SAFEMASTER STS

Design Guide

Modular safety switch and key transfer system for highest demands

DOLD
Our experience. Your safety.
The functional design of the SAFEMASTER STS is based on DIN EN ISO 13849-1. 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 guarded 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 fulfills 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 fulfill this requirement. The personal keys can be carried by operators when entering a dangerous area as protection against being locked in. More information can be found in the standard DIN EN ISO 12100-2 paragraph 5.5.3: „Measures to release and save trapped persons“. 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 defeat 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. 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

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

Attention!
A complete system can include multiple hazards 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

<table>
<thead>
<tr>
<th>Risk parameters</th>
<th>S - severity of injury</th>
<th>S1 - light (normally reversible) injury</th>
<th>S2 - severe (normally irreversible/ injury including death</th>
</tr>
</thead>
<tbody>
<tr>
<td>F - Frequency and/or duration of exposure to danger</td>
<td>F1 - seldom to sometimes and/or duration of exposure is short</td>
<td>F2 - frequent to continuous and/or duration of exposure is long</td>
<td></td>
</tr>
<tr>
<td>P - Possibility to avoid the danger or to limit the damage</td>
<td>P1 - possible under certain conditions</td>
<td>P2 - nearly impossible</td>
<td></td>
</tr>
<tr>
<td>a, b, c, d, e intended of safety related performance level, PLr</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relationship between PL, SC, DC, MTTF<sub>d</sub>

<table>
<thead>
<tr>
<th>PL</th>
<th>SC</th>
<th>DC</th>
<th>MTTF&lt;sub&gt;d&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1</td>
<td>low</td>
<td>1 low (3 up to 10 years)</td>
</tr>
<tr>
<td>b</td>
<td>2</td>
<td>med</td>
<td>2 med (10 up to 30 years)</td>
</tr>
<tr>
<td>c</td>
<td>3</td>
<td>high</td>
<td>3 high (30 up to 100 years)</td>
</tr>
</tbody>
</table>

MTTF<sub>d</sub> = (Mean Time To Failure) dangerous

The diagram shows the procedure to select the category in combination with MTTF<sub>d</sub> for each channel and the DC<sub>avg</sub> 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 risk graph (PLr ).

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

**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.

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.

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 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.

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**Abbreviations:**
- `i`: connection
- `c`: cross monitoring
- `l, l1, l2`: 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

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**SXBA + CS + C**

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Mean Time To Failure dangerous for each channel (MTTFd)

The MTTFd value for safety components is calculated using the B10d values in the following formula:

General formula to calculate the MTTFd for components with given B10d value:

\[ \text{MTTFd} = \frac{B10d}{0.1 \times n_{op}} \]

with

\[ n_{op} = \frac{d_{op} \times h_{op} \times 3600 \text{ s/h}}{t_{cycle}} \]

with the following data specified for the application:

- \( n_{op} \) is the average 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 B10d 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 MTTFd or Lambda d values. For SAFEMASTER STS the B10d values can be found in the data sheets.

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

The B10d value of a unit allows calculation of the maximum operating life T10d. The T10d value specifies the time for which a safety component can be used in an application. A safety component with an MTTFd value of e.g. 150 years has a maximum operating life (T10d) of 15 years and must 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 B10d value:

\[ T10d = \frac{B10d}{n_{op}} \]

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

<table>
<thead>
<tr>
<th>MTTFd</th>
<th>Rating for each channel</th>
<th>Range for each channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td></td>
<td>3 years to 10 years</td>
</tr>
<tr>
<td>med</td>
<td></td>
<td>10 years to 30 years</td>
</tr>
<tr>
<td>high</td>
<td></td>
<td>30 years to 100 years</td>
</tr>
</tbody>
</table>

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

The MTTFd avg value is used to specify if the system values are sufficient to achieve the required PL (PLr). This can be done by using the table on page 3 or by using the simplified procedure on page 9.
### Diagnostic coverage (DC)

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

<table>
<thead>
<tr>
<th>Rating</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>DC &lt; 60 %</td>
</tr>
<tr>
<td>low</td>
<td>60 % ≤ DC &lt; 90 %</td>
</tr>
<tr>
<td>med</td>
<td>90 % ≤ DC &lt; 99 %</td>
</tr>
<tr>
<td>high</td>
<td>99 % ≤ DC</td>
</tr>
</tbody>
</table>

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

### Calculation of DC $DC_{avg}$

$$DC_{avg} = \frac{DC_1 \cdot MTTF_{d1} + DC_2 \cdot MTTF_{d2} + DC_3 \cdot MTTF_{d3} + ... + DC_N \cdot MTTF_{dn}}{MTTF_{d1} + MTTF_{d2} + MTTF_{d3} + ... + MTTF_{dn}}$$

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.

### 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, MTTFd 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 comparing 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%.

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

### 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

<table>
<thead>
<tr>
<th>Unit</th>
<th>cat. 2</th>
<th>cat. 3</th>
<th>cat. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_01BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>S_01M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>S_A</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>S_BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>SX01A</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>SX02M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>SXB01M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>SV01A</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
</tbody>
</table>

#### Group of basic unit: Solenoid locking

<table>
<thead>
<tr>
<th>Unit</th>
<th>cat. 2</th>
<th>cat. 3</th>
<th>cat. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZR_01A</td>
<td>60%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_01BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_01M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_02M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_A</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>ZR_B01M</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>ZR_BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_BB01M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_BVM</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_V01M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_VA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>ZR_VBA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
</tbody>
</table>

#### Group of basic unit: Mechanical

<table>
<thead>
<tr>
<th>Unit</th>
<th>cat. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10A</td>
<td>90%</td>
</tr>
<tr>
<td>M10B01M</td>
<td>90%</td>
</tr>
<tr>
<td>M10BA</td>
<td>99%</td>
</tr>
<tr>
<td>M10BB01M</td>
<td>99%</td>
</tr>
<tr>
<td>M10BVM</td>
<td>99%</td>
</tr>
<tr>
<td>M10BV01M</td>
<td>99%</td>
</tr>
<tr>
<td>M10VA</td>
<td>90%</td>
</tr>
<tr>
<td>M10VBA</td>
<td>99%</td>
</tr>
<tr>
<td>M10VBM</td>
<td>90%</td>
</tr>
<tr>
<td>M10VM</td>
<td>99%</td>
</tr>
<tr>
<td>M11A</td>
<td>90%</td>
</tr>
<tr>
<td>M11BA</td>
<td>99%</td>
</tr>
<tr>
<td>M12M</td>
<td>99%</td>
</tr>
<tr>
<td>MK01M</td>
<td>90%</td>
</tr>
<tr>
<td>MK11M</td>
<td>90%</td>
</tr>
<tr>
<td>MKK01M</td>
<td>99%</td>
</tr>
<tr>
<td>MKK11M</td>
<td>99%</td>
</tr>
</tbody>
</table>
### DC calculation tables of the SAFEMASTER STS basic units

#### Switches

<table>
<thead>
<tr>
<th>Unit</th>
<th>cat. 2</th>
<th>cat. 3</th>
<th>cat. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_10A</td>
<td>90%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>R_10B01M</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_10BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>R_10BB01M</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>R_10K01M</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_10KK01M</td>
<td>90%</td>
<td></td>
<td>99%</td>
</tr>
<tr>
<td>R_11A</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_11BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>R_11M</td>
<td>90%</td>
<td></td>
<td>99%</td>
</tr>
<tr>
<td>R_K01M</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_K11M</td>
<td>90%</td>
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<td>99%</td>
</tr>
<tr>
<td>R_KK01M</td>
<td>90%</td>
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</tr>
<tr>
<td>R_KK11M</td>
<td>90%</td>
<td></td>
<td>99%</td>
</tr>
</tbody>
</table>

#### Solenoid locking

<table>
<thead>
<tr>
<th>Unit</th>
<th>cat. 2</th>
<th>cat. 3</th>
<th>cat. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>YR_10BB01M</td>
<td>90%</td>
<td>99%</td>
<td>99%</td>
</tr>
<tr>
<td>YR_10A</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>YR_10B01M</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>YR_10BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>YR_11A</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>YR_11BA</td>
<td>90%</td>
<td>90%</td>
<td>99%</td>
</tr>
<tr>
<td>YR_11M</td>
<td>90%</td>
<td></td>
<td>99%</td>
</tr>
<tr>
<td>YR_K01M</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YR_KK01M</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YR_KKM</td>
<td>90%</td>
<td>99%</td>
<td>99%</td>
</tr>
<tr>
<td>YR_KM</td>
<td>60%</td>
<td>90%</td>
<td></td>
</tr>
</tbody>
</table>
Simplified procedure to evaluate the achieved PL of a SRP/CS

<table>
<thead>
<tr>
<th>Category</th>
<th>B</th>
<th>1</th>
<th>2</th>
<th>2</th>
<th>3</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC_{avg}</td>
<td>no</td>
<td>no</td>
<td>low</td>
<td>med</td>
<td>low</td>
<td>med</td>
<td>high</td>
</tr>
<tr>
<td>MTTF_{d} per channel</td>
<td>low</td>
<td>a</td>
<td>Not applicable</td>
<td>a</td>
<td>b</td>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>med</td>
<td>b</td>
<td>Not applicable</td>
<td>b</td>
<td>c</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td></td>
<td>high</td>
<td>Not applicable</td>
<td>c</td>
<td>c</td>
<td>d</td>
<td>d</td>
<td>e</td>
</tr>
</tbody>
</table>

Besides picture 5 of EN ISO 13849-1, shown on page 3 of this document, that explains the relation between categories, DC_{avg} and 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.

<table>
<thead>
<tr>
<th>No.</th>
<th>Integrated measures / proposals for SAFEMASTER STS units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units with switch module</td>
</tr>
<tr>
<td>1</td>
<td>Separation of signal paths</td>
</tr>
<tr>
<td>2</td>
<td>Diversity</td>
</tr>
<tr>
<td>3.1</td>
<td>Protection against overvoltage, overpressure, overcurrent</td>
</tr>
<tr>
<td>3.2</td>
<td>Proven components</td>
</tr>
<tr>
<td>4</td>
<td>FMEA validation</td>
</tr>
<tr>
<td>5</td>
<td>Education</td>
</tr>
<tr>
<td>6.1</td>
<td>Electrical influences</td>
</tr>
<tr>
<td>6.2</td>
<td>Mechanical influences</td>
</tr>
</tbody>
</table>

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 assessment?

Please contact our sales organisation. Competent advisors are available.
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 safeguarded with a guard, that has 3 gates, PL "e" and cat 4 is required. The solenoid lock at gate A is a ZRHB02M, the base unit according to the table is ZR_BB01M. The DC-value is 99% less 1% = 98% (due to the additional key module 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".

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 B10d values are taken from the individual STS data sheets.

Application example 1: Performance Level  e cat. 4

Gate A: ZRHB02M

\[ n_{op} = d_{op} \times \text{daily operations} = 220 \frac{d}{a} \times 20 \frac{1}{d} = 4400 \frac{1}{a} \]

\[ \text{MTTF}_{d_{avg}} = \frac{1}{I} \cdot \frac{B_{10d}}{0.1 \times n_{op}} = \frac{2 \times 10^6}{0.1 \times 4400 \frac{1}{a}} = 4545 \frac{a}{1} \]

Gate B / C: M10BA

\[ n_{op} = d_{op} \times \text{daily operations} = 220 \frac{d}{a} \times 5 \frac{1}{d} = 1100 \frac{1}{a} \]

\[ \text{MTTF}_{d_{avg}} = \frac{1}{IV} \cdot \frac{B_{10d}}{0.1 \times n_{op}} = \frac{2 \times 10^6}{0.1 \times 1100 \frac{1}{a}} = 18182 \frac{a}{1} \]

\[ \text{MTTF}_{d_{avg}} = 3030 \frac{a}{1} \]

hence: once the MTTF<sub>d</sub> value has exceeded 100 years, it will be limited to them \( \Rightarrow \text{MTTF}_{d} = 100 \text{ years} = \text{high} \)

conclusion from \([I]\) and \([III]\):

\[ T_{10d} = 0.1 \times \text{MTTF}_{d} \]

Gate A: \( T_{10d} = 0.1 \times 4545 \frac{a}{1} = 455 \frac{a}{1} \)

Gate B / C: \( T_{10d} = 0.1 \times 18182 \frac{a}{1} = 1818 \frac{a}{1} \)

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

Logic an wiring to cat. 4 \([V]\)

\[ \frac{\text{DC}_{avg}}{1} = \frac{98\%}{4545 \frac{a}{1}} + \frac{99\%}{18182 \frac{a}{1}} + \frac{99\%}{18182 \frac{a}{1}} = 98.3\% \]

Attention!

After a complete safety system is designed and calculated a validation according to EN ISO 13849-2 must be 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 MTTFd. 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_{tot} -values (see individual data sheets) n_{tot}, see [II]
MTTF_{d} and T_{10d} -values see [I] and [II],
DC (see DC calculation tables on page 6 and 7)

<table>
<thead>
<tr>
<th>Unit</th>
<th>B_{tot}</th>
<th>n_{tot} [%]</th>
<th>MTTF_{d} [a]</th>
<th>T_{10d} [a]</th>
<th>DC</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZRHVB02M</td>
<td>2 x 10^6</td>
<td>10240</td>
<td>1953</td>
<td>20</td>
<td>88</td>
<td>3</td>
</tr>
<tr>
<td>M10VA</td>
<td>2 x 10^6</td>
<td>10240</td>
<td>1953</td>
<td>20</td>
<td>90</td>
<td>3</td>
</tr>
<tr>
<td>M10VA</td>
<td>2 x 10^6</td>
<td>10240</td>
<td>1953</td>
<td>20</td>
<td>90</td>
<td>3</td>
</tr>
</tbody>
</table>

MTTF_{d} \approx \approx 651 a \Rightarrow\text{limited to} 100 \text{years} = \text{high}
DC_{\text{avg}} = 89.3\% = \text{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 fulfills 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 P1). 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 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_{tot} -values (see individual data sheets) n_{tot}, see [II]
MTTF_{d} and T_{10d} -values see [I] und [II],
DC (see DC calculation tables on page 6 and 7)

<table>
<thead>
<tr>
<th>Unit</th>
<th>B_{tot}</th>
<th>n_{tot} [%]</th>
<th>MTTF_{d} [a]</th>
<th>T_{10d} [a]</th>
<th>DC</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZRH02M</td>
<td>2 x 10^6</td>
<td>1850</td>
<td>10810</td>
<td>20</td>
<td>89</td>
<td>2</td>
</tr>
<tr>
<td>M10BM</td>
<td>2 x 10^6</td>
<td>1800</td>
<td>11111</td>
<td>20</td>
<td>90</td>
<td>2</td>
</tr>
<tr>
<td>M11BM</td>
<td>2 x 10^6</td>
<td>50</td>
<td>399202</td>
<td>20</td>
<td>90</td>
<td>2</td>
</tr>
</tbody>
</table>

MTTF_{d} \approx \approx 1843 a \Rightarrow\text{limited to} 100 \text{years} = \text{high}
DC_{\text{avg}} = 89.1\% = \text{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 fulfills 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
System with 2 danger zones:

- **Area A**: PL "d"
  - Hatch 1 is opened four times and hatch 2 three times a day.
  - Hatch 1 is fixed to the cover in a way that it cannot get loose and cannot break. Hatch 2 is a sliding gate.
  - The access gate is guarded with a M11A unit with CS-actuator.

- **Area B**: PL "c"
  - Area B is fenced and has a double wing safety gate with full body access.
  - The gate is protected by the unit M10VA with a CS-actuator.

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.

**Application example 4: Performance Level c and d combined**

**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 than 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

$MTTF_d$ and $T_{10d}$-values see [I] and [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"**

<table>
<thead>
<tr>
<th>Unit</th>
<th>$B_{10d}$</th>
<th>$n_{10d}$</th>
<th>$MTTF_d$</th>
<th>$T_{10d}$</th>
<th>DC</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>SX04M</td>
<td>$2 \times 10^6$</td>
<td>4290</td>
<td>4662</td>
<td>20</td>
<td>88 %</td>
<td>3</td>
</tr>
<tr>
<td>M11A</td>
<td>$2 \times 10^6$</td>
<td>330</td>
<td>6060</td>
<td>20</td>
<td>90 %</td>
<td>3</td>
</tr>
<tr>
<td>M10A</td>
<td>$2 \times 10^6$</td>
<td>990</td>
<td>15152</td>
<td>20</td>
<td>90 %</td>
<td>3</td>
</tr>
<tr>
<td>M10BA</td>
<td>$2 \times 10^6$</td>
<td>1320</td>
<td>20202</td>
<td>20</td>
<td>99 %</td>
<td>4</td>
</tr>
</tbody>
</table>

$MTTF_d$ avg = 2886 a $\Rightarrow$ limited to 100 years = high

DC avg = 90% = med

Architecture to category 3

**Area B: PL "c"**

<table>
<thead>
<tr>
<th>Unit</th>
<th>$B_{10d}$</th>
<th>$n_{10d}$</th>
<th>$MTTF_d$</th>
<th>$T_{10d}$</th>
<th>DC</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>SX04M</td>
<td>$2 \times 10^6$</td>
<td>4290</td>
<td>4662</td>
<td>20</td>
<td>88 %</td>
<td>3</td>
</tr>
<tr>
<td>M10A</td>
<td>$2 \times 10^6$</td>
<td>1650</td>
<td>12121</td>
<td>20</td>
<td>90 %</td>
<td>2</td>
</tr>
</tbody>
</table>

$MTTF_d$ avg = 3367 a $\Rightarrow$ 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

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 centrallywitched off where the lowest PL is, = 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 10⁶ switching cycles  DC 0%
M20L1-Px-xxx B 10d : 2 x 10⁶ switching cycles  DC 0%
M30L1-Px-xxx B 10d : 2 x 10⁶ switching cycles  DC 0%
M40L1-Px-xxx B 10d : 2 x 10⁶ switching cycles  DC 0%
M50L1-Px-xxx B 10d : 2 x 10⁶ 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 10⁶ switching cycles  DC 99 %
SAFEMASTER STS Power Interlocking

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 \times 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 \times 10^6 switching cycles  DC 99 %
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a,b,c,d,e</td>
<td>Designations for the Performance Levels</td>
</tr>
</tbody>
</table>
| RC           | RequirementClass 
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_{\text{lost}} | Number of cycles until 10 % of the components have dangerously failed (for pneumatic and electromechanical compo- nents). [EN ISO 12100-1] |
| CCF          | Common Cause Failure 
Failures of various units due to a single event in which the failures are not based on mutual cause. |
| DC           | Diagnostic Coverage 
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          | Failure In Time 
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: λ = 1/10^9 h, i.e. once in approx. 114,000 years. |
| 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_{\text{d}} | Mean Time To Failure dangerous 
Expected value of the mean time to dangerous failure. |
| PL           | Performance Level 
Discrete level for safety-related performance. PL"a" is the lowest, PL"e" the highest level [DIN EN ISO 13849]. |
| PFD          | Probability of Failure on Demand or mean probability that the safety function is not executed on demand. |
| PFH_{\text{d}} | Probability of Failure dangerous per Hour 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          | Safe Failure Fraction 
Portion of non-hazardous failures |
| SIL          | Safety Integrity Level. 
The 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          | Schlüssel-Transfer-System (= 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 |
EC Declaration of Conformity

EG-Konformitätserklärung
Déclaration de conformité européenne

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

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

Produktbeschreibung: Modular aufgebaute Produktxreihe von Schaltern, elektromechanischen Zuhaltnngen 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: 2004/108/EG
EMC-Directive: / Directives-CEM:
Maschinenrichtlinie: 2006/42/EG
Machinery directive: / Directives Machines:

Prüfgrundlagen:
Basis of Testing / Lignes de contrôle:
EN ISO 13849-1:2008 + AC2009
EN ISO 13849-2:2012
GS-ET 15:2011
GS-ET 19:2011
GS-ET 31:2010

Die Übereinstimmung eines Baumusters des bezeichneten Produktes mit der oben genannten Maschinenrichtlinie 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:

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein
51105 Köln / Germany
Tel.: +49 221 806 0
Internet: www.fs-products.com
email: IS@de.tuv.com

Nummer der Bescheinigung:
Certification number / Numéro de certificat:
Nr./No.: 968/EZ 382.01/14 Ausstelldatum: 04.12.2014
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
Name und Unterschrift / Nom et signature

Stefan Cavic
Entwicklungsleiter
Development Manager / Responsable de développement
Name und Unterschrift / Nom et signature

E. Dold & Söhne KG
Bregstraße 18
78120 Furtwangen

Diese Original-Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zurückweisung 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

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

<table>
<thead>
<tr>
<th>Prüfgegenstand</th>
<th>Sicherheitsschalter- und Schlüsseltransfersystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product tested</td>
<td>Safety Switch and Trapped Key System</td>
</tr>
<tr>
<td>Zertifikatsinhaber</td>
<td>E. Dold &amp; Söhne KG</td>
</tr>
<tr>
<td>Certificate holder</td>
<td>Bregstraße 18</td>
</tr>
<tr>
<td></td>
<td>78120 Furtwangen</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
</tr>
<tr>
<td>Typbezeichnung / Type designation</td>
<td>SAFEMASTER STS, SAFEMASTER STS/K</td>
</tr>
<tr>
<td></td>
<td>EN ISO 13849-2:2012</td>
</tr>
<tr>
<td></td>
<td>ISO 14119:2013</td>
</tr>
<tr>
<td>Bestimmungsgemäß / Intended application</td>
<td>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 fulfills 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.</td>
</tr>
<tr>
<td>Besondere Bedingungen / Specific requirements</td>
<td>Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sind zu beachten. The instructions of the associated Installation and Operating Manual shall be considered.</td>
</tr>
<tr>
<td>Gültig bis / Valid until</td>
<td>2020-09-18</td>
</tr>
<tr>
<td>Ausstellung / Issuance</td>
<td>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 unabhängig von 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.</td>
</tr>
</tbody>
</table>

Certification Body for Machinery, NB 0035

Dipl.-Ing. Eberhard Frejno

www.fs-products.com
www.tuv.com
Certificate

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

Client Reference: Frank Arthur Aartsen

Certified Product: Safety Switch- and Key Interlock System
Listing Category: Industrial Control Equipment

Model Designation:
Safemaster STS: STS-A, STS-B, STS-K, STS-D, STS-E,
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

Appendix: 1

Licensed Test mark:  TÜV Rheinland

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

TÜV Rheinland of North America, Inc., 12 Commerce Road, Newtown, CT 06470, Tel (203) 426-4888 Fax (203) 426-4308
Certificate

Certificate no.  

CU 72150143 02

License Holder:  
E. Dold & Söhne KG  
Wreggstrasse 18  
78120 Pfurtwang  
Germany

Manufacturing Plant:  
E. Dold & Söhne KG  
Wreggstrasse 18  
78120 Pfurtwang  
Germany

Test report no.:  
USA-DS 31580140 001

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

Client Reference:  
Frank Arthur Aartsen

Certified Product:  Safety Switch- and Key Interlock System

Listing Category:  Industrial Control Equipment

Rated Voltage:  AC/DC 24V

Rated Power:  6W

Operating Temperature:  -25°C to 60°C

Licensed Test mark:  

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

TÜV Rheinland of North America, Inc. 12 Commerce Road, Newtown, CT 06470, Tel (203) 420-0000 Fax (203) 420-4009

www.dold.com
Our experience. Your safety.

The right solution for every application

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 your 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 handheld transmitter and an optional infrared receiver.

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.