INTERNATIONAL STANDARD

ISO 13856-2

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Safety of machinery — Pressure-sensitive protective devices —

Part 2: General principles for the 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 199 was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

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 the design and testing of pressure-sensitive edges and pressure-sensitive bars*

Introduction

ISO 13856 covers safety devices that detect the presence of a person through the application of a pressure or force by a part of the person's body. After actuation, the safety devices give a stop command which is used by the control system of the machine to provide protection for the person who caused the device to be actuated.

Annex A of this part of ISO 13856 presents timing diagrams for devices with and without reset. Annex B explains the relationship between operating speed, the force exerted on the body and the distance travelled by the device following actuation. Annex C provides guidance to users on the selection of a suitable device. It is advisable that the supplier and customer liaise to examine carefully the constraints presented by the application before placing an order for the equipment.

The safeguarding of machinery (see ISO 12100-1:2003, 3.20) can be achieved by many different means. These means include guards which prevent access to the hazard zone by means of a physical barrier (e.g. fixed guards according to ISO 14120, or interlocking guards according to ISO 14119), protective devices (e.g. electro-sensitive protective equipment according to IEC 61496) and pressure-sensitive protective devices according to this document.

Type-C standards makers and designers of machinery/installations (see page vi for an explanation of the different types of machinery safety standards) need to 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 14121). The best solution may combine several of these different means. It is advisable, too, that the machinery/installation supplier and the user examine together carefully the existing constraints before making their decision on the choice of safeguarding means.

Annex D gives guidance regarding the design of pressure-sensitive edges and pressure-sensitive bars. Annex E gives guidance on the application of pressure-sensitive edges and pressure-sensitive bars. Annex F gives guidance on installation, commissioning and testing. Annex G covers general considerations for meeting category 2 according to ISO 13849-1.

This part of ISO 13856 does not specify the dimensions or the configuration of the effective sensing surface of pressure-sensitive edges or pressure-sensitive bars in relation to any particular application. However, there is a requirement for the manufacturer of any safety device to provide sufficient information to enable the user (i.e. the machinery manufacturer and/or user of the machinery) to specify an adequate arrangement.

Pressure-sensitive edges and pressure-sensitive bars are safety devices of the “mechanically actuated trip device” type. General requirements for these devices (as well as other safety devices) are given in ISO 12100-2:2003, 5.1 and 5.2.

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

Pressure-sensitive edges and pressure-sensitive bars may be fitted to a moving part of a machine at the point where a trapping, crushing or collision hazard may occur. They may also be fitted to a fixed part of a machine or an obstacle to prevent trapping or crushing hazards with a moving 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, bars, bumpers and barriers have many similarities. Table 1 summarises the differences which generally apply between the two types of devices covered by this part of ISO 16856 and gives guidance for their application.

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

Feature	Edge	Bar
	According to this part of ISO 13856-2	
Cross section	Regular	Regular
Length/width ratio	>1	Any ratio
Effective sensing surface	Deflects locally	Moves as a whole
Intended to detect…	finger hand arm leg head torso	finger hand arm leg head torso

The structure of safety standards in the field of machinery is as follows:

— type-A standards (basis safety standards) giving basic concepts, principle for design, and general aspects that can be applied to machinery;

— 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-hands controls, interlocking devices, pressure-sensitive devices, guards);

— type-C standards (machinery safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This part of ISO 13856 is a type-B2 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 -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.

ISO/TC 199 has a mandate in this area to produce type-A and type-B standards, which will allow verification of conformity with the essential safety requirements.

ISO 13856-2 is based on EN 1760-2:2001, published by the European Committee for Standardization (CEN).

Safety of machinery — Pressure-sensitive protective devices —

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

1 Scope

This part of ISO 13856 specifies the general principles and requirements for the design and testing of pressure-sensitive edges and pressure-sensitive bars for use as safety devices and not as actuating devices for normal operation. It is applicable to pressure-sensitive edges and pressure-sensitive bars, with or without an external reset facility, used to detect persons or parts of persons who may be exposed to danger such as hazardous moving parts. Its purpose relates primarily to safety and reliability rather than suitability (for the relationship between safety and reliability, see ISO 13849-1:1999, Annex D).

This part of ISO 13856 is restricted to the functioning of pressure-sensitive edges and pressure-sensitive bars and does not specify the requirements for their application. However, Clause 6 does contain requirements for the information for use to be provided by the manufacturer. This document does not specify the dimensions of the pressure-sensitive edges or bars in relation to a particular application. It is not applicable to stopping devices according to IEC 60204-1 used only for normal operational, including emergency stopping, of machinery. Additional requirements could be necessary where pressure-sensitive edges and pressure-sensitive bars are used in locations accessible to elderly or disabled people or children.

NOTE It may not be possible to carry out all the tests in this document for pressure-sensitive edges and pressure-sensitive bars when they have been designed and built into the machinery by the manufacturer.

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 4413, *Hydraulic fluid power — General rules relating to systems*

ISO 4414, *Pneumatic fluid power — General rules relating to systems*

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

ISO 13849-2:1999, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

IEC 60068-2-6, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14, *Environmental testing — Part 2: Tests — Test N: Change of temperature*

IEC 60068-2-29, *Environmental testing — Part 2: tests. Test Eb and guidance: bump*

IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

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

IEC 60439-1:1999, *Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

IEC 60664-1:1992, *Insulation co-ordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*

IEC 60947-5-1:1997, *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: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test — Basic EMC publication*

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: Testing and measurement techniques — Section 4: Electrical fast transient/burst immunity test — Basic EMV publication*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 5: Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 6: 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 61000-6-3, *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments*

IEC 61496-1, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests*

IEC 61496-2, *Safety of machinery — Electrosensitive protective equipment — Part 2: Particular requirements for equipment using active optoelectronic protective devices*

IEC 61496-3, *Safety of machinery — Electro-sensitive protective equipment — Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)*

3 Terms and definitions

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

3.1
pressure-sensitive edge
safety device of the “mechanically activated trip” type intended to detect the touch of a person or part of a person and comprising

a) sensor(s) which generates a signal when pressure is applied to part of its surface, where

— the length is greater than the width,

— the cross section throughout the pressure-sensitive area is constant,

— the width of the cross section is greater than 8 mm,

— the effective sensing surface is deformed locally to actuate the sensor(s), and

b) control unit, which responds to the signal from the sensor and generates an output signal(s) to the control system of a machine

See Figure 1.

NOTE The width of the sensor's cross section is usually ⩽ 80 mm.

3.2
pressure-sensitive bar
safety device comprising

a) sensor(s) which generates a signal when pressure is applied to part of its surface, where

— the length is greater than the width,

— the cross section throughout the pressure-sensitive area is constant,

— the width of the cross section is greater than 8 mm,

— the effective sensing surface moves as a whole to actuate the sensor(s), and

b) control unit, which responds to the signal from the sensor and generates an output signal(s) to the control system of a machine

See Figure 1.

NOTE 1 The width of the sensor's cross section is usually ⩽ 80 mm.

NOTE 2 The surface of a pressure-sensitive bar can also deform locally but the deformation does not actuate the sensor(s).

3.3
sensor
part of the pressure-sensitive edge or pressure-sensitive bar which generates a signal in response to sufficient pressure applied to part of its surface

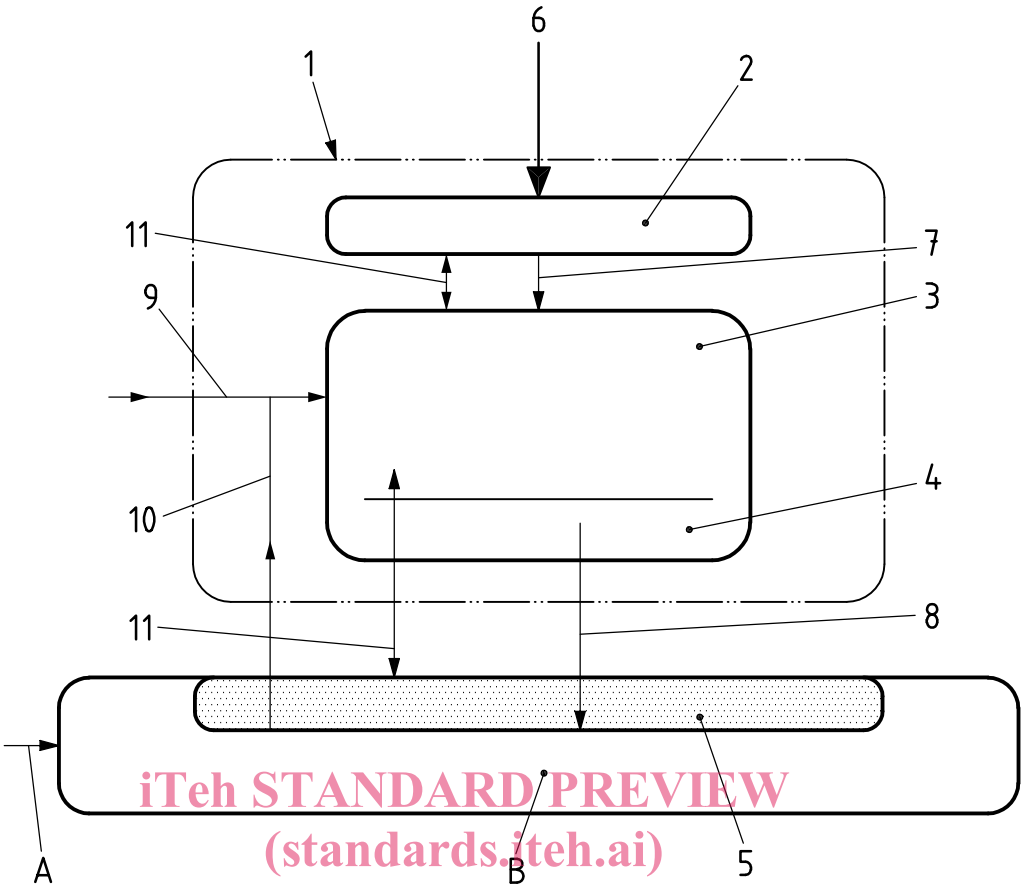
NOTE Definitions 3.3 to 3.5 define the functional components of a pressure-sensitive edge or bar. These functions may be integrated into a single assembly or may be contained in any number of separate assemblies (see Figure 1). For example, a simple pressure-sensitive edge or pressure-sensitive bar actuating a position detection switch may 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 or pressure-sensitive bar which responds to the condition of the sensor and generates output signals to the machine control system

NOTE Definitions 3.3 to 3.5 define the functional components of a pressure-sensitive edge or bar. These functions may be integrated into a single assembly or may 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 detection switch may 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 or pressure-sensitive bar which is connected to the machine control system and transmits output signals

NOTE Definitions 3.3 to 3.5 define the functional components of a pressure-sensitive edge or bar. These functions may be integrated into a single assembly or may 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 detection switch may be considered to be the sensor, the control unit, and the output signal switching device.



Key

A Manual reset signal to machine control system (where appropriate alternative to 9).

B Machine control system(s)

1 pressure-sensitive edge or bar
2 sensor(s)
3 control unit [a]
4 output signal switching device(s) [a]
5 part of machine control system for pressure-sensitive edge/pressure-sensitive bar output signal processing
6 actuating force
7 sensor output signal
8 on state/off state signal
9 manual reset signal (where appropriate alternative to A)
10 reset signal from machine control system (where appropriate)
11 monitoring signals (optional)

[a] May be located within the machine control system enclosure or be part of the machine control system.

Figure 1 — Pressure-sensitive edge or bar applied to machine

3.6
ON state
state in which the output circuit(s) of an output signal switching device 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 is broken and interrupts the flow of current or fluid

3.8
actuating force
any force applied to the sensor which causes the output signal switching device(s) to go to the OFF state

3.9
effective sensing surface
part of the surface of the sensor or a combination of sensors within the effective sensing angle and the effective sensing length where the application of an actuating force creates an OFF state in the output signal switching device

NOTE See, for example, Figures 2 and 3.

3.10
effective sensing length
length of the effective sensing surface

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

See Figures 2 and 3.

3.12
effective sensing angle
angle around the reference axis, which limits the effective sensing surface along the effective sensing length

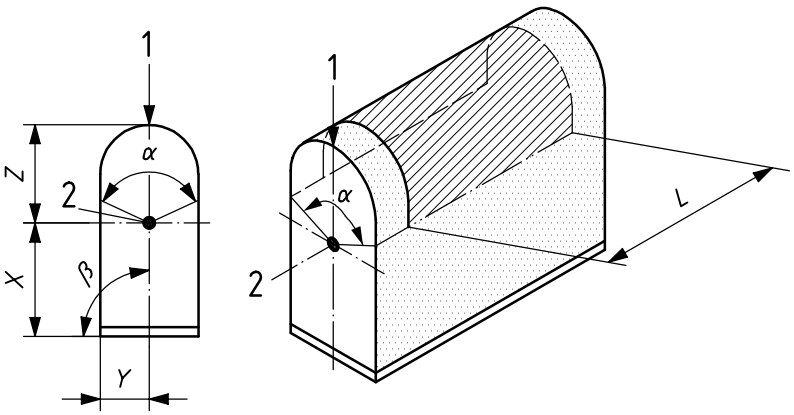
See Figures 2 and 3.

3.13
reference direction
direction of actuation, from a point on the effective sensing surface towards the reference axis, which bisects the effective sensing angle and is normal to the reference axis

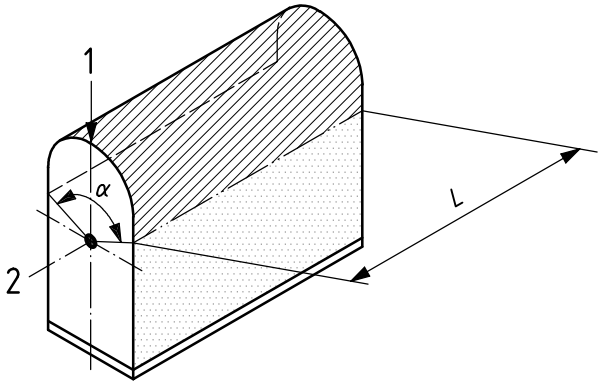
See Figures 2 and 3.

3.14
dead surface(s)
part of the surface area of the sensor outside the effective sensing surface

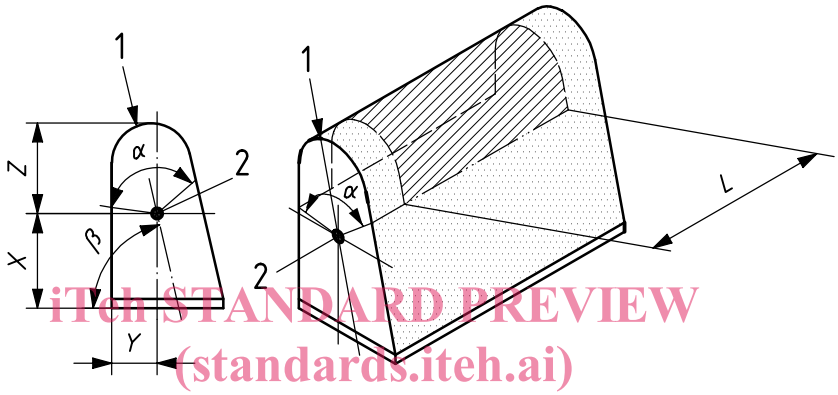
See Figures 2 and 3.



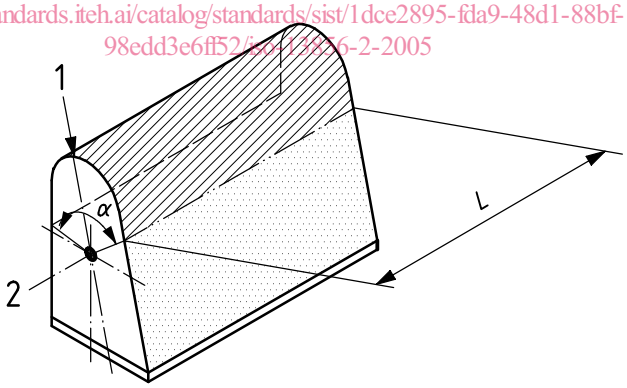
a) Symmetrical with dead surface at ends



b) Symmetrical without dead surface at ends



c) Asymmetrical with dead surface at ends



d) Asymmetrical without dead surface at ends

Key

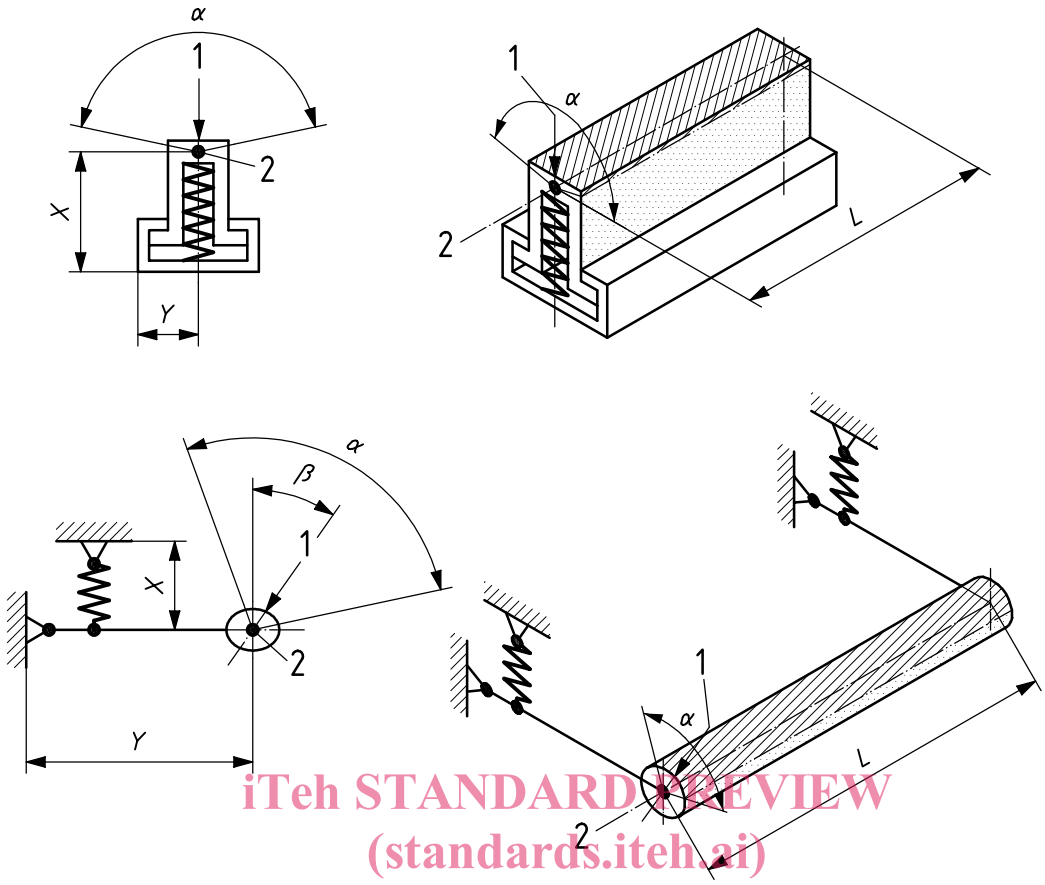
effective sensing surface

dead surface

L effective sensing length
α effective sensing angle
β see 7.5.2

1 reference direction
2 reference axis

Figure 2 — Effective sensing surfaces of pressure-sensitive edges



Key

effective sensing surface

dead surface

L	effective sensing length	1	reference direction
α	effective sensing angle	2	reference axis
β	see 7.5.2		

Figure 3 — Effective sensing surface of pressure-sensitive bars

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

See Figure 4.

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

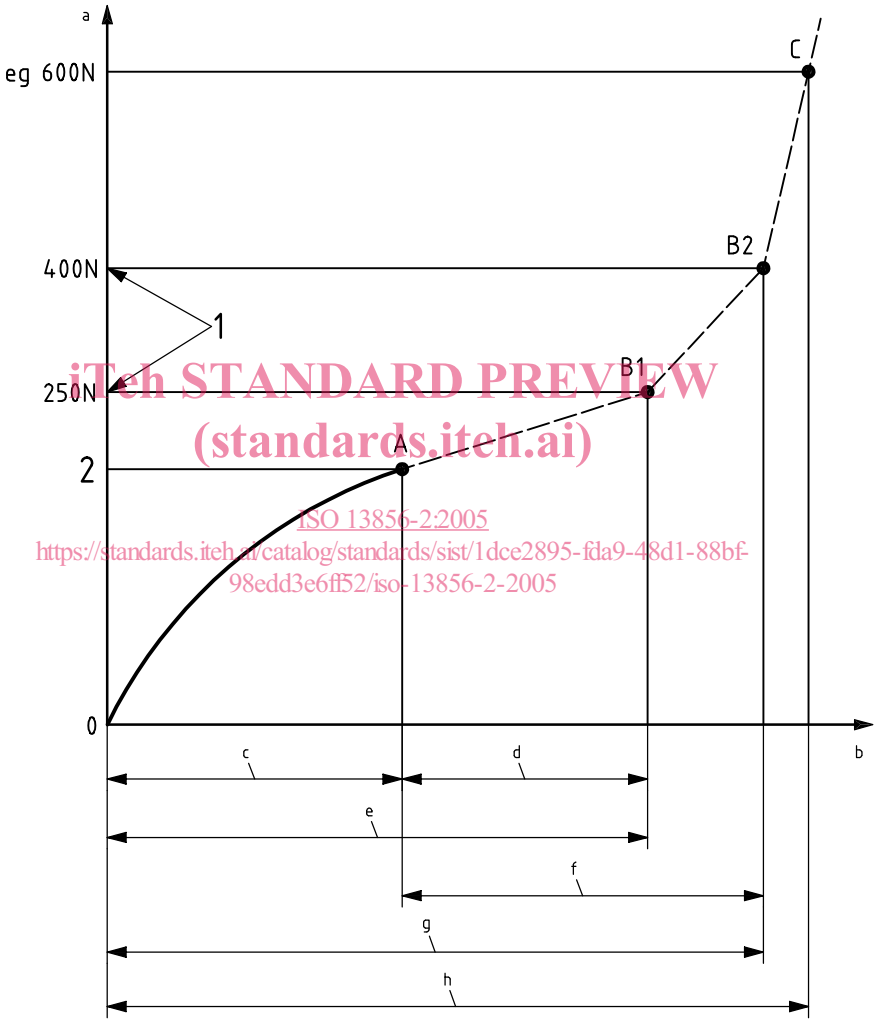
See Figure 4.

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

See Figure 4.

3.18
force–travel relationship
relationship between force applied normal to the reference axis and the distance travelled by a specified object normal to the reference axis under specified conditions

See Figure 4.



Test piece 1 according to Figure 6 is used to apply the forces.

Key

A pre-travel (actuating point and actuating maximum operating)
B working travel (for example, occurs at 250 N or 400 N operating speed of less than or equal to 10 mm/s)
C total travel (for example, occurs at 600 N operating speed of less than or equal to 10 mm/s)

1 stated limit force
2 lowest actuating force

a Force (N).
b Travel (mm).
c Pre-travel.
d Overtravel at 250 N.
e Working travel at 250 N.
f Overtravel at 400 N.
g Working travel at 400 N.
h Total travel.

Figure 4 — Diagram of force — Travel relationship