IB IL 24 PSDI 8-PAC
Inline module with safe digital inputs

User manual

PHOENIX CONTACT
INSPIRING INNOVATIONS

User manual

IB IL 24 PSDI 8-PAC Inline module with safe digital inputs

UM EN IB IL 24 PSDI 8-PAC, revision 07 2017-11-29

This user manual is valid for:

Designation	Revision as of HW/FW	Order No.
IB IL 24 PSDI 8-PAC	00/201	2985688

7602_en_07

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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.

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 input module parameters, the INTERBUS-Safety, SafetyBridge, or PROFIsafe system can detect various errors within the safety equipment.

Do not carry out any repairs

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

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

Do not open the housing

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

Measures to prevent mismatching and polarity reversal

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

1.4 Electrical safety

WARNING: Hazardous shock currents and the loss of functional safety

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

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

Direct/Indirect contact

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

This can be achieved by:

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

Power supply units for 24 V supply

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

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

Insulation rating

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

The IB IL 24 PSDI 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.

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 143).

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 confugurable 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 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

Check hardware and parameterization

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

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

Use your test report to ensure that:

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

1.6 Directives and standards

The manufacturers and operators of machines and systems, in which the IB IL 24 PSDI 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/catalog.

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 PSDI 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 11, “Technical data and ordering data” on page 125 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 sensors, which can be used in association with safety technology.
For example, the module can be used in the following applications:

– Single or two-channel emergency stop or safety door equipment
– Applications with enable button
– Applications with two-hand control devices
– Applications with mode selector switches
– As secondary switchgear for safety-related photoelectric barriers
– Safety circuits according to EN 60204 Part 1

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/catalog.

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

Please also observe the relevant information about the bus system used.

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 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.

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

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-fault 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
OSSD	OSSD Output signal switching device OSSD is the part of electrosensitive protective equipment, which is connected to the machine control system and switches off if the sensor part responds during correct operation.

For terms and abbreviations used for PROFIsafe, please refer to “Appendix: PROFIsafe terms used in the user manual” on page 135.

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

2 Product description

2.1 Brief description of the safety module

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

The IB IL 24 PSDI 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 digital inputs for two-channel assignment or eight safe digital inputs for single-channel assignment.

The inputs can be parameterized according to the application and enable the integration of sensors in the safe INTERBUS (INTERBUS safety), in SafetyBridge or in PROFIsafe.

Within an INTERBUS-Safety, SafetyBridge or PROFIsafe system, the IB IL 24 PSDI 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

2.2 Structure of the safety module

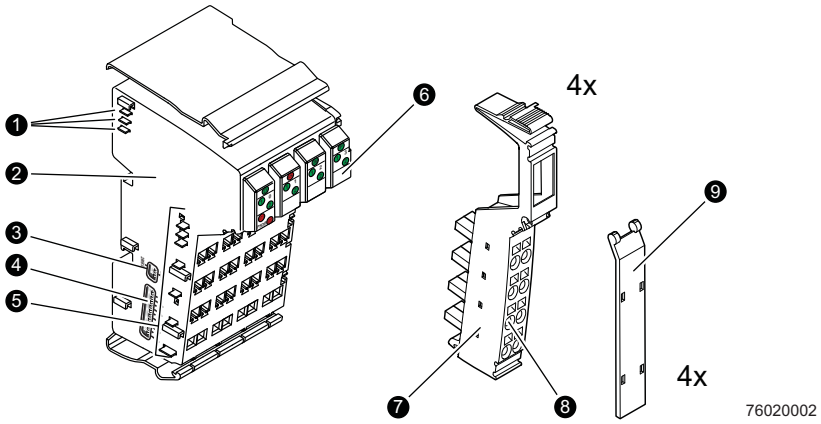


Figure 2-1 Structure of the safety module

1 Data jumpers (local bus)

2 Electronics base with labeling including hardware/firmware version designation (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 38.

5 Potential jumper

6 Diagnostic and status indicators; for assignment and meaning see Section “Local diagnostic and status indicators” on page 24

7 Inline connector; for assignment see Section “Terminal point assignment” on page 34

8 Terminal points

9 Labeling field

2.3 Housing dimensions

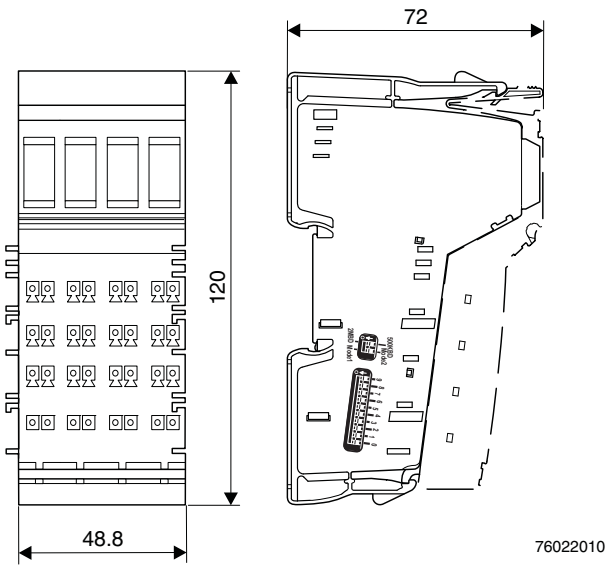


Figure 2-2 Housing dimensions (in mm)

2.4 Safe digital inputs and clock outputs UT1 and UT2

2.4.1 Safe digital inputs

The safety module has four safe digital inputs for two-channel assignment or eight safe digital inputs for single-channel assignment. The supply voltage for the inputs can be provided externally or via the clock outputs.

Technical data

For the technical data for the safe inputs, please refer to page 129.

Parameterization

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

The safety integrity level (SIL, SILCL, Cat., PL) and error detection that can be achieved depend on the parameterization, the structure of the sensor, and the cable installation (see “Connection examples for safe inputs” on page 57).

For information on the parameterization of the inputs, please refer to Section “Parameterization of the safe inputs” on page 48.

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 about the diagnostic messages of the inputs, please refer to Section “Safe digital input errors” on page 113.

CAUTION: Diagnostic data is not safety-related

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

Requirements for controlling devices/ sensors

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

- To acquire input signals, the signal duration must be greater than the parameterized filter time.
- The sensors must be suitable for the application.
  Only use appropriately qualified sensors (suitable for the required category, SIL, SILCL, PL).
- Use switches with a positive opening contact according to IEC 60947-5-1. Part 5 of this standard includes a description of the specific requirements for control switches with positive opening operation. All positive opening control switches, which meet these specific requirements, are marked with the following symbol:

- Use reliable components. These include, for example:
  - Mechanical position switches with personal protection function with positive opening contact according to EN 60947-5-1
  - Cam-operated switches with positive opening contact
  - Emergency stop buttons/cable-operated switches with positive opening contact according to EN 60947-5-1
- Controlling devices can be evaluated on a single-channel or two-channel connection depending on the application.
- Under certain circumstances, switches (e.g., for position monitoring) must be designed redundantly depending on the risk.
- In order to achieve Cat. 3/Cat. 4, SIL 3/SILCL 3 or PL d or e, controlling devices must usually be designed redundantly.
- Please observe any special environmental requirements in your application when selecting the controlling devices.
- Please observe the applicable C standards in your application (e.g., EN 1010), in which, for example, the number of controlling devices required to achieve a particular category is specified.

2.4.2 Clock outputs UT1 and UT2

The module has two independent clock outputs. They provide the supply voltage for the safe inputs. Each of these clock outputs can provide a pulse pattern to detect cross circuits and short circuits in the external wiring of the inputs. Intelligent sensors can also be supplied by the clock outputs. Depending on the application, the two clock outputs can be parameterized differently.

Parameterization

For information about the parameterization of the clock outputs, please refer to Section “Parameterization of clock outputs UT1 and UT2” on page 52.

The clock outputs are also switched on and monitored when not parameterized. If a short circuit occurs at a clock output when it is in this state, the clock output is switched off. This is indicated by the local diagnostic LED.

To exit the error, parameterize the device and acknowledge the error message.

Technical data

For the technical data for the clock outputs, please refer to page 130.

Behavior in the event of an error

In the event of short circuit to GND or overload of the clock outputs, the clock outputs are switched off. At the same time, the error is indicated at the UT1 and/or UT2 LEDs and a diagnostic message is generated at the safe controller (INTERBUS-Safety, PROFIsafe) or at a configurable safety module (SafetyBridge). This error must be acknowledged so that the system can be started up again following error removal.

Error detection

Error detection depends on both the parameterization of the clock outputs and which input is assigned to which clock output. As there are two clock outputs for eight inputs, there may be reciprocal effects between the inputs.

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 clock outputs, please refer to Section “Clock output UT1 and UT2 errors” on page 115.

CAUTION: Diagnostic data is not safety-related

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

2.5 Connection options for sensors depending on the parameterization

Sensors that meet various safety requirements depending on the parameterization can be connected to the inputs. For connection examples, please refer to Section 7, “Connection examples for safe inputs”.

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 7, “Connection examples for safe inputs”)
– Observe the requirements of the standards with regard to the external wiring and the sensors to be used to achieve a SIL/SILCL/Cat./PL, see (“Measures required to achieve a specific safety integrity level” on page 59).

	Input										
Connection to the Inline connectors	Single-channel sensor or redundant sensor			Two-channel redundant controlling device/sensor							Intelli-gent sensor
Input signal				Equivalent				Non-equivalent			See separate documentation for intelligent sensors
Clocking (UT1, UT2)	With	Without		2x	1x	Without		2x	1x	Without	
Sensors that can be connected: – Contact-based	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes	
– With OSSD outputs	No		Yes	No	No		Yes	No	No	No	
Achievable SIL/SILCL/Cat./PL	SIL 2 SILCL 2 Cat. 3* PL d	SIL 2 SILCL 2 Cat. 2 PL d	SIL 2 SILCL 2 Cat. 2 PL d	SIL 3 SILCL 3 Cat. 4 PL e	SIL 3 SILCL 3 Cat. 4 PL e	SIL 3 SILCL 3 Cat. 3 PL d	SIL 3 SILCL 3 Cat. 4** PL e	SIL 3 SILCL 3 Cat. 4 PL e	SIL 3 SILCL 3 Cat. 4 PL e	SIL 3 SILCL 3 Cat. 3 PL d	
For connection example, see page	62	64	67	72	75 78 81	84	87	92	95 98 101	104	

Key:

* Cat. 3 can only be achieved with a redundant sensor.

** The category that can be achieved depends on the sensor used.

Clocking

The clocking for the inputs is provided when clock outputs UT1 and UT2 are parameterized accordingly. The parameterization of UT1 and UT2 applies to the entire module. When parameterizing the inputs, specify which clock output is assigned to which input.

For two-channel inputs there are various options for assignment:

2x:	Both channels are assigned different clock outputs with clocking switched on.
1x:	Only one channel is assigned a clock output with clocking switched on or both channels are assigned the same clock output with clocking switched on.
Without:	Either a clock output with clocking switched off is assigned or no clock output is assigned.

For information about error detection according to clocking, please refer to Section “Clock outputs UT1 and UT2” on page 22.

Error detection

For information about the special features of error detection, please refer to the connection examples.

2.6 Local diagnostic and status indicators

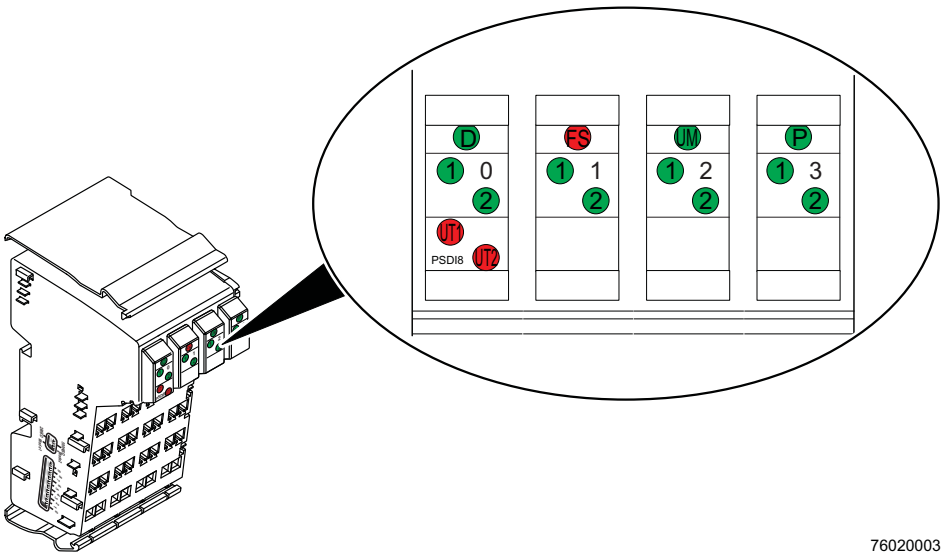


Figure 2-3 Local diagnostic and status indicators on the IB IL 24 PSDI 8-PAC module

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 (INTERBUS-Safety, PROFIsafe) or configurable safety module (SafetyBridge) disabled
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
UT1, UT2	Red LED	Diagnostic message (error) for each clock output
	Off:	No error
	Flashing at 1 Hz:	Cross circuit of an input with external signals
	On:	Short circuit or overload of the clock output
	The clock output is switched off until the acknowledgment is received by the safety module (see also Section “Clock output UT1 and UT2 errors” on page 115).	
IN 0.1 - 3.2	Green LED	Status of each input (see “Terminal point assignment” on page 34)
	On:	Input at logic 1
	Off:	Input at logic 0
	Even when the module is not parameterized, the physical state at the inputs is indicated. However, substitute value “0” is transmitted to the safe controller.	

2.7 Safe state

The safe state for the module is the transmission of the value equal to “0” in the image of the inputs to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge).

PROFIsafe:
The safe state for the F-Input data is “0”.
The safe state is entered by means of passivation (see “Passivation” on page 136).

The safe state can be entered in the following cases:

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

2.7.1 Operating state

In the operating state, the inputs can enter states “1” or “0”. In general, state “0” is the safe state. An exception is a non-equivalent parameterized input. For channel 2 of this input, “1” is the safe state, “0” is represented in the process image of the two-channel input.

Table 2-2 Operating state depending on the state of the inputs

Type of input	Operating state equals 1 in input state	Operating state equals 0 (safe state)
Single-channel	High (1)	Low (0)
Two-channel equivalent	High/High (1/1)	other
Two-channel non-equivalent	High/Low (1/0)	other

Please observe the state transitions (see Section “Symmetry / Start inhibit” on page 50).

2.7.2 Error detection in I/O devices

Inputs

If an error is detected at an input, the safe state is set at this input and a “0” is represented in the process image of the input (“0” = safe state).

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

– Short circuit
– Cross-circuit
– Overload/short circuit of the clock outputs

The relevant diagnostic message is transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge) (see Section “Safe digital input errors” on page 113). For information about which errors are detected and when, please refer to Section “Connection examples for safe inputs” on page 57.

2.7.3 Device errors

Device errors can lead to safe communication being set.

Inputs

If a hardware fault in the internal circuit is detected at an input, **all** module inputs enter the safe state and “0” values are represented in the process image of the inputs (“0” = safe state).

The relevant diagnostic message is transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge) (see Section “Safe digital input errors” on page 113).

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 (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge) (see Section “Errors: messages and removal” on page 111).

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 error

Parameterization errors are indicated:

- As long as the module is not parameterized

or

- In the event of faulty parameterization

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

In the event of faulty parameterization, the relevant diagnostic message is transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge) (see Section “Parameterization errors” on page 116).

2.8 Process data words

2.8.1 INTERBUS

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

The input data can only be accessed via the safe INTERBUS controller. The safe INTERBUS controller provides the input data for the standard control system as standard 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.

Assignment of inputs to the process data input 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	Input (single-channel)	IN3 _Ch2	IN3 _Ch1	IN2 _Ch2	IN2 _Ch1	IN1 _Ch2	IN1 _Ch1	IN0 _Ch2	IN0 _Ch1	Reserved							
	Input (two-channel)	0	IN3 _Ch 1&2	0	IN2 _Ch 1&2	0	IN1 _Ch 1&2	0	IN0 _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

Input	IN0_Ch1	IN0_Ch2	IN1_Ch1	IN1_Ch2	IN2_Ch1	IN2_Ch2	IN3_Ch1	IN3_Ch2
Two-channel	X	X					X	X
Single-channel			X	X	X	X		

(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	Input	0	IN3 _Ch 1&2	IN2 _Ch2	IN2 _Ch1	IN1 _Ch2	IN1 _Ch1	0	IN0 _Ch 1&2	Reserved							

2.8.2 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 input data can only be accessed via the standard control system.

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.

Assignment of inputs to the process data input word in the standard control system

(Word.bit) view	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Module	Input (single-channel)	IN3 _Ch2	IN3 _Ch1	IN2 _Ch2	IN2 _Ch1	IN1 _Ch2	IN1 _Ch1	IN0 _Ch2	IN0 _Ch1	Reserved							
	Input (two-channel)	0	IN3 _Ch 1&2	0	IN2 _Ch 1&2	0	IN1 _Ch 1&2	0	IN0 _Ch 1&2								

The diagnostic data is transmitted to the standard control system via the configurable safety module.

2.8.3 PROFIsafe (PROFIBUS, PROFINET)

The module occupies four words in the Inline system and three words in the PROFIBUS 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.

2.9 Programming data / Configuration data

2.9.1 Local bus (INTERBUS)

Protocol	INTERBUS-Safety	SafetyBridge	PROFIsafe
Protocol/address switch	$3FF_{hex}$	9_{hex} .... FF_{hex} determined by the configurable safety module	Any, 1_{hex} .... $3FE_{hex}$
Operating mode	Mode 1	Mode 2	Mode 1
ID code	AF_{hex} (175_{dec})	$A3_{hex}$ (163_{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.
– The switch position of the protocol/address switch is specified by the configurable safety module (see documentation for the configurable safety module).

2.9.2 Other bus systems (PROFIBUS, PROFINET, etc.)

For the programming data/configuration data of other bus systems, please refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

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 128.

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 vial 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 input circuits and the clock outputs. For the technical data for the supply voltage U_M, please refer to Section “Supply voltage U_M (sensors, clock outputs)” on page 128.

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.

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 a fault at the supply voltage U_M, please refer to Section “Supply voltage errors” on page 115.

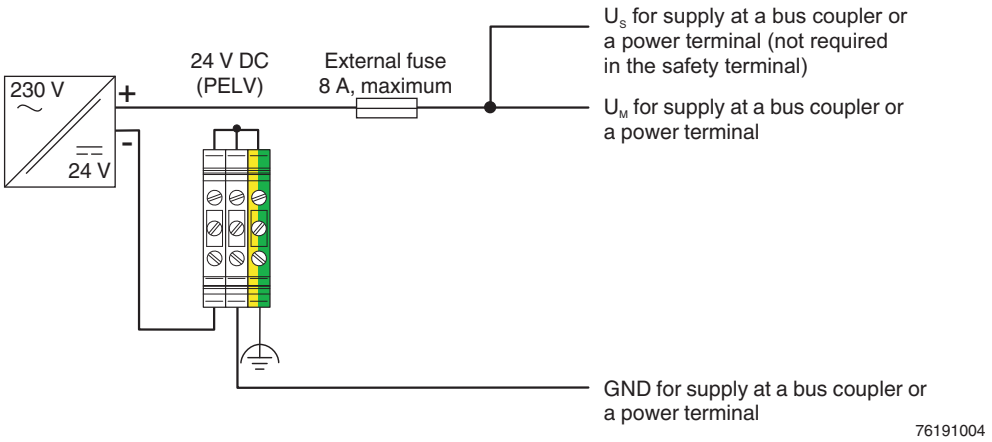


Figure 3-1 Supply U_M with connection to functional earth ground according to EN 60204-1

NOTE: Damage to module electronics in the event of surge voltage
Do not use a DC distribution network.

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

3.4 Terminal point assignment

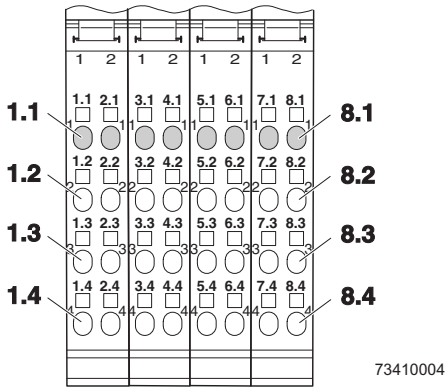


Figure 3-2 Terminal point assignment

The Inline connectors are supplied with the module. They are coded and marked accordingly for connection to prevent polarity reversal.

Only use the connectors supplied with the module.

The following applies for the tables below:

- All inputs are safe digital inputs
  The assignment to the clock output must be parameterized (see “Parameterization of the safe inputs” on page 48)
- 0 V (GND): Common ground of inputs and clock outputs
- FE: Common functional earth ground
- UT1: Controlled by first channel
- UT2: Controlled by second channel

Table 3-1 Terminal point assignment for plug 1

Terminal point	Signal	Channel assignment	LED
1.1	IN0_Ch1	Input 0, channel 1	0.1
2.1	IN0_Ch2	Input 0, channel 2	0.2
1.2	UT1	Clock output 1	UT1
2.2	UT2	Clock output 2	UT2
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		

Table 3-2 Terminal point assignment for plug 2

Terminal point	Signal	Channel assignment	LED
3.1	IN1_Ch1	Input 1, channel 1	1.1
4.1	IN1_Ch2	Input 1, channel 2	1.2
3.2	UT1	Clock output 1	
4.2	UT2	Clock output 2	
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	IN2_Ch1	Input 2, channel 1	2.1
6.1	IN2_Ch2	Input 2, channel 2	2.2
5.2	UT1	Clock output 1	
6.2	UT2	Clock output 2	
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	IN3_Ch1	Input 3, channel 1	3.1
8.1	IN3_Ch2	Input 3, channel 2	3.2
7.2	UT1	Clock output 1	
8.2	UT2	Clock output 2	
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		

WARNING: Loss of functional safety due to parasitic voltages
For sensors that require a GND, these must be wired to 0 V (GND) on the module.

4 Assembly, removal, and electrical installation

4.1 Assembly 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

WARNING: Unintentional machine startup

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

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

Make sure the entire 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 PSDI 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.

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.

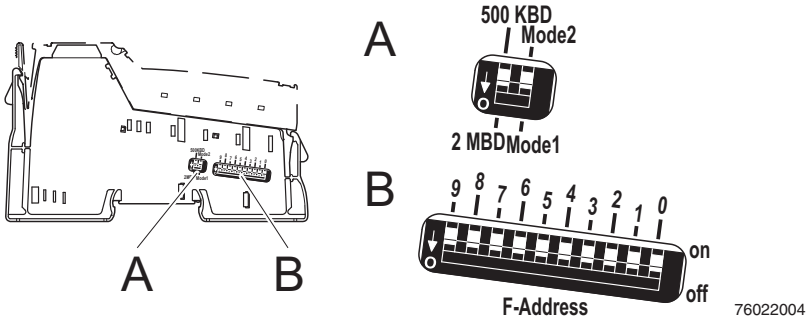


Figure 4-1 DIP switch

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

INTERBUS-Safety

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

Changing the setting:

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

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

INTERBUS-Safety switch position

Table 4-1 Switch position for INTERBUS-Safety

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

PROFIsafe

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

Changing the setting:

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

PROFIsafe switch position

Table 4-2 Switch position for PROFIsafe

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

SafetyBridge

WARNING: Loss of safety function during mixed operation

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

Take the following action:

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

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

Changing the setting:

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

For more detailed information on the SafetyBridge address, please refer to the documentation for the logic module used (IB IL 24 LPSDO 8-PAC, 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 V1 and V2 switch positions

Table 4-4 Switch position for SafetyBridge V1 and V2 (IB IL 24 LPSDO 8-PAC or IB IL 24 LPSDO 8 V2-PAC logic module used)

SafetyBridge V1 and 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}		

Multiplexer mode switch position

Table 4-5 Switch position for SafetyBridge V1 and V2 in multiplexer mode

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

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

4.1.4 Assembly and removal of the safety module

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

Assembly

- Set the DIP switches prior to mounting (see Section “Setting the DIP switches” on page 38). 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.

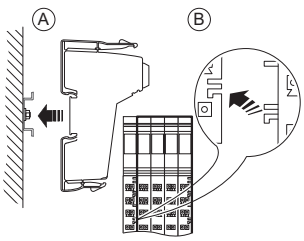


Figure 4-2 Snapping on the safety module base

- 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.

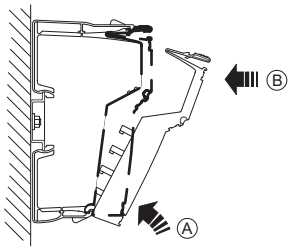


Figure 4-3 Inserting the plugs

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).

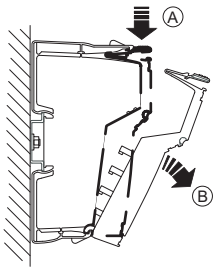


Figure 4-4 Removing the plug

– Remove base

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

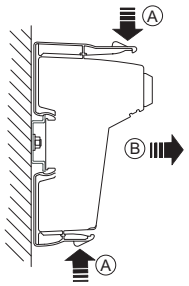


Figure 4-5 Removing the safety module base

4.2 Electrical installation

WARNING: Electric shock / Unintentional machine startup

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

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

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

4.2.1 Electrical installation of the Inline station

Electrical installation of the Inline station includes the following:

– Connecting the bus system to the Inline station
– Connecting the supply voltages for the Inline station

Carry out the electrical installation for the Inline station according to the IL SYS INST UM E user manual. 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 incorrect connection, polarity reversal, and manipulation of connections.

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

The sensors 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 34.

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

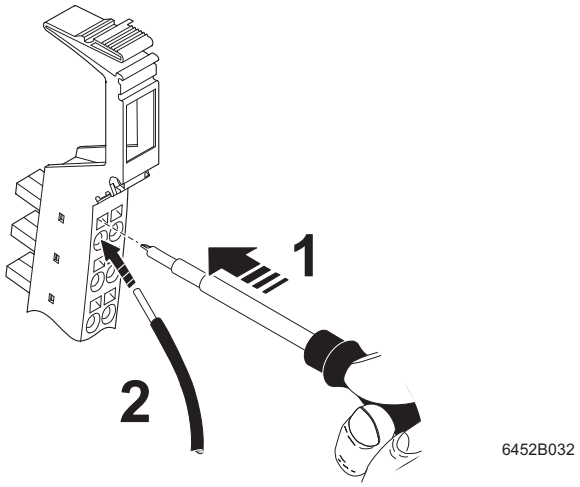


Figure 4-6 Connecting unshielded cables

- Insert the assembled plugs in the corresponding module slot (see Section “Terminal point assignment” on page 34).
- Mark all connections to prevent connections to the Inline plugs being mixed up (see IL SYS INST UM E user manual).

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 inputs and clock 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 the inputs and clock outputs

The parameterization of the safe inputs and clock 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 inputs and clock outputs are valid and transmitted without errors. Valid input data is only read in this state. In every other state, the safe state is transmitted for each input (“0” in the input data).

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.

5.2 Parameterization in a SafetyBridge system

Parameterization includes the following:

– Assigning the SafetyBridge address for the corresponding configurable safety module
– Parameterizing the inputs and clock 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 PSDI 8-PAC) is based on the island number of the configurable safety module and the position in the bus navigator of the software tool.

Set this address via the DIP switches prior to mounting the safety module (see “Setting the DIP switches” on page 38).

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

Parameterization of the inputs and clock outputs

The parameterization of the safe inputs and clock 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 supply voltage must be present and the local bus 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 inputs and clock outputs are valid and transmitted without errors. Valid input data is only read in this state. In every other state, the safe state is transmitted for each input (“0” in the process image of the inputs).

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.

5.3 Parameterization in a PROFIsafe system

Parameterization includes the following:

– Assigning the PROFIsafe address via the configuration software of the control system manufacturer
– Parameterizing the inputs and clock outputs
– Assigning 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 38).

Parameterization of the inputs and clock outputs

The parameterization of the safe inputs and clock 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 local bus is in the RUN state.
– 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 inputs and clock outputs are valid and transmitted without errors. Valid input data is only read in this state. In every other state, the safe state is transmitted for each input (“0” in the process image of the inputs).

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 Section “Errors: messages and removal” on page 111.

F-Parameters and iParameters

Assign the parameterizable F-Parameters and iParameters. For an overview of the module parameters and possible settings, please refer to “Appendix: F-Parameters and iParameters” on page 137.

5.4 Parameterization of the safe inputs

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

Two-channel

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

- IN0_Ch1 to IN0_Ch2
- IN1_Ch1 to IN1_Ch2
- IN2_Ch1 to IN2_Ch2
- IN3_Ch1 to IN3_Ch2

Single-channel

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

Position of the data in the process data 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	Input (single-channel)	IN3 _Ch2	IN3 _Ch1	IN2 _Ch2	IN2 _Ch1	IN1 _Ch2	IN1 _Ch1	IN0 _Ch2	IN0 _Ch1	Reserved							
	Input (two-channel)	0	IN3 _Ch 1&2	0	IN2 _Ch 1&2	0	IN1 _Ch 1&2	0	IN0 _Ch 1&2								

Clock outputs

Please observe the settings of clock outputs UT1 and UT2 when parameterizing the safe inputs.

If the safe inputs are assigned the same or no clock output, cross-circuit detection is not possible.

Parameterization

Parameterize all safe inputs individually. The parameterization options are described in Figure 5-1.

Table 5-1 Parameterization of inputs

Parameterization	Value range	Comment
Assignment	Not used Used	For unused inputs, the data is filled with 0.
Evaluation	Single-channel Two-channel	For “two-channel”: The assignment of the inputs to one another is specified and cannot be parameterized.
Sensor type	Standard sensor Intelligent sensor	If intelligent sensors are used, the clock outputs for “standard sensor” mode are no longer available. In this case, all inputs that are operated with standard sensors are operated without clock outputs. Select the clock output setting “no assignment” for these inputs. Please note that error diagnostics for I/O devices are only limited in this operating mode.
Filter time (t_{Filter})	1.5 ms 3 ms 5 ms 15 ms	The filter time is used to suppress interference for the input signals. Select the filter time so that the duration of the input signal is greater than the filter time. For inputs that are parameterized for two-channel operation, select the same filter time for both channels.
	The filter time directly affects the response time of the safety function.	
Symmetry	Disabled 10 ms 50 ms 100 ms 1 s 5 s	Parameterization is only active if the input is parameterized for two-channel operation. Select the same value for both channels. See also “Symmetry / Start inhibit” on page 50.
Start inhibit due to symmetry violation	Disabled Enabled	Disabled (default setting): A diagnostic message is generated in the event of symmetry violation. Enabled: a diagnostic message is generated in the event of symmetry violation. In addition, the affected input is set to the safe state.

Table 5-1 Parameterization of inputs (Fortsetzung)

Parameterization	Value range	Comment
Clock selection	No assignment UT1 UT2	Assignment of the input to a clock output. Only relevant for standard sensors. When using intelligent sensors, UT1 is used as the power supply and UT2 as the pulse generator for all inputs.
Bounce time monitoring	Disabled Enabled	Monitoring of the activation and deactivation of the bouncing time. See also “Bounce time monitoring” on page 50.
Input signal	Non-equivalent Equivalent	Parameterization is only active if the input is parameterized for two-channel operation. Select the same setting for both channels. Non-equivalent: Connect N/C contact to INx_Ch1 Connect N/O contact to INx_Ch2 Equivalent: Connect N/C contact to both channels

Bounce time monitoring

The bouncing of an input signal may lead to delayed state transitions. If a detected state transition is 200% longer than the parameterized filter time, a corresponding diagnostic message is sent. The exception is a filter time of 15 ms. For this filter time, the duration of the state transition can be increased by a maximum of 100%.

Symmetry / Start inhibit

Symmetry monitoring can be used to monitor the contact wear of the switch. Symmetry monitoring checks the extent to which the related (filtered) inputs enter another state simultaneously. Symmetry is violated if the inputs indicate different states for a time greater than the value parameterized for “symmetry”. This applies for positive and negative edges.

The safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge) is informed of a symmetry violation by a diagnostic message. If “start inhibit due to symmetry violation” is enabled, symmetry violation causes the affected input to enter the safe state.

Key for the following diagrams:

S	Symmetry monitoring
Diag	Diagnostics
Q	Acknowledgment of the diagnostic message. After acknowledging the diagnostic message, the current state is read.

For non-equivalent parameterization, a negated signal is present at input IN0_Ch2 shown in the diagrams.

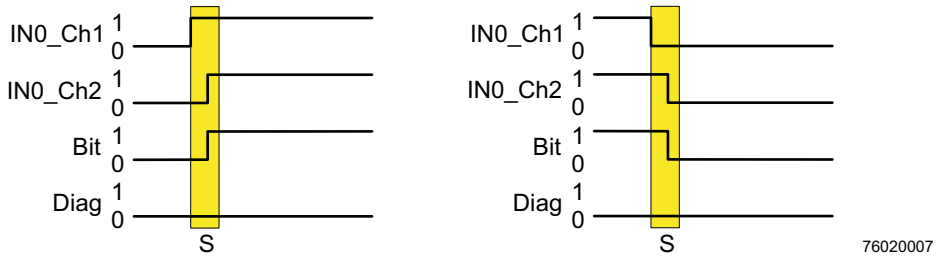


Figure 5-1 Example for a signal change within the parameterized time for symmetry monitoring

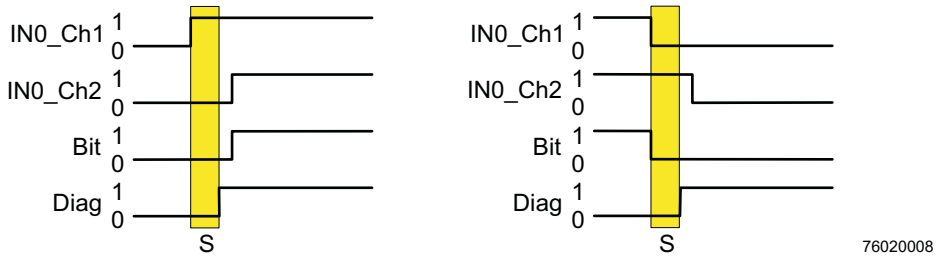


Figure 5-2 Example for a signal change outside the parameterized time for symmetry monitoring; start inhibit due to symmetry violation is disabled

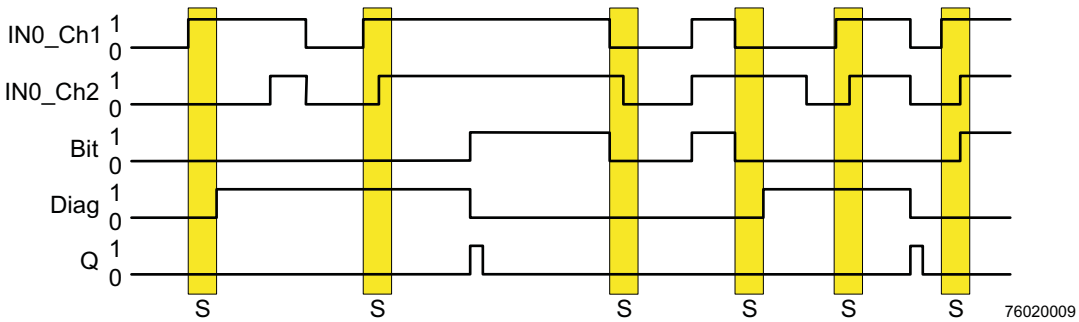


Figure 5-3 Example for a signal change outside the parameterized time for symmetry monitoring; start inhibit due to symmetry violation is enabled

After acknowledging the diagnostic message (see Section “Acknowledging an error” on page 120), the current state at the input is immediately transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge). If a startup inhibit is required following error acknowledgment, this must be implemented by the user in the application program.

A symmetry violation can also be triggered by a cross circuit (see Section “Connection examples for safe inputs” on page 57).

Processing time of input t_{IN} in the event of a safety demand

The processing time of input t_{IN} in the event of a safety demand consists of the parameterized filter time t_{Filter} and the firmware runtime t_{FW}. It is calculated for the IB IL 24 PSDI 8-PAC module according to the following formula:

$$t_{IN} = t_{Filter} + t_{FW}$$

Where:

t_{IN} Processing time of the input

t_{Filter} Parameterized filter time

t_{FW} Firmware runtime:

- For standard sensors: 250 µs
- For intelligent sensors:
  For additional information, please refer to the data sheet for the Phoenix Contact intelligent sensor used.

5.5 Parameterization of clock outputs UT1 and UT2

As long as the module is not parameterized:

- The clock outputs are enabled if no errors are present.
- Short circuit detection is activated.

Select the parameterization of clock outputs according to Figure 5-2.

Table 5-2 Parameterization of clock outputs

Values	Comment
UT1 on / UT2 on	Clocking for UT1 and UT2 enabled
UT1 on / UT2 off	Clocking for UT1 enabled Clocking for UT2 disabled (constant 24 V)
UT1 off / UT2 on	Clocking for UT1 disabled (constant 24 V) Clocking for UT2 enabled
Off	Clocking for UT1 and UT2 disabled (constant 24 V)
Manufacturer and sensor designation	Setting for intelligent sensors; for additional information, see separate documentation for intelligent sensors

If clock outputs are parameterized without clock pulses, no cross circuits or short circuits can be detected between the channels.

If clocking is enabled, the clock output is operated with a maximum pulse width of 1 ms and a maximum period length of 80 ms.
The time offset between the clocks of the clock outputs is approximately 50% of the period length.

If both channels of a two-channel input are assigned the same clock output, cross-circuit detection has no effect.

Typical pulse pattern for parameterizing UT1 on and UT2 on

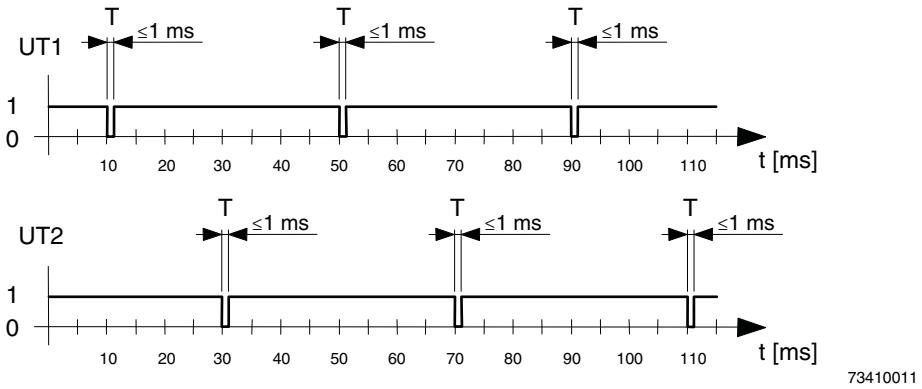


Figure 5-4 Typical pulse pattern (standard sensor)

Key:

T	Test pulse
	Pulse width ≤ 1 ms
	Period length ≤ 80 ms

6 Duration of a safety demand

The duration of a safety demand must be greater than the processing time of the corresponding input (t_{IN}, see also “Processing time of input t_{IN} in the event of a safety demand” on page 52).

6.1 INTERBUS-Safety

If the safety module detects a safety demand after the processing time of the input t_{IN} elapsed, when using INTERBUS-Safety this time is extended by the module until the safe controller has received the safety demand.

6.2 SafetyBridge

If the safety module detects a safety demand after the processing time of the input t_{IN} elapsed, when using SafetyBridge this time is extended by the module until the configurable safety module has received the safety demand.

6.3 PROFIsafe

If the safety module detects a safety demand (safe “0”) after the processing time of the input t_{IN} has elapsed, when using PROFIsafe this time is extended by the module until the consecutive number has changed twice.

WARNING: Loss of functional safety

Observe the behavior of the controller when processing the safe inputs.

In addition to the processing time of input t_{IN}, observe the system-specific PROFIsafe behavior (e.g., watchdog time, duration of demand, processing time of the safe controller).

7 Connection examples for safe inputs

7.1 Explanation of the examples

Depending on the type of wiring, the inputs 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 sensors to the safe inputs.
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 (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge) 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 111.
  The symmetry violation diagnostic message is only displayed if it was not disabled during parameterization of the affected input.
– **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Key for all figures and tables in this section:

Table 7-1 Figures

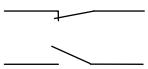
Representation	Meaning
 73410009	Floating switch (mechanical or electrical)

Table 7-2 “Device diagnostics and behavior of the module in the event of an error” tables

Representation	Meaning
SF	Safety function
UTx	UT1 or UT2 LED; diagnostic message for each clock output
Clocked	Clocking enabled

Table 7-3 Parameterization tables

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

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

For all examples, please also observe the measures specified in the individual tables, which must be taken to achieve the specified SIL/SILCL/Cat./PL and all measures according to standards EN 61508, EN 62061, EN 954-1, and EN ISO 13849-1 to achieve the specified SIL/SILCL/Cat./PL.

The input signals can be supplied externally or by the clock outputs. The clock outputs and the assignment of the input signals to the clock outputs are parameterized as required.

7.2 Measures required to achieve a specific safety integrity level

The safety integrity (SIL, SILCL, category, and performance level) 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 7-4 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 and basic safety principles according to EN ISO 13849-2.
- Use appropriately qualified sensors (see Section “Requirements for controlling devices/ sensors” on page 21).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Take appropriate measures (e.g., fuse protection, redundancy, positive opening, etc.) to ensure that the contacts can be opened (e.g., following welding or mechanical failure) when a switch is actuated.
- 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.

Cat. 3

- Use proven and basic safety principles according to EN ISO 13849-2.
- Use appropriately qualified sensors (see Section “Requirements for controlling devices/ sensors” on page 21).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Take appropriate measures (e.g., fuse protection, redundancy, positive opening, etc.) to ensure that the contacts can be opened (e.g., following welding or mechanical failure) when a switch is actuated.
- Please take into consideration errors with a common cause.
- All errors 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.
- Ensure that **a single** error does not result in the loss of the safety function.
- If single-channel sensors are not available for this category, use two-channel sensors.

Cat. 4

- Use proven and basic safety principles according to EN ISO 13849-2.
- Use appropriately qualified sensors (see Section “Requirements for controlling devices/ sensors” on page 21).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- All errors 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.
- 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.
- Please take into consideration errors with a common cause.

7.3 Single-channel assignment of safe inputs

For the single-channel assignment of safe inputs, the inputs operate independently of one another. The assignment of each input signal to the clock output can be freely selected.

For the following examples, please note the resulting behavior in the event of an error:

Note about cross-circuits

- Please note that cross-circuits with other inputs can only be detected if the input signals are assigned to different clock outputs and clocks are enabled for the clock outputs.
- The **cross-circuit** error results in the transmission of the safe state in the process data image of the affected inputs.
  Remove the error and then acknowledge the message.
- Please observe the maximum failure detection time of 80 ms.
  If a “1” signal is present at the input and an error occurs, a maximum of 80 ms elapses until the error is detected. Within this time, another “1” can also be transmitted, even in the event of an error.
  Within the failure detection time (80 ms, maximum), the error can cause the state to change unexpectedly from “0” to “1”.
  Ensure that such a change in state cannot restart the system unintentionally.

  Please note that the processing time for the input t_{IN} increases by up to 80 ms in the event of an error.

The following supply options are available for single-channel assignment:

1 UT1, clocking enabled
2 UT2, clocking enabled
3 UT1, clocking disabled
4 UT2, clocking disabled
5 External supply (external +24 V or OSSD)

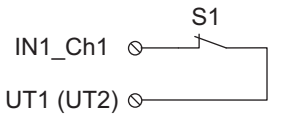
State evaluation

The module evaluates the states of the inputs and transmits the result to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge).

In the process data image of a safe input:

- A “0” is transmitted if a “0” signal is present at the input **or** an error has been detected.
- A “1” is transmitted if a “1” signal is present at the input **and** no error has been detected.

7.3.1 Single-channel: Supply through UT1 (clocking enabled) or UT2 (clocking enabled)



S1 Safety switch

Figure 7-1 Single-channel assignment of the inputs, supply through UT1 (clocked) or UT2 (clocked)

Basic specifications

Sensor	Single-channel
Sensor supply	Internally through clock output UT1 (clocked) or UT2 (clocked)
Achievable SIL/SILCL/Cat./PL	SIL 2 / SILCL 2 / Cat. 3 / PL d

WARNING: Loss of electrical and functional safety
- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor 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 sensors that can achieve the required safety integrity.

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

Table 7-5 Single-channel: Supply through UT1 (clocked) or UT2 (clocked)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function.
A contact will not close	**No**	None	No	The error cannot be detected.
Other errors (depending on the sensor)				**Please take into consideration possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	None	No	**– Behavior when the input is in state “1”:** The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.** **– Behavior when the input is in state “0”:** **Please note that if this error causes the safety switch to be switched on again, this can result in delayed transmission of state “1” in the process data image of the inputs (e.g., due to a loose contact).**

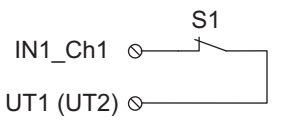
Table 7-5 Single-channel: Supply through UT1 (clocked) or UT2 (clocked) (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Cross-circuit				
Input to input	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed. If the inputs are assigned to different clock outputs, this error is detected as a cross-circuit after 80 ms.
Input to assigned clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Note about cross-circuits” on page 61.
Clock output to clock output	Yes	Cross-circuit	No	The error is only detected in state “1” of the input.
Short circuit				
Input to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**
Clock output to ground	Yes	Short circuit UTx ON	No	The affected clock output is disabled.

Typical parameterization

Parameterization	Parameterized as	Comment
Input		
Assignment	**Used**	
Evaluation	**Single-channel**	
Sensor type	**Standard sensor**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	Disabled	Not relevant
Clock selection	UT1	Or UT2
Bounce time monitoring	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Not relevant
Input signal	Equivalent	Not relevant
Clock output		
	UT1 ON (UT2 any)	If clock selection = UT1

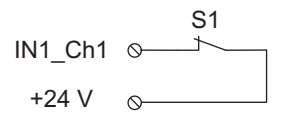
7.3.2 Single-channel: Supply through UT1 (clocking disabled) or UT2 (clocking disabled) or external supply



S1
Safety switch

UT1 (UT2)
Supply through UT1 **or** UT2

Figure 7-2 Single-channel assignment of inputs:
Supply through UT1 or UT2 (clocking disabled for each)



S1
Safety switch

+24 V
Supply through external 24 V

Figure 7-3 Single-channel assignment of inputs: External supply

Basic specifications

Sensor	Single-channel switch
Sensor supply	– Internally through clock output UT1 or UT2; clocking disabled for each – External (24 V)
Achievable SIL/SILCL/Cat./PL	SIL 2 / SILCL 2 / Cat. 2 / PL d

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, cross-circuits must be avoided.
- Please note that in order to achieve the specified PL, the sensor must have a medium level of diagnostic coverage (90% to 99%) and high MTTFd. A high level of diagnostic coverage (> 99%) is recommended for the application according to PL d.
- Use sensors that can achieve the required safety integrity.

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

Table 7-6 Single-channel: Supply through UT1 (clocking disabled) or UT2 (clocking disabled), external supply or OSSD

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function.
A contact will not close	**No**	None	No	The error cannot be detected.
Other errors (depending on the sensor)				**Please take into consideration possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	None	No	**– Behavior when the input is in state “1”:** The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.** **– Behavior when the input is in state “0”:** **Please note that if this error causes the safety switch to be switched on again, this can result in delayed transmission of state “1” in the process data image of the inputs (e.g., due to a loose contact).**
Cross-circuit				
Input to input; the inputs are assigned different clock outputs	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to input; the inputs are assigned the same clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to assigned clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to non-assigned clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Clock output to clock output	**No**	None	No	The error cannot be detected as clocking is disabled.

Table 7-6 Single-channel: Supply through UT1 (clocking disabled) or UT2 (clocking disabled), external supply or OSSD (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Short circuit				
Input to external 24 V	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**
Clock output to external 24 V	**No**	None	No	The error cannot be detected as clocking is disabled.
Clock output to ground	Yes	Short circuit UTx ON	No	The affected clock output is disabled.
External 24 V to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). Make sure that this change in state cannot restart the system unintentionally.

Typical parameterization

Parameterization	Parameterized as	Comment
Input		
Assignment	**Used**	
Evaluation	**Single-channel**	
Sensor type	**Standard sensor**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	Disabled	Not relevant
Clock selection	UT1	Or UT2 or no assignment
Bounce time monitoring	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Not relevant
Input signal	Equivalent	Not relevant
Clock output		
	UT1 OFF (24 V) (UT2 any)	If clock selection = UT1

7.3.3 Single-channel: Supply through OSSD

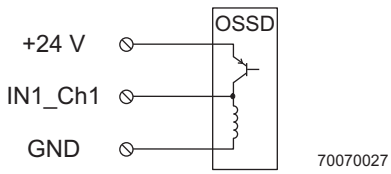


Figure 7-4 Single-channel assignment of inputs: External supply (OSSD)

WARNING: Loss of functional safety due to parasitic voltages
Connect the sensor ground directly to terminal point GND of the safety module. Use of an external ground is not permissible.

Basic specifications

Sensor	Single-channel OSSD output (with internal testing)
Sensor supply	External (OSSD sensor)
Achievable SIL/SILCL/Cat./PL	SIL 2 / SILCL 2 / Cat. 2 / PL d

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, cross-circuits must be avoided.
- Please note that in order to achieve the specified PL, the sensor must have a medium level of diagnostic coverage (90% to 99%) and high MTTFd. A high level of diagnostic coverage (> 99%) is recommended for the application according to PL d.
- Use sensors that can achieve the required safety integrity.

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

Table 7-7 Single-channel: supply through OSSD

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
(depending on the sensor)				**Please take into consideration possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	None	No	**– Behavior when the input is in state “1”:** The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.** **– Behavior when the input is in state “0”:** **Please note that if this error causes the safety switch to be switched on again, this can result in delayed transmission of state “1” in the process data image of the inputs (e.g., due to a loose contact).**
Input (Cable interrupt between sensor and GND)	No	None	No	The error must be detected by the sensor. **The sensor must ensure that the safe state is entered in the event of an error.**
Cross-circuit				
Input to input; the inputs are assigned different clock outputs	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to input; the inputs are assigned the same clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to assigned clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to non-assigned clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Clock output to clock output	**No**	None	No	The error cannot be detected as clocking is disabled.

Table 7-7 Single-channel: supply through OSSD (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Short circuit				
Input to external 24 V	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**
Clock output to external 24 V	**No**	None	No	The error cannot be detected as clocking is disabled.
Clock output to ground	Yes	Short circuit UTx ON	No	The affected clock output is disabled.
External 24 V to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). Make sure that this change in state cannot restart the system unintentionally.

Typical parameterization

Parameterization	Parameterized as	Comment
Input		
Assignment	**Used**	
Evaluation	**Single-channel**	
Sensor type	**Standard sensor**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	Disabled	Not relevant
Clock selection	No assignment	
Bounce time monitoring	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Not relevant
Input signal	Equivalent	Not relevant
Clock output		
	UT1 OFF (24 V) (UT2 any)	Not relevant

Set the filter time for the input to a value greater than the width of the test pulse for the OSSD sensor.

The input must not be assigned to a clock.

7.4 Two-channel equivalent assignment of safe inputs

For two-channel assignment of the inputs, two adjacent inputs are always used. This assignment is fixed and cannot be parameterized. (see Section “Two-channel” on page 48)

For two-channel equivalent assignment, the state changes from “0” to “1” only when both inputs change state from “0” to “1”. If symmetry monitoring is enabled and the state at both inputs does not change within the parameterized time, a diagnostic message is generated.

An input is active when the state of the signal is equal to “1”.

Cross-circuits between different inputs can only be detected if the input signals are assigned to different clock outputs and clocks are enabled for the clock outputs.

Please note that if switching on the safety switch again, a delayed change in state at one of the two inputs can result in delayed transmission of state “1” in the process data image of the inputs (e.g., due to a loose contact).

Example of correct and incorrect signal change

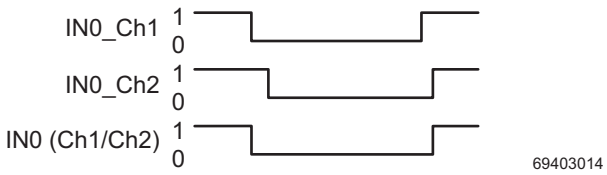


Figure 7-5 **Correct** signal change

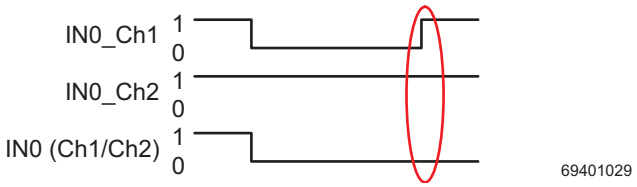


Figure 7-6 **Error** during signal change

In Figure 7-6, the condition that both signals must be in state “0” before the change in state from “0” to “1” is not met. In this case, diagnostic message 018x$_{hex}$ is generated.

Key for Figure 7-5 and Figure 7-6

IN0_Ch1	Signal sequence at input 0 channel 1
IN0_Ch2	Signal sequence at input 0 channel 2
IN0 (Ch1/Ch2)	Safety-related signal for two-channel input 0 channel 1 and channel 2 at the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge)

State evaluation

The module evaluates the states of the inputs and transmits the result to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge).

In the process data image of the safe inputs:

– A “0” is transmitted if a “0” signal is present at at least one of the two inputs **or** an error has been detected.
– A “1” is transmitted if a “1” signal is present at both inputs **and** no error has been detected and the conditions are met for a change in state according to Figure 7-6.

7.4.1 Notes about errors for two-channel equivalent assignment of safe inputs

For the following examples, please note the resulting behavior in the event of an error:

Note about cross-circuits

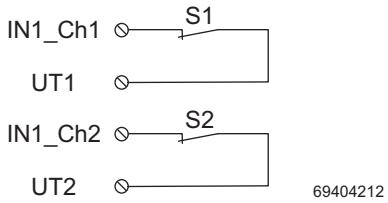
– The **cross-circuit** error results in the transmission of the safe state in the process data image of the affected inputs.
  Remove the error and then acknowledge the message.
  Acknowledging the diagnostic message deletes the message and activates the input. The states at the input are detected immediately. **In your safe application program, ensure that the system cannot be restarted unintentionally following acknowledgment of the diagnostic message.**
– Please observe the maximum failure detection time of 80 ms.
  Exceptions in the failure detection time are indicated in the tables.
  If a “1” signal is present at the input and an error occurs, a maximum of 80 ms elapses until the error is detected. Within this time, another “1” can also be transmitted, even in the event of an error.
  Within the failure detection time (80 ms, maximum), the error can cause the state to change unexpectedly from “0” to “1”.
  Ensure that such a change in state cannot restart the system unintentionally.

Note about symmetry violation

– The symmetry violation diagnostic message is only displayed if it was not disabled during parameterization of the affected input.
– **Start inhibit due to symmetry violation disabled:**
  The symmetry violation message does **not** result in the transmission of the safe state (see also “Symmetry / Start inhibit” on page 50).
  The message must be acknowledged. However, the current status of the inputs is displayed in the process data image of the inputs.
– **Start inhibit due to symmetry violation enabled:**
  The symmetry violation message results in the transmission of the safe state (see also “Symmetry / Start inhibit” on page 50).
  The message must be acknowledged. The current status of the inputs is displayed in the process data image of the inputs following acknowledgment.
– The message can be used to monitor the wear of the safety switch.

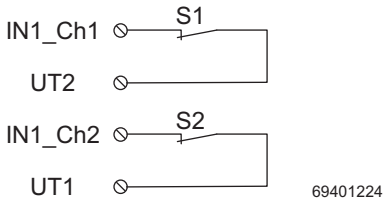
7.4.2 Two-channel equivalent: Supply through UT1 and UT2 (clocking enabled for both)

Possible wiring versions:



S1, S2
Two switching elements

Figure 7-7 Two-channel equivalent assignment of inputs, supply through UT1 and UT2 (both clocked)



S1, S2
Two switching elements

Figure 7-8 Two-channel equivalent assignment of inputs, supply through UT1 and UT2 (both clocked)

Basic specifications

Sensor	Two-channel equivalent
Sensor supply	Internally through clock output UT1 **and** UT2 (both clocked)
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

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

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 70.

Table 7-8 Two-channel equivalent: Supply through UT1 and UT2 (both clocked)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. **– Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. **– Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
A contact will not close	Yes	Symmetry violation	No	On a change in state from “0” to “1”, a “0” is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	The error is detected in state “1”.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. **– Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. **– Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to state “0”.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Note about cross-circuits” on page 71.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs that are assigned to different clock outputs.
Short circuit				
Input to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same value
Symmetry	10 ms	10 ms	Application-specific, same value
Clock selection	UT1	UT2	Or vice versa
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Equivalent**	**Equivalent**	
Clock output			
	UT1 ON and UT2 ON		

7.4.3 Two-channel equivalent: Supply through UT1 and UT2 (of which one clock pulse is disabled)

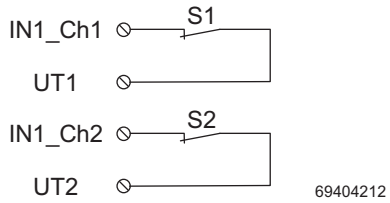


Figure 7-9 Two-channel equivalent assignment of inputs, supply through UT1 and UT2 (of which one clock pulse is disabled)

Basic specifications

Sensor	Two-channel equivalent
Sensor supply	Internally through clock output UT1 **and** UT2 (of which one clock pulse is disabled)
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

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

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 70.

Table 7-9 Two-channel equivalent: Supply through UT1 and UT2 (of which one clock pulse is disabled)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
A contact will not close	Yes	Symmetry violation	No	On a change in state from “0” to “1”, a “0” is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	The error is detected in state “1”.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to state “0”.
Input (assigned to the clock output that is not clocked) to non-assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs.
Clock output (clocked) to clock output (not clocked)	Yes	Cross-circuit	No	The error is detected for inputs, that are assigned to the clocked clock output.

Table 7-9 Two-channel equivalent: Supply through UT1 and UT2 (of which one clock pulse is disabled) (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Short circuit				
Input to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel. The error is also detected as a short circuit of the clock output.

For all inputs that are assigned to the clock output that is not clocked, cross-circuits and short circuits are not detected by the device diagnostics, but only on a change in state of the input signals, as the state only changes in one channel. Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same value
Symmetry	10 ms	10 ms	Application-specific, same value
Clock selection	UT1	UT2	Or vice versa
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Equivalent**	**Equivalent**	
Clock output			
	UT1 ON and UT2 OFF (24 V)		Or vice versa

7.4.4 Two-channel equivalent: Supply through a clock output (clocking enabled) and external supply

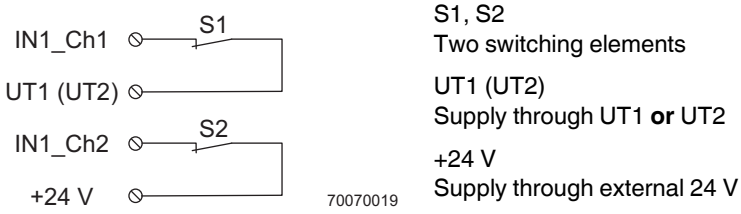


Figure 7-10 Two-channel equivalent assignment of inputs, supply through UT1 (or UT2) and externally

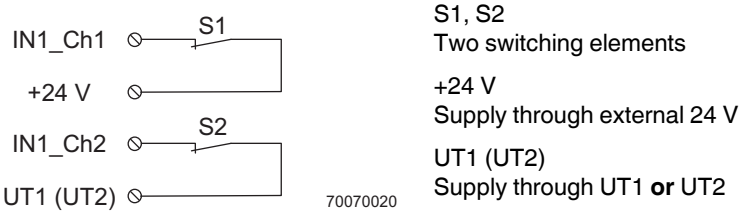


Figure 7-11 Two-channel equivalent assignment of inputs, supply through UT1 (or UT2) and externally

Basic specifications

Sensor	Two-channel equivalent
Sensor supply	Internally through clock output UT1 (or UT2) **and** externally
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

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

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 70.

Table 7-10 Two-channel equivalent: Supply through a clock output (clocked) and external supply

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
A contact will not close	Yes	Symmetry violation	No	On a change in state from “0” to “1”, a “0” is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	The error is detected in state “1”.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to state “0”.
Input (not assigned to a clock output) to clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs, that are assigned to the clocked clock output.

Table 7-10 Two-channel equivalent: Supply through a clock output (clocked) and external supply (continued)

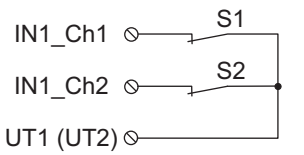
Error type	Detection	Diagnostics	Loss of SF	Comment
Short circuit				
Input (assigned to the clocked clock output) to external 24 V	Yes	Cross-circuit	No	The error is detected by the absence of the clock pulses of the clock output.
Input (not assigned to any clock output) to external 24 V	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs.
Input to ground	Yes	Symmetry violation	No	**The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.**
Clocked clock output to external 24 V	Yes	Cross-circuit	No	The error is detected by the absence of the clock pulses of the clock output.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.
External 24 V to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.

For all inputs that are not assigned to a clock output, cross-circuits and short circuits are not detected by the device diagnostics, but only on a change in state of the input signals, as the state only changes in one channel. Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same value
Symmetry	10 ms	10 ms	Application-specific, same value
Clock selection	UT1	No assignment	Or vice versa
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Equivalent**	**Equivalent**	
Clock output			
	UT1 ON (UT2 any)		For specified clock selection

7.4.5 Two-channel equivalent: Supply through a clock output (clocking enabled)



S1, S2
Two switching elements

UT1 (UT2)
Supply through UT1 **or** UT2

Figure 7-12 Two-channel equivalent assignment of inputs, supply through UT1 (or UT2) (clocked)

Basic specifications

Sensor	Two-channel equivalent
Sensor supply	Internally through a clock output UT1 (or UT2) (clocked)
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 3 / PL d

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor 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 sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 70.

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

Table 7-11 Two-channel equivalent: Supply through a clock output (clocked)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
A contact will not close	Yes	Symmetry violation	No	On a change in state from “0” to “1”, a “0” is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Cable interrupt between clock output and sensor	Yes	None	No	– **Behavior when the input is in state “1”:** The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**
Cable interrupt between sensor and input	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Cross-circuit				
Input to input	**No**	None	No	The error is not detected. **An accumulation of errors can result in the loss of the safety function.**
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – **Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to state “0”.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Note about cross-circuits” on page 71.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs, that are assigned to the clocked clock output.

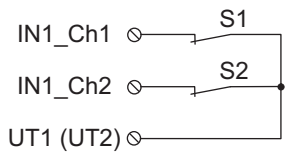
Table 7-11 Two-channel equivalent: Supply through a clock output (clocked) (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Short circuit				
Input to ground	Yes	None	No	**– Behavior when the input is in state “1”:** The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.** The error is also detected as a short circuit of the clock output. The affected clock output is disabled.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same value
Symmetry	10 ms	10 ms	Application-specific, same value
Clock selection	UT1	UT1	Or both UT2
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Equivalent**	**Equivalent**	
Clock output			
	UT1 ON (UT2 any)		Where clock selection = UT1

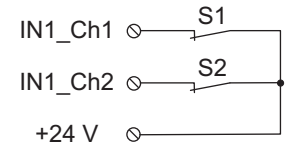
7.4.6 Two-channel equivalent: Supply through a clock output (clocking disabled) or external supply



S1, S2
Two switching elements

UT1 (UT2)
Supply through UT1 **or** UT2

Figure 7-13 Two-channel equivalent assignment of inputs, supply through UT1 (or UT2) (clocking disabled)



S1, S2
Two switching elements

+24 V
External supply

Figure 7-14 Two-channel equivalent assignment of inputs, external supply

Basic specifications

Sensor	Two-channel equivalent
Sensor supply	Internally through clock output UT1 (or UT2) (clocking disabled) **or** externally
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 3 / PL d

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor 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 sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 70.

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

Table 7-12 Two-channel equivalent: Supply through a clock output (clocking disabled) or external supply

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. **– Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. **– Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
A contact will not close	Yes	Symmetry violation	No	On a change in state from “0” to “1”, a “0” is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Cable interrupt between clock output or external supply and sensor	Yes	None	No	**– Behavior when the input is in state “1”:** The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**
Cable interrupt between sensor and input	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Cross-circuit				
Input to input	**No**	None	No	**An accumulation of errors can result in the loss of the safety function.**
Input to clock output (assigned or not assigned)	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. **– Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. **– Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to “0”.
Clock output to clock output	**No**	None	No	The error is not detected.
Short circuit				
Input to external 24 V	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. **– Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. **– Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the inputs, as the faulty input was not previously set to “0”.
Input to ground	Yes	None	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output that is not clocked to external 24 V	**No**	None	No	The error is not detected.

Table 7-12 Two-channel equivalent: Supply through a clock output (clocking disabled) or external supply (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.** The error is also detected as a short circuit of the clock output. The affected clock output is disabled.
External 24 V to ground	Yes	None	No	The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible (e.g., due to a loose contact). **Make sure that this change in state cannot restart the system unintentionally.**

For all inputs that are not assigned to a clock output, cross-circuits and short circuits are not detected by the device diagnostics, but only on a change in state of the input signals, as the state only changes in one channel. Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same value
Symmetry	10 ms	10 ms	Application-specific, same value
Clock selection	UT1	UT1	Or both UT2; or both no assignment
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Equivalent**	**Equivalent**	
Clock output			
	UT1 OFF (24 V) (UT2 any)		Where clock selection = UT1

7.4.7 Two-channel equivalent: External supply (OSSD)

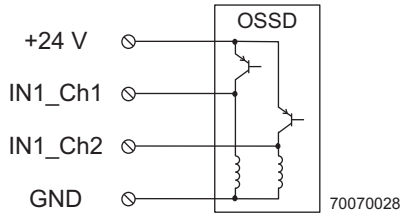


Figure 7-15 Two-channel equivalent assignment of inputs, external supply (OSSD)

WARNING: Loss of functional safety due to parasitic voltages
Connect the sensor ground directly to terminal point GND of the safety module. Use of an external ground is not permissible.

Basic specifications

Sensor	Two-channel OSSD output (with internal testing)
Sensor supply	External (OSSD sensor)
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety
- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

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

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 70.

Table 7-13 Two-channel equivalent: External supply (OSSD)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
Channel failure	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. **– Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. **– Change in state from “0” to “1”:** A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**

Table 7-13 Two-channel equivalent: External supply (OSSD) (continued)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the wiring				
Interrupt				
Input (Cable interrupt between sensor and input)	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Input (Cable interrupt between sensor and GND)	No	None	No	The error must be detected by the sensor. **The sensor must ensure that the safe state is entered in the event of an error.**
Cross-circuit				
Input to input	No	None	**Yes**	The error must be detected by the sensor. **The sensor must ensure that the safe state is entered in the event of an error.**
Input to clock output	Yes	Symmetry violation	No	The error is detected on a change in state if the clock output is set to “1”, as the state only changes in one channel.
Short circuit				
Input to 24 V	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel.
Input to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same value
Symmetry	10 ms	10 ms	Application-specific, same value
Clock selection	No assignment	No assignment	
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Equivalent**	**Equivalent**	
Clock output			
	Any		

Set the filter time for the input to a value greater than the width of the test pulse for the OSSD sensor.

The input must not be assigned to a clock.

7.5 Two-channel non-equivalent assignment of safe inputs

For two-channel assignment of the safe inputs, two adjacent inputs are always used. This assignment is fixed and cannot be parameterized (see Section “Two-channel” on page 48).

For two-channel non-equivalent assignment, the state changes from “0” to “1” only when input INx_Ch1 changes state from “0” to “1” and input INx_Ch2 changes state from “1” to “0”. If symmetry monitoring is enabled and the state at both inputs does not change within the parameterized time, a diagnostic message is generated.

The state is active when the state of the signal at channel 1 is equal to “1” and the signal at channel 2 is equal to “0”.

Cross-circuits can only be detected if the input signals are assigned to different clock outputs and clocks are enabled for the clock outputs.

Please note that if switching on the safety switch again, a delayed change in state at one of the two inputs can result in delayed transmission of state “1” in the process data image of the inputs (e.g., due to a loose contact).

Example of correct and incorrect signal change

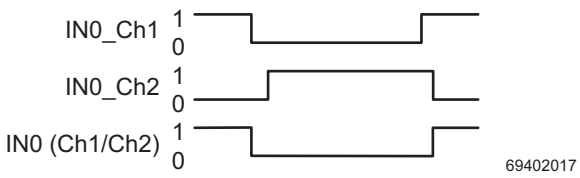


Figure 7-16 **Correct** signal change

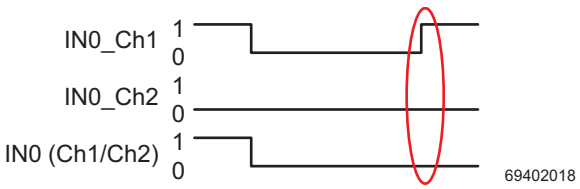


Figure 7-17 **Error** during signal change

In Figure 7-17, the condition that both signals must be in the opposite state before the change in state is not met. In this case, diagnostic message 018x$_{hex}$ is generated.

Key for Figure 7-5 and Figure 7-6

IN0_Ch1	Signal sequence at input 0 channel 1
IN0_Ch2	Signal sequence at input 0 channel 2
IN0 (Ch1/Ch2)	Safety-related signal for two-channel input 0 channel 1 and channel 2 at the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge)

State evaluation

The module evaluates the states of the inputs and transmits the result to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable safety module (SafetyBridge).

In the process data image of the safe inputs:

– A “1” is transmitted if a “1” signal is present at channel 1 of the input and a “0” signal is present at channel 2 of the input **and** no error has been detected and the conditions are met for a change in state according to Figure 7-17.
– A “0” is transmitted in all other cases.

7.5.1 Notes about errors for two-channel non-equivalent assignment of safe inputs

For the following examples, please note the resulting behavior in the event of an error:

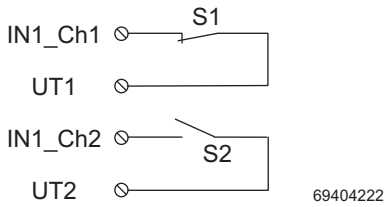
Note about cross-circuits

– The **cross-circuit** error results in the transmission of the safe state in the process data image of the affected inputs.
Remove the error and then acknowledge the message.
Acknowledging the diagnostic message deletes the message and activates the input. The states at the input are detected immediately. **In your safe application program, ensure that the system cannot be restarted unintentionally following acknowledgment of the diagnostic message.**
– Please observe the maximum failure detection time of 80 ms.
Exceptions in the failure detection time are indicated in the tables.
If a “1” signal is present at the input and an error occurs, a maximum of 80 ms elapses until the error is detected. Within this time, another “1” can also be transmitted, even in the event of an error.
Within the failure detection time (80 ms, maximum), the error can cause the state to change unexpectedly from “0” to “1”.
Ensure that such a change in state cannot restart the system unintentionally.

Note about symmetry violation

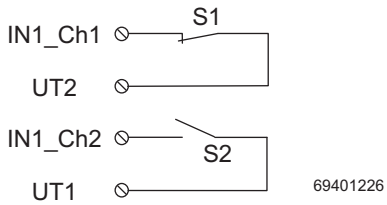
- The symmetry violation diagnostic message is only displayed if it was not disabled during parameterization of the affected input.
- **Start inhibit due to symmetry violation disabled:**
  The symmetry violation message does **not** result in the transmission of the safe state (see also “Symmetry / Start inhibit” on page 50).
  The message must be acknowledged. However, the current status of the inputs is displayed in the process data image of the inputs.
- **Start inhibit due to symmetry violation enabled:**
  The symmetry violation message results in the transmission of the safe state (see also “Symmetry / Start inhibit” on page 50).
  The message must be acknowledged. The current status of the inputs is displayed in the process data image of the inputs following acknowledgment.
- The message can be used to monitor the wear of the safety switch.

7.5.2 Two-channel non-equivalent: Supply through UT1 and UT2 (clocking enabled for both)



S1, S2
Two switching elements

Figure 7-18 Two-channel non-equivalent assignment of inputs, supply through UT1 and UT2 (both clocked)



S1, S2
Two switching elements

Figure 7-19 Two-channel non-equivalent assignment of inputs, supply through UT1 and UT2 (both clocked)

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output UT1 **and** UT2 (both clocked)
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety
- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 89.

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

Table 7-14 Two-channel non-equivalent: Supply through UT1 and UT2 (both clocked)

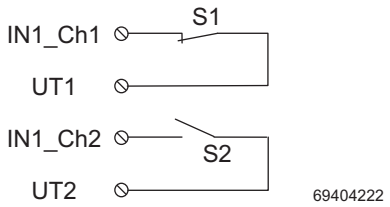
Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
A contact will not close				
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	The error is detected if the other input is set to “1”.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Note about cross-circuits” on page 90.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs that are assigned to different clock outputs.
Short circuit				
Input to ground	Yes	None	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected on a change in state at the latest, as the state only changes in one channel. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.

An error in input circuit INx_Ch2 can only be detected in the event of a requested safety function. Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

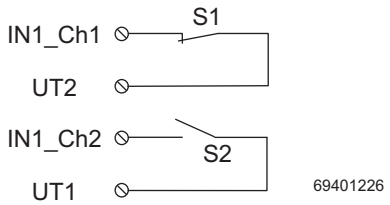
Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same for both inputs
Symmetry	10 ms	10 ms	Application-specific, same for both inputs
Clock selection	UT1	UT2	Or vice versa
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Non-equivalent**	**Non-equivalent**	Same for both inputs
Clock outputs			
	UT1 ON and UT2 ON		

7.5.3 Two-channel non-equivalent: Supply through UT1 and UT2 (of which one clock pulse is disabled)



S1, S2
Two switching elements

Figure 7-20 Two-channel non-equivalent assignment of inputs, supply through UT1 and UT2 (of which one clock pulse is disabled)



S1, S2
Two switching elements

Figure 7-21 Two-channel non-equivalent assignment of inputs, supply through UT1 and UT2 (of which one clock pulse is disabled)

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output UT1 **and** UT2, of which one clock pulse is disabled
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 89.

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

Table 7-15 Two-channel non-equivalent: Supply through UT1 and UT2 (of which one clock pulse is disabled)

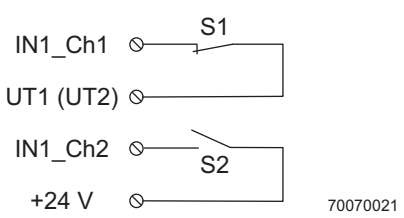
Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
A contact will not close				
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	Cross-circuit detection depends on the switch position. A **cross-circuit** is detected if the expected behavior of the input with regard to the test pulse of the assigned clock output is not achieved (test pulse exceeded). This error can also result in **symmetry violation**, as the signal cannot be changed in both channels simultaneously.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from "1" to "0":** The faulty input remains at "1". A "0" is transmitted in the process data image of the affected inputs.
Input (assigned to the clocked clock output) to non-assigned clock output	Yes	Cross-circuit	No	See "Note about cross-circuits" on page 90.
Input (assigned to the clock output that is not clocked) to non-assigned clock output	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs, that are assigned to the clocked clock output. The error is detected if the input assigned to the clocked clock output is active. **In this case, please note that the failure detection time depends on the switch position.**
Short circuit				
Input to ground	Yes	Symmetry violation	No	The error is detected in state "1" or on a change in state from "0" to "1", as the state only changes in one channel.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected in state "1" or on a change in state from "0" to "1", as the state only changes in one channel. The error is also detected as a short circuit of the clock output.

For all inputs that are assigned to the clock output that is not clocked, cross-circuits and short circuits are not detected by the device diagnostics, but only on a change in state of the input signals, as the state only changes in one channel. Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same for both inputs
Symmetry	10 ms	10 ms	Application-specific, same for both inputs
Clock selection	UT1	UT2	Or vice versa
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Non-equivalent**	**Non-equivalent**	Same for both inputs
Clock outputs			
	UT1 ON and UT2 OFF (24 V)		For specified clock selection

7.5.4 Two-channel non-equivalent: Supply through a clock output (clocking enabled) and external supply

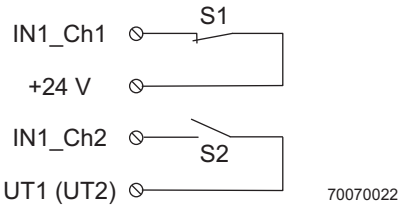


S1, S2
Two switching elements

UT1 (UT2)
Supply through UT1 **or** UT2

+24 V
Supply through external 24 V

Figure 7-22 Two-channel non-equivalent assignment of inputs, internal supply through a clock output (clocked) and external supply



S1, S2
Two switching elements

+24 V
Supply through external 24 V

UT1 (UT2)
Supply through UT1 **or** UT2

Figure 7-23 Two-channel non-equivalent assignment of inputs, internal supply through a clock output (clocked) and external supply

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output UT1 (or UT2) (clocked) and externally
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety
- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 89.

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

Table 7-16 Two-channel non-equivalent: Supply through a clock output (clocked) and external supply

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
A contact will not close				
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	Cross-circuit detection depends on the switch position. A **cross-circuit** is detected if the expected behavior of the input with regard to the test pulse of the assigned clock output is not achieved (test pulse exceeded). This error can also result in **symmetry violation**, as the signal cannot be changed in both channels simultaneously.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs.
Input (assigned to the clocked clock output) to non-assigned clock output	Yes	Cross-circuit	No	See “Note about cross-circuits” on page 90.
Input (not assigned to a clock output) to non-assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs, that are assigned to the clocked clock output. Error detection depends on the switch position. The error is detected if the input assigned to the clocked clock output is active. **In this case, please note that the failure detection time depends on the switch position.**
Short circuit				
Input (assigned to the clocked clock output) to external 24 V	Yes	Cross-circuit	No	The error is detected by the absence of the clock pulses of the clock output.
Input (not assigned to any clock output) to external 24 V	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs.
Input to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clocked clock output to external 24 V	Yes	Cross-circuit	No	The error is detected by the absence of the clock pulses of the clock output. **In this case, please note that the failure detection time depends on the switch position.**

Table 7-16 Two-channel non-equivalent: Supply through a clock output (clocked) and external supply (continued)

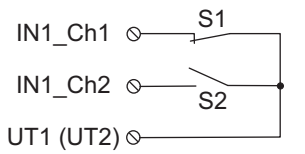
Error type	Detection	Diagnostics	Loss of SF	Comment
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel. The error is also detected as a short circuit of the clock output.
External 24 V to ground	Yes	Symmetry violation	No	**The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.**

For all inputs that are not assigned to a clock output, cross-circuits and short circuits are not detected by the device diagnostics, but only on a change in state of the input signals, as the state only changes in one channel. Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same for both inputs
Symmetry	10 ms	10 ms	Application-specific, same for both inputs
Clock selection	UT1 (or UT2)	No assignment	Or vice versa
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Non-equivalent**	**Non-equivalent**	Same for both inputs
Clock outputs			
	UT1 ON (UT2 any)		For specified clock selection

7.5.5 Two-channel non-equivalent: Supply through a clock output (clocking enabled)



S1, S2
Two switching elements

UT1 (UT2)
Supply through UT1 **or** UT2

Figure 7-24 Two-channel non-equivalent assignment of inputs, supply through UT1 or UT2 (clocked)

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output UT1 (or UT2) (clocked)
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 4 / PL e

WARNING: Loss of electrical and functional safety
- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor must have a high level of diagnostic coverage (> 99%) and high MTTFd.
- Use sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 89.

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

Table 7-17 Two-channel non-equivalent: Supply through a clock output (clocked)

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
A contact will not close				
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected on a change in state at the latest, as the state only changes in one channel.

Table 7-17 Two-channel non-equivalent: Supply through a clock output (clocked) (continued)

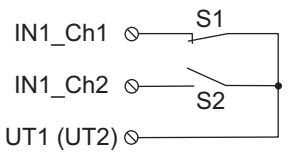
Error type	Detection	Diagnostics	Loss of SF	Comment
Cross-circuit				
Input to input	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
Input to assigned clock output	Yes	Symmetry violation	No	The error is detected on a change in state, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Note about cross-circuits” on page 71.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs, that are assigned to the clocked clock output. **In this case, please note that the failure detection time depends on the switch position.**
Short circuit				
Input to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected as a change in state from “1” to “0”. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.

Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same for both inputs
Symmetry	10 ms	10 ms	Application-specific, same for both inputs
Clock selection	UT1	UT1	Or both UT2
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Non-equivalent**	**Non-equivalent**	Same for both inputs
Clock outputs			
	UT1 ON (24 V) (UT2 any)		Or vice versa

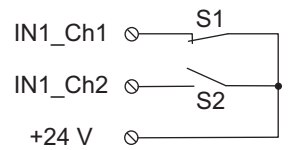
7.5.6 Two-channel non-equivalent: Supply through a clock output (clocking disabled) or external supply



S1, S2
Two switching elements

UT1 (UT2)
Supply through UT1 **or** UT2

Figure 7-25 Two-channel non-equivalent assignment of inputs, supply through UT1 (or UT2) (clocking disabled)



S1, S2
Two switching elements

+24 V
Supply through external 24 V

Figure 7-26 Two-channel non-equivalent assignment of inputs, external supply

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output UT1 (or UT2) (clocking disabled) **or** externally
Achievable SIL/SILCL/Cat./PL	SIL 3 / SILCL 3 / Cat. 3 / PL d

WARNING: Loss of electrical and functional safety

- To achieve the specified category, please refer to Section “Measures required to achieve a specific safety integrity level” on page 59.
- Please note that in order to achieve the specified PL, the sensor 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 sensors that can achieve the required safety integrity.

To understand the change in state, please refer to “Example of correct and incorrect signal change” on page 89.

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

Table 7-18 Two-channel non-equivalent: Supply through a clock output (clocking disabled) or external supply

Error type	Detection	Diagnostics	Loss of SF	Comment
Error in the sensor				
A contact will not open	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
A contact will not close				
Other errors (depending on the sensor)				**Please take into consideration all possible errors that can occur in the sensor.**
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel.
Input to clock output (assigned or not assigned)	Yes	Symmetry violation	No	The error is detected, as the state only changes in one channel. – **Change in state from “1” to “0”:** The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs.
Clock output to clock output	**No**	None	No	The error is not detected.
Short circuit				
Input to external 24 V	Yes	Symmetry violation	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Input to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output to external 24 V	**No**	None	No	The error is not detected.
Clock output to ground	Yes	Short circuit UTx ON	No	The error is detected as a change in state from “1” to “0”. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.
External 24 V to ground	Yes	Symmetry violation	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.

Early error detection, e.g., by testing the safety function at regular intervals, is required, as an accumulation of errors may result in the loss of the safety function.

Typical parameterization

Parameterization	Parameterized as		Comment
Input	**Channel 1**	**Channel 2**	
Assignment	**Used**	**Used**	
Evaluation	**Two-channel**	**Two-channel**	
Sensor type	**Standard sensor**	**Standard sensor**	
Filter time (t_{Filter})	3 ms	3 ms	Application-specific, same for both inputs
Symmetry	10 ms	10 ms	Application-specific, same for both inputs
Clock selection	UT1	UT1	Or both UT2 or no assignment (external)
Bounce time monitoring	Disabled	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Disabled	Application-specific, same for both inputs
Input signal	**Non-equivalent**	**Non-equivalent**	Same for both inputs
Clock outputs			
	UT1 OFF (24 V) (UT2 any)		Where clock selection = UT1

8 Startup and validation

8.1 Initial startup

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

Table 8-1 Steps for startup

Step	Relevant section and literature
Set the transmission speed and the mode.	Section “Setting the DIP switches” on page 38
Set the protocol/address.	Section “Setting the DIP switches” on page 38
Install the safety module within the Inline station.	Section “Assembly, removal, and electrical installation” on page 37
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 inputs according to your application.	Section “Assembly, removal, and electrical installation” on page 37 Section “Inline potential and data routing, and Inline connectors” on page 31 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
Once the operating voltage has been applied: – If possible, measure the waveform of the voltages to make sure that there are no deviations. – Measure the input voltages on the module to make sure that they are in the permissible range. – Use the LEDs on the module to check that the module starts up without any errors.	
Check the mounting and installation.	Checklist “Assembly and electrical installation” on page 145
Carry out the necessary parameterization.	Section “Parameterization of the safety module” on page 45 Documentation for the SafetyProg software (INTERBUS-Safety) Documentation for the configurable safety module used (SafetyBridge) Documentation for the controller used (PROFIsafe)

Table 8-1 Steps for startup (Fortsetzung)

Step	Relevant section and literature
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 147 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 147

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 111.

8.2 Restart after replacing a safety module

8.2.1 Replacing a safety module

WARNING: Unintentional machine startup

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

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

Make sure the entire 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 “Assembly, removal, and electrical installation” on page 37).

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

– Same device type
– Same or later version

8.2.2 Restart

Once the safety module has been replaced, proceed as described for initial startup (see section “Initial startup” on page 107).

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

8.3 Validation

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

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

Determine whether:

– The correct safe sensors 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 sensors correctly

Perform a function test and error simulation.

Please observe the checklist “Validation” on page 147 during validation.

9 Errors: messages and removal

Depending on the error type, errors that are diagnosed are displayed via the local diagnostics indicators and/or transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or the configurable 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, which 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 120.

Module replacement following an error

If in the event of failure the safety module is replaced, please proceed as described in section 4, “Assembly, removal, and electrical installation” and section “Restart after replacing a safety module” on page 109.

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.,	012	x

Error code

The error code is specified in figure 9-1 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., IN0_Ch1).
Some errors only occur for inputs/outputs parameterized for two-channel operation. Here, the channel pair is specified as the error location (e.g., IN0_Ch1&2).

Example:

Safe input errors (figure 9-1)

Error cause	Error Code (Hex)
Cross-circuit	012x
x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	

012x Cross-circuit

012**x** Error location

This means, for example:

0122 Cross-circuit at IN2_Ch1 (input 2 channel 1)

012 A Cross-circuit at IN3_Ch2 (input 3 channel 2)

LED

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

Acknowledgment

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

9.1 Safe digital input errors

Table 9-1 Safe digital input errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Permissible bouncing time was exceeded x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**011x**	–	Not safety-related. Poor switch quality; contact bouncing is too long compared to the filter time.	Inputs continue to be detected and their states transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or a configurable safety module (SafetyBridge)	Check switches and replace, if necessary Check parameterized filter time	Yes (1)
Cross-circuit x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**012x**	–	Cross-circuit with another input or with a clock output	Affected input is in the safe state	Check sensor Check clock outputs Check connector and cabling	Yes (2)
Symmetry violation x = 0 ... 3: IN0 Ch1&2 ... IN3_Ch1&2	**013x**	–	Not safety-related. Only for inputs parameterized for two-channel operation: Used to evaluate the contacts of connected switches. State change in both channels takes longer than the value parameterized for symmetry This message can also be triggered by a cross-circuit/short circuit.	"Start inhibit due to symmetry violation" is disabled: Inputs continue to be detected and their states transmitted to the safe controller (INTERBUS-Safety, PROFIsafe) or a configurable safety module (SafetyBridge) "Start inhibit due to symmetry violation" is enabled: Affected input is in the safe state.	Check whether the message was triggered by a short circuit/cross-circuit If not: Check value for symmetry Check switches Replace switches during next maintenance. Activate connected I/O devices once (e.g., activate and unlock emergency stop).	Yes (4)
Hardware fault x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**014x**	–		All module inputs are in the safe state	Power up with error-free selftest Exchange	Yes (3)
Sensor error x = 0 ... 3: IN0 Ch1&2 ... IN3_Ch1&2	**015x**	–	At the input that was parameterized for an intelligent sensor	Affected input is in the safe state	Check sensor	Yes (2)

Table 9-1 Safe digital input errors (continued)

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Signal error x = 0 ... 3: IN0 Ch1&2 ... IN3_Ch1&2	**016x**	–	At the input that was parameterized for an intelligent sensor (incorrect or distorted clock signal, e.g., due to short circuit; different states at both inputs)	Affected input is in the safe state	Check sensor	Yes (2)
Hardware fault	**0170**	–		All module inputs are in the safe state	Power up with error-free selftest Exchange	Yes (3)
Error during signal change x = 0 ... 3: IN0 Ch1&2 ... IN3_Ch1&2	**018x**	–	Only for inputs parameterized for two-channel operation; implausible signal change at indicated input pair	Affected inputs in the safe state	Set both inputs to the safe state	Yes (1)

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

Acknowledgment: Yes (2) Acknowledging the diagnostic message deletes the message and activates the input. The states at the input are detected immediately. In your safe application program, ensure that the system cannot be restarted unintentionally following acknowledgment of the diagnostic message.

Acknowledgment: Yes (3) Acknowledging the diagnostic message deletes the message. The module can only be restarted following power up and error-free selftest.

Acknowledgment: Yes (4) “Start inhibit due to symmetry violation” is disabled:
Acknowledging the diagnostic message deletes the message.

“Start inhibit due to symmetry violation” is enabled:
Acknowledging the diagnostic message deletes the message and activates the disabled inputs again.

9.2 Clock output UT1 and UT2 errors

Table 9-2 Clock output errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Short circuit or overload x = 0: Clock output UT1; x = 7: Clock output UT2	**01Ex**	UT1 or UT2 ON		Affected clock output is disabled. Assigned inputs are set to “0”.	Check connector and cabling (acknowledge error at all inputs, if necessary)	Yes (1)

Acknowledgment: Yes (1) Acknowledging the diagnostic message deletes the message and re-enables the clock output and the assigned inputs. In your safe application program, ensure that the system cannot be restarted unintentionally following acknowledgment of the diagnostic message.

The clock outputs are also switched on and monitored when not parameterized. If a short circuit occurs at a clock output when it is in this state, the clock output is switched off.

To exit the error, parameterize the device and acknowledge the error message.

9.3 Supply voltage errors

Table 9-3 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 inputs 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 inputs.

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

9.4 Parameterization errors

Table 9-4 Parameterization errors

Error cause	Error Code (Hex)	LED	Comment	Effect	Remedy	Acknowledgment
Incorrect parameterization	See figure 9-5	FS (flashing)	Each input and clock 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 software to access the safe controller (INTERBUS-Safety, PROFIsafe) or the standard control system (SafetyBridge) 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 9-5 Parameterization error

Error code		Short description	Remedy
(hex)	(dec)		
031x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**784**: IN0_Ch1 : **787**: IN3_Ch1; **791**: IN0_Ch2 : **794**: IN3_Ch2	The filter time setting for the input is outside the permissible range.	Correct value and resend parameter data to the module.
032x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**800**: IN0_Ch1 : **803**: IN3_Ch1; **807**: IN0_Ch2 : **810**: IN3_Ch2	The clock assignment for the input is outside of the permissible range.	Correct value and resend parameter data to the module.
033x x = 0 ... 3: IN0_Ch1&2 ... IN3_Ch1&2	**816**: IN0_Ch1&2 : **819**: IN3_Ch1&2	The parameterization of two related inputs does not correspond to the two-channel setting.	Correct values and resend parameter data to the module.
034x x = 0 ... 3: IN0_Ch1&2 ... IN3_Ch1&2	**832**: IN0_Ch1&2 : **835**: IN3_Ch1&2	The setting for the symmetry monitoring of related inputs is not the same.	Inputs that are parameterized for two-channel operation must have the same symmetry settings. Correct values and resend parameter data to the module.

Table 9-5 Parameterization error (continued)

Error code		Short description	Remedy
(hex)	(dec)		
035x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**848**: IN0_Ch1 : **851**: IN3_Ch1; **855**: IN0_Ch2 : **858**: IN3_Ch2	The value for symmetry monitoring is outside the permissible range.	Correct value and resend parameter data to the module.
036x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**864**: IN0_Ch1 : **867**: IN3_Ch1; **871**: IN0_Ch2 : **874**: IN3_Ch2	Intelligent sensor has been connected to an input parameterized for single-channel operation.	Connect intelligent sensor to an input parameterized for two-channel operation and parameterize inputs accordingly. Correct values and resend parameter data to the module.
037x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**880**: IN0_Ch1 : **883**: IN3_Ch1; **887**: IN0_Ch2 : **890**: IN3_Ch2	Even though the input was parameterized for intelligent sensors, bounce time monitoring has been activated.	The bounce time monitoring function can only be activated for operation with standard sensors. Correct value and resend parameter data to the module.
038x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**896**: IN0_Ch1 : **899**: IN3_Ch1; **903**: IN0_Ch2 : **906**: IN3_Ch2	Even though the input was parameterized for intelligent sensors, symmetry monitoring has been activated for the input.	The symmetry monitoring function can only be activated for operation with standard sensors. Correct value and resend parameter data to the module.
039x x = 0 ... 3: IN0_Ch1 ... IN3_Ch1; x = 7 ... A: IN0_Ch2 ... IN3_Ch2	**912**: IN0_Ch1 : **915**: IN3_Ch1; **919**: IN0_Ch2 : **922**: IN3_Ch2	Even though the input was parameterized for intelligent sensors, antivalent signal processing has been activated for the input.	Non-equivalent processing of two-channel inputs may only be activated for operation with standard sensors. Correct value and resend parameter data to the module.
03Ax x = 0 ... 3: IN0_Ch1&2 ... IN3_Ch1&2	**928**: IN0_Ch1&2 : **931**: IN3_Ch1&2	The settings for the input signal for the indicated input and the related input differ.	Assign the same setting for the input signal to related inputs and resend parameter data to the module.
03Cx x = 0 ... 3: IN0_Ch1&2 ... IN3_Ch1&2	**960**: IN0_Ch1&2 : **963**: IN3_Ch1&2	The filter time of inputs parameterized for two-channel operation differs.	Assign the same setting for the filter time to related inputs and resend parameter data to the module.

Table 9-5 Parameterization error (continued)

Error code		Short description	Remedy
(hex)	(dec)		
03Ex x = 0: Clock output UT1; x = 7: Clock output UT2	**992**: Clock output UT1; **999**: Clock output UT2	The setting for the clock output is outside the permissible range.	Clock output parameters are not permissible or do not harmonize with the set sensor type. Correct value 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.

9.5 General errors

Table 9-6 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 – 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 corresponding function block (see documentation for the controller used). Acknowledge diagnostic message 01F3 so that the next message from the error memory can be indicated.	Yes (1)
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.

9.6 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 139.

– PROFIBUS or PROFINET system errors. For information about these errors, please refer to the documentation for the system used.

9.7 Acknowledging an error

9.7.1 Acknowledging an error for INTERBUS-Safety

– Remove the cause of the error.
– Then acknowledge the diagnostic message 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 input 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, “Assembly, removal, and electrical installation” and section 8.2, “Restart after replacing a safety module”.

9.7.2 Acknowledging an error for SafetyBridge

An IB IL 24 PSDI 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.

9.7.3 Acknowledging an error for PROFIsafe

– Remove the cause of the error.
– Then acknowledge the diagnostic message.

For instructions on error acknowledgment, please refer to the documentation for the controller 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 input 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, “Assembly, removal, and electrical installation” and section 8.2, “Restart after replacing a safety module”.

10 Maintenance, repair, decommissioning, and disposal

10.1 Maintenance

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

The duration of use of the module is 20 years.

Repeat testing within this time is not required.

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

10.2 Repair

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

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

10.3 Decommissioning and disposal

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

When decommissioning an INTERBUS-Safety, SafetyBridge or PROFIsafe system or parts thereof, ensure that the safety modules used:

– Are correctly reused in another system
  In this case, please observe the storage and transport requirements according to the technical data (see “IB IL 24 PSDI 8-PAC” on page 126).
  Or
– are disposed of in accordance with the applicable environmental regulations, and in this case can never be reused.

11 Technical data and ordering data

11.1 System data

11.1.1 INTERBUS-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

11.1.2 SafetyBridge

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

11.1.3 PROFIsafe

PROFIsafe	
PROFIsafe profile	2.4

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

11.2 IB IL 24 PSDI 8-PAC

General data	
Housing dimensions (width x height x depth)	48.8 mm x 120 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 60664-1
Protection class	III (PELV)
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

General data (continued)	
Resistance of the housing material to fungal decay	Resistant
Ambient compatibility	Not resistant to chloroform
Connection data for Inline connectors	
Connection method	Spring-cage terminal blocks
Conductor cross section	0.2 mm^2 ... 1.5 mm^2 (solid or stranded), AWG 24-16

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 characteristics 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 sensors depending on the parameterization” on page 23 and section “Connection examples for safe inputs” on page 57)
Probability of a dangerous failure on demand by the safety function (PFD)	SIL 2: 1% of 10^{-2}, maximum (corresponds to 1 x 10^{-4}) SIL 3: 1% of 10^{-3}, maximum (corresponds to 1 x 10^{-5})
Probability of a dangerous failure per hour for the entire module (PFH)	SIL 2: 1% of 10^{-6}, maximum (corresponds to 1 x 10^{-8}) SIL 3: 1% of 10^{-7}, maximum (corresponds to 1 x 10^{-9}) Depends on the parameterization (see Table 7-4 on page 59)
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years

Safety characteristics according to DIN 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 sensors depending on the parameterization” on page 23, section “Connection examples for safe inputs” on page 57)
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 x 10^{-8}) SIL 3: 1% of 10^{-7}, maximum (corresponds to 1 x 10^{-9}) Depends on the parameterization (see Table 7-4 on page 59)
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years

Safety characteristics according to EN ISO 13849-1	
Achievable performance level	PL e (two-channel) PL d (single-channel) Depends on the parameterization and wiring (see section “Connection options for sensors depending on the parameterization” on page 23 and section “Connection examples for safe inputs” on page 57)
Diagnostic coverage (DC)	99 %
Mean time to dangerous failure (MTTFd)	For single-channel assignment: 76 years For two-channel assignment: 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	180 mA, maximum

Supply voltage U_M (sensors, clock outputs)

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

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

Nominal voltage	24 V DC according to EN 61131-2 and EN 60204
Tolerance	-15%/+20% including an entire AC voltage component with peak value of 5%
Ripple	3.6 V_{PP}
Permissible voltage range	19.2 V DC to 30.0 V DC, ripple included
Current consumption	25 mA, typical (**plus** current consumption of the inputs when supplied through the clock outputs **plus** current consumption of the connected initiators when supplied through the clock outputs)
Permissible interrupt time	10 ms (output voltage of the clock outputs can fail)

Supply voltage U_M (sensors, clock outputs) (continued)	
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 17 V, approximately
Diagnostics indicators	Green U_M LED (see “Local diagnostic and status indicators” on page 24)
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 inputs	
Number	4 two-channel or 8 single-channel
Input design	According to the requirements of EN 61131-2 Type 3
Supply	Via clock outputs UT1 and UT2 or external supply
Input current	Approximately 4.2 mA at 24 V, typical
Maximum permissible current for “0”	2 mA
Minimum permissible current for “1”	3.1 mA
Permissible input voltage range	-3 V to +30 V
Voltage range for “0”	-3 V to +5 V
Voltage range for “1”	11 V to 30 V
Maximum switching frequency	10 Hz
Filter time t_{Filter}	Can be parameterized; see section “Parameterization of the safe inputs” on page 48
Minimum filter time	1.5 ms, accuracy +0 ms, -0.5 ms
Processing time of the input	$t_{IN} = t_{Filter} + t_{FW}$ (see “Processing time of input t_{IN} in the event of a safety demand” on page 52)
Simultaneity	100 %
Symmetry evaluation	Yes, can be parameterized, accuracy ±25%
Derating	No

Safe digital inputs (continued)	
Permissible cable lengths	200 m from the clock output to the safe input (total based on forward and return path)
Status indicators	One green LED per input (see “Local diagnostic and status indicators” on page 24)

The switching state of the inputs is constantly monitored. In the event of an error, e.g., if a component fails, the error is indicated at the safe controller (INTERBUS-Safety, PROFIsafe) or a configurable safety module (SafetyBridge).

Clock outputs	
Number	2
Supply	From U_M
Maximum switching current	0.4 A short circuit and overload protection
Saturation voltage	U_M –1 V
Simultaneity	100 %
Derating	No
Permissible cable lengths	The total length of the connected cables must not exceed 200 m per clock output
Status indicators	None
Diagnostics indicators	One red LED for each (UT1, UT2) (see “Local diagnostic and status indicators” on page 24)

Power dissipation	
If U_M = 24 V, no input is set, without load at clock outputs UT1 and UT2	1560 mW
If U_M = 24 V, 8 inputs are set, load at clock outputs UT1 and UT2 is 100 mA each	2330 mW

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.

The isolating distance between U_M and FE is covered by a varistor.

Approvals

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

11.3 Conformance with EMC Directive

Conformance with EMC Directive 2014/30/EU

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

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

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

Noise emission	EN 55011	Class A Industrial

11.4 Ordering data

11.4.1 Ordering data: Safety module

Description	Type	Order No.	Pcs./Pkt.
Inline module with safe digital inputs	IB IL 24 PSDI 8-PAC	2985688	1

11.4.2 Ordering data: Accessories

Description	Type	Order No.	Pcs./Pkt.
Plug set, consisting of four Inline connectors with integrated discharge electronics	IB IL 24 PSDI 8-PLSET/CP/R	2700720	1 set

11.4.3 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-PAC
User manual Inline module with integrated safety logic and safe digital outputs	UM EN IB IL 24 LPSDO 8 V2-PAC
User manual Inline module with integrated safety logic and safe digital outputs	UM EN IB IL 24 LPSDO 8 V3-PAC
PROFIsafe	
Quick start guide Configuring Inline modules with safe inputs or outputs under PROFIsafe on a SIMATIC® S7 controller	UM QS EN IB IL 24 PSDX - S7

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

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

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

A Appendix: PROFIsafe terms used in the user manual

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

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

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")

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.

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 inputs" on page 57).
F_CRC_Length	*3-byte CRC*	This parameter transmits the length of the CRC2 code to be expected in the safety telegram to the safe controller.
F_Block_ID	*1*	Parameter block type identification. 1: the parameter block of the F-Parameters contains the F_iPar_CRC parameter.
F_Par_Version	*1*	Version number of the F-Parameter block. 1: valid for V2 mode.
F_iPar_CRC	0	CRC checksum via the iParameters The value must be greater than 0. When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices. If not, check the iParameters and the CRC checksum in the iParameter and F-Parameter.

B 2 iParameter

The iParameters are individual device parameters. These include:

– Device parameters (see "Parameterization of the safe inputs" and "Parameterization of clock outputs UT1 and UT2")
– PST_Device_ID (10_{hex} for IB IL 24 PSDI 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.

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.

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 (10_{hex} for IB IL 24 PSDI 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 Parameter errors

SafetyBridge error code		Error cause	Remedy
dec	hex		
1088	440	SafetyBridge: 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.
1095	447	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.

C Appendix: Conditions for use at altitudes greater than 2000 m above sea level

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

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

C 1 Conditions

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

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

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

For relay outputs:

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

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

C 2 Example calculation

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

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

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

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

Calculation:

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

Reduced derating:

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

D Appendix: Checklists

The checklists listed in this section provide support during the planning, assembly and electrical installation, startup, parameterization, and validation of the IB IL 24 PSDI 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 the validation, initial startup, and regular testing performed by qualified personnel.

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

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

Checklist . . .				
Device type / Equipment identification		IB IL 24 PSDI 8-PAC / BK20NA10		
Version: HW/FW	00/200	**Date**	2008-01-17	
Test engineer 1	John Smith	**Test engineer 2**	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	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.
Test engineer 1/2	Enter the names of the test engineers.
Comment	Where necessary, enter a comment.
Requirement (mandatory)	These requirements must be met for a safety application, in order to complete the relevant phase using the checklist.
Requirement (optional)	These requirements are optional. For points that are not met, please enter an appropriate remark in the relevant field.

D 1 Planning

Checklist for planning the use of the safety module			
Device type / Equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
Comment			

No.	Requirement (mandatory)	Yes	Comment
1	Has the current module user manual been used as the basis for planning?	☐	Revision:
2	Are the sensors approved for connection to the module (according to the technical data and parameterization options)?	☐	
3	Has the power supply been planned according to the specifications for the protective extra-low voltage in accordance with PELV?	☐	
4	Is external protection of the module planned (according to the specifications in this user manual for supply voltage U_M)?	☐	
5	Are measures planned to prevent simple tampering?	☐	
6	Are measures planned to prevent connectors being mixed up?	☐	
7	Are requirements for the sensors and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved and is the corresponding implementation planned?	☐	
8	Are the specifications for the parameterization for each channel defined?	☐	
9	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
10	Does the planned use correspond to the intended use?	☐	
11	Are the ambient conditions observed according to the technical data?	☐	
12	Have test intervals been defined?	☐	

No.	Requirement (optional)	Yes	No	Comment
13	Have the accessories to be used been planned according to the ordering data in this user manual (cables, connectors)?	☐	☐	
14	Have specifications for assembly and electrical installation been defined (e.g., EPLAN) and communicated to the relevant personnel?	☐	☐	
15	Have specifications for startup been defined and communicated to the relevant personnel?	☐	☐	

	Date	Signature (test engineer 1)
	Date	Signature (test engineer 2)

D 2 Assembly and electrical installation

Checklist for assembly and electrical installation of the safety module			
Device type / Equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
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 and the operating mode set correctly according to the specifications?	☐	☐	
5	Is the protocol/address set correctly according to the specifications?	☐	☐	

Date	Signature (test engineer 1)
Date	Signature (test engineer 2)

D 3 Startup and parameterization

Checklist for startup and parameterization of the safety module			
Device type / Equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
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 inputs?	☐	
4	For inputs that are parameterized for two-channel operation, are both channels parameterized correctly for each other?	☐	
5	Is the assignment to the clock outputs parameterized for the inputs?	☐	
6	Are the clock outputs parameterized?	☐	

No.	Requirement (optional)	Yes	No	Comment
7	Have safety distances that must be observed been calculated according to the response and delay times implemented?	☐	☐	

Date	Signature (test engineer 1)
Date	Signature (test engineer 2)

D 4 Validation

Checklist for validating the safety module			
Device type / Equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
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 inputs and clock outputs correspond to the version and the actual connection of the controlling devices?	☐	
5	Has the assignment of the sensors to the inputs 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	Is external fuse protection of the module implemented (according to the specifications in this user manual for supply voltage UM)?	☐	
11	Have measures been taken to prevent simple tampering?	☐	
12	Have measures been taken to prevent plugs being mixed up?	☐	
13	Are requirements for the sensors and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved?	☐	
14	Are the specifications for the parameterization for each channel implemented?	☐	
15	For PROFIsafe: Is the F_iPar_CRC parameter greater than 0 for all devices?	☐	
16	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 (test engineer 1)
		Date	Signature (test engineer 2)

E Appendix: Index

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F Appendix: Revision history

Revision	Date	Contents	
01	07/2008	First publication	
02	08/2009	Extended to include the SafetyBridge system; completely revised	
03	2010-03-25	p. 11-1	For SafetyBridge and PROFIsafe Module processing time Moduls t_{IN} deleted
04	2010-12-09		Global: Editorial revision Standard EN 954-1 removed; Cat. 4 assigned to EN ISO 13849-1 LPSDO no longer referred to as the product, but generally referenced as the configurable safety module
			FW 200 changed to 201
		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
		p. 2-6	Added under note about parameterization: The clock outputs are also...
		p. 2-9	Added: Note about state when not parameterized
		p. 5-9	Added: As long as the module is not parameterized: ...
		p. 9-1	Added: Module replacement following an error
		p. 9-4	Added: Error 018x
		p. 11-7	Added: User manual for the IB IL 24 LPSDO 8 V2-PAC
		Tab. B-2, Tab. B-3	Completely revised
05	2011-07-29		FW 201 added
		p. 2-2	Mode added
		p. 2-9	“Status display for communication” changed to “Status display for safe communication”
		Tab. 4-2	1_{dec} to 6_{dec} corrected to 1_{dec} bis 5_{dec}
		Tab. 8-1	Operating mode changed to mode
		p. 11-6	Accessories ordering data added
06	2013-06-25	p. 4-3	Switch position for SafetyBridge V3 added

Revision	Date	Contents	
07	2017-11-29	Book	New cover + rear cover added
		Book	Page number format changed
		Cover page	Order number for user manual removed HW/FW version updated (**from** HF/FW)
		Section 1	Labeling for warning notes and qualification of the users added (previously on the cover)
		Section 4	Section 4.1.3 "Setting the DIP switches" revised
		Table 4-3	Switch position for SafetyBridge V3 changed
		Page 9 Page 123	Information about safety seals removed
		Page 131	Updated EMC directive
		Page 132	Order No. and Pcs./Pkt. columns removed from table "Ordering data: Documentation", UM EN IB IL 24 LPSDO 8 V3-PAC added
		Page 141	Appendix “Conditions for use at altitudes greater than 2,000 m above sea level” added

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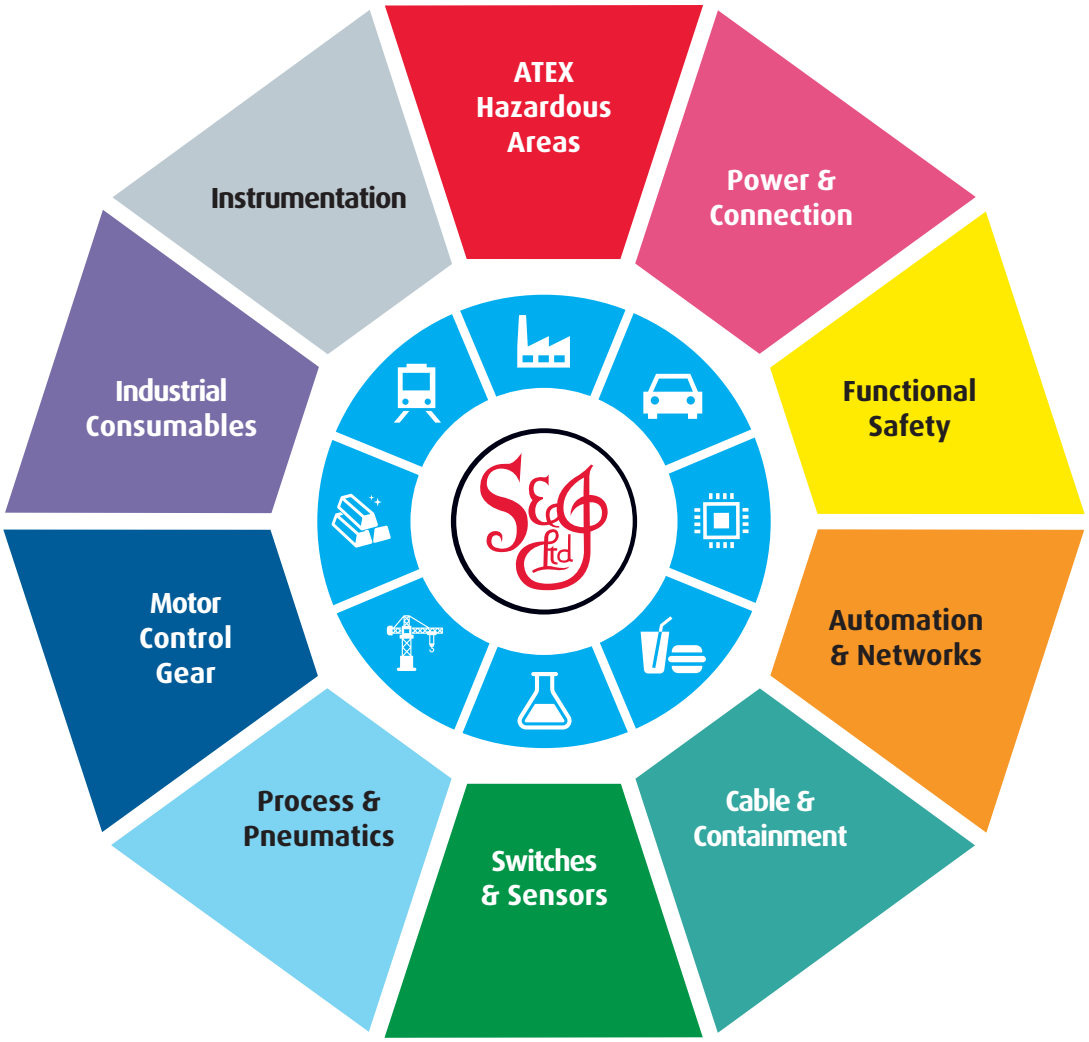

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