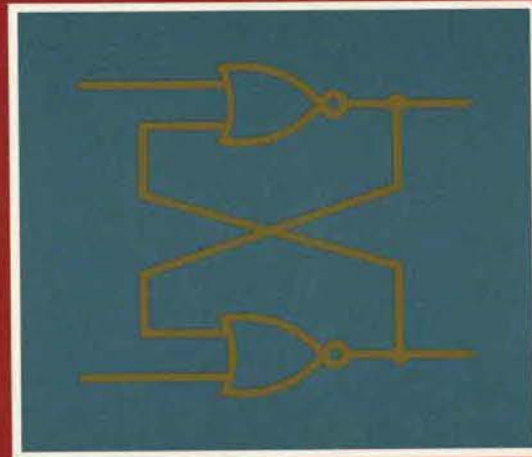


DIGITAL MICROELECTRONICS



HALDUN HAZNEDAR

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HALDUN HAZNEDAR

*Texas Instruments
Semiconductor Group
Design Automation Division, Houston, Texas*



THE BENJAMIN/CUMMINGS PUBLISHING COMPANY, INC.

Redwood City, California Menlo Park, California Reading, Massachusetts
New York Don Mills, Ontario Wokingham, U.K. Amsterdam
Bonn Sydney Singapore Tokyo Madrid San Juan

*To my grandparents
and
my parents, Nükhet and Mazhar Haznedar*

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Library of Congress Cataloging-in-Publication Data

Haznedar, Haldun.

Digital microelectronics / Haldun Haznedar.

p. cm.

Includes bibliographical references and index.

ISBN 0-8053-2821-1

1. Digital electronics. 2. Microelectronics. I. Title.

TK7868.D5H36 1991

621.381—dc20

90-46494

CIP

A B C D E F G H I J - M A 9 5 4 3 2 1 0

The Benjamin/Cummings Publishing Company, Inc.

390 Bridge Parkway

Redwood City, California 94065

these techniques when dealing with analog inputs and outputs, the inputs are first quantized and converted to digital form, then the digital information is processed, and finally the digital outputs are converted back to analog forms. Both types of conversion require *data converters*. Naturally, this conversion process between different forms of information requires extra time and adds complexity and expense. However, the advantages of digital techniques far outweigh these shortcomings.

Digital Circuits

Digital systems use switches to represent the information that is being processed in *binary* form. We can arbitrarily define an *open* switch to represent *logical 0* and a *closed* switch to represent *logical 1*. In electronic digital systems, binary information is usually represented by voltages that are present at the inputs or outputs of various circuits. Typically, the *logical states* are described by two nominal voltage levels, the higher of which, corresponding to the power *supply* voltage, V_{CC} , represents **1** in *positive logic* while the *ground* (i.e., 0 V) represents **0**. However, as stated before, the circuits are actually designed to respond to input voltages and to produce output voltages that fall within prescribed voltage ranges.

Since a digital circuit obeys a certain set of logic rules, it is also called a *logic circuit*. Almost all the digital circuits used in digital systems are ICs. Several fabrication technologies are used to produce digital ICs, the most common being the *transistor-transistor logic* (TTL) and *complementary metal-oxide semiconductor* (CMOS). The former uses the bipolar transistor as its switching element, whereas CMOS employs the MOS transistor.

A logic circuit with one or more inputs and outputs is an interconnection of several logic devices designed to perform a desired function. The outputs of a *combinational* logic circuit at any particular time are each a function of the combination of inputs at that time, regardless of the previous combination of inputs. Therefore, the circuit does not possess any memory. The basic building blocks of combinational circuits are *gates*. A logic circuit with a memory is called a *sequential* circuit, the output of which at any particular time is a function of both the inputs and the state of the circuit at that time. The state in turn depends on what has happened to the circuit previously. The basic building blocks of sequential circuits are *flip-flops*.

Entire systems containing thousands of components can be fabricated on a single chip. The term *microelectronics* refers to the design and fabrication of these high-density ICs. The levels of integration include *small-scale integration* (SSI), with about 1 to 10 gates per chip; *medium-scale integration* (MSI), with 10 to 100 gates per chip; *large-scale integration* (LSI), with 100 to 1000 gates per chip; *very-large-scale integration* (VLSI), with 1000 to 100,000 gates per chip; and *ultra-large-scale integration* (ULSI), with more than 100,000 gates per chip.

The design of any given circuit, whether it be on a printed circuit board or at the IC level, involves an ongoing iteration among the setting of system performance specifications and circuit parameters as well as the selection of basic materials and the fabrication aspects of design. Thus, a systems approach to digital electronics design requires a designer to gain a broad appreciation of all the important factors that enter