

Safety-related controls SIRIUS Safety Integrated

Protective door monitoring with automatic start
up to SIL 3 acc. to IEC 62061 and
PL e acc. to ISO 13849-1
with/without operational switching
with a SIRIUS 3TK28 safety relay
with contactor relays

safety
INTEGRATED

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Comments

"Safety Integrated" Functional Examples are functional, tested automation configurations based on A&D standard products for the simple, quick and low-cost performance of automation tasks involving safety technology. Each of these Functional Examples covers one frequently occurring aspect of a typical customer problem in the field of safety technology.

In addition to containing a list of all of the necessary software and hardware components, and a description of their interwiring, the Functional Examples also contain tested and commented code. This enables the functions described here to be adapted quickly and thus used as a basis for individual extensions.

Important note

The Safety Functional Examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The Safety Functional Examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible in ensuring that the described products are correctly used.

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1 Guarantee, Liability and Support

We do not accept any liability for the information contained in this document.

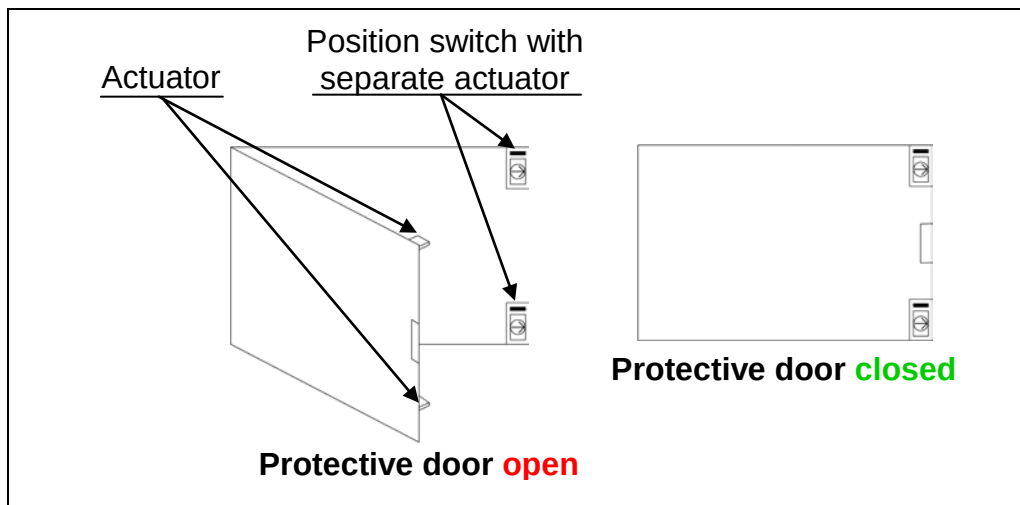
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2 Function

2.1 Description of Functionality

This Safety Functional Example describes a mechanically isolating protective mechanism in the form of a protective door. The most frequently used solution for plants and machines to secure hazardous areas is mechanically isolating protective equipment or access hatches. In this case, the function is to monitor unauthorized entry into plant and system areas as well as to prevent potentially hazardous machine functions if the protective equipment - in this case protective door - is not closed.



The protective door is monitored by two SIRIUS position switches with positively-opening contacts using a SIRIUS 3TK28 safety relay with contactor relays. This setup is applicable up to SIL 3 according to IEC 62061 and PL e according to ISO 13849-1.

If this protective door is opened, the safety relay shuts down via its contactor relays with positively-opening contacts according to Stop Category 0 in compliance with EN 60204. If the protective door is closed and after the position switch and the contactors of the safety relay are checked, the drive automatically starts. It is possible to operationally switch (on/off) the contactors. Either a floating (electrically isolated) contact is connected between terminal 3 and terminal 4 or a non-floating (non-electrically isolated) output (24 V DC) - e.g. from a standard PLC - at terminal 4. The operational switching has a lower priority than the safety function. If the operational switching is no longer required, a wire link (jumper) should be connected between terminal 3 and terminal 4 (refer to Point 3.2).

Note

Position switches must be arranged such that they cannot be damaged by being hit or run over. Therefore, they must not be used as mechanical stops.

2.2 Advantages / Customer Benefits

- Pure hardware engineering without having to configure/program software
- Little wiring is required and it is simple
- Space-saving design using compact safety relay
- Can be simply expanded using expansion devices

3 Components Required

Hardware components

Table 3-1

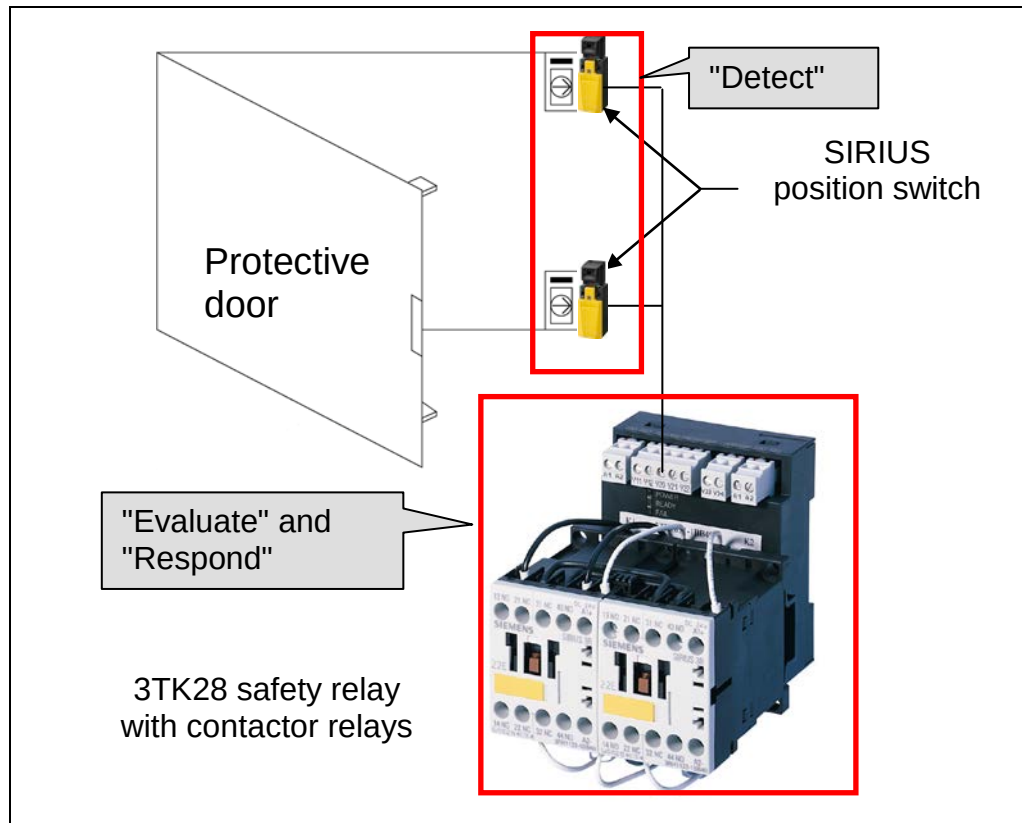
Hardware components Component	Type	Order No. / Order Information	Qty.	Manufacturer
SIRIUS position switch	Position switch with separate actuator	3SE5 232-0RV40	2	SIEMENS
Actuator for position switch	Radius actuator	3SE5 000-0AV05	2	
3TK28 safety relay with contactor relays	3TK28	3TK2853-1BB40	1	

Note

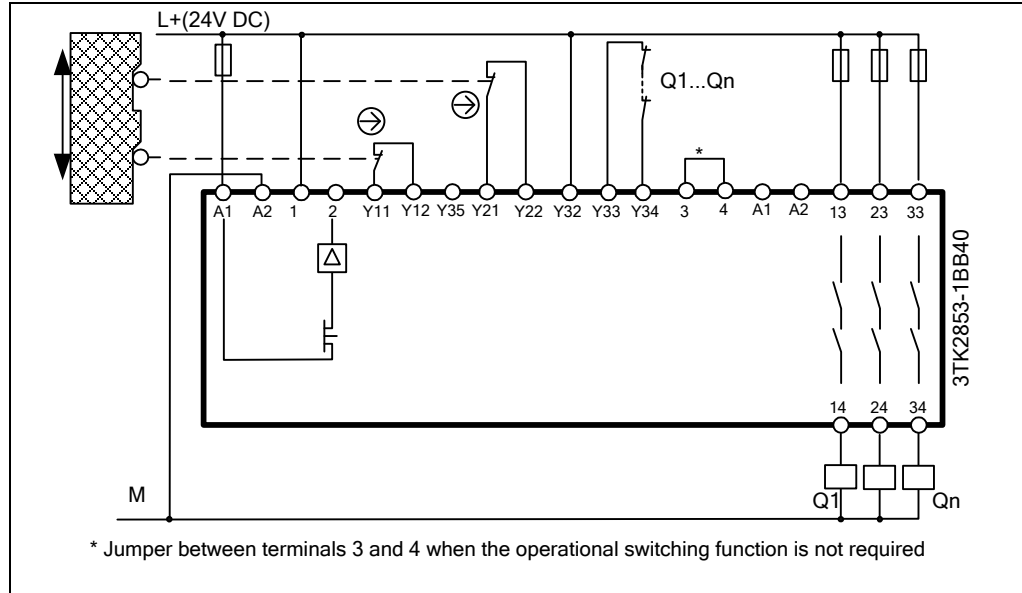
Functionality was tested with the specified hardware components. Similar products not found in this list may also be used (e.g. a different safety relay 3TK28). If this is the case, please consider that changes to the wiring of the hardware components (e.g. different terminal assignment) might be required.

4 Structure and wiring

4.1 Overview of Hardware Setup



4.2 Connecting-up the hardware components



5 Evaluation according to IEC 62061 and ISO 13849-1:2006

5.1 Safety Function

Safety function

Further considerations are based on the following safety function:

Safety function	
SF 1	The motor must be switched off when the protective door is opened.

The safety function listed above is evaluated below according to the two standards IEC 62061 and ISO 13849-1:2006.

5.2 Evaluation according to IEC 62061

Parameters for the calculation of PFH_D for emergency stop and contactor

Parameter	Value	Reason	Definition
B10 Position switches Contactor	$1 * 10^6$ $1 * 10^6$	Manufacturer specifications	Siemens
Proportion of hazardous failures Position switches Contactor	0.2 0.73	Manufacturer specifications (20%) (73%)	
T1 Service life	175,200h (20 years)	Manufacturer specifications	
C Number of actuations of position switch Number of operations of contactors	0.125/h 0.125/h	Assumptions: Actuated once per shift, i.e. every 8 hours. Actuation takes place every day of the year (365 days).	User
T2 Diagnostics test interval position switches Diagnostics test interval contactor	8h 8h	When the protective door is opened, a defective contact is detected in the 3TK. An actuation takes place once per shift, i.e. every 8 hours (see "C"). When actuated, a defective contactor is detected in the 3TK. An actuation takes place once per shift, i.e. every 8 hours (see "C").	
β (CCF Factor) Proneness toward failures as a result of common cause	0.1	If installed according to IEC 62061, a CCF factor of 0.1 (10%) can be assumed. With this value the user plays it safe ("conservative value").	
DC Degree of diagnostic coverage	0.99 (99%)	Discrepancy evaluation for position switches; Evaluation of read-back signals (positively-driven contacts) of both contactors.	

Evaluation parameter

Parameter	Component	Value	Definition
PFH_D (3TK)	3TK2853	$1,08 * 10^{-08}$	Siemens

Results

IEC 62061				
	SILCL		PFH_D	
Detect	3	Hardware error tolerance: HFT = 1 Proportion of safe failures: SFF ≥ 0.99 (99%)	$2.50 * 10^{-10}$	Architecture: Basic sub-system architecture D
Evaluate	3	Manufacturer specifications	$1.08 * 10^{-08}$	Manufacturer specifications
Respond	3	Hardware error tolerance: HFT = 1 Proportion of safe failures: SFF ≥ 0.99 (99%)	$9.12 * 10^{-10}$	Architecture: Basic sub-system architecture D
Results	3	SILCL of all tasks of the supplementary safety function is at least 3. PFH_D ($= 1.19 * 10^{-08}$) of the entire supplementary safety function fulfills SIL 3.		

5.3 Evaluation according to ISO 13849-1:2006

Parameters for the calculation of $MTTF_d$ for emergency stop and contactor

Parameter	Value	Reason	Definition
B10 - B10 value position switch B10 value contactor	$1 \cdot 10^6$ $1 \cdot 10^6$	Manufacturer specifications	Siemens
Proportion of hazardous failures Position switches Contactor	0.2 0.73	Manufacturer specifications	
d_{op} Mean operating time in days per year	365 days per year	Assumption: Actuation takes place every day of the year.	User
h_{op} Mean operating time in hours per day	24 hours per day		
T_{Cycle} Mean time between the start of two consecutive cycles of the component Position switches	8 h/Cycle	Assumption: There is an interval of 8 hours (one shift) between each protective door opening/contactor actuation.	
Contactor	8 h/Cycle		

Interim results (are identical in this example for position switch and contactor):

Interim results		Reason
$MTTF_d$	High	$MTTF_d \geq 30$ years
DC	High	DC=99% discrepancy evaluation/evaluation of read-back signals (positively-driven contacts) in the 3TK
Measures against CCF	Fulfilled	It is assumed that the necessary measures are taken by the user.
Category	4	System behavior: A single fault does not cause the loss of the safety function. The single fault is detected. $MTTF_d$ =high; DC=high; measures against CCF fulfilled

Evaluation parameter

Parameter	Component	Value	Definition
PFH_D (3TK)	3TK2853	$1,08 * 10^{-08}$	Siemens

Results

ISO 13849-1:2006		
	PL	PFH_D
Detect	e	$2.47 * 10^{-08}$ (from Annex K; see note)
Evaluate	e	$1,08 * 10^{-08}$
Respond	e	$2.47 * 10^{-08}$ (from Annex K; see note)
Results	e	PL of all tasks of the supplementary safety function is at least e. Number of tasks is less than or equal to 3.

Note: The $MTTF_d$ for each channel is limited to max. 100 years!

5.4 Summary

	IEC 62061		ISO 13849-1:2006	
	SILCL	PFH _D	PL	PFH _D
Detect	3	$2.50 * 10^{-10}$	e	$2.47 * 10^{-08}$
Evaluate	3	$1,08 * 10^{-08}$	e	$1,08 * 10^{-08}$
Respond	3	$9.12 * 10^{-10}$	e	$2.47 * 10^{-08}$

Results	SIL 3	PL e
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6 Contacts

Technical Assistance for Low-Voltage Controls and Distribution

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e-mail: technical-assistance@siemens.com

Internet: www.siemens.com/automation/support-request

By fax around the clock

Fax: +49 (911)-895-5907

7 History

Table 7-1 History

Version	Date	Change
V1.0	02.06.2005	First issue
V2.0	30.04.2008	<ul style="list-style-type: none">- Update of the position switch order numbers- Revision of the hardware configuration overview- New chapter: Evaluation according to IEC 62061 and ISO 13849-1
V3.0	13.09.2013	<ul style="list-style-type: none">- Revision of title and description of functionality- Adjustment of Proportion of hazardous failures for contactors to 73% and resulting PFH_D values- Adjustment of PFH_D value of 3TK2853 to $1.08 \cdot 10^{-08}$