Your Global Automation Partner

TURCK

IMX12-CD | IM12-CD
Relay Coupler

Safety Manual

Contents

1 About this Document

This safety manual contains all information that is required to operate the device in functional safety systems. Read this manual carefully before using the device.

This document addresses only functional safety according IEC 61508. Other aspects, such as intrinsic safety, are not considered.

All instructions must be followed in order to assure functional safety.

Always make sure that this is the latest version of the safety manual at www.turck.com. The English version is considered the definitive document. Care was taken in the production of the translations of this document. If there is any uncertainty in its interpretation, refer to the English version of the safety manual or contact Turck directly.

2 Scope

This safety manual is valid for the following devices.

Ident no.	Product Name	Number of channels	Terminal Block Design	Power-Bridge connection
7580620	IMX12-CD01-2R-2U-0/L	2	screw clamps	no
7580621	IMX12-CD01-2R-2U-0/L/CC	2	spring type terminals	no
7580622	IM12-CD01-2R-1U-0/L	1	screw clamps	no
7580623	IM12-CD01-2R-1U-0/L/CC	1	spring type terminals	no

In the following chapters the devices are divided
- IMX12-CD01-2R-2U
- IM12-CD01-2R-1U

3 Safety Integrity Level

The devices are rated to a SIL of

SIL3

4 Product Description

In the following chapter the individual variants are described.

All information provided in this chapter is not part of safety function.

The devices are intended exclusively for industrial use. The relay couplers of the IM12-CD… series ensure safe galvanic isolation between contact and control circuits. Possible applications are e.g. remote reset, fire alarm test or the remote calibration of strain gauges.

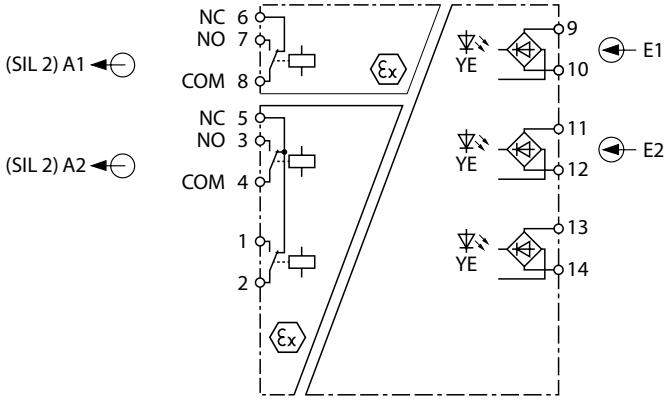
The devices can also be used for safety-related applications up to and including SIL3 (high and low demand according to IEC 61508) (hardware fault tolerance HFT = 1).

IMX12-CD01-2R-2U	The IMX12-CD… relay couplers are equipped with three relay outputs (change-over switches). Depending on the input level, the input signals are interpreted as low or high level and provided as a corresponding output signal. The inputs are not polarized. Input E1 and input E2 switch output A1 or output A2 With input E3, output A1, output A2 and output A3 are controlled simultaneously. The device is powered by the input signal (Loop Powered)
IM12-CD01-2R-1U	The IM12-CD… relay couplers are equipped with two relay outputs (changeover switches). Depending on the input level, the input signal is interpreted as low or high level and provided as a corresponding output signal. The inputs are not polarized. Input E1 switches output A1 and output A2 The device is powered by the input signal (Loop Powered).

4.1 Safety function

4.1.1 Safety Function IMX12-CD01-2R-2U

SIL2 – Loop Powered mode with independent channels

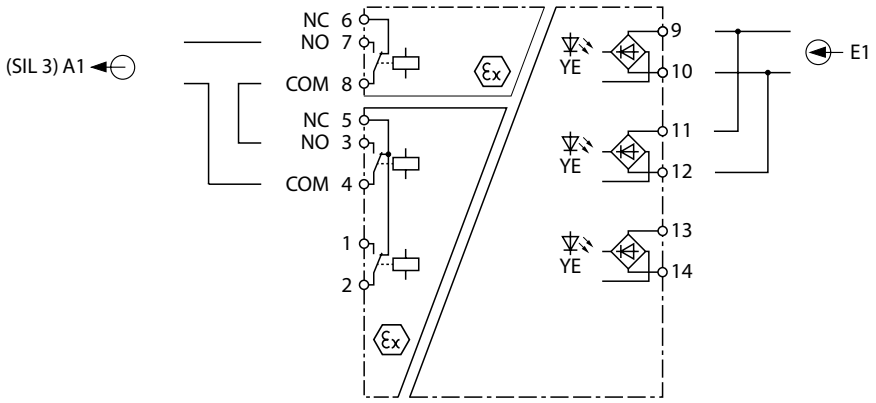
SIL2 [E1] → [A1] or [E2] → [A2]	**Safety Function:** If a Low signal is present at input [E1, E2], the corresponding output relay (A1, A2) is de-energized within maximum 40 ms, so that NO contact is open and NC contact is closed.  **NE load connection:** Safety Function for NE (Normally Energized) load (de-energized in safe state) is available at Terminal Blocks 7…8 (A1) and Terminal Blocks 3…4 (A2). **ND load connection:** Safety Function for ND (Normally De-Energized) load is available at Terminal Blocks 6…8 (A1) and Terminal Blocks 5…4 (A2).

SIL3 – Loop Powered mode with 1oo2 channel architecture and E1+E2 as input

SIL3

[E1+E2] → [A1+A2]
NE load

Safety Function:
If a simultaneous low signal is present at input [E1] and [E2], connected in parallel by a single SIL3 signal source or two SIL2 signal sources, the output relay [A1] and [A2] are de-energized within maximum 40 ms, so in serial connected NO contacts are open.

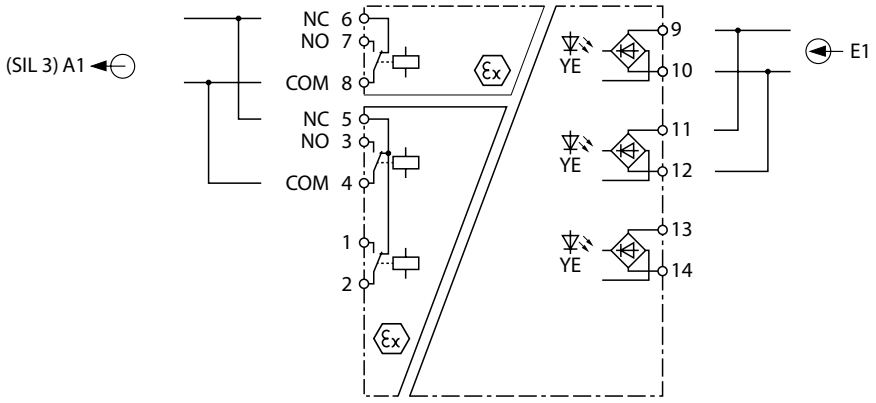


NE load connection:
SIL 3 Safety Function for NE (Normally Energized) load (de-energized in safe state) is available at Terminal Blocks 7…4. Two NO contacts in series connection.

SIL3

[E1+E2] → [A1+A2]
ND load

Safety Function:
If a simultaneous low signal is present at input [E1] and [E2], connected in parallel by a single SIL3 signal source or two SIL2 signal sources, the output relay [A1] and [A2] are de-energized within maximum 40 ms, so in parallel connected NC contacts are closed.

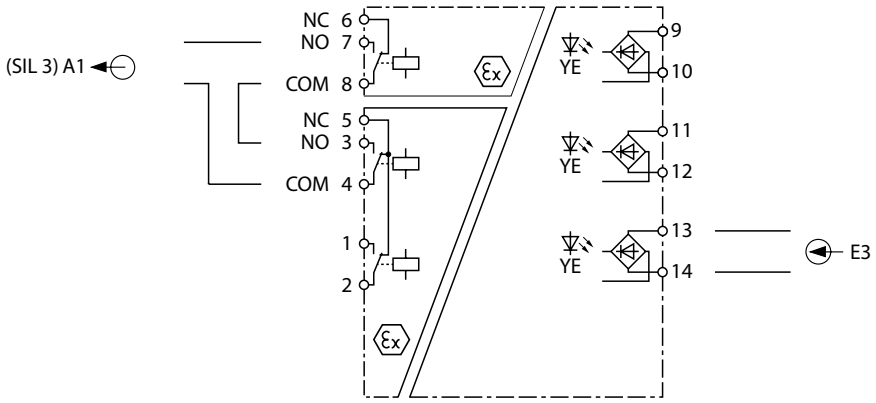


ND load connection:
SIL 3 Safety Function for ND (Normally De-Energized) load (energized in safe state) is available at Terminal Blocks 6…8 (or 5…4 because externally connected in parallel). Two NC contacts in parallel connection.

SIL3

[E3] → [A1+A2]
NE load

Safety Function:
If a simultaneous low signal is present at input [E3], connected by a single SIL3 signal source, the output relay [A1] and [A2] are de-energized within maximum 40 ms, so in serial connected NO contacts are open.

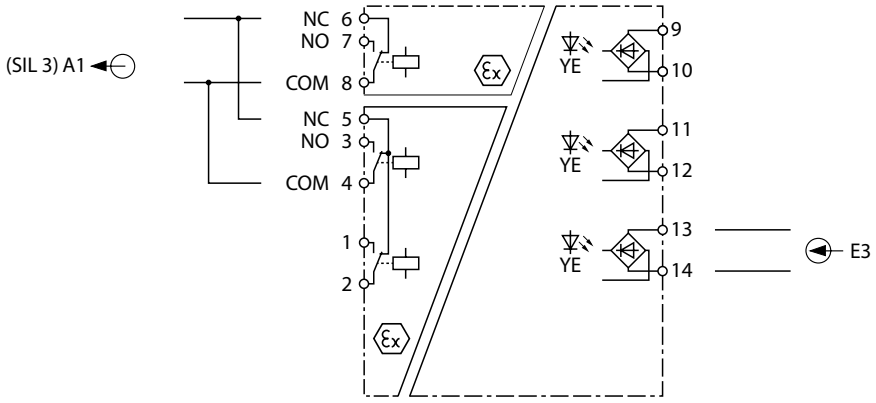


NE load connection:
SIL 3 Safety Function for NE (Normally Energized) load (de-energized in safe state) is available at Terminal Blocks 7…4. Two NO contacts in series connection.

SIL3

[E3] → [A1+A2]
ND load

Safety Function:
If a simultaneous low signal is present at input [E3], connected by a single SIL3 signal source, the output relay [A1] and [A2] are de-energized within maximum 40 ms, so in parallel connected NC contacts are closed.

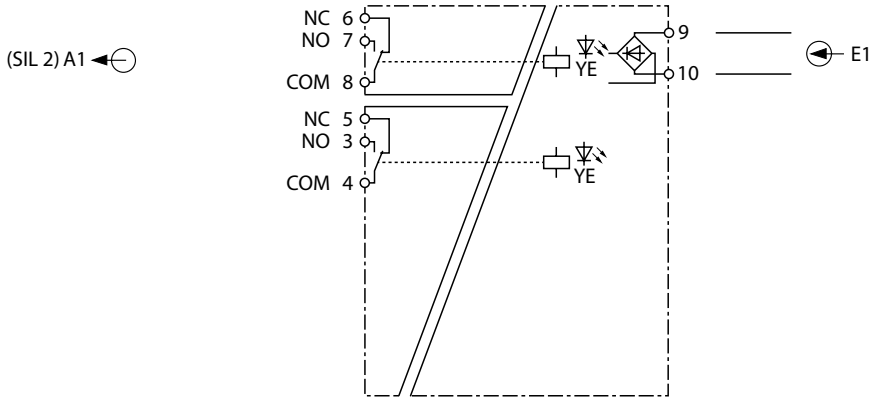


ND load connection:
SIL 3 Safety Function for ND (Normally De-Energized) load (energized in safe state) is available at Terminal Blocks 6…8 (or 5…4 because externally connected in parallel). Two NC contacts in parallel connection.

4.1.2 Safety Function IM12-CD01-2R-1U

SIL2 – Loop Powered mode with one channel

SIL2 [E1] → [A1]	**Safety Function:** If a Low signal is present at input [E1], the corresponding output relay (A1) is de-energized within maximum 40 ms, so that NO contact is open and NC contact is closed.

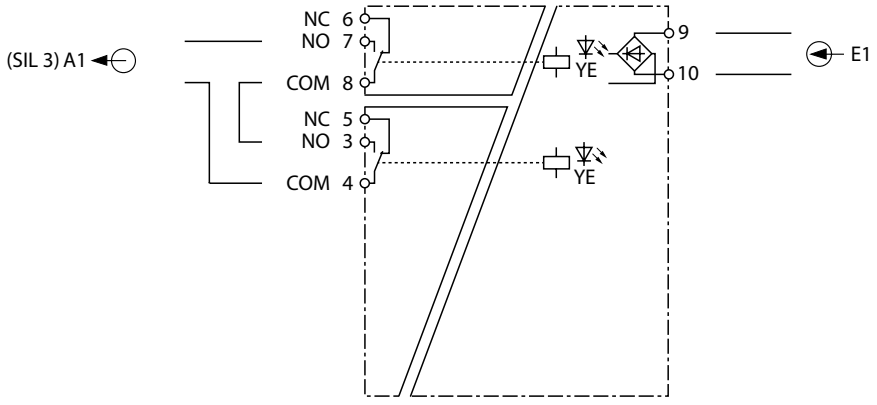


NE load connection:
Safety Function for NE (Normally Energized) load (de-energized in safe state) is available at Terminal Blocks 7…8 [A1].

ND load connection:
Safety Function for ND (Normally De-Energized) load is available at Terminal Blocks 6…8 [A1].

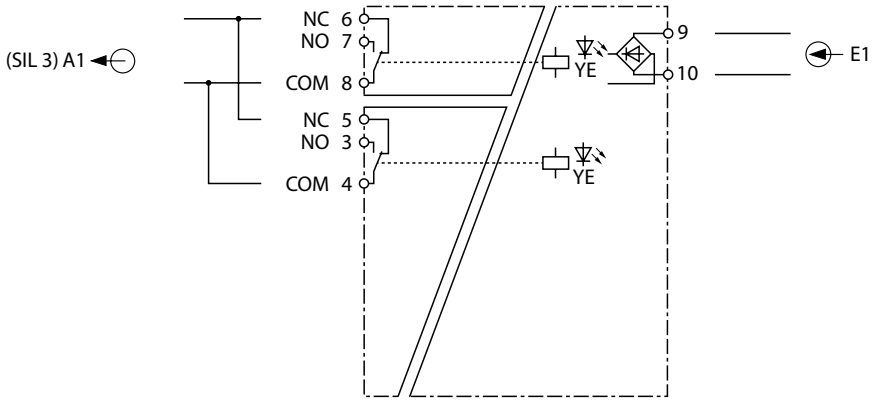
SIL3 – Loop Powered mode with 1oo2 channel architecture

SIL3 [E1] → [A1+A2] NE load	**Safety Function:** If a low signal is present at input [E1], connected by a single SIL3 signal source, the output relay [A1] and [A2] are de-energized within maximum 40 ms, so in serial connected NO contacts are open



NE load connection:
SIL 3 Safety Function for NE (Normally Energized) load (de-energized in safe state) is available at Terminal Blocks 7…4. Two NO contacts in series connection.

SIL3 [E1] → [A1+A2] ND load	**Safety Function:** If a simultaneous low signal is present at input [E1], connected by a single SIL3 signal source, the output relay [A1] and [A2] are de-energized within maximum 40 ms, so in parallel connected NC contacts are closed.



ND load connection:
SIL 3 Safety Function for ND (Normally De-Energized) load (energized in safe state) is available at Terminal Blocks 6…8 (or 5…4 because externally connected in parallel). Two NC contacts in parallel connection.

4.2 Safe state

IMX12-CD01-2R-2U	The safe state is defined as the output relay is de-energized, so that NO contact is open and NC contact is closed. (A1, A2, A3)
IM12-CD01-2R-1U	The safe state is defined as the output relay is de-energized, so that NO contact is open and NC contact is closed. (A1, A2).

Faults do not have to be acknowledged. If the fault is rectified, the device automatically resumes operation and leaves the safe state.

5 Safety Planning

This chapter provides information for planning a safety-related loop.

The device is not specified for a certain application. Make sure that the data provided in this chapter is valid for your target application.

Special application-specific factors may cause the premature wear of the device and must be taken into consideration when planning systems; take special measures to compensate for a lack of experience based values, e.g. through implementation of shorter test intervals.

The suitability for specific applications must be assessed by considering the particular overall safety-related system with regard to the requirements of IEC 61508.

Safety-planning must only be carried out by trained and qualified personnel. In case of doubt contact Turck directly.

5.1 Architectural specifications

Due to architectural considerations the following characteristics are specified:

Type	A
HFT	1

The internal structure is partly HFT 0 or HFT 1.

The redundancy of the circuit components was already taken into account in the probabilistic calculations.

The failure probabilities, SFF, PFD and PFH has to be used with HFT = 0.

Experience has shown that the useful lifetime often lies within a range of 8 to 12 years. It can be significantly less if elements are operated near their specification limits. However, it can be extended by appropriate measures. For example, heavy temperature fluctuations could potentially decrease the useful lifetime, as constant temperature below 40 °C could potentially increase the useful lifetime.

For the relay outputs (cos phi=1, I=2A AC) the useful lifetimes is 8 to 12 years or 30.000 switching cycles. The relay must be protected against an over current.

5.2 Assumptions

- Failure rates are constant for 10 years, wear out mechanisms are not included
- Propagation of failures is not relevant
- External power supply failure rates are not included
- All components that are not part of the safety function and cannot influence the safety function (feedback immune) are excluded.

5.3 FMEDA results

The following safety characteristic are the results of the FMEDA.

IMX12-CD01-2R-2U	λSD	λSU	λDD	λDU	No effect	DC	SFF
SIL2 – [E1] → [A1] or [E2] → [A2]	0.0	134.97	0.0	18.07	235.76	0%	88.19%
SIL3 – [E1+E2] → [A1+A2]	0.0	134.97	0.0	18.07	235.76	0%	88.19%
SIL3 – [E3] → [A1+A2]	0.0	135.57	0.0	18.07	235.16	0%	88.24%

IM12-CD01-2R-1U	λSD	λSU	λDD	λDU	No effect	DC	SFF
SIL2 - [E1] → [A1]	0.0	43.04	0.0	18.07	32.29	0%	70.4%
SIL3 - [E1] → [A1+A2]	0.0	43.04	0.0	18.07	32.29	0%	70.4%

The stated Safe Failure Fraction (SFF) is for reference only. The complete subsystem will need to be evaluated to determine the overall SFF.

The failure rates used in this analysis are the basic failure rates from the Siemens standard SN 29500 based on the average ambient temperature of components of 40 °C.

"No effect" is a failure mode of a component that plays part in implementing the safety function but is neither a safe nor a dangerous failure. According to IEC 62061, it would be possible to classify the "No effect" failures as "Safe Undetected" failures. Not doing so represents the worst-case.

5.4 Examples for using the results

5.4.1 Probability of dangerous failure per hour (High Demand mode)

The sum of the diagnostic test interval and the time to achieve the specified safe/alarm state is less than 40ms. The ratio of the diagnostic test rate to the demand rate shall equal or exceed 100.

IMX12-CD01-2R-2U - safety functions	PFH
SIL2 – [E1] → [A1] or [E2] → [A2]	1.807E-08 1/h
SIL3 – [E1+E2] → [A1+A2]	1.81E-09 1/h
SIL3 – [E3] → [A1+A2]	1.81E-09 1/h

IMX12-CD01-2R-2U - safety functions	PFH
SIL2 - [E1] → [A1]	1.807E-08 1/h
SIL3 - [E1] → [A1+A2]	1.96E-09 1/h

5.4.2 Average probability of dangerous failure on demand (Low Demand mode)

With the FMEDA results and the values specified in the following table the average frequency of dangerous failure can be calculated exemplarily:

T1	8760 h
MTTR	24 h

IMX12-CD01-2R-2U - safety functions	**PFDavg**
SIL2 – [E1] → [A1] or [E2] → [A2]	7.96E-05
SIL3 – [E1+E2] → [A1+A2]	7.97E-06
SIL3 – [E3] → [A1+A2]	7.97E-06

IMX12-CD01-2R-2U - safety functions	**PFDavg**
SIL2 - [E1] → [A1]	7.96E-05
SIL3 - [E1] → [A1+A2]	8.64E-06

6 Safety Operating Instructions

6.1 General

- ➤ The device must be registered online: www.turck.com/SIL or with the supplied SIL registration card. This must be filled in with all required information upon receipt and sent to Turck.
- ➤ The device must only be carried out, fitted, installed, operated, commissioned and maintained by trained and qualified personnel.
- ➤ The device is not specified for a certain application. Make sure that application-specific aspects are considered.
- ➤ Data from other documents, e.g. data sheets, is not valid for functional safety operation. Devices must be used in cabinets in an typical industrial field environment only. The following restrictions describe the operation and storage conditions:
  - ➤ Ensure that the environment complies with the following ratings

Minimum ambient temperature	-25 °C
Maximum ambient temperature	70 °C
Minimum storage temperature	-40 °C
Maximum storage temperature	80 °C
Maximum air humidity	95 %
Minimum air pressure	80 kPa
Maximum air pressure	110 kPa

  - ➤ The average temperature over a long period of time directly on the exterior sidewall of the housing must be maximum 40 °C.
  - – The temperature on the exterior sidewall of the housing can deviate considerably from the temperature in the control cabinet.
  - – The temperature on the exterior sidewall of the housing must be observed in a steady state.
  - – In case the temperature on the exterior sidewall of the housing is higher, the failure rates from „5.3 FMEDA results“ on page 13 must be adjusted:
    For a higher average temperature of 60 °C on the exterior sidewall of the housing, the failure rates are multiplied by an experience factor of 2.5.
  - ➤ Ensure that sufficient heat dissipation is provided.
  - ➤ Protect the device from radiated heat and severe temperature fluctuations.
  - ➤ Protect the device from dust, dirt, moisture, shock, vibration, chemical stress, increased radiation and other environmental influences.
  - ➤ Ensure a degree of protection of at least IP20 according to IEC 60529 at the mounting location.
  - ➤ Ensure that the electromagnetic stress does not increase the requirements of IEC 61326-3.1.
- ➤ If there is a visible error, e.g. defective housing the device must not be used.
- ➤ During operation of the device, surface temperatures may occur that could lead to burns if touched.
- ➤ The device must not be repaired. If problems occur with regard to functional safety, Turck must be notified immediately and the device must be returned immediately to:

  Hans Turck GmbH & Co. KG
  Witzlebenstraße 7
  45472 Mülheim an der Ruhr
  Germany

6.2 Before operation

➤ Fasten the device to a rail according EN 60715 (TH35) as follows:

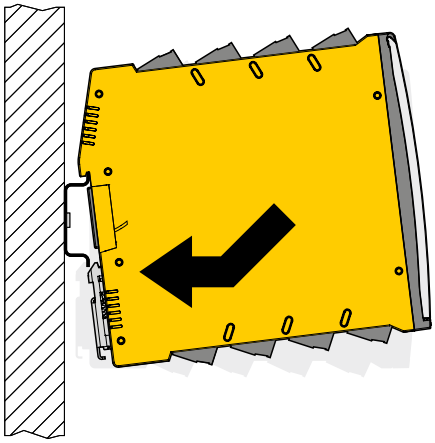


Fig. 1: Fasten the device

➤ Connect cables according to the wiring diagrams in „7 Appendix: Connection and Wiring Diagrams“ on page 19.
➤ Use cables with Terminal cross section.
– rigid: 0.2 mm² to 2.5 mm² or
– flexible 0.2 mm² to 2.5 mm²
➤ When wiring with stranded wires: Fix the wiring ends with ferrules.

Connection via screw terminals:

➤ Insert the stripped cable ends (7 mm) in the guides of the cable glands.
➤ Fasten the screws with a screwdriver (max. tightening torque 0.5 Nm) to fix the cable ends.

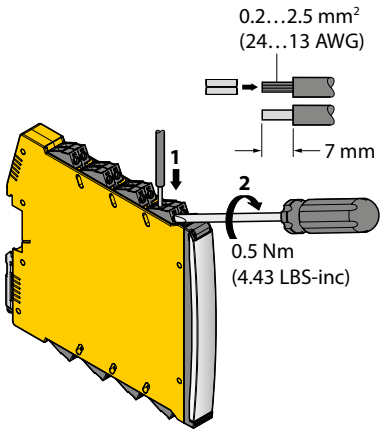


Fig. 2: Connection with screw terminals

Connection with spring-type terminals:

➤ Push the opening lever with a suitable screwdriver.
➤ Insert the stripped cable ends (7 mm) in the guides of the spring-type terminals.
➤ Pull the screwdriver to fix the cable ends.

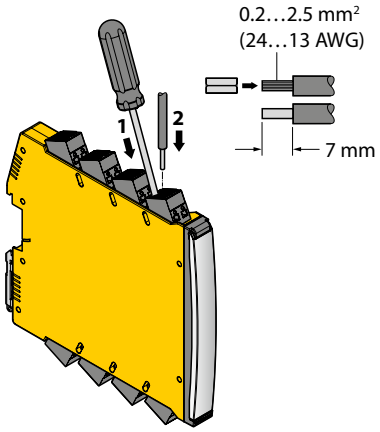


Fig. 3: Connection with spring-type terminals

➤ Make sure that only suitable equipment, e.g. sensors, are connected to the device (see „7 Appendix: Connection and Wiring Diagrams“ on page 19).
➤ Make sure that a suitable power supply with the following characteristic is used:

Minimum voltage	10 VDC
Maximum voltage	30 VDC
Minimum Power	4 W

➤ The relay outputs shall be protected by a fuse that limits the current to 2 A to avoid contact welding.
➤ The configuration shall be validated by the user.
➤ The device shall not be re-configured after the validation of the configuration.

6.3 Operation

➤ If the device is used in low demand mode, proof tests shall be executed according to T1 (see „9 Appendix: Proof Tests“ on page 21).
➤ Ensure that the plug connections and cables are always in good condition.
➤ The device must be replaced immediately if the terminals are faulty or the device has any visible faults.
➤ If cleaning is required, do not use any liquid or statically charging cleaning agent. Perform proof tests after each cleaning (see „„9 Appendix: Proof Tests“ on page 21).
➤ The proof test shall be executed each time after installation and parameterization in order to check the requested function.

The LED State is not part of the safety function.

6.4 After operation

➤ Undo the terminal connection on the device.
➤ Remove the device from its rail fixing as shown in the figure:

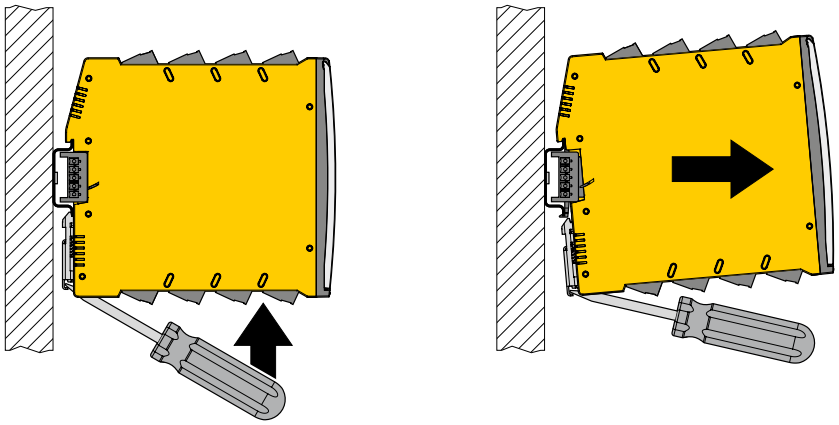


Fig. 4: Remove device

➤ Ensure the proper disposal of the device.

7 Appendix: Connection and Wiring Diagrams

The pin number assignment can be found at the front label.
The connection of a deactivated input is unnecessary.

7.1 IMX12-CD01-2R-2U

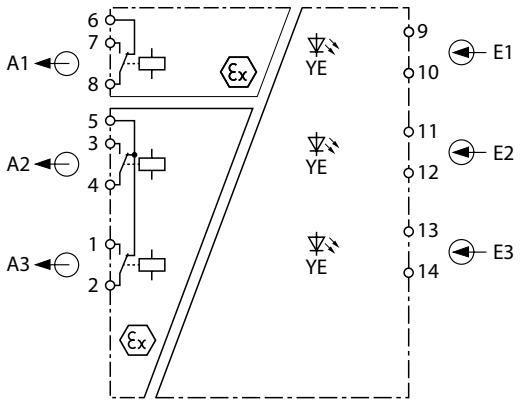


Fig. 5: Block diagram IMX12-CD01-2R-2U

7.2 IM12-CD01-2R-1U

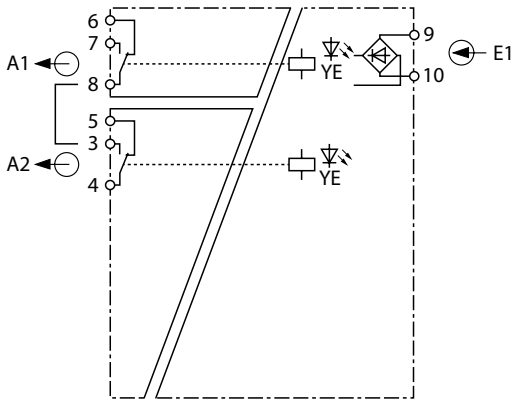


Fig. 6: Block diagram IM12-CD01-2R-1U

7.3 Output relay – Load curve

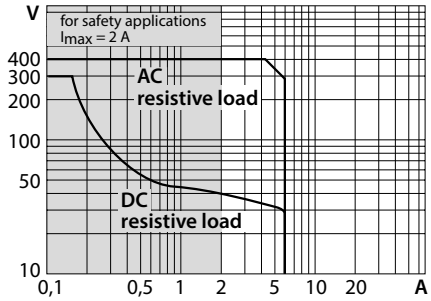


Fig. 7: Output relay load curve

8 Appendix: Terms and Abbreviations

DC	Diagnostic Coverage
FIT	1 FIT is 1 failure per 10E09 hours
FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware failure tolerance
λ_{AU}	Undetected Annunciation failure rate (per hour) Annunciation failures do not directly impact safety but impact the ability to detect a future fault (such as a fault in diagnostic circuit).
λ_{DD}	Detected dangerous failure rate (per hour)
λ_{DU}	Undetected dangerous failure rate (per hour)
λ_{SD}	Detected safe failure rate (per hour)
λ_{SU}	Undetected safe failure rate (per hour)
MTTR	Mean time to restoration (hour)
PFD_{avg}	Average probability of failure on demand
PFH	Probability of dangerous failure per hour
SFF	Safe Failure Fraction
SIL	Safety Integrity Level
T1	Proof test interval (hour)
Type A	"Non-complex" element (all failure modes are well defined); for details see 7.4.4.1.2 of IEC 61508-2
Type B	"Complex" element (using micro controlllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2

9 Appendix: Proof Tests

Proof tests shall be undertaken to reveal dangerous faults which are undetected by diagnostic tests. This means that it is necessary to specify how dangerous undetected faults which have been noted during the FMEDA can be detected during proof testing.

Ensure that the proof test is only carried out by qualified personnel.

A suggested proof test consists of the following steps:

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip.
2	Provide appropriate input-/control signals to the interface modules and verify the expected signal input/output conditions for the interfaces.
3	Verify if internal fault detection is working in case it is activated.
4	Provide appropriate input-/control signals to the interface modules and verify that the safety function is carried out correctly.
5	Remove the bypass and otherwise restore normal operation.

Once the test has been completed, document and archive the results.

10 Appendix: Document History

Document Version	Date	Modifications
1.0	2019-04-09	Initial version

11 Appendix: Certificate

These products are certified by SGS-Saar for the use in safety-related applications. The certificate can be found under the following Link: www.turck.com.

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60 representations worldwide!

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