The Drive & Control Company

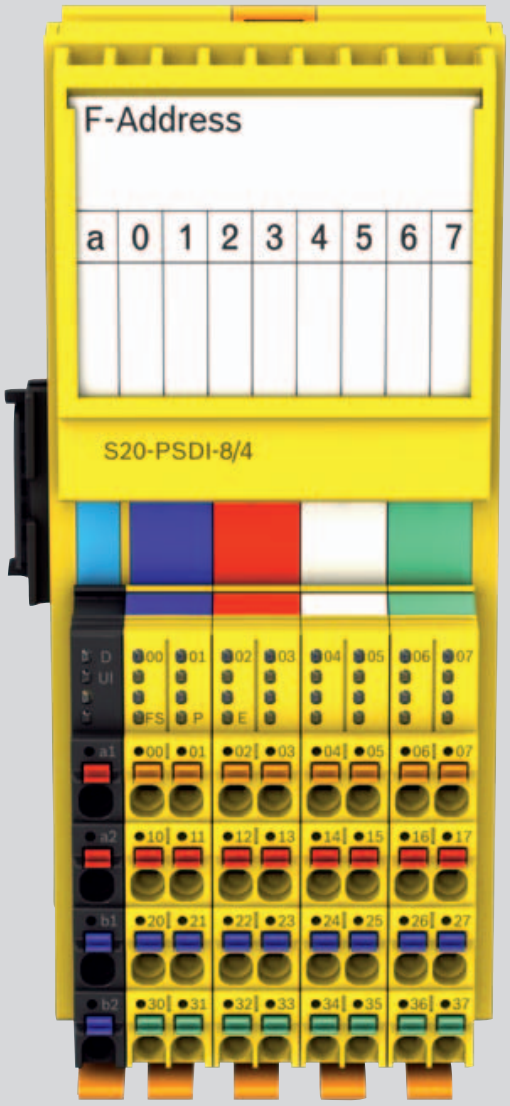
Rexroth
Bosch Group

IndraControl S20 Module

With Safe Digital Inputs S20-PSDI-8/4

Application Description
R911369168

Edition 02



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S20 Module
With Safe Digital Inputs S20-PSDI-8/4

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1 Use of the safety instructions

1.1 Structure of the safety instructions

The safety instructions are structured as follows:

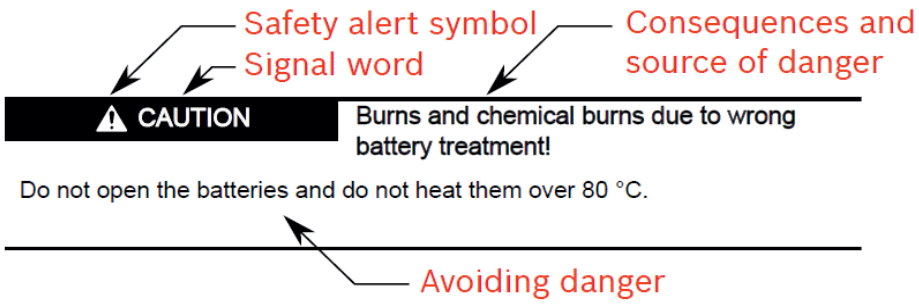


Abb. 1-1 Structure of the safety instructions

1.2 Explaining signal words and safety alert symbol

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

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

Use of the safety instructions

1.3 Symbols used

Hints are represented as follows:

This is an information.

Tipps werden wie folgt dargestellt:

This is a tip.

1.4 Signal graphic explanation on the device

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

2 For your safety

Purpose of this application description

This application description provides information about how the module works, its operating and connection elements, and its parameter settings.

Validity of this application description

This application description is valid for the S20-PSDI-8/4 module in the version indicated on the inner cover page, as well as for the same or later versions if replaced with the devices of the same type.

2.1 General safety notes

⚠ WARNING **Risk of injury**

Depending on the application, inappropriate use of the module may result in serious injury.

- Observe all the safety notes and warning instructions provided in this chapter and elsewhere in this application description.

Qualified personnel

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

Furthermore, knowledge of the following topics and products is required:

- Non-safety-related target system (e.g., PROFIBUS, PROFINET)
- PROFIsafe
- Components used
- IndraControl S20 product range
- Operation of the software tools
- Safety regulations in the field of application

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

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

Documentation

Observe all information in this application description and accompanying documents: see “Documentation” on page 10.

Safety of personnel and equipment

The safety of personnel and equipment can only be assured if the module is used correctly: see “Intended use” on page 9.

Error detection

Depending on the wiring and the parameterization, the module detects errors within the safety equipment.

For your safety

Do not carry out any repairs or modifications

It is prohibited for the user to carry out repair work or make modifications to the module. The housing must not be opened. The module is protected against tampering by means of security labels. The security label is damaged in the event of unauthorized repairs or opening of the housing. In this case, the correct operation of the safety module can no longer be ensured.

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

Mismatching and polarity reversal of connections

Take care to avoid the mismatching, polarity reversal or tampering of connections. For increased protection against mismatching, connectors and slot markings are color coded.

2.2 Electrical safety

⚠ WARNING **Loss of safety function/hazardous shock currents**

Incorrect installation can result in the loss of the safety function as well as hazardous shock currents.

- Observe the notes on electrical safety.
- Plan the modules used and their installation in the system according to the specific requirements.
- Recheck plants and systems retrofitted with PROFIsafe.

Direct/indirect contact

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

Measures required:

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

Power supply units for 24 V supply

Only use power supply units with safe isolation and PELV according to EN 50178/VDE 0160 (PELV). These power supply units prevent short circuits between the primary and secondary side.

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

Insulation rating

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

The module is designed for overvoltage category II (according to DIN EN 60664-1). If you expect surge voltages in the system, which exceed the values defined in overvoltage category II, implement additional measures for voltage limitation.

2.3 Safety of the machine or system

The machine/system manufacturer and the operator are responsible for the safety of the machine or system and the application in which the machine or system is used.

Draw up and implement a safety concept

In order to use the module, a safety concept is required for your machine or system. This includes a hazard and risk analysis as well as a test report (checklist) for validating the safety function: see "Directives and standards" on page 9 and "Checklists" on page 89.

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

Validate hardware and parameterization

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

Use your test report to ensure that:

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

2.4 Directives and standards

The standards to which the module conforms are listed in the certificate issued by the approval body and in the EC declaration of conformity: see www.boschrexroth.com/electrics.

2.5 Intended use

The S20-PSDI-8/4 module is designed exclusively for use in a PROFIsafe system. It can only perform its tasks in the system if it is used according to the specifications in this document.

Only use the module according to the defined technical data and ambient conditions: see "Technical data and ordering data" on page 77.

The module is designed for connecting single-channel or two-channel sensors, which can be used in association with safety technology.

Examples of use for the module:

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

For your safety

2.6 Documentation

Currentness and availability of documentation

Always use the latest documentation. Changes or additions can be found on the Internet: see www.boschrexroth.com/electrics.

PROFIsafe application descriptions

Application descriptions:

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

Observe the information on PROFIBUS, PROFINET and PROFIsafe which is available on the Internet: see www.profisafe.net.

Documentation for the IndraControl S20 product range

IndraControl S20: System and Installation application description
DOK-CONTRL-S20*SYS*INS-AP..-EN-P

Documentation for the bus coupler used

2.7 Abbreviations used

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

Fig. 2-1 Abbreviations for safety requirements

Abbreviation	Meaning
PELV	Protective extra-low voltage according to EN 50178/VDE 0160
EUC	Equipment under control

Fig. 2-2 General abbreviations

Explanations of terms and abbreviations used in the context of PROFIsafe: see “PROFIsafe glossary” on page 83.

2.8 Safety hotline

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

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

3 Product description

3.1 Short description of the module

The S20-PSDI-8/4 module is an input module for use in an IndraControl S20 station at any point in a PROFIsafe system.

The PROFIsafe address is set via a DIP switch.

The module has four safe digital inputs for two-channel assignment or eight safe digital inputs for single-channel assignment.

The inputs can be parameterized according to the specific application and enable the integration of sensors in the safe PROFIsafe system.

In the PROFIsafe system, the module can be used to achieve safety functions with the following requirements depending on the operating conditions:

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

Product description

3.2 Structure of the module

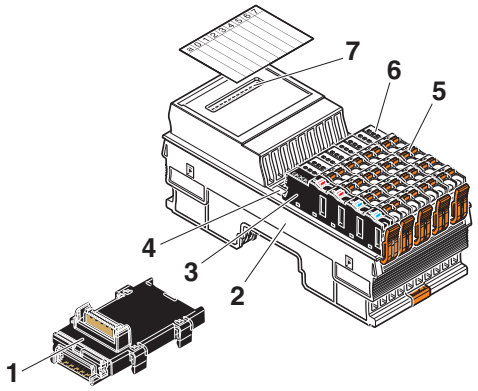


Fig. 3-1 Structure of the module

1 Bus base module
2 Electronics module
3 Connector for connecting the supply voltage
4 Function identification
5 I/O connector
6 Diagnostics and status indicators
7 DIP switch

More detailed information on setting the switch: see “Setting the DIP switch” on page 26.

3.3 Housing dimensions

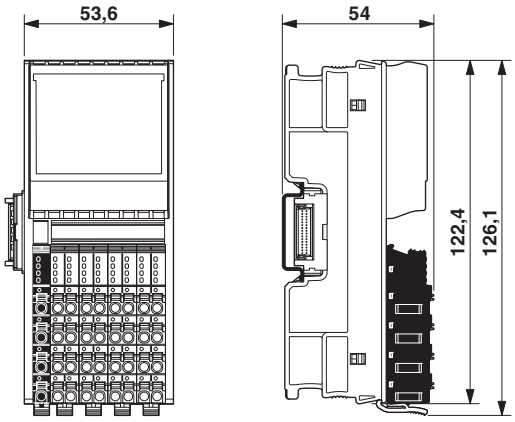


Fig. 3-2 Housing dimensions (in mm)

3.4 Safe digital inputs and clock outputs T1 and T2

3.4.1 Safe digital inputs

The module has safe digital inputs which can be used as follows:

- For two-channel assignment: four two-channel inputs
- For single-channel assignment: eight single-channel inputs

Technical data for the safe inputs: see “Safe digital inputs” on page 80. The supply voltage for the inputs can be provided externally or via the clock outputs.

Parameterization

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

The safety integrity level (SIL, SILCL, Cat., PL) and error detection that can be achieved depend on the parameterization, the structure of the sensor, and the cable installation: see “Connection examples for safe inputs” on page 37.

Information on the parameterization of the inputs: see “Parameterization of the safe inputs” on page 32.

Diagnostics

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

Information on the diagnostic messages of the inputs: see “Errors: messages and removal” on page 65.

⚠ WARNING Loss of safety function

Using diagnostic data for safety-related functions can result in the loss of the safety function as diagnostic data is not safety-related.

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

Requirements for sensors/controlling devices

Functional safety places requirements on the design of sensors/controlling devices.

- Use suitable sensors/controlling devices which are described in the applicable safety standards, for example.

The module’s ability to detect errors depends on the parameterization.

- Adapt the module parameterization to the relevant sensor/controlling device: see “Parameterization of the module” on page 31.

3.4.2 Clock outputs T1 and T2

The module has two independent clock outputs. These clock outputs provide the supply voltage for the safe inputs. Both clock outputs provide a pulse pattern to detect cross-circuits in the external wiring of the inputs if cross-circuit monitoring has been activated for at least one input pair.

Typical pulse pattern

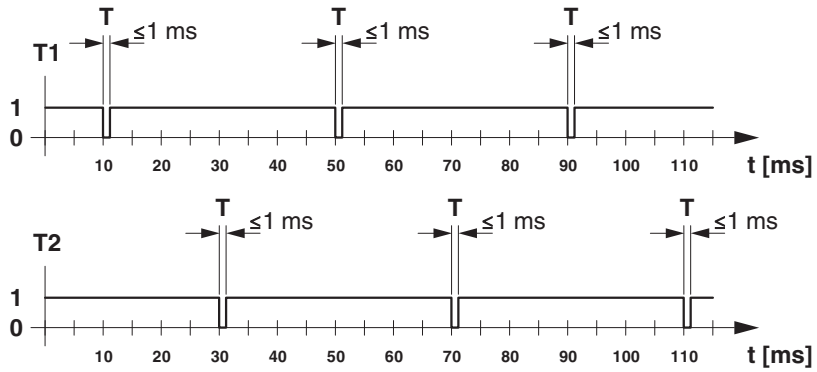


Fig. 3-3 Typical pulse pattern

Key:

T	Test pulse
	Pulse width ≤ 1 ms
	Period length ≤ 40 ms

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

Technical data for the clock outputs: see “Clock outputs” on page 80.

Behavior in the event of an error

In the event of short circuit to GND or overload of the clock outputs, the clock outputs are switched off. At the same time, the error is indicated at the E (Error) LED and a diagnostic message is generated and transmitted to the controller. This error must be acknowledged so that the system can be started up again following error removal, see “Errors: messages and removal” on page 65.

As there are two clock outputs for eight inputs, there may be reciprocal effects between the inputs.

Diagnostics

⚠ WARNING Loss of safety function

Using diagnostic data for safety-related functions can result in the loss of the safety function as diagnostic data is not safety-related.

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

Diagnostics are provided via both the local diagnostics indicators and the diagnostic messages, which are transmitted to the controller.
Information on the diagnostic messages of the clock outputs: see “Parameterization errors” on page 73.

Cross-circuit monitoring

If all inputs are parameterized without cross-circuit monitoring, a DC voltage can be tapped at the clock outputs without clock pulses. As soon as cross-circuit monitoring has been parameterized for at least one input pair, pulses are output at clock outputs T1 and T2.

For inputs that are parameterized with cross-circuit monitoring, the assignment is as follows:

- Inputs for channel 1 (INx_CH1) are assigned to clock output T1.
- Inputs for channel 2 (INx_CH2) are assigned to clock output T2.

Observe the information on error detection according to clocking: see “Clock outputs T1 and T2” on page 14.

Product description

3.5 Connection options for sensors depending on the parameterization

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

The maximum achievable SIL/SILCL/Cat./PL is specified in the table.
In order to meet the safety requirements:

- Observe the information in the connection examples: see "Connection examples for safe inputs" on page 37.
- Observe the requirements of the standards with regard to the external wiring and the sensors to be used to achieve a SIL/SILCL/Cat./PL: see "Measures to achieve a specific safety integrity level" on page 38.

		Input							
Connection to the IndraControl S20 connectors		Single-channel sensor or redundant sensor			Two-channel redundant controlling device/sensor				
Input signal					Equivalent			Non-equivalent	
Cross-circuit monitoring		With	Without		With	Without		With	Without
Sensors that can be connected: – Contact-based		Yes	Yes	-	Yes	Yes	-	Yes	Yes
– With OSSD outputs		No	-	Yes	No	-	Yes	No	No
Achievable safety integrity	SIL	2	2	2	3	3	3	3	3
	SILCL	2	2	2	3	3	3	3	3
	Cat.	3*	2	2	4	3	4**	4	3
	PL	d	d	d	e	d	e	e	d
For connection example, see page		40	42	44	49	51	53	58	59

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

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

3.6 Local diagnostics and status indicators

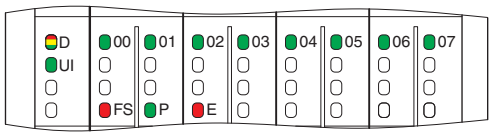


Fig. 3-4 Local diagnostics and status indicators

Desig-nation	Color	State	Description
D	Red/ yellow/ green	**Diagnostics for local bus communication**	
		OFF	Devices are in the (power) reset state.
		Flashing red	Device is operating, but is not connected to the previous device.
		Red ON	The device is ready for operation, but has lost the connection to the bus head.
		Yellow ON	The device is ready for operation, but has still not detected a valid cycle after power-on.
		Flashing yellow	The device is not (yet) part of the active configuration.
		Green/yellow alternating	The device is ready for operation, communication within the station is OK. Output data **cannot** be output and/or input data **cannot** be read. There is a fault on the I/O side of the module.
		Flashing green	The device is ready for operation, communication within the station is OK. The data is **not** valid. Valid data from the controller/higher-level network is not available. There is no fault in the module.
		Green ON	The device is ready for operation, communication within the station is OK. All data is valid. There are no faults.
UI	Green	**Diagnostics for digital input supply**	
		Green ON	Supply for the digital inputs is present and is > around 17 V DC.
		Flashing green	Supply for the digital inputs is not present or is < around 17 V DC.
FS	Red	**Diagnostics for failure state**	
		OFF	The safety application has valid F-Parameters and i-Parameters. (Only applies if UI is on at the same time.)
		Red ON	Hardware fault. Communication to the higher-level safe controller is disabled.
		Flashing red	Module not parameterized or parameterization was not accepted.
P	Green	**Diagnostics for safe communication protocol**	
		OFF	No safe communication
		Green ON	Safe communication is running without errors.
		Flashing green	Safe communication is running. The controller is requesting “operator acknowl-edgment”.
E	Red	**Diagnostics for safety application**	
		OFF	No error
		Red ON	Diagnostic message present

Fig. 3-5 Overview of diagnostics LEDs

Desig-nation	Color	State	Description
00-07	Green	**Status of each input from 0 - 7**	
		OFF	Input at logic “0”
		Green ON	Input at logic “1”

Fig. 3-5 Overview of diagnostics LEDs [...]

3.7 Safe state

The safe state for the module is the transmission of the value “0” in the image of the inputs to the safe controller.

The safe state for the F-Input data is “0”.
Passivation results in a change to the safe state: see “Passivation” on page 84.

The safe state can be entered in the following cases:

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

3.7.1 Operating state

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

3.7.2 Error detection in I/O devices

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

Operating time in the error state:
If an error state is entered on the modules, this error must be assessed, acknowledged or removed by the user within 72 hours. This action ensures the safe operating state of the module. In the error state, internal module tests are no longer run and it is possible that the safe state may be exited due to an accumulation of errors.

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

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

The diagnostic message is transmitted to the controller: see “Errors: messages and removal” on page 65. Information on which errors occur and when: see “Connection examples for safe inputs” on page 37.

3.7.3 Device errors

Device errors can stop safe communication.

Inputs

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

The diagnostic message is transmitted to the controller: see “Errors: messages and removal” on page 65.

Serious errors

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

The following serious errors result in the safe state:

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

The diagnostic message is transmitted to the controller: see “Errors: messages and removal” on page 65.

⚠ WARNING Loss of safety function

Sequential errors can result in the loss of the safety function.

- In the event of a device error, the module should be disconnected completely from the power supply and replaced so as to prevent sequential errors.

3.7.4 Parameterization errors

Parameterization errors are indicated in the following states:

- Faulty parameterization

The module switches to the safe state following parameterization errors. The FS LED on the module flashes.

In the event of faulty parameterization, a diagnostic message is transmitted to the controller: see “Parameterization errors” on page 73.

3.8 Programming data/configuration data

Bosch Rexroth provides device description files for various control systems.

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

Product description

4 Local bus integration

For operation in an IndraControl S20 station, the module is integrated in the PROFIsafe system.

More detailed information on the structure of an IndraControl S20 station: see DOK-CONTRL-S20*SYS*INS-AP..-EN-P application description.

⚠ WARNING Loss of safety function

The use of unsuitable power supplies can result in the loss of the safety function.

- Only use power supplies according to EN 50178/VDE 0160 (PELV) for the voltage supply to the bus coupler.
- Make sure that the output voltage of the power supply for the bus coupler does not exceed 32 V even in the event of an error.
- Observe the general safety notes: see “Electrical safety” on page 8.

4.1 Supply voltage of the module logic

The supply voltage for the module logic is generated in the bus coupler and led to the IndraControl S20 module via the bus base module.

Technical data for the supply voltage: see “Supply voltage U_{BUS} (logic)” on page 79.

The current carrying capacity for supply voltage U_{BUS} depends on the bus coupler used.

- Observe the technical data and information in the documentation for the bus coupler.

4.2 Supply voltage U_I

⚠ WARNING Loss of safety function

The use of unsuitable power supplies can result in the loss of the safety function.

- Observe the general safety notes: see “Electrical safety” on page 8.

Supply voltage U_I supplies the input circuits, the clock outputs, and the switching elements on the I/O side. Technical data for the supply voltage U_I: see “Supply voltage U_I (sensors, clock outputs, I/O)” on page 79.

The maximum current carrying capacity via the U_I connector is 8 A.

NOTICE **Module damage**

Parallel protection against polarity reversal is only implemented in the module for a limited period. The following measures must be taken to prevent damage to the module:

- Due to the maximum current capacity of 8 A, protect power supply U_I externally with an 8 AT fuse.
- Only use PELV power supply units with at least four times the nominal tripping current, as this is the only way to ensure release times of less than 300 ms.

The supply of supply voltage U_I should feature a connection to functional earth ground according to EN 60204-1.

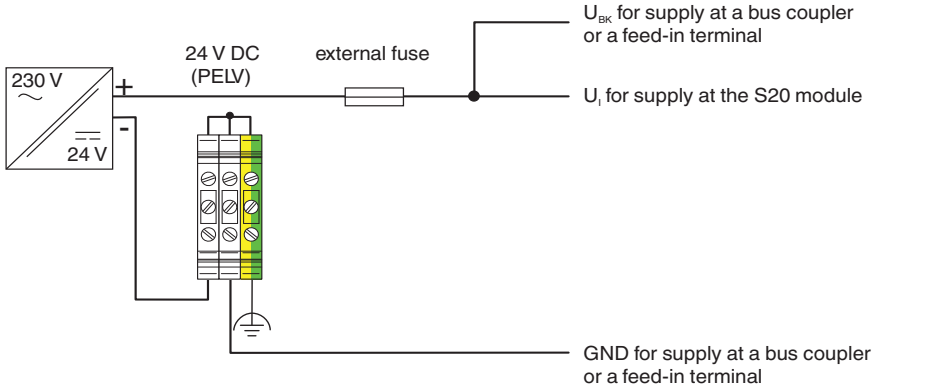


Abb. 4-1 Supply U_I with connection to functional earth ground according to EN 60204-1

Observe the information regarding the behavior of the module in the event of an error at supply voltage U_I: see "Supply voltage errors" on page 72.

4.3 DC distribution network according to IEC 61326-3-1

NOTICE **Damage to module electronics**

A surge voltage will damage the module electronics.

- Do not use a DC distribution network.

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

4.4 Terminal point assignment

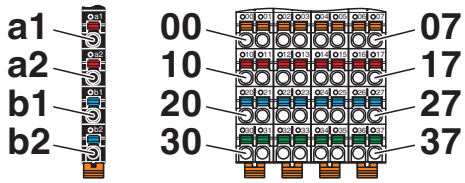


Abb. 4-2 Terminal point assignment

The IndraControl S20 connectors are supplied with the module. They are color coded and marked for connection.

Only use the connectors supplied with the module.

The following applies for the tables below:

- All inputs are safe digital inputs
- 0 V (GND): common ground of inputs and clock outputs
- FE: common functional earth ground
- T1: clock output 1
- T2: clock output 2

Terminal point	Color	Assignment	
a1, a2	Red	24 V DC (UI)	UI: supply of the digital inputs (internally connected)
b1, b2	Blue	GND	Reference potential of the supply voltage (internally connected)

Abb. 4-3 Terminal point assignment of the voltage connection

	Color	Connector 1 (blue)		Connector 2 (red)		Connector 3 (white)		Connector 4 (green)	
Terminal point	Orange	00	01	02	03	04	05	06	07
Function		IN0_CH1	IN0_CH2	IN1_CH1	IN1_CH2	IN2_CH1	IN2_CH2	IN3_CH1	IN3_CH2
Terminal point	Red	10	11	12	13	14	15	16	17
Function		Clock T1	Clock T2	Clock T1	Clock T2	Clock T1	Clock T2	Clock T1	Clock T2
Terminal point	Blue	20	21	22	23	24	25	26	27
Function		GND	GND	GND	GND	GND	GND	GND	GND
Terminal point	Green	30	31	32	33	34	35	36	37
Function		FE							

Abb. 4-4 Terminal point assignment of the I/O connection

⚠ WARNING **Loss of safety function**

Parasitic voltages can result in the loss of the safety function.

- Wire sensors that require a GND to the corresponding slot for 0 V (GND).

Local bus integration

5 Assembly, removal, and electrical installation

5.1 Assembly and removal

5.1.1 Unpacking the module

NOTICE **Electrostatic discharge**

The module contains components that can be damaged or destroyed by electrostatic discharge.

- When handling the module, observe the safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-2.
- Read the package slip and follow the instructions.

The module may only be installed and removed by qualified personnel.

5.1.2 Preparation and assembly

⚠ WARNING **Unintentional machine startup**

Make sure that the power to the system is disconnected before carrying out assembly and removal work as this could cause unintentional machine startup.

- Before assembling or removing the module, disconnect the power to the module and the entire IndraControl S20 station and ensure that the system cannot be switched on again.
- Make sure the entire system is reassembled before switching the power back on and that neither the station nor the system poses a hazard.
  Observe the diagnostics indicators and any diagnostic messages.
- Mount the module on a 35 mm DIN rail in a control cabinet or junction box protected from dust and humidity (IP54 or higher).
- Secure the control cabinet/junction box to prevent unauthorized opening.
- Only connect the cables using the supplied IndraControl S20 connectors.

5.1.3 Setting the DIP switch

A DIP switch is located on the top of the module.

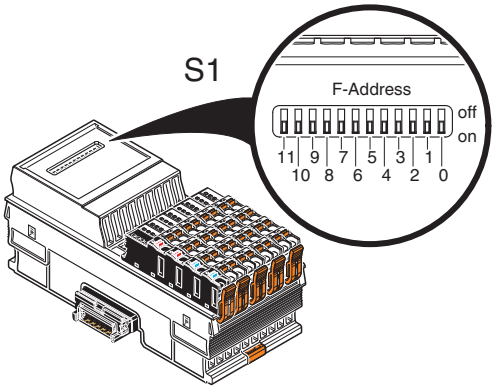


Fig. 5-1 DIP switch

S1 Switch for setting the PROFIsafe address

12-pos. DIP switch: address

Set the PROFIsafe address (F-Address) for the PROFIsafe device. PROFIsafe addresses 1 ... 1023 (1_{hex} ... $3FF_{hex}$) are permitted.

Overview of the switch positions

PROFIsafe											
Address switch											
11	10	9	8	7	6	5	4	3		1	0
Reserved		MSB									LSB
1_{hex} ... $3FF_{hex}$											

Fig. 5-2 Switch position for PROFIsafe

MSB The most significant bit (MSB) has the highest value.

LSB The least significant bit (LSB) has the lowest value.

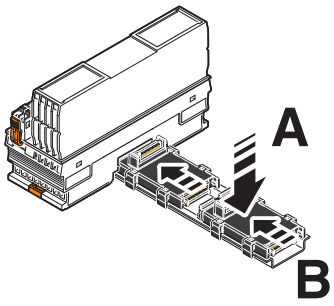
Setting the address

- Remove the marking field and set the address in the switch below it.
- Reattach the marking field to the module.

The set address is only applied on power up. If the address is adjusted during operation, the module responds with a failure state. Positions 10 and 11 of the 12-pos. DIP switch are reserved for the module operating mode and are preset by default. If a change is made to the preset setting for positions 10 and 11, the module responds with a failure state.

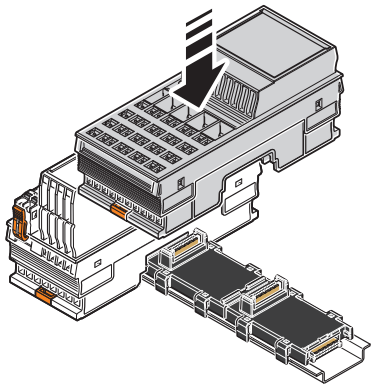
5.1.4 Mounting and removing modules

Mounting the bus base module



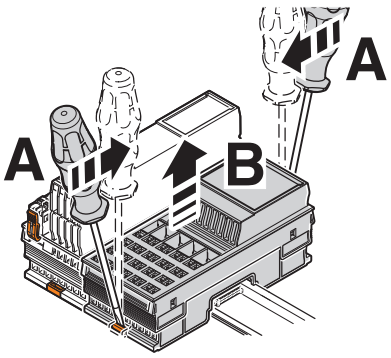
- Place all bus base modules required for the station on the DIN rail (A).
- Push the bus base modules into the bus coupler connection or the previous bus base module (B).

Snapping on and removing the electrical module



Snap on

- Place the electronics module vertically on the corresponding bus base module on the DIN rail until it snaps into place with a click.
  Make sure that the device connector for the bus base connection is situated above the corresponding socket on the bus base module.

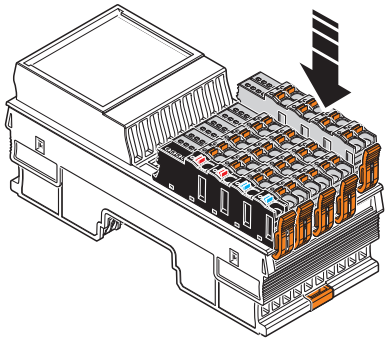


Remove

- Before removing the module, remove all connectors.
- Insert a suitable tool (e.g., bladed screwdriver) in the upper and lower snap-on mechanisms (base latches) of the module one after the other to release it (A).
- Remove the module perpendicular to the DIN rail (B).

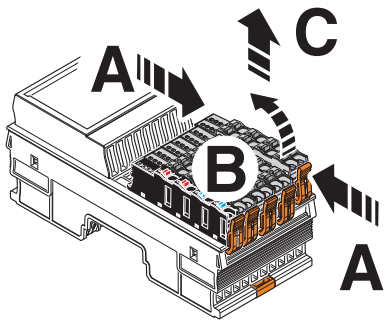
Assembly, removal, and electrical installation

Inserting and removing the connector



Insert

- Place the connector vertically in its position.
  Note the color markings of connectors/slots.
  Assignment from left to right:
  blue, red, white, green.
- Press firmly on the connector. Make sure that the locking latch snaps in.



Remove

- Release the locking latch (A).
- Tilt the connector upwards slightly (B).
- Remove the connector from the module (C).

5.2 Electrical installation

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

Make sure that the power to the system is disconnected before carrying out installation work as this could cause a hazardous electric shock as well as unintentional machine startup.

- Prior to installation work, disconnect the power to the system and make sure that it cannot be switched on again unintentionally.
- Make sure all work is completed before switching the power back on and that neither the station nor the system poses a hazard.
  Observe the diagnostics indicators and any diagnostic messages.

5.2.1 Electrical installation of the IndraControl S20 station

Electrical installation of the IndraControl S20 station includes the following:

- Connection to the higher-level bus system
- Connecting the supply voltages for the IndraControl S20 station
- Carry out electrical installation for the IndraControl S20 station according to the following application descriptions:
  - IndraControl S20: System and Installation application description DOK-CONTRL-S20*SYS*INS-AP..-EN-P
  - IndraControl S20 system manual for your bus system
- Observe the additional information in the documentation for the bus coupler.

5.2.2 Electrical installation of the module

Observe the general safety notes: see “Electrical safety” on page 8.

⚠ WARNING **Loss of safety function/damage to equipment**

Improper installation, e.g., due to the mismatching or polarity reversal of connections, can result in the loss of the safety function as well as damage to equipment.

- Take measures to prevent the mismatching or polarity reversal of connections.
- Prevent the tampering of connections.

The supply voltage for the module electronics is fed to the bus coupler. From this, the supply voltage of the module logic is provided via the bus base module. The supply voltage of the input circuits, clock outputs and I/O devices is fed directly to the module.

The sensors are connected via IndraControl S20 connectors.

- Wire the connectors according to your application: see “Terminal point assignment” on page 23.

Assembly, removal, and electrical installation

6 Parameterization of the module

6.1 Setting the F-Parameters and i-Parameters

Parameterization includes the following:

- Assigning the PROFIsafe address
- Parameterizing inputs

The communication address configured in the controller project must match the address set on the device.
The settings on the device take effect after a power up.

PROFIsafe address

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

- Set the address that you assigned earlier in the configuration software using the DIP switch on the module: see “Setting the DIP switch” on page 26.

Parameterization of the inputs and clock outputs

The parameterization of the safe inputs determines the behavior of the module and influences the safety integrity level that can be achieved.

The controller automatically writes the parameterization created in the parameterization tool to the module on every power up or reset.

The following conditions must be met:

- Supply voltage is present.
- Local bus is in the RUN state.
- Communication connection has been established between the controller and the module.

The module cannot be operated if it is not parameterized. The FS LED flashes.

The module is ready to operate if the parameters for all inputs are valid and transmitted without errors. Valid input data is only read in this state. In every other state, the safe state is transmitted for each input (“0” in the process image of the inputs).

If errors are detected during parameterization, the parameterization data is not applied. The FS LED flashes to indicate that the parameterization is invalid.

In addition, the error is reported to the controller. In this case, check and correct the settings. Information on error messages and troubleshooting: see “Errors: messages and removal” on page 65.

F-Parameters and i-Parameters

Assign the parameterizable F-Parameters and i-Parameters. Overview of the module parameters and possible settings: see “F-Parameters and i-Parameters” on page 85.

6.2 Parameterization of the safe inputs

The individual input pairs of a module can be parameterized differently, which means that different safety integrity levels (SIL, SILCL, Cat., PL) can be achieved.

Two-channel

The fixed assignment for two-channel operation of the inputs is as follows:

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

The input information of both inputs is mapped to one bit. The unused bits are always set to “0”.

Single-channel

For single-channel assignment, the inputs can be parameterized so that they operate independently of one another.

Parameterization

The safe inputs are parameterized in pairs for each connector. Fig. 6-1 describes the parameterization options.

Parameterization	Value range	Remark
Assignment	**Not used** Used, both single-channel Two-channel equivalent Two-channel non-equivalent	Parameterize the input pairs in pairs. For unused inputs, the data is filled with “0”. In two-channel operation, the inputs have a fixed assignment to one another.
Filter time (t_{Filter})	1.5 ms **3 ms** 5 ms 15 ms	The filter time is used to suppress interference for the input signals. Select the filter time so that the duration of the input signal is greater than the filter time.
	NOTICE **The filter time affects the response time of the safety function.**	
Symmetry	**Disabled** 100 ms 1 s 5 s	Parameterization is only active if the input is parameterized for two-channel operation. See also “Symmetry/ start inhibit” on page 33.

Fig. 6-1 Parameterization of each input pair

Parameterization	Value range	Remark
Start inhibit due to 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-circuit detection	No cross-circuit monitoring **Cross-circuit monitoring** INx_CH1 -> T1 INx_CH2 -> T2	As soon as cross-circuit 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**.		

Fig. 6-1 Parameterization of each input pair

Symmetry/ start inhibit

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

Key for the following diagrams:

S	Set time for symmetry monitoring
Diag	Diagnostics
Q	Acknowledgment of the diagnostic message. After acknowledging the diagnostic message, the current state is read in.

For non-equivalent parameterization, a negated signal is present at input IN0_Ch2 as illustrated.

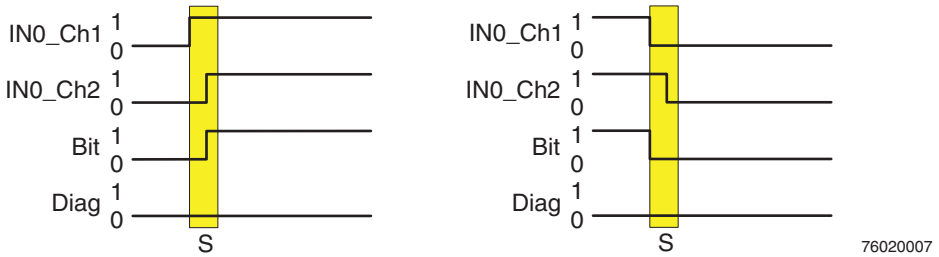


Fig. 6-2 Example for a signal change in the parameterized time for symmetry monitoring

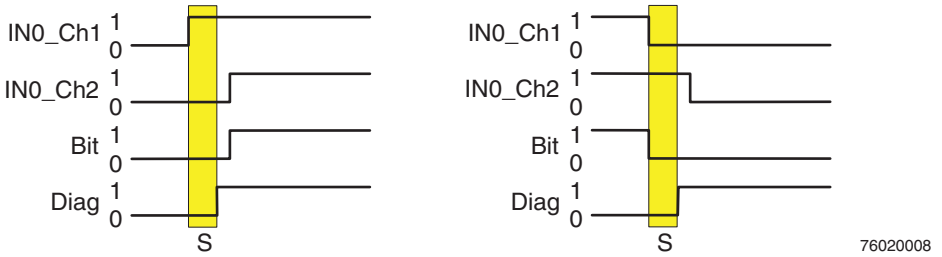


Fig. 6-3 Example for a signal change outside the parameterized time for symmetry monitoring, start inhibit due to symmetry violation is disabled

Parameterization of the module

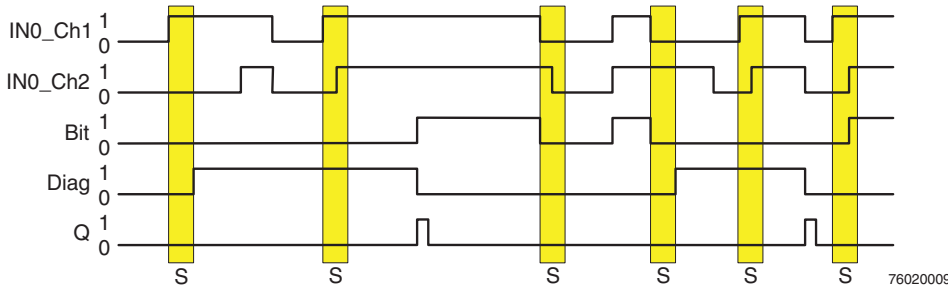


Fig. 6-4 *Example for a signal change outside the parameterized time for symmetry monitoring, start inhibit due to symmetry violation is enabled*

After acknowledging the diagnostic message, the current state at the input is immediately transmitted to the controller: see "Acknowledging an error for PROFIsafe" on page 74. If required, the user must implement a startup inhibit in the application program following error acknowledgment.

A symmetry violation can also be triggered by a cross-circuit: see "Connection examples for safe inputs" on page 37.

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

The processing time of input t_{IN} in the event of a safety demand consists of the parameterized filter time t_{Filter} and the firmware runtime t_{FW}:

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

Where:

t_{IN}	Processing time of the input
t_{Filter}	Parameterized filter time
t_{FW}	Firmware runtime: 1 ms

7 Duration of a safety demand

The duration of a safety demand must be greater than the processing time of the corresponding input t_{IN}: see “Processing time of input t_{IN} in the event of a safety demand” on page 34.

If the safety module detects a safety demand (safe “0”) after the processing time of input t_{IN} has elapsed, this time is extended by the module until the safety demand has been transmitted to the safe controller.

⚠ WARNING **Loss of safety function**

If the duration of the safety demand is too short, this can result in the loss of the safety function.

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

Duration of a safety demand

8 Connection examples for safe inputs

8.1 Explanation of the examples

⚠ WARNING Loss of safety function

Improperly executed applications can result in the loss of the safety function.

- Observe the information to achieve the specified category: see "Measures to achieve a specific safety integrity level" on page 38.
- Make sure that the sensor has appropriate diagnostic coverage and an appropriate MTTFd for achieving the specified PL. For applications according to PL d, high diagnostic coverage (>99%) is recommended, however medium diagnostic coverage (90% ... 99%) and a medium MTTFd are required at the very least.
  For applications according to PL e, high diagnostic coverage (>99%) and a high MTTFd are required.
- Use sensors that can achieve the required safety integrity level.

For the examples, please also observe the measures specified in the tables as well as standards IEC 61508, EN 62061, and EN ISO 13849-1 to achieve the specified SIL/SILCL/Cat./PL.

The above notes apply in general for all of the connection examples in this chapter.
Also observe the notes listed in the individual connection examples.

If the settings do not contradict one another, the inputs of a module can achieve different safety integrity levels (SIL, SILCL, Cat., PL) simultaneously.

The examples only describe the options for the electrical connection of sensors to the safe inputs.
Should you have any questions regarding your applications, please contact the Bosch Rexroth safety hotline: see "Safety hotline" on page 10.

The following are specified for each example:

- **Basic specifications**
  The table specifies the main data for the example.
- **Device diagnostics and behavior of the module in the event of an error**
  Diagnostic capability depends on the parameterization.
  If a message is transmitted to the controller in the event of an error, the message is specified in the tables. Information on the error code as well as possible solutions and information as to whether the error message must be acknowledged: see "Errors: messages and removal" on page 65. The symmetry violation diagnostic message is only displayed if it was not disabled during parameterization of the affected input.
- **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Connection examples for safe inputs

Key for tables in this chapter:

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

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

8.2 Measures to achieve a specific safety integrity level

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

SIL/SILCL

Use the standard to determine the probability of failure in your application according to IEC 61508 (SIL) and EN 62061 (SILCL).

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

Fig. 8-1 PFD and PFH depending on the SIL/SILCL

Performance level

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

Category The categories are achieved with the following measures:

Measure	Cat. 2	Cat. 3	Cat. 4
Use proven and basic safety principles according to EN ISO 13849-2.	x	x	x
Use qualified sensors: see “Requirements for sensors/controlling devices” on page 13.	x	x	x
Please note that mechanical failure of the switching device can result in the loss of the safety function.	x	x	x
Prevent (e.g., by means of protection, redundancy, positive opening operation) contacts from failing to open (e.g., due to welding or mechanical failure) when a switch is actuated.	x	x	
Please note that a single error can result in the loss of the safety function between tests.	x		
Make sure that the external wiring is tested by the machine controller on machine startup and at suitable intervals. This test must detect the loss of the safety function.	x		
Please take into consideration errors with a common cause.		x	x
Please note that all errors that cannot be detected can result in the loss of the safety function. Take measures to prevent these errors (e.g., protected cable installation or double insulation). Observe the notes in the following tables.		x	x
Make sure that a single error does not result in the loss of the safety function.		x	
If single-channel sensors are not available for this category, use two-channel sensors.		x	
An accumulation of errors must not result in the loss of the safety function. Following the third error, evaluation can be aborted if the probability of further errors occurring is low.			x

Connection examples for safe inputs

8.3 Single-channel assignment of safe inputs

For the single-channel assignment of safe inputs, the inputs operate independently of one another. The assignment of each input signal to the clock output cannot be freely selected.

8.3.1 Notes

Please observe the following notes:

Cross-circuit

- Please note that cross-circuits with other inputs can only be detected if cross-circuit monitoring is enabled.

The cross-circuit error results in the transmission of the safe state in the process data image of the affected inputs.

- Remove the error and then acknowledge the message.
- Observe the maximum failure detection time of 64 ms.

If a “1” signal is present at the input and an error occurs, a maximum of 64 ms elapses until the error is detected. During this time, another “1” can be transmitted, even in the event of an error.
Within the failure detection time (64 ms, maximum), the error can cause the state to change unexpectedly from “0” to “1”.

- Make sure that the system cannot be restarted unintentionally as a result of this change in state.
- Please note that the processing time for input t_{IN} increases by up to 64 ms in the event of an error.

For the power supply for single-channel assignment, use the relevant clock output or an external power supply (external +24 V or OSSD).

State evaluation

The module evaluates the states of the inputs and transmits the result to the controller.

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

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

8.3.2 Cross-circuit monitoring enabled

If an input pair is parameterized as single-channel with cross-circuit monitoring, the fixed assignment is as follows:

- INx_Ch1 is permanently assigned to clock output T1.
- INx_Ch2 is permanently assigned to clock output T2.

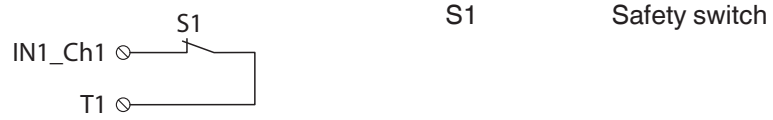


Fig. 8-2 Single-channel assignment of inputs

Basic specifications

Sensor	Single-channel
Sensor supply	Internally through clock output T1 (clocked) or T2 (clocked)
Achievable SIL/SILCL/Cat./PL	SIL 2/SILCL 2/Cat. 3/PL d

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

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
A contact fails to open.	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function.
A contact fails to close.	**No**	None	No	The error cannot be detected.
Other errors (depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	None	No	– Behavior when the input is in state “1”: The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally. – Behavior when the input is in state “0”: Please note that if switching on the safety switch again, this error can result in delayed transmission of state “1” in the process data image of the inputs.
Cross-circuit				
Input to input	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed. If the inputs are assigned different clock outputs, this error is detected as a cross-circuit after 64 ms.
Input to assigned clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Cross-circuit” on page 40.
Clock output to clock output	Yes if state “1”	Cross-circuit	No	The error is only detected in state “1” of the input.
Short circuit				
Input to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally.
Clock output to ground	Yes	Short circuit	No	The affected clock output is disabled.

Fig. 8-3 Single-channel: supply through T1 (clocked) or T2 (clocked)

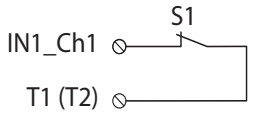
[1] SF = safety function

Connection examples for safe inputs

Typical parameterization

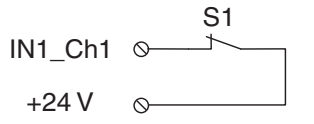
Parameterization	Parameterized as/value range	Remark
Input xx channel 1/channel 2		
Assignment	**Both single-channel**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	**Disabled**	
Start inhibit due to symmetry violation	**Disabled**	
Cross-circuit monitoring	**Cross-circuit monitoring**	

8.3.3 Cross-circuit monitoring disabled, supply through T1



S1 Safety switch
T1 Supply through T1

Fig. 8-4 Single-channel assignment of inputs: supply through T1



S1 Safety switch
+24 V Supply through external 24 V

Fig. 8-5 Single-channel assignment of inputs: external supply

Basic specifications

Sensor	Single-channel switch
Sensor supply	Internally through clock output T1 or T2; cross-circuit monitoring disabled Externally (24 V)
Achievable SIL/SILCL/Cat./PL	SIL 2/SILCL 2/Cat. 2/PL d

⚠ WARNING Loss of safety function

Cross-circuits can result in the loss of the safety function.

- Prevent cross-circuits to achieve the specified PL.

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

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
A contact fails to open.	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function.
A contact fails to close.	**No**	None	No	The error cannot be detected.
Other errors (depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	None	No	– Behavior when the input is in state “1”: The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally. – Behavior when the input is in state “0”: Please note that if switching on the safety switch again, this error can result in delayed transmission of state “1” in the process data image of the inputs.
Cross-circuit				
Input to input	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Short circuit				
Input to external 24 V	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to ground	Yes if state “1”	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally.
Clock output to external 24 V	**No**	None	No	The error cannot be detected as clocking is disabled.
Clock output to ground	Yes	Short circuit	No	The affected clock output is disabled.
External 24 V to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally.

Fig. 8-6 Single-channel without cross-circuit monitoring: supply through T1/T2, external supply or OSSD

[1] SF = safety function

Connection examples for safe inputs

Typical parameterization

Parameterization	Parameterized as/value range	Remark
Input xx channel 1/channel 2		
Assignment	**Both single-channel**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	**Disabled**	
Start inhibit due to symmetry violation	**Disabled**	
Cross-circuit monitoring	**No cross-circuit monitoring**	

8.3.4 Supply through OSSD

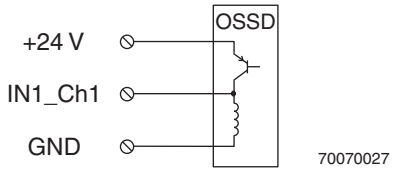


Fig. 8-7 Single-channel assignment of inputs: external supply (OSSD)

⚠ WARNING Loss of safety function

Parasitic voltages can result in the loss of the safety function.

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

Basic specifications

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

⚠ DANGER Loss of safety function

Cross-circuits can result in the loss of the safety function.

- Prevent cross-circuits to achieve the specified PL.

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

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
(depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between sensor and input)	Yes	None	No	– Behavior when the input is in state “1”: The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally. – Behavior when the input is in state “0”: Please note that if switching on the safety switch again, this error can result in delayed transmission of state “1” in the process data image of the inputs.
Input (cable interrupt between sensor and GND)	No	None	No	The sensor must detect the error. The sensor must ensure that the safe state is entered in the event of an error.
Cross-circuit				
Input to input	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to clock output	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Short circuit				
Input to external 24 V	**No**	None	**Yes**	The error cannot be detected and results in the loss of the safety function, as the safety switch is bypassed.
Input to ground	Yes if state “1”	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally.
Clock output to external 24 V	**No**	None	No	The error cannot be detected as clocking is disabled.
Clock output to ground	Yes	Short circuit	No	The affected clock output is disabled.
External 24 V to ground	Yes	None	No	The error is only detected as a change in state from “1” to “0” in state “1” of the input. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally.

Fig. 8-8 Single-channel: supply through OSSD

[1] SF = safety function

Connection examples for safe inputs

Typical parameterization

Parameterization	Parameterized as/value range	Remark
Input xx channel 1/channel 2		
Assignment	**Both single-channel**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	**Disabled**	
Start inhibit due to symmetry violation	**Disabled**	
Cross-circuit monitoring	**No cross-circuit monitoring**	

Set the filter time for the input to a value greater than the width of the test pulse for the OSSD sensor.
The input must be parameterized without cross-circuit monitoring.

8.4 Two-channel equivalent assignment of safe inputs

For two-channel assignment of the inputs, two adjacent inputs of the same connector are used. This assignment cannot be parameterized: see “Two-channel” on page 32.

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

The input is active when the state of the signal is “1”.

Please note that if switching on the safety switch again, a delayed change in state at one of the two inputs can result in delayed transmission of state “1” in the process data image of the inputs.

Example of correct and incorrect signal change

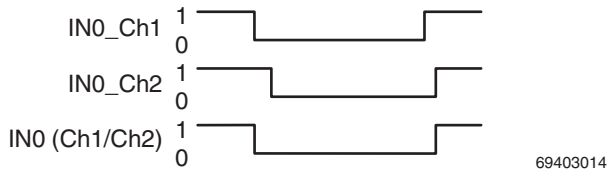


Fig. 8-9 Correct signal change

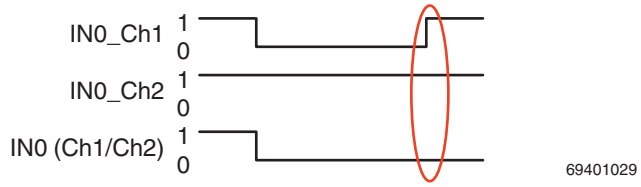


Fig. 8-10 Error during signal change

Key for Fig. 8-9 and Fig. 8-10

IN0_Ch1	Signal sequence at input 0 channel 1
IN0_Ch2	Signal sequence at input 0 channel 2
IN0 (Ch1/Ch2)	Safety-related signal for two-channel input 0, channel 1 and channel 2 to the controller

In Fig. 8-10, the condition that both signals must be in state “0” before the change in state from “0” to “1” is not met. In this case, the diagnostic message is generated.

State evaluation

The module evaluates the states of the inputs and transmits the result to the controller.

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

- “0” if a “0” signal is present at at least one of the two inputs **or** an error has been detected.
- “1” if a “1” signal is present at both inputs **and** no error has been detected and the conditions are met for a change in state according to Fig. 8-10.

Connection examples for safe inputs

8.4.1 Notes on errors

Please observe the following notes on cross-circuit and symmetry violation:

Cross-circuit

The **cross-circuit** error results in the transmission of the safe state in the process data image of the affected inputs.

- Remove the error and then acknowledge the message.

Acknowledging the diagnostic message deletes the message and activates the input. The states at the input are detected immediately.

- In the safe application program, make sure that the system cannot be restarted unintentionally after acknowledging the diagnostic message.
- Observe the maximum failure detection time of 64 ms.

Exceptions in the failure detection time are indicated in the tables below.
If a “1” signal is present at the input and an error occurs, a maximum of 64 ms elapses until the error is detected. During this time, another “1” can be transmitted, even in the event of an error.
During the failure detection time, the error can cause the state to change unexpectedly from “0” to “1”.

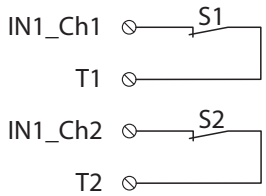
- Make sure that the system cannot be restarted unintentionally as a result of this change in state.

Symmetry violation

- The symmetry violation diagnostic message is only displayed if it was not disabled during parameterization of the affected input.
- **Start inhibit due to symmetry violation disabled:**
  The symmetry violation message does **not** result in the transmission of the safe state: see “Symmetry/ start inhibit” on page 33.
  The message must be acknowledged. However, the current status of the inputs is always displayed in the process data image of the inputs.
- **Start inhibit due to symmetry violation enabled:**
  The symmetry violation message results in the transmission of the safe state: see “Symmetry/ start inhibit” on page 33.
  The message must be acknowledged. The current status of the inputs is displayed in the process data image of the inputs.
- The message can be used to monitor the wear of the safety switch.

8.4.2 Cross-circuit monitoring enabled, supply through T1 and T2

Possible wiring versions:



S1, S2 Switching elements
T1, T2 Supply through T1 **and** T2

Fig. 8-11 Two-channel equivalent assignment of inputs, supply through T1 and T2 (both clocked)

Basic specifications

Sensor	Two-channel equivalent with cross-circuit monitoring
Sensor supply	Internally through clock output T1 **and** T2 (both clocked)
Achievable SIL/SILCL/Cat./PL	SIL 3/SILCL 3/Cat. 4/PL e

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

Observe the information to understand the change in state: see "Example of correct and incorrect signal change" on page 47.

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
A contact fails to open.	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel. – Change in state from "1" to "0": The faulty input remains at "1". A "0" is transmitted in the process data image of the affected inputs. – Change in state from "0" to "1": A "0" is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state "0".
A contact fails to close.	Yes	Symmetry violation[2]	No	On a change in state from "0" to "1", a "0" is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation[2]	No	The error is detected in state "1" or on a change in state from "0" to "1", as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	The error is detected in state "1".

Fig. 8-12 Two-channel equivalent with cross-circuit monitoring: supply through T1 and T2

Connection examples for safe inputs

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Input to assigned clock output	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel. – Change in state from “1” to “0”: The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – Change in state from “0” to “1”: A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to state “0”.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Cross-circuit” on page 48.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs which are assigned to different clock outputs.
Short circuit				
Input to ground	Yes	Symmetry violation[2]	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output to ground	Yes	Short circuit	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.

Fig. 8-12 Two-channel equivalent with cross-circuit monitoring: supply through T1 and T2 [...]

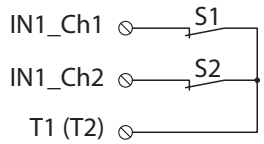
[1] SF = safety function

[2] Only applies when symmetry monitoring is active.

Typical parameterization

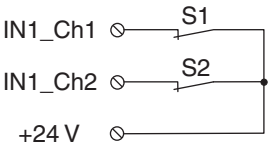
Parameterization	Parameterized as/value range	Remark
Input xx channel 1/channel 2		
Assignment	**Two-channel equivalent**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	100 ms	Application-specific
Start inhibit due to symmetry violation	Enabled	Application-specific
Cross-circuit monitoring	**Cross-circuit monitoring**	

8.4.3 Cross-circuit monitoring disabled, supply through a clock output or external supply



S1, S2 Two switching elements
T1 (T2) Supply through T1 **or** T2

Fig. 8-13 Two-channel equivalent assignment of inputs, supply through T1 (or T2), cross-circuit monitoring disabled



S1, S2 Two switching elements
+24 V External supply

Fig. 8-14 Two-channel equivalent assignment of inputs, external supply, cross-circuit monitoring disabled

Basic specifications

Sensor	Two-channel equivalent
Sensor supply	Internally through clock output T1 (or T2) **or** externally
Achievable SIL/SILCL/Cat./PL	SIL 3/SILCL 3/Cat. 3/PL d

Observe the information to understand the change in state: see “Example of correct and incorrect signal change” on page 47.

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

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
A contact fails to open.	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel. – Change in state from “1” to “0”: The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – Change in state from “0” to “1”: A “0” is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state “0”.
A contact fails to close.	Yes	Symmetry violation[2]	No	On a change in state from “0” to “1”, a “0” is transmitted in the process data image of the affected inputs, as only one channel reports this change in state.
Other errors (depending on the sensor)				Please take into consideration all errors that can occur in the sensor.

Fig. 8-15 Two-channel equivalent, cross-circuit monitoring disabled: supply through a clock output or external supply

Connection examples for safe inputs

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the wiring				
Interrupt				
Cable interrupt between clock output or external supply and sensor	Yes	None	No	– Behavior when the input is in state “1”: The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible. Make sure that such a change in state cannot restart the system unintentionally.
Cable interrupt between sensor and input	Yes	Symmetry violation[2]	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Cross-circuit				
Input to input	**No**	None	No	An accumulation of errors can result in the loss of the safety function.
Input to clock output	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel. – Change in state from “1” to “0”: The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – Change in state from “0” to “1”: A “0” is transmitted in the process data image of the inputs, if the faulty input was not previously set to “0”.
Clock output to clock output	**No**	None	No	The error is not detected.
Short circuit				
Input to external 24 V	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel. – Change in state from “1” to “0”: The faulty input remains at “1”. A “0” is transmitted in the process data image of the affected inputs. – Change in state from “0” to “1”: A “0” is transmitted in the process data image of the inputs, as the faulty input was not previously set to “0”.
Input to ground	Yes	None	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output that is not clocked to external 24 V	**No**	None	No	The error is not detected.
Clock output to ground	Yes	Short circuit	No	The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.
External 24 V to ground	Yes	None	No	The error is detected as a change in state from “1” to “0”. An unexpected change from “0” to “1” is possible. Make sure that this change in state cannot restart the system unintentionally.

Fig. 8-15 Two-channel equivalent, cross-circuit monitoring disabled: supply through a clock output or external supply [...]

[1] SF = safety function

[2] Only applies when symmetry monitoring is active.

For all inputs that are parameterized without cross-circuit monitoring, cross-circuits and short circuits are not detected by the device diagnostics, but only on a change in state of the input signals, as the state only changes in one channel.

⚠ DANGER **Loss of safety function**

An accumulation of errors can result in the loss of the safety function.
Test the safety function at suitable intervals to detect errors at an early stage.

Typical parameterization

Parameterization	Parameterized as	Remark
Input xx channel 1/channel 2		
Assignment	**Two-channel equivalent**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	100 ms	Application-specific
Start inhibit due to symmetry violation	Disabled	Application-specific
Cross-circuit monitoring	**No cross-circuit monitoring**	

8.4.4 External supply (OSSD)

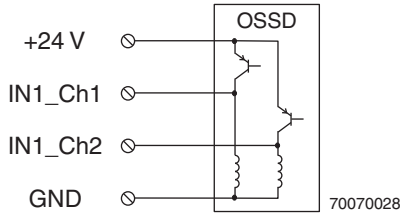


Fig. 8-16 *Two-channel equivalent assignment of inputs, external supply (OSSD)*

⚠ WARNING **Loss of safety function**

Parasitic voltages can result in the loss of the safety function.

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

Basic specifications

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

Connection examples for safe inputs

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

Observe the information to understand the change in state: see "Example of correct and incorrect signal change" on page 47.

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
Channel failure	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel. – Change in state from "1" to "0": The faulty input remains at "1". A "0" is transmitted in the process data image of the affected inputs. – Change in state from "0" to "1": A "0" is transmitted in the process data image of the affected inputs, as the faulty input was not previously set to state "0".
Other errors (depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between sensor and input)	Yes	Symmetry violation[2]	No	The error is detected in state "1" or on a change in state from "0" to "1", as the state only changes in one channel.
Input (cable interrupt between sensor and GND)	No	None	No	The error must be detected by the sensor. The sensor must ensure that the safe state is entered in the event of an error.
Cross-circuit				
Input to input	No	None	**Yes**	The error must be detected by the sensor. The sensor must ensure that the safe state is entered in the event of an error.
Input to clock output	Yes	Symmetry violation[2]	No	The error is detected on a change in state if the clock output is set to "1", as the state only changes in one channel.
Short circuit				
Input to 24 V	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel.
Input to ground	Yes	Symmetry violation[2]	No	The error is detected in state "1" or on a change in state from "0" to "1", as the state only changes in one channel.

Fig. 8-17 Two-channel equivalent: external supply (OSSD)

[1] SF = safety function

[2] Only applies when symmetry monitoring is active.

Typical parameterization

Parameterization	Parameterized as	Remark
Input xx channel 1/channel 2		
Assignment	**Two-channel equivalent**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	100 ms	Application-specific
Start inhibit due to symmetry violation	Disabled	Application-specific
Cross-circuit monitoring	**No cross-circuit monitoring**	

Set the filter time for the input to a value greater than the width of the test pulse for the OSSD sensor.
Cross-circuit detection must be disabled.

8.5 Two-channel non-equivalent assignment of safe inputs

For two-channel assignment of the safe inputs, two adjacent inputs of the same connector are always used. This assignment cannot be parameterized: see “Two-channel” on page 32.

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

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

Please note that if switching on the safety switch again, a delayed change in state at one of the two inputs can result in delayed transmission of state “1” in the process data image of the inputs.

Connection examples for safe inputs

Example of correct and incorrect signal change

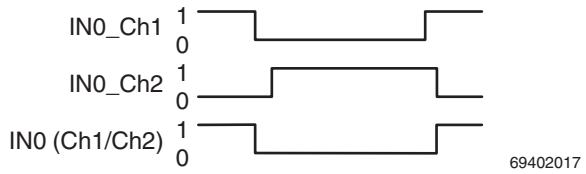


Fig. 8-18 Correct signal change

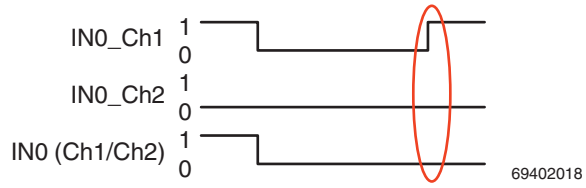


Fig. 8-19 Error during signal change

Key for Fig. 8-18 and Fig. 8-19

IN0_Ch1	Signal sequence at input 0 channel 1
IN0_Ch2	Signal sequence at input 0 channel 2
IN0 (Ch1/Ch2)	Safety-related signal for two-channel input 0, channel 1 and channel 2 to the controller

In Fig. 8-19, the condition that both signals must be in the opposite state before the change in state is not met. In this case, the diagnostic message is generated.

State evaluation

The module evaluates the states of the inputs and transmits the result to the controller.

The following values are transmitted 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** no error has been detected and the conditions are met for a change in state according to Fig. 8-19.
- A “0” is transmitted in all other cases.

8.5.1 Notes on errors

Please observe the following notes on cross-circuit and symmetry violation:

Cross-circuit

The cross-circuit error results in the transmission of the safe state in the process data image of the affected inputs.

- Remove the error and then acknowledge the message.

Acknowledging the diagnostic message deletes the message and activates the input. The states at the input are detected immediately.

- In the safe application program, make sure that the system cannot be restarted unintentionally after acknowledging the diagnostic message.
- Observe the maximum failure detection time of 64 ms.

Exceptions in the failure detection time are indicated in the tables below.
If a “1” signal is present at the input and an error occurs, a maximum of 64 ms elapses until the error is detected. During this time, another “1” can be transmitted, even in the event of an error.
During the failure detection time, the error can cause the state to change unexpectedly from “0” to “1”.

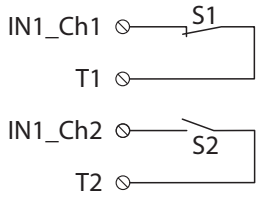
- Make sure that the system cannot be restarted unintentionally as a result of this change in state.

Symmetry violation

- The symmetry violation diagnostic message is only displayed if it was not disabled during parameterization of the affected input.
- **Start inhibit due to symmetry violation disabled:**
  The symmetry violation message does **not** result in the transmission of the safe state: see “Symmetry/ start inhibit” on page 33.
  The message must be acknowledged. However, the current status of the inputs is always displayed in the process data image of the inputs.
- **Start inhibit due to symmetry violation enabled:**
  The symmetry violation message results in the transmission of the safe state: see “Symmetry/ start inhibit” on page 33.
  The message must be acknowledged. Following acknowledgment, the current status of the inputs is displayed in the process data image of the inputs.
- The message can be used to monitor the wear of the safety switch.

Connection examples for safe inputs

8.5.2 Cross-circuit monitoring enabled, supply through T1 and T2



S1, S2 Two switching elements

Fig. 8-20 Two-channel non-equivalent assignment of inputs, supply through T1 and T2, cross-circuit monitoring enabled

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output T1 **and** T2, cross-circuit monitoring enabled
Achievable SIL/SILCL/Cat./PL	SIL 3/SILCL 3/Cat. 4/PL e

Observe the information to understand the change in state: see “Example of correct and incorrect signal change” on page 56.

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

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
A contact fails to open.	Yes	Symmetry violation[2]	No	The error is detected, as the state only changes in one channel.
A contact fails to close.				
Other errors (depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation[2]	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Cross-circuit	No	The error is detected if the other input is set to “1”.
Input to assigned clock output	Yes	Symmetry violation[2]	No	The error is detected on a change in state, as the state only changes in one channel.
Input to non-assigned clock output	Yes	Cross-circuit	No	See “Cross-circuit” on page 57.
Clock output to clock output	Yes	Cross-circuit	No	The error is detected for inputs which are assigned to different clock outputs.

Fig. 8-21 Two-channel non-equivalent with cross-circuit monitoring: supply through T1 and T2

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Short circuit				
Input to ground	Yes	None	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Clock output to ground	Yes	Short circuit	No	The error is detected on a change in state at the latest, as the state only changes in one channel. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.

Fig. 8-21 Two-channel non-equivalent with cross-circuit monitoring: supply through T1 and T2 [...]

1 SF = safety function

2 Only applies when symmetry monitoring is active.

An error in input circuit INx_Ch2 can only be detected in the event of a requested safety function.

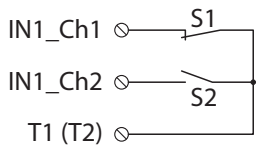
⚠ WARNING Loss of safety function

An accumulation of errors can result in the loss of the safety function.
Test the safety function at suitable intervals to detect errors at an early stage.

Typical parameterization

Parameterization	Parameterized as/value range	Remark
Input xx channel 1/channel 2		
Assignment	**Two-channel non-equivalent**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	Disabled	Application-specific
Start inhibit due to symmetry violation	Disabled	Application-specific
Cross-circuit monitoring	**Cross-circuit monitoring**	

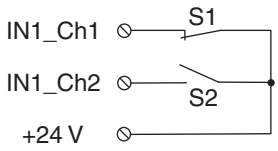
8.5.3 Cross-circuit monitoring disabled, supply through a clock output or external supply



S1, S2 Two switching elements
T1 (T2) Supply through T1 **or** T2

Fig. 8-22 Two-channel non-equivalent assignment of inputs, supply through T1 (or T2), cross-circuit monitoring disabled

Connection examples for safe inputs



S1, S2 Two switching elements
+24 V Supply through external 24 V

Fig. 8-23 Two-channel non-equivalent assignment of inputs, external supply

Basic specifications

Sensor	Two-channel non-equivalent
Sensor supply	Internally through clock output T1 (or T2) (clocking disabled) **or** externally
Achievable SIL/SILCL/Cat./PL	SIL 3/SILCL 3/Cat. 3/PL d

Observe the information to understand the change in state: see "Example of correct and incorrect signal change" on page 56.

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

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Error in the sensor				
A contact fails to open.	Yes	Symmetry violation[2]	No	The error is detected, as the state only changes in one channel.
A contact fails to close.				
Other errors (depending on the sensor)				Please take into consideration errors that can occur in the sensor.
Error in the wiring				
Interrupt				
Input (cable interrupt between clock output and sensor or between sensor and input)	Yes	Symmetry violation[2]	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Cross-circuit				
Input to input	Yes	Symmetry violation[2]	No	The error is detected, as the state only changes in one channel.
Input to clock output	Yes	Symmetry violation[2]	No	The error is detected, as the state only changes in one channel. – Change in state from "1" to "0": The faulty input remains at "1". A "0" is transmitted in the process data image of the affected inputs.
Clock output to clock output	**No**	None	No	The error is not detected.

Fig. 8-24 Two-channel non-equivalent without cross-circuit monitoring: supply through a clock output or external supply

Error type	Detection	Diagnostics	Loss of SF[1]	Remark
Short circuit				
Input to external 24 V	Yes	Symmetry violation[2]	No	The error is detected on a change in state at the latest, as the state only changes in one channel.
Input to ground	Yes	Symmetry violation[2]	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.
Clock output to external 24 V	**No**	None	No	The error is not detected.
Clock output to ground	Yes	Short circuit	No	The error is detected as a change in state from “1” to “0”. The error is also detected as a short circuit of the clock output. The affected clock output is disabled.
External 24 V to ground	Yes	Symmetry violation[2]	No	The error is detected in state “1” or on a change in state from “0” to “1”, as the state only changes in one channel.

Fig. 8-24 Two-channel non-equivalent without cross-circuit monitoring: supply through a clock output or external supply

[1] SF = safety function

[2] Only applies when symmetry monitoring is active.

⚠ DANGER **Loss of safety function**

An accumulation of errors can result in the loss of the safety function.
Test the safety function at suitable intervals to detect errors at an early stage.

Connection examples for safe inputs

Typical parameterization

Parameterization	Parameterized as/value range	Remark
Input xx channel 1/channel 2		
Assignment	**Two-channel non-equivalent**	
Filter time (t_{Filter})	3 ms	Application-specific
Symmetry	100 ms	Application-specific
Start inhibit due to symmetry violation	Enabled	Application-specific
Cross-circuit monitoring	**No cross-circuit monitoring**	

9 Startup and validation

9.1 Initial startup

Step	Relevant chapters and literature
Set the address.	See “Setting the DIP switch” on page 26.
Install the module in the IndraControl S20 station.	See “Assembly, removal, and electrical installation” on page 25. DOK-CONTRL-S20*SYS*INS-AP..-EN-P application description
Connect the bus system and supply voltage cables to the IndraControl S20 station.	DOK-CONTRL-S20*SYS*INS-AP..-EN-P application description or documentation for the bus coupler
Wire the inputs according to your application.	See “Connection examples for safe inputs” on page 37.
Before applying the operating voltage: • Make sure that there are no wiring errors (e.g., cross-circuit or short circuit) or grounding errors by testing with a multimeter. • Make sure that functional earth ground is connected.	
Connect the necessary voltages to the IndraControl S20 module.	DOK-CONTRL-S20*SYS*INS-AP..-EN-P application description or documentation for the module
Once the operating voltage has been applied: • If possible, measure the waveform of the voltages to make sure that there are no deviations. • Measure the input voltages on the module to make sure that they are in the permissible range. • Use the LEDs on the module to check that the module starts up without any errors.	
Check the assembly and installation.	Checklist: see “Assembly and electrical installation” on page 91.
Carry out the necessary parameterization.	See “Parameterization of the module” on page 31. Documentation for the PROFIsafe controller
Program the safety function.	Application descriptions for the function blocks used Documentation for the PROFIsafe controller
Perform a function test and validation. Check whether the safety function responds as planned during programming and parameterization.	Checklist: see “Validation” on page 93.
When connecting the supply voltages, use the diagnostics and status indicators to check whether the module has started up correctly or whether any errors are indicated.	For instructions on how to proceed in the event of an error: see “Errors: messages and removal” on page 65.

Fig. 9-1 Steps for startup

9.2 Restart after replacing a module

9.2.1 Replacing a module

⚠ WARNING Unintentional machine startup

Make sure that the power to the system is disconnected before carrying out assembly and removal work as this could cause unintentional machine startup.

- Before assembling or removing the module, disconnect the power to the module and the entire IndraControl S20 station and ensure that the system cannot be switched on again.
- Make sure the entire system is reassembled before switching the power back on and that neither the station nor the system poses a hazard.
  Observe the diagnostics indicators and any diagnostic messages.

If replacing a module, proceed as described for assembly and removal: see “Assembly, removal, and electrical installation” on page 25
or IndraControl S20: System and Installation application description DOK-CONTRL-S20*SYS*INS-AP..-EN-P.

- Install the new module at the correct position in the station.
- Observe the color coding of the connector/slot when mounting the connectors.

The new module must meet the following requirements:

- Same device type
- Same or later version

9.2.2 Restart

Once the module has been replaced, proceed as described for initial startup: see “Initial startup” on page 63.

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

9.3 Validation

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

- When validating your EUC, check the assignment of the individual sensor connections.
- Make sure that the following requirements are met:
  - The correct safe sensors are connected to the module.
  - The parameterization of the module is correct.
  - The variables used in your application program have been linked to the safe sensors correctly.
- Perform a function test and error simulation.

Observe the information on validation provided in the checklist: see “Validation” on page 93.

10 Errors: messages and removal

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

10.1 Reading diagnostic messages

Diagnostic messages are read via communication objects. For additional information on communication objects and general IndraControl S20 error messages, please refer to the following application descriptions:

Documentation

- IndraControl S20: System and Installation
  DOK-CONTRL-S20*SYS*INS-AP..-EN-P
- IndraControl S20: Error Messages
  DOK-CONTRL-S20*DIAG*ER-AP..-EN-P

Error code

The error code is specified for all diagnostic messages via the “Code” component of DiagState object 0x0018, subindex 4. Description of possible error codes: see “Error codes” on page 70.

Error location

The error location is indicated for all diagnostic messages via the “Channel/Group/Module” component of DiagState object 0x0018, subindex 3 or via DiagStateChannelNo object 0x0033.

The error location reported via the “Channel/Group/Module” component corresponds to the terminal point of the input 00 to 07, see Abb. 4-4 “Terminal point assignment of the I/O connection” on page 23..

Channel number 255 (0xFF) means that the entire module is affected.

Terminal point	00	01	02	03	04	05	06	07
Input	IN0		IN1		IN2		IN3	
	IN0_CH1	IN0_CH2	IN1_CH1	IN1_CH2	IN2_CH1	IN2_CH2	IN3_CH1	IN3_CH2
Diagnostics “Channel”	0	1	2	3	4	5	6	7

Fig. 10-1 Assignment of inputs to diagnostic messages

Example:

In case of a short circuit at terminal point 05 of the IN2_CH2 input, the value 0x05 is indicated in the DiagState object 0x0018, subindex 3. The error location of the diagnostics is “Channel 5”.

Errors: messages and removal

The following applies for the tables below:

Abbreviation	Meaning
N	Number of elements
L [bytes]	Length of the element in bytes
R	Read
W	Write

Fig. 10-2 Key for the following tables

Object type	Meaning
Var	Object with only one element (simple variable)
Array	Object with several simple variables of the same data type with the same length
Record	Object with several simple variables of different data types or of the same data type with different lengths

Fig. 10-3 Object types

Data type	Meaning
Visible string	Byte string with only printable ASCII characters The byte string finishes with 00_{hex} (null-terminated) and is therefore one byte longer than the user data.
Octet string	Byte string with any contents
Unsigned 8	Value without sign, only positive values 00_{hex} ... FF_{hex}
Unsigned 16	Value without sign, only positive values 0000_{hex} ... $FFFF_{hex}$
Unsigned 32	Value without sign, only positive values 0000 0000_{hex} ... FFFF $FFFF_{hex}$

Fig. 10-4 Data types

10.1.1 DiagState object 0x0018

The diagnostic object DiagState 0x0018 has the following structure:

Index	Object name	Object type	Data type	N	L [bytes]	Rights	Meaning
0x0018	DiagState	Record		6		R	Diagnostic state
.1	Lfd.Nr.	Var	Unsigned 16	1	2	R	Consecutive error number since the last reset or error memory reset
.2	Priority	Var	Unsigned 8	1	1	R	Priority of the message: 1: highest priority, error that cannot be acknowledged 2: error that can be acknowledged
.3	Channel/ Group/ Module	Var	Unsigned 8	1	1	R	Channel, group or module where the error occurred FF: entire device
.4	Code	Var	Octet string	1	2	R	Error code (see “Error codes” on page 70)
.5	MoreFollows	Var	Bit string 8	1	1	R	Additional error information: 00 - channel number that can be read via DiagStateChannelNo. (see “DiagStateChannelNo object 0x0033” on page 68) 01 - additional information that can be read via the DiagStateLong object 02 - AddValue that can be read via DiagStateAddValue (see “DiagStateAddValue object 0x0034” on page 68) 04 - a group is affected 08 - a module is affected
.6	Text	Var	Visible string	1	Max. 50 + 1	R	Plain text message. Default: status OK

Fig. 10-5 DagState object

Errors: messages and removal

10.1.2 DiagStateChannelNo object 0x0033

If it is indicated under MoreFollows in the DiagState object that a channel number is available, this can be determined via DiagStateChannelNo object 0x0033.

Index	Object name	Object type	Data type	N	L [bytes]	Rights	Meaning
0x0033	DiagState-ChannelNo	Record		6		R	Diagnostic state
.1	Lfd.Nr.	Var	Unsigned 16	1	2	R	Consecutive error number since the last reset or error memory reset
.2	ChannelNo	Var	Unsigned 8	1	1	R	Affected channel

Fig. 10-6 DiagStateChannelNo object

10.1.3 DiagStateAddValue object 0x0034

If it is indicated under MoreFollows in the DiagState object that an AddValue is available, this can be determined via DiagStateAddValue object 0x0034.

Index	Object name	Object type	Data type	N	L [bytes]	Rights	Meaning
0x0034	DiagState-AddValue	Record		6		R	Diagnostic state
.1	Lfd.Nr.	Var	Unsigned 16	1	2	R	Consecutive error number since the last reset or error memory reset
.2	AddValue	Var	Unsigned 32	1	4	R	Associated value for the error code (parameterization error) (see “Parameterization errors” on page 73)

Fig. 10-7 DiagStateAddValue object

10.1.4 ResetDiag object 0x0019

Priority 2 errors are acknowledged via ResetDiag object 0x0019. “05hex” is written to the object to acknowledge and delete the last error that occurred. No other values are supported by this module. The next error is then output.

Index	Object name	Object type	Data type	N	L [bytes]	Rights	Meaning
0x0019	ResetDiag	Var	Unsigned 8	1	1	W	Reset diagnostics; deletes the corresponding diagnostic memory and acknowledges the message

Fig. 10-8 ResetDiag object

10.1.5 Examples for reading a diagnostic message

Example 1: Reading an error due to cross-circuit at channel 3 (priority 2) with subsequent acknowledgment

Read DiagState object 0x0018

DiagState of slot 1:

Lfd.Nr.:	1
Priority:	0x02 (2), warning active
Channel/ Group/Module:	3
Code:	0x2141 (8513), cross-circuit to another input or external voltage
MoreFollows:	02 DiagStateAddValue available
Text:	

Read DiagStateChannelNo object 0x0033

Lfd.Nr.:	1
ChannelNo:	0x03

You can acknowledge the error after removing the error cause.

- Write “05hex” to ResetDiag object 0x0019.

Example 2: Reading a parameterization error (priority 1)

Read DiagState object 0x0018

DiagState of slot 1:

Lfd.Nr.:	2
Priority:	0x01 (1), alarm active
Channel/ Group/Module:	0
Code:	0x6320 (25376), parameter table invalid
MoreFollows:	02 DiagStateAddValue available
Text:	

Read DiagStateChannelNo object 0x0033

Lfd.Nr.:	2
ChannelNo:	0x0000

Read DiagStateAddValue object 0x0034

Lfd.Nr.:	2
AddValue:	0x0340

This error cannot be acknowledged as it is a priority 1 error.

- Check and correct the parameterization.

10.2 Error codes

Please contact Bosch Rexroth if error codes are indicated by the system which do not appear in:

- The tables below in this application description
- The IndraControl S20: System and Installation application description DOK-CONTRL-S20*SYS*INS-AP..-EN-P
- The IndraControl S20: Error Messages application description DOK-CONTRL-S20*DIAG*ER-AP..-EN-P

Module replacement following an error

If you replace the module in the event of an error, refer to the following chapters: see "Assembly, removal, and electrical installation" on page 25, see "Restart after replacing a module" on page 64.

LED

The "LED" column specifies which local diagnostics LED indicates the error.

Acknowledgment and restart

For every error that occurs, first remove the cause of the error. If necessary, acknowledge the error. The "Acknowledgment/remedy" column specifies whether an error must be acknowledged and which special conditions apply for re-enabling an input or the module.

⚠ WARNING Hazardous machine state/unintentional machine startup

With the exception of a few special cases, the acknowledgment of an error can result in a hazardous state as well as unintentional machine startup since the safe input is immediately returned to the operating state.

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

⚠ WARNING Unintentional machine startup

Startup/restart following power up and when there is no longer a demand of the safety function can result in unintentional machine startup.

- Please note that:
  - The module starts up once the configuration and parameterization data record has been downloaded successfully and internal testing has been completed without errors.
  - A safety-related input is automatically reset to "1" when the safety function trigger is reset.
- If you do not want the machine to restart automatically, configure the safety logic accordingly.

10.2.1 Safe digital input errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x2140	Cross-circuit between two inputs	E ON	A cross-circuit with another input, an external voltage or an external clock output has been detected. The affected input is kept in the safe state.	Read channel number via DiagStateChannelNo object 0x033. Check sensor, clock outputs, connectors, and cabling. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the input and the assigned inputs. If the error is still present, the message is output again.
0x2141	Cross-circuit between external voltage and an input			
0x2142	Cross-circuit between indicated input and clock output			
0x3183	Implausible signal change at indicated input pair	E ON	An implausible signal change has been detected at an input pair in two-channel operation.	Read channel number via DiagStateChannelNo object 0x033. To reset the error state, both inputs must be switched to the safe state. In order to map a “1” signal for the affected input pair, both inputs must now be set (note negation for non-equivalent inputs). This diagnostic message can be acknowledged. Acknowledgment deletes the message.
0x5010	Hardware fault reference voltage source	E ON	A hardware fault at the reference voltage source of the inputs has been detected by internal selftest mechanisms. As a result all inputs are kept in the safe state.	This diagnostic message can be acknowledged. Acknowledgment deletes the diagnostic message. Restart is only possible following an error-free power up selftest. If the power up selftest is not error-free, the module must be replaced.
	Hardware fault at indicated input	E ON	A hardware fault has been detected at the indicated input by internal tests. As a result all inputs are kept in the safe state.	Read channel number via DiagStateChannelNo object 0x033. This diagnostic message can be acknowledged. Acknowledgment deletes the message. Restart is only possible following an error-free power up selftest. If the power up selftest is not error-free, the module must be replaced.

Errors: messages and removal

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x8F01	Symmetry violation at indicated input	E ON	A violation of the parameterized symmetry has been detected at an input pair in two-channel operation. It is only used to evaluate the contacts of connected switches. If the start inhibit due to symmetry violation is activated, the inputs are disabled until the diagnostic message is acknowledged. Otherwise the input information continues to be collected and sent to the controller.	Read channel number via DiagStateChannelNo object 0x033. Check switches. This diagnostic message can be acknowledged. Acknowledgment deletes the message.

Fig. 10-9 Safe digital input errors

10.2.2 Clock output errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x2345	Short circuit or overload at indicated clock output	E ON	A short circuit or overload has been detected at the indicated clock output and the affected clock output has therefore been switched off. The assigned inputs are set to “0”.	Read channel number via DiagStateChannelNo object 0x033. Check connector and cabling. This diagnostic message can be acknowledged. Acknowledgment deletes the message and re-enables the clock output and the assigned inputs.

Fig. 10-10 Clock output errors

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

10.2.3 Supply voltage errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x3411	Undervoltage at supply U_l	Ul flashing	An undervoltage has been detected at supply U_l. If U_l < 17 V, a diagnostic message is generated. All module inputs are kept in the safe state. The U_l LED is permanently on again as soon as no undervoltage can be detected.	Check supply voltage and correct. Check supply line length and load. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the inputs.

Fig. 10-11 Supply voltage error

10.2.4 Parameterization errors

Parameterization errors generate priority 1 diagnostic messages in the DiagState object. These errors cannot be acknowledged. The parameterization must be checked and corrected.

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

Code + AddValue	Error cause	LED	Description/effect	Remedy
0x6320 **+ 0x034X**	Symmetry monitoring has been enabled and the input pairs are parameterized as single-channel.	FS flashing	The module is kept in the safe state.	Disable symmetry monitoring or parameterize the input pairs as two-channel.
0x6320 **+ 0x035X**	Restart inhibit has been parameterized and the input pairs are single-channel and/or symmetry monitoring is not activated.			Deactivate restart inhibit. Parameterize input pairs as two-channel. Activate symmetry monitoring.
0x6320 **+ 0x03F2**	Calculated and received parameter data checksums do not match.			Check checksums and resend parameter data to the module.
0x6320 **+ 0x03FB**	Wrong device type ID or wrong module used			Check whether the correct module is being used. If you cannot resolve the problem, please contact Bosch Rexroth.

Fig. 10-12 Parameterization errors (cannot be acknowledged)

10.2.5 General errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x4210	Critical module temperature	E ON	The module temperature has reached a critical value. Immediate shutdown. A further temperature increase causes the device firmware to switch the module to the safe state.	Check ambient conditions and switching frequency and adjust, if required. This diagnostic message can be acknowledged. Acknowledgment deletes the diagnostic message.
0xA012	Hardware fault or application on the module not ready	FS ON	Communication to the higher-level safe controller is disabled. The module switches to the safe state.	Perform power up. If an error message is output again, the module is faulty and must be replaced.
	DIP switch moved during operation	FS ON	The module switches to the safe state.	Check DIP switch position. Perform power up. This diagnostic message cannot be acknowledged.

Fig. 10-13 General errors

10.3 PROFIsafe errors

The following errors can also occur:

- PROFIsafe system errors: see “Diagnostic messages for parameter errors for PROFIsafe” on page 87.
- PROFIBUS or PROFINET system errors: For information on these errors, refer to the documentation for the system used.

10.4 Acknowledging an error for PROFIsafe

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

Parameterization errors cannot be acknowledged. In this case, proceed as follows:

- Check the parameterization.
- Adapt the parameterization.
- Download the new data record.

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

⚠ WARNING **Hazardous machine state/unintentional machine startup**

With the exception of a few special cases, the acknowledgment of an error can result in a hazardous state as well as unintentional machine startup since the safe input is immediately returned to the operating state.

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

⚠ WARNING **Unintentional machine startup**

Startup/restart following power up and when there is no longer a demand of the safety function can result in unintentional machine startup.

- Please note that:
  - The module starts up once the configuration and parameterization data record has been downloaded successfully and internal testing has been completed without errors.
  - A safety-related input is automatically reset to “1” when the safety function trigger is reset.
- If you do not want the machine to restart automatically, configure the safety logic accordingly.

11 Maintenance, repair, decommissioning and disposal

11.1 Maintenance

The module does not require maintenance. Depending on the application and connected I/O devices, the function of the I/O devices and the safety chain must be tested regularly.

The duration of use of the module is 20 years, or 25 years with a low demand rate.

Repeat testing during this time is not required.

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

11.2 Repair

It is prohibited for the user to carry out repair work or make modifications to the module. The housing must not be opened. The module is protected against tampering by means of security labels. The security label is damaged in the event of unauthorized repairs or opening of the housing. In this case, the correct operation of the safety module can no longer be ensured.

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

11.3 Decommissioning and disposal

Carry out decommissioning according to the requirements of the machine or system manufacturer.

When decommissioning the PROFIsafe system or parts of the system, ensure the following for the modules used:

Fate of the module	Measure
The modules will continue to be used correctly.	Observe the storage and transport requirements according to the technical data: see “S20-PSDI-8/4 module data” on page 77.
Modules will no longer be used.	Dispose of modules in accordance with the environmental regulations. Make sure that the modules can never be reused.

Maintenance, repair, decommissioning and disposal

12 Technical data and ordering data

12.1 PROFIsafe system data

PROFIsafe	
PROFIsafe profile	2.4

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

12.2 S20-PSDI-8/4 module data

General data	
Housing dimensions without bus base module with connector (width x height x depth)	53.6 mm x 126.1 mm x 54 mm
Weight (with connectors)	220 g, approximately
Operating mode	
PROFIsafe	Process data mode with 4 words
Ambient temperature	
Operation	–35°C ... +60°C (any mounting position) –35°C ... +55°C (according to CUL_{US})
Storage/transport	–40°C ... +85°C
Humidity	
Operation	75% on average, 85% occasionally (non-condensing)

Measures against increased humidity must be taken.

Storage/transport	75% (non-condensing)

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

Air pressure	
Operation	70 kPa ... 108 kPa (up to 3000 m above sea level)
Storage/transport	66 kPa ... 108 kPa (up to 3500 m above sea level)
Degree of protection	IP20; operation in at least IP54 installation space
Housing material	Plastic PBT, self-extinguishing (V0)
Air clearances and creepage distances	According to IEC 60664-1
Protection class	III (PELV)
Gases that may endanger functions according to DIN 40046-36, DIN 40046-37	Not resistant to gas that may endanger functions (sulfur dioxide (SO_2), hydrogen sulfide (H_2S))
Resistance of housing material to fungal decay	Resistant
Ambient compatibility	Not resistant to organic chlorine compounds

Technical data and ordering data

General data [...]	
Connection data for IndraControl S20 connectors	
Connection method	Spring-cage terminal blocks
Conductor cross section	Solid: 0.5 mm^2 ... 1.5 mm^2 Stranded without sleeve: 0.25 mm^2 ... 1.5 mm^2 Stranded with sleeve: 0.25 mm^2 ... 1.5 mm^2 24 AWG ... 16 AWG
Mechanical requirements	
Vibration according to IEC 60068-2-6	10 Hz ... 57 Hz: 0.35 mm with constant amplitude 57 Hz ... 150 Hz; 5g acceleration, constant amplitude
Shock according to IEC 60068-2-27	30g over 11 ms, Criterion A
Safety characteristics according to EN 61508	
Achievable SIL	SIL 2 (single-channel) SIL 3 (two-channel) Depends on the parameterization and wiring: see “Connection options for sensors depending on the parameterization” on page 16, see “Connection examples for safe inputs” on page 37.
Probability of a dangerous failure on demand by the safety function (PFD)	SIL 2: 1% of 10^{-2}, maximum (corresponds to 1 x 10^{-4}) SIL 3: 1% of 10^{-3}, maximum (corresponds to 1 x 10^{-5})
Probability of a dangerous failure per hour for the entire module (PFH)	SIL 2: 1% of 10^{-6}, maximum (corresponds to 1 x 10^{-8}) SIL 3: 1% of 10^{-7}, maximum (corresponds to 1 x 10^{-9}) Depends on the parameterization: see Fig. 8-3 on page 41.
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years, 25 years with a low demand rate
Safety characteristics according to EN 62061	
Achievable SIL claim limit	SILCL = SIL 2 (single-channel) SILCL = SIL 3 (two-channel) Depends on the parameterization and wiring: see “Connection options for sensors depending on the parameterization” on page 16, see “Connection examples for safe inputs” on page 37.
Safe failure fraction (SFF)	99%
Probability of a dangerous failure per hour for the entire module (PFH)	SIL 2: 1% of 10^{-6}, maximum (corresponds to 1 x 10^{-8}) SIL 3: 1% of 10^{-7}, maximum (corresponds to 1 x 10^{-9}) Depends on the parameterization: see Fig. 8-3 on page 41.
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years, 25 years with a low demand rate Operation in the error state: 72 h

Safety characteristics according to EN ISO 13849-1	
Achievable performance level	PL d (single-channel) PL e (two-channel) Depends on the parameterization and wiring: see "Connection options for sensors depending on the parameterization" on page 16, see "Connection examples for safe inputs" on page 37.
Diagnostic coverage (DC)	99%
Mean time to dangerous failure (MTTFd)	100 years (regardless of whether single-channel or two-channel operation)

Supply voltage U_{BUS} (logic)

The bus coupler or a feed-in terminal in the station supply the module with communications power U_{BUS}. For the technical data, please refer to the data sheet for the bus coupler or the feed-in terminal.

Communications power (logic voltage)	5 V DC
Current consumption from U_{BUS}	280 mA, typical (all inputs set; supply by U_I of 19.2 V DC ... 30.2 V DC) 310 mA, maximum

Supply voltage U_I (sensors, clock outputs, I/O)

⚠ WARNING **Loss of safety function**

The use of unsuitable power supplies can result in the loss of the safety function.
- Use power supplies according to EN 50178/VDE 0160 (PELV).

Nominal voltage	24 V DC according to EN 61131-2 and EN 60204
Ripple	3.6 V_{PP}
Permissible voltage range	19.2 V DC ... 30.2 V DC (including all tolerances, ripple included)
Current consumption	9 mA, typical (all inputs set; supply by U_I with 30.2 V DC; without supply to the sensors via clock supplies T1 and T2)
Permissible interrupt time	1 ms (output voltage of the clock outputs can fail)
Surge protection	Yes
Protection against polarity reversal	Parallel protection against polarity reversal for a limited period

NOTICE **Module damage**

Parallel protection against polarity reversal is only implemented in the module for a limited period. The following measures must be taken to prevent damage to the module:
- Due to the maximum current capacity of 8 A, protect power supply U_I externally with an 8 AT fuse.
- Only use PELV power supply units with at least four times the nominal tripping current, as this is the only way to ensure release times of less than 300 ms.

Undervoltage detection	At 16.6 V
Diagnostics indicators	Green U_I LED: See "Local diagnostics and status indicators" on page 17.
External protection	8 A slow-blow, maximum

Technical data and ordering data

Safe digital inputs	
Number	4 two-channel or 8 single-channel
Input design	According to the requirements of EN 61131-2 Type 3
Supply	Via clock outputs T1 and T2 or external supply
Input current	Approximately 4.2 mA at 24 V, typical
Maximum permissible current for “0”	2 mA
Minimum permissible current for “1”	2.5 mA
Permissible input voltage range	–3 V ... +30.2 V
Voltage range for “0”	–3 V ... +5 V
Voltage range for “1”	11 V ... 30 V
Maximum switching frequency	10 Hz
Filter time t_{Filter}	1.5/3/5/15 ms (can be parameterized): see “Filter time (t_{Filter})” on page 32.
Accuracy of filter time	+0 ms, –0,5 ms
Processing time of the input	$t_{IN} = t_{Filter} + t_{FW}$ See “Processing time of input t_{IN} in the event of a safety demand” on page 34.
Simultaneity	100%
Symmetry evaluation	Yes, can be parameterized, accuracy ±20%
Derating	No
Permissible cable lengths	1000 m from clock output to safe input (total length of the connected cables)
Status indicators	One green LED per input See “Local diagnostics and status indicators” on page 17.

The switching state of the inputs is constantly monitored. In the event of an error, e.g., if a component fails, the error is indicated at the controller.

Clock outputs	
Number	2
Supply	From U_I
Limiting continuous current (total)	0.4 A short-circuit and overload protection
Saturation voltage	U_I –1 V
Simultaneity	100%
Derating	No
Permissible cable lengths	The total length of the connected cables must not exceed 1000 m per clock output
Status indicators	None
Diagnostics indicators	E LED for mapping the diagnostic state See “Local diagnostics and status indicators” on page 17.

Approvals

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

12.3 Conformance with EMC directive

Conformance with EMC directive 2014/30/EU		
Noise immunity test according to DIN EN 61000-6-2		
Electrostatic discharge (ESD)	EN 61000-4-2 (IEC 61000-4-2)	Criterion 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)	Test intensity 2, Criterion A DC supply lines: 1.0 kV/1.0 kV (symmetrical/asymmetrical) Signal lines: 1.0 kV/2.0 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6 (IEC 61000-4-6)	Criterion A, test voltage 10 V
Noise emission test according to DIN EN 61000-6-3		
Noise emission	EN 55022	Class B, residential

12.4 Ordering data

12.4.1 Ordering data: module

Description	Type	MNR	Pcs./Pkt.
IndraControl S20 module with safe digital inputs	S20-PSDI-8/4	R911173254	1

12.4.2 Ordering data: documentation

Description	Type	MNR	Pcs./Pkt.
IndraControl S20			
Application description IndraControl S20: System and Installation	DOK-CONTRL-S20*SYS*INS-AP..-EN-P	R911335988	1
Application description IndraControl S20: Error Messages	DOK-CONTRL-S20*DIAG*ER-AP..-EN-P	R911344826	1
PROFIsafe			
Specification PROFIsafe - Profile for Safety Technology on PROFIBUS DP and PROFINET IO, Version 2.4, February 2007	See www.profisafe.net.		

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

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

Technical data and ordering data

13 PROFIsafe glossary

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

CRC Cyclic Redundancy Check

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

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

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

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

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

F-CPU Failsafe controller, safe controller

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

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

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

F-Slave Failsafe slave

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

PROFIsafe glossary

F-System Failsafe system

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

i-Parameter Individual safety parameters of a module

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

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

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

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

PROFIsafe address Each safe module has a PROFIsafe address. Set this address on the safety module (F-I/O device) via DIP switches and then configure it in the configuration tool for the safe controller.

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

This time is parameterized in the F_WD_Time F-Parameter.

14 F-Parameters and i-Parameters

14.1 F-Parameters

The values indicated in italics in Tabelle 14-1 are preset by the system and cannot be modified manually.

F-Parameter	Default value	Description
F_Source_ Address	*Automatic*	The parameter uniquely identifies the PROFIsafe source address (controller address). The address is assigned automatically.
F_Destination_ Address	*Automatic*	PROFIsafe destination address (address of the safe module) The address is assigned automatically. However, the value can be modified. Make sure that the value set under F_Destination_Address is the same as the value that you have set via the 12-pos. DIP switch. Value range: 1 ... 1023
F_WD_Time	150	Monitoring time in the module A valid current safety telegram must arrive from the safe controller during the monitoring time. Otherwise the module enters the safe state. The selected monitoring time must be sufficiently high for telegram delays to be tolerated by the communication, but still ensure a sufficiently fast error response in the event of an error (e.g., interruption in communication). Value range: 1 ... 10000, in 1 ms increments Unit: ms
F_SIL	*SIL 3*	Safety integrity (SIL according to IEC 61508) of the module Safety functions up to SIL 3 can be achieved with the module. The safety integrity level that can actually be achieved depends on the parameterization, the structure of the sensor, and the cable installation: see “Connection examples for safe inputs” on page 37.
F_CRC_Length	*3-byte CRC*	This parameter transmits the length of the CRC2 code to be expected in the safety telegram to the safe controller.
F_Block_ID	*1*	Parameter block type identification 1: the parameter block of the F-Parameters contains the F_iPar_CRC parameter.
F_Par_Version	*1*	Version number of the F-Parameter block 1: valid for V2 mode
F_iPar_CRC	0	CRC checksum via the i-Parameters The value must be greater than 0. When verifying the safety function, check whether the F_iPar_CRC parameter is greater than 0 for all modules. If not, check the i-Parameters and the CRC checksum in the i-Parameter and F-Parameter.

Tabelle 14-1 Overview of the F-Parameters for the module

14.2 i-Parameters

The i-Parameters are individual module parameters. These include:

- Module parameters: see “Parameterization of the safe inputs” on page 32.
- PST-Device_ID (device type ID)

iPar_CRC The module parameters are verified with a checksum: iPar_CRC.

14.3 Diagnostic messages for parameter errors for PROFIsafe

Error code		Error cause	Remedy
dec	hex		
64	40	The parameterized 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 are the same.
65	41	Invalid parameterization of F_Destination_Address Addresses 0000_{hex} and $FFFF_{hex}$ are not permitted.	Correct value.
66	42	Invalid parameterization of F_Source_Address Addresses 0000_{hex} and $FFFF_{hex}$ are not permitted.	Correct value.
67	43	Invalid parameterization of F_WD_Time A monitoring time of 0 ms is not permitted.	Correct value.
68	44	Invalid parameterization of F_SIL The safety module (F-Module) cannot support the required SIL.	Use a module with the required SIL. The safety module achieves SIL 3, maximum.
69	45	Invalid parameterization of F_CRC_Length The CRC length generated by the safety module (F-Module) does not match the required length.	Check device description.
70	46	Invalid F-Parameter record version The safety module (F-Module) version does not match the required version.	Check device description. Only V2 mode permitted.
71	47	The checksum determined by the safety module (F-Module) via the PROFIsafe parameters (CRC1) does not match the CRC1 transmitted in the parameter telegram.	Check F-Parameters. Repeat calculation.
72	48	Device-specific diagnostics	
73	49	Save i-Parameter watchdog time exceeded	
74	4A	Restore i-Parameter watchdog time exceeded	
75	4B	Invalid F_iParCRC	Correct value.
76	4C	F_Block_ID not supported	Check device description.
77	4D	Reserved	
78	4E	Reserved	
79	4F	Non-specified (unknown) error	

Tabelle 14-2 F-Parameter parameter errors

AddValue (hex)	Error cause	Remedy
03F2	iPar_CRC is incorrect.	Check i-Parameters. Repeat calculation.
03FB	PST_Device_ID is incorrect.	Contact Bosch Rexroth.

Tabelle 14-3 i-Parameter parameter errors

F-Parameters and i-Parameters

15 Checklists

The checklists listed in this chapter provide support when carrying out the following tasks on the S20-PSDI-8/4 module: planning, assembly and electrical installation, startup, parameterization, and validation.

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

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

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

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

Checklist . . .					
Device type/equipment identification		S20-PSDI-8/4 / S20-PN-BK+			
Version: HW/FW	00/101	**Date**	2008-01-17		
Test engineer 1	John Smith	**Test engineer 2**	Jane Brown		
Remark	System XXX has been checked for engine hood production				
No.	**Requirement (mandatory)**	**Yes**		**Remark**	
X	. . .	☐			
No.	**Requirement (optional)**	**Yes**	**No**	**Remark**	
Y	. . .	☐	☐		

Key:

Equipment identification	Enter the device type and/or the equipment identification for the relevant module.
Version: HW/FW	Enter the hardware and firmware version of the module: see “Structure of the module” on page 12.
Date	Enter the date on which you began to fill in this checklist.
Test engineer 1/2	Enter the names of the test engineers.
Remark	Enter a remark, if required.
Requirement (mandatory)	These requirements must be met for a safety application, in order to complete the relevant phase using the checklist.
Requirement (optional)	These requirements are optional. For points that are not met, please enter a remark.

Checklists

15.1 Planning

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

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

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

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

15.2 Assembly and electrical installation

Checklist for assembly and electrical installation of the module			
Device type/equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Was assembly completed according to the specifications (specifications from the planning phase or according to the application description)?	☐	
2	Was the module installed in the control cabinet (IP54) and secured correctly?	☐	
3	Do the cable cross sections and installations correspond to the specifications?	☐	
4	Does the connection technology correspond to the specifications in the technical data and in the relevant application description?	☐	

No.	Requirement (optional)	Yes	No	Remark
5	Is the protocol/address set correctly according to the specifications?	☐	☐	

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

Checklists

15.3 Startup and parameterization

Checklist for startup and parameterization of the module			
Device type/equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Was startup completed according to the specifications (specifications from the planning phase or according to the application description)?	☐	
2	During startup, is it ensured that any person starting hazardous movements intentionally can only do so with a direct view of the danger zone?	☐	
3	Are all parameters parameterized for the inputs and is the F_WD_Time set correctly?	☐	
4	For inputs that are parameterized for two-channel operation, are both channels parameterized correctly for each other?	☐	
5	Is the assignment to the clock outputs parameterized for the inputs?	☐	
6	Are the clock outputs parameterized?	☐	

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

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

15.4 Validation

Checklist for validating the module			
Device type/equipment identification			
Version: HW/FW		**Date**	
Test engineer 1		**Test engineer 2**	
Remark			

No.	Requirement (mandatory)	Yes	Remark
1	Have all the mandatory requirements for the „Planning“ checklist been met?	☐	
2	Have all the mandatory requirements for the „Assembly and electrical installation“ checklist been met?	☐	
3	Have all the mandatory requirements for the „Startup and parameterization“ checklist been met?	☐	
4	Does the parameterization of the safe inputs and clock outputs correspond to the version and the actual connection of the controlling devices?	☐	
5	Has the assignment of the sensors to the inputs and the variables of the safe application program been tested (online status in SafetyProg)?	☐	
6	Has a function test been performed to check all safety functions in which the module is involved?	☐	
7	Have measures been taken to achieve a specific Cat.?	☐	
8	Do all cables correspond to the specifications?	☐	
9	Does the power supply correspond to the specifications for the protective extra-low voltage (PELV)?	☐	
10	Is external protection of the module implemented (according to the specifications in this application description for supply voltage U_I)?	☐	
11	Have measures been taken to prevent simple tampering?	☐	
12	Are the requirements for the sensors and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved?	☐	
13	Are the specifications for the parameterization for each channel implemented?	☐	
14	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
		Date	Signature (test engineer 1)
		Date	Signature (test engineer 2)

Checklists

16 Disposal

16.1 General information

Dispose the products according to the respective valid national standard.

16.2 Return

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

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

Send the products free of charge to the following address:

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

16.3 Packaging

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

For ecological reasons, please do not return empty packages.

16.4 Batteries and accumulators

Batteries and accumulators can be labelled with this symbol.

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

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

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

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

Disposal

17 Service and support

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

Service Germany

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

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

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

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

Service worldwide

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

Preparing information

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

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

Service and support

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Notes

The Drive & Control Company

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