
Safety of machinery — Pressure-sensitive protective devices —

**Part 2:
General principles for design and
testing of pressure-sensitive edges
and pressure-sensitive bars**

Sécurité des machines — Dispositifs de protection sensibles à la pression —

Partie 2: Principes généraux de conception et d'essai des bords et barres sensibles à la pression

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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 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13856-2 was prepared by Technical Committee ISO/TC 199, *Safety of machinery* and by Technical Committee CEN/TC 114, *Safety of machinery* in collaboration.

This second edition cancels and replaces the first edition (ISO 13856-2:2005), which has been technically revised.

ISO 13856 consists of the following parts, under the general title *Safety of machinery — Pressure-sensitive protective devices*:

- Part 1: *General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors*
- Part 2: *General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*
- Part 3: *General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices*

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 type 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.

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.

The safeguarding of machinery (see ISO 12100:2010, 3.21) can be achieved by many different means. These means include guards which prevent access to the hazard zone by means of a physical barrier (for example, interlocking guards according to ISO 14119 or fixed guards according to ISO 14120) and protective devices (for example, electro-sensitive protective equipment according to IEC 61496-1 or pressure-sensitive protective devices according to this part of ISO 13856).

Type-C standards makers and designers of machinery/installations should consider the best way to achieve the required level of safety taking into account the intended application and the results of the risk assessment (see ISO 12100).

The required solution can also be to combine several of these different means. The machinery/installation supplier and the user examine together carefully the existing hazards and constraints before making their decision on the choice of safeguarding.

Pressure-sensitive edges and pressure-sensitive bars are safeguards of the *mechanically-actuated trip device* type. General requirements for these safeguards (as well as others) are given in ISO 12100:2010, 6.3.1 and 6.3.2.

Pressure-sensitive edges and pressure-sensitive bars are used in a wide range of applications with different conditions of use relating, for example, to extremes of loading or electrical, physical and chemical environments. They are interfaced with machine controls to ensure that the machine reverts to a safe condition if the sensitive protective equipment is actuated.

This part of ISO 13856 is restricted to the design of pressure-sensitive edges and pressure-sensitive bars so that they can be used when the risk assessment carried out by the machine manufacturer and/or relevant type-C standard, when available, shows this to be appropriate.

Pressure-sensitive edges and pressure-sensitive bars can be fitted to a fixed or moving part of a machine or an obstacle to prevent trapping or crushing hazards from another part of a machine. Pressure-sensitive edges and pressure-sensitive bars are designed, selected, installed and/or interfaced with the control system of the machine so that the force/pressure applied to a person or parts of the body do not exceed certain limits.

Pressure-sensitive edges, pressure-sensitive bars, pressure-sensitive bumpers and similar devices have many similarities. [Table 1](#) summarizes the differences which generally apply between the two types of

pressure-sensitive protective devices covered by this part of ISO 13856 and pressure-sensitive bumpers (covered by ISO 13856-3 and gives guidance for their application).

Table 1 — Characteristic features of pressure-sensitive edges, pressure-sensitive bars and pressure-sensitive bumpers

Cross-section	Pressure-sensitive edge	Pressure-sensitive bar	Pressure-sensitive bumper
	Regular	Regular	Regular/irregular
Length/width ratio	>1	Any ratio	Any ratio
Effective sensing surface	Deforms locally	Moves as a whole	Deforms locally and/or moves as a whole
Body part(s) intended to be detected	Finger	Finger	—
	Hand	Hand	Hand
	Arm	Arm	Arm
	Leg	Leg	Leg
	Head	Head	Head
	Torso	Torso	Torso

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Safety of machinery — Pressure-sensitive protective devices —

Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars

1 Scope

This part of ISO 13856 establishes general principles and specifies requirements for the design and testing of pressure-sensitive edges and pressure-sensitive bars used as safeguards and not as actuating devices for normal operation.

This part of ISO 13856 is applicable to pressure-sensitive edges and pressure-sensitive bars, with or without an external reset facility, used to detect persons or body parts that can be exposed to hazards such as those caused by the moving parts of machines.

It is not applicable to

- determining the suitability of a pressure-sensitive edge or pressure-sensitive bar for a particular safeguarding application,
- selection of an appropriate performance level for safety-related parts of control systems (SRP/CSs) other than to give minimum values,
- dimensioning or configuring of the effective sensing area of pressure-sensitive edges or pressure-sensitive bars in relation to any particular application,
- stopping devices according to IEC 60204-1 used only for normal operation, including emergency stopping of machinery.

Requirements for the information to be provided by the manufacturer are given to assist in the selection of a suitable pressure-sensitive edge or pressure-sensitive bar and its application.

Additional requirements can be necessary where pressure-sensitive edges or pressure-sensitive bars are used in locations accessible to elderly or disabled people or children.

2 Normative references

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

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

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

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

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

- IEC 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*
- IEC 60068-2-14, *Environmental testing — Part 2-14: Tests — Test N: Change of temperature*
- IEC 60068-2-27, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*
- IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*
- IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*
- IEC 60529, *Degrees of protection provided by enclosures (IP code)*
- IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*
- IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*
- IEC 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measuring techniques — Electrostatic discharge immunity test*
- IEC 61000-4-3, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test*
- IEC 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test*
- IEC 61000-4-5, *Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques — Surge immunity test*
- IEC 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields*
- IEC 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments*
- IEC 61439-1:2011, *Low-voltage switchgear and controlgear assemblies — Part 1: General rules*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 13849-1 and the following apply.

3.1

pressure-sensitive edge

sensitive protective equipment of the “mechanically activated trip” type comprising a *sensor* (3.3) or sensors and a control unit and one or more *output signal switching devices* (3.5) intended to detect contact with a person or body part of a person and where the *effective sensing surface* (3.9) is deformed locally to actuate the sensor(s)

Note 1 to entry: The sensor or sensors generate(s) a signal when pressure is applied to part of its surface. The control unit responds to the signal from the sensor and generates an output signal(s) to the control system of a machine.

Note 2 to entry: The length of the sensor(s) is greater than the width. The cross-section throughout the pressure-sensitive area is constant and its width is usually within the range from 8 mm to 80 mm.

Note 3 to entry: For the definition of sensitive protective equipment see ISO 12100:2010, 3.28.5.

3.2**pressure-sensitive bar**

sensitive protective equipment of the “mechanically activated trip” type comprising a *sensor* (3.3) or sensors and a control unit and one or more *output signal switching devices* (3.5) intended to detect contact with a person or body part of a person and where the *effective sensing surface* (3.9) moves as a whole to actuate the sensor(s)

Note 1 to entry: The sensor or sensors generate(s) a signal when pressure is applied to part of its surface. The control unit responds to the signal from the sensor and generates an output signal(s) to the control system of a machine.

Note 2 to entry: The length of the sensor(s) is greater than the width. The cross-section throughout the pressure-sensitive area is constant and its width is usually within the range from 8 mm to 80 mm.

Note 3 to entry: For the definition of sensitive protective equipment see ISO 12100:2010, 3.28.5.

3.3**sensor**

part of the *pressure-sensitive edge* (3.1) or *pressure-sensitive bar* (3.2) which generates a signal in response to sufficient pressure applied to part of its surface

Note 1 to entry: 3.3 to 3.5 define the functional components of a pressure-sensitive edge or pressure-sensitive bar. These functions can be integrated into a single assembly or can be contained in any number of separate assemblies (see [Figure 1](#)). For example, a simple pressure-sensitive edge or pressure-sensitive bar actuating a position switch can be considered to be the sensor, the control unit, and the output signal switching device.

3.4**control unit**

part of the *pressure-sensitive edge* (3.1) or *pressure-sensitive bar* (3.2) which responds to the condition of the *sensor* (3.3) and generates output signals to the machine control system

Note 1 to entry: 3.3 to 3.5 define the functional components of a pressure-sensitive edge or pressure-sensitive bar. These functions can be integrated into a single assembly or can be contained in any number of separate assemblies (see [Figure 1](#)). For example, a simple pressure-sensitive edge or pressure-sensitive bar actuating a position switch can be considered to be the sensor, the control unit, and the output signal switching device.

3.5**output signal switching device**

part of the control unit of a *pressure-sensitive edge* (3.1) or *pressure-sensitive bar* (3.2) which is connected to the machine control system and transmits output signals

Note 1 to entry: 3.3 to 3.5 define the functional components of a pressure-sensitive edge or pressure-sensitive bar. These functions can be integrated into a single assembly or can be contained in any number of separate assemblies (see [Figure 1](#)). For example, a simple pressure-sensitive edge or pressure-sensitive bar actuating a position switch can be considered to be the sensor, the control unit, and the output signal switching device.

3.6**ON state**

state in which the output circuit(s) of an *output signal switching device* (3.5) is complete and permits the flow of current or fluid

3.7**OFF state**

state in which the output circuit(s) of an *output signal switching device* (3.5) is broken and interrupts the flow of current or fluid

3.8**actuating force**

any force applied to the *sensor* (3.3) which causes an *output signal switching device* (3.5) to go to the *OFF state* (3.7)

3.9
effective sensing surface
part of the surface of the *sensor* (3.3) or a combination of sensors within the *effective sensing angle* (3.12) and the *effective sensing length* (3.10) where the application of an *actuating force* (3.8) creates an *OFF state* (3.7) in the *output signal switching device* (3.5)

Note 1 to entry: See, for example, [Figures 2](#) and [3](#).

3.10
effective sensing length
length of the *effective sensing surface* (3.9)

3.11
reference axis
line in the direction of the length of the *sensor* (3.3), whose position in the cross-sectional view of the sensor is used to define the *effective sensing surface* (3.9)

Note 1 to entry: See [Figures 2](#) and [3](#).

3.12
effective sensing angle
angle around the *reference axis* (3.11) which limits the *effective sensing surface* (3.9) along the *effective sensing length* (3.10)

Note 1 to entry: See [Figures 2](#) and [3](#).

3.13
reference direction
direction of actuation, from a point on the *effective sensing surface* (3.9) towards the *reference axis* (3.11), which bisects the *effective sensing angle* (3.12) and is perpendicular to the reference axis

Note 1 to entry: See [Figures 2](#) and [3](#).

3.14
dead surface
part of the surface area of the *sensor* (3.3) outside the *effective sensing surface* (3.9)

Note 1 to entry: See [Figures 2](#) and [3](#).

3.15
pre-travel
distance travelled by an object moving in a direction perpendicular to the *reference axis* (3.11) and in the axis of the applied *actuating force* (3.8), measured from where this object touches the *effective sensing surface* (3.9) to where the *output signal switching device(s)* (3.5) changes to an *OFF state* (3.7) under specified conditions

Note 1 to entry: See [Figure 4](#).

3.16
working travel
distance travelled by an object, moving in a direction perpendicular to the *reference axis* (3.11), from where this object touches the *effective sensing surface* (3.9), under specified conditions, to where a stated limit force is exerted on the object

Note 1 to entry: See [Figure 4](#).

3.17
overtravel
difference between the *working travel* (3.16) and the *pre-travel* (3.15) when both are measured with the same object applied under the same conditions

Note 1 to entry: See [Figure 4](#).

3.18**force-travel relationship**

relationship between force applied perpendicular to the *reference axis* (3.11) and the distance travelled by a specified object perpendicular to the reference axis under specified conditions

Note 1 to entry: See [Figure 4](#).

3.19**reset**

function which permits an *ON state* (3.6) in an *output signal switching device* (3.5) provided that certain conditions are met

Note 1 to entry: See [Annex A](#).

3.20**total travel**

movement or deformation of the *effective sensing surface* (3.9) of a *pressure-sensitive edge* (3.1) or *pressure-sensitive bar* (3.2) which is measured in the direction of the *actuating force* (3.8) from the point of contact to the point at which no further significant deformation of the effective sensing surface occurs (e.g. at a force of 600 N)

3.21**start interlock**

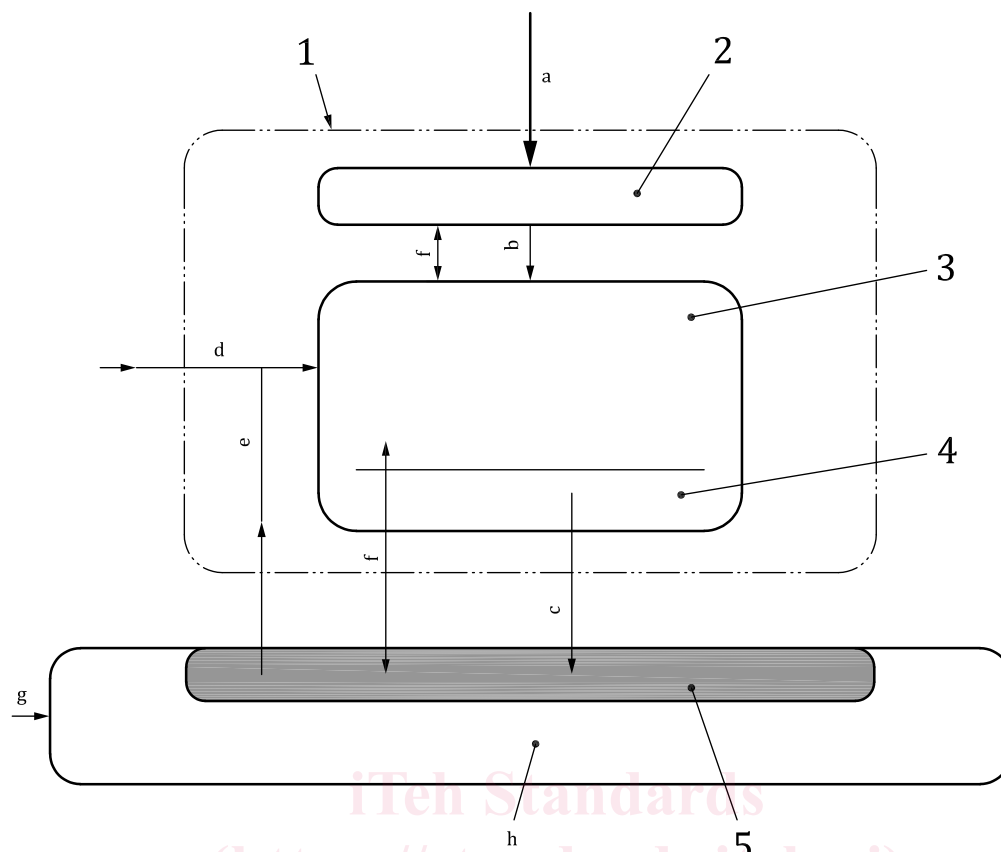
means which prevents the start of an automatic machine when power (e.g. the electrical supply) is switched on to the *pressure-sensitive edge* (3.1) or *pressure-sensitive bar* (3.2), or is interrupted and restored

3.22**operating speed**

any speed at which an object is pressed against the *sensor* (3.3) and which causes the *output signal switching device* (3.5) to go to the *OFF state* (3.7)

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Key

- 1 pressure-sensitive edge or pressure-sensitive bar
- 2 sensor(s)
- 3 control unit*
- 4 output signal switching device(s)*
- 5 part of the machine control system for pressure-sensitive edge or pressure-sensitive bar output signal processing
- a Actuating force.
- b Sensor output signal.
- c ON state/OFF state signal.
- d Manual reset signal**.
- e Reset signal from machine control system (where appropriate).
- f Monitoring signals (optional).
- g Manual reset signal to machine control system***.
- h Machine control system(s).
- * Can be located within the machine control system or as part of the machine control system.
- ** Where appropriate, this may be used as an alternative to g.
- *** Where appropriate, this may be used as an alternative to d.

Figure 1 — Systematic sketch of pressure-sensitive edge or pressure-sensitive bar as applied to machine