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TECHNICAL REPORT

RAPPORT TECHNIQUE

colour inside

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

Réseaux de communication industriels – Profils – Lignes directrices pour l'évaluation des appareils de sécurité utilisant les profils de communication pour la sécurité fonctionnelle (FSCP) de la CEI 61784-3

IEC/TR 62685:2010

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

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

FOREWORD

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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.

This bilingual version (2013-04) corresponds to the monolingual English version, published in 2010-12.

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.

The French version of this standard has not been voted upon.

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,
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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.

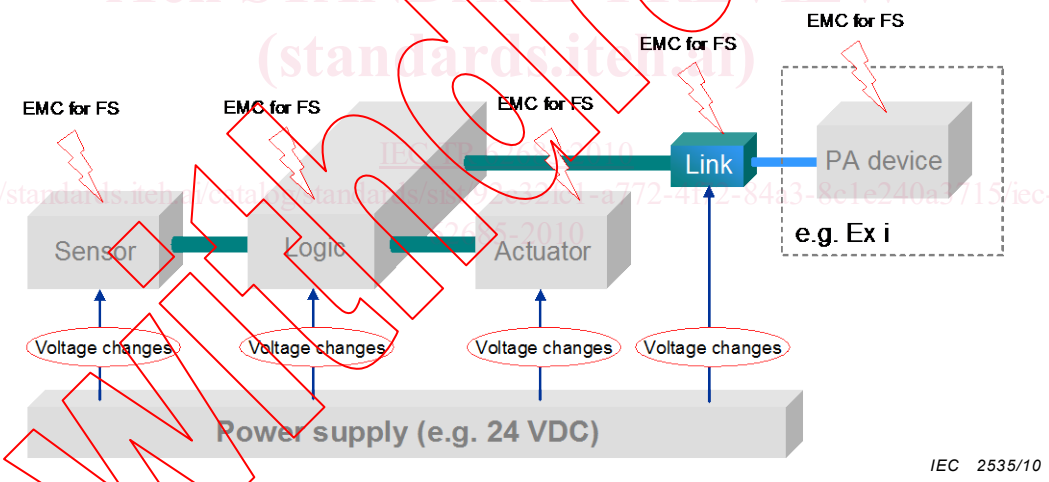

Figure 1 – Environmental view on safety functions

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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

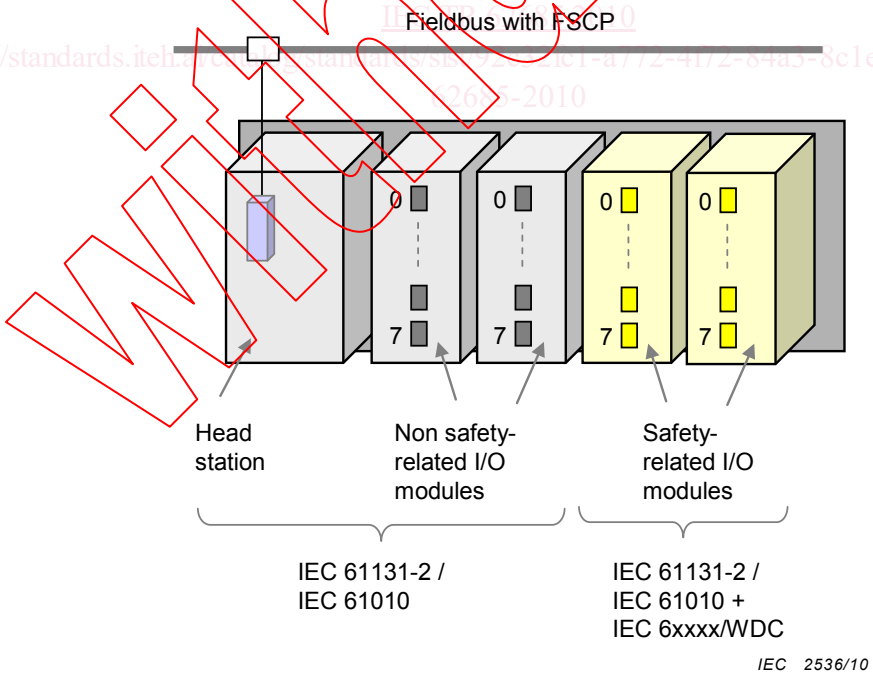
ESD Electrostatic Discharge

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.