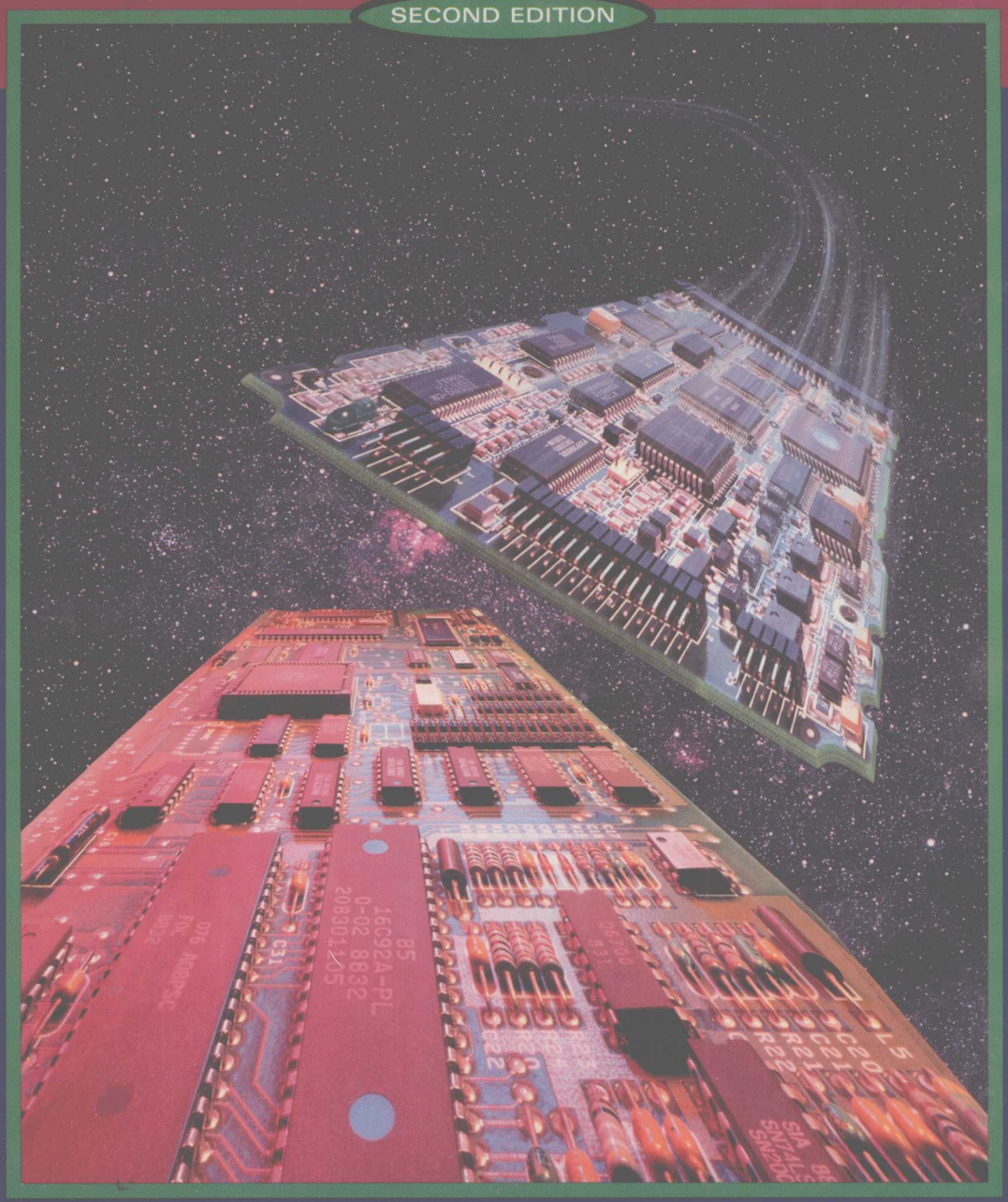
INDUSTRIAL ELECTRONICS

Applications for Programmable Controllers, Instrumentation & Process Control, and Electrical Machines & Motor Controls

SECOND EDITION



Thomas E. Kissell

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INDUSTRIAL ELECTRONICS

APPLICATIONS FOR PROGRAMMABLE CONTROLLERS, INSTRUMENTATION AND PROCESS CONTROL, AND ELECTRICAL MACHINES AND MOTOR CONTROLS

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Library of Congress Cataloging-in-Publication Data
Kissell, Thomas E.
Industrial electronics : applications for programmable controllers, instrumentation & process control and electrical machines & motor controls / Thomas E. Kissell.
p. cm.
ISBN 0–13–012697–7
1. Industrial electronics. I. Title.
TK7881.K58 2000
621.381--dc21 99–32916
CIP

Cover photo: The Stock Market
Publisher: Charles E. Stewart, Jr.
Production Editor: Alexandrina Benedicto Wolf
Production Coordination: Lisa Garboski, bookworks
Cover Design Coordinator: Karrie Converse-Jones
Cover Designer: Curt Besser
Production Manager: Deidra M. Schwartz
Marketing Manager: Ben Leonard

This book was set in Times Roman and Univers by The Clarinda Company and was printed and bound by Von Hoffmann Press. The cover was printed by Von Hoffmann Press.

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

ISBN: 0-13-012697-7

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

PREFACE

Students who enter the job market and become electronics technicians must be prepared to work on industrial electronics in many forms. The job responsibilities for these fields are rapidly changing because electronic devices and circuits have become thoroughly integrated into all aspects of modern industrial control systems during the past ten years. As industries have learned to compete in the global marketplace, the role of technicians has changed to the point where they are expected to work on every aspect of an industrial system from the simplest electrical components, such as fuses and motors, to the most complex such as electronic boards, motor drives, and programmable controllers.

This book is designed for students in two-year technical and community colleges and by students in engineering technology programs and engineering programs at four-year universities. It is designed to be used in courses that cover one semester or one quarter, or to be used in a series of courses covering one year. The book also provides sufficient depth to be a useful resource after students finish school and are working on the job.

The book is different from many current texts in that it provides detailed industrial applications for each device and circuit discussed in every chapter. The author has worked for over twenty years on automated industrial systems and has a distinctive position wherein he teaches the theory and operation of these systems to traditional college students several days each week. He also provides seminars and consulting directly with technicians and engineers currently working on these systems in industry. The author has taken the course material that he uses in teaching technicians and engineers at Ford Motor Company, General Motors, Campbell Soup, Union Carbide, Kelsey Hayes, H. J. Heinz Company, and many other manufacturing and process industries and incorporated it into this text. Each chapter includes examples of the numerous control circuits and systems that technicians and engineers will be expected to understand and troubleshoot when they finish school and arrive on the job.

ORGANIZATION OF THE TEXT

Individual components and smaller circuits are introduced in the early chapters and larger circuits and complete systems are added along the way, specifically in later chapters. Each chapter is also written to stand alone. This allows teachers to change the order of the sequence of chapters if their course syllabus is slightly different from the order of the chapters. Often chapters in books are linked so that they only make sense when they are read in the order they are presented. With this text the teacher can feel free to change the order of the chapters and the student will still understand everything in each chapter.

The first two chapters introduce solid-state devices and logic devices used in industrial electronic circuits. Chapter 3 provides a comprehensive study of programmable controllers. It explains the basic parts of all programmable controllers and then provides numerous applications that show how instructions are used. It also provides much more

information and applications than merely reviewing the instruction set from a typical programmable controller. The Allen-Bradley MicroLogix 1000, SLC500 family, PLC2, and PLC5 are used as examples.

Chapter 4 provides an in-depth study of power devices such as thyristors and power transistors and the types of circuit applications where they are commonly used in industrial electronic circuits. Chapter 5 introduces the triggering devices used to control the power electronic devices and Chapter 6 provides in-depth coverage of optoelectronic devices and industrial lasers. To supplement the information in these chapters a complete set of manufacturer's data sheets for each major device discussed in these three chapters is provided in the appendix.

Chapter 7 provides an in-depth study of power supplies inverters and converters that are found in all types of industrial electronic circuits, such as AC and DC motor drives, stepper motor and servomotor drives, and other power control circuits. It explains switch-mode power supplies electronic boards. Chapter 8 provides detailed information about operational amplifiers and Chapter 9 provides information about open-loop and closed-loop systems found in industrial applications.

Chapter 10 provides a comprehensive study of all types of input sensors and instruments. It provides details about the theory of operation and troubleshooting information for all of the major sensors and instruments used in the manufacturing and process industry today. Chapter 11 covers output devices such as solenoids, valves, relays, AC and DC motor drives, stepper motors, and servomotors. This chapter has perhaps the most information provided in any text today on variable-frequency AC motor drives and industrial DC motor drives including stepper and servo amplifiers. Chapter 12 discusses information about traditional industrial DC motors and single-phase and three-phase AC motors.

In-depth case studies of four industrial systems are provided in Chapter 13 and shows how all of the devices and components studied to this point operate together in typical industrial systems. Chapter 14 is devoted to robots and other motion control systems such as CNC machines. It helps students understand how servo and stepper motors must be integrated into complete multiple-axis systems. Chapter 15 provides an in-depth study of traditional motor control devices and circuits.

The final chapter in the book provides a study of data communications used in modern industrial applications such as linking programmable controllers, robots, and other automated systems to computer networks to pass data. Today students are expected to have experience with networks and understand how different electronic boards and systems, such as programmable controllers, robots, servo and stepper systems, can be interconnected through networks. This chapter helps students to understand all the parts of data communications systems and how they are integrated with modern industrial systems. Examples of the most widely used industrial networks are provided along with a complete explanation of network standards and protocols.

Each chapter begins with a job assignment that each student is expected to solve after reading the chapter. The assignments are actual jobs that technicians perform today. Each chapter also has a comprehensive list of objectives outlining what the student is expected to learn from the chapter. At the end of each chapter a variety of true or false, multiple choice, open-ended questions, and problems are provided for the student to complete. The solution to the job assignment is given at the end of each chapter and the answers to the questions and problems are provided in a separate instructor's manual.

This text uses only applied mathematics and each formula is accompanied with example problems worked out. Additional problems are provided at the point in the chapter where the topic is discussed, and solutions to these problems are worked out on a separate page. This allows the student to practice working a problem and immediately receive feedback about the solution. Problems that the teacher can assign to test each

student's comprehension are also provided at the end of each chapter. The answers to these problems are available in the instructor's manual.

New to this edition is the *Laboratory Manual to accompany Industrial Electronics* (ISBN: 0-13-025671-4).

ACKNOWLEDGMENTS

I would like to thank my wife, Kathy, for all of her help in creating art, keeping track of permissions, and taking care of sending and receiving the large volume of material needed to bring a book to life. I also want to thank her for her support during this time.

The author wants to thank Steve W. Hamlin of Sandusky, Ohio, for his extensive help in editing this edition. The author also personally thanks the following people and companies for providing pictures, diagrams, and research material.

Scott Lynch, ABB Instrumentation; Ann Smith, ABB Flexible Automation; Robert Greenfield, Acromag Inc.; Dan Shingold, Analog Devices; Richard Stern, Automatic Switch Co.; John Hitch, Belden Wire & Cable Company; Saul Estreicher, Bridgeport Machines Inc.; Robert Roderique, Bussmann; Steven Rosenthal, Danaher Controls; David Darrah, Darrah Electric Company; Louis Ted Keys, Delta Controls Corporation; Joseph Portada, Dynamics Research Corporation; John Reiley, Eaton Cuttler-Hammer; Al Anthony, EG&G VACTEC, EG&G Optoelectronics Group; Jon Bauer, EIT; Jennifer Loffer and Beverly Odegaard, Electro-Craft, A Rockwell Automation Business; Carl Fields, Electrical Apparatus Service Association; Jennifer Howe, Fairbanks Scales; Jennifer Dondero and Emmily Bopp, Fanuc Robotics; Gene Kimmel, Fostoria Industries; Daniel Gilmore, The Foxboro Company; Patricia Pruis, GE Motors & Industrial Systems, Fort Wayne, IN; Thomas Hausman, Harris Semiconductors; Robert Rice, Hyde Park Electronics Inc.; Armstrong Wong, Hewlett Packard Company; Richard Dute, Instrumentation & Controls Systems; Donyel Smith, Johnson Controls Inc.; Lori Cahil, Kistler-Morse; Manfred Kersten, Klockner Desma; Lee McBride, Liebert Inc.; Sally Parker, Masoneilan, Dresser Valve and Controls Division; Kathleen Bee, Micro Motion; Marlyn Smit, Honeywell Micro Switch Division; Sally Fairchild, Motoman; Linda Capcara, Motorola; Cy Pfeifer, National Controls Corporation; Dennis Berry, National Fire Protection Association; Eric Heise, MTS Systems Corporation; William Reilly, Novatec; Maria Psychopeas, Omega Engineering; Jim Krill, Omron Electronics; Gary George, Opto 22; Thomas Barnett Jr., Parker Compumotor Division; Robert Mitchel, Parker, Hannifin Corp, Daedal Division; James Lally, PCB Piezotronics; Lawrence Fogel, Philips Semiconductors; Claudia Tapper, POWEREX Inc.; Robert Donaghy, Princo Instrumentation Inc.; Aaron Weida, Rexroth Corporation; Linda Sorenson, Rockwell Automation's Allen Bradley Business; David Herkkiuen, Sankyo Robotics; Brent Hart, Sensotec Inc.; Mark Thompson, SMC Penumatics, Inc.; Shoun Kerbaugh, SMS Engineering; Jennifer Toffler, SQUARE D COMPANY/GROUPE SCHNEIDER; John Murray, Superior Electric, Warner Electric; John O'Meara Jr., Tapeswitch Corporation; Gary Honeycutt, Texas Instruments; Brenda Dodson, Pacific Scientific; Gary E. Gramke, Cincinnati Milacron, Plastic Machinery Group; and Paul Handle, Eaton Corporation Cutler-Hammer Products

Additionally, the authors thanks the following individuals for reviewing the manuscript and providing helpful comments:

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