TECHNICAL REPORT

IEC TR 61131-8

Second edition
2003-09

Programmable controllers –

Part 8:
Guidelines for the application and implementation of programming languages

Automates programmables –

Partie 8:
Lignes directrices pour l'application et la mise en oeuvre des langages de programmation

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
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CONTENTS

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PROGRAMMABLE CONTROLLERS –

Part 8: Guidelines for the application and implementation of programming languages

FOREWORD

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IEC 61131-8, which is a technical report, has been prepared by subcommittee 65B: Devices, of IEC technical committee 65: Industrial-process measurement and control.

This second edition cancels and replaces the first edition, published in 2000, and constitutes a technical revision.

The main changes with respect to the previous edition are to make IEC 61131-8 consistent with IEC 61131-3, 2nd edition.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
65B/478/DTR	65B/492/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This part of IEC 61131 is being issued as a technical report in order to provide guidelines for the implementation and application of the programming languages defined in IEC 61131-3: 2003, second edition.

Its contents answer a number of frequently asked questions about the intended application and implementation of the normative provisions of IEC 61131-3, second edition and about its differences from IEC 61131-3:1993, first edition.

PROGRAMMABLE CONTROLLERS –

Part 8: Guidelines for the application and implementation of programming languages

1 General

1.1 Scope

This part of IEC 61131, which is a technical report, applies to the programming of programmable controller systems using the programming languages defined in IEC 61131-3. It also provides guidelines for the implementation of these languages in programmable controller systems and their programming support environments (PSEs).

IEC 61131-4 should be consulted for other aspects of the application of programmable controller systems.

NOTE Neither IEC 61131-3 nor this technical report explicitly addresses safety issues of programmable controller systems or their associated software. The various parts of IEC 61508 should be consulted for such considerations.

1.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61131-1:1992, *Programmable controllers – Part 1: General information*

IEC 61131-2:2003, *Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61131-3:2003, *Programmable controllers – Part 3: Programming languages*

IEC 61131-5:2000, *Programmable controllers – Part 5: Communications*

1.3 Abbreviated terms

FB	Function Block
FBD	Function Block Diagram
LD	Ladder Diagram
IL	Instruction List
POU	Program Organization Unit
PSE	Programming Support Environment
SFC	Sequential Function Chart
ST	Structured Text

1.4 Overview

The intended audience for this technical report consists of

– *users* of *programmable controller systems* as defined in IEC 61131-3, who must program, configure, install and maintain programmable controllers as part of industrial-process measurement and control systems; and

– *implementors* of *programming languages,* as defined in IEC 61131-3, for programmable controller systems. This may include vendors of *software* and *hardware* for the preparation and maintenance of *programs* for these systems, as well as vendors of the programmable controller systems themselves.

IEC 61131-3 is mainly oriented toward the *implementors* of programming languages for programmable controllers. *Users* who wish a general introduction to these languages and their application should consult any of several generally available textbooks on this subject. Subclause 1.4 of IEC 61131-3 should be consulted by those who wish a "top-down" overview of the contents of that standard.

Clause 2 of this technical report provides a general introduction to IEC 61131-3, while Clause 3 provides complementary information about the application of some of the programming language elements specified in IEC 61131-3. Clause 4 provides information about the intended implementation of some of these programming language elements, while Clause 5 provides general information about requirements for hardware and software for program development and maintenance. Hence, it is expected that users of programmable controllers will find Clauses 2 and 3 of this technical report most useful, while programming language implementors will find Clauses 4 and 5 more useful, referring to the background material in Clauses 2 and 3 as necessary.

2 Introduction to IEC 61131-3

2.1 General considerations

In the past, the limited capabilities of expensive hardware components imposed severe constraints on the design process for industrial-process control, measurement and automation systems. Software design and implementation were tightly tailored to the selected hardware. This required specialists who were highly skilled, both in solving process automation problems and in dealing with complicated, often hardware-specific computer programming constructs.

With the rapid innovation in microelectronics and related technologies, the cost/performance ratio of system hardware has decreased dramatically. At present, a small programmable controller may cost many times less than the cost of programming it.

Driven by rapidly decreasing hardware cost, a trend has become established of replacing large, centrally installed process computers or other comparatively large, isolated controllers by systems with spatially and functionally distributed parts.

As illustrated in Figure 1, the essential backbone of such systems is the communication subsystem, which provides the mechanism for information exchange between the distributed automating devices. Connected to this backbone are the devices, such as programmable controllers, which deliver the distributed processing power of the system. Each device, under the control of its own software, performs a dedicated subtask to achieve the required overall system functionality. Each device is chosen with the size and performance required to meet the demands of its particular subtask.

In a different environment, programmable controllers are used in stand-alone applications as illustrated in Figure 2. Users of these applications also stand to gain by the evolution outlined above. Due to the present low cost of hardware components, many new, relatively small, automation tasks can be solved profitably and flexibly by programmable controllers.

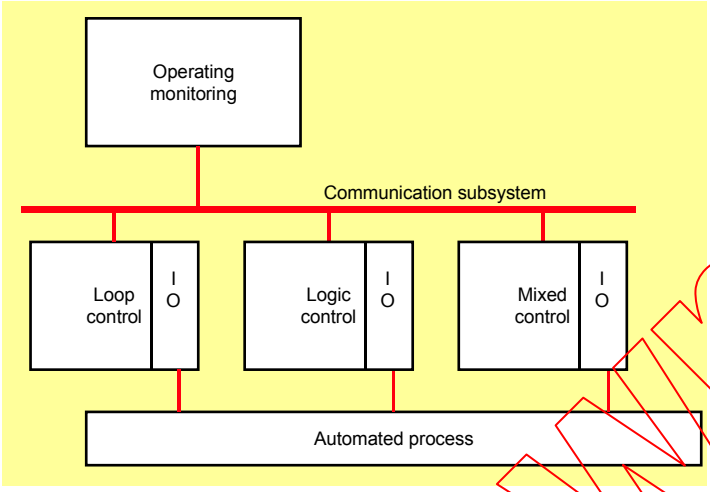

Figure 1 – A distributed application

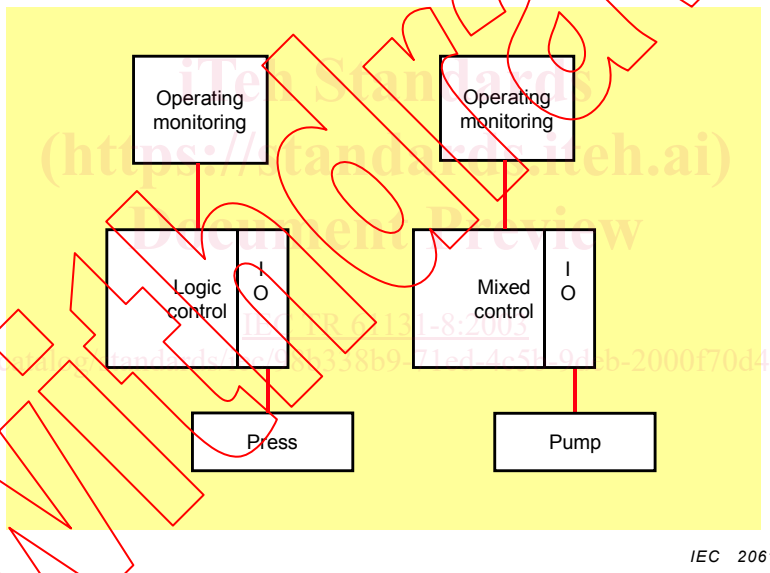

Figure 2 – Stand-alone applications

In addition to their low hardware price, the intensive use of programmable controllers in solving automation tasks is also advanced by their straightforward operating and programming principles, which are easily understood and applied by the shop-floor personnel involved in programming, operation and maintenance.

Programmable controllers typically employ the principles of cyclic or periodic program execution illustrated in Figure 3. Cyclically running programs restart execution as fast as possible after they have terminated execution. Periodic execution of a program is triggered by a clock mechanism at equidistant points in time.

These principles are well known and applied in the operation of digital signal processing systems to simulate the operation of continuously operating analog or electromechanical systems. Process values are read into the device and written out to the process as discrete samples at random or equidistant points in time, depending on the control task that has to be fulfilled.

The advantage of these operating principles is that they allow the construction of programs for programmable controllers using elements closely related to the principles of hard-wired logic or continuous control circuits previously used for the same purpose.

The operating principles of programmable controllers thus enable the provision of application-specific, graphical programming languages. Combined with appropriate man-machine interfaces, these languages enable the control engineer to concentrate on solving the problems of the application, without extensive training in software engineering. The control engineer's technological specifications can be mapped direct to the corresponding language elements.

Another particular advantage of such programming languages is that the representation they offer can be used not only for program input and documentation, but also for on-line test and diagnosis as well. Thus, programming support environments (PSEs) for programmable controllers are able to provide the graphically oriented representation and documentation that are already familiar to the application engineer and shop-floor personnel.

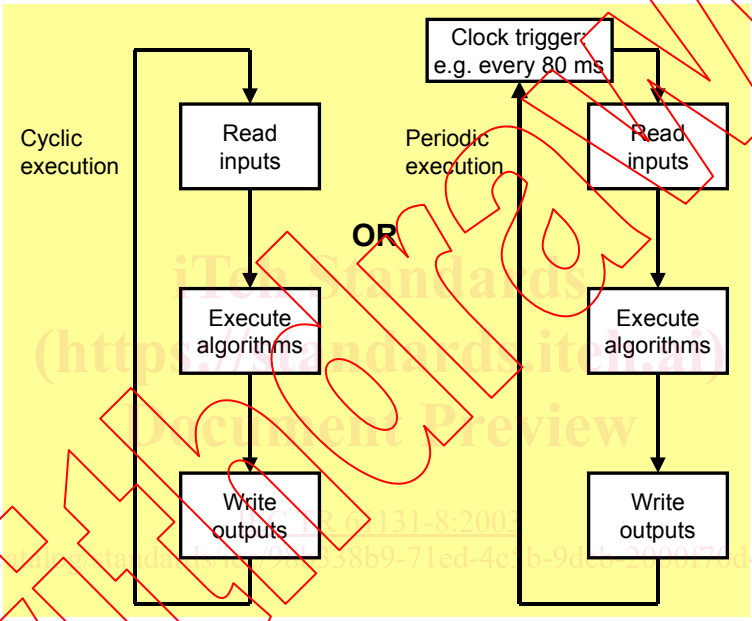

Figure 3 – Cyclic or periodic scanning of a program

2.2 Overcoming historical limitations

Automation system designers are often required to use programmable controllers from various manufacturers in different automation systems, or even in the same system. However, the hardware of programmable controllers from different manufacturers may have very little in common. In the past, this has resulted in significant differences in the elements and methods of programming the software as well. This has led to the development of manufacturer-specific programming and debugging tools, which generally carried very specialized software for programming, testing and maintaining particular controller "families".

Changing from one controller family to another often required the designer to read large manuals for both the hardware and software of the new family. Often, the manual had to be reviewed several times in order to understand the exact meaning and to use the new controller family in an appropriate way. Due to the concentrated, tedious work necessary to read and understand the new, vendor-specific material, few people did it. For this reason, many people regarded the design and the programming of such controllers as some black magic to be avoided. Thus, the knowledge of how to use such systems effectively was concentrated in one or a few specialists and could not be transferred effectively to those responsible for system operation, maintenance, and upgrade.