Integral Safety Relay ISR

Option X107 (single channel)

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1. Product description

1.1. Definition of applied Standard

Applied standard: EN ISO 13849-1:2006

Explanation of the term 'Performance Level PL'

Safety functions of an electrical system can be done according to several so-called safety classes, starting from simple switch-based solutions up to complex and self-monitoring safety systems. The 'Performance Level 'PL' is an indicator specifying how extensively the safety-related parts of a system are performing the task. The most important factors for the PL are:

- Reliability of the used parts within the safety system (**MTTFd**)
- Ability of the system for self-monitoring (**DC_{ave}**)
- Architecture of the safety system

The reliability of used parts is defined by the parameter MTTFd and refers to the conditional probability of failure of the used parts inside each of the respective safety channels. According to the type and number of parts, a number of years can be calculated.

- For 3 years < MTTFd < 10 **years**, MTTFd is 'low`
- For 10 years < MTTFd < 30 years, MTTFd is 'fair'
- For 30 years < MTTFd < 100 years MTTFd is 'high'

The capability of the safety system to detect malfunctions within the safety system itself is expressed by the parameter DCave. This number is expressed by the %-ratio of:

- number of identified failures which led to an ordinary shut down, to:
- number of all failures, including these not being identified by the system

This ratio, expressed in %, has the following meaning:

- DC < 60% means DCave = Null;
  (System detects own malfunctions only occasionally)
- 60% < DC < 90% means DCave =' low'
- 90% < DC < 99% means DCave = 'fair'
- DC > 99% means DCave = 'high'
  (system detects own malfunctions completely and safely)

The term is derived from the category of the safety system and relates to the type of electro-mechanical/electronic architecture of the safety system. For more details please refer to the regulations EN ISO 13849-1:2006.

If the above explained three terms are given, the Performance Level PL can be determined out of the following Fig 1.

As an example: A safety system uses a circuit defined as **Cat 2**. The MTTFd was calculated as to be 20 years -> **MTTFd** = 'fair' and DC = 75% -> **DC_{ave}** = 'low'.

The small triangle within Fig. 1 shows the rating of the system as to be **PL c.**

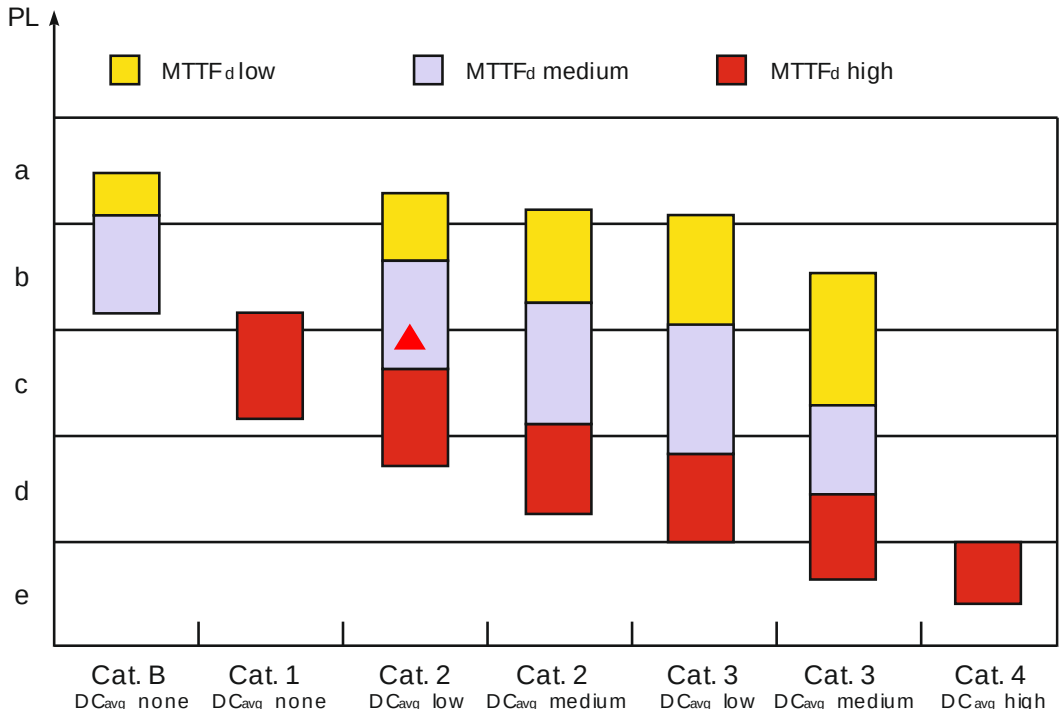

Fig. 1 Relationship between **DC_{ave}**, MTTFd and Performance Level PL

Legende	
PL	**P**erformance **L**evel
$MTTF_d$	**M**ean **T**ime **t**o **d**angerous **f**ailure
DC_{avg}	**av**erag**e** **D**iagnostic **C**overage
Cat.	**Cat**egory

Tab. 1 Legend of Fig. 1

1.2. General function

TopCon High power supplies TC.P and TC.GSS may be equipped with the Integral Safety Relay option ISR. Fitted with ‘restraint driven contacts’, ISR is connected to external safety switch elements providing safe concepts for emergency shut-down of the power supply or system.

As an important feature, ISR is acting directly on the alimentation of the power conversion stages and blocks therefore any energy flow in an emergency case.

Integration of the ISR option is done at the time point of initial manufacturing. A later integration is possible but needs the unit to be returned to the factory.

Function of ISR in a single power supply

ISR is to be connected to the external ‘safety switch loop’ via the X107 interface. If the external loop is opened, the DC-output of the power supply is powered down immediately. In the case of a TC.GSS (bidirectional power supply), the DC output as also the AC input stage are blocked in the same manner. (See also chapters 1.3 and 1.4)

Please note, that an ‘X107 Dummy plug’ has to be plugged onto the X107 interface if the external safety loop is not connected. (See chapter 2.2 for details)

Function of ISR in a multi-unit power supply system

A multi-unit power supply system may also be equipped with an external safety shutdown loop, using the individual X107 interfaces. Note that all respective units have to be equipped with the ISR option. Breaking the external loop or any fault condition of an individual power supply will immediately shut down the entire system. (Refer to the application examples in chapter 3)

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The above stated principle of operation is valid for TopCon TC.P. unidirectional power supplies as also for the TC.GSS bidirectional series.

1.3. The function of TopCon TC.P devices

The ISR safety relay breaks the low voltage power supply for the primary H-bridge circuit in an independent way. By this, power semiconductors are no longer working and therefore the power transformer is unable to convert energy to the secondary. Because the relay disposes of restraint-driven signal contacts, the state of the relay is routed to the interface X107 in a redundant way.

Refer to the functional block diagram depicted in Fig. 2 for details.

This safety architecture allows for a Performance Level of PL c.

Performance level vs. operation mode	
Quadrant 1- (Source mode)	**PL c**

Tab. 2 Performance level vs. Operation mode.

Applicationexamples	
Single safety loop	See chapter 3.1, on page 10.
Double safety loop	See chapter 3.2, on page 11.
With ext. Safety building block, double loop	See chapter 3.3, on page 12

Tab. 3 Application variants of safety system.

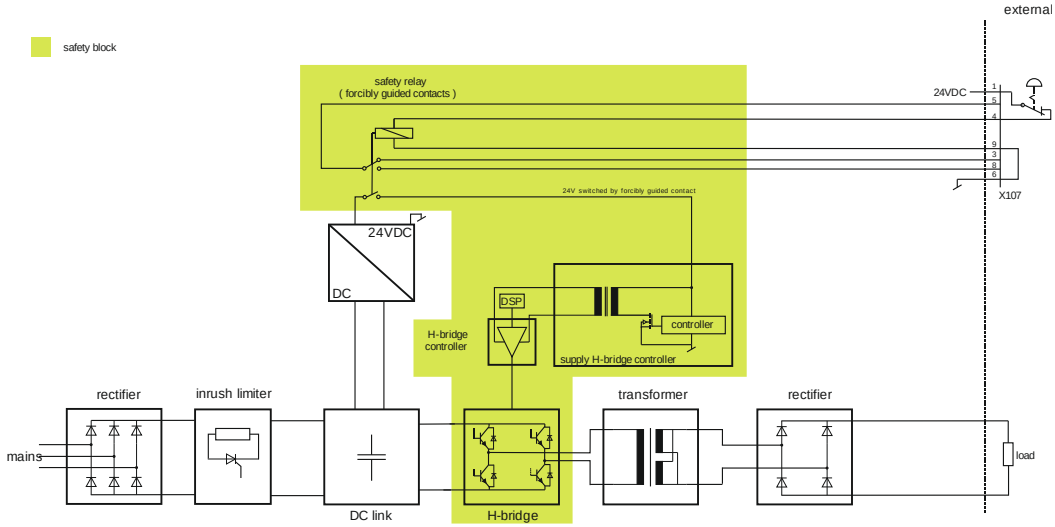

Fig. 2 Functional block diagram of ISR feature in TC.P. units.

1.4. Detailed description of ISR in TopCon TC.GSS power supplies

Due to the more complex architecture of TC.GSS bidirectional power supplies, the ISR has to act on several power blocks simultaneously, therefore two relays are used. The ISR's block the primary and the secondary H-bridges in order to disable any energy flow neither sourcing nor sinking the load, at the same time the active mains input/output rectifier/inverter is blocked too in the same way to isolate the unit from the mains. Again, the restraint-driven signal contacts of the ISR's transmit the state of the relays redundantly to the interface X107. Refer to Fig. 3 for more details.

Please note that TC.GSS Safety Performance Level is different depending on the operation mode.

In source mode, two ISR's break the energy flow independently and therefore a Performance Level of PL e is obtainable. In sink mode - due to technical reasons – one ISR breaks the energy flow and therefore a Performance Level of PL c is given. Of course the PL could be increased for example by adding an additional AC circuit breaker.

Performance level vs. operation mode	
Source mode	**PL e**
Sink mode	**PL c**

Tab. 4 Performance level vs. Operation mode.

Applicationexamples	
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Double safety loop	See chapter 3.2, on page 11.
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Tab. 5 Application variants of safety system

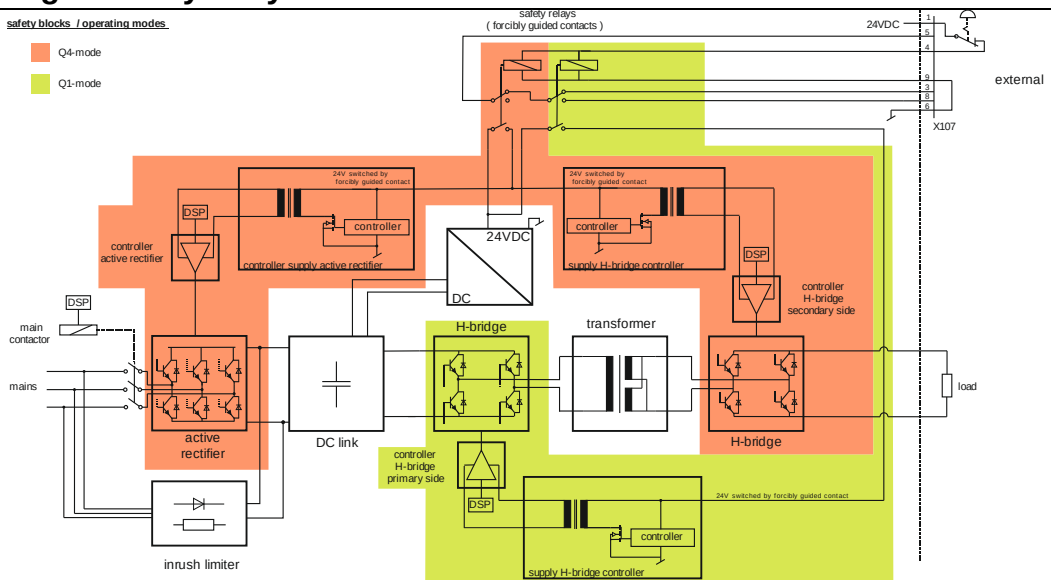

Fig 3: Block diagram of TC.GSS power supply

2. Technical Data

2.1. Interface X107

Please note that interface X107 is available only if ISR option is built in.

D-Sub Buchse
9pol (female)

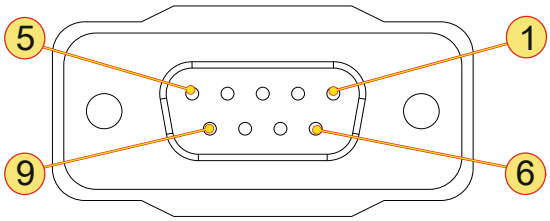

Fig. 4 Pin layout of interface X107, front view

Pin	Signal	I/O	Description
1	**+24VDC**	O	Internal low voltage supply +24V_{DC}
2	**---**	---	---
3	**NC**	I/O	ISR contact NC (normally closed)
4	**RELAY[1]**	I	ISR coil a)
5	**COMMON**	I/O	ISR common contact
6	**GND**	O	GND of internal 24 V_{DC}
7	**---**	---	---
8	**NO**	I/O	ISR contact NO (normally open)
9	**RELAY[1]**	I	ISR coil b)
Chassis	**Shield**	---	Tied to chassis ground

Tab. 6 Interface X107, pin assignement
[1]Polarity of 24 V_{DC} at pins 4 and 9 is of no importance

2.2. Dummy plug for interface X107

A TopCon power supply equipped with ISR option needs either to be connected to an external safety loop as described above, or alternatively a dummy plug “X107 Safety-shutdown” has to be connected to interface X107. If the interface X107 is left open, the power supply will rest in the ‘Emergency OFF’ state and is inoperative.

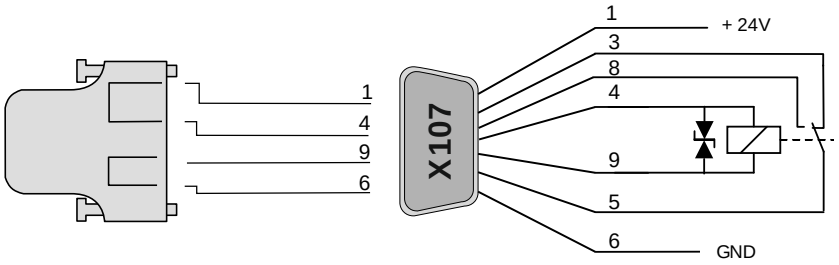

Fig. 5 Dummy plug for interface X107

3. Application examples

3.1. Example 1: Category 1 PL c

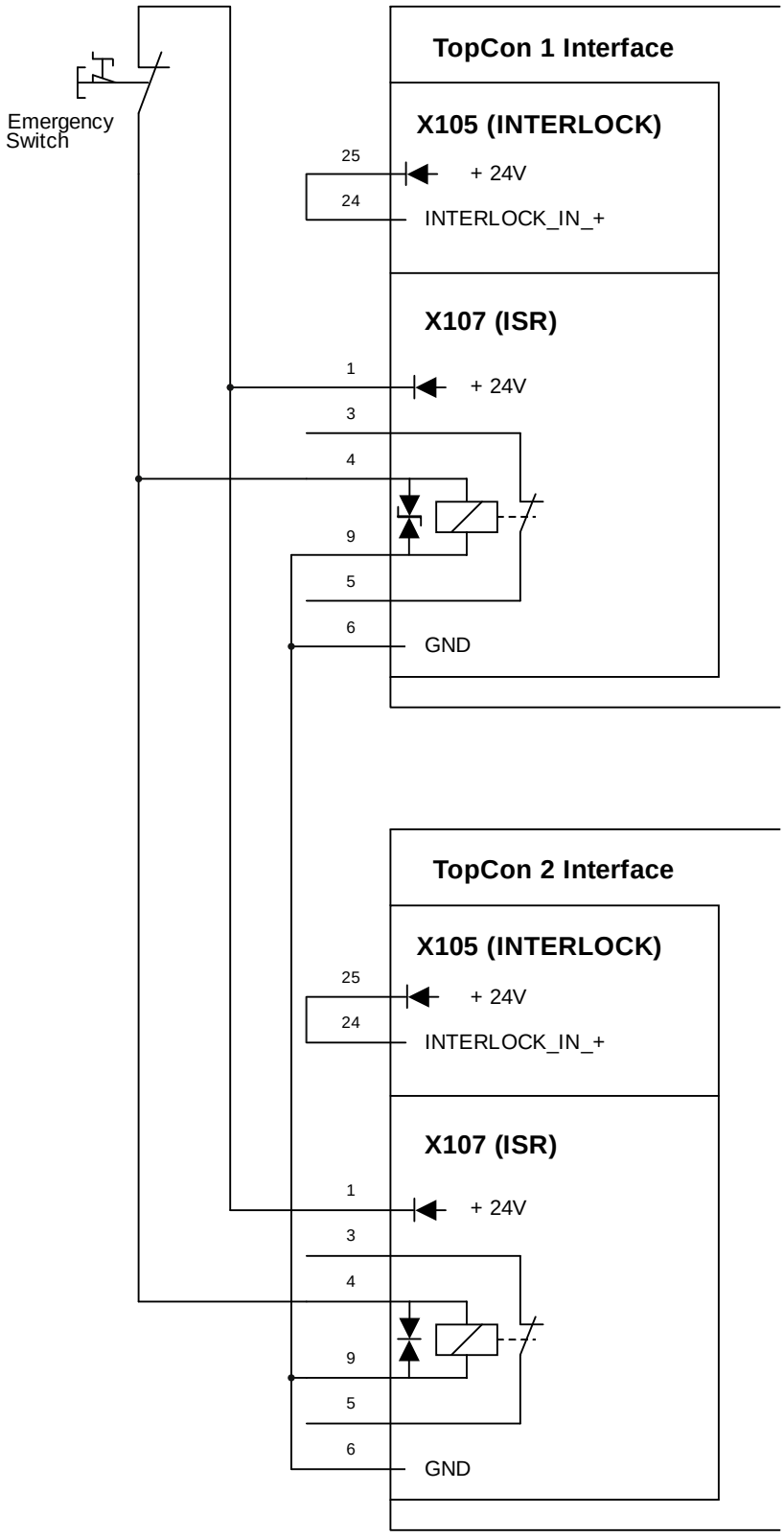

Fig. 6: Wiring diagram using a single pole external safety loop.

3.2. Example 2: Category 1 PL c

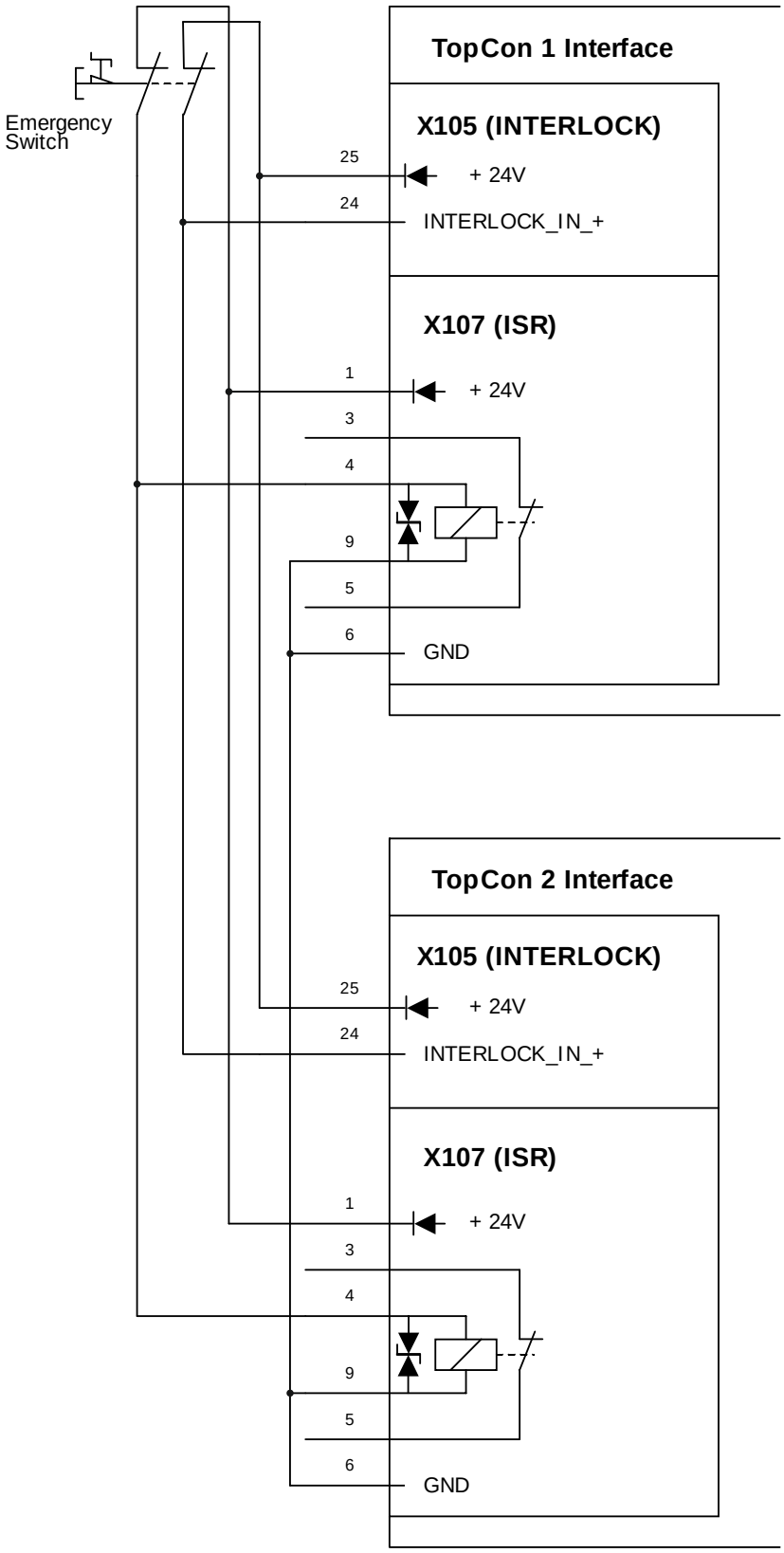

Fig 7: Wiring diagram using a double pole external safety loop.

3.3. Example 3: Category 1 PL c

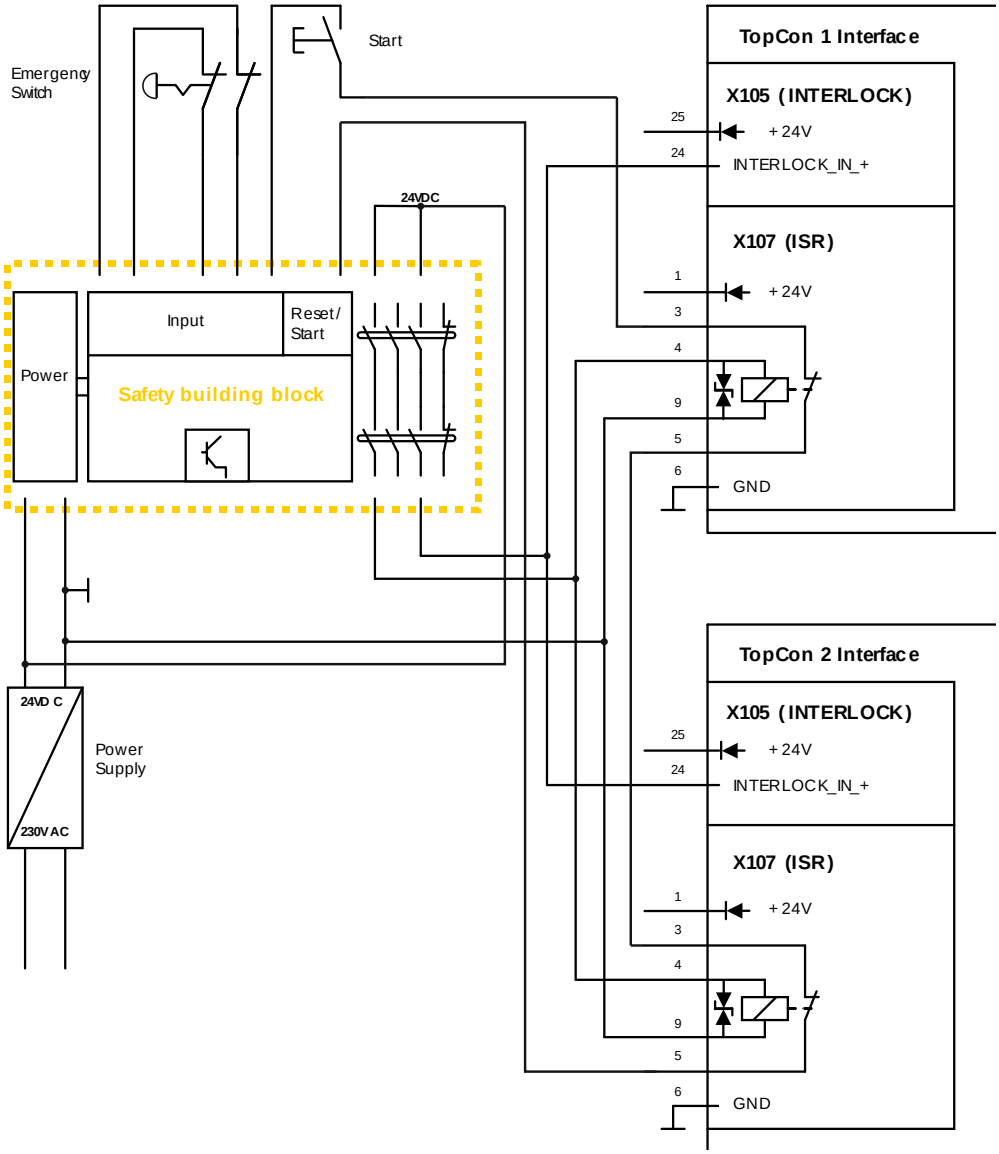

Fig 8: Wiring diagram using an external Safety Module

4. Enhancement of the Performance Level

Alternatives

- Additional DC breaker disconnecting the load
- Additional AC breaker disconnecting the mains input
- Use of Integrated ISR-Option X112 from REGATRON