

Perimeter Guarding with Embedded Safety Module

Guard switch / Contactor

Cat.4 PL e, SIL 3 / Stop Category 0



Function:

- Safety-related stop function initiated by the moveable guards designed to protect the access to a hazardous zone.
- The opening of each guard is detected by using two limit switches in combination mode (positive mode + negative mode), which are checked by the safety module allowing detection of the opening or the removal of the protective guard.
- Opening of any of these guards causes the deactivation of the safety module outputs (stop category 0 according to EN/IEC 60204-1), which results in a switch-off of the motor power supply to prevent possible hazardous movements or states by means of the contactors (K3 and K4).
- The main contactors are monitored by the safety module to detect e.g. contact welding, by means of their mirror contacts.

Typical applications:

Assembling, textile, printing or similar machines where the access to the hazardous area is limited to maintenance interventions.



Design:

- The safety function employs well-tried safety principles and is robust in the event of one component failure by means of two contactors (K3 & K4) and two limit switches on a guard (S1 & S2).
- Two different limit switches are used for diversity reasons to increase CFF evaluation.
- A contactor fault is detected by the safety module at the next demand of the safety function by the restart interlock pushbutton.
- The start button (S3) must be located outside the hazardous area and at a point from which the potential danger is visible.
- The limit switches (S1 & S2) have direct opening action in accordance with EN/IEC 60947-5-1 and are regarded as well-tried components.
- The safety module fulfills the requirements up to performance level PL e according to EN ISO 13849-1 and SILCL 3 according to EN/IEC 62061.
- The contactors (K3 and K4) have mirror contacts in accordance with EN/IEC 60947-4-1, meaning that the normally closed auxiliary contacts cannot be in the closed state unless the main

Perimeter Guarding with Embedded Safety Module

poles are open. They are also considered as well-ried components.

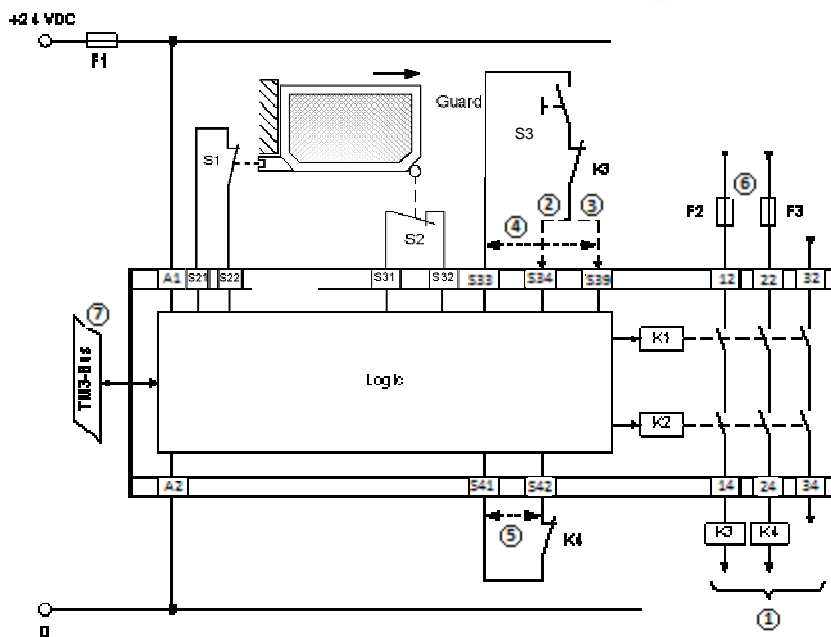
- Protection against overcurrent must be provided in accordance with EN/IEC 60947-4-1.
- The module TM3SAK6R(G) provides the synchronization time monitoring of the two inputs.

Safety Chain Products:

- Safety switches - [Preventa XCSA and XCSM](#)
- Safety Module - [Modicon TM3SAK6R\(G\)](#)
- Contactor - [TeSys D](#)

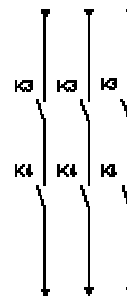
Related Products:

- Switches, pushbuttons, emergency stop - [Harmony XB4](#)
- Switch mode Power supply - [Phaseo ABL8](#)
- Modular beacon and tower light - [Harmony XVB](#)



SCS18/0514D

switch 1
switch 2



by outputs
tored start
monitored start
matic start, when
9 shorted
DM channel, to be
l if not used
use ratings see data

safe Bus

Perimeter Guarding with Embedded Safety Module

Chain structure:

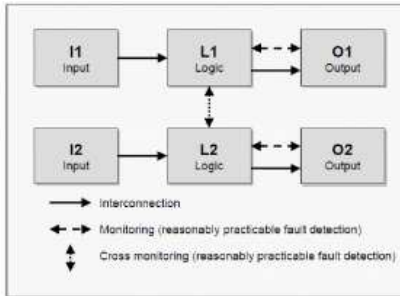


Figure 1

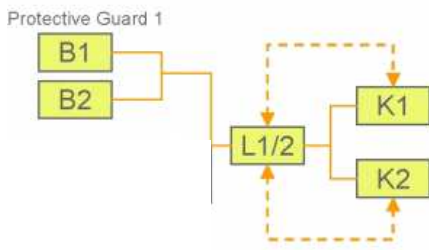


Figure 2

- The circuit diagram SCS18/0514D is a conceptual schematic diagram and is limited to present the safety function with only the relevant safety components.
- For the designated architecture of category 3, two redundant channels are implemented.
- The circuit arrangement can be divided into three function blocks per channel with the input (I), logic (L) and output (O) blocks on each channel.
- The possibility of fault detection by monitoring the outputs is indicated by the broken lines (see figure 1).
- Since each protective guard forms part of a dedicated safety function, the calculation of the performance level considers only one of them.
- The functional channel can be represented by a single protective guard actuating two limit switches (i.e. S1 and S2) that would correspond to the input (see figure 2).
- The safety module (TM3SAK6R(G)) corresponds to the logic block (L1/L2), which maintains the internal redundancy of the safety circuits required for this architecture.
- The output block is represented by two redundant contactors (K3 and K4) that are monitored by the logic block (safety module) to detect any failure.
- The complete wiring must be in accordance to EN 60204-1 and the necessary means to avoid short circuits has to be provided (EN ISO 13849-2 Table D.4).

Cycle time (s)	60
Number of hours' operation per day	12
Number of days' operation per year	220
Number of operations per year	158400

		Values	
		Channel 1	Channel 2
Input device XCSA / XCSM	PL	e	
	Category	4	
	MTTF _d resulting (years)	100	100
	DC _{avg}	95%	95%
	CCF	65	65
	PFH _d resulting (1/h)	3,28E-08	
Logic TM3SAK6R(G)	PL	e	
	Category	3	
	PFH _d resulting (1/h)	5,00E-09	
Output TeSys D	PL	e	
	Category	4	
	MTTF _d resulting (years)	100	100
	DC _{avg}	99%	99%
	CCF	65	65
	PFH _d resulting (1/h)	2,47E-08	
Safety function	PL attained	e	
	PFH _d resulting (1/h)	6,25E-08	

Safety level calculation:

- A required performance level (PL_r) must be specified for each intended safety function following a risk evaluation. The performance level (PL) attained by the control system must be validated by verifying if it is greater than or equal to the PL_r.
- At 220 working days per year, 12 working hours per day and a cycle time of 1 minutes, the number of operations (n_{op}) would be 158 400.
- Mean time to dangerous failure (MTTF_d) values exceeding 100 years will be limited to this value in order for the component reliability not to be overstated in comparison with the other main influencing variables such as the architecture or tests.
- A B10_d value of 50 000 000 cycles (XCSM) and 5 000 000 cycles (XCSA) is stated for the mechanical aspects of B1 and B2. In accordance with the assumed n_{op} value, the MTTF_d would be 286,96 years for both components.

Perimeter Guarding with Embedded Safety Module

ENVIRONMENTAL CONDITIONS	Guard switch Preventa XC5M and XC5A	Safety module TM3SAK6R/G and Contactor - TeSys D inside a cabinet
General		
Degree of protection according to IEC/EN 60529	IP66	
Terminals:		IP 20
Enclosure:		IP 20
Ambient operating temperature (horizontal installation)	-25...70 °C	- 10...+55 °C (+ 14...+ 130 °F)
For use in max. height above sea of		2000 m (6560 ft)
Storage temperature	-40...70 °C	- 40...+70 °C (- 40...+158 °F)
For storage in max. relative humidity of		95 % non condensing
For storage in height above sea level of		0..3000 m (0...9842 ft)
Overvoltage category		III (4 kV)
Pollution degree		2
Rated insulation voltage according to IEC/EN 60664-1		~ 300 V
Supply		
Supply voltage		SELV/PELV c 24 V – 15/ +20 %
Max. protection		4 A fuse gG
Rated power		
Bus 5 VDC		0.2 W
External Supply 24 VDC		2.4 W
Output circuit		
Max. current per output path		6:00 A
The sum of simultaneous currents on all of the outputs is limited to		$\Sigma I_{th} \leq 18 \text{ A}$
Protection of outputs		max.: 4 A fuse gG or 6 A fast blow
Maximum switching capacity of outputs		
AC-15		~ 230 V, 5 A
DC-13		24 VDC, 4 A

- These values are therefore limited to 100 years ("high").
- A PFH_d value of 5×10^{-9} is stated for the safety module (TM3AK6R(G)). This value comes directly from the safety device data and it is certified by an accepted standards body.
- For the redundant contactors K3 and K4, the B10 value corresponds under low mechanical load to an electrical lifetime of 10 000 000 switching cycles. If 50% of failures are assumed to be dangerous, the B10_d value is 20 000 000 operations. With the assumed value for n_{op}, it results in a MTTF_d of 1262,6 years for each component. These values are therefore limited to 100 years ("high").
- Measures against common cause failures (Annex F of EN ISO 13849-1) must attain at least 65 points (i.e. separation (15), overvoltage protection etc. (15) and environmental conditions (25+10)).
- The safety-related control system corresponds to category 3 with high MTTF_d. The complete functional safety chain results in average probability of dangerous failure (PFH_d) of 6.25×10^{-8} .
- This corresponds to PL e and SIL 3.

ATTENTION

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