CE

Original operating instructions
PROFIsafe IO-Link device

AL200S GB

Contents

GB

1 Preliminary note

This document applies to devices of the type "Profisafe IO-Link device" (art. no. AL200S). It is part of the device.

Read this manual carefully and keep it for future reference.

Instructions, technical data, software downloads, approvals, accessories and further information at www.ifm.com.
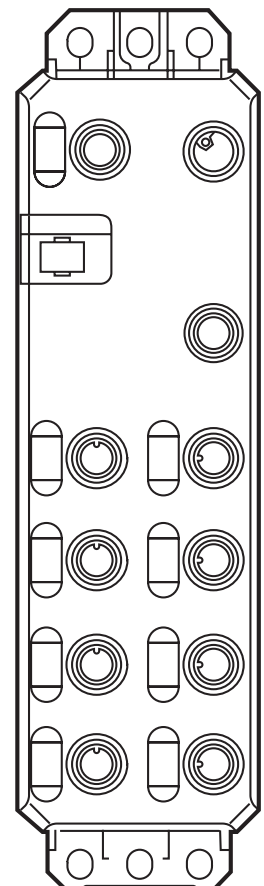
1.1 Scope of application of this manual

- Hardware HW00
- Firmware 110/110

1.2 Labelling of warning notes

Symbols

⚠ 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 warns the reader of actions that might cause property damage or a malfunction.

[ℹ] Here you will find additional information or detailed sources of information.

→   Cross-reference

1.3 Qualification of users

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

- qualified personnel, who plan and develop safety equipment for machines and systems and are familiar with safety regulations in the workplace and accident prevention measures.
- qualified personnel, who install and operate safety equipment in machines and systems.

Qualified personnel

Qualified personnel are people who, because of their education, experience, and training, and their knowledge of relevant standards, regulations, accident prevention, and operating conditions, have been authorised by those responsible for the safety of the plant to carry out any required operations and who are able to recognise and avoid any possible dangers.

Requirements

Knowledge of the following topics is required:

- – handling safety components
- – valid EMC regulations
- – valid regulations governing occupational safety and accident prevention

GB

In addition, knowledge of the following topics and products is required:

- – non-safety related target system, e.g. PROFINET
- – PROFIsafe system
- – components used
- – product family PROFIsafe IO-Link
- – using the software tools
- – safety regulations in the field of application

When using the system, the following operations must be carried out by qualified personnel:

- – planning
- – configuration, parameter setting, programming
- – installation, set-up, servicing
- – maintenance, decommissioning

1.4 Change history

Date	Version	Modification
04/2020	00	First publication
08/2020	01	Chapter 3.5.2 Changes made in table "Connection options for actuators"
		Chapter 3.8.1 Firmware runtime modified Chapter 3.8.3 "Switch-off time of the safe output" modified
		Chapter 8.4 "Parameterisation of the safe outputs" Changes made to the note on test pulses
		Chapter 10.4 "Two-channel assignment of positive and negative switching outputs" Note on test pulses added
		Chapter 12.2 "Error codes" Error codes 6320 + 024X ... 6320 + 032X, 8F00 added
		Chapter 15 Technical data Permissible cable lengths for safe inputs and safe outputs added
01/2021	01	Chapter 8.4.1 Behaviour of the outputs with stop category 1 Warning note on incorrect / old condition data of the device added
02/2021	01	Chapter 8.2.1 Safety address instead of device ID
		Chapter 5.1 Electronic type label byte lengths modified
		Chapter 5.1 Electronic type label change to AL200S effected in "Content" column
		Chapter 3.1 Brief description further article number added
		Chapter 8.4.1 Note on SafetyBridge deleted in table
		Chapter 12.2 Error codes Deleted: The affected output is retained in the safe state.
		Chapter 12.2 Error codes Double entry of error code 3413 deleted
		Chapter 12.1 Two function blocks explicitly specified
04/2021	01	Chapter 1.4.1 IO-Link masters AL1400....added
08/2021	02	SILCL became SIL throughout the document
		Chapter 3.6.1 Description LED "P"
		Chapter 4 Table "Process data length" deleted
		Chapter 7.2.3 Table "Input sockets" added
		Chapter 7.2.4 Table "Output sockets" added and table "Pin assignment" modified
		Chapter 8.2 Information added
		Chapter 8.2.1 "Address assignment" modified
		Chapter 10.4 "Key data" modified
		Chapter 12.2 Legend extended, LED display and description added in error codes 3411, 3413, 3421, 3423 Error code 6351 Remedy/acknowledgement
		Chapter 15 Technical data - weight modified
		Chapter 16 Error codes added
		Chapter 1.1 Hardware and software versions inserted

Date	Version	Modification
		Chapter 1.8 Applicable documentation inserted
		Chapter 1 Reference to ifm homepage inserted
		Chapter 15.3 Data for download inserted
		Chapter 3.8.5, 8.2.1, 12 Notes on PROFIsafe removed

1.5 Field of application of the product

1.5.1 Intended use

The device is intended to be exclusively used in a PROFIsafe system and to be operated solely with ifm IO-Link masters AL1400, AL1401, AL1402, AL1403.

The device is designed for connecting safe single-channel or two-channel sensors and suitable single-channel or two-channel actuators.

Safety functions

The module executes the following safety functions:

– safe reading

– safe output

– safe transmission of I/O signals

Safe switch-off

The intended use of the safety module is safe switching-off. Safe switching-on does not correspond to the intended use.

> ⓘ → chapter "Product description" → "Safe state"

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

Achievable safety integrity

Depending on the conditions of use, you can achieve the following safety integrity level with the safety module within a system:

– up to SIL 3 according to IEC 61508 und EN62061

– up to Cat. 4/PL e according to EN ISO 13849-1

Technical data and environmental conditions

Only use the device according to the defined technical data and environmental conditions.

> ⓘ → chapter "Technical data"

Safety of personnel and equipment

The safety of personnel and equipment can only be assured if the safety module is used correctly.

1.5.2 Foreseeable misuse

⚠️ **WARNING: Serious risks due to inappropriate use**

Inappropriate or unintended use, as well as manipulation of the safety module, can lead to serious danger for the user and/or damage to equipment.

1.5.3 Product changes

Modifications to hardware and firmware of the device are not permitted.

Improperly performed work or modifications to the device can endanger your safety or damage the device. Do not repair the device yourself. If the device is defective, please contact ifm.

1.6 Safety instructions

1.6.1 Safety of machines or systems

Draw up and implement a safety concept

The safety of the machine or system and of the application in which the machine or system is used is the responsibility of the machine/system manufacturer and the operating company.
In order to use the device described in this document you must have drawn up an appropriate safety concept for your machine or system. This includes the hazard and risk analysis, among others, according to the directives and standards listed in chapter "Directives and standards" on page 8.

Risk assessment, validation and function test

- Before using the device, perform a risk assessment for the machine or system.

- Validate your entire safety system.

- Carry out a new validation every time you make a safety-related modification.

- Perform a function test on a regular basis.

Achievable safety integrity

Functional safety is guaranteed for the device as a single component. However, this does not guarantee functional safety for the entire machine or system. In order to achieve the desired safety level for the entire machine or system, define the safety requirements for the machine or system, as well as how to implement them, from both a technological and organisational perspective.

1.6.2 Safety when starting applications

Start conditions

Take the following into consideration when determining the start conditions for your machine or system:

– The machine or system may only be started if it can be ensured that nobody is present in the danger zone.

– Meet the requirements of EN ISO 13849-1 with regard to the manual reset function.

GB

This applies for:

– the switching on of safe participants

– the acknowledgement of device error messages

– the acknowledgement of communication faults

– the acknowledgement of function block error messages in the application

– the cancelling of start interlocks for safety functions

Observe the following when programming/configuring your safety logic:

– Changing from the safe state (substitute value = 0) to the operating state can cause an edge change (zero-to-one edge).

– Provide measures in the safety logic that prevent this edge change from leading to an unexpected start or restart of the machine/system.

1.7 Directives and standards

The directives and standards complied with by the safety module can be found in the certificate issued by the approval body and in the EC declaration of conformity.

These documents are available online at ifm.com.

1.8 Documentation

The symbol indicates that you must follow the instructions for use. Only install and operate the device when you have familiarised yourself with its features with the help of the user documentation.

Latest documentation

Always use the latest documentation. Changes or additions to documentation can be found online at ifm.com.

Also observe the documentation of any additional devices used together with the safety module.

● Original operating instructions

● Software manual - IPARCRC CALC parameter settings

● Operating instructions IO-Link masters

PROFIsafe user manuals

User manuals:

- – on the safe control system used
- – on the safe PROFIsafe input/output modules used
- – on the function blocks of the PROFIsafe system

Please observe the information on PROFINET and PROFIsafe available on the Internet.
See: profisafe.net.

2 Transport, storage and unpacking

NOTE: Electrostatic discharge

Electrostatic discharge can damage or destroy components. When handling the device, observe the necessary safety measures against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

2.1 Transport

The device is delivered in cardboard packaging. Please note the instructions regarding handling on the packaging.

Suitable transport packaging

● Only transport the device in its original packaging or in packaging suitable for transport.

2.1.1 Technical data and environmental conditions

● During transport, observe the specifications regarding air humidity and air pressure.

→ chapter "Technical data"

2.2 Storage

Suitable storage location

The storage location must meet the following requirements:

- – dry
- – protected from external influences
- – protected from harmful environmental influences such as UV light

Technical data and environmental conditions

● During storage, observe the specifications regarding temperature range, air humidity and air pressure.

🛈 → chapter "Technical data"

2.3 Unpacking

The device is delivered in packaging together with a packing slip that provides installation instructions.

2.3.1 Observing the packing slip

Read the complete packing slip carefully before unpacking the device.

● Keep the packing slip.

Checking the delivery

● Check delivery for damage and completeness.

● Submit claims for any transport damage immediately.

3 Product description

3.1 Brief device description

The device is a safe input/output device suited for use in the field according to protection rating IP 65 / IP 67.

The module is intended for use in one of the following safe systems:

– PROFIsafe

The module has eight safe digital inputs and four safe digital positive/negative switching outputs. The inputs and outputs can be parameterised according to the application. They enable sensors or actuators to be integrated into the safe system.

As an IO-Link device, the module is solely compatible for operation with the ifm IO-Link masters AL1400, AL1401, AL1402 and AL1403. Via the IO-Link masters, use within different networks is possible.

In the PROFIsafe system, the configuration is done via the engineering tool of the safety controller used.

3.2 Module structure
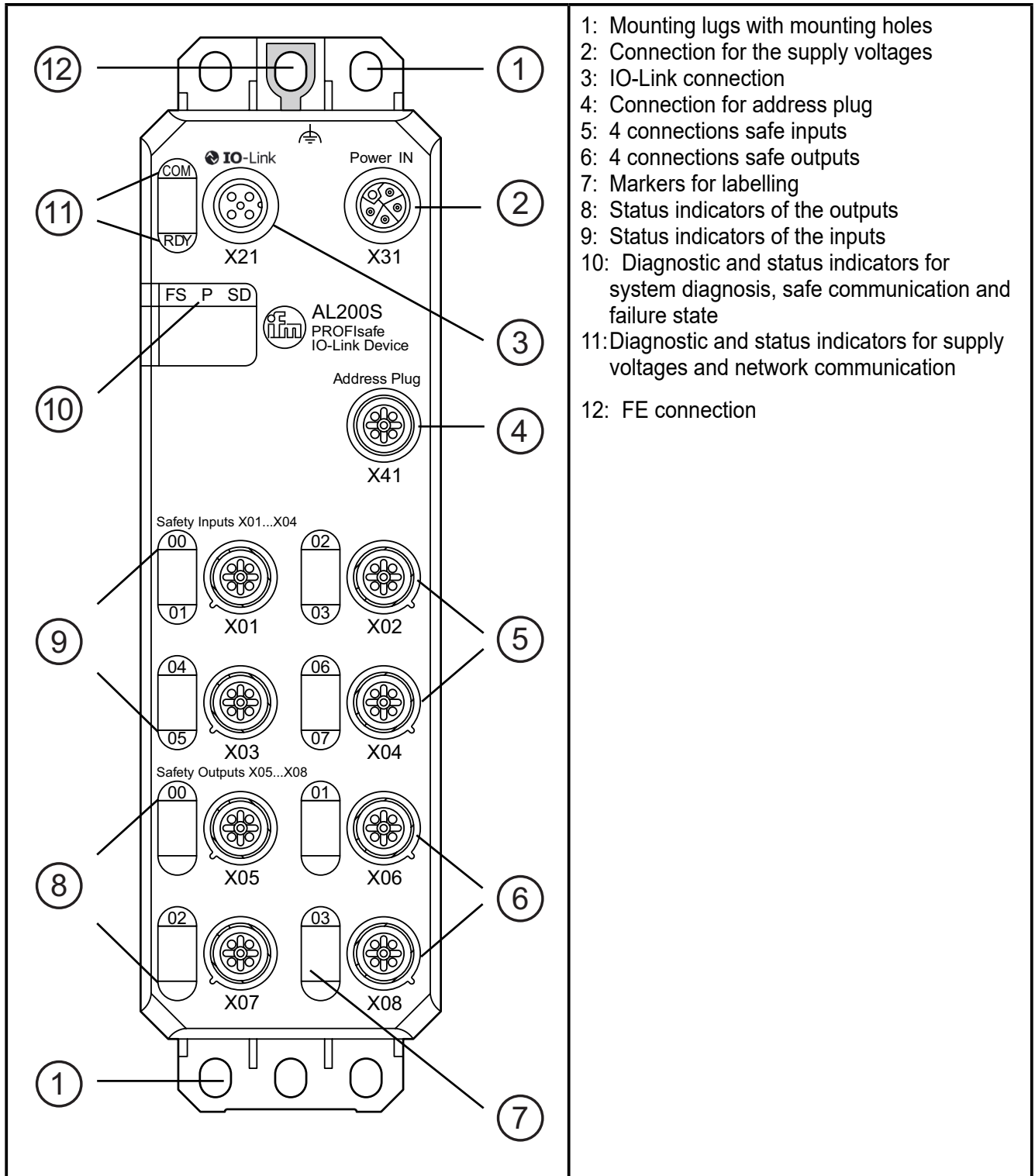
1: Mounting lugs with mounting holes
2: Connection for the supply voltages
3: IO-Link connection
4: Connection for address plug
5: 4 connections safe inputs
6: 4 connections safe outputs
7: Markers for labelling
8: Status indicators of the outputs
9: Status indicators of the inputs
10: Diagnostic and status indicators for system diagnosis, safe communication and failure state
11: Diagnostic and status indicators for supply voltages and network communication

12: FE connection

Labelling

Next to the connections, there are spaces for labelling fields. If you want to replace a label, lever it out of the recess using a screwdriver.

3.3 Scale drawing
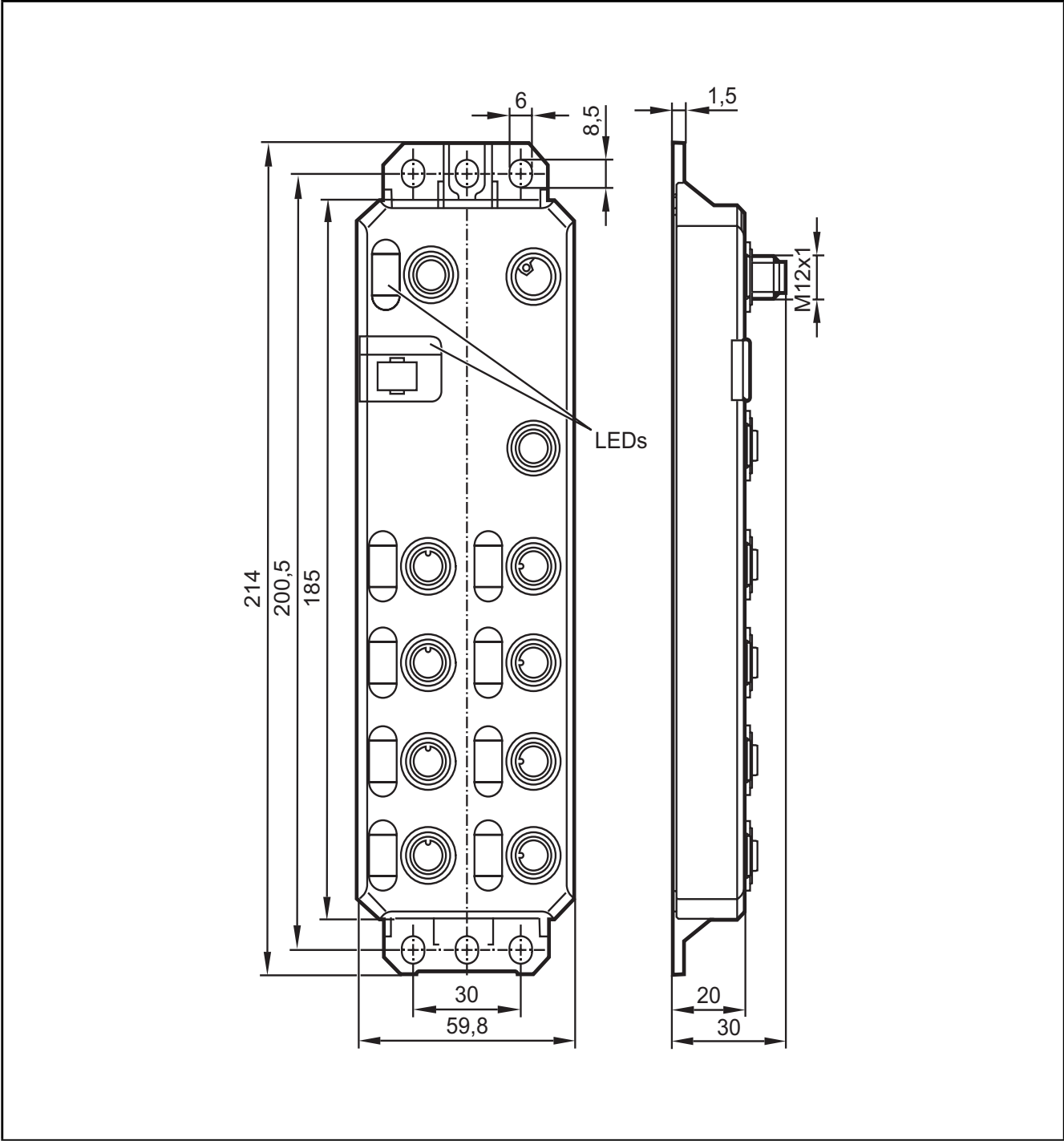
3.4 Safe digital inputs

Assignment

The module is provided with safe digital inputs that can be used as follows:

- – for 2-channel assignment: four 2-channel inputs
- – for 1-channel assignment: eight 1-channel inputs

Technical data

> ⓘ → chapter "Technical data"

Parameterisation

The safe digital inputs of the module can be parameterised in pairs. This means that the inputs can be adapted to various operating conditions and different safety integrity levels (SIL, SIL, Cat., PL) can be implemented.

> ⓘ The attainable safety integrity (SIL, SIL, Cat., PL) and error detection depend on:
>
> - – the parameterisation
> - – the design of the sensor
> - – the cable routing
>
> → chapter "Parameterisation of the module" → "Parameterisation of the safe inputs"
>
> → chapter "Connection examples for safe inputs"

Error detection time

Observe the error detection time.

> ⓘ → chapter "Product description" → "Safety-related system times"
> → "Error detection time".

3.4.1 Clock outputs T1 and T2

The module is provided with two clock outputs which are independent from each other. These clock outputs supply the safe inputs. Both clock outputs provide a pulse pattern to detect cross faults in the external wiring of the inputs if cross-monitoring is enabled for at least one input pair.

Exemplary pulse pattern

1: T   Test pulse width
2: P   Period

GB
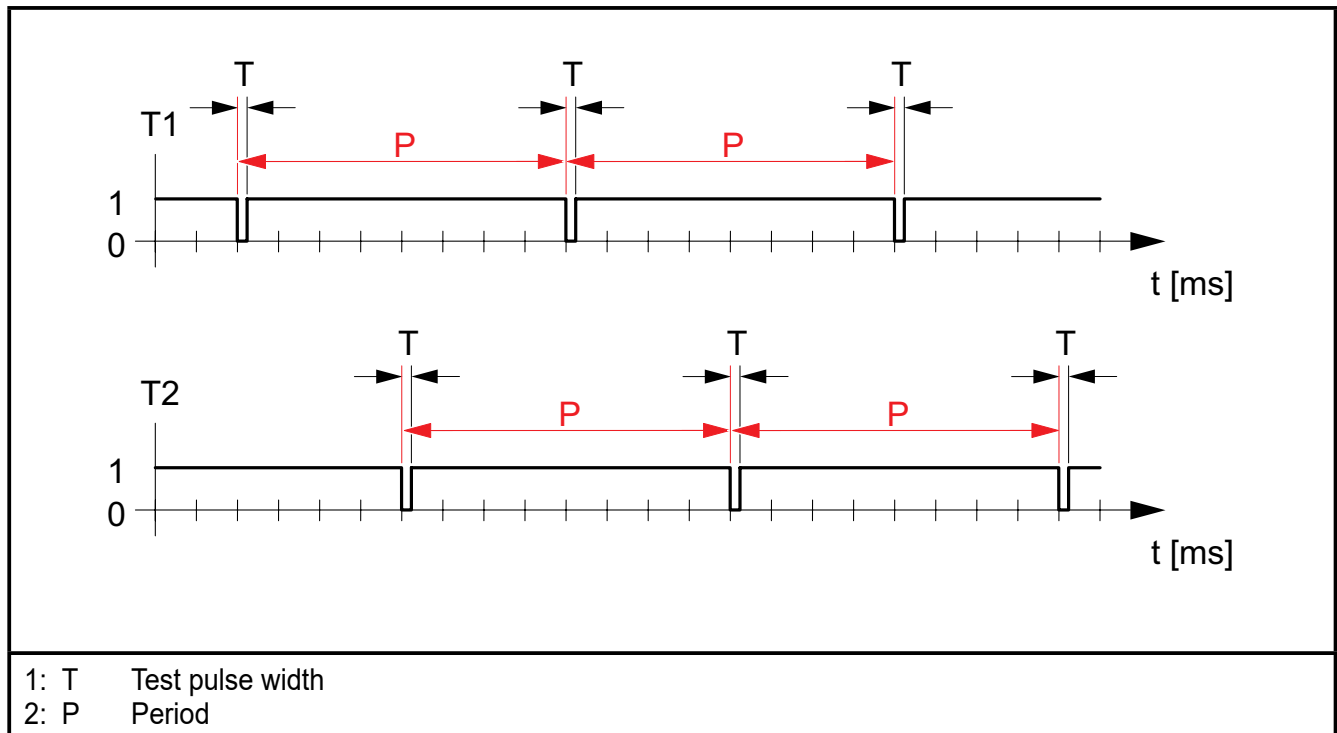
Technical data

ℹ️   → chapter "Technical data"

Behaviour in case of an error

The clock outputs are also switched on and monitored if the module is in an unparameterised state.

In case of a short circuit against GND or overload of the clock outputs, the clock outputs are disabled. A diagnostic message is generated. The message is signalled by the LED "SD". Acknowledge this error to commission the system again after eliminating the error.

ℹ️   → chapter "Errors: messages and removal"

ℹ️   As two clock outputs are available for the eight inputs, interactions between the inputs are possible.

Cross-monitoring

If all inputs are parameterised without cross-monitoring, the clock outputs provide a DC voltage without clock pulses. When at least one input pair is parameterised with cross-monitoring, pulses are output at the clock outputs T1 and T2.

For inputs parameterised with the cross-monitoring, the following applies:

– Inputs of channel 1 (INx_CH1) are assigned to clock output T1.

– Inputs of channel 2 (INx_CH2) are assigned to clock output T2.

> ⓘ Observe the error detection with regard to the clocking.
> → chapter "Connection examples for safe inputs"

3.4.2 Connection options for sensors

Sensors that meet various safety requirements depending on the parameterisation can be connected to the inputs.

The maximum attainable SIL/SIL/Cat./PL is specified in the table. To meet the safety integrity level:

● Observe the specifications in the connection examples.

> ⓘ → chapter "Connection examples for safe inputs"

● Meet the requirements of the standards with regard to the external wiring and the sensors to be used.

		Input							
Plug connection		1-channel commanding device/ sensor			2-channel commanding device/sensor				
Input signal		-	-	-	Equivalent			Complementary	
Cross-monitoring		With	Without		With	Without		With	Without
Connectable sensors: – with contacts		Yes	Yes	-	Yes	Yes	-	Yes	Yes
– with OSSD outputs		No	-	Yes	No	-	Yes	No	No
Attainable safety integrity	SIL	2	2	2	3	3	3	3	3
	SIL	2	2	2	3	3	3	3	3
	Cat.	2*	2	2	4	3	4**	4	3
	PL	d	d	d	e	d	e	e	d
* Cat. 3 can be attained by linking two 1-channel sensors in the control logic.									
** The attainable category depends on the sensor used.									

3.5 Safe digital outputs

Assignment

The module is provided with safe digital positive and negative switching outputs that can be used as follows:

– for 2-channel assignment: four 2-channel positive and negative switching outputs

– for 1-channel assignment: four 1-channel positive switching outputs

GB

Technical data

> ⓘ → chapter "Technical data"

Parameterisation

Each safe digital output of a safety module can be parameterised differently. This means that the outputs can be adapted to different operating conditions and different safety integrity levels (SIL, SIL, Cat., PL) can be implemented.

> ⓘ The attainable safety integrity (SIL, SIL, Cat., PL) and error detection depend on:
>
> – the parameterisation
>
> – the design of the actuator
>
> – the cable routing
>
> → chapter "Parameterisation of the module" → "Parameterisation of the safe outputs"
>
> → chapter "Connection examples for safe outputs"

Error detection

To achieve a high error detection, switch on the test pulses. If this is not possible for the connected loads, disable the test pulses. In this case, however, error detection is lower.

Disabling the test pulses affects the error detection of the module. Observe the attainable safety integrity.

→ chapter "Connection examples for safe outputs"

Error detection time

Observe the error detection time.

> ⓘ → chapter "Product description" → "Safety-related system times"
> → "Error detection time".

3.5.1 Requirements on command devices and actuators

The module's capability to detect errors depends on the parameterisation. This results in certain requirements on the actuators.

If the outputs are parameterised with test pulses, the test pulses test the circuits of the outputs at regular intervals. The test pulses are visible at the output.

For 1-channel parameterisation

⚠ **WARNING: Unintentional machine start-up**

Test pulses at the outputs can cause an unintentional machine start-up.

● Please observe the following requirements on actuators and loads.

– The test pulses can lead to undesirable reactions with quick responding actuators.

– If the process does not tolerate this behaviour, use actuators with sufficient inertia.

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

– In general do not use fast actuators that react in a safety-critical manner to pulses of less than 1 ms.

For 2-channel parameterisation

– For 2-channel parameterisation of the outputs, a load must always be connected, as otherwise an error message will be issued.

3.5.2 Connection options for actuators

Actuators that meet various safety requirements depending on the parameterisation can be connected to the outputs.

The maximum attainable SIL/SIL/Cat./PL is specified in the table. To meet the safety integrity level:

● Observe the specifications in the connection examples.

ℹ → chapter "Connection examples for safe outputs"

● Meet the requirements of the standards with regard to the external wiring and the actuators to be used.

	Output	
Parameterisation "output"	1-channel	2-channel
Test pulses	Any	On
Achievable safety integrity	SIL 2/SIL 2/Cat. 3/PL d	SIL 3/SIL 3/Cat. 4/PL e
Connection example output 1-channel	→ chapter "Connection examples for safe outputs" → "Single-channel assignment of positive switching outputs"	
Connection example output 2-channel	→ chapter "Connection examples for safe outputs" → "Two-channel assignment of positive and negative switching outputs"	

3.6 Local diagnostic and status indicators

Diagnostics

The diagnostic indicators (green/yellow/red) indicate whether an error is present or not. In case of an error, they indicate the error type and location.

Status

The status indicators of the inputs and outputs (green/red) indicate the signal state of the corresponding input or output.

3.6.1 Indicators for IO-Link communication, power supply and operating status of the device

Indicators for IO-Link communication, power supply and operating status of the device
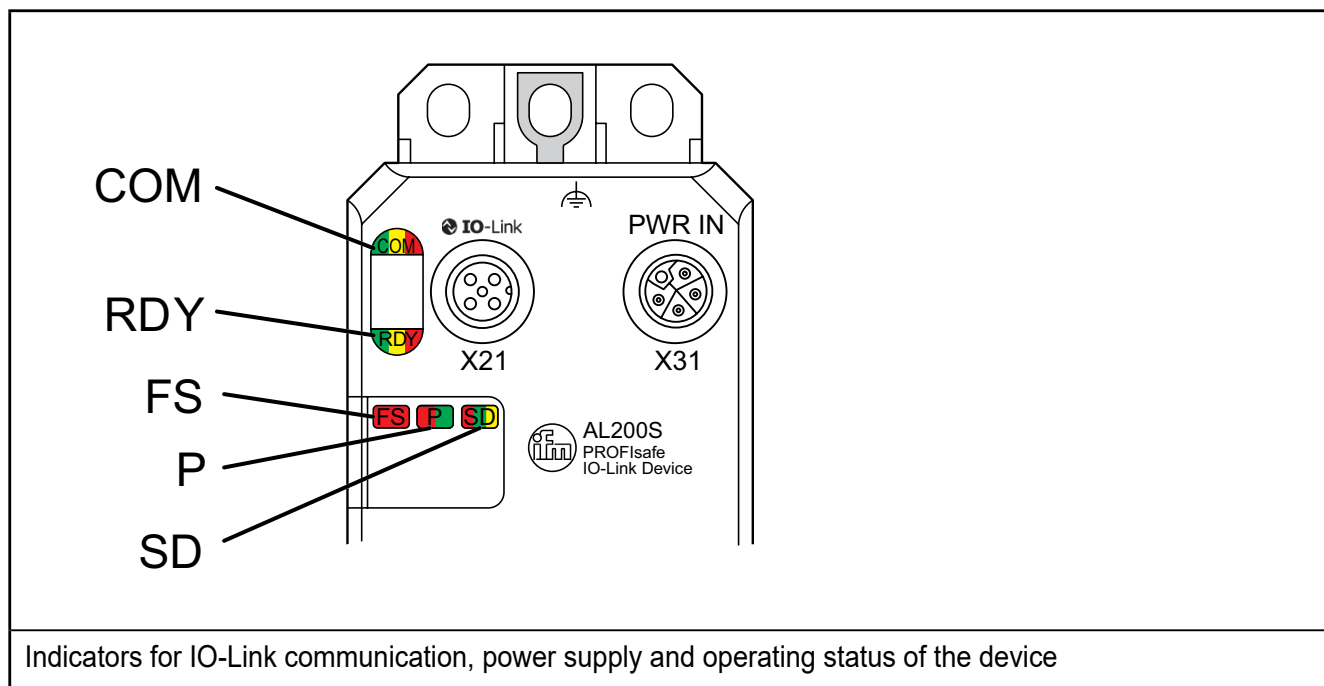
Designation	Colour	Meaning	State	Description
COM	Green/yellow/ red	Communication: status of the device	Green on	IO-Link power supply is present IO-Link communication is not present
			Green flashing	IO-Link power supply is present IO-Link communication is present
			Off	IO-Link power supply is not present IO-Link communication is not present
			Yellow/red flashing	Interface for safe communication is not accessible

Designation	Colour	Meaning	State	Description
RDY	Green/yellow/red	Ready: status of the device	Green on	Peripheral supply is present. Device is ready for operation.
			Yellow on	Device booting
			Green/red flashing	Actuator supply U_A outside the permissible range
			Red on	Device is not ready for operation
			Off	Sensor supply U_S is not present
			Yellow flashing	Firmware update running
			Green/yellow flashing	Sensor supply U_S outside the permissible range
FS	Red	Failure state	Red on	Failure state, device is in safe state. Safe communication is blocked
			Off	No error
			Red flashing	Device is not parameterised or parameterisation was not accepted
P	Green/red	Status of the safe communication	Green on	Safe communication is running without any interruption
			Green flashing	Safe communication is running. User intervention required
			Off	Safe communication not present
			Red on	▶ The power supply or the IO-Link cable is not connected. ▶ Check COM LED.
SD	Yellow/red	System diagnosis safety application	Yellow on	Acknowledgeable warning message is present
			Red on	Not acknowledgeable error message is present
			Off	No error, no warning

3.6.2 Indicators of the inputs and outputs

Indicators of the inputs and outputs
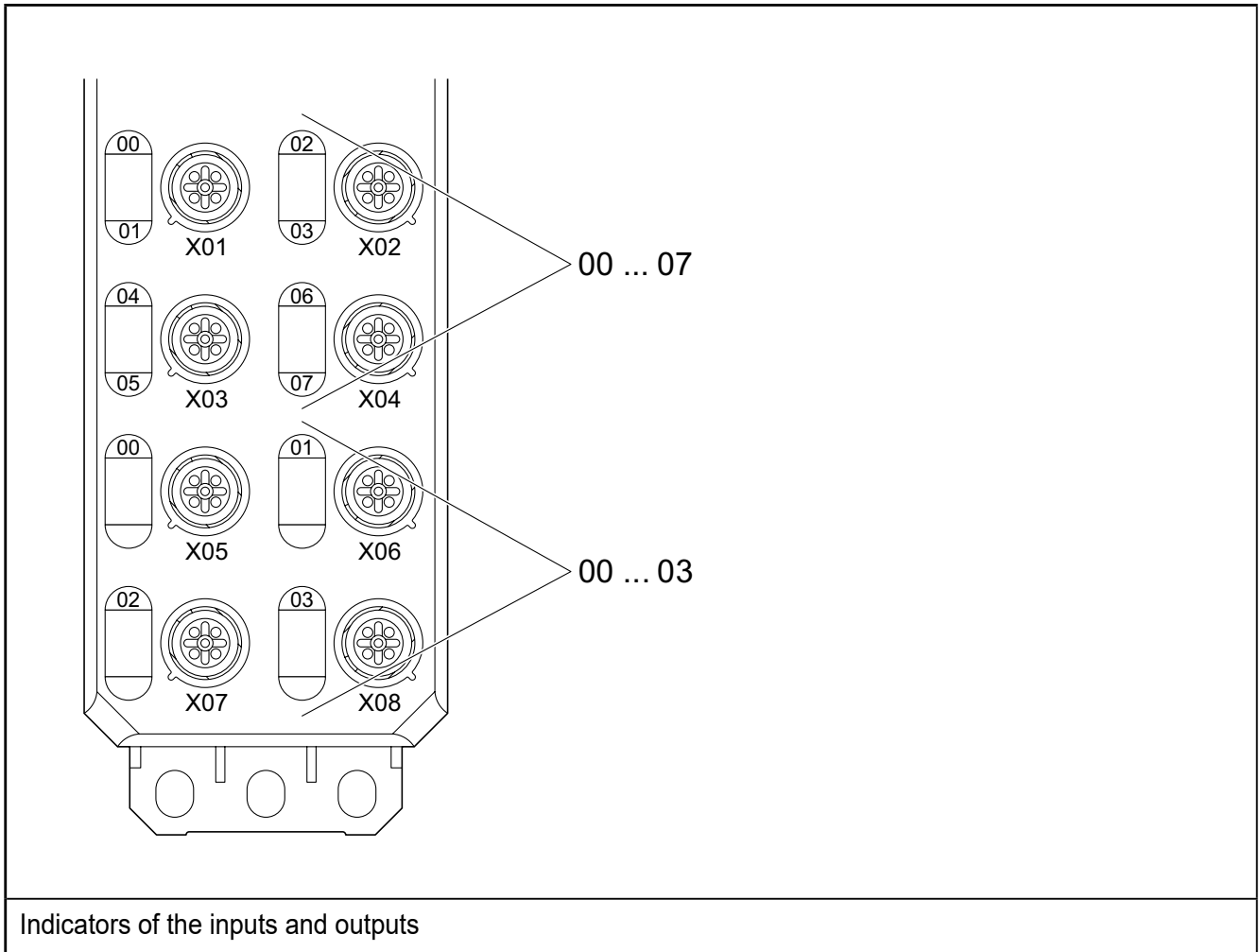
Designation	Colour	Meaning	State	Description
00 ... 07	Green	Status of the inputs	Green on	Input is set
			Off	Input is not set
00 ... 03	Green, red	Status of the outputs	Green on	Output is set. No error
			Off	Output is not set. No error
			Red on	Error at the output

3.7 Safe state

The safe state for the module is:

– transfer of the value "0" in the image of the inputs to the safe control system

– voltage-free state at the outputs

The safe state can be assumed in the following cases:

1. operating state

2. error detection in the periphery

3. device error

4. parameterisation error or unparameterised state

5. error detection in the safe communication

3.7.1 Operating state

In the operating state, the inputs and outputs can assume either state "1" or state "0". State "0" is the safe state.

3.7.2 Error detection in the periphery

Inputs

If an error is detected at an input, the safe state is entered at this input. "0" is displayed in the process image of the input ("0" = safe state).

Outputs

If an error is detected at an output, this output is switched off ("0" = safe state).

> ℹ️ If an error occurs at a channel of a 2-channel parameterised output, the corresponding other channel also assumes the safe state.

Depending on the parameterisation, the following errors can be detected at the inputs and outputs:

– short circuit and cross fault of the inputs and outputs

– overload of the outputs

– overload or short circuit of the clock outputs

Diagnostic messages

The diagnostic message is transferred to the control system.

> ℹ️ → chapter "Errors: messages and removal"

For information on which error occurs in which case, see

→ chapter "Connection examples for safe inputs"

→ chapter "Connection examples for safe outputs"

3.7.3 Device errors

Operating time in incorrect state

> ⚠️ WARNING: Loss of the safe state in the error state
>
> In the error state, no module-internal tests run anymore. Due to an increasing number of errors, it is possible that the safe state is left.
>
> ● If the module goes into an incorrect state, please check, acknowledge or eliminate the error within the next 72 hours.

Failure state: fatal errors

Fatal errors that can lead to loss or limitation of the safety function will result in the following:

– The complete module goes into the safe state.

– The LED "FS" is lit permanently at the module.

The failure state can only be left through a power-up. If the condition cannot be corrected by a power-up, a hardware error exists. The device has to be replaced.

⚠ WARNING: Loss of the safety function

Subsequent faults can cause the loss of the safety function.

● To avoid subsequent faults, disconnect the module completely from the voltage supply and replace it within 72 hours if there is a device fault.

GB

Diagnostic messages

The diagnostic message is transferred to the control system.

ℹ → chapter "Errors: messages and removal"

3.7.4 Parameterisation errors

Operating time in incorrect state

⚠ WARNING: Loss of the safe state in the error state

In the error state, no module-internal tests run anymore. Due to an increasing number of errors, it is possible that the safe state is left.

● If the module goes into an incorrect state, please check, acknowledge or eliminate the error within the next 72 hours.

Diagnostic messages

The diagnostic message is transferred to the control system.

ℹ → chapter "Errors: messages and removal"

3.8 Safety-related system times

3.8.1 Processing time of the safe input

The processing time of the input t_{IN} for a safety requirement consists of the parameterised filter time t_{Filter} and the runtime of the firmware t_{FW}.

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

Legend:

t_{IN} Processing time of the input

t_{Filter} Parameterised filter time

t_{FW} Firmware runtime: 4 ms

> ⓘ Observe the error detection time of the inputs in 1-channel operation → chapter "Product description" → "Safety-related system times" → "Error detection time".

3.8.2 Duration of a safety requirement

> ⚠ A loss of the safety function can occur if the duration of the safety requirement is too short.

The duration of a safety requirement has to be higher than the processing time of the respective input t_{IN}.

If the safety module identifies a safety requirement after the processing time of the input t_{IN} elapsed, the safety requirement is prolonged by the safety module until the control system has received it.

3.8.3 Switch-off time of the safe output

The switch-off time of the output t_{OUT} for a safety requirement consists of the internal processing time of 3.5 ms and the parameterised switch-off delay t_{delay}.

$t_{OUT} = 3.5$ ms $+ t_{delay}$

Legend:

t_{OUT} = Switch-off time of the output

t_{delay} = Parameterised switch-off delay

3.5 ms = Internal processing time (= firmware processing time + signal propagation time)

> ⓘ Observe the error detection time of the outputs in 1-channel operation → chapter "Product description" → "Error detection time".

3.8.4 Error detection time

Safe input

If an error occurs in a 1-channel assigned input, the error is detected at the latest after 64 ms. During this period, "1" can still be transferred in case of an error.

> ⓘ NOTE
> Prolongation of the processing time if an error occurs in 1-channel operation
>
> In 1-channel operation, the error detection time affects the processing time of the input.
>
> For 1-channel assigned inputs, the processing time t_{IN} should equal the error detection time.
>
> → chapter "Product description" → "Processing time of the safe input"

Safe output

The error detection time of a safe output with 1-channel assignment is 20 ms. High pulses of this width can occur in the event of an error of the safe output.

⚠ **WARNING: Unexpected machine start-up**

High pulses can cause an unexpected machine start-up.

● Make sure that high pulses of this width do not lead to a safety-critical behaviour of the application.

3.8.5 Response time

Observe the determination of the response time as specified by the control system manufacturer.

4 Programming/configuration data

A device description file (IO Device Description, IODD) for the device is provided in the download section.
It contains information on identification, communication characteristics and the structure of the user interface in engineering tools.

ℹ The valid device description file is available at ifm.com.

You can also download the device description file from the official IO-Link site ioddfinder.io-link.com under "IODDfinder".

In systems in which you do not have a device description available, the following information may be required to configure an IO-Link port of the IO-Link master:

Identification	hex	dec
Vendor ID (ifm)	0136	310
Device ID	0520	1312

IO-Link protocol specific version	hex	dec
Revision ID	11	17

IO-Link parameter data storage function
Not supported.

5 IO-Link standard parameter objects

The device supports the following standard IO-Link parameter objects:

5.1 Electronic type label

The electronic type label contains information about the manufacturer and the device.

Index (hex)	Object name	Length in bytes *	Per-mis-sions	Meaning	Content
0010	VendorName	15	R	Name of the manufacturer	"ifm electronic"
0011	VendorText	15	R	Description	"ifm electronic"
0012	ProductName	7	R	Product designation	"AL200S"
0013	ProductID	7	R	Article no.	"AL200S"
0014	ProductText	33	R	Product text	"PROFIsafe IO-Link Device 8P IP67"
0015	SerialNumber	11	R	Serial number of the device	e.g."0000000000"
0016	HardwareRevision	3	R	Hardware revision	e.g. "00"
0017	FirmwareRevision	8	R	Firmware revision (IO-LinkFW/Safety- FW)	e.g. "00/110/110"
Legend:					
* The objects are of type "Visible String". Each "Visible String" ends with a null terminator (00_{hex}). Thus, the length of an element of the type "Visible String" is one byte longer than the number of user data.					
R = Read					

6 Mounting and removal

6.1 Mounting instructions

Qualified personnel

Mounting and removal may only be performed by qualified personnel.

⚠️ **WARNING: Electric shock / unintentional machine start-up**

Mounting, removal and installation works without ensuring that the system is free of voltage can result in dangerous electric shocks.

Unexpected machine start-up during mounting, removal and installation works may result in death or serious injury.

The system may only be started provided the station and the system do not pose a hazard.

- Make sure that the dangerous machine function is switched off and remains switched off.
- Before working on the device, disconnect the safety relay and the entire station from the power supply.
- Ensure the voltage cannot be switched on again.
- Make sure system set-up has been completed before switching the voltage back on.
- Observe the diagnostic indicators and any diagnostic messages.

GB

⚠️ **WARNING: Loss of safety function due to humidity at the connections**

- Only use IP 67 rated connectors and cables.
- To ensure IP 65 / IP 67 protection, cover unused connections with protective caps.

🛈 **NOTE: Data corruption or loss**

Functional earthing is required for interference-free operation.

- Implement the FE connection via the FE connection lug. Use a tooth lock washer to ensure contacting.

6.2 Perform mounting and removal

Mounting

1. Screw the device directly onto the flat mounting surface via the drill holes (1) of the mounting lugs.

Use standard M5 screws.

Functional earthing

2. Implement the FE connection via the FE connection lug (2). Use a tooth lock washer to ensure contacting.
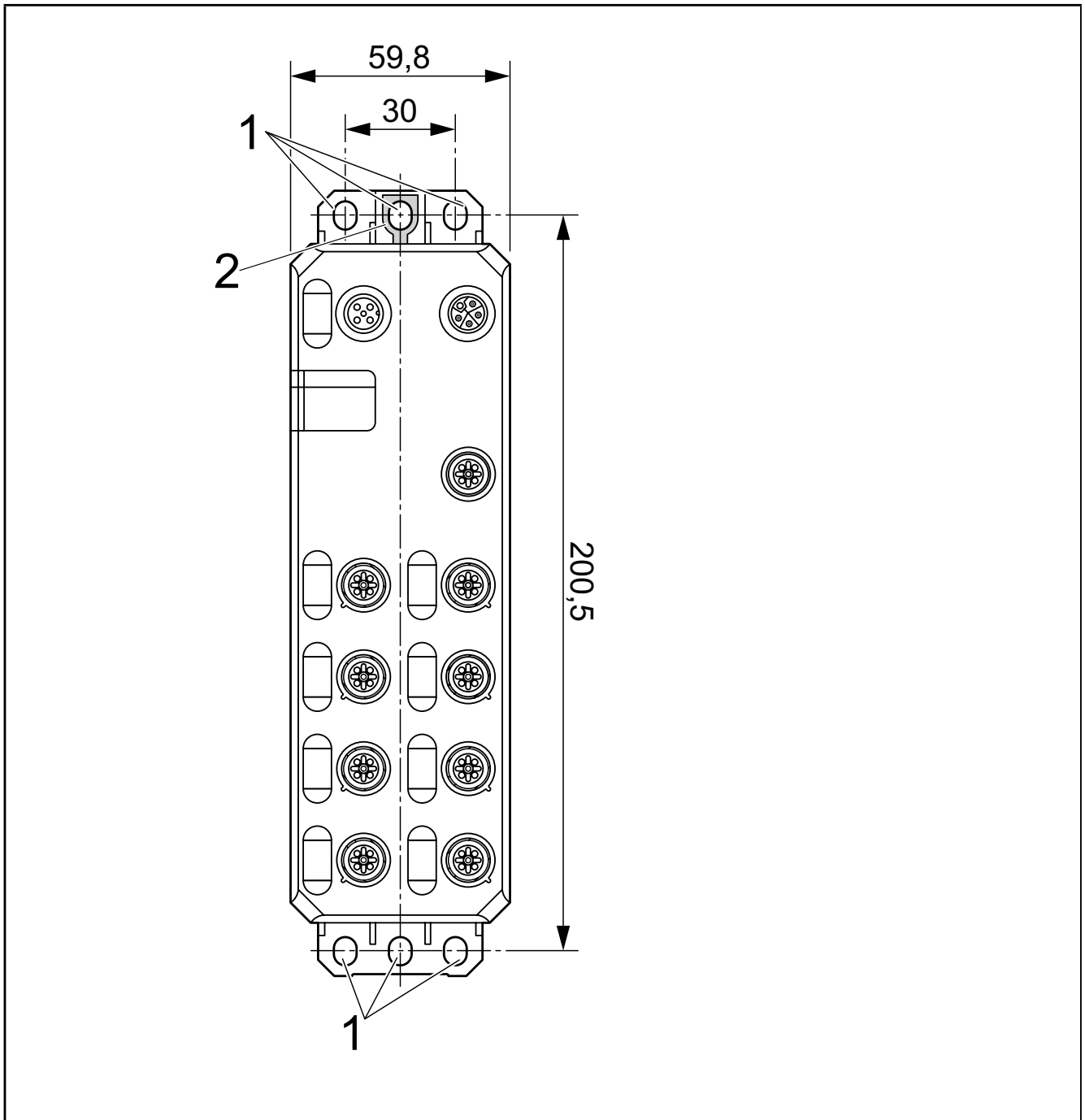
Removal

For removal, loosen the screw connections.

7 Electrical installation

7.1 Installation instructions

Qualified personnel

Electrical installation may only be performed by qualified personnel.

⚠️ **WARNING: Electric shock / unintentional machine start-up**

Mounting, removal and installation works without ensuring that the system is free of voltage can result in dangerous electric shocks.

Unexpected machine start-up during mounting, removal and installation works may result in death or serious injury.

The system may only be started provided the station and the system do not pose a hazard.

- Make sure that the dangerous machine function is switched off and remains switched off.

- Before working on the device, disconnect the safety relay and the entire station from the power supply.

- Ensure the voltage cannot be switched on again.

- Make sure system set-up has been completed before switching the voltage back on.

- Observe the diagnostic indicators and any diagnostic messages.

⚠️ **WARNING: Loss of the safety function / property damage**

Improper installation, e.g. due to misconnection or incorrect polarity of the connections, can result in a loss of the safety function and property damage.

- Take measures to prevent misconnection or polarity reversal.

- Prevent tampering at the connections.

⚠️ **WARNING: Loss of safety function due to humidity at the connections**

- Only use IP 67 rated connectors and cables.

- To ensure IP 65 / IP 67 protection, cover unused connections with protective caps.

☐ **NOTE: Data corruption or loss**

Functional earthing is required for interference-free operation.

- Implement the FE connection via the FE connection lug. Use a tooth lock washer to ensure contacting.

7.2 Module connections

The electrical connection of the safety module is made via the M12 connectors on the device.

Cover unused connections with appropriate protective caps.
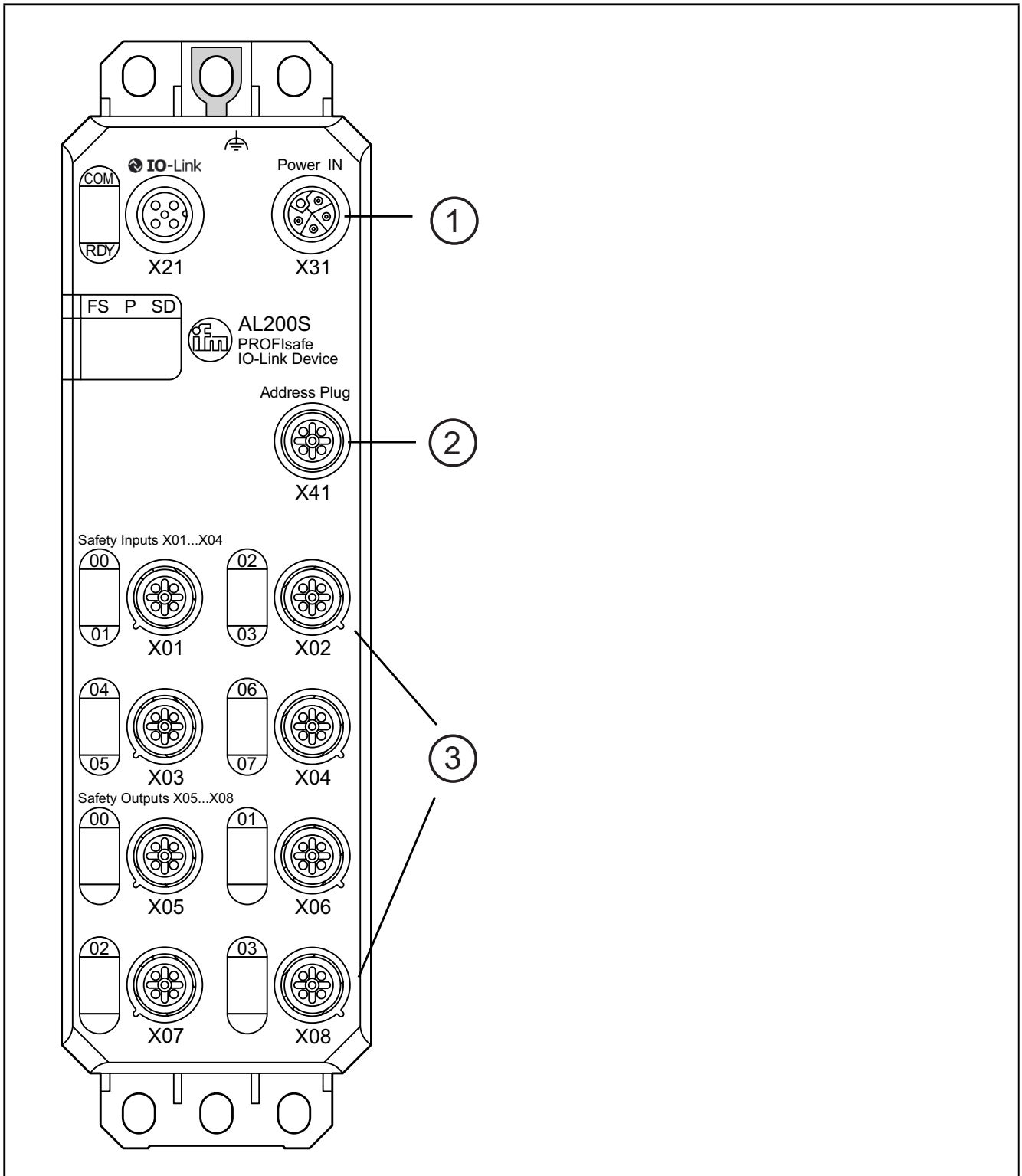
1: IO-Link and voltage supply
2: Addressing socket
3: Periphery

7.2.1 Supply voltages

The device requires two different supply voltages:

- – U_S to supply the logic and the sensors
- – U_A to supply the actuators

The connection of the power supply for U_S and U_A is made via connector X31 (PWR IN).

⚠ WARNING: Loss of the safety function

The use of unsuitable voltage supplies can cause the loss of the safety function.

● Observe the following voltage supply requirements.

❗ NOTE: Data corruption or loss

A parallel reverse polarity protection is implemented in the module. This protection is only temporally limited.

● To avoid a module defect, observe the following voltage supply requirements.

PELV voltage supply

● Only use power supply units with safe isolation and SELV/PELV voltage according to EN 50178/VDE 0160.

● Make sure that also in case of a fault the output voltage of the voltage supply does not exceed 32 V.

Fusing of the voltage supply

● Protect the voltage supply U_S externally with a fuse of max 8 A.

● Protect the voltage supply U_A externally with a fuse of max 8 A.

● Make sure that the power supply unit can provide four times the nominal current of the external fuse. This ensures safe triggering in case of a fault.

Avoid polarity reversal

● Avoid polarity reversal of supply voltages U_S and U_A.

DC distribution network according to IEC 61326-3-1

❗ NOTE: Destruction of module electronics

Overvoltage destroys the module electronics

● Do not use a DC distribution network.

● A DC distribution network is a DC distribution net supplying a complete industrial warehouse with direct voltage. Any devices can be connected to it.
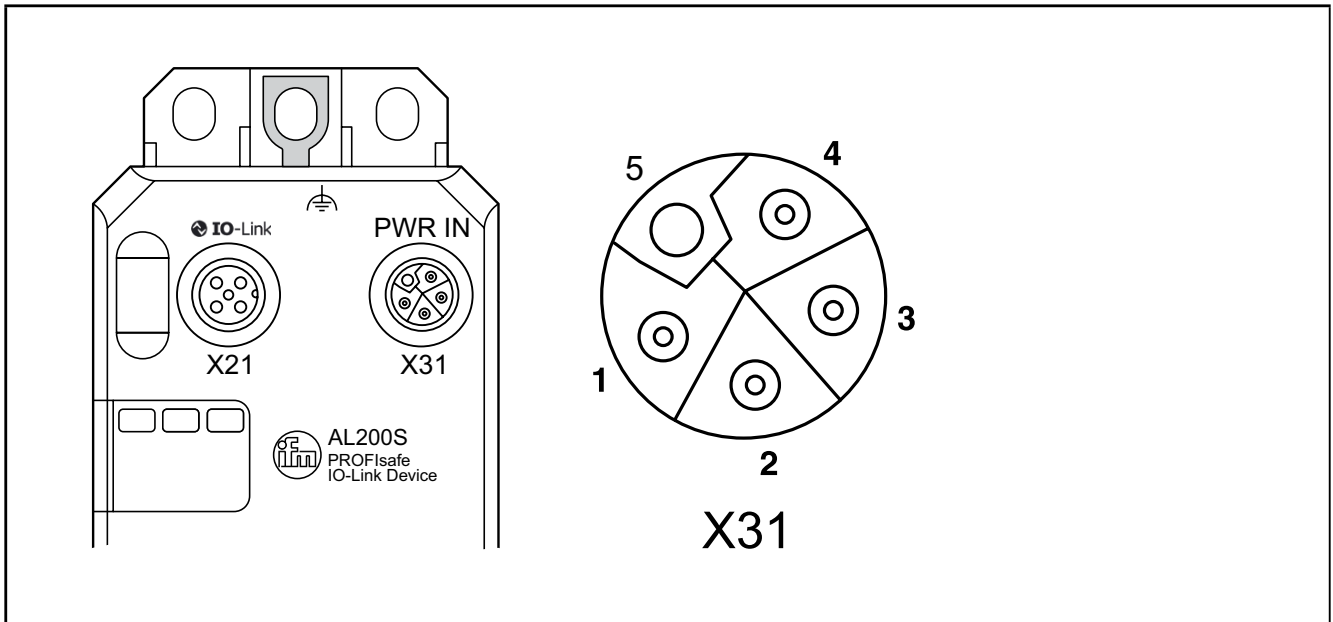
Pin assignment

Pin	Assignment
1	+24 V DC (U_S)
2	GND (U_A)
3	GND (U_S)
4	+24 V DC (U_A)
5	Not used
Type: M12, male, L coding	

7.2.2 IO-Link port

The connection to an IO-Link master is made via the X21 connection (IO-Link). The X21 connection is implemented as an IO-Link A-port.
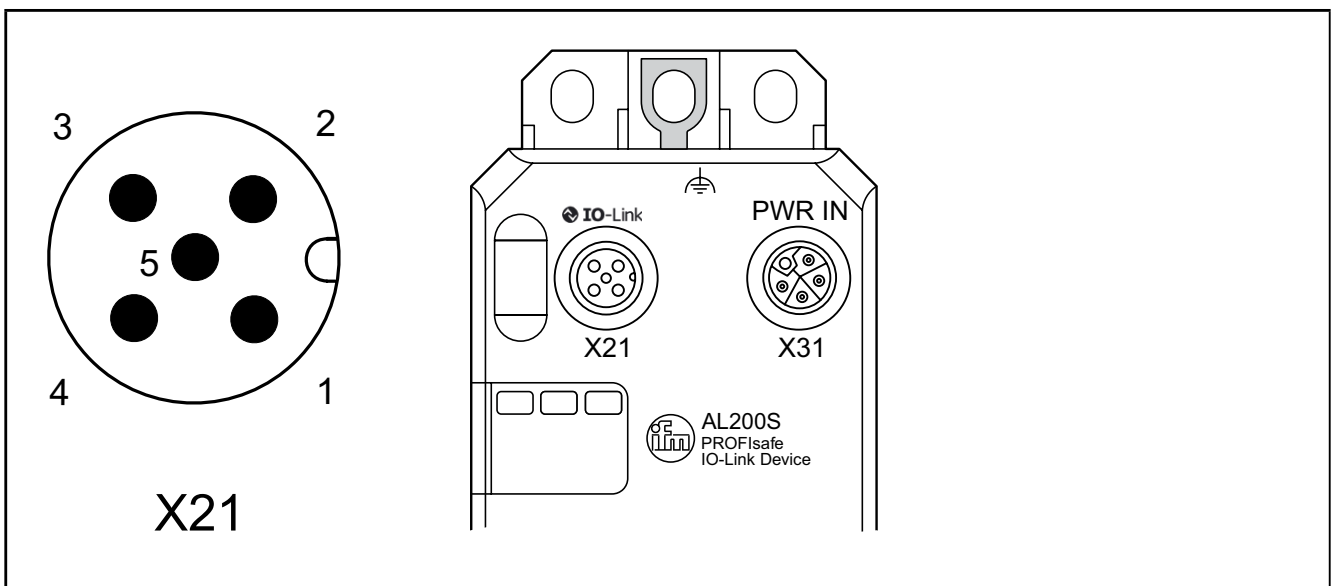
Pin assignment

Pin	Assignment
1	+24 V DC (L+)
2	Not used
3	GND (L-)
4	IO-Link data transmission (C/Q)
5	Not used
Type: M12, male, A coding	

7.2.3 Safe inputs

Suitable sensors are connected via the connections X01 ... X04.
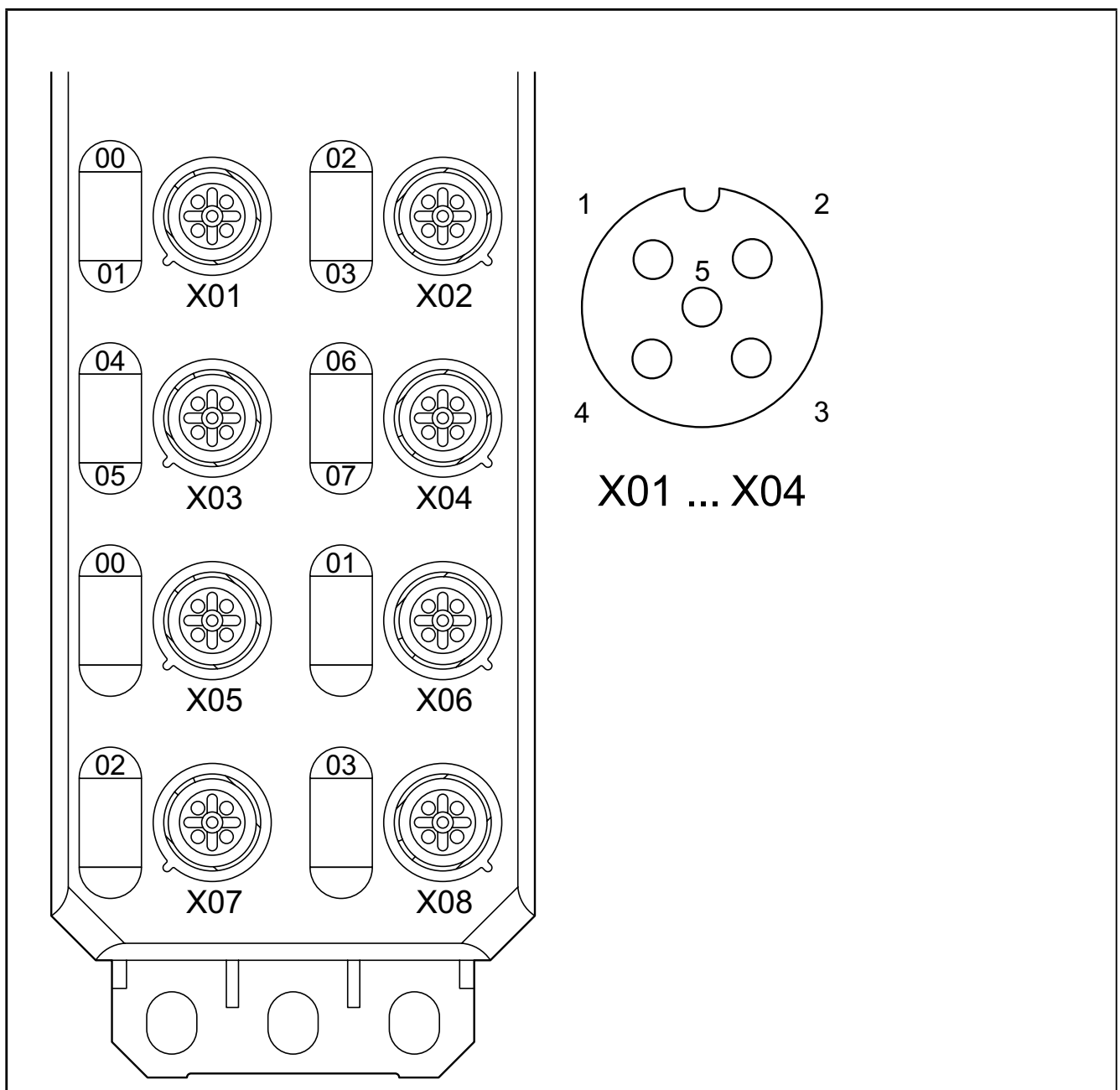
Input sockets

Socket	Function
X01	IN0_Ch1 and IN0_Ch2
X02	IN1_Ch1 and IN1_Ch2
X03	IN2_Ch1 and IN2_Ch2
X04	IN3_Ch1 and IN3_Ch2

Pin assignment

Pin	Assignment
1	Clock output T1
2	INx_Ch2
3	GND (U_s)
4	INx_Ch1
5	Clock output T2
Type: M12, female, A coding	

7.2.4 Safe outputs

Suitable actuators are connected via the connections X05 ... X08.
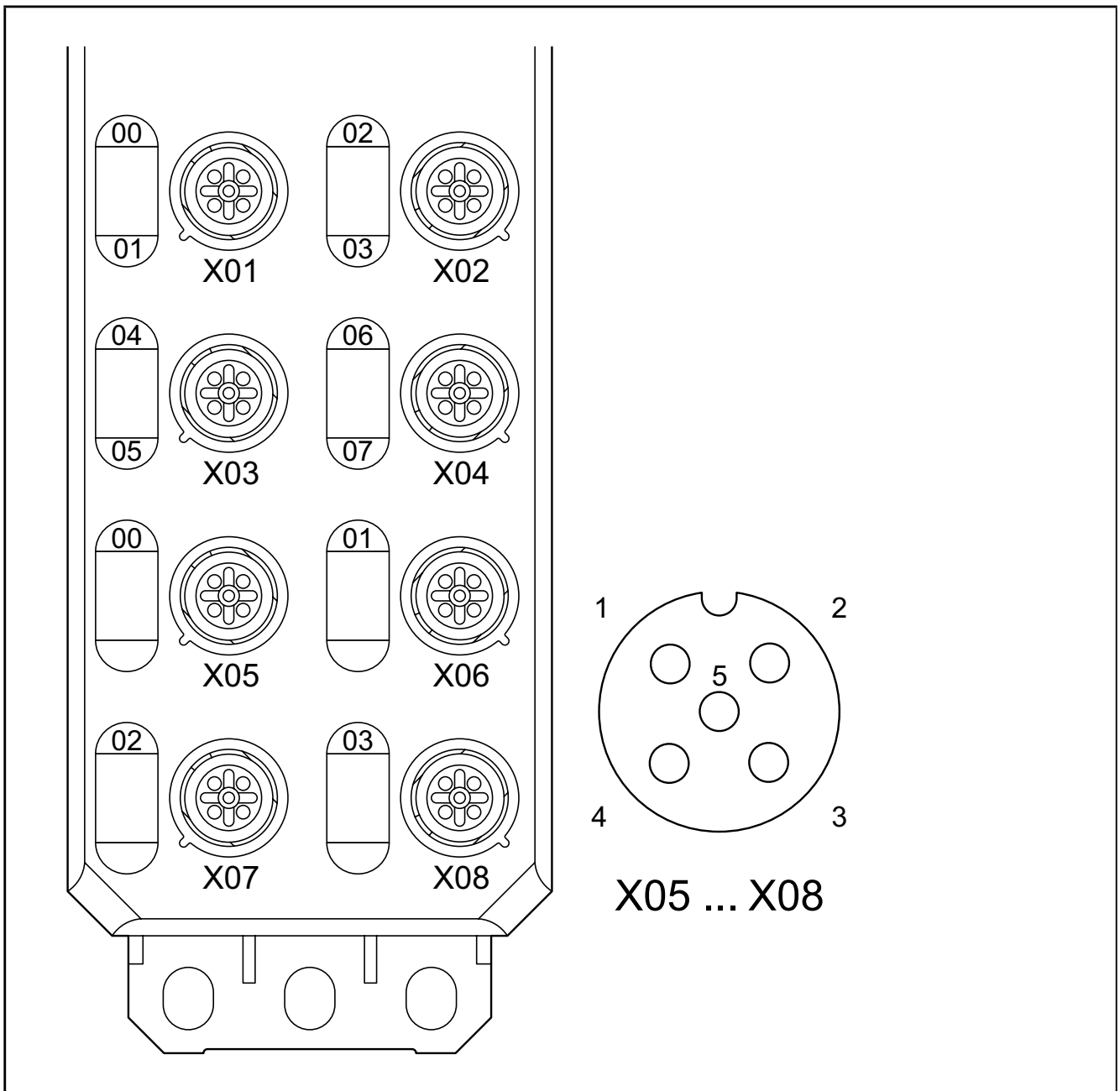
Output sockets

Socket	Function
X05	OUT0_Ch1 and OUT0_Ch2
X06	OUT1_Ch1 and OUT1_Ch2
X07	OUT2_Ch1 and OUT2_Ch2
X08	OUT3_Ch1 and OUT3_Ch2

Pin assignment

Pin	Assignment
1	Not used
2	Not used
3	OUTx_Ch2 (negative-switching NPN)
4	OUTx_Ch1 (positive-switching PNP)
5	Not used
Type: M12, female, A coding	

7.2.5 Address storage (option)

Connection X41 is used to connect the address storage plug E7700S.
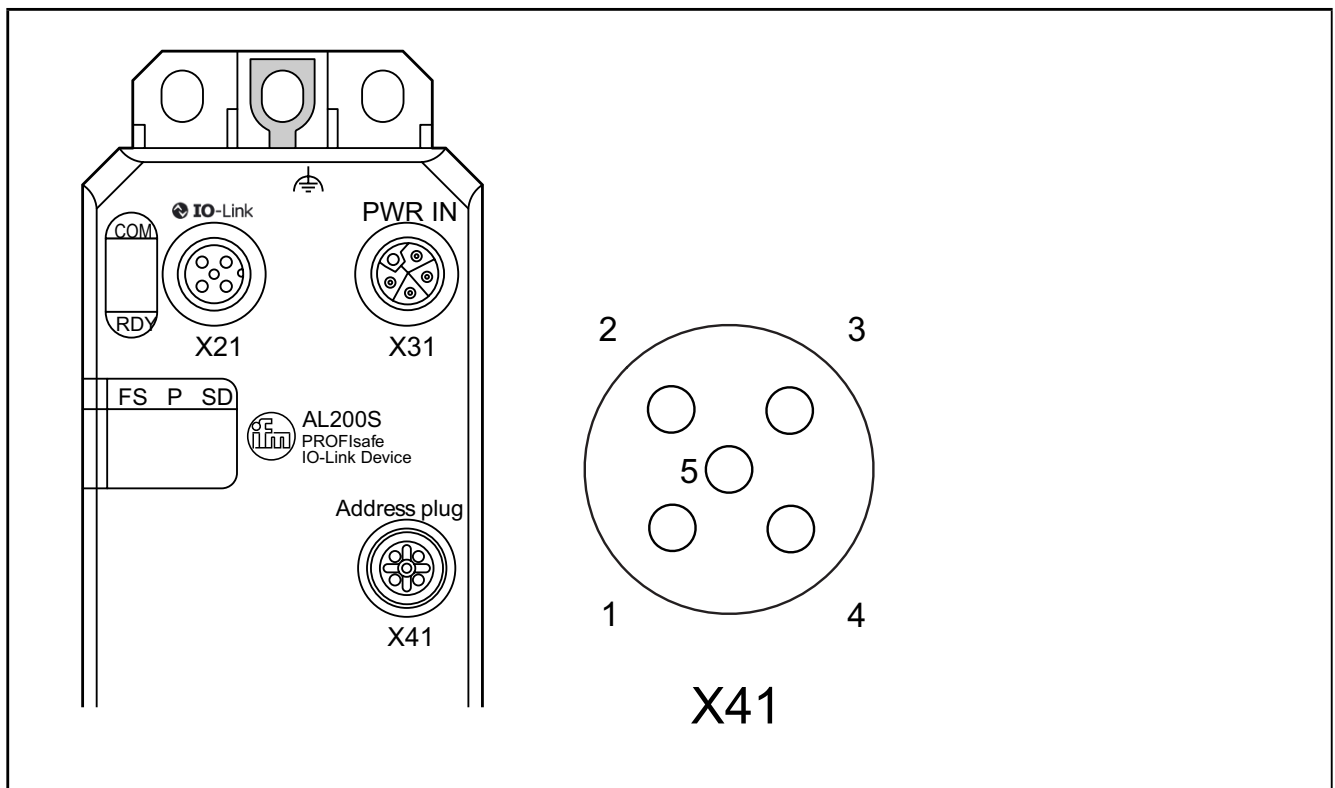
Type: M12, female, B coding

8 Parameterisation

8.1 Parameterisation in a PROFIsafe system

Parameterisation includes the following:

– PROFIsafe address assignment

– watchdog timing

– parameterisation of inputs

– parameterisation of outputs

ℹ️ The projected communication address in the project of the control system has to match the address set on the device/address storage.

GB

PROFIsafe address

The PROFIsafe address is a unique module ID in the PROFIsafe network topology. It is specified in the configuration software.

● Set the address previously specified in the configuration software for the safety module.

ℹ️ → chapter "Parameterisation of the module" →"Setting the safety address"

Parameterisation of the inputs and outputs

Parameterisation of the inputs and outputs determines the module behaviour and has an effect on the safety integrity level that can be achieved.

Whenever adding voltage or upon reset, the control system automatically writes the parameterisation created in the parameterisation tool to the module.

The following conditions have to be met:

– supply voltage present

– IO-Link communication present

– communication between control system and module is established. The module cannot be operated if it is not parameterised. The LED "FS" flashes.

The module is ready to operate if the parameters for all inputs and outputs are valid and transmitted without errors. Only in this state valid input data is read and output data is written. In every other state, the safe state is transferred for each input ("0" in the process image of the inputs). Every output is set to the safe state.

If errors are detected during parameterisation, the parameterisation data is not adopted. The flashing LED "FS" indicates that the parameterisation is invalid. The error is additionally reported to the control system.

• In this case, check and correct the settings.

ℹ️ → chapter "Errors: messages and removal"

8.2 Setting the safety address

ℹ️ When used for the first time, the stored address can only be read out after a restart.

There are two possible procedures for setting the safety address:

– Generally possible:
address assignment via the function block of the control system.

– Possible after the address has initially been written to the address storage device via the function block:
address assignment via the address storage plug E7700S

8.2.1 Address assignment via the function block

The address is set via function blocks in the respective control system used.

1. Connect the function block according to its specifications.

2. Set the desired safety address as an input parameter of the function block.

\> The function block displays the serial number of the module.

3. Compare the serial number displayed at the function block with the serial number of the module.

4. If the serial numbers match, start the address writing process via an input at the function block.

No address storage plug connected

If no address storage plug is connected, the address is stored on the module in a non-volatile way.

Address storage plug connected

If an address storage plug is connected before the module is switched on, the address is stored in the address storage device. The address is not stored on the module. Any address previously stored on the module is deleted.

For more information refer to the startup package → Chapter 15.3 Data for download → Function block.

8.2.2 Address assignment via the address storage plug

The E7700S address plug is a changeable address storage plug for the safety address. The address storage device enables easy device replacement.

To use the address storage plug for device replacement, initially write the safety address to the address storage plug via the function block.

> 🛈 → chapter "Parameterisation of the module" → chapter "Address assignment via the function block"

The address storage plug must be plugged in before switching on the device and must remain plugged in during operation. Connection X41 of the safety module is used for this.

When replacing a device, connect the address storage plug to the new safety module before switching it on. When switched on, the safety module automatically receives the address from the address storage plug.

8.3 Parameterisation of the safe inputs

Each input pair of a module can be parameterised differently and can therefore achieve different safety integrity levels (SIL, SIL, Cat., PL).

The safe inputs are parameterised in pairs. For the parameterisation options, refer to the following table.

Parameterisation per input pair

Parameterisation	Value range	Comment
Assignment	– Both not used – Used, both 1-channel – Used, 2-channel equivalent – Used, 2-channel complementary	Parameterise the input pairs in pairs. In 2-channel operation, the inputs have a fixed assignment to one another. – IN0_Ch1 to IN0_Ch2 – IN1_Ch1 to IN1_Ch2 – IN2_Ch1 to IN2_Ch2 – IN3_Ch1 to IN3_Ch2 In 1-channel operation the inputs can operate independently of each other. The input information of 2-channel parameterised inputs is mapped to one bit. The unused bits are always set to "0".
Filter time (t_{Filter})	– 1.5 ms – **3 ms** – 5 ms – 15 ms	The input signals are suppressed during the filter time. When selecting the filter time, ensure that the duration of the input signal is longer than the filter time. WARNING: The filter time affects the response time of the safety function. → chapter "Product description" → "Processing time of the safe input"
Symmetry	– Disabled – 100 ms – 1 s – 5 s	Parameterisation is only active if the input is parameterised for 2-channel operation. → chapter "Parameterisation of the module" → "Symmetry/switch-on inhibit"
Switch-on inhibit for symmetry violation	– Disabled – Enabled	Disabled: Only 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.
Cross-monitoring	– Disabled – Enabled	As soon as cross-monitoring is enabled for an assigned input pair, clock outputs T1 and T2 are clocked. Otherwise, the clock outputs are enabled without clocking.
The default values are shown in bold.		

GB

Symmetry/switch-on inhibit

The symmetry monitoring checks to what extent the (filtered) inputs belonging together simultaneously assume a different state. The symmetry is considered as violated if the inputs report non-matching states for a period longer than the value parameterised for the "symmetry". This applies to negative and positive edges.

Example of a signal change in the parameterised period for symmetry monitoring

Example of a signal change outside the parameterised period for symmetry monitoring, switch-on inhibit due to symmetry violation disabled

Example of a signal change outside the parameterised period for symmetry monitoring, switch-on inhibit due to symmetry violation disabled

S = time set for symmetry monitoring

Diag = diagnostics

Bit = transmitted state of the inputs

Q = acknowledgement of the diagnostic message. After acknowledging the diagnostic message, the current state is read in

> After acknowledging the diagnostic message, the state present at the input is immediately transferred to the control system.
>
> ● If required, implement a start-up inhibit following error acknowledgement in the application program.
>
> → chapter "Errors: messages and removal"

> A symmetry violation can also be triggered by a cross fault.
> → chapter "Connection examples for safe inputs"

8.4 Parameterisation of the safe outputs

Each output pair of a module can be parameterised differently and can therefore achieve different safety integrity levels (SIL, SIL, Cat., PL).
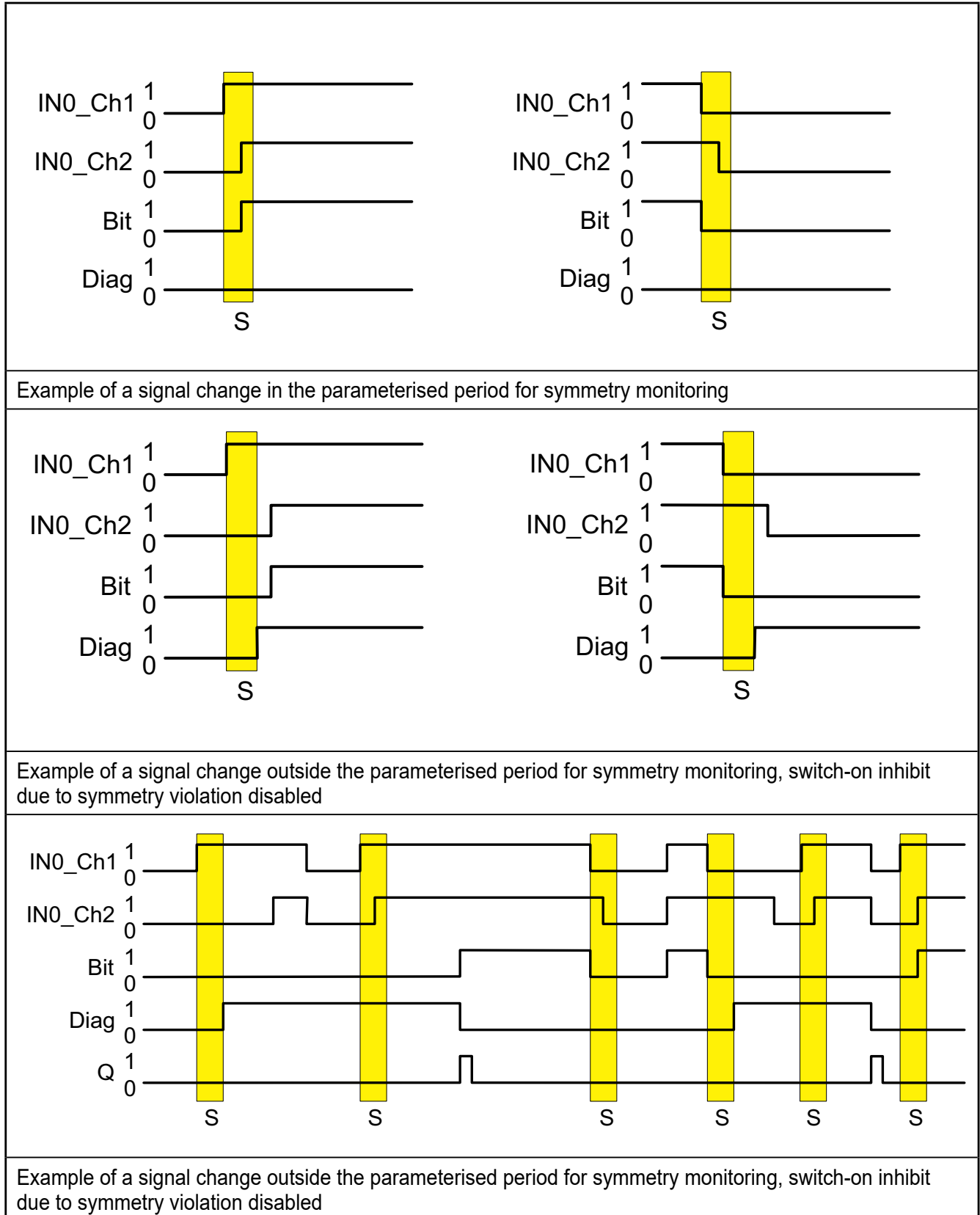
The safe outputs are parameterised in pairs. For the parameterisation options, refer to the following table.

Parameterisation per output pair

Parameterisation	Value range	Comment
Assignment	– Not used – Used, 1-channel (+switching) – Used, 2-channel (+/-switching)	The unused outputs are disabled. However, the monitoring of these outputs remains active. In two-channel operation (positive/negative switching), the outputs have a fixed assignment to one another. – OUT0_Ch1 to OUT0_Ch2 – OUT1_Ch1 to OUT1_Ch2 – OUT2_Ch1 to OUT2_Ch2 – OUT3_Ch1 to OUT3_Ch2 In 1-channel operation, only the positive switching outputs can be used. The negative switching outputs are not available in 1-channel operation and are permanently switched to GND. In this case, the following assignment applies: – OUT0_Ch1 to GND – OUT1_Ch1 to GND – OUT2_Ch1 to GND – OUT3_Ch1 to GND

Parameterisation	Value range	Comment
Switch-off delay	– Disabled – 250 ms / 500 ms / 1 s / 2 s / 4 s / 8 s / 16 s / 32 s / 64 s / 128 s	Disabled (default value): no switch-off delay Enabled: outputs switch after the set switch-off delay. Accuracy: ± 5 % of the set value
Test pulses	– Disabled – Enabled	Enabling and disabling of test pulses (switch-on pulses). For these test pulses, the output drivers that are disabled are temporarily enabled for test purposes. Observe the note below the table, see "Test pulses".
ZVEI class	– **Class 0: up to 3 ms** – Class 1: up to 1 ms – Class 2: up to 500 μs	Use the ZVEI class setting to select the maximum test pulse duration while the output is switched on (switch-off pulses). Setting the ZVEI class allows a simplified compatibility check of device interfaces. → chapter "Technical data" → „Interface types according to ZVEI classification"
The default values are shown in bold.		

Test pulses

When using positive/negative switching outputs, the test pulses always have to be enabled.

With 2-channel positive/negative switching outputs, the test pulse does not cause current to flow through the load.

If the test pulses are deactivated, cross faults and short circuits cannot be detected while the output is switched off. Outputs parameterised as "not used" are nevertheless tested with test pulses.

> ⓘ Please also note the additional information:
> → chapter "Connection examples for safe outputs"

8.4.1 Behaviour of the outputs with stop category 1

The time until the actual switching off of the outputs depends on the following factors:

– parameterisation of the switch-off delay

– event leading to switch-off of the outputs

Switch-off of the outputs depending on the trigger event and the parameterisation

Switch-off of the outputs	Influence of set switch-off delay	Switch-off of the outputs
Through the safe control system	Yes	After the set switch-off delay has elapsed
After a bus error	Yes	After the set switch-off delay has elapsed
After a short circuit, cross fault, supply voltage failure or hardware error	No	Immediately (only stop category 0)

⚠ **WARNING: Delayed switch-off**

Stop category 1 leads to delayed switch-off.

- Observe the following for stop category 1:
  - The relevant outputs are only brought into the safe state at the end of the switch-off delay.
  - In case of an error (except bus error) the relevant outputs are switched off immediatly (without delay). In this case only stop category 0 is supported.

⚠ **WARNING: Incorrect/insufficient dimensioning of the safety distances**

The wrong switch-off delay can lead to incorrectly dimensioned safety distances.

- Take into account the selected switch-off delay when dimensioning the safety distances.

Observe during switch-off:

- The switch-off can be stopped by switching the output on again.
- If you change the parameterisation of the module, it will only be adopted once all outputs are switched off.
- If you change the parameterisation before the switch-off is completed, a diagnostic message is generated.
- If the parameterisation is changed, the switch-off delay can cause a delayed start-up.

Perform a validation after changing the parameterisation.

⚠ **WARNING: Incorrect / old condition data of the device**

Incorrect and old condition data of the device can lead to malfunctions.

Execute a safety validation and a power reset of the system after each new or reconfiguration.

9 Connection examples for safe inputs

9.1 Explanation of the examples

The following examples describe how sensors can be electrically connected to the safe inputs. They do not describe complete applications.

Safety integrity of the inputs

If the settings match, the inputs of a module can meet different safety integrity levels (SIL, SIL, Cat., PL) at the same time.

> [icon] In addition to the actions mentioned in the examples, also observe the standards IEC 61508, EN 62061 and EN ISO 13849-1 to meet the specified SIL/SIL/Cat./PL.

Prerequisite of fault exclusion

Errors (e.g. cross faults, short circuits) which can be prevented by correct installation are not described in the following examples. Correct installation includes e.g.:

– protected cable routing

– isolated cable routing

– double insulation

– use of wire end ferrules

Only errors between inputs which are on the same plug are described in the following examples. For example, if the installation is correct, cross faults with inputs and outputs of other plugs cannot occur.

Requirements on the sensor

To achieve the desired safety integrity, the requirements of the standards with regard to the external wiring and the sensors to be used must be met.

Observe the technical data of the safe inputs when selecting the sensor.

> [icon] → chapter "Technical data"

9.2 Single-channel assignment of the safe inputs

For the 1-channel assignment of the safe inputs, the inputs operate independently from each other. The assignment of each input signal to the clock output is fixed.

9.2.1 Notes on errors

Cross fault

⚠️ **WARNING: Loss of the safety function**

Note that cross faults to other inputs are only detected if cross-monitoring is enabled.

The error "cross fault" causes the transfer of the safe state in the process data image of the affected inputs.

● Eliminate the error and acknowledge the message.

Error detection time

• Observe the error detection time.

🛈 → chapter "Product description" → "Safety-related system times" → "Error detection time".

Voltage supply

To supply the voltage for the 1-channel assignment, use the respective clock output or an external voltage supply (external +24 V or OSSD).

State analysis

The module evaluates the input states and sends the result to the control system.

The following values are transferred in the process data image of a safe input:

  – "0" if a "0" signal is present at the input or if an error was detected
  – "1" if a "1" signal is present at the input and if no error was detected

9.2.2 Cross-monitoring enabled

If an input pair is parameterised for 1-channel operation with cross-monitoring, the following assignment applies:

  – fixed assignment of INx_Ch1 to clock output T1
  – fixed assignment of IINx_Ch2 to clock output T2

S1 Safety switch
IN0_Ch1 ⊘——S1——⌐   T1 ⊘——————⌐
1-channel assignment of inputs
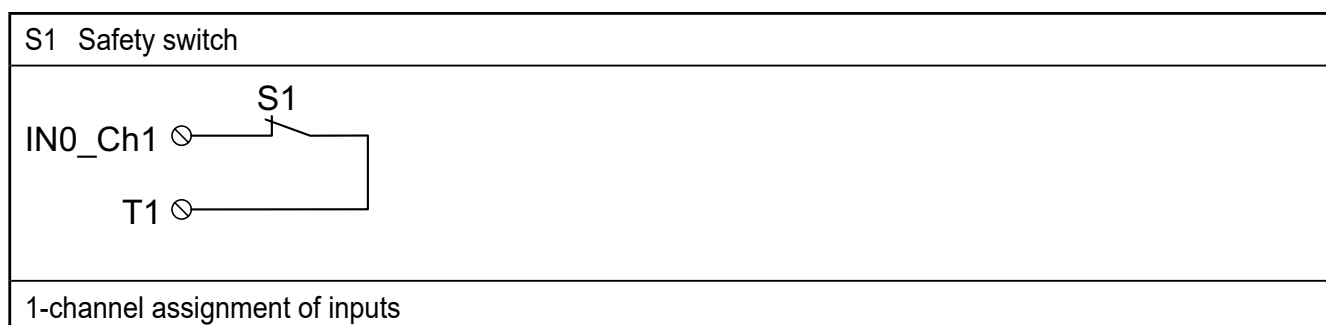
Key data

Sensor	1-channel
Sensor supply	Internal by clock output T1 (clocked) or T2 (clocked)
Achievable safety integrity	SIL 2/SIL 2/Cat. 2*/PL d
Cat. 3 can be attained by linking two 1-channel sensors in the control logic.	

Device diagnosis and module behaviour in case of error

1-channel: supply by T1 (clocked) or T2 (clocked)

Error type	Identifica-tion	Diagnos-tics	Loss of the SF*	Comment
Error in the sensor				
Non-opening of a contact	No	None	Yes	The error cannot be detected and causes a loss of the safety function.
Non-closing of a contact	No	None	No	The error cannot be detected.
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Input (interruption of the line between clock output and sensor or between sensor and input)	Yes	None	No	Behaviour in state "1" of the input: The error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart. Behaviour in state "0" of the input: Note that when switching the safety switch on again, this error can cause a delayed transfer of state "1" in the process data image of the inputs.
Cross fault				
Input to input	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged. If the inputs are assigned to different clock outputs, this error is identified as a cross fault after 64 ms.
Input to assigned clock output	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Input to unas-signed clock output	Yes	Cross fault	No	→ chapter "Connection example for safe inputs" → "Notes on errors" →"Cross fault".

Error type	Identifica-tion	Diagnos-tics	Loss of the SF*	Comment
Clock output to clock output	Yes, if state is "1"	Cross fault	No	The error is only detected in state "1" of the input.
Short circuit				
Input to ground	Yes	None	No	Only in state "1" of the input, the error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
Clock output to ground	Yes	Short circuit	No	The affected clock output is disabled.
*SF = safety function				

Example parameterisation

Parameterisation	Parameterised as/value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, both 1-channel	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	Disabled	Mandatory setting
Switch-on inhibit for symmetry violation	Disabled	Mandatory setting
Cross-monitoring	Enabled	Mandatory setting

9.2.3 Cross-monitoring disabled, supplied by T1 or external supply

S1 safety switch / T1 supply by T1
1-channel assignment of inputs: supplied by T1

S1 safety switch / + 24 V supply by external 24 V
1-channel assignment of inputs: external supply

Key data

Sensor	1-channel
Sensor supply	– Internal by clock output T1 or T2; cross-monitoring disabled – External (24 V)
Achievable safety integrity	SIL 2/SIL 2/Cat. 2/PL d

⚠ **WARNING: Loss of the safety function**

Cross faults can cause the loss of the safety function. Exclude the cross faults to attain the specified PL.

Device diagnosis and module behaviour in case of error

1-channel without cross-monitoring:
supplied by T1/T2, external supply or OSSD

Error type	Identifica-tion	Diagnos-tics	Loss of the SF*	Comment
Error in the sensor				
Non-opening of a contact	No	None	Yes	The error cannot be detected and causes a loss of the safety function.
Non-closing of a contact	No	None	No	The error cannot be detected.
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Input (interruption of the line between clock output and sensor or between sensor and input)	Yes	None	No	Behaviour in state "1" of the input: The error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart. Behaviour in state "0" of the input: Note that when switching the safety switch on again, this error can cause a delayed transfer of state "1" in the process data image of the inputs.
Cross fault				
Input to input	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Input to clock output	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Short circuit				

Error type	Identifica-tion	Diagnos-tics	Loss of the SF*	Comment
Input to external 24 V	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Input to ground	Yes, if state is "1"	None	No	Only in state "1" of the input, the error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
Clock output to external 24 V	No	None	No	The error cannot be detected as the clocking is switched off.
Clock output to ground	Yes	Short circuit	No	The affected clock output is disabled.
External 24 V to ground	Yes	None	No	Only in state "1" of the input, the error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
*SF = safety function				

Example parameterisation

Parameterisation	Parameterised as/value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, both 1-channel	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	Disabled	Mandatory setting
Switch-on inhibit for symmetry violation	Disabled	Mandatory setting
Cross-monitoring	Disabled	Mandatory setting

9.2.4 Supply by OSSD

OSSD - OSSD sensor
1-channel assignment of inputs: external supply (OSSD)

51

⚠ **WARNING: Loss of the safety function**

Unwanted stray or induced voltages may lead to a loss of the safety function.

● Connect the ground of the sensor directly to the "GND" terminal point (U_S) of the corresponding M12 connection. Using an external ground is not permitted.

Key data

Sensor	1-channel OSSD output (with internal testing)
Sensor supply	External (OSSD sensor)
Achievable safety integrity	SIL 2/SIL 2/Cat. 2/PL d

⚠ **WARNING: Loss of the safety function**

Cross faults can cause the loss of the safety function.

● Exclude the cross faults to attain the specified PL.

Device diagnosis and module behaviour in case of error

1-channel: supply by OSSD

Error type	Identification	Diagnostics	Loss of the SF*	Comment
Error in the sensor				
(depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Input (interruption of the line between sensor and input)	Yes	None	No	Behaviour in state "1" of the input: The error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart. Behaviour in state "0" of the input: Note that when switching the safety switch on again, this error can cause a delayed transfer of state "1" in the process data image of the inputs.
Input (interruption of the line between sensor and GND)	No	None	No	The sensor must detect the error. The sensor must ensure that the safe state is assumed when the error occurs.

Error type	Identifica-tion	Diagnos-tics	Loss of the SF*	Comment
Cross fault				
Input to input	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Input to clock output	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Short circuit				
Input to external 24 V	No	None	Yes	The error cannot be detected and causes the loss of the safety function as the safety switch is bridged.
Input to ground	Yes, if state is "1"	None	No	Only in state "1" of the input, the error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
Clock output to external 24 V	No	None	No	The error cannot be detected as the clocking is switched off.
Clock output to ground	Yes	Short circuit	No	The affected clock output is disabled.
External 24 V to ground	Yes		No	Only in state "1" of the input, the error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
*SF = safety function				

Example parameterisation

Parameterisation	Parameterised as/ Value range	Comment
Input xx channel 1/channel 2		
Assignment	Both 1-channel	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	Disabled	Mandatory setting
Switch-on inhibit for symmetry violation	Disabled	Mandatory setting
Cross-monitoring	No cross-monitoring	Mandatory setting

9.3 Two-channel equivalent assignment of the safe inputs

For the 2-channel operation of the inputs, the channel assignment is fixed.

For the 2-channel equivalent assignment of the inputs, the following applies:
The state only changes from "0" to "1" if both inputs change the state from "0" to "1".

If symmetry monitoring is set, the following applies:
If the state does not change at the two inputs within the parameterised period, a diagnostic message is generated.

If the signal state is "1", the input is active.

> ⓘ Note when switching the sensor on again:
> A delayed change in state at one of the two inputs can cause a delayed transfer of state "1" in the process data image of the inputs.

Example of a correct and an incorrect signal change
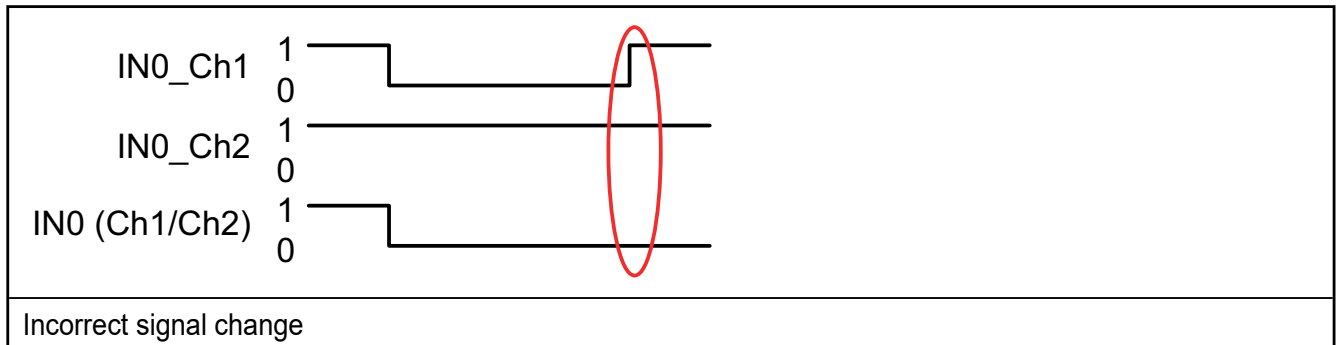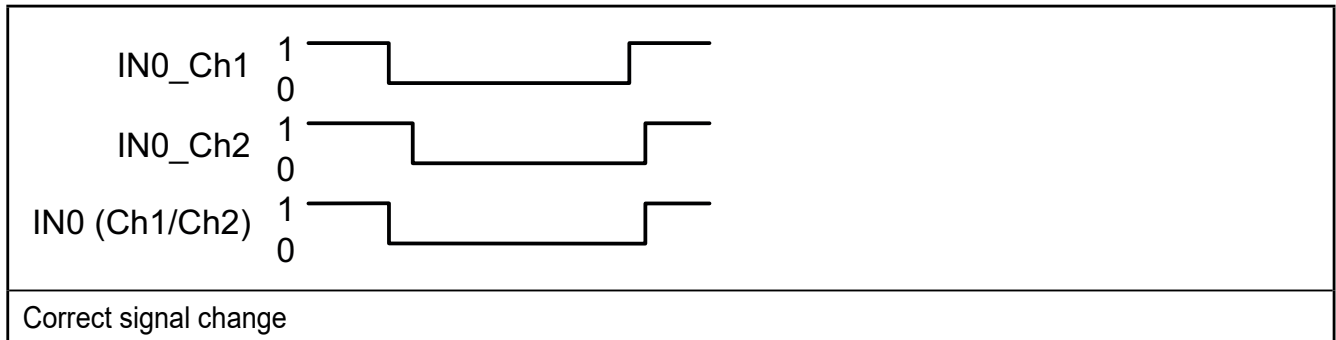
Correct signal change

Incorrect signal change

IN0_Ch1 Signal sequence at input 0 channel 1

IN0_Ch2 Signal sequence at input 0 channel 2

IN0 (Ch1/Ch2)   Safety-relevant signal for the 2-channel input 0, channel 1 and channel 2 at the control system

In the lower image the following condition is not met:
Both signals had to be in state "0" before changing the state from "0" to "1". Since the condition is not met, the diagnostic message is generated.

State analysis

The module evaluates the input states and sends the result to the control system.

The following values are transferred in the process data image of the safe inputs:

– "0" if a "0" signal is present at least at one of the two inputs or if an error was detected

– "1" if a "1" signal is present at both inputs and if no error was detected and if the conditions to change the state are met as in the image below

9.3.1 Notes on errors

Cross fault

The error "cross fault" causes the transfer of the safe state in the process data image of the affected inputs.

● Eliminate the error and acknowledge the message.

Acknowledging the diagnostic message deletes the message and switches the input to active. The states at the input are immediately detected.

● Ensure in the safe application program that the system does not accidentally start again after acknowledging the diagnostic message.

Symmetry violation

– The diagnostic message "Symmetry violation" is only displayed if it is enabled during parameterisation of the affected input.

– Switch-on inhibit disabled for symmetry violation:
The message "Symmetry violation" does not cause the transfer of the safe state:
→ chapter "Parameterisation of the module" → "Symmetry/switch-on inhibit"
The message has to be acknowledged. However, the current status of the inputs is always displayed in the process data image of the inputs.

– Switch-on inhibit enabled for symmetry violation:
The message "Symmetry violation" causes the transfer of the safe state:
→ chapter "Parameterisation of the module" → "Symmetry/switch-on inhibit"
The message has to be acknowledged. After acknowledgment, the current status of the inputs is displayed in the process data image of the inputs.

9.3.2 Cross-monitoring enabled, supplied by T1 and T2

Possible assignment variants

S1, S2 - switching elements
T1, T2 - supply by T1 and T2
2-channel equivalent assignment of the inputs, supplied by T1 and T2 (both clocked)
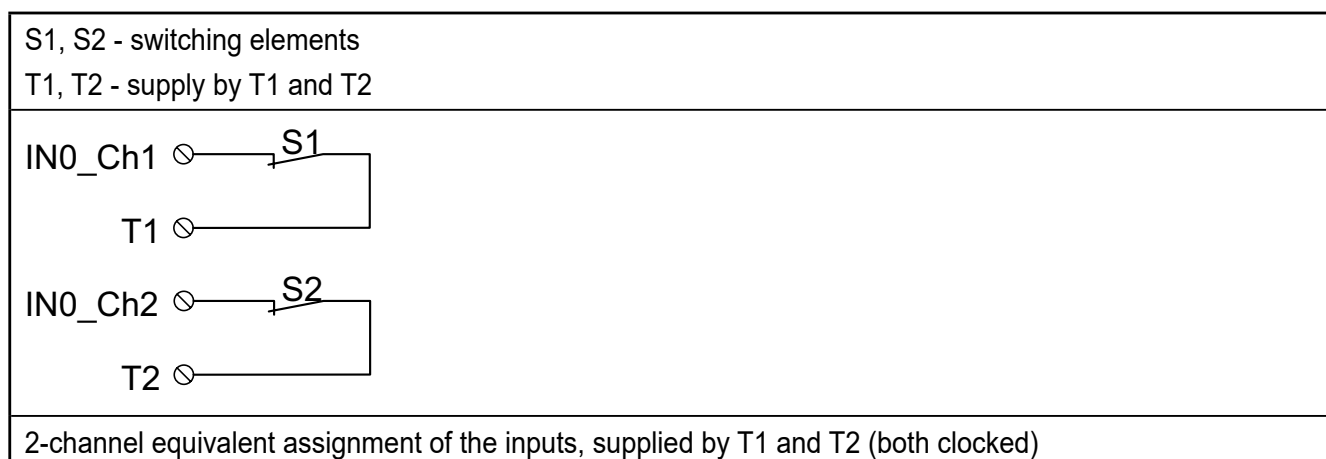
Key data

Sensor	2-channel equivalent with cross-monitoring
Sensor supply	Internal by clock output T1 and T2 (both clocked)
Achievable safety integrity	SIL 3/SIL 3/Cat. 4/PL e

Device diagnosis and module behaviour in case of error

Observe the information to understand the change in state:
→ chapter "Connection examples for safe inputs" → "Example of a correct and an incorrect signal change".

2-channel equivalent with cross-monitoring: supply by T1 and T2

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Error in the sensor				
Non-opening of a contact	Yes	Symmetry viola-tion [2]	No	The error is detected when the state is changed, as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs. – Change of state from "0" to "1": "0" is transferred in the process data image of the corresponding inputs as the incorrect input did not previously assume state "0".
Non-closing of a contact	Yes	Symmetry viola-tion [2]	No	When changing the state from "0" to "1", "0" is transferred in the process data image of the affected inputs as only one channel signals this change of state.
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Input (interruption of the line between clock output and sensor or between sensor and input)	Yes	Symmetry viola-tion [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
Cross fault				

Error type	Identifica- tion	Diagnostics	Loss of the SF*	Comment
Input to input	Yes	Cross fault	No	The error is detected in state "1".
Input to assigned clock output	Yes	Symmetry viola- tion [2]	No	The error is detected when the state is changed, as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs. – Change of state from "0" to "1": "0" is transferred in the process data image of the inputs if the incorrect input did not previously assume state "0".
Input to assigned clock output on both channels simultaneously	No	None	Yes	Carry out a fault exclusion on the cable routing of the sensor circuits.
Input to unas- signed clock output	Yes	Cross fault	No	→ chapter "Connection examples for safe inputs" → "Notes on errors" → "Cross fault"
Clock output to clock output	Yes	Cross fault	No	The error is detected at the inputs assigned to different clock outputs.
Short circuit				
Input to ground	Yes	Symmetry viola- tion [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
Clock output to ground	Yes	Short circuit	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel. The error is also detected as short circuit of the clock output. The affected clock output is disabled.
*SF = safety function				
2 Applies only if symmetry monitoring is enabled				

Example parameterisation

Parameterisation	Parameterised as/ Value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, 2-channel equivalent	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	100 ms	Depending on the application

GB

Parameterisation	Parameterised as/ Value range	Comment
Switch-on inhibit for symmetry violation	Enabled	Depending on the application
Cross-monitoring	Enabled	Mandatory setting

9.3.3 Cross-monitoring disabled, supplied by a clock output or external supply

S1, S2 - switching elements T1 (T2) - supply by T1 or T2
IN0_Ch1 ⊘————⌐ S1 IN0_Ch2 ⊘————⌐ S2   T1 (T2) ⊘————
2-channel equivalent assignment of the inputs, supplied by T1 (or T2), cross-monitoring disabled

S1, S2 - switching elements +24 V - supply by external 24 V
IN0_Ch1 ⊘————⌐ S1 IN0_Ch2 ⊘————⌐ S2   +24 V ⊘————
2-channel equivalent assignment of the inputs, external supply, cross-monitoring disabled

Key data

Sensor	2-channel equivalent
Sensor supply	Internal by clock output T1 (or T2) or external
Achievable safety integrity	SIL 3/SIL 3/Cat. 3/PL d

ℹ️ Observe the information to understand the change in state:
→ chapter "Connection examples for safe inputs" → "Example of a correct and an incorrect signal change".

Device diagnosis and module behaviour in case of error

2-channel equivalent, cross-monitoring disabled:
supplied by a clock output or external supply

GB

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Error in the sensor				
Non-opening of a contact	Yes	Symmetry violation [2]	No	The error is detected when the state is changed, as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs. – Change of state from "0" to "1": "0" is transferred in the process data image of the corresponding inputs as the incorrect input did not previously assume state "0".
Non-closing of a contact	Yes	Symmetry violation [2]	No	When changing the state from "0" to "1", "0" is transferred in the process data image of the affected inputs as only one channel signals this change of state.
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Interruption of the line between clock output or external supply and sensor)	Yes	None	No	– Behaviour in state "1" of the input: The error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
Interruption of the line between sensor and input	Yes	Symmetry violation [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
Cross fault				
Input to input	No	None	No	An accumulation of faults can lead to a loss of the safety function.

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Input to clock output	Yes	Symmetry violation [2]	No	The error is detected when the state is changed, as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs. – Change of state from "0" to "1": "0" is transferred in the process data image of the inputs if the incorrect input did not previously assume state "0".
Clock output to clock output	No	None	No	The error is not detected.
Short circuit				
Input to external 24 V	Yes	Symmetry violation [2]	No	The error is detected when the state is changed, as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs. – Change of state from "0" to "1": "0" is transferred in the process data image of the inputs as the incorrect input did not previously assume state "0".
Input to ground	Yes	None	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
Unclocked clock output to external 24 V	No	None	No	The error is not detected.
Clock output to ground	Yes	Short circuit	No	The error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart. The error is also detected as short circuit of the clock output. The affected clock output is disabled.

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
External 24 V to ground	Yes	None	No	The error is detected as change in state from "1" to "0". An unexpected change from "0" to "1" is possible. Make sure that such a change in state does not cause an accidental system restart.
*SF = safety function				
2 Applies only if symmetry monitoring is enabled				

ℹ️ For all inputs parameterised without cross-monitoring, cross faults and short circuits are not detected by the device diagnostics, but only when the state of the input signals changes, as the state changes only in one channel.

⚠️ **WARNING: Loss of the safety function**

An accumulation of faults can lead to a loss of the safety function.

● Test the safety function at reasonable intervals to detect errors early.

Example parameterisation

Parameterisation	Parameterised as/ Value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, 2-channel equivalent	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	100 ms	Depending on the application
Switch-on inhibit for symmetry violation	Disabled	Depending on the application
Cross-monitoring	Disabled	Mandatory setting

9.3.4 External supply (OSSD)

OSSD - OSSD sensor
2-channel equivalent assignment of the inputs, external supply (OSSD)

Key data

Sensor	2-channel OSSD output (with internal testing)
Sensor supply	External (OSSD sensor)
Achievable safety integrity	SIL 3/SIL 3/Cat. 4/PL e

Device diagnosis and module behaviour in case of error

ℹ️ Observe the information to understand the change in state:
→ chapter "Connection examples for safe inputs" → "Example of a correct and an incorrect signal change".

2-channel equivalent: external supply (OSSD)

Error type	Identification	Diagnostics	Loss of the SF*	Comment
Error in the sensor				
Channel failure	Yes	Symmetry violation [2]	No	The error is detected when the state is changed, as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs. – Change of state from "0" to "1": "0" is transferred in the process data image of the corresponding inputs as the incorrect input did not previously assume state "0".
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Input (interruption of the line between sensor and input)	Yes	Symmetry violation [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
Input (interruption of the line between sensor and GND)	No	None	No	The error has to be detected by the sensor. The sensor must ensure that the safe state is assumed when the error occurs.
Cross fault				

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Input to input	No	None	Yes	The error has to be detected by the sensor. The sensor must ensure that the safe state is assumed when the error occurs.
Input to clock output	Yes	Symmetry violation [2]	No	The error is detected upon change in state if the clock output is set to "1", as the state changes only in one channel.
Short circuit				
Input to 24 V	Yes	Symmetry violation [2]	No	The error is detected when the state is changed, as the state changes only in one channel.
Input to ground	Yes	Symmetry violation [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
*SF = safety function				
2 Applies only if symmetry monitoring is enabled				

GB

Example parameterisation

Parameterisation	Parameterised as/ Value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, 2-channel equivalent	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	100 ms	Depending on the application
Switch-on inhibit for symmetry violation	Disabled	Depending on the application
Cross-monitoring	Disabled	Mandatory setting

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

Disable the cross-fault monitoring.

9.4 Two-channel complementary assignment of the safe inputs

For the 2-channel operation of the inputs, the channel assignment is fixed.

For 2-channel complementary assignment of the inputs, the following applies:
The state only changes from "0" to "1" if the input INx_Ch1 changes its state from "0" to "1" and the input INx_Ch2 changes its state from "1" to "0".

If symmetry monitoring is set, the following applies:
If the state does not change at the two inputs within the parameterised period, a diagnostic message is generated.

The state is active if the signal state at channel 1 is "1" and if the signal state at channel 2 is "0".

> ℹ️ Note when switching the sensor on again:
> A delayed change in state at one of the two inputs can cause a delayed transfer of state "1" in the process data image of the inputs.

> ℹ️ For applications in PL e, the safety function must be requested once a month.

Example of a correct and an incorrect signal change
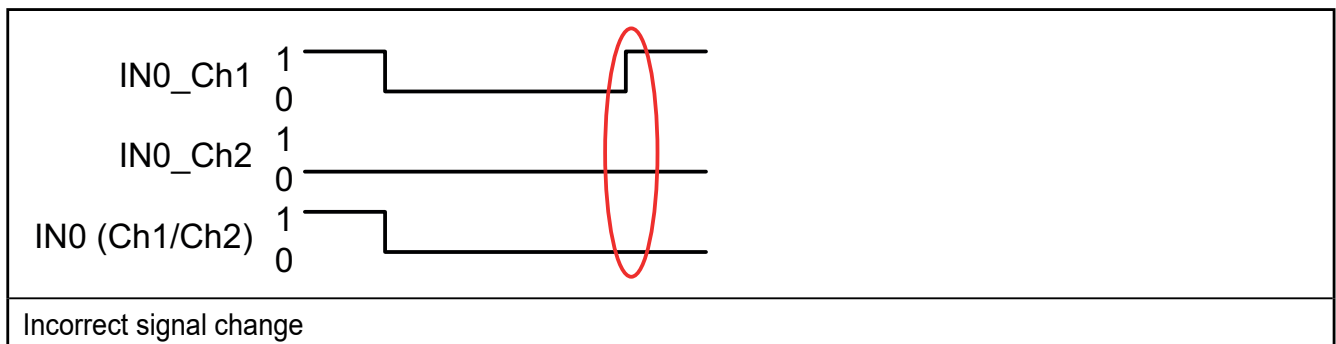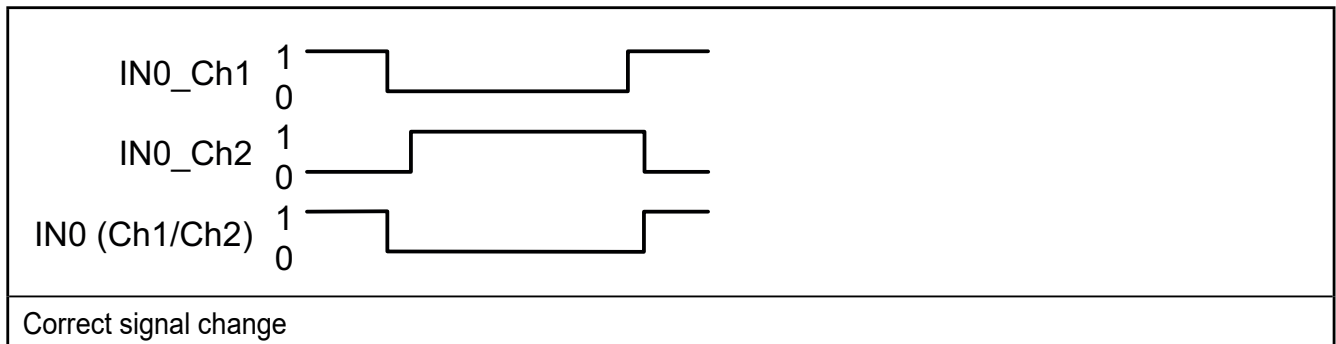
Correct signal change

Incorrect signal change

IN0_Ch1 Signal sequence at input 0 channel 1

IN0_Ch2 Signal sequence at input 0 channel 2

IN0 (Ch1/Ch2)   Safety-relevant signal for the 2-channel input 0, channel 1 and channel 2 at the control system

In the lower image the following condition is not met:
Both signals have to be in opposite state before the change of state. Since the condition is not met, the diagnostic message is generated.

State analysis

The module evaluates the input states and sends the result to the control system.

The following values are transferred in the process data image of the safe inputs:

– "1" 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 if no error was detected
and if the conditions to change the state are met according to the image above.

– In all other cases, "0" is transferred.

9.4.1 Notes on errors

Cross fault

The error "cross fault" causes the transfer of the safe state in the process data image of the affected inputs.

● Eliminate the error and acknowledge the message.

Acknowledging the diagnostic message deletes the message and switches the input to active. The states at the input are immediately detected.

● Ensure in the safe application program that the system does not accidentally start again after acknowledging the diagnostic message.

symmetry violation

– The diagnostic message "Symmetry violation" is only displayed if it is enabled during parameterisation of the affected input.

– Switch-on inhibit disabled for symmetry violation:
The message "Symmetry violation" does not cause the transfer of the safe state:
→ chapter "Parameterisation of the module" → "Symmetry/switch-on inhibit"
The message has to be acknowledged. However, the current status of the inputs is always displayed in the process data image of the inputs.

– Switch-on inhibit enabled for symmetry violation:
The message "Symmetry violation" causes the transfer of the safe state:
→ chapter "Parameterisation of the module" → "Symmetry/switch-on inhibit"
The message has to be acknowledged. After acknowledgment, the current status of the inputs is displayed in the process data image of the inputs.

9.4.2 Cross-monitoring enabled, supplied by T1 and T2

S1, S2 - switching elements
T1, T2 - supply by T1 and T2

IN0_Ch1 ⊘———⸻ S1

T1 ⊘————

IN0_Ch2 ⊘———⸻ S2

T2 ⊘————

2-channel complementary assignment of the inputs,
supply by T1 and T2, cross-monitoring enabled
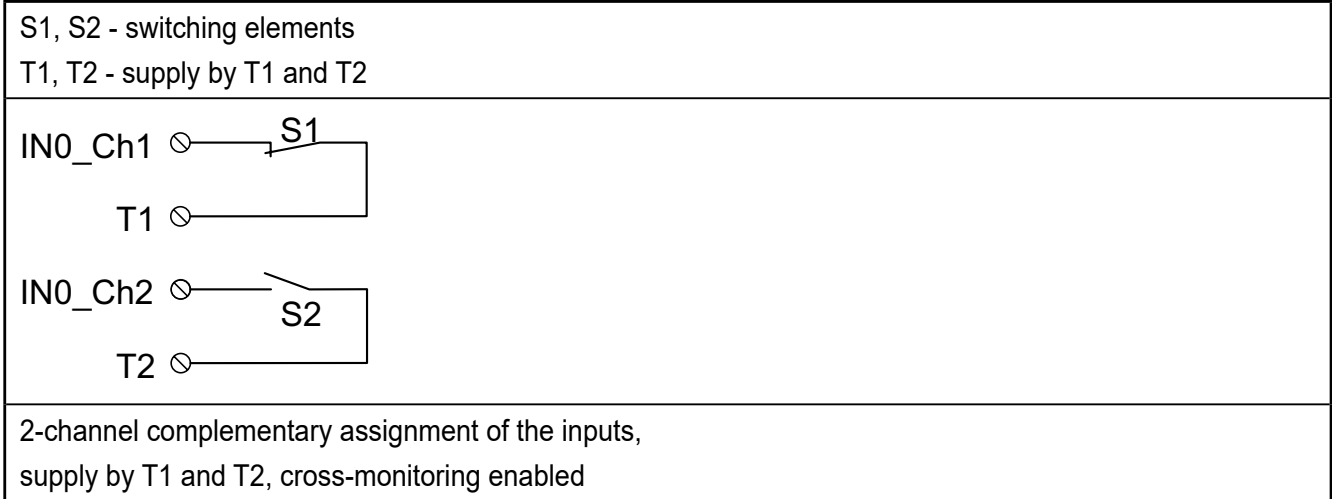
Key data

Sensor	2-channel complementary
Sensor supply	Internal by clock output T1 and T2, cross-monitoring enabled
Achievable safety integrity	SIL 3/SIL 3/Cat. 4/PL e

> 🛈 Observe the information to understand the change in state:
> → chapter "Connection examples for safe inputs"
> → "Two-channel complementary assignment of the safe inputs"
> → "Example of a correct and an incorrect signal change".

Device diagnosis and module behaviour in case of error

2-channel complementary with cross-monitoring: supply by T1 and T2

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Error in the sensor				
Non-opening of a contact	Yes	Symmetry viola-tion [2]	No	The error is detected as the state changes only in one channel.
Non-closing of a contact	Yes	Symmetry viola-tion [2]	No	The error is detected as the state changes only in one channel.
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Input (interruption of the line between clock output and sensor or between sensor and input)	Yes	Symmetry viola-tion [2]	No	The error is detected at the latest when the state is changed, as the state changes only in one channel.
Cross fault				
Input to input	Yes	Cross fault	No	The error is detected if the other input is set to "1".
Input to assigned clock output	Yes	Symmetry viola-tion [2]	No	The error is detected when the state is changed, as the state changes only in one channel.
Input to unas-signed clock output	Yes	Cross fault	No	→ chapter "Connection examples for safe inputs" → "Notes on errors" → "Cross fault"
Clock output to clock output	Yes	Cross fault	No	The error is detected at the inputs assigned to different clock outputs.
Short circuit				
Input to ground	Yes	None	No	The error is detected at the latest when the state is changed, as the state changes only in one channel.
Clock output to ground	Yes	Short circuit	No	The error is detected at the latest when the state is changed, as the state changes only in one channel.

The error is also detected as short circuit of the clock output. The affected clock output is disabled. |
| *SF = safety function | | | | |
| 2 Applies only if symmetry monitoring is enabled | | | | |

> An error in input circuit INx_Ch2 can only be detected if the safety function was requested.

⚠ **WARNING: Loss of the safety function**
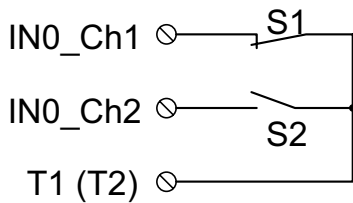
An accumulation of faults can lead to a loss of the safety function.
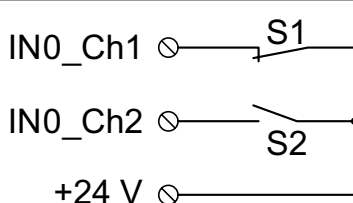
● Test the safety function at reasonable intervals to detect errors early.

Example parameterisation

Parameterisation	Parameterised as/ Value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, 2-channel complementary	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	100 ms/1 s/5 s (depending on the application)	Mandatory setting
Switch-on inhibit for symmetry violation	Disabled	Depending on the application
Cross-monitoring	Enabled	Mandatory setting

9.4.3 Cross-monitoring disabled, supplied by a clock output or external supply

S1, S2 - switching elements T1 (T2) - supply by T1 or T2
IN0_Ch1   S1 IN0_Ch2   S2 T1 (T2)
2-channel complementary assignment of the inputs, supplied by T1 (or T2), cross-monitoring disabled

S1, S2 - switching elements +24 V - supply by external 24 V
IN0_Ch1   S1 IN0_Ch2   S2 +24 V
2-channel complementary assignment of the inputs, external supply

Key data

Sensor	2-channel complementary
Sensor supply	Internal by clock output T1 (or T2) (clocking switched off) or external
Achievable safety integrity	SIL 3/SIL 3/Cat. 3/PL d

> Observe the information to understand the change in state:
> → chapter "Connection examples for safe inputs" → "Two-channel complementary assignment of the safe inputs" → "Example of a correct and an incorrect signal change".

Device diagnosis and module behaviour in case of error

2-channel complementary without cross-monitoring:
supplied by a clock output or external supply

Error type	Identification	Diagnostics	Loss of the SF*	Comment
Error in the sensor				
Non-opening of a contact	Yes	Symmetry violation [2]	No	The error is detected as the state changes only in one channel.
Non-closing of a contact	Yes	Symmetry violation [2]	No	The error is detected as the state changes only in one channel.
Other errors (depending on the sensor)				Consider errors that can occur in the sensor.
Error in the wiring				
Interruption				
Input (interruption of the line between clock output and sensor or between sensor and input)	Yes	Symmetry violation [2]	No	The error is detected at the latest when the state is changed, as the state changes only in one channel.
Cross fault				
Input to input	Yes	Symmetry violation [2]	No	The error is detected as the state changes only in one channel.
Input to clock output	Yes	v	No	The error is detected as the state changes only in one channel. – Change of state from "1" to "0": The incorrect input remains on "1". "0" is transferred in the process data image of the corresponding inputs.
Clock output to clock output	No	None	No	The error is not detected.
Short circuit				
Input to external 24 V	Yes	Symmetry violation [2]	No	The error is detected at the latest when the state is changed, as the state changes only in one channel.

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Input to ground	Yes	Symmetry violation [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
Clock output to external 24 V	No	None	No	The error is not detected.
Clock output to ground	Yes	Short circuit	No	The error is detected as change in state from "1" to "0". The error is also detected as short circuit of the clock output. The affected clock output is disabled.
External 24 V to ground	Yes	Symmetry violation [2]	No	The error is detected in state "1" or when changing the state from "0" to "1", as the state changes only in one channel.
*SF = safety function				
2 Applies only if symmetry monitoring is enabled				

⚠ **WARNING: Loss of the safety function**

An accumulation of faults can lead to a loss of the safety function.

● Test the safety function at reasonable intervals to detect errors early.

Example parameterisation

Parameterisation	Parameterised as/ Value range	Comment
Input xx channel 1/channel 2		
Assignment	Used, 2-channel complementary	Mandatory setting
Filter time (tFilter)	3 ms	Depending on the application
Symmetry	100 ms	Depending on the application
Switch-on inhibit for symmetry violation	Enabled	Depending on the application
Cross-monitoring	Disabled	Mandatory setting

10 Connection examples for safe outputs

10.1 Explanation of the examples

The following examples describe how command devices and actuators can be electrically connected to the safe outputs. They do not describe complete applications.

Safety integrity of the outputs

If the settings match, the outputs of a module can meet different safety integrity levels (SIL, SIL, Cat., PL) at the same time.

> ⓘ In addition to the actions mentioned in the examples, also observe the standards IEC 61508, EN 62061 and EN ISO 13849-1 to meet the specified SIL/SIL/Cat./PL.

Prerequisite of fault exclusion

Errors (e.g. cross faults, short circuits) which can be prevented by correct installation are not described in the following examples. Correct installation includes e.g.:

– protected cable routing,

– isolated cable routing

– double insulation

– use of wire end ferrules

Only errors between outputs which are on the same plug are described in the following examples. For example, if the installation is correct, cross faults with inputs and outputs of other plugs cannot occur.

Requirements on the actuator

To achieve the desired safety integrity, the requirements of the standards with regard to the external wiring and the actuators to be used must be met.

Observe the technical data of the safe outputs when selecting the actuator.

> ⓘ → chapter "Technical data"

Prevent feedback and external voltages

> ⚠ **WARNING: Loss of the safety function due to feedback or external voltage**
>
> Feeding (back) an external voltage into an output (e.g. through cross faults) is not permitted. Such faults can affect the function of the module (up to its destruction) and thus lead to the loss of the safety function.
>
> ● Prevent feedback of external voltages to the outputs.
>
> ● Ensure cross-circuit protection when laying the cables for connection of the actuators.
>
> ● Observe the load capacity of the outputs
> → chapter "Technical data"

10.2 Notes on the protective circuit for external relays or contactors (freewheeling circuit)
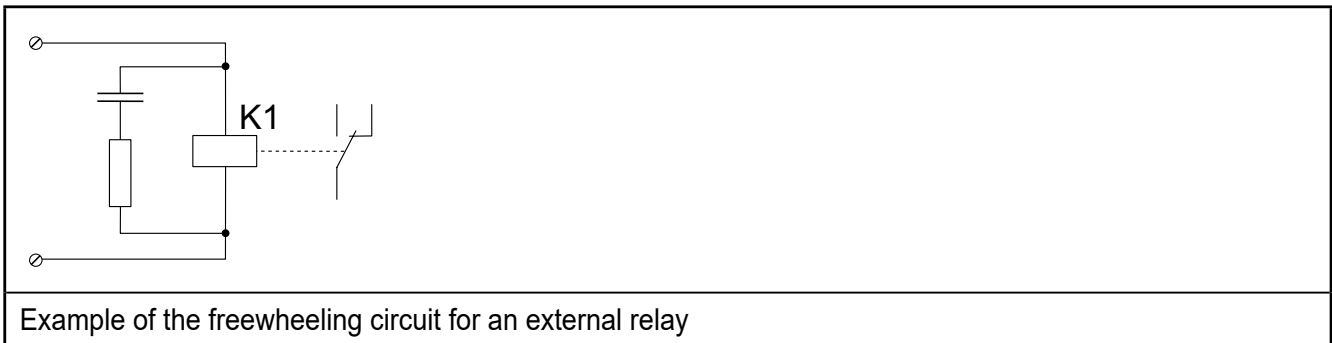
Example of the freewheeling circuit for an external relay

Observe the following:

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

● Please note that the freewheeling circuit affects the drop-out time and the service life of the contactor.

● Please observe the specifications of the relay manufacturer when sizing the protective circuit of the relay.

10.3 Single-channel assignment of positive switching outputs
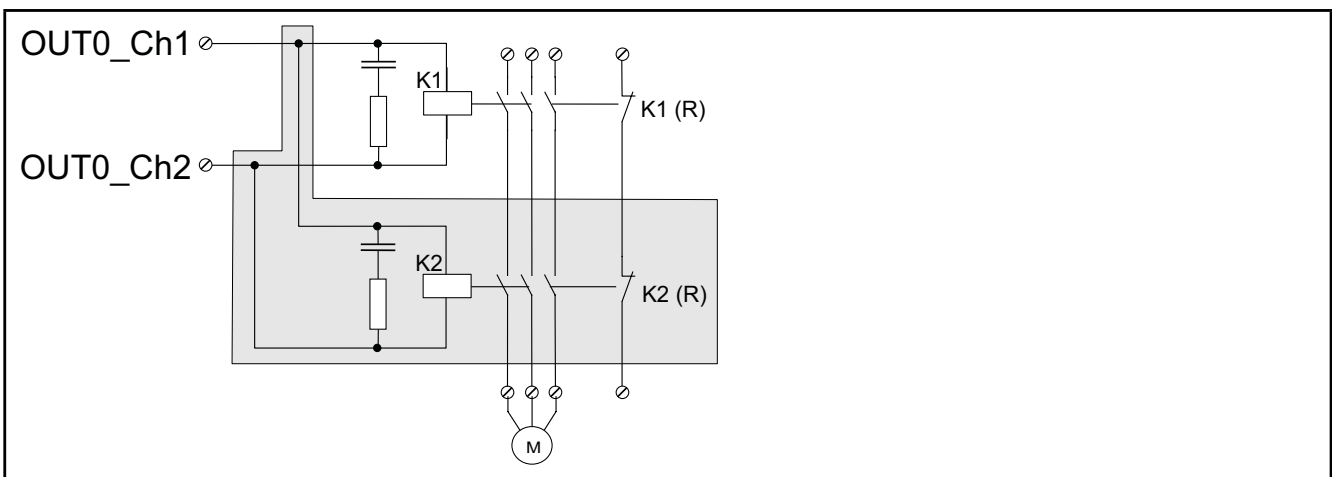
1-channel assignment of the positive switching outputs

In order to achieve Cat. 3 or PL d with 1-channel assignment of the outputs, use a 2-channel actuator. The 2-channel operation of the actuator with the corresponding connection is represented on a grey background.

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

⚠️ **WARNING: Loss of the safety function**

Improperly executed applications can lead to the loss of the safety function.

● Connect the actuator completely and exclusively via the M12 connector to the used output of the module.

● To achieve SIL 2/Cat. 3 and PL d, the test pulses must be enabled.

● Evaluate the feedback contacts to achieve the corresponding safety integrity level.

Error detection time

GB

Observe the error detection time.

ℹ️ → chapter "Product description" → "Safety-related system times"
→ "Error detection time".

Key data

Actuator	1-channel	2-channel
Achievable SIL//SIL/Cat./PL	SIL 2 / SIL 2 / Cat. 2 / PL c	SIL 2 / SIL 2 / Cat. 3 / PL d

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

1-channel: test pulses enabled

Error type	Identification	Diagnostics	Loss of the SF*	Comment
Error in the actuator				
Despite being switched off, the actuator does not go into the safe state (e.g. a contact will not open)	No	None	Yes	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. Test the switch-off capability of the actuator at appropriate intervals. If necessary, use a 2-channel actuator.
Actuator cannot be switched on (e.g. interruption)	No	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. Ensure that this error does not result in delayed system start-up.
Other errors (depending on the actuator)				Consider errors that can occur in the actuator.
Error in the wiring				
Interruption				

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Interruption of the line between output and actuator or between actuator and ground	No	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. Ensure that this error does not result in delayed or unexpected system start-up.
Cross fault				
Output to output	Yes	All OUT LEDs red on	Yes	When the outputs are disabled, a cross fault between the outputs is only detected if the test pulses are enabled. If an error is detected, the module disables all its outputs.
Short circuit				
Output to ground or output to FE	Yes	OUTx LED	No	Short circuit or overload. The error is detected in the ON state. The output is disabled (safe state).

⚠ WARNING: Unexpected machine start-up

Acknowledging the error can lead to an unexpected machine start-up.

● Please note that an acknowledgement can result in the outputs being re-enabled.

Example parameterisation

Parameterisation	Parameterised as	Comment
Assignment	Used, 1-channel (+switching)	-
Switch-off delay	Disabled	Or enabled (depending on the application)
Test pulses	Disabled	Or enabled (depending on the application)
ZVEI class	Class X	Depending on the application

ⓘ With two 1-channel outputs, you can achieve max. PL d, SIL 2.

Please observe the maximum output current per channel.
→ chapter "Technical data".

10.4 Two-channel assignment of positive and negative switching outputs

For the 2-channel operation of the outputs, the channel assignment on a socket is fixed.
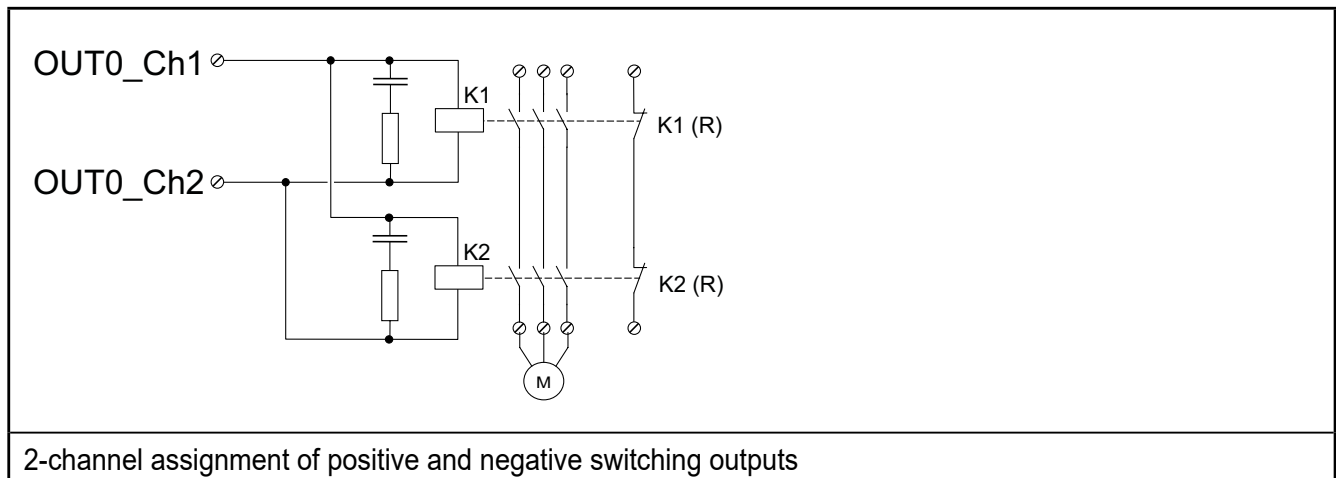
2-channel assignment of positive and negative switching outputs

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

⚠ **WARNING: Loss of the safety function**

A connection between load or output and ground reduces the safety integrity and results in a diagnostic message.

● Do not connect the load or the outputs with ground (isolated structure).

⚠ **WARNING: Loss of functional safety**

Evaluate the feedback contacts to achieve Cat. 3 or Cat. 4.

Key data

Actuator	2-channel
Achievable safety integrity	SIL 3 / Cat. 4 / PL e

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

2-channel

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
Error in the actuator				
Despite being disabled, a switching element of the 2-channel actuator does not go into the safe state (e.g. a contact will not open)	No	None	No	No loss of the safety function as the second switching element of the 2-channel actuator can be disabled. Detect errors using external monitoring. Implement a restart disable for this error case. Please take into consideration all the possible errors for the actuator used. Test the switch-off capability of the actuator at appropriate intervals.
Actuator cannot be switched on (e.g. interruption)	No	None	No	Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. Ensure that this error does not result in delayed system start-up.
Other errors (depending on the actuator)				Consider errors that can occur in the actuator.
Error in the wiring				
Interruption				
Interruption of the line between P output and actuator or between actuator and N output	Yes	All OUT LEDs red on	No	Interruptions which mean that the minimum load is not reached (see technical data) are detected. If an error is detected, the module disables all its outputs. Detect errors using external monitoring. Please take into consideration all the possible errors for the actuator used. Ensure that this error does not result in delayed system start-up.
Cross fault				
P output to N output	Yes	Short circuit OUTx	No	Cross fault between the outputs is detected as a short circuit when the outputs are enabled. If an error is detected, the module disables all its outputs.
Short circuit				

Error type	Identifica-tion	Diagnostics	Loss of the SF*	Comment
P output to ground or FE	Yes	OUTx-LED	No	Short circuit or overload. The output is disabled (safe state). **WARNING:** **Unexpected machine start-up** Acknowledging the error can lead to an unexpected machine start-up. Please note that an acknowledgement can result in the outputs being re-enabled.
N output to ground or FE	Yes	All OUT LEDs red on	No	If an error is detected, the module disables all its outputs.
Legend: P output Positive-switching output N output Negative-switching output				

Example parameterisation

Parameterisation	Parameterised as	Comment
Assignment	Used, 2-channel (+/-switching)	Mandatory setting
Switch-off delay	Disabled	Or enabled (depending on the application)
Test pulses	Enabled	Mandatory setting
ZVEI class	Class X	Depending on the application

With positive/negative switching outputs, always enable the test pulses.

11 Set-up and validation

11.1 Initial set-up

Steps for set-up

Step	Relevant chapters and literature
Install the module within the system.	→ chapter "Mounting and removal"
Connect the bus system and supply voltage cables.	User manual ifm IO-Link master
Wire the inputs according to your application.	→ chapter "Connection examples for safe inputs"
Wire the outputs according to your application.	→ chapter "Connection examples for safe outputs"
Before applying the operating voltage: ● Ensure that there are no wiring faults (e.g. cross fault or short circuit) or grounding errors by testing with a multimeter. ● Ensure that the functional earth is connected correctly.	
Connect the required voltages to the device.	→ chapter "Electrical installation"
Once the operating voltage has been applied: ● If possible: Measure the wave form of the voltages to ensure that there are no deviations. ● Measure the input voltages on the module to ensure 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 assembly and installation.	
Set the address.	→ chapter "Parameterisation of the module" → "Setting the safety address".
Make the necessary parameter settings.	→ chapter "Parameterisation of the module"
Program the safety function.	Online help for configuration software SAFECONF Documentation for control system (PROFIsafe)
When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all devices.	
Perform a function test and validation. Check whether the safety function responds as planned during programming and parameterisation	
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.	How to proceed in the event of an error: → chapter "Errors: messages and removal"

11.2 Restart after replacing a module

11.2.1 Replacing a module

⚠ **WARNING: Electric shock / unintentional machine start-up**

Mounting, removal and installation works without ensuring that the system is free of voltage can result in dangerous electric shocks.

Unexpected machine start-up during mounting, removal and installation works may result in death or serious injury.

The system may only be started provided the station and the system do not pose a hazard.

- Make sure that the dangerous machine function is switched off and remains switched off.
- Before working on the device, disconnect the safety relay and the entire station from the power supply.
- Ensure the voltage cannot be switched on again.
- Make sure system set-up has been completed before switching the voltage back on.
- Observe the diagnostic indicators and any diagnostic messages.

When replacing a module, proceed as described in the following chapters:

- → chapter "Mounting and removal"
- → chapter "Electrical installation"
- → chapter "Parameterisation of the module" →"Setting the safety address".

The new module must meet the following requirements:

- same device type
- same or later version

11.2.2 Restart

Once the safety module has been replaced, proceed as described for initial set-up:

- → chapter "Set-up and validation" → "Initial set-up".

The parameter settings of the previous module remain the same and are transmitted to the new module when the system is started.

11.3 Validation

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

12 Errors: messages and removal

12.1 Indicating and reading out errors

⚠ **WARNING: Loss of the safety function**

Using diagnostic data for safety-related functions can lead to the loss of the safety function, since diagnostic data are not safety-related.

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

Diagnostic indicators and messages

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

ⓘ → chapter "Product description" → "Local diagnostic and status indicators"

Error detection time

Observe the error detection time.

ⓘ → chapter "Product description" → "Safety-related system times"
→ "Error detection time".

Function blocks

Diagnostic messages are read out via controller-specific function blocks. They are available online at ifm.com.

Use the function blocks PRSF_AL200S and PRSF_AL200S_Diag. Only then, the functionality of the device is ensured.

Error code and error location

The error codes and error locations reported at the function block are described in the table "Error codes".

The error location consists of the components "function group" and "channel".

ⓘ Error location 255 (0xFF) means that an entire function group or module is affected.

12.2 Error codes

ⓘ If error codes are indicated by the system which do not appear in the table below please contact ifm.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge- ment
	FG	Chan- nel [hex]	Connection point				
0000	-	-	-	-	No error is present.		
2140	S_DI	00 01 02 03 04 05 06 07	IN0_Ch1 IN0_Ch2 IN1_Ch1 IN1_Ch2 IN2_Ch1 IN2_Ch2 IN3_Ch1 IN3_Ch2	SD yellow on	Cross fault between two inputs. Cross fault between external voltage and an input... Cross fault between displayed input and clock output	A cross fault to another input, an ex- ternal voltage or an external clock output was detected.	• Check sensors, clock outputs, plugs and cabling. This diagnostic message can be acknowl- edged. The acknowledge- ment deletes the message and enables the input. If the error is still present, the message is output again.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge- ment
2344	S_DI	00 01	Clock output T1 Clock output T2	SD yellow on	Short circuit or overload at the displayed clock output	A short circuit or overload was detected at the displayed clock output. The affected clock output is disabled and thus the assigned inputs are no longer supplied.	● Check the plugs and cabling. This diagnostic message can be acknowl- edged. The acknowledge- ment deletes the message and enables the clock output again and thus the supply of the assigned inputs.
					The clock outputs are also switched on and monitored in the unparameterised state. If a short circuit occurs at a clock output in this state, the clock output is disabled. To exit the error, parameterise the module and acknowledge the error message.		
	S_DO	00 01 02 03 04 05 06 07	OUT0_Ch1 OUT0_Ch2 OUT1_Ch1 OUT1_Ch2 OUT2_Ch1 OUT2_Ch2 OUT3_Ch1 OUT3_Ch2	SD yellow on OUTx red on	● Short circuit or overload at the displayed output	A short circuit or overload was detected at the displayed output. As a result, the affected output is retained in the safe state.	● Check the actuator, plug and cabling. ● Check the freewheeling circuit at the contactor. This diagnostic message can be acknowl- edged. The acknowledge- ment deletes the message and enables the output. With 2-channel parameterisa- tion, this also applies to the other poten- tially error-free output.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
2370	S_DO	00 01 02 03 04 05 06 07	OUT0_Ch1 OUT0_Ch2 OUT1_Ch1 OUT1_Ch2 OUT2_Ch1 OUT2_Ch2 OUT3_Ch1 OUT3_Ch2	SD yellow on All OUT red on	Cross fault between two outputs. Cross fault be-tween external voltage and an output.	A cross fault to another output or an external voltage was detected. As a result, all outputs are retained in the safe state.	● Check the actuator, plug and cabling. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the outputs. If the error is still present, the message is output again.
2380	S_DO	00 01 02 03 04 05 06 07	OUT0_Ch1 OUT0_Ch2 OUT1_Ch1 OUT1_Ch2 OUT2_Ch1 OUT2_Ch2 OUT3_Ch1 OUT3_Ch2	SD yellow on All OUT red on	Hardware or cross fault	The indicated output cannot be disabled. As a result, all outputs are retained in the safe state.	This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the outputs.
2382	-	FF	Entire module	SD yellow on FS flashes red	At least one output with parameterised switch-off delay is still perform-ing a switch-off operation.	The module is retained in the safe state.	● Wait until the switch-off operation is complete. ● Resend the parameter data to the module.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledgement
3183	S_DI	00	IN0_Ch1 &Ch2	SD yellow on	Implausible signal change at an input pair	An implausible signal change was detected at an input pair in 2-channel operation.	To reset the error state: • Set both inputs to the safe state. • Reset both inputs (note the negation for complementary inputs). • This diagnostic message can be acknowledged. The acknowledgement deletes the message.
		02	IN1_Ch1 &Ch2				
		04	IN2_Ch1 &Ch2				
		06	IN3_Ch1 &Ch2				
3411	-	FF	Entire module	SD yellow on RDY flashes yellow/ green	Undervoltage U_S supply	Undervoltage was detected at the U_S supply. A diagnostic message is generated if U_S < 17 V. As a result, all inputs and outputs are retained in the safe state.	• Check and correct the supply voltage. • Check the length and load of the supply lines. This diagnostic message can be acknowledged. The acknowledgement deletes the message and enables the inputs and outputs.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
3413	-	FF	Entire module	SD yellow on RDY flashes yellow/ green	Overvoltage U_S supply	Overvoltage was detected at the U_S supply. A diagnostic message is generated if $U_S > 30.5$ V. As a result, all inputs and outputs are retained in the safe state.	● Check and correct the supply voltage. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the inputs and outputs.
3421	-	FF	Entire module	SD yellow on RDY flashes red/ green	Undervoltage U_A supply	Undervoltage was detected at the U_A supply. A diagnostic message is generated if $U_A < 17$ V. As a result, all outputs are retained in the safe state.	● Check and correct the supply voltage. ● Check the length and load of the supply lines. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the inputs and outputs.

GB

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
3423	-	FF	Entire module	SD yellow on RDY flashes red/ green	Overvoltage U_A supply	Overvoltage was detected at the U_A supply. A diagnostic message is generated if $U_A > 30.5$ V. As a result, all outputs are retained in the safe state.	● Check and correct the supply voltage. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the inputs and outputs.
4210	-	FF	Entire module	SD yellow on	Critical module temper-ature	The module temperature reached a critical value. The switch-off is imminent. If the temperature increases further, the module will go into the safe state.	● Check the ambient con-ditions and switching fre-quency and modify them if required. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
5010	S_DI	FF	Entire func-tion group	SD yellow on	Hardware error input	A hardware error was detected at an input. As a result, all inputs are retained in the safe state.	This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the inputs.
	S_DI	00 01 02 03 04 05 06 07	IN0_Ch1 IN0_Ch2 IN1_Ch1 IN1_Ch2 IN2_Ch1 IN2_Ch2 IN3_Ch1 IN3_Ch2				
	S_DO	FF	Entire func-tion group	SD yellow on All OUT red on	Hardware error output	A hardware error was detected at an output. As a result, all outputs are retained in the safe state.	This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the outputs.

GB

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
6320 + 024X					The test pulses for 2-channel parameterised +/-switching outputs must not be deacti-vated.	The module is retained in the safe state.	Correct the parameter setting. – Enable the test pulses.
					ⓘ With 2-channel positive/negative switching outputs, the test pulse does not cause current to flow through the load.		
6320 + 02CX	-	FF	Entire module	SD yellow on FS flashes red	Invalid value for assignment	The module is retained in the safe state.	Correct the parameter setting. – Set a valid value for assignment.
6320 + 02EX					Invalid value for delay time		Correct the parameter setting. – Set a valid value for delay time.
6320 + 032X					Invalid value for ZVEI class		Correct the parameter setting. – Set a valid value for ZVEI class.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge- ment
6320 + 034X					Symmetry monitoring was set and the input pairs are parameterised for 1-channel operation.		Correct the parameter setting: – disable symmetry monitoring – or parameterise input pairs for 2-channel operation
6320 + 035X	-	FF	Entire module	SD yellow on FS flashes red	Reswitch-on inhibit was parameterised and the input pairs are 1-channel and/ or symmetry monitoring is not enabled.	The module is retained in the safe state.	Correct the parameter setting: – disable reswitch-on inhibit – parameterise input pairs for 2-channel operation – enable symmetry monitoring
6320 + 03F2					The calculated and received checksums of the parameter data do not match.		● Check the checksum. ● Resend the parameter data to the module.
6320 + 03FB					The device ID is incorrect or the wrong module is used.		Check that the correct module is used. If you cannot eliminate the error, contact ifm.
6350	-	FF	Entire module	SD yellow on	Serial number incorrect	Transmitted serial number does not match internal serial number.	● Perform the addressing again.

GB

89

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
6351	-	FF	Entire module	SD yellow on	F-Address incorrect	Transmitting F-Address not in the permissible range from 1 to 1023.	• Perform the addressing again. • Diagnostic messages related to parameter errors for PROFIsafe → Chapter 16 error code 40
6352	-	FF	Entire module	SD yellow on	Safe communi-cation is active	Safe com-munication is already active during the addressing attempt. The new address is discarded and safe communi-cation is maintained.	• Stop the safe communica-tion. • Perform an acknowl-edgement.
8F00	S_DI or S_ DO	FF	-	SD yellow on	Rejected ac-knowledgement attempt	After ac-knowledging a class 2 error, a new error was detected. Before under-taking a new acknowledge-ment attempt, you have to wait for 30 s. The affected function group is retained in the safe state.	Remove the cause of the error. Wait for at least 30 s. Acknowledge the error. If you cannot eliminate the error, contact ifm.

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
8F01	S_DI	00 01 02 03 04 05 06 07	IN0_Ch1 IN0_Ch2 IN1_Ch1 IN1_Ch2 IN2_Ch1 IN2_Ch2 IN3_Ch1 IN3_Ch2	SD yellow on	Symmetry violation at the displayed input (without switch-on inhibit)	A violation of the parame-terised sym-metry was detected at an input pair in 2-channel mode. If the switch-on inhibit is not enabled for the symmetry violation: The input information is still detected and sent to the control system.	● Check the sensor. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message.
					Symmetry violation at the displayed input (with switch-on inhibit)	A violation of the parame-terised sym-metry was detected at an input pair in 2-channel mode. If the switch-on inhibit is enabled for the symmetry violation: The inputs are blocked until the diagnostic message is acknowl-edged.	● Check the sensor. This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the inputs.

GB

Error code (+ Add Value) [hex]	Error location FG / Channel [hex] / Connection point			LED	Error cause	Description/ effect	Remedy/ acknowledge-ment
8F08	S_DO	00 01 02 03 04 05 06 07	OUT0_Ch1 OUT0_Ch2 OUT1_Ch1 OUT1_Ch2 OUT2_Ch1 OUT2_Ch2 OUT3_Ch1 OUT3_Ch2	SD yellow on All OUT red on	Test pulse error at the displayed output (switch-on pulses)	An error was detected at an output due to the test pulses (brief switch-on). As a result, all outputs are retained in the safe state. A possible cause can be a short circuit event in the external wiring during the test.	This diagnostic message can be acknowl-edged. The acknowl-edgement deletes the message and enables the outputs.
8F09	S_DO	00 01 02 03 04 05 06 07	OUT0_Ch1 OUT0_Ch2 OUT1_Ch1 OUT1_Ch2 OUT2_Ch1 OUT2_Ch2 OUT3_Ch1 OUT3_Ch2	SD yellow on All OUT red on	Test pulse error at the displayed output (switch-off pulses)	An error was detected at an output due to the test pulses (brief switch-off). As a result, all outputs are retained in the safe state.	This diagnostic message can be acknowl-edged. The acknowledge-ment deletes the message and enables the outputs.
-	-	-	-	FS red on	Hardware error or application on the module is not ready	The commu-nication to the higher-level safe control system is locked. The module goes into the safe state.	● Execute a power-up. If the error mes-sage is output again, the mod-ule is defective and has to be replaced.
					Exceeding of the permissible module temperature.	The module is retained in the safe state.	● Check the ambient con-ditions and switching fre-quency and modify them if required. ● Execute a power-up.

Legend

FG - function group
S_DI - safe input
S_DO - safe output
OUTx - LED display 00...03 of the corresponding output
PSD-ID - PROFIsafe Device ID
x - Hexadecimal number for error code specification

> ⓘ For all other LEDs → chapter "Product description"

12.3 PROFIsafe errors

In addition, the following errors can occur:

– PROFIsafe system errors

> ⓘ → chapter "Appendix"

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

12.4 Acknowledging an error

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

With the exception of the specified cases, the acknowledgment of an error immediately returns the safe input or output to the operating state.

- Before acknowledging an error, ensure that the acknowledgment will not cause a hazardous system state.
- When planning the machine or the system, ensure that acknowledgment is only possible if the danger zone is visible.

⚠ **WARNING: Unintended machine start-up**

The start or restart after switch on of the voltage in addition to resetting the no longer required safety function can cause an unintended machine start-up.

- Note:
  - The module starts after the successful download of the configuration and parameter data set and successful processing of the internal check.
  - A safety-related input is automatically set to "1" again if the trigger of the safety function is reset.
- If an automatic restart is not intended, make the corresponding settings in the safety logic.

Acknowledgement

To acknowledge an error, proceed as follows:

- Remove the cause of the error.
- Acknowledge the diagnostic message.

Parameterisation errors cannot be acknowledged. In such a case, proceed as follows:

- Check the parameter setting.
- Adapt the parameter setting.
- Download the new data set.

ℹ The error acknowledgement procedure is described in the documentation of the function block used.

13 Device replacement, device defect and repair

13.1 Device replacement

The device can be replaced if necessary.

To replace the device, proceed as described in the following chapters:

- → chapter "Mounting and removal"
- → chapter "Electrical installation"

Observe device type and version

The new device must meet the following requirements:

- same device type
- same or later version

13.2 Device defect and repair

Do not open the housing

Repairs may only be carried out by ifm. Do not open the housing. If the housing is opened, the function of the device can no longer be ensured.

Defective devices

Please contact ifm.

14 Maintenance, decommissioning and disposal

14.1 Maintenance

The device is maintenance-free within its permissible service life. For the duration of use of the device see the technical data.

Depending on the application and the connected periphery, it may be necessary to check the function of the peripherals and the safety chain at regular intervals.

> Maintain the connected peripherals as described in the manufacturer's specifications.

14.2 Decommissioning and disposal

Carry out decommissioning in accordance with the requirements of the machine or system manufacturer.

When decommissioning the system or parts of the system, ensure the following for the devices used.

The device will continue to be used correctly:

● Please observe the storage and transport requirements.

> → chapter "Transport, storage and unpacking"

The device will no longer be used:

The device contains valuable materials which should be recycled.

Dispose of the device

● Do not dispose of the device with household waste; it should instead be disposed of in accordance with the currently applicable national regulations.

Dispose of the packaging

● Dispose of packaging materials that are no longer needed (cardboard packaging, paper, bubble wrap sheets, tubular bags, etc.) with household waste in accordance with the currently applicable national regulations.

15 Technical data

General data	
Housing dimensions (width x height x depth)	59.8 mm x 214 mm x 30 mm (data incl. mounting lugs and connectors)
Colour	Yellow RAL1018
Housing material	Plastic POCAN B4239 GF30 YE 1018
Weight	380 g
Operating mode	
PROFIsafe	Process data mode with 4 words
Ambient temperature	
Operation	–25 to +60 °C (any installation position)
Storage/transport	-40 °C to +85 °C
Air pressure	
Operation	70 kPa to 108 kPa (up to 3000 m above sea level)
Storage/transport	66 kPa to 108 kPa (up to 3500 m above sea level)
Operating altitude	Max. 3000 m above sea level
Protection rating	IP65/IP67
Protection class	III, IEC 61140, EN 61140, VDE 0140-1
Air clearances and creepage distances	Acc. to IEC 60664-1
Gases that may endanger functions acc. to DIN 40046-36, DIN 40046-37	Resistant to gas that may endanger functions (sulphur dioxide (SO_2), hydrogen sulphide (H_2S))
Installation position	Freely selectable
Connection data	
Connection method	M12 connector
Note on connection method	Acc. to IEC 61076-2-101, M12 connection technology
Supply: module electronics and sensors (U_S)	

Connection method	M12 connector (L-coded)
Number of poles	2
Supply voltage	24 V DC
Nominal supply voltage range	19.2...30.2 V DC (including all tolerances, including ripple)
Current consumption	67 mA
Reverse polarity protection	Parallel, temporally limited reverse polarity protection
External protection	Max. 8 A slow time-lag
Power supply: actuators (U_A)	
Connection method	M12 connector (L-coded)
Number of poles	2
Supply voltage	24 V DC
Nominal supply voltage range	19.2 V DC ... 30.2 V DC (including all tolerances, including ripple)
Current consumption	34 mA (without connected actuators)
Reverse polarity protection	Serial reverse polarity protection
External protection	Max. 8 A slow time-lag
IO-Link A-port	
Number of ports	1
Connection method	M12 connector (A-coded)
Connection technology	3-wire
Specification	V1.1.2
Reverse polarity protection	Yes
Transmission rate	230.4 Kbits/s (COM3)
Frame type	1
Cycle time	≥ 4 ms
Process data update	≥ 4 ms
Quantity of process data	64 bits (input and output data)
Permissible cable length	Max. 20 m
IO-Link port supply L+	
Nominal peripheral supply voltage	24 V DC (provided via the IO-Link interface of the IO-Link master)
Nominal current for each device	Approx. 15 mA
Reverse polarity protection	Yes
Safe digital inputs	
Number	4 (2-channel)
	8 (1-channel)
Connection technology	M12 connector (A-coded)

GB

Description of the input	IEC 61131-2 type 3
Nominal input voltage	24 V DC
Nominal input current	Typ. 3.7 mA (at 24 V DC) Max. 4.3 mA (at 30.2 V DC)
Input voltage range "0" signal	-30...5 V DC
Input voltage range "1" signal	11...30.2 V DC
Input filter time	1.5/3/5/15 ms (configurable, accuracy +0 ms / -0.5 ms)
Max. permissible current for "0"	2 mA
Max. permissible current for "1"	2.5 mA
Switching frequency	Max. 1 Hz
Processing time of the input	$t_{IN} = t_{Filter} + t_{FW}$
Simultaneity	100 %
Evaluation of the symmetry	Yes, configurable, accuracy ± 20 %
Overload protection, short-circuit protection of the sensor supply	Yes
Derating	No
Status indicators	One green LED per input
Permissible cable length	Max. 200 m
Clock outputs	
Number	2
Supply	From U_S
Limiting continuous current (in total)	1 A (short-circuit and overload protection)
Saturation voltage	U_S –1 V
Simultaneity	100 %
Test pulse duration	Max. 30 ms (period)
Test pulse width	Test pulse width < 1ms
Derating	No
Status indicators	None
Permissible cable length	Max. 200 m (total of connected cables per clock output)
Safe digital outputs	
Number	4 (2-channel, positive/negative switching) 4 (1-channel, positive switching)

⚠ **WARNING: Loss of the safety function**

for 1-channel assignment:

● Connect the actuator completely and exclusively via the M12 connector to the used output of the module.

Connection method	M12 connector (A-coded)
Connection technology	2-wire
Nominal output voltage	24 V DC (from the voltage U_A)
Output current	Max. 2 A (per channel), max. 2 A (per output), max. 6 A (total current of all outputs, observe derating)
Maximum leakage current in low state	2 mA

> ⚠ **WARNING: Loss of the safety function**
>
> At this current, the load must not switch to or remain in the ON state and must not react in a safety-critical manner.
>
> ● Please consider this when selecting an actuator.

Safe digital outputs

Output voltage in low state	< 5 V

> ⚠ **WARNING: Loss of the safety function**
>
> At this voltage, the load must not switch on, must not remain in the switched-on state and must not react in a safety-critical manner.
>
> ● Please consider this when selecting an actuator.

Minimum withstand voltage of the connected loads	> 5 V

> ⚠ **WARNING: Loss of the safety function**
>
> At control voltages ≤ 5 V, each connected actuator must put itself into the safe state.
>
> ● Please consider this when selecting an actuator.

Minimum withstand current of the connected loads	> 2 mA
Inductive load	Max. 1.1 H / 12 Ω (at 24 V DC)
Capacitive load	Max. 10 µF (at 24 V DC)
Minimum load	2.4 kΩ (10 mA at 24 V DC)
Limitation of the voltage induced on circuit interruption	-15 V
Output voltage	U_A - approx. 1.4 V
Simultaneity	100 % (observe maximum current load)
Switching frequency	Max. 1 Hz
Switch-off delay for shutdown according to stop category 1	Configurable: Off, 250 ms ... 128 s
Maximum duration of test pulses (when switched off; active driving)	0.5 ms
Maximum duration of test pulses (when switched on)	3 ms (configurable, depending on the load capacity)

GB

> ⚠️ **WARNING: Loss of the safety function**
>
> The connected load must not respond in a hazardous way to test pulses (switch-on and switch-off pulses).
>
> ● Please consider this when selecting an actuator.

Reverse voltage proof	No

> ⚠️ **WARNING: Loss of the safety function**
>
> Feeding (back) an external voltage into an output (e.g. through cross faults) is not permitted. Such faults can affect the function of the module (up to its destruction) and thus lead to the loss of the safety function.

Overload protection, short-circuit protection of the outputs	Yes
Derating	Up to 40 °C total current of all outputs max. 6 A. Up to 60 °C total current of all outputs max. 4 A.
Status indicators	One two-colour LED (green/red) per output
Permissible cable length	Max. 50 m
Characteristic safety values to EN 62061	
Achievable SIL claim limit	SIL 2 (1-channel assignment) SIL 3 (2-channel assignment) Depends on the parameterisation and wiring.
Safe failure fraction (SFF)	99 %
Probability of a dangerous failure per hour for the entire module (PFH)	Max. 1.00×10^{-8} (1-channel assignment) Max. 1.00×10^{-9} (2-channel assignment)
Hardware error tolerance (HFT) of the module	0 (1-channel assignment) 1 (2-channel assignment)
Permissible duration of use	20 years Operation in the faulty state: max. 72 h
Characteristic safety values to EN ISO 13849-1	
Achievable performance level	PL d (1-channel assignment) PL e (2-channel assignment) Depends on the parameterisation and wiring.
Diagnostic coverage (DC)	99 %
Mean time to a dangerous failure (MTTFd)	100 years
Characteristic safety values to EN 61508	
Achievable SIL	SIL 2 (1-channel assignment) SIL 3 (2-channel assignment) Depends on the parameterisation and wiring.
Probability of a dangerous failure on demand of the safety function (PFD)	Max. 1.00×10^{-4} (1-channel assignment) Max. 1.00×10^{-5} (2-channel assignment)

Probability of a dangerous failure per hour for the entire module (PFH)	Max. 1.00×10^{-8} (1-channel assignment) Max. 1.00×10^{-9} (2-channel assignment)
Hardware error tolerance (HFT) of the module	0 (1-channel assignment) 1 (2-channel assignment)
Permissible duration of use	20 years Operation in the faulty state: max. 72 h
Mechanical tests	
Vibration resistance acc. to EN 60068-2-6/IEC 60068-2-6	5 g
Shock acc. to EN 60068-2-27/IEC 60068-2-27	30, 11 ms duration, half-sine shock pulse
Continuous shock acc. to EN 60068-2-27/IEC 60068-2-27	10 g

GB

Conformity with the EMC Directive 2014/30/EU		
Noise immunity test acc. to DIN EN 61000-6-2		
Electrostatic discharge (ESD)	EN 61000-4-2 (IEC 61000-4-2)	Criterion A 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 A Test voltage 2 kV
Transient overvoltage (surge)	EN 61000-4-5 (IEC 61000-4-5)	Testing severity 2, criterion A Supply lines DC: 1 kV / 2 kV (symmetric/asymmetric) Signal lines: 1 kV / 2 kV (symmetric/asymmetric)
Line-fed disturbances	EN 61000-4-6 (IEC 61000-4-6)	Criterion A Test voltage 10 V
Noise emission test acc. to DIN EN 61000-6-4		
Emission	EN 55011	Class A Industrial applications

15.1 Interface types according to ZVEI classification

Safe digital outputs

Depending on the parameterisation, the safe outputs of the module correspond to one of the following classes.

→ chapter "Parameterisation of the module" → "Parameterisation of the safe outputs"

Source/ sink	Interface type	Additional measure	Source/ sink	Suitable interface type	Suitable interface type	Suitable interface type	Suitable interface type
Source	C0	M	Sink	C0	-	-	-
	C1	M		C1	-	-	-
	C2	M		C2	-	-	-
	D0	M		D0	-	-	-
	D1	M		D1	-	-	-
	D2	M		D2	-	-	-

Interface type C - source Class C0/C1/C2 [1]			
Parameter	Min.	Typ. (24 V)	Max.
Test pulse duration t_i	-	-	C0: 3 ms C1: 1 ms C2: 500 µs
Test pulse interval T	15 s	-	20 s
Nominal current I_N	0.016 A [2]	-	2 A [2]
Capacitive load C_L	-	-	40 µF [3]
Inductive load L_L	-	-	1 H [4]
Additional measure M	1-channel assignment, pulses up to 3 ms		
Remarks: 1) For 1-channel parameterisation 2) Depending on the ambient temperature, observe derating 3) Depending on the resistive load component 4) Depending on the switching frequency			

Interface type D - source Class D0/D1/D2 [1]			
Parameter	Min.	Typ. (24 V)	Max.
Test pulse duration t_i	-	-	D0: 3 ms D1: 1 ms D2: 500 µs
Test pulse interval T	15 s	-	20 s
Nominal current I_N	0.016 A [2]	-	2 A [2]
Capacitive load C_L	-	-	40 µF [3]
Inductive load L_L	-	-	1 H [4]
Additional measure M	2-channel assignment, pulses up to 3 ms		

Interface type D - source Class D0/D1/D2 [1]			
Parameter	Min.	Typ. (24 V)	Max.
Remarks:			

Remarks:

1) For 2-channel parameterisation

2) Depending on the ambient temperature, observe derating

3) Depending on the resistive load component

4) Depending on the switching frequency

15.2 Approvals

For the latest approvals, please visit ifm.com.

15.3 Data for download

● Startup package - PROFIsafe
Siemens S7 - TIA
(PROFIsafe PLC setup / operating instructions / function block / iParCRC tool / V4.0.0)

● IODD - IO device description

● Original operating instructions

● Device manual

● Software manual IPARCRC CALC

> Make sure you are always using the latest documentation. It can be found in the download area of the respective article at the address www.ifm.com.

16 Appendix

Diagnostic messages related to parameter errors for PROFIsafe

F-Parameter errors

Error code		Error cause	Remedy
dec	hex		
64	40	The parameterised F_Destination_Address does not match the PROFIsafe address set on the module (F-Module).	Make sure that the PROFIsafe address of the module and the value in F_Destination_Address match.
65	41	Invalid parameterisation of F_Destination_Address. The addresses 0000hex and FFFFhex are not permitted.	Correct value.
66	42	Invalid parameterisation of F_Source_Address. The addresses 0000hex and FFFFhex are not permitted.	Correct value.
67	43	Invalid parameterisation of F_WD_Time. A monitoring time of 0 ms is not permitted.	Correct value.

Error code		Error cause	Remedy
68	44	Invalid parameterisation of F_SIL. The safety module (F-Module) cannot support the required SIL.	Use a module with the required SIL. The safety module supports up to SIL 3.
69	45	Invalid parameterisation 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 version of the safety module (F-Module) 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.
72	48	Device-specific diagnosis	
73	49	Save i-Parameter watchdog time exceeded.	
74	4A	Restore of the i-Parameter watchdog time exceeded.	
75	4B	Invalid F_iParCRC.	Correct value.
76	4C	F_Block_ID is not supported.	Check device description.
77	4D	Reserved.	
78	4E	Reserved.	
79	4F	Unspecified (unknown) error	
80	50	Reserved: Do not use these codes, do not evaluate these codes.	
81	51	Reserved: Do not use these codes, do not evaluate these codes.	
82	52	Reserved: Do not use these codes, do not evaluate these codes.	
83	53	Reserved: Do not use these codes, do not evaluate these codes.	
84	54	Reserved: Do not use these codes, do not evaluate these codes.	
85	55	Reserved: Do not use these codes, do not evaluate these codes.	
86	56	Reserved: Do not use these codes, do not evaluate these codes.	
87	57	Reserved: Do not use these codes, do not evaluate these codes.	
88	58	Reserved: Do not use these codes, do not evaluate these codes.	
89	59	Reserved: Do not use these codes, do not evaluate these codes.	

Error code		Error cause	Remedy
90	5A	Reserved: Do not use these codes, do not evaluate these codes.	
91	5B	Reserved: Do not use these codes, do not evaluate these codes.	
92	5C	Reserved: Do not use these codes, do not evaluate these codes.	
93	5D	Reserved: Do not use these codes, do not evaluate these codes.	
94	5E	Reserved: Do not use these codes, do not evaluate these codes.	
95	5F	Reserved: Do not use these codes, do not evaluate these codes.	

GB