Manual

Safety Field Box SFB-EC

SCHMERSAL

THE DNA OF SAFETY

SCHMERSAL

Table of Contents

1 Introduction

1.1 About this document

1.1.1 Purpose of this document

This manual provides all the information required for mounting, commissioning, safe operation and also disassembly of the safety fieldbox.

This document instructs the technical staff of the machine manufacturer or machine operator on the safe use of the devices.

1.1.2 Further applicable documents

Document	Part number	Location
Operating instructions SFB-EC	103047532	Included in the scope of delivery or downloadable from www.products.schmersal.com [1]
Manual SFB-EC	103047534	Downloadable from www.products.schmersal.com [1]
ESI File	---	Stored in the device and downloadable with the web server or from Internet at www.products.schmersal.com [1]
1) Enter search term "SFB-EC" in the Schmersal Online Catalog at www.products.schmersal.com		

1.1.3 Target group: authorized qualified personnel

All operations described in this manual must be carried out by trained specialist personnel, authorised by the plant operator only.

Please make sure that you have read and understood these manual and the operating instructions and that you know all applicable legislations regarding occupational safety and accident prevention prior to installation and putting the component into operation.

The machine builder must carefully select the harmonised standards to be complied with as well as other technical specifications for the selection, mounting and integration of the components.

1.1.4 Explanation of the symbols used

	⚠ CAUTION
⚠	Failure to comply with this warning notice could lead to failures or malfunctions.

	⚠ WARNING
⚠	Failure to comply with this warning notice could lead to physical injury and/or damage to the machine.

	INFORMATION
i	This symbol is used for identifying useful additional information.

SCHMERSAL

Short form	Meaning
SFB	Safety Field Box
EC	EtherCAT® with FSoE
FSoE	FailSafe over EtherCAT®
ETG	EtherCAT® Technology Group
ESI	EtherCAT Slave Information
PDO	Process Data Object
SDO	Service Data Object
CoE	CANopen over EtherCAT
EoE	Ethernet over EtherCAT
1oo1	1 out of 1, single channel application (IEC 61508)
1oo2	1 out of 2, two channel (redundant) application (IEC 61508)
OSSD	Output Signal Switching Device / safety PNP semiconductor switching output
PELV	Protective Extra Low Voltage / protective extra low voltage with safe isolation

EtherCAT® and Safety over EtherCAT®

"EtherCAT®" and "Safety over EtherCAT®" are registered trademark and patented technology,
 licensed by Beckhoff Automation GmbH, Germany."

1.2 Safety instructions

1.2.1 General safety instructions

The user must observe the safety instructions in this manual and the operating instructions, the country specific installation standards as well as all prevailing safety regulations and accident prevention rules.

	INFORMATION
i	Further technical information can be found in the Schmersal catalogues or in the online catalogue on the Internet at www.products.schmersal.com .

The information contained in this operating instruction manual is provided without liability and is subject to technical modifications.

There are no residual risks, provided that the safety instructions as well as the instructions regarding mounting, commissioning, operation and maintenance are observed.

1.2.2 Appropriate use

The products described in these operating instructions are developed to execute safety-related functions as part of an entire plant or machine. It is the responsibility of the manufacturer of a machine or plant to ensure the correct functionality of the entire machine or plant.

The safety fieldbox must only be used according to the following versions or for applications that are approved by the manufacturer.

Detailed information regarding the range of applications can be found in chapter 2 "Product description".

1.2.3 Warning about misuse

	⚠ WARNING
⚠	In the event of improper or unintended use or tampering, use of the safety fieldbox could expose persons to danger or cause damage to the machine or system components.

	⚠ CAUTION
⚠	The SFB-EC is only for use in LAN, not for connection to telecommunication circuits.

1.2.4 Exclusion of liability

We shall accept no liability for damages and malfunctions resulting from defective mounting or failure to comply with this manual / operating instruction.
The manufacturer shall accept no liability for damages resulting from the use of unauthorized spare parts or accessories.

For safety reasons, invasive work on the device as well as arbitrary repairs, conversions and modifications to the device are strictly forbidden; the manufacturer shall accept no liability for damages resulting from such invasive work, arbitrary repairs, conversions and/or modifications to the device.

2 Product description

2.1 Module description

2.1.1 Purpose, ordering code, module overview

The SFB-EC-8M12-IOP safety fieldbox is designed for connection of up to 8 safety switchgear units with parallel IO signals to a EtherCAT® / FSoE network.

A maximum of 4 BDF200-FB control panels can be connected to the device ports X4 – X7.

⚠	**⚠ WARNING**
	Only safety switchgears are allowed to be connected for which the feedback of an external voltage can be safely excluded.

The safety signals from the connected safety switchgear are forwarded to a safety controller via the safety field bus for evaluation.

For larger safety applications, multiple fieldboxes can be connected to the power supply and field bus in series.

⚠	**⚠ WARNING**
	The user must evaluate and design the safety chain in accordance with the relevant standards and the required safety level.

The non-safe IO signals of the connected devices are connected to the control system via the field bus.

Safety switchgear with parallel IO signals can be connected to device ports X0 - X7.

ℹ	**INFORMATION**
	BDF200-FB control panels can only be connected to device ports X4 - X7.

Ordering code

This manual applies to the following types:

SFB-EC-8M12-IOP

Option	Description
SFB	Safety Field Box
EC	EtherCAT® with FSoE
8M12	8 device ports for M12 connector, 8-pole
IOP	Device connection: I/O parallel

Module overview

Device ports X0 – X3

Device ports X4 – X7
FB-Interface for BDF200-FB

Error-LED X3

Device port X3

Input-LED X3

Error-LED X7

Device port X7

Input-LED X7

Error-LED X2

Device port X2

Input-LED X2

Error-LED X6

Device port X6

Input-LED X6

Error-LED X1

Device port X1

Input-LED X1

Error-LED X5

Device port X5

Input-LED X5

Error-LED X0

Device port X0

Input-LED X0

Error-LED X4

Device port X4

Input-LED X4

SCHMERSAL

Rotary coding switch
FSoE Safety Address

IN EC OUT

LED LINK/ACTIVITY IN

ETHERCAT IN

RUN

ERR

LED LINK/ACTIVITY OUT

ETHERCAT OUT

LED Fieldbox-Diagnosis

LED Field box-Power

Diag

Pwr

LED ETHERCAT RUN

LED ETHERCAT ERROR

Power-IN connector

I Power O

Power-OUT connector

FE connection field box

2 Product description

SCHMERSAL

2.1.2 Safety inputs and test pulse outputs

The SFB-EC-8M12-IOP has two safety inputs and two test pulse outputs for the supply of dry contacts at each of the 8 device ports X0 - X7.

These safety inputs are usable for:

1 channel safety switches (1oo1) with dry NC contacts

- Cross fault monitoring to all other safety inputs of the fieldbox
- Debounce filter / stable time filter for the input signal
- Supply contact by test pulse outputs with test pulse duration 1 ms and test pulse interval 500 ms

2 channel safety switches (1oo2) with dry NC contacts

- Cross fault monitoring to all other safety inputs of the fieldbox
- Debounce filter / stable time filter for the input signals
- Supply contacts by test pulse outputs with test pulse duration 1 ms and test pulse interval 500 ms

2 channel Safety switches (1oo2) with 24 V-PNP solid state outputs (OSSDs)

- **No cross fault monitoring** of the device connection cables by the fieldbox
- Debounce filter / stable time filter for the input signals
- Supply safety inputs of the safety switchgear with 24 VDC **without test pulses**
- When the OSSD is switched on, **negative test pulses** with a length of 10 µs to 1 ms and an interval of 20 ms to 120 s must be sent.

⚠	⚠ **WARNING**
	For safety switchgear with electronic OSSDs, cross fault detection of the device connection cable must be carried out by the safety switchgear!

2.1.3 Safety outputs

The SFB-EC-8M12-IOP has a safety digital output at each of the 8 device ports X0 - X7 for controlling loads up to 0.8 A and a configurable safety signal output for controlling 2-channel safety inputs up to 15 mA.

Safety output via 1 wire (digital output DO)

- Safety digital output (PP switching) up to PL d, for controlling e.g. solenoids in interlocks
- Tested output, short-circuit and overload protected

Safety output via 2 wires (digital output DO and test pulse output Y1)

- Safety digital outputs (2P switching) up to PL e, for controlling e.g. interlocks with 2-channel locking functions or for 2-channel control of safety relay modules, e.g. SRB-E-301ST
- Tested outputs, short-circuit and overload protected

2.1.4 Diagnostic input / FB interface

The SFB-EC-8M12-IOP has one diagnostic input at each of the 8 device ports X0 - X7 for status signals of the connected safety switchgear.

At the 4 device ports X4 - X7 a FB interface is additionally integrated on this input.

The non-safe signals from command and signalling devices, e.g. the BDF200-FB, can be transmitted via the single-wire FB-Interface interface.

FB interface automatically detects if a safety switchgear with integrated FB interface is connected.

2.1.5 FailSafe over EtherCAT® communication

FailSafe over EtherCAT® (FSoE) is a functionally safe expansion of standard communication via EtherCAT®. Communication based on FSoE is safe against alteration, transmission errors and changes to the telegram sequence, etc.

The Safety Field Box SFB-EC is a FSoE module in the EtherCAT® network.

The module establishes a safety communication to a FSoE master and transmits safety data via "FSoE" and functional data via "EtherCAT®".

SCHMERSAL

2.1.6 EtherCAT® Linear topology

The SFB-EC supports the Linear topology.
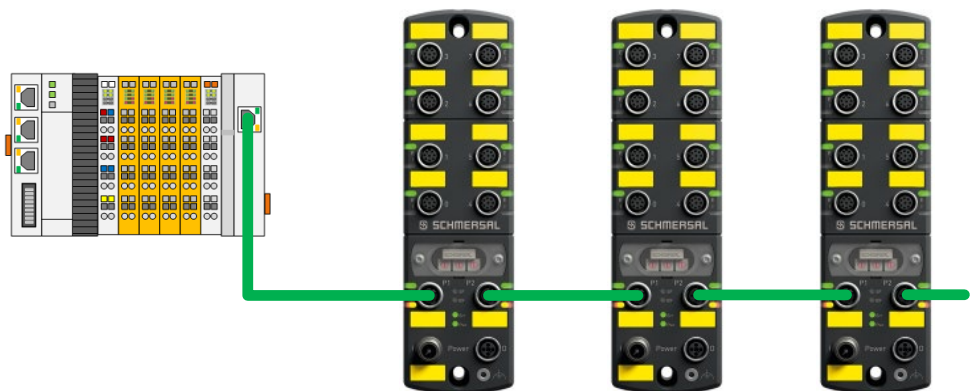
	INFORMATION
i	Further information about the configuration of **Linear topology** can be found in the documentation of your EtherCAT® Master.

2.1.7 System Layout SFB-EC

A typical system layout with the wiring of the safety switchgears is shown in the figure below.
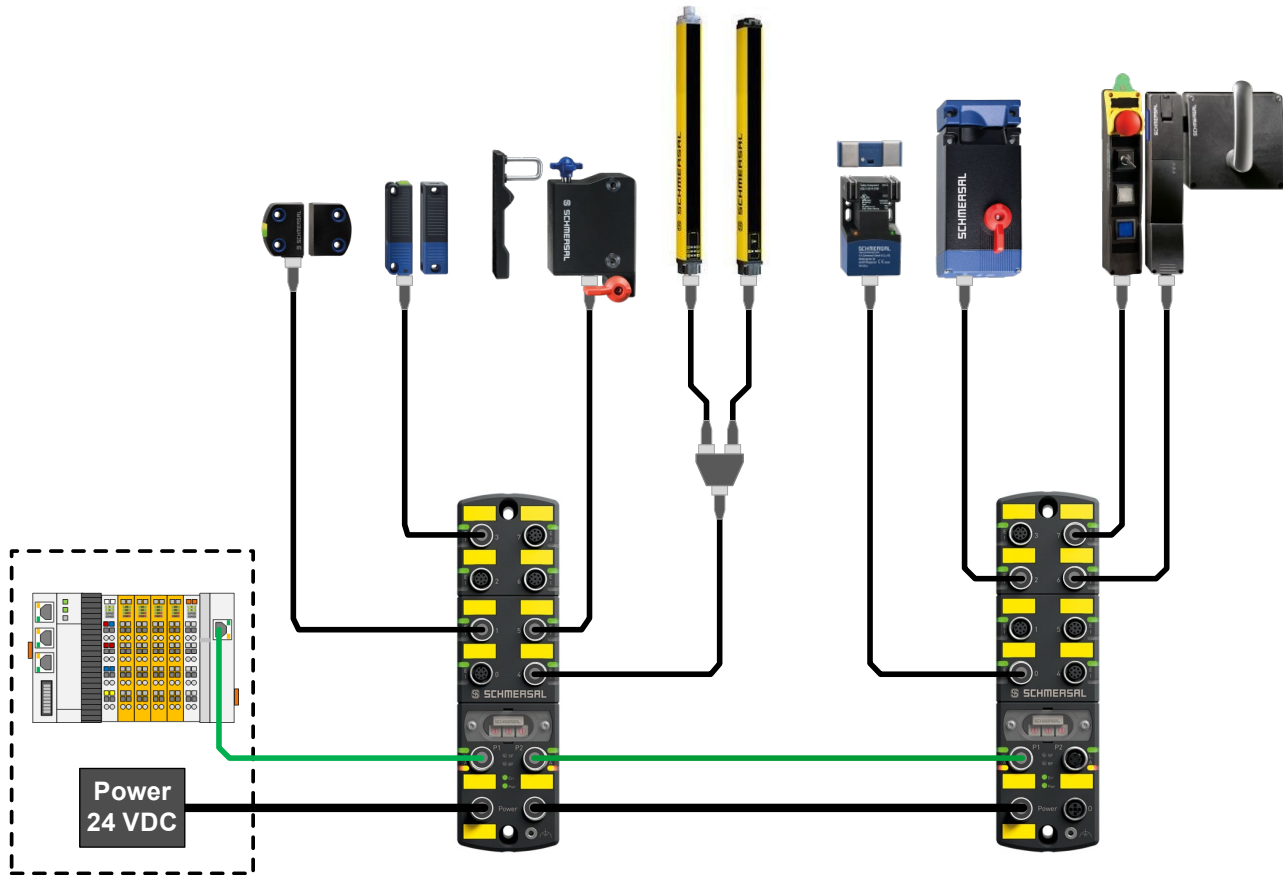
	INFORMATION
ℹ	Further information about the connection of the different safety switchgear can be found in chapter 2.2 and 2.3.

2 Product description **SCHMERSAL**

2.2 Configurable functions SFB-EC

2.2.1 Parameter data sets of the device ports

Four different configurations (Types) can be selected for each device port.

The parameter data sets (Types) are used to configure the device ports for the different safety switchgears.

A debounce filter / stable time filter is integrated for all safety inputs.

The parameters for the stable time filter are fixed for the different parameter data set types.

The operation of the stable time filter is described in chapter 2.2.2.

Type	Device Parameters	Parameters Stable-Time-Filter
A	**Input:** 2 channel OSSD / **Output:** 1 wire	Stable time: 0,1 s / Monitoring time: 2 s
B	**Input:** 2 channel OSSD / **Output:** 2 wires	Stable time: 0,1 s / Monitoring time: 2 s
C	**Input:** 2 channel Contacts / **Output:** 1 wire	Stable time: 0,5 s / Monitoring time: 10 s
D	**Input:** 2x 1 channel Contact / **Output:** 1 wire	Stable time: 0,5 s / Monitoring time: 10 s

Parameter data set Type A, safety monitoring 1oo2

Cross fault detection: OFF / Safety switchgear handles cross fault detection.

– for electronic safety switches and sensors with 2-channel OSSD output
– for electronic solenoid interlocks with 2-channel OSSD output and 1 wire control of the unlocking function

Parameter data set Type B, safety monitoring 1oo2

Cross fault detection: OFF / Safety switchgear handles cross fault detection.

– for electronic solenoid interlocks with 2-channel OSSD output and 2 wires control of the unlocking function
– for Safety-Relay-Modules (SRB-E) with 2 channel safety inputs

⚠	**⚠ WARNING**
	For safety switchgear with electronic OSSDs, cross fault detection of the device connection cable must be carried out by the safety switchgear! The SFB-EC monitors the test pulses on the outputs of the safety switchgear.

Parameter data set Type C, safety monitoring 1oo2

Cross fault detection: ON / SFB handles cross fault detection.

‒ for electromechanics safety switches and sensors with 2 NC contacts
‒ for electromechanics solenoid interlocks with 2 NC contacts and
1 wire control of the unlocking function

Parameter data set Type D, safety monitoring 1oo1

Cross fault detection: ON / SFB handles cross fault detection.

‒ for 2 individual electromechanical safety switches with 1 NC contact

	INFORMATION
i	Further information about the connection of the different safety switchgear can be found in chapter 2.3.

2.2.2 Description stable time filter

The stable time filter is used for bouncing safeguards.

The stable time filter automatically detects when a bouncing safeguard has come to a standstill, in other words when it has come to a "stable" situation.
If a constant switch-on signal is received at both inputs for the duration of the stable time, the safety function is switched on.

In difference to discrepancy time filters, the release of the safety function is only delayed by the set stable time in the stable time filter and the release of the safety function is not time-dependent, but only when the safeguard has actually come to a standstill.

The stability time filter is required for safety switchgear with contacts.
In safety switchgear with electronic OSSDs, the output signals are normally filtered internally.

Operation of the stable time filter when using 2 channel safety inputs

‒ The stability time filter effects an intelligent discrepancy monitoring of the input signals.
‒ If one contact is switched on for the first time, the monitoring time is started.
‒ If both contacts are switched on for the duration of the stable time inside the set monitoring time, the safety function is switched on.
‒ If the contacts do not come to a standstill, the fault message "Discrepancy / stability time fault Device-Port X…" is displayed after the monitoring time has passed.
‒ If only one contact, temporary or permanent, is switched off or the two contacts do not come to a standstill, the fault message is also displayed after the monitoring time has passed.

Operation of the stable time filter when using 1 channel safety inputs

– The stable time filter effects a debounce function for the input signal.
– If the contact is switched on for the first time, the monitoring time is started.
– If the contact is switched on for the duration of the stable time inside the set monitoring time, the safety function is switched on.
– If the contact does not come to a standstill, the fault message "Discrepancy / stability time fault Device-Port X…" is displayed after the monitoring time has passed.
– If the contact switches off temporary or does not come to a standstill, the error message is also displayed after the monitoring time has passed

Frequency limit of the input signal:

The maximum switching frequency of the input signal depends on the adjusted stability time.

The switch-on time and also the switch-off time of the input signal must both be present at the input for at least 2 x the adjusted stable time.

The cut-off frequency of the input signal is therefore 2.5 Hz for the parameter data sets Type A and Type B.

For the parameter data sets Type C and Type D, the cut-off frequency is therefore 0.5 Hz.

2.3 Wiring examples and parameterization

2.3.1 Electronic safety sensor, 8-pole M12 connector

Type A: Safety sensor with electronic OSSD, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	1 wire (PL d)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 – up to Cat 4 / PL e / SIL 3 Output DO: –		

SCHMERSAL devices: CSS range, RSS range, …

2.3.2 Electronic safety sensor / AOPD, 4/5-pole M12 connector

Type A: Safety sensor with electronic OSSD, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	1 wire (PL d)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 – up to Cat 4 / PL e / SIL 3 Output DO: –		

Various safety switchgears from different manufacturers.

SCHMERSAL

2.3.3 Electronic safety interlock, interlock function via 1 wire

Type A: Solenoid interlock with electronic OSSD, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	1 wire (PL d)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 − up to Cat 4 / PL e / SIL 3 Output DO: − up to Cat 3 / PL d / SIL 2		

SCHMERSAL devices: MZM 100, AZM 200, AZM 201, AZM 300, AZM 40, …

2.3.4 Electronic safety interlock, interlock function via 2 wires

Type B: Solenoid interlock with electronic OSSD, monitoring 1oo2

Parameters	Values Type B	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	2 wires (PL e)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 − up to Cat 4 / PL e / SIL 3 Outputs DO & Y1: − up to Cat 4 / PL e / SIL 3		

SCHMERSAL devices: AZM 400, …

	INFORMATION
ℹ	The safety output Y1 can be loaded with a maximum of 15 mA.

2.3.5 Electromechanical safety interlock, interlock function via 1 wire

Type C: Solenoid interlock with dry contacts equivalent, monitoring 1oo2

Parameters	Values Type C	Connection example
Safety inputs	2 channels	
Cross-fault detection	**ON**	
Safety outputs	1 wire (PL d)	
Monitoring time	10 s	
Stable time	0.5 s	
Safety classification Inputs X1 & X2 – up to Cat 4 / PL e / SIL 3 Output DO: – up to Cat 3 / PL d / SIL 2		

SCHMERSAL devices: AZM 161-FB, AZM 170-FB, AZM 150-ST, …

	⚠ WARNING
⚠	For safety switchgear with dry contacts, cross-fault detection must be activated ! **Set to parameter type C.**

2.3.6 Electronic E-STOP and control panels with FB-Interface, 8-pole M12 connector

Type A: E-STOP pushbuttons with electronic OSSD and FB-Interface, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	1 wire (PL d)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 – up to Cat 4 / PL e / SIL 3 Output DO: –		

SCHMERSAL devices: BDF 200-FB, …

SCHMERSAL

2.3.7 Electromechanical safety sensor or safety switch, 4-pole M12 connector

Type C: Safety switch or sensor with dry contacts equivalent, monitoring 1oo2

Parameters	Values Type C	Connection example
Safety inputs	2 channels	
Cross-fault detection	**ON**	
Safety outputs	1 wire (PL d)	
Monitoring time	10 s	
Stable time	0.5 s	
Safety classification Inputs X1 & X2 − up to Cat 4 / PL e / SIL 3 Output DO: −		

SCHMERSAL devices: BNS range, TESK, …

⚠ WARNING
For safety switchgear with dry contacts, cross-fault detection must be activated ! **Set to parameter type C.**

2.3.8 Electromechanical safety switch, 8-pole M12 connector

Type C: Safety switch with dry contacts equivalent, monitoring 1oo2

Parameters	Values Type C	Connection example
Safety inputs	2 channels	
Cross-fault detection	**ON**	
Safety outputs	1 wire (PL d)	
Monitoring time	10 s	
Stable time	0.5 s	
Safety classification Inputs X1 & X2 − up to Cat 4 / PL e / SIL 3 Output DO: − up to Cat 3 / PL d / SIL 2		

SCHMERSAL devices: AZ range, PS range, BDF 100-NH(K), ZQ range, …

⚠ WARNING
For safety switchgear with dry contacts, cross-fault detection must be activated ! **Set to parameter type C.**

2.3.9 Connection of single-channel safety switches

Type D: One or two safety switches 1 channel with dry contacts, monitoring 1oo1

Parameters	Values Type D	Connection example
Safety inputs	1 channel	
Cross-fault detection	**ON**	
Safety outputs	1 wire (PL d)	
Monitoring time	10 s	
Stable time	0.5 s	
Safety classification Inputs X1 & X2 – up to Cat 2 / PL d / SIL 1 Output DO: –		

Various safety switchgear from different manufacturers.

	⚠ WARNING
⚠	For safety switchgear with dry contacts, cross-fault detection must be activated ! **Set to parameter type D.**

2.3.10 Safety-Relay-Module SCHMERSAL SRB-E

Type A: Safety-Relay-Modules with 2 channel safety inputs, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	2 wires (PL e)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 – Outputs DO & Y1: – up to Cat 4 / PL e / SIL 3		

	INFORMATION
i	The safety output Y1 can be loaded with a maximum of 15 mA.

All SCHMERSAL Safety-Relay-Modules of the SRB-E series with 2 inputs for pulsed 24V signals
up to a load of < 15 mA can be connected. (e.g. SRB-E-301ST, SRB-E-201ST/LC, etc.)

2.3.11 Optoelectronic AOPD SCHMERSAL, 4/8-pole M12 connector

Type A: Active opto-electronic protective devices AOPD with electronic OSSD, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	1 wire (PL d)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 − up to Cat 4 / PL e / SIL 3 Output DO: −		

SCHMERSAL devices: SLC 440 range, SLG 440 range, …

2.3.12 Optoelectronic AOPD, 4/5-pole M12 connector

Type A: Active opto-electronic protective devices AOPD with electronic OSSD, monitoring 1oo2

Parameters	Values Type A	Connection example
Safety inputs	2 channels	
Cross-fault detection	OFF	
Safety outputs	1 wire (PL d)	
Monitoring time	2 s	
Stable time	0.1 s	
Safety classification Inputs X1 & X2 − up to Cat 4 / PL e / SIL 3 Output DO: −		

SCHMERSAL devices: SLC 440-COM range, SLG 440-COM range, SLB 440 range, …

2.4 Technical Data

2.4.1 General technical Data

Designation	Value
Standards	EN 61131-1, EN 61131-2, EN 60947-5-3, EN ISO 13849-1, IEC 61508
Time to readiness	≤ 12 s
Reaction Time Safety Input SFB	≤ 30 ms
Reaction Time Safety Output SFB	≤ 50 ms
Device Watchdog Time SFB	12 ms
Device Acknowledgement Time SFB	≤ 25 ms
Materials	
Enclosure	Polyamide / PA 6 GF
Viewing window	Polyamide / PACM 12
Encapsulation	Polyurethane / 2K PU
Labelling plates	Polyamide / PA
Mechanical Data	

Electrical connection version
   Device ports X0 – X7
   Power I/O
   EtherCAT® IN/OUT
	Build in socket / connector
	M12 / 8-pole A-coded
	M12-POWER / 4-pole, T-coded
	M12 / 4-pole, D-coded

M12 connector tightening torque Recommended for SCHMERSAL cables	min. 0.8 Nm / max. 1.5 Nm 1.0 Nm
Fixing screws Tightening torque	2x M6 max. 3.0 Nm
Viewing window screws Tightening torque	2x Torx 10 0.5 … 0.6 Nm
Ambient conditions	
Ambient temperature	-25°C ... +55°C
Storage and transport temperature	-25°C ... +70°C
Relative humidity	10 % … 95 %, non-condensing
Resistance to shock	30 g / 11 ms
Resistance to vibration	5 … 10 Hz, amplitude 3.5 mm 10 … 150 Hz, amplitude 0.35 mm / 5 g
Degree of protection	IP66 / IP67 to EN 60529
Installation altitude above sea level	max. 2,000 m
Protection class	III

Insulation values to EN 60664-1
   Rated insulation voltage U_i
   Rated impulse withstand voltage U_{imp}
   Over-voltage category
   Degree of pollution
	
	32 VDC
	0.8 kV
	III
	3

⚠ CAUTION
Protection class IP66 / IP67 is only reached if all M12 connectors and blanking plugs, as well as the viewing window are properly fastening with screws.

⚠ CAUTION
All fieldboxes have a good resistance against chemicals and oil. When used in aggressive media (e.g. chemicals, oils, lubricants and coolants in high concentrations) the material resistance must in each case be checked in advance for the specific application.

SCHMERSAL

2.4.2 Electrical Data

Designation	Value
Electrical Data – Power I / O	
Supply voltage U_B	24 VDC -15% / +10% (stabilised PELV mains unit)
Rated operating voltage U_e	24 VDC
Current consumption SFB	200 mA
Rated operating current I_e	10 A (external fuse protection required)
Device fuse rating	≤ 10A slow blow when used to UL 61010
Electrical Data – Device ports X0 – X7	
Maximum cable length X0 – X7	30 m
Safety inputs	**X1 and X2**
Switching threshold (acc. EN 61131, type 1)	- 3 V … 5 V (Low) 13 V … 30 V (High)
Current consumption per input	< 10 mA / 24 V
Permissible residual drive current	< 1.0 mA
Accepted test pulse duration on input signal With test pulse interval of	0.01 … 1.0 ms 20 ms … 120 s
Classification	ZVEI CB24I

Sink:		C1		Source:		C1	C2	C3	

Designation	Value
Test pulse outputs	**Y1 and Y2**
Switching elements	p-type, short-circuit proof
Rated operating voltage U_e	24 VDC
Rated operating current I_e	Y1: 15 mA Y2: 10 mA at 24 V / 30 mA at GND
Leakage current I_r	≤ 0.5 mA
Voltage drop U_d	≤ 1 V
Test pulse duration	≤ 1 ms
Test pulse interval	500 ms
Classification	ZVEI CB24I

Sink:		C1		Source:		C1			

Designation	Value
Digital output	**DO**
Switching elements	2 p-type, short-circuit proof
Utilisation category	DC 12 / DC 13
Rated operating voltage U_e	24 VDC
Rated operating current I_e	0.8 A
Leakage current I_r	≤ 0.5 mA
Voltage drop U_d	≤ 2 V
Inductive load	≤ 400 mH
Switching frequency output	≤ 1 Hz
Test pulse duration	≤ 1 ms
Test pulse interval	15 … 500 ms
Classification	ZVEI CB24I

Sink:		C1		Source:		C1			

> ⚠ **CAUTION**
> The sum of the total current of the individual device ports X0 - X7 for outputs A1 (power supply to devices) and DO (digital output) should not exceed 850 mA.

Designation	Value
Diagnostic input / FB interface	**DI**
Switching thresholds	- 3 V … 5 V (Low) 13 V … 30 V (High)
Current consumption per input	< 12 mA / 24 V
Permissible residual drive current	< 1.0 mA
Input debounce filter	10 ms
FB interface data transmission rate	19.2 kBaud
Power supply devices	**A1 and A2**
Rated operating voltage U_e	24 VDC
Rated operating current I_e	0.8 A
Device port line fuse	1.5 A (integrated automatic resettable fuse)
Electrical Data – EtherCAT®	
Field bus protocol	EtherCAT® / FSoE

Specification:
  - EtherCAT®
  - FSoE
	
	V1.0.10
	V1.2.0

Transmission rate	100 Mbit/s Full Duplex
Addressing	Topology dependent
Integrated Switch	Dual Port, 100 Mbit/s
Communication Watchdog-Time (WD-Com), minimum	25 ms
Service interface	WEB-Interface HTTP

2.5 Safety classification

2.5.1 Safety inputs 2 cannels

Designation	Value
Standards	EN ISO 13849-1, IEC 61508, EN 62061
PL	e
Category	4
DC	99 %
PFH	1.1×10^{-9} /h
PFD_{avg}	9.6×10^{-5}
SIL	suitable for SIL 3 applications
Mission time	20 years
Response time of local safety input > EtherCAT	30 ms

The SFB fulfils the requirements as PDDB (proximity switch with defined behaviour under fault conditions) according to EN 60947-5-3 in combination with magnetic sensors (2 NC contacts) up to PL e / SIL 3.

2 Product description

2.5.2   Safety inputs 1-channel

Designation	Value
Standards	EN ISO 13849-1, IEC 61508, EN 62061
PL	d
Category	2
DC	90 %
PFH	2.3×10^{-7} /h
PFD_{avg}	2.0×10^{-2}
SIL	suitable for SIL 1 applications
Mission time	20 years
Response time of local safety input > EtherCAT	30 ms
Test interval for error detection	10 s

2.5.3   Safety outputs 1 wire (PL d)

Designation	Value
Standards	EN ISO 13849-1, IEC 61508, EN 62061
PL	d
Category	3
DC	90 %
PFH	1.0×10^{-7} /h
PFD_{avg}	8.8×10^{-3}
SIL	suitable for SIL 2 applications
Mission time	20 years
EtherCAT reaction time > local safety output	50 ms

2.5.4   Safety outputs 2 wires (PL e)

Designation	Value
Standards	EN ISO 13849-1, IEC 61508, EN 62061
PL	e
Category:	4
DC	99 %
PFH	1.2×10^{-9} /h
PFD_{avg}	1.1×10^{-4}
SIL	suitable for SIL 3 applications
Mission time	20 years
EtherCAT reaction time > local safety output	50 ms

2.5.5 Safety response time SFB-EC

The SFB-EC operates in a modular safety system, which exchanges safety-related data via the Safety-over-EtherCAT protocol.
In the following, the calculation of the safety response time for the complete system is described on the next 3 pages.
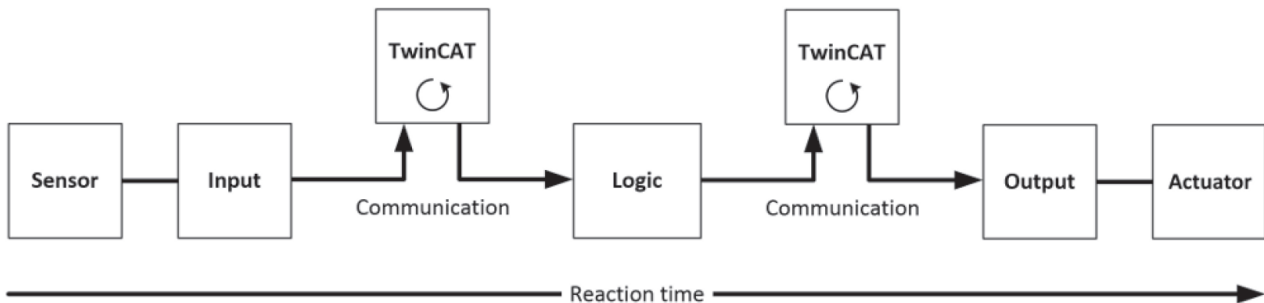
Typical Reaction Time (RT)

The **typical** reaction time is the time required to transmit information from the sensor to the actuator when the complete system is operating **error-free** in normal mode.

The overall reaction time of a safety function is made up of the following individual times:

- RT-Sensor Reaction time of connected safety switchgear
(see operating instructions safety switchgear)

- RT-Input Reaction time of the safety input, e.g. SFB-EC inputs
- WC Delay Time Safety Inputs SFB: ***30 ms***

- RT-Com Reaction time of the communication
This is typically 4x the EtherCAT cycle time, because new data can only be sent in a new Safety-over-EtherCAT telegram.
These times depend directly on the higher-level standard controller (cycle time of the PLC/NC).

- RT-Logic Reaction time of the safety logic (e.g. logic terminal)
This is the cycle time of the safety logic, this is typically 0.5 ms to 10 ms depending on the size of the safety project.
The actual cycle time can be read out from the safety logic (e.g. logic terminal).

- RT-Output Reaction time oft he safety Output,
like e.g. the output terminal or output of the SFB-EC
- WC Delay Time Safety Outputs SFB: ***50 ms***

- RT-Actor Reaction time of the safety shut-off device (Actuator)
(see operating instruction actuator)

⚠ WARNING
In addition to the maximum reaction times of the SFB-EC, the reaction times of the connected safety switchgear, the configured watchdog time of the communication, the reaction time of the safety logic, the reaction time of output and the reaction times of other components, as for example actuators, must be taken into calculation.

⚠ WARNING
The maximum acceptable response times of the safety functions are defined in the risk analysis of the machine!

The "Safety Function Response Time" (SFRT) is the **maximum** time in which the safety system responds to changes in input signals or to module errors.

In order to calculate the reaction time of a safety function, the overall system from the safety switching device to the actuator must always be considered.
(Refer to DIN EN IEC 61784-3-2)
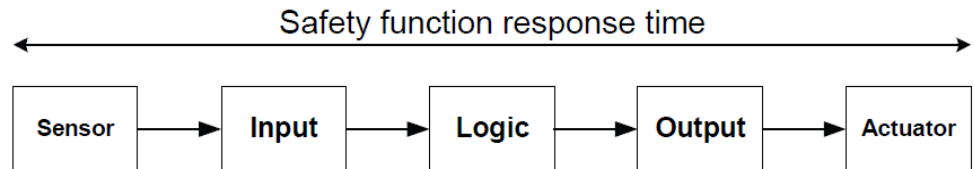
For individual components in the safety function, a risk time or watchdog time (WD_Time) may be specified in the data sheet in addition to the **typical** reaction time.

For a **1-fault safety system**, the **longest watchdog time difference** (ΔT WD_Time) must be added to the sum of all typical reaction times to calculate the Safety Function Response Time (SFRT).

The safety field box SFB-EC has the following specifications:

WC Delay Time Safety Inputs SFB:	30 ms	(Reaction time Safety Input)
WC Delay Time Safety Outputs SFB:	50 ms	(Reaction time Safety Output)
Device Watchdog Time SFB:	12 ms	(Device WD_Time)
Device Acknowledgement Time SFB:	25 ms	(Device ACK_Time)

The configured watchdog time applies to the FSoE master:

The watchdog time for the communication (**WD_Com**) can be found in the tab "Connection" after double clicking on the "Alias-Device" of the SFB.
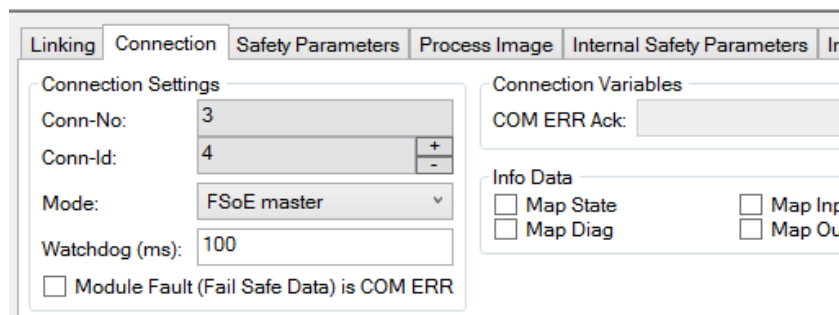
Default value is set to 100 ms !
Setting range Watchdog SFB-EC: 25 - 500 ms

Recommended setting for EtherCAT cycle times ≤ 1 ms: **30 ms !**

INFORMATION
The minimum watchdog time for the SFB-EC is calculated as follows: **SFB ACK-Time (25 ms) + 4x set EtherCAT cycle time** EtherCAT cycle times > 100 ms are not supported !

The watchdog time (WD-Com) must be calculated twice for the SFRT, because the safety outputs are also controlled via the EtherCAT®.

Calculation of the "Safety Function Response Time" (SFRT)

Example:

Calculation of the "Safety Function Response Time" (SFRT)
for a **Safety Input Function** of the SFB-EC:

Based on:

Cycle time EtherCAT:		1 ms	
RT-Com:		4 ms	
WD_Time FSoE-Master:		30 ms	

RT-Sensor:	Safety Sensor	100 ms	(100 ms Reaction Time Sensor)
∆T WD_Time:	*Safety Sensor*	***+100 ms***	*(200 ms Risk Time Sensor)*
RT-Input:	Safety Input SFB	30 ms	(30 ms Reaction Time SFB)
∆T WD_Time:	*Safety Input SFB*	*+12 ms*	*(12 ms WD_Time SFB)*
RT-Com:	Communication	4 ms	(4x Cycle time EtherCAT, 1 ms)
∆T WD_Time:	*2x WD_Com*	*+60 ms*	*(30 ms WD_Time FSoE-Master)*
RT-Logic:	Safety Logic	10 ms	(Cycle time FSoE-Master)
RT-Com:	Communication	4 ms	(4x Cycle time EtherCAT, 1 ms)
RT-Output:	Safety Output	3 ms	(e.g. Output terminal)
Reaction Time:	Output-Switchgear	30 ms	(Power contactor)
Reaction Time:	Actuator	**??? ms**	(e.g. Drive)

Total Reaction Time:	181 ms	
Safety Function Response Time:	**281 ms**	*(+ longest ∆T WD_Time)*

i	**INFORMATION**
	Further information about the typical Reaction Time (RT) and about the Safety Function Response Time (= SFRT) can be found in the documentation of your FSoE Master.

⚠	⚠ **WARNING**
	The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative.

SCHMERSAL

3 Installation

3.1 Mounting

⚠	⚠ **CAUTION**
	The field box must be installed in a way that only authorised specialist personnel can access it.

3.1.1 General mounting instructions

Fasten fieldbox with two M6-screws on a flat mounting surface, for mechanically strain-free installation. The maximum tightening torque is 3.0 Nm.
Any mounting position.

⚠	⚠ **CAUTION**
	Do not install fieldbox outside closed rooms.

3.1.2 Dimensions

All measurements in mm.
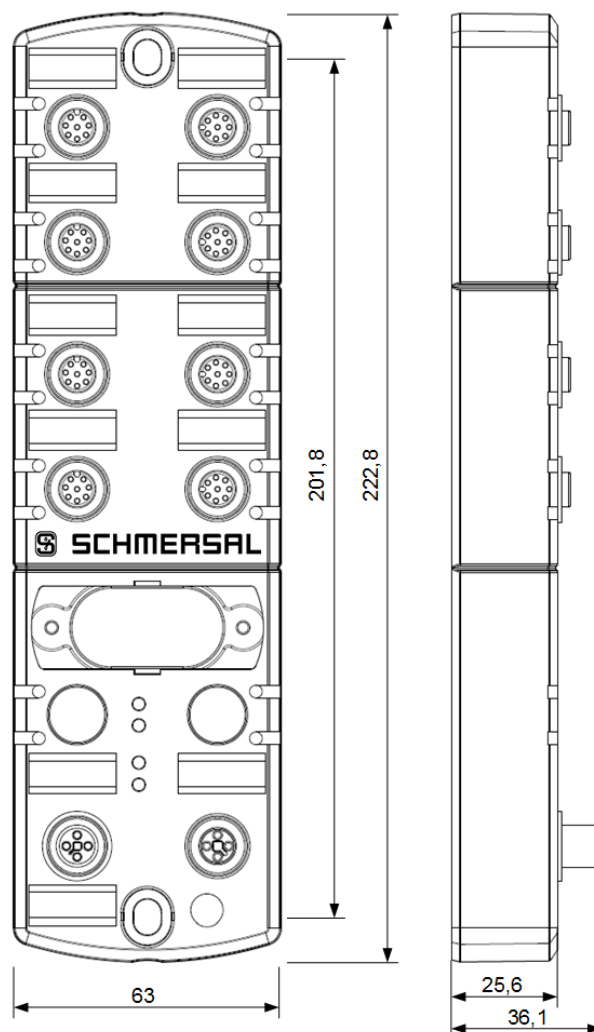
3.1.3 Disassembly and disposal

Only disassemble the safety fieldbox if it is in de-energized state.

Dispose of the safety fieldbox properly in accordance with national regulations and laws.

3.1.4 Accessories

	INFORMATION
i	Further accessories can be found under the search term "SFB-EC" in the Schmersal Online Catalogue at **products.schmersal.com**.

Pre-wired and connecting cables

	Description	Length [m]	Type designation	Part number
M12 Power cables, 4-poe, straight, T-coded	Pre-wired cable, female connector	5,0	**A-K4P-M12P-S-G-5M-BK-2-X-T-4**	**103013430**
		10,0	**A-K4P-M12P-S-G-10M-BK-2-X-T-4**	**103013431**
		20,0	**A-K4P-M12P-S-G-20M-BK-2-X-T-4**	**103038975**
		30,0	**A-K4P-M12P-S-G-30M-BK-2-X-T-4**	**103038976**
	Connecting cable, male / female	1,5	**V-SK4P-M12P-S-G-1,5M-BK-2-X-T-4**	**103025136**
		3,0	**V-SK4P-M12P-S-G-3M-BK-2-X-T-4**	**103013432**
		5,0	**V-SK4P-M12P-S-G-5M-BK-2-X-T-4**	**103013433**
		7,5	**V-SK4P-M12P-S-G-7,5M-BK-2-X-T-4**	**103013434**
		10,0	**V-SK4P-M12P-S-G-10M-BK-2-X-T-4**	**103038978**
M12 Ethernet cables, 4-pole, straight, D-coded, shielded	Connecting cable, RJ45 to M12	5,0	**AIE-S4P-M12/RJ45-S-G-5M-GN-2-X-D-1**	**103013435**
		7,5	**AIE-S4P-M12/RJ45-S-G-7,5M-GN-2-X-D-1**	**103013436**
		10,0	**AIE-S4P-M12/RJ45-S-G-10M-GN-2-X-D-1**	**103013437**
		20,0	**AIE-S4P-M12/RJ45-S-G-20M-GN-2-X-D-1**	**103038980**
	Connecting cable, male / male	1,5	**VIE-SS4P-M12-S-G-1,5M-GN-2-X-D-1**	**103038982**
		3,0	**VIE-SS4P-M12-S-G-3M-GN-2-X-D-1**	**103013438**
		5,0	**VIE-SS4P-M12-S-G-5M-GN-2-X-D-1**	**103013439**
		7,5	**VIE-SS4P-M12-S-G-7,5M-GN-2-X-D-1**	**103013440**
		10,0	**VIE-SS4P-M12-S-G-10M-GN-2-X-D-1**	**103038983**
M12 Device connection cables, 8-pole, straight, A-coded	Connecting cable, male / female	0,5	**V-SK8P-M12-S-G-0,5M-BK-2-X-A-4-69**	**101217786**
		1,0	**V-SK8P-M12-S-G-1M-BK-2-X-A-4-69**	**101217787**
		1,5	**V-SK8P-M12-S-G-1,5M-BK-2-X-A-4-69**	**101217788**
		2,5	**V-SK8P-M12-S-G-2,5M-BK-2-X-A-4-69**	**101217789**
		3,5	**V-SK8P-M12-S-G-3,5M-BK-2-X-A-4-69**	**103013428**
		5,0	**V-SK8P-M12-S-G-5M-BK-2-X-A-4-69**	**101217790**
		7,5	**V-SK8P-M12-S-G-7,5M-BK-2-X-A-4-69**	**103013429**
		10,0	**V-SK8P-M12-S-G-10M-BK-2-X-A-4-69**	**103013125**
		15,0	**V-SK8P-M12-S-G-15M-BK-2-X-A-4-69**	**103038984**
		20,0	**V-SK8P-M12-S-G-20M-BK-2-X-A-4-69**	**103038566**
		30,0	**V-SK8P-M12-S-G-30M-BK-2-X-A-4-69**	**103038567**

Adapter cables

	Description	Length [m]	Type designation	Part number
Adapter connecting cables, 8-pole M12 to 4-pole M12, Sensors with OSSD.	Connecting cable, male / female	2,5	**VFB-SK8P/4P-M12-S-G-2,5M-BK-2-X-A-4**	**103032864**
		5,0	**VFB-SK8P/4P-M12-S-G-5M-BK-2-X-A-4**	**103032865**
Y-Adapter cables for Schmersal AOPD, SLC/G-440, SLC/G-440-COM and SLB-440.	Y-Adapter cable, male / female	1,0	**SFB-Y-SLCG-8P-S-G-1M-BK-2-X-A-4**	**103032867**
		1,0	**SFB-Y-SLCG-COM-8P-S-G-1M- BK-2-X-A-4**	**103032866**

Further accessories

	Description	Amount	Type description	Part number
Further accessories	Labels for PFB/SFB	20 pcs.	**ACC-PFB-SFB-LAB-SN-20PCS-V2**	**103035090**
	M12 Protective caps for PFB/SFB	10 pcs.	**ACC-PFB-SFB-M12-PCAP-10PCS**	**103013920**
	Adhesive seal for PFB/SFB	4 pcs.	**ACC-PFB-SFB-SLLAB-4PCS**	**103013919**

3.2 Electrical connection

3.2.1 General information for electrical connection

⚠ CAUTION
The electrical connection may only be carried out by authorised personnel in a de-energised condition.

To supply the safety fieldbox, M12 power connectors, cables with a cross-section of max. 1.5 mm² can be connected to the fieldbox.

⚠ WARNING
In case of a fault, a voltage of up to 60 V can be applied to the device ports.

3.2.2 Notes for replacing the device

To replace a defective SFB-EC, follow the steps below:

- Bring the machine and the SFB into a de-energized state
- Disconnect all cables and dismount the old device.
- Set the rotary coding switch on the replacement device to the selected TwinSAFE address.
- Close the viewing window, mount the device and install all cables.
- Put the system and SFB back into operation

⚠ WARNING
The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative after a device replacement.

3.2.3   Overview of connections and LED indicators

Device ports X0 – X3

Device ports X4 – X7
FB-Interface for BDF200-FB

Error-LED X3 — Device port X3 — Input-LED X3 — (port 3)

Error-LED X7 — Device port X7 — Input-LED X7 — (port 7)

Error-LED X2 — Device port X2 — Input-LED X2 — (port 2)

Error-LED X6 — Device port X6 — Input-LED X6 — (port 6)

Error-LED X1 — Device port X1 — Input-LED X1 — (port 1)

Error-LED X5 — Device port X5 — Input-LED X5 — (port 5)

Error-LED X0 — Device port X0 — Input-LED X0 — (port 0)

Error-LED X4 — Device port X4 — Input-LED X4 — (port 4)

SCHMERSAL

Rotary coding switch
FSoE Safety Address

LED LINK/ACTIVITY IN — ETHERCAT IN — IN EC OUT — RUN — ERR

LED LINK/ACTIVITY OUT — ETHERCAT OUT

LED Fieldbox-Diagnosis — Diag
LED Fieldbox-Power — Pwr

LED ETHERCAT RUN
LED ETHERCAT ERROR

Power-IN connector — I Power O

Power-OUT connector

FE connection field box

3.2.4   Power supply and fuse protection

The supply voltage of the safety fieldbox is to be protected with a fuse of 10 A.
In order to increase the cable cross section for the supply voltage of the fieldbox, both connections from Us and GND must be connected in parallel. Pins 1 + 4 and 2 + 3 in the fieldbox are bridged.
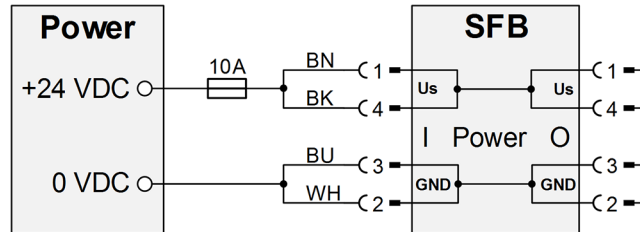
Internal fuse elements device ports

The device ports X0 - X7 are designed for 0.8 A continuous current and equipped in each case with an auto-resettable fuse of 1.5 A for line protection. If the fuse element is triggered, the red LED on the device port flashes with 4 pulses.

After eliminating the overload at one of the device ports, the fuse resets itself after a short cool-down phase.
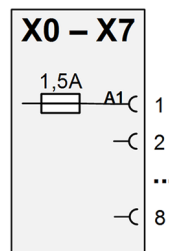
3.2.5   Earth concept and shielding

A functional earth is connected for fault-free operation of the safety fieldbox.
Earth loops must be avoided when connecting the functional earth.

The FE functional earth is normally connected via the switch. In the event of EMC problems, the fieldbox can be earthed via the separate FE connection.
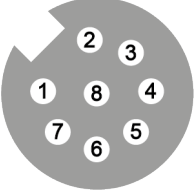
An earth strap is available as an accessory.

Wiring examples for avoidance of earth loops:
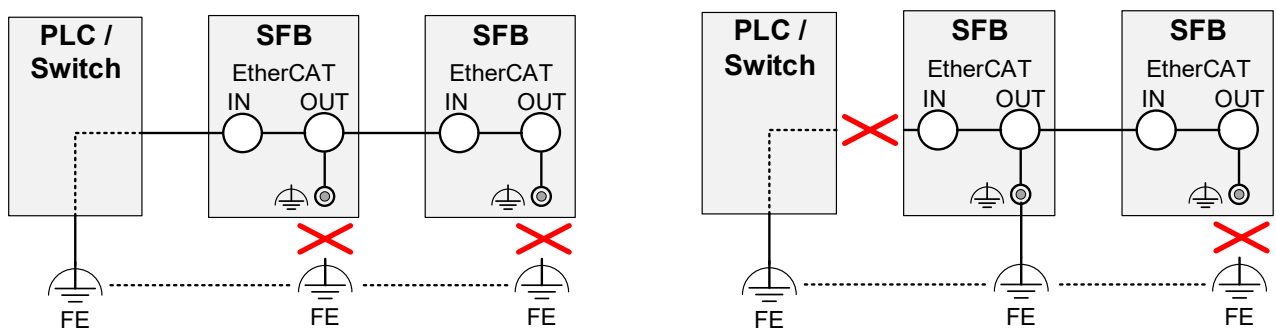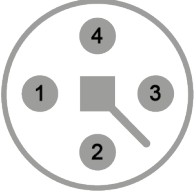
3.2.6   Connector device ports X0 – X7

Version: M12 socket, 8-pin, A-coded

Pin assignment	Pin	Colour	Signal	Description of fieldbox signals
	1	WH	A1	+24 VDC device supply, internal fused, max. 0.8 A
	2	BN	Y1	Test pulse output 1, supply safety channel 1
	3	GN	A2	0 VDC device supply
	4	YE	X1	Safety input 1
	5	GY	DI	Diagnostic input / FB-Interface
	6	PK	Y2	Test pulse output 2, supply safety channel 2
	7	BU	X2	Safety input 2
	8	RD	DO	Safety output, max. 0.8 A

⚠	⚠ CAUTION
	The pulse output / safety output Y1 can be loaded with a maximum of 15 mA at 24 VDC. The pulse output / safety output Y2 can be loaded with a maximum of 10 mA at 24 VDC and of 30 mA at 0 VDC.

⚠	⚠ WARNING
	In case of a fault, a voltage of up to 60 V can be applied to the device ports.
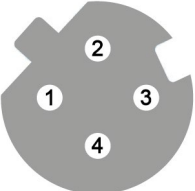
3.2.7   Connector Power I/O

Version: M12-Power connector / socket, 4-pin, T-coded

Pin assignment	Pin	Colour	Signal	Description of fieldbox signals
	1	BN	Us	+24 VDC power supply SFB (bridged with Pin 4)
	2	WH	GND	0 VDC power supply SFB (bridged with Pin 3)
	3	BU	GND	0 VDC power supply SFB (bridged with Pin 2)
	4	BK	Us	+24 VDC power supply SFB (bridged with Pin 1)

3.2.8   Connector EtherCAT IN / OUT

Version: M12 socket, 4-pin, D-coded

Pin assignment	Pin	Colour	Signal	Description of fieldbox signals
	1	YE	TD+	Transmit-Data +
	2	WH	RD+	Receive-Data +
	3	OG	TD-	Transmit-Data -
	4	BU	RD-	Receive Data -
	Flange		FE	Ethernet shielding

Colour code of the SCHMERSAL M12 cables, acc. DIN 47100

M12, 4-pin			M12, 8-pin					
Pin	Wire colour		Pin	Wire colour		Pin	Wire colour	
1	BN	Brown	1	WH	White	5	GY	Grey
2	WH	White	2	BN	Brown	6	PK	Pink
3	BU	Blue	3	GN	Green	7	BU	Blue
4	BK	Black	4	YE	Yellow	8	RD	Red

SCHMERSAL

3.3 LED diagnostic indicators

3.3.1 LED indicators, device ports X0 – X7

There are 2 LED indicators on each device port.

A green/red error LED and a yellow input LED to display the switching condition at the safety inputs.

Error LED device ports (E)

The error LED may exhibit the following display and flashing pattern:

LED	Display	Description
🟢	Green, ON	No fault at device port
(green, striped)	Green, flashes	Device port fault can be acknowledged *Send acknowledgement pulse or power reset*
(red, striped)	Red, flashes 1 pulses	Cross-fault safety inputs *Check cord set and device*
(red, striped)	Red, flashes 2 pulses	Parameter fault / Fault safety inputs *No test pulses, check parameter, cord set and device*
(red, striped)	Red, flashes 3 pulses	Fault test pulse outputs *Check cord set and device*
(red, striped)	Red, flashes 4 pulses	Overload device power supply *Fuse device power supply has tripped, check cord set and device*
(red, striped)	Red, flashes 5 pulses	Overload digital output *Current limiter activated, check cord set and device*
(red, striped)	Red, flashes 6 pulses	Cross-fault digital output *Check cord set and device*
(red, striped)	Red, flashes 7 pulses	Fault FB-Interface (only device port 4-7) *Check cord set and device*

	INFORMATION
ℹ	Some errors can no longer be detected after passivation of the device port. The red flashing patterns for these errors are displayed at the affected port for approx. 60 seconds.

Input-LED device ports (I)

The input LED may exhibit the following display and flashing pattern:

LED	Display	Description
⚪	OFF	Both safety inputs LOW
🟡	Yellow, ON	Both safety inputs HIGH
(yellow, striped)	Yellow, flashes	Only one safety input HIGH, or discrepancy / stable time error

3.3.2   LED indicators, EtherCAT® ports IN/OUT

There is one LED indicator at the Ethernet ports.

A green Link / Activity LED.

Link / Activity LED (L/A)

The Link / Activity LED may exhibit the following display and flashing pattern:

LED	Display	Description
⚪	OFF	No Link active
🟢	Green, flashes 10 Hz	Link and data exchange active
🟢	Green, ON	Link active, but no data exchange
🟢	Green, n Flash	PHY Auto Negoitation Error

3.3.3   Central LED indicators of SFB-EC

There are 4 LEDs for central diagnostics of the fieldbox:

- – (RUN)   = green LED for EtherCAT RUN status
- – (ERR)   = red LED for EtherCAT Error status
- – (Diag)   = green / red dual LED for Fieldbox diagnosis
- – (Pwr)   = green LED for power supply

The RUN-LED and the ERR-LED comply with the specifications according to the ETG.1300.

EtherCAT® RUN status LED (RUN)

The RUN LED shows the operating state of the EtherCAT-State-Machine.

The RUN status LED may exhibit the following display and flashing pattern:

LED	Display	Description
⚪	OFF	INITIALISATION *The SFB is in state: INIT*
🟢	Green, flashes	PRE-OPERATIONAL *The SFB is in state: PRE-OPERATIONAL*
🟢	Green, Single Flash	SAFE-OPERATIONAL *The SFB is in state: SAFE-OPERATIONAL*
🟢	Green, ON	OPERATIONAL *The SFB works error free and is in state: OPERATIONAL*
🟢	Green, flashes 10 Hz	INITIALISATION or BOOTSTRAP *The SFB is booting and is not yet in the state: INIT*

SCHMERSAL

EtherCAT® ERROR status LED (ERR)

The ERR LED shows the error state of the EtherCAT-State-Machine.
The ERROR status LED may exhibit the following display and flashing pattern:

LED	Display	Description
⚪	OFF	No Error *SFB operates without error*
🔴	Red, flashes	Invalid Configuration *General Configuration Error*
🔴	Red, Single Flash	Local Error *SFB has changed to the SafeOpError state*
🔴	Red, Double Flash	Watchdog Timeout *Sync Manager Watchdog Timeout*
🔴	Red, flashes 10 Hz	Booting Error *Booting Error was detected*
🔴	Red, ON	Application Controller Failure *Communication or Application Controller Error detected*

Fieldbox Diagnosis LED (Diag)

The diagnosis LED may exhibit the following display and flashing pattern:

LED	Display	Description
🟢	Green, ON	Fieldbox in RUN
🟢	Green, flashes	Module fault can be acknowledged *Acknowledge via global acknowledgement pulse or by power reset*
🔴	Red, ON	Internal fieldbox fault *Try power reset / module defective*
🔴	Red, flashes 1 pulses	Internal over temperature fault *Check ambient temperature*
🔴	Red, flashes 2 pulses	Fault: Invalid FSoE slave address *Check safety address*
🔴	Red, flashes 3 pulses	Fault: Invalid FSoE CRC *Connection failure*
🔴	Red, flashes 4 pulses	Fault acknowledgement pulse length *Check 500 ms pulse time for acknowledgement*
🔴	Red, flashes 5 pulses	Fault overload test pulse outputs *Check cord set and device*
🔴	Red, flashes 6 pulses	Over voltage fieldbox U > 29 V *Check power supply*

Power-LED fieldbox (Pwr)

The power LED may exhibit the following display and flashing pattern:

LED	Display	Description
🟢	Green, ON	Supply voltage of fieldbox OKAY
🟢	Green, flashes 1 Hz	Low voltage warning U < 20 V *Check power supply*
🟢	Green, flashes 3 Hz	Low voltage fault U < 17 V *Check power supply*
⚪	OFF	Fieldbox switched off U < 12 V or U > 34 V *Check power supply*

4 Set-up

4.1 Set-up and maintenance

4.1.1 Set-up

A check must be carried out to ensure that the projected safety function
is effective.

⚠ WARNING
The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety specialist/safety representative.

4.1.2 Maintenance

The safety fieldbox operates maintenance-free if installed and used properly.

SCHMERSAL

4.2 Configuration of the SFB-EC

4.2.1 Project engineering

The project engineering of the SFB-EC in TwinCAT is done in two data areas:

Cyclic data (PDO)

The cyclic communication transports the safety I/O data and the functional status information via the corresponding "Process Data Object" (PDO).

Acyclic data (SDO)

For the transfer of acyclic data the "Service Data Objects" (SDO) are used with EtherCAT®. For this a mailbox procedure is used, with which the EtherCAT® Master can exchange data with an EtherCAT® Slave.

The SFB-EC transmits the diagnostic history, the device slot parameters, the module status and a timestamp in the "CANopen over EtherCAT" (CoE) service.

The data areas are described in chapter 4.3.1 and 4.3.2.

The project engineering of the SFB-EC should be done in the following steps

– Copy ESI file of SFB-EC to TwinCAT directory
– Set designated TwinSafe address on the SFB (refer to chapter 4.2.11)
– Connect and configure EtherCAT master with TwinCAT
– Add SFB-EC as EtherCAT device
– Make EoE settings
– Link Signal "Acknowledge Fault"
– Create and configure a TwinSAFE project
– Create and configure FSoE connection
– Configuring the safety parameters of the SFB-EC device ports
– Project engineering of the TwinSAFE group and error acknowledgement
– Linking the Group Ports
– Programming the safety logic
– Download of the project in the FSoE Master
– Implementing a program for the acknowledgement of module faults and device port faults

	INFORMATION
i	Further information about the project engineering can be found in the documentation of your EtherCAT® master and your FSoE Master. For comprehensive documentation, please refer to the Beckhoff Information System: https://infosys.beckhoff.com/

	⚠ WARNING
⚠	The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative.

4.2.2 Install ESI file

The device data required for project planning is saved in ESI files
(**E**therCAT **S**lave **I**nformation).

You will find the ESI file for the SFB-EC:

− Online at www.products.schmersal.com / search keyword "SFB-EC"

− Downloadable from device via the web server info page (Refer to chapter 6)

the documentation of your EtherCAT® Master you will find the procedure to
import ESI files.

All device description files are located within a TwinCAT installation.

The default folder for this is:
C:\TwinCAT\3.1\Config\Io\EtherCAT

- Copy the device description file of the SFB for EtherCAT® into the
  corresponding TwinCAT folder

- Restart TwinCAT or select in the menu item:
  „TWINCAT" -> „EtherCAT Devices" -> „Reload Device Descriptions"

SCHMERSAL

4.2.3 Connecting EtherCAT® Master with TwinCAT

Create the connection with your EtherCAT® Master (target system) in the TwinCAT user interface.
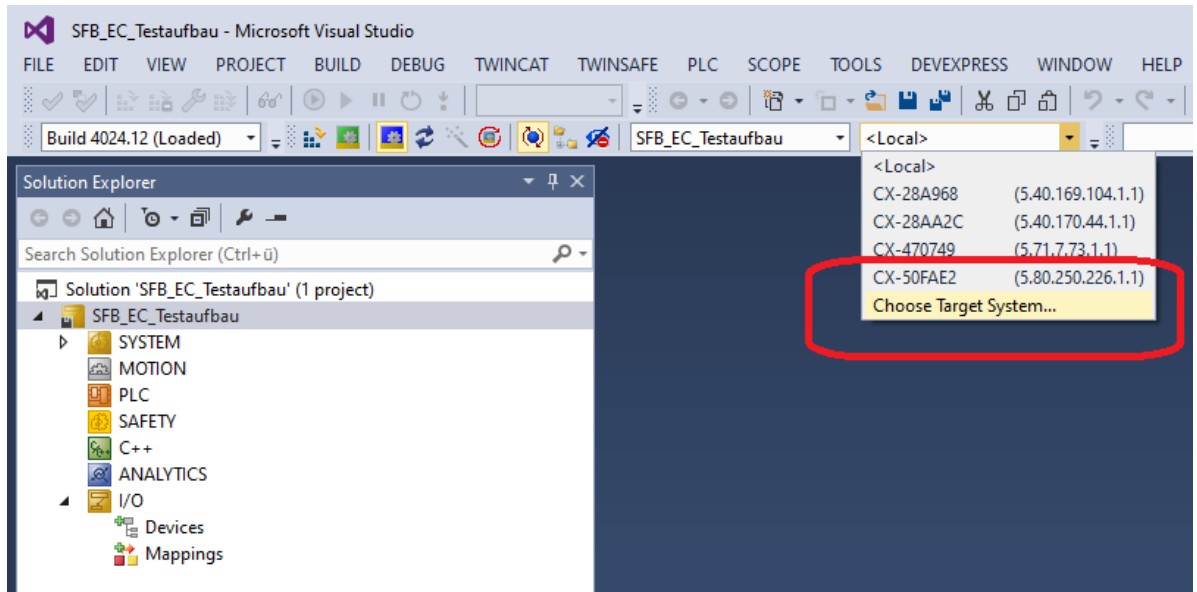
Choose the relevant device in the dialog and confirm with OK.
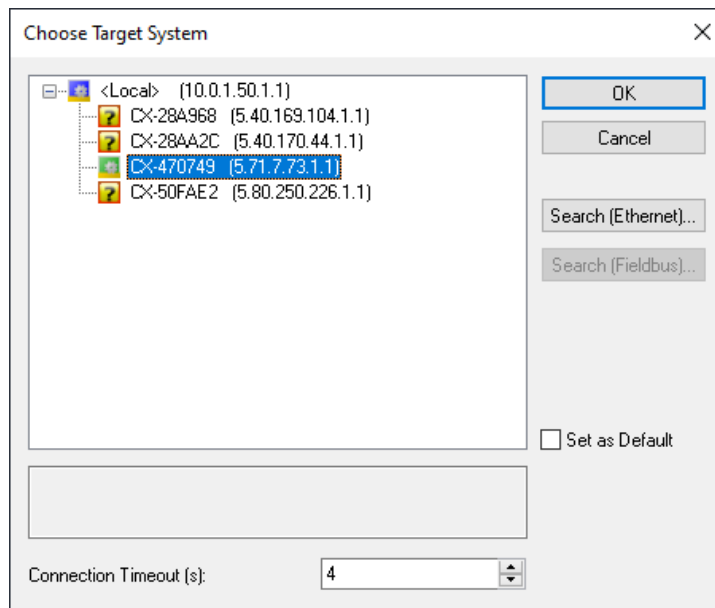
If the device is not listed, it can be searched for in the network via the "Search (Ethernet)" button.

A following message to change the platform must be confirmed.

	INFORMATION
ℹ️	TwinCAT allows a local network card to be operated as an EtherCAT® Master, so that no additional hardware such as an external EtherCAT® master is required.

	⚠ CAUTION
⚠️	Never choose a network card used for a local Ethernet (e.g. Intranet) for operation with EtherCAT®.

4.2.4   Activate TwinCAT Config Mode

Changes to the configuration of the devices can only be made in TwinCAT if Config Mode has been activated.

Select the Config Mode menu item from the menu bar or click on the icon in the toolbar.
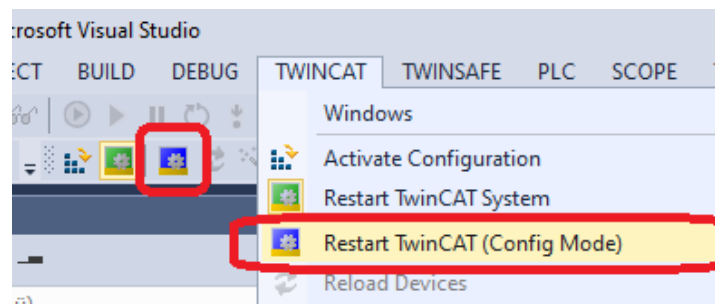
The symbol at the lower right side of the status bar gives information about the operating mode of the Master.

Run   **Config**   **Error**

SCHMERSAL

4.2.5 Device scan EtherCAT® devices

Via a device scan all connected EtherCAT® devices can be listed in their correct topology.

This method only works if the system structure is already complete and the devices can be accessed online.

Right-click on "Devices" in the Solution Explorer and select the "Scan" option.
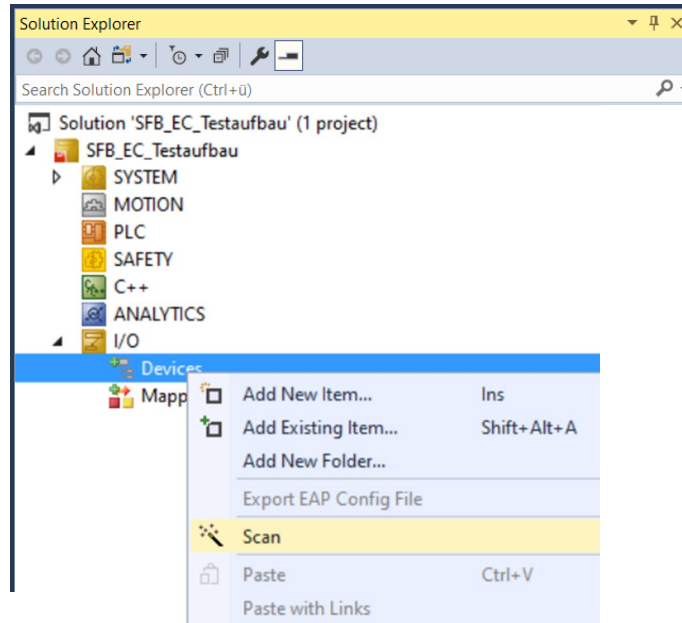
Depending on the Master device the Ethernet interface of the Master must be selected:
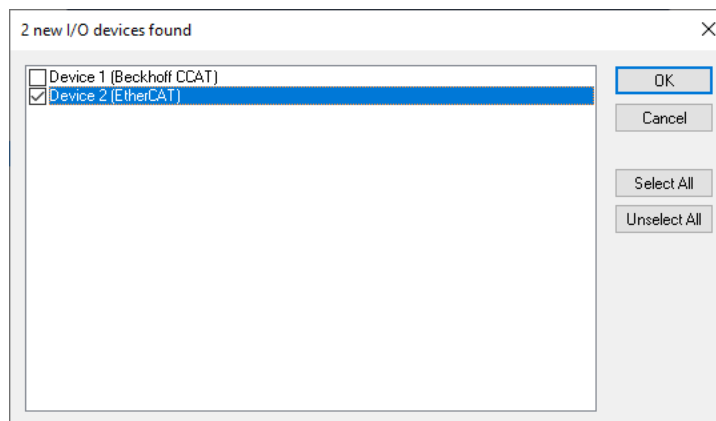
Select here „Device 2 (EtherCAT)".
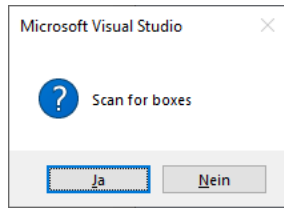
The following automatic request "Scan for Boxes" can be confirmed with "Yes".
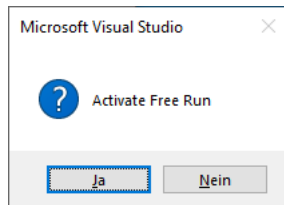
The Free Run mode can be activated after a scan.

After scanning, all devices are displayed in the Solution Explorer hierarchy.

4 Set-up   **SCHMERSAL**
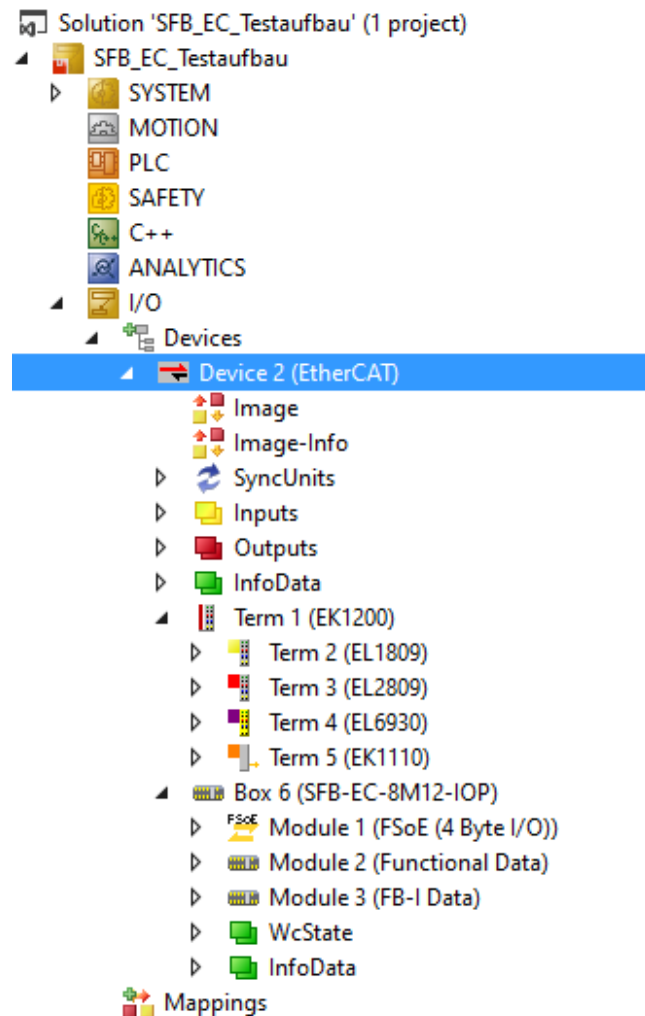
	INFORMATION
	If devices are already present, TwinCAT shows the changes compared to the configuration in a comparison view.
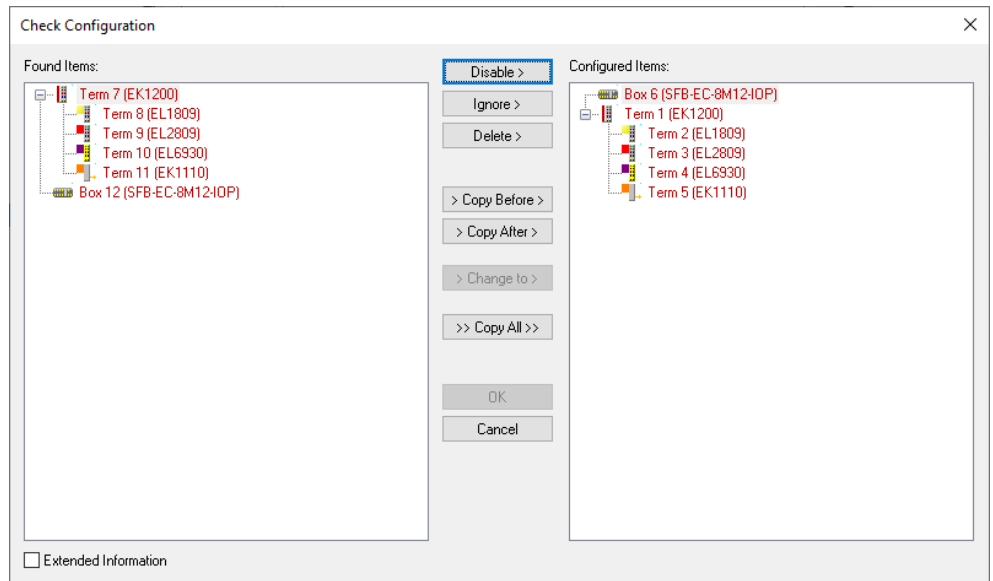
By the option **">> Copy All >>"** the scanned device configuration can be transferred.
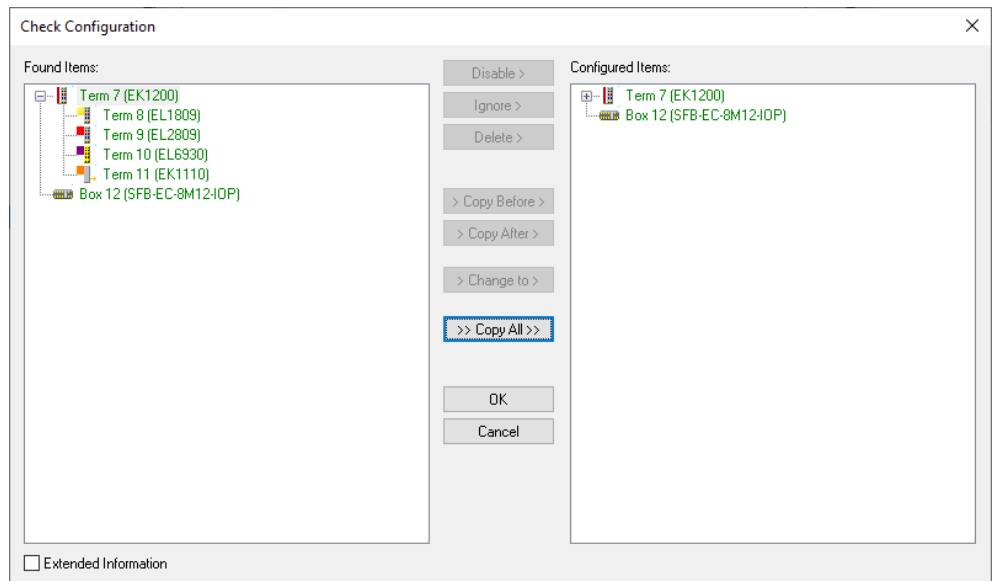
If the selection is identical, the selection is green or a corresponding message is displayed.
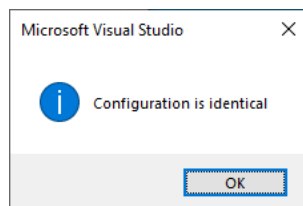
4.2.6 Manual adding EtherCAT® Device

An EtherCAT® device can also be added manually to the configuration.

For this click with the right mouse button in the Solution Explorer on the EtherCAT® Master and select "Add New Item".
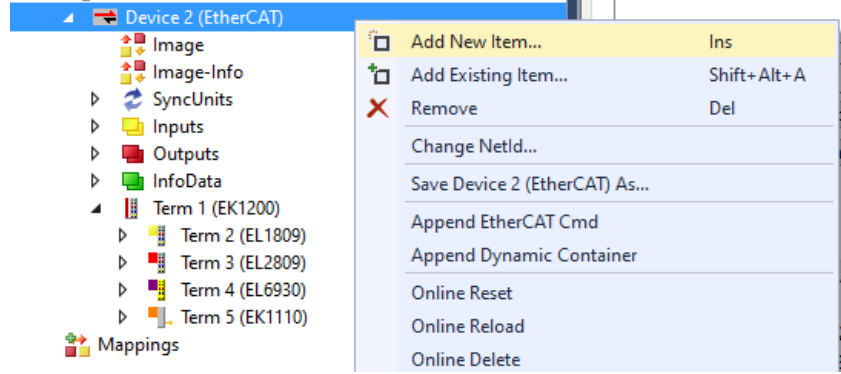
In the selection, the SFB can be found by navigation or by using the "Search" field.
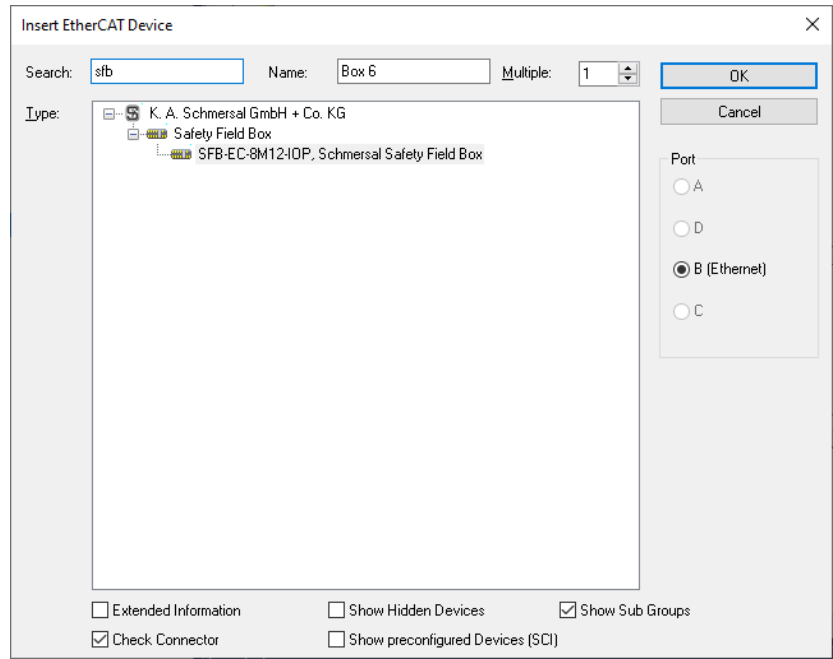
Select the device and click OK.

After adding or scanning devices, the current device hierarchy must first be activated by restarting the TwinCAT system.

Click on "Restart TwinCAT (Config Mode)" in the "TWINCAT" menu.

	INFORMATION
i	The physical device topology must be observed when adding devices. Therefore make sure that - in order - each device is connected from EtherCAT-Out to EtherCAT-In port.

4.2.7 Configure EoE service

To access the WebServer of the SFB, the IP settings of the device must be set in the EoE service.

Select the SFB in the Solution Explorer and click on "Advanced Settings" in the "EtherCAT" tab.
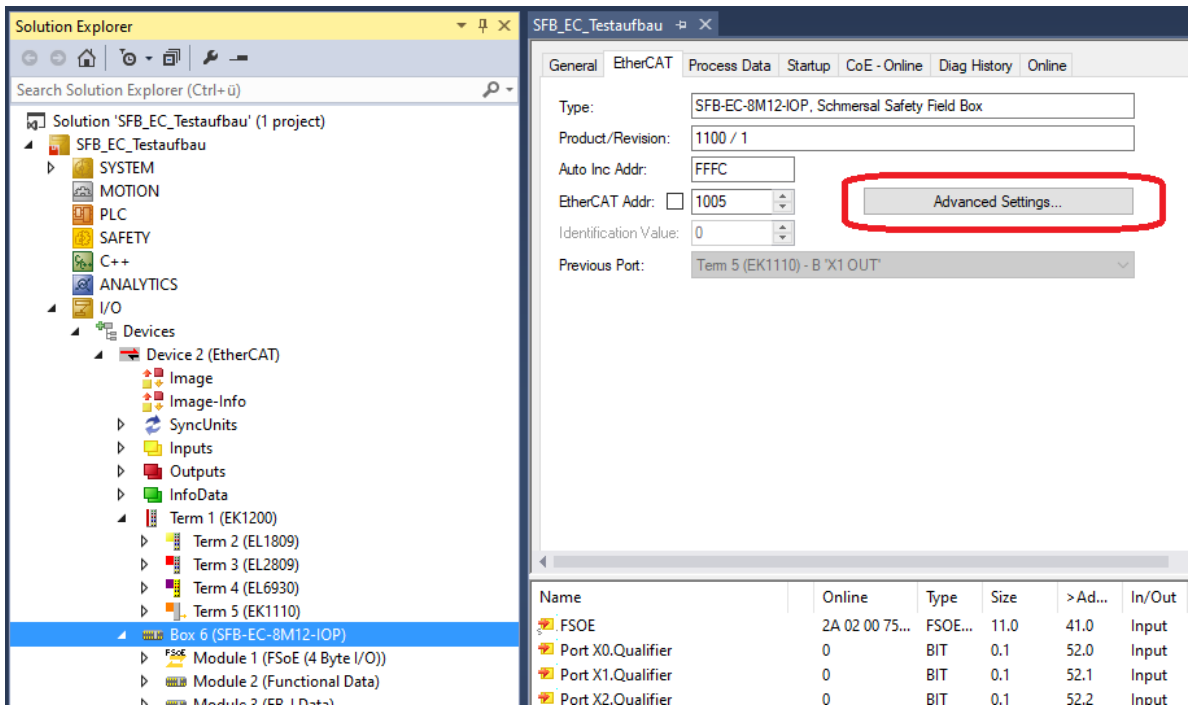
Select the menu item "Mailbox -> EoE" in the opened dialog.
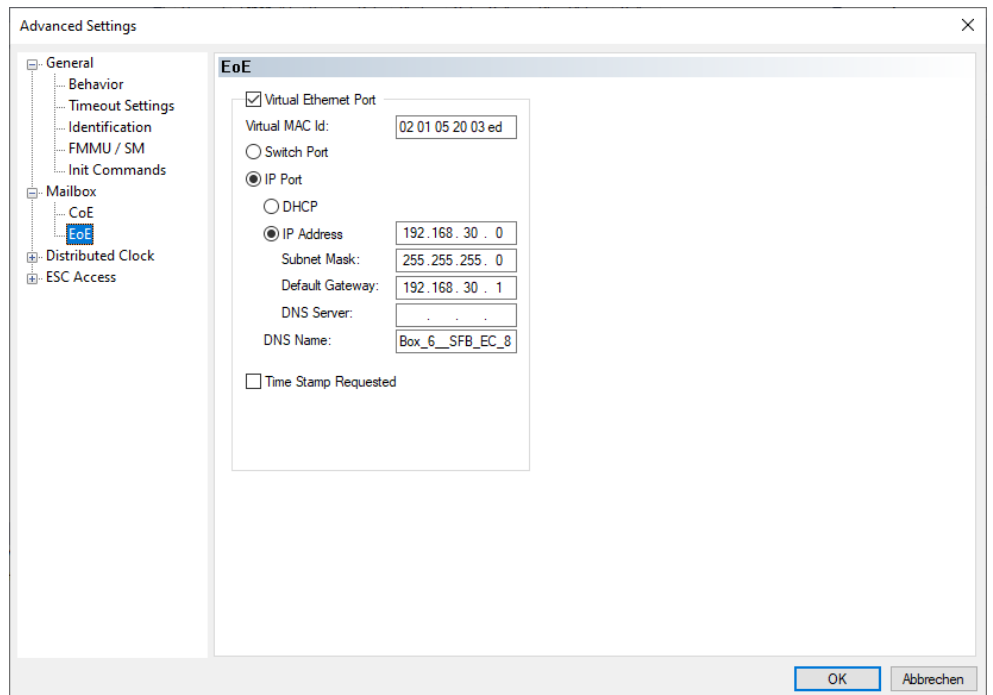
After a scan, the IP address of the gateway (= Ethernet port of the CX) is already entered.

The IP address of the SFB-EC is still not valid.

Enter a valid IP address for the SFB-EC.

The web page of the device can now be accessed via an Internet browser.

The EoE service can be disabled by deselecting the "Virtual Ethernet Port" option.

	INFORMATION
i	If an external device is used as an EtherCAT® master (e.g. Beckhoff CX), it must be configured as a TCP/IP gateway in order to achieve external access to a device in the EtherCAT® fieldbus via EoE. In addition, the corresponding routing setting must be made on the source PC.

SCHMERSAL

4.2.8 Link Acknowledge Fault

The signal Acknowledge Fault is provided as PDO of the SFB to acknowledge present faults.
It is necessary during project engineering and must be linked to an input.

Select "Acknowledge Fault global" of the SFB in the Solution Explorer.
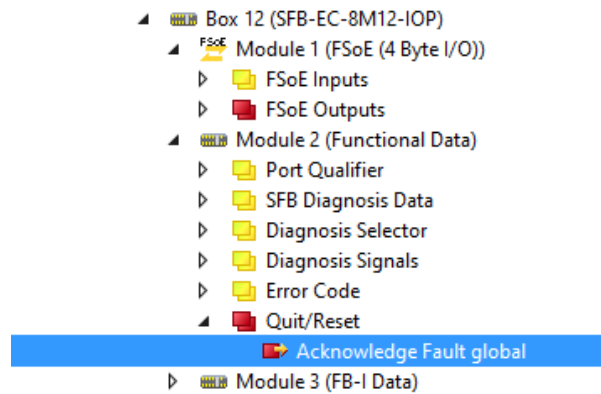
Select the "Linked to..." button.
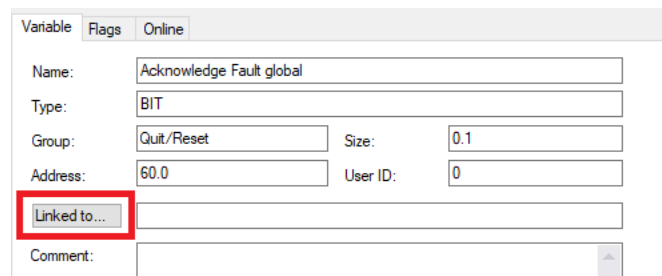
Link the signal to an input of your choice that you want to use for error acknowledgement.
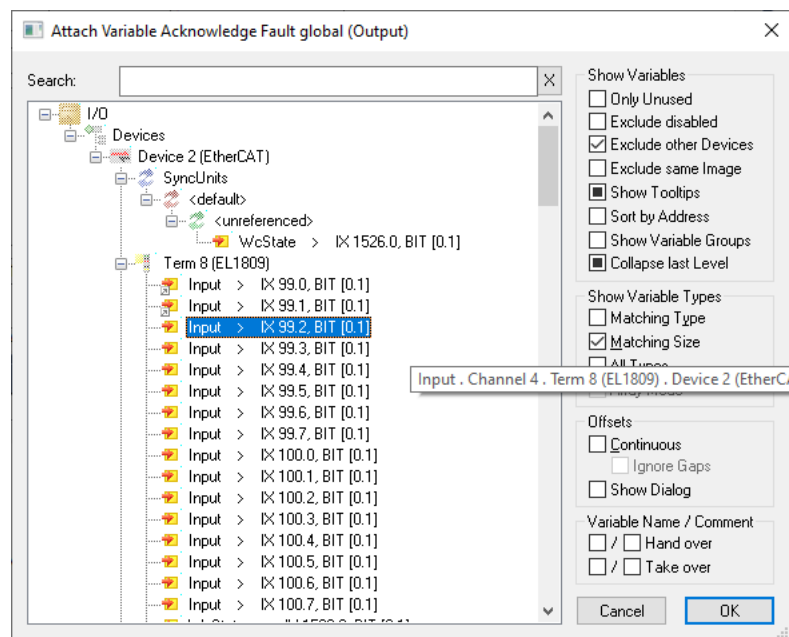
	INFORMATION
ℹ	It may be necessary to adjust the filters on the right side of the "Link" selection window to find the needed variable in the view.

4.2.9 Free Run Mode

The "Free Run" option switches the EtherCAT fieldbus to OP status and communication with the devices starts.

In contrast to the "Run" mode the "Free Run" has no real-time character and is only suitable for commissioning.
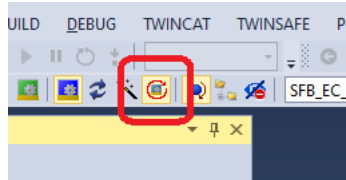
In the menu item of the EtherCAT master "Device 2 (EtherCAT)" the status of all devices is displayed in an overview.

Different buttons can be used to switch the operating state of the bus.
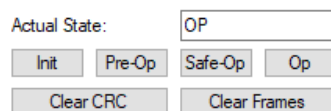
TwinCAT can be set to real-time mode via the Run Mode button.

	⚠ WARNING
⚠	In Run mode, only devices that are used in at least one task are updated. If no task is created in the project besides the I/O Idle task, no data exchange is executed.

Click with the right mouse button on "Tasks" in the Solution Explorer.

Select "Add New Item".
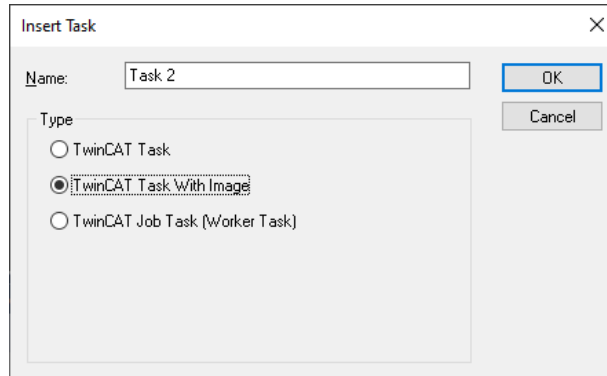
Select "TwinCAT Task With Image" and confirm with OK.
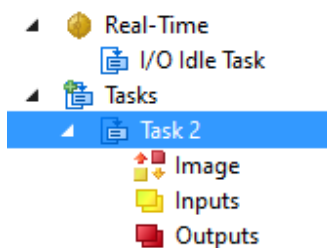
A new task with I/O image was created.

Click with the right mouse button in the Solution Explorer on "Inputs"
of the created task.
- Select "Add New Item
- Select the data type BIT and confirm the selection with OK.
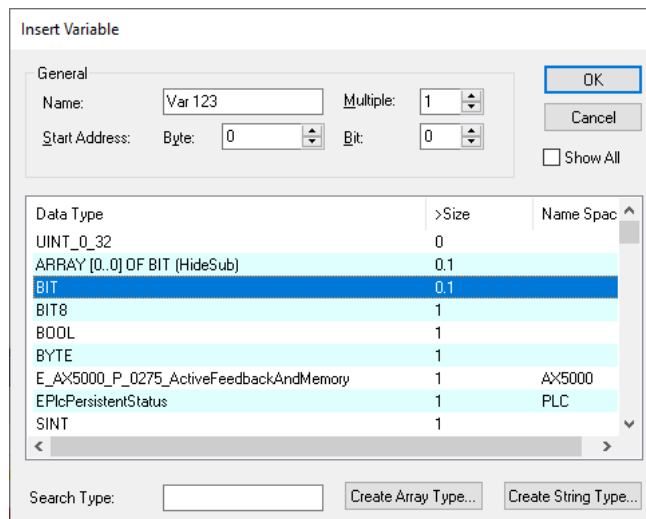
The task now contains a new variable that can be linked to a device so that communication takes place in real-time mode.
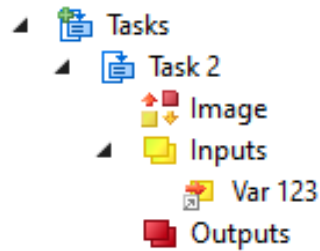
Select the variable and click on "Linked to...".

Select an input of the SFB and click OK.
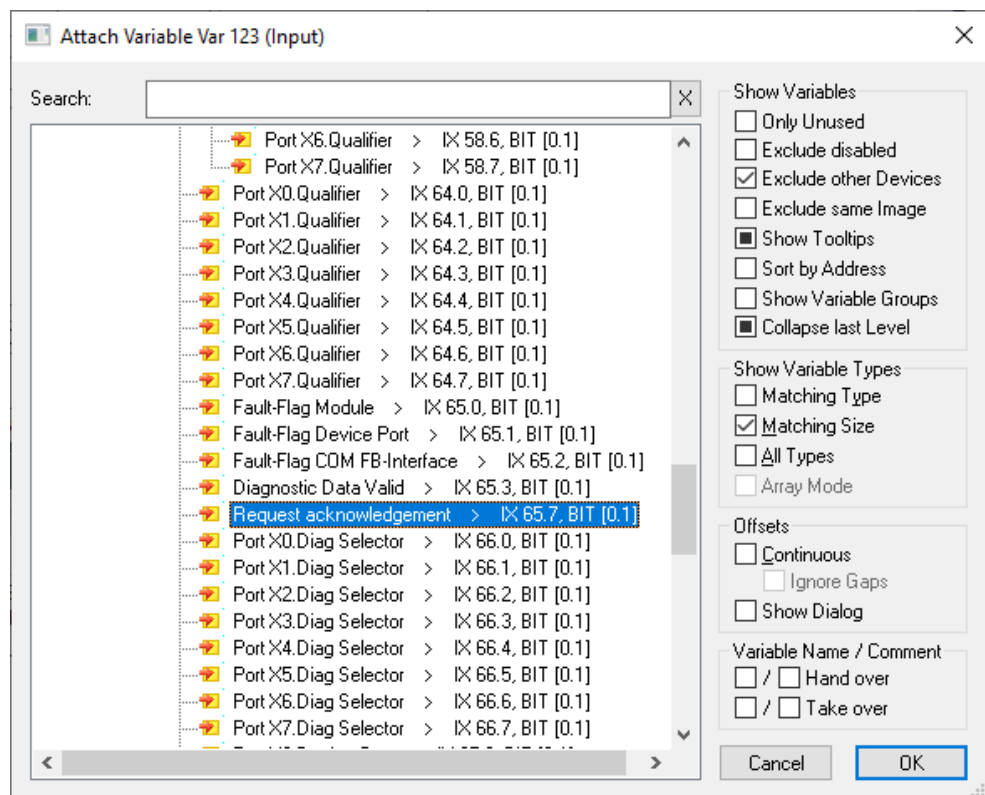
	INFORMATION
i	It may be necessary to adjust the filters on the right side of the "Link" selection window to find the needed variable in the view.

Click on the button "Restart TwinCAT System".

All changes will be activated and the system will start the Run Mode.

4.2.11 Setting the TwinSAFE address of the SFB

The 3 rotary coding switches behind the viewing window can be used to set the TwinSAFE address of the SFB-EC.

Carefully remove the viewing window. (Screws Torx 10)

	⚠ CAUTION
⚠	**The screws in the viewing window are not locked!** Keep the screws safe so that they do not get lost.

	⚠ CAUTION
⚠	When you open the inspection window, ensure that no moisture or excessive humidity penetrates into the fieldbox.

	⚠ CAUTION
⚠	**Electrostatically sensitive components!** Do not touch the printed circuit board directly.

	⚠ WARNING
⚠	Make sure that the correct TwinSAFE address is set for the module. Double addressing must be avoided.

x 100   x 10   x 1
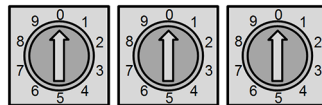
TwinSAFE address

0 0 0   Invalid TwinSAFE address,
             Reset Station-Alias is executed
             (delivery state, SFB carries out LED test)

0 0 1 … 999 Valid TwinSAFE address range

Select TwinSAFE address

- Switch SFB-EC de-energized
- Select TwinSAFE address
- Close the viewing window again
- Supply SFB-EC with power again

	⚠ WARNING
⚠	The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative.

4.2.12 Create a TwinSAFE project

To set up a FSoE connection the TwinSAFE extension within TwinCAT is necessary. Safety logic is inserted in a safety project.

Each safety project is assigned to a target system as safety master, which executes the logic of the TwinSafeGroups.

Devices can be inserted into a TwinSafeGroup as alias devices.
This means that a TwinSAFE project can also be saved separately and used in other TwinCAT projects.

The assignment of alias device to real safety device can also be created or changed subsequently.

In the example, a new safety project is created with a minimal configuration.

Right-click on the "SAFETY" item in the Solution Explorer and select "Add New Item...".
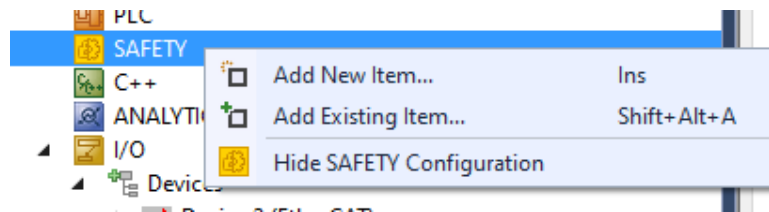
Select "TwinCAT Safety Project Preconfigured ErrAck" and enter a name.
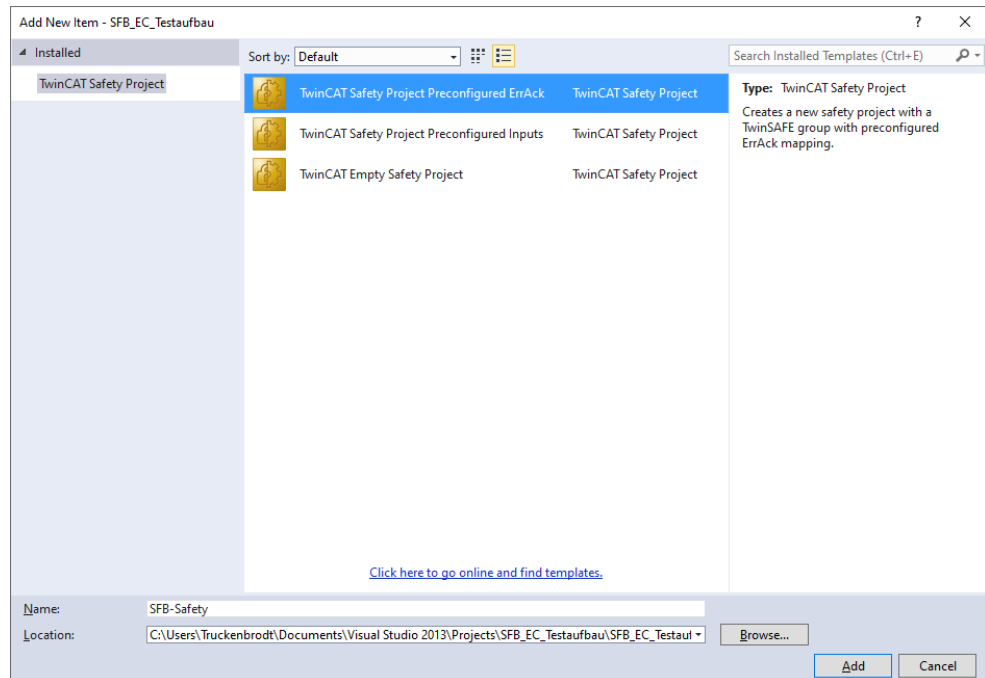
Then confirm with "Add".

Confirm the settings of the TwinCAT 3 Safety Wizard with OK.

SCHMERSAL
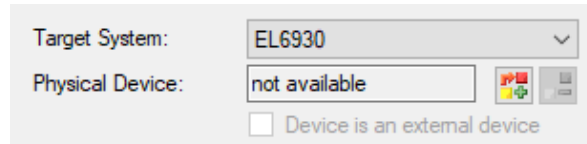
A preconfigured Safety project can now be found in the Solution Explorer.
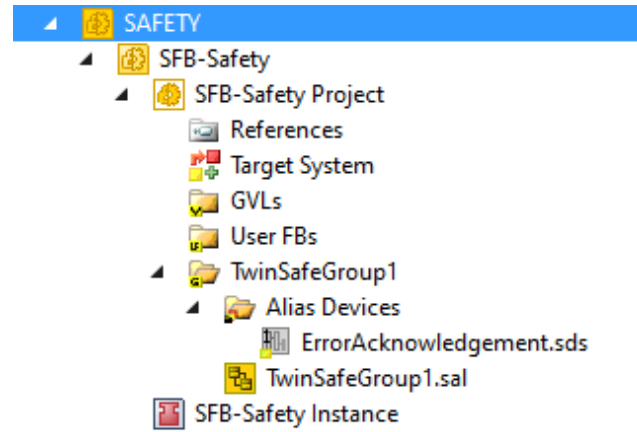
4.2.13 Select FSoE Master

Select the FSoE master (target system) on which the safety project is to run.

Double-click on the "Target System" entry in the safety project.
Select your connected FSoE master terminal (here EL6930).
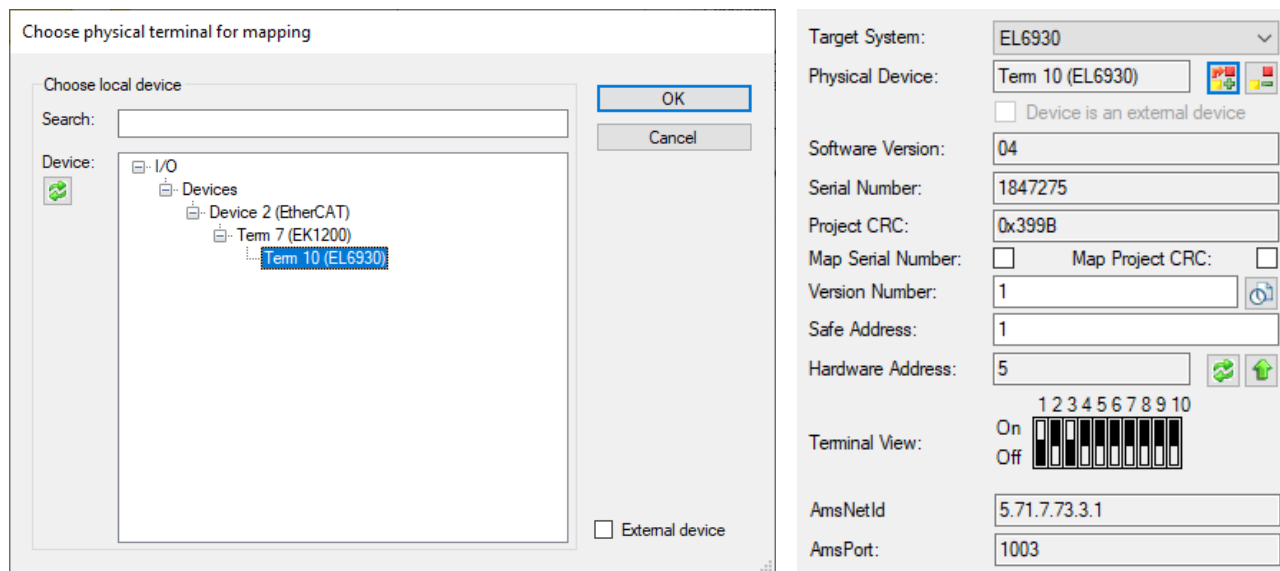
Click the Select button in the Physical Device section.

          Select / Link

Select the corresponding master terminal from the project hierarchy in the dialog and confirm the selection with OK.
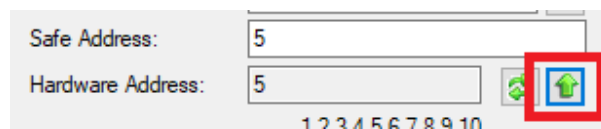
The settings of the master are supplemented by this.

Set the safety address of the master in the software according to the position of the hardware switch.

The button with the arrow copies the hardware address into the Safe Address field.

SCHMERSAL

4.2.14 Inserting the FSoE connection

Right-click on the "Alias Devices" element in the Safety project and select "Import Alias Device(s) from I/O-configuration".
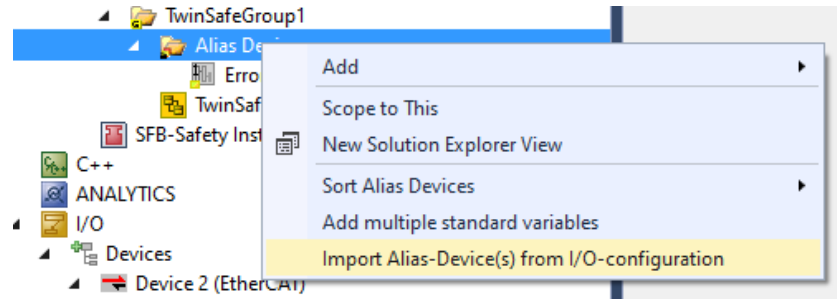
Select the FSoE module of the SFB and confirm the selection with OK.
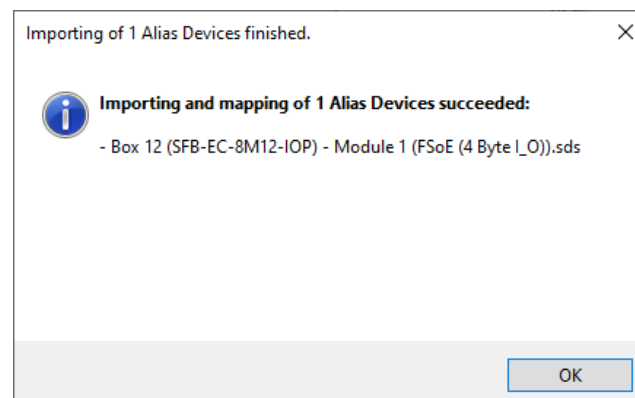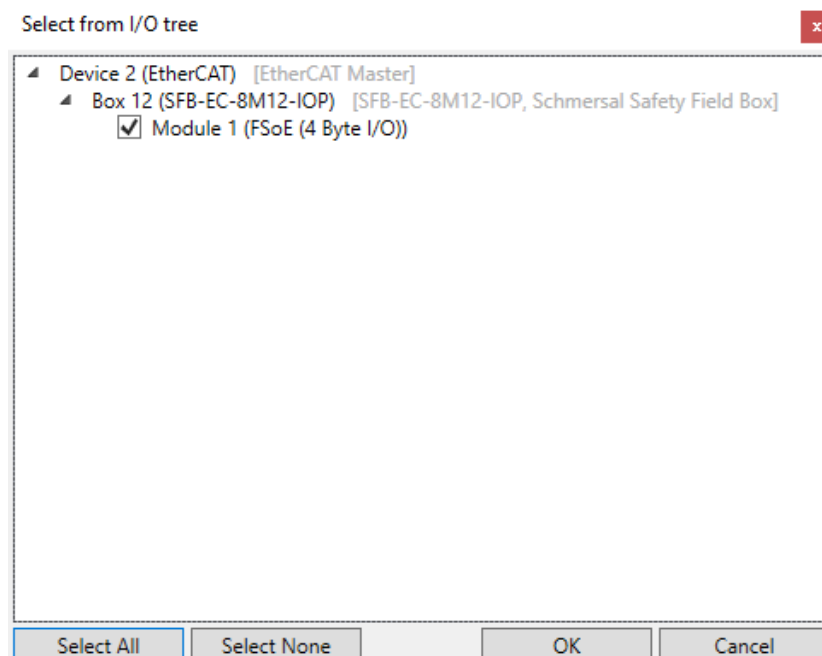
4.2.15 Setting the FSoE connection

Each FSoE connection has different settings.
These are stored in the master and sent to the device and checked each time the system starts up.

All FSoE devices have a safety address and a watchdog time as settings.
At least the safety address in the "Linking" tab must be entered for each device.

Double-click the alias device of the SFB in the safety project.
In the "FSoE Address" field, set the safety address identical to the rotary coding switch of the SFB.
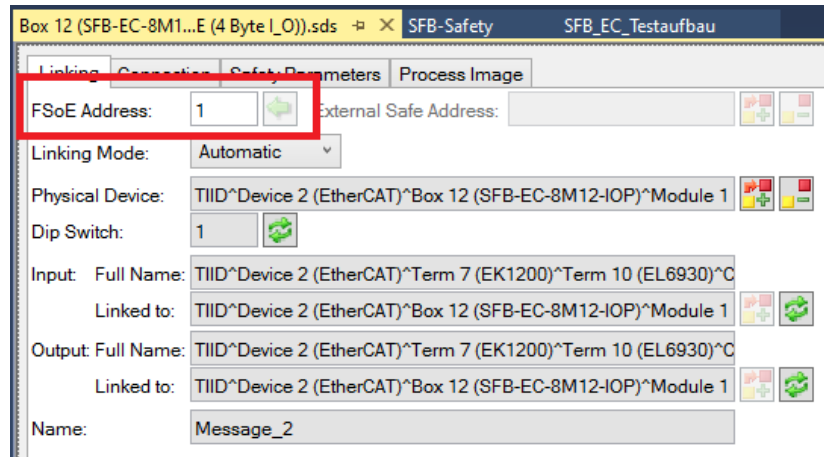
The watchdog time contains a default value and can be changed in the "Connection" tab.
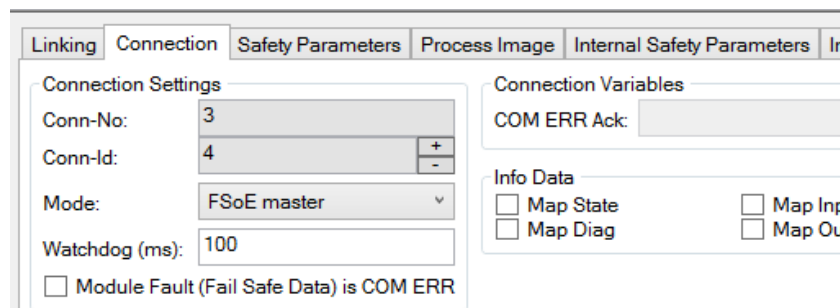
Default value is set to 100 ms !

Minimum Watchdog time SFB-EC: 25 ms
Setting range Watchdog SFB-EC: 25 - 500 ms

Recommended setting for EtherCAT cycle times ≤ 1 ms: **30 ms !**

	INFORMATION
i	The minimum watchdog time for the SFB-EC is calculated as follows: **SFB ACK-Time (25 ms) + 4x set EtherCAT cycle time** EtherCAT cycle times > 100 ms are not supported !

	⚠ WARNING
⚠	The watchdog time has a direct effect on the Safety response time. (Refer to chapter 2.5.5)

	⚠ WARNING
⚠	The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative.

4.2.16 Setting the safety parameters

The safety parameters for the individual device connections of the SFB-EC are also stored in the FSoE master and sent to the device during startup.

Double-click the alias device of the SFB in the safety project.
In the "Safety Parameters" tab, select the port parameter settings for each device port of the SFB-EC.

Box 12 (SFB-EC-8M1...E (4 Byte I_O)).sds ⊟ ✕ SFB-Safety SFB_EC_Testaufbau		
Linking	Connection	Safety Parameters	Process Image
Index	**Name**	**Value**
▲ 8000:0	I/O Mode Config	>8<
8000:01	Port X0	(A) Input: 2 channel OSSD / Output: 1 w…
8000:02	Port X1	(A) Input: 2 channel OSSD / Output: 1 w…
8000:03	Port X2	(A) Input: 2 channel OSSD / Output: 1 w…
8000:04	Port X3	(A) Input: 2 channel OSSD / Output: 1 w…
8000:05	Port X4	(A) Input: 2 channel OSSD / Output: 1 w…
8000:06	Port X5	(A) Input: 2 channel OSSD / Output: 1 w…
8000:07	Port X6	(A) Input: 2 channel OSSD / Output: 1 w…
8000:08	Port X7	(A) Input: 2 channel OSSD / Output: 1 w…

By double-clicking on an option, one of the available configurations can be selected in a dialog.

Set Value Dialog	✕
Dec: 1	OK
Hex: 0x01	Cancel
Enum: (A) Input: 2 channel OSSD / Outpu ▾	

(A) Input: 2 channel OSSD / Output: 1 wire (For Switches, Sensors & Interlocks with 2 channel OSSD outputs and 1 wire input for solenoid control)
(B) Input: 2 channel OSSD / Output: 2 wires (For Interlocks with 2 channel OSSD outputs and 2 wire inputs for solenoid control)
(C) Input: 2 channel Contacts / Output: 1 wire (For Switches & Interlocks with 2 channel contact outputs and 1 wire input for solenoid control)
(D) Input: 2x 1 channel Contact / Output: 1 wire (For Switches with 1 channel contact output and 1 wire input for output control)

Binary:
Bit Size:

4.2.17 Project engineering TwinSAFE Group

The logical processing of the safety data can be parameterized via a TwinSAFE group. It contains the safety program and is executed on the FSoE master.

Input and output data can be mapped here between the various alias devices of the safety project.

A TwinSAFE group has different group ports that can be connected to non-safety signals.

Here the following two signals are necessary to activate the processing:

Err Ack	Error acknowledgement at transition from 0 -> 1
Run/Stop	Operating mode of the TwinSAFE Group 0 = STOP; no execution 1 = RUN; is executed

Error Acknowledgement

Insert a non-safe input as Error Acknowledgement for the group port.

Double click on the "ErrorAcknowledgement" alias device.
To do this, click on the Select button.
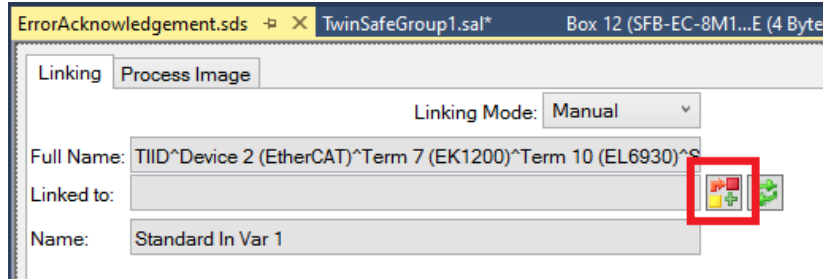
Link this input bit to the desired digital input that is to be used for error acknowledgement.

Confirm the selection with OK.
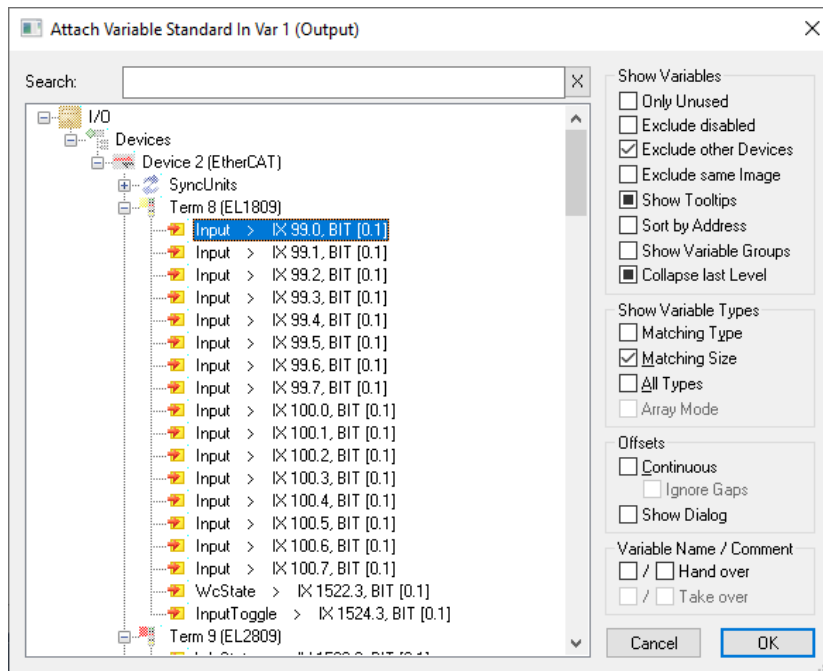
	INFORMATION
ℹ️	It may be necessary to adjust the filters on the right side of the "Link" selection window to find the needed variable in the view.

SCHMERSAL

Run/Stop

Insert a non-safety input as Run/Stop indicator for the corresponding Group Port.

Right-click on "Alias Devices" and select "Add" -> "New Item...".
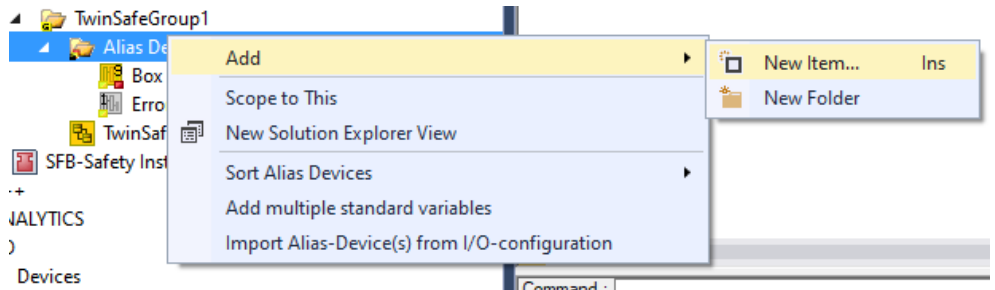
Select "1 Digital Input (Standard)" in the following dialog and assign a name.
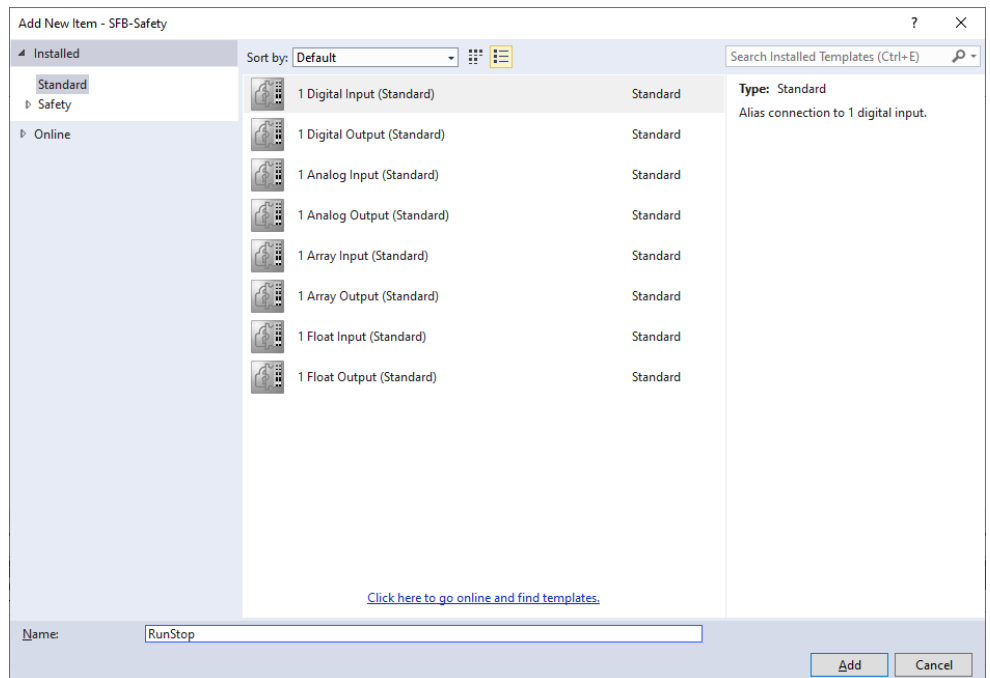
In the example the name "RunStop" is selected, because this signal should release the RUN state.

Confirm the selection with "Add". Double-click the newly created "RunStop" alias device and link the status bit to an input of your choice.

The procedure here corresponds to that of the Error Acknowledgement.

	INFORMATION
ℹ	The selected input must be permanently active (= 1) to activate processing. It must be physically activatable via a switch or hardwired.

4.2.18 Mapping of the Group Ports

Double-click on the "TwinSafeGroup1" element in the safety project and select the "Variables" tab under "Variable Mapping" at the bottom.
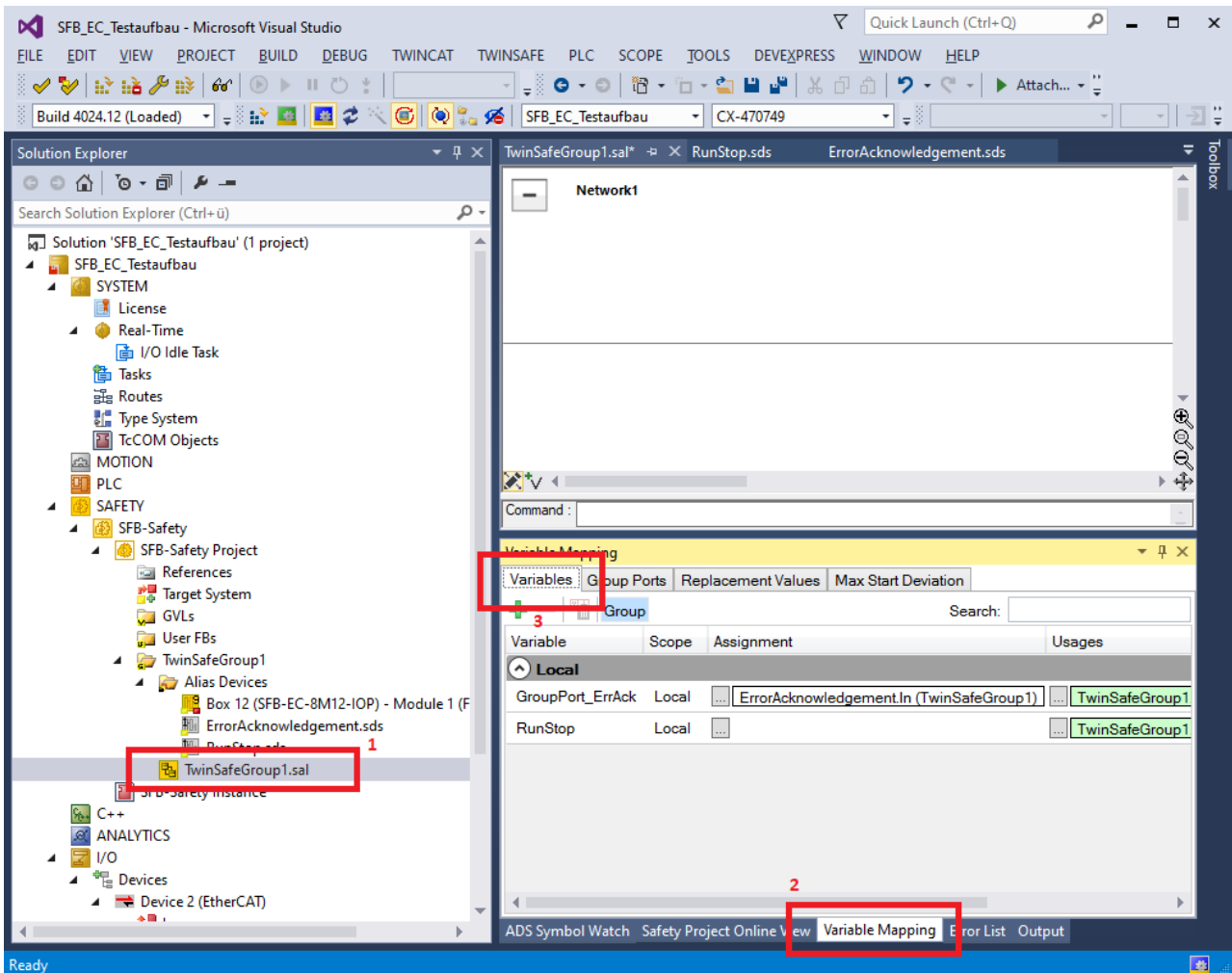
Here the alias device "Error Acknowledgement" is already preconfigured.

Click on the drop-down button in the "Assignment" column of the "RunStop" alias device.
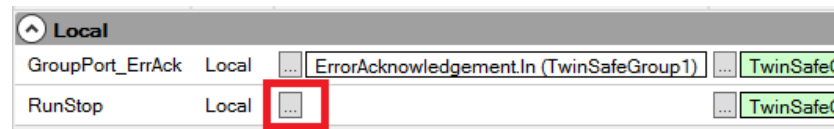
Select "RunStop" in the selection window under Alias Devices and select "Channel 1 - In".

Confirm the selection with OK.
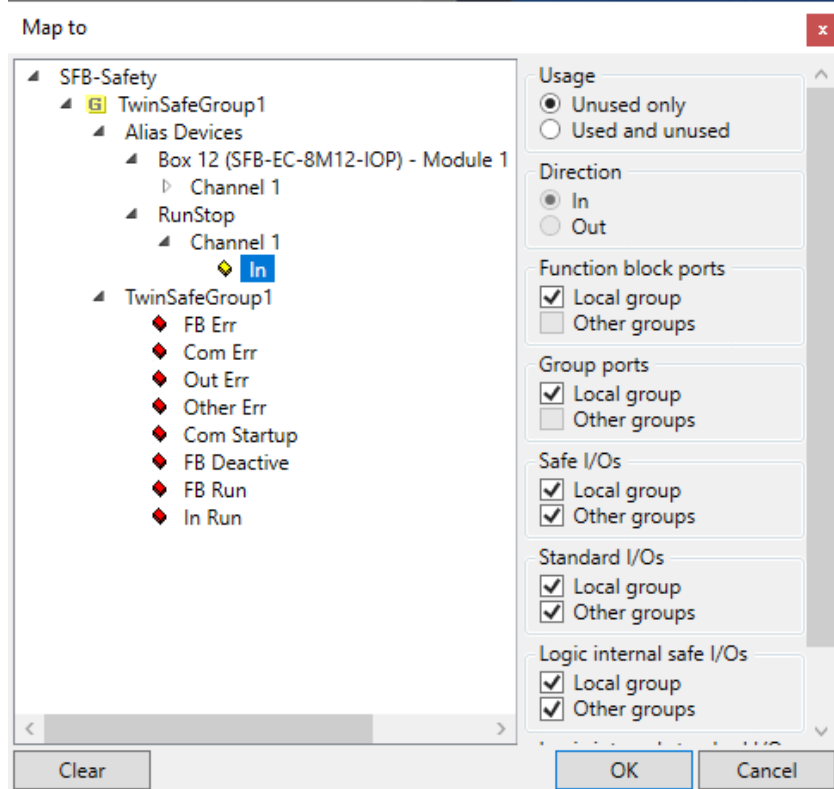
The TwinSAFE Group is now configured and can be used.
It is executed as long as the RunStop input is active.

Errors can be reset via the Error Acknowledge input.

	INFORMATION
[i]	The complete safety project is only active after it has been loaded into the FSoE master.

4.2.19 Programming of the safety logic

To link the safe inputs and outputs of the different safety devices, proceed as follows:

Double-click "TwinSafeGroup" in the Solution Explorer. Open the "Toolbox" to display various function blocks.

	INFORMATION
i	If you do not see a toolbox, this window can be activated in the menu under "View" -> "Toolbox".
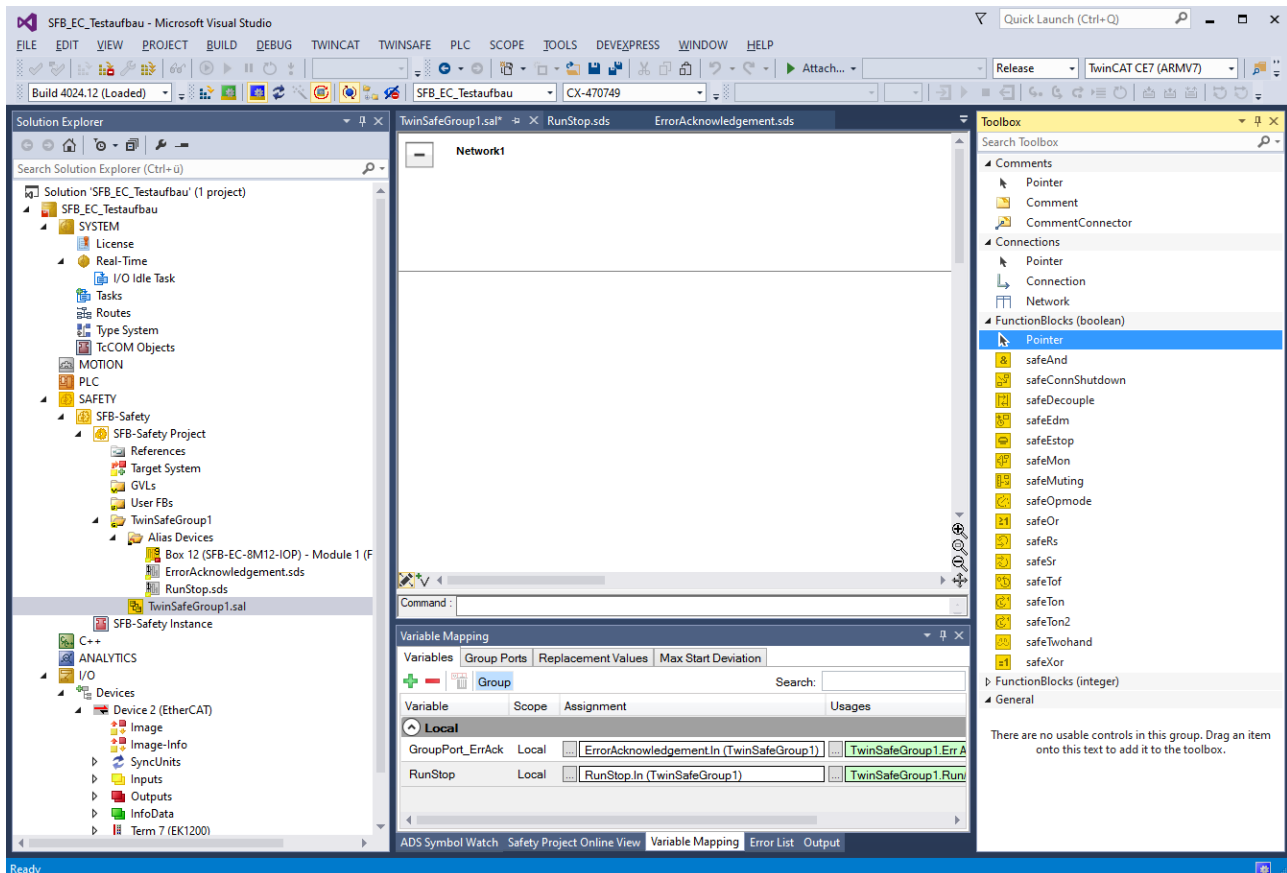
	⚠ WARNING
⚠	The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative.

SCHMERSAL

Drag and drop the element "safeDecouple" from the toolbox into the middle area of "Network1". Repeat the step to get a total of 2 decouple blocks.
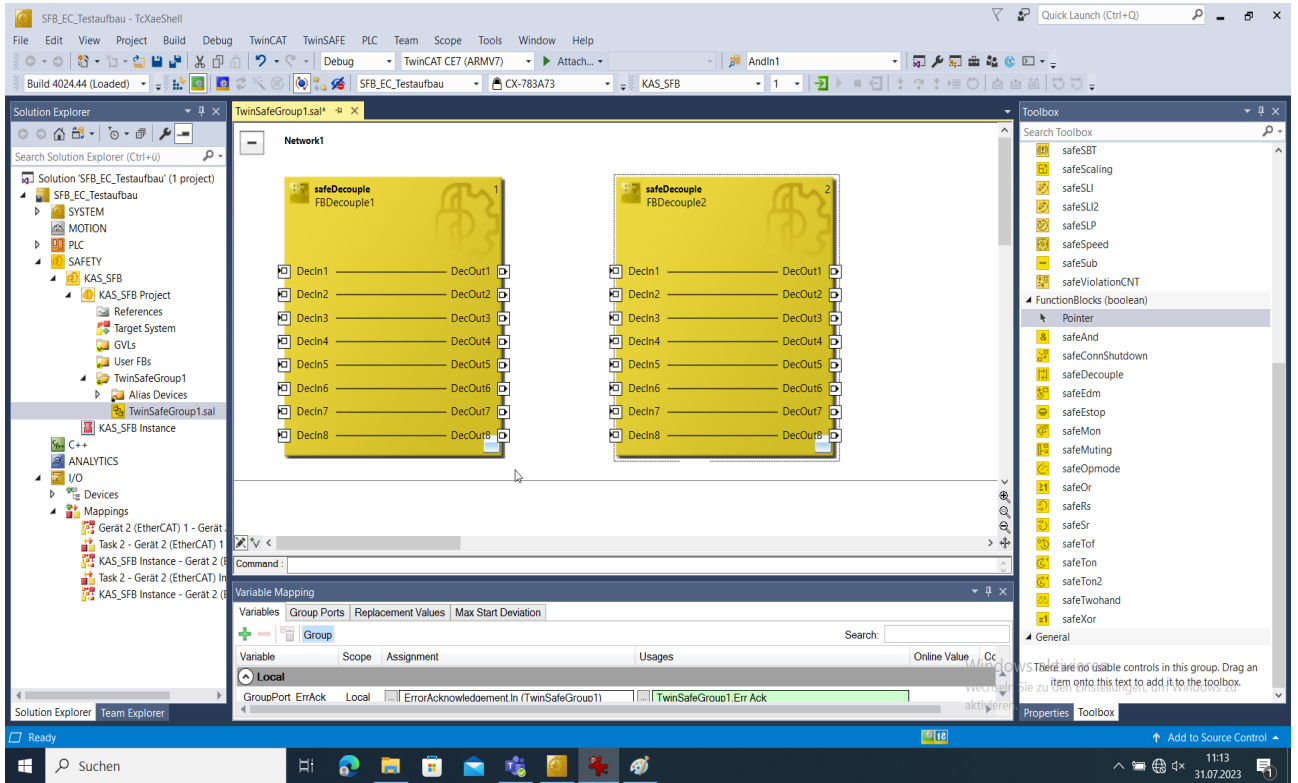
Select "DecIn1" from "FBDecouple1".
Select a variable name in the properties (here "iInX0").
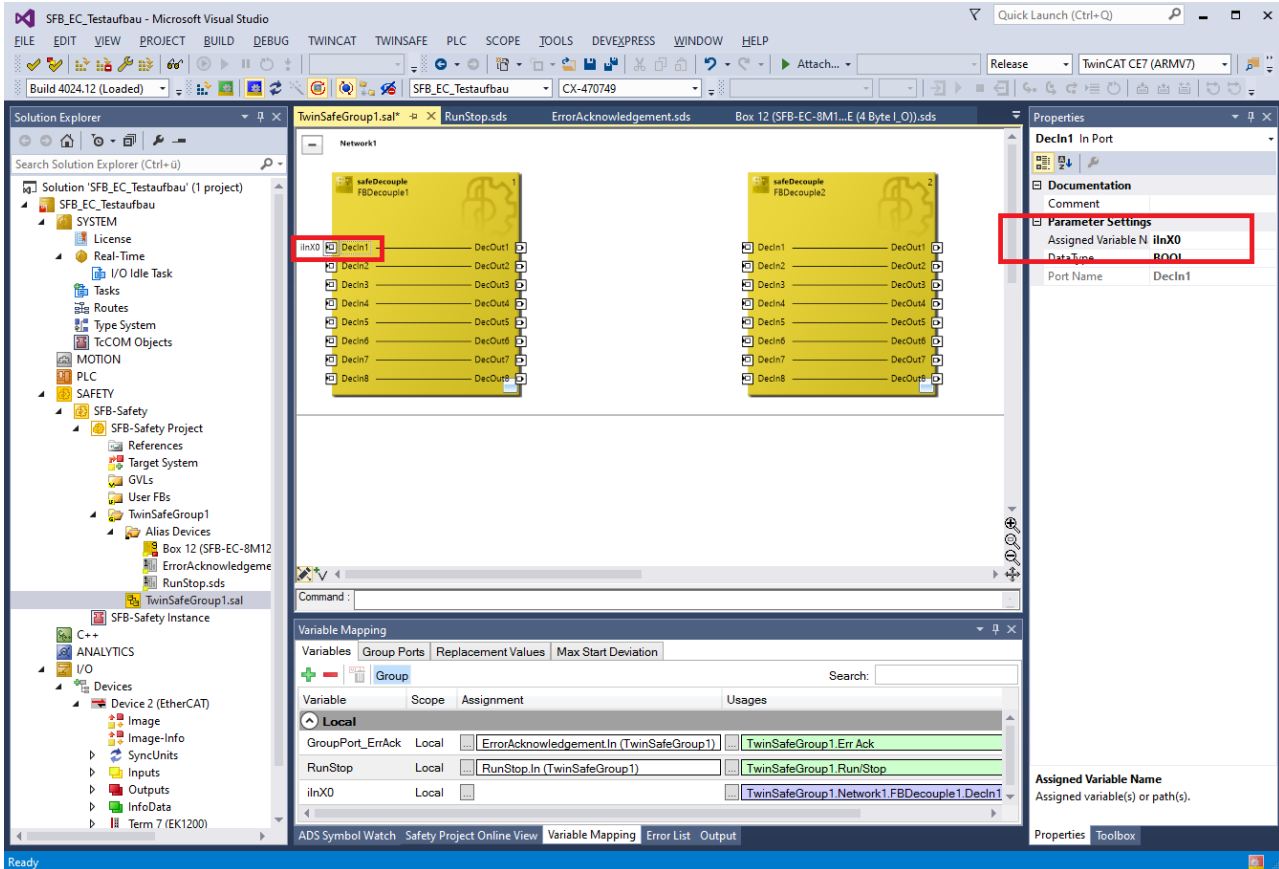
Create a name for the output DecOut1 at FBDecouple2 (here "oDOX0").

ℹ️	**HINWEIS**
	If you do not see the "Properties" window, it can be activated via the "View" menu or by pressing "F4".

Now 2 bits have been defined in the safety program, which can be used in the logic and must be mapped to a safety device.

For a simple example logic link DecOut1 with DecIn1 by drag&drop.
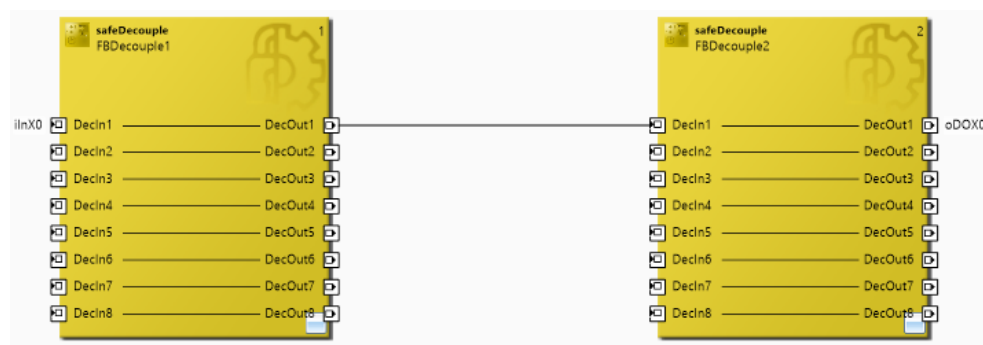
This passes the input iInX0 directly to the output oDOX0.

4 Set-up   SCHMERSAL

In the "Variable Mapping" -> "Variables" area, now link both variables with an input respectively output of the SFB.

Input mapping

Output mapping

4.2.20 Download Safety Project

The Safety project is executed inside the FSoE Master and must first be compiled and downloaded.

	INFORMATION
i	Further information about downloading a "Safety Project" can be found in the documentation of your FSoE Master.

Example FSoE Master terminal

Navigate to Safety Target System and note or copy the serial number of the FSoE master terminal.

The necessary functions for downloading and verifying a safety project can be found in the toolbar or in the TwinSAFE menu.

Click on „Verify Complete Safety Project"

Errors in the safety project may be displayed in the "Error List" tab.

Click on „Download Safety Project"

Enter your login data in the Safety Project download window.
- Default values Beckhoff: Username: Administrator / Password: TwinSAFE

The serial number must be entered based on the Target system.

Confirm the next steps of the Download Wizard:

Activating the configuration in TwinCAT

or restart Config Mode

	⚠ WARNING
⚠	The safety functions, configuration of the safety fieldbox and correct installation must be checked by a responsible safety administrator / safety representative.

SCHMERSAL

4.2.21 FSoE Diagnosis

The following chapters show different ways to diagnose a Safety Connection.

FSoE PDOs

The state of a FSoE connection can be diagnosed inside their PDOs:
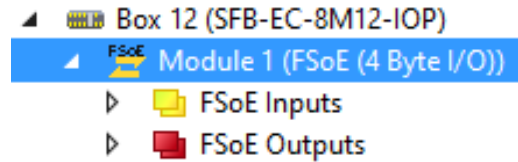
The first byte of the PDO provides information about the FSoE state.

Name	[X]	Online
FSOE	X	36 00 00 B3 C4 00 00 29 63 ...

- "36" in FSoE Inputs:
  FSoE PDO sent by SFB, means "Process Data".
  -> Safety data are OK and available

Name	[X]	Online
FSOE	X	08 00 00 69 B0 02 00

- "08" in FSoE Outputs:
  FSoE PDO sent by FSoE Master, means "Failsafe Data".
  -> The safety data are still passivated

This is the initial state after the successful establishment of a safety connection. The connection was correctly established, but the master still prevents an automatic startup and expects an "Error Acknowledge".

After activating the group port linked to the error acknowledge,
the Master also switches his data to "Process Data" (36).

	INFORMATION
i	The naming of the PDOs is always from the view of the master: Input: Formed and sent by the slave (e.g. status digital inputs). Output: Formed and sent by the master (e.g. logic level digital outputs).

TwinSAFE View
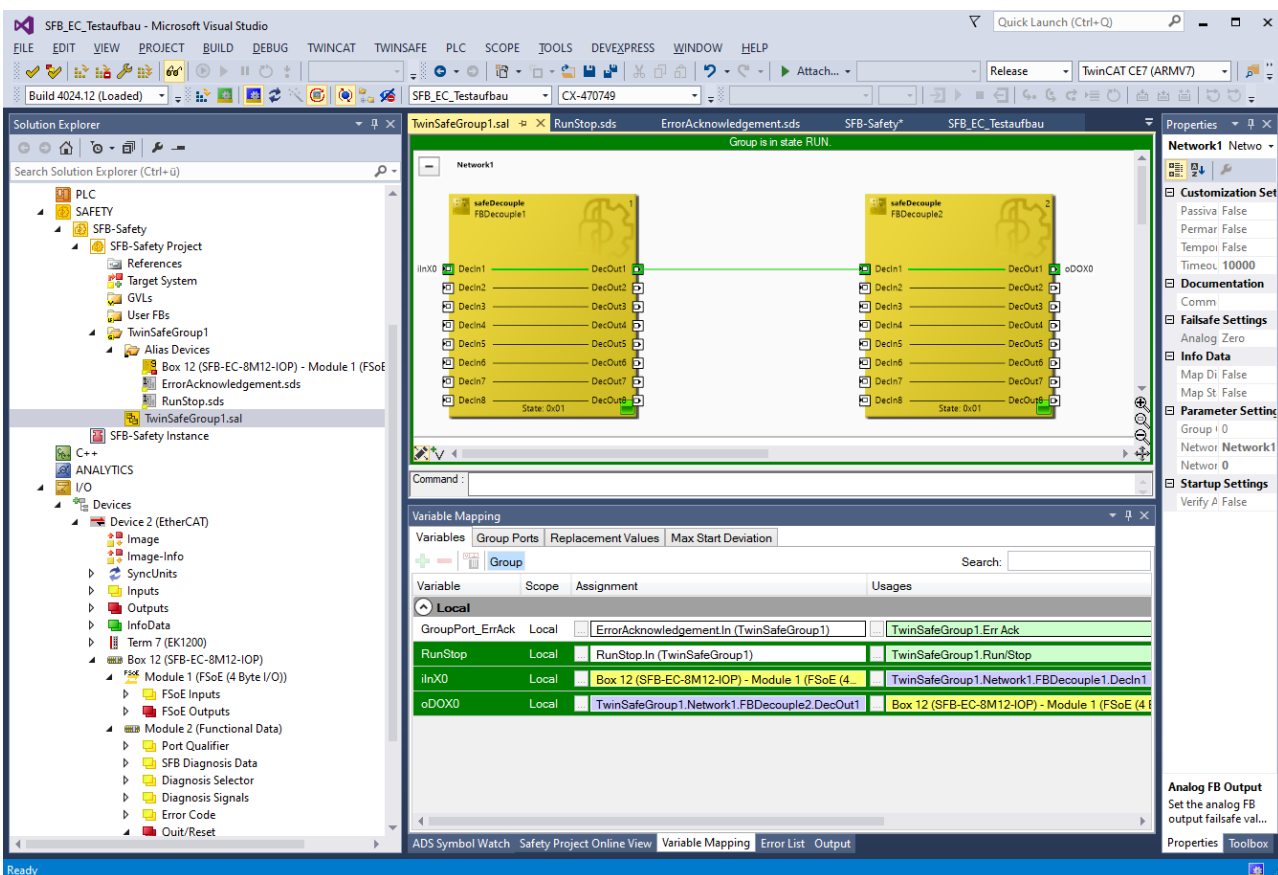
The TwinSAFE Group supports an online view in which the states of the FSoE connections as well as the data can be analyzed.

Double-click on the TwinSafeGroup in your safety project.

Select the button "Show Online Data" in the toolbar or via the TwinSAFE menu.
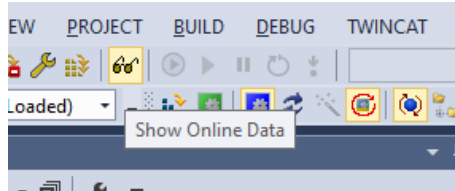
The TwinSAFE view now changes and shows the status and signals.

Active signals are highlighted in green.

In the list in the lower part, more detailed information on the individual
TwinSAFE groups, alias devices and I/Os can be found under the
"Safety Project Online View" tab.
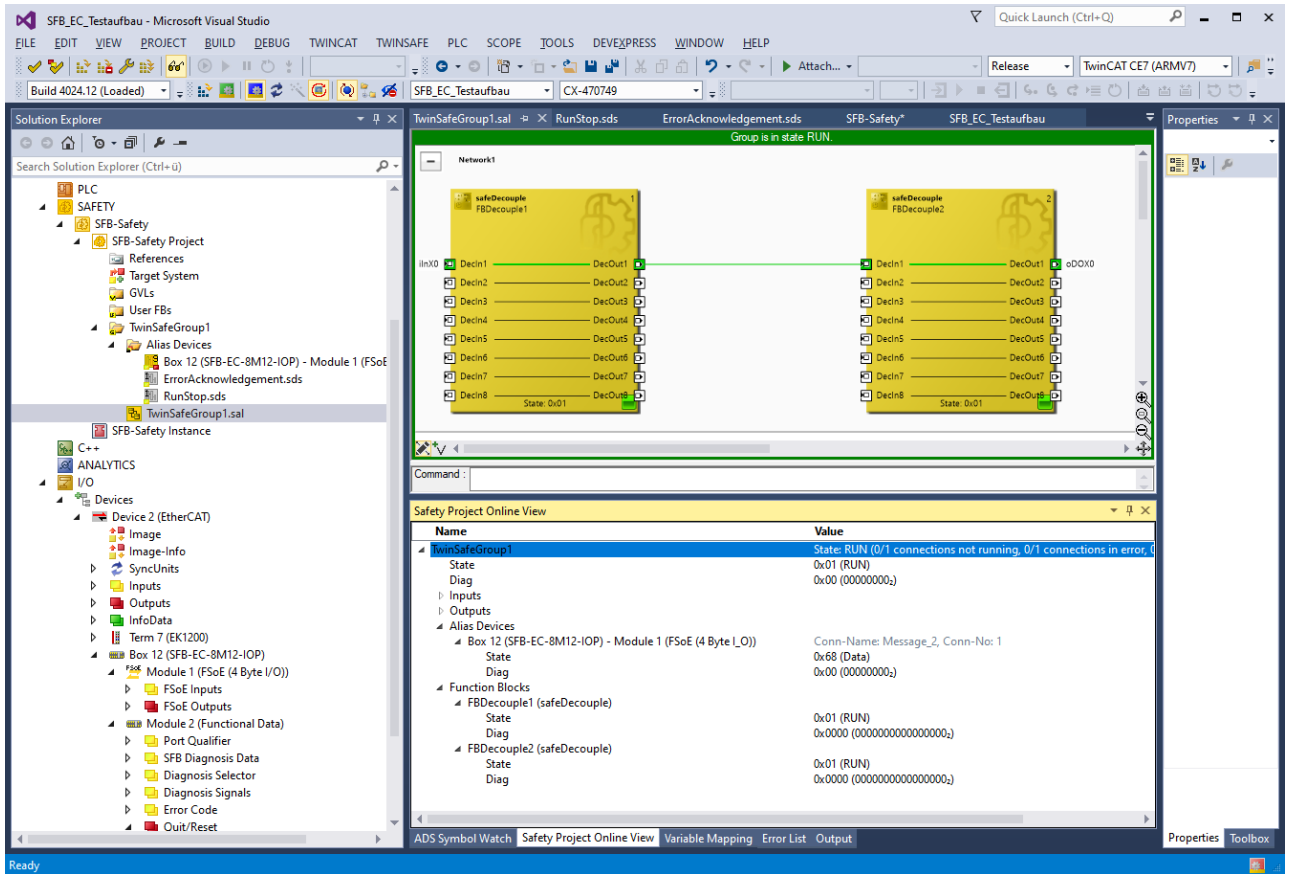
4.3 Data Layout SFB-EC

4.3.1 Cyclic data (PDO)

The cyclic communication transports the safety I/O data and the functional status information via the corresponding Process Data Object (PDO).

The direction of the data to be transferred is always defined from the PLC's point of view.

The data structure is defined in the ESI file. The ESI file must copy to the corresponding TwinCAT folder (Refer to chapter 4.2.2).

Module Definition: SFB-EC
Menu selection: Solution Explorer
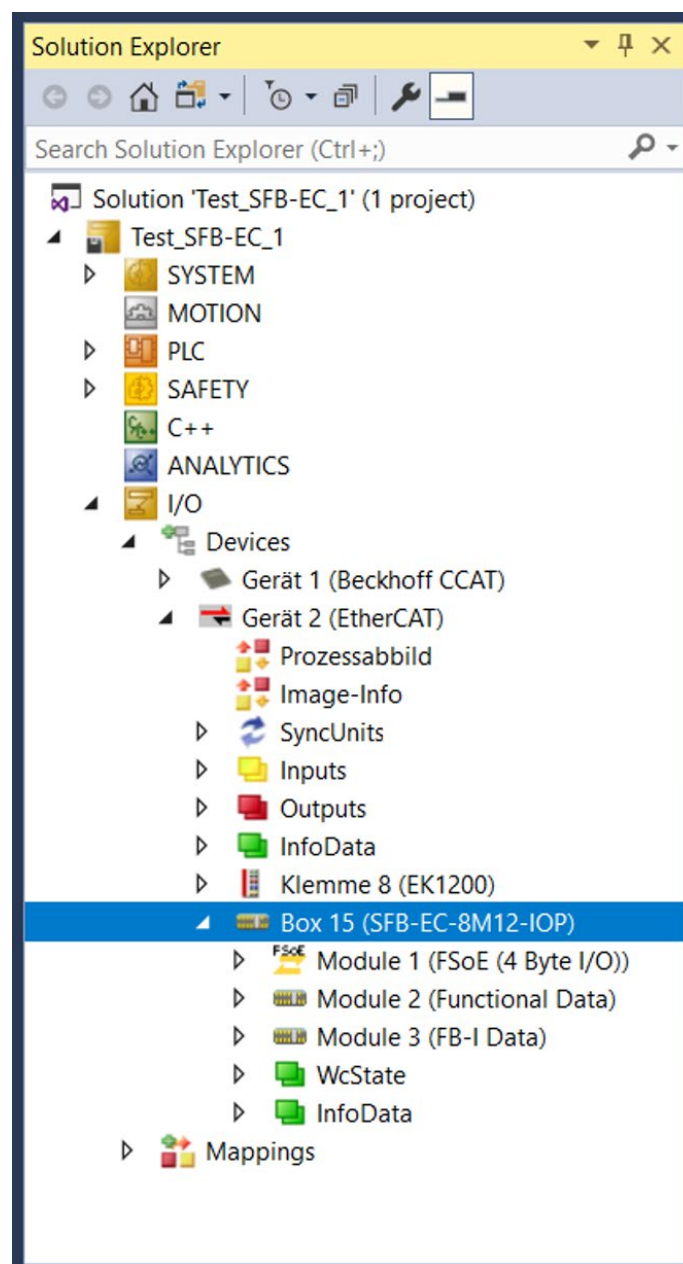
The bit assignment of the data bytes in the individual PDO are described below.

Module 1 / FSoE Data, Safety Input data (SFB => PLC)

◢ ⛉ **Module 1** (FSoE (4 Byte I/O))

Data Label	[Type]	SFB Data	Signal
		Safety Input Data	

◢ 🗀 FSoE Inputs
  ⮞ Port X0.Input X1 AND X2
  ⮞ Port X1.Input X1 AND X2
  ⮞ Port X2.Input X1 AND X2
  ⮞ Port X3.Input X1 AND X2
  ⮞ Port X4.Input X1 AND X2
  ⮞ Port X5.Input X1 AND X2
  ⮞ Port X6.Input X1 AND X2
  ⮞ Port X7.Input X1 AND X2
	[BIT]	**Safety Input X1/X2**
		
		2-channel device
		Safety Inputs X1 AND X2
		
		1-channel device
		Safety Input X1
			Device port X0
			Device port X1
			Device port X2
			Device port X3
			Device port X4
			Device port X5
			Device port X6
			Device port X7

◢ 🗀 FSoE Inputs
  ⮞ Port X0.Input X2
  ⮞ Port X1.Input X2
  ⮞ Port X2.Input X2
  ⮞ Port X3.Input X2
  ⮞ Port X4.Input X2
  ⮞ Port X5.Input X2
  ⮞ Port X6.Input X2
  ⮞ Port X7.Input X2
	[BIT]	**Safety Input X2**
		
		2-channel device
		--- 	
		
		1-channel device
		Safety Input X2
			Device port X0
			Device port X1
			Device port X2
			Device port X3
			Device port X4
			Device port X5
			Device port X6
			Device port X7

◢ 🗀 FSoE Inputs
  ⮞ Port X0.Qualifier
  ⮞ Port X1.Qualifier
  ⮞ Port X2.Qualifier
  ⮞ Port X3.Qualifier
  ⮞ Port X4.Qualifier
  ⮞ Port X5.Qualifier
  ⮞ Port X6.Qualifier
  ⮞ Port X7.Qualifier
	[BIT]	**Qualifier-Bit Device port**
		
		0 = Device port passivated
		1 = Device port active
		
		A copy of the qualifier bits are found in:
		◢ 🗀 Port Qualifier
		  ⮞ Port Xx.Qualifier
			Qualifier port X0
			Qualifier port X1
			Qualifier port X2
			Qualifier port X3
			Qualifier port X4
			Qualifier port X5
			Qualifier port X6
			Qualifier port X7

ℹ️	**INFORMATION** If **one** 2-channel device is connected, only **1** safety bit for the device is transmitted into **FSoE Inputs** in **Port Xx.Input X1 AND X2**. If **two** 1-channel devices are connected, **2** safety bits are transmitted separately for each device. One bit in **Port Xx.Input X1 AND X2** and the other bit in **Port Xx.Input X2**.

Module 1 / FSoE Data, Safety Output data (PLC => SFB)

◢ ⛉ **Module 1** (FSoE (4 Byte I/O))

Data Label	[Type]	SFB Data	Signal
		Safety Output Data	

◢ 🟥 FSoE Outputs
  ⮞ Port X0.Output DO
  ⮞ Port X1.Output DO
  ⮞ Port X2.Output DO
  ⮞ Port X3.Output DO
  ⮞ Port X4.Output DO
  ⮞ Port X5.Output DO
  ⮞ Port X6.Output DO
  ⮞ Port X7.Output DO
	[BIT]	**Safety Output**
		
		Safety Outputs DO
			Device port X0
			Device port X1
			Device port X2
			Device port X3
			Device port X4
			Device port X5
			Device port X6
			Device port X7

◢ ▦ **Module 2** (Functional Data)

Data Label	[Type]	SFB Data	Signal
		Functional Input / Output Data	
◢ 📁 Port Qualifier 📩 Port X0.Qualifier 📩 Port X1.Qualifier 📩 Port X2.Qualifier 📩 Port X3.Qualifier 📩 Port X4.Qualifier 📩 Port X5.Qualifier 📩 Port X6.Qualifier 📩 Port X7.Qualifier	[BIT]	**Qualifier-Bit Device port** 0 = Device port passivated 1 = Device port active *Copy of the qualifier bits from:* ◢ 📁 FSoE Inputs 📩 Port Xx.Qualifier	 Device port X0 Device port X1 Device port X2 Device port X3 Device port X4 Device port X5 Device port X6 Device port X7
◢ 📁 SFB Diagnosis Data 📩 Fault-Flag Module 📩 Fault-Flag Device Port 📩 Fault-Flag COM FB-Interface 📩 Diagnostic Data Valid 📩 Request acknowledgement	[BIT]	**Fault-Flags** 0 = Fault detected 1 = No fault present Request fault acknowledgement 0 = no request 1 = Fault can be acknowledged	 Fault-Flag Module Fault-Flag Device port Fault-Flag COM FB interface Diagnostic data valid Request acknowledgement
◢ 📁 Diagnosis Selector 📩 Port X0.Diag Selector 📩 Port X1.Diag Selector 📩 Port X2.Diag Selector 📩 Port X3.Diag Selector 📩 Port X4.Diag Selector 📩 Port X5.Diag Selector 📩 Port X6.Diag Selector 📩 Port X7.Diag Selector	[BIT]	**Diagnosis Selector** 0 = IO-Device diagnosis 1 = FB-Interface device diagnosis Device port X0 – X3 **only IO** Device port X4 – X7 **IO or FB**	 Device diagnosis X0 Device diagnosis X1 Device diagnosis X2 Device diagnosis X3 Device diagnosis X4 Device diagnosis X5 Device diagnosis X6 Device diagnosis X7
◢ 📁 Diagnosis Signals 📩 Port X0.Device Out 📩 Port X1.Device Out 📩 Port X2.Device Out 📩 Port X3.Device Out 📩 Port X4.Device Out 📩 Port X5.Device Out 📩 Port X6.Device Out 📩 Port X7.Device Out	[BIT]	**Diagnosis signals IO-Devices only** 0 = Device diagnosis Bit is LOW 1 = Device diagnosis Bit is HIGH	 Device diagnosis X0 Device diagnosis X1 Device diagnosis X2 Device diagnosis X3 Device diagnosis X4 Device diagnosis X5 Device diagnosis X6 Device diagnosis X7
◢ 📁 Error Code 📩 Error Code	[USINT]	**Module or port fault number** - 0 no fault - 1...99 Fault number	Fault number 0…99 -> Poll fault list ! *(Refer to chapter 4.3.2)*
◢ 🟥 Quit/Reset 📩 Acknowledge Fault global	[BIT]	**Acknowledge fault** *High Pulse 500 ms = Acknowledge fault*	Global fault acknowledge

◢ ▦▦▦ **Module 3** (FB-I Data)

Data Label	[Type]	FB-Interface Data	Signal
		FB-Interface Input Data	
◢ 📁 FB-I Port 4 Inputs 🔸 Port X4.E-STOP not actuated 🔸 Port X4.Pos 2 NO contact 🔸 Port X4.Pos 2 NC contact 🔸 Port X4.Pos 3 NO contact 🔸 Port X4.Pos 3 NC contact 🔸 Port X4.Pos 4 NO contact 🔸 Port X4.Fault warning FB-I device 🔸 Port X4.Fault at FB-I device	[BIT]	**FB-I Response data from device at X4** 0/1 = FB-I response bits BDF200 *FB-I response data, see also* *operating instructions BDF200-SD/FB*	E-STOP **not** actuated NO contact Pos. 2 NC contact Pos. 2 NO contact Pos. 3 NC contact Pos. 3 NO contact Pos. 4 Fault warning FB device Fault at FB device
◢ 📁 FB-I Port 5 Inputs 🔸 Port X5.E-STOP not actuated 🔸 Port X5.Pos 2 NO contact 🔸 Port X5.Pos 2 NC contact 🔸 Port X5.Pos 3 NO contact 🔸 Port X5.Pos 3 NC contact 🔸 Port X5.Pos 4 NO contact 🔸 Port X5.Fault warning FB-I device 🔸 Port X5.Fault at FB-I device	[BIT]	**FB-I Response data from device at X5** 0/1 = FB-I response bits BDF200 *FB-I response data, see also* *operating instructions BDF200-SD/FB*	E-STOP **not** actuated NO contact Pos. 2 NC contact Pos. 2 NO contact Pos. 3 NC contact Pos. 3 NO contact Pos. 4 Fault warning FB device Fault at FB device
◢ 📁 FB-I Port 6 Inputs 🔸 Port X6.E-STOP not actuated 🔸 Port X6.Pos 2 NO contact 🔸 Port X6.Pos 2 NC contact 🔸 Port X6.Pos 3 NO contact 🔸 Port X6.Pos 3 NC contact 🔸 Port X6.Pos 4 NO contact 🔸 Port X6.Fault warning FB-I device 🔸 Port X6.Fault at FB-I device	[BIT]	**FB-I Response data from device at X6** 0/1 = FB-I response bits BDF200 *FB-I response data, see also* *operating instructions BDF200-SD/FB*	E-STOP **not** actuated NO contact Pos. 2 NC contact Pos. 2 NO contact Pos. 3 NC contact Pos. 3 NO contact Pos. 4 Fault warning FB device Fault at FB device
◢ 📁 FB-I Port 7 Inputs 🔸 Port X7.E-STOP not actuated 🔸 Port X7.Pos 2 NO contact 🔸 Port X7.Pos 2 NC contact 🔸 Port X7.Pos 3 NO contact 🔸 Port X7.Pos 3 NC contact 🔸 Port X7.Pos 4 NO contact 🔸 Port X7.Fault warning FB-I device 🔸 Port X7.Fault at FB-I device	[BIT]	**FB-I Response data from device at X7** 0/1 = FB-I response bits BDF200 *FB-I response data, see also* *operating instructions BDF200-SD/FB*	E-STOP **not** actuated NO contact Pos. 2 NC contact Pos. 2 NO contact Pos. 3 NC contact Pos. 3 NO contact Pos. 4 Fault warning FB device Fault at FB device

◢ ▦ **Module 3** (FB-I Data)

Data Label	[Type]	FB-Interface Data	Signal
		FB-Interface Output Data	
◢ 🟥 FB-I Port 4 Outputs	[BIT]	**FB-I Request data for device at X4**	
🔴 Port X4.G24 signal lamp RED			LED G24 Signal lamp red
🔴 Port X4.G24 signal lamp GREEN		0/1 = FB-I request bits BDF200	LED G24 Signal lamp green
🔴 Port X4.Pos 2 LED push button			LED in push button Pos. 2
🔴 Port X4.Pos 3 LED push button			LED in push button Pos. 3
🔴 Port X4.Pos 4 LED push button		*FB-I request data, see also*	LED in push button Pos. 4
🔴 Port X4.Acknowledge device fault		*operating instructions BDF200-SD/FB*	Acknowledge device fault
◢ 🟥 FB-I Port 5 Outputs	[BIT]	**FB-I Request data for device at X5**	
🔴 Port X5.G24 signal lamp RED			LED G24 Signal lamp red
🔴 Port X5.G24 signal lamp GREEN		0/1 = FB-I request bits BDF200	LED G24 Signal lamp green
🔴 Port X5.Pos 2 LED push button			LED in push button Pos. 2
🔴 Port X5.Pos 3 LED push button			LED in push button Pos. 3
🔴 Port X5.Pos 4 LED push button		*FB-I request data, see also*	LED in push button Pos. 4
🔴 Port X5.Acknowledge device fault		*operating instructions BDF200-SD/FB*	Acknowledge device fault
◢ 🟥 FB-I Port 6 Outputs	[BIT]	**FB-I Request data for device at X6**	
🔴 Port X6.G24 signal lamp RED			LED G24 Signal lamp red
🔴 Port X6.G24 signal lamp GREEN		0/1 = FB-I request bits BDF200	LED G24 Signal lamp green
🔴 Port X6.Pos 2 LED push button			LED in push button Pos. 2
🔴 Port X6.Pos 3 LED push button			LED in push button Pos. 3
🔴 Port X6.Pos 4 LED push button		*FB-I request data, see also*	LED in push button Pos. 4
🔴 Port X6.Acknowledge device fault		*operating instructions BDF200-SD/FB*	Acknowledge device fault
◢ 🟥 FB-I Port 7 Outputs	[BIT]	**FB-I Request data for device at X7**	
🔴 Port X7.G24 signal lamp RED			LED G24 Signal lamp red
🔴 Port X7.G24 signal lamp GREEN		0/1 = FB-I request bits BDF200	LED G24 Signal lamp green
🔴 Port X7.Pos 2 LED push button			LED in push button Pos. 2
🔴 Port X7.Pos 3 LED push button			LED in push button Pos. 3
🔴 Port X7.Pos 4 LED push button		*FB-I request data, see also*	LED in push button Pos. 4
🔴 Port X7.Acknowledge device fault		*operating instructions BDF200-SD/FB*	Acknowledge device fault

4.3.2 Acyclic Data (SDO)

For the transfer of acyclic data the "Service Data Objects" (SDO) are used by EtherCAT®. For this a mailbox procedure is used, with which the EtherCAT master can exchange data with an EtherCAT slave.

The SFB-EC transmits the diagnostic history, the device slot parameters, the module status and a timestamp in the "CANopen over EtherCAT" (CoE) service.

i	**INFORMATION** Further information about the configuration of "CANopen over EtherCAT" (CoE) can be found in the documentation of your EtherCAT Master.

i	**INFORMATION** Do not poll the acyclic CoE objects in a shorter interval than 100 ms !

Diagnostic history

The list of the diagnostic history shows the last 100 fault messages.

list of current faults shows the last 30 fault messages.

In the list of faults, active ("Detected") and no longer active ("Removed") faults are displayed.

The currently passivated device ports are also displayed in this list.
(Fault message 10 – 17)

The list is organized as a mapping object with individual data objects:

Name: **Diagnosis History**
Index: **0x10F3**

Sub-Index	Content / Data	Description	Datatype
0	105	Number of Subindices	UINT8
1	0 … 99	Number of existing diagnostic messages	UINT8
2-5	---	*Internal*	
6	Fault message 0	Last occurred diagnostic message	STRING
…			STRING
105	Fault message 99	Diagnostic message 100, end of diagnostic history	STRING

Current Timestamp

The current timestamp in "**nano-seconds** after power ON of the SFB-EC"
can be read out separately.

Name: Timestamp
Index: 0x10F8

Sub-Index	Content / Data	Description	Datatype
0	Value	Timestamp in ns after Power ON of the SFB	UINT64

List of device port parameters

The list of device port parameters shows the parameter types set for the individual
device ports.

1 = Type A   Input: 2 channel OSSD / Output: 1 wire
2 = Type B   Input: 2 channel OSSD / Output: 2 wires
3 = Type C   Input: 2 channel Contacts / Output: 1 wire
4 = Type D   Input: 2x 1 channel Contact / Output: 1 wire

(s. a. chapter 2.2.1)

The list is organized as a mapping object with individual data objects:

Name: I/O Mode Config
Index: 0x8000

Sub-Index	Content / Data	Description	Datatype
0	8	Number of Subindices	UINT8
1	1 / 2 / 3 / 4	Parameter type for device port X0	UINT32
2	1 / 2 / 3 / 4	Parameter type for device port X1	UINT32
3	1 / 2 / 3 / 4	Parameter type for device port X2	UINT32
4	1 / 2 / 3 / 4	Parameter type for device port X3	UINT32
5	1 / 2 / 3 / 4	Parameter type for device port X4	UINT32
6	1 / 2 / 3 / 4	Parameter type for device port X5	UINT32
7	1 / 2 / 3 / 4	Parameter type for device port X6	UINT32
8	1 / 2 / 3 / 4	Parameter type for device port X7	UINT32

SCHMERSAL

The list of module status messages shows the status of the different module sections.

The following information is available:

- Fault status module / port
- Status and value of the power supply
- Status and value of module temperature

The list is organized as a mapping object with individual data objects:

Name: Module Status
Index: 0x2000

Sub-Index	Content / Data	Description		Datatype
0	6	Number of Subindices		UINT8
	---	***Internal***		
1		Current Timestamp of SFB-EC		UINT32
2		Status module:	Bit 0: 1 = RUN Bit 0: 0 = Module fault active	UINT8
		Status device ports:	Bit 1: 1 = OK Bit 1: 0 = Fault on device port	
3		Status supply voltage:	Bit 0: 1 = OK Bit 1: 1 = Limit range 　　　　U < 20 V *or* 　　　　U > 29 V Bit 2: 1 = Undervoltage *or* 　　　　Overvoltage	UINT8
4		Value supply voltage:	WORD:　237 = 23,7 Volt	UINT16
5		Status SFB temperature:	Bit 0: 1 = OK Bit 1: 1 = Limit range Bit 2: 1 = Over temperature	UINT8
6		Value SFB temperature:	BYTE:　53 = 53° C	INT8

5 Diagnostic system

5.1 SFB-EC Diagnostics

The safety fieldbox SFB-EC can detect module faults and device port faults.

In case of module faults, the SFB-EC is completely passivated.
Module faults are for example, over temperature of the SFB, under voltage or internal module faults.

In case of device port faults, only the affected device port X0 - X7 is passivated. Device port faults are for example, cross-faults on the device connection cables or faults in the connected safety switchgear.

Module faults and device port faults are acknowledged via a uniform acknowledgement mechanism. (Refer to chapter 5.3)

The SFB-EC transmits all diagnostic information via CoE objects.

These can be read acyclically by the PLC via "Service Data Objects" (SDO). (Refer to chapter 4.3.2)

INFORMATION
Further information about the configuration of "Service Data Objects" (SDO) can be found in the documentation of your EtherCAT Master.

5.1.1 Diagnostic messages Module faults

Error No.	Error message
	Module faults SFB
99	Internal fault SFB, try power reset, SFB defect
90	Communication break FSoE/EtherCAT, check Ethernet connection and Watch-Dog time
91	Invalid FSoE Command
92	Invalid FSoE Connection Parameter
93	Invalid FSoE Application Parameter
01	Invalid FSoE Slave Address, check Safety Address
02	Invalid CRC, Connection failure
03	Invalid acknowledgement pulse, check pulse time 500 ms
04	Warning Undervoltage 17.0 V < Ub < 20.4 V, check supply voltage
05	Fault Undervoltage 12.0 V < Ub < 17.0 V, check supply voltage
06	Overload pulse outputs Device-Port X0 - X7, check wiring
07	Fault Overvoltage U > 29 V, check supply voltage
08	Warning Over temperature T > 80 °C, check ambient temperature
09	Fault internal Over Temperature T > 85 °C, check ambient temperature

INFORMATION
At error 06 "Overload pulse outputs" the pulse outputs are switched off. The error can therefore no longer be detected and the message "Fault removed" appears.

SCHMERSAL

5.1.2   Diagnostic messages Device-Port faults

The "Device-Port passivated" status indicates that a device port has been switched to the safety state due to a fault.

Error No.	Error message
	Status Device-Ports
10	Device-Port X0 passivated, see message single error at X0
11	Device-Port X1 passivated, see message single error at X1
12	Device-Port X2 passivated, see message single error at X2
13	Device-Port X3 passivated, see message single error at X3
14	Device-Port X4 passivated, see message single error at X4
15	Device-Port X5 passivated, see message single error at X5
16	Device-Port X6 passivated, see message single error at X6
17	Device-Port X7 passivated, see message single error at X7

	INFORMATION
i	"Device port passivated" is reported if a previous fault had passivated the device port.

Error No.	Error message
	Fault Safety-Inputs
20	Fault on Safety inputs Device-Port X0, check parameter cross-wire monitoring and wiring
21	Fault on Safety inputs Device-Port X1, check parameter cross-wire monitoring and wiring
22	Fault on Safety inputs Device-Port X2, check parameter cross-wire monitoring and wiring
23	Fault on Safety inputs Device-Port X3, check parameter cross-wire monitoring and wiring
24	Fault on Safety inputs Device-Port X4, check parameter cross-wire monitoring and wiring
25	Fault on Safety inputs Device-Port X5, check parameter cross-wire monitoring and wiring
26	Fault on Safety inputs Device-Port X6, check parameter cross-wire monitoring and wiring
27	Fault on Safety inputs Device-Port X7, check parameter cross-wire monitoring and wiring

i	**INFORMATION**
	"Fault safety inputs" is reported if either the cross-fault-monitoring was not activated when connecting contacts or a cross-fault is detected by a safety input X1 or X2 against +24 VDC, 0 VDC or between them.
i	**INFORMATION**
	This fault can only be acknowledged after the safety guard has been opened one time without fault.
i	**INFORMATION**
	The message "Fault safety inputs" is automatically reset when test pulses are detected on the safety inputs for 10 s after the safety guard is closed again.

SCHMERSAL

Error No.	Error message
	Fault Pulse-Outputs
30	Fault on pulse outputs Device-Port X0, check wiring
31	Fault on pulse outputs Device-Port X1, check wiring
32	Fault on pulse outputs Device-Port X2, check wiring
33	Fault on pulse outputs Device-Port X3, check wiring
34	Fault on pulse outputs Device-Port X4, check wiring
35	Fault on pulse outputs Device-Port X5, check wiring
36	Fault on pulse outputs Device-Port X6, check wiring
37	Fault on pulse outputs Device-Port X7, check wiring

	INFORMATION
i	"Fault pulse outputs" is reported if there is a cross-fault between a pulse output Y1 or Y2 and +24 VDC, 0 VDC or between them. All pulse outputs are switched off if there is a cross-fault to 0 VDC.

	INFORMATION
i	10 s after correcting the fault, the message "Fault removed" appears and the fault can be acknowledged.

Error No.	Error message
	Overload fault at device Power-Supply
40	Overload power supply Device-Port X0, fuse tripped, check wiring
41	Overload power supply Device-Port X1, fuse tripped, check wiring
42	Overload power supply Device-Port X2, fuse tripped, check wiring
43	Overload power supply Device-Port X3, fuse tripped, check wiring
44	Overload power supply Device-Port X4, fuse tripped, check wiring
45	Overload power supply Device-Port X5, fuse tripped, check wiring
46	Overload power supply Device-Port X6, fuse tripped, check wiring
47	Overload power supply Device-Port X7, fuse tripped, check wiring

	INFORMATION
i	"Overload power supply device port" is reported if the internal auto-resettable fuse has tripped.

Error No.	Error message
	Overload fault Digital-Output
50	Overload digital output Device-Port X0, check load and wiring
51	Overload digital output Device-Port X1, check load and wiring
52	Overload digital output Device-Port X2, check load and wiring
53	Overload digital output Device-Port X3, check load and wiring
54	Overload digital output Device-Port X4, check load and wiring
55	Overload digital output Device-Port X5, check load and wiring
56	Overload digital output Device-Port X6, check load and wiring
57	Overload digital output Device-Port X7, check load and wiring

	INFORMATION
i	"Overload digital output" is reported if the electronic current limitation of the digital output has tripped.

	INFORMATION
i	If the device port is passivated, the error can no longer be detected and the message "Fault removed" appears.

Error No.	Error message
	Fault Digital-Output
60	Fault on digital output Device-Port X0, check wiring
61	Fault on digital output Device-Port X1, check wiring
62	Fault on digital output Device-Port X2, check wiring
63	Fault on digital output Device-Port X3, check wiring
64	Fault on digital output Device-Port X4, check wiring
65	Fault on digital output Device-Port X5, check wiring
66	Fault on digital output Device-Port X6, check wiring
67	Fault on digital output Device-Port X7, check wiring

	INFORMATION
i	"Fault digital output" is reported if there is a cross-fault from a digital output to +24 VDC, 0 VDC or an external potential.

	INFORMATION
i	If there is a cross-fault between the digital output and +24V, the master switch is switched off internally and all digital outputs DO 0 - DO 7 are switched off.

	INFORMATION
i	If the error message appears several times, there is a permanent short circuit. If the device port is passivated, the error can no longer be detected and the message "Fault removed" appears".

5 Diagnostic system SCHMERSAL

Error No.	Error message
	Discrepancy- / Stable time fault
70	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
71	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
72	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
73	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
74	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
75	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
76	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard
77	Discrepancy / stable time error Device-Port X0, check parameter stable time filter and safety guard

	INFORMATION
ℹ	A "discrepancy / stability time error" is reported if there is either a temporary or permanent discrepancy (a difference) between the two input signals, or the input signals are not stable *(Refer to chapter 2.2.2).* This error is also reported if the safeguard has not been closed correctly or if a temporary single-channel switch-off has occurred.

	INFORMATION
ℹ	Discrepancy errors can also be detected for electronic safety switchgear (= switched off cross-fault detection) if there is a short circuit to +24 VDC or 0 VDC at the safety inputs X1/X2 or the pulse outputs Y1/Y2. Check device connection cables!

	INFORMATION
ℹ	This fault can only be acknowledged after the safety guard has been opened one time without fault. For certain types of interlocks, it may be necessary to switch off the operating voltage of the interlock or of the SFB one time in order to acknowledge the fault.

Error No.	Error message
	Fault FB-Interface
84	Fault on FB-Interface Device-Port X4, check device and wiring
85	Fault on FB-Interface Device-Port X5, check device and wiring
86	Fault on FB-Interface Device-Port X6, check device and wiring
87	Fault on FB-Interface Device-Port X7, check device and wiring

	INFORMATION
ℹ	"Fault FB-Interface" is reported as long as no communication with the FB-Interface device (BDF200-FB) is possible.

5.2 System behaviour in the event of an error

	INFORMATION
i	**During power-up, module errors can be detected by the SFB !** The SFB then sets an "acknowledgement request" and in the web server all displays on the "Status Device Ports" page are set to RED. To cancel the passivation, it may be necessary to send an initial acknowledgement pulse. *(Refer to chapter 5.3.1)*

	⚠ WARNING
⚠	The user must specify depending on the necessary safety requirements whether an automatic restart of the safety function is permissible.

5.2.1 Module error

If a module error is detected, the SFB-EC responds as follows:

− The SFB is completely passivated, i.e. all 8 device ports are passivated.
  All input and output data are set to "0".

− All qualifier bits of the device ports X0 - X7 are reset to "0".
  („1" = Device port activated and „0" = Device port passivated)
  *(Port Xx.Qualifier   - **Module 1** (FSoE (4 Byte i/O)), refer to chapter 4.3.1)*
  *(Port Xx.Qualifier   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

− The Diagnosis LED (Diag) of the SFB displays a RED flashing code.
  (Refer to chapter 3.3.3)

− The SFB sets the fault flag "Module" as collective error message.
  *(Fault-Flag Module   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

− The SFB sends the fault number in the cyclic data.
  *(Error Code   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

− The SFB writes the fault number into the diagnostic history.
  (SDO "Diagnosis History" (0x10F3) „ Acyclic data", refer to chapter 4.3.2)

− Normally, a message (LED or display) is also signalled on the PLC.
  This depends on the type of PLC used.

5.2.2 Device port error

If a device port fault is detected, the SFB-EC responds as follows:

– The device port is passivated, all input and output data are set to "0".

– The qualifier bit of the faulty device ports X0 - X7 are reset to "0".
  (*„1" = Device port activated and „0" = Device port passivated*)
  *(Port Xx.Qualifier   - **Module 1** (FSoE (4 Byte i/O)), refer to chapter 4.3.1)*
  *(Port Xx.Qualifier   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

– The Error LED (E) at the device port shows a RED flashing code.
  (Refer to chapter 3.3.1)

– The SFB sets the fault flag "Device Port" as collective error message.
  *(Fault-Flag Device Port - **Module 2** (Functional Data), refer to chapter 4.3.1)*

– At FB-Interface communication errors the fault flag "COM FB-Interface" is set.
  *(Fault-Flag COM FB-I   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

– The SFB sends the fault number in the cyclic data.
  *(Error Code   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

– The SFB writes the fault number into the diagnostic history.
  (SDO "Diagnosis History" (0x10F3) „ Acyclic data", refer to chapter 4.3.2)

5.2.3 Errors in safety related communication to Safety Controller

Errors in safety-related communication are detected by mechanisms defined in the FSoE protocol.
The system reacts according to the responses defined in the FSoE specification.

In the event of an error in the safety related communication, all input and output data of the SFB-EC are set to "0" and the module remains passivated until the error in the communication has been corrected.

After eliminating the error in the safety-related communication, the module error must be acknowledged. (Refer to chapter 5.3.1)

5.3   Acknowledgement corrected faults

5.3.1   Acknowledgement module faults

If a module error is detected, all device ports are passivated.
(Refer to chapter 5.2.1)

An acknowledge request is sent when the detected module fault is removed and when no further module fault is detected.

Acknowledgement Request:
*(Request acknowledgement   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

The module faults are acknowledged with the global acknowledge pulse.

Acknowledgement Pulse:
*(Acknowledge Fault global   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

5.3.2   Acknowledgement device port faults

If a device port fault is detected, only the faulty device port is passivated.
(Refer to chapter 5.2.2)

If a port is free of faults again, i.e. all port faults at this port are removed and at the same time no module fault is active, an acknowledge request is sent.

This is also done if further faults have been detected at some other port.

Acknowledgement Request:
*(Request acknowledgement   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

The device port faults are acknowledged with the global acknowledge pulse.

Acknowledgement Pulse:
*(Acknowledge Fault global   - **Module 2** (Functional Data), refer to chapter 4.3.1)*

	INFORMATION
i	For the acknowledgement of module faults and device port faults, the qualifier bits, the error flags, one bit for the request of the fault acknowledgement (fault removed) and one bit for the acknowledgement pulse are used. These bits are described in chapter 4.3.1 "Cyclic Data (PDO)".

SCHMERSAL

### 5.3.3 Acknowledgement with global acknowledgement pulse

The real acknowledgement is done via an acknowledgement pulse of 500 ms (+/- 150 ms) which is sent from the PLC to the SFB-EC.

The pulse always globally acknowledges all removed module faults and device port faults !

Faults that have not yet been removed are not acknowledged.

Module fault / Device port fault is removed / can be acknowledged:

- **Module faults:**
  The Diagnosis-LED (Diag) flashes GREEN. (s. a. chapter 3.3.3)
- **Device port faults:**
  Error-LED (E) of the device port flashes GREEN. (s. a. chapter 3.3.1)
- SFB-EC sets the "Fault acknowledgement request" to "1".
  (*Request acknowledgement* - **Module 2** (Functional Data), refer to 4.3.1)
  The acknowledge request for a removed module or port fault can be evaluated by the PLC.
- The fault can then be acknowledged with an acknowledgement pulse of 500 ms (+/- 150 ms) and the module or the device port is reactivated.
  (*Acknowledge Fault global* - **Module 2** (Functional Data), refer to 4.3.1)
- The qualifier bits of the device ports are set to "1" again.
  (*Port Xx.Qualifier* - **Module 1** (FSoE (4 Byte i/O)), refer to chapter 4.3.1)
  (*Port Xx.Qualifier* - **Module 2** (Functional Data), refer to chapter 4.3.1)

- **Module faults:**
  Diagnosis LED (Diag) lights GREEN again (*s. a. chapter 3.3.3*)
- **Device port faults:**
  The Error-LED (E) of the device port lights GREEN again (*s. a. chapter 3.3.1*)
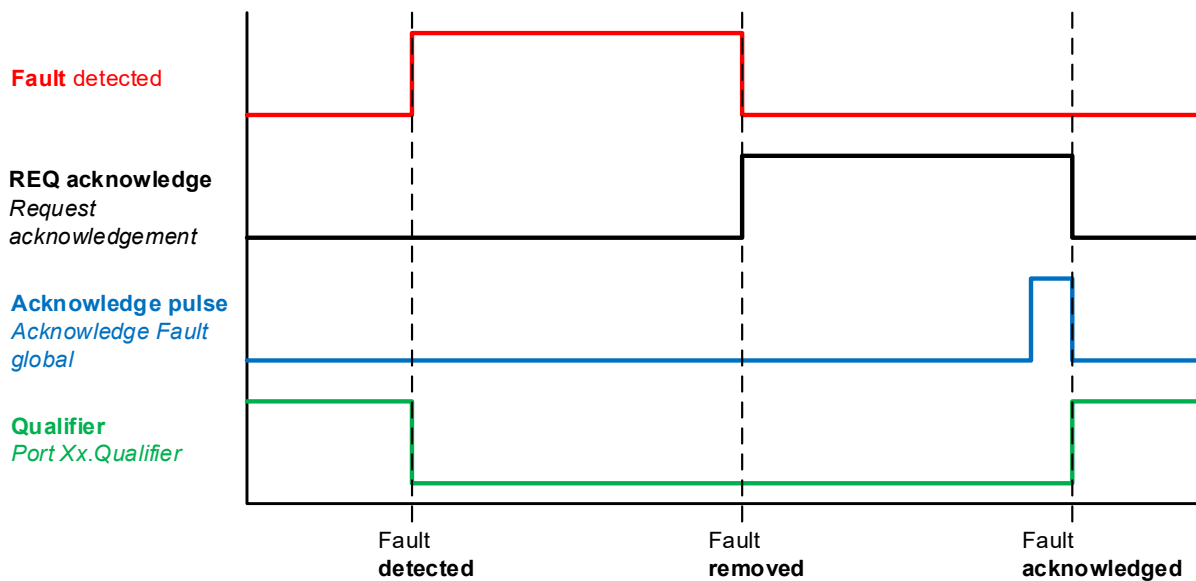
6 Web Server

6.1 Description Web server

A web server for displaying status and diagnostic data is integrated in the SFB-EC.

To access the WebServer of the SFB, the IP settings of the device
must be set in the EoE service.
This procedure is described in chapter 4.2.7 "Configure EoE service".
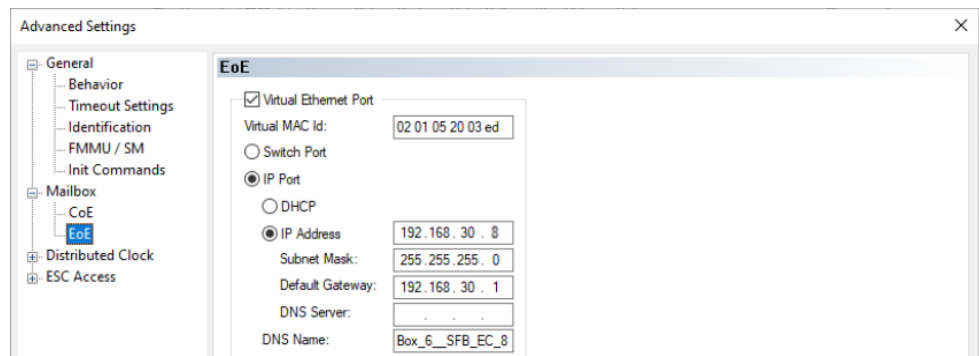
If the IP address is known, the web server can be started by entering the
IP address in the address bar of an Internet browser.

You can find the IP address set for the SFB-EC as follows:
Select the SFB in the Solution Explorer and click on "Advanced Settings" in the
"EtherCAT" tab.
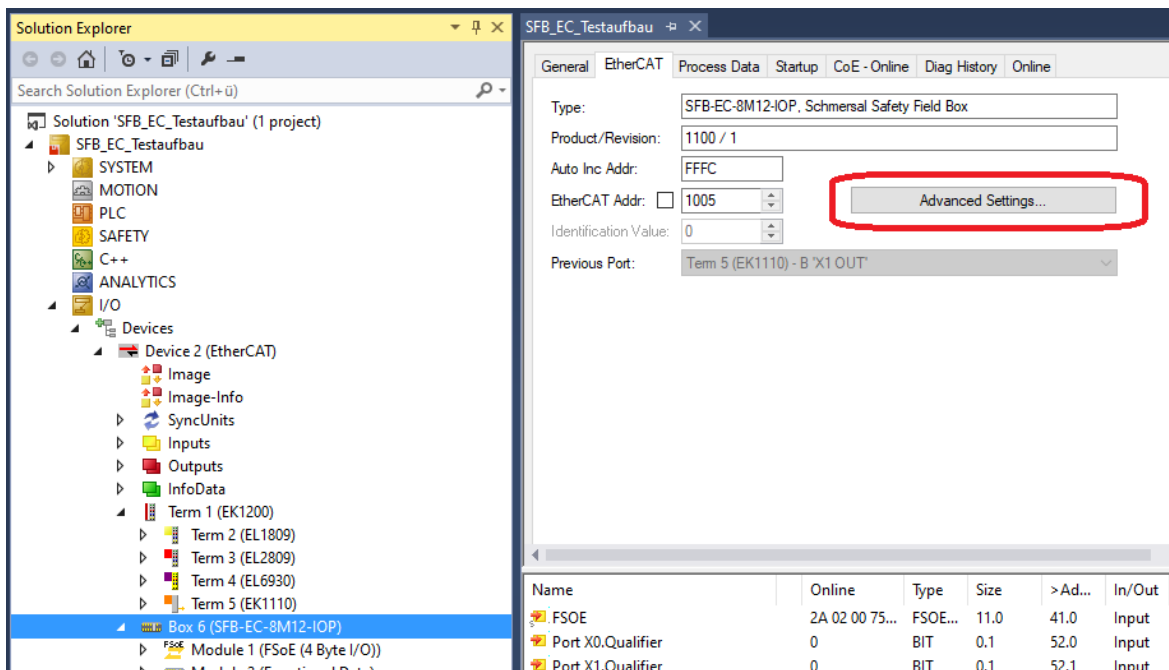
Select the menu item "Mailbox -> EoE" in the opened dialog.

	INFORMATION
ℹ️	The field box and the network adapter of the computer must be in the same network (IP area).

6.1.1 Page: SFB Home

The "SFB Home" page displays an overview of the most important status, network and device data.

Pos.	Graphic	Definition	Description
1	DE EN	Language	The language of the display can be changed between German and English with the language buttons.
2	Blink SFB	Blink SFB	The "Blink SFB" button sends a signal to a connected field box. In response, the RUN LED flashes green and the ERR LED flashes red for a few seconds.
3	Refresh Page	Refresh Page (actualisation)	The page is updated automatically every 4 seconds. The "Refresh Page" button can be used to manually refresh the page at any time.

6.1.2 Page: Diagnostic

DE **EN**	**SFB Sichere Feld Box** Diagnostic Buffer	**SCHMERSAL** THE DNA OF SAFETY

SFB Home				
Diagnostic	Erase corrected faults		✓ Fault corrected ⊓ Fault active	Time from start - *0d 00:32:18*
Status Device Ports	**Time**	**Status Failure**	**Description**	
	0d 00:31:48	⊓ 12	Device-Port X2 passivated	
Parameters	0d 00:31:48	⊓ 22	Fault: safety inputs Device-Port X2	
	0d 00:21:52	✓ 12	Device-Port X2 passivated	
	0d 00:21:47	✓ 22	Fault: safety inputs Device-Port X2	
Help	0d 00:10:08	⊓ 12	Device-Port X2 passivated	
	0d 00:10:08	⊓ 22	Fault: safety inputs Device-Port X2	
Info				

Blink SFB
Refresh Page

The "Diagnostics" page displays the fault messages that the field box has sent to the PLC. The fault messages should be stored in the controller.

The SFB-EC stores these fault messages only so long as switched on.

Each fault message is displayed with a time stamp, a status icon, the fault number and the fault description.

Time stamp	Display when a fault was detected after power-on of the field box. The time starts again after each power-on of the field box!
Status icon	⊓ Fault active „Fault incoming" ✓ Fault fixed „Fault outgoing"
Fault number	Displays the fault number which was detected.
Description	Display of the fault message with the fault description. If you move the mouse pointer over the description, the help text of the fault message is displayed!

Delete faults from the list

If faults have been fixed (outgoing), they can be deleted from the fault list of the SFB-EC via the button "Erase corrected faults".

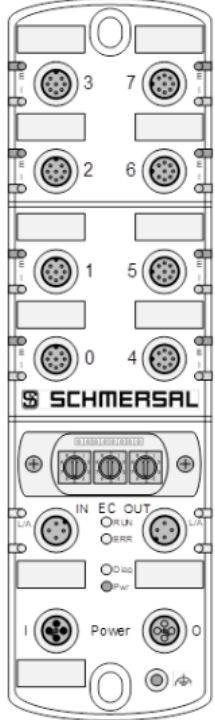### 6.1.3   Page: Status Device Ports

DE **EN**	**SFB Sichere Feld Box** Status Device Ports			**SCHMERSAL** THE DNA OF SAFETY

SFB Home	**Device Port 3**		**Device Port 7**	
	Error Status	🟩	Error Status	🟩
Diagnostic	Status Safety Inputs	🟥	Status Safety Inputs	🟥
	Status Safety Outputs	🟥	Status Safety Outputs	🟥
Status Device Ports	**Device Port 2**		**Device Port 6**	
	Error Status	🟥	Error Status	🟩
Parameters	Status Safety Inputs	🟥	Status Safety Inputs	🟥
	Status Safety Outputs	🟥	Status Safety Outputs	🟥
	Device Port 1		**Device Port 5**	
	Error Status	🟩	Error Status	🟩
Help	Status Safety Inputs	🟩	Status Safety Inputs	🟥
	Status Safety Outputs	🟩	Status Safety Outputs	🟥
Info	**Device Port 0**		**Device Port 4**	
	Error Status	🟩	Error Status	🟩
	Status Safety Inputs	🟥	Status Safety Inputs	🟩
	Status Safety Outputs	🟥	Status Safety Outputs	🟥

Blink SFB

Refresh Page

The "Status Device Ports" page displays the fault status and I/O status of each device port.

The meaning of the colours of the status indicators are explained on the "Help" page. (Refer to chapter 6.1.5)

Device-Port Error Status	🟩	Device-Port OK
	🟥	Device-Port Failure
Device-Port Status Safety-Inputs	🟩	Safety-Inputs ON
	🟧	Discrepance-Failure
	🟥	Safety-Inputs OFF
Device-Port Status Safety-Output	🟩	Safety-Output ON
	🟥	Safety-Output OFF

6.1.4 Page: Parameters

DE EN

SFB Sichere Feld Box
Device Parameters

SCHMERSAL
THE DNA OF SAFETY

- SFB Home
- Diagnostic
- Status Device Ports
- **Parameters**
- Help
- Info

Blink SFB
Refresh Page

DevicePort3

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

DevicePort7

Configuration Type	3
Cross fault detection	On
Safety Inputs	2 channels
Stable time	0.5 s
Monitoring time	10 s
Safety Outputs	1 wire (PLd)

DevicePort2

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

DevicePort6

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

DevicePort1

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

DevicePort5

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

DevicePort0

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

DevicePort4

Configuration Type	1
Cross fault detection	Off
Safety Inputs	2 channels
Stable time	0.1 s
Monitoring time	2 s
Safety Outputs	1 wire (PLd)

The "Parameters" page displays the "Configuration Type" and the set parameter values from each device port.

If the SFB-EC has not been parameterized yet, the parameter values are empty!

Display		Status	
Diagnosis Status Module	🟩	RUN	
	🟥	Module Failure	
Status Power Supply	🟩	OK	U > 20,4 VDC
	🟧	Limit Range	U > 17,0 VDC
	🟥	Under or over Limit	U < 17 VDC or U > 29 VDC
Module Temperature	🟩	OK	T < 80 ° C
	🟧	Limit Range	T > 80 ° C
	🟥	Over Limit	T > 85 ° C
RUN Indicator	🟩	Operational	
	🟧	Pre/Safe-Operational	
ERROR Indicator	OFF	No Error	
Link Port 1/2	🟩	Link active	
	🟥	Link down	
Device-Port Error Status	🟩	Device-Port OK	
	🟥	Device-Port Failure	
Device-Port Status Safety-Inputs	🟩	Safety-Inputs ON	
	🟧	Discrepance-Failure	
	🟥	Safety-Inputs OFF	
Device-Port Status Safety-Output	🟩	Safety-Output ON	
	🟥	Safety-Output OFF	

Navigation (left menu): SFB Home, Diagnostic, Status Device Ports, Parameters, Help, Info, Blink SFB, Refresh Page

Header: DE **EN** — SFB Sichere Feld Box / Help — SCHMERSAL THE DNA OF SAFETY

The "Help" page shows the meaning of the colours of all status displays on the web server.

In addition, the limit values are displayed for the supply voltage and the field box temperature.

6.1.6 Page: Info
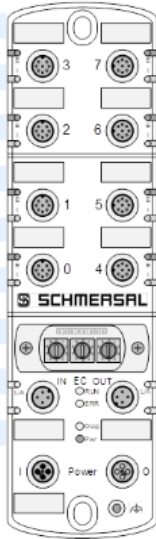
The "Info" page shows the type designation, the order number and the support address of Schmersal.

The ESI file saved in the field box can be downloaded using the "Download ESI File" button.

7 Annex

7.1 Configuration examples for power supply

If each field box is supplied with power individually, the maximum length of a field box line is limited only by the maximum cable length of the field bus.

However, if the power supply is looped through from field box to field box, the maximum ratings given below apply.

Three different configurations are shown for each of the different SCHMERSAL devices. One configuration with long cable lengths (maximum), one configuration with medium cable lengths (medium) and one configuration with shorter cable lengths (small).

The design examples listed in the table on the next page,
apply to the following assumptions:

- The examples represent maximum configurations.
  If individual cable length is reduced, larger systems are possible.
- Wiring of the power supply with 2 x 1.5 mm² and fuse protection with 10 A.
- Use of SCHMERSAL cables.
- The cable lengths listed in the table between the power supply and the 1st field box, as well as between the field boxes, are the maximum lengths.
  Reducing the individual cable length is not critical.
- These designs assume simultaneous control of all lock or unlock functions for the connected solenoid interlocks.
 Larger systems are possible with time shift activation of the lock or unlock function.

	INFORMATION
ℹ️	A useful design tool for calculating the real voltage drops is available on the Internet at www.system-engineering-tool.com .

Device / configuration version	Max. number of devices	Number of field boxes	Length of cable (A) until 1st field box	Length of cables (B) between the field boxes	Length of cables (C) for device connection
AZM 201 / Maximum	16	2	10.0 m	10.0 m	7.5 m
AZM 201 / Medium	20	2.5	7.5 m	7.5 m	5.0 m
AZM 201 / Small	24	3	7.5 m	5 m	3.5 m
MZM 100 / Maximum	20	2.5	1.0 m	10.0 m	7.5 m
MZM 100 / Medium	24	3	7.5 m	7.5 m	5.0 m
MZM 100 / Small	28	3.5	7.5 m	5 m	3.5 m
AZM 300 / Maximum	28	3.5	10.0 m	10.0 m	7.5 m
AZM 300 / Medium	32	4	7.5 m	7.5 m	5.0 m
AZM 300 / Small	40	5	7.5 m	5 m	3.5 m
AZM 400 / Maximum	16	2	10.0 m	10.0 m	7.5 m
AZM 400 / Medium	16	2	7.5 m	7.5 m	5.0 m
AZM 400 / Small	16	2	7.5 m	5 m	3.5 m
AZM 1xx / Maximum	20	2.5	10.0 m	10.0 m	7.5 m
AZM 1xx / Medium	24	3	7.5 m	7.5 m	5.0 m
AZM 1xx / Small	28	3.5	7.5 m	5 m	3.5 m
RSS, CSS / Maximum	48	6	10.0 m	10.0 m	7.5 m
RSS & CSS / Medium	56	7	7.5 m	7.5 m	5.0 m
RSS & CSS / Small	64	8	7.5 m	5 m	3.5 m
Mixed / Maximum	24	3	10.0 m	10.0 m	7.5 m
Mixed / Medium	28	3.5	7.5 m	7.5 m	5.0 m
Mixed / Small	32	4	7.5 m	5 m	3.5 m
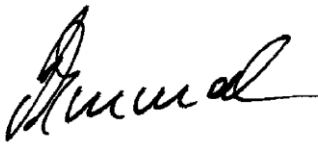
Mixed assembly of the field box: 2 x AZM 201, 2 x MZM 100, 2 x AZM 300 and 2 x RSS / CSS
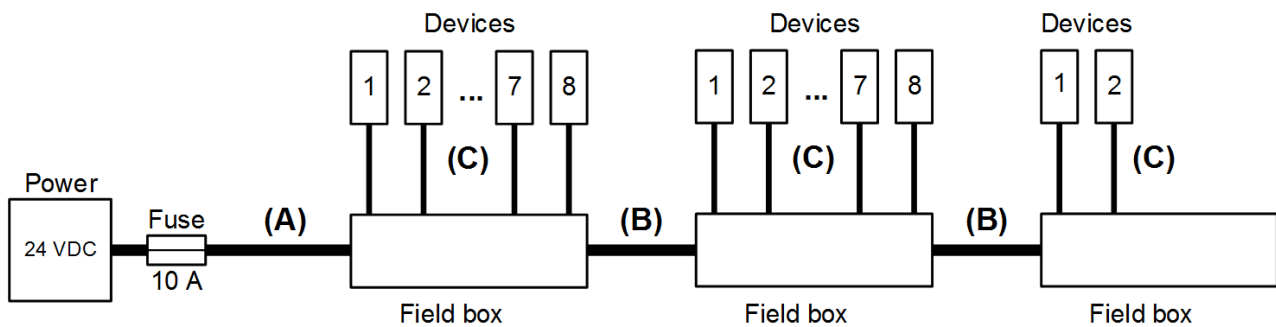
	INFORMATION
i	A useful design tool for calculating the real voltage drops is available on the Internet at www.system-engineering-tool.com .

SCHMERSAL

7.2 EU Declaration of conformity

EU Declaration of conformity **SCHMERSAL**

Original

K.A. Schmersal GmbH & Co. KG
Möddinghofe 30
42279 Wuppertal
Germany
Internet: www.schmersal.com

We hereby certify that the hereafter described components both in their basic design and construction conform to the applicable European Directives.

Name of the component: SFB-EC

Type: See ordering code

Description of the component: Safety fieldbox (IO module with fieldbox interface)

Relevant Directives:
2006/42/EC	Machinery Directive
2014/30/EU	EMC-Directive
2011/65/EU	RoHS-Directive

Applied standards:
EN 61131-2:2007
EN 60947-5-3:2013
EN ISO 13849-1:2015
IEC 61508 parts 1-7:2010

Notified body for the prototype test:
TÜV Rheinland Industrie Service GmbH
Am Grauen Stein, 51105 Köln
ID n°: 0035

EC-prototype test certificate: 01/205/5878.02/23

Person authorised for the compilation of the technical documentation:
Oliver Wacker
Möddinghofe 30
42279 Wuppertal

Place and date of issue: Wuppertal, September 25, 2023

Authorised signature
Philip Schmersal
Managing Director

SFB-EC-A-EN

INFORMATION
The currently valid declaration of conformity can be downloaded from the internet at www.products.schmersal.com .

CE

SCHMERSAL
THE DNA OF SAFETY

www.schmersal.com