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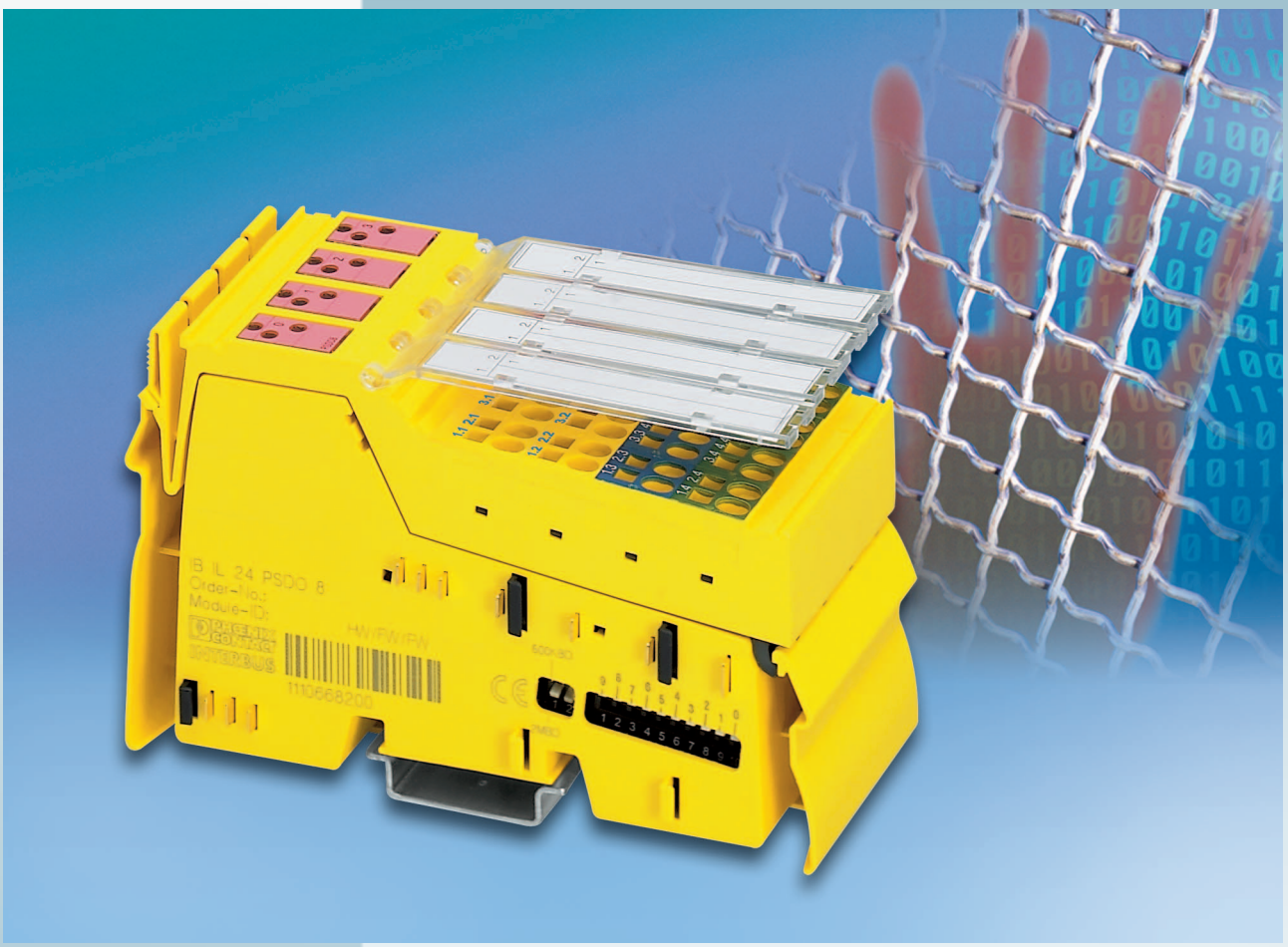

IB IL 24 PSDO 8-PAC Inline module with safe digital outputs

User manual

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User manual

IB IL 24 PSDO 8-PAC Inline module with safe digital outputs

UM EN IB IL 24 PSDO 8-PAC, revision 05 2017-11-08

This user manual is valid for:

Designation	Revision as of HF/FW/FW	Order No.
IB IL 24 PSDO 8-PAC	00/201/100	2985631

7619_en_05

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1 For your safety

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

1.1 Labeling of warning notes

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

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

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

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

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

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

1.2 Qualification of users

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

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

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1.3 General safety notes

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

When working with the safety module within the INTERBUS-Safety, SafetyBridge, or PROFIsafe system, please observe all safety notes included in this section.

Requirements

Knowledge of the following is required:

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

Qualified personnel

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

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

This user manual is therefore aimed at:

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

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

Safety of personnel and equipment

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

Error detection

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

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Do not carry out any repairs

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

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

Do not open the housing

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

Measures to prevent mismatching and polarity reversal

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

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1.4 Electrical safety

WARNING: Hazardous shock currents and the loss of functional safety

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

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

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 that meet the requirements of safe isolation.

Power supply units for 24 V supply

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

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

Insulation rating

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

The IB IL 24 PSDO 8-PAC module is designed for overvoltage category II (according to DIN EN 60664-1). If you expect surge voltages in the system, which exceed the values defined in overvoltage category II, take into consideration additional measures for voltage limitation.

Installation and configuration

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

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

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

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1.5 Safety of the machine or system

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

Draw up and implement a safety concept.

In order to use the safety module described in this document, you must have drawn up an appropriate safety concept for your machine or system. This includes a hazard and risk analysis according to the directives and standards specified in Section “Directives and standards” on page 12, as well as a test report (checklist) for validating the safety function (see “Appendix: Checklists” on page 99).

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

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

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

Within an INTERBUS-Safety, SafetyBridge or PROFIsafe system, the IB IL 24 PSDO 8-PAC safety module can be used to achieve safety functions with the following requirements:

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

Check hardware and parameterization

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

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

Use your test report to ensure that:

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

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1.6 Directives and standards

The manufacturers and operators of machines and systems, in which the IB IL 24 PSDO 8-PAC module is used, are responsible for adhering to all applicable directives and legislation.

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

1.7 Intended use

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

The IB IL 24 PSDO 8-PAC safety module is designed exclusively for use in an INTERBUS-Safety, SafetyBridge or PROFIsafe system.
It can only perform its safety-related tasks within the system if it has been integrated into the execution process correctly and in such a way as to avoid errors.

You must observe all information in this user manual as well as in the documents listed in “Documentation” on page 13. In particular, only use the module according to the technical data and ambient conditions specified in Section 10, "Technical data and ordering data" on Page 82 and onwards.

Within an INTERBUS-Safety, SafetyBridge or PROFIsafe system, the safety module can be used to achieve safety functions with the following requirements depending on the conditions of use:

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

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

– Safety circuits according to EN 60204 Part 1
– Safe shutdown of contactors, motors (24 V DC), valves, ohmic, 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 additional information about stop categories, please refer to the INTERBUS-Safety system description UM EN INTERBUS-SAFETY SYS.

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1.8 Documentation

Latest documentation

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

INTERBUS-Safety

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

UM EN INTERBUS-SAFETY SYS
INTERBUS-Safety system description

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

User manuals

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

SafetyBridge

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

User manuals

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

PROFIsafe

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

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

User manuals

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

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

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Standard INTERBUS

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

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

IBS SYS PRO INST UM E
Configuring and installing INTERBUS

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

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

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

IBS SYS FW G4 UM E
Firmware services and error messages

Inline product range

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

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

Documentation for the bus coupler used

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1.9 Abbreviations used

Table 1-1 Abbreviations used

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

Table 1-2 Abbreviations used

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

For terms and abbreviations used for PROFIsafe, please refer to “Appendix: PROFIsafe terms used in the user manual” on page 91.

1.10 Safety hotline

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

Phone: +49 5281 9462777

E-mail: safety-service@phoenixcontact.com

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2 Product description

2.1 Brief description of the safety module

The IB IL 24 PSDO 8-PAC module is an output module that is designed for use within an Inline station.

The IB IL 24 PSDO 8-PAC safety module can be used as part of an Inline station at any point within an INTERBUS-Safety, SafetyBridge or PROFIsafe system.

The transmission speed of the Inline local bus can be set to 500 kBaud or 2 MBaud on the safety module using a switch.
One transmission speed must be used seamlessly in an **INTERBUS system**.
One transmission speed must be used seamlessly in the relevant Inline station in a **SafetyBridge** or **PROFIsafe system**.

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

The module has four safe positive switching digital outputs for two-channel assignment or eight safe positive switching digital outputs for single-channel assignment.

The outputs can be parameterized according to the application and enable the integration of actuators in the safe INTERBUS system (INTERBUS-Safety), in the SafetyBridge system, or in the PROFIsafe system.

Within an INTERBUS-Safety, SafetyBridge or PROFIsafe system, the safety module can be used to achieve safety functions with the following requirements depending on the conditions of use:

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

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

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2.2 Structure of the safety module

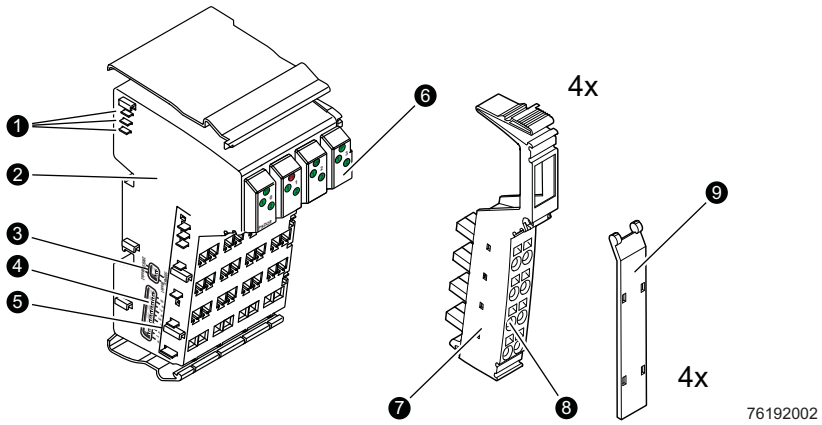

Figure 2-1 Structure of the safety module

1 Data jumpers (local bus)

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

3 Switch for setting the transmission speed and the operating mode

4 Switch for setting the protocol and address

For more detailed information about setting the switches, please refer to Section “Setting the DIP switches” on page 40.

5 Potential jumper

6 Diagnostic and status indicators; for assignment and meaning see Section “Local diagnostic and status indicators” on page 23

7 Inline connector; for assignment see Section “Terminal point assignment” on page 35

8 Terminal points

9 Marking field

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2.3 Housing dimensions

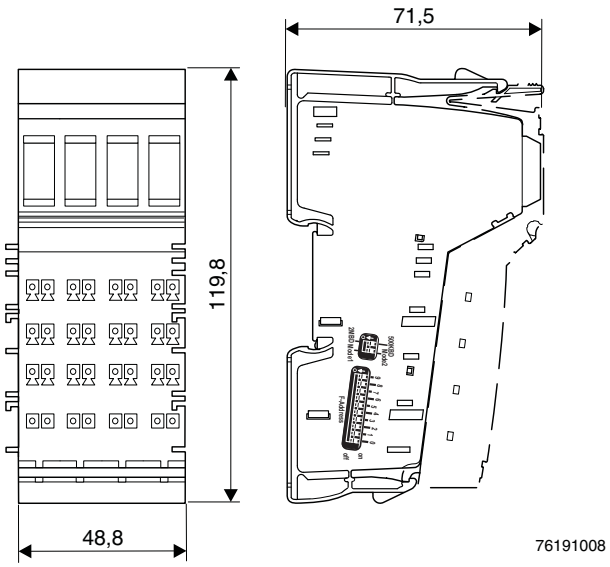

Figure 2-2 Housing dimensions (in mm)

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2.4 Safe digital outputs

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

- For two-channel assignment:
  - Four two-channel outputs
- For single-channel assignment:
  - Eight single-channel outputs

Technical data

For the technical data for the safe outputs, please refer to Page 85.

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, SILCL, 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, SILCL, 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 55).

For information on parameterization, please refer to Section “Parameterization of the safe outputs” on page 50.

Diagnostics

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

For information on the diagnostic messages of the outputs, please refer to Section “Safe digital output errors” on page 71.

CAUTION: Diagnostic data is not safety-related

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

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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.

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 must **generally not** 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 Section “Connection examples for safe outputs” on page 55.

The failure detection time is 20 ms. Please refer to “Single-channel assignment of safe outputs” on page 59 and “Two-channel assignment of safe outputs” on page 62 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 force-guided contacts according to DIN EN 50205
– Use relays or contactors with forcibly guided N/C contacts to safely monitor the state (pick-up, drop-out).
– Please observe any special environmental requirements in your application when selecting the controlled devices.
– Please observe the applicable C standards in your application (e.g., EN 1010), in which, for example, the number of controlled devices required to achieve a particular category is specified.

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2.5 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 Section 6, "Connection examples for safe outputs".

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

– Observe the information in the connection examples (see Section 6, "Connection examples for safe outputs")
– Observe the requirements of the standards with regard to the external wiring and the actuators to be used to achieve a SIL/SILCL/Cat./PL (see “Measures required to achieve a specific safety integrity level” on page 57).

	Output OUT0 to OUT3	
“Output” parameterization	Single-channel	Two-channel
Test pulses	Any	ON/OFF*
Achievable category	SIL 2 / SILCL2 / Cat. 3 / PL d	SIL 3 / SILCL 3 / Cat. 4 / PL e
For connection example, see page	59	62

Key:

* If the test pulses are disabled, a cross-circuit between the outputs is only detected if the output is enabled.

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

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2.6 Local diagnostic and status indicators

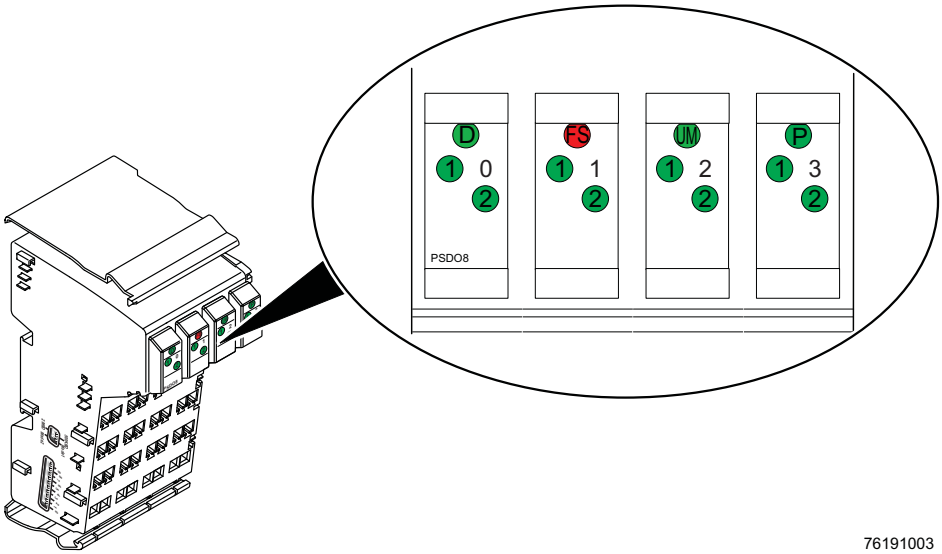

Figure 2-3 Local diagnostic and status indicators on the IB IL 24 PSDO 8-PAC module

Table 2-1 Local diagnostic and status indicators

D	Green LED	Diagnostics
	Off:	Communications power not present
	Flashing at 0.5 Hz:	Communications power present, local bus not active
	Flashing at 4 Hz:	Communications power present, error at the interface between previous and flashing terminal (the terminals after the flashing terminal cannot be addressed). (For example, 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.

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

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 (PROFIsafe, SafetyBridge only)	Green LED	Status indicator for safe communication
	Off:	No safe communication
	Flashing at 0.5 Hz:	Safe communication running, the controller requests operator acknowledgment
	On:	Safe communication is running without errors
OUT 0.1 - 3.2	Green/red LED	Status of each output (see “Terminal point assignment” on page 35)
	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.)
	Flashing red at 1 Hz:	INTERBUS-Safety only: Parameterized shutdown time of the output exceeded (This diagnostic message is stored temporarily on the module. The message is stored in the volatile memory and will be lost after a voltage reset.)
		In the event of an error (red LED ON or flashing), the output is switched off until the acknowledgment sent by the safe controller is received by the safety module (see also Section “Safe digital output errors” on page 71).

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2.7 Safe state

The safe state for the module is the low state at the output terminals (see Section “Safe digital outputs” on page 20).

PROFIsafe:

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

The safe state is entered by means of passivation (see “Passivation” on page 92).

The safe state can be entered in the following cases:

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

2.7.1 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.

2.7.2 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
– Violation of the parameterized shutdown time (INTERBUS-Safety only)

The relevant diagnostic message is transmitted to the safe controller (see Section “Safe digital output errors” on page 71). For information on which errors are detected and when, please refer to “Connection examples for safe outputs” on page 55.

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

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2.7.3 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 Section “Safe digital output errors” on page 71).

Serious errors

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

The following errors result in the safe state:

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

The relevant diagnostic message is transmitted to the safe controller (see Section “Errors: Messages and removal” on page 69).

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.

2.7.4 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 Section “Parameterization errors” on page 73).

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.

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2.8 Enabling safe outputs for PROFIsafe

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

A “0” is always forwarded.

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

2.9 Process data words

2.9.1 INTERBUS

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

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

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

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

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

In the following tables, both the maximum single-channel and maximum two-channel assignments are presented. Depending on the parameterization, other process data word assignments are also possible (for an example, see Page 28).

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

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Module	Output (single-channel)	OUT-3_Ch2	OUT-3_Ch1	OUT-2_Ch2	OUT-2_Ch1	OUT-1_Ch2	OUT-1_Ch1	OUT-0_Ch2	OUT-0_Ch1	Reserved							
	Output (two-channel)	0	OUT3_Ch 1&2	0	OUT2_Ch 1&2	0	OUT1_Ch 1&2	0	OUT0_Ch 1&2								

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

Example for mixed single-channel and two-channel parameterization

Outputs:

Output	OUT0_Ch1	OUT0_Ch2	OUT1_Ch1	OUT1_Ch2	OUT2_Ch1	OUT2_Ch2	OUT3_Ch1	OUT3_Ch2
Two-channel			X	X	X	X		
Single-channel	X	X					X	not used

Process data output word

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Module	Output	0	OUT-3_Ch1	0	OUT-2_Ch 1&2	0	OUT-1_Ch 1&2	OUT-0_Ch2	OUT-0_Ch1	Reserved							

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2.9.2 SafetyBridge

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

The module has feedback data and enable data.

Feedback data

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

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

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

The structure and function of the register are as follows:

Table 2-1 Feedback data register (mirrored data)

7	6	5	4	3	2	1	0
OUT3 _Ch2	OUT3 _Ch1	OUT2 _Ch2	OUT2 _Ch1	OUT1 _Ch2	OUT1 _Ch1	OUT0 _Ch2	OUT0 _Ch1

Enable

The enable principle is implemented in the SafetyBridge system. For this, all modules with local outputs have an enable function integrated in the device firmware (ANDed bit-by-bit) for each safe output channel. The enable function can be parameterized (enabled/disabled) for each specific channel (see Section “Parameterization of the safe outputs” on page 50). The structure and function of the register are as follows:

Table 2-2 Enable data register

7	6	5	4	3	2	1	0
OUT3 _Ch2	OUT3 _Ch1	OUT2 _Ch2	OUT2 _Ch1	OUT1 _Ch2	OUT1 _Ch1	OUT0 _Ch2	OUT0 _Ch1

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

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

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

The following figure illustrates the enable principle.

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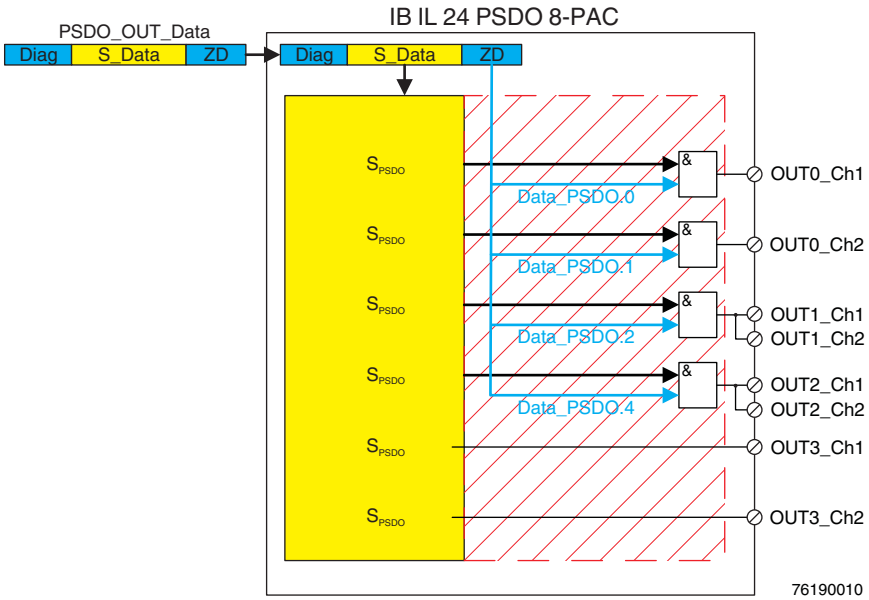

Figure 2-1 Enable principle (example)

PSDO_OUT_Data	Output data from the configurable logic module to the IB IL 24 PSDO 8-PAC
S_Data	Safety data from the configurable logic module
Diag	Diagnostic data
ZD	Enable data from the standard controller
&	Standard function block for ANDing
S_{PSDO}	Safe control signal from the configurable logic module
Data-PSDO.x	Standard data of the standard controller, which is to enable the IB IL 24 PSDO 8-PAC; bit x
OUTx_Chy	Safe output x, channel y
	Internal sequences

Table 2-3 Parameterization of output channels for the example in Figure 2-1

Output/channel	Output	Enable
OUT0_Ch1	Single-channel	Enabled
OUT0_Ch2	Single-channel	Enabled
OUT1_Ch1	Two-channel	Enabled
OUT1_Ch2	Two-channel	Enabled
OUT2_Ch1	Two-channel	Enabled
OUT2_Ch2	Two-channel	Enabled
OUT3_Ch1	Single-channel	Disabled
OUT3_Ch2	Single-channel	Disabled

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2.9.3 PROFIsafe (PROFIBUS, PROFINET)

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

2.10 Programming data / Configuration data

2.10.1 Local bus (INTERBUS)

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

The PCP channel is only used internally.

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

2.10.2 Other bus systems (PROFIBUS, PROFINET)

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

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3 Inline potential and data routing, and Inline connectors

3.1 Inline potential and data routing

In order to operate the safety module it must be integrated in an Inline station within the INTERBUS-Safety, SafetyBridge or PROFIsafe system.

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

For more detailed information on potential and data routing within an Inline station, please refer to the IL SYS INST UM E user manual.

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

3.2 Supply voltage U_L

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

WARNING: Loss of the safety function when using unsuitable power supplies
Please note for the voltage supply 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 a fault.
Please also observe the points in Section “Electrical safety” on page 10.

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 84.

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

3.3 Supply voltage U_M

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

WARNING: Loss of the safety function when using unsuitable power supplies
Please observe the points in Section “Electrical safety” on page 10.

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 Section “Supply voltage: U_M (actuators)” on page 84.

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

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

NOTE: Module damage due to polarity reversal

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

For the behavior of the safety module in the event of an error at the supply voltage, please refer to Section “Supply voltage errors” on page 72.

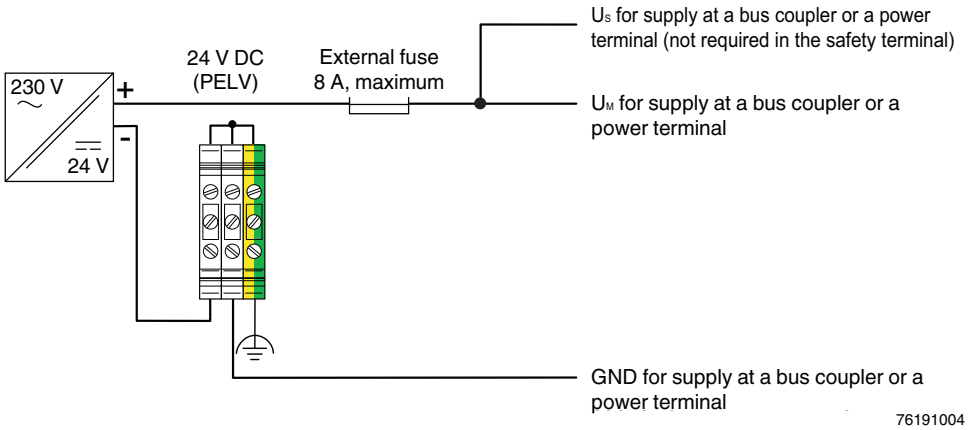

Figure 3-1 Supply U_M with connection to functional earth ground according to EN 60204-1

WARNING: Loss of functional safety due to parasitic voltages

Supply the supply voltages U_M and U_S at a bus coupler and/or a power terminal from the same power supply unit, so that the loads of IB IL 24 PSDO 8-PAC are not affected by parasitic voltages in the event of an error.

NOTE: Damage to module electronics in the event of surge voltage

Do not use a DC distribution network.

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

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3.4 Terminal point assignment

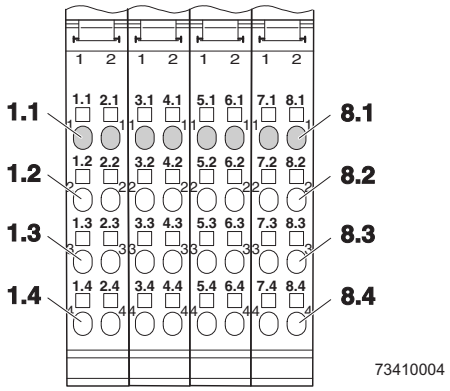

Figure 3-2 Terminal point assignment

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

Only use the plugs supplied with the module or plugs that are approved as replacement items (see “Ordering data: Accessories” on page 88).

The following applies for the tables below:

– All outputs are safe digital outputs
– 0 V (GND): common ground of outputs
– FE: Common functional earth ground

Table 3-1 Terminal point assignment for plug 1

Terminal point	Signal	Channel assignment	LED
1.1	OUT0_Ch1	Output 0, channel 1	0.1
2.1	OUT0_Ch2	Output 0, channel 2	0.2
1.2	not used		
2.2	not used		
1.3	0 V (GND)	Channel 1 and channel 2	
2.3	0 V (GND)	Channel 1 and channel 2	
1.4	FE		
2.4	FE		

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Table 3-2 Terminal point assignment for plug 2

Terminal point	Signal	Channel assignment	LED
3.1	OUT1_Ch1	Output 1, channel 1	1.1
4.1	OUT1_Ch2	Output 1, channel 2	1.2
3.2	not used		
4.2	not used		
3.3	0 V (GND)	Channel 1 and channel 2	
4.3	0 V (GND)	Channel 1 and channel 2	
3.4	FE		
4.4	FE		

Table 3-3 Terminal point assignment for plug 3

Terminal point	Signal	Channel assignment	LED
5.1	OUT2_Ch1	Output 2, channel 1	2.1
6.1	OUT2_Ch2	Output 2, channel 2	2.2
5.2	not used		
6.2	not used		
5.3	0 V (GND)	Channel 1 and channel 2	
6.3	0 V (GND)	Channel 1 and channel 2	
5.4	FE		
6.4	FE		

Table 3-4 Terminal point assignment for plug 4

Terminal point	Signal	Channel assignment	LED
7.1	OUT3_Ch1	Output 3, channel 1	3.1
8.1	OUT3_Ch2	Output 3, channel 2	3.2
7.2	not used		
8.2	not used		
7.3	0 V (GND)	Channel 1 and channel 2	
8.3	0 V (GND)	Channel 1 and channel 2	
7.4	FE		
8.4	FE		

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WARNING: Loss of functional safety due to parasitic voltages

Connect the actuator ground to the ground terminal point of the corresponding output on the Inline connector. An external ground may not be used.

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4 Mounting, removal, and electrical installation

4.1 Mounting and removal

4.1.1 Unpacking the module

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

NOTE: Electrostatic discharge

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

4.1.2 General information

WARNING: Unintentional machine startup

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

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

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

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

The IB IL 24 PSDO 8-PAC safety terminal is designed for use within an Inline station. Only use the safety terminal in the 24 V DC area of an Inline station.

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

Mount all Inline terminals on 35 mm DIN rails.

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

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4.1.3 Setting the DIP switches

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.

The module has a 2-pos. and a 10-pos. DIP switch.
The DIP switches are located on the left-hand side of the safety module.

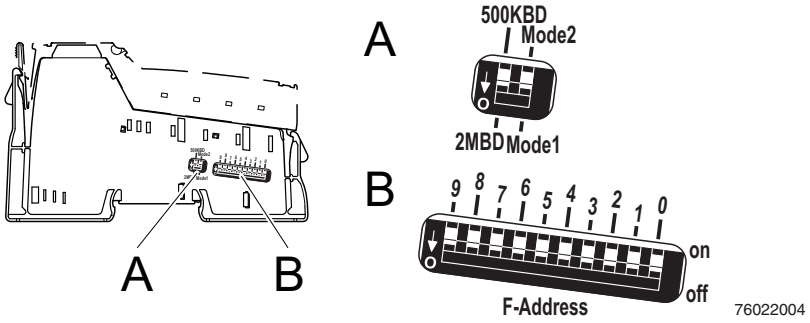

Figure 4-1 DIP switch

A 2-pos. DIP switch

B 10-pos. DIP switch (address switch)

2-pos. DIP switch

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

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

10-pos. DIP switch (address switch)

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

Default setting / Delivery state

The following values are preset by default:

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

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INTERBUS-Safety

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

Changing the setting:

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

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

INTERBUS-Safety switch position

Table 4-1 Switch position for INTERBUS-Safety

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

PROFIsafe

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

Changing the setting:

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

PROFIsafe switch position

Table 4-2 Switch position for PROFIsafe

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

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SafetyBridge

WARNING: Loss of safety function during mixed operation

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

Take the following action:

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

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

Changing the setting:

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

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

SafetyBridge V3 switch position

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

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

SafetyBridge V2 switch position

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

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

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4.1.4 Mounting and removal of the safety module

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

Mounting

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

- Disconnect the power to the station.

– Snap on base

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

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

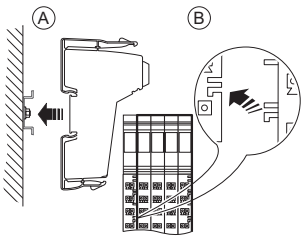

Figure 4-2 Snapping on the safety module base

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

– Insert plugs

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

Only use the plugs supplied with the module or plugs that are approved as replacement items (see “Ordering data: Accessories” on page 88).

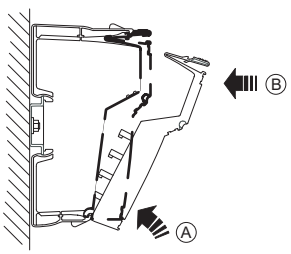

Figure 4-3 Inserting the connectors

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Removal

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

– Remove plugs

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

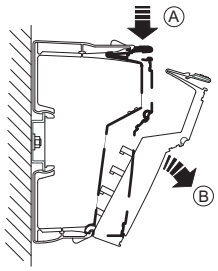

Figure 4-4 Removing the connectors

– Remove base

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

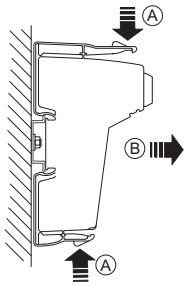

Figure 4-5 Removing the safety module base

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4.2 Electrical installation

WARNING: Electric shock / Unintentional machine startup

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

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

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

4.2.1 Electrical installation of the Inline station

Electrical installation of the Inline station includes the following:

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

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

4.2.2 Electrical installation of the safety module

During installation, always observe the instructions in “Electrical safety” on page 10.

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

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

The actuators are connected via Inline plugs.

- Wire the plugs according to your application. For the terminal point assignment, please refer to Section “Terminal point assignment” on page 35.

For wiring, proceed as follows:

- Strip 8 mm off the cable.

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

- Push a screwdriver into the actuation shaft of the appropriate terminal point (Figure 4-6, detail 1), so that you can insert the conductor into the spring opening.
  Phoenix Contact recommends using a SZF 1 - 0.6X3.5 screwdriver (Order No. 1204517; see Phoenix Contact "CLIPLINE” part catalog).
- Insert the conductor (Figure 4-6, detail 2). Remove the screwdriver from the opening. This clamps the conductor.

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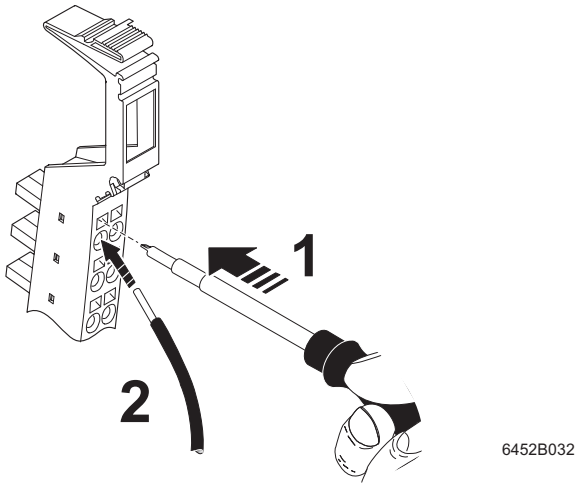

Figure 4-6 Connecting unshielded cables

- Insert the assembled plugs in the corresponding module slot (see Section “Terminal point assignment” on page 35).
- Mark all connections to prevent connections to the Inline plugs being mixed up (see IL SYS INST UM E user manual).

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5 Parameterization of the safety module

5.1 Parameterization in an INTERBUS-Safety system

Parameterization includes the following:

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

Location ID

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

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

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

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

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

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

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

If errors are detected during parameterization, the parameterization data is not transmitted. The invalidity of the parameterization is indicated on the module by the flashing FS LED. In addition, errors are indicated at the safe INTERBUS controller. In this case, check and correct the settings.

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5.2 Parameterization in a SafetyBridge system

Parameterization includes the following:

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

SafetyBridge address

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

The address of the connected satellites (here: IB IL 24 PSDO 8-PAC) is based on the island number of the configurable safety module and the position in the hardware editor of the SAFECONF software tool.

Set this address via the DIP switches prior to mounting the safety module (see “Setting the DIP switches” on page 40).

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

Parameterization of outputs

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

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

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

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

If errors are detected during parameterization, the parameterization data is not transmitted. The invalidity of the parameterization is indicated on the module by the flashing FS LED. In addition, errors are indicated at the configurable safety module. In this case, check and correct the settings.

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5.3 Parameterization in a PROFIsafe system

Parameterization includes the following:

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

PROFIsafe address

The PROFIsafe address is a unique ID for the safety module in the PROFIsafe structure. It is assigned in the configuration software. Set this address via the DIP switches prior to mounting the safety module (see “Setting the DIP switches” on page 40).

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 invalidity of the parameterization is indicated on the module by the flashing FS LED. 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 “Errors: Messages and removal” on page 69.

F-Parameters and iParameters

Assign the parameterizable F-Parameters and iParameters. For an overview of the module parameters and possible settings, please refer to Section “Appendix: F-Parameters and iParameters” on page 93.

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5.4 Parameterization of the safe outputs

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

Two-channel

If the 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 outputs can be parameterized in such a way that they operate independently of one another (single-channel).

Parameterization

Parameterize all safe outputs individually. The parameterization options are described in Table 5-1.

Table 5-1 Parameterization of outputs

Parameterization	Value range	Comment
	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.
Value of shutdown time (INTERBUS-Safety only)	1 to 63	Time conversion according to the parameterization of the “Value range of shutdown time” parameter. Permissible value range: OUT0 to OUT3: 15 ms to 6.3 s Accuracy: -5% of the parameterized value - 2 ms/+0 ms Please observe the notes below this table.
“Value range of shutdown time” (INTERBUS-Safety only)	Value in ms Value x 10 in ms Value x 100 in ms	Value range/unit for the parameterization of the “Shutdown time” parameter. Please observe the notes below this table.
Switch-off delay for stop category 1	Disabled Enabled	Disabled (default): no switch-off delay. Enabled: the outputs are switched off once the parameterized switch-off delay has elapsed. Please observe the notes below this table.
Switch-off delay for stop category 1	1 to 63	Time conversion according to the parameterization of the “Value range of switch-off delay for stop category 1” parameter. Permissible value range: OUT0 to OUT3: 150 ms to 630 s Accuracy: ±5% of parameterized value Please observe the notes below this table.

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Table 5-1 Parameterization of outputs (Fortsetzung)

Parameterization	Value range	Comment
	OUT0 - OUT3	
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.
Enable	Disabled Enabled	Disabled (default value): the corresponding safe output is operated exclusively according to the safety logic. Enabled: Enable is active; the safe output data is output after being ANDed with the standard output data of the standard control system. See also Section “SafetyBridge” on page 29.
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.

Test pulses

Note on test pulses

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 “Requirements for controlled devices/actuators” on page 21 and Section “Connection examples for safe outputs” on page 55.

Shutdown time (INTERBUS-Safety only)

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

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

Shutdown time = “Switch-off time” x “Value range of switch-off time”

Example:

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

Shutdown time = 20 x 10 ms = 200 ms

Parameterize the lowest possible value for the shutdown time according to your application in order to ensure short response times.

For an example of calculating the minimum parameterizable shutdown time for your application, please refer to the UM EN INTERBUS-SAFETY SYS user manual.

If the shutdown time is parameterized with a value less than 15 ms, this value is rejected as a parameterization error (error code $021x_{hex}$).

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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 shutdown time (for INTERBUS-Safety) and the switch-off delay for stop category 1 are the same for both channels. This means that the time must have the same value and the same value range.

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

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

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

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

WARNING: Delayed shutdown when using stop category 1

For stop category 1 please take into consideration the following:

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

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

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

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

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

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

– The switch-off operation can be interrupted by switching the output on again.

– If the parameterization of the module is modified, the modified parameterization does not take effect until all the outputs have been switched off.
If the parameterization is modified before the switch-off operation is complete, diagnostic message $02F2_{hex}$ is generated.

– Carry out a validation every time the parameterization is modified.

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

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6 Connection examples for safe outputs

6.1 Explanation of the examples

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

The following examples only describe the options for the electrical connection of controlled devices/actuators to the safe outputs.
Should you have any questions regarding applications to be implemented, please contact the Phoenix Contact safety hotline (see “Safety hotline” on page 15).

The following are specified for each example:

– **Basic specifications**
  The main data for the example is specified in the table.
– **Device diagnostics and behavior of the module in the event of an error**
  Diagnostic capability depends on the parameterization.
  If a message is transmitted to the safe controller in the event of an error, the message is specified in the tables. For information about the relevant error code, possible remedies, and information about whether acknowledgment is required, please refer to Section “Errors: Messages and removal” on page 69.
– **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Key for all tables in this section:

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

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

Table 6-2 Parameterization tables

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

Errors (cross-circuits, short circuits), 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 plug, are described. For example, in the event of correct installation, cross-circuits with outputs of other connectors cannot occur.

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

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

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 therefore 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 20.

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

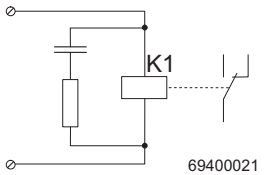

Figure 6-1 Example of the freewheeling circuit for an external relay

- Limit the voltage induced on circuit interruption to < -15 V (e.g., with RC elements, suppressor diodes or varistors).
- Please note that the freewheeling 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.

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6.3 Measures required to achieve a specific safety integrity level

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

SIL, SILCL

In order to determine the probability of failure according to EN 61508 (SIL), use the specifications from the INTERBUS-Safety system user manual or the standard.

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

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

Table 6-3 PFD and PFH depending on the SIL/SILCL

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

Performance level

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

Category

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

Cat. 2

- Use proven safety principles.
- Use appropriately qualified actuators (see Section “Requirements for controlled devices/actuators” on page 21).
- 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.
- Make sure that the external wiring is tested by the machine control system on machine startup and at suitable intervals. This test must detect the loss of the safety function.
- In the event of an error, either safe disconnection must be implemented or a warning (optical and/or audible) must be generated depending on the application.

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Cat. 3

- Use proven safety principles.
- Use appropriately qualified actuators (see Section “Requirements for controlled devices/actuators” on page 21).
- 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 Section “Requirements for controlled devices/actuators” on page 21).
- 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.

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6.4 Single-channel assignment of safe outputs

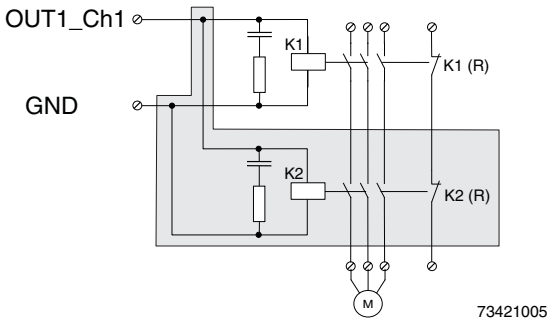

Figure 6-2 Single-channel assignment of outputs

- 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.
- The failure detection time is 20 ms. This means that high pulses of this width can occur in the event of an error.
  If the application responds to these pulses, use the two-channel assignment of the outputs.

K1 (R) and K2 (R) represent the force-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. Use of an external ground is not permissible.

Basic specifications

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

WARNING: Loss of electrical and functional safety

- To achieve the specified safety integrity level, please refer to Section “Measures required to achieve a specific safety integrity level” on page 57.
- 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.
- Evaluate the readback contacts to achieve the corresponding safety integrity level.

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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.

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

Table 6-4 Single-channel: test pulses enabled

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the actuator				
Despite being disabled, the actuator does not switch to the safe state (e.g., a contact will not open)	**No**	None	Yes	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. **Test the shutdown capability of the actuator at regular intervals. 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 OUT LEDs: 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 therefore result in the outputs being re-enabled.

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Typical parameterization

Parameterization	Parameterized as	Comment
Assignment	**Used**	
Output	**Single-channel**	
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	20	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Application-specific
Switch-off delay for stop category 1	Enabled	Or disabled
Switch-off delay for stop category 1	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Application-specific
Enable	Enabled	Or disabled
Test pulses (output disabled) (in software: test impulses (output switched off))	Enabled	Or disabled

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

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

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6.5 Two-channel assignment of safe outputs

For two-channel assignment of the safe outputs, two adjacent outputs are always used. This assignment is fixed and cannot be parameterized (see Section “Two-channel” on page 50).

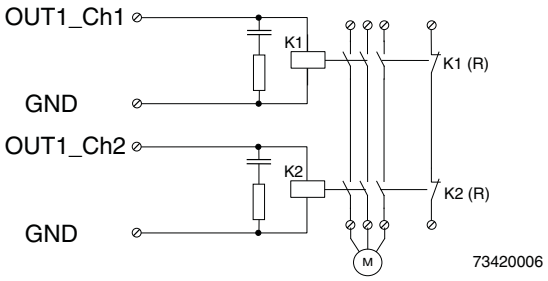

Figure 6-3 Two-channel assignment of outputs

K1 (R) and K2 (R) represent the force-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. Use of an external ground is not permissible.
- The failure detection time is 20 ms. This means that high pulses of this width can occur at the faulty output (channel) in the event of an error. The two-channel assignment means that this does not result in a hazardous state.

Basic specifications

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

WARNING: Loss of electrical and functional safety

- To achieve the specified safety integrity level, please refer to Section “Measures required to achieve a specific safety integrity level” on page 57.
- 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.
- 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.

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.

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

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Table 6-5 Two-channel

Error type	Detection	Diagnostics	Loss of SF	Comment
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 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 (conditional)	All OUT LEDs: red on	No	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. **If the test pulses have been disabled, test the circuit and the external wiring at regular intervals by enabling the 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 therefore result in the outputs being re-enabled.

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Typical parameterization

Parameterization	Parameterized as		Comment
	Channel 1	Channel 2	
Assignment	**Used**	**Used**	
Output	**Two-channel**	**Two-channel**	
Shutdown time (in software: switch-off time) (INTERBUS-Safety only)	20	20	Application-specific
Value range of the shutdown time (in software: value range of switch-off time) (INTERBUS-Safety only)	Value x 10 in ms	Value x 10 in ms	Application-specific
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Switch-off delay for stop category 1	30	30	Application-specific
Value range of switch-off delay for stop category 1	Value in s	Value in s	Application-specific
Enable	Enabled	Enabled	Or disabled
Test pulses (output disabled) (in software: test impulses (output switched off))	**Enabled**	**Enabled**	

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

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

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7 Startup and validation

7.1 Initial startup

To start up, proceed as described in Table 7-1.

Table 7-1 Steps for startup

Step	Relevant section and literature
Set the transmission speed and the mode.	Section “Setting the DIP switches” on page 40
Set the protocol/address.	Section “Setting the DIP switches” on page 40
Install the safety module within the Inline station.	Section “Mounting, removal, and electrical installation” on page 39
Connect the bus system and supply voltage cables to the Inline station.	IB IL SYS PRO UM E user manual (INTERBUS), IL SYS INST UM E or documentation for the bus coupler
Wire the outputs according to your application.	Section “Mounting, removal, and electrical installation” on page 39 Section “Inline potential and data routing, and Inline connectors” on page 33 User manuals for the function blocks used
Before applying the operating voltage: – Make sure that there are no wiring errors (e.g., cross-circuit or short circuit) or grounding errors by testing with a multimeter. – Check whether the ground connection is safe.	
Connect the necessary voltages to the Inline station.	IB IL SYS PRO UM E user manual (INTERBUS), IL SYS INST UM E or documentation for the bus coupler
Connect the required voltages (U_M) to the safety module.	Section “Supply voltage U_M” on page 33
Once the operating voltage has been applied: – If possible, measure the wave form of the voltages to ensure that there are no deviations. – Measure the output voltages on the module, as well as the supply voltages that supply the connected loads (e.g., motor) to ensure that they are in the permissible range. – Use the LEDs on the devices to check that the module starts up without any errors (there must be no red LEDs permanently on; the FS LED flashes because the device is not parameterized).	
Check the mounting and installation.	Checklist “Mounting, removal, and electrical installation” on page 39

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Table 7-1 Steps for startup (Fortsetzung)

Step	Relevant section and literature
Carry out the necessary parameterization.	Section “Parameterization of the safety module” on page 47 Documentation for the SafetyProg software (INTERBUS-Safety) Documentation for the configurable safety module used (SafetyBridge) Documentation for the controller used (PROFIsafe)
Program the safety function.	User manuals for the function blocks used Documentation for the SafetyProg software (INTERBUS-Safety) Documentation for the configurable safety module used (SafetyBridge) Documentation for the controller used (PROFIsafe)
For PROFIsafe: When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices. If not, modify the settings.	Checklist “Validation” on page 104 Quick Start Guide for configuring Inline modules with safe inputs or outputs under PROFIsafe on your controller
Perform a function test and validation. Check whether the safety function responds as planned during programming and parameterization.	Checklist “Validation” on page 104

When connecting the supply voltages, use the diagnostic and status indicators to check whether the module has started up correctly or whether any errors are indicated. For instructions on how to proceed in the event of an error, please refer to Section “Errors: Messages and removal” on page 69.

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7.2 Restart after replacing a safety module

7.2.1 Replacing a safety module

WARNING: Unintentional machine startup

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

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

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

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

If replacing a module, proceed as described for mounting and removal (see Section “Mounting, removal, and electrical installation” on page 39).

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

7.2.2 Restart

Once the safety module has been replaced, proceed as described for initial startup (see Section “Initial startup” on page 65).

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

Plug the Inline plugs into the correct connections.

Perform a function test after replacing the module

7.3 Validation

Carry out a safety validation every time you make a safety-related modification to the INTERBUS-Safety, SafetyBridge or PROFIsafe system.

When validating your individual EUC, check the assignment of the 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 observe the checklist “Validation” on page 104 during validation.

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8 Errors: Messages and removal

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

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

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

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

If error codes are indicated by the system that do not appear in the tables below, please contact Phoenix Contact.

Error removal

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

Error acknowledgment

Instructions on how to acknowledge an error can be found in Section “Acknowledging an error” on page 76.

WARNING: Unexpected machine startup

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

Module replacement following an error

If in the event of failure the safety module is replaced, please proceed as described in Section 4, "Mounting, removal, and electrical installation" and Section “Restart after replacing a safety module” on page 67.

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Notes on the tables below

The error code of a diagnostic message consists of the code for the error cause and the code for the error location.

Structure of the error code

	Error code	
	Code for error cause	Code for error location
e.g.,	003	x

Error code

The error code is specified in Table 8-1 and onwards.

Error location

In the error code specified, “x” specifies the location of the error. The value range for “x” is specified in the relevant row of the table.
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:

Safe output errors (Table 8-1)

Error cause	Error Code (Hex)
Short circuit or overload	003x
x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	

003x Short circuit or overload

003**x** Error location

This means, for example:

0032 Cross circuit at OUT2_Ch1 (output 2 channel 1)

003 A Cross circuit at OUT3_Ch2 (output 3 channel 2)

LED

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

Acknowledgment

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

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8.1 Safe digital output errors

Table 8-1 Safe output errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Hardware fault x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**001x**	All OUT: red ON	The indicated output cannot be disabled	All module outputs are in the safe state	Power up with error-free selftest Exchange	Yes (1)
Shutdown time was exceeded x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**002x**	OUTy: Red flashing	The shutdown time parameterized for the output was exceeded If the affected output was parameterized for two-channel operation, the error is indicated for channel 1. INTERBUS-Safety only.	Affected output is in the safe state	Check parameterized shutdown time and correct, if necessary Check quality of INTERBUS communication	Yes (2)
Short circuit or overload x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**003x**	OUTy: red ON		Affected output is in the safe state	Check actuator Check connector and cabling Check freewheeling circuit at the contactor	Yes (2)
Error at the output or short circuit during the test x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**005x**	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 Exchange	Yes (1)
Error at the output or short circuit during the test x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**006x**	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 Exchange	Yes (1)
Hardware fault	**0091**	All OUT: red ON	Detected by internal tests.	All module outputs are in the safe state	Power up with error-free selftest Exchange	Yes (1)
Cross circuit at the indicated output x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**00Ax**	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)

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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 re-started 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 therefore result in the outputs being re-enabled.

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

8.2 Supply voltage errors

Table 8-2 Supply voltage U_M errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Undervoltage U_M	**01F0**	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)

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

Undervoltage at U_M: Supply voltage U_M is measured. A diagnostics message is generated for $U_M < 17$ V.

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8.3 Parameterization errors

Table 8-3 Parameterization errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Incorrect parameterization	See Table 8-4	FS LED (flashing)	Each output is parameterized individually	Module is in the safe state	Check and correct parameterization.	–

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

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

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

Table 8-4 Parameterization errors

Error code		Short description	Remedy
(hex)	(dec)		
021x x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**528**: OUT0_Ch1 : **531**: OUT3_Ch1; **535**: OUT0_Ch2 : **538**: OUT3_Ch2	The parameterized shutdown time for the output is outside the permissible value range. INTERBUS-Safety only.	Correct value and resend parameter data to the module.
022x x = 0 ... 3: OUT0_Ch1&2 ... OUT-3_Ch1&2	**545**: OUT0_Ch1&2 : **547**: OUT3_Ch1&2	For outputs parameterized for two-channel operation, the same shutdown times were not assigned. INTERBUS-Safety only.	Correct value and resend parameter data to the module.
023x x = 0 ... 3: OUT0_Ch1&2 ... OUT-3_Ch1&2	**560**: OUT0_Ch1&2 : **563**: OUT3_Ch1&2	The parameterization of two related outputs does not correspond to the two-channel setting.	Correct value and resend parameter data to the module.
028x x = 0 ... 3: OUT0_Ch1 ... OUT3_Ch1; x = 7 ... A: OUT0_Ch2 ... OUT3_Ch2	**640**: OUT0_Ch1 : **643**: OUT3_Ch1; **647**: OUT0_Ch2 : **650**: OUT3_Ch2	The parameterized switch-off delay time for the output is outside the permissible value range.	Correct value and resend parameter data to the module.
029x x = 0 ... 3: OUT0_Ch1&2 ... OUT-3_Ch1&2	**656**: OUT0_Ch1&2 : **659**: OUT3_Ch1&2	For outputs parameterized for two-channel operation, the same settings were not assigned for the switch-off delay.	Correct setting and resend parameter data to the module.

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Table 8-4 Parameterization errors (Fortsetzung)

Error code		Short description	Remedy
(hex)	(dec)		
02F2	**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.
03F1	**1009**	The new location ID received from the safe controller is not within the permissible value range. INTERBUS-Safety only.	The valid value range for the location ID is between 1 and 126. Correct value and resend parameter data to the module.
03F3	**1011**	An error occurred while saving the new location ID. INTERBUS-Safety only.	Resend parameter data to the module. If the same error occurs again, there is a hardware fault.

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8.4 General errors

Table 8-5 General errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Device temperature at critical value	**01F2**			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	**01F3**		Error due to receipt of an unexpected message while acknowledging a diagnostic message. The device firmware handles this diagnostic message with the highest priority. Only when this message has been acknowledged correctly are other errors indicated (if present).	The acknowledgment process, during which an unexpected message was received, is aborted. The corresponding error remains in the error memory. Diagnostic message 01F3 is indicated.	Check and adapt the assignment of the diagnostic and confirmation variables at the DEVICE_STATE function block. Acknowledge diagnostic message 01F3 so that the next message from the error memory can be indicated.	Yes (1)
Error due to receipt of an unexpected message in the process data image	**01F4**		At least one reserved bit in the process data image has been set.	All outputs are disabled immediately. A parameterized switch-off delay is not observed.	Check the process data assignment.	Yes (2)
Hardware fault		FS on	Error in the logic area	Module is in the safe state	Exchange	

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

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

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8.5 PROFIsafe errors

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

– PROFIsafe system errors: These messages can be found in Section “Diagnostic messages for parameter errors” on page 95.
– PROFIBUS or PROFINET system errors. For information about these errors, please refer to the documentation for the system used.

8.6 Acknowledging an error

8.6.1 Acknowledging an error for INTERBUS-Safety

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

WARNING: Acknowledgment may result in a hazardous system state

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

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

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

If in the event of failure the safety module is replaced, please proceed as described in Section 4, "Mounting, removal, and electrical installation" and Section “Restart after replacing a safety module” on page 67.

8.6.2 Acknowledging an error for SafetyBridge

An IB IL 24 PSDO 8-PAC error is acknowledged completely via the configurable safety module.

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

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8.6.3 Acknowledging an error for PROFIsafe

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

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

WARNING: Acknowledgment may result in a hazardous system state

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

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

If in the event of failure the safety module is replaced, please proceed as described in Section 4, "Mounting, removal, and electrical installation" and Section “Restart after replacing a safety module” on page 67.

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9 Maintenance, repair, decommissioning, and disposal

9.1 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.

9.2 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 Phoenix Contact or contact Phoenix Contact immediately and engage a service engineer.

9.3 Decommissioning and disposal

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

When decommissioning an INTERBUS safety or PROFIsafe system or parts of it, 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 “IB IL 24 PSDO 8-PAC” on page 82).
  Or
– Are disposed of in accordance with the applicable environmental regulations, and in this case can never be reused.

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10 Technical data and ordering data

10.1 System data

10.1.1 INTERBUS-Safety

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

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

10.1.2 SafetyBridge

SafetyBridge	
Processing time of the module	1.5 ms

For the system data for your system, please refer to the corresponding documentation for the configurable logic module used.

10.1.3 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.

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10.2 IB IL 24 PSDO 8-PAC

General data	
Housing dimensions (width x height x depth)	48.8 mm x 119.8 mm x 71.5 mm
Weight (with connectors)	200 g
Operating mode	
INTERBUS-Safety	Process data mode with 3 words
SafetyBridge	Process data mode with 4 words
PROFIsafe	Process data mode with 4 words and 1 word PCP (internal use)
Transmission speed (INTERBUS/local bus)	500 kbaud or 2 Mbaud
Ambient temperature	
Operation	-25 °C to +55 °C
Storage/Transport:	-25 °C to +70 °C
Humidity	
Operation	75% on average, 85% occasionally (non-condensing)

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

Storage/Transport:	75 % on average; 85% occasionally (non-condensing)

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

Air pressure	
Operation	80 kPa to 108 kPa (up to 2000 m above sea level)
Storage/Transport:	66 kPa to 108 kPa (up to 3500 m above sea level)
Degree of protection	IP20
Housing material	Plastic PBT, self-extinguishing (V0)
Air clearances and creepage distances	According to IEC 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	
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 the housing material to termites	Resistant

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General data (Fortsetzung)	
Resistance of the housing material to fungal decay	Resistant
Ambient compatibility	Not resistant to chloroform
Connection data for Inline connectors	
Connection method	Spring-cage terminal blocks
Conductor cross section	0.2 mm^2 to 1.5 mm^2 (solid or stranded), 24 - 16 AWG
Supported stop category according to EN 60204	0 1 im fehlerfreien Zustand

Mechanical requirements	
Vibration according to IEC 60068-2-6	Operation: 2 g, Criterion A
Shock according to IEC 60068-2-27	15 g over 11 ms, Criterion 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 Section “Connection options for actuators depending on the parameterization” on page 22, Section “Connection examples for safe outputs” on page 55)
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 * 10^{-8}) SIL 3: 1 % of 10^{-7} maximum (corresponds to 1 * 10^{-9}) Depends on the parameterization (see Table 6-3 on page 57)
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 a

Safety characteristic data according to EN 62061	
Achievable SIL Claim limit	SILCL = SIL 2 (single-channel) SILCL = SIL 3 (two-channel) Depends on the parameterization and wiring (see Section “Connection options for actuators depending on the parameterization” on page 22, Section “Connection examples for safe outputs” on page 55)
Safe failure fraction (SFF)	99 %
Probability of a dangerous failure per hour for the entire module (PFH)	SIL 2: 1 % of 10^{-6} maximum (corresponds to 1 * 10^{-8}) SIL 3: 1 % of 10^{-7} maximum (corresponds to 1 * 10^{-9}) Depends on the parameterization (see Table 6-3 on page 57)
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 a

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Safety characteristic data according to EN ISO 13849-1	
Achievable performance level	PL d (single-channel) PL e (two-channel) Depends on the parameterization and wiring (see Section “Connection options for actuators depending on the parameterization” on page 22 and Section “Connection examples for safe outputs” on page 55)
Diagnostic coverage (DC)	99 %
Mean time to dangerous failure (MTTFd)	For single-channel assignmennt: 100 years For two-channel assignmennt: 100 years

Supply voltage U_L (logic)

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

Current consumption	230 mA, maximum

Supply voltage: U_M (actuators)

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

WARNING: Loss of the safety function when using unsuitable power supplies
Only use power supplies according to EN 50178/VDE 0160 (PELV).

Nominal voltage	24 V DC according to EN 61131-2 and EN 60204
Tolerance	-15%/+20% including an entire AC voltage component with peak value of 5%
Ripple	3.6 V_{PP}
Permissible voltage range	19.2 V DC to 30.0 V DC, including all tolerances, ripple included
Current consumption	30 mA, typical (all outputs set) (plus actuator current)
Permissible interrupt time	10 ms Within this time, the output voltage for the safe outputs fails as the outputs are not internally buffered.

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Supply voltage: U_M (actuators) (Fortsetzung)	
Surge protection	Yes (in the bus coupler / power terminal)
Protection against polarity reversal	Yes (in the bus coupler / power terminal)

NOTE: Module damage due to polarity reversal

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

Undervoltage detection	Yes, at approx. 17 V
Diagnostics indicators	Green U_M LED (see “Local diagnostic and status indicators” on page 23)
External protection	8 A slow-blow, maximum

NOTE: Module damaged when overloaded

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

Safe digital outputs OUT0 to OUT3	
Number	4 two-channel or 8 single-channel (positive switching)
Supply	From supply voltage U_M
Maximum output current per output	2 A
Maximum output current for all outputs (total current)	6 A (observe derating and maximum output current for each group)
Maximum output current for each group (total current)	
Group 1 (OUT0_K1, OUT1_K1, OUT2_K1, OUT3_K1)	3 A
Group 2 (OUT0_K2, OUT1_K2, OUT2_K2, OUT3_K2)	3 A
Maximum output voltage in the low state	< 5 V

WARNING: Loss of safety function

At this voltage, the load must not switch and not remain in the switched on condition! 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 and not remain in the switched on condition! Please take this into consideration when selecting the actuator.

Minimal non-release voltage of the connected loads	> 5 V
Maximum inductive load	1 H

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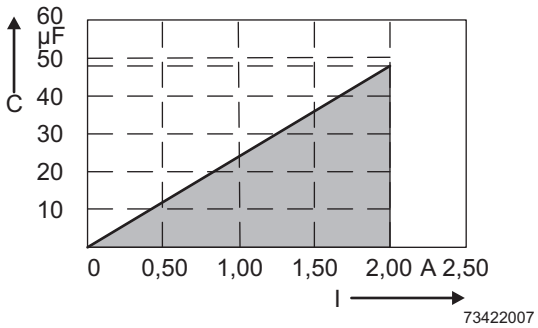
Safe digital outputs OUT0 to OUT3 (Fortsetzung)	
Maximum capacitive load depending on the current	C = 1 s/(R x 1400) Where: C Load capacity in F R Load resistance in ohms
Maximum capacitive load depending on the load current	 Key: C Load capacity in µF I Load current in A Shaded area: permissible range
Minimum load	1.5 kΩ (16 mA for 24 V)
Limitation of the voltage induced on circuit interruption	-15 V
Output voltage	U_M - 1 V, approximately
Simultaneity	100% up to 45 °C (observe maximum current load)
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
Maximum switching frequency	1 Hz; 0.2 Hz at > 1 A
Filter time	None
Shutdown time (t_{OUT}) (INTERBUS-Safety only)	Can be parameterized; 15 ms to 6.3 s; see Section “Parameterization of the safe outputs” on page 50 Accuracy - (2 ms + 6% of the parameterized value)/+0 ms
Switch-off delay for shutdown according to stop category 1	Can be parameterized; 150 ms to 630 s; see Section “Parameterization of the safe outputs” on page 50 Accuracy ±5% of the parameterized value
Maximum duration of the test pulses (when disabled, drive active)	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 23)
Diagnostics indicators	One red LED (two-color LED green/red) per output (see “Local diagnostic and status indicators” on page 23)

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Safe digital outputs OUT0 to OUT3 (Fortsetzung)

WARNING: Loss of safety function

– Connect the ground of the actuator directly to the ground terminal point of the corresponding output on the Inline plug. Use of an external ground is not permissible.
– The connected load must not respond in a hazardous way to test pulses.

Electrical isolation / Isolation of the voltage ranges

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

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

- Test distance	- Test voltage
5 V supply of incoming remote bus / 7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
5 V supply of outgoing remote bus / 7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min.
7.5 V supply (bus logic) / 24 V supply U_M, FE	500 V AC, 50 Hz, 1 min.

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

10.3 Conformance with EMC Directive

Conformance with EMC Directive 2014/30/EU

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

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

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

Noise emission	EN 55011	Class A Industrial

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10.4 Ordering data

10.4.1 Ordering data: Safety module

Description	Type	Order No.	Pcs./Pkt.
Inline module with safe digital outputs	IB IL 24 PSDO 8-PAC	2985631	1

10.4.2 Ordering data: Accessories

Description	Type	Order No.	Pcs./Pkt.
Plug set as replacement item	IB IL 24 SDO 8-PLSET/CP	2916927	1 set
Plug set, consisting of four Inline connectors with integrated discharge electronics	IB IL 24 PSDO 8-PLSET/CP/R	2700722	1 set

10.4.3 Ordering data: Documentation

Description	Type
Inline	
User manual “Automation terminals of the Inline product range”	IL SYS INST UM E
User manual Configuring and installing the INTERBUS Inline product range	IB IL SYS PRO UM E
INTERBUS-Safety	
User manual INTERBUS-Safety system description	UM EN INTERBUS-SAFETY SYS
User manual DEVICE-STATE function block	UM EN IB FB DEVICE-STATE
SafetyBridge	
User manual Inline module with integrated safety logic and safe digital outputs	UM EN IB IL 24 LPSDO 8 V2-PAC
User manual Inline module with integrated safety logic and safe digital outputs	UM EN IB IL 24 LPSDO 8 V3-PAC
PROFIsafe	
Quick start guide Configuring Inline modules with safe inputs or outputs under PROFIsafe on a SIMATIC® S7 controller	UM QS EN IB IL 24 PSDX - S7
Specification PROFIsafe - Profile for Safety Technology on PROFIBUS DP and PROFINET IO, Version 2.4, February 2007	See profisafe.net

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Description	Type
INTERBUS (general)	
User manual General introduction to the INTERBUS system	IBS SYS INTRO G4 UM E
User manual Configuring and installing INTERBUS	IBS SYS PRO INST UM E
User manual INTERBUS Diagnostics Guide	IBS SYS DIAG DSC UM E
User manual Firmware services and error messages	IBS SYS FW G4 UM E
“INTERBUS addressing” data sheet	DB GB IBS SYS ADDRESS
Documentation for software	
Quick start guide SafetyProg	UM QS EN SAFETYPROG
Quick start guide Config+	UM QS EN CONFIG+
Quick start guide PC WorX	UM QS EN PC WORX

Make sure you always use the latest documentation.
This is available on the Internet at phoenixcontact.net/products for download.

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

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A Appendix: PROFIsafe terms used in the user manual

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

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

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.

Consecutive number

Consecutive number

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

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-CPU

Failsafe controller, safe controller

F_Destination_Address

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

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")

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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 reported to the safe controller. For a safe input module when the F-System is passivated, instead of the process values present at the safe inputs, (0) substitute values are provided for the safety program. For a safe output module when the F-System is passivated, instead of the output values provided by the safety program, substitute values (0) are transferred to the safe outputs.
PROFIsafe	Safety-related bus profile based on PROFIBUS DP or PROFINET. It defines the communication between a safety program and the safe I/O device (F-I/O device) in a safe system (F-System).
PROFIsafe address	Each safe module has a PROFIsafe address. This address must be set on the safety module (F-I/O device) via DIP switches and then configured in the configuration tool for the safe controller used.
PROFIsafe monitoring time	Monitoring time for safety-related communication between the safe controller (F-CPU) and safe I/O device (F-I/O device). This time is parameterized in the F_WD_Time F-Parameter.
Consecutive number	See "Consecutive number"

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B Appendix: F-Parameters and iParameters

B 1 F-Parameters

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

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

F-Parameter	Default value	Description
F_Source_ Address	*automatic*	The parameter uniquely identifies the PROFIsafe source address (controller address). The address is assigned automatically.
F_Destination_ Address	*automatic*	PROFIsafe destination address (address of the safe device) The address is assigned automatically. However, the value can be modified. Make sure that the value set under F_Destination_Address and the value that you have set via the 10-pos. DIP switch are the same. Value range: 1 ... 1022
F_WD_Time	150	Monitoring time in the safety module A valid current safety telegram must arrive from the safe controller within the monitoring time. Otherwise, the safety module enters the safe state. The selected monitoring time must be sufficiently high for telegram delays to be tolerated by the communication, but still ensure a sufficiently fast error response in the event of an error (e.g., interruption in communication). Value range: 1 ... 65534, in 1 ms increments Unit: ms
F_SIL	*SIL 3*	Safety integrity (SIL according to IEC 61508) of the safety module **WARNING:** Safety functions up to SIL 3 can be achieved with the safety module. The safety integrity level that can actually be achieved depends on the parameterization, the structure of the sensor, and the cable installation (see “Connection examples for safe outputs” on page 55).
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.

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B 2 iParameter

The iParameters are individual device parameters. These include:

– Device parameters from INTERBUS-Safety (see Section “Parameterization of the safe outputs” on page 50)
– PST_Device_ID (20_{hex} for IB IL 24 PSDO 8-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.

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B 3 Diagnostic messages for parameter errors

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

Table B-2 F-Parameter parameter errors

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

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Table B-3 iParameter parameter errors

Error Code (Hex)	Error cause	Remedy
03F2	iPar_CRC is incorrect	Check iParameters, repeat calculation.
03FA	iPar_CRC is not equal to F_iPar_CRC	Apply correct value.
03FB	PST_Device_ID is incorrect	Correct value (20_{hex} for IB IL 24 PSDO 8-PAC).
03FC	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.
03FD	Incorrect order of iParameter blocks	Check infrastructure components.

B 3.2 Diagnostic messages for parameter errors for SafetyBridge

Table B-4 F-Parameter parameter errors

Error code		Error cause	Remedy
dec	hex		
1088	440	The parameterized SafetyBridge address does not match the address set on the safety module.	Make sure that the addresses are the same.
1089 ... 1094	441 ... 446	Internal error	Please contact Phoenix Contact.
71	47	The configurable safety module detected a distortion in the configuration and parameter data record.	Attempt transmission again. If the error occurs permanently, the data record in the controller is distorted. In this case, you can get SAFECONF to generate a new data record.

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

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

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

C 1 Conditions

Use of the module at altitudes **greater than 2,000 m above sea level to a maximum of 4,500 m above sea level** is possible under the following conditions:

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

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

For relay outputs:

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

Max. switching voltage according to the technical data for the module	Max. switching voltage when used at altitudes greater than 2,000 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

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C 2 Example calculation

The following calculation is an example for using a safe Inline I/O module at an altitude of 3,000 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

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D Appendix: Checklists

The checklists listed in this section provide support during the planning, mounting, and electrical installation, startup, parameterization, and validation of the IB IL 24 PSDO 8-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 validation, initial start-up as well as regular testing by qualified personnel.

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

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

Checklist . . .				
Device type / Equipment identification		IB IL 24 PSDO 8-PAC / BK20NA10		
Version: HW/FW/FW	00/100/100	**Date**	2008-01-03	
Editor	John Smith	**Test engineer**	Jane Brown	
Comment	System XXX has been checked for engine hood production			

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

No.	**Requirement (optional)**	**Yes**	**No**	**Comment**
Y	. . .	☐	☐	

Key:

Equipment identification	Enter the device type and/or the equipment identification for the relevant device.
Version: HW/FW/FW	Enter the hardware and firmware version of the device (see Section “Structure of the safety module” on page 18).
Date	Enter the date on which you began to fill in this checklist.
Editor	Enter the names of the editor.
Test engineer	Enter the name of the test engineer.
Comment	Where necessary, enter a comment.
Requirement (mandatory)	These requirements must be met for a safety application, in order to complete the relevant phase using the checklist.
Requirement (optional)	These requirements are optional. For points that are not met, please enter an appropriate remark in the relevant field.

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D 1 Planning

Checklist for planning the use of the safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Editor		**Test engineer**	
Comment			

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

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No.	Requirement (optional)	Yes	No	Comment
17	Have specifications for assembly and electrical installation been defined (e.g., EPLAN) and communicated to the relevant personnel?	❑	❑	
18	Have specifications for startup been defined and communicated to the relevant personnel?	❑	❑	
		Date		Signature (editor)
		Date		Signature (test engineer)

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D 2 Assembly and electrical installation

Checklist for assembly and electrical installation of the safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Editor		**Test engineer**	
Comment			

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

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

Date	Signature (editor)
Date	Signature (test engineer)

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D 3 Startup and parameterization

Checklist for startup and parameterization of the safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Editor		**Test engineer**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
1	Was startup completed according to the specifications (specifications from the planning phase or according to the user manual)?	☐	
2	During startup, is it ensured that any person starting hazardous movements intentionally can only do so with a direct view of the danger zone?	☐	
3	Are all parameters parameterized for the outputs?	☐	
4	Are both channels for outputs that are parameterized as two-channel matched to each other?	☐	
5	INTERBUS-Safety: Are the shutdown times for the outputs calculated and parameterized?	☐	
6	Are the output test pulses parameterized according to the actuator to be connected?	☐	
7	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?	☐	

No.	Requirement (optional)	Yes	No	Comment
8	Are the safety distances to be maintained dimensioned according to the implemented response and delay times (reaction times)?	☐	☐	

Date	Signature (editor)
Date	Signature (test engineer)

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D 4 Validation

Checklist for validating the safety module			
Device type / Equipment identification			
Version: HW/FW/FW		**Date**	
Editor		**Test engineer**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
1	Have all the mandatory requirements for the "Planning" checklist been met?	☐	
2	Have all the mandatory requirements for the "Assembly and electrical installation" checklist been met?	☐	
3	Have all the mandatory requirements for the "Startup and parameterization" checklist been met?	☐	
4	Does the parameterization of the safe outputs correspond to the version and the actual connection of the controlled devices?	☐	
5	Has the assignment of the actuators to the outputs and the variables of the safe application program been tested (also as online status in SafetyProg)?	☐	
6	Has a function test been performed to check all safety functions in which the module is involved?	☐	
7	Have measures been taken to achieve a specific Cat.?	☐	
8	Do all cables correspond to the specifications?	☐	
9	Does the power supply correspond to the specifications for the protective extra-low voltage in accordance with PELV?	☐	
10	Has the power supply of U_M and U_S in the Inline system from a power supply unit been implemented?	☐	
11	Is external protection of the module implemented (according to the specifications in this user manual for supply voltage U_M)?	☐	
12	INTERBUS-Safety: Is the shutdown time to be parameterized implemented according to the planning? (Uniform shutdown time, derived from the system specifications or shutdown time per channel)	☐	
13	Have measures been taken to prevent simple tampering?	☐	
14	Have measures been taken to prevent plugs being mixed up?	☐	
15	Are requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved?	☐	
16	Are the specifications for the parameterization for each channel implemented?	☐	
17	Have test intervals been defined for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
18	For PROFIsafe: Is the F_iPar_CRC parameter greater than 0 for all devices?	☐	

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No.	Requirement (mandatory)	Yes	Comment
19	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
		Date	Signature (editor)
		Date	Signature (test engineer)

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E Appendix: Index

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F Appendix: Revision history

Revision	Date	Contents	
01	07/2008	First publication	
02	2011-02-15	Global	Editorial revision Standard EN 954-1 removed; Cat. 4 assigned to EN ISO 13849-1 SILCL added Added SafetyBridge (e.g., documentation, process data words, programming data/configuration data, DIP switches, parameterization, errors, technical data, and ordering data) Labeling for the DIP switches changed
			HW/FW/FW changed to 01/200/100
		p. 1-2	Transmission speed deleted
		p. 1-3	Added under “Power supply units for 24 V supply”: Make sure...
		p. 1-5	List of standards deleted, refer to EC declaration of conformity
		p. 1-8	Abbreviation “SELV” removed Safety hotline details corrected
		p. 2-2	Printing and description for the DIP switches adapted
		p. 2-8	P LED description changed
		p. 2-12	INTERBUS-Safety 4-word mode removed
		p. 2-15	Programming data/configuration data table adapted INTERBUS-Safety 4-word mode removed
		p. 4-2 and onwards	DIP switch description adapted
		p. 5-5	“Enable” parameterization added
		p. 10-2	Ambient temperature for storage/transport adapted Air pressure for storage/transport adapted Protection class standards added
		p. 10-3	Safety characteristic data for all standards added
		p. 10-5	Data for maximum switching frequency corrected
		p. 10-8	SAFETY INTRO UM E removed UM EN IB IL 24 LPSDO 8 V2-PAC added
03	2011-07-28		FW 201 added
		Tab. 2-1	“Status display for communication” changed to “Status display for safe communication”
		Tab. 7-1	“Data width” changed to “Mode”
		p. 10-7	Connector set 2700722 added
04	2013-06-25	p. 4-3	Switch position SafetyBridge V3 added

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Revision	Date	Contents	
05	2017-11-08	Book	New cover + rear cover added
		Book	Page number format changed
		Cover page	Order number for user manual removed HW/FW/FW version updated (**as of** HW/FW/FW)
		Section 1	Marking of warning notes and qualification of users recorded (previously contained in the cover)
		Section 4	Section 4.1.3 "Setting the DIP switches" revised
		Table 4-3	Switch position for SafetyBridge V3 modified
		Page 9 Page 79	Information about safety seals removed
		Page 87	Updated EMC directive
		Page 88	Column for order number and Pcs./Pkt. from table "Ordering data: Documentation" removed, UM EN IB IL 24 LPSDO 8 V3-PAC added
		Page 97	Appendix “Conditions for use at altitudes greater than 2,000 m above sea level” added

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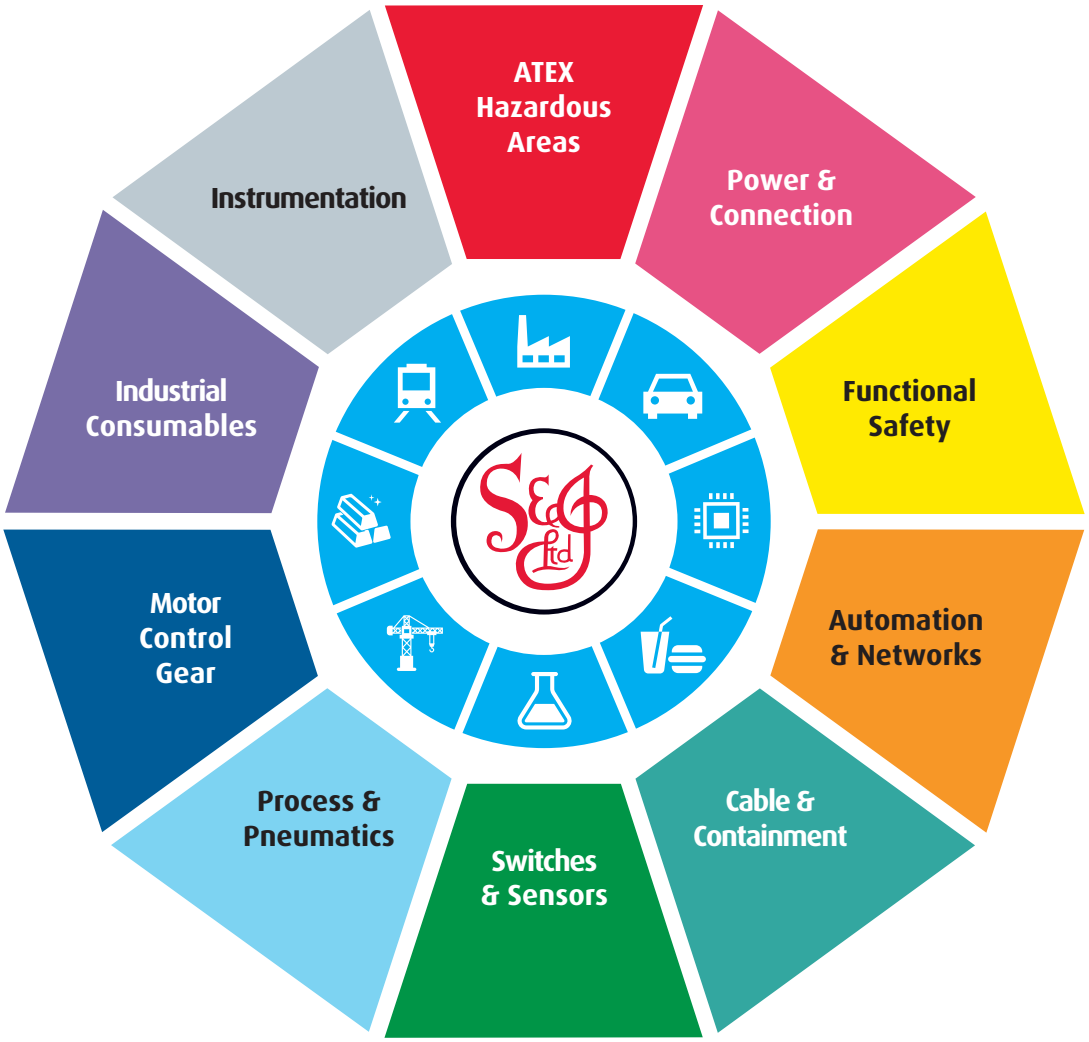

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