Safety functions according to EN ISO 13849-1

Type	EC type test certificate	PL	Kat.	$MTTF_d$ [years]	DC_{avg} [%]	
Industrial door (signal transmission and switching devices)						
InTra6 2	E 6934 and [4]	d	2	254	94	[1]
InTra6 3	E 6935 and [4]	e	3	247	95	[1]
RFGate 2	E 6945 and [4]	c	2	28.8	76	[1]
RFGate 3	E 7161 and [4]	d	3	46	77	[1]
EsGate 2	E 6937 and [4]	d	2	123	94	[2]
EsGate 3	E 6936 and [4]	e	3	73	95	[2]
XRF	E 7239 and [4]	c	2	98	82	[1]
XRF	E 7239 and [4]	d	3	98	82	[1]
Machine safety (switching devices)						
EsMatix 3	E 7142 and[4),11]	e	3	100	90	[2]
ESD3	E 7259 and[4),11]	e	3	24 (8)	99	(2) I=500mA (I=2A)
ESR31C /32	E 7260 and[4),11]	e	3	26 (8)	99	[2] I=500mA (I=2A)

Type	EC type test certificate	PL	Kat.	$MTTF_d$ [years]	DC_{avg} [%]	
Pedestrian door (revolving, sliding, swing door)						
PrimeTec A, PrimeScan A	4420512403013-001[7]	d	2	253	86	[8]
PrimeTec A, PrimeScan A	4420512403013-001[7]	d	3	281	91	[9]
PrimeTec B, PrimeScan B	4420512403013-002[7]	d	2	253	86	[8]
PrimeTec B, PrimeScan B	4420512403013-003[7]	d	2	253	86	[10]
US beam, UniScan	4420512413806-001[7]	d	2	153	99	[8]

Type				$MTTF_d$ [years]	B_{10d} [x 10^6]	
Safety edges; Safety mats; Forklift mats (Sensors)						
ELE	-	-	-	[3]	5	
XL	-	-	-	[3]	5	
ESM	-	-	-	[3]	6	
EMP	-	-	-	[3]	6	
Loop detectors						
ProLoop2				73	7	[6]
ProLoop lite				73	7	[6]

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Type	$MTTF_d$ with safety edge [1] [years]	$MTTF_d$ with safety mat [5] [years]
Industrial door (signal transmission and switching devices)		
InTra6 2	200	-
InTra6 3	167	-
RFGate 2	28	-
EsGate 2	266	-
EsGate 3	217	-
Machine safety (switching devices)		
EsMatix 3	386	72
ESD3	>100	14
ESR31C / 32	>100	15

1) Door application assumed parameters: d_{op} = 365d/a, h_{op} = 24h/d, t_{cycle} = 3'600s (n_{op} = 8'760/a)
2) Machine application assumed parameters: dop = 365d/a, hop = 24h/d, tcycle = 60s (nop = 525'600/a)
3) MTTFd = level and value depending application (see calculation model page 3)
4) In combination with safety edges, certified according to EN ISO 13856-2
5) Assumed parameters: dop = 250d/a, hop = 16h/d, tcycle = 60s (nop = 280'000/a)
6) Assumed parameters: dop = 365d/a, hop = 24h/d, tcycle = 30s
7) EC type-examination certificate tested according to DIN EN ISO 13849-1 and EN 61508
8) Safety function presensce detection tested according DIN 18650 and EN 16005
9) Safety function motion in escape routes DIN 18650 and EN 16005
10) Safety function presensce detection tested according to EN 16005
11) In combination with safety mats, certified according to EN ISO 13856-1

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Calculation signal transmission and switching units
Products in accordance with DIN EN ISO 13849-1

How to determine the $MTTF_d$ of a sensor

$$MTTF_d = \frac{B_{10d}}{0{,}1 \times n_{op}}$$

Example 1: **Safety edge** on a sliding gate with 2 actuations a day during 365 days a year.
n_{op} = 2 actuations/day × 365 days = 730 actuations a year
$MTTF_d = B_{10d} / (0{,}1 \times n_{op})$ = 5'000'000 / (0,1 × 730) = 68'493 years → „high“

Example 2: **Safety mat** installed in processing centre with 30-s tact, 2 shifts during 250 days a year.
n_{op} = 60 actuations/h × 16 h/day × 250 days = 240'000 actuations a year
$MTTF_d = B_{10d} / (0{,}1 \times n_{op})$ = 6'000'000 / (0,1 × 240'000) = 250 years → „high“

How to determine the overall-MTTFd (simplified description!)

$$\frac{1}{MTTF_d} = \frac{1}{MTTF_{d\ Sensor}} + \frac{1}{MTTF_{d\ Signal\ transmission}}$$

Example 3: **Safety edge** connected to signal transmission InTra6 2.
$MTTF_{d\ Sensor}$ = 68'493 years
$MTTF_{d\ Signal\ transmission}$ = 254 years
→ $MTTF_d$ = 253 years → „high“

Note: This calculation is highly simplified. The various $MTTF_d$-values could be based on different actuations per year (n_{op}). Furthermore, the connection between sensor and switching device is not considered.

Glossary

B_{10d}	Number of switching cycles, of which 10 % of specimens failed during a lifetime test (for electromechanical components)
DC_{avg}	Average diagnostics coverage, probability-based measure of the effectiveness of the diagnosis. It expresses the ratio between detected dangerous failures and the total number of hazardous errors (errors weighted with $MTTF_d$-value)
$MTTF_d$	Meantime to a dangerous failure
n_{op}	Actuations per year
h_{op}	Average operating time in hours per day
d_{op}	Average operating time in days per year
t_{cycle}	Average time between the start of two successive cycles of the component in seconds per cycle
PL	Performance level; value of the safety level. Stands for the quality of risk-reducing measures, respectively specifies the ability of safety-related parts of a control system, to perform a safety function under foreseeable conditions.

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