INTERNATIONAL STANDARD

ISO 13851

Second edition
2019-03

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

Reference number
ISO 13851:2019(E)

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

Published in Switzerland

Contents

Page

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.

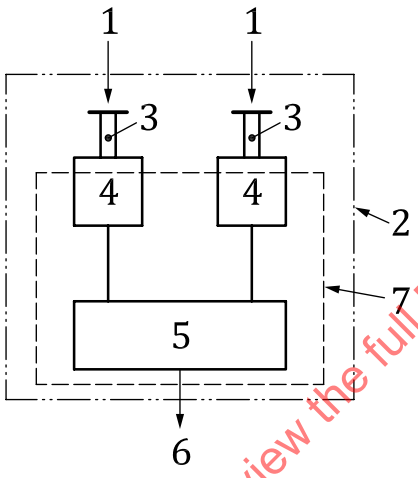
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— 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).

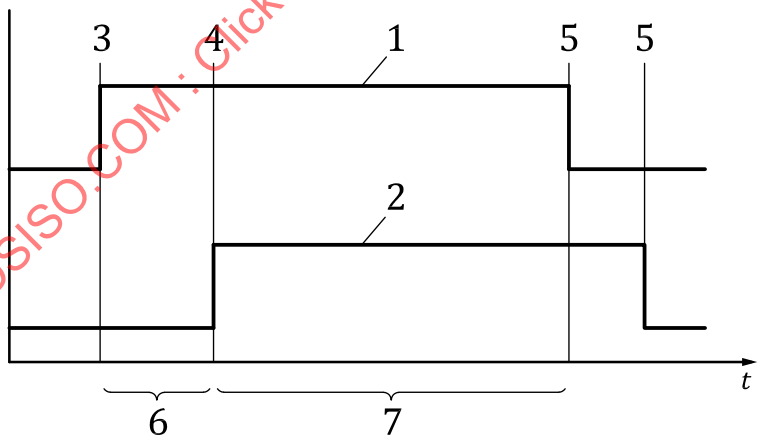
5.7 Re-initiation of the output signal

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.

NOTE When two or more THCDs are used to operate one machine, synchronous actuation is required only within each THCD and is not required between THCDs.

6 Two hand control safety functions

6.1 Prevention of unexpected start-up

The output signal from the THCD shall only become “active” (allowing a start of a hazardous movement in the interfaced machine) while both control actuating devices of the THCD are actuated and remain actuated. To prevent an unexpected start-up, this safety function shall comply with the category and PL or SIL indicated in Table 1 for the type of the THCD.

6.2 Releasing of actuators

A subsequent output signal from the THCD shall not be possible unless the THCD actuators have both been released, this applies for type II and type III. This safety function shall comply with the category and PL or SIL indicated in Table 1 for the type of the THCD.

6.3 Synchronous actuation

See 5.8.

7 Prevention of accidental actuation and of defeat

7.1 Common considerations

The control actuating devices of a THCD shall be designed and arranged in such a way that the protective effect of the THCD cannot be easily defeated and that the probability of accidental actuation is minimized, in accordance with the risk assessment for the particular application.

The use of one hand alone, the use of possible combinations of one hand and/or other parts of the body and/or the use of simple aids which allow defeat shall all be taken into account to prevent accessing the danger zone during a hazardous situation. Accidental actuation (e.g. by the clothes of the operator) shall also be taken into account.

NOTE 1 Simple aids can be e.g. bridges, cords or tapes.

The selection of dissimilar actuating directions, covers, shapes, etc., shall minimize the possibilities of defeat.

NOTE 2 Total protection from “defeat” is not possible.

7.2 to 7.6 show some separate individual ways in which defeat is possible, together with some precautionary measures for prevention. The methods of defeat that shall be considered depend upon the design of the THCD, the operating conditions, the method of attachment and positioning of the THCD and the specified safety distance requirements, etc.

7.7 shows some ways of preventing accidental actuation.

The precautionary measures listed may be required singly or in combination to comply with this document. The test procedures which shall be applied to the most common types of design are set out in 9.5. For other designs of the THCD, these test procedures may or may not be applicable. In these cases, a hazard analysis and an assessment of the risk of the possible use and/or misuse of that design of the THCD shall be carried out and appropriate measures shall be taken to comply with this document.

7.2 Prevention of defeat using one hand

Measures to prevent defeat by using one hand shall be provided. Examples of suitable measures are:

— the separation of the control actuating devices by at least 260 mm (internal dimension);

— the provision of one or more shields or an elevated area between the control actuating devices, designed in such a way that the control actuating devices are separated by a distance of at least 260 mm measured over or around the shields.

NOTE See A.2 for requirements on measurement tests.

7.3 Prevention of defeat using the hand and elbow of the same arm

Measures to prevent defeat by using the hand and elbow of the same arm shall be provided. Examples of suitable measures are:

— the separation of the control actuating devices by at least 550 mm (internal dimension); for ergonomic reasons, this distance should not exceed 600 mm;

— the provision of one or more shields or an elevated area between the control actuating devices, designed in such a way that the control actuating devices cannot be touched by the elbow and the tips of the fingers of the same arm at the same time;

— the provision of covers designed in such a way that the control actuating devices cannot be operated by the elbow;

— the use of control actuating devices with different types and/or directions of operation.

NOTE See A.3 for requirements on measurement tests.

7.4 Prevention of defeat using the forearm(s) or elbow(s)

Measures to prevent defeat by using the forearm(s) and/or elbow(s) shall be provided, if the distance of the hands from the hazard as a result of using forearm(s) and/or elbow(s) is smaller than the required safety distance.

A suitable measure is using covers and/or collars which are designed so that the control actuating devices cannot be operated by the forearm(s) and/or the elbow(s).

NOTE See A.4 for requirements on measurement tests.

7.5 Prevention of defeat using one hand and any other part of the body

Measures to prevent defeat by using other parts of the body (e.g. knee, hip) in conjunction with one hand shall be provided. Examples of suitable measures are:

— the arrangement of the control actuating devices on a horizontal or nearly horizontal surface which is at least 1 100 mm above the floor or level of access. This is intended to prevent actuation by the hip;

— in the case of attachment to a vertical or near vertical surface, the provision of a protective collar around the control actuating devices;

— the provision of covers and/or shields which are designed in such a way that the control actuating devices cannot be operated by one hand and any other part of the body.

NOTE See A.5 for requirements on measurement tests.

7.6 Measures to prevent blocking of control actuating device(s)

For type II and type III THCDs, measures to prevent defeat by blocking one actuating device shall be provided.

Blocking of control actuating devices causes a THCD to become a one-hand control and may cause a permanent input signal to be generated by the blocked actuating device. This consequently may allow the output signal of the THCD to be generated by using only one hand. Suitable measures to prevent this method of defeat are:

— To prevent re-initiation of the output signal for further operation by one hand, it shall be necessary to include the characteristic of re-initiation in the design of the THCD (see 5.7).

— To prevent the first start by one hand, it shall be necessary to include the characteristic of synchronous operation in the design of the THCD (see 5.8).

NOTE 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/or re-initiation can be neglected.

7.7 Accidental actuation

The probability of accidental actuation of a THCD shall be minimized.

The measures given in 7.2 to 7.6 can help to minimize accidental actuation. Other suitable measures to prevent accidental actuation are:

— for mechanical control actuating devices, the need for deliberate actuation with respect to the force and the travel required;

— for non-mechanical control actuating devices (e.g. photoelectric devices, capacitive devices), the need for sensitivity levels which will only allow deliberate actuation.

8 General requirements

8.1 Ergonomic requirements

There can sometimes be a conflict between good ergonomic principles (see ISO 9355-3) and the design of a THCD in order to prevent defeat or accidental actuation (e.g. the size of openings and the need to wear gloves for certain operations).

Means and measures to achieve safety need to reflect the balance between

— the need to follow good ergonomic principles, and

— the need to provide measures to prevent defeat and accidental actuation.

The balance between ergonomic requirements and defeatability/prevention of accidental actuation requirements shall provide adequate protection against access to hazardous parts of the machine for the particular risks.

For ergonomic reasons, time lag for synchronous actuation should not to be smaller than 0,25 s (see also 5.8).

8.2 Operating conditions and environmental influences

The parts of a THCD shall be selected, installed and linked together in such a way that they withstand the operating stresses to be expected and fulfil the requirements of the relevant standards concerning such stresses (e.g. with regard to switching capacity and switching frequency) as well as the requirements of

the relevant standards dealing with the environmental influences to be expected (e.g. vibration, impact, temperature, foreign objects, moisture, oil and electromagnetic fields).

8.3 Enclosures

8.3.1 Enclosures and their mountings shall be designed to withstand the expected operating and ambient stresses.

8.3.2 Corners, edges, etc., shall be rounded or bevelled so as to avoid injury.

8.3.3 Covers and parts which are intended to be removed or opened for service and repair shall be constructed so that they can only be removed or opened with the aid of a tool.

8.3.4 When enclosures containing control actuating devices are mounted on stands, the stands shall be provided with facilities for secure mounting to the enclosures and to the floor.

8.3.5 Enclosures shall be mounted and positioned so that the operator, after releasing an actuator, cannot reach the danger zone until the hazardous situation has ceased (see 8.8 and 11.2).

8.3.6 If the enclosure supporting the control actuating devices is adjustable (e.g. vertical or horizontal position), it shall be provided with means for locking it in position (for relocatable THCDs, see 8.7).

8.4 Selection, design and installation of control actuating devices

8.4.1 Control actuating devices shall be selected, designed, arranged and installed in such a way that they can be actuated without undue fatigue (e.g. as a result of awkward posture, unsuitable movements or high operating forces) (see ISO 9355-3).

8.4.2 Control actuating devices shall not be red.

8.4.3 Control actuating devices shall not form any crushing or shearing points with any other parts.

8.4.4 The THCD and its interconnection(s) shall be designed and integrated to comply with the functional safety requirements according to ISO 13849-1 or IEC 62061 (for THCD see Table 1).

8.5 Prevention of unintended output signals by acceleration forces

Foreseeable forces caused by acceleration imparted to the THCD shall not cause an output signal (e.g. falling over, accidental impact or shockloading). See 8.2.

8.6 Unintended operation of hand-held machines

8.6.1 A THCD shall be designed to prevent unintended operation due to handling.

8.6.2 A THCD shall be designed so that separate and dissimilar actions of the control actuating devices are required to give the input signal to start the dangerous motion of the machine.

NOTE 1 The provision of the two control actuating devices in separate handles does not satisfy this requirement unless their method of operation is different.

NOTE 2 The provision of an automatic lock-out facility on one of the control actuating devices provides a higher level of protection.

8.7 Relocatable THCDs

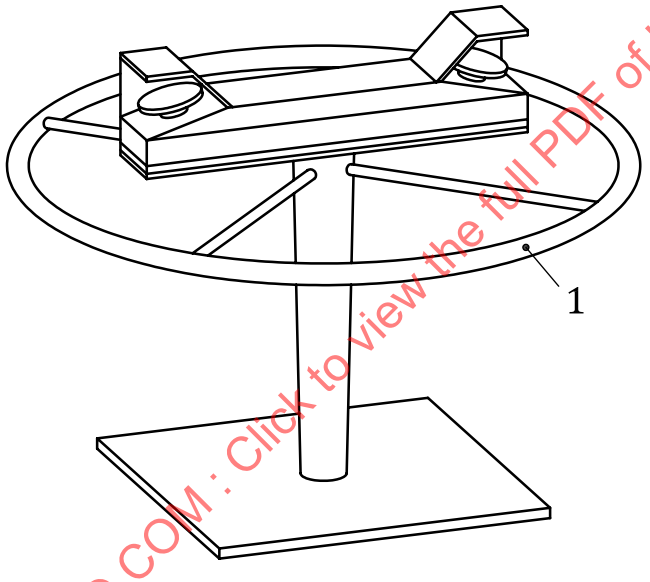
8.7.1 The actuators of a relocatable THCD and their supporting enclosure shall be stable in intended use (see ISO 12100).

NOTE This can be fulfilled by including a large mass or any other suitable means.

8.7.2 Relocatable THCDs shall be provided with means to prevent movement when being operated. If this is not possible, the position of the THCD shall be monitored resulting in that the moving of the THCD during operation shall initiate a cessation of the output signal. The monitoring function of the position shall have the same required PL/SIL as the actual two hand device safety function.

NOTE This can be fulfilled by including a large mass, use of lockable wheels or any other suitable means.

8.7.3 Facilities shall be available for maintaining and verifying the required safety distance between the control actuating devices and the danger zone (see 8.8 and 11.2) (e.g. by means of a distance ring — see Figure 3).



Key

1 distance ring

Figure 3 — Example of a relocatable THCD with a distance ring

8.7.4 Pipes, cables and connections shall be protected against damage using the considerations presented in 8.2 and 8.4.4.

8.8 Safety distance

To calculate the required safety distance (referred to as the minimum distance in ISO 13855) between the control actuating devices and the danger zone, the following shall be taken into account:

— the hand/arm speed (see ISO 13855);

— the shape and arrangement of the THCD;

— the response time of the THCD;

— the maximum time taken to stop the machine, or remove the hazard, following cessation of the output signal of the THCD;

— the intended use and foreseeable misuse of the machine (see ISO 12100);

— relevant type C standards.

9 Verification and validation

9.1 General requirements for verification and validation

Compliance with the requirements specified for a THCD, shall be verified and validated by visual inspection, theoretical assessment of the design and by practical tests as appropriate. A summary of the verification procedures is given in Table 2.

NOTE Table 2 is not relevant for integrators using pre-assessed THCD.

Table 2 — Verification and validation

Clause	Safety requirements	Procedure			Remarks
		Visual inspection	Performance test	Measurement	
General					
8.2	Operating conditions and environmental influences		X	X	Apply relevant standards
8.3	Requirements on enclosures	X	X		By type testing
8.4	Selection, design and installation of control actuating devices	X	X	X	
8.5	Unintended output signal caused by acceleration forces		X	X	
8.6	Unintended control actuation	X	X		For hand-held machines
8.7	Stability		X		For relocatable THCDs
8.8	Response time			X	
10	Marking	X			
Functional characteristics					
5.2	Use of both hands	X	X		
5.3	Relationship input/output signal		X		
5.4	Cessation of output signal		X		
5.5	Accidental operation	X	X	X	Use the methods of Clause 8
5.6	Defeating	X	X	X	By applying 9.5
5.7	Re-initiation		X		Resetting verification
5.8	Synchronous operation		X	X	

The THCD subsystem shall be validated according to ISO 13849-2 or IEC 62061.

The verification procedures concern exclusively the THCD itself and do not take into consideration the possible effect of the control system of the machinery to which the THCD is connected. Feedback signal(s) from the machine control system, which might eventually be required by the design of the THCD, shall be simulated.

The verification procedures that shall be considered will depend upon the design of the THCD, the type of the THCD, the operating conditions, the method of attachment and positioning of the THCD and the specific safety distance requirement, etc. These verification procedures include visual inspection, performance testing, measurement and theoretical assessment. This document gives some guidance

on test procedures, in particular on “prevention of defeat”, but it does not specify detailed test methodologies.

The designer and/or the manufacturer shall arrange for the THCD to be verified and/or type-tested so as to demonstrate that the device conforms to the design specifications. The requirements of these specifications may be given in standards (e.g. IEC 60204-1) or by the designer where no standard exists.

9.2 Visual inspection

Visual inspection shall be performed to verify the features required for the specific type of THCD just by physical examination and shall be applied to the items listed in Table 2.

Any components used as well-tried components shall be specifically identified by the THCD manufacturers’ documentation.

9.3 Performance test

Performance tests shall be performed to verify the features required for the specific type of THCD operation. The fault simulation is based on the fault analysis of the THCD design. It includes simulation of all safety-related faults for type II, type IIIB and type IIIC (see Table 1 and Table 2).

9.4 Measurement

Measurement shall be performed to verify the specified dimensions, binary signals, mechanical features, times, etc.

9.5 Prevention of defeat

The prevention of defeat shall be in accordance with Annex A.

For the most common types of design, some or all of the measurement tests shall be applied (see also Clause 7). The intended use and the shape of the THCD indicate which of the measurement tests in Annex A are necessary since some of the measurement tests are contained within others and some are complementary.

These combinations of tests are intended to prevent defeat by using one hand only and also defeat by using one hand and the elbow, the knee, the hip, the thigh or the stomach.

10 Marking

10.1 The requirements in ISO 12100 shall be followed.

10.2 A THCD complying with this document, and which is not an integral part of a machine, shall be labelled clearly and durably with the following details:

— the name and address of the manufacturer and/or responsible supplier;

— the manufacturer's model or type reference;

— the manufacturer's serial number and the year of manufacture;

— the type of THCD in accordance with Clause 4 and Table 1, and the number of this document.

EXAMPLE

ISO 13851: Type IIIC

— the response time of the THCD, as defined in 3.7;

— in the case of electrical THCDs, the appropriate rating information (see IEC 60204-1);

— in the case of pneumatic, mechanical and other non-electrical THCDs, the operating pressure and/or other relevant information.

10.3 If the THCD consists of two or more separate units, at least one unit shall be marked as required in 10.2. These units shall each be marked in such a way that they can be identified as parts of the same THCD.

10.4 In the case of a THCD, complying with this document, which is an integral part of a machine, at least the type of THCD and the number of this document shall be marked on the machine. Other instructions and the technical data for the THCD shall be given in the machine instruction handbook.

NOTE This marking can be on the main machine marking plate or close to the control actuating devices.

10.5 Components of THCDs shall be identifiable, if necessary, for the purpose of maintenance and/or repair.

11 Information for installation, use and maintenance

11.1 Information for use

The information to be supplied to the user and the manner in which it is presented shall comply with ISO 12100:2010, 6.4.

The information may be given in the form of drawings, diagrams, tables and/or written information.

11.2 Installation instructions

Unless the THCD is an integral part of the machine, the following information shall be given:

— its physical dimensions;

— the space required for e.g. installation, inspection, maintenance, etc.;

— mounting details;

— information on the determination of the minimum distance according to ISO 13855;

— the value of the response time;

— the properties required according to ISO 13849-1 or IEC 62061, including guidance on selecting PL and categories as specified in ISO 13849-1 or selecting SIL as specified in IEC 62061 for the correct interaction and interconnection between the THCD and the relevant safety-related part of the machine control system;

— the size and type of supply lines and interconnecting lines (e.g. cables, solid or flexible pipes and their recommended arrangement);

— details of protective devices (e.g. fuses or pressure-reducing valves);

— instructions for the initial start-up procedure;

— adjustment and setting instructions;

— test procedures to verify that the THCD and the relevant parts of the machine control system are operating in the correct manner;

— details of any limitations on the intended use;

— details of provisions against foreseeable misuse.

11.3 Operating instructions

Operating instructions shall be given in clear and unambiguous language enabling the THCD to be used correctly and safely.

The operating instructions shall contain information that the THCD only offers protections for the person operating it.

Pictures, diagrams, symbols and figures shall be used where appropriate.

The operating instructions shall provide information to verify the correct functioning and to enable malfunctions to be recognized.

11.4 Maintenance instructions

The maintenance instructions shall contain:

— all information necessary for maintenance and repair (where appropriate, the instructions shall include drawings, spare parts list and circuit diagrams);

— appropriate safety instructions as a part of any schedule for maintenance and/or repair;

— a schedule for systematic maintenance.

Annex A
(normative)

Measurement test for the prevention of defeat

A.1 General

Measurement tests A.2 to A.5 are the tests required in 9.5 to verify the measures required in Clause 7. Figures A.1 to A.12 are illustrations of the principles given in the text for the prevention of defeat and do not represent all the details required for the design of a THCD.

A.2 Prevention of defeat using one hand (see 7.2)

A.2.1 Separation of the control actuating devices by a distance equal to or greater than 260 mm (see Figure A.1).

Dimensions in millimetres

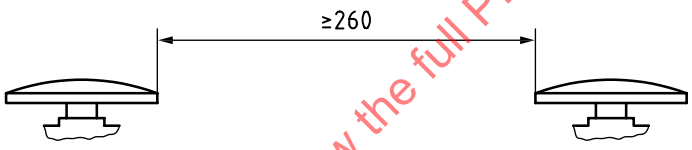


Figure A.1 — Separation by distance

A.2.2 Separation of the control actuating devices by one or more shields or an elevated area designed in such a way that the control actuating devices cannot be touched with the ends of a 260 mm cord representing the finger-span (see Figure A.2).

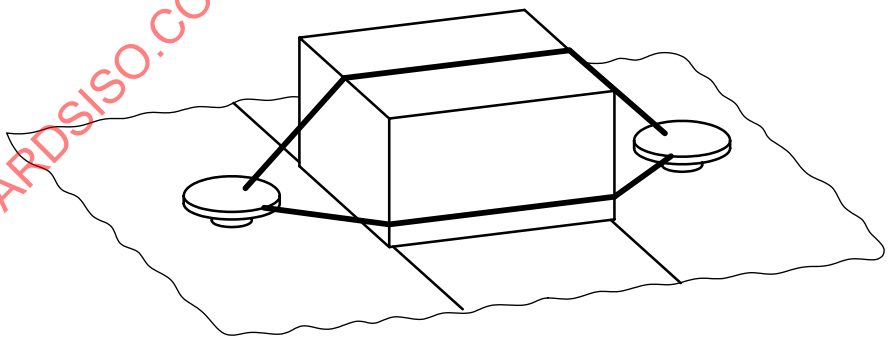


Figure A.2 — Separation by an elevated area

A.2.3 Separation of the control actuating devices by collars and by orientation in such a way that the control actuating devices cannot be touched with the ends of a 260 mm cord (see Figure A.3).

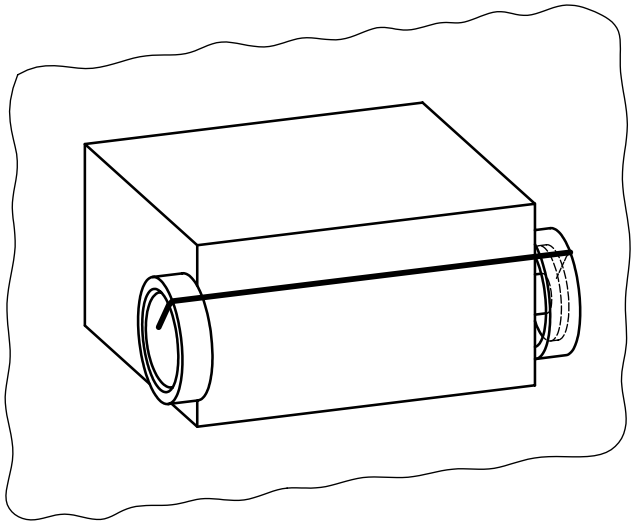


Figure A.3 — Separation by collars and by orientation

A.3 Prevention of defeat using hand and elbow of the same arm (see 7.3)

A.3.1 Separation of the control actuating devices by a distance equal to or more than 550 mm (see Figure A.4).

Dimensions in millimetres

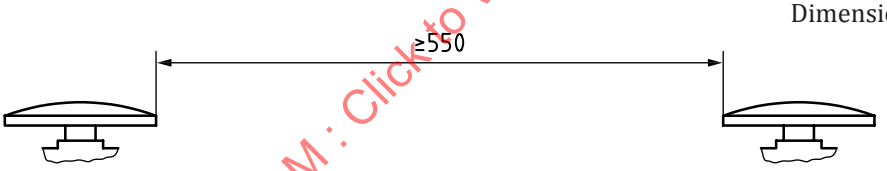


Figure A.4 — Separation by distance

A.3.2 Separation of the control actuating devices by the provision of one or more shields or an elevated area, designed in such a way that the control actuating devices cannot be touched at the same time with both ends of measurement equipment consisting of a 300 mm rigid bar not exceeding 5 mm in