

## Safety mats SM



EN | Product information

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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.

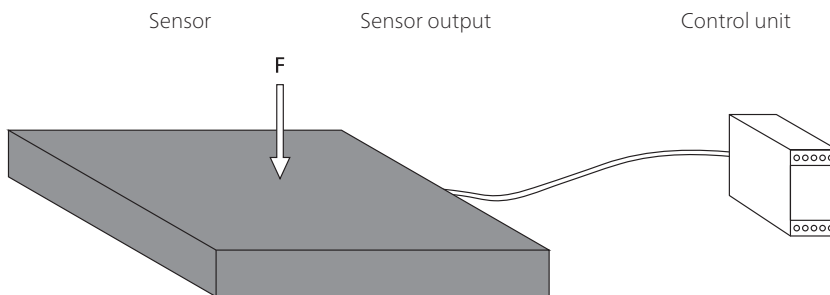
Always observe the safety instructions on the following pages under **ATTENTION**. Only use the product for the purpose described in the product information.

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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:**

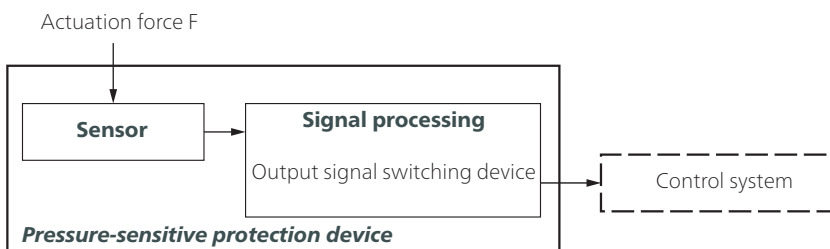
See also Chapter 3 **Terms** in ISO 13856-1.

#### 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

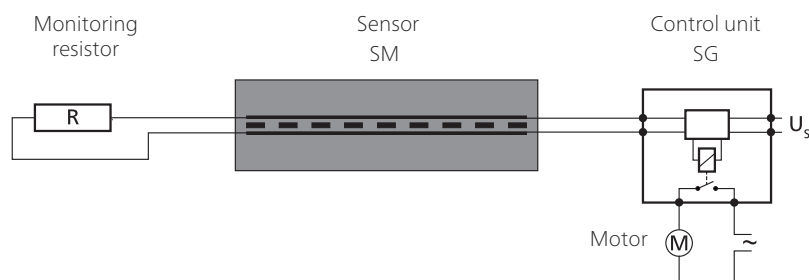
The signal processing is the part of the pressure-sensitive protection device that converts the output signal of the sensor and controls the status of the output signal switching device. The output signal switching device is that part of the signal processing which is connected to the machine controls 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 1k2. 8k2 and 22k1 are also available.

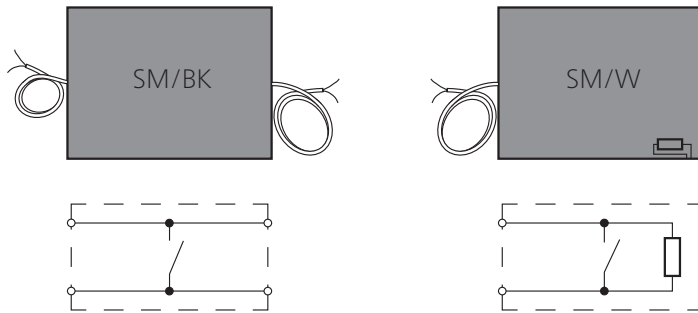
For your safety:

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).

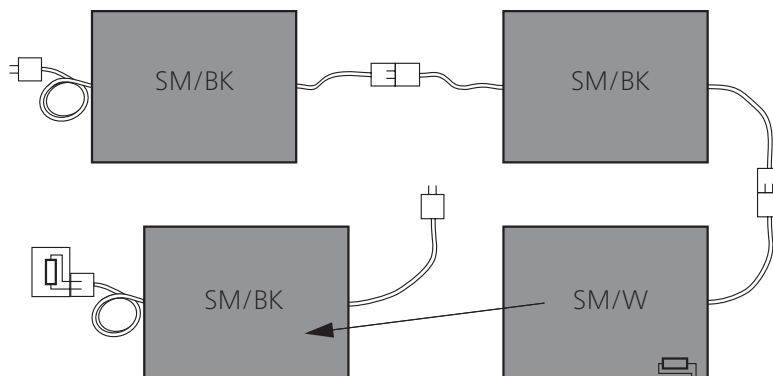
## Design

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

SM/W as an end sensor with integrated monitoring resistor



## Combination of sensors



Model with external resistor, thus avoiding variety in type

Combination:

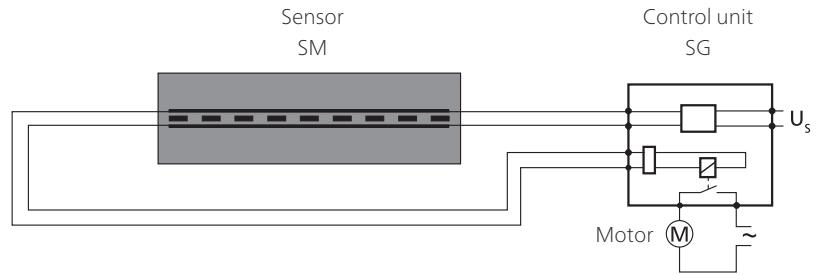
- connection of more than one sensor
- only one control unit required
- individual design of control areas with regard to size and shape

## 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.

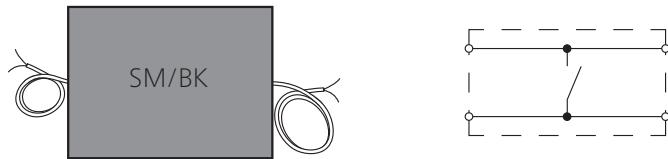


For your safety:

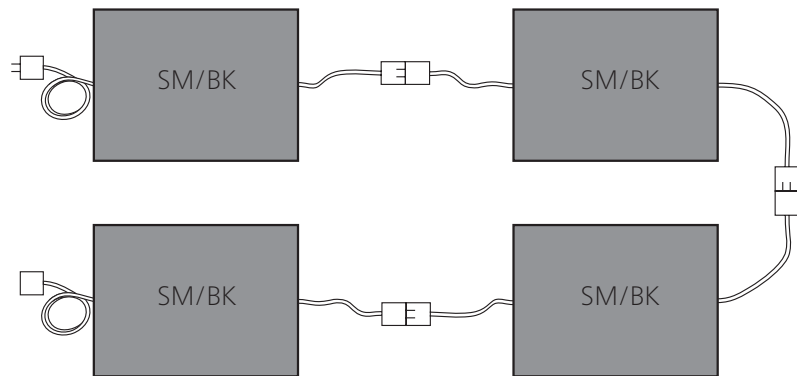
Sensor and connecting cables are constantly monitored for function. This is possible because of signal transmission feedback – without monitoring resistor.

**Design**

SM/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 sensor is suitable for detection of walking aids.

- 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
- Max. 9 sensors type BK and 1 sensor type W 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

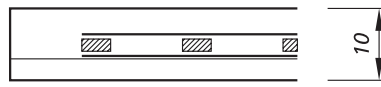
- for detecting individuals who weigh less than 35 kg.

## Program selection

The safety mat SM range supplies individual solutions in terms of size and shape. Safety mats SM are highly resistant to environmental influences and normal chemicals.

If you only require sensors that meet low demands, our safety mats SM11 or safety mats TS may also be a suitable solution.

## Design



### Standard version

moulded on plastic plate  
Degree of protection: IP65

### Customised versions

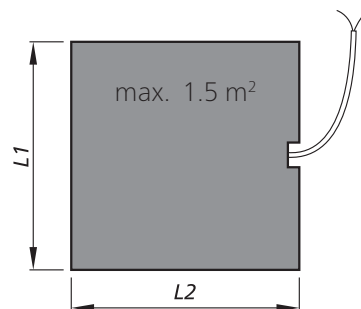
Customised versions are available for special conditions, e.g. aggressive substances (fuels, solvents etc.).

### Note:

The standard version comes with a fully-bonded rubber surface topping GM1, GM4 or GM5 (see chapter *Surface toppings* and *Rubber surface toppings*).

## Available sizes

Sensors are available up to a max. size of 1.5 m<sup>2</sup>.  
The side lengths must be within a range of 200 to 3,000 mm.



L1: cable side  
L2: not cable side

$$L1 \times L2 \leq 1.5 \text{ m}^2$$

The cable exit on safety mats can be on the wide or the narrow side.

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

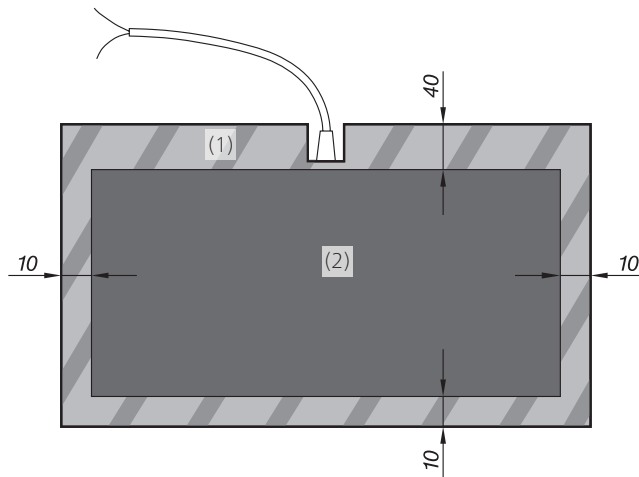
The non-sensitive edges must be taken into account (see Chapter *Non-sensitive edges*).



## 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

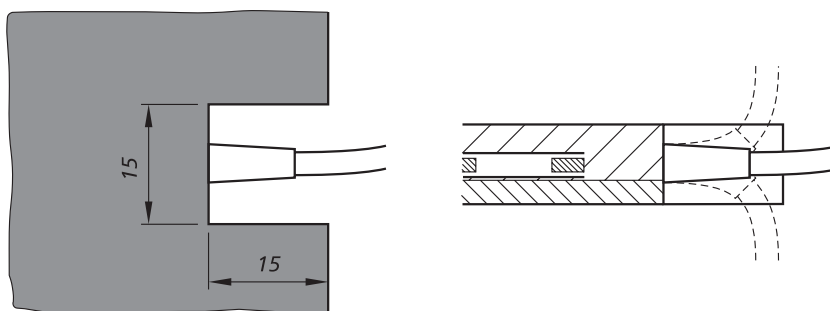
With a combination of sensors, only the sides with an edge area of 10 mm may be placed together.

## Connection

### Cable exit

The multifunctional cutout also allows the cable to be laid upwards or downwards.

The cable exit is in the middle of the mat side.



## Cable connection

### ATTENTION

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

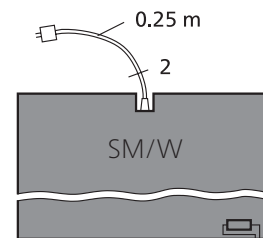
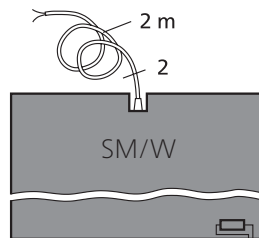
### Without plug (standard)

- Universally applicable
- Variable cable length

### With plug

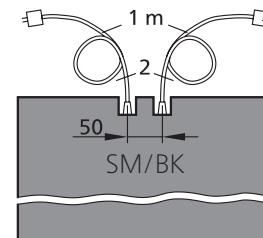
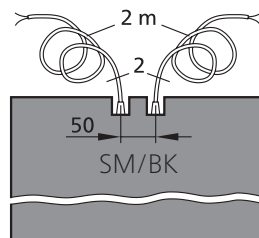
- Service-friendly
- Easy assembly
- Safe connection
- Watertight plug connection possible

### Sensor type W



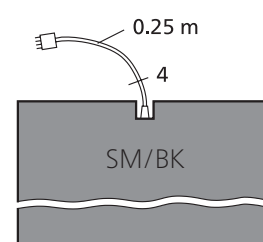
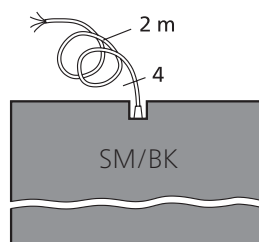
- As an individual sensor type W or an end sensor type W
- Integrated resistor
- 2-wire cable ( $\varnothing$  5 mm;  $2 \times 0.5 \text{ mm}^2 \text{ Cu}$ )

### Sensor type BK with 2 lines



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

### Sensor type BK with 1 line



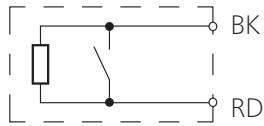
- As a feed-through sensor type BK
- Without resistor
- 4-wire cable ( $\varnothing$  5 mm;  $4 \times 0.34 \text{ mm}^2 \text{ Cu}$ )

Subject to technical modifications.

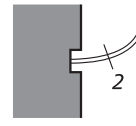
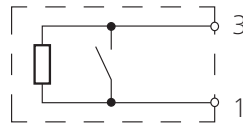
## Wire colours

### Without plug (standard)

#### Sensor type W



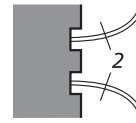
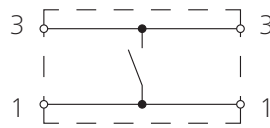
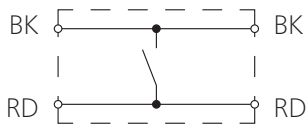
### With plug (M8)



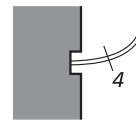
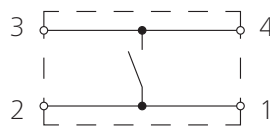
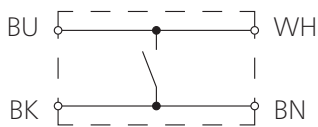
### Colour coding

RD Red	BK Black
BU Blue	BN Brown
WH White	

#### Sensor type BK with 2 lines



#### Sensor type BK with 1 line

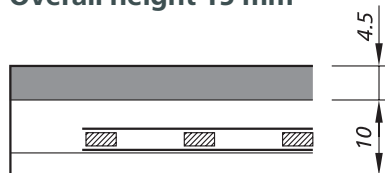


## Sensor surface

A rubber surface topping provides a non-slip surface and mechanical protection.

The toppings are bonded in the factory.

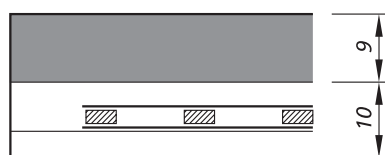
### Overall height 15 mm



GM 1 or GM 4

Sensor

### Overall height 19 mm



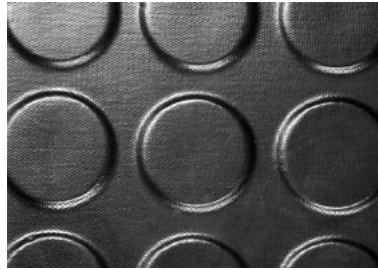
GM 5

Sensor

150917 v3.00

*Subject to technical modifications.*

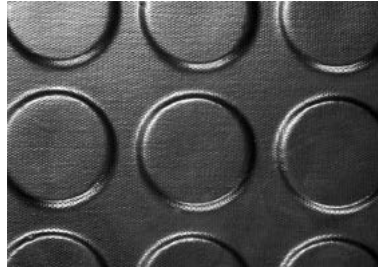
## Rubber surface toppings



### GM 1 SBR

Round nap topping, black  
Round nap topping, yellow

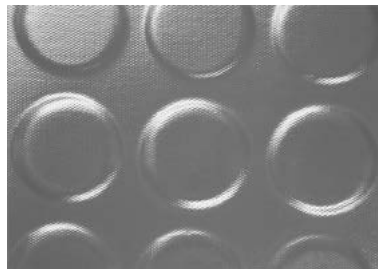
Thickness: 4.5 mm  $\pm 0.5$   
Max. size: 1.0 m x 10 m  
1.2 m x 10 m



### GM 4 NBR

Round nap topping, black  
Round nap topping, yellow

Thickness: 4.5 mm  $\pm 0.5$   
Max. size: 1.0 m x 10 m  
1.2 m x 10 m



### GM 5 NBR

Round nap topping, green  
with high mechanical strength

Thickness: 9 mm  $\pm 0.5$   
Max. size: 1.2 m x 10 m

## Resistances

The condition for the resistances listed in the following (at room temperature 23 °C) is a sensor with a rubber surface topping adhered over the entire area and with an undamaged surface.

### Physical resistance

Rubber surface topping	GM 1	GM 4	GM 5
IEC 60529: Degree of protection	IP65	IP65	IP65
DIN 53516: Abrasion	120 mg	120 mg	120 mg
Static load (up to 8 h)	800 N/cm <sup>2</sup>	800 N/cm <sup>2</sup>	1200 N/cm <sup>2</sup>
DIN 4102: Behaviour in fire	B2	B2	B2
Smouldering tobacco products	+	+	+
DIN 5510: Flammability class	S3	S3	S3
Stress when subjected to climate changes	+	+	+
UV-resistance	+	+	+

### Explanation of symbols:

+ = resistant

Subject to technical modifications.

## 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.

Rubber surface topping	GM 1	GM 4	GM 5
Acetone	+	+	+
Ammonia	+	+	+
Brake fluid	-	±	±
Cutting emulsion	-	±	±
Acetic acid	±	±	±
Greases	±	+	+
Caustic potash solution	+	+	+
Cooling lubricant	-	+	+
Metal working oil	-	+	+
Methyl alcohol	±	±	±
Sodium hydroxide	+	+	+
Cellulose thinner	±	±	±
Hydrochloric acid 10 %	±	+	+
Suds	+	+	+
White spirit (ethyl alcohol)	+	+	+
Water	+	+	+
Petroleum ether/ petrol	-	+	+
Citric acid	+	+	+
Drawing compound	-	±	±

### Explanation of symbols:

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

### Note:

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

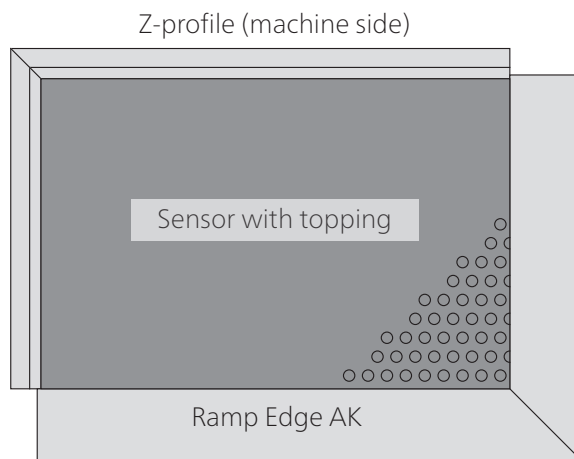
## Weight

Sensor with variable rubber surface topping GM and cable without plug.

SM without GM	11.4 kg/m <sup>2</sup>
SM with GM 1	17.4 kg/m <sup>2</sup>
SM with GM 4	17.4 kg/m <sup>2</sup>
SM with GM 5	24.0 kg/m <sup>2</sup>

## Sensor attachment

Ramp edges can be installed quickly and easily.

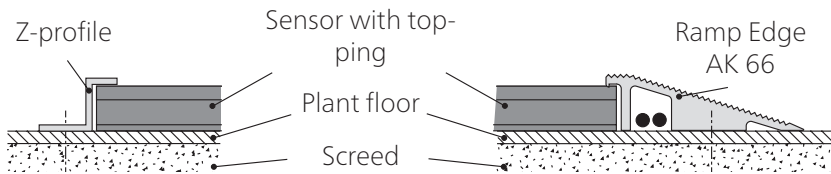


## Overview of fixing material

Sensor	Sensor height	Fixing material	See page
SM with GM 1 SM with GM 4	15 mm	Z-profile	16
		AK 66	16
		AK 105	17
		UP 80	18
SM with GM 5	19 mm	Z/1-profile	16
		AK 105/1	17

*Subject to technical modifications.*

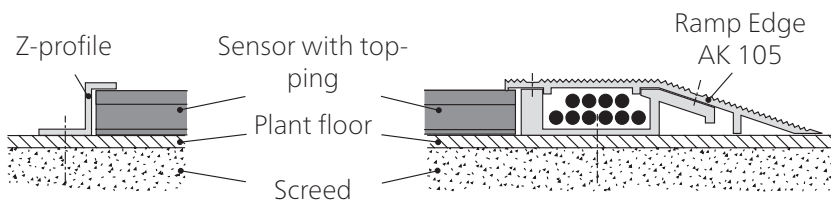
## Ramp Edge AK 66



- Not suitable for plug-in cable connections
- Cable conduit for max. 2 cables

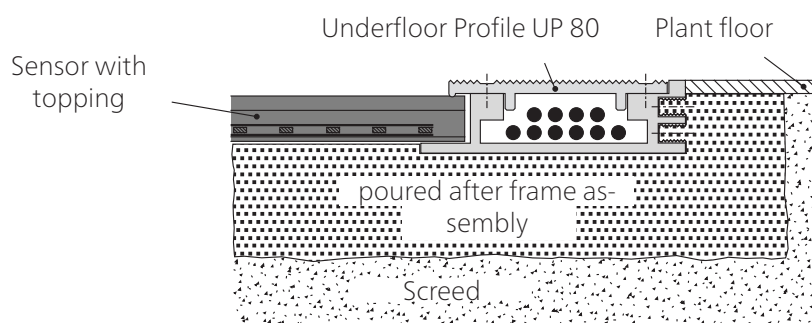
For dimensions, see page 16.

## Ramp Edge AK 105 and AK 105/1



- Suitable for plug-in cable connections
  - Cable conduit for max. 10 cables
- Ramp Edge AK 105/1 only for sensors with GM 5 surface topping.  
For dimensions, see page 17.

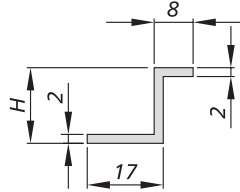
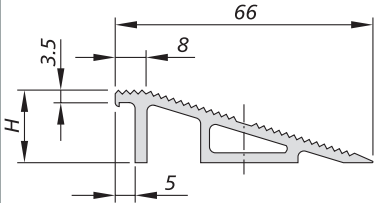
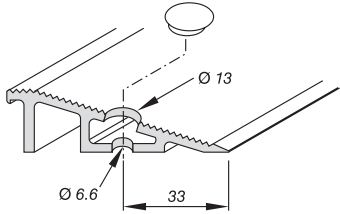
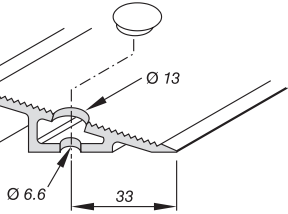
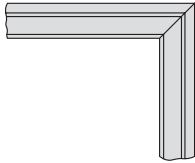
## Underfloor Profile UP 80



- Suitable for plug-in cable connections
  - Cable conduit for max. 10 cables
- For dimensions, see page 18.

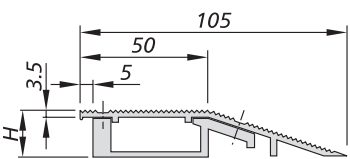
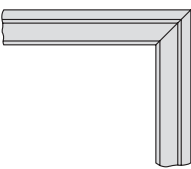
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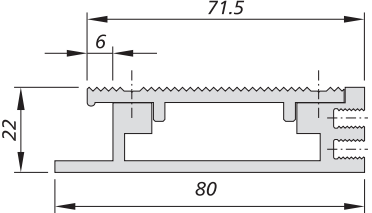
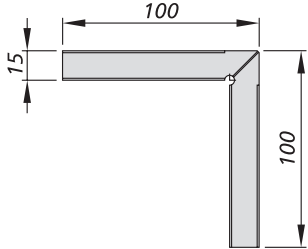
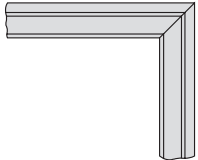
*Subject to technical modifications.*

<p><b>Aluminium Z- and aluminium Z/1-profile</b></p> <ul style="list-style-type: none"> <li>• Edging at the machine or wall side</li> <li>• Aluminium Z-profile for sensor with GM 1 and GM 4: H = 17.0mm</li> <li>• Aluminium Z/1-profile for sensor with GM 5: H = 21.0mm</li> <li>• Aluminium Z-profile: Rod, 3 m (7500054), Rod, 6 m (1000011) or fixed length</li> <li>• Aluminium Z/1-profile: Rod, 3 m (7500738), Rod, 6 m (1001478) or fixed length</li> </ul>	
<p><b>Aluminium Ramp Edge AK 66</b></p> <ul style="list-style-type: none"> <li>• 1-part with cable conduit</li> <li>• Combination of sensors up to max. 2 sensors</li> <li>• Sensor without plug</li> <li>• Aluminium Ramp Edge for sensors with GM 1 und GM 4: H = 18.7mm</li> <li>• Rod, 3 m (7500053), Rod, 6 m (1000008) or fixed length</li> </ul>	
<p><b>Threaded hole for AK 66</b></p> <ul style="list-style-type: none"> <li>• For fixing aluminium Ramp Edge AK 66</li> </ul>	
<p><b>Stopper</b></p> <ul style="list-style-type: none"> <li>• Closes threaded hole (1000615)</li> </ul>	
<p><b>Mitre cut</b></p> <ul style="list-style-type: none"> <li>• For corner connections</li> </ul>	

Subject to technical modifications.



<p><b>Aluminium Ramp Edge AK 105 and AK 105/1</b></p> <ul style="list-style-type: none"> <li>• 2-part with cable conduit</li> <li>• For combination of sensors</li> <li>• Sensors with or without plugs</li> <li>• Aluminium Ramp Edge AK 105 for sensors with GM 1 und GM 4: H = 17.5mm</li> <li>• Aluminium Ramp Edge AK 105/1 for sensors with GM 5: H = 21.0mm</li> <li>• Aluminium Ramp Edge AK 105: Rod, 3 m upper and lower sections (7500052), Rod, 6 m upper section (1000009), Rod, 6 m lower section (1000010), or fixed length</li> <li>• Aluminium Ramp Edge AK 105/1: Rod, 3 m upper and lower sections (7500224), Rod, 6 m upper sections (1000992), Rod, 6 m lower sections (1000010), or fixed length</li> </ul>	
<p><b>Mitre cut</b></p> <ul style="list-style-type: none"> <li>• For corner connections</li> </ul>	

<p><b>Aluminium Underfloor Profile UP 80</b></p> <ul style="list-style-type: none"><li>• Edge profile with top cover</li><li>• For installation flush with the floor</li><li>• For individual sensor or a combination of sensors</li><li>• Sensors with or without plugs</li><li>• For GM 1 and GM 4</li><li>• Rod, 3 m upper and lower sections (7500134), Rod, 6 m upper section (1000025), Rod, 6 m lower section (1000026), or fixed length</li></ul>	
<p><b>UP corner connection section</b></p> <ul style="list-style-type: none"><li>• For corner connection of the UP profiles when installing (1000599)</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

### area

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

$$S = (K \times T) + C \quad \text{where:} \quad K = 1600 \text{ mm/s}$$

$$T = t_1 + t_2$$

$$C = 1200 \text{ mm} - 0.4H$$

#### 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 300 ms, the response time of the protective device is 18 ms.

$$S = (1600 \text{ mm/s} \times (300 \text{ ms} + 18 \text{ ms})) + 1200 \text{ mm}$$

$$S = 509 \text{ mm} + 1200 \text{ mm}$$

$$S = 1709 \text{ mm}$$

### Example 2

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

$$S = (1600 \text{ mm/s} \times (300 \text{ ms} + 18 \text{ ms})) + (1200 - (0,4 \times 150)) \text{ mm}$$

$$S = (1600 \text{ mm/s} \times 0,318 \text{ s}) + (1200 - 60) \text{ mm}$$

$$S = 509 \text{ mm} + 1140 \text{ mm}$$

$$S = 1649 \text{ mm}$$

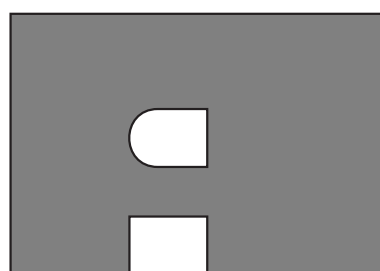
## Customised designs

### Customised shapes



e.g. different corner shapes

Different shapes such as circles, circle segments, trapeze shapes etc. are possible.



e.g. cut-outs

Mats can be ready-manufactured with cut-outs, e.g. for machine feet, switch cabinets etc.

## 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

Safety mat:	SM/W with SG-EFS 1X4 ZK2/1	SM/BK with SG-EFS 104/4L
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) $\varnothing 11 \text{ mm}$	< 300 N	
Test piece (cylinder) $\varnothing 80 \text{ mm}$	< 300 N	
Test piece (cylinder) $\varnothing 200 \text{ mm}$	< 600 N	
Response time with Control Unit	18 ms	38 ms
<b>Safety classifications</b>		
ISO 13856: Reset function	with/without	with/without
ISO 13849-1:2015	category 3 PL d	category 3 PL d
MTTF <sub>D</sub> (Pressure-sensitive protection device)	246 a	65 a
MTTF <sub>D</sub> (sensor)	1142 a	1142 a
B <sub>10D</sub> (sensor)	$6 \times 10^6$	$6 \times 10^6$
n <sub>op</sub> (acceptance)	52560/a	52560/a
<b>Mechanical operating conditions</b>		
Sensor size	max. 1.5 m <sup>2</sup>	
Side length (min./max.)	200 mm / 3000 mm	
Cable length (min./max.)	10 cm / 200 m	
Static load (up to 8 h)	max. 800 N/cm <sup>2</sup>	
Driving on with industrial trucks	not suitable	
IEC 60529: Degree of protection	IP65	
max. humidity (23 °C)	95% (non-condensing)	
Operating temperature		
individual sensor	+5 to +55 °C	
combination of sensors	-5 to +55 °C	
Storage temperature	-20 to +55 °C	
<b>Electrical operating conditions</b>		
Connection cable	$\varnothing 5.0 \text{ mm PVC } 2 \times 0.5 \text{ mm}^2 \text{ or } 4 \times 0.34 \text{ mm}^2$	
Sensor	DC 24 V / max. 10 mA	
Number of sensors type BK	max. 10 in series	
<b>Dimensional tolerances</b>		
Length dimension	ISO 2768-c	
Perpendicularity	ISO 2768-c	

## 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, ...)⬇ Please do not write ⬇  
in this column!

For internal notes only

**Environmental conditions** Dry Water Oil Aggressive  
substances: Coolant, type: \_\_\_\_\_ Solvent, type: \_\_\_\_\_ Other: \_\_\_\_\_ Room temperature Other: from \_\_\_\_\_ °C to \_\_\_\_\_ °C**Mechanical conditions** Only adults Also children Falling objects with \_\_\_ kg maximum weight Vehicles with \_\_\_\_\_ kg maximum weight Vehicle type: \_\_\_\_\_**Area to be secured:**

(Diagram incl. edge profiles and cable routing)