

## Safety mats TS



EN | Product information

### **Mayser GmbH & Co. KG**

Oerlinger Strasse 1–3

89073 Ulm

GERMANY

Phone: +49 731 2061-0

Fax: +49 731 2061-222

E-mail: [info.ulm@mayser.com](mailto:info.ulm@mayser.com)

Internet: [www.mayser.com](http://www.mayser.com)

Original instructions

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### Important information

Read through the product information carefully. It contains important information on operation, safety and maintenance of the product. Retain the product information for later reference.

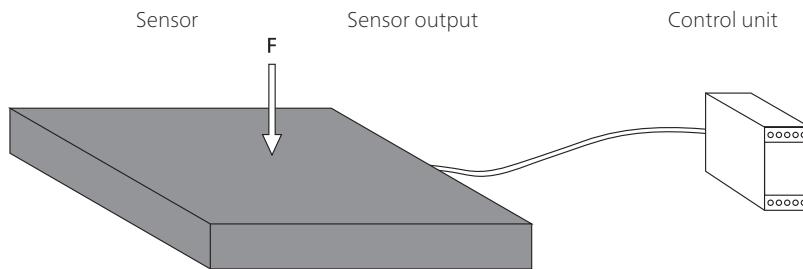
Always observe the safety instructions on the following pages under **ATTENTION**. Only use the product for the purpose described in the product information.

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## Definitions

### Pressure-sensitive protection device

A pressure-sensitive protection device consists of pressure-sensitive sensor(s), signal processing and output signal switching device(s). The control unit is made up of the signal processing and output signal switching device(s). The pressure-sensitive protection device is triggered when the sensor is activated.



**Note:**

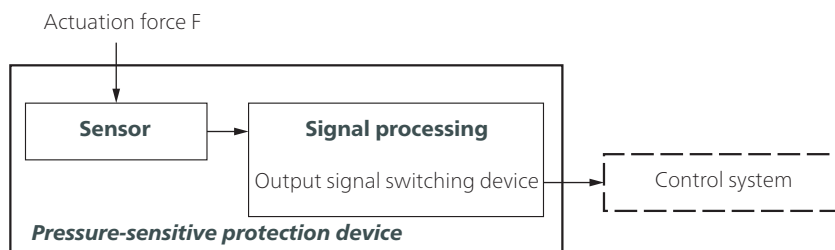
See also Chapter 3 **Terms** in ISO 13856-1.

#### Sensor

The sensor is the part of the pressure-sensitive protection device that generates a signal when the actuating force  $F$  is applied. Mayser safety systems have a sensor whereby the actuating surface is deformed locally.

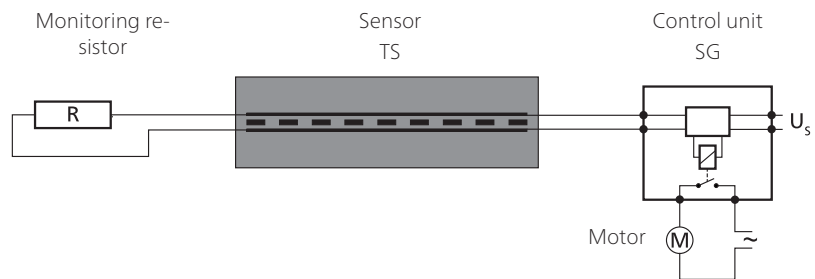
#### Signal processing

The signal processing is the part of the pressure-sensitive protection device that converts the output signal of the sensor and controls the status of the output signal switching device. The output signal switching device is that part of the signal processing which is connected to the machine controls and transmits safety output signals such as STOP.



**Criteria for selecting the sensor type**

- Category in accordance with ISO 13849-1
- Performance level of pressure-sensitive protection device = at least  $PL_r$
- Temperature range
- Degree of protection in accordance with IEC 60529:  
IP65 is the standard for safety mats.  
Higher degree of protection must be checked individually.
- Environmental influences such as swarf, oil, coolant, outdoor use...
- Recognition of persons weighing < 35 kg necessary?

**Operation principle 2-wire-technology**

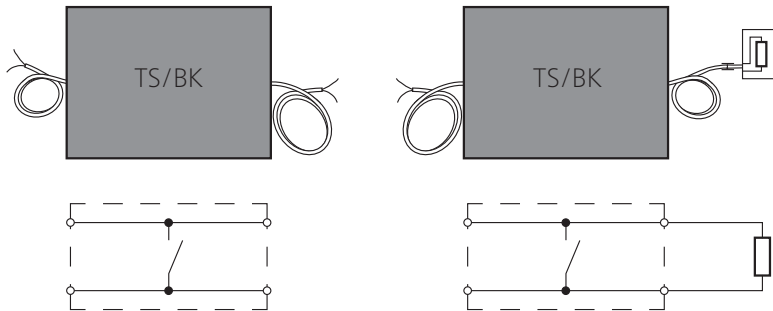
The monitoring resistor must be compatible with the control unit.  
Standard value is 1k $\Omega$ . 8k $\Omega$  and 22k $\Omega$  are also available.

For your safety:

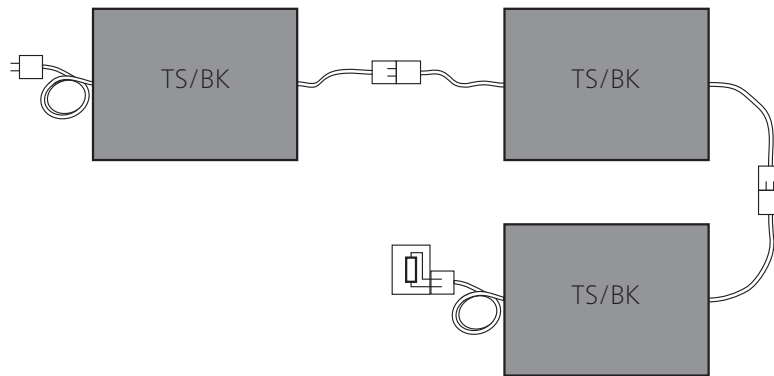
Sensor and connecting cables are constantly monitored for function.  
Monitoring is carried out by controlled bridging of the contact surfaces with a monitoring resistor (closed current principle).

## Design

TS/BK with cables on both sides as a through sensor or as an end sensor with external monitoring resistor



## Combination of sensors



Combination:

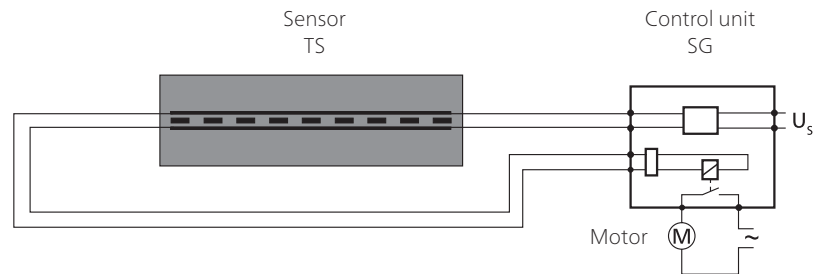
- connection of more than one sensor
- only one control unit required
- individual design of control areas with regard to size and shape

## Operation principle 4-wire-technology

Unlike 2-wire technology, 4-wire-technology works **without** a monitoring resistor.

### Note:

The 4-wire technology can be used only together with control unit SG-EFS 104/4L.



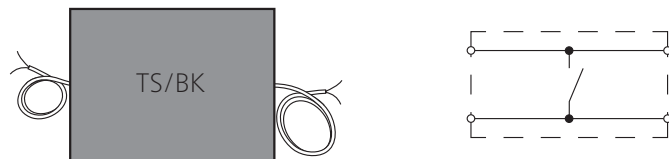
For your safety:

Sensor and connecting cables are constantly monitored for function.

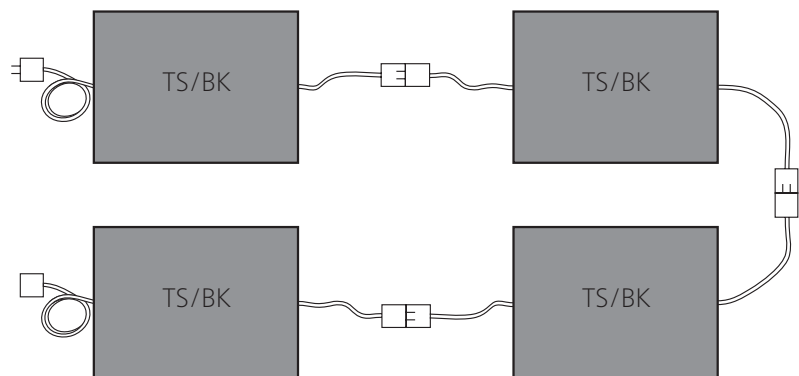
This is possible because of signal transmission feedback – without monitoring resistor.

### Design

TS/BK with cables on both sides as a through sensor



### Combination of sensors



Combination:

- connection of more than one sensor
- only one control unit required
- individual design of control areas with regard to size and shape

*Subject to technical modifications.*

## Intended use

A safety mat detects a person that is standing on or stepping onto it. It is a protective device covering a certain area and monitoring the presence of a person on it as a safety function. Its purpose is to prevent possible hazardous situations for personnel within a danger zone.

Typical applications are in the area of moving units on machines and plants.

Safe operation of a safety mat depends entirely on

- The surface condition of the mounting surface,
- the correct selection of size and resistance as well as
- correct installation.

### Tip

See Annex B of ISO 13856-1, especially Figures B.1 and B.2.

## Limits

- Max. 10 sensors type BK on one control unit
- System size max. 15 m<sup>2</sup>  
= max. number × max. sensor size

## Exclusions

Sensors are not suitable

- for detecting walking aids.
- for detecting individuals who weigh less than 20 kg.
- for navigating with industrial trucks.

Sensor combinations are not suitable

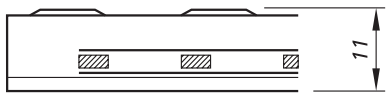
- for detecting individuals who weigh less than 35 kg.

## Program selection

Sensors in the safety mats TS programme are only available in fixed, predefined sizes. The surface is resistant to a certain extent to external influences and normal chemical influences.

If you have higher requirements of the sensors, we recommend our line of customised safety mats.

Design



Standard version

Moulded onto a plastic plate.  
The surface structure created during casting ensures the necessary non-slip protection as well as mechanical protection.

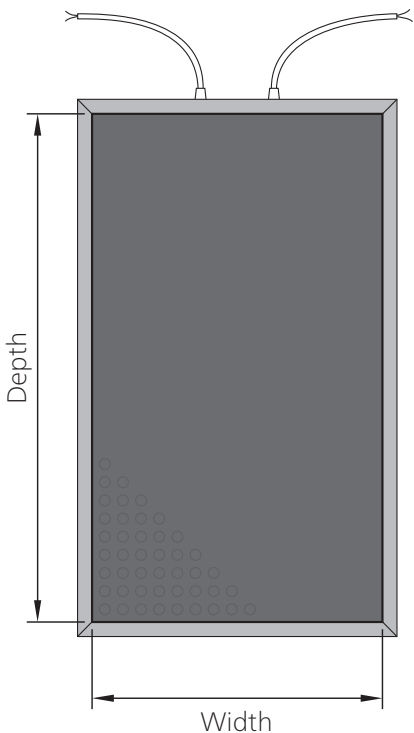
Load capacity: max. 800 N/cm<sup>2</sup>

Degree of protection: IP65

Available sizes

TS sensors are only available in fixed sizes:

| Part number |       | Width x Depth  |
|-------------|-------|----------------|
| 5001881     | TS/BK | 500 x 1200 mm  |
| 5000777     | TS/BK | 500 x 1600 mm  |
| 5001882     | TS/BK | 750 x 1200 mm  |
| 5001005     | TS/BK | 750 x 1600 mm  |
| 5001238     | TS/BK | 1000 x 1200 mm |
| 5000776     | TS/BK | 1000 x 1600 mm |



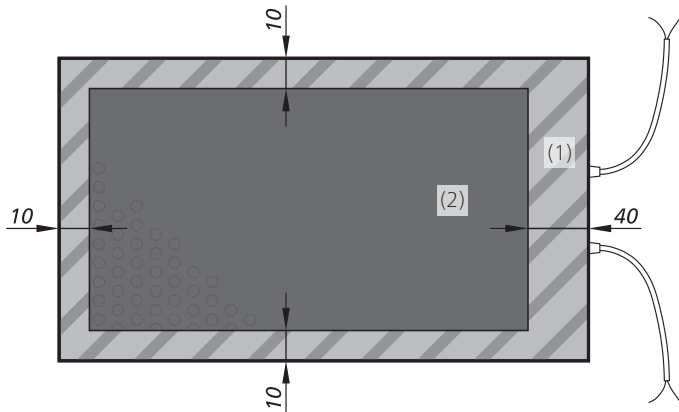
According to ISO 13855, the minimum depth to the danger zone must be taken into account (see Chapter *Calculation of the necessary actuation area*).  
The non-sensitive edges must be taken into account (see Chapter *Non-sensitive edges*).



## Non-sensitive edges

A non-sensitive edge (1) surrounds the effective actuation area (2):

- 40 mm = on cable exit side
- 10 mm = on remaining three sides



### Note

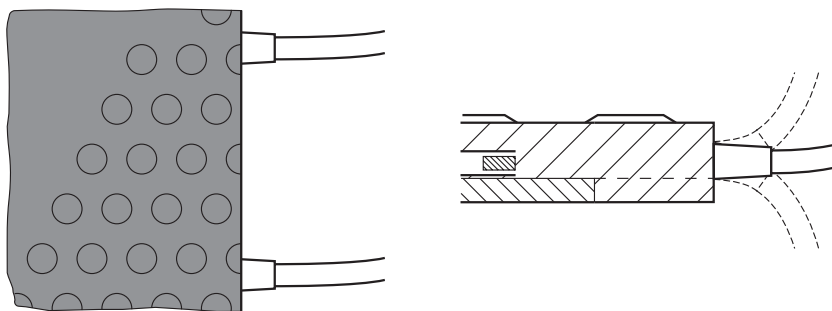
With a combination of sensors, only the sides with an edge area of 10 mm may be placed together.

## Connection

### Cable exit

The cable exit is only available in the centre of the narrow side.

Lay the cables in the attached cable conduit. They can only be laid upwards or downwards to a limited extent.



## Cable connection

### ATTENTION

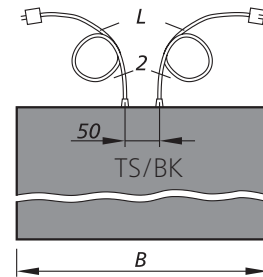
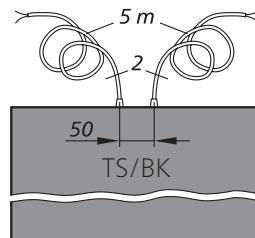
The maximum overall cable length up to signal processing is 100 m.

### Without plug (standard)

- Universally applicable
- Variable cable length

### With plug

- Service-friendly
- Easy assembly
- Safe connection
- Watertight plug connection possible
- Standard cable lengths  
 $L = B/2 + 200 \text{ mm}$   
 (Other cable lengths available on request.)

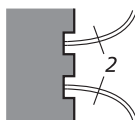


- As a feed-through sensor type BK
- Without resistor
- 2 two-wire cables ( $\varnothing 5 \text{ mm}$ ;  $2 \times 0.5 \text{ mm}^2 \text{ Cu}$ )

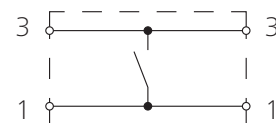
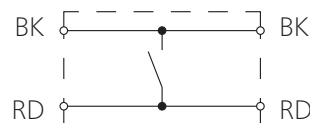
## Wire colours

### Without plug (standard)

### With plug (M8)



### Sensor type BK with 2 lines

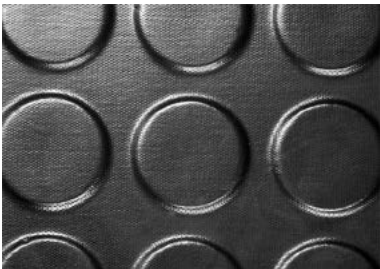


### Colour coding

RD Red      BK Black

Sensor cover

The rubber nub structure is produced during the manufacturing process at the factory. It prevents slipping and provides mechanical protection. Further covering of the sensor is not necessary.



Resistances

The condition for the resistances listed in the following (at room temperature 23 °C) is a sensor with an undamaged surface.

Physical resistance

| Surface                                  | PUR       |
|--|-----------|
| IEC 60529: degree of protection          | IP65      |
| DIN 53516: abrasion                      | 120 mg    |
| DIN 51130: non-Slip                      | R9        |
| static load (8 h)                        | 800 N/cm² |
| DIN 4102: behaviour in fire              | B2        |
| Stress when subjected to climate changes | +         |
| UV-resistance                            | +         |

Explanation of symbols:  
+ = resistant

**Chemical resistance**

The sensor is resistant against normal chemical influences such as diluted acids and alkalis as well as alcohol over an exposure period of 24 hrs.

The values in the table are results of tests carried out in our laboratory. The suitability of our products for your special area of application must always be verified with your own practical tests.

**Explanation of symbols:**

- + = resistant
- ± = resistant to a certain extent
- = not resistant

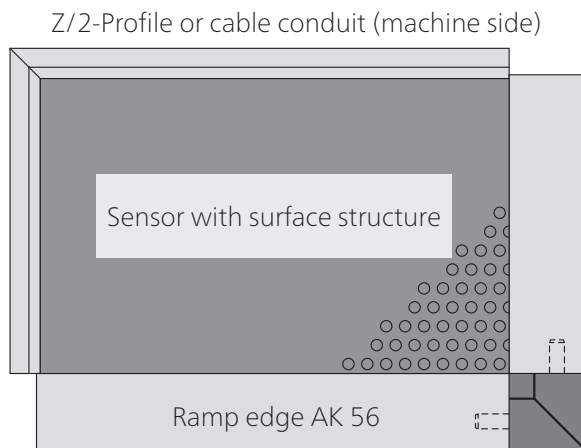
**Note:**

Tests are carried out at room temperature (+23 °C).

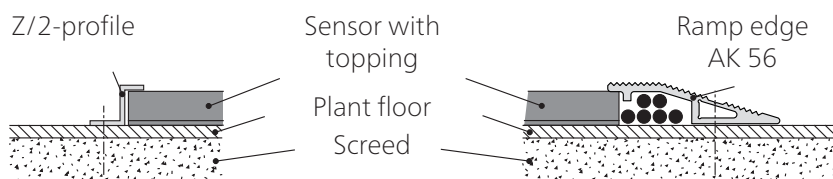
| Surface                      | PUR |
|------------------------------|-----|
| Acetone                      | -   |
| Formic acid 5 %              | +   |
| Ammonia                      | +   |
| ATF gear oil                 | +   |
| Brake fluid DOT 4            | -   |
| Cutting emulsion             | +   |
| Demineralised water          | +   |
| Diesel                       | ±   |
| Acetic acid 10 %             | +   |
| Ethanol                      | -   |
| Greases                      | -   |
| Hydraulic oil                | +   |
| Caustic potash solution 10 % | +   |
| Saline solution 5 %          | +   |
| Cooling lubricant            | ±   |
| Metal working oil            | +   |
| Methanol                     | -   |
| Mineral oil                  | +   |
| Caustic soda 10 %            | ±   |
| Cellulose thinner            | -   |
| Hydrochloric acid 10 %       | ±   |
| Salt water 10 %              | +   |
| Suds 5 %                     | +   |
| White spirit (ethyl alcohol) | -   |
| Universal thinner            | -   |
| Water                        | +   |
| Petroleum ether / petrol     | -   |
| Citric acid 10 %             | +   |
| Drawing compound             | -   |

## Sensor attachment

Ramp edges can be installed quickly and easily.

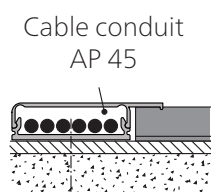


## Ramp edge AK 56



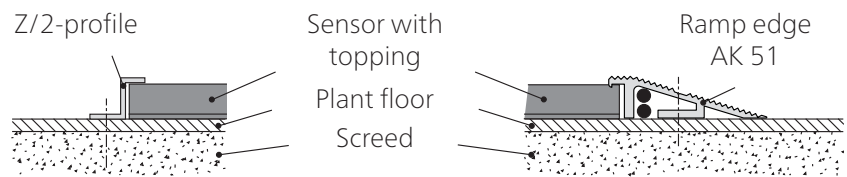
- Not suitable for plug-in cable connections
- Cable conduit for max. 6 cables

## Cable conduit AP 45



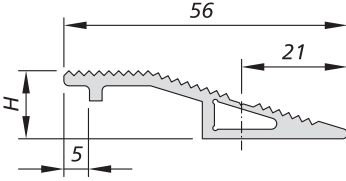
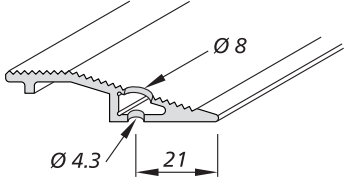
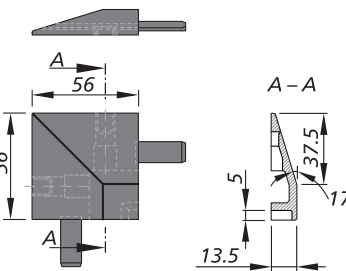
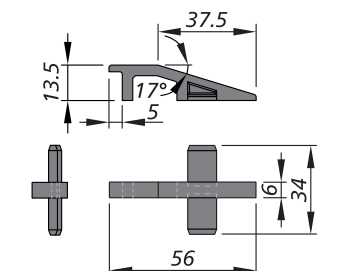
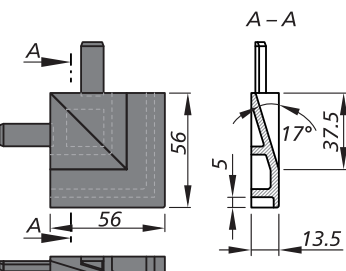
- Cable conduit AP 45 instead of Z/2-Profile
- Suitable for plug-in cable connections
- Cable conduit for max. 6 cables

## Ramp edge AK 51



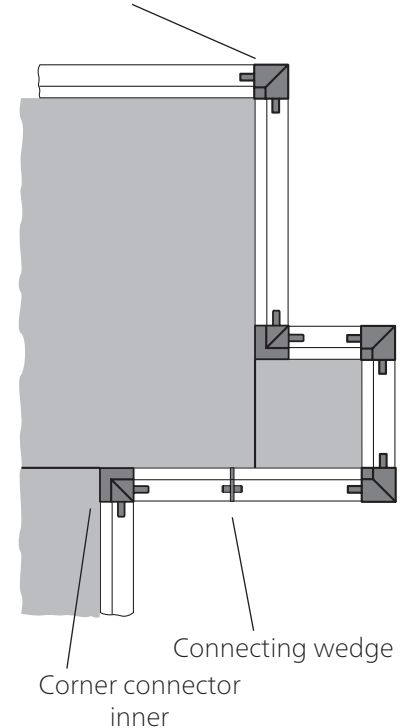
- Not suitable for plug-in cable connections
- Cable conduit for max. 2 cables
- Corner joints are only available with mitre cuts (not suitable for corner connectors and wedge connectors)

*Subject to technical modifications.*

|  |   |
|--|---|
| <p><b>Aluminium ramp edge AK 56</b></p> <ul style="list-style-type: none"> <li>• 1-part with cable conduit</li> <li>• For combination of several sensors</li> <li>• Sensors with or without plugs</li> <li>• Rod 3 m (7501014), Rod 6 m (1002684) or fixed length</li> </ul> |    |
| <p><b>Threaded hole for AK 56</b></p> <ul style="list-style-type: none"> <li>• For fixing ramp edge AK 56</li> </ul>   |    |
| <p><b>Corner connector E1 AK 56 outer</b></p> <ul style="list-style-type: none"> <li>• For corner connectors ramp edge AK 56</li> <li>• Material: plastic black (1002751)</li> </ul>   |   |
| <p><b>Connecting wedge Vk AK 56</b></p> <ul style="list-style-type: none"> <li>• For longitudinal connection of ramp edge AK 56</li> <li>• Material: plastic black (1002996)</li> </ul>  |  |
| <p><b>Corner connector E2 AK 56 inner</b></p> <ul style="list-style-type: none"> <li>• For corner connectors ramp edge AK 56</li> <li>• Material: plastic black (1002752)</li> </ul>   |  |

**Example:**

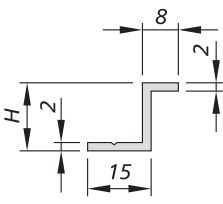
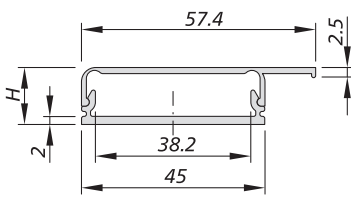
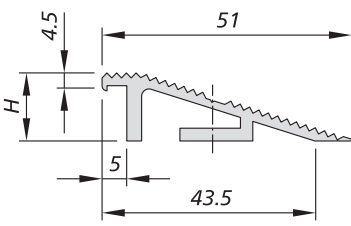
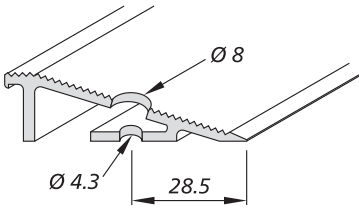
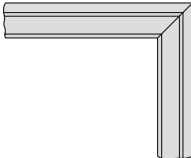
Corner connector outer



**Note**

Corner connector and connecting wedge are not suitable for ramp edge AK 51.

*Subject to technical modifications.*

|  |   |
|--|---|
| <p><b>Aluminium-Z/2-Profile</b></p> <ul style="list-style-type: none"> <li>• Edging at the machine or wall side</li> <li>• Rod 3 m (7500385),<br/>Rod 6 m (1001666)<br/>or fixed length</li> </ul>   |    |
| <p><b>Aluminium cable conduit AP 45</b></p> <ul style="list-style-type: none"> <li>• 2-part with cable conduit</li> <li>• For combination of several sensors</li> <li>• Sensors with or without plugs</li> <li>• Upper section is clipped into lower section</li> <li>• Rod 3 m upper part (1002546),<br/>Rod 3 m bottom part (1002547)<br/>or fixed length upper and bottom part</li> </ul> |    |
| <p><b>Aluminium ramp edge AK 51</b></p> <ul style="list-style-type: none"> <li>• 1-part with cable conduit</li> <li>• Combinations up to max. 2 sensors</li> <li>• Sensor without plug</li> <li>• Rod 3 m (7500384),<br/>Rod 6 m (1001667)<br/>or fixed length</li> </ul>  |   |
| <p><b>Threaded hole for AK 51</b></p> <ul style="list-style-type: none"> <li>• For fixing ramp edge AK 51</li> </ul>   |  |
| <p><b>Mitre cut</b></p> <ul style="list-style-type: none"> <li>• For corner connections</li> </ul>   |  |



## Calculation of the necessary actuation area

In accordance with ISO 13855, the necessary effective actuation area in relation to the danger area is calculated with the following:

$$S = (K \times T) + C \quad \text{where:} \quad \begin{aligned} K &= 1600 \text{ mm/s} \\ T &= t_1 + t_2 \\ C &= 1200 \text{ mm} - 0.4H \end{aligned}$$

### With installation at floor level

$H = 0$ ; hence:

$$S = (1600 \text{ mm/s} \times T) + 1200 \text{ mm}$$

### With installation on a step

$H \neq 0$ ; hence:

$$S = (1600 \text{ mm/s} \times T) + (1200 \text{ mm} - 0.4H)$$

$S$  = Minimum distance between the danger zone and the furthest edge of the sensor [ mm ]

$K$  = Approximation parameters [ mm/s ]

$T$  = Follow-through of the complete system [ s ]

$t_1$  = Response time of the protective device

$t_2$  = Stopping time of the machine

$C$  = Safety tolerance [ mm ]

$H$  = Step height [ mm ]

## Calculation examples

### Example 1

A safety mat detects non-permitted access to the danger zone of an automated movement. The mat is installed flush to the floor, i.e.  $H = 0$ . The follow-through time of the movement is 212 ms, the response time of the protective device is 38 ms.

$$S = (1600 \text{ mm/s} \times (212 \text{ ms} + 38 \text{ ms})) + 1200 \text{ mm}$$

$$S = 400 \text{ mm} + 1200 \text{ mm}$$

$$S = 1600 \text{ mm}$$

### Example 2

The same conditions as Example 1, however, a step with a height of 150 mm must be negotiated to the danger zone.

$$S = (1600 \text{ mm/s} \times (212 \text{ ms} + 38 \text{ ms})) + (1200 - (0.4 \times 150)) \text{ mm}$$

$$S = (1600 \text{ mm/s} \times 0.25 \text{ s}) + (1200 - 60) \text{ mm}$$

$$S = 400 \text{ mm} + 1140 \text{ mm}$$

$$S = 1540 \text{ mm}$$

*Subject to technical modifications.*

## Safety aspects

### Without reset function

When a safeguard without reset function is used (automatic reset), the reset function must be made available in some other way.

### Performance Level (PL)

The PL was determined during a simplified procedure according to ISO 13849-1.

Fault exclusion according to ISO 13849-2 Table D.8: Non-closing of contact by pressure-sensitive equipment according to ISO 13856. In this case, the sensor will no longer be taken into account in determining the PL. The overall system safety mat (pressure-sensitive protection device) can reach a maximum of PL d.

### Is the safeguard appropriate?

The PL required for the hazard must be decided by the integrator. This is followed by the choice of safeguard.

Finally, the integrator needs to check whether the category and PL of the safeguard chosen are appropriate.

## Maintenance and cleaning

The sensor is virtually maintenance-free.

The control unit also monitors the sensor.

### Regular inspection

Depending on the load, the sensors are to be tested at regular intervals (at least monthly)

- for correct functioning: by activation or by applying the relevant test sample.
- for damage: by visual checking.

### Cleaning

If necessary, clean the sensor with a mild cleaning agent.

## Technical data

|   |                                     |
|---|-------------------------------------|
| <b>Safety mat:</b>  | <b>TS/BK with SG-EFS 104/4L</b>     |
| Testing basis:  | ISO 13856-1                         |
| <b>Switching characteristics at <math>v_{\text{test}} = 250 \text{ mm/s}</math></b> |                                     |
| Switching operations at 0.1 A   | $> 4 \times 10^6$                   |
| Actuation forces  |                                     |
| Test piece (cylinder) Ø 11 mm   | $< 300 \text{ N}$                   |
| Test piece (cylinder) Ø 80 mm   | $< 300 \text{ N}$                   |
| Test piece (cylinder) Ø 200 mm  | $< 600 \text{ N}$                   |
| Response time with control unit   | 38 ms                               |
| <b>Safety classifications</b>   |                                     |
| ISO 13856: reset function   | with/without                        |
| ISO 13849-1:2015  | category 3 PL d                     |
| MTTF <sub>D</sub> (pressure-sensitive protection device)                            | 65 a                                |
| MTTF <sub>D</sub> (sensor)  | 1142 a                              |
| B10 <sub>D</sub> (sensor)   | $6 \times 10^6$                     |
| n <sub>op</sub> (acceptance)  | 52560 per year                      |
| <b>Mechanical operating conditions</b>  |                                     |
| Sensor size   | max. 1.6 m <sup>2</sup>             |
| Static load (up to 8 h)   | max. 800 N/cm <sup>2</sup>          |
| Driving on with industrial trucks   | not suitable                        |
| Weight  | 13.5 kg/m <sup>2</sup>              |
| IEC 60529: degree of protection   | IP65                                |
| max. humidity (23 °C)   | 95% (not-condensing)                |
| Operating temperature   |                                     |
| individual sensor   | -5 to +55 °C                        |
| combined sensor   | +5 to +55 °C                        |
| Storage temperature   | -20 to +55 °C                       |
| <b>Electrical operating conditions</b>  |                                     |
| Connection cable  | Ø 5.0 mm PVC 2× 0.5 mm <sup>2</sup> |
| Sensor  | DC 24 V / max. 100 mA               |
| Number of sensors type BK   | max. 10 in series                   |
| <b>Dimensional tolerances</b>   |                                     |
| Length dimension  | ISO 2768-c                          |
| Perpendicularity  | ISO 2768-c                          |

*Subject to technical modifications.*

## Request for quotation

### Submitted by

Company

Department

Surname, first name

P.O. Box

Postcode

Town/city

Street

Postcode

Town/city

Phone

Fax

E-mail

**Fax:**

**+49 731 2061-222**

### Area of application

(e.g. metalworking, textile machines, timber processing, tube drawing, local public transport, ...)

#### Protection of the danger zone with:

- |  |                 |
|--|-----------------|
| <input type="checkbox"/> TS/BK 500 × 1200  | Quantity: _____ |
| <input type="checkbox"/> TS/BK 500 × 1600  | Quantity: _____ |
| <input type="checkbox"/> TS/BK 750 × 1200  | Quantity: _____ |
| <input type="checkbox"/> TS/BK 750 × 1600  | Quantity: _____ |
| <input type="checkbox"/> TS/BK 1000 × 1200 | Quantity: _____ |
| <input type="checkbox"/> TS/BK 1000 × 1600 | Quantity: _____ |

#### Fixing with:

- |  |  |
|--|--|
| <input type="checkbox"/> Ramp edge AK 56       | <input type="checkbox"/> Aluminium cable conduit AP 45 |
| <input type="checkbox"/> Aluminium-Z/2-profile | <input type="checkbox"/> Ramp edge AK 51               |

#### Area to be secured:

(Diagram incl. cable routing)

⬇ Please do not write ⬇  
in this column!  
For internal notes only