

Operating Manual

HSM[®]

Safety mats

(Translation of Original Manual)

HSM - S

HSM - U



Read the operating manual before beginning any work!

HAAKE[®]

Haake Technik GmbH
Master Esch 72
48691 Vreden, Germany
info@haake-technik.com
www.haake-technik.com
Tel.: +49 2564 39650
Fax: +49 2564 396590

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Contents

1	Scope	3
2	Intended use.....	3
3	Symbol Explanation	3
4	Disposal	3
5	Foreseeable misuse	3
6	Identification	4
7	Safety related functioning	4
8	Fault exclusion.....	4
9	Scope of delivery	5
10	Structure and function	5
	10.1 Description.....	5
	10.2 Example	5
11	Safety measures	6
	11.1 Organisational measures	6
	11.2 Safety of persons	6
	11.3 Avoid property damage	6
	11.4 Operating conditions and limitations of use.....	6
	11.5 Assembly.....	6
	11.6 Repairs / Alterations	6
	11.7 Electrical equipment	6
12	Installation.....	7
	12.1 Preparation	7
	12.2 General approach.....	7
	12.3 Installation instructions	7
	12.4 Electrical connection	8
13	Performance check	9
14	Operation	10
15	Attention!.....	11
16	Cleaning.....	11
17	De-installation.....	11
18	Troubleshooting	11
19	Transport, handling, unpacking, storage	12
	19.1 Transportation and handling	12
	19.2 Unpacking	12
	19.3 Storage	12
20	Technical Data.....	13
21	Dimensions	15
22	Actuating forces and response times:	Fehler! Textmarke nicht definiert.
23	Selection procedure	16
24	Application example	17
25	Acceptance report.....	17
26	EC Declaration of Conformity	19

1 Scope

This operating manual is intended for persons who have been authorized to carry out tasks involving the safety mat of the HSM-series. International, national and, where appropriate, regional regulations are to be observed when handling key transfer systems.

If you have any questions which are not answered in this manual, please get in touch with your regional customer service centre or else make direct contact with

Haake Technik GmbH

Master Esch 72, 48691 Vreden, Germany

Telephone +49 2564 39650

Fax +49 2564 396590

Info@haake-technik.com

2 Intended use

Safety mats from the HSM series are area-securing protection devices according to the conditions mentioned in chapter 20, 21 and 23.

They are applied as access guarding in danger zones, e.g. automatic door systems, automatic production systems, shelf alleys, woodworking machinery or robotic systems.

Other applications are prohibited.

3 Symbol Explanation

Warnings are indicated by symbols. The notices are introduced by signal words to indicate the extent of the hazard.



Attention!

... indicates a potentially hazardous situation, which may lead to personal injury and damage to property if it is not avoided.



NOTE!

... highlights useful tips and recommendations as well as information for efficient and fault-free operation.

4 Disposal



The device must be properly disposed of in accordance with national laws and regulations.

5 Foreseeable misuse

Examples for reasonably foreseeable misuse

- Safety mats may not be covered additionally.
- Transport vehicles (e.g. forklift) may not drive on safety mats.
- Safety mats may not be connected to voltage ≥ 50 V AC, 75 V DC.
- Safety mats may not be stressed by currents greater than 0.5 A.
- Connection lines may not be installed without protection.

6 Identification

For exact identification, you will find the type designation, serial number and year of construction on the type labels of the safety mats.

Note these details (prior to installation, if necessary), so that they can be provided in case of questions or for ordering spare parts.

7 Safety related functioning

The safety mats carry out the following safety functions:

1. Interruption of the closed circuit through force application on the sensor surface
2. The interruption of the closed circuit is maintained as long as the force is applied to the sensor surface.

8 Fault exclusion

Due to the construction, materials, and components used for the component, the faults listed in the table can be excluded:

Potential Defect	Elimination of Defect	Limitations of Use	Reason
Deformation by overload	Admissible in accordance with Table A.4. of DIN E ISO 13849-2.	See: Intended use in section 2 and technical information in section 20.	Use of carefully selected materials and manufacturing procedures; using special mounting types. With overloading the safety mat the inlet items will be disrupted permanent.
Modifications of the geometry or breakage of the contact chain	Admissible in accordance with Table A.4. of DIN E ISO 13849-2.	See: Intended use in section 2 and technical information in section 20.	Use of carefully selected materials and manufacturing procedures; use of special fastening types; over-dimensioning.
Short circuit in the lines and line connections	Admissible in accordance with Table D.4. of DIN E ISO 13849-2.	See: Installation in section 12	Use of doubly insulated sheathed cables and protected cable installation
Welding of the contacts	Admissible in accordance with Table D.8 of DIN E ISO 13849-2.	See: Installation in section 12 and technical information in section 20.	Use of a fuse (0.5 A) in the supply circuit of the safety mats.

9 Scope of delivery

1 x Safety mat



NOTE!

Means of attachment and fuse (0.5 A) are not included in the scope of the delivery.

10 Structure and function

10.1 Description

The safety mats basically have the same construction, independent of dimensions and shape.

They consist of the components:

- Haake safety Inlett items HSM[®] (normally closed type)
- PU-coating of the Inlett-items with special surface structure
- Aluminum profiles for mounting the safety mat and for tripping protection.
- A variety of line connection arrangements depending on the application
- Doubly insulated connection lines for machine control

When the safety mat is actuated, the current flow is interrupted by the special geometry of the Inlett-items chain links in the interior of the sensor. This interruption represents the OFF state of the output signal switching device and thus transmits the safety output signal to the downstream machine control. The safety mats meet the requirements for automatic resetting because they shift to ON state when the actuating force is removed.

Should work with a manual reset be required, this should be implemented by the machine control in accordance with DIN EN ISO 13856-2, Section 4.11.

Due to the closed circuit principle (forced interruption of the contact chain) no separate evaluation unit is necessary for provision of the output signal.

The safety mat and downstream machine control must together meet the performance level that was determined by the risk assessment.

10.2 Example

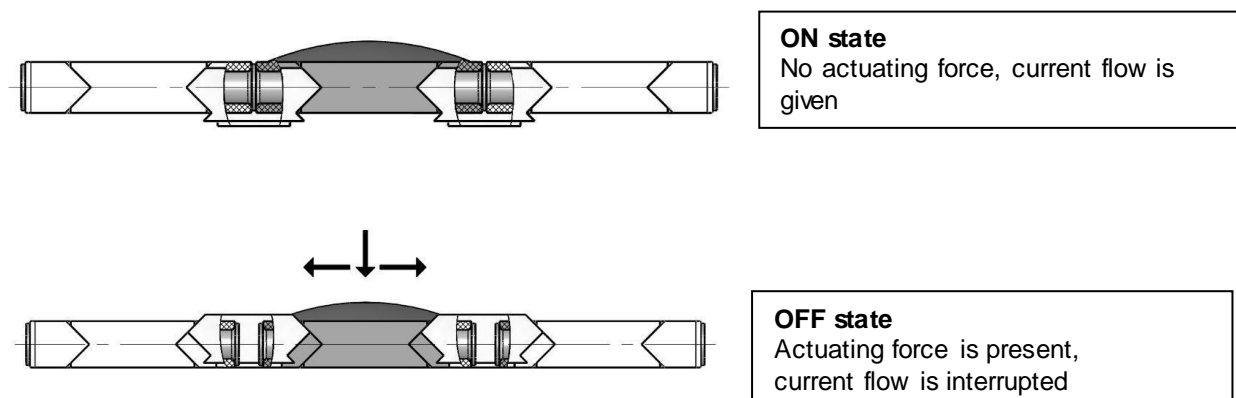


Figure shows HSM as a functional principle (sensor profile is not shown)

11 Safety measures

11.1 Organisational measures

Persons who have been authorised to carry out tasks involving the installation or removal of the safety mat must have read and understood this manual prior to commencing such tasks.

The operator of the plant or machine has an obligation to ensure the installation and de-installation is carried out safely and with no hazards by implementing appropriate safety measures.

11.2 Safety of persons

Personnel responsible for installation or removal tasks have to be suitably skilled or else have to be instructed by suitably skilled persons. On account of their technical training and experience, such skilled persons have sufficient knowledge of the installation or machine. These persons are sufficiently familiar with the applicable domestic work protection and accident prevention regulations of relevance here, that they are able to assess the operational safety of the installation or machine.

It is necessary to implement accident- and fall-prevention measures, whenever tasks are performed or areas are traversed at height.

11.3 Avoid property damage

Please note the **intended use** (cf. section 2) and the **technical information** (cf. section 19) described in this manual.

11.4 Operating conditions and limitations of use

Please note the **intended use** described in this instruction manual (cf. section 2), **foreseeable misuse** (cf. section 5) and the **technical information** (cf. section 20). The safety mat and downstream machine control must together meet the performance level that was determined by the risk assessment.



Attention!

During a hazard, the machine must not be restarted.

11.5 Assembly

Perform the assembly as described in section 12 and always carry out a function test afterwards. Do not make any alterations to the installation after the function test has been successfully carried out.

11.6 Repairs / Alterations

Do not carry out any repairs to the safety mat. Do not replace or exchange any parts. Send damaged or faulty components to Haake Technik GmbH to be repaired.

Do not make any alterations to the component. Otherwise, this could lead to malfunctions, which can cause serious personal injury and irreparable damage to property.

In the event of non-compliance, the guarantee is invalidated and Haake Technik GmbH does not accept any liability.

11.7 Electrical equipment

Electrical connections may only be carried out by qualified electricians who are familiar with all international, national and, where appropriate, regional electrical engineering regulations.

Work must only be carried out when the power supply has been shut off.

Always ensure external protection of the safety mat with an overcurrent fuse of 0.5 A (rated value).

12 Installation



Attention!

Always select an attachment that is sufficiently secured against loosening for installation. The overall safety of the machine depends on the proper execution of the installation.

12.1 Preparation

Before starting installation, make sure that the type designation specified in this instruction manual matches the type name on the safety mat.

When installing the safety mat, you will need the following hardware that is **not** included in the scope of delivery:

- Screw locking (e.g. gear wheels, disc springs, wave washers or screw glue)
- Protective hoses, cable ducts for connection cables

The following tools (tools) are needed to assemble the safety mat:

- Drilling machine, and drill bit 6.6 mm; 9.0 mm
- Countersink 90°
- Crosstip screwdriver
- Voltage tester

The underground has to be cleaned (clean swept) and even. Easy unevenness are compensated by the safety mat.

Clean the work environment by removing dirt, grease and oil.

12.2 General approach

Use suitable tools when installing the safety mat. Otherwise, bolts and nuts may become damaged and unusable.

Do not exceed the max. torque when tightening the nuts.

Always use one of the screw locks specified in section 12.1.

12.3 Installation instructions

Make the mounting holes according to the design of the safety mat. The location of the mounting holes is specified by the customer's order and to take there.

The mounting procedure depends on local circumstances. Based on the application there are different Aluminum profiles available. Observe the following basic instructions:



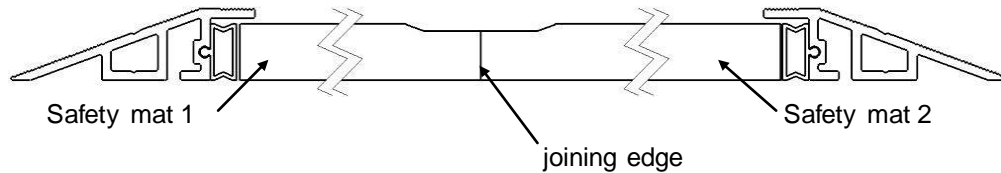
Attention!

The Aluminum profiles may only be mounted on a flat surface. Cavities under the profiles may lead to permanent deformations and prohibit the safety functions of the system.

When mounting the Aluminum profiles as tripping protection (ramp profile) there is to be ensured that the safety mat is not clamped too firmly within the Aluminum profiles. In locations with high temperature variation there is to be considered that the boundary profiles are mounted with sufficient air to the safety mat, so that it can expand accordingly.
(see section 20)

There is a snap-in expansion profile for the for the Aluminum profiles. This expansion profile will deform if the safety mat expands itself. The expansion profile has to be snapped in before mounting the Aluminum profiles.

When assembling two or more safety mats, the safety mats have to be mounted according to the following drawing. The shaping of the two joining edges have to be aligned together.



Side view of two safety mats showing the joinability

At the outlets of the connection lines between safety mat and transition to the Aluminum profiles the connection lines have to be protected against damage by protective hoses, cable ducts or similar.

To prevent mechanical damage, the connection cables should be routed on a safe way (e.g. in the profile, in protective hoses or cable ducts).

With the supplied Aluminum profiles, the safety mat may be assembled on a leveled floor. The Aluminum profiles (R1 and R2) also serve as tripping protection. In the profile there are holes, which have been completed with sealing plugs. The required mounting screws and anchors are included. Other mounting options have to be discussed with the manufacturer.

If the safety mat will be mounted in a depression in the floor, the Aluminum profile can be omitted, if the safety mat does not rise more than 4 mm above the floor level.

The arrangement and dimensions of the bottom depression is determined analogously to the previously mentioned investigation of the safety mat size. The surcharges for the Aluminum profile can be omitted. The depth of the bottom depression must be the height of the safety mat (see Section 20, Technical data). There must be no tripping hazards caused larger than 4 mm. Otherwise, additional measures must be taken to prevent the risk of tripping.



Attention!

Shortening of safety mats is not allowed!

Should it be necessary for operational reasons, to cut a switch mat, this must be carried by the manufacturer only.

No liability is accepted in the event of improper installation!

12.4 Electrical connection

The integration of the safety mat in the control circuits of the machine control is performed according to EN 60204-1 "Electrical equipment of machines". The core piece of the control unit creates e.g. a logical unit for safety functions which realizes the required performance level in conjunction with the safety mat.

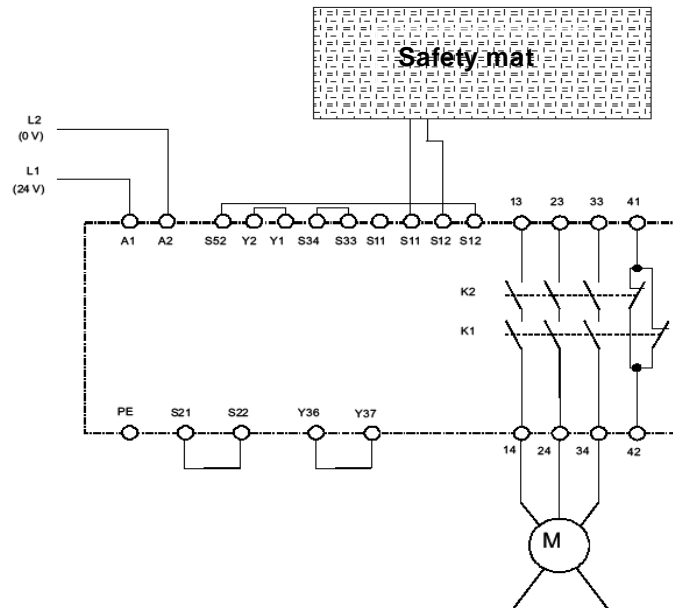
Due to the positively driven contact, it can be directly connected to a safety switching device responsible for the implementation of safety-related signals of the safety mat.

The electrical connection of the safety mat. must be carried out according to the following instructions:

- Rated voltage: < 50 V AC, 75 V DC (with safe disconnection to the grid).
- A voltage source for SELV or PELV systems according to DIN VDE 0100-410 must be used.

Rated current: < 0.5 A

The power supply of the safety mat must be protected externally!
Overcurrent protection of 0.5A (rated value)



Connection example (symbolic representation).

For information on the respective safety switching device, please refer to the operating instructions of the respective product.

Additional installation instructions for cable connections:

- After cutting to the required length, all cable ends must be provided with crimp contacts.
- With safety mat that have been joined together, cable connections must be arranged in an offset manner, properly connected and separately insulated from each other.
- The safety mat enclosure and the connection cables must not be damaged.
- All lines must be laid with protection against external mechanical influences.
- Depending on the type of cable connection, protection rating IP 65 must be ensured also at connection points, e.g. by appropriate sheaths or enclosures (cabinet installation).

No liability is accepted in the event of improper installation!

13 Performance check



Attention!

The protective effectiveness of the safety mat must be checked regularly

- at least once a year

or

- in intervals according to national operating instructions

Once installed, do not loosen any bolts or nuts or remove any pins; otherwise, the effectiveness of the safety-related functions is no longer guaranteed.

Run the following tests after installation and document the results in the acceptance report (section 22):

- Check all wire connections on the machine control for proper arrangement and fixed connection.
- Check with a resistance meter to the connection lines, the proper function of the safety mat (Not actuated = contact closed; Actuated = interruption).
- Check the fastening of the Aluminum profiles.
- Check the safety mat surface thoroughly for external damage (visual inspection).
- Check the safety function of the total system by repeated actuation of the safety mat at different points of the effective actuation area, preferably by a test body of Ø 80 mm with a maximum force of 150 N.
- Check the reset function, if available.

With a high degree of pollution or at temperatures below freezing point, short test intervals (at least once before each shift) are advisable.

14 Commissioning, Operation

After the safety mat have been properly installed, connected and tested, the technical equipment on which the safety mat was installed can be turned on and operated in accordance with its intended use.

No further work on the safety mat is required.

15 Attention!



Attention!

Adapt the frequency of checks to the environmental conditions at the application site.

No maintenance of the internal parts of the safety mat is required.

Damaged or defective safety mats must be replaced.

16 Cleaning

As a rule, no cleaning is required. Soiled safety mats can be cleaned by wiping with a cloth and mild soap.



Attention!

Only use other cleaning methods after prior consultation with the manufacturer.

17 De-installation



Attention!

Only uninstall the safety mat when power to the electrical system is switched off.

- Disconnect the electrical connection (section 12.4).
- Loosen the attachment of the safety mat, depending on the version. (Section 12.3).

18 Troubleshooting

Fault	Possible cause	Remedy
No interruption of the signal	Connection cable is damaged, short-circuit	Contact Haake Technik GmbH.
	Expansion profile not inserted	Realign the Aluminum profile and insert the Expansion profile.
No ON signal.(OFF-Signal after switching on).	Defective connecting terminals	Tighten terminal screws.
	Cable break	Contact Haake Technik GmbH.
	No leveled surface	Create a leveled surface
	Impurity below the safety mat	Remove impurity
	Contact elements (Inlett) damaged	Contact Haake Technik GmbH.
Safety Mat is clamped by the border profile	Loosen the border profile and check whether the safety mat works. Contact Haake Technik GmbH.	

19 Transport, handling, unpacking, storage



Attention!

Note the total weight of a packaging unit and always use a suitable transport means.

Dimensions and mass of the packing can be taken from the scope of the order. The products are placed in an overpack. Depending on the number of parts to be shipped, cardboard boxes, crates, pallets or containers are used for packaging. Wooden boxes are provided with a lid.

19.1 Transportation and handling

If weight is unevenly distributed, the center of gravity is indicated on the wooden box. Depending on their length, safety mat must be handled by one or two people.

In each transport container, products are lined with filling material for loose gaps, to ensure the goods are protected in transit.

Returned goods must be similarly packed to avoid damage in transit.

Improperly packaged returns will be invoiced if the goods are damaged.

19.2 Unpacking

Special care is needed when opening the packaging.

Open **products in cartons** with a knife at the points where adhesive tape was used. When opening, make sure you cut with the knife away from your body.

The lid of **wooden boxes** is attached by nails or screws to the box. Therefore use a claw or screwdriver when opening. Always pull nails or screws entirely out of the wood to avoid injuries.

Remove product from the filling material and place it on a clean surface.

19.3 Storage

Do never bend or roll up the Safety mat (signal generator), store it always flat; Aluminum profiles must rest fully on the pad.

If safety mats are to be stored for a long time, they should be placed in the original packaging. A dry environment with a temperature range of 5 to 55 °C must be chosen for storage. This prevents damage caused by external interferences or environmental influences.

20 Technical Data

Types:	HSM xxxx-xx-S HSM xxxx-xx-U <i>Note: xxxx-xx is continuous type designation e.g. 3817-00</i> -S standard version -U overmolded version
Environment:	Indoor
Temperature range:	+5° C to +50° C
Humidity:	to 100% (standard climate)
Material:	
Sensor profile:	PU
Mounting profile:	Aluminum
Connecting line:	PVC, double insulated, highly flexible single core cables, d=3.5 mm Other lines are possible after consultation with the manufacturer.
Ambient atmosphere:	industrial environments
Resistance of the sensor surface:	
Resistance to ozone:	good
UV-Beständigkeit:	good
Organic acids:	short-term
Mineral acids:	short-term
Water:	good
Coolant:	short-term
Drilling emulsion:	good
Oil resistance:	short-term
Resistance to detergents:	short-term
Amines:	short-term
Alcohols, ketones:	short-term
	<i>Note: The resistances indicated refer to the material of the outer shell of the signal generator (safety mat housing), which is usually exposed to the media. Depending on the application it should be noted that other outer parts of the component (such as connection cables for example) can be continuously exposed to special media. Appropriate resistances are available on request.</i>
Service life:	10 years
Values according to DIN EN ISO 13849-1:	
B10d-Value:	1 756 338 (Sample safety mat HSM 3817-00-S)
Category:	3
Performance Level:	d is possible
Mean failure probability (MTTF _d):	Depending on the application
Protection class:	IP 54 (HSM-S series) IP 65 (HSM-U series)

Rated voltage:	<50 V AC, 75 V DC
Rated current:	≤ 0.5 A
Person recognition:	>35 Kg (walking aids are recognized)
Weight:	18 Kg/m ²
Trafficability:	Not suitable for starting, braking, rotating of wheel vehicles
Joinability:	Suitable for joining edges (see section 12.3) For the maximum number of joined safety mats contact the manufacturer

21 Dimensions

Dimensional specifications in mm.

Inactive rim zone:

HSM-S: surrounding width 30 mm
Leitungsführungsseite 40 mm

HSM-U: umlaufend 35 mm
Cable routing side 45 mm

Minimum dimensions:

Length:

50 mm (active region)

Width:

60 mm (active region)
(based on single safety mat)

Maximum dimensions:

Length:

2000 mm (active region)

Width:

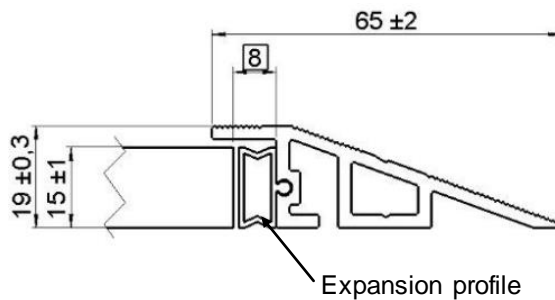
1000 mm (active region)
(based on single safety mat)

Construction height:

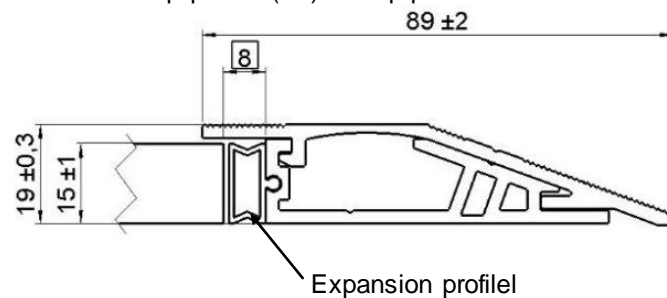
15±1 mm (w/o Aluminum profile)

Profiles:

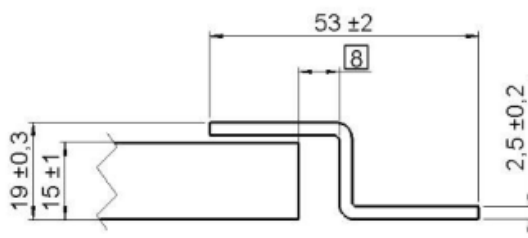
1. Aluminum ramp profile (R1) as trip protection:



2. Aluminum ramp profile (R2) as trip protection:



3. Aluminum Z-Profil (Z):



22 Selection procedure

The three most important parameters for selecting the appropriate safety mats are:

- Determination of the required performance level
- Speed of the dangerous movement
- Measuring the stopping distance of the hazardous elements

The evaluation proceeds stepwise as follows:

Step	Action	Remark
1	Determination of the required PL according to DIN ISO 13849-1	a) Results from the information in the C standard b) Results from the risk assessment to be carried out, based on the particular application
2	Determining the necessary overtravel distance (SN)	a) Measuring or calculating the stopping distance (SA) of the hazardous elements. b) Determining the safety factor (F); min. 1,2 c) Calculation: $SN = SA \times F$
3	Specifying the environmental conditions	a) Determining, which people (e.g. the elderly, children, etc.) and what body parts are to recognize. b) Determine the required degree of protection.
4	Choosing the Safety mat	a) Selection of the system taking into account the obtained values. b) Calculate the active actuating surface of the safety mat. ¹⁾

¹⁾The active surface of the safety mat is calculated by the formula according to DIN EN ISO 13855:

$$S = 1600 \text{ (mm/s)} \times T \text{ (s)} + 1200 \text{ (mm)} - 0,4 \times H \text{ (mm)}$$

S = Safety distance in millimeters

T = Total response time (response time of the safety mat + processing time of the machine control + overtravel time of the drive)

H = Platform height of the safety mat (For floor mounting H=0)



NOTE!

Category and performance level of the safety mat must correspond to the information obtained from the risk assessment of the machine.

The user has to determine the performance level for their particular application.

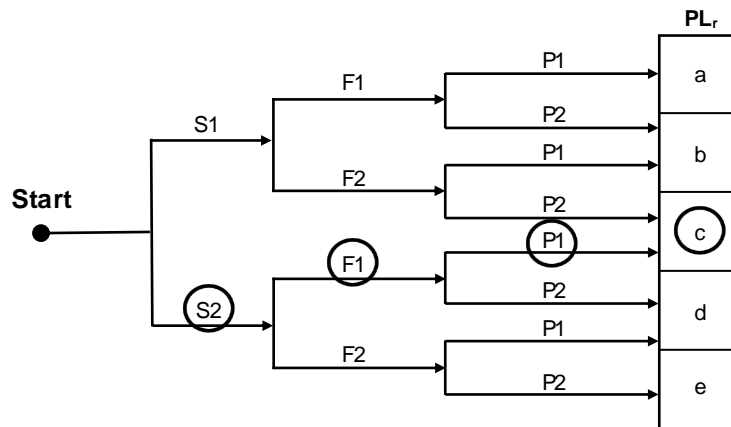
23 Application example

For the safety of an automated manufacturing system a safety mat as protection against stepping behind is needed (Protection against unintentional start-up).

The manufacturing facility is operated 24 hours per day, on 5 days a week and 220 days a year.

The safety area must be entered 12 times per shift (8 hours) to perform work for a period of about 2 minutes. Access is secured with a movable separating safety guard (safety door). The start of the production system after a standstill is slow.

Determining the PL_r according to DIN EN ISO 13849-1



Risk parameters:

S	Severity of injury	F	Frequency of and/or duration of exposure to hazard	P	Possibility of avoiding the hazard
S1	slight (normally reversible injury)	F1	seldom-to-less-often and/or exposure to hazard time is short	P1	Is possible under specific conditions
S2	serious (normally irreversible injury or death)	F2	frequent-to-continuous and/or exposure to hazard time is long	P2	Is scarcely possible

Calculating the Mean Time Between Failures (MTTF_d) according to DIN EN ISO 13849-1:


Mean operating time in days per year (d _{op}):	220 days/year
Mean operating time in hours per day (h _{op}):	24 h/day
Mean time between the start of two consecutive cycles of the safety mat (t _{cycle}):	2400 sec/cycle
Mean number of annual actuations (n _{op}):	7920 cycles/year (calculated)
MTTF _d :	1 756 338 (Sample safety mat HSM 3817-00-S) = 2217 years

Determining the PL according to DIN EN ISO 13849-1

Category:	3
MTTF _d :	100 years = high (Limited in accordance with DIN EN ISO 13849-1)
Performance Level:	d

24 Acceptance report

The acceptance report must be completed by the operator:

Haake Technik GmbH Vreden		Acceptance report Safety mat – type:				
Operator:		Object:		Company:		
		Safety mat:		Name:		
Order number:		Serial No.:		Date:		
				Signature:		
No.	Activity	Measurement		Free of defects		Remark
		Target	Actual	Yes	No	
1.0	Visual inspection, if appropriate also of the deformation chamber, with regard to penetrated objects					
1.1	Attachment of safety mat					
1.2	Damage to the safety mat					
1.3	Damage to the connection lines					
1.4	Damage to the cable gland					
1.5	Connection for cables					
1.6	Reset button / function					
1.7	Dimensions of the safety mat					
1.7	Protective effect overall system					

25 EC Declaration of Conformity



EG-Konformitätserklärung im Sinne der EG-Richtlinie 2006/42/EG Anhang II A.

Hiermit erklärt die Firma: **Haake Technik GmbH**
Master Esch 72
48691 Vreden

dass die Schaltmatten der Baureihe: **HSM-S**
HSM-U

Typ: **HSM xxxx-xx-S**
HSM xxxx-xx-U
Anmerkung: xxxx-xx steht für eine fortlaufende Zeichnungsnummer

in der gelieferten Ausführung folgenden einschlägigen Bestimmungen entsprechen:

EG-Richtlinien: **Maschinenrichtlinie 2006/42/EG**

Harmonisierte Norm: **DIN EN ISO 13856-1**

Schaltmatten der Baureihe HSM werden zur Absicherung von Gefahrenbereichen an Maschinen, bei denen eine Anwesenheit oder Zugang von Personen bei laufender Maschine verhindert werden muss, eingesetzt.

Bevollmächtigter für die Zusammenstellung der technischen Unterlagen ist:

HAAKE Technik GmbH
Herr Sven Buss
Master Esch 72
48691 Vreden

Vreden, den 05.12.2013



André Haake
(Geschäftsführer)



Haake Technik GmbH
Master Esch 72
48691 Vreden, Deutschland
info@haake-technik.com
www.haake-technik.com
Tel.: +49 2564 39650
Fax: +49 2564 396590