The Drive & Control Company

Rexroth
Bosch Group

Rexroth Inline Module with

safe digital outputs

R-IB IL 24 PSDO 4/4-PAC

Application Description
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Edition 04

Title Rexroth Inline Module with
safe digital outputs
R-IB IL 24 PSDO 4/4-PAC

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

Record of revision

Edition	Release date	Note
02	12.2013	First edition
03	04.2016	Modification in Table 13-1 (rows 1 + 2)
04	05.2018	HW/FW/FW version updated (as of...) Chapters updated: Use of the Safety Instructions, Disposal, Service and Support Information about safety seals removed (Chapter General Safety Notes and Chapter Repair) Information on test pulses in the chapter Safe digital outputs added EMC Directive updated Conditions for Use at Altitudes greater than 2000 m above Sea Level inserted

Editorial department Engineering automation systems control hardware, SB

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1 Use of the Safety Instructions

1.1 Structure of the Safety Instructions

The safety instructions are structured as follows:

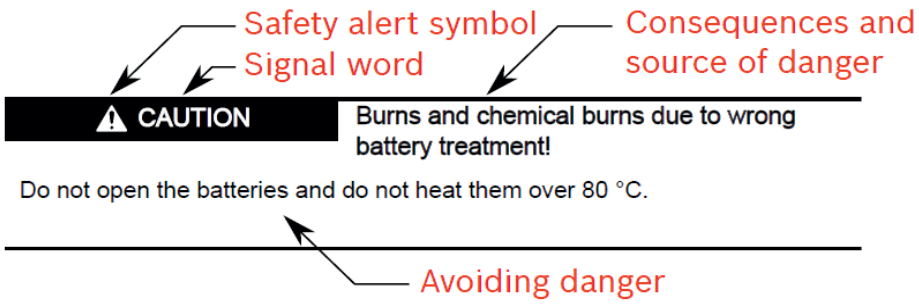


Abb. 1-1 Structure of the safety instructions

1.2 Explaining Signal Words and Safety Alert Symbol

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

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ VCAUTION

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

NOTICE

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

Use of the Safety Instructions

1.3 Symbols used

Hints are represented as follows:

This is an information.

Tips are represented as follows:

This is a tip for the user.

1.4 Signal Graphic Explanation on the Device

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

2 For Your Safety

Purpose of this application description

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

Validity of the application description

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

User group of this application description

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

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

2.1 General Safety Notes

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

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

Requirements

Knowledge of the following is required:

- The non-safety-related target system (e.g., PROFIBUS, PROFINET)
- The 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

For Your Safety

Qualified personnel

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

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

This application description is, therefore, aimed at:

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

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

Documentation

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

Safety of personnel and equipment

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

Error detection

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

Do not carry out any repairs

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

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

Do not open the housing

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

Measures to prevent incorrect connection and polarity reversal

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

2.2 Electrical Safety

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

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

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

Direct/indirect contact

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

This can be achieved by:

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

Power supply units for 24 V supply

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

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

Insulation rating

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

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

Installation and configuration

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

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

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

2.3 Safety of the Machine or System

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

Draw up and implement a safety concept

In order to use the safety module described in this document, you must have drawn up an appropriate safety concept for your machine or system. This includes a hazard and risk analysis according to the directives and standards specified in Chapter “Directives and Standards” on page 11, as well as a test report (checklist) for validating the safety function (see “Checklists” on page 81).

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

Within a PROFIsafe system, the safety module can be used to achieve safety functions with the following requirements:

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

Check hardware and parameterization

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

Use your test report to ensure that:

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

2.4 Directives and Standards

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

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

2.5 Correct Usage

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

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

You must observe all information in this application description as well as in the documents listed in “Documentation” on page 12. In particular, only use the module according to the technical data and ambient conditions specified in Chapter “Technical Data and Ordering Data” on page 67 and onwards.

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

- Up to SIL 3 according to standard EN 61508
- Up to SIL CL 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, inductive, and capacitive loads

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

For Your Safety

2.6 Documentation

Latest documentation

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

PROFIsafe

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

Application descriptions:

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

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

Rexroth Inline product range

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

Documentation for the bus coupler used

2.7 Abbreviations Used

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

Fig. 2-1 Abbreviations used

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

Fig. 2-2 Abbreviations used

For terms and abbreviations used for PROFIsafe, please refer to Chapter “PROFIsafe Terms Used in the Application Description” on page 75.

2.8 Safety Hotline

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

Phone: + 49 9352 40 5060
E-mail: service.svc@boschrexroth.de

For Your Safety

3 Product Description

3.1 Brief Description of the Safety Module

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

The safety module can be used as part of an Inline station at any point within a PROFIsafe system.

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

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

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

The module has four safe digital positive switching outputs, which can be operated via one or two channels depending on the parameterization, and four safe digital negative switching outputs, which can only be operated via two channels. The module therefore has four safe outputs for two-channel assignment or four safe positive switching outputs for single-channel assignment.

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

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

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

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

Product Description

3.2 Structure of the Safety Module

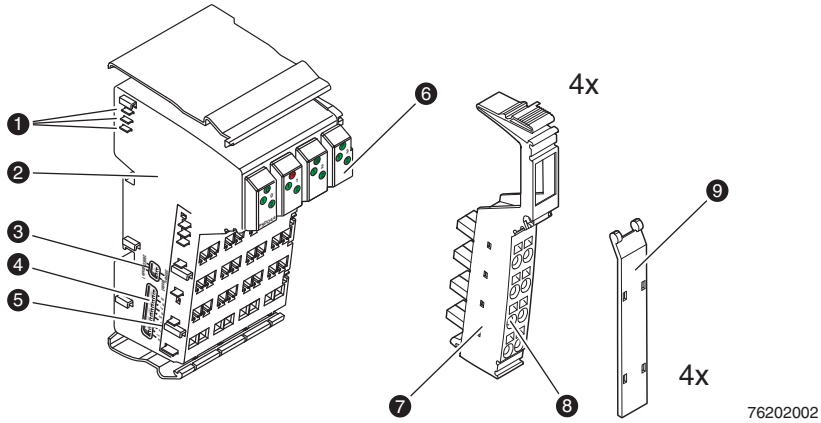


Fig. 3-1 Structure of the safety module

1 Data jumpers (local bus)
2 Electronics base with labeling including hardware/firmware/firmware version designation (not shown)
3 Switch for setting the transmission speed and mode
4 Switch for setting the address

For more detailed information about setting the switches, please refer to Chapter “Setting the DIP Switches” on page 32.

5 Potential jumper
6 Diagnostic and status indicators; for assignment and meaning see Chapter “Local Diagnostic and Status Indicators” on page 19
7 Inline connector; for assignment see Chapter “Terminal Point Assignment” on page 28
8 Terminal points
9 Labeling field

3.3 Housing Dimensions

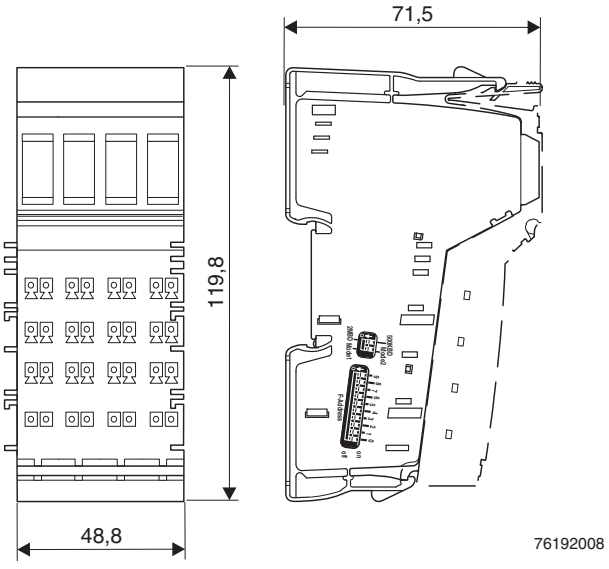


Fig. 3-2 Housing dimensions (in mm)

3.4 Safe Digital Outputs

The safety module has safe positive and negative switching digital outputs, which can be used as follows:

- For two-channel assignment:
  - Four two-channel positive and negative switching outputs
- For single-channel assignment:
  - Four single-channel positive switching outputs

The negative switching outputs cannot be used for single-channel operation.

Technical data

For the technical data for the safe outputs, please refer to page 70.

Parameterization

The individual safe digital outputs of a safety module can be parameterized differently. This means that the outputs can be adapted to various operating conditions and different safety integrity levels (SIL, SIL CL, Cat., PL) can be implemented.

In order to achieve a high level of error detection, the test pulses must be enabled. If this is not possible for the connected loads, the test pulses can be disabled. However, in this case error detection is reduced.

The safety integrity level (SIL, SIL CL, Cat., PL) and error detection that can be achieved depend on the parameterization, the structure of the actuator, and the cable installation (see “Connection Examples for Safe Outputs” on page 41).

For information about parameterization, please refer to Chapter “Parameterization of the Safe Outputs” on page 38.

Diagnostics

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

For information about the diagnostic messages of the outputs, please refer to Chapter “Safe Digital Output Errors” on page 58.

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

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

Product Description

Requirements for controlled devices/actuators

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

If the outputs are parameterized with test pulses, the output circuits are tested by test pulses at regular intervals. These test pulses are visible at the output and can trigger undesirable reactions with quick responding actuators.The test pulses are either light pulses (brief activation) which can be disabled or dark pulses (brief de-activation) which cannot be disabled.

⚠ WARNING **Unintentional machine startup**

If the process does not tolerate this behavior, actuators with sufficient inertia must be used.

In general, the load must not be so dynamic that it causes dangerous states within 1 ms.

Quick actuators, which offer a safety-related response to pulses in under 1 ms, may **not generally** be used.

Note: Switching off the test pulses affects the error detection of the module. Please observe the achievable safety integrity level, which is specified in Chapter “Connection Examples for Safe Outputs” on page 41.

The failure detection time is 20 ms. Please refer to “Single-Channel Assignment of Positive Switching Outputs” on page 45 and “Two-Channel Assignment of Positive and Negative Switching Outputs with a Common Load” on page 48 for additional information.

- Only use appropriately qualified actuators.
- Use reliable components. These include, for example:
  - Control contactors according to EN 60947-4-1
  - Power contactors
  - Relays with forcibly guided contacts according to DIN EN 50205
- Use relays or contactors with forcibly guided N/C contacts to safely monitor the state (pick-up, drop-out).
- Please observe any special environmental requirements in your application when selecting the controlled devices.
- Please note applicable C standards in your application (e.g., EN 1010), in which, for example, the number of controlled devices required to achieve a particular category is specified.

3.5 Connection Options for Actuators Depending on the Parameterization

Actuators that meet various safety requirements depending on the parameterization can be connected to the outputs. For connection examples, please refer to Chapter “Connection Examples for Safe Outputs” on page 41.

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

- Observe the information in the connection examples (see Chapter “Connection Examples for Safe Outputs” on page 41)
- Observe the requirements of the standards with regard to the external wiring and the actuators to be used to achieve a SIL/SIL CL/Cat./PL (see “Measures Required to Achieve a Specific Safety Integrity Level” on page 43)

	Output OUT0 to OUT3	
“Output” parameterization	Single-channel	Two-channel
Positive or positive and negative switching	Positive switching	Positive and negative switching
Test pulses	Any	ON
Achievable category	SIL 2/SIL CL 2/Cat. 3/PL d	SIL 3/SIL CL 3/Cat. 4/PL e
For connection example, see page	45	48

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

3.6 Local Diagnostic and Status Indicators

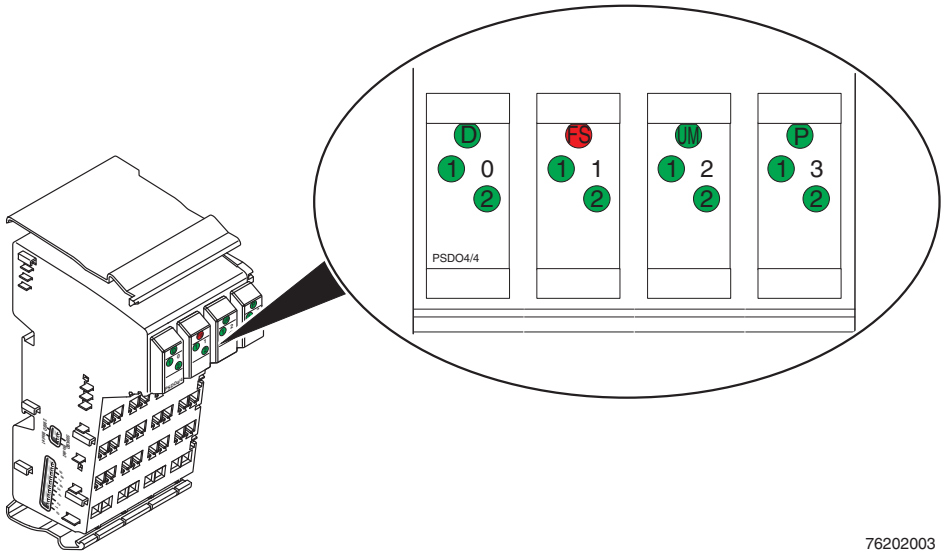


Fig. 3-3 Local diagnostic and status indicators on the R-IB IL 24 PSDO 4/4-PAC module

Product Description

D	Green LED	Diagnostics
	OFF:	Communications power not present
	Flashing at 0.5 Hz:	Communications power present, local bus not active
	Flashing at 4 Hz:	Communications power present, error at the interface between previous and flashing terminal (the terminals after the flashing terminal cannot be addressed). (E.g., loose contact at the bus interface, terminal before the flashing terminal has failed, another terminal was snapped on during operation (not permitted))
	Observe the module startup time of approximately 16 s. During this time the D LED flashes at 4 Hz and the bus cannot be started up.	
	ON:	Communications power present, local bus active
FS	Red LED	Failure state
	Flashing at 1 Hz:	Device not parameterized or parameterization was not accepted
	ON:	Hardware fault Communication to safe controller disabled and output driver enable reset.
UM	Green LED	Monitoring the supply voltage U_M
	OFF:	Communications power not present
	Flashing at 1 Hz:	U_M below the permissible voltage range (undervoltage)
	ON:	U_M present
P	Green LED	Status indicator for safe communication
	OFF:	No safe communication
	Flashing at 0.5 Hz:	Safe communication running, the controller requests operator acknowledgment
	ON:	Safe communication running without errors
OUT 0.1 - 3.2	Green/red LED	Status of each output (see “Terminal Point Assignment” on page 28)
	Green:	Output at logic 1
	OFF:	Output at logic 0, no error
	Red ON:	Short circuit/overload of an output (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), the output is switched off until the acknowledgment sent by the safe controller is received by the safety module (see also Chapter “Safe Digital Output Errors” on page 58).	

Fig. 3-4 Local diagnostic and status indicators

3.7 Safe State

The safe state for the module is the low state at the output modules (see Chapter “Safe Digital Outputs” on page 17).

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

The safe state is entered by means of passivation (see “Passivation” on page 76).

The safe state can be entered in the following cases:

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

3.7.1 Operating State

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

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

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

3.7.2 Error Detection in I/O Devices

Outputs

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

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

- Short circuit
- Cross circuit
- Overload

The relevant diagnostic message is transmitted to the safe controller (see Chapter “Safe Digital Output Errors” on page 58). For information about which errors are detected and when, please refer to Chapter “Connection Examples for Safe Outputs” on page 41.

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

3.7.3 Device Errors

Outputs

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

The relevant diagnostic message is transmitted to the safe controller (see Chapter “Safe Digital Output Errors” on page 58).

Serious errors

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

The following errors result in the safe state:

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

The relevant diagnostic message is transmitted to the safe controller (see Chapter “Errors: Messages and Removal” on page 55).

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

In the event of a device error, the following measures should be taken to prevent sequential errors:

Disconnect the module from the power supply and replace it.

3.7.4 Parameterization Errors

Parameterization errors are indicated:

- As long as the module is not parameterized

or

- In the event of faulty parameterization

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

In the event of faulty parameterization, the relevant diagnostic message is transmitted to the safe controller (see Chapter “Parameterization Errors” on page 62).

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

3.8 Enabling Safe Outputs

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

A “0” is always forwarded.

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

3.9 PROFIsafeProcess Data Words (PROFIBUS, PROFINET)

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

3.10 Programming Data/Configuration Data

3.10.1 Local Bus

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

The PCP channel is only used internally.

3.10.2 PROFIBUS, PROFINET

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

Product Description

4 Inline Potential and Data Routing, and Inline Connectors

4.1 Inline Potential and Data Routing

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

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

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

The segment circuit is looped through the safety module and is available again after the module. The segment circuit cannot be accessed in the safety module.

4.2 Supply Voltage U_L

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

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

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

The supply voltage **U_L** is used to supply the communications power. For the technical data for the supply voltage U_L, please refer to “Supply voltage U_L (logic)” on page 69.

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

4.3 Supply Voltage U_M

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

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

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

The supply voltage **U_M** is used to supply the output circuits. For the technical data for the supply voltage U_M, please refer to Chapter “Supply voltage U_M (actuators)” on page 69.

The maximum current carrying capacity for the main circuit U_M is 8 A (total current with the segment circuit that is not used in the safety module). This current carrying capacity can be reduced if certain terminals are used. Please refer to the information in the terminal-specific data sheets.

If the limit value of the potential jumpers U_M and U_S is reached (total current of U_S and U_M), a new power terminal must be used.

NOTICE **Module damage due to polarity reversal**

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

For the behavior of the safety module in the event of an error at the supply voltage, please refer to Chapter “Supply Voltage Errors” on page 60.

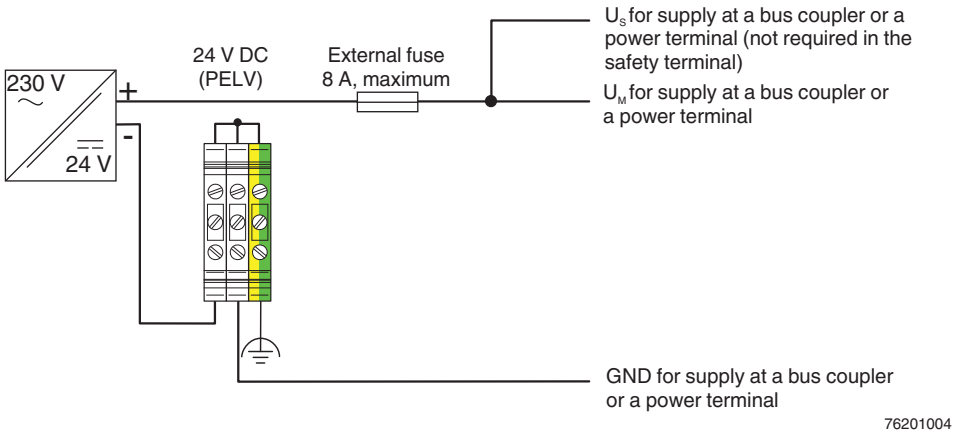


Fig. 4-1 Supply U_M with connection to functional earth ground according to EN 60204-1

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

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

NOTICE

Damage to module electronics in the event of surge voltage

Do not use a DC distribution network.

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

4.4 Terminal Point Assignment

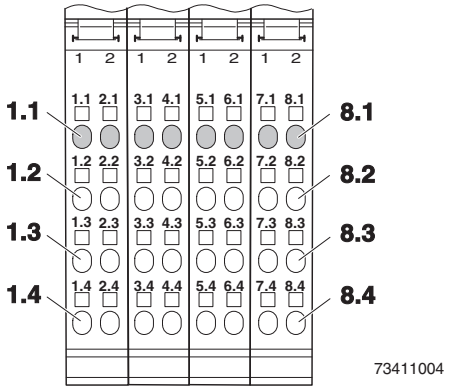


Fig. 4-2 Terminal point assignment

The Inline connectors are supplied with the terminal. They are keyed and labeled accordingly for connection to prevent polarity reversal. If other connectors are used according to the ordering data, they must also be keyed.

Only use the connectors supplied with the terminal or connectors that are approved as replacement items (see "Ordering data" on page 73).

The following applies for the tables below:

- All outputs are safe digital outputs
- 0 V (GND): Common ground for outputs
- FE: Common functional earth ground
- Negative switching outputs can only be used for two-channel assignment

Terminal point	Signal	Channel assignment	LED	Remark
1.1	OUT0_Ch1	Output 0, channel 1	0.1	Positive switching
2.1	OUT0_Ch1	Output 0, channel 1	0.1	Positive switching
1.2	OUT0_Ch2	Output 0, channel 2	0.2	Negative switching
2.2	OUT0_Ch2	Output 0, channel 2	0.2	Negative switching
1.3	0 V (GND)	Channel 1		
2.3	0 V (GND)	Channel 1		
1.4	FE			
2.4	FE			

Fig. 4-3 Terminal point assignment for connector 1

Terminal point	Signal	Channel assignment	LED	Remark
3.1	OUT1_Ch1	Output 1, channel 1	1.1	Positive switching
4.1	OUT1_Ch1	Output 1, channel 1	1.1	Positive switching
3.2	OUT1_Ch2	Output 1, channel 2	1.2	Negative switching
4.2	OUT1_Ch2	Output 1, channel 2	1.2	Negative switching
3.3	0 V (GND)	Channel 1		
4.3	0 V (GND)	Channel 1		
3.4	FE			
4.4	FE			

Fig. 4-4 Terminal point assignment for connector 2

Terminal point	Signal	Channel assignment	LED	Remark
5.1	OUT2_Ch1	Output 2, channel 1	2.1	Positive switching
6.1	OUT2_Ch1	Output 2, channel 1	2.1	Positive switching
5.2	OUT2_Ch2	Output 2, channel 2	2.2	Negative switching
6.2	OUT2_Ch2	Output 2, channel 2	2.2	Negative switching
5.3	0 V (GND)	Channel 1		
6.3	0 V (GND)	Channel 1		
5.4	FE			
6.4	FE			

Fig. 4-5 Terminal point assignment for connector 3

Terminal point	Signal	Channel assignment	LED	Remark
7.1	OUT3_Ch1	Output 3, channel 1	3.1	Positive switching
8.1	OUT3_Ch1	Output 3, channel 1	3.1	Positive switching
7.2	OUT3_Ch2	Output 3, channel 2	3.2	Negative switching
8.2	OUT3_Ch2	Output 3, channel 2	3.2	Negative switching
7.3	0 V (GND)	Channel 1		
8.3	0 V (GND)	Channel 1		
7.4	FE			
8.4	FE			

Fig. 4-6 Terminal point assignment for connector 4

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

For single-channel assignment: Connect the ground of the actuator to the ground terminal point of the corresponding output on the Inline connector. An external ground may not be used.

Inline Potential and Data Routing, and Inline Connectors

5 Assembly, Removal, and Electrical Installation

5.1 Assembly and Removal

5.1.1 Unpacking the Module

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

NOTICE **Electrostatic discharge**

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

5.1.2 General

⚠ WARNING **Unintentional machine startup**

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

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

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

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

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

To ensure reliable operation, install the safety module 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 modules on 35 mm DIN rails.

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

Assembly, Removal, and Electrical Installation

5.1.3 Setting the DIP Switches

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

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

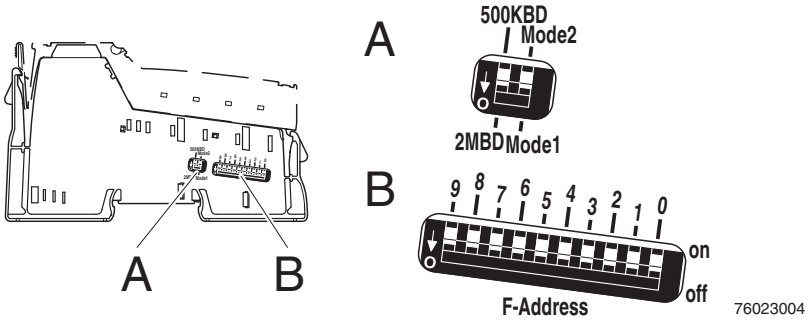


Fig. 5-1 DIP switches

A Switch for setting the transmission speed and the mode

B Switch for setting the address

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

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

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

Right switch: Mode For PROFIsafe, set Mode 1.

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

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

Overview of the switch positions

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

Fig. 5-2 Switch position for PROFIsafe

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

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

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

5.2 Assembly and Removal of the Safety Module

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

Mounting

- Set the DIP switches prior to assembly (see Chapter “Setting the DIP Switches” on page 32). The DIP switches cannot be accessed when the safety module is installed in the Inline station.
- Observe a mounting distance of 30 mm above and 40 mm below the safety module. Shorter distances may inhibit proper handling during installation.

– Snap on base

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

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

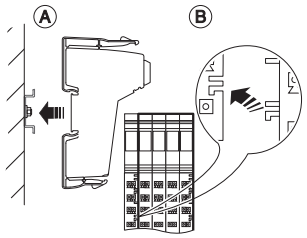


Fig. 5-3 Snapping on the safety module base

– Insert connectors

- Check that all the snap-on mechanisms are securely snapped into place.
- Insert the connectors in the specified order (A, B).

Only use the connectors supplied with the module or connectors that are approved as replacement items (see “Ordering data” on page 73).

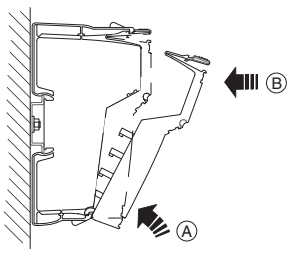


Fig. 5-4 Inserting the connector

Assembly, Removal, and Electrical Installation

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.

– Remove connectors

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

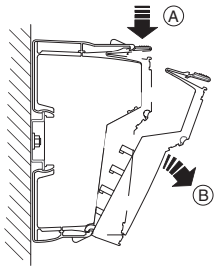


Fig. 5-5 Removing the connector

– Remove base

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

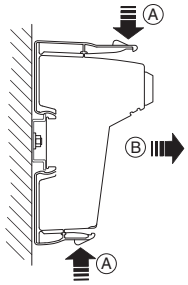


Fig. 5-6 Removing the safety module base

5.3 Electrical Installation

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

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

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

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

5.3.1 Electrical Installation of the Inline Station

Electrical installation of the Inline station includes the following:

- Connecting 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 DOK-CONTRL-ILSYSINS***-AW..-EN-P application description or the application description for your bus system. Please also observe the specifications in the documentation for the bus coupler used.

5.3.2 Electrical Installation of the Safety Module

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

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

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

The actuators are connected via Inline connectors.

- Wire the connectors according to your application. For the terminal point assignment, please refer to Chapter “Terminal Point Assignment” on page 28.

For wiring, proceed as follows:

- Strip 8 mm off the cable.

Inline wiring is normally done without ferrules. However, it is possible to use ferrules. If using ferrules, make sure they are properly crimped.

- Push a screwdriver into the slot of the appropriate terminal point (Fig. 5-7, detail 1), so that you can insert the wire into the spring opening.
  Bosch Rexroth recommends a screwdriver with a 0.6 mm x 3.5 mm x 100 mm shaft.
- Insert the wire (Fig. 5-7, detail 2). Remove the screwdriver from the opening. This clamps the wire.

Assembly, Removal, and Electrical Installation

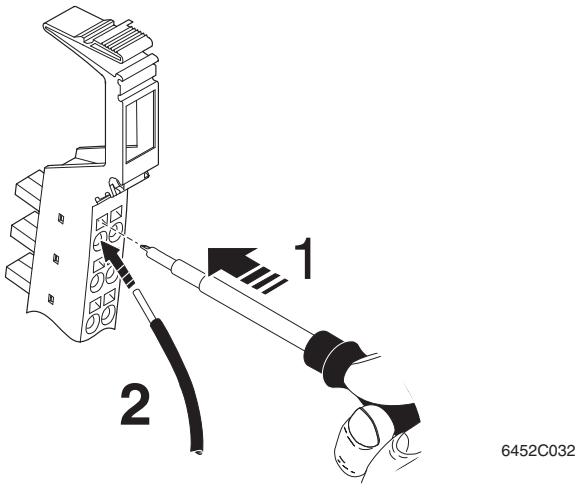


Fig. 5-7 Connecting unshielded cables

- Insert the assembled connectors in the corresponding module slot (see Chapter “Terminal Point Assignment” on page 28).
- Label all connections to prevent connections to the Inline connectors being mixed up (see DOK-CONTRL-ILSYSINS***-AW..-EN-P application description).

6 Parameterization of the Safety Module

6.1 Parameterization in a PROFIsafe System

Parameterization includes the following:

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

PROFIsafe address

The PROFIsafe address is a unique ID for the safety module in the PROFIsafe structure. It is assigned in the configuration software. Set this address via the DIP switches prior to assembling the safety module (see “Setting the DIP Switches” on page 32).

Parameterization of outputs

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

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

The following conditions must be met:

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

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

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

If errors are detected during parameterization, the parameterization data is not transmitted. The FS LED on the module flashes to indicate that the parameterization is invalid. In addition, errors are indicated at the safe controller. In this case, check and correct the settings. For information about error messages and instructions for their removal, please refer to Chapter “Errors: Messages and Removal” on page 55.

F-Parameters and iParameters

Assign the parameterizable F-Parameters and iParameters. For an overview of the module parameters and possible settings, please refer to Chapter “F-Parameters and iParameters” on page 77.

6.2 Parameterization of the Safe Outputs

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

Two-channel

If the outputs are operated via two channels, the following fixed assignment applies:

- OUT0_Ch1 to OUT0_Ch2
- OUT1_Ch1 to OUT1_Ch2
- OUT2_Ch1 to OUT2_Ch2
- OUT3_Ch1 to OUT3_Ch2

Single-channel

If two-channel operation in the external wiring of the outputs is not required, the **positive switching** outputs can be parameterized in such a way that they operate independently of one another (single-channel).
The **negative switching** outputs are not available for single-channel wiring. In this case, the following assignment applies:

- OUT0_Ch1 to GND
- OUT1_Ch1 to GND
- OUT2_Ch1 to GND
- OUT3_Ch1 to GND

Parameterization

Parameterize all safe **positive switching** outputs individually. The parameterization options are described in Fig. 6-1.

The safe **negative switching** outputs are not parameterized.
The OUTx_Ch2 outputs are negative switching outputs. They can only be used in two-channel operation with the assigned positive switching output (OUTx_Ch1). If a positive switching output is parameterized as “used” and “two-channel”, its parameterization is automatically applied internally for the assigned negative switching output.

Parameterization	Value range	Remark
	OUT0 - OUT3	
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.
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.

Fig. 6-1 Parameterization of outputs

Parameterization	Value range	Remark
	OUT0 - OUT3	
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: OUT0 to OUT3: 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.
Test pulses (output disabled) (in software: test impulses (output switched off))	Disabled Enabled	Enabling and disabling of test pulses. For these test pulses, the output drivers that are disabled are temporarily enabled for test purposes. See note below this table.

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

Test pulses

Note on test pulses

When using positive and negative switching outputs, the test pulses must be enabled.

If the test pulses are disabled, cross circuits and short circuits cannot be detected.

Regardless of the parameterization selected under “Test impulses (output switched off)”, the outputs parameterized as “Not used” are tested by test pulses.

Please also refer to Chapter “Requirements for controlled devices/actuators” on page 18 and Chapter “Connection Examples for Safe Outputs” on page 41.

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 $028x_{hex}$).

Two-channel parameterization

Please note the following for two-channel parameterization:

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

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

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

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

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

⚠ WARNING **Delayed shutdown when using stop category 1**

For stop category 1 please take into consideration the following:

In the event of an error (excluding bus errors) the affected outputs 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 parameterized switch-off delay
- The monitoring time (F_WD_Time)
- The processing time of the module

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.
- Please note that when the parameterization is modified, this can result in delayed startup due to the switch-off delay time.

7 Connection Examples for Safe Outputs

7.1 Explanation of the Examples

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

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

The following are specified for each example:

- **Basic specifications**
  The main data for the example is specified in the table.
- **Device diagnostics and behavior of the module in the event of an error**
  Diagnostic capability depends on the parameterization.
  If a message is transmitted to the safe controller in the event of an error, the message is specified in the tables. For information about the relevant error code, possible remedies, and information about whether acknowledgment is required, please refer to Chapter “Errors: Messages and Removal” on page 55.
- **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Key for all tables in this section:

Representation	Meaning
SF	Safety function
OUTx	OUT1 or OUT2 LED; diagnostic message for each output

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

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

Fig. 7-2 Parameterization tables

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

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

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

An external voltage may not be supplied in an output (e.g. via cross circuits). These errors can adversely affect the operation of the module (or even destroy the module) and thus result in the loss of the safety function. Therefore, these errors must be prevented. Install the connecting cables for connecting the actuators so that they are protected against cross circuits.

Please observe the load capacity of the outputs according to the technical data in "Safe Digital Outputs" on page 17.

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

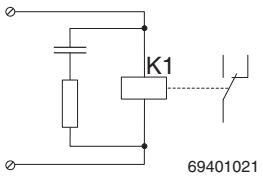


Fig. 7-3 Example for the free running circuit for an external relay

- Limit the voltage induced on circuit interruption to < -15 V (e.g., with RC elements, suppressor diodes or varistors).
- Please note that the free running circuit affects the fall time and the service life of the contactor.
- Please observe the specifications of the relay manufacturer when sizing the relay protective circuit.

7.3 Measures Required to Achieve a Specific Safety Integrity Level

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

SIL, SIL CL

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

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

When the SIL/SIL CL is specified, the module takes up 1% of the specified SIL/SIL CL.

	PFD	PFH
SIL 2/SIL CL 2	1% of 10^{-2}	1% of 10^{-6}
SIL 3/SIL CL 3	1% of 10^{-3}	1% of 10^{-7}

Fig. 7-4 PFD and PFH depending on the SIL/SIL CL

Performance level

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

Category

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

Cat. 2

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

Cat. 3

- Use proven safety principles.
- Use appropriately qualified actuators (see Chapter “Requirements for controlled devices/actuators” on page 18).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts on the connected contactors or safety relays 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.
- Once the test pulses have been disabled, test the shutdown capability of the actuators at regular intervals.

Cat. 4

- Use proven safety principles.
- Use appropriately qualified actuators (see Chapter “Requirements for controlled devices/actuators” on page 18).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts on the connected contactors or safety relays 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.
- Once the test pulses have been disabled, test the shutdown capability of the actuators at regular intervals.

7.4 Single-Channel Assignment of Positive Switching Outputs

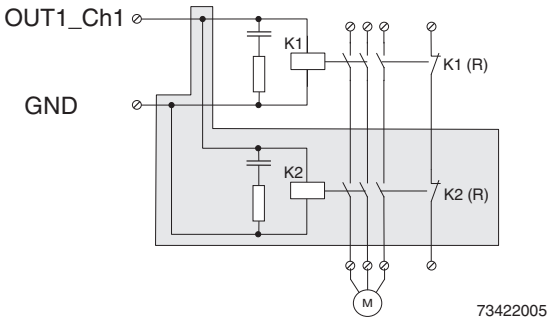


Fig. 7-5 Single-channel assignment of positive switching outputs

In order to achieve Cat. 3 or PL d with single-channel assignment of the outputs,
a two-channel actuator must be used. The two-channel operation of the actuator with the corresponding connection is represented on a gray background.

K1 (R) and K2 (R) represent the forcibly guided N/C contacts for monitoring the state of the relay (readback contacts). Connect these contacts via safe digital inputs. Evaluate the readback and thus the state of the switching elements in your safe application program.

⚠ WARNING Loss of safety function

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

Basic specifications

Actuator	Single-channel	Two-channel
Achievable SIL/SIL CL/Cat./PL	SIL 2/SIL CL 2/Cat. 2/PL c	SIL 2/SIL CL 2/Cat. 3/PL d

⚠ WARNING Loss of electrical and functional safety

- To achieve the specified safety integrity level, please refer to Chapter “Measures Required to Achieve a Specific Safety Integrity Level” on page 43.
- 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 MTTFd. A high level of diagnostic coverage (> 99%) is recommended for the application according to PL d.
- To achieve Cat. 3 and PL d the test pulses must be enabled.
- Use actuators that can achieve the required safety integrity level.
- Evaluate the readback contacts to achieve the corresponding safety integrity level.

Enable the test pulses to improve device diagnostics.

If the test pulses for the actuator are faulty, they can be disabled. In this case, test the switching capability of the outputs at regular intervals.

Connection Examples for Safe Outputs

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

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite being disabled, the actuator does not switch to the safe state (e.g., a contact will not open)	**No**	None	Yes	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals.** **If necessary, use a two-channel actuator.**
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	Yes	All LEDs OUT: Red ON	Yes	When the outputs are disabled, a cross circuit between the outputs is only detected if the test pulses are enabled. If an error is detected, the module disables all its outputs.
Short circuit				
Output to ground or output to FE	Yes	Short circuit or overload, OUTx	No	The error is detected in the ON state. The output is disabled (safe state). The module cannot be switched on again with an edge from “0” to “1” until the error has been removed and acknowledged. **⚠ WARNING** **Unexpected machine startup** An operator acknowledgment leads to a positive edge and can thus result in the outputs being re-enabled.

Fig. 7-6 Single-channel: Test pulses enabled

Typical parameterization

Parameterization	Parameterized as	Remark
Assignment	**Used**	
Output	**Single-channel**	
Switch-off delay for stop category 1	Enabled	Or disabled
Switch-off delay for stop category 1	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Application-specific
Test pulses (output disabled) (in software: test impulses (output switched off))	Enabled	Or disabled

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.

7.5 Two-Channel Assignment of Positive and Negative Switching Outputs with a Common Load

For two-channel assignment, the assignment of the safe outputs is predefined and cannot be modified (see Chapter “Two-channel” on page 38).

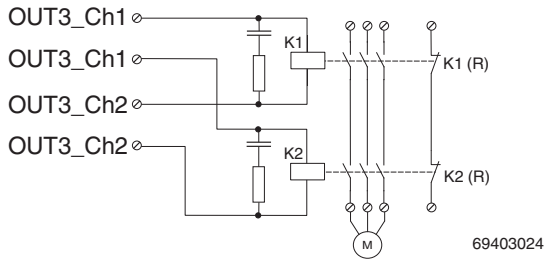


Fig. 7-7 Two-channel assignment of positive and negative switching outputs

K1 (R) and K2 (R) represent the forcibly guided N/C contacts for monitoring the state of the relay (readback contacts). Connect these contacts via safe digital inputs. Evaluate the readback and thus the state of the switching elements in your safe application program.

⚠ WARNING Loss of safety function

Do not connect the load or the outputs with ground (isolated structure) as this would result in a diagnostic message.

Basic specifications

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

⚠ WARNING Loss of electrical and functional safety

- To achieve the specified safety integrity level, please refer to Chapter “Measures Required to Achieve a Specific Safety Integrity Level” on page 43.
- 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 MTTFd. A high level of diagnostic coverage (> 99%) is recommended for the application according to PL d.
- Use actuators that can achieve the required safety integrity level.
- Evaluate the readback contacts to achieve Cat. 3 or Cat. 4.
- If the test pulses are disabled:
  Test the outputs and external wiring by enabling the outputs at regular intervals. The time between two tests must not exceed eight hours.

Always enable the test pulses for positive and negative switching outputs.

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

Error type	Detection	Diagnostics	Loss of SF	Remark
Error in the actuator				
Despite being disabled, 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. **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.**
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 P output and actuator or between actuator and N output	**Yes**	All LEDs OUT: Red ON	No	Interruptions, which mean that the minimum load is not reached (see technical data), are detected. If an error is detected, the module disables all its outputs. 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				
P output to N output	Yes	Short circuit, OUTx	No	Cross circuit between the outputs is detected as a short circuit when the outputs are enabled. If an error is detected, the module disables all its outputs.
Short circuit				
P output to ground or FE	Yes	Short circuit or overload, OUTx	No	The output is disabled (safe state). The module cannot be switched on again with an edge from “0” to “1” until the error has been removed and acknowledged. **⚠ WARNING** **Unexpected machine startup** An operator acknowledgment leads to a positive edge and can thus result in the outputs being re-enabled.
N output to ground or FE	Yes	All LEDs OUT: Red ON	No	If an error is detected, the module disables all its outputs.

Fig. 7-8 Two-channel

Key:

P output	Positive switching output
N output	Negative switching output

Connection Examples for Safe Outputs

Typical parameterization

Parameterization	Parameterized as	Remark
Assignment	**Used**	
Output	**Two-channel**	
Switch-off delay for stop category 1	**Enabled**	Or disabled
Switch-off delay for stop category 1	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Application-specific
Test pulses (output disabled)	**Enabled**	

For two-channel assignment, only parameterize the positive switching output (see Chapter “Parameterization of the Safe Outputs” on page 38).

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

8 Startup and Validation

8.1 Initial Startup

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

Step	Relevant section and literature
Set the transmission speed and the mode.	Chapter “Setting the DIP Switches” on page 32.
Set the address.	Chapter “Setting the DIP Switches” on page 32.
Install the safety module within the Inline station.	Chapter “Assembly, Removal, and Electrical Installation” on page 31.
Connect the bus system and supply voltage cables to the Inline station.	DOK-CONTRL-ILSYSINS***-AW..-EN-P or application description for the bus coupler.
Wire the outputs according to your application.	Chapter “Assembly, Removal, and Electrical Installation” on page 31. Chapter “Inline Potential and Data Routing, and Inline Connectors” on page 25. Application descriptions for the function blocks used.
Before applying the operating voltage: • Ensure that there are no wiring errors (e.g., cross circuit or short circuit) or grounding errors by testing with a multimeter. • Check whether the ground connection is safe.	
Connect the required voltages to the Inline station.	DOK-CONTRL-ILSYSINS***-AW..-EN-P or application description for the bus coupler.
Connect the required voltages (U_M) to the safety module.	Chapter “Supply Voltage U_M” on page 26.
Once the operating voltage has been applied: • If possible, measure the wave form of the voltages to ensure that there are no deviations. • Measure the output voltages on the module, as well as the supply voltages, which supply the connected loads (e.g., motor) to ensure that they are in the permissible range. • Use the LEDs on the devices to check that the module starts up without any errors (there must be no red LEDs permanently on; the FS LED flashes because the device is not parameterized).	
Check the assembly and installation.	Checklist “Assembly, Removal, and Electrical Installation” on page 31.
Carry out the necessary parameterization.	Chapter “Parameterization of the Safety Module” on page 37. Documentation for the controller used.
Program the safety function.	Application descriptions for the function blocks used. Documentation for the controller used.
For PROFIsafe: When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices. If not, modify the settings.	Checklist “Validation” on page 85.
Perform a function test and validation. Check whether the safety function responds as planned during programming and parameterization.	Checklist “Validation” on page 85.

Fig. 8-1 Steps for startup

Startup and Validation

When connecting the supply voltages, use the diagnostic and status indicators to check whether the module has started up correctly or whether any errors are indicated. For instructions on how to proceed in the event of an error, please refer to Chapter “Errors: Messages and Removal” on page 55.

8.2 Restart after Replacing a Safety Module

8.2.1 Replacing a Safety Module

⚠ WARNING **Unintentional machine startup**

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

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

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

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

If replacing a module, proceed as described for assembly and removal (see Chapter “Assembly, Removal, and Electrical Installation” on page 31).

Ensure that the new 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 Chapter “Initial Startup” on page 51).

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

Plug the Inline 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 PROFIsafe system.

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

Determine whether:

- The correct safe actuators are connected to the safety module
- The safety module has been parameterized correctly
- The variables used in your application program have been linked to the safe actuators correctly

Please follow the checklist “Validation” on page 85 during validation.

Startup and Validation

9 Errors: Messages and Removal

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

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

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

Diagnostic code	Error type	See
X010 ... X0AA	Safe digital output errors	Chapter 9.1 on page 58
X1F0	Supply voltage errors	Chapter 9.2 on page 60
X1F2 ... X1F4	General errors	Chapter 9.3 on page 61
X210 ... X3F3	Parameterization errors	Chapter 9.4 on page 62
	PROFIsafe errors	Chapter 9.5 on page 63

Fig. 9-1 Overview of diagnostic codes

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

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

Error removal

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

Error acknowledgment

Instructions on how to acknowledge an error can be found in Chapter “Acknowledging an Error” on page 63.

WARNING **Unexpected machine startup**

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

Module replacement following an error

If in the event of failure the safety module is replaced, please proceed as described in Chapter “Assembly, Removal, and Electrical Installation” on page 31 and Chapter “Restart after Replacing a Safety Module” on page 53.

Errors: Messages and Removal

Notes on the tables below

Diagnostic code

The diagnostic register of the module includes both the diagnostic selector and the diagnostic code. This diagnostic code, which is represented in bits 11 to 0 of the register, is specified in Fig. 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)

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

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

Diagnostic code specified in the documentation: $X281_{hex}$ (see Fig. 9-7 on page 62).

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

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

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

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

Example: Channels in the diagnostic code

Safe output errors (Fig. 9-3)

Error cause	Diagnostic code (hex)
Error at the output or short circuit during the test	X06n
X060: OUT0_Ch1 X061: OUT1_Ch1 X062: OUT2_Ch1 X063: OUT3_Ch1	X067: OUT0_Ch2 X068: OUT1_Ch2 X069: OUT2_Ch2 X06A: OUT3_Ch2

X06n Short circuit or overload

X06**n** Error location

This means, for example:

X062 Cross circuit at OUT2_Ch1 (output 2 channel 1)

X06A Cross circuit at OUT3_Ch2 (output 3 channel 2)

LED

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

Acknowledgment

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

Errors: Messages and Removal

9.1 Safe Digital Output Errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknowledgment
Hardware fault X010: OUT0_Ch1 X011: OUT1_Ch1 X012: OUT2_Ch1 X013: OUT3_Ch1	**X01n**	All OUT: Red ON	The indicated output cannot be disabled	All module outputs are in the safe state	Power up with error-free selftest Replacement	Yes (1)
Short circuit or overload X030: OUT0_Ch1 X031: OUT1_Ch1 X032: OUT2_Ch1 X033: OUT3_Ch1	**X03n**	OUTy: Red ON	If the affected output was parameterized for two-channel operation, the error is indicated for channel 1	Affected output is in the safe state	Check actuator Check connector and cabling Check free running circuit at the contactor	Yes (2)
Error at the output or short circuit during the test X050: OUT0_Ch1 X051: OUT1_Ch1 X052: OUT2_Ch1 X053: OUT3_Ch1 X057: OUT0_Ch2 X058: OUT1_Ch2 X059: OUT2_Ch2 X05A: OUT3_Ch2	**X05n**	All OUT: Red ON	Pulse test (brief activation) at the output failed	All module outputs are in the safe state	Power up with error-free selftest Replacement	Yes (1)
Error at the output or short circuit during the test X060: OUT0_Ch1 X061: OUT1_Ch1 X062: OUT2_Ch1 X063: OUT3_Ch1 X067: OUT0_Ch2 X068: OUT1_Ch2 X069: OUT2_Ch2 X06A: OUT3_Ch2	**X06n**	All OUT: Red ON	Pulse test (brief deactivation) at the output failed	All module outputs are in the safe state	Power up with error-free selftest Replacement	Yes (1)
External wiring and parameterization do not match X070: OUT0_Ch1 X071: OUT1_Ch1 X072: OUT2_Ch1 X073: OUT3_Ch1	**X07n**	All OUT: Red ON	Error can only be detected once U_M has been connected	All module outputs are in the safe state	Check wiring and parameterization and modify, if necessary Power up with error-free selftest Replacement	Yes (1)
States do not correspond to the values expected X080: OUT0_Ch1 X081: OUT1_Ch1 X082: OUT2_Ch1 X083: OUT3_Ch1	**X08n**	All OUT: Red ON	The states do not correspond to the values expected or the wiring of the affected outputs could not be determined Either a hardware fault has occurred or the common load was removed during operation	All module outputs are in the safe state	Check wiring and modify, if necessary Check supply U_M and modify, if necessary Power up with error-free selftest Replacement	Yes (1)

Fig. 9-3 Safe output errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknow-ledgment
Hardware fault	**X091**	All OUT: Red ON	Detected by internal tests	All module outputs are in the safe state	Power up with error-free selftest Replacement	Yes (1)
Cross circuit at the indicated output X0A0: OUT0_Ch1 X0A1: OUT1_Ch1 X0A2: OUT2_Ch1 X0A3: OUT3_Ch1	**X0An** X0A7: OUT0_Ch2 X0A8: OUT1_Ch2 X0A9: OUT2_Ch2 X0AA: OUT3_Ch2	All OUT: Red ON	Cross circuit with another output or with an external signal	All module outputs are in the safe state	Remove error Power up with error-free selftest	Yes (1)

Fig. 9-3 Safe output errors [...]

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

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

⚠ WARNING Unexpected machine startup

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

9.2 Supply Voltage Errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknow-ledgment
Undervoltage U_M	**X1F0**	UM flashing	U_M below the permissible voltage range	All module outputs are in the safe state	Check supply voltage level and correct Check supply line length and load	Yes (1)

Fig. 9-4 Supply voltage U_M errors

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

Undervoltage at U_M: Supply voltage U_M is measured. If U_M < 17 V, a diagnostic message is generated.

9.3 General Errors

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

Fig. 9-5 General errors

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

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

9.4 Parameterization Errors

Error cause	Error code (hex)	LED	Remark	Effect	Remedy	Acknowledgment
Incorrect parameterization	See Fig. 9-7	FS LED (flashing)	Each output is parameterized individually	Module is in the safe state	Check and correct parameterization.	–

Fig. 9-6 Parameterization errors

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

Error code		Short description	Remedy
(hex)	(dec)		
X24n X240: OUT0_Ch1 X241: OUT1_Ch1 X242: OUT2_Ch1 X243: OUT3_Ch1	**576**: OUT2_Ch1 **577**: OUT2_Ch1 **578**: OUT2_Ch1 **579**: OUT3_Ch1	The test pulse at positive and negative switching outputs was disabled, this is not permitted.	Enable the test pulses and resend parameter data to the module.
X26n X260: OUT0_Ch1&2 X261: OUT1_Ch1&2 X262: OUT2_Ch1&2 X263: OUT3_Ch1&2	**608**: OUT0_Ch1&2 **609**: OUT1_Ch1&2 **610**: OUT2_Ch1&2 **611**: OUT3_Ch1&2	An electrical load could not be detected at the positive and negative switching output.	A common electrical load must be connected to outputs that are parameterized for positive and negative switching operation. Correct value and resend parameter data to the module.
X27n X270: OUT0_Ch1 X271: OUT1_Ch1 X272: OUT2_Ch1 X273: OUT3_Ch1	**624**: OUT0_Ch1 **625**: OUT0_Ch1 **626**: OUT0_Ch1 **627**: OUT3_Ch1	A common electrical load was detected at outputs parameterized as “single-channel” or “not used”.	Correct value and resend parameter data to the module.
X28n X280: OUT0_Ch1 X281: OUT1_Ch1 X282: OUT2_Ch1 X283: OUT3_Ch1	**640**: OUT0_Ch1 **641**: OUT0_Ch1 **642**: OUT0_Ch1 **643**: OUT3_Ch1	The parameterized switch-off delay time for the output is outside the permissible value range.	Correct value and resend parameter data to the module.
X2F2	**754**	At least one output with parameterized switch-off delay is still performing a switch-off operation.	Wait until the switch-off operation is complete and resend parameter data to the module.
X3F2	**1010**	An error occurred while comparing the received and calculated checksum.	Resend parameter data to the module.

Fig. 9-7 Parameterization errors

9.5 PROFIsafe Errors

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

- PROFIsafe system errors: These messages can be found in Chapter “F-Parameters and iParameters” on page 77.
- PROFIBUS or PROFINET system errors: For information about these errors, please refer to the documentation for the system used.

9.6 Acknowledging an Error

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

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

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

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

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

If in the event of failure the safety module is replaced, please proceed as described in Chapter “Assembly, Removal, and Electrical Installation” on page 31 and Chapter “Restart after Replacing a Safety Module” on page 53.

Errors: Messages and Removal

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.

Repeat testing within this time is not required.

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, correct operation can no longer be ensured.

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

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

- Are correctly reused in another system.
  In this case, please observe the storage and transport requirements according to the technical data (see Chapter “R-IB IL 24 PSDO 4/4-PAC” on page 67).
  Or
- Are disposed of according to the applicable environmental regulations, and in this case can never be reused.

Maintenance, Repair, Decommissioning, and Disposal

11 Technical Data and Ordering Data

11.1 System Data

11.1.1 Rexroth Inline

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

11.1.2 PROFIsafe

PROFIsafe	
PROFIsafe profile	2.4
Processing time of the module	1.5 ms

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

11.2 R-IB IL 24 PSDO 4/4-PAC

General data	
Housing dimensions (width x height x depth)	48.8 mm x 120 mm x 72 mm
Weight (with connectors)	200 g
Operating mode	
PROFIsafe	Process data mode with 4 words and 1 word PCP (internal use)
Transmission speed (local bus)	500 kbaud or 2 Mbaud
Ambient temperature	
Operation	-25°C to +55°C
Storage/transport	-25°C to +70°C
Humidity	
Operation	75% on average, 85% occasionally (no condensation)

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

Storage/transport	75% on average; 85% occasionally (no condensation)

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

Air pressure	
Operation	80 kPa to 108 kPa (up to 2000 m above sea level)
Storage/transport	66 kPa to 108 kPa (up to 3500 m above sea level)
Degree of protection	IP20
Housing material	Plastic PBT, self-extinguishing (V0)
Air and creepage distances	According to IEC 60439-1, derived from IEC 60664-1
Protection class	III (PELV), IEC 61140, EN 61140, VDE 0140-1

Gases that may endanger functions according to DIN 40046-36, DIN 40046-37

Technical Data and Ordering Data

General data [...]	
Sulfur dioxide (SO_2)	Concentration 10 ±0.3 ppm Ambient conditions: – Temperature 25°C ±2 K – Humidity 75% ±5% – Test duration 10 days
Hydrogen sulfide (H_2S)	Concentration 1 ±0.3 ppm Ambient conditions: – Temperature 25°C ±2 K – Humidity 75% ±5% – Test duration 4 days
Resistance of housing material to termites	Resistant
Resistance of housing material to fungal decay	Resistant
Ambient compatibility	Not resistant to chloroform
Connection data for Inline connectors	
Connection method	Spring-cage terminals
Conductor cross section	0.2 mm^2 to 1.5 mm^2 (solid or stranded), 24 - 16 AWG
Supported stop category according to EN 60204	0 1 in error-free state

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

Safety characteristic data according to IEC 61508/EN 61508	
Achievable SIL	SIL 2 (single-channel) SIL 3 (two-channel) Depends on the parameterization and wiring (see Chapter “Connection Options for Actuators Depending on the Parameterization” on page 19 and Chapter “Connection Examples for Safe Outputs” on page 41)
Probability of a dangerous failure on demand by the safety function (PFD)	SIL 2: 1% of 10^{-2}, maximum (corresponds to 1 x 10^{-4}) SIL 3: 1% of 10^{-3}, maximum (corresponds to 1 x 10^{-5})
Probability of a dangerous failure per hour for the entire module (PFH)	SIL 2: 1% of 10^{-6}, maximum (corresponds to 1 x 10^{-8}) SIL 3: 1% of 10^{-7}, maximum (corresponds to 1 x 10^{-9}) Depends on the parameterization (see Fig. 7-4 on page 43)
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years

Safety characteristic data according to DIN EN 62061	
Achievable SIL claim limit	SIL CL = SIL 2 (single-channel) SIL CL = SIL 3 (two-channel) Depends on the parameterization and wiring (see Chapter “Connection Options for Actuators Depending on the Parameterization” on page 19 and Chapter “Connection Examples for Safe Outputs” on page 41)
Safe failure fraction (SFF)	99%

Safety characteristic data according to DIN EN 62061	
Probability of a dangerous failure per hour for the entire module (PFH)	SIL CL 2: 1% of 10^{-6}, maximum (corresponds to 1 x 10^{-8}) SIL CL 3: 1% of 10^{-7}, maximum (corresponds to 1 x 10^{-9}) Depends on the parameterization (see Fig. 7-4 on page 43)
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years

Safety characteristic data according to EN ISO 13849-1	
Achievable performance level	PL e (two-channel) PL d (single-channel) Depends on the parameterization and wiring (see Chapter “Connection Options for Actuators Depending on the Parameterization” on page 19 and Chapter “Connection Examples for Safe Outputs” on page 41)
Diagnostic coverage (DC)	99%
Mean time to dangerous failure (MTTFd)	For single-channel assignment: 100 years For two-channel assignment: 100 years

Supply voltage U_L (logic)

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

Current consumption	230 mA, maximum

Supply voltage U_M (actuators)

The safety module is supplied with main voltage U_M via the bus coupler or a power terminal in the station. The main voltage is led in the Inline station via potential routing. 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 (all outputs set) (plus actuator current)
Permissible interruption time	10 ms; Within this time, the output voltage for the safe outputs fails as the outputs are not internally buffered.
Surge protection	Yes (in the bus coupler/power terminal)
Protection against polarity reversal	Yes (in the bus coupler/power terminal)

⚠ WARNING 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.

Technical Data and Ordering Data

Supply voltage U_M (actuators) [...]	
Undervoltage detection	Yes, at 17 V, approximately
Diagnostic indicators	Green U_M LED (see “Local Diagnostic and Status Indicators” on page 19)
External fuse protection	8 A slow-blow, maximum

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

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

Safe digital outputs OUT0 to OUT3	
Number	4 two-channel or 4 single-channel (positive switching)
Of which	
Positive switching	4 (OUT0_Ch1, OUT1_Ch1, OUT2_Ch1, OUT3_Ch1)
Negative switching	4 (OUT0_Ch2, OUT1_Ch2, OUT2_Ch2, OUT3_Ch2) (only operate together with the appropriate OUTx_Ch1 positive switching outputs)
Supply	From supply voltage U_M
Maximum output current per output	2 A
Maximum output current for all outputs (total current)	3 A
Maximum output voltage in the low state	< 5 V

⚠ WARNING **Loss of safety function**

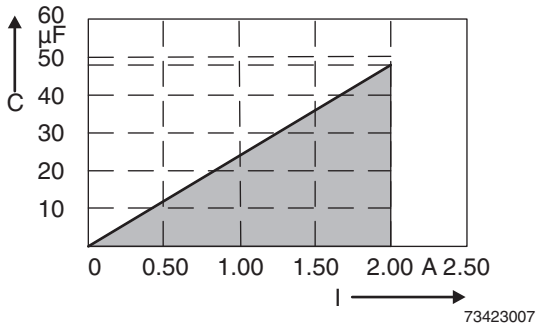
At this voltage, the load must not switch to nor remain in the ON state. Please take this into consideration when selecting the actuator.

Maximum leakage current in the low state	2 mA

⚠ WARNING **Loss of safety function**

At this current, the load must not switch to nor remain in the ON state. Please take this into consideration when selecting the actuator.

Minimum withstand voltage of the connected loads	> 5 V
Maximum inductive load	1 H

Safe digital outputs OUT0 to OUT3 [...]	
Maximum capacitive load depending on the current	C = 1 s/(R x 1400) Where: C Load capacity in F R Load resistance in ohms
Maximum capacitive load depending on the load current	 Key: C Load capacity in µF I Load current in A Shaded area: Permissible range
Minimum load	1.5 kΩ (16 mA at 24 V)
Limitation of the voltage induced on circuit interruption	-15 V
Output voltage	U_M - 1 V, approximately
Simultaneity	100% (observe maximum current load)
Maximum switching frequency	1 Hz; 0.2 Hz at > 1 A
Filter time	None
Switch-off delay for shutdown according to stop category 1	Can be parameterized; 150 ms to 630 s; see Chapter “Parameterization of the Safe Outputs” on page 38 Accuracy ±5% of the parameterized value
Maximum duration of the test pulses (when switched off; active driving)	1 ms
Maximum duration of the test pulses (when switched on)	3 ms (depending on the load capacity)
Status indicators	One green LED (two-color LED green/red) per output (see “Local Diagnostic and Status Indicators” on page 19)
Diagnostic indicators	One red LED (two-color LED green/red) per output (see “Local Diagnostic and Status Indicators” on page 19)

⚠ WARNING **Loss of safety function**

For single-channel assignment: Connect the ground of the actuator directly to the ground terminal point of the corresponding output on the Inline connector. An external ground may not be used.

The connected load must not respond in a hazardous way to test pulses.

Electrical isolation/isolation of the voltage areas

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

Separate potentials in the system comprising bus coupler/power terminal and safety module	
- Test distance	**- Test voltage**
5 V supply incoming remote bus/7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
5 V supply outgoing remote bus/7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
7.5 V supply (bus logic)/24 V supply U_M, FE	500 V AC, 50 Hz, 1 min.

Approvals

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

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
Surge voltage	EN 61000-4-5 (IEC 61000-4-5)	Test intensity 2, Criterion B DC supply lines: 0.5 kV/0.5 kV (symmetrical/asymmetrical) Signal lines: 1.0 kV/2.0 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6 (IEC 61000-4-6)	Criterion A, test voltage 10 V
Noise emission test according to DIN EN 61000-6-4		
Noise emission	EN 55011	Class A, industrial applications

11.4 Ordering data

11.4.1 Ordering Data: Safety Module

Description	Order code	MNR	Pcs. / Pkt.
Rexroth Inline module with safe digital outputs	R-IB IL 24 PSDO 4/4-PAC	R911172849	1

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

11.4.2 Ordering Data: Documentation

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

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

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

Technical Data and Ordering Data

12 PROFIsafe Terms Used in the Application Description

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

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

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

CRC Cyclic Redundancy Check

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

F-CPU Failsafe control system, safe controller

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

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

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

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

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

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

F-Slave Failsafe slave

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

PROFIsafe Terms Used in the Application Description

F-System Failsafe system

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

iParameter Individual safety parameter of a device

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

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

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

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

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

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

This time is parameterized in the F_WD_Time F-Parameter.

13 F-Parameters and iParameters

13.1 F-Parameters

The values indicated in italics in Table 13-1 are preset by the system and cannot be modified manually.

F-Parameter	Default value	Description
F_Source_ Address	-	The parameter uniquely identifies the PROFIsafe source address (controller address). The address is assigned manually.
F_Destination_ Address	-	PROFIsafe destination address (address of the safe device) The address is assigned manually and the value can be modified. Make sure that the value set under F_Destination_Address and the value that you have set via the 10-pos. DIP switch are the same. Value range: 1 ... 1022
F_WD_Time	150	Monitoring time in the safety module. A valid current safety telegram must arrive from the safe controller within the monitoring time. Otherwise, the safety module enters the safe state. The selected monitoring time must be sufficiently high for telegram delays to be tolerated by the communication, but still ensure a sufficiently fast error response in the event of an error (e.g., interruption in communication). Value range: 1 ... 65534, in 1 ms increments Unit: ms
F_SIL	*SIL 3*	Safety integrity (SIL according to IEC 61508) of the safety module **⚠ WARNING** Safety functions up to SIL 3 can be achieved with the safety module. The safety integrity level that can actually be achieved depends on the parameterization, the structure of the sensor, and the cable installation (see “Connection Examples for Safe Outputs” on page 41).
F_CRC_Length	*3-byte CRC*	This parameter transmits the length of the CRC2 code to be expected in the safety telegram to the safe controller.
F_Block_ID	*1*	Parameter block type identification 1: The parameter block of the F-Parameters contains the F_iPar_CRC parameter.
F_Par_Version	*1*	Version number of the F-Parameter block. 1: Valid for V2 mode
F_iPar_CRC	0	CRC checksum via the iParameters The value must be greater than 0. When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices. If not, check the iParameters and the CRC checksum in the iParameter and F-Parameter.

Table 13-1 Overview of the F-Parameters for the module

13.2 iParameters

The iParameters are individual device parameters. These include:

- Device parameters (see Chapter “Parameterization of the Safe Outputs” on page 38)
- PST_Device_ID (40_{hex} for R-IB IL 24 PSDO 4/4-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.

13.3 Diagnostic Messages for Parameter Errors

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

Table 13-2 F-Parameter parameter errors

Error code (hex)	Error cause	Remedy
X3F2	iPar_CRC is incorrect	Check iParameters, repeat calculation.
X3FA	iPar_CRC is not equal to F_iPar_CRC	Apply correct value.
X3FB	PST_Device_ID is incorrect	Correct value (40_{hex} for R-IB IL 24 PSDO 4/4-PAC).
X3FC	F_Destination_Address in the iParameters is incorrect	Correct value. Make sure that the value set under F_Destination_Address and the value that you have set via the 10-pos. DIP switch are the same.
X3FD	Incorrect order of iParameter blocks	Check infrastructure components.

Table 13-3 iParameter parameter errors

Diagnostic Messages for Parameter Errors

14 Checklists

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

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

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

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

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

Checklist . . .				
Device type/equipment identification		R-IB IL 24 PSDO 4/4-PAC/BK20NA10		
Version: HW/FW/FW	01/201/100	**Date**	December 01, 2013	
Author	John Smith	**Test engineer**	Jane Brown	
Remark	System XXX has been checked for engine hood production			
No.	**Requirement (mandatory)**	**Yes**		**Remark**
X	. . .	☐		
No.	**Requirement (optional)**	**Yes**	**No**	**Remark**
Y	. . .	☐	☐	

Key:

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

14.1 Planning

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

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

No.	Requirement (optional)	Yes	No	Remark
16	Have specifications for assembly and electrical installation been defined (e.g., EPLAN) and communicated to the relevant personnel?	☐	☐	
17	Have specifications for startup been defined and communicated to the relevant personnel?	☐	☐	

Date	Signature (author)
Date	Signature (test engineer)

14.2 Assembly and Electrical Installation

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

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

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

Date	Signature (author)
Date	Signature (test engineer)

14.3 Startup and Parameterization

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

No.	Requirement (mandatory)	Yes	Remark
1	Was startup completed according to the specifications (specifications from the planning phase or according to the application description)?	☐	
2	During startup, is it ensured that any person starting hazardous movements intentionally can only do so with a direct view of the danger zone?	☐	
3	Are all parameters parameterized for the outputs?	☐	
4	For outputs that are parameterized for two-channel operation, are both channels parameterized correctly for each other?	☐	
5	Are the output test pulses parameterized according to the actuator to be connected?	☐	
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	Remark
7	Are safety distances that must be observed calculated according to the response and delay times implemented?	☐	☐	

Date	Signature (author)
Date	Signature (test engineer)

14.4 Validation

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

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

Validation

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

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

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

15.1 Conditions

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

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

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

For relay outputs:

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

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

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

15.2 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

16 Disposal

16.1 General Information

Dispose the products according to the respective valid national standard.

16.2 Return

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

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

Send the products free of charge to the following address:

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

16.3 Packaging

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

For ecological reasons, please do not return empty packages.

16.4 Batteries and Accumulators

Batteries and accumulators can be labelled with this symbol.

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

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

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

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

Disposal

17 Service and Support

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

Service Germany

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

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

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

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

Service worldwide

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

Preparing information

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

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

Service and Support

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Notes

The Drive & Control Company

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Bosch Group

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