Logix 5000 Controllers IEC 61131-3 Compliance

1756 ControlLogix, 1756 GuardLogix, 1769 CompactLogix, 1769 Compact GuardLogix, 1789 SoftLogix, 5069 CompactLogix, 5069 Compact GuardLogix, Studio 5000 Logix Emulate

Programming Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

⚠ **WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

⚠ **ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

⚠ **SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

⚠ **BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

⚠ **ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Summary of changes

This manual includes new and updated information. Use these reference tables to locate changed information.

Grammatical and editorial style changes are not included in this summary.

Global changes

This table identifies changes that apply to all information about a subject in the manual and the reason for the change. For example, the addition of new supported hardware, a software design change, or additional reference material would result in changes to all of the topics that deal with that subject.

Change	Topic
Updated Legal notices.	Legal notices on page 8
Updated branding.	Throughout

New or enhanced features

None in this release.

Preface

This manual explains the series of specifications developed by the International Electrotechnical Commission (IEC) for programmable controllers and how to use them with your Logix5000™ controller and programming application.

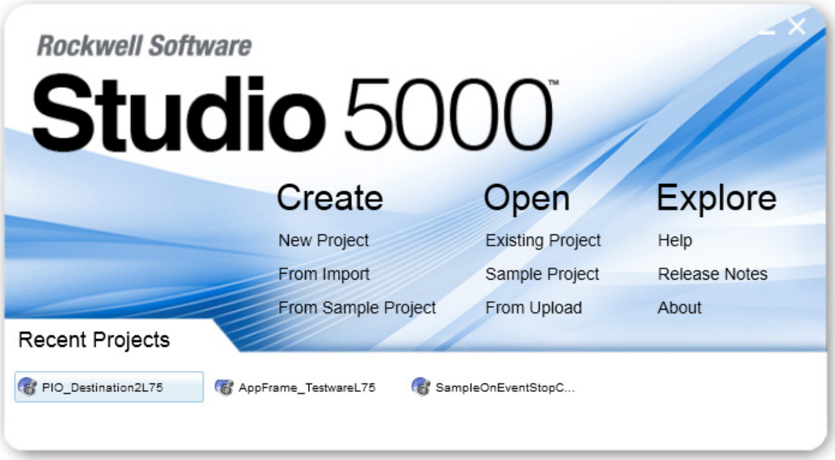
This manual is one of a set of related manuals that show common procedures for programming and operating Logix5000 controllers. For a complete list of common procedures manuals, see the Logix 5000 Controllers Common Procedures Programming Manual, publication 1756-PM001.

The term Logix5000 controller refers to any controller that is based on the Logix5000 operating system, such as:

- CompactLogix controllers
- Compact GuardLogix controllers
- GuardLogix controllers
- ControlLogix controllers
- DriveLogix controllers
- FlexLogix controllers
- SoftLogix5800 controllers
- Studio 5000 Logix Emulate

Studio 5000 environment

The Studio 5000 Automation Engineering & Design Environment® combines engineering and design elements into a common environment. The first element is the Studio 5000 Logix Designer® application. The Logix Designer application is the rebranding of RSLogix 5000® software and will continue to be the product to program Logix 5000™ controllers for discrete, process, batch, motion, safety, and drive-based solutions.



The Studio 5000® environment is the foundation for the future of Rockwell Automation® engineering design tools and capabilities. The Studio 5000 environment is the one place for design engineers to develop all elements of their control system.

Additional resources

These documents contain additional information concerning related Rockwell Automation products.

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications webpage, available at http://ab.rockwellautomation.com	Provides declarations of conformity, certificates, and other certification details.

View or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact the local Rockwell Automation distributor or sales representative.

Legal notices

Rockwell Automation publishes legal notices, such as privacy policies, license agreements, trademark disclosures, and other terms and conditions on the Legal Notices page of the Rockwell Automation website.

End User License Agreement (EULA)

You can view the Rockwell Automation End User License Agreement (EULA) by opening the license.rtf file located in your product's install folder on your hard drive.

The default location of this file is:

C:\Program Files (x86)\Common Files\Rockwell\license.rtf.

Open Source Software Licenses

The software included in this product contains copyrighted software that is licensed under one or more open source licenses.

You can view a full list of all open source software used in this product and their corresponding licenses by opening the oss_license.txt file located your product's OPENSOURCE folder on your hard drive. This file is divided into these sections:

- Components
  Includes the name of the open source component, its version number, and the type of license.
- Copyright Text
  Includes the name of the open source component, its version number, and the copyright declaration.
- Licenses
  Includes the name of the license, the list of open source components citing the license, and the terms of the license.

The default location of this file is:

C:\Program Files (x86)\Common Files\Rockwell\Help\<*product name*>\Release Notes\OPENSOURCE\oss_licenses.txt.

You may obtain Corresponding Source code for open source packages included in this product from their respective project web site(s). Alternatively, you may obtain complete Corresponding Source code by contacting Rockwell Automation via the **Contact** form on the Rockwell Automation website: http://www.rockwellautomation.com/global/about-us/contact/contact.page. Please include "Open Source" as part of the request text.

IEC61131-3 Compliance

Introduction

This manual is compliant with the International Electrotechnical Commission specification (IEC61131) Third Edition.

The IEC has developed a series of specifications for programmable controllers. These specifications are intended to promote international unification of equipment and programming languages for use in the controls industry. These standards provide the foundation for Logix5000 controllers and the Logix Designer application.

The IEC programmable controller specification (IEC61131) breaks down into five parts, each focusing on another aspect of the control system.

- Part 1: General Information
- Part 2: Equipment and Requirements Test
- Part 3: Programming Languages
- Part 4: User Guidelines
- Part 5: Messaging Service Specification

The controls industry as a whole has focused on part 3 (IEC61131-3), Programming Languages, because it provides the cornerstone for implementing the other standards and provides the most significant end user benefit by reducing training cost. Because of this, only IEC61131-3 is addressed here.

The IEC61131-3 programming language specification addresses numerous aspects of programmable controllers, including the operating system execution, data definitions, programming languages, and instruction set. Components of the IEC61131-3 specification are categorized by the specification as required, optional, or extensions. By so doing, the IEC61131-3 specification provides a minimum set of functionality that can be extended to meet end user application needs. The downside to this approach is that each programmable control system vendor may implement different components of the specification or provide different extensions.

Operating System

The multitasking operating system (OS) of Logix5000 controllers complies with the IEC61131-3 definition. In IEC61131-3, the programmable controller OS can contain zero or more tasks, that can execute one or more programs each containing one or more functions or routines. According to IEC61131-3, the number of each of these components is implementation dependent. Logix5000 controllers provide multiple tasks, each containing multiple programs and an unlimited number of functions or routines.

IEC61131-3 provides an option for creating task execution classifications. Tasks may be configured as continuous, periodic, or event based. Logix5000 controllers support both continuous and periodic tasks. A continuous task does not need to be scheduled, because it uses any left over processing time when other tasks are dormant. Periodic tasks are scheduled to operate based on a reoccurring time period, configurable starting as low as 1 millisecond (ms). The IEC61131-3 specification does not specify a time base for periodic task configuration. An IEC61131-3 event based task triggers upon detection of the rising edge of a configured input.

Data Definitions

The IEC61131-3 specification provides access to memory through the creation of named variables, consisting of a minimum of six characters (Logix Designer application supports a minimum of 1 character) starting with an underscore "_" or an alpha character (A-Z), followed by one or more characters consisting of an underscore "_", alpha character (A-Z) or a number (0-9). Optionally, lower case alpha characters (a-z) can be supported as long as they are case insensitive (A = a, B = b, C = c ...). Logix 5000 controllers provide full compliance with this definition, support the lower case option, and extend the name to support up to 40 characters.

Data variables in IEC61131-3 may be defined so that they are accessible to all programs within a resource or controller, or limited access is provided only to the functions or routines within a single program. To pass data between multiple resources or controllers, access paths may be configured to define the location of the data within a system. Logix 5000 controllers provide compliance by providing program scoped or controller scoped data and permitting the configuration of access paths using produced/consumed data.

The memory interpretation of a variable within IEC61131-3 is defined through the use of an elementary data type or an optional derived data type created from a group of multiple data types. Logix 5000 controllers support the use of the BOOL (1 bit), SINT (8 bit signed integer), INT (16 bit signed integer), DINT (32 bit signed integer), and LINT (64 bit signed integer), REAL (32-bit floating point number), LREAL (64-bit, floating point number), USINT (8 bit unsigned integer), UINT (16 bit unsigned integer), UDINT (32 bit unsigned), and ULINT (64 bit unsigned integer) elementary data types. Additionally, the optional derived data types are supported through the creation of user defined structures and arrays.

Programming Languages

The IEC61131-3 specification defines five programming languages and a set of common elements. All languages are defined as optional, but at least one must be supported to claim compliance with the specification. The IEC61131-3 programming language components are defined as follows.

- Common Language Elements
- Common Graphical Elements
- Instruction List (IL) Language Elements
- Structured Text Language (ST) Elements
- Ladder Diagram (LD) Language Elements

- Sequential Function Chart (SFC) Language Elements
- Function Block Diagram (FBD) Language Elements

Logix5000 controllers and the Logix Designer application provide support for the common language elements and the Structured Text, Ladder Diagram, Sequential Function Chart, and Function Block Diagram language options. Additionally, the environment utilizes an ASCII import/export format based on the Structured Text language. The instruction set and program file exchange features are discussed in detail in the sections that follow.

Instruction Set

The instruction set specified by IEC61131-3 is entirely optional. The specification lists a limited set of instructions that if implemented must conform to the stated execution and visual representation. IEC61131-3 however, does not limit the instructions set to those listed within the specification. Each PLC vendor can implement additional functionality in the form of instructions beyond those listed by the specification. Examples of such extended instructions are those needed to perform diagnostics, PID loop control, motion control, and data file manipulation. Because extended instructions are not defined by the IEC61131-3 specification, there is no guarantee that the implementation between different PLC vendors will be compatible. Use of these instructions may preclude the movement of logic between vendors.

Logix5000 controllers and the Logix Designer application provide a suite of instructions that execute as defined by the IEC61131-3 specification. The physical representation of these instructions maintain their look and feel with existing systems so as to reduce the training cost associated with working with the environment. A full range of instructions from existing products have been brought forward into the environment so that no functionality is lost.

IEC61131-3 Program Portability

One of the goals of creating programs in an IEC61131-3 compliant environment is the movement or portability of programs between controllers developed by different vendors. This area is a weakness of IEC61131-3 because no file exchange format is defined by the specification. This means that any program created in one vendor's environment requires manipulation to move it to another vendor's system.

To minimize the effort involved in performing cross-vendor portability, the Logix Designer application for the controllers includes a full ASCII export and import utility. The file format used by this utility is based on a hybrid of the IEC61131-3 Structured Text language definition. Controller operating system and data definitions follow the IEC61131-3 formats. Extensions were implemented to convert Ladder Diagram logic into ASCII text since this is not defined by IEC61131-3.

For more information on the ASCII export and import utility of the Logix Designer application, see the Logix5000 Controllers Import/Export Reference Manual, publication 1756-RM084.

IEC Compliance Tables

Logix5000 controllers and the Logix Designer application comply with the requirements of IEC61131-3 for the following language features:

Character Set

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
1	1	ISO/IEC 10646	UTF-8 encoding aligned with ASCII
1	2a	Lower case letters	none
1	2b	Number sign (#)	Used for immediate value data type designation
1	2c	Dollar sign ($)	Used for description and string control character

Identifiers

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
2	1	Identifiers: upper case letters and numbers	Task, program, routine, structure and tag names along with controllers and Add On Instructions.
2	2	Identifiers: upper and lower case letters, numbers, embedded underscores	Task, program, routine, structure and tag names along with controllers and Add On Instructions.
2	3	Identifiers: upper and lower case letters, numbers, leading or embedded underscores	Task, program, routine, structure and tag names along with controllers and Add On Instructions.

Comments

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
3	1	Comments: Single-line comment with // …	ST Comments, also support /* Comment */, and // End of line comments.
3	2a	Comments: Multi-line comment with (* … *)	none
3	2b	Comments: Multi-line comment with /* … */	none

Numeric Literals

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
5	1	Integer literal	12, 0, -12
5	2	Real literal	12.5, -12.5
5	3a	Real literal with exponents	-1.34E-12, 1.234e6
5	4	Binary (Base 2) literal	2#0101_0101
5	5	Octal (Base 8) literal	8#377
5	6	Hexadecimal (Base 16) literal	16#FFE0 or 16#eff0
5	7	Boolean zero and one	0 or 1

Character String Literals

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
6	1A	Empty String (length zero) ''	none
6	1B	String of length one containing a character 'A'	String may contain up to 512 characters

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
6	1C	String of length one containing a space ' '	String may contain up to 512 characters
6	1D	String of length one containing a single quote character '$''	String may contain up to 512 characters
6	1E	String of length one containing a double quote character ""	String may contain up to 512 characters
6	1F	String containing two character combinations of Table 7	String may contain up to 512 characters
6	1G	String containing character representation with ‘$’ and two hexadecimal	String may contain up to 512 characters

Two-character combination in character strings

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
7	1	String dollar sign '$$'	none
7	2	String single quote '$''	none
7	3	String Line Feed '$L' or '$l'	none
7	4	String New-line '$N' or '$n'	none
7	5	String From Feed (page) '$P' or '$p'	none
7	6	String Carriage return '$R' or '$r'	none
7	7	String Tab '$T' or '$t'	none

Elementary data types

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
10	1	BOOL Data Type	Tag variable or structure member definition
10	2	SINT Data Type	Tag variable or structure member definition
10	3	INT Data Type	Tag variable or structure member definition
10	4	DINT Data Type	Tag variable or structure member definition
10	5	LINT Data Type	Tag variable or structure member definition.
10	6	USINT Data Type	Tag variable or structure member definition.
10	7	UINT Data Type	Tag variable or structure member definition.
10	8	UDINT Data Type	Tag variable or structure member definition.
10	9	ULINT Data Type	Tag variable or structure member definition.
10	10	REAL Data Type	Tag variable or structure member definition
10	11	LREAL Data type	Tag variable or structure member definition
10	16a	STRING data type	Single byte characters

Declaration of user-defined data types and initialization

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
11	4a,4b	Array data types	Applicable to String types only
11	5a,5b	FB types as array elements	User defined data type structures with initialization
11	6a,6b	Structured Data types	User defined data type structures with initialization
11	7a,7b	FB types as structure elements	User defined data type structures with initialization
11	11a,11b	Directly derived data types	User defined data type structures with initialization

Declaration of variables

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
13	1	Variable with elementary data type	none
13	2	Variable with user defined data type	none
13	3	Array	none

Initialization of variables

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
14	1	Initialization of a variable with elementary data type	Tag variable definition and via import
14	2	Initialization of a variable with user-defined data type	Tag variable definition and via import
14	3	Array	none

Partial access of ANY_BIT variables

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
17	1a	Partial access of SINT/USINT variables	In lieu of ANY_BIT variables
17	1b	Partial access of INT/UINT variables	In lieu of ANY_BIT variables
17	1c	Partial access of DINT/UDINT variables	In lieu of ANY_BIT variables
17	1d	Partial access of LINT/ULINT variables	In lieu of ANY_BIT variables

Execution control graphically using EN an ENO

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
18	1	Usage without EN and ENO	Available in FBD
18	2	Usage of EN only	Available in FBD
18	3	Usage of ENO only	Available in FBD
18	4	Use of EN and ENO	Function present in LD but not labeled. Available in FBD.

Functional call

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
20	2	Non-formal call (textual only)	none
20	4	Function without function result	none

Typed and overloaded functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
21	1a	Overloaded functions e.g., ADD(ANY_NUM to ANY_NUM)	All overloaded types that are supported are documented with each instruction

Data type conversion function

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
22	1a	_TO_ conversion function	RAD, DEG instructions Radians to/from Decimal. String numeric conversion STOD, STOR, RTOS, DTOS. Others not needed because of instruction overloading
22	2a	Truncate conversion function	TRN instruction in LD and TRUNC function in ST
22	3b	BCD to INT Convert	FRD instruction in LD
22	4b	INT to BCD Convert	TOD instruction in LD

Data type conversion of numeric data types

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
23	1	LREAL to REAL	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	2	LREAL to LINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	3	LREAL to DINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	4	LREAL to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	5	LREAL to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	6	LREAL to ULINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	7	LREAL to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	8	LREAL to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	9	LREAL to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	10	REAL to LREAL	Implicit conversion. Minor fault support if Report Overflow Faults enabled
23	11	REAL to LINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	12	REAL to DINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	13	REAL to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	14	REAL to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	15	REAL to ULINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	16	REAL to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	17	REAL to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	18	REAL to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	19	LINT to LREAL	Implicit conversion (Minor Fault support not needed)

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
23	20	LINT to REAL	Implicit conversion (Minor Fault support not needed)
23	21	LINT to DINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	22	LINT to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	23	LINT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	24	LINT to ULINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	25	LINT to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	26	LINT to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	27	LINT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	28	DINT to LREAL	Implicit conversion (Minor Fault support not needed)
23	29	DINT to REAL	Implicit conversion (Minor Fault support not needed).
23	30	DINT to LINT	Implicit conversion (Minor Fault support not needed)
23	31	DINT to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	32	DINT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	33	DINT to ULINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	34	DINT to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	35	DINT to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	36	DINT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	37	INT to LREAL	Implicit conversion (Minor Fault support not needed).
23	38	INT to REAL	Implicit conversion (Minor Fault support not needed)
23	39	INT to LINT	Implicit conversion (Minor Fault support not needed)
23	40	INT to DINT	Implicit conversion (Minor Fault support not needed)
23	41	INT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	42	INT to ULINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	43	INT to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	44	INT to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	45	INT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	46	SINT to LREAL	Implicit conversion (Minor Fault support not needed)
23	47	SINT to REAL	Implicit conversion (Minor Fault support not needed)
23	49	SINT to DINT	Implicit conversion (Minor Fault support not needed)
23	50	SINT to INT	Implicit conversion (Minor Fault support not needed)

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
23	51	SINT to ULINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	52	SINT to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	53	SINT to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	54	SINT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	55	ULINT to LREAL	Implicit conversion (Minor Fault support not needed)
23	56	ULINT to REAL	Implicit conversion (Minor Fault support not needed)
23	57	ULINT to LINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	58	ULINT to DINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	59	ULINT to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	60	ULINT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	61	ULINT to UDINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	62	ULINT to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	63	ULINT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	64	UDINT to LREAL	Implicit conversion (Minor Fault support not needed)
23	65	UDINT to REAL	Implicit conversion (Minor Fault support not needed)
23	66	UDINT to LINT	Implicit conversion (Minor Fault support not needed)
23	67	UDINT to DINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	68	UDINT to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	69	UDINT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	70	UDINT to ULINT	Implicit conversion (Minor Fault support not needed)
23	71	UDINT to UINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	72	UDINT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	73	UINT to LREAL	Implicit conversion (Minor Fault support not needed)
23	74	UINT to REAL	Implicit conversion (Minor Fault support not needed)
23	75	UINT to LINT	Implicit conversion (Minor Fault support not needed)
23	76	UINT to DINT	Implicit conversion (Minor Fault support not needed)
23	77	UINT to INT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	78	UINT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	79	UINT to ULINT	Implicit conversion (Minor Fault support not needed)
23	80	UINT to UDINT	Implicit conversion (Minor Fault support not needed)
23	81	UINT to USINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
23	82	USINT to LREAL	Implicit conversion (Minor Fault support not needed)
23	83	USINT to REAL	Implicit conversion (Minor Fault support not needed)
23	84	USINT to LINT	Implicit conversion (Minor Fault support not needed)
23	85	USINT to DINT	Implicit conversion (Minor Fault support not needed)
23	86	USINT to INT	Implicit conversion (Minor Fault support not needed)
23	87	USINT to SINT	Implicit conversion with Minor Fault support if Report Overflow Faults enabled
23	88	USINT to ULINT	Implicit conversion (Minor Fault support not needed)
23	89	USINT to UDINT	Implicit conversion (Minor Fault support not needed)
23	90	USINT to UINT	Implicit conversion (Minor Fault support not needed)

Numerical and arithmetic functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
28	1	Absolute value	ABS instruction
28	2	Square root	SQR instruction in LD and FBD and SQRT function in ST.
28	3	Natural log	LN instruction
28	4	Log base 10	LOG instruction
28	6	Sine in radians	SIN instruction / function
28	7	Cosine in radians	COS instruction / function
28	8	Tangent in radians	TAN instruction / function
28	9	Principal arc sine	ASN instruction in LD and FBD, and ASIN function in ST
28	10	Principal arc cosine	ACS instruction in LD and FBD, and ACOS function in ST
28	11	Principal arc tangent	ATN instruction in LD and FBD, and ATAN function in ST

Arithmetic functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
29	1	Arithmetic add	ADD instruction in LD, FBD and FBD function, and ST, and + in ST.
29	2	Arithmetic multiplication	MUL instruction in LD, FBD and FBD function, and ST, and * in ST.
29	3	Arithmetic subtraction	SUB instruction in LD, FBD and FBD function, and ST, and - in ST.
29	4	Arithmetic divide	DIV instruction in LD, FBD and FBD Function, and ST, and / in ST.
29	5	Modulo	MOD instruction LD, FBD, FBD Function, and ST
29	6	Exponentiation	XPY instruction in LD and FBD, and ** in ST.
29	7	Value move	MOV instruction in LD, and := in ST.

Bit Shift functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
30	1	Bit shift left	Functionality contained in BSL instruction in LD for shift or 1
30	2	Bit shift right	Functionality contained in BSR instruction in LD for shift or 1
30	3	Bit rotate left	Functionality contained in BSL instruction in LD for shift or 1
30	4	Bit rotate right	Functionality contained in BSR instruction in LD for shift or 1

Bitwise Boolean functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
31	1	Bitwise Boolean And	Bitwise: AND in LD, FBD, and ST, "&" operator in expressions Boolean: BAND instruction in FBD and FBD Function, AND in ST, and "AND,&" operator in LD expressions (i.e., CMP/FSC)
31	2	Bitwise Boolean Or	Bitwise: OR in LD, FBD, and ST Boolean: BOR instruction in FBD and FBD function, OR in ST and OR in LD expressions (i.e., CMP/FSC)
31	3	Bitwise Boolean Exclusive Or	Bitwise: XOR in LD, FBD, and ST, Boolean: BXOR instruction in FBD and FBD Function, XOR in ST and XOR in LD expressions (i.e., CMP/FSC)
31	4	Bitwise Boolean Not	Bitwise: NOT in LD, FBD, and ST, Boolean: BNOT instruction in FBD and FBD Function, NOT in ST and NOT in LD expressions (i.e., CMP/FSC)

Select functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
32	1	SELECT	SEL instruction in FBD
32	2	Maximum select MAX	Functionality contained in ESEL instruction in FBD and ST
32	3	Minimum select MIN	Functionality contained in ESEL instruction in FBD and ST
32	4	High/Low limit LIMIT	HLL instruction in FBD and ST
32	5	Multiplexer MUX	MUX instruction in FBD

Comparison functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
33	1	Comparison greater-than	GRT instruction in LD and FBD, and > in ST.
33	2	Comparison greater-than or equal	GRE instruction in LD and FBD, and >= in ST.
33	3	Comparison equal	EQU instruction in LD and FBD, and = in ST.
33	4	Comparison less-than	LES instruction in LD and FBD, and < in ST.
33	5	Comparison less-than or equal	LEQ instruction in LD and FBD, and <= in ST.

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
33	6	Comparison not equal	NEQ instruction in LD and FBD, and <> in ST.

Character string functions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
34	1	String length LEN	Use STRING.LEN or SIZE in LD and ST.
34	4	Middle string MID	MID instruction in LD and ST
34	5	String concatenation CONCAT	CONCAT instruction in LD and ST
34	6	String insert INSERT	INSERT instruction in LD and ST
34	7	String delete DELETE	DELETE instruction in LD and ST
34	9	Find string FIND	FIND instruction in LD and ST

Function block type declaration

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
40	1	Declaration of function block type	Add On Instructions provide Function Block equivalent
40	2a	Declaration of inputs	Add On Instructions provide Function Block equivalent
40	2b	Declaration of outputs	Add On Instructions provide Function Block equivalent
40	2c	Declaration of in-outs	Add On Instructions provide Function Block equivalent
40	2e	Declaration of static variables	Add On Instructions provide Function Block equivalent
40	3a	Initialization of inputs	Add On Instructions provide Function Block equivalent
40	3b	Initialization of outputs	Add On Instructions provide Function Block equivalent
40	3c	Initializations of static variables	Add On Instructions provide Function Block equivalent

Function block instance declaration

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
41	1	Declaration of function block instances	Add On Instructions provide Function Block equivalent
41	2	Declaration of function block instances with initialization	Add On Instructions provide Function Block equivalent

Function block call

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
42	1	Complete formal call (textual only)	Add on Instructions provide Function Block equivalent. User selectable.
42	2	Incomplete formal call (textual only)	Add on Instructions provide Function Block equivalent. In-outs are required. User Selectable.
42	3	Graphical call	Add on Instructions provide Function Block equivalent. EN/ENO are optional.
42	6a	Textual call with separate assignment of input	Add on Instructions provide Function Block equivalent
42	7	Textual output read after FB call	Add on Instructions provide Function Block equivalent
42	10a	Textual call with function block instance name as VAR_IN_OUT	Add on Instructions provide Function Block equivalent

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
42	10b	Graphical call with function block instance name as VAR_IN_OUT	Add on Instructions provide Function Block equivalent

Standard bistable

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
43	1b	Bistable set dominant (long names)	SETD instruction in FBD and ST
43	2b	Bistable reset dominant (long names)	RESD instruction in FBD and ST

Standard edge detection function blocks

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
44	1	Rising edge detector	OSR instruction in LD and OSRI instruction in FBD and ST
44	2	Falling edge detector	OSF instruction in LD and OSFI instruction in FBD and ST

Standard counter function blocks

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
45	1b	Up-counter	Functionality contained in CTU and RES instructions in LD and in CTUD instruction in FBD and ST
45	2b	Down-counter	Functionality contained in CTD and RES instructions in LD and in CTUD instruction in FBD and ST
45	3b	UpDown-counter	CTUD instruction in FBD and ST

Standard timer function blocks

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
46	2b	On-delay timer using TIME	Functionality contained in TON instruction in LD and TONR instruction in FBD and ST
46	3b	Off-delay timer using TIME	Functionality contained in TOF instruction in LD and TOFR instruction in FBD and ST

Program declaration

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
47	1	Declaration of a program	none
47	2a	Declaration of inputs	none
47	2b	Declaration of outputs	none
47	2c	Declaration of in-outs	none
47	2e	Declaration of static variables	none
47	3a	Initialization of inputs	none
47	3b	Initialization of outputs	none
47	3c	Initialization of static variables	none

SFC step

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
54	1a	SFC Step	none
54	1b	SFC initial Step	none
54	2a	SFC Step Textual	Import/export, step name is specified using the format "Operand := step_name"
54	2b	SFC initial Step textual	Import/export, uses "InitialStep" Parameter and step name is specified using the format "Operand := step_name"
54	3a	SFC Step Flag general form	Step backing tag
54	4	Step elapsed time general form	Step backing tag

SFC transition and transition conditions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
55	1	Transition using ST	none
55	7	Transition textual form	Import/export with different formatting
55	9	Transition Name	Transition Backing Tag
55	10	Transition Set by LD	Transition Backing Tag
55	11	Transition Set by FBD	Transition Backing Tag
55	13	Transition Set by ST	Transition Backing Tag

SFC declarations of actions

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
56	1	Action Boolean	Action Backing tag
56	3s	Action textual representation	Import/export

Step/action associations

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
57	1	Horizontal line	none
57	2	Vertical line	none
57	3	Horizontal / Vertical connection	Import/export with different formatting
57	4	Line crossings without connection	Embedded ST

Action block

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
58	1	Action Block Qualifier	none
58	2	Action Block Name	none
58	3	Action Indicator Tag	Extended this to support DINT, INT, SINT, or REAL in addition to BOOL
58	4s	Action using ST	Supports both embedded ST and JSR to ST routine
58	5l	Action using LD	Using JSR to LD routine
58	5f	Action using FBD	Using JSR to FBD Routine

Action qualifiers

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
59	1	Action Qualifier None	Default is N when none is explicitly entered
59	2	Action Qualifier N - Non-stored	none
59	3	Action Qualifier R - Reset	none
59	4	Action Qualifier S - Set / Stored	none
59	5	Action Qualifier L - Time Limited	none
59	6	Action Qualifier D - Time Delayed	none
59	7	Action Qualifier P - Pulse	none
59	8	Action Qualifier SD - Stored and Time Delayed	none
59	9	Action Qualifier DS - Delayed and Stored	none
59	10	Action Qualifier SL - Stored and time limited	none
59	11	Action Qualifier P1 - Pulse Rising Edge	none
59	12	Action Qualifier P0 - Pulse Falling Edge	none

Action control features

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
60	1	Action Control with final scan	none
60	2	Action Control without final scan	none

Sequence evolution - graphical

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
61	1	SFC Single Sequence	none
61	2a	SFC Divergence of sequence with left to right priority	Use of line connections vs. asterisk
61	2b	SFC Divergence of sequence with numbered branches	none
61	2c	SFC Divergence of sequence with mutual exclusion	none
61	3	SFC Convergence of sequence	none
61	4a	SFC Simultaneous divergence after a single transition	none
61	4b	SFC Simultaneous divergence after convergence	none
61	4c	SFC Simultaneous convergence before a single transition	none
61	4d	SFC Simultaneous convergence before a sequence selection	none
61	5a, b, c	SFC Sequence Skip	none
61	6a, b, c	SFC Sequence Loop	none
61	7	SFC Loop directional arrows	When wire is hidden

Configuration and resource declaration

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
62	3	Resource declaration	Controller is our equivalent

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
62	3a	Textual association with PROGRAMs	
62	3b	Textual association with function blocks	
62	4	Global variables	Controller scope variables
62	5a	Periodic TASK	none
62	5b	Non-periodic TASK	none
62	6a	Program to Task association	Schedule a Program to a Task
62	6c	Program without tasks	Unscheduled Programs

Task

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
63	1a	Textual declaration of periodic tasks	
63	1b	Textual declaration of non-periodic tasks	

Operators of the ST language

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
71	1	ST Parenthesization (expression)	none
71	2	ST Function Evaluation	Using non-formal form of invocation for built in functions. JSR used within ST language to call user developed code.
71	4	ST Negation -	none
71	6	ST Complement	none
71	7	ST Exponentiation **	none
71	8	ST Multiply *	none
71	9	ST Divide /	none
71	10	ST Modulo MOD	none
71	11	ST Add +	none
71	12	ST Subtract -	none
71	13	ST Comparison <, >, <=, >=	none
71	14	ST Equality =	none
71	15	ST Inequality <>	none
71	16a	ST Boolean And as AND	none
71	16b	ST Boolean And as &	none
71	17	ST Boolean XOR	none
71	18	ST Boolean OR	none

ST language statements

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
72	1a,b	ST Assignment :=	none
72	2a,b	ST Function Block invocation	none
72	3	ST RETURN	RET( ) with multiple Parameters
72	4	ST IF / ELSIF / ELSE/ END_IF	none

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
72	5	ST CASE OF / ELSE / END_CASE	none
72	6	ST FOR / END_FOR	none
72	7	ST WHILE DO / END_WHILE	none
72	8	ST REPEAT / UNTIL / END_REPEAT	none
72	10	ST EXIT	none
72	11	ST Empty Statement ;	none

Graphic execution control elements

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
73	1b	Unconditional jump	JMP to LBL without conditions
73	2b	Conditional jump	JMP to LBL with conditions
73	3a	Conditional return	RET instruction in LD with conditions
73	4	Unconditional return	RET instruction in LD

Power rails and link elements

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
74	1	Left hand power rail	LD editor
74	2	Right hand power rail	LD editor
74	3	Horizontal link	LD editor
74	4	Vertical link	LD editor

Contacts

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
75	1	Normally open contact --| |--	XIC instruction in LD
75	2	Normally close contact --| / |--	XIO instruction in LD
75	3	Positive transition sensing contact -| P |-	ONS instruction in LD

Coils

Table Number	Feature Number:	Feature Description:	Extensions and Implementation Notes:
76	1	Coil --( )--	OTE instruction in LD
76	3	Set (latch) coil	Functionality contained in OTL instruction in LD
76	4	Reset (unlatch) coil	Functionality contained in OTU instruction in LD
76	8	Positive transition sensing coil	OSR instruction in LD
76	9	Negative transition sensing coil	OSF instruction in LD

Index

Rockwell Automation support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	rok.auto/pcdc

Documentation feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

Rockwell Otomayson Ticaret A.Ş. Kar Plaza İş Merkezi E Blok Kat:6 34752, İçerenkÖy, İstanbul, Tel: +90 (216) 5698400 EEE YÖnetmeliğine Uygundur

Connect with us.

rockwellautomation.com — expanding **human possibility**™

AMERICAS: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
EUROPE/MIDDLE EAST/AFRICA: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
ASIA PACIFIC: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Supersedes Publication 1756-PM018G-EN-P - November 2018