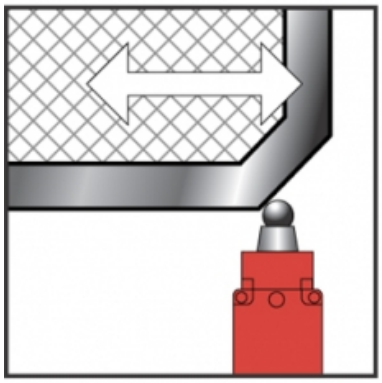
Safety Chain Solution – Motor starter

PL c, SIL 1

Simplicity and efficiency made by well-tried components



Function:

- Stop function initiated by a moveable protective guard.
- Opening of this guard is detected by a guard switch, which interrupts the control voltage of the motor starter (stop category 0 according to EN/IEC 60204-1) to help prevent possible hazardous movements.
- The break contact of this guard switch interrupts the control circuit directly when the protective guard is not in the safe position.
- The motor is also de-energized when either of the emergency stop devices (S1 or S2) are actuated.(*)
- The safety function is fully dependent upon the reliability of the components.

(*) The emergency stopping function is a protective measure which complements the safety functions for the safeguarding of hazardous zones in accordance with EN ISO 12100-2

Typical applications:

- Machine-tools or similar machines with low inertia (no rundown time), where the access to the hazardous area is limited to maintenance interventions.

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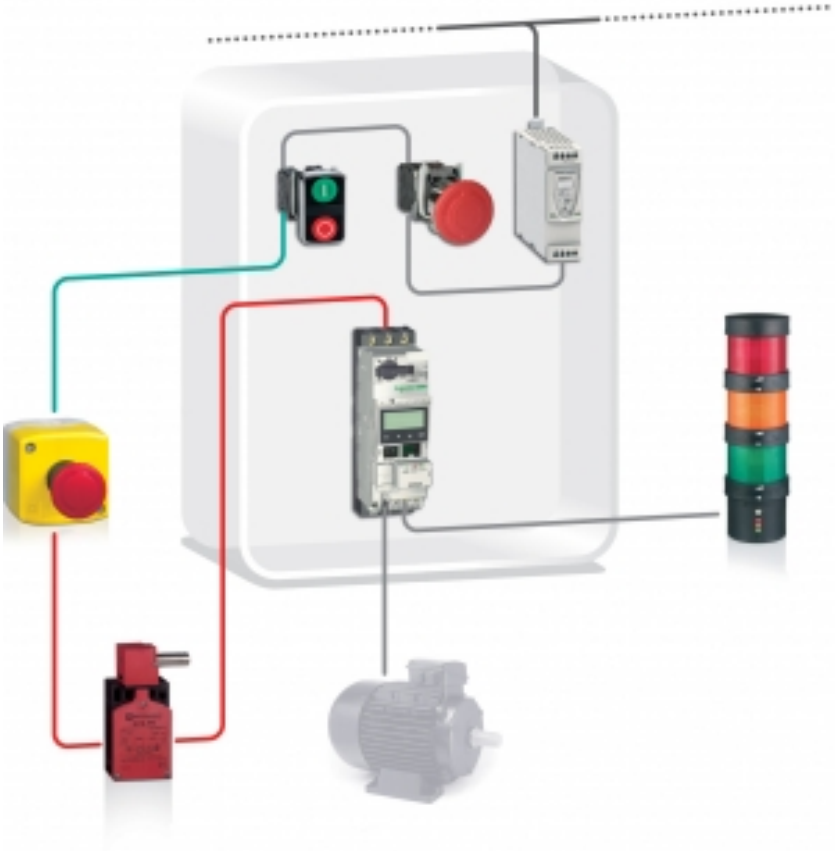
Design:

- The safety function is designed with the use of well-tried components and safety principles to help minimize or exclude failures and thus to reduce the probability of faults.
- The emergency stop devices are designed according to EN ISO 13850 and are considered well-tried components as well as having direct opening operation in accordance with EN/IEC 60947-5-5.
- The guard switch B1 is an electromechanical component with direct opening action in accordance with EN/IEC 60947-5-1 and is also regarded as a well-tried component.
- Only rigid mechanical parts (no spring elements between actuator and contact) are employed in the switch mechanism.
- The motor starter provides total coordination (continuity of service) of the overload protection devices conforming to EN/IEC 60947-6-2 in case of a short-circuit.
- The maximum overcurrent is limited by the motor starter in accordance with EN/IEC 60947-4-1.
- The contactor (K1) is also considered as a well-tried component.

Related products

- Switches, pushbuttons, emergency stop - Harmony XB4
- Emergency stop function - Harmony XALK
- Switch mode Power supply - Phaseo ABL8
- Motor starter - TeSys U
- Safety Guard switches - Preventa XCS
- Modular beacon and tower lights - Harmony XVB



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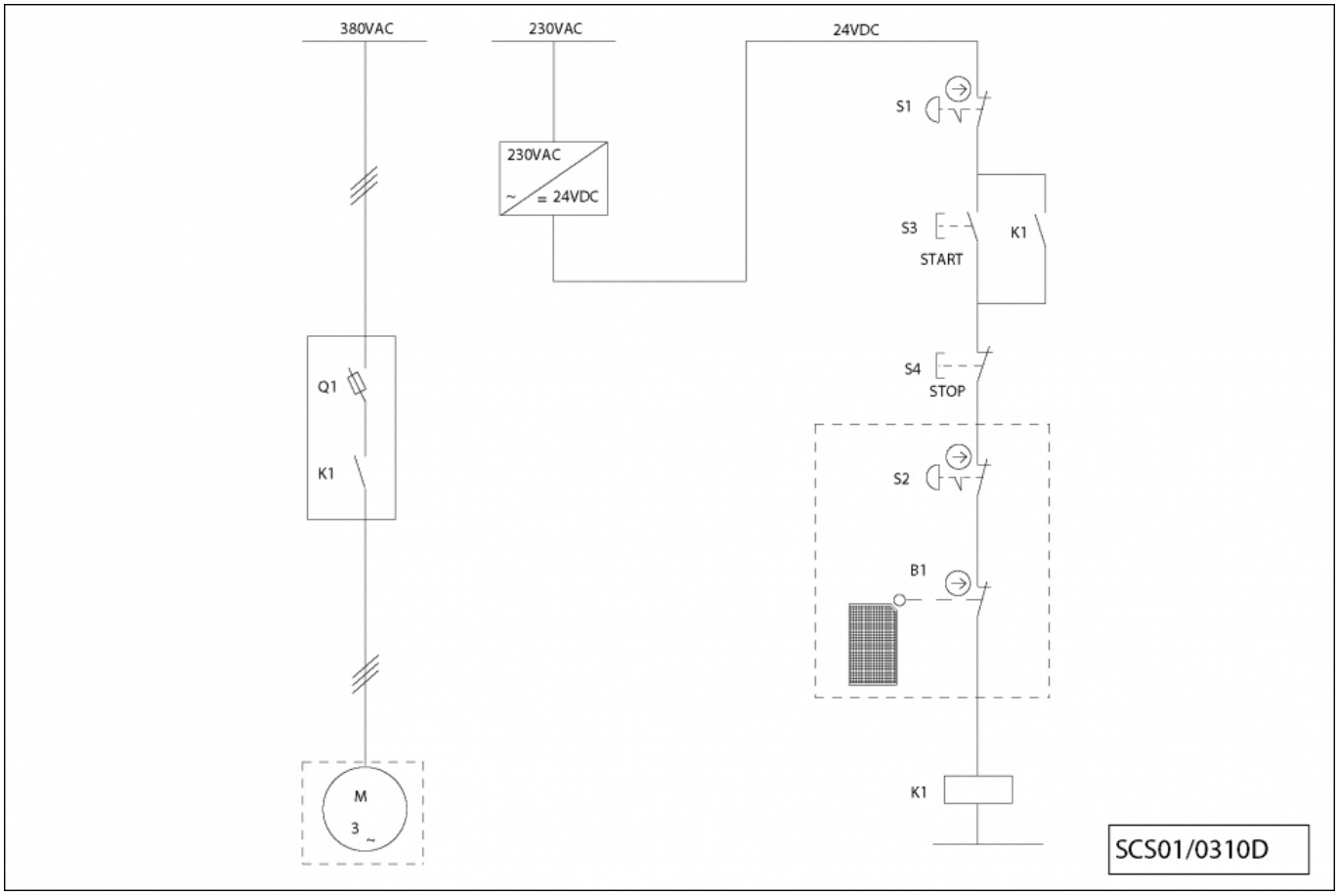

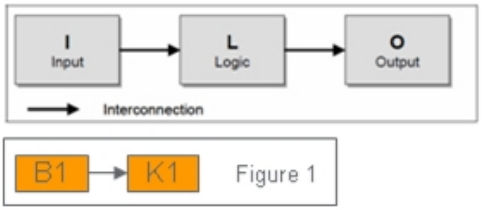

Chain structure:

- The circuit diagram SCS01/0310D is a conceptual schematic diagram and is presented to illustrate the safety function with only the relevant safety components shown.
- The designated architecture for category 1 corresponds to a single channel system with input (I), logic (L) and output (O) blocks.
- In this case the guard switch B1 corresponds to the input and the contactor K1 to the output following a very simple structure (see figure 1).
- The logic block is considered to be performed by the wiring diagram.
- The complete wiring must be in accordance with EN 60204-1 and measures to avoid short circuits have to be provided (EN ISO 13849-2 Table D.4).

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Cycle time (s)	1800
Number of hours' operation per day (h)	12
Number of days' operation per year	220
Number of operations per year (n_{op})	5280

		Values
Input devices XCS	B10 (operations)	1 000 000
	% dangerous failure	20
	$B10_d$ (operations)	5 000 000
	$T10_d$ (years)	947
	$MTTF_d$ (years)	9469.7
	$MTTF_d$ resulting (years)	100
	PFH_d resulting (1/h)	1.14×10^{-5}
	DC (%)	0
Output (actuator) LC1	B10 (operations)	1 000 000
	% dangerous failure	73
	$B10_d$ (operations)	1 369 863
	$T10_d$ (years)	259
	$MTTF_d$ (years)	2594.4
	$MTTF_d$ resulting (years)	100
	PFH_d resulting (1/h)	1.14×10^{-5}
	DC (%)	0
Safety function	$MTTF_{dC}$	**50 (high)**
	DC_{avg}	-
	PFH_d resulting (1/h)	**2.28×10^{-6}**
	PL attained	**c**
	SIL attained	**1**

Safety level calculation:

- A required performance level (PLr) 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 PLr.
- A fault exclusion is assumed for the emergency stop devices in accordance with EN ISO 13849-2, since the maximum number of switching cycles of these devices is not exceeded within the mission time (20 years).
- At 220 working days by year, 12 working hours per day and a cycle time of 30 minutes, the number of operations (nop) would be 5 280.
- An MTTFd value of each channel greater than 100 years is not acceptable because SRP/CS for high risks should not depend on the reliability of components alone.
- Mean time to dangerous failure (MTTFd) 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.
- A B10d value of 5 000 000 cycles is stated for B1. In accordance with the assumed nop value, the MTTFd would be 9469 years for this component.
- For contactor (K1), the B10 value corresponds under nominal load to an electrical lifetime of 1 000 000 switching cycles. If 73% of failures are assumed to be dangerous, the B10d values is 1 369 863 operations. With the assumed value for nop, this results in a MTTFd of 2594.4 years for K1. This value is therefore limited to 100 years ("high").
- The combination of B1 and K1 results in a MTTFd of 50 years (high) for the total chain.
- DCavg and measures against common cause failures are not considered in category 1.
- The operation time before replacement (T10d) of these components is longer than the mission time in this application (20 years recommended).
- The complete electromechanical control system corresponds to Category 1 with high MTTFd. This results in an average probability of dangerous failure (PFHd) of 2.28×10^{-6} per hour. This value corresponds to PL c and SIL 1.

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