SLOVENSKI STANDARD
SIST-TS IEC/TS 61000-1-2:2010

01-januar-2010

Nadomeģļa:
SIST-TS IEC/TS 61000-1-2:2004

Elektromagnetna združljivost (EMC) - 1-2. del: Splošno - Metodologija za doseganje funkcionalne varnosti električnih in elektronske opreme v zvezi z elektromagnetnimi pojavi

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

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Ta slovenski standard je istoveten z: **IEC/TS 61000-1-2**

ICS:

33.100.99	Drugi vidiki v zvezi z EMC	Other aspects related to EMC

SIST-TS IEC/TS 61000-1-2:2010 **en,fr**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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SIST-TS IEC/TS 61000-1-2:2010

IEC/TS 61000-1-2

Edition 2.0 2008-11

TECHNICAL SPECIFICATION

BASIC SAFETY PUBLICATION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XC

ICS 33.100.99

ISBN 2-8318-1019-5

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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

FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 61000-1-2, which is a technical specification, has been prepared by technical committee 77: Electromagnetic compatibility. It has the status of a basic safety publication in accordance with IEC Guide 104.

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This second edition cancels and replaces the first edition published in 2001 and constitutes a technical revision.

The main changes are the following.

- For safety-related systems that use electrical, electronic or programmable electronic technologies, the technical information, definitions, terminology and text of this second edition have been aligned to IEC 61508.
- Risk assessment requirements and methodologies have been deleted from this document, so as not to duplicate or clash with IEC 61508.
- It now makes a clear distinction between complete safety-related systems and items of equipment that might be used in such systems, and clarifies its application by the different types of end-users.
- This technical specification focuses more on appropriate design methods, and their verification and validation.
- The methodology for assessing and specifying electromagnetic environments has been extended.
- The combination of electromagnetic and physical/climatic influences are taken into account.

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

Enquiry draft	Report on voting
77/356/DTS	77/359A/RVC

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Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

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This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

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INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

Part 3: Limits

Emission limits

Immunity limits (insofar as they do not fall under the responsibility of the product committees)

Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

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Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

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Part 6: Generic standards

Part 9: Miscellaneous

Each part is further subdivided into several parts, published either as international standards, technical specifications or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and completed by a second number identifying the subdivision (example: IEC 61000-3-11).

Particular considerations for IEC 61000-1-2

The function of electrical or electronic systems should not be affected by external influences in a way that could lead to an unacceptable risk of harm to the users, other persons, animals or property. A comprehensive safety analysis should consider various factors of climatic, mechanical, electrical nature and reasonably foreseeable misuse. Electromagnetic disturbances are present in most environments and should therefore be considered during such an analysis.

The purpose of this document is to provide guidance relating to the achievement of functional safety of electrical or electronic systems exposed to electromagnetic disturbances.

With respect to consistency within IEC, the document makes use, as far as appropriate, of existing relevant basic IEC standards. It considers the work of SC 65A relating to functional safety concepts of the IEC 61508 series and of TC 77, its subcommittees and CISPR relating to the electromagnetic environments. For details on these subjects reference should be made to the standards of these committees.

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IEC 61508 has the status of a basic safety publication and it deals with the topic of functional safety of electric/electronic/programmable electronic (E/E/PE) safety-related systems. It sets the overall requirements to achieve functional safety. Sufficient immunity to electromagnetic interference is one of those requirements. However, it is limited in scope to systems that carry out safety functions that have integrity requirements assessed in the range of safety integrity level (SIL) 1 to SIL 4 range, and it does not give detailed requirements relating to electromagnetic immunity. This part of IEC 61000-1 gives guidance to achieve adequate immunity of the safety-related systems and equipment that are intended to be used in safety-related systems.

The concept of IEC 61508 is based on a lifecycle model (see Figure 1). The concept comprises application-specific activities and activities relating to the design of the equipment. The application-specific activities are contained in phases both before and after the phases for equipment design. The interface between the earlier application-specific phases and the equipment design phases is the safety requirements specification (SRS), see Table 1. It specifies all relevant requirements of the intended application(s):

a) definition of the safety-related function(s), based on a risk assessment of the intended application(s) (which function(s) may cause a hazard in case of failure).

b) selection of appropriate safety integrity level (required) based on a risk assessment of the intended application(s).

c) definition of the environment in which the system will work.

The safety-related system intended to implement the specified function(s) has to fulfil the safety requirements specification (SRS). Equipment intended for use in that system has to fulfil the relevant requirements derived from the safety requirements specification (SRS).

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Table 1 – Safety requirements specification, interfaces and responsibilities according to IEC 61508

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Functional safety	
Safety-related system (IEC 61508)	
Application (system level)	Safety requirements specification (SRS) a) Definition of safety-related function, based on a risk assessment of the intended application (IEC 61508) (which function may cause a dangerous failure) b) Selection of appropriate safety integrity level (required) based on a risk assessment of the intended application (IEC 61508) c) Definition of the environment in which the system will work (IEC 61508, IEC 61000-1-2, IEC 61000-2-5)
E/E/PE equipment intended for use in a safety-related system	Equipment manufacturer has to fulfil the relevant requirements of the safety requirements specification (SRS). This includes: ensuring that there is adequate confidence that electromagnetic disturbances will not result in dangerous systematic failures (systematic capability with respect to electromagnetic disturbances); and producing evidence that appropriate methods and techniques have been employed.

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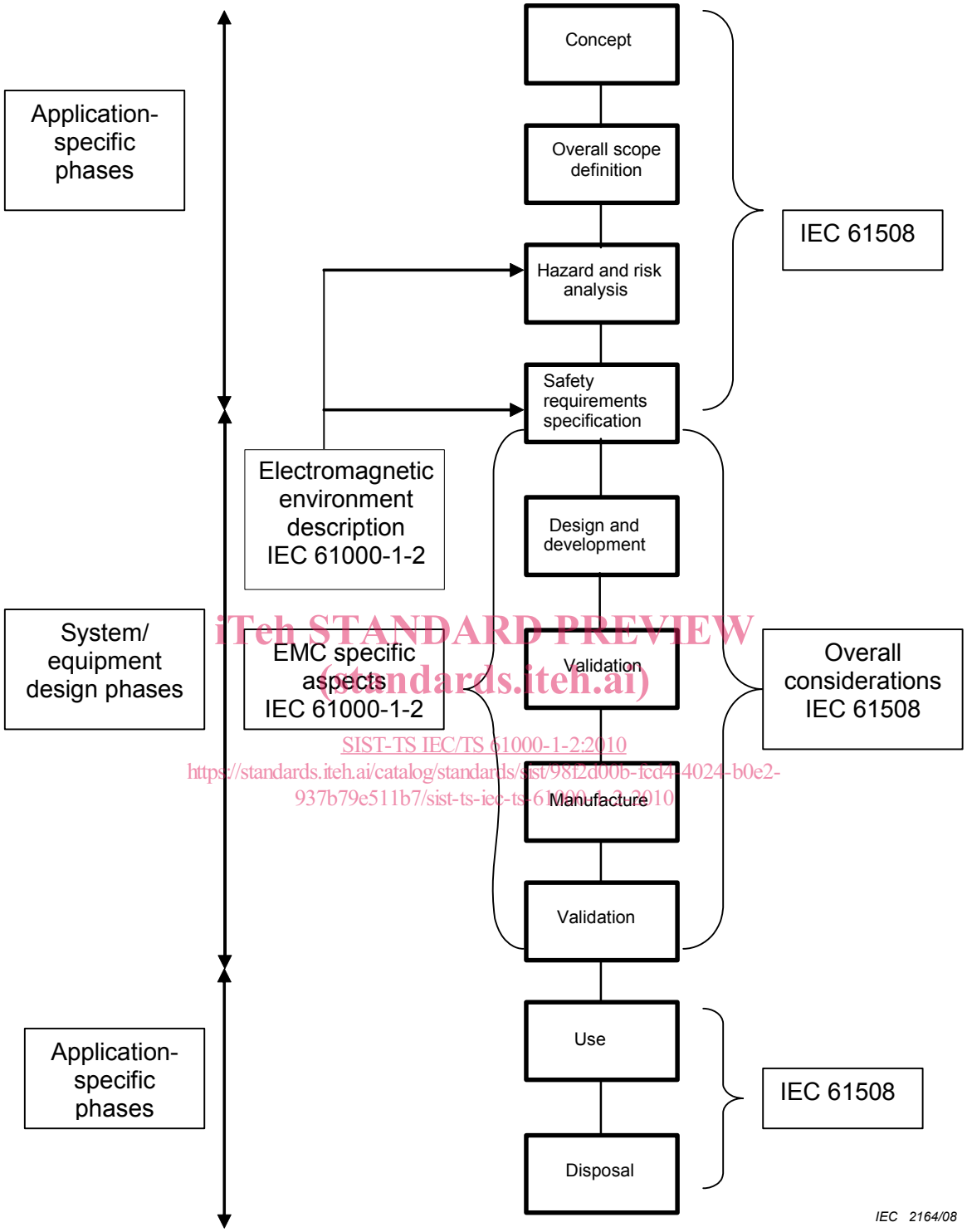

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NOTE 1 The diagram shows a simplified overview of the relationship between IEC 61508 and IEC 61000-1-2. It should be noted that EMC issues may need careful consideration during lifecycle stages other than those covered by IEC 61000-1-2, e.g. maintenance activities for EMC characteristics may be required during the "use-of-equipment" phase to ensure continued safety-related system performance.

NOTE 2 Verification is not shown in the diagram but it is relevant to all lifecycle phases.

Figure 1 – Relationship between IEC 61000-1-2 and the simplified lifecycle as per IEC 61508

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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

1 Scope and object

This part of IEC 61000 establishes a methodology for the achievement of functional safety only with regard to electromagnetic phenomena of electrical and electronic systems and installations, as installed and used under operational conditions. This methodology includes the implication it has on equipment used in such systems and installations.

This technical specification:

a) applies to safety-related systems incorporating electrical/electronic/programmable electronic equipment;

b) considers the influence of the electromagnetic environment on safety-related systems; it is intended for designers, manufacturers and installers of safety-related systems and can be used as a guide by IEC committees;

c) is not concerned with direct hazards from electromagnetic fields on living beings nor is it concerned with safety related to breakdown of insulation or other mechanisms by which persons can be exposed to electrical hazards.

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It mainly covers EMC related aspects of the design phase of safety-related systems and equipment used therein, and deals in particular with

– some basic concepts in the area of functional safety,

– the various EMC specific steps for the achievement and management of functional safety,

– the description and assessment of the electromagnetic environment,

– the EMC aspects of the design and integration process taking into account the process of EMC safety planning on system as well as on equipment level,

– the validation and verification processes regarding the immunity against electromagnetic disturbances,

– the performance criterion and some test philosophy considerations for safety-related systems and the equipment used therein,

– aspects related to testing of the immunity of safety-related systems and equipment used therein against electromagnetic disturbances.

This Technical Specification is applicable to safety-related systems intended to comply with the requirements of IEC 61508 and/or associated sector-specific functional safety standards.

For safety-related systems covered by other functional safety standards, a consideration shall be made of the requirements of this Technical Specification in order to identify the appropriate measures that shall be taken with relation to EMC and functional safety.

This Technical Specification may also be used as a guide for considering EMC requirements for other systems having a direct contribution to safety.

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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 60050(161), *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 61000-2-5, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5: Classification of electromagnetic environments*

IEC 61000-2-13, *Electromagnetic compatibility (EMC) – Part 2-13: Environment – High-power electromagnetic (HPEM) environments – Radiated and conducted*

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques*

IEC 61000-4-1, *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series*

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

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

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

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

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

3 Terms, definitions and abbreviations

For the purposes of this document, the definitions contained in IEC 60050(161) as well as the following apply.

3.1
degradation (of performance)
undesired departure in the operational performance of any device, equipment or system from its intended performance

NOTE The term "degradation" can apply to temporary or permanent failure.

[IEV 161-01-19]

3.2
electrical/electronic/programmable electronic
E/E/PE
based on electrical and/or electronic and/or programmable electronic technology

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NOTE The term is intended to cover any and all devices or systems operating on electrical principles.

EXAMPLE Electrical/electronic/programmable electronic devices include

– electro-mechanical devices (electrical);

– solid-state non-programmable electronic devices (electronic);

– electronic devices based on computer technology (programmable electronic).

[IEC 61508-4]

3.3
electromagnetic compatibility
EMC
ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[IEV 161-01-07]

3.4
electromagnetic compatibility level
specified electromagnetic disturbance level used as a reference level for co-ordination in the setting of emission and immunity limits

NOTE 1 By convention, the compatibility level is chosen so that there is only a small probability that it will be exceeded by the actual disturbance level. However, electromagnetic compatibility is achieved only if the emission and immunity levels are controlled such that, at each location, the disturbance level resulting from the cumulative emissions is lower than the immunity level for each device, equipment and system situated at the same location.

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NOTE 2 The compatibility level may be phenomena, time- or location-dependent.

[IEV 161-03-10]

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3.5
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[IEV 161-01-05]

3.6
electromagnetic environment
totality of electromagnetic phenomena existing at a given location

[IEV 161-01-01]

3.7
electromagnetic interference
EMI
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

NOTE Disturbance and interference are respectively cause and effect.

[IEV 161-01-06]

3.8
equipment
part of system

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NOTE Equipment as used in this specification is a very general term that refers to a wide variety of possible subsystems, modules, devices and other assemblies of products. It does not include people.

3.9
equipment under control
EUC
equipment, machinery or plant used for manufacturing, process, transportation, medical or other activities

3.10
equipment requirements specification
ERS
equipment specification covering safety-related requirements only with regard to electromagnetic phenomena

NOTE An equipment requirements specification (ERS) is created for each item of equipment within the safety-related system. Included in each equipment requirements specification is an electromagnetic performance specification based upon the maximum electromagnetic environment expected over the lifetime for that particular item of equipment.

3.11
failure
termination of the ability of an item to perform a required function

NOTE 1 The definition in IEV 191-04-01 is the same, with additional notes.

NOTE 2 For further information, see IEC 61508-4.

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NOTE 3 Performance of required functions necessarily excludes certain behaviour, and some functions may be specified in terms of behaviour to be avoided. The occurrence of such behaviour is a failure.

NOTE 4 Failures are either random (in hardware) or systematic (in hardware or software).

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[ISO/IEC 2382-14-04-11, modified] [IEC 61508-4]

3.12
fault
abnormal condition that may cause a reduction in, or loss of, the capability of an item to perform a required function

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

[ISO/IEC 2382-14-04-06, modified]

3.13
functional safety
part of the overall safety relating to the Equipment under Control (EUC) and the EUC control system which depends on the correct functioning of the E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities

[IEC 61508-4]

NOTE In the context of this EMC document, functional safety is that part of the overall safety relating to the electromagnetic environment in which the safety-related system exists.

3.14
installation
combination of equipment, components and systems assembled and/or erected (individually) in a given area; for physical reasons (e.g. long distances between individual items) it is in many cases not possible to test an installation as a unit

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3.15
EMC planning
engineering method by which EMC aspects of a project are systematically considered and investigated in order to achieve EMC; all activities connected to it are described in an EMC plan

3.16
EMC safety planning
EMC planning which also considers functional safety aspects

3.17
safety integrity
probability of a safety-related system satisfactorily performing the required safety functions under all the stated conditions within a stated period of time

[IEC 61508-4, modified]

3.18
safety integrity level
SIL
discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

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NOTE The target failure measures for the four safety integrity levels are specified in Tables 2 and 3 of IEC 61508-1.

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[IEC 61508-4]

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3.19
safety-related system
designated system that both implements

– the required safety functions necessary to achieve or maintain a safe state for the equipment under control, and

– is intended to achieve, on its own or with other E/E/PE safety-related systems, other technology safety-related systems or external risk reduction facilities, the necessary safety integrity for the required safety functions

NOTE 1 A safety-related system includes all the hardware, software, human operators and supporting services (for example, power supplies) necessary to carry out the specified safety function (sensors, other input devices, final elements (actuators) and other output devices are therefore included in the safety-related system).

NOTE 2 For further information, see IEC 61508-4.

[IEC 61508-4, modified]

3.20
safety requirements specification
SRS
specification containing, for each safety function, the safety function requirements (what the function does), and the safety integrity requirements (the likelihood of the safety function being performed satisfactorily) that have to be performed/met by the safety-related systems

3.21
system
combination of equipment and/or active components constituting a single functional unit and intended to be installed and operated to perform (a) specific task(s)