Programmable controllers - Part 6: Functional safety (IEC 61131-6:2012)

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Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

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ICS 25.040.40, 35.240.50

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61131-6

November 2012

ICS 25.040.40; 35.240.50

English version

Programmable controllers - Part 6: Functional safety
(IEC 61131-6:2012)

Automates programmables - Partie 6: Sécurité fonctionnelle (CEI 61131-6:2012)

Speicherprogrammierbare Steuerungen – Teil 6: Funktionale Sicherheit (IEC 61131-6:2012)

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Ref. No. EN 61131-6:2012 E

Foreword

The text of document 65B/831/FDIS, future edition 1 of IEC 61131-6, prepared by SC 65B, "Devices & process analysis", of IEC TC 65, "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61131-6:2012.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-08-06
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2015-11-06

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Endorsement notice

The text of the International Standard IEC 61131-6:2012 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60300-3-2:2004	NOTE Harmonized as EN 60300-3-2:2005 (not modified).
IEC 61000 series	NOTE Harmonized in EN 61000 series (not modified).
IEC 61025:2006	NOTE Harmonized as EN 61025:2007 (not modified).
IEC 61069-7:1999	NOTE Harmonized as EN 61069-7:1999 (not modified).
IEC 61078:2006	NOTE Harmonized as EN 61078:2006 (not modified).
IEC 61131-3:2003	NOTE Harmonized as EN 61131-3:2003 (not modified).
IEC 61165:2006	NOTE Harmonized as EN 61165:2006 (not modified).
IEC 61496-1:2004 + A1:2007	NOTE Harmonized as EN 61496-1:2004 (modified) + A1:2008 (not modified).
IEC 61496-3:2008	NOTE Harmonized as CLC/TS 61496-3:2008 (not modified).
IEC 61508 series	NOTE Harmonized in EN 61508 series (not modified).
IEC 61508-4:2010	NOTE Harmonized as EN 61508-4:2010 (not modified).
IEC 61508-5:2010	NOTE Harmonized as EN 61508-5:2010 (not modified).
IEC 61508-7:2010	NOTE Harmonized as EN 61508-7:2010 (not modified).
IEC 61511-1:2003	NOTE Harmonized as EN 61511-1:2004 (not modified).
IEC 61511-2:2003	NOTE Harmonized as EN 61511-2:2004 (not modified).
IEC 61511-3:2003	NOTE Harmonized as EN 61511-3:2004 (not modified).

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IEC 62061:2005	NOTE	Harmonized as EN 62061:2005 (not modified).
IEC 62079:2001	NOTE	Harmonized as EN 62079:2001 (not modified).
CISPR 11:2009	NOTE	Harmonized as EN 55011:2009 (modified).
ISO 8402:1994	NOTE	Harmonized as EN ISO 8402:1995 (not modified).
ISO 9000-3:1997	NOTE	Harmonized as EN ISO 9000-3:1997 (not modified).
ISO 9001:2008	NOTE	Harmonized as EN ISO 9001:2008 (not modified).
ISO 13849-1:2006	NOTE	Harmonized as EN ISO 13849-1:2008 (not modified).
ISO 13849-2:2003	NOTE	Harmonized as EN ISO 13849-2:2003 (not modified).
ISO 14224:2006	NOTE	Harmonized as EN ISO 14224:2006 (not modified).

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60947-5-1	2003	Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices	EN 60947-5-1 + corr. July	2004 2005
IEC/TS 61000-1-2	2008	Electromagnetic compatibility (EMC) - Part 1-2: General - Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena	-	-
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	2009
IEC 61000-4-3	2006	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3	2006
IEC 61000-4-4	2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	2012
IEC 61000-4-5 + corr. October	2005 2009	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2006
IEC 61000-4-6	2008	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2009
IEC 61000-4-8	2009	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8	2010
IEC 61131-1	2003	Programmable controllers - Part 1: General information	EN 61131-1	2003
IEC 61131-2	2007	Programmable controllers - Part 2: Equipment requirements and tests	EN 61131-2	2007
IEC/TR 61131-4	2004	Programmable controllers - Part 4: User guidelines	-	-

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Publication	Year	Title	EN/HD	Year
IEC 61326-3-1 + corr. August	2008 2008	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications	EN 61326-3-1	2008
IEC 61326-3-2	2008	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - Industrial applications with specified electromagnetic environment	EN 61326-3-2	2008
IEC 61508-1	2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements	EN 61508-1	2010
IEC 61508-2	2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems	EN 61508-2	2010
IEC 61508-3	2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements	EN 61508-3	2010
IEC 61508-6	2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3	EN 61508-6	2010
IEC 61784-3	2010	Industrial communication networks - Profiles – Part 3: Functional safety fieldbuses - General rules and profile definitions	EN 61784-3	2010
IEC 62443	Series	Security for industrial process measurement and control - Network and system security	-	-
IEC Guide 104	2010	The preparation of safety publications and the use of basic safety publications and group safety publications	-	-
ISO/IEC Guide 51	1999	Safety aspects - Guidelines for their inclusion in standards	-	-
EN 50205	2002	Relays with forcibly guided (mechanically linked) contacts	-	-

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INTRODUCTION

General

IEC 61131 series consists of the following parts under the general title *Programmable controllers*:

Part 1: General information
Part 2: Equipment requirements and tests
Part 3: Programming languages
Part 4: User guidelines
Part 5: Communications
Part 6: Functional safety
Part 7: Fuzzy control programming
Part 8: Guidelines for the application and implementation of programming languages

This Part of IEC 61131 series constitutes Part 6 of a series of standards on programmable controllers and the associated peripherals and should be read in conjunction with the other parts of the series.

As this document is the FS-PLC product standard, the provisions of this part should be considered to govern in the area of programmable controllers and their associated peripherals.

Compliance with Part 6 of IEC 61131 cannot be claimed unless the requirements of Clause 4 of this part are met.

Terms of general use are defined in Part 1 of IEC 61131. More specific terms are defined in each part.

In keeping with 1.1 of IEC 61508-1:2010, this part encompasses the product specific requirements of IEC 61508-1, 61508-2 and 61508-3 as pertaining to programmable controllers and their associated peripherals.

This document's intent is to follow the IEC 61508 series structure, in principle. But some aspects do not have a direct correlation and thus need to be addressed somewhat differently. In part, this is due to addressing hardware, software, firmware, etc. in a single document.

Framework of this part

IEC 61508-1:2010, Figure 2 is included here, and is designated Figure 1. It has been adjusted to show how an FS-PLC fits into the overall E/E/PE safety-related system safety lifecycle. Though Figure 1 box 10 includes sensors, logic subsystem and final elements (e.g. actuators), from the viewpoint of IEC 61508-1, the FS-PLC is given emphasis here by including a reference to Figure 3.

As such, the Realization Phase, Figure 1, box 10, embodies only the logic subsystem, from this part's perspective.

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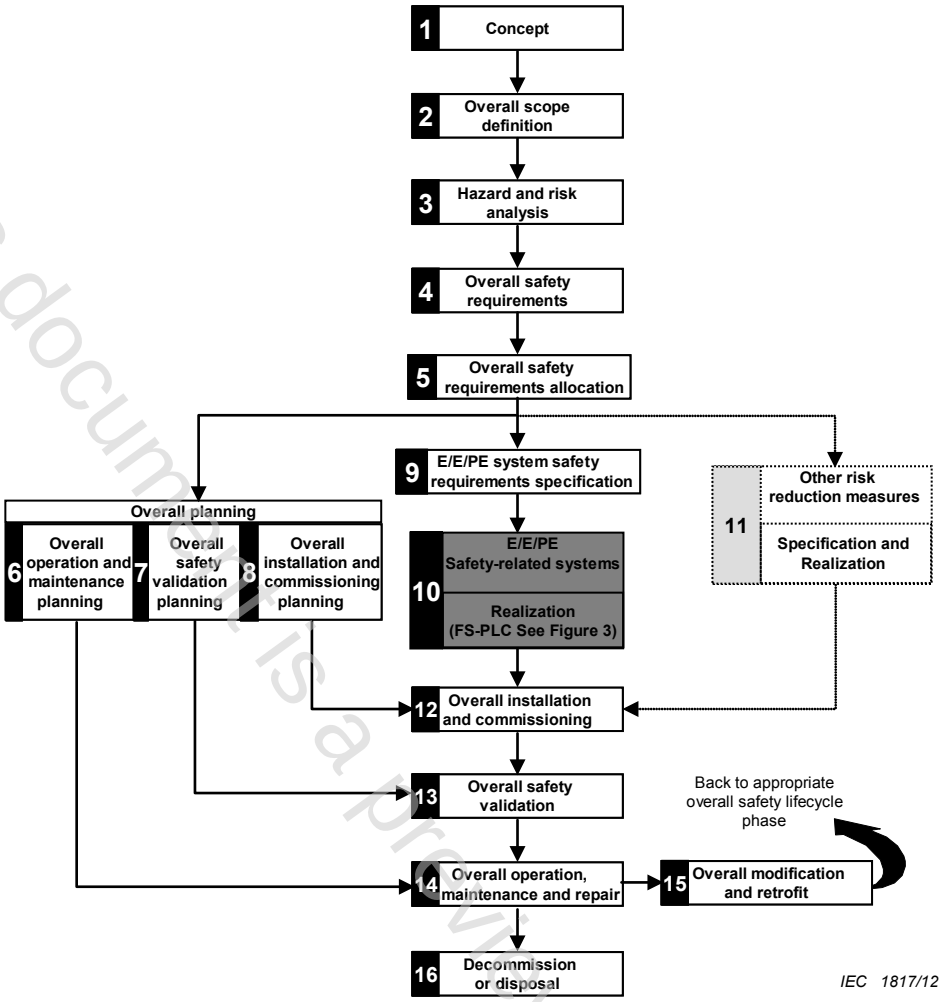

NOTE 1 Activities relating to verification, management of functional safety and functional safety assessment are not shown for reasons of clarity but are relevant to all overall, E/E/PE system and software safety lifecycle phases.

NOTE 2 The phases represented by box 11 is outside the scope of this standard.

NOTE 3 IEC 61508-2 and IEC 61508-3 deal with box 10 (realization) but they also deal, where relevant, with the programmable electronic (hardware and software) aspects of boxes 13, 14 and 15.

NOTE 4 See IEC 61508-1, Table 1 for a description of the objectives and scope of the phases represented by each box.

NOTE 5 The technical requirements necessary for the overall operation, maintenance, repair Modification, retrofit and decommissioning or disposal will be specified as part of the information provided by the supplier of the E/E? PE safety-related system and its elements and components.

Figure 1 – FS-PLC in the overall E/E/PE safety-related system safety lifecycle phases

The areas included in this part are FS-PLC safety lifecycle management, functional safety requirements allocation, and development planning; with the major emphasis on the Realization Phase (Box 10) of the overall safety lifecycle, shown in Figure 1. The assumption of this part is that the FS-PLC is utilized as a logic subsystem for the overall E/E/PE system.

The Figure 1, Realization (box 10), includes:

- the allocation of the FS-PLC safety aspects to FS-PLC hardware, software or firmware, or any combination,
- FS-PLC hardware architectures,
- verification and validation activities at the FS-PLC level,
- FS-PLC modification requirements,
- operation and maintenance information for the FS-PLC user,
- information to be provided by the FS-PLC manufacturer for the user.

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PROGRAMMABLE CONTROLLERS –

Part 6: Functional safety

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1 Scope

This Part of the IEC 61131 series specifies requirements for programmable controllers (PLCs) and their associated peripherals, as defined in Part 1, which are intended to be used as the logic subsystem of an electrical/electronic/programmable electronic (E/E/PE) safety-related system. A programmable controller and its associated peripherals complying with the requirements of this part is considered suitable for use in an E/E/PE safety-related system and is identified as a functional safety programmable logic controller (FS-PLC). An FS-PLC is generally a hardware (HW) / software (SW) subsystem. An FS-PLC may also include software elements, for example predefined function blocks.

An E/E/PE safety-related system generally consists of sensors, actuators, software and a logic subsystem. This part is a product specific implementation of the requirements of the IEC 61508 series and conformity to this part fulfils all of the applicable requirements of the IEC 61508 series related to FS-PLCs. While the IEC 61508 series is a system standard, this part provides product specific requirements for the application of the principles of the IEC 61508 series to FS-PLC.

This Part of the IEC 61131 series addresses only the functional safety and safety integrity requirements of an FS-PLC when used as part of an E/E/PE safety-related system. The definition of the functional safety requirements of the overall E/E/PE safety-related system and the functional safety requirements of the ultimate application of the E/E/PE safety-related system are outside the scope of this part, but they are inputs for this part. For application specific information the reader is referred to standards such as the IEC 61511 series, IEC 62061, and the ISO 13849 series.

This part does not cover general safety requirements for an FS-PLC such as requirements related to electric shock and fire hazards specified in IEC 61131-2.

This part applies to an FS-PLC with a Safety Integrity Level (SIL) capability not greater than SIL 3.

The objective of this part is:

- to establish and describe the safety life-cycle elements of an FS-PLC, in harmony with the general safety life-cycle identified in IEC 61508-1, -2 and -3;
- to establish and describe the requirements for FS-PLC HW and SW that relate to the functional safety and safety integrity requirements of a E/E/PE safety-related system;
- to establish evaluation methods for a FS-PLC to this part for the following parameters/criteria:
  - a Safety Integrity Level (SIL) claim for which the FS-PLC is capable,
  - a Probability of Failure on Demand (PFD) value,
  - an average frequency of dangerous failure per hour value (PFH),
  - a value for the safe failure fraction (SFF),
  - a value for the hardware fault tolerance (HFT),
  - a diagnostic coverage (DC) value,
  - a verification that the specified FS-PLC manufacturer’s safety lifecycle processes are in place,

  - the defined safe state,
  - the measures and techniques for the prevention and control of systematic faults, and
  - for each failure mode addressed in this part, the functional behaviour in the failed state;
- to establish the definitions and identify the principal characteristics relevant to the selection and application of FS-PLCs and their associated peripherals.

This part is primarily intended for FS-PLC manufacturers. It also includes the critical role of FS-PLC users through the user documentation requirements. Some user guidelines for FS-PLCs may be found in IEC 61131-4.

The requirements of ISO/IEC Guide 51 and IEC Guide 104, as they relate to this part, are incorporated herein.

2 Normative references

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

IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC/TS 61000-1-2:2008, *Electromagnetic compatibility (EMC) – Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61131-1:2003, *Programmable controllers – Part 1: General information*

IEC 61131-2:2007, *Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61131-4:2004, *Programmable controllers – Part 4: User guidelines*

IEC 61326-3-1:2008, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for*

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equipment intended to perform safety-related functions (functional safety) – General industrial applications

IEC 61326-3-2:2008, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – Industrial applications with specified electromagnetic environment*

IEC 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-6:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3*

IEC 61784-3:2010, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 62443 (all parts), *Industrial communication networks – Network and system security*

IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:1999, *Safety aspects – Guidelines for their inclusion in standards*

EN 50205:2002, *Relays with forcibly guided (mechanically linked) contacts*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
application program
application software
part of the software of a programmable electronic system that specifies the functions that perform a task related to the EUC rather than the functioning of, and services provided by the programmable device itself

[SOURCE: IEC 61508-4:2010, 3.2.7]

3.2
application specific integrated circuit
ASIC
integrated circuit designed and manufactured for specific function, where its functionality is defined by the product developer

[SOURCE: IEC 61508-4:2010, 3.2.15]

3.3
architecture
specific configuration of hardware and software elements in a system

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