PD CLC/TR 62685:2011

BSI Standards Publication

Industrial communication networks – Profiles – Assessment guideline for safety devices using IEC 61784-3 functional safety communication profiles (FSCPs)

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National foreword

This Published Document is the UK implementation of PD CLC/TR 62685:2011. It is identical to IEC/TR 62685:2010. It supersedes PD IEC/TR 62685:2010, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AMT/7, Industrial communications - process measurement and control, including fieldbus.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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TECHNICAL REPORT

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English version

Industrial communication networks - Profiles - Assessment guideline for safety devices using IEC 61784-3 functional safety communication profiles (FSCPs)

(IEC/TR 62685:2010)

Réseaux de communications industrielles - Profils - Recommandations d'évaluation pour les équipements de sécurité utilisant les profils de sécurité de communication (FSCP) de la CEI 61784-3 (CEI/TR 62685:2010)

Industrielle Kommunikationsnetze - Profile - Beurteilungsleitfaden für Sicherheitsgeräte, die funktional sichere Übertragung nach den Profilen der IEC 61784-3 verwenden (IEC/TR 62685:2010)

This Technical Report was approved by CENELEC on 2011-10-03.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This document (CLC/TR 62685:2011) consists of the text of IEC/TR 62685:2010 prepared by SC 65C, "Industrial networks", of IEC TC 65, "Industrial-process measurement, control and automation".

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC/TR 62685:2010 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:

[2]	IEC 60204-1	NOTE Harmonized as EN 60204-1.
[3]	IEC 60947-5-1	NOTE Harmonized as EN 60947-5-1.
[4]	IEC 61000-4-2	NOTE Harmonized as EN 61000-4-2.
[5]	IEC 61000-4-4	NOTE Harmonized as EN 61000-4-4.
[6]	IEC 61000-4-5	NOTE Harmonized as EN 61000-4-5.
[7]	IEC 61000-4-8	NOTE Harmonized as EN 61000-4-8.
[8]	IEC 61000-4-11	NOTE Harmonized as EN 61000-4-11.
[9]	IEC 61000-4-16	NOTE Harmonized as EN 61000-4-16.
[10]	IEC 61000-4-29	NOTE Harmonized as EN 61000-4-29.
[12]	IEC 61508-1:2010	NOTE Harmonized as EN 61508-1:2010.
[13]	IEC 61508-4:2010	NOTE Harmonized as EN 61508-4:2010.
[14]	IEC 61508-5:2010	NOTE Harmonized as EN 61508-5:2010.
[15]	IEC 61508-7:2010	NOTE Harmonized as EN 61508-7:2010.
[16]	IEC 61158 series	NOTE Harmonized in EN 61158 series.
[17]	IEC 61784-1	NOTE Harmonized as EN 61784-1.
[18]	IEC 61784-2	NOTE Harmonized as EN 61784-2.
[19]	IEC 61800-3	NOTE Harmonized as EN 61800-3.
[20]	IEC 61800-5-2	NOTE Harmonized as EN 61800-5-2.
[21]	IEC 61918	NOTE Harmonized as EN 61918.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

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 60068-2	Series	Environmental testing - Part 2: Tests	EN 60068-2	Series
IEC 60079	Series	Explosive atmospheres	EN 60079	Series
IEC 60300-3-2	-	Dependability management - Part 3-2: Application guide - Collection of dependability data from the field	EN 60300-3-2	-
IEC 60721-3	Series	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities	EN 60721-3	Series
IEC 60721-3-1	-	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 1: Storage	EN 60721-3-1	-
IEC 60721-3-2	-	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation	EN 60721-3-2	-
IEC 60721-3-3	-	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weatherprotected locations	EN 60721-3-3	-
IEC/TS 61000-1-2	-	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 61000-4-3	-	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3	-
IEC 61000-4-6	-	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	-
IEC 61000-6-2	-	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments	EN 61000-6-2	-
IEC 61010	Series	Safety requirements for electrical equipment for measurement, control and laboratory use	EN 61010	Series

Publication	Year	Title	EN/HD	Year
IEC 61131-2	2007	Programmable controllers - Part 2: Equipment requirements and tests	EN 61131-2	2007
IEC 61241	Series	Electrical apparatus for use in the presence of combustible dust	EN 61241	Series
IEC 61326	Series	Electrical equipment for measurement, control and laboratory use - EMC requirements	EN 61326	Series
IEC 61326-1	-	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	EN 61326-1	-
IEC 61326-3-1	-	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	-
IEC 61326-3-2	-	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	-
IEC 61496-1 + A 1	-	Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests	EN 61496-1 + A 1	-
IEC 61508	Series	Functional safety of electrical/electronic/programmable electronic safety-related systems	EN 61508	Series
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 61511	Series	Functional safety - Safety instrumented systems for the process industry sector	EN 61511	Series
IEC 61779	Series	Electrical apparatus for the detection and measurement of flammable gases	EN 61779	Series
IEC 61784-3	Series	Industrial communication networks - Profiles - Part 3: Functional safety fieldbuses - General rules and profile definitions	EN 61784-3	Series
IEC 61784-3	2010	Industrial communication networks - Profiles - Part 3: Functional safety fieldbuses - General rules and profile definitions	EN 61784-3	2010

Publication	Year	Title	EN/HD	Year
IEC 62013	Series	Caplights for use in mines susceptible to firedamp	EN 62013	Series
IEC 62061	-	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	EN 62061	-
IEC 62086-1	-	Electrical apparatus for explosive gas atmospheres - Electrical resistance trace heating - Part 1: General and testing requirements	EN 62086-1	-
ISO 13849-1	-	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design	EN ISO 13849-1	-

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TECHNICAL REPORT

Industrial communication networks – Profiles – Assessment guideline for safety devices using IEC 61784-3 functional safety communication profiles (FSCPs)

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

Assessment guideline for safety devices using IEC 61784-3 functional safety communication profiles (FSCPs)

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, Publicly Available Specifications (PAS) 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.
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The main task of IEC 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 62685, which is a technical report, has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

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

Enquiry draft	Report on voting
65C/610/DTR	65C/626/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 the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

During the development of IEC 61784-3:2010, the need was recognized for a separate document covering environmental tests, proofs and information checks, which were currently specified in the German document GS-ET-26 [37][1]. This document has been one of the starting points for IEC 61784-3 and most of its contents have been already taken into account in IEC 61784-3. The material related to environmental tests, proofs and information checks has been transformed, updated and supplemented into this new document.

NOTE IEC 61784-3 explains the relevant principles for functional safety communications with reference to IEC 61508 series and specifies several safety communication layers (profiles and corresponding protocols) based on the communication profiles and protocol layers of IEC 61784-1, IEC 61784-2 and the IEC 61158 series.

The combination of the IEC 61508 series[2], with its new view on complete safety functions, and of the FSCPs in the IEC 61784-3 series, eases the implementation of safety functions. Further benefits can be achieved, if the environmental conditions can be defined and harmonized for FSCP devices.

The objective of this document is to specify the requirements for FSCP devices on how to fulfill environmental and deployment conditions. It addresses the needs of designers, manufacturers, assessment bodies, and test laboratories.

Figure 1 provides a basic overview on safety functions, FSCP devices and the impact of the environment. It demonstrates the necessity of harmonized environmental requirements.

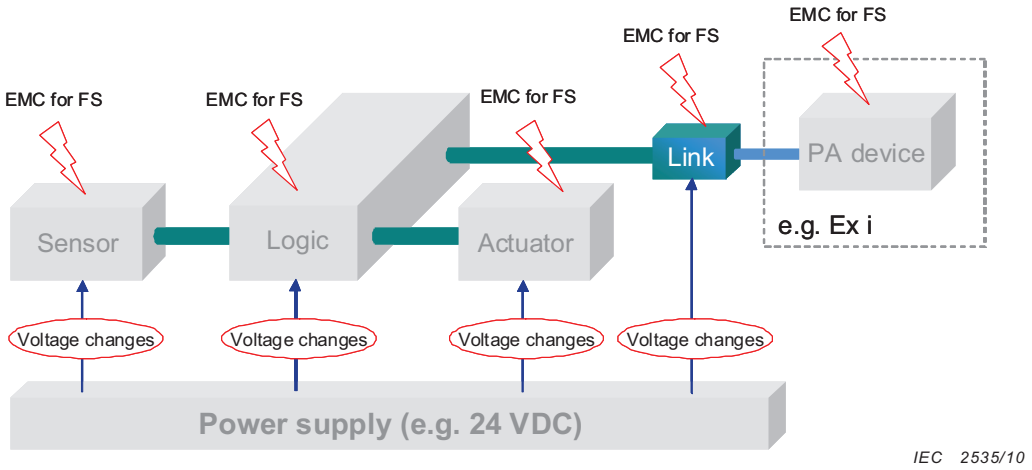

Figure 1 – Environmental view on safety functions

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1 Numbers in square brackets refer to the Bibliography.

2 In this Technical Report, “IEC 61508” is used for “IEC 61508 series”.

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

Assessment guideline for safety devices using IEC 61784-3 functional safety communication profiles (FSCPs)

1 Scope

This Technical Report provides information about the assessment aspects of safe communication such as test beds, proof of increased interference immunity (EMC for functional safety), electrical safety, and other environmental requirements.

This document is only applicable to safety devices for functional safety communication which are developed according to IEC 61508 and IEC 61784-3.

NOTE This document does not cover the more complex aspects of preserving existing devices and applications in the field and migration from safety rules before IEC 61508.

The scope covers general industrial environments such as defined in IEC 61131-2 or IEC 61000-6-2 and process automation environments such as those covered in the IEC 61326 series.

Reference is made to the ERS (Equipment Requirements Specification) and/or SRS (Safety Requirements Specification) of a particular safety application to verify the necessary immunity of devices and systems according to IEC 61508.

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 60068-2 (all parts)[3], *Environmental testing – Part 2-x: Tests*

IEC 60079 (all parts)[3], *Explosive atmospheres*

IEC 60300-3-2, *Dependability management – Part 3-2: Application guide – Collection of dependability data from the field*

IEC 60721-3 (all parts)[3], *Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities*

IEC 60721-3-1, *Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 1: Storage*

IEC 60721-3-2, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

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3 Relevant parts of the series depend on the context – see detailed requirements in the following clauses.

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

IEC/TS 61000-1-2*, 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 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated radio-frequency electromagnetic field immunity test*

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

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61010 (all parts)[4], *Safety requirements for electrical equipment for measurement, control, and laboratory use*

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

IEC 61241 (all parts)[4], *Electrical apparatus for use in the presence of combustible dust*

IEC 61326 (all parts)[4], *Electrical equipment for measurement, control and laboratory use – EMC requirements*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61326-3-1, *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*

IEC 61326-3-2, *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 61496-1, *Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests*

IEC 61496-1, Amendment 1 (2007)

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

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*

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4 Relevant parts of the series depend on the context – see detailed requirements in the following clauses.

IEC 61511 (all parts), *Functional safety – Safety instrumented systems for the process industry sector*

IECEx 61779-x (all parts), *IECEx Test Report for IEC 61779-x (1998) ed 1.0 – Electrical apparatus for the detection and measurement of flammable gases*

IEC 61784-3 (all parts)[5], *Industrial communication networks – Profiles – Functional safety fieldbuses*

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

IEC 62013 (all parts)[5], *Caplights for use in mines susceptible to firedamp*

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IECEx 62086-1, *IECEx Test Report for IEC 62086-1 (2001) ed 1.0 – Electrical apparatus for explosive gas atmospheres – Electrical resistance trace heating – Part 1: General and testing requirements*

ISO 13849-1, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
communication system
arrangement of hardware, software and propagation media to allow the transfer of *messages* (ISO/IEC 7498 application layer) from one application to another

3.1.2
error
discrepancy between a computed, observed or measured value or condition and the true, specified or theoretically correct value or condition

[IEC 61508-4:2010], [IEC 61158]

NOTE 1 Errors may be due to design mistakes within hardware/software and/or corrupted information due to electromagnetic interference and/or other effects.

NOTE 2 Errors do not necessarily result in a *failure* or a *fault*.

3.1.3
failure
termination of the ability of a functional unit to perform a required function or operation of a functional unit in any way other than as required

NOTE 1 The definition in IEC 61508-4 is the same, with additional notes.

[IEC 61508-4:2010, modified], [ISO/IEC 2382-14.01.11, modified]

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5 Relevant parts of the series depend on the context – see detailed requirements in the following clauses.

NOTE 2 Failure may be due to an *error* (for example, problem with hardware/software design or message disruption).

3.1.4
fault
abnormal condition that may cause a reduction in, or loss of, the capability of a functional unit to perform a required function

NOTE IEV 191-05-01 defines "fault" as a state characterized by the inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.

[IEC 61508-4:2010, modified], [ISO/IEC 2382-14.01.10, modified]

3.1.5
fieldbus
communication system based on serial data transfer and used in industrial automation or process control applications

3.1.6
hazard
state or set of conditions of a system that, together with other related conditions will inevitably lead to harm to persons, property or environment

3.1.7
message
ordered series of octets intended to convey information

[ISO/IEC 2382-16.02.01, modified]

3.1.8
performance level (PL)
discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions

[ISO 13849-1]

3.1.9
risk
combination of the probability of occurrence of harm and the severity of that harm

NOTE For more discussion on this concept see Annex A of IEC 61508-5:2010.

[IEC 61508-4:2010], [ISO/IEC Guide 51:1999, definition 3.2]

3.1.10
safety communication layer (SCL)
communication layer that includes all the necessary measures to ensure safe transmission of data in accordance with the requirements of IEC 61508

3.1.11
safety data
data transmitted across a safety network using a safety protocol

NOTE The safety communication layer does not ensure safety of the data itself, only that the data is transmitted safely.

3.1.12
safety device
device designed in accordance with IEC 61508 and which implements the functional safety communication profile

3.1.13
safety function
function to be implemented by an E/E/PE safety-related system or other risk reduction measures, that is intended to achieve or maintain a safe state for the EUC, in respect of a specific hazardous event

NOTE The definition in IEC 61508-4 is the same, with an additional example and reference.

[IEC 61508-4:2010, modified]

3.1.14
safety function response time
worst case elapsed time following an actuation of a safety sensor connected to a fieldbus, before the corresponding safe state of its safety actuator(s) is achieved in the presence of errors or failures in the safety function channel

NOTE This concept is introduced in IEC 61784-3:2010, 5.2.4 and addressed by the functional safety communication profiles defined in the other parts of the IEC 61784-3 series.

3.1.15
safety integrity level (SIL)
discrete level (one out of a possible four), corresponding to a range of safety integrity values, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

NOTE 1 The target failure measures (see IEC 61508-4:2010, 3.5.17) for the four safety integrity levels are specified in Tables 2 and 3 of IEC 61508-1:2010.

NOTE 2 Safety integrity levels are used for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems.

NOTE 3 A safety integrity level (SIL) is not a property of a system, subsystem, element or component. The correct interpretation of the phrase “SILn safety-related system” (where n is 1, 2, 3 or 4) is that the system is potentially capable of supporting safety functions with a safety integrity level up to n.

[IEC 61508-4:2010]

3.1.16
safety measure
<this standard> measure to control possible communication *errors* that is designed and implemented in compliance with the requirements of IEC 61508

NOTE 1 In practice, several safety measures are combined to achieve the required safety integrity level.

NOTE 2 Communication *errors* and related safety measures are detailed in IEC 61784-3:2010, 5.3 and 5.4.

3.1.17
safety-related application
programs designed in accordance with IEC 61508 to meet the SIL requirements of the application

3.1.18
safety-related system
system performing *safety functions* according to IEC 61508

3.2 Symbols and abbreviations

EMC Electromagnetic Compatibility

EMF Electromagnetic Field

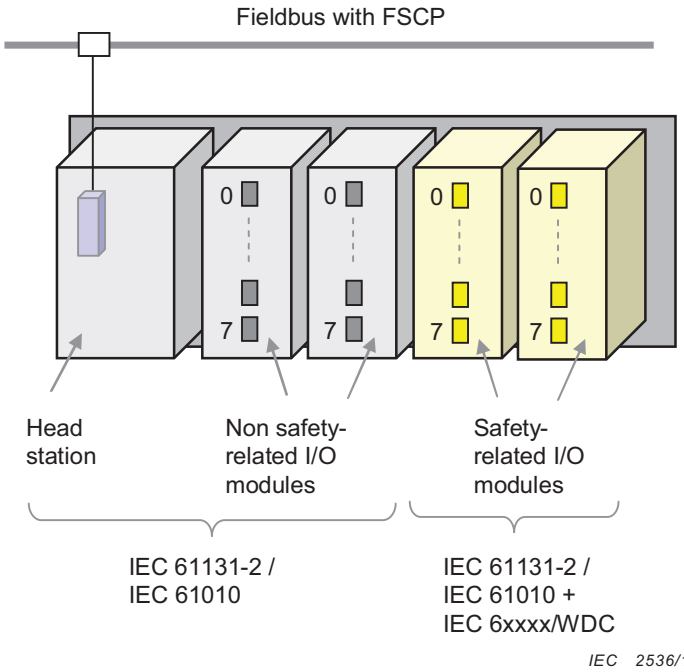
ESD Electrostatic Discharge

EUC Equipment Under Control [IEC 61508-4:2010]

EUT	Equipment Under Test	
E/E/PE	Electrical/Electronic/Programmable Electronic	[IEC 61508-4:2010]
FS	Functional Safety	
FSCP	Functional Safety Communication Profile	
IP	Ingress Protection	
PC	Performance Criterium	
PDS	Power Drive System	
PL	Performance Level	[ISO 13849-1]
RF	Radio Frequency	
SIL	Safety Integrity Level	[IEC 61508-4:2010]
SR	Safety Relevant	

4 General

As a general rule, the environmental and electrical safety requirements should be the same as for non-safety devices, except EMC, where more stringent requirements apply (see Clause 11). Thus, designers and users are not forced to consider many different standards. IEC 61131-2 is such a standard that is considered to provide minimum requirements for non-safety and for safety fieldbus devices, as well as for devices combining non-safety and safety modules (see Figure 2). More specific or stringent requirements may be defined by sector, application specific, or product standards.



NOTE The relative positions of safety and non safety modules shown here are only examples.

Figure 2 – Example of a mixed module remote I/O

This guideline applies to general industrial environments such as defined in IEC 61131-2 or IEC 61000-6-2 and process automation environments such as those covered in the IEC 61326 series (see Table 1).

Table 1 – Overview of the environmental tests for safety devices

Issue	Factory automation (machinery, industrial environments such as defined in IEC 61000-6-2)	Process automation (specified electromagnetic environment)	Remarks
Test bed and operations	See Clause 5	See Clause 5 Extensions of the test bed for intrinsically safe fieldbus physics	Concepts include but are not limited to barriers, FISCO (Fieldbus Intrinsically Safe Concept), etc.
General test conditions	See Clause 6	See Clause 6 Depending on the deployment area: See classification in the IEC 60721-3 series	
Climatic tests	See Clause 7	See Clause 7, classifications in IEC 60721-3-3	
Mechanical tests	See Clause 8, IEC 61131-2	See Clause 8, classifications in IEC 60721-3-1	
Markings and identification	See Clause 9	See Clause 9	
User manual	See Clause 10	See Clause 10	
Electromagnetic immunity	See Clause 11 IEC 61326-3-1 with special requirements in IEC 61496-1	See Clause 11 IEC 61326-3-2	See Figure 4 for selection of the appropriate standard
Electrical safety	See Clause 12	See Clause 12	
Ingress protection (IP)	See 12.2	See 12.2, type "field device" shall be ≥ IP65, other types ≥ IP20	
Insulation rating	See 12.3	See NOTE	
Electrical shock	See 12.4	See 12.4	
Clearance and creepage distances	See 12.5	See NOTE	
Flame-retardancy	See 12.6	See NOTE	
Suitability of components	See Clause 13	See Clause 13	
Simple circumvention	See Clause 14	See Clause 14	
Explosive atmosphere	-	See Clause 15	
Field verification	-	See Clause 16	SIL2 devices designed to achieve SIL3 via e.g. 1oo2 shall have software designed for SIL3
Product, sector and application specific requirements	See Annex B	See Annex B	
NOTE Usually no requirements, exceptions possible depending on deployment.			

5 Test bed and operations

As far as feasible, all parts of a safety bus system shall be tested together. Otherwise, parts of a safety bus system can be tested separately. In this case, reference systems (test beds) or simulators shall be defined by the particular FSCPs and made available. Effectiveness of all implemented safety measures as well as conformance to a particular FSCP shall be proved by the test bed software.

A test bed shall be chosen that takes into account worst case conditions, for example shortest possible connections of devices. Signals that are required for the safety function shall be emulated.

Relevant operational modes shall be defined such as cyclic data exchange of safety process values or acyclic data exchange of safety parameterization data.

Figure 3 shows an example test bed for EMC and other testing. It is highly recommended for FSCPs to define their appropriate test beds in order to achieve situations close to worst case topologies and repeatable and comparable test results. In addition, it is highly recommended to specify the critical network operations during testing.

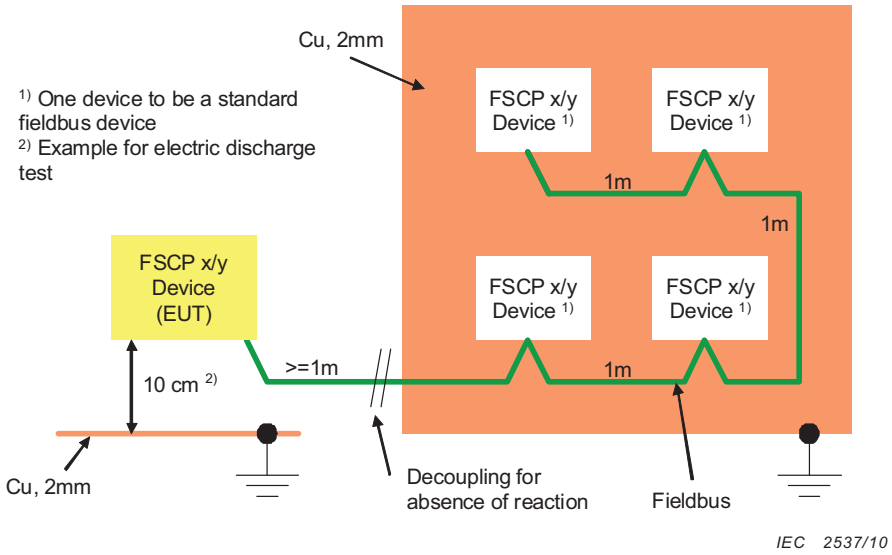


Figure 3 – Example test bed for EMC and other testing

6 General test conditions

During the tests, the equipments under test (EUT) shall be operated at the test conditions outlined in the product documentation or at the conditions defined by the particular safety communication profile.

Default test conditions are specified in Table 2.

Table 2 – General test conditions

Item	Test conditions
Equipment power supply	Rated voltage and frequency
Temperature	15 °C to 35 °C
Relative humidity	≤ 75 %
Barometric pressure	86 kPa to 106 kPa
Outputs	Rated load
Pollution (see 12.5)	Pollution degree 2 (temporarily through condensation)

The tests shall ensure that the safety bus system meets the specified technical data. At the beginning of each test sequence, the correct operation of the equipment under test shall be verified. Objective of the tests is to proof that the equipment under test performs during all the tests according to its safety-related specifications.

The test criteria are (amongst others):

- Operation of the equipment under test as intended in the technical specifications
- No destruction of components in the equipment under test (except EMC)
- No faulty or unexpected operation of the equipment under test (except EMC)
- No indications of overheating of any component
- No active part that intentionally carries dangerous voltages shall be touchable
- No damage to the housing

Uncertainties of measurement shall not exceed the following limits:

- for the measurement of reaction times: ±1 ms
- for temperature measurements: ±3 K
- for electrical measurements: ±1 %, as far as technically feasible and sensible
- for the measurement of relative humidity (RH): ±3 % RH

All measurements shall be carried out after stable temperature conditions have been reached. This can be assumed when the temperature increase or decrease is less than 2 K/h.

7 Climatic tests

Climatic tests concern dry heat, cold, and cyclic damp heat withstand according to IEC 61131-2.

Safety devices intended for safety instrumented systems (process automation) are classified according to IEC 60721-3-3 and tested according to applicable parts of the IEC 60068-2 series.

Assessment: Inspections of information provided by the manufacturer and/or tests shall be carried out.

8 Mechanical tests

All components of bus systems for the transmission of safety data shall have a sufficient mechanical strength against the expected stresses, for example vibration, shock, impact, and rigidity according to IEC 61131-2.

For components intended to be mounted on vibrating machinery, extended tests shall be applied according to the individual safety requirement specification or to an applicable product standard.

NOTE An example of such applicable product standards is IEC 61496-1 (electro-sensitive protective equipment).

Safety devices intended for safety instrumented systems (process automation) are classified according to IEC 60721-3-2 and shall be tested according to the IEC 60068-2 series.

Assessment: Mechanical tests shall be carried out according to the standards specified in this subclause, or more stringent standards specified by the manufacturer in accordance with the application scope. Performance criterion A applies.

9 Markings and identification

The safety components shall be marked according to IEC 61131-2 and/or relevant parts of the IEC 61010 series.

The minimum size of symbols, letters and figures shall be 2 mm. The inscriptions shall be durable.

Assessment: Inspection/measurement of the inscriptions (completeness, correctness, unambiguity), rubbing each for 15 s with a water and a gasoline soaked cloth; afterwards, the inscriptions shall be clearly legible, labels shall not be detached.

10 User manual

The EUT shall come with a user manual that allows for proper installation, configuration, parameterization, programming, commissioning, troubleshooting, maintenance, and decommissioning. It shall consider and cover all the appropriate issues listed in:

- IEC 61131-2, Clause 7 (general information to be provided by the manufacturer);
- IEC 61508-2:2010, Annex D (safety manual for compliant items);
- IEC 61508-3:2010, 7.4.2.12 and Annex D (safety manual for compliant items, additional requirements for software elements);
- IEC 61784-3-x, 9.7 (safety manual of a particular safety communication profile).

These documents require, as far as applicable, the following items:

a) Intended use
b) Name of the manufacturer (brand, picture mark)
c) Type designation or serial number
d) Nominal operating voltage(s) with indication of voltage type and frequency
e) Power/current consumption
f) SIL claim according IEC 61508. In case of factory automation additionally PL/Category according to ISO 13849-1 (successor of EN 954-1 [28]).
g) Statements on parameterization, configuration and programming as far as required
h) Advice on how to determine the safety function response times and/or maximum reaction time(s) as required for example by IEC 61784-3 profiles
i) Required short circuit and overvoltage protection means, as far as applicable
j) Operating temperature range
k) Ingress protection class (IPxy); if required, separate statements on the individual components
l) Rated insulation voltages and the degree of pollution
m) Required wiring and functional description of wiring blocks and connectors
n) Required safety instructions
o) Instructions on how to act in case of faults
p) Proof tests and proof test interval for the safety device

Assessment: Inspection of supplied technical information; check for completeness, correctness and unambiguity.

11 Electromagnetic immunity

11.1 Test bed for EMC testing

See Clause 5.

11.2 Existing EMC standards for functional safety

IEC 61784-3 recommends using IEC 61326-3-1 and IEC 61326-3-2 for electromagnetic immunity requirements.

Figure 4 illustrates the different scopes of these two standards. IEC 61326-3-1 is related to the machinery related part of an automation application (for example upstream logistics and downstream logistics), whereas IEC 61326-3-2 is related to the process automation part (production process) with specified electromagnetic environment, for example Ex-i.

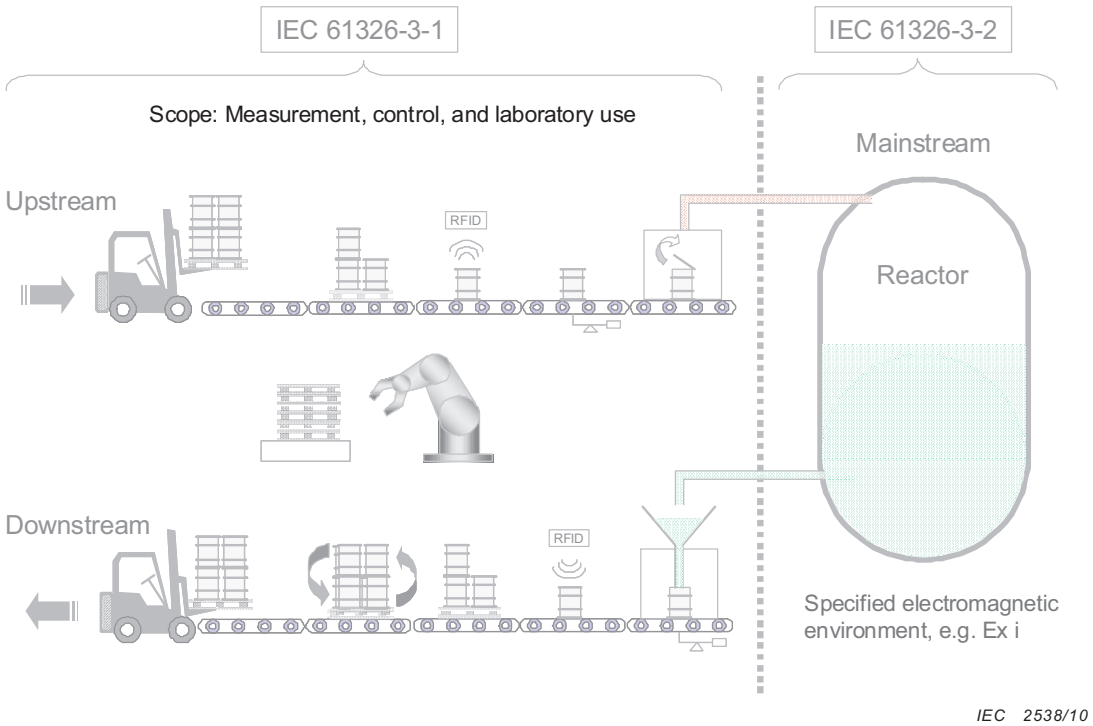


Figure 4 – Example of application areas within an automation application

NOTE In order to generalize the application of IEC 61326-3-1, work on the new generic standard IEC 61000-6-7 (see [11]) has been initiated. This standard will cover EMC requirements for functional safety. This Technical report will be updated when IEC 61000-6-7 is published.

11.3 Phase *I* testing (normal immunity)

The EMC tests defined in IEC 61326-3-1 consist of two phases. In phase *I* the correct function of a safety EUT shall be tested at the test levels and durations defined in IEC 61326-1 for non-safety devices. This proposal differs from IEC 61326-3-1. Due to more stringent requirements in IEC 61000-6-2 than those stated in IEC 61326-1, IEC 61000-6-2 shall be used for phase *I* EMC testing. Few of the levels and durations are slightly deviating from IEC 61326-1 (see comparison table in Annex A). The performance criteria for phase *I* are the same in both standards:

- Performance criterion **A**: The device under test shall continue to operate as intended during and after the test within the specified ranges;
- Performance criterion **B**: During testing, temporary degradation, or loss of function or performance which is self-recovering;

- Performance criterion **C**: During testing, temporary degradation, or loss of function or performance which requires operator intervention or system reset occurs.

In contrast to IEC 61326-3-1, this proposal excludes performance criterion C as an option for safety functions during phase *I* testing except in case of power supply voltage changes.

Figure 5 shows the generic concept for phase *I* and *II* testing. In phase *II* the equipment is tested with increased test levels and durations according to IEC 61326-3-1 ("increased immunity" according to IEC 61508).

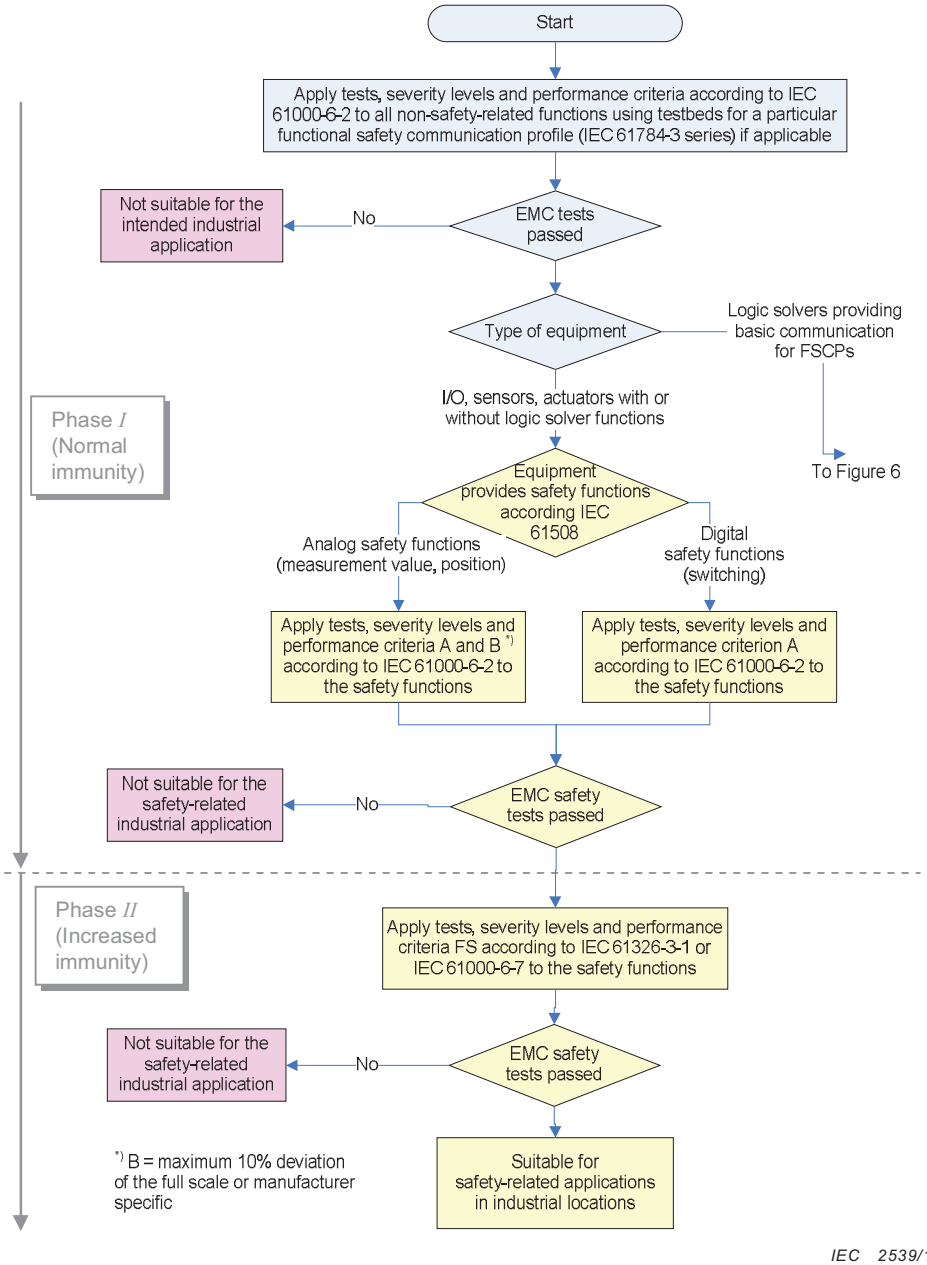


Figure 5 – Generic procedural model for safety EMC testing (part 1)

This document differentiates between equipment directly exposed to the automation process such as remote input/out devices, sensors, and actuators (with or without logic solver functions) and logic solvers that are only processing data (including safety data). This document further differentiates for sensors and actuators between digital safety functions such as tripping, shut-down, stand-still, and analog safety functions such as measurement sensors or safe operating stop with drives. For digital safety functions only performance criterion A is permitted (a motor shall not start in any case). For analog safety functions

performance criteria A or B are permitted, with a maximum deviation of 10 % of the full scale. In case of combined analog and digital safety data in one message, the tests can be performed in one step. However, the different performance criteria for analog and digital safety functions shall be observed. Device manufacturers can specify more stringent deviations.

Figure 6 shows the logic solver related part of the generic procedural model for safety EMC testing. This testing shall be achieved by implementing one of two possible options:

- option 1 based on phase *I* and *II* testing; or,
- option 2 based on a proof of immunity through appropriate analytical evidence.

NOTE For example option 2 is more suitable for safety logic solver software solutions used on general purpose industrial computer platforms, while option 1 is suitable for dedicated combinations of safety hardware and software.

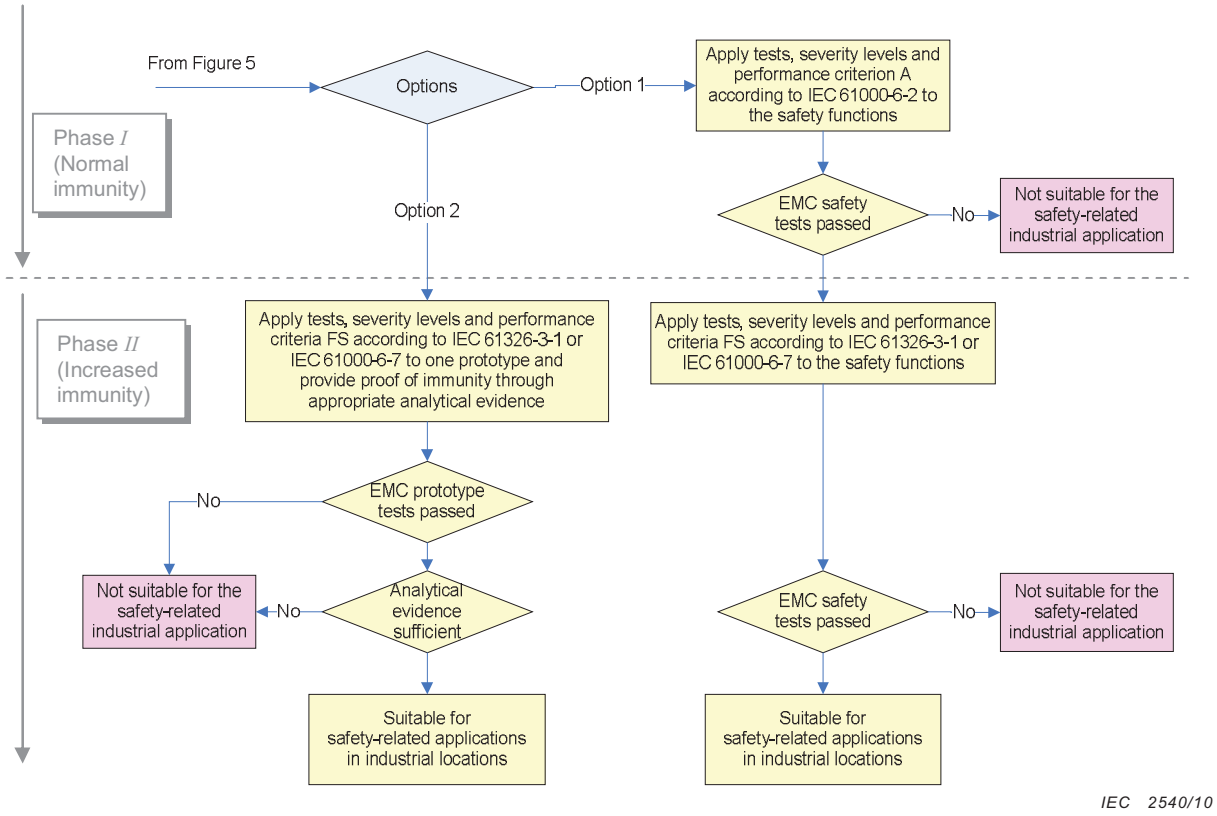


Figure 6 – Generic procedural model for safety EMC testing (part 2)

Generalized performance criteria **A**, **B** and **C** as defined in IEC 61000-6-2 are not related to functional safety aspects and should therefore not be used as performance criteria in test phase *II* with increased test levels and durations.

11.4 Phase *II* testing (increased immunity)

A specific performance criterion has been defined taking into account functional safety aspects. This performance criterion, FS, is defined in IEC 61326-3-1 or IEC/TS 61000-1-2 as follows:

- The functions of the equipment under test (EUT) intended for safety applications are not affected outside their specification, or
- The functions of the equipment under test (EUT) intended for safety applications may be affected temporarily or permanently if the EUT reacts to a disturbance in a way that detectable, defined state or states of the EUT are
  - maintained or,

  - achieved within a stated time.
- Also destruction of components is allowed if a defined state of the EUT is
  - maintained or,
  - achieved within a stated time.

The functions not intended for safety-related applications may be disturbed temporarily or permanently as defined in IEC 61326-3-1.

11.5 Rules

- The generic EMC standard IEC 61000-6-2 already requires 10 V for the conducted RF test according IEC 61000-4-6 with a performance criterion A. Thus, the increased immunity test level in this case shall be raised to 20 V (performance criterion FS) instead of the level defined in IEC 61326-3-1.
- In case EMC product or sector standards for factory automation (safety for machinery) require lower test levels or shorter duration of tests than those defined in IEC 61326-3-1, the manufacturer of an EUT shall specify, how the increased immunity levels and durations of IEC 61326-3-1 (including the exception of 20 V for conducted RF) can be achieved via cabinets, optional shielding, or other auxiliary means (mitigation). Figure 7 shows an example of how a control cabinet can be used for EMC testing. For all tests the doors of the cabinet can be closed except for the high frequency field test according to IEC 61000-4-3.

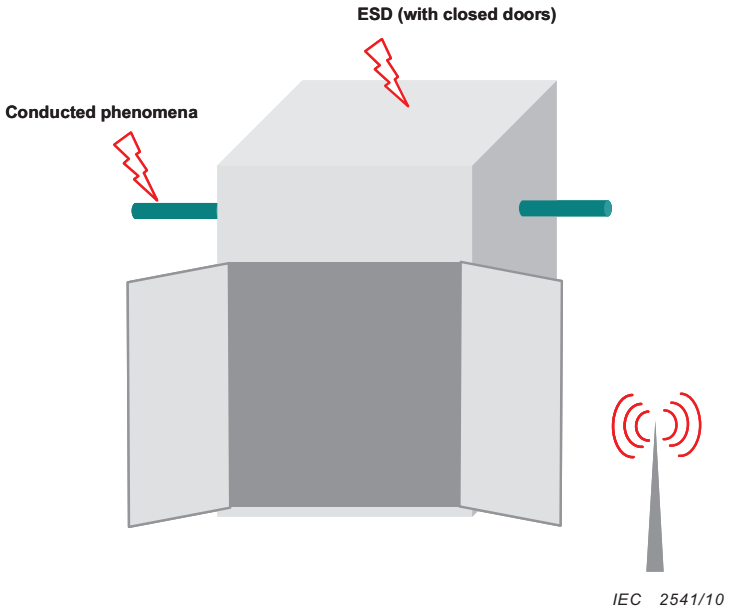


Figure 7 – EMC mitigation using a cabinet

Assessment: Performance of EMC tests while using test beds as defined by the particular safety communication profile. Check of documentation on analytical evidence if applicable (option 2 only). If product standards with more stringent test levels and durations apply, those instructions shall be observed.

12 Electrical safety

12.1 General

The requirements in this section cover electrical safety for FSCP safety devices and should not differ from the requirements for non-safety field devices. Thus, Clause 11 of IEC 61131-2:2007 is the primary source for electrical safety requirements, additional product specific standards may be found in relevant parts of the IEC 61010 series.

12.2 Ingress protection (IP)

All components of bus systems for the transmission of safety data shall be designed such that they withstand the normal environmental conditions of the intended use. Ingress protection shall be ≥ IP20 according to IEC 61131-2.

Safety devices intended for safety instrumented systems (process automation) are classified according to the IEC 60721-3 series. The ingress protection for type "field device" shall be ≥ IP65, other types ≥ IP20.

Assessment: Inspections of information provided by the manufacturer and/or tests shall be carried out.

12.3 Insulation rating

All components of bus systems for the transmission of safety data shall have insulation ratings according to the equipment classes in IEC 61131-2 or relevant parts of the IEC 61010 series.

Assessment: Inspections of information provided by the manufacturer shall be carried out according to the standards specified in this subclause.

12.4 Electrical shock

All components of bus systems for the transmission of safety data shall provide protection against electrical shock according to IEC 61131-2 or relevant parts of the IEC 61010 series.

Assessment: Inspections of information provided by the manufacturer and/or tests shall be carried out, in particular

- Inspection of the technical documentation and comparison with the equipment under test
- Test with jointed test fingers; measurement of openings and distances
- Measurement of currents to ground.

12.5 Clearance and creepage distances

The clearance and creepage distances shall be designed according to IEC 61131-2 or relevant parts of the IEC 61010 series.

Assessment: Inspections of information provided by the manufacturer shall be carried out.

12.6 Flame-retardancy

Insulating parts shall be sufficiently heat- and fire proof as specified in IEC 61131-2.

Assessment: Inspections of information provided by the manufacturer and/or tests shall be carried out.

13 Suitability of components

All components of bus systems in use for the transmission of safety data shall:

- Comply with existing standards and the requirements of a particular functional safety fieldbus profile
- Be suitable for the intended use
- Be operated within their specified limits

Assessment: Inspection; if applicable: calculations according IEC 62061 and/or ISO 13849-1 and comparison with technical data

14 Simple circumvention

All components of bus systems for the transmission of safety data shall provide measures against simple circumvention of safety functions, for example password protection of separate engineering software.

Assessment: Inspection, plausibility check.

15 Explosive atmosphere

Devices intended for use in explosive atmosphere shall be designed according to the relevant standards within the IEC 60079 series, the IEC 61241 series, the IEC 61779 series, the IEC 62013 series, and/or IEC 62086-1.

Assessment: Inspections of IECEx or ATEX assessment reports provided by the manufacturer shall be carried out.

16 Field verification (process automation devices)

Special procedures are required for field devices in process automation that are intended for use in safety instrumented systems as laid down in the IEC 61511 series. Additionally to the error and failure aspects associated with software and electronics known with safety devices for factory automation or machinery, these process automation devices are exposed to the media they are expected to measure and/or control (Figure 8).

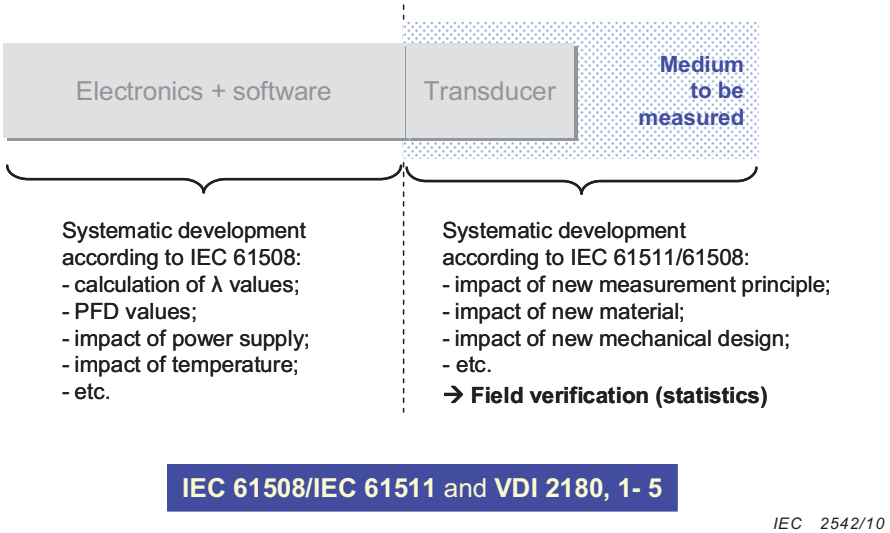


Figure 8 – Justification for field verification with process automation devices

Case 1: For devices with a new or changed type of transducer (see Figure 8) and, developed according to IEC 61508 and, assessed by a competent body, it is highly recommended to establish a period of field verification (experience). This verification shall comprise at least 10 devices within several different applications and last for at least six months in continuous operation.

NOTE Instructions on possible procedures can be found in IEC 61508-7 or within consortia in [40].

Manufacturers need to arrange for this field verification with their customers to obtain problem reports with the help of forms agreed upon by the competent body (see IEC 60300-3-2). These reports for the particular safety device will be delivered to the competent body, which in turn will confirm the successful field verification.

Case 2: For safety devices with "proven-in-use" transducers assessed entirely according to IEC 61508, it is possible to omit this field verification.

Assessment: Inspections of information provided by the manufacturers/user organizations and/or tests shall be carried out.

Annex A
(informative)

Comparison of immunity levels in several IEC standards

Table A.1 provides a comparison of immunity levels in several IEC standards.

NOTE The content of this Annex does not provide an exhaustive list.

Table A.1 – Comparison of immunity levels

Phenomenon	Basic standard	IEC 61131-2 Ind. App. Zone B	PC	IEC 61000-6-2 Ind. app. generic	PC	IEC 61800-3 Variable speed drive	PC	IEC 61326-1 Industrial location	PC	IEC 61326-3-1 Industrial location	PC	IEC 61000-6-7 Ind. app. generic	PC	IEC 61800-5-2 IFA Test PDS(SR)	PC	NOTES
ESD	IEC 61000-4-2	4/8 kV	B	4/8 kV	B	4/8 kV	B	4/8 kV	B	6/8 kV (x3)	FS	6/8 kV (x3)	FS	6/**15 kV** (x?)	FS	(x3) = No. of discharges (SIL3)
EMF	IEC 61000-4-3															
80 MHz - 1 GHz 1,4 GHz - 2 GHz 2 GHz - 2,7 GHz	(Enclosure)	10 V/m 3 V/m 1 V/m	A	10 V/m 3 V/m 1 V/m	A	10 V/m 3 V/m 1 V/m	A	10 V/m 3 V/m 1 V/m	A	**20 V/m** 10 V/m 3 V/m	FS	**20 V/m** 10 V/m 3 V/m	FS	**20 V/m** 10 V/m 3 V/m	FS	
Burst	IEC 61000-4-4															
AC Power		2 kV	B	2 kV	B	2kV	B	2 kV	B	3 kV (x5)	FS	3 kV (x5)	FS	4 kV (x?)	FS	(x5) = Duration of test (SIL3)
DC Power		2 kV	B	2 kV	B	**1kV**	B	2 kV	B	3 kV (x5)	FS	3 kV (x5)	FS	2 kV (x?)	FS	
I/O Signal + FE		1 kV	B	1 kV	B	1kV/2kV	B	1 kV	B	2 kV (x5)	FS	2 kV (x5)	FS	2 kV/ 4 kV (x?)	FS	
I/O Signal + PS		2 kV	B	––	––	—	––	2 kV	B	3 kV (x5)	FS	3 kV (x5)	FS	—	––	

Phenomenon	Basic standard	IEC 61131-2 Ind. App. Zone B	PC	IEC 61000-6-2 Ind. app. generic	PC	IEC 61800-3 Variable speed drive	PC	IEC 61326-1 Industrial location	PC	IEC 61326-3-1 Industrial location	PC	IEC 61000-6-7 Ind. app. generic	PC	IEC 61800-5-2 IFA Test PDS(SR)	PC	NOTES
Surge	IEC 61000-4-5															
AC Power		1 kV/2 kV	B	1 kV/2 kV	B	1 kV/2 kV	B	1 kV/2 kV	B	2 kV/4 kV (x3)	FS	2 kV/4 kV (x3)	FS	2 kV/4 kV (x?)	FS	(x3) = Number of pulses (SIL3)
DC Power		**0,5 kV**	B	**0,5 kV**	B	––	––	1 kV/2 kV	B	1 kV/ 2 kV (x3)	FS	1 kV/2 kV (x3)	FS	**0,5 kV** (x?)	FS	
I/O Signal		1 kV	B	1 kV	B	1 kV	––	1 kV	B	2 kV (x3)	FS	2 kV (x3)	FS	2 kV (x?)	FS	
I/O Signal + PS		1 kV/2 kV	B	—	––	––	––	1 kV/2 kV	B	2 kV/ 4 kV (x3)	FS	2 kV/4 kV (x3)	FS	—	––	
Conducted RF	IEC 61000-4-6															
AC Power		**10 V**	A	**10 V**	A	10 V	A	3 V	A	10 V	FS	**20 V**	FS	20 V (x?)	FS	
DC Power		**10 V**	A	**10 V**	A	10 V	A	3 V	A	10 V	FS	**20 V**	FS	20 V (x?)	FS	
I/O Signal		**10 V**	A	**10 V**	A	10 V	A	3 V	A	10 V	FS	**20 V**	FS	20 V (x?)	FS	
I/O Signal + PS		**10 V**	A	––	—	––	––	3 V	A	10 V	FS	**20 V**	FS	—	––	
Magnetic field	IEC 61000-4-8															
50/60 Hz	(Enclosure)	30 A/m	A	30 A/m	A	—	––	30 A/m	A	30 A/m	FS	30 A/m	FS	—	––	If applicable
Voltage dips	IEC 61000-4-11															
1 cycle 10/12 cycles 25/30 cycles	(AC Power)	0 % (0,5 cycle) 40 % 70 %	 **A** C C	0 % 40 % 70 %	B C C	––	––	0 % 40 % 70 %	B C C	0 % 40 % 70 %	FS FS FS	0 % 40 % 70 %	FS FS FS	—	––	
Voltage interr.	IEC 61000-4-11															
250/300 cycles	(AC Power)	0%	C	0%	C	––	––	0%	C	0%	FS	0%	FS	—	––	
Common mode	IEC 61000-4-16	––	—	––	—	––	––	—	—	Not required for FSCP based devices, see NOTE		Not required for FSCP based devices, see NOTE		—	––	Installation shall follow IEC 61918, IEC 60204-1, and FSCP specific if available

Phenomenon	Basic standard	IEC 61131-2 Ind. App. Zone B	PC	IEC 61000-6-2 Ind. app. generic	PC	IEC 61800-3 Variable speed drive	PC	IEC 61326-1 Industrial location	PC	IEC 61326-3-1 Industrial location	PC	IEC 61000-6-7 Ind. app. generic	PC	IEC 61800-5-2 IFA Test PDS(SR)	PC	NOTES
Voltage dips	IEC 61000-4-29															
DC Power		––	––	––	––	––	––	––	––	40 % (10 ms)	FS	40 % (10 ms)	FS	––	––	
Voltage interr.	IEC 61000-4-29															
DC Power		––	––	––	––	––	––	––	––	0 % (20 ms)	FS	0 % (20 ms)	FS	––	––	

NOTE IFA is the German "Institut Für Arbeitsschutz", i.e. the Institute for Occupational Safety and Health of the German Social Accident Insurance.

Annex B
(informative)

Product, sector and application specific requirements

B.1 General

This Annex provides an overview of the requirements of product, sector and application specific requirements relevant for safety devices using IEC 61784-3 functional safety communication profiles.

NOTE The content of this Annex does not provide an exhaustive list.

B.2 Sensors (safety for machinery)

IEC 61496-1 requires some more stringent EMC tests for a large group of sensors such as light curtains (electro-sensitive protective equipment). Amendment 1 of IEC 61496-1, published in 2007, covers data interface issues such as FSCPs. This amendment shall be observed for the design of the devices and for testing.

Assessment: Inspections of assessment reports provided by the manufacturer shall be carried out.

B.3 Low-voltage switchgear and controlgear devices

Assessment requirements for these devices are specified in IEC 60947-5-1 [3].

NOTE Additional more stringent requirements for functional safety are specified in GS-ET-20 [36].

B.4 Burner management systems (BMS)

Devices intended for use in burner management systems shall be validated according to the relevant standards for the region/country.

NOTE In CENELEC countries, EN 13611 [29] and EN 14459 [30] will apply. Additionally, EN 298 [26] will be observed if relevant.

In the USA, parts of NFPA 85 [38] & NFPA 86 [39] Appendices, ANSI/ISA 84.00.01-2004 Parts 1-3 ([31], [32], [33], ISA TR84.00.02-2002 [34], ISA-d TR84.00.05 [35] will apply.

Assessment: Inspections of assessment reports provided by the manufacturer shall be carried out.

B.5 Pressure equipment directive (PED)

Devices shall be validated according to the relevant standards.

NOTE In countries of the European Union, devices within the scope of the Pressure Equipment Directive (97/23/EC) will be validated according to EN 764-7 [27] or other relevant harmonised standards within the PED.

Assessment: Inspections of assessment reports provided by the manufacturer shall be carried out.

Bibliography

[1] IEC 60050 (all parts), *International Electrotechnical Vocabulary*

NOTE See also the IEC Multilingual Dictionary – Electricity, Electronics and Telecommunications (available on CD-ROM and at <http://domino.iec.ch/iev>).

[2] IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

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

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

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

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

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

[8] IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions, and voltage variations immunity test*

[9] IEC 61000-4-16, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

[10] IEC 61000-4-29, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions, and voltage variations on d.c. input power port immunity test*

[11] IEC 61000-6-7[6], *Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) in industrial environments*

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

[13] IEC 61508-4:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

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[15] IEC 61508-7:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*

[16] IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

[17] IEC 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

[18] IEC 61784-2, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

[19] IEC 61800-3, *Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods*

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