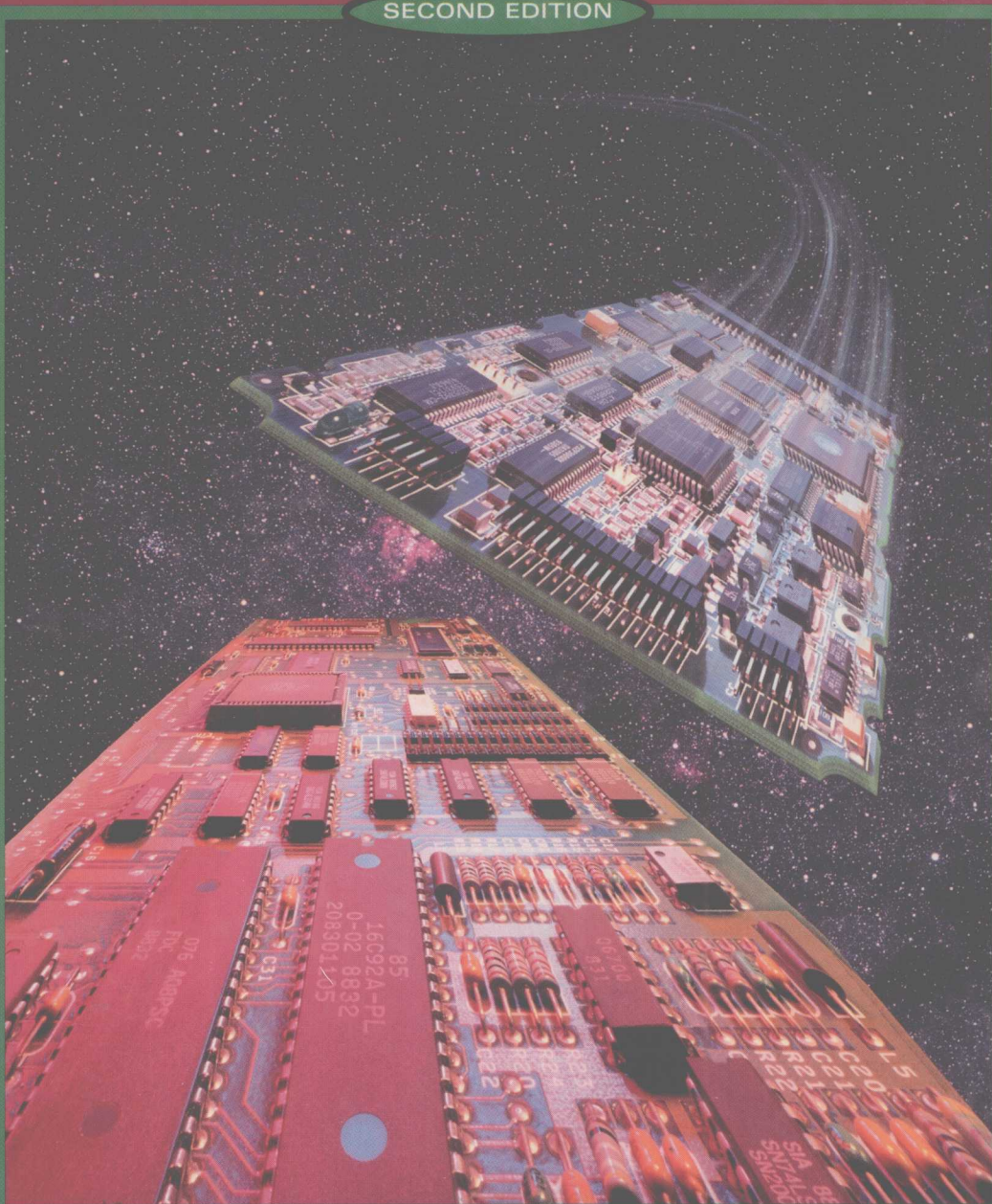


INDUSTRIAL ELECTRONICS

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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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).



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