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Safety of machinery — Two-hand control devices — Functional aspects and design principles

Sécurité des machines — Dispositifs de commande bimanuelle — Aspects fonctionnels et principes de conception

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

International Standard ISO 13851 was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

Annex A forms a normative part of this International Standard. Annexes B and C are for information only.

Introduction

A two-hand control device is a safety device (safety component). It provides a measure of protection for the operator against reaching danger zones during hazardous situations by locating the control actuating devices in a specific position. For hand-held machinery, it should be taken into consideration that the danger zone is not stationary.

The selection of a two-hand control device as an appropriate safety device will depend upon the risk assessment made by designers, standard makers and others in accordance with ISO/TR 12100-1 and ISO 14121.

The definition of a two-hand control device is given in 3.1 and takes precedence over the definition given in ISO/TR 12100-1:1992, 3.23.4.

In some arrangements, enabling devices (see ISO/TR 12100-1:1992, 3.23.2) and/or hold-to-run devices (see ISO/TR 12100-1:1992, 3.23.3) may comply with the definition of a two-hand control device in this International Standard. Additionally, some special control devices — such as teach pendants for robots and some crane controls — require the use of two hands and can comply with the definition of a two-hand control device in this International Standard.

This International Standard has been prepared as a harmonized standard in the sense of the Machinery Directive of the European Union and the rules of the European Free Trade Association (EFTA) which are associated with it. This International Standard is based on EN 574:1996, published by the European Committee for Standardization (CEN).

Safety of machinery — Two-hand control devices — Functional aspects and design principles

1 Scope

This International Standard specifies the safety requirements of a two-hand control device and the dependency of the output signal from the input signals.

This International Standard describes the main characteristics of two-hand control devices 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 International Standard does not specify with which machines two-hand control devices shall be used. It also does not specify which types of two-hand-control device shall be used. Moreover, it does not specify the distance between the two-hand control device and the danger zone (see 9.8).

This International Standard provides requirements and guidance on the design and selection (based on a risk assessment) of two-hand control devices including their assessment, the prevention of defeat and the avoidance of faults. It also provides requirements and guidance for two-hand control devices containing a programmable electronic system (see clause 7).

This International Standard applies to all two-hand control devices, independent of the energy used, including:

— two-hand control devices which are or are not integral parts of a machine;

— two-hand control devices which consist of one or more than one separate element.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TR 12100-1:1992, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO/TR 12100-2:1992, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*

ISO 13849-1:1999, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13855:2002, *Safety of machinery — Positioning of protective equipment with respect to the approach speeds of parts of the human body*

ISO 14121, *Safety of machinery — Principles of risk assessment*

IEC 60204-1:1997, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

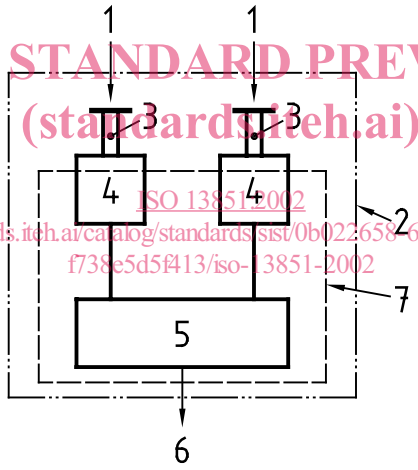
EN 894-3, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
two-hand control device
a device which requires at least simultaneous actuation by the use of both hands in order to initiate and to maintain, whilst a hazardous condition exists, any operation of a machine thus affording a measure of protection only for the person who actuates it

See Figure 1.



Key

1 Input signal
2 Two-hand control device
3 Control actuating device
4 Signal converter(s)
5 Signal processor(s)
6 Output signal
7 Logic unit

Figure 1 — Schematic representation of a two-hand control device

3.2
input signal
the externally actuated signal applied by hand to a control-actuating device

See Figure 1.

3.3
control actuating device
a component of the two-hand control device which senses an input signal from one hand and transmits it to a signal converter

See Figure 1.

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

See Figure 2.

NOTE In the English language, the word “concurrent” and the word “simultaneous” are often used synonymously (see e.g. IEC60204-1:1997, 9.2.5.7).

3.5
synchronous actuation
a particular case of simultaneous actuation where the time lag between the start of one input signal and the start of the other is less than or equal to 0,5 s

See Figure 3.

3.6
signal converter
a component of the two-hand control device which receives an input signal from a control actuating device and which transmits and/or converts this signal into a form acceptable to the signal processor

See Figure 1.

3.7
signal processor
a part of the two-hand control device which generates the output signal as a consequence of the two input signals

See Figure 1.

3.8
output signal
the signal generated by the two-hand control device to be fed into the machinery to be controlled, and which is based on one pair of input signals

See Figure 1.

3.9
response time
the time between the release of a control actuating device and the cessation of the output signal

See also 9.8.

3.10
mobile two-hand control device
a device which can be moved and used in more than one definable position relative to the danger zone of the machine which it controls

4 Types of two-hand control device and their selection

Table 1 defines three types of two-hand control device. It sets out the functional characteristics and the minimum measures for the safety of each type of two-hand control device in this International Standard. All two-hand control devices shall comply with ISO/TR 12100 and with IEC 60204-1.

Table 1 — List of types of two-hand control device and minimum safety requirements

Requirements	Subclause	Type				
		I	II	III		
				A	B	C
Use of both hands (simultaneous actuation)	5.1	X	X	X	X	X
Relationship between input signals and output signal	5.2	X	X	X	X	X
Cessation of the output signal	5.3	X	X	X	X	X
Prevention of accidental operation	5.4	X	X	X	X	X
Prevention of defeat	5.5	X	X	X	X	X
Re-initiation of the output signal	5.6	[a]	X	X	X	X
Synchronous actuation	5.7			X	X	X
Use of category 1 (see ISO 13849-1)	6.2	X		X		
Use of category 3 (see ISO 13849-1)	6.3		X		X	
Use of category 4 (see ISO 13849-1)	6.4					X

[a] For the selection of type I, see 8.6.

The selection and the design of the type (see Table 1) of two-hand control device will depend on

— the hazard(s) present;

— the risk assessment;

— 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 8), as well as other conditions (see ISO/TR 12100-2:1992, clause 3)].

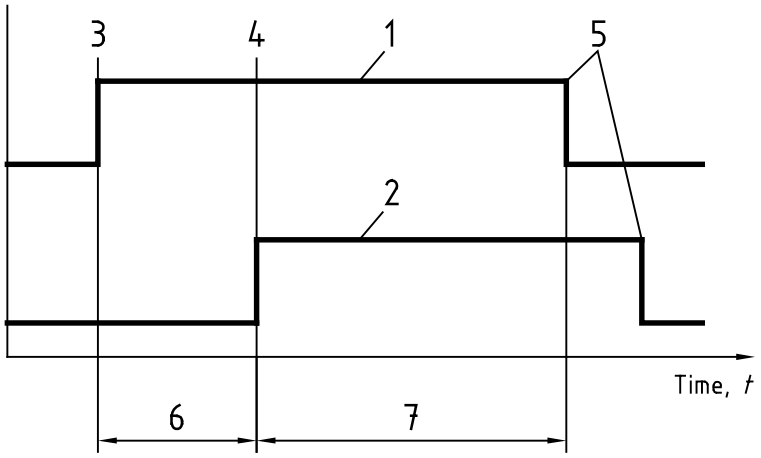
NOTE Guidance on risk assessment may be found in ISO/TR 12100-1 and detailed guidance is given in ISO 14121.

5 Characteristics of safety functions

The characteristics of safety functions described in 5.1 to 5.7 shall be included in two-hand control devices in accordance with Table 1.

5.1 Use of both hands (simultaneous actuation)

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



Key

1 First hand
2 Second hand
3 Initiation of first input signal
4 Initiation of second input signal
5 Cessation of input signals
6 Time lag undefined, simultaneous actuation
7 Time period of simultaneous actuation

Figure 2 — Input signals in the case of simultaneous actuation

5.2 Relationship between input signals and output signal

The input signals applied to each of the two control actuating devices shall together initiate and maintain the output signal from the two-hand control device only so long as both input signals are applied. The form of the output signal (e.g. number of channels, pulse, shape, etc.) may vary depending on the design requirements in each case. It shall always be regarded as, and shall be identified as, a single output signal by the machine control circuit.

5.3 Cessation of the output signal

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

5.4 Prevention of accidental operation

The probability of operating the control actuating devices accidentally shall be minimized (see clauses 8 and 9).

5.5 Prevention of defeat

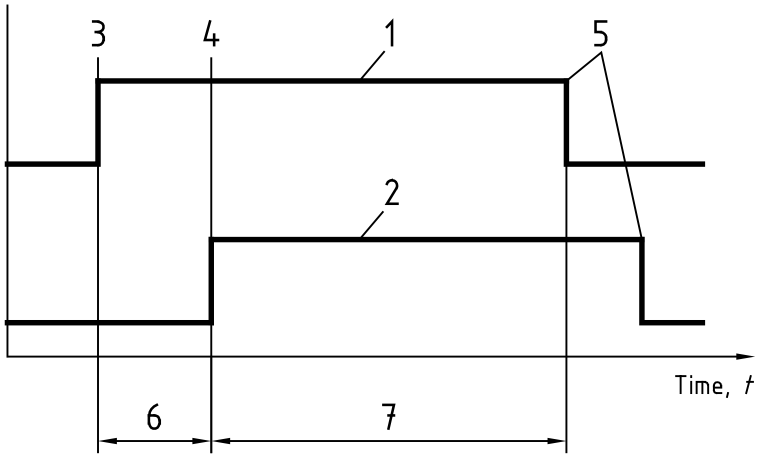
The protective effect of the two-hand control device shall not be easily defeated (see clauses 8 and 9).

5.6 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.

5.7 Synchronous actuation

5.7.1 An output signal shall be generated only when both control actuating devices are actuated in a time lag which is less than or equal to 0,5 s (see Figure 3).



Key

1 First hand
2 Second hand
3 Initiation of first input signal
4 Initiation of second input signal
5 Cessation of input signals
6 Time lag ⩽ 0,5 s, synchronous actuation
7 Time period of simultaneous actuation

Figure 3 — Input signals in the case of synchronous actuation

5.7.2 Mechanical two-hand control devices shall only generate an output signal by satisfying particular spatial requirements for the travel of both of the control actuating devices.

5.7.3 If the control actuating devices 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.

NOTE Where two or more two-hand control devices are used to operate one machine, synchronous actuation is required only within each two-hand control device and is not required between devices.

6 Requirements related to categories of control

6.1 Category selection

The behaviour of parts of a two-hand control device in the case of failure shall be in accordance with the selected category of ISO 13849-1 (see Table 2).

The category of control of two-hand control devices shall not be less than the category of control of the relevant safety related part of the machine control system (see ISO 13849-1).

Annex B describes the relationship between the types of two-hand control devices and the categories according to ISO 13849-1.

6.2 Use of category 1

Well-tried safety components and safety principles in accordance with, at least, category 1 of ISO 13849-1 shall be used in type I and type IIIA two-hand control devices.

NOTE In order to achieve high reliability and high availability, it is recommended that well-tried safety components and safety principles be used in all types of two-hand control device.

