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

© IEC 2003 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

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



PRICE CODE



CONTENTS

FC	REW	ORD		6
IN	TROD	UCTION	V	8
1	Gan	aral		٥
•				
	1.1	•	Aire malanamana	
	1.2		ative references	
	1.3		viated terms	
^	1.4	Overvi	to IEC 61131-3	10
2				
	2.1	Genera	al considerations	
	2.2	Overco	oming historical limitations	12
	2.3	Basic	features in IEC 61131-3eatures in the second edition of IEC 61131-3	13
	2.4	New te	eatures in the second edition of IEC 61131-3	14
	2.5	Softwa	Application of software engineering principles	14
		2.5.1	Application of software engineering principles	14
_	A I	2.5.2	Portabilityguidelines	17
3		ication g	f data types	18
	3.1			
		3.1.1	Type versus variable initialization	18
		3.1.2	Use of enumerated and subrange types	18
		3.1.3	Use of BCD data	19
		3.1.4		
		3.1.5	Use of character string data types	
			Use of time data types	
		3.1.7	Declaration and use of multi-element variables	
	3.2		Strongly typed assignment	
	3.2	^ \	passing	
	<	\ \ \	In-out (VAR_IN_OUT) variables	
			Formal and non-formal invocations and argument lists	
	3.3		function blocks	
	5.5	3.3.1	Function block types and instances	
		3.3.2	Scope of data within function blocks	
		3.3.3	Function block access and invocation	
	3.4		ences between function block instances and functions	
	3.5		f indirectly referenced function block instances	
	0.0	3.5.1	Establishing an indirect function block instance reference	
		3.5.2	Access to indirectly referenced function block instances	
		3.5.3	Invocation of indirectly referenced function block instances	
		3.5.4	Recursion of indirectly referenced function block instances	
		3.5.5	Execution control of indirectly referenced function block instances	
		3.5.6	Use of indirectly referenced function block instances in functions	
	3.6		sion within programmable controller programming languages	
	3.7		and multiple invocation	
		J -	1	

	3.8	Langua	age specific features	.42
		3.8.1	Edge-triggered functionality	
		3.8.2	Use of EN/ENO in functions and function blocks	
		3.8.3	Use of non-IEC 61131-3 languages	
	3.9		SFC elements	
	0.0	3.9.1	Action control	
		3.9.2	Boolean actions	
		3.9.3	Non-SFC actions	
		3.9.4	SFC actions	
		3.9.5	SFC function blocks	
		3.9.6	"Indicator" variables	
	3.10	Schedu	uling, concurrency, and synchronization mechanisms	
			Operating system issues	
		3.10.2	Task scheduling	.54
		3.10.3	Semaphores	.55
		3.10.4	Messaging	.56
		3.10.5	Time stamping	.56
	3.11	Commi	unication facilities in ISO/IEC 9506/5/and IEC 61131-5	.57
		3.11.1	Communication channels	.57
		3.11.2	Reading and writing variables Communication function blocks	.57
		3.11.3	Communication function blocks	.58
	3.12	Depred	cated programming practices	.59
		3.12.1	Global variables	.59
			Jumps in FBD language	.59
		3.12.3	Multiple invocations of function block instances in FBD	.59
		3.12.4	Coupling of SFC networks	.59
			Dynamic modification of task priorities	
			Execution control of function block instances by tasks	
			Incorrect use of WHILE and REPEAT constructs	
			TRUNC and REAL_TO_INT functions	
4	Imple	mentati	on guidelines	.62
	4.1	Resour	ce allocation	.62
	4.2 <	Implem	nentation of data types	.62
		4.2.1	REAL and LREAL data types	.62
		4.2.2	Bit strings	.62
		4.2.3	Character strings	.63
		4.2.4	Time data types	.63
		4.2.5	Multi-element variables	
	4.3	Execut	ion of functions and function blocks	.64
		4.3.1	Functions	.64
		4.3.2	Function blocks	.64
	4.4	Implem	nentation of SFCs	.65
		4.4.1	General considerations	.65
		4.4.2	SFC evolution	
	4.5		cheduling	
		4.5.1	Classification of tasks	
		4.5.2	Task priorities	.67

	4.6	Error handling	
		4.6.1 Error-handling mechanisms	67
		4.6.2 Run-time error-handling procedures	69
	4.7	System interface	71
	4.8	Compliance	71
		4.8.1 Compliance statement	
		4.8.2 Controller instruction sets	
		4.8.3 Compliance testing	
5	PSE	requirements	
	5.1	User interface	
	5.2	Programming of programs, functions and function blocks	
	5.3	Application design and configuration	73
	5.4	Separate compilation	74
	5.5	Separation of interface and body	<i>.</i> 75
		5.5.1 Invocation of a function from a programming unit	75
		5.5.2 Declaration and invocation of a function block instance	76
	5.6	Linking of configuration elements with programs	77
	5.7	Library management Analysis tools 5.8.1 Simulation and debugging	79
	5.8	Analysis tools	79
		5.8.1 Simulation and debugging	79
		5.6.2 Performance estimation	
		5.8.3 Feedback loop analysis	80
	- 0	5.8.4 SFC analysis	80
	5.9		ەە
	5.10 5.11		
	5.11	On-line facilities	03
۸	n a v A	(informative) Obange to NEC 01121 2 Count addition	0.4
		(informative) Changes to EC 61131-3, Second edition	
		(informative) Software quality measures	
An	nex C	(informative) Relationships to other standards	96
INI	DEX		97
Bik	oliogra	phy	109
	J		
Fic	iure 1	– A distributed application	11
_		- Stand-alone applications	
_		Cyclic or periodic scanning of a program	
		- Function block BCD_DIFF	
_		- Function block SBCD_DIFFF	
_		_	
_		- ST example of time data type usage	
		- Example of declaration and use of "anonymous array types"	
		– Examples of VAR_IN_OUT usage	
_		– Hiding of function block instances	
Fig	jure 10) – Graphical use of a function block name	37
Fig	ure 11	- Access to an indirectly referenced function block instance	37

Figure 12 – Invocation of an indirectly referenced function block instance	39
Figure 13 – Timing of edge triggered functionality	43
Figure 14 – Execution control example	44
Figure 15 – Timing of Boolean actions	49
Figure 16 – Example of a programmed non-Boolean action	50
Figure 17 – Use of the pulse (P) qualifier	51
Figure 18 – An SFC function block	52
Figure 19 – Example of incorrect and allowed programming constructs	61
Figure 20 – Essential phases of POU creation	
Figure 21 – Essential phases of application creation	74
Figure 22 – Separate compilation of functions and function blocks	74
Figure 23 – Compiling a program accessing external or directly represented variables	75
Figure 24 – Compiling a function that invokes another function	75
Figure 25 – Compiling a program containing local instances of function blocks	76
Figure 26 – Separate compilation example	77
Figure 27 – The configuration process	78
Figure 28 – Reduction steps	81
Figure 29 – Reduction of SFCs	82
Table 1 – IEC 61131-3 elements supporting encapsulation and hiding	15
Table 2 – Examples of textual invocations of functions and function blocks	31
Table 3 – Differences between multi-user and real-time systems	54
Table 4 – Recommended run-time error-handling mechanisms	68
Table A.1 – Changes in usage to achieve program compliance	93
\	

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROGRAMMABLE CONTROLLERS -

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEO technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

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