c250-S

C25BAYSQ

Translation

Operating Instructions EN

c250-S Safety controller

1 Version Details

1.1 Revisions

1.1.1 Manual

Modification history		
Version	**Date**	**Comments / modifications**
1.0	03/07/2017	First Version for Release
1.1	02/08/2017	Minor Corrections
1.2	29/08/2017	Corrections oft he Safety Ratings, Chapter 7.1
1.3	31/01/2018	Corrections
1.5	17/07/2019	Corrections (Version 1.4 skipped)
1.6	13/05/2020	Corrections
1.7	19/10/2022	Corrections

1.1.2 Manual version / Safety controller c250-S version

The following table describes the relationship between the module release (module version) and the corresponding manual version.

Module release			
Version	**Manual**	**Date**	**Comments / modifications**
1.0	1.0	03/07/2017	Applies to module release V 1.0 (Softwareversion V1.2.0, Hardwareversion V1.00)
1.0	1.1	02/08/2017	Applies to module release V 1.0 (Softwareversion V1.2.0, Hardwareversion V1.00)
1.0	1.2	29/08/2017	Applies to module release V 1.0 (Softwareversion V1.2.0, Hardwareversion V1.00)
1.04	1.3	31/01/2018	Applies to module release V 1.04 (Softwareversion V1.2.0, Hardwareversion V1.00)
1.04	1.5	17/07/2019	Applies to module release V 1.04 (Softwareversion V1.2.0, Hardwareversion V1.00)
1.04	1.6	13/05/2020	Applies to module release V 1.04 (Softwareversion V1.2.0, Hardwareversion V1.00)
1.04	1.7	19/10/2022	Applies to module release V 1.04 (Softwareversion V1.2.0, Hardwareversion V1.00)

1.1.3 Terminology

Terminology	
Term	**Explanation**
Safety controller c250-S	The safety control unit described in this document
Standard PLC	Main control of the system that provides the EtherCAT master
»PLC Designer«	Programming environment for the standard PLC
Safety package	»PLC Designer« safety extension
PLCopen Safety	Certified library of safety function blocks
»PLC Designer« safety extension	Certified safety programming environment
Logical exchange variables	Let you exchange information between the Safety controller c250-S and the standard PLC (see »PLC Designer« Safety Manual)

2 Preface

2.1 About this Operating Instruction

This document is the manual for users of the Safety controller c250-S module assigned product number C25BAYSQ.

For your work with the module, always consult the »PLC Designer« Safety User Guide version certified for »PLC Designer« Safety 1.2.0 as provided by Lenze SE.

This document is intended for the target group described in section 2.2.2 Target Groups. It does not contain any availability information. We reserve the rights for errors, omissions and modifications. Pictures are similar.

> **I** ***Information***
>
> Always use the current version of the manual.
> You will find information and aids relating to the Lenze products in the Internet: http://www.lenze.com ► Download

2.1.1 Limitation of Liability

The content of this publication has been checked for consistency with the hardware and software described. Deviations can nevertheless not be excluded, so that we can not guarantee for the complete conformity. The information contained in this publication is regularly checked and necessary corrections are included in the subsequent editions.

All specifications are only of a descriptive nature and must not 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 reasons - are excluded, except in instances of deliberate intent or gross negligence on our part.

2.1.2 Terms of Delivery

The general conditions of sales and service of Lenze shall apply.

2.1.3 Copyright

Trademarks

- Microsoft®, Windows® and the Windows® logo are registered trademarks of Microsoft Corp. in the USA and other countries.
- EtherCAT® (incl. FSoE) is a registered brand and patented technology, licenced by Beckhoff Automation GmbH, Germany.
- Safety over EtherCAT is a registered trademark and patented technology, licenced by Beckhoff Automation GmbH, Germany.
- PLCopen ® is a registered trademark of PLCopen Association. Further information about the PLCopen organisation is available at www.plcopen.org.
- CiA® and CANopen® are registered joint brands of CAN in Automation e.V.

Title to all companies and company names mentioned herein as well as to products and product names is held by the respective enterprises.

2.1.4 Warranty

Warranty is subject to the provisions of the conditions of sale of Lenze or any contractual agreements between the parties.

The warranty will be voided by:

- improper assembly and use,
- repairs or inadmissible servicing,
- opening the module housing,
- modifying or removing the Safetynumber or rendering it illegible.

2.1.5 Symbols and Means of Presentation

You will find the following symbols and means of presentation throughout this Operating Instruction:

Symbols and Means of Presentation	
Symbol	**Explanation**
I	Further product information

2.2 Reliability, Safety

2.2.1 Applicability

This Operating Instruction contains all the information you need to use the product described as intended.

2.2.2 Target Groups

The Operating Instruction 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 Hazard and Other Warnings

Despite the actions described in section 2.2.5Safety , 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 Operating Instruction. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

Every alert and hazard warning is made up as follows:

- Type and source of risk
- Brief description of risk and potential consequences of
- Preventive measures

The signal words below are used for warnings you must respect for your own safety and to avoid material damage.

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

2.2.4 Other Notices

> **I**
>
> ***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).

2.2.5 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 humans or material/equipment.

> ***DANGER***
>
> **Non-compliance with the Operating Instruction**
> Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.
> ⇨ Carefully read the Operating Instruction.
> ⇨ Take particular heed of the hazard warnings.

> **I**
>
> ***Information***
>
> To achieve a high degree of conceptual safety in planning and installing an electronic controller, it is essential to exactly follow the instructions given in the Operating Instruction because wrong handling could lead to rendering measures against dangers ineffective or to creating additional dangers.

2.2.6 Project Planning and Installation

- Comply with the safety and precautions regulations for qualified applications.
- 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.
- Always comply with the relevant standards and VDE regulations.
- Control elements are to be installed in such a way as to exclude unintended operation.

2.2.7 Maintenance and Servicing

- Accident prevention regulations to be observed when measuring or checking a controller after power-up.
- The Safety controller c250-S is maintenance free, no spare parts available.
- You are not allowed to repair the Safety controller c250-S module. Please return the defective module and a problem description to Lenze service GmbH.
- De-energise the module before making changes to the structure or wiring. You may otherwise destroy the module or jeopardise its functionality. In addition, unexpected danger situations can arise, which can lead to accidents.

2.2.8 General Notes 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).

I

Information

In order to safely install the Safety controller c250-S, take heed of the information in section 6 Installation and Operation and later.

Interference emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

I

Information

If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.

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 .

> **Information**
>
> 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 noise voltages are limited to tolerable levels.

Electrical immission safeguard

To eliminate electromagnetic interference, connect the control system to the protective earth conductor.

Cable routing and wiring

Keep power circuits separate from control circuits:

• DC voltage,	60 … 400 V
• AC voltage,	25 … 400 V
•	

Jointly lay the following control circuits only:

• data signals	shielded
• analogue signals	shielded
• digital I/O lines	shielded
• DC voltages	< 60 V, unshielded
• AC voltages	< 25 V, unshielded

Location of installation

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

Temperature

Consider heat sources: general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use suitable casings to avoid possible negative influences due to humidity, corrosive gas, liquids or conducting dust (e.g. installation in a suitable control cabinet).

Impact and vibration

Consider potential 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.

3 System Description

The Safety controller c250-S integrates functional safety in the control system, making the separate wiring of safety circuits a thing of the past. The job of the Safety controller c250-S is to run the safety application programme and to share the safety-related control information with the assigned safe slave modules.

Safety controller c250-S

Using the Safety controller c250-S requires the use of a higher-level control unit based on »PLC Designer« and referred to as the standard PLC below as well as EtherCAT as the fieldbus for data exchange.

3.1 Control System – Overview of Functionality

The picture below illustrates an example of a control system featuring a Safety controller c250-S.

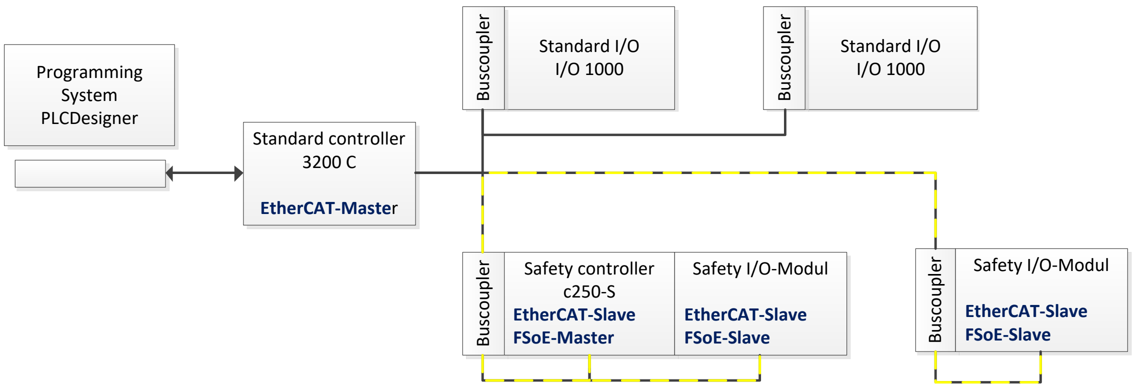


Fig. 1: System overview

Ethernet links the programming PC running the »PLC Designer« Safety Extension with the standard PLC in order to program it. Making use of the EtherCAT fieldbus, the standard PLC may then program one or several Safety controller c250-S.

In normal service mode, EtherCAT exchanges the process data between the standard PLC and the standard actuators and sensors.

At the same time, the Safety controller c250-S uses the EtherCAT fieldbus and the protocol “FSoE” to exchange the safety-related signals with safe I/O modules or drives.

3.2 EtherCAT® – Ethernet Control

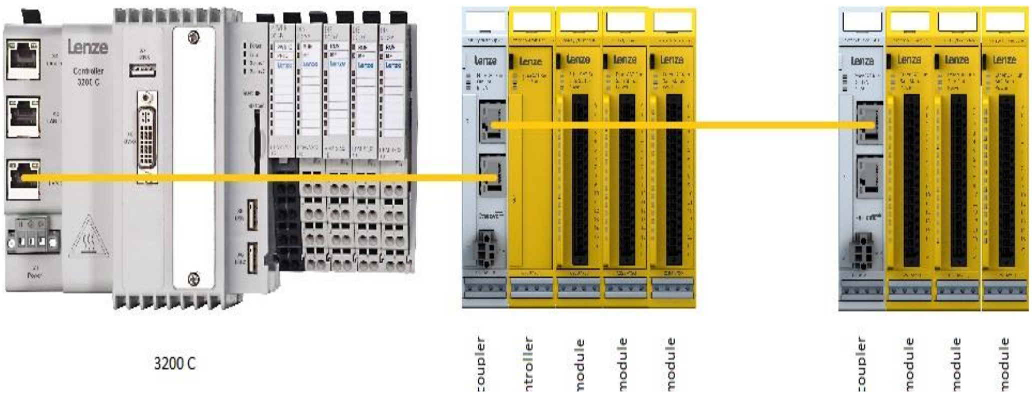
EtherCAT in an Ethernet-based fieldbus system whose speed makes it a good choice of a fast drive and I/O bus of control units (industrial PC or PLC).

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 controllers thus nearly act like centralised control systems,

3.3 c250-S Safety system

The c250-S system consists of the Safety bus coupler, the Safety controller c250-S and various Safety I/O modules.

Acting as the head module, the Safety bus coupler converts the twisted pair-based transfer to LVDS (E-bus) and generates the system voltages for the LVDS modules. The standard 100 Base Tx lines used for communications connect to the one side, the Safety I/O modules for the process signals stack up at the other. This is how the EtherCAT protocol is retained right through to the last Safety I/O module.



c250-S system

3.4 Safety System

The c250-S safety system adds the Safety controller c250-S of this guide and Safety I/O modules to the Standard PLC, making the separate wiring of safety circuits a thing of the past. The EtherCAT protocol is used to transfer both safe and standard signals to the Safety controller c250-S. This integration is based on the certified FSoE safety protocol.

3.4.1 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. Both the protocol and its implementation are certified to comply with Safety Integrity Level 3 (SIL 3) to IEC 61508. In 2010, IEC 61784-3-12 was published as the international reference standard for Safety over EtherCAT.

Safety over EtherCAT®

Fig. 2: FSoE logo

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 left out of the safety assessment.

3.4.2 Safety controller c250-S

The Safety controller c250-S links the Safety I/O system's inputs and outputs to the safety-related signals of other FSoE equipment of the installation.

It generally interacts with a higher-level »PLC Designer« PLC referred to as the standard PLC in this guide. The Safety controller c250-S has a two-channel architecture which supports communication with both the programming system via the standard PLC and with the standard PLC's non-safe variables and its inputs and outputs using logical exchange variables (see »PLC Designer«Safety Manual - "Logical I/Os").

3.4.3 »PLC Designer«Safety

A certified and fully integrated plug-in (safety package) of the »PLC Designer« development system is used to program the Safety controller c250-S.

In the tree of units, the Safety controller c250-S is shown under the standard PLC as an EtherCAT slave node with its own application, a task, lists of global variables, POUs and logical I/Os. It provides all functions described in the »PLC Designer«® Safety Manual for »PLC Designer« version 1.2.0, the only restriction being that the only way of integrating it is using EtherCAT as the medium of communicating with the Safety controller c250-S.

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 »PLC Designer« user manual.

At the basic level, certified function blocks (PLCopen safety) are graphically "wired up" to establish the system's safety programme. In case 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.
Further software functions are available for safeguarding the safety functions by change tracking, safe flow of signals, safe version control (pinning), separating safe operation, and debugging mode.

3.4.4 PLCopen Safety Library in the »PLC Designer« Environment

The PLCopen components have been defined and certified by the PLCopen organisation, its members and external organisations specialising in all safety-related aspects. The components interlink by logical operations which behave like logical wiring and admit the reliable programming of a safety application.

Fig. 3: PLCopen

> ***Information***
>
> The use of certified secure blocks alone does not guarantee that the user program is fault-free. Each program must be developed and thoroughly tested for safety.

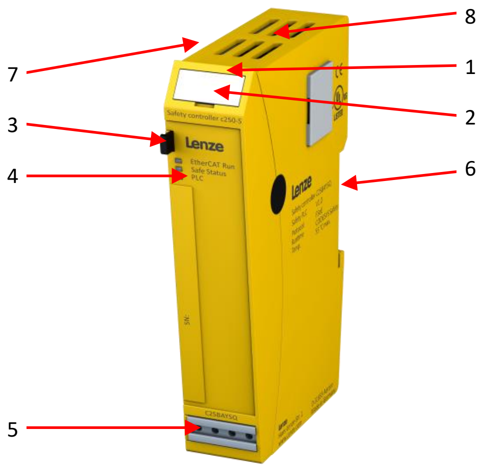
4 Product Description

4.1 Safety controller c250-S

The job of the Safety controller c250-S is to integrate safety functions in a control system. The Safety controller c250-S essentially consists of two microprocessors which implement the safety functions, exchange process data and mutually monitor each other. A third microprocessor manages all external communication processes.

To support its integration in an EtherCAT system, the Safety controller c250-S is designed as a stackable module which may be installed on a 35mm DIN rail in a switching cabinet.

General view



External features of the Safety controller c250-S module

Item	Designation	Item	Designation
1	Grip	5	Shield-to-housing mount connector
2	Labelling clip	6	DIN rail mount and functional earth
3	Unlock button	7	Module lock, E-bus
4	Status LEDs	8	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 LEDs, the side faces and the front are made of plastic and contain the module.

4.2 Application

4.2.1 Intended Use

The c250-S safety with the Safety controller c250-S, Safety I/O module and the »PLC Designer« Safety Software provides functions which allow the use of the Safety I/O modules for applications demanding the functional safety of machinery.

It is intended for applications requiring 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. By definition, a wattless state is "fail-safe". 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 Operating Instruction's Technical Data section must be read carefully and obeyed at any time. The system is not designed 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. Forbidden 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.

In particular, only use within the framework of the applicable Machinery Directive (Directive 2006/42 / EC) [UKCA: S.I.2008/1597] is authorized.

WARNING

Using unsuitable EtherCAT Modules reduces the safety level!

⇨ To ensure the correct operation of the safety application, run the Safety controller c250-S with ETG compliant modules only.

WARNING

Impairment of safety when using unsuitable FSoE Slave modules!

⇨ The Safety controller c250-S can only be used with FSoE compliant and certified slave modules.

4.2.2 Qualified Persons

The safety-related products may be used by the following persons only:

- 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.

This manual's safety instructions construe qualified persons as 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 manual are therefore part of this qualification.

WARNING

Improper operation by unqualified persons!

⇨ Have only properly qualified persons install and program the Safety controller c250-S.

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 standards and directives,
- unauthorised modifications of devices, connections or settings,
- the 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. It is the aimed-for safe functional state at which the system works without problems.
- The second one is the fail-safe state assumed in response to any internal fault or error. The second one is the fail-safe state and is assumed in the case of an internal or external detected fault.

4.3.1 Safe Functional State

The state is functionally safe when everything is working as it should.

It includes errors indicated to the Safety controller c250-S by any of the modules connected to it. These errors generally do not change the safe functional state and are therefore handled by the safety application (e.g. loss of communication with a safe I/O module).

4.3.2 Fail-Safe State

Internal error

The state of the Safety controller c250-S is considered "fail-safe" when valid FSoE frames are no longer sent to the associated safe FSoE slaves. In the absence of valid FSoE telegrams, the outputs of the FSoE slaves will change to safe state (Outputs currentless).

If affecting safety, internal errors are responded to by changing to the fail-safe state which also stops FSoE communication. To the extent possible, EtherCAT communication will still be enabled and provide diagnostic options.

External Error

The module monitors its supply voltage (high and low voltage) and the admissible operating temperature. Whenever either of the two is outside the admissible range, the Safety controller c250-S changes to the fail-safe state and stops sending FSoE frames.

To quit the fail-safe state

The only way of quitting the fail-safe state is to turn off the power supply to the head module (bus coupler). Initialising after powering up again includes a complete self-test.

In conformity with the FSoE specification, FSoE slaves linked into the system will change to the safe state if a correct FSoE frame fails to be received before the watchdog times out.

4.3.3 Traceability

Traceability means that the time, place and entity that produced, processed, stored, transported, consumed or disposed of a product or trading good can be traced back at any time.

Whereas Lenze is able to meet this requirement with regard to production, processing, storage and transport, the purchaser is responsible for all further whereabouts of the product.

Identification and, thus, traceability of the product is ensured by its Safetynumber which is printed on the front of the module and on a decal on the underside of the module. Or you can retrieve it by software means. To ensure proper traceability, the purchaser is obliged to note down this number together with the machine's name, place of installation and end customer.

> I
>
> ***Information***
>
> The purchaser must ensure the units' traceability by means of their Safetynumber.

4.4 Useful Lifetime

The Safety controller c250-S modules have a design lifetime of max. 20 years after the date of manufacture (see section 5.1 Labelling and Identification). The module to be removed from service not later than one week before the end of this 20-year period (see section 6.10.3 Taking out of Service).

> I
>
> ***Information***
>
> The date of manufacture is part of the Safetynumber printed on the housing and stored in the Safety controller c250-S's memory (see section 5.1.2 Safetynumber).

4.5 Technical Data

4.5.1 General specifications

Designation	Value
Device data	
Product name	Safety controller c250-S
Fieldbus	EtherCAT 100 Mbps
E-bus port	10-pin system plug in side wall
Memory for PLCDesigner Safety application and Safety configuration data	A total of 512kbytes are available: : • 400kByte for the PLCDesigner Safety application • 112kByte for the configuration data
Electrical insulation	all modules electrically insulated from one another and from the bus
Diagnosis	LEDs (see section 5.3 Status LEDs)
E-bus load	max. 240 mA (system power supply)
Terminating module	module bus to be covered on the last module
System power supply	
Supply voltage	5 VDC via E-bus link supplied by the head module (bus coupler in accordance with EN 61131-2 which is powered by 24 VDC, min. -15% / +20% SELV/PELV)
Overvoltage category	category II to IEC 60664-1 in conformity with EN 61131-2
Reverse polarity safeguard	yes
Susceptibility to noise	install in zone B (61000-6-2 in conformity with EN61131-2), install on earthed DIN rail in an earthed switching cabinet. Lay the earth cable according to service conditions (see section 6.2.1 Earthing)
Storage and transport conditions	
Ambient temperature	–25 °C…+70 °C
Rel. humidity	5% … 95%, non-condensing
Atmospheric pressure	70 kPa…108 kPa
Vibration	5 Hz…8.4 Hz: ±3.5 mm amplitude, 8.4 Hz…150 Hz: 10 m/ s² (1g) to IEC 60068-2-6, Fc test
Shock	150 m/s² (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Service conditions	
Mounting position	horizontal, stackable
Degree of contamination	II to IEC 60664-3
Admissible operating environment	operation restricted to environments complying with IP54 or better to IEC 60529 (e.g. suitable control cabinet)
Operating temperature	0 °C…+55 °C
Relative humidity	5% … 95%, non-condensing
Atmospheric pressure	80 kPa…108 kPa
Altitude of site	max. 2000 m above MSL
Vibration	5 Hz…8.4 Hz: ±3.5 mm amplitude, 8.4 Hz…150 Hz: 10 m/s² (1g), to IEC 60068-2-6, Fc test
Shock	150 m/s² (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Mechanical properties	
Installation	35 mm DIN rail (top-hat rail)
Dimensions (W x H x D)	25 mm x 120 mm x 90 mm
Ingress protection	IP20

Designation	Value
Housing mount	aluminium
Shield	connects straight to module housing

4.5.2 Size of FSoE Data Frame

According to the FSoE protocol, the maximum frame size is 1322 bytes. This is also the maximum amount of data that a Safety controller c250-S can exchange with the FSoE slaves.

To calculate the maximum number of FSoE slaves supported by a Safety controller c250-S, just add up the safe I/O data of every slave plus the protocol overhead (the result corresponds to the size of the image). Refer to the product description of the FSoE slave in question to find the relevant size details.

Typical values for the size of the FSoE image of an FSoE slave depending on the safe I / O user data:

Payload data (Bytes)	Value
1	6
2	7
4	11
8	19
16	35
32	67

The general rule:

Size of the FSoE image = 2 × secure I / O data + 3 byte data (CMD + Connection ID)

The minimum size of the image is 6 bytes

> **I** ***Information***
> A safety application will fail to start if its configuration exceeds the above maximum size of the FSoE data frame.

4.5.3 Cycle Time Setup of Safety Application

The programming system is used to set the cycle time of the safety application. Settings in the range from 4 ms to 600 ms can be varied at steps of 1 millisecond.

> **I** ***Information***
> Values outside the range can not be set.
> When the Safety Application is loaded onto the Safety controller c250-S, a fault message is displayed.

For new safety projects it is recommended to set the cycle time to a high value (for example 50ms). When the application is running, the actual cycle can be read out in Communication Object (Object 2220, subindex 4). This value can then be set plus a buffer (e.g. + 20%).

4.5.4 Response Time

The total response time of a safety system (consisting of the Safety controller c250-S, safe I/O modules linked in via FSoE, and the sensors and actuators connected to the safe I/O modules) is made up of the signal processing times of each of the components (see picture below). The response time of the Safety controller c250-S of this Operating Instruction equals the task cycle time set in the safety application.

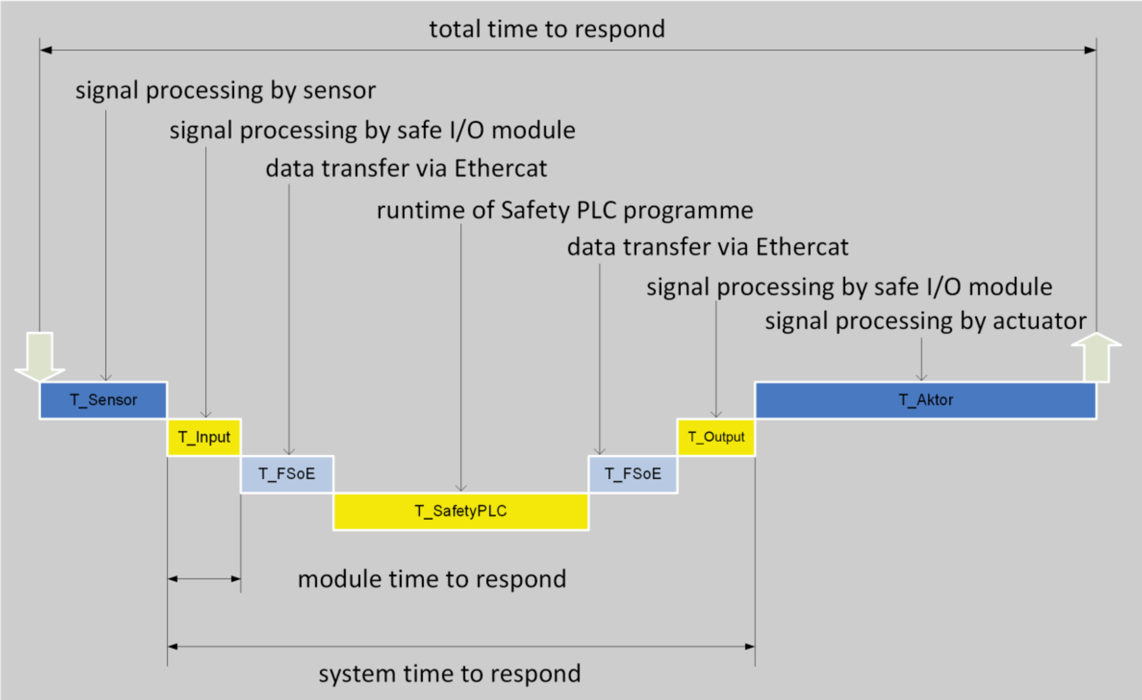


Fig. 4: Response time in the system (example)

Definition	Description
T_Sensor	Sensor's processing time up until it delivers the signal to the interface. This time is normally specified by sensor manufacturer.
T_Input	Processing time of a safe input, e.g. a SI4/SO2 module. This time is listed among the input module's technical data.
T_WDInput (not marked)	Set Watchdog time in the Safety PLC (safety controller c250-S) for safe input, e.g. Safety I/O module.
T_FSoE	Communication processing time amounting to max. 3x the EtherCAT cycle time. This is due to the fact that sending any new data must wait for the next safety-over-EtherCAT frame and that, after sending, the higher-level standard PLC must first of all copy the data. The communication processing time therefore directly depends on the cycle time of the EtherCAT master.
T_SafetyPLC	Processing time of the Safety controller c250-S which is the same as the cycle time set for the safety application. The Safety controller c250-S will change to the safe state if this time is not achieved due to an excessive level of program complexity.
T_Output	Processing time of a safe output, e.g. a SI4/SO2 module. This time is listed among the output module's technical data.
T_WDOutput (not marked)	Set Watchdog time in the Safety PLC (safety controller c250-S) for safe output, e.g. Safety I/O module.

T_Aktor	Actuator's processing time. This time is normally specified by actuator manufacturer.

CAUTION

To calculate the safe response time, take account of the fieldbus runtimes and the Safety controller c250-S's cycle time.

⇨ The fieldbus runtimes and the Safety controller c250-S's cycle time must be taken account of to rate and calculate the safe response time.

⇨ In the worst case, the fieldbus runtime T_FSoe must be assumed to amount to 3x the EtherCAT cycle time per direction of data transfer.

According to ETG.5100, the calculation of the safety reaction time is performed as follows

$T_{Reaktion1}$				$T_{Reaktion2}$			
2	*	T_Sensor		2	*	T_Sensor	
2	*	T_Input	+			T_WDInput	+
		T_FSoE+		2	*	T_SafetyPLC	+
2	*	T_SafetyPLC	+			T_FSoE	+
2	*	T_ SafetyPLC	+	2	*	T_Output	+
		T_WDOutput	+	2	*	T_Aktor	
2	*	T_Aktor					

Safety response time = max { $T_{Reaktion1}$, $T_{Reaktion2}$ }

Information

Since an error can occur during the Safety controller c250-S cycle, the maximum system reaction time must always be assumed for the reaction time. This is adjustable by the watchdog time oft he FSoE Slaves.

4.5.5 Dimensions

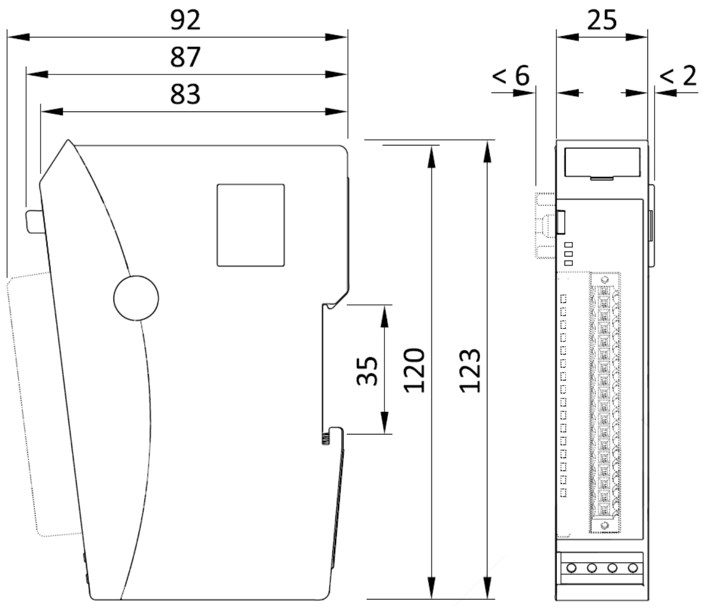


Fig. 5: Dimensions, in mm

4.6 Transport and Storage

At times of transport and storage, protect the Safety controller c250-S against inadmissible exposure such as mechanical stress, temperature, humidity and/or aggressive atmospheres.

- Transport and keep the Safety controller c250-S in its original packaging.
- Avoid soiling or damaging the contacts when picking the product or placing it in a different box.
- Keep and transport the Safety controller c250-S in suitable containers/packages in due compliance with ESD instructions.

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

- When putting the Safety controller c250-S module into service or when doing any maintenance, take the required precautions against electrostatic discharge (ESD).

CAUTION

Electrostatic discharge!
Destruction of or damage to the unit.
⇨ Use the original packaging for transporting or storing the Safety controller c250-S module.
⇨ Ensure that the ambient conditions are as specified at all times during transport and storage.
⇨ Handle the Safety controller c250-S 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

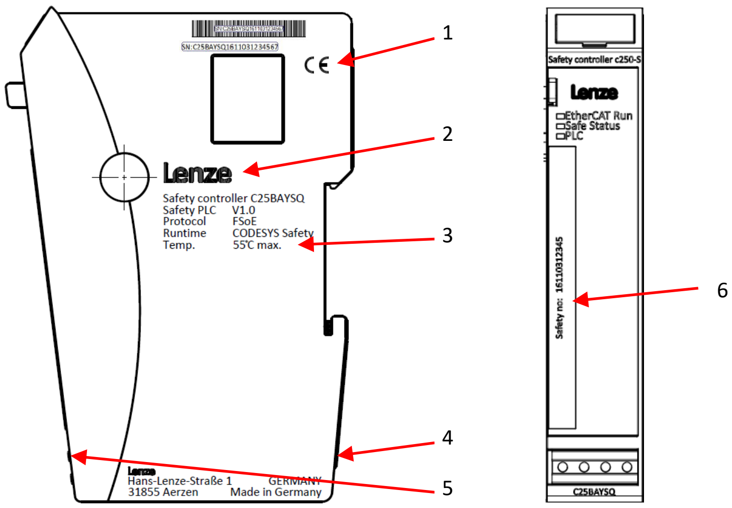


Fig. 6: Imprinted texts and symbols

Item	Designation	Item	Designation
1	mark of approval	4	serial number on underside
2	manufacturer's label	5	operative earth
3	operating conditions	6	Safetynumber on front side

5.1.2 Safetynumber

The serial number is vertically printed on the front panel. You will also find it on the decal on the back of the module.

The numerical code incorporates the production date and a serial number. It allows Lenze to identify the unit's history, model, software and hardware revision.

Fig. 7: Front view showing the serial number (SN)

Make-up of serial number: YY MM DD NNNNN

Y = year (production date)
M = month (production date)
D = day (production date)
N = consecutive number

> **Information**
>
> The serial number is also stored in sub-index 4 of object 1018h and can be accessed by an EtherCAT SDO (see section 7.2.7 Identity Object 1018h).

5.2 Contents of Package

- Safety controller c250-S
- Module bus cover
- Mounting Instructions

5.3 Status LEDs

Fig. 8: Status LEDs

Indicators:

- "EtherCAT Run": state of EtherCAT communication
- "Safe Status" (bicolor LED): state of the module regarding its safety function
- "PLC " (tricolor LED): state of the module

LED	State	Explanation
LED "EtherCAT Run"		
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, on	Op	Operational, unrestricted data exchange
LED "Safe Status"		
Green, on	OK	Module in safe functional state
Red, on	Error	Module in fail-safe state
LED "PLC "		
Off	–	Safety application not loaded
Off/yellow, 1:1	–	Loading safety application
Yellow, on	–	Safety application loaded
Green, on	–	Executing safety application
Red, on	–	Safety application stopped
Off/red, 1:1	–	Safety application aborted
Off/green, 1:1	–	Safety application in debug mode

I

Information

The status LEDs are not a safety-related display. In other words the LEDs could not be used alone as a safe indicator for the operating state of the module, etc.

5.4 Operating Software

The Safety controller c250-S is part of a distributed control system based on »PLC Designer«. The Safety controller c250-S is programmed using a programming system based on »PLC Designer« and extended by a certified plug-in (»PLC Designer« safety extension) which provides the safety functions.

WARNING

Wrong programming and parameter setup!

⇨ Verify that the »PLC Designer« safety extension used for programming and parameter setup is approved for use with the »PLC Designer« safety runtime system version 1.2.0.
⇨ The version of the PLCDesigner mustr be V3.15 or higher.
⇨ Programming and parameter setup to take heed of the correct »PLC Designer« User Manual.

6 Installation and Operation

- Before installing the safety module, verify that it has been transported and stored at the ambient conditions specified in sections 4.6 Transport and Storage and 4.5 Technical Data.
- Module operation is subject to the service conditions specified in section 4.5 Technical Data.

> ***CAUTION***
>
> **Inappropriate operation!**
> Malfunction of the Safety controller c250-S module.
> ⇨ Only persons qualified for dealing with safety matters are allowed to add, replace and put Safety controller c250-S modules into operation.
> ⇨ Prior to installing, servicing or putting the Safety controller c250-S module into operation, read the safety instructions contained in this documentation.
> ⇨ Prior to putting the module into operation, verify that all safety functions work as specified (validation of safety functions).

6.1 Mechanical Installation

> ***Information***
>
> No tools are required to install and uninstall the Safety controller c250-S. Please refer to Chapter 6.1.3 to Chapter 6.1.6.

Environment of installation

Protect the unit against inadmissible contamination (comply with contamination degree II of IEC 60664-3).

A suitable means would be an IP54 enclosure, e.g. a suitable switching cabinet. Operation under 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

The unit is intended for installation on a rail (to DIN EN 50022, 35 x 7.5 mm). Mount the DIN rail horizontally and check that the module's status LEDs are at the front.

To ensure that enough air gets in 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.

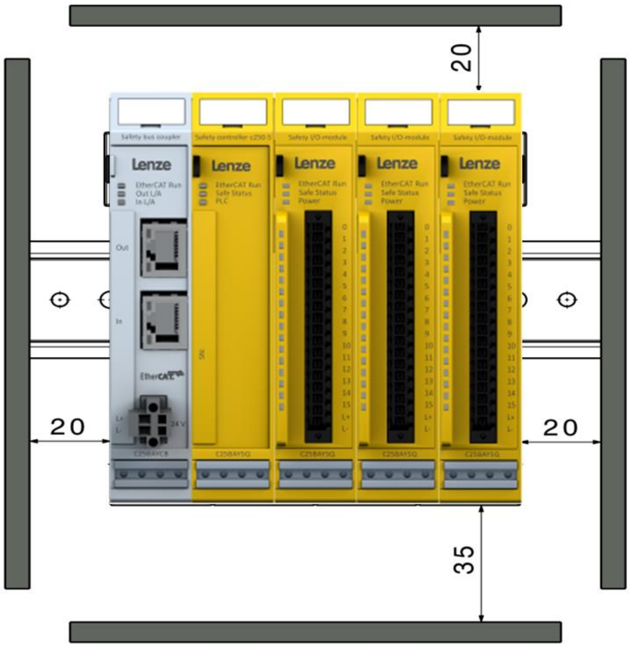


Fig. 9: Mounting position and minimum distances, in mm

6.1.2 E-bus Connector and Module Lock

The system connectors and the module lock are located on the sides of the Safety controller c250-S module. These contact pins interconnect the modules. They supply power to the module's electronic circuitry and transfer the EtherCAT signals. Leave the end cap from the package in place to protect the module bus connector of the last module to the right of the terminal unit against contamination.

The integrated module lock prevents the modules from coming apart under mechanical load or vibration.

6.1.3 To Snap on a Single Module

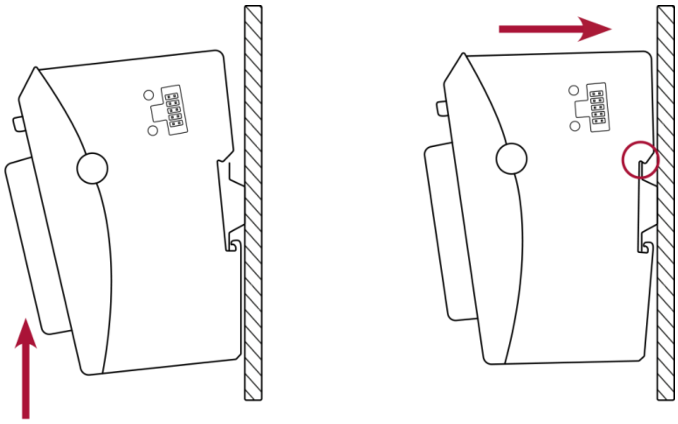


Fig. 10: Mounting a module

- Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
- Push the top of the module against the mounting wall until it snaps in.

6.1.4 To Interconnect Two Modules

- Remove cover of E-Bus
- If a module has previously been snapped on to the rail, place the next module about 1 cm away from it to the right and snap it on.
- Then push the new module left towards the other module until the unlock button snaps out.
- To prevent inadmissible contamination, mount the cover of the module bus connector on the rightmost module of the I/O system.

CAUTION

Risk of injury by the module bus contacts shorting out!
A short of the module bus contacts may cause the communication with the safe module to fail.
⇨ Verify that the end-of-bus cap is in place on the last module of a series of modules.

6.1.5 To Disconnect Two Modules

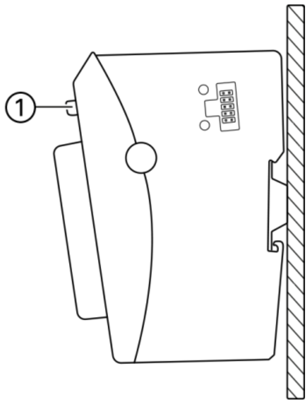


Fig. 11: Disconnecting modules

- Push the unlock button (1) of the module you wish to remove.
- Push both modules about 1 cm apart.

6.1.6 To Take Down a Single Module

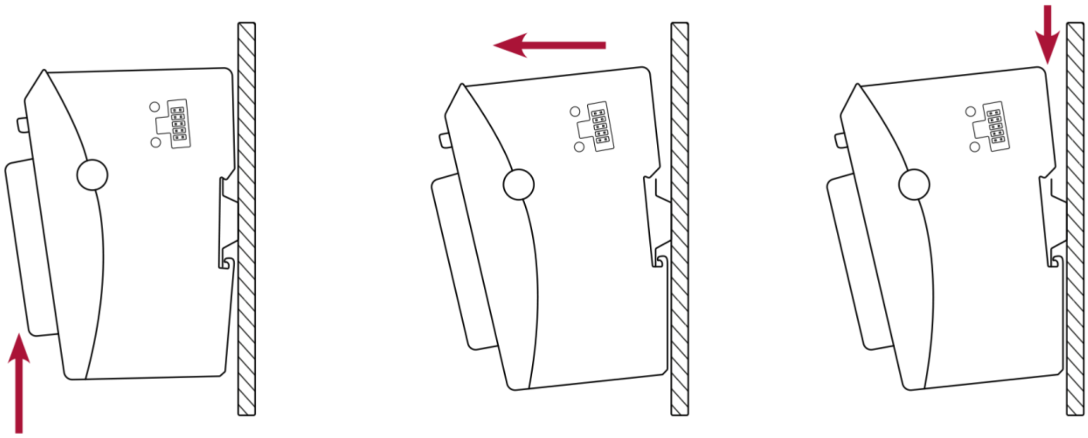


Fig. 12: Removing a module

- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module forward and away from the rail as shown in the illustration.
- Pull the module down and out of the mounting rail.

6.2 Electrical Installation

6.2.1 Earthing

Every module needs to be earthed by connecting the internal metal housing to functional earth which dissipates HF currents and is of utmost importance to the module's immunity to noise.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to a functional earth connector.

Snapping the module on to the rail normally provides a high-conductivity earth connection between the module housing and the rail. The rail has a high-conductivity connection to the switching cabinet which is earthed well in itself.

If need be, the earth connection can be screwed to the front of the module (see (1) in the figure below).

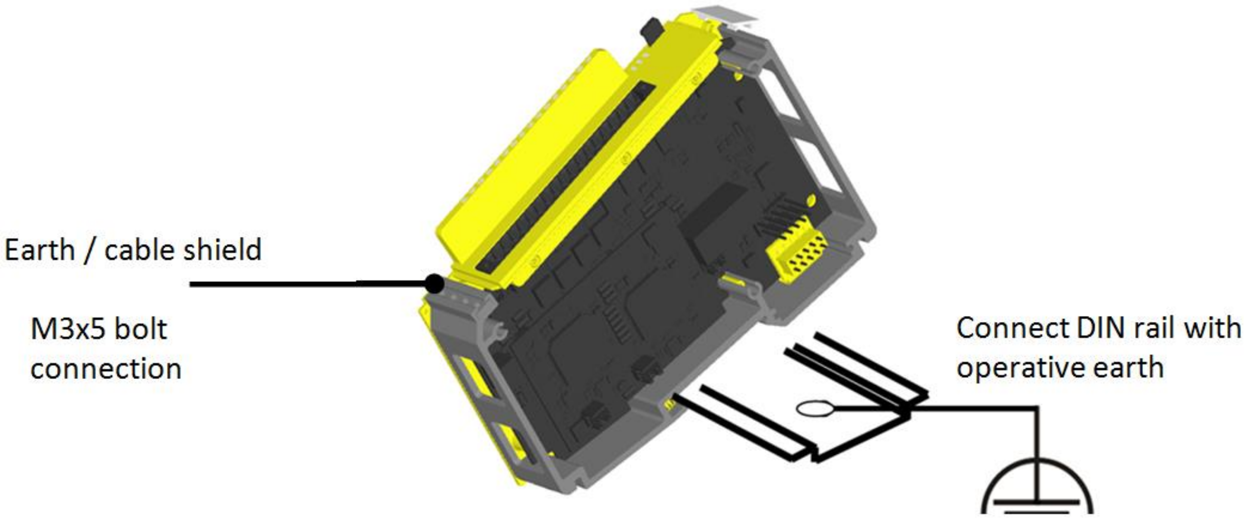


Fig. 13: Earthing (example of an I/O module)

Item	Designation	Item	Designation
1	Earthing/cable shield, connected by a M3x5 bolt	2	DIN rail, connected to functional earth

I ***Information***

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

> **I** ***Information***
>
> When installing production or other lines, measure the earth potential of the DIN rail as specified in the applicable guidelines (earth test to VDE 0100) . Measuring the earth potential must show that every protective and operational earthing is within the boundaries set by the applicable standards.
> Also consider the repeat testing frequency resulting from the hazard assessment.

6.2.2 Module Interconnection

The modules electrically interconnect by completely pushing the modules together. This automatically connects the modules to both the EtherCAT bus and the system power supply. Refer to section 6.1 "Mechanical Installation" for details about how to interconnect two modules.

6.2.3 System Power Supply to the Series of Modules

> **I** ***Information***
>
> To supply the Safety controller c250-S only modules may be used (bus couplers in accordance with EN 61131-2), which have a polarity reversal protection for the 24V voltage supply.

Power to each module's logical circuitry is supplied by the head module via the modules' backplane bus. The number of stackable modules depends on the head module's power output. A typical power output of 3 A supports up to about 10 modules. To link in a larger number of modules, just make up blocks of modules and have a separate bus coupler supply power to each of the blocks.

> **I** ***Information***
>
> ⇨ Take note of 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 instructions in this Operating Instruction.
> ⇨ Note that the maximum current supplied by the head module limits the number of mo-dules you may connect to a single block.

> **I** ***Information***
>
> The number of interconnected modules provokes varying voltage ratios on the E-bus with reference to the module position.
> ⇨ In order to provide a maximum of availability, try to place the Safety controller c250-S module as close to the head module as possible.

WARNING

Damage caused by wrong power supply!
Supplying the wrong voltages may damage or destroy the unit.
Preventive measures:

- ⇨ Only use PELV/SELV-ready power supply units to EN50178 or EN60950-1 to supply 24 VDC to bus couplers or compact PLCs that any Safety controller c250-S modules are connected to.
- ⇨ 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.
- ⇨ 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 block of I/O modules.

6.3 Putting into Service

Information

The Safety controller c250-S may only be operated with FSoE-compliant FSoE slaves.

Information

Whenever you work on the safety system, check that the safety functions are provided properly afterwards.

6.3.1 Configuration

Only the operating software is used to configure the Safety controller c250-S. The module as such does not provide options to change any of the settings.

6.4 Software Installation

6.4.1 Installing the Safety Extension

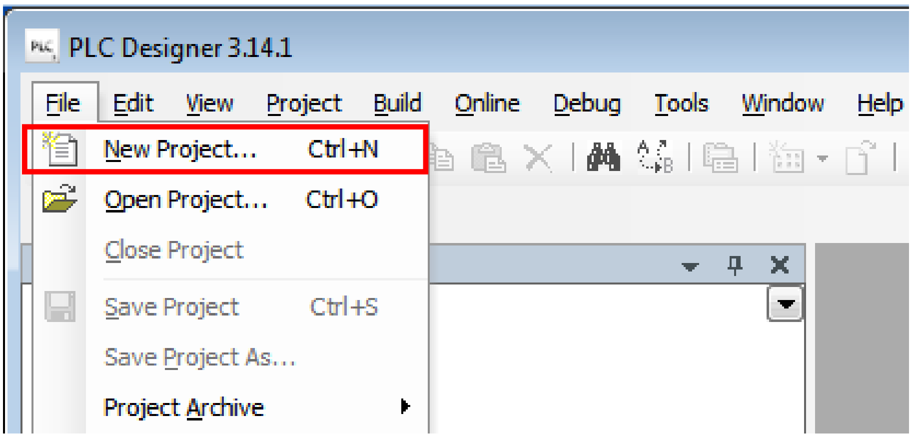
»PLC Designer« safety extension ist automatically installed with »PLC Designer«. Separate actions are not required.

6.4.2 Installing the Safety Device Description

All Safety Device Description are automatically installed durching the installation of »PLC Designer«. Separate actions are not required.

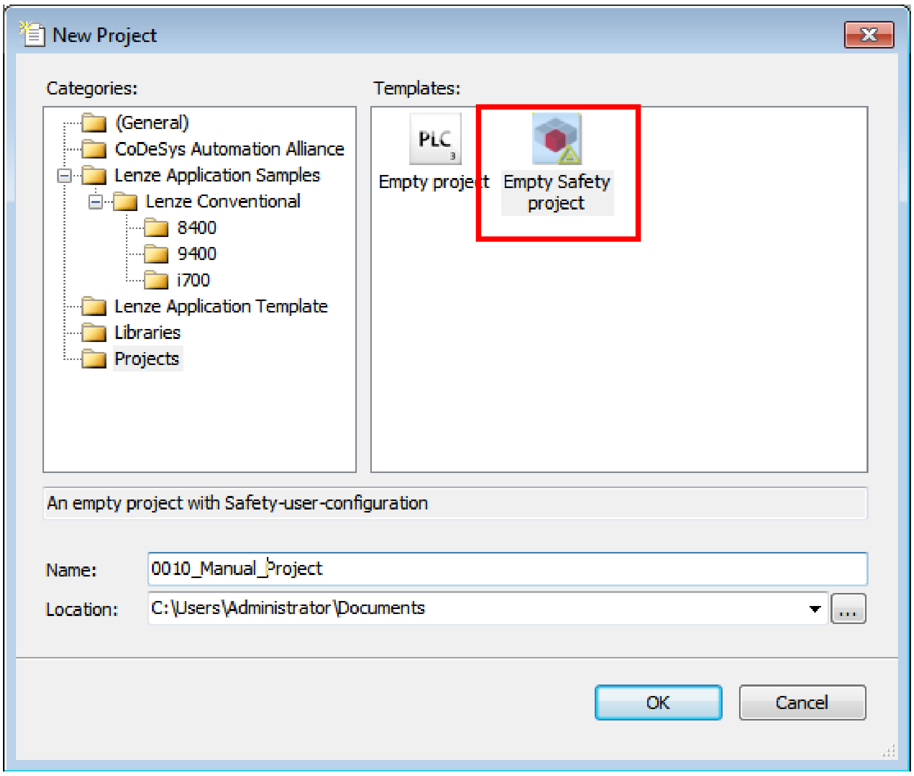
6.4.3 Creating a Safety Project

1. Start »PLC Designer« V3.15 or higher.
2. On the standard »PLC Designer« home page choose "**File** ⟶ **New Project**..." to create a new project.

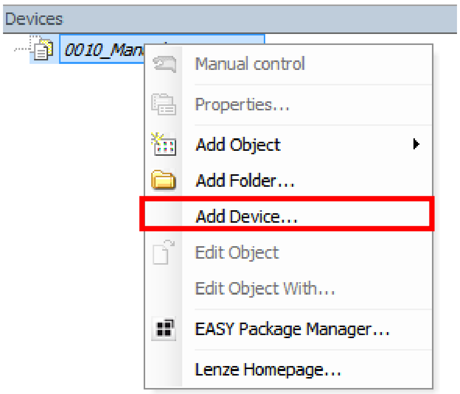


3. Pick template "Empty Safety Projekt".

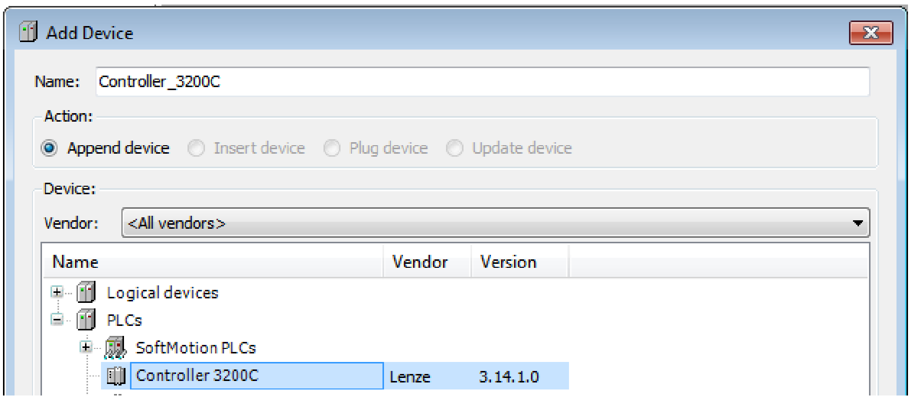
4. Assign a "**Name**", choose a storage location, and click on "**OK**" to actually create the project.



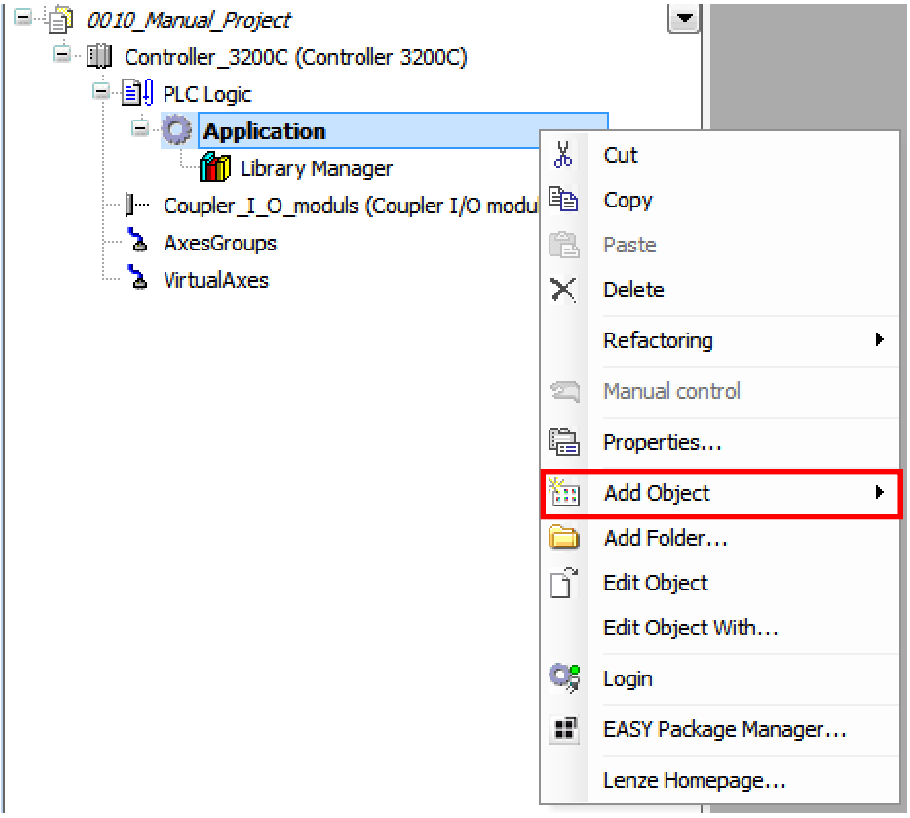
5. Add a standard PLC to the empty project by right-clicking on "**[project name] → Add Device...**".



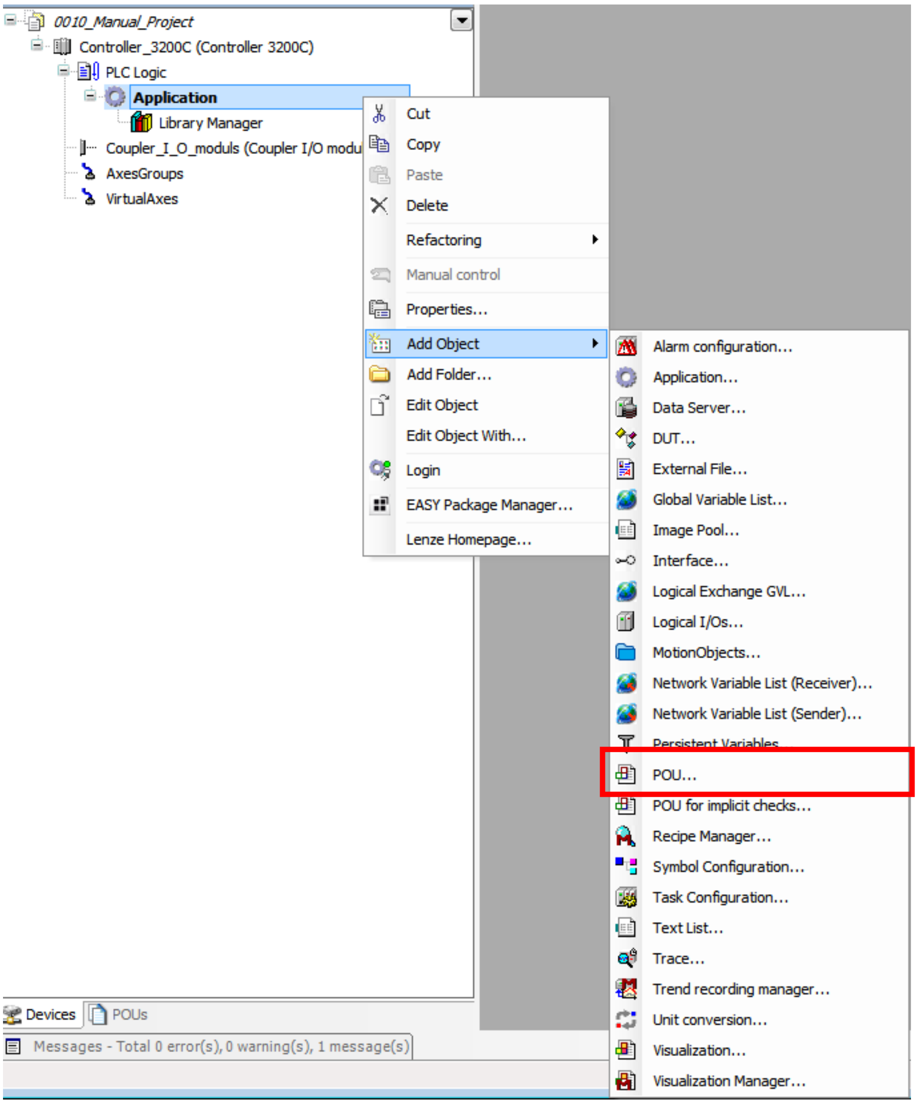
6. Pick the correct type of your standard PLC.



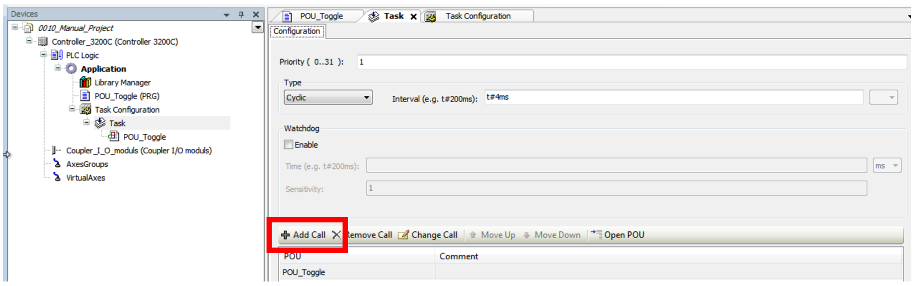
7. To add objects to your application, right-click on "**Application** → **Add Object**".



A list of available objects appears. Click on any of the objects to add it to the application.

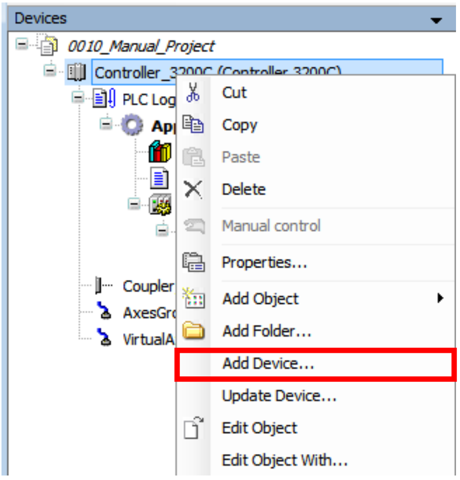


8. Add a POU (programme). Assign a name, here "PLC_PRG".
9. Add a task configuration.
10. To run the POU using the task configuration: Click on "**Add Call**" and pick the POU from the list.

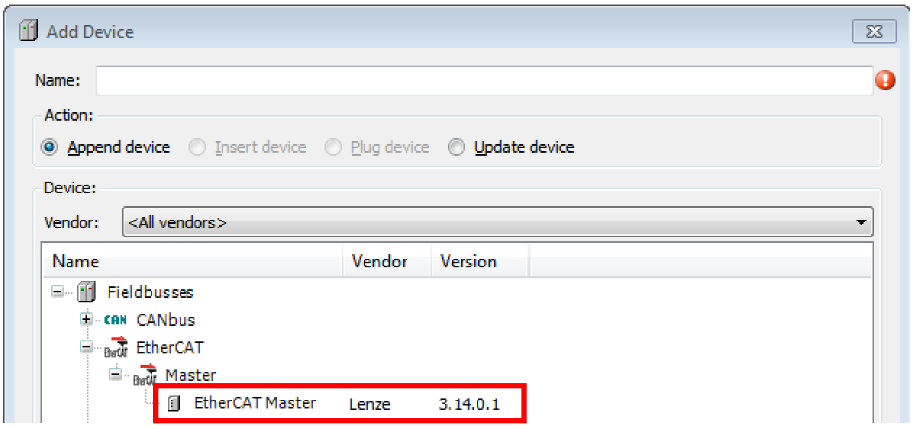


Since the Safety controller c250-S is an EtherCAT-based module, you will still need an EtherCAT master:

11. Right-click on the standard PLC you added before.
12. In the dialog, click on "**Add Device...**".

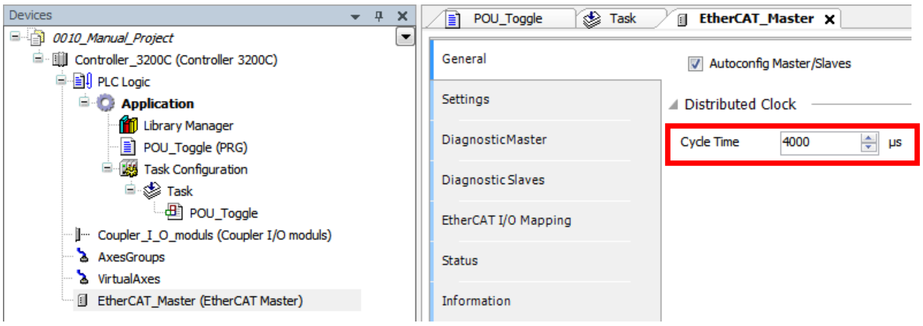


13. In the next dialog, choose "**Fieldbuses → EtherCat → Master → EtherCAT Master**".
14. Click on " **Add Device**“ to add the EtherCAT master to your project.



The EtherCAT master has been added to the list of devices and, thus, to your project. The Ether-CAT master's task configuration has been create automatically.

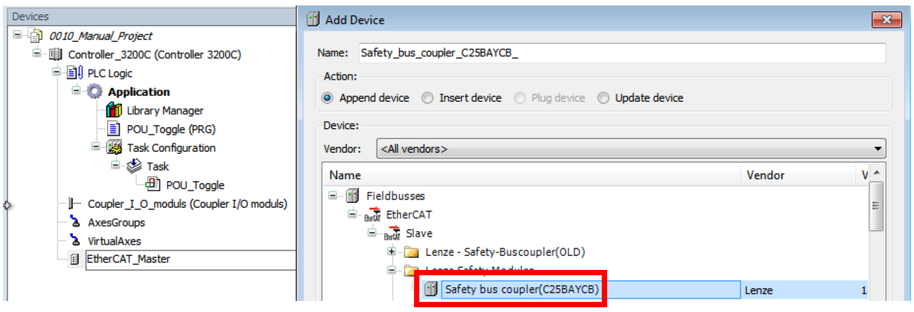
> **Information**
>
> If the EtherCAT master operates with distributed clocks (DC Distributed Clocks), the cycle time of the EtherCAT master must be equal to the cycle time in the task configuration.

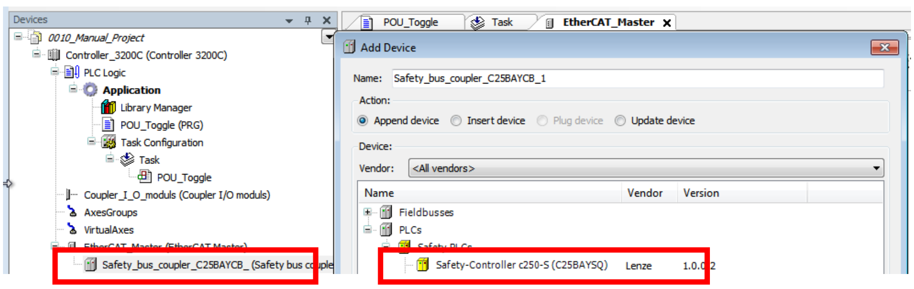


Add EtherCAT devices manually

1. Right-click on "**EtherCAT Master** → **Add Device**".
2. Choose the devices.

> **Information**
>
> To insert the Safety controller c250-S or a Safety I/O module, these modules must be attached to a Safety bus coupler.
> The setting of the Safety bus coupler to Distributed Clock (DC) is fixed.
> It is recommended to use the Safety bus coupler as DC Master only if no other DC Master are present in the system.



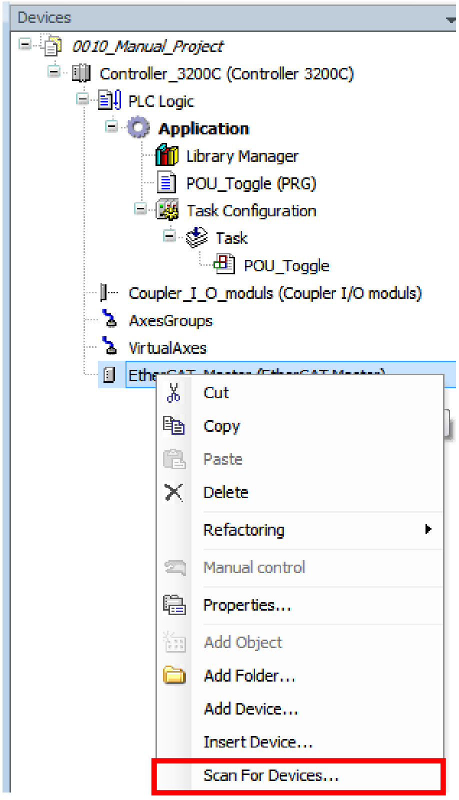


To add devices by searching EtherCAT

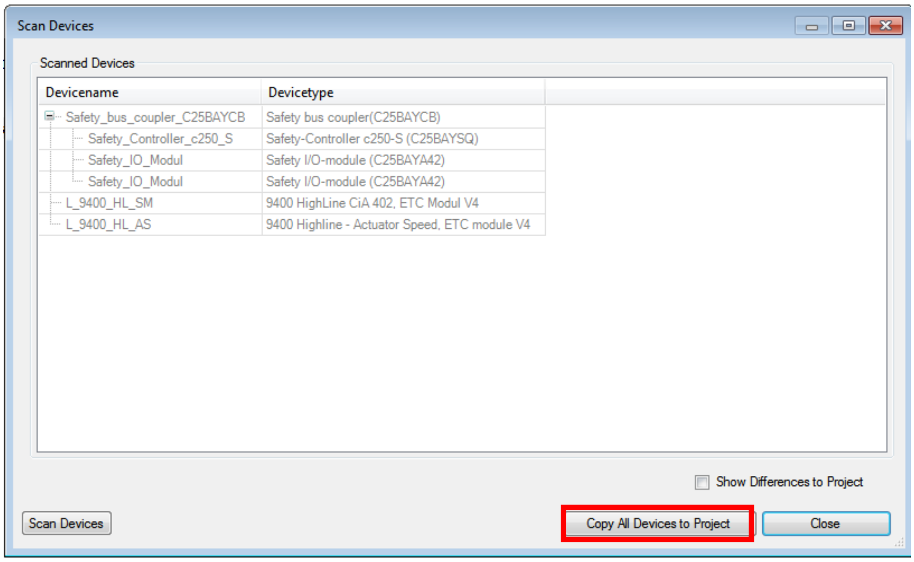
There is a more convenient way of adding modules than to pick them manually.

Available EtherCAT devices can be searched for automatically and added to the project. Before you can do so, check that the standard PLC hosts an executable and compilable application featuring an EtherCAT master. Also, all further modules you need have to be connected.

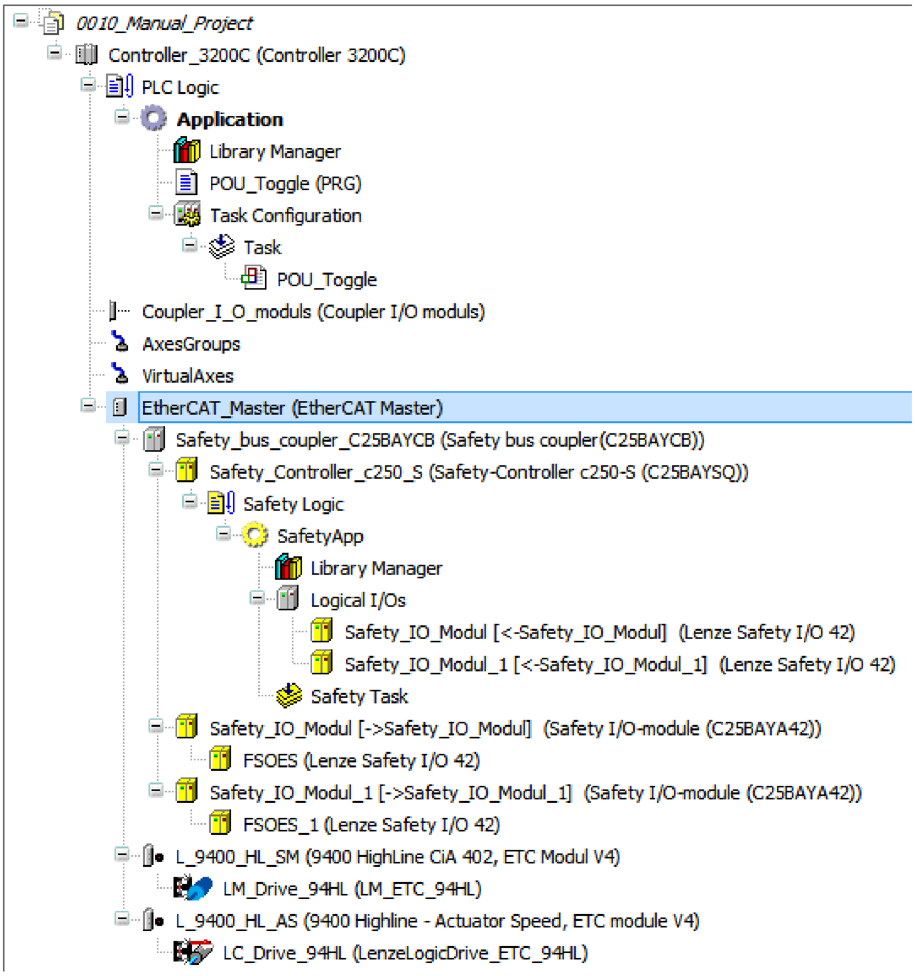
1. Right-click on "**EtherCAT Master → Scan for Devices**" to display the scan dialog.



After the search, the dialog lists all devices found on the EtherCAT network.



2. Click on "**Copy All Devices to Project**" to automatically append all devices below the EtherCAT master.



The safety application is in the EtherCAT module of the Safety controller c250-S. The programming system treats the Safety controller c250-S like a "normal" standard PLC (set active application, log on, log off).

I

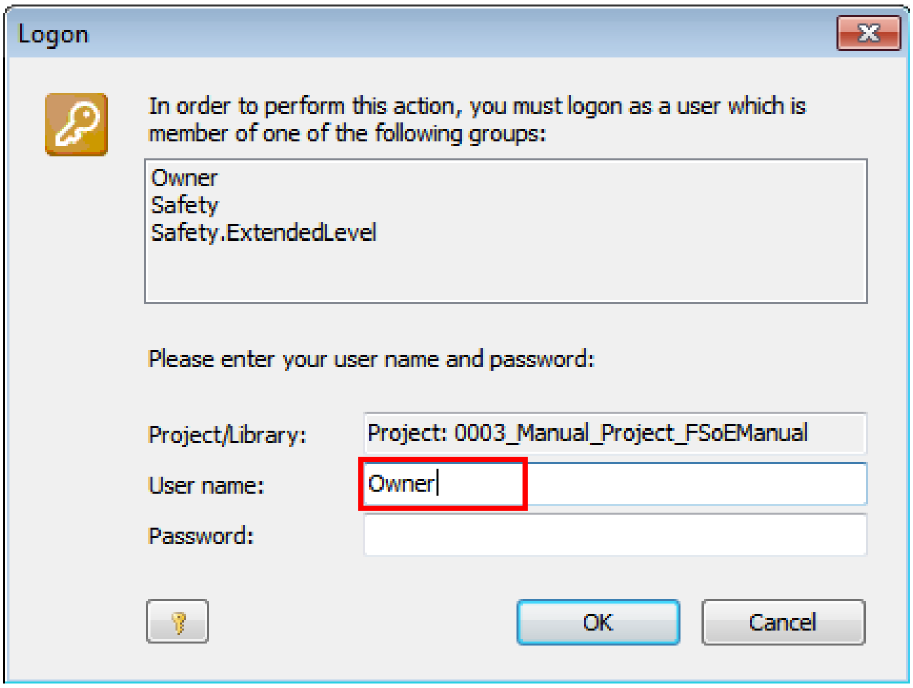
Information

The »PLC Designer« Safety manual explains how to create the safety application.

By default, a newly created empty safety project will have a user administration.

This will normally be a user called "Owner" with no password assigned.

A user must authenticate before changes made to a safety application become effective.



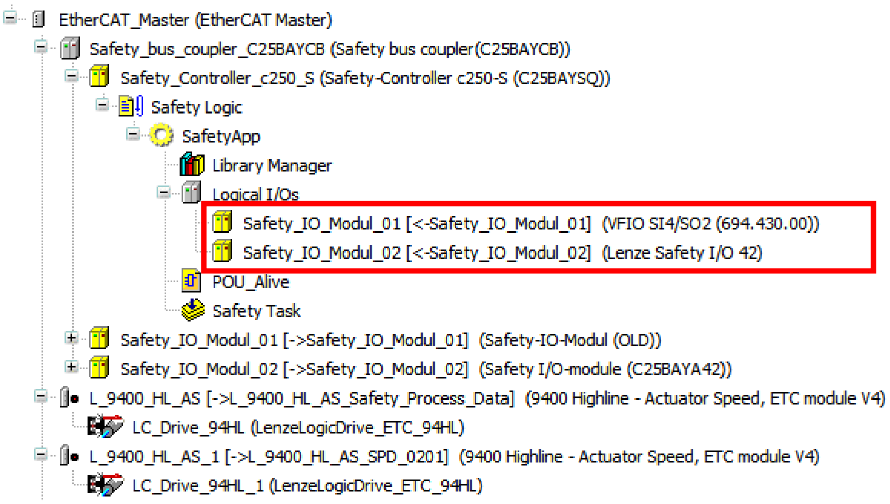
I

Information

Safety-Modules and Safety-Application should general protected dy a password against unauthorized access.

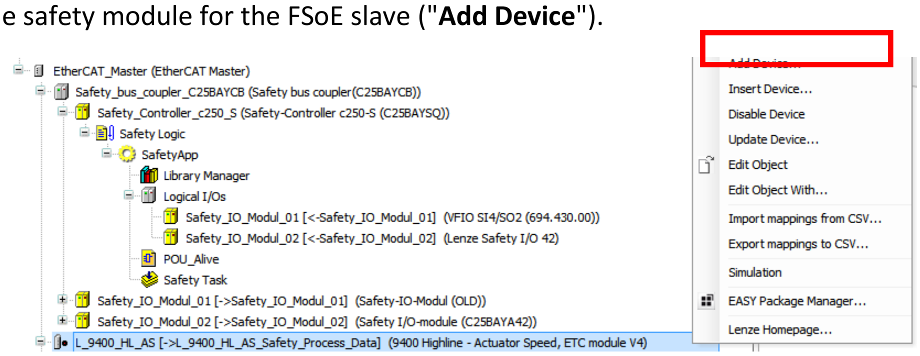
Manual connect FSoE master with FSoE slave

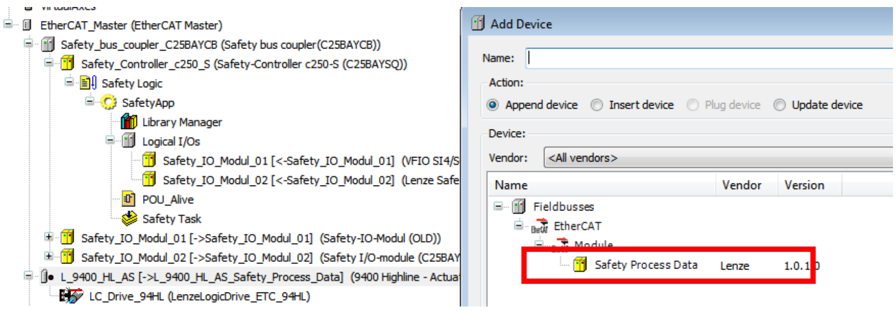
The exchange between the SafetyController c250-S as FSoE master and the FSoE slave (e.g Safety I/O module) is carried out via the "**Logical I/Os**" of the "**SafetyApp**".

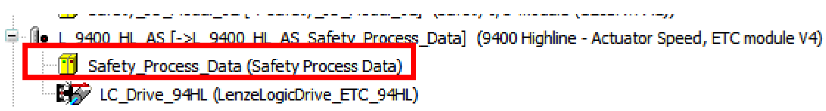


If the entry in "**Logical I/Os**" is not created automatically, you must proceed as follows.
Note: This is the case, for example, if the safety function in the device is only available as an option.

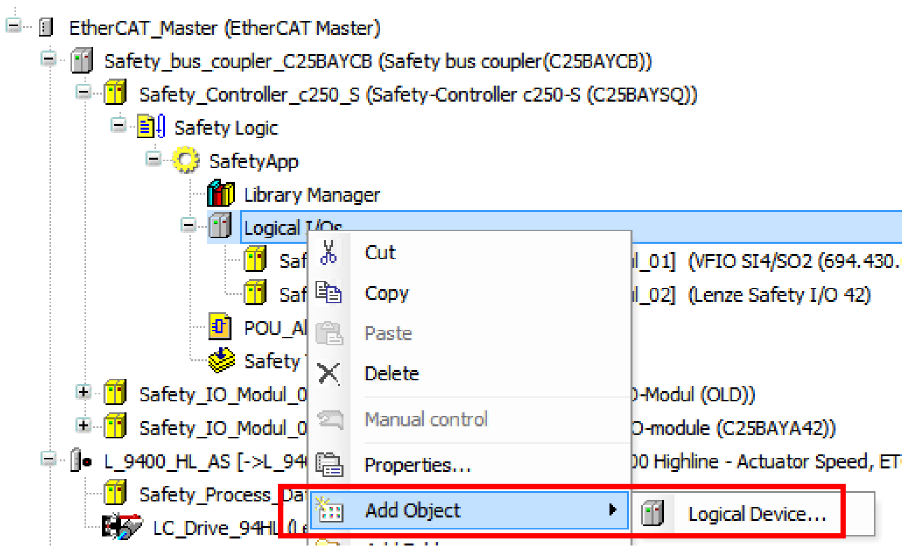
3. Insert the safety module for the FSoE slave ("**Add Device**").



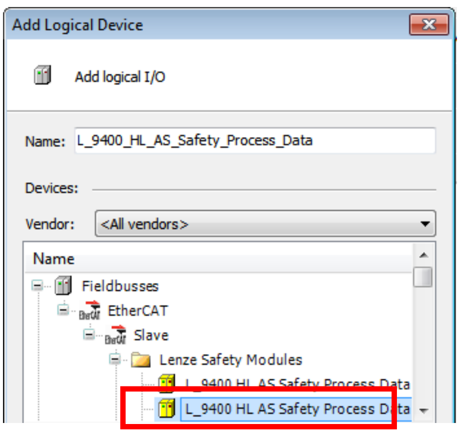


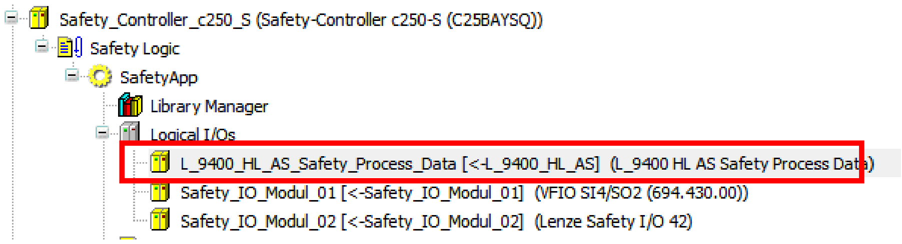


4. Add the suitable Logical I/O to the FSoE Master ("**Add Object**").

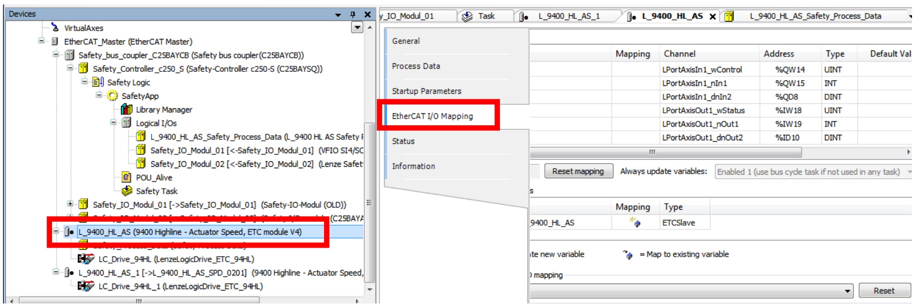


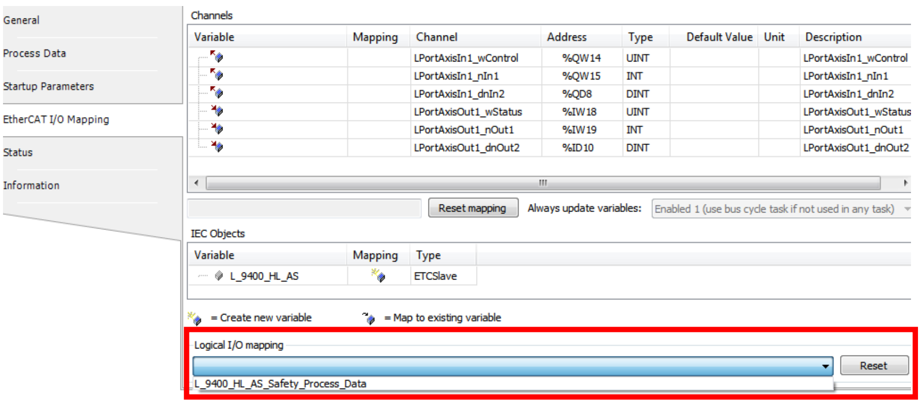
Select the appropriate application of the Servo Drive!



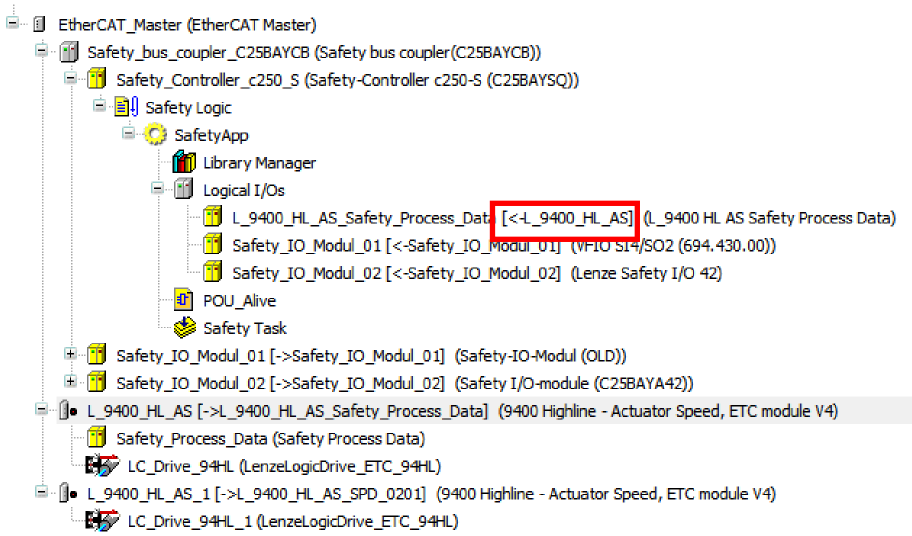


5. Connect the FSoE slave to the Logical I/Os (tab "EtherCAT I/O Mapping").





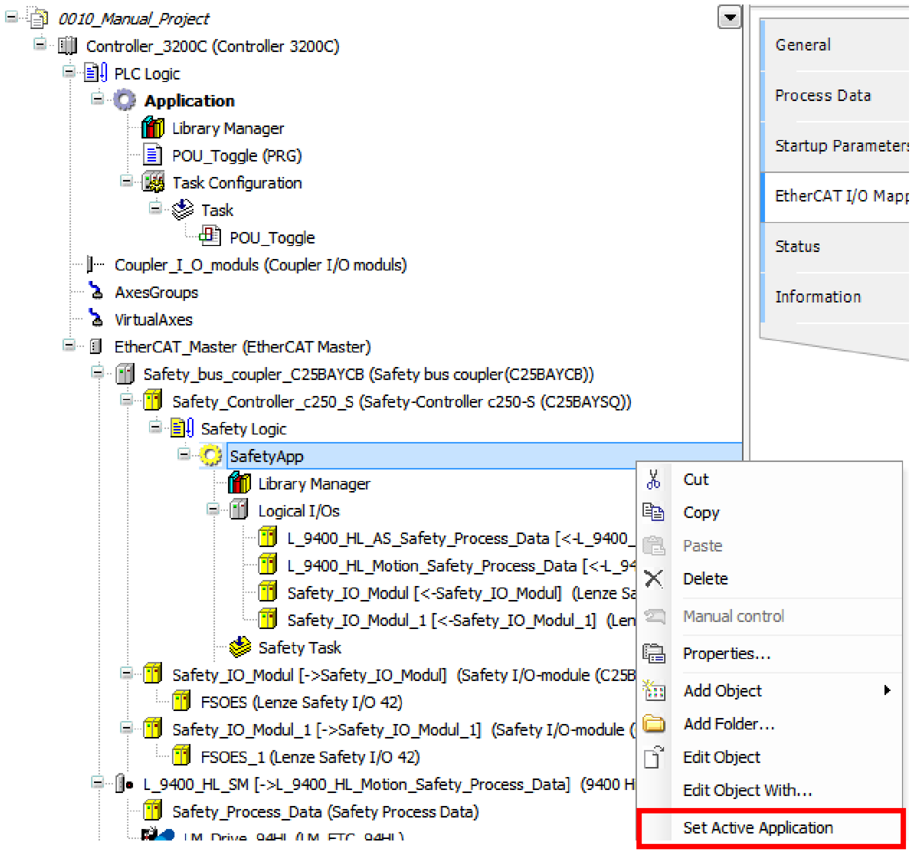
6. The link is shown in "**Logical I/Os**"



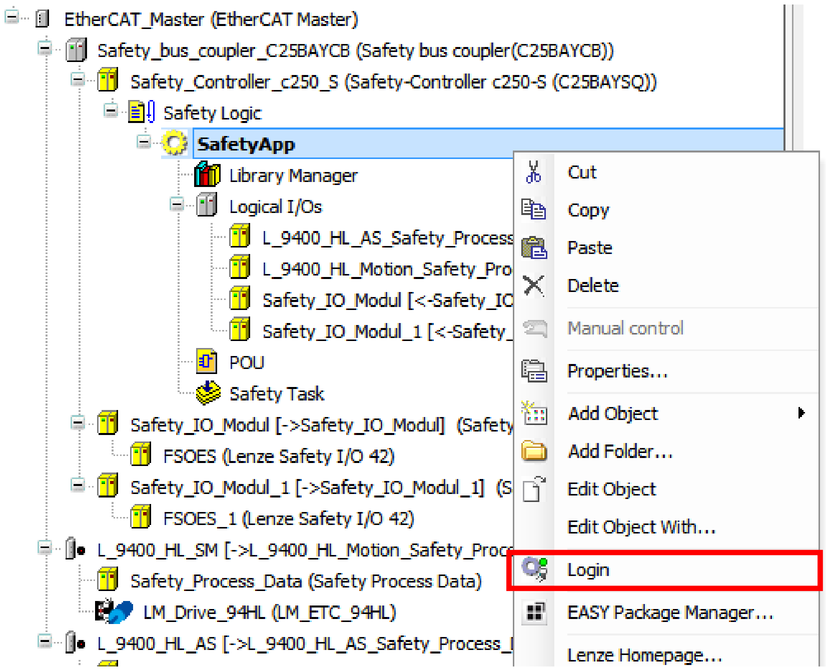
6.4.4 Safety controller c250-S - Logging on and Downloading an Application

Before connecting to the Safety controller c250-S, verify that the standard PLC has an EtherCAT master with a correct EtherCAT configuration and that the configuration has been started to ensure that the EtherCAT master is running properly.

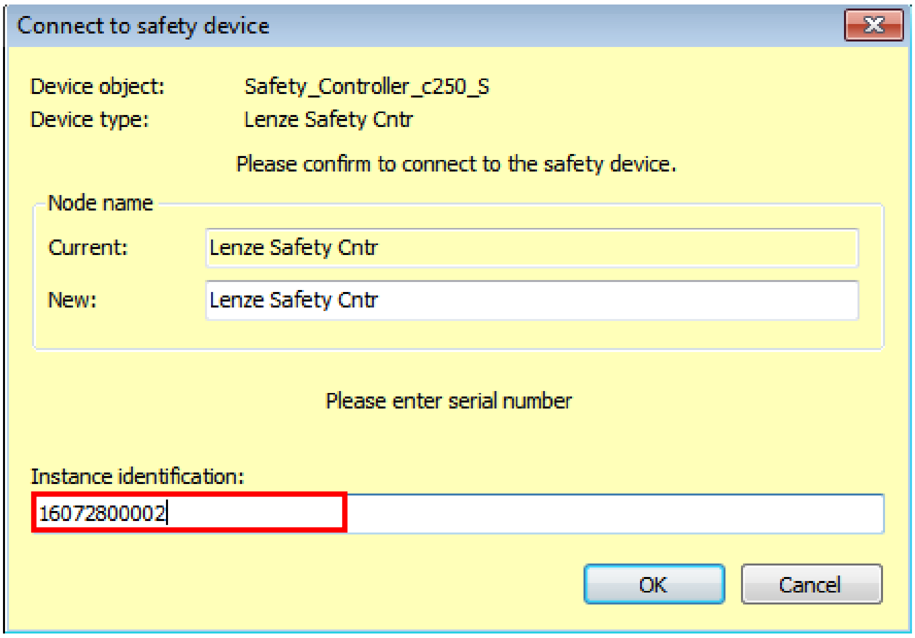
1. Log on and right-click on "**SafetyApp → Set Active Application**" and make the Safety controller c250-S the active application.



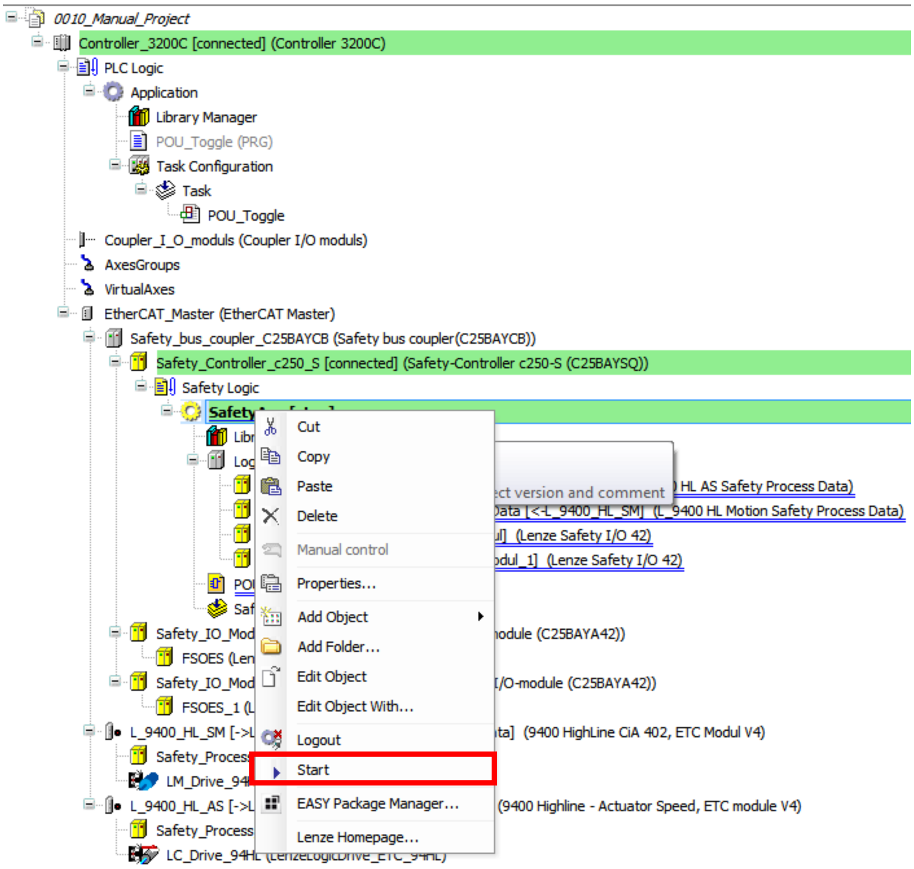
2. Right-click on "**SafetyApp → Login**" to log on to the Safety controller c250-S.



3. Load the application to the PLC.
   When logging on, you will be prompted for the Safety controller c250-S's serial number. This is to avoid changing the Safety controller c250-S and the application it hosts by mistake.



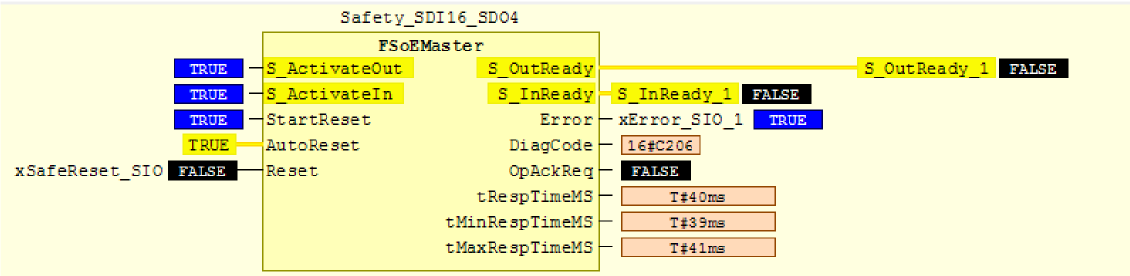
4. Right-click on "SafetyApp" -> Start to start the application.



6.4.5 Safety controller c250-S – FSoE (Safety over EtherCAT)

The Safety controller c250-S uses FSoE (Safety over EtherCAT) to communicate with other safety modules. In this setup, the Safety controller c250-S is the FSoE master, while the other safety modules are FSoE slaves. The master uses a unique ID to address the FSoE slaves. This will only work if the FSoE slave ID is unique within the EtherCAT network and has been added to both the master's and slave module's configuration. (Refer to the Operating Instruction of the slave module concerned to learn how to set the module's FSoE ID)

Errors in the communication are detected by the FSoE master and can be read out by the FSoEMaster Function Block.



Meaning of the Error Codes:

C0xx-Error codes: Initialization error

Error code		Description
C001$_h$ - C004$_h$	49153 - 49156	Internal error
C005$_h$	49157	Length of safe data is not supported (max. 32 byte data is supported)
C006$_h$ - C00A$_h$	49158 - 49162	Internal error
C00B$_h$	49163	Invalid monitoring time; value 0 (parameter WatchdogTime) is not permitted
C00C$_h$	49164	Internal error, invalid logical module ID

C1xx-Error codes: Receiver error master

Error code		Description
C100$_h$	49408	Local reset or confirmation of a reset command
C101$_h$	49409	Unexpected command in the received telegram
C102$_h$	49410	Unknown command in the received telegram
C103$_h$	49411	Invalid connection ID in the received telegram
C104$_h$	49412	CRC error for the received telegram
C105$_h$	49413	Monitoring time error, no valid telegram received within the WatchdogTime
C106$_h$	49414	Invalid FSoE Safety Device Address
C107$_h$	49415	Invalid safety data in the received telegram
C1FE$_h$	49662	Error reset signal
C1FF$_h$	49663	Prompt for acknowledging the restart

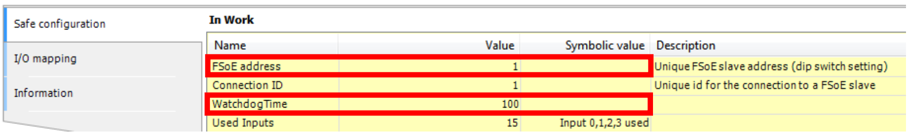
C2xx-Error codes: Error reported from safety device

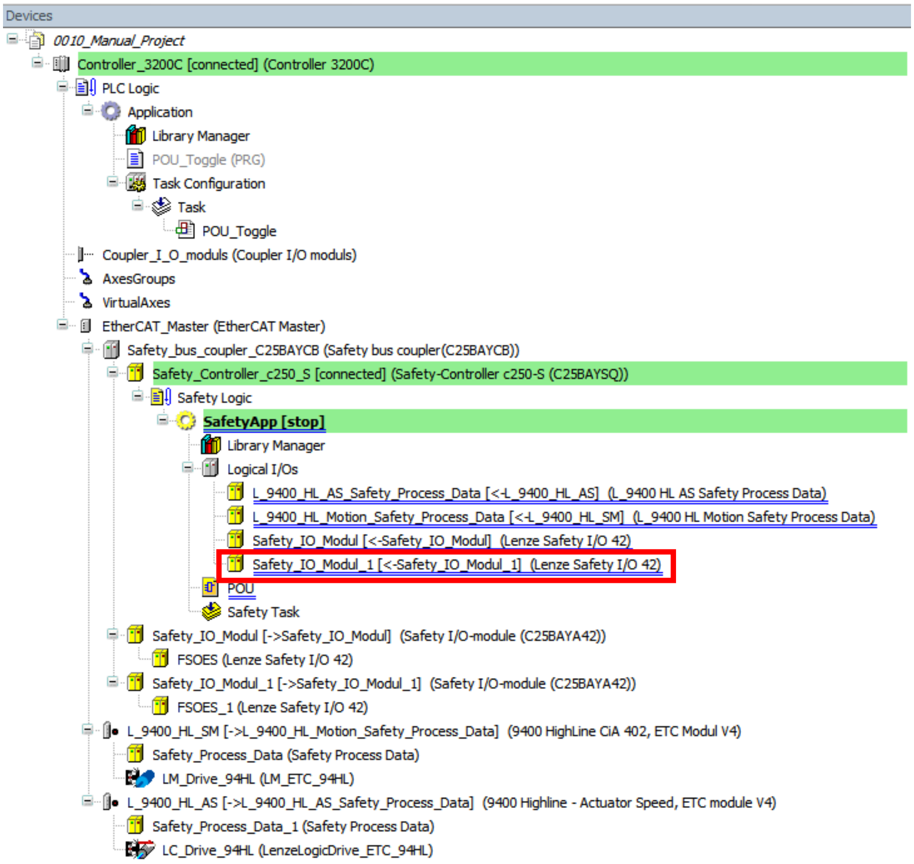
Error code		Description
$C200_h$	49664	Local reset or acknowledgement of a RESET command
$C201_h$	49665	Unexpected command (INVALID_CMD)
$C202_h$	49666	Unknown command (UNNKOWN_CMD)
$C203_h$	49667	Invalid connection ID (INVALID_CONNID)
$C204_h$	49668	CRC error (INVALID_CRC)
$C205_h$	49669	Watchdog has expired (WD_EXPIRED)
$C206_h$	49670	Invalid FSoE Slave Address (INVALID_ADDRESS)
$C207_h$	49671	Invalid safety data (INVALID_DATA)
$C208_h$	49672	Invalid communication parameter length (INVALID_COMMPARALEN)
$C209_h$	49673	Invalid communication parameter data (INVALID_COMPARA)
$C210_h$	49674	Invalid application parameter length (INVALID_USERPARALEN)
$C211_h$	49675	Invalid application parameter data (INVALID_USERPARA)
$C280_h$-$C2FF_h$	49792 - 49919	Invalid SafePara (device-specific)

6.4.6 Setting the FSoE Slave IDs and Watchdog Time in the Safety controller c250-S

Run »PLC Designer« Safety to configure the FSoE (Safety over EtherCAT) slave modules in the Safety controller c250-S.

To configure the FSoE slave modules, go to the Safety controller c250-S and find the "**Logical I/Os**" entry under "**SafetyApp**". This is where the system adds the slave modules and where you can adapt them manually.





Enter the FSoE slave's configuration in the associated Configuration dialog by assigning a unique FSoE address and Connection ID to the module.

A watchdog time must also be set for each FSoE slave in ms. According to the FSoE specification, FSoE slaves change to the safe state the watchdog time has elapsed.

6.5 Validation of Safety Functions

After completing the installation and setting up the safety application, the latter must be checked for proper operation.

DANGER

Validation of Safety Functions!
The implementation and operation of safety applications in the overall system must be checked.

⇨ Validate and document the overall system as described in the »PLC Designer« Safety manual

CAUTION

Behavior on failure / breakdown of a FSoE slave!
The Safety Controller c250-S is not in a safe state in the event of a fault / breakdown of a FSoE slave. The data of the FSoE slave can have undefined values in the SafetyApp.

⇨ The correct execution of the safety function is to be checked especially under this aspect.

⇨ It is recommended to integrate all diagnostic options of a FSoE slave with the implementation of a safety function.

CAUTION

Access to inputs / outputs of a FSoE slave
Access to inputs / outputs of an FSoE slave should only be made via mapped variables. Unmapped variables can take undefined values.

⇨ Special attention during the verification / validation of the safety application.

6.6 Diagnosis

6.6.1 Self-test

When system voltage is supplied to the Safety controller c250-S, it initially runs a complete system test. Only if this system test is passed will the module be able to operate and first of all change to its "fail-safe" state.

This state is indicated by LED "Safe Status" lighting up red.

The fail-safe state of the Safety controller c250-S will be retained until the required internal tests have been passed.

After the self-test, the Safety controller c250-S will start the safety application from its memory. This defines as the safe functional state which is indicated by LED "Safe Status" lighting up green.

The module will retain its fail-safe state if it fails to qualify for the safe state, e.g. because of errors in the application's module setup.

In normal op mode, the system test will be repeated as a cyclic background process. Any errors encountered will again provoke the fail-safe state and an entry in the »PLC Designer« log.

6.6.2 Safety controller c250-S Module Errors

The cyclic self-tests performed in compliance with the standards listed in the certificate will discover all errors in due time and change the module state to "fail-safe".

This is indicated by LED "Safe Status" lighting up red (see section 5.3 Status LEDs).

Information

The status LEDs are not a safety-related display. In other words the LEDs could not be used alone as a safe indicator for the operating state of the module, etc.

DANGER

Use of devices in a fail-safe state

Subsequent faults may provoke a hazard.

⇨ When an error occurs, have the actions taken required to find and remove the root cause and initiate any replacements, as appropriate.

Information

Inform Lenze of all severe intrenal modul faults or errors in conjunction with the Safety controller c250-S.

6.6.3 Temperature Faults

The module is designed for ambient temperatures between 0 °C and max. 55 °C and for being installed in a control cabinet. The Safety controller c250-S features an internal temperature sensor. If the temperature is out of the specified range during operation, the state will change to "fail-safe". You cannot start the module if the temperature is out of the specified range.

CAUTION

Do not operate the Safety controller c250-S module out of the specified range!

High or low temperature fault.

⇨ Operate the module under the ambient conditions listed in section Technical Data only.

VORSICHT

Use of the internal temperature sensor for safety applications is not permitted!

Non-safety-oriented temperature sensor.

⇨ The internal temperature sensor must not be used for the realization of safety applications.

6.6.4 Error Handling and Logging

The Safety controller c250-S's diagnostic LEDs indicate faults and errors according to the type of fault detected. The log screen of the relevant Safety controller c250-S in the programming system will also list all error messages. Furthermore, the standard PLC can use COE objects (see object dictionary) to retrieve errors from specific registers of the Safety controller c250-S.

6.7 Resetting / Acknowledging Errors

Safety controller c250-S errors are distinguished as errors of the Safety controller c250-S as such and errors occurring when communicating with sensors and actuators or the errors provoked by sensors and actuators.

Safety controller c250-S errors can be acknowledged by restarting the PLC only. To restart the PLC, perform a PowerCycle (supply off/on) at the head module.

A loss of communication or errors of sensors or actuators provoke an error of the associated safety module. They can be detected via the safety application and acknowledged by the associated reset inputs of the modules (e.g. the FSoE master). During that time, the Safety controller c250-S will retain its safe functional state.

PowerCycle

After removing the cause of an error, reset the Safety controller c250-S by performing a PowerCycle at the head module (power off/on).

WARNING

Resetting / acknowledging may cause a dangerous state!

⇨ 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.

6.8 Maintenance / Servicing

6.8.1 General

Only qualified persons are allowed to work on the Safety controller c250-S.

CAUTION

Unsafe and undefined machine state!
Destruction or malfunction of the Safety controller c250-S.

- ⇨ The modul housing should not be opened.
- ⇨ The modul should not be repaired.
- ⇨ Do not plug, mount, unplug or touch the connectors during operation!
- ⇨ Turn off all power sources before working on the modules. This also applies to any peripherals connected such as encoders, programming devices with external power source, etc.
- ⇨ Check that none of the ventilation slots is covered.

6.8.2 Servicing

For the specified service life, the Safety controller c250-S needs neither servicing nor any other actions. Due to this reason spatre parts are not available.

During operation and storage, the safety controller c250-S must be protected against contamination, outside the usual contamination occurring in the defined ambient conditions.

Prevent inadmissible contamination, outside the usual contamination occurring in the defined ambient conditions, while operating and storing the Safety controller c250-S. Do not use, clean or continue to use the module in case it has been exposed to inadmissible contamination.

DANGER

Risk of injury caused by an unsafe and undefined machine state!

- ⇨ You are not allowed to operate an inadmissibly contaminated module.
- ⇨ Neither is cleaning the unit allowed.

6.9 Replacing a Safety controller c250-S

CAUTION

Risk of injury caused by an unsafe and undefined machine state!
Risk of injury.
⇨ Before replacing a Safety controller c250-S module, turn off the power supply of the Safety controller c250-S and the modules connected to it.
⇨ After replacing a Safety controller c250-S module and before restarting the machine or system, verify that the associated safety function is provided properly.

6.9.1 Replacement Procedure

Preparation

1. Verify that the new module meets the following requirements:
   - Same type of device
   - Same or higher version, see section 5.1 Labelling and Identification.
2. Enable the safe system or machine state.
3. Turn off the power supply to the head module and the modules connected to it.

Remove the old module

4. Split up the line of I/O module, as necessary: press the unlock button of the adjacent module and push the two modules about 1 cm apart (refer to the instructions of the other module).
5. Push the module up and against the metal spring located on the underside of the rail guide (see section 6.1.6 To Take Down a Single Module).
6. Tip the module forward and away from the rail.
7. Pull the module down and out of the mounting rail.

Install and program the new module

8. Place the new module at the position in the line of module previously occupied by the old module (see section 6.1.3 To Snap on a Single Module).
9. Turn on the power supply to the head module and the modules connected to it.
10. Load the validated new safety application.

6.9.2 Restart

1. Verify that the machine or system is in a safe state and that there is nothing and nobody in

the danger zone.

2. Turn the power back on.
3. After replacing the safety module, repeat the initial startup procedure (see section 6.3 Putting into Service).
4. Check all safety functions after replacing a module.

6.10 Durability

The Safety controller c250-S modules have a design life of max. 20 years after the date of manufacture (see section 5.1 Labelling and Identification).

WARNING

Risk of injury caused by using a module beyond its design life!

⇨ Remove the module from service when it is at the end of its design life at the latest (see section 6.10.3 Taking out of Service).

6.10.1 Repairs / Customer Service

You are not allowed to open a Safety controller c250-S module or to attempt any other repairs. If you do, proper operation of the Safety controller c250-S module is no longer warranted.

Information

In case a module failure is potentially hazardous, return the module to the manufacturer where the fault will be identified.
Refer to section 8 Sales & Service for the manufacturer's address.

6.10.2 Warranty

The statutory period and conditions of warranty apply. Warranty expires if unauthorised attempts are made to repair the unit / product or any other intervention is performed.

6.10.3 Taking out of Service

The manufacturer of the machine or system specifies the procedure of taking the product out of service.

- Verify that used modules taken out of service are provided for further use as intended.
- Comply with the storage and transport requirements specified in the Technical Data section.

6.10.4 Disposal

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

7 Appendix

7.1 Safety Ratings of the Safety controller c250-S

The table below lists the safety ratings of the Safety controller c250-S. 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	
Highest safety integrity level to EN 62061:2010	SIL3	
Highest safety integrity level to IEC 61508:2010	SIL3	
Highest performance level to EN ISO 13849-1:2015	Cat. 4/PL e	
Hardware fault tolerance (HFT) (IEC 61508:2010/EN ISO 13849-1:2015)	1 (a fault of the application need not cause the safeguard to fail)	
	Ambient temp. 25 °C	**Ambient temp. 55 °C**
Probability of failure on demand (PFDavg), proof test interval: 20 years (IEC 61508:2010)	$2.57 * 10^{-5}$ (2,57% of entire PFD_{avg} of 10^{-3} at SIL3)	$2.99 * 10^{-5}$ (2.99% of entire PFD_{avg} of 10^{-3} at SIL3)
Probability of failure per hour (PFHd), proof test interval: 20 years (IEC 61508:2010)	$3.04 * 10^{-10}$ 1/h (0,3% of entire PFH of 10^{-7} at SIL3)	$3.55 * 10^{-10}$ 1/h (0.36% of entire PFH of 10^{-7} at SIL3)
Diagnostic coverage (DC) to EN ISO 13849-1:2015	97.24 % (acc. EN13849-1:2015 rounded to 99%)	98.49 % (acc. EN13849-1:2015 rounded to 99%)
Safe failure fraction (SFF)	98.6 %	97.2 %
MTTFD to EN ISO 13849-1:2015	225 years	221 years

7.2 Communication Objects

7.2.1 Device Type 1000_h

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	Set
Default Value	89130000h

7.2.2 Error Register 1001_h

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	00h

Bit analysis to CANopen DS301:

Bit7	80_h	not used
Bit6	40_h	not used
Bit5	20_h	not used
Bit4	10_h	not used
Bit3	08_h	temperature error
Bit2	04_h	voltage error
Bit1	02_h	not used
Bit0	01_h	general faults

7.2.3 Device Name 1008_h

Designation	Value
Name	Device Name
Index	1008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING
Access	Read only
PDO Mapping	no
Value Range	Set

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

7.2.4 Hardware Version 1009_h

Designation	Value
Name	Manufacturer Hardware Version
Index	1009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING
Access	Read only
PDO Mapping	No
Value Range	Set
Default Value	12E3030 h (1.00)

7.2.5 Software Version $100A_h$

Designation	Value
Name	Software Version
Index	$100A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING
Access	Read only
PDO Mapping	No
Value Range	Set
Default Value	1.2.0

7.2.6 CANopen 'Restore Default Parameters' obj. 1011_h

Designation	Value
Name	CANopen 'Restore Default Parameters' obj.
Index	1011_h
Object Code	RECORD
No. of Elements	5

Designation	Value
Name	Number of entries
Subindex	00h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	No default

Designation	Value
Name	Restore all parameters (not used)
Subindex	01_h
Data Type	UNSIGNED32
PDO Mapping	No

Designation	Value
Name	Restore communication parameters (not used)
Subindex	02_h
Data Type	UNSIGNED32
PDO Mapping	No

Designation	Value
Name	Restore application parameters (not used)
Subindex	03_h
Data Type	UNSIGNED32
PDO Mapping	No

Designation	Value
Name	Restore file system Procedure • write 64_h 61_h $6F_h$ $6C_h$ • comes into effect on next power cycle; request will be cleared after 1 min if no power cycle occurs
Subindex	04_h
Data Type	UNSIGNED32
Access	Read / write

PDO Mapping	No
Designation	**Value**
Name	Delete Boot Application Procedure • write 64_h 61_h $6F_h$ $6C_h$; • comes into effect on next power cycle; request will be cleared after 1 min if no power cycle occurs
Subindex	05_h
Data Type	UNSIGNED32
Access	Read / write
PDO Mapping	No

7.2.7 Identity Object 1018h

Designation	**Value**
Name	Identity Object
Index	1018h
Object Code	RECORD
No. of Elements	4
Data Type	IDENTITY

Designation	**Value**
Name	Number of entries
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

Designation	Value
Name	Product Code
Subindex	02_h
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No

Designation	Value
Name	Revision
Subindex	03_h
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No

Designation	Value
Name	Serial Number
Subindex	04_h
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No
Units	yyyyyy mmmm ddddd nnnnnnnnnnnnnnnnn 6 bits 4 bits 5 bits 17 bits Year 2014 is coded as '0'.
Value Range	14 01 01 00001 (00420001_h) … 77 12 31 99999 ($FF3F869F_h$)
Example	16052300001 = $096E0001_h$

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

7.3 Manufacturer-specific Objects

7.3.1 CPU 1: Reference Voltage [mV] 2000_h

Designation	Value
Name	CPU 1: Reference Voltage [mV]
Index	2000_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

7.3.2 MC 1: 5 V Supply Voltage [mV] 2002_h

Designation	Value
Name	MC 1: 5 V Supply Voltage [mV]
Index	2002_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

7.3.3 CPU 1: 3.3 V Supply Voltage [mV] 2003_h

This is the supply voltage of CPU 2 measured by CPU 1.

Designation	Value
Name	CPU 1: 3.3 V Supply Voltage [mV]
Index	2003_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

7.3.4 Temperature Sensor [0.01 °C] 2006_h

Designation	Value
Name	Temperature Sensor [0.01 °C]
Index	2006_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No
Units	0.01 °C
Value Range	0 … 8000
Default Value	No default value

7.3.5 CPU 1: Error Code 2007_h

Designation	Value
Name	CPU 1: Error Code
Index	2007_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No

The table below explains every entry in object 2007_h "Errorcode".

Id	Hex	Explanation	
0	0000_h	OK: No error	
1	0001_h	HWT_PARAMETER_ERROR	Hardware test parameter error
2	0002_h	HWT_INIT_ERROR	Hardware test initialisation error
100	0064_h	HWT_MEM_MARCHC_ERROR	Hardware test RAM check error
101	0065_h	HWT_MEM_GALPAT_ERROR	Hardware test RAM check error
200	$00C8_h$	HWT_STACK_UNDERFLOW_ERROR	Hardware test stack underflow
201	$00C9_h$	HWT_STACK_OVERFLOW_ERROR	Hardware test stack overflow
300	$012C_h$	HWT_CPU_ERROR	Hardware test CPU error
400	0190_h	WT_FW_ERROR	Hardware test firmware error
500	$01F4_h$	HWT_FWINTERFACE_ERROR	Hardware test firmware error
504	$01F8_h$	HWT_ADC_ERROR:	Test handler: error in ADC value range checks. Hardware test AD converter error
505	$01F9_h$	HWT_DMA_ERROR:	Test handler: error in DMA check. Hardware test DMA checksum error
506	$01FA_h$	HWT_CRC_ERROR:	Test handler: Error in CRC check. Hardware test checksum error
507	$01FB_h$	HWT_TIMER_ERROR:	Test handler: error in timer check. Hardware test CPU timer error
508	$01FC_h$	HWT_CLOCK_ERROR:	Test handler: error in clock signal check. Hardware test CPU clock error
512	0200_h	TIMEOUT_ERR:	I2C communication timeout detected. Software timeout detected
513	0201_h	OUT_OF_RANGE_ERR:	Parameter or value out of allowed range. Parameter range error
514	0202_h	OVERWRITE_ERR:	Register buffer data overwrite occured. Data overflow
516	0204_h	PRG_CNTRL_ERR:	Program sequence control detected error. Programme sequence error
517	0205_h	“Soft-Error” detected	Software error
528	0210_h	INIT_ERROR:	Initialization error
592	0250_h	ASSERT_TRUE_ERR:	Assertion for expression yields ''true'' failed. Asserting "true” failed
593	0251_h	ASSERT_NOT_NULL_ERR:	Assertion for unequal to NULL failed. Asserting unequal to "NULL” failed

Id	Hex	Explanation	
594	0252$_h$	ASSERT_GE_ERR:	Assertion for ''>='' comparison failed. Asserting ">=" failed
595	0253$_h$	ASSERT_GT_ERR:	Assertion for ''>'' comparison failed. Asserting ">" failed
596	0254$_h$	ASSERT_LE_ERR:	Assertion for ''<='' comparison failed. Asserting "<=" failed
597	0255$_h$	ASSERT_LT_ERR:	Assertion for ''<'' comparison failed. Asserting "<" failed
598	0256$_h$	ASSERT_NE_ERR:	Assertion for ''<>'' comparison failed. Asserting "<>" failed
599	0257$_h$	ASSERT_EQ_ERR:	Assertion for ''='' comparison failed. Asserting "=" failed
600	0258$_h$	ASSERT_FALSE_ERR:	Assertion for expression yields ''false'' failed. Asserting "false" failed
672	02A0$_h$	MRAM	not initialized
673	02A1$_h$	MRAM_READ_ERR:	MRAM read error.
676	02A4$_h$	MRAM_CORRUPT_PAGE_SIZE:	Invalid MRAM page size.
677	02A5$_h$	MRAM_CRC_ERR:	MRAM data CRC check failed. MRAM checksum error (CRC error)
688	02B0$_h$	LZS logging not yet initialized.	
689	02B1$_h$	LZS logging initialized.	
692	02B4$_h$	LZS world time timer initialized.	
696	02B8$_h$	Request file system reset.	
697	02B9$_h$	Request deleting boot app from file system.	
698	02BA$_h$	Boot app deleted from file system.	
699	02BB$_h$	Reset of file system activated.	
700	02BC$_h$	System request cancelled due to timeout.	
768	0300$_h$	RESET_LOW_POWER:	Reset due to low power supply.
769	0301$_h$	RESET_WINDOW_WD:	Reset due to window watchdog.
770	0302$_h$	RESET_INDEPENDENT_WD:	Reset due to independent watchdog. Reset by watchdog timer
771	0303$_h$	RESET_SW:	Reset due to software reset.
772	0304$_h$	RESET_POWER_ON_DOWN:	Reset due to power up or down.
773	0305$_h$	RESET_NMI:	Reset due to non-maskable interrupt.
774	0306$_h$	RESET_BROWNOUT:	Reset due to brown out detection. Reset by low CPU voltage
775	0307$_h$	RESET_NO_REASON:	Reset for unknown reason.
778	0310$_h$	Reset for invalid reason	

Id	Hex	Explanation	
1024	0400$_h$	ADC_REF_LOW:	AD converter reference voltage too low.
1025	0401$_h$	ADC_REF_HIGH:	AD converter reference voltage too high.
1028	0404$_h$	ADC_5V_LOW:	5 V supply voltage too low. (ErrReg: 4)
1029	0405$_h$	ADC_5V_HIGH:	5 V supply voltage too high. (ErrReg: 4) Upper limit of internal 5 V supply exceeded
1030	0406$_h$	ADC_3_3V_LOW:	3.3 V supply voltage too low. Power below internal 3.3 V limit
1031	0407$_h$	ADC_3_3V_HIGH:	3,3 V supply voltage too high. Upper limit of internal 3.3 V supply exceeded
1032	0408$_h$	ADC_TEMP_LOW:	On-chip temperature too low. (ErrReg: 8) Ambient temperature too low
1033	0409$_h$	ADC_TEMP_HIGH:	On-chip temperature too high. (ErrReg: 8) Ambient temperature too high
1034	040A$_h$	ADC_CURR_HIGH:	Total output current too high. (ErrReg: 2)
1036	040C$_h$	Temperature at warning limit	
1037	040D$_h$	Data value not yet available	
1280	0500$_h$	LINE_TIMEOUT:	Invalid sync line level from base board Sync line level monitoring timeout
1282	0502$_h$	TIMEOUTTIMERERR:	Timeout timer error occurred
1283	0503$_h$	HW_REVISION_ERROR:	Invalid HW revision detected (the SW currently running is not designed for this HW revision) Wrong hardware / PCB revision (current software not intended for this HW revision)
1664	0680$_h$	MC1_NOTREADY:	MC1 has not yet initiated communication with MC3
2048	0800$_h$	BCOM_NOTREADY:	Base board communication not ready / operational
2049	0801$_h$	BCOM_BUSY:	Base board communication is busy
2050	0802$_h$	BCOM_NONEWDATA:	No new data received from base board Communication with base board – no new data received
2051	0803$_h$	BCOM_CRCERR:	Base board communication CRC error detected Communication with base board – CRC error
2052	0804$_h$	BCOM_BITERR:	Communication with base board – shifted bits detected Communication with base board – shifted bits
2304	0900$_h$	XCOM_NOTREADY:	Communication with safety partner microcontroller (MC) not ready / operational
2305	0901$_h$	XCOM_BUSY:	Safety partner MC communication is busy

Id	Hex	Explanation	
2306	0902_h	XCOM_NONEWDATA:	Communication with safety partner MC – no new data received
2307	0903_h	XCOM_CRCERR:	Safety partner communication CRC error detected Communication with safety partner MC – CRC error
2336	0920_h	3S RTS background communication with safety partner MC not operational	
2337	0921_h	3S RTS background communication with safety partner is busy	
2338	0922_h	3S RTS background communication has not yet received new data from safety partner MC	
2339	0923_h	3S RTS background safety partner communication CRC error detected	
2340	0924_h	BGCOM_QUEUEERR:	3S RTS background safety partner communication queue error detected
2352	0930_h	3S RTS VM-to-safety partner MC communication not operational yet	
2353	0931_h	3S RTS VM-to-safety partner communication is busy	
2354	0932_h	3S RTS VM communication has not received new data from safety partner MC	
2355	0933_h	3S RTS VM-to-safety partner communication CRC error detected	
2560	$0A00_h$	I2C_TIMEOUT:	I2C communication timeout detected
2561	$0A01_h$	I2C_BUSY:	I2C bus is busy
2976	$0BA0_h$	FSoE Master finished initialization	
2977	$0BA1_h$	FSoE Master is shutting down	
3329	$0D01_h$	MC1_ID_INVALID:	Identifying MC 1 failed
3330	$0D02_h$	MC2_ID_INVALID:	Identifying MC 2 failed
3331	$0D03_h$	MC3_ID_INVALID:	Identifying MC 3 failed
3841	$0F01_h$	FLASH_TIMEOUT:	FLASH write operation timeout
3842	$0F02_h$	FLASH_LOCKED: could not be reset	FLASH write operation failed because ''LOCK'' bit
3851	$0F0B_h$	FLASH_BUSY:	FLASH operation busy. Flash programming sequence error
3854	$0F0E_h$	FLASH_ERROR:	FLASH operation error. Programming the FLASH memory failed

7.3.6 MC 1: Error Line 2008_h

Designation	Value
Name	CPU 1: Errorline
Index	2008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	No

7.3.7 CPU 1: Error Module 2009_h

Designation	Value
Name	CPU : Error Module
Index	2009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	No

The table below explains every entry in object 2009_h "Err.module".

Id	Hex	Explanation	
0	00_h	OBJ_UNKNOWN_ID	Error from module: unknown
4	04_h	OBJ_PRGCONTROLTASK_ID	Error from module: CProgramControlTask.cpp
8	08_h	OBJ_SAFETYHAL_ID	Error from module: CSafetyHal.cpp
12	$0C_h$	OBJ_MAINTASK_ID	Error from module: CMainTask.cpp
16	10_h	OBJ_PRGCONTRLTASK_ID	Error from module: CProgramControlTask.cpp
20	14_h	OBJ_SYNCSAFETYPARTNER_ID	Error from module: CSyncSafetyPartner.cpp
24	18_h	OBJ_XCOM_ID	Error from module: CXcom.cpp
28	$1C_h$	OBJ_BBCOM_ID	Error from module: CBBCom.cpp
29	$1D_h$	OBJ_VMCOM_ID	Error from module: CVMCom module
30	$1E_h$	OBJ_BGCOM_ID	Error from module: CBGCom module
52	34_h	OBJ_HELPER_ID	Error from module: CHelper.cpp
56	38_h	OBJ_SYNCLINE_ID	Error from module: CSyncSafetyPartner.cpp - sync()
58	40_h	OBJ_TESTHANDLER_ID	Error from module: CTestHandler.cpp
72	48_h	OBJ_DIAGNOSTIC_ID	Error from module: CDiagnostic.cpp
74	50_h	OBJ_FSOEMASTER_ID	Error from module: CHAL_FSoEMaster_Template.cpp
88	58_h	OBJ_INTHANDLER_ID	Error from module: InterruptHandler.cpp
192	$C0_h$	OBJ_SPI_ID	Error from module: CSpi.cpp
193	$C1_h$	OBJ_TIMER_ID	Error from module: CTimer.cpp
194	$C2_h$	OBJ_BACKUPSRAM_ID	Error from module: CBackupSRam.cpp
195	$C3_h$	OBJ_PWR_ID	Error from module: CPwr.cpp
196	$C4_h$	OBJ_RCC_ID	Error from module: CRcc.cpp
197	$C5_h$	OBJ_GPIO_ID	Error from module: CGpio.cpp
198	$C6_h$	OBJ_DMASTREAM_ID	Error from module: CDmaStream.cpp
199	$C7_h$	OBJ_ADC_ID	Error from module: CAdc.cpp
200	$C8_h$	OBJ_WD_ID	Error from module: CWatchdog.cpp
201	$C9_h$	OBJ_FLASH_ID	Error from module: CFlash.cpp
202	CA_h	OBJ_CRC_ID	Error from module: CCrc.cpp
203	CB_h	OBJ_I2C_ID	Error from module: CI2c.cpp
208	$D0_h$	OBJ_APPIF_ID	Error from module: CECatApplInterface.cpp

7.3.8 CPU 1: Error Class 200A$_h$

Designation	Value
Name	CPU 1: Error Class
Index	200A$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read
PDO Mapping	No

The table below explains every entry in object 200A$_h$ "Err.class".

Id	Explanation
0	No error
1	Serious or synchronization error
2	Internal communication error
3	I/O error
4	TestHandler error

7.3.9 CPU 1: System Uptime [s] 200C$_h$

Designation	Value
Name	CPU 1: System Uptime [s]
Index	200C$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	s
Default Value	No default value

7.3.10 Read / Write World Time [s] (LOG Time) 200D$_h$

Designation	Value
Name	Read / write world time [s] (GMT, UTC)
Index	200D$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read / Write
PDO Mapping	No
Units	s
Default Value	No default value

7.3.11 CPU 2: Reference Voltage [mV] 2010$_h$

Designation	Value
Name	CPU 2: Reference Voltage [mV]
Index	2010$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	mV
Default Value	No default value

7.3.12 CPU 2: 5 V Supply Voltage [mV] 2012$_h$

Designation	Value
Name	CPU 2: 5 V Supply Voltage [mV]
Index	2012$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	mV
Default Value	No default value

7.3.13 CPU 3: 3.3 V Supply Voltage [mV] 2013_h

Designation	Value
Name	CPU 3: 3.3 V Supply Voltage [mV]
Index	2013_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Units	mV
Default Value	No default value

7.3.14 Temperature Warning 2016_h

Designation	Value
Name	Temperature warning
Index	2016_h
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

7.3.15 CPU 1: LZS ComponentId 2017_h

Designation	Value
Name	CPU 1: Safety runtime system Component Id
Index	2017_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Default Value	No default value

7.3.16 MC 1: LZS FileId 2018_h

Designation	Value
Name	CPU 1: Safety runtime system File Id
Index	2018_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Default Value	No default value

7.3.17 MC 1: LZS Line 2019_h

Designation	Value
Name	CPU 1: Safety runtime system Error line
Index	2019_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Default Value	No default value

7.3.18 CPU 1: Read Number of CORA Test Cycles 201A$_h$

Designation	Value
Name	CPU 1: Read Number of CORA Test Cycles
Index	201A$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Default Value	No default value

7.3.19 CPU 1: Read Number of File System Test Cycles 201B$_h$

Designation	Value
Name	CPU 1: Read Number of File System Test Cycles
Index	201B$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Default Value	No default value

7.3.20 CPU 1: Read Number of RAM Test Cycles 201C$_h$

Designation	Value
Name	CPU 1: Read Number of RAM Test Cycles
Index	201C$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	No
Default Value	No default value

7.3.21 Read CPU 3 Error 2210_h

Designation	Value
Name	CPU 3: Read Error
Index	2210_h
Object Code	RECORD
No. of Elements	3

Designation	Value
Name	Number of Entries
Subindex	00_h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	3

Designation	Value
Name	CPU 3: Error Number
Subindex	01_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	CPU 3: Error Line
Subindex	02_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	CPU 3: Error Module
Subindex	03_h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No

7.3.22 CPU 1 Runtimes 2220_h

Designation	Value
Name	CPU 1: RunTime
Index	2220h
Object Code	RECORD
No. of Elements	6

Designation	Value
Name	Number of Entries
Subindex	00h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	6

Designation	Value
Name	Runtime Main Loop [µs] (Act RT)
Subindex	01h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Maximum of Main Loop Runtime [µs] (Max RT)
Subindex	02h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Safety Application Cycle Time (Par. from PS) [µs] (App Cycle)
Subindex	03h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Safety Application Runtime [µs] (App RT)
Subindex	04h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	CORA test Library Runtime [µs] (App RT)
Subindex	05h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Reserved [µs]
Subindex	06_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

7.3.23 CPU 3 Main Loop Cycle Time and Max Cycle Time 2221_h

Designation	Value
Name	CPU 3 Main Loop Cycle Time and Max Cycle Time [µs] (RunTime MC3)
Index	2221_h
Object Code	RECORD
No. of Elements	2

Designation	Value
Name	Number of Entries
Subindex	00_h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	2

Designation	Value
Name	Runtime Main Loop [µs] (Act RT)
Subindex	01_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Maximum of Main Loop Runtime [µs] (Max RT)
Subindex	02_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

7.3.24 Free Disk Space / App Size Information 2230_h

Designation	Value
Name	Free Disk Space / App Size Information (Free Disk Space)
Index	2230_h
Object Code	RECORD
No. of Elements	4

Designation	Value
Name	Number of Entries
Subindex	00_h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	4

Designation	Value
Name	Actual Local Free Disk Space [Byte] max. 19kB (Local)
Subindex	01_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Actual Global Free Disk Space [Byte] max. 896kB (Global)
Subindex	02_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Actual Application Code Size [Byte] max. 400kB (App Code)
Subindex	03_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Actual Application Data Size [Byte] max. 112kB (App Data)
Subindex	04_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

7.3.25 CPU 1: Chip Id (96-bit Serial Number) 5001_h

Designation	Value
Name	CPU 1: Chip Id (96-bit Serial Number) (Id MC1)
Index	5001_h
Object Code	RECORD
No. of Elements	4

Designation	Value
Name	Number of Entries
Subindex	00_h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No

Designation	Value
Name	CPU 1 Id Received : 1 - OK, 0 - failed (Id rx from MC1)
Subindex	01h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Id Bits 0...31 (Bits 0-31)
Subindex	02h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Id Bits 32...63 (Bits 32-63)
Subindex	03h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Id Bits 64...95 (Bits 64-95)
Subindex	04h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

7.3.26 CPU 3: Chip ID (96-bit Serial Number) 5003_h

Designation	Value
Name	CPU 3: Chip Id (96-bit Serial Number) (Id MC3)
Index	5003_h
Object Code	RECORD
No. of Elements	4

Designation	Value
Name	Number of Entries
Subindex	00_h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	4

Designation	Value
Name	Identification State: 1 - OK, 0 - failed (Id valid)
Subindex	01_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Id Bits 0...31
Subindex	02_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Id Bits 32...63
Subindex	03_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

Designation	Value
Name	Id Bits 64...95
Subindex	04_h
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No

7.4 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.

Object	Explanation/Designation
$10F1_h$	Error Settings
$1C00_h$	Sync Manager Type
$1C32_h$	SM Output Parameter
$1C33_h$	SM Input Parameter
2000_h	Ref Voltage for µC1
2002_h	Supply 5 Voltage to µC1
2003_h	Supply 3.3 Voltage to µC1
$200B_h$	Number of CORA Test Cycles of µC1
2020_h	MaxAsicDataUnequalCounter
2220_h	MC1 Main Loop Cycle Time
5001_h	Id MC1
5003_h	Id MC3
$5E5E_h$	Creates the 'device stamp'

7.5 Standards Complied With

7.5.1 Product Standard Applied

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

7.5.2 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

7.5.3 EMC Standards

EMC immunity to noise:

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

Elevated immunity levels of safety-related applications

- EN 61131-6:201
  Programmable logic controllers – Part 6: Functional safety

EMC noise emission

- Generic standard EN 61000-6-4:2007 + A1:2011
  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

7.6 Directives and Declarations

The original EC Declarations of Conformity and the accompanying documentation are kept at the disposal of the competent authorities. Please contact the product management department if necessary.

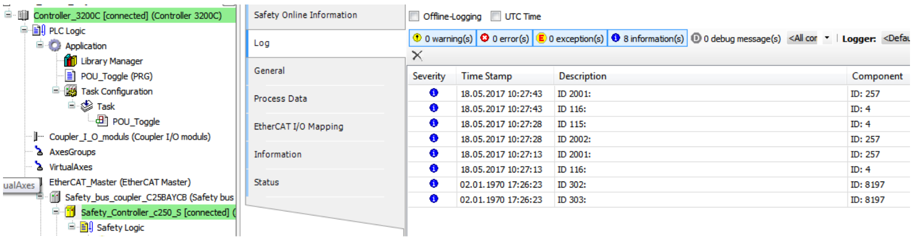
7.7 Approvals

The following certifications were issued for the Safety Controller c250-S module:

EC Type-Examination by Notified Body according Annex IX of Directive 2006/42/EG	TÜV Rheinland, Notified Body for Machinery, NB 0035 EC Type-Examination Certificate Reg.-Nr./No.: 01/205/5598.00/17
$_{C}UL_{US}$	File Number E343358
EtherCAT Conformance tested	Compliance test and the interoperability test in an EtherCAT Test Center (ETC).
RoHS 2011/65/EU	Corresponds to RoHS Directive 2011/65 / EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
UK CA	TÜV Rheinland UK Ltd. UK Type-Examination Certificate Reg.-No.: 01/205U/5598.00/22

7.8 Log Entries

The logbook of the safety controller c250-S can be read out via the Log tab



The following is a list of the meaning of the logbook entries

Component BootapplicationManager ID: 4, 004_h

ID	Hex	Bedeutung
100	0064_h	Initialization, error reading local index file
101	0065_h	Initialization, inconsistent global index file
102	0066_h	Initialization, error reading global index file
103	0067_h	Initialization, inconsistent bootapplication's file(s)
104	0068_h	Initialization, error writing the local index file after bootapplication exchange
105	0069_h	Create bootapplication, wrong application status
106	$006A_h$	Create bootapplication, global index file already exist
107	$006B_h$	Create bootapplication, wrong number of meta or auxiliary files
108	$006C_h$	Create bootapplication, error check global files
109	$006D_h$	Create bootapplication, error writing local index file
110	$006E_h$	Create bootapplication, error writing global index file
111	$006F_h$	Delete bootapplication. error delete global index file
112	0070_h	Error loading the bootapplication
113	0071_h	Activate bootapplication on device
114	0072_h	Change bootapplication on device
115	0073_h	Load bootapplication on device
116	0074_h	Delete bootapplication on device

Component ApplicationManager ID: 256, 100_h

ID	Hex	Bedeutung
100	0064_h	error loading IEC code version '{p0}' (see next message)
101	0065_h	error loading IEC object {p0} (see next message)
102	0066_h	error in IEC access to instance '{p0}' (see next message)
300	$012C_h$	runtime error occured in FB called in '{p0}'
301	$012D_h$	runtime error occured in FB-call on instance '{p0}'
1000	$03E8_h$	IEC error (format): object {p0} corrupted
1001	$03E9_h$	IEC error (format): Application corrupted, required CRC {p0}, calculted CRC {p1}
1002	$03EA_h$	IEC error (format): Code illegal begin: Codeword {p0}
1065	0429_h	IEC error (limit): application data size {p0} exeeds limit of {p1} byte
1066	$042A_h$	IEC error (limit): application signature data {p0} exeeds limit by {p1} byte
2101	0835_h	truncated application code after {p0} byte
2116	0844_h	IEC error (format): object {p0}: unknown section #{p1}
2117	0845_h	IEC error (format): object {p0}: unknown section format #{p1}
2118	0846_h	IEC error (format): object {p0}: section #{p1} has size 0
2119	0847_h	IEC error (format): object {p0}: section #{p1} at unexpected position
2120	0848_h	IEC error (format): object {p0}: has size 0
2121	0849_h	IEC error (format): object {p0}: corrupted object header
2122	$084a_h$	IEC error (format): object {p0}: code not terminated
2148	0864_h	IEC error (link): no task in loaded application
2149	0865_h	IEC error (link): no application object in loaded application
2164	0874_h	IEC error (limit): application code size exceeds limit of {p0} byte
2167	0877_h	IEC error (limit): execution version #{p0} not supported
2168	0878_h	IEC error (limit): external implementation in version '{p0}' not supported
2169	0879_h	IEC error (limit): task time {p0} not supported
2216	$08A8_h$	IEC error (format): object {p0}: illegal opcode {p0}
2217	$08A9_h$	IEC error (format): object {p0}: access to undefined value #{p0}
2218	$08AA_h$	IEC error (format): access to undefined variable '{p0}'
2248	$08C8_h$	IEC error (link): no definition of accessed object '{p0}'
2264	$08D8_h$	IEC error (limit): object {p0}: no support for conversions with {p0} bits
2416	0970_h	IEC error (format): object {p0}: undefined variable name
2417	0971_h	IEC error (format): {p0}: undefined initial value
2418	0972_h	IEC error (format): {p0}: undefined type name
2419	0973_h	IEC error (format): {p0}: used for element access
2420	0974_h	IEC error (format): {p0}: parent instance is not declared
2432	0980_h	IEC error (syntax): {p0}: cannot be VAR_EXTERNAL
2448	0990_h	IEC error (link): {p0}: type is not defined
2449	0991_h	IEC error (link): {p0}: no VAR_GLOBAL declaration

ID	Hex	Bedeutung
2450	0992_h	IEC error (link): {p0}: not an element of parent instance's type
2464	$09A0_h$	IEC error (limit): {p0}: instantiated POU contains too many levels of function blocks
2764	$0ACC_h$	IEC error (limit): object {p0}, network #{p1}: expression too complex
2780	$0ADC_h$	IEC error (logical): object {p0}, network #{p1}: Division by zero
2781	$0ADD_h$	IEC error (logical): object {p0}, network #{p1}: MUX with negative first input value
2782	$0ADE_h$	IEC error (logical): object {p0}, network #{p1}: MUX with first input value too large
2783	$0ADF_h$	IEC error (logical): object {p0}, network #{p1}: value with highest bit cannot be converted
2784	$0AE0_h$	IEC error (logical): object {p0}, network #{p1}: positive value too big for conversion
2785	$0AE1_h$	IEC error (logical): object {p0}, network #{p1}: negative value too big for conversion

Component CommunicationManager ID: 257, 101h

ID	**Hex**	**Bedeutung**
100	0064_h	Receive error
101	0065_h	Receive timeout
102	0066_h	Send error
103	0067_h	Send timeout
2000	$07D0_h$	Create bootapplication by user {p0}
2001	$07D1_h$	Delete bootapplcation by user {p0}
2002	$07D2_h$	Restart bootapplication by user {p0}
2003	$07D3_h$	Reset origin by user {p0}
2004	$07D4_h$	Reset origin pin name {p0}
2005	$07D5_h$	Reset origin pin with info {p0}
2006	$07D6_h$	Error create bootapplication by user {p0}, feedback bootapplication manager
2007	$07D7_h$	Error create bootapplication by user {p0}, CRC32 of active application different to bootapplication
2008	$07D8_h$	Error create bootapplication by user {p0}, message format error
2009	$07D9_h$	Error delete bootapplication by user {p0}, PLC operation state is undefined
2010	$07DA_h$	Error reset origin by user {p0}, PLC operation state is undefined
2100	0834_h	Timeout while waiting for new connection confirmation
2101	0835_h	Connection loss
2102	0836_h	Error online message sequence (internal error)
3000	$0BB8_h$	Change to unsafe mode by user {p0}
3001	$0BB9_h$	Restart bootapplication
3002	$0BBA_h$	Error within application download

8 Sales & Service

Please visit our Internet site to find a comprehensive overview of our sales and service network including all the relevant addresses. Feel free to also contact us at our headquarters in Aerzen/Germany:

8.1 Declaration of Conformity

Lenze

2366614.02

EU-Konformitätserklärung	EU Declaration of Conformity
LENZE SE, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY	
erklärt in alleiniger Verantwortung die Übereinstimmung der Produkte	declares under sole responsibility compliance of the products

Safety Programmable Logic Controller (PLC) with FSoE Interface C25BAYSQ

mit der	with the
Maschinenrichtlinie 2006/42/EG Anhang VIII und IX	**Machinery Directive** 2006/42/EC Annex VIII and IX
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

		EN 60204-1	:2018		
	Kategorie 4 Performance Level (PL): PL e	EN ISO 13849-1	:2015	Category 4 Performance Level (PL): PL e	
Sicherheitsfunktionen siehe Betriebsanleitung.	SIL 3	EN 61508 1-7 EN 62061 +AC +A1 +A2 EN 61131-2	:2010 :2005 :2010 :2013 :2015 :2007	SIL 3	For safety functions see manual.

Konformitätsbewertung		Conformity assessment	
CE 0035	Benannte Stelle	notified body	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
	Zertifikate	Certificates	01/205/5598.01/22
	Gültigkeit	Date of expiry	2027-06

EMV- Richtlinie 2014/30/EU	**EMC Directive** 2014/30/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

EN 61000-6-7:2015
EN 61131-2:2008

RoHS- Richtline 2011/65/EU	**RoHS Directive** 2011/65/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

EN IEC 63000:2018

Die Sicherheitshinweise der Betriebanleitung sind zu beachten.	The safety instructions of the manual are to be considered.
Die Produkte sind bestimmt zum Einbau in Maschinen. Die Inbetriebnahme ist solange untersagt bis festgestellt wurde, dass die Maschine, in welche diese Produkte eingebaut werden sollen, den Bestimmungen der o.g. EU-Richtlinie entsprechen.	These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned EU Directive.

Ort / Datum Place / date	**Geschäftsführer** Managing Director	**Dokumentationsverantwortlicher** Responsible for documentation
Aerzen 11.07.2022	Dipl.-Ing. Frank Maier	i.V. T. Wedemeyer

Lenze

2469500.00

UK Declaration of Conformity

LENZE SE, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

declares under sole responsibility compliance of the products

Safety Programmable Logic Controller (PLC) C25BAYSQ

with the

The Supply of Machinery (Safety) Regulations 2008			S.I. 2008 No. 1597
Applied designated standards:			
	EN 60204-1	:2018	
	EN ISO 13849-1	:2015	Category 4 Performance Level: PL e
For safety functions see manual.	EN 61508 1-7	:2010	
	EN 62061 +AC +A1 +A2	:2005 :2010 :2013 :2015	SIL 3

Conformity assessment

UK CA

notified body	TUV Rheinland UK Ltd 1011 Stratford Road Solihull, B90 4BN
Certificates	01/205U/5598.00/22
Date of expiry	2027-06

The Electromagnetic Compatibility Regulations 2016 — S.I. 2016 No. 1091

Applied designated standards:

EN 61000-6-7:2015
EN 61131-2:2008

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 — S.I. 2012 No. 3032

Applied designated standards:

EN IEC 63000:2018

Authorised representative
LENZE Ltd., 6, Abbey Court Fraser Road Priory, Business Park, MK44 3WH Bedford

The safety instructions of the manual are to be considered.
These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned Regulations.

Place / date		Chief Technology Officer	Responsible for documentation
Aerzen	19.10.2022	Dipl.-Ing. Frank Maier	i.V. Torsten Wedemeyer

c250-S

C25BAYCB

Translation

Operating Instructions EN

c250-S Safety bus coupler

13524973

Lenze

1 Preface

1.1 Version information

Document History	
Date	**Comments / modification**
31/01/2017	Version 1.0
02/08/2017	Version 1.1
13/05/2020	Version 1.2
31/05/2021	Version 1.3

1.2 Information about this Operating Instructions

This Operating Instructions contains general Information for parameterization, configuration and diagnosis of the Lenze Safety System.

Target Group

This Operating Instructions is directed to Persons, who project and setup the Lenze Safety System with the Engineering Tool

Information

Information and Tools about the Lenze Products can be found in the Internet http://www.lenze.com ► Download

Copyright

Structure and goal of this Operating Instructions

This guide aims to familiarize you with the use of the modules.

In examples preferably »PLC Designer« Version 3.14 and the Lenze Controller 32xx C which contains an EtherCAT Master is used.

Further knowledge of the programming in accordance with IEC 611131-3, please refer to the »PLC Designer« online help or the literature.

For beginners in »PLC Designer« it may be appropriate to use the comprehensive training offer from Lenze.

1.2.1 Literature

Titel / Theme	Number/ Author	Source
EtherCAT, Technology, FAQs, Downloads		http://www.ethercat.org
SPS Programmierung nach IEC 61131-3	Heinrich Lepers	Franzis Verlag GmbH

1.3 Reliability, Safety

Scope

For reasons of personal safety and to avoid material damages when working with or handling this Lenze product, you are advised to take heed of the notes and information contained in this instruction manual.

Target Group of Operating Instructions

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

Intended Use

Lenze products are designed, developed and manufactured for standard industrial use. They must not be used for any other purposes than the ones specified in the catalogue or the associated technical documentation. Proper and safe operation depends on the products being transported, stored, lined up, mounted, installed, put into service, operated, and serviced correctly. Ambient conditions must be within the admissible limits. Notes and information in the associated documentation apply at all times.

Reliability

Reliability of Lenze 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.

1.3.1 Hazard and other Warnings

Despite the actions described in section 1.3, 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 instruction manual. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

Every alert and hazard warning is made up as follows:

- Type and source of risk
- Potential consequences of non-observance
- Preventive measures

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.

NOTE

A NOTE makes you aware of a potentially hazardous situation which MAY cause damage to this or other devices if not observed.

1.3.2 Other Notices

Informations

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).

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 humans or material/equipment.

DANGER

Non-observance of the instruction manual

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

⇨ Thoroughly read the instruction manual

⇨ Take particular heed of the hazard warnings

Information

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

Project Planning

- 24 VDC power supply: generate as electrically safely separated low voltage. Suitable devices include split-winding transformers built in compliance with European Standard EN 60742 (corresponds to VDE 0551).
- Power breakdowns or power fades: the program structure is to ensure that a defined state at restart excludes all dangerous states.
- Emergency-off installations must comply with EN 60204/IEC 204 (VDE 0113). They must be operative at any time.
- 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 controller operation or its functionality.
- Because the Safety bus coupler use capacities for voltage equalization , it is recomended to use line circuit breakers with characteristic B or C.

Maintenance and Servicing

- Precautions regulation to be observed when measuring or checking a controller after power-up.
- Repairs may only be carried out by qualified Lenze personnel. Otherwiese warranty is lost.
- Spare parts: Only use parts approved of by Lenze. Only genuine Lenze modules must be used in modular controllers.
- Modular systems: always plug or unplug modules in a power-down state. You may otherwise damage the modules or (possibly not immediately recognizably!) inhibit their functionality.
- Always dispose of (rechargeable) batteries as hazardous waste.

Electromagnetic Compatibility

Definition

Electromagnetic compatibility is the ability of a device to function satisfactorily in its electromagnetic environment without itself causing any electromagnetic interference that would be intolerable to other devices in this environment.

Of all known phenomena of electromagnetic noise, only a certain range occurs at the location of a given device. These kinds of noise are specified in the applicable product standards.

IEC 61131-2 which, in Europe, has been the basis for European Standard EN 61131-2.

> ***Information***
>
> 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 noise voltages are limited to tolerable levels.

Interference Emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

> ***Information***
>
> If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011.
>
> Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.

General Notes 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).

Electrical Immission Safeguard

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

Cable Routing and Wiring

Keep power circuits separate from control circuits:

- DC voltages 60 V ... 400 V
- AC voltages 25 V ... 400 V

Joint laying of control circuits is allowed for:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- 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

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use suitable casings 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 extra voltages to a minimum.

Throttling 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.

2 Introduction

2.1 EtherCAT® — Ethernet Control Automation Technology

EtherCAT is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale. EtherCAT moves beyond the limits of conventional fieldbus systems. 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 controllers thus nearly act like centralised control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

2.2 Lenze Safety System

The Lenze Safety System is a system of I/O modules for connecting the process signals to an EtherCAT network.

The Lenze Safety System consists of the Safety bus coupler and a range of other modules.

The Safety bus coupler converts the physical transfer technology (twisted pair) to 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, the Safety I/O-modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 BaseTx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.

If the bus coupler is the last device of the EtherCAT network, i.e. the RJ45-socket "Out" remains free, the connection of the forward and return line are closed automatically.

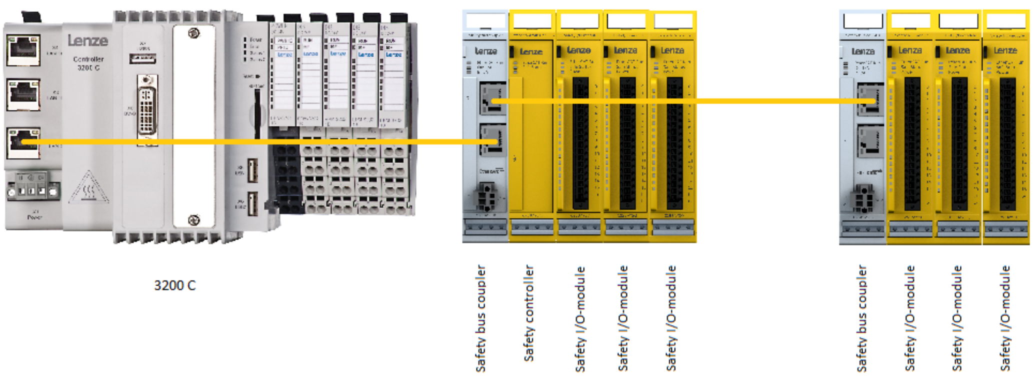


Figure 1: Safety bus coupler with Safety I/O-Modules

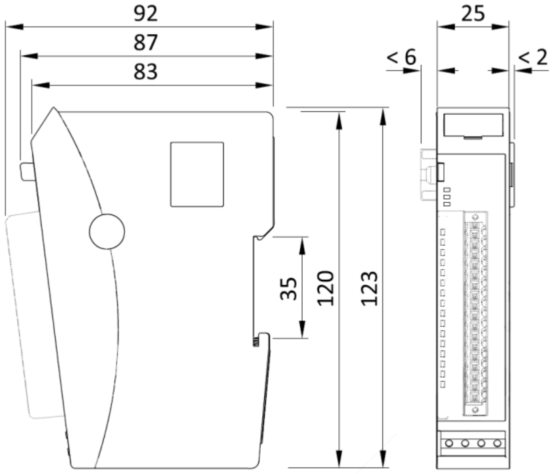
3 System Description

3.1 General conditions of use

This section describes the general characteristics of Safety modules which are important for the installation, wiring and troubleshooting.

You can find an overview of the system properties in section 5.1.1 System features on page 21.

3.2 Dimensions



3.3 Mechanical Design

The Safety bus coupler and the Safety I/O-modules differ in their connectors and indicators, however.

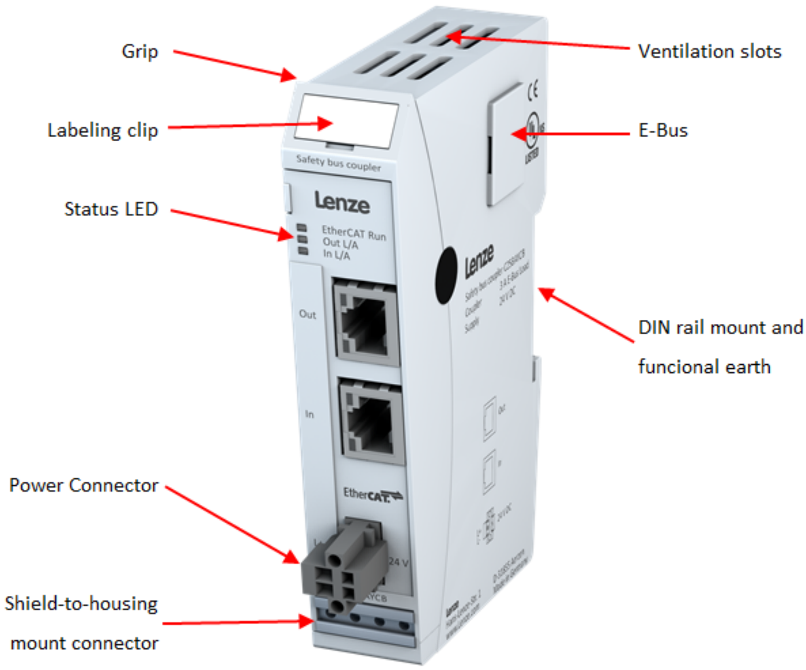


Figure 2 Module layout

The housing mount consists of an aluminum profile with an integral snap-on device used to snap the module to a 35mm DIN rail. The housing trough including the optical fibers for the status indicators, the side face and the front is made of plastic and contains the module. The optical fibers for the signal state indicators (LEDs) are located next to the spring-assisted combi plug. They slightly protrude from the housing and allow a clear diagnosis at a glance.

3.3.1 Earth

Connect the Safety modules to earth by attaching the metal housing to operative earth.

Since the operative earth connector dissipates HF currents, it is of utmost importance for the module's noise immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to an operative earth connector.

You will normally have to ensure that

- the connection between module housing and DIN rail conducts well,
- the connection between DIN rail and switching cabinet conducts well,
- the switching cabinet is safely connected to earth.

In special cases you may attach the earth wire straight to the module.

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

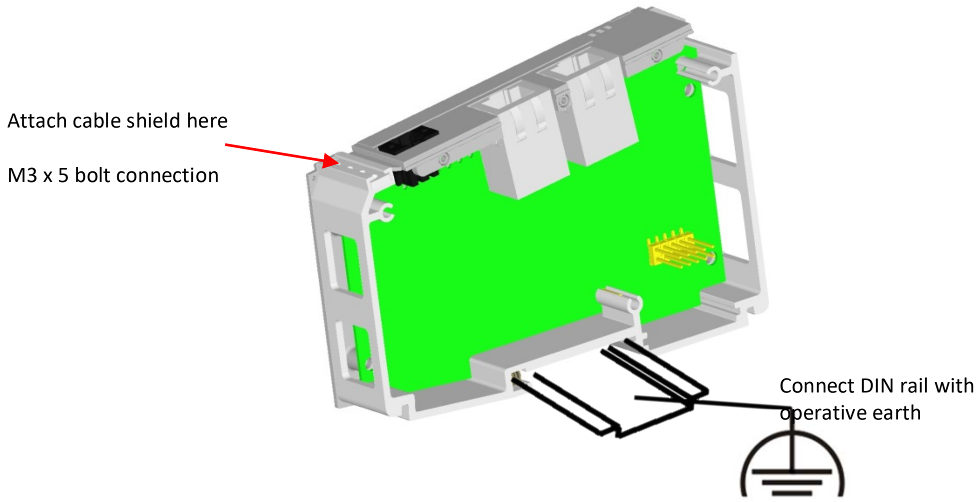


Figure 3: Aluminium profile

3.3.2 Installation

The modules of the Lenze Safety System are intended for mounting rail installation (DIN EN 50022, 35 x 7.5 mm).

Installation position

The mounting rail is placed horizontally and the female connector strip of the modules face forward. For a sufficient ventilation of the convection slits the minimum distance must not fall below 20mm upward and 35mm to adjacent equipment and control cabinets The lateral distance to external devices and cabinet controls must not fall below 20mm.

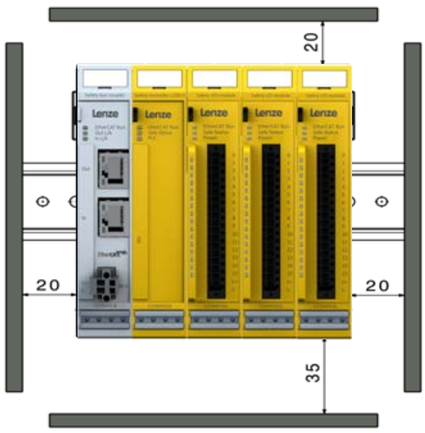


Figure 3: Installation position

Installation order in the Lenze Safety System

> ***NOTE***
>
> To ensure smooth function of the entire Lenze Safety System, the Safety modules must be arranged based on their e-bus load. The modules with the biggest e-bus load are to be arranged directly next to the head modules (bus coupler or controller). Make sure that you note the maximum bus load of the head module.
> Safety I/O-modules shall be arranged directly next to the head module.

To snap on a single module

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

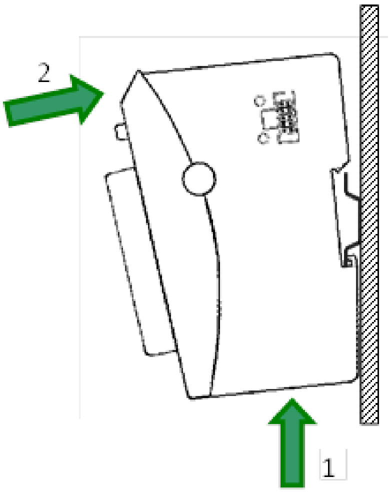


Figure 4: Rail mounting of module

To interconnect two modules

1. After snapping on the first module to the rail, snap on the second module about 1cm away towards the right of the first module.
2. Push the second module along the rail towards the first module until you hear the locking device snap in.

To disconnect two modules

1. Push down the unlock button (see Figure 5) of the module that you wish to disconnect from the module to the left of it.
2. Push both modules away from one another until they are about 1 cm apart.

To take down a single module

1. Push the module up and against the metal spring located on the underside of the rail guide.
2. Tip the module away from the rail as shown in the illustration.
3. Pull the module down and out of the mounting rail.

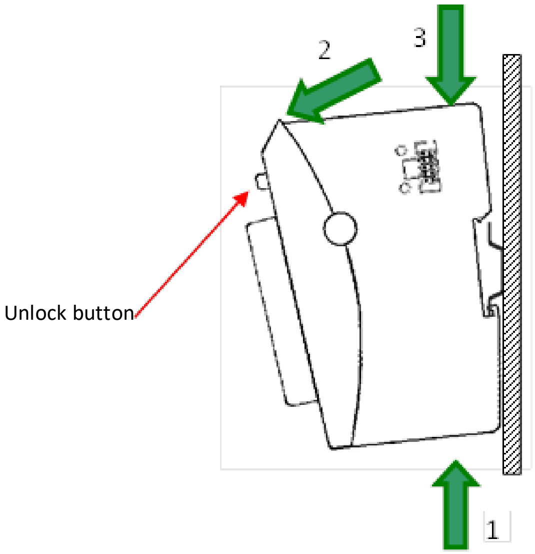


Figure 5: Uninstall a module

3.4 System Power Supply

3.4.1 General

Multipole connectors stand for high port density in a confined space.

- Release latches facilitate the separation of the plug connection in tight spaces.
- Screw flanges ensure for a snug fit, if the plugs are small

Spring-assisted plugs ensure quick and easy wiring.

MSC model:		Weidmüller, OMNIMATE Signal - Serie BL/SL 3.50, BLZF	
1-row:	Tool:	Screwdriver blade 0,4 x 2,5 x 75 (DIN 5264-A)	
	Wires:	320V/ 10 A/ 0.2 – 1.5 mm²	(IEC)
	Rated current:	300V/ 10 A/ 28 - 14 AWG	(UL)

Connectable conductors with ferrules:

	Conductor cross ssection [mm²]						
Type of core end sleeve	**0,13**	**0,25**	**0,34**	**0,50**	**0,75**	**1**	**1,5**
with collar to DIN 46 228/4	8 / 10	8 / 10	8 / 10				
without collar to DIN 46 228/1	8 / 10	8 / 10	8 / 10				

Stripping length [mm] / sleeve length [mm]

The Push-in spring connector enables fast, tool-free wire connection by direct plug-in technology. The stripped solid wires or flexible wires with crimped ferrules are plugged all the way into the terminal point.

MSC model:		Weidmüller, OMNIMATE Signal - Serie BL/SL 3.50, BLF	
2-row:	Wires:	320V/ 13.4 A/ 0.14 – 1.5 mm²	(IEC)
	Rated current:	300V/ 9.5A/ 26 - 16 AWG	(UL)

Connectable conductors with ferrules:

	Conductor cross ssection [mm2]						
Type of core end sleeve	**0,14**	**0,25**	**0,34**	**0,50**	**0,75**	**1**	**1,5**
with collar to DIN 46 228/4	8 / 10	8 / 10	8 / 10	10 / 12	12 / 14	12 / 15	
without collar to DIN 46 228/1							10 / 10

Stripping length [mm] / sleeve length [mm]

> ***NOTE***
>
> The power supply lines may not be connected by one supply terminal of the Lenze Safety Module to the next. In order to ensure trouble-free operation, the supply lines must be routed in star formation with the shortest possible lines from a central supply terminal to Lenze Safety Module.

3.4.2 Safety Bus coupler

A 2-pin plug-in terminal block with screw flange is used to connect the system supply to the bus coupler. Since the bus coupler supplies power to both the E-bus and the logic circuits of the Safety controller c250-S and the Safety I/O-modules, its power consumption depends on the Safety controller c250-S and the number of Safety I/O-modules connected.

Power to the I/O module outputs is supplied separately

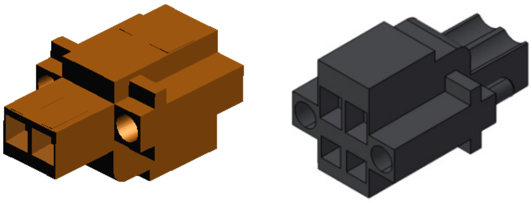


Figure 6: Spring-assisted terminal block with screw flange / Push-In terminal block for the Bus coupler

3.5 Statusanzeigen

3.5.1 LED "EtherCAT Run"

An LED labeled "EtherCAT Run" is located on both the bus coupler and the I/O modules. It indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation	
Init	Off	Initialisierung,	no data exchange
Pre-Op	Off /green, 1:1	Pre Operational,	no data exchange
Safe-Op	Off /green, 5:1	Safe Operational,	inputs readable
Op	Green, On	Operational,	unrestricted data exchange

Due to the specification "ETG.1300 Indicator and Labeling" successively following changes in name and flashing were performed from October 2012.

Name old	Name new	LED old	LED new
EtherCAT	EtherCAT Run	red/green	Off/green
In, Out	In L/A, Out L/A		no change

3.5.2 LED "In L/A", LED "Out L/A"

The "In L/A" and "Out L/A" LEDs are located on the bus coupler. They indicate the physical state of the Ethernets (Link/Activity).

State	LED, flash code	Explanation
Not connected	Off	No Ethernet connection
Connected	Green, On	Connected to Ethernet
Traffic	Green, flashing	Exchanging telegrams

3.5.3 LED "IO"

Every I/O module has an LED labeled "IO". It indicates the state of the module's I/Os. Refer to the I/O module sections in this manual to know which states of a module are monitored and indicated.

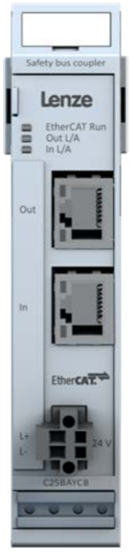
3.5.4 LED "Power"

An LED labeled "Power" is located on every module that has a power supply connector (e.g. for digital outputs). It indicates the state of the Safety-I/O module's I/O power supply.

State	LED flash code	Bedeutung
On	Green, On	24 V DC supply ok
Off	Off	24 V DC supply not ok

4 Module

4.1 Safety bus coupler



The Safety bus coupler Converts the physical transfer technology (twisted pair) to LVDS (E-bus) and gene rates the system Voltages required by the LVDS modules. The standard 100 Base Tx lines used for office communications network connect to the one side, the Lenze Safety modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the load I / O modules. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being did another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.

You will get the best results concerning disturbing emission, if you put the shielding of the EtherCAT cable on the function earth.

Figure 7: Bus coupler front view

4.1.1 Terminals

Module Power Supply

L+	24 V DC
L-	0 V

EtherCAT

IN	RJ45-Buchse	input (from previous EtherCAT station)
OUT	RJ45-Buchse	output (to next EtherCAT station)

NOTE

The following notes must be observed during configuration

⇨ The Safety bus coupler is always DC-Synchron.

⇨ It is not recommended to use the Safety Bus Coupler as DC-Master
Exception: There is no other DC-Master in the system, then the Safety bus coupler must be used as a DC-Master.

4.1.2 Status LEDs

The LED labeled "EtherCAT Run" indicates the state of the EtherCAT ASIC

State	LED flash code	Explanation	
Init	Off	Initialisierung,	no data exchange
Pre-Op	Off /green, 1:1	Pre Operational,	no data exchange
Safe-Op	Off /green, 5:1	Safe Operational,	inputs readable
Op	Green, On	Operational,	unrestricted data exchange

LED "In L/A", LED "Out L/A"

Die LED "In L/A" und "Out L/A" zeigt den physikalischen Zustand des jeweiligen Ethernet-Ports an (Link/Activity).

State	LED flash code	Explanation
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing	Exchanging Telegrams

4.1.3 Function

see page 19

Module state

Variable	Data type	Explanation
Undervoltage	BOOL	Low voltage (supplied power < 19,2V)

Technical data

General device date	
Function	Connects a 100 Base-TX EtherCAT with the Lenze Safety modules. Generates the LVDS system voltages.
Controller	ASIC ET1100
Baud rate	100 Mbit/s
Cable	CAT5
Length of cable	max. 100m between 2 Safety bus couplers
Ports	2 x RJ45
Power supply	24 V DC -20 % +20 %
Connector Power	Plug 2-pole (part of the module)
Input current	50 mA + E-Bus-Supply
E-Bus power supply	max. 3 A
E-Bus load	195 mA
Part no	13520258
Approvals	EtherCAT Conformance tested

EtherCAT telegram size	
Input	1 Byte
Output	0 Byte
FSoE Input	0 Byte
FSoE Output	0 Byte

5 Appendix

5.1 Technical data (Overview)

5.1.1 System features

General device date	
Fieldbus	EtherCAT 100 Mbit/s
Dimensions	25 mm x 120 mm x 90 mm (B x H x T)
Housing mount	aluminium
Shield	connected straight to module housing
Installation	35mm DIN rail (top-hat rail)
IO connection	spring-assisted combi plug with mechanical ejector, 4 … 36-pin
Signal indication	LED located next to the terminal
Diagnosis	LED: bus state, module state, broken wire/excessive current
Number of ports	up to 32 digital I/Os on every module
Supply voltage	24 V DC -20 % / +20 %
Number of I/O modules	Limited by max. power consumption: 3A
Electrical insulation	modules electrically insulated from one another and from the bus
Storage temperature	-25 °C … + 70 °C
Operating temperature	0°C … + 55 °C
Rel. humidity	5 % … 95 %, non-condensing
Protection	IP20
Susceptibility to noise	zone B to EN 61131-2, Installation on an earthed top hat rail in the earthed control

5.1.2 Safety bus coupler

General device date	
Part no	13520258
Fieldbus	EtherCAT 100Mbit/s 100 Base TX to IEEE802.3
Connector	2 x RJ45
Controller	ASIC ET1100
Extensions	connection to first Safety Modul integrated in side panel of module
Diagnosis	LED: Modul state In/Out state

Lenze SE
Postfach 101352 · 31763 Hameln
Hans-Lenze-Straße 1 · 31855 Aerzen
GERMANY
Hannover HRB 204803

+49 5154 82-0

+49 5154 82-2800

sales.de@lenze.com

www.lenze.com

Lenze Service GmbH
Breslauer Straße 3, 32699 Extertal

GERMANY

008000 2446877 (24 h helpline)

+49 5154 82-1112

service.de@lenze.com

10 9 8 7 6 5 4 3 2 1

c250-S

C25BAYA42, C25BAYA82,
C25BAYA160, C25BAYA164

c250-S Safety I/O-module

Translation

Operating Instructions EN

Lenze

Information Safety I/O-module C25BAYA42

The operating instructions begin on page 3.

Information Safety-I/O-Module C25BAYA82, C25BAYA160, C25BAYA164

The operating instructions begin on page 116.

ATTENTION: There are significant deviations from the Safety I/O Module C25BAYA42 in some Technical Data.

---

1 Version Details

1.1 Revision

1.1.1 Manual

Manual History		
Version	**Date**	**Comments / modification**
1.0	01/31/2017	Creation
1.1	04/05/2017	Release
1.2	08/02/2017	Corrections
1.3	08/29/2017	Corrections
2.0	09/27/2019	Corrections
2.1	05/13/2020	Corrections
2.2	04/20/2021	Corrections
2.3	10/19/2022	Corrections

1.1.2 Safety I/O-module (C25BAYA42)

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

Modul release			
Version	**Manual**	**Date**	**Comments / modifications**
V1.0	1.0	01/31/2017	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	1.1	04/05/2017	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	1.2	08/02/2017	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	1.3	08/29/2017	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	2.0	09/27/2019	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	2.1	05/13/2020	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	2.2	04/20/2021	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)
V1.0	2.3	10/19/2022	Applies to module release V1.0 (Softwareversion V1.0x, Hardwareversion V2.1)

2 Preface

2.1 About this Operating Instructions

This document is the original Operating Instructions to Safety I/O-module, order number C25BAYA42. Your module work should always be based on the correct Operating Instructions version ▶ 1.1.1 Manual.

This document is primarily directed to system designers and project engineers. It does not contain any availability information. We reserve the rights for errors, omissions and modifications. Pictures are similar.

> **I** ***Information***
>
> Always use the current version of the manual.
> Information and Tools about the Lenze Products can be found in the Internet
> http://www.lenze.com ▶ Download

2.1.1 Limitation of Liability

Specifications are for description only 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 Terms of Delivery

The general conditions of sales and service of Lenze SE shall apply.

2.1.3 Copyright

Microsoft®, Windows® and the Windows® logo are registered trademarks of Microsoft Corp. in the USA and other countries.

EtherCAT® is a registered brand and patented technology, licenced by Beckhoff Automation GmbH, Germany.

Safety over EtherCAT is a registered trademark and patented technology, licenced by Beckhoff Automation GmbH, Germany

Further information about the PLCopen organisation is available at www.plcopen.org. CiA® and CANopen® are registered joint brands of CAN in Automation e.V. Title to all companies and company names mentioned herein as well as to products and product names is held by the respective enterprises.

2.1.4 Warranty

Warranty is subject to the provisions of the conditions of sale of Lenze 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

2.2 Reliability, Safety

2.2.1 Applicability

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

2.2.2 Target Group

The Operating Instructions 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 Lenze 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 Operating Instructions. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

Every alert and hazard warning is made up as follows:

- Type and source of risk
- Potential consequences of non-observance
- Preventive measures

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 humans or material/equipment.

> ***DANGER***
>
> **Non-compliance with the Operating Instructions**
> Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.
> Carefully read the Operating Instructions
> Take particular heed of the hazard warnings

> ***Information***
>
> To achieve a high degree of conceptual safety in planning and installing an electronic controller, it is essential to exactly follow the instructions given in the Operating Instructions because wrong handling could lead to rendering measures against dangers ineffective or to creating additional dangers.

2.2.7 Project Planning and Installation

- Emergency-off installations must comply with EN 60204/IEC 204 (VDE 0113). They must be operative at any time.
- 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 controller operation or its functionality.

2.2.8 Maintenance and Servicing

- You are not allowed to repair Safety I/O-module. Please return the module to Lenze if defective.
- Spare parts:
  Only use parts approved of by Lenze. Only genuine Lenze modules may be used in modular controllers.
- 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 Notes 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).

> **_Information_**
>
> In order to safely install c250-S Safety System, please read section ▶ 2.2.7 Project Planning and Installation and following.

Interference emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

> **_Information_**
>
> If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.

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 .

> **_Note_**
>
> 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 noise voltages are limited to tolerable levels.

Electrical immission safeguard

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

Cable routing and wiring

Keep power circuits separate from control circuits:

- DC voltages 60 V ... 400 V
- AC voltages 25 V ... 400 V

Joint laying of control circuits is allowed for:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- 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

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use suitable casings 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 extra voltages to a minimum. Throttling 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.

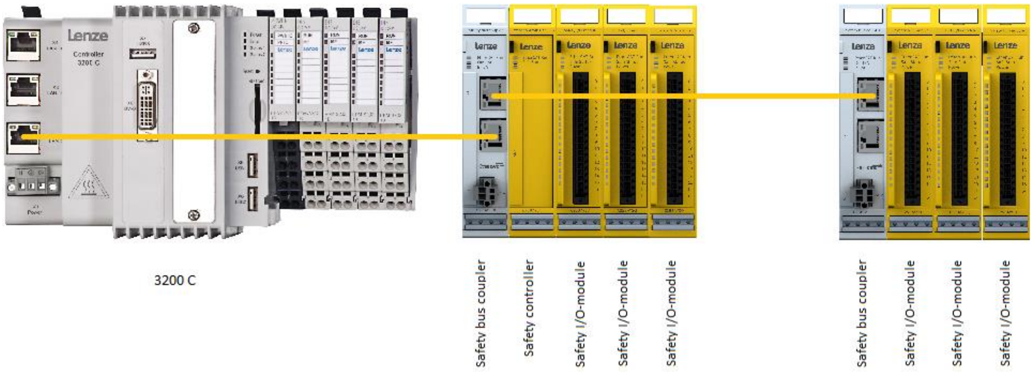
3 System Description

3.1 EtherCAT® – Ethernet Control

EtherCAT® is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale.

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 controllers thus nearly act like centralised control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.



3.2 c250-S Safety System

The c250-S System consists of the Safety bus coupler, the Safety controller and a range of Lenze Safety I/O-modules.

The Safety bus coupler converts the physical transfer technology (twisted pair) to 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, the Safety I/O-modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last Safety I/O-module.

The c250-S Safety System allows users to add Safety I/O-modules with safe signals to the EtherCAT control unit, making the separate wiring of safety circuits a thing of the past. The EtherCAT protocol is used to transfer both safe and standard signals to the Safety controller c250-S. This integrated transfer process is based on FSoE (Fail Safe over EtherCAT), the safety protocol certified by TÜV, the German Technical Testing & Inspection Association.

3.2.1 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. In 2010, IEC 61784-3-12 was published as the international reference standard for Safety over EtherCAT.

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 left out of the safety assessment.

3.2.2 Safety controller c250-S

Safety controller c250-S links up the inputs and outputs of Safety I/O-module and other FSoE system devices. At the basic level, certified function blocks are graphically "wired up" to establish the system's safety programme. In case 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.

Safety controller c250-Shas been designed as an add-on to a normal PLCDesigner control unit. This is a two-channel system which uses the normal control unit to communicate with the PLCDesigner Development System and all non-safe I/Os. Programming is based on a certified plug-in that is fully integrated in the PLCDesigner Development System.

3.2.3 Safety I/O-module

Safety I/O-module provides connections for standard security appliances. It installs at any place of the c250-S block. Its signals are transferred by the EtherCAT bus of Safety controller c250-S and processed in a safe manner. The module outputs safely switch actuators such as contactors, signal lamps or servo converters.

3.2.4 PLCDesigner Safety

Programming of Safety controller c250-S is based on a certified plug-in that is fully integrated in the PLCDesigner Development System.

Safety controller c250-S is a sub-node of the standard control unit and provides 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. Further software functions are available for safeguarding the safety functions by change tracking, safe flow of signals, safe version control (pinning), separating safe operation, debugging mode, etc..

3.2.5 PLCDesigner SafetyPLCopen Library

The PLCopen components have been defined by the PLCopen organisation, its members and external organisations specialising in all safety-related aspects. Since these are certified components, they reduce the time and costs involved in developing, verifying and testing a safety application for acceptance. 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.

4 Product Description

4.1 General Description

Safety-I/O module features 4 safe inputs and 2 safe outputs for distributed installation. Figure 1: Module layout shows the basic layout of c250-S Safety.

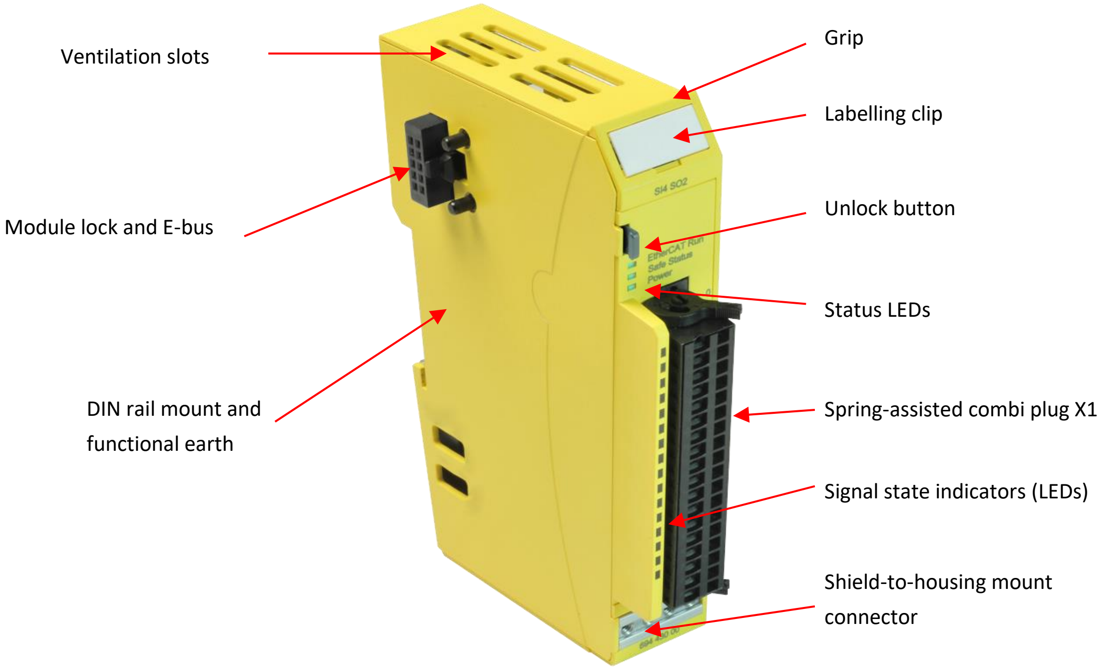


Figure 1: Module layout

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. They slightly protrude from the housing and allow a clear diagnosis at a glance.

4.2 Application

4.2.1 Intended Use

The c250-S Safety System comprising Safety controller c250-S, Safety I/O-module and PLCDesigner Safety Software make the Safety I/O-module fit for the functional safety of machinery.

The intended applications of the c250-S 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 which, in case of the c250-S Safety System, is a wattless 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 Operating Instruction's Technical Data section must be read carefully and obeyed at any time.

The c250-S Safety System is not designed 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 by the following persons only:

- 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.

This manual's safety instructions construe qualified persons as 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 manual 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. It is the aimed-for safe functional state at which the system works without problems.

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 deenergised 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 an external fault occurs (short circuit, cross-fault etc.), all outputs are deenergised (outputs "null") and the inputs return "null" to the safe control unit. FSoE communication is not stopped.

A fail-safe state is wattless.

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 deenergised (output "null"). Both FSoE communication and the transfer of input information stops.

A fail-safe state is wattless.

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

CAUTION

Uncontrolled movement of suspended loads, for example

Injury caused by moving or non-braked machine parts

⇨ Additional external safety measures such as a mechanical brake of suspended loads should be provided for applications whose safe state requires an actuator to be actively turned 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 Kendrion 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, refer to section ► 5.1 Labelling and Identification. 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.

I

Note, information

The purchaser must ensure the units' retraceability by means of their serial number.

4.4 Useful Lifetime

The Safety I/O-module is designed for a maximum lifetime of 20 years.

It must therefore be taken out of service not later than one week before the end of this 20-year period (calculated as of Lenze's production date).

The production date is printed on the module as part of its serial number, see section ► 5.1.2 Serial Number

4.5 Technical Data

4.5.1 General Specifications

General specifications	
Product name	Safety I/O-module
Fieldbus	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 one another and from the bus
Diagnosis	LED: bus state, module state, broken wire/excessive current ► 6.5 Diagnosis
IO/power connection	male 18-pole connector (not included in module package) 18-pole spring-assisted combi plug with mechanical ejector
E-bus load	max. 300 mA (system power supply)
Terminating module	not required

Power supply (Safety I/O-module / system power supply)	
Supply voltage	24 VDC -15%/+20%
Overvoltage category	category II to EN 61131-2:2007
Module power consumption	approx. 7 mA plus load current
Reverse polarity safeguard	yes
Nominal insulation voltage	500 Veff measured between Safety I/O-module supply and E-bus
Susceptibility to noise	zone B to EN 61131-2:2007, mounted on earthed DIN rail in earthed control cubicle
Storage and transport conditions	
Temperature	-25°C … + 70°C
Rel. humidity	5% … 95%, non-condensing
Atmospheric pressure	70 kPa to 108 kPa / 0 to 3000 m above msl
Vibration	5 Hz to 8.4 Hz: +/- 3.5 mm amplitude, 8.4 Hz to150 Hz: 10 m/ s^2 (1g) to IEC 60068-2-6, Fc test
Shock	150 m/s^2 (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Service conditions	
Mounting position	horizontal, stackable
Degree of contamination	II to IEC 60664-3
Admissible operating environment	operation restricted to environments complying with IP54 or better to IEC 60529 (e.g. suitable control cabinet)
Operating temperature	0°C ... + 55°C
Rel. humidity	5% … 95%, non-condensing
Atmospheric pressure	80 kPa to 108 kPa / 0 to 2000 m above msl
Vibration	5 Hz to 8.4 Hz: +/- 3.5 mm amplitude, 8.4 Hz to150 Hz: 10 m/ s^2 (1g) to IEC 60068-2-6, Fc test
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)
Size	25 mm x 120 mm x 90 mm (W x H x D)
Ingress Protection	IP20
Housing mount	aluminium
Shield	connects straight to module housing

EtherCAT telegram size	
Input	0 Byte
Output	0 Byte
FSoE Input	6 Byte
FSoE Output	6 Byte

4.5.2 Safe Digital Inputs

Safe digital inputs	
Quantity and type	4x single-channel or 2x two-channel, (EN 61131-2:2007, Type 3)
Diagnosis	cross-fault, external power supply
Highest safety level (depending on configuration)	Single-channel use: Cat. 2/PL d to EN ISO 13849-1:2015, SIL2 to EN 62061:2010 / IEC 61508:2010 Two-channel use: Cat. 3/PL d to EN ISO 13849-1:2015, SIL3 to EN 62061:2010 / IEC 61508:2010
Input delay	300 µs ... 1500 µs (configurable)
Sensor type	use of sensors with OSSD outputs to EN 61496, contact-type sensors
Electrical insulation	channel/channel: no channel/E-bus: 500 Veff
Signal level	Off: -3 … 5 V, I_{Lmin} = nicht festgelegt, I_{Lmax} = 15mA On: 11 V … 30 V, I_{Hmax} = 15mA, I_{Hmin} = 2mA
Maximum voltage	33 V (max. voltage to input even in case of error)
Signal indication	LED located next to terminal and parallel to input
Duration of test impulse	300 µs ... 1500 µs (configurable), phase-shifted to each channel, tolerance -100 µs ... +50 µs
Safe response time	< 5 ms; see section "Response Time"
Input current	typ. 3.3 mA
Input resistance	typ. 7.3 kΩ
Input capacitance	typ. 100 nF
Maximum line length	100 m (between sensors / module terminals)

4.5.3 Safe Digital Test Pulse Outputs

Safe digital test pulse outputs	
Quantity and type	4
Nominal output current	50 mA, short-circuit-proof
Signal indication	LED located next to the terminal
Switching voltage	24 VDC -15%/+20%
Electric strength	33 V (max. voltage to output even in case of error)
Duration of test impulse	300 µs ... 1500 µs, phase-shifted to each channel, tolerance -100 µs ... +50 µs
Maximum line length	100 m (between sensor / module terminals)

4.5.4 Safe Digital Outputs

Safe digital outputs	
Quantity and type	2x semiconductor, 24 VDC, tolerance 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
Diagnosis	cross-fault, external power supply
Signal indication	LED located next to the terminal, controlled by CPU
Minimum output current	2 mA, see ► 6.2.8 Actuator Connection for details
Maximum output current	2,0 A, short-circuit-proof, comply with total load and derating See section ► 6.2.8 Actuator Connectionfor - Derating of Total Load for details
Capacitive load	yes, see section ► 6.2.8 Actuator Connectionfor - switching of capacity loads for details
Braking voltage while turning off inductive loads	typ. 40 VDC
Inductive load	yes, see section ► 6.2.8 Actuator Connection - switching of inductive loads for details
Maximum line 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 modulemax	4 A, comply with total load and derating See section ► 6.2.8 Actuator Connectionfor - Derating of Total Load for details
Load resistance range (at nominal voltage)	12 Ω ... 12 kΩ
Electrical insulation	channel/channel: no channel/E-bus: 500 Veff
Approved actuators	DC 13 to EN60947-5-1 Table 4 DC 1 to EN60947-4
Duration of test impulse	configurable: 500 µs ... 1500 µs (configurable)
Supply voltage	24 VDC -15%/+20%
Electric strength	33 V (max. voltage to output even in case of error)

4.6 Safety-related Input Ratings

4.6.1 Safety-related Ratings of a Single-channel Application

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.

Safety-related ratings of a single-channel application		
Highest safety integrity level to EN 62061:2010	SIL2	
Highest safety integrity level to EN 61508:2010	SIL2	
Highest 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 of the application may cause the safeguard to fail)	
Safety-related ratings	**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 fieldbus)	$5.40 * 10^{-6}$ (0.06% of entire PFD_{avg} of 10^{-2} at SIL2)	$2.23 * 10^{-5}$ (0.23% of entire 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 fieldbus)	$1.24 * 10^{-10}$ 1/h (0.02% of entire PFH of 10^{-6} at SIL2)	$5.27 * 10^{-10}$ 1/h (0.05% of entire 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 fieldbus)	$1.10 * 10^{-5}$ (0.11% of entire PFD_{avg} of 10^{-2} at SIL2)	$4.77 * 10^{-5}$ (0.48% of entire 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 fieldbus)	$1.28 * 10^{-10}$ 1/h (0.02% of entire PFH of 10^{-6} at SIL2)	$5.79 * 10^{-10}$ 1/h (0.06% of entire PFH of 10^{-6} at SIL2)
Diagnostic coverage (DC) 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 Safety-related Ratings of a Two-channel Application

The table below lists the safety-related ratings of a two-channel safety function that uses two 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.

Safety-related ratings of a two-channel application		
Highest safety integrity level to EN 62061:2010	SIL3	
Highest safety integrity level to IEC 61508:2010	SIL3	
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 ISO 13849-1:2015)	1 (a fault of the application need not cause the safeguard to fail)	
Safety-related ratings	**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 fieldbus)	5,21 * 10^{-6} (0.51% of entire PFD_{avg} of 10^{-3} at SIL3)	2.16 * 10^{-5} (2.16% of entire 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 fieldbus)	1.20 * 10^{-10} 1/h (0.12% of entire PFH of 10^{-7} at SIL3)	5.11 * 10^{-10} 1/h (0.51% of entire 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 fieldbus)	1.06 * 10^{-5} (1.06% of entire PFD_{avg} of 10^{-3} at SIL3)	4.62 * 10^{-5} (4.62% of entire 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 fieldbus)	1.24 * 10^{-10} 1/h (0.12% of entire PFH of 10^{-7} at SIL3)	5.62 * 10^{-10} 1/h (0.56% of entire PFH of 10^{-7} at SIL3)
Diagnostic coverage (DC) 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 Safety-related Ratings of a Single-channel Application

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.

Safety-related ratings of a single-channel application		
Highest safety integrity level to EN 62061:2010	SIL2	
Highest safety integrity level to IEC 61508:2010	SIL2	
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 ISO 13849-1:2015)	0 (a fault of the application may cause the safeguard to fail)	
Safety-related ratings	**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 (up to fieldbus)	$5.36 * 10^{-6}$ (0.06% of entire PFD_{avg} of 10^{-2} at SIL2)	$2.24 * 10^{-5}$ (0.23% of entire PFD_{avg} of 10^{-2} at SIL2)
Probability of failure per hour (PFH), proof test interval: 10 years, (IEC 61508:2010) for one output (up to fieldbus)	$1.24 * 10^{-10}$ 1/h (0.02% of entire PFH of 10^{-6} at SIL2)	$5.31 * 10^{-10}$ 1/h (0.06% of entire PFH of 10^{-6} at SIL2)
Probability of failure on demand (PFD_{avg}), proof test interval: 20 years, (IEC 61508:2010) for one output (up to fieldbus)	$1,10 * 10^{-5}$ (0.11% of entire PFD_{avg} of 10^{-2} at SIL2)	$4,82 * 10^{-5}$ (0.48% of entire PFD_{avg} of 10^{-2} at SIL2)
Probability of failure per hour (PFH), proof test interval: 20 years, (IEC 61508:2010) for one output (up to fieldbus)	$1.28 * 10^{-10}$ 1/h (0.02% of entire PFH of 10^{-6} at SIL2)	$5.89 * 10^{-10}$ 1/h (0.06% of entire PFH of 10^{-6} at SIL2)
Diagnostic coverage (DC) 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 Safety-related Ratings of a Two-channel Application

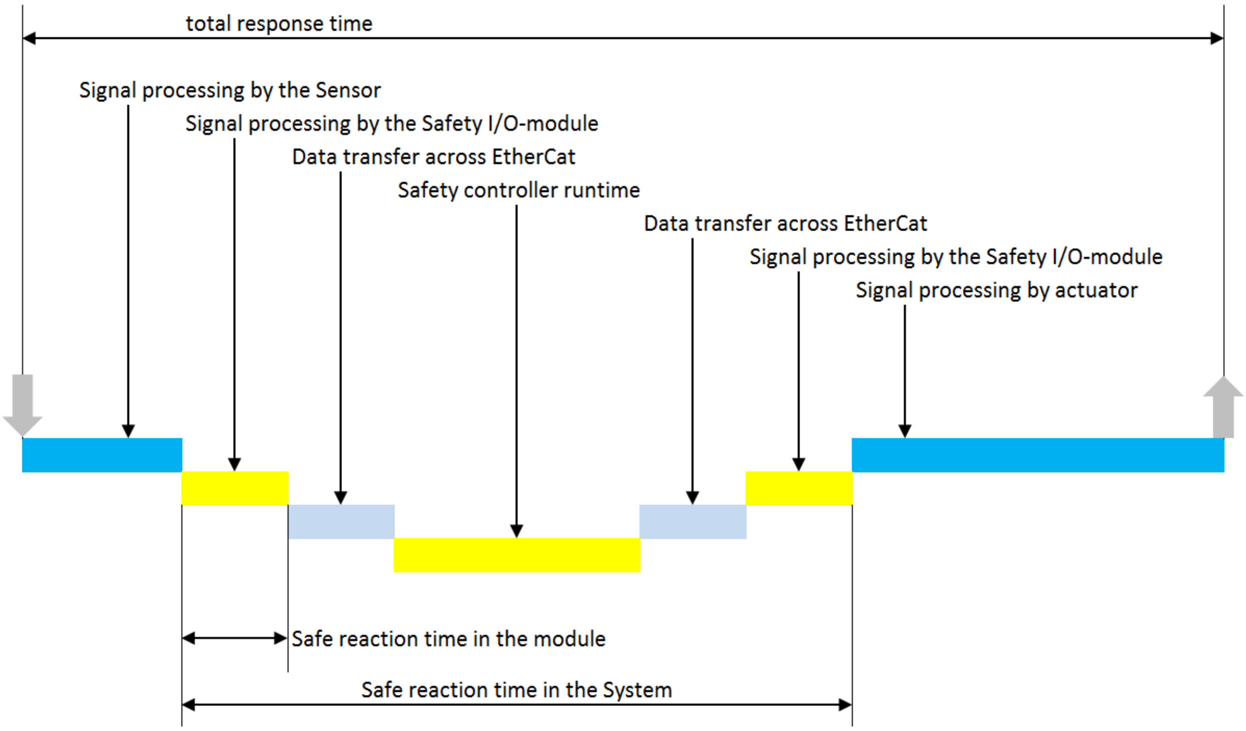
The table below lists the safety-related ratings of a two-channel safety function that uses two outputs of the safe I/O module. All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Safety-related ratings of a two-channel application		
Highest safety integrity level to EN 62061:2010	SIL3	
Highest safety integrity level to IEC 61508:2010	SIL3	
Highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e	
Hardware fault tolerance (HFT) in two-channel application (IEC 61508:2010/EN ISO 13849-1:2015)	1 (a fault of the application need not cause the safeguard to fail)	
Safety-related ratings	**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 (up to fieldbus)	$5.52 * 10^{-6}$ (0.55% of entire PFD_{avg} of 10^{-3} at SIL3)	$2.33 * 10^{-5}$ (2.33% of entire PFD_{avg} of 10^{-3} at SIL3)
Probability of failure per hour (PFH), proof test interval: 10 years, (IEC 61508:2010) for one output (up to fieldbus)	$1.28 * 10^{-10}$ 1/h (0.13% of entire PFH of 10^{-7} at SIL3)	$5.53 * 10^{-10}$ 1/h (0.56% of entire PFH of 10^{-7} at SIL3)
Probability of failure on demand (PFD_{avg}), proof test interval: 20 years, (IEC 61508:2010) for one output (up to fieldbus)	$1.13 * 10^{-5}$ (1.13% of entire PFD_{avg} of 10^{-3} at SIL3)	$5.03 * 10^{-5}$ (5.03% of entire PFD_{avg} of 10^{-3} at SIL3)
Probability of failure per hour (PFH), proof test interval: 20 years, (IEC 61508:2010) for one output (up to fieldbus)	$1.32 * 10^{-10}$ 1/h (0.13% of entire PFH of 10 -7 at SIL3)	$6.18 * 10^{-10}$ 1/h (0.62% of entire PFH of 10^{-7} at SIL3)
Diagnostic coverage (DC) 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 by the Safety I/O-module
- time of input data transfer across the EtherCAT bus between the Safety I/O-module and the safe PLC
- safe PLC program runtime
- time of output data transfer across the EtherCAT bus between the Safety controller c250-S and the Safety I/O-module
- signal processing by the Safety I/O-module
- signal processing by actuator



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 fieldbus runtimes and the Safety PLC's cycle time must be taken account of to rate and calculate the safe response time.

As a general rule, a safe response time of max. 5 ms may be assumed for the Safe I/O-module. This time ensures that the input and output signals will change and a safe state will be achieved.

The configurable Input filters (adjustable between 0.3 ms and 1.5 ms) influence the maximum response time of the Safe I/O-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:

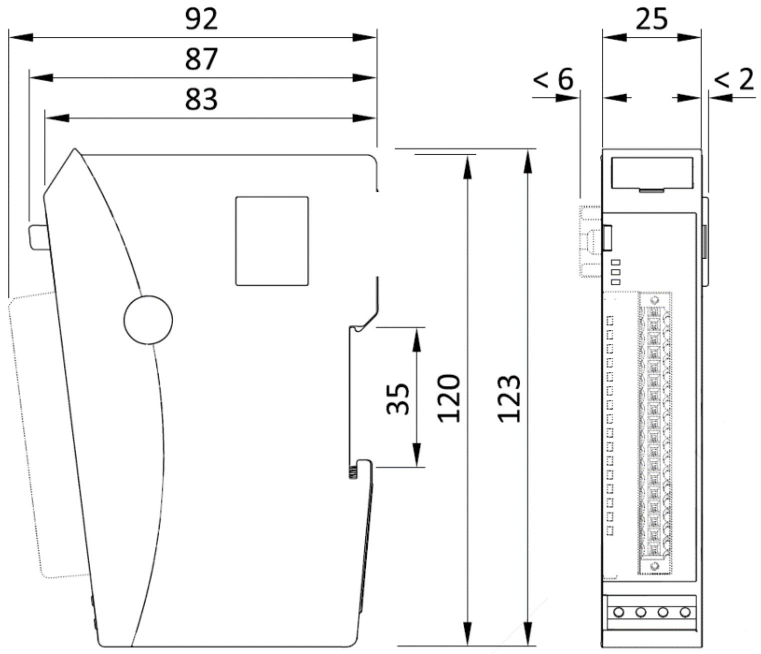
- fault detected at the module inputs
- fault detected at the module outputs
- internal module fault (self-diagnosis)

CAUTION

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



4.10 Transport and Storage

At times of transport and storage, protect Safety I/O-module against inadmissible exposure such as mechanical stress, temperature, humidity and/or aggressive atmospheres. Transport and store Safety I/O-module in its original packaging if possible.

Verify that the contacts are neither soiled nor damaged when consigning the unit to stock or re-packaging it. Keep and transport Safety I/O-module in a container/packaging ensuring electrostatic discharge (ESD) compliance. Some parts of the units are sensitive to ESD and may be damaged if handled inappropriately. Thus, best transport practice is to place open assemblies in statically shielded transport bags with a metal coating which avoid contamination by amines, amides or silicone. When putting Safety I/O-module into service and performing any maintenance, you should also take the appropriate precautions against electrostatic discharge.

CAUTION

Electrostatic discharge

Destruction of or damage to the unit.

⇨ Transport and store Safety I/O-module in its original packaging.

⇨ Ensure that the ambient conditions are as specified at all times during transport and storage.

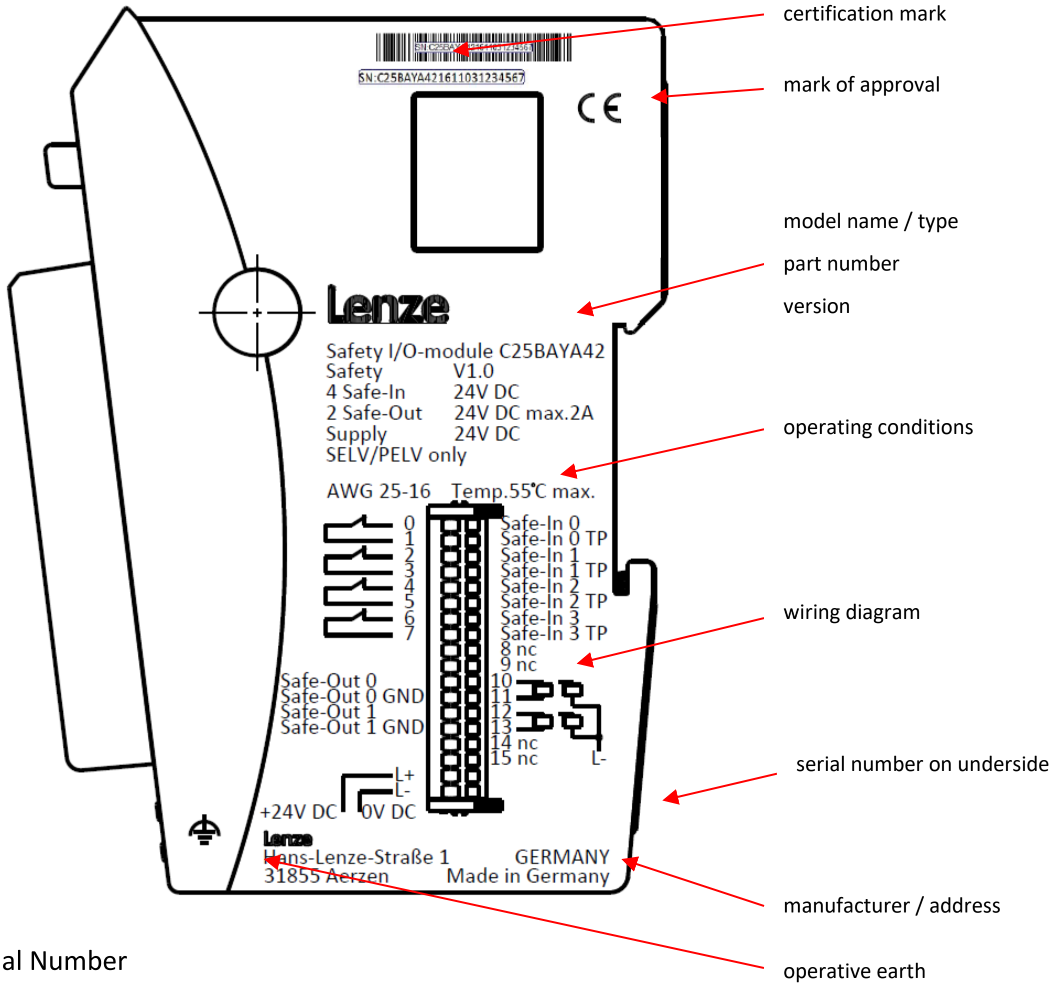
⇨ Handle Safety I/O-module in a well-earthed environment (persons, place of work, packaging).

⇨ 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

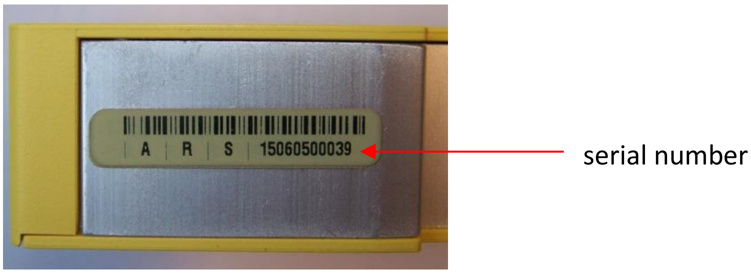
5.1.1 Imprinted Texts and Symbols



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. lenze can use the numerical code to distinctly identify the model, software and hardware release date. It is a means of traceability.



Make-up of serial number:

YY MM DD NNNNN

Example:

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

15 06 05 00039

five-digit number of nth unit built on that day

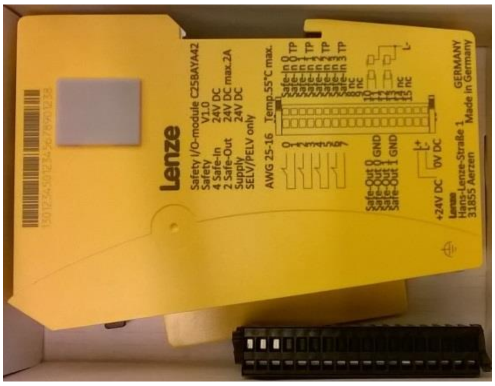
production date as year month day

The serial number is also stored in object 1018 sub-index 4 and can be retrieved by SDO Transfer ► 8.1.6 Identification 1018_h

5.2 Contents of Package

The Safety I/O-modules package contains:

- Safety I/O-module
- Module bus cover
- Connector
- Mounting Instruction



5.3 Connectors

5.3.1 E-bus and Module Lock

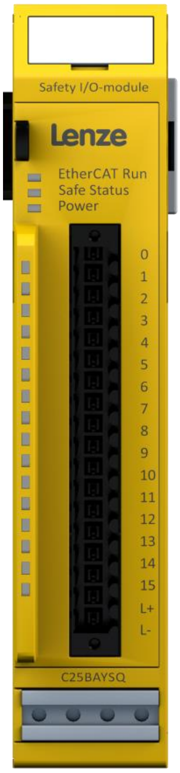
The system plugs and the module lock are located on the sides of Safety I/O-mdoule. These contact pins interconnect the modules. They supply power to the module's electronic circuitry and transfer the EtherCAT signals. Verify that the end cap from the package is in place to protect the module bus connector 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 unit's mechanical elements
> ⇨ Use approved modules in a c250-S network only.

5.3.2 Spring-assisted Combi Plug X1

The spring-assisted combi plug is located at the front of Safety I/O-module. The sensors and actuators and the module's power supply all attach to this connector.



Connector X1		
Pin	Function	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-

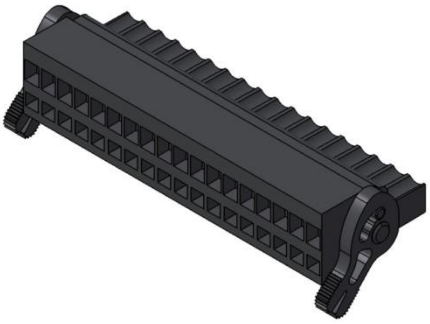


Figure 2 : Single-row spring-assisted connector with releasing lever

I

Note, information

Connection to the Safety I/O-module must be made by the spring-assisted connector from the package only. Refer to section ► 6.2 Electrical Installation further down 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 module's safe function.

5.3.3 Wiring Example

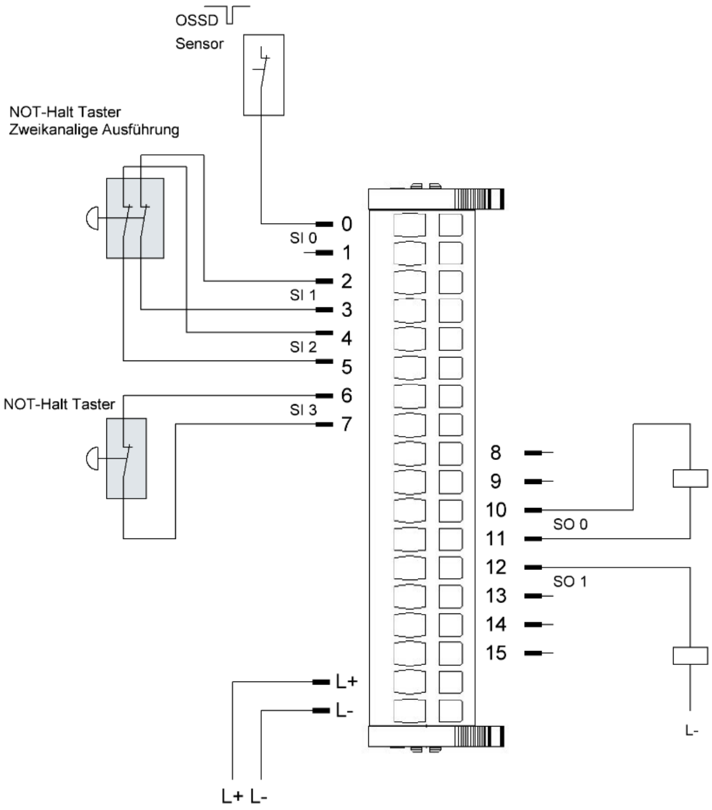


Figure 3: Example of how to wire the inputs and outputs

The Safety I/O-module is intended to provide functional safety to industrial automation and to protect humans and machines in conformity with Machinery Directive 2006/42/EC [UKCA: S.I. 2008/1597].

It therefore supports the connection of many different safety-related sensors.

Examples:

- Single-channel and two-channel contact-type sensors such as EMERGENCY STOP switches
- Sensors with single and two-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, see section ► 4.5.4 Safe Digital Outputs.

Note, information

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 Safety I/O-module will detect cross-faults between the inputs / outputs and other signal lines 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 Safety I/O-module Supply

The Safety I/O-module supply of the safe outputs and the associated test pulse outputs connects to terminals L+ and L-. The supply voltage is rated at 24 VDC. It is monitored.

The cord must have external protection against short circuit and overload triggering at max. 10 A.

Power to Safety I/O-module may be supplied by PELV/SELV-ready 24 VDC power supply units to EN50178 / EN60950-1 only. This applies to both the system power supply ► 6.2.3 System Power Supply and the I/O supply ► 6.2.4 Safety I/O-module Supply.

CAUTION

Risk of fire by overload or overvoltage
Damage to the unit
- ⇨ Power to Safety I/O-module may be supplied by PELV/SELV-ready 24 VDC power supply units to EN50178 / EN60950-1 only.
- ⇨ The maximum voltage supplied must not exceed 33 V even in case of an error.
- ⇨ The cord 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
Although Safety I/O-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 ► 6.5.7 Error Codes.

Refer to section ► 6.5 Diagnosis for further details on how the module responds to a non-conforming supply of power.

5.4 Indicators and Controls

5.4.1 LED "EtherCAT Run"

LED "EtherCAT Run" indicates the state of EtherCAT communication.

LED "EtherCAT Run"		
LED	**State**	**Explanation / State**
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, on	Op	Operational, unrestricted data exchange

5.4.2 LED "Safe Status"

Duo LED safe "status" indicates the state of the module regarding its safety function.

LED "Safe Status"		
LED	**State**	**Explanation**
Green, on	OK	Safety I/O provides safe functionality
Red, on	Error	Safety I/O in fail-safe state

5.4.3 LED "Power"

LED "Power" indicates the state of the power supply to Safety I/O-module.

LED "Power"		
LED	**State**	**Explanation**
Off		No power supplied to the module.
Green, on	OK	Operating voltage supplied to the module.

> ***Information***
>
> Safety I/O-module feature a voltage watchdog for the 24 VDC supply voltage. It enables the module's safe state when a voltage is out of the specified range.

5.4.4 LEDs "Channel"

The "Channel" LEDs are allocated to the module's 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 position	**Channel**	**Function**	**LED**	**Explanation**
0	Input SI 0	SI0 state	Off	No valid input signal on channel 0, logical "0"
			Green	24 VDC supplied to channel 0, logical "1"
1		SI0 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
2	Input SI 1	SI1 state	Off	No valid input signal on channel 1, logical "0"
			Green	24 VDC supplied to channel 1, logical "1"
3		SI1 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
4	Input SI 2	SI2 state	Off	No valid input signal on channel 2, logical "0"
			Green	24 VDC supplied to channel 2, logical "1"
5		SI2 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
6	Input SI 3	SI3 state	Off	No valid input signal on channel 3, logical "0"
			Green	24 VDC supplied to channel 3, logical "1"
7		SI3 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault

I

Information

⇨ 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 VDC 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 outputs SO 0 and SO 1				
LED position	**Channel**	**Function**	**LED**	**Explanation**
10	Output SO 0	Status	Off	No output signal at output 0, logical "0"
			Green	Output signal at output 0, logical "1"
11		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
12	Output SO 1	Status	Off	No output signal at output 1, logical "0"
			Green	Output signal at output 1, logical "1"
13		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault

5.5 Operating Software

The FSoE master's configuration tool is used for operation and configuration . Refer to the FSoE master Operating Instructions for further information and details.

6 Installation and Operation

Before installing the Safety I/O-module, verify that it has been transported and stored at the ambient conditions specified in sections ▶ 4.10 Transport and Storage and ▶ 4.5 Technical Data.

Module operation is subject to the service conditions specified in section ▶ 4.5 Technical Data.

CAUTION

Inappropriate operation
Malfunction of Safety I/O-module

- ⇨ Only persons qualified for dealing with safety matters are allowed to add, replace and put Safety I/O Modules into operation.
- ⇨ Before installing, servicing or putting Safety I/O-module into service, please also read the safety information in the preface of this document.
- ⇨ Before putting the unit into service, verify that all safety functions work as specified.

6.1 Mechanical Installation

Environment of installation

Protect Safety I/O-module against inadmissible contamination. Do not allow the units to contaminate more than specified for degree II in IEC 60664-3.

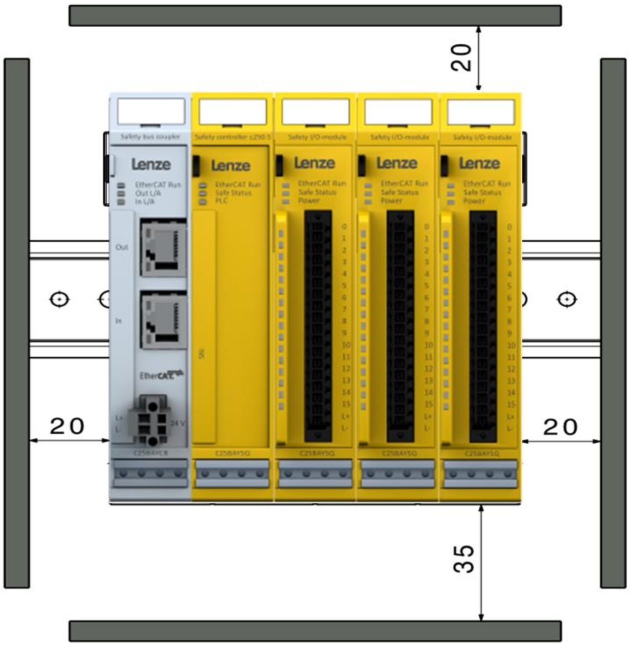
Whereas an enclosure providing IP 54 protection (e.g. an appropriate control cabinet) ensures that degree of contamination II is complied with, please consider that operation under condensing humidity is NOT allowed.

WARNING

Potentially hazardous failures due to contamination
Contaminations more severe than those described for degree of contamination II of IEC 60664 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



Safety I/O-moduless mount on 35 mm x 7.5 mm rails to EN 50022. Mount with rail horizontally with the modules' multiple socket connectors pointing away from the wall. To ensure that enough air gets in 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.

Order of modules in multi-c250-S systems

> **I** ***NOTE***
>
> Order of modules in multi-c250-S systems
> In order to ensure that the entire c250-S system works properly, arrange the c250-S 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 head module's maximum bus load.
> If possible, place the Safety I/O-module immediately next to the head module.

6.1.2 To Snap on a Single Module

- Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
- Push the top of the module against the mounting wall until it snaps in.

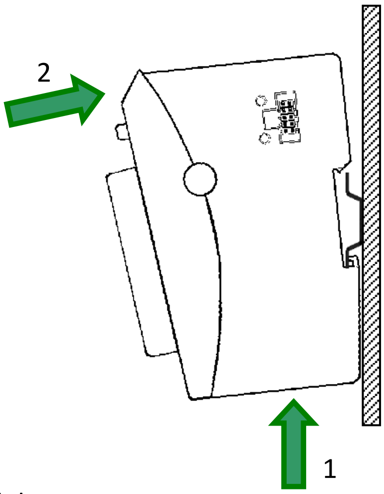


Figure 4: Rail mounting of module

6.1.3 To Interconnect Two Modules

- After snapping on the first module to the rail, snap on the second module about 1 cm away towards the right of the first module.
- Push the second module along the rail towards the first module until you hear the locking device snap in. Correctly mounting the modules is the only way of ensuring that the system works properly.
- To prevent inadmissible contamination, mount the cover of the module bus connectors on the rightmost module of the c250-S system.

CAUTION

Short circuit fault of module bus contacts
A short 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 c250-S system.

6.1.4 To Disconnect Two Modules

- Push down the unlock button (see Figure 5: Uninstalling a module) of the module that you wish to disconnect from the module to the left of it.
- Push both modules away from one another until they are about 1 cm apart.

6.1.5 To Take Down a Single Module

- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module away from the rail as shown in the illustration.
- Pull the module down and out of the mounting rail.

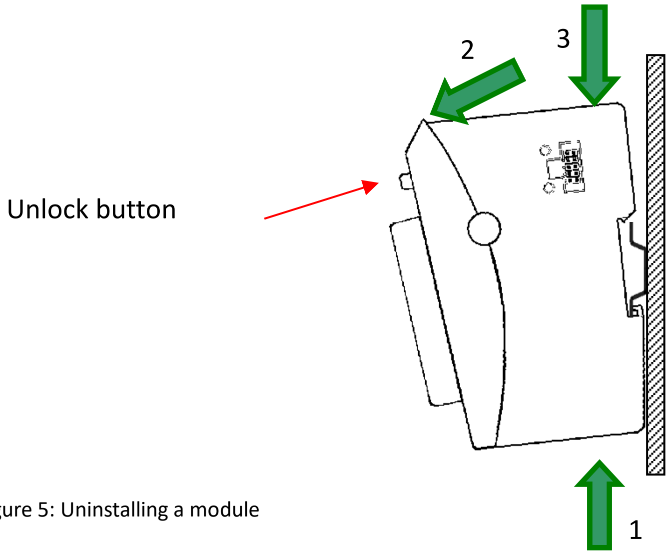


Figure 5: Uninstalling a module

6.2 Electrical Installation

6.2.1 Earth

Connect the c250-S modules to earth by attaching the metal housing to functional earth. Since the functional earth connector dissipates HF currents, it is of utmost importance for the module's noise immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to a functional earth connector. 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.

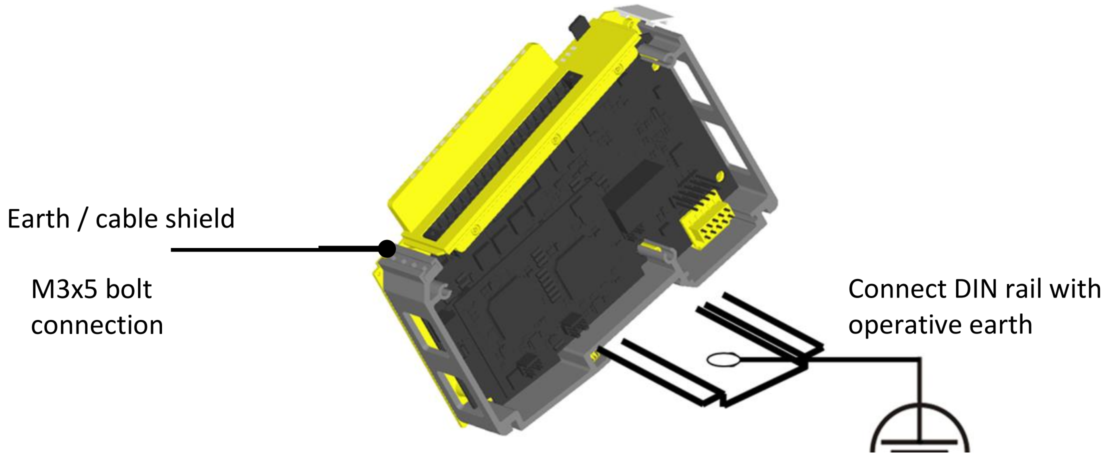


Figure 6: Aluminium profile in the FIO module

> **I** ***Information***
>
> Earth wires should be short and have a large surface (copper mesh). Refer to http://de.wikipedia.org/wiki/ground_(electronics) for further details

> **I** ***Note***
>
> When installing production or other lines, measure the earth potential of the DIN rail as specified in the applicable guidelines (earth test to VDE 0100) . Measuring the earth potential must show that every protective earthing and operational earthing is within the boundaries set by the applicable standards. Also consider the repeat testing frequency resulting from the hazard assessment.

6.2.2 Module Interconnection

The c250-S modules electrically connect by completely pushing the modules together. This automatically connects the modules to both the EtherCAT bus and the system power supply. If possible, place the

Safety I/O-module immediately next to the head module. Refer to section ► 6.1 Mechanical Installation for details about how to interconnect two modules.

Please note that the maximum current supplied by the bus coupler limits the number of c250-S modules you may connect to a single block.

6.2.3 System Power Supply

A system connector supplies the Safety I/O-module 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.

I

Note, information

Please take note of 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 Operating Instructions.

WARNING

Potentially hazardous failures due to wrong voltages supplied

Supplying the wrong 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 VDC to bus couplers or compact PLCs that any Safety I/O-modules are connected to.
- ⇨ 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.
- ⇨ Application in unearthed electrical networks, e.g. IT-Net, is only allowed after consulting Lenze.
- ⇨ Remember that, even in case 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 block of c250-S modules.

6.2.4 Safety I/O-module Supply

The power supplied to the safe outputs and the associated test pulse outputs connects to terminals L+ and L-. The supply voltage is rated at 24 VDC. It is monitored. In case of overvoltage (> +20%) and low voltage (> -15%) alike, the module changes to its safe state.

WARNING

Potentially hazardous failures due to wrong voltages supplied
Supplying the wrong 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 VDC to the I/Os of Safety I/O-module.
⇨ Fuse the I/O power supply of Safety I/O-module with max. 10 A.
⇨ 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.
⇨ Application in unearthed electrical networks, e.g. IT-Net, is only allowed after consulting Lenze.
⇨ Remember that, even in case of a fault, a maximum voltage of U max. < 33 V may be supplied to these assemblies.
⇨ Do not reuse but replace units operated on voltages > 33 V.
⇨ 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 block of c250-S modules.

Safety I/O-mdoule power supply fusing

The cord 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 triggering at max. 10 A.

6.2.5 Sensor and Actuator Power Supply

All sensors and actuators of the Safety I/O-module system supplied with power from an external source must still run on safe low operating voltage (SELV/PELV). This power may also be fed to the I/Os of the Safety I/O-module.

WARNING

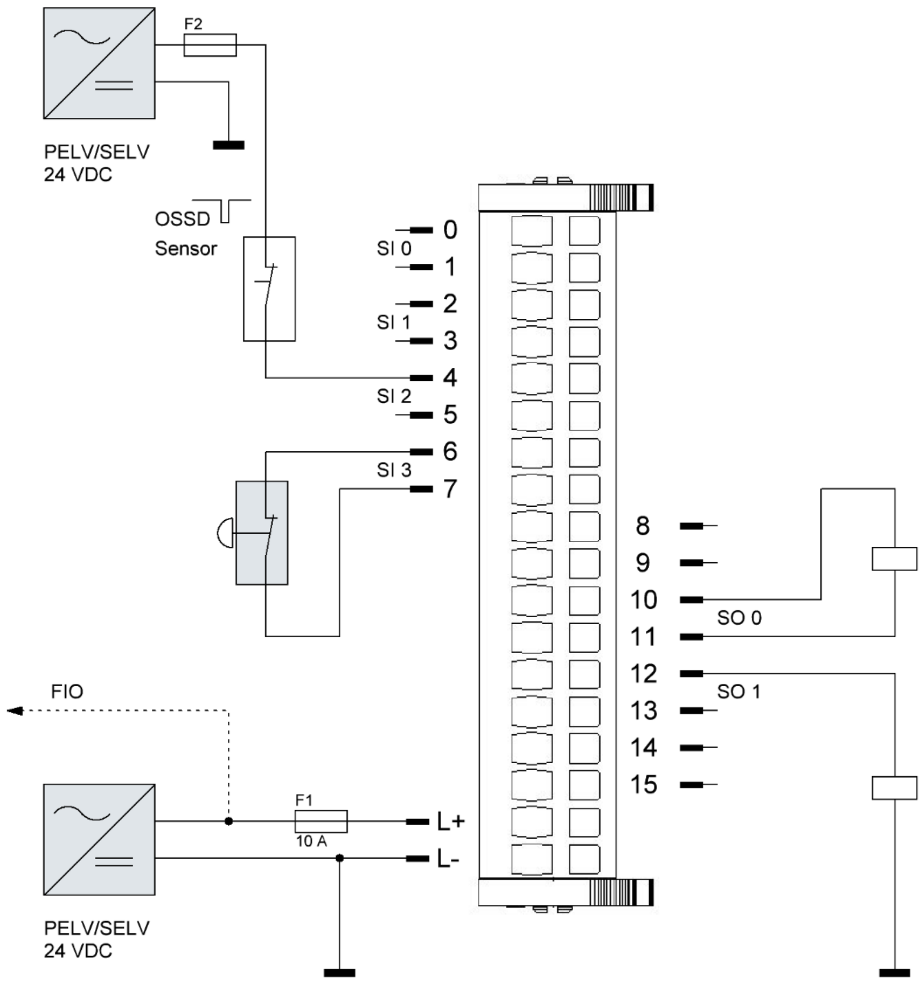
Potentially hazardous failures due to wrong voltages supplied to sensors and actuators

Supplying the wrong 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 VDC to sensors and actuators connected to the Safety I/O-modules.
- ⇨ 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.
- ⇨ Application in unearthed electrical networks, e.g. IT-Net, is only allowed after consulting Lenze.
- ⇨ Remember that, even in case of a fault, a maximum voltage of U max. < 33 V may be supplied to the sensors and actuators.
- ⇨ Do not reuse but replace units operated on voltages > 33 V.
- ⇨ To prevent that voltages are carried over, provide a low-impedance connection between the chassis ground of the unit supplying power to the sensors and actuators and the unit supplying 24 VDC to the I/Os of the Safety I/O-module.

6.2.6 Power Supply Wiring Example

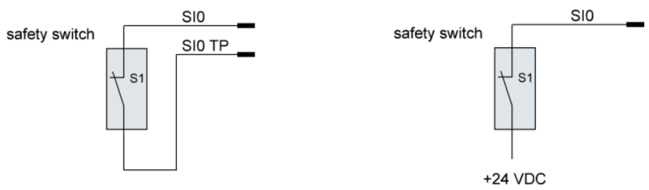


6.2.7 Sensor Connection

Single-channel contact-type sensor

> ***CAUTION***
>
> **Maximum state change time of the application**
> For single-channel applications (inputs and outputs), the test pulse frequency must be adapted to the application. It must be ensured that for 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 6.3.2 FSoE Parameters.

The inputs of single-channel contact-type sensors work entirely separate from one another. Wiring should take account of the fact that every input signal is allocated to the test pulse output. Use the configuration to separately enable each of the inputs ► 6.3.3 Input Parameters



Analysis of states

The module checks the states of the inputs and transfers the result to the safe control unit.

The process data image of a safe input transfers

- "0" if a "0" signal is supplied to the input or if an error has been detected;
- "1" if a "1" signal is supplied to the input or if an error has not been detected.

To disable 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 corrupt 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 filter with direct connection of the module to the 24V supply**
> In general, the use of the safe inputs with the module-based test pulse outputs or OSSD outputs from external sensors is recommended. A direct connection of the safe inputs is only allowed to a 24V supply filtered in accordance with EN 61326-3-1 (interference level for surge, burst and conducted RF interference for I / O signals with direct mains supply).

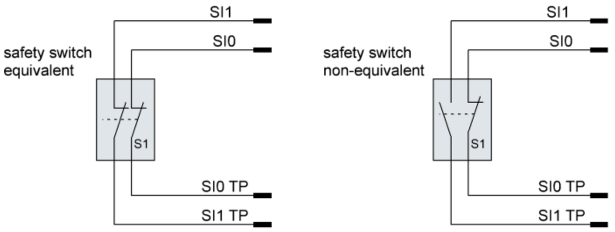
Refer to section ► 7.1 Safety Function with Single-channel Input for connection examples.

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 configuration to enable the safe inputs you use ► 6.3.3 Input Parameters

.



The process data image of a safe input transfers

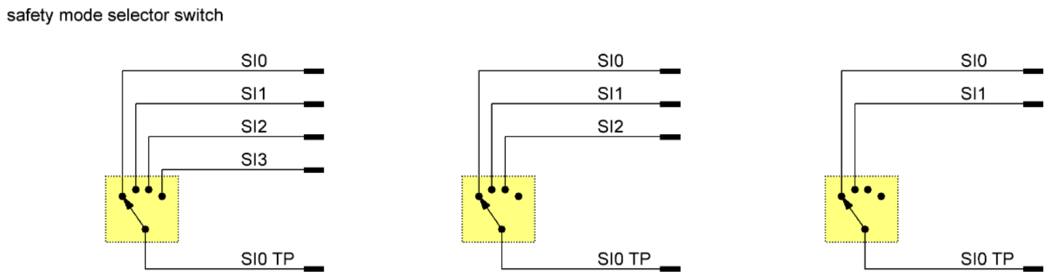
- "0" if a "0" signal is supplied to the input or if an error has been detected;
- "1" if a "1" signal is supplied to the input or if an error has not been detected.

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 switchgear connect to several safe inputs only using test pulse output SI0 TP to provide the correct function. You must use the configuration to enable the safe inputs you use and parameter "External Inputs" to choose the mode selector function ▶ 6.3.3 Input Parameters and 7.4 Mode Selector, Rotary Table.

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



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.

PLCopen module "Mode Selector" or a similar module of the safe control unit is used for multi-channel analysis. The achievable category to EN ISO 13849 depends on the switching device's error model (e.g. mode selector) and must needs be analysed in conjunction with the PLCopen module's error detection.

Refer to section ▶ 7.4 Mode Selector, Rotary Table for connection examples.

NOTE

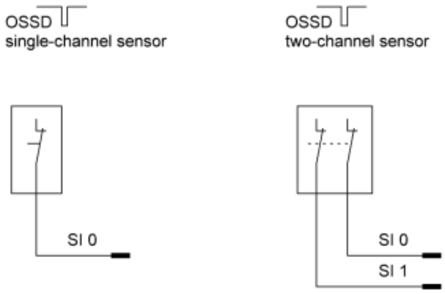
Test pulse output
In mode selector mode, test pulse output TP0 can be set to "0". However, this will not affect the test pulse as such since, in mode selector mode, the test pulse always runs at maximum frequency.

NOTE

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.



Wiring of sensors providing OSSD signals

Two-channel sensors delivering OSSD signals can be connected to any safe input of the Safety I/O-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's test pulses. You must therefore set the input channels to "Test pulse duration =0" ►6.3.3 Input Parameters.

To prevent voltages from being carried over, provide a low-impedance connection between the chassis ground of both the sensor and the Safety I/O-module.

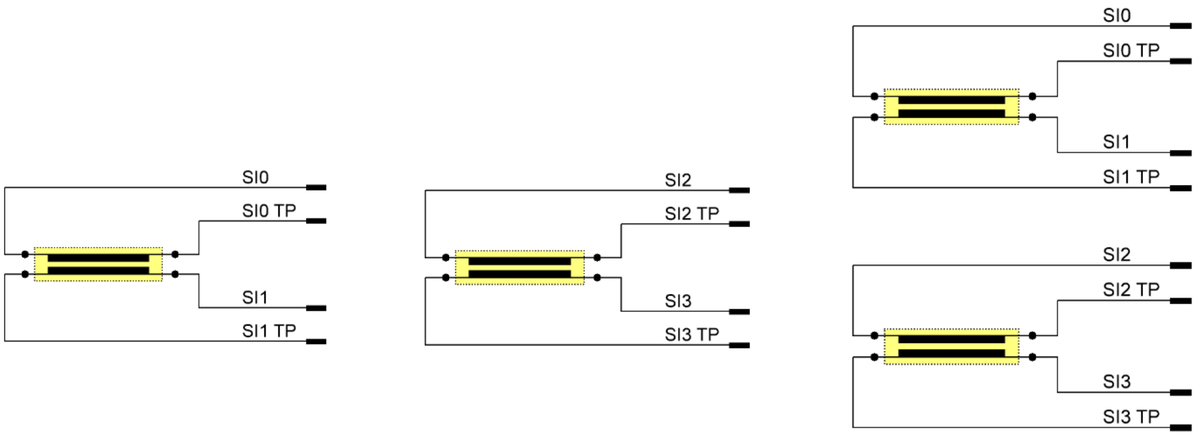
Pressure-sensitive mat, bumper

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. If so, the Safety I/O-module sends a null signal to the control unit.

Safety I/O-module supports four-wire mats. Two safe digital inputs and the associated test pulse output are used for one mat / bumper.

You must use the configuration to enable the safe inputs you use and parameter "External Inputs" to choose the bumper function ► 6.3.3 Input Parameters.

You may use up to two mat channels.



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.

PLCopen module "SF_ESPE" or a similar module of the safe control unit is used for mat / bumper analysis. 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 module's error detection.

Refer to section ► 7.5 Safety Mats, Connecting Blocks and Bumpers for connection examples.

NOTE

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 Safety 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

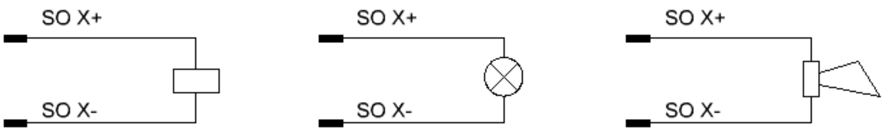
Safety function pressure-sensitive mat requires a response time of 50 ms
Avoid personal injury and damage to property
⇨ The pressure-sensitive mat function achieves a response time of 50 ms between a change in mat state and providing the information on the EtherCAT bus.

6.2.8 Actuator Connection

NOTE

Faults at the outputs provoke a change to the safe state
The outputs are protected against overload and short circuit, see section ▶ 4.5.4 Safe Digital Outputs for details. Overload and short circuit cause the module to change to its safe state. The module responds in the same way to external power fed to and 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 Safety I/O-module. They also support signal lamps dissipating resistive power of up to 10 W.

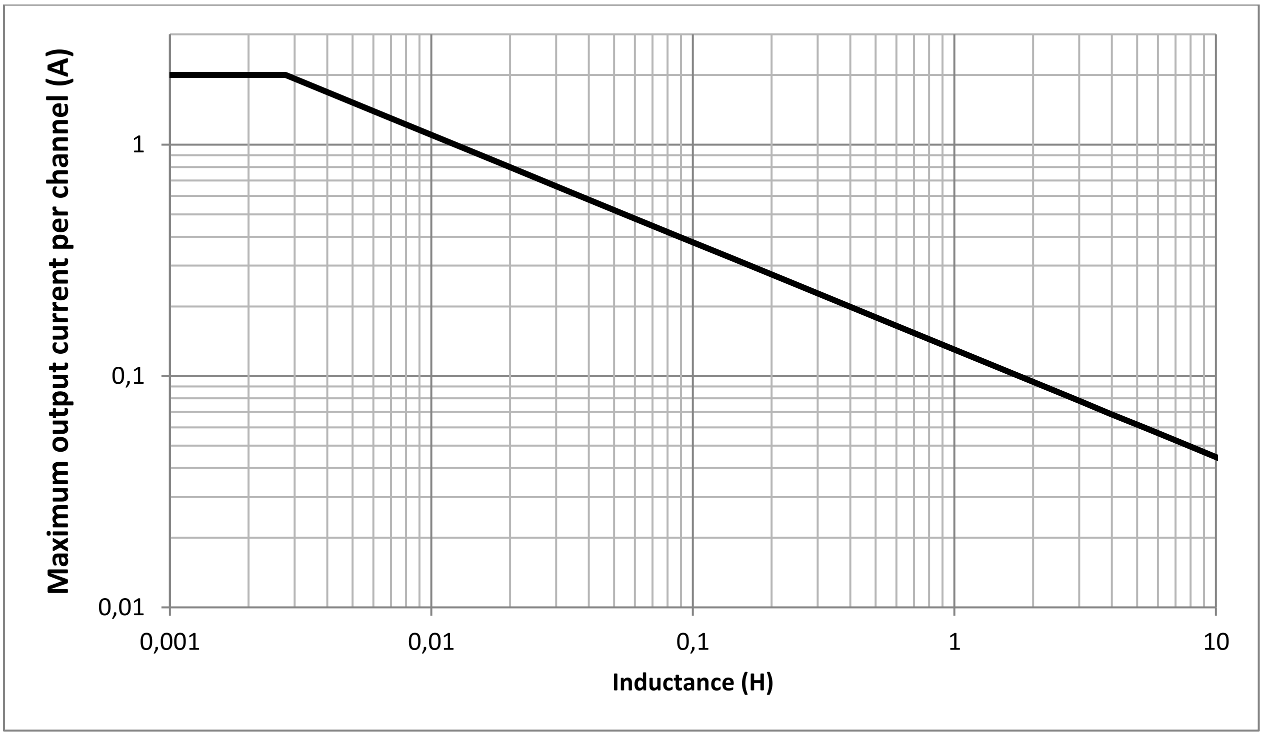


Actuators with external GND reference

Provided that the configuration is taken account of, actuators with external GND reference can be connected to the Safety I/O-module.

Switching of inductive loads

If the internal free wheel circuit is enabled, the digital power outputs of the Safety I/O-module can be used to operate inductive loads. The graph below illustrates the maximum inductance of the load vs. the load current.



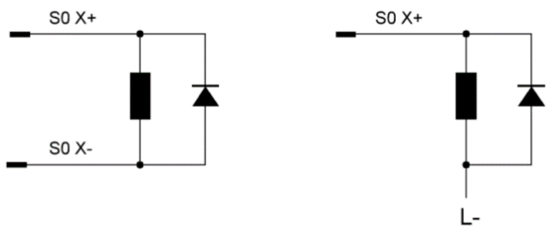
> **NOTE**
>
> Defect caused by thermal overload due to excessive inductance!
> Setting the inductance and the load current to higher than the specified values may thermally destroy the digital power output. Destroying the digital power output may cause the safety function to fail.

Use an external free wheel circuit if the external load exceeds the specified inductance limits.

External free wheel circuit

> **NOTE**
>
> Take heed of the perturbation of the external free wheel circuit
> Depending on the actual safety function, it may or may not be affected by the external free wheel circuit which the safety assessment must take account of.

An external free wheel circuit will transduce the magnetic energy when turning off the inductive load.



Verify that the external free wheel 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 wheel element you choose to anything smaller than -30 V because the digital output will otherwise transduce the magnetic energy to heat.

> **NOTE**
>
> Note the heat dissipated by the external free wheel element!
> If you choose the correct external free wheel element, this element instead of the safe I/O module will transduce the magnetic energy when turning off the inductive load.
> Verify that the external free wheel circuit is designed to withstand the ensuing dissipation heat.

Switching of digital inputs

Digital inputs of Safety I/O-module can be switched by the module's SO X+ outputs. Verify that you have enabled parameter "extGroundOutput" of the output you use. Output test pulse configuration must consider the input capacitance of the input to be actuated. See the section on the switching of capacitive loads below.

To ensure that the test pulses of the digital power outputs are filtered properly when the safe digital inputs of the Safety IO module are used, the inputs' configurable filters should be set to the same test pulse duration (parameter "Test pulse duration") as the digital power output.

Switching of capacity loads

Switching of capacitive loads must take account of the limits below described with reference to the output current and the test pulse length.

Test pulses cyclically test the module's 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. Every output supports a maximum capacitive load of 2.2 µF.

Output capacity of actuators with external GND reference or digital inputs to SOX+		
Test pulse length	**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 capacity of actuators with GND reference connected to SOX+ and SOX-		
Test pulse length	**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

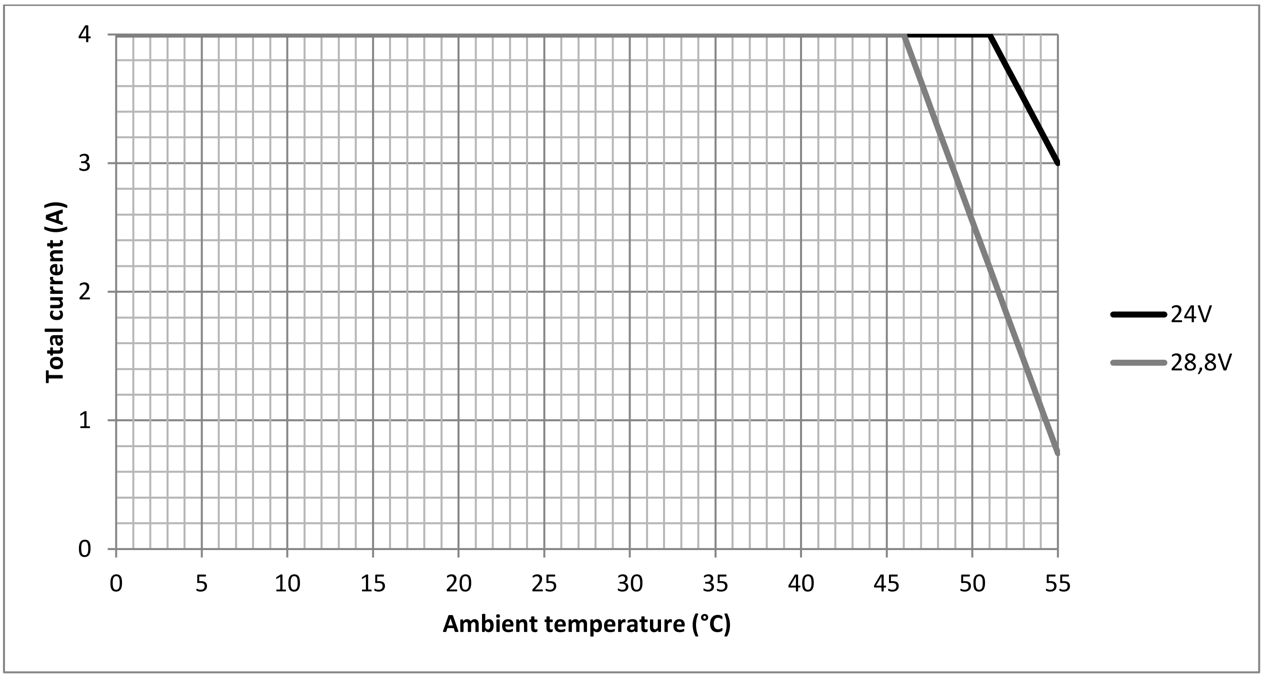
CAUTION

Do not operate the Safety I/O-module out of the specified range

Faults by component overload

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

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

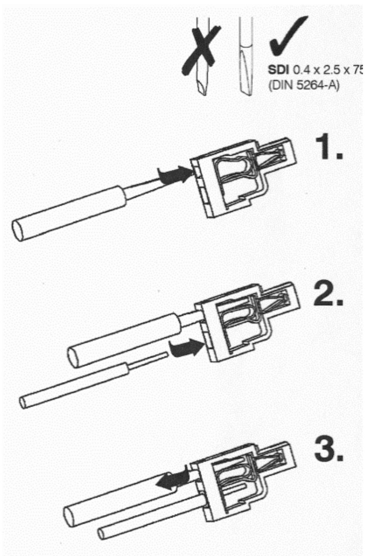


The output current derating shown on the graph was measured under free convection in a typical installation (I/O modules on the left and right, 50% duty cycle, identical supply voltage).

6.2.9 Multiple socket connector (MSC)

The multiple socket connector features tension springs which make wiring quick and easy. Use the unlock button to easily disconnect the wires where there is little space.Only use the MSC from the package to connect to c250-S module.

MSC model:	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
Wire diameter, single-wire,	min. H05(07) V-U 0.2 mm² ... max. H05(07) V-U 1.5 mm²
Wire diameter, fine wire,	min. H05(07) V-K 0.2 mm² ... max. H05(07) V-K 1.5 mm²
Wire diameter with connector sleeve to DIN 46 228/1,	min. 0.2 mm² ... max. 1.5 mm²
Wire diameter with connector sleeve with collar to DIN 46 228/4,	min. 0.2 mm² ... max. 1 mm²
Stripped end 10 mm	
Nominal current:	10 A (CSA) / 10 A (UL)



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 proper wiring

NOTE

Destruction by wrong tool
Damage to Safety I/O-module
⇨ Use suitable tools for wiring the multiple socket connector only!
⇨ Tool: Screwdriver, 0.4 x 2.5 x 75 [mm] blade (DIN 5264-A)

6.3 Configuration

> ***Attention***
>
> Check the safety function
> Potential faults due to maladjusted configuration
> ⇨ After initial installation and after replacing a module, check the safety function!

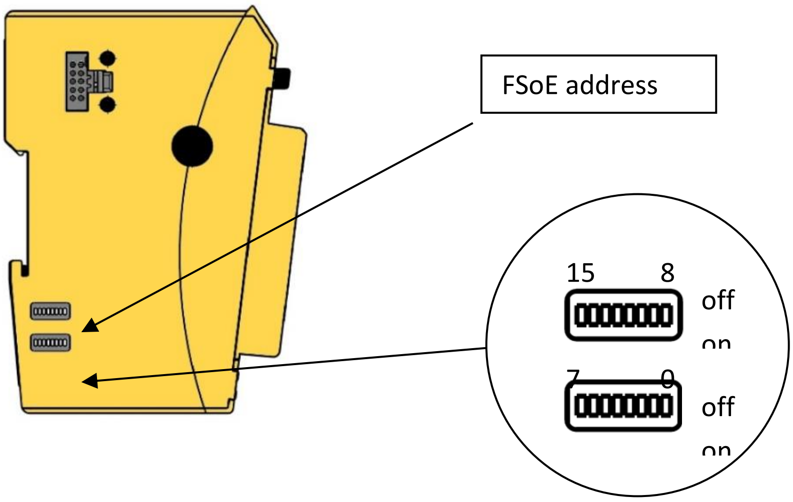
6.3.1 Address Setup

c250-S Safety has a safe module address (FSoE slave address) which clearly identifies it in 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.

> ***Information***
>
> After setting the FSoE address, disconnect the c250-S Safety module once from the power supply to ensure that the address is accepted and a module test started automatically.

> ***Information***
>
> 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.



NOTE

Destruction by wrong tool
Damage to Safety I/O-module
⇨ Use suitable tools for setting the address only!
Use a suitable object (e.g. the tip of a ball pen or a screwdriver) to set the DIP switches. Do not exert pressure on the switching elements!

NOTE

Inappropriate setup actions at the Safety I/O-module
Machine failure and damage to the c250-S Safety module
⇨ Turn off the I/O supply before removing the Safety I/O-module from the row of module for setup.

Attention

Safety function not available
Startup disallowed by wrongly set address
⇨ Do a function test to verify that the address coding switches have been set correctly.

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

Information

The FSoE address you set may only occur once in the communication network. The master will find and notify the user of a FSoE address that occurs more than once or is not used.

6.3.2 FSoE Parameters

CAUTION

Improper operation of parameter setup
Malfunction of Safety I/O-module due to bad parameter setup

- ⇨ Only persons qualified for dealing with safety matters are allowed to add, replace and put Safety I/O Modules into operation.
- ⇨ Before installing, servicing or putting c250-S Safety into service, please also 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 parameter			
Parameter			**Unit**
Range	**[Default]**	**Description / note**	
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	
WatchdogTime			ms
20 ... 65534 ($FFFE_h$)	[100]	Watchdog time of FSoE frame	
Used Inputs			Dec
0 15	[15]	Enables the inputs used Selection from a drop-down list depends on the configurator	
External Inputs			Dec
Bits 0-3 0000_2.... 1111_2	[0000_2]	Disables the generation of the module's 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)	
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)	

Used Inputs selection:

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

FSoE parameter		
Parameter		**Unit**
Range [Default]	**Description / note**	
Bits 6,7	Pressure-sensitive mat / bumper, bits 6 & 7	
00_2 … 11_2 [00_2]	00 disabled 01 inputs 0 & 1 10 inputs 2 & 3 11 inputs 0 & 1 and inputs 2 & 3	

Bit								Decimal	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 - 2)
0	0	1	1	0	0	0	0	48	Mode selector, four channels (inputs 0 - 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

Red cells:

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

Green cells:

- 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

Blue cells:

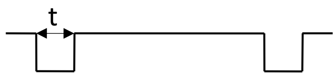
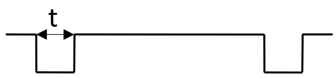
- Test pulse outputs can be disabled

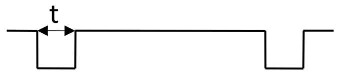
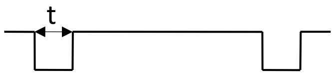
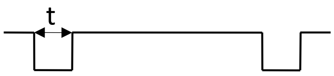
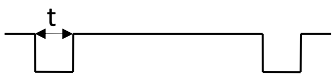
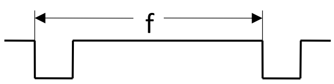
Example:

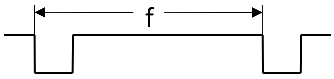
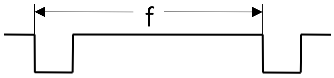
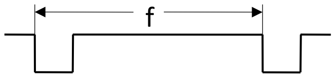
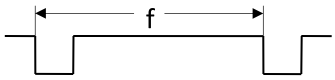
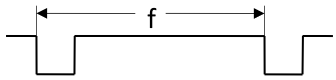
Assuming you wish to run a pressure-sensitive mat at inputs 0&1 of the Safety I/O-module while disabling the test pulses of the other inputs (2&3). Set up as follows:

64 + 4 + 8 = 76

WatchdogTime	100
usedInputs	15
externalInputs	76
usedOutputs	3
extGroundOutputs	3

FSoE parameter			
Parameter			**Unit**
Range	**[Default]**	**Description / note**	
usedOutputs			Dec
00_2.... 11_2	[11_2]	Enables the outputs you use (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	
extGroundOutputs			Dec
00_2 .... 11_2	[00_2]	Enable if the actuator is not connected to module terminal SO X- but uses an external ground connection. Selection from a drop-down list depends on the configurator	
Test pulse duration input 0			µs
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. The Safety I/O-module checks whether the digital inputs may turn Null and whether there are any short circuits to noise voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	
Test pulse duration input 1			µs
300 ... 1500	[500]	Test pulse length of input 1 Input filter of input 1  The digital test pulse output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the digital inputs may turn Null and whether there are any short circuits to noise voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	

FSoE parameter			
Parameter			**Unit**
Range	**[Default]**	**Description / note**	
Test pulse duration input 2			µs
300 ... 1500	[500]	Test pulse length of input 2 Input filter of input 2  The digital test pulse output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the digital inputs may turn Null and whether there are any short circuits to noise voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	
Test pulse duration input 3			µs
300 ... 1500	[500]	Test pulse length of input 3 Input filter of input 3  The digital test pulse output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the digital inputs may turn Null and whether there are any short circuits to noise voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	
Test pulse duration output 0			µs
500... 1500	[800]	Test pulse length of input 0  The digital power output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the power outputs may be turned off and whether there are any short circuits to noise voltages on the output line. Adapt the test pulse duration to the load applied.	
Test pulse duration output 1			µs
500... 1500	[800]	Test pulse length of input 1  The digital power output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the power outputs may be turned off and whether there are any short circuits to noise voltages on the output line. Adapt the test pulse duration to the load applied.	
Test frequency input 0			Hz
0 ... 25	[1]	Test pulse frequency of input 0 Value "0" means without Test pulse 	

FSoE parameter			
Parameter			**Unit**
Range	**[Default]**	**Description / note**	
Test frequency input 1			Hz
0 ... 25	[1]	Test pulse frequency of input 1 Value "0" means without Test pulse 	
Test frequency input 2			Hz
0 ... 25	[1]	Test pulse frequency of input 2 Value "0" means without Test pulse 	
Test frequency input 3			Hz
0 ... 25	[1]	Test pulse frequency of input 3 Value "0" means without Test pulse 	
Test frequency output 0			min^{-1}
0 ... 25	[10]	Test pulse frequency of output 0 Value "0" means without Test pulse[1] 	
Test frequency output 1			min^{-1}
0 ... 25	[10]	Test pulse frequency of output 1 Value "0" means without Test pulse[2] 	

[1] The test pulses of both outputs must be deactivated so that no more test pulses are generated. Please also observe the notes in chapter 6.3.4 Output Parameters.

.

6.3.3 Input Parameters

Parameters "Used Inputs" and "External Inputs"

> ***CAUTION***
>
> **Maximum state change time of the application**
> For single-channel applications (inputs and outputs), the test pulse frequency must be adapted to the application. It must be ensured that for 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 6.3.2 FSoE Parameters.

Use these parameters to enable the inputs of the Safety I/O-module and to select the input function. Use parameter "External Inputs" to disable the module's test pulse outputs that deliver test pulses to each of the inputs. Use this setting for sensors generating their own test pulses (some light barriers, for example).

> ***WARNING***
>
> **Non-detection of a corrupt 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 protecting the cables and/or laying them 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. Disable the test pulse outputs you do not need. Refer to manual section ►7.4 Mode Selector for a wiring example. Inputs you do not use 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. Parameter "External Input" allows you to separately choose the function of inputs 0 & 1 and 2 & 3. Inputs you do not use and the associated test pulse outputs can be used for other functions. Refer to manual section ►7.5 Safety Mats, Connecting Blocks and Bumpers for a wiring example.

Parameter "Test pulse duration input"

If used together with the module's test pulse outputs, test pulses cyclically check the input circuit connected to the Safety I/O-module for faults such as short circuits or internal defects. 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 the signals are affected by capacitive properties of the input circuit, for example.

Parameter "Test frequency input"

If used together with the module's test pulse outputs, test pulses cyclically check the input circuit connected to the Safety I/O-module for faults such as short circuits or internal defects. 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 corrupt 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 protecting the cables and/or laying them separately to ensure a sufficient degree of safety.

6.3.4 Output Parameters

CAUTION

Consideration of the parametrization

For single-channel applications (inputs and outputs), the test pulse frequency must be adapted to the application. It must be ensured that for 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 6.3.2 FSoE Parameters.

Parameter "extGroundOutputs"

Enable if the sensor is not connected to module terminal SO X- but uses an external ground connection. Pick from a drop-down list provided by the configurator software. Linking the sensor to an external ground connection instead of terminal SO X- disallows you to control an external 24 VDC power supply.

Also set this parameter if output SO X+ supplies an electronic load such as a digital input of an Safety I/O-module.

Parameter "Used Outputs"

Enables the outputs you use (SO 0 and / or SO 1)

Pick from a drop-down list

Parameter "Test pulse duration output"

Test pulses cyclically check the digital outputs of the Safety I/O-module for faults such as short circuits or internal defects. 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.

NOTE

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 Safety I/O-module. Parameter "Test frequency output" sets the switching frequency and, thus, the frequency of test pulses allocated to a digital output. Adapt this parameter to real-life 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

Non-detection of incorrect 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 protecting the cables and/or laying them 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.

NOTE

Test pulse error at the outputs
If you experience one of the following error messages, you can increase the availability by increasing the test pulse frequency of the outputs.

1796	0704_h	Output test pulse of high side switch timed out
1797	0705_h	Output test pulse of low side switch timed out

Change the parameter "Test frequency output x" to 10/min.
See also 6.3.4 Output Parameters.

WARNING

Reduced diagnosis with deactivated test pulses at the outputs
Switching off the test pulses is expressly not recommended; it may reduce the safety of the application. When the test pulses at the outputs are switched off, the diagnosis of the outputs must be maintained:

⇨ The outputs must be switched once a year. Switching can be functional (by application) or by switching the device completely off.

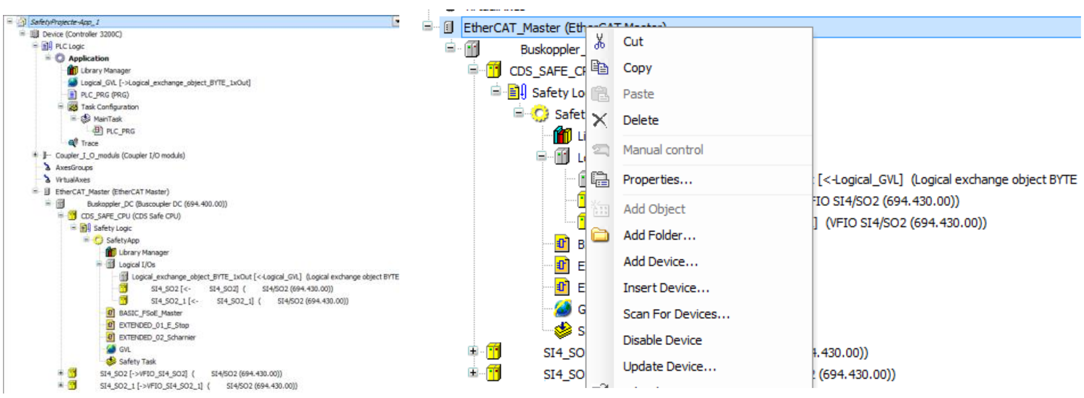
6.4 Putting into Service

> **I**
>
> ***Note, information***
>
> Usage note
> Safety I/O-module may be used ETG-compliant configurations with conforming products. Such products include slave services, master and development systems, and functional safety products. Check the products for the "EtherCAT Conformance tested" to see if they have passed an official test for conformity. Certified products are listed in the EtherCAT Product Guide published by the EtherCAT Technology Group.

Topology of PLCDesigner devices

Like in all other PLCDesigner 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 search for devices in PLCDesigner. Right-click on the EtherCAT master and pick "Geräte suchen..." (Find devices) from the context menu. In the next dialog, you just need to confirm to "Alle Geräte ins Projekt kopieren" (Copy all devices to project).

PLCDesigner configuration example:



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

6.5 Diagnosis

6.5.1 Self-test

When system voltage is supplied to the Safety I/O-module, it initially runs a complete system test. Only if this system test is passed will the module be able to operate and first of all change to its "fail-safe" state.

This is indicated by LED "Safe Status" lighting up red.

The Safety I/O-module will retain the fail-safe state until all internal tests have been passed, valid data has been received from the control unit, and faults are not 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.

The module will retain its fail-safe state if it fails to qualify for the safe state, e.g. because of errors in the application's module setup. To find the cause of the problem, check the error code in the service block ► 6.5.6 Table of Faults.

In service, the system test is repeated cyclically as a background process.

To repeat the initial system test, just turn the power supply off and back on again.

6.5.2 Safety I/O-module Module Faults

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

Wiring faults such as

- a cross-fault between the inputs,
- external power supplied to the inputs,
- wrong TP allocation to a specific input,
- external power supplied to the outputs, or
- a short at the outputs

will change the Safety I/O-module to its safe state. The red Diagnosis LED of the affected channel lights up.

Error messages may also be provoked by badly adjusted loads. Please refer to sections ► 4.5.4 Safe Digital Outputs and ► 6.2.8 Actuator Connection.

6.5.4 Temperature Faults

> ***CAUTION***
>
> **Do not operate the Safety I/O-module out of the specified range**
>
> Faults by component overload caused by excessive temperature
>
> ⇨ Operate the module under the ambient conditions listed in section Technical Data only while observing the derating of the outputs.

The module is designed for ambient temperatures between 0 °C and max. 55 °C and for being installed in a control cabinet. The Safety I/O-module features an extra internal temperature sensor. Excess temperature will change the module to its safe state. You cannot start the module at temperatures below 0 °C.

6.5.5 Wrong Supply Voltage

The supply voltage is rated at 24 VDC. It is monitored. In case of overvoltage (> +20%) and low voltage (< -15%) alike, the module changes to its safe state.

6.5.6 Table of Faults

Depending on their type, faults detected are indicated by the diagnosis LEDs of the Safety I/O-module and made available as a diagnostic message in error register object 1001h. Diagnostic messages help you identify the fault and to 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 remove its cause and acknowledge the fault in the error register according to instructions.

Table of faults		
Fault	**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

Table of faults		
Fault	**Possible Cause**	**Corrective Action**
Module is in safe state, diagnosis LEDs of the inputs light up red	Wrong wiring, e.g. test pulse signals swapped Cross-fault between the inputs External power supplied to the outputs	Check error code in the service block Check module wiring
Module is in safe state, one diagnosis LED at the output lights up red	Overload on an output Cross-fault at an output External power supplied to an output	Check error code in the service block Check module wiring Check the output current of the output
Module is in safe state, LED "Safe Status" lights up red	EtherCAT connection interrupted Internal module fault	Check wiring of the EtherCAT fieldbus cables Check that c250-S modules interconnect properly
Module is in safe state, LED "Safe Status" lights up red	Safety I/O-module power is low	Check Safety I/O-module power Check wiring

6.5.7 Error Codes

Error codes (object dictionary 2007_h or 2017_h - Errorcode)		
Error Code (hex)	**Cause**	**Comment**
Effect	**Corrective Action**	
0x0001	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	Module RESET by turning the system power off and back on again – self-test repeats. Replace module if error prevails	
0x0002	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	Module RESET by turning the system power off and back on again – self-test repeats. Replace module if error prevails	
0x0402	Low voltage	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 actual system power supplied Check length and stress on the feed line	
e.g. 0x0201	Parameter error	Module fails to change to its functional state.
Module in safe state	Check module parameter setup Use parameter settings in the admissible range only	

<table>
<tr><th colspan="4">Error codes (object dictionary 2007_h or 2017_h - Errorcode)</th></tr>
<tr><th>Error Code (hex)</th><th colspan="2">Cause</th><th>Comment</th></tr>
<tr><th colspan="2">Effect</th><th colspan="2">Corrective Action</th></tr>
<tr><td>e.g. 0x0291</td><td colspan="2">Cross-fault at or external power supplied to input</td><td>Cross-fault to another input or test pulse output or external power supplied; red diagnosis LED of affected channel lights up.
Inputs and outputs turn "0" at the module and in the process map.</td></tr>
<tr><td colspan="2">Module in safe state</td><td colspan="2">Check sensor
Check test pulse outputs
Check connector and wiring</td></tr>
<tr><td>0x0291</td><td colspan="2">Short circuit or overload</td><td>Short circuit in the output wiring or wrong output load, red diagnosis LED of affected channel lights up</td></tr>
<tr><td colspan="2">Module in safe state</td><td colspan="2">Check actuator
Check connector and wiring
Check free wheel wiring at contactor</td></tr>
<tr><td>0x0280</td><td colspan="2">Cross-fault at or external power supplied to output</td><td>Cross-fault to another output or another signal; red diagnosis LED of affected channel lights up</td></tr>
<tr><td colspan="2">Module in safe state</td><td colspan="2">Check actuator
Check connector and wiring</td></tr>
</table>

I

Information

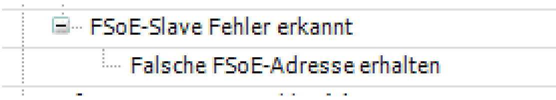
For a detailed description of the entry in object 2007h or 2017h "Errorcode", refer to the table in section 0.

6.5.8 EtherCAT Link Lost

All modules change to their safe state when the EtherCAT link is lost or interrupted. Once the fault has been removed, an Error Acknowledge is enough to restart the EtherCAT bus.

6.5.9 Wrong FSoE Address

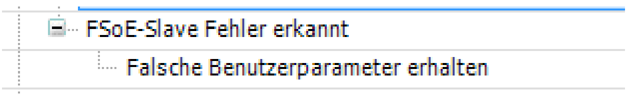
A wrong FSoE address causes all modules to retain their safe state. The fault is detected by the master and cannot be acknowledged.



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

6.5.10 Wrong Configuration of the Safety I/O-Module

By design, safety control units prevent configuration errors from provoking dangerous states. Therefore, after downloading a safety project with a bad configuration, all safety module are in a safe state. The master shows the incorrect configuration.



To restart the safety modules, first remove the incorrect configuration, then download the project again and finally Acknowledge the error (Provided that there are no faults).

6.6 Reset / Acknowledge Error

The error class decides whether and how an error can be acknowledged, see section ► 8.1.13. Errorclass CPU 1: 200Ah.

Error Class	Explanation	Acknowledged / Reset by
0	No error	Not required
1	Serious or synchronization error	PowerCycle
2	Internal communication error	PowerCycle
3	I/O error	Error Acknoledge
4	Error in ErrorHandler or at the outputs	PowerCycle
5	Fatal error	Non-acknowledgeable

PowerCycle:

After removing the cause of the error, you can reset the Safety I/O-module by a power cycle (PowerCycle -> turn off and back on) provided that the automatic self-test is passed.

Error Acknowledge:

Input or output errors can be reset by the Safety controller c250-S.

WARNING

Reset / acknowledge 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 are allowed to work on c250-S Safety.

> **CAUTION**
>
> **Unsafe and undefined machine state**
> Destruction or malfunction
> ⇨ Do not plug, mount, unplug or touch the connectors during operation!
> ⇨ Turn off all power sources before working on the modules. This also applies to any peripherals such as encoders or programming devices with external power source, etc.
> ⇨ Check that none of the ventilation slots is covered.

6.7.2 Servicing

c250-S Safety requires neither servicing for the specified service life nor any action if it is kept and operated at the admissible ambient conditions specified in section Technical Data.

6.7.3 Preventive Maintenance

Prevent inadmissible contamination while operating and storing c250-S Safety. Do not use or continue to use the Safety I/O-module in case it has been exposed to inadmissible contamination.

> **CAUTION**
>
> **Unsafe and undefined machine state**
> Risk of injury
> ⇨ You are not allowed to operate an inadmissibly contaminated module. Neither is cleaning the unit allowed.

6.8 Replacing a Safety I/O-module

When you replace a Safety I/O-module, its configuration is retained and transferred to the new module when you restart the system. The programming environment will tell you is the new module is incompatible. You must carry out appropriate tests to verify whether there are any other failure modes such as using the wrong terminals or making wiring mistakes.

The text below describes how to replace a Safety I/O-module with a Safety I/O-module of the same type.

CAUTION

Unsafe and undefined machine state

Risk of injury

⇨ Turn off the power supply of the control unit and the c250-S modules before replacing a Safety I/O-module.

⇨ After you have replaced any Safety I/O-modules, separately test the safety function before you restart the machine or system.

⇨ Design you wiring tests such that you will reliably discover the use of a wrong terminal.

NOTE

You must set up your entire project again if you replace a Safety I/O-module with a module of another type. If so, refer to the Operating Instructions of the new module.

Procedure

- Verify that the new module meets the following requirements:
    - Same type of device
    - Same or higher version, see section ► 5.1 Labelling and Identification
- Enable the safe system or machine state.
- Turn off the power supply of the control unit and the c250-S modules.
- To remove the old module (see sections ► 6.1.4 To Disconnect Two Modules and 6.1.5 To Take Down a Single Module):
    - Dissolve the line of c250-S modules by pressing the unlock button of the module to be separated from the module to its left and sliding both modules about 1 cm apart.
    - Push the module up and against the metal spring located on the underside of the rail guide.
    - Tip the module away from the rail as shown in the illustration.
    - Pull the module down and out of the mounting rail.
- Locate the FSoE address at the address coding switch of the module you are replacing and transfer that address to the new module ► 6.3.1 Address Setup

- Install the new module at the same place within the line of c250-S modules as one you just removed (► 6.1.2 To Snap on a Single Module).
- Plug the inline connectors to the correct ports.

Restart

- Verify that the machine or system is in a safe state and that there is nothing and nobody in the danger zone.
- Turn the supply voltage back on.
- Start the new safety module as if you initially operate a module ► 6.4 Putting into Service
- The configuration of the old module has been retained and will be transferred to the new module when you restart the system.
- Check all safety functions after replacing a module.

6.9 Durability

Safety I/O-modules have a design life of max. 20 years after the date of manufacture (5.1.2 Serial Number) by lenze. Take the module out of service at the end of its useful life ► 6.9.3 Taking out of Service.

6.9.1 Repairs / Customer Service

You are not allowed to open or try to repair a Safety I/O-module.

Doing so will void the warranty.

> I
>
> ***Note, information***
>
> In case of a potentially hazardous failure
> In case a module failure is potentially hazardous, return the module to the manufacturer where the fault will be identified.
>
> ⇨ The manufacturer's address is printed on the Safety I/O-module and in this. manual

6.9.2 Warranty

The statutory period and conditions of warranty apply. Warranty expires if unauthorised attempts are made to repair the unit / product or any other intervention is performed, see section 2.1.4 Warranty.

6.9.3 Taking out of Service

The manufacturer of the machine or system specifies the procedure of taking the product out of service. The process must fully comply with the specified procedure.

Make sure that the modules of the c250-S Safety system you are taking out of service are provided for further use as intended. Refer to section Technical Data for detailed transport and storage requirements.

6.9.4 Disposal

Dispose of the c250-S 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 Safety I/O-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 Operating Instructions of you safe devices for further details.

⇨ Configure your Safety I/O-module with reference to 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 only apply if the test pulses are enabled.

WARNING

Non-detection of a corrupt 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 protecting the cables and/or laying them separately to ensure a sufficient degree of safety.

WARNING

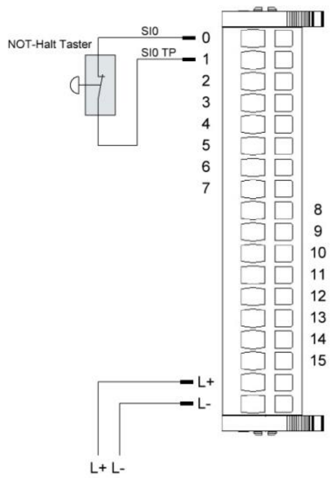
Reduced diagnosis with deactivated test pulses at the outputs

Switching off the test pulses is expressly not recommended; it may reduce the safety of the application. When the test pulses at the outputs are switched off, the diagnosis of the outputs must be maintained:

⇨ The outputs must be switched once a year. Switching can be functional (by application) or by switching the device completely off.

7.1 Safety Function with Single-channel Input

> ***CAUTION***
>
> **Consideration of the parametrization**
> For single-channel applications (inputs and outputs), the test pulse frequency must be adapted to the application. It must be ensured that for 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 6.3.2 FSoE Parameters.



You may connect contact-type sensors such as emergency stop buttons straight 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 VDC, 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).

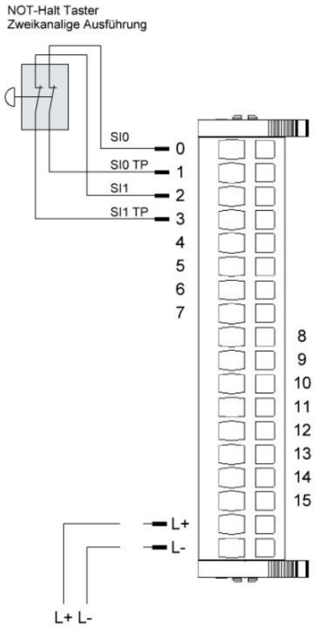
Whenever an emergency stop button is pressed, the safety PLC will generate a stop signal. Resetting the emergency stop device must not be enough to initiate a restart signal.

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 solely apply 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. 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 **when applying the module's test pulses to single-channel contact-type sensors**	
Highest safety integrity level to EN 62061:2010	SIL2
Highest 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 of the application may cause the safeguard to fail)

7.2 Safety Function with Two-channel Input



For applications requiring single-fault safety such as EMERGENCY OFF, EMERGENCY STOP, you may connect two digital inputs to two switching devices of safe sensors and further 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's discrepancy time monitoring is enabled for two-channel applications.

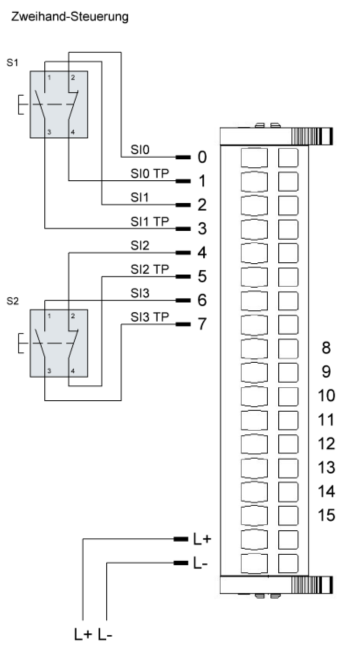
Discrepancy time monitoring: The discrepancy time defines as the maximum length of time both inputs may be in different states without the component interpreting this as a fault. Discrepancy time monitoring starts whenever the state of one input changes. The components will detect a fault if, at the end of the discrepancy time, both 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 solely apply 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. 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 **when applying the module's test pulses to two-channel contact-type sensors**	
Highest safety integrity level to EN 62061:2010	SIL3
Highest 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



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.

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.

Software component " FB_TWOHAND_TYP3" 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.

Note: 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 solely apply 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. 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 function two-hand operation	
Highest safety integrity level to EN 62061:2010	SIL3
Highest 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)

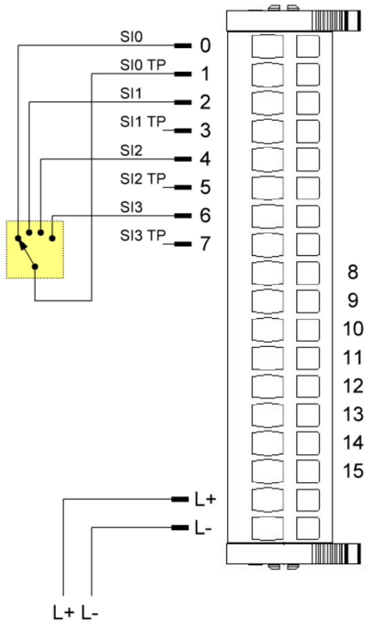
CAUTION

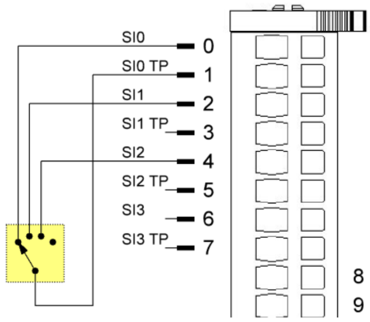
Safety hazard due to wrong handling of the two-hand circuit

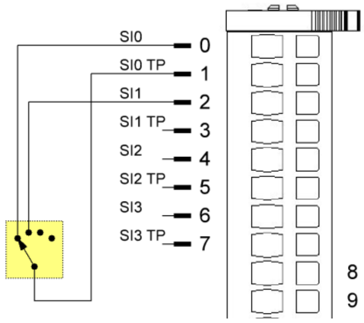
⇨ Comply with EN 574:2008 and other requirements and standards published on two-hand circuits.

⇨ Switches/sensors, wiring and application must comply with EN 574:2008.

7.4 Mode Selector, Rotary Table







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 FSoE parameter "External Input" to enable the "Mode Selector" function. Refer to manual section ► 6.3.3 Input Parameters for further details.

Safety ratings of mode selector applications in conjunction with switches/sensors approved to EN 13849-2, Table D.3	
Highest safety integrity level to EN 62061:2010	SIL2
Highest 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 of the application may cause the safeguard to fail)

Safety ratings of mode selector applications in conjunction with certified switches/sensors of the appropriate safety classification	
Highest safety integrity level to EN 62061:2010	SIL3
Highest 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)

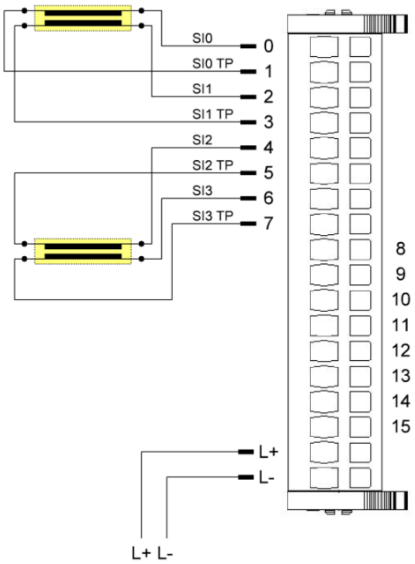
NOTE

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.

NOTE

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



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. The picture illustrates that one area of contact is allocated to one channel and the other area to another channel. Mechanical load on the area of contact makes the inputs connect. This is not interpreted as a short circuit but as actuation. Use FSoE parameter "External Input" to enable the "Bumper" function. Refer to manual section ▶ 6.3.3 Input Parameters for further details. This mode only supports pressure-sensitive mats working according to the open circuit principle, i.e. the test pulses required to maintain a safe function are supplied by the safe I/O module.

The function uses either inputs SI0 and SI1 and/or 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 for pressure-sensitive mat applications	
Highest safety integrity level to EN 62061:2010	SIL3
Highest 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)

NOTE

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.

NOTE

The supply lines of the Safety Mats and Bumpers must be laid together.
For each Safety Mat or Bumper, the four conductors used (e.g. SI0, SI0 TP, SI1, SI1 TP) must be laid together in order to avoid influences and fault functions caused by EMC influences.

CAUTION

"Short circuit in mat" fault is not detected
The Safety 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.

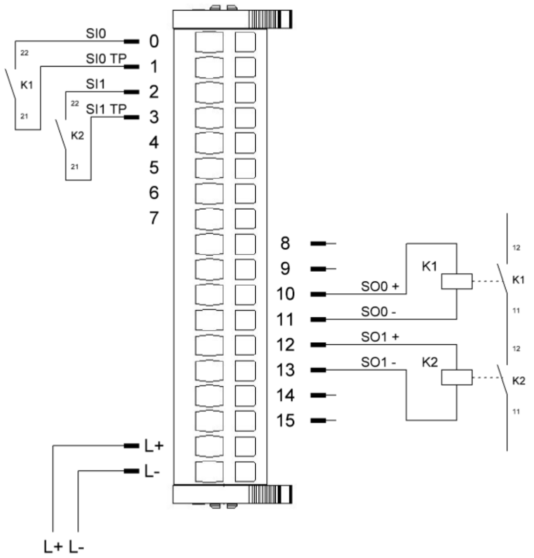
⇨ Periodically check that the mat is working properly.

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.

7.6 Connecting Two Actuators with Internal GND Reference



The wiring example illustrates how two outputs of the Safety 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 external power is supplied to an cross-faults affect the actuator (contact SOX+). Whereas you may set up this circuit without the SOX- terminals, you must ensure that external power and cross-faults are excluded if you do.

t connect the positively drive n.c. contacts of K1 to analyse the values returned and, thus, the

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 solely apply 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. Only use approved actuators in due consideration of their B10d value. The safety assessment of the safety function must also consider the safety ratings of the safe PLC used in the application.

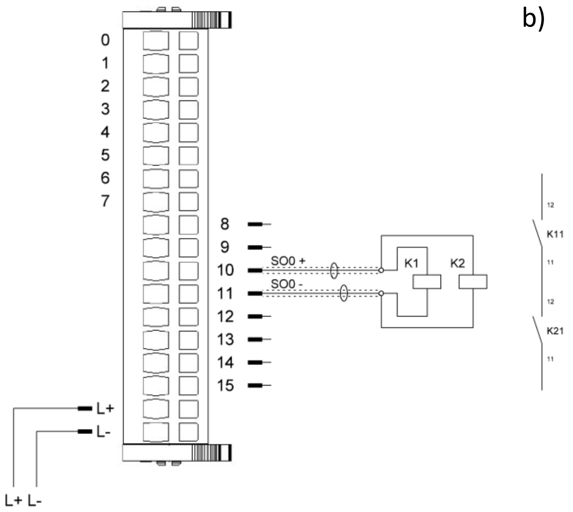
Safety ratings of applications using two outputs for a safety function	
Highest safety integrity level to EN 62061:2010	SIL3
Highest safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 3/PL e
Hardware fault tolerance (HFT) in two-channel application (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

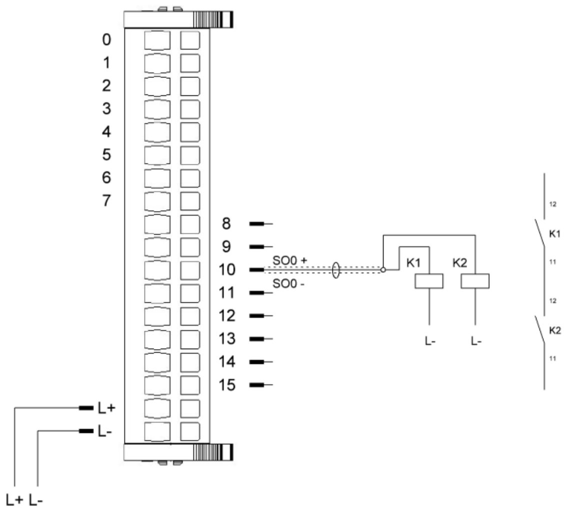
CAUTION

Consideration of the parametrization
For single-channel applications (inputs and outputs), the test pulse frequency must be adapted to the application. It must be ensured that for 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 6.3.2 FSoE Parameters.

a)



b)



The wiring example illustrates how one output of the Safety I/O-module is used to actuate a safety function.

Use a two-channel actuator to achieve the safety integrity levels of the table below. Before connecting it to the I/O module, verify that short circuits and cross-faults on the connecting lead are excluded.

Note, information, Picture a)

Fault prevention required!
Take the actions required to prevent a short circuit or cross-fault on the lead connecting the Safety I/O-module's contact and the safe actuators.

Note, information, Picture b)

To detect errors in the wiring, it is necessary to activate the test pulses for the corresponding output.

> **I**
>
> ***Note, information***
>
> **Consider the fault detection time!**
> The setup needs 5 ms to detect a fault. Faults may therefore produce high impulses of this width.
> Use a two-channel connection of the outputs in case your application responds to these impulses.

In order to monitor the relay states, you must connect the positively drive n.c. contacts of K1 and K2 to safe digital inputs. Set the safe PLC to analyse the values returned and, thus, the states of the switching devices.

Best safety ratings of applications using one output for a safety function	
Highest safety integrity level to EN 62061:2010	SIL3
Highest 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 Type 1000_h

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

8.1.2 Error Register 1001_h

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 case of an error, the associated error bit is set. If the error is not active, the bit will automatically deleted.

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

GEN:	Generic fault	non-acknowledgeable, power cycle required
CUR:	Current	non-acknowledgeable, power cycle required
VOL:	Voltage	acknowledgeable via EtherCAT or by power cycle
TEMP:	Temperature	non-acknowledgeable, power cycle required
COM:	Communication	non-acknowledgeable, power cycle required
PROF:	Device profile	acknowledgeable via EtherCAT
RES:	Reserved, always "0"	non-acknowledgeable, power cycle required

8.1.3 Name 1008_h

Designation	Value
Name	Name
Index	1008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING (27)
BitSize	216
Access	read only
PDO Mapping	no
Value Range	set
Default Value	Lenze c250-S SI4/SO2

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

8.1.4 Hardware Version 1009_h

Designation	Value
Name	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	set
Default Value	2.10

8.1.5 Software Version $100A_h$

Designation	Value
Name	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	set
Default Value	1.00

8.1.6 Identification 1018_h

Designation	Value
Name	Identification
Index	1018_h
Object Code	RECORD
No. of Elements	5
Data Type	IDENTITY
BitSize	144

Designation	Value
Name	Number of Entries
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	$0000003B_h$

Designation	Value
Name	Product Code
Subindex	02_h
Data Type	UNSIGNED32
Access	read only
PDO Mapping	no
Default Value	43000402_h (1124074498)

Designation	Value
Name	Revision
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 nnnnnnnnnnnnnnnnn 6-bit 4-bit 5-bit 17-bit Year 2014 is coded as '0'.
Value Range	14 01 01 00001 (00420001_h) … 77 12 31 99999 ($FF3F869F_h$)
Example	16052300001 ⇔ $096E0001_h$

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

8.1.7 24V Voltage CPU 1: 2001_h and CPU 2: 2011_h

Designation	Value
Name	24V Voltage
Index	2001_h / 2011_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 Output 0/1 Current CPU 1: 2005_h and CPU 2: 2015_h

Designation	Value
Name	Output 0/1 Current
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

Remark: Only the low-order 16 Bit are evaluable

8.1.9 CPU 1: External Temperature Sensor 2006_h

Designation	Value
Name	External Temperature Sensor
Index	2006_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	no
Units	0,01 °C
Value Range	0 … 8000
Default Value	No default Value

I

Note, Information

In order to display the temperature, only the least significant 16 bits may be evaluated.

8.1.10 Errorcode CPU 1: 2007_h and CPU 2: 2017_h

Designation	Value
Name	Errorcode
Index	2007_h / 2017_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read
PDO Mapping	no
Default Value	00000000_h

The table below explains the entries in object 2007h or 2017_h "Errorcode".

Id	Hex	Explanation	
0	0000_h	OK	No error
1	0001_h	HWT_PARAMETER_ERROR	Hardware test parameter error
2	0002_h	HWT_INIT_ERROR	Hardware test initialisation error
100	0064_h	HWT_MEM_MARCHC_ERROR	Hardware test RAM check error
101	0065_h	HWT_MEM_GALPAT_ERROR	Hardware test RAM check error
200	$00C8_h$	HWT_STACK_UNDERFLOW_ERROR	Hardware test stack underflow
201	$00C9_h$	HWT_STACK_OVERFLOW_ERROR	Hardware test stack underflow
300	$012C_h$	HWT_CPU_ERROR	Hardware test CPU error
400	0190_h	WT_FW_ERROR	Hardware test firmware error
500	$01F4_h$	HWT_FWINTERFACE_ERROR	Hardware test firmware error
504	$01F8_h$	HWT_ADC_ERROR	Test handler: error in ADC value range checks
505	$01F9_h$	HWT_DMA_ERROR	Test handler: DMA checksum error
506	$01FA_h$	HWT_CRC_ERROR	Test handler: CRC check error
507	$01FB_h$	HWT_TIMER_ERROR	Test handler: CPU timer check error
508	$01FC_h$	HWT_CLOCK_ERROR	Test handler: CPU clock signal check error
509	$01FD_h$	HWT_SOFTERROR	Soft error detected in hardware test
510	$01FE_h$	HWT_DIVZERO	division by 0 detected in hardware test
512	0200_h	TIMEOUT_ERR	Software timeout detected
513	0201_h	OUT_OF_RANGE_ERR	Parameter or value out of allowed range
514	0202_h	OVERWRITE_ERR	Register buffer data overwritten

Id	Hex	Explanation	
515	0203_h	UNDERFLOW_ERR	Register buffer data underflow
516	0204_h	PRG_CNTRL_ERR	Program sequence control error detected
528	0210_h	INIT_ERROR	Initialization error
592	0250_h	ASSERT_TRUE_ERR	Assertion of expression = ''true'' failed
593	0251_h	ASSERT_NOT_NULL_ERR	Assertion of unequal to NULL failed
594	0252_h	ASSERT_GE_ERR	Assertion of ''>='' comparison failed
595	0253_h	ASSERT_GT_ERR	Assertion of ''>'' comparison failed
596	0254_h	ASSERT_LE_ERR	Assertion of ''<='' comparison failed
597	0255_h	ASSERT_LT_ERR	Assertion of ''<'' comparison failed
598	0256_h	ASSERT_NE_ERR	Assertion of ''<>'' comparison failed
599	0257_h	ASSERT_EQ_ERR	Assertion of ''='' comparison failed
600	0258_h	ASSERT_FALSE_ERR	Assertion of expression = ''false'' failed
640	0280_h	TP_OUT_NOT_SPECIFIED	Bad output test pulse - internal sequence error (ErrReg: 32)
641	0281_h	TP_OUT_NOT_RECOGNIZED	Output test pulse not detected (ErrReg: 32)
642	0282_h	TP_OUT_NOT_ACTIVE	Output test pulse not enabled (ErrReg: 32)
656	0290_h	TP_INP_BUSY	Input test pulse operation is busy (ErrReg: 32) input test pulse monitoring not completed before a new test pulse occurred
657	0291_h	TP_INP_CROSSTALK	Input test pulse cross talk detected (ErrReg: 32)
658	0292_h	TP_INP_NOT_RECOGNIZED	Input test pulse not detected (ErrReg: 32)
659	0293_h	TP_INTINP_NOT_RECOGNIZED	Internal input test pulse not detected (ErrReg: 32)
660	0294_h	TP_INP_LOST	Internal input test pulse lost (ErrReg: 32)
661	0295_h	TP_INVALID_COUNT_FOR_SELECTOR	Test pulse error in mode selector mode (ErrReg: 32)
673	$02A1_h$	MRAM_READ_ERR	MRAM Read error
674	$02A2_h$	MRAM_WRITE_ERR	MRAM write error
675	$02A3_h$	MRAM_INDEX_OUT_OF_RANGE	MRAM address index out of valid range
676	$02A4_h$	MRAM_CORRUPT_PAGE_SIZE	MRAM invalid page size
677	$02A5_h$	MRAM_CRC_ERR	MRAM data CRC check failed
678	$02A6_h$	MRAM_MAGICNUMBER_ERR	MRAM magic number not recognized
768	0300_h	RESET_LOW_POWER	Reset due to low power supply
769	0301_h	RESET_WINDOW_WD	Reset by window watchdog
770	0302_h	RESET_INDEPENDENT_WD	Reset by independent watchdog timer
771	0303_h	RESET_SW	Reset by software reset
772	0304_h	RESET_POWER_ON_DOWN	Reset by power up or down
773	0305_h	RESET_NMI	Reset by non-maskable interrupt
774	0306_h	RESET_BROWNOUT	Reset by CPU brown out detection
775	0307_h	RESET_NO_REASON	Reset for unkown reason
1024	0400_h	ADC_REF_LOW: ADC	reference voltage too low
1025	0401_h	ADC_REF_HIGH: ADC	reference voltage too high

Id	Hex	Explanation	
1026	0402$_h$	ADC_24V_LOW	24 V ADC supply voltage too low (< 24V - 10%) (ErrReg: 4)
1027	0403$_h$	ADC_24V_HIGH	24 V ADC supply voltage too high (> 24V + 15%) (ErrReg: 4)
1028	0404$_h$	ADC_5V_LOW	Internal 5 V supply voltage too low (ErrReg: 4)
1029	0405$_h$	ADC_5V_HIGH	Internal 5 V supply voltage too high (ErrReg: 4)
1030	0406$_h$	ADC_3_3V_LOW	Internal 3.3 V supply voltage too low
1031	0407$_h$	ADC_3_3V_HIGH	Internal 3.3 V supply voltage too high
1032	0408$_h$	ADC_TEMP_LOW	On-chip temperature too low (ErrReg: 8)
1033	0409$_h$	ADC_TEMP_HIGH	On-chip temperature too high (ErrReg: 8)
1034	040A$_h$	ADC_CURR_HIGH	Total output current too high (ErrReg: 2)
1035	040B$_h$	ADC_24V_FATAL	24 V ADC supply voltage much too high (> 60V) (ErrReg: 4)
1280	0500$_h$	LINE_TIMEOUT	Sync line level monitoring timeout from base board
1281	0501$_h$	NOVALIDCPUID	Invalid CPU identifier setting
1282	0502$_h$	TIMEOUTTIMERERR	Timeout timer error
1283	0503$_h$	DIPSWITCHREADERR	DIP switch could not be read
1284	0504$_h$	DIPSWITCHCHANGED	DIP switch setting changed in service
1285	0505$_h$	DIPSWITCHXCHGERROR	CPU-to-CPU exchange of address DIP settings failed
1286	0506$_h$	DIPSWITCH_INVALID_ADDRESS	Invalid FSoE address selected (address = 0) (ErrReg: 32)
1312	0520$_h$	CLK_ERROR	Partner clock frequency out of valid range
1313	0521$_h$	CLK_PARTNER_LOW	Partner clock frequency too low
1314	0522$_h$	CLK_PARTNER_HIGH	Partner clock frequency too high
1328	0530$_h$	HW_REVISION_ERROR	Invalid PCB HW revision detected (the SW currently running not designed for this HW revision)
1536	0600$_h$	INPUTXCHGERROR	CPU-to-CPU exchange of safety input information failed
1537	0601$_h$	INPUT_TIMEOUT	Input test pulse timed out (ErrReg: 32)
1552	0610$_h$	INPUT_EXTMATTE_KS	Short circuit detected in external safety input carpet (ErrReg: 32) not used
1553	0611$_h$	INPUT_EXTMATTE_OPEN	Safety mat not connected / open load, short circuit or wire failure (ErrReg: 32)
1792	0700$_h$	OUTPUTXCHGERROR	CPU-to-CPU exchange of safety output information failed
1793	0701$_h$	OUTPUTFAIL	Output test pulse not detected (ErrReg: 32)
1794	0702$_h$	OUTPUT_WAITFB	Output test pulse waiting for feedback signal (ErrReg: 32)
1795	0703$_h$	OUTPUT_TIMEOUT	Timeout in handling of output (ErrReg: 32)
1796	0704$_h$	OUTPUT_HSTP_TIMEOUT	Output test pulse of high side switch timed out
1797	0705$_h$	OUTPUT_LSTP_TIMEOUT	Output test pulse of low side switch timed out
1798	0706$_h$	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

Id	Hex	Explanation	
1799	0707_h	OUTPUT_USTP_TIMEOUT	Output test pulse of common high side switch timed out
1800	0708_h	OUTPUT_NOPAR_USED	Output is parameterized as not used and shall be switched on (ErrReg: 32)
2048	0800_h	BCOM_NOTREADY	Communication with base board not ready / operational
2049	0801_h	BCOM_BUSY	Communication with base board is busy
2050	0802_h	BCOM_NONEWDATA	Communication with base board - no new data received
2051	0803_h	BCOM_CRCERR	Communication with base board – CRC error
2052	0804_h	BCOM_BITERR	Communication with base board – shifted bits detected
2304	0900_h	XCOM_NOTREADY	Communication with safety partner MC not ready / operational
2305	0901_h	XCOM_BUSY	Communication with safety partner MC is busy
2306	0902_h	XCOM_NONEWDATA	Communication with safety partner MC – no new data received
2307	0903_h	XCOM_CRCERR	Communication with safety partner MC – CRC error detected
2560	$0A00_h$	I2C_TIMEOUT	I2C communication timeout detected
2561	$0A01_h$	I2C_BUSY	I2C bus is busy
2816	$0B00_h$	FSOE_RESET_IND	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – FSoE slave returns error to FSoE master
2817	$0B01_h$	FSOE_INVALID_CMD	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid command
2818	$0B02_h$	FSOE_UNKNOWN_CMD	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – unknown command
2819	$0B03_h$	FSOE_INVALID_CONNID	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid connection ID
2820	$0B04_h$	FSOE_INVALID_CRC	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – checksum error
2821	$0B05_h$	FSOE_WD_EXPIRED	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – Watchdog time out
2822	$0B06_h$	FSOE_INVALID_ADDRESS	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid address
2823	$0B07_h$	FSOE_INVALID_DATA	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid data
2824	$0B08_h$	FSOE_INVALID_COMMPARALEN	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid length of communication parameters
2825	$0B09_h$	FSOE_INVALID_COMMPARA	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid communication parameters
2826	$0B0A_h$	FSOE_INVALID_USERPARALEN	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid length of user parameters
2827	$0B0B_h$	FSOE_INVALID_USERPARA	Test pulse error in mode selector mode (ErrReg: 16) FailSafeOverEtherCAT – invalid user parameters
2828	$0B0C_h$	FSOE_INVALID_TP_INP_DURATION	FailSafeOverEtherCAT – invalid safety input parameter test pulse duration (ErrReg: 16)
2829	$0B0D_h$	FSOE_INVALID_TP_INP_FREQUENCY	FailSafeOverEtherCAT – invalid safety input test pulse frequency (ErrReg: 16)

Id	Hex	Explanation	
2830	$0B0E_h$	FSOE_INVALID_TP_OUT_DURATION	FailSafeOverEtherCAT – invalid safety output parameter test pulse duration (ErrReg: 16)
2831	$0B0F_h$	FSOE_INVALID_TP_OUT_FREQUENCY	FailSafeOverEtherCAT – invalid safety output test pulse frequency (ErrReg: 16)
2832	$0B10_h$	FSOE_INVALID_WATCHDOG_TIME	FailSafeOverEtherCAT – invalid safety parameter watchdog time (ErrReg: 16)
2833	$0B11_h$	FSOE_INVALID_INP_EXT_SUPPLY	FailSafeOverEtherCAT – invalid safety parameter for inputs having external supply (ErrReg: 16) or inputs not used according to parameter setup
2834	$0B12_h$	FSOE_INVALID_INP_IN_USE	FailSafeOverEtherCAT – invalid safety parameter for inputs in use (ErrReg: 16)
2835	$0B13_h$	FSOE_INVALID_INP_USED_EXT_MISMATCH	FailSafeOverEtherCAT – mismatch of safety parameters for inputs in use and externally supplied inputs (ErrReg: 16)
2836	$0B14_h$	FSOE_INVALID_OUT_IN_USE	FailSafeOverEtherCAT – invalid safety parameter for outputs in use (ErrReg: 16)
2837	$0B15_h$	FSOE_INVALID_OUT_USED_EXT_MISMATCH	FailSafeOverEtherCAT – mismatch of safety parameters for outputs in use and externally earthed outputs (ErrReg: 16)
2944	$0B80_h$	FSOE_EXTENDED_ERROR	FailSafeOverEtherCAT – test pulse error in mode selector mode, extended error (ErrReg: 16)
2992	$0BB0_h$	FSOE_ERROR	FailSafeOverEtherCAT – invalid internal state in safety stack (ErrReg: 16)
3072	$0C00_h$	TH_GLOBAL_ERROR	Global hardware test error
3073	$0C01_h$	TH_TIMEOUT	Internal hardware test sequence timeout
3329	$0D01_h$	MC1_ID_INVALID	Identification of MC 1 failed
3330	$0D02_h$	MC2_ID_INVALID	Identification of MC 2 failed
3331	$0D03_h$	MC3_ID_INVALID	Identification of MC 3 failed
3584	$0E00_h$	FOREIGN_ERROR_DETECTED	Error detected by other MC
3841	$0F01_h$	FLASH_TIMEOUT	Timeout writing to FLASH
3842	$0F02_h$	FLASH_LOCKED	FLASH operation failed because ''LOCK'' bit could not be reset
3851	$0F0B_h$	FLASH_BUSY	FLASH operation busy, sequence error in FLASH programming
3854	$0F0E_h$	FLASH_ERROR	FLASH operation error, programmer the FLAH memory failed

8.1.11 Errorline CPU 1: 2008_h and CPU 2: 2018_h

Designation	Value
Name	Errorline
Index	2008_h / 2018_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read
PDO Mapping	no
Default Value	00000000_h

8.1.12 Errormodule CPU 1: 2009_h and CPU 2: 2019_h

Designation	Value
Name	Errormodule
Index	2009_h / 2019_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 or 2019_h "Errormodule".

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"

Id	Explanation	
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"
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 Errorclass CPU 1: $200A_h$ and CPU 2: $201A_h$

Designation	Value
Name	Errorclass
Index	$200A_h$ / $201A_h$
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 $200A_h$ or $201A_h$ "Errorclass".

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

8.1.14 System Uptime [s] $200C_h$

Designation	Value
Name	System uptime [s]
Index	$200C_h$
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 2016_h

Designation	Value
Name	Temperature warning
Index	2016_h
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 configuring and their values cannot be retrieved.

Object	Meaning
$10F1_h$	Error Settings
1600_h	FSOE Rx PDO Mapping
$1A00_h$	FSOE Tx PDO Mapping
$1C00_h$	Sync Manager Type
$1C12_h$	Rx PDO Assign
$1C13_h$	Tx PDO Assign
$1C32_h$	SM Output Parameter
$1C33_h$	SM Input Parameter
2000_h	Ref Voltage for µC1
2010_h	Ref Voltage for µC2
2002_h	Supply 5 Voltage to µC1
2012_h	Supply 5 Voltage to µC2
2003_h	Supply 3.3 Voltage to µC1
2013_h	Supply 3,3 Voltage to µC2
2004_h	IC Temperature (Uncalibrated) for µC1
2014_h	IC Temperature (Uncalibrated) for µC2
$200B_h$	Number of CORA Test Cycles of µC1
$201B_h$	Number of CORA Test Cycles of µC2
2020_h	MaxAsicDataUnequalCounter
2220_h	MC1 Main Loop Cycle Time
2221_h	MC2 Main Loop Cycle Time
5001_h	Id MC1
5002_h	Id MC2
5003_h	Id MC3
6000_h	FSOE Slave Frame Elements
6001_h	FSOE Inputs
7000_h	FSOE Master Frame Elements
7001_h	FSOE Outputs
8000_h	Input Parameter
8001_h	Output Parameter
8002_h	Test Pulse Duration
8003_h	Test Frequency
9001_h	FSOE Communication Parameter
$F980_h$	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 immunity to:

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

Elevated immunity levels of safety-related applications:

- 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 noise emission to:

- Generic standard 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 Regulations and Declarations

8.3.1 Mark of Conformity

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

8.4 Permits

Safety I/O-module has been granted the following permits:

EC Type-Examination by Notified Body according Annex IX of Directive 2006/42/EG	TÜV Rheinland, Notified Body for Machinery, NB 0035 EC Type-Examination Certificate Reg.-Nr./No.: 01/205/5581.00/20
UK CA	TÜV Rheinland UK Ltd. UK Type-Examination Certificate Reg.-No.: 01/205U/5581.00/22
$_c$UL$_{US}$	File Number E343358
EtherCAT. Conformance tested	Conformance and interoperability tests passed at an EtherCAT Test Center (ETC).
RoHS 2011/65/EU	Conforms to RoHS Directive 2011/65/EU limiting the use of certain hazardous substances in electrical and electronic equipment
S.I. 2012/3032	The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

8.5 Order Specifications

8.5.1 Basic Units

Technical Data		
Safety I/O-module	**C25BAYA42**	
Safe input/output module		
Safety protocol:	FSoE	
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 3 / PL e	
Number of inputs:	4 safe inputs (configurable properties)	
Number of outputs:	2 safe outputs (Imax = 2.0 A)	
Test pulse outputs (OSSD):	4	
Extended diagnostic information:	via CoE	

8.5.2 Accessories

Technical Data		
Safety controller c250-S	**C25BAYSQ**	
Safety control unit		
Safety protocol:	FSoE	
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 3 / PL e	
Permits:	CE, $_c$UL$_{us}$, TÜV Rheinland	
Runtime system:	PLCDesigner RT Safety	
Programming tool:	PLCDesigner v3.15 or higher with integrated safety function modules	

8.5.3 Spare Parts

There are no spare parts for the Safety I/O-module.

You are not allowed to repair Safety I/O-module. Please return the defective module to Lenze.

8.6 Declaration of Conformity

Lenze

2366613.03

EU-Konformitätserklärung	EU Declaration of Conformity

LENZE SE, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

erklärt in alleiniger Verantwortung die Übereinstimmung der Produkte	declares under sole responsibility compliance of the products

C25BAYA42

mit der	with the
Maschinenrichtlinie 2006/42/EG Anhang VIII und IX	**Machinery Directive** 2006/42/EC Annex VIII and IX
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

		EN 60204-1	**:2018**			
	Kategorie 3 Performance Level (PL): PL e	**EN ISO 13849-1**	**:2015**	Category 3 Performance Level (PL): PL e		
		EN 61508 1-7	**:2010**			
Sicherheitsfunktionen siehe Betriebsanleitung.	SIL 3	**EN 62061** **+AC +A1 +A2**	**:2005** **:2010 :2013 :2015**		SIL 3	For safety functions see manual.

Konformitätsbewertung		**Conformity assessment**	
CE 0035	**Benannte Stelle**	**notified body**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
	Zertifikate	Certificates	01/205/5581.03/21
	Gültigkeit	Date of expiry	2025-02

EMV- Richtlinie 2014/30/EU	**EMC Directive** 2014/30/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

EN 61000-6-7:2015
EN 61131-2:2008

RoHS- Richtlinie 2011/65/EU	**RoHS Directive** 2011/65/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

EN IEC 63000:2018

Die Sicherheitshinweise der Betriebanleitung sind zu beachten.

The safety instructions of the manual are to be considered.

Die Produkte sind bestimmt zum Einbau in Maschinen. Die Inbetriebnahme ist solange untersagt bis festgestellt wurde, dass die Maschine, in welche diese Produkte eingebaut werden sollen, den Bestimmungen der o.g. EU-Richtlinie entsprechen.

These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned EU Directive.

Ort / Datum Place / date	**Geschäftsführer** Managing Director	**Dokumentationsverantwortlicher** Responsible for documentation
Aerzen 05.08.2021	*Dipl.-Ing. Frank Maier*	i.V. T. Wedemeyer *i.V. T. Wedemeyer*

2447040.00

UK Declaration of Conformity

LENZE SE, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

declares under sole responsibility compliance of the products

Safety I/O Module C25BAYA42

with the

The Supply of Machinery (Safety) Regulations 2008 — **S.I. 2008 No. 1597**

Applied designated standards:

	EN 60204-1	**:2018**	
	EN ISO 13849-1	**:2015**	Category 3 Performance Level: PL e
For safety functions see manual.	**EN 61508 1-7**	**:2010**	
	EN 62061 **+AC +A1 +A2**	**:2005** **:2010 :2013 :2015**	SIL 3

Conformity assessment

UK CA	**notified body**	TUV Rheinland UK Ltd 1011 Stratford Road Solihull, B90 4BN
	Certificates	01/205U/5581.00/22
	Date of expiry	2025-02

The Electromagnetic Compatibility Regulations 2016 — **S.I. 2016 No. 1091**

Applied designated standards:

EN 61000-6-7:2015
EN 61131-2:2007

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 — **S.I. 2012 No. 3032**

Applied designated standards:

EN IEC 63000:2018

Authorised representative
LENZE Ltd., 6, Abbey Court Fraser Road Priory, Business Park, MK44 3WH Bedford

The safety instructions of the manual are to be considered.
These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned Regulations.

Place / date		Chief Technology Officer	Responsible for documentation
Aerzen	29.08.2022	*Dipl.-Ing. Frank Maier*	i.V. G. Wedemeyer *i.V. Torsten Wedemeyer*

---

9 Version Information

9.1 Version Details

9.1.1 Manual

Modification History		
Version	**Date**	**Comments / Modifications**
2.0	09/27/2019	Original Version 2.0
2.1	05/13/2020	Corrections
2.2	04/20/2021	Corrections
2.3	10/19/2022	Corrections

9.1.2 Safety I/O-module

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

Module Release			
Version	**Manual**	**Date**	**Comments Modifications**
V1.0	2.0	09/27/2019	Applies to module release V1.00 (Software Version 1.03, Hardware Version V1.10)
V1.0	2.1	05/13/2020	Applies to module release V1.00 (Software Version 1.03, Hardware Version V1.10)
V1.0	2.2	04/20/2021	Applies to module release V1.00 (Software Version 1.03, Hardware Version V1.10)
V1.0	2.3	10/19/2022	Applies to module release V1.00 (Software Version 1.03, Hardware Version V1.10)

10 Preface

10.1 About this User Guide

This document is the original user guide of the Safety I/O-modules specified in its title. Your module work should always be based on the correct user guide version ▶ 9.1 Version Details.

This document is primarily directed to system designers, project engineers and device developers. It does not contain any availability information. We reserve the rights for errors, omissions and modifications. Pictures are similar.

I

Note, information

Always keep in mind to use the latest version of the manual.
Information and resources on Lenze products can be found in the Internet: http://www.lenze.com ▶ Download

10.1.1 Limitation of Liability

Specifications are for description only 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.

10.1.2 Terms of Delivery

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

10.1.3 Copyright

Microsoft®, Windows® and the Windows® logo are registered trademarks of Microsoft Corp. in the USA and other countries.

EtherCAT® is a registered brand and patented technology, licenced by Beckhoff Automation GmbH, Germany.

Safety over EtherCAT is a registered trademark and patented technology, licenced by Beckhoff Automation GmbH, Germany

Further information about the PLCopen organisation is available at www.plcopen.org. CiA® and CANopen® are registered joint brands of CAN in Automation e.V. Title to all companies and company names mentioned herein as well as to products and product names is held by the respective enterprises.

10.1.4 Warranty

Warranty is subject to the provisions of the conditions of sale of Lenze 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

10.2 Reliability, Safety

10.2.1 Applicability

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

10.2.2 Target Group

The user guide 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.

10.2.3 Reliability

Reliability of Lenze 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 / vendors,
- 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 certification

10.2.4 Hazard and Other Warnings

Despite the actions described in section ►10.2 Reliability, Safety, 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 guide. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

Every alert and hazard warning is made up as follows:

Type and source of risk

Potential consequences of non-observance

⇨ Preventive measures

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.

10.2.5 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).

10.2.6 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 humans or material/equipment.

DANGER

Non-compliance with the user guide
Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.

⇨ Carefully read the user guide
⇨ Take particular heed of the hazard warnings

ATTENTION

The safety-related products may be used by the following persons only.

⇨ 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.

Note, information

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

10.2.7 Project Planning and Installation

- Emergency-off installations must comply with EN 60204/IEC 204 (VDE 0113). They must be operative at any time.
- 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 controller operation or its functionality.

10.2.8 Maintenance and Servicing

- Accident prevention regulations (in Germany: BGV A3 - VBG 4.0) to be observed when measuring or checking a controller after power-up. This applies to section 8 (Admissible deviations when working on parts) in particular.
- You are not allowed to repair Safety I/O-module. Please return the module to Lenze Automation GmbH if defective.
- 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.

11 System Description

11.1 EtherCAT® – Ethernet Control

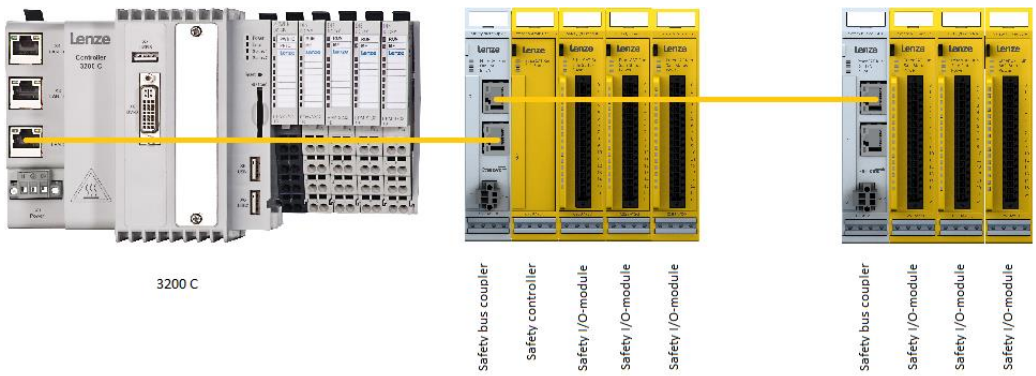
EtherCAT® is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale.

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 controllers thus nearly act like centralised control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

The Safety bus coupler converts the physical transfer technology (twisted pair) to 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, the Safety I/O-modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last Safety I/O-module.

PLC with IO1000 expansion modules EtherCAT® IO with c250-S expansion modules



11.2 c250-S Safety System

The c250-S System consists of the Safety bus coupler, the Safety controller and a range of Lenze Safety I/O-modules.

The c250-S Safety System allows users to add Safety I/O-modules with safe signals to the EtherCAT control unit, making the separate wiring of safety circuits a thing of the past. The EtherCAT protocol is used to transfer both safe and standard signals to the Safety controller c250-S. This integrated transfer process is based on FSoE (Fail Safe over EtherCAT), the safety protocol certified by TÜV, the German Technical Testing & Inspection Association.

11.2.1 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. In 2010, IEC 61784-3-12 was published as the international reference standard for Safety over EtherCAT.

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 left out of the safety assessment.

11.2.2 Safety controller c250-S

Safety controller c250-S links up the inputs and outputs of c250-S Safety System and other FSoE system devices. At the basic level, certified function blocks are graphically "wired up" to establish the system's safety programme. In case 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.

Safety controller c250-S has been designed as an add-on to a normal PLCDesigner control unit. This is a two-channel system which uses the normal control unit to communicate with the PLCDesigner Development System and all non-safe I/Os. Programming is based on a certified plug-in that is fully integrated in the PLCDesigner Development System.

11.2.3 Safety I/O-module

Safety I/O-module provides connections for standard security appliances. It installs at any place of the c250-S block. Its signals are transferred by the EtherCAT bus of a certified Safety controller c250-S and processed in a safe manner. The module outputs safely switch actuators such as contactors, signal lamps or servo converters.

11.2.4 PLCDesigner Safety

Programming of Safety controller c250-S is based on a certified plug-in that is fully integrated in the PLCDesigner Development System.

Safety controller c250-S is a sub-node of the standard control unit and provides 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. Further software functions are available for safeguarding the safety functions by change tracking, safe flow of signals, safe version control (pinning), separating safe operation, debugging mode, etc.

11.2.5 PLCDesigner SafetyPLCopen Library

The PLCopen components have been defined by the PLCopen organisation, its members and external organisations specialising in all safety-related aspects. Since these are certified components, they reduce the time and costs involved in developing, verifying and testing a safety application for acceptance. 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.

12 Product Description

12.1 General Description

The Safety I/O-modules are distributed terminals, several variants of which are available.

- Safety I/O-module 8 safe Inputs (SDI8) 2 safe Outputs (SDO2) C25BAYA82[2]
- Safety-I/O-Module 16 safe Inputs (SDI16) C25BAYA160[3]
- Safety-I/O-Module 16 safe Inputs (SDI16) 4 safe Outputs (SDO4) C25BAYA164

Figure 1: Module layout shows the basic layout of c250-S Safety.

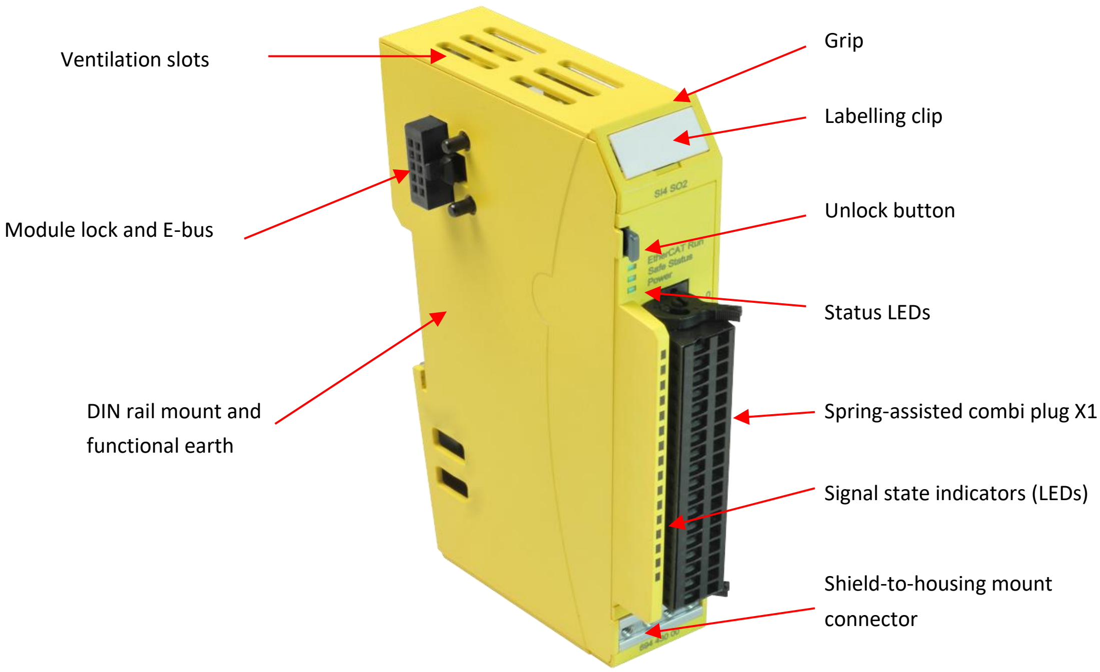


Figure 1: Module layout

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. They slightly protrude from the housing and allow a clear diagnosis at a glance.

[2] Module in preparation
[3] Module in preparation

12.2 Application

12.2.1 Intended Use

c250-S Safety 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 c250-S Safety System comprising Safety controller c250-S, Safety I/O-modules and PLCDesigner Safety Software make the c250-S Safety system fit for the functional safety of machinery.

The intended applications of the c250-S 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 which, in case of the c250-S Safety System, is a wattless 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 obeyed at any time.

The c250-S Safety System is not designed 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.

> ***Note, information***
>
> **Usage note**
> Lenze's Safety I/O-module may be used ETG-compliant configurations with conforming products. Such products include slave services, master and development systems, and functional safety products. Check the products for the "EtherCAT Conformance tested" to see if they have passed an official test for conformity. Certified products are listed in the EtherCAT Product Guide published by the EtherCAT Technology Group.

12.2.2 Qualified Persons

The safety-related products may be used by the following persons only:

- 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.

This manual's safety instructions construe qualified persons as 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 manual are therefore part of this qualification.

> ***ATTENTION***
>
> The safety-related products may be used by the following persons only.
>
> ⇨ 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.

12.2.3 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
- unauthorized 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

12.3 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. It is the aimed-for safe functional state at which the system works without problems.

The second one is the fail-safe state and applies whenever a fault or error occurs in any of the monitored components.

12.3.1 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 deenergised at the output. The data frame again reflects this state by "null" in the process map.

12.3.2 Fail-Safe State – External Fault

In case an external fault occurs (short circuit, cross-fault etc.), all outputs are deenergised (outputs "null") and the inputs return "null" to the safe control unit. FSoE communication is not stopped.

A fail-safe state is wattless.

The safety PLC is able to reset this state.

12.3.3 Fail-Safe State – Internal Fault

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

A fail-safe state is wattless.

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

CAUTION

Uncontrolled movement of suspended loads, for example
Injury caused by moving or non-braked machine parts
Additional external safety measures such as a mechanical brake of suspended loads should be provided for applications whose safe state requires an actuator to be actively turned on.

12.3.4 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 Lenze 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, refer to ▶ 13.1 Labelling and Identification. 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.

> **I** ***Note, information***
>
> The purchaser must ensure the units' retraceability by means of their serial number.

12.4 Useful Life

The Lenze Safety I/O-module is designed for a maximum life of 20 years.

It must therefore be taken out of service not later than one week before the end of this 20-year period (calculated as of Lenze's production date).

The production date is printed on the module as part of its serial number, see section ▶ 13.1.2 Serial Number.

12.5 Technical Data

12.5.1 General Specifications

General Specifications	
Product name	Safety I/O-module SDI8 / SDO2 C25BAYA82 Safety I/O-module SDI16 C25BAYA160 Safety I/O-module SDI16 / SDO4 C25BAYA164
Fieldbus	EtherCAT 100Mbit/s
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Electrical insulation	All modules are electrically insulated from the bus
Diagnosis	LED: Bus Status, Module Status, I/O Diagnosis ▶ 14.6 Diagnosis.
IO/power connection	Safety I/O-module SDI16 SDO4 0.5A and Safety I/O-module SDI16: Push-in plug (36-pole) Safety I/O-module SDI8 SDO2 0.5A: 18-pole spring-assisted combi plug with mechanical ejector
E-bus load	typ. 210 mA @ 5V (max. 300 mA)
Terminating module	not required

Power supply (I/O / system power supply)	
Supply voltage	24 VDC -15% / +20%
Overvoltage category	category II to EN 61131-2
Module power consumption	approx. 7 mA plus load current
Reverse polarity safeguard	yes
Nominal insulation voltage	500 V_{eff} measured between I/O supply and E-bus
Noise immunity	Zone B to EN 61131-2, mounted on earthed DIN rail in earthed control cubicle
Maximum interruption period (0V)	PS1 (Safe Output respond on voltage variations >1ms)
Storage and transport conditions	
Temperature	-40 °C ... + 70 °C
Rel. humidity	5% ... 95%, non-condensing
Atmospheric pressure	70 kPa to 108 kPa / 0 to 3000 m above msl
Vibration	5 Hz to 8.4 Hz: +/- 3.5 mm amplitude, 8.4 Hz to150 Hz: 10 m/s2 (1g), to IEC 60068-2-6, Fc test
Shock	150 m/s^2 (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Service conditions	
Mounting position	horizontal, stackable
Degree of contamination	II to IEC 60664-3
Admissible operating environment	operation restricted to environments complying with IP54 or better to IEC 60529 (e.g. suitable control cabinet)
Operating temperature	0 °C ... + 55 °C
Rel. humidity	5% ... 95%, non-condensing
Atmospheric pressure	80 kPa to 108 kPa / 0 to 2000 m above msl
Vibration	5 Hz to 8.4 Hz: +/- 3.5 mm amplitude, 8.4 Hz to150 Hz: 10 m/s2 (1g), to IEC 60068-2-6, Fc test
Shock	150 m/s^2 (15g), 11 ms semi-sinusoidal wave to IEC 60068-2-27
Mechanical properties	
Installation	35 mm DIN rail (top-hat rail)
Dimensions	25 mm x 120 mm x 90 mm (W x H x D)
Weight	approx. 140 gram (without packaging)
Ingress protection	IP20
Housing mount	aluminium
Shield	connects straight to module housing

EtherCAT Telegram				
Input	0 Byte			
Output	0 Byte			
FSoE Input	Safety-I/O-Modul	SDI8 / SDO2	C25BAYA82	6 Byte
	Safety-I/O-Modul	SDI16	C25BAYA160	7 Byte
	Safety-I/O-Modul	SDI16 / SDO4	C25BAYA164	7 Byte
FSoE Output	Safety-I/O-Modul	SDI8 / SDO2	C25BAYA82	11 Byte
	Safety-I/O-Modul	SDI16	C25BAYA160	12 Byte
	Safety-I/O-Modul	SDI16 / SDO4	C25BAYA164	13 Byte

Note, information

Install and operate the Safety IO at max. 2000 m above msl.

12.5.2 Safe Digital Inputs

Safe Digital Inputs	
Quantity and type	Safety I/O-module SDI16 SDO4 0.5A and Safety I/O-module SDI16: 16x single-channel or 8x two-channel, (EN 61131-2, Type 3) Safety I/O-module SDI8 SDO2 0.5A: 8x single-channel or 4x two-channel, (EN 61131-2, Type 3)
Diagnosis	cross-fault, external power supply
Highest safety level (depending on configuration)	Single-channel use: Cat. 2/PL d to EN ISO 13849-1, SIL2 to EN 62061 / IEC 61508 Two-channel use: Cat. 4/PL e to EN ISO 13849-1, SIL3 to EN 62061 / IEC 61508
Rising delay / filter time	1 ms + configurable filter time of external sensors (0.5 ms to 1.5 ms) or 1 ms + test pulse length of test pulse outputs (1.5 ms)
Sensor type	use of sensors with OSSD outputs to EN 61496, contact-type sensors
Electrical insulation	channel/channel: no channel/E-bus: 500 V_{eff}
Signal level	(EN 61131-2, Type 3) Off: -3 ... 5 V $I_L$min = not specified, $I_L$max = 15 mA. On: 11 V ... 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	green LED located next to the terminal
Safe response time	< 5 ms; see section "Response Time"
Input current	typ. 3.3 mA (24 V and 24 °C)
Input resistance	typ. 7.3 kΩ
Input capacitance	typ. 100 nF
Maximum line length	100 m (between sensors / module terminals)

12.5.3 Digital Test Pulse Outputs

Digital Test Pulse Outputs	
Quantity and type	Safety I/O-module SDI16 SDO4 0.5A and Safety I/O-module SDI16: 8x Safety I/O-module SDI8 SDO2 0.5A: 4x
Nominal output current	50 mA, short-circuit-proof
Signal indication	LED located next to the terminal (input error LED only)
Switching voltage	24 VDC -15% / +20%
Electric strength	33 V (max. voltage to output even in case of error)
Test pulse length	1500 µs, phase-shifted to each channel
Maximum line length	100 m (between sensor / module terminals)

12.5.4 Safe Digital Outputs

Safe Digital Outputs	
Quantity and type	Safety I/O-module SDI16 SDO4 0.5A 4x semiconductor, 0.5 A, 24 VDC, tolerance to EN 61131-2 Safety I/O-moduel SDI8 SDO2 0.5A: 2x semiconductor, 0.5 A, 24 VDC, tolerance to EN 61131-2 Safety /O-module SDI16: No outputs
Max. safety levels	Cat. 4/PL e to EN ISO 13849-1, SIL3 to EN 62061, SIL3 to IEC 61508
Diagnosis	cross-fault, external power supply
Signal indication	green LED located next to terminal SOX, controlled by CPU
Minimum output current	2 mA, see ▶ 14.3.9 Actuator Connection for details
Maximum output current	0.5 A, short-circuit-proof, comply with total load and derating See section ▶ 14.3.9 Actuator Connection - Derating of Total Load for details
Capacitive load	yes, see section ▶ 14.3.9 Actuator Connection for details Switching of capacity loads
Braking voltage while turning off inductive loads	typ. 40 VDC
Inductive load	yes, see section ▶ 14.3.9 Actuator Connection for details Switching of inductive loads up to 2.5 Hz
Maximum line length	100 m (between sensor / module terminals)
Response threshold of output overload protection	typ. 1.6 A
Output current module$_{max}$	Safety I/O-module SDI16 SDO4 0.5A: 2 A, comply with derating See section ▶ 14.3.9 Actuator Connection - Derating of Total Load for details Safety I/O-module SDI8 SDO2 0.5A: 1 A
Load resistance range (at nominal voltage)	48 Ω ... 12 kΩ
Electrical insulation	channel/channel: no channel/E-bus: 500 V_{eff}
Approved actuators	DC13 to EN60947-5-1 Table 4 DC1 to EN60947-4
Test pulse length	configurable: 500 µs ... 1500 µs (configurable)
Supply voltage	24 VDC -15% / +20%
Electric strength	33 V (max. voltage to output even in case of error)
Maximum line length	100 m (between actuator / module terminals)

12.6 Safety-related Ratings of a Single-channel Application

The table below lists the safety-related ratings of a single-channel safety function that uses one input and/or output of the safe I/O module.

Note: All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Safety-related ratings of a single-channel application				
Highest safety integrity level to EN 62061	SIL2			
Highest safety integrity level to IEC 61508	SIL2			
Highest performance level to EN ISO 13849-1	Cat. 2/PL d			
Hardware fault tolerance (HFT) in single-channel application (IEC 61508)	0 (a fault of the application may cause the safeguard to fail)			
Safety-related ratings of a single-channel application				
Safety-related ratings	Ambient module temperature	1x input (up to fieldbus)	Logic circuitry	1x output (from fieldbus)
Probability of failure on demand (PFDavg), proof test interval: 20 years (IEC 61508)	25 °C	$7.5 * 10^{-7}$	$4.01 * 10^{-6}$	$1.27 * 10^{-8}$
	55 °C	$2.92 * 10^{-6}$	$9.00 * 10^{-6}$	$4.09 * 10^{-8}$
Probability of failure per hour (PFH), proof test interval: 20 years (IEC 61508)	25 °C	$8.56 * 10^{-11}$ 1/h	$4.58 * 10^{-10}$ 1/h	$1.45 * 10^{-12}$ 1/h
	55 °C	$3.33 * 10^{-10}$ 1/h	$1.03 * 10^{-9}$ 1/h	$4.66 * 10^{-12}$ 1/h
DC (diagnostic coverage) to EN ISO 13849-1	25 °C	99 %	98.14 %	99 %
	55 °C	99 %	97.38 %	99 %
Safe failure fraction (SFF)	25 °C	99.83 %	99.04 %	99.68 %
	55 °C	99.79 %	98.95 %	99.68 %
MTTF d (Mean Time To Failure dangerous) to EN ISO 13849-1	25 °C	100 years (calc.: 13341 years)	100 years (calc.: 226 years)	100 years (calc.: 9110 years)
	55 °C	100 years (calc..: 3425 years)	100 years (calc.: 197 years)	100 years (calc.: 2982 years)

The safety-related ratings are calculated by combining the values of inputs, logic circuitry and outputs to describe their interdependency with the safety function. The rule is to combine the logic circuitry with the relevant number of inputs or outputs once per safe I/O module.

Example of single-channel safety functions:

- 1x logic & 1x input = safety rating of the module from the input to the fieldbus.
- 1x logic & 1x output = safety rating of the module from the fieldbus to the output.
- 1x input & 1x logic & 1x output = safety rating of input + output

12.7 Safety-related Ratings of a Two-channel Application

The table below lists the safety-related ratings of a two-channel safety function that uses two inputs and/or two outputs of the safe I/O module.

Note: All components involved in the safety function must be taken into account in order to assess whether the desired safety level is achieved.

Safety-related ratings of a two-channel application				
Highest safety integrity level to EN 62061	SIL3			
Highest safety integrity level to IEC 61508	SIL3			
Highest performance level to EN ISO 13849-1	Cat. 4/PL e			
Hardware fault tolerance (HFT) in single-channel application (IEC 61508)	1 (a fault of the application need not cause the safeguard to fail)			
Safety-related ratings of a two-channel application				
Safety-related ratings	Ambient module temperature	1x input (up to fieldbus)	Logic circuitry	1x output (from fieldbus)
Probability of failure on demand (PFDavg), proof test interval: 20 years (IEC 61508)	25 °C	$7.51 * 10^{-9}$	$4.01 * 10^{-6}$	$1.27 * 10^{-8}$
	55 °C	$2.94 * 10^{-8}$	$9.00 * 10^{-6}$	$4.09 * 10^{-8}$
Probability of failure per hour (PFH), proof test interval: 20 years (IEC 61508)	25 °C	$8.57 * 10^{-13}$ 1/h	$4.58 * 10^{-10}$ 1/h	$1.45 * 10^{-12}$ 1/h
	55 °C	$3.35 * 10^{-12}$ 1/h	$1.03 * 10^{-9}$ 1/h	$4.66 * 10^{-12}$ 1/h
DC (diagnostic coverage) to EN ISO 13849-1	25 °C	99.00 %	98.14 %	99.00 %
	55 °C	99.00 %	97.38 %	99.00 %
Safe failure fraction (SFF)	25 °C	99.83 %	99.04 %	99.68 %
	55 °C	99.79 %	98.95 %	99.68 %
MTTF d (Mean Time To Failure dangerous) to EN ISO 13849-1	25 °C	100 years (calc.: 13341 years)	100 years (calc.: 226 years)	100 years (calc.: 9110 years)
	55 °C	100 years (calc.: 3425 years)	100 years (calc.: 197 years)	100 years (calc.: 2982 years)

The safety-related ratings are calculated by combining the values of inputs, logic circuitry and outputs to describe their interdependency with the safety function. The rule is to combine the logic circuitry with the relevant number of inputs or outputs once per safe I/O module.

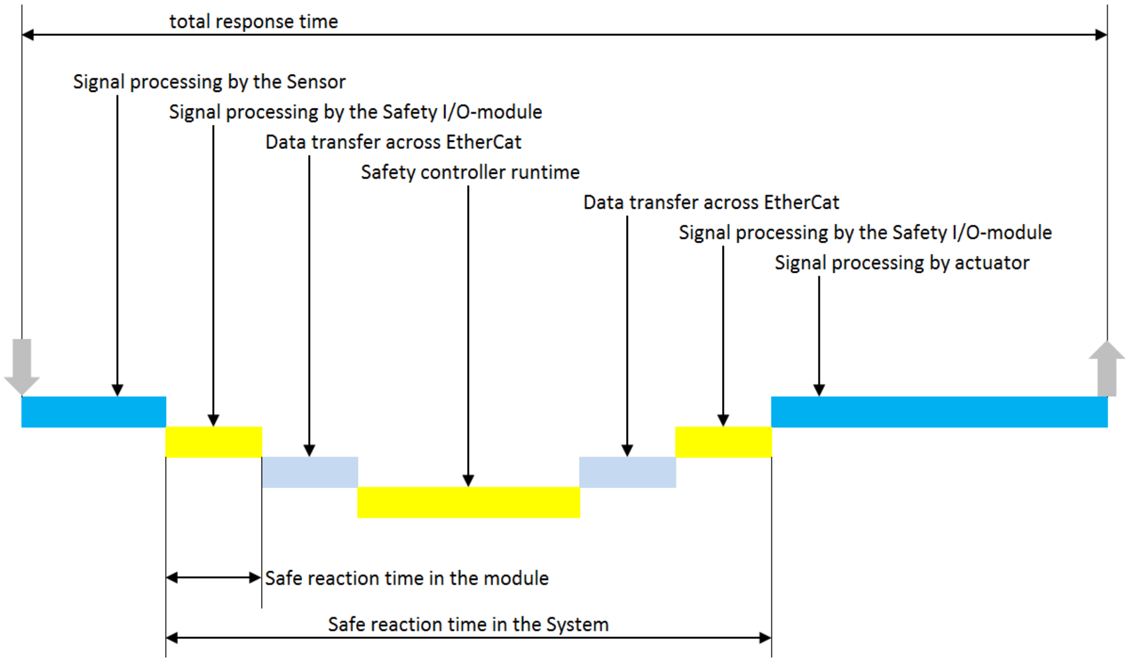
Examples of two-channel safety functions:

- 1x logic & 2x input = safety rating of the module from the pair of inputs to the fieldbus.
- 1x logic & 2x output = safety rating of the module from the fieldbus to the pair of outputs.
- 2x input & 1x logic & 2x output = safety rating of pairs of inputs + outputs

12.8 Response Time

In a safety system, the total reaction time typically consists of the following partial reaction times:

- signal processing by sensor
- signal processing by the Safety I/O-module
- time of input data transfer across the EtherCAT bus between the Safety I/O-module and the safe PLC
- safe PLC program runtime
- time of output data transfer across the EtherCAT bus between the Safety controller c250-S PLC and the Safety I/O-module
- signal processing by the Safety I/O-module
- signal processing by actuator



> **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 fieldbus runtimes and the Safety PLC's cycle time must be taken account of to rate and calculate the safe response time.

As a general rule, a safe response time of max. 5 ms may be assumed for the safe I/O module. This time ensures that the input and output signals will change and a safe state will be achieved.

Remember to consider the filter time because it influences the I/O module's maximum response time. An inalterable filter time of 1 ms is set for the inputs. This is supplemented by a configurable input filter for external sensors (adjustable between 0.5 ms and 1.5 ms). A 1.5 ms filter time is preset for using the module's own test pulse outputs.

Examples:

Using **external sensors**:

• Configurable input filter set to:	1.2	ms
• Inalterable internal filter time:	1	ms
• Total filter time:	2.2	ms

Using the **module's own test pulse**:

• Preset input filter time:	1.5	ms
• Inalterable internal filter time:	1	ms
• Total filter time:	2.5	ms

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.

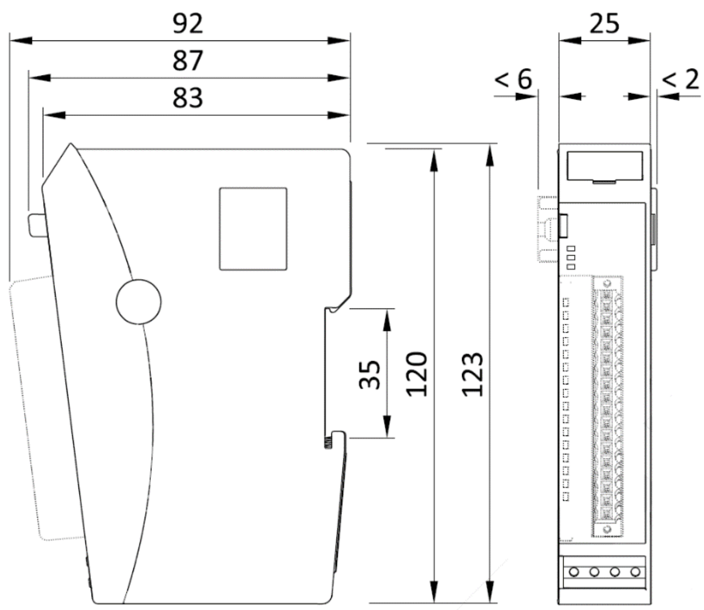
The safe response time of digital outputs defines as the maximum time it takes until the signal of a digital output changes after the EtherCAT module has received a FSoE frame.

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:

- Faults detected at the module inputs
- Faults detected at the module outputs
- Internal module faults (self-diagnosis)

> ***CAUTION***
>
> **Safety function pressure-sensitive mat requires a response time of 25 ms**
> Avoid personal injury and damage to property
> The pressure-sensitive mat function achieves a set response time of 25 ms between a change in mat state and providing the information on the EtherCAT bus.

12.9 Dimensions



12.10 Transport and Storage

At times of transport and storage, protect Safety I/O-module against inadmissible exposure such as mechanical stress, temperature, humidity and/or aggressive atmospheres. Transport and store Safety I/O-module in its original packaging if possible.

Verify that the contacts are neither soiled nor damaged when consigning the unit to stock or re-packaging it. Keep and transport Safety I/O-module in a container/packaging ensuring electrostatic discharge (ESD) compliance. Some parts of the units are sensitive to ESD and may be damaged if handled inappropriately. Thus, best transport practice is to place open assemblies in statically shielded transport bags with a metal coating which avoid contamination by amines, amides or silicone. When putting Safety I/O-module into service and performing any maintenance, you should also take the appropriate precautions against electrostatic discharge.

CAUTION

Electrostatic discharge

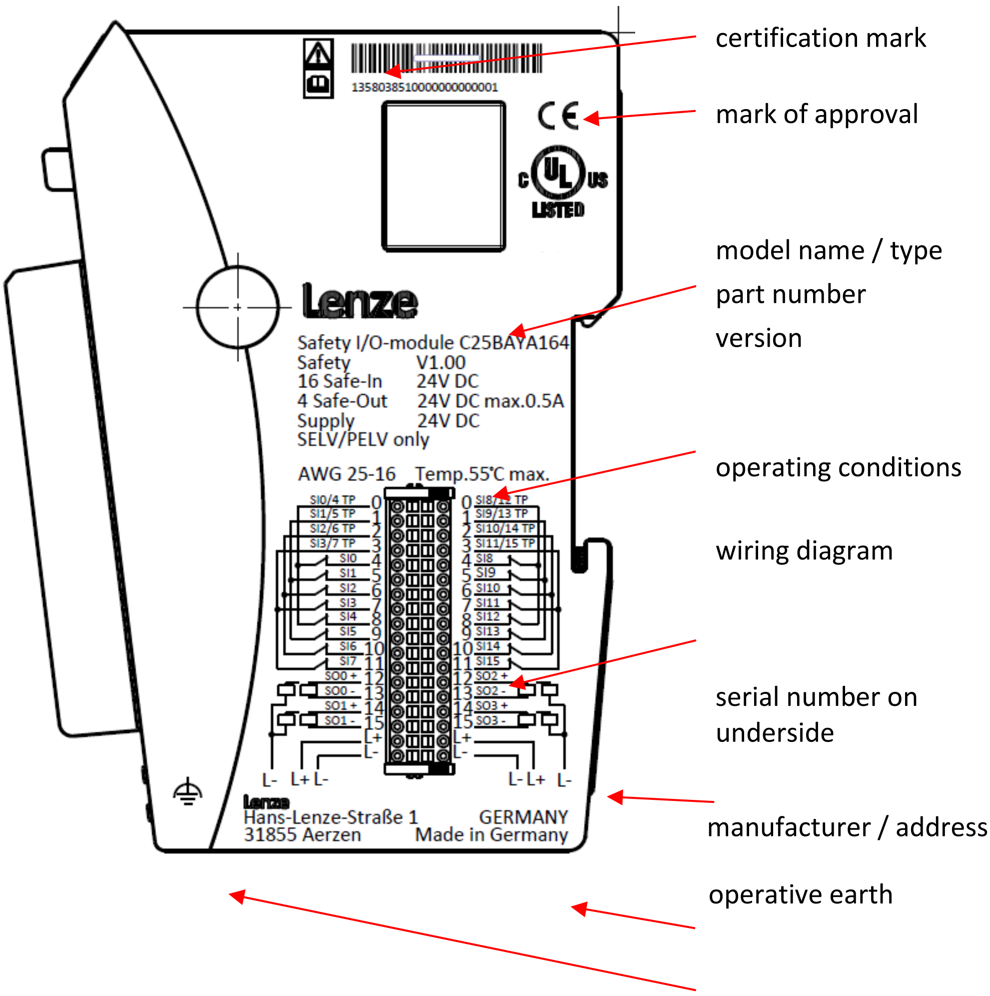
Destruction of or damage to the unit.

⇨ Transport and store Safety I/O-module in its original packaging.
⇨ Ensure that the ambient conditions are as specified at all times during transport and storage.
⇨ Handle Safety I/O-module 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.

13 Construction and Functionality

13.1 Labelling and Identification

13.1.1 Imprinted Texts and Symbols



13.1.2 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. Lenze can use the numerical code to distinctly identify the model, software and hardware release date. It is a means of traceability.

Serial number

Make-up of serial number YY MM DD NNNNN

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

15 06 05 00039

five-digit number of nth unit built on that day

production date as year month day

The serial number is also stored in object 1018 sub-index 4 and can be retrieved by SDO Transfer ► 16.1.7 Identity Object 1018h.

13.2 Contents of Package

The Safety I/O-module package contains:

- Safety I/O-module
- Module bus cover
- Connector
- Mounting Instruction

13.3 Connectors

13.3.1 E-bus and Module Lock

The system plugs and the module lock are located on the sides of Safety I/O. These contact pins interconnect the modules. They supply power to the module's 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 unit's mechanical elements
Use approved modules in a c250-S network only.

13.3.2 Combi Plug X1

Note, information

Only use the connector (spring-assisted or push-in) from the package to connect a unit to the Safety I/O-module. Refer to section ▶ 14.3 Electrical Installation further down below for details on how to connect sensors and actuators

CAUTION

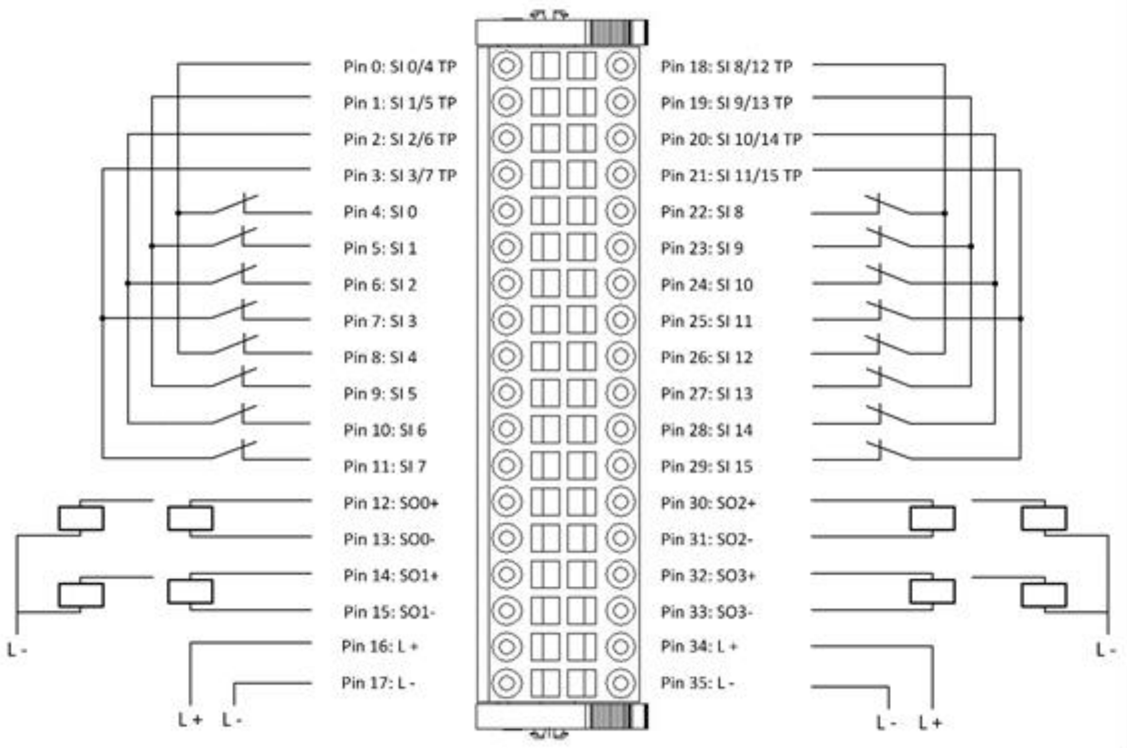
Safe function jeopardised by cross-faults

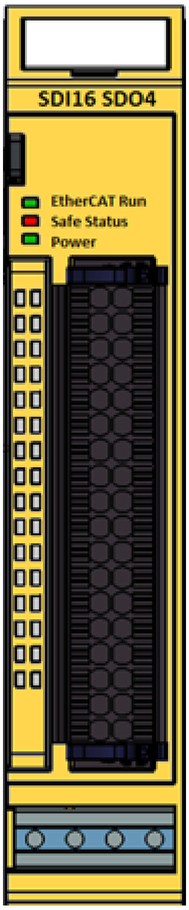
Improper installation may cause malfunctions due to cross-faults at the contacts

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

13.3.3 Safety I/O-module SDI16 / SDO4

The combi plug is located at the front of Safety I/O-module. The sensors and actuators and the module's power supply all attach to this connector.

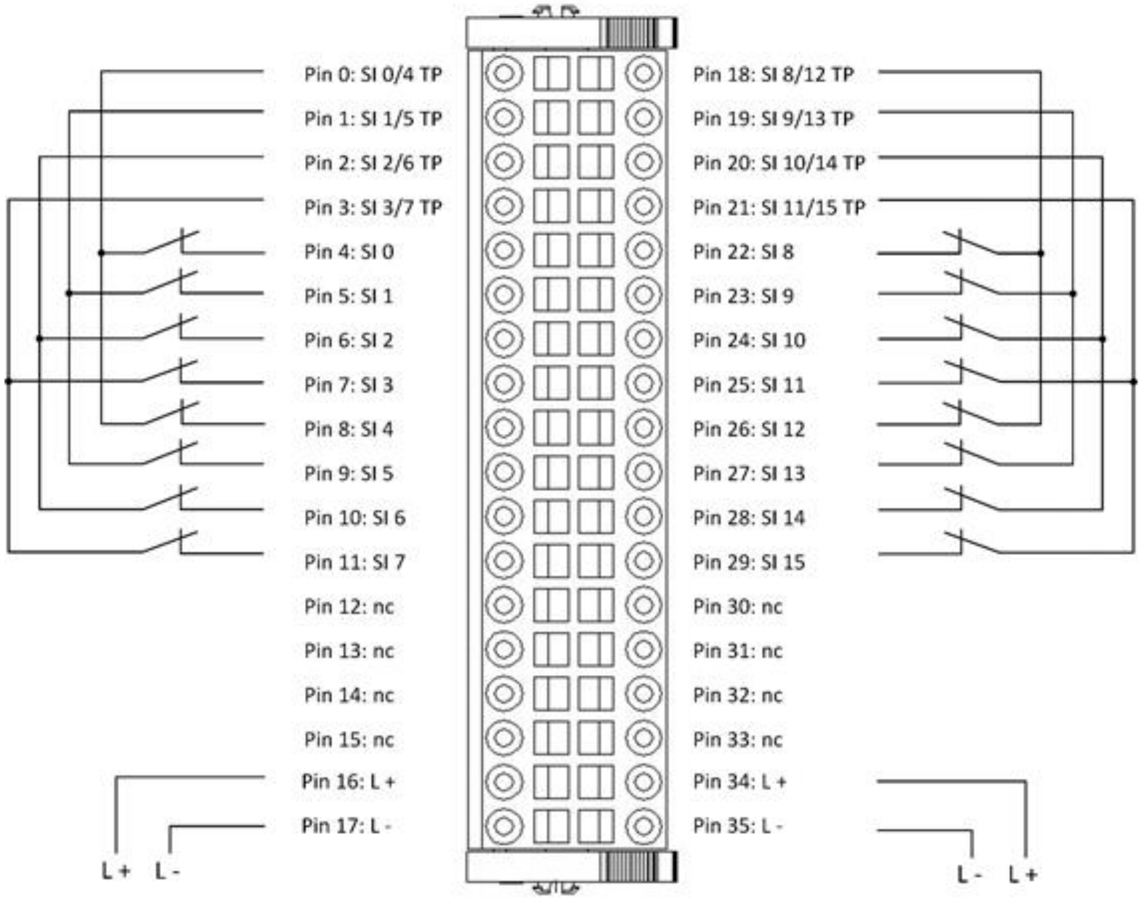


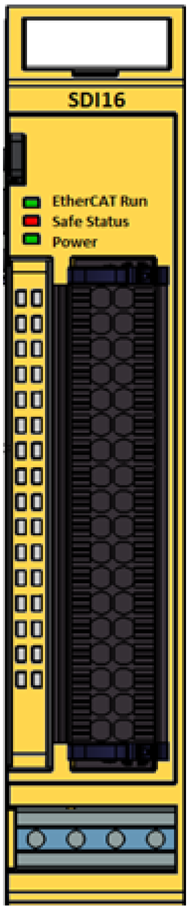


Connector X1		
Pin	Function	Signal
0	Test pulse output Safe-In 0/4 TP	SI 0/4 TP
1	Test pulse output Safe-In 1/5 TP	SI 1/5 TP
2	Test pulse output Safe-In 2/6 TP	SI 2/6 TP
3	Test pulse output Safe-In 3/7 TP	SI 3/7 TP
4	Safe input Safe-In 0	SI 0
5	Safe input Safe-In 1	SI 1
6	Safe input Safe-In 2	SI 2
7	Safe input Safe-In 3	SI 3
8	Safe input Safe-In 4	SI 4
9	Safe input Safe-In 5	SI 5
10	Safe input Safe-In 6	SI 6
11	Safe input Safe-In 7	SI 7
12	Safe output Safe-Out 0 +	SO0 +
13	Safe output Safe-Out 0 -	SO0 -
14	Safe output Safe-Out 1 +	SO1 +
15	Safe output Safe-Out 1 -	SO1 -
16	24 V supply to the outputs	L+
17	GND	L-
18	Test pulse output Safe-In 8/12 TP	SI 8/12 TP
19	Test pulse output Safe-In 9/13 TP	SI 9/13 TP
20	Test pulse output Safe-In 10/14 TP	SI 10/14 TP
21	Test pulse output Safe-In 11/15 TP	SI 11/15 TP
22	Safe input Safe-In 8	SI 8
23	Safe input Safe-In 9	SI 9
24	Safe input Safe-In 10	SI 10
25	Safe input Safe-In 11	SI 11
26	Safe input Safe-In 12	SI 12
27	Safe input Safe-In 13	SI 13
28	Safe input Safe-In 14	SI 14
29	Safe input Safe-In 15	SI 15
30	Safe output Safe-Out 2 +	SO2 +
31	Safe output Safe-Out 2 -	SO2 -
32	Safe output Safe-Out 3 +	SO3 +
33	Safe output Safe-Out 3 -	SO3 -
34	24 V supply to the outputs	L+
35	GND	L-

13.3.4 Safety I/O-module SDI16

The combi plug is located at the front of Safety I/O-module. The sensors and actuators and the module's power supply all attach to this connector.

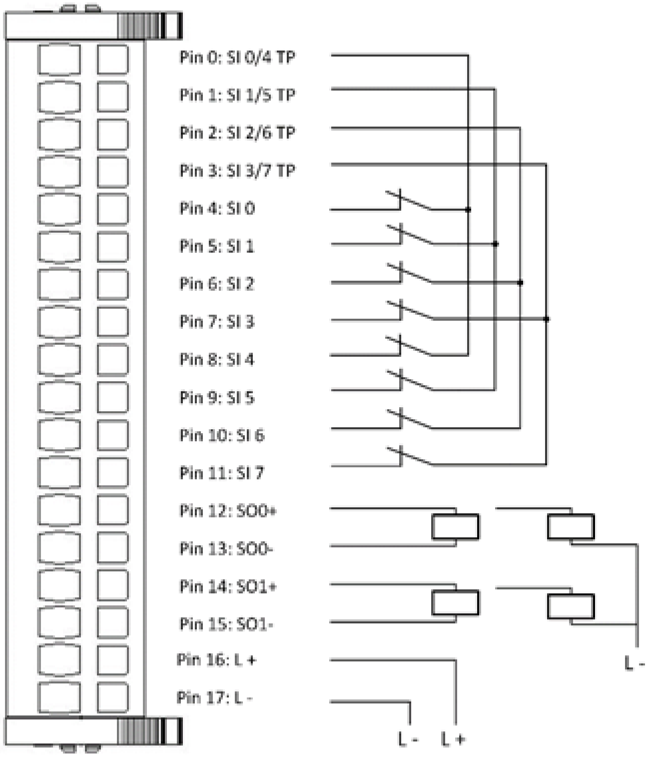


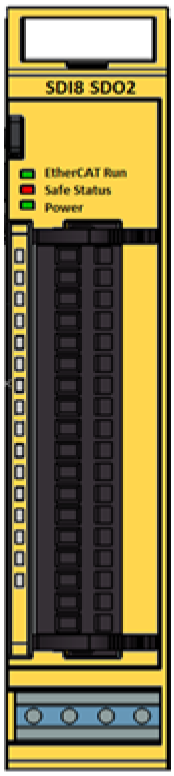


Connector X1		
Pin	Function	Signal
0	Test pulse output Safe-In 0/4 TP	SI 0/4 TP
1	Test pulse output Safe-In 1/5 TP	SI 1/5 TP
2	Test pulse output Safe-In 2/6 TP	SI 2/6 TP
3	Test pulse output Safe-In 3/7 TP	SI 3/7 TP
4	Safe input Safe-In 0	SI 0
5	Safe input Safe-In 1	SI 1
6	Safe input Safe-In 2	SI 2
7	Safe input Safe-In 3	SI 3
8	Safe input Safe-In 4	SI 4
9	Safe input Safe-In 5	SI 5
10	Safe input Safe-In 6	SI 6
11	Safe input Safe-In 7	SI 7
12	- Do not connect -	nc
13	- Do not connect -	nc
14	- Do not connect -	nc
15	- Do not connect -	nc
16	24 V supply to the outputs	L+
17	GND	L-
18	Test pulse output Safe-In 8/12 TP	SI 8/12 TP
19	Test pulse output Safe-In 9/13 TP	SI 9/13 TP
20	Test pulse output Safe-In 10/14 TP	SI 10/14 TP
21	Test pulse output Safe-In 11/15 TP	SI 11/15 TP
22	Safe input Safe-In 8	SI 8
23	Safe input Safe-In 9	SI 9
24	Safe input Safe-In 10	SI 10
25	Safe input Safe-In 11	SI 11
26	Safe input Safe-In 12	SI 12
27	Safe input Safe-In 13	SI 13
28	Safe input Safe-In 14	SI 14
29	Safe input Safe-In 15	SI 15
30	- Do not connect -	nc
31	- Do not connect -	nc
32	- Do not connect -	nc
33	- Do not connect -	nc
34	24 V supply to the outputs	L+
35	GND	L-

13.3.5 Safety I/O-module SDI8 / SDO2

The spring-assisted combi plug is located at the front of Safety I/O-module. The sensors and actuators and the module's power supply all attach to this connector.





Connector X1		
Pin	Function	Signal
0	Test pulse output Safe-In 0/4 TP	SI 0/4 TP
1	Test pulse output Safe-In 1/5 TP	SI 1/5 TP
2	Test pulse output Safe-In 2/6 TP	SI 2/6 TP
3	Test pulse output Safe-In 3/7 TP	SI 3/7 TP
4	Safe input Safe-In 0	SI 0
5	Safe input Safe-In 1	SI 1
6	Safe input Safe-In 2	SI 2
7	Safe input Safe-In 3	SI 3
8	Safe input Safe-In 4	SI 4
9	Safe input Safe-In 5	SI 5
10	Safe input Safe-In 6	SI 6
11	Safe input Safe-In 7	SI 7
12	Safe output Safe-Out 0 +	SO0 +
13	Safe output Safe-Out 0 -	SO0 -
14	Safe output Safe-Out 1 +	SO1 +
15	Safe output Safe-Out 1 -	SO1 -
16	24 V supply to the outputs	L+
17	GND	L-

13.3.6 Wiring Example

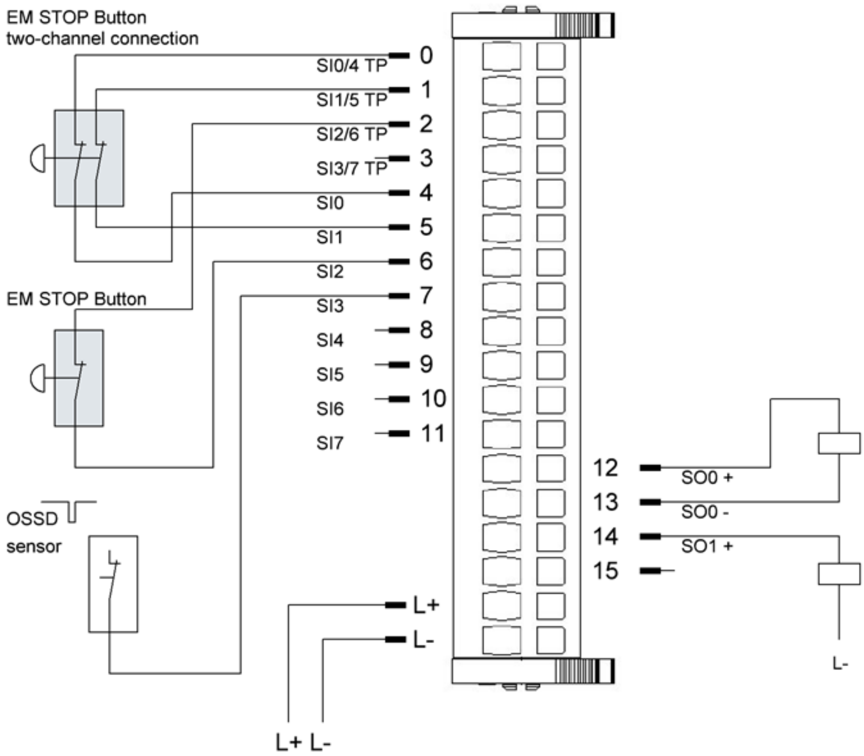


Figure 2: Example of how to wire the inputs and outputs

The Safety I/O-module is intended to provide functional safety to industrial automation and to protect humans and machines in conformity with Machinery Directive 2006/42/EC [UKCA S.I. 2008/1597].

It therefore supports the connection of many different safety-related sensors.

Examples:

- Single-channel and two-channel contact-type sensors such as EMERGENCY STOP button
- Sensors with single and two-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, see section ► 12.5.4 Safe Digital Outputs.

> **I**
>
> ***Note, information***
>
> Refer to ► section 0 Connection Examples for examples of how to connect various sensors and actuators.

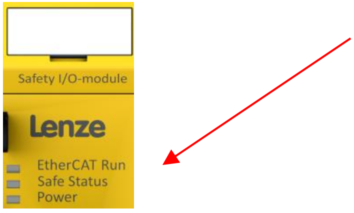
CAUTION

Safe function jeopardised by cross-faults
Improper installation may cause malfunctions due to cross-faults at the contacts When test pulses are enabled, the Safety I/O-module will detect cross-faults between the inputs / outputs and other signal lines 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.

13.4 Indicators and Controls

13.4.1 LED "EtherCAT Run"

LED "EtherCAT Run" indicates the state of EtherCAT communication.



LED "EtherCAT Run"		
LED	**State**	**Explanation / State**
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, on	Op	Operational, unrestricted data exchange

13.4.2 LED "Safe Status"

Duo LED safe "status" indicates the state of the module regarding its safety function.

LED "Safe Status"		
LED	**State**	**Explanation**
Green, on	OK	Safety I/O provides safe functionality
Red, on	Error	Safety I/O in fail-safe state

13.4.3 LED "Power"

LED "Power" indicates the state of the power supply to Lenze's Safety I/O-module module.

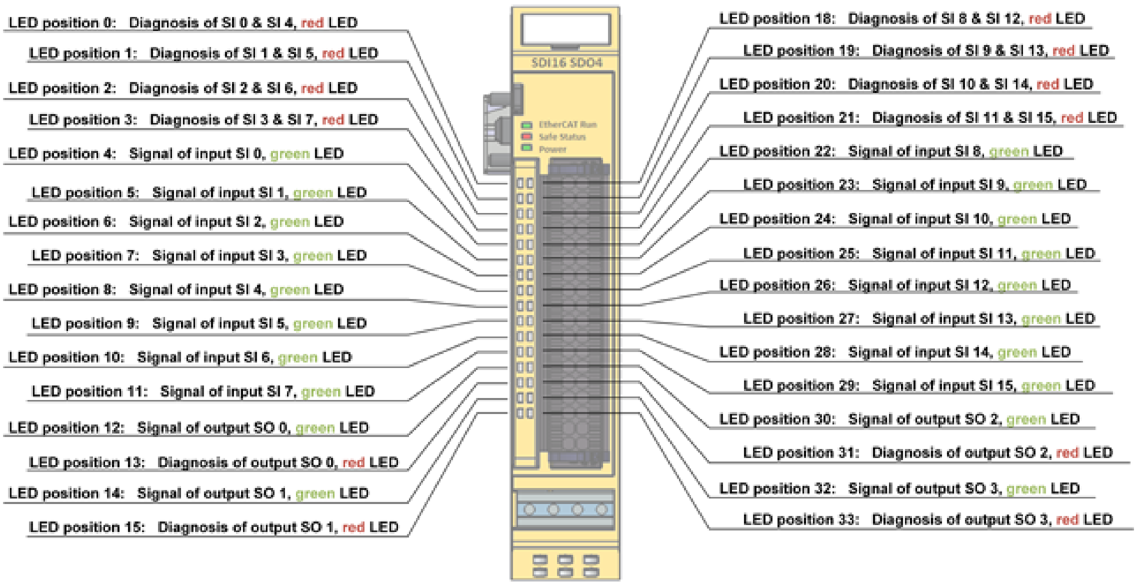
LED "Power"	State	Explanation
Off		**No power supplied to the module.**
Red on	Error	Wrong power supplied to the module. ≤ 18.5 V or ≥ 29.45 V
Green, on	OK	Correct voltage of 24 VDC -15% / +20% supplied to the module.

> **I** ***Note, information***
>
> Lenze's Safety I/O-module module features a high/low voltage watchdog for the 24 VDC supply voltage.
> Its fail-safe state is enabled at voltages above typ. 29.45 V or below typ. 18.5 V.

13.4.4 LEDs "Channel"

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

"Channel" LEDs of Safety I/O-module SDI16 / SDO4



LEDs "Channel"; Safe digital inputs SI 0 .. SI 7				
LED position	**Channel**	**Function**	**LED**	**Explanation**
0	Inputs SI 0 & SI 4	SI 0 & SI 4 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault at SI 0 or SI 4
1	Inputs SI 1 & SI 5	SI 1 & SI 5 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault at SI 1 or SI 5
2	Inputs SI 2 & SI 6	SI 2 & SI 6 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault at SI 2 or SI 6
3	Inputs SI 3 & SI 7	SI 3 & SI 7 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault at SI 3 or SI 7
4	Input SI 0	SI 0 state	Off	No valid input signal on channel 0, logical "0"
			Green	24 VDC supplied to channel 0, logical "1"
5	Input SI 1	SI 1 state	Off	No valid input signal on channel 1, logical "0"
			Green	24 VDC supplied to channel 1, logical "1"
6	Input SI 2	SI 2 state	Off	No valid input signal on channel 2, logical "0"
			Green	24 VDC supplied to channel 2, logical "1"
7	Input SI 3	SI 3 state	Off	No valid input signal on channel 3, logical "0"
			Green	24 VDC supplied to channel 3, logical "1"
8	Input SI 4	SI 4 state	Off	No valid input signal on channel 4, logical "0"
			Green	24 VDC supplied to channel 4, logical "1"

LEDs "Channel"; Safe digital inputs SI 0 .. SI 7				
LED position	**Channel**	**Function**	**LED**	**Explanation**
9	Input SI 5	SI 5 state	Off	No valid input signal on channel 5, logical "0"
			Green	24 VDC supplied to channel 5, logical "1"
10	Input SI 6	SI 6 state	Off	No valid input signal on channel 6, logical "0"
			Green	24 VDC supplied to channel 6, logical "1"
11	Input SI 7	SI 7 state	Off	No valid input signal on channel 7, logical "0"
			Green	24 VDC supplied to channel 7, logical "1"
18	Inputs SI 8 & SI 12	SI 8 & SI 12 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 8 or SI 12
19	Inputs SI 9 & SI 13	SI 9 & SI 13 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 9 or SI 13
20	Inputs SI 10 & SI 14	SI 10 & SI 14 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 10 or SI 14
21	Inputs SI 11 & SI 15	SI 11 & SI 15 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 11 or SI 15
22	Input SI 8	SI 8 state	Off	No valid input signal on channel 8, logical "0"
			Green	24 VDC supplied to channel 8, logical "1"
23	Input SI 9	SI 9 state	Off	No valid input signal on channel 9, logical "0"
			Green	24 VDC supplied to channel 9, logical "1"
24	Input SI 10	SI 10 state	Off	No valid input signal on channel 10, logical "0"
			Green	24 VDC supplied to channel 10, logical "1"
25	Input SI 11	SI 11 state	Off	No valid input signal on channel 11, logical "0"
			Green	24 VDC supplied to channel 11, logical "1"
26	Input SI 12	SI 12 state	Off	No valid input signal on channel 12, logical "0"
			Green	24 VDC supplied to channel 12, logical "1"
27	Input SI 13	SI 13 state	Off	No valid input signal on channel 13, logical "0"
			Green	24 VDC supplied to channel 13, logical "1"
28	Input SI 14	SI 14 state	Off	No valid input signal on channel 14, logical "0"
			Green	24 VDC supplied to channel 14, logical "1"
29	Input SI 15	SI 15 state	Off	No valid input signal on channel 15, logical "0"
			Green	24 VDC supplied to channel 15, logical "1"

I

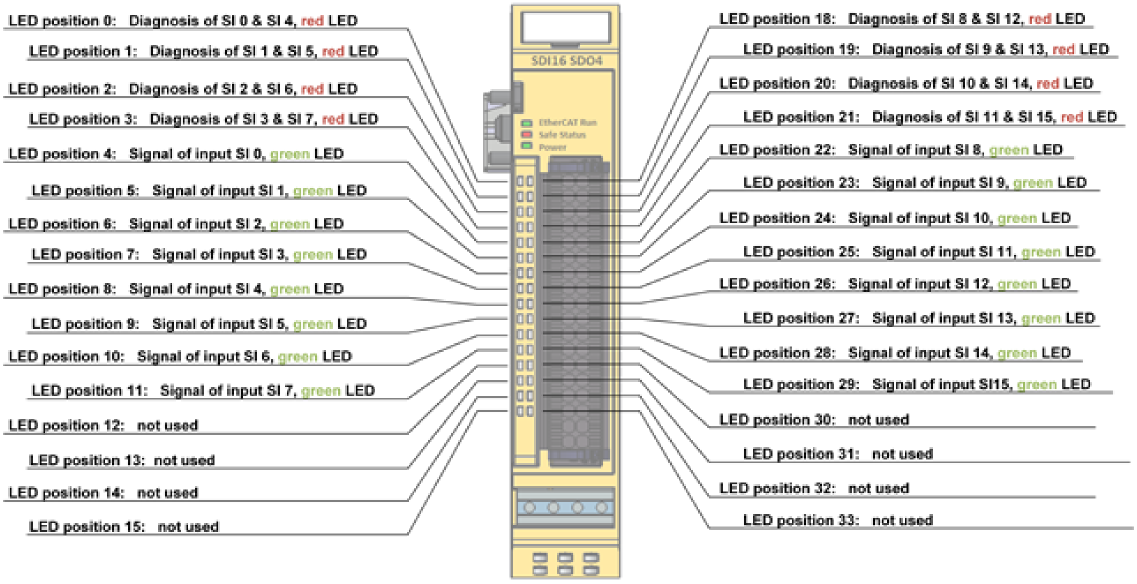
Note, information

⇨ 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 VDC signal at an input even if that input has not been set up in the configuration.

LEDs "Channel"; Safe digital outputs SO 0 and SO 1				
LED position	**Channel**	**Function**	**LED**	**Explanation**
12	Output SO 0	Status	Off	No output signal at output 0, logical "0"
			Green	Output signal at output 0, logical "1"
13		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
14	Output SO 1	Status	Off	No output signal at output 1, logical "0"
			Green	Output signal at output 1, logical "1"
15		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
30	Output SO 2	Status	Off	No output signal at output 2, logical "0"
			Green	Output signal at output 2, logical "1"
31		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
32	Output SO 3	Status	Off	No output signal at output 3, logical "0"
			Green	Output signal at output 3, logical "1"
33		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault

"Channel" LEDs of Safety I/O-module SDI16



LEDs "Channel"; Safe digital inputs SI 0 .. SI 7				
LED position	**Channel**	**Function**	**LED**	**Explanation**
0	Inputs SI 0 & SI 4	SI 0 & SI 4 Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault at SI 0 or SI 4
1	Inputs SI 1 & SI 5	SI 1 & SI 5 diagnosis	Off	Normal operation
			Red	External power supply or cross-fault at SI 1 or SI 5
2	Inputs SI 2 & SI 6	SI 2 & SI 6 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 2 or SI 6
3	Inputs SI 3 & SI 7	SI 3 & SI 7 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 3 or SI 7
4	Input SI 0	SI 0 state	Off	No valid input signal on channel 0, logical "0"
			Green	24 VDC supplied to channel 0, logical "1"
5	Input SI 1	SI 1 state	Off	No valid input signal on channel 1, logical "0"
			Green	24 VDC supplied to channel 1, logical "1"
6	Input SI 2	SI 2 state	Off	No valid input signal on channel 2, logical "0"
			Green	24 VDC supplied to channel 2, logical "1"
7	Input SI 3	SI 3 state	Off	No valid input signal on channel 3, logical "0"
			Green	24 VDC supplied to channel 3, logical "1"
8	Input SI 4	SI 4 state	Off	No valid input signal on channel 4, logical "0"
			Green	24 VDC supplied to channel 4, logical "1"
9	Input SI 5	SI 5 state	Off	No valid input signal on channel 5, logical "0"
			Green	24 VDC supplied to channel 5, logical "1"
10	Input SI 6	SI 6 state	Off	No valid input signal on channel 6, logical "0"
			Green	24 VDC supplied to channel 6, logical "1"

LEDs "Channel"; Safe digital inputs SI 0 .. SI 7				
LED position	**Channel**	**Function**	**LED**	**Explanation**
11	Input SI 7	SI 7 state	Off	No valid input signal on channel 7, logical "0"
			Green	24 VDC supplied to channel 7, logical "1"
18	Inputs SI 8 & SI 12	SI 8 & SI 12 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 8 or SI 12
19	Inputs SI 9 & SI 13	SI 9 & SI 13 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 9 or SI 13
20	Inputs SI 10 & SI 14	SI 10 & SI 14 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 10 or SI 14
21	Inputs SI 11 & SI 15	SI 11 & SI 15 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 11 or SI 15
22	Input SI 8	SI 8 state	Off	No valid input signal on channel 8, logical "0"
			Green	24 VDC supplied to channel 8, logical "1"
23	Input SI 9	SI 9 state	Off	No valid input signal on channel 9, logical "0"
			Green	24 VDC supplied to channel 9, logical "1"
24	Input SI 10	SI 10 state	Off	No valid input signal on channel 10, logical "0"
			Green	24 VDC supplied to channel 10, logical "1"
25	Input SI 11	SI 11 state	Off	No valid input signal on channel 11, logical "0"
			Green	24 VDC supplied to channel 11, logical "1"
26	Input SI 12	SI 12 state	Off	No valid input signal on channel 12, logical "0"
			Green	24 VDC supplied to channel 12, logical "1"
27	Input SI 13	SI 13 state	Off	No valid input signal on channel 13, logical "0"
			Green	24 VDC supplied to channel 13, logical "1"
28	Input SI 14	SI 14 state	Off	No valid input signal on channel 14, logical "0"
			Green	24 VDC supplied to channel 14, logical "1"
29	Input SI 15	SI 15 state	Off	No valid input signal on channel 15, logical "0"
			Green	24 VDC supplied to channel 15, logical "1"

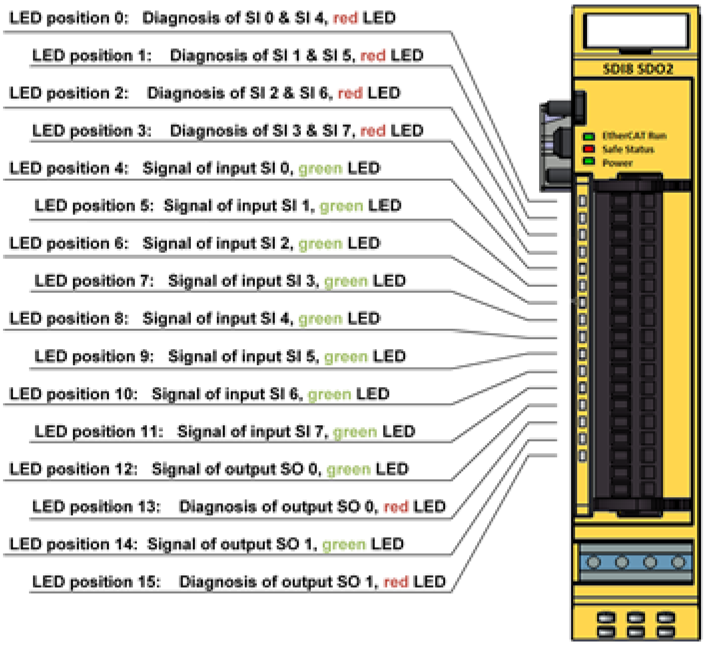
I

Note, information

⇨ 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 VDC signal at an input even if that input has not been set up in the configuration.

"Channel" LEDs of Safety I/O-module SDI8 / SDO2



LEDs "Channel"; Safe digital inputs SI 0 .. SI 7				
LED position	**Channel**	**Function**	**LED**	**Explanation**
0	Inputs SI 0 & SI 4	SI 0 & SI 4 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 0 or SI 4
1	Inputs SI 1 & SI 5	SI 1 & SI 5 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 1 or SI 5
2	Inputs SI 2 & SI 6	SI 2 & SI 6 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 2 or SI 6
3	Inputs SI 3 & SI 7	SI 3 & SI 7 diagnosis	Off	Normal operation
			Red	Cross-fault or external power to SI 3 or SI 7
4	Input SI 0	SI 0 state	Off	No valid input signal on channel 0, logical "0"
			Green	24 VDC supplied to channel 0, logical "1"
5	Input SI 1	SI 1 state	Off	No valid input signal on channel 1, logical "0"
			Green	24 VDC supplied to channel 1, logical "1"
6	Input SI 2	SI 2 state	Off	No valid input signal on channel 2, logical "0"
			Green	24 VDC supplied to channel 2, logical "1"
7	Input SI 3	SI 3 state	Off	No valid input signal on channel 3, logical "0"
			Green	24 VDC supplied to channel 3, logical "1"
8	Input SI 4	SI 4 state	Off	No valid input signal on channel 4, logical "0"
			Green	24 VDC supplied to channel 4, logical "1"

LEDs "Channel"; Safe digital inputs SI 0 .. SI 7				
LED position	**Channel**	**Function**	**LED**	**Explanation**
9	Input SI 5	SI 5 state	Off	No valid input signal on channel 5, logical "0"
			Green	24 VDC supplied to channel 5, logical "1"
10	Input SI 6	SI 6 state	Off	No valid input signal on channel 6, logical "0"
			Green	24 VDC supplied to channel 6, logical "1"
11	Input SI 7	SI 7 state	Off	No valid input signal on channel 7, logical "0"
			Green	24 VDC supplied to channel 7, logical "1"

I

Note, information

⇨ 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 VDC signal at an input even if that input has not been set up in the configuration.

LEDs "Channel"; Safe digital outputs SO 0 and SO 1				
LED position	**Channel**	**Function**	**LED**	**Explanation**
12	Output SO 0	Status	Off	No output signal at output 0, logical "0"
			Green	Output signal at output 0, logical "1"
13		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault
14	Output SO 1	Status	Off	No output signal at output 1, logical "0"
			Green	Output signal at output 1, logical "1"
15		Diagnosis	Off	Normal operation
			Red	External power supply or cross-fault

13.5 Operating Software

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

14 Installation and Operation

Before installing the Lenze Safety I/O-modules, verify that it has been transported and stored at the ambient conditions specified in sections ▶ 12.10 Transport and Storage and ▶ 12.5 Technical Data.

Module operation is subject to the service conditions specified in section ▶12.5 Technical Data.

> ***CAUTION***
>
> **Inappropriate operation**
> Malfunction of Lenze's Safety I/O-module module
> ⇨ Only persons qualified for dealing with safety matters are allowed to add, replace and put Safety I/O Modules into operation.
> ⇨ Before installing, servicing or putting Safety I/O-module Module into service, please also read the safety information in the preface of this document.
> ⇨ Before putting the unit into service, verify that all safety functions work as specified.

14.1 General Notes 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 (same as VDE 0113).

> ***Note, information***
>
> In order to safely install Lenze's c250-S Safety System, please read section ▶ 10.2.7 Project Planning and Installation and following.

Interference emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

> ***Note, information***
>
> If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.

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

Note, information

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 noise voltages are limited to tolerable levels.

Electrical immission safeguard

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

Cable routing and wiring

Keep power circuits separate from control circuits:

- DC voltages 60 V ... 400 V
- AC voltages 25 V ... 400 V

Common laying of control circuits is possible in the following cases:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- unshielded DC voltages < 60 V
- unshielded AC voltages < 25 V

CAUTION

The safe wiring method depends on the application

The safety function may be lost

Safely wire up the signal lines if the application requires it. Take heed of the information in ► section 0.

Location of installation

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

Please also note ►14.2 Mechanical Installation.

Temperature

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use suitable casings 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 extra voltages to a minimum.

Reducing elements may be diodes, Z-diodes, varistors or RC elements. Their rating should conform to the specifications provided by the manufacturer or supplier of the actuators.

14.2 Mechanical Installation

Environment of installation

Protect Lenze Safety I/O-module against inadmissible contamination. Do not allow the units to contaminate more than specified for degree II in IEC 60664-3.

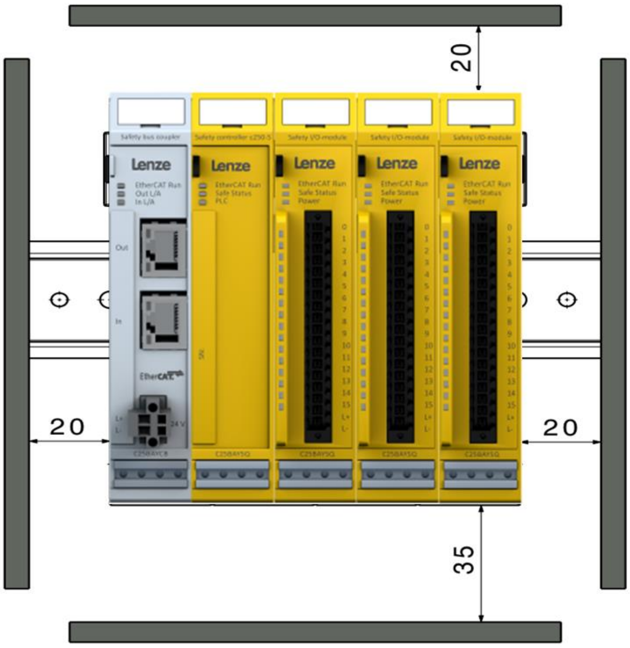
Whereas an enclosure providing IP 54 protection (e.g. an appropriate control cabinet) ensures that degree of contamination II is complied with, please consider that operation under condensing humidity is NOT allowed.

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

14.2.1 Mounting Position

Lenze Safety I/O-module mount on 35 mm rails to EN 50022. Mount the rail horizontally and make sure that the modules' multiple socket connectors are pointing away from the wall. To ensure that enough air gets in 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.



CAUTION

Do not operate the Safety I/O-module module out of the specified range
Faults by component overload caused by excessive temperature
Operate the module under the ambient conditions listed in section Technical Data only while observing the derating of the outputs – see ► section 14.3.10.

14.2.2 Order of Safety I/O-modules in c250-S Systems

Power to the logic circuitry of the safe I/O modules is drawn from the 5 V of the backplane bus. Withdrawing the required current will also provoke a drop in the backplane bus voltage. The more modules there are on the backplane bus, the further the voltage may drop. The safe I/O modules monitor the 5 V supply to the logical circuit and change to the safe state when there is not enough voltage for sustained operation. Remember the fact when installing the system.

> **I** ***Note, information***
>
> **Order of modules in c250-S systems**
> In order to ensure that the entire c250-S system works properly, arrange the c250-S 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 head module's maximum bus load.
> If possible, place the Safety I/O-module immediately next to the head module.

> **I** ***Note, information***
>
> Stick to the order of modules set in PLCDesigner because it will otherwise be impossible to get the system operational.

14.2.3 Snapping on a Single Module

- Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
- Push the top of the module against the mounting wall until it snaps in.

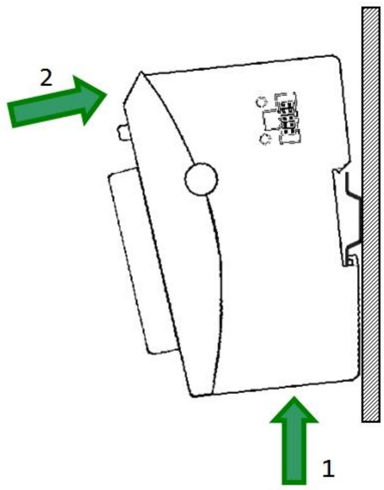


Figure 3: Rail mounting of module

14.2.4 Interconnecting Two Modules

- After snapping on the first module to the rail, snap on the second module about 1 cm away towards the right of the first module.
- Push the second module along the rail towards the first module until you hear the locking device snap in. Correctly mounting the modules is the only way of ensuring that the system works properly.
- To prevent inadmissible contamination, mount the cover of the module bus connectors on the rightmost module of the c250-S system.

> ***CAUTION***
>
> **Short circuit fault of module bus contacts**
> A short 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 c250-S system.

14.2.5 Disconnecting Two Modules

- Push down the unlock button (see Figure 4) of the module that you wish to disconnect from the module to the left of it.
- With the button still pressed, push both modules away from one another until they are about 1 cm apart.

14.2.6 Taking Down a Single Module

- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module away from the rail as shown in the illustration.
- Pull the module down and out of the mounting rail.

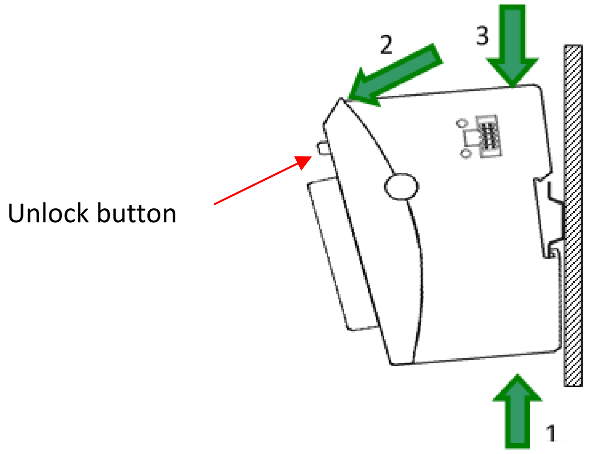


Figure 4: Uninstalling a module

14.3 Electrical Installation

WARNING

Potentially hazardous failures due to wrong voltages supplied
Supplying the wrong 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 VDC to
  - the I/Os of Safety I/O-module
  - the bus couplers or compact PLCs that Safety I/O-modules are connected to
  - the sensors and actuators connected to the Safety I/O-modules.
- ⇨ Check that your upstream bus coupler or the compact PLC is protected against reversing the 24 V supply voltage.
- ⇨ 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 case of a fault, a maximum voltage of U max. < 33 V may be supplied to these assemblies.
- ⇨ Do not reuse but replace units operated on voltages > 33 V because such voltages may irreversibly damage the unit.
- ⇨ 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 block of c250-S modules.
- ⇨ Use for the c250-S Modules and for each actuator a separate GND line to a common GND potential rail and **no** GND sum lines.

CAUTION

Danger caused by improper installation under voltage
Failure of Lenze’s Safety I/O-module module
Always de-energise Lenze’s Safety I/O-module module before installing it.

14.3.1 Earthing

WARNING

Danger of malfunction caused by EMC interference!
Improperly installing the modules may provoke malfunction of the modules by EMC interference.
Preventive measures:

- ⇨ Properly earth the module.
- ⇨ Look at the entire chain, i.e.: earth the module, DIN rail, electrical cabinet etc.
- ⇨ Check the earthing in conformity with VDE 0100.

Connect the c250-S modules to earth by attaching the metal housing to functional earth. Since the functional earth connector dissipates HF and surge currents, it is of utmost importance for the module's noise immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to a functional earth connector. 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.

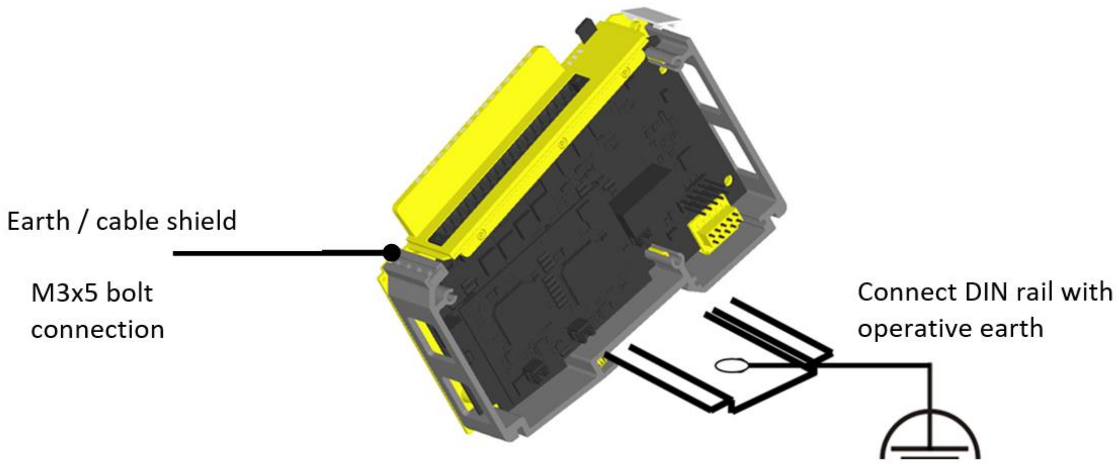


Figure 5: Aluminium profile in the Safety I/O-module

> **I** ***Note, information***
>
> Earth wires should be short and have a large surface (copper mesh). Refer to http://de.wikipedia.org/wiki/ground_(electronics) for further details

> **I** ***Note, information***
>
> When installing production or other lines, measure the earth potential of the DIN rail as specified in the applicable guidelines (earth test to VDE 0100). Measuring the earth potntial must show that every protective earthing and operational earthing is within the boundaries set by the applicable standards. Also consider the repeat testing frequency resulting from the hazard assessment.

14.3.2 Ground connection

When connecting the ground potential (GND or "L-") of the module and the connected actuators, the following instructions must be observed:

- Use a separate GND line for each actuator to a common GND potential rail and no GND sum lines which can cause a critical error for two or more actuators due to a single error.
- Non-safety-relevant output modules and their actuators must be routed to the GND potential rail via their own GND line and must not share a GND line with safety-relevant functions!
- Ensure a safe connection of the module GND potential ("L-", pin 17 and pin 35 of the front connector of the modules) with the GND potential rail.

Observe these instructions when connecting the actuator. See section 14.3.9 and the warnings there.

> ***CAUTION***
>
> **Ground breaking of the load can lead to safety-critical reverse currents**
> A ground fault of one or more loads at the same time can lead to a dangerous state that switches on the loads, taking into account the possible reverse currents 200mA (typ.) into the output.
> If a reverse supply of 200mA (typ.) can activate the load, follow the instructions in this chapter (14.3.2).

14.3.3 Module Interconnection

The c250-S modules electrically connect by completely pushing the modules together. This automatically connects the modules to both the EtherCAT bus and the system power supply. If possible, place the Safety I/O-module immediately next to the head module. Refer to section ► 14.1 General Notes on Installation for details about how to interconnect two modules.

Please note that the maximum current supplied by the bus coupler limits the number of c250-S modules you may connect to a single block.

14.3.4 System Power Supply

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

> ***Note, information***
>
> Please take note of 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 guide.

14.3.5 I/O Supply

The I/O supply of the safe outputs and the associated test pulse outputs connects to terminals L+ and L-. The supply voltage is rated at 24 VDC. It is monitored. In case of overvoltage (> +27.5%) and low voltage (> -25%) alike, the module changes to its safe state.

The cord must have external protection against short circuit and overload triggering at max. 10 A.

Power to Safety I/O-module may be supplied by PELV/SELV-ready 24 VDC power supply units to EN50178 / EN60950-1 only. This applies to both the system power supply ► 14.3.4 System Power Supply and the I/O supply ► 14.3.5 I/O Supply.

CAUTION

Module defect by reversing the polarity of the voltage supplied
Although Lenze's Safety I/O-module 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.
⇨ Before starting to operate the module, check its wiring for a potentially wrongly connected I/O power supply.

Note, information

Module response to brief voltage interruptions

Lenze's Safety I/O-module module permanently monitors the I/O power and the states of all inputs and outputs. Voltage interruptions will change the state of the outputs which, in turn, will provoke the fail-safe state because voltage interruptions cannot be distinguished from other faults.

Voltage interruptions may have a severity of up to level PS1 (1 ms).

You can reset the module if the supply voltage fails completely (see ▶ section 14.6.5 Wrong Supply Voltage).

In case the supply of power is interrupted the module will change to the safe state and output the appropriate error code to the service block ▶ 14.6.7 Error Codes.

Refer to section ▶ 14.6 Diagnosis for further details on how the module responds to a non-conforming supply of power.

I/O power **supply fusing**

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

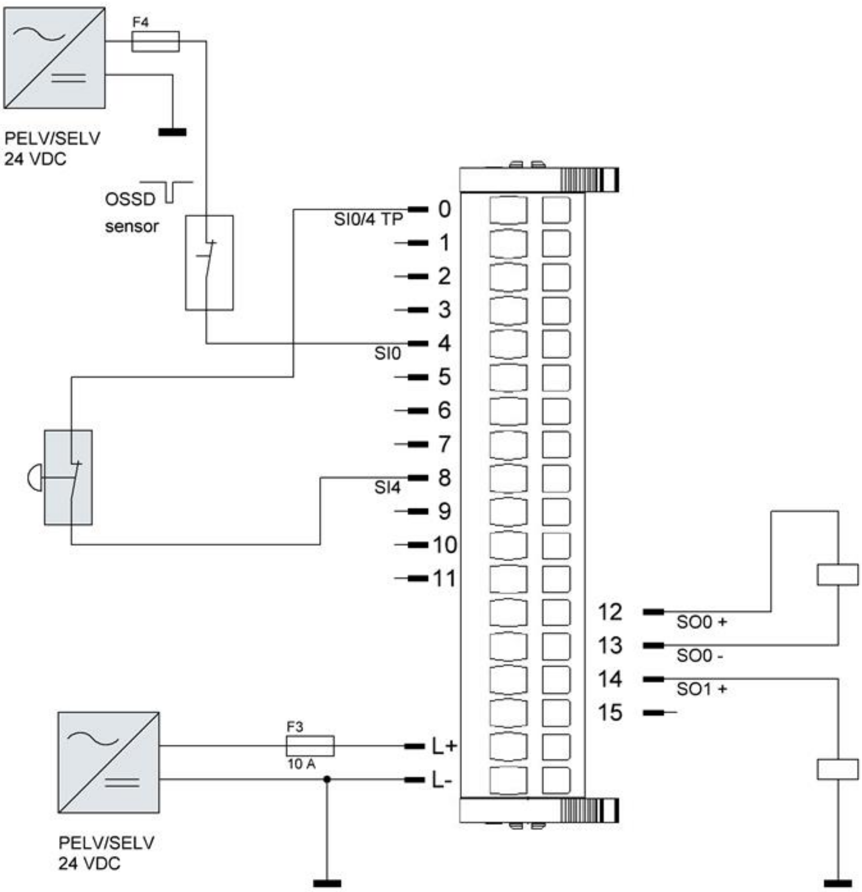
WARNING

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 triggering at max. 10 A.

14.3.6 Sensor and Actuator Power Supply

All sensors and actuators of the Safety I/O-module system supplied with power from an external source must still run on safe low operating voltage (SELV/PELV). This power may also be fed to the I/Os of the Safety I/O-module module.

14.3.7 Power Supply Wiring Example



14.3.8 Sensor Connection

The Safety I/O-module modules accept contact-type sensors connected to the module's own test pulse outputs or external sensors equipped with OSSD outputs. Choose the type of sensor when configuring the module refer to section ▶ 14.4.3 Input Parameters.

You may also set the parameters to completely disabling the inputs. If so, they will always return logical null to the safe PLC, i.e. irrespective of the voltage supplied to the input.

I

Note, information

Note on configuring the inputs
Specifically configured inputs (e.g. inputs set up for external sensors (External Inputs parameter) or mode selector = on) are expected to be actually used by the application. Therefore, you may not also disable such inputs in the configuration ("Input not used"). If you do, the module will discover a bad configuration.

General safety information on using the inputs

> ***WARNING***
>
> Non-detection of a corrupt external wiring when test pulse outputs are disabled
> Unsafe machine state, safety hazard
> You may use parameter External Inputs to set up the safe module inputs for external sensors. Such inputs will neither be expected to send test pulses nor will they be checked for such pulses. Consequently, the external sensors must provide means of detecting wiring corruptions. Using passive safety switchgear without test pulses will make it impossible to detect external wiring corruptions.
>
> ⇨ Always use the correct and enabled test pulse output to supply power to contact-type sensors.
>
> ⇨ Do not link inputs to the associated test pulse output if they are set up for external sensors by parameter External Inputs because such inputs will ignore the test pulses and therefore render the functional safety ineffective.

> ***WARNING***
>
> **Do not directly link the module inputs to the 24 V power supply**
> Safety hazard.
> Increased EMC noise levels on the supply lines may provoke malfunctions of the inputs. Without test pulses, cross-faults between the inputs cannot be detected. In general, use of the safe inputs is only permitted with the module's own test pulse outputs, with OSSD outputs from external sensors or with digital outputs from controllers.

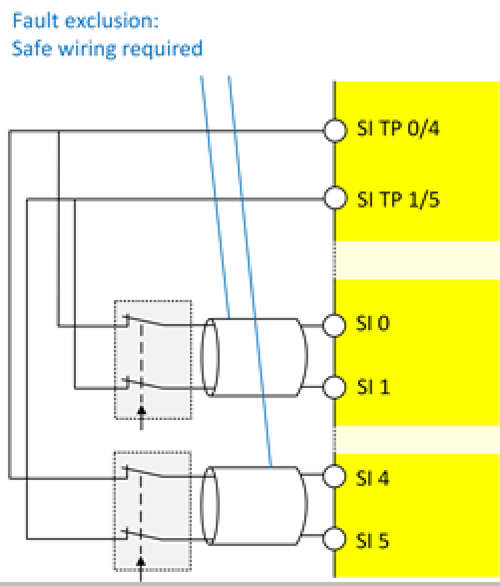
> ***CAUTION***
>
> **Safe function jeopardised by cross-faults with other modules**
> Improper installation in conjunction with other modules may cause malfunctions due to cross-faults at the contacts
> When test pulses are enabled, the Safety I/O-module will detect cross-faults between the inputs / outputs and other signal lines 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.

> ***CAUTION***
>
> No wiring of disabled or inactive test pulse outputs
> Connected inputs may turn on inadvertently or the safety function may be installed wrongly.
>
> ⇨ Test pulse outputs both of whose inputs have been disabled or have been set up for external sensors (External Inputs parameters) turn off.
>
> ⇨ Do not wire up test pulse outputs not used for a safety function.
>
> ⇨ The test pulse outputs are solely designed for the function with the associated safe inputs.

CAUTION

Safe wiring required
A cross-fault between a safe input and the associated test pulse signal will reduce the two-channel characteristic when assessing initial faults.
Example #1: A cross-fault between safe input "Safe-In 0" and the associated test pulse output "Safe In 0/4 TP" will be considered a steadily running piece of safety switchgear and, thus, as an active safe input.
Example #2: A cross-fault between safe input "Safe-In 0" and another safe input "Safe In 4" supplied by the same associated test pulse signal will also be considered a steadily running piece of safety switchgear and, thus, as an active safe input.
The application must prevent both cases because they will both lead to the safe module not being detected.

⇨ Prevent cross-faults by safely wiring up the lines.

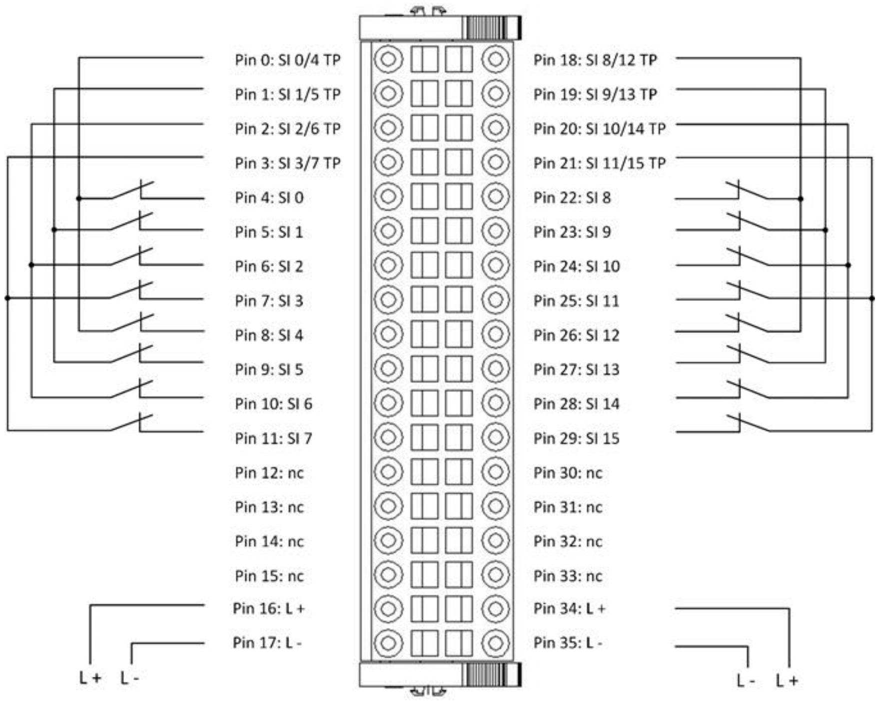


⇨ Another option of detecting potential wiring faults is to periodically test the safety function by operating the safety switchgear. This requires the operator to make the required test and repeat it at sufficiently close intervals.

Allocation of safe outputs to the test pulse outputs

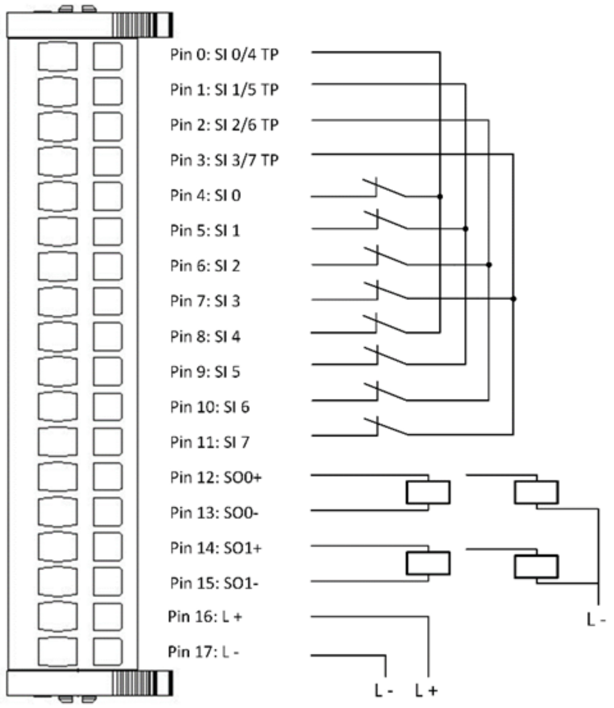
> ***CAUTION***
>
> **Do not use two inputs with the same test pulse signal for any one safety function**
>
> Faulty wiring will not be detected.
>
> ⇨ The inputs used for a safety function must not be supplied power from the same test pulse output.
>
> ⇨ Correct example: Use SI0 with SI 0/4 TP and SI1 with SI 1/5 TP for the same safety function.
>
> ⇨ Incorrect example: Use SI0 with SI 0/4 TP and SI4 with SI 0/4 TP for a safety function. (Impermissible!)

Allocation of safe inputs to the test pulse outputs (Safety I/O-module SDI16 and Safety I/O-module SDI16 SDO4 0.5A):



Connector X1		
Pin	**Function**	**Associated signal**
0	Test pulse output Safe-In 0/4 TP	Safe input Safe-In 0 – pin 4
		Safe input Safe-In 4 – pin 8
1	Test pulse output Safe-In 1/5 TP	Safe input Safe-In 1 – pin 5
		Safe input Safe-In 5 – pin 9
2	Test pulse output Safe-In 2/6 TP	Safe input Safe-In 2 – pin 6
		Safe input Safe-In 6 – pin 10
3	Test pulse output Safe-In 3/7 TP	Safe input Safe-In 3 – pin 7
		Safe input Safe-In 7 – pin 11
4	Safe input Safe-In 0	Test pulse output Safe-In 0/4 TP – Pin0
5	Safe input Safe-In 1	Test pulse output Safe-In 1/5 TP – Pin1
6	Safe input Safe-In 2	Test pulse output Safe-In 2/6 TP – Pin2
7	Safe input Safe-In 3	Test pulse output Safe-In 3/7 TP – Pin3
8	Safe input Safe-In 4	Test pulse output Safe-In 0/4 TP – Pin0
9	Safe input Safe-In 5	Test pulse output Safe-In 1/5 TP – Pin1
10	Safe input Safe-In 6	Test pulse output Safe-In 2/6 TP – Pin2
11	Safe input Safe-In 7	Test pulse output Safe-In 3/7 TP – Pin3
18	Test pulse output Safe-In 8/12 TP	Safe input Safe-In 8 – pin 22
		Safe input Safe-In 12 – pin 26
19	Test pulse output Safe-In 9/13 TP	Safe input Safe-In 9 – pin 23
		Safe input Safe-In 13 – pin 27
20	Test pulse output Safe-In 10/14 TP	Safe input Safe-In 10 – pin 24
		Safe input Safe-In 14 – pin 28
21	Test pulse output Safe-In 11/15 TP	Safe input Safe-In 11 – pin 25
		Safe input Safe-In 15 – pin 29
22	Safe input Safe-In 8	Test pulse output Safe-In 8/12 TP – Pin18
23	Safe input Safe-In 9	Test pulse output Safe-In 9/13 TP – Pin19
24	Safe input Safe-In 10	Test pulse output Safe-In 10/14 TP – Pin20
25	Safe input Safe-In 11	Test pulse output Safe-In 11/15 TP – Pin21
26	Safe input Safe-In 12	Test pulse output Safe-In 8/12 TP – Pin18
27	Safe input Safe-In 13	Test pulse output Safe-In 9/13 TP – Pin19
28	Safe input Safe-In 14	Test pulse output Safe-In 10/14 TP – Pin20
29	Safe input Safe-In 15	Test pulse output Safe-In 11/15 TP – Pin21

Allocation of safe inputs to the test pulse outputs (Safety I/O-module SDI8 / SDO2 0.5A):



Connector X1		
Pin	**Function**	**Associated signal**
0	Test pulse output Safe-In 0/4 TP	Safe input Safe-In 0 – pin 4
		Safe input Safe-In 4 – pin 8
1	Test pulse output Safe-In 1/5 TP	Safe input Safe-In 1 – pin 5
		Safe input Safe-In 5 – pin 9
2	Test pulse output Safe-In 2/6 TP	Safe input Safe-In 2 – pin 6
		Safe input Safe-In 6 – pin 10
3	Test pulse output Safe-In 3/7 TP	Safe input Safe-In 3 – pin 7
		Safe input Safe-In 7 – pin 11
4	Safe input Safe-In 0	Test pulse output Safe-In 0/4 TP – Pin0
5	Safe input Safe-In 1	Test pulse output Safe-In 1/5 TP – Pin1
6	Safe input Safe-In 2	Test pulse output Safe-In 2/6 TP – Pin2
7	Safe input Safe-In 3	Test pulse output Safe-In 3/7 TP – Pin3
8	Safe input Safe-In 4	Test pulse output Safe-In 0/4 TP – Pin0
9	Safe input Safe-In 5	Test pulse output Safe-In 1/5 TP – Pin1
10	Safe input Safe-In 6	Test pulse output Safe-In 2/6 TP – Pin2
11	Safe input Safe-In 7	Test pulse output Safe-In 3/7 TP – Pin3

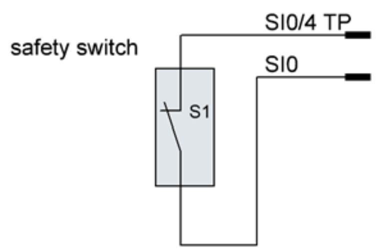
Single-channel contact-type sensor

> ***CAUTION***
>
> **Setting the Test Pulse Rate**
> In single-channel applications (inputs same as outputs), adapt the test pulse frequency to the application. In applications with frequent changes of state, the test pulse frequency should be at least 100x higher than the time of change of application state.
> In single-channel applications, the error response time of the inputs should be 3x the test pulse interval (25 Hz = 120 ms).
> Refer to section 6.4.2 "FSoE Parameters"

The inputs of single-channel contact-type sensors work entirely separate from one another. Wiring should take account of the fact that every input signal is allocated to a single test pulse output.

This allocation allows the system to detect cross-faults at the connector.

Use the configuration to separately enable each of the inputs ►14.4.3 Input Parameters.



Analysis of states

The module checks the states of the inputs and transfers the result to the safe control unit.

The process data image of a safe input transfers

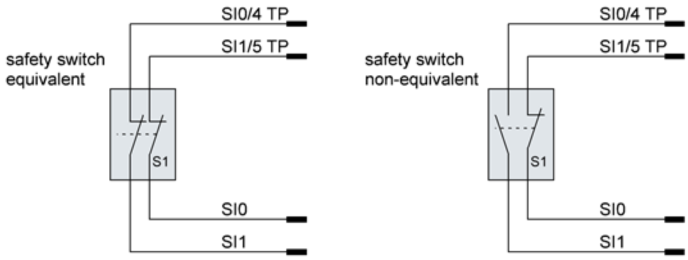
- "0" if a "0" signal is supplied to the input or if an error has been detected;
- "1" if a "1" signal is supplied to the input or if an error has not been detected.

Refer to section ► 15.1 Safety Function with Single-channel Input for connection examples.

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 configuration to enable the safe inputs you use ► 14.4.3 Input Parameters.



The process data image of a safe input transfers

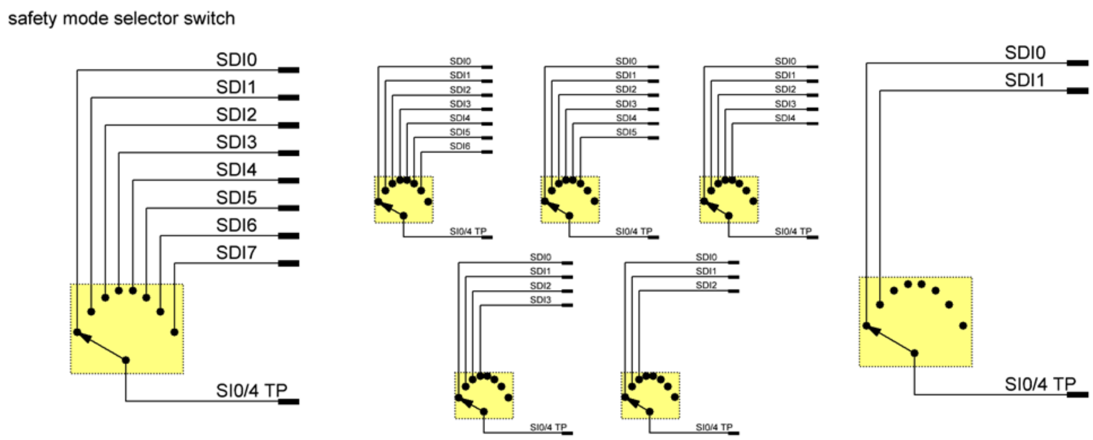
- "0" if a "0" signal is supplied to the input or if an error has been detected;
- "1" if a "1" signal is supplied to the input or if an error has not been detected.

Refer to section ► 15.2 Safety Function with Two-channel Input for connection examples.

Multi-channel contact-type sensors

Multi-channel switches such as mode selectors or switchgear with a "toggle" functionality connect to several safe inputs. Remember, though, that the correct function is provided only if test pulse outputs SI 0/4 TP and SI 8/12 TP (Safety I/O-module SDI16 SDO4 0.5A or Safety I/O-module SDI16) are used. Use the configuration to enable the safe inputs you use and parameter Rotary Switch to choose the mode selector function ▶ 14.4.3 Input Parameters and ▶ 15.4 Mode Selector, Rotary Table.

Switches with 2 to 8 channels can be analysed.



Allocation of safe inputs for the mode selector function		
No. of channels	**Safe inputs to use**	**Clock signal**
2	SI 0, SI 1	SI 0/4 TP
	SI 8, SI 9	SI 8/12 TP
3	SI 0, SI 1, SI 2	SI 0/4 TP
	SI 8, SI 9, SI 10	SI 8/12 TP
4	SI 0, SI 1, SI 2, SI 3	SI 0/4 TP
	SI 8, SI 9, SI 10, SI 11	SI 8/12 TP
5	SI 0, SI 1, SI 2, SI 3, SI 4	SI 0/4 TP
	SI 8, SI 9, SI 10, SI 11, SI 12	SI 8/12 TP
6	SI 0, SI 1, SI 2, SI 3, SI 4, SI 5	SI 0/4 TP
	SI 8, SI 9, SI 10, SI 11, SI 12, SI 13	SI 8/12 TP
7	SI 0, SI 1, SI 2, SI 3, SI 4, SI 5, SI 6	SI 0/4 TP
	SI 8, SI 9, SI 10, SI 11, SI 12, SI 13, SI14	SI 8/12 TP
8	SI 0, SI 1, SI 2, SI 3, SI 4, SI 5, SI6, SI7	SI 0/4 TP
	SI 8, SI 9, SI 10, SI 11, SI 12, SI 13, SI14, SI15	SI 8/12 TP

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

Note, information

Use of safe inputs along with the mode selector mode
Two safe inputs are allocated to every test pulse output. If a mode selector is used, you may still use inputs SI 4 and SI 12 (if available) with the associated test pulse output (SI 0/4 TP / SI8/12 TP).

PLCopen module "Mode Selector" or a similar module of the safe control unit is used for multi-channel analysis. The achievable category to EN ISO 13849-1 depends on the switching device's error model (e.g. mode selector) and must needs be analysed in conjunction with the PLCopen module's error detection.

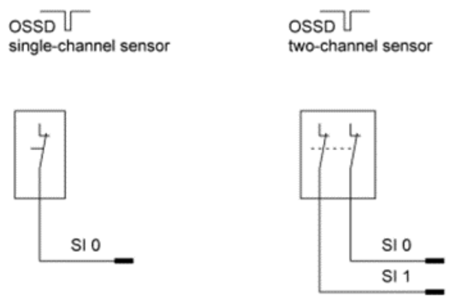
Refer to section ► 15.4 Mode Selector, Rotary Table for connection examples.

Note, information

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 diagnostic functions, the retrieval of signals by the sensor itself is able to detect cross-faults between the 24 V power supply and earth as well as cross-faults between the sensor signals.



Wiring of sensors providing OSSD signals

Two-channel sensors delivering OSSD signals can be connected to any safe input of the Safety I/O-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's test pulses. You must therefore set the input channels to "External Inputs" = 1 ▶ 14.4.3 Input Parameters. A safe input configured like that can no longer diagnose external faults such as cross-faults or supply of external power. The sensor connected to it must provide this function.

Use parameter "Input x filter time" to set the filter time of the digital inputs in case you are working with external safety sensors. You may have to modify the test pulse duration if the signals are affected by capacitive properties of the input circuit, for example.

CAUTION

Avoid the carrying over of voltages
Malfunction and module defects are likely.
To prevent that voltages are carried over, provide a low-impedance interconnection between GND and the chassis ground of the unit supplying power to the sensors and actuators and the unit supplying 24 VDC to the I/Os of the Safety I/O-module.

Note, information

Test pulse output signal of inputs set up for external sensors

Test pulse signals are no longer generated if both inputs allocated to the test pulse output have been set up for “Input External” or to "Input not used"

Pressure-sensitive mat, bumper

CAUTION

Lay the feed lines of pressure-sensitive mats and bumpers together
EMC interference may provoke malfunctions.
In order to avoid influences and malfunctions due to EMC effects, lay the four wires (e.g. Safe-In 0, Safe-In 0/4 TP, Safe-In 1, Safe-In 1/5 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

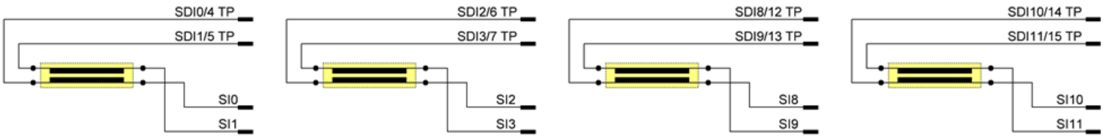
Safety function pressure-sensitive mat requires a response time of 25 ms
Avoid personal injury and damage to property
The pressure-sensitive mat function achieves a response time of 25 ms between a change in mat state and providing the information on the EtherCAT bus.

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. If so, the I/O module sends a null signal to the control unit.

Lenze’s Safety I/O-module module supports four-wire mats. Two safe digital inputs and the associated test pulse output are used for one mat / bumper.

You must use the configuration to enable the safe inputs you use and parameter Safety Mat to choose the bumper function ▶ 14.4.3 Input Parameters.

You may use up to two mat channels.



Allocation of safe inputs for the bumper function			
Parameters "Safety Mats 0" to "Safety Mats 3"		**Safe inputs to use**	**Test pulse output to use**
Safety Mats 0	0	Pressure-sensitive mat / bumper function 1 not selected	none
Safety Mats 0	1	SI 0 and SI 1	SI 0/4 TP and SI 1/5 TP
Safety Mats 1	0	Pressure-sensitive mat / bumper function 2 not selected	None
Safety Mats 1	1	SI 2 and SI 3	SI 2/6 TP and SI 3/7 TP
Safety Mats 2	0	Pressure-sensitive mat / bumper function 3 not selected	None
Safety Mats 2	1	SI 8 and SI 9	SI 8/12 TP and SI 9/13 TP
Safety Mats 3	0	Pressure-sensitive mat / bumper function 4 not selected	none
Safety Mats 3	1	SI 10 and SI 11	SI 10/14 TP and SI 11/15 TP

Safe inputs not needed for the pressure-sensitive mat may be used for external sensors.

I

Note, information

Use of safe inputs along with the pressure-sensitive mats / bumper
Two safe inputs are allocated to every test pulse output. If a pressure-sensitive mat / bumper is used, the inputs not involved in providing the function must not be allocated to the associated test pulse outputs but set up as External Inputs instead.

PLCopen module "SF_ESPE" or a similar module of the safe control unit is used for mat / bumper analysis. The achievable category to EN ISO 13849-1 depends on the switching device's error model and must needs be analysed in conjunction with the PLCopen module's error detection.

Refer to section ► 15.5 Safety Mats, Connecting Blocks and Bumpers for connection examples.

14.3.9 Actuator Connection

Resistive loads, inductive loads and resistive loads with some capacitive fractions can be connected to the digital power outputs of the Safety I/O-module module.

General safety information on using the outputs

CAUTION

A current of 200 mA (typ.) may be fed back to output SOX+ if external power is supplied and a cross-fault occurs. This fact should be considered when planning the safety function.

The module will recognise external power and cross-faults by the test pulses returned by all inputs and outputs. It will respond by enabling the safe state and turning off all outputs. External power or cross-faults at the outputs will cause current to flow into the module. If external power is supplied "downstream" the actuator (at the SOX connector), this may generate a current flow through the actuator and into the module, which may then activate an actuator.

Take the following precautions if a reverse flow of 200 mA (typ.) may activate the load:

⇨ Use a two-channel actuation of a safety function with two safe outputs. A supply of external power or a cross-fault will be detected and enable the safe state of all module outputs.

⇨ Ensure that the line between the SOX connector and the actuator is laid safely. Preventing external power or a cross-fault between the SOX connector and the actuator will also prevent a dangerous flow of current through the load.

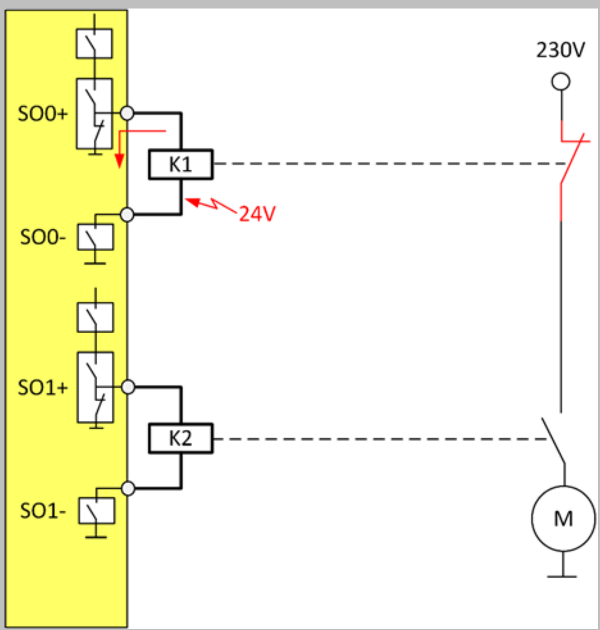


Figure 6: Reverse current potentially provoked by external power

---

CAUTION

A break of the load's ground connection may generate safety-critical reverse currents

Taking account of all contingent reverse currents, a break of the ground connection of one or several loads at the same time may turn on the load(s). Take the following precautions if a reverse flow of 200 mA (typ.) may activate the load:

⇨ Use a separate GND line for every actuator and connect it to a common GND potential busbar instead of connecting two or more actuators to the same GND line, along which a single fault may turn into a critical fault.

⇨ Output modules and their actuators not relevant to safety must link to the GND potential busbar through separate GND lines. They must not share the same GND line with functions relevant to safety!

⇨ Make sure that the module's GND potential ("L-", pins 17 and 35 of the connector at the front of the modules) safely links to the GND potential busbar.

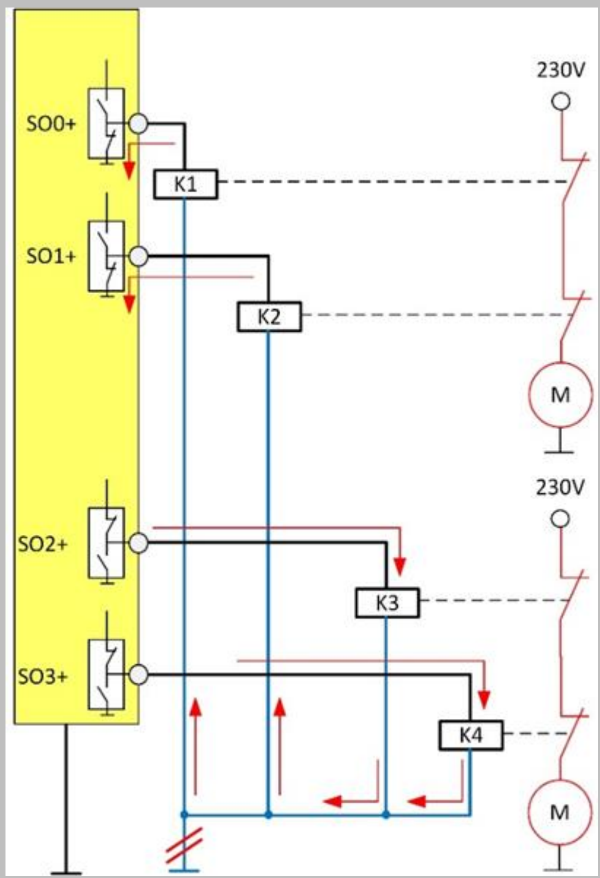


Figure 7: Dangerous state if the GND connection of several actuators is lost.

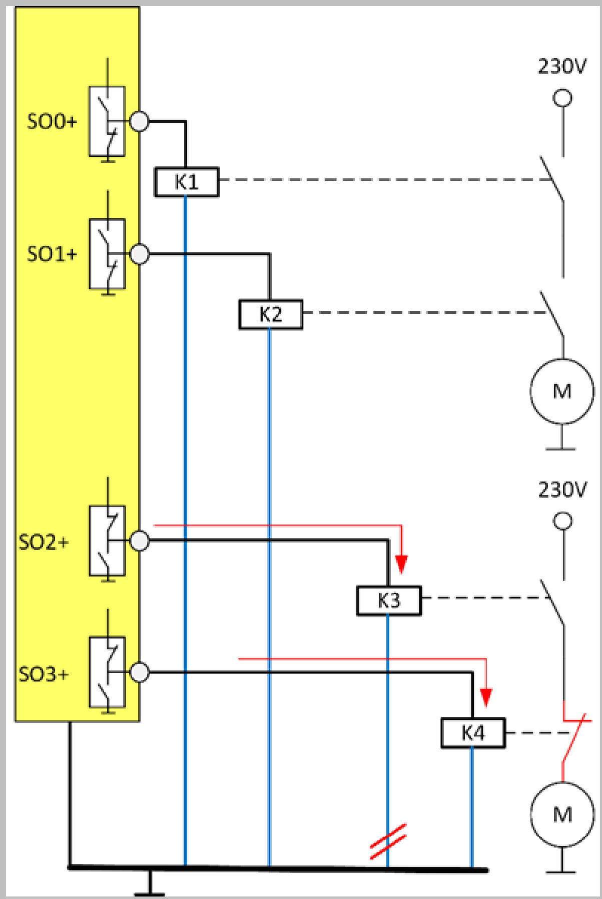


Figure 8: A GND potential busbar controls single faults and prevent current from flowing back into the module

---

CAUTION

External power from another network may provoke a defect of the safe I/O module

The outputs' test pulses can detect a cross-fault or external power supplied to the module outputs and set the module to a safe state. External power of a higher voltage supplied to the module from another network and through the outputs may cause current to flow into the module and destroy the it. Although this will jeopardise the availability of the module, the module will still achieve a safe state because the fault is detected and can be controlled safely.

⇨ Avoid the supply of external power from any source. Take particular care to safeguard the module against an external supply of higher mains voltages by implementing appropriate means in the application.

⇨ One such effective means could be to safely lay the output line.

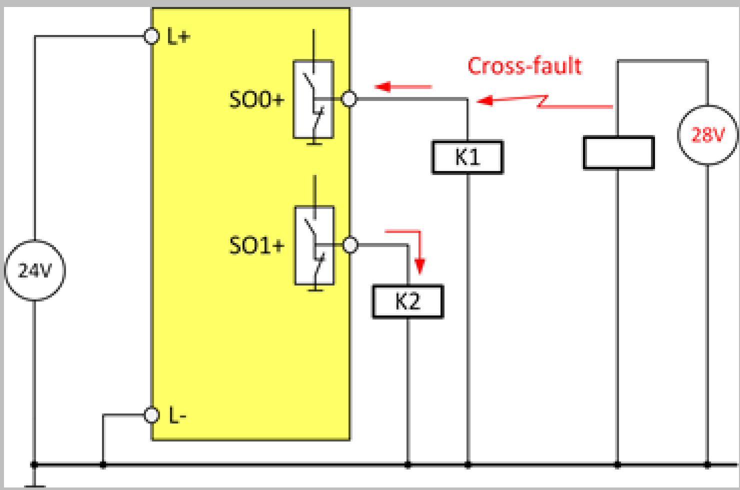


Figure 9: Avoid a supply of external power, particularly of higher mains voltages

CAUTION

Safe function jeopardised by cross-faults with other modules

Improper installation in conjunction with other modules may cause malfunctions due to cross-faults at the contacts

⇨ When test pulses are enabled, the Safety I/O-module will detect cross-faults between the inputs / outputs and other signal lines 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.

Output faults

Note, information

Faults at the outputs provoke a change to the fail-safe state - external fault
The outputs are protected against overload and short circuit, see section ► 12.5.4 Safe Digital Outputs for details. Overload and short circuit cause the module to change to its fail-safe state - external fault. The module responds in the same way to external power fed to and cross-faults at the outputs. In case the outputs are badly adapted to the loads (e.g. if a capacity is too high), test pulse may not be detected and cause the module to change to its fail-safe state.

Actuators with active GND reference

As long as the parameter settings are taken into account, you are free to connect actuators to both output connectors (SOX+ and SOX-). This allows external power and cross-faults at the positive load connectors to be controlled by opening the module's GND reference.

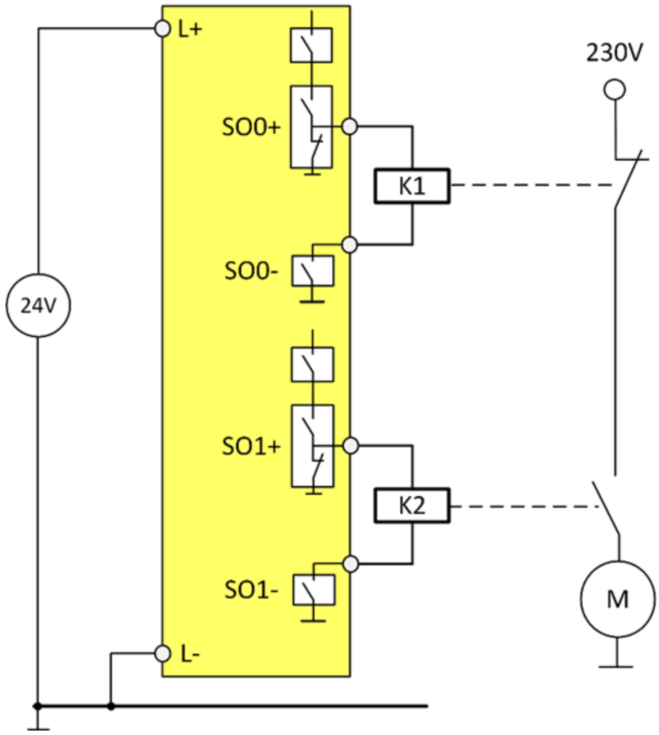


Figure 10: Actuators with active GND reference

CAUTION

Wrong use of the module outputs

Incorrect start of the safety function!

⇨ Do not use the module's SOX connectors to actuate the loads of a safety function.

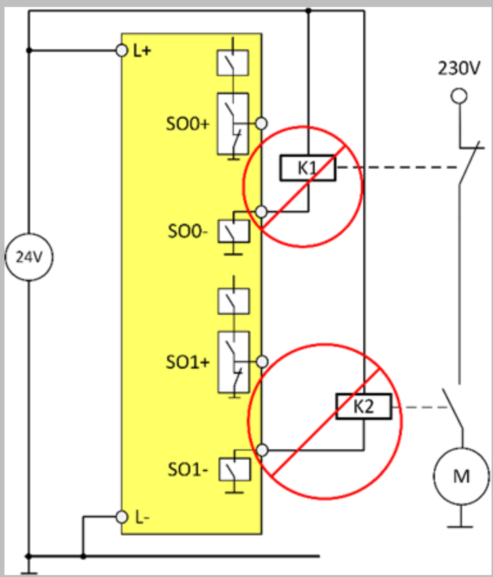


Figure 11: Do not use the SOX connectors to actuators any of the actuators.

⇨ The module will prevent sustained operation.

Actuators with external GND reference

Provided that the configuration is taken account of, actuators with external GND reference can be connected to the Safety I/O-module.

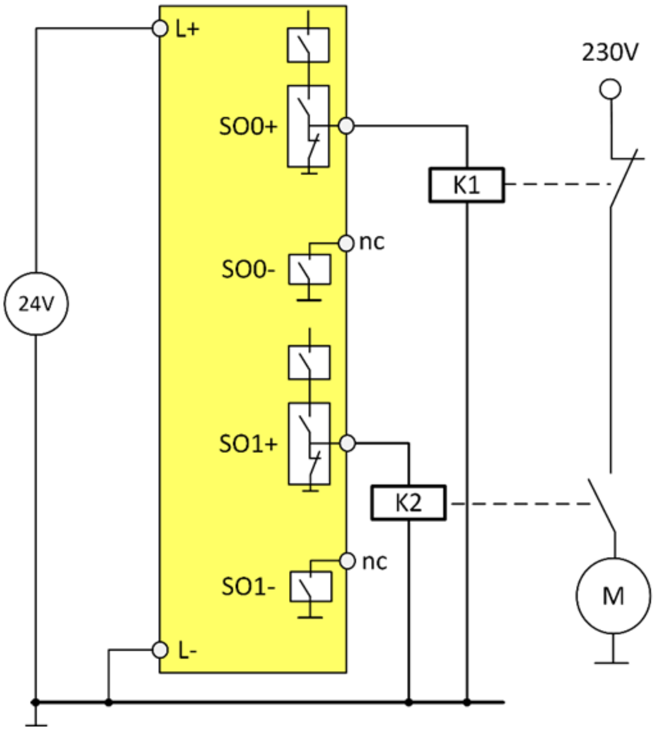


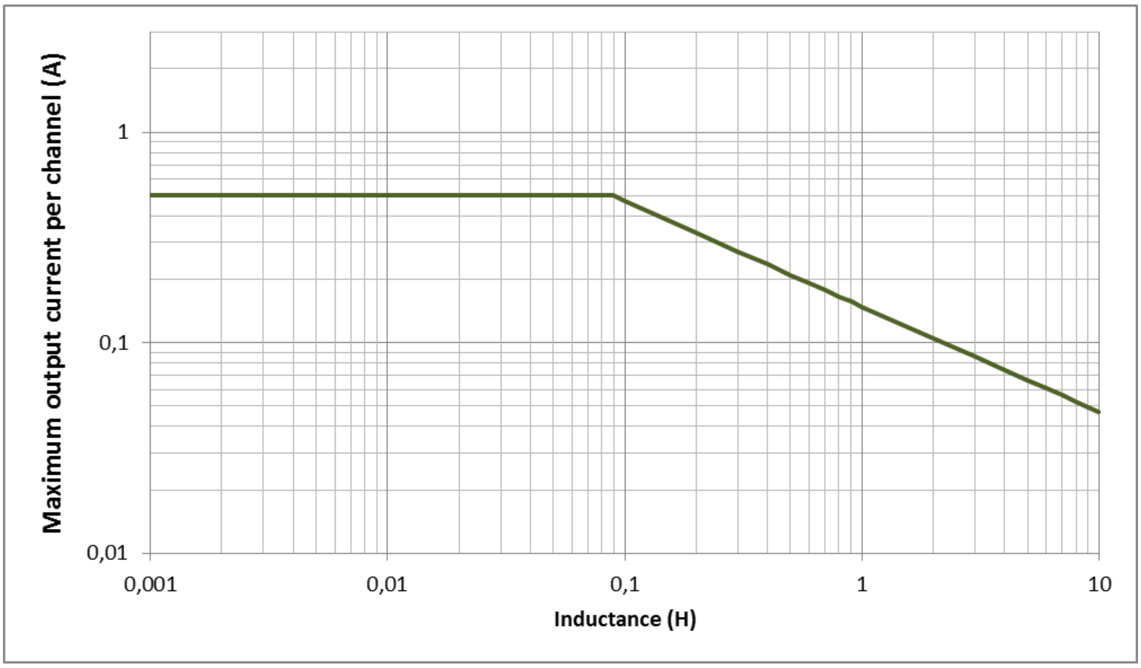
Figure 12: Actuators with external GND reference

CAUTION

Avoid the carrying over of voltages
Malfunction and module defects are likely.
To prevent that voltages are carried over, provide a low-impedance interconnection between GND and the chassis ground of the unit supplying power to the sensors and actuators and the unit supplying 24 VDC to the I/Os of the Safety I/O-module.

Switching of inductive loads

If the internal free wheel circuit is enabled, the digital power outputs of the Safety I/O-module module can be used to operate inductive loads. The graph below illustrates the maximum inductance of the load vs. the load current at a maximum output switching frequency of 2.5 Hz. The maximum inductance is limited to 10 H.



CAUTION

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. Destroying the digital power output may cause the safety function to fail.
⇨ Use an external free wheel circuit if the external load exceeds the specified inductance limits

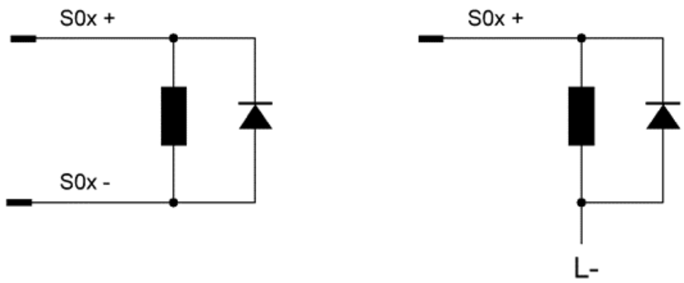
Note, information

Take heed of the fast clearing by the internal free wheel circuit
The internal free wheel circuit impacts the way the actuators (e.g. relays) release. The power dissipated in the module when turning off the outputs causes actuators to release faster than they would do if an external recovery diode was used. This should be considered with particular regard to the test pulses at a particular output. The actuators connected should not respond to the test pulses.
Consider using an external recovery diode, depending on the actuator connected and the falling delay required.

External free wheel circuit

> I
>
> ***Note, information***
>
> **Take heed of the perturbation of the external free wheel circuit**
> Depending on the actual safety function, it may or may not be affected by the external free wheel circuit which the safety assessment must take account of.

An external free wheel circuit will transduce the magnetic energy when turning off the inductive load.



Verify that the external free wheel circuit is designed to withstand the ensuing dissipation heat.

When connecting the inductive load to the outputs, be sure to limit the voltage of the external free wheel element you choose to anything smaller than -30 V because the digital output will otherwise transduce the magnetic energy to heat.

> I
>
> ***Note, information***
>
> **Note the heat dissipated by the external free wheel element!**
> If you choose the correct external free wheel element, this element instead of the safe I/O module will transduce the magnetic energy when turning off the inductive load.
> Verify that the external free wheel circuit is designed to withstand the ensuing dissipation heat.

Switching of digital inputs

Digital inputs of I/O modules can be switched by the module's SO X+ outputs. Verify that you have enabled parameter "extGroundOutput" of the output you use. Output test pulse configuration must consider the input capacitance of the input to be actuated. See the section on the switching of capacitive loads below.

To ensure that the test pulses of the digital power outputs are filtered properly when the safe digital inputs of the Safety IO module are used, the inputs' configurable filters should be set to the same test pulse duration (parameter "Test pulse duration") as the digital power output.

Switching of capacitive loads

Switching of capacitive loads must take account of the limits below described with reference to the output current and the test pulse length.

Test pulses cyclically test the module's digital outputs. If a capacitive load is connected 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. Every output supports a maximum capacitive load of 470 µF.

Output capacity of actuators with external GND reference or digital inputs to SOX+	
Test pulse length	**Output current 2 mA … 0.5 A**
700 µs to 1500µs	470 nF

Output capacity of actuators with GND reference connected to SOX+ and SOX-		
Test pulse length	**Output current 2 mA**	**Output current 20 mA**
700 µs	22 nF	300 nF
1000 µs	43 nF	470 nF
1500 µs	77 nF	470 nF

14.3.10 Derating the Modules with Reference to Ambient Temperature

> ***CAUTION***
>
> **Do not operate the Safety I/O-module module out of the specified range**
> Faults by component overload
> Operate the module under the ambient conditions listed in section Technical Data only while observing the appropriate derating.

Safety I/O-module SDI16 SDO4 0.5A

The maximum rated total current and the maximum number of available I/O module inputs depend on the ambient temperature of the safe I/O module. A derating is not required if the 24 V are supplied. If the maximum voltage of 28.8 V is supplied, refer to the diagram for the resulting total current and number of inputs to also be limited with reference to the temperature.

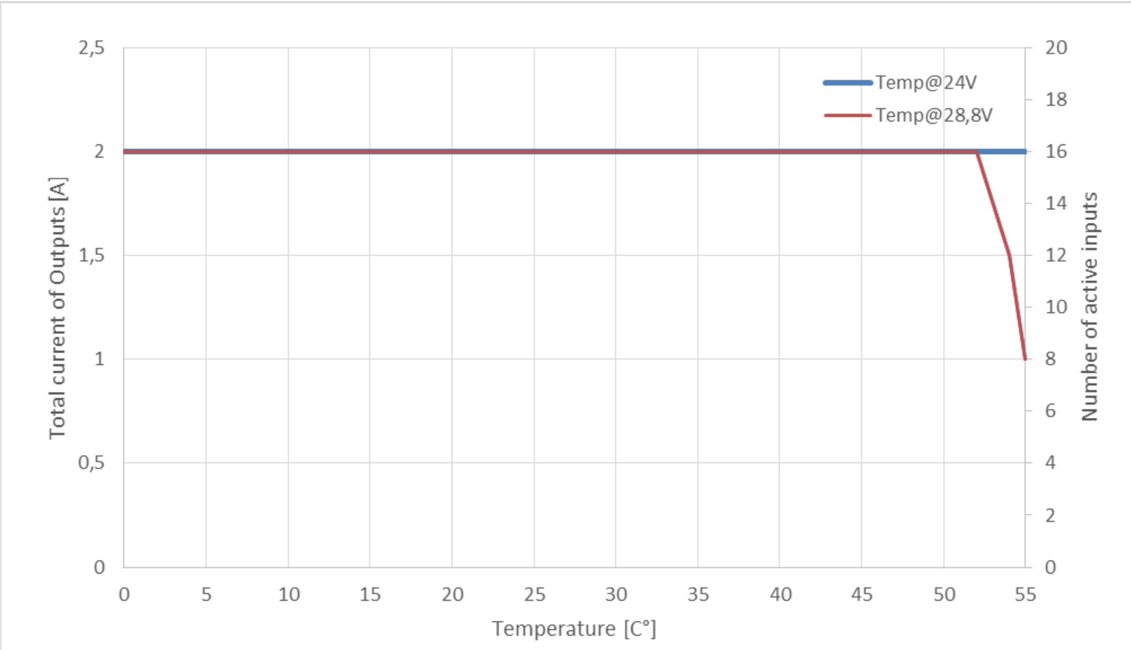


Figure 13: Derating of total output current and number of inputs

The output current derating shown on the graph was measured under free convection in a configuration with I/O modules on the left and right, 100% duty cycle and identical supply voltage.

Safety I/O-module SDI16 & Safety I/O-module SDI8 SDO2 0.5A

Derating not required.

14.3.11 Multiple Socket Connector (MSC)

CAUTION

Safe function jeopardised by cross-faults with other modules
Improper installation in conjunction with other modules may cause malfunctions due to cross-faults at the contacts
When test pulses are enabled, the Safety I/O-module will detect cross-faults between the inputs / outputs and other signal lines 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.

Note, information

To avoid excessive force being exerted on the board or problems with the contacts, do not expose the connectors to inadmissibly high tension / pressure. One reason for too much pulling force is the wiring being too short.

Note, information

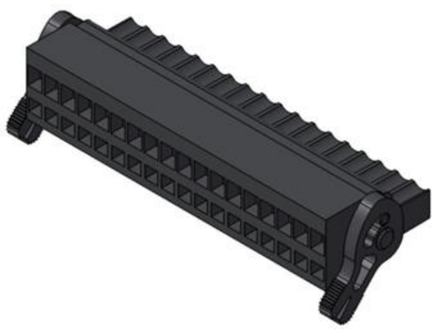
Only use the MSC from the package to connect to Lenze’s Safety I/O-module.

Safety I/O-module SDI8 / SDO2 0.5A

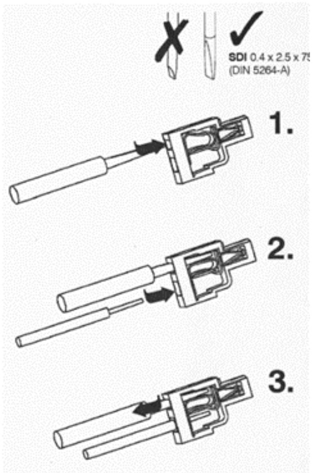
Spring-assisted multiple socket connectors support quick and easy wiring. Use the unlock button to easily disconnect the wires where there is little space.

Single row

MSC model:	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. 0.2 mm² max. 1.5 mm²
Wire diameter AWG:	min. AWG 25 max. AWG 14
Outside diameter of insulation:	max. 2.9 mm
Wire diameter, single-wire:	min. H05(07) V-U 0.2 mm² … max. H05(07) V-U 1.5 mm²
Wire diameter, fine wire:	min. H05(07) V-K 0.2 mm² … max. H05(07) V-K 1.5 mm²
Wire diameter	
w/ connector sleeve, DIN 46 228/1:	min. 0.2 mm² … max. 1.5 mm² Wire diameter
w/ connector sleeve w/ collar, DIN 46 228/4:	min. 0.2 mm² … max. 1 mm²
Stripped end:	10 mm
Rated current:	10 A (CSA) / 10 A (UL)
Thermal stability of cable:	min. 75 °C (UL)



Single-row spring-assisted connector with releasing lever



How to connect

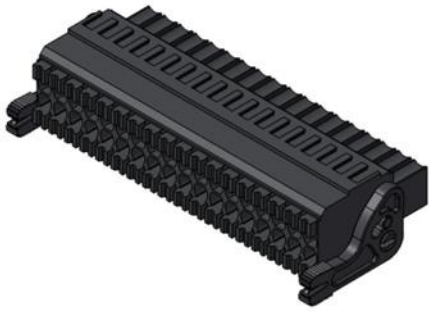
> **I** *Note, information*
>
> **Destruction by wrong tool**
>
> Damage to Lenze's Safety I/O-module module
>
> ⇨ Use suitable tools for wiring the multiple socket connector only!
>
> ⇨ Tool: Screwdriver, 0.4 x 2.5 x 75 [mm] blade (DIN 5264-A)

Safety I/O-module SDI16 / SDO4 0.5A & Safety I/O-module SDI16

The spring-assisted PUSH-IN connector allows you to quickly attach the wires by direct insertion without any tools. Just insert the connector sleeve end of the stripped solid or fine wire in the correct opening.

Two rows:

MSC model:		Weidmüller, OMNIMATE Signal - series model B2C/S2C 3.50, two-row
Clamping range, rated connection:		min. 0.2 mm² … max. 1.5 mm²
Wire diameter AWG:		min. AWG 25 … max. AWG 16
Outside diameter of insulation:		max. 2.9 mm
Wire diameter, single-wire:		min. H05(07) V-U 0.2 mm² … max. H05(07) V-U 1.5 mm²
Wire diameter, fine wire:		min. H05(07) V-K 0.2 mm² … max. H05(07) V-K 1.5 mm²
Wire diameter		
w/ connector sleeve, DIN 46 228/1:		min. 0.2 mm² … max. 1.5 mm² Wire diameter
w/ connector sleeve w/ collar, DIN 46 228/4:		min. 0.2 mm² … max. 1 mm²
Stripped end:		10 mm
Rated current:		9.5 A (CSA) / 9.5 A (UL)
Thermal stability of cable:	min.	75 °C (UL)



Two-row push-in connector with releasing lever

14.4 Configuration

Note, information

Check the safety function
Potential faults due to maladjusted configuration
⇨ After initial installation and after replacing a module, check the safety function!

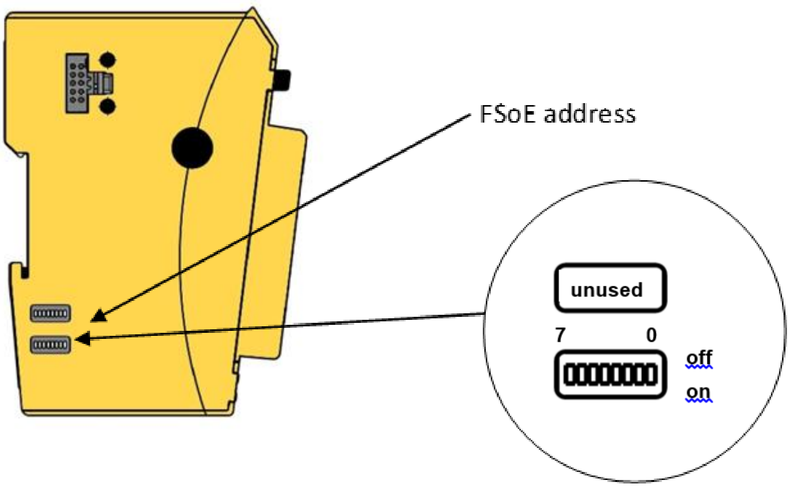
14.4.1 Address Setup

c250-S Safety has a safe module address (FSoE slave address) which clearly identifies it in the safe communication network. The address is set manually by means of binary switches on the left side of the module.

Use the 8 DIP switches to set the FSoE address. Addresses range between 1 and 255.

CAUTION

Destruction by wrong tool or operation
Damage to Lenze's Safety I/O-module module
⇨ Use suitable tools for setting the address only!
Use a non-metal and suitable object (e.g. a plastic screwdriver) to set the DIP switches.
⇨ Do not exert pressure on the switching elements!
⇨ Do not start the module if any components inside are damaged! Replace the module instead!



WARNING

Potentially hazardous failures by starting damaged modules

Damages to the internal circuitry caused by wrong handling may jeopardise the safe use of the module.

Do not start the module if any components inside are damaged! Replace the module instead!

ATTENTION

Safety function not available

Startup disallowed by wrongly set address

Do a function test to verify that the address coding switches have been set correctly.

DIP switch								
Address	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 (inadmissible)	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
…	…	…	…	…	…	…	…	…
255	ON	ON	ON	ON	ON	ON	ON	ON

Note, information

Inappropriate setup actions at the Safety I/O-module
Machine failure and damage to the Safety I/O-module
Turn off the I/O supply before removing the Safety I/O-module from the row of module for setup.

Note, information

The FSoE address you set may only occur once in the communication network. The master will find and notify the user of a FSoE address that occurs more than once or is not used.

Note, information

Stick to the order of modules set in PLCDesigner because it will otherwise be impossible to get the system operational.

Note, information

There is no access to the DIP switches once several modules have been lined up.

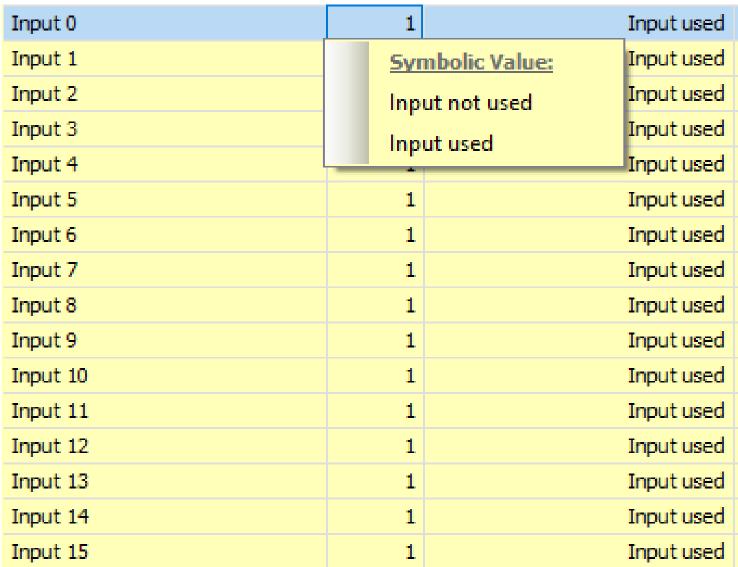
To set the FSoE slave address at the DIP switch, first remove the module from the row of modules.

14.4.2 FSoE Parameters

CAUTION

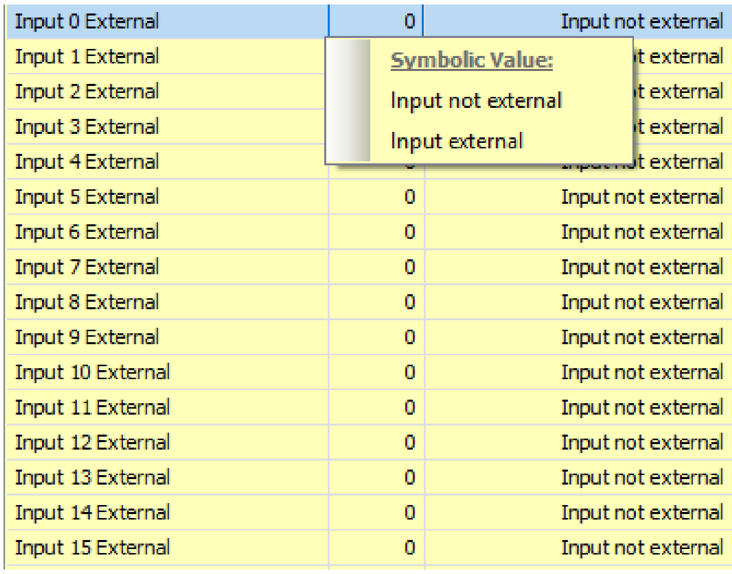
Improper operation of parameter setup
Malfunction of Lenze's Safety I/O-module module due to bad parameter setup

⇨ Only persons qualified for dealing with safety matters are allowed to add, replace and put Safety I/O Modules into operation.
⇨ Before installing, servicing or putting Safety I/O-module Module into service, please also 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.

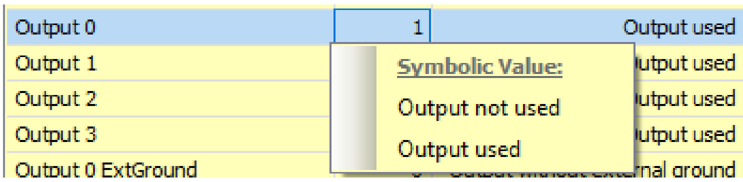
FSoE parameter		
Parameter		**Unit**
Safety module **Setting / range [Default]**	**Description / note**	
FSoE address		-
1 ... 255 [1]	FSoE slave address set at DIP switch	
Connection ID		-
1 ... 65535 [1]	Unique ID of the connection to a FSoE slave	
WatchdogTime		ms
20 ... 65534 (0xFFFE) [500]	Watchdog time of FSoE frame	
Used Inputs		Dec
SDI16 SDO4 and SDI16 Input0 - Input15 SDI8 SDO2 Input0 - Input7	Enables the inputs used. Selection from a drop-down list depends on the configurator. 	

<table>
<tr><th colspan="2">FSoE parameter</th><th></th></tr>
<tr><th colspan="2">Parameter</th><th>Unit</th></tr>
<tr><th>Safety module
Setting / range [Default]</th><th colspan="2">Description / note</th></tr>
<tr><td colspan="2">External Inputs</td><td>Dec</td></tr>
<tr><td>SDI16 SDO4 and SDI16
Input0External - Input15External

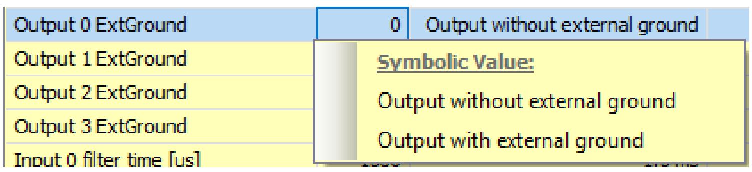
SDI8 SDO2
Input0External - Input7External</td><td colspan="2">Disables the generation of the module's test pulses of the inputs, or at the outputs if the sensors generate their own test pulses (OSSD), or, optionally, for operation without test pulses (OSSD). Selection from a drop-down list depends on the configurator.

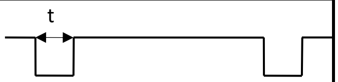
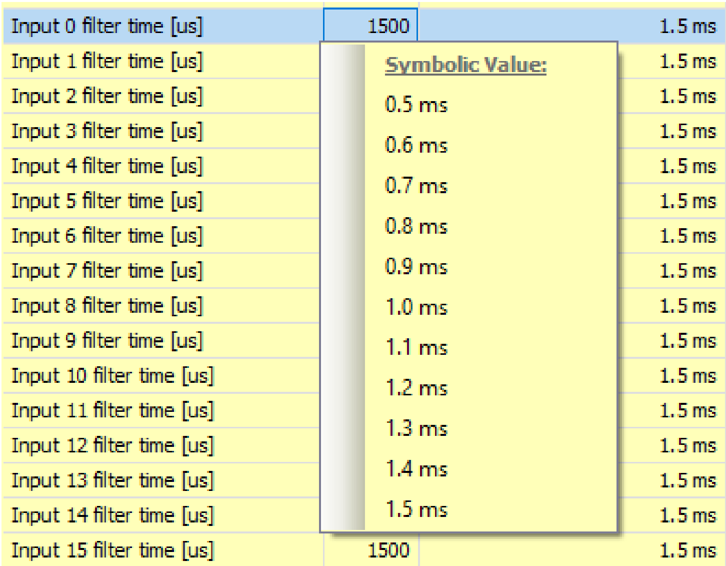

</td></tr>
<tr><td colspan="2">usedOutputs</td><td>Dec</td></tr>
<tr><td>SDI16/SDO4
Output0 - Output3

SDI8/SDO2
Output0 - Output1</td><td colspan="2">Enables the outputs used. Selection from a drop-down list depends on the configurator.

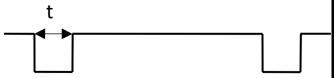

</td></tr>
<tr><td colspan="2">extGroundOutputs</td><td>Dec</td></tr>
<tr><td>SDI16/SDO4
Output0ExtGround - Output3ExtGround

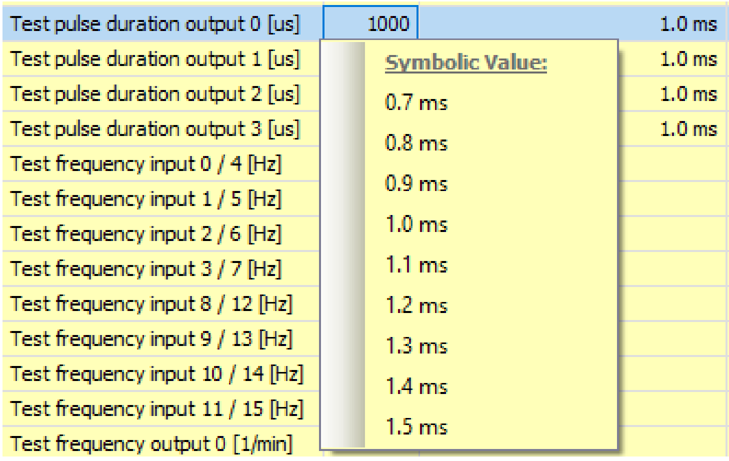
SDI8/SDO2
Output0ExtGround - Output1ExtGround</td><td colspan="2">Enable if the actuator is not connected to module terminal SO X- but uses an external ground connection.
Selection from a drop-down list depends on the configurator.


</td></tr>
</table>

FSoE parameter		
Parameter		**Unit**
Safety module **Setting / range** **[Default]**	**Description / note**	
Input x filter time [µs]		µs
SDI16/SDO4 and SDI16 Input 0 filter time [µs] - Input 15 filter time [µs] 500 ... 1500 [1500] SDI8/SDO2 Input 0 filter time [µs] - Input 7 filter time [µs] 500 ... 1500 [1500]	Test pulse length of input x Input filter of input x  The digital test pulse output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the digital inputs may turn Null and whether there are any short circuits to noise voltages on the signal line. Adapt the test pulse duration to the peripherals you use. 	

FSoE parameter		
Parameter		**Unit**
Safety module **Setting / range [Default]**	**Description / note**	
Test pulse duration output x		µs
SDI16/SDO4 Test pulse duration output0 - Test pulse duration output3 700 ... 1500 [1000] SDI8/SDO2 Test pulse duration output0 - Test pulse duration output1 700 ... 1500 [1000]	Test pulse duration of output x The digital test pulse output is interrupted for the set duration of every test pulse. The Safety I/O-module checks whether the digital outputs may turn Null and whether there are any short circuits to noise voltages on the signal line. Adapt the test pulse duration to the peripherals you use.	

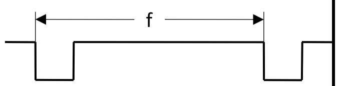




Test pulse duration output 0 [us]	1000	1.0 ms
Test pulse duration output 1 [us]		1.0 ms
Test pulse duration output 2 [us]		1.0 ms
Test pulse duration output 3 [us]		1.0 ms
Test frequency input 0 / 4 [Hz]		
Test frequency input 1 / 5 [Hz]		
Test frequency input 2 / 6 [Hz]		
Test frequency input 3 / 7 [Hz]		
Test frequency input 8 / 12 [Hz]		
Test frequency input 9 / 13 [Hz]		
Test frequency input 10 / 14 [Hz]		
Test frequency input 11 / 15 [Hz]		
Test frequency output 0 [1/min]		

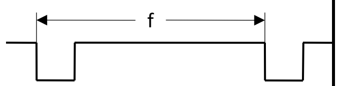
Symbolic Value:
0.7 ms
0.8 ms
0.9 ms
1.0 ms
1.1 ms
1.2 ms
1.3 ms
1.4 ms
1.5 ms

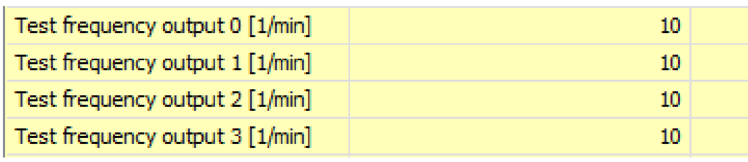
Test frequency input x		Hz
SDI16/SDO4 and SDI16 Test frequency input 0/4 - Test frequency input 11/15 0 ... 25 [25] SDI8/SDO2 Test frequency input 0/4 - Test frequency input 3/7 0 ... 25 [25]	Test pulse frequency of input x "0" = no test pulse	



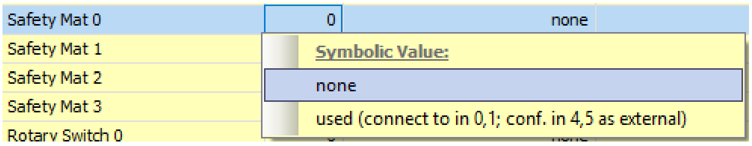
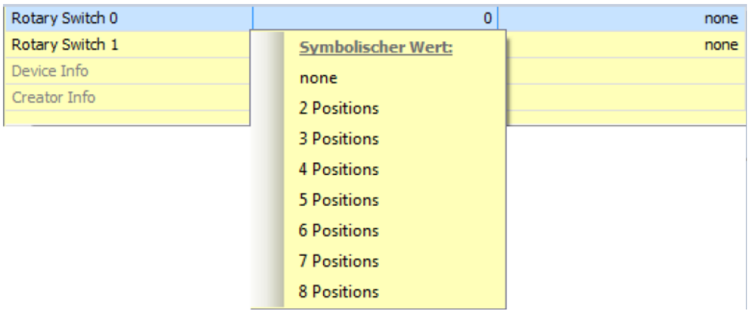
Test frequency input 0 / 4 [Hz]	25
Test frequency input 1 / 5 [Hz]	25
Test frequency input 2 / 6 [Hz]	25
Test frequency input 3 / 7 [Hz]	25
Test frequency input 8 / 12 [Hz]	25
Test frequency input 9 / 13 [Hz]	25
Test frequency input 10 / 14 [Hz]	25
Test frequency input 11 / 15 [Hz]	25

Test frequency output x		min-1
SDI16/SDO4 Test frequency output 0 - Test frequency output 3 1 ... 25 [10] SDI8/SDO2 Test frequency output 0 - Test frequency output 1 1 ... 25 [10]	Test pulse frequency of output x	





Test frequency output 0 [1/min]	10
Test frequency output 1 [1/min]	10
Test frequency output 2 [1/min]	10
Test frequency output 3 [1/min]	10

FSoE parameter		
Parameter		**Unit**
Safety module **Setting / range [Default]**	**Description / note**	
Safety Mat x		Dec
SDI16/SDO4 and SDI16 Safety Mat 0 - Safety Mat 3 0 ... 1 [0] SDI8/SDO2 Safety Mat 0 - Safety Mat 1 0 ... 1 [0]	Safety mat modes (safety mat / bumper)  If the safety mat function is used, be sure to set all parameter inputs to InputxExternal. If Safety Mat 0 is used, SI0 (FSoE_Input 0), SI1 (FSoE_Input 1) and test pulse outputs SI0/4 TP and SI1/5 TP are used for the modes. Inputs SI4 (FSoE_Input 4) and SI5 (FSoE_Input 5) must then be set to and used as External, i.e. for sensors with their own or without OSSD signals.	
Rotary Switch x		Dec
SDI16/SDO4 and SDI16 Rotary Switch 0 – Rotary Switch 1 0 ... 8 [0] SDI8/SDO2 Rotary Switch 0 0 ... 8 [0]	Rotary Switch Modes (mode selector)  Rotary Switch mode supports mode selectors with up to eight positions. In this case, test pulse output SI0/4 TP is used for Rotary Switch 0 and all switch positions and test pulse output SI8/12 TP for Rotary Switch1.	

14.4.3 Input Parameters

Parameters "Used Inputs" and "External Inputs"

CAUTION

Setting the Test Pulse Rate
In single-channel applications (inputs same as outputs), adapt the test pulse frequency to the application. In applications with frequent changes of state, the test pulse frequency should be at least 100x higher than the time of change of application state.
In single-channel applications, the error response time of the inputs should be 3x the test pulse interval (25 Hz = 120 ms).
Refer to section ▶ 14.4.2 FSoE Parameters.

Use these parameters to enable the inputs of the Safety I/O-module and to select the input function. Use parameter "External Inputs" to disable the module's test pulse outputs that deliver test pulses to each of the inputs. Use this setting for sensors generating their own test pulses (some light barriers, for example).

WARNING

Non-detection of a corrupt 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 protecting the cables and/or laying them separately to ensure a sufficient degree of safety.

In mode selector mode "Mode Selector", you may connect 2to 8 inputs of test pulse output SI0/4 TP to a mode selector (test pulse output SI8/12 TP for Rotary Switch 1). Disable the test pulse outputs you do not need. Refer to manual section ▶ 15.4 Mode Selector, Rotary Table for a wiring example. Inputs you do not use and the associated test pulse outputs can be used for other functions.

Parameter "Input filter time"

If used together with the module's test pulse outputs, test pulses cyclically check the input circuit connected to the Safety I/O-module for faults such as short circuits or internal defects. In this case, the test pulse duration is preset to 1.5 ms and cannot be modified by a parameter.

Use parameter "Input x filter time" to set the filter time of the digital inputs in case you are working with external safety sensors. You may have to modify the test pulse duration if the signals are affected by capacitive properties of the input circuit, for example. In this case, the inputs have a preset filter of 1000 µs. The configurable part from 500 µs to 1500 µs will be added to this value.

Note: The sum total of the fixed and the set filter time will affect the module's failover time. Refer to section 4.8 Response Time

---

Parameter "Test frequency input"

If used together with the module's test pulse outputs, test pulses cyclically check the input circuit connected to the Safety I/O-module for faults such as short circuits or internal defects. 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 corrupt 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 protecting the cables and/or laying them separately to ensure a sufficient degree of safety.

14.4.4 Output Parameters

CAUTION

Setting the Test Pulse Rate
In single-channel applications (inputs same as outputs), adapt the test pulse frequency to the application. In applications with frequent changes of state, the test pulse frequency should be at least 100x higher than the time of change of application state.
In single-channel applications, the error response time of the inputs should be 3x the test pulse interval (25 Hz = 120 ms).
Refer to section ▶ 14.4.2 FSoE Parameters.

Parameter "Outputs external Ground"

Enable if the sensor is not connected to module terminal SO X- but uses an external ground connection. Pick from a drop-down list provided by the configurator software. Linking the sensor to an external ground connection instead of terminal SO X- disallows you to control an external 24 VDC 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"

Enables the outputs used.

Pick from a drop-down list

Parameter "Test pulse duration output"

Test pulses cyclically check the digital outputs of the Safety I/O-module for faults such as short circuits or internal defects. 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.

Note, information

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 Safety I/O-module. Parameter "Test frequency output" sets the switching frequency and, thus, the frequency of test pulses allocated to a digital output. Adapt this parameter to real-life conditions particularly when using inductive or capacitive loads.

WARNING

Non-detection of incorrect 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 protecting the cables and/or laying them separately to ensure a sufficient degree of safety.

⇨ You are strictly advised against turning off the test pulses because this reduce the safety of the application.

WARNING

Reduced diagnosis if the test pulses at the outputs are deactivated

You are strictly advised against turning off the test pulses because this reduce the safety of the application. If you turn off the test pulses at the outputs, ensure that the outputs are still diagnosed by:

Setting the outputs once a year and making sure that they are switched by a function (of the application) or by completely shutting the device down and restarting it.

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 pulses 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.

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.

14.5 Putting into Service

ATTENTION

The safety-related products may be used by the following persons only.

- ⇨ 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.

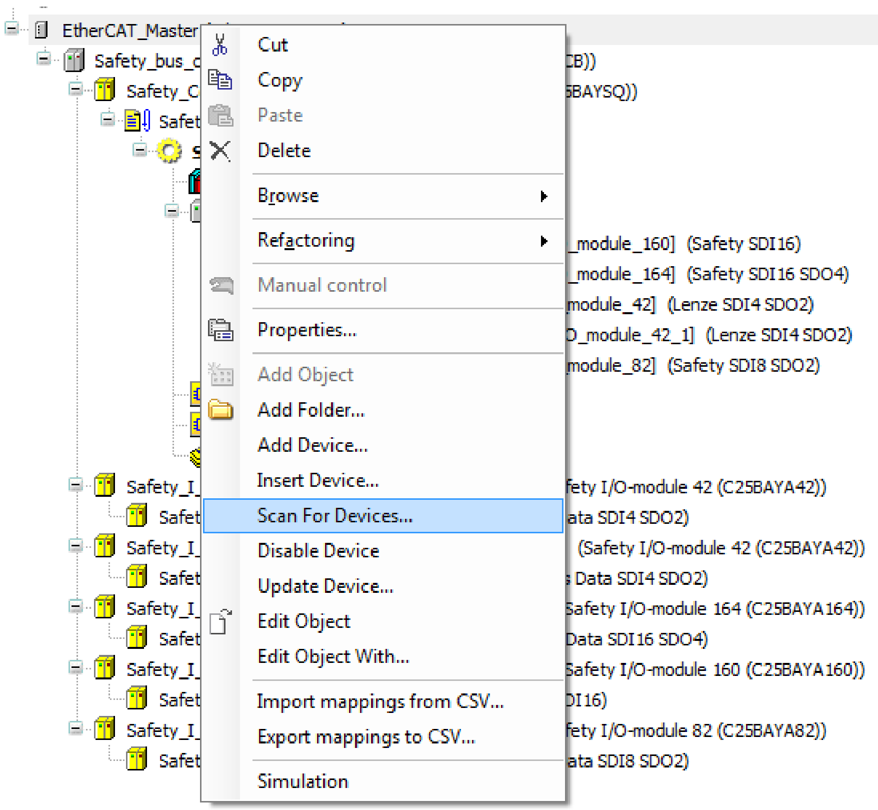
Note, information

Usage note

Lenze’s Safety I/O-module module may be used ETG-compliant configurations with conforming products. Such products include slave services, master and development systems, and functional safety products. Check the products for the "EtherCAT Conformance Tested" logo to see if they have passed an official test for conformity. Certified products are listed in the EtherCAT Product Guide published by the EtherCAT Technology Group.

Topology of PLCDesigner devices

Like in all other PLCDesigner 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 search for devices in PLCDesigner. Right-click on the EtherCAT master and pick "Geräte suchen..." (Find devices) from the context menu. In the next dialog, you just need to confirm to "Alle Geräte ins Projekt kopieren" (Copy all devices to project).



PLCDesigner configuration example:

- Safety_bus_coupler_C25BAYCB (Safety bus coupler(C25BAYCB))
  - Safety_Controller_c250_S (Safety-Controller c250-S (C25BAYSQ))
    - Safety Logik
      - **SafetyApp**
        - Bibliotheksverwalter
        - Logische E/As
          - Safety_I_O_module_160 [<-Safety_I_O_module_160] (Safety SDI16)
          - Safety_I_O_module_164 [<-Safety_I_O_module_164] (Safety SDI16 SDO4)
          - Safety_I_O_module_42 [<-Safety_I_O_module_42] (Safety SDI4 SDO2)
          - Safety_I_O_module_42_1 [<-Safety_I_O_module_42_1] (Safety SDI4 SDO2)
          - Safety_I_O_module_82 [<-Safety_I_O_module_82] (Safety SDI8 SDO2)
        - POU_App
        - POU_Monitor
        - Safety Task
  - Safety_I_O_module_42 [->Safety_I_O_module_42] (Safety I/O-module 42 (C25BAYA42))
    - Safety_Process_Data_SDI4_SDO2 (Safety Process Data SDI4 SDO2)
  - Safety_I_O_module_42_1 [->Safety_I_O_module_42_1] (Safety I/O-module 42 (C25BAYA42))
    - Safety_Process_Data_SDI4_SDO2_1 (Safety Process Data SDI4 SDO2)
  - Safety_I_O_module_164 [->Safety_I_O_module_164] (Safety I/O-module 164 (C25BAYA164))
    - Safety_Process_Data_SDI16_SDO4 (Safety Process Data SDI16 SDO4)
  - Safety_I_O_module_160 [->Safety_I_O_module_160] (Safety I/O-module 160 (C25BAYA160))
    - Safety_Process_Data_SDI16 (Safety Process Data SDI16)
  - Safety_I_O_module_82 [->Safety_I_O_module_82] (Safety I/O-module 82 (C25BAYA82))
    - Safety_Process_Data_SDI8_SDO2 (Safety Process Data SDI8 SDO2)

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

14.6 Diagnosis

14.6.1 Self-test

When system voltage is supplied to the Lenze Safety I/O-module, it initially runs a complete system test. Only if this system test is passed will the module be able to operate and first of all change to its "fail-safe" state.

This is indicated by LED "Safe Status" lighting up red.

The Safety I/O-module module will retain the fail-safe state until all internal tests have been passed, valid data has been received from the control unit, and faults are not 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.

The module will retain its fail-safe state if it fails to qualify for the safe state, e.g. because of errors in the application's module setup. To find the cause of the problem, check the error code in the service block ►14.6.6 Table of Faults.

In service, the system test is repeated cyclically as a background process.

To repeat the initial system test, just turn the power supply off and back on again.

14.6.2 Safety I/O-module Module Faults

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.

14.6.3 Wrong Wiring

Wiring faults such as

- a cross-fault between the inputs,
- external power supplied to the inputs,
- wrong test pulse output allocation to a specific input,
- external power supplied to the outputs, or
- a cross-fault between the outputs,
- wrong allocation of SOX+ to the associated SOX- connector of the outputs,
- a short at the outputs

will change the Safety I/O-module to its safe state. The red Diagnosis LED of the affected channel lights up.

Error messages may also be provoked by badly adjusted loads. Please refer to sections ► 12.5.4 Safe Digital Outputs and ►14.3.9 Actuator Connection.

14.6.4 Temperature Faults

> ***CAUTION***
>
> **Do not operate the Safety I/O-module module out of the specified range**
> Faults due to overloading of components due to over- or undertemperature
> Operate the module under the ambient conditions listed in section Technical Data only while observing the derating of the outputs – see ► section 14.3.10.

The module is designed for ambient temperatures between 0 °C and max. 55 °C and for being installed in a control cabinet. The Safety I/O-module module features an extra internal temperature sensor. Excess temperature will change the module to its safe state. You cannot start the module at temperatures below 0 °C.

14.6.5 Wrong Supply Voltage

The supply voltage is rated at 24 VDC. It is monitored. In case of overvoltage (> +27.5%) and low voltage (< -25%) alike, the module changes to its safe state.

Power to the logic circuitry of the safe I/O modules is drawn from the 5 V of the backplane bus. The safe I/O modules monitor the 5 V supply to the logical circuit and change to the safe state when there is not enough voltage (< 4.55 V) for sustained operation.

14.6.6 Table of Faults

Depending on their type, faults detected are indicated by the diagnosis LEDs of the Safety I/O-module and made available as a diagnostic message in error register object 1001h. Diagnostic messages help you identify the fault and to 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 remove its cause and acknowledge the fault in the error register according to instructions.

Table of Faults		
Fault	**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 still enabled although outputs are in safe state Inputs still enabled	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 safe state, diagnosis LEDs of the inputs light up red	Wrong wiring, e.g. test pulse signals swapped Cross-fault between the inputs External power supplied to the outputs	Check error code in the service block Check module wiring
Module is in safe state, one diagnosis LED at the output lights up red	Overload on an output Cross-fault at an output External power supplied to an output	Check error code in the service block Check module wiring Check the output current of the output
Module is in safe state, LED "Safe Status" lights up red	EtherCAT connection interrupted Internal module fault	Check wiring of the EtherCAT fieldbus cables Check that c250-S modules interconnect properly
Module is in safe state, LED "Safe Status" lights up red	I/O power is low	Check I/O power Check wiring

14.6.7 Error Codes

<table>
<tr><th colspan="3">Error codes (object dictionary 0x2007 or 0x2017 - Err.code)</th></tr>
<tr><th>Error Code (hex)</th><th>Cause</th><th>Comment</th></tr>
<tr><th colspan="2">Effect</th><th>Corrective Action</th></tr>
<tr><td>0x0001</td><td>Internal software error</td><td>Internal module monitoring has detected an error. Inputs and outputs change to the safe state, FSoE communication stops.</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Module RESET by turning the system power off and back on again – self-test repeats.
Replace module if error prevails</td></tr>
<tr><td>0x0002</td><td>Internal hardware fault</td><td>Internal module monitoring has detected a hardware fault. Inputs and outputs change to the safe state, FSoE communication stops.</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Module RESET by turning the system power off and back on again – self-test repeats.
Replace module if error prevails</td></tr>
<tr><td>0x0243</td><td>Low voltage</td><td>Voltage supplied to the module is below the admissible range. Inputs and outputs change to the safe state, FSoE communication stops.</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Check actual system power supplied
Check length and stress on the feed line</td></tr>
<tr><td>e.g.:
0x0F50</td><td>Parameter error</td><td>Module fails to change to its functional state.</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Check module parameter setup
Use parameter settings in the admissible range only</td></tr>
<tr><td>e.g.:
0x0630</td><td>Cross-fault at or external power supplied to input</td><td>Cross-fault to another input or test pulse output or external power supplied; red diagnosis LED of affected channel lights up.
Inputs and outputs turn "0" at the module and in the process map.</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Check sensor
Check test pulse outputs
Check connector and wiring</td></tr>
<tr><td>e.g.:
0x0660</td><td>Short circuit or overload</td><td>Short circuit in the output wiring or wrong output load, red diagnosis LED of affected channel lights up</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Check actuator
Check connector and wiring
Check free wheel wiring at contactor</td></tr>
<tr><td>e.g.:
0x0670</td><td>Cross-fault at or external power supplied to output</td><td>Cross-fault to another output or another signal; red diagnosis LED of affected channel lights up</td></tr>
<tr><td colspan="2">Module in safe state</td><td>Check actuator
Check connector and wiring</td></tr>
</table>

I

Note, information

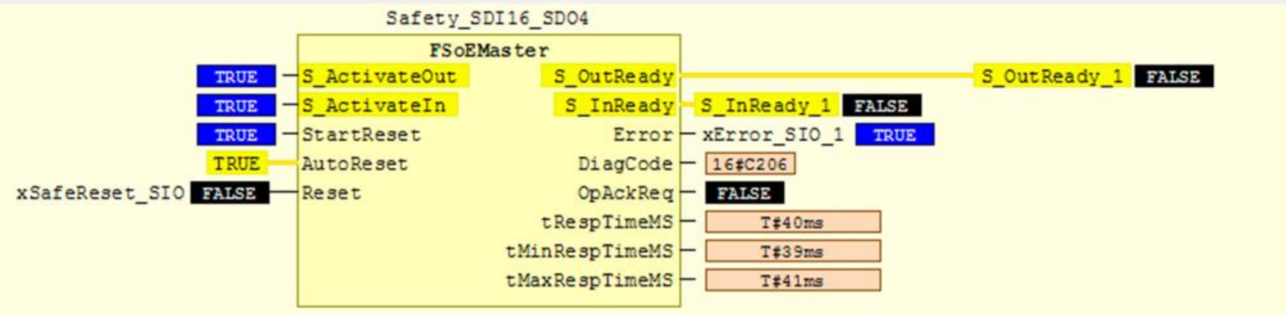
For a detailed description of the entry in object 2007h or 2017h "Err.code", refer to the table in section 8.1.13.

14.6.8 EtherCAT Link Lost

All modules change to their fail-safe state when the EtherCAT link is lost or interrupted. Once the fault has been removed, an Error Acknowledge is enough to restart the EtherCAT bus.

14.6.9 Wrong FSoE Address

A wrong FSoE address causes the affected modules to retain their fail-safe state. The fault is detected by the master and cannot be acknowledged.

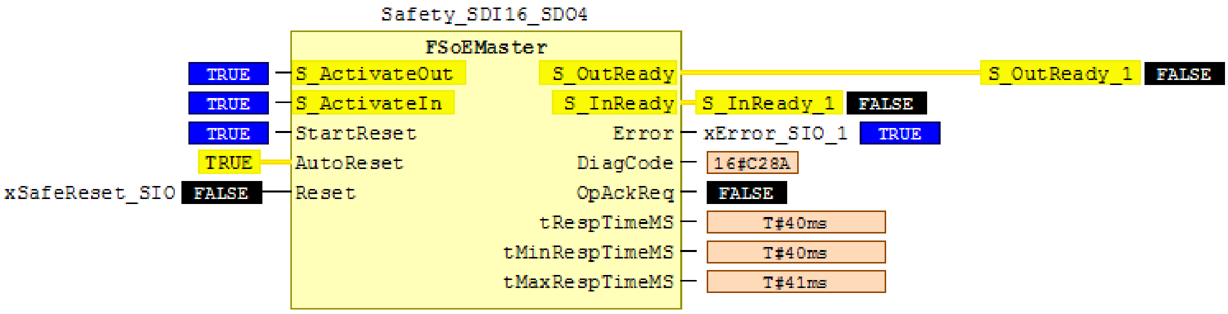


Error code	Description
0xC200	Local reset or acknowledgement of a RESET command
0xC201	Unexpected command (INVALID_CMD)
0xC202	Unknown command (UNNKOWN_CMD)
0xC203	Invalid connection ID (INVALID_CONNID)
0xC204	CRC error (INVALID_CRC)
0xC205	Watchdog has expired (WD_EXPIRED)
0xC206	Invalid FSoE Slave Address (INVALID_ADDRESS)
0xC207	Invalid safety data (INVALID_DATA)
0xC208	Invalid communication parameter length (INVALID_COMMPARALEN)
0xC209	Invalid communication parameter data (INVALID_COMPARA)
0xC210	Invalid application parameter length (INVALID_USERPARALEN)
0xC211	Invalid application parameter data (INVALID_USERPARA)
0xC280- 0xC2FF	Invalid SafePara (device-specific)

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

14.6.10 Wrong configuration of the Lenze Safety I/O-module

By design, safety control units prevent configuration errors from provoking dangerous states. Therefore, after downloading a safety project with a bad configuration, all safety module are in a fail-safe state. The master shows the incorrect configuration.



To restart the safety modules, first remove the incorrect configuration, then download the project again and finally Acknowledge the error .

14.7 Reset / Acknowledge Error

The error class decides whether and how an error can be acknowledged, see section ► 16.1.16 Errorclass $200A_h$ for CPU1 and $201A_h$ for CPU2.

Error Class	Explanation	Acknowledged / Reset by
0	No error	Not required
1	Internal, communication, synchronisation, parameter, TP, FB error	PowerCycle
2	Error in Test Handler (BIST)	PowerCycle
3	External, I/O Error	Error Acknowledge

PowerCycle:

After removing the cause of the error, you can reset the Safety I/O-modules by a power cycle (PowerCycle -> turn off and back on) provided that the automatic self-test is passed.

Error Acknowledge:

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

WARNING

Reset / acknowledge 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.
⇨ Ensure a safe restart if necessary.

14.8 Maintenance / Servicing

14.8.1 General

Only qualified persons are allowed to work on c250-S Safety System.

CAUTION

Unsafe and undefined machine state

Destruction or malfunction

⇨ Do not plug, mount, unplug or touch the connectors during operation!

⇨ Turn off all power sources before working on the modules. This also applies to any peripherals connected such as encoders, programming devices with external power source, etc.

⇨ Check that none of the ventilation slots is covered.

14.8.2 Servicing

Safety I/O-modules requires neither servicing for the specified service life nor any action if it is kept and operated at the admissible ambient conditions specified in section Technical Data.

14.8.3 Preventive Maintenance

Prevent inadmissible contamination while operating and storing Safety I/O-modules. Do not use or continue to use the Safety I/O-module in case it has been exposed to inadmissible contamination.

CAUTION

Unsafe and undefined machine state

Risk of injury

You are not allowed to operate an inadmissibly contaminated module. Neither is cleaning the unit allowed.

14.9 Replacing a Safety I/O-module Module

When you replace a Safety I/O-module, its configuration is retained and transferred to the new module when you restart the system. The programming environment will tell you is the new module is incompatible. You must carry out appropriate tests to verify whether there are any other failure modes such as using the wrong terminals or making wiring mistakes.

The text below describes how to replace a Safety I/O-module with a Safety I/O-module of the same type.

CAUTION

Unsafe and undefined machine state

Risk of injury

⇨ Turn off the power supply of the control unit and the c250-S modules before replacing a Safety I/O-module.

⇨ After you have replaced any Safety I/O-modules, separately test the safety function before you restart the machine or system.

⇨ Design you wiring tests such that you will reliably discover the use of a wrong terminal.

I

Note, information

You must set up your entire project again if you replace a Safety I/O-module with a module of another type. If so, refer to the user guide of the new module.

Procedure

- Verify that the new module meets the following requirements:
- Same type of device
- Same or higher version, see section ▶ 13.1 Labelling and Identification
- Enable the safe system or machine state.
- Turn off the power supply of the control unit and the Safety I/O-modules.
- To remove the old module see section ▶ 14.2.6
- Disconnecting Two Modules and ▶14.2.6 Taking Down a Single Module:
- Dissolve the line of Safety I/O-modules by pressing the unlock button of the module to be separated from the module to its left and sliding both modules about 1 cm apart.
- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module away from the rail as shown in the illustration.
- Pull the module down and out of the mounting rail.
- Locate the FSoE address at the address coding switch of the module you are replacing and transfer that address to the new module ▶ 14.4.1 Address Setup
- Install the new module at the same place within the line of Safety I/O-modules as one you just removed (▶ 14.2.3 Snapping on a Single Module).
- Plug the inline connectors to the correct ports.

Restart

- Verify that the machine or system is in a safe state and that there is nothing and nobody in the danger zone.
- Turn the supply voltage back on.
- Start the new safety module as if you initially operate a module ▶ 14.5 Putting into Service.
- The configuration of the old module has been retained and will be transferred to the new module when you restart the system.
- Check all safety functions after replacing a module.

14.10 Durability

Safety I/O-modules have a design life of max. 20 years after the date of manufacture (see ▶ 13.1.2 Serial Number) by Lenze Automation GmbH. Take the module out of service at the end of its useful life ▶ 14.10.3 Taking out of Service.

14.10.1 Repairs / Customer Service

You are not allowed to open or try to repair a Safety I/O-module module.

Doing so will void the warranty.

> I
>
> ***Note, information***
>
> **In case of a potentially hazardous failure**
> In case a module failure is potentially hazardous, return the module to the manufacturer where the fault will be identified.
> The manufacturer's address is printed on the Safety I/O-module.

14.10.2 Warranty

The statutory period and conditions of warranty apply. Warranty expires if unauthorised attempts are made to repair the unit / product or any other intervention is performed see section ▶ 10.1.4 Warranty.

14.10.3 Taking out of Service

The manufacturer of the machine or system specifies the procedure of taking the product out of service. The process must fully comply with the specified procedure.

Make sure that the modules of the c250-S Safety system you are taking out of service are provided for further use as intended. Refer to section Technical Data for detailed transport and storage requirements.

14.10.4 Disposal

Dispose of the c250-S 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.

15 Connection Examples

This section describes examples of applications that make use of the Safety I/O-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 guide of your safe devices for further details.
> - ⇨ Configure your Safety I/O-module with reference to the actual environment.

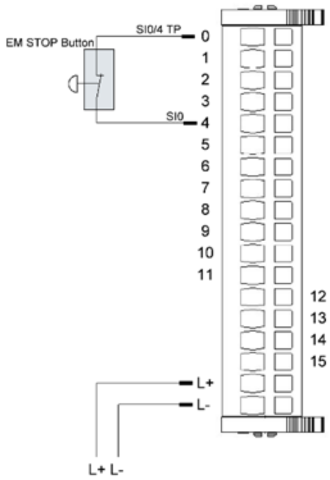
The safety ratings listed for the examples below solely apply to the part of the safety function covered by the safe I/O module. Please note that the safety ratings below only apply if the test pulses are enabled.

> ***WARNING***
>
> **Non-detection of a corrupt 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 protecting the cables and/or laying them separately to ensure a sufficient degree of safety.

15.1 Safety Function with Single-channel Input

CAUTION

Setting the Test Pulse Rate
In single-channel applications (inputs same as outputs), adapt the test pulse frequency to the application. In applications with frequent changes of state, the test pulse frequency should be at least 100x higher than the time of change of application state.
In single-channel applications, the error response time of the inputs should be 3x the test pulse interval (25 Hz = 120 ms).
Refer to section ► 14.4.2 FSoE Parameters



You may connect contact-type sensors such as emergency stop buttons straight to a safe digital input.

Every test pulse output is allocated to two safe inputs, see section ►14.3.8 Sensor Connection. This test pulse output supplies a specific signal you may use to detect wiring problems such as a short circuit to 24 VDC, GND or other signal channels. The state of connected switches is indicated by LEDs allocated to the channels (see section ► 13.4 Indicators and Controls).

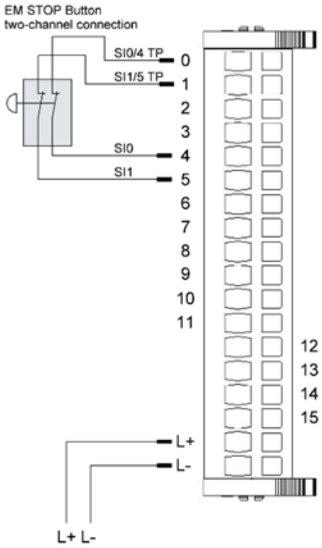
Whenever an emergency stop button is pressed, the safety PLC will generate a stop signal. Resetting the emergency stop device must not be enough to initiate a restart signal.

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 solely apply 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. 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 when applying the module's test pulses to single-channel contact-type sensors	
Highest safety integrity level to EN 62061:2010	SIL2
Highest 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) in single-channel application (IEC 61508:2010/EN)	0 (a fault of the application may cause the safeguard to fail)

15.2 Safety Function with Two-channel Input



For applications requiring single-fault safety such as EMERGENCY OFF, EMERGENCY STOP, you may connect two digital inputs to two switching devices of safe sensors and further 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's discrepancy time monitoring is enabled for two-channel applications.

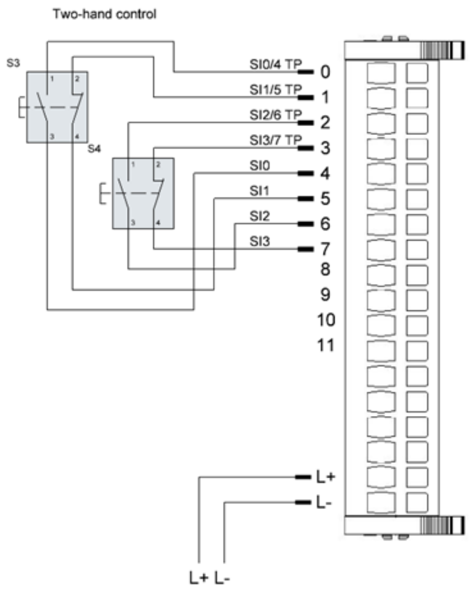
Discrepancy time monitoring: The discrepancy time defines as the maximum length of time both inputs may be in different states without the component interpreting this as a fault. Discrepancy time monitoring starts whenever the state of one input changes. The components will detect a fault if, at the end of the discrepancy time, both 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 solely apply 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. 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 when applying the module's test pulses to two-channel contact-type sensors	
Highest safety integrity level to EN 62061:2010	SIL3
Highest safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 4/PL e
Hardware fault tolerance (HFT) in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

15.3 Two-hand Actuation



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. 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

Software component " FB_TWOHAND_TYP3" 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.

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 solely apply 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. 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 function two-hand operation	
Highest safety integrity level to EN 62061:2010	SIL3
Highest safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 4/PL e
Hardware fault tolerance (HFT) in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

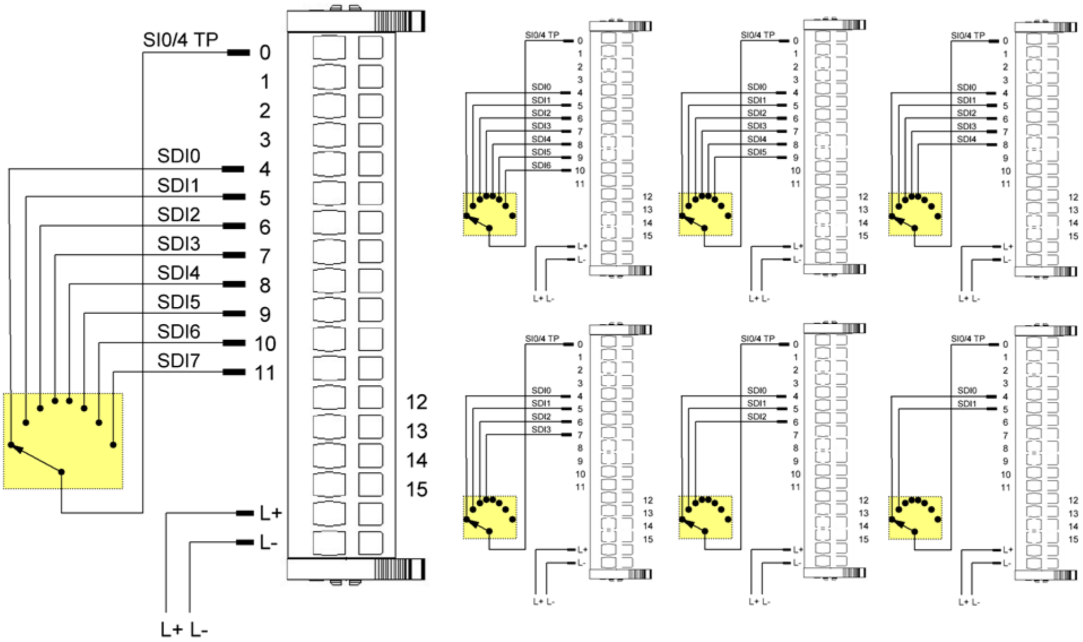
CAUTION

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

⇨ Comply with EN 574 and other requirements and standards published on two-hand circuits.

⇨ Switches/sensors, wiring and application must comply with EN 574.

15.4 Mode Selector, Rotary Table



In mode selector mode "Mode Selector", you may connect 2to 8 inputs of test pulse output SI0/4 TP to a mode selector (test pulse output SI8/12 TP for Rotary Switch 1). 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.

Function "Rotary Switch" can be configured. Refer to manual section ►14.4.3 Input Parameters for further details.

Safety ratings of mode selector applications in conjunction with trusted switches/sensors to EN 13849-2, Table D.3	
Highest safety integrity level to EN 62061:2010	SIL2
Highest 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) in two-channel application (IEC 61508:2010/EN)	0 (a fault of the application may cause the safeguard to fail)

Safety ratings of mode selector applications in conjunction with certified switches/sensors of a matching safety rating	
Highest safety integrity level to EN 62061:2010	SIL3
Highest 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) in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application need not cause the safeguard to fail)

Note, information

Test pulse frequency

In mode selector mode, you can set up parameter "test frequency input" for the input you are using. This will not affect the test pulse frequency because, in test selector mode, that frequency is automatically set to a frequency of 50 Hz

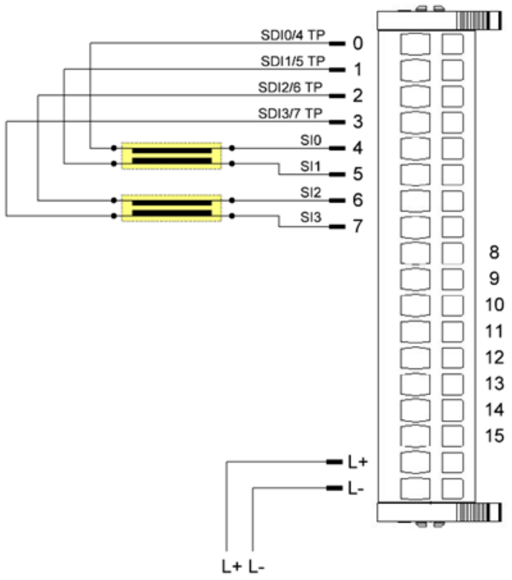
Note, information

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

15.5 Safety Mats, Connecting Blocks and Bumpers

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. The picture illustrates that one area of contact is allocated to one channel and the other area to another channel. Mechanical load on the area of contact makes the inputs connect. This is not interpreted as a short circuit but as actuation. Use FSoE parameter "Safety Mat x" to choose function "Safety Mat" (bumper). Refer to manual section ► 14.4.3 Input Parameters for further details. This mode only supports pressure-sensitive mats working according to the open circuit principle, i.e. the test pulses required to maintain a safe function are supplied by the safe I/O module.



If the safety mat function is used, be sure to set all parameter inputs to InputxExternal.

Function Safety Mat 0 uses inputs SI0, SI1 and test pulse outputs SI0/4 TP and SI1/5 TP for the modes. If so, set up and use inputs SI4 and SI5 as External, i.e. for sensors with their own or without OSSD signals. The pressure-sensitive mat function achieves a response time of 25 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 solely apply 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 a safety 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 of applications using two outputs for a safety function	
Highest safety integrity level to EN 62061:2010	SIL3
Highest safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 4/PL e
Hardware fault tolerance (HFT) in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application cannot cause the safeguard to fail)

CAUTION

Lay the feed lines of pressure-sensitive mats and bumpers together
EMC interference may provoke malfunctions.
In order to avoid influences and malfunctions due to EMC effects, lay the four wires (e.g. Safe-In 0, Safe-In 0/4 TP, Safe-In 1, Safe-In 1/5 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

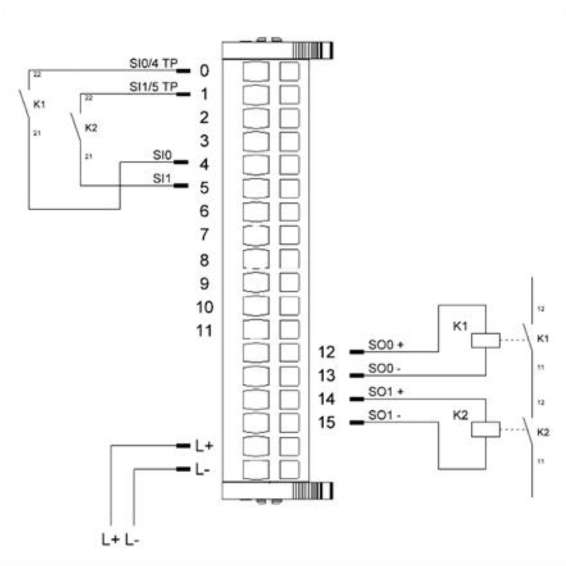
Safety function pressure-sensitive mat requires a response time of 25 ms
Avoid personal injury and damage to property
The pressure-sensitive mat function achieves a response time of 25 ms between a change in mat state and providing the information on the EtherCAT bus.

Note, information

Use of safe inputs along with the pressure-sensitive mats / bumper
Two safe inputs are allocated to every test pulse output. If a pressure-sensitive mat / bumper is used, the inputs not involved in providing the function must not be allocated to the associated test pulse outputs but set up as External Inputs instead.
Example: if SI0, SI0/4 TP, SI1, SI1/5 TP are used, set up the associated partner inputs SI4 and SI5 as External Inputs.

15.6 Connecting Two Actuators with Internal GND Reference

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 external power is supplied to an cross-faults affect the actuator (contact SOX+). Whereas you may set up this circuit without the SOX- terminals, you must ensure that external power and cross-faults are excluded if you do.

In order to monitor the relay states, you must connect the positively drive n.c. contacts of K1 and K2 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 solely apply 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. Only use approved actuators in due consideration of their 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 of applications using two outputs for a safety function	
Highest safety integrity level to EN 62061:2010	SIL3
Highest safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 4/PL e
Hardware fault tolerance (HFT) in two-channel application (IEC 61508:2010/EN)	1 (a fault of the application cannot cause the safeguard to fail)

15.7 Connecting Two Parallel Actuators to One Safe Output

CAUTION

Setting the Test Pulse Rate

In single-channel applications (inputs same as outputs), adapt the test pulse frequency to the application. In applications with frequent changes of state, the test pulse frequency should be at least 100x higher than the time of change of application state.

Refer to section ▶ 14.4.2 FSoE Parameters.

CAUTION

A current of 200 mA (typ.) may be fed back to output SOX+ if external power is supplied and a cross-fault occurs. This fact should be considered when planning the safety function.

The module will recognise external power and cross-faults by the test pulses returned by all inputs and outputs. It will respond by enabling the safe state and turning off all outputs. External power or cross-faults at the outputs will cause current to flow into the module. If external power is supplied "downstream" the actuator (at the SOX connector), this may generate a current flow through the actuator and into the module, which may then activate an actuator.

Take the following precautions if a reverse flow of 200 mA (typ.) may activate the load:

⇨ Use a two-channel actuation of a safety function with two safe outputs. A supply of external power or a cross-fault will be detected and enable the safe state of all module outputs.

⇨ Ensure that the line between the SOX connector and the actuator is laid safely. Preventing external power or a cross-fault between the SOX connector and the actuator will also prevent a dangerous flow of current through the load.

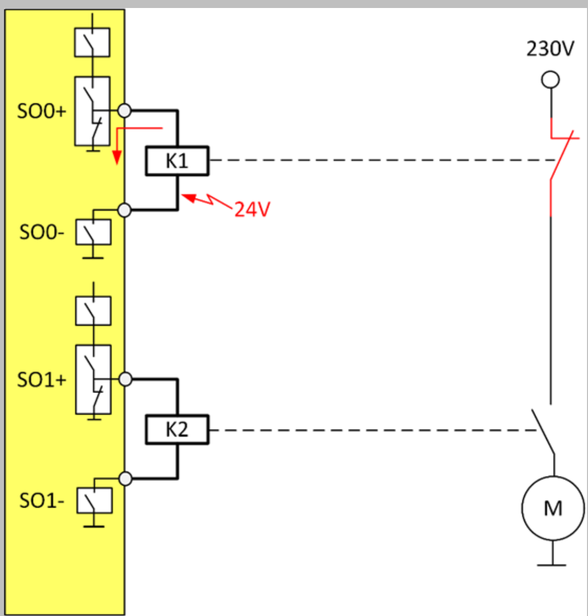
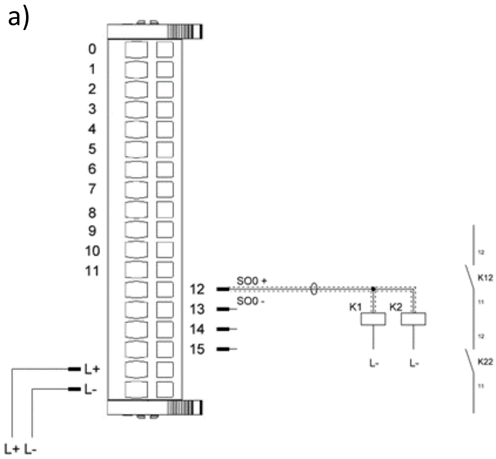
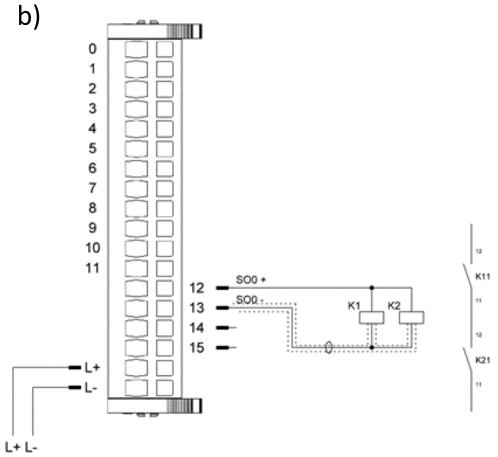


Figure 14: Reverse current potentially provoked by external power

a)



b)



The wiring example illustrates how one output of the safe I/O module is used to actuate a safety function.

Use a two-channel actuator to achieve the safety integrity levels of the table below. Please read the sections below to better understand the wiring examples.

CAUTION

Fault exclusion required - schematic a)

Take precautions against short circuits or cross-faults on the lead connecting the output contact (SOX+) and the safe actuators.

Safely lay the leads, for example.

CAUTION

Consider the fault detection time - schematic a)

Consider a fault detection time of 0.5 ms, which may produce high impulses of this width in case of a fault.

- ⇨ Use a two-channel connection of the outputs for a safety function in case your application responds to these impulses.
- ⇨ Consider an input filter time of 1 ms for the loads you connect.
- ⇨ This will mainly affect safe digital inputs. If an input filter is not used, the higher impedance in relation to other loads may cause a change of state. In this case, an input filter of at least 1 ms will help to ignore an impulse.

CAUTION

Fault exclusion required - schematic b)

Take precautions against short circuits or cross-faults on the lead connecting the output contact (SOXSO0-) and the safe actuators.

Safely lay the leads, for example.

In order to monitor the relay states, you must connect the positively drive n.c. contacts of K1 and K2 to safe digital inputs. Set the safe PLC to analyse the values returned and, thus, the states of the switching devices.

Best safety ratings of applications using one output for a safety function	
Highest safety integrity level to EN 62061:2010	SIL3
Highest safety integrity level to IEC 61508:2010	SIL3
Category and highest performance level to EN ISO 13849-1:2015	Cat. 4/PL e
Hardware fault tolerance (HFT) in single-channel application (IEC 61508:2010/EN)	1 (a fault of the application does not cause the safeguard to fail)

16 Appendix

16.1 Object Dictionary

16.1.1 Device Type 1000_h

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

16.1.2 Error Register 1001_h

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

In case of an error, the associated error bit is set. The EtherCAT I/O map also shows the error register.

Bit	Name
0	Generic Error
1	Current Error
2	Voltage Error
3	Temperature Error
4	Communication Error
5	Profile-specific Error
6	Empty
7	Manufacturer-specific Error

The 8.1.16 decides whether a reset by the software or power cycle is possible.

16.1.3 Predefined Error Field 1003_h

Designation	Value
Name	Predefined Error Field
Index	1003_h
Object Code	VARIABLE
No. of Elements	8
Data Type	UNSIGNED8
Access	Read/Write
PDO Mapping	No

The predefined error field stores the last eight errors that occurred. A power cycle clears the memory.

SubIndex	Data Type	Name
0	UNSIGNED8	Number of Elements
1	UNSIGNED32	Latest Error
2	UNSIGNED32	2nd Error
3	UNSIGNED32	3rd Error
4	UNSIGNED32	4th Error
5	UNSIGNED32	5th Error
6	UNSIGNED32	6th Error
7	UNSIGNED32	7th Error
8	UNSIGNED32	8th Error

16.1.4 Device Name 1008_h

Designation	Value
Name	Device Name
Index	1008_h
Object Code	VARIABLE
No. of Elements	0
Data Type	STRING (27) - STRING (29)
BitSize	216 - 232
Access	Read only
PDO Mapping	No
Value Range	Fix
Default Value	Lenze Safety I/O 164 or Lenze Safety I/O 82 or Lenze Safety I/O 160

16.1.5 Hardware Version 1009_h

Designation	Value
Name	Hardware Version
Index	1009_h
Object Code	VARIABLE
No. of Elements	0
Data Type	STRING (4)
BitSize	32
Access	Read only
PDO Mapping	No
Value Range	Fix
Default Value	312E3130 (1.10)

16.1.6 Software Version $100A_h$

Designation	Value
Name	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	312E3033 (1.03)

16.1.7 Identity Object 1018_h

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

Designation	Value
Name	Identity Object
Index	1018_h
Object Code	RECORD
No. of Elements	5
Data Type	IDENTITY
BitSize	144

Designation	Value
Name	Number of Entries
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	$3B_h$

Designation	Value
Name	Product Code
Subindex	02_h
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	0x43001004 (1124077572– Safety I/O-module SDI16 / SDO4) 0x43000802 (1124075522 – Safety I/O-module SDI8 / SDO2) 0x43001000 (1124077568 – Safety I/O-module SDI16)

Designation	Value
Name	Revision Number
Subindex	03_h
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	$0000000A_h$ (191661 – Safety I/O-module SDI16 / SDO4) 00000008_h (191681 – Safety I/O-module SDI8 / SDO2) 00000008_h (191682 – Safety I/O-module SDI16)

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 nnnnnnnnnnnnnnnnn 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

16.1.8 Supply 24V Voltage 2001_h for CPU1 and 2011_h for CPU2

Designation	Value
Name	Supply 24V Voltage
Index	2001_h / 2011_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

16.1.9 Supply 5 V voltage 2002_h for CPU1 and 2012_h for CPU2

Designation	Value
Name	Supply 5V Voltage
Index	2002_h / 2012_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

16.1.10 Supply 3.3 V voltage 2003_h for CPU1 and 2013_h for CPU2

Designation	Value
Name	Supply 3.3V Voltage
Index	2003_h / 2013_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	mV
Value Range	0 … 65535
Default Value	No default value

16.1.11 Temperature 2004_h for CPU1

Designation	Value
Name	CPU1 Temperature
Index	2004_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Units	0.1 °C
Value Range	0 … 1500
Default Value	No default value

16.1.12 Ext. Temperature 2006_h for CPU1 and 2016_h for CPU1

Designation	Value
Name	External Temperature
Index	2006_h / 2016_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No
Units	0.1 °C
Value Range	0 … 1500
Default Value	No default value

I

Note, information

Only analyse the lowest 16 bit to be shown the temperature.

I

Note, information

The temperature value is not intended for safety-related evaluation.
Do not use in safety functions!

16.1.13 Errorcode 2007_h for CPU1 and 2017_h for CPU2

Designation	Value
Name	Errorcode
Index	2007_h / 2017_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Default Value	0000_h

The table below explains the entries in object 2007_h or 2017_h "Err.code".

Id	Hex	Explanation	
0	0x0000	OK	No error
1	0x0001	HWT_PARAMETER_ERROR	Test library: Parameter Error
2	0x0002	HWT_INIT_ERROR	Test library: Initialisation Error
100	0x0064	HWT_MEM_MARCHC_ERROR	Test library: Error RAM Test
101	0x0065	HWT_MEM_GALPAT_ERROR	Test library: Error RAM Test
200	0x00C8	HWT_STACK_UNDERFLOW_ERROR	Test library: Underflow Error
201	0x00C9	HWT_STACK_OVERFLOW_ERROR	Test library: Overflow Error
300	0x012C	HWT_CPU_ERROR	Test library: CPU Test Error
400	0x0190	HWT_FW_ERROR	Test library: FW Error
500	0x01F4	HWT_FWINTERFACE_ERROR	Test library: FW Interface Error
504	0x01F8	HWT_ADC_ERROR	Test handler: Error in ADC value range checks
505	0x01F9	HWT_DMA_ERROR	Test handler: Error in DMA check
506	0x01FA	HWT_CRC_ERROR	Test handler: Error in CRC check
507	0x01FB	HWT_TIMER_ERROR	Test handler: Error in timer check
508	0x01FC	HWT_CLOCK_ERROR	Test handler: Eerror in clock signal check
509	0x01FD	HWT_SOFTERROR	Soft error detected
510	0x01FE	HWT_DIVZERO	Division by 0
544	0x0220	INIT_ERROR	Initialisation error
576	0x0240	TIMEOUT_ERR	I2C communication timeout detected
578	0x0242	TIMEOUTTIMERERR	Timeout occurred
579	0x0243	POWERUP_TIMEOUT	Timeout occurred while waiting for valid supply voltage values during power up

Id	Hex	Explanation	
672	0x02A0	MRAM_NOT_INITIALIZED	MRAM communication is not initialized.
673	0x02A1	MRAM_READ_ERR	MRAM read error.
674	0x02A2	MRAM_WRITE_ERR	MRAM write error.
675	0x02A3	MRAM_INDEX_OUT_OF_RANGE	MRAM entry index out of valid range.
676	0x02A4	MRAM_CORRUPT_PAGE_SIZE	MRAM page size invalid.
677	0x02A5	MRAM_CRC_ERR	MRAM data CRC check failed.
678	0x02A6	MRAM_MAGICNUMBER_ERR	MRAM magic number not recognized.
768	0x0300	CONF_MAXSWITCH_EXCEEDED	Excessive number of mode selectors
769	0x0301	CONF_MAXSWITCHPOS_EXCEEDED	Excessive number of mode selector positions
770	0x0302	CONF_SWITCH_MAT_ERR	Wrong number of safety mats and mode selectors
771	0x0303	CONF_INP_DURATION_ERR	Wrong input test pulse duration
1344	0x0540	Sync of MC1 and MC2 failed.	CPU Synchronisation Error
1456	0x05B0	MAT_CNTRL_ERR	Mat 0 sequence control detected error
1457	0x05B1	MAT_CNTRL_ERR	Mat 1 sequence control detected error
1458	0x05B3	MAT_CNTRL_ERR	Mat 3 sequence control detected error
1459	0x05B3	MAT_CNTRL_ERR	Mat 3 sequence control detected error
1471	0x05BF	PRG_CNTRL_ERR	Program sequence control detected error
1472	0x05C0	RSW_CNTRL_ERR	Rotary switch control detected error (Input 0).
1473	0x05C1	RSW_CNTRL_ERR	Rotary switch control detected error (Input 1)
1474	0x05C2	RSW_CNTRL_ERR	Rotary switch control detected error (Input 2)
1475	0x05C3	RSW_CNTRL_ERR	Rotary switch control detected error (Input 3)
1476	0x05C4	RSW_CNTRL_ERR	Rotary switch control detected error (Input 4)
1477	0x05C5	RSW_CNTRL_ERR	Rotary switch control detected error (Input 5)
1478	0x05C6	RSW_CNTRL_ERR	Rotary switch control detected error (Input 6)
1479	0x05C7	RSW_CNTRL_ERR	Rotary switch control detected error (Input 7)
1480	0x05C8	RSW_CNTRL_ERR	Rotary switch control detected error (Input 8)
1481	0x05C9	RSW_CNTRL_ERR	Rotary switch control detected error (Input 9)
1482	0x05CA	RSW_CNTRL_ERR	Rotary switch control detected error (Input 10)
1483	0x05CB	RSW_CNTRL_ERR	Rotary switch control detected error (Input 11)
1484	0x05CC	RSW_CNTRL_ERR	Rotary switch control detected error (Input 12)
1485	0x05CD	RSW_CNTRL_ERR	Rotary switch control detected error (Input 13)
1486	0x05CE	RSW_CNTRL_ERR	Rotary switch control detected error (Input 14)
1487	0x05CF	RSW_CNTRL_ERR	Rotary switch control detected error (Input 15
1488	0x05D0	BIST_SEQ_ERR	BIST sequence control detected error.
1504	0x05E0	RESET_LOW_POWER	Reset due to low power supply.
1505	0x05E1	RESET_WINDOW_WD	Reset due to window watchdog.
1506	0x05E2	RESET_INDEPENDENT_WD	Reset due to independent watchdog.
1507	0x05E3	RESET_SW	Reset due to software reset.

Id	Hex	Explanation	
1508	0x05E4	RESET_POWER_ON_DOWN	Reset due to power up or down.
1509	0x05E5	RESET_NMI	Reset due to non maskable interrupt.
1510	0x05E6	RESET_BROWNOUT	Reset due to brown out detection.
1511	0x05E7	RESET_NO_REASON	Reset due to unknown reason.
1537	0x0601	INPUT_TIMEOUT	Input test pulse timed out. (ErrReg 32)
1552	0x0610	INP_EXTMATTE_NOTOK	Safety mat 0 not connected / open load (ErrReg 32).
1553	0x0611	INP_EXTMATTE_NOTOK	Safety mat 1 not connected / open load (ErrReg 32).
1554	0x0612	INP_EXTMATTE_NOTOK	Safety mat 2 not connected / open load (ErrReg 32).
1555	0x0613	INP_EXTMATTE_NOTOK	Safety mat 3 not connected / open load (ErrReg 32).
1568	0x0620	INP_TP_BUSY	Input 0 test pulse operation is busy.
1569	0x0621	INP_TP_BUSY	Input 1 test pulse operation is busy.
1570	0x0622	INP_TP_BUSY	Input 2 test pulse operation is busy.
1571	0x0623	INP_TP_BUSY	Input 3 test pulse operation is busy.
1572	0x0624	INP_TP_BUSY	Input 4 test pulse operation is busy.
1573	0x0625	INP_TP_BUSY	Input 5 test pulse operation is busy.
1574	0x0626	INP_TP_BUSY	Input 6 test pulse operation is busy.
1575	0x0627	INP_TP_BUSY	Input 7 test pulse operation is busy.
1576	0x0628	INP_TP_BUSY	Input 8 test pulse operation is busy.
1577	0x0629	INP_TP_BUSY	Input 9 test pulse operation is busy.
1578	0x062A	INP_TP_BUSY	Input 10 test pulse operation is busy.
1579	0x062B	INP_TP_BUSY	Input 11 test pulse operation is busy.
1580	0x062C	INP_TP_BUSY	Input 12 test pulse operation is busy.
1581	0x062D	INP_TP_BUSY	Input 13 test pulse operation is busy.
1582	0x062E	INP_TP_BUSY	Input 14 test pulse operation is busy.
1583	0x062F	INP_TP_BUSY	Input 15 test pulse operation is busy.
1584	0x0630	INP_TP_CROSSTALK	Input 0 test pulse cross talk detected.
1585	0x0631	INP_TP_CROSSTALK	Input 1 test pulse cross talk detected.
1586	0x0632	INP_TP_CROSSTALK	Input 2 test pulse cross talk detected.
1587	0x0633	INP_TP_CROSSTALK	Input 3 test pulse cross talk detected.
1588	0x0634	INP_TP_CROSSTALK	Input 4 test pulse cross talk detected.
1589	0x0635	INP_TP_CROSSTALK	Input 5 test pulse cross talk detected.
1590	0x0636	INP_TP_CROSSTALK	Input 6 test pulse cross talk detected.
1591	0x0637	INP_TP_CROSSTALK	Input 7 test pulse cross talk detected.
1592	0x0638	INP_TP_CROSSTALK	Input 8 test pulse cross talk detected.
1593	0x0639	INP_TP_CROSSTALK	Input 9 test pulse cross talk detected.
1594	0x063A	INP_TP_CROSSTALK	Input 10 test pulse cross talk detected.
1595	0x063B	INP_TP_CROSSTALK	Input 11 test pulse cross talk detected.
1596	0x063C	INP_TP_CROSSTALK	Input 12 test pulse cross talk detected.

Id	Hex	Explanation	
1597	0x063D	INP_TP_CROSSTALK	Input 13 test pulse cross talk detected.
1598	0x063E	INP_TP_CROSSTALK	Input 14 test pulse cross talk detected.
1599	0x063F	INP_TP_CROSSTALK	Input 15 test pulse cross talk detected.
1600	0x0640	INP_TP_NOT_RECOGNIZED	Safety input 0/4 test pulse not detected (TPO 0).
1601	0x0641	INP_TP_NOT_RECOGNIZED	Safety input 1/5 test pulse not detected (TPO 1).
1602	0x0642	INP_TP_NOT_RECOGNIZED	Safety input 2/6 test pulse not detected (TPO 2).
1603	0x0643	INP_TP_NOT_RECOGNIZED	Safety input 3/7 test pulse not detected (TPO 3).
1604	0x0644	INP_TP_NOT_RECOGNIZED	Safety input 8/12 test pulse not detected (TPO 4).
1605	0x0645	INP_TP_NOT_RECOGNIZED	Safety input 9/13 test pulse not detected (TPO 5).
1606	0x0646	INP_TP_NOT_RECOGNIZED	Safety input 10/14 test pulse not detected (TPO 6).
1607	0x0647	INP_TP_NOT_RECOGNIZED	Safety input 11/15 test pulse not detected (TPO 7).
1616	0x0650	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 0).
1617	0x0651	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 1).
1618	0x0652	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 2).
1619	0x0653	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 3).
1620	0x0654	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 4).
1621	0x0655	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 5).
1622	0x0656	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 6).
1623	0x0657	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 7).
1624	0x0658	INP_TP_INV_CNT_FOR_SEL:	Invalid number of test pulses detected for safety selector switch (Input 8).
1625	0x0659	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 9).
1626	0x065A	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 10).
1627	0x065B	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 11).
1628	0x065C	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 12).
1629	0x065D	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 13).

Id	Hex	Explanation	
1630	0x065E	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 14).
1631	0x065F	INP_TP_INV_CNT_FOR_SEL	Invalid number of test pulses detected for safety selector switch (Input 15).
1632	0x0660	INP_INTTP_NOT_RECOGNIZED	Internal input 0 test pulse not detected.
1633	0x0661	INP_INTTP_NOT_RECOGNIZED	Internal input 1 test pulse not detected.
1634	0x0662	INP_INTTP_NOT_RECOGNIZED	Internal input 2 test pulse not detected.
1635	0x0663	INP_INTTP_NOT_RECOGNIZED	Internal input 3 test pulse not detected.
1636	0x0664	INP_INTTP_NOT_RECOGNIZED	Internal input 4 test pulse not detected.
1637	0x0665	INP_INTTP_NOT_RECOGNIZED	Internal input 5 test pulse not detected.
1638	0x0666	INP_INTTP_NOT_RECOGNIZED	Internal input 6 test pulse not detected.
1639	0x0667	INP_INTTP_NOT_RECOGNIZED	Internal input 7 test pulse not detected.
1640	0x0668	INP_INTTP_NOT_RECOGNIZED	Internal input 8 test pulse not detected.
1641	0x0669	INP_INTTP_NOT_RECOGNIZED	Internal input 9 test pulse not detected.
1642	0x066A	INP_INTTP_NOT_RECOGNIZED	Internal input 10 test pulse not detected.
1643	0x066B	INP_INTTP_NOT_RECOGNIZED	Internal input 11 test pulse not detected.
1644	0x066C	INP_INTTP_NOT_RECOGNIZED	Internal input 12 test pulse not detected.
1645	0x066D	INP_INTTP_NOT_RECOGNIZED	Internal input 13 test pulse not detected.
1646	0x066E	INP_INTTP_NOT_RECOGNIZED	Internal input 14 test pulse not detected.
1647	0x066F	INP_INTTP_NOT_RECOGNIZED	Internal input 15 test pulse not detected.
1648	0x0670	INP_INTTP_CROSSTALK	Internal input 0 test pulse cross talk detected.
1649	0x0671	INP_INTTP_CROSSTALK	Internal input 1 test pulse cross talk detected.
1650	0x0672	INP_INTTP_CROSSTALK	Internal input 2 test pulse cross talk detected.
1651	0x0673	INP_INTTP_CROSSTALK	Internal input 3 test pulse cross talk detected.
1652	0x0674	INP_INTTP_CROSSTALK	Internal input 4 test pulse cross talk detected.
1653	0x0675	INP_INTTP_CROSSTALK	Internal input 5 test pulse cross talk detected.
1654	0x0676	INP_INTTP_CROSSTALK	Internal input 6 test pulse cross talk detected.
1655	0x0677	INP_INTTP_CROSSTALK	Internal input 7 test pulse cross talk detected.
1656	0x0678	INP_INTTP_CROSSTALK	Internal input 8 test pulse cross talk detected.
1657	0x0679	INP_INTTP_CROSSTALK	Internal input 9 test pulse cross talk detected.
1658	0x067A	INP_INTTP_CROSSTALK	Internal input 10 test pulse cross talk detected.
1659	0x067B	INP_INTTP_CROSSTALK	Internal input 11 test pulse cross talk detected.

Id	Hex	Explanation	
1660	0x067C	INP_INTTP_CROSSTALK	Internal input 12 test pulse cross talk detected.
1661	0x067D	INP_INTTP_CROSSTALK	Internal input 13 test pulse cross talk detected.
1662	0x067E	INP_INTTP_CROSSTALK	Internal input 14 test pulse cross talk detected.
1663	0x067F	INP_INTTP_CROSSTALK	Internal input 15 test pulse cross talk detected.
1664	0x0680	SWINP_TP_CROSSTALK	Rotary switch 1 rests at inclined position.
1665	0x0681	SWINP_TP_CROSSTALK	Rotary switch 2 rests at inclined position.
1680	0x0690	SWINP_TP_INV_OUT_WIRING	Rotary switch 1 connected to invalid wired lines.
1681	0x0691	SWINP_TP_INV_OUT_WIRING	Rotary switch 2 connected to invalid wired lines.
1696	0x06A0	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1697	0x06A1	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1698	0x06A2	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1699	0x06A3	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1700	0x06A4	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1701	0x06A5	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1702	0x06A6	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1703	0x06A7	SWINP_TP_NOT_RECOGNIZED	Rotary switch 1 - Internal input test pulse lost.
1704	0x06A8	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1705	0x06A9	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1706	0x06AA	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1707	0x06AB	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1708	0x06AC	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1709	0x06AD	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1710	0x06AE	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1711	0x06AF	SWINP_TP_NOT_RECOGNIZED	Rotary switch 2 - Internal input test pulse lost.
1793	0x0701	OUT_FAILSAFE	Change to fail safe state.
1824	0x0720	OUT_WAITFB	Output 0 test pulse waiting for feedback signal (ErrReg 32).
1825	0x0721	OUT_WAITFB	Output 1 test pulse waiting for feedback signal (ErrReg 32).
1826	0x0722	OUT_WAITFB	Output 2 test pulse waiting for feedback signal (ErrReg 32).
1827	0x0723	OUT_WAITFB	Output 3 test pulse waiting for feedback signal (ErrReg 32).
1840	0x0730	OUT_TIMEOUT	Timeout in handling of output 0 (ErrReg 32).
1841	0x0731	OUT_TIMEOUT	Timeout in handling of output 1 (ErrReg 32).
1842	0x0732	OUT_TIMEOUT	Timeout in handling of output 2 (ErrReg 32).
1843	0x0733	OUT_TIMEOUT	Timeout in handling of output 3 (ErrReg 32).
1856	0x0740	OUT_THERMOERR	Output 0 detected overload signal from output driver chip.

Id	Hex	Explanation	
1857	0x0741	OUT_THERMOERR	Output 1 detected overload signal from output driver chip.
1858	0x0742	OUT_THERMOERR	Output 2 detected overload signal from output driver chip.
1859	0x0743	OUT_THERMOERR	Output 3 detected overload signal from output driver chip.
1872	0x0750	OUT_LSTP_TIMEOUT	Output 0 test pulse of low side switch timed out.
1873	0x0751	OUT_LSTP_TIMEOUT	Output 1 test pulse of low side switch timed out.
1874	0x0752	OUT_LSTP_TIMEOUT	Output 2 test pulse of low side switch timed out.
1875	0x0753	OUT_LSTP_TIMEOUT	Output 3 test pulse of low side switch timed out.
1904	0x0770	OUT_USTP_TIMEOUT	Output 0 test pulse of common high side switch timed out.
1905	0x0771	OUT_USTP_TIMEOUT	Output 1 test pulse of common high side switch timed out.
1906	0x0772	OUT_USTP_TIMEOUT	Output 2 test pulse of common high side switch timed out.
1907	0x0773	OUT_USTP_TIMEOUT	Output 3 test pulse of common high side switch timed out.
1936	0x0790	OUT_OUTP_INIT_ERR	Output 0 init test not OK.
1937	0x0791	OUT_OUTP_INIT_ERR	Output 1 init test not OK.
1938	0x0792	OUT_OUTP_INIT_ERR	Output 2 init test not OK.
1939	0x0793	OUT_OUTP_INIT_ERR	Output 3 init test not OK.
1944	0x0798	OUT_OUTP_US_INIT_ERR	Output 0 Test not OK during test of supiror switch.
1945	0x0799	OUT_OUTP_US_INIT_ERR	Output 1 Test not OK during test of supiror switch.
1946	0x0800	OUT_OUTP_US_INIT_ERR	Output 2 Test not OK during test of supiror switch.
1947	0x0801	OUT_OUTP_US_INIT_ERR	Output 3 Test not OK during test of supiror switch.
1952	0x07A0	OUT_TP_NOT_RECOGNIZED	Output 0 test pulse not detected. (ErrReg 32).
1953	0x07A1	OUT_TP_NOT_RECOGNIZED	Output 1 test pulse not detected. (ErrReg 32).
1954	0x07A2	OUT_TP_NOT_RECOGNIZED	Output 2 test pulse not detected. (ErrReg 32).
1955	0x07A3	OUT_TP_NOT_RECOGNIZED	Output 3 test pulse not detected. (ErrReg 32).
1968	0x07B0	OUT_TP_NOT_ACTIVE	Output 0 test pulse not activated. (ErrReg 32).
1969	0x07B1	OUT_TP_NOT_ACTIVE	Output 1 test pulse not activated. (ErrReg 32).
1970	0x07B2	OUT_TP_NOT_ACTIVE	Output 2 test pulse not activated. (ErrReg 32).
1971	0x07B3	OUT_TP_NOT_ACTIVE	Output 3 test pulse not activated. (ErrReg 32).
2048	0x0800	MAT_PARA_DURATION	Inconsistent time values for test pulses of inputs of mat 0.
2049	0x0801	MAT_PARA_DURATION	Inconsistent time values for test pulses of inputs of mat 1.
2050	0x0802	MAT_PARA_DURATION	Inconsistent time values for test pulses of inputs of mat 2.

Id	Hex	Explanation	
2051	0x0803	MAT_PARA_DURATION	Inconsistent time values for test pulses of inputs of mat 3.
2064	0x0810	MAT_TP_DIFF	Inconsistent test pulses stay present for mat 0.
2065	0x0811	MAT_TP_DIFF	Inconsistent test pulses stay present for mat 1.
2066	0x0812	MAT_TP_DIFF	Inconsistent test pulses stay present for mat 2.
2067	0x0813	MAT_TP_DIFF	Inconsistent test pulses stay present for mat 3.
2528	0x09E0	TESTTIMER_DEVIATION	Runtimes of 1 ms und 1 µs timer deviate more than allowed limit
2529	0x09E1	TESTFUNCTION_TIMEOUT	Call of test function not at expected period time
2530	0x09E2	TST_CALLCNT_INV	Call counts of test functions not at same level
2640	0x0A50	ASSERT_TRUE_ERR	Assertion for expression yields true failed.
2641	0x0A51	ASSERT_NOT_NULL_ERR	Assertion for unequal to NULL failed.
2642	0x0A52	ASSERT_GE_ERR	Assertion for >= comparision failed.
2643	0x0A53	ASSERT_GT_ERR	Assertion for > comparision failed.
2644	0x0A54	ASSERT_LE_ERR	Assertion for <= comparision failed.
2645	0x0A55	ASSERT_LT_ERR	Assertion for < comparision failed.
2646	0x0A56	ASSERT_NE_ERR	Assertion for <> comparision failed.
2647	0x0A57	ASSERT_EQ_ERR	Assertion for = comparision failed.
2648	0x0A58	ASSERT_FALSE_ERR	Assertion for expression yields false failed.
2768	0x0AD0	ADC_REF_LOW	Reference voltage too low.
2769	0x0AD1	ADC_REF_HIGH	Reference voltage too high.
2770	0x0AD2	ADC_24V_LOW	24 V supply voltage too low (< 24V - 15%). (ErrReg 4)
2771	0x0AD3	ADC_24V_HIGH	24 V supply voltage too high (> 24V + 20%). (ErrReg 4)
2772	0x0AD4	ADC_5V_LOW	5 V supply voltage too low. (ErrReg 4)
2773	0x0AD5	ADC_5V_HIGH	5 V supply voltage too high. (ErrReg 4)
2774	0x0AD6	ADC_3_3V_LOW	3.3 V supply voltage too low.
2775	0x0AD7	ADC_3_3V_HIGH	3,3 V supply voltage too high.
2776	0x0AD8	ADC_TEMP_LOW	Temperature too low. (ErrReg 8)
2777	0x0AD9	ADC_TEMP_HIGH	Temperature too high. (ErrReg 8)
2778	0x0ADA	ADC_CURR_HIGH	Total output current too high. (ErrReg 2)
2780	0x0ADC	ADC_SYSTEMP_ERR	Temperature measurement inconsistent at CPU1 and CPU2 (Possible cause_ ground fault / short circuit of the output).
2782	0x0ADE	ADC_RANGE_ERR	AD Range error.
2816	0x0B00	BUSY_WAITING	Busy waiting

Id	Hex	Explanation	
3073	0x0C01	TH_TIMEOUT	Internal test sequence timeout
3088	0x0C10	MC1_ID_INVALID	Identification CPU1 failed
3089	0x0C11	MC2_ID_INVALID	Identification CPU 2 failed
3090	0x0C12	MC3_ID_INVALID	Identification CPU 3 failed
3104	0x0C20	CLK_ERROR	Partner clock frequency is out of valid range
3105	0x0C21	CLK_PARTNER_LOW	Partner clock frequency is below lower limit
3106	0x0C22	CLK_PARTNER_HIGH	Partner clock frequency is above upper limit
3120	0x0C30	HW_REVISION_ERROR	Invalid HW revision detected (the SW currently running is not designed for this HW revision)
3232	0x0CA0	XCOM_NOTREADY	Communication to safety partner CPU not ready / operational
3233	0x0CA1	XCOM_BUSY	Communication to safety partner is busy
3234	0x0CA2	XCOM_NONEWDATA	No new data received from EC master.
3235	0x0CA3	XCOM_CRCERR	Communication to safety partner detected a CRC error
3236	0x0CA4	XCOM_BITERR	Bit (shift) error detected in communication to partner CPU.
3237	0x0CA5	XCOM_TRANSACT_ERR	Transaction numbers not equal error detected in communication to partner CPU.
3298	0x0CE2	ECAT_NONEWDATA	No new data received from safety partner CPU.
3329	0x0D01	OUT_OF_RANGE_ERR	Parameter or value out of allowed range.
3330	0x0D02	OVERWRITE_ERR	Register buffer data overwrite occured.
3344	0x0D10	DIPSW_READERR	DIP switch could not be read
3345	0x0D11	DIPSW_IDINV	XCom id not valid -> XCom out of sync ?
3346	0x0D12	DIPSW_CHANGED	DIP switch setting changed
3347	0x0D13	DIPSW	_XCHGERROR Exchange of address DIP settings failed
3354	0x0D1A	DPSW_ADDRINV	Invalid FSoE address selected (ErrReg 32)
3355	0x0D1C	DIPSW_CMDINV	XCom command not valid -> XCom out of sync ?
3585	0x0E01	ERROR_LINE_DETECTED	Error line set by other MC
3600	0x0E10	FGTSK_ASYNC_ERROR	ForeGround tasks out of sync
3873	0x0F21	FLASH_TIMEOUT	FLASH operation timeout
3874	0x0F22	FLASH_LOCKED	FLASH operation failed because LOCK bit could not be reset
3883	0x0F2B	FLASH_BUSY	FLASH operation busy
3886	0x0F2E	FLASH_ERROR	FLASH operation error
3920	0x0F50	FSOE_RESET_IND	Received FSoE reset indication (ErrReg 16)
3921	0x0F51	FSOE_INVALID_CMD	Received invalid or out of sequence FSoE command (ErrReg 16)

Id	Hex	Explanation	
3922	0x0F52	FSOE_UNKNOWN_CMD	(ErrReg 16)
3923	0x0F53	FSOE_INVALID_CONNID	FSoE frame contains invalid connection id (ErrReg 16)
3924	0x0F54	FSOE_INVALID_CRC	FSoE frame contains invalid CRC (ErrReg 16)
3925	0x0F55	FSOE_WD_EXPIRED	FSoE watchdog timer expired (ErrReg 16)
3926	0x0F56	FSOE_INVALID_ADDRESS	FSoE address set on DIP and as safe parameter are not identical (ErrReg 16)
3927	0x0F57	FSOE_INVALID_DATA	FSoE frame contains invalid data (ErrReg 16)
3928	0x0F58	FSOE_INVALID_COMMPARALEN	Invalid number of FSoE communication parameters (ErrReg 16)
3929	0x0F59	FSOE_INVALID_COMMPARA	Received invalid FSoE communication parameter (ErrReg 16)
3930	0x0F5A	FSOE_INVALID_USERPARALEN	Invalid number of FSoE user parameters (ErrReg 16)
3931	0x0F5B	FSOE_INVALID_USERPARA	Received invalid FSoE user parameter (ErrReg 16)
4048	0x0FD0	FSOE_INVALID_TP_INP_DURATION	Safety parameter input test pulse duration invalid (ErrReg 16)
4049	0x0FD1	FSOE_INVALID_TP_INP_FREQUENCY	Safety parameter input test pulse frequency invalid (ErrReg 16)
4050	0x0FD2	FSOE_INVALID_TP_OUT_DURATION	Safety parameter output test pulse duration invalid (ErrReg 16)
4051	0x0FD3	FSOE_INVALID_TP_OUT_FREQUENCY	Safety parameter output test pulse frequency invalid (ErrReg 16)
4056	0x0FD8	FSOE_INVALID_WATCHDOG_TIME	Safety parameter watchdog time invalid (ErrReg 16)
4057	0x0FD9	FSOE_INVALID_INP_EXT_SUPPLY	Safety parameter for inputs having external supply invalid (ErrReg 16)
4058	0x0FDA	FSOE_INVALID_INP_IN_USE	Safety parameter for inputs in use invalid (ErrReg 16)
4059	0x0FDB	FSOE_INVALID_INP_ USED_EXT_MISMATCH	Safety parameters for inputs in use and externally supplied mismatch (ErrReg 16)
4060	0x0FDC	FSOE_INVALID_OUT_IN_USE	Safety parameter for outputs in use invalid (ErrReg 16)
4061	0x0FDD	FSOE_INVALID_OUT_ USED_EXT_MISMATCH	Safety parameters for outputs in use and externally grounded mismatch (ErrReg: 16)
4064	0x0FE0	FSOE_ERROR	Invalid internal state in safety stack

16.1.14 Errorposition 2008_h for CPU1 and 2018_h for CPU2

Designation	Value
Name	Errorposition
Index	2008_h / 2018_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Default Value	0000h

16.1.15 Errormodule 2009_h for CPU1 and 2019_h for CPU2

Designation	Value
Name	Errormodule
Index	2009_h / 2019_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	00_h

The table below explains the entries in object 2009_h or 2019_h "Err.module".

Id	Explanation	
0	OBJ_UNKNOWN_ID	Error in Module "Unknown module"
4	OBJ_FSOETASK_ID	Error in Module "CFSoETask.cpp"
8	OBJ_INPUT_ID	Error in Module "CInput.cpp"
12	OBJ_MAINTASK_ID	Error in Module "CMainTask.cpp"
16	OBJ_LOGGER_ID	Error in Module "CLogger.cpp"
20	OBJ_SYNCSAFETYPARTNER_ID	Error in Module "CSyncSafetyPartner.cpp"
24	OBJ_XCOM_ID	Error in Module "CXCom.cpp"
26	OBJ_SAFEDATAXCHG_ID	Error in Module "CSafedataExchange.cpp"
28	OBJ_SAFETYHAL_ID	Error in Module "CSafetyHal.cpp"
32	OBJ_USTIMER_ID	Error in Module "CusTimer.cpp"
36	OBJ_MSTIMER_ID	Error in Module "CmsTimer.cpp"
40	OBJ_MICROCONTROLLER_ID	Error in Module "CMicrocontroller.cpp"
48	OBJ_DIPSWITCH_ID	Error in Module "CDIPSwitch.cpp"
52	OBJ_HELPER_ID	Error in Module "CHelper.cpp"

Id	Explanation	
56	OBJ_SYNCLINE_ID	Error in Module "CSyncSafetyPartner.cpp"
60	OBJ_TIMETABLE_ID	Error in Module "CTimeTableManager.cpp"
64	OBJ_TESTHANDLER_ID	Error in Module "CTestHandler.cpp"
68	OBJ_CLOCKTEST_ID	Error in Module "CClockTest.cpp"
72	OBJ_TEMPSENSOR_ID	Error in Module "CTempSensor.cpp"
80	OBJ_TIME_ITERATOR_ID	Error in Module "CTimeTableIterator.cpp"
84	OBJ_INTHANDLER_ID	Error in Module "InterruptHandler.cpp"
85	OBJ_FOREGROUND_ID	Error in Module "CForeGround.cpp"
86	OBJ_BACKGROUND_ID	Error in Module "CBackGround.cpp"
87	OBJ_CONFIG_ID	Error in Module "CConfig.cpp"
88	OBJ_MATMNGR_ID	Error in Module "CMatMngr.cpp"
89	OBJ_SWITMNGR_ID	Error in Module "CSwitMngr.cpp"
96	OBJ_SPI_ID	Error in Module "CSpi.cpp"
97	OBJ_TIMER_ID	Error in Module "CTimer.cpp"
98	OBJ_BACKUPSRAM_ID	Error in Module "CBackupSRam.cpp"
99	OBJ_PWR_ID	Error in Module "CPwr.cpp"
100	OBJ_RCC_ID	Error in Module "CRcc.cpp"
101	OBJ_GPIO_ID	Error in Module "OBJ_GPIO_ID"
102	OBJ_DMA_ID	Error in Module "CDma.cpp"
103	OBJ_ADC_ID	Error in Module "CAdc.cpp"
104	OBJ_WD_ID	Error in Module "CWatchdog.cpp"
105	OBJ_FLASH_ID	Error in Module "CFlash.cpp"
106	OBJ_I2C_ID	Error in Module "CI2c.cpp"
107	OBJ_MRAM_ID	Error in Module "CMRam.cpp"
109	OBJ_EXTI_ID	Error in Module "CExtI.cpp"
110	OBJ_SYSCFG_ID	Error in Module "CSyscfg.cpp"
111	OBJ_NVIC_ID	Error in Module "CNvic.cpp"
112	OBJ_RNG_ID	Error in Module "CRng.cpp"
114	OBJ_FLASHPRG_ID	Error in Module "CFlashProgram.cpp"
120	OBJ_VOLTCHECK_ID	Error in Module "CVoltageCheck.cpp"
121	OBJ_VOLTMEANCHECK_ID	Error in Module "CVoltageMeanCheck.cpp"
122	OBJ_SUPLVOLTCHECK_ID	Error in Module "CSupplyVoltageCheck.cpp"
124	OBJ_DIAG_ID	Error in Module "CDiagnostic.cpp"
126	OBJ_MPUUNPRIV_ID	Error in Module "CMpuUnpriv.cpp"
127	OBJ_MPUPRIV_ID	Error in Module "CMpuPriv.cpp"
128	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp"
129	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 1)"

Id	Explanation	
130	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 2)"
131	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 3)"
132	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 4)"
133	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 5)"
134	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 6)"
135	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 7)"
136	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 8)"
137	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 9)"
138	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 10)"
139	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 11)"
140	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 12)"
141	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 13)"
142	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 14)"
143	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 15)"
144	OBJ_INPUTMNGR_ID	Error in Module " CInputMngr.cpp (Safe-In 16)"
160	OBJ_OUTPUTMNGR_ID	Error in Module "COutputMngr.cpp"
164	OBJ_OUTPUT_USLS_ID	Error in Module "COutput_USLS.cpp"
176	OBJ_BBMAIN_ID	Error in Module "CBBMainTask.cpp"
178	OBJ_ECATAPPIF_ID	Error in Module "ECatApplInterface.cpp"
180	OBJ_BBDIAG_ID	Error in Module "CBBDiagnostic.cpp"
184	OBJ_BBHAL_ID	Error in Module "CBaseBoardHal.cpp"
192	OBJ_IO_TSK_ID	Error in Module "CIO_TaskHandler.cpp"
196	OBJ_GLERRHDL_ID	Error in Module "CGlobalError.cpp"
200	OBJ_ERRHDLR_ID	Error in Module "CErrorHandler.cpp"
219	OBJ_DBGLEDS_ID	Error in Module "CDebugLEDs.cpp"
224	OBJ_ECATSLV_ID	Error in Module "ECATslv.cpp"

16.1.16 Errorclass $200A_h$ for CPU1 and $201A_h$ for CPU2

Designation	Value
Name	Errorclass CPU 1/2
Index	$200A_h$ / $201A_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	00_h

The table below explains the entries in object $200A_h$ or $201A_h$ "Err.class".

Id	Explanation
0	No error
1	Internal, communication, synchronisation, parameter, TP, FB error
2	Test handler error (BIST)
3	External, I/O error (resettable)

16.1.17 System Uptime [s] $200C_h$

Designation	Value
Name	System Uptime
Index	$200C_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32
Access	Read only
PDO Mapping	No
Unit	s
Default Value	No default value

16.1.18 AD Converter Reference Voltage 2010_h

Designation	Value
Name	AD Converter Reference Voltage
Index	2010_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16
Access	Read only
PDO Mapping	No
Unit	mV
Default Value	No default value

16.1.19 EtherCAT Read Errors $0x2020_h$

Designation	Value
Name	EtherCAT Read Errors
Index	2020_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Value	Number of times EtherCAT ASIC read out errors were detected
Default Value	00

16.1.20 Temperature Warning $0x2026_h$

Designation	Value
Name	Temperature Warning
Index	2026_h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Value	5 °C – 50 °C = 0; <5° C or >50 °C = 1
Default Value	No default value

16.1.21 Safe State 0x2055$_h$

Designation	Value
Name	Safe State
Index	2055$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Value	0xF0 (functional operating) – 0x55 (safe state)
Default Value	No default value

16.1.22 Fail Safe Command 0x250E$_h$

Designation	Value
Name	Fail Safe Command
Index	250Eh
Object Code	VARIABLE
No. of Elements	3
Data Type	IDENTITY
BitSize	32

Designation	Value
Name	Number of Entries
Subindex	00h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	No
Default Value	2

Designation	Value
Name	Rx FSoE Command
Subindex	01$_h$
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	Tx PDO
Value	0 Undefined 8 Fail Safe Data 42 Reset 54 Data 78 Session 82 Parameter 100 Connection
Default Value	No default value

Designation	Value
Name	Tx FSoE Command
Subindex	02h
Data Type	UNSIGNED8
Access	Read only
PDO Mapping	Tx PDO
Value	0 Undefined 8 Fail Safe Data 42 Reset 54 Data 78 Session 82 Parameter 100 Connection
Default Value	No default value

16.1.23 Objects - For internal use only

The following objects are objects whose use is not intended by the end user. They are partly used for configuration purposes and are not readable.

Objekt	Bedeutung
0x1010h	Store Parameters
0x1011h	Restore default parameters
0x10F0h	Backup parameter handling
0x10F1h	Error settings
0x10F8h	Timestamp object
0x1600h	FSOE Rx PDO Mapping
0x1601h	'gray' RxPDO-Map
0x1A00h	FSOE Tx PDO Mapping
0x1A01h	'gray' TxPDO-Map
0x1C00h	Sync Manager type
0x1C12h	Rx PDO assign
0x1C13h	Tx PDO assign
0x1C3xh	SyncManager x parameter
0x1C32h	SyncManager 2 parameter
0x1C33h	SyncManager 3 parameter
0x2000h	Ref Voltage für CPU1
0x210Ah	SW Build number
0x2110h	Read number of MC1's CORA test cycles
0x2111h	Read maximum runtime at MC1 of CORA test cycles [s]
0x2120h	Read number of MC2's CORA test cycles
0x2200h	Access log entries
0x2212h	POST error flags of MC1 (sub1) and MC2 (sub2)
0x2220h	MC1 read main loop cycle time and max cycle time
0x2221h	MC2 read main loop cycle time and max cycle time
0x5001h	Id MC1
0x5002h	Id MC2
0x6000h	FSOE Slave Frame Elements, Command, Data, CRC0, ConnectionID
0x6001h	FSOE Inputs
0x7000h	FSOE Master Frame Elements, Command, Data, CRC0, ConnectionID
0x7001h	FSOE Outputs

Objekt	Bedeutung
0x8000h	Input Parameter
0x8001h	Output Parameter
0x8002h	Test pulse duration
0x8003h	Test frequency
0x9001h	FSOE Communication Parameter
0xF980h	Safe Address

16.2 Standards Complied With

16.2.1 Product Standard Applied

- EN 61131-2:2008-04
  Programmable logic controllers – Part 2: Equipment requirements and tests

16.2.2 Safety Standards and Directives

- IEC 61508:2011-02 Parts 1-7
  Functional safety of electrical/electronic/programmable electronic safety-related systems

- EN ISO 13849-1:2016-06
  Safety of machinery – Safety-related parts of control systems
  Part 1: General principles for design

- EN 62061:2016-05
  Safety of machinery - Functional safety of electrical, electronic and programmable electronic safety-related control systems

16.2.3 EMC Standards

EMC immunity to:

- Generic standard EN 61000-6-2:2006-03
  Electromagnetic compatibility (EMC) – Part 6-2: Generic standards - Immunity for industrial environments

- Product standard EN 61131-2:2008-04
  Programmable logic controllers – Part 2: Equipment requirements and tests
  Elevated immunity levels of safety-related applications:

Increased EMC immunity levels for safety-related applications:

For the testing of the safety I / O modules, the following three standards for safety-related applications were taken into account. The interfaces were tested with the highest test levels from the standards.

- Product Standard EN 61131-6:2013-10
  Programmable controllers. Part 6. Functional safety

- EN 61326-3-1:2018-04
  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

- Generic Standard EN 61000-6-7:2015-12
  Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations

EMC noise emission to:

- Generic standard EN 61000-6-4:2011-09
  Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments

- Product standard EN 61131-2:2008-04
  Programmable logic controllers – Part 2: Equipment requirements and tests

16.3 Regulations and Declarations

16.3.1 Mark of Conformity

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

16.4 Approvals

Lenze's Safety I/O-module module has been granted the following permits:

EC Type-Examination by Notified Body according Annex IX of Directive 2006/42/EG	TUV Rheinland, Notified Body for Machinery, NB 0035 EC Type-Examination Certificate Reg.-Nr./No.: 01/205/5581.00/20
UK CA	TÜV Rheinland UK Ltd. UK Type-Examination Certificate Reg.-No.: 01/205U/5581.00/22
$_{c}$UL$_{us}$	File Number E343358
EtherCAT Conformance tested	Conformance and interoperability tests passed at an EtherCAT Test Center (ETC).
RoHS 2011/65/EU	Conforms to RoHS Directive 2011/65/EU limiting the use of certain hazardous substances in electrical and electronic equipment.
S.I. 2012/3032	The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

16.5 Order Specifications

16.5.1 Basic Units

Technical Data			
Safety I/O-module SDI4 SDO2		**C25BAYA42**	
Safe input/output module			
Safety protocol:	FSoE		
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 3 / PL e		
Number of inputs:	4 safe inputs (configurable properties)		
Number of outputs:	2 safe outputs (Imax = 2.0 A)		
Test pulse outputs (OSSD):	4		
Extended diagnostic information:	Via CoE		

Technical Data			
Safety I/O-module SDI8 SDO2		**C25BAYA82**	
Safe input/output module			
Safety protocol:	FSoE		
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 4 / PL e		
Number of inputs:	8 safe inputs (configurable properties)		
Number of outputs:	2 safe outputs (Imax = 0.5 A)		
Test pulse outputs (OSSD):	4		
Extended diagnostic information:	Via CoE		

Technical Data			
Safety I/O-module SDI16		**C25BAYA160**	
Safe input module			
Safety protocol:	FSoE		
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 4 / PL e		
Number of inputs:	16 safe inputs (configurable properties)		
Extended diagnostic information:	Via CoE		

Technical Data			
Safety I/O-module SDI16 SDO4		**C25BAYA164**	
Safe input/output module			
Safety protocol:	FSoE		
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 4 / PL e		
Number of inputs:	16 safe inputs (configurable properties)		
Number of outputs:	4 safe outputs (Imax = 0.5 A)		
Test pulse outputs (OSSD):	8		
Extended diagnostic information:	Via CoE		

16.5.2 Accessories

Technical Data			
Safety controller c250-S		**C25BAYSQ**	
Safety control unit			
Safety protocol:	FSoE		
Safety standard:	IEC 61508 SIL3 and EN ISO 13849-1 Cat. 3 / PL e		
Approvals:	CE, $_{c}UL_{us}$, TÜV Rheinland		
Runtime system:	PLCDesigner RT Safety		
Programming tool:	PLCDesigner v3.15 SP5 or higher with integrated safety function modules		

16.5.3 Spare Parts

There are no spare parts for the Safety I/O-module module.

You are not allowed to repair Lenze's Safety I/O-module module. Please return the defective module to Lenze Automation GmbH.

16.6 Declaration of Conformity

2435000.02

EU-Konformitätserklärung	EU Declaration of Conformity
LENZE SE, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY	
erklärt in alleiniger Verantwortung die Übereinstimmung der Produkte	declares under sole responsibility compliance of the products
C25BAYA82, C25BAYA160, C25BAYA164	
mit der	with the
Maschinenrichtlinie 2006/42/EG Anhang VIII und IX	**Machinery Directive** 2006/42/EC Annex VIII and IX
Angewandte harmonisierte Normen:	**Applied harmonized standards:**

		EN 60204-1	:2018		
	Kategorie 4 Performance Level (PL): PL e	EN ISO 13849-1	:2015	Category 4 Performance Level (PL): PL e	
Sicherheitsfunktionen siehe Betriebsanleitung.	SIL 3	EN 61508 1-7	:2010	SIL 3	For safety functions see manual.
		EN 62061 +AC +A1 +A2	:2005 :2010 :2013 :2015		

Konformitätsbewertung		**Conformity assessment**	
CE 0035	Benannte Stelle	notified body	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
	Zertifikate	Certificates	01/205/5581.03/21
	Gültigkeit	Date of expiry	2025-02

EMV- Richtlinie 2014/30/EU	**EMC Directive** 2014/30/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**
EN 61000-6-7:2015 EN 61131-2:2008	
RoHS- Richtline 2011/65/EU	**RoHS Directive** 2011/65/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**
EN IEC 63000:2018	

Die Sicherheitshinweise der Betriebanleitung sind zu beachten.

The safety instructions of the manual are to be considered.

Die Produkte sind bestimmt zum Einbau in Maschinen. Die Inbetriebnahme ist solange untersagt bis festgestellt wurde, dass die Maschine, in welche diese Produkte eingebaut werden sollen, den Bestimmungen der o.g. EU-Richtlinie entsprechen.

These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned EU Directive.

Ort / Datum Place / date	**Geschäftsführer** Managing Director	**Dokumentationsverantwortlicher** Responsible for documentation
Aerzen 05.08.2021	Dipl.-Ing. Frank Maier	i.V. T. Wedemeyer

Lenze

2462018.00

UK Declaration of Conformity

LENZE SE, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

declares under sole responsibility compliance of the products

Safety I/O Modules C25BAYA82, C25BAYA160, C25BAYA164

with the

The Supply of Machinery (Safety) Regulations 2008 — **S.I. 2008 No. 1597**

Applied designated standards:

	EN 60204-1	:2018	
	EN ISO 13849-1	:2015	Category 4 Performance Level: PL e
For safety functions see manual.	EN 61508 1-7	:2010	
	EN 62061 +AC +A1 +A2	:2005 :2010 :2013 :2015	SIL 3

Conformity assessment

UK CA

notified body	TUV Rheinland UK Ltd 1011 Stratford Road Solihull, B90 4BN
Certificates	01/205U/5581.00/22
Date of expiry	2025-02

The Electromagnetic Compatibility Regulations 2016 — **S.I. 2016 No. 1091**

Applied designated standards:

EN 61000-6-7:2015
EN 61131-2:2007

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 — **S.I. 2012 No. 3032**

Applied designated standards:

EN IEC 63000:2018

Authorised representative
LENZE Ltd., 6, Abbey Court Fraser Road Priory, Business Park, MK44 3WH Bedford

The safety instructions of the manual are to be considered.
These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned Regulations.

Place / date		Chief Technology Officer	Responsible for documentation
Aerzen	29.08.2022	Dipl.-Ing. Frank Maier	i.V. Torsten Wedemeyer