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colour inside

Safety of machinery – Functional safety of safety-related control systems

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SAFETY OF MACHINERY – FUNCTIONAL SAFETY OF SAFETY-RELATED CONTROL SYSTEMS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 62061 edition 2.1 contains the second edition (2021-03) [documents 44/885/FDIS and 44/888/RVD] and its amendment 1 (2024-03) [documents 44/1020/FDIS and 44/1024/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

IEC 62061 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects. It is an International Standard.

This second constitutes a technical revision.

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

– structure has been changed and contents have been updated to reflect the design process of the safety function,
– standard extended to non-electrical technologies,
– definitions updated to be aligned with IEC 61508-4,
– functional safety plan introduced and configuration management updated (Clause 4),
– requirements on parametrization expanded (Clause 6),
– reference to requirements on security added (Subclause 6.8),
– requirements on periodic testing added (Subclause 6.9),
– various improvements and clarification on architectures and reliability calculations (Clause 6 and Clause 7),
– shift from "SILCL" to "maximum SIL" of a subsystem (Clause 7),
– use cases for software described including requirements (Clause 8),
– requirements on independence for software verification (Clause 8) and validation activities (Clause 9) added,
– new informative annex with examples (Annex G),
– new informative annexes on typical $MTTF_D$ values, diagnostics and calculation methods for the architectures (Annex C, Annex D and Annex H).

The language used for the development of this International Standard 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 in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document and its amendment will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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

As a result of automation, demand for increased production and reduced operator physical effort, Safety-related Control Systems (referred to as SCS) of machines play an increasing role in the achievement of overall machine safety. Furthermore, the SCS themselves increasingly employ complex electronic technology.

IEC 62061 specifies requirements for the design and implementation of safety-related control systems of machinery. This document is machine sector specific within the framework of IEC 61508.

NOTE While IEC 62061 and ISO 13849-1 are using different methodologies for the design of safety related control systems, they intend to achieve the same risk reduction.

This International Standard is intended for use by machinery designers, control system manufacturers and integrators, and others involved in the specification, design and validation of an SCS. It sets out an approach and provides requirements to achieve the necessary performance and facilitates the specification of the safety functions intended to achieve the risk reduction.

This document provides a machine sector specific framework for functional safety of an SCS of machines. It only covers those aspects of the safety lifecycle that are related to safety requirements allocation through to safety validation. Requirements are provided for information for safe use of SCS of machines that can also be relevant to later phases of the lifecycle of an SCS.

There are many situations on machines where SCS are employed as part of safety measures that have been provided to achieve risk reduction. A typical case is the use of an interlocking guard that, when it is opened to allow access to the danger zone, signals the safety related parts of the machine control system to stop hazardous machine operation. In automation, the machine control system that is used to achieve correct operation of the machine process often contributes to safety by mitigating risks associated with hazards arising directly from control system failures. This document gives a methodology and requirements to:

- assign the required safety integrity for each safety function to be implemented by SCS;
- enable the design of the SCS appropriate to the assigned safety (control) function(s);
- integrate safety-related subsystems designed in accordance with other applicable functional safety-related standards (see 6.3.4);
- validate the SCS.

This document is intended to be used within the framework of systematic risk reduction, in conjunction with risk assessment described in ISO 12100. Suggested methodologies for a safety integrity assignment are given in informative Annex A.

SAFETY OF MACHINERY – FUNCTIONAL SAFETY OF SAFETY-RELATED CONTROL SYSTEMS

1 Scope

This International Standard specifies requirements and makes recommendations for the design, integration and validation of safety-related control systems (SCS) for machines. It is applicable to control systems used, either singly or in combination, to carry out safety functions on machines that are not portable by hand while working, including a group of machines working together in a co-ordinated manner.

This document is a machinery sector specific standard within the framework of IEC 61508 (all parts).

The design of complex programmable electronic subsystems or subsystem elements is not within the scope of this document. This is in the scope of IEC 61508 or standards linked to it; see Figure 1.

NOTE 1 Elements such as systems on chip or microcontroller boards are considered complex programmable electronic subsystems.

The main body of this sector standard specifies general requirements for the design, and verification of a safety-related control system intended to be used in high/continuous demand mode.

This document:

– is concerned only with functional safety requirements intended to reduce the risk of hazardous situations;
– is restricted to risks arising directly from the hazards of the machine itself or from a group of machines working together in a co-ordinated manner;

NOTE 2 Requirements to mitigate risks arising from other hazards are provided in relevant sector standards. For example, where a machine(s) is part of a process activity, additional information is available in IEC 61511.

This document does not cover

– electrical hazards arising from the electrical control equipment itself (e.g. electric shock – see IEC 60204-1);
– other safety requirements necessary at the machine level such as safeguarding;
– specific measures for security aspects – see IEC ~~TR~~ TS 63074.

This document is not intended to limit or inhibit technological advancement.

Figure 1 illustrates the scope of this document.

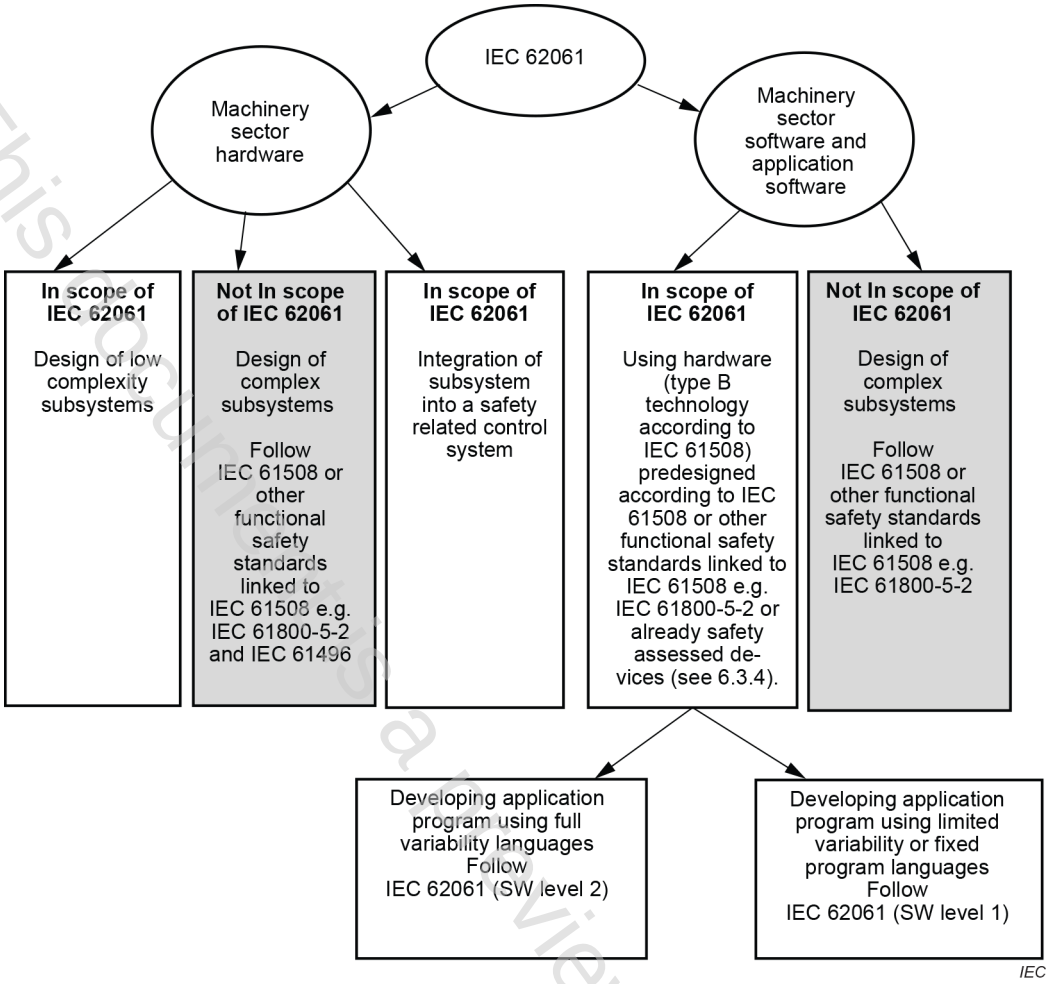

Figure 1 – Scope of this document

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 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 61000-1-2:2016, *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 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*

ISO 12100:2010, *Safety of machinery – General principles for design – Risk assessment and risk reduction*

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

ISO 13849-1:2015, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 13849-2:2012, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation*

3 Terms, definitions and abbreviations

3.1 Alphabetical list of definitions

Terms used throughout IEC 62061 are given in Table 1. Also included are some common abbreviations related to machinery safety.

Table 1 – Terms used in IEC 62061

Term	Definition number
application software	3.2.59
architectural constraint	3.2.46
architecture	3.2.45
average frequency of dangerous failure per hour (PFH)	3.2.29
average probability of dangerous failure on demand (PFD_{avg})	3.2.31
baseline (configuration)	3.2.67
bypass	3.2.17
common cause failure (CCF)	3.2.56
complex component	3.2.8
configuration management	3.2.66
continuous mode	3.2.28
dangerous failure	3.2.52
demand	3.2.25
diagnostic coverage (DC)	3.2.49
diagnostic test interval	3.2.50
embedded software	3.2.60
failure	3.2.51
fault	3.2.33
fault tolerance	3.2.34
full variability language (FVL)	3.2.61
functional safety	3.2.10
hardware fault tolerance (HFT)	3.2.35
hardware safety integrity	3.2.22
harm	3.2.12
hazard	3.2.11
high demand mode	3.2.27
integrator	3.2.13