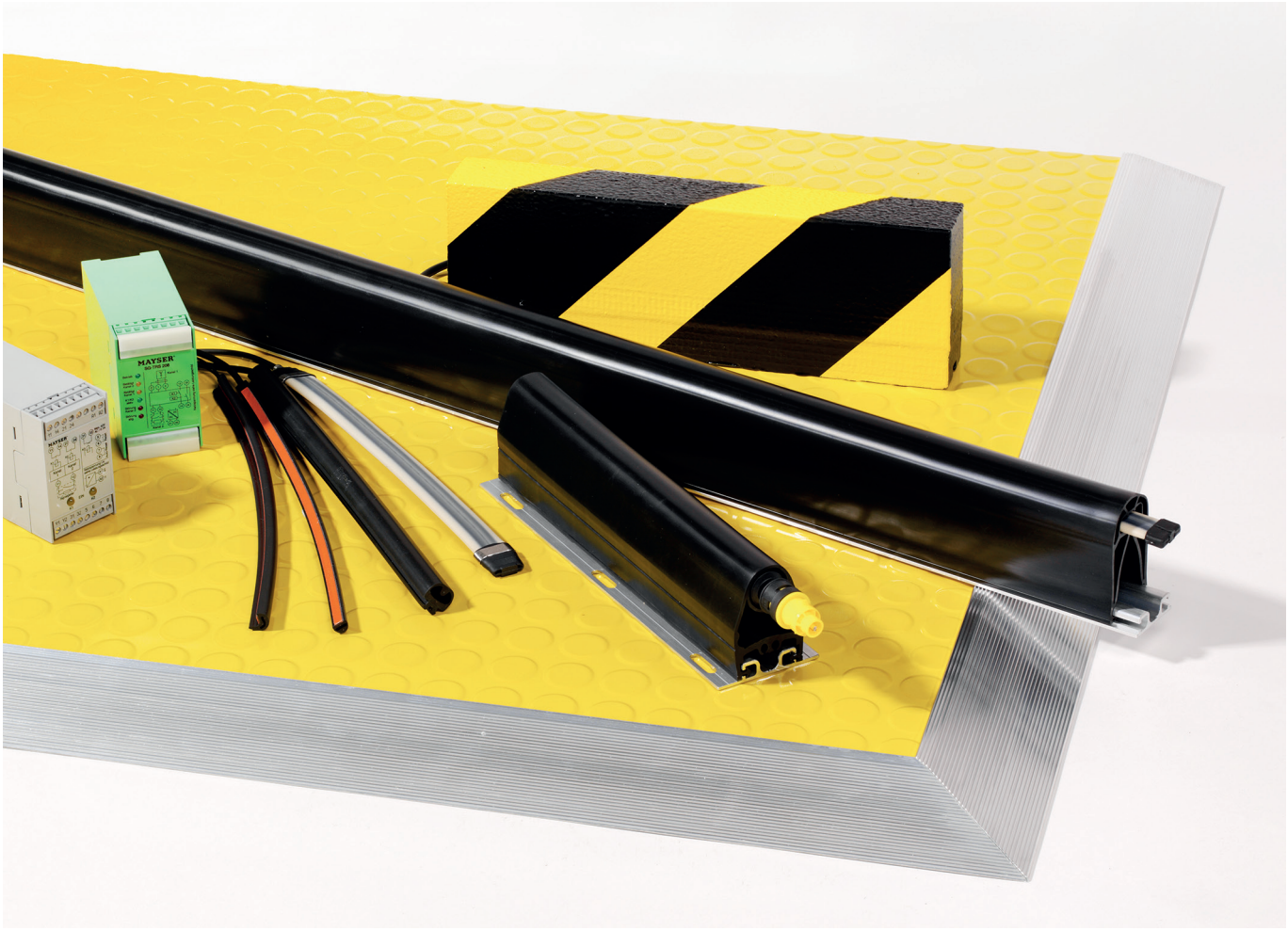
MAYSER®

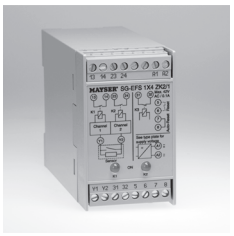
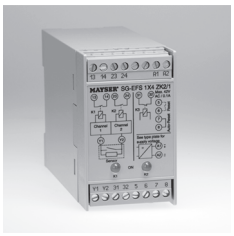
Innovative by tradition.



Consensus with ISO 13849-1

EN | Overview

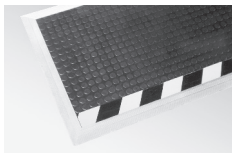
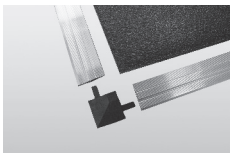
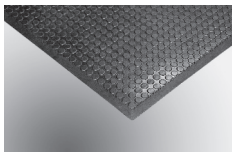
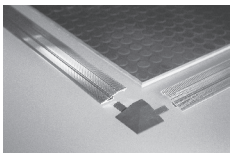
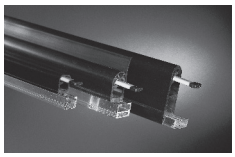
Mayser GmbH & Co. KG
Örlinger Straße 1–3
89073 Ulm
GERMANY
Tel.: +49 731 2061-0
Fax: +49 731 2061-222
E-Mail: info.ulm@mayser.com
Internet: www.mayser.com

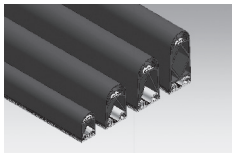
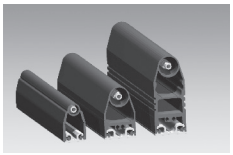
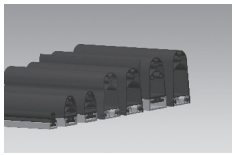
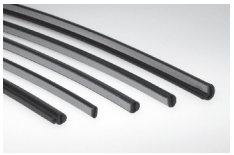
				
Type	**SG-EFS 104/4L**	**SG-EFS 104/2W**	**SG-EFS 1X4 ZK2/1**	**SG-EFS 1X4 ZK2/1 8k2**
Safety according to ISO 13849-1:2015	Category 3 PL e	Category 3 PL d	Category 3 PL e	Category 3 PL e
Performance Level	e	d	e	e
Category	3	3	3	3
$MTTF_D$ level	high	high	high	high
$MTTF_D$	100 a [1]	257 a [1]	313 a [1]	313 a [1]
DC_{avg} level	medium	low	medium	medium
DC_{avg}	90 %	60 %	90 %	90 %
B_{10D} [× 10^6]	0.4	1.8	2	2
Reaction time	DC: 30 ms / AC: 50 ms	< 15 ms	< 10 ms	< 10 ms

				
Type	**SG-SLE X4-0X1**	**SG-RST 204**	**SG-RST 153**	**SG-RS 204**
Safety according to ISO 13849-1:2015	Category 3 PL e	Category 3 PL e	Category 2 PL c	Category 1 PL c
Performance Level	e	e	c	c
Category	3	3	2	1
$MTTF_D$ level	high	high	high	high
$MTTF_D$	279 a [1]	306 a [1]	33 a [1]	155 a [1]
DC_{avg} level	medium	medium	medium	medium
DC_{avg}	90 %	90 %	90 %	–
B_{10D} [× 10^6]	2	2	0,18	1
Reaction time	< 14 ms	< 20 ms	< 5 ms	< 15 ms

[1] assumed parameters: d_{op} = 365 d/a, h_{op} = 24 h/d, t_{cycle} = 600 s (n_{op} = 52560/a)
[2] Suitable for installation of Category 3 systems up to PL d.
[3] $MTTF_D$ level and value are dependent on the particular application.
[4] dependent on profile

120919 v2.02

				
Safety mats SM	**Safety mats SM11**	**Safety mats SM8**	**Safety mats TS**	**Safety edges SL**
–	–	–	–	–
–	–	–	–	–
1 [2]	1 [2]	1 [2]	1 [2]	1 [2]
[3]	[3]	[3]	[3]	[3]
[3]	[3]	[3]	[3]	[3]
–	–	–	–	–
–	–	–	–	–
6	6	6	6	4
8 ms	8 ms	8 ms	8 ms	[4]

				
Safety edges SL NO	**NC safety edges SL NC II**	**Sensor profiles SP**	**Miniature safety edges EKS**	**Safety bumper SB**
–	Category 3 PL d	–	–	–
–	d	–	–	–
1 [2]	3	1 [2]	1 [2]	1 [2]
[3]	high	[3]	[3]	[3]
[3]	380 a [1]	[3]	[3]	[3]
–	high	–	–	–
–	99 %	–	–	–
4	2	2	2	2
[4]	[4]	[4]	[4]	[4]

[1] assumed parameters: d_{op} = 365 d/a, h_{op} = 24 h/d, t_{cycle} = 600 s (n_{op} = 52560/a)
[2] Suitable for installation of Category 3 systems up to PL d.
[3] $MTTF_D$ level and value are dependent on the particular application.
[4] dependent on profile

120919 v2.02

Category 3

Sensors considered in isolation are allocated to Category 1. According to ISO 13856 – if Category 3 is required – the architecture of the pressure-sensitive protection device may deviate from the architecture according to ISO 13849-1:2015, 6.2, as long as the required PL is achieved. Mayser pressure-sensitive protection devices are developed, designed and manufactured in accordance with the requirements of ISO 13856. They are therefore considered the same as pressure-sensitive protection devices of Category 3 if the required PL is achieved.

Switch type NO: exclusion of error

For pressure-sensitive equipment according to ISO 13856, "non-closing of contacts" in accordance with ISO 13849-2 Table D.8 can be ruled out. This exclusion of error applies to Mayser pressure-sensitive protection devices with switch type NO (normally open).
In this case, no DC value is calculated for the sensor and therefore is not used in determining the PL of the pressure-sensitive protection device. Assuming the control unit has a high $MTTF_D$ value, such a pressure-sensitive protection device can achieve the maximum value PL d.

Determining the $MTTF_D$

If the sensor is disregarded due to an exclusion of error, then only the $MTTF_D$ value of the control unit remains.
The table on page 2 lists the $MTTF_D$ values for assumed n_{op} = 52560/a.

Example: SG-EFS 104/2W acc. to table — $MTTF_D$ = 257 a, $MTTF_D$ level high

$MTTF_D$ level	Zone
low	3 years < $MTTF_D$ < 10 years
medium	10 years ≤ $MTTF_D$ < 30 years
high	30 years ≤ $MTTF_D$ < 100 years

The calculated $MTTF_D$ level is used in the next step to determine the achieved PL.

120919 v2.02

Determining the PL

If the categorie and $MTTF_D$ are known, the performance level (PL) can be determined based on the table.
The table shows a simplified procedure for assessment and is used in the first step for estimating the PL.

Simplified process for determining the achieved PL				
Category	B	1	2	**3**
$MTTF_D$ low	**a**	**–**	**a**	**b**
$MTTF_D$ medium	**b**	**–**	**b**	**c**
$MTTF_D$ **high**	**–**	**c**	**c**	**d**

Example: SG-EFS 104/2W
Category 3
$MTTF_D$ = 257 a = high
Result: **PL d**

Switch type NC: no exclusion of error

For Mayser pressure-sensitive protection devices with switch type NC (normally closed) no exclusion of error according to ISO 13849-2 is made. The sensor parameters are used for calculation of the PL.
In principle it is even possible to dispense with a control unit, because switch type NC already provides the required output signal for the downstream controller – directly via the force-guided NC contacts. In this case only the $MTTF_D$ value of the sensor is used for determining the PL.
Force guiding of the NC contacts (input and output unit) results in a value a DC_{avg} value of 99 % according to ISO 13849-1 Table E.1.

Determining the $MTTF_D$

The $MTTF_D$ value of the sensor, in addition to the B_{10D} value, depends primarily on the number of actuations n_{op}.
Assumption: If a Mayser pressure-sensitive protection device with switch type NC is actuated every 10 min, 24 h/d and 365 d/a, the result is

$$n_{op} = 6 \times 24 \times 365 = 52560/a.$$

120919 v2.02

For $MTTF_D$SX NC the following applies:

$$MTTF_D\text{SX NC} = \frac{B_{10D}}{0.1 \times n_{op}}$$

B_{10D}: 2,000,000
n_{op}: 52,560/a

$$MTTF_D\text{SX NC} = \frac{2{,}000{,}000}{0.1 \times 52{,}560/a} = 380\ a$$

That corresponds to the $MTTF_D$ level high.
If the sensor is used **without a control unit** then the PL is calculated with this $MTTF_D$ level (see *Determining the PL*).

With a control unit the following formula applies:

$$\frac{1}{MTTF_D} = \frac{1}{MTTF_D\text{SX NC}} + \frac{1}{MTTF_D\text{SG}}$$

Both $MTTF_D$ values are dependent on the number of actuations n_{op}.

The $MTTF_D$ value for the control unit can be taken directly from the table on page 2, since a number n_{op} = 52,560/a is likewise assumed for the values stated there.

$MTTF_D$SG = 257 a
$MTTF_D$SX NC = 380 a

The total value is calculated as follows:

$$\frac{1}{MTTF_D} = \frac{1}{380\ a} + \frac{1}{257\ a} = \frac{257 + 380}{(380 \times 257)\ a} = \frac{637}{97660\ a}$$

$$MTTF_D = 153\ a$$

That corresponds to the $MTTF_D$ level high.

$MTTF_D$ level	Zone
low	3 years < $MTTF_D$ < 10 years
medium	10 years ≤ $MTTF_D$ < 30 years
high	30 years ≤ $MTTF_D$ < 100 years

The calculated $MTTF_D$ level is used in the next step to determine the achieved PL (see *Determining the PL*).

120919 v2.02

Determining the PL

If the categories, DC_{avg} and

Overview DC_{avg}	
DC_{avg}	**Bereich**
none	$DC_{avg} < 60\ \%$
low	$60\ \% \leq DC_{avg} < 90\ \%$
medium	$90\ \% \leq DC_{avg} < 99\ \%$
high	$99\ \% \leq DC_{avg}$

$MTTF_D$ are known, the performance level (PL) can be determined based on the table.
The table shows a simplified procedure for assessment and is used in the first step for estimating the PL.

Simplified process for determining the achieved PL							
Category	B	1	2	2	**3**	**3**	4
DC_{avg}	none	none	low	medium	**low**	**medium**	high
$MTTF_D$ low	**a**	**–**	**a**	**b**	**b**	**c**	**–**
$MTTF_D$ medium	**b**	**–**	**b**	**c**	**c**	**d**	**–**
$MTTF_D$ **high**	**–**	**c**	**c**	**d**	**d**	**d**	**e**

Examples:

without control unit
SL NC II
Category 3
DC_{avg} = 99 % = high
$MTTF_D$ = 380 a = high
Result: **PL d**

with control unit
SL NC II with SG-EFS 104/2W
Category 3
DC_{avg} = 60 % = low
$MTTF_D$ = 257 a = high
Result: **PL d**

Comparison with PL_r

For each selected safety function it is first necessary to determine the required performance level (PL_r) and to compare it with the performance level (PL) achieved by the Mayser pressure-sensitive protection device. The PL of the pressure-sensitive protection device must be equal to or higher than the required PL_r of the chosen safety function.

120919 v2.02

PL => SIL

Performance Level (ISO13849)	Safety Integrity Level (IEC 61508)	Probability of a dangerous failure (PFH) [1/h]
PL a	–	$10^{-4} > X \geq 10^{-5}$
PL b	SIL 1	$10^{-5} > X \geq 3x\ 10^{-6}$
PL c	SIL 1	$3x\ 10^{-6} > X \geq 10^{-6}$
PL d	SIL 2	$10^{-6} > X \geq 10^{-7}$
PL e	SIL 3	$10^{-7} > X \geq 10^{-8}$

Safety mats, safety edges, or safety bumpers can reach a maximum performance level of PL d, with exclusion of error.

Conformity procedure

In the machinery directive, pressure-sensitive protection devices are equivalent to machines. This means that a pressure-sensitive protection device must go through a complete conformity procedure with documentation.
The conformity procedure results in the **EC declaration of conformity**.
Mayser pressure-sensitive protection devices are delivered with EC declarations of conformity.

If a sensor of a pressure-sensitive protection device is marketed separately, then it is a "partly completed machine" according to the syntax of the 2006/42/EC Machinery Directive. An EC declaration of conformity may not be issued for a "partly completed machine".
Instead, the manufacturer must provide a **declaration of incorporation**.

Whoever combines the sensor with any type of analysis unit completes the "partly complete machine" to create a new pressure-sensitive protection device. With all of the **consequences**: For the previously non-existent product he must carry out the entire conformity procedure according to 2006/42/EC, including documentation, and assume responsibility for the new pressure-sensitive protection device in the form of an EC declaration of conformity.

120919 v2.02