USER MANUAL 1.40

B-Nimis SC-I/O S-DI4 S-DO2

B-Nimis System Safety Terminal (formerly E-I/O S-DI4 S-DO2)

Original Operating Instructions

Product number S-01060201-0000

BERGHOF

Disclaimer of Liability
The contents of the publication have been checked for compliance with the hardware and software that are described. Deviations however cannot be entirely excluded, so we undertake no guarantee of complete compliance. The data in this publication are regularly checked and any necessary corrections are incorporated in subsequent issues.

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About this User Manual
This user manual is intended for qualified specialists and contains the information necessary for the correct use of the product.
For proper understanding and error-free application of technical descriptions, instructions for use and particularly of notes of danger and warning, extensive knowledge of automation technology and functional safety is compulsory.

You can reach us under:
Berghof Automation GmbH
Arbachtalstr. 26
72800 Eningen
Germany
T +49.7121.894-0
F +49.7121.894-100
E-mail: controls@berghof.com
www.berghof.com

Berghof Automation GmbH is certified to DIN EN ISO 9001:2015.

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1. Legal Notice

1.1. Contact Details

Berghof Automation GmbH
Arbachtalstr. 26
72800 Eningen
Germany
T +49.7121.894-0
F +49.7121.894-100
E-mail: controls@berghof.com
www.berghof.com

1.2. Version Details

1.2.1. User Manual

Revision history		
Version	**Date**	**Comments / changes**
1.0	20.06.2017	First issue 1.0, for module release V1.0
1.10	16.11.2017	Declaration of Conformity and TÜV certification added
1.20	28.05.2018	Designation for outputs corrected in the table of safety related ratings 4.7. (No changes to the safety related ratings). Footnote in chap. 6.3.2 FSoE overview of parameters added. Note added to the ERRATA_Sheet_Safety. Note added for single-channel applications. (Chap. 6.2.7). Note on dual-channel applications added. (Chap. 6.2.7 and 7.5).
1.30	05.02.2020	Several Hazard and other Warnings adapted. (Chap. 6.3.4 and 7) Change in chapter 6.2.7 Sensor Connection, “A high signal is sent from both inputs when the Safety Mat is stepped on”
1.40	20.07.2021	Changed Module Description - B-Nimis SC-I/O S-DI4 S-DO2 Changed Partnumber - S-01060201-0000

1.2.2. B-Nimis SC-IO S-DI4 S-DO2 safety module

The table below summarises the module releases, manual versions, production dates and the changes to the functionality.

Module release			
Version	**User Manual**	**Date**	**Comments / changes**
V 1.0.0	V 1.0	From 20.06.2017	Valid for module release V1.00 (software version V1.0, hardware version V2.1)
V 1.1.0	V 1.20	From 28.25.2018	Valid for module release V1.01 (software version V1.0, hardware version V2.1)
V 1.2.0	V 1.30	From 05.02.2020	Manual updated Valid for module release V1.02 (software version V1.0, hardware version V2.1)
V 1.2.0	V 1.40	From 20.07.2021	Changes of module name and Partnumber (in function and design identical to 204809000)

2. Preface

2.1. About this User Manual

This document is the original user manual to the Berghof B-Nimis SC-IO S-DI4 S-DO2 safety module with the product number 204809000. Your module work should always be based on the correct user manual version, see section 1.2 Version Details.
This document is primarily directed to system designers, project engineers and device developers.
It does not contain any information about deliveries. We reserve the right to make changes and correct errors and omissions. Illustrations are similar.

Refer to the Safety ERRATA document for the current relevant safety warnings.
The current version con be found on our home page https://www.berghof-automation.com
Under Products → Safety Controls → General Information

2.1.1. Limitation of Liability

Specifications are only for product description and are not to be understood as guaranteed product properties in a legal sense. Exact properties and characteristics shall be agreed in the specific contract. Claims for damages against us - on whatever grounds - are excluded, except in instances of deliberate intent or gross negligence on our part.

2.1.2. Conditions of delivery

The general conditions of sales and service of Berghof Automation GmbH shall apply.

2.1.3. Copyright

2.1.4. Warranty

Warranty is subject to the provisions of the conditions of sale of Berghof Automation GmbH or any contractual agreements between the parties.
The warranty will be voided by:

→ improper assembly and use,
→ repairs or inadmissible servicing,
→ modifications or rendering the serial number illegible or removing it.

2.1.5. Symbols and means of portrayal

The following symbols and means of portrayal are used in this User Manual:

Symbol		Explanation
→	…	List entry
▶	…	Individual operational instructions or list with operational instructions, which can be displayed in any sequence.
1. 2.	… …	List with operational instructions, which can be displayed in any sequence.
		Further information on the product

2.2. Reliability, Safety

2.2.1. Area of application

This user manual contains all information necessary for the use of the described product (control device, control terminal, software, etc.) according to instructions.

2.2.2. Target groups of this User Manual

The user manual is written for design, project planning, servicing and commissioning experts. For proper understanding and error-free application of technical descriptions, instructions for use and particularly of notes of danger and warning, extensive knowledge of automation technology and functional safety is compulsory.

2.2.3. Reliability

Reliability of Berghof products is brought to the highest possible standards by extensive and cost-effective means in their design and manufacture.
These include:

- → selecting high-quality components
- → quality agreements with our suppliers
- → actions to avoid static charges when handling MOS circuits
- → worst case planning and design of all circuits
- → visual inspections at various stages of fabrication
- → computer-aided tests of all assemblies and their interaction in the circuit
- → statistical assessment of the quality of fabrication and of all returned goods for the immediate taking of appropriate corrective actions
- → standardised returns handling process
- → ISO 9001:2015 certification

2.2.4. Hazard and Other Warnings

Despite the actions described in section 2.2.3 Reliability, the occurrence of faults or errors in electronic control units - even if most highly improbable - must be taken into consideration.
Please pay particular attention to the additional notices which we have marked by symbols throughout this user manual. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described below in descending order of importance.

Every alert and hazard warning is made up as follows:

⚠ WARNING

Type and source of risk

Brief description and potential consequences of non-observance

- ▶ Preventive measures

The signal terms described below are used for warning instructions which you must comply with for your personal safety and for avoiding damage to property.

⚠ DANGER

A DANGER warning makes you aware of an immediately hazardous situation which will cause a serious or fatal accident if not observed.

⚠ WARNING

A WARNING makes you aware of a potentially hazardous situation which may cause a serious or fatal accident or damage to this or other devices if not observed.

CAUTION

A CAUTION alert makes you aware of a potentially hazardous situation which may cause an accident or damage to this or other devices if not observed.

ATTENTION

An Attention notice makes you aware of a potentially hazardous situation which may cause damage to this or other devices if not observed.

2.2.5. Other Notices

Note, Information

This symbol draws your attention to additional information concerning the use of the described product. This may include cross references to information found elsewhere (e.g. in other manuals).

2.2.6. Safety

Our products normally become part of larger systems or installations. The information below is intended to help you integrate the product into its environment without dangers to people or materials/equipment.

DANGER

Non-compliance with the user manual

Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.

- Read the user manual carefully.
- Take particular heed of the hazard warnings.

To achieve a high degree of conceptual safety in planning and installing an electronic control unit, it is essential to exactly follow the instructions given in the user manual because wrong handling could lead to rendering measures against dangers ineffective or to creating additional dangers.

2.2.7. Project Planning and Installation

→ Emergency stop systems must comply with EN 60204/IEC 204 (VDE 0113) and be effective at all times.
→ Safety and precautions regulations for qualified applications have to be complied with.
→ Please pay particular attention to the notices of warning which, at relevant places, will make you aware of possible sources of dangerous mistakes or faults.
→ Relevant standards and VDE regulations are to be complied with in every case.
→ Control elements are to be installed in such a way as to exclude unintended operation.
→ Lay control cables such that interference (inductive or capacitive) is excluded if this interference could influence control unit operation or its functionality.

2.2.8. Maintenance and Servicing

- → Accident prevention regulations (in Germany: BGV A3 - VBG 4.0) must be observed when measuring or checking a control unit after power-up, in particular §8 (permissible deviations when working on parts).
- → Repair work on the B-Nimis SC-IO S-DI4 S-DO2 module is not permitted. In the event of a defect, return the module to Berghof Automation GmbH.
- → Spare parts:
  Only use parts approved of by Berghof Automation GmbH. Only genuine Berghof modules may be used in Berghof modular controllers.
- → In respect of modular systems: Modular systems: always plug or unplug modules in a power-down state. You may otherwise damage the modules or (possibly not immediately recognisably!) inhibit their functionality.
- → Always dispose of (rechargeable) batteries as hazardous waste.

2.2.9. General Instructions on Installation

As component parts of machines, facilities and systems, electronic control systems must comply with valid rules and regulations, depending on their field of application.
General requirements concerning the electrical equipment of machines and aiming at the safety of these machines are contained in Part 1 of European Standard EN 60204 (corresponds to VDE 0113).

For safe installation of our B-Nimis SC safety system, the instructions described in section 2.2.7 must be complied with.

Emission of interference
Emission of electromagnetic field interference, HF
compliant with EN 55011, limit value class A, Group 1

If the control unit is used in residential areas, high-frequency emissions must comply with limit value class B as described in EN 55011.

A shielding compliant to the above standard can be achieved by fitting the control unit into earthed metal cabinets and installing filters in the supply lines.

The design and immunity to interference of programmable logic controllers are internationally governed by standard IEC 61131-2:2007 which, in Europe, has been the basis for European Standard EN 61131-2:2007.

Refer to IEC 61131-4, User's Guideline, for general installation instructions to be complied with to ensure that hardware interface factors and the ensuing interference voltages are limited to tolerable levels.

Protection against the effects of external electrical interference

- ▶ To eliminate electromagnetic interference, connect the control system to the protective earth conductor. Practice best cable routing

Cable routing and wiring

- ▶ Route power circuits separately from control circuits:
  DC voltages 60 V…400 V
  AC voltages 25 V…400 V
- ▶ Route only the following control circuits together:
  Shielded data signals
  Shielded analogue signals
  Unshielded Digital I/O cables
  Unshielded DC voltages < 60 V
  Unshielded AC voltages < 25 V

Location of installation

- ▶ Ensure that temperatures, contaminations, impact, vibration or electromagnetic interference are no impediment to the installation.

Temperature

- ▶ Take heat sources into account: general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

- ▶ Use suitable enclosures to avoid possible negative influences due to humidity, corrosive gas, liquid or conducting dust.

Impact and vibration

- ▶ Consider possible influences caused by motors, compressors, transfer lines, presses, ramming machines and vehicles.

Electromagnetic interference

- ▶ Consider electromagnetic interference from various local sources: motors, switching devices, switching thyristors, radio-controlled devices, welding equipment, arcing, switched-mode power supplies, converters / inverters.

Particular sources of interference: Inductive actuators

Switching off inductances (such as from relays, contactors, solenoids or switching magnets) produces surge voltages.

- ▶ It is necessary to reduce these interference voltages to a minimum.
  Damping elements could be diodes, Z-diodes, varistors or RC elements. Their rating should conform to the specifications provided by the manufacturer or supplier of the actuators.

3. System Description

3.1. EtherCAT® – Ethernet Control

EtherCAT is a powerful Ethernet-based field bus system. Its speed, flexible topology and ease of configuration make it suitable for use as a fast motion control and I/O bus in the field of control technology (it can achieve a performance such as 1000 I/Os in 30 µs).

Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT control units thus act virtually as centralised control systems. Bus transfer times that conventional fieldbus systems are burdened with.

3.2. B-Nimis I/O system

The B-Nimis I/O system is a system of I/O modules for incorporation into an EtherCAT network for transmission of process signals. It consists of the bus coupler (B-Nimis I/O bus coupler or small control unit) and a range of I/O modules.
The B-Nimis I/O bus coupler converts the transmission from twisted pair into LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, B-Nimis I/O modules for the process signals connect to the other. The Ethernet EtherCAT protocol is retained right through to the last I/O module.

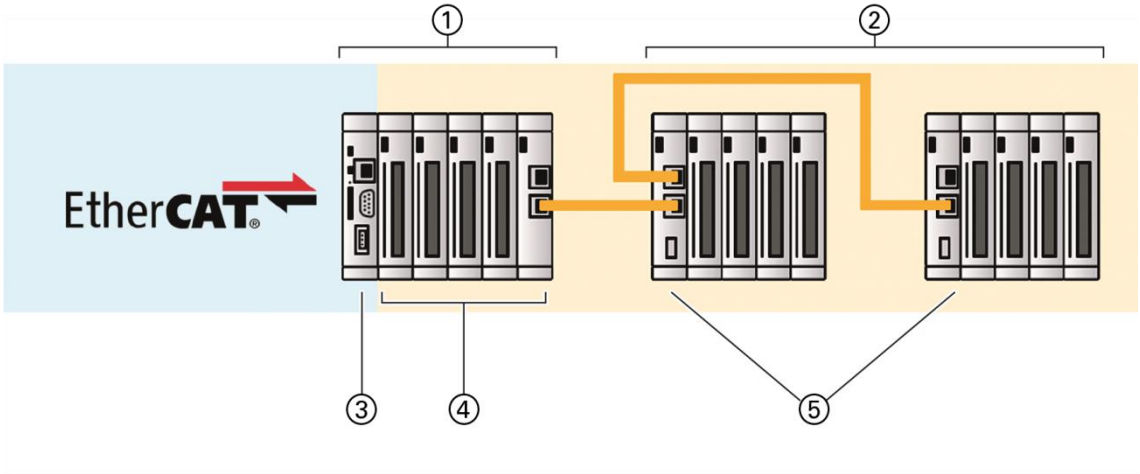


Fig. 1: B-Nimis I/O System

Item	Designation	Item	Designation
1	PLC with B-Nimis I/O expansion modules	4	Expansion Modules
2	EtherCAT I/O with B-Nimis I/O expansion modules	5	Bus Coupler
3	Control Head		

3.3. B-Nimis SC- Safety System

The B-Nimis SC Safety System extends the Berghof B-Nims I/O system to safe inputs and outputs. There is no need to provide separately cabled safety circuits. The EtherCAT protocol is used to transfer both safe and standard signals to the B-Nimis SC-1000 safety PLC. This integrated transfer process is based on FSoE (Fail Safe over EtherCAT), the safety protocol certified by TÜV, the German Technical Testing & Inspection Association.

3.3.1. Safety over EtherCAT (FSoE)

Along with EtherCAT, a safety protocol was developed and made available for EtherCAT as "Safety over EtherCAT" (FSoE = Fail Safe over EtherCAT). It is the backbone of providing functional safety over EtherCAT. TÜV has since certified both the protocol and its implementation to comply with Safety Integrity Level 3 (SIL 3) to IEC 61508. Since 2010, Safety over EtherCAT has been defined in an international standard, IEC 61784-3-12.
Since EtherCAT is used as a single-channel medium of communication, Safety over EtherCAT does not impose any constraints regarding the transfer rate and cycle time. The transport medium is considered a "black channel" which is disregarded in the safety assessment.

Fig. 2: Safety over EtherCAT Logo

3.3.2. B-Nimis SC-1000 safety PLC

The B-Nimis SC-1000 safety PLC module links the inputs and outputs of the B-Nimis SC safety System and other FSoE devices of the system.
The B-Nimis SC-1000 safety PLC module is designed as an addition to a CODESYS standard PLC. This is a two-channel system which uses the normal control unit to communicate with the CODESYS Development System and all non-safe inputs and outputs. Programming is based on a certified plug-in that is fully integrated in the CODESYS Development System.

3.3.3. B-Nimis SC-IO S-DI4 S-DO2 safety module

The B-Nimis SC-IO S-DI4 S-DO2 safety module permits the connection of popular safety devices and can be installed at any point of the B-Nimis I/O block. Its signals are transmitted by the EtherCAT bus to the B-Nimis SC-1000 safety PLC and processed there in a safe manner. The outputs of the module can be safely incorporated into circuits with actuators such as contactors, signal lamps or servo converters.

Fig. 3: B-Nimis I/O-Block with B-Nimis SC-IO S-DI4 S-DO2 and B-Nimis SC-1000 safety PLC

3.3.4. CODESYS Safety

The B-Nimis SC-1000 safety PLC is programmed within the CODESYS Development System by means of a certified fully integrated plug-in and appears as a sub-node of the standard control unit with an application, task, lists of global variables, POEs and logical I/Os.
The integrated function diagram (FD) safety editor (to IEC 61131-3, certified for use with IEC 61508 SIL3 applications) is used for basic or extended-level programming by means of certified function blocks (IEC 61131-3 or PLCopen Safety) as specified in the user manual.
At the basic level, certified function blocks are graphically "wired up" to establish the system's safety programme. In the event that a project demands more than the technology of the certified blocks can provide, the extra instructions available at the extended level can be used to expand the safety programme.
The software offers further functions for safeguarding the safety functions by change tracking, safe flow of signals, safe version control (pinning), separating safe operation, debugging mode, etc..

Fig. 4: CODESYS Logo

3.3.5. PLCopenSafety library in CODESYS

The PLCopen components have been defined by the PLCopen organisation, its members and external organisations specialising in all safety-related aspects. These modules are certified thereby reduce the time and cost of development, verification and acceptance of a safety application. They interlink by logical operations which behave like logical wiring and therefore minimise the time and programming efforts needed to create major parts of safety applications.

Fig. 5: PLCopen safety Logo

4. Product Description

4.1. General Description

The B-Nimis SC-I/O S-DI4 S-DO2 safety module is an input and output module with 4 safe inputs and 2 safe outputs for incorporation into an B-Nimis I/O system.

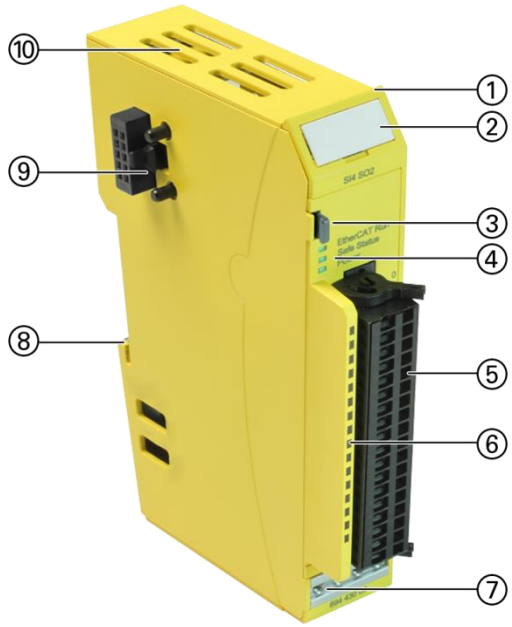


Fig. 6: Module layout

Item	Designation	Item	Designation
1	Grip	6	Signal state indicators (LEDs)
2	Labelling clip	7	Shield connection to housing
3	Unlock button	8	DIN rail attachment and effective earth
4	Status LEDs	9	Module locking, E-bus
5	Spring-assisted combi plug X1	10	Ventilation slots

The housing mount consists of an aluminium profile with an integrated clamping fixture used to attach the module to a 35 mm DIN rail. The housing trough including the optical fibres for the status indicators, the side faces and the front are made of plastic and contain the module. The optical fibres for the signal state indicators (LEDs) are located next to the spring-assisted combi plug. This allows clear diagnosis at a glance.

4.2. Application

4.2.1. Intended Use

The B-Nimis I/O system is a system of I/O modules for interconnecting the process signals in an EtherCAT network. It consists of the bus coupler and a range of I/O modules.
The B-Nimis I/O-System with B-Nimis SC-1000 safety PLC, B-Nimis SC-I/O S-DI4 S-DO2 module and the CODESYS safety software extend the B-Nimis I/O system to provide functions permitting its use in the field of functional safety of machinery.

The intended applications of the B-Nimis SC I/O safety System include safety functions of machines and all industrial automation tasks immediately associated with them. Thus, the system may only be used for applications providing a defined fail-safe state. The defined fail-safe state of the B-Nimis SC safety System is the de-energised state.

Running any of the safety-related control components is subject to the safety precautions applicable to industrial control units, i.e. guarding by emergency stop and similar safety equipment as specified by the relevant national and/or international regulations. The same applies to connected equipment such as drives or light grids. Before installing and putting the system into operation, the safety instructions, connection specifications (nameplate and documentation) and the limiting values listed in this user guide's Technical Data section must be read carefully and complied with in every respect.

The B-Nimis SC safety System is not suitable for applications causing potentially fatal risks or dangers to the life and health of many persons or disastrous ecological hazards unless exceptionally strict safety precautions are taken. Such applications specifically include the monitoring of nuclear reactions in nuclear power stations as well as the control of flight or air traffic control systems, means of mass transit, medical life support systems and weapon systems.

4.2.2. Qualified Persons

The safety-related products may be used only by the following persons:
- → Qualified persons who know the applicable concepts of functional safety as well as the relevant standards and regulations.
- → Qualified persons who plan, design, install and put machine and system safety equipment into operation.

Qualified persons in the sense of this User Manual are persons whose training, experience, instructions and knowledge of the applicable standards, codes, accident prevention regulations and operating conditions authorise them to perform the required work and enable them to recognise and avoid potential hazards associated with that work. Language skills sufficient to understand this Guide are therefore part of this qualification.

4.2.3. Disclaimer of Liability

The operator is responsible for self-reliantly running the safety-related control components in conformity with the requirements set by the competent authority.
The manufacturer shall neither be held liable nor accept any warranty for damages caused by:

- → inappropriate use,
- → non-compliance with standard and directives,
- → unauthorised modifications of devices, connections or settings,
- → use of unapproved or unsuitable equipment or equipment groups,
- → non-observance of the safety instructions contained in this manual.

4.3. Safe State

There are two different types of "safe states”:

- → The first one is functional and depends on the machine's application, operation and software. This is the desired **safe functional state**. The system is operating free of defects.
- → The second one is the **fail-safe state** and applies whenever a fault or error occurs in any of the monitored components.

4.3.1. Safe Functional State

The system is in a safe functional state when the safe process map shows that all inputs are "null" and when the outputs reflect this "null" state by being de-energised at the output. The data frame again reflects this state by "null" in the process map.

4.3.2. Fail-Safe State – External Fault

In case of an external fault (short circuit, fault between conductors etc.), all outputs are de-energised (outputs "null") and the inputs return "null" to the safe control unit. FSoE communication is not stopped.

A fail-safe state is the de-energised state.

- → The safety PLC is able to reset this state.

4.3.3. Fail-Safe State – Internal Fault

In case of an internal module fault, all outputs are de-energised (output "null"). Both FSoE communication and the transfer of input information stops.

A fail-safe state is the de-energised state.

→ Recovering from this state requires a reset by switching the supply voltage off. This involves a complete self-test as part of the initialisation phase.

⚠ CAUTION

Uncontrolled movement, such as suspended loads

Injury caused by moving or non-braked machine parts

- Additional external safety measures such as mechanical braking of suspended loads should be provided for applications whose safe state requires an actuator to be actively switched on.

4.3.4. Traceability

Traceability means that the time and entity that produced, processed, stored, transported, consumed or disposed of a product or trading good can be traced back at any time.
Whereas Berghof Automation GmbH is able to meet this requirement with regard to the production, processing, storage and transport, the purchaser is responsible for all further whereabouts of the product.
The serial number on the label stuck to the underside and stored in the object dictionary is the means of distinctly identifying and tracing the product. To ensure proper traceability, the purchaser is obliged to not down this number together with the machine's name, place of installation and end customer.

The purchaser must ensure traceability of the devices by means of their serial numbers.

4.4. Useful Life

The B-Nimis SC-I/O S-DI4 S-DO2 safety module is designed for life of max. 20 years from their date of manufacture (see section 5.1 Labelling and Identification). The module must be taken out of use no later than one week before expiry of these 20 years (see section 6.9.3 Decommissioning).

4.5. Technical Data

4.5.1. General specifications

Designation	Value
Device data	
Product name / Article number	B-Nimis SC-I/O S-DI4 S-DO2 S-01060201-0000 formerly: E-I/O S-DI4 S-DO4 - 204809000 (identical in function and design)
Field bus	EtherCAT 100 Mbit/s
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Electrical insulation	All modules electrically insulated from each another and from the bus
Diagnostics	LEDs: Status bus, status module, broken wire/excessive current (see section 6.5 Diagnostics)
I/O connection, Power	18-pin plug connector (not included in module package) 18-pin spring-assisted combi plug with mechanical ejector
E-bus load	max. 300 mA (system power supply)
Terminating module	Not required
Power supply (I/O / system power supply)	
Supply voltage	24 V DC -15%/+20%
Overvoltage category	category II to EN 61131-2:2007
Module power consumption	Approx. 7 mA + load current
Reverse polarity safeguard	yes
Nominal insulation voltage	500 V_{eff} measured between I/O supply and E-bus
Immunity to interference	Zone B to EN 61131-2:2007, mounted on an earthed DIN rail in an earthed control cabinet
Storage and transport conditions	
Ambient temperature	-25 °C…+70 °C
Rel. humidity	5…95 % non-condensing
Atmospheric pressure	70…108 kPa / 0…3000 m above mean sea level
Vibration	5…8.4 Hz: ±3.5 mm amplitude, 8.4…150 Hz: 10 m/s² (1g), to IEC 60068-2-6, test Fc

Designation	Value
Shock	150 m/s² (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27

Operating conditions	
Installation position	horizontal, stackable
Degree of contamination	Degree of contamination II to IEC 60664-3
Permissible operating environment	Operation is restricted to environments complying with IP54 or at least IEC 60529 (e. g. in a suitable control cabinet)
Operating temperature	0…+55 °C
Relative humidity	5…95 % non-condensing
Atmospheric pressure	80…108 kPa / 0…2000 m above mean sea level
Vibration	5…8.4 Hz: ±3.5 mm amplitude, 8.4…150 Hz: 10 m/s² (1g), to IEC 60068-2-6, test Fc
Shock	150 m/s² (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Mechanical properties	
Mounting	35 mm DIN rail (top-hat rail)
Dimensions (W x H x D)	25 mm x 120 mm x 90 mm
Ingress Protection	IP20
Housing mount	Aluminium
Screen connection	connects straight to module housing

4.5.2. Safe digital inputs

Designation	Value
Quantity and type	4x single-channel or 2x two-channel, (EN 61131-2:2007, type 3)
Diagnostics	Cross-fault, external power supply
Highest achievable safety classes (depending on the configuration)	**Single-channel use:** Cat. 2/PL d to EN ISO 13849-1:2015, SIL2 to EN 62061:2010 / IEC 61508:2010 **Twin-channel use:** Cat. 3/PL e to EN ISO 13849-1:2015, SIL3 to EN 62061:2010 / IEC 61508:2010
Input delay	300…1500 µs (configurable)
Sensor type	use of sensors with OSSD outputs to EN 61496, contact-type sensors
Electrical insulation	Channel/channel: no

Designation	Value
	Channel/E-bus: 500 V_{eff}
Signal level	Out: –3…5 V $I_L$min = not specified, $I_L$max = 15 mA. In: 11…30 V $I_H$max = 15 mA, $I_H$min = 2 mA
Maximum voltage	33 V (max. voltage to input even in case of error)
Signal indication	LED located next to terminal and parallel to input
Test pulse length	300…1500 µs (configurable), phase-shifted at the individual channels
Safe response time	< 5 ms, see section 4.8 Response Time
Input current	typ. 3.3 mA
Input resistance	typ. 7.3 kΩ
Input capacitance	typ. 100 nF
Maximum cable length	100 m (between sensors / module terminals)

4.5.3. Safe Digital Test Pulse Outputs

Designation	Value
Quantity and type	4
Nominal output current	50 mA, short-circuit-proof
Signal indication	LED located next to the terminal
Switching voltage	24 V DC -15%/+20%
Electric strength	33 V (max. voltage to output even in case of error)
Test pulse length	300…1500 µs, phase-shifted at the individual channels
Maximum cable length	100 m (between sensor / module terminals)

4.5.4. Safe digital outputs

Designation	Value
Quantity and type	2x semiconductors, 24 V DC, tolerances to EN 61131-2:2007
Max. safety levels	2x cat. 3/PL e to EN ISO 13849-1:2015, 2x SIL3 to EN 62061:2010, 2x SIL3 to IEC 61508:2010
Diagnostics	Cross-fault, external power supply
Signal indication	LED located next to the terminal, controlled by CPU
Minimum output current	2 mA (see sec. 6.2.8 Actuator Connection)
Maximum output current	2.0 A, short-circuit-proof, comply with total load and derating (see sec. 6.2.8 Actuator Connection – Derating of the Total Load)
Capacitive load	Yes (see sec. 6.2.8 Actuator Connection – Switching of Capacitive Loads)
Braking voltage whilst disconnecting inductive loads	typ. 40 V DC
Inductive load	Yes (see sec. 6.2.8 Actuator Connection – Switching of Inductive Loads)
Maximum cable length	100 m (between sensor / module terminals)
Response threshold of output overload protection	Min. 2.5 A typ. 3.5 A max. 5.5 A
Output current module$_{max}$	4 A, comply with total load and derating (see sec. 6.2.8 Actuator Connection – Derating of the Total Load)
Load resistance range (at nominal voltage)	12 Ω ... 12 kΩ
Electrical insulation	Channel/channel: no Channel/E-bus: 500 V_{eff}
Approved actuators	For DC13 to EN60947-5-1 Table 4 For DC1 to EN60947-4
Test pulse length	500…1500 µs (configurable)
Supply voltage	24 V DC -15%/+20%
Electric strength	33 V (max. voltage appearing at the output even in case of error)

4.6. Safety-related Input Ratings

4.6.1. Single-channel application (inputs)

The table below lists the safety-related ratings of a single-channel safety function that uses one input of the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Designation	Value	
Maximum safety integrity level to EN 62061:2010	SIL2	
Maximum safety integrity level to IEC 61508:2010	SIL2	
Maximum performance level to EN ISO 13849-1:2015	Cat. 2/PL d	
Hardware fault tolerance (HFT) in single-channel application (IEC 61508:2010/ EN ISO 13849-1:2015)	0 (a fault in the application may cause the safeguard to fail)	
	Ambient temperature, 25 °C	**Ambient temperature, 55 C**
Probability of failure on demand (PFD_{avg}), proof test interval: 10 years, (IEC 61508:2010) for one input (up to field bus)	$5.40 * 10^{-6}$ (0.06 % of the total PFD_{avg} of 10^{-2} at SIL2)	$2.23 * 10^{-5}$ (0.23 % of the total PFD_{avg} of 10^{-2} at SIL2)
Probability of failure per hour (PFH), proof test interval: 10 years, (IEC 61508:2010) for one input (up to field bus)	$1.24 * 10^{-10}$ 1/h (0.02 % of the total PFH of 10^{-6} at SIL2)	$5.27 * 10^{-10}$ 1/h (0.05 % of the total PFH of 10^{-6} at SIL2)
Probability of failure on demand (PFD_{avg}), proof test interval: 20 years, (IEC 61508:2010) for one input (up to field bus)	$1.10 * 10^{-5}$ (0.11 % of the total PFD_{avg} of 10^{-2} at SIL2)	$4.77 * 10^{-5}$ (0.48 % of the total PFD_{avg} of 10^{-2} at SIL2)
Probability of failure per hour (PFH), proof test interval: 20 years, (IEC 61508:2010) for one input (up to field bus)	$1.28 * 10^{-10}$ 1/h (0.02 % of the total PFH of 10^{-6} at SIL2)	$5.79 * 10^{-10}$ 1/h (0.06 % of the total PFH of 10^{-6} at SIL2)
DC (diagnostic coverage) to EN ISO 13849-1:2015	98.32%	95.89%
Safe failure fraction (SFF)	99.27%	98.51%
Mean time to dangerous failure (MTTF d) to EN ISO 13849-1:2015	100 years (calculated: 283 years)	100 years (calculated: 185 years)

4.6.2. Two-channel application (inputs)

The table below lists the safety-related ratings of a two-channel safety function that uses 2 inputs of the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Designation	Value	
Maximum safety integrity level to EN 62061:2010	SIL3	
Maximum safety integrity level to IEC 61508:2010	SIL3	
Maximum performance level to EN ISO 13849-1:2015	Cat. 3/PL e	
Hardware fault tolerance HFT of twin-channel application (IEC 61508:2010/ EN ISO 13849-1:2015)	1 (a fault in the application may not cause the safeguard to fail)	
	Ambient temperature, 25 °C	**Ambient temperature, 55 °C**
Probability of failure on demand (PFD_{avg}), proof test interval: 10 years, (IEC 61508:2010) for one input (up to field bus)	$5.21 * 10^{-6}$ (0.51 % of the total PFD_{avg} of 10^{-3} at SIL3)	$2.16 * 10^{-5}$ (2.16 % of the total PFD_{avg} of 10^{-3} at SIL3)
Probability of failure per hour (PFH), proof test interval: 10 years, (IEC 61508:2010) for one input (up to field bus)	$1.20 * 10^{-10}$ 1/h (0.12 % of the total PFH of 10^{-7} at SIL3)	$5.11 * 10^{-10}$ 1/h (0.51 % of the total PFH of 10^{-7} at SIL3)
Probability of failure on demand (PFD_{avg}), proof test interval: 20 years, (IEC 61508:2010) for one input (up to field bus)	$1.06 * 10^{-5}$ (1.06 % of the total PFD_{avg} of 10^{-3} at SIL3)	$4.62 * 10^{-5}$ (4.62 % of the total PFD_{avg} of 10^{-3} at SIL3)
Probability of failure per hour (PFH), proof test interval: 20 years, (IEC 61508:2010) for one input (up to field bus)	$1.24 * 10^{-10}$ 1/h (0.12 % of the total PFH of 10^{-7} at SIL3)	$5.62 * 10^{-10}$ 1/h (0.56 % of the total PFH of 10^{-7} at SIL3)
DC (diagnostic coverage) to EN ISO 13849-1:2015	98.32%	95.93 %
Safe failure fraction (SFF)	99.28 %	98.59 %
Mean time to dangerous failure (MTTF d) to EN ISO 13849-1:2015	100 years (calculated: 283 years)	100 years (calculated: 185 years)

4.7. Safety-related Output Ratings

4.7.1. Single-channel application (outputs)

The table below lists the safety-related ratings of a single-channel safety function that uses one output of the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Designation	Value	
Maximum safety integrity level to EN 62061:2010	SIL2	
Maximum safety integrity level to IEC 61508:2010	SIL2	
Maximum performance level to EN ISO 13849-1:2015	Cat. 2/PL d	
Hardware fault tolerance HFT of single-channel application (IEC 61508:2010/ EN ISO 13849-1:2015)	0 (a fault in the application may cause the safeguard to fail)	
	Ambient temperature, 25 °C	**Ambient temperature, 55 °C**
Probability of failure on demand (PFD_{avg}), proof test interval: 10 years, (IEC 61508:2010) for one output (from fieldbus)	$5.36 * 10^{-6}$ (0.06 % of the total PFD_{avg} of 10^{-2} at SIL2)	$2.24 * 10^{-5}$ (0.23 % of the total PFD_{avg} of 10^{-2} at SIL2)
Probability of failure on demand PFH, proof test interval: 10 years, (IEC 61508:2010) for one output (from fieldbus)	$1.24 * 10^{-10}$ 1/h (0.02 % of the total PFH of 10^{-6} at SIL2)	$5.31 • 10^{-10}$ 1/h (0.06 % of the total PFH of 10^{-6} at SIL2)
Probability of failure on demand (PFD_{avg}), proof test interval: 20 years, (IEC 61508:2010) for one output (from fieldbus)	$1.10 * 10^{-5}$ (0.11 % of the total PFD_{avg} of 10^{-2} at SIL2)	$4.82 * 10^{-5}$ (0.48 % of the total PFD_{avg} of 10^{-2} at SIL2)
Probability of failure on demand PFH, proof test interval: 20 years, (IEC 61508:2010) for one output (from fieldbus)	$1.28 * 10^{-10}$ 1/h (0.02 % of the total PFH of 10^{-6} at SIL2)	$5.89 * 10^{-10}$ 1/h (0.06 % of the total PFH of 10^{-6} at SIL2)
DC (diagnostic coverage) to EN ISO 13849-1:2015	98.40 %	96.56 %
Safe failure fraction (SFF)	99.34 %	98.81 %
Mean time to dangerous failure (MTTF d) to EN ISO 13849-1:2015	100 years (calculated: 264 years)	100 years (calculated: 152 years)

4.7.2. Two-channel application (outputs)

The table below lists the safety-related ratings of a two-channel safety function that uses 2 outputs of the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Designation	Value	
Maximum safety integrity level to EN 62061:2010	SIL3	
Maximum safety integrity level to IEC 61508:2010	SIL3	
Maximum performance level to EN ISO 13849-1:2015	Cat. 3/PL e	
Hardware fault tolerance HFT of twin-channel application (IEC 61508:2010/ EN ISO 13849-1:2015)	1 (a fault in the application may not cause the safeguard to fail)	
	Ambient temperature, 25 °C	**Ambient temperature, 55 °C**
Probability of failure on demand (PFD_{avg}), proof test interval: 10 years, (IEC 61508:2010) for two outputs (from fieldbus)	$5.52 * 10^{-6}$ (0.55 % of the total PFD_{avg} of 10^{-3} at SIL3)	$2.33 * 10^{-5}$ (2.33 % of the total PFD_{avg} of 10^{-3} at SIL3)
Probability of failure on demand PFH, proof test interval: 10 years, (IEC 61508:2010) for two outputs (from fieldbus)	$1.28 * 10^{-10}$ 1/h (0.13 % of the total PFH of 10^{-7} at SIL3)	$5.53 * 10^{-10}$ 1/h (0.56 % of the total PFH of 10^{-7} at SIL3)
Probability of failure on demand (PFD_{avg}), proof test interval: 20 years, (IEC 61508:2010) for two outputs (from fieldbus)	$1.13 * 10^{-5}$ (1.13 % of the total PFD_{avg} of 10^{-3} at SIL3)	$5.03 * 10^{-5}$ (5.03 % of the total PFD_{avg} of 10^{-3} at SIL3)
Probability of failure on demand PFH, proof test interval: 20 years, (IEC 61508:2010) for two outputs (from fieldbus)	$1.32 * 10^{-10}$ 1/h (0.13 % of the total PFH of 10^{-7} at SIL3)	$6.18 * 10^{-10}$ 1/h (0.62 % of the total PFH of 10^{-7} at SIL3)
DC (diagnostic coverage) to EN ISO 13849-1:2015	98.42 %	96.78 %
Safe failure fraction (SFF)	99.36 %	98.90 %
Mean time to dangerous failure (MTTF d) to EN ISO 13849-1:2015	100 years (calculated: 254 years)	100 years (calculated: 140 years)

4.8. Response Time

In a safety system, the total response time is made up of the following separate times:

- → Signal processing by sensor
- → Signal processing in the B-Nimis SC-I/O S-DI4 S-DO2 safety module
- → Time of input data transfer across the EtherCAT bus between the B-Nimis SC-I/O S-DI4 S-DO2 safety module and the safety PLC
- → Safety PLC program runtime
- → Time of output data transfer across the EtherCAT bus between the safety PLC and B-Nimis SC-I/O S-DI4 S-DO2 safety module
- → Signal processing in the B-Nimis SC-I/O S-DI4 S-DO2 safety module
- → Signal processing by the actuator

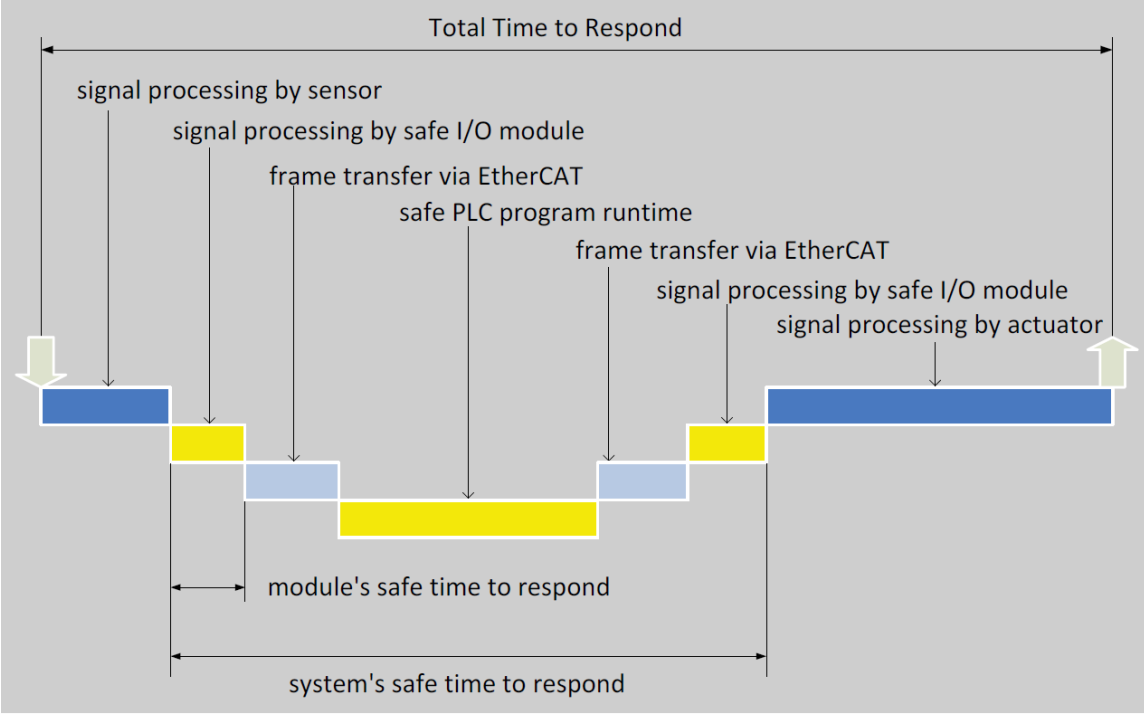


Fig. 7: Response Time in the safety system

⚠ CAUTION

To calculate the safe response time, take account of the fieldbus runtimes and the Safety PLC's cycle time.

Avoid personal injury and damage to property.

- ▶ The field bus runtimes and the Safety PLC cycle time must be taken account of to calculate the safe response time.

The B-Nimis SC-I/O S-DI4 S-DO2 safety module generally achieves a safety response time of **max. 5 ms.** This time ensures that the input and output signals will change and a safe state will be achieved.

The configurable input filters (configurable between 0.3 ms and 1.5 ms) influence the maximum response time of the IO module.

The safe response time of digital inputs defines as the maximum time it takes before the FSoE frame is available on the EtherCAT bus after the signal of an input changes. The safe response time of digital outputs defines as the maximum time it takes until the signal of a digital output changes after the EtherCAT module has received a FSoE frame.

Even if a fault occurs will the module be in a safe state before the safe response time is over.
The following failure sources will provoke a change to the safe state:

→ Fault detected at the module inputs
→ Fault detected at the module outputs
→ Internal module fault (self-diagnosis)

⚠ CAUTION

The safety function pressure-sensitive mat requires a response time of 50 ms!

Avoid personal injury and damage to property.

- The pressure-sensitive mat function achieves a set response time of 50 ms between a change in mat state and providing the information on the EtherCAT bus.

4.9. Dimensions

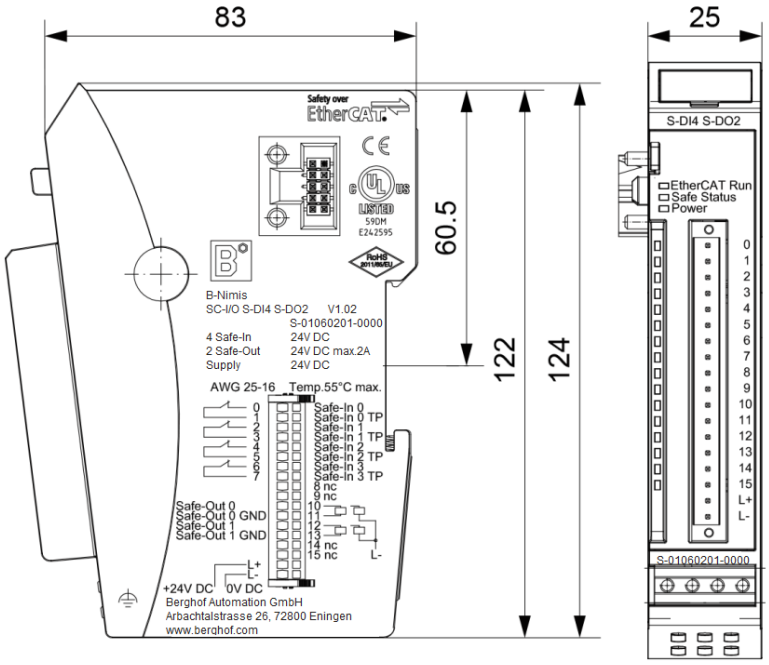


Fig. 8: Dimensions in mm

4.10. Transport and Storage

At times of transport and storage, protect the B-Nimis SC-I/O S-DI4 S-DO2 safety module against inadmissible stresses such as mechanical stresses, temperature, humidity and/or aggressive atmospheres.

- As far as possible, transport and store the B-Nimis SC-I/O S-DI4 S-DO2 safety module in its original packaging.
- When stock picking or unpacking, take care not to contaminate or damage the contacts.
- Comply with the ESD instructions - store and transport the B-Nimis SC-I/O S-DI4 S-DO2 safety module in suitable containers/packaging.

Some parts of the units are sensitive to ESD and may be damaged if handled inappropriately.

- Best transport practice is to place open assemblies in statically screened transport bags with a metal coating which avoid contamination by amines, amides or silicones.
- When commissioning and performing maintenance on the B-Nimis SC-I/O S-DI4 S-DO2 safety module, take the appropriate precautions against electrostatic discharge (ESD).

⚠ CAUTION

Electrostatic discharge

Destruction of or damage to the unit.

- Transport and store the B-Nimis SC-I/O S-DI4 S-DO2 safety module in its original packaging.
- Ensure that the ambient conditions are as specified at all times during transport and storage.
- Handle B-Nimis SC-I/O S-DI4 S-DO2 safety modules in a well-earthed environment (persons, place of work, packaging).
- Do not touch electrically conductive parts such as data contacts. Some of the electronic components may be destroyed if exposed to electrostatic discharge.

5. Construction and Functionality

5.1. Labelling and Identification

5.1.1. Imprinted Texts and Symbols

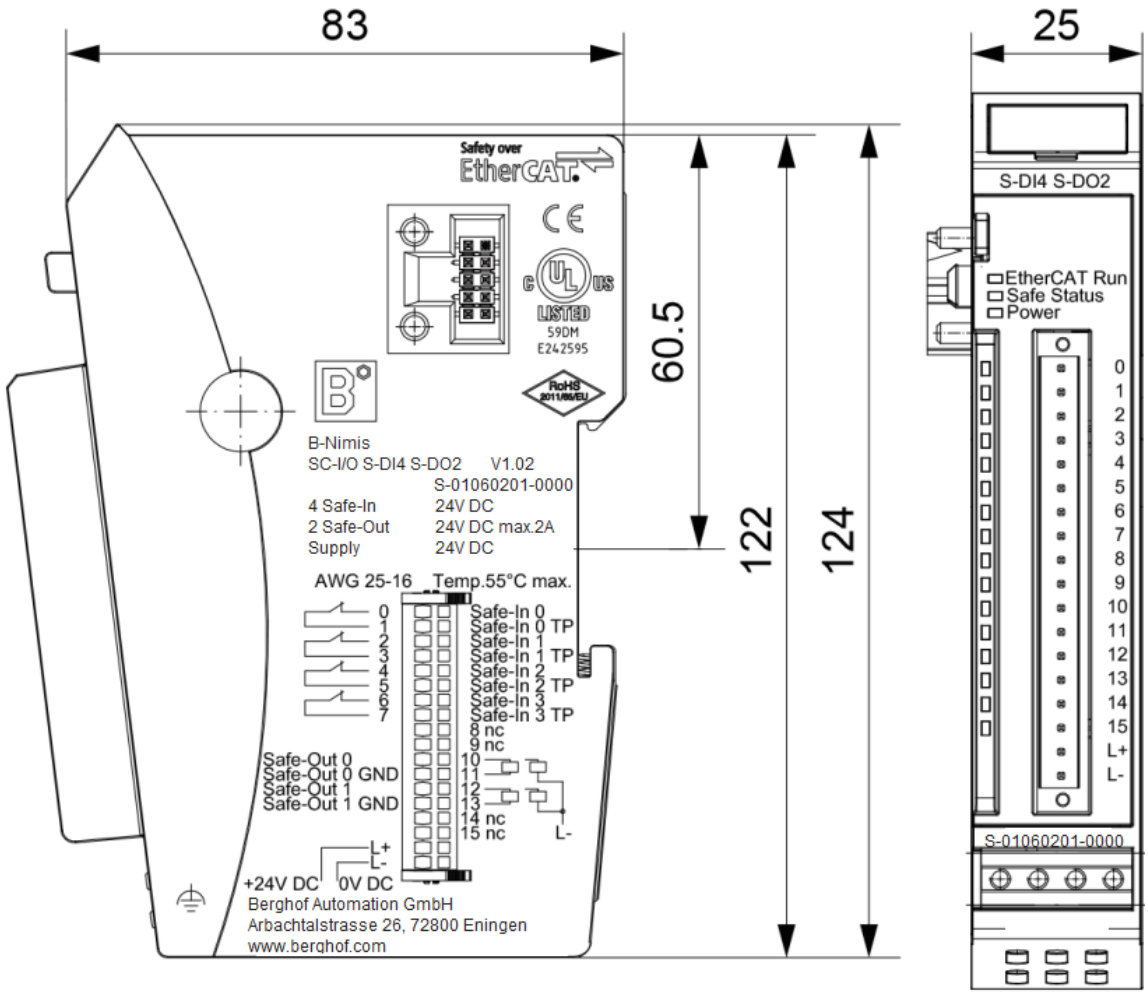


Fig. 9: Imprinted Texts and Symbols

Item	Designation	Item	Designation
1	Operating conditions	4	Connection diagram
2	Manufacturer’s label	5	Serial number on the underside
3	Wiring diagram	6	Operative earth

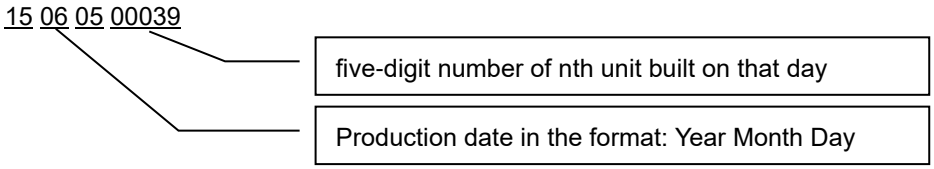
5.1.2. Serial number

A label showing the serial number is affixed to the aluminium mount on the back of the module.
The numerical code incorporates the production date and a serial number. The numerical code permits Berghof Automation GmbH to perform distinct identification of the model, software and hardware release date (it will be used for traceability).

Fig. 10: Sticker with the serial number

Structure of the serial number:
YY MM DD NNNNN
Y = Year
M = Month
D = Day
N = Sequential number

Example:
The unit shown above was manufactured on 15th June 2015 and has the serial number 00039.



The serial number is also stored in object 1018 sub-index 4 and can be retrieved by SDO Transfer.

5.2. Scope of delivery

Scope of delivery
→ B-Nimis SC-I/O S-DI4 S-DO2 safety module
→ Module bus cover
→ Connector

5.3. Overview of connectors

5.3.1. E-bus and Module Lock

The system plug connectors and the module lock are located on the sides of the B-Nimis SC-I/O S-DI4 S-DO2 safety module. These plug connectors interconnect the modules. They supply power to the module electronic circuitry and transfer the EtherCAT signals. Verify that the end cap from the package is in place to protect the module bus connector on the last module at the right-hand side of a terminal unit against dirt.
The integrated module lock prevents the modules from coming apart under mechanical load or vibration.

⚠ CAUTION

Interconnecting units of different design

Damage to the mechanical elements of the unit.

- ▶ Use only approved modules in an B-Nimis I/O network.

5.3.2. Spring-assisted Combi Plug X1

The spring-assisted Combi Plug is located at the front of the B-Nimis SC-I/O S-DI4 S-DO2 safety module. The sensors and actuators and the power supply to the module all attach to this connector.

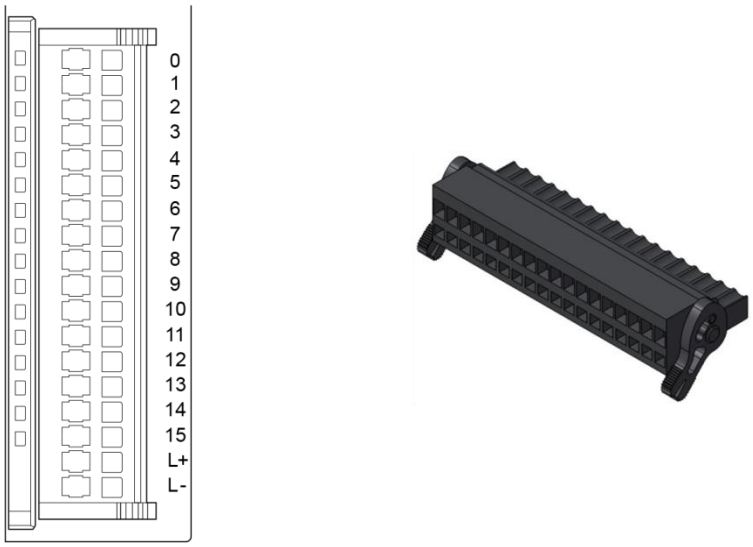


Fig. 11: Spring-assisted Combi Plug X1 pin assignment and a single row of spring-assisted plugs with release levers

Pin	Funktion	Signal
0	Safe-In 0	SI0
1	Safe-In 0 TP	SI0 TP
2	Safe-In 1	SI1
3	Safe-In 1 TP	SI1 TP
4	Safe-In 2	SI2
5	Safe-In 2 TP	SI2 TP
6	Safe-In 3	SI3
7	Safe-In 3 TP	SI3 TP
8	– Do not connect –	GND
9	– Do not connect –	GND
10	Safe-Out 0	SO0 +
11	Safe-Out 0 GND	SO0 –
12	Safe-Out 1	SO1 +
13	Safe-Out 1 GND	SO1 –
14	– Do not connect –	GND
15	– Do not connect –	GND
16	24 V supply to power element (outputs)	L+
17	GND	L–

Only the spring-assisted connector included in the package may be used for connection of the B-Nimis SC-I/O S-DI4 S-DO2 safety module. Refer to section 6.2 Electrical Installation below for details on how to connect sensors and actuators

CAUTION

Safe function jeopardised by cross-faults

Improper installation may cause malfunctions due to cross-faults at the contacts.

- By design and if installed correctly, the spring-assisted connector prevents cross-faults at the contacts. Ensure a correct and technically perfect installation because cross-faults or shorts may jeopardise the safe functioning of the module.

5.3.3. Wiring Example

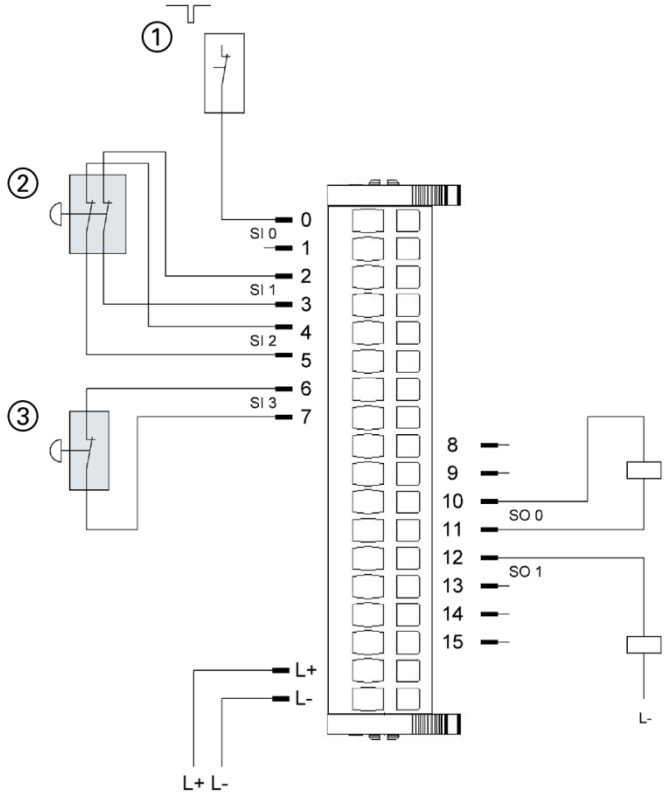


Fig. 12: Example of how to wire the inputs and outputs

Item	Designation	Item	Designation
1	OSSD sensor	3	Emergency Stop button (single channel)
2	Emergency Stop button (two channel)		

The Berghof B-Nimis SC-I/O S-DI4 S-DO2 module is intended to provide functional safety to industrial automation and to protect humans and machines in conformity with Machinery Directive 2006/42/EC. It therefore supports the connection to this module of many different safety-related sensors

Examples:
→ Single-channel and twin-channel contact-type sensors such as EMERGENCY STOP switches
→ Sensors with single and twin-channel OSSD signals such as light grids
→ Selector switches, safety mats and connecting blocks

Provided that the admissible maximum installed loads are not exceeded, resistive and inductive loads can be operated at the outputs.

Refer to section 7 Connection Examples for examples of how to connect various sensors and actuators.

CAUTION

Safe function jeopardised by cross-faults

Improper installation may cause malfunctions due to cross-faults at the contacts.

- When test pulses are enabled, the B-Nimis SC-I/O S-DI4 S-DO2 module detects cross-faults by activation of test pulses at the inputs and outputs with other signal cables of the same module. Note that you must prevent cross-faults with the security functions of other modules. You should therefore protect the signal lines and/or lay them separately.

5.3.4. I/O Supply

The I/O supply to the safe outputs and the associated test pulse outputs is connected to terminals L+ and L-. The supply voltage is 24 V DC and is monitored.
The supply cable must have external protection against short circuit and overload triggering at max. 10 A.
The B-Nimis SC-I/O S-DI4 S-DO2 module may be supplied only by PELV/SELV-ready 24 V DC power supply units to EN 50178 / EN 60950-1. This applies both to the system power supply and also to the I/O power supply.

CAUTION

Risk of fire by overload or overvoltage

Damage to the unit.

- The B-Nimis SC-I/O S-DI4 S-DO2 module may be supplied only by PELV/SELV-ready 24 V DC power supply units to EN50178 or EN60950-1.
- The maximum voltage supplied must not exceed 33 V even in the event of an error.
- The supply cable must have external protection against short circuit and overload triggering at max. 10 A.

CAUTION

Module defect by reversing the polarity of the voltage supplied

The B-Nimis SC-I/O S-DI4 S-DO2 module is reverse polarity-proof, reversing the polarity will still put considerable stress on the electronic circuitry and may cause module defects.

- Avoid a reversal of polarity.

In case the supply of power is interrupted, drops or increases beyond the rated limits, the module will change to the safe state and output the appropriate error code to the service block.
Refer to section 6.5 Diagnostics for further details on how the module responds to a non-conforming supply of power.

5.4. Indicators and Controls

5.4.1. Status LEDs

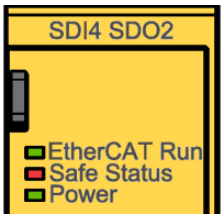


Fig. 13: Status LEDs

Displays:

→ “EtherCAT Run” LED: State of the EtherCAT communication
→ LED "Safe Status" (Duo-LED): State of the module regarding its safety function
→ "Power” LED: State the power supply to the module

LED	State	Explanation
"EtherCAT Run” LED		
Off	Init	Initialising, no data exchange
Off/green, 1:1	Pre-Op	Pre-operational, no data exchange
Off/green, 5:1	Safe-Op	Safe operation, inputs readable
Green continuous	Op	Operational, unrestricted data exchange
"Safe Status” LED		
Continuous green display	OK	Module is in the functional safe state
Red, continuous	Error	The module is in the fail-safe state
"Power” LED		
Off	–	No power supply available to the module
Continuous green display	OK	Power supply available to the module

The B-Nimis SC-I/O S-DI4 S-DO2 safety module features a voltage watchdog for the 24 V DC power supply. If the voltage is not within the specified range, the module adopts a safe state.

5.4.2. "Channel" LEDs

The "Channel" LEDs are allocated to the module terminals. Every group of 2 LEDs indicates the state of the associated functional unit of output and/or input.

Safe digital inputs SI 0 … SI 3 in conjunction with test pulse outputs

LEDs "Channel"; safe digital inputs SI 0 … SI 3			
LED item	**Channel**	**Function**	**Explanation**
0	Input SI 0	Status SI 0	Off: No valid input signal on channel 0, logical "0" Green: 24 V DC is present at channel 0, logical "1"
1	Input SI 0	Diagnostics SI 0	Off: Normal operation Red: External power supply or cross-faults
2	Input SI 1	Status SI 1	Off: No valid input signal on channel 1, logical "0" Green: 24 V DC present at channel 1, logical "1"
3	Input SI 1	Diagnostics SI 1	Off: Normal operation Red: External power supply or cross-faults
4	Input SI 2	Status SI 2	Off: No valid input signal on channel 2, logical "0" Green: 24 V DC present at channel 2, logical "1"
5	Input SI 2	Diagnostics SI 2	Off: Normal operation Red: External power supply or cross-faults
6	Input SI 3	Status SI 3	Off: No valid input signal on channel 3, logical "0" Green: 24 V DC present at channel 3, logical "1"
7	Input SI 3	Diagnostics SI 3	Off: Normal operation Red: External power supply or cross-faults

→ The red "diagnosis" LEDs are disabled if the safe digital inputs are used without the safe digital test pulse outputs.

→ The green "status" LEDs of the inputs will indicate the presence of a 24 V DC signal at an input even if that input has not been set up in the configuration.

Safe digital outputs SO 0 and SO 1

LEDs “Channel"; safe digital inputs SI 0 … SI 3			
LED item	**Channel**	**Function**	**Explanation**
10	Output SO 0	Status SO 0	Off: No output signal at channel 0, logical "0" Green: Output signal at output 0, logical "1"
11	Output SO 0	Diagnostics SO 0	Off: Normal operation Red: External power supply or cross-faults
12	Output SO 1	Status SO 1	Off: No output signal at channel 1, logical "0" Green: Output signal at output 1, logical "1"
13	Output SO 1	Diagnostics SO 1	Off: Normal operation Red: External power supply or cross-faults

5.5. Operating Software

The FSoE master configuration tool is used for operation and configuration. Refer to the FSoE master user guide for further information and details.

6. Installation and Operation

Before installing the B-Nimis SC-I/O S-DI4 S-DO2 safety module verify that it has been transported and stored under the ambient conditions specified in section "4.10 Transport and Storage" and section "4.5 Technical Data“.

Module operation is subject to the specified conditions of use (see section 4.5 Technical Data).

⚠ CAUTION

Incorrect operation

Malfunction of the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

- Only persons qualified for dealing with safety matters are allowed to add, replace and commission the B-Nimis SC-I/O S-DI4 S-DO2 safety modules.
- Before installing, servicing or commissioning the B-Nimis SC-I/O S-DI4 S-DO2 safety module, read the safety information in the preface of this document.
- Before commissioning the unit, verify that all safety functions work as specified.

6.1. Mechanical Installation

Instructions for the installation environment

Protect the Berghof B-Nimis SC-I/O modules against inadmissible contamination. Do not allow the units to be contaminated more than the specified degree II in IEC 60664-3.
Installation in an enclosure providing IP 54 protection (e.g. an appropriate control cabinet) can ensures that this degree of contamination II is complied with. Operation under conditions of condensing humidity is **not** allowed.

⚠ WARNING

Potentially hazardous failures due to contamination

Contaminations more severe than those described for degree of contamination II of IEC 60664-3 may cause potentially hazardous failures.

- Do ensure that the operating environment complies with at least IP 54, e. g. by installing the unit in a suitable control cabinet.

6.1.1. Mounting position

Berghof B-Nimis I/O modules are intended to be mounted on 35 mm x 7.5 mm rails (to DIN EN 50022). Mount the rail horizontally and arrange the module multiple socket connectors pointing away from the wall. To ensure that enough air enters through the ventilation slots, leave at least 20 mm to the top and 35 mm to the bottom of a module and any adjacent devices or cabinet surfaces. Leave at least 20 mm of lateral distance to third-party units and cabinet surfaces.

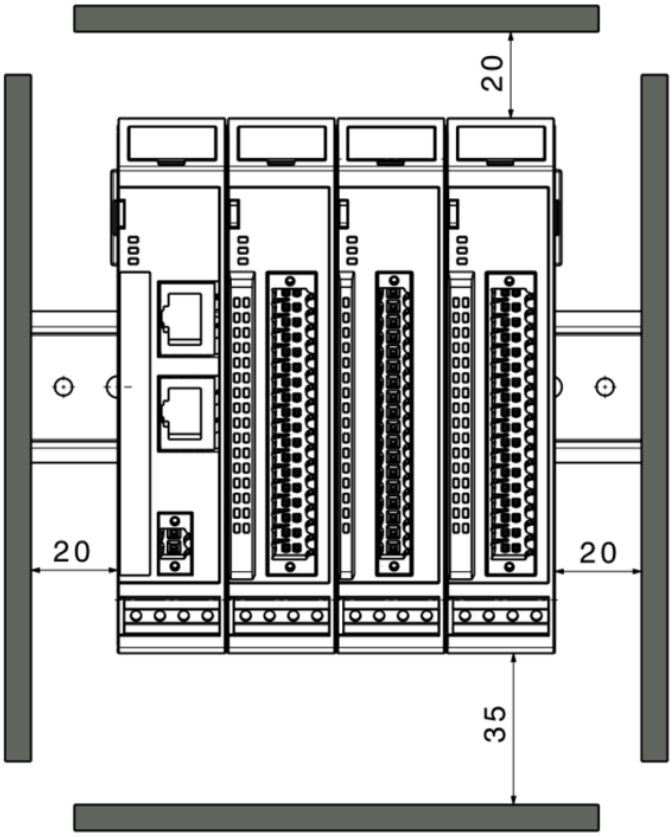


Fig. 14: Installation position and minimum clearances in mm

Sequence of modules in multiple B-Nimis I/O systems

ATTENTION

Sequence of modules in multiple B-Nimis I/O systems

In order to ensure that the entire B-Nimis I/O system works properly, arrange the B-Nimis I/O modules by their specific E-bus load, placing the modules with the highest E-bus load immediately next to the head module (bus coupler or controller). Take account of the maximum bus load for the head module.

- The B-Nimis SC-I/O S-DI4 S-DO2 module should be placed as close as possible to the head module.

6.1.2. To Snap on a Single Module

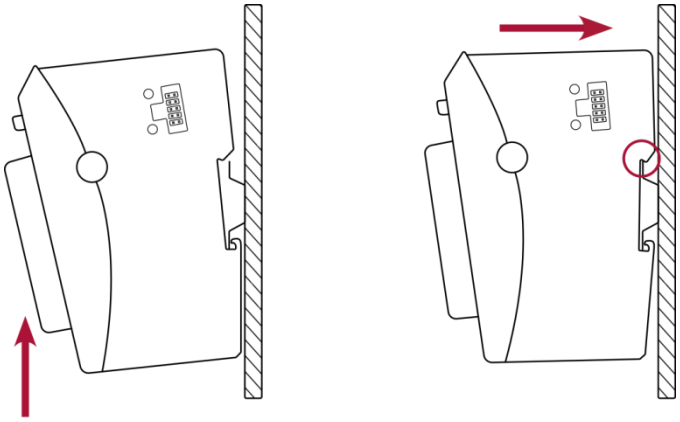


Fig. 15: Installing a module

1st Push the module up against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
2nd Push the module upwards against the mounting wall until it snaps in.

6.1.3. Interconnecting two modules

1st After snapping on the first module to the rail, snap on the second module to the right of the first module at a distance of about 1 cm.
2nd Push the second module leftwards along the rail towards the first module until you hear the locking device snap in.
3rd To prevent inadmissible contamination, fit the cover of the module bus connector on to the rightmost module of the B-Nimis I/O system.

⚠ CAUTION

Short circuit fault of module bus contacts

A short circuit of the module bus contacts may cause the communication with the safe module to fail.

- Verify that the cover of the module bus connector is mounted on the rightmost module of the B-Nimis I/O system.

6.1.4. Disconnecting two modules

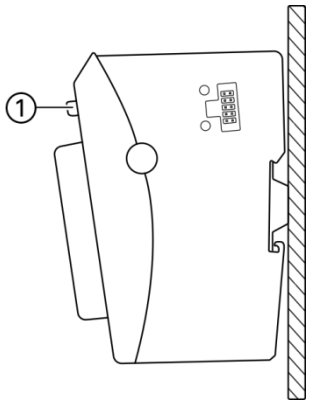


Fig. 16: Disconnecting modules

1st Press the locking device (1) of the module to be disconnected.
2nd Push the two modules away from one another until they are about 1 cm apart.

6.1.5. Removing a single module

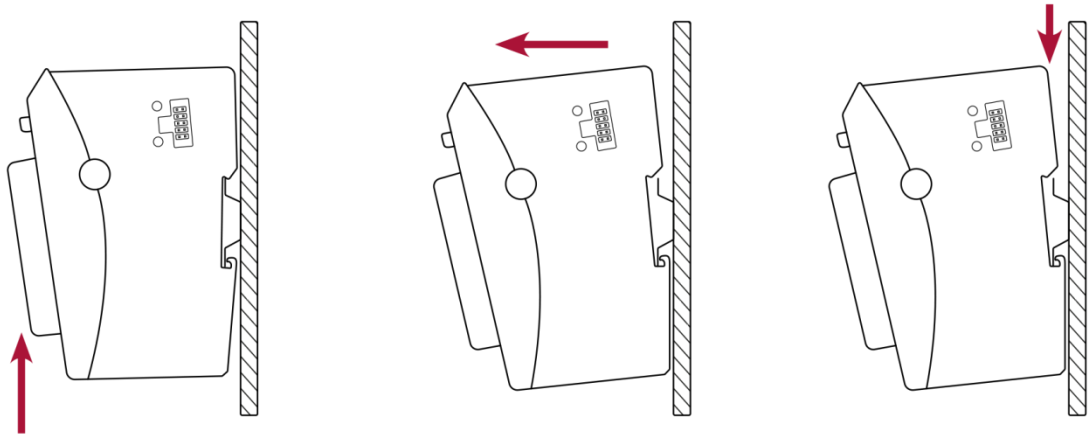


Fig. 17: Removing a module

1st Push the module upwards against the metal spring located on the underside of the rail guide.
2nd Tip the module forwards away from the rail as shown in the illustration.
3rd Pull the module downwards and off the mounting rail.

6.2. Electrical Installation

6.2.1. Earth

Berghof B-Nimis I/O modules must be earthed. To do this, connect the metal housing to functional earth. Since the functional earth dissipates HF currents and is of the utmost importance for the interference immunity of the module.
HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to an effective earth. You would normally ensure that the connection between the module housing and the DIN rail as well as the connection between the DIN rail and the control cabinet conducts well and that the control cabinet is properly connected to earth. In exceptional cases, you may connect earth directly to the front of the module.

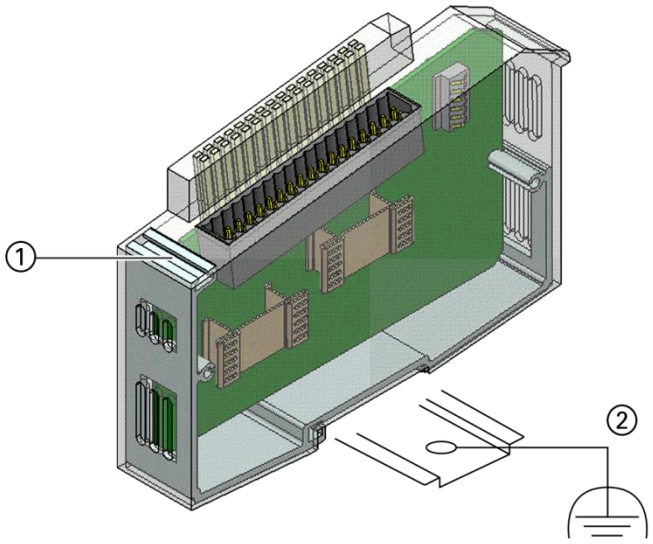


Fig. 18: Earth

Item	Designation	Item	Designation
1	Earth/cable screen attached using a M3x5 screw	2	DIN rail connected to an effective earth

Earth conductors should be short and have a large surface (copper mesh).

When installing systems, measure the earthing of the DIN rail as specified in the applicable guidelines (earth test to VDE 0100). Measuring the earthing must show that every protective earthing and operational earthing are within the limits set by the applicable standards.

- Perform repeat testing at intervals determined by the risk assessment.

6.2.2. Interconnection between modules

The electrical connection between the B-Nimis /O modules is achieved by pushing the modules together. This creates the connections to both the EtherCAT bus and the system power supply. The B-Nimis SC-I/O S-DI4 S-DO2 safety module must be placed as close as possible to the head module. Please note that the maximum current supplied by the bus coupler limits the number of B-Nimis I/O modules you may connect to a single block.

6.2.3. System Power Supply

A system connector supplies the B-Nimis SC-I/O safety system with system power from an upstream bus coupler or a compact controller. This system power supply is used for the analysis circuitry and for bus communication only.

- Please comply with the system power supply details provided in the operating instructions of the upstream bus couplers or compact PLCs as well as the additional system power supply instruction in this user manual.

⚠ WARNING

Potentially hazardous failures due to wrong supply voltage

The wrong supply voltages may damage or destroy the unit and may provoke potentially hazardous failures.

Preventive measures:

- Only use PELV/SELV-ready power supply units to EN50178 or EN60950-1 to supply 24 V DC to bus couplers or compact PLCs to which any B-Nimis SC-I/O safety modules are connected.
- Only use the GND terminal to connect the power supply unit to earth (PELV system). Do not use earthing variants that connect earth to +24V.
- Remember that, even in the event of a fault, a maximum voltage of U max. < 33 V may be supplied to these assemblies.
- To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible between the central point and the B-Nimis I/O module block.

6.2.4. I/O Supply

The power supplied to the safe outputs and the associated test pulse outputs connects to terminals L+ and L-. The supply voltage is 24 V DC and is monitored. In the event of overvoltage (> +20%) and low voltage (> 15%) alike, the module switches to its safe state.

⚠ WARNING

Potentially hazardous failures due to wrong supply voltage

The wrong supply voltages may damage or destroy the unit and may provoke potentially hazardous failures.

Preventive measures:

- Only use PELV/SELV-ready power supply units to EN50178 or EN60950-1 to supply 24 V DC to the B-Nimis SC-I/O S-DI4 S-DO2 module.
- Protect the I/O power supply of the B-Nimis SC-I/O S-DI4 S-DO2 safety module with a fuse of maximum 10 A rating.
- Only use the GND terminal to connect the power supply unit to earth (PELV system). Do not use earthing variants that connect earth to +24V.
- Remember that, even in the event of a fault, a maximum voltage of U max. < 33 V may be supplied to these assemblies.
- If the unit is exposed to a supply voltage > 33 V, replace it, because it must no longer be used.
- To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible between the central point and the B-Nimis I/O module block.

I/O power supply fusing

The supply cable must have external protection against short circuit and overload triggering at max. 10 A, min. 60 V.

⚠ WARNING

Risk of fire due to short circuit!

A short circuit in the module or the power supply lines may cause the system to overheat or provoke a fire.

Preventive measures:

- Install a fuse with a maximum tripping current of 10 A.

6.2.5. Sensor and Actuator Power Supply

All sensors and actuators connected to the B-Nimis SC-I/O S-DI4 S-DO2 safety module that are supplied with power from an external source must still run on safe low voltage (SELV/PELV) supply. The power supply may at the same time also be taken from the I/O power supply of the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

⚠ WARNING

Potentially hazardous failures due to wrong voltages supplied to sensors and actuators

The wrong supply voltages may damage or destroy the unit and may provoke potentially hazardous failures.

Preventive measures:

- Use only PELV/SELV-ready power supply units to EN50178 or EN60950-1 for the 24 V DC power supply to sensors and actuators connected to the B-Nimis SC-I/O S-DI4 S-DO2 module.
- Only use the GND terminal to connect the power supply unit to earth (PELV system). Do not use earthing variants that connect earth to +24V.
- Remember that, even in the event of a fault, a maximum voltage of U max. < 33 V may be supplied to the sensors and actuators.
- If the unit is exposed to a supply voltage > 33 V, replace it, because it must no longer be used.
- To prevent the transfer of parasitic voltages, provide a low-impedance connection between the chassis ground of the unit supplying power to the sensors and actuators and the unit supplying 24 V DC to the I/Os of the B-Nimis SC-I/O S-DI4 S-DO2 module.

6.2.6. Power Supply Wiring Example

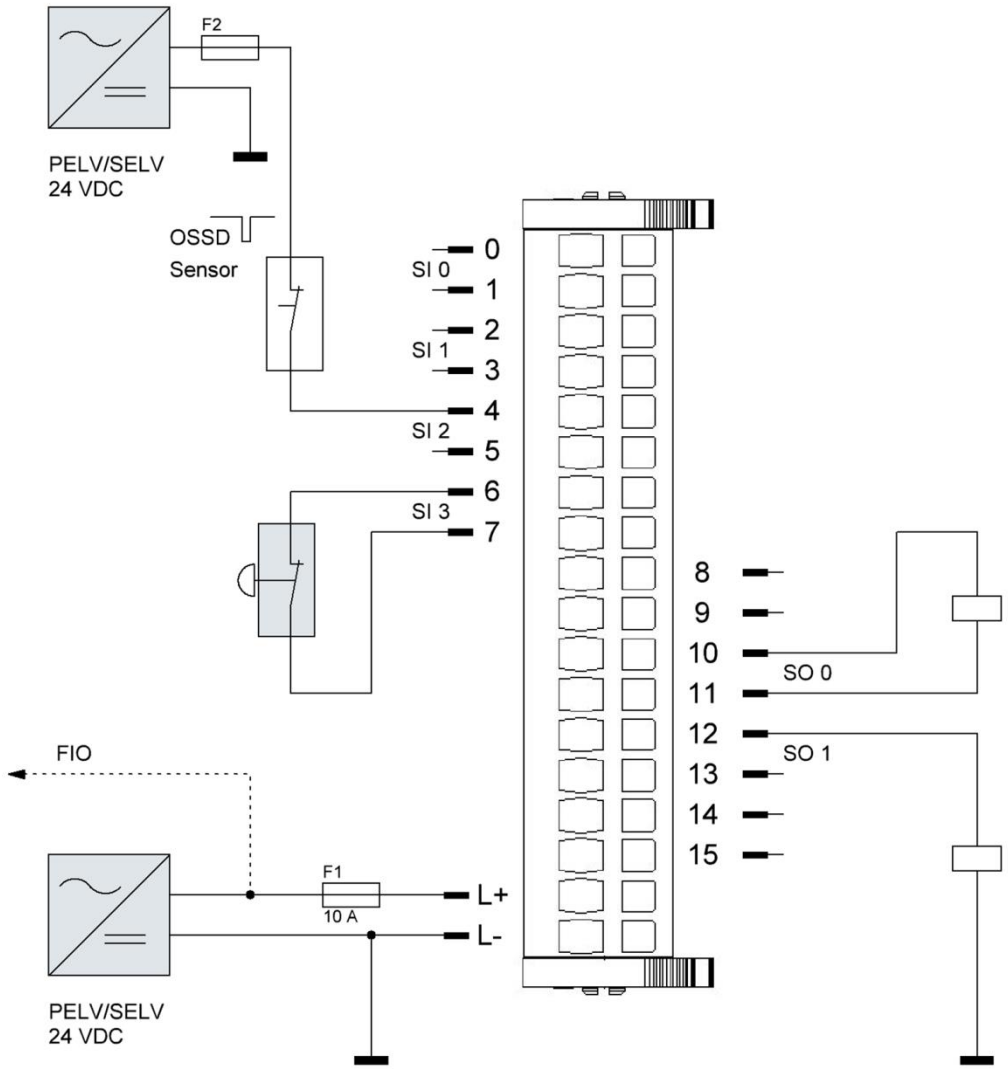


Fig. 19: Power Supply Wiring Example

6.2.7. Sensor connection

Single-channel contact-type sensor
The inputs of single-channel contact-type sensors work entirely independently of each other.
Wiring should take account of the fact that every input signal is allocated to the test pulse output.
Use the parameter settings to enable each of the inputs separately.

⚠ CAUTION

Compliance with the parameter settings

For single-channel applications (inputs and outputs), adjust the test pulse frequency to suit the application. Make sure that for applications subject to frequent changes of state the test pulse frequency is set to a value at least 100x greater than the interval between changes of state of the application.

▶ In the respect see the FSoE Parameter Overview 6.3.2

Fig. 20: Connection example of a single-channel sensor

Item	Designation
1	Safety switch

Evaluation of states
The module checks the states of the inputs and transfers the result to the safe control unit.
In the process data image of a safe input
→ a "0" is transmitted if a "0" is present at the input **or** if an error has been detected,
→ a "1" is transmitted if a “1" is present at the input **and** no error has been detected.

Disabling the clock signals
If the appropriate parameter disables the clock signals, you may supply 24 V DC to the sensor from an external power source. If so, please remember that disabled test pulse outputs prevent the detection of faults in the external wiring.

⚠ WARNING

Non-detection of a defective external wiring when test pulse outputs are disabled

Unsafe machine state, safety hazard.

- ▶ Always use the correct and enabled test pulse output to supply power to contact-type sensors.

⚠ WARNING

External filters at the direct connection of the module to the 24V power supply

In general, it is recommended to use safe inputs together with test pulse outputs generated by the module itself or with OSSD outputs from external sensors. Only a 24V power supply that is filtered according to EN 61326-3-1 (interference level for surge, burst and conductor-borne HF interference for I/O signals with direct mains power supply) may be connected directly to the safe inputs.

Refer to section 7.1

Safety Function with Single-channel Input.

Two-channel contact-type sensors

Two-channel contact-type sensors allow different inputs to be connected to the test pulse output of a two-channel sensor. A software module of the safe control unit provides the required analysis of the input signals.

The software can be used to interconnect any of the safe inputs. Wiring should take account of the fact that every input signal is allocated to the test pulse output. You must use the parameter settings to enable the safe inputs you use.

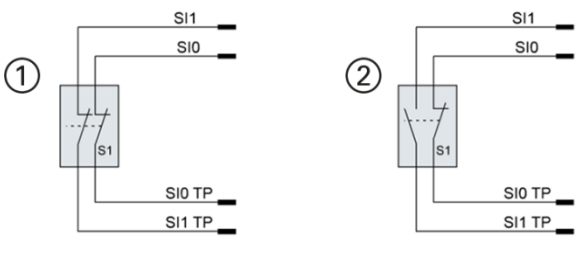


Fig. 21: Connection example of a twin-channel sensor

Item	Designation	Item	Designation
1	Safety switch, equivalent	2	Safety switch, antivalent

In the process data image of a safe input

→ a "0" is transmitted if a "0" is present at the input **or** if an error has been detected.

→ a "1" is transmitted if a “1" is present at the input **and** no error has been detected.

Refer to section 7.2 Safety Function with two-channel input for connection examples

Multi-channel contact-type sensors

Multi-channel switches such as mode selectors or "toggle" type switches connect to several safe inputs using only test pulse output SI0 TP to provide the correct function. The safe inputs that are used must be enabled in the parameter settings and the selector switch function selected in the "external inputs" parameter.

Switches with 2, 3 or 4 channels can be analysed.

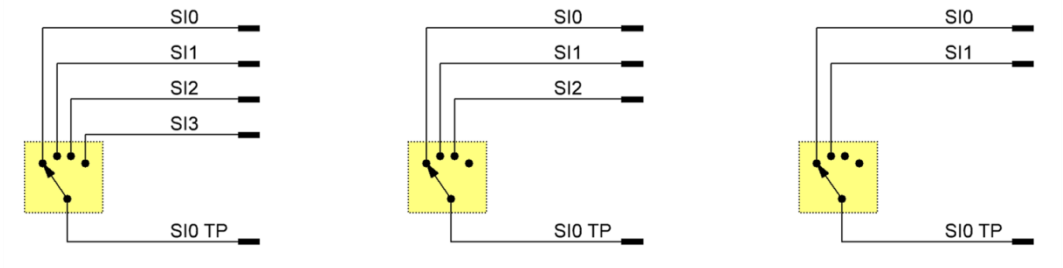


Fig. 22: Multi-channel sensors

Allocation of safe inputs for the mode selector function

No. of channels	Safe inputs used	Clock signal
4	SI0, SI1, SI2, SI3	SI0 TP
3	SI0, SI1, SI2	SI0 TP
2	SI0, SI1	SI0 TP

Safe inputs you do not use are available for other functions.

Multi-channel evaluation is performed in the safe PLC, using for instance the PLCopen "Mode Selector" module. The achievable category to EN ISO 13849 depends on the switching device error model (e.g. mode selector) and must needs be analysed in conjunction with the PLCopen of the module error detection.

Refer to section 7.4 Selector switch, rotary table for connection examples

Test pulse output

In mode selector mode, test pulse output TP0 can be set to "0". However, this will not affect the test pulse as such since, in mode selector mode, the test pulse always runs at maximum frequency.

Time discrepancy in mode selector/rotary table mode

A set time discrepancy of 100 ms has been implemented for signals missing at the inputs when changing to mode selector mode.

Electronic sensors, OSSD sensor
The OSSD sensor provides the fault detection function when connecting an OSSD sensors. Depending on the sensor's functionality, the retrieval of signals is able to detect cross-faults between the 24 V power supply and earth as well as cross-faults between the sensor signals.

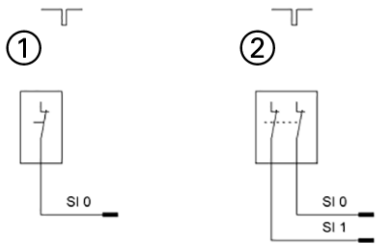


Fig. 23: Wiring Example OSSD Sensor

Item	Designation	Item	Designation
1	OSSD, single-channel sensor	2	OSSD, two-channel sensor

Two-channel sensors delivering OSSD signals can be connected to any safe input of the B-Nimis SC-I/O S-DI4 S-DO2 safety module. A software module of the safe control unit provides the required allocation and analysis of the input signals.

Sensors with OSSD signals do not support the module test pulses. You must therefore set the input channels to "Test pulse duration =0”. (Chap. 6.3.3 Input Parameters)

To prevent the transfer of parasitic voltages, provide a low-impedance connection between the earth of the sensor and the earth of the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

Pressure-sensitive mats, bumpers
Pressure-sensitive mats and bumpers are used to safeguard the floor around a machine. The mats are placed in the danger zone and make the control unit change to its safe functional state whenever pressure is exerted on them. In this case, a high signal is sent from both inputs.

The E-I/ S-DI4 S-DO2 safety module can evaluate pressure-sensitive mats using 4-wire circuitry. This is done using 2 safe digital inputs and the associated test pulse outputs for one pressure-sensitive mat/one bumper.

You must use the parameter settings to enable the safe inputs you use and to select the bumper function in the "External Inputs“ parameter.
You may use up to two mat channels.

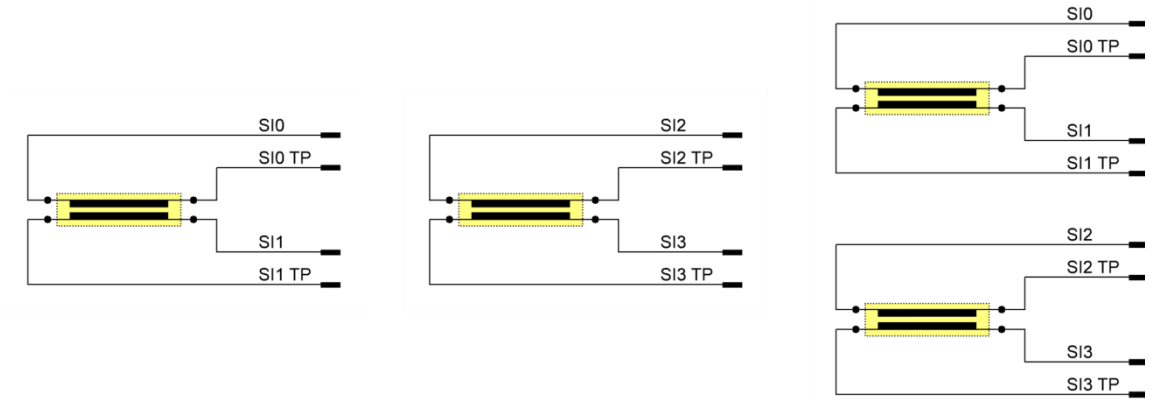


Fig. 24: Connection example for pressure-sensitive mats/bumpers

Allocation of safe inputs for the bumper function			
Parameter "External Inputs"		**Safe inputs used**	**Safe inputs used**
Bit 7	**Bit 6**		
0	0	Bumper function not selected	none
0	1	SI0, SI1	SI0 TP, SI1 TP
1	0	SI2, SI3	SI2 TP, SI3 TP
1	1	SI0, SI1, SI2, SI3	SI0 TP, SI1 TP, SI2 TP, SI3 TP

Safe inputs you do not use are available for other functions.
Evaluation of the pressure-sensitive mats/bumpers is performed in the safe PLC, for instance with the PLCopen "SF_ESPE” module. The achievable category to EN ISO 13849 depends on the switching device's error model and must needs be analysed in conjunction with the PLCopen error detection module.

You can find connection examples in section 7.5 Safety Mats, Connecting Blocks and Bumpers

Lay the feed lines of pressure-sensitive mats and bumpers together
In order to avoid influences and malfunctions due to EMC effects, lay the four wires (e.g. SI0, SI0 TP, SI1, SI1 TP) together.

⚠ CAUTION

"Short circuit in mat" fault is not detected

The safe I/O module fails to detect a short circuit between the mat contacts. This is interpreted as the mat being actuated. You must also verify that the safeguard is wired correctly.

- ▶ Periodically check that the mat is working properly.

⚠ CAUTION

Safety function pressure-sensitive mat requires a response time of 50 ms

Avoid personal injury and damage to property.

- ▶ The pressure-sensitive mat function achieves a response time of 50 ms between a change in mat state and providing the information on the EtherCAT bus.

6.2.8. Actuator Connection

ATTENTION

Faults at the outputs provoke a change to the safe state

The outputs are protected against overload and short circuit. Overload and short circuit cause the module to switch into its safe state. The module responds in the same way to detection of an external power feed to and to cross-faults at the outputs.

Resistive loads, inductive loads and resistive loads with some capacitive fractions can be connected to the digital power outputs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module. Signal lamps dissipating a resistive power of up to 10 W can also be connected.

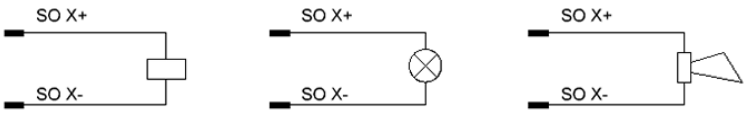


Fig. 25: Actuator Connection

Actuators with an external GND reference

Provided that the parameters are set correctly, actuators with external GND reference can be connected to the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

Switching inductive loads

If the internal free wheeling circuit is enabled, the digital power outputs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module can be used to drive inductive loads. The diagram below shows the maximum inductance of the load vs. the load current.

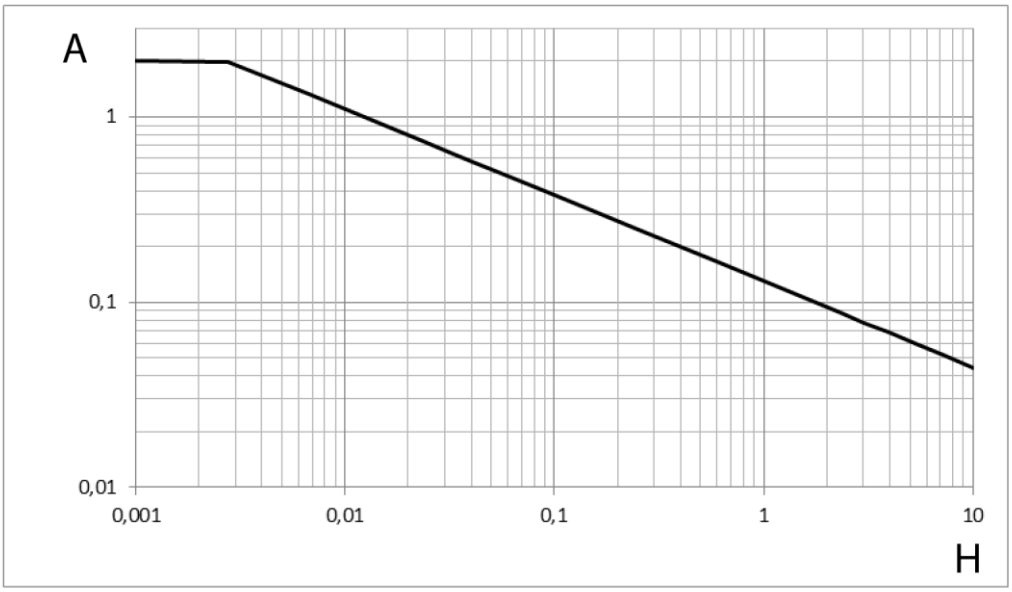


Fig. 26: Load inductance as a function of load current

→ X-axis: Inductance (H)
→ Y-axis: Maximum output current per channel (A)

ATTENTION

Defect caused by thermal overload due to excessive inductance!

Setting the inductance and the load current to higher than the specified values may thermally destroy the digital power output. Destruction of the digital power output may cause the safety function to fail.

External free wheeling circuit

If the external load exceeds the specified inductance limits, an external free wheeling circuit must be used.

ATTENTION

Effects of the external free wheeling circuit

Depending on the actual safety function, the external free wheeling circuit may affect the safety function, and must be considered in the safety assessment.

When an external free wheeling circuit is used, the magnetic energy released when an inductive load is switched off is transferred to the external free wheeling circuit.

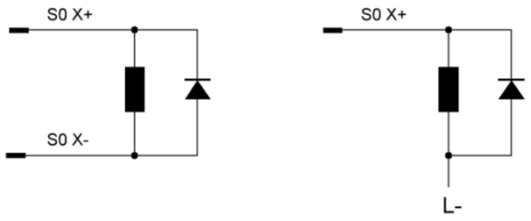


Fig. 27: External free wheeling circuit

Verify that the external free wheeling circuit is designed to withstand the ensuing dissipation heat. When connecting the inductive load to the outputs, be sure to limit the negative voltage of the external free wheeling element you choose to anything smaller than 30 V because the digital output will otherwise transduce the magnetic energy to heat.

ATTENTION

Note the heat dissipated by the external free wheeling element!

If you choose the correct external free wheeling element, this element instead of the safe I/O module will transduce the magnetic energy when switching off the inductive load.

- ▶ Verify that the external free wheeling circuit is designed to withstand the ensuing dissipation heat.

Switching digital inputs

Digital inputs of I/O modules can be switched by the SO X+ outputs of the module. For this purpose the parameter "extGroundOutput" must be enabled. When setting the parameters of the output test pulse you must consider the input capacitance of the input to be actuated.

To ensure that the test pulses of the digital power outputs are filtered properly when the safe digital inputs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module are used, the configurable filters for the inputs should be set to the same test pulse duration (parameter "Test pulse duration") as the digital power output.

Switching capacitive loads
Switching capacitive loads must take account of the limits below described with reference to the output current and the test pulse length.
The test pulses cyclically test the module digital outputs. If you connect a capacitive load to the digital power output, you may have to modify the test pulse duration. A test pulse length not adapted to the load may cause the module to change to its safe state.

The outputs support loads connected to SOX+ and SOX- as well as to SOX+ and an external GND potential. Different maximum capacitive loads apply to both configurations because they are built around a different internal composition of the outputs. Each output can support a maximum capacitive load of 2.2 µF.

Output capacitance of actuators with external GND reference or digital inputs connected to SOX+		
Duration of test impulse	**Output current 2 mA**	**Output current 20 mA**
500 µs	50 nF	300 nF
1000 µs	110 nF	600 nF
1500 µs	175 nF	1000 nF

Output capacitance of actuators with switched GND between SOX+ and SOX-		
Duration of test impulse	**Output current 2 mA**	**Output current 20 mA**
500 µs	17 nF	310 nF
1000 µs	48 nF	620 nF
1500 µs	77 nF	950 nF

Total current derating

CAUTION

Do not operate the B-Nimis SC-I/O S-DI4 S-DO2 safety module outside the specified range

Faults due to component overload.

- Operate the module under the ambient conditions listed in section Technical Data only whilst observing the derating of the outputs.

The maximum rated total current of the output module varies with the ambient temperature of the I/O module. Refer to the diagram below for the resulting total current.

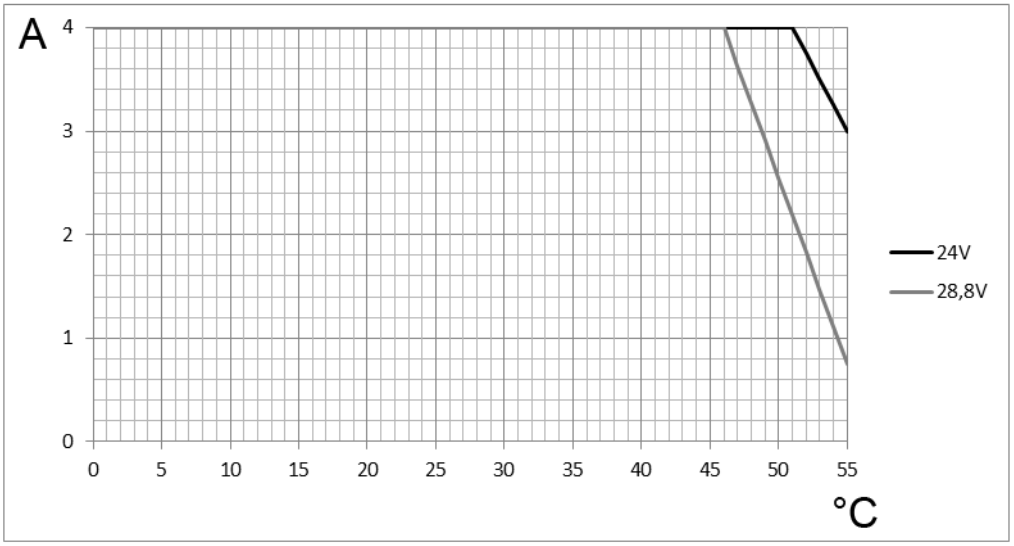


Fig. 28: Total current

→ X-axis: Ambient temperature (°C)
→ Y-axis: Total current (A)

The output current derating shown on the diagram was measured under free convection in a typical installation (I/O modules on the left and right, 50% duty cycle, identical supply voltage).

6.2.9. Connection to the multiple socket connector (MSC)

The multiple socket connector features tension springs with a release lever for releasing the plug connector. Use only the multiple socket connector supplied to connect the B-Nimis SC-I/O S-DI4 S-DO2 module.

Specifications of the connection to the socket connector	
Type of multiple socket connector	Weidmüller, OMNIMATE Signal – BL/SL series 3.50
Tool	Screwdriver, 0.4 x 2.5 x 75 [mm] blade (DIN 5264-A)
Clamping range, rated connection	min. 0.14 mm² … max. 1.5 mm²
Wire diameter AWG	min. AWG 26 … max. AWG 14
Outside diameter of insulation	max. 2.9 mm
Single wire cross-section	min. H05(07) V-U 0.2 mm² … max. H05(07) V-U 1.5 mm²
Stranded wire cross-section	min. H05(07) V-K 0.2 mm² … max. H05(07) V-K 1.5 mm²
Wire cross-section with end ferrule to DIN 46228/1	min. 0.2 mm² … max. 1.5 mm²
Wire cross-section with end ferrule with collar to DIN 46228/4	min. 0.2 mm² … max. 1.0 mm²
Stripped end length	10 mm
Rated current	10 A (CSA) / 10 A (UL)

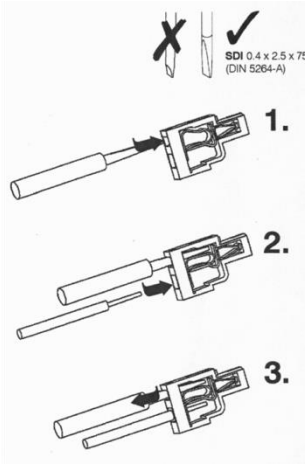


Fig. 29: Connection to the multiple socket connector

Connecting the multiple socket connector

1st Open the tension spring using a screwdriver SDI 0.4 x 2.5 x 75 [mm] blade (DIN 5264-A).
2nd Insert the wire into the terminal.
3rd Remove the screwdriver.
The tension spring will now clamp the wire in the terminal.

⚠ WARNING

Potentially hazardous failure due to improper wiring

Short circuits between adjacent terminals may damage or destroy the unit and may provoke potentially hazardous failures.

Preventive measures:

- ▶ Ensure wiring is performed correctly.

ATTENTION

Serious damage due to use of the wrong tool

Damage to the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

- ▶ Use only suitable tools for wiring the multiple socket connector
  Tool: Screwdriver, 0.4 x 2.5 x 75 [mm] blade (DIN 5264-A).

6.3. Configuration

WARNING

Check the safety function

Potential faults due to maladjusted configuration.

- After initial installation and after replacing a module, check the safety function.

6.3.1. Address Setup

The B-Nimis SC-I/O S-DI4 S-DO2 safety module operates with a secure module address (FSoE slave address) which clearly identifies it within the safe communication network. The address is set manually by means of binary switches on the left side of the module.
Use the 2x 8 DIP switches to set the FSoE address. Addresses range between 1 and 65535.

After the FSoE address has been set, disconnect the B-Nimis SC-I/O S-DI4 S-DO2 safety module once from the power supply to ensure that the address is accepted and a module test started automatically.

There is no access to the DIP switches once several modules have been lined up.
To set the FSoE slave address at the DIP switch, first remove the module from the row of modules.

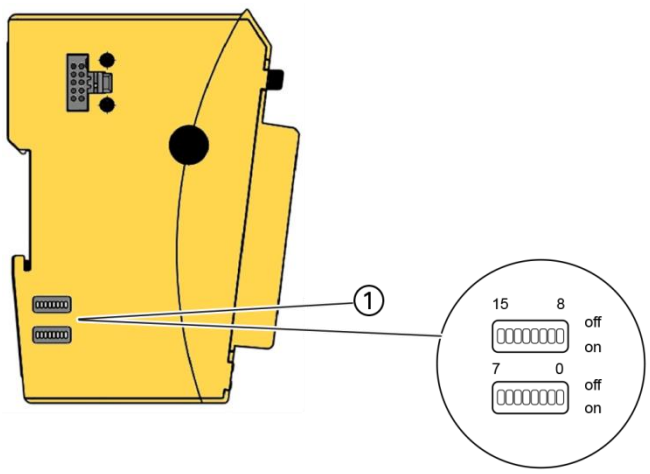


Fig. 30: Address Setup

Item	Designation
1	DIP switch for the FSoE address

ATTENTION

Serious damage due to use of the wrong tool

Damage to the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

- Use only suitable tools for adjustment.
- Use a suitable object (such as the tip of a ball-point pen or a screwdriver) to set the DIP switches.
- Under no circumstances exert pressure on the switching elements.

ATTENTION

Incorrect adjustment work on the B-Nimis SC-I/O S-DI4 S-DO2 safety module

Machine failure and damage to the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

- Switch the I/O supply off before removing the B-Nimis SC-I/O S-DI4 S-DO2 safety module from the row of modules in order to perform settings.

ATTENTION

Safety function not available

Start-up disallowed by wrongly set address.

- ▶ Perform a function test to verify that the address coding switches have been set correctly.

Binary setting of the DIP switch																
Address	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
1	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	**On**
2	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	**On**	Off
3	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	**On**	**On**
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
65535	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**	**On**

The FSoE address you set must be unique within the communication network. The master will find and notify the user of a FSoE address that is duplicated or is not used.

6.3.2. FSoE Parameter Overview

⚠ CAUTION

Improper operation of parameter setup

Malfunction of the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

- Only persons qualified for dealing with safety matters are allowed to add, replace and commission B-Nimis SC safety modules.
- Before installing, servicing or commissioning the B-Nimis SC-I/O S-DI4 S-DO2 safety module, read the safety information in the preface of this document.
- Before putting the unit into service, verify that all safety functions work as specified.
- The module will not work if parameter settings are out of the specified valid range.

FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
FSoE address		
1…65535 [1]	FSoE slave address set at DIP switch	–
Connection ID		
1…65535 [1]	Unique ID of the connection to a FSoE slave	–
Watchdog Time		
20 … 65534 (0xFFFE) [100]	Watchdog time of FSoE frame	ms
Used Inputs		
0 … 15 [15]	Activation of the inputs that are used; Selection from a drop-down list is available depending on the configurator	Dec

Binary	Decimal	Active Inputs
0 0 0 0	0	No inputs used
0 0 0 1	1	Input 0 used
0 0 1 0	2	Input 1 used
0 0 1 1	3	Inputs 0, 1 used
0 1 0 0	4	Input 2 used
0 1 0 1	5	Inputs 0, 2 used
0 1 1 0	6	Inputs 1, 2 used
0 1 1 1	7	Inputs 0, 1, 2 used
1 0 0 0	8	Input 3 used
1 0 0 1	9	Inputs 0, 3 used
1 0 1 0	10	Inputs 1, 3 used
1 0 1 1	11	Inputs 0, 1, 3 used
1 1 0 0	12	Inputs 2, 3 used
1 1 0 1	13	Inputs 0, 2, 3 used
1 1 1 0	14	Inputs 1, 2, 3 used
1 1 1 1	15	Inputs 0, 1, 2, 3 used

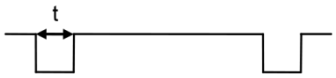
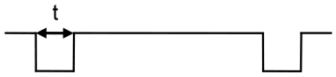
FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
External Inputs		
Bits 0–3 00002 … 111112 [0000_2]	Disables the generation of the module test pulses if the sensors connected generate their own test pulses (OSSD) at the outputs or, optionally, for operation without test pulses (OSSD) and disables special functions rotary switch and pressure-sensitive mat. Test pulse outputs, bits 0–3 0 Test pulse output is used 1 Test pulse output is not used (external test pulses enabled)	Dec
Bits 4, 5 00_2 … 11_2 [00_2]	Mode selector, bits 4 and 5 00 disabled 01 2 channels (inputs 0 + 1) 10 3 channels (inputs 0 – 2) 11 4 channels (inputs 0 – 3)	Dec
Bits 6, 7 00_2 … 11_2 [00_2]	Pressure-sensitive mat / bumper, bits 6 & 7 00 disabled 01 Inputs 0 + 1 10 Inputs 2 + 3 11 Inputs 0 + 1 and inputs 2 + 3	Dec

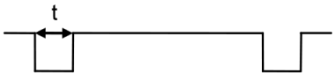
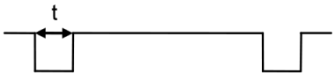
Bit								Dec	Setting
7	6	5	4	3	2	1	0		
0	0	0	0	0	0	0	0	0	No function
0	0	0	0	0	0	0	1	1	Test pulse output of input 0 disabled
0	0	0	0	0	0	1	0	2	Test pulse output of input 1 disabled
0	0	0	0	0	1	0	0	4	Test pulse output of input 2 disabled
0	0	0	0	1	0	0	0	8	Test pulse output of input 3 disabled
0	0	0	0	1	1	1	1	15	All test pulse outputs of all inputs disabled
0	0	0	1	0	0	0	0	16	Mode selector, two channels (inputs 0 + 1)
0	0	1	0	0	0	0	0	32	Mode selector, three channels (inputs 0 to 2)
0	0	1	1	0	0	0	0	48	Mode selector, four channels (inputs 0 to 3)
0	1	0	0	0	0	0	0	64	Pressure-sensitive mat, inputs 0 + 1
1	0	0	0	0	0	0	0	128	Pressure-sensitive mat, inputs 2 + 3
1	1	0	0	0	0	0	0	192	Pressure-sensitive mat, inputs 0 + 1 and 2 + 3

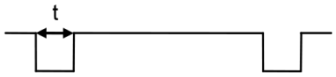
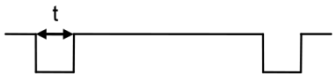
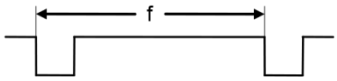
Cells marked red:
In mode selector or pressure-sensitive mat modes, disabling a test pulse output will provoke an error message. Settings in cells marked red are therefore forbidden.

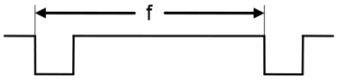
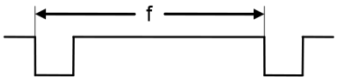
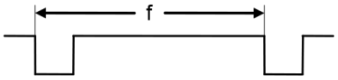
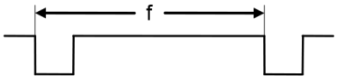
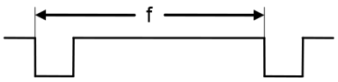
Cells marked green:
Pressure-sensitive mat mode available for inputs 0&1 or 2+3
Mode selector mode available for inputs 0&1, 0-2 or 0-3

FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
	Blue cells: Test pulse outputs can be disabled Example: A pressure-sensitive mat should be operated at the inputs 0 + 1 of the B-Nimis SC-I/O S-DI4 S-DO2 safety module and the remaining inputs (2 + 3) should be operated without any test pulses. For this, the following settings should be made: 64 + 4 + 7 = **76** WatchdogTime 100 usedInputs 15 externalInputs 76 usedOutputs 3 extGroundOutputs 3	
Used Outputs		
00_2 … 11_2 [00_2]	Activation of the outputs that are used. (0 and / or 1) Selection from a drop-down list depends on the configurator 00 Outputs disabled 01 SO 0 enabled, SO 1 disabled 10 SO 0 disabled, SO 1 enabled 11 SO 0 enabled, SO 1 enabled	Dec

FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
extGroundOutputs		
00_2 … 11_2 [00_2]	Enable these if the sensor is not connected to module terminal SO X- but uses an external ground connection. Selection from a drop-down list depends on the configurator	Dec
Test pulse duration input 0		
300 … 1500 [500]	Test pulse length of input 0 Input filter of input 0  The digital test pulse output is interrupted for the set duration of every test pulse. In this way the B-Nimis SC-I/O S-DI4 S-DO2 safety module checks whether the digital inputs are capable of taking the value zero and whether there are any short circuits to external voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	µs
Test pulse duration input 1		
300 … 1500 [500]	Test pulse length at input 1 Input filter at input 1  The digital test pulse output is interrupted for the set duration of every test pulse. In this way the B-Nimis SC-I/O S-DI4 S-DO2 safety module checks whether the digital inputs are capable of taking the value zero and whether there are any short circuits to external voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	µs

FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
Test pulse duration input 2		
300 … 1500 [500]	Test pulse length at input 2 Input filter at input 2  The digital test pulse output is interrupted for the set duration of every test pulse. In this way the B-Nimis SC-I/O S-DI4 S-DO2 safety module checks whether the digital inputs are capable of taking the value zero and whether there are any short circuits to external voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	µs
Test pulse duration input 3		
300 … 1500 [500]	Test pulse length at input 3 Input filter at input 3  The digital test pulse output is interrupted for the set duration of every test pulse. In this way the B-Nimis SC-I/O S-DI4 S-DO2 safety module checks whether the digital inputs are capable of taking the value zero and whether there are any short circuits to external voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	µs

FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
Test pulse duration output 0		
500 … 1500 [800]	Test pulse length at input 0  The digital power output is interrupted for the set duration of every test pulse. In this way the B-Nimis SC-I/O S-DI4 S-DO2 safety module checks whether the digital inputs are capable of being switched off and whether there are any short circuits to external voltages on the output line. The test pulse duration must be set to suit the load.	µs
Test pulse duration output 1		
500 … 1500 [800]	Test pulse length at input 1  The digital power output is interrupted for the set duration of every test pulse. In this way the B-Nimis SC-I/O S-DI4 S-DO2 safety module checks whether the digital inputs are capable of being switched off and whether there are any short circuits to external voltages on the output line. The test pulse duration must be set to suit the load.	µs
Test frequency input 0		
0 … 25 [1]	Test pulse frequency at input 0 "0" = no test pulse  	Hz

FSoE parameters		
Range [Default]	**Description / instruction**	**Unit**
Test frequency input 1		
0 … 25 [1]	Test pulse frequency at input 1 "0" = no test pulse 	Hz
Test frequency input 2		
0 … 25 [1]	Test pulse frequency at input 2 "0" = no test pulse 	Hz
Test frequency input 3		
0 … 25 [1]	Test pulse frequency at input 3 "0" = no test pulse 	Hz
Test frequency output 0		
0 … 25 [1]	Test pulse frequency at output 0 Value "0" = no test pulse[1] 	min^{-1}
Test frequency output 1		
0 … 25 [1]	Test pulse frequency of output 1 Value "0" = no test pulse 	min^{-1}

[1] 1 To stop the generation of test pulses, you must disable the test pulses to both outputs. See the notes in section 6.3.4 Parameters for outputs

6.3.3. Input Parameters

Parameters "Used Inputs" and "External Inputs"
Use these parameters to enable the inputs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module and to select the input function. Use the parameter "External Inputs" to disable the module test pulse outputs that deliver test pulses to each of the inputs. Use this setting for sensors that generate their own test pulses (some light barriers, for example).

WARNING

Non-detection of a defective external wiring when test pulse outputs are disabled

Unsafe machine state, safety hazard.

- Always use the correct and enabled test pulse output to supply power to contact-type sensors.
- Note: Consider the use of screened cables and/or cables laid separately, to ensure a sufficient degree of safety.

In "Mode Selector" mode, you can connect 2, 3 or 4 inputs to test pulse output SI0 TP and to a mode selector. Deactivate test pulse outputs that are not required (see section 7.4 Selector switch, rotary table). Unused inputs and the associated test pulse outputs can be used for other functions.

Pressure-sensitive Mat/"Bumper" mode uses pairs of 2 inputs and the associated test pulse outputs. Use the parameter "External Input" to choose the function of inputs 0 & 1 and 2 & 3 separately from each other. Unused inputs and the associated test pulse outputs can be used for other functions (see section 7.5 Safety Mats, Connecting Blocks and Bumpers).

Parameter "Test pulse duration input"
If used together with the module test pulse outputs, test pulses cyclically check the input circuit connected to the B-Nimis SC-I/O S-DI4 S-DO2 safety module for faults such as short circuits or internal defects. The parameter "Test pulse duration output" sets the time of a test pulse allocated to a digital test pulse output. It also sets the filtering time of the digital inputs. You may have to modify the test pulse duration if for instance the signals are affected by the capacitive properties of the input circuit.

Parameter "Test frequency input"
If used together with the module test pulse outputs, test pulses cyclically check the input circuit connected to the B-Nimis SC-I/O S-DI4 S-DO2 safety module for faults such as short circuits or internal defects. The parameter "Test pulse duration input" sets the switching frequency and thus the frequency of test pulses allocated to a digital test pulse output.

WARNING

Non-detection of a defective external wiring when test pulse outputs are disabled

Unsafe machine state, safety hazard.

- Always use the correct and enabled test pulse output to supply power to contact-type sensors.
- Note: Consider the use of screened cables and/or cables laid separately, to ensure a sufficient degree of safety.

6.3.4. Parameters of outputs

⚠ CAUTION

Consideration of the parameterization

For single-channel applications (inputs and outputs), the test pulse frequency should be adapted to the application. It must be ensured that in applications in which a frequent change of state occurs, the test pulse frequency is selected at least 100 times greater than the state change time of the application.

▶ See FSoE Parameters 6.3.2

Parameter “extGroundOutputs”
This parameter is set if the sensor is not connected to module terminal SO X- but uses an external ground connection. Pick it from a drop-down list provided by the configurator software. Linking the sensor to an external ground connection instead of terminal SO X does not allow you to control an external 24 V DC power supply.
Also set this parameter if output SO X+ supplies an electronic load such as a digital input of an I/O module.

Parameter "Used Outputs"
Activation of the outputs that are used. (SO 0 and / or SO 1)
Pick it from a drop-down list

Parameter "Test pulse duration output"
Test pulses cyclically check the digital outputs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module for faults such as short circuits or internal defects. The parameter "Test pulse duration output" sets the time of a test pulse allocated to a digital output. If you connect a capacitive load to the digital power output, you may have to modify the test pulse duration.

ATTENTION

Test pulses to the outputs

▶ Match the connected loads and the test pulse duration setting such that the test pulses are prevented from switching the loads.

Parameter "Test frequency output"
Test pulses cyclically test the digital outputs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module. The parameter "Test frequency output" sets the switching frequency and thus the frequency of test pulses allocated to a digital output. Adapt this parameter to the actual conditions particularly when using inductive or capacitive loads.

⚠ CAUTION

Shut-off of test pulses to the output

Owing to the construction of the outputs, shutting off the test pulses to an output channel will not stop test pulses from being generated at that output if test pulse are still set for the other output channel. Frequency and length of these test pulses are determined by the other output. Verify that these test pulses cannot switch the actuators connected.

- ▶ To stop the generation of test pulses, you must disable the test pulses to both outputs.

⚠ WARNING

Failure to detect defective external wiring while test pulses are disabled

Unsafe machine state, safety hazard.

- ▶ Use the output test pulses to detect cross-faults at the outputs and other faults.
- ▶ Note: Consider the use of screened cables and/or cables laid separately, to ensure a sufficient degree of safety.

⚠ CAUTION

Minimum length of test pulses

Owing to the construction of the outputs, different test pulse length settings of the two output channels will generate test pulses of the minimum length set for both outputs of both channels.

- ▶ Verify that both outputs comply with this minimum value to ensure that all test pulses are of a minimum length. Verify that this minimum test pulse length cannot switch the actuators connected.

⚠ WARNING

Reduced diagnosis with deactivated test pulses at the outputs

Switching off the test pulses is not recommended, it can reduce the safety of the application. With the test pulses switched off at the outputs, it is necessary to maintain the diagnosis of the outputs manually.

- ▶ The outputs must be switched once a year functionally (by the application itself) or by completely turning the device off.

6.4. Initial commissioning

The B-Nimis SC-I/O S-DI4 S-DO2 safety module may be used only in ETG-compliant configurations with conforming products. Such products include slave services, master and development systems, and products for functional safety. Products that have passed an official test for conformity are permitted to carry the EtherCAT Conformance tested logo. All certified products are listed in the EtherCAT Product Guide published by the EtherCAT Technology Group.

Topology of CODESYS devices

Like in all other CODESYS projects, the project environment of safety projects must identically reflect the hardware topology. You can either set up the topology manually or, provided that all device descriptions have been installed, start a device search in CODESYS:

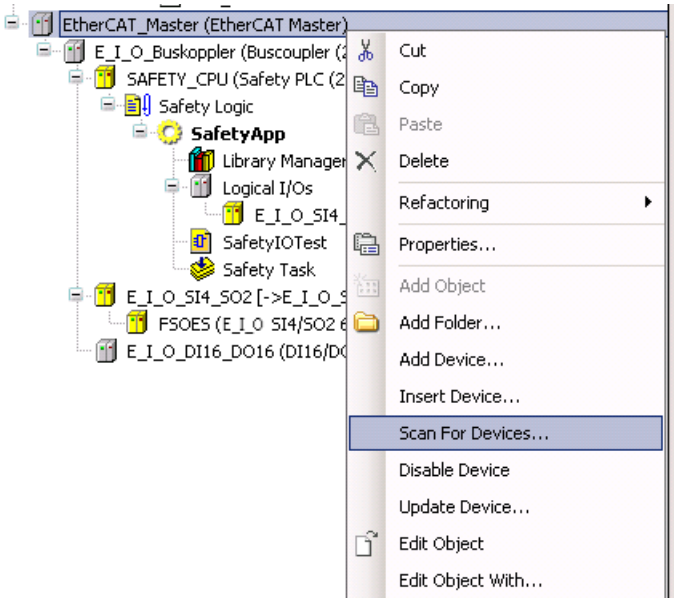


Fig. 31: Context menu

1st Right-click on the EtherCAT master and select "Find devices..." in the context menu.
2nd In the next dialog, select “Copy all devices to project”.

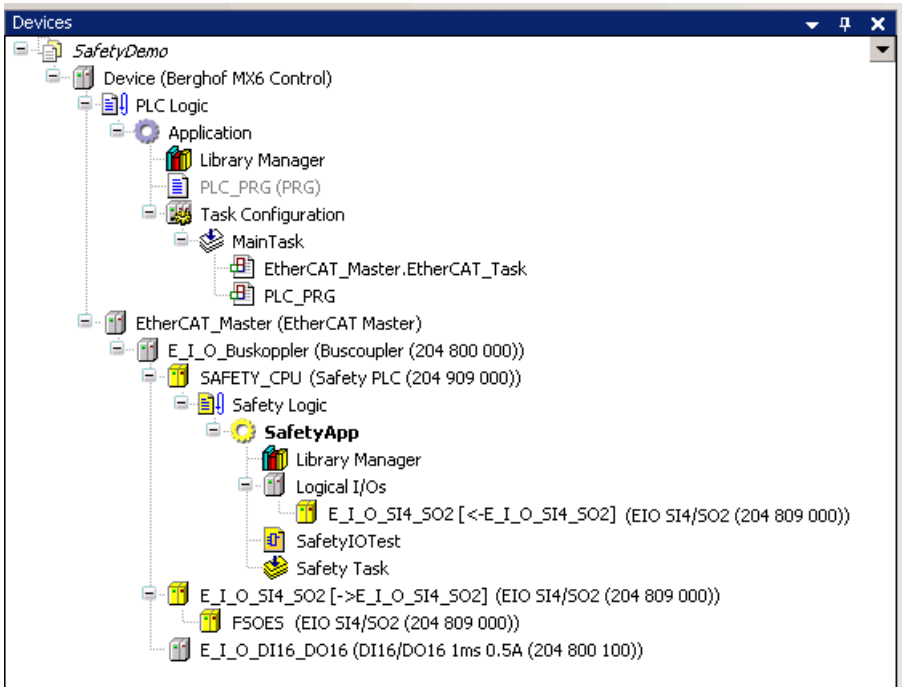


Fig. 32: Example for Configuration in CODESYS

Refer to the manual of your PLC to know how to set up a CODESYS project.

6.5. Diagnostics

6.5.1. Selftest

When system voltage is applied to the B-Nimis SC-I/O S-DI4 S-DO2 safety module, initially it runs a complete system test. Only if this system test is passed can the module become operational and only then does it switch to the "fail-safe" state in which protection is provided.
The "fail-safe" state is indicated by the "Safe Status" LED lighting up red.

The B-Nimis SC-I/O S-DI4 S-DO2 safety module will remain in the fail-safe state as long as all internal tests are passed, valid data are received from the control unit, and no faults are detected in any of the external hardware, sensors, actuators and their wiring.
A safe functional state is indicated by LED "Safe Status" lighting up green.
If the state is not achieved, for instance if it was not configured correctly in the application – the module still remains in the fail-safe state. To find the cause of the problem, check the error code in the service block, see section 6.5.6 Table of faults.
In service, the system test is repeated cyclically as a background process.
To repeat the initial system test, switch the power supply off and back on again.

6.5.2. Faults in the B-Nimis SC-I/O S-DI4 S-DO2 safety module

The cyclic system test will duly detect all faults in the module within the minimum safe failover time specified in section Technical Data in conformity with the requirements of the standards listed in the certificate. The module will change to its fail-safe state.
This is indicated by LED "Safe Status" lighting up red.

DANGER

Use of devices in a fail-safe state

The following faults may provoke a hazard.

- Whenever a fault occurs, initiate all the required repairs or replacements.

6.5.3. Wrong wiring

Examples of wrong wiring:
→ Faults between the inputs
→ External power supplied to the outputs
→ wrong allocation of a TP to a specific input
→ external power supplied to the outputs, or
→ a short circuit at the outputs

If the event of a wiring error the B-Nimis SC-I/O S-DI4 S-DO2 safety module switches into the safe state. The red diagnostic LED on the relevant channel lights up.

Error messages may also be provoked by badly adjusted loads (see section 6.2.7 Sensor connection and 6.2.8 Actuator Connection).

6.5.4. Temperature Faults

CAUTION

Do not operate the B-Nimis SC-I/O S-DI4 S-DO2 safety module outside the specified range

Faults by component overload caused by overtemperature.

- Operate the module under the ambient conditions listed in section Technical Data only whilst observing the derating of the outputs.

The module is designed for ambient temperatures between 0 °C and max. 55 °C and to be installed in a control cabinet. The B-Nimis SC-I/O S-DI4 S-DO2 safety module features an additional internal temperature sensor. Excess temperature will cause the module to switch to the safe state. You cannot start the module at temperatures below 0 °C.

6.5.5. Wrong Supply Voltage

The power supply voltage is 24 V DC and is monitored by the module.
In the event of overvoltage (> +20%) and undervoltage (< 15%) alike, the module switches to the safe state.

6.5.6. Table of faults

Depending on their type, faults detected are indicated by the diagnostic LEDs of the B-Nimis SC-I/O S-DI4 S-DO2 safety module and are made available as a diagnostic message in the error register object 1001h. Diagnostic messages help you to identify the fault and take the required corrective actions.
The tables below list and describe the faults, their causes, effects and corrective actions.

- ▶ Whenever a fault occurs, you should first of all rectify its cause and acknowledge the fault in the error register according to instructions.

Table of faults		
Fault pattern	**Possible Cause**	**Corrective Action**
Module fails to start, inputs are not read.	Wrong FSoE address set at the binary switch	▶ Check address setting at the module. ▶ Check address selected in the safety PLC. ▶ Check module for mechanical damage and replace as necessary.
Inputs enabled although outputs are in safe state.	FSoE slave address changed in service; System power supply interrupted; System power supply too low	▶ Check error code in the service block. ▶ Do not change the address coding switch in service. ▶ Check module for mechanical damage and replace as necessary. ▶ Check supply voltage.

Module is in the safe state, the diagnostic LEDs at the inputs light up red.	Wiring error, such as test pulse signals crossed; Inter-conductor faults between inputs; External power supplied to the outputs	▶ Check error code in the service block. ▶ Check the wiring of the module.
Module is in safe state but a diagnostic LED at the output lights up red.	Overload at an output; Faults between conductors at an output; External power supplied to an output	▶ Check error code in the service block. ▶ Check the wiring of the module. ▶ Check the output current at the output.
Module is in safe state but the "Safe Status" LED lights up red.	EtherCAT connection broken; Internal fault within the module	▶ Check the wiring of the EtherCAT fieldbus cables. ▶ Check the interconnect between the modules.
Module is in safe state but the "Safe Status" LED lights up red.	I/O power supply is low	▶ Check the I/O power supply. ▶ Check the wiring.

6.5.7. Error Codes

Error codes (object dictionary 0x2007 or 0x2017 - error code)		
Error Code (hex)	**Cause** **Effect**	**Comment** **Corrective Action**
0001	Internal software error	Internal module monitoring has detected an error. Inputs and outputs change to the safe state, FSoE communication stops.
	Module in safe state	► RESET the module by switching the system power off and back on again – self-test repeats. ► If the error persists, replace the module.
0002	Internal hardware fault	Internal module monitoring has detected a hardware fault. Inputs and outputs change to the safe state, FSoE communication stops.
	Module in safe state	► RESET the module by switching the system power off and back on again – self-test repeats. ► If the error persists, replace the module.
0402	Undervoltage	Voltage supplied to the module is below the admissible range. Inputs and outputs change to the safe state, FSoE communication stops.
	Module in safe state	► Check the power supply value. ► Check the length and load on the feed line.
e.g. 0201	Parameter error	Module fails to switch to its functional state.
	Module in safe state	► Check the parameter settings on the module. ► Use parameter settings only within the permissible range.
e.g. 0291	Faults between conductors or external power supplied to input	Faults between conductors to another input or test pulse output or external power supplied; the red diagnostic LED of the affected channel lights up. Inputs and outputs return "0" at the module and in the process map.
	Module in safe state	► Check sensor. ► Check test pulse outputs. ► Check connector and wiring.
e.g. 0291	Short circuit or overload	Short circuit in the output wiring or wrong output load, red diagnostic LED of the respective channel lights up.
	Module in safe state	► Check actuator. ► Check connector and wiring. ► Check free wheeling wiring at contactor.

Error codes (object dictionary 0x2007 or 0x2017 - error code)		
Error Code (hex)	**Cause** **Effect**	**Comment** **Corrective Action**
e.g. 0280	Faults between conductors at or external power supplied to output	Faults between conductors to another output or another signal; red diagnostic LED of affected channel lights up.
	Module in safe state	▶ Check actuator. ▶ Check connector and wiring.

For a detailed description of the entry in object 2007_h or 2017_h "error code", refer to the table in section 8.1.10 Error code 2007_h for µC1 and 2017_h for µC2.

6.5.8. EtherCAT Link Lost

If the EtherCAT link is lost or broken, all modules switch to the safe state. Once the fault has been rectified, an Error Acknowledge is sufficient to restart the EtherCAT bus.

6.5.9. Wrong FSoE Address Setting

If a wrong FSoE address is set, all modules to remain in the safe state. The fault is detected by the master and cannot be acknowledged.

Once all FSoE addresses are correct, the safety modules will restart normal operation after one power cycle.

6.5.10. Wrong configuration of the B-Nimis SC-I/O S-DI4 S-DO2 safety module

By design, safety control units prevent configuration errors from provoking dangerous states. Therefore, after downloading a safety project with a defective configuration, all safety module will remain in a safe state. The wrong user configuration is displayed in the master.

Once the defective configuration has been rectified and the project no longer defective has been downloaded, after acknowledgment of the error the safety modules will restart.

6.6. Resetting/acknowledging an error

Error Classes

The error class determines whether and how an error can be acknowledged, see section 8.1.13 Error class $200A_h$ for µC1 and $201A_h$ for µC2.

Error Class	Explanation	Resetting/ acknowledging by
0	No Error	Not required
1	Serious error or synchronisation error	Power Cycle
2	Internal communication error	Power Cycle
3	I/O Error	Error Acknowledgement
4	Error in Error Handler or at the outputs	Power Cycle
5	Fatal error	Non-acknowledgeable

Power Cycle
After removing the cause of the error, you can reset the B-Nimis SC-I/O S-DI4 S-DO2 safety module by a power cycle (Power Cycle -> switch off and back on) provided that the automatic self-test is passed.

Error Acknowledgement
Input or output errors can be reset by the safety PLC.

⚠ WARNING

Resetting / acknowledging may cause a dangerous state

Apart from the exceptions specified, acknowledging an error will immediately restore the safe output to its normal state of operation.

- Before acknowledging an error, verify that its cause has been removed professionally.
- Before acknowledging an error, verify that acknowledging it will not cause a dangerous machine state.
- At the machine or system planning stage, make sure that acknowledging an error must not be possible unless you have full view of the danger zone.

6.7. Maintenance / Servicing

6.7.1. General

Only qualified persons may perform work on the B-Nimis SC-I/O S-DI4 S-DO2 safety module.

⚠ CAUTION

Unsafe and undefined machine state

Destruction or malfunction.

- Do not plug, mount, unplug or touch the connectors during operation.
- Switch off all power sources before working on the modules. This also applies to any peripherals such as encoders or programming devices with external power sources, etc.
- Check that none of the ventilation slots is covered.

6.7.2. Servicing

The B-Nimis SC-I/O S-DI4 S-DO2 safety module requires neither servicing for the specified service life nor any action provided it is kept and operated under the permissible ambient conditions specified in the Technical Data.

6.7.3. Spare parts

No spare parts are available for the B-Nimis SC-I/O S-DI4 S-DO2 safety module. No repair work is permitted on the B-Nimis SC-I/O S-DI4 S-DO2 safety module. In the event of a defect, return the module to Berghof Automation GmbH.
(See Chap. 9 Customer Service / Addresses)

6.7.4. Preventive Maintenance

Prevent inadmissible contamination whilst operating and storing B-Nimis SC-I/O S-DI4 S-DO2 safety module. If the module if it has been exposed to inadmissible contamination, do not use it or continue to use it.

⚠ CAUTION

Unsafe and undefined machine state

Risk of injury.

- It is not permissible to operate an inadmissibly contaminated module. Cleaning the unit is also impermissible.

6.8. Replacing an B-Nimis SC-I/O S-DI4 S-DO2 safety module

When you replace an B-Nimis SC-I/O S-DI4 S-DO2 safety module, its configuration is retained and transferred to the new module when you restart the system. The programming environment will tell you if the new module is incompatible. You must carry out appropriate tests to verify for instance whether there are any other errors such as using the wrong terminals or making wiring mistakes. The instructions below describe the replacement of an B-Nimis SC-I/O S-DI4 S-DO2 safety module with another module of the same type.

⚠ CAUTION

Unsafe and undefined machine state

Risk of injury.

- Switch the power supply to the PLC and to the B-Nimis SC-I/O S-DI4 S-DO2 Module before you undertake the replacement of an B-Nimis SC-I/O S-DI4 S-DO2 safety module.
- Once an B-Nimis SC-I/O S-DI4 S-DO2 safety module has been replaced, separately test the safety function before restarting the machine or system.
- Design you wiring tests such that you will reliably discover the use of a wrong terminal.

Replacement of an B-Nimis SC-I/O S-DI4 S-DO2 safety module with a module of a different type requires redesign of the entire project.

- In this event, refer to the User Manual for the new module.

6.8.1. Replacement

Preparation

1st Ensure that the new module satisfies the following conditions:
→ Same type of device
→ The same or higher version, see section 5.1 Labelling and Identification.
2nd Bring the system or machine into a safe state.
3rd Switch off the power supply to the PLC unit and the modules.

Remove the old module

4th Separating the row of B-Nimis SC-I/O modules: Press the locking device of the module of the module to the left of that to be separated, and push the two modules apart by about a distance of 1 cm (see section 6.1.4 Disconnecting two modules).

5. Push the module upwards against the metal spring located on the underside of the rail guide. (see section 6.1.5 Removing a single module).

6th Tip the module forwards away from the rail.

7th Pull the module downwards and off the mounting rail.

Installing and mounting the new module

8th Read the FSoE address at the address switch of the old module and load this setting to the substitute module (see section 6.3

Configuration).

9th Install the substitute module at the same place within the row of FIO modules as the one that was removed (see section 6.1.2 To Snap on a Single Module).

10th Plug the inline connectors to the correct ports.

6.8.2. Recommissioning

1st Ensure that the machine or system is in a safe state and that there is nothing and nobody in the danger zone.

2nd Switch the supply voltage on again.

3rd After the replacement safety module has been plugged in, proceed as for initial commissioning, see section 6.4

Initial commissioning.
The parameter settings of the old module will have been retained and will be transferred to the new module when you restart the system.

4th After replacing a module, perform a check of all safety functions.

6.9. Working Life

B-Nimis SC-I/O S-DI4 S-DO2 safety module s have a design life of max. 20 years from their date of manufacture (see section 5.1 Labelling and Identification). Take the module out of service at the end of its useful life (see section 6.9.3 Decommissioning).

6.9.1. Repairs / Customer Service

It is prohibited to open or try to repair an B-Nimis SC-I/O S-DI4 S-DO2 safety module. In such an event the function of the B-Nimis SC-I/O S-DI4 S-DO2 safety module can no longer be guaranteed.

If a module failure is potentially hazardous, return the module to the manufacturer where the fault will be identified.

For the manufacturer’s address see section 9 Customer Service / Addresses

6.9.2. Warranty

The statutory warranty is applicable. It lapses if the device/product is subjected to unauthorised attempts at repairs or other interventions.

6.9.3. Decommissioning

The manufacturer of the machine or system specifies the procedure for decommissioning the product. The decommissioning process must fully comply with the specified procedure.

- During decommissioning, ensure that the used modules of the B-Nimis SC safety system are presented for further use for the intended purpose.
- Comply with the transport and storage requirements specified in the Technical Data.

6.9.4. Disposal

- Dispose of the safety system in conformity with the applicable environmental regulations and make sure that it is not returned into circulation.
- Treat the packaging as recyclable paper and cardboard.

7. Connection Examples

This section describes examples of applications that make use of the B-Nimis SC-I/O S-DI4 S-DO2 safety module functions to provide a safety function. It also describes the resulting safety ratings.

⚠ CAUTION

Using the examples described in this section is not enough to obtain the safety function needed to reduce the risk as established in the risk assessment (SIL/Cat./PL).

Personal injury and damage to property

- Choose suitable and approved sensors (e. g. to EN 60947-5-1 / -5.) and make sure that your switching devices have the appropriate B10d value.
- You may have to take further actions to obtain the safety function when using the system together with safe devices, sensor and actuators (e.g. reading the relay contact signals). Refer to the user manual of your safe devices for further details.
- The parameter settings of the B-Nimis SC-I/O S-DI4 S-DO2 safety module must be correct for the actual environment.

The safety ratings listed for the examples below solely apply to the part of the safety function covered by the safe I/O module.
Please note that the safety ratings below apply only if the test pulses are enabled.

⚠ WARNING

Non-detection of a defective external wiring when test pulse outputs are disabled

Unsafe machine state, safety hazard.

- Always use the correct and enabled test pulse output to supply power to contact-type sensors.
- Use the output test pulses to detect cross-faults at the outputs and other faults.
- Note: Consider the use of screened cables and/or cables laid separately, to ensure a sufficient degree of safety.

⚠ WARNING

Reduced diagnosis with deactivated test pulses at the outputs

Switching off the test pulses is not recommended, it can reduce the safety of the application. With the test pulses switched off at the outputs, it is necessary to maintain the diagnosis of the outputs manually.

- The outputs must be switched once a year by functionally (by the application) or by completely turning the device off.

7.1. Safety Function with Single-channel Input

CAUTION

Consideration of the parameterization

For single-channel applications (inputs and outputs), the test pulse frequency should be adapted to the application. It must be ensured that in applications in which a frequent change of state occurs, the test pulse frequency is selected at least 100 times greater than the state change time of the application.

▶ See FSoE Parameters 6.3.2

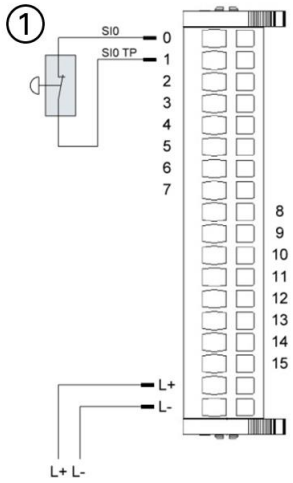


Fig. 33: Emergency Stop button

Item	Designation
1	Emergency Stop button, single channel

Contact-type sensors such as emergency stop buttons may be connected directly to a safe digital input.

By default, a test pulse output is dedicated to every input channel. This test pulse output supplies a specific signal you may use to detect wiring problems such as a short circuit to 24 V DC, GND or other signal channels. The state of connected switches is indicated by LEDs allocated to the channels (see section 5.4 Indicators and Controls).

Whenever an emergency stop button is pressed, the safety PLC will generate a stop signal. Resetting the emergency stop device must not be enough to initiate a restart signal.

Safety ratings of single-channel sensors

The safety ratings listed in the table below reflect the maximum values a single-channel safety function may achieve when using a single input of the safe I/O module. They apply solely to the part of the safety function covered by the safe I/O module.
All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved.

The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a single-channel sensor. Only approved sensors only (e. g. to EN 60947-5-1 / -5.) may be used. These must take account of the B10d value of the switching device.
The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety-related ratings when applying the module test pulses to single-channel contact-type sensors	
Maximum safety integrity level to EN 62061:2010	SIL2
Maximum safety integrity level to IEC 61508:2010	SIL2
Category and highest performance level to EN ISO 13849-1:2015	Cat. 2/PL d
Hardware fault tolerance (HFT) of single-channel application (IEC 61508:2010/EN)	0 (a fault in the application may cause the safeguard to fail)

7.2. Safety Function with two-channel input for connection examples

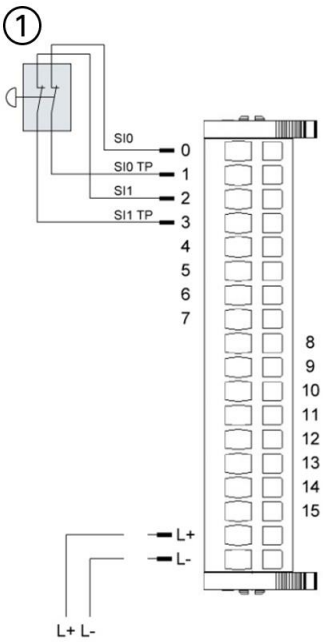


Fig. 34: Emergency Stop button, two channel

Item	Designation
1	Emergency Stop button, two channel

Safety Function with Two-channel Input, such as: For EMERGENCY OFF, EMERGENCY STOP, you may connect two digital inputs via two switching devices of safe sensors to the safety module. A software module of the safety PLC provides the required analysis of the switching contacts.

"FB_ESTOP" is a safety-related component intended to monitor an EMERGENCY STOP button. FB_ESTOP can be used for both the emergency switch off function (stop category 0) or – with the assistance of additional peripherals - the EMERGENCY STOP function (stop categories 1 or 2). FB_ESTOP can be used to monitor single and two-channel EMERGENCY STOP switches. The component discrepancy time monitoring is enabled for two-channel applications.

Discrepancy time monitoring
The discrepancy time defines as the maximum length of time both inputs may be in different states without the component interpreting this as a fault. Discrepancy time monitoring starts whenever the state of one input changes. The components will detect a fault if at the end of the discrepancy time the two inputs are in different states.

Safety ratings of two-channel sensors
The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using two inputs of the safe I/O module. They apply solely to the part of the safety function covered by the safe I/O module.
All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved.

The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a two-channel sensor. Only approved sensors only (e. g. to EN 60947-5-1 / -5.) may be used. These must take account of the B10d value of the switching device.

The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety-related ratings when applying the module test pulses to two-channel contact-type sensors	
Maximum safety integrity level to EN 62061:2010	SIL3
Maximum safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) of two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

7.3. Two-hand actuation

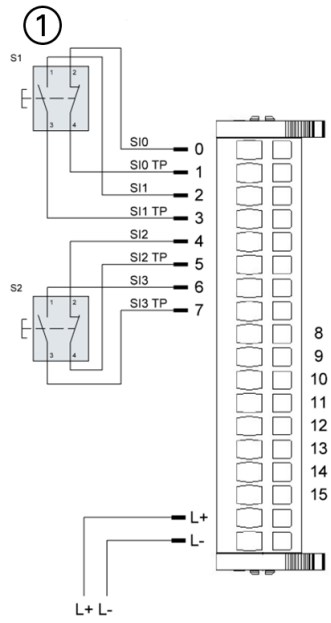


Fig. 35: Two-hand actuation

Item	Designation
1	Two-hand control

Two contact-type sensors can be connected to four safe digital inputs.
A software module of the safety PLC provides the analysis required for two-hand operation.

Two-hand circuit type 2
Software component " FB_TWOHAND_TYP2" supports function "two-hand circuit type 2" in conformity with European Standard EN 574:2008. If S1 and S2 are set to TRUE in the correct order, bTwoHandOut will also become TRUE. The component also checks that both buttons have been released before setting output bTwoHandOut to TRUE again.

Two-hand circuit type 3
The " FB_TWOHAND_TYP3" block supports function "two-hand circuit type 3" in conformity with the European standard. If S1 and S2 are set to TRUE in the correct order and within 500 ms, bTwoHandOut will also become TRUE. The component also checks that both buttons have been released before setting output S_TwoHandOut to TRUE again.

Category 3 does not support more than one two-hand circuit of type III B.

Safety ratings of two-channel sensors
The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using four inputs of the safe I/O module. They apply solely to the part of the safety function covered by the safe I/O module.
All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved.

The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a two-hand operation. Only approved sensors only (e. g. to EN 60947-5-1 / -5.) may be used. These must take account of the B10d value of the switching device.

The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings for function two-hand operation	
Maximum safety integrity level to EN 62061:2010	SIL3
Maximum safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) of two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

⚠ CAUTION

Safety hazard due to wrong operation of the two-hand circuit

- ▶ Comply with the relevant requirements and standards for two-hand circuits, such as EN 574:2008.
- ▶ Switches/sensors, wiring and application must comply with EN 574:2008.

7.4. Selector switch, rotary table

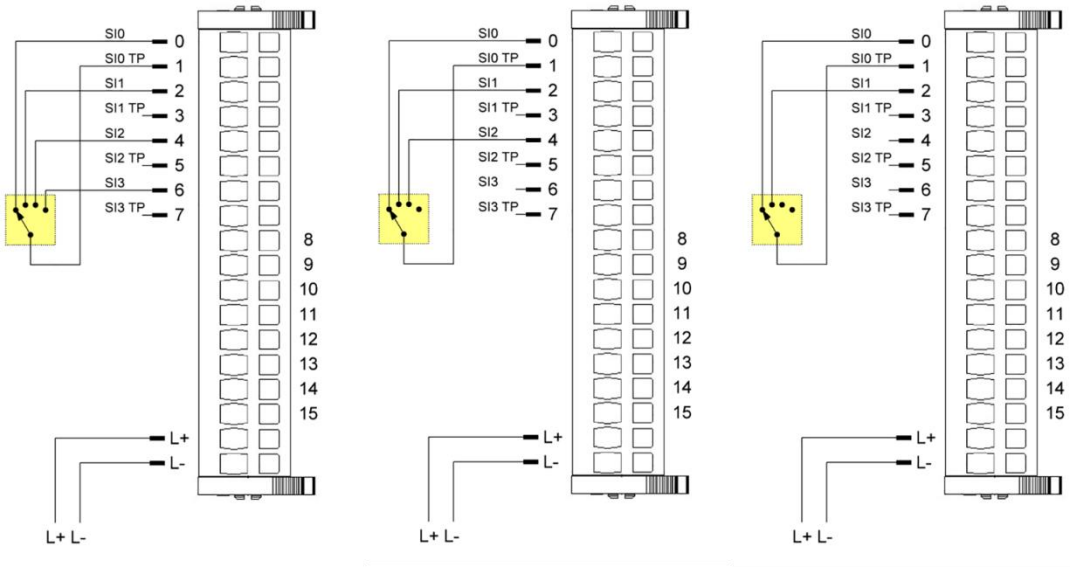


Fig. 36: Selector switch

In "Mode Selector" mode, you can connect 2, 3 or 4 inputs to a mode selector and to test pulse output SI0 TP. Disable the test pulse outputs you do not need.
Use this setup together with PLC component FB_MODE to implement a mode selector switch.
The associated logical output sets only if an input is set. All other outputs remain in a safe state.
If no or more than one input is set, all logical outputs retain their safe state.

Use the FSoE parameter "External Input" to enable the "Mode Selector" function. For further information see section 6.3.3 Input Parameters.

Safety ratings of mode selector applications in conjunction with switches/sensors approved to EN 13849-2, Table D.3	
Maximum safety integrity level to EN 62061:2010	SIL2
Maximum safety integrity level to IEC 61508:2010	SIL2
Category and highest performance level to EN ISO 13849-1:2015	Cat. 1/PL c
Hardware fault tolerance (HFT) of two-channel application (IEC 61508:2010/EN)	0 (a fault in the application may cause the safety device to fail)

Safety ratings with certified switches/sensors with appropriate safety classification, using selector switch applications	
Maximum safety integrity level to EN 62061:2010	SIL3
Maximum safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) of two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

ATTENTION

Test pulse output

In mode selector mode, test pulse output TP0 can be set to "0". However, this will not affect the test pulse as such since, in mode selector mode, the test pulse always runs at maximum frequency.

ATTENTION

Time discrepancy in mode selector/rotary table mode

A set time discrepancy of 100 ms has been implemented for signals missing at the inputs when changing to mode selector mode.

7.5. Safety Mats, Connecting Blocks and Bumpers

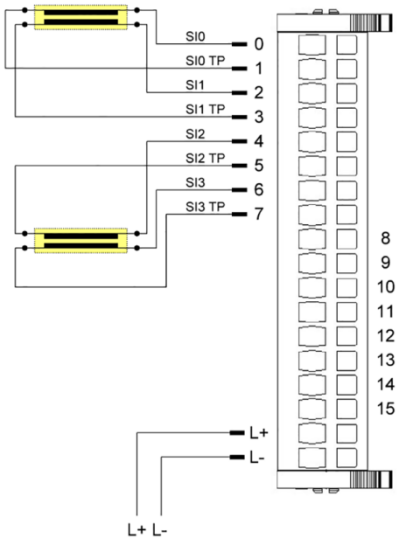


Fig. 37: Safety mats

Safety mats protect operators in danger zones. Connecting blocks and bumpers are normally used as safeguards along closing edges or against potentially hazardous moving objects. They share the same tripping method: Two parallel areas of contact are kept at a certain distance and do not make contact until the device is actuated.
An electric current going through the areas of contact ensures that they are ready for use. As shown in the illustration, areas of contact are assigned to different channels. When a mechanical load is placed on the area of contact, a connection is established between the inputs. This connection is evaluated not as a short circuit but as an actuation.
Use the FSoE parameter "External Input" to enable the "Bumper" function. For further information see section 6.3.3 Input Parameters. This mode supports only pressure-sensitive mats working according to the open circuit principle. That means the test pulses required to maintain a safe function are supplied by the safe I/O module.
The function uses either the inputs SI0 and SI1 and/or the inputs SI2 and SI3. The pressure-sensitive mat function achieves a response time of 50 ms between a change in mat state and providing the information on the EtherCAT bus.

Safety ratings of two-channel sensors
The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using two inputs of the safe I/O module. They apply solely to the part of the safety function covered by the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings
are achieved.

The quality of the safe sensor is of crucial importance with particular regard to the safety function of analysing a pressure-sensitive mat application. Use approved sensors only (e.g. to EN 60947-5-1 / -5.) and take account of your switching device's B10d value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

Safety ratings for pressure-sensitive mat applications	
Maximum safety integrity level to EN 62061:2010	SIL3
Maximum safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) of two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

ATTENTION

Lay the feed lines of pressure-sensitive mats and bumpers together

The four wires (e.g. SI0, SI0 TP, SI1, SI1 TP) for each pressure-sensitive mat or bumper must be laid together in order to avoid influences and malfunctions due to EMC effects.

⚠ CAUTION

Short circuits within pressure-sensitive mats cannot be detected

The safe I/O module fails to detect a short circuit between the mat contacts. This is interpreted as the mat being actuated. You must also verify that the safeguard is wired correctly.

- ▶ Periodically check that the mat is working properly.

⚠ CAUTION

The safety function pressure-sensitive mat requires a response time of 50 ms!

Avoid personal injury and damage to property.

- ▶ The pressure-sensitive mat function achieves a response time of 50 ms between a change in mat state and providing the information on the EtherCAT bus.

7.6. Connecting two Actuators with Internal GND Reference

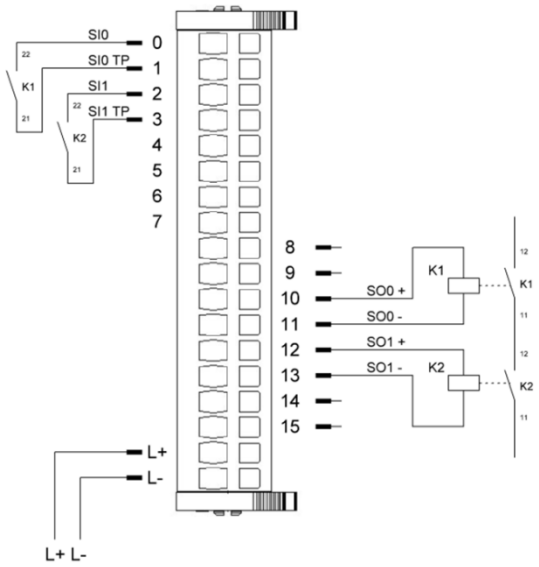


Fig. 38: Activation of a safety function, two channel actuator

The wiring example illustrates how two outputs of the safe I/O module are used to actuate a safety function. Switch contacts K1 and K2 both affect the safety function together.
Using the SOX terminals of the outputs allows the actuator to separate from the GND connection and thus change to its safe state when an external voltage is supplied or there are cross-faults of he actuator (contact SOX+). Whilst this circuit can also be set up without the SOX- terminals, in this case it must be ensured that external power supplies and cross-faults are excluded.
In order to monitor the relay states, the positively driven NC contacts of K1 and K2 must be connected to safe digital inputs. Set the safe PLC to analyse the values returned and thus the states of the switching devices.

Safety ratings of two-channel actuators
The safety ratings listed in the table below reflect the maximum values a two-channel safety function may achieve when using two outputs of the safe I/O module. They apply solely to the part of the safety function covered by the safe I/O module.
All components involved in the safety function must be taken into account in order to assess whether the desired safety ratings are achieved.

The quality of the safe actuator is of crucial importance with particular regard to the safety function of analysing a two-channel actuator. Use only approved actuators and make sure that those actuators have the appropriate B10d value.
The safety assessment of the safety function must also consider the safety ratings of the safety PLC used in the application.

Safety ratings of applications using two outputs for a safety function	
Maximum safety integrity level to EN 62061:2010	SIL3
Maximum safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) of two-channel application (IEC 61508:2010/EN)	1 (a fault of the application cannot cause the safeguard to fail)

7.7. Connecting Two Parallel Actuators to One Safe Output

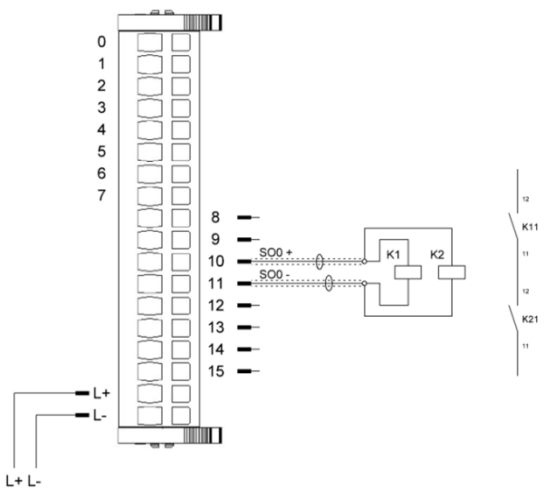
CAUTION

Consideration of the parameterization!

For single-channel applications (inputs and outputs), the test pulse frequency should be adapted to the application. It must be ensured that in applications in which a frequent change of state occurs, the test pulse frequency is selected at least 100 times greater than the state change time of the application.

- ▶ See FSoE Parameters 6.3.2

a)



b)

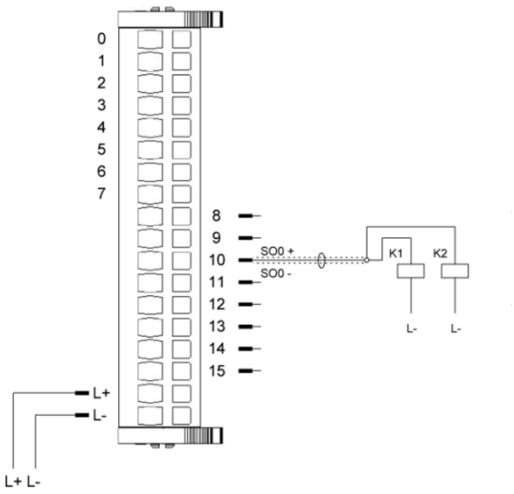


Fig. 39: Activation of a safety function, two parallel actuators

The wiring example illustrates how one output of the safe I/O module can be used to actuate a safety function.
Use a two-channel actuator to achieve the safety integrity levels of the table below. For the connection to the IO module, the possibility of short circuits and cross-faults in the connection cable must be excluded.

Note on image a)

Appropriate action must be taken to exclude cross-faults in the connection cable between the contact of the B-Nimis SC-I/O S-DI4 S-DO2 safety module and the safe actuators. The signal cables between the safe actuator and the B-Nimis SC-I/O S-DI4 S-DO2 safety module must be laid in a segregated and protected manner to EN 60204-1 and EN ISO 13849-2 (e. g. as separately sheathed cables or in separate cable ducts).

Note on image b)

In order to detect faults in the wiring, it is necessary to activate the test pulses for the corresponding output

An fault detection time of 5 ms must be maintained. This means that in the possible event of a fault, a high pulse of this width may be generated.

- Comply with the fault detection time.
- If the application responds to this pulse, use the two-channel assignment of the outputs.

In order to monitor the relay states, the positively driven NC contacts of K1 and K2 must be connected to safe digital inputs. Set the safe PLC to evaluate the values returned and thus the states of the switching devices.

Maximum safety ratings of applications using one output for a safety function	
Maximum safety integrity level to EN 62061:2010	SIL3
Maximum safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) of single-channel application (IEC 61508:2010/EN)	1 (a fault of the application does not cause the safeguard to fail)

8. Appendix

8.1. Object Dictionary

8.1.1. Device Type 1000h

Designation	Value
Name	Device Type
Index	1000_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No
Value Range	Fix
Default Value	1389_h

8.1.2. Error Register 1001h

Designation	Value
Name	Error Register
Index	1001_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No, TX-PDO
Default Value	00_h

In the event of an error, the associated error bit is set:

7	6	5	4	3	2	1	0
RES	RES	PROF	COM	TEMP	VOL	CUR	GEN

Bit	Des.	Explanation	Acknowledgement
7	RES	Reserved, always "0"	non-acknowledgeable, power cycle required
6	RES	Reserved, always "0"	non-acknowledgeable, power cycle required
5	PROF	Device profile	acknowledgeable via EtherCAT
4	COM	Communication	non-acknowledgeable, power cycle required
3	TEMP	Temperature	non-acknowledgeable, power cycle required
2	VOL	Voltage	acknowledgeable via EtherCAT or by power cycle
1	CUR	Current	non-acknowledgeable, power cycle required
0	GEN	Generic fault	non-acknowledgeable, power cycle required

8.1.3. Manufacturer’s Device Name 1008_h

Designation	Value
Name	Manufacturer Device Name
Index	1008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (26)
BitSize	208
Access	Read only
PDO Mapping	No
Value Range	Fix
Default Value	B-Nimis SC-I/O S-DI4 S-DO2

Sub-index 0 of this object contains the string length. Sub-index 1 contains each of the characters.
The character string has no terminating zero.

8.1.4. Manufacturer's Hardware Version 1009_h

Designation	Value
Name	Manufacturer Hardware Version
Index	1009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (4)
BitSize	32
Access	Read only
PDO Mapping	No
Value Range	Fix
Default Value	322E3130 (2.10)

8.1.5. Manufacturer's Software Version $100A_h$

Designation	Value
Name	Manufacturer Software Version
Index	$100A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (4)
BitSize	32
Access	Read only
PDO Mapping	No
Value Range	Fix
Default Value	312E3030 (1.00)

8.1.6. Identity Object 1018_h

Designation	Value
Name	Identity object
Index	1018_h
Object Code	RECORD
No. of Elements	5
Data Type	IDENTITY

Designation	Value
Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	4

Designation	Value
Name	Vendor-ID
Subindex	01_h
Data type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	0000023B

Designation	Value
Name	Product Code
Subindex	02_h
Data type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	$0x2B487_h$ (177287)

Designation	Value
Name	Revision number
Subindex	03_h
Data type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	$0000002A_h$ (42)

Designation	Value
Name	Serial number
Subindex	04_h
Data type	UNSIGNED32
Access	Read only
PDO Mapping	No
Units	YY MM DD NNNNN yyyyyy mmmm ddddd nnnnnnnnnnnnnnnn 6-bit 4-bit 5-bit 17-bit Year 2014 is coded as '0'.
Value Range	14 01 01 00001 (0x00420001) … 77 12 31 99999 (0xFF3F869F)
Example	16052300001 ⇔ 0x096E0001

The object contains details of the manufacturer, the product code and the revision and serial number.

8.1.7. Supply 24V Voltage 2001_h for µC1 and 2011_h for µC2

Designation	Value
Name	Supply24Voltage
Index	2000_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

8.1.8. Out 1 Current 2005_h for µC1 and 2015_h for µC2

Designation	Value
Name	Out1Current
Index	2005_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Units	mA
Value Range	0 … 2400
Default Value	No default Value

8.1.9. Ext Temperature 2006_h for µC1

Designation	Value
Name	Ext Temperature
Index	2006_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	0,01 °C
Value Range	0 … 8000
Default Value	No default Value

For displaying the temperature, only the least significant 16-bit can be evaluated.

8.1.10. Error code 2007_h for µC1 and 2017_h for µC2

Designation	Value
Name	Err.code
Index	2007_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Default Value	00000000_h

The table below explains the entries in object 2007_h and 2017_h "error code".

Id	Hex	Explanation
0	0x0000	OK: No error No error
1	0x0001	HWT_PARAMETER_ERROR Hardware test parameter error
2	0x0002	HWT_INIT_ERROR Hardware test initialisation error

Id	Hex	Explanation
100	0x0064	HWT_MEM_MARCHC_ERROR Hardware test RAM check error
101	0x0065	HWT_MEM_GALPAT_ERROR Hardware test RAM check error
200	0x00C8	HWT_STACK_UNDERFLOW_ERROR Hardware test stack underflow
201	0x00C9	HWT_STACK_OVERFLOW_ERROR Hardware test stack overflow
300	0x012C	HWT_CPU_ERROR Hardware test CPU error
400	0x0190	WT_FW_ERROR Hardware test firmware error
500	0x01F4	HWT_FWINTERFACE_ERROR Hardware test firmware error
504	0x01F8	HWT_ADC_ERROR: Test handler: error in ADC value range checks Hardware test AD converter error
505	0x01F9	HWT_DMA_ERROR: Test Handler: error in DMA check Hardware test DMA checksum error
506	0x01FA	HWT_CRC_ERROR: Test Handler: error in CRC check Hardware test CRC checksum error
507	0x01FB	HWT_TIMER_ERROR: Test handler: error in timer check Hardware test CPU timer error
508	0x01FC	HWT_CLOCK_ERROR: Test Handler: error in clock signal check Hardware test CPU clock error
509	0x01FD	HWT_SOFTERROR: Soft error detected Hardware test soft error detected
510	0x01FE	HWT_DIVZERO: Division by 0 Hardware test division by zero detected
512	0x0200	TIMEOUT_ERR: Timeout detected. Software timeout detected
513	0x0201	OUT_OF_RANGE_ERR: Parameter or value out of allowed range. Parameter range error
514	0x0202	OVERWRITE_ERR: Register buffer data overwrite occurred. Data overflow occurred
515	0x0203	UNDERFLOW_ERR: Register buffer data underflow occurred. Data underflow occurred
516	0x0204	PRG_CNTRL_ERR: Program sequence control detected error. Program execution error detected
528	0x0210	INIT_ERROR: Initialisation error

Id	Hex	Explanation
		Initialisation error
592	0x0250	ASSERT_TRUE_ERR: Assertion for expression yields "true" failed. Assertion for "true" failed
593	0x0251	ASSERT_NOT_NULL_ERR: Assertion for unequal to NULL failed. Assertion for unequal to NULL failed
594	0x0252	ASSERT_GE_ERR: Assertion for ">=" comparison failed. Assertion for ">=" comparison failed
595	0x0253	ASSERT_GT_ERR: Assertion for ">" comparison failed. Assertion for ">" comparison failed
596	0x0254	ASSERT_LE_ERR: Assertion for "<=" comparison failed. Assertion for "<=” failed
597	0x0255	ASSERT_LT_ERR: Assertion for "<" comparison failed. Assertion for "<” failed
598	0x0256	ASSERT_NE_ERR: Assertion for "<>" comparison failed. Assertion for "<>" failed
599	0x0257	ASSERT_EQ_ERR: Assertion for "=" comparison failed. Assertion for "=" failed
600	0x0258	ASSERT_FALSE_ERR: Assertion for expression yields "false" failed. Assertion for "false" failed
640	0x0280	TP_OUT_NOT_SPECIFIED: Output test pulse not specified. (ErrReg: 32) Output test pulse defective - internal sequence error
641	0x0281	TP_OUT_NOT_RECOGNIZED: Output test pulse not detected. (ErrReg: 32) Output test pulse not detected
642	0x0282	TP_OUT_NOT_ACTIVE: Output test pulse not activated. (ErrReg: 32) Output test pulse not activated
656	0x0290	TP_INP_BUSY: Input test pulse operation is busy. (ErrReg: 32) Input test pulse monitoring had not been closed before a new test pulse occurred
657	0x0291	TP_INP_CROSSTALK: Input test pulse cross talk detected. (ErrReg: 32) Cross talk between input test pulse signals
658	0x0292	TP_INP_NOT_RECOGNIZED: Input test pulse not detected. (ErrReg: 32) Input test pulse not detected
659	0x0293	TP_INTINP_NOT_RECOGNIZED: Internal input test pulse not detected. (ErrReg: 32) Internal input test pulse not detected
660	0x0294	TP_INP_LOST: Internal input test pulse lost. (ErrReg: 32) Internal input test pulse lost
661	0x0295	TP_INVALID_COUNT_FOR_SELECTOR: (ErrReg: 32) Test pulse error in mode selector mode

Id	Hex	Explanation
662	0x0296	TP_INVALID_OUTPUT_WIRING Output wiring error
672	0x02A0	MRAM_NOT_INITIALIZED MRAM not initialised
673	0x02A1	MRAM_READ_ERR: MRAM Read error. MRAM read error
674	0x02A2	MRAM_WRITE_ERR: MRAM write error. MRAM write error
675	0x02A3	MRAM_INDEX_OUT_OF_RANGE: MRAM entry index out of valid range. MRAM addressing error
676	0x02A4	MRAM_CORRUPT_PAGE_SIZE: MRAM invalid page size. MRAM page size error
677	0x02A5	MRAM_CRC_ERR: MRAM data CRC check failed. MRAM checksum error (CRC error)
678	0x02A6	MRAM_MAGICNUMBER_ERR: MRAM magic number not recognised. MRAM error in magic number
768	0x0300	RESET_LOW_POWER: Reset due to low power supply. Reset due to undervoltage
769	0x0301	RESET_WINDOW_WD: Reset due to window watchdog. Reset due to window watchdog
770	0x0302	RESET_INDEPENDENT_WD: Reset due to independent watchdog. Reset due to watchdog timer
771	0x0303	RESET_SW: Reset due to software reset. Reset due to software reset
772	0x0304	RESET_POWER_ON_DOWN: Reset due to power up or down. Reset due to switching on or switching off
773	0x0305	RESET_NMI: Reset due to non-maskable interrupt. Reset due to non-maskable interrupt
774	0x0306	RESET_BROWNOUT: Reset due to brown out detection. Reset due to CPU undervoltage
775	0x0307	RESET_NO_REASON: Reset due to unknown reason. Reset for no known reason
1024	0x0400	ADC_REF_LOW: Reference voltage too low. AD converter reference voltage too low
1025	0x0401	ADC_REF_HIGH: Reference voltage too high. AD converter reference voltage too high
1026	0x0402	ADC_24V_LOW: 24 V supply voltage too low (< 24V - 10%). (ErrReg: 4) 24V load power supply below the tolerance range
1027	0x0403	ADC_24V_HIGH: 24 V supply voltage too high (> 24V + 15%). (ErrReg: 4)

Id	Hex	Explanation
		24V load power supply above the tolerance range
1028	0x0404	ADC_5V_LOW: 5 V supply voltage too low. (ErrReg: 4) 5V load power supply below the tolerance range
1029	0x0405	ADC_5V_HIGH: 5 V supply voltage too high. (ErrReg: 4) 5V load power supply above the tolerance range
1030	0x0406	ADC_3_3V_LOW: 3.3 V supply voltage too low. Internal 3.3V power supply below the tolerance range
1031	0x0407	ADC_3_3V_HIGH: 3.3 V supply voltage too high. Internal 3.3V power supply above the tolerance range
1032	0x0408	ADC_TEMP_LOW: On-chip temperature too low. (ErrReg: 8) Ambient temperature too low
1033	0x0409	ADC_TEMP_HIGH: On-chip temperature too high. (ErrReg: 8) Ambient temperature too high
1034	0x040A	ADC_CURR_HIGH: Total output current too high. (ErrReg: 2) Total output current too high
1035	0x040B	ADC_24V_FATAL: 24 V supply voltage much too high (> 60V). (ErrReg: 4) The 24 V load supply voltage is much too high (> 60V)
1280	0x0500	LINE_TIMEOUT: Invalid sync line level from base board Synchronisation wire level monitoring timed out
1281	0x0501	NOVALIDCPUID: Invalid CPU identifier setting Invalid CPU identifier
1282	0x0502	TIMEOUTTIMERERR: Timeout occurred Timeout timer error
1283	0x0503	DIPSWITCHREADERR: DIP switch could not be read Address switch could not be read
1284	0x0504	DIPSWITCHCHANGED: DIP switch setting changed Address changed in service
1285	0x0505	DIPSWITCHXCHGERROR: Exchange of address DIP settings failed Address switch setting transmission from CPU to CPU failed
1286	0x0506	DIPSWITCH_INVALID_ADDRESS: Invalid FSoE address selected (ErrReg: 32) Invalid address setting (address set to zero)
1312	0x0520	CLK_ERROR: Partner clock frequency is out of valid range Clock monitoring defective
1313	0x0521	CLK_PARTNER_LOW: Partner clock frequency is below lower limit Partner clock frequency too low
1314	0x0522	CLK_PARTNER_HIGH: Partner clock frequency is above upper limit Partner clock frequency too high
1328	0x0530	HW_REVISION_ERROR: Invalid HW revision detected (the SW currently running is not designed for this HW revision)

Id	Hex	Explanation
		Hardware revision on the circuit board incompatible with the software version
1536	0x0600	INPUTXCHGERROR: Exchange of safety input information failed Safety state comparison between the CPUs failed
1537	0x0601	INPUT_TIMEOUT: Input test pulse timed out. (ErrReg: 32) Input test pulse monitoring timed out
1552	0x0610	INPUT_EXTMATTE_KS: Short circuit detected in external safety input carpet (ErrReg: 32) not used
1553	0x0611	INPUT_EXTMATTE_OPEN: Safety mat not connected / open load (ErrReg: 32) Error in the safety mat wiring: Short circuit or open circuit
1792	0x0700	OUTPUTXCHGERROR: Exchange of safety output information failed Output state comparison between the CPUs failed
1793	0x0701	OUTPUTFAIL: Output test pulse not detected (ErrReg: 32) Output test pulse not detected
1794	0x0702	OUTPUT_WAITFB: Output test pulse waiting for feedback signal (ErrReg: 32) Output test pulse feedback signal not detected
1795	0x0703	OUTPUT_TIMEOUT: Timeout in handling of output (ErrReg: 32) Timeout in handling of output
1796	0x0704	OUTPUT_HSTP_TIMEOUT: Output test pulse of high side switch timed out Output test pulse of high side switch timed out
1797	0x0705	OUTPUT_LSTP_TIMEOUT: Output test pulse of low side switch timed out Output test pulse of low side switch timed out
1798	0x0706	OUTPUT_LSTP_CONNECT_ERR: Output test pulse of low side switch timed out Bad wiring - output set to external ground, wrong signal detected on feedback line.
1799	0x0707	OUTPUT_USTP_TIMEOUT: Output test pulse of common high side switch timed out. Output HighSideSwitchTestPulse time monitoring error
1800	0x0708	OUTPUT_NOPAR_USED: Output is parameterized as not used and shall be switched on (ErrReg: 32) Error - an unconfigured output is set to be switched on
2048	0x0800	BCOM_NOTREADY: Communication to base board not ready / operational Base-board communication not ready / operational
2049	0x0801	BCOM_BUSY: Communication to base board is busy Base-board communication overloaded
2050	0x0802	BCOM_NONEWDATA: No new data received from base board Base-board communication – no new data received
2051	0x0803	BCOM_CRCERR: Communication to base board detected a CRC error Base-board communication – checksum error detected

Id	Hex	Explanation
2052	0x0804	BCOM_BITERR: Shifted bits detected Base-board communication - shifted bit detected
2304	0x0900	XCOM_NOTREADY: Communication with safety partner MC not ready / operational Communication with safety partner microcontroller not ready / operational
2305	0x0901	XCOM_BUSY: Communication with safety partner is busy Communication with safety partner microcontroller overloaded
2306	0x0902	XCOM_NONEWDATA: Communication with safety partner microcontroller – no new data received
2307	0x0903	XCOM_CRCERR: Communication with safety partner detected a CRC error Communication with safety partner microcontroller – checksum error detected
2560	0x0A00	I2C_TIMEOUT: I2C communication timeout detected Timeout in the I2C communication detected
2561	0x0A01	I2C_BUSY: I2C bus is busy IC2 is overloaded
2816	0x0B00	FSOE_RESET_IND: (ErrReg: 16) FailSafeOverEtherCAT – FSoE slave error report to FSoE master
2817	0x0B01	FSOE_INVALID_CMD: (ErrReg: 16) FailSafeOverEtherCAT – invalid command
2818	0x0B02	FSOE_UNKNOWN_CMD: (ErrReg: 16) FailSafeOverEtherCAT – unknown command
2819	0x0B03	FSOE_INVALID_CONNID: (ErrReg: 16) FailSafeOverEtherCAT – invalid connection id
2820	0x0B04	FSOE_INVALID_CRC: (ErrReg: 16) FailSafeOverEtherCAT – checksum error
2821	0x0B05	FSOE_WD_EXPIRED: (ErrReg: 16) FailSafeOverEtherCAT – watchdog time out
2822	0x0B06	FSOE_INVALID_ADDRESS: (ErrReg: 16) FailSafeOverEtherCAT – invalid address
2823	0x0B07	FSOE_INVALID_DATA: (ErrReg: 16) FailSafeOverEtherCAT – invalid data
2824	0x0B08	FSOE_INVALID_COMMPARALEN: (ErrReg: 16) FailSafeOverEtherCAT – invalid communication parameter length
2825	0x0B09	FSOE_INVALID_COMMPARA: (ErrReg: 16) FailSafeOverEtherCAT – invalid communication parameter

Id	Hex	Explanation
2826	0x0B0A	FSOE_INVALID_USERPARALEN: (ErrReg: 16) FailSafeOverEtherCAT – invalid user parameter length
2827	0x0B0B	FSOE_INVALID_USERPARA: (ErrReg: 16) FailSafeOverEtherCAT – invalid user parameter
2828	0x0B0C	FSOE_INVALID_TP_INP_DURATION: Safety parameter input test pulse duration invalid (ErrReg: 16) FailSafeOverEtherCAT – test pulse length of the safety input parameter invalid
2829	0x0B0D	FSOE_INVALID_TP_INP_FREQUENCY: Safety parameter input test pulse frequency invalid (ErrReg: 16) FailSafeOverEtherCAT – test pulse frequency of the safety input parameter invalid
2830	0x0B0E	FSOE_INVALID_TP_OUT_DURATION: Safety parameter output test pulse duration invalid (ErrReg: 16) FailSafeOverEtherCAT – test pulse length of the safety output parameter invalid
2831	0x0B0F	FSOE_INVALID_TP_OUT_FREQUENCY: Safety parameter output test pulse frequency invalid (ErrReg: 16) FailSafeOverEtherCAT – test pulse frequency of the safety output parameter invalid
2832	0x0B10	FSOE_INVALID_WATCHDOG_TIME: Safety parameter watchdog time invalid (ErrReg: 16) FailSafeOverEtherCAT – watchdog time of the safety parameter invalid
2833	0x0B11	FSOE_INVALID_INP_EXT_SUPPLY: Safety parameter for inputs having external supply invalid (ErrReg: 16) FailSafeOverEtherCAT – input parameter setting invalid or use of the inputs does not match the parameter settings.
2834	0x0B12	FSOE_INVALID_INP_IN_USE: Safety parameter for inputs in use invalid (ErrReg: 16) FailSafeOverEtherCAT – safety parameter invalid for the inputs used
2835	0x0B13	FSOE_INVALID_INP_USED_EXT_MISMATCH: Safety parameters for inputs in use and externally supplied mismatch (ErrReg: 16) FailSafeOverEtherCAT – safety parameters for used and externally supplied inputs do not match
2836	0x0B14	FSOE_INVALID_OUT_IN_USE: Safety parameter for outputs in use invalid (ErrReg: 16) FailSafeOverEtherCAT – safety parameters invalid for the outputs used
2837	0x0B15	FSOE_INVALID_OUT_USED_EXT_MISMATCH: Safety parameters for outputs in use and externally grounded mismatch (ErrReg: 16) FailSafeOverEtherCAT – safety parameters for used and externally earthed outputs do not match
2944	0x0B80	FSOE_EXTENDED_ERROR: (ErrReg: 16) FailSafeOverEtherCAT – extended error
2992	0x0BB0	FSOE_ERROR: Invalid internal state in safety stack (ErrReg: 16)

Id	Hex	Explanation
		FailSafeOverEtherCAT – invalid internal state in the safety stack
3072	0x0C00	TH_GLOBAL_ERROR: Global hardware test error
3073	0x0C01	TH_TIMEOUT: Internal test sequence timeout Timeout during hardware test
3329	0x0D01	MC1_ID_INVALID: Identification of MC 1 failed Identification of microcontroller 1 failed
3330	0x0D02	MC2_ID_INVALID: Identification of MC 2 failed Identification of microcontroller 2 failed
3331	0x0D03	MC3_ID_INVALID: Identification of MC 3 failed Identification of microcontroller 3 failed
3584	0x0E00	FOREIGN_ERROR_DETECTED: Other MC detected an error Error detected by another microcontroller
3841	0x0F01	FLASH_TIMEOUT: FLASH operation timeout Timeout when writing to the FLASH memory
3842	0x0F02	FLASH_LOCKED: FLASH operation failed because "LOCK" bit could not be reset Flash operation failed because "LOCK" bit could not be reset
3851	0x0F0B	FLASH_BUSY: FLASH operation busy, sequence error in flash programming
3854	0x0F0E	FLASH_ERROR: FLASH operation error, programming of the flash memory failed

8.1.11. Error line 2008_h for µC1 and 2018_h for µC2

Designation	Value
Name	Err.line CPU 1/2
Index	2008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	no
Default Value	00000000_h

8.1.12. Error module 2009_h for µC1 and 2019_h for µC2

Designation	Value
Name	Error module CPU 1/2
Index	2009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	no
Default Value	00000000_h

The table below explains the entries in object 2009_h and 2019_h "error code".

Id	Explanation
0	OBJ_UNKNOWN_ID – unknown module
4	OBJ_FSOETASK_ID – error occurred in "CFSoETask.cpp"
8	OBJ_INPUT_ID - error occurred in "CInput.cpp"
12	OBJ_MAINTASK_ID - error occurred in "CMainTask.cpp"
16	OBJ_PRGCONTRLTASK_ID - error occurred in "CProgramControlTask.cpp"
20	OBJ_SYNCSAFETYPARTNER_ID - error occurred in "CSyncSafetyPartner.cpp"
24	OBJ_XCOM_ID - error occurred in "CXCom.cpp"
28	OBJ_SAFETYHAL_ID - error occurred in "CSafetyHal.cpp"
32	OBJ_YSTIMER_ID - error occurred in "CysTimer.cpp"
36	OBJ_MSTIMER_ID - error occurred in "CmsTimer.cpp"
44	OBJ_BASEBOARDCOM_ID - error occurred in "CBaseBoardComm.cpp"
48	OBJ_DIPSWITCH_ID - error occurred in "CDIPSwitch.cpp"
52	OBJ_HELPER_ID - error occurred in "CHelper.cpp"
56	OBJ_SYNCLINE_ID - error occurred in "CSyncSafetyPartner.cpp"
60	OBJ_TIMETABLE_ID - error occurred in "CTimeTableManager.cpp"
64	OBJ_TESTHANDLER_ID - error occurred in "CTestHandler.cpp"
80	OBJ_TIME_ITERATOR_ID - error occurred in "CTimeTableIterator.cpp"
96	OBJ_SPI_ID - error occurred in "CSpi.cpp"
97	OBJ_TIMER_ID - error occurred in "CTimer.cpp"

Id	Explanation
98	OBJ_BACKUPSRAM_ID - error occurred in "CBackupSRam.cpp"
99	OBJ_PWR_ID - error occurred in "CPwr.cpp"
100	OBJ_RCC_ID - error occurred in "CRcc.cpp"
101	OBJ_GPIO_ID - error occurred in "OBJ_GPIO_ID"
102	OBJ_DMASTREAM_ID - error occurred in "CDmaStream.cpp"
103	OBJ_ADC_ID - error occurred in "CAdc.cpp"
104	OBJ_WD_ID - error occurred in "CWatchdog.cpp"
105	OBJ_FLASH_ID - error occurred in "CFlash.cpp"
106	OBJ_I2C_ID - error occurred in "CI2c.cpp"
128	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 1) "
129	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 2) "
130	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 3)"
131	OBJ_INPUTHANDLER_ID - error occurred in "CInputHandler.cpp (Safe-In 4)"
144	OBJ_OUTPUT_ID - error occurred in "COutput.cpp (Safe-Out 1)"
145	OBJ_OUTPUT_ID - error occurred in "COutput.cpp (Safe-Out 2)"
148	OBJ_USTESTPULSE_ID - error occurred in "CUSTestOuls.cpp"
160	OBJ_OUTPUTHANDLER_ID - error occurred in "COutputHandler.cpp"
164	OBJ_OUTPFSWITCH_ID - error occurred in "COutpFSSwitch.cpp"

8.1.13. Error class $200A_h$ for µC1 and $201A_h$ for µC2

Designation	Value
Name	Error Class CPU 1/2
Index	$200A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	no
Default Value	00000000_h

The table below explains the meaning of the entries in object $200A_h$ and $201A_h$ "Error Class".

Id	Explanation
0	No Error
1	Serious error or synchronisation error
2	Internal communication error
3	I/O Error
4	Error in Error Handler or at the outputs
5	Fatal error

8.1.14. System uptime [s] 200Ch

Designation	Value
Name	System uptime [s] (implicit MRAM test)
Index	200Ch
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	no
Units	sec
Default Value	No default Value

8.1.15. Temperature warning 0x2016h

Designation	Value
Name	Temperature warning
Index	2016h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	no
Value	0°C – 55°C = 0; <0°C or >55°C = 1
Default Value	No default Value

8.1.16. Objects - For Internal Use Only

The objects listed below are not intended for use by the end user. Some of them are used for configuration purposes and their values cannot be retrieved.

Object	Meaning/Designation
0x10F1h	Error Settings
0x1600h	FSOE Rx PDO Mapping
0x1A00h	FSOE Tx PDO Mapping
0x1C00h	Sync Manager Type
0x1C12h	Rx PDO Assign
0x1C13h	Tx PDO Assign
0x1C32h	SM Output Parameter
0x1C33h	SM Input Parameter
0x 2000h	Ref Voltage for µC1
0x 2010h	Ref Voltage for µC2
0x 2002h	Supply 5 Voltage for µC1
0x 2012h	Supply 5 Voltage for µC2
0x 2003h	Supply 3.3 Voltage for µC1
0x 2013h	Supply 3,3 Voltage for µC2
0x 2004h	IC Temperature (uncalibrated) for µC1
0x 2014h	IC Temperature (uncalibrated) for µC2
0x 200Bh	Number of CORA Test Cycles for µC1
0x 201Bh	Number of CORA Test Cycles for µC2
0x 2020h	MaxAsicDataUnequalCounter
0x 2220h	MC1 Main Loop Cycle Time
0x 2221h	MC2 Main Loop Cycle Time
0x 5001h	Id MC1
0x 5002h	Id MC2
0x 5003h	Id MC3
0x 6000h	FSOE Slave Frame Elements
0x 6001h	FSOE Inputs
0x 7000h	FSOE Master Frame Elements
0x 7001h	FSOE Outputs

Object	Meaning/Designation
0x 8000h	Input Parameter
0x 8001h	Output Parameter
0x 8002h	Test Pulse Duration
0x 8003h	Test Frequency
0x 9001h	FSOE Communication Parameter
0x F980h	Safe Address

8.2. Standards Complied With

8.2.1. Product Standard Applied

→ EN 61131-2:2007
Programmable logic controllers – Part 2: Equipment requirements and tests

8.2.2. Safety Standards and Directives

→ IEC 61508:2010 Parts 1-7
Functional safety of electrical/electronic/programmable electronic safety-related systems
→ EN ISO 13849-1:2015
Safety of machinery – Safety-related parts of control systems Part 1: General principles for design
→ EN 62061:2005 + AC:2010 + A1:2013 + A2:2015
Safety of machinery - Functional safety of electrical, electronic and programmable electronic safety-related control systems
→ EN 60204-1:2006 + A1:2009 + AC:2010 (excerpts)
Safety of machinery – Safety-related parts of control systems -Part 1: General principles for design

8.2.3. EMC Standards

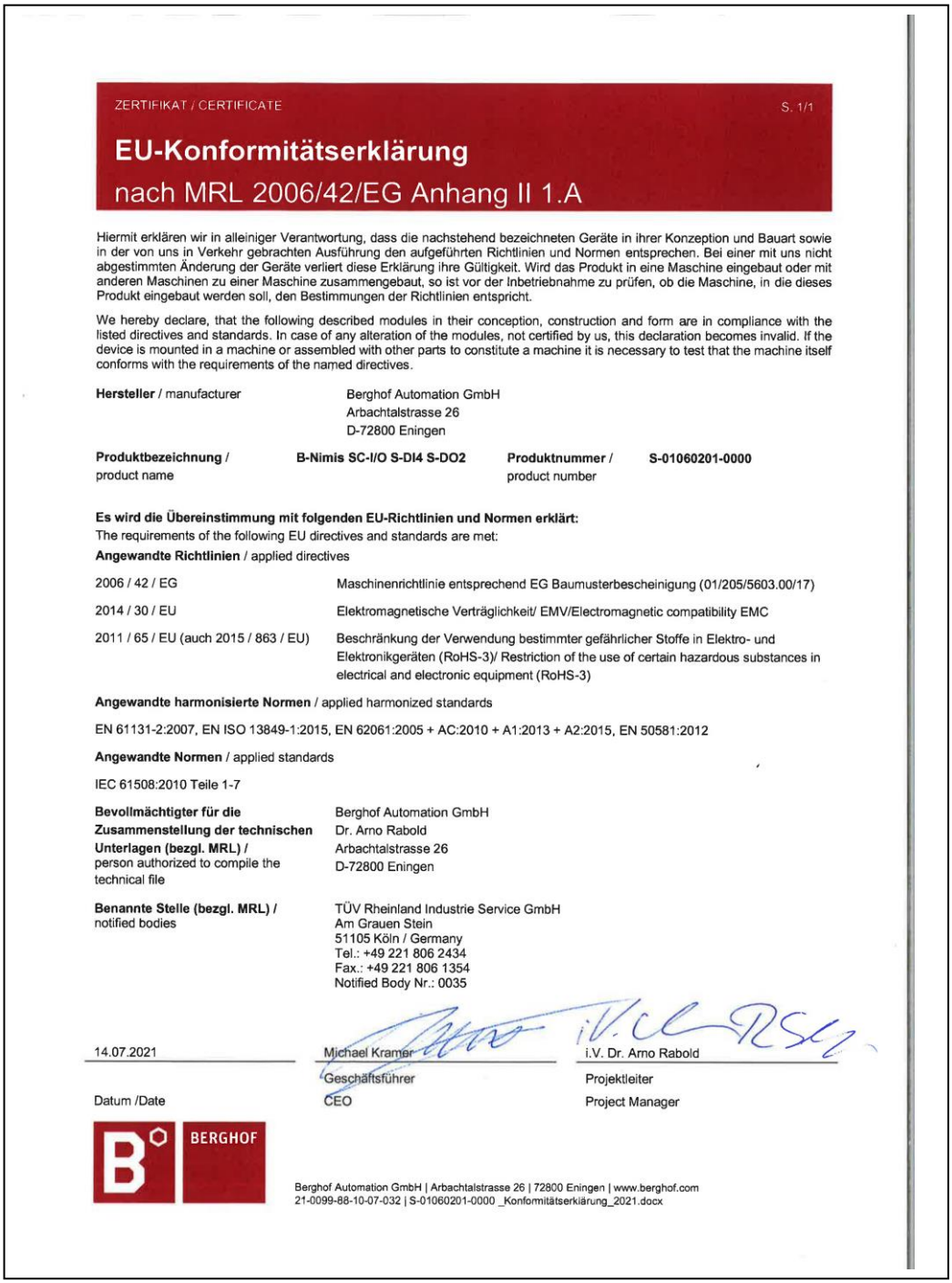
EMC Susceptibility to interference
→ Generic standard DIN EN 61000-6-2:2005
Electromagnetic compatibility (EMC) – Part 6-2: Generic standards - Immunity for industrial environments
→ Product standard DIN EN 61131-2:2007
Programmable logic controllers – Part 2: Equipment requirements and tests

Enhanced interference immunity levels of safety-related applications
→ DIN EN 61326-3-1:2008
Electrical equipment for measurement, control and laboratory use - EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications

EMC interference emission to
→ Generic standard DIN EN 61000-6-4:2007
Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
→ Product standard EN 61131-2:2007
Programmable logic controllers – Part 2: Equipment requirements and tests

8.3. Directives and Declarations

8.3.1. Declaration of Conformity



ZERTIFIKAT / CERTIFICATE S. 1/1

EU-Konformitätserklärung
nach MRL 2006/42/EG Anhang II 1.A

Hiermit erklären wir in alleiniger Verantwortung, dass die nachstehend bezeichneten Geräte in ihrer Konzeption und Bauart sowie in der von uns in Verkehr gebrachten Ausführung den aufgeführten Richtlinien und Normen entsprechen. Bei einer mit uns nicht abgestimmten Änderung der Geräte verliert diese Erklärung ihre Gültigkeit. Wird das Produkt in eine Maschine eingebaut oder mit anderen Maschinen zu einer Maschine zusammengebaut, so ist vor der Inbetriebnahme zu prüfen, ob die Maschine, in die dieses Produkt eingebaut werden soll, den Bestimmungen der Richtlinien entspricht.

We hereby declare, that the following described modules in their conception, construction and form are in compliance with the listed directives and standards. In case of any alteration of the modules, not certified by us, this declaration becomes invalid. If the device is mounted in a machine or assembled with other parts to constitute a machine it is necessary to test that the machine itself conforms with the requirements of the named directives.

Hersteller / manufacturer — Berghof Automation GmbH, Arbachtalstrasse 26, D-72800 Eningen

Produktbezeichnung / product name: **B-Nimis SC-I/O S-DI4 S-DO2** — **Produktnummer** / product number: **S-01060201-0000**

Es wird die Übereinstimmung mit folgenden EU-Richtlinien und Normen erklärt:
The requirements of the following EU directives and standards are met:

Angewandte Richtlinien / applied directives

2006 / 42 / EG	Maschinenrichtlinie entsprechend EG Baumusterbescheinigung (01/205/5603.00/17)
2014 / 30 / EU	Elektromagnetische Verträglichkeit/ EMV/Electromagnetic compatibility EMC
2011 / 65 / EU (auch 2015 / 863 / EU)	Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten (RoHS-3)/ Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS-3)

Angewandte harmonisierte Normen / applied harmonized standards

EN 61131-2:2007, EN ISO 13849-1:2015, EN 62061:2005 + AC:2010 + A1:2013 + A2:2015, EN 50581:2012

Angewandte Normen / applied standards

IEC 61508:2010 Teile 1-7

Bevollmächtigter für die Zusammenstellung der technischen Unterlagen (bezgl. MRL) / person authorized to compile the technical file: Berghof Automation GmbH, Dr. Arno Rabold, Arbachtalstrasse 26, D-72800 Eningen

Benannte Stelle (bezgl. MRL) / notified bodies: TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln / Germany, Tel.: +49 221 806 2434, Fax.: +49 221 806 1354, Notified Body Nr.: 0035

14.07.2021	Michael Kramer	i.V. Dr. Arno Rabold
	Geschäftsführer	Projektleiter
Datum /Date	CEO	Project Manager

BERGHOF

Berghof Automation GmbH | Arbachtalstrasse 26 | 72800 Eningen | www.berghof.com
21-0099-88-10-07-032 | S-01060201-0000 _Konformitätserkiärung_2021.docx

The original Declaration of Conformity and the associated documentation can be made available to the competent authorities. Please contact the Project Management, as necessary.

8.3.2. TÜV Certificate

EC Type-Examination Certificate

Reg.-Nr./No.: 01/205/5603.02/21

Prüfgegenstand **Product tested**	Sichere digitale Ein-/Ausgabebaugruppe mit sicherer Kommunikation über FSoE Safe digital I/O module with safe communication FSoE	**Zertifikats-inhaber** **Certificate holder**	Berghof Automation GmbH Arbachtalstrasse 26 72800 Eningen Germany
Typbezeichnung **Type designation**	B-Nimis SC-I/O S-DI4 S-DO2 Typ-Nr. S-01060201-0000 E-I/O S-DI4 S-DO2 / Typ-Nr. 204809000		
Prüfgrundlagen **Codes and standards**	EN ISO 13849-1:2015 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015		EN 61508 Parts 1-7:2010 EN 61131-2:2007
Bestimmungsgemäße Verwendung **Intended application**	Das I/O-Modul erfüllt die Anforderungen der Prüfgrundlagen (Kat. 3 / PL e nach EN ISO 13849-1, SILCL 3 nach EN 62061 / EN 61508) und kann in Anwendungen bis zu diesen Sicherheitsleveln eingesetzt werden. Das Gerät kann im Anwendungsbereich der EN 60204-1:2018 eingesetzt werden. The I/O module complies with the requirements of the relevant standards (Cat. 3 / PL e according to EN ISO 13849-1, SILCL 3 according to EN 62061 / EN 61508) and can be used in applications up to these safety levels. The product can be used in the application area of EN 60204-1:2018.		
Besondere Bedingungen **Specific requirements**	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sowie des Sicherheitshandbuchs sind zu beachten. The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Es wird bestätigt, dass der Prüfgegenstand mit den Anforderungen nach Anhang I der Richtlinie 2006/42/EG über Maschinen übereinstimmt.
It is confirmed, that the product tested complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.

Gültig bis / Valid until 2026-08-04

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. 968/FSP 1259.03/21 vom 26.07.2021 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen.
The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 1259.03/21 dated 2021-07-26.
This certificate is valid only for products which are identical with the product tested.

Köln, 2021-08-04

Notified Body for Machinery, NB 0035

Dipl.-Ing. Jelena Stenzel

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TÜVRheinland®
Precisely Right.

TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln / Germany
Tel.: +49 221 806-2434, Fax: +49 221 806-1354, E-Mail: industrie-service@de.tuv.com

8.4. List of figures

9. Customer Service / Addresses

Repair work on the B-Nimis SC-I/O S-DI4 S-DO2 safety module is not permitted. In the event of a defect, return the module to Berghof Automation GmbH Customer Service.

9.1. Customer Service

Berghof Automation GmbH
Arbachtalstr. 26
72800 Eningen
Germany
T +49.7121.894-183
F +49.7121.894-100
e-mail: support-controls@berghof.com
www.berghof.com