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TECHNICAL SPECIFICATION

colour inside

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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

IEC TS 62998-1, which is a Technical Specification, has been prepared by IEC technical committee TC 44: Safety of machinery – Electrotechnical aspects.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
44/826/DTS	44/839A/RVDTS

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.

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

A list of all parts in the IEC 62998 series, published under the general title *Safety of machinery*, can be found on the IEC website.

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- withdrawn,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

A bilingual version of this publication 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

Safety related sensors are applied to machinery presenting a risk of personal injury. They provide protection by causing the machine to revert to a safe condition before a person can be placed in a hazardous situation.

IEC 61496 (all parts) provides design and performance requirements of electro-sensitive protective equipment (ESPE). It gives a clear but limited guideline for

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

Autonomous systems like automated guided vehicles (AGV), service robotics or human machine interaction in industries show an increasing demand, for example in

– new sensor technologies (e.g. radar, ultrasonic sensors),
– new kind of sensor functions (e.g. classification of objects, position of an object), and
– combination of different sensor technologies in a sensor system.

Sensor manufacturers or integrators use in such cases generic functional safety standards as guideline for the safety related product design. Generic functional safety standards like IEC 61508 (all parts) or sector specific machinery standards like IEC 62061 or ISO 13849 (all parts) are general and product design can be carried out without inappropriate limitations. Applying these standards would require a dedicated analysis of systematic capabilities of a sensor or sensor system (e.g. dependability of the sensing function under tolerance conditions and environmental influences). There is not enough guidance given in these standards to prevent design failures or insufficient capability to detect the specified object in certain environmental conditions. This can result in an intolerable risk for 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 Technical Specification gives requirements for the development and integration of safety related sensors (SRS) and safety related sensor systems (SRSS) used for protection of persons with special attention to systematic capabilities.

This generic standard only applies if

– protection of persons is to be performed by using sensors, and
– standards for functional safety of electrical control systems address sensor(s) as subsystem or subsystem element, and
– product specific sensor standards (e.g. IEC 61496 (all parts), IEC 60947-5-2) do not contain all necessary provisions, or product specific sensor standards are not developed.

The approach of examination of systematic capabilities by using different safety related sensor standards is described in Annex A.

The requirements and methods within this document are limited to the purpose of protection of persons

– by detection of potentially hazardous objects,

– by detection of a body, parts of a body and objects associated to parts of a body entering a hazardous area, or
– by classification respective discrimination of these against other objects.

NOTE 1 Application of SRS/SRSS in public can require detecting not only of persons, but also their associated equipment, for example 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 There will be no definitions of or interconnections to the types as defined in IEC 61496-1 within this document to simplify and prevent misuse. Simplification for end users is achieved by correlation to existing PL, SIL or SIL_{cl}.

Special attention is given to the sensing function and dependability of the detection capability. Environmental influences and tests for indoor and outdoor use are defined which influence the sensing function and dependability of the detection capability.

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

This document can be relevant to applications other than those for the protection of persons in industries, for example, for the protection of persons in public like agriculture or metro stations.

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

2 Normative references

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

IEC 60068 (all parts), *Environmental testing*

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

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

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

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

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

IEC 61496-1:2012, *Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests*

IEC 62061:2005, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*
IEC 62061:2005/AMD1:2012
IEC 62061:2005/AMD2:2015

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

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

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

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*

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

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 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 within which specified safety related object(s) will be detected

3.1.3
sensing zone
zone defined by length, area or volume within which objects are detected and an SRS or SRSS 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 of 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).

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 of 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, 3.5.9]

3.1.5
detection
determination of the presence and/or value of a physical property

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

3.1.6
detection capability
ability to perform the detection within the limits of use as specified by the manufacturer

3.1.7
loss of detection capability
event of SRS/SRSS when detection 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 degradation of detection capability. A degradation 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
closeness of agreement between a measured quantity value and a true quantity value of a measurand

SEE: Figure 1.

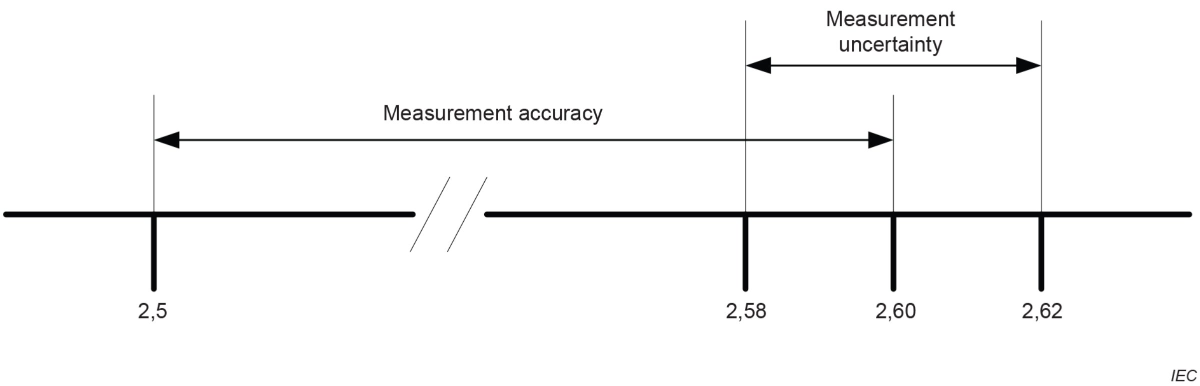

Figure 1 – Measurement accuracy and measurement uncertainty

[SOURCE: ISO/IEC Guide 99:2007, 2.13, modified – The notes to entry have been removed, and the figure has been added.]

3.1.10
measurement uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

[SOURCE: ISO/IEC Guide 99:2007, 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, 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, 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, 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, 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, 192-04-01, modified – The specific use "of an item" given after the term has been removed.]