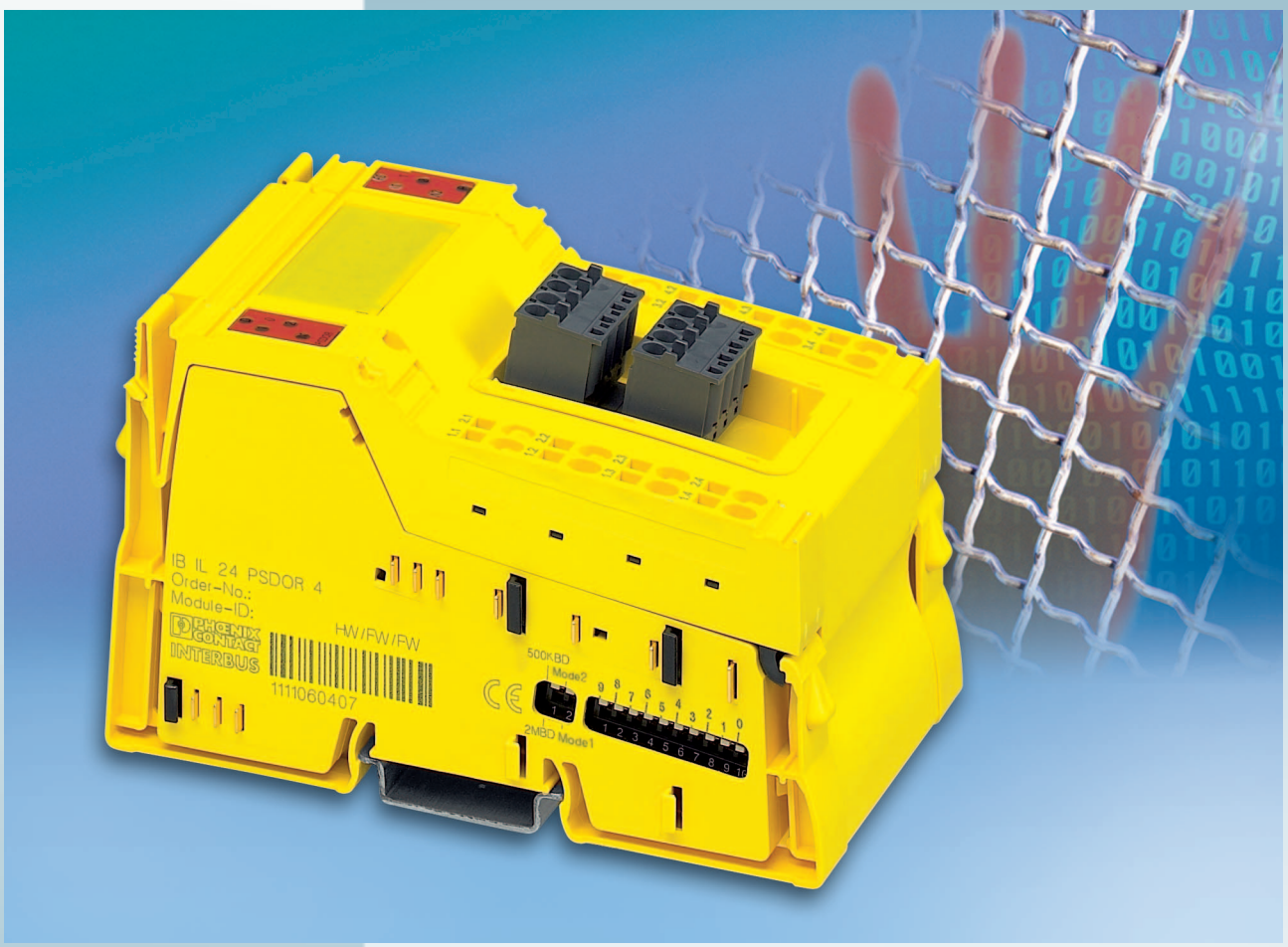

IB IL 24 PSDOR 4-PAC Inline module with safe relay outputs

User manual

PHOENIX CONTACT
INSPIRING INNOVATIONS

User manual

IB IL 24 PSDOR 4-PAC Inline module with safe relay outputs

UM EN IB IL 24 PSDOR 4-PAC, revision 05 2017-11-08

This user manual is valid for:

Designation	Revision as of HW/FW	Order No.
IB IL 24 PSDOR 4-PAC	00/201/100	2985864

7722_en_05

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phoenixcontact.com

Table of contents

1 For your safety

Read this user manual carefully and keep it for future reference.

1.1 Marking of warning notes

This symbol indicates hazards that could lead to personal injury.
There are three signal words indicating the severity of a potential injury.

DANGER
Indicates a hazard with a high risk level. If this hazardous situation is not avoided, it will result in death or serious injury.

WARNING
Indicates a hazard with a medium risk level. If this hazardous situation is not avoided, it could result in death or serious injury.

CAUTION
Indicates a hazard with a low risk level. If this hazardous situation is not avoided, it could result in minor or moderate injury.

This symbol together with the **NOTE** signal word alerts the reader to a situation which may cause property damage or a malfunction.

Here you will find additional information or detailed sources of information.

1.2 Qualification of users

The use of products described in this user manual is oriented exclusively to:

– Qualified electricians or electrically skilled persons. The users must be familiar with the relevant safety concepts of automation technology as well as applicable standards and other regulations.
– Qualified application programmers and software engineers. The users must be familiar with the relevant safety concepts of automation technology as well as applicable standards and other regulations.

1.3 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 INTERBUS-Safety-, SafetyBridge- or 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 (INTERBUS, PROFIBUS, PROFINET)
- The INTERBUS-Safety, SafetyBridge or PROFIsafe system
- The components used in your application
- The Inline product range
- Operation of the software tools used
- Safety regulations in the field of application

Qualified personnel

In the context of the use of the INTERBUS-Safety, SafetyBridge or PROFIsafe system, the following operations may only be carried out by qualified personnel:

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

This user manual is therefore aimed at:

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

In terms of the safety notes in this user manual, 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 user manual as well as in the documents listed in Section “Documentation” on page 13.

Safety of personnel and equipment

The safety of personnel and equipment can only be assured if the safety module is used correctly (see Section “Intended use” on page 12).

Error detection

Depending on the wiring and the corresponding setting of the safe output module parameters, the INTERBUS-Safety, SafetyBridge or 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 Phoenix Contact immediately, engage a service engineer or send the faulty module directly to Phoenix Contact.

Do not open the housing

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

Measures to prevent mismatching and polarity reversal

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

1.4 Electrical safety

WARNING: Hazardous shock currents and the loss of functional safety

Disregarding instructions for electrical safety may result in hazardous shock 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 equipment, please take into consideration the dirt and surge voltages which may occur during operation.

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

Installation and configuration

Please observe the instructions for installing and configuring the system (see Section “Documentation” on page 13).

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 INTERBUS-Safety, SafetyBridge or PROFIsafe must be checked and tested again in this respect.

1.5 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 Section “Directives and standards” on page 11, as well as a test report (checklist) for validating the safety function (see “Appendix: Checklists” on page 125).

INTERBUS-Safety: Please also refer to the example description in the INTERBUS-Safety system description UM EN INTERBUS-SAFETY SYS.

SafetyBridge: Please refer to the documentation for the configurable logic module used.

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 an INTERBUS-Safety, SafetyBridge or PROFIsafe system, the 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.

INTERBUS-Safety: Use the “Validation” checklist in the UM EN INTERBUS-SAFETY SYS user manual to help you.

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).

1.6 Directives and standards

The manufacturers and operators of machines and systems, in which the 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 phoenixcontact.net/products.

1.7 Intended use

Only use the INTERBUS-Safety, SafetyBridge or PROFIsafe system in accordance with the instructions in this section.

The IB IL 24 PSDOR 4-PAC safety module is designed exclusively for use in an INTERBUS-Safety, SafetyBridge or 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 user manual as well as in the documents listed in “Documentation” on page 13. In particular, only use the module according to the technical data and ambient conditions specified in Section 11, “Technical data and ordering data” on page 105 and onwards.

Within an INTERBUS-Safety, SafetyBridge, or 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 that 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.

For additional information about stop categories, please refer to the INTERBUS-Safety system description UM EN INTERBUS-SAFETY SYS.

1.8 Documentation

Latest documentation

Make sure you always use the latest documentation. Changes or additions to this document can be found on the Internet at phoenixcontact.net/products.

INTERBUS-Safety

When working on the INTERBUS-Safety system and its components, you must always keep this user manual and other items of product documentation to hand and observe the information therein.

UM EN INTERBUS-SAFETY SYS
INTERBUS-Safety system description

UM QS EN SAFETYPROG or online help
Quick start guide and/or online help for the SafetyProg software

User manuals

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

SafetyBridge

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

User manuals

- For the controller used
- For SafetyBridge I/O modules
- For SafetyBridge function blocks

PROFIsafe

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

UM QS EN IB IL 24 PSDX - S7
Configuring Inline modules with safe inputs or outputs under PROFIsafe on a SIMATIC® S7 controller

User manuals

- 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 profisafe.net.

StandardINTERBUS

When working on the INTERBUS system and its components, you must always keep the following user manuals and other items of product documentation to hand and observe the information therein.

IBS SYS INTRO G4 UM E
General introduction to the INTERBUS system

IBS SYS PRO INST UM E
Configuring and installing INTERBUS

IBS SYS DIAG DSC UM E
INTERBUS Diagnostics Guide for Generation 4 controller boards

UM QS EN Config+ and/or Config+ online help
Quick Start Guide and/or online help for the Config+ software

UM QS EN PC WORX or online help
Quick start guide and/or online help for the PC WorX software

IBS SYS FW G4 UM E
Firmware services and error messages

Inline product range

IL SYS INST UM E
Automation terminals of the Inline product range (configuration and installation)

IB IL SYS PRO UM E
Configuring and installing the INTERBUS Inline product range

Documentation for the bus coupler used

1.9 Abbreviations used

Table 1-1 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

Table 1-2 Abbreviations used

Abbreviation	Meaning
PELV	Protective extra-low voltage A circuit in which the voltage cannot exceed 30 V AC, 42.4 V peak value or 60 V DC under normal conditions, and under single error 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

For terms and abbreviations used for PROFIsafe, please refer to “Appendix: PROFIsafe terms used in the user manual” on page 117.

1.10 Safety hotline

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

Phone: +49 5281 9462777

E-mail: safety-service.de@phoenixcontact.com

2 Product description

2.1 Brief description of the safety module

The IB IL 24 PSDOR 4-PAC module is an output module that is designed for use within an Inline station.

The IB IL 24 PSDOR 4-PAC safety module can be used as part of an Inline station at any point within an INTERBUS-Safety, SafetyBridge or 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 terminals may be used in the safety-related segment circuit (see “Safety-related segment circuit” on page 21). 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 a switch.
One transmission speed must be used seamlessly in an **INTERBUS system**.
One transmission speed must be used seamlessly in the relevant Inline station in a **SafetyBridge** or **PROFIsafe system**.

The module has a 10-pos. DIP switch, This is used to select the protocol (INTERBUS-Safety, SafetyBridge or PROFIsafe). If you are working with SafetyBridge or PROFIsafe, the switch is used to set the SafetyBridge or PROFIsafe address.

The module has four safety relays that 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 safe INTERBUS system (INTERBUS-Safety), in the SafetyBridge system or in the PROFIsafe system.

The module can be used to create a safety-related segment circuit within an Inline station (see “Safety-related segment circuit” on page 21).

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

Within an INTERBUS-Safety, SafetyBridge or 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.

2.2 Structure of the safety module

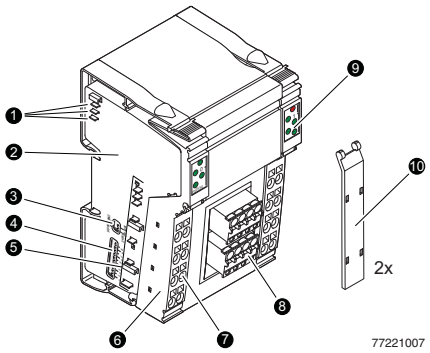


Figure 2-1 Structure of the safety module

1 Data jumpers (local bus)

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

3 Switch for setting the transmission speed and the mode

4 Switch for setting the protocol and address

For more detailed information about setting the switches, please refer to “Setting the DIP switches” on page 42.

5 Potential jumper

6 Inline connector; for assignment see Section “Terminal point assignment” on page 38

7 Terminal points

8 COMBICON connectors

9 Diagnostic and status indicators; for assignment and meaning see Section “Local diagnostic and status indicators” on page 25

10 Marking field

2.3 Housing dimensions

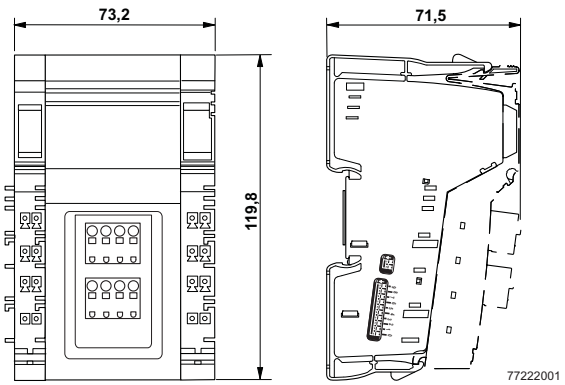


Figure 2-2 Housing dimensions (in mm)

2.4 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

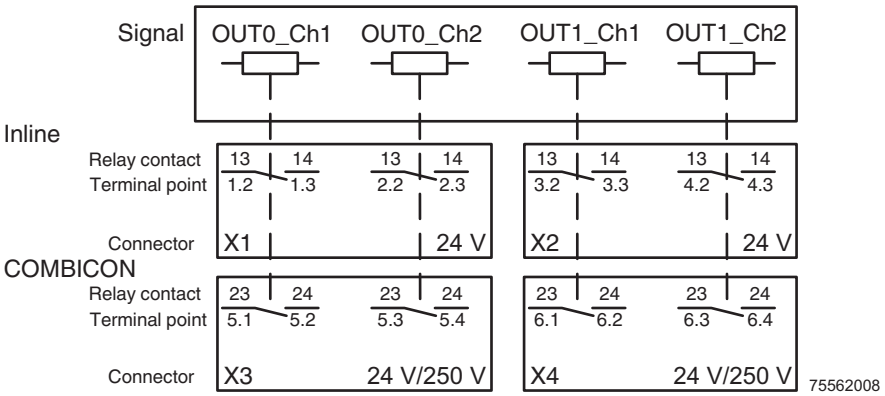


Figure 2-3 Basic representation of the relay outputs

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 38)

Technical data

For the technical data for the safe relay outputs, please refer to page 109.

Fuse protection

Protect the relay outputs against overcurrent with a suitable fuse. Fuses with an I2t 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.

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 for the safe relay outputs and the safety-related segment circuit” on page 59).

For information on parameterization, please refer to Section “Parameterize all safe relay outputs individually” on page 54.

Diagnostics

Diagnostics are provided via both the local diagnostics indicators and the diagnostic messages that are transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or to the configurable logic module used (SafetyBridge).

For information about the diagnostic messages of the relay outputs, please refer to Section “Safe digital relay output errors” on page 96.

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 force-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 observe the 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 Section “Abbreviations used” on page 15).
- A protective circuit via the relay contacts is not permitted.

Achievable safety integrity

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 109).

2.5 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 terminal before another power supply unit or at the end of the station. Only Inline terminals 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 terminals 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 Section “Ordering data: Documentation” on page 115).

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

This document can be downloaded at phoenixcontact.net/products.

2.6 Clock outputs UT1 and UT2

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

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

NOTE: Incorrect use of the clock outputs or signal inputs may damage the device

– The clock outputs and signal 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 consumers.

Parameterization

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

Technical data

For the technical data for the clock outputs, please refer to page 112.

Error detection

Error detection is via the assigned signal input.

Diagnostics

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

2.7 Signal inputs IN1 and IN2

The module has two signal inputs, IN1 and IN2 that only operate together with the assigned clock outputs, UT1 and UT2. They are used to monitor the contacts of externally connected switching elements. With this function, the contacts of externally connected switching elements can be monitored. 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 signal inputs is fixed and cannot be parameterized.

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

If an signal 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.

Signal inputs IN1 and IN2 can only be assigned to an output once. Parallel connection of the signal contact is not permitted.

Technical data

For the technical data for the signal inputs, please refer to page 112.

Error detection and behavior in the event of an error

The status of the signal 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 that can occur internally in the circuit or externally in the wiring, are detected.

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

Diagnostics

Diagnostics of the signal inputs are provided via both the local diagnostics indicators and the diagnostic messages that are transmitted to the safe controller.

For information about the diagnostic messages of the signal inputs, please refer to Section “Safe digital relay output errors” on page 96.

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

2.8 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 Section 6, “Connection examples for the safe relay outputs and the safety-related segment circuit”.

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

– Observe the information in the connection examples (see Section 6, “Connection examples for the safe relay outputs and the safety-related segment circuit”)
– Observe the requirements of the standards with regard to the external wiring and the actuators to be used to achieve a SILCL/Cat./PL (see “Measures required to achieve a specific safety integrity level” on page 61).

	Relay output		Safety-related segment circuit
“Output” parameterization	Single-channel	Two-channel	Two-channel
Achievable safety integrity	SILCL 1 / Cat. 1*)/ PL c	SILCL 3/Cat. 4/PL e	SILCL 3/Cat. 4/PL e
For connection example, see page	63	67 71	77 80

*) suitable up to Cat. 2 depending on the application.

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

2.9 Local diagnostic and status indicators

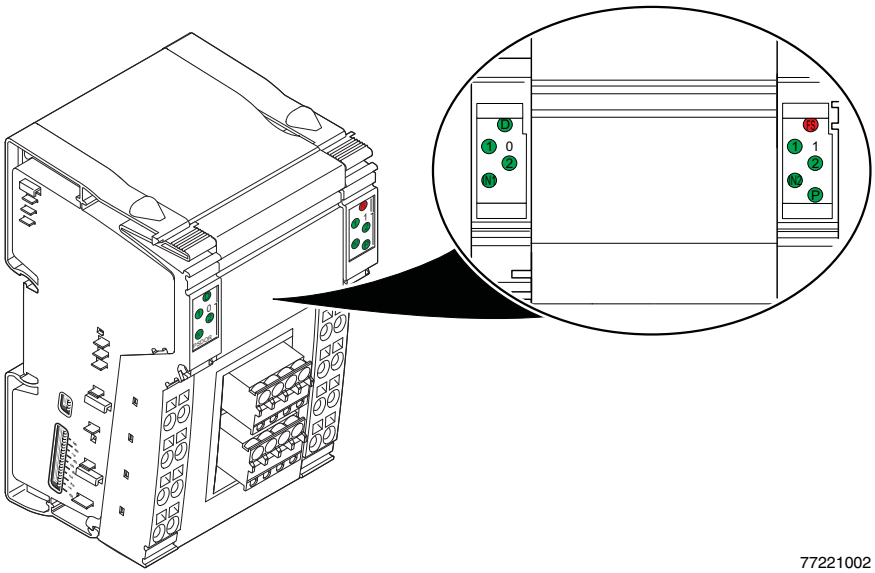


Figure 2-4 Local diagnostic and status indicators on the IB IL 24 PSDOR 4-PAC module

Function identification: Dark red

Table 2-1 Local diagnostic and status indicators

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.

Table 2-1 Local diagnostic and status indicators (Fortsetzung)

OUT 0.1, 0.2 1.1, 1.2	Green/red LED	Status of each relay output (see “Terminal point assignment” on page 38) 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 signal input. (This diagnostic message is stored temporarily on the module. The message is stored in the volatile memory and will be lost after a voltage reset.)
	Flashing red at 1 Hz:	INTERBUS-Safety only: Parameterized shutdown time of the relay output exceeded (This diagnostic message is stored temporarily on the module. 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 or flashing), the relay output is switched off until the acknowledgment sent by the safe controller is received by the safety module (see also Section “Safe digital relay output errors” on page 96).
IN1 IN2	Green LED	Status of each signal input (see “Terminal point assignment” on page 38)
	Green:	Input at logic 1
	Off:	Input at logic 0, no error
		If an error occurs on an signal input of an output parameterized as “two-channel”, the other corresponding channel also enters the safe state.
P (PROFIsafe, SafetyBridge only)	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 is running without errors

2.10 Safe state

The safe state for the module is the zero current state at the output terminals, i.e., the relay contacts are open (see Section “Safe digital relay outputs (floating contacts)” on page 19).

PROFIsafe:

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

The safe state is entered by means of passivation (see “Passivation” on page 118).

The safe state can be entered in the following cases:

1. Operating state
2. Error detection in I/O devices
3. Device error
4. Parameterization error

2.10.1 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.

2.10.2 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 signal inputs are used)
– An external load does not drop out (if the signal inputs are used)

The relevant diagnostic message is transmitted to the safe controller (see Section “Safe digital relay output errors” on page 96). For information about which errors are detected and when, please refer to Section “Connection examples for the safe relay outputs and the safety-related segment circuit” on page 59.

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

2.10.3 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 Section "Safe digital relay output errors" on page 96).

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 completely 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 Section "Errors: Messages and removal" on page 93).

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 completely from the power supply and replace it.

2.10.4 Parameterization error

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 Section “Parameterization errors” on page 98).

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.

2.11 Enabling safe outputs for PROFIsafe

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).

2.12 Process data words

2.12.1 INTERBUS

The module occupies three words in the INTERBUS system. In the standard control system, the input and output data is mapped to a single word.

The process data input word is specified for internal use only.

The standard control system provides the output data for the safe INTERBUS controller as standard data. The relay outputs are only controlled by the safe INTERBUS controller.

The input data only indicates the actual status of the relay outputs if no bus errors or device errors are present. Even during the parameterized switch-off delay in stop category 1, the status of the outputs on the module does not correspond to the status of the outputs on the safe controller.

The parameterization of the relay outputs determines whether the input data is mapped in single-channel or two-channel mode. The value for “parameterized output” for the relay outputs is also set for the input data.

In the following tables, both the maximum single-channel and maximum two-channel assignment are illustrated. Depending on the parameterization, other process data word assignments are also possible (for an example, see page 30).

Assignment of relay outputs to the process data output word in the standard control system

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
module	Output (single-channel)	Reserved				OUT1_ Ch2	OUT1_ Ch1	OUT0_ Ch2	OUT0_ Ch1	Reserved							
	Output (two-channel)					0	OUT1_ Ch1&2	0	OUT0_ Ch1&2								

For the assignment of the illustrated (Byte.Bit) view to your control or computer system, please refer to the DB D IBS SYS ADDRESS data sheet.

Example for mixed single-channel and two-channel parameterization

Relay outputs:

Output	OUT0_Ch1	OUT0_Ch2	OUT1_Ch1	OUT1_Ch2
Two-channel			X	X
Single-channel	X	not used		

Process data output word

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
module	Output	Reserved				0	OUT1_Ch 1&2	0	OUT0_Ch1	Reserved							

2.12.2 SafetyBridge

The module occupies four words in the Inline system. For information about how these words are mapped, please refer to the documentation for the configurable logic module used.

The module has feedback data and enable data.

Feedback data

The bits in this register mirror the states of the digital outputs as diagnostic data. This data can be used if an output has been parameterized with a switch-off delay. In this case, the feedback data can be used to determine the actual state of the output and derive information for the standard control process from this.

Please note that the feedback data for certain errors (e.g., communication error) can differ from the actual state of the outputs.

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

The structure and function of the register are as follows:

Table 2-1 Feedback data register (mirrored data)

	7	6	5	4	3	2	1	0
Single-channel	0	0	0	0	OUT1_ Ch2	OUT1_ Ch1	OUT0_ Ch2	OUT0_ Ch1
Two-channel	0	0	0	0	Do not evaluate	OUT1_ Ch1&2	Do not evaluate	OUT0_ Ch1&2

Enable

The enable principle is implemented in the SafetyBridge system. For this, all modules with local outputs have an enable function integrated in the device firmware (ANDed bit-by-bit) for each safe output channel. The enable function can be parameterized (enabled/disabled) for each specific channel (see Section “Parameterize all safe relay outputs individually” on page 54). The structure and function of the register are as follows:

Table 2-2 Enable data register

	7	6	5	4	3	2	1	0
Single-channel	0	0	0	0	OUT1_ Ch2	OUT1_ Ch1	OUT0_ Ch2	OUT0_ Ch1
Two-channel	0	0	0	0	0	OUT1_ Ch1&2	0	OUT0_ Ch1&2

When the enable function is enabled, the relevant safe output is ANDed bit-by-bit with the corresponding output bit of the standard control system (Data-PSDO register). This output is then only set if the result of the safety function calculation permits this and the standard control system has set the corresponding output in the Data-PSDO register (see also user manual for the configurable logic module used).

The enable function is performed according to the single-channel or two-channel parameterization of the safe outputs.

The enable function is not graphically represented in SAFECONF in the safety logic editor. Parameterize the enable function when parameterizing the channels.

The following figure illustrates the enable principle.

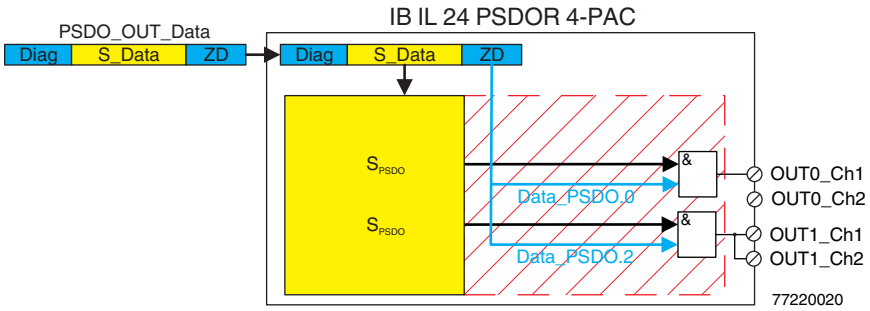


Figure 2-5 Enable principle (example)

PSDO_OUT_Data	Output data from the configurable logic module to the IB IL 24 PSDOR 4-PAC
S_Data	Safety data from the configurable logic module
Diag	Diagnostic data
ZD	Enable data from the standard controller
&	Standard function block for ANDing
S_{PSDO}	Safe control signal from the configurable logic module
Data-PSDO.x	Standard data of the standard controller that is to enable the IB IL 24 PSDOR 4-PAC; bit x
OUTx_Chy	Safe output x, channel y
	Internal sequences

Table 2-3 Parameterization of output channels for the example in Figure 2-5

Output/channel	Output	Enable
OUT0_Ch1	Single-channel	Enabled
OUT0_Ch2	not used	Disabled
OUT1_Ch1	Two-channel	Enabled
OUT1_Ch2	Two-channel	Enabled

2.12.3 PROFIsafe (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 quick start guide for the controller.

The switch position for selecting the data width has no function in PROFIsafe operation.

2.13 Programming data/configuration data

2.13.1 Local bus (INTERBUS)

	INTERBUS-Safety	SafetyBridge	PROFIsafe
Mode switch	Mode 1	Mode 2	Mode 1
ID code	AF_{hex} (175_{dec})	$A7_{hex}$ (167_{dec})	CB_{hex} (203_{dec})
Length code	03_{hex} (03_{dec})	04_{hex} (04_{dec})	04_{hex} (04_{dec})
Input address area	1 words	Controller-specific	Controller-specific
Output address area	1 words	Controller-specific	Controller-specific
Parameter channel (PCP)	0 words	0 words	1 words
Register length	3 words	4 words	4 words

The PCP channel is only used internally.

INTERBUS-Safety
The process data input word is specified for internal use only.

2.13.2 Other bus systems (PROFIBUS, PROFINET)

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

3 Inline potential and data routing, and Inline connectors

3.1 Inline potential and data routing

In order to operate the safety module it must be integrated in an Inline station within the INTERBUS-Safety, SafetyBridge or 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 on potential and data routing within an Inline station, please refer to the IL SYS INST UM E user manual.

The safety module interrupts the potential routing of the 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.

3.2 Supply voltage U_L

Supply the 24 V supply voltage $U_{BK}/U_{24\ V}$ at a bus coupler or a suitable power terminal (IB IL 24 PWR IN/R). 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 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 a fault.
Please also observe the points in Section “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 Section “Supply voltage U_L (logic, relay)” on page 108.

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.

3.3 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 Section “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 Section “Supply voltage U_M (clock outputs)” on page 109.

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 terminal).
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.

NOTE: 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.

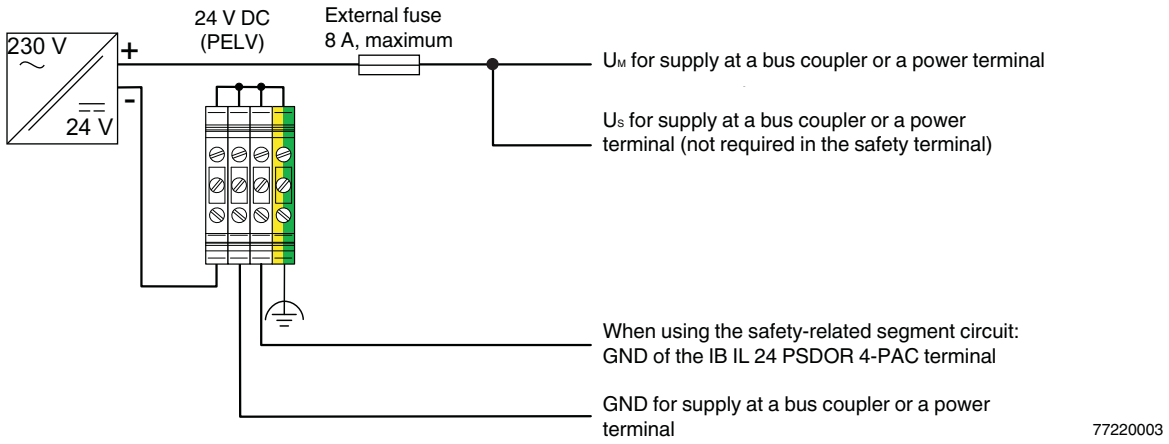


Figure 3-1 Supply U_M with connection to functional earth ground according to EN 60204-1

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 IB IL 24 PSDOR 4-PAC are not affected by parasitic voltages in the event of an error.

NOTE: 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 that 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 intended for a typical system or machine distribution, the DC connections are viewed and tested as I/O signals according to IEC 61326-3-1.

3.4 Supply voltage U_S

The safety module interrupts the potential routing of the Inline station for the segment circuit (see also Section “Internal basic circuit diagram” on page 40).

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 Section “Safety-related segment circuit” on page 21; for connection examples, please refer to Section “Safety-related segment circuit” on page 75.
2. 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 Section “Safety-related segment circuit” on page 75.

3.5 Terminal point assignment

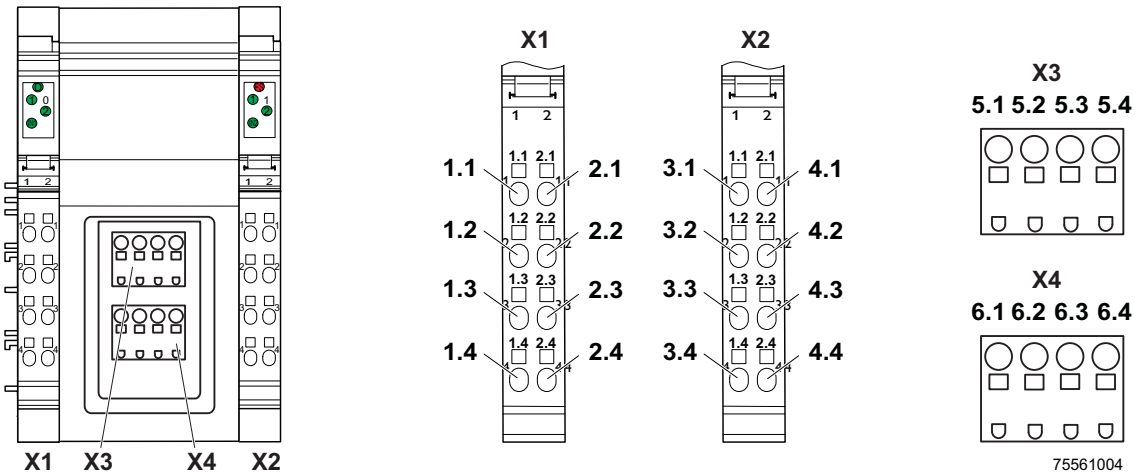


Figure 3-2 Assignment of connectors on the module

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

Only use the plugs supplied with the module or plugs that are approved as replacement items (see “Ordering data: Accessories” on page 114).

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 Figure 2-3 “Basic representation of the relay outputs”.

WARNING: Loss of electrical and functional safety due to surge voltage

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

Table 3-1 Terminal point assignment for Inline connector X1

Terminal point	Signal	Channel assignment	Comment
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	Signal input channel 1	

Table 3-2 Terminal point assignment for Inline connector X2

Terminal point	Signal	Channel assignment	Comment
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	Signal input channel 2	

Table 3-3 Terminal point assignment for COMBICON connector X3

Terminal point	Signal	Channel assignment	Comment
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

Table 3-4 Terminal point assignment for COMBICON connector X4

Terminal point	Signal	Channel assignment	Comment
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

"24 V" and "250 V" refer to the relevant voltage ranges (see also Figure 2-3 "Basic representation of the relay outputs"). For the actual switching voltage ranges, please refer to the technical data ("Safe digital relay outputs" on page 109).

3.6 Internal basic circuit diagram

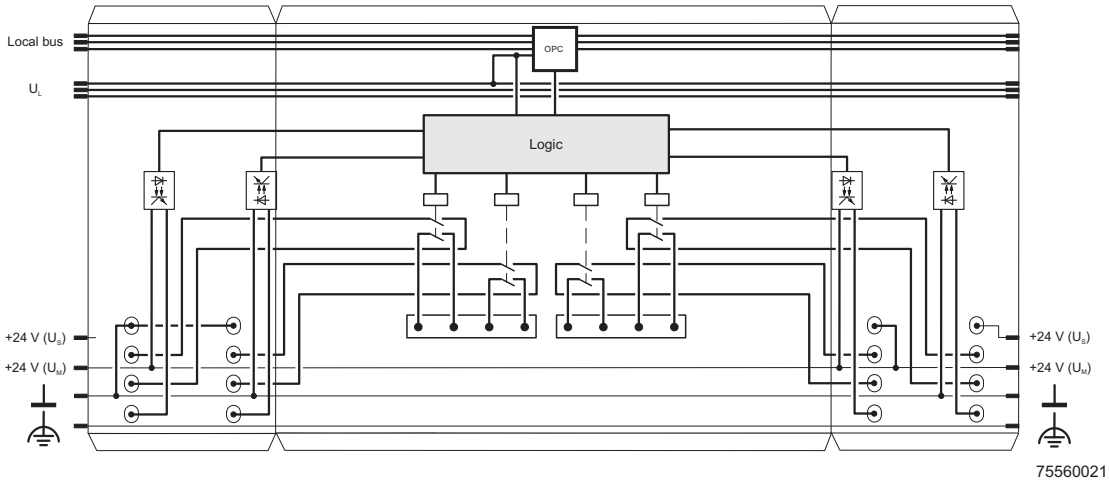


Figure 3-3 Internal basic circuit diagram

Key:

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

4 Mounting, removal, and electrical installation

4.1 Mounting and removal

4.1.1 Unpacking the module

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

NOTE: 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.

4.1.2 General information

WARNING: Electric shock / Unintentional machine startup

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

Before mounting 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 system is reassembled before switching the power back on. Observe the diagnostics indicators and any diagnostic messages.

The system must only be started when neither the station nor the system can cause any damage.

The IB IL 24 PSDOR 4-PAC safety terminal is designed for use within an Inline station. Only use the safety terminal in the 24 V DC area of an Inline station.

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

Mount all Inline terminals 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.

4.1.3 Setting the DIP switches

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

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.

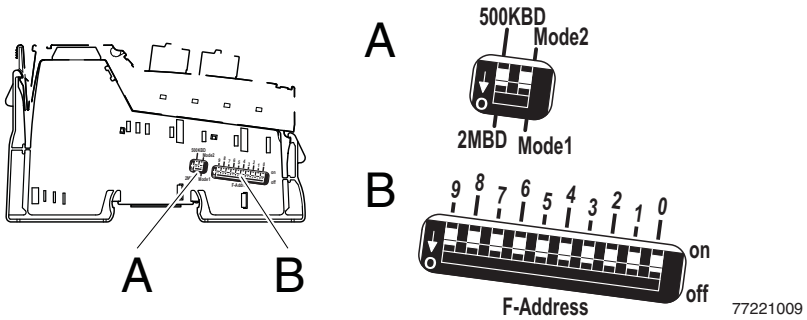


Figure 4-1 DIP switch

A 2-pos. DIP switch

B 10-pos. DIP switch (address switch)

2-pos. DIP switch

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

Left switch:	The transmission speed can be set to 500 kbaud or 2 Mbaud.
Right switch: (Mode switch)	For INTERBUS-Safety or PROFIsafe, set Mode 1. For SafetyBridge, set Mode 2.

10-pos. DIP switch (address switch)

The **protocol** (for INTERBUS safety) or the **address** (for PROFIsafe, SafetyBridge) is set by the 10-pos. DIP switch.

Default setting / Delivery state

The following values are preset by default:

Transmission speed:	2 Mbaud
Mode switch:	Mode 1
Address switch:	$3FF_{hex}$ (INTERBUS-Safety) This address is not valid for a SafetyBridge- or PROFIsafe system

INTERBUS-Safety

Only use devices with a uniform transmission speed in an INTERBUS system. It is not possible to operate a mixture of devices with different transmission speeds.

Changing the setting:

1. Set Mode 1.
2. Set the 10-pos. DIP switch to $3FF_{hex}$ (1023_{dec}, all switches set to “on”).

The switch position ensures that the safety module is detected as an INTERBUS-Safety module. The setting is not used further in the INTERBUS-Safety system.

INTERBUS-Safety switch position

Table 4-1 Switch position for INTERBUS-Safety

INTERBUS-Safety										
Mode switch	**Address switch**									
	9	8	7	6	5	4	3	2	1	0
Mode 1	on	on	on	on	on	on	on	on	on	on
	$3FF_{hex}$									

PROFIsafe

Only use devices with a uniform transmission speed within an Inline station (a local bus). It is not possible to operate a mixture of devices with different transmission speeds.

Changing the setting:

1. Set Mode 1.
2. Set the PROFIsafe address for the PROFIsafe device.
   PROFIsafe addresses 1 to 1022 (1_{hex} to $3FE_{hex}$) are permitted.

PROFIsafe switch position

Table 4-2 Switch position for PROFIsafe

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

SafetyBridge

WARNING: Loss of safety function during mixed operation

During mixed operation between SafetyBridge V1 and/or SafetyBridge V2 with SafetyBridge V3, incorrect addressing may lead to a loss of the safety function.

Take the following action:

- Make sure that the island number of the SafetyBridge **V3 s**ystems ≥ 8 is on a controller.

Only use devices with a uniform transmission speed within an Inline station (a local bus). It is not possible to operate a mixture of devices with different transmission speeds.

Changing the setting:

1. Set Mode 2.
2. Set the SafetyBridge address specified in SAFECONF.

For more detailed information on the SafetyBridge address, please refer to the documentation for the logic module used (IB IL 24 LPSDO 8 V2-PAC or IB IL 24 LPSDO 8 V3-PAC).

SafetyBridge V3 switch position

Table 4-3 Switch position for SafetyBridge V3 (IB IL 24 LPSDO 8 V3-PAC logic module used)

SafetyBridge V3										
Mode switch	**Address switch**									
	Island number					Satellite number				
	9	8	7	6	5	4	3	2	1	0
Mode 2										
	1_{dec} to 31_{dec}					1_{dec} to 16_{dec}				

Switch position SafetyBridge V2

Table 4-4 Switch position for SafetyBridge V2 (logic module used: IB IL 24 LPSDO 8 V2-PAC)

SafetyBridge V2										
Mode switch	**Address switch**									
			Island number					Satellite number		
	9	8	7	6	5	4	3	2	1	0
Mode 2	off	off								
			1_{dec} to 31_{dec}					1_{dec} to 5_{dec}		

4.1.4 Mounting and removal of the safety module

For general information on mounting and removing Inline terminals, please refer to the IL SYS INST UM E user manual.

Mounting

- Set the DIP switches prior to mounting (see Section “Setting the DIP switches” on page 42). The DIP switches cannot be accessed when the safety module is installed in the Inline station.
- Maintain 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 terminal and the adjacent Inline connector from the neighboring Inline terminal on the left. This prevents the potential routing knife contacts and the keyway/featherkey connection 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 terminals are **securely** interlocked.

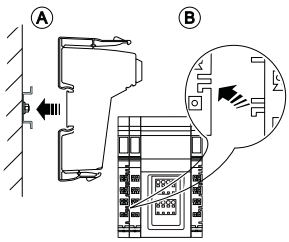


Figure 4-2 Snapping on the safety module base

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

– Inserting the connectors

Only use the connectors supplied with the module or connectors that are approved as replacement items (see “Ordering data: Accessories” on page 114).

– Inserting the Inline connectors

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

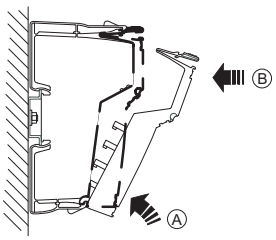


Figure 4-3 Inserting the connectors

– **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).

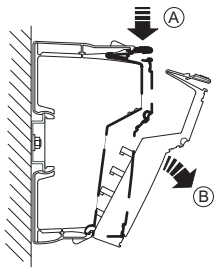


Figure 4-4 Removing the connectors

– **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).

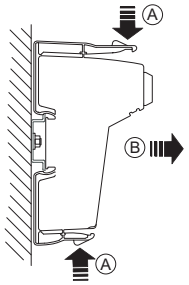


Figure 4-5 Removing the safety module base

4.2 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.

4.2.1 Electrical installation of the Inline station

Electrical installation of the Inline station includes the following:

– Connecting INTERBUS, PROFIBUS or PROFINET to the Inline station
– Connecting the supply voltages for the Inline station

Carry out electrical installation for the Inline station according to the IL SYS INST UM E user manual or the Inline system manual for your bus system. Please also observe the specifications in the documentation for the bus coupler used.

4.2.2 Electrical installation of the safety module

During installation, always observe the instructions in Section “Electrical safety” on page 9.

Take measures to prevent the mismatching, 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 Section “Terminal point assignment” on page 38.
- Mark all connections to prevent connections to the connectors being mixed up (for Inline connectors, see user manual IB IL SYS PRO UM E).

Inline connectors

Observe the following points during installation:

– Only use cables with a cross section approved for the terminal point (see Section “General data” on page 106).
– Observe the maximum permissible current carrying capacity of the Inline connectors of 4 A.
– Protect the connectors against 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 actuation shaft of the appropriate terminal point (Figure 4-6, detail 1), so that you can insert the conductor into the spring opening.
  Phoenix Contact recommends using a SZF 1 - 0.6X3.5 screwdriver (Order No. 1204517; see Phoenix Contact "CLIPLINE" part catalog).
- Insert the conductor in the corresponding terminal point of the connector (Figure 4-6, detail 2). Remove the screwdriver from the opening. This clamps the conductor.

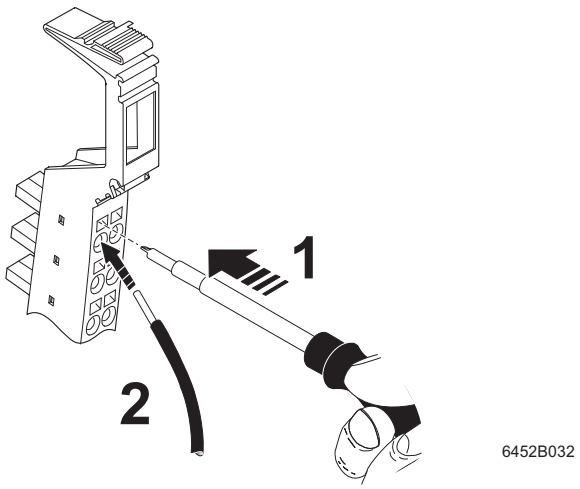


Figure 4-6 Connecting unshielded cables

- Insert the assembled connectors in the corresponding module slot (see Section “Terminal point assignment” on page 38).

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

Ensure that the cables 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 Section “General data” on page 106).
– 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 conductor in the corresponding terminal point of the connector.
- Insert the assembled connectors in the corresponding module slot (see Section “Terminal point assignment” on page 38).

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

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

5 Parameterization of the safety module

5.1 Parameterization in an INTERBUS-Safety system

Parameterization includes the following:

– Specifying the location ID via the Config+ or PC WorX software
– Parameterizing relay outputs using the SafetyProg software

Location ID

The location ID is a unique ID for the safety module in the INTERBUS structure.

The location ID is automatically assigned to each safety module in the Config+ or PC WorX software. If required, the assigned location ID can be modified later.

The location ID can be freely selected between 1 and 126. Each location ID within the INTERBUS-Safety system can only be assigned once. It is transmitted to the module along with the safe parameterization data when downloading the safe application program.

For additional information, please refer to the UM EN INTERBUS-SAFETY SYS user manual.

Parameterization of relay outputs

The parameterization of the safe relay 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 INTERBUS controller created in SafetyProg is automatically written to the module on every power up or reset. The supply voltage must be present and INTERBUS must be in the RUN state.

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 relay outputs are valid and transmitted without errors. Valid output data is only written in this state. In any other state, every relay 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 INTERBUS controller. In this case, check and correct the settings.

5.2 Parameterization in a SafetyBridge system

Parameterization includes the following:

– Specifying the SafetyBridge address for the corresponding configurable logic module
– Parameterization of outputs

SafetyBridge address

The SafetyBridge address is a unique ID for the safety module in the SafetyBridge structure. It is assigned in the configuration software for the assigned configurable logic module.

The address of the connected satellites (here: IB IL 24 PSDOR 4-PAC) is based on the island number of the configurable logic module and the position in the hardware editor of the SAFECONF software tool.

Set this address via the DIP switches prior to mounting the safety module (see Section “Setting the DIP switches” on page 42).

For more detailed information about the SafetyBridge address, please refer to the documentation for the configurable logic module used.

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 configurable logic module created in the parameterization tool is automatically written to the module on every power up or reset.

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 invalidity of the parameterization is indicated on the module by the flashing FS LED. In addition, errors are indicated at the configurable logic module. In this case, check and correct the settings.

5.3 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 mounting the safety module (see “Setting the DIP switches” on page 42).

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 Section “Errors: Messages and removal” on page 93.

F-Parameters and iParameters

Assign the parameterizable F-Parameters and iParameters. For an overview of the module parameters and possible settings, please refer to Section “Appendix: F-Parameters and iParameters” on page 119.

5.4 Parameterize all safe relay outputs individually

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 Table 5-1.

Table 5-1 Parameterization of relay outputs

Parameterization	Value range	Comment
	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 signal input IN1 for monitoring the external wiring and external power gain (e.g., contactors). If IN1 is activated, both the internal signal 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. Note: Input IN1 must only be assigned once, to one output. Parallel connection of the signal inputs 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 signal input. All other parameterizations are rejected with a parameterization error.

Table 5-1 Parameterization of relay outputs (Fortsetzung)

Parameterization	Value range	Comment
	OUT0 - OUT1	
IN2	Do not evaluate Evaluate	Assignment to signal input IN2 for monitoring the external wiring and external power gain (e.g., contactors). If IN2 is activated, both the internal signal 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. Note: Input IN2 must only be assigned once, to one output. Parallel connection of the signal inputs 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 signal input. All other parameterizations are rejected with a parameterization error.
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.
Shutdown time (INTERBUS-Safety only)	1 to 63	Time conversion according to the parameterization of the “Value range of shutdown time” parameter. Permissible value range: Value range: – Single-channel: 25 ms to 6.3 s – Two-channel: 35 ms to 6.3 s Accuracy: – Single-channel: - (10 ms + 6 % of parameterized value)/+0 ms – Two-channel: - (20 ms + 6 % of parameterized value)/+0 ms Please observe the notes below this table.
“Value range of shutdown time” (INTERBUS-Safety only)	Value in ms Value x 10 in ms Value x 100 in ms	Value range/unit for the parameterization of the “Shutdown time” parameter. 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.

Table 5-1 Parameterization of relay outputs (Fortsetzung)

Parameterization	Value range	Comment
	OUT0 - OUT1	
Enable (SafetyBridge only)	Disabled Enabled	Disabled (default value): the corresponding safe output is operated exclusively according to the safety logic. Enabled: Enable is active; the safe output data is output after being ANDed with the standard output data of the standard control system. See also Section “SafetyBridge” on page 32.

Two-channel parameterization

Please note the following for two-channel parameterization:

Ensure that the values for the shutdown time (for INTERBUS-Safety) and 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}).

Shutdown time (INTERBUS-Safety only)

This parameter is only available in an INTERBUS-Safety system.

The **shutdown** time is calculated from the “Value of the shutdown time” and “Value range of shutdown time” parameters.

Shutdown time = “Shutdown time” x “value range of shutdown time”

Example:

Shutdown time	20
“Value range of shutdown time”	Value x 10 in ms

Shutdown time = 20 x 10 ms = 200 ms

The value to be set for the shutdown time is calculated based on the maximum permitted response time for your application. The value must satisfy the condition of the following formula.

t_{OUT} ^{3} 1.064 x (14 x t_{IBS} + t_{SDOR4})

Where:

t_{OUT}	Parameterized shutdown time
t_{IBS}	INTERBUS-Safety system cycle time (see UM EN INTERBUS-SAFETY SYS user manual)
t_{SDOR4}	Constant, depends on the parameterization of the output Single-channel: 10 ms Two-channel: 20 ms

- Please refer to the information about the parameterized shutdown time t_{OUT} in theUM EN INTERBUS-SAFETY SYS user manual.
- For an example of calculating the minimum parameterizable shutdown time, please refer to the UM EN INTERBUS-SAFETY SYS user manual.
  Please note the differences when calculating the minimum parameterizable shutdown time for the IB IL 24 PSDOR 4-PAC.
- If the shutdown time is parameterized with a value less than 25 ms (single-channel) or 35 ms (two-channel), this value is rejected as a parameterization error (error code $021x_{hex}$).

5.5 Behavior of the relay outputs in the event of enabled switch-off delay for stop category 1

Depending on the event that causes the relay outputs to be switched off, the parameterization of the switch-off delay, and also on the parameterization of the shutdown time in the case of INTERBUS-Safety, the time until the relay outputs are actually switched off can vary.

Table 5-2 Switching off the relay outputs according to the trigger event and the parameterization

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

WARNING: Delayed shutdown when using stop category 1

For stop category 1 please take into consideration the following:

- If the parameterized shutdown time is exceeded, the affected outputs (safety relay) are only set to the safe state once the switch-off delay has elapsed.
- 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.

5.6 Parameterization of clock outputs and signal inputs

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

For the assignment of an signal output to a relay output, please refer to the parameterization of the relay output (see page 54).

6 Connection examples for the safe relay outputs and the safety-related segment circuit

6.1 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) simultaneously (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 Phoenix Contact safety hotline (see “Safety hotline” on page 15).

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 Section “Errors: Messages and removal” on page 93.
– **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Key for all tables in this section:

Table 6-1 “Device diagnostics and behavior of the module in the event of an error” tables

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

Table 6-2 Parameterization tables

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

Errors (cross-circuits, short circuits) that 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 that 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 Section “Safe digital relay outputs (floating contacts)” on page 19.

Please observe the load capacity of the relay outputs according to the technical data in “Safe digital relay outputs (floating contacts)” on page 19 and protect the contacts against overload using an appropriate fuse.

For all examples, please also observe the measures specified in the individual tables that 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.

6.2 Notes on the protective circuit for external relays/contactors (freewheeling circuit)

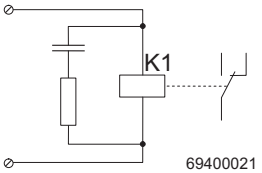


Figure 6-1 Example of the freewheeling circuit for an external relay

A protective circuit via the relay contacts is not permitted.

6.3 Measures required to achieve a specific safety integrity level

The safety integrity (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 specifications from the INTERBUS-Safety system user manual.

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

In order to determine PFH and PFD depending on the SIL, see “Determining PFH, PFD, and $MTTF_d$” on page 83.

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 Section “Requirements for controlled devices/actuators” on page 20).
- 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.
- Make sure 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 Section “Requirements for controlled devices/actuators” on page 20).
- 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 Section “Requirements for controlled devices/actuators” on page 20).
- 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.

6.4 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 signal input. Activate this function in the parameterization (IN1 or IN2, see Section “Parameterize all safe relay outputs individually” on page 54).

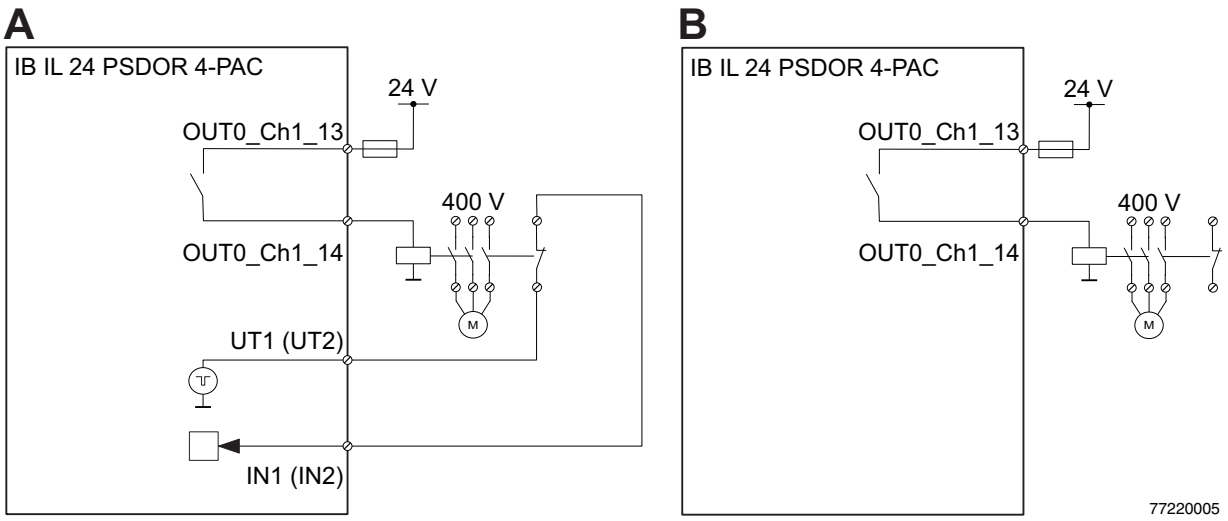


Figure 6-2 Single-channel assignment of floating contacts with readback (A) and without readback (B)

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 signal 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 signal inputs are used, no errors can be detected in the external load or in the wiring.
External wiring requirements	The error analysis for the connected loads and for the external wiring must be performed by the user.

*) suitable up to Cat. 2 depending on the application.

WARNING: Loss of electrical and functional safety

- To achieve the specified safety integrity level, please refer to Section “Measures required to achieve a specific safety integrity level” on page 61.
- 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.
- 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

Table 6-3 Single-channel: Signal input assigned

Error type	Detection	Diagnostics	Loss of SF	Comment
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/signal 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/signal input to external signal	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Table 6-3 Single-channel: Signal input assigned

Error type	Detection	Diagnostics	Loss of SF	Comment
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 an upstream fuse.
Clock output/signal input to 24 V	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Clock output/signal input to ground	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Typical parameterization

Table 6-4 Single-channel: Signal input assigned; typical parameterization

Parameterization	Parameterized as	Comment
Assignment	**Used**	
Output	**Single-channel**	
Signal input IN1	Evaluate	Or do not evaluate
Signal input IN2	Do not evaluate	Or evaluate
Switch-off delay for stop category 1	Enabled	Or disabled
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	20	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Application-specific
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
Enable (SafetyBridge only)	Enabled	Or disabled

According to the “Value range of switch-off time” and “Switch-off time” parameters, in this example, the shutdown time is 20 x 10 ms = 200 ms.

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.

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

Table 6-5 Single-channel: No signal input assigned

Error type	Detection	Diagnostics	Loss of SF	Comment
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 an upstream fuse.

Typical parameterization

Table 6-6 Single-channel: No signal input assigned; typical parameterization

Parameterization	Parameterized as	Comment
Assignment	**Used**	
Output	**Single-channel**	
IN1	**Do not evaluate**	
IN2	**Do not evaluate**	
Switch-off delay for stop category 1	30	Application-specific
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	20	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	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
Enable (SafetyBridge only)	Enabled	Or disabled

According to the “Value range of switch-off time” and “Switch-off time” parameters, in this example, the shutdown time is 20 x 10 ms = 200 ms.

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.

6.5 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 Section “Two-channel” on page 54).

It is possible to monitor external loads and the wiring for errors. In this case, a clock output (UT1 or UT2) with the associated signal input must be used. Activate this function in the parameterization (IN1 or IN2, see Section “Parameterize all safe relay outputs individually” on page 54).

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

6.5.1 Monitoring via common readback

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

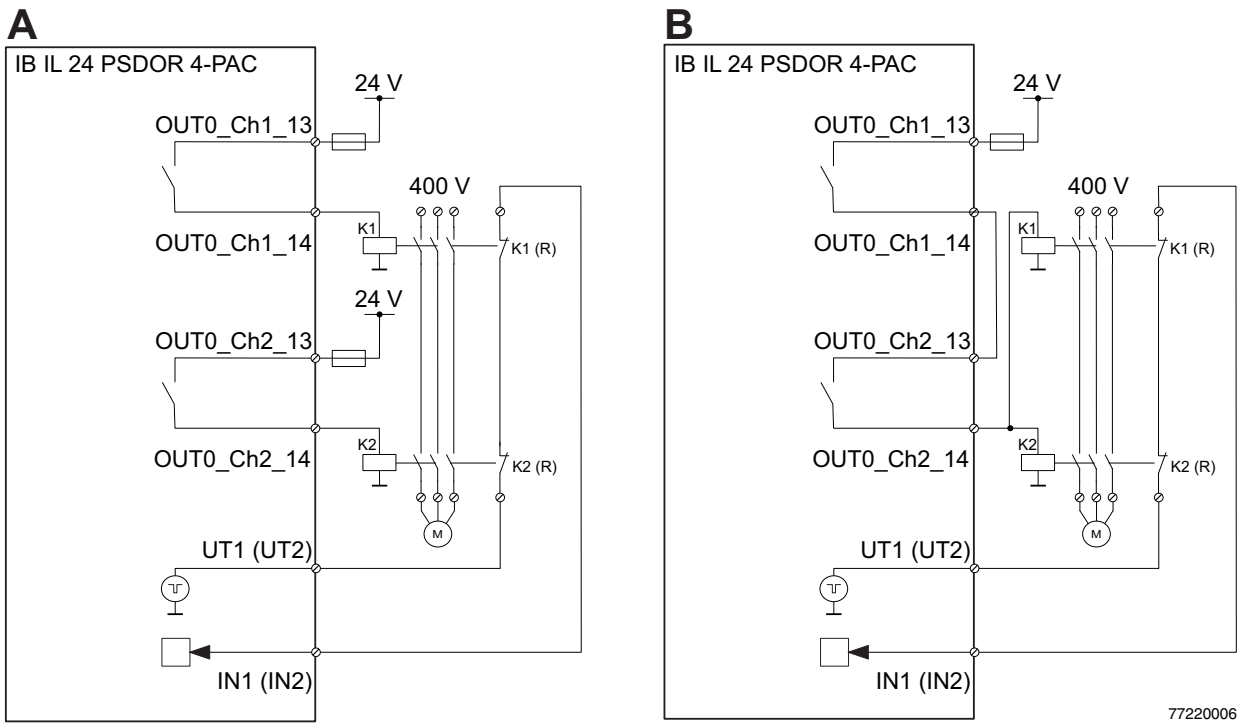


Figure 6-3 Two-channel assignment of floating contacts with common readback

WARNING: 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 109).

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)	Signal input IN1 or IN2

K1 (R) and K2 (R) represent the force-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 signal input IN1 (IN2) as illustrated. In this case, the signal input must be assigned to the output. Parallel connection of the signal inputs 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 signal 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 signal inputs are used, no errors can be detected in the external load or in the wiring.
External wiring requirements	The error analysis for the connected loads and for the external wiring must be performed by the user.

WARNING: Loss of electrical and functional safety

- To achieve the specified safety integrity level, please refer to Section “Measures required to achieve a specific safety integrity level” on page 61.
- 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.
- 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

Table 6-7 Two-channel with monitoring by the signal input

Error type	Detection	Diagnostics	Loss of SF	Comment
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/signal 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/signal 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 Figure 6-3 on page 67)	Yes	Yes	No	**Prevent this error, e.g., through protected cable installation.**
Output to 24 V (for version B in Figure 6-3 on page 67)	Yes	Yes	**Yes**	**Prevent this error, e.g., through protected cable installation.**
Output to ground	Yes	Yes	No	Protect the output against damage using an upstream fuse.
Clock output/signal input to 24 V	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Clock output/signal input to ground	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Typical parameterization

Table 6-8 Two-channel with monitoring by the signal input; typical parameterization

Parameterization	Parameterized as		Comment
	Channel 1	**Channel 2**	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Signal input IN1	Evaluate	Evaluate	Or do not evaluate
Signal input IN2	Do not evaluate	Do not evaluate	Or evaluate
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	20	20	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Value x 10 in ms	Application-specific
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
Enable (SafetyBridge only)	Enabled	Enabled	Or disabled

According to the “Value range of switch-off time” and “Switch-off time” parameters, in this example, the shutdown time is 20 x 10 ms = 200 ms.

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.

6.5.2 Monitoring via separate readback

Monitoring is separate for each channel of an output, using one signal input for each. In this case, both signal 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.

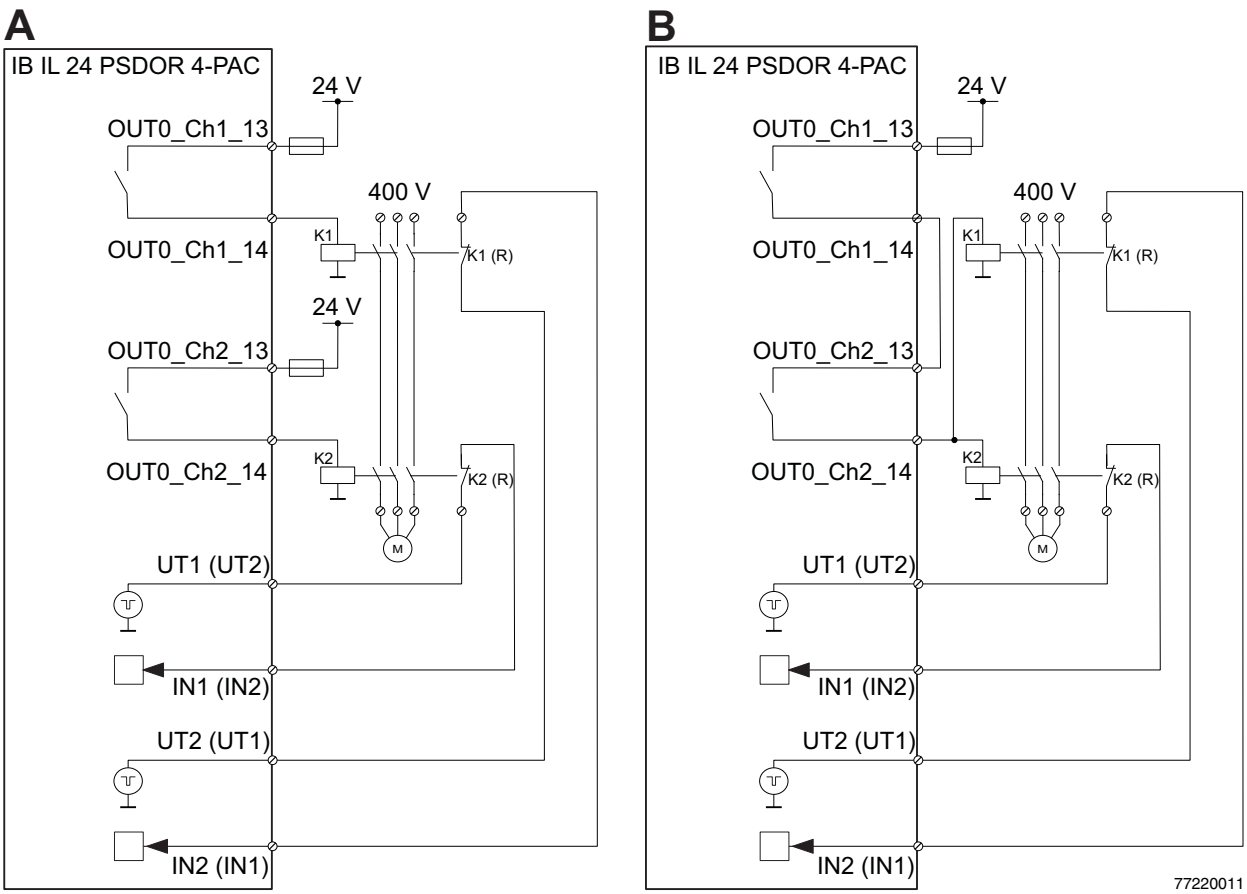


Figure 6-4 Two-channel assignment of floating contacts with separate readback

WARNING: 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 109).

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)	Signal input IN1 or IN2
UT2 (UT)	Clock output UT2 or UT1
IN2 (IN1)	Signal input IN2 or IN1

K1 (R) and K2 (R) represent the force-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 signal input IN1 and IN2 as illustrated. In this case, the signal inputs must be assigned to the outputs. Parallel connection of the signal inputs 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 signal 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 signal inputs are used, no errors can be detected in the external load or in the wiring.
External wiring requirements	The error analysis for the connected loads and for the external wiring must be performed by the user.

WARNING: Loss of electrical and functional safety
- To achieve the specified safety integrity level, please refer to Section “Measures required to achieve a specific safety integrity level” on page 61.
- 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.
- 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

Table 6-9 Two-channel with monitoring by two signal inputs

Error type	Detection	Diagnostics	Loss of SF	Comment
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/signal 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/signal 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 Figure 6-3 on page 67)	Yes	Yes	No	**Prevent this error, e.g., through protected cable installation.**
Output to 24 V (for version B in Figure 6-3 on page 67)	Yes	Yes	**Yes**	**Prevent this error, e.g., through protected cable installation.**
Output to ground	Yes	Yes	No	Protect the output against damage using an upstream fuse.
Clock output/signal input to 24 V	Yes	Yes	No	The error is detected by clocking or by the plausibility check.
Clock output/signal input to ground	Yes	Yes	No	The error is detected by clocking or by the plausibility check.

Typical parameterization

Table 6-10 Two-channel with monitoring by two signal inputs; typical parameterization

Parameterization	Parameterized as		Comment
	Channel 1	Channel 2	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Signal input IN1	Evaluate	Do not evaluate	Or do not evaluate/evaluate
Signal input IN2	Do not evaluate	Evaluate	Or evaluate/do not evaluate
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	20	20	Application-specific

Table 6-10 Two-channel with monitoring by two signal inputs; typical parameterization

Parameterization	Parameterized as		Comment
	Channel 1	Channel 2	
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Value x 10 in ms	Application-specific
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
Enable (SafetyBridge only)	Enabled	Enabled	Or disabled

According to the “Value range of switch-off time” and “Switch-off time” parameters, in this example, the shutdown time is 20 x 10 ms = 200 ms.

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.

6.5.3 External monitoring

Assigning no signal 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.

6.6 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 Section “Ordering data: Documentation” on page 115).

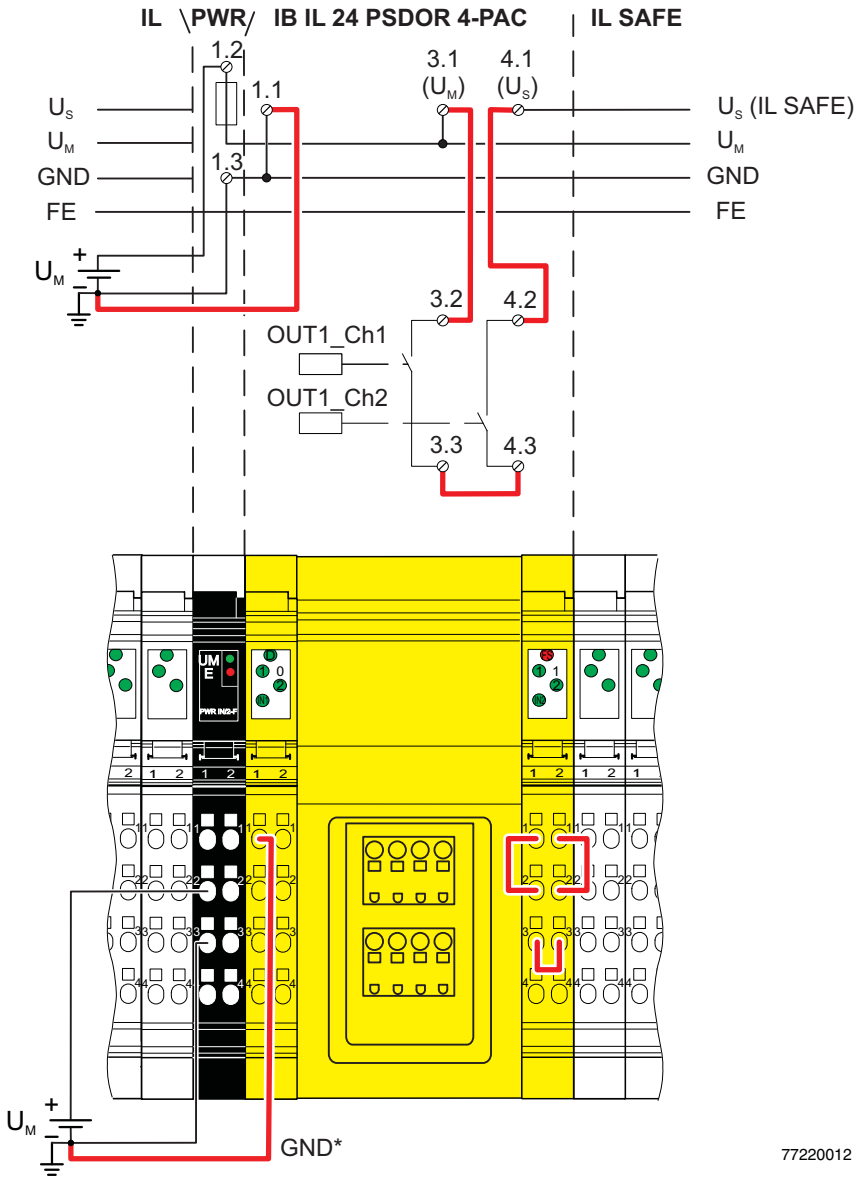


Figure 6-5 Internal and external wiring of the IB IL 24 PSDOR 4-PAC for the use of the safety-related segment circuit

Key:

IL	Standard Inline
IL SAFE	Safety-related segment circuit
PWR	Power terminal with fuse or power terminal with fuse and diagnostics (see “Ordering data: Power terminals” on page 115)
Red (bold)	External wiring to the safety terminal (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 terminal.

Protecting the supply voltage U_M

Protect the supply voltage. Two options are available:

– Use a power terminal with fuse for the main circuit (see “Ordering data: Power terminals” on page 115). This version is shown in Figure 6-5.
Replace the fuse that is supplied as standard with a fuse with an I^2t value of less than 100 A^2s and maximum 4 A.

– If a power terminal with fuse is not used, protect the supply U_M using an external fuse.

6.6.1 Assignment with single-channel actuators

The segment circuit of the Inline system is safely switched via the appropriate wiring with jumpers (see Figure 6-5 on page 75). 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 terminals that are installed in the safety-related segment circuit is disconnected. Only terminals that are specifically designed for the safety-related segment circuit may be used. The outputs of standard DO terminals can be controlled individually via process data, however their disconnection is not safety-related. In the event of a safety demand, the IB IL 24 PSDOR 4-PAC safety-related segment circuit and all the outputs of DO terminals connected in the safety-related segment circuit are switched off regardless of the actual switching state of the standard outputs.

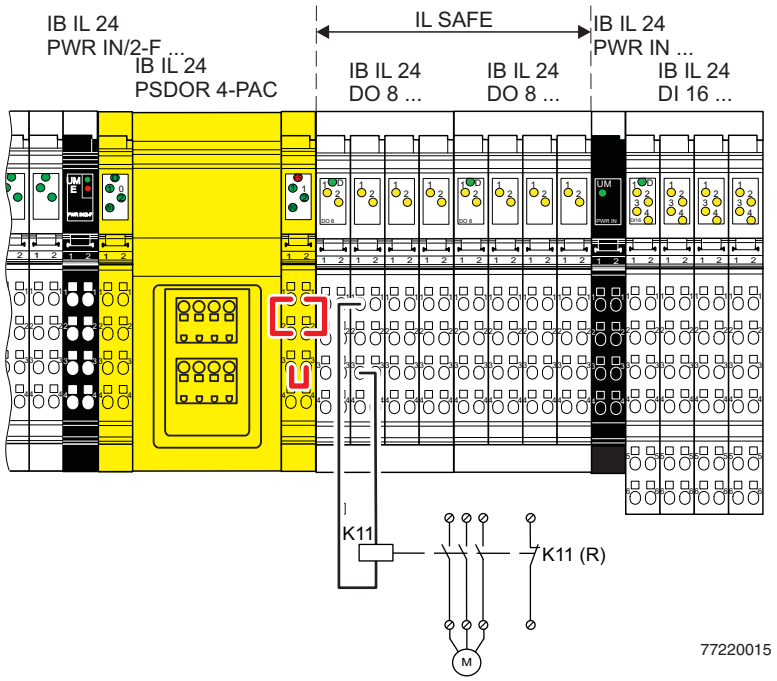


Figure 6-6 Single-channel actuators in the safety-related segment circuit

Key:
IL SAFE: Safety-related segment circuit

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 is not permitted.

Basic specifications

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

*) suitable up to Cat. 2 depending on the application.

To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 61.

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

Table 6-11 Safety-related segment circuit: Assignment with single-channel actuators

Error type	Detection	Diagnostics	Loss of SF	Comment
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. Ensure that cross-circuits/short circuits with external signals cannot be created. Observe the versions in the document for the safety-related segment circuit in the Inline system (see “Ordering data: Documentation” on page 115).
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 Section “Fuse protection” on page 19.

Typical parameterization

Table 6-12 Safety-related segment circuit: Assignment with single-channel actuators; typical parameterization

Parameterization	Parameterized as		Comment
	Channel 1	**Channel 2**	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Signal input IN1	**Do not evaluate**	**Do not evaluate**	
Signal input IN2	**Do not evaluate**	**Do not evaluate**	
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	40	40	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Value x 10 in ms	Application-specific
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
Enable (SafetyBridge only)	Enabled	Enabled	Or disabled

According to the “Value range of switch-off time” and “Switch-off time” parameters, in this example, the shutdown time is 40 x 10 ms = 400 ms.

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.

6.6.2 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 Figure 6-5 on page 75). 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 terminals that are installed in the safety-related segment circuit is disconnected. Only terminals that are specifically designed for the safety-related segment circuit may be used. The outputs of standard DO terminals can be controlled individually via process data, however their disconnection is not safety-related. In the event of a safety demand, the IB IL 24 PSDOR 4-PAC safety-related segment circuit and all the outputs of DO terminals connected in the safety-related segment circuit are switched off regardless of the actual switching state of the standard outputs.

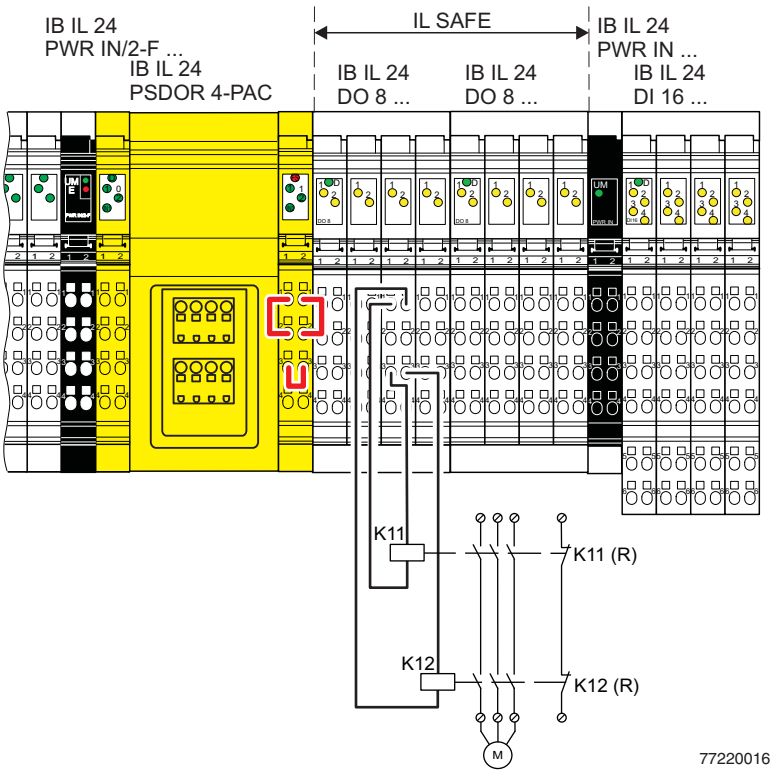


Figure 6-7 Two-channel actuators in the safety-related segment circuit

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 is not permitted.

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 Section “Measures required to achieve a specific safety integrity level” on page 61.
- Evaluate the readback contacts to achieve Cat. 3 or Cat. 4.

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

Table 6-13 Safety-related segment circuit: Assignment with two-channel actuators

Error type	Detection	Diagnostics	Loss of SF	Comment
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. Detect errors 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. Ensure that cross-circuits/short circuits with external signals cannot be created. Observe the versions in the document for the safety-related segment circuit in the Inline system (see “Ordering data: Documentation” on page 115).
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 Section “Fuse protection” on page 19.

Typical parameterization

Table 6-14 Safety-related segment circuit: Assignment with two-channel actuators; typical parameterization

Parameterization	Parameterized as		Comment
	Channel 1	Channel 2	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Signal input IN1	**Do not evaluate**	**Do not evaluate**	
Signal input IN2	**Do not evaluate**	**Do not evaluate**	
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	40	40	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Value x 10 in ms	Application-specific
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
Enable (SafetyBridge only)	Enabled	Enabled	Or disabled

According to the “Value range of switch-off time” and “Switch-off time” parameters, in this example, the shutdown time is 40 x 10 ms = 400 ms.

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 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

7.1 Single-channel operation

7.1.1 Determining PFD for single-channel operation

The value always refers to one internal safety relay (see assignment of outputs to the safety relay in Section “Terminal point assignment” on page 38).

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

7.1.2 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 then be added up.

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 Section “Terminal point assignment” on page 38).

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 Table 7-1 [% x h]

Table 7-1 Factor for calculating PFH depending on the load for the contacts

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

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

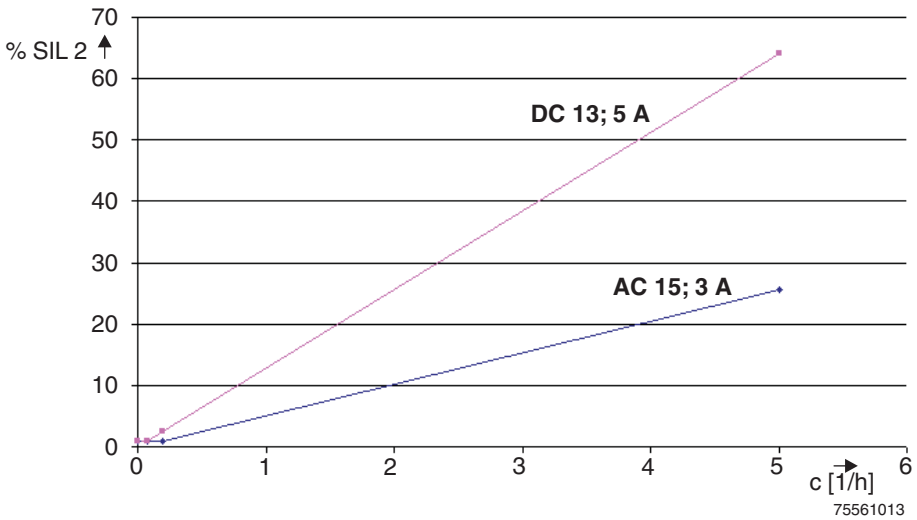


Figure 7-1 PFH values depending on switching frequency c

7.1.3 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 Section “Terminal point assignment” on page 38).

Table 7-2 $MTTF_d$ depending on the load for the contacts and the switching frequency

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

7.2 Two-channel operation

7.2.1 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 Section “Terminal point assignment” on page 38).

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

7.2.2 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 then be added up.

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 Section “Terminal point assignment” on page 38).

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 Table 7-3 [% x h]

Table 7-3 Factor for calculating PFH depending on the load for the contacts

Version in Figure 6-3 on page 67	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

Channel 2 zero current: See alternative B in Figure 6-3 and Figure 6-4.

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

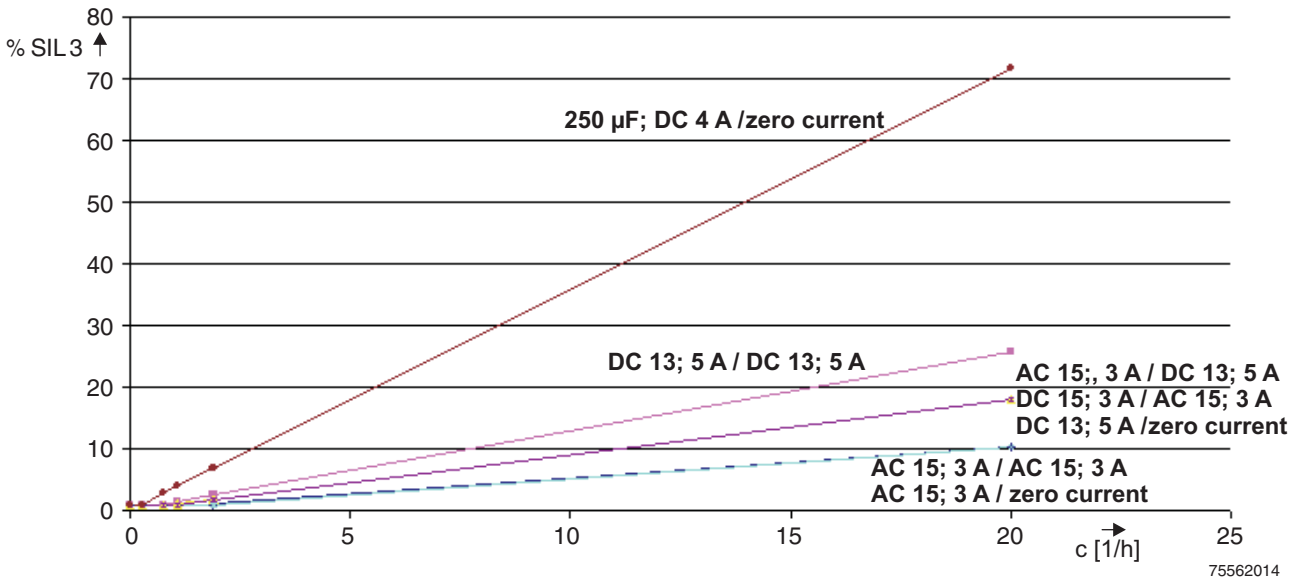


Figure 7-2 PFH values depending on switching frequency c

7.2.3 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 Section “Terminal point assignment” on page 38).

Table 7-4 $MTTF_d$ depending on the load for the contacts and the switching frequency

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

7.3 Other marginal conditions

1. Operation with capacitive loads is only permitted for two-channel assignment (see alternative B in Figure 6-3 and Figure 6-4).
2. 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 Figure 6-3 and Figure 6-4).
3. The minimum switching frequency is 1 cycle in 6 months.
4. The values are only valid if an appropriate external fuse is provided to protect the contacts against overload.

8 Startup and validation

8.1 Initial startup

To start up, proceed as described in Table 8-1.

Table 8-1 Steps for startup

Step	Relevant section and literature
Set the transmission speed and the mode.	Section “Setting the DIP switches” on page 42
Set the protocol/address.	Section “Setting the DIP switches” on page 42
Install the safety module within the Inline station.	Section “Mounting, removal, and electrical installation” on page 41
Connect the bus system and supply voltage cables to the Inline station.	IB IL SYS PRO UM E user manual (INTERBUS), IL SYS INST UM E or documentation for the bus coupler
Wire the relay outputs according to your application.	Section “Mounting, removal, and electrical installation” on page 41 Section “Inline potential and data routing, and Inline connectors” on page 35 User manuals for the function blocks used
Before applying the operating voltage: – Make sure 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 necessary voltages to the Inline station.	IB IL SYS PRO UM E user manual (INTERBUS), IL SYS INST UM E or documentation for the bus coupler
Connect the required voltages (U_M) to the safety module.	Section “Supply voltage U_M” on page 36
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 that 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 mounting and installation.	Checklist “Mounting, removal, and electrical installation” on page 41

Table 8-1 Steps for startup (Fortsetzung)

Step	Relevant section and literature
Carry out the necessary parameterization.	Section “Parameterization of the safety module” on page 51 Documentation for SafetyProg software Documentation for the configurable logic module used (SafetyBridge) Documentation for the controller used (PROFIsafe)
Program the safety function.	User manuals for the function blocks used Documentation for the SafetyProg software (INTERBUS-Safety) Documentation for the configurable logic module used (SafetyBridge) Documentation for the controller used (PROFIsafe)
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 130 Quick Start Guide for configuring 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 130

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 Section “Errors: Messages and removal” on page 93.

8.2 Restart after replacing a safety module

8.2.1 Replacing a safety module

WARNING: Electric shock / Unintentional machine startup

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

Before mounting 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 system is reassembled before switching the power back on. Observe the diagnostics indicators and any diagnostic messages.

The system must only be started when neither the station nor the system can cause any damage.

If replacing a module, proceed as described for mounting and removal (see Section “Mounting, removal, and electrical installation” on page 41).

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

8.2.2 Restart

Once the safety module has been replaced, proceed as described for initial startup (see Section “Initial startup” on page 89).

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

8.3 Validation

Carry out a safety validation every time you make a safety-related modification to the INTERBUS-Safety, SafetyBridge or 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 ranges are observed.
- If the safety-related segment circuit is used, only Inline terminals 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 observe the checklist “Validation” on page 130 during validation.

9 Errors: Messages and removal

Depending on the error type, errors that are diagnosed are displayed via the local diagnostics indicators and/or transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable logic module (SafetyBridge) as diagnostic messages.

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

For SafetyBridge, please also refer to the documentation for the configurable logic module used.

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

Table 9-1 Overview of diagnostic codes

Diagnostic code	Error type	See
X020 ... X0B8	Safe digital relay output errors	Section 9.1 on page 96
X1F2 ... X1F4	General errors	Section 9.2 on page 98
X210 ... X3F3	Parameterization error	Section 9.3 on page 98
	PROFIsafe errors	Section 9.4 on page 100

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 that do not appear in the tables below, please contact Phoenix Contact.

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 Section “Acknowledging an error” on page 101.

WARNING: Unexpected machine startup

An operator acknowledgment leads to a positive edge and can therefore 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 Section 4, “Mounting, removal, and electrical installation” and Section “Restart after replacing a safety module” on page 91.

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 Table 9-3 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 in SafetyBridge operating mode)

Table 9-2 Relationship between the diagnostic code indicated and the diagnostic code specified in the documentation

		15	14	13	12	11	10	...							0
Diagnostics 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**	

Diagnostic code specified in the documentation: $X281_{hex}$ (see Table 9-6 on page 99).

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 (Table 9-3)

Error cause	Error Code (Hex)
Signal error at signal input	X0Bn
X0B0: OUT0_Ch1; X0B1: OUT1_Ch1 X0B7: OUT0_Ch2; X0B8: OUT1_Ch2	

X0Bn Signal error at signal input

X0B**n** Error location

This means, for example:

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

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

LED

The LED column specifies which LED of the local diagnostics indicators is used to signal 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.

9.1 Safe digital relay output errors

Table 9-3 Safe relay output errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Shutdown time was exceeded X020: OUT0_Ch1 X021: OUT1_Ch1 X027: OUT0_Ch2 X028: OUT1_Ch2	**X02n**	OUTy: red flashing	The shutdown time parameterized for the output was exceeded If the affected output was parameterized for two-channel operation, the error is indicated for channel 1. INTERBUS-Safety only.	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 97).	Check parameterized shutdown time and correct, if necessary Check quality of INTERBUS communication	Yes (2)
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 signal input X0B0: OUT0_Ch1 X0B1: OUT1_Ch1 X0B7: OUT0_Ch2 X0B8: OUT1_Ch2	**X0Bn**	OUTy: red ON	A signal error was detected at an signal 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 signal 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 97).	Check function of the monitored actuator. Check wiring	Yes (2)

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 selftest.

Acknowledgment: Yes (2)

Acknowledging the diagnostic message deletes the message and enables a restart. 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 therefore result in the outputs being re-enabled.

INTERBUS-Safety: Diagnostic message $002x_{hex}$ ("The shutdown time parameterized for the output was exceeded") is also deleted in the event of a bus reset.

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 signal inputs. In the event of an error at this signal input, a diagnostic message is only generated for OUT0_Ch1, and OUT0_Ch2 is also disabled. When the single diagnostic message is acknowledged, both outputs are enabled at the same time (as for 002X message).

9.2 General errors

Table 9-4 General errors

Error cause	Error Code (Hex)	LED	Comment	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 message in the process data image	**X1F4**		At least one reserved bit in the process data image has been set.	All outputs are disabled immediately. A parameterized switch-off delay is not observed.	Check the process data assignment.	Yes (2)
Hardware fault		FS on	Error in the logic area	Module is in the safe state	Exchange	

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

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

9.3 Parameterization errors

Table 9-5 Parameterization errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Incorrect parameterization	see Table 9-6	FS LED (flashing)	Each output is parameterized individually	Module is in the safe state	Check and correct parameterization.	–

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.

For example, with the SafetyProg software and INTERBUS-Safety proceed as follows:

- Using the SafetyProg software, access the safe controller online.
- Click on the “Safety controller” button.
- Click on “Errors” in the window that opens.
  The errors can now be read.
- In the message window, switch to the “Safety controller errors” tab.
  The device-specific error code is displayed in decimal notation.

Table 9-6 Parameterization errors

Error code		Short description	Remedy
(hex)	(dec)		
X21n X210: OUT0_Ch1 X211: OUT1_Ch1 X217: OUT0_Ch2 X218: OUT1_Ch2	**528**: OUT0_Ch1 **529**: OUT1_Ch1 **535**: OUT0_Ch2 **536**: OUT1_Ch2	The parameterized shutdown time for the output is outside the permissible value range. INTERBUS-Safety only.	Correct value and resend parameter data to the module.
X22n X220: OUT0_Ch1&2 X221: OUT1_Ch1&2	**545**: OUT0_Ch1&2 **546**: OUT1_Ch1&2	For outputs parameterized for two-channel operation, the same shutdown times were not assigned. INTERBUS-Safety only.	Correct value and resend parameter data to the module.
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 signal input. Either more than one signal input is assigned to an output or the selected signal 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.

Table 9-6 Parameterization errors (Fortsetzung)

Error code		Short description	Remedy
(hex)	(dec)		
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.
X3F1	**1009**	The new location ID received from the safe controller is not within the permissible value range. INTERBUS-Safety only.	The valid value range for the location ID is between 1 and 126. Correct value and resend parameter data to the module.
X3F3	**1011**	An error occurred while saving the new location ID. INTERBUS-Safety only.	Resend parameter data to the module. If the same error occurs again, there is a hardware fault.

9.4 PROFIsafe errors

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

– PROFIsafe system errors: These messages can be found in Section “Diagnostic messages for parameter errors” on page 121.
– PROFIBUS or PROFINET system errors. For information about these errors, please refer to the documentation for the system used.

9.5 Acknowledging an error

9.5.1 Acknowledging an error for INTERBUS-Safety

After removing the cause of an error, the diagnostic message must be acknowledged using the DEVICE_STATE_Vx_yz function block.

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 hazardous state.

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

For instructions on error acknowledgment, please refer to the UM EN INTERBUS-SAFETY SYS and UM EN IB FB DEVICE-STATE user manuals, and the documentation for the SafetyProg software.

If in the event of failure the safety module is replaced, please proceed as described in Section 4, “Mounting, removal, and electrical installation” and Section 8.2, “Restart after replacing a safety module”.

9.5.2 Acknowledging an error for SafetyBridge

An IB IL 24 PSDOR 4-PAC error is acknowledged completely via the configurable logic module.

For instructions on error acknowledgment, please refer to the documentation for the configurable logic module used.

9.5.3 Acknowledging an error for PROFIsafe

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 hazardous 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 Section 4, “Mounting, removal, and electrical installation” and Section “Restart after replacing a safety module” on page 91.

10 Maintenance, repair, decommissioning, and disposal

10.1 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 switching cycles of the relays (see “Safe digital relay outputs” on page 109).

Switch the safety relays at regular intervals. (For the proof test interval, see “Safe digital relay outputs” on page 109).

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

10.2 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, the function can no longer be ensured.

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

10.3 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 an INTERBUS-Safety or 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 Section “IB IL 24 PSDOR 4-PAC” on page 106).
  Or
– Are disposed of in accordance with the applicable environmental regulations, and in this case can never be reused.

11 Technical data and ordering data

11.1 System data

11.1.1 INTERBUS and Inline

For system data, please refer to the following user manuals:

INTERBUS	IBS SYS PRO INST UM E
INTERBUS-Safety	UM EN INTERBUS-SAFETY SYS
Inline (INTERBUS)	Configuring and installing the Inline product range INTERBUS IB IL SYS PRO UM E
Inline (general)	Automation terminals of the Inline product range IL SYS INST UM E

11.1.2 SafetyBridge

SafetyBridge	
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 for the configurable logic module used.

11.1.3 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.

11.2 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	
INTERBUS-Safety	Process data mode with 3 words
SafetyBridge	Process data mode with 4 words
PROFIsafe	Process data mode with 4 words and 1 word PCP (internal use)
Transmission speed (INTERBUS/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 (non-condensing)

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

Storage/Transport:	75 % (non-condensing)

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 clearances and creepage distances	According to IEC 60664-1
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 the housing material to termites	Resistant

General data (continued)	
Resistance of the housing material to fungal decay	Resistant
Ambient compatibility	Not resistant to chloroform
Connection data for Inline connectors	
Connection method	Spring-cage terminal blocks
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 terminal blocks
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: 2 g, Criterion A
Shock according to IEC 60068-2-27	15 g 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 Section “Connection options for actuators depending on the parameterization” on page 24 and Section “Connection examples for the safe relay outputs and the safety-related segment circuit” on page 59)
Probability of a dangerous failure on demand by the safety function (PFD)	See Section “Determining PFH, PFD, and $MTTF_d$” on page 83.
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 Section “Determining PFH, PFD, and $MTTF_d$” on page 83.
For single-channel assignment	1 %, maximum of SIL 2, depending on the load, switching frequency, parameterization, and wiring
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 a

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 Section “Connection options for actuators depending on the parameterization” on page 24, Section “Connection examples for the safe relay outputs and the safety-related segment circuit” on page 59)
Safe failure fraction (SFF)	99 %
Probability of a dangerous failure per hour for the entire module (PFH)	See Section “Determining PFH, PFD, and $MTTF_d$” on page 83.
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 a

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 Section “Connection options for actuators depending on the parameterization” on page 24 and Section “Connection examples for the safe relay outputs and the safety-related segment circuit” on page 59)
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 Section “Determining PFH, PFD, and $MTTF_d$” on page 83)

Supply voltage U_L (logic, relay)

The safety terminal 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
Diagnostics indicators	Indirect via green D LED (see “Local diagnostic and status indicators” on page 25)

Supply voltage U_M (clock outputs)

The safety terminal 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 interrupt 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)

NOTE: 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
Diagnostics indicators	None
External protection	8 A slow-blow, maximum

NOTE: Module damaged when overloaded
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 V AC/DC to 30 V AC/DC
At COMBICON connector	5 V AC/DC to 250 V AC/DC

Safe digital relay outputs (continued)	
Maximum output current per contact	
At Inline connector	4 A (observe derating, see “Derating” on page 111)
At COMBICON connector	6 A (observe derating, see “Derating” on page 111)
Potential areas	see Figure 2-3 on page 19
Maximum output current for all contacts (total current)	see “Derating” on page 111
Mechanical service life	> 10 x 10^6 switching cycles
N/O contact bouncing time	2 ms, typical
Maximum switching frequency	1 time per second (depending on the SIL requirement; see also Section “Determining PFH, PFD, and $MTTF_d$” on page 83)
Proof test interval	6 months
External protection	Nominal current ≤ 6 A, I^2t value < 100 A^2s (see also Section “Fuse protection” on page 19)
Simultaneity	100 % (observe maximum current load)
Derating	see “Derating” on page 111
Shutdown time (t_{OUT})	Can be parameterized: Single-channel: 25 ms to 6.3 s; two-channel: 35 ms to 6.3 s; see Section “Parameterize all safe relay outputs individually” on page 54 Accuracy: Single-channel: - (10 ms + 6 % of parameterized value)/+0 ms; Two-channel: - (20 ms + 6 % of parameterized value)/+0 ms
Switch-off delay for shutdown according to stop category 1	Can be parameterized: 150 ms to 630 s; see Section “Parameterize all safe relay outputs individually” on page 54 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 25)
Diagnostics indicators	One red LED (two-color LED green/red) per relay output (see “Local diagnostic and status indicators” on page 25)

Derating

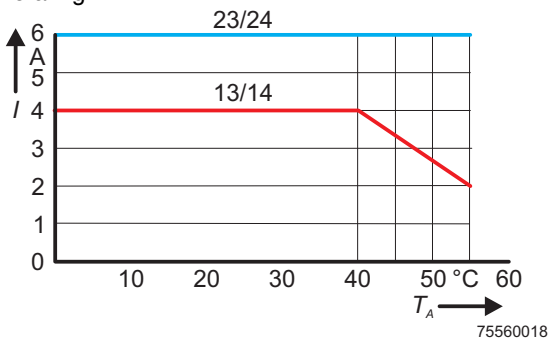
The three derating curves are valid at 100 % simultaneity of the relay outputs.

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

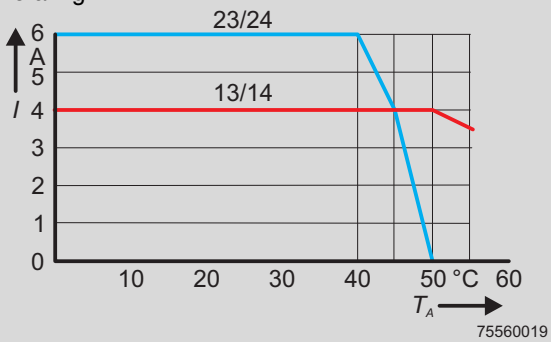
Use only one diagram to determine the derating of the safety module.

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.

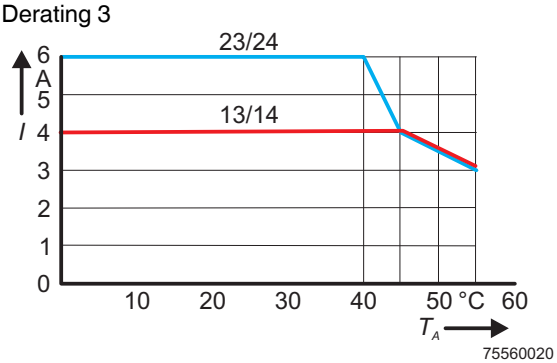
Derating 1



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/V AC to 250 V DC/V AC
Switching current range (guide value)	5 mA to 6 A

Contact data for the safety relay used (continued)	
Switching power range (guide value)	60 mW to 1500 W (VA)
Contact resistance	≤ 100 mW (when new)
Short-circuit withstand capability	1000 A SCPD (6 A gG backup fuse)
Maximum switching capacity (DIN EN 60947-4-1, DIN EN 60947-5-1)	
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 (t = 0 ms)	
24 V DC	144 W
48 V DC	96 W
110 V DC	66 W
250 V DC	63 W
250 V AC	1500 VA
Maximum interrupting rating for inductive load (t = 40 ms)	
24 V DC	35 W
48 V DC	35 W
110 V DC	35 W
250 V DC	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
Diagnostics indicators	None

Signal 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 signal input (see “Local diagnostic and status indicators” on page 25)
Diagnostics indicators	None

Electrical isolation / Isolation of the voltage ranges

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 user manual.)

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

- Test distance	- Test voltage
5 V supply of incoming remote bus / 7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
5 V supply of 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 phoenixcontact.net/products.

11.3 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
Transient overvoltage (surge)	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 disturbance variables	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

11.4 Ordering data

11.4.1 Ordering data: Safety module

Description	Order designation	Order No.	Pcs./Pkt.
INTERBUS-Safety Inline module with safe digital relay outputs; including accessories (connectors and marking fields)	IB IL 24 SDOR 4-PAC	2985864	1

11.4.2 Ordering data: Accessories

Description	Order designation	Order No.	Pcs./Pkt.
Plug set as replacement item	IB IL 24 SDOR 4-PLSET/CP	2916914	1 set

11.4.3 Ordering data: Power terminals

Description	Order designation	Order No.	Pcs./Pkt.
Inline power terminal, complete with accessories (connector and marking field), 24 V DC, with fuse (main and segment voltage), transmission speed of 500 kbps	IB IL 24 PWR IN/2-F-PAC	2862136	1
Inline power terminal, complete with accessories (connector and marking field), 24 V DC, with fuse (main and segment voltage) and diagnostics, transmission speed of 500 kbps	IB IL 24 PWR IN/2-F-D-PAC	2862152	1
Inline power terminal, complete with accessories (connector and marking field), 24 V DC, with fuse (main and segment voltage) and diagnostics, transmission speed of 2 Mbps	IB IL 24 PWR IN/2F-D-2MBD-PAC	2863821	1
Inline power terminal, complete with accessories (connector and marking field), 24 V DC, with fuse (main and segment voltage) and diagnostics, transmission speed of 2 Mbps	IB IL 24 PWR IN/2F-DF-2MBD-PAC	2863834	1

11.4.4 Ordering data: Documentation

Description	Order designation
Inline	
User manual “Automation terminals of the Inline product range”	IL SYS INST UM E
User manual Configuring and installing the INTERBUS Inline product range	IB IL SYS PRO UM E
Application note Safety-related segment circuit	AH EN IL SAFE
INTERBUS-Safety	
User manual INTERBUS-Safety system description	UM EN INTERBUS-SAFETY SYS
User manual DEVICE-STATE function block	UM EN IB FB DEVICE-STATE
SafetyBridge	
User manual Inline module with integrated safety logic and safe digital outputs	UM EN IB IL 24 LPSDO 8 V2-PAC
User manual Inline module with integrated safety logic and safe digital outputs	UM EN IB IL 24 LPSDO 8 V3-PAC
PROFIsafe	
Quick start guide Configuring Inline modules with safe inputs or outputs under PROFIsafe on a SIMATIC® S7 controller	UM QS EN IB IL 24 PSDX - S7

Description	Order designation
Specification PROFIsafe - Profile for Safety Technology on PROFIBUS DP and PROFINET IO, Version 2.4, February 2007	See profisafe.net
INTERBUS general	
User manual General introduction to the INTERBUS system	IBS SYS INTRO G4 UM E
User manual Configuring and installing INTERBUS	IBS SYS PRO INST UM E
User manual INTERBUS Diagnostics Guide	IBS SYS DIAG DSC UM E
User manual Firmware services and error messages	IBS SYS FW G4 UM E
“INTERBUS addressing” data sheet	DB GB IBS SYS ADDRESS
Documentation for software	
Quick start guide SafetyProg	UM QS EN SAFETYPROG
Quick start guide Config+	UM QS EN CONFIG+
Quick start guide PC WorX	UM QS EN PC WORX

Make sure you always use the latest documentation.
It can be downloaded at phoenixcontact.net/products.

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

A Appendix: PROFIsafe terms used in the user manual

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

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

Consecutive number

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 controller, 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”)

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
Consecutive number	see “Consecutive number”
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 reported to the safe controller. For a safe input module when the F-System is passivated, instead of the process values present at the safe inputs, (0) substitute values 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.

B Appendix: F-Parameters and iParameters

B 1 F-Parameters

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

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

F-Parameter	Default value	Description
F_Source_ Address	*automatic*	The parameter uniquely identifies the PROFIsafe source address (controller address). The address is assigned automatically.
F_Destination_ Address	*automatic*	PROFIsafe destination address (address of the safe device) The address is assigned automatically. However, 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 for the safe relay outputs and the safety-related segment circuit” on page 59).
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.

B 2 iParameter

The iParameters are individual device parameters. These include:

- Device parameters from INTERBUS-Safety (see Section “Parameterize all safe relay outputs individually” on page 54)
- PST_Device_ID (30_{hex} for 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.

B 3 Diagnostic messages for parameter errors

B 3.1 Diagnostic messages for F-Parameters and iParameters for PROFIsafe

Table B-2 F-Parameter 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).	Match the PROFIsafe address of the safety module and the value in F_Destination_Address.
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 that 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 B-3 iParameter 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 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.

B 3.2 Diagnostic messages for parameter errors for SafetyBridge

Table B-4 F-Parameter parameter errors

Error code		Error cause	Remedy
dec	hex		
1088	440	The parameterized SafetyBridge address does not match the address set on the safety module.	Make sure that the addresses are the same.
1089 ... 1094	441 ... 446	Internal error	Please contact Phoenix Contact.

C Appendix: Conditions for use at altitudes greater than 2,000 m above sea level

This section describes the conditions for using safe Inline I/O modules at altitudes greater than 2,000 above sea level up to a maximum of 4,500 m above sea level.

Observe the relevant data (technical data, derating, etc.) that is specific to the module being used. Refer to the data in the respective user documentation for the module.

C 1 Conditions

Use of the module at altitudes **greater than 2,000 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

C 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

D Appendix: Checklists

The checklists listed in this section provide support during the planning, mounting, and electrical installation, startup, parameterization, and validation of the 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.

For more comprehensive checklists, please refer to the UM EN INTERBUS-SAFETY SYS user manual.

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

Checklist . . .				
Device type / Equipment identification		IB IL 24 PSDOR 4-PAC / BK20NA10		
Version: HW/FW/FW	00/100/100	**Date**	2008-01-03	
Author	John Smith	**Test engineer**	Jane Brown	
Comment	System XXX has been checked for engine hood production			

No.	**Requirement (mandatory)**	**Yes**	**Comment**
X	. . .	☐	

No.	**Requirement (optional)**	**Yes**	**No**	**Comment**
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 Section “Structure of the safety module” on page 18).
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.
Comment	Where necessary, enter a comment.
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.

D 1 Planning

Checklist for planning the use of the INTERBUS-Safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
1	Has the current module user manual been used as the basis for planning?	☐	Revision:
2	Are the actuators permitted for connecting to the module (as per technical data and parameter setting options)?	☐	
3	Has the power 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 user manual for supply voltage UM)?	☐	
6	Is external fuse protection of the relay contacts planned?	☐	
7	INTERBUS-Safety: Is the shutdown time to be parameterized specified (uniform shutdown time, derived from the system specifications or shutdown time per channel)?	☐	
8	Are measures planned to prevent simple tampering?	☐	
9	Are measures planned to prevent connectors being mixed up?	☐	
10	Are requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved and the appropriate implementation planned?	☐	
11	Are the specifications for the parameterization for each channel defined?	☐	
12	Have test intervals been defined for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
13	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
14	Does the planned use correspond to the intended use?	☐	
15	Are the ambient conditions observed according to the technical data?	☐	
16	Have test intervals been defined?	☐	
17	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?	☐	
18	Have the selected terminals for the safety-related segment circuit been designed for this purpose?	☐	

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

D 2 Assembly and electrical installation

Checklist for assembly and electrical installation of the INTERBUS-Safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
1	Was mounting completed according to the specifications (specifications from the planning phase or according to the user manual)?	☐	
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	Comment
4	Is the transmission speed set correctly according to the specifications?	☐	☐	
5	Is the data width set correctly according to the specifications?	☐	☐	
6	Is the profile/PROFIsafe address set correctly according to the specifications?	☐	☐	

Date	Signature (author)
Date	Signature (test engineer)

D 3 Startup and parameterization

Checklist for startup and parameterization of the INTERBUS-Safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
1	Was startup completed according to the specifications (specifications from the planning phase or according to the user manual)?	☐	
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	Are both channels for outputs that are parameterized as two-channel matched to each other?	☐	
5	INTERBUS-Safety: Are the shutdown times for the outputs calculated and parameterized?	☐	
6	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	Comment
7	Are the safety distances to be maintained dimensioned according to the implemented response and delay times (reaction times)?	☐	☐	

	Date	Signature (author)
	Date	Signature (test engineer)

D 4 Validation

Checklist for validating the INTERBUS-Safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Author		**Test engineer**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
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 devices?	☐	
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 SafetyProg)?	☐	
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 power 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 Inline system from a power supply unit been implemented?	☐	
11	Is external protection of the module implemented (according to the specifications in this user manual for supply voltage U_M)?	☐	
12	Is external fuse protection of the relay contacts implemented?	☐	
13	Have the separate voltage ranges been taken into account?	☐	
14	Have specifications for the safety-related segment circuit been implemented (jumpers, approved terminals, fuse protection)?	☐	
15	INTERBUS-Safety: Is the shutdown time to be parameterized implemented according to the planning? (Uniform shutdown time, derived from the system specifications or shutdown time per channel)	☐	
16	Have measures been taken to prevent simple tampering?	☐	
17	Have measures been taken to prevent plugs being mixed up?	☐	
18	Are requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved?	☐	

No.	Requirement (mandatory)	Yes	Comment
19	Are the specifications for the parameterization for each channel implemented?	☐	
20	Have test intervals been defined for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
21	For PROFIsafe: Is the F_iPar_CRC parameter greater than 0 for all devices?	☐	
22	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
		Date	Signature (author)
		Date	Signature (test engineer)

E Appendix: Index

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F Appendix: Revision history

Revision	Date	Contents	
01	07/2008	First publication	
02	2011-05-06	Removed: EN 954-1, IB IL 24 SAFE 2 Added: EN 61508, SILCL, SafetyBridge Step 2	
		Section 7	$MTTF_d$ added
03	2011-07-28	FW 201 added	
04	2015-07-15	Section 2, 6, 11 Section 11	Adapted: Achievable safety integrity for single-channel assignment Added: Ordering data UM EN IB IL 24 LPSDO 8 V2-PAC
05	2017-11-08	Book	New cover + rear cover added
		Book	Page number format changed
		Cover page	Order number for user manual removed HW/FW/FW version updated (**as of** HW/FW/FW)
		Section 1	Marking of warning notes and qualification of users recorded (previously contained in the cover)
		Section 4	Section 4.1.3 “Setting the DIP switches” revised
		Table 4-3	Switch position for SafetyBridge V3 added
		Page 8 Page 115	Information about safety seals removed
		Page 114	Updated EMC directive
		Page 115	Column Order No. and Pcs./Pkt. from table “Ordering data: Documentation” removed
		Page 123	Appendix “Conditions for use at altitudes greater than 2,000 m above sea level” added

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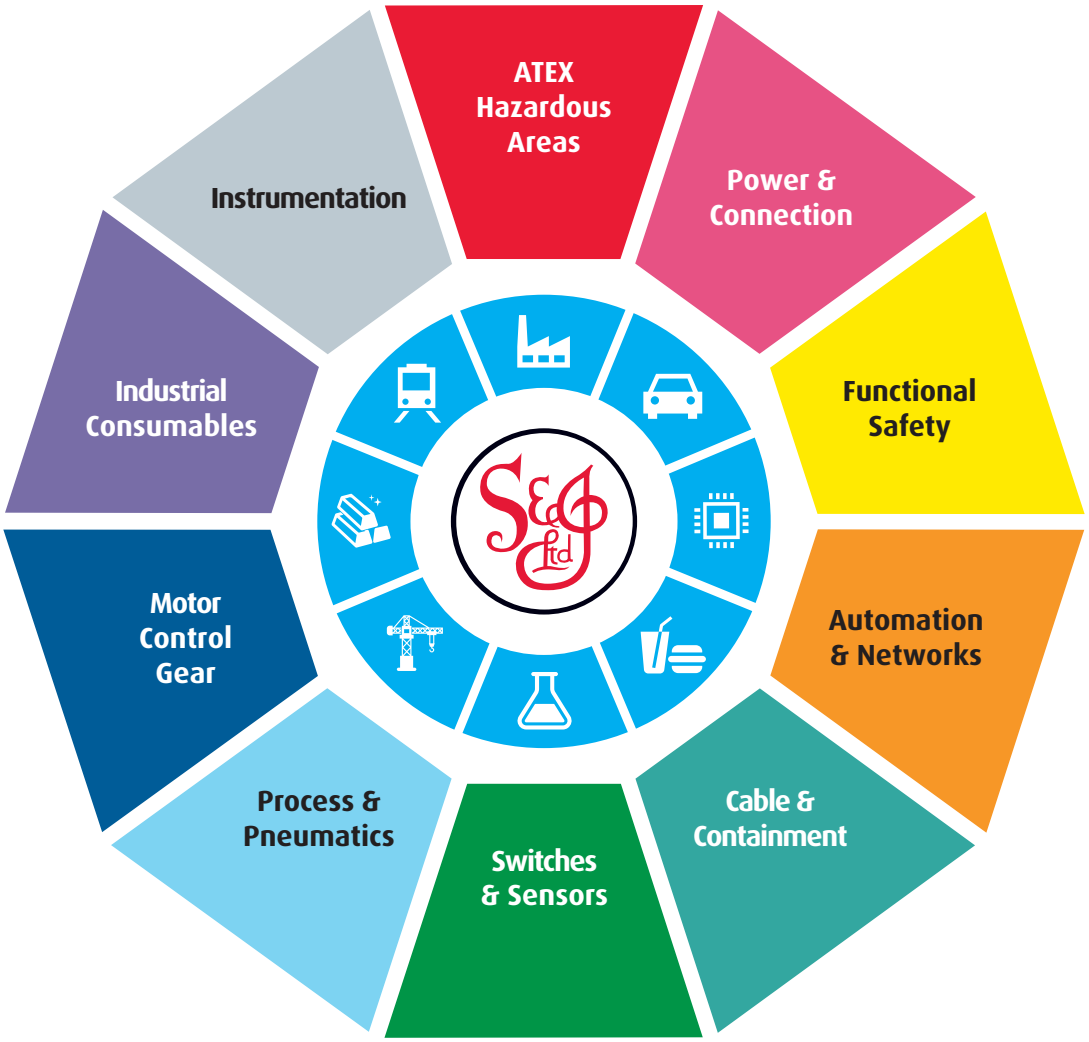

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