The Drive & Control Company

Rexroth
Bosch Group

Rexroth Inline Module with

safe relay outputs

R-IB IL 24 PSDOR 4-PAC

Application Description
R911336651

Edition 04

Title Rexroth Inline Module with
safe relay outputs
R-IB IL 24 PSDOR 4-PAC

Type of Documentation Application Description

Document Typecode DOK-CONTRL-ILPSDOR4***-AP04-EN-P

Internal File Reference 8308_en_04, R911336651_04.pdf

Purpose of Documentation This document describes the Rexroth Inline Module with safe relay outputs R-IB IL 24 PSDOR 4-PAC as of the version HW/FW/FW 01/201/100.

Record of revision

Edition	Release date	Note
02	12.2013	First edition
03	08.2015	Achievable safety integrity level for single-channel assignment adapted in chapter 3, 7 and 12 Modification in Table 14-1 (rows 1 + 2)
04	05.2018	HW/FW/FW version updated (as of...) Chapters updated: Use of the Safety Instructions, Disposal, Service and Support Information about safety seals removed (Chapter General Safety Notes and Chapter Repair) EMC Directive updated Conditions for Use at Altitudes greater than 2000 m above Sea Level inserted

Editorial department Engineering automation systems control hardware, SB

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1 Use of the Safety Instructions

1.1 Structure of the Safety Instructions

The safety instructions are structured as follows:

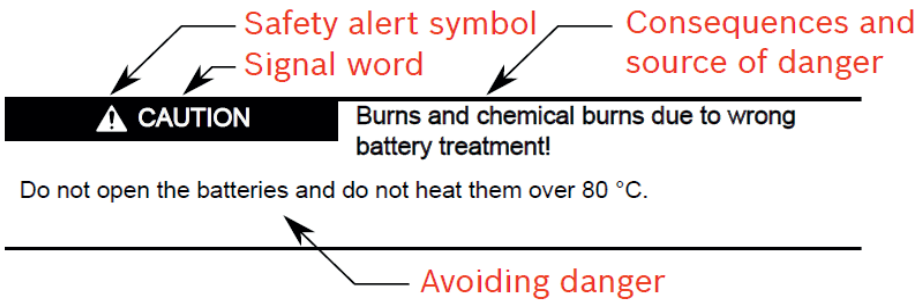


Abb. 1-1 Structure of the safety instructions

1.2 Explaining Signal Words and Safety Alert Symbol

The safety instructions in this documentation contain specific signal words (danger, warning, caution, notice) and, if necessary, a safety alert symbol (according to ANSI Z535.6-2006).

The signal word is used to draw attention to the safety instruction and also provides information on the severity of the hazard.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words danger, warning and caution is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **can** occur.

⚠ VCAUTION

In case of non-compliance with this safety instruction, minor or moderate injury can occur.

NOTICE

In case of non-compliance with this safety instruction, material damage can occur.

Use of the Safety Instructions

1.3 Symbols used

Hints are represented as follows:

This is an information.

Tips are represented as follows:

This is a tip for the user.

1.4 Signal Graphic Explanation on the Device

Prior to the installation and commissioning of the device, refer to the device documentation.

2 For Your Safety

Purpose of this application description

The information in this document is designed to familiarize you with how the R-IB IL 24 PSDOR 4-PAC safety module works, its operating and connection elements, and its parameter settings. This information will enable you to use the module within a PROFIsafe system according to your requirements.

Validity of the user application description

This application description is only valid for the R-IB IL 24 PSDOR 4-PAC module in the version indicated on the inner cover page.

User group of this application description

The use of products described in this application description is oriented exclusively to qualified electricians or persons instructed by them, who are familiar with applicable standards and other regulations regarding electrical engineering and, in particular, the relevant safety concepts.

Bosch Rexroth accepts no liability for erroneous handling or damage to products from Bosch Rexroth or third-party products resulting from disregard of information contained in this application description.

2.1 General Safety Notes

⚠ WARNING **Depending on the application, incorrect handling of the safety module can pose serious risks for the user**

When working with the safety module within the PROFIsafe system, please observe all the safety notes included in this section.

Requirements

Knowledge of the following is required:

- The non-safety-related target system (PROFIBUS, PROFINET)
- The PROFIsafe system
- The components used in your application
- The Rexroth-Inline product range
- Operation of the software tools used
- Safety regulations in the field of application

For Your Safety

Qualified personnel

In the context of the use of the PROFIsafe system, the following operations may only be carried out by qualified personnel:

- Planning
- Configuration, parameterization, programming
- Installation, startup, servicing
- Maintenance, decommissioning

This application description is, therefore, aimed at:

- Qualified personnel who plan and design safety equipment for machines and systems and are familiar with regulations governing safety in the workplace and accident prevention
- Qualified personnel who install and operate safety equipment in machines and systems

In terms of the safety notes in this application description, qualified personnel are persons who, because of their education, experience and instruction, and their knowledge of relevant standards, regulations, accident prevention, and service conditions, have been authorized to carry out any required operations, and who are able to recognize and avoid any possible dangers.

Documentation

You must observe all information in this application description as well as in the documents listed in Chapter “Documentation” on page 12.

Safety of personnel and equipment

The safety of personnel and equipment can only be assured if the safety module is used correctly (see Chapter “Correct Usage” on page 11).

Error detection

Depending on the wiring and the corresponding setting of the safe output module parameters, the PROFIsafe system can detect various errors within the safety equipment.

Do not carry out any repairs

Repair work may not be carried out on the safety module.

In the event that an error cannot be removed, please contact Bosch Rexroth immediately, engage a service engineer or send the faulty module directly to Bosch Rexroth.

Do not open the housing

It is strictly prohibited to open the housing. If the housing is opened, correct operation of the module can no longer be ensured.

Measures to prevent incorrect connection and polarity reversal

Take measures to prevent the incorrect connection, polarity reversal, and manipulation of connections.

2.2 Electrical Safety

⚠ WARNING **Hazardous body currents and the loss of functional safety**

Disregarding instructions for electrical safety may result in hazardous body currents and the loss of functional safety.

In order to ensure electrical safety, please observe the following points.

⚠ WARNING **Dangerous contact voltage**

Hazardous voltages may occur at the relay contacts of the safety module. Failure to observe these instructions can lead to damage to health or even life-threatening injury.

- Work on the safety module may only be carried out by qualified personnel who are familiar with the necessary safety precautions.
- Before working on the safety module or the system, disconnect the mains voltage and ensure that it cannot be switched on again.
- Only connect or remove the COMBICON connector when the mains voltage is disconnected.

Direct/indirect contact

Protection against direct and indirect contact according to VDE 0100 Part 410 must be ensured for all components connected to the system. In the event of an error, parasitic voltages must not occur (single-fault tolerance).

This can be achieved by:

- Using power supply units with safe isolation (PELV).
- Decoupling circuits, which are not PELV systems, using optocouplers, relays, and other components, which meet the requirements of safe isolation.

Power supply units for 24 V supply

Only use power supply units with safe isolation and PELV according to EN 50178/VDE 0160 (PELV). This prevents short circuits between primary and secondary sides.

Make sure that the output voltage of the power supply does not exceed 32 V even in the event of an error.

Insulation rating

When selecting the operating equipment, please take into consideration the contamination and surge voltages, which may occur during operation.

The R-IB IL 24 PSDOR 4-PAC module is designed for surge voltage category II (according to DIN EN 60664-1). If you expect surge voltages in the system, which exceed the values defined in surge voltage category II, take into consideration additional measures for voltage limitation.

Installation and configuration

Please observe the instructions for installing and configuring the system (see Chapter “Documentation” on page 12).

⚠ WARNING **Depending on the application, incorrect installation and upgrades can pose serious risks for the user**

The user is obliged to design the devices used and their installation in the system according to these requirements. This also means that existing plants and systems retrofitted with PROFIsafe must be checked and tested again in this respect.

2.3 Safety of the Machine or System

The machine/system manufacturer and the operator are solely responsible for the safety of the machine or system and the implemented application, in which the machine or system is used. The Machinery Directive must therefore be observed.

Draw up and implement a safety concept

In order to use the safety module described in this document, you must have drawn up an appropriate safety concept for your machine or system. This includes a hazard and risk analysis according to the directives and standards specified in Chapter “Directives and Standards” on page 11, as well as a test report (checklist) for validating the safety function (see “Checklists” on page 103).

The target safety integrity level (SIL according to EN 61508, SILCL according to EN 62061 or performance level and category according to EN ISO 13849-1) is ascertained on the basis of the risk analysis. The safety integrity level ascertained determines how to connect and parameterize the safety module within the overall safety function.

Within a PROFIsafe system, the R-IB IL 24 PSDOR 4-PAC safety module can be used to achieve safety functions with the following requirements:

- Up to SIL 3 according to standard EN 61508
- Up to SILCL 3 according to standard EN 62061
- Up to Cat. 4/PL e according to standard EN ISO 13849-1

Check hardware and parameterization

Carry out a **validation** every time you make a safety-related modification to your overall system.

Use your test report to ensure that:

- The safe devices are connected to the correct safe sensors and actuators
- The safe input and output devices have been parameterized correctly
- The variables have been linked to the safe sensors and actuators correctly (single-channel or two-channel)

2.4 Directives and Standards

The manufacturers and operators of machines and systems, in which the R-IB IL 24 PSDOR 4-PAC module is used, are responsible for adhering to all applicable directives and legislation.

For the standards observed by the module, please refer to the certificate issued by the approval body and the EC declaration of conformity. These documents are available on the Internet at www.boschrexroth.com/electrics.

2.5 Correct Usage

Only use the PROFIsafe system in accordance with the instructions in this section.

The safety module is designed exclusively for use in a PROFIsafe system.
It can only perform its safety-related tasks within the system if it has been integrated into the execution process correctly and in such a way as to avoid errors.

You must observe all information in this application description as well as in the documents listed in Chapter “Documentation” on page 12. In particular, only use the module according to the technical data and ambient conditions specified in Chapter “Technical Data and Ordering Data” on page 87 and onwards.

Within a PROFIsafe system, the safety module can be used to achieve safety functions with the following requirements depending on the conditions of use:

- Up to SIL 3 according to standard EN 61508
- Up to SILCL 3 according to standard EN 62061
- Up to Cat. 4/PL e according to standard EN ISO 13849-1

It is designed for connecting single-channel or two-channel actuators, which can be used in association with safety technology.
For example, the module can be used in the following applications:

- Safety circuits according to EN 60204 Part 1
- Safe shutdown of contactors, motors (24 V DC), valves, ohmic and inductive loads as well as electronic loads, which are approved for this purpose

The module is not suitable for applications, in which stop category 1 also has to be observed in the event of an error.

2.6 Documentation

Latest documentation

Make sure you always use the latest documentation. Changes or additions to this document can be found on the Internet at www.boschrexroth.com/electrics.

PROFIsafe

When working on the PROFIsafe system and its components, you must always keep this application description and other items of product documentation to hand and observe the information therein.

Application descriptions:

- For the safe controller used
- For PROFIsafe I/O modules
- For PROFIsafe function blocks

Please also observe the relevant information about PROFIBUS, PROFINET, and PROFIsafe, which is available on the Internet at www.profisafe.net.

Inline product range

DOK-CONTRL-ILSYSINS***-AW..-EN-P
Automation modules of the Rexroth Inline product range (configuration and installation)

Documentation for the bus coupler used

2.7 Abbreviations Used

Abbreviation	Meaning	Standard	Example
SIL	Safety integrity level	EN 61508	SIL 2, SIL 3
SILCL	SIL claim limit	EN 62061	SILCL 3
Cat.	Category	EN ISO 13849-1	Cat. 2, Cat. 4
PL	Performance level	EN ISO 13849-1	PL e, PL d

Fig. 2-1 Abbreviations used

Abbreviation	Meaning
PELV	Protective extra-low voltage A circuit in which the voltage does not exceed 30 V AC, 42.4 V peak value or 60 V DC under normal conditions or single-fault conditions, except in the event of grounding errors in other circuits. A PELV circuit is like a SELV circuit, but is connected to protective earth ground. (According to EN 61131-2)
EUC	Equipment under control

Fig. 2-2 Abbreviations used

For terms and abbreviations used for PROFIsafe, please refer to “PROFIsafe Terms Used in the Application Description” on page 97.

2.8 Safety Hotline

Should you have any technical questions, please contact our 24-hour hotline.

Phone: + 49 9352 40 5060

E-mail: service.svc@boschrexroth.de

For Your Safety

3 Product Description

3.1 Brief Description of the Safety Module

The R-IB IL 24 PSDOR 4-PAC module is an output module, which is designed for use within a Rexroth Inline station.

The safety module can be used as part of a Rexroth Inline station at any point within a PROFIsafe system. There are no restrictions for previous modules. If you want to use the option to switch off the safety-related segment circuit, only suitable modules may be used in the safety-related segment circuit (see “Safety-Related Segment Circuit” on page 19). Following a boost using a suitable power terminal, there are no restrictions for subsequent modules.

The transmission speed of the Inline local bus can be set to 500 kbaud or 2 Mbaud on the safety module using switches.

One transmission speed must be used seamlessly in an Inline station.Please note that standard Inline terminals operate with 500 kbaud only. Therefore, you also have to set the baud rate of the safety modules to 500 kbaud in a combined system.

The module has a 10-pos. DIP switch, which is used to set the PROFIsafe address.

The module has four safety relays, which can be operated via one or two channels depending on the parameterization.

The relay outputs can be parameterized according to the application and enable the integration of actuators in the PROFIsafe system.

The module can be used to create a safety-related segment circuit within a Rexroth Inline station (see “Safety-Related Segment Circuit” on page 19).

The module also has two clock outputs with assigned alarm inputs for optional monitoring of external contact extensions.

Within a PROFIsafe system, the safety module can be used to achieve safety functions with the following requirements depending on the conditions of use:

- Up to SIL 3 according to standard EN 61508
- Up to SILCL 3 according to standard EN 62061
- Up to Cat. 4/PL e according to standard EN ISO 13849-1

The output data is exchanged between the safe controller and the module using safety-relevant messages.

Product Description

3.2 Structure of the Safety Module

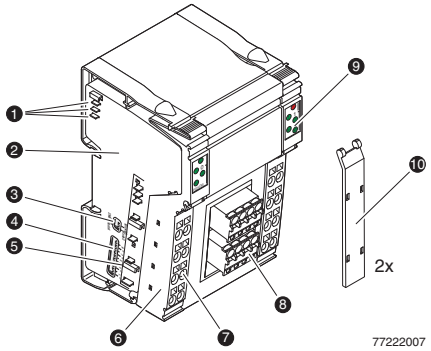


Fig. 3-1 Structure of the safety module

1 Data jumpers (local bus)

2 Electronics base with labeling including hardware/firmware/firmware version designation (not shown)

3 Switch for setting the transmission speed and mode

4 Switch for setting the address

For more detailed information about setting the switches, please refer to “Setting the DIP Switches” on page 34.

5 Potential jumper

6 Inline connector; for assignment see Chapter “Terminal Point Assignment” on page 30

7 Terminal points

8 COMBICON connector

9 Diagnostic and status indicators; for assignment and meaning see Chapter “Local Diagnostic and Status Indicators” on page 21

10 Labeling field

3.3 Housing Dimensions

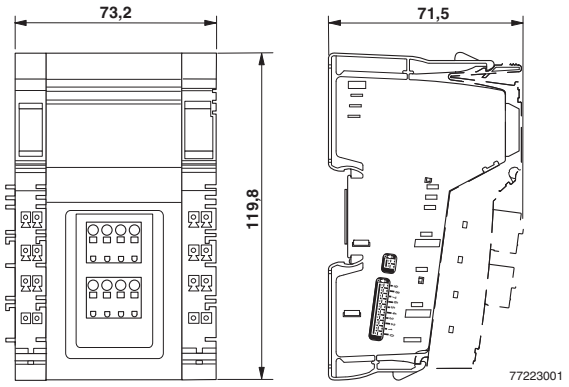


Fig. 3-2 Housing dimensions (in mm)

3.4 Safe Digital Relay Outputs (Floating Contacts)

The safety module has four safety relays each with two floating relay contacts (relay outputs), which can be used as follows:

For two-channel assignment:

- Two two-channel relay outputs

For single-channel assignment:

- Four single-channel relay outputs

Basic structure

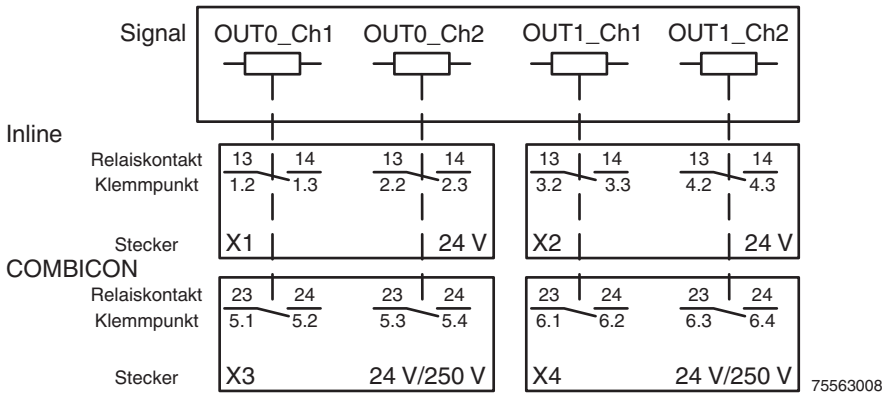


Fig. 3-3 Basic representation of the relay outputs

Key:

OUT0_Ch1	Relay output 0, channel 1
OUT0_Ch2	Relay output 0, channel 2
OUT1_Ch1	Relay output 1, channel 1
OUT1_Ch2	Relay output 1, channel 2

(For connections, see “Terminal Point Assignment” on page 30)

Technical data For the technical data for the safe relay outputs, please refer to page 90.

Fuse protection Protect the relay outputs against overcurrent with a suitable fuse. Fuses with an I^2t value of less than 100 A^2s and a nominal current of less than or equal to 6 A are permitted.

⚠ WARNING **Loss of the safety function when using miniature circuit breakers**

Miniature circuit breakers are not suitable for protection in the 230 V 50/60 Hz mains and must not be used.

At 24 V DC, a 4 A miniature circuit breaker with characteristic C can be used, whereby the maximum short-circuit current (IK) of 250 A must not be exceeded. Make sure that the miniature circuit breaker trips in the event of a short circuit for your DC application. This depends on the power supply unit used.

Product Description

Parameterization

The individual safe digital relay outputs of a safety module can be parameterized differently. This means that the relay outputs can be adapted to various operating conditions and different safety integrity levels can be implemented (SIL, SILCL, Cat., PL) (see “Connection Examples” on page 45).

For information about parameterization, please refer to Chapter “Parameterization of the Safe Relay Outputs” on page 42.

Diagnostics

Diagnostics are provided via both the local diagnostic indicators and the diagnostic messages, which are transmitted to the safe controller.

For information about the diagnostic messages of the relay outputs, please refer to Chapter “Safe Digital Relay Output Errors” on page 81.

⚠ CAUTION **Diagnostic data is not safety-related**

Do not use the diagnostic data to execute safety-related functions or actions.

Requirements for controlled devices/actuators

The error detection of the module varies depending on the parameterization. This results in specific requirements for the actuators.

- Only use appropriately qualified actuators.
- Use reliable components. These include, for example:
  - Control contactors according to EN 60947-4-1
  - Power contactors
  - Relays with forcibly guided contacts according to DIN EN 50205
- Use relays or contactors with forcibly guided N/C contacts to safely monitor the state (pick-up, drop-out).
- Please observe any special environmental requirements in your application when selecting the controlled devices.
- Please note applicable C standards in your application (e.g., EN 1010), in which, for example, the number of controlled devices required to achieve a particular category is specified.
- Observe the required measures for safe isolation between areas with voltages greater than PELV and PELV areas (for an explanation of PELV, see Chapter “Abbreviations Used” on page 13).
- A protective circuit via the relay contacts is not permitted.

Achievable safety integrity level

The achievable safety integrity level (SIL, SILCL, Cat., PL) depends on the following parameters:

- Parameterization (two-channel or single-channel)
- Load wiring (error prevention can also play a role here)
- Load (DC, AC, current, voltage, etc.)
- Switching frequency

In order to detect all errors, the safety relays must be switched at regular intervals (for proof test interval, see “Safe digital relay outputs” on page 90).

3.5 Safety-Related Segment Circuit

The module can be used to create a safety-related segment circuit.

The safety-related segment circuit starts at the safety module and finishes at the last module before another power supply unit or at the end of the station. Only Rexroth Inline modules that are specifically designed for this safety-related segment circuit may be used.

The safety module can be used to safely connect or disconnect the supply voltage (segment supply) to the subsequent Inline modules in the safety-related segment circuit.

A maximum of 4 A can be switched in this safety-related segment circuit.

Observe the specifications for the safety-related segment circuit in the “Safety-related segment circuit” application note
(see Chapter “Ordering Data: Documentation” on page 95).

The application note includes lists of approved modules, requirements for wiring, and safety notes.

The document is available on the Internet at www.boschrexroth.com/electrics.

3.6 Clock Outputs UT1 and UT2

The module has two clock outputs, UT1 and UT2, which only operate together with the assigned alarm inputs, IN1 and IN2.

The clock outputs provide the input voltage for the alarm inputs. Each of these clock outputs provides a pulse pattern for monitoring the external wiring and the connected loads.

NOTICE **Incorrect use of the clock outputs or alarm inputs may damage the device**

- The clock outputs and alarm inputs are not safe inputs and outputs. They are used for diagnostic purposes only and are not available to the safe controller.
- The clock outputs must not be used to supply external loads.

Parameterization The assignment of clock outputs to alarm inputs is fixed and cannot be parameterized.

Technical data For the technical data for the clock outputs, please refer to page 93.

Error detection Error detection is via the assigned alarm input.

Diagnostics The diagnostics of clock outputs and the associated alarm inputs are based on the expected behavior for the corresponding signals depending on the switching state of the monitored load.

3.7 Alarm Inputs IN1 and IN2

The module has two alarm inputs, IN1 and IN2, which only operate together with the assigned clock outputs, UT1 and UT2. They are used for contact monitoring for externally connected switching elements. This function can be used to monitor the contacts of externally connected switching elements. The monitoring function is performed locally on the device and does not have to be carried out in the safe application program.

As an option, the monitoring function can be parameterized and assigned to a relay output.

Parameterization

The assignment of clock outputs to alarm inputs is fixed and cannot be parameterized.

The assignment of an alarm input to a relay output is specified during parameterization of the relay output.

If an alarm input is assigned to the relay output, ensure that:
When an output is switched off, the output can only be switched on again after 300 ms because the internal circuit is subject to internal checks during this time.

Alarm inputs IN1 and IN2 can only be assigned to an output once. Parallel connection of the alarm contacts is not permitted.

Technical data

For the technical data for the alarm inputs, please refer to page 93.

Error detection and behavior in the event of an error

The status of the alarm inputs is constantly compared with the desired status of the assigned outputs. In the event of deviations, the affected outputs are switched off and a diagnostic error message is sent to the safe controller.

Through the dynamization of signals and the corresponding expected behavior in the device firmware, all errors, which can occur internally in the circuit or externally in the wiring, are detected.

For two-channel assignment, both outputs are switched off if an alarm input indicates an error.

Diagnostics

Diagnostics of the alarm inputs are provided via both the local diagnostic indicators and the diagnostic messages, which are transmitted to the safe controller.

For information about the diagnostic messages of the alarm inputs, please refer to Chapter “Safe Digital Relay Output Errors” on page 81.

The diagnostic data is not safety-related. This data must not be used to execute safety-related functions.

3.8 Connection Options for Actuators Depending on the Parameterization

Actuators that meet various safety requirements depending on the parameterization can be connected to the relay outputs and the output modules in the safety-related segment circuit. For connection examples, please refer to Chapter 7, "Connection Examples".

The maximum achievable SIL/SILCL/Cat./PL is specified in the table.
In order to achieve this:

- Observe the information in the connection examples (see Chapter 7, "Connection Examples")
- Observe the requirements of the standards with regard to the external wiring and the actuators to be used to achieve a SIL/SILCL/Cat./PL (see "Measures Required to Achieve a Specific Safety Integrity Level" on page 47)

	Relay output		Safety-related segment circuit
"Output" parameterization	Single-channel	Two-channel	Two-channel
Achievable safety integrity level	SILCL 1/Cat. 1*)/PL c	SILCL 3/Cat. 4/PL e	SILCL 3/Cat. 4/PL e
For connection example, see page	49	53 57	63 66

*) Depending on the application, suitable up to cat. 2.

To achieve Cat. 3 or 4, two-channel actuators are usually used.

3.9 Local Diagnostic and Status Indicators

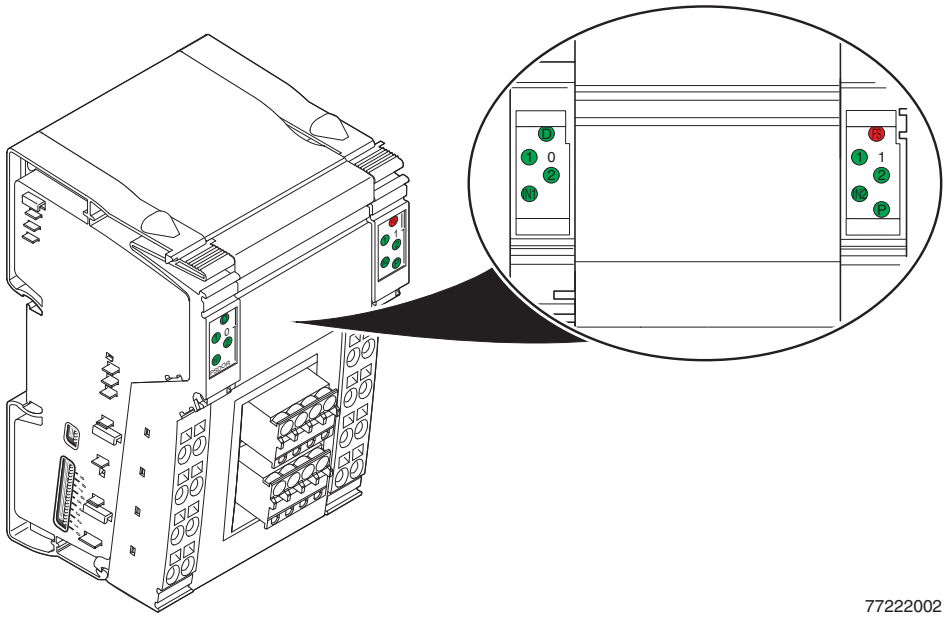


Fig. 3-4 Local diagnostic and status indicators on the R-IB IL 24 PSDOR 4-PAC module

Product Description

D	Green LED	Diagnostics
	OFF:	Communications power not present
	Flashing at 0.5 Hz:	Communications power present, local bus not active
	Flashing at 4 Hz:	Communications power present, error at the interface between previous and flashing, terminal (the terminals after the flashing terminal cannot be addressed). (E.g., loose contact at the bus interface, terminal before the flashing terminal has failed, another terminal was snapped on during operation (not permitted))
	Observe the module startup time of approximately 16 s. During this time the D LED flashes at 4 Hz and the bus cannot be started up.	
	ON:	Communications power present, local bus active
FS	Red LED	Failure state
	Flashing at 1 Hz:	Device not parameterized or parameterization was not accepted
	ON:	Hardware fault Communication to safe controller disabled and output driver enable reset
OUT **0.1, 0.2** **1.1, 1.2**	Green/red LED	Status of each relay output (see “Terminal Point Assignment” on page 30) 0.1 Relay output 0, channel 1; 0.2 Relay output 0, channel 2 1.1 Relay output 1, channel 1; 1.2 Relay output 1, channel 2
	Green:	Relay output at logic 1
	OFF:	Relay output at logic 0, no error
	Red ON:	An error has occurred, the output is switched off. Hardware fault or signal error at an alarm input. (This diagnostic message is stored temporarily on the terminal. The message is stored in the volatile memory and will be lost after a voltage reset.)
	In the event of an error (red LED ON), the relay output is switched off until the acknowledgment sent by the safe controller is received by the safety module (see also Chapter “Safe Digital Relay Output Errors” on page 81).	
IN1 **IN2**	Green LED	Status of each alarm input (see “Terminal Point Assignment” on page 30)
	Green:	Input at logic 1
	OFF:	Input at logic 0, no error
	If an error occurs on an alarm input of an output parameterized as “two-channel”, the other corresponding channel also enters the safe state.	
P	Green LED	Status indicator for safe communication
	OFF:	No safe communication
	Flashing at 0.5 Hz:	Safe communication running, the controller requests operator acknowledgment
	ON:	Safe communication running without errors

Fig. 3-5 Local diagnostic and status indicators

3.10 Safe State

The safe state for the module is the zero current state at the output modules, i.e., the relay contacts are open (see Chapter “Safe Digital Relay Outputs (Floating Contacts)” on page 17).

The safe state for the F-Output data is “0”.

The safe state is entered by means of passivation (see “Passivation” on page 98).

The safe state can be entered in the following cases:

1. Operating state
1. Error detection in I/O devices
1. Device errors
1. Parameterization errors

3.10.1 Operating State

In the operating state, the relay outputs can enter states “1” or “0”. In general, state “0” is the safe state.

⚠ WARNING **No communication; loss of the safety function possible due to undetected accumulation of errors**

If there is no communication with the safe controller: Disconnect the module from the supply voltage after a maximum of eight hours.

3.10.2 Error Detection in I/O Devices

Relay outputs

If an error is detected at a relay output, the affected relay output is disabled (“0” = OFF = safe state).

Depending on the parameterization, the following errors can be detected at relay outputs:

- An external load does not pick up (if the alarm inputs are used)
- An external load does not drop out (if the alarm inputs are used)

The relevant diagnostic message is transmitted to the safe controller (see Chapter “Safe Digital Relay Output Errors” on page 81). For information about which errors are detected and when, please refer to Chapter “Connection Examples” on page 45.

If an error occurs on a channel of an output parameterized as “two-channel”, the other corresponding channel also enters the safe state.

3.10.3 Device Errors

Relay outputs

If a hardware fault in the internal circuit is detected at a relay output, **all** module relay outputs are disabled (“0” = OFF = safe state).

The relevant diagnostic message is transmitted to the safe controller (see Chapter “Safe Digital Relay Output Errors” on page 81).

⚠ WARNING **Loss of safety function**

On a device error in Cat.2 applications (single-channel), it is not always possible to enter the safe state.

In the event of a device error, the following measures should be taken:
Disconnect the module from the power supply and replace it.

Serious errors

All serious errors that can result in the loss of or adversely affect the safety function cause the entire module to enter the safe state. The FS LED on the safety module is permanently on.

The following errors result in the safe state:

- Serious hardware faults in the internal circuit
- User errors
- Module overload
- Module overheating
- Incorrect supply

The relevant diagnostic message is transmitted to the safe controller (see Chapter “Errors: Messages and Removal” on page 79).

⚠ WARNING **Loss of the safety function due to sequential errors**

In the event of a device error, the following measures should be taken to prevent sequential errors:
Disconnect the module from the power supply and replace it.

3.10.4 Parameterization Errors

Parameterization errors are indicated:

- As long as the module is not parameterized

or

- In the event of faulty parameterization

Parameterization errors cause the entire module to enter the safe state. The FS LED on the safety module flashes.

In the event of faulty parameterization, the relevant diagnostic message is transmitted to the safe controller (see Chapter “Parameterization Errors” on page 83).

Exception:
If an output is operated in stop category 1 and this output is within the switch-off delay time, then faulty parameterization results in the entire module switching to the safe state only once the switch-off delay time has elapsed.

3.11 Enabling Safe Outputs

A “1” is only forwarded by the PST (PROFIsafe driver for F-Slaves) to the SAL (safety application layer) for a safe output if the consecutive number has changed in the corresponding PROFIsafe container.

A “0” is always forwarded.

This prevents the toggling of an output by telegrams with the same consecutive number (e.g., by changing the order of PROFIsafe containers with the same consecutive number).

3.12 PROFIsafe Process Data Words (PROFIBUS, PROFINET)

The module occupies four words in the Inline system. The way in which these words are mapped in the higher-level control system is specific to the controller used and is described in the system documentation for the controller.

Product Description

3.13 Programming Data/Configuration Data

3.13.1 Local Bus

	PROFIsafe
Switch address	Any, 1_{hex} .... $3FE_{hex}$
Mode switch	Mode 1
ID code	CB_{hex} (203_{dec})
Length code	04_{hex} (04_{dec})
Input address area	Controller-specific
Output address area	Controller-specific
Parameter channel (PCP)	1 word
Register length	4 words

The PCP channel is only used internally.

3.13.2 PROFIBUS, PROFINET

The programming data/configuration data is defined in the device description (e.g., GSD, GSDML, etc.) according to the bus or network used.

4 Inline Potential and Data Routing, and Inline Connectors

4.1 Inline Potential and Data Routing

In order to operate the safety module it must be integrated in an Inline station within the PROFIsafe system.

The bus signals are transmitted via the Inline data jumpers. The required supply voltages are transmitted via the Inline potential jumpers.

For more detailed information about potential and data routing within a Rexroth Inline station, please refer to the DOK-CONTRL-ILSYS-INS***-AW..-EN-P application description.

The safety module interrupts the potential routing of the Rexroth Inline station for the segment circuit.

If a new segment is to be opened in the Inline station after the safety-related segment circuit, the supply voltages U_M and U_S must be boosted at the power terminal designed for the safety-related segment circuit.

4.2 Supply Voltage U_L

Supply the 24 V supply voltage U_{BK}/U_{24V} at a bus coupler or a suitable power terminal (R-IB IL 24 PWR IN/R-PAC). The 7.5 V voltage U_L is generated from this 24 V supply voltage in the bus coupler or power terminal. It is supplied to the safety module via the Inline potential jumper U_L.

⚠ WARNING **Loss of the safety function when using unsuitable power supplies**

Please note for the voltage supply at the bus coupler or the power terminal that:
Only power supplies according to EN 50178/VDE 0160 (PELV) may be used.
Make sure that the output voltage of the power supply does not exceed 32 V even in the event of an error.
Please also observe the points in Chapter “Electrical Safety” on page 9.

The supply voltage **U_L** is used to supply the communications power and the relays. For the technical data for the supply voltage U_L, please refer to Chapter “Supply voltage U_L (logic, relay)” on page 89.

The maximum current carrying capacity for the supply voltage U_L is 2 A.
This current carrying capacity can be reduced if certain terminals are used. Please refer to the information in the terminal-specific data sheets.

4.3 Supply Voltage U_M

Supply the supply voltage at a bus coupler or a power terminal. It is supplied to the safety module via the Inline potential jumper U_M.

⚠ WARNING **Loss of the safety function when using unsuitable power supplies**

Please observe the points in Chapter “Electrical Safety” on page 9.

The supply voltage **U_M** is used to supply the clock outputs. For the technical data for the supply voltage U_M, please refer to Chapter “Supply voltage U_M (clock outputs)” on page 90.

The maximum current carrying capacity for the main circuit U_M is 8 A (total current with the segment circuit that is not used in the safety module).
This current carrying capacity can be reduced if certain terminals are used. Please refer to the information in the terminal-specific data sheets.
If the limit value of the potential jumpers U_M and U_S is reached (total current of U_S and U_M), a new power terminal must be used.

NOTICE **Module damage due to polarity reversal**

Polarity reversal places a burden on the electronics and, despite protection against polarity reversal, can damage the module. Therefore, polarity reversal must be prevented.

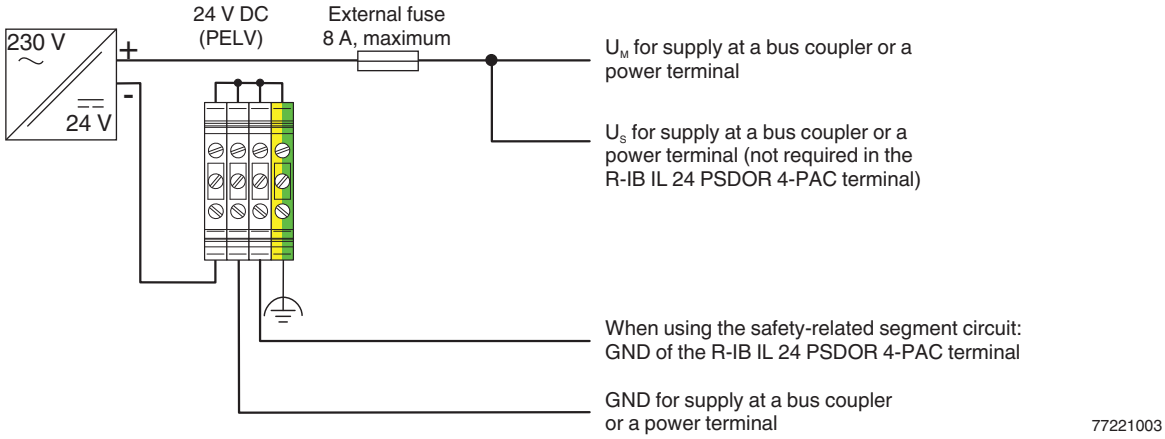


Fig. 4-1 *Supply U_M with connection to functional earth ground according to EN 60204-1*

⚠ WARNING **Loss of functional safety due to parasitic voltages**

Supply the supply voltages U_M and U_S at a bus coupler and/or a power terminal from the same power supply unit, so that the loads of R-IB IL 24 PSDOR 4-PAC are not affected by parasitic voltages in the event of an error.

NOTICE

Damage to module electronics in the event of surge voltage

Do not use a DC distribution network.

DC distribution network according to IEC 61326-3-1:
A DC distribution network is a DC power supply network, which supplies a complete industrial hall with DC voltage and to which any device can be connected. A typical system or machine distribution is not a DC distribution network. For devices that are provided for a typical system or machine distribution, the DC connections are viewed and tested as I/O signals according to IEC 61326-3-1.

4.4 Supply Voltage U_S

The safety module interrupts the potential routing of the Inline station for the segment circuit (see also Chapter “Internal Basic Circuit Diagram” on page 32).

There are two options for inserting additional Inline terminals after the safety module:

1. Use of the safety-related segment circuit.
   For general information, please refer to Chapter “Safety-Related Segment Circuit” on page 19; for connection examples, please refer to Chapter “Safety-Related Segment Circuit” on page 61.
1. Use of the segment circuit.
   In order to use the interrupted segment circuit, the segment voltage must be supplied again. The following options are available:
   - Insert a jumper between terminal points 3.1 (U_M) and 4.1 (U_S).

   or
   - Insert a segment or power terminal after the safety module.

When using the safety-related segment circuit, observe the notes in Chapter “Safety-Related Segment Circuit” on page 61.

4.5 Terminal Point Assignment

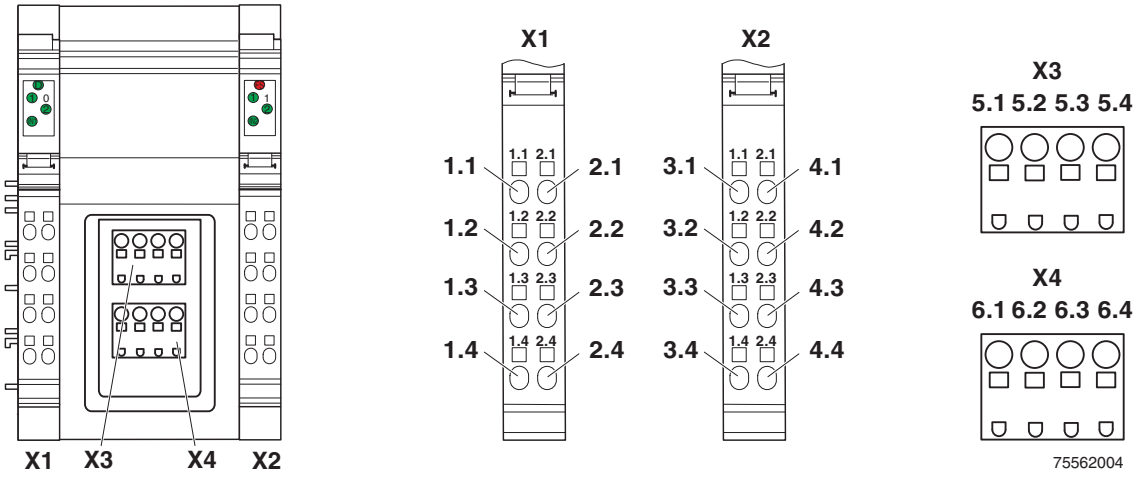


Fig. 4-2 Assignment of plug-in connectors on the terminal

For the IB IL 24 SDOR 4-PAC, the Inline and COMBICON connectors are supplied with the terminal. They are keyed and labeled accordingly for connection to prevent polarity reversal. If other connectors are used according to the ordering data, they must also be keyed.

Only use the connectors supplied with the terminal or connectors that are approved as replacement items (see “Ordering Data” on page 95).

The following applies for the tables below:

- All relay outputs are safe digital relay outputs.
- All relay contacts are floating N/O contacts.

⚠ WARNING **Loss of electrical and functional safety if potential areas are not observed**

There is no safe isolation between the contacts of a COMBICON connector.

Only connect one voltage range to a COMBICON connector.
See also Fig. 3-3 "Basic representation of the relay outputs".

⚠ WARNING **Loss of electrical and functional safety due to surge voltage**

The terminal is not suitable for switching linked voltages.
Make sure that no linked voltages occur.

Terminal point	Signal	Channel assignment	Remark
1.1	GND	None	0 V
2.1	GND	None	0 V
1.2	OUT0_Ch1_13	Relay output 0, channel 1, contact 13	24 V
2.2	OUT0_Ch2_13	Relay output 0, channel 2, contact 13	24 V
1.3	OUT0_Ch1_14	Relay output 0, channel 1, contact 14	24 V
2.3	OUT0_Ch2_14	Relay output 0, channel 2, contact 14	24 V
1.4	UT1	Clock output channel 1	Feedback circuit 1 (external contact monitoring)
2.4	IN1	Alarm input channel 1	

Fig. 4-3 Terminal point assignment for Inline connector X1

Terminal point	Signal	Channel assignment	Remark
3.1	U_M	None	
4.1	U_S	None	
3.2	OUT1_Ch1_13	Relay output 1, channel 1, contact 13	24 V
4.2	OUT1_Ch2_13	Relay output 1, channel 2, contact 13	24 V
3.3	OUT1_Ch1_14	Relay output 1, channel 1, contact 14	24 V
4.3	OUT1_Ch2_14	Relay output 1, channel 2, contact 14	24 V
3.4	UT2	Clock output channel 2	Feedback circuit 2 (external contact monitoring)
4.4	IN2	Alarm input channel 2	

Fig. 4-4 Terminal point assignment for Inline connector X2

Terminal point	Signal	Channel assignment	Remark
5.1	OUT0_Ch1_23	Relay output 0, channel 1, contact 23	24 V or 250 V
5.2	OUT0_Ch1_24	Relay output 0, channel 1, contact 24	24 V or 250 V
5.3	OUT0_Ch2_23	Relay output 0, channel 2, contact 23	24 V or 250 V
5.4	OUT0_Ch2_24	Relay output 0, channel 2, contact 24	24 V or 250 V

Fig. 4-5 Terminal point assignment for COMBICON connector X3

Terminal point	Signal	Channel assignment	Remark
6.1	OUT1_Ch1_23	Relay output 1, channel 1, contact 23	24 V or 250 V
6.2	OUT1_Ch1_24	Relay output 1, channel 1, contact 24	24 V or 250 V
6.3	OUT1_Ch2_23	Relay output 1, channel 2, contact 23	24 V or 250 V
6.4	OUT1_Ch2_24	Relay output 1, channel 2, contact 24	24 V or 250 V

Fig. 4-6 Terminal point assignment for COMBICON connector X4

"24 V" and "250 V" refer to the relevant voltage ranges (see also Fig. 3-3 "Basic representation of the relay outputs"). For the actual switching voltage ranges, please refer to the technical data ("Safe digital relay outputs" on page 90).

4.6 Internal Basic Circuit Diagram

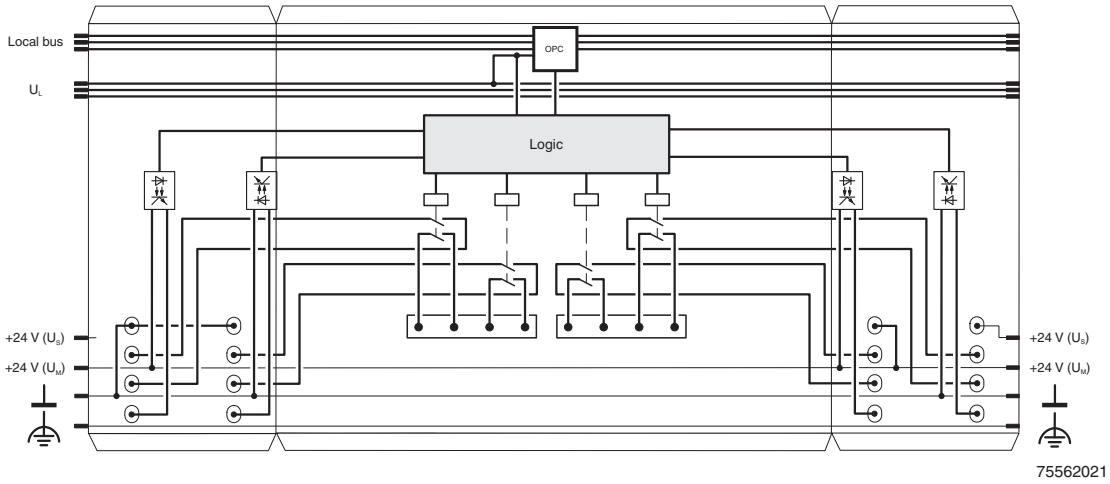


Fig. 4-7 Internal basic circuit diagram

Key:

OPC	Protocol chip (bus logic including voltage conditioning)	○	Terminal point
	Logic circuit		Potential or data jumpers with jumper contacts on the side
	Optocoupler	x	Cable(s); x indicates the number of cables
	Forcibly guided N/O contact		COMBICON connection

5 Assembly, Removal, and Electrical Installation

5.1 Assembly and Removal

5.1.1 Unpacking the Module

The module is supplied in an ESD box together with a package slip with installation instructions. Please read the complete package slip carefully.
The module may only be installed and removed by qualified personnel.

NOTICE **Electrostatic discharge**

The safety module contains components that can be damaged or destroyed by electrostatic discharge. When handling the safety module, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and EN 61340-5-2.

5.1.2 General

⚠ WARNING **Electric shock/unintentional machine startup**

Do not assemble or remove the module while the power is connected.

Before assembling or removing the module, disconnect the power to the module and the entire Inline station and ensure that it cannot be switched on again.

Make sure the entire station is reassembled before switching the power back on. Observe the diagnostic indicators and any diagnostic messages.

The system may only be started provided neither the station nor the system poses a hazard.

The safety module is designed for use within an Inline station. Only use the safety module in the 24 V DC area of a Rexroth Inline station.

To ensure reliable operation, install the safety module in housing protected from dust and humidity (IP54 or above). In order to prevent manipulation, secure the housing (control cabinet/control box) against being opened by unauthorized persons.

Mount all Rexroth Inline modules on 35 mm DIN rails.

Only connect the cables using the supplied Inline and COMBICON connectors or Inline and COMBICON connectors listed in the ordering data.

Assembly, Removal, and Electrical Installation

5.1.3 Setting the DIP Switches

The module has a 2-pos. and a 10-pos. DIP switch.

The DIP switches are located on the left-hand side of the safety module.

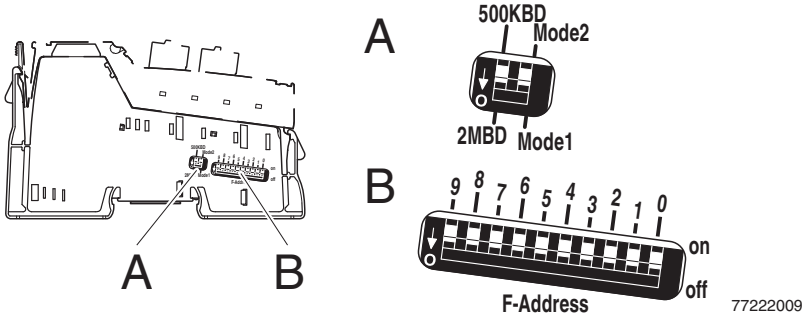


Fig. 5-1 DIP switches

A Switch for setting the transmission speed and the mode

B Switch for setting the address

2-pos. DIP switch: The transmission speed and the mode are set via the 2-pos. DIP switch.

Left switch: Transmission speed The transmission speed can be set to 500 kbaud or 2 Mbaud.
The transmission speed is set to 500 kbaud by default.

Only use devices with a uniform transmission speed within a Rexroth Inline station (a local bus). A mixture of devices with different transmission speeds cannot be operated.

Right switch: Mode For PROFIsafe, set Mode 1.

10-pos. DIP switch: Address Use this DIP switch to set the PROFIsafe address (F-Address).

PROFIsafe addresses 1 to 1022 (1_{hex} to $3FE_{hex}$) are permitted. Address $3FF_{hex}$ is not valid. The default address is 200_{hex} (switch DIP-9 to “ON”).

Overview of the switch positions

PROFIsafe										
Mode switch	**Address switch**									
	9	8	7	6	5	4	3	2	1	0
Mode 1										
	1_{hex} to $3FE_{hex}$									

Fig. 5-2 Switch position for PROFIsafe

Procedure If the DIP switch settings have to be modified, proceed as follows:

- Use the switch to set the transmission speed to 500 kbaud or 2 Mbaud.
- Set the address.

Set the DIP switches **before** assembling the module in the Inline station. The switches cannot be accessed when the safety module is installed in the Inline station.

5.1.4 Assembly and Removal of the Safety Module

For general information about assembling and removing Inline modules, please refer to the DOK-CONTRL-ILSYSINS***-AW..-EN-P application description.

Mounting

- Set the DIP switches prior to assembly (see Chapter “Setting the DIP Switches” on page 34). The DIP switches cannot be accessed when the safety module is installed in the Inline station.
- Observe a mounting distance of 30 mm above and 40 mm below the safety module. Shorter distances may inhibit proper handling during installation.

- Disconnect the power to the station.
- Before snapping on the safety module, remove the inserted Inline connectors from the safety module and the adjacent Inline connector from the neighboring Inline terminal on the left. This prevents the potential routing knife contacts and the keyway/featherkey connections from being damaged.
- Hold the safety module perpendicular and snap it onto the DIN rail (7.5 mm in height).

Ensure that **all** featherkeys and keyways on adjacent modules are **securely** interlocked.

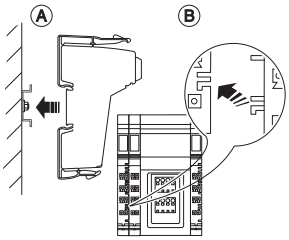


Fig. 5-3 Snapping on the safety module base

- Check that all the snap-on mechanisms are securely snapped into place.

Assembly, Removal, and Electrical Installation

– **Insert connectors**

Only use the connectors supplied with the module or connectors that are approved as replacement items (see “Ordering Data” on page 95).

– **Inserting the Inline connectors**

- Insert the connectors in the specified order (A, B).

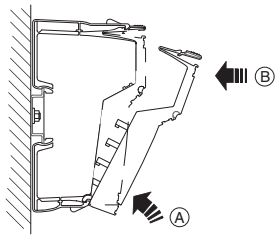


Fig. 5-4 Inserting the connector

– **Inserting the COMBICON connectors**

- Insert the connectors.

Removal

- Disconnect the power to the station.
- Before snapping on the safety module, remove the connectors from the safety module and the adjacent connector from the neighboring Inline terminal on the left.

– **Removing the Inline connectors**

- Remove the connectors by pressing the back shaft latching (A) and levering off the connector (B).

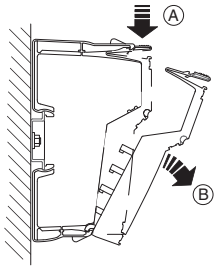


Fig. 5-5 Removing the connector

– **Removing the COMBICON connectors**

The module can be removed without removing the COMBICON connectors.

- Pull the COMBICON connectors from the module. Hold onto the COMBICON connector housing when removing it. Do not pull on the cables to remove the COMBICON connector.

– Remove base

- Release the base by pressing on the front and back snap-on mechanisms (A) and pull it out perpendicular to the DIN rail (B).

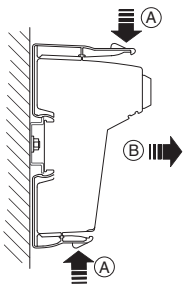


Fig. 5-6 Removing the safety module base

5.2 Electrical Installation

⚠ WARNING **Electric shock/unintentional machine startup**

Prior to electrical installation, disconnect the power to the system and make sure that it cannot be switched on again unintentionally.

Make sure installation has been completed before switching the power back on.

The system may only be started provided the system does not pose a hazard.

5.2.1 Electrical Installation of the Inline Station

Electrical installation of the Inline station includes the following:

- Connecting PROFIBUS or PROFINET to the Rexroth Inline station
- Connecting the supply voltages for the Inline station

Carry out electrical installation for the Inline station according to the DOK-CONTRL-ILSYSINS***-AW..-EN-P application description or the Inline system application description for your bus system. Please also observe the specifications in the documentation for the bus coupler used.

5.2.2 Electrical Installation of the Safety Module

During installation, always observe the instructions in Chapter “Electrical Safety” on page 9.

Take measures to prevent the incorrect connection, polarity reversal, and manipulation of connections.

The supply voltages are supplied at a bus coupler and/or a power terminal and are supplied to the safety module via the potential jumpers. Therefore, the electrical installation of the safety module only involves connecting the actuators.

The actuators are connected via Inline connectors and/or COMBICON connectors.

- Wire the connectors according to your application. For the terminal point assignment, please refer to Chapter “Terminal Point Assignment” on page 30.
- Label all connections to prevent connections to the connectors being mixed up (for Inline connectors, see DOK-CONTRL-ILSYSINS***-AW..-EN-P application description).

Inline connectors

Observe the following points during installation:

- Only use cables with a cross section approved for the terminal point (see Chapter “General data” on page 87).
- Observe the maximum permissible current carrying capacity of the Inline connectors of 4 A.
- Protect the connectors from overload using a ≤ 4 A fuse.
- Observe the current carrying capacity when selecting the cables.

To wire the Inline connectors, proceed as follows:

- Strip 8 mm off the cable.
- For multi-strand cables, fit the stripped cable ends with suitable ferrules and ensure that they are properly crimped.
- Push a screwdriver into the slot of the appropriate terminal point (Fig. 5-7, detail 1), so that you can insert the wire into the spring opening.
  Bosch Rexroth recommends a screwdriver with a 0.6 mm x 3.5 mm x 100 mm shaft.
- Insert the cable in the corresponding terminal point of the connector (Fig. 5-7, detail 2). Remove the screwdriver from the opening. This clamps the wire.

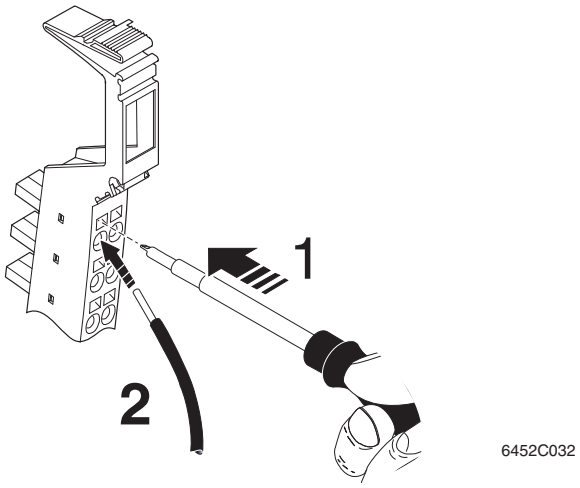


Fig. 5-7 Connecting unshielded cables

- Insert the assembled connectors in the corresponding terminal slot (see Chapter “Terminal Point Assignment” on page 30).

⚠ WARNING **A short circuit between adjacent terminal points can lead to the loss of the safety function**

Ensure that the wires are connected properly. This is essential to prevent the error “short circuit between adjacent terminal points/cables”.

COMBICON connectors

Observe the following points during installation:

- Only use cables with a cross section approved for the terminal point (see “General data” on page 87).
- Observe the current carrying capacity when selecting the cables.

To wire the COMBICON connectors, proceed as follows:

- Strip 10 mm off the cable.
- For multi-strand cables, fit the stripped cable ends with suitable ferrules and ensure that they are properly crimped.
- Insert the cable in the corresponding terminal point of the connector.
- Insert the assembled connectors in the corresponding terminal slot (see Chapter “Terminal Point Assignment” on page 30).

⚠ WARNING

A short circuit between adjacent terminal points can lead to the loss of the safety function

Ensure that the wires are connected properly. This is essential to prevent the error “short circuit between adjacent terminal points/cables”.

Assembly, Removal, and Electrical Installation

6 Parameterization of the Safety Module

6.1 Parameterization in a PROFIsafe System

Parameterization includes the following:

- Assigning the PROFIsafe address via the configuration software of the control system manufacturer
- Parameterization of outputs
- Specifying the parameterizable F-Parameters and iParameters

PROFIsafe address

The PROFIsafe address is a unique ID for the safety module in the PROFIsafe structure. It is assigned in the configuration software. Set this address via the DIP switches prior to assembling the safety module (see “Setting the DIP Switches” on page 34).

Parameterization of outputs

The parameterization of the safe outputs determines the behavior of the module and thus has a considerable effect on the safety integrity level that can be achieved.

To parameterize the module, the parameterization of the safe controller created in the parameterization tool is automatically written to the module on every power up or reset.

The following conditions must be met:

- The supply voltage is present.
- The communication connection has been established between the controller and safety module.

The module cannot be operated if it is not parameterized.
In this case, the FS LED flashes.

The module is ready to operate if the parameters for all outputs are valid and transmitted without errors. Valid output data is only written in this state. In any other state, every output is set to the safe state.

If errors are detected during parameterization, the parameterization data is not transmitted. The FS LED on the module flashes to indicate that the parameterization is invalid. In addition, errors are indicated at the safe controller. In this case, check and correct the settings. For information about error messages and instructions for their removal, please refer to Chapter “Errors: Messages and Removal” on page 79.

F-Parameters and iParameters

Assign the parameterizable F-Parameters and iParameters. For an overview of the module parameters and possible settings, please refer to Chapter “F-Parameters and iParameters” on page 99.

6.2 Parameterization of the Safe Relay Outputs

The individual outputs of a safety module can be parameterized differently and thus achieve different safety integrity levels (SIL, SILCL, Cat., PL).

Two-channel If the relay outputs are operated via two channels, the following fixed assignment applies:

- OUT0_Ch1 to OUT0_Ch2
- OUT1_Ch1 to OUT1_Ch2

Single-channel If two-channel operation in the external wiring of the relay outputs is not required, the relay outputs can be parameterized in such a way that they operate independently of one another (single-channel).

Parameterization Parameterize all safe relay outputs individually. The parameterization options are described in Fig. 6-1.

Parameterization	Value range	Remark
	OUT0 - OUT1	
Assignment	Not used Used	The unused outputs are disabled. However, the monitoring of these outputs remains active.
Output	Single-channel Two-channel	In two-channel operation, the assignment of the outputs to one another is specified and cannot be parameterized. Please observe the notes below this table.
IN1	Do not evaluate Evaluate	Assignment to alarm input IN1 for monitoring the external wiring and external power gain (e.g., contactors). If IN1 is activated, both the internal alarm contacts of the safety relay and the status of input IN1 are detected. If the status does not correspond to the desired status, the output is disabled and a diagnostic message is transmitted to the safe controller. Remark: Input IN1 must only be assigned once, to one output. Parallel connection of the alarm contacts is not permitted. Dual assignment is only permitted if the output is parameterized for two-channel operation. In this case, both fixed assigned outputs can be assigned to the same alarm input. All other parameterizations are rejected with a parameterization error.
IN2	Do not evaluate Evaluate	Assignment to alarm input IN2 for monitoring the external wiring and external power gain (e.g., contactors). If IN2 is activated, both the internal alarm contacts of the safety relay and the status of input IN2 are detected. If the status does not correspond to the desired status, the output is disabled and a diagnostic message is transmitted to the safe controller. Remark: Input IN2 must only be assigned once, to one output. Parallel connection of the alarm contacts is not permitted. Dual assignment is only permitted if the output is parameterized for two-channel operation. In this case, both fixed assigned outputs can be assigned to the same alarm input. All other parameterizations are rejected with a parameterization error.

Fig. 6-1 Parameterization of relay outputs

Parameterization	Value range	Remark
	OUT0 - OUT1	
Switch-off delay for stop category 1	Disabled Enabled	Disabled (default): No switch-off delay. Enabled: The outputs are switched off once the parameterized switch-off delay has elapsed. Please observe the notes below this table.
Switch-off delay for stop category 1	1 to 63	Time conversion according to the parameterization of the “Value range of switch-off delay for stop category 1” parameter. Permissible value range: Value range: 150 ms to 630 s Accuracy: ±5% of parameterized value Please observe the notes below this table.
Value range of switch-off delay for stop category 1	Value x 10 in ms Value x 100 in ms Value in s Value x 10 in s	Value range/unit for the parameterization of the “Switch-off delay for stop category 1” parameter. Please observe the notes below this table.

Fig. 6-1 Parameterization of relay outputs [...]

Two-channel parameterization

Please note the following for two-channel parameterization:

Ensure that the values for the switch-off delay for stop category 1 are the same for both channels. This means that the time must have the same value and the same value range.

Switch-off delay for stop category 1

The **switch-off delay for stop category 1** is calculated from the “Switch-off delay for stop category 1” and “Value range of switch-off delay for stop category 1” parameters.

Switch-off delay for stop category 1 =
Switch-off delay for stop category 1 x
Value range of switch-off delay for stop category 1

If the switch-off delay for stop category 1 is parameterized with a value less than 150 ms, this value is rejected as a parameterization error (error code $028x_{hex}$).

6.3 Behavior of the Relay Outputs in the Event of Enabled Switch-Off Delay for Stop Category 1

The time until the relay outputs are actually switched off can vary depending on the event that causes the relay outputs to be switched off and depending on parameterization of the switch-off delay.

Switch off of relay outputs	Influence of parameterized switch-off delay	Switch off of relay outputs
By the safe controller	Yes	Once the parameterized switch-off delay has elapsed
After a bus error	Yes	Once the parameterized switch-off delay has elapsed
After a short circuit, cross circuit, failure of the supply voltage or hardware fault	No	Immediately (only stop category 0)

Fig. 6-2 Switching off the relay outputs according to the trigger event and the parameterization

⚠ WARNING Delayed shutdown when using stop category 1

For stop category 1 please take into consideration the following:

In the event of an error (excluding bus errors) the affected outputs (safety relay) are switched off immediately (without delay). In this case, only stop category 0 is supported.

⚠ WARNING Incorrect design of safety distances due to incorrect calculation of the overall shutdown time

When designing the safety distances, please take into consideration the following:

The overall shutdown time of the outputs is calculated as the sum of the parameterized shutdown time and the parameterized switch-off delay time.

For the switch-off operation, please take into consideration the following:

- The switch-off operation can be interrupted by switching the output on again.
- If the parameterization of the module is modified, the modified parameterization does not take effect until all the outputs have been switched off.
  If the parameterization is modified before the switch-off operation is complete, diagnostic message $02F2_{hex}$ is generated.
- Carry out a validation every time the parameterization is modified.

6.4 Parameterization of Clock Outputs and Alarm Inputs

The assignment of clock outputs to alarm inputs is fixed and cannot be parameterized.

For the assignment of an alarm output to a relay output, please refer to the parameterization of the relay output (see page 42).

7 Connection Examples

7.1 Safe Relay Outputs

7.1.1 Explanation of the Examples

Depending on the type of wiring, the relay outputs of a module can achieve different safety integrity levels (SIL, SILCL, Cat., PL) at the same time (as long as the settings do not contradict one another).

The following examples only describe the options for the electrical connection of controlled devices/actuators to the safe relay outputs.
Should you have any questions regarding applications to be implemented, please contact the Bosch Rexroth safety hotline (see “Safety Hotline” on page 13).

The following are specified for each example:

- **Basic specifications**
  The main data for the example is specified in the table.
- Device diagnostics and behavior of the module in the event of an error
  Diagnostic capability depends on the parameterization.
  If a message is transmitted to the safe controller in the event of an error, the message is specified in the tables. For information about the relevant error code, possible remedies, and information about whether acknowledgment is required, please refer to Chapter “Errors: Messages and Removal” on page 79.
- **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Key for all tables in this section:

Representation	Meaning
SF	Safety function
OUTx	OUT0 or OUT1 LED; diagnostic message for each relay output

Fig. 7-1 “Device diagnostics and behavior of the module in the event of an error” tables

Representation	Meaning
Bold	Mandatory setting
Normal	Typical setting, another setting is possible depending on the application
–	Not evaluated

Fig. 7-2 Parameterization tables

Errors (cross circuits, short circuits), which can be prevented by correct installation (e.g., protected cable installation, isolated cable installation, double insulation, use of ferrules) are not described in the following tables.
Therefore, for example, only errors between relay outputs, which are on the same connector, are described. For example, in the event of correct installation, cross circuits with relay outputs of other connectors cannot occur.

When assigning the contacts, observe the potential areas according to Chapter “Safe Digital Relay Outputs (Floating Contacts)” on page 17.

Please observe the load capacity of the relay outputs according to the technical data in “Safe Digital Relay Outputs (Floating Contacts)” on page 17 and protect the contacts against overload using an appropriate fuse.

For all examples, please also observe the measures specified in the individual tables, which must be taken to achieve the specified SIL/SILCL/Cat./PL and all measures according to standards EN 61508, EN 62061, and EN ISO 13849-1 to achieve the specified SIL/SILCL/Cat./PL.

⚠ WARNING **Disregarding this warning may lead to the loss of the safety function**

- When operating the safety-related segment circuit, observe the information in the application note for the safety-related segment circuit. Ensure that an external supply cannot be connected in the safety-related segment circuit.
- An interrupt of the output signals must not result in a hazardous system state.
- Ensure that cross circuits with external signals cannot be created.
- Ensure safe isolation to the PELV signals.

7.1.2 Notes on the Protective Circuit for External Relays/Contactors (Free Running Circuit)

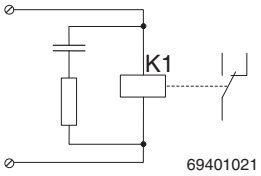


Fig. 7-3 Example of the free running circuit for an external relay

A protective circuit via the relay contacts is not permitted.

7.1.3 Measures Required to Achieve a Specific Safety Integrity Level

The safety integrity level (SIL, SILCL, performance level, and category) that can be achieved is specified for each connection example.

SIL, SILCL

In order to determine the probability of failure according to EN 61508 (SIL), use the standard.

In order to determine the probability of failure according to EN 62061 (SILCL), use the standard.

In order to determine PFH and PFD depending on the SIL, see “Determining PFH, PFD, and $MTTF_d$” on page 69.

Performance level

Use standard EN ISO 13849-1 to determine the performance level.

Category

In order to actually achieve the specified category, the required measures listed below must be implemented.

Cat. 2

- Use proven safety principles.
- Use appropriately qualified actuators (see Chapter “Requirements for controlled devices/actuators” on page 18).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts with appropriate protection against overcurrent and surge voltage.
- Please note that **a single** error can result in the loss of the safety function between tests.
- Ensure that the external wiring is tested by the machine control system on machine startup and at suitable intervals. This test must detect the loss of the safety function.
- In the event of an error, either safe disconnection must be implemented or a warning (optical and/or audible) must be generated depending on the application.

Cat. 3

- Use proven safety principles.
- Use appropriately qualified actuators (see Chapter “Requirements for controlled devices/actuators” on page 18).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts with appropriate protection against overcurrent and surge voltage.
- All errors (e.g., cross circuits) that cannot be detected can result in the loss of the safety function. Take appropriate measures to prevent such errors. Suitable measures include, for example, protected cable installation or double insulation. Please note the information in the following tables.
- Please take into consideration errors with a common cause.
- Ensure that **a single** error does not result in the loss of the safety function.
- Test the shutdown capability of the actuators at regular intervals.

Cat. 4

- Use proven safety principles.
- Use appropriately qualified actuators (see Chapter “Requirements for controlled devices/actuators” on page 18).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts with appropriate protection against overcurrent and surge voltage.
- An accumulation of errors must not result in the loss of the safety function. Following the third error, evaluation can be aborted if the probability of further errors occurring is low.
- All errors (e.g., cross circuits) that cannot be detected can result in the loss of the safety function. Take appropriate measures to prevent such errors. Suitable measures include, for example, protected cable installation or double insulation. Please note the information in the following tables.
- Please take into consideration errors with a common cause.
- Test the shutdown capability of the actuators at regular intervals.

7.1.4 Single-Channel Assignment of Safe Relay Outputs

For single-channel assignment, the safety relays operate independently of one another. This means that they are controlled individually by the safe controller. It is possible to monitor external loads and the wiring for errors. In this case, use a clock output (UT1 or UT2) with the associated alarm input. Activate this function in the parameterization (IN1 or IN2, see Chapter “Parameterization of the Safe Relay Outputs” on page 42).

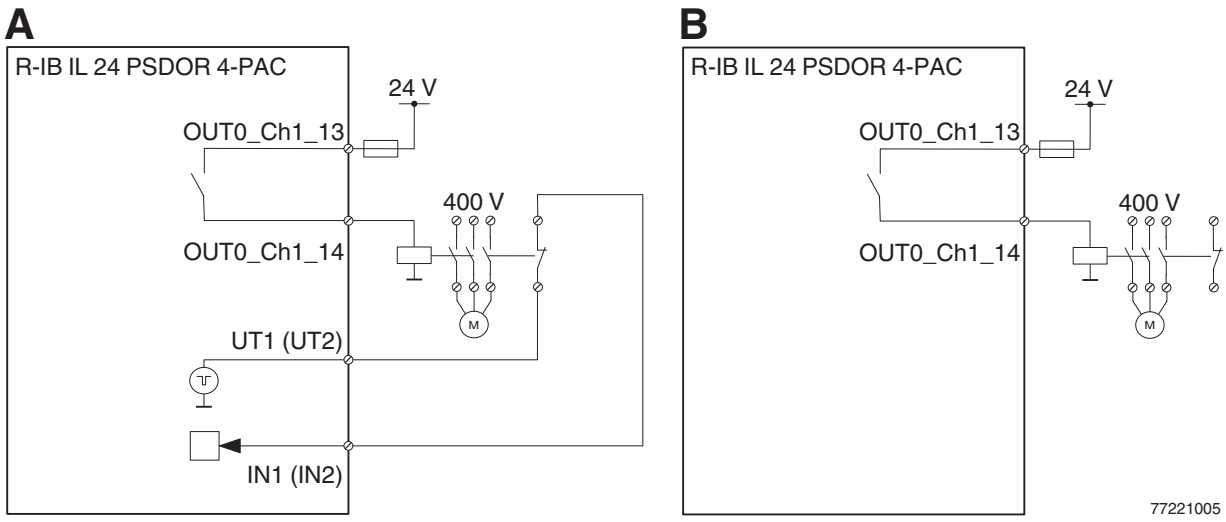


Fig. 7-4 *Single-channel assignment of floating contacts with readback (A) and without readback (B)*

Key:

OUT0_Ch1_13	Output 0, channel 1, contact 13
OUT0_Ch1_14	Output 0, channel 1, contact 14
UT1 (UT2)	UT1 or UT2
IN1 (IN2)	IN1 or IN2

The illustrated 24 V voltage is not provided by the Inline station.

Basic specifications

Actuator	Single-channel
Achievable SILCL/Cat./PL	SILCL 1/Cat. 1*)/PL c
External errors that can be detected	If alarm inputs IN1 or IN2 are used: 1. An external load does not pick up 2. An external load does not drop out
Errors that cannot be detected	If no alarm inputs are used, no errors can be detected in the external load or in the wiring.
External wiring requirements	The user is responsible for error analysis for the connected loads and for the external wiring.

*) Depending on the application, suitable up to cat. 2.

⚠ WARNING **Loss of electrical and functional safety**

- To achieve the specified safety integrity level, please refer to Chapter "Measures Required to Achieve a Specific Safety Integrity Level" on page 47.
- Please note that in order to achieve the specified PL, the actuator must have a medium level of diagnostic coverage (90% to 99%) and medium $MTTF_d$.
- Use actuators that can achieve the required safety integrity level.
- Evaluate the readback contacts to achieve the corresponding safety integrity level.
- Please note that when switching mains voltages, safe isolation to the PELV areas is required.

Device diagnostics and behavior of the module in the event of an error

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite being disabled, the actuator does not switch to the safe state (e.g., a contact will not open)	Yes	Yes	**Yes**	Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals.**
Actuator cannot be enabled (e.g., interrupt at coil)	Yes	Yes	No	Please take into consideration all the possible errors for the actuator used.
Interrupt on the N/C contact	Yes	Yes	No	The error is detected in the OFF state of the output.
Short circuit on the N/C contact	Yes	Yes	No	The error is detected in the ON state of the output. The output is switched off.
Other errors (depending on the actuator)				**Please take into consideration all possible errors that can occur in the actuator.**
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	Yes	Yes	No	The error is detected in the ON state of the output. The output is switched off.
Cable interrupt between clock output/alarm input and actuator	Yes	Yes	No	The error is detected in the OFF state of the output.
Cross circuit				
Output to output	**No**	None	**Yes**	**Prevent this error.**
Clock output/alarm input to external signal	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Short circuit				
Output to 24 V	Yes	Yes	**Yes**	The error is detected in the OFF state of the output. Prevent this error.
Output to ground	Yes	Yes	No	The error is detected in the ON state of the output. Protect the output against damage using a preconnected fuse.
Clock output/alarm input to 24 V	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Clock output/alarm input to ground	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Fig. 7-5 Single-channel: Alarm input assigned

Typical parameterization

Parameterization	**Parameterized as**	**Remark**
Assignment	**Used**	
Output	**Single-channel**	
Alarm input IN1	Evaluate	Or do not evaluate
Alarm input IN2	Do not evaluate	Or evaluate
Switch-off delay for stop category 1	Enabled	Or disabled
Switch-off delay for stop category 1	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Application-specific

Fig. 7-6 Single-channel: Alarm input assigned; typical parameterization

According to the “Value range of switch-off delay for stop category 1” and “Switch-off delay for stop category 1” parameters, in this example, the switch-off delay is 30 x 1 s = 30 s.

Connection Examples

Device diagnostics and behavior of the module in the event of an error

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite being disabled, the actuator does not switch to the safe state (e.g., a contact will not open)	**No**	None	**Yes**	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals.**
Actuator cannot be enabled (e.g., interrupt)	**No**	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Ensure that this error does not result in delayed system startup.**
Other errors (depending on the actuator)				**Please take into consideration all possible errors that can occur in the actuator.**
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	**No**	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Ensure that this error does not result in delayed system startup.**
Cross circuit				
Output to output	**No**	None	**Yes**	The error leads to the loss of the safety function. Prevent this error.
Short circuit				
Output to 24 V	**No**	None	**Yes**	The error leads to the loss of the safety function.
Output to ground	**No**	None	No	Protect the output against damage using a preconnected fuse.

Fig. 7-7 Single-channel: No alarm input assigned

Typical parameterization

Parameterization	Parameterized as	Remark
Assignment	**Used**	
Output	**Single-channel**	
IN1	**Do not evaluate**	
IN2	**Do not evaluate**	
Switch-off delay for stop category 1	30	Application-specific
Switch-off delay for stop category 1	Enabled	Or disabled
Value range of switch-off delay for stop category 1	Value in s	Application-specific

Fig. 7-8 Single-channel: No alarm input assigned; typical parameterization

According to the “Value range of switch-off delay for stop category 1” and “Switch-off delay for stop category 1” parameters, in this example, the switch-off delay is 30 x 1 s = 30 s.

7.1.5 Two-Channel Assignment of Floating Contacts

For two-channel assignment, the safety relays for both channels operate together. This assignment is fixed and cannot be parameterized (see Chapter “Two-channel” on page 42).

It is possible to monitor external loads and the wiring for errors. In this case, a clock output (UT1 or UT2) with the associated alarm input must be used. Activate this function in the parameterization (IN1 or IN2, see Chapter “Parameterization of the Safe Relay Outputs” on page 42).

If you are using monitoring via one or both alarm inputs with two-channel assignment, set the corresponding alarm input to “Evaluate” for both channels of the output.

7.1.5.1 Monitoring via Common Readback

Monitoring is common for both channels of an output. In this case, the second alarm input is available for other outputs.

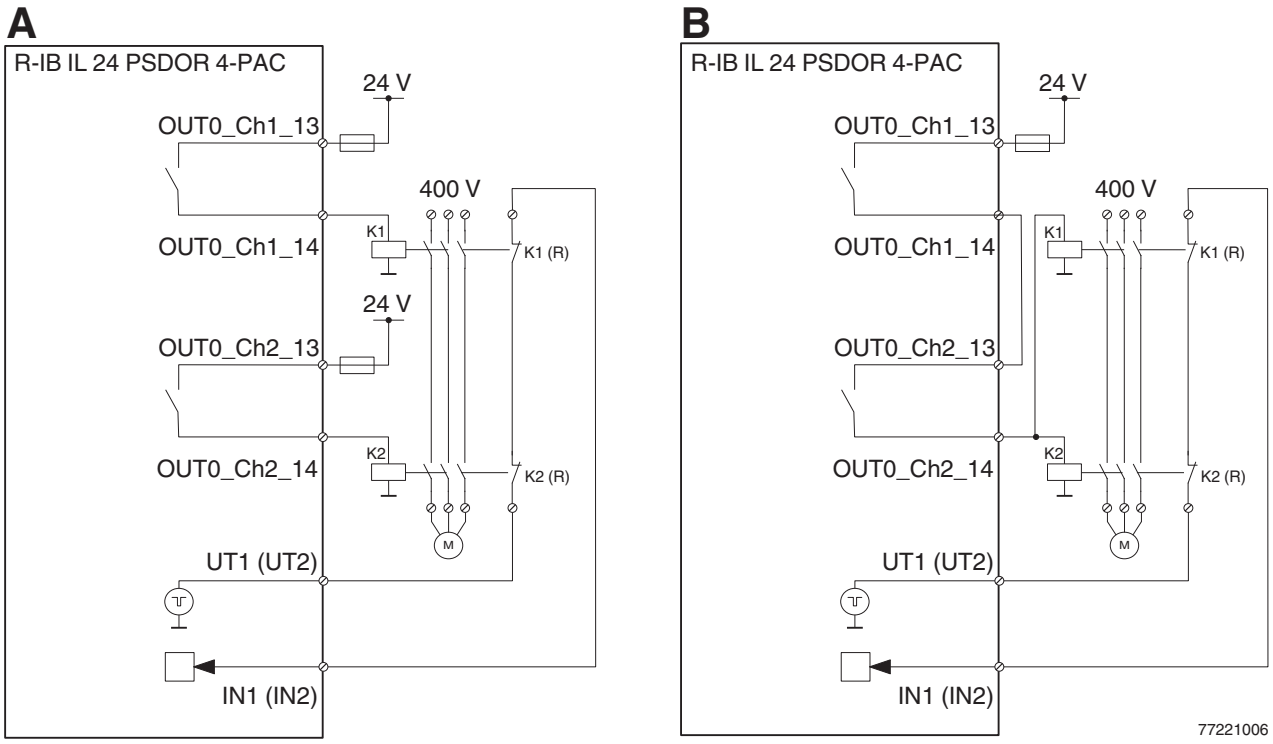


Fig. 7-9 Two-channel assignment of floating contacts with common readback

NOTICE **Failure of the safety relay contacts due to overload**

Protect all safety relay contacts against overload with suitable fuses (see “Safe digital relay outputs” on page 90).

The illustrated 24 V voltage is not provided by the Inline station.

Key:

A	Alternative A
B	Alternative B
OUT0_Ch1_13	Output 0, channel 1, contact 13
OUT0_Ch1_14	Output 0, channel 1, contact 14
OUT0_Ch2_13	Output 0, channel 2, contact 13
OUT0_Ch2_14	Output 0, channel 2, contact 14
UT1 (UT2)	Clock output UT1 or UT2
IN1 (IN2)	Alarm input IN1 or IN2

K1 (R) and K2 (R) represent the forcibly guided N/C contacts for monitoring the state of the relay (readback contacts).

To use the function for external contact monitoring, wire the N/C contacts to alarm input IN1 (IN2) as illustrated. In this case, the alarm input must be assigned to the output. Parallel connection of the alarm contacts is not permitted.

These contacts can also be read via safe digital inputs. In this case, evaluate the readback and thus the state of the switching elements in your safe application program.

When calculating the SIL values for both alternatives, take the different failure rates into consideration.

⚠ WARNING **Loss of the safety function due to external supply**

Make sure that no cross circuits can occur.

Basic specifications

Actuator	Two-channel
Achievable SILCL/Cat./PL	SILCL 3/Cat. 4/PL e
External errors that can be detected	If alarm inputs IN1 or IN2 are used: 1. An external load does not pick up Note: If one of the two external relays does not pick up, this cannot be detected if the other relay is operating normally. 2. An external load does not drop out
Errors that cannot be detected	If no alarm inputs are used, no errors can be detected in the external load or in the wiring.
External wiring requirements	The user is responsible for error analysis for the connected loads and for the external wiring.

⚠ WARNING **Loss of electrical and functional safety**

- To achieve the specified safety integrity level, please refer to Chapter "Measures Required to Achieve a Specific Safety Integrity Level" on page 47.
- Please note that in order to achieve the specified PL, the actuator must have a medium level of diagnostic coverage (90% to 99%) and medium $MTTF_d$. A high level of diagnostic coverage (> 99%) is recommended for the application according to PL d.
- Use actuators that can achieve the required safety integrity level.
- Evaluate the readback contacts to achieve Cat. 3 or Cat. 4.
- Test the relay outputs and the external wiring by enabling the relay outputs at regular intervals.
- Please note that when switching mains voltages, safe isolation to the PELV areas is required.
- Capacitive loads can only be switched with alternative B.

Device diagnostics and behavior of the module in the event of an error

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite being disabled, an actuator does not switch to the safe state (e.g., a contact will not open)	Yes	Yes	No	The error is detected by the forced guidance of the N/C contacts. Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals.**
Actuator cannot be enabled (e.g., interrupt at coil)	**No**	None	No	**Ensure that this error does not result in delayed system startup.**
Interrupt at an N/C contact	Yes	Yes	No	The error is detected in the OFF state of the outputs.
Short circuit of an N/C contact	**No**	None	No	**Prevent this error, as an accumulation of errors can lead to the loss of the safety function.**
Other errors (depending on the actuator)				**Please take into consideration all possible errors that can occur in the actuator.**
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	Yes	Yes	No	**Ensure that this error does not result in delayed system startup.**
Cable interrupt between clock output/alarm input and actuator	Yes	Yes	No	**The error is detected in the OFF state of the outputs.**
Cross circuit				
Output to output	Yes	Yes	**Yes**	**Prevent this error, e.g., through protected cable installation.**
Clock output/alarm input to external signal	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Short circuit				
Output to 24 V (for version A in Fig. 7-9 on page 53)	Yes	Yes	No	**Prevent this error, e.g., through protected cable installation.**
Output to 24 V (for version B in Fig. 7-9 on page 53)	Yes	Yes	**Yes**	**Prevent this error, e.g., through protected cable installation.**
Output to ground	Yes	Yes	No	Protect the output against damage using a preconnected fuse.
Clock output/alarm input to 24 V	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Clock output/alarm input to ground	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Fig. 7-10 Two-channel with monitoring by the alarm input

Connection Examples

Typical parameterization

Parameterization	Parameterized as		Remark
	Channel 1	**Channel 2**	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Alarm input IN1	Evaluate	Evaluate	Or do not evaluate
Alarm input IN2	Do not evaluate	Do not evaluate	Or evaluate
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Switch-off delay for stop category 1	30	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Value in s	Application-specific

Fig. 7-11 Two-channel with monitoring by the alarm input; typical parameterization

According to the “Value range of switch-off delay for stop category 1” and “Switch-off delay for stop category 1” parameters, in this example, the switch-off delay is 30 x 1 s = 30 s.

7.1.5.2 Monitoring via Separate Readback

Monitoring is separate for each channel of an output, using one alarm input for each. In this case, both alarm inputs are assigned and are not available for the other output. The advantage of this wiring is that, in the event of an error, diagnostics are more accurate than for common readback.

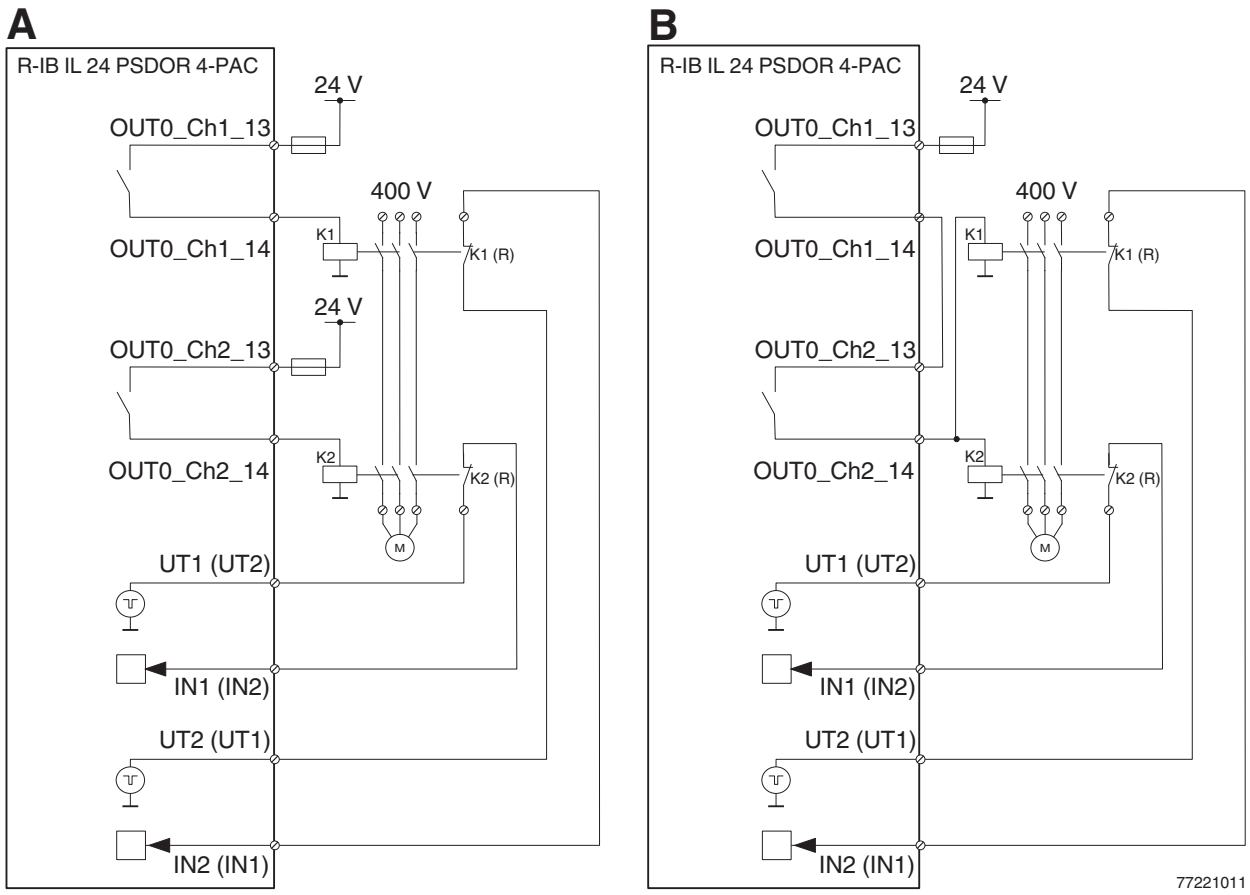


Fig. 7-12 Two-channel assignment of floating contacts with separate readback

NOTICE	**Failure of the safety relay contacts due to overload** Protect all safety relay contacts against overload with suitable fuses (see "Safe digital relay outputs" on page 90).

The illustrated 24 V voltage is not provided by the Inline station.

Key:

A	Alternative A
B	Alternative B
OUT0_Ch1_13	Output 0, channel 1, contact 13
OUT0_Ch1_14	Output 0, channel 1, contact 14
OUT0_Ch2_13	Output 0, channel 2, contact 13

OUT0_Ch2_14	Output 0, channel 2, contact 14
UT1 (UT2)	Clock output UT1 or UT2
IN1 (IN2)	Alarm input IN1 or IN2
UT2 (UT)	Clock output UT2 or UT1
IN2 (IN1)	Alarm input IN2 or IN1

K1 (R) and K2 (R) represent the forcibly guided N/C contacts for monitoring the state of the relay (readback contacts).

To use the function for external contact monitoring, wire the N/C contacts to the alarm input IN1 and IN2 as illustrated. In this case, the alarm inputs must be assigned to the outputs. Parallel connection of the alarm contacts is not permitted.

These contacts can also be read via safe digital inputs. In this case, evaluate the readback and thus the state of the actuators in your safe application program.

When calculating the SIL values for both alternatives, take the different failure rates into consideration.

⚠ WARNING **Loss of the safety function due to external supply**
Make sure that no cross circuits can occur.

Basic specifications

Actuator	Two-channel
Achievable SILCL/Cat./PL	SILCL 3/Cat. 4/PL e
External errors that can be detected	If alarm inputs IN1 and IN2 are used: 1. An external load does not pick up 2. An external load does not drop out
Errors that cannot be detected	If no alarm inputs are used, no errors can be detected in the external load or in the wiring.
External wiring requirements	The user is responsible for error analysis for the connected loads and for the external wiring.

⚠ WARNING **Loss of electrical and functional safety**

- To achieve the specified safety integrity level, please refer to Chapter “Measures Required to Achieve a Specific Safety Integrity Level” on page 47.
- Please note that in order to achieve the specified PL, the actuator must have a medium level of diagnostic coverage (90% to 99%) and medium $MTTF_d$. A high level of diagnostic coverage (> 99%) is recommended for the application according to PL d.
- Observe the switching frequency depending on the load and the proof test interval.
- Use actuators that can achieve the required safety integrity level.
- Evaluate the readback contacts to achieve Cat. 3 or Cat. 4.
- Test the relay outputs and the external wiring by enabling the relay outputs at regular intervals.
- Please note that when switching mains voltages, safe isolation to the PELV areas is required.
- Capacitive loads can only be switched with alternative B.

Device diagnostics and behavior of the module in the event of an error

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite being disabled, an actuator does not switch to the safe state (e.g., a contact will not open)	Yes	Yes	No	The error is detected by the forced guidance of the N/C contacts. Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals.**
Actuator cannot be enabled (e.g., interrupt at coil)	Yes	Yes	No	**Ensure that this error does not result in delayed system startup.**
Interrupt at an N/C contact	Yes	Yes	No	The error is detected in the OFF state of the outputs.
Short circuit of an N/C contact	Yes	Yes	No	The error is detected in the ON state of the outputs. The outputs are disabled.
Other errors (depending on the actuator)				**Please take into consideration all possible errors that can occur in the actuator.**
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	Yes	Yes	No	The error is detected in the ON state of the outputs. The outputs are disabled.
Cable interrupt between clock output/alarm input and actuator	Yes	Yes	No	**The error is detected in the OFF state of the outputs.**
Cross circuit				
Output to output	Yes	Yes	**Yes**	**Prevent this error, e.g., through protected cable installation.**
Clock output/alarm input to external signal	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Short circuit				
Output to 24 V (for version A in Fig. 7-9 on page 53)	Yes	Yes	No	**Prevent this error, e.g., through protected cable installation.**
Output to 24 V (for version B in Fig. 7-9 on page 53)	Yes	Yes	**Yes**	**Prevent this error, e.g., through protected cable installation.**
Output to ground	Yes	Yes	No	Protect the output against damage using a preconnected fuse.
Clock output/alarm input to 24 V	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Clock output/alarm input to ground	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Fig. 7-13 Two-channel with monitoring by two alarm inputs

Typical parameterization

Parameterization	Parameterized as		Remark
	Channel 1	**Channel 2**	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Alarm input IN1	Evaluate	Do not evaluate	Or do not evaluate/evaluate
Alarm input IN2	Do not evaluate	Evaluate	Or evaluate/do not evaluate
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Switch-off delay for stop category 1	30	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Value in s	Application-specific

Fig. 7-14 Two-channel with monitoring by two alarm inputs; typical parameterization

According to the “Value range of switch-off delay for stop category 1” and “Switch-off delay for stop category 1” parameters, in this example, the switch-off delay is 30 x 1 s = 30 s.

7.1.5.3 External Monitoring

Assigning no alarm input to an output is also permitted. The module does not interpret this as an error. In this case, monitor the switching state via the application or the control program and respond appropriately to any errors, if required.

7.2 Safety-Related Segment Circuit

When implementing the safety-related segment circuit, two-channel parameterization of the output is required. This means setting the following parameters for channel 1 and channel 2: “Assignment: used” and “Output: two-channel”.

Observe the notes in the document for the safety-related segment circuit in the Inline system (see Chapter “Ordering Data: Documentation” on page 95).

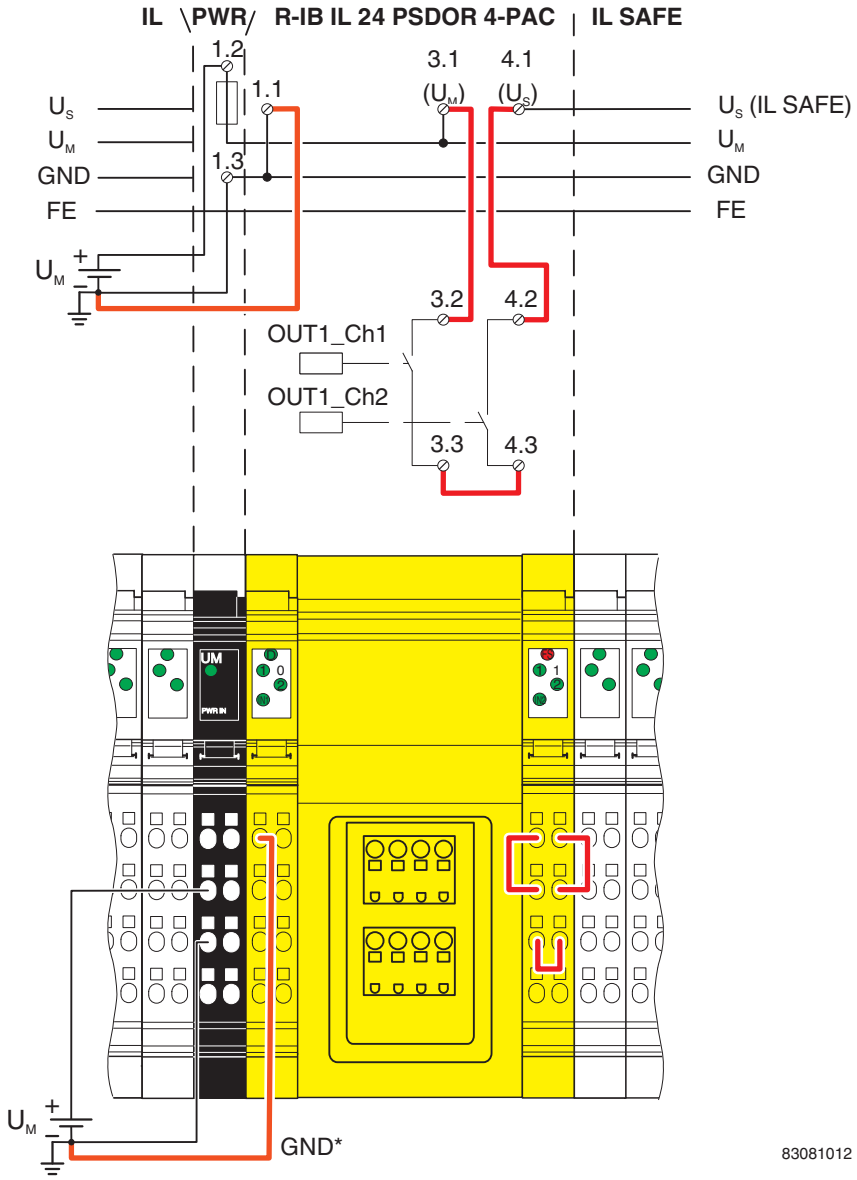


Fig. 7-15 *Internal and external wiring of the R-IB IL 24 PSDOR 4-PAC for the use of the safety-related segment circuit*

Key:

IL	Standard Rexroth-Inline
IL SAFE	Safety-related segment circuit

Connection Examples

PWR	Power terminal with fuse or (protection of U_M required))
Red (bold)	External wiring to the safety module (by the user)
GND*	Separate cable ^{3} 0.75 mm^2 to power supply unit GND

Notes on wiring:

Additional ground cable

Connect an additional separate ground cable between the ground of the power supply unit and terminal point 1.1 or 2.1 (GND) of the safety module.

Protecting the supply voltage U_M

Protect the supply voltage U_M with an external fuse. Use a **fuse with an I^2t value of less than 100 A^2s and maximum 4 A.**

7.2.1 Assignment with Single-Channel Actuators

The segment circuit of the Inline system is safely switched via the appropriate wiring with jumpers (see Fig. 7-15 on page 61). In the event of a safety demand, the voltage to the safety-related segment circuit is disconnected by output OUT1. Therefore, the actuator supply for all DO modules that are installed in the safety-related segment circuit is disconnected. Only modules that are specifically designed for the safety-related segment circuit may be used. The outputs of standard DO modules can be controlled individually via process data, however their disconnection is not safety-related. In the event of a safety demand, the R-IB IL 24 PSDOR 4-PAC safety-related segment circuit and all the outputs of DO modules connected in the safety-related segment circuit are switched off regardless of the actual switching state of the standard outputs.

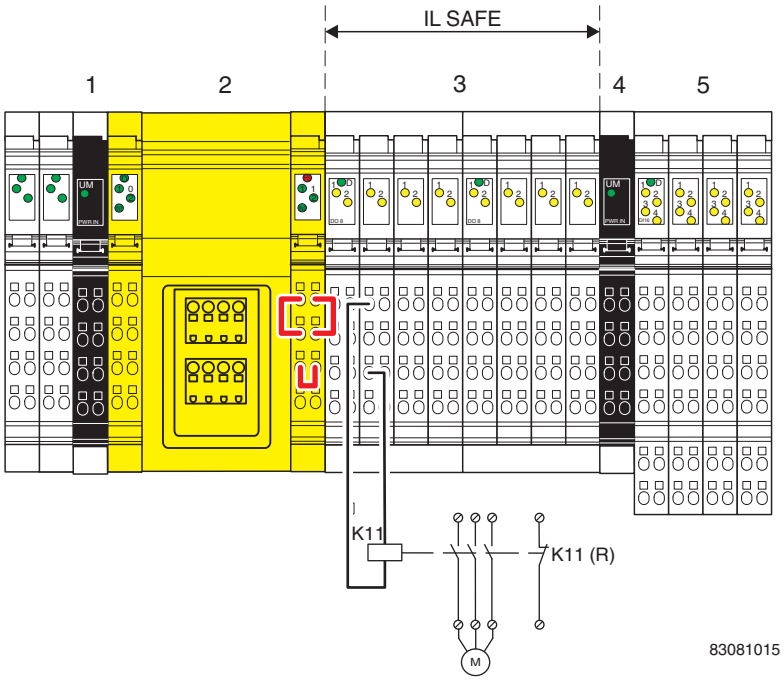


Fig. 7-16 Single-channel actuators in the safety-related segment circuit

Key:

1	Standard Rexroth Inline power terminal (protection of U_M required)
2	R-IB IL 24 PSDOR 4-PAC
3 IL SAFE	Safety-related segment circuit
4	Standard Rexroth-Inline power terminal
5	Standard Rexroth-Inline

K11 (R) represents the forcibly guided N/C contact of the relay. Connect this contact via a safe digital input. Evaluate the readback and thus the state of the switching element in your safe application.

⚠ WARNING Loss of safety function

Connect the actuator ground directly to terminal point GND of the DO terminal. An external ground may not be used.

Connection Examples

Basic specifications

Actuator	Single-channel
Achievable SILCL/Cat./PL	SILCL 1/Cat. 1*)/PL c

*) Depending on the application, suitable up to cat. 2.

To achieve the specified category, please refer to Chapter “Measures Required to Achieve a Specific Safety Integrity Level” on page 47.

Device diagnostics and behavior of the module in the event of an error

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite the safe segment output being disabled, the switching element of the single-channel actuator does not switch to the safe state (e.g., a contact will not open)	**No**	None	**Yes**	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals, at least once every six months.**
Actuator cannot be enabled (e.g., interrupt)	**No**	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Ensure that this error does not result in delayed system startup.**
Other errors (depending on the actuator)				**Please take into consideration all possible errors that can occur in the actuator.**
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	**No**	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Ensure that this error does not result in delayed system startup.**
Cross circuit				
Output to output (only safety-related segment circuit outputs)	**No**	None	No	A cross circuit between the outputs cannot be detected. This is not critical since in the event of a safety demand, all actuators connected to the safety-related segment circuit are switched off.
Safety-related segment circuit output to output that is not part of the safety-related segment circuit	**No**	None	**Yes**	The error is not detected. **⚠ WARNING** **The voltage in the safety-related segment circuit cannot be disconnected** It is no longer possible to disconnect the voltage to the safety-related segment circuit. All safety functions that were implemented via the safety-related segment circuit are lost. Therefore prevent cross circuits/short circuits with external signals. Observe the versions in the document for the safety-related segment circuit in the Inline system (see “Ordering Data: Documentation” on page 95).
Short circuit				
Output to ground or output to FE	Yes	None	No	The error is not detected. To protect the relay output against overload, observe the notes on protecting the relay outputs in Chapter “Fuse protection” on page 17.

Fig. 7-17 Safety-related segment circuit: Assignment with single-channel actuators

Typical parameterization

Parameterization	**Parameterized as**		**Remark**
	Channel 1	**Channel 2**	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Alarm input IN1	**Do not evaluate**	**Do not evaluate**	
Alarm input IN2	**Do not evaluate**	**Do not evaluate**	
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Switch-off delay for stop category 1	30	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Value in s	Application-specific

Fig. 7-18 Safety-related segment circuit: Assignment with single-channel actuators; typical parameterization

According to the “Value range of switch-off delay for stop category 1” and “Switch-off delay for stop category 1” parameters, in this example, the switch-off delay is 30 x 1 s = 30 s.

Connection Examples

7.2.2 Assignment with Two-Channel Actuators: Use of DO Terminals

The segment circuit of the Inline system is safely switched via the appropriate wiring with jumpers (see Fig. 7-15 on page 61). In the event of a safety demand, the voltage to the safety-related segment circuit is disconnected by output OUT1. Therefore, the actuator supply for all DO modules that are installed in the safety-related segment circuit is disconnected. Only modules that are specifically designed for the safety-related segment circuit may be used. The outputs of standard DO modules can be controlled individually via process data, however their disconnection is not safety-related. In the event of a safety demand, the R-IB IL 24 PSDOR 4-PAC safety-related segment circuit and all the outputs of DO modules connected in the safety-related segment circuit are switched off regardless of the actual switching state of the standard outputs.

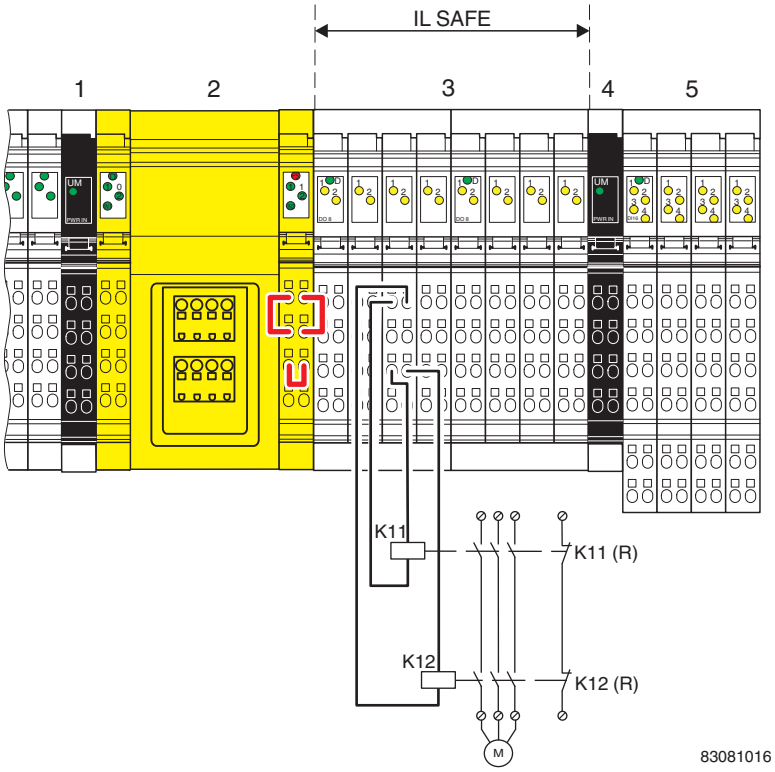


Fig. 7-19 Two-channel actuators in the safety-related segment circuit

Key:

1	Standard Rexroth-Inline power terminal (protection of U_M required)
2	R-IB IL 24 PSDOR 4-PAC
3 IL SAFE	Safety-related segment circuit
4	Standard Rexroth-Inline power terminal
5	Standard Rexroth-Inline

K11 (R) and K12 (R) represent the forcibly guided N/C contacts of the relay. Connect these contacts via safe digital inputs. Evaluate the readback and thus the state of the switching elements in your safe application.

⚠ WARNING **Loss of safety function**

Connect the actuator ground directly to terminal point GND of the DO terminal. An external ground may not be used.

The loads can also be connected in parallel to **one** standard output.

Basic specifications

Actuator	Two-channel
Achievable SILCL/Cat./PL	SILCL 3/Cat. 4/PL e

To achieve the specified category, please refer to Chapter “Measures Required to Achieve a Specific Safety Integrity Level” on page 47. Evaluate the readback contacts to achieve Cat. 3 or Cat. 4.

Device diagnostics and behavior of the module in the event of an error

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite the safe segment output being disabled, a switching element of the two-channel actuator does not switch to the safe state (e.g., a contact will not open)	**No**	None	No	No loss of the safety function as the second switching element of the two-channel actuator can be disabled. Implement error detection using external monitoring to prevent an accumulation of errors. **Implement a restart inhibit in the event of this error.** Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals, at least once every six months.**
Actuator cannot be enabled (e.g., interrupt)	**No**	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Ensure that this error does not result in delayed system startup.**
Other errors (depending on the actuator)				**Please take into consideration all possible errors that can occur in the actuator.**
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	**No**	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Ensure that this error does not result in delayed system startup.**
Cross circuit				
Output to output (only safety-related segment circuit outputs)	**No**	None	No	A cross circuit between the outputs cannot be detected. This is not critical since in the event of a safety demand, all actuators connected to the safety-related segment circuit are switched off.
Safety-related segment circuit output to output that is not part of the safety-related segment circuit	**No**	None	**Yes**	The error is not detected. **⚠ WARNING** **The voltage in the safety-related segment circuit cannot be disconnected** It is no longer possible to disconnect the voltage to the safety-related segment circuit. All safety functions that were implemented via the safety-related segment circuit are lost. Therefore prevent cross circuits/short circuits with external signals. Observe the versions in the document for the safety-related segment circuit in the Inline system (see “Ordering Data: Documentation” on page 95).

Fig. 7-20 Safety-related segment circuit: Assignment with two-channel actuators

Connection Examples

Error type	Detection	Diagnostics	Loss of SF	Remark
Short circuit				
Output to ground or output to FE	**No**	None	No	The error is not detected. To protect the relay output against overload, observe the notes on protecting the relay outputs in Chapter “Fuse protection” on page 17.

Fig. 7-20 Safety-related segment circuit: Assignment with two-channel actuators

Typical parameterization

Parameterization	Parameterized as		Remark
	Channel 1	**Channel 2**	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Alarm input IN1	**Do not evaluate**	**Do not evaluate**	
Alarm input IN2	**Do not evaluate**	**Do not evaluate**	
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Switch-off delay for stop category 1	30	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Value in s	Application-specific

Fig. 7-21 Safety-related segment circuit: Assignment with two-channel actuators; typical parameterization

According to the “Value range of switch-off delay for stop category 1” and “Switch-off delay for stop category 1” parameters, in this example, the switch-off delay is 30 x 1 s = 30 s.

8 Determining PFH, PFD, and $MTTF_d$

PFH	Probability of Failure per Hour
PFD	Probability of Failure on Demand
$MTTF_d$	Mean time to dangerous failure

8.1 Single-Channel Operation

8.1.1 Determining PFD for Single-Channel Operation

The value always refers to one internal safety relay (see assignment of outputs to the safety relay in Chapter “Terminal Point Assignment” on page 30).

This means that if several internal relays are used in a safety function, they should be considered with 1% each of SIL 2.

The logic has been taken into account within 1%.

PFD = 1% of SIL 2 per internal safety relay

8.1.2 Determining PFH for Single-Channel Operation

The value for PFH depends on the load for the contacts and the switching frequency.

In this section, the values are given for single-channel assignment, and these values only refer to one internal safety relay. This means that if several safety relays are used for a safety function, the values must be added together.

If the contacts of a safety relay have different loads, use the least favorable load for the calculation (see assignment of outputs to the safety relay in Chapter “Terminal Point Assignment” on page 30).

The value for PFH is determined using the following formula:

PFH = 0.01% + b x c [% of SIL 2]

Where:

c Switching frequency of the relay per hour [1/h]

b Factor, see Fig. 8-1 [% x h]

Load for the contacts (according to DIN EN 60947-4-1/ DIN EN 60947-5-1)	**Factor b [% x h]**
AC 15; 3 A	5.102
DC 13; 5 A	12.821

Fig. 8-1 Factor for calculating PFH depending on the load for the contacts

If the calculated PFH value is < 1%, a value of 1% should be used.

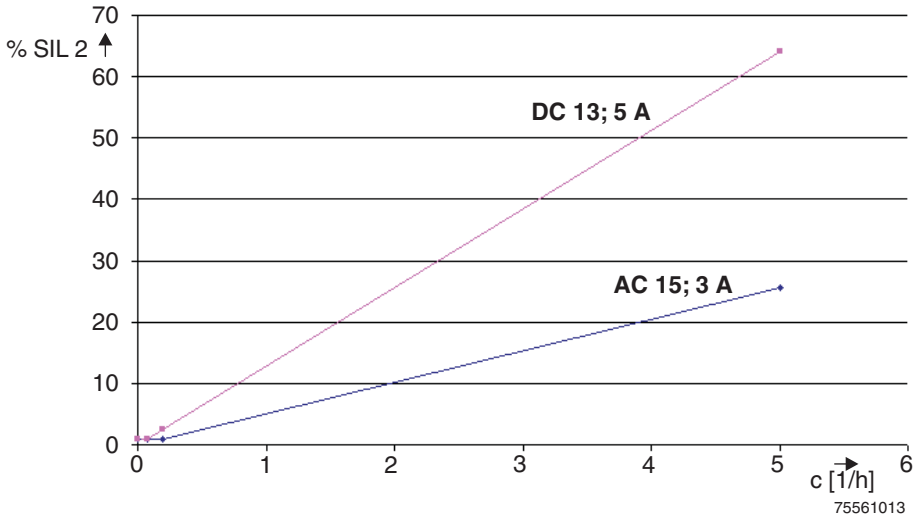


Fig. 8-2 PFH values depending on switching frequency c

8.1.3 Determining $MTTF_d$ for Single-Channel Operation

The value for $MTTF_d$ depends on the load for the contacts and the switching frequency.

In this section, the values are given for single-channel assignment, and these values only refer to one internal safety relay.

If the contacts of a safety relay have different loads, use the least favorable load for the calculation (see assignment of outputs to the safety relay in Chapter “Terminal Point Assignment” on page 30).

Load for the contacts (according to DIN EN 60947-4-1/ DIN EN 60947-5-1) Channel 1 or channel 2	**$MTTF_d$ > 10 years**	**$MTTF_d$ > 30 years**	**$MTTF_d$ > 100 years**
	Switching frequency [1/h]		
AC 15; 3 A	< 214	< 65	< 13
DC 13; 5 A	< 85	< 25	< 5

Fig. 8-3 $MTTF_d$ depending on the load for the contacts and the switching frequency

8.2 Two-Channel Operation

8.2.1 Determining PFD for Two-Channel Operation

The value always refers to two internal safety relays (two-channel assignment; see assignment of outputs to the safety relay in Chapter “Terminal Point Assignment” on page 30).

This means that if several safety relays are used in a safety function, they should be considered with 1% each of SIL 3.

The logic has been taken into account within 1%.

PFD = 1% of SIL 3 per two internal safety relays in two-channel operation

8.2.2 Determining PFH for Two-Channel Operation

The value for PFH depends on the load for the contacts and the switching frequency.

In this section, the values are given for two-channel assignment, and these values refer to two internal safety relays. This means that if several safety relays are used for a safety function, the values must be added together.

If the contacts of a safety relay have different loads, use the least favorable load for the calculation (see assignment of outputs to the safety relay in Chapter “Terminal Point Assignment” on page 30).

The value for PFH is determined using the following formula:

PFH = 0.04% + b x c [% of SIL 3], per two internal safety relays in two-channel operation

Where:

c Switching frequency of the relay per hour [1/h]

b Factor, see Fig. 8-4 [% x h]

Version in Fig. 7-9 on page 53	Load for the contacts (according to DIN EN 60947-4-1/DIN EN 60947-5-1)		Factor B [% x h]
	Channel 1	Channel 2	
A	AC 15; 3 A	AC 15; 3 A	0.510
A	DC 13; 5 A	DC 13; 5 A	1.282
A	AC 15; 3 A	DC 13; 5 A	0.896
A	DC 13; 5 A	AC 15; 3 A	0.896
B	AC 15; 3 A	Zero current	0.505
B	DC 13; 5 A	Zero current	0.891
B	250 µF; DC 4 A	Zero current	3.583

Fig. 8-4 Factor for calculating PFH depending on the load for the contacts

Channel 2 zero current: See alternative B in Fig. 7-9 and Fig. 7-12.

If the calculated PFH value is < 1%, a value of 1% should be used.

Determining PFH, PFD, and $MTTF_d$

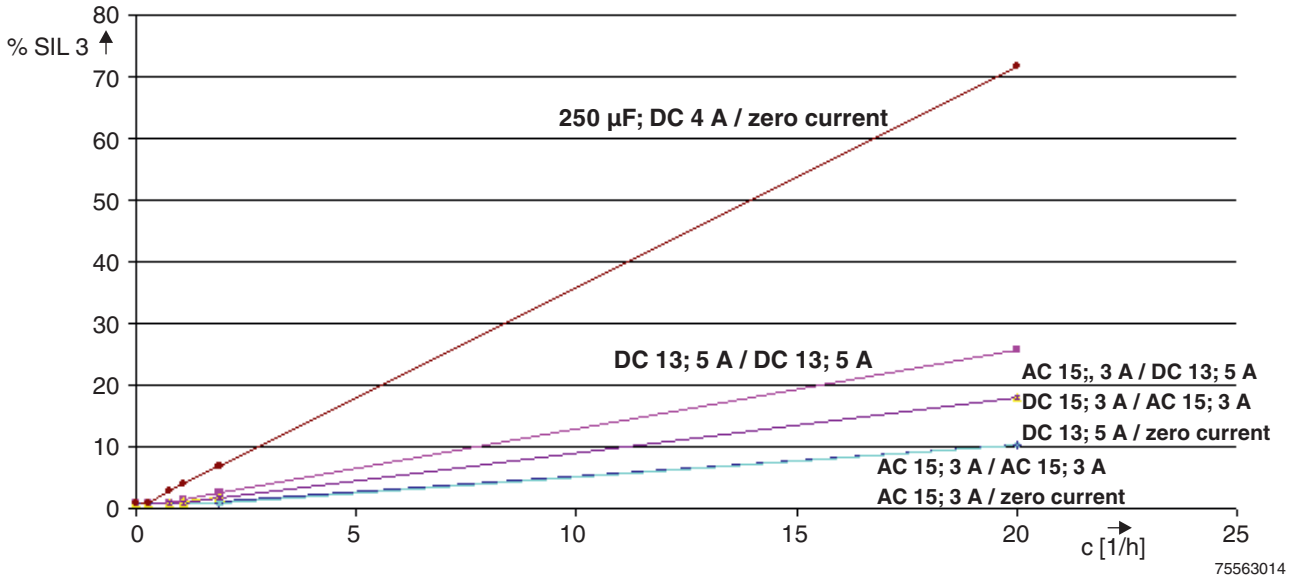


Fig. 8-5 PFH values depending on switching frequency c

8.2.3 Determining $MTTF_d$ for Two-Channel Operation

The value for $MTTF_d$ depends on the load for the contacts and the switching frequency.

In this section, the values are given for two-channel assignment, and these values refer to two internal safety relays.

If the contacts of a safety relay have different loads, use the least favorable load for the calculation (see assignment of outputs to the safety relay in Chapter “Terminal Point Assignment” on page 30).

Load for the contacts (according to DIN EN 60947-4-1/DIN EN 60947-5-1)		$MTTF_d$ > 10 years	$MTTF_d$ > 30 years	$MTTF_d$ > 100 years
Channel 1	Channel 2	Switching frequency [1/h]		
AC 15; 3 A	AC 15; 3 A	< 214	< 65	< 13
DC 13; 5 A	DC 13; 5 A	< 85	< 25	< 5
AC 15; 3 A	DC 13; 5 A	< 159	< 48	< 9
DC 13; 5 A	AC 15; 3 A	< 159	< 48	< 9
AC 15; 3 A	Zero current	< 216	< 65	< 13
DC 13; 5 A	Zero current	< 161	< 49	< 9
250 µF; DC 4 A	Zero current	< 146	< 44	< 8

Fig. 8-6 $MTTF_d$ depending on the load for the contacts and the switching frequency

8.3 Other Marginal Conditions

1. Operation with capacitive loads is only permitted for two-channel assignment (see alternative B in Fig. 7-9 and Fig. 7-12).
1. All relays of the second channel are enabled and disabled with a time delay, so that zero current switching can be assumed for the first channel if the contacts of the first and second channel are connected in series (see alternative B in Fig. 7-9 and Fig. 7-12).
1. The minimum switching frequency is 1 cycle in 6 months.
1. The values are only valid if an appropriate external fuse is provided to protect the contacts against overload.

Determining PFH, PFD, and $MTTF_d$

9 Startup and Validation

9.1 Initial Startup

To start up, proceed as described in Fig. 9-1.

Step	Relevant section and literature
Set the transmission speed and the mode.	Chapter “Setting the DIP Switches” on page 34
Set the address.	Chapter “Setting the DIP Switches” on page 34
Install the safety module within the Inline station.	Chapter “Assembly, Removal, and Electrical Installation” on page 33
Connect the bus system and supply voltage cables to the Inline station.	DOK-CONTRL-ILSYSINS***-AW..-EN-P application description or documentation for the bus coupler
Wire the relay outputs according to your application.	Chapter “Assembly, Removal, and Electrical Installation” on page 33 Chapter “Inline Potential and Data Routing, and Inline Connectors” on page 27 Application descriptions for the function blocks used
Before applying the operating voltage: • Ensure that there are no wiring errors (e.g., cross circuit or short circuit) or grounding errors by testing with a multimeter. • Check whether the ground connection is safe.	
Connect the required voltages to the Inline station.	DOK-CONTRL-ILSYSINS***-AW..-EN-P application description or documentation for the bus coupler
Connect the required voltages (U_M) to the safety module.	Chapter “Supply Voltage U_M” on page 28
Once the operating voltage has been applied: • If possible, measure the wave form of the voltages to ensure that there are no deviations. • Measure the output voltages on the module, as well as the supply voltages, which supply the connected loads (e.g., motor) to ensure that they are in the permissible range. • Use the LEDs on the devices to check that the module starts up without any errors (there must be no red LEDs permanently on; the FS LED flashes because the device is not parameterized).	
Check the assembly and installation.	Checklist “Assembly, Removal, and Electrical Installation” on page 33
Carry out the necessary parameterization.	Chapter “Parameterization of the Safety Module” on page 41 Documentation for the controller used

Fig. 9-1 Steps for startup

Startup and Validation

Step	Relevant section and literature
Program the safety function.	Application descriptions for the function blocks used Documentation for the controller used
For PROFIsafe: When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices. If not, modify the settings.	Checklist “Validation” on page 108 Quick start guide for configuring Rexroth-Inline modules with safe inputs or outputs under PROFIsafe on your controller
Perform a function test and validation. Check whether the safety function responds as planned during programming and parameterization.	Checklist “Validation” on page 108

Fig. 9-1 Steps for startup [...]

When connecting the supply voltages, use the diagnostic and status indicators to check whether the module has started up correctly or whether any errors are indicated. For instructions on how to proceed in the event of an error, please refer to Chapter “Errors: Messages and Removal” on page 79.

9.2 Restart after Replacing a Safety Module

9.2.1 Replacing a Safety Module

⚠ WARNING **Electric shock/unintentional machine startup**

Do not assemble or remove the module while the power is connected.

Before assembling or removing the module, disconnect the power to the module and the entire Inline station and ensure that it cannot be switched on again.

Make sure the entire station is reassembled before switching the power back on. Observe the diagnostic indicators and any diagnostic messages.

The system may only be started provided neither the station nor the system poses a hazard.

If replacing a module, proceed as described for assembly and removal (see Chapter “Assembly, Removal, and Electrical Installation” on page 33).

Ensure that the new safe safety module is mounted at the correct position in the local bus. The new module must meet the following requirements:

- Same device type
- Same or later version

9.2.2 Restart

Once the safety module has been replaced, proceed as described for initial startup (see Chapter “Initial Startup” on page 75).

The parameterization of the previous module remains the same and is transmitted to the new module when the system is started.

Plug the Inline and COMBICON connectors into the correct connections.

Perform a function test after replacing the module.

9.3 Validation

Carry out a safety validation every time you make a safety-related modification to the PROFIsafe system.

When validating your individual EUC, check the assignment of the sensor and actuator connections.

Determine whether:

- The correct safe actuators are connected to the safety module
- The relay contacts are protected
- The voltage areas are observed
- If the safety-related segment circuit is used, only Inline modules that are specifically designed for this safety-related segment circuit are used
- The safety module has been parameterized correctly
- The variables used in your application program have been linked to the safe actuators correctly

Please follow the checklist “Validation” on page 108 during validation.

10 Errors: Messages and Removal

Depending on the error type, errors that are diagnosed are displayed via the local diagnostic indicators and/or transmitted to the safe controller as diagnostic messages.

The tables below provide an overview of the diagnosed errors, their causes, effects, and possible measures for error removal.

In this application description, diagnostic codes are sorted in ascending order by error type. The following errors are possible:

Diagnostic code	Error type	See
X020 ... X0B8	Safe digital relay output errors	Chapter 10.1 on page 81
X1F2 ... X1F4	General errors	Chapter 10.2 on page 82
X210 ... X3F3	Parameterization errors	Chapter 10.3 on page 83
	PROFIsafe errors	Chapter 10.4 on page 84

Fig. 10-1 Overview of diagnostic codes

For every error that occurs, the cause of the error must first be removed. If necessary, the error is then acknowledged. Errors that must be acknowledged are indicated in the “Acknowledgment” column in the tables below.

If error codes are indicated by the system, which do not appear in the tables below, please contact Bosch Rexroth.

Error removal

To remove the cause of an error, please proceed as described in the “Remedy” column in the tables below.

Error acknowledgment

Instructions on how to acknowledge an error can be found in Chapter “Acknowledging an Error” on page 84.

⚠ WARNING Unexpected machine startup

An operator acknowledgment leads to a positive edge and can thus result in the outputs being re-enabled.

Module replacement following an error

If in the event of failure the safety module is replaced, please proceed as described in Chapter 5, "Assembly, Removal, and Electrical Installation" and Chapter “Restart after Replacing a Safety Module” on page 77.

Notes on the tables below

Diagnostic code

The diagnostic register of the module includes both the diagnostic selector and the diagnostic code. This diagnostic code, which is represented in bits 11 to 0 of the register, is specified in Fig. 10-3 and onwards. However, it is the code of the entire diagnostic register that is indicated. To obtain the diagnostic code specified in the documentation, logically AND the code of the diagnostic register indicated with the code $07FF_{hex}$.

Example: ANDing the diagnostic code

Diagnostic code indicated: $E281_{hex}$
(Example for an error)

		15	14	13	12	11	10	...							0
Diagnostic register in the event of an error		Diagnostic selector			Not relevant	**Diagnostic code**									
Assignment of the diagnostic register in the event of an error		1	1	1	0	**Diagnostic code**									
Diagnostic code indicated	hex	**E**				**2**				**8**				**1**	
	bin	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1
Mask ($0FFF_{hex}$)	bin	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Diagnostic code in the documentation	bin	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1
	hex	0 -> **X** (not relevant)				**2**				**8**				**1**	

Fig. 10-2 Relationship between the diagnostic code indicated and the diagnostic code specified in the documentation

Diagnostic code specified in the documentation: $X281_{hex}$ (see Fig. 10-6 on page 83).

As the first digit is never relevant, the code always starts with an X.

If the same error can occur at different outputs/channels, a generalizing diagnostic code is indicated with an n where the error location is specified.

Generalizing diagnostic code specified in the documentation: $X03n_{hex}$

For some errors a single channel is specified as the error location (e.g., OUT0_Ch1).
Some errors only occur for outputs parameterized for two-channel operation. Here, the channel pair is specified as the error location (e.g., OUT0_Ch1&2).

Example: Channels in the diagnostic code

Safe output errors (Fig. 10-3)

Error cause	Error code (hex)
Signal error at alarm input	X0Bn
X0B0: OUT0_Ch1; X0B1: OUT1_Ch1 X0B7: OUT0_Ch2; X0B8: OUT1_Ch2	

X0Bn Signal error at alarm input

X0B**n** Error location

This means, for example:

X0B0 Signal error at alarm input at OUT0_Ch1 (relay output 0 channel 1)

X0B8 Signal error at alarm input at OUT1_Ch2 (relay output 1 channel 2)

LED

The “LED” column specifies which local diagnostic LEDs indicate the error.

Acknowledgment

Errors that must be acknowledged are indicated with “Yes” in the “Acknowledgment” column. Special conditions for re-enabling an output or the module are specified in brackets [e.g., Yes (1)] in the “Acknowledgment” column and explained below the relevant table.

10.1 Safe Digital Relay Output Errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknowledgment
Hardware fault	**X091**	All OUT: Red ON	Detected by internal tests.	**It is possible that a relay output could not be disabled.**	**Please replace module/remove module from system immediately.**	–
Signal error at alarm input X0B0: OUT0_Ch1 X0B1: OUT1_Ch1 X0B7: OUT0_Ch2 X0B8: OUT1_Ch2	**X0Bn**	OUTy: Red ON	A signal error was detected at an alarm input that was assigned to the displayed output during parameterization. Possible causes: • Incorrect static states • Absence of clock pulses • Incorrect clock pulses at the affected alarm input.	Affected output is in the safe state Depending on the error cause, error-free outputs are also disabled and a diagnostic message is generated (see "Example for disabling error-free outputs:" on page 81).	Check function of the monitored actuator. Check wiring.	Yes (2)

Fig. 10-3 Safe relay output errors

Acknowledge all errors that are present. Only then can the outputs be re-enabled.

Acknowledgment: Yes (1) Acknowledging the diagnostic message deletes the message. The module can only be restarted following power up and error-free self-test.

Acknowledgment: Yes (2) Acknowledging the diagnostic message deletes the message and enables a re-start. Following successful acknowledgment, the module also expects a positive edge from the application for the output. For two-channel parameterization, this also applies to the other, potentially error-free output.

⚠ WARNING Unexpected machine startup

An operator acknowledgment leads to a positive edge and can thus result in the outputs being re-enabled.

Example for disabling error-free outputs: OUT0_Ch1 and OUT0_Ch2 are parameterized for two-channel operation, but only OUT0_Ch1 is assigned to one of the two alarm inputs. In the event of an error at this alarm input, a diagnostic message is only generated for OUT0_Ch1, and OUT-0_Ch2 is also disabled. When the single diagnostic message is acknowledged, both outputs are enabled at the same time (as for 002X message).

10.2 General Errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknowledgment
Device temperature at critical value	**X1F2**			Immediate shutdown. Further temperature increase causes the module to switch to the safe state.	Check and adapt: • Ambient conditions • Derating • Output loads • Switching frequency	Yes (1)
Error due to receipt of an unexpected message	**X1F3**		Error due to receipt of an unexpected message while acknowledging a diagnostic message. The device firmware handles this diagnostic message with the highest priority. Only when this message has been acknowledged correctly are other errors indicated (if present).	The acknowledgment process, during which an unexpected message was received, is aborted. The corresponding error remains in the error memory. Diagnostic message 01F3 is indicated.	Check and adapt the assignment of the diagnostic and confirmation variables at the DEVICE_STATE function block. Acknowledge diagnostic message 01F3 so that the next message from the error memory can be indicated.	Yes (1)
Error due to receipt of an unexpected value in the process data image	**X1F4**		At least one reserved bit in the process data image was set.	All outputs are disabled immediately. A parameterized switch-off delay is not observed.	Check process data assignment.	Yes (2)
Hardware fault		FS ON	Error in the logic area.	Module is in the safe state.	Replacement	

Fig. 10-4 General errors

Acknowledgment: Yes (1) Acknowledging the diagnostic message deletes the message.

Acknowledgment: Yes (2) Acknowledging the diagnostic message deletes the message and enables the outputs.

10.3 Parameterization Errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknowledgment
Incorrect parameterization	See Fig. 10-6	FS LED (flashing)	Each output is parameterized individually	Module is in the safe state	Check and correct parameterization.	–

Fig. 10-5 Parameterization errors

In order to determine what type of parameterization error has occurred, use the corresponding control software to access the safe controller online and read the error.

F

Error code (hex)	Error code (dec)	Short description	Remedy
X23n X230: OUT0_Ch1&2 X231: OUT1_Ch1&2	**560**: OUT0_Ch1&2 **561**: OUT1_Ch1&2	The parameterization of two related outputs does not correspond to the two-channel setting.	Correct value and resend parameter data to the module.
X28n X280: OUT0_Ch1 X281: OUT1_Ch1 X287: OUT0_Ch2 X281: OUT1_Ch2	**640**: OUT0_Ch1 **641**: OUT1_Ch1; **647**: OUT0_Ch2 **648**: OUT1_Ch2	The parameterized switch-off delay time for the output is outside the permissible value range.	Correct value and resend parameter data to the module.
X29n X290: OUT0_Ch1&2 X291: OUT1_Ch1&2	**656**: OUT0_Ch1&2 **657**: OUT1_Ch1&2	For outputs parameterized for two-channel operation, the same settings were not assigned for the switch-off delay.	Correct setting and resend parameter data to the module.
X2An X2A0: OUT0_Ch1 X2A1: OUT1_Ch1 X2A7: OUT0_Ch2 X2A8: OUT1_Ch2	**672**: OUT0_Ch1 **673**: OUT1_Ch1; **679**: OUT0_Ch2 **680**: OUT1_Ch2	Impermissible assignment of an alarm input. Either more than one alarm input is assigned to an output or the selected alarm input has already been assigned to another output. Dual assignment is only supported for two-channel outputs.	Correct setting and resend parameter data to the module.
X2F2	**754**	At least one output with parameterized switch-off delay is still performing a switch-off operation.	Wait until the switch-off operation is complete and resend parameter data to the module.

Fig. 10-6 Parameterization errors

10.4 PROFIsafe Errors

In addition to the module errors specified, the following errors can occur:

- PROFIsafe system errors: These messages can be found in Chapter “Diagnostic Messages for Parameter Errors” on page 101.
- PROFIBUS or PROFINET system errors: For information about these errors, please refer to the documentation for the system used.

10.5 Acknowledging an Error

After removing the cause of an error, the diagnostic message must be acknowledged.

For instructions on error acknowledgment, please refer to the documentation for the system used.

⚠ WARNING **Acknowledgment may result in a hazardous system state**

With the exception of a few special cases, the acknowledgment of an error immediately returns the safe output to the operating state. Before acknowledging an error you must, therefore, make sure that the acknowledgment will not cause the machine to switch to a dangerous state.

When planning the machine or system, make sure that acknowledgment is only possible if the danger zone is visible.

If in the event of failure the safety module is replaced, please proceed as described in Chapter 5, "Assembly, Removal, and Electrical Installation" and Chapter “Restart after Replacing a Safety Module” on page 77.

11 Maintenance, Repair, Decommissioning, and Disposal

11.1 Maintenance

The device is designed in such a way that maintenance work is not required during the duration of use. However, depending on the application and connected I/O devices it may be necessary to test the function of the I/O devices and the safety chain at regular intervals.

The duration of use of the module is 20 years.

Observe the cycles of the relays (see “Safe digital relay outputs” on page 90).

Switch the safety relays at regular intervals (for proof test interval see “Safe digital relay outputs” on page 90).

Carry out maintenance of connected I/O devices (e.g., light grid) according to the relevant manufacturer specifications.

11.2 Repair

It is prohibited for the user to carry out repair work or make modifications to the module. The housing must not be opened. If the housing is opened, correct operation can no longer be ensured.

In the event of an error, send the module to Bosch Rexroth or contact Bosch Rexroth immediately and engage a service engineer.

11.3 Decommissioning and Disposal

The machine or system manufacturer specifies the procedure for decommissioning.
Decommissioning may only take place according to these specified procedures.

When decommissioning a PROFIsafe system or parts thereof, ensure that the safety modules used:

- Are correctly reused in another system.
  In this case, please observe the storage and transport requirements according to the technical data (see Chapter “R-IB IL 24 PSDOR 4-PAC” on page 87).
  Or
- Are disposed of according to the applicable environmental regulations, and in this case can never be reused.

Maintenance, Repair, Decommissioning, and Disposal

12 Technical Data and Ordering Data

12.1 System Data

12.1.1 Rexroth Inline

For the system data for the Rexroth-Inline system, please refer to the application description DOK-CONTRL-ILSYSINS***-AW..-EN-P.

12.1.2 PROFIsafe

PROFIsafe	
PROFIsafe profile	2.4
Processing time of the module	
Single-channel	7 ms
Two-channel	17 ms

For the system data for your system, please refer to the corresponding documentation.

12.2 R-IB IL 24 PSDOR 4-PAC

General data	
Housing dimensions (width x height x depth)	73.2 mm x 119.8 mm x 71.5 mm
Weight (with connectors)	310 g
Operating mode	
PROFIsafe	Process data mode with 4 words and 1 word PCP (internal use)
Transmission speed (local bus)	500 kbaud or 2 Mbaud
Ambient temperature	
Operation	-25°C to +55°C
Storage/transport	-25°C to +70°C
Humidity	
Operation	75% on average, 85% occasionally (no condensation)

In the range from -25°C to +55°C appropriate measures against increased humidity must be taken.

Storage/transport	75% (no condensation)

For a short period, slight condensation may appear on the outside of the housing.

Air pressure	
Operation	80 kPa to 108 kPa (up to 2000 m above sea level)
Storage/transport	66 kPa to 108 kPa (up to 3500 m above sea level)
Degree of protection	IP20
Housing material	Plastic PBT, self-extinguishing (V0)
Air and creepage distances	According to IEC 60664-1

Technical Data and Ordering Data

General data [...]	
Protection class	II, IEC 61140, EN 61140, VDE 0140-1
Gases that may endanger functions according to DIN 40046-36, DIN 40046-37	
Sulfur dioxide (SO2)	Concentration 10 ±0.3 ppm Ambient conditions: – Temperature 25°C ±2 K – Humidity 75% ±5% – Test duration 10 days
Hydrogen sulfide (H2S)	Concentration 1 ±0.3 ppm Ambient conditions: – Temperature 25°C ±2 K – Humidity 75% ±5% – Test duration 4 days
Resistance of housing material to termites	Resistant
Resistance of housing material to fungal decay	Resistant
Ambient compatibility	Not resistant to chloroform
Connection data for Inline connectors	
Connection method	Spring-cage terminals
Conductor cross section	0.2 mm^2 to 1.5 mm^2 (solid or stranded), 24 - 16 AWG
Permissible current	4 A, maximum
Fuse protection	4 A, maximum
Connection data for COMBICON connectors	
Connection method	Spring-cage terminals
Conductor cross section	0.2 mm^2 to 2.5 mm^2 (solid or stranded), 24 - 12 AWG
Conductor cross section with ferrule with/without plastic sleeve	0.25 mm^2 to 2.5 mm^2 (stranded), 24 - 12 AWG
Supported stop category according to EN 60204	0 1 in error-free state

Mechanical requirements	
Vibration according to IEC 60068-2-6	Operation: 2g, Criterion A
Shock according to IEC 60068-2-27	15g over 11 ms, Criterion B

Safety characteristic data according to IEC 61508/EN 61508	
Achievable SIL	SIL 2 (single-channel) SIL 3 (two-channel) Depends on the parameterization and wiring (see Chapter “Connection Options for Actuators Depending on the Parameterization” on page 21 and Chapter “Connection Examples” on page 45)
Probability of a dangerous failure on demand by the safety function (PFD)	See Chapter “Determining PFH, PFD, and $MTTF_d$” on page 69.
For single-channel assignment	1 %, maximum of SIL 2
For two-channel assignment	1 %, maximum of SIL 3
Probability of a dangerous failure per hour for the entire module (PFH)	See Chapter “Determining PFH, PFD, and $MTTF_d$” on page 69.
For single-channel assignment	1 %, maximum of SIL 2, depending on the load, switching frequency, parameterization, and wiring

Safety characteristic data according to IEC 61508/EN 61508 [...]	
For two-channel assignment	1 %, maximum of SIL 3, depending on the load, switching frequency, parameterization, and wiring
Hardware fault tolerance (HFT) of the module	
For single-channel assignment	0
For two-channel assignment	1
Permissible duration of use	20 years

Safety characteristic data according to DIN EN 62061	
Achievable SIL claim limit	SILCL 1 (single-channel) SILCL 3 (two-channel) Depends on the parameterization and wiring (see Chapter "Connection Options for Actuators Depending on the Parameterization" on page 21 and Chapter "Connection Examples" on page 45)
Safe failure fraction (SFF)	99%
Probability of a dangerous failure per hour for the entire module (PFH)	See Chapter "Determining PFH, PFD, and $MTTF_d$" on page 69.
For single-channel assignment	1%, maximum of 10^{-6}, depending on the load, switching frequency, parameterization, and wiring
For two-channel assignment	1%, maximum of 10^{-7}, depending on the load, switching frequency, parameterization, and wiring
Hardware fault tolerance (HFT) of the module	
For single-channel assignment	0
For two-channel assignment	1
Permissible duration of use	20 years

Safety characteristic data according to EN ISO 13849-1	
Achievable performance level	PL c (single-channel) PL e (two-channel) Depends on the parameterization and wiring (see Chapter "Connection Options for Actuators Depending on the Parameterization" on page 21 and Chapter "Connection Examples" on page 45)
Diagnostic coverage (DC)	99%
Mean time to dangerous failure ($MTTF_d$)	For single-channel assignment: 100 years For two-channel assignment: 100 years Depends on the load, switching frequency, parameterization, and wiring (see Chapter "Determining PFH, PFD, and $MTTF_d$" on page 69)

Supply voltage U_L (logic, relay)

The safety module is supplied with communications power via the bus coupler or a designated power terminal in the station. Potential routing is used for the communications power in the Inline station. For the technical data, please refer to the data sheet for the bus coupler or power terminal used.

Current consumption	360 mA, maximum
Diagnostic indicators	Indirect via green D LED (see "Local Diagnostic and Status Indicators" on page 21)

Technical Data and Ordering Data

Supply voltage U_M (clock outputs)

The safety module is supplied with main voltage U_M via the bus coupler or a power terminal in the station. Potential routing is used for the main voltage in the Inline station. For the technical data, please refer to the data sheet for the bus coupler or power terminal used.

⚠ WARNING **Loss of the safety function when using unsuitable power supplies**

Only use power supplies according to EN 50178/VDE 0160 (PELV).

Nominal voltage	24 V DC according to EN 61131-2 and EN 60204
Tolerance	-15%/+20% including an entire AC voltage component with peak value of 5%
Ripple	3.6 V_{PP}
Permissible voltage range	19.2 V DC to 30.0 V DC, ripple included
Current consumption	30 mA, typical
Permissible interruption time	10 ms; Within this time, the output voltage for the clock outputs fails as the clock outputs are not internally buffered. A dip in the supply voltage can switch off the safety relay and result in a diagnostic message.
Surge protection	Yes (in the bus coupler/power terminal); Additional internal surge protection (suppressor diode between U_M and GND)
Protection against polarity reversal	Yes (in the bus coupler/power terminal)

NOTICE **Module damage due to polarity reversal**

Polarity reversal places a burden on the electronics and, despite protection against polarity reversal, can damage the module. Therefore, polarity reversal must be prevented.

Undervoltage detection	No
Diagnostic indicators	None
External fuse protection	8 A slow-blow, maximum

NOTICE **Module damage in the event of overload**

The power supply unit must be able to supply four times (400%) the nominal current of the external fuse

Safe digital relay outputs

Number of safety relays	4
Number of floating contacts	8
Supply for the coils	From supply voltage U_L
Permissible switching voltage range	
At Inline connector	5 VAC/DC to 30 V AC/DC
At COMBICON connector	5 V AC/DC to 250 V AC/DC
Maximum output current per contact	
At Inline connector	4 A (observe derating, see “Derating” on page 92)
At COMBICON connector	6 A (observe derating, see “Derating” on page 92)
Potential areas	See Fig. 3-3 on page 3-17
Maximum output current for all contacts (total current)	See “Derating” on page 92

Safe digital relay outputs [...]	
Mechanical service life	> 10 x 10^6 cycles
N/O contact bouncing time	2 ms, typical
Maximum switching frequency	1 time per second (depending on the SIL requirement; see also Chapter “Determining PFH, PFD, and $MTTF_d$” on page 69)
Proof test interval	6 months
External fuse protection	Nominal current ≤ 6 A, I^2t value < 100 A^2s (see also Chapter “Fuse protection” on page 17)
Simultaneity	100% (observe maximum current load)
Derating	See “Derating” on page 92
Switch-off delay for shutdown according to stop category 1	Can be parameterized: 150 ms to 630 s; see Chapter “Parameterization of the Safe Relay Outputs” on page 42 Accuracy: ±5% of parameterized value
Status indicators	One green LED (two-color LED green/red) per relay output (see “Local Diagnostic and Status Indicators” on page 21)
Diagnostic indicators	One red LED (two-color LED green/red) per relay output (see “Local Diagnostic and Status Indicators” on page 21)

Technical Data and Ordering Data

Derating

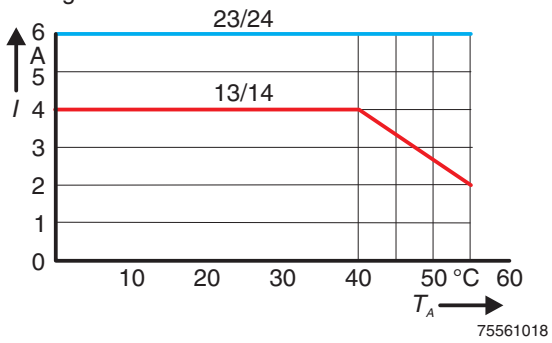
The three derating curves are valid at 100% simultaneity of the relay outputs.

A distinction is made between contacts 13/14 and 23/24.

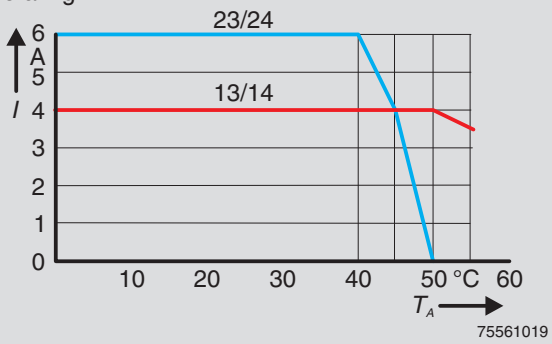
Use only one diagram to determine the derating of the safety module.

Example (derating 1):
If contacts 23/24 are loaded with 6 A at T_A = 50°C, then contacts 13/14 can only be loaded with a maximum of 2.6 A.

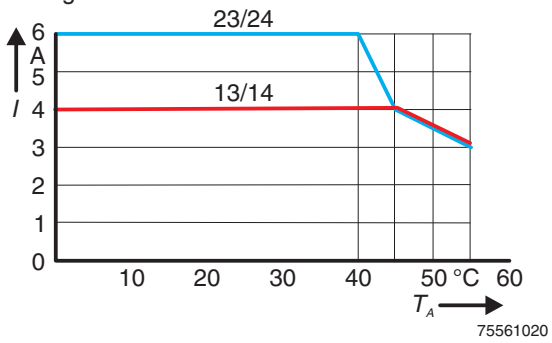
Derating 1



Derating 2



Derating 3



Contact data for the safety relay used

Contact material	AgCUNi + 0.2-0.4 µm Au
Type of contact	Single contact
Nominal switching power	250 V AC, 6 A AC1 1500 VA
Electrical service life	100,000 AC1 (360 switching operations/h), approximately
Inrush current	30 A for 20 ms, maximum
Switching voltage range	5 V DC/AC to 250 V DC/AC
Switching current range (guide value)	5 mA to 6 A
Switching power range (guide value)	60 mW to 1500 W (VA)
Contact resistance	≤ 100 mΩ (when new)
Immunity to short-circuiting	1000 A SCPD (6 A gG backup fuse)
Maximum switching capacity (DIN EN 60947-4-1, DIN EN 60947-5-1)	

Contact data for the safety relay used [...]	
AC 1	250 V/6 A
AC 15	230 V/3 A
DC 1	24 V/6 A
DC 13	24 V/5 A/0.1 Hz
Maximum interrupting rating for ohmic load (τ = 0 ms)	
DC 24 V	144 W
DC 48 V	96 W
DC 110 V	66 W
DC 250 V	63 W
AC 250 V	1500 VA
Maximum interrupting rating for inductive load (τ = 40 ms)	
DC 24 V	35 W
DC 48 V	35 W
DC 110 V	35 W
DC 250 V	35 W

Clock outputs	
Number	2
Supply	From U_M
Maximum switching current	15 mA short-circuit and overload protection, approximately
Simultaneity	100%
Derating	No
Status indicators	None
Diagnostic indicators	None

Alarm inputs	
Number	2
Supply	From clock outputs UT1 and UT2
Typical input current	5.5 mA
Simultaneity	100%
Derating	No
Status indicators	One green LED per alarm input (see “Local Diagnostic and Status Indicators” on page 21)
Diagnostic indicators	None

Technical Data and Ordering Data

Electrical isolation/isolation of the voltage areas

To provide electrical isolation between the logic level and the I/O area, it is necessary to supply the bus coupler and this safety module from separate power supply units. Interconnection of the power supply units in the 24 V area is not permitted (see also application description).

Separate potentials in the system comprising bus coupler/power terminal and safety module

- Test distance	- Test voltage
5 V supply incoming remote bus/7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
5 V supply outgoing remote bus/7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
7.5 V supply (bus logic)/ 24 V supply U_M, 24 V supply U_S, GND, clock outputs, relay outputs, FE	500 V AC, 50 Hz, 1 min.
24 V supply U_M, 24 V supply U_S, GND, clock outputs/ 7.5 V supply (bus logic), relay outputs	500 V AC, 50 Hz, 1 min.
COMBICON X3 relay outputs/COMBICON X4 relay outputs, Inline connector relay outputs, 7.5 V supply (bus logic), 24 V supply U_M, 24 V supply U_S, GND, clock outputs, FE	2500 V AC, 50 Hz, 1 min.
COMBICON X4 relay outputs/COMBICON X3 relay outputs, Inline connector relay outputs, 7.5 V supply (bus logic), 24 V supply U_M, 24 V supply U_S, GND, clock outputs, FE	2500 V AC, 50 Hz, 1 min.

Approvals

For the latest approvals, please visit www.boschrexroth.com.

12.3 Conformance with EMC Directive

Conformance with EMC Directive 2014/30/EU

Noise immunity test according to DIN EN 61000-6-2

Electrostatic discharge (ESD)	EN 61000-4-2 (IEC 61000-4-2)	Criterion B 6 kV contact discharge, 8 kV air discharge
Electromagnetic fields	EN 61000-4-3 (IEC 61000-4-3)	Criterion A, field strength 10 V/m
Fast transients (burst)	EN 61000-4-4 (IEC 61000-4-4)	Criterion B, test voltage 2 kV
Surge voltage	EN 61000-4-5 (IEC 61000-4-5)	Test intensity 2, Criterion B DC supply lines: 0.5 kV/0.5 kV (symmetrical/asymmetrical) Signal lines: 1.0 kV/2.0 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6 (IEC 61000-4-6)	Criterion A, test voltage 10 V

Noise emission test according to DIN EN 61000-6-4

Noise emission	EN 55011	Class A, industrial applications

12.4 Ordering Data

12.4.1 Ordering Data: Safety Module

Description	Order code	MNR	Pcs. / Pkt.
Rexroth Inline module with safe digital relay outputs; including accessories (connectors and labeling fields)	R-IB IL 24 PSDOR 4-PAC	R911172848	1

For additional ordering data (accessories), please refer to the product catalog at www.boschrexroth.com/electrics.

12.4.2 Ordering Data: Documentation

Description	Order code	MNR	Pcs. / Pkt.
Inline			
“Automation modules of the Rexroth Inline product range” application description	DOK-CONTRL-ILSYSINS***-AW..-EN-P	R911317021	1
“The safety-related segment circuit” application description	DOK-CONTRL-ILSAFE*SEG*-AP..-EN-P	R911335486	1
PROFIsafe			
“PROFIsafe - Profile for Safety Technology on PROFIBUS DP and PROFINET IO, Version 2.4, February 2007” specification	See http://www.profisafe.net		

Make sure you always use the latest documentation.
It can be downloaded at www.boschrexroth.com/electrics.

Documentation for PROFIsafe, PROFIBUS, and PROFINET is available on the Internet at www.profibus.com/pall/meta/downloads.

Technical Data and Ordering Data

13 PROFIsafe Terms Used in the Application Description

Some of the terms that are used in connection with PROFIsafe in this manual are described below.

A definition of PROFIsafe terms is also provided in the PROFIsafe profile.

Consecutive number Method for ensuring that the safe data is transmitted completely and in the correct order.

CRC Cyclic Redundancy Check

A cyclic redundancy check is used to verify the validity of the process data contained in the safety telegram, check whether the assigned address relationships are correct, and verify the safety-related parameters. This value is part of the safety telegram.

F-CPU Failsafe control system, safe controller

F_Destination_Address F-Parameter; PROFIsafe destination address; address of the safe device (see also "F-Parameter")

F-Parameter (According to PROFIsafe system description, Version 09, November 2007)

F-Parameters contain information for adapting the PROFIsafe layer to specific customer specifications and for checking the parameterization by means of a separate method (diverse). The main F-Parameters are:

F_S/D_Address (F-Address for short)	A unique address for F-Devices within a PROFIsafe island. The technology part of the F-Device compares the value with the address switch locally or with an assigned F-Address in order to check the authenticity of the connection.
F_WD_Time	Specifies the millisecond value for the watchdog timer. The timer monitors the time that elapses until the next valid PROFIsafe message is received.
F_SIL	Indicates the SIL that the user can expect from the relevant F-Device. It is compared with the manufacturer's specification that is stored locally.
F_iPar_CRC	A checksum that is calculated from all iParameters of the technology-specific part of the F-Device.
F_Par_CRC	A CRC signature, which is created via all F-Parameters and ensures error-free transmission of the F-Parameters.

F-I/O device Failsafe I/O device; safe input and/or output modules

Modules with integrated safety functions, which are approved for safety-related operation.

F-Slave Failsafe slave

F_Source_Address F-Parameter; PROFIsafe source address; address of the safe controller (see also "F-Parameter")

PROFIsafe Terms Used in the Application Description

F-System Failsafe system

A failsafe system is a system that remains in the safe state or immediately enters a safe state when specific failures occur.

iParameter Individual safety parameter of a device

Passivation If the safety module (F-I/O device) detects an error, it switches the affected channel or all channels of the module to the safe state; the channels are then passivated. The detected errors are indicated at the safe controller.

For a safe input module when the F-System is passivated, instead of the process values present at the safe inputs, substitute values (0) are provided for the safety program.

For a safe output module when the F-System is passivated, instead of the output values provided by the safety program, substitute values (0) are transferred to the safe outputs.

PROFIsafe Safety-related bus profile based on PROFIBUS DP or PROFINET. It defines the communication between a safety program and the safe I/O device (F-I/O device) in a safe system (F-System).

PROFIsafe address Each safe module has a PROFIsafe address. This address must be set on the safety module (F-I/O device) via DIP switches and then configured in the configuration tool for the safe controller used.

PROFIsafe monitoring time Monitoring time for safety-related communication between the safe controller (F-CPU) and safe I/O device (F-I/O device).

This time is parameterized in the F_WD_Time F-Parameter.

14 F-Parameters and iParameters

14.1 F-Parameters

The values indicated in italics in Table 14-1 are preset by the system and cannot be modified manually.

F-Parameter	Default value	Description
F_Source_ Address	-	The parameter uniquely identifies the PROFIsafe source address (controller address). The address is assigned manually.
F_Destination_ Address	-	PROFIsafe destination address (address of the safe device) The address is assigned manually and the value can be modified. Make sure that the value set under F_Destination_Address and the value that you have set via the 10-pos. DIP switch are the same. Value range: 1 ... 1022
F_WD_Time	150	Monitoring time in the safety module. A valid current safety telegram must arrive from the safe controller within the monitoring time. Otherwise, the safety module enters the safe state. The selected monitoring time must be sufficiently high for telegram delays to be tolerated by the communication, but still ensure a sufficiently fast error response in the event of an error (e.g., interruption in communication). Value range: 1 ... 65534, in 1 ms increments Unit: ms
F_SIL	*SIL 3*	Safety integrity (SIL according to IEC 61508) of the safety module **⚠ WARNING** Safety functions up to SIL 3 can be achieved with the safety module. The safety integrity level that can actually be achieved depends on the parameterization, the structure of the sensor, and the cable installation (see “Connection Examples” on page 45).
F_CRC_Length	*3-byte CRC*	This parameter transmits the length of the CRC2 code to be expected in the safety telegram to the safe controller.
F_Block_ID	*1*	Parameter block type identification 1: The parameter block of the F-Parameters contains the F_iPar_CRC parameter.
F_Par_Version	*1*	Version number of the F-Parameter block. 1: Valid for V2 mode
F_iPar_CRC	0	CRC checksum via the iParameters The value must be greater than 0. When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices. If not, check the iParameters and the CRC checksum in the iParameter and F-Parameter.

Table 14-1 Overview of the F-Parameters for the module

14.2 iParameters

The iParameters are individual device parameters. These include:

- Device parameters (see Chapter “Parameterization of the Safe Relay Outputs” on page 42)
- PST_Device_ID (30_{hex} for R-IB IL 24 PSDOR 4-PAC)
- F_Destination_Address (not included in the checksum calculation)

iPar_CRC The device parameters are verified with a checksum: iPar_CRC.

F_Destination_Address This address is the PROFIsafe address of the module. Make sure that it matches the switch position of the 10-pos. DIP switch.

14.3 Diagnostic Messages for Parameter Errors

Error code		Error cause	Remedy
dec	hex		
64	40	The parameterized F_Destination_Address does not match the PROFIsafe address set on the safety module (F-Module).	Make sure that the PROFIsafe address of the safety module and the value in F_Destination_Address are the same.
65	41	Invalid parameterization of F_Destination_Address. Addresses 0000_{hex} and $FFFF_{hex}$ are not permitted.	Correct value.
66	42	Invalid parameterization of F_Source_Address. Addresses 0000_{hex} and $FFFF_{hex}$ are not permitted.	Correct value.
67	43	Invalid parameterization of F_WD_Time. A monitoring time of 0 ms is not permitted.	Correct value.
68	44	Invalid parameterization of F_SIL. The safety module (F-Module) cannot support the required SIL.	Use a device with the required SIL. The safety module achieves SIL 3, maximum.
69	45	Invalid parameterization of F_CRC_Length. The CRC length generated by the safety module (F-Module) does not match the required length.	Check device description.
70	46	Invalid F-Parameter record version. The safety module (F-Module) version does not match the required version.	Check device description. Only V2 mode permitted.
71	47	The checksum determined by the safety module (F-Module) via the PROFIsafe parameters (CRC1) does not match the CRC1 transmitted in the parameter telegram.	Check F-Parameters, repeat calculation.
255	FF	During active process data communication, a new F-Parameter block was received, which differs from the F-Parameter block currently used. Incorrect type ID for the F-Parameter block (F_Block_ID).	Only send modified parameter data when process data communication is not active. Check device description.

Table 14-2 F-Parameter parameter errors

Error code (hex)	Error cause	Remedy
X3F2	iPar_CRC is incorrect	Check iParameters, repeat calculation.
X3FA	iPar_CRC is not equal to F_iPar_CRC	Apply correct value.
X3FB	PST_Device_ID is incorrect	Correct value (30_{hex} for R-IB IL 24 PSDOR 4-PAC).
X3FC	F_Destination_Address in the iParameters is incorrect	Correct value. Make sure that the value set under F_Destination_Address and the value that you have set via the 10-pos. DIP switch are the same.
X3FD	Incorrect order of iParameter blocks	Check infrastructure components.

Table 14-3 iParameter parameter errors

Diagnostic Messages for Parameter Errors

15 Checklists

The checklists listed in this section provide support during the planning, assembly and electrical installation, startup, parameterization, and validation of the R-IB IL 24 PSDOR 4-PAC module.

These checklists may be used as planning documentation and/or as verification to ensure the steps in the specified phases are carried out carefully.

Archive the completed checklists to use as reference for recurring tests.

The checklists do not replace the validation, initial startup, and regular testing performed by qualified personnel.

The following section of a checklist shows an example of a completed checklist.

Checklist . . .				
Device type/equipment identification		R-IB IL 24 PSDOR 4-PAC/BK20NA10		
Version: HW/FW/FW	01/201/100	**Date**	December 1, 2012	
Author	John Smith	**Test engineer**	Jane Brown	
Remark	System XXX has been checked for engine hood production			
No.	**Requirement (mandatory)**	**Yes**		**Remark**
X	. . .	☐		
No.	**Requirement (optional)**	**Yes**	**No**	**Remark**
Y	. . .	☐	☐	

Key:

Equipment identification	Enter the device type and/or the equipment identification for the relevant device.
Version: HW/FW/FW	Enter the hardware and firmware version of the device (see Chapter “Structure of the Safety Module” on page 16).
Date	Enter the date on which you began to fill in this checklist.
Author	Enter the name of the author.
Test engineer	Enter the name of the test engineer.
Remark	Enter a remark, if necessary.
Requirement (mandatory)	These requirements must be met for a safety application, in order to complete the relevant phase using the checklist.
Requirement (optional)	These requirements are optional. For points that are not met, please enter an appropriate remark in the relevant field.

15.1 Planning

Checklist for planning the use of the safety module			
Device type/equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Has the current module application description been used as the basis for planning?	☐	Revision:
2	Are the actuators approved for connection to the module (according to the technical data and parameterization options)?	☐	
3	Has the voltage supply been planned according to the specifications for the protective extra-low voltage in accordance with PELV?	☐	
4	Has the power supply of U_M and U_S from a power supply unit been planned?	☐	
5	Is external fuse protection of the module planned (according to the specifications in this application description for supply voltage UM)?	☐	
6	Is external fuse protection of the relay contacts planned?	☐	
7	Are measures planned to prevent simple manipulation?	☐	
8	Are measures planned to prevent connectors being mixed up?	☐	
9	Are requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved and is the corresponding implementation planned?	☐	
10	Are the specifications for the parameterization for each channel specified?	☐	
11	Are test intervals specified for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
12	Has it been ensured that any person intentionally starting hazardous movements has a direct view of the danger zone?	☐	
13	Does the planned use correspond to the intended use?	☐	
14	Are the ambient conditions observed according to the technical data?	☐	
15	Have test intervals been defined?	☐	
16	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?	☐	
17	Have the selected modules for the safety-related segment circuit been designed for this purpose?	☐	

No.	Requirement (optional)	Yes	No	Remark
18	Have specifications for assembly and electrical installation been defined (e.g., EPLAN) and communicated to the relevant personnel?	☐	☐	
19	Have the separate voltage areas been taken into account?	☐	☐	
20	Have specifications for the safety-related segment circuit been taken into account (jumpers, approved modules, fuse protection)?	☐	☐	
21	Have specifications for startup been defined and communicated to the relevant personnel?	☐	☐	
		Date		Signature (author)
		Date		Signature (test engineer)

15.2 Assembly and Electrical Installation

Checklist for assembly and electrical installation of the safety module			
Device type/equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Was assembly completed according to the specifications (specifications from the planning phase or according to the application description)?	☐	
2	Was the safety module installed in the control cabinet (IP54)?	☐	
3	Do the cable cross sections correspond to the specifications?	☐	

No.	Requirement (optional)	Yes	No	Remark
4	Is the transmission speed set correctly according to the specifications?	☐	☐	
5	Is the profile/PROFIsafe address set correctly according to the specifications?	☐	☐	

Date	Signature (author)
Date	Signature (test engineer)

15.3 Startup and Parameterization

Checklist for startup and parameterization of the safety module			
Device type/equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Was startup completed according to the specifications (specifications from the planning phase or according to the application description)?	☐	
2	During startup, is it ensured that any person starting hazardous movements intentionally can only do so with a direct view of the danger zone?	☐	
3	Are all parameters parameterized for the outputs?	☐	
4	For outputs that are parameterized for two-channel operation, are both channels parameterized correctly for each other?	☐	
5	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?	☐	

No.	Requirement (optional)	Yes	No	Remark
6	Are safety distances that must be observed calculated according to the response and delay times implemented?	☐	☐	

Date	Signature (author)
Date	Signature (test engineer)

15.4 Validation

Checklist for validating the safety module			
Device type/equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Have all the mandatory requirements for the "Planning" checklist been met?	☐	
2	Have all the mandatory requirements for the "Assembly and Electrical Installation" checklist been met?	☐	
3	Have all the mandatory requirements for the "Startup and Parameterization" checklist been met?	☐	
4	Does the parameterization of the safe outputs correspond to the version and the actual connection of the controlled device?	☐	
5	Has the assignment of the actuators to the outputs and the variables of the safe application program been tested (also as online status in the software)?	☐	
6	Has a function test been performed to check all safety functions, in which the module is involved?	☐	
7	Have measures been taken to achieve a specific Cat.?	☐	
8	Do all cables correspond to the specifications?	☐	
9	Does the voltage supply correspond to the specifications for the protective extra-low voltage in accordance with PELV?	☐	
10	Has the power supply of U_M and U_S in the Rexroth-Inline system from a power supply unit been implemented?	☐	
11	Is external fuse protection of the module implemented (according to the specifications in this application description for supply voltage U_M)?	☐	
12	Is external fuse protection of the relay contacts implemented?	☐	
13	Have the separate voltage areas been taken into account?	☐	
14	Have specifications for the safety-related segment circuit been implemented (jumpers, approved modules, fuse protection)?	☐	
15	Have measures been taken to prevent simple manipulation?	☐	
16	Have measures been taken to prevent connectors being mixed up?	☐	
17	Are the requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved?	☐	
18	Are the specifications for the parameterization for each channel implemented?	☐	
19	Are test intervals specified for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
20	For PROFIsafe: Is the F_iPar_CRC parameter greater than 0 for all devices?	☐	

Validation

No.	Requirement (mandatory)	Yes	Remark
21	Has it been ensured that any person intentionally starting hazardous movements has a direct view of the danger zone?	☐	
		Date	Signature (author)
		Date	Signature (test engineer)

Validation

16 Conditions for Use at Altitudes greater than 2000 m above Sea Level

This section describes the conditions for using safe Inline I/O modules at altitudes greater than 2000 m above sea level to a maximum of 4500 m above sea level.

Observe the relevant data (technical data, derating, etc.) that is specific to the module being used.

16.1 Conditions

Use of the module at altitudes **greater 2000 m above sea level to a maximum of 4,500 m above sea level** is possible under the following conditions:

1. Determine the maximum ambient temperature for operation with the corresponding factor in accordance with the table below.
2. If derating is specified, offset all the derating points by the corresponding factor in accordance with the table below.

Altitude above sea level	Temperature derating factor
2000 m	1
2500 m	0.953
3000 m	0.906
3500 m	0.859
4000 m	0.813
4500 m	0.766

For relay outputs:

3. Limit the maximum switching voltage for relay outputs in accordance with the table below. Observe the technical data for the module.

Max. switching voltage according to the technical data for the module	Max. switching voltage when used at altitudes greater than 2000 m above sea level
< 150 V AC/DC	Max. switching voltage according to the technical data for the module still valid
> 150 V AC/DC	Limited to max. 150 V AC/DC

Conditions for Use at Altitudes greater than 2000 m above Sea Level

16.2 Example Calculation

The following calculation is an example for using a safe Inline I/O module at an altitude of 3000 m above sea level.

Perform the actual calculation for the module used according to the technical data from the user documentation for the module.

Data in the “Technical data and ordering data” section (example):

Derating	Up to 50 °C, total current of all outputs 6 A, maximum Up to 55 °C, total current of all outputs 4 A, maximum

Calculation:

50 °C • 0.906 ≈ 45 °C
55 °C • 0.906 ≈ 50 °C

Reduced derating:

Derating at 3,000 m above sea level	Up to **45 °C**, total current of all outputs 6 A, maximum Up to **50 °C**, total current of all outputs 4 A, maximum

17 Disposal

17.1 General Information

Dispose the products according to the respective valid national standard.

17.2 Return

For disposal, our products can be returned free of charge. However, the products must be free of remains like oil and grease or other impurities.

Furthermore, the products returned for disposal must not contain any undue foreign substances or components.

Send the products free of charge to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Bürgermeister-Dr.-Nebel-Straße 2
D-97816 Lohr am Main, Germany

17.3 Packaging

The packaging material consists of cardboard, plastics, wood or styrofoam. Packaging material can be recycled anywhere.

For ecological reasons, please do not return empty packages.

17.4 Batteries and Accumulators

Batteries and accumulators can be labelled with this symbol.

The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the health of the individual when they are stored incorrectly or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be disposed of according to the country-specific collection system.

Disposal

18 Service and Support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries.
You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

Service and Support

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Notes

The Drive & Control Company

Rexroth
Bosch Group

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