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Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2023)

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 13849-1:2023 sisaldab Euroopa standardi EN ISO 13849-1:2023 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 13849-1:2023 consists of the English text of the European standard EN ISO 13849-1:2023.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 17.05.2023.	Date of Availability of the European standard is 17.05.2023.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2023)

Sécurité des machines - Parties des systèmes de commande relatives à la sécurité - Partie 1: Principes généraux de conception (ISO 13849-1:2023)

Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen - Teil 1: Allgemeine Gestaltungsleitsätze (ISO 13849-1:2023)

This European Standard was approved by CEN on 3 March 2023.

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European foreword

This document (EN ISO 13849-1:2023) has been prepared by Technical Committee ISO/TC 199 "Safety of machinery" in collaboration with Technical Committee CEN/TC 114 “Safety of machinery” the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2023, and conflicting national standards shall be withdrawn at the latest by May 2026.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 13849-1:2015.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) / Regulation(s).

For the relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

Any feedback and questions on this document should be directed to the users’ national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Endorsement notice

The text of ISO 13849-1:2023 has been approved by CEN as EN ISO 13849-1:2023 without any modification.

Contents

Page

Foreword ... **vi**
Introduction ... **viii**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms, definitions, symbols and abbreviated terms ... **2**
3.1 Terms and definitions ... 2
3.2 Symbols and abbreviated terms ... 10
4 Overview ... **12**
4.1 Risk assessment and risk reduction process at the machine ... 12
4.2 Contribution to the risk reduction ... 14
4.3 Design process of an SRP/CS ... 14
4.4 Methodology ... 15
4.5 Required information ... 16
4.6 Safety function realization by using subsystems ... 17
5 Specification of safety functions ... **17**
5.1 Identification and general description of the safety function ... 17
5.2 Safety requirements specification ... 18
5.2.1 General requirements ... 18
5.2.2 Requirements for specific safety functions ... 21
5.2.3 Minimizing motivation to defeat safety functions ... 24
5.2.4 Remote access ... 25
5.3 Determination of required performance level (PL_r) for each safety function ... 25
5.4 Review of the safety requirements specification (SRS) ... 26
5.5 Decomposition of SRP/CS into subsystems ... 26
6 Design considerations ... **27**
6.1 Evaluation of the achieved performance level ... 27
6.1.1 General overview of performance level ... 27
6.1.2 Correlation between performance level (PL) and safety integrity level (SIL) ... 29
6.1.3 Architecture — Categories and their relation to $MTTF_D$ of each channel, average diagnostic coverage and common cause failure (CCF) ... 29
6.1.4 Mean time to dangerous failure ($MTTF_D$) ... 36
6.1.5 Diagnostic coverage (DC) ... 37
6.1.6 Common cause failures (CCFs) ... 38
6.1.7 Systematic failures ... 38
6.1.8 Simplified procedure for estimating the performance level for subsystems ... 39
6.1.9 Alternative procedure to determine the performance level and PFH without $MTTF_D$ ... 40
6.1.10 Fault consideration and fault exclusion ... 42
6.1.11 Well-tried component ... 43
6.2 Combination of subsystems to achieve an overall performance level of the safety function ... 43
6.2.1 General ... 43
6.2.2 Known PFH values ... 43
6.2.3 Unknown PFH values ... 44
6.3 Software based manual parameterization ... 44
6.3.1 General ... 44
6.3.2 Influences on safety-related parameters ... 45
6.3.3 Requirements for software based manual parameterization ... 46
6.3.4 Verification of the parameterization tool ... 47
6.3.5 Documentation of software based manual parameterization ... 47
7 Software safety requirements ... **47**
7.1 General ... 47

7.2 Limited variability language (LVL) and full variability language (FVL) 49
7.2.1 Limited variability language (LVL) 49
7.2.2 Full variability language (FVL) 49
7.2.3 Decision for limited variability language (LVL) or full variability language (FVL) 49
7.3 Safety-related embedded software (SRESW) 51
7.3.1 Design of safety-related embedded software (SRESW) 51
7.3.2 Alternative procedures for non-accessible embedded software 52
7.4 Safety-related application software (SRASW) 52
8 Verification of the achieved performance level 55
9 Ergonomic aspects of design 55
10 Validation 55
10.1 Validation principles 55
10.1.1 General 55
10.1.2 Validation plan 57
10.1.3 Generic fault lists 58
10.1.4 Specific fault lists 58
10.1.5 Information for validation 58
10.2 Validation of the safety requirements specification (SRS) 59
10.3 Validation by analysis 60
10.3.1 General 60
10.3.2 Analysis techniques 60
10.4 Validation by testing 60
10.4.1 General 60
10.4.2 Measurement accuracy 61
10.4.3 Additional requirements for testing 62
10.4.4 Number of test samples 62
10.4.5 Testing methods 62
10.5 Validation of the safety functions 63
10.6 Validation of the safety integrity of the SRP/CS 63
10.6.1 Validation of subsystem(s) 63
10.6.2 Validation of measures against systematic failures 64
10.6.3 Validation of safety-related software 65
10.6.4 Validation of combination of subsystems 66
10.6.5 Overall validation of safety integrity 66
10.7 Validation of environmental requirements 66
10.8 Validation record 67
10.9 Validation maintenance requirements 67
11 Maintainability of SRP/CS 67
12 Technical documentation 68
13 Information for use 68
13.1 General 68
13.2 Information for SRP/CS integration 68
13.3 Information for user 69
Annex A (informative) **Guidance for the determination of required performance level (PL_r) 71**
Annex B (informative) **Block method and safety-related block diagram 76**
Annex C (informative) **Calculating or evaluating $MTTF_D$ values for single components 78**
Annex D (informative) **Simplified method for estimating $MTTF_D$ for each channel 86**
Annex E (informative) **Estimates for diagnostic coverage (DC) for functions and subsystems 88**
Annex F (informative) **Method for quantification of measures against common cause failures (CCF) 92**
Annex G (informative) **Systematic failure 96**

Annex H (informative) **Example of a combination of several subsystems** **100**
Annex I (informative) **Examples for the simplified procedure to estimate the PL of subsystems** **103**
Annex J (informative) **Example of SRESW realisation** **111**
Annex K (informative) **Numerical representation of Figure 12** **115**
Annex L (informative) **Electromagnetic interference (EMI) immunity** **120**
Annex M (informative) **Additional information for safety requirements specification (SRS)** **124**
Annex N (informative) **Avoiding systematic failure in software design** **126**
Annex O (informative) **Safety-related values of components or parts of control systems** **146**
Bibliography **149**

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 199, *Safety of machinery,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 114, *Safety of machinery,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 13849-1:2015), which has been technically revised.

The main changes are as follows:

— the whole document was reorganized to better follow the design and development process for control systems;

— new Clause 4 on recommendation for risk assessment;

— specification of the safety functions (updated Clause 5);

— combination of several subsystems (updated in Clause 6);

— new Clause 7 on software safety requirements;

— new Clause 9 on ergonomic aspects of design;

— validation (updated Clause 8 and moved to Clause 10);

— new G.5 on management of the functional safety;

— new Annex L on electromagnetic interference (EMI) immunity;

— new Annex M with additional information for safety requirements specification;

— new Annex N on fault-avoiding measures for the design of safety related software;

— new Annex O with safety-related values of components or parts of the control systems.

A list of all parts in the ISO 13849 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The structure of safety standards in the field of machinery is as follows:

a) Type-A standards (basis standards) give basic concepts, principles for design and general aspects that can be applied to machinery.

b) Type-B standards (generic safety standards) deal with one or more safety aspect(s), or one or more type(s) of safeguards that can be used across a wide range of machinery:

   — type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

   — type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure sensitive devices, guards).

c) Type-C standards (machinery safety standards) deal with detailed safety requirements for a particular machine or group of machines.

This document is a type-B1 standard as defined in ISO 12100:2010.

The first edition of this document was published in 1999 based on EN 954-1:1996 (withdrawn standard). The second edition was revised in 2006 and the third edition was revised in 2015.

This document is of relevance, in particular for the following stakeholder groups with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organisations, market surveillance).

Others can be affected by the level of machinery safety achieved with the means of the document:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (i.e. machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate in the drafting process of this document.

In addition, this document is intended for standardization bodies elaborating type-C standards, as defined in ISO 12100:2010.

The requirements of this document can be supplemented or modified by a type-C standard.

For machines which are covered by the scope of a type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that type-C standard take precedence.

NOTE 1 The examples and basis for most content is based on stationary machines in factory applications. However, other machines are not excluded. This document was written without considering if certain machinery (e.g. mobile machinery) has specific requirements. However, this document is intended to be used across many machinery industries and as a basis for type-C standards developers, as far as applicable.

This document is intended to give guidance to those involved in the design and assessment of control systems, and those preparing type-B2 or type-C standards.

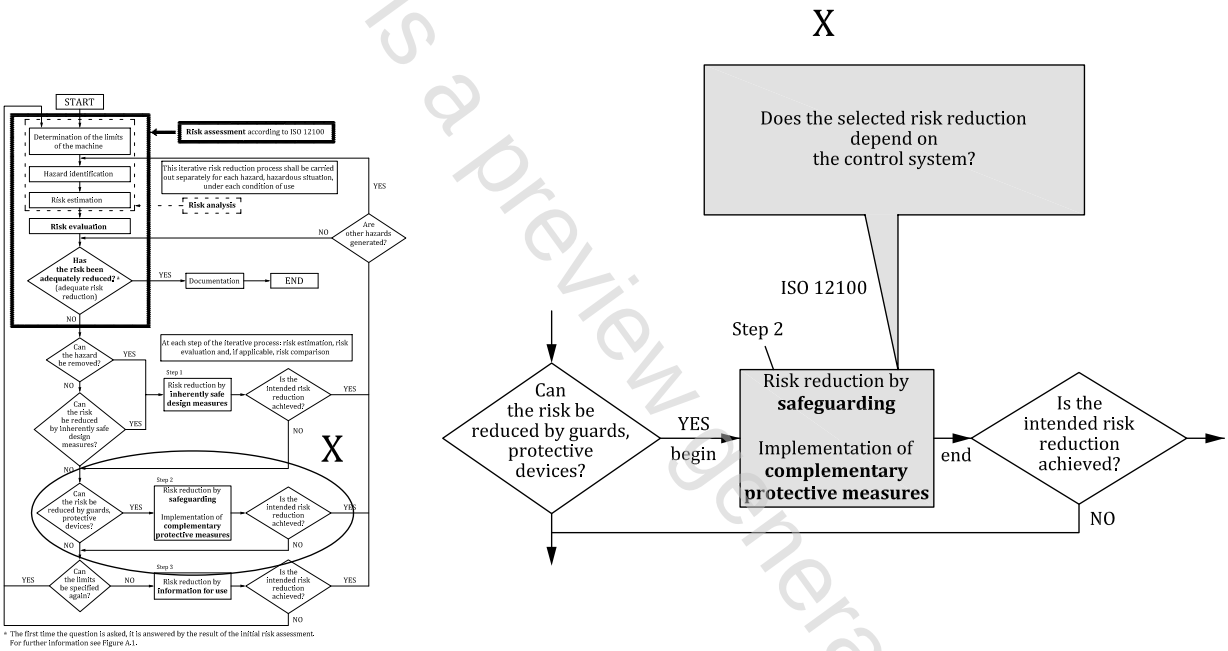
Risk reduction according to ISO 12100:2010, Clause 6, is accomplished by applying, in the following sequence, inherently safe design measures, safeguarding and/or complementary risk reduction

measures and information for use. A designer can reduce risks by risk reduction measures that can have safety functions. Parts of machinery control systems that are assigned to provide safety functions are called safety-related parts of control systems (SRP/CS). These can consist of hardware or a combination of hardware and software and can either be separate from the machine control system or an integral part of it. In addition to implementing safety functions, SRP/CS can also implement operational functions.

ISO 12100:2010 is used for risk assessment of the machine. Annex A of this document can be used for the determination of the required performance level (PL_r) of a safety function performed by the SRP/CS, where its PL_r is not specified in the applicable type-C standard. This document is relevant for the SRP/CS safety functions that are used to address risks for cases where a risk assessment conducted according to ISO 12100:2010 determines that a risk reduction measure is needed that relies on a safety function (e.g. interlocking guard). In those cases, the safety-related control system performs a safety function. This document is intended to be used to design and evaluate the SRP/CS. Only the part of the control system that is safety-related falls under the scope of this document.

Figure 1 illustrates the relationship between ISO 12100:2010 and this document. For a detailed overview see Figure 2.

NOTE 2 See also ISO/TR 22100-2:2013 for further information.



NOTE Based on ISO/TR 22100-2:2013, Figure 2.

Figure 1 — Integration of this document (ISO 13849-1) within the risk reduction process of ISO 12100:2010

NOTE 3 Figure 1 shows where the SRP/CS contributes to the risk reduction process of ISO 12100:2010: Step 2. The SRP/CS supports the combined risk reduction measures by the implementation of safety functions. The ability of safety-related parts of control systems to perform a safety function under foreseeable conditions is allocated one of five levels, called performance levels (PL). The required performance level (PL_r) for a particular safety function (depending on the required risk reduction) will be determined by risk estimation.

Informative Annex A of this document contains a method for risk estimation and can be used for the determination of the PL_r of a safety function performed by the SRP/CS. Any risk estimation method will show a variance because of the subjective nature of the evaluation criteria. In comparison to Annex A, type-C standards can have more specific risk estimation methods for specific machine applications.

The frequency of dangerous failure of the safety function depends on several factors, including but not limited to, hardware and software structure, the extent of fault detection mechanisms [diagnostic

coverage (DC)], reliability of components [mean time to dangerous failure ($MTTF_D$), common cause failure (CCF)], design process, operating stress, environmental conditions and operation procedures.

In order to facilitate the design of SRP/CS and the assessment of achieved PL, this document employs a methodology based on the categorization of architectures with specific design criteria (e.g. $MTTF_D$, DC_{avg}) and specified behaviour under fault conditions. These architectures are allocated one of five levels termed Categories B, 1, 2, 3 and 4.

Functional safety considers the failure characteristics of elements/components performing a safety function. For each safety function, this failure characteristic is expressed as the frequency of dangerous failure per hour (PFH).

The performance levels and categories can be applied to SRP/CS, e.g.:

— control units (e.g. a logic unit for control functions, data processing, monitoring);

— electro-sensitive protective devices (e.g. photoelectric barriers), pressure sensitive devices.

The performance levels can be defined, and categories determined, for subsystems of SRP/CS using safety parts (components), e.g.:

— protective devices (e.g. two-hand control devices, interlocking devices);

— power control elements (e.g. relays, valves);

— sensors and HMI elements (e.g. position sensors, enable switches).

Machinery covered by this document can range from simple (e.g. small kitchen machines, or automatic doors and gates) to complex (e.g. packaging machines, printing machines, presses and integrated machinery into a system).

This document and IEC 62061 both specify a methodology and provide related guidance for the design and implementation of safety-related control systems of machinery.

The requirements of Clause 10 of this document supersede the requirements of ISO 13849-2:2012 (excluding the informative annexes).

Safety of machinery — Safety-related parts of control systems —

Part 1: General principles for design

1 Scope

This document specifies a methodology and provides related requirements, recommendations and guidance for the design and integration of safety-related parts of control systems (SRP/CS) that perform safety functions, including the design of software.

This document applies to SRP/CS for high demand and continuous modes of operation including their subsystems, regardless of the type of technology and energy (e.g. electrical, hydraulic, pneumatic, and mechanical). This document does not apply to low demand mode of operation.

NOTE 1 See 3.1.44 and the IEC 61508 series for low demand mode of operation.

This document does not specify the safety functions or required performance levels (PL_r) that are to be used in particular applications.

NOTE 2 This document specifies a methodology for SRP/CS design without considering if certain machinery (e.g. mobile machinery) has specific requirements. These specific requirements can be considered in a Type-C standard.

This document does not give specific requirements for the design of products/components that are parts of SRP/CS. Specific requirements for the design of some components of SRP/CS are covered by applicable ISO and IEC standards.

This document does not provide specific measures for security aspects (e.g. physical, IT-security, cyber security).

NOTE 3 Security issues can have an effect on safety functions. See ISO/TR 22100-4 and IEC/TR 63074 for further information.

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.

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

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

ISO 13855:2010, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body*

ISO 20607:2019, *Safety of machinery — Instruction handbook — General drafting principles*

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 3: Software requirements*

IEC 62046:2018, *Safety of machinery — Application of protective equipment to detect the presence of persons*

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

IEC/IEEE 82079-1:2019, *Preparation of information for use (instructions for use) of products — Part 1: Principles and general requirements*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
safety-related part of a control system
SRP/CS
part of a control system that performs a *safety function* (3.1.27), starting from a safety-related input(s) to generating a safety-related output(s)

Note 1 to entry: The safety-related parts of a control system start at the point where the safety-related inputs are initiated (including, for example, the actuating cam and the roller of the position switch) and end at the output of the power control elements (including, for example, the main contacts of a contactor).

3.1.2
machine control system
system which responds to input signals from parts of machine elements, operators, external control equipment or any combination of these and generates output signals causing the machine to behave in the intended manner

Note 1 to entry: The machine control system can use any technology or any combination of different technologies (e.g. electrical/electronic, hydraulic, pneumatic and mechanical).

3.1.3
safety requirements specification
SRS
specification containing the requirements for the *safety functions* (3.1.27) that have to be met by the safety-related control system in terms of characteristics of the safety functions (functional requirements) and *required performance levels (PL_r)* (3.1.6)

[SOURCE: IEC 61508-4:2010, 3.5.11, modified — Information from IEC 61508-4:2010, 3.5.12 has been included.]

3.1.4
category
classification of the *subsystem* (3.1.45) in respect to its resistance to *faults* (3.1.8) and the subsequent behaviour in the fault condition which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability

3.1.5
performance level
PL
discrete level used to specify the ability of *safety-related parts of control systems (SRP/CS)* (3.1.1) to perform a *safety function* (3.1.27) under foreseeable conditions

Note 1 to entry: See 6.1 for a general overview of performance level.