SAFEMASTER STS

Design Guide

Modular safety switch and key transfer system
for highest demands

DOLD

Our experience. Your safety.

SAFEMASTER STS
Design Guide

Content:

Introduction

Info **This design guide provides an assistance to the application of DIN EN ISO 13849-1 and 13849-2. It does not replace any requirements of the application or any other standards.**

The safety switch / trapped key system, SAFEMASTER STS has been designed to secure guards and to force specific operating sequences. It combines the advantages and features of safety switches, solenoid locks, trapped key systems and personal safety measures.

Today, safety switches either with or without solenoid locking are well accepted in the market, but trapped key systems are often unknown, although these can be regarded as one of the origins for discrete guarding safety.

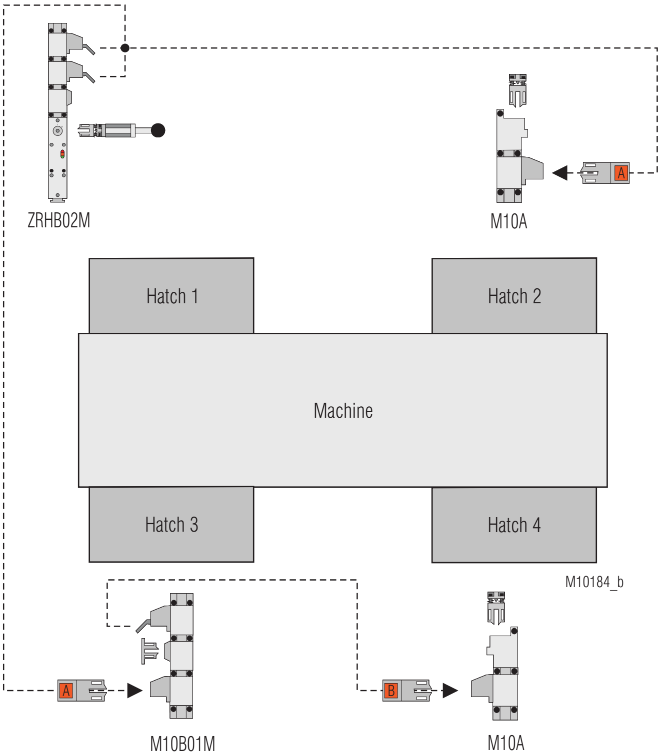
Trapped key systems have been designed and used since the twenties and have proven to be reliable method for over 80 years. A trapped key system forces a specific safe operating sequence and can function without wiring. Trapped key system functions are standardised in EN ISO 14119 and more recently in ISO 14119 also. The introduction of EN 954-1 with the division of safety categories had nearly no influence on the use of these products.

However the new standard and its implementation now has a significant effect on this type of safety system. While EN 954-1 concentrated on electrical circuits, the new standard DIN EN ISO 13849-1 also includes mechanical safety products and demands among others things, measures to be taken against common cause failure and mechanisms to be in place to detect failures, this is termed diagnostic coverage. The life cycle time of the product also becomes important.
SAFEMASTER STS has been designed to comply mainly with the corresponding standards DIN EN 14119:2013, DIN EN 60947 and DIN EN ISO 13849, where the requirements of DIN EN ISO 13849-1 played a main role. The reason for this is simple: In DIN EN ISO 13849-1 the quality and reliability of the safety related components becomes a major decision criteria. Besides the designated safety categories, the mean time before a dangerous failure (Mean Time To Failure dangerous, $MTTF_d$), Diagnostic Coverage (DC) and Common Cause Failure (CCF) now play an important role in safety product selection.

SAFEMASTER STS does not claim over dimensioning (even though it is made of stainless steel) but the system does possess increased diagnostic coverage by redundant design of the electromechanical and mechanical units (see DC table). Also measures have been taken to prevent common cause failures (CCF). The failure detection mechanisms in the mechanical units allows detection of failures upon the next operation and secures the unit in a safe blocked state. This behaviour forces the complete system, or at least the access with the fault to remain in a safe blocked state until the fault is removed. When correctly installed, faults are detected as they happen or latest at the next demand of the safety function. After a mechanical fault is removed, the units of SAFEMASTER STS can reset themselves into a functional state. For applications that require a safety category 3 or 4 according to DIN EN ISO 13849-1 the SAFEMASTER STS units can be equipped with a second actuator. This gives the units a mechanical structure equivalent to safety category 4 and they can be used in these applications **without a second solenoid lock or door switch** are standardised in EN ISO 14219 and EN ISO 13849-1.

The functional design of the SAFEMASTER STS is based on DIN EN ISO 14119. The SAFEMASTER STS system not only complies with all requirements of this standard, but sets new standards by exceeding the requirements. The main advantages are excellent ergonomic, robustness and the ability to function in hostile operating conditions such as dust, humidity, dirt, etc as well as extreme ambient temperatures and reduces wiring costs.

Example:
An example that clearly indicates all these features and advantages is shown in the following key exchange plan. Hatch 1 on the machine (see drawing) is safe guardes by an electromechanical solenoid lock ZRHB02M. The other hatches are locked with mechanical units, M10A and M10B01M. After release of the solenoid lock, hatch 1 can be opened ergonomically without an extra action. The other 3 hatches are mechanically safe guarded, which saves significant time and cost for wiring. The SAFEMASTER STS units also withstand the rugged ambient operating conditions.



Design of a system with SAFEMASTER STS
As of today there are no standards completely covering the design of a SAFEMASTER STS system, so we have orientated ourselves at the requirements for software based safety related products. For the conception of every system based on customers requirements of SAFEMASTER STS a procedure has to be observed as described in fig 6 chapter 4.6.1 of DIN EN ISO 13849-1.

Important: Before ordering and installation of a proposed solution, the user has to prove that the proposed solution covers all requirements and the access points are correctly secured.
Key exchange plans are proposals, which are created according to the requirements provided by the customer.

Requirements of the machine directive 2006/42/EG annex IV

In annex IV of the machine directive 2006/42/EG products are listed, that have to be approved by a certifying body, before they can be brought on the market. In this list there are also logic systems that are not technology specific. I. e. according to this list logic systems can be of electric, electronic, pneumatic or mechanical type. This also includes trapped key systems. SAFEMASTER STS has been tested by TÜV according to the requirements of ISO 14119, EN ISO 13849-1 and other relevant standards and therefore fulfils the requirements of the machine directive 2006/42/EG annex IV. The EC type examination certificate can be found on page 17.

Entrapment

In addition to functions for monitored access to plant and machinery SAFEMASTER STS can also be used for protection against being trapped in a machine. The machinery directive 2006/42/EG states, in appendix 1 under 1.5.14 „Risk of being trapped in a machine“, the following: „Machinery must be designed, constructed or fitted with a means of preventing a person from being enclosed within it or, if that is impossible, with a means of summoning help“.

SAFEMASTER STS safety keys can be used to fulfil this requirement. The personal keys can be carried by operators when entering a dangerous area as protection against being locked in. In many cased the personal key is the only possibility to avoid being trapped e.g. when entering tanks, mixers or small rooms. More information can be found in the standard DIN EN ISO 12100-2 paragraph 5.5.3: „Measures to release and save trapped persons“.

Info

SAFEMASTER STS personal keys are mechanically monitored (DC) and must not be compared with traditional blocking keys. A blocking key only locks a component in a safe switched off state when the key is removed, but the correct function and the key mechanism is not monitored. If a part of the key mechanism is worn or broken off, it cannot be detected and leads easily to a loss of the safety function. An STS personal key with monitored function (DC), can be compared to safety mats and optoelectronic safety devices.

In case an increased motivation to defent exist, SAFEMASTER STS units containing actuators with low coding level have to be installed in a hidden, concealed or out of reach fashion. These requirements do not apply if actuators are used having a middle coding level. In this case, the units and actuators have to be mounted, for example, using one-way screws, rivets or other non-removable fastenings (see ISO 14119:2013).
The coded screws included in delivery can be used If it can be expected that repair, maintenance or modification work will be carried out throughout the whole life time.

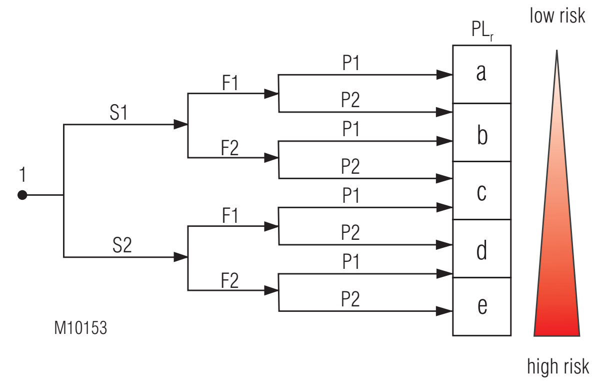
Main requirements of EN ISO 13849-1

Befor planning a safety system a risk assesment according to EN ISO 12100:2011-03 has to be made. When using EN ISO 13849-1 the required performance level (PL_r) has to be defined by using the risk graph.

Attention!

A complete system can include multiple hazzards and can have different operation modes. All of those have to be evaluated. This means that a system can have different performance levels in different areas. To evaluate the performance level, the risk graph shown on page 3 from EN ISO 13849-1 is used.

Risk Graph



Risk parameters

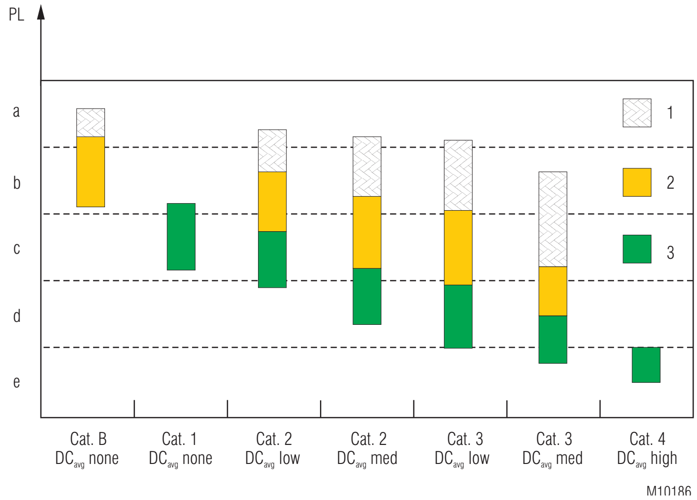
S - severity of injury
- S1 - light (normally reversible) injury
- S2 - severe (normally irreversible/ injury including death

F - Frequency and/or duration of exposure to danger
- F1 - seldom to sometimes and/or duration of exposure is short
- F2 - frequent to continuous and/or duration of exposure is long

P - Possibility to avoid the danger or to limit the damage
- P1 - possible under certain conditions
- P2 - nearly impossible

a, b, c, d, e intended of safety related performance level, PL_r

Relationsship between PL, SC, DC, $MTTF_d$



PL = Performance Level (see risk graph)
DC= Diagnostic Coverage (see diagnostic coverage)

$MTTF_d$ each channel

☐	1	low (3 up to 10 years)
■	2	med (10 up to 30 years)
■	3	high (30 up to 100 years)

$MTTF_d$ = (**M**ean **T**ime **T**o **F**ailure **d**angerous)

The diagram shows the procedure to select the category in combination with $MTTF_d$ for each channel and the DC_{avg}, to achieve the PL required for every safety function.

In above diagram the requirements show how to reach a performance level that is evaluated using the risc graph (PL_r).

Attention!

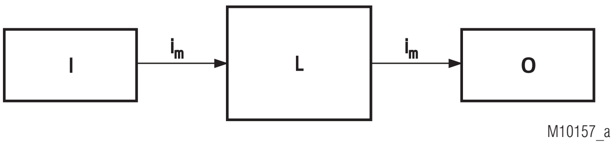
The Performance Level (PL) can be reduced acc. to EN ISO 13849-1 when several solenoid locks and/or switches are connected in series.

Designated architectures of category 1, 2, 3 and 4

Abbreviations:

i_m:	connection
c:	cross monitoring
I, I1, I2:	input unit e.g. sensor
L, L1, L2:	logic
m:	monitoring
O, O1, O2:	output unit e,g, main contactor
TE:	testing
OTE:	test output

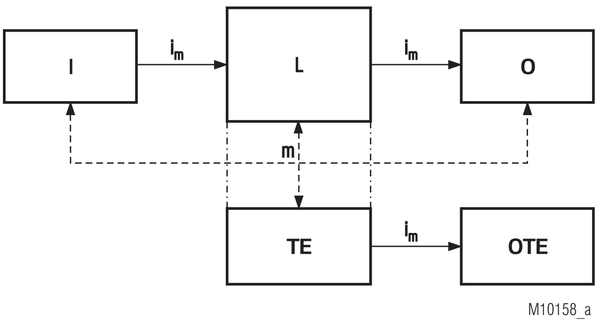
Designated architecture for category 1



The architecture of category 1 is only applicable to SAFEMASTER STS when single channel logic is used without a test function.

System behaviour category 1:
One failure could lead to a loss of the safety function, but the probability of a failure is less then in category B.

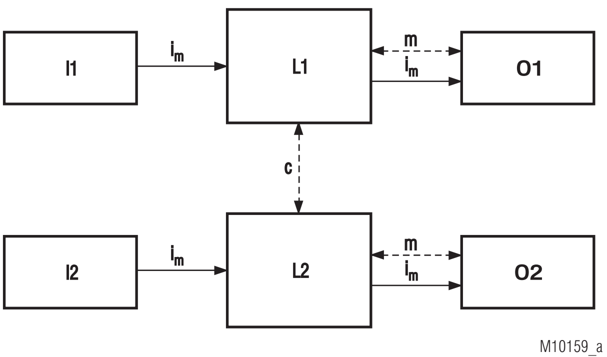
Designated architecture for category 2



The dotted lines show the typical failure detection paths.
The architecture of category 2 can be applied for PL "c" as well as for PL "d". When STS is installed in a PL "d" application, the actuator has to be fixed in a way that its loosening can be excluded. When using a suitable monitoring device and integrating 2 signalling channels, 90% diagnostic coverage must to be achieved.

System behaviour category 2:
One failure could lead to a loss of the safety function between tests. The loss of the safety function is detected by the next demand of the safety function.

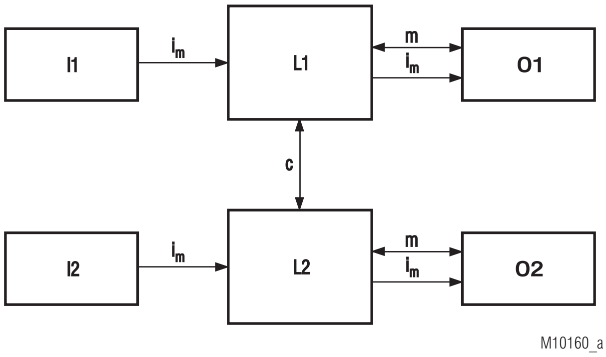
Designated architecture for category 3



The dotted lines show the typical failure detection paths.
The architecture of category 3 can be applied for PL "d". Use of 1 actuator is only permitted when its loosening and damage can be excluded. If this is not possible a second actuator is necessary. When using a suitable monitoring device and integrating 2 signalling channels 60% diagnostic coverage must to be achieved.

System behaviour category 3:
A single fault does not lead to a loss of the safety function. Some but not all faults are detected. A series of undetected faults can lead to the loss of the safety function.

Designated architecture for category 4

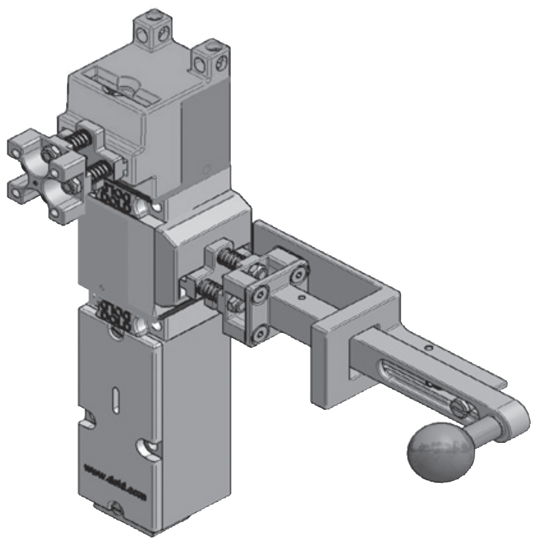


The full lines indicating the monitoring functions show a higher grade of diagnostic coverage as is required for the architecture for the category 3.
The architecture of category 4 can be applied for PL "e" and requires the use of 2 actuators, so that the failure of one actuator does not lead to the loss of the safety function. When using a suitable monitoring device and integrating 2 signalling channels 99% diagnostic coverage must to be achieved.

System behaviour category 4:
A single failure does not lead to a loss of the safety function. The detection of a series of failures can reduce the probability of the loss of the safety function (high DC). The failures are detected in time to avoid the loss of the safety function.

Application areas for category 3 and 4
In DIN EN ISO 13849-1 the requirement of safety category 3 is for the safety function to be up held when a single fault occurs. For safety category 4, a single fault must not lead to a loss of the safety function and failures are detected in time.

All SAFEMASTER STS units have a diagnostic coverage (DC value) stated in the tables on page 6 and 7. Faults that could happen inside the SAFE-MASTER STS units, are detected by the units themselves or in the system. However when inserting the actuators (position monitoring), a fault could occur e.g. breaking or loosening of the actuator. To avoid this, actuators that are sufficiently strong (e.g. CS- or J-actuators) that in addition could be fixed by welding or divergent mounting. When comparing the holding and shearing forces of the SAFEMASTER STS units with the application (design of the guard) over dimensioning could also be claimed, but this must be well proven. A simpler solution is to use a unit with a second actuator. Such a unit can be used as single unit in combination with the required logic and output, up to PL "e". A second door switch or solenoid lock is not necessary with this system, see picture below of an SXBA with a CS- and a C-actuator. This design does not only provide diverse redundancy and DC high, but also enough protection against simple manipulation and a measure against common cause failures.



SXBA + CS + C

Mean Time To Failure dangerous for each channel ($MTTF_d$)

The $MTTF_d$ value for safety components is calculated using the $B10_d$ values in the following formula:

General formula to calculate the $MTTF_d$ for components with given $B10_d$ value:

$$MTTF_d = \frac{B10_d}{0{,}1 \times n_{op}}$$

with

$$n_{op} = \frac{d_{op} \times h_{op} \times 3\,600\ s/h}{t_{cycle}}$$

with the following data specified for the application:
n_{op} is the avarage number of operations per year;
h_{op} is the average operation time in hours per day;
d_{op} is the average operation time in days per year;
t_{Cycle} is the average time between 2 starts in a sequence of 2 operations of a component (e.g. switching of a valve) in seconds per cycle.

The $B10_d$ value has to be provided by the manufacturer of the safety components. If a manufacturer is not able to provide these data they can be taken from annexe C of EN ISO 13849-1. Manufacturers can also decide to additionally provide $MTTF_d$ or Lambda d values. For SAFEMASTER STS the $B10_d$ values can be found in the data sheets.

The $MTTF_d$ value is a theoretical value that describes the reliability of a component. This is stated in years.

The $B10_d$ value of a unit allows calculation of the maximum operating life $T10_d$. The $T10_d$ value specifies the time for which a safety component can be used in a application. A safety component with an $MTTF_d$ value of e.g. 150 years has a maximum operating life ($T10_d$) of 15 years and must to be replaced after this time. The maximum operating time for an architecture (category) and therefore for the safety components used is 20 years.

General formula to calculate the operation time of a component with given $B10_d$ value:

$$T10_d = \frac{B10_d}{n_{op}}$$

With the $MTTF_d$ value of the components, the $MTTF_d$ value of a complete system can be calculated. The $MTTF_d$ values for each channel are devided in 3 steps (see table) and must be calculated individually (e.g. a single channel or each channel of a redundant system). For $MTTF_d$ the max. achivable value is 100 years.

$MTTF_d$	
Rating for each channel	**Range for each channel**
low	3 years to 10 years
med	10 years to 30 years
high	30 years to 100 years

For the values shown in the table an accuracy of 5% can be assumed.

The $MTTF_{d\ avg}$ value is used to specify if the system values are sufficient to achieve the required PL (PL_r). This can be done by using the table on page 3 or by using the simplified procedure on page 9.

General formula to calculate the $MTTF_d$ for each channel (parts-count method):

$$\frac{1}{MTTF_d} = \sum_{i=1}^{\tilde{N}} \frac{1}{MTTF_{di}} = \sum_{j=1}^{\tilde{N}} \frac{n_j}{MTTF_{dj}}$$

with
$MTTF_d$ for the complete channel and $MTTF_{di}$ or $MTTF_{dj}$ for each safety related component. The first sum is an addition of all single components; the second sum is equal, but all components n_j with identical $MTTF_d$ are put together.

The use of this formula is explained in application example 1 on page 9 top right side.

With the $B10_d$ values of the data sheets, the $MTTF_d$ values for the units and the $MTTF_{d\ avg}$ for a system can be calculated using the above formula.

The $MTTF_{d\ avg}$ value is necessary to evaluate if the system corresponds to the required PL.

The $MTTF_d$ value gives no guarantee that a safety component will work without failure for the maximum operating time. It is a value that together with the architecture (category) and the diagnostic coverage, defines the probability of failures per hour and therefore the compliance of a system to a required PL.

Diagnostic coverage (DC)

The values for DC are divided into 4 steps (see table)

DC	
Rating	**Range**
none	DC < 60 %
low	60 % ≤ DC < 90 %
med	90 % ≤ DC < 99 %
high	99 % ≤ DC

For the values in this table an accuracy of 5% is assumed

Calculation of DC DC_{avg}

$$DC_{avg} = \frac{\frac{DC_1}{MTTF_{d1}} + \frac{DC_2}{MTTF_{d2}} + \frac{DC_3}{MTTF_{d3}} + \ldots + \frac{DC_N}{MTTF_{dN}}}{\frac{1}{MTTF_{d1}} + \frac{1}{MTTF_{d2}} + \frac{1}{MTTF_{d3}} + \ldots + \frac{1}{MTTF_{dN}}} \quad [V]$$

The diagnostic coverage is a system value that is necessary to evaluate if a system is suitable for the required PL. For SAFEMASTER STS this value is stated in the DC calculation tables for the units. With this value the DC_{avg} for a complete system can be calculated. Examples can be found on the following pages.

The diagnostic coverage in SAFEMASTER STS detects a mechanical fault when it occurs but it does not cause a machine stop. Instead of this, the access to the dangerous area is blocked or the restart of the system is disabled. To evaluate the DC of the logic, please refer to annex E of EN ISO 13849-1

DC calculation tables of the SAFEMASTER STS basic units

The DC values listed, are taken from table E of DIN EN ISO 13849-1 and adapted to the integrated diagnostic measures of the SAFEMASTER STS system. If SAFEMASTER STS is used as a system, DC, $MTTF_d$ and safety category must be evaluated as a sub-system according to EN 13849-1. The values of the sub-system have then to be used to evaluate the complete safety system. The tables below make it easier to get the DC values of the different SAFEMASTER STS units. The DC values listed indicate the DC of the mechanical part in combination with the influence of the safety circuits and logic. For all electrical units the DC values of wiring and logic are stated as categories cat. 2, cat. 3, and cat. 4.
On mechanical units wiring and logic have no influence.

Example:
SXBB01M with logic and wiring according to safety category 3 (cat. 3). From the table for SX-units the line with SXBB01M and column cat 3 is selected. This indicates the DC value to be 90%.

Units which have 2 B's or a combination of A and B in the product key have 2 input functions (actuator modules). These units have at least 2 cross comparrasing and a plausibility tests. If the units used are with logic, output and wiring to cat3 or cat4 a complete cat3 or cat4 structure is achieved.

For units that are not listed, the base unit must first be selected and the DC-value can be taken from the table. For every module added to the base unit it's DC-value is reduced by 1% (DC*99%). This is necessary to avoid complex application designs and calculations for SAFEMASTER STS systems, where PL "e" or cat 4 is required.

Example:
For a ZRH05M, cat 4. the base unit for this unit is a ZRH02M. According to the table the DC-value is 99%. As 3 modules are now added to this base unit to make an 05M, the DC-value is reduced from 99% less 3% to 96%.

$DC_{ZRH05M} = DC_{ZRH02M} \times 99\%^{3} = 96\ \%$

DC calculation tables of the SAFEMASTER STS basic units

Function of the tables:
Select the base STS unit that is to be used and choose the safety category of the wiring and logic for the application. The DC value can now be taken from the table.

Group of basic unit:
Switches

Unit	cat. 2	cat. 3	cat. 4
S_01BA	90%	90%	99%
S_01M	90%	90%	99%
S_A	60%	90%	
S_BA	90%	90%	99%
SX01A	90%	90%	
SX02M	90%	90%	99%
SXB01M	90%	90%	
SXBB01M	90%	90%	99%
SV01A	60%	90%	
SVB01M	60%	90%	

Group of basic unit:
Solenoid locking

Unit	cat. 2	cat. 3	cat. 4
ZR_01A	60%	90%	
ZR_01BA	90%	90%	99%
ZR_01M	90%	90%	99%
ZR_02M	90%	90%	99%
ZR_A	60%	90%	
ZR_B01M	60%	90%	
ZR_BA	90%	90%	99%
ZR_BB01M	90%	90%	99%
ZR_BBVM	90%	90%	99%
ZR_BVM	90%	90%	
ZR_V01M	90%	90%	99%
ZR_VA	90%	90%	
ZR_VBA	90%	90%	99%

Group of basic unit:
Mechanical

Unit	
M10A	90%
M10B01M	90%
M10BA	99%
M10BB01M	99%
M10BBVM	99%
M10BV01M	99%
M10VA	90%
M10VBA	99%
M10VBM	90%
M10VM	99%
M11A	90%
M11BA	99%
M12M	99%
MK01M	90%
MK11M	90%
MKK01M	99%
MKK11M	99%

DC calculation tables of the SAFEMASTER STS basic units

Group of basic unit:
Switches

Unit	cat. 2	cat. 3	cat. 4
R_10A	90%	90%	
R_10B01M	90%	90%	
R_10BA	90%	90%	99%
R_10BB01M	90%	90%	99%
R_10K01M	90%	90%	
R_10KK01M	90%	90%	99%
R_11A	90%	90%	
R_11BA	90%	90%	99%
R_11M	90%	90%	99%
R_K01M	90%	90%	
R_K11M	90%	90%	
R_KK01M	90%	90%	99%
R_KK11M	90%	90%	99%

Group of basic unit:
Solenoid locking

Unit	cat. 2	cat. 3	cat. 4
YR_10 BB01M	90%	99%	99%
YR_10A	60%	90%	
YR_10B01M	60%	90%	
YR_10BA	90%	90%	99%
YR_11A	60%	90%	
YR_11BA	90%	90%	99%
YR_11M	90%	99%	99%
YR_K01M	90%	90%	
YR_KK01M	90%	99%	99%
YR_KKM	90%	99%	99%
YR_KM	60%	90%	

Simplified procedure to evaluate the achieved PL of a SRP/CS

Category	B	1	2	2	3	3	4
DC_{avg}	no	no	low	med	low	med	high
$MTTF_d$ per channel							
low	a	Not applicable	a	b	b	c	Not applicable
med	b	Not applicable	b	c	c	d	Not applicable
high	Not applicable	c	c	d	d	d	e

Besides picture 5 of EN ISO 13849-1, shown on page 3 of this document, that explains the relation between categories, DC_{avg}, $MTTF_d$ of each channel and PL, there is an other simplified procedure in table 7 of EN ISO 13849-1

Measures against common cause failures CCF

In the table below, the CCF quantification requirements from table F of EN ISO 13849-1 are listed for using SAFEMASTER STS.

		Integrated measures / proposals for SAFEMASTER STS units			
No.		**Units with switch module**	**Units with solenoid lock**	**Mechanical units**	**Max. ponits**
1	Separation of signal paths	**Airgap and creepage distances are fulfilled** piped/separate routing of wiring (15)	**Airgap and creepage distances are fulfilled** piped/separate routing of wiring (15)	**Signal path via key** (15)	15
2	Diversity	**Antivalent design of mechanics** *Redundant or antivalent electrical circuits for door/key position available* (20)	**Antivalent design of mechanics** *Redundant or antivalent electrical circuits for door/key position available* *Redundant or antivalent electrical circuits for solenoid position available* (20)	**Antivalent design of mechanics** (20)	20
3.1	Protection against overvoltage, overpressure, overcurrent	*Monitoring devices* (15)	*Monitoring devices* (15)	**No influence** (15)	15
3.2	**Proven components**	**TÜV approvals** (5)	**TÜV approvals** (5)	**TÜV approvals** (5)	**5**
4	**FMEA validation**	**FMEA part of the test** (5)	**FMEA part of the test** (5)	**FMEA part of the test** (5)	**5**
5	**Education**	**Key transfer plans by experienced DOLD specialists** (5)	**Key transfer plans by experienced DOLD specialists** (5)	**Key transfer plans by experienced DOLD specialists** (5)	**5**
6.1	**Electrical influences**	**Stainless steel enclosure, test by TÜV** (25)	**Stainless steel enclosure, test by TÜV** (25)	**Mechanical, not applicable** (25)	**25**
6.2	**Mechanical influences**	**• A4 stainless steel compon. • failure tolerance up to 20% • limitation of maximum applied forces • IP 65 sealing** (10)	**• A4 stainless steel compon. • failure tolerance up to 20% • limitation of maximum applied forces • IP 65 sealing** (10)	**• A4 stainless steel compon. • failure tolerance up to 20% • limitation of maximum applied forces • IP 20, resistant against liquids and dirt** (10)	**10**
	Total points	50 + (x)	50 + (x)	100	100
	65 or better	Specifications met			
	less than 65	Procedure failed ⇒ Selection of additional measures ⇒ Implementation of the proposals			

bold text: standard integrated measures in SAFEMASTER STS
text in italics: Proposals for measures

ATTENTION!

Safety components must be suitable for the application!
Just fulfilling the PL is not sufficient.
Misuse must be taken into consideration.

We recommend to obtain a valid edition of the EN ISO 13849-1 and EN ISO 13849-2.

The table only refers to SAFEMASTER STS, but not to the whole safety system.

Mechanical units already reach 100 points acc. to the table. Further measures need to be taken for units with electric modules. By implementing the normally printed proposals, the required number of points of at least 65 can be easily reached. SAFEMASTER STS is delivered with 2 coded M4 screws for each unit and 1 coded screw for each actuator as protection against manipulation. The required tool can be purchased separately.

Would you like advice on standards, necessary documentation and risk assesment?

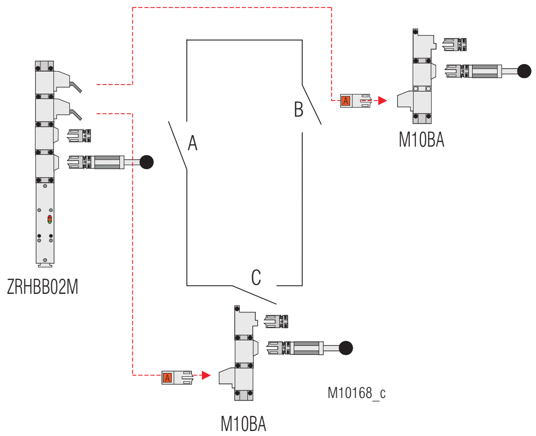
Please contact our sales organisation. Competent advisors are available.

Application example 1: Performance Level e cat. 4

The application example 1 shows in detail how to use the system values in the corresponding formulae. In example 2, 3 and 4 the applications are described.

An installation is safe guarded with a guard, that has 3 gates, PL "e" and cat 4 is required. The solenoid lock at gate A is a ZRHBB02M, the base unit according to the table is ZR_BB01M. The DC-value is 99% less 1% = 98% (due to the additional key m odule required to make it 02M). The gates B and C are secured with M10BA units which according to the table have a DC value of 99%. These 3 units have been selected because of the double input (actuator) function which is required for cat. 4 / PL"e".

Rolling mill:



Gate A is opened 20 times a day (for 220 days per year), the gates B and C are operated 5 times a day. The $B10_d$ values are taken from the individual STS data sheets.

General formula:

Application example 1, calculation

$d_{op} = 220\ ^{d}/_{a}$

daily operations = $20\ ^{1}/_{d}$

$B_{10d} := 2 \times 10^6$ (see data sheets for switching cycles)

to be determined:

n_{op}, $MTTF_d$, $MTTF_{d\,avg}$, DC, DC_{avg}, T_{10d}

<u>Gate A: ZRHBB02M</u>

n_{op} = d_{op} x daily operations

$= 220\ ^{d}/_{a} \times 20\ ^{1}/_{d}$

$= 4400\ ^{1}/_{a}$

$$\text{in [I]} \quad MTTF_d = \frac{B_{10d}}{0.1 \times n_{op}} = \frac{2 \times 10^6}{0.1 \times 4400\ ^{1}/_{a}} = 4545\ a$$

<u>Gate B / C: M10BA</u>

n_{op} = d_{op} x daily operations

$= 220\ ^{d}/_{a} \times 5\ ^{1}/_{d}$

$= 1100\ ^{1}/_{a}$

$$\text{in [I]} \quad MTTF_d = \frac{B_{10d}}{0.1 \times n_{op}} = \frac{2 \times 10^6}{0.1 \times 1100\ ^{1}/_{a}} = 18182\ a$$

$$\text{in [IV]} \quad \frac{1}{MTTF_{d\,avg}} = \frac{1}{4545\ a} + \frac{1}{18182\ a} + \frac{1}{18182\ a} = \frac{1}{3030\ a}$$

$MTTF_{d\,avg} = 3030\ a$

hence: once the $MTTF_d$ value has exceeded 100 years, it will be limited to them ⇒ $MTTF_d$ = 100 years = high

conclusion from [I] and [III] : $T_{10d} = 0.1 \times MTTF_d$

Gate A: $T_{10d} = 0.1 \times 4545\ a = 455\ a$

Gate B / C: $T_{10d} = 0.1 \times 18182\ a = 1818\ a$

According to EN ISO 13849-1 the maximum life of an architecture is limited to 20 years

Logic an wiring to cat. 4 [V]

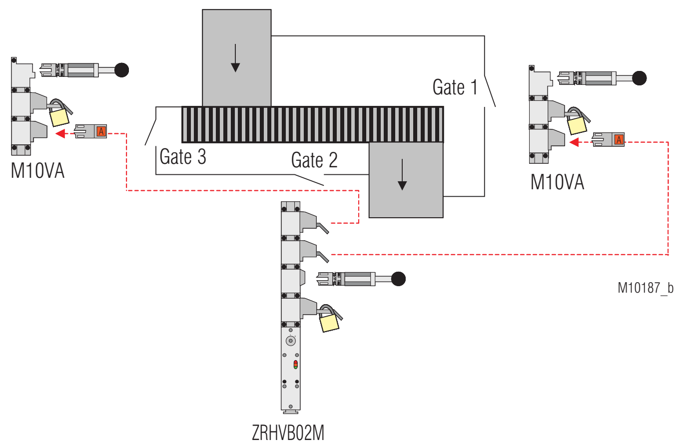
$$DC_{avg} = \frac{\frac{98\,\%}{4545\ a} + \frac{99\%}{18182\ a} + \frac{99\%}{18182\ a}}{\frac{1}{4545\ a} + \frac{1}{18182\ a} + \frac{1}{18182\ a}} = 98{,}3\ \%$$

Attention!

After a complete safety system is designed and calculated a validation according to EN ISO 13849-2 <u>**m u s t**</u> carried out.

Application example 2: Performance Level d, cat. 3

System with 2 dangerous areas:



Procedure and risk specification:
The installation has a guarded area that is divided in 2 danger zones by the conveyor and has 3 gates with full body access. The severity of an injury could be irreversible (risk graph S2). If a danger is recognised, it may be possible to avoid injury (risk graph P1).

At 320 working days per year with 16 hours each, the dangerous areas are entered 2 times per hour (risk graph F2). Performance level is therefore defined as PL "d" and the safety system is designed in category 3.

Operating sequence:
To enter the dangerous area the installation must be in a safe state, e. g. at the end of a machine cycle. This enables the solenoid lock ZRHVB02M on gate 2 after the padlock module is operated gate 2 can be opened. When the gate is open 2 more keys can be extracted from ZRHVB02M. These keys can be inserted into the units M10VA at gate 1 and gate 3. Through this forced procedure the escape route is provided at gate 2.

There is no difference between the accessible areas so all gates are calculated in a similar manner concerning DC and $MTTF_d$. The M10VA include a padlock module that requires forced operation. Trained operating staff can insert in the module with a padlock to avoid being locked in. The CS-actuators are mounted in a way that they cannot loosen themselves.

Procedure of calculating the values:

B_{10d} -values (see individual data sheets)
n_{op} see [II]
$MTTF_d$ and T_{10d} -values see [I] and [II],
DC (see DC calculation tables on page 6 and 7)

Unit	B_{10d}	n_{op} [1/a]	$MTTF_d$ [a]	T_{10d} [a]	DC	Category
ZRHVB02M	2 x 10^6	10240	1953	20	88 %	3
M10VA	2 x 10^6	10240	1953	20	90 %	3
M10VA	2 x 10^6	10240	1953	20	90 %	3

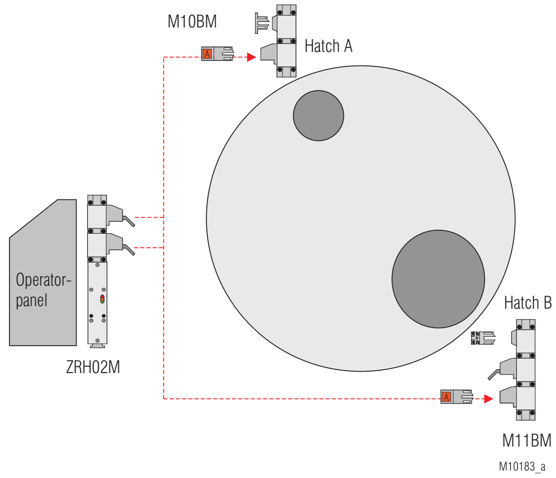
$MTTF_{d\ avg}$ = 651 a ⇒ limited to 100 years = high
DC_{avg} = 89.3% = low
Architecture to category 3

Result from calculated values and table 5 of EN ISO 13849-1:
If the logic, wiring and output corresponds to the architecture for category 3, this system fulfils the requirements of the necessary performance level PL "d".

The above mentioned system values can be used for a calculation without software. When using calculation software as e.g. Sistema, the values and structure of the single units can be entered together with the logic and output in reference to table E in EN ISO 13849-1

Application example 3: Performance Level c, cat. 2

Mixer:



Procedure and risk specification:
The machine in this example is a container with mixer running at 6 rpm. The mixer is locked with mechanical access locks on each of the 2 hatches. Inspection hatch A with part body access is safeguarded with an M10BM. Maintenance hatch B is safeguarded with M11BM. This hatch allows full body access to the mixer. The Inspection hatch A is opened 2 times per shift, at 3 shifts per day and 300 working days per year. The maintenance hatch B is opened 1 time a week for a short period for cleaning (risk graph F1). If the machine is started without intention while someone is inside the mixer an escape is possible through cover B (risk graph P1). An irreversible injury is possible by crushing a part of the body (risk graph S2). The machine is classified performance level PL "c". An architecture of category 2 (see page 4) is planned.

Operating sequence:
If standstill is detected a control signal is generated that unlocks the solenoid lock for key release ZRH02M at the operator panel. Both keys can be extracted to open hatches A and B. For protection against being trapped inside the maintenance hatch B is equipped with a mechanical dual access lock M11BM that only allows access when the personal safety key is removed. At inspection hatch A it is possible to crush an arm or hand when reaching into the machine getting caught by rotating parts (risk graph S2).

Because of high pollution in this area actuator module B is used instead of actuator module A (M10A and M11A). The B actuator module only has one actuator opening on the side and is therefore better protected against pollution.

Procedure of calculating the values:

B_{10d} -values (see individual data sheets)
n_{op} see [II]
$MTTF_d$ and T_{10d} -values see [I] und [II],
DC (see DC calculation tables on page 6 and 7)

Unit	B_{10d}	n_{op} [1/a]	$MTTF_d$ [a]	T_{10d} [a]	DC	Category
ZRH02M	2 x 10^6	1850	10810	20	89 %	2
M10BM	2 x 10^6	1800	11111	20	90 %	2
M11BM	2 x 10^6	50	399202	20	90 %	2

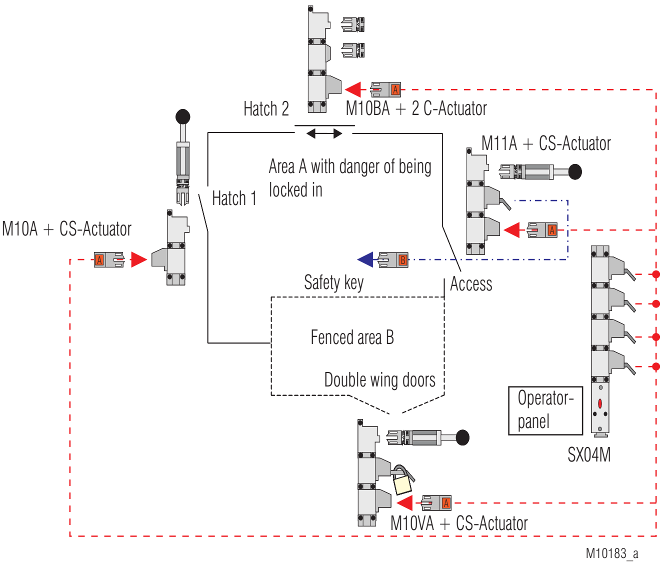
$MTTF_{d\ avg}$ = 1843 a ⇒ limited to 100 years = high
DC_{avg} = 89.1% = low
Architecture to category 2

Result from calculated values and table 5 of EN ISO 13849-1:
If the logic, wiring and output corresponds to the architecture for category 2, this system fulfils the requirements of the necessary performance level PL "c".

The above mentioned system values can be used for a calculation without software. When using calculation software as e.g. Sistema, the values and structure of the single units can be entered together with the logic and output in reference to table E in EN ISO 13849-1

Application example 4: Performance Level c and d combined

System with 2 danger zones:



Procedure and risk specification:
Zone A has 2 hatches with part body access and 1 gate with full body access. In this area somebody can be locked in. Because of getting crushed, or sharp edges, irreversible injuries can occur (risk graph S2). This part of the machine is accessed once a day. Hatch 1 is opened four times and hatch 2 three times a day (risk graph F1). Because of the high starting speed an escape from the dangerous area is nearly impossible (risk graph P2). For this area PL "d" is required.

The CS-actuator is fixed to the cover 1 in a way that it cannot get loose and cannot break. Hatch 2 is a sliding gate. Here a loosening of the actuator cannot be excluded so unit M10BA with 2 C-actuators is used (see picture below of an M11BA unit). The access gate is guarded with a M11A unit with CS-actuator. By suitable construction, loosening or breaking of the CS-actuator can be excluded. The second key has to be extracted before opening of the gate as to protect against being trapped inside.

Area B is fenced and has a double wing safety gate with full body access. Here a fork lift can remove pallets. The gate is protected by the unit M10VA with a CS-actuator. In this position loosening of the CS-actuator cannot be excluded. This part of the machine needs to be blocked while the gate is open, so that the complete machine is on standstill. It is unlikely that somebody can get locked in as the complete area is visible from the operator panel. For additional safety an integrated padlock module can be used.
An irreversible injury is possible (risk graph S2). Area B is accessed 5 times per day (risk graph F1). Because of low machine speed an easy escape from the dangerous area (risk graph P1) is possible. For this area PL "c" is necessary.

M11BA with two C-actuators

Operating sequence:
To switch off the plant a key is removed from an SX04M unit at the operator panel. The machine runs down into a safe state. The reaction time of the machine is shorter then the time to open a gate. With the 4 released keys all gates or hatches can be opened. Only at the access gate to area A a safety key has to be extracted before somebody can enter the zone. For restart all entries have to be closed and the keys must be back in the SX04M unit at the operator panel.

The SX04M unit on at the operator panel is monitored by a DOLD e-stop module SAFEMASTER LG 5925. In addition it monitors 2 contactors. Cross fault monitoring is activated on this module.

Procedure of calculating the values
B_{10d} -values see individual data sheets)
n_{op} see [II]
$MTTF_d$ and T_{10d} -values see [I] und [II],
DC (see DC calculation tables on page 6 and 7)

Zone A requires PL "d", zone B requires PL "c". Therefore the areas are calculated separately. The system is operated 330 days a year.

Area A: PL"d"

Unit	B_{10d}	n_{op} [$^1/_a$]	$MTTF_d$ [a]	T_{10d} [a]	DC	Category
SX04M	2 x 10^6	4290	4662	20	88 %	3
M11A	2 x 10^6	330	60606	20	90 %	3
M10A	2 x 10^6	990	15152	20	90 %	3
M10BA	2 x 10^6	1320	20202	20	99 %	4

$MTTF_{d\ avg}$ = 2886 a ⇒ limited to 100 years = high
DC_{avg} = 90% = med
Architecture to category 3

Area B: PL"c"

Unit	B_{10d}	n_{op} [$^1/_a$]	$MTTF_d$ [a]	T_{10d} [a]	DC	Category
SX04M	2 x 10^6	4290	4662	20	88 %	3
M10VA	2 x 10^6	1650	12121	20	90 %	2

$MTTF_{d\ avg}$ = 3367 a ⇒ limited to 100 years = high
DC_{avg} = 88.6% = med
Architecture to category 2

The above mentioned system values can be used for a calculation without software. When using calculation software as e.g. Sistema, the values and structure of the single units can be entered together with the logic and output in reference to table E in EN ISO 13849-1

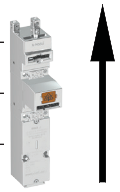
SAFEMASTER STS product key

SAFEMASTER STS has a self-explaining product key that reads as follows:
The additional letters or figures describe the units starting from left to right indicating the used modules and their functions as well as the sequence of first operation i.e. from bottom to top. Reading and operation direction are indicated by an arrow. The modules and their function are described in table 1.

Beispiel 1: SX01A

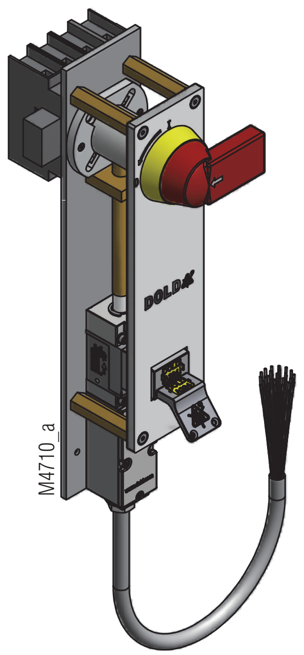
STS- SX 01 A

Actuator module A
Key module 01
Switch module SX
SAFEMASTER STS



Info

You find further information on SAFEMASTER STS in customer information covering assembly, actuator selection, overload. materials and assembly work



General

SAFEMASTER STS Power Interlocking is a special kind of disconnecting of power of an installation. Instead of switching via an electric/electronic control level, a machine or installation in the case of STS Power Interlocking is, in addition, positively switched On/Off and locked via switch disconnectors.

The safety function of a machine being switched off via the SAFEMASTER STS Power Interlocking system corresponds to the safety-related Stop function that is initiated by a protective device. If the system is part of a larger installation and the Stop function is routed via the control unit, the safety function can be regarded as prevention of an unexpected start or as insulation and energy dissipation function. The switch disconnector employed in SAFEMASTER STS Power Interlocking may be rated as emergency stopping function using a red-yellow operating lever.

Category and diagnostic coverage (DC) of SAFEMASTER STS Power Interlocking can only be determined in the system taking the diverse circuits into account. The safety-related characteristic values of the whole mechanical part of the SAFEMASTER STS system can be determined by the specified category using the DC determination table on page 6 and 7.

The mechanical versions of SAFEMASTER STS Power Interlocking represent the exceptions (vd. circuit example 1). Since these mechanical versions do not have 2-channel structures and are without any fault detection mechanisms, these units have a structure acc. to category 1 without DC. This has also an impact on an associated SAFEMASTER STS system which, therefore, can also reach a maximum structure of category 1. A higher category and higher DC can only be attained through integration of additional SAFEMASTER STS units which can additionally be integrated into safety-oriented circuits. This is reasonable for installations with different Performance Levels which, however, can be centrally witched off where the lowest PL is $_r$ = PL'c'.

The following 4 circuit examples represent simplified circuit diagrams where some functions, such as Start/Stop and feedback circuit are not being contemplated in order to reducing drawing complexity.

Mechanical versions of M10SL1-Px-xxx up to M50SL1-Px-xxx

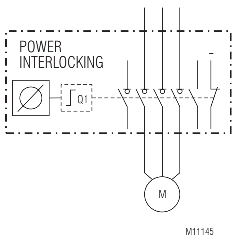
Circuit example 1

This system allows removing 1 to 5 keys only if the switch disconnector (Q1) has been switched off. Any fault in the switch disconnector interlocking mechanism results in the release of all keys. This constitutes a system behaviour acc. to category 1.

The mechanical versions are suitable for applications where the time between disconnecting the machine and opening of the movable separating protective device is longer than this machine safely coming to a complete stop.

It was ascertained in a calculation of finite elements that the interlocking mechanism shows greater stability by factor 1.3 than the operational controls. The operational controls will only be damaged at torques ranging from 80 and 100 Nm. These torques were documented by means of destruction tests. A fault exclusion cannot be substantiated based on these values since factor 2 is required as per test standard GS-ET-31.

M10L1-Px-xxx	B_{10d} : 2 x 10^6 switching cycles	DC 0%
M20L1-Px-xxx	B_{10d} : 2 x 10^6 switching cycles	DC 0%
M30L1-Px-xxx	B_{10d} : 2 x 10^6 switching cycles	DC 0%
M40L1-Px-xxx	B_{10d} : 2 x 10^6 switching cycles	DC 0%
M50L1-Px-xxx	B_{10d} : 2 x 10^6 switching cycles	DC 0%



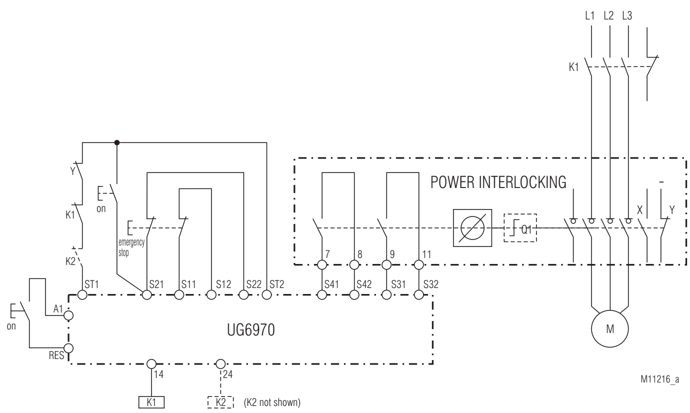
Circuit example 2
Version with switch SX01SL-Px-xxx
Basic unit: SX01M

This version with switch allows removing the key only if the switch disconnector (Q1) has been switched off.

Auxiliary contact X is also closed on switching the switch disconnector. Guard monitoring device UG 6970 switches and contactor K1 drops. The key monitoring safety contact is switched upon removing the key. Switching the switch disconnectors must also include removing the key in order to restart the installation since otherwise the multifunctional safety module UG 6970 cannot be reseted. A fault in the switch disconnector interlocking mechanism leads to releasing the key which would trigger an emergency stop via the switch contacts. This constitutes a system behaviour acc. to category 4. A maximum of category 1 is reached without additional logic and contactor K1.

The version with a switch is suitable for applications where the time between disconnecting the machine and opening of the safety guard is longer than the time required for the machine to achieve a safe state.

SX01SL-Px-xxx	B_{10d}: 2 x 10^6 switching cycles	DC 99 %



Circuit example 3
Version with solenoid lock without logic ZRH01SL-Px-xxx
Basic unit: ZRH01M

In the case of the version with solenoid lock without logic, the key can only be removed if the switch disconnector (Q1) was switched off and the solenoid lock.

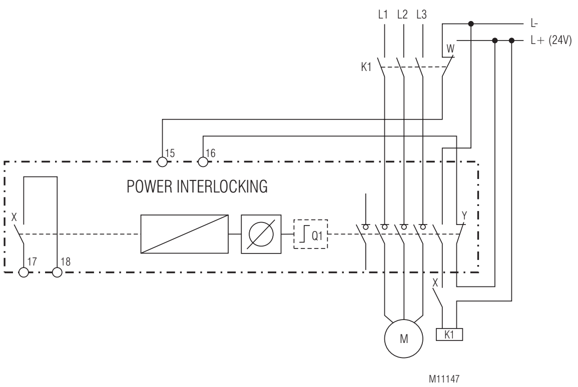
An auxiliary contact is opened upon switching the switch disconnector. This causes the contactor K1 to drop. Closing of the contactor auxiliary contact Y and auxiliary contact W form a self-locking system that causes the solenoid lock respectively the solenoid disengaged. of key monitoring to remain attracted, allowing the key to be removed. The attracting solenoid causes safety contact X to open that in turn takes care that contactor K1 remains switched off. The key monitoring solenoid is being mechanically retained on removing the key.

A fault in the system prevents the key from being released. However, a fault in the interlocking mechanism mechanics cannot always be detected. This constitutes a system behaviour acc. to category 3.

The version with a solenoid lock without logic is suitable for applications where the time between disconnecting the machine and opening of the movable separating protective device is longer than the time for the machine to achieve a safe state.

The SAFEMASTER STS system even without contactor K1 reaches mechanically a behaviour acc. to category 3, but max. category 1 is reached electrically.

ZRH01SL-Px-xxx B_{10d}: 2 x 10^6 switching cycles DC 90%



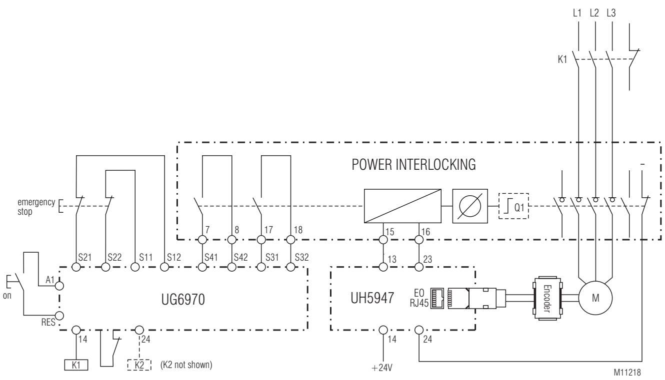
Circuit example 4
Version with solenoid lock with logic ZRH01SL-Px-xxx
Basic unit: ZRH01M

In the case of the version with solenoid lock with logic, the key can only be removed if the switch disconnector (Q1) was switched off and the solenoid disengaged.

The solenoid will only be control-activated once the machine has reached a safe state, for example, detected by speed monitor UH 5947. An auxiliary contact Y is closed on switching the switch disconnector. This operates the solenoid and the monitoring safety contacts open. As a result, the multifunctional safety module UG 6970 switches and contactor K1 drops.

A fault in the system prevents the key from being released and will be discovered at the next action of the safety function. This constitutes a system behaviour acc. to category 4.

ZRH01SL-Px-xxx B_{10d}: 2 x 10^6 switching cycles DC 99 %



Abbreviation	Explanation
a,b,c,d,e	Designations for the Performance Levels
RC	**R**equirement**C**lass According to DIN 19250, assignment of requirements of protective device realisation that should lead to a performance of the facility that is appropriate to the safety-related risk. It essentially results from the product of extent of damage and probability of occurrence.
B, 1, 2, 3, 4	Designation for the categories
B_{10d}	Number of cycles until 10 % of the components have dangerously failed (for pneumatic and electromechanical components). [EN ISO 13849-1]
CCF	**C**ommon **C**ause **F**ailure Failures of various units due to a single event in which the failures are not based on mutual cause.
DC	**D**iagnostic **C**overage Ratio of failure rate of the discovered dangerous failures and failure rate of the total of dangerous failures
Diversity	Diverse redundancy System design using various measures for the same goal to avoid systematic faults.
FIT	**F**ailure **I**n **T**ime Describes the failure rate of technical components, particularly electronic components The FIT unit states the number of components which fail in 10^9 hours. Components having a high FIT value will fail more frequently than those with low value. Failure rate with a FIT: $\lambda = 1/10^9$ h, i.e. once in approx. 114,000 years.
λ_d	Component dangerous failure rate in → FIT
Category (C)	Classification of the safety-related parts of a control unit with regard to their resistance (C, B, 1, 2, 3 and 4) to faults and their behaviour under fault condition that is attained due to the structural arrangement of the parts and/or their dependability. [DIN EN 954-1, see also DIN EN ISO 13849-1].
$MTTF_d$	**M**ean **T**ime **T**o **F**ailure **d**angerous Expected value of the mean time to dangerous failure.
PL	**P**erformance **L**evel Discrete level for safety-related performance. PL"a" is the lowest, PL"e" the highest level [DIN EN ISO 13849].
PFD	**P**robability of **F**ailure on **D**emand or mean probability that the safety function is not executed on demand.
PFH_d	**P**robability of **F**ailure dangerous per **H**our or probability of a dangerous failure per hour. The limit value of failure PFD is assigned to small demand rates while the limit value of failure PFH applies for large or continuous demand rates.
Risk	Combination of a probability of occurrence of damage and the magnitude of damage. [EN ISO 12100-1] *NOTE:* Influence have gravity of damage, exposure to hazard, probability of occurrence and lack of possibilities of escape [EN ISO 14121] → risk assessment
Risk assessment	Assessment of safety-oriented requirements, taking into account magnitude of damage, probability of occurrence, risk classification. *NOTE:* The sequence of hazards generally represents the risk magnitude of damage element. Each risk will then require to either determine the limit of probability or to estimate the frequency of occurrence or determine a permissible limit. The sequence of hazards establishes the correlation between the acknowledged hazards and the risk assessment. The sequence of hazards associates hazards and dangerous events that may result in an accident. Severity of hazards is the result of assigning a → Category (C), a → Requirement Class (RC) of a → Safety Integrity Level (SIL) or a Performance-Level (PL). EN ISO 14121-1 contains procedures that are necessary to performing a risk assessment. Hence, the risk assessment initially includes a risk analysis and a subsequent risk assessment.
SFF	**S**afe **F**ailure **F**raction Portion of non-hazardous failures
SIL	**S**afety **I**ntegrity **L**evel. Discrete stage to set the requirements on the safety integrity of safety functions. SIL 3 is the highest, SIL 1 the lowest stage = target measure of failure probability for the execution of risk-reduced functions [DIN EN 62061].
STS	**S**chlüssel-**T**ransfer-**S**ystem (= Key Transfer System)
Separating protective device	Mechanical separation between the danger zone and operational environment *NOTE:* Separation can be designed to function as safety guard, safety door, housing, cover, safety enclosure, distance guard, fencing, screen, etc. It can be stand-alone or part of the machine.
Interlocking device	Mechanical, electrical or other devices designed to prevent the operation of a machine element under certain conditions (normally for as long as the movable safety guard is not closed). [DIN EN 1088] (see safety switches and SAFEMASTER STS) key transfer system overview
Solenoid locking device	Device to lock a →Separating Protective Device in the closed position and which is connected to the control system in such a way that the machine cannot run if the protective device is not closed and kept closed, and the separating protective device is kept being locked until the risk of injury is no longer present. [DIN EN 1088]. (see safety switches and SAFEMASTER STS) key transfer system overview

EG-Konformitätserklärung
Declaration of Conformity
Déclaration de conformité européenne

DOLD

Hersteller: Manufacturer: Fabricant:	E. Dold & Söhne KG 78120 Furtwangen Bregstraße 18 Germany

Produktbezeichnung: Product description: Désignation du produit:	**SAFEMASTER STS**	**Sicherheitsschalter und Schlüsseltransfersystem** Safety Switch and Trapped Key Interlock System Système de serrures de sécurité et de transfert de clés

Produktbeschreibung:	Modular aufgebaute Produktreihe von Schaltern, elektromechanischen Zuhaltungen und Schlüsseltransfersysteme für Sicherheitsfunktionen
Product description:	Modular product range of switches, electromechanical guard locks and key transfer systems for operator safety
Description du produit:	Série de produits sécuritaires modulaires de serrures de sécurité et de systèmes de transfert de clés sécuritaires

Das bezeichnete Produkt stimmt mit den Vorschriften folgender Europäischer Richtlinien überein:
We declare that this product conforms to the following European Standards:
Le produit désigné est conforme aux instructions des directives européennes:

EMV-Richtlinie: EMC-Directive: / Directives-CEM:	2004/108/EG		
Maschinenrichtlinie: Machinery directive: / Directives Machines:	2006/42/EG		
Prüfgrundlagen: Basis of Testing: / Lignes de contrôle:	EN ISO 13849-1	:2008	+ AC2009
	EN ISO 13849-2	:2012	
	EN 60947-5-1	:2004	+ Cor. :2005 + A1 :2009
	EN 14119	:2013	(DIN EN ISO 14119:2014-03)
	GS-ET 15	:2011	
	GS-ET 19	:2011	
	GS-ET 31	:2010	

Die Übereinstimmung eines Baumusters des bezeichneten Produktes mit der oben genannten Maschinen-Richtlinie wurde bescheinigt durch:
Consistency of a production sample with the marked product in accordance to the above machines directive has been certified by:
La conformité d'un échantillon du produit désigné aux directives machine susmentionnées a été certifiée par:

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email: IS@de.tuv.com

Nummer der Bescheinigung: Nr./No.: 968/EZ 382.01/14 Ausstelldatum: 04.12.2014
Certification number: / Numéro de certificat: Date of issue: / Date de délivrance:

Für die Zusammenstellung der technischen Unterlagen ist bevollmächtigt:
For the compilation of technical documents is authorized: / Pour la composition des documents techniques est autorisé:

Arthur Aartsen Business Development Manager	Stefan Cavcic Entwicklungsleiter Development Manager / Responsable de développement
Name und Unterschrift Name and signature / nom et signature	Name und Unterschrift Name and signature / nom et signature
Furtwangen, 04.12.2014 Ort und Datum der Ausstellung Place and date of issue / Lieu et date de délivrance	E. Dold & Söhne KG Bregstraße 18 78120 Furtwangen

Diese Original-Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften.
Die Sicherheitshinweise der Produktdokumentation sind zu beachten.

This original declaration confirms the conformity of the mentioned directives but does not comprise any guarantee of the product characteristics.
The safety directives of the product documentation are to be considered.

Cette déclaration d'originale certifie la conformité des directives nommées mais ne comprend aucune garantie des caractéristiques du produit.
Les directives de sécurité de la documentation du produit sont à considérer.

EC Type-Examination Certificate

Product Safety
Functional
Safety

TÜVRheinland®
CERTIFIED

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ID 0600000000

Reg.-Nr./No.: 01/205/5418.01/15

Prüfgegenstand **Product tested**	Sicherheitsschalter- und Schlüsseltransfersystem Safety Switch and Trapped Key System	**Zertifikats-** **inhaber** **Certificate** **holder**	E. Dold & Söhne KG Bregstraße 18 78120 Furtwangen Germany

Typbezeichnung
Type designation

SAFEMASTER STS,
SAFEMASTER STS/K

Prüfgrundlagen
Codes and standards

EN ISO 13849-1:2008 + AC:2009	GS-ET- 31:2010
EN ISO 13849-2:2012	GS-ET- 19:2015
EN 60947-5-1:2004 + A1:2009	GS-ET- 15:2015
ISO 14119:2013	

Bestimmungsgemäße Verwendung
Intended application

Das Sicherheitsschalter- und Schlüsseltransfersystem SAFEMASTER STS und SAFEMASTER STS/K erfüllt die Anforderungen der zugrunde gelegten Normen und kann zur Absicherung von Gefahrenbereichen mit trennenden Schutzeinrichtungen bis maximal Kat. 4, PL e gemäß EN ISO 13849-1 und somit auch bis SIL 3 nach EN 62061 eingesetzt werden.
The Safety Switch and Trapped Key System SAFEMASTER STS and SAFEMASTER STS/K fulfils the requirements of the relevant standards and is suitable to be used for safeguarding of hazardous areas with interlock devices up to Cat. 4, PL e acc. to EN ISO 13849-1 and up to SIL 3 acc. to EN 62061.

Besondere Bedingungen
Specific requirements

Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sind zu beachten.
The instructions of the associated Installation and Operating Manual shall be considered.

Es wird bestätigt, dass der Prüfgegenstand mit den Anforderungen nach Anhang I der Richtlinie 2006/42/EG über Maschinen übereinstimmt.
It is confirmed, that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.

Gültig bis / Valid until 2020-09-18

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. 968/EZ 382.02/15 vom 18.09.2015 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen. Es wird ungültig bei jeglicher Änderung der Prüfgrundlagen für den angegebenen Verwendungszweck.
The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/EZ 382.02/15 dated 2015-09-18.
This certificate is valid only for products which are identical with the product tested. It becomes invalid at any change of the codes and standards forming the basis of testing for the intended application.

TÜV Rheinland 0035 Notified Body

Berlin, 2015-09-18

Certification Body for Machinery, NB 0035

Dipl.-Ing. Eberhard Frejno

TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany
Tel.: +49 30 7562-1557, Fax: +49 30 7562-1370, E-Mail: industrie-service@de.tuv.com

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Certificate

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Certificate no. CU 72150143 01

License Holder:
E. Dold & Söhne KG
Bregstrasse 18
78120 Furtwangen
Germany

Manufacturing Plant:
E. Dold & Söhne KG
Bregstrasse 18
78120 Furtwangen
Germany

Test report no.: USA-DS 31580140 001

Client Reference: Frank Arthur Aartsen

Tested to: UL 508:1999 R10.13
CAN/CSA C22.2.14-13

Certified Product: Safety Switch- and Key Interlock System

License Fee - Units

Listing Category: Industrial Control Equipment

Model Designation:
Safemaster STS: STS-A, STS-B, STS-K, STS-D, STS-E, 7
STS-01, STS-10, STS-R1, STS-01S, STS-10S, STS-R1S,
STS-V, STS-W, STS-SX, STS-SV, STS-RX, STS-RV,
STS-ZRX, STS-ZRH, STS-ZRN, STS-ZRF, STS-ZAX,
STS-ZAH, STS-ZAN, STS-ZAF, STS-YRX, STS-YRH,
STS-YRN, STS-YAX, STS-YAH, STS-YAN,
STS-L (STS-Power Interlocking), STS-T, STS-S,
STS-C, STS-CS, STS-J, STS-TK, STS-CK, STS-CKS,
STS-JK, STS-M, STS-Bayonet Ring, STS-Key contd.

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Appendix: 1

Licensed Test mark:

TÜVRheinland
C US

Date of Issue (day/mo/yr)
14/05/2015

TUV Rheinland of North America, Inc., 12 Commerce Road, Newtown, CT 06470, Tel (203) 426-0888 Fax (203) 426-4009

Certificate

TÜVRheinland

Certificate no. CU 72150143 02

License Holder:	**Manufacturing Plant:**
E. Dold & Söhne KG Bregstrasse 18 78120 Furtwangen Germany	E. Dold & Söhne KG Bregstrasse 18 78120 Furtwangen Germany

Test report no.: USA-DS 31580140 001

Client Reference: Frank Arthur Aartsen

Tested to: UL 508:1999 R10.13
CAN/CSA C22.2.14-13

Certified Product: Safety Switch- and Key Interlock System

License Fee - Units

(contd.)
Listing Category: Industrial Control Equipment

Rated Voltage: AC/DC 24V
Rated Power: 6W
Operating Temperature: -25° to 60°C

Licensed Test mark:

TÜVRheinland
C US

Date of Issue (day/mo/yr)
14/05/2015

TUV Rheinland of North America, Inc., 12 Commerce Road, Newtown, CT 06470, Tel (203) 426-0888 Fax (203) 426-4009

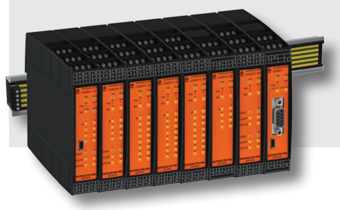
Our experience. Your safety.

The right solution for every application

Innovative safety concepts

From monofunctional modules for simple safety applications up to multifunctional, modular safety systems for hierarchic groupings, DOLD offers the tailor-made solution for your personnel and system protection.

We will gladly inform you about further safety solutions from our company.



SAFEMASTER C

The multifunctional safety module UG 6970 from DOLD's SAFEMASTER C family monitors two independent safety functions. Select any functions from the basic range of functions emergency stop, safety door, two-hand control, safety mat/ safety strip, antivalent switches and light barrier.

SAFEMASTER S

The SAFEMASTER S series speed monitors provide increase in productivity and safety of the operating staff thanks to the combination of safe speed and standstill monitoring.

SAFEMASTER PRO

The modular and configurable SAFEMASTER PRO safety system monitors all safety circuits of you machinery and installations – in a simple, flexible and safe way., The number of inputs and outputs of the central control unit can be upgraded via extension modules at any time.

SAFEMASTER W

SAFEMASTER W, the wireless companion for your safety. This allows you to switch off any dangerous movements in just a fraction of a second. The Wireless Safety System consists of a radio safety switching device, a hand-held transmitter and an optional infrared receiver.

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