Allen-Bradley PLCs:

An Emphasis on Design and Application

Kelvin T. Erickson

Missouri University of Science and Technology

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Dedicated to Fran, Esther, David and Amanda

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PREFACE

Programmable logic controllers (PLCs) are the workhorses of modern manufacturing automation. Automatic control allows the production of a consistent product at a reasonable cost and the PLC is the most prevalent control technology in manufacturing..

This book presents the subject of programming Allen-Bradley PLCs with an emphasis on the design of the programs. Many texts teach one how to program the PLC in its languages, but little, if any, attention is paid to how does one attack the problem: "Given a set of operational specifications, how does one develop the PLC program?" This book develops the design process: the tasks involved, breaking the program into manageable pieces, standard code for the various parts, and handling the sequential parts of the problem. The emphasis is toward those who will be programming PLCs.

The text emphasizes the following Allen-Bradley controllers: ControlLogix, CompactLogix, MicroLogix, and SLC-500. Furthermore, because of its popularity (now and in the future), ladder logic is the language that is used for the text. The industry trend is toward using the IEC 61131-3 (formerly IEC 1131-3) standard, which also defines four other languages: function block diagram, structured text, instruction list, and sequential function chart. One interested in the other languages and in programming PLCs from Modicon, Siemens, and GE, should see Erickson (2011).

Since a typical manufacturing plant may contain discrete, continuous, and batch processes, all of these applications are treated in this text, although the emphasis is on discrete and continuous processes. The emphasis is on a methodology that can be applied to any automation project, regardless of the size.

Throughout, the book contains example problems demonstrating good design practice. In addition, these problems are solved with each PLC covered in the book.

This book takes a practical approach to the design of PLC control systems. Some mathematical theory is used to backup the presentation on PID controllers. However, the theory is not detailed and can be omitted.

Except for Chapter 1, every chapter begins with a scenario that reflects the experience of the author and his colleagues in the challenging world of factory automation. These scenarios present a small problem and the solution and are intended to illustrate troubleshooting techniques.

Objectives

The main objectives of this text are to teach:

- PLC ladder logic programming for Allen-Bradley PLCs
- Approach to sequential problems
- Good program design practice
- Simple PID control tuning

- Introduction to sensors and actuators
- Human-machine interface (HMI) concepts

Content Overview

The book starts by introducing programmable logic controllers (PLCs) and their distinguishing characteristics. Chapters 2 – 5 cover basic ladder logic programming: contact, timer, and counter instructions. As part of the basics, the memory structure of the three particular PLCs and installation topics are treated. Chapter 6 covers ladder logic program design for sequential applications, probably the most significant contribution of the text. Chapters 7 and 8 treat computation, comparison, and advanced ladder logic instructions. PLC troubleshooting is covered in Chapter 9 and PID controller tuning is covered in Chapter 10. Sensors and actuators appear in Chapter 11. Chapter 12 introduces factory communication networks. Operator interface, often called human-machine interface (HMI), issues are treated in Chapter 13. PLC selection is introduced in Chapter 14 and it also covers the PLCs from Siemens, Modicon, and GE. Chapter 15 presents the perspective of an entire automation project, bringing together the various pieces of PLC control design and then outlines a full-length project case study. Details about number systems and drawing symbols are included as appendices, rather than interrupt the flow of the text material.

Throughout the text, any reference to ControlLogix also applies to the CompactLogix, which is a smaller version of the ControlLogix. Also, much of the MicroLogix and SLC-500 ladder logic programming also apply to the PLC-5 processors.

The Audience

This book primarily serves the academic market, at the two-year technical school level, though the material on PID controllers will be more challenging than the typical PLC textbook for this level of student. This text is also suitable for junior or senior undergraduate electrical, mechanical, or industrial engineering or engineering technology level.

In addition, this text serves the professional market. Economic and regulatory pressures in the manufacturing, chemical, petrochemical, pharmaceutical, and food industries have forced control engineers to design new systems or retrofit existing control systems. Hence, there are many control engineers (primarily chemical and electrical) who need to rapidly educate themselves in an area of technology in which they are probably only somewhat familiar. This book is valuable to this audience.

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Disclaimer

Reference

Erickson, Kelvin T., 2011. *Programmable Logic Controllers: An Emphasis on Design and Application,* 2nd Edition, Dogwood Valley Press, Rolla, MO.