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Safety of machinery — Two-hand control devices — Principles for design and selection

Sécurité des machines — Dispositifs de commande bimanuelle — Principes de conception et de choix

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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*.

This second edition cancels and replaces the first edition (ISO 13851:2002), which has been technically revised.

The main change compared to the previous edition is the adaptation of the safety-related parts of the control system from the categories to the Performance Level (PL) (according to ISO 13849-1) or SIL with the allocated HTF (according to IEC 62061).

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** (basic safety standards) giving basic concepts, principles for design and general aspects that can be applied to all machinery;

b) **type-B standards** (generic safety standards) dealing with one safety aspect or one or more type(s) of safeguard 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** (machine safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This document is a type-B2 standard as stated in ISO 12100.

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

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

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

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

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

— machine users/employees (e.g. trade unions, organizations for people with special needs);

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

— consumers (in case of machinery intended for use by consumers).

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

In addition, this document is intended for standardization bodies elaborating type-C standards.

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

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

A two-hand control device (THCD) is a protective device. It provides protection for the operator against reaching danger zones during hazardous situations by locating the control actuating devices in a specific position and distance from the danger zone(s).

The selection of a THCD as an appropriate safety device depends upon the risk assessment made by designers, standard makers and others in accordance with ISO 12100.

The definition of a THCD is given in 3.1 and takes precedence over the definition given in ISO 12100.

In some arrangements, enabling devices (see ISO 12100) and/or hold-to-run devices (see ISO 12100) may comply with the definition of a THCD in this document. Additionally, some special control devices — such as some crane controls — require the use of two hands and can comply with the definition of a THCD in this document.

Safety of machinery — Two-hand control devices — Principles for design and selection

1 Scope

This document specifies the safety requirements of a two-hand control device (THCD) and the dependency of the output signal from the actuation by hand of the control actuating devices.

This document describes the main characteristics of THCDs for the achievement of safety and sets out combinations of functional characteristics for three types. It does not apply to devices intended to be used as enabling devices, as hold-to-run devices or as special control devices.

This document does not specify with which machines THCDs shall be used. It also does not specify which types of two-hand-control device shall be used for a specific application. Moreover, while guidance is given, it does not specify the required distance between the THCD and the danger zone (see 8.8).

This document provides requirements for design and guidance on the selection (based on a risk assessment) of THCDs including the prevention of defeat, the avoidance of faults and verification of compliance.

NOTE 1 A THCD only offers protection for the person using it.

NOTE 2 For specific machines, the suitability of a two-hand control as a suitable protective device can be defined in a type-C standard. If such a standard does not exist or is not appropriate, the risk assessment and determination of suitable protective measures is the responsibility of the manufacturer of the machine.

This document applies to all THCDs, independent of the energy used, including:

— THCDs which are fully assembled for installation;

— THCDs which are assembled by the machine manufacturer or integrator.

This document is not applicable to THCDs manufactured before the date of its publication.

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 13849-1:2015, *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*

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

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

3 Terms and definitions

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

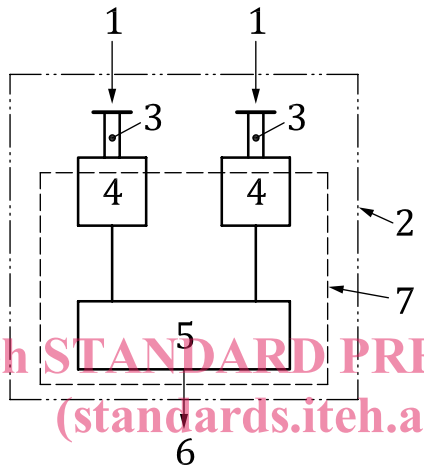
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

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

3.1
two-hand control device
THCD
device which requires simultaneous actuation by the use of both hands in order to initiate and to maintain hazardous machine functions, thus providing protective measure only for the person who actuates it

Note 1 to entry: See Figure 1.



Key

1	actuation by hands	5	signal processor(s)
2	THCD	6	output signal(s)
3	control actuating devices (actuators)	7	logic unit
4	signal converter(s)		

Figure 1 — Schematic representation of a THCD

Note 2 to entry: Inclusion of Figure 1 is a modification of ISO 12100:2010, 3.28.4.

3.2
input signal
externally actuated signal applied by hand to a *control actuating device* (3.3)

Note 1 to entry: See Figure 1.

3.3
control actuating device
actuator
component of the *THCD* (3.1) which senses an *input signal* (3.2) from one hand and transmits it to a *signal converter* (3.6)

Note 1 to entry: See Figure 1.

3.4
simultaneous actuation
continuing actuation of both *control actuating devices* (3.3) during the same time period, whatever the time lag is between the start of one *input signal* (3.2) and the start of the other

Note 1 to entry: See Figure 2.

3.5
synchronous actuation
particular case of *simultaneous actuation* (3.4) within a defined time period

Note 1 to entry: See also 5.8.

3.6
signal converter
component of the *THCD* (3.1) which receives an *input signal* (3.2) from a *control actuating device* (3.3) and which transmits and/or converts this signal into a form acceptable to the *signal processor* (3.7)

Note 1 to entry: See Figure 1.

3.7
signal processor
part of the *THCD* (3.1) which generates the *output signal* (3.8) as a consequence of the actuation by hands

Note 1 to entry: See Figure 1.

3.8
output signal
signal generated by the *THCD* (3.1) intended to be processed by a control system

Note 1 to entry: See Figure 1.

3.9
response time
time between the release of a *control actuating device* (3.3) and the cessation of the *output signal* (3.8)

Note 1 to entry: See also 8.8.

3.10
relocatable THCD
device which can be moved and used in more than one definable position relative to the danger zone of the machine with which it is interfaced

4 THCD selection and THCD types

4.1 Selection

The selection of a THCD as a protective device depends upon the risk assessment (e.g. made by machine manufacturer and integrators, designers and standards requirements).

The selection and the design of the type (see Table 1) of the THCD depend on

— the hazard(s) present;

— the risk assessment in accordance with ISO 12100;

— experience in use of the technology;

— other factors, which shall be specified for each application [e.g. the prevention of accidental actuation and of defeat (see Clause 7), as well as other conditions (see ISO 12100:2010, 5.5.3)].

NOTE 1 Guidance on risk assessment is given in ISO 12100 and detailed examples can be found in ISO/TR 14121-2.

NOTE 2 Additional information for the selection of the THCD can be found in relevant type C-standards.

4.2 Types of THCD

Table 1 defines three types of the THCD. It sets out the functional characteristics and the minimum measures for the safety of each type of the THCD in this document.

Table 1 — List of types of the THCD and minimum safety requirements

Requirements	Subclause	Type				
		I[a]	II	III		
				A	B	C
Use of both hands (simultaneous actuation)	5.2	X	X	X	X	X
Relationship between input signals and output signal	5.3	X	X	X	X	X
Cessation of the output signal	5.4	X	X	X	X	X
Prevention of accidental operation	5.5	X	X	X	X	X
Prevention of defeat	5.6	X	X	X	X	X
Re-initiation of the output signal	5.7		X	X	X	X
Synchronous actuation	5.8			X	X	X
At least PL c (according to ISO 13849-1) or SIL 1 (according to IEC 62061)		X		X		
At least PL d with category 3 (according to ISO 13849-1) or SIL 2 with HFT=1 (according to IEC 62061)			X		X	
Use of PL e with category 4 (according to ISO 13849-1) or SIL 3 with HFT=1 (according to IEC 62061)						X

[a] Whenever the selection of a type I THCD is being considered, it is important to carry out the risk assessment carefully to determine whether the characteristics of synchronous operation and of re-initiation can be neglected.

5 Requirements for the design of two-hand control devices

5.1 General

The characteristics described in 5.2 to 5.8 shall be included in THCDs in accordance with Table 1. The objective is to ensure that the operator's hands or, when appropriate, body are located safely and to prevent an unexpected start-up.

The safety functions and their requirements, e.g. "synchronous actuation", shall be carried out under all environmental conditions stated by the manufacturer.

5.2 Use of both hands (simultaneous actuation)

The THCD shall be designed and integrated so that the operator must use both hands simultaneously, one hand on each control actuating device, to operate the machine. This is simultaneous actuation independent of any time lag between the initiations of each of the two input signals (see Figure 2).

NOTE Requirements for synchronous actuation define the permitted time lag between the initiations of each of the two input signals.

5.3 Relationship between actuation by hand and output signal(s)

The actuation by hand applied to each of the control actuating devices shall together initiate and maintain the output signal(s) from the THCD as long as they remain actuated. The form of the output

signal(s) [e.g. number of channels, pulse(s), shape(s), source(s) of energy etc.] may vary depending on the design requirements in each case.

5.4 Cessation of the output signal

The release of either one or both control actuating devices shall initiate the cessation of the output signal.

5.5 Prevention of accidental operation

The probability of operating the control actuating devices accidentally shall be minimized (see Clauses 7 and 8).

5.6 Prevention of defeat

The protective effect of the THCD shall not be easily defeated (see Clauses 7 and 8).

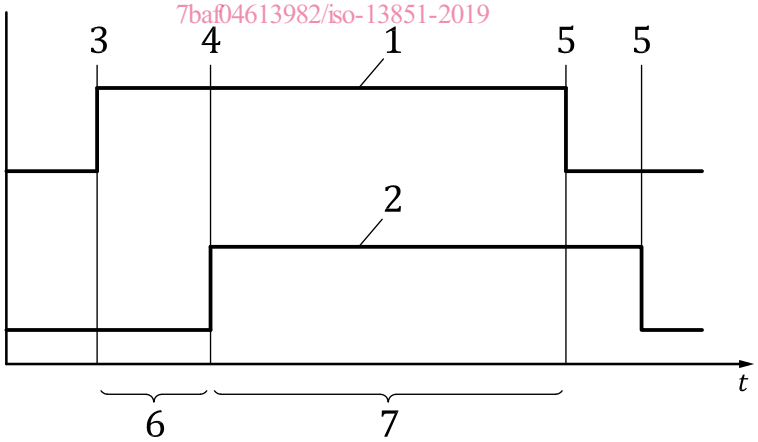
5.7 Re-initiation of the output signal

The re-initiation of the output signal shall only be possible after the release of both control actuating devices (see 6.2).

5.8 Synchronous actuation

5.8.1 For type III the control actuating devices shall be actuated with a tolerance on the simultaneity of actuation less than or equal to 0,5 s between the actuation of one control actuating device and the actuation of the second control actuating device. This is considered to be synchronous operation. See Figure 2.

For ergonomic requirements, see also 8.1.



Key

1	first hand	5	cessation of input signals
2	second hand	6	time lag ≤0,5 s, synchronous actuation
3	initiation of the first input signal	7	time period of simultaneous actuation
4	initiation of the second input signal		

Figure 2 — Input signals in the case of synchronous actuation

5.8.2 If the control actuating devices type III are not actuated synchronously, the output signal shall be prevented and it shall be necessary to release both control actuating devices and to re-apply both input signals.