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Interested committees:

Title: Draft BS EN 62998-1 Safety of machinery - Safety-related sensors used for the protection of persons

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



44/1057/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: IEC 62998-1 ED1	
DATE OF CIRCULATION: 2025-01-31	CLOSING DATE FOR COMMENTS: 2025-04-18
SUPERSEDES DOCUMENTS: 44/1046/RR	

IEC TC 44 : SAFETY OF MACHINERY - ELECTROTECHNICAL ASPECTS	
SECRETARIAT: United Kingdom	SECRETARY: Mrs Nyomee Hla-Shwe Tun
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 65, SC 65A	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Safety	

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Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Safety of machinery - Safety-related sensors used for the protection of persons

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

Safety of machinery - Safety-related sensors used for the protection of persons –

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IEC 62998-1 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects. It is an International Standard.

This first edition of the International Standard cancels and replaces the first edition of the Technical Specification, published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) addition of requirements for the control of radiation hazards of specific sensor technologies in clause 4.2.2.2;
- b) addition of requirements for the control of hazards related to security vulnerabilities in clause 4.2.2.4;
- c) addition of the “practical use” option in clause 4.2.3.

- d) clarification of the influence of other relevant objects in relation to IEC TS 62998-3 in clause 5.8.3.3;

The text of this Standard is based on the following documents:

FDIS	Report on voting
44/XX/	44/XX/

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this document is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Safety-related sensors are used on machinery that presents a risk of personal injury. They provide protection by ensuring that the machine is reverted to a safe condition before a person can be placed in a hazardous situation.

IEC 61496 (all parts) provides design and performance requirements for electro-sensitive protective equipment (ESPE). It provides clear, though limited, guideline on:

- specific sensor technologies (such as optical sensors) or sensing functions (such as the capability to detect a specified object);
- typical conditions representative of indoor use in industrial environments;
- the detection of objects representing parts of the body of adults using the properties of geometry and reflectivity;
- the design, functional requirements and tests to be conducted in accordance with ESPE specific safety performance classification in types (2,3 and 4).

Autonomous systems such as automated guided vehicles (AGV), service robotics or human-machine interaction in industries are showing an increased demand, for example for:

- new sensor technologies (e.g. radar, ultrasonic sensors);
- new kinds of sensor functions (e.g. classification of objects, position of an object); and
- combinations of different sensor technologies in a sensor system.

In such cases, sensor manufacturers or integrators use generic functional safety standards as a guideline for the safety-related product design. Functional safety standards, such as IEC 61508 (all parts), or sector specific machinery standards, such as IEC 62061 or ISO 13849 (all parts) are generic and allow product design without specific, inappropriate limitations. Applying these standards would require a dedicated analysis of the systematic capabilities of a sensor or sensor system (e.g. dependability of the sensing function under tolerance conditions and environmental influences). These standards do not provide sufficient guidance to prevent design failures in safety-related sensors or insufficient systematic capability to detect the specified object under certain environmental conditions. This can result in an intolerable risk to persons.

This document fills the gap for the examination of systematic capabilities between design-specific sensor standards and generic functional safety standards of electrical, electronic or programmable electronic control systems.

NOTE 1 Examples for the examination of systematic capabilities by using different safety-related sensor standards are given in [Annex A](#).

This document is addressed to safety-related sensor manufacturers and integrators of safety-related sensors into a safety-related sensor system.

NOTE 2 Examples for addressed user groups are given in [Annex B](#).

Safety of machinery - Safety-related sensors used for the protection of persons –

1 Scope

This document set out the requirements for the development and integration of safety-related sensors (SRS) and safety-related sensor systems (SRSS) used for the protection of persons with particular attention to systematic capabilities.

This generic standard applies if:

- protection of persons is to be performed by using sensors; and
- product specific sensor standards (e.g. IEC 61496 (all parts), EN IEC 60947-5-2) do not contain the necessary provisions, or product specific sensor standards are not developed.

This generic standard can be applied also for other protective goals like protection of the environment or prevent production goods damages.

The examination of systematic capabilities using different safety-related sensor standards is described in [Annex A](#).

The requirements and methods set out in this document are intended for the purpose of protection of persons by:

- detection of potentially hazardous objects;
- detection of a body, parts of a body and objects associated to parts of a body entering a hazardous area; or
- classification and/or discrimination of these against other objects.

NOTE 1 The application of SRS/SRSS in a public setting can require the detection of not only persons, but also their associated equipment, such as wheelchairs, walking sticks or infusion stands.

Performance classes of sensors and sensor systems are defined in accordance with existing functional safety standards (e.g. IEC 62061, IEC 61508 (all parts), and ISO 13849 (all parts)).

NOTE 2 This document does not define or interconnect the types as defined in IEC 61496-1 to simplify the process and prevent misuse. By correlating to existing PL or SIL, we have achieved simplification for end users.

Specific attention is devoted to the evaluation of the sensing function and dependability of the detection capability. Environmental influences and tests for indoor and outdoor use are defined that influence the sensing function and the dependability of the detection capability.

NOTE 3 Environmental influences, their classification and test procedures are primarily specified in accordance with generic environmental standards. In the absence of respective standards, more specific requirements and tests are described.

This document can be relevant for applications other than the protection of persons in industry, such as agriculture or public transportation (e.g. metro stations).

This document does not consider or address proven in-use (e.g. processes or elements) as defined in IEC 61508-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 (all parts), *Environmental testing*

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

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60654-1, *Industrial-process measurement and control equipment - Operating conditions - Part 1: Climatic conditions*

IEC 60721 (all parts), *Classification of environmental conditions*

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 60721-3-4, *Classification of environmental conditions - Part 3-4: Classification of groups of environmental parameters and their severities - Stationary use at non-weatherprotected locations*

IEC 60721-3-5, *Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities -Section 5: Ground vehicle installations*

IEC 60721-3-6, *Classification of environmental conditions. Part 3: Classification of groups of environmental parameters and their severities. Ship environment*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60947-5-2, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*

IEC 60947-5-3, *Low-voltage switchgear and controlgear – Part 5-3: Control circuit devices and switching elements – Requirements for proximity devices with defined behaviour under fault conditions (PDDb)*

IEC 61000-6-7, *Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

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

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

IEC 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements (see Functional Safety and IEC 61508)*

IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems (see Functional Safety and IEC 61508)*

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

IEC 62061:2021, *Safety of machinery - Functional safety of safety-related control systems*

IEC 62061, *Safety of machinery - Functional safety of safety-related control systems*

IEC 62061:2005/AMD2: 2015, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC 62311, *Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)*

IEC 62471, *Photobiological safety of lamps and lamp systems*

IEC TS 62998-3, *Safety of machinery - Safety-related sensors used for the protection of persons - Part 3: Sensor technologies and algorithms*

ISO 7250 (all parts), *Basic human body measurements for technological design*

ISO 10218-1, *Robots and robotic devices — Safety requirements for industrial robots — Part 1: Robots*

ISO 10218-2, *Robots and robotic devices — Safety requirements for industrial robots — Part 2: Robot systems and integration*

ISO 13482, *Robots and robotic devices — Safety requirements for personal care robots*

ISO 13849 (all parts), *Safety of machinery – Safety-related parts of control systems*

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

ISO 15003, *Agricultural engineering — Electrical and electronic equipment — Testing resistance to environmental conditions*

ISO 15998, *Earth-moving machinery — Machine-control systems (MCS) using electronic components — Performance criteria and tests for functional safety*

ISO 25119 (all parts), *Tractors and machinery for agriculture and forestry – Safety-related parts of control systems*

ISO 26262 (all parts), *Road vehicles – Functional safety*

EN 50125-1, *Railway applications - Environmental conditions for equipment - Part 1: Rolling stock and on-board equipment*

EN IEC 60947-5-2, *Low-voltage switchgear and controlgear - Part 5-2: Control circuit devices and switching elements - Proximity switches*

CEN/CENELEC Guide 14, *Child safety – Guidance for its inclusion in standards*

IEC 61496 (all parts), *Safety of machinery – Electro-sensitive protective equipment*

IEC 62443 series, *Security for industrial automation and control systems*

ISO/IEC 27000, *Information technology — Security techniques — Information security management systems — Overview and vocabulary*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Characteristics and performance criteria

3.1.1

automation-related zone

part of the sensing zone (IEV 428-06-21) within which specified objects(s) are detected in order to perform an automation-related function

3.1.2

safety-related zone

part of the sensing zone (IEV 428-06-21) within which specified safety-related object(s) are detected

3.1.3

sensing zone

zone defined by length, area or volume within which objects are detected and a function is performed

3.1.4

systematic capability

measure (expressed on a scale of SC 1 to SC 4) of the confidence that the systematic safety integrity of an element meets the requirements of the specified SIL, in respect to the specified element safety function, when the element is applied in accordance with the instructions specified in the compliant safety manual for the element

Note 1 to entry: Systematic capability is determined with reference to the requirements for the avoidance and control of systematic faults (see IEC 61508-2 and [IEC 61508-3 \[2\]](#)).

Note 2 to entry: What a relevant systematic failure mechanism is, will depend on the nature of the element. For example, for an element comprising solely software, only software failure mechanisms will need to be considered. For an element comprising hardware and software, it will be necessary to consider both systematic hardware and software failure mechanisms.

Note 3 to entry: A systematic capability of SC N for an element, in respect to the specified element safety function, means that the systematic safety integrity of SIL N has been met when the element is applied in accordance with the instructions specified in the compliant item safety manual for the element.

[SOURCE: [IEC 61508-4:2010 \[1\]](#)]

3.1.5

detection

<of safety-related sensors> determination of the presence and/or value of a physical property (IEV 428-06-17)

Note 1 to entry: As an example, classification can be a step of detection containing other steps such as reception of physical signal and filtering.

3.1.6

detection capability

<of safety-related sensors> ability to perform the detection (IEV 428-06-08) within the limits of use as specified by the manufacturer

3.1.7

loss of detection capability

event when detection (IEV 428-06-08) is not achieved within the limits of use as specified by the manufacturer

Note 1 to entry: A loss of detection could result from a deterioration of detection capability. A deterioration could be of interest for analysis of reduced integrity of detection resulting in a dangerous state.

3.1.8

physical property

individual measurable property of an object being observed

3.1.9**measurement accuracy**
accuracy of measurement
accuracy

<of safety-related sensors> closeness of agreement between a measured quantity value and a true quantity value of a measurand [Figure 1](#).

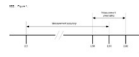


Figure 1 – Measurement accuracy and measurement uncertainty

[SOURCE: [ISO/IEC Guide 99 \[3\]](#), 2.13, modified – The notes to entry have been removed, and the figure has been added.]

3.1.10**measurement uncertainty**

<of safety-related sensors> non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

[SOURCE: [ISO/IEC Guide 99 \[3\]](#), 2.26, modified – The two other terms "uncertainty of measurement" and "uncertainty" has been removed as well as the notes to entry.]

3.2 Dependability**3.2.1****availability**

ability to be in a state to perform as required

Note 1 to entry: Availability depends upon the combined characteristics of the reliability (192-01-24), recoverability (192-01-25), and maintainability (192-01-27) of the item, and the maintenance support performance (192-01-29).

Note 2 to entry: Availability may be quantified using measures defined in Section 192-08, *Availability related measures*.

[SOURCE: [IEC 60050-192:2015 \[4\]](#), 192-01-23]

3.2.2**dependability**

ability to perform as and when required

Note 1 to entry: Dependability includes availability (192-01-23), reliability (192-01-24), recoverability (192-01-25), maintainability (192-01-27), and maintenance support performance (192-01-29), and, in some cases, other characteristics such as durability (192-01-21), safety and security.

Note 2 to entry: Dependability is used as a collective term for the time-related quality characteristics of an item.

[SOURCE: [IEC 60050-192:2015 \[4\]](#), 192-01-22, modified – The specific use "of an item" given after the term has been removed.]

3.2.3**reliability**

ability to perform as required, without failure, for a given time interval, under given conditions

Note 1 to entry: The time interval duration can be expressed in units appropriate to the item concerned, for example calendar time, operating cycles, distance run, etc., and the units should always be clearly stated.

Note 2 to entry: Given conditions include aspects that affect reliability, such as: mode of operation, stress levels, environmental conditions, and maintenance.

Note 3 to entry: Reliability can be quantified using measures defined in Section 192-05, *Reliability related concepts: measures*.

[SOURCE: [IEC 60050-192:2015 \[4\]](#), 192-01-24, modified - The specific use "of an item" given after the term has been removed.]

3.2.4**error**

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

[SOURCE: IEC 60050-192:2015 [4], 192-03-02, modified – The notes to entry have been removed.]

3.2.5**failure**

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

Note 1 to entry: After failure, the item has a fault.

Note 2 to entry: "Failure" is an event, as distinguished from "fault", which is a state.

Note 3 to entry: This concept, as defined, does not apply to items consisting of software only.

Note 4 to entry: In practice, the terms "fault" and "failure" are often used synonymously.

3.2.6**failure to danger**

failure which results in the inability to perform the safety-related function within the stated response time

3.2.7**fault**

inability to perform as required, due to an internal state

Note 1 to entry: A fault of an item results from a failure, either of the item itself, or from a deficiency in an earlier stage of the life cycle, such as specification, design, manufacture or maintenance. See latent fault (192-04-08).

Note 2 to entry: Qualifiers, such as specification, design, manufacture, maintenance or misuse, may be used to indicate the cause of a fault.

Note 3 to entry: The type of fault may be associated with the type of associated failure, for example wear-out fault and wear-out failure.

Note 4 to entry: The adjective "faulty" designates an item having one or more faults.

[SOURCE: IEC 60050-192:2015 [4], 192-04-01, modified – The specific use "of an item" given after the term has been removed.]

3.3 Procedures and architectural deliberations**3.3.1****risk analysis**

systematic use of available information to identify hazards and to estimate the risk

[SOURCE: ISO/IEC Guide 51:2014 [5], 3.10]

3.3.2**risk reduction measure****protective measure**

action or means to eliminate hazards or reduce risks

Note 1 to entry: Inherently safe design; protective devices; personal protective equipment; information for use and installation; organization of work; training; application of equipment; supervision.

[SOURCE: ISO/IEC Guide 51:2014 [5], 3.13]

3.3.3**tolerable risk**

level of risk that is accepted in a given context based on the current values of society

[SOURCE: ISO/IEC Guide 51:2014 [5], 3.15, modified – The note to entry has been removed.]

3.3.4**design and development**

activities that take an idea or requirement and transform these into a product

Note 1 to entry: The process of design and development usually follows a series of defined steps starting with an initial idea, transforming that into a formal specification, and resulting in the creation of a working prototype and whatever documentation is required to support production of the goods or provision of the service.

[SOURCE: IEC 62430:2009 [6], 3.1]

3.3.5

simulation

modelling via calculation or via a software behavioural model used for a systematic and/or stochastic analysis of functional performance and the correct dimensioning and interaction of its subsystems (IEV 428-04-40)

3.3.6

calibration

set of operations which establishes, by reference to standards, the relationship which exists, under specified conditions, between an indication and a result of a measurement

Note 1 to entry: This term is based on the "uncertainty" approach.

Note 2 to entry: The relationship between the indications and the results of measurement can be expressed, in principle, by a calibration diagram.

Note 3 to entry: Standards used as reference could be scale of length objects located in the sensing zone continuously or temporarily.

Note 4 to entry: Within this document, only calibration at the user side is specifically addressed. Calibration used during production of an SRS/SRSS is a measure which can be used to achieve the stated detection capability at manufacturer side, is part of analysis during design and development and not specifically addressed.

[SOURCE: IEC 60050-311 [7], 311-01-09, modified – Notes 3 and 4 to entry have been added.]

3.3.7

calibration procedure

documented, verified, and validated procedure that specifically describes a set of operations used in the performance of particular measurements according to a given method

Note 1 to entry: Calibration procedure used in the context of this document includes both calibration and adjustment.

[SOURCE: [8], modified – The note to entry has been added.]

3.3.8

machinery

machine assembly, fitted with or intended to be fitted with a drive system consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application

Note 1 to entry: The term "machinery" also covers an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole.

Note 2 to entry: Annex A of ISO 12100:2010 [9] provides a general schematic representation of a machine.

[SOURCE: ISO 12100:2010 [9], 3.1, modified – The second term "machine" has been removed, but added to the definition before "assembly".]

3.3.9

safety-related system

designated system that both

- implements the required safety functions necessary to achieve or maintain a safe state for the EUC (equipment under control); and
- is intended to achieve, on its own or with other E/E/PE safety-related systems and other risk reduction measures, the necessary safety integrity for the required safety functions

[SOURCE: IEC 61508-4:2010 [10], 3.4.1, modified – The notes to entry have been removed.]

3.3.10**safety-related control system****SCS**

part of the control system of a machine which implements a safety function by one or more subsystems

[SOURCE: IEC 62061:2021 [11], 3.2.3, modified - Note 1 to entry has been removed.]

3.3.11**safety-related sensor****SRS**

one or more sensing units combined to perform the safety-related function

Note 1 to entry: A safety-related sensor can be regarded as a subsystem (IEV 428-04-40) in a safety-related control system (IEV 428-04-01) or as a subsystem element in a safety-related control system (IEV 428-04-01) if the safety-related sensor is used as part of a safety-related sensor system (IEV 428-06-19).

Note 2 to entry: A sensing unit can contain one or more sensing elements.

3.3.12**safety-related sensor system****SRSS**

combination of two or more safety-related sensors performing the safety-related function

3.3.13**electro-sensitive protective equipment****ESPE**

assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising as a minimum

- a sensing device;
- controlling/monitoring devices;
- output signal switching devices and/or a safety-related data interface

Note 1 to entry: An ESPE is a protective device used as risk reduction measure.

[SOURCE: IEC 61496-1:2020 [12], 3.5, modified – The notes to entry have been replaced by a new Note 1 to entry.]

3.3.14**sector****industry**

group of enterprises or organizations that produce or supply goods, services, or sources of income

3.3.15**sensor technology****sensing technology**

set of characteristics that include the wavelength range used, the measurement method used and consideration of the arrangement of the sensor unit

3.4 Terms related to system**3.4.1****subsystem**

entity of the top-level architectural design of a safety-related system where a dangerous failure of the subsystem results in a dangerous failure of a safety function

Note 1 to entry: This differs from common language where “subsystem” may mean any sub-divided part of an entity, the term “subsystem” is used in this document within a strongly defined hierarchy of terminology: “subsystem” is the first level subdivision of a system. The parts resulting from further subdivision of a subsystem are called “subsystem elements”.

[SOURCE: IEC 62061:2021 [11], 3.2.4, modified - The notes 2 ,3 and 4 to entry have been removed.]

3.4.2

subsystem element

part of a subsystem comprising a single component or any group of components that performs one or more element functions

Note 1 to entry: A subsystem element may comprise hardware and software.

[SOURCE: IEC 62061:2021 [11], 3.2.6, modified – The words "that performs one or more element functions" have been added to the definition, and the note 2 and 3 to entry have been removed.]

3.4.3

complexity

property of an SRS/SRSS or a safety function that is characterized by multiple subsystem elements or sub-functions interacting in a non-trivial way

Note 1 to entry: The degree of complexity of an SRS/SRSS may depend on the role or perspective within the supply chain. While an SRS under development can be judged highly complex by the manufacturer due to its many interacting subsystem elements and the number of external influences that have to be taken into account, an integrator who employs it within the limits of intended use might model it as a black box system with few defined outputs and judge it to be of low complexity.

Note 2 to entry: The detailed behaviour of a complex system or complex function is not accessible by simple calculation

3.4.4

demand rate

number of events that occur in a defined time which cause the SRS/SRSS to perform its safety-related function

Note 1 to entry: Low demand mode is a mode of operation in which the safety-related function of an SRS/SRSS is only performed on demand and where the demand rate is no greater than one per year.

Note 2 to entry: High demand mode is a mode of operation in which the safety-related function of an SRS/SRSS is only performed on demand and where the demand rate is greater than one per year. As an orientation, high demand rates are given in Table G.1 (stated values are in accordance with ISO 13849 (all parts)).

Note 3 to entry: Continuous mode is a mode of operation in which the safety-related function of an SRS/SRSS is performed perpetually (continuously). Finally, the limiting factor for the applicable demand rate in continuous mode is the response time of the SRS/SRSS.

Note 4 to entry: The demand rate for the safety-related functions of the SRS/SRSS can be different than the demand rate for the safety function performed in a SCS.

3.4.5

safe state

state of the EUC (equipment under control) when safety is achieved

Note 1 to entry: The safe state might be initiated by the decision information.

Note 2 to entry: The safe state might be initiated by the confidence information.

Note 3 to entry: The safe state might be related to different output signals depending on the intended use and performed SRS/SRSS function.

[SOURCE: IEC 61508-4:2010 [10], 3.1.13, Notes to entry have been added.]

3.4.6

normal operating condition

<of safety-related sensors> operating condition that represents as closely as possible the range of normal use that can reasonably be expected

3.4.7

normal operation

state of an SRS/SRSS where it operates as specified and where no faults are detected

3.4.8

intended use

use in accordance with information provided with a product or system, or, in the absence of such information, by generally understood patterns of usage

[SOURCE: [ISO/IEC Guide 51:2014 \[5\]](#), 3.6]

3.4.9

limit of use

definition of limits on achieved detection capability, sensing zone, environmental, mounting, safety-related information at the output unit and SRS/SRSS performance class provided by the manufacturer of an SRS/SRSS or integrator of SRS into an SRSS

Note 1 to entry: The limits of use are essential to validate if the SRS/SRSS is appropriate for the application respective the intended use.

3.4.10

practical use

practical use that involves real situations and events, rather than just ideas, theories or generally understood patterns of usage

EXAMPLE Derivation of real situations, events and scenarios from the application of the SRS/SRSS in the end user environment.

Note 1 to entry: The practical use can be a subset or an expansion of the intended use.

3.5 Fusion

3.5.1

alignment

processing of measurements to achieve a common time base and a common spatial reference

3.5.2

diversity

different means of performing a required function

Note 1 to entry: Diversity may be achieved by different physical methods or different design approaches.

[SOURCE: [IEC 61508-4:2010 \[10\]](#), 3.3.7]

3.5.3

fusion

act or process of combining or associating data or information in an explicit or implicit knowledge framework to improve the capability (or provide a new capability) for detection (IEV 428-06-08), identification, or characterization of an entity

3.5.4

redundancy

provision of more than one means for performing a function

Note 1 to entry: The additional means of performing the function can be intentionally different (diverse) to reduce the potential for common mode failures (192-03-19).

[SOURCE: [IEC 60050-192:2015 \[4\]](#), 192-10-02, modified - The specific use "of a system" given after the term has been removed]

3.6 Safety-related information

3.6.1

analog signal

signal which directly represents the respective variable quantity

Note 1 to entry: An analog signal may be a continuous-value or a discrete-value signal as well as a continuous-time or a discrete-time signal. Examples may be the pressure in a pneumatic final controlling element with continuous-value and continuous-time information parameter (value of the pressure) as well as a position-modulated pulse signal as an output signal of a computer based controller.

[SOURCE: [IEC 60050-351:2013 \[13\]](#), 351-41-24, modified – The words "each information parameter of" have been removed from the definition, and note 2 to entry has been removed.]

3.6.2

coverage interval

<of safety-related sensors> interval containing the set of true quantity values of a measurement information (IEV 428-06-15) with a stated probability, based on the information available

Note 1 to entry: A coverage interval does not need to be centred on the chosen measured quantity value.

3.6.3

coverage probability

<of safety-related sensors> probability that the set of true quantity values of a measurement information (IEV 428-06-15) is contained within a specified coverage interval (IEV 428-06-04)

3.6.4

confidence information

safety-related probability measure that supplements a measurement information (IEV 428-06-15) or a decision information (IEV 428-06-06)

Note 1 to entry: Confidence information includes coverage probability (IEV 428-06-05) and coverage interval (IEV 428-06-04) if measurement information is provided and decision probability (IEV 428-06-07) if decision information is provided.

3.6.5

decision probability

probability that the decision information (IEV 428-06-06) be correct

3.6.6

digital signal

discretely-timed signal in which information is represented by a finite number of well defined discrete values that one of its characteristic quantities may take in time

[SOURCE: IEC 60050-704:1993 [14], 704-16-03]

3.6.7

binary digital signal

binary signal

digital signal in which each signal element has one of two permitted discrete values

[SOURCE: IEC 60050-704:1993 [14], 704-16-03]

3.6.8

***n*-ary digital signal**

***n*-ary signal**

digital signal in which each signal element has one of *n* permitted discrete values

[SOURCE: IEC 60050-704:1993 [14], 704-16-05]

3.6.9

serial digital transmission

serial transmission

successive transmission of signal elements over a single path between two points

[SOURCE: IEC 60050-704:1993 [14], 704-16-27]

3.6.10

parallel digital transmission

parallel transmission

simultaneous transmission of a group of signal elements over the appropriate number of parallel paths between two points

[SOURCE: IEC 60050-704:1993 [14], 704-16-28]

3.6.11

fault reaction function

<of safety-related sensors> function that is initiated when a fault is detected by a diagnostic function

3.6.12**fault response time**

maximum time between initiation of the signal to initiate the fault reaction function (IEV 428-06-26) and achievement of the appropriate safety-related information provided

3.6.13**decision information**

information that represents the decision performed a respective variable quantity

Note 1 to entry: An example is a decision representing the entrance of an object in a safety-related zone (IEV 428-06-20) resulting in a switching signal.

Note 2 to entry: A respective variable quantity could be the properties of the object or environmental information.

3.6.14**SRS/SRSS measurement information**

information which represents the respective variable quantity

Note 1 to entry: An example is the location of an object in a sensing zone provided as digital n -ary output signal.

3.7 Test**3.7.1****acceptance test**

contractual procedure to demonstrate, to the customer, that acceptance criteria are met

[SOURCE: IEC 60050-192:2015 [4], 192-09-03]

3.7.2**endurance test**

procedure carried out to investigate how the properties of the item are affected by the duration or repeated application of stated stresses

[SOURCE: IEC 60050-192:2015 [4], 192-09-07, modified – The note has been removed.]

3.7.3**field test**

test carried out under user operational conditions

Note 1 to entry: The operating, environmental, maintenance and measurement conditions present at the time of the test may be monitored or recorded.

[SOURCE: IEC 60050-192:2015 [4], 192-09-06]

3.7.4**laboratory test**

test made under prescribed and controlled conditions that may or may not simulate field conditions

[SOURCE: IEC 60050-192:2015 [4], 192-09-05]

3.7.5**maintenance test**

test carried out periodically on an item to verify that its performance remains within specified limits, after having made certain adjustments, if necessary

[SOURCE: IEC 60050-151:2001 [15], 151-16-25]

3.7.6**qualification test**

procedure to verify conformance to the requirements of a specification

Note 1 to entry: A qualification test is generally performed before starting production of an item on a larger scale.

[SOURCE: IEC 60050-192:2015 [4], 192-09-04]

3.7.7**routine test**

test made on each individual item during or after manufacture

Note 1 to entry: A routine test is performed before supplying.

3.7.8**simulation test**

test that imposes anticipated environmental and operating stresses of intended use

Note 1 to entry: In practice, the test conditions only approximate to the true conditions of use, the accuracy of their reproduction being known as the degree of simulation.

[SOURCE: IEC 60050-192:2015 [4], 192-09-18]

3.7.9**system test**

test of a complete system to detect instances of non-conformity with the respective functional specification

Note 1 to entry: System test is mainly for verification (192-01-17), but may include some validation (192-01-18).

[SOURCE: IEC 60050-192:2015 [4], 192-09-25]

3.7.10**test**

determination according to requirements for a specific intended use or application

Note 1 to entry: If the result of a test shows conformity, it can be used for purposes of validation.

[SOURCE: ISO 9000:2015 [16], 3.11.8]

3.7.11**type test**

test of one or more devices under test made to a certain design to show that the design meets certain specifications

[SOURCE: IEC 60050-411:1996 [17], 411-53-01, modified – The word "machines" has been replaced by "devices under test".]

3.8 User groups**3.8.1****integrator**

entity who integrates an SRS and/or SRSS into an SCS and/or machinery or an SRS into an SRSS

Note 1 to entry: The entity who integrates can be a manufacturer, assembler, engineering company or the user.

Note 2 to entry: The integrator in sense of this document can be a manufacturer of an SRSS, SCS or machinery.

Note 3 to entry: The integrator is defined in ISO 11161 [18] as "the entity who designs, provides, manufactures or assembles an integrated manufacturing system and is in charge of the safety strategy, including the protective measures, control interfaces and interconnections of the control system". It is changed in this document respectively to cover the relevant steps of integration up to integrated manufacturing system which is covered by the definition of machinery.

3.8.2**supplier****SRS/SRSS supplier**

role in supply chain activities of organizations moving a product or service and corresponding information for use to customer and finally to the operator

Note 1 to entry: Supply chain activities involve the transformation of natural resources, raw materials, components and corresponding information into a finished product that is delivered to the end customer organisation.

Note 2 to entry: Supplier in the sense of this document might be manufacturer of an SRS, SRSS or machinery using SRS/SRSS.

3.8.3**user****SRS/SRSS user**

addressed group or person at customer side organization

Note 1 to entry: A user might be the integrator, machinery manufacturer or operator.

3.9 Verification and validation**3.9.1****failure modes and effects analysis****FMEA**

qualitative method of analysis that involves the study of possible failure modes and faults in sub items, and their effects at various indenture levels

Note 1 to entry: The term "fault mode and effects analysis" in IEC 60050-191:1990 (now withdrawn; replaced by IEC 60050-192:2015) is deprecated, since a fault (192-04-01) is a state and cannot logically have a mode, whereas a failure mode (192-03-17) is a change of state.

[SOURCE: IEC 60050-192:2015 [4], 192-11-05, modified – The used term "DEPRACATED: fault mode and effects analysis" has been removed.]

3.9.2**fault tree analysis****FTA**

deductive analysis using fault trees

Note 1 to entry: See also fault tree (192-11-07).

[SOURCE: IEC 60050-192:2015 [4], 192-11-08]

3.9.3**formal design review**

independent, documented examination of a design and its requirements to assess the design's ability to meet specified and implied requirements of the item concerned

Note 1 to entry: In this context, "design" includes requirements, specifications, drawings, and supporting documentation.

Note 2 to entry: See IEC 61160 [19] for more detail on design review practices.

[SOURCE: IEC 60050-192:2015 [4], 192-12-07]

3.9.4**inspection**

examination of a product design, product, process or installation and determination of its conformity with specific requirements or, on the basis of professional judgement, with general requirements

Note 1 to entry: Inspection of a process may include inspection of persons, facilities, technology and methodology.

[SOURCE: ISO/IEC 17000:2004 [20], 4.3]

3.9.5**life cycle**

series of identifiable stages through which an item goes, from its conception to disposal

Note 1 to entry: A typical system life cycle consists of: concept and definition; design and development; construction, installation and commissioning; operation and maintenance; mid-life upgrading, or life extension; and decommissioning and disposal.

Note 2 to entry: The stages identified will vary with the application.

[SOURCE: IEC 60050-192:2015 [4], 192-01-09]

3.9.6**prediction**

computation process used to obtain the predicted value of a quantity

[SOURCE: IEC 60050-192:2015 [4], 192-11-02]

3.9.7

reliability model

mathematical model used for prediction or estimation of reliability measures

Note 1 to entry: See IEC 61703 [21], *Mathematical expressions for reliability, availability, maintainability and maintenance support terms*, for more detail on reliability modelling.

Note 2 to entry: Modelling techniques can be applied to other dependability characteristics, such as maintainability and availability.

[SOURCE: IEC 60050-192:2015 [4], 192-11-02]

3.9.8

verification

confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

Note 1 to entry: The objective evidence needed for a verification can be the result of an inspection (3.9.4) or of other forms of determination (ISO 9000:2015 [16], 3.11.1) such as performing alternative calculations or reviewing documents (ISO 9000:2015 [16], 3.8.5).

Note 2 to entry: The activities carried out for verification are sometimes called a qualification process (ISO 9000:2015 [16], 3.4.1).

Note 3 to entry: The word "verified" is used to designate the corresponding status.

[SOURCE: ISO 9000:2015 [16], 3.8.12, modified - The references in note 1 and note 2 to entry have been clarified.]

3.9.9

validation

confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: The objective evidence needed for a validation is the result of a test or other form of determination such as performing alternative calculations or reviewing documents

Note 2 to entry: The word "validated" is used to designate the corresponding status.

Note 3 to entry: The use conditions for validation can be real or simulated.

[SOURCE: ISO 9000:2015 [16], 3.8.13]

3.10 Abbreviations

AGV automated guided vehicles

ASIL automotive safety integrity level

E/E/PE electrical, electronic and programmable electronic

EMC electromagnetic compatibility

ESPElectro-sensitive protective equipment

EUC equipment under control

FMEA failure modes and effects analysis

FTA fault tree analysis

LIDAR light detection and ranging

PFH probability of dangerous failure per hour

PLperformance level

Radar radio detection and ranging

SC systematic capability

SCS safety-related control system

Ser.No. serial number

SIL safety integrity level

SRS safety-related sensor

SRS/SRSS safety-related sensor and/or safety-related sensor system

SRSS safety-related sensor system

4 Life cycle and interconnection to safety-related control systems

4.1 General

An SRS (see [Figure 2](#) and [Figure 3](#)) or an SRSS (see [Figure 4](#)) used as a protective measure shall perform function(s) in accordance with [5.2](#).

An SRS consists of, at least:

- a sensing unit,
- a processing unit, and
- an output unit (an input unit is optional).

An SRSS consists of at least two SRS in combination with a processing unit and an output unit (an input unit is optional).

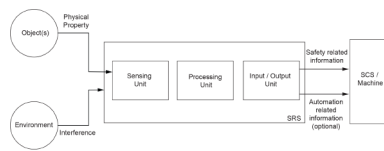


Figure 2 – Example 1 of an SRS architecture

NOTE 1 An SRS can be designed in such a way that safety-related and automation-related functions are performed in separate or common sensing, processing and output unit.

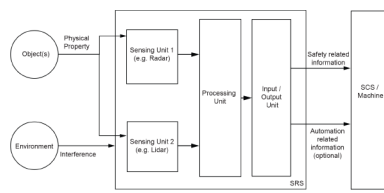


Figure 3 – Example 2 of an SRS architecture

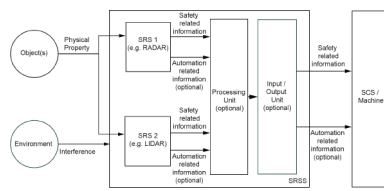


Figure 4 – Example of an SRSS architecture

The sensing unit performs the sensing function by collecting information about the physical properties of object(s) and/or environmental influences in order to provide this as input to the processing unit.

NOTE 2 The sensing unit can contain an emitting element or not.

The processing unit performs the processing function by processing information generated by the sensing unit in order to produce safety-related information.