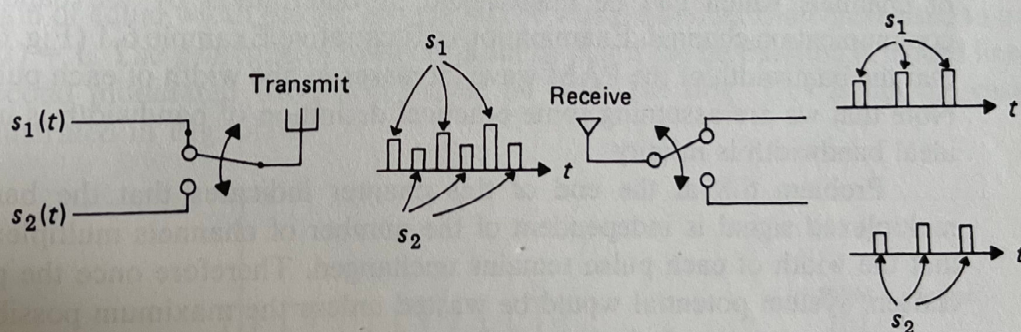


FIGURE 6.13 TDM of two signals.

If we now increase to 10 channels, we get a system as shown in Fig. 6.14.

The switch must make one complete rotation fast enough so that it arrives at channel # 1 in time for the second sample. The receiver switch must rotate in synchronism with that at the transmitter. In practice, this synchronization is not trivial to effect. If we knew exactly what was being sent as # 1, we could identify its samples at the receiver. Indeed, a common method of synchronization is to sacrifice one of the channels and send a known synchronizing signal in its place.

The only thing that limits how fast the switch can rotate, and therefore how many channels can be multiplexed, is the fraction of time required for each PAM