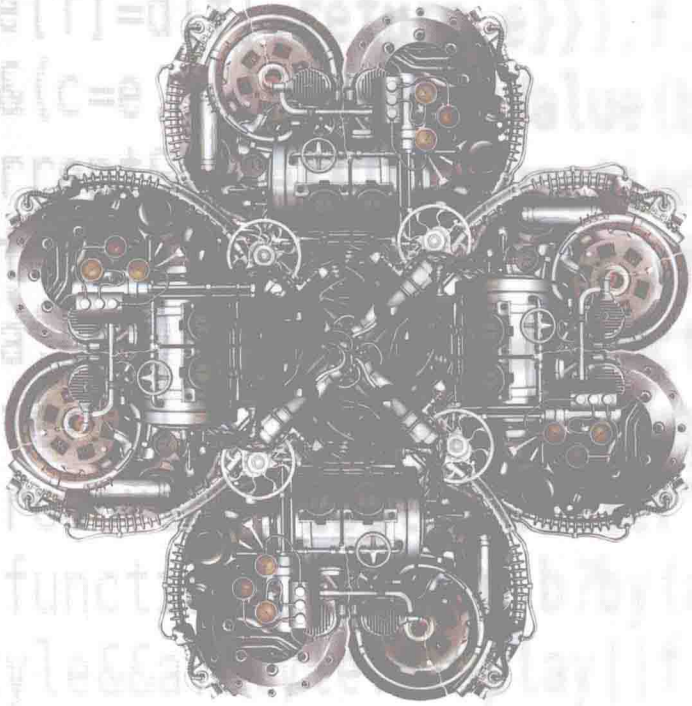
DAG H. HANSSEN



PROGRAMMABLE LOGIC CONTROLLERS

A PRACTICAL APPROACH TO IEC 61131-3 USING CODESYS®

WILEY

PROGRAMMABLE LOGIC CONTROLLERS

A PRACTICAL APPROACH TO IEC 61131-3 USING CODESYS

Dag H. Hanssen
Institute of Engineering and Safety, University of Tromsø, Norway

Translated by
Dan Lufkin

WILEY

This edition first published 2015

Registered Office
John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

Authorised Translation from the Norwegian language edition published by Akademika forlag, Programmerbare Logiske Styringer – basert på IEC 61131-3, 4. Utgave. This translation has been published with the financial support of NORLA.

Library of Congress Cataloging-in-Publication Data

Hanssen, Dag Håkon, author.
Programmable Logic Controllers: A Practical Approach to IEC 61131-3 using CODESYS / Dag Hakon Hanssen.
pages cm
Includes bibliographical references and index.
ISBN 978-1-118-94924-5 (pbk.)
1. Sequence controllers, Programmable. 2. Programmable logic devices. I. Title.
TJ223.P76H36 2015
621.39'5–dc23

2015018742

A catalogue record for this book is available from the British Library.

Set in 10/12pt Times by SPi Global, Pondicherry, India
Printed and bound in Singapore by Markono Print Media Pte Ltd

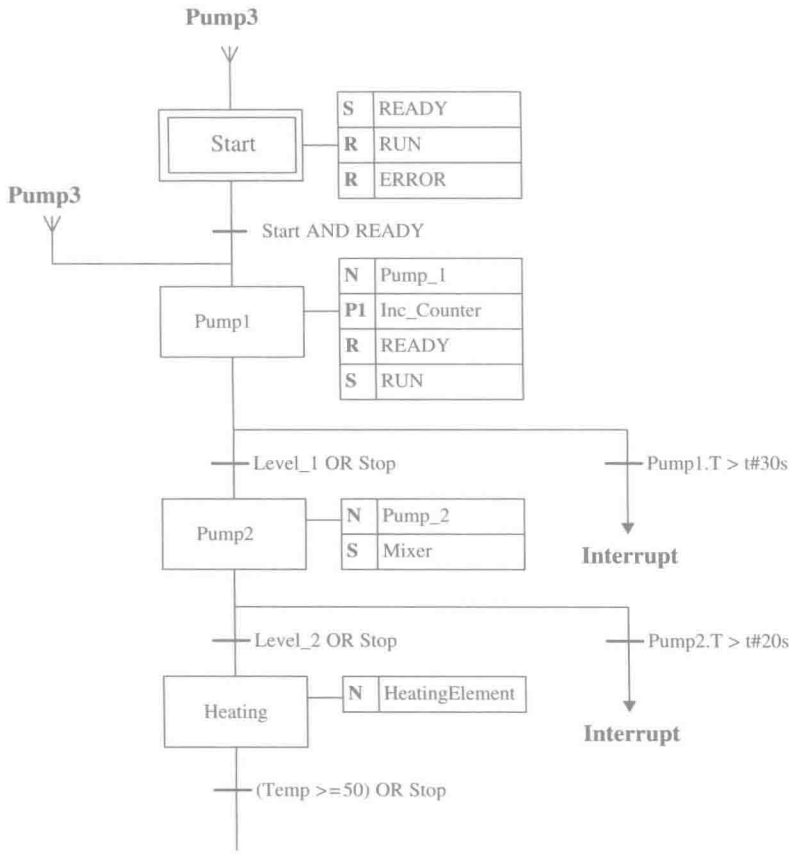
1 2015

PROGRAMMABLE LOGIC CONTROLLERS

Programmable Logic Controllers

A Practical Approach to IEC 61131-3 Using CODESYS

First edition



Dag H. Hanssen

Preface

As long as there have been competing producers of PLCs on the market, there have been different programming languages from one PLC brand to another. Even though the same languages, beginning with Instruction Lists (IL) and Ladder diagram (LD), have been used by most of the producers, all of them added their own "dialects" to the languages. When physical programming terminals replaced software-based programming tools, the differences between languages of the various producers escalated. Several programming languages also saw the light of day. This development was the natural result of the attempt by the producers to make themselves stand out among increasing competition by developing the most user-friendly languages and tools.

When the IEC[1] 61131-3 standard came out in 1993, the situation started to improve. This standard was the result of the work that had been ongoing for several years in which the best from the various languages and dialects from different producers was assembled into a single document. This is not a rigid standard in the sense that the producers *must* follow all requirements and specifications, but more a set of guidelines that the producers could choose to follow to a certain extent. Today, most of the equipment producers have come to realize the advantages of organizing themselves in accordance with the standard. All of the major producers of PLCs, such as Telemecanique, Wago, Mitsubishi, Klockner Moeller, Allen-Bradley, Omron, Siemens, and so on, have therefore, to a greater or lesser extent, adapted their programming tools to IEC 61131-3.

This book covers close to 100% of the specifications and guidelines that are given in Standard (International Electrotechnical Commission, 2013).[2] The book will therefore be interested to everyone who works with, or wants to learn about programming PLCs, no matter which PLC brand they use.

---

[1] IEC—International Electrotechnical Commission. This edition of the book was updated in conformity with the 3rd edition of IEC 61131-3, issued February 2013.

[2] The Standard IEC 61131-3 is introduced in Chapter 5.

The book does not assume any previous knowledge of programming.
Comments and suggestions for contents will be gratefully received.
The book is divided into five main parts:

- Part 1: Hardware Chapters 1–3
- Part 2: Methodic Chapter 4
- Part 3: IEC 61131-3 Chapters 5–8
- Part 4: Programming Chapters 9–13
- Part 5: Implementation Chapters 14–15

Chapter 1 contains a brief history and a short description of the design and operation of PLCs in general. Chapters 2 and 3 give a basic introduction to digital and analog signals and equipment for detection, measurement, and manipulation of discrete and continuous quantities.

Chapter 4 focuses on methods for planning and design of structurally efficient programs. It also provides an introduction into Boolean algebra. Chapters 5 and 6 introduce the IEC standard elements such as literals, keywords, data types, variables, and addressing. Chapters 7 and 8 cover standardized functions and functional blocks.

Chapters 9 to 13 deal with programming: Chapter 9 covers programming with LD. Chapter 10 covers functional block diagrams (FBD). Chapter 11 covers the structured text (ST) language. The last language covered in the book is actually not a programming language as such, but rather a tool for structuring program code. This is called a Sequential Function Chart (SFC) and is described in Chapter 12.

Chapter 13 contains some larger practical programming examples.

The last two chapters in the book cover programming tools. Here, I have chosen to focus on CODESYS. There are several reasons for this; first, CODESYS follows the standard almost 100%. Furthermore, CODESYS is a hardware-independent programming tool that is currently used by well over 250 hardware suppliers. Finally yet importantly, the program can be downloaded free and it contains a simulator. Most of the program code in the book was written and tested with this tool.

I would like to thank the following persons and companies:

- Associate Professor Tormod Drengstig, University of Stavanger, for much good feedback, suggestions for improvements, and the contribution of several examples
- Assistant Professor Inge Vivås, Bergen University College, for giving his permission to reuse some problems (Section 4.6.4 and Problems 4.10 and 10.5)
- Assistant Professor Veslemøy Tyssø, Oslo and Akershus University College of Applied Science, for having read an earlier edition of the book and having provided expert contributions
- Colleagues and management at the University of Tromsø, Department of Engineering and Safety, for the support and patience
- Schneider Electric for granting me permission to use material from their "Automation Solution Guide" when writing about sensors in Chapter 2

Dag H. Hanssen

Contents

Part One

Hardware