The Drive & Control Company

Rexroth
Bosch Group

IndraControl S20 Module

With Safe Digital Outputs S20-PSDO-8/3

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S20 Module
With Safe Digital Outputs S20-PSDO-8/3

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1 Use of the safety instructions

1.1 Structure of the safety instructions

The safety instructions are structured as follows:

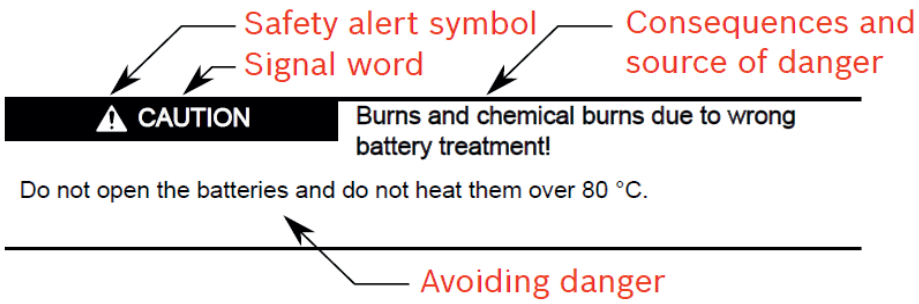


Abb. 1-1 Structure of the safety instructions

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-PSDO-8/3 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**, see “Checklists” on page 69.

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-PSDO-8/3 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 57.

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

Examples of use for the module:

- Safety circuits according to EN 60204 Part 1
- Safe shutdown of contactors, motors (24 V DC), valves, ohmic, inductive, and capacitive loads

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

For your safety

2.6 Documentation

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 63.

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-PSDO-8/3 module is an output 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 positive switching digital outputs for two-channel assignment or eight safe positive switching digital outputs for single-channel assignment.

The outputs can be parameterized according to the specific application and enable the integration of actuators 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

The safe controller and the module exchange output data via safe messages.

Product description

3.2 Structure of the module

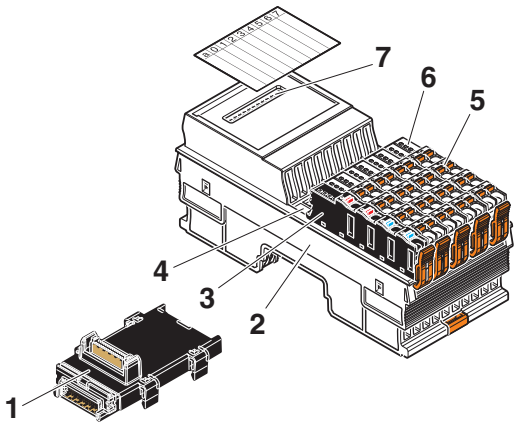


Fig. 3-1 Structure of the module

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 24.

3.3 Housing dimensions

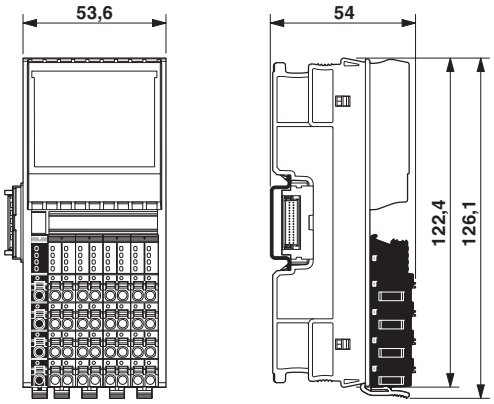


Fig. 3-2 Housing dimensions (in mm)

3.4 Safe digital outputs

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

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

Technical data for the safe outputs: see “Safe digital outputs” on page 60.

Parameterization

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

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

The safety integrity level (SIL, SILCL, Cat., PL) and error detection that can be achieved depend on the parameterization, the structure of the actuator, and the cable installation: see “Connection examples for safe outputs” on page 33.

Information on the parameterization of the outputs: see “Parameterization of the module” on page 29.

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 outputs: see “Errors: messages and removal” on page 43.

⚠ 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 actuators/controlled devices

Functional safety places requirements on the design of actuators/controlled devices.

- Use suitable actuators/controlled 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 actuator/controlled device: see “Parameterization of the module” on page 29.

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

⚠ WARNING **Unintentional machine startup**

Reactions from test pulses can cause unintentional machine startup.

- If the process does not tolerate this behavior, the following measures must be taken:
  - Use actuators with sufficient inertia.
  - Make sure that the load is not so dynamic that it causes hazardous states within 1 ms.

Quick actuators which respond to pulses less than 1 ms in a safety-critical way are generally not permitted.

Disabling the test pulses affects the error detection of the module.

- Observe the achievable safety integrity: see "Connection examples for safe outputs" on page 33.
- Observe the notes on the safe assignment of outputs: see "Single-channel assignment of safe outputs" on page 36, see "Two-channel assignment of safe outputs" on page 38.

3.5 Connection options for actuators depending on the parameterization

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

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 outputs" on page 33.
- Observe the requirements of the standards with regard to the external wiring and the actuators to be used to achieve a SIL/SILCL/Cat./PL: see "Measures to achieve a specific safety integrity level" on page 35.

	Output OUT0 to OUT3	
"Output" parameterization	Single-channel	Two-channel
Test pulses	Any	ON/OFF*
Achievable safety integrity	SIL 2/SILCL 2/Cat. 3/PL d	SIL 3/SILCL 3/Cat. 4/PL e
For connection example, see page	36	38

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

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

3.6 Local diagnostics and status indicators

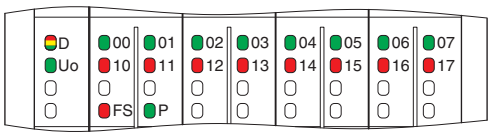


Fig. 3-3 Local diagnostics and status indicators

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.
UO	Green	**Diagnostics for digital output supply**	
		Green ON	Supply for the digital outputs is present and is > around 17 V DC.
		Flashing green	Supply for the digital outputs 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 UO 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”.
00-07	Green	**Status of each output from 0 - 7**	
		OFF	Output at logic “0”
		Green ON	Output at logic “1”

Desig-nation	Color	State	Description
10-17	Red	**Diagnostics for each output from 0 - 7**	
		OFF	No error present at the output
		Red ON	Error at the output (e.g., short circuit)

Fig. 3-4 Overview of diagnostics LEDs

3.7 Safe state

The module is in the safe state when power is disconnected from the output terminal blocks: see “Safe digital outputs” on page 13.

The safe state for the F-Output data is “0”.
Passivation results in a change to the safe state: see “Passivation” on page 64.

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 outputs can enter states “1” or “0”. State “0” is the safe state.

3.7.2 Error detection in I/O devices

Outputs If an error is detected at an output, this output is disabled (“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 outputs:

- Short circuit
- Cross-circuit
- Overload

The diagnostic message is transmitted to the controller: see “Errors: messages and removal” on page 43. Information on which errors are detected and when: see “Connection examples for safe outputs” on page 33.

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

3.7.3 Device errors

Outputs

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

The diagnostic message is transmitted to the controller: see “Errors: messages and removal” on page 43.

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

The diagnostic message is transmitted to the controller: see “Errors: messages and removal” on page 43.

⚠ 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 51.

Exception:

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

Product description

3.8 Enabling safe outputs for PROFIsafe

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

A “0” is always forwarded.

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

3.9 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.

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 at 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 59.

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_O

⚠ 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.

⚠ WARNING Loss of safety function

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

- Supply the supply voltage U_{BUS} and supply voltage U_O at the bus coupler from the same power supply unit so that the module loads are not affected by parasitic voltages in the event of an error.

Supply voltage U_O supplies the output circuits. Technical data for the supply voltage U_O: see “Supply voltage U_O (actuators)” on page 59.

The maximum current carrying capacity for the main circuit U_O is 8 A.

NOTICE **Module damage**

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

- Due to the maximum current carrying capacity of 8 A, protect supply voltage U_O 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.

Supply voltage U_O should feature a connection to functional earth ground according to EN 60204-1.

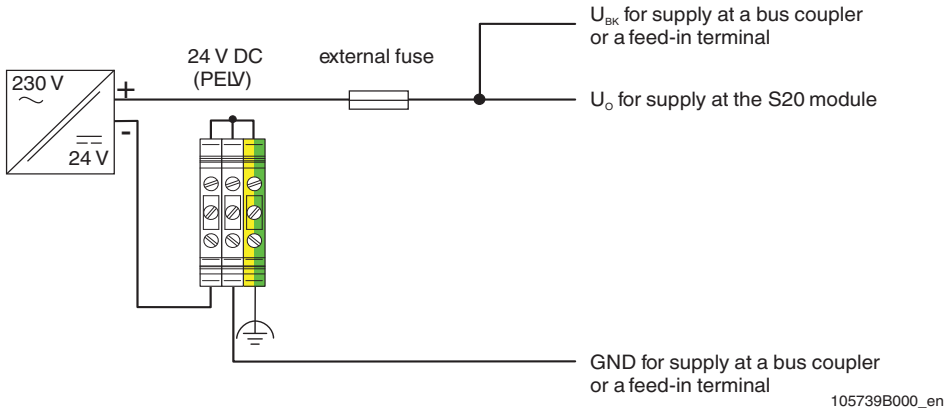


Fig. 4-1 Supply voltage U_O with connection to functional earth ground according to EN 60204-1

Observe the information regarding the behavior of the module in the event of an error at supply voltage U_O: see "Supply voltage errors" on page 50.

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

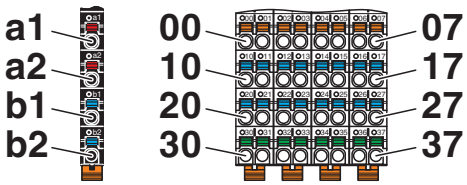


Fig. 4-2 Terminal point assignment

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 outputs are safe digital outputs.
- 0 V (GND): common ground of outputs
- FE: common functional earth ground

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

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

	Color	Connector 1 (blue)		Connector 2 (red)	
Terminal point	Orange	00	01	02	03
Function		OUT0_CH1	OUT0_CH2	OUT1_CH1	OUT1_CH2
Terminal point	Blue	10	11	12	13
Function		GND	GND	GND	GND
Terminal point	Blue	20	21	22	23
Function		GND	GND	GND	GND
Terminal point	Green	30	31	32	33
Function		FE			

Fig. 4-4 Terminal point assignment of the I/O connection, connectors 1 and 2

Local bus integration

	Color	Connector 3 (white)		Connector 4 (green)	
Terminal point	Orange	04	05	06	07
Function		OUT2_CH1	OUT2_CH2	OUT3_CH1	OUT3_CH2
Terminal point	Blue	14	15	16	17
Function		GND	GND	GND	GND
Terminal point	Blue	24	25	26	27
Function		GND	GND	GND	GND
Terminal point	Green	34	35	36	37
Function		FE			

Fig. 4-5 Terminal point assignment of the I/O connection, connectors 3 and 4

⚠ WARNING Loss of safety function

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

- Connect the ground of the actuator to the ground terminal point of the corresponding output on the IndraControl S20 connector. An external ground may not be used.

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.

Assembly, removal, and electrical installation

5.1.3 Setting the DIP switch

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

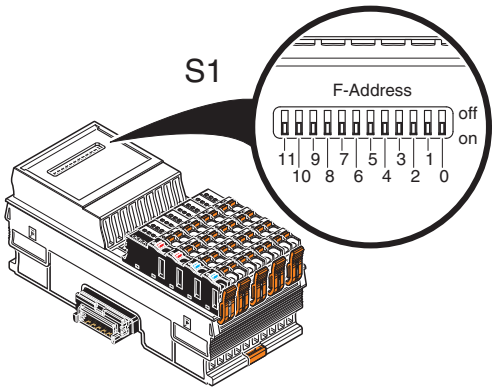


Fig. 5-1 DIP switch

S1 Switch for setting the PROFIsafe address

12-pos. DIP switch: address

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

Overview of the switch positions

PROFIsafe											
Address switch											
11	10	9	8	7	6	5	4	3	2	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.

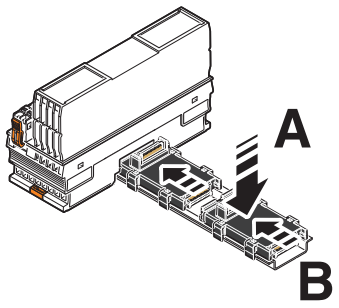
Setting the address

- 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.

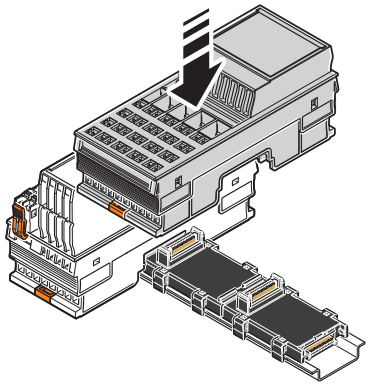
5.1.4 Mounting and removing the module

Mounting the bus base module



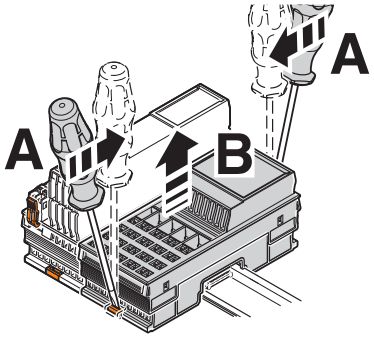
- Place all bus base modules required for the station on the DIN rail (A).
- Push the bus base modules into the bus coupler connector or the previous bus base module (B).

Snapping on and removing the electronics 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.

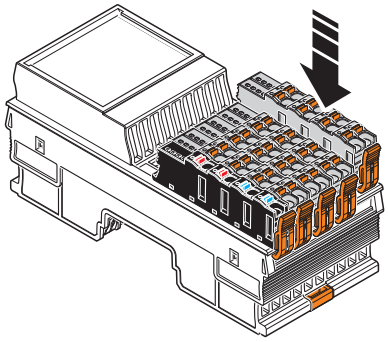


Remove

- 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).

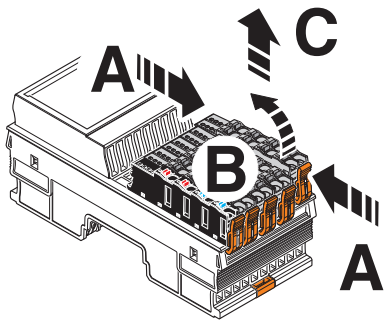
Assembly, removal, and electrical installation

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 output circuits is fed directly to the module.

The actuators are connected via IndraControl S20 connectors.

- Wire the connectors according to your application: see “Terminal point assignment” on page 21.

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 outputs

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 24.

Parameterization of outputs

The parameterization of the safe outputs 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 outputs are valid and transmitted without errors. Valid output data is only written in this state. In any other state, every output is set to the safe state.

If errors are detected during parameterization, the parameterization data is not 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 43.

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 65.

Parameterization of the module

6.2 Parameterization of the safe outputs

The individual output 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 is as follows:

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

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

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

Parameterization	Value range	Remark
Assignment	**Not used** Used, single-channel Used, two-channel	The unused outputs are disabled. However, the monitoring of these outputs remains active. In two-channel operation, the assignment of the outputs is fixed.
Test pulses (output disabled)	Disabled **Enabled**	Enabling and disabling of test pulses. For these test pulses, the output drivers that are disabled are temporarily enabled for test purposes (light pulses). Observe the notes below this table.
Switch-off delay for stop category 1	**Disabled** Enabled	Disabled (default): no switch-off delay Enabled: the outputs switch off once the set switch-off delay has elapsed (250 ms/500 ms/1 s/2 s/4 s/8 s/16 s/32 s/64 s/128 s). Accuracy:±5% of the set value
Assignment of the switch-off delay	**Two-channel** to channel 2	Either two-channel assignment or assignment to just channel 2 is possible for the switch-off delay.
The default values are shown in **bold**.		

Fig. 6-1 Parameterization of each output pair

Test pulses If the light pulses are disabled, cross-circuits and short circuits cannot be detected when the output is switched off.

However, outputs parameterized as “Not used” are tested with test pulses.
Observe the additional information: see “Requirements for actuators/controlled devices” on page 13, see“Connection examples for safe outputs” on page 33.

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

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

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

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

⚠ WARNING Delayed switch-off

Stop category 1 results in delayed switch-off.

- Note the following for stop category 1:
  - The affected outputs are only set to the safe state once the switch-off delay has elapsed.

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

⚠ WARNING Incorrect/insufficient safety distances

Selecting the wrong switch-off delay can result in incorrect safety distances being designed.

- When designing the safety distances, take the selected switch-off delay into consideration.

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

  - Switch-off can be interrupted by switching the output on again.
  - If the parameterization of the module is modified, the modified parameterization does not take effect until all the outputs have been switched off.
  - If the parameterization is modified before switch-off is complete, a diagnostic message is generated.
  - If the parameterization is modified, this can result in delayed startup due to the switch-off delay.
- Carry out a validation every time the parameterization is modified.

Parameterization of the module

7 Connection examples for safe outputs

7.1 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 safety integrity level: see “Measures to achieve a specific safety integrity level” on page 35.
- Make sure that the actuator 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 actuators that can achieve the required safety integrity level.
- Evaluate the readback contacts to achieve Cat. 3 or Cat. 4.

⚠ WARNING **Loss of safety function**

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

- Prevent the supply of an external voltage in an output (e.g., due to cross-circuits).
- Install the connecting cables for the actuators so that they are protected against cross-circuits.
- Observe the load capacity of the outputs: see “Safe digital outputs” on page 13.

NOTICE **Damage to equipment**

Incorrect supply of an external voltage can damage the module.

- Prevent the supply of an external voltage in an output (e.g., due to cross-circuits).

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 outputs 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 controlled devices/actuators to the safe outputs.
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 relevant 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 43.
- **Typical parameterization**
  The table illustrates an example of all the parameters for the specified assignment.

Key for tables in this chapter:

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

Fig. 7-1 Parameterization tables

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

7.2 Notes on the protective circuit of external relays/contactors (freewheeling circuit)

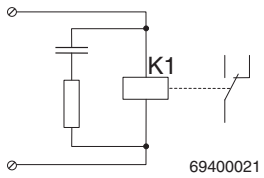


Fig. 7-2 Example of the freewheeling circuit for an external relay

Observe the following measures:

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

7.3 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. 7-3 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 actuators: see “Requirements for actuators/controlled 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 the welding of contacts on the connected contactors or safety relays with protection against overcurrent and surge voltage.	x	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		
Make sure that in the event of an error the module shuts down safely or generates a warning (optical and/or audible) depending on the application.	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
Please take into consideration errors with a common cause.		x	x
Make sure that a single error does not result in the loss of the safety function.		x	
Test the shutdown capability of the actuators at adequate and regular intervals for test pulses that are disabled.		x	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 outputs

7.4 Single-channel assignment of safe outputs

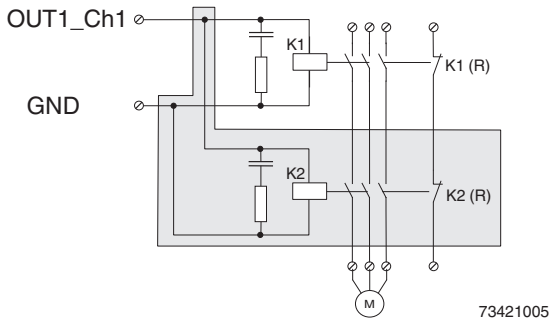


Fig. 7-4 Single-channel assignment of outputs

In order to achieve Cat. 3 or PL d with single-channel assignment of the outputs:

- Use a two-channel actuator.

The two-channel operation of the actuator with the corresponding connection is represented on a gray background.

The failure detection time is 20 ms. High pulses of this width can occur in the event of an error.

If the application responds to these pulses:

- Use the two-channel assignment of the outputs.

K1 (R) and, if required, K2 (R) represent the force-guided N/C contacts for monitoring the state of the relays (readback contacts). Connect these contacts via safe digital inputs. Evaluate the readback and therefore the state of the switching elements in the safe application program.

⚠ WARNING Loss of safety function

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

- Connect the actuator ground to the ground terminal point of the corresponding output on the IndraControl S20 connector. An external ground may not be used.

Basic specifications

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

⚠ WARNING **Loss of safety function**

The specified safety category can only be achieved under the following condition:

- Enable the test pulses in order to achieve Cat. 3 and PL d.

Enable the test pulses to improve device diagnostics and for long off times.

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 actuator				
Despite being disabled, the actuator does not switch to the safe state (e.g., a contact will not open).	**No**	None	Yes	Detect errors using external monitoring. Please note all errors that can occur in the actuator. Test the shutdown capability of the actuator at suitable intervals. If necessary, use a two-channel actuator.
Actuator cannot be enabled (e.g., interrupt).	**No**	None	No	Detect errors using external monitoring. Please note all errors that can occur in the actuator. Ensure that this error does not result in delayed system startup.
Other errors (depending on the actuator)				Please note all errors that can occur in the actuator.
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	**No**	None	No	Detect errors using external monitoring. Please note all errors that can occur in the actuator. Ensure that this error does not result in delayed system startup.
Cross-circuit				
Output to output	Yes	All LEDs OUT: red on	Yes	When the outputs are disabled, a cross-circuit between the outputs is only detected if the test pulses are enabled. If an error is detected, the module disables all its outputs.
Short circuit				
Output to ground or output to FE	Yes	Short circuit or overload, OUTx[2]	No	The error is detected in the ON state. The output is disabled (safe state). The module cannot be switched on again with an edge from “0” to “1” until the error has been removed and acknowledged. **⚠ WARNING** **Unexpected machine startup** An operator acknowledgment can result in unexpected machine startup. • Please note that an operator acknowledgment can result in the outputs being re-enabled.

Fig. 7-5 Single-channel: test pulses enabled

[1] SF = safety function, [2] OUTx = diagnostic message (LED) for each output X

Connection examples for safe outputs

Typical parameterization

Parameterization	Parameterized as	Remark
Assignment	**Assigned**	
Test pulses (output disabled)	Enabled	Or disabled
Switch-off delay for stop category 1	Enabled	Or disabled
Output	**Single-channel**	

7.5 Two-channel assignment of safe outputs

For two-channel assignment of the safe outputs, two adjacent outputs of the same connector are used. This assignment cannot be parameterized: see "Two-channel" on page 30.

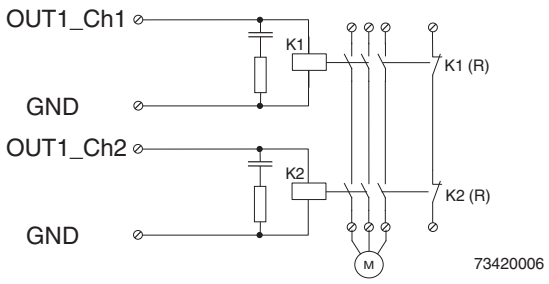


Fig. 7-6 Two-channel assignment of outputs

K1 (R) and K2 (R) represent the force-guided N/C contacts for monitoring the state of the relays (readback contacts).

- Connect these contacts via safe digital inputs.
- Evaluate the readback and therefore the state of the switching elements in the safe application program.

⚠ WARNING Loss of safety function

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

- Connect the actuator ground to the ground terminal point of the corresponding output on the IndraControl S20 connector. An external ground may not be used.

The failure detection time does not have to be taken into consideration for two-channel assignment.

Basic specifications

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

Enable the test pulses to improve device diagnostics and for long off times.

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 actuator				
Despite being disabled, a switching element of the two-channel actuator does not switch to the safe state (e.g., a contact will not open).	**No**	None	No	No loss of the safety function as the second switching element of the two-channel actuator can be disabled. Detect errors using external monitoring. Implement a restart inhibit in the event of this error. Please note all errors that can occur in the actuator. Test the shutdown capability of the actuator at suitable intervals.
Actuator cannot be enabled (e.g., interrupt)	**No**	None	No	Detect errors using external monitoring. Please note all errors that can occur in the actuator. Ensure that this error does not result in delayed system startup.
Other errors (depending on the actuator)				Please note all errors that can occur in the actuator.
Error in the wiring				
Interrupt				
Cable interrupt between output and actuator or between actuator and ground	**No**	None	No	Detect errors using external monitoring. Please note all errors that can occur in the actuator. Ensure that this error does not result in delayed system startup.
Cross-circuit				
Output to output	Yes (conditional)	All LEDs OUT: red on	No	When the outputs are disabled, a cross-circuit between the outputs is only detected if the test pulses are enabled. If an error is detected, the module disables all its outputs. If the test pulses have been disabled, test the circuit and the external wiring at suitable intervals by enabling the outputs.
Short circuit				
Output to ground or output to FE	Yes	Short circuit or overload, OUTx[2]	No	The error is detected in the ON state. The output is disabled (safe state). The module cannot be switched on again with an edge from “0” to “1” until the error has been removed and acknowledged. **⚠ WARNING** **Unexpected machine startup** An operator acknowledgment can result in unexpected machine startup. • Please note that an operator acknowledgment can result in the outputs being re-enabled.

Fig. 7-7 Two-channel

[1] SF = safety function

[2] OUTx = diagnostic message (LED) for each output X

Connection examples for safe outputs

Typical parameterization

Parameterization	**Parameterized as**		**Remark**
	Channel 1	**Channel 2**	
Assignment	**Assigned**	**Assigned**	
Test pulses (output disabled)	**Enabled**	**Enabled**	
Switch-off delay for stop category 1	Enabled	Enabled	Or disabled
Output	**Two-channel**	**Two-channel**	

8 Startup and validation

8.1 Initial startup

Step	Relevant chapters and literature
Set the address.	See “Setting the DIP switch” on page 24.
Install the module in the IndraControl S20 station.	See “Assembly, removal, and electrical installation” on page 23. 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 outputs” on page 33.
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 required voltages to the IndraControl S20 station.	DOK-CONTRL-S20*SYS*INS-AP..-EN-P application description or documentation for the module
Connect the necessary voltages (U_O) to the module.	See “Supply voltage U_O (actuators)” on page 59.
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, removal, and electrical installation” on page 23.
Carry out the necessary parameterization.	See “Parameterization of the module” on page 29. 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 73.
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 43.

Fig. 8-1 Steps for startup

8.2 Restart after replacing a module

8.2.1 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 23 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

8.2.2 Restart

Once the module has been replaced, proceed as described for initial startup: see “Initial startup” on page 41.

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

8.3 Validation

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

- When validating your EUC, check the assignment of the individual actuator connections.
- Make sure that the following requirements are met:
  - The correct safe actuators 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 actuators correctly.

Observe the information on validation provided in the checklist: see “Validation” on page 73.

9 Errors: messages and removal

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

9.1 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 48.

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 output 00 to 07, see Fig. 4-4 “Terminal point assignment of the I/O connection, connectors 1 and 2” on page 21 and Fig. 4-5 “Terminal point assignment of the I/O connection, connectors 3 and 4” on page 22.

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

Terminal point	00	01	02	03	04	05	06	07
Output	OUT0		OUT1		OUT2		OUT3	
	OUT0_CH1	OUT0_CH2	OUT1_CH1	OUT1_CH2	OUT2_CH1	OUT2_CH2	OUT3_CH1	OUT3_CH2
Diagnostics “Channel”	0	1	2	3	4	5	6	7

Fig. 9-1 Assignment of outputs to diagnostic messages

Example:

In case of a short circuit at terminal point 05 of the OUT2_CH2 output, 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. 9-2 Key for tables in this chapter

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. 9-3 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. 9-4 Data types

9.1.1 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 48)
.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 46) 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 46) 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. 9-5 DiagState object

Errors: messages and removal

9.1.2 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. 9-6 DiagStateChannelNo object

9.1.3 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 51)

Fig. 9-7 DiagStateAddValue object

9.1.4 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. 9-8 ResetDiag object

9.1.5 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:	0x2371 (9073), cross-circuit to another output 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:	0x0230

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

- Check and correct the parameterization.

9.2 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 23, see “Restart after replacing a module” on page 42.

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 output 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.

9.2.1 Safe digital output errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x2370	Cross-circuit between two outputs	All OUT: red on	A cross-circuit with another output or an external voltage has been detected. As a result all outputs are kept in the safe state.	Read channel number via DiagStateChannelNo object 0x033. Check actuator, connector and cabling. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the outputs. If the error is still present, the message is output again.
0x2371	Cross-circuit between external voltage and an output			
0x2344	Short circuit or overload at the indicated output	OUT: red on	A short circuit or overload has been detected at the indicated output. As a result the affected output is kept in the safe state.	Read channel number via DiagStateChannelNo object 0x033. Check actuator, connector and cabling, check freewheeling circuit at the contactor. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the outputs. Following successful acknowledgment, the safe module also expects a positive edge from the application for the switched output. For two-channel parameterization, this also applies to the other, potentially error-free output.
0x8F08	Light test error at the indicated output	All OUT: red on	An error has been detected at the indicated output by the test pulses (brief activation). As a result all outputs are kept in the safe state. A possible cause may also be a short-circuit event in the external wiring during the test.	Read channel number via DiagStateChannelNo object 0x033. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the outputs.
0x8F09	Dark test error at the indicated output	All OUT: red on	An error has been detected at the indicated output by the test pulses (brief deactivation). As a result all outputs are kept in the safe state.	Read channel number via DiagStateChannelNo object 0x033. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the outputs. The error may need to be acknowledged several times.
0x2380	Hardware fault or cross-circuit error	All OUT: red on	The indicated output cannot be disabled. As a result all outputs are kept in the safe state.	Read channel number via DiagStateChannelNo object 0x033. This diagnostic message can be acknowledged. Acknowledgment deletes the message and enables the outputs.

Errors: messages and removal

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x5010	Hardware fault	All OUT: red on	A hardware fault at the reference voltage source of the outputs has been detected by internal selftest mechanisms. As a result all outputs 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.

Fig. 9-9 Safe digital output errors

9.2.2 Supply voltage errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x3411	Undervoltage at supply U_O	UO flashing	An undervoltage has been detected at supply U_O. If U_O < 17 V, a diagnostic message is generated. All module outputs are kept in the safe state. The U_O 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 outputs.

Fig. 9-10 Supply voltage error

9.2.3 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
0x2382 + 0x02F2	At least one output with parameterized switch-off delay is still performing a switch-off operation.	FS flashing	The module is kept in the safe state.	Wait until the switch-off operation is complete and resend parameter data to the module.
0x6320 + 0x023X	The parameterization of two related outputs does not correspond to the two-channel setting.			Correct value and resend parameter data to the module.
0x6320 + 0x02EX	The parameterized switch-off delay time is outside the permissible value range.			Correct value and resend parameter data to the module.
0x6320 + 0x029X	For outputs parameterized for two-channel operation, the same settings were not assigned for the switch-off delay.			Correct value and resend parameter data to the module.
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. 9-11 Parameterization errors (cannot be acknowledged)

Errors: messages and removal

9.2.4 General errors

Code	Error cause	LED	Description/effect	Acknowledgment/remedy
0x4210	Critical module temperature	-	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. 9-12 General errors

9.3 PROFIsafe errors

The following errors can also occur:

- PROFIsafe system errors: see “Diagnostic messages for parameter errors for PROFIsafe” on page 67.
- PROFIBUS or PROFINET system errors: For information on these errors, refer to the documentation for the system used.

9.4 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 outputs are 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.

Errors: messages and removal

10 Maintenance, repair, decommissioning and disposal

10.1 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.

10.2 Repair

It is prohibited for the user to carry out repair work or make modifications to the module. The housing must not be opened. 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.

10.3 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-PSDO-8/3” on page 57.
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

11 Technical data and ordering data

11.1 PROFIsafe system data

PROFIsafe	
PROFIsafe profile	2.4
Processing time of the module	1.5 ms

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

11.2 S20-PSDO-8/3

General data	
Housing dimensions (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}; at max. total current 6 A; 4 outputs loaded with 1.5 A or 8 outputs loaded with 0.75 A)
Storage/transport	–40°C ... +85°C
Humidity	
Operation	75% on average, 85% occasionally

Measures against increased humidity must be taken.

Storage/transport	75% on average, 85% occasionally

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 60439-1, derived from IEC 60664-1
Protection class	III (PELV), IEC 61140, EN 61140, VDE 0140-1
Gases that may endanger functions according to DIN 40046-36, DIN 40046-37	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
Supported stop category according to EN 60204	0 1 in error-free state

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 characteristic data according to EN 61508	
Achievable SIL	SIL 2 (single-channel) SIL 3 (two-channel) Depends on the parameterization and wiring: see "Connection options for actuators depending on the parameterization" on page 14, see "Connection examples for safe outputs" on page 33.
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 "SIL, SILCL" on page 35.
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years, 25 years with a low demand rate

Safety characteristic data according to EN 62061	
Achievable SIL claim limit	SILCL = SIL 2 (single-channel) SILCL = SIL 3 (two-channel) Depends on the parameterization and wiring: see "Connection options for actuators depending on the parameterization" on page 14, see "Connection examples for safe outputs" on page 33.
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 "SIL, SILCL" on page 35.
Hardware fault tolerance (HFT) of the module	1
Permissible duration of use	20 years, 25 years with a low demand rate

Safety characteristic data according to EN ISO 13849-1	
Achievable performance level	PL d (single-channel) PL e (two-channel) Depends on the parameterization and wiring: see "Connection options for actuators depending on the parameterization" on page 14, see "Connection examples for safe outputs" on page 33.
Diagnostic coverage (DC)	99%
Mean time to dangerous failure (MTTFd)	100 years

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}	260 mA, typical (all outputs set; supply by U_O of 19.2 V DC ... 30.2 V DC) 280 mA, maximum

Supply voltage U_O (actuators)

⚠ 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	25 mA, typical (all outputs set, supply by U_O with 30.2 V DC; without actuator supply)
Permissible interrupt time	10 ms Within this time, the output voltage for the safe outputs fails as the outputs are not internally buffered.
Surge protection	Yes (in the module)
Protection against polarity reversal	Yes (in the module)

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 carrying capacity of 8 A, protect power supply U_O 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.

Technical data and ordering data

Supply voltage U_O (actuators)	
Undervoltage detection	Yes, at approximately 17 V
Diagnostics indicators	Green U_O LED: See “Local diagnostics and status indicators” on page 15.
External protection	8 A slow-blow, maximum

Safe digital outputs	
Number	4 two-channel or 8 single-channel (positive switching)
Supply	From supply voltage U_O
Maximum output current per output (channel)	2 A 1.5 A (according to CUL_{US})
Maximum output current for all outputs (total current)	8 A 6 A (according to CUL_{US})
Maximum output current for each group (total current)	
Group 1 (OUT0_K1, OUT1_K1, OUT2_K1, OUT3_K1)	4 A 3 A (according to CUL_{US})
Group 2 (OUT0_K2, OUT1_K2, OUT2_K2, OUT3_K2)	4 A 3 A (according to CUL_{US})
Maximum output voltage in the low state	<5 V

⚠ 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.

Maximum leakage current in the low state	2 mA

⚠ WARNING **Loss of safety function**

Switching the load at the maximum leakage current can result in the loss of the safety function.
- Please note that at this current, the load must not be switched or remain in the ON state.
- Please take this into consideration when selecting the actuator.

Minimum withstand voltage of the connected loads	>5 V

⚠ WARNING **Loss of safety function**

Switching the load at the minimum withstand voltage can result in the loss of the safety function.
- Please note that at this voltage, the load must not be switched or remain in the ON state.
- Please take this into consideration when selecting the actuator.

Maximum inductive load	1 H
Maximum capacitive load	10 µF per channel 10 µF in total
Minimum load	1.5 kΩ (16 mA at 24 V)
Limitation of the voltage induced on circuit interruption	-15 V

Safe digital outputs	
Output voltage	U_O - 1 V, approximately
Simultaneity	100% up to 45°C (observe maximum current load)
Maximum switching frequency	1 Hz; 0.2 Hz at > 1 A
Filter time	None
Switch-off delay for shutdown according to stop category 1	250 ms/500 ms/1 s/2 s/4 s/8 s/16 s/32 s/64 s/128 s Accuracy: ±5% of the set value See “Parameterization of the safe outputs” on page 30.
Maximum duration of the test pulses (when switched off; active driving)	1 ms

⚠ WARNING **Loss of safety function**

The switch-on pulse can result in the loss of the safety function.
- Please note that the load on a switch-on pulse (light test) of 1 ms must not fail or respond in a safety-critical way.
- Please take this into consideration when selecting the actuator.

Maximum duration of the test pulses (when switched on)	3 ms (depending on the load capacity)

⚠ WARNING **Loss of safety function**

The switch-off pulse can result in the loss of the safety function.
- Please note that the load on a switch-off pulse (dark test) of 3 ms must not fail or respond in a safety-critical way.
- Please take this into consideration when selecting the actuator.

Status indicators	One green LED per output See “Local diagnostics and status indicators” on page 15.
Diagnostics indicators	One red LED per output: See “Local diagnostics and status indicators” on page 15.

⚠ WARNING **Loss of safety function**

Parasitic voltages can result in the loss of the safety function.
- Connect the ground of the actuator to the ground terminal point of the corresponding output on the IndraControl S20 connector. An external ground may not be used.
- The connected load must not respond in a hazardous way to test pulses.

Approvals

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

Technical data and ordering data

11.3 Conformance with EMC directive

Conformance with EMC directive 2014/30EU		
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: 0.5 kV/0.5 kV (symmetrical/asymmetrical) Signal lines: 1.0 kV/2.0 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6 (IEC 61000-4-6)	Criterion A, test voltage 10 V
Noise emission test according to DIN EN 61000-6-3		
Noise emission	EN 55022	Class B, residential

11.4 Ordering data

11.4.1 Ordering data: module

Description	Type	MNR	Pcs./Pkt.
IndraControl S20 module with safe digital outputs	S20-PSDO-8/3	R911173255	1

11.4.2 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/.

12 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 relationships 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 specific customer specifications and for checking the parameterization by means of a separate method (diverse). The main F-Parameters are:

F_S/D_Address (F-Address for short)	A unique address for F-Devices within a PROFIsafe island. The technology part of the F-Device compares the value with the address switch locally or with an assigned F-Address in order to check the authenticity of the connection.
F_WD_Time	Specifies the millisecond value for the watchdog timer. The timer monitors the time that elapses until the next valid PROFIsafe message is received.
F_SIL	Indicates the SIL that the user can expect from the relevant F-Device. It is compared with the manufacturer's specification that is stored locally.
F_iPar_CRC	A checksum that is calculated from all 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 device:
see also "F-Parameter".

F-I/O device Failsafe I/O devices; 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 device

Passivation If the safety module (F-I/O device) detects an error, it switches the affected channel or all channels of the module to the safe state; the channels are then passivated. The detected 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. It defines the communication between a safety program and the safe I/O device (F-I/O device) in a safe system (F-System).

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

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

This time is parameterized in the F_WD_Time F-Parameter.

13 F-Parameters and i-Parameters

13.1 F-Parameters

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

F-Parameter	Default value	Description
F_Source_ Address	*Automatic*	The parameter uniquely identifies the PROFIsafe source address (controller address). The address is assigned automatically.
F_Destination_ Address	*Automatic*	PROFIsafe destination address (address of the safe device) The address is assigned automatically. However, the value can be modified. Make sure that the value set under F_Destination_Address 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 ... 65534, 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 outputs” on page 33.
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 devices. If not, check the i-Parameters and the CRC checksum in the i-Parameter and F-Parameter.

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

13.2 i-Parameters

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

- Module parameters: see Chapter 6.2 “Parameterization of the safe outputs” on page 30.
- PST-Device_ID (device type ID)

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

13.3 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 device with the required SIL. The safety module achieves SIL 3, maximum.
69	45	Invalid parameterization of F_CRC_Length The CRC length generated by the safety module (F-Module) does not match the required length.	Check device description.
70	46	Invalid F-Parameter record version The safety module (F-Module) version does not match the required version.	Check device description. Only V2 mode permitted.
71	47	The checksum determined by the safety module (F-Module) via the PROFIsafe parameters (CRC1) does not match the CRC1 transmitted in the parameter telegram.	Check F-Parameters. Repeat calculation.
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	

Table 13-2 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.

Table 13-3 i-Parameter parameter error

F-Parameters and i-Parameters

14 Checklists

The checklists listed in this chapter provide support when carrying out the following tasks on the S20-PSDO-8/3 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-PSDO-8/3 / S20-PN-BK+		
Version: HW/FW	00/101	**Date**	2008-01-03	
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”.
Date	Enter the date on which you began to fill in this checklist.
Editor	Enter the name of the editor.
Test engineer	Enter the name of the test engineer.
Remark	Enter a remark, if necessary.
Requirement (mandatory)	These requirements must be met for a safety application, in order to complete the relevant phase using the checklist.
Requirement (optional)	These requirements are optional. For points that are not met, please enter an appropriate remark in the relevant field.

Checklists

14.1 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 actuators 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	Has the power supply of U_O and U_{BK} from a power supply unit been planned?	☐	
5	Is external protection of the module planned (according to the specifications in this application description for supply voltage U_O)?	☐	
6	Are measures planned to prevent simple tampering?	☐	
7	Are measures planned to prevent connectors being mixed up?	☐	
8	Are requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved and is the corresponding implementation planned?	☐	
9	Are the specifications for the parameterization for each channel defined?	☐	
10	Have test intervals been defined for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
11	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
12	Does the planned use correspond to the intended use?	☐	
13	Are the ambient conditions as well as the maximum mechanical load observed according to the technical data?	☐	
14	Have test intervals been defined and has the maximum duration of use been taken into consideration?	☐	
15	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?	☐	

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

Date	Signature (editor)
Date	Signature (test engineer)

14.2 Assembly and electrical installation

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

No.	Requirement (mandatory)	Yes	Remark
1	Was assembly completed according to the specifications (specifications from the planning phase or according to the application description)?	☐	
2	Was the module installed in the control cabinet (IP54) and secured correctly?	☐	
3	Do the cable cross sections and installation 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 data width set correctly according to the specifications?	☐	☐	
6	Is the profile/PROFIsafe address set correctly according to the specifications?	☐	☐	

Date	Signature (editor)
Date	Signature (test engineer)

Checklists

14.3 Startup and parameterization

Checklist for startup and parameterization of the module					
Device type/equipment identification					
Version: HW/FW		**Date**			
Editor		**Test engineer**			
Remark					
No.	**Requirement (mandatory)**	**Yes**		**Remark**	
1	Was startup completed according to the specifications (specifications from the planning phase or according to the application description)?	❑			
2	During startup, is it ensured that any person starting hazardous movements intentionally can only do so with a direct view of the danger zone?	❑			
3	Are all parameters parameterized for the outputs and is the F_WD_Time set correctly?	❑			
4	For outputs that are parameterized for two-channel operation, are both channels parameterized correctly for each other?	❑			
5	Are the output test pulses parameterized according to the actuator to be connected?	❑			
6	Has the switch-off delay for stop category 1 been observed in the calculation of the total response time for the machine/system?	❑			
No.	**Requirement (optional)**	**Yes**	**No**	**Remark**	
7	Have safety distances that must be observed been calculated according to the response and delay times implemented?	❑	❑		
		Date		Signature (editor)	
		Date		Signature (test engineer)	

14.4 Validation

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

No.	Requirement (mandatory)	Yes	Remark
1	Have all the mandatory requirements for the "Planning" checklist been met?	☐	
2	Have all the mandatory requirements for the "Assembly and electrical installation" checklist been met?	☐	
3	Have all the mandatory requirements for the "Startup and parameterization" checklist been met?	☐	
4	Does the parameterization of the safe outputs correspond to the version and the actual connection of the controlled device?	☐	
5	Has the assignment of the actuators to the outputs and the variables of the safe application program been tested (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	Has the power supply of U_O and U_{BK} in the IndraControl S20 system from a power supply unit been implemented?	☐	
11	Is external protection of the module implemented (according to the specifications in this application description for supply voltage U_O)?	☐	
12	Have measures been taken to prevent simple tampering?	☐	
13	Are the requirements for the actuators and cable installation observed according to the SIL/SILCL/Cat./PL to be achieved?	☐	
14	Are the specifications for the parameterization for each channel implemented?	☐	
15	Have test intervals been defined for testing the shutdown capability of the actuators, if this is required to achieve a SIL/SILCL/Cat./PL?	☐	
16	Has it been ensured that any person intentionally starting hazardous movements can only do so with a direct view of the danger zone?	☐	
		Date	Signature (editor)
		Date	Signature (test engineer)

Checklists

15 Disposal

15.1 General information

Dispose the products according to the respective valid national standard.

15.2 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

15.3 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.

15.4 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

16 Service and support

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

Service Germany

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

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

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

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

Service worldwide

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

Preparing information

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

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

Service and support

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Notes

The Drive & Control Company

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Bosch Group

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