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Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design (ISO 13849-1:2006)

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Denna standard ersätter SS-EN ISO 13849-1:2006, utgåva 1.

The European Standard EN ISO 13849-1:2008 has the status of a Swedish Standard. This document contains the official English version of EN ISO 13849-1:2008.

This standard supersedes the Swedish Standard SS-EN ISO 13849-1:2006, edition 1.

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English Version

**Safety of machinery - Safety-related parts of control systems -
Part 1: General principles for design (ISO 13849-1:2006)**

Sécurité des machines - Parties des systèmes de
commande relatives à la sécurité - Partie 1: Principes
généraux de conception (ISO 13849-1:2006)

Sicherheit von Maschinen - Sicherheitsbezogene Teile von
Steuerungen - Teil 1: Allgemeine Gestaltungsleitsätze (ISO
13849-1:2006)

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Foreword

The text of ISO 13849-1:2006 has been prepared by Technical Committee ISO/TC 199 "Safety of machinery" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 13849-1:2008 by 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of an identical text or by endorsement, at the latest by December 2008, and conflicting national standards shall be withdrawn at the latest by December 2009.

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

This document supersedes EN ISO 13849-1:2006.

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

For relationship with EC Directive(s), see informative Annexes ZA and ZB, which are integral part of this document.

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 13849-1:2006 has been approved by CEN as a EN ISO 13849-1:2008 without any modification.

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-hands 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 part of ISO 13849 is a type-B-1 standard as stated in ISO 12100-1.

When provisions of a type-C standard are different from those which are stated in type-A or type-B standards, the provisions of the type-C standard take precedence over the provisions of the other standards for machines that have been designed and built according to the provisions of the type-C standard.

This part of ISO 13849 is intended to give guidance to those involved in the design and assessment of control systems, and to Technical Committees preparing Type-B2 or Type-C standards which are presumed to comply with the Essential Safety Requirements of Annex I of the Council Directive 98/37/EC, The Machinery Directive. It does not give specific guidance for compliance with other EC directives.

As part of the overall risk reduction strategy at a machine, a designer will often choose to achieve some measure of risk reduction through the application of safeguards employing one or more safety functions.

Parts of machinery control systems that are assigned to provide safety functions are called safety-related parts of control systems (SRP/CS) and these can consist of hardware and software and can either be separate from the machine control system or an integral part of it. In addition to providing safety functions, SRP/CS can also provide operational functions (e.g. two-handed controls as a means of process initiation).

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). These performance levels are defined in terms of probability of dangerous failure per hour (see Table 3).

The probability of dangerous failure of the safety function depends on several factors, including 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 assist the designer and help facilitate the assessment of achieved PL, this document employs a methodology based on the categorization of structures according to specific design criteria and specified behaviours under fault conditions. These categories are allocated one of five levels, termed Categories B, 1, 2, 3 and 4.

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The performance levels and categories can be applied to safety-related parts of control systems, such as

- protective devices (e.g. two-hand control devices, interlocking devices), electro-sensitive protective devices (e.g. photoelectric barriers), pressure sensitive devices,
- control units (e.g. a logic unit for control functions, data processing, monitoring, etc.), and
- power control elements (e.g. relays, valves, etc),

as well as to control systems carrying out safety functions at all kinds of machinery — from simple (e.g. small kitchen machines, or automatic doors and gates) to manufacturing installations (e.g. packaging machines, printing machines, presses).

This part of ISO 13849 is intended to provide a clear basis upon which the design and performance of any application of the SRP/CS (and the machine) can be assessed, for example, by a third party, in-house or by an independent test house.

Information on the recommended application of IEC 62061 and this part of ISO 13849

IEC 62061 and this part of ISO 13849 specify requirements for the design and implementation of safety-related control systems of machinery. The use of either of these International Standards, in accordance with their scopes, can be presumed to fulfil the relevant essential safety requirements. The following table summarizes the scopes of IEC 62061 and this part of ISO 13849.

Table 1 — Recommended application of IEC 62061 and ISO 13849-1

	Technology implementing the safety-related control function(s)	ISO 13849-1	IEC 62061
A	Non-electrical, e.g. hydraulics	X	Not covered
B	Electromechanical, e.g. relays, and/or non complex electronics	Restricted to designated architectures ^a and up to PL = e	All architectures and up to SIL 3
C	Complex electronics, e.g. programmable	Restricted to designated architectures ^a and up to PL = d	All architectures and up to SIL 3
D	A combined with B	Restricted to designated architectures ^a and up to PL = e	X ^c
E	C combined with B	Restricted to designated architectures (see Note 1) and up to PL = d	All architectures and up to SIL 3
F	C combined with A, or C combined with A and B	X ^b	X ^c
X indicates that this item is dealt with by the International Standard shown in the column heading.			
^a Designated architectures are defined in 6.2 in order to give a simplified approach for quantification of performance level.			
^b For complex electronics: use designated architectures according to this part of ISO 13849 up to PL = d or any architecture according to IEC 62061.			
^c For non-electrical technology, use parts in accordance with this part of ISO 13849 as subsystems.			

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

Part 1: General principles for design

1 Scope

This part of ISO 13849 provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software. For these parts of SRP/CS, it specifies characteristics that include the performance level required for carrying out safety functions. It applies to SRP/CS, regardless of the type of technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.), for all kinds of machinery.

It does not specify the safety functions or performance levels that are to be used in a particular case.

This part of ISO 13849 provides specific requirements for SRP/CS using programmable electronic system(s).

It does not give specific requirements for the design of products which are parts of SRP/CS. Nevertheless, the principles given, such as categories or performance levels, can be used.

NOTE 1 Examples of products which are parts of SRP/CS: relays, solenoid valves, position switches, PLCs, motor control units, two-hand control devices, pressure sensitive equipment. For the design of such products, it is important to refer to the specifically applicable International Standards, e.g. ISO 13851, ISO 13856-1 and ISO 13856-2.

NOTE 2 For the definition of *required performance level*, see 3.1.24.

NOTE 3 The requirements provided in this part of ISO 13849 for programmable electronic systems are compatible with the methodology for the design and development of safety-related electrical, electronic and programmable electronic control systems for machinery given in IEC 62061.

NOTE 4 For safety-related embedded software for components with $PL_r = e$ see IEC 61508-3:1998, Clause 7.

NOTE 5 See also Table 1.

2 Normative references

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

ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 13849-2:2003, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

ISO 14121¹⁾, *Safety of machinery — Principles of risk assessment*

IEC 60050-191:1990, *International electrotechnical vocabulary — Chapter 191: Dependability and quality of service*, and IEC 60050-191-am1:1999 and IEC 60050-191-am2:2002:1999, *Amendment 1 and Amendment 2, International Electrotechnical Vocabulary. Chapter 191: Dependability and quality of service*

IEC 61508-3:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements*, and IEC 61508-3 Corr.1:1999, *Corrigendum 1 — Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 3: Software requirements*

IEC 61508-4:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 4: Definitions and abbreviations*, and IEC 61508-4 Corr.1:1999, *Corrigendum 1 — Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 4: Definitions and abbreviations*

1) To be published. (Revision of ISO 14121:1999)