

Introduction to PLCs

Introduction to PLCs

SECOND EDITION

Jay F. Hooper

CAROLINA ACADEMIC PRESS
Durham, North Carolina

Copyright © 2006
Jay F. Hooper
All Rights Reserved

ISBN 1-59460-331-6
LCCN 2006932360

CAROLINA ACADEMIC PRESS
700 Kent Street
Durham, North Carolina 27701
Telephone (919) 489-7486
Fax (919) 493-5668
www.cap-press.com

Printed in the United States of America

Contents

Preface	ix
Foreword	xi
1 Overview	3
An Origin Story	3
The Four Parts of a PLC	5
PLC Symbols	7
PLC Terminal Numbers	7
PLC Logic Symbols	8
2 Hardware	13
Input Rack	13
Output Rack	15
<i>Different Voltage Levels</i>	15
<i>Current Drains</i>	16
Terminal Diagrams	16
Seven General Rules	18
<i>General Rule #1</i>	18
<i>General Rule #2</i>	19
3 Programming Basics	23
Inputs and Outputs	23
The IO Scan	24
<i>General Rule #3</i>	25
Branching	26
<i>General Rule #4</i>	27
Gates	27
Symbols on Terminal Diagrams	28
4 Basic Logic	29
AND and OR	29
NOT	31
OUT	31

Contents

NAND and NOR	31
Logic in Everyday Speech and in the PLC	32
<i>General Rule #5</i>	33
5 Ladder Logic	37
Control Relays	37
Contactors and Motor Starters	38
Two-Wire (Automatic) Control Circuits	38
Three-Wire (No-Voltage Protection)	
Control Circuits	39
Open vs. NO and Closed vs. NC	40
Photo Eyes and Proximity Detectors	42
Mechanically Interconnected Switches	43
6 Counters	45
Count Up and Count Down Counters	45
<i>General Rule #6</i>	45
Preset, Reset, and Accumulated Values	45
Enable and Done Bits	47
Example of a Light Chaser Circuit	48
7 Timers	55
Timer On Delay (TON)	55
Timer Off Delay (TOF)	55
One-Shot Timer	56
Preset, Reset, Accumulated Values,	
and Time Units	58
One-Shot Timed Contact	60
8 Sequencers	61
Sequencer Symbol (SQO)	61
Sequencer Output Table	62
File, Mask, Destination, Control, Length,	
and Position Values	64
Example of a Light Chasing Circuit	66
9 Math Functions and	
Analog Inputs and Outputs	71
Addition, Subtraction, Multiplication, and	
Division Functions	71

Less Than, Greater Than, and Equal To Functions	72
Analog Inputs and A-to-D Conversion	72
Analog Outputs and D-to-A Conversion	73
Example of a Deadband Circuit	73
<i>General Rule #7</i>	76
Appendix A	79
Symbols in the Electrician World	79
Symbols in the Electronic World	90
Logic	92
Appendix B	95
Exercises	99
Selected Solutions	103

Preface

This book is intended for the people working on and doing the day to day troubleshooting on the factory floor, and those interested in learning how PLCs work. The material in this book is presented in a format so that someone with no prior knowledge of PLCs (just some motor control, electronic, or computer exposure) can be successful in developing a good understanding of the issues and concepts involved in the workings of PLCs.

Although the examples use AB type numbering, the text is oriented to a middle of the road approach to understanding PLCs, regardless of the specific type of PLC that you use.

This book grew out of a course designed to get people from a wide variety of educational backgrounds (machine fixers and electricians through engineers) up to speed on PLCs. Almost any large or expensive piece of equipment these days comes into the workplace with a PLC attached. Close to 100% of ads for maintenance mechanics, control electricians, and manufacturing engineers require PLC knowledge.

While some generalizations have been made in the text, they are for the purpose of enhancing the overall understanding of the PLC material presented.

Jay F. Hooper
Greensboro, NC

Foreword

This introductory book on PLCs is oriented to the line mechanic and the electrician working on the factory floor. It is directed to their world view (series and parallel). However, I have included logic circuit equivalents from the computer world and the electronic world (AND, OR, NOT, NOR NAND, etc.) in an Appendix for Chapter 4.

The book does not go into the design of PLCs or the design of PLC systems as this would be beyond the scope of an introductory book.

The material presented would be most useful as a text for community college courses (both curriculum and continuing education) for electrical programs, industrial systems programs, or industrial maintenance programs. It would also be highly useful as a lab manual for four year college or university electrical, electronic, or systems courses.

Trouble shooting of PLC programs and problems is usually accomplished in labs. Software glitches are usually handled on a vendor specific basis and hardware glitches (using volt-ohm meters, etc.) is usually covered in a prerequisite course such as motor controls or during on the job training.

The various aspects of this approach have been thoroughly tested over a wide range of audiences over the past dozen years.

Jay F. Hooper
Greensboro, NC

