



# SLOVENSKI STANDARD

## SIST EN 1760-3:2004

01-november-2004

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Safety of machinery - Pressure sensitive protective devices - Part 3: General principles for the design and testing of pressure sensitive bumpers, plates, wires and similar devices

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Sicherheit von Maschinen - Druckempfindliche Schutzeinrichtungen - Teil 3: Allgemeine Leitsätze für die Gestaltung und Prüfung von Schuttpuffern, Schaltflächen, Schaltleinen und ähnlichen Einrichtungen

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Sécurité des machines - Dispositifs de protection sensibles a la pression - Partie 3 : Principes généraux de conception et d'essai des pare-chocs, plaques, câbles et dispositifs analogues sensibles a la pression

**Ta slovenski standard je istoveten z: EN 1760-3:2004**

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13.110

Varnost strojev

Safety of machinery

**SIST EN 1760-3:2004**

**en**

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ICS 13.110

English version

Safety of machinery - Pressure sensitive protective devices -  
Part 3: General principles for the design and testing of pressure  
sensitive bumpers, plates, wires and similar devices

Sécurité des machines - Dispositifs de protection sensibles  
à la pression - Partie 3 : Principes généraux de conception  
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This European Standard was approved by CEN on 21 May 2004.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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## Foreword

This document (EN 1760-3:2004) has been prepared by Technical Committee CEN/TC 114 "Safety of machinery", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This is the third part of a multi-part standard dealing with pressure sensitive protective devices which will cover safety devices that detect the presence of a person through the application of a pressure or force by a part of the persons body. After actuation they give a stop command which is used by the control system of a machine to provide protection for the person who caused the device to be actuated.

The other parts are:

EN 1760-1, *Safety of machinery - Pressure sensitive protective devices - Part 1: General principles for the design and testing of pressure sensitive mats and pressure sensitive floors.*

EN 1760-2, *Safety of machinery - Pressure sensitive protective devices - Part 2: General principles for design and testing of pressure sensitive edges and pressure sensitive bars.*

The safeguarding of machinery (see EN 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 to EN 953 and interlocking guards to EN 1088); and protective devices, (e.g. electro-sensitive protective equipment to EN 61496 and pressure-sensitive protective devices to this European Standard).

Designers of machinery (including e.g. vehicles) should consider the way to achieve the required level of safety taking into account the intended application and the results of the risk assessment (see EN 1050). The best solution may combine several of these different means. It is recommended that the machinery / vehicle supplier and the user examine together carefully the existing constraints before making their decision on the choice of safeguarding means.

This European Standard does not specify the dimensions and the configuration of the effective sensing surface of pressure sensitive protective devices 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 the user of the machinery) to specify an adequate arrangement.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

## Introduction

Pressure sensitive protective devices are used in a wide range of applications with different conditions of use relating, for example, to the maximum and minimum values of loading, electrical, physical and chemical environments. They are interfaced with machinery controls to ensure that the machine reverts to a safe condition when the device is actuated.

The forces given in this document should not be considered as those which will always avoid injury or fatal accidents. This depends upon several criteria which include the sensor, the actuating speed, the contact area, the material used and the part of the body affected.

The forces given in this document are primarily intended for the purpose of assessing the performance of the pressure-sensitive protective devices. These forces are under further investigation.

Each type of application of pressure sensitive protective devices can present particular hazards. It is not the intention of this document to identify those hazards nor to recommend specific applications to particular equipment. Particular applications may also necessitate special requirements which are not included in this document.

This document is a type B standard as stated in EN 1070.

The provisions of this document may be supplemented or modified by a type C standard.

NOTE For machines which are covered by the scope of a type C standard and which have been designed and built according to the provisions of that standard, the provisions of that type C standard take precedence over the provisions of this type B standard.

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## 1 Scope

This document deals with requirements for pressure sensitive protective devices which are not specified in EN 1760-1 and EN 1760-2. The majority of these devices are produced for specific applications and are not available as off-the-shelf items.

The purpose of this document relates primarily to safety and reliability rather than suitability. For the relationship between safety and reliability, see EN 954-1: 1996, Annex D.

This document specifies requirements for pressure sensitive protective devices with and without an external reset facility.

This document does not specify the dimensions of pressure sensitive protective devices in relation to any particular application. Specific requirements for particular applications may be set out in relevant type C standards.

The document does not cover stopping devices used only for the regular operation, including emergency stopping, of machinery. It also does not apply to use in locations accessible to elderly or disabled persons or children, where special additional requirements may be necessary.

Basic requirements are given for pressure sensitive protective devices not covered in EN 1760-1 and EN 1760-2.

Specific requirements are given for the following devices:

- pressure sensitive bumpers;
- pressure sensitive plates;
- pressure sensitive wires (trip wires). [SIST EN 1760-3:2004](https://standards.iteh.ai/catalog/standards/sist/cfb84107-8980-4f55-8fb1-88a4b66a347e/en-1760-3-2004)

NOTE Some requirements are made with respect to electromagnetic compatibility (EMC). These are intended to meet the requirements of the Council Directive 98/37/EC ("Machinery Directive") [1] only and not those of Council Directive 89/336/EC ("EMC Directive") [2].

## 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.

EN 954-1:1996, *Safety of machinery – Safety-related parts of control systems - Part 1: General principles for design*.

EN 982, *Safety of machinery - Safety requirements for fluid power systems and their components - Hydraulics*.

EN 983, *Safety of machinery - Safety requirements for fluid power systems and their components - Pneumatics*.

EN 999:1998, *Safety of machinery - The positioning of protective equipment in respect of approach speeds of parts of the human body*.

EN 1070:1998, *Safety of machinery – Terminology*.

EN 60068-2-6, *Environmental testing - Part 2: Tests - Tests Fc: Vibration (sinusoidal) (IEC 60068-2-6:1995 + Corrigendum 1995)*.

## EN 1760-3:2004 (E)

EN 60068-2-14, *Environmental testing - Part 2: Tests - Test N. Change of temperature* (IEC 60068-2-14:1984 + A1:1986).

EN 60068-2-29, *Basic environmental testing procedures - Part 2: Tests; Test Eb and guidance: bump* (IEC 60068-2-29:1987).

EN 60204-1:1997, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements* (IEC 60204-1:1997).

EN 60439-1:1999, *Low-voltage switchgear and controlgear assemblies - Part 1: Type-tested and partially type-tested assemblies* (IEC 60439-1:1999).

EN 60529, *Degrees of protection provided by enclosures (IP code)* (IEC 60529:1989).

EN 60947-5-1, *Low-voltage switchgear and controlgear - Part 5-1: Electromechanical control circuit devices* (IEC 60947-5-1:1997).

EN 60947-5-5:1997, *Low-voltage switchgear and controlgear - Part 5-5: Control circuit devices and switching elements - Electrical emergency stop device with mechanical latching function* (IEC 60947-5-5:1997).

EN 61000-4-2, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test - Basic EMC publication* (IEC 61000-4-2:1995).

EN 61000-4-3, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques; Radiated, radio-frequency, electromagnetic field immunity test* (IEC 61000-4-3:2002).

EN 61000-4-4, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test - Basic EMV publication* (IEC 61000-4-4:1995).

EN 61000-4-5, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 5: Surge immunity test* (IEC 61000-4-5:1995).

EN 61000-4-6, *Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields* (IEC 61000-4-6:1996).

EN 61000-6-2, *Electromagnetic compatibility (EMC) - Part 6-2: Generic standards; Immunity for industrial environments* (IEC 61000-6-2:1999).

EN ISO 12100-1:2003, *Safety of machinery - Basic concepts, general principles for design – Part 1: Basic terminology, methodology* (ISO 12100-1:2003).

EN ISO 12100-2:2003, *Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles* (ISO 12100-2:2003).

EN ISO 13849-2, *Safety of machinery - Safety-related parts of control systems - Part 2: Validation* (ISO 13849-2:2003).

EN 60068-2-78, *Environmental testing - Part 2-78: Tests; Test Cab: Damp heat, steady state* (IEC 60068-2-78:2001).

EN 60664-1:2003, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests* (IEC 60664-1:1992).



### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1070:1998 and the following apply.

#### 3.1

##### **pressure sensitive protective device**

safety device of the 'mechanically actuated trip type' which can also act as an impeding device as defined in EN ISO 12100-1: 2003, 3.27 intended to detect the touch of a person or part of a person

NOTE 1 They consist of:

- a sensor(s) which generates a signal when pressure is applied to part of its outer surface, and
- a control unit, which responds to the signal from the sensor and generates an output signal(s) to the control system of a machine.

NOTE 2 Pressure sensitive protective devices can be used as tripping devices as well as presence-sensing devices as defined in EN ISO 12100-1:2003, 3.26.5

#### 3.1.1

##### **pressure sensitive bumper**

pressure sensitive protective device with a sensor which has the following characteristics:

- the cross section throughout the pressure sensitive area may be regular or irregular;
- the width of the cross section is usually greater than 80 mm.
- the effective sensing surface is deformed locally or may move as a whole

#### 3.1.2

##### **pressure sensitive plate**

pressure sensitive protective device with a sensor which has the following characteristics:

- the effective sensing surface is normally, but not necessarily, flat;
- the width of the effective sensing surface is usually greater than 80 mm;
- the effective sensing surface moves as a whole

#### 3.1.3

##### **pressure sensitive wire**

pressure sensitive protective device with a sensor which has the following characteristics:

- a wire, cord, rope, or cable held in tension;
- a change in the tension is detected to give an output signal

#### 3.2

##### **sensor**

that part of the pressure sensitive protective device which generates a signal in response to sufficient pressure applied to part of its surface

#### 3.3

##### **control unit**

that part of the pressure sensitive protective device which responds to the condition of the sensor and generates output signals to the machine control system

NOTE Definitions above describe the functional components of a pressure sensitive protective device. These functions may be integrated into a single assembly or may be contained in any number of separate assemblies. (see Figure 1).

**3.4  
output signal switching device**

part of the control unit of a pressure sensitive protective device which is connected into the machine control system and transmits safety output signal(s)

**3.5  
ON State of output signal switching devices**

state in which the output circuit(s) is complete and permits the flow of current or fluid

**3.6  
OFF State of output signal switching devices**

state in which the output circuit(s) is broken and interrupts the flow of current or fluid

**3.7  
actuating force**

any force applied to the sensor which causes the output signal switching device to go to the OFF state

**3.8  
approach speed**

approach speed is the relative speed at which contact is made between the surface of the sensor and a part of the body

**3.9  
effective sensing surface**

that part of the surface of the sensor or a combination of sensors, as stated by the manufacturer, where the application of an actuating force creates an OFF state in the output signal switching device

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**3.10  
effective sensing direction(s)**

direction(s) of the actuating force from which the sensor will be actuated

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**3.11  
dead surface**

part of the surface area of the sensor outside the effective sensing surface

**3.12  
actuating travel**

distance travelled by a specified object, moving in the direction of the applied actuating force measured from the point where this object touches the effective sensing surface to the point where the output signal switching device changes to an OFF state under specified conditions (see Figure 2)

NOTE Actuating travel can differ from pre-travel. Pre-travel on an edge or bar (see EN 1760-2) is travel in the direction normal to the reference axis. Actuating travel is in the direction of the applied force.

**3.13  
working travel**

distance travelled by a specified object, moving in the direction of the applied actuating force measured from the point where this object touches the effective sensing surface, under specified conditions, to where a specified force is exerted on the object (see Figures 2 and B.1)

**3.14  
over travel**

difference between the working travel and the actuating travel when both of these distances are measured with the same object applied under the same conditions (see Figure 2)

**3.15**

**force-travel relationship**

relationship between the force applied and the distance travelled by a pressure sensitive protective device in operation (see Figure 2)

**3.16**

**reset**

function which permits an ON state in the output signal switching device provided that certain conditions are met

**3.17**

**mounting orientations**

position in space of the sensor

**3.18**

**presence-sensing device (PSD)**

device that creates a sensing field, area or plane to detect the presence of a part of or a whole person

NOTE See 3.1, note 2.

**3.19**

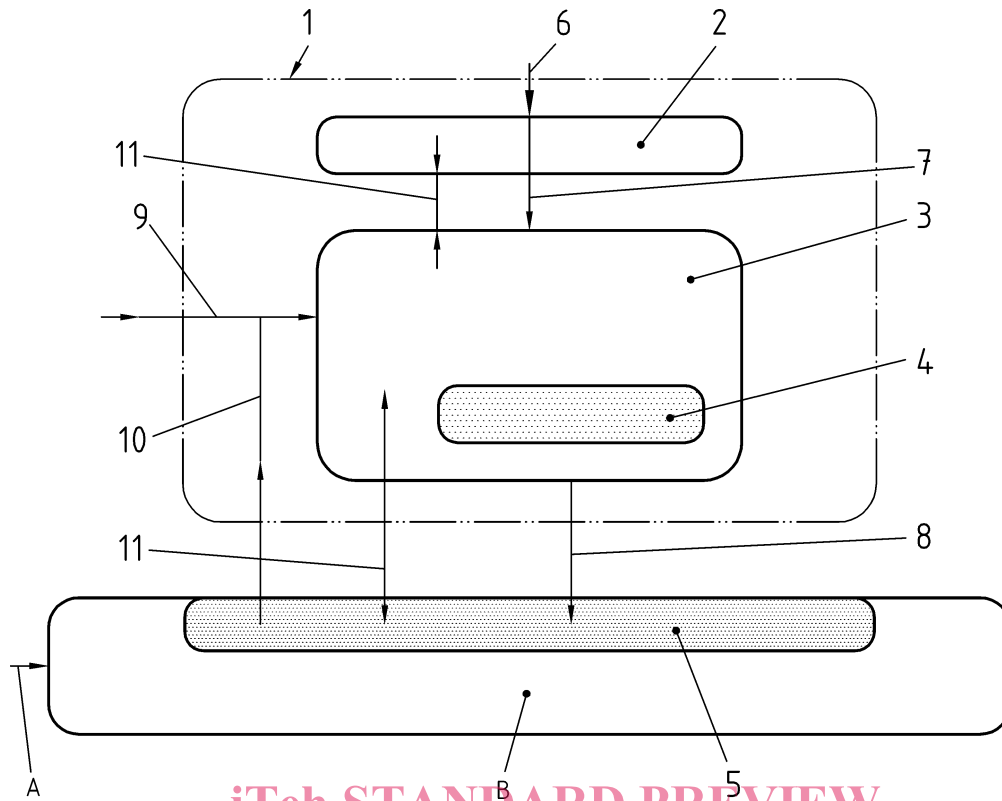
**total travel**

movement or deformation of the effective sensing surface of a pressure sensitive protective device which is measured in the direction of the actuating force, from the point of contact to the point where no further significant deformation of the effective sensing surface occurs

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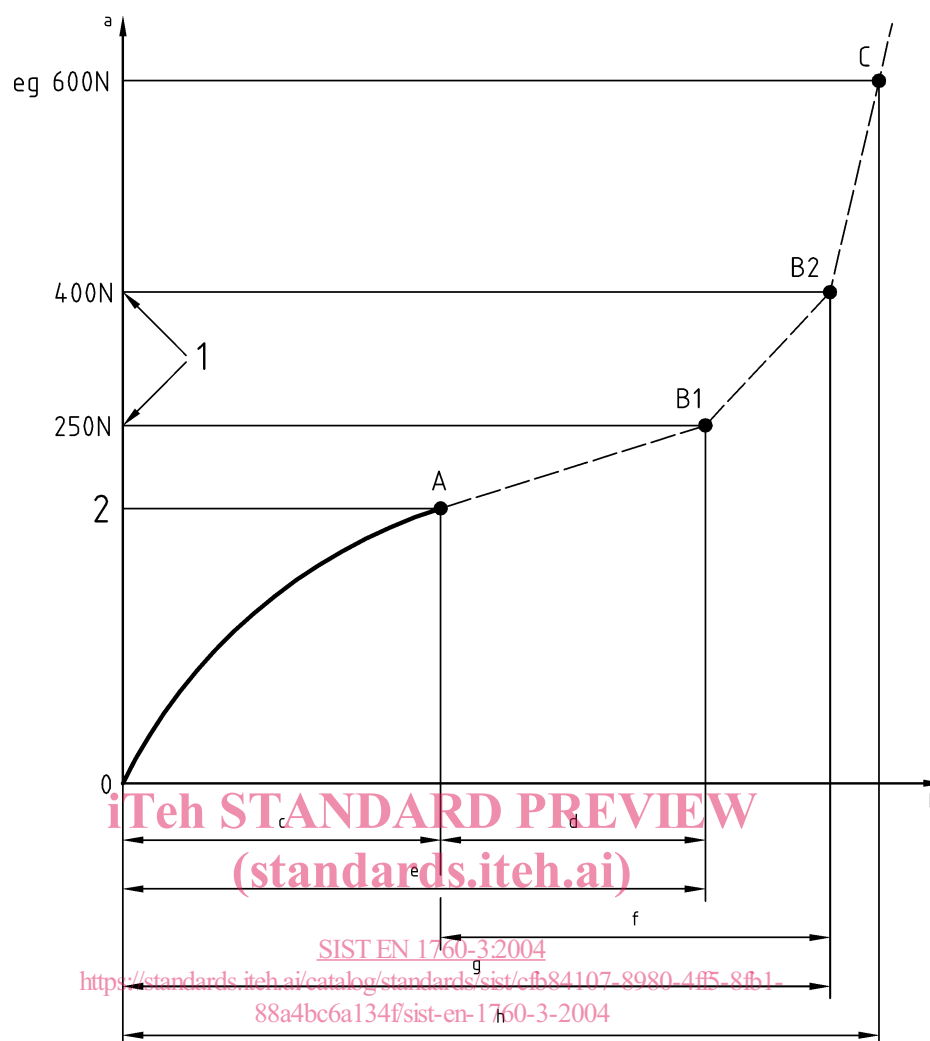


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**Key**

- 1 pressure sensitive protective device
- 2 sensor(s)
- 3 control unit (may be located within the machine control system or be part of the machine control system e.g. as a logic block)
- 4 output signal switching device
- 5 part of the machine control system for pressure sensitive protective device 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 manual reset signal to the machine control system (where appropriate alternative to 9)
- B machine control system(s)

**Figure 1 — Pressure sensitive protective device applied to a machine**

**Key**

- 1 stated limit force
- 2 lowest actuating force
- a force (N)
- b travel (mm)
- c actuating travel
- d over travel at 250 N
- e working travel at 250 N
- f over travel at 400 N
- g working travel at 400 N
- h total travel
- A actuating point and actuating force at maximum operating speed
- B force travel points B1 and B2 occur at a force of 250 N or 400 N at an operating speed of less than or equal to 10 mm/s
- C The force-travel point occurs at e.g. 600 N at an operating speed of less than or equal to 10 mm/s

NOTE Test piece 1 according to Table 1 is used to apply the forces.

**Figure 2 — An example of a force-travel diagram**

## 4 Requirements

### 4.1 General

The majority of devices covered by this standard are made for specific applications. Where appropriate, the device manufacturer and the machine builder shall agree the requirements in accordance with the risk assessment and specify the essential force-travel data for the application.

The device shall have dimensions and be positioned in such a way that the sensor shall detect by touch the approach of a person or part of a person to a dangerous situation or a danger zone.

In general, there are two types of application:

- the device is used to stop the dangerous parts of machinery which are remote from the sensor. In this application, the distance between the sensor and the moving parts of the machine shall be such that the machine stops before any part of the body can reach the hazardous zone. The distance shall be calculated on the basis of the principles presented in EN 999. See example in C.3.2;
- the sensor is mounted on the dangerous part of the machine or adjacent to it, so that the machine will stop or reverse to a safe position after the sensor is actuated and before injury can occur. See example in C.2.10.

The following basic requirements apply to all the devices covered by this document. Additional specific requirements are given for pressure sensitive bumpers, pressure sensitive plates and pressure sensitive wires. These specific requirements have priority over the basic requirements.

### 4.2 Basic requirements

#### 4.2.1 Actuating force

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NOTE 1 See 7.1.1 and 7.1.5 for verification.

The lowest actuating force(s) necessary to cause the output signal switching device to go to an OFF state shall not exceed those specified in table 1 when applied:

- in the reference direction(s);
- over the effective sensing surface;
- at the relevant approach speed(s);
- with the sensor in the mounting orientations;
- with the relevant test piece and
- over the temperature range;

which the manufacturer of the device has specified or which have been agreed by the manufacturer of the device and the machine builder(s).

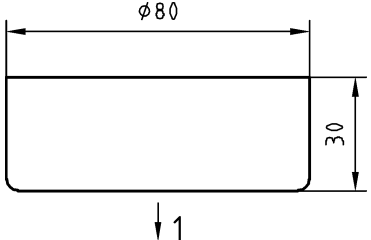
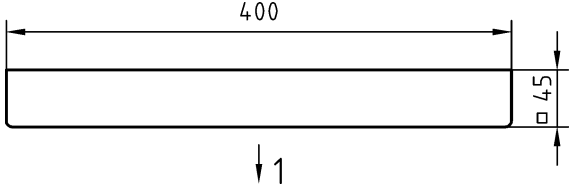


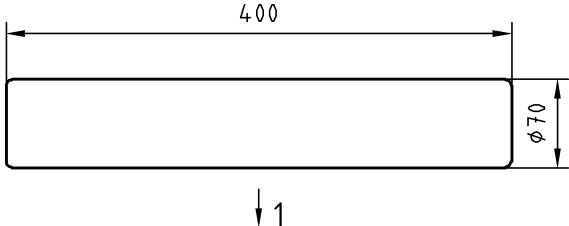
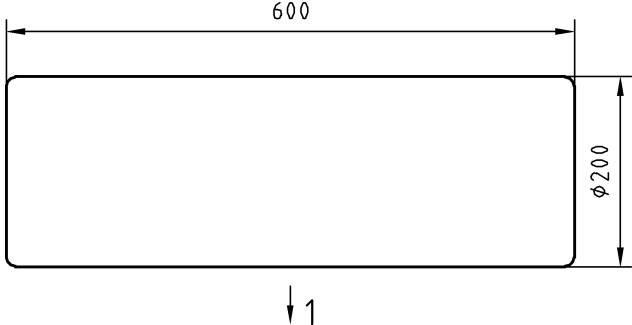
The lowest actuating force may need to be less than that stated in the table for specific applications and designs of sensor. For example, see 4.5.3 for the lowest actuating force necessary to cause the control unit for pressure sensitive wires to go to the OFF state.

NOTE 2 The risk assessment will show which part(s) of the body is to be considered for a particular application, enabling the relevant test piece(s) to be used.

NOTE 3 The forces specified in this clause are primarily intended for the purpose of assessing the pressure sensitive performance of the device. These forces should not be considered as safe forces (see Annex C and EN 953: 1997, 5.2.5.2 for guidance).

NOTE 4 Certain applications, e.g. protecting the neck, may require a higher sensitivity device, i.e. actuating forces lower than those shown in Table 1.

**Table 1 — Test pieces, actuating forces and test directions**

<p><b>Test piece 1</b> Actuating force: 150N Test piece to simulate body part: Head or hand</p>	
<p><b>Test piece 2</b> Actuating force: 400 N Body part: Shoulder</p>	
<p><b>Test piece 3</b> Actuating force: 50 N Body part: Finger (Knuckle)</p>	
<p><b>Test piece 4</b> Actuating force: 50 N Body part: Finger (Tip)</p>	
<p><b>Test piece 5</b> Actuating force: 250 N Body part: Arm or leg</p>	
<p><b>Test piece 6</b> Actuating force: 400 N Body part: Whole body</p>	
<p>NOTE 1 is the test direction.</p>	