



Consensus with ISO 13849-1



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Туре	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	

Туре	SG-SLE X4-0X1	NAVER SOUTH OF THE	KATSER: ICC BILLING 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	С	С
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: $d_{op} = 365 \text{ d/a}$, $h_{op} = 24 \text{ h/d}$, $t_{cycle} = 600 \text{ s}$ ($n_{op} = 52560/a$) ²⁾ Suitable for installation of Category 3 systems up to PL d.

 $^{\rm 3)}$ ${\rm MTTF}_{\rm D}$ level and value are dependent on the particular application.

⁴⁾ dependent on profile



Safety mats SM	Safety mats SM11	Safety mats TS	Safety mats SM8	Sensor profiles SP	
_	_	_	_	_	
_	-	-	-	-	
1 2)	1 2)	1 2)	1 2)	1 2)	
3)	3)	3)	3)	3)	
3)	3)	3)	3)	3)	
_	_	_	_	_	
-	_	-	_	-	
6	6	6	6	2	
8 ms	8 ms	8 ms	8 ms	4)	

Safety edges SL	Safety edges SL NO	NC safety edges SL NC II	Miniature safety edges EKS	Safety bumper SB
_	_	Category 3 PL d	_	_
-	_	d	-	-
1 2)	1 2)	3	1 2)	1 2)
3)	3)	high	3)	3)
3)	3)	380 a 1)	3)	3)
_	-	high	-	_
-	-	99 %	-	-
4	4	2	2	2
4)	4)	4)	4)	4)

¹⁾ assumed parameters: $d_{op} = 365 \text{ d/a}$, $h_{op} = 24 \text{ h/d}$, $t_{cycle} = 600 \text{ s}$ ($n_{op} = 52560/a$) 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



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 D.8

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 $\rm MTTF_{\rm D}$ 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	$MTTF_{D} = 257 a$
	acc. to table	$MTTF_{D}$ level high

MTTF _D level	Zone
low	3 years < MTTF _D < 10 years
medium	10 years \leq MTTF _D $<$ 30 years
high	30 years ≤ MTTF _D < 100 years

The calculated $\mathsf{MTTF}_{\scriptscriptstyle \mathsf{D}}$ level is used in the next step to determine the achieved PL.



Determining the PL

If the categorie and ${\rm MTTF}_{\rm D}$ 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	В	1	2	3	
MTTF _D	а	-	а	b	
MTTF _D medium	b	_	b	c	
MTTF _D high	-	с	с	d	

Example:	SG-EFS 104/2W
	Category 3
	$MTTF_{D} = 257 a = high$
Result.	PId

Result:

Switch type NC: no exclusion of error D.4

In pressure-sensitive equipment according to ISO 13856, the possibility of a "short circuit between two conductors that are permanently installed and protected against external damage" can be excluded in accordance with ISO 13849-2 Table D.4. This exclusion of error applies to Mayser pressure-sensitive protection devices with switching type NC (normally closed contact). In this case the diagnostic coverage (DC) of the cables is not calculated and is not used in determining the PL. Assuming the sensor has a high MTTF_D value, such a pressure-sensitive protection device can achieve a maximum performance level of PL d. 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

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

For MTTF_DSX NC the following applies:

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

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

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

That corresponds to the $MTTF_{D}$ level high.

MTTF _D level	Zone
low	3 years < MTTF _D < 10 years
medium	10 years \leq MTTF _D $<$ 30 years
high	$30 \text{ years} \le \text{MTTF}_{D} < 100 \text{ years}$

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

Determining the PL

If the categories, DC_{avg} and

Overview DC _{avg}				
DC _{avg}	Zone			
none	$DC_{avg} < 60 \%$			
low	$60 \% \le DC_{avg} < 90 \%$			
medium	$90 \% \le DC_{avg} < 99 \%$			
high	99 % $\leq DC_{avg}$			

 $\mathrm{MTTF}_{\mathrm{D}}$ 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	В	1	2	2	3	3	4
DCavg	none	none	low	medium	low	medium	high
MTTF _D	а	_	а	b	b	с	_
MTTF _D medium	b	_	b	с	с	d	-
MTTF _D high	_	с	с	d	d	d	е

Examples: SLNCII

Category 3 $DC_{avg} = 99 \% = high$ $MTTF_{D} = 380 a = high$ **PL d**

Result:

Comparison with PL,

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.

PL => SIL

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

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

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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 conform-***ity*.

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.