Integrated Safety Relay ISR

Option X112/ X112-2 (dual 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
- number of all failures, including these not being identified by the system

↳ DC < 60% means DC_{avg} = Null;
(System detects own malfunctions only occasionally)

↳ 60% < DC < 90% means DC_{avg} =' low'

↳ 90% < DC < 99% means DC_{avg} = 'fair'

↳ DC > 99% means DC_{avg} = '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 from the following Abb 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_{avg}** = 'low'.

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

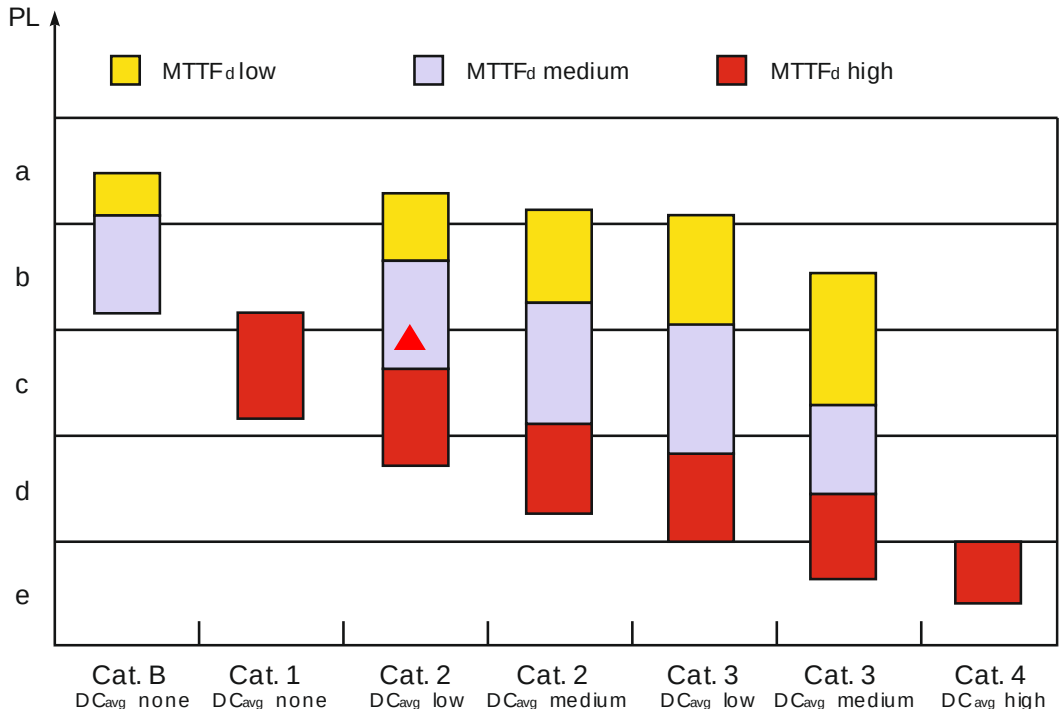

Fig. 1 Relationship between **DC_{avg}**, MTTFd and Performance Level PL

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 X112 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 the AC input stage too are blocked in the same manner. (See also chapters 1.3 and 1.4)

Please note, that an ‘X112 Safety-Shutdown plug’ has to be plugged onto the X112 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 X112 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)

REGATRON power supplies

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

Both ISR safety relays break the low voltage power supply for the primary H-bridge circuit in an independent way. By this, power semiconductors may no longer work and therefore the power transformer is unable to convert energy to the secondary. Because the relays dispose of restraint-driven signal contacts, the state of the relays is routed to the interface X112 in a redundant way.

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

Because of two independent acting safety relays it is possible to reach a safety Performance Level of **PL e.**

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

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.

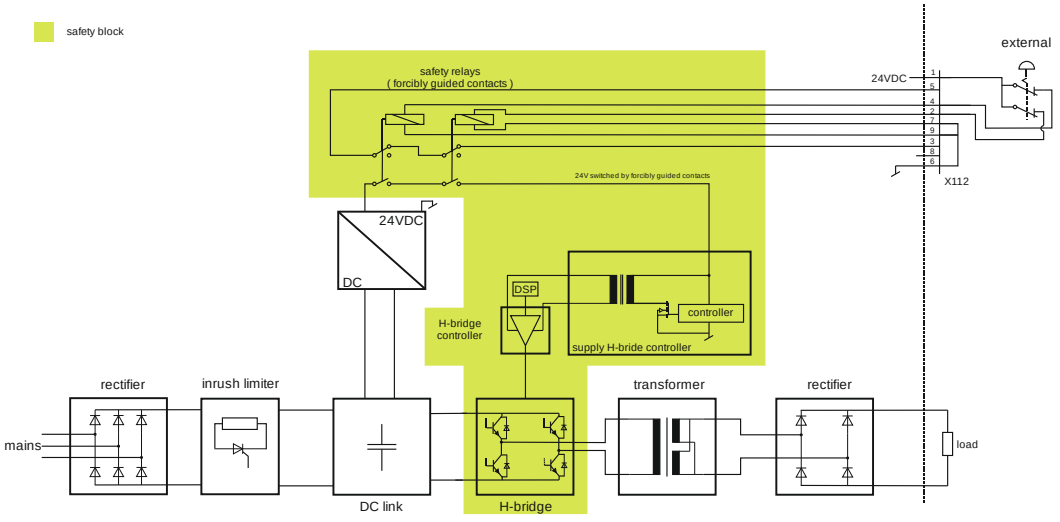

Fig. 2 Functional block diagram of ISR feature in TC.P. units.

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's have to act on several power blocks simultaneously. ISR's block the primary and the secondary H-bridges in order to disable any energy flow whether 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 X112. Refer to Picture 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.

Device dependent Performance Level PL:

- **Devices with the interface labelling X112**
  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.
- **Devices with the interface labelling X112-2**
  In sink mode, two ISR's break the energy flow independently and therefore a Performance Level of PL e is obtainable.

Performance level vs. operation mode	
Source mode	**PL e**
Sink mode	**Device dependent Performance Level PL** Labelling X112: **PL c** Labelling X112-2: **PL e**

Tab. 4 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. 5 Application variants of safety system

Functional block diagram of TC.GSS devices with the labelling X112

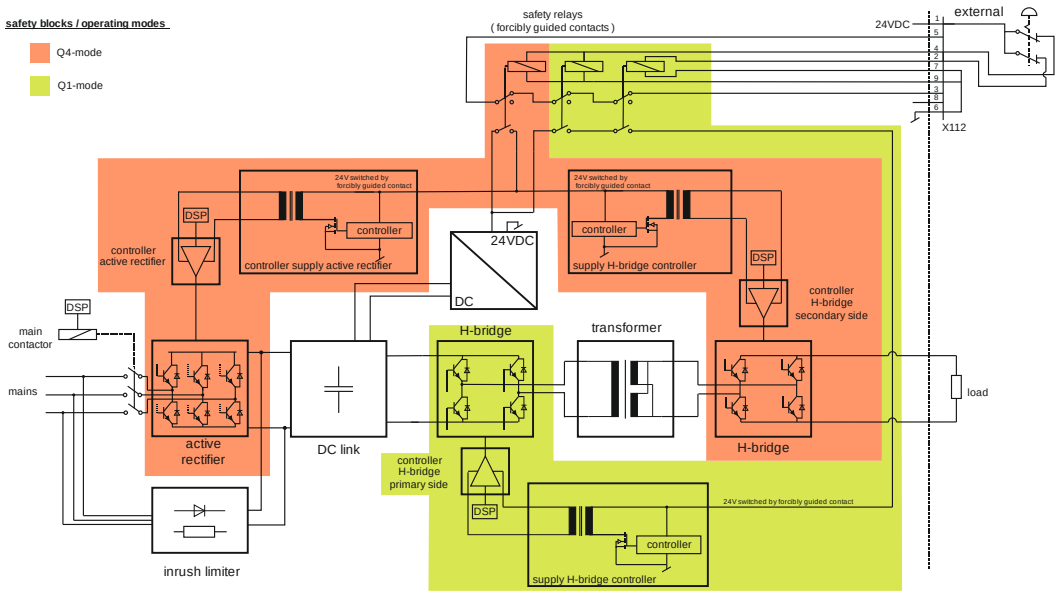

Fig. 3 Functional block diagram of ISR feature in TC.GSS unit with the labelling X112.

Functional block diagram of TC.GSS devices with the labelling X112-2

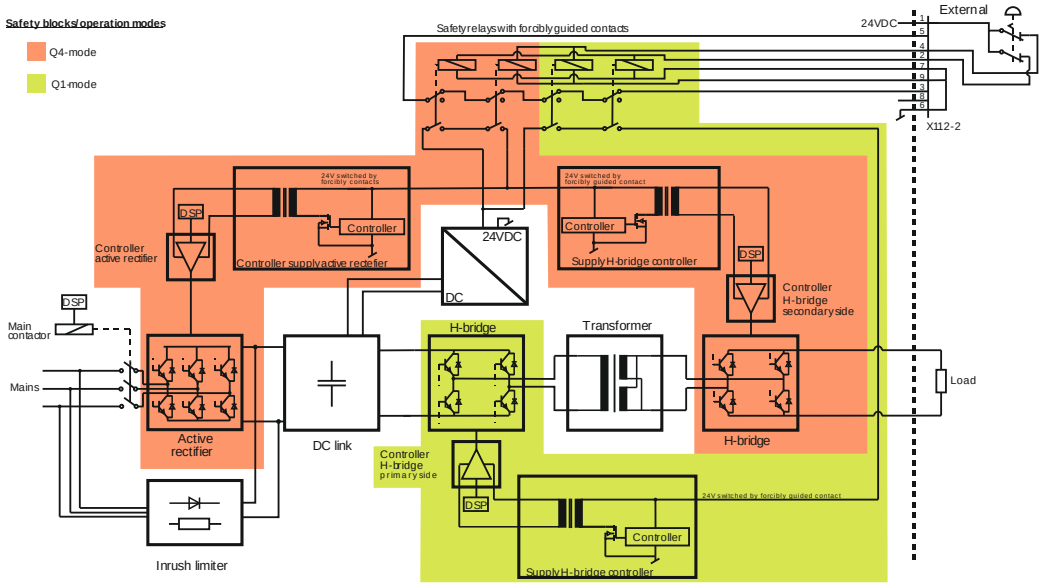

Fig. 4 Functional block diagram of ISR feature in TC.GSS unit with the labelling X112-2.

2. Technical Data

2.1. Interface X112/ X112-2

Please note that interface X112 is available only if ISR option is built in.

D-Sub Buchse
9pol (female)

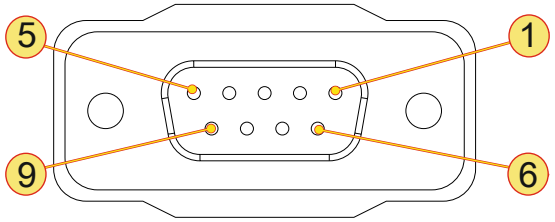

Fig. 5 Pin layout of interface X112/ X112-2, front view

Pin	Signal	I/O	Description
1	**+24VDC**	O	Low voltage internal supply + 24 V_{DC}
2	**RELAY2**[1]	I	Coil a) of ISR relay#2
3	**NC**	I/O	Relay contact NC
4	**RELAY1**[1]	I	Coil a) of ISR relay#1
5	**COMMON**	I/O	Common contact
6	**GND**	O	Low voltage 0 V_{DC}
7	**RELAY2**[1]	I	Coil b) of ISR#2
8	**---**	---	---
9	**RELAY1**[1]	I	Coil b) of ISR#1
Cover	**Shield**	---	Cable screen, tied to earth (PE) internally

Tab. 6 Interface X112/ X112-2, pin assignment.
[1] Polarity of relay coil pins 2 and 7 resp. 4 and 9 of no importance.

2.2. Dummy plug for interface X112/ X112-2

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 “X112 Safety-shutdown” has to be connected to interface X112/ X112-2. If the interface X112/ X112-2 is left open, the power supply will rest in the ‘Emergency OFF’ state and is inoperative.

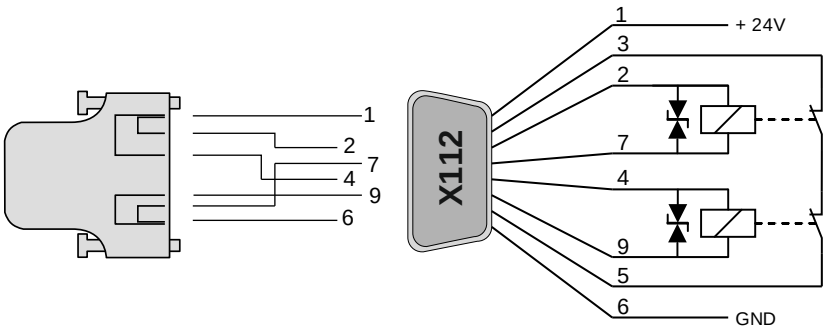

Fig. 6

2.3. Adapter for equipment with an X107 interface

Many TopCon power supplies are equipped with the ‘Single channel ISR option X107’. By the aid of a special adapter, X107 ISR equipped units may be operated together with X112/ X112-2 equipped units. Refer to picture 6 for details.

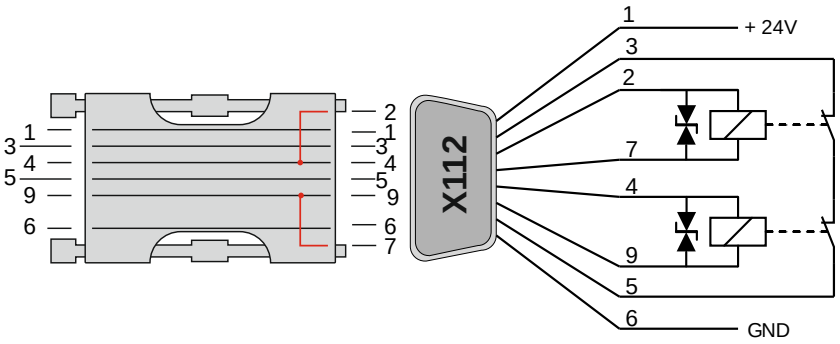

Fig. 7 Adapter for connecting ISR X107 units to ISR X112 units.

3. Application examples

3.1. Example 1: Category 1 PL c

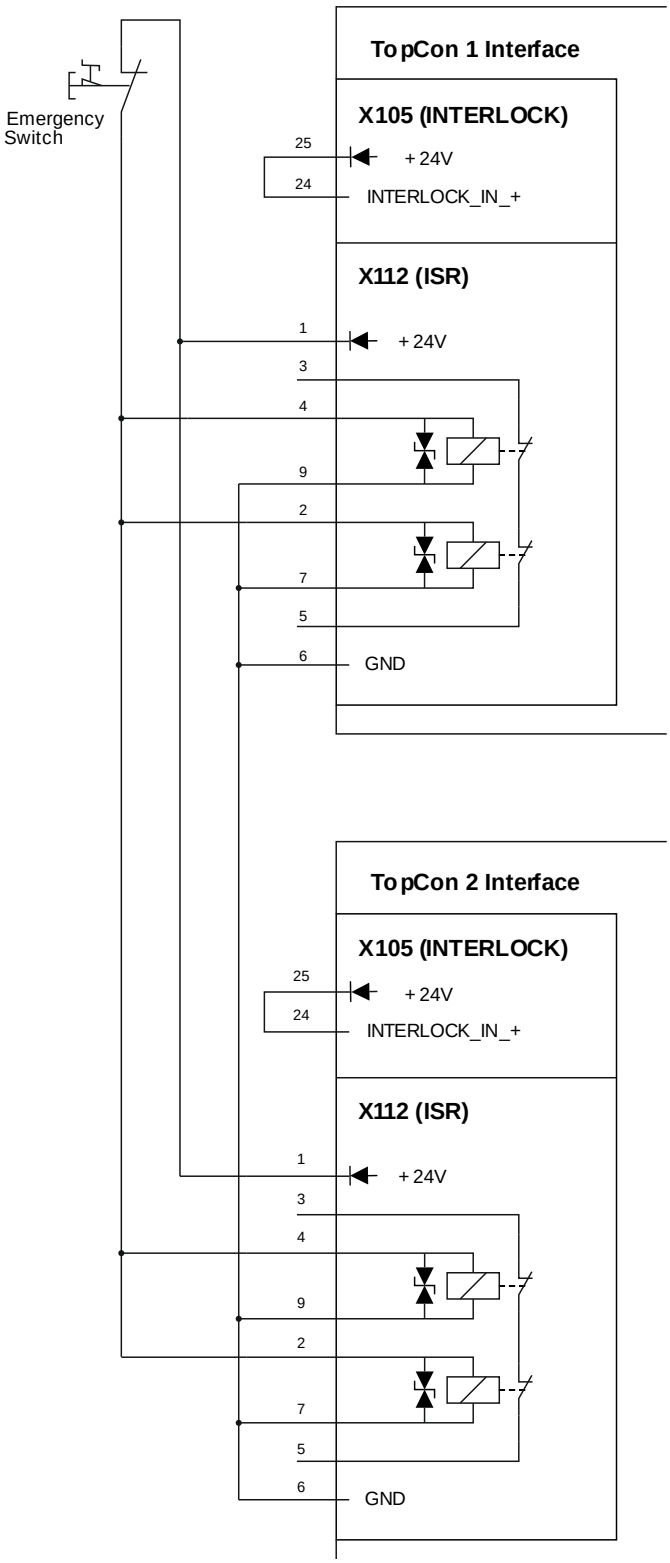

Fig. 8 Wiring diagram using a single pole external safety loop.

3.2. Example 2: Category 1 PL c

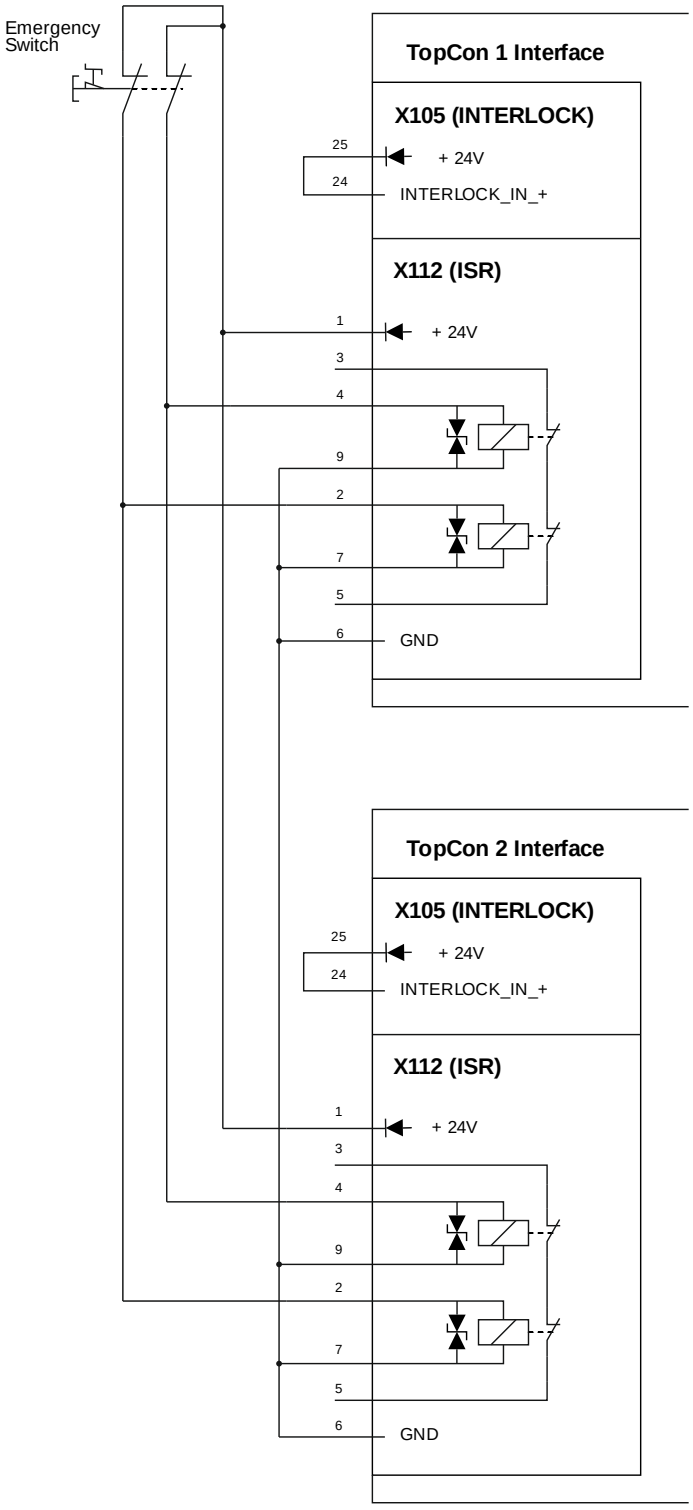

Fig. 9 Wiring diagram using a double pole external safety loop.

3.3. Example 3: Category 3 PL e

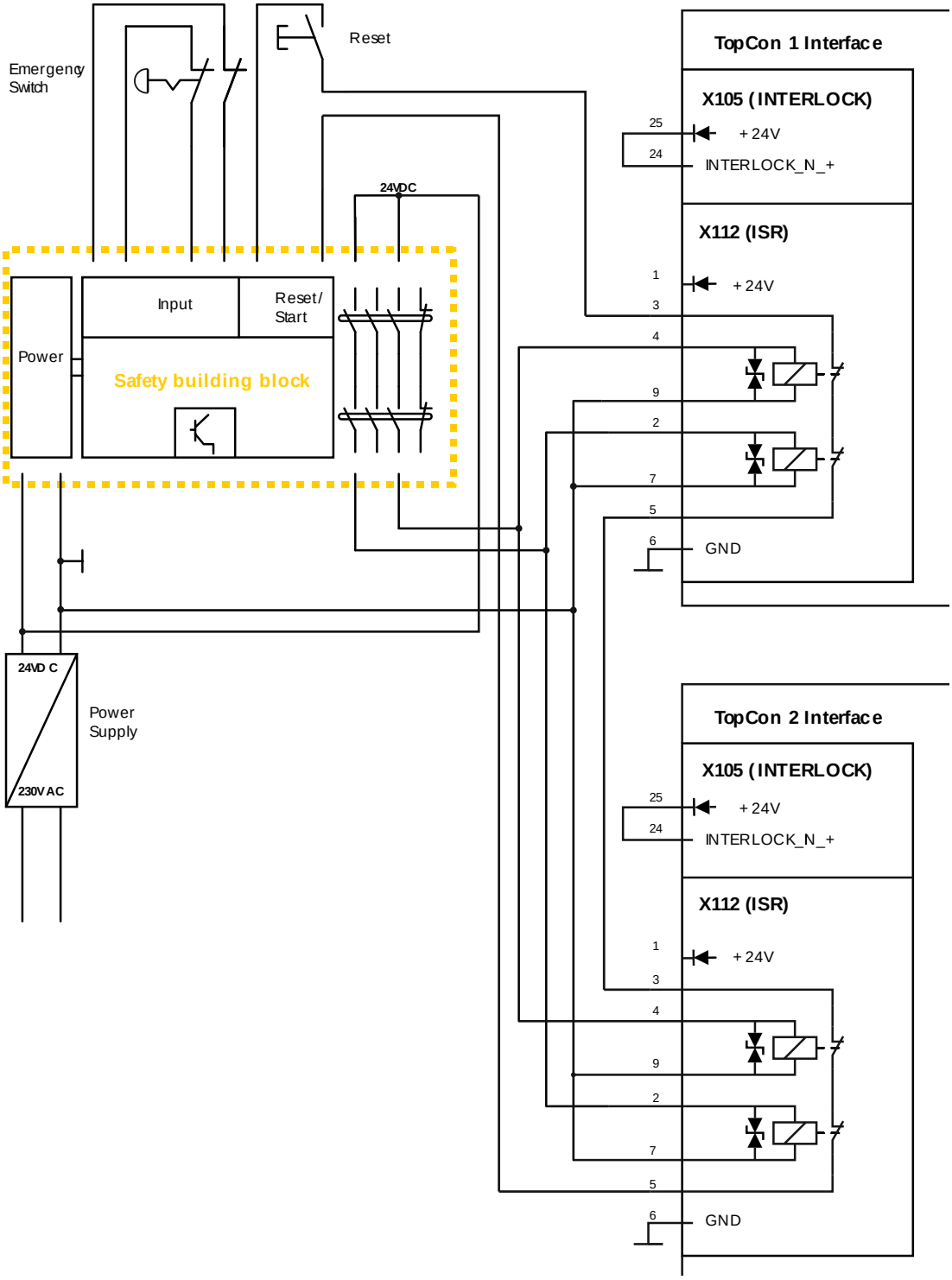

Fig. 10 Wiring diagram using an external safety module, double pole safety loop